Mt. Pleasant Creek Restoration Project
Bowman Property
Randolph County, North Carolina
SCO ID # 060678701

Restoration Plan Final

December 13, 2007

Prepared for:

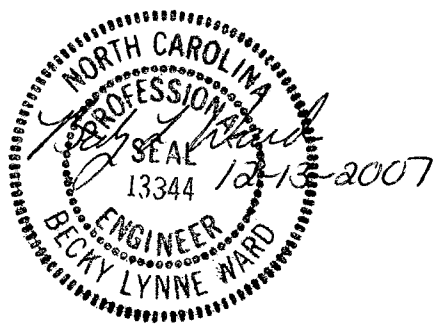
Ecosystem Enhancement

NCDENR-EEP
Parker Lincoln Building
2728 Capital Boulevard, Suite 1H-103
Raleigh, NC 27606

Mt. Pleasant Creek Restoration Project
Bowman Property
Randolph County, North Carolina
SCO ID # 060678701

Restoration Plan prepared by:

Ward Consulting Engineers, P.C.
Project Manager: Becky Ward
8386 Six Forks Road, Suite 101
Raleigh, NC 27615-5088
Ph: 919-870-0526
Fax: 919-870-5359



Becky L. Ward, P.E.

The Catena Group

Biological, Vegetative and Soils Analysis by:
The Catena Group Inc.
410-B Millstone Drive
Hillsborough, NC 27278
Ph: 919-732-1300
Fax: 919-732-1303

Executive Summary

Mt. Pleasant Creek is a perennial stream located in the Cape Fear River Basin in Randolph County, North Carolina. The portion of Mt. Pleasant Creek undergoing restoration in this project is an existing 1880 linear feet segment located on the property owned by Martha and Mickey Bowman.

The existing stream is an incised gravel bed G4 stream. The 5.24-acre watershed contributing drainage to the stream restoration segment is located in a rural setting. The Federal Emergency Management Agency (FEMA) has established 100-year water surface elevations and no-encroachment limits on Mt. Pleasant Creek. The adjacent land at the restoration site has been used for cattle grazing and has wooded uplands and a cleared floodplain field. A vegetated buffer along the stream, narrow on most of the right bank, is located within the stream corridor. The existing stream ranges from 28 to 40 feet wide at the top with steep to moderate side slopes. The channel has incised approximately 1.2 feet in depth along the stream length and has bank height ratios that range from 1.2 to 1.7.

The restoration goals for this project are:

- Improve water quality with the construction of stable stream banks, removal of cattle access, and the establishment of a protective buffer.
- Control transport of sediment due to clearing of adjacent floodplains.
- Improve the stream function and habitat with the connection of the channelized and incised stream back to its floodplain.
- Restore long-term stability with the restoration of channel pattern, profile and dimension.
- Improve in-stream habitat with the installation of root wads, constructed riffles and single wing rock vanes to enhance pool depths.

The project objectives will include:

- The restoration of 827 linear feet of stream with a Priority II Restoration and 657 linear feet of Priority I restoration in order to raise the stream elevation, reconnect the floodplain, restore pattern, and re-establish channel dimension.
- Enhance 173 liner feet through Priority II enhancement.
- Preserve 50 linear feet of stream.
- Establish a riparian buffer of a minimum of 15 linear feet from the stream bank with an average distance of 80 feet. Buffer enhancement on 3.7 acres along the stream length will be established with the planting of riparian vegetation and 4.72 acres of wooded buffer will be preserved.

The total proposed stream length of the project is 1707 linear feet. A reduction in stream length is proposed for this project. This reduction in length occurs within the Priority I restoration segment. The reduction is due to the following factors:

- Re-establishment of pattern and sinuosity appropriate for the stream size and future stability. The existing pattern in the Priority I restoration stream segment has a sinuosity which is 1.39 which is too high for the stability of this stream as

evidenced by its existing condition and was reduced to within the design parameters for the new channel.

- Confined relocation area between the existing conservation easement previously recorded by the NCDOT and the steep valley slope.
- Opportunity to preserve existing mature clusters of existing hardwood trees within the floodplain.

There are no wetlands present on the project site and therefore there are no potential impacts. The project is located in a Local Watershed Planning area.

TABLE OF CONTENTS

Longitudinal Profile

11.0 Appendices

Appendix 1. Restoration Site Photographs
Appendix 2. Restoration Site NCDWQ Stream Classification Forms
Appendix 3. Restoration Site Cross Sections
Appendix 4. Reference Site Photographs
Appendix 5. Reference Site NCDWQ Stream Classification Forms
Appendix 6. Reference Site Cross Sections
Appendix 7. HEC-RAS Analysis
Appendix 8. Restoration Site Soil Boring Location Map and Log
Appendix 9. Boundary Survey and Conservation Easement Dedication Map
Appendix 10. Categorical Exclusion Approved Check List

1.0 Introduction

The North Carolina Ecosystem Enhancement Program (EEP) will complete a stream restoration project along Mt. Pleasant Creek consisting of 1,609 linear feet of stream restoration, 115 feet of stream enhancement II, and 50 linear feet of stream preservation, located on the property of Mickey and Martha Bowman in Randolph County, North Carolina. The project begins at the intersection of the northern property line at Mt. Pleasant Creek and ends at the southwest corner of the property. Mt. Pleasant Creek flows from north to south within the property. The conservation easement acreage recorded on the project property is 9.70 Acres.

1.1 Directions to Project Site

The Bowman site is located approximately 0.5 miles northeast of the intersection of Ramseur Julian Road (SR 2442) and Whites Chapel Road (SR 2456) in Randolph County. From Raleigh, take U.S. Highway 64 west to Siler City and then take U.S. Highway 421 north to N.C. Highway 49. Take a left onto Highway 49 and go approximately 3 miles and take a right onto Whites Chapel Road. Stay on Whites Chapel Road for approximately 5 miles and then the access driveway will be located on the right side of the road.

1.2 USGS Hydrologic Unit Code

The United States Geological Survey (USGS) uses a multi-tiered system to divide and sub-divide the country's watersheds into successively smaller hydrological units. Each hydrologic unit is identified by a unique hydrologic unit code (HUC), consisting of various numbers of digits depending on the level of classification within the hydrologic unit system. Under the USGS system, the Cape Fear River basin contains seven 8-digit hydrologic units (New, Haw, Deep, Upper Cape Fear, Lower Cape Fear, Northeast Cape Fear, and Black). The Mt. Pleasant Creek-Bowman property project site is located in the Deep River Basin, HUC 03030003.

The 8-digit units are further sub-divided into smaller 14-digit hydrologic units that are used for smaller scale planning. The Project Site is located in the 14-digit HUC 03030003020010.

1.3 NC DWQ River Basin Designations

The North Carolina Division of Water Quality (NCDWQ) uses a two-tiered system to divide the state into watershed units. The state is divided into seventeen major river basins with each basin further subdivided into sub-basins (NCDWQ 6-digit sub-basins).

The project area is located within sub-basin 03-06-09 of the Cape Fear River Basin (DWQ 2000). This area is part of USGS Hydrologic Unit 03030003 of the South Atlantic/Gulf Region. This river basin covers 9,393 square miles (24,328 square kilometers) and 24 counties (DWQ 2005).

1.4 Project Vicinity Map

The project vicinity map is included in Section 9.0, Figure 1. An aerial vicinity map is included on Figure 2.

Longitudinal Profile

11.0 Appendices

Appendix 1. Restoration Site Photographs
Appendix 2. Restoration Site NCDWQ Stream Classification Forms
Appendix 3. Restoration Site Cross Sections
Appendix 4. Reference Site Photographs
Appendix 5. Reference Site NCDWQ Stream Classification Forms
Appendix 6. Reference Site Cross Sections
Appendix 7. HEC-RAS Analysis
Appendix 8. Restoration Site Soil Boring Location Map and Log
Appendix 9. Boundary Survey and Conservation Easement Dedