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SCUPPERNONG RIVER CORRIDOR MITIGATION PROJECT

Forested Wetland Restoration and Monitoring Plan

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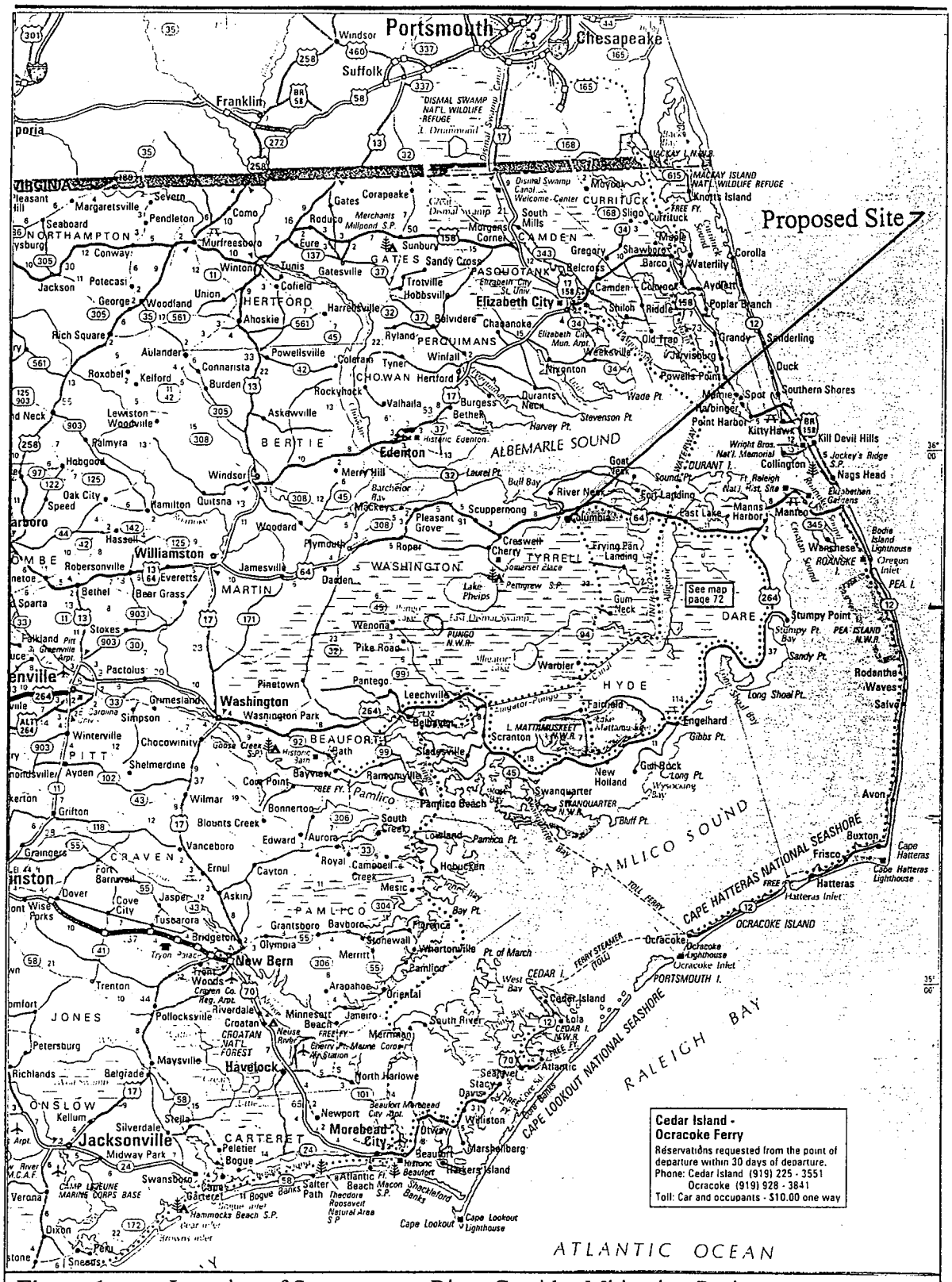


Figure 1 - Location of Scuppernong River Corridor Mitigation Project Tyrrell Co., near Columbia, North Carolina.

Figure 2

Scuppernong River Corridor Mitigation Project

Tyrrell County
Columbia, North Carolina

During the winter, this area floods, providing considerable open water area used intensively by waterfowl.

2.2 Soils:

Tomotley and Augusta Series comprise the soils on the tract with Augusta being found on the central and north western portions and Tomotley found on the south and eastern sections adjacent to the natural forested wetlands (Figure 3). Tomotley soils are poorly drained with a very dark gray fine sandy loam surface soil. The subsoil is gray sandy clay loam in the upper part and light brownish gray sandy loam in the lower part. Tomotley soils are frequently flooded and wetness persists much of the year resulting in poor to fair potential for agricultural crops and fair potential for trees. Augusta soils are somewhat poorly drained with a surface layer that is dark grayish brown, fine sandy loam. The subsoil is light olive brown, sandy clay loam in the upper part and gray to light gray in the lower part. Augusta soils are subject to moderate to severe wetness much of the year, have fair to good potential for agricultural crops, and are well suited for hardwood trees. Augusta soils frequently have inclusions of Tomotley soils.

2.3 Vegetation:

The vegetation on this 38 acre tract can be separated into three categories: 1.) Wet flat Hardwoods (WFH), 2.) Black Gum/Red Maple Swamp Hardwoods (SH), and 3.) PC, Agricultural Fields.

1. ***Wet flat Hardwoods***: The overstory tree species that dominate this type include: Liquidamber styraciflua - sweetgum, Acer rubrum - red maple, Liriodendron tulipifera - tulip poplar, Quercus michauxii - swamp chestnut oak, Nyssa sylvatica - black gum, Quercus phellos/nigra - willow/water oak, Fraxinus pennsylvanica - green ash, and Pinus taeda - loblolly pine. Understory trees and shrubs include: Persea borbonia - red bay, Gordonia lasianthus - loblolly bay, Carpinus caroliniana - ironwood, Celtis laevigata - sugarberry, Ilex opaca - holly, and Ilex coriacea - gallberry. The non-woody understory is rich in species and includes: Arundinaria gigantea - giant cane, Woodwardia aereolata - netted chain fern, Osmunda cinnamomi - cinnamon fern, Mitchella repens - partridgeberry, Toxicodendron radicans - poison ivy, Vitus rotundifolia - wild grape, Similax rotundifolia - greenbriar, plus others.

2. ***Black Gum/Red Maple Swamp Hardwoods***: The overstory tree species which dominate this type include: Nyssa sylvatica var biflora - swamp black gum, Acer rubrum - red maple, Taxodium distichum - bald cypress, Fraxinus pennsylvanica - green ash, Salix nigra - black willow, Liquidambar styraciflua - sweetgum and Pinus taeda - loblolly pine. The shrub understory species include: redbay, loblolly bay, gallberry, red maple, Lyonia lucida - fetterbush, Symplocos tinctoria - horse

Scuppernong River Corridor Mitigation Project

Tyrrell County

Columbia, North Carolina

Soil Survey Map

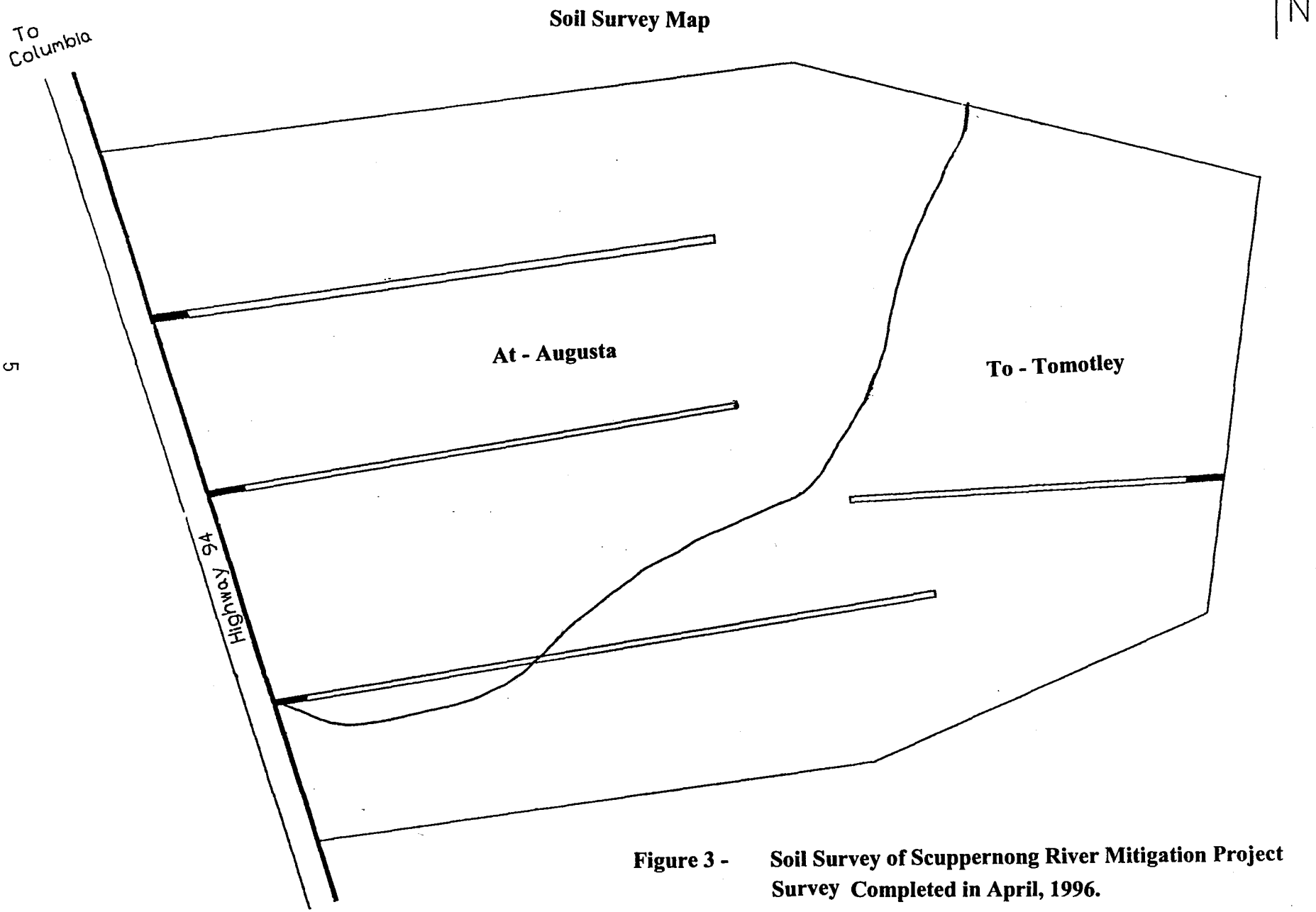


Figure 3 - Soil Survey of Scuppernong River Mitigation Project Survey Completed in April, 1996.

sugar, and Vaccinium corymbosum - highbush blueberry. Other understory ferns and vines include: netted chain fern, cinnamon fern, greenbriar, and wild grape.

3. ***PC, Agricultural Field***: The major crops grown in this field have included corn, soybeans, and winter wheat. In addition to common weed species, numerous wetland plants including Juncus spp., Cephalanthus occidentalis - buttonbush, and Salix spp. - willow are found on the site. Because of frequent saturated soil conditions, crops have not been harvested every year prior to establishment of the mitigation project.

2.4 Ecological Processes and Functions:

A variety of ecological processes and functions can be attributed to both swamp hardwood and wet flat wetland types. These functions are directly related to the geomorphic/landscape setting and hydrologic attributes of the wetland types. The characteristic hydroperiod of these wetland types varies from seasonally saturated (wet flats) to semipermanently flooded (swamp hardwoods). The fluctuating hydroperiod promotes alternating cycles of aerobic and anaerobic soil conditions and increases the potential primary productivity, organic matter decomposition, nutrient mineralization, and denitrification functions. Seasonally saturated wetlands (wet flats) are usually located at relatively high landscape positions and exhibit high subsurface water storage functions. Depressional wetlands (swamp hardwoods) located at relatively low landscape positions generally exhibit high floodflow retention functions. The high degree of microrelief in both wetland types promotes retention of surface flow/upland runoff and increases the sediment trapping functions within the wetlands. The short-term surface water retention also results in increased contact time between organic matter and surface water, and increased carbon export functions. Some of the wetlands types within the Scuppernong River Corridor are subject to periodic flooding by wind-driven tides. Periodic tidal flooding events provide an additional nutrient subsidy and increase the primary productivity and biogeochemical cycling functions. In addition, periodic tidal connections to the Albemarle Sound promotes access to a variety of vertebrate and invertebrate species common in the estuary and increases the wildlife habitat value of the wetlands.

2.5 Hydrogeomorphic Classification of Swamp Hardwood Wetlands:

The geomorphic description of a SH wetland is a depressional, low-gradient, precipitation, and vertically fluctuating setting. The inundation is continuous during the cool season from precipitation and low ET. These wetland areas provide good conditions for fluctuating water tables and are conducive to rapid biogeochemical cycling and strong atmospheric exchanges. As a nutrient trap, food web support is strong and reducing conditions strongly favor obligate and facultative wet wetland species. Qualitative evidence of inundation is supported by muck soils and amphibian breeding that indicate prolonged ponding and anaerobiosis. These areas

provide significant functions for groundwater storage and for depressional wetland community development.

The SH swales and sloughs are more frequently inundated and remain flooded for a major portion of the growing season compared to the WFH wetland ecosystem. The soils in the SH habitats are dominantly anaerobic and tend to accumulate organic detritus in addition to silt and clay particles.

2.6 Hydrogeomorphic Classification of Wet flat Hardwood Habitats:

The geomorphic/landscape setting of wet flat wetlands can be characterized as broad interstream flats with no apparent inlet or outlets. These broad wet flats are hydrologically driven by precipitation. The seasonal hydroperiod (which meets the jurisdictional definition of a wetland) arises from precipitation inputs combined with low or absent evapotranspiration during the dormant season and early growing season, slow internal soil drainage, and regionally shallow groundwater table. The important functions typically attributed to these wetland types include subsurface water storage, short-term surface water retention, carbon export, and wildlife habitat. A diverse group of plant community types is associated with the wet flat wetland type in North Carolina. Historically, the extent of wet flat wetlands within North Carolina coincided with the natural range of longleaf pine (*Pinus palustris*). Extensive fire-maintained longleaf pine forests were once common throughout the region, although mixed hardwood stands occupied the wettest sites protected from natural wildfires. Fire suppression combined with large scale conversion of the natural longleaf pine forests has eliminated 95% of the natural longleaf pine flatwoods throughout the Southeast. Today, the plant communities associated with wet flat wetland types include remnant longleaf pine flatwoods and savannas, mixed pond pine (*Pinus serotina*) woodland, pine plantations (*Pinus taeda /Pinus elliottii*), mixed pine/hardwood flats, and wet flat hardwoods. The existing plant community types found on these sites today are representative of past management activities and fire history. Wet flat hardwoods generally occupy the wet flat sites with long hydroperiods. Precipitation is the primary input, therefore, these sites are not subject to overbank flooding and nutrient influxes as exhibited in swamp and wet flat hardwood wetlands. During periods of low evapotranspiration, precipitation and surface runoff collects in microdepressional areas creating small pools. These pools facilitate a high degree of interaction between surface water and organic material. Dissolved organic carbon is exported from the microdepressions as evapotranspiration increase and the water table recedes. Seasonal fluctuations in the water table allows for substantial subsurface water storage during the growing season. Subsurface water storage in wet flats ultimately results in recharge and maintenance of characteristic hydroperiod in surrounding headwater tributaries and swamp hardwood wetland types.

3.0 MITIGATION

The Section 404 (b)(1) guidelines of the Clean Water Act (16 USC 1344), as described in 40 CFR Part 230, states that unavoidable wetland loss resulting from filling activities may be offset by effective mitigation actions. According to the National Environmental Policy Act (NEPA) of 1969, mitigation actions should include avoidance, minimization, restoration, enhancement and compensation for unavoidable impacts. After all practical attempts to avoid and minimize wetland losses have been accomplished, compensatory mitigation in any of the forms -- creation, restoration, enhancement, preservation and acquisition -- should be developed.

As identified in the Memorandum of Agreement between the USACE and USEPA (November 15, 1989), wetland restoration is the most desirable form of mitigation. Creation is the second most desirable form, and is generally deemed more desirable than enhancement or preservation of wetlands. Acquisition of existing wetlands (preservation) is favored for corridor protection and as a means to hedge against future destruction or unfavorable habitat impacts. Ideally, compensatory mitigation should be in-kind and on-site to provide for functional replacement. Wetland areas at or adjacent to project sites have historically been created, restored, enhanced or protected to compensate for impacted wetland functions and values. However, in areas with significant long-term development pressures, the quantity and quality of the wetlands that can be successfully restored and/or created around the periphery of a wetland impact site may be limited. Therefore, off-site mitigation may be the best alternative. A compensatory Mitigation Planning Checklist has been completed as a preliminary action for this project (Appendix I).

3.1 Proposed Actions

3.1.1 Hydrology:

During April, 1996 ditch plugs were installed in all lateral ditches (Figure 4). Installation conformed to Natural Resource Conservation Service Guidelines. Each ditch plug was 100 feet long and was composed of on-site material (Appendix II, Ditch Plug Cross Section and Plan View). Ditch plugs were installed using a 65 hp Ford tractor with a backhoe attachment. Ditch berm material and subsoil adjacent to the ditch were used to fill the ditches. Following filling, the area was graded and compacted. Saturated soil conditions have been prevalent during the growing season during 1994-96 as evidenced by data from 3 groundwater monitoring wells plus iron oxidation rods randomly established on the project area plus two wells in an adjacent reference areas (See Appendix II). These wells have been established to provide baseline water table levels and changes in hydrology over time. Wells have been established according to guidelines outlined by the U.S. Army Corps, Waterways Experiment Station (WRP, 1993). Based on initial review of this plan, 3 additional wells and rods were installed during May, 1996 which better

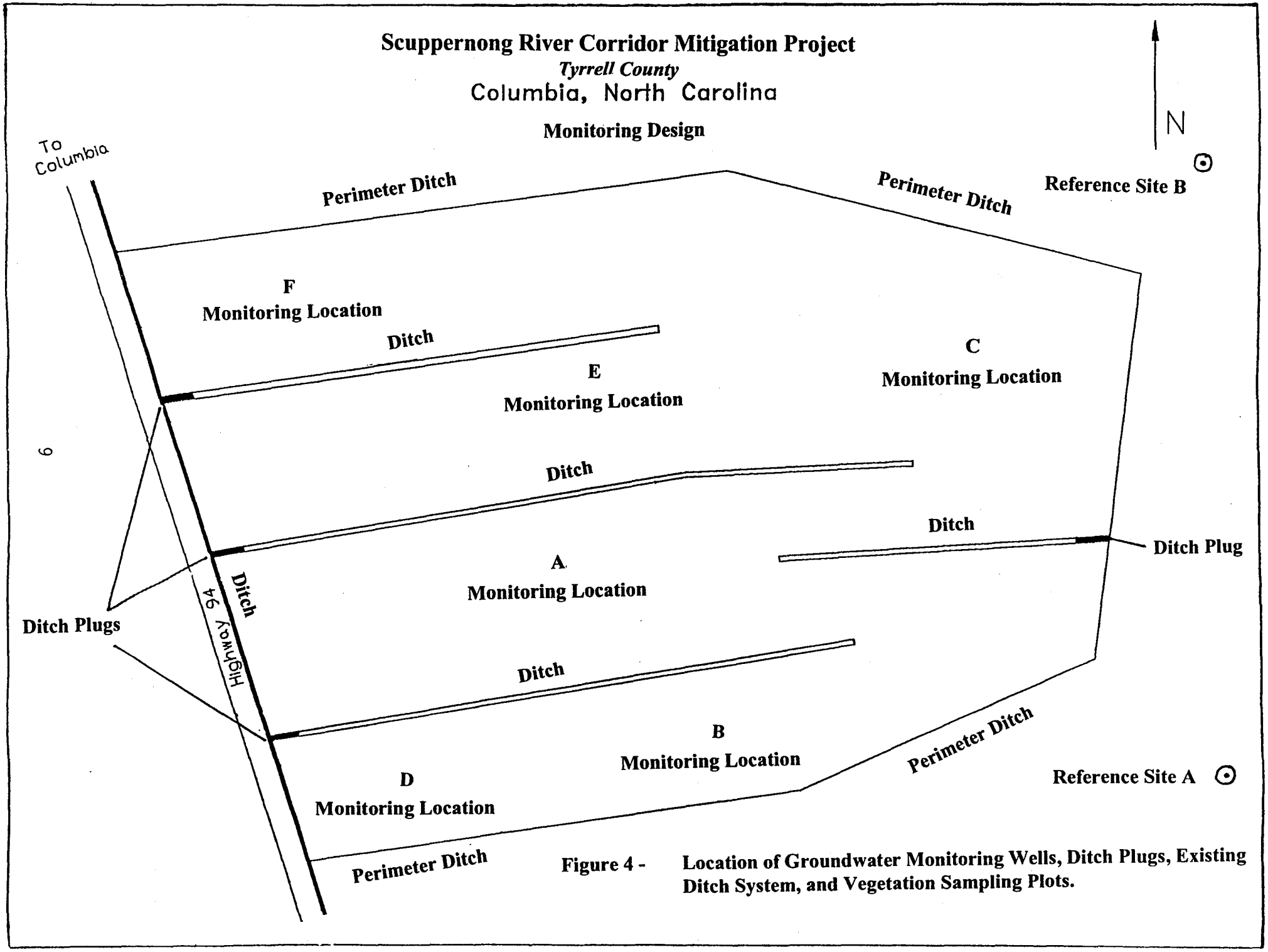


Figure 4 - Location of Groundwater Monitoring Wells, Ditch Plugs, Existing Ditch System, and Vegetation Sampling Plots.

represent the soils of the site. Wells and rods will be measured monthly during the early dormant season and weekly during the growing season for a minimum of 3 years. The depth of the soil reducing conditions will be determined using the iron rod method as described by McKee (1978) and Hook et al. (1987). The iron rod technique is based on the principle that an iron rod placed in poorly drained soils will rust rapidly in the aerated zone of the soil, but not in the saturated zone associated with the water table. This method has been shown to be a reliable indicator of the average soil water table levels on poorly drained heavier soils, and is one of several methods used to determine soil water levels in jurisdictional wetland determinations (McKee 1978). Correlation for this method will also be obtained by measuring oxidation reduction (redox) potential using platinum electrodes (Faulkner et al. 1986). The platinum electrode test provides a good correlation since this technique provides a quantitative measure of the degree of saturation, as well as the level at which saturation occurs.

3.1.2 Soils:

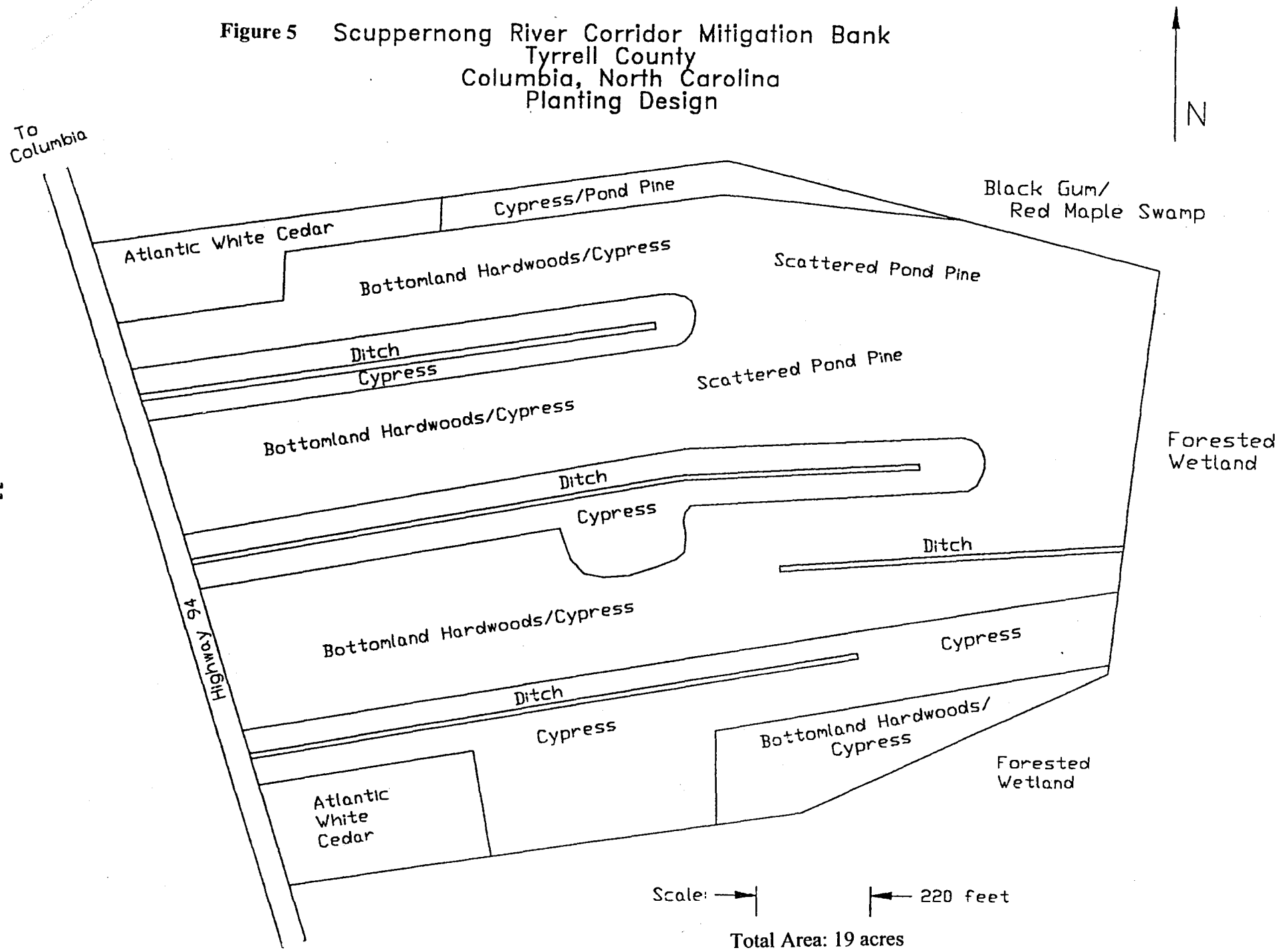
Project success is dependent on the presence of hydric soils and wetland hydrology. Areas of existing hydric soils on the 19 acre field have been delineated by TWC using the hydric soil criteria outlined in Hydric Soils of the United States (1987) in conjunction with the field indicators of hydric soils listed in the U.S. Army Corps of Engineers 1987 Wetland Delineation Manual (WTI, 1991). The soils have been examined by personnel with the U.S. Army Corps of Engineers on several occasions. The entire field is designated prior converted (PC) cropland (See Appendix III - Wetland Determination).

There unlikely will be a need to enhance soil fertility as part of our restoration procedures. Conversion of PC cropland to WFH and SH wetlands seldom involves supplemental fertilization and lime because nitrogen, phosphorus, and potassium fertilizers have been added as part of the cropping sequence and less frequent lime additions have enhanced base saturation and reduced acidity. Our restoration plans will be compatible with long-term objectives of improving water quality by sequestering nitrogen and phosphorus on-site in the rapidly developing wetland communities. Therefore, our planned amelioration of the soils will be minimal. Soil samples have been collected to document nutritional status and any needed supplements. Soils were classified by soil Taxonomy and sample pits described in Appendix IV - Soils Report.

3.1.3 Vegetation:

The Scuppernong River Mitigation Project is designed to promote development of a mixture of wetland types: 1.) WFH and SH wetlands found in adjacent areas and 2.) Atlantic white cedar and Pond Pine habitats (Figure 5). The planting design and description of the establishment conditions and seedling quantities are found in the Appendix V. With the exception of the Atlantic white cedar and cypress plantings which are single species, the other plantings are mixtures of both overstory and understory species which typify WFH and SH wetland habitat types.

Figure 5 Scuppernong River Corridor Mitigation Bank
Tyrrell County
Columbia, North Carolina
Planting Design



Total Area: 19 acres

Plants were established during 1993 and 1994 at a 6 x 10 foot spacing (726 plants/acre). Tree and shrub mixtures were matched to specific hydrologic zones within the field area (Figure 5). Species mixtures followed subtle elevational differences to simulate natural distribution in variable wetland conditions. Our strategy of planting 726 tree/acre was to provide adequate insurance of meeting the required plant survival even under severe abiotic and biotic conditions. No ground cover plants were planted given the seed bank within the surface soils and the extensive recruitment of propaguels associated with flooding. There has been high germination of indigenous wetland tree and shrub species and ground flora since the initial planting.

Following planting, preemergent herbicides were applied by a licensed applicator in strict adherence to labeling. In every instance, the planting stock was locally grown by the State Forest Service and/or forest industry nurseries. The seed sources for the plant material were obtained from the North Carolina Coastal Plain, and when available, genetically improved seedlings were used. Only the highest quality, 1/0 bare root seedlings were planted. The seedlings were hardened off and had well-developed fibrous root systems and healthy buds. At the nursery, seedlings were packaged in groups of 100 to 200 in Kraft seedling bags. Bags were kept in cold storage prior to planting making certain that the temperature did not fall below freezing.

Supplemental planting was also conducted in the dormant season during 1994 in areas of low initial survival (Appendix V). In all cases, the principals of Triangle Wetland Consultants were on-site to supervise the planting.

During May, 1996 woody competition control was completed in the Atlantic white cedar plantings and portions of the mixed hardwood/cypress plantings. Competing Loblolly pine and various volunteer hardwoods were mechanically removed using hand tools and a chainsaw. Over 2 acres were treated adjacent to Highway 94.

3.2 Reference Plot Location:

The reference locations for the restoration area were established in undisturbed locations in a wet flat hardwood forest and a swamp hardwood forest adjacent to the PC field area (See Figure 4 and Appendix VI). Both reference locations meet 1987 Corps Manual criteria for jurisdictional wetlands. Monitoring of these reference stands will follow guidelines outlined in a later section of this Plan. The hydrogeomorphic target conditions for the forested wetland restoration will be those of the undisturbed forested wetlands that are described.

3.3 Water Budget Analysis:

The objective of this section is to document the water budget/hydroperiod during the early growing season for a 19-acre drained, former agricultural site proposed as a forest wetland mitigation site. The water budget is used to examine the soil water status or wetland hydrologic

criterion at the site. The criterion specifies that saturated soil conditions be within 30 cm of the surface for at least 12 percent of the growing season. Hydroperiod is defined as the seasonal pattern of water level fluctuations as affected by inflow, outflow, and storage at a given site. Water budget (balance) calculations can provide valuable estimates of hydroperiod for guidance during wetland mitigation design and as an indication of design feasibility (SCS, 1992a; Jones, 1992). The basic information needed in evaluating the water budget of a wetland site is meteorology, soils, vegetation, hydrology and hydraulic components. Therefore, each of these components is discussed below:

3.3.1 Meteorology:

The site does not have a weather station for collecting meteorological data. The nearest weather station is approximately 40 km west at the N. C. Agricultural Research Service Station near Plymouth. This station collects data on daily rainfall and temperature. The long term annual rainfall and temperature used for this study was for a 30-year (1951-80) period (Epperson et al. , 1987). An additional 1.4-year (1994-95) hourly rainfall and temperature data collected at nearby Tidewater Research Site weather station (Chescheir et, al. 1995) was also used. The long-term (1951-80) monthly rainfall and 1.4-year (1994-95) monthly rainfall for the two stations are presented in Table 1.

Water loss due to potential evapotranspiration, ET is a significant component of the water balance of forested wetlands. Potential ET (PET) is the major factor contributing to this water loss. The temperature- based Thornthwaite method was used to compute PET. The monthly PET was adjusted with correction factors developed for the Coastal Plain region in eastern North Carolina (Amatya et, al. 1992). The long-term mean annual PET of 916 mm for the years 1951-80 was comparable with the mean annual PET of 978 mm estimated by the Penman-Monteith method for the Coastal Plain in eastern North Carolina.

Data on the average growing season length at the site was based on data for Plymouth. The date of the last spring frost was April 13 and the first fall frost was October 25 with about 12 days of standard deviation (Epperson et, al. 1987). Since the study site was slightly east of Plymouth, a wider 28-day (March 24 - April 20) early growing season period was used to evaluate the water budget.

3.3.2 Soils:

The site is located within a large watershed and flood plain system of the Scuppernong River draining into Albemarle Sound (Daniels et, al. 1984). The soils, on this nearly flat tract have less than 2 percent slope, are poorly to somewhat poorly drained and have a fine loamy texture (SCS, 1988). Augusta, fine loamy, mixed, Thermic, Aeric Ochraquults and Tomotley, fine loamy, mixed, Thermic Typic Ochraquults series are the dominant soils on the site. The comparison of soil water properties of Tomotley and Augusta soil series published by SCS (1988) is presented in Table 2. A complete soil description is included in Appendix IV.

Table 1. 30-year (1951-80) longterm mean monthly rainfall, temperature and adjusted Thornthwaite potential evapotranspiration (PET) for Plymouth station, NC. Monthly rainfall and PET for 1994 and 1995 at Tidewater Station (TRS) near Plymouth, NC.

Station No. 320000; Longitude 76 deg 39' W; Latitude: 35 deg 52' N; Elevation 6.4 m a.m.s.l.

Months of the year	Longterm mean monthly Rainfall Mean cm	Temperature deg C	PET cm	1994 Rainfall at TRS cm	1995 Rainfall at TRS cm	1994 PET at TRS cm	1995 PET at TRS cm
1	10.59	5.6	1.56	12.50	8.43	1.70	3.38
2	10.11	6.6	2.69	8.81	16.69	3.26	3.32
3	10.62	10.5	5.80	18.29	8.23	7.44	7.75
4	7.98	15.7	10.39	3.33	5.05	12.90	12.29
5	11.84	19.8	11.82	8.46	7.52	9.58	12.90
6	11.51	23.5	13.53	20.57		13.37	
7	16.00	25.6	13.43	8.30		13.02	
8	14.86	25.2	11.67	17.53		10.63	
9	11.73	22.2	9.78	11.71		9.78	
10	8.51	16.4	5.99	10.03		7.08	
11	7.87	11.3	3.35	5.69		6.15	
12	8.43	7.0	1.58	3.96		4.64	
Annual:	130.0	15.8	91.60	129.18		99.55	

(Source for rainfall and temperature data: Epperson et al., 1987)

(Source for TRS rainfall data for 1994-95: Chescheir et al., 1995)

Table 2. Comparison of soil water properties of Tomotley (To) and Augusta (At) soil series as published in the SCS Soil Survey Report for Tyrrell County in North Carolina.

Properties	For soil series: Tomotley (To)		Augusta (At)	
Family or higher taxonomic class:	Fine-loamy, mixed, thermic Typic Aeric Ochraquults		Fine loamy, mixed, thermic Ochraquults	
USDA texture by depth: (in cm)	0-20	Fine sandy loam	0- 15	Fine sandy loam
	20-75	Fine sandy to sandy clay to clay loam	15-125	Sandy clay loam
	75-90	Sandy loam to sandy clay loam to sandy clay		
Permeability by depth (cm), in cm/hr	0-20	5.0-15.0	0- 15	5.0-15.0
	20-75	1.5- 5.0	15-125	1.5- 5.0
	75-90	0.5- 5.0		
Available water capacity, cm/cm:	0-20	0.10-0.15	0- 15	0.10-0.15
	20-75	0.12-0.18	15-125	0.12-0.18
	75-90	0.12-0.18		
Organic matter at top layer, %	1 - 6		0.5 - 2.0	
Hydrologic soil group:	A		C	
Apparent high water table (during December to May):	0.0 - 30.0 cm		30.0 - 60.0 cm	
Flooding Frequency:	Rare		None	

On-site visual observations of the soil profiles were conducted by hand augering four randomly located holes across the site to a depth of 90 cm. The soil profile was homogeneous and observations indicated 15 to 20 cm of dark gray to blackish color fine sandy or silty loam in the top layer. The subsurface layer has a somewhat tight gray clayey loam at a depth of 20 to 70 cm and somewhat silty to sandy loam in the lower layers. These sandy clay loam soils have moderate permeability rates (SCS, 1988). The water holding capacity varies from 100 mm for sandy loam to 150 mm depending upon specific soil and vegetation types. A value of 125 mm was estimated for the 90 cm soil profile assuming a 10 % capacity for the top 20 cm depth and a 15 % capacity for the lower 70 cm of soil. These soils are characteristic of high water tables in natural undrained conditions with a rapid response to rainfall and ET. Data in Figure 6, based on measurements during 1994-95, show the response of measured water table depths to rainfall and ET for existing drained conditions at the site. During the reconnaissance survey, water table depth varied from ponded water at the surface to about 20 cm depth depending upon the location of the bored holes. Field observations plus published data show similar soil water properties for both Augusta and Tomotley soils through 76 to 90 cm depth.

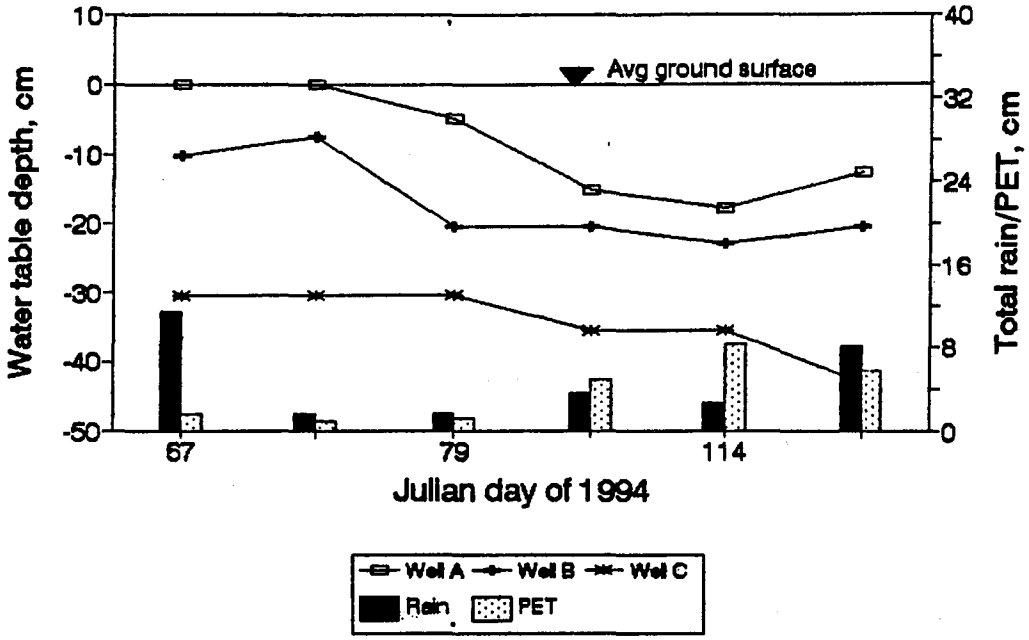
3.3.3 Vegetation:

Current vegetation on the site includes planted hardwood trees, cypress, pond pine, Atlantic white cedar and understory shrub species established between 1993-95 plus a variety of grasses and broadleaf herbaceous species (See Appendix V).

3.3.4 Hydrology and Drainage system:

The hydrologic features of the general area consist of the Scuppernong river to the west, Riders Creek to the southeast and a smaller creek to the north of the site and south of the Town of Columbia. The site is drained by three lateral drainage ditches and a surrounding perimeter ditch, all of which drain into a main roadside collector ditch running adjacent and on the east side of Highway 94. The collector ditch discharges into the small creek about half a mile to the north along Highway 94. The site is located on an inter-stream divide and maintains soil saturation for long periods because of poor surface and subsurface drainage.

The perimeter ditch system receives water from the lateral ditches which effectively drain the site. These ditches are 60 to 75 cm deep and have a top width of about 3 to 4.3 m. The calculated carrying capacity of the perimeter ditch at the outlet is about 1800 m^3/hr. using a free uniform flow for a slope of 1 meter per 50 meters and a Manning roughness of 0. 04. The ditch may occasionally over-flood at narrower sections due to backwater effects at the outlet during larger events. This is due to the very flat slope of the roadside ditch, which is a characteristic of drainage systems on the Coastal Plain. The three lateral ditches are 50 m to 90 m apart. Depth of the lateral ditches varies between 40 and 60 cm deep. The large surface storage of the field is evidenced by the ponded water in several sections. There are three water table monitoring wells which have been randomly installed at the site (Figure 4). Data for two growing season periods during 1994 and 1995 are presented in Figure 6. Data and a description of these wells are included in the Appendix II.



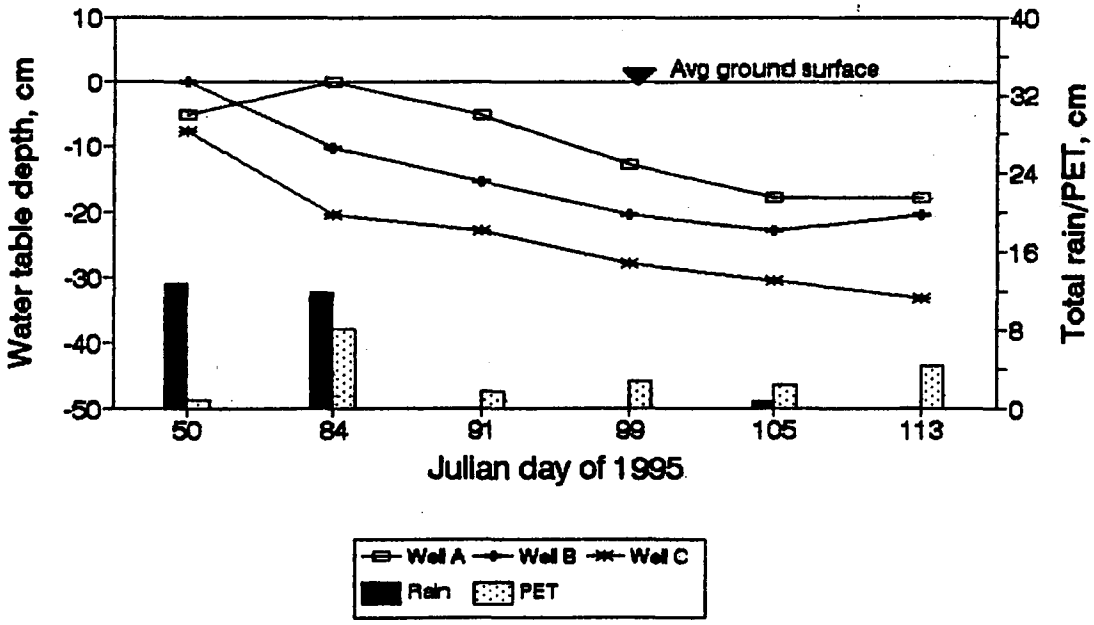


Figure 6. Measured water table depths, rainfall and estimated PET for two early growing seasons of 1994 and 1995 at Scuppernong Wetland mitigation site, Tyrrell county, NC.

3.4 Hydrologic Analyses

3.4.1 SCS Water Budget Method:

The hydrologic water budget of the site is described by using the SCS (1992a) method. The basic formula for the water budget is as follows:

$$\Delta S/\Delta t = Q_i - Q_o$$

where, $\Delta S/\Delta t$ = the change in storage volume per change in time,

Q_i = the inflow rate entering the site, vol./time and
Q_o = the outflow rate leaving the site, vol./time.

The inflow rates include direct precipitation, storm water runoff from contributing uplands, base flow entering the site, seepage, water pumped or artificially added and tidal flow. Rainfall recorded at the nearest station at Plymouth (40 km to the west) was used as the direct precipitation.

Since the site is surrounded by the forested wetlands on three sides, additional storm runoff from these lands into the site via overflow of perimeter ditch was assumed negligible. All other event runoff were assumed to be intercepted by the perimeter ditch. Excess spillage, if any, would quickly infiltrate into the fine sandy soils with moderate permeability rates. The high surface storage of the existing soil surface on the site enhances infiltration. However, because of the presence of a tighter sandy clay loam soil in the subsurface, the surface becomes saturated quickly. Excess runoff then fills the surface storage areas before running off into the lateral ditches.

The lateral seepage in and out of the site is assumed negligible because of the low water table gradient between the perimeter ditch and the field surface. The situation is similar between the field and the roadside ditch to the west. Deep seepage is assumed negligible for the Augusta and Tomotley soils because of the impeding horizons at about 1. 7 meters (Table 2). This component is generally considered very small or about 2 to 3 percent of total annual rainfall. Heath (1975) estimated an annual deep seepage loss of about 12 mm per year for the Albemarle-Pamlico region of North Carolina. Furthermore, that there will be no water pumped out or artificially added from the nearby canals. Tidal inflows are negligible for this site. The outflow rates leaving the site include drainage outflow rates, evaporational and transpirational (ET) losses, stormwater outflow, base flow or lateral seepage, deep seepage, water pumped or artificially removed and tidal outflows. The ET loss is the most significant loss in the water balance of forests in eastern North Carolina (Amatya, et al. , 1996). As much as 70-75 percent of the total annual rainfall was reported to be lost to ET leaving the rest for drainage and seepage for drained forested lands at Carteret site near Morehead City in eastern North Carolina.

Total drainage (surface runoff and subsurface flow) through the ditch network is another significant component of the water loss. The drainage rate to the ditch is about (200 m^3/hr) based on existing conditions of soil and the free drainage ditch system. The SCS Runoff Curve Number method (SCS, 1986) for this site with an estimated CN = 70 yielded approximately 3.9 and 7.5 cm of total storm runoff for a 2-year and a 10-year return period with rainfall amounts of 10.9 and 15.7 cm, respectively. The corresponding estimated peak discharges were 700 m^3/hr and 3100 m^3/hr , respectively using the method of Gunter et al. , (1987) for coastal watersheds. The section at the outlet ditch would easily carry the 2-year return period flood discharges given no backwater effects at the control. However, site observations indicate that the roadside outlet ditch may occasionally overflood during larger events, probably, due to additional inflow from the upstream areas and to the very flat slopes. The other potential loss due to surface runoff from the site is likely due to the overflooding of the perimeter ditches during extremely high floods. Part of this spillage would be inflow back to the site adding to the soil water storage.

Total lateral seepage losses across the boundaries of the site and vertical deep seepage were considered minimal. Therefore, the evapotranspiration component is considered the main potential water loss followed by the drainage in the water budget.

The long-term mean annual rainfall of 130. 0 cm and 91. 6 cm of PET computed by the adjusted Thornthwaite method in Table 1 shows that there is generally excess soil water available in the region. The fact is further supported by the additional 1. 4 years (1994-95) of average rainfall and PET data. The 1994 rainfall was close to long term normal.

The annual rainfall and PET are not necessarily the indicators of seasonal soil moisture status of a wetland. On a seasonal or monthly basis, the soil water or hydroperiod of wetlands may be highly variable as affected by variability in rainfall, PET, vegetation dynamics and hydrology of the adjacent sites. Mean monthly soil water obtained as a difference of mean monthly rainfall and PET for a 30-year period was plotted in Figure 7. Data shows that monthly soil water in excess of about 20 mm and higher exists from July through March. Soil water deficits of little more than 20 mm tend to occur in April and June. However, the cumulative mean monthly soil water throughout the year is positive and higher than 90 mm at all times based on the data from the Plymouth station (Figure 8). This is because the deficit is fulfilled by surplus water stored during the winter and early growing season when ET demands are still low and there are no other losses. Similar analyses conducted for the early springs of 1994 and 1995 resulted in soil water deficit of more than 70 mm in April in both years. However, the cumulative soil water at the end of April showed a surplus of more than 116 mm due to the unusually larger amount of rain in March of 1994 and February of 1995. **These results show that the site has a soil water surplus through the early growing season for normal and wetter weather conditions given no other losses.** The soil water state during a season or a month is site specific and is also strongly influenced not only by the weather conditions but also water holding capacity of the soil and vegetation growing on the site. Therefore, a mean monthly water balance for the site was conducted using long term mean monthly rainfall and PET data for a site specific soil and vegetation type with the estimated average water holding capacity.

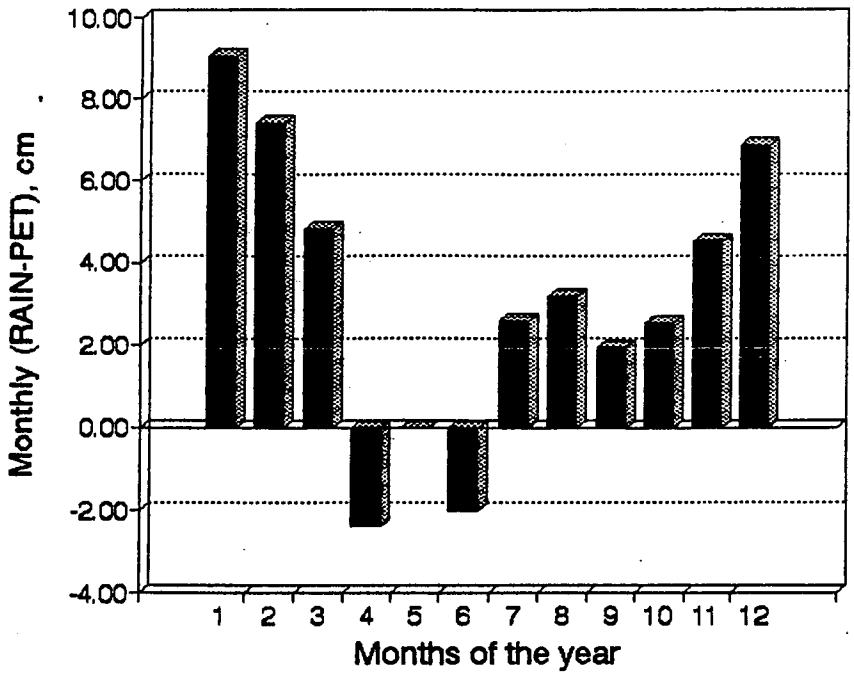


Figure 7. Mean monthly soil water storage (R-PET) using long term (1951-80) monthly temperature and rainfall data for Plymouth station, NC.

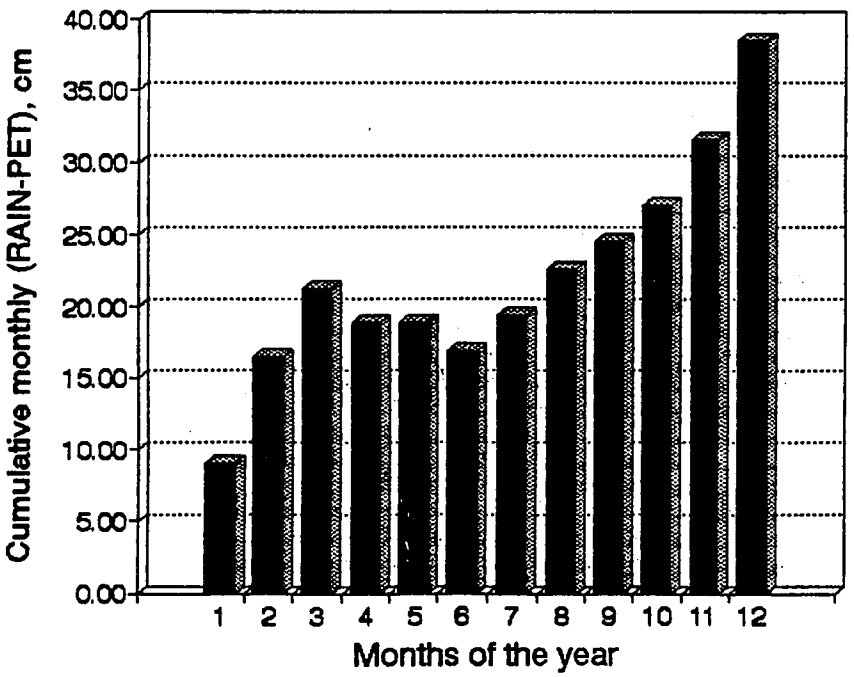


Figure 8. Cumulative monthly soil water storage (R-PET) using long term (1951-80) mean monthly temperature and rainfall data for Plymouth station, NC.

3.4.2 Method of Thornthwaite and Mather (1957):

This method described by Dingman (1994) was used to conduct the monthly water balance for a fine sandy loam soil with about 125 mm water holding capacity for vegetation with shrubs and bushes. The methods of computation are explained in footnotes in Table 3. The computed data in Table 3 and plot in Figure 9 show surplus water beyond the middle of April. Beyond mid April the deficit was fulfilled by utilizing the surplus water from previous months. Small soil water deficits were noticed only in early May due to increase in ET demands. For the rest of the year there was surplus water. Similar analyses were conducted for the 1994 and 1995 growing seasons (Figure 10). Soil moisture deficits started to occur beginning the third week of April in 1994 and first week of April, 1995. However, antecedent surplus moisture retained in the profile was being utilized to satisfy ET requirements during the deficit period. The cumulative daily water balance as the difference of only rainfall and PET plotted in Figures 11 and 12 for 1994 and 1995 clearly indicate the surplus of at least 100 mm during the period assuming no drainage and runoff losses.

Although the above analyses give clues to the average wetness status of the site during March and April, it is difficult to assess the water table depths corresponding to this status for evaluating wetland criteria. One way of evaluating the water table depths is to directly monitor them at the site. The periodically measured water table depths from three monitoring wells at the site are illustrated in Figure 4. Data indicate that the soil is generally saturated during the early growing season. Due to increased ET demands and lower than normal rainfall in March and April, 1995, the water table depth measured at the three wells was declining by end of April compared to 1994 which recorded normal rainfall.

When long term hydrology data is not available for a specific site, computer simulation modeling can be used to estimate hydroperiod for the wetland status (Skaggs et al. , 1991a). Meanwhile, it is important to understand all the methods and assumptions used to predict the hydrologic processes in the model, and its reliability and limitations before making its application.

3.4.3 DRAINMOD (Skaggs, 1980; SCS, 1992b):

DRAINMOD is a computer simulation model developed for poorly drained, shallow water table soils. The model does the water balance for a soil column at the midpoint between parallel ditches. The model predicts, on an hour-by-hour, day-by-day basis, the water table depth, soil water content, drainage, ET, and surface runoff for given climatological conditions, soil properties, plant cover and site conditions. These predicted water table depths are analyzed for evaluating whether wetland hydrologic criteria are satisfied or not for a given tract (Skaggs et al. , 1991a). Reliability of the model predictions has been verified in extensive field measurements as reported by Skaggs et al. , (1994). Skaggs et al. , (1991b) evaluated the effects of surface depressional storage, land-use changes and the drainage changes on the hydrology of pocosin watersheds in eastern North Carolina.

Table 3. Calculation of monthly water balance using the method of Thornthwaite Water Balance Model for sandy loam to sandy clay loam soil with 125 mm water holding capacity for wetland vegetation I proposed Scuppernong Wetland Mitigation Project for long term (1951-80) weather data from Plymouth station, NC.

Initial soil water capacity = 125 mm

		<<<<<	<<<<<	<<<<<	Long term (1951-80) mean			>>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
Water Balance Component (mm)	**DEC 0 12/31**	**JAN 1 1/31**	**FEB 2 2/28**	**MAR 3 3/31**	**APR 4 4/30**	**MAY 5 5/31**	**JUN 6 6/30**	**JUL 7 7/31**	**AUG 8 8/31**	**SEP 9 9/30**	**OCT 10 10/31**	**NOV 11 11/30**	**DEC 12 12/31**
P	84.3	105.9	101.1	106.2	79.8	118.4	115.1	160	148.6	117.3	85.1	78.7	84.3
PET	15.8	15.6	26.9	58	103.9	118.2	135.3	134.3	116.7	97.8	59.9	33.5	15.8
P - PET	68.5	90.3	74.2	48.2	-24.1	0.2	-20.2	25.7	31.9	19.5	25.2	45.2	68.5
Acc Pot WL					-24.1	-23.9	-44.1	-18.4					
SM	125.0	125.0	125.0	125.0	103.1	103.3	87.9	113.6	125.0	125.0	125.0	125.0	125.0
SM change	0	0	0	0	-21.9	0.2	-15.4	25.7	11.4	0.0	0.0	0.0	0.0
AET	15.8	15.6	26.9	58	101.7	118.2	130.5	134.3	116.7	97.8	59.9	33.5	15.8
SMD	0	0	0	0	2.2	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0
SMS	68.5	90.3	74.2	48.2	0	0	0	0	20.5	19.5	25.2	45.2	68.5

Explanation of parameters in calculations given above:

1.) P = Long term (1951-80) mean monthly rainfall from Plymouth weather station no. 320000
2.) PET = Mean monthly long term (1951-80) adjusted Thornthwaite method computed potential evapotranspiration (PET);
3.) P-PET = Rainfall minus potential evapotranspiration;
4.) Acc Pot WL = Accumulated potential water loss, accumulation of negative values of (P-PET) for the dry season only;
5.) SM = Soil moisture calculated using the relationship of accumulated potential water loss versus water retained in the soil given by Dunne & Leopold (1978); (This can also be computed by the relationship given by Alley (1984) as shown by Dingman (1994);
6.) AET = Actual evapotranspiration equal to PET when P is larger than PET and equal to sum of P and soil moisture withdrawn from storage when P is less than PET.
7.) SMD = Soil moisture deficit is difference between PET and AET;
8.) SMS = Soil moisture surplus when excess rainfall is stored in the soil during the wet season. It is zero during the dry period.

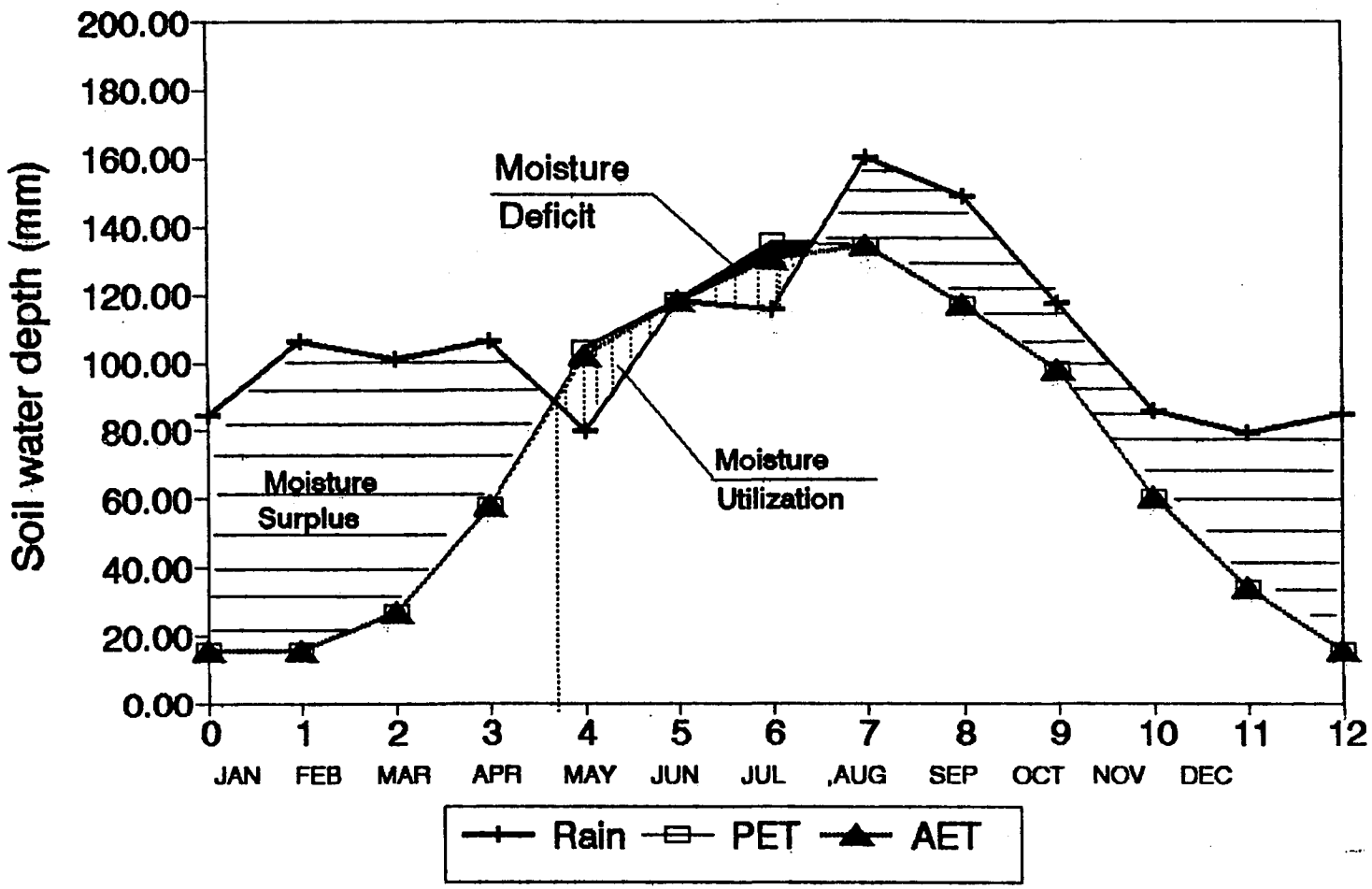


Figure 9. Monthly estimated water balance for proposed Scuppernong Wetland Mitigation Site Tyrrell county, NC using long term (1951-80) monthly rainfall and adjusted Thornthwaite PET for Plymouth, NC. The estimate is for sandy clay loam soil with 125 mm water holding capacity for tall wetland vegetation. No inflows and outflows from the site are assumed.

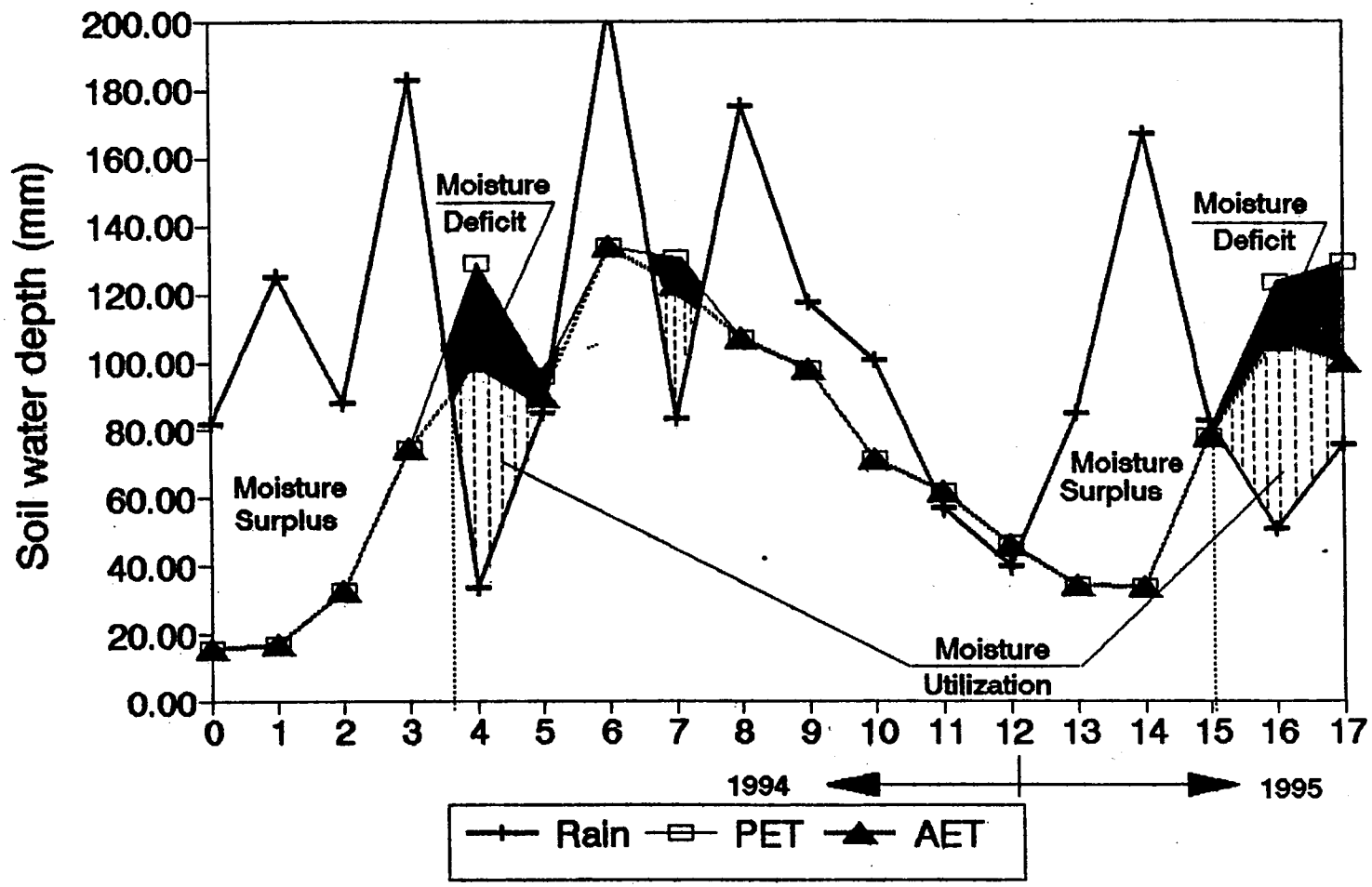


Figure 10. Monthly estimated water balance for proposed Scuppernong Wetland Mitigation Site Tyrrell county, NC using 1994-95 monthly rainfall and adjusted Thornthwaite PET for TRS site near Plymouth, NC. The estimate is for the same conditions as in Figure 7.

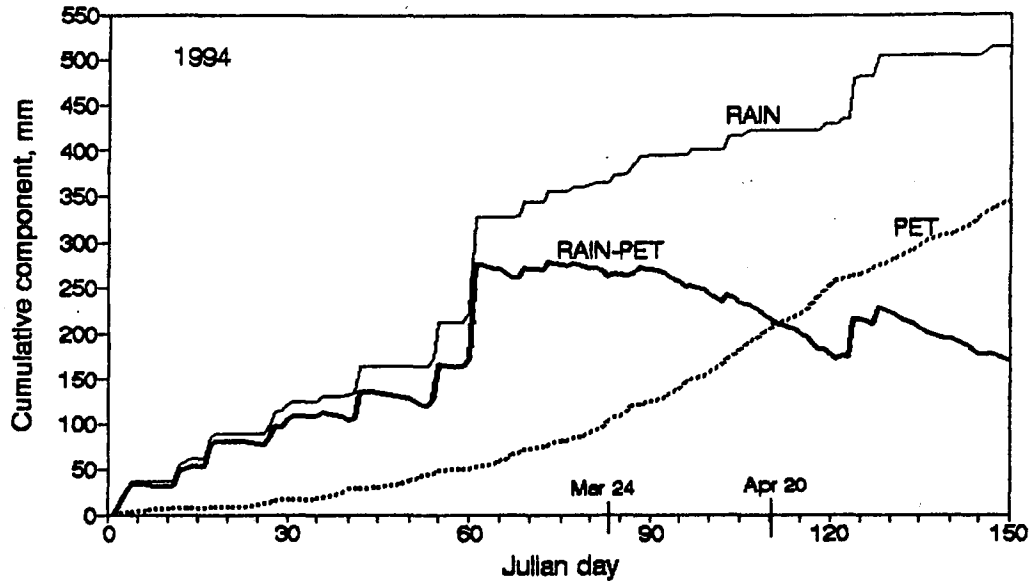


Figure 11. Cumulative daily rainfall, PET and soil water balance (RAIN-PET) using daily weather data for 1994 from TRS site at Plymouth, NC.

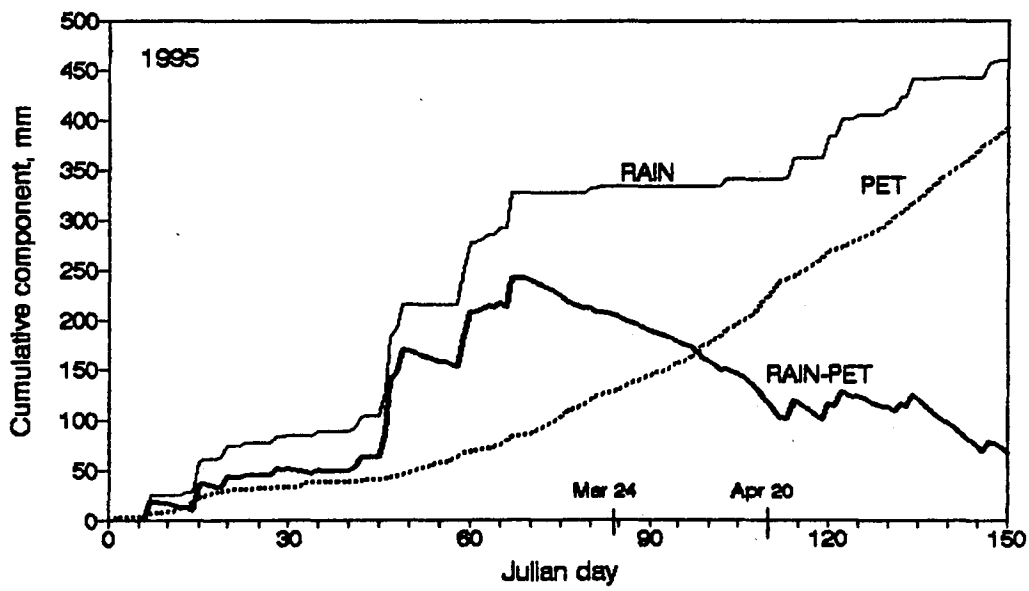


Figure 12. Cumulative daily rainfall, PET, and soil water balance (RAIN-PET) using daily weather data for 1995 from TRS site at Plymouth, NC.

DRAINMOD was used to assess the hydroperiods of the Scuppernong site because the soils have been classified as poorly drained with shallow water tables. The main input parameters for DRAINMOD are weather data, soil properties, rooting depth, and wilting point of the crop, etc. Rainfall data for a 40-year (1951-90) period from the Plymouth station were used as weather parameters for simulating long term hydrology (Skaggs et al., 1995). Daily PET in the model was computed by the Thornthwaite method using adjustment factors as described earlier. Soil properties include data on soil water characteristics, volume drained, upward flux versus water table depths, water holding capacity at saturation and wilting point, number and depth of layers and saturated hydraulic conductivity. Similarly, rooting depth function and wilting point of the crop are the vegetation input parameters in the model.

Since no measured site specific soils data were available, existing published data on Tomotley sandy loam soil (Skaggs and Tabrizi, 1986) were used for the preliminary evaluation of the hydroperiods using DRAINMOD (Table 4). Data on Augusta sandy loam soil was not available for simulation. A 50 cm deep ditch with 90 m spacing (middle field) was used for the simulations. Limited data on water table observations for two growing seasons (1994-95) were used in an effort to calibrate the soil input parameters in the model. Data in Figure 13 show the comparison between measured and DRAINMOD predicted water table depths for two early growing seasons in 1994-95. Model predictions were in good agreement for 1994 and early 1995. However, the deeper water table depths predicted in April, 1995 were due to over-prediction of ET by the Thornthwaite method for that month and the variability in rainfall between the site and Plymouth. Rainfall is generally higher to the east toward the coast. But these discrepancies in the model were assumed to be on the conservative side of the simulation analysis. The model was then run to simulate the wetland hydrology of the site using long term 40-year (1951-90) weather data for the existing conditions. The conditions assumed were free drainage for tall grasses, small trees and shrubs with an assumed rooting depth of 20 to 30 cm. Two ditch spacings, 90 and 50 m found at the site, were simulated for an average 50 cm depth.

The model outputs of simulated annual average (1951-90) water balance parameters are presented in Table 5(a). ET losses were as high as 73 percent. Most of the remaining water was lost to drainage and surface runoff. As expected, drainage was higher and runoff was lower for the 50 m ditch spacing and vice versa for the 90 m spacing. This runoff portion is assumed to fill all depressions on the site followed by ponding on the surface. It is then lost either to ET or infiltration. The average annual water balance shows the potential surplus soil water (runoff + drainage) on an annual basis.

In order to achieve this potential surplus soil water estimated above by different methods, it is suggested that the lateral ditches draining the site to the roadside ditch be plugged. Simulated long-term mean wetland hydrologic parameters averaged for the period March 24 through April 20 are presented in Table 5(b). The water table remained within 30 cm depth from the surface for about 21 and 17 days in average for 90 and 50 m spacings, respectively. Similarly, the average predicted water table depths for the period were 19 and 27 cm for the 90 and 50 m spacings, respectively. The longest consecutive days with water table

Table 4. Parameters of Tomotley soil series input to DRAINMOD used for simulating hydrology of Scuppernong River Corridor Mitigation Site, Tyrrell county, NC.

Depth to impermeable layer, cm	170
Hydraulic conductivity, cm/hr	1.0(100)
(Depth range, cm)	3.0(100-170)
Saturated water content in root zone, cm^3/cm^3	0.46
Water content at wilting point, cm^3/cm^3	0.12
Effective rooting depth, cm (for brushes, grasses & small trees)	30.0
Surface storage, cm	2.0

Relationship between water table depth, volume drained and upward flux :

Tomotley		
Water Table Depth cm	Volume Drained cm	Upward Flux cm/hr
0	0.00	0.5000
0.2	0.40	0.0600
0.4	0.92	0.0400
0.6	1.85	0.0063
0.8	3.40	0.0016
1.0	5.50	0.0011
1.2	7.50	0.0005
1.4	10.45	0.0003
1.6	13.40	0.0000
2.0	19.30	0.0000
2.5	27.22	0.0000
3.0	35.40	0.0000
4.0	43.72	0.0000
4.5	48.86	0.0000

Notes:
Data for Tomotley soil extracted from Skaggs & Tabrizi (1986).

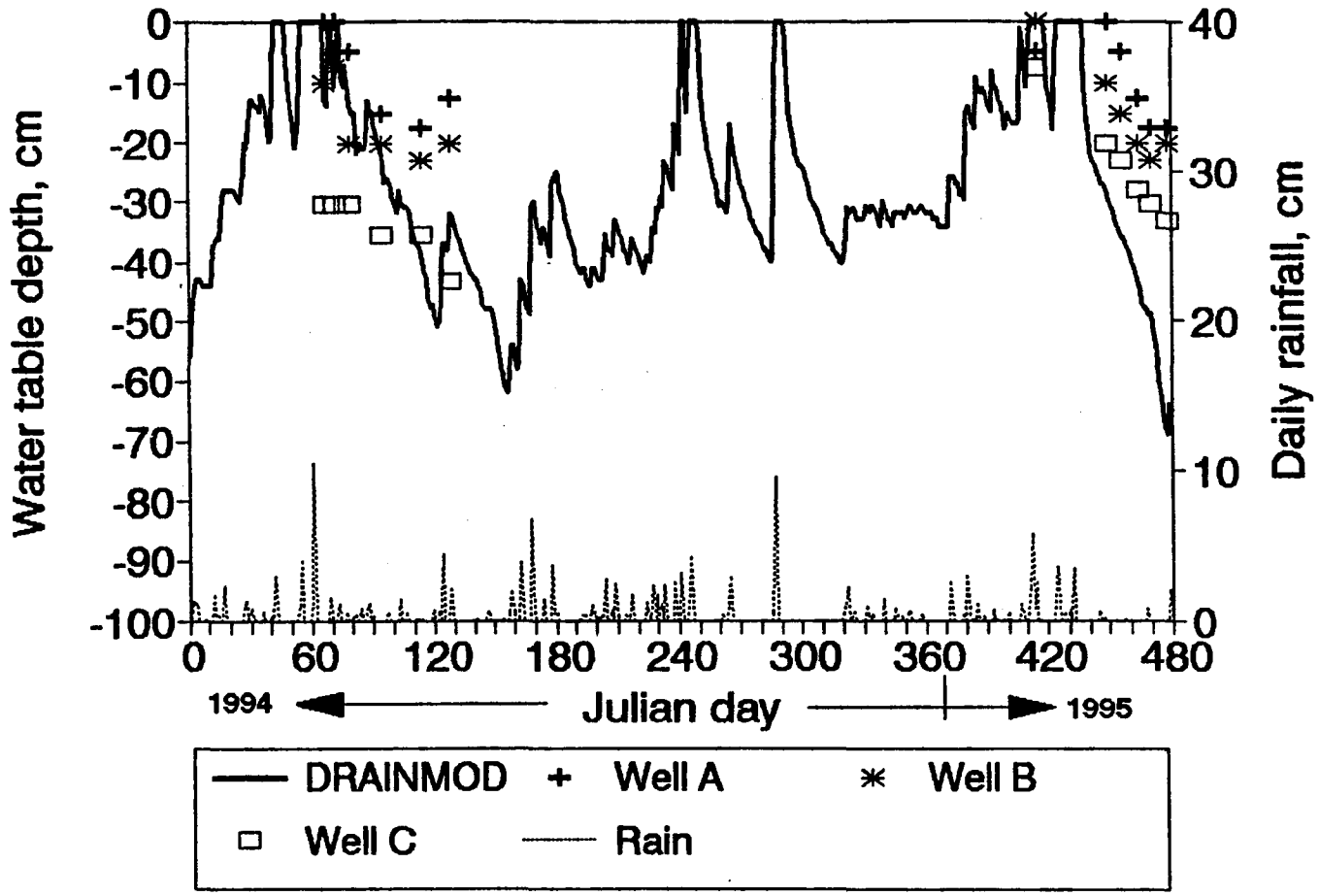


Figure 13. Comparison of measured and DRAINMOD predicted water table depths at Scuppernong wetland mitigation site for 1994-95 early growing seasons. Weather data from TRS site near Plymouth was used with Tomotley s.l. soil for ditch depth=50 cm and spacing = 90 m.

Table 5. DRAINMOD simulated water balance and wetland hydrologic parameters for a poorly drained Tomotley s.l. soil in the Scuppernong Wetland Restoration site using 1951-90 weather data from Plymouth, NC. For ditch depth = 50 cm, Ditch spacings = 90 amd 50 m and baseline conditions.

a. Longterm annual average water balance parameters:

Parameter	Ditch Spacings 90 m	50 m
Rainfall, cm	129.5	129.5
ET, cm	95.2	94.9
Drainage, cm	19.5	28.4
Runoff, cm	14.9	6.4

b. Mean wetland hydrologic parameters for 1951-90 averaged for the early growing season MAR 24 - APR 20

Parameter	Ditch spacings 90 m	50 m
Avg Days water table within 30 cm depth	21	17.3
Longest consecutive wet days	28	28
Years satisfying wetland criteria	29 /40 72.5 %	23 /40 57.5 %
Average water table depth, cm	19.3	27.4

within 30 cm depth was 28 for both scenarios. The wetland hydrologic criteria for the early growing season was satisfied in 29 out of 40 years (72 percent of time) for 90 m spacing and 23 out of 40 years (57 percent of time) for 50 m spacing, respectively. Since the criteria was satisfied more than 50 percent of time even for the narrower ditch spacing, it is expected that it would be met for the site for the normal weather conditions given the proposed conditions for soils, vegetation and surface storage are met.

These predicted average annual water balance parameters and water table depths, which depend on the soil water status, are in agreement with results obtained by other methods.

3.5 Summary and Recommendations:

Long-term (1951-80) mean monthly weather data from the nearest weather station at Plymouth showed that the Scuppernong River Corridor Mitigation Project site has wet conditions. Mean monthly soil water balance using the method of Thornthwaite and Mather for a sandy clay loam soil, characteristic of the site, with 125 mm available water capacity resulted in surplus water at least through mid-April assuming no other losses for normal and wetter seasons. The results were comparable to periodically measured water table data for 1994-95 collected at the site.

DRAINMOD, a water management model for poorly drained soils used for simulating long term hydroperiods, was first calibrated with limited data on measured water table depths for 1994-95. Simulations were then conducted using long term (1951-90) weather data from Plymouth for Tomotley sandy loam soil. The simulation results revealed that the criterion was satisfied 57 percent or more of the time during early growing season (24th March through 20th April) under existing site conditions.

One of the suggested measures for hydrological restoration of the site is to plug the existing lateral ditches for preventing drainage and to store more water in the soil profile. Simulations conducted for the plugged ditch scenario resulted in criteria being satisfied at least 80 percent of the time. The wetness of the site would be further enhanced by the rough surface storage that will be created by the litter and other wetland vegetation with higher rooting zone.

It is also recommended that the actual site specific soil water properties be obtained and the water table be continued to be monitored during the mitigation phase in order to accurately determine the input parameters. The reliability of model simulations can then be maximized by the use of these input parameters including water table data (Skaggs et. al. 1991a). This would not only help in redesigning some activities such as a mid-course corrections during the mitigation to achieve the goals of the restoration but also be used as a measure for evaluating the success of the mitigation later.

4.0 SCUPPERNONG RIVER CONSERVATION AREA

The 19 acre restoration site is adjacent to extensive natural forested wetlands plus an established wetland restoration project, Kitty Hawk Woods, near the Tyrrell County Elementary School (Figure 2). This Scuppernong River Project contains an additional 19 acres of mature wet flat and swamp hardwood habitats on the north, east, and south sides which will function as a buffer to protect the restored field and also serve as the site of the two reference plots. This buffer area contains a very high quality swamp blackgum/cypress swamp which includes some open water emergent wetlands. This area contains a rich understory and overstory of deciduous and evergreen plants (See Section 2.3 Vegetation). In addition, it serves as a corridor and refuge for wildlife in the area. It is used by whitetail deer, black bear, redfox, raccoons, and many small mammals. Waterfowl including wood ducks, mallards, and black ducks use the emergent marsh/black gum and cypress areas. It is also used by herons and other wading birds. During the spring of 1996, a pair of pileated woodpeckers was observed nesting in the area. It is hydrologically connected to both the Scuppernong River Corridor restoration area and the 26 acre Kitty Hawk Woods Project which is currently owned the State of North Carolina. Other land adjacent to the Scuppernong River Corridor Project include a privately owned 5 acre Atlantic white cedar restoration planting and forestland. Across Highway 94 but contiguous with the Scuppernong River Mitigation Project is land owned by the U.S. Fish and Wildlife Service which is part of the Partnership for the Sounds, Wetlands Interpretive Project (Appendix VII). This tract includes frontage on the Scuppernong River and adjacent forested wetlands north to Highway 64. The 38 acre, Scuppernong River Mitigation Corridor Project will be transferred to the Pocosin Lake National Wildlife Refuge. The purpose of this transfer is to guarantee the protection of the area and the permanence of wetland functions and values. This tract will be used for education and the promotion of the value of restoring wetland systems. The North Carolina Coastal Land Trust may be an intermediary in the transfer of this 38 acre tract to the U.S. Fish and Wildlife Service. All activities will be coordinated with the Corps of Engineers and other regulatory agencies.

5.0 WETLAND EDUCATIONAL VALUES

There is great potential for using the Scuppernong River Corridor site for educational purposes associated with the Tyrrell County Elementary School and the Partnership for the Sounds Facility. This site could be combined with the adjacent Kitty Hawk Woods Project near the Tyrrell county Elementary School site for a total of 45 acres of restored forested wetlands plus the adjacent 19 acres of mature, natural forested wetlands. Total forested wetland area protected and available for education would be 64 acres.

Trail construction will include clearing a 3-4 ft. wide walking path and building several bridges over existing ditches. The walking path will be cleared of stumps and brush and maintained regularly to keep it clear. Even though the site is a wetland, no elevated walkways will be necessary and all trail sections will be on existing grade. Bridges will be constructed with pressure treated pine for maximum durability.

The interpretive trail system is designed for both tracts which would incorporate both restored fields and the natural wetland forested areas (Appendix VII). The trail is designed to connect the Tyrrell County Elementary School and a parking area along Highway 94. This trail could continue through lands owned by the U.S. Fish and Wildlife Service and connect to the Partnership for the Sounds Interpretive Facility. (Appendix IX - Baseline Photos).

Discussions on this trail system have taken place with Rick Van Schoik, former Partnership for the Sounds Director and most recently with Linda Cieslik (Appendix VII). They have endorsed the project and recommended that the Scuppernong and Tyrrell County School sites be made part of the field interpretive facilities for Partnership for the Sounds. Ms. Betsy Stallings, Superintendent of the Tyrrell County Schools has also been supportive and has offered to use this outdoor facility in their science program. And finally, Mr. John Dorf with the Youth Conservation Corp (YCC) has offered to cooperate in trail construction.

6.0 MONITORING

Monitoring provides a quantitative and qualitative accounting of ecosystem processes to ensure that fully functioning wetlands are established. Performance of the mitigation project is assessed by comparing monitored data from the mitigation site to adjacent, undisturbed reference wetland habitat types.

The intensity of monitoring varies with the degree of disturbance at the impact site and the probability of successfully achieving targeted wetland functions. Selected target goals and functions for the Scuppernong River Corridor site are included in the Corps Mitigation Worksheet (Appendix I). Our monitoring program will comprehensively measure and evaluate the major structural and functional parameters on the Scuppernong site and these will be compared to data collected at the reference site.

Baseline data on vegetation and hydrology have been collected during 1992-95 and are included in Appendix VIII. Ongoing activities include permanent vegetation plots, measuring hydrology, and photo documentation.

Characterizing the success of this project and obtaining functional wetlands will require continued measurement and analyses of the following for at least two additional years.

6.1 Hydrology:

Ditches have been plugged and hydrology will be monitored using 6 shallow groundwater monitoring wells as previously described (Figure 4). Indirect hydrological indicators will be recorded according to the Federal Interagency Committees for Wetland Delineation, 1987 Federal Manual for Identifying and Delineating Jurisdictional Wetlands (WTI, 1991). Measurements will occur monthly (early dormant season) and weekly (growing season) for 4 years or regulatory release. Two years of monitoring have already been completed.

Hydrology data from the restoration area will meet the 1987 Corps manual and be comparable to data from the adjacent reference stands.

6.2 Vegetation:

Vegetation monitoring will be conducted in accordance with sampling procedures described for comprehensive wetland determination in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (WTI 1991). Six permanently established, 1/10 acre circular plots will be established randomly across the 19 acre site. Plot centers will correspond to hydrology monitoring plot centers (Figure 4). Sampling will be conducted between August and November (inclusive) of each monitoring year.

Species composition and dominance will be measured within each plot. Planted trees and shrubs and natural regeneration will be sampled within each, 1/10 acre circular plot. Dominance of planted trees and shrubs, plus natural tree regeneration recruitment will be determined by obtaining measurements of the number of stems and average height in each plot respectively. Survival and height growth of trees and shrubs will be summarized in a report at the end of each year for 4 years. The second year report has been completed. For regulatory release, a mean density of 320 trees per acre including planted trees and natural regeneration must be attained in 5 years. Trees must average 6 feet tall.

7.0 CONTINGENCY PLAN

Contingency planning is an important and necessary component of mitigation. The proposed wetland restoration project will be monitored for the duration of the project, at which time the success of the mitigation will be reviewed by the Corps in consultation with other state and federal regulators. If the mitigation is determined partially successful, additional monitoring may be conducted or the contingency plan will be implemented.

The success of this wetland restoration will be based on review of the monitoring results. Evaluation criteria will follow the "Mandatory Technical Criteria for Wetland Identification: described in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (WTI, 1991).

8.0 LITERATURE CITED

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APPENDIX

Appendix I

DRAFT

Compensatory Mitigation Planning Checklist

ACTION ID:

SITE NAME: **Scuppernong River Corridor**

LOCATION/WATERBODY/COUNTY: **Tyrrell County, one half mile south of Columbia on Highway 94 adjacent to Scuppernong River.**

USGS QUAD(s): **Columbia East Quadrangle N 3552.5 - W 7607.5/7.5**

SOIL SURVEY SHEET NO.(S): **1**

PREPARED BY: **D.J. Frederick** **DATE:** **February 21, 1996**

I. INTRODUCTION

A. Type of Mitigation (circle / A separate checklist may be prepared if more than one type.)

1. **Restoration** Creation Enhancement **Preservation**

   a. In-kind Out-of kind **Both**
   b. On-site Off-site **Both**

2. Up-front Concurrent After-the-fact **All**

B. Wetland types and acreage **Impacted** / Attach or Describe:
Wet Flat Hardwoods (WFH), Swamp Hardwoods (SH), Atlantic white cedar (AWC) - areas to be determined.

C. Wetland types and acreage **Mitigated** / Attach or Describe:
WFH, SH, AWC, emergent freshwater marsh (EFM) wetlands - 19 ac. restoration, 19 ac. preservation.

D. Describe mitigation **Ratios**:
To be determined.

		YES	NO
E.	Will any Endangered Species, Archeological Resources, or Haz/Tox sites be impacted by this effort?	____	x
F.	Has a wetland determination been undertaken and verified?	____	x

II. TARGET GOALS AND FUNCTIONS

		YES	NO
A.	Are there stated **GOALS**?	x	____

Describe:

To fully restore in structure and function WFH, SH, and AWC wetlands on a 19 ac. P.C. field near the Scuppernong River.

B. Describe **Success Criteria**:

Attain average planted tree density of 400 trees/ac. and 6 ft. tall after 5 yrs, hydrological soil parameters on mitigation site will meet 1987 Corps Manual.

			YES	NO
Are they:	1.	Specific	x	____
	2.	Measurable	x	____
	3.	Attainable	x	____

		YES	NO
C.	Target **FUNCTIONS** chosen and indicated?	x	____

Describe:

Biomass accumulation, water quality improvement, wildlife habitat, food chain support, nutrient cycling retention, flood storage.

		YES	NO
D.	Was a **Reference Ecosystem** (RE) report prepared? (Attach)	x	____

1. Describe comparison between the RE and the Mitigation Plan:

Tables itemizing vegetation hydrological and soil characteristics of 2 adjacent reference stand have been prepared and are included in the mitigation Plan.

III. STRUCTURAL COMPONENT

A. VEGETATION:

		YES	NO
1.	Are plantings listed to species?	x	____
2.	Are "local" (200 Miles North/South) propagules to be planted and verified by a nursery certificate?	x	____
3.	Have diversity and densities of species within the RE been considered in the plan?	x	____
4.	Has consideration been given to planting the interface between the mitigation site and upland habitats with suitable transition zone species?	x	____

5. Describe Quality Control during planting:

All planting directly supervised by Drs. Russ Lea and Doug Frederick. Also seedling source, lifting, packaging, transportation, site preparation, post planting care.

B. SOILS:

		YES	NO
1.	Have the soils been mapped?	x	____

2. Soils Series / Phases:

Augusta - fine sandy loam
Tomotley - fine sandy loam

C. **HYDROLOGY**:

		YES	NO
1.	Were the principles of HGM or other classification system considered?	x	____

Describe:

An HGM Analysis (Brinson, 1993) was completed for the site. Geomorphic setting is a low gradient depressional wetland with a surface inlet and outlet. Hydrology is dominated by lateral surface flow and groundwater discharge.

2. Describe the primary hydrologic input(s):
   precipitation, groundwater, tidal

		YES	NO
3.	Was a **Hydrology Model/Water Budget** developed?	x	
	a. Were low, average, and high precipitation/water table/ flood conditions considered?	x	____

Describe the Water Budget:

Meteorological data obtained from Plymouth, NC. Penman -Monteith and Thornthwaite methods used to determine potential evaporation - transpiration (PET). DRAINMOD used for soil wetness and meeting 1987 Corps Manual hydrology parameter.

4.	Will the hydrologic regime predicted by the Water Budget be appropriate for the target wetland?	x	____

Describe:

The hydrologic regime with recommended modifications to the lateral ditches will result in the restoration of natural wetland hydrology.

	YES	NO
5. Have **Monitoring Wells**/tide/ flood gauges been installed?	x	____

Describe:

Three monitoring wells have been installed and two full years of data collected (See attached Hydrological Monitoring Reports).

NOTES:

IV. MONITORING

A. Name and number of person responsible for the success of this project: Dr. D.J. Frederick (919) 515-7788
Dr. Russ Lea

	YES	NO
B. Is there a **Monitoring Plan**?	x	____

Describe:

See text, Restoration and Monitoring Plan, February, 1996.

	YES	NO
C. **As Built** Report provided?	x	____
D. Procedure to account for beneficial natural regeneration?	x	____

Describe:

See text, Restoration and Monitoring Plan, February, 1996.

V. CONSIDERATION OF CAUSES OF FAILURE

A. How does project rate regarding the following:

1. **Elevation**:
   Project area lies below 2.0 ft. MSL and is directly connected to groundwater and tidal sources.

		YES	NO	N/A
a.	Have **Biological Benchmarks** been established?	x	____	____
b.	Is there a **Grading Plan**?	____	____	x
c.	Is the grading plan specific?	____	____	x
d.	Is disking proposed after grading and/or prior to planting?	____	x	____

2. Describe provisions for **Drainage**:
   Two years of hydrological monitoring show marginal wetland hydrology. Ditch plugs will be installed in all lateral ditches draining into perimeter ditches.

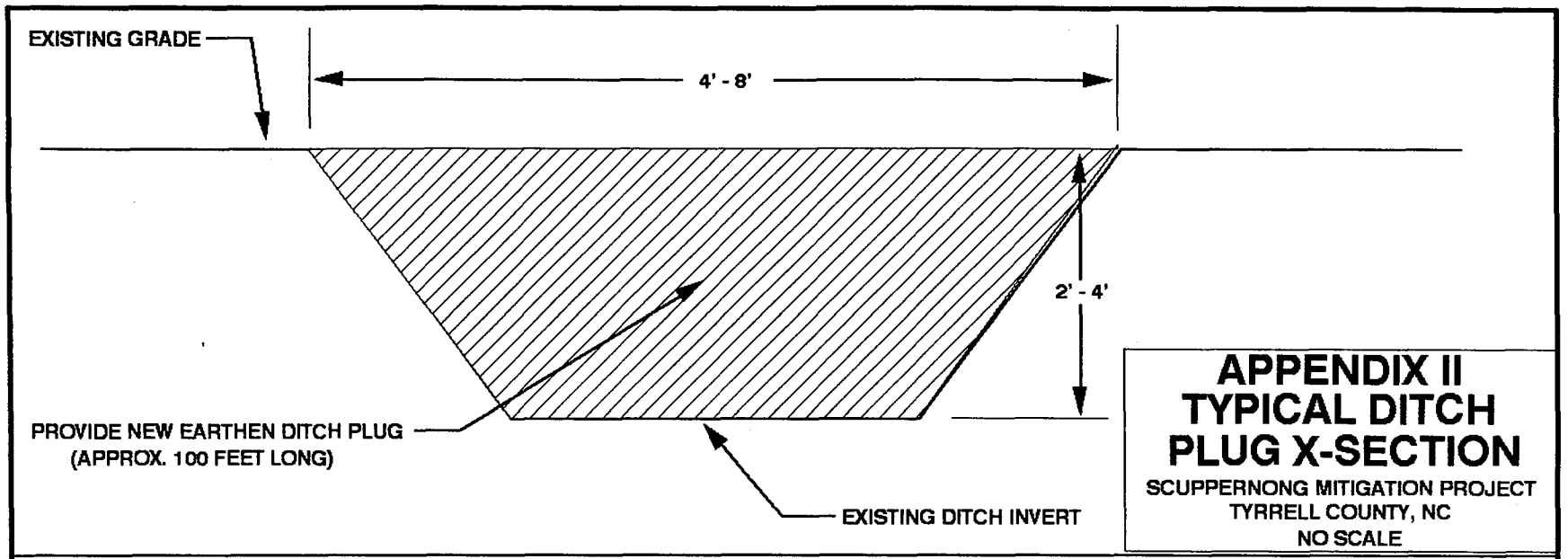
3. Describe **Erosion** Control Measures:
   NA

4. Describe management of **Human Impacts**:
   Project area is not currently gated. Adjacent owners are cooperating to prevent vandalism.

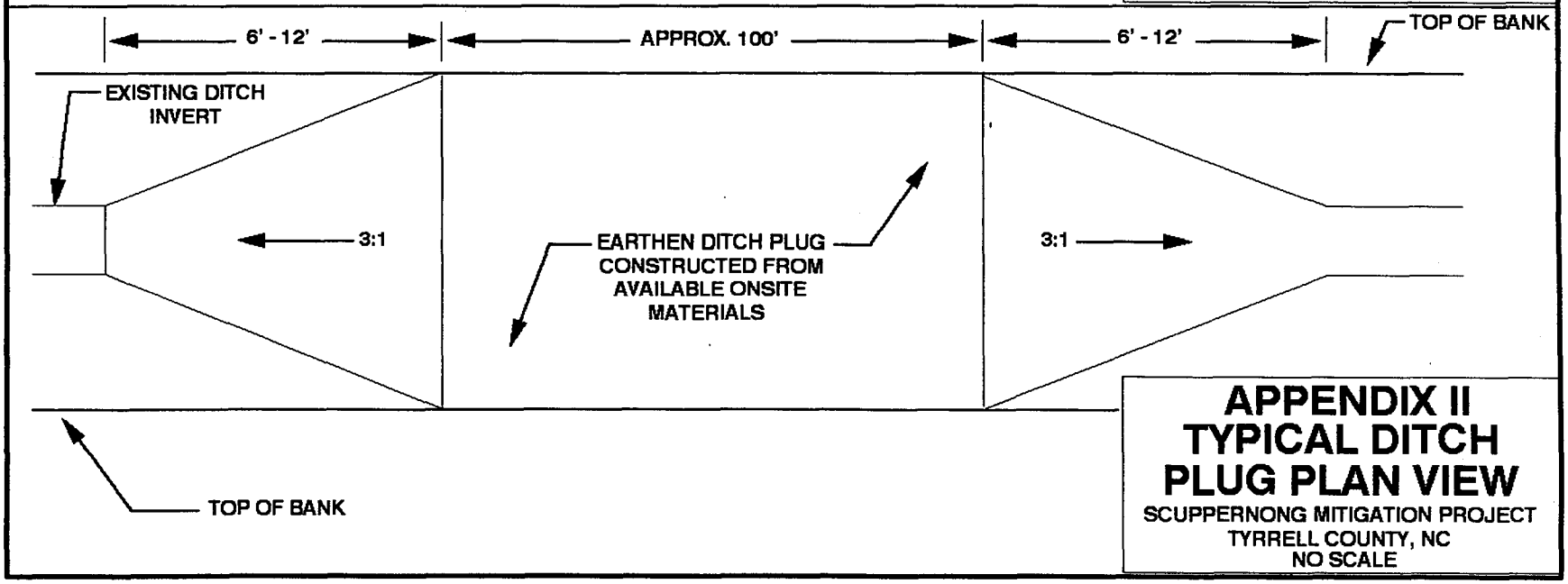
5. Describe management of **Herbivory/Noxious Plants**:
   Herbivory/noxious plants being monitored - no threat or problems after 2 years..

	YES	NO
B. Are there **Contingency Plans** built into the proposal to address these factors?	x	____

Appendix II



APPENDIX II
TYPICAL DITCH PLUG X-SECTION
SCUPPERNONG MITIGATION PROJECT
TYRRELL COUNTY, NC
NO SCALE



APPENDIX II
TYPICAL DITCH PLUG PLAN VIEW
SCUPPERNONG MITIGATION PROJECT
TYRRELL COUNTY, NC
NO SCALE

TRIANGLE
WETLAND CONSULTANTS

Post Office Box 33604
Raleigh, North Carolina 27636
Phone (919) 782-3792
Fax (919) 787-4999

SCUPPERNONG RIVER CORRIDOR MITIGATION BANK

TYRRELL COUNTY
COLUMBIA, NORTH CAROLINA

PRELIMINARY
HYDROLOGICAL MONITORING DATA

1994

Data are based on 3 shallow, slotted groundwater wells established during November, 1993. Wells are 4 ft. in length and placed at 30 inches below ground with 18 inches above ground level. All wells were sealed with benonite clay and included a top cap. Adjacent to each well, a 5 ft. iron rebar was placed to a 30 inch depth to measure oxidation depth. The 3 wells and rods were measured at 6 dates during March, April, and May, 1994. (See attached map showing well locations). No hydrological modifications have been done on this site.

DATE

Plot	March 8		March 13		March 20		Apr. 4		Apr. 24		May 8	
	1] well	2] rod	well	rod	well	rod	well	rod	well	rod	well	rod
A	12	10	12	10	12	12	14	12	14	13	17	14
B	4	4	3	3	8	8	8	4	9	6	8	5
C	4	4	3	3	8	8	8	4	9	6	8	5

1] surface to groundwater (inches)
2] surface to oxidation limit (inches)

TRIANGLE
WETLAND CONSULTANTS

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Raleigh, North Carolina 27636
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Fax (919) 787-4999

SCUPPERNONG RIVER CORRIDOR MITIGATION PROJECT

Tyrrell County
Columbia, North Carolina

HYDROLOGICAL MONITORING DATA

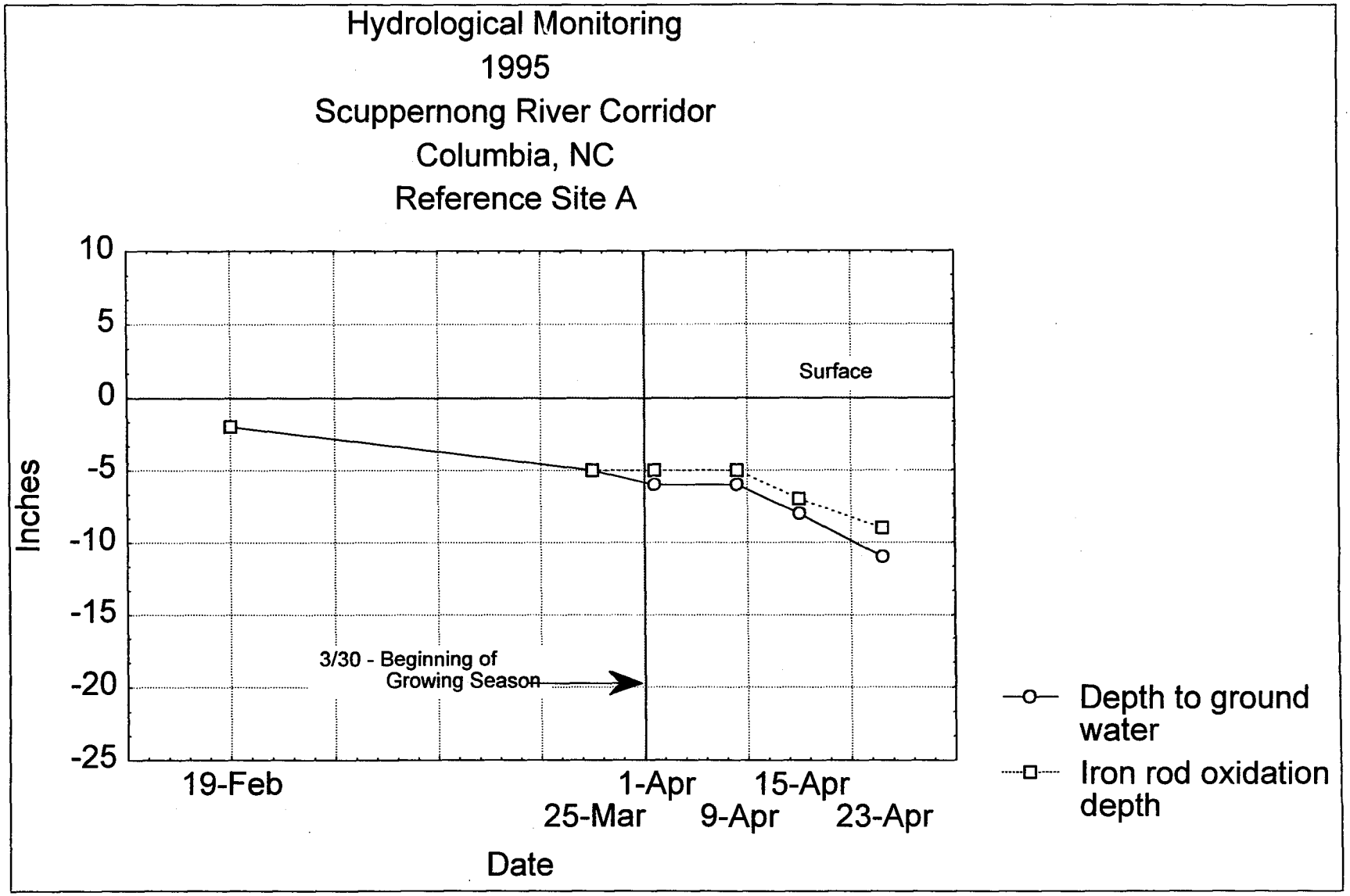
1995

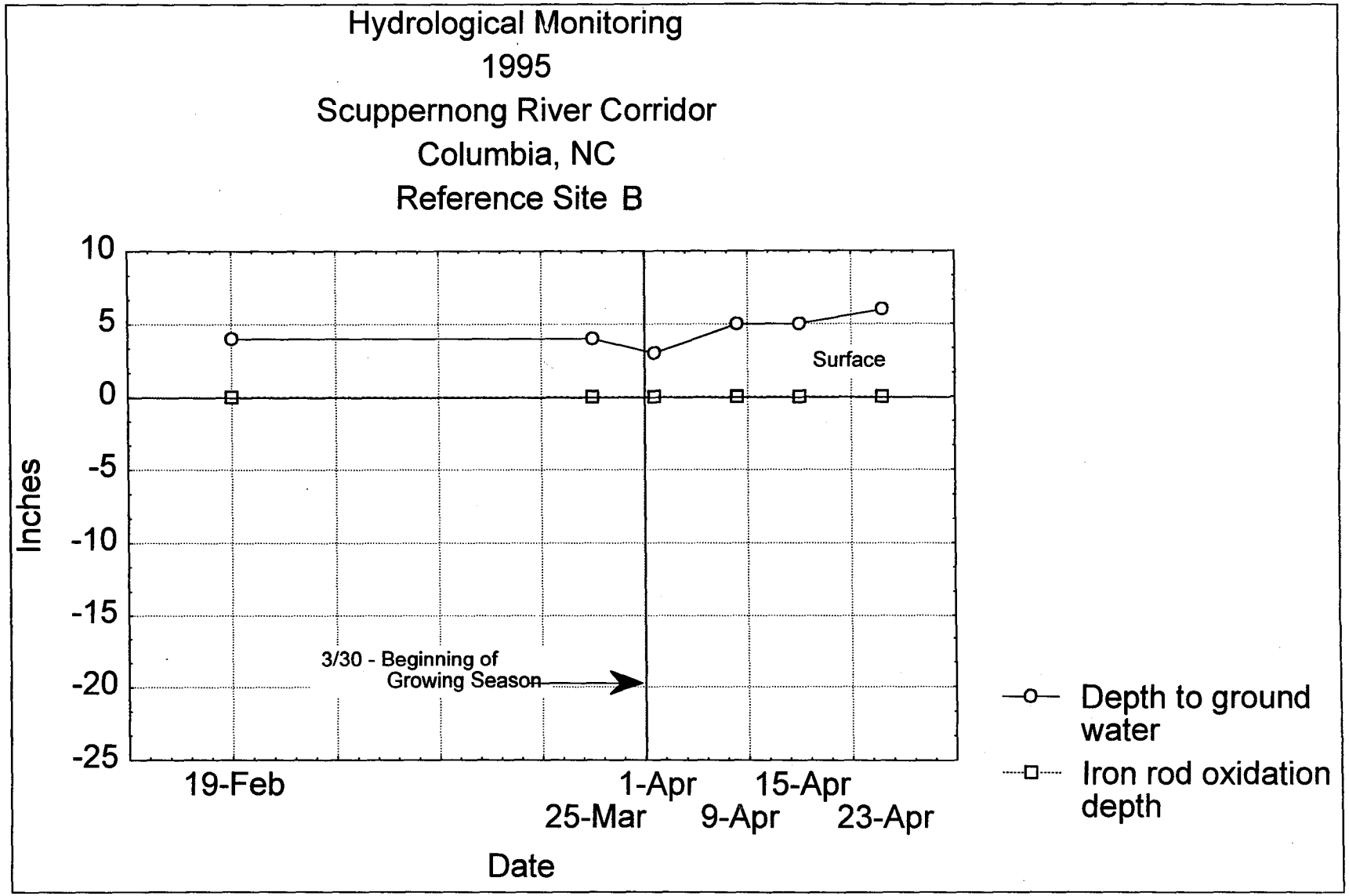
Data are based on 3 shallow, slotted groundwater wells established during November, 1993. Wells are 4 ft. in length and placed at 30 inches below ground with 18 inches above ground level. All wells were sealed with benonite clay and included a top cap. Adjacent to each well, a 5 ft. iron rebar was placed to a 30 inch depth to measure oxidation depth. The 3 wells and rods were measured at 6 dates during February, March, and April, 1995. No hydrological modifications have been done on this site.

DATE

Plot	Feb. 19		March 25		April 1		April 9		April 15		April 23	
	well [1]	rod [2]	well	rod	well	rod	well	rod	well	rod	well	rod
A	3	5	8	6	9	7	11	10	12	12	13	13
B	0	0	4	3	6	5	8	3	9	7	8	4
C	2	0	0	0	2	1	5	2	7	3	7	3
Ref. A	2	2	5	5	6	5	6	5	8	7	11	9
Ref. B	4	0	-4	0	-3	0	-5	0	-5	0	-6	0

1] surface to groundwater (inches)
2] surface to oxidation limit (inches)


Hydrological Monitoring
1995
Scuppernong River Corridor
Columbia, NC
Reference Site A
10
5
0
-5
-10
-15
-20
-25
Inches
Surface
3/30 - Beginning of
Growing Season
19-Feb
1-Apr
15-Apr
25-Mar
9-Apr
23-Apr
Date
Depth to ground water
Iron rod oxidation depth


Hydrological Monitoring
1995
Scuppernong River Corridor
Columbia, NC
Reference Site B
10
5
0
-5
-10
-15
-20
-25
Inches
Surface
3/30 - Beginning of
Growing Season
19-Feb
25-Mar
1-Apr
9-Apr
15-Apr
23-Apr
Date
Depth to ground water
Iron rod oxidation depth

TRIANGLE
WETLAND CONSULTANTS

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Fax (919) 787-4999

SCUPPERNONG RIVER CORRIDOR MITIGATION PROJECT

Tyrrell County
Columbia, North Carolina

HYDROLOGICAL MONITORING DATA

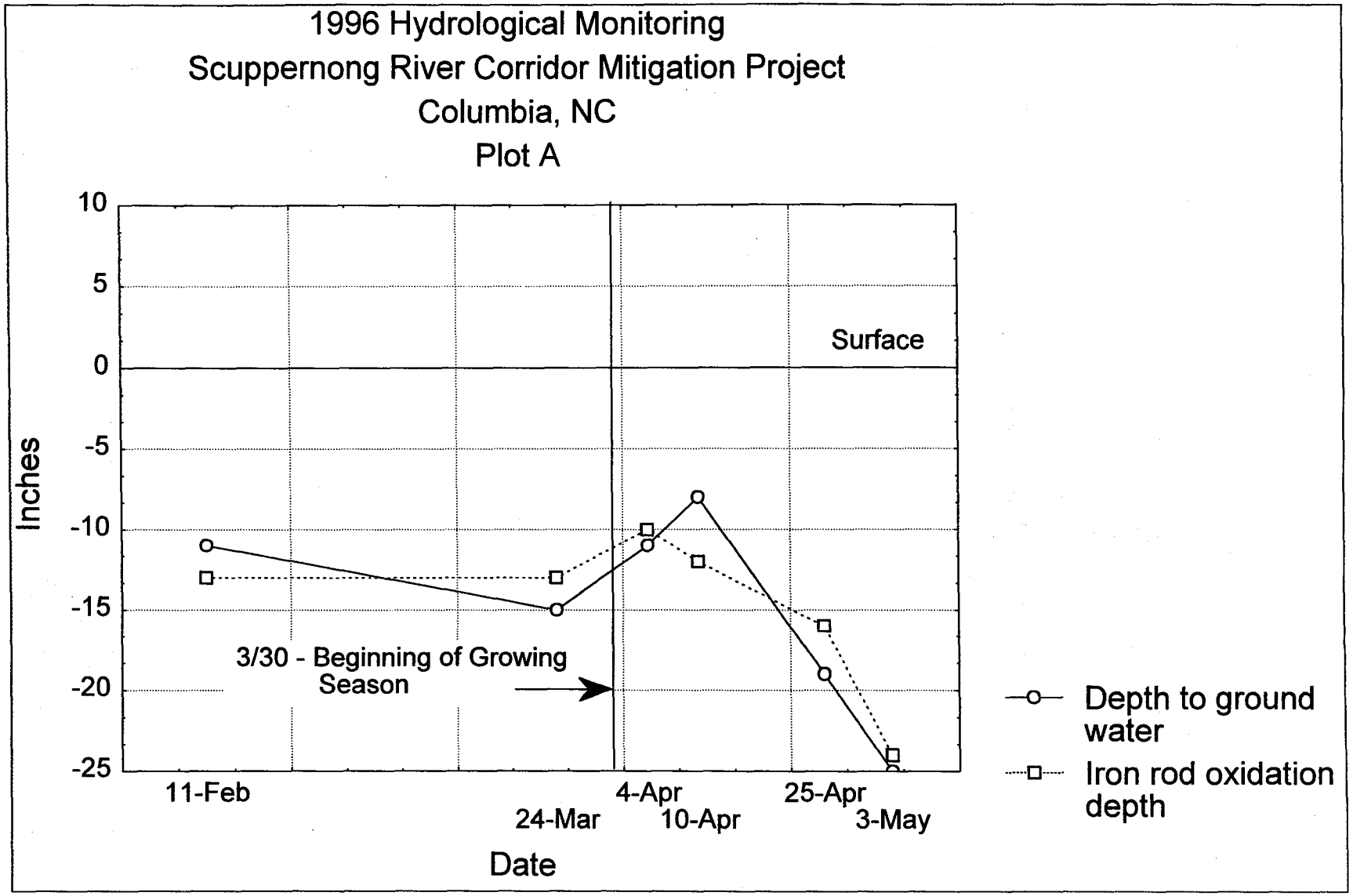
1996

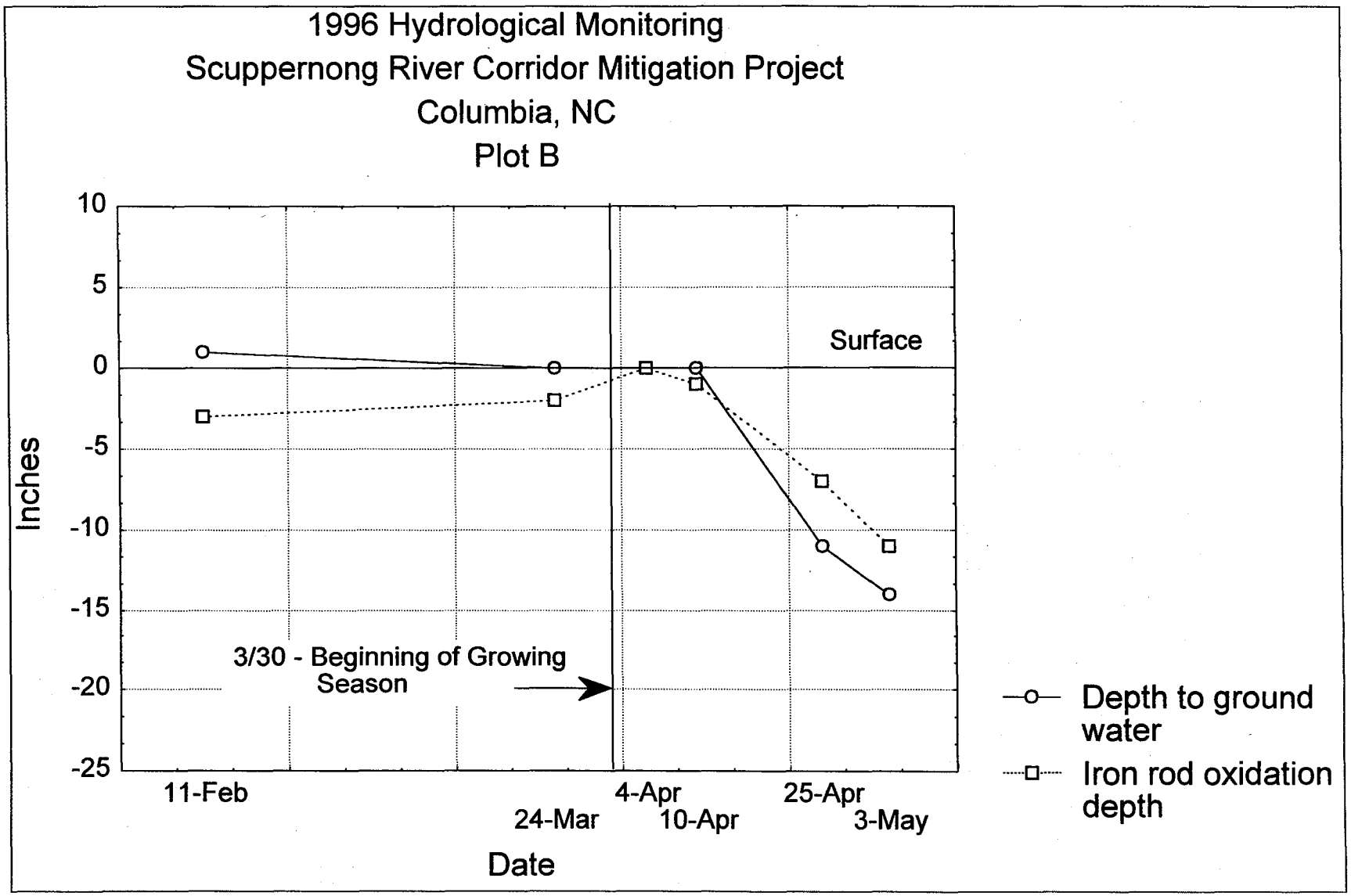
Data are based on 3 shallow, slotted groundwater wells established during November, 1993 (Figure 4). Wells are 4 ft. in length and placed at 30 inches below ground with 18 inches above ground level. All wells were sealed with benonite clay and included a top cap. Adjacent to each well, a 5 ft. iron rebar was placed to a 30 inch depth to measure oxidation depth. The 3 wells and rods were measured at 6 dates during February, March, April, and May, 1996. Ditch plugs were installed during April, 1996 (See page 8 - Proposed Actions - Hydrology, this report). Three (3) additional wells were installed during April , 1996. Data collection will begin during 1997.

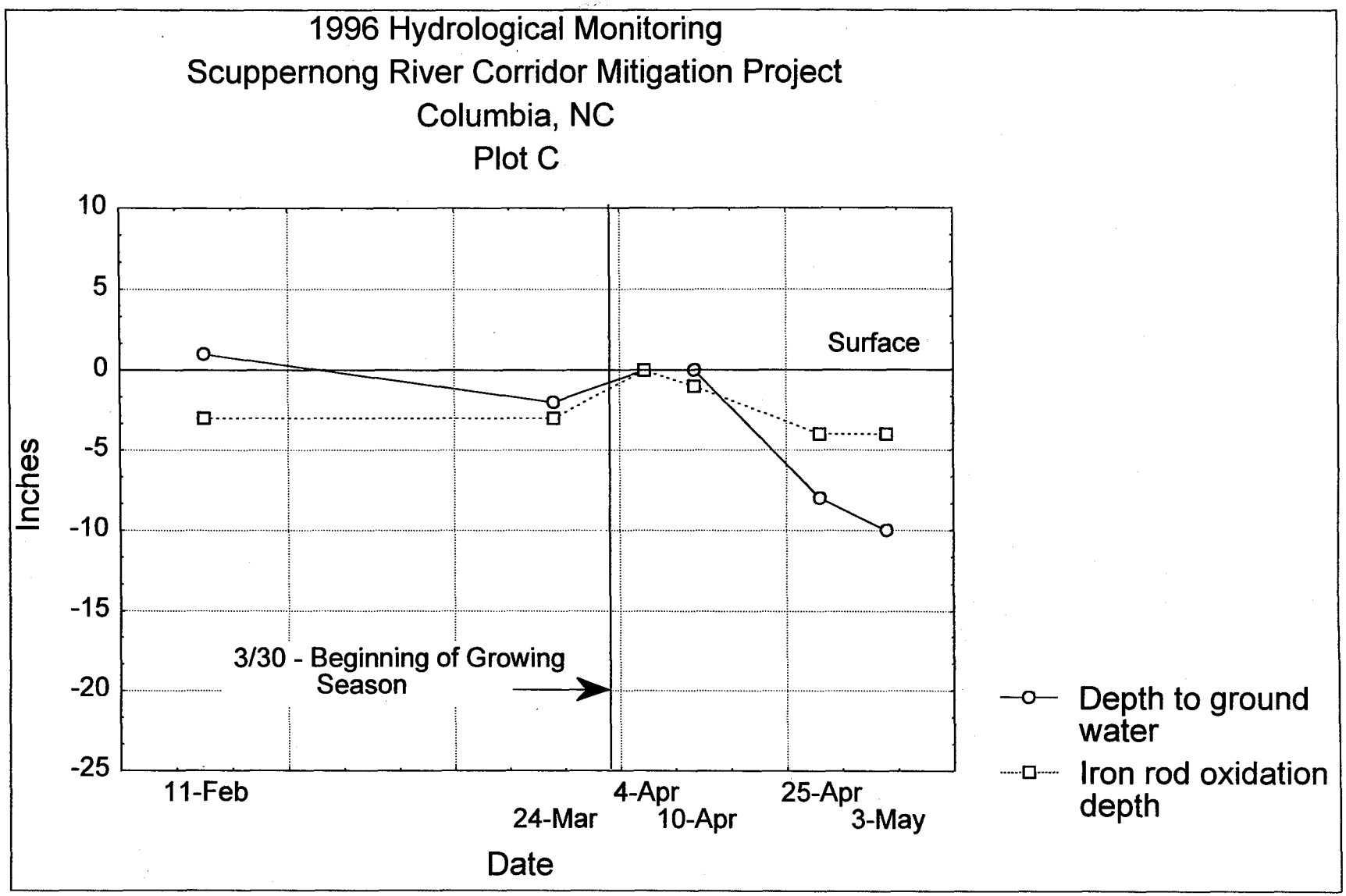
DATE

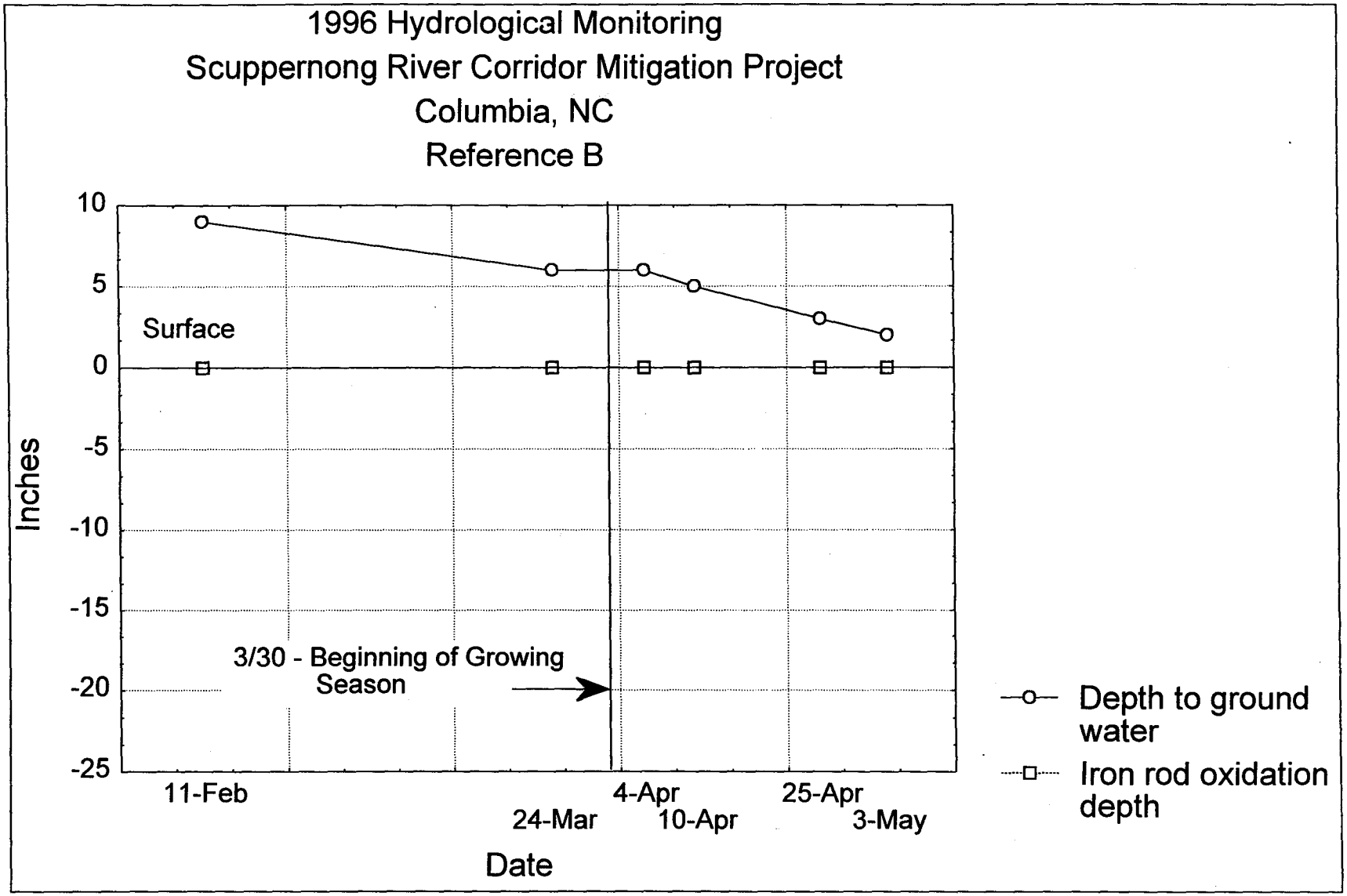
Plot	Feb. 11		March 24		April 4		April 10		April 25		May 3	
	well [1]	rod [2]	well	rod	well	rod	well	rod	well	rod	well	rod
A	11	13	15	13	11	10	8	12	19	16	25	24
B	-1	3	0	2	0	0	0	1	11	7	14	11
C	-1	3	2	3	0	0	0	1	8	4	10	4
Ref. A	0	1	2	4	7	10	11	10	10	11	11	13
Ref. B	-9	0	-6	0	-6	0	-5	0	-3	0	-2	0

1] surface to groundwater (inches)
2] surface to oxidation limit (inches)


1996 Hydrological Monitoring
Scuppernong River Corridor Mitigation Project
Columbia, NC
Plot A
Inches
10
5
0
-5
-10
-15
-20
-25
Surface
3/30 - Beginning of Growing Season
11-Feb
24-Mar
4-Apr
10-Apr
25-Apr
3-May
Date
Depth to ground water
Iron rod oxidation depth


1996 Hydrological Monitoring
Scuppernong River Corridor Mitigation Project
Columbia, NC
Plot B
10
5
0
-5
-10
-15
-20
-25
Inches
Surface
3/30 - Beginning of Growing Season
11-Feb
24-Mar
4-Apr
10-Apr
25-Apr
3-May
Date
Depth to ground water
Iron rod oxidation depth


1996 Hydrological Monitoring
Scuppernong River Corridor Mitigation Project
Columbia, NC
Plot C
Inches
10
5
0
-5
-10
-15
-20
-25
Surface
3/30 - Beginning of Growing Season
11-Feb
24-Mar
4-Apr
10-Apr
25-Apr
3-May
Date
Depth to ground water
Iron rod oxidation depth


1996 Hydrological Monitoring
Scuppernong River Corridor Mitigation Project
Columbia, NC
Reference B
10
5
0
-5
-10
-15
-20
-25
Inches
Surface
3/30 - Beginning of Growing Season
11-Feb
24-Mar
4-Apr
10-Apr
25-Apr
3-May
Date
Depth to ground water
Iron rod oxidation depth

Appendix III

U.S.D.A.
Soil Conservation Service

SCS-CPA-026
(5-89)

HIGHLY ERODIBLE LAND AND WETLAND CONSERVATION DETERMINATION

1. Name and Address of Person: Harry T Phelps Sr. Rt 2 Box 2A Creswell, NC 27928

2. Date of Request: 12-3-90

3. County: Tyrrell

4. Name of USDA Agency or Person Requesting Determination: ASCS

5. Farm No. and Tract No.: 740 T116, T224, T351, T352, T3 T10 12

SECTION 1 - HIGHLY ERODIBLE LAND

	Yes	No	Field No.(s)	Total Acres
6. Is soil survey now available for making a highly erodible land determination?	/			
7. Are there highly erodible soil map units on this farm?		/		
8. List highly erodible fields that, according to ASCS records, were used to produce an agricultural commodity in any crop year during 1981-1985.				
9. List highly erodible fields that have been or will be converted for the production of agricultural commodities and, according to ASCS records, were not used for this purpose in any crop year during 1981-1985; and were not enrolled in a USDA set-aside or diversion program.				

10. This Highly Erodible Land determination was completed in the : Office [/] Field [ ]

NOTE: If you have highly erodible cropland fields, you may need to have a conservation plan developed for these fields. For further information, contact the local office of the Soil Conservation Service.

SECTION II - WETLAND

	Yes	No	Field No.(s)	Total Wetland Acres
11. Are there hydric soils on this farm?	/			
List field number sand acres, where appropriate, for the following:				
12. Wetlands (W), including abandoned wetlands, or Farmed Wetlands (FW). Wetlands may be farmed under natural conditions. Farmed Wetlands may be farmed and maintained in the same manner as they were prior to December 23, 1985, as long as they are not abandoned.				
13. Prior Converted Wetlands (PC) - The use, management, drainage, and alteration of prior converted wetlands (PC) are not subject to FSA unless the area reverts to wetland as a result of abandonment. You should inform SCS of any area to be used to produce an agricultural commodity that has not been cropped, managed, or maintained for 5 years or more.			SCC 2C5-CPA-026A	
14. Artifical Wetlands (AW) - Artifical Wetlands includes irrigation induced wetlands. These Wetlands are not subject to FSA.				
15. Minimal Effect Wetlands (MW) - These wetlands are to be farmed according to the minimal effect agreement signed at the time the minimal effect determination was made.				
16. Converted Wetlands (CW) - In any year that an agricultural commodity is planted on these Converted Wetlands, you will be ineligible for USDA benefits. If you believe that the conversion was commenced before December 23, 1985, or that the conversion was caused by a third party, contact the ASCS office to request a commenced or third party determination.				

17. The planned alteration measures on wetlands in fields _____ are considered maintenance and are in compliance with FSA.

18. The planned alteration measures on wetlands in fields _____ are not considered to be maintenance and if installe will cause the area to become a Converted Wetland (CW). See item 16 for information on CW.

19. This wetland determination was completed in the : Office [/] Field [ ]

20. This determination was: Delivered [ ] Mailed [/] To the Person on Date: 12-14-90

NOTE: If you do not agree with this determination, you may request a reconsideration from the person that signed this form in Block 22 below. The reconsideration is a prerequisite for any further appeal. The request for the reconsideration must be in writing and must state your reasons for the request. The request must be mailed or delivered within 15 days after this determination is mailed to or otherwise made available to you. Please see reverse side of the producer's copy of this form for more information on appeals procedure.

NOTE: If you intend to convert additional land to cropland or alter any wetlands, you must initiate another Form AD-1026 at the local office of ASCS. Abandonment is where land has not been cropped, managed, or maintained for 5 years or more. You should inform SCS if you plan to produce an agricultural commodity on abandoned wetlands.

21. Remarks

22. Signature of SCS District Conservationist: Reid R. Ballance SCT

23. Date: 12-14-90

Assistance and programs of the Soil Conservation Service available without regard to race, religion, color, sex, age, handicap, etc.

ASCS Copy

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Services

SCS-CPA-026A
1-88

HIGHLY ERODIBLE LAND AND WETLAND CONSERVATION DETERMINATION
(Continuation Form)

1. NAME AND ADDRESS OF PERSON
Harry T Phelps, Sr
Rt -2 Box 2A
C Re.swell, NC. 27928

2. COUNTY Tyrrell
3. FARM NUMBER 740
4. SHEET 1 OF 1

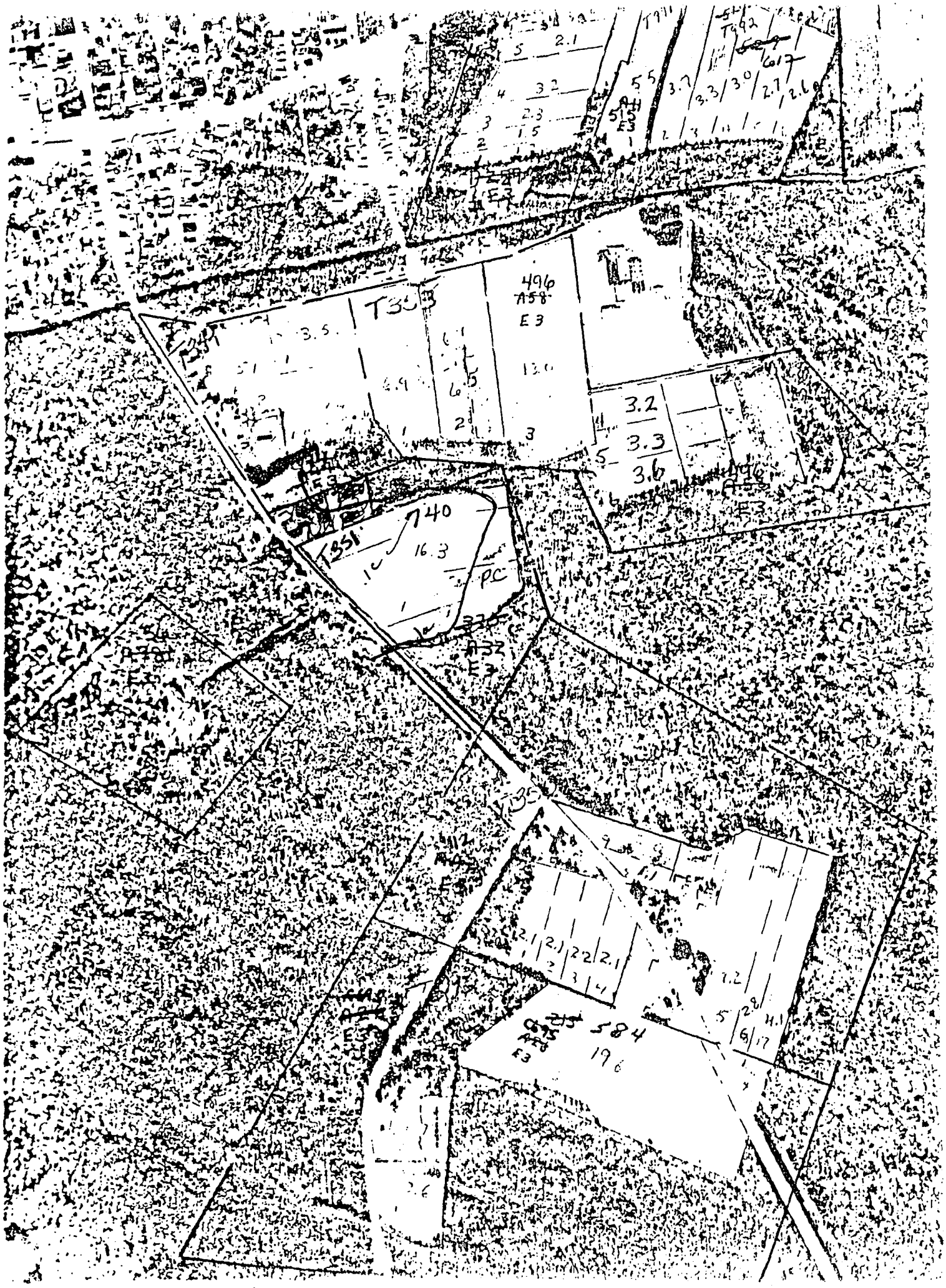
ITEM NUMBERS FROM SCS-CPA-026	TRACT NUMBER	FIELD NUMBERS																	ACRES (subtotal)[1]
13	116	1	2	3	4														13.1
	376	1	2	3															9.7
	351	1a	1c																17.5
	352	1	2	3	4	5	6	7	8										40.6
	1072	1	2	3	4	5	6	7	8										16.9
	224	7	8	9															8.7

REMARKS:

5. SIGNATURE OF SCS DISTRICT CONSERVATIONIST
Rudy R. Ballance SCT

6. DATE
12-11-90

[1] These acres need to be included in the totals on the parent SCS-CPA-026 form.


T35
496
A58
E3
3.5
13.0
3.2
3.3
3.6
740
16.3
T351
PC
A32
E3
584
19.6

Appendix IV

Appendix IV

Soils Report for Scuppernong River Corridor Mitigation Project

Soils developed at the Scuppernong Mitigation Bank consist of very poorly drained, nearly level soils formed in a broad flat area between Riders Creek and the Scuppernong River in north-central Tyrrell County, North Carolina. These soils have formed in Coastal Plain and stream sediments in the Scuppernong drainage basin. The seasonal high water table is strongly affected by elevated groundwater, and localized flooding during severe precipitation or wind tide events on Albelmarle Sound.

The soils at this location typically have a surface layer that is very dark gray fine sandy loam 8 inches thick. The subsoil extends to a depth of about 3 ft. and is characteristically a gray sandy clay loam in the upper part and a light brownish gray loam in the lower part. Permeability is moderately slow with virtually no shrink-swell potential. The mitigation area was artificially drained for agricultural production of corn and soybeans. The area originally was likely forested with a mixture of loblolly pine and swamp hardwoods.

The soil diagnostics below were performed using *SOIL TAXONOMY* with quantitatively defined features to differentiate between soil taxa.

SOIL PIT A

Ap 0 to 8 inches, dark grayish brown (10YR 4/2) sandy loam; weak medium subangular blocky structure; loose, nonsticky and nonplastic, many fine roots; thin coatings of organic matter on sand grains; acid; distinct, wavy boundary.

Bt 8 to 14 inches, pale brown matrix (10YR 6/3) sandy clay loam; common fine distinct light yellowish brown mottles (10 YR 6/4); moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; acid; abrupt smooth boundary.

Btg 14 to 38 inches, gray matrix (10YR 6/1) sandy clay loam; many coarse prominent yellowish brown mottles (10 YR 5/4); moderate medium subangular blocky structure, friable, slightly sticky and slightly plastic; acid; gradual smooth boundary.

Cg 38^{+} inches, light brownish gray matrix (10 YR 6/2) loamy sand; few fine faint mottles, massive structure, friable, nonsticky and nonplastic; acid

The soil was classified as a fine, mixed, thermic Aeric Ochraquult

SOIL PIT B

Ap 0 to 8 inches, dark gray (10 YR 4/1) sandy loam; weak medium subangular blocky structure; loose, nonsticky and nonplastic, many fine roots; thin coatings of organic matter on sand grains; acid; clear smooth boundary

Btg1 8 to 24 inches, light brownish gray matrix (10YR 6/2) sandy clay loam; few fine faint yellowish brown mottles (10 YR 5/6); weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; acid; gradual smooth boundary

Btg2 24 to 36 inches, gray matrix (10 YR 5/1) sandy clay loam; few medium faint yellowish brown mottles (10 YR 5/6); weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; acid; gradual smooth boundary

Cg 36^+ inches, light gray matrix (10 YR 7/1) sandy loam; few medium faint brownish yellow mottles (10 YR 6/6); massive structure; friable, nonsticky and nonplastic; acid

The soil was classified as a fine-loamy, mixed, thermic Typic Ochraquult

SOIL PIT C

Ap 0 to 8 inches, dark gray matrix (10 YR 4/1) fine sandy loam; weak fine granular structure; loose, nonsticky and nonplastic, many fine roots; thin coatings of organic matter on sand grains; acid; clear smooth boundary

Btg1 8 to 15 inches, gray matrix (10 YR 5/1) sandy clay loam; few medium distinct yellowish brown mottles (10 YR 5/6); moderate coarse subangular blocky structure; friable, slightly sticky and slightly plastic; acid; gradual smooth boundary

Btg2 15 to 34 inches, gray matrix (10 YR 5/1) sandy clay loam; few coarse distinct brownish yellow mottles (10 YR 6/6); moderate coarse subangular blocky structure; friable, slightly sticky and slightly plastic; acid; gradual smooth boundary

Cg 34^{+} inches, gray matrix (10 YR 6/1) sandy loam; few coarse distinct light yellowish brown mottles (10 YR 6/4); massive structure; friable, slightly sticky and nonplastic; acid

The soil was classified as a fine-loamy, mixed, thermic Typic Ochraquult

Soil Test Summary

Scuppernong River Corridor Mitigation Site
and
Forested Wetland Reference Areas

Dr. C.B. Davey, Soil Scientist

February, 1996

Three soil cores were collected at permanent sampling points at the Scuppernong River Corridor Mitigation site and two cores at the adjacent reference sites. These cores were submitted to the NC Department of Agriculture, Agronomic Division for analysis. Results were returned on December 19, 1994.

Restoration Site:
All cores collected at the banking site showed no major deficiencies in macro or micro nutrients. The only macronutrient that would be considered present in low amounts is K. Based on this analysis, this site is well suited for growing hardwood trees and reflects a past history of fertilization and liming while agricultural crops were being grown on the site.

Reference Areas:
The reference sites are deficient in most macronutrients, micronutrients, and have low pH values. These sites have always been in forest and have not had the benefit of fertilizer and lime additions in the past.

SOIL TEST REPORT

AGRONOMIC DIVISION, N.C. DEPT. OF AGRICULTURE
4300 REEDY CREEK ROAD
RALEIGH, N.C. 27607-6465

PHONE: (919) 733-2655

COPIES SENT TO:
X COUNTY EXTENSION DIRECTOR

REPORT NO.14904

12/19/94

11.$

TO: FREDERICK, D. J.
4405 DEWEES CT
RALEIGH NC 27612-

FARM LOCATION (COUNTY): TYRRELL

SERVING N.C. CITIZENS FOR OVER 50 YEARS

FIELD INFORMATION / TEST RESULTS *

SAMPLE NO	PREVIOUS CROP	APPLIED LIME Mo.	APPLIED LIME Yr.	APPLIED LIME T/A	FERT. LAST CROP P_2O_5	FERT. LAST CROP K_2O	SOIL CLASS	HM-%	W/V	CEC	BS-%	Ac	pH	P-I	K-I	Ca-%	Mg-%	Mn-I	Zn-I	Cu-I	S-I	SS-I	NO_3N	NH_4N	Na
100							MIN	0.6	1.10	3.3	64	1.2	5.2	166+	14	51.7	9.7	30	(020) 020	30					

SUGGESTED TREATMENT FOR FIRST CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE
HARDWOOD M	0.3T	80-120	0	040-060	$	0	$			11

SUGGESTED TREATMENT FOR SECOND CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE
HARDWOOD M	0.0	80-120	0	040-060	$	0	$			11

FIELD INFORMATION / TEST RESULTS *

SAMPLE NO.	PREVIOUS CROP	APPLIED LIME Mo.	APPLIED LIME Yr.	APPLIED LIME T/A	FERT. LAST CROP P_2O_5	FERT. LAST CROP K_2O	SOIL CLASS	HM-%	W/V	CEC	BS-%	Ac	pH	P-I	K-I	Ca-%	Mg-%	Mn-I	Zn-I	Cu-I	S-I	SS-I	NO_3N	NH_4N	Na
200							MIN	1.1	1.20	4.0	70	1.2	5.2	166+	10	59.6	9.4	111	(030) 030	82					

SUGGESTED TREATMENT FOR FIRST CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE
HARDWOOD M	0.3T	80-120	0	050-070	$	0	0			11

SUGGESTED TREATMENT FOR SECOND CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE
HARDWOOD M	0.0	80-120	0	050-070	$	0	0			11

FIELD INFORMATION / TEST RESULTS *

SAMPLE NO.	PREVIOUS CROP	APPLIED LIME Mo.	APPLIED LIME Yr.	APPLIED LIME T/A	FERT. LAST CROP P_2O_5	FERT. LAST CROP K_2O	SOIL CLASS	HM-%	W/V	CEC	BS-%	Ac	pH	P-I	K-I	Ca-%	Mg-%	Mn-I	Zn-I	Cu-I	S-I	SS-I	NO_3N	NH_4N	Na
300							MIN	1.1	1.16	2.8	58	1.2	5.0	021	12	42.3	13.4	6	(010) 010	20					

SUGGESTED TREATMENT FOR FIRST CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE
HARDWOOD M	0.4T	80-120	020-040	040-060	0	$	$			11

SUGGESTED TREATMENT FOR SECOND CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE
HARDWOOD M	0.0	80-120	020-040	040-060	0	$	$			11

FIELD INFORMATION / TEST RESULTS *

SAMPLE NO.	PREVIOUS CROP	APPLIED LIME Mo.	APPLIED LIME Yr.	APPLIED LIME T/A	FERT. LAST CROP P_2O_5	FERT. LAST CROP K_2O	SOIL CLASS	HM-%	W/V	CEC	BS-%	Ac	pH	P-I	K-I	Ca-%	Mg-%	Mn-I	Zn-I	Cu-I	S-I	SS-I	NO_3N	NH_4N	Na
400							MIN	1.1	0.97	5.1	69	1.6	4.9	132	32	49.2	16.1	24	(035) 035	40					

SUGGESTED TREATMENT FOR FIRST CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE
HARDWOOD M	0.6T	80-120	0	010-030	0	0	0			11

SUGGESTED TREATMENT FOR SECOND CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE
HARDWOOD M	0.0	80-120	0	010-030	0	0	0			11

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SUGGESTED TREATMENT FOR FIRST CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE

SUGGESTED TREATMENT FOR SECOND CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE

* TEST RESULTS (N.C. tests will not compare directly to numbers obtained by other methods.)

Soil Class: MIN = Mineral
M-O = Mineral-Organic
ORG = Organic
HM-% = Humic Matter, Percent by vol.
W/V = Weight per Volume, g/cm³
CEC = Cation Exch. Cap., meq/100 cm³
BS-% = Base Saturation, % of CEC
Ac = Acidity, meq/100 cm³
pH = Hydrogen-ion Activity
P-I = Phosphorus Index
K-I = Potassium Index
Ca-% = Calcium, % of CEC
Mg-% = Magnesium, % of CEC
Mn-I = Manganese Index
Zn-I = Zinc Index
Cu-I = Copper Index
S-I = Sulfate Sulfur Index
SS-I = Soluble Salt Index
NO_3N = Nitrate N, mg/dm³
NH_4N = Ammonium N, mg/dm³
Na = Sodium, meq/100 cm³

** TREATMENT, lbs/a unless specified

LIME: T = tons a, M = lbs./1000 sq. ft.
N = Nitrogen, M = lbs./1000 sq. ft.
P_2O_5 = Phosphate, M = lbs./1000 sq. ft.
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Mg = Magnesium
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B = Boron
Mn = Manganese

$ Test Level is questionable. See supplemental material.

READ SUPPLEMENTAL MATERIAL AND BACK OF REPORT FOR FURTHER DETAIL

SOIL TEST REPORT

AGRONOMIC DIVISION, N.C. DEPT. OF AGRICULTURE
4300 REEDY CREEK ROAD
RALEIGH, N.C. 27607-6465

PHONE: (919) 733-2655

COPIES SENT TO:
X COUNTY EXTENSION DIRECTOR

REPORT NC-21409

03/07/95

11,$

TO: FREDERICK, DOUGLAS
4405 DEWEES CT
RALEIGH NC 27612-

FARM LOCATION (COUNTY): TYRRELL

SERVING N.C. CITIZENS FOR OVER 50 YEARS

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10S	HARDWOOD M						MIN	2.2	0.71	6.8	41	4.0	4.8	028	60	23.5	13.5	25	(061) 061	40					

SUGGESTED TREATMENT FOR FIRST CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE
HARDWOOD M	1.6T	80-120	010-030	0	0	0	0			11

SUGGESTED TREATMENT FOR SECOND CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE

FIELD INFORMATION / TEST RESULTS *

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20U	HARDWOOD M						MIN	2.5	0.90	4.9	27	3.6	4.3	010	18	8.1	17.0	21	(022) 022	14					

SUGGESTED TREATMENT FOR FIRST CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE
HARDWOOD M	1.9T	80-120	050-070	030-050	0	$	$			11

SUGGESTED TREATMENT FOR SECOND CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE

FIELD INFORMATION / TEST RESULTS *

SAMPLE NO.	PREVIOUS CROP	APPLIED LIME Mo.	APPLIED LIME Yr.	APPLIED LIME T/A	FERT. LAST CROP P_2O_5	FERT. LAST CROP K_2O	SOIL CLASS	HM-%	W/V	CEC	BS-%	Ac	pH	P-I	K-I	Ca-%	Mg-%	Mn-I	Zn-I	Cu-I	S-I	SS-I	NO_3N	NH_4N	Na

SUGGESTED TREATMENT FOR FIRST CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE

SUGGESTED TREATMENT FOR SECOND CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE

FIELD INFORMATION / TEST RESULTS *

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SUGGESTED TREATMENT FOR FIRST CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE

SUGGESTED TREATMENT FOR SECOND CROP (OR YEAR) **

CROP TO BE GROWN	LIME	N	P_2O_5	K_2O	Mg	Cu	Zn	B	Mn	SEE NOTE

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Cu-I = Copper Index
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Mg = Magnesium
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Zn = Zinc
B = Boron
Mn = Manganese

$ Test Level is questionable. See supplemental material.

Appendix V

TRIANGLE
WETLAND CONSULTANTS

Post Office Box 33604
Raleigh, North Carolina 27636
Phone (919) 782-3792
Fax (919) 787-4999

Establishment Report

Scuppernong River Corridor
Mitigation Bank
Tyrrell County
Columbia, North Carolina

March 24, 1993

On March 7 and 17, 1993, a forested wetland planting consisting of bottomland hardwoods and red maple/cypress wetland types was esablished on a 16 acre, prior converted (PC) field, one-half mile south of Columbia, NC on Highway 94. (See attached map) The tract is part of a 38 acre parcel formerly owned by the H.T. Phelps estate and presently owned by D. J. Frederick. The tract borders a 25 acre mitigation planting to the north owned by the State of North Carolina.

Species Description, Status and Quantity:

Trees		Status	Quantity
Quercus nigra/phellos	Water-willow oak	FAC/FACW	2500
Taxodium distichum	Bald cypress	OBL	1700
Cupressus thyoides	Atlantic white cedar	OBL	1500
Betula nigra	River birch	FACW	1250
Pinus serotina	Pond pine	FACW	800
Fraxinus pennsylvanica	Green ash	FACW	700
Acer rubrum	Red maple	FACW	700
Platanus occidentalis	Sycamore	FAC	600
Liquidambar styraciflua	Sweetgum	FAC	500
Diospyris virginiana	Persimmon	FAC	400
Morus rubra	Red mulberry	FAC	400
Quercus michauxii	Swamp chestnut oak	FACW	375
Celtis laevigata	Sugarberry	FACW	140
Juglans nigra	Black walnut	FACU	40
		Subtotal:	11605

Shrubs		Status	Quantity
Alnus serrulata	Hazel alder	OBL	350
Ilex cassine	Dahoon holly	FACW	200
Cephalanthus occidentalis	Buttonbush	FACW	140
Cornus florida	Dogwood	FACU	40
Cercis canadensis	Redbud	FACU	40
Crataegus spp.	Hawthorne	OBL	20
Prunus augustifolia	Chickasaw plum	FACU	20
		Subtotal:	845
		Total:	12450

Spacing and Area:

Atlantic white cedar	- 6 x 6 ft	1.25 acres
All other species	- 6 x 10 ft	14.75 acres

Weather:

Partly cloudy and cool, 55°F light winds

Site Conditions:

Disked within past year, currently fallow, saturated soils, standing water in ditches.

Planting Specifics:

Specific planting areas for each species and mixtures were determined through site analysis of soils, hydrology and comparison with adjacent forest. Species mixtures were determined from samples of natural bottomland hardwood and swamp hardwood habitat types. Planting was done by hand with a 7 man crew using hodads and planting dibbles. All seedling mixtures were pre-packaged at the nursery and stored in Kraft bags prior to planting and transferred to hip bags during planting. Seedling roots were spray protected with Hydro-Gel during packaging and all Kraft bags were sealed with tape or steel banding.

TRIANGLE
WETLAND CONSULTANTS

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SCUPPERNONG RIVER CORRIDOR

MITIGATION BANK

TYRRELL COUNTY, NORTH CAROLINA

Supplemental Planting
March, 1994

Species, Description, Status, and Quantity:

Trees	Status	Quantity
Quercus pagodifolia - Cherrybark oak	FACW	2,000
Nyssa sylvatica var.biflora - Swamp blackgum	OBL	600
Taxodium distichum - Cypress	OBL	500
Platanus occidentalis - Sycamore	FACW	500
	Subtotal:	3,600

Shrubs		
Alnus serrulata - Hazel alder	OBL	500
Persea borbonia - Red bay	FACW	400
Gordonia lasianthus - Loblolly bay	FACW	400
Lindera benzoine - Spicebush	FACW	300
Cephalanthus occidentalis - Buttonbush	OBL	300
Ilex cassine - Dahoon holly	FACW	300
Diospyros virginiana - Persimmon	FAC	300
Baccharis halimifolia - Baccharris	FAC	200
Myrica cerifera - Waxmyrtle	FAC	200
	Subtotal:	2,900
	Total:	**6,500**

Appendix VI

Tyrrell County Mitigation Project
Bottomland Hardwoods
Reference Stand Inventory

July 6, 1992

Stand Location : Approximately 200 feet southeast of the culvert on the south drainage ditch at the end of the 60 foot right-of-way areas

Overstory Trees

Species	Diameter (inches)	Species	Diameter (inches)
RM	2.4	R. Bay	1.8
RM	1.0	R. Bay	10.6
SG	10.5	RM	3.4
BG	11.0	SG	9.0
BG	2.1	RM	1.9
BG	2.3	SG	4.6
RM	1.4	R. Bay	2.2
RM	1.8	RM	5.6
RM	2.0	BG	9.3
RM	3.0	BE	3.5
WO	18.8	SG	4.5
BG	4.2	R. Bay	2.3
LOB	17.0	R. Bay	3.5
L. Bay	4.3	WO	16.1
BG	4.2	BG	12.7
LOB	17.0	SCO	2.1
L. Bay	4.3	R. Bay	1.0
BG	3.8	R. Bay	2.2
BG	3.0	R. Bay	1.0
R. Bay	3.0	BG	10.0
RM	2.0	SG	3.7
RM	1.0	RM	4.2
SCO	14.6	RM	4.2
WO	12.3	RM	12.5
BG	3.2	SG	5.7
SG	10.9	SG	4.8
RM	3.6		
RM	4.2		
Holly	2.1		
RM	7.9		
SCO	4.3		
R. Bay	1.7		
R. Bay	2.5		
SG	7.6		
R. Bay	2.3		
BE	2.0		
RM	1.8		
RM	2.2		

L. Bay	Loblolly bay *Gordonia lassianthus*
WO	Water oak *Quercus phellos*
Holly	*Ilex opaca*
BE	Beech *Fagus grandifolia*
R. Bay	Red bay *Persea borbonia*
SCO	Swamp chestnut oak *Quercus michauxii*
BG	Black gum *Nyssa sylvatica var. biflora*
RM	Red maple *Acer rubrum*
SG	Sweetgum *Liquidambar syraciflua*
LOB	Loblolly pine *Pinus taeda*

Tyrrell County Mitigation Project
Bottomland Hardwoods
Reference Stand Inventory

July 6, 1992

Understory

	Average Coverage (%)
Shrubs/Trees	
Quercus phellos	< 5 %
Acer rubrum	< 5 %
Lyonia lucida	< 5 %
Symplocos tinctoria	< 5%
Ilex coriacea	< 5 %
Vaccinium corymbosum	< 5 %
Herbaceous	
Arundinaria gigantea	15-25 %
Woodwardia areolata	5-15 %
Osmunda cinnamomi	< 5 %
Mitchella repens	< 5 %
Sphagnum spp.	< 5 %
Vines	
Toxicodendron radicans	< 5 %
Vitus rotundifolia	< 5 %

Tyrrell County Mitigation Project
Reference Black Gum/Red Maple Stand Inventory

July 6, 1992

Stand Location : Approximately 300 feet southwest of the southern plantation border and connection to the natural blackgum/red maple swamp.

Overstory Trees

Species	Diameter (inches)	Species	Diameter (inches)	Species	Diameter (inches)
RM	1.0	BG	3.8	BG	10.8
RM	2.8	BG	4.6	RM	10.0
RM	8.5	RM	1.6	BG	8.6
RM	3.0	BG	7.8	RM	1.0
RM	1.0	RM	3.2	SG	3.2
RM	1.9	RM	3.4	BW	12.8
RM	1.0	LOB	11.0	BW	11.2
RM	1.0	RM	6.5	BG	5.2
RM	1.0	RM	3.9	BG	10.2
SG	13.0	RM	1.0	RM	2.3
SG	6.1	RM	1.0	RM	1.0
RM	1.0	RM	1.8	RM	1.0
RM	2.0	RM	4.0	SG	9.8
BG	8.5	RM	2.1	RM	8.0
RM	2.0	BG	12.0	RM	1.0
SG	3.0	BG	9.0	RM	1.7
RM	7.0	BG	5.2	RM	1.0
RM	9.5	BG	7.8	RM	1.3
RM	3.0	RM	4.2		
LOB	6.7	BG	6.4		
RM	6.3	BG	4.8		
RM	2.5	BG	3.2		
RM	1.0	BG	1.0		
RM	1.0	BG	2.0		
RM	1.0	BG	2.2		
BG	5.8	BG	2.8		
RM	2.8	BG	4.1		
BG	6.7	BG	2.3		
BG	4.2	BG	3.2		
BW	10.5	BG	7.6		
RM	4.6	BG	4.3		
BG	4.6	BG	3.6		
RM	6.0	BG	2.9		
RM	3.0	BG	6.9		
RM	2.3	LO	3.6		
BG	2.0	RM	1.8		
BG	9.8	BG	11.5		
BG	5.6	BG	13.4		
BG	6.0	WO	2.4		
BG	1.8	SG	5.1		

RM	Red maple *A. rubrum*
SG	Sweetgum *L. styraciflua*
LOB	Loblolly pine *P. taeda*
BG	Black gum *Nyssa sylvatica var. biflora*
BW	Black willow *Salix nigra*
LO	laurel oak *Q. laurifolia*
WO	Water oak *Q. nigra*

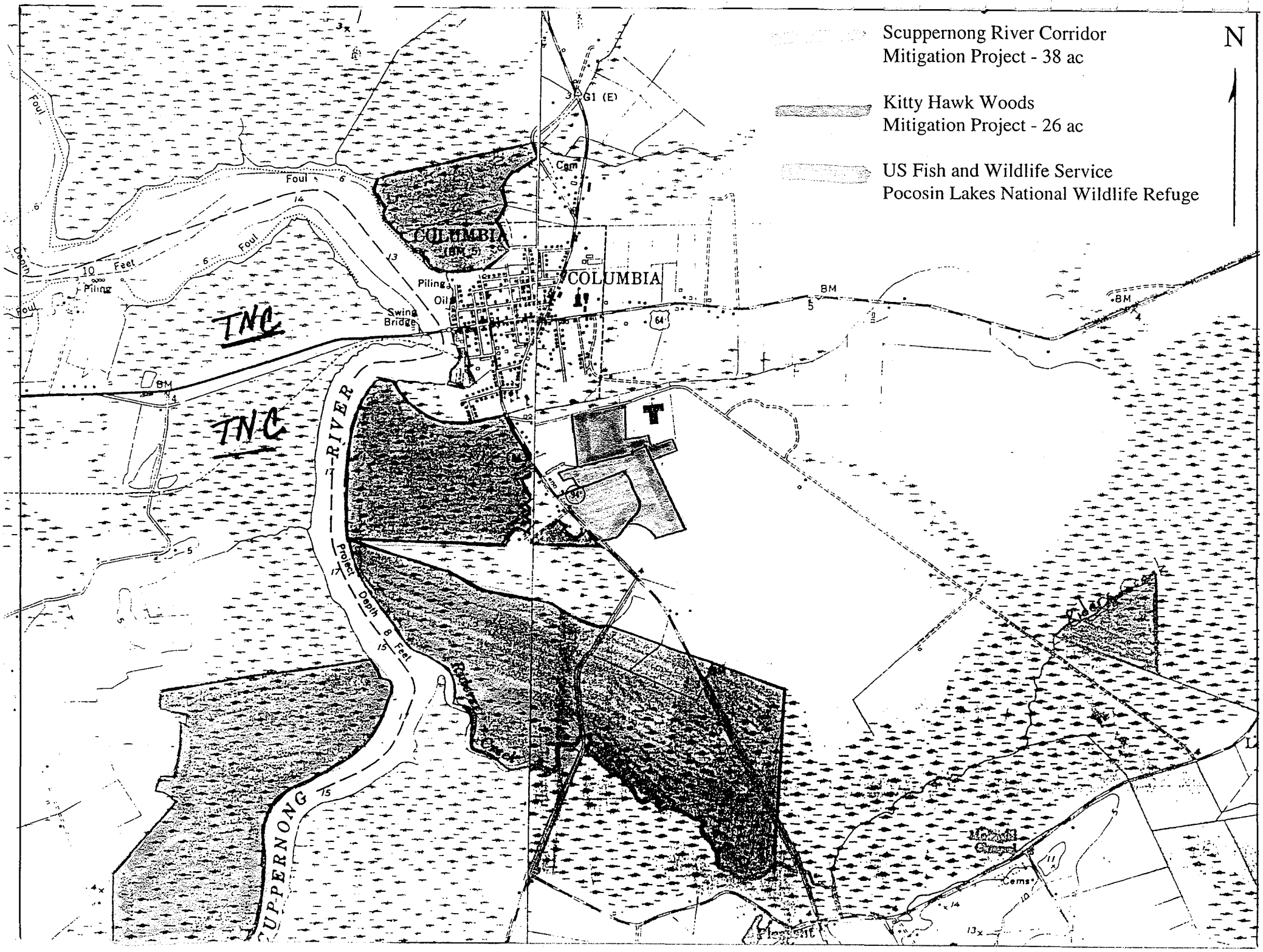
Tyrrell County Mitigation Project
Reference Black Gum/Red Maple Stand Inventory

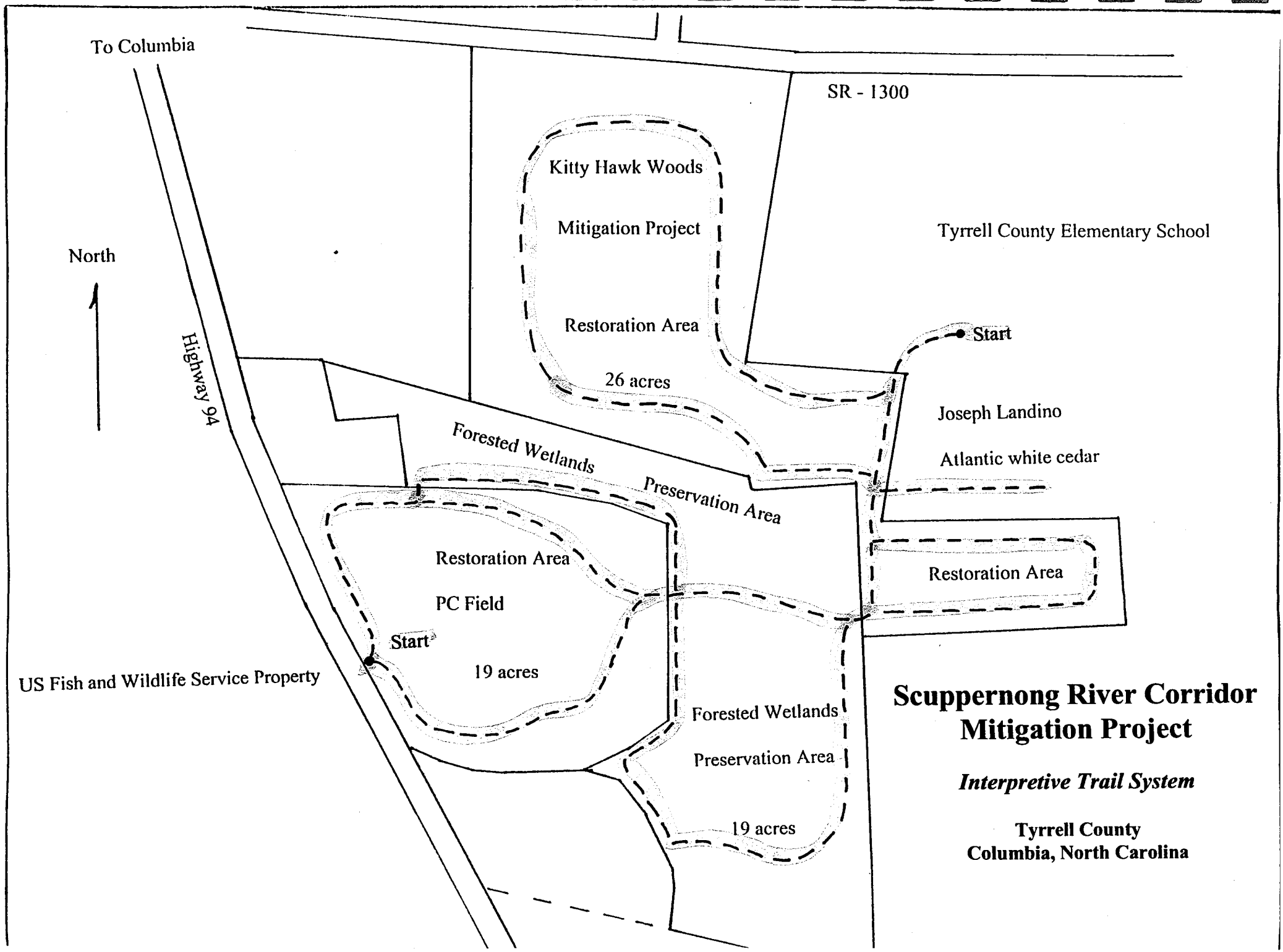
July 6, 1992

Understory

	Average Coverage (%)
Shrubs/Trees	
Acer rubrum	< 5 %
Ilex opaca	< 5 %
Myrica cerifera	< 5 %
Herbaceous	
Woodwardia areolata	< 5 %
Vines	
Smilax rotundifolia	< 5 %
Vitus rotundifolia	< 5 %

Appendix VII


Scuppernong River Corridor
Mitigation Project - 38 ac
Kitty Hawk Woods
Mitigation Project - 26 ac
US Fish and Wildlife Service
Pocosin Lakes National Wildlife Refuge
N
COLUMBIA
COLUMBIA
TNC
TNC
SCUPPERNONG RIVER
Project Depth 8 Feet
Foul
10 Feet
Piling
Oil
Swing Bridge
BM
Cem
G1 (E)
64
Cems


To Columbia
SR - 1300
Kitty Hawk Woods
Mitigation Project
Restoration Area
26 acres
Tyrrell County Elementary School
North
Highway 94
Start
Joseph Landino
Atlantic white cedar
Forested Wetlands
Preservation Area
Restoration Area
Restoration Area
PC Field
Start
19 acres
US Fish and Wildlife Service Property
Forested Wetlands
Preservation Area
19 acres
Scuppernong River Corridor
Mitigation Project
Interpretive Trail System
Tyrrell County
Columbia, North Carolina

PARTNERSHIP FOR THE SOUNDS

P.O. BOX 55
919-796-1000
COLUMBIA, NC 27925

August 2, 1994

Drs. Douglas Frederick and Russ Lea
Triangle Wetland Consultants
PO Box 33604
Raleigh, NC 27636

On behalf of the Board of Directors, I want to thank you for the time and materials that you have shared with me. The recovered wetland is a great resource both for mitigation and as an educational asset. It is especially nice to have the site so close to our schools and the future site of the Walter B. Jones Center for the Sounds. We plan to establish a trail system both on the site and through some natural wetlands and use it for primary and secondary instruction. It also fits well with our plans to develop alternative economic opportunities in the region.

We heartily endorse your project and hope to see more wetland restoration in the future. Please feel free to call on us at any time.

Sincerely,

D. Rick Van Schoik
Executive Director

TRIANGLE
WETLAND CONSULTANTS

Post Office Box 33604
Raleigh, North Carolina 27636
Phone (919) 782-3792
Fax (919) 787-4999

August 29, 1995

Ms. Linda Cieslik, Ph.D.
Environmental Programs Director
Partnership for the Sounds
P.O. Box 55
Columbia, NC 27925

Dear Linda

I enjoyed meeting with you last week in Columbia and discussing your program and restored wetland mitigation site which we are developing. After I left your office, I met with Betsy Stallings, Superintendent of the Tyrrell County Schools. She reaffirmed her support for developing a trail system on our site for use by the schools. She indicated that Marcia Manning, her science coordinator would be the best person to work with on the project.

I have not yet talked with John Dorf, but I will continue to try to contact him and explore the possibilities of using the Youth Conservation Corps for trail construction. I would appreciate it if you could share the information on the site I have sent to Rick. I will try to get John out to the site if he is interested.

I hope we can develop this site so it can be used by the school children and also by your program. As I told you, I am willing to flag the trails and further facilitate the project and ultimately arrange for transfer of ownership to the NWR or other public trust entity.

Sincerely,

Triangle Wetland Consultants, Inc.

Douglas J. Frederick, Ph.D.

cc: Ms. Betsy Stallings

Coast Office • 275 Redfox Trail • Hampstead, North Carolina 28443 • Phone (919) 270-2485

TRIANGLE
WETLAND CONSULTANTS

Post Office Box 33604
Raleigh, North Carolina 27636
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November 30, 1995

Mr. John Dorf, Director
Youth Conservation Corps
Columbia, NC 27925

Dear John,

It was our pleasure meeting you on Tuesday (11/28) at our mitigation sites near the Tyrrell County Elementary School. Now that you have seen the restoration sites and surrounding forested wetlands, we hope we will be able to cooperate with you and develop an interesting trail system on the sites. As we told you, we want to see these sites utilized to their fullest extent for wetlands education. We intend to keep this goal as a prime objective as we develop these sites for mitigation. Their use in conjunction with the Partnership for the Sounds and the Tyrrell County School Systems seems to be their best use. Again, thanks for your time.

Please stay in contact with us as we all work to make this project happen.

Sincerely,

Triangle Wetland Consultants, Inc.

Douglas J. Frederick, Ph.D. Russ Lea, Ph.D.

cc: Dr. Linda Cieslik

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Appendix VIII

TRIANGLE
WETLAND CONSULTANTS

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Scuppernong River Corridor Mitigation Bank

Tyrrell County, North Carolina

Vegetation Monitoring - 1/20 ac. plots
November, 1994

Plot	Trees/Plot Planted	Trees/Plot Natural	Trees/Acre Planted	Trees/Acre Natural	Average Height of Planted Trees (ft.)
1	46	21	920	420	2.2
2	45	37	900	240	3.8
3	40	12	800	240	2.9
4	47	39	940	780	2.9
5	45	57	900	1140	3.4
6	41	34	820	680	3.3
7	42	52	840	1040	2.9
8	38	126	760	2520	2.6
9	45	18	900	360	2.2
10	42	61	840	1220	3.0
11	38	84	760	1680	2.6
12	41	16	820	320	3.7
13	40	47	800	940	3.7
14	42	61	840	1220	3.1
15	38	66	760	1320	2.8
16	39	101	780	2020	3.5
17	46	33	920	660	3.0
18	43	47	860	940	4.1
19	40	70	800	1400	3.0
20	46	60	920	1240	2.5
Average:	**42.2**	**52**	**844**	**1044**	**3.1**

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Scuppernong River Corridor Mitigation Bank

Tyrrell County, North Carolina

Planted Tree Species Inventory
November, 1994

Species	Avg. # of Trees/Plot	Percentage	Avg. # of Trees/Acre
Water oak	3.2	7.5	64
Willow oak	2.9	6.8	58
Cherrybark oak	4.2	9.9	85
Cypress	5.0	11.8	100
Atlantic white cedar	6.0	14.1	120
River birch	3.25	7.7	65
Pond pine	2.25	5.3	45
Green ash	2.05	4.8	41
Sycamore	3.0	7.1	60
Swamp black gum	1.60	3.9	32
Persimmon	1.20	2.8	24
Hazel alder	1.40	3.3	28
Mulberry	0.70	1.8	14
Swamp chestnut oak	1.15	2.7	23
Red bay	1.20	2.8	24
Loblolly bay	1.00	2.4	20
Spicebush	0.35	0.9	7
Buttonbush	0.55	1.4	12
Dahoon holly	0.25	0.7	5
Baccharis	0.50	1.2	10
Waxmyrtle	0.45	1.1	9
Total:	**42.45**	**100.00**	**844**

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Scuppernong River Corridor Mitigation Bank

Tyrrell County, North Carolina

Natural Regeneration Inventory
November, 1994

Species	Avg. # of Trees/Plot	Percentage	Avg. # of Trees/Acre
Loblolly pine	21.77	41.7	435
Sweetgum	16.86	32.3	337
Red maple	9.45	18.1	189
Red bay	1.25	2.4	25
Yellow poplar	1.15	2.2	23
Baccharis	1.15	2.2	23
Black willow	0.57	1.1	11
Total:	**52.20**	**100.0**	**1044**

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Scuppernong River Corridor Mitigation Bank

Seedling Inventory

November 15, 1995
Based on 1/10 ac. (37.2 ft. radius) plots

Plot A:

Planted Species	No./Plot	No./Ac.	Mean Ht. (ft.)	Max. Ht. (ft.)
Sycamore	10	100	6.8	9.5
Water oak	12	120	4.3	7.6
River birch	11	110	5.9	7.2
Overcup oak	7	70	4.4	7.4
Red bay	9	90	2.3	3.8
Cypress	5	50	5.1	6.3
Sweetgum	3	30	4.5	5.9
Swamp chestnut oak	2	20	3.1	3.8
Willow oak	1	10	1.3	1.3
Dahoon holly	1	10	2.0	2.0
Subtotal:	*61*	*610*	*4.0*	*5.5*
Natural Regeneration				
Loblolly pine	115	1150	2.6	3.8
Baccharis	4	40	2.8	4.0
Sweetgum	16	160	1.8	2.3
Subtotal:	*135*	*1350*	*2.4*	*3.4*
Total:	**196**	**1960**		

Plot B:

Planted Species	No./Plot	No./Ac.	Mean Ht. (ft.)	Max. Ht. (ft.)
Cypress	72	720	5.8	7.2
Green ash	2	20	9.0	11.0
Subtotal:	*74*	*740*	*7.4*	*9.1*
Natural Regeneration				
Red maple	235	2350	2.0	4.0
Loblolly pine	6	60	2.0	4.5
Red bay	22	20	2.0	2.5
Baccharis	2	20	3.6	3.2
Cottonwood	1	10	2.0	2.0
Subtotal:	*256*	*2450*	*2.3*	*3.2*
Total:	**320**	**3200**		

Plot C:

Planted Species	No./Plot	No./Ac.	Mean Ht. (ft.)	Max. Ht. (ft.)
Overcup oak	8	80	3.3	6.5
Sweetgum	9	90	2.8	3.8
Green ash	8	80	4.0	5.2
Sycamore	7	70	5.7	7.2
Willow oak	7	70	2.7	3.1
Water oak	5	50	2.9	3.4
River birch	2	20	6.4	6.8
Buttonbush	1	10	5.5	5.5
Persimmon	1	10	2.4	2.4
Subtotal:	*48*	*480*	*4.0*	*4.8*
Natural Regeneration				
Loblolly pine	58	580	3.6	7.5
Red maple	49	490	3.1	4.6
Baccharis	6	60	4.7	5.2
Subtotal:	*113*	*1130*	*3.88*	*5.8*
Total:	**161**	**1610**		

Plot D:

Planted Species	No./Plot	No./Ac.	Mean Ht. (ft.)	Max. Ht. (ft.)
Green ash	10	100	4.5	7.5
River birch	8	80	5.1	6.9
Overcup oak	8	80	3.7	5.1
Sycamore	7	70	5.8	8.1
Willow oak	5	50	3.5	3.8
Swamp chestnut oak	3	30	3.3	4.7
Persimmon	2	20	3.7	4.5
Hazel alder	2	20	2.8	3.1
Red bay	1	10	2.5	2.5
Subtotal:	*46*	*460*	*3.9*	*5.1*
Natural Regeneration				
Loblolly pine	83	830	1.9	4.5
Red maple	160	1600	1.6	4.6
Waxmyrtle	4	40	4.3	5.0
Baccharis	4	40	4.7	5.1
Subtotal:	*251*	*2510*	*3.1*	*4.8*
Total:	**297**	**2970**		

Plot E:

Planted Species	No./Plot	No./Ac.	Mean Ht. (ft.)	Max. Ht. (ft.)
Overcup oak	14	140	4.9	
River birch	12	120	6.8	8.8
Waxmyrtle	12	120	6.3	7.0
Cypress	8	80	4.2	5.0
Water oak	6	60	6.0	6.7
Sycamore	4	40	10.2	11.0
Baccharis	2	20	5.5	5.5
Green ash	2	20	8.5	8.5
Subtotal:	*60*	*600*	*6.6*	*7.5*
Natural Regeneration				
Loblolly pine	112	1120	4.0	7.0
Sweetgum	88	880	4.2	7.8
Subtotal:	*200*	*2000*	*4.1*	*7.4*
Total:	**260**	**2600**		

Plot F:

Planted Species	No./Plot	No./Ac.	Mean Ht. (ft.)	Max. Ht. (ft.)
Atlantic white cedar	152	1520	6.2	10.3
Green ash	4	40	7.1	8.1
Overcup oak	2	20	8.0	8.0
Baccharris	2	20	7.2	7.2
Waxmyrtle	2	20	7.0	7.0
Subtotal:	*162*	*1620*	*7.1*	*8.2*
Natural Regeneration				
Loblolly pine	60	600	4.0	6.2
Sweetgum	72	720	3.6	5.8
Subtotal:	*132*	*1320*	*3.8*	*6.0*
Total:	**294**	**2940**		

Permanent Photo Locations

South Station - Photo 1

South Station - Photo 2

Permanent Photo Locations

South Station - Photo 3

South Station - Photo 4

Permanent Photo Locations

North Station - Photo 1

North Station - Photo 2

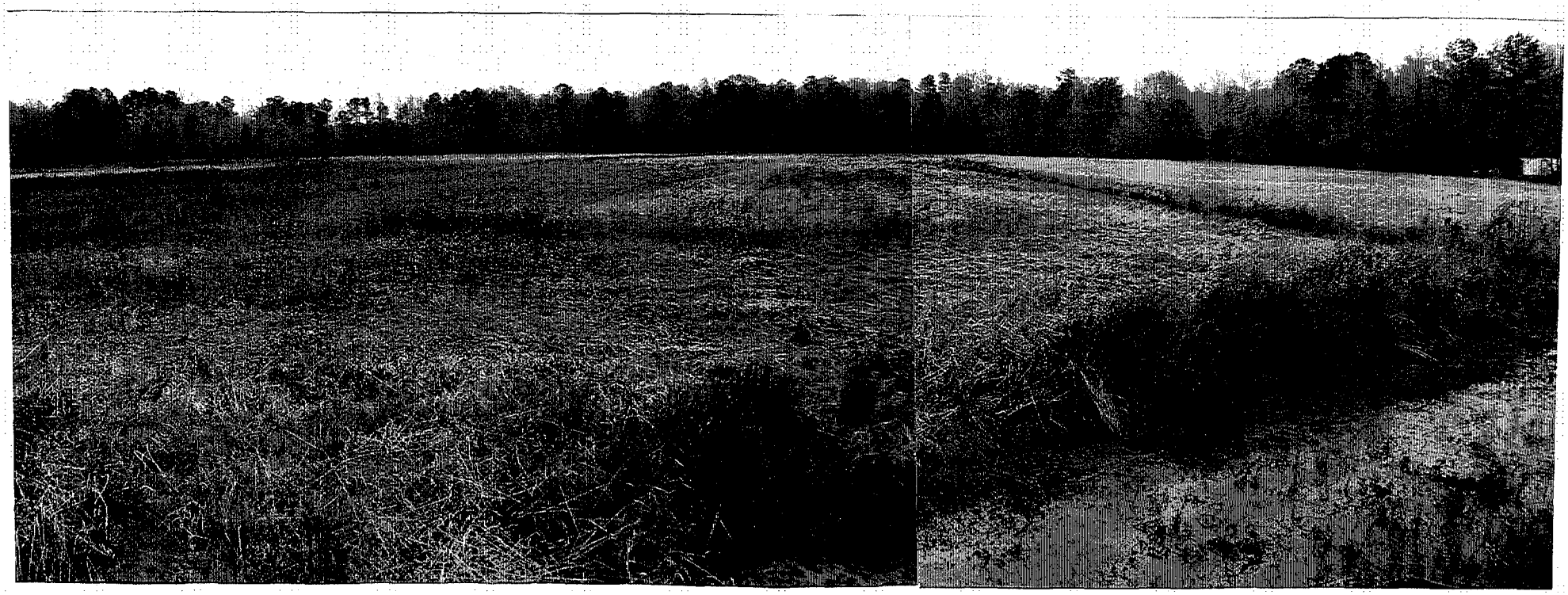
Permanent Photo Locations

North Station - Photo 3

North Station - Photo 4

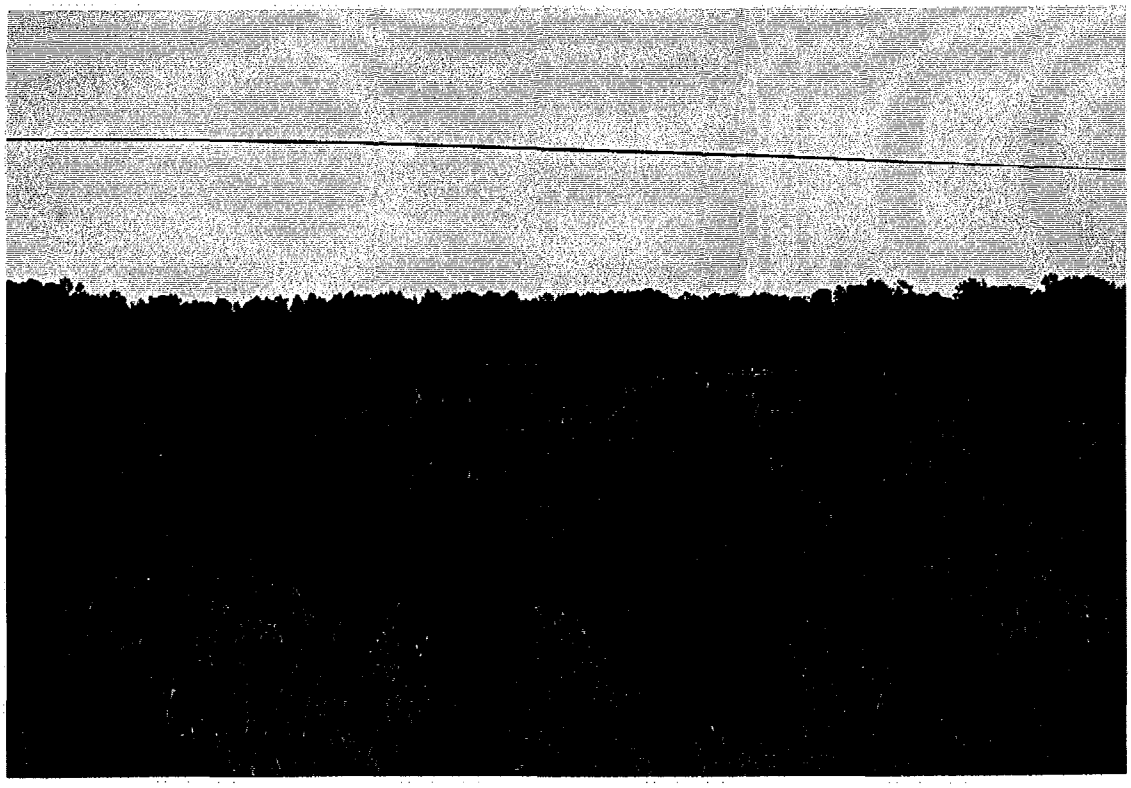
Appendix IX

Baseline Photos



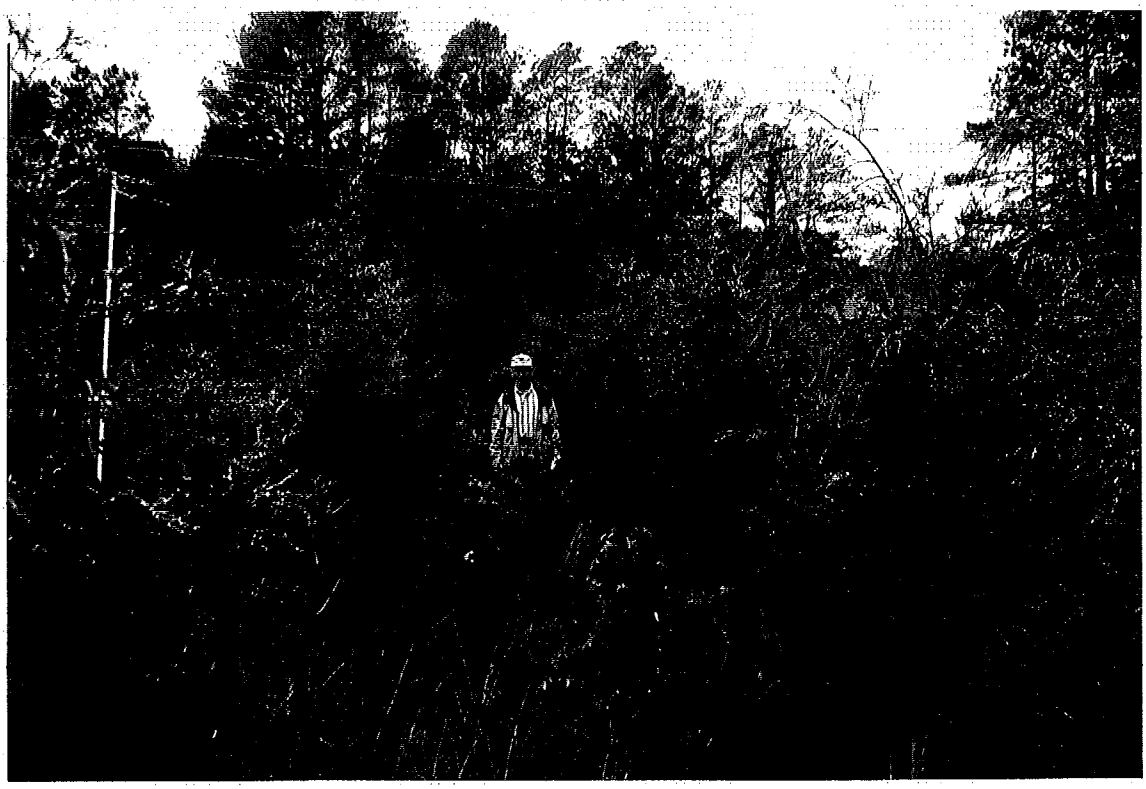
Scuppernong River Corridor Project - Prior Converted (PC) field in 1992 before wetland restoration activities began.

Baseline Photos



Three-year-old mixed bottomland hardwood restoration plus hardwood and loblolly pine natural regeneration.

Planted bald cypress and mixed hardwoods with a mixture of natural wetland subordinate plants.

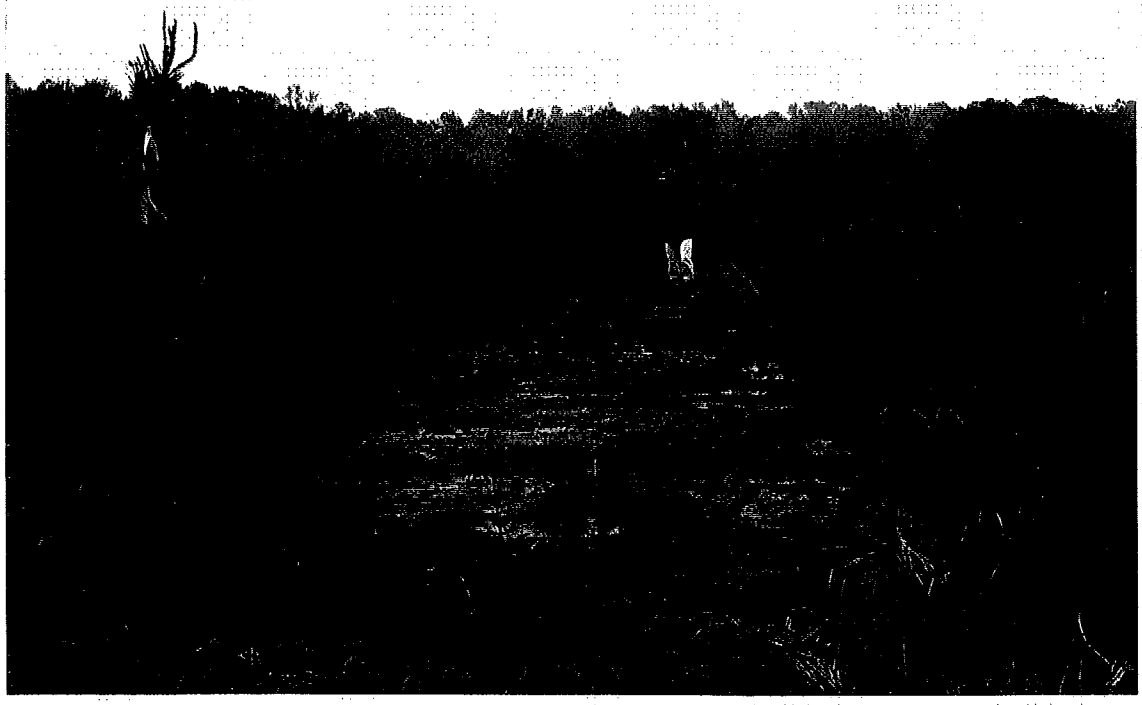


Three-year-old Atlantic white cedar block averaging over 5 ft. tall.

Mixture of planted bottomland hardwoods and saltbush plus hardwood and pine natural regeneration.

Baseline Photos

Beginning of fourth growing season, April, 1996 showing mixed hardwoods plus hardwood and pine natural regeneration.



One-hundred foot plug installed in lateral ditch plus grading of soil surface.

Reference Stand Photo Locations

Swamp hardwood (SH) forested wetland reference stand.

Wet flat (WF) forested wetland reference stand.

Interpretive boardwalk in a natural forested wetland along the Scuppernong River and adjacent to the Scuppernong River Mitigation Project.

Albemarle Regional Canoe Trail System adjacent to the Scuppernong River Mitigation Project.