

MEMORANDUM

TO: Todd Tugwell, Chair
Interagency Review Team

FROM: Tracy Stapleton, Project Manager

THROUGH: Jeff Schaffer, Eastern WPPI Supervisor and Marc Recktenwald, WPPI Manager

RE: Second Follow Up on Project Strategy
Little River (IMS #226)
Cape Fear 03030004

DATE: 19 January 2011

This memo serves as an update of the restoration approach for the subject project, and to seek approval of the monitoring and credit strategy for this project.

As you may recall, the Little River project is located near Vass in Moore County, in CF 04 (Figure 1). It is a WRP-originated project that originally proposed a large amount of stream restoration. In 2001 the site was timbered, streams channelized, soil bedded and loblolly pines planted in much of the floodplain wetlands by the owners for silviculture. The conservation easement was purchased by EEP in 2003. During design development visits to the site with agency staff and a change in design firm delayed and changed the restoration strategy at the site. In 2009, Stantec finalized plans to enhance the bedded pine plantation wetlands by removing pines and re-planting. Concerns at EEP continued, though, including bringing large equipment into the site, and disturbing the recovering soils. After another site visit with agencies, and internal discussion, EEP decided to plant a small portion of the site, below existing pines, for enhancement of the stream and wetlands and comparison of bottomland hardwood community development in planted and unplanted portions of the pine plantation.

<i>Wetland Community type</i>	<i>Acres</i>
Wetland pine plantation	48
Wetland grassy fields	7
BLH preservation	49
Total	104
<i>Warm Stream</i>	<i>Linear ft</i>
Channel A	1726
<u>Channel B</u>	<u>1867</u>
Total	3593

As discussed in the June 2010 IRT meeting, an approach being considered for restoration was to contract for burning of the site to clear the existing underbrush for bareroot planting. EEP contracted with ASIS to burn the site in December 2010. The burning was successful in opening up the understory at the site. Therefore EEP is changing its restoration approach and the resulting credits from the approach's implementation. EEP will now plant all 55 acres of wetland and stream buffer (pine plantation and grassy fields) with bare roots of climax community species. The pine plantation, including stream buffer, will be planted at a rate of 300 stems per acre, with a target of 150 planted stems per acre at Year 5. These bare roots will mimic the understory development of these species, at a lower density than other wetland enhancement projects because of the high density of pines forming a canopy above them. We anticipate more closely mimicking a jump-started successional community by bringing in climax species to the nine year old loblolly stand. The grassy fields will be planted at a rate of 600 stems per acre.

Most of EEP's wetland enhancement projects involve planting bare roots in a jurisdictional wetland barren of woody stems. For these projects, the ratio of 2:1 has been set by agreements that establish EEP policy. For this project, we propose 2.5: 1 credit in pine plantation areas because of the lower density of planted woody stems. In the grassy fields, we anticipate 2:1 credit. This would result in approximately 19.2 credits from the pine plantation, 3.5 credits from the grassy field area, and 9.8 credits from the preservation area. The total anticipated wetland credits from this site are 32.5 riparian wetland mitigation units, all of which are restoration equivalent credits. Stream credits total 1437 credits, attributed to Enhancement II of 3593 linear feet of stream through planting.

Summary Table of Little River Proposed Mitigation

Type	Acres/lf	Ratio	Total Credits
Riparian Wetland Enh (pine plantation)	48	2.5:1	19.2
Riparian Wetland Enh (grassy field)	7	2:1	3.5
Riparian Wetland Pres	49	5:1	9.8
Stream Enh 2	3593	2.5:1	1,437.2

Monitoring

In the pine plantation wetlands, monitoring will include 8 CVS monitoring plots. Success will be met if 150 planted woody stems per acre are surviving in year 5 of monitoring in the pine plantation area, while 260 planted woody stems per acre must be surviving after 5 years of monitoring in the grassy field area. This lower density in the plantation area is a result of the loblolly pine presence and abundance. The grassy field area will have 2 CVS vegetation plots. In addition, five monitoring wells will be re-installed to collect hydrology data about the site.

The stream portion of the site will be equipped with a crest gage, photo points, and 6 CVS vegetation plots. Stream buffer plots, because they are within the planted pine plantation, will also have a stem density requirement of 150 planted woody stems per acre surviving in year 5 of monitoring to meet success.

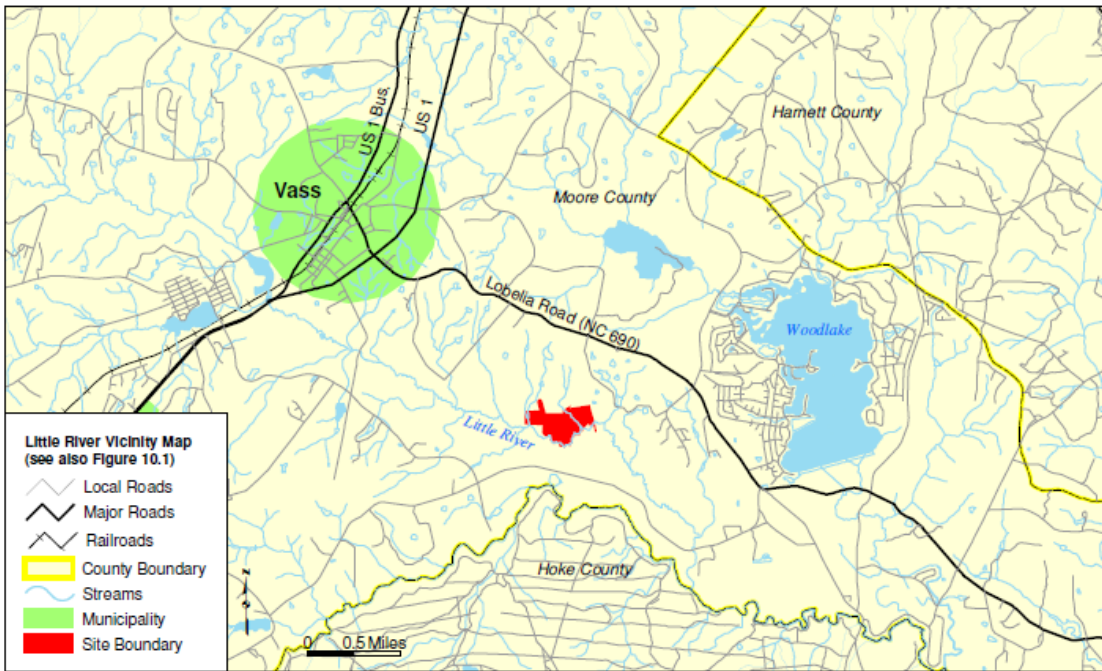
If you have any questions, please feel free to call me at 715-1658.

References

Parker, G.R. and W. T. Swank. *Tree Species Response to Clear-cutting a Southern Appalachian Watershed*, 1982: Coweeta Hydrologic Laboratory, US Forest Service. North Carolina, USA.

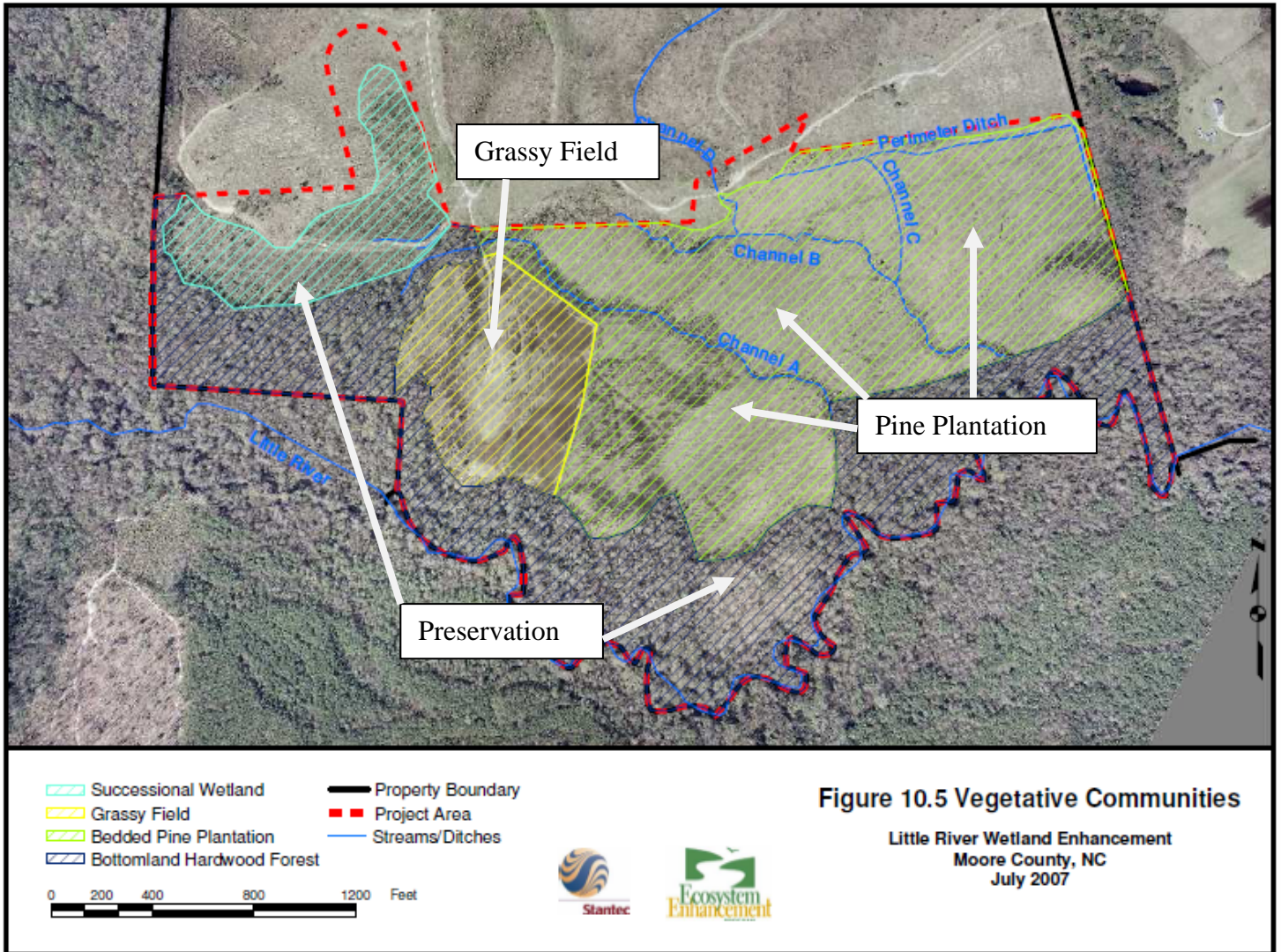
Cain, Michael D. and Michael G. Shelton. *Secondary forest succession following reproduction cutting on the Upper Coastal Plain of southeastern Arkansas, USA*, 2000: USDA Forest Service, Southern Research Station, Monticello, Arkansas.

Figure 1.0 Project Vicinity Map and Directions



Directions to Little River project site: *From Raleigh follow US 1 South approximately 50 miles to Vass. Take the NC 690 exit and follow NC 690 east for approximately 2.3 miles. Turn right into project site.*

Figure 2.0 Project Vegetative Communities



LITTLE RIVER WETLAND ENHANCEMENT

RESTORATION PLAN

Moore County, North Carolina
SCO Project Number D07062S



Prepared for:
North Carolina Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652



Status of Plan: Final
Submission Date: September 28, 2007

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EXECUTIVE SUMMARY

The Little River Wetland project is being undertaken to enhance and protect functional aspects of streams and wetlands within a 125± acre conservation easement located approximately 3.5 miles southeast of US Highway 1 along Little River in Moore County, North Carolina. The project is funded by the NC Ecosystem Enhancement Program (EEP). Initial project research and design began in 2002 and was undertaken by BLUE: Land, Water, Infrastructure, PA (BLWI). Multiple scope changes were made and the project went from having a major stream restoration component to primarily wetland enhancement and preservation. The project transitioned from BLWI to Stantec Consulting Services, Inc. (Stantec) in the spring of 2007. Portions of BLWI's initial data collection are presented here.

The project is located on property sometimes referred to as the "Little River J-Bar Ranch," "New J-Bar Ranch," or simply "J-Bar." Historically, the property was sometimes known as the "McKeithen Tract." The property is currently owned by J.J. Barnes and his family. The property is actively managed for wildlife habitat to facilitate hunting on the overall tract.

The overall project site limits are defined by the conservation easement boundary. The project site is bounded on the west by the tract property boundary, on the south by the Little River primary channel, on the east by the tract property boundary, and partially on the north by the Little River floodplain edge. The project site is dominated by a cutover and bedded area. Prior to the initiation of this project, this area was planted with loblolly pine (*Pinus taeda*). Various herbaceous and woody species, in addition to the loblolly pine, are also found at the project site. A bottomland hardwood forest approximately 200 to 500 feet in width is located between the timbered area and the Little River primary channel.

Several channels traverse the project site. These channels are natural streams with headwaters forming within watersheds of the northern slope. Small portions of the channels appear to have been altered in the past but currently appear stable. No restoration or enhancement of streams will be a part of this project.

The overall goal of the Little River / J-Bar project is to facilitate the development of a natural system which exhibits desired functions appropriate to the existing geomorphic setting of the site. Specific goals include: 1) water quality improvement; and 2) natural community enhancement.

The proposed project components include: 1) removal of undesired vegetation using mechanical methods; 2) planting of the project site with specific native species to control erosion and enhance natural habitat; 3) plugging of an approximately 1200 lf ditch to restore natural hydrology to the northeast corner of the easement.

Restoration Summary for Little River

Restoration Segment	Restoration Type	Linear Footage or Acreage
Bedded pine plantation	Enhancement	45.7 acres
	Restoration	2.3 acres
Grassy fields	Enhancement	7.5 acres
Bottomland hardwood forest	Preservation	40 acres
Successional wetland	Preservation	9.5 acres
Total Wetland Restoration		2.3 acres
Total Wetland Enhancement		53.2 acres
Total Wetland Preservation		49.5 acres
Total Wetland Acres		105 acres
Stream Reach A	Preservation	1726 feet
Stream Reach B	Preservation	1867 feet
Stream Reach C	Preservation	550 feet
Stream Reach D	Preservation	290 feet
Total Stream Length		4,433 feet

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1.0 Project Site Location

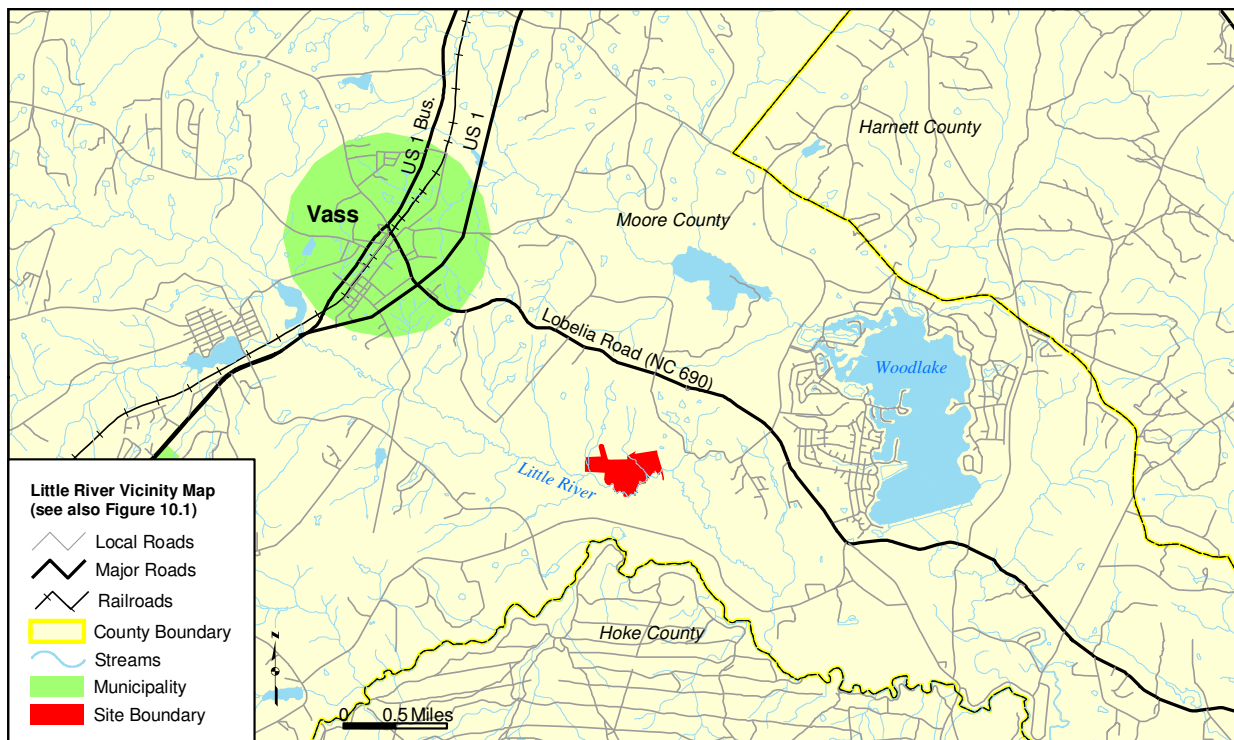
1.1 DIRECTIONS TO PROJECT SITE

The Little River / J-Bar project site is part of the J-Bar Ranch, which is owned and operated by J. J. Barnes and his family. The project site is near Vass in Moore County which is located approximately 60 miles south of Raleigh on US Highway 1. From US Highway 1 in Vass, travel approximately 3.5 miles southeast along Lobelia Road (NC Highway 690) and turn right onto the dirt access road. A key is necessary to access the gate to drive down the dirt road leading to the site. Follow the dirt road approximately 0.25 miles and then bear left at the fork in the road. Continue an additional 0.65 miles along the dirt road to a second fork. The right hand side of the fork leads into the easement while the left hand fork follows the northern boundary of the easement (Figure 10.1).

1.2 USGS HUC & NCDWQ RIVER BASIN DESIGNATIONS

The site is located at 35.22⁰ North / 79.24⁰ West on the northwestern portion of the United States Geological Survey (USGS) 7.5 Minute Topographic Quadrangle *Lobelia* (Figure 10.2). The project site is located in the Cape Fear River basin, within the USGS 14-digit hydrologic unit 03030004070050.

1.3 PROJECT VICINITY MAP



2.0 Watershed Characterization

2.1 DRAINAGE AREA

The Little River project site contains a number of unnamed tributaries to Little River with a watershed of approximately 335 acres at the confluence with Little River (Figure 10.2). The project is unique in that the majority of the watershed is within the larger property boundary.

2.2 SURFACE WATER CLASSIFICATION / WATER QUALITY

The unnamed streams are tributaries of Little River which has been designated Stream Index 13-06-14 by the North Carolina Division of Water Quality (NCDWQ). This portion of Little River is designated as High Quality Waters (HQW) from its source to Crane Creek, based on Excellent biological (benthos) data generated by the NCDWQ.

2.3 PHYSIOGRAPHY, GEOLOGY AND SOILS

The site and contributing watersheds are located in the Sandhills physiographic region of North Carolina. This is a distinct region of sandy rolling hills which extends from south central North Carolina, through the middle of South Carolina and Georgia, into east central Alabama. Elevations in the watershed range from 220 feet to 310 feet above sea level with the most relief being outside the project area. Soil types from the USDA-NRCS Moore County Soil Survey were combined by BLUE: Land, Water, Infrastructure (BLWI) with the digitized USDA-NRCS Moore County Soil Survey field sheets to get a more detailed assessment of the soils in the watershed. The most prevalent soil types are Bibb (33.7%), Kalmia (21.62%), and Ailey (19.53%). Bibb is a poorly drained sandy soil that forms in alluvial deposits, while the well-drained sandy Kalmia occurs on stream terraces and Ailey is a well-drained sandy upland soil (Figure 10.3). However, the soils onsite contain much more clay than those mapped. The watershed geology is made up Cretaceous material including the Cape Fear Formation which consists of sandstone and sandy mudstone with yellowish gray to bluish gray, mottled red to yellowish orange, indurated, graded and laterally continuous bedding and blocky clay. Faint cross-bedding, feldspar and mica are also common.

2.4 HISTORICAL LAND USE AND DEVELOPMENT TRENDS

The watershed is mixture of mixed shrubs/trees (69.1%), hardwood forest (16.0%), southern yellow pine (11.7%), pasture (1.1%), roadways/pathways (1.1%), cultivated (0.8%), and water (0.1%) (Table 9.2). The majority of the hardwood forest occurs in the floodplain of the Little River, particularly in the vegetated buffer directly adjacent to the primary channel.

Expected foreseeable land use / land cover change in the project site watershed is expected to include general reforestation and expanded habitat management. The new US Highway 1 bypass in the Vass area is expected to increase land development near the project site as the highway is less than three miles away and includes an exit ramp onto Lobelia Road.

2.5 PROTECTED SPECIES

According to the 2007 Natural Heritage Element Occurrence GIS file from the NC Center for Geographic Information and Analysis (CGIA), no threatened or endangered species are located in the project area. No significant natural heritage areas are present in the project area. Further analysis was not undertaken.

2.6 CULTURAL RESOURCES

There are no known cultural resources in the project area.

2.7 POTENTIAL CONSTRAINTS

2.7.1 Property Ownership and Boundary

The Little River site is owned by J.J. Barnes. A conservation easement has been placed on approximately 125 acres in the southern portion of the property. The eastern and western easement boundaries coincide with the property boundary. The southern boundary coincides with the property boundary and Little River. The northern easement boundary crosses the property generally along an east-west dirt road with the slope break defining the upland from the floodplain. A few dirt roads are present within the northern edges of the easement; the majority of these roads are expected to remain. The road in the far northeast corner of the easement will be removed for wetland restoration purposes.

2.7.2 Site Access

The site is accessible from the northern edge of the property on Lobelia Road, and a key is necessary get into the gate. The project area is beyond a network of dirt roads. For more detailed directions see Section 1.1.

2.7.3 Utilities

No utilities are present on the project site.

2.7.4 FEMA / Hydrologic Trespass

A check of FEMA flood zone mapping for Moore County indicates that almost all of the easement is within the 100-year flood hazard zone with the exception of a small piece on the northern edge (<http://www.ncfloodmaps.com/default.swf.asp>).

A perimeter ditch, approximately 1200 feet long, is located in the floodplain in the northeast portion of the easement. The ditch is not connected hydrologically to any jurisdictional streams and primarily drains groundwater. It has no surface flow and no significant drainage area. A portion of the wetland enhancement includes plugging this ditch which will raise groundwater within the floodplain. Upstream properties will not be affected.

3.0 Project Site Streams

The streams/ditches that flow through the project site are indicated on the Hydrological Features Map (Figure 10.4) and are labeled A, B, C, D, and 'perimeter ditch.' Channel A begins on the western side of the project area and flows through a culvert under the dirt access road, then southeast across the site and eventually into the Little River. Channel B appears on the United States Geological Survey (USGS) Lobelia 7.5 Minute Topographic Quadrangle and the Moore County Soil Survey as a "blue-line" stream. It is a second order stream, according to USGS, with a drainage area of approximately 128 acres. Flow was monitored in this stream as it enters the site (flow data can be found in earlier Little River documents). Channel B flows from the headwaters in the northern portion of the Barnes property, and then through a culvert under the dirt road that bounds the project area. A few hundred feet after it leaves the culvert it joins with Channel D and then flows southeast across the project area to the Little River. Upon entering the forested area, both Channels A and B lose the most of their channel definition. Channels C and D are both small tributaries to channel B. Photographs of the site are included in Appendix 1.

A perimeter ditch, approximately 1,200 feet in length, is located in the northeast corner of the project site. The perimeter ditch is separated from Channel C by a small berm (as seen during field visits in 2007). The ditch appears to have been constructed to assist with drainage of the northeast corner of the pine plantation by intercepting subsurface drainage from the steep topography on the north side and directing it around to the south.

The existing stream conditions were assessed by BLWI in 2004 using a Rosgen Level II Classification (Rosgen 1996). Channel A was determined to have an average Rosgen classification of C5, and Channel B and C are classified as E5. Meanders for onsite channels are smaller than what would be found in a natural Sandhills system. The longitudinal slope of Channels A and B is 0.002 ft/ft while Channel C is 0.01 ft/ft. Stream bankfull depth in Channel A varies from approximately 0.38 to 0.54 feet deep while bankfull width ranges between 5.5 and 14.88 feet. Channel B is a slightly deeper and narrower channel where bankfull depth varies from approximately 0.36 to 3.2 feet deep and bankfull width ranges from 3.5 to 6.4 feet. Channel A has the smallest average cross-sectional area at 4.88 square feet while Channel B and C have similar cross-sectional areas at 15.5 and 14.31 square feet, respectively. Streambed samples for channels A and B were taken and sent off to a lab for particle size analysis. The resultant d50 for each channel fell into the fine and medium sand categories, respectively.

The stream channels were briefly reassessed in April 2007 by Stantec (Appendix 2). The geomorphological determinations above appear to remain consistent with what was observed by BLWI. Most of the channels appear stable even though they may have been altered in the past. Upper portions of Channels A and B near the project boundary show some detrimental effects from the small culverts under the dirt roads and from some sediment washing in from the dirt roads. Beaver activity and several small beaver dams were observed along the channels. Overall, the banks are stable and the streams are able to access the adjacent floodplain.

4.0 Project Site Wetlands

The project site is dominated by an 82 acre clear cut containing a recently planted pine plantation of approximately 55 acres. The planted area was bedded and planted with loblolly pine (*Pinus taeda*) in 2001. The planted pines currently range in height from 6 to 20 feet across the site. Various herbaceous and woody species have also volunteered in the plantation area. Much of this vegetation is dominated by blackberry (*Rubus* sp.), titi (*Cyrilla racemiflora*), red maple (*Acer rubrum*), and various sedges (*Carex* spp.). Along the stream channels willow oak (*Quercus phellos*), water oak (*Quercus nigra*), and green ash (*Fraxinus pennsylvanica*) have volunteered from the adjacent forest.

On the west side of the easement, just west of the bedded and planted area, two large grassy fields were cleared and planted with a wildlife seed mix. The fields currently consist of a variety of sedges and grasses with loblolly pines and titi beginning to invade those areas. A significant portion of these fields are uplands. Further to the west, a cutover portion of the project site has been left to re-vegetate on its own. These areas are now dominated by loblolly pine, black gum (*Nyssa sylvatica*), titi, red maple, blackberry, smilax (*Smilax* spp.) and a variety of other species.

South of the pine plantation is a mature bottomland hardwood forest along the Little River. The portion within the project area is approximately 200 to 500 feet in width and is approximately the same width on the opposite bank of the Little River. This forest has been cut in the past but enough time has passed for it to regenerate. Most of the canopy is dominated by willow oak, red maple, green ash, water oak, swamp laurel oak (*Quercus laurifolia*), black gum, and sweetgum (*Liquidambar styraciflua*) and a smaller portion, including a number of old meander bends and depressional areas, is dominated by swamp tupelo (*Nyssa biflora*) and scattered bald cypress (*Taxodium distichum*). Photographs of the wetlands are included in Appendix 1.

4.1 JURISDICTIONAL WETLANDS

The methods outlined in the US Army Corps of Engineers (USACE) Wetlands Delineation Manual (Environmental Laboratory, 1987) were used in February 2005 by BLWI to delineate the jurisdictional wetlands within the cutover area south and east of the Channel A road crossing. Remaining wetland areas within the easement, including the bottomland hardwood forest, were assessed by Stantec in July 2007 using USACE methods and the approximate wetland boundaries were located to complete a jurisdictional wetland map of the project site.

Much of the project site consists of jurisdictional wetlands, which is consistent with typical river valley floodplains. Upland areas, with slightly higher elevation and drier soils are scattered throughout the property as shown on Figure 10.4. There are approximately 105 acres of existing wetlands within the project site. Of this, 48 acres of wetlands are located within the pine plantation, 17 acres in the other clear cut areas (grassy fields and successional area), and 40 acres in the bottomland hardwood forest. Wetland determination forms and wetland rating forms are located in Appendix 3.

4.2 HYDROLOGICAL CHARACTERIZATION

Hydrologic input for the wetland areas on the project site comes from overbank flooding of the stream channels through the site and the Little River, as well as direct rainfall and poorly drained soils. There is evidence of flow patterns through much of the bottomland hardwood forest and along Channels A, B, and D. High flood flows from the Little River may get into the lower portions of the pine plantation, back water up into the tributaries, and increase flows in Channel A by pushing water up into the forest at the eastern side of the site.

Standing water has been observed between the rows of pines throughout the plantation and in the lower portions of the fields confirming the generally poor drainage of the site. In 2003, seven Infinity monitoring wells were installed by BLWI in the project area to record groundwater elevations (Figure 10.4). These wells were visited by Stantec in July 2007 to determine their status and refresh the batteries. Gauge data downloaded from each of the Infinity wells was sporadic and did not cover an entire growing season since installation. Hydrologic data is included for the three currently functioning Infinity gauges in Appendix 4. Stantec also installed an additional three Ecotone wells across the site, one of which is located in the onsite bottomland hardwood forest for reference purposes. One rain gauge is located along the dirt road near Channel D. During the 2007 visit, a clog in the rain gauge was removed and batteries were replaced. Precipitation data ranges from July 2004 to June 2006 (Appendix 4).

4.3 SOIL CHARACTERIZATION

Soils are a vital component of any wetland enhancement project. Soil properties can affect vegetation survival, and groundwater hydrology, while at the same time exhibit indicators indicative of historic conditions. Multiple soil parameters were intensely investigated for the purposes of this project.

4.3.1 Taxonomic Classification

The soil series that are mapped on the project site in the Moore County Soil Survey are Bibb and Kalmia (Wyatt 1995). Bibb soils are poorly drained soils occurring on floodplains and consist of about 12 inches of dark loam overlaying light-colored sandy loam subsoil. Bibb soils in Moore County are a taxadjunct to the soil series and are coarse-loamy, siliceous, acid, thermic Typic Fluvaquents. Bibb soils are also classified as a hydric soil. The soil series Kalmia is a well drained soil that occurs on stream terraces and formed in loamy fluvial sediments. Kalmia typically consists of about 12 inches of light-colored sandy loam over yellowish sandy clay loam that transitions to light-colored sand. Kalmia is a fine-loamy over sandy or sandy-skeletal, siliceous, thermic Aquic Hapludult.

4.3.2 Profile Description

Soils in the cutover portion of the project area were auger-sampled and mapped by BLWI based on hydric soil features according criteria referenced in the 1987 US Army Corps of Engineers Wetland Delineation Manual (Figure 10.3). Eighty soil descriptions were taken in transects across the project area. Eight topsoil samples from the cutover area were analyzed by the NC Department of Agriculture's Soil Testing Lab (Appendix 5). In general, the drier Kalmia-type soils were not as abundant as shown in the soil survey. Only 21 acres of uplands were found. A portion of the upland area consisted of transitional areas that included areas that had hydric features too deep to be classified as a hydric soil. The remaining soils in the project area were found to have hydric features at or near the surface.

The average topsoil pH in the cutover area is 4.6 (average base saturation = 24%). According to the soil test report, the project area has sufficient nitrogen, yet potassium and magnesium levels are low and phosphorus levels are very low for establishing hardwood trees.

4.4 PLANT COMMUNITY CHARACTERIZATION

Plant communities and vegetation were assessed within the project site (Figure 10.5). Approximately 55 acres of the site consists of a young pine plantation. This area was clear-cut, prepped and planted with loblolly pine in 2001. No further forest management was performed on the site, allowing herbaceous and woody vegetation to grow among the pines. The dominant woody species is loblolly pine, although there is also winged sumac (*Rhus copallina*), inkberry (*Ilex glabra*), water oak, willow oak, titi, sweetgum, and red maple. Herbaceous species include, blackberry, greenbriar, and various sedges. The loblolly pine saplings range in height from 6 to 20 feet with the taller plants in the slightly higher, drier areas. Blackberry is the dominant herbaceous species in the drier areas. The other emerging woody species are similar to those found in a bottomland hardwood forest.

As mentioned earlier, a mature bottomland hardwood forest occurs along the Little River in the southern portion of the project site. Much of the canopy is dominated by green ash, willow oak, water oak, swamp laurel oak, loblolly pine, black gum, and red maple. There is an open understory of similar species as well as American holly (*Ilex opaca*), sweetbay magnolia (*Magnolia virginiana*), and titi. The sparse herbaceous layer is dominated by false nettle (*Boehmeria cylindrica*), Virginia chainfern (*Woodwardia virginica*), royal fern (*Osmunda regalis*), and sedges, with scattered thickets of greenbriar and giant cane (*Arundinaria gigantea*). Along the Little River and its overflow channels there is a greater abundance of swamp tupelo with scattered bald cypress within the forest. Also, scattered within the forest are depressional areas dominated by stands of swamp tupelo and black gum.

Other disturbed areas within the project site include cutover areas that were not bedded and planted (successional area), and several small open fields that are located near the access road on the west side of the site. Various saplings typical of the adjacent forests have begun to colonize these areas. Scattered sweetgum and titi are found throughout the grassy area. Dominant herbaceous species are spikerush (*Eleocharis* sp.), bulrush (*Scirpus* sp.), rice cutgrass (*Leersia oryzoides*), and bur reed (*Sparganium americanum*).

5.0 Reference Wetlands

BLWI originally identified a reference wetland site on private land across the Little River south of the project site. A new reference wetland site has been identified within the bottomland hardwood forest in the western portion of the site to facilitate ease in monitoring. A groundwater gauge has been installed in the new reference wetland to compare groundwater levels within the project site. For the purpose of species selection for the planting of the wetland enhancement areas, species composition across the onsite bottomland hardwood forest as well as descriptions of the “Coastal Plain Bottomland Hardwoods” from Schafale and Weakley (1990) were used.

5.1 HYDROLOGICAL CHARACTERIZATION

The reference site gauge is located approximately 500 feet from the Little River and should have direct flooding from the river only during the highest flows. This area was chosen to mimic much of the rest of the site where hydrology is mostly supported through flooding of the tributaries, rainfall and poor drainage, as well as high water tables within stream valley. Hydrology on the site will be monitored by four groundwater gauges within the enhancement and restoration areas, as well as one groundwater gauge in the reference site.

BLWI gathered river stage data upstream and downstream of the site at four separate locations. Overbank channel data was also obtained at the site. Through associated stage-discharge information, statistical analysis, and surface water hydraulics analysis, the water level stage within the Little River floodplain upstream and downstream could be determined. This data is not repeated here and can be found in previous restoration documents for the Little River site (BLWI 2005, 2006).

5.2 SOIL CHARACTERIZATION

5.2.1 Taxonomic Classification

According to the Moore County Soil Survey (Wyatt 1995), the reference site primarily consists of Bibb soils with a small portion of Kalmia soils. A description of Bibb and Kalmia soils can be found in Section 3.3 of this report. Soils in the onsite bottomland hardwood forest were assessed in July 2007 and were typically gray clay with strong brown redoximorphic features and also periodic areas of sandy river sediments.

5.3 PLANT COMMUNITY CHARACTERIZATION

5.3.1 Community Description

The reference wetland is made up of the mature bottomland hardwood forest onsite described in section 4.4.

5.3.2 Basal Area

The woody vegetation basal area for the wetland reference area was calculated using a prism with basal area factor of 10. The basal area for the bottomland hardwood reference is approximately 180 square feet per acre.

6.0 Project Site Restoration Plan

6.1 RESTORATION PROJECT GOALS AND OBJECTIVES

The overall goal of the Little River project is to preserve and restore a natural floodplain system which exhibits desired functions appropriate to the existing geomorphic setting of the site. The main functions of this system are: nutrient processing, aquatic and terrestrial habitat, and floodwater storage.

The preservation areas of the site will provide for perpetual protection of these currently functioning areas. Wetland enhancement on the site will improve aquatic and terrestrial habitat by restoring the natural diverse plant community to existing wetlands. Wetland restoration at the site will improve nutrient processing and floodwater storage by restoring a natural wetland hydrology; and improve aquatic and terrestrial habitat by planting the natural diverse plant community

Specific steps to achieve the goal are:

- Removal of the majority of planted loblolly pines and planting of native bottomland hardwood trees and shrubs on 48 acres;
- Preservation of 4,433 linear feet of perennial stream channels, 40 acres of bottomland hardwood wetlands along the Little River, and 9.5 acres of successional wetlands;
- Restoration of 2.3 acres of wetland hydrology by plugging and filling a man-made drainage ditch.

The bottomland hardwood wetland enhancement will be accomplished with site preparation and minimal earthwork by removing undesirable existing vegetation and planting native vegetation. The ditch in the northeast corner of the site will be plugged and partially filled, thereby restoring the hydrology to the surrounding area. The conversion of the pine plantation and associated riparian areas to hardwood species will greatly improve the wildlife habitat on the property and improve the aquatic species diversity and abundance in the stream channels on the site.

6.2 HYDROLOGIC MODIFICATIONS

This project will not incorporate any mass grading due to the fact that the site will naturally heal itself with the help of vegetation enhancement. The only hydrologic modification on the project site will be the plugging of the perimeter ditch located along the northeastern corner of the easement. This 1200-foot linear ditch is easily accessible from adjacent dirt road along the eastern edge. Plugging this ditch should raise groundwater in the adjacent areas and restore hydrology to approximately 2.3 acres of wetland. The remainder of the project site hydrology will not be modified. It is expected that the low flow velocity within the channels will lead to aggradation and a more natural hydrologic response over time.

6.3 SOIL RESTORATION

Soils investigations found that natural wetland floodplain soils exist on most of the site. Soil restoration will focus on targeted fertilizer application where vegetation is planted.

6.4 NATURAL PLANT COMMUNITY RESTORATION

6.4.1 Narrative & Plant Community Restoration

As previously discussed, the target wetland community is bottomland hardwood forest throughout the project site. Upland areas within the project boundary will not be planted. The upland areas within the pine plantation and the fields will be left undisturbed to provide some diversity of habitat while the bottomland hardwood forest becomes established. The planting plan is designed to include species that would be found in the existing bottomland hardwood forest community as well as the “Coastal Plain Bottomland Hardwoods” community described by Schafale and Weakley’s Classification of the Natural Communities of North Carolina (1990).

A majority of the existing loblolly pines within the bedded plantation will be removed before establishing the bottomland hardwood forest. Removal will include cutting the pines trees near ground level and chipping them when feasible. The plantation area will then be bush hogged where needed to remove dense thickets of blackberries which will make planting easier and reduce the immediate competition with the hardwoods. Desirable species will be left where practical.

The bedded plantation area and the grassy fields within the wetland areas will be planted entirely with native, non-invasive vegetation (Table 10.3 Designed Vegetative Community). Most of the species will be planted as bare roots at 400 stems per acre. The stream banks of Channel A and Channel B will be live staked at greater densities in order to maintain bank stability and to quickly establish a woody buffer to shade the stream channel and improve habitat.

6.4.2 On-site Invasive Species Management

It is not anticipated that invasive plant species will be a significant problem on the Little River Site. During the first year of monitoring, any invasive species problems will be noted and specific management options will be proposed. These management options may involve chemical treatments, mechanical or hand removal of undesirable species.

7.0 Performance Criteria

7.1 WETLANDS

The project involves the enhancement of existing jurisdictional areas within the pine plantation, restoration of a small area surrounding an existing ditch, and the preservation of existing wetlands and streams within the conservation easement. Therefore, except for the small restoration area, hydrology is already assumed to be present due to the presence of hydric soil indicators and lack of drainage. In order to monitor and confirm the hydrology, five continuous groundwater gauges are planned for the site. Four of the gauges are located in the jurisdictional areas of the pine plantation and a fifth is located in the reference wetland at the west side of the project. A rainfall gauge is also located on the site to monitor precipitation.

Recorders will be programmed to record water table data on a daily basis. Water level data will be compared with data recorded at the reference site to determine success. Data from each of the gauges will be downloaded on a bi-monthly basis.

Hydrologic success for the small restoration area will be based on the following success criterion:

Years One through Three - Hydrologic success criteria at the restored site will be met for years one through three if the site demonstrates saturation for a maximum deviation of 50% from the duration of saturation at the reference site during the growing season. Saturation is defined here as groundwater being present within 12" of the soil surface.

Years Four and Five - Hydrologic success criteria at the restored site will be met for years four and five if the site demonstrates saturation for a maximum deviation of 20% from the duration of saturation at the reference site during the growing season. Saturation is defined here as groundwater being present within 12" of the soil surface.

Based on reference conditions and the stated criterion, it is expected that soil saturation for years one through five at the site will meet hydrologic success conditions within the growing season for Moore County (USACE 1992). The growing season for Moore County as defined by the Moore County Soil Survey occurs from March 23 to November 7, a total of 228 days.

Reference areas will be monitored for the minimum of five years. The small restoration area will be compared to the references in order to track changes in expected hydrology due to regional environmental conditions.

7.2 VEGETATION

Vegetative sample plots will be quantitatively monitored during the growing season. According to NCEEP guidance, 1-2% of the planted area should be sampled. Based on the approximate areas of the two planting types (bottomland hardwood forest and streambank zone), ten 100-meter square vegetation plots will be established on the Little River site. Vegetation sampling plots will be proximal to groundwater monitoring gauges, wherever practical, to assist in correlating vegetation and hydrology parameters. Vegetation will be monitored based on the Carolina Vegetative Survey methodology version 4.0. In each plot, species composition, density, and survival of the installed vegetation will be monitored. Volunteer plant species will not be considered in vegetative success determinations. The four plot corners will be located using a Global Positioning System (GPS), permanently located with metal conduit stakes, and included in the mitigation plan for the Little River Site.

The vegetative success of the bottomland hardwood forest will be evaluated based on the species density and survival rates. Wetland vegetation monitoring will be considered successful if at least 260 trees/acre are surviving at the end of five years.

8.0 References

BLUE: Land, Water, Infrastructure, PA (BLWI), 2005 Little River / J-Bar Streams and Wetlands, Restoration Plan Report. November 24, 2004 revised October 31, 2005.

BLUE: Land, Water, Infrastructure, PA (BLWI), 2006 Little River / J-Bar Wetland Enhancement Project, Draft Restoration Plan Report. August 1, 2006.

Environmental Laboratory, 1987 United States Army Corps of Engineers. Wetlands Delineation Manual, Technical Report Y-87-1. United States Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Rosgen, D L, 1996 Applied River Morphology. Wildland Hydrology Books, Pagosa Springs, CO

Schafale, M P and A S Weakley. 1990. Classification of Natural Communities of North Carolina - Third Approximation. North Carolina Natural Heritage Program, Raleigh, NC.

USACE. 1992. Clarification and interpretation of the 1987 Manual. Memo to USACE districts from Headquarters, US Army Corps of Engineers, Washington, DC, March 6, 1992; signed by MG Arthur E. Williams, Directorate of Civil Works.

Wyatt, Perry W. 1995. Soil Survey of Moore County, North Carolina. USDA-Natural Resource Conservation Service.

9.0 Tables

TABLE 9.1 RESTORATION STRUCTURE AND OBJECTIVES

TABLE 9.2 LAND USE OF WATERSHED

TABLE 9.3 DESIGNED VEGETATIVE COMMUNITIES BY ZONE

Table 9.1 Restoration Structure and Objectives SCO Project Number D07062S		
Restoration Segment	Restoration Type	Linear Footage or Acreage
Bedded pine plantation	Enhancement	45.7 acres
	Restoration	2.3 acres
Grassy fields	Enhancement	7.5 acres
Bottomland hardwood forest	Preservation	40 acres
Successional wetland	Preservation	9.5 acres
Total Wetland Restoration		2.3 acres
Total Wetland Enhancement		53.2 acres
Total Wetland Preservation		49.5 acres
Total Wetland Acres		105 acres
Stream Reach A	Preservation	1726 feet
Stream Reach B	Preservation	1867 feet
Stream Reach C	Preservation	550 feet
Stream Reach D	Preservation	290 feet
Total Stream Length		4,433 feet

Table 9.2 Land Use of Watershed SCO Project Number D07062S		
Land Use	Acreage	Percentage
Mixed shrubs/trees	231.5	69.1%
Hardwoods	53.6	16.0%
Southern yellow pine	39.2	11.7%
Pasture	3.7	1.1%
Roadways/Pathways	3.7	1.1%
Cultivated	2.8	0.8%
Water	0.5	0.1%

Table 9.3 Designed Vegetative Communities by Zone
SCO Project Number D07062S

Common Name	Scientific Name	Southeast Region Indicator
Zone 1 Streambank		
Smooth alder	<i>Alnus serrulata</i>	Facultative Wetland +
Swamp dogwood	<i>Cornus stricta</i>	Facultative Wetland -
Elderberry	<i>Sambucus Canadensis</i>	Facultative Wetland -
Virginia willow	<i>Itea virginica</i>	Facultative Wetland +
Zone 2 Bottomland Hardwood Forest		
Overcup Oak	<i>Quercus lyrata</i>	Obligate Wetland
Swamp Laurel Oak	<i>Quercus laurifolia</i>	Facultative Wetland
Swamp Chestnut Oak	<i>Quercus michauxii</i>	Facultative Wetland -
Green ash	<i>Fraxinus pennsylvanica</i>	Facultative Wetland
Swamp tupelo	<i>Nyssa biflora</i>	Obligate
Cherrybark Oak	<i>Quercus falcata</i> var. <i>pagodaefolia</i>	Facultative +
Water Oak	<i>Quercus nigra</i>	Facultative
Sycamore	<i>Platanus occidentalis</i>	Facultative Wetland -
Swamp cottonwood	<i>Populus heterophylla</i>	Obligate Wetland
Sweetbay	<i>Magnolia virginiana</i>	Facultative Wetland +
Titi	<i>Cyrilla racemiflora</i>	Facultative Wetland
Inkberry	<i>Ilex glabra</i>	Facultative Wetland
Swamp dog-hobble	<i>Leucothoe racemosa</i>	Facultative Wetland
Black highbush blueberry	<i>Vaccinium fuscatum</i>	Facultative +

10.0 Figures

FIGURE 10.1. VICINITY MAP

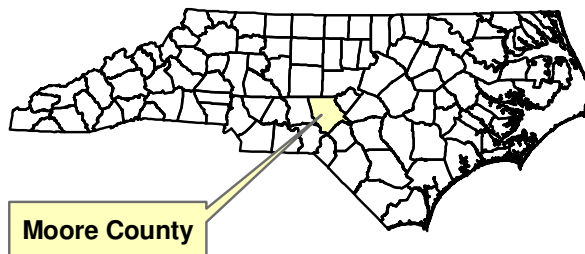
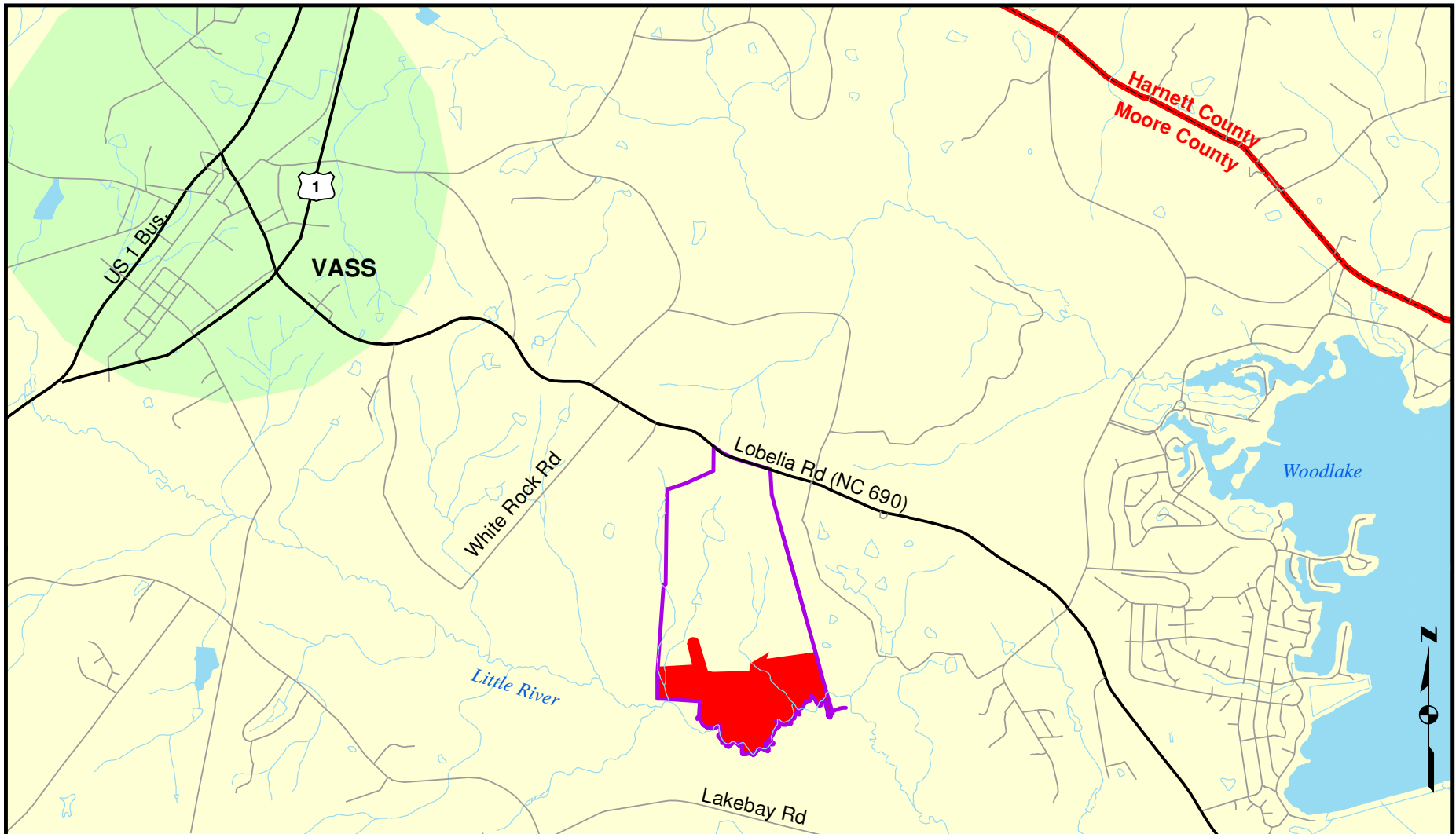
FIGURE 10.2. WATERSHED MAP

FIGURE 10.3. NRCS SOIL SURVEY MAP

FIGURE 10.4. HYDROLOGICAL FEATURES MAP WITH GAUGE LOCATIONS

FIGURE 10.5. VEGETATIVE COMMUNITIES MAP

FIGURE 10.6. RESTORATION SUMMARY MAP










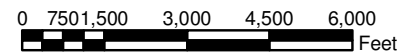
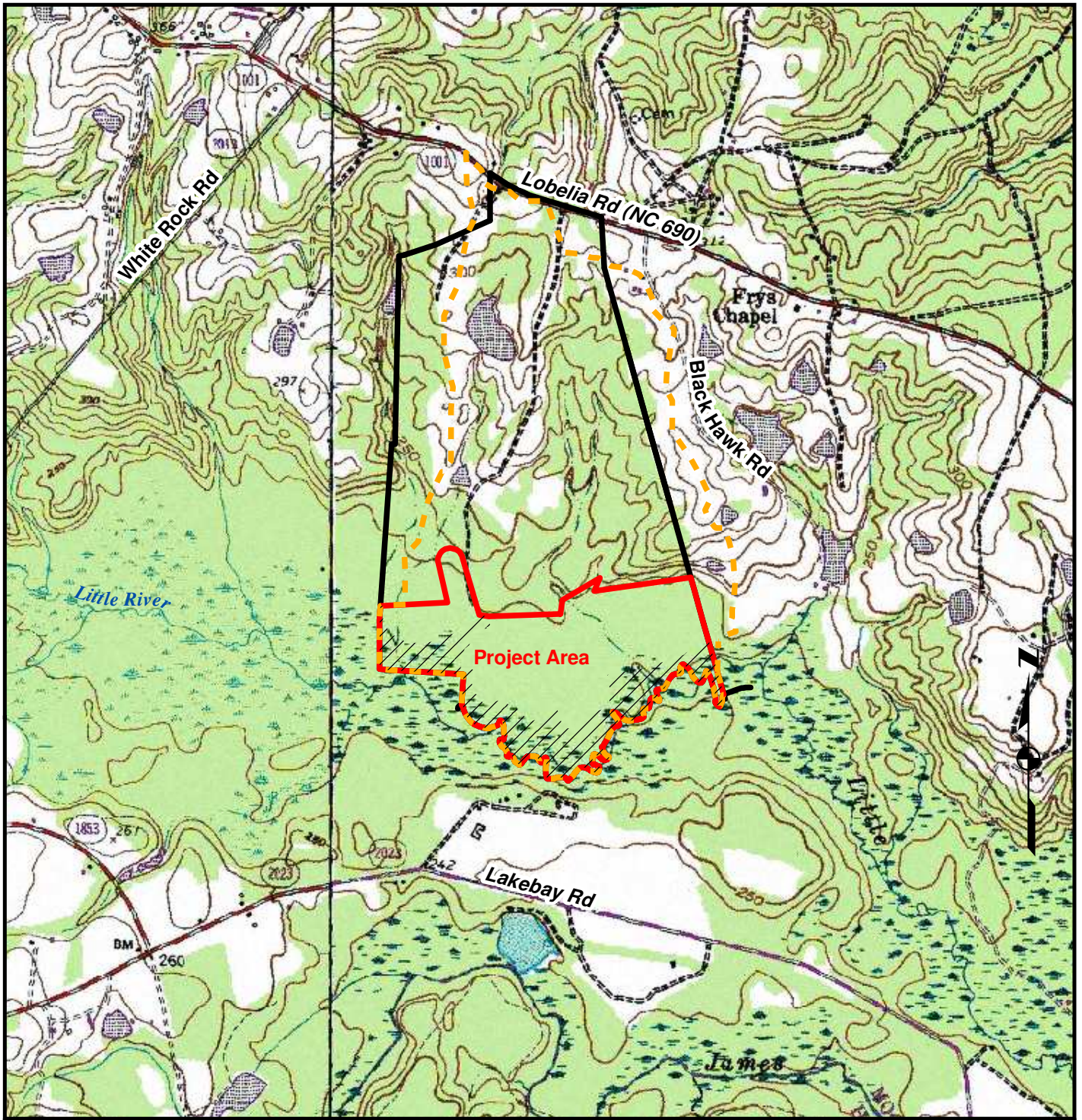
-  Property Boundary
-  County Line
-  Municipality
-  Project Area
-  Streams
-  Local Roads
-  Major Roads



Figure 10.1 Vicinity Map

Little River Wetland Enhancement
Moore County, NC
July 2007





- Watershed Boundary (delineated by BLWI)
- Easement Boundary
- Property Limits
- //// Bottomland Hardwood Forest (Reference)

Lobelia and Niagra Topographic Quadrangles
 (Project site is located on the Lobelia topoquad)

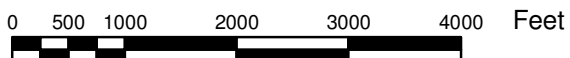
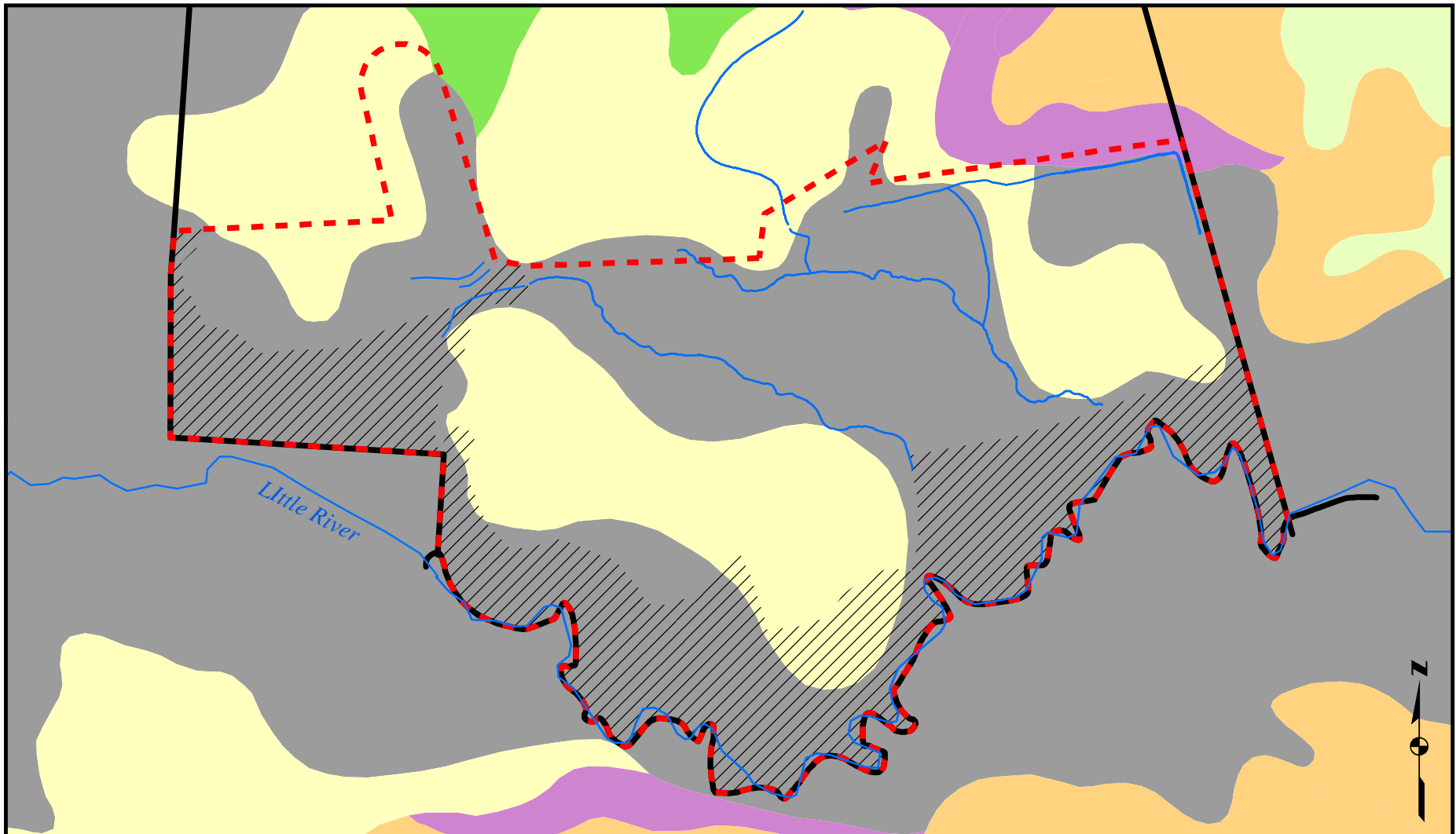


Figure 10.2 Watershed Map
 Little River Wetland Enhancement
 Moore County, NC
 July 2007



Stantec





Moore County Soil Survey

- AeB; AeD - Ailey
- Bb - Bibb
- GhB; GhD - Gilead
- KaA - Kalmia
- KeB - Kenansville
- VaB; VaD; VaE - Vaucluse

- Project Area
- Property Boundary
- Roads
- Streams/Ditches
- Bottomland Hardwood Forest (Reference)

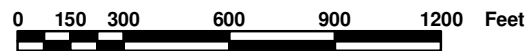
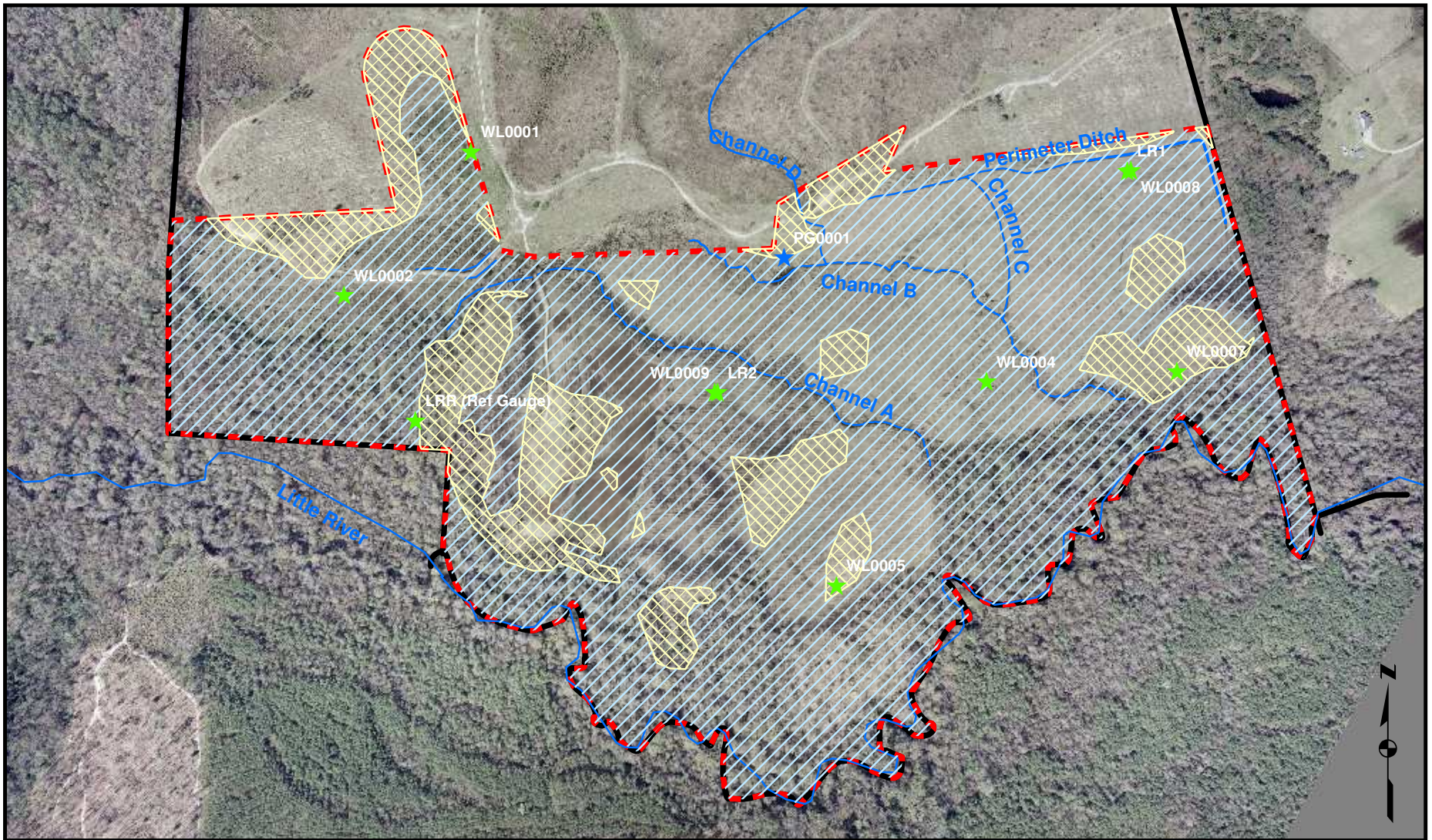


Figure 10.3 - NRCS Soil Survey Map

Little River Wetland Enhancement
 Moore County, NC
 July 2007





- Uplands (21 acres)
- Wetlands (105 acres)
- Precipitation Gauge
- Water Level Recorder
- Property Boundary
- Project Area
- Streams/Ditches

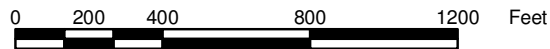
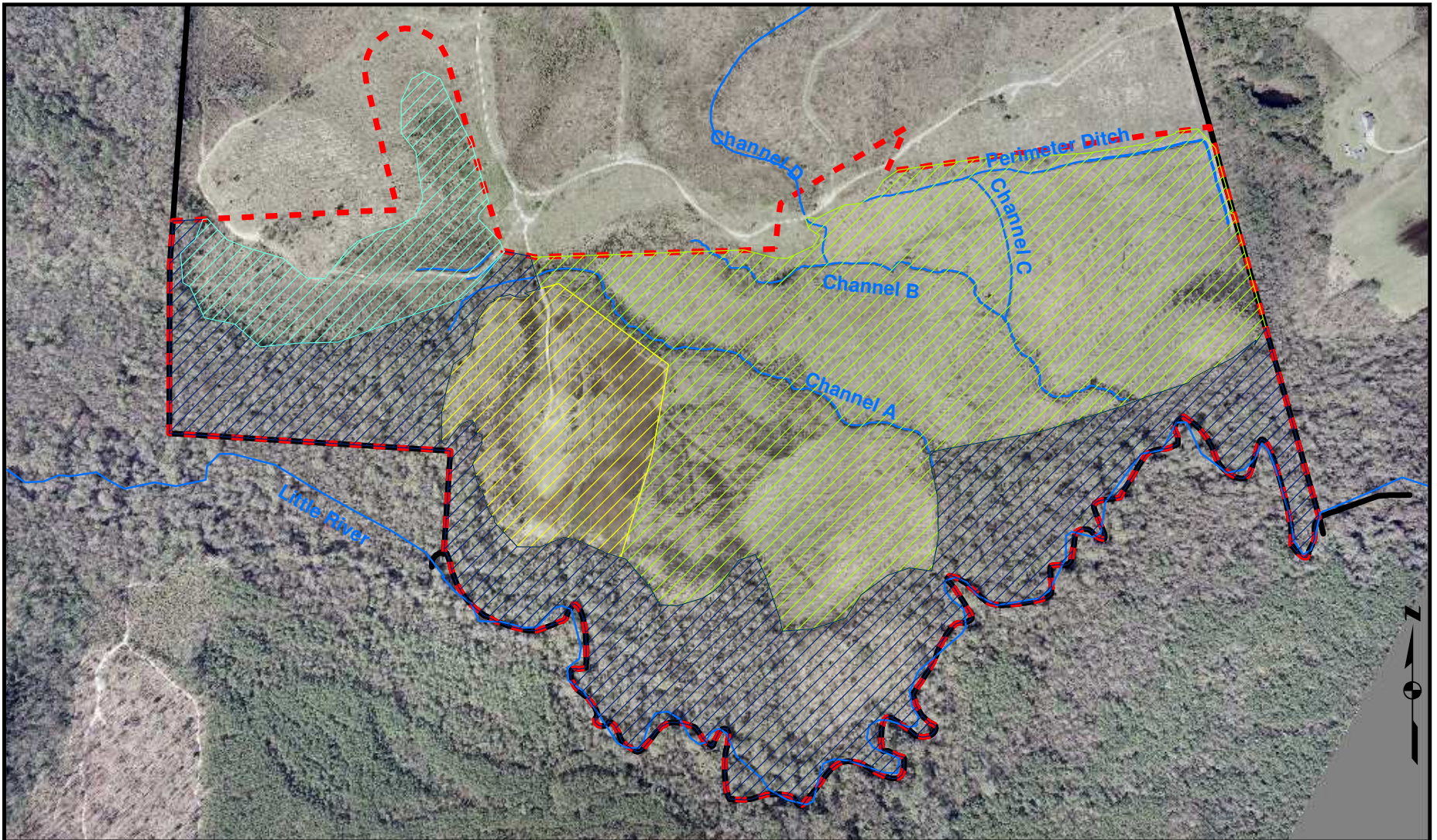









Figure 10.4 Hydrological Features

Little River Wetland Enhancement
 Moore County, NC
 July 2007



- | | |
|--|---|
|  Successional Wetland |  Property Boundary |
|  Grassy Field |  Project Area |
|  Bedded Pine Plantation |  Streams/Ditches |
|  Bottomland Hardwood Forest | |

0 200 400 800 1200 Feet


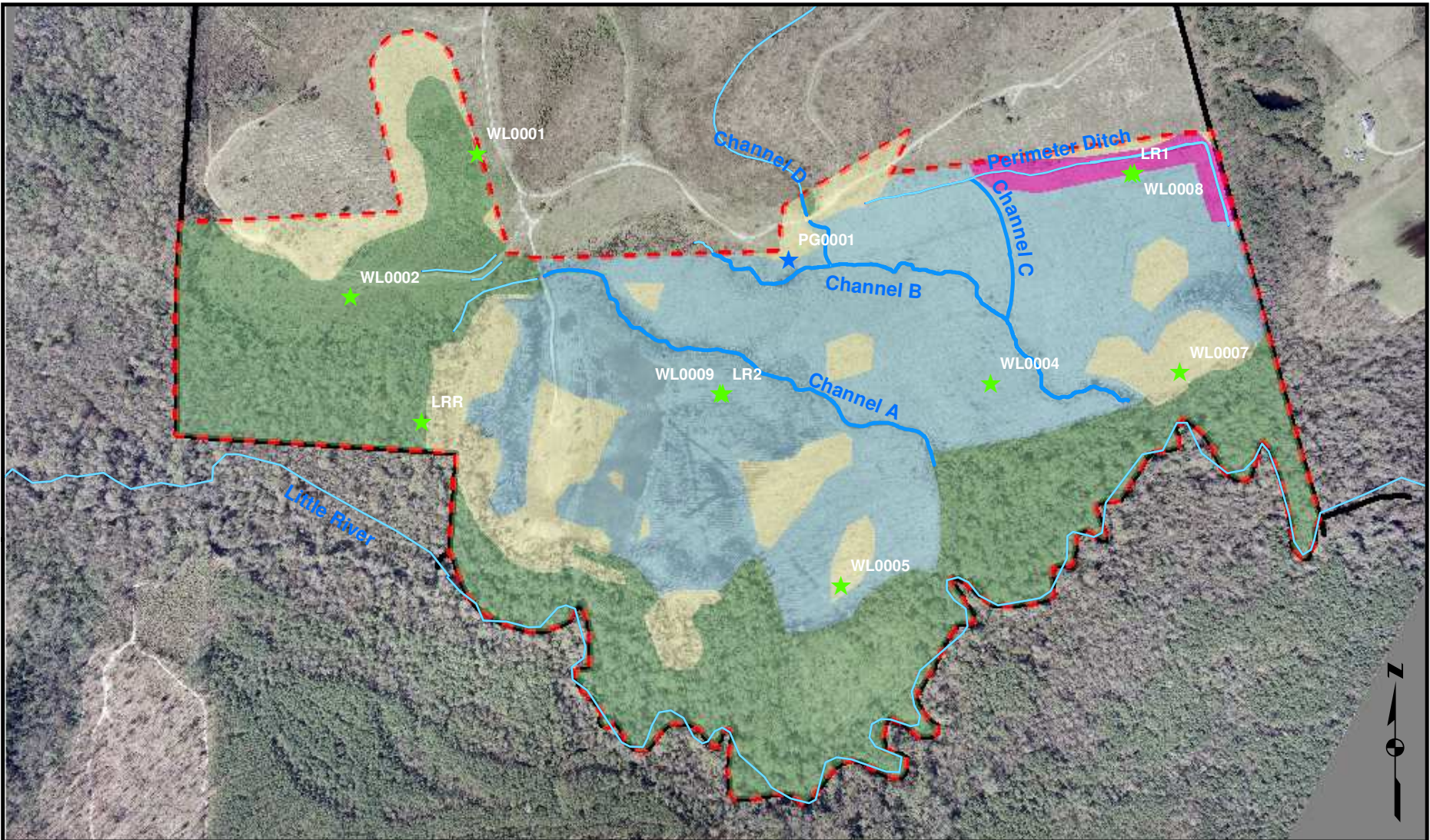



Figure 10.5 Vegetative Communities

Little River Wetland Enhancement
 Moore County, NC
 July 2007



- ★ Precipitation Gauge
- ★ Water Level Recorder
- Streams / Ditches
- Stream Preservation (4433lf)
- Project Area
- Wetland Enhancement (53.2ac)
- Wetland Preservation (49.5ac)
- Wetland Restoration (2.3ac)
- Upland
- Property Boundary

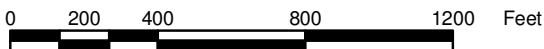


Figure 10.6 Restoration Summary Map

Little River Wetland Enhancement
 Moore County, NC
 July 2007

11.0 Designed Sheets

SHEET 11.1. CHANNEL PLUG DETAIL

SHEET 11.2. PLAN VIEW OF DITCH PLUG

SHEET 11.3. PLANTING PLAN

12.0 Appendices

APPENDIX 1. PHOTOGRAPHS

APPENDIX 2. STREAM CLASSIFICATION FORMS

APPENDIX 3. USACE ROUTINE WETLAND DETERMINATION DATA FORMS AND WETLAND RATING FORM

APPENDIX 4. HYDROLOGIC GAUGE DATA SUMMARY, GROUNDWATER AND RAINFALL INFORMATION

APPENDIX 5. SOIL TEST REPORTS

APPENDIX 1. PROJECT SITE PHOTOGRAPHS



Channel A



Channel B, facing downstream



Channel C



Channel D, facing downstream



Perimeter ditch



Beaver dam on channel B



Onsite bottomland hardwood forest
(reference wetland)



Onsite bottomland hardwood forest
(reference wetland)



Onsite bottomland hardwood forest
(reference wetland)



Pine plantation covers approximately 55 acres of the project site

APPENDIX 2. STREAM CLASSIFICATION FORMS

**APPENDIX 3. USACE ROUTINE WETLAND DETERMINATION DATA FORMS AND
DWQ WETLAND RATING FORMS**

DATA FORM
 ROUTINE WETLAND DETERMINATION
 (1987 COE Wetlands Delineation Manual)

Project/Site: Little River Bottomland Hardwood (reference)		Date: 7/3/07
Applicant / Owner: NC EEP		County: Moore
Investigator: A Coleman / M Ruiz		State: NC
Do Normal Circumstances exist on the site?	YES NO	Community ID: wetland
Is the site significantly disturbed (Atypical Situation)?	YES NO	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse)	YES NO	Plot ID: by well LRR

VEGETATION

Dominant Plant Species	Scientific Name	Stratum	Indicator
1 swamp tupelo	<i>Nyssa biflora</i>	Tree	OBL
2 smilax	<i>Smilax rotundifolia</i>	Herb	FAC
3 giant cane	<i>Arundinaria gigantea</i>	Herb	FACW
4 water oak	<i>Quercus nigra</i>	Herb	FAC
5			
6			
7			
8			
9			
10			
Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-): 100%			
Remarks:			

HYDROLOGY

<input type="checkbox"/> Recorded Data (Describe in Remarks) <input type="checkbox"/> Stream, Lake, or Tide Gauge <input type="checkbox"/> Aerial Photographs <input type="checkbox"/> Other <input checked="" type="checkbox"/> No Recorded Data Available		WETLAND HYDROLOGY INDICATORS Primary Indicators: <input type="checkbox"/> Inundated <input type="checkbox"/> Saturated in Upper 12 Inches <input checked="" type="checkbox"/> Water Marks <input checked="" type="checkbox"/> Drift Lines <input type="checkbox"/> Sediment Deposits <input checked="" type="checkbox"/> Drainage Patterns in Wetlands	
FIELD OBSERVATIONS		Secondary Indicators (2 or more Required)	
Depth of Surface Water	(in)	<input checked="" type="checkbox"/> Oxidized Root Channels in Upper 12 inches	
Depth of Free Water in Pit	2 (in)	<input checked="" type="checkbox"/> Water-stained Leaves	
Depth to Saturated Soil	2 (in)	<input checked="" type="checkbox"/> Local Soil Survey Data	
		<input checked="" type="checkbox"/> FAC-Neutral Test	
		<input type="checkbox"/> Other (Explain in Remarks)	
Remarks:			

SOILS

Map Unit Name (Series and Phase): Bibb				Drainage Class:	
Taxonomy (Subgroup):			Field Observations Confirm Mapped Type? YES NO		
PROFILE DESCRIPTION					
Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-7	A	10YR3/2			Sandy loam
7-18+	B	10YR4/2	10YR5/6 10YR2/1	Common Few	Clay
HYDRIC SOIL INDICATORS:					
<input type="checkbox"/> Histosol <input type="checkbox"/> Histic Epipedon <input type="checkbox"/> Sulfidic Odor <input type="checkbox"/> Aquic Moisture Regime <input type="checkbox"/> Reducing Conditions <input checked="" type="checkbox"/> Gleyed or Low-Chroma Colors		<input type="checkbox"/> Concretions <input type="checkbox"/> High Organic Content in Surface Layer in Sandy Soils <input type="checkbox"/> Organic Streaking in Sandy Soils <input type="checkbox"/> Listed on Local Hydric Soils List <input type="checkbox"/> Listed on National Hydric Soils List <input type="checkbox"/> Other (Explain in Remarks)			
Remarks:					

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	YES NO	Is this Sampling Point Within a Wetland? YES NO
Wetland Hydrology Present?	YES NO	
Hydric Soil Present?	YES NO	
Remarks:		

DATA FORM
 ROUTINE WETLAND DETERMINATION
 (1987 COE Wetlands Delineation Manual)

Project/Site: Little River Bottomland Hardwood (pine plantation)		Date: 7/3/07
Applicant / Owner: NC EEP		County: Moore
Investigator: A Coleman / M Ruiz		State: NC
Do Normal Circumstances exist on the site?	YES NO	Community ID: wetland
Is the site significantly disturbed (Atypical Situation)?	YES NO	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse)	YES NO	Plot ID: pine plantation

VEGETATION

Dominant Plant Species	Scientific Name	Stratum	Indicator
1 loblolly pine	<i>Pinus taeda</i>	Tree	FAC
2 titi	<i>Cyrilla racemiflora</i>	Shrub	FACW
3 red maple	<i>Acer rubrum</i>	Tree	FAC
4 sweetgum	<i>Liquidambar styraciflua</i>	Tree	FAC+
5			
6			
7			
8			
9			
10			
Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-): 100%			
Remarks:			

HYDROLOGY

<input checked="" type="checkbox"/> Recorded Data (Describe in Remarks) <input type="checkbox"/> Stream, Lake, or Tide Gauge <input type="checkbox"/> Aerial Photographs <input checked="" type="checkbox"/> Other <input type="checkbox"/> No Recorded Data Available		WETLAND HYDROLOGY INDICATORS Primary Indicators: <input type="checkbox"/> Inundated <input checked="" type="checkbox"/> Saturated in Upper 12 Inches <input type="checkbox"/> Water Marks <input type="checkbox"/> Drift Lines <input type="checkbox"/> Sediment Deposits <input type="checkbox"/> Drainage Patterns in Wetlands	
FIELD OBSERVATIONS		Secondary Indicators (2 or more Required) <input checked="" type="checkbox"/> Oxidized Root Channels in Upper 12 inches <input checked="" type="checkbox"/> Water-stained Leaves <input checked="" type="checkbox"/> Local Soil Survey Data <input checked="" type="checkbox"/> FAC-Neutral Test <input type="checkbox"/> Other (Explain in Remarks)	
Depth of Surface Water	(in)		
Depth of Free Water in Pit	7 (in)		
Depth to Saturated Soil	0 (in)		
Remarks: Groundwater wells on site: data meets USACE hydrology requirements			

SOILS

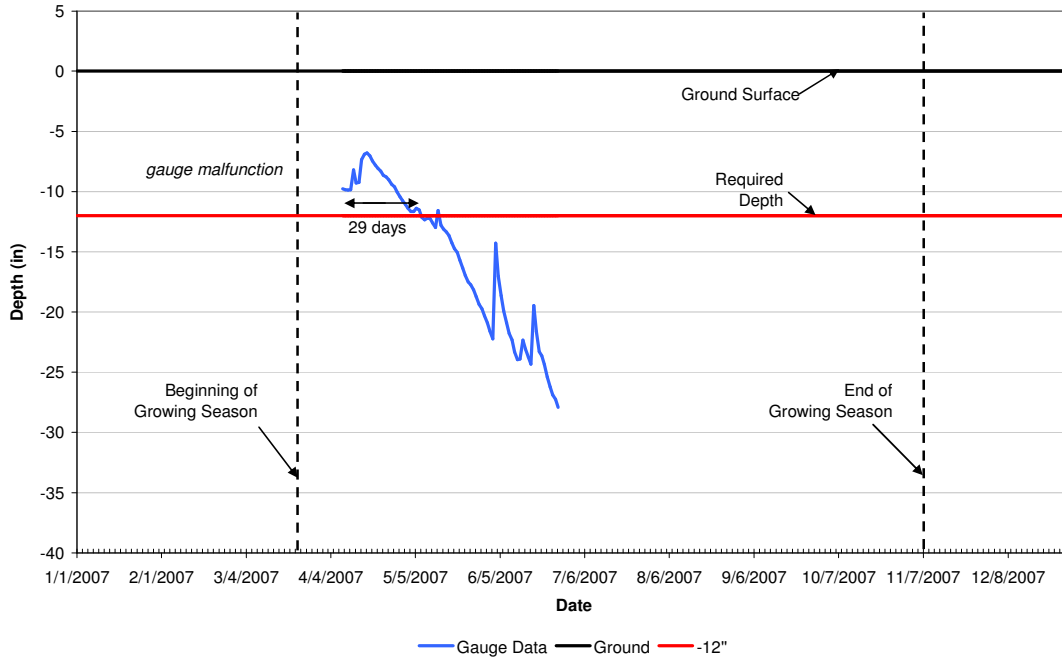
Map Unit Name (Series and Phase): Bibb				Drainage Class:	
Taxonomy (Subgroup):			Field Observations Confirm Mapped Type? YES NO		
PROFILE DESCRIPTION					
Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3	A	10YR4/2			Sandy loam
3-18+	B	10YR5/1	10YR2/1	Common	Clay
			7.5YR5/6	Few	
HYDRIC SOIL INDICATORS:					
<input type="checkbox"/> Histosol <input type="checkbox"/> Histic Epipedon <input type="checkbox"/> Sulfidic Odor <input type="checkbox"/> Aquic Moisture Regime <input checked="" type="checkbox"/> Reducing Conditions <input checked="" type="checkbox"/> Gleyed or Low-Chroma Colors		<input type="checkbox"/> Concretions <input type="checkbox"/> High Organic Content in Surface Layer in Sandy Soils <input type="checkbox"/> Organic Streaking in Sandy Soils <input type="checkbox"/> Listed on Local Hydric Soils List <input type="checkbox"/> Listed on National Hydric Soils List <input type="checkbox"/> Other (Explain in Remarks)			
Remarks:					

WETLAND DETERMINATION

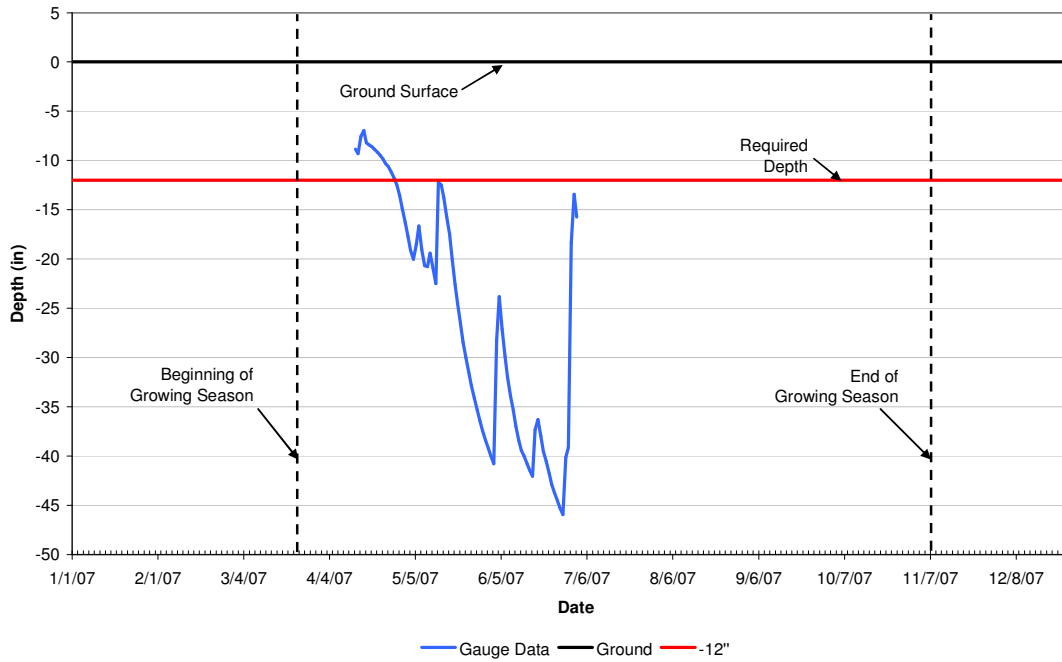
Hydrophytic Vegetation Present?	YES NO	Is this Sampling Point Within a Wetland? YES NO
Wetland Hydrology Present?	YES NO	
Hydric Soil Present?	YES NO	
Remarks:		

APPENDIX 4. HYDROLOGIC GAUGE DATA SUMMARY, GROUNDWATER AND RAINFALL INFORMATION

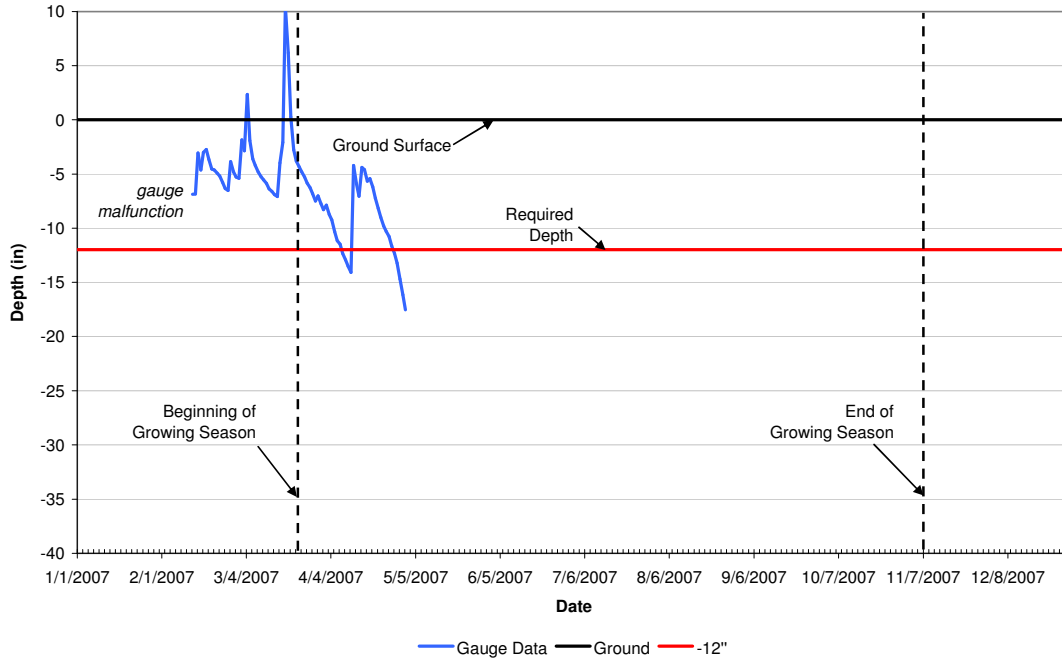
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**Little River - 2007 Groundwater Data
WL0004 (SN: N3EBAD4A)**



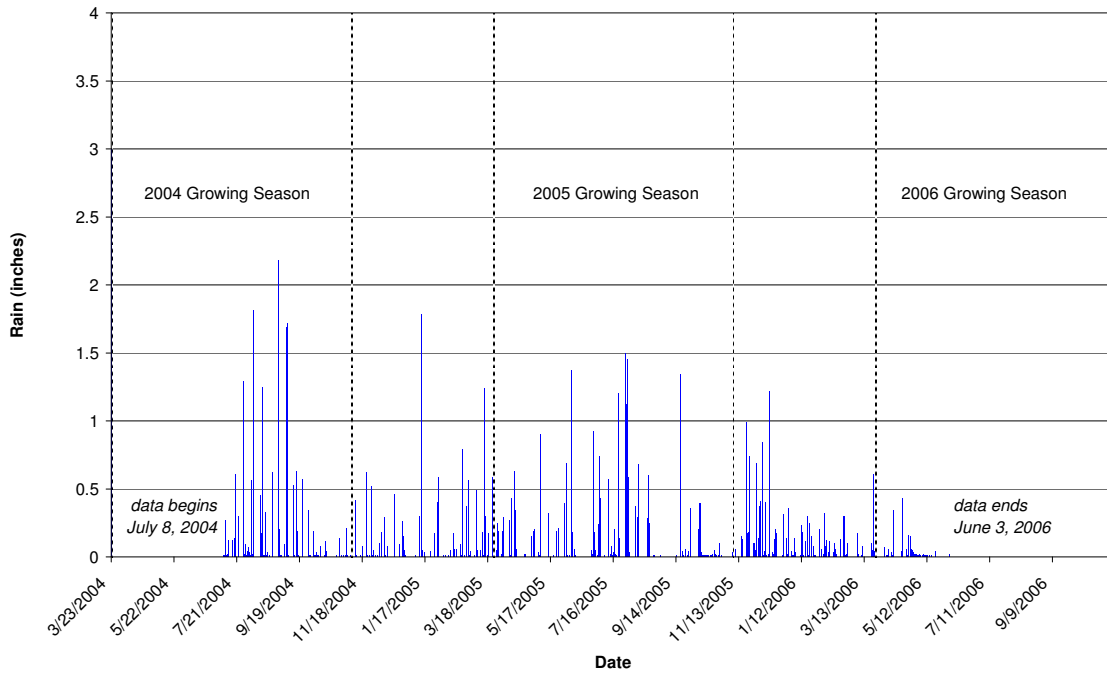
**Little River - 2007 Groundwater Data
WL0009 (SN: N3EBACE5)**



The following gauges contained no current data and were malfunctioning at the time of download:

- WL0002
- WL0005
- WL0007
- WL0008

Little River - Rainfall



APPENDIX 5. SOIL TEST REPORTS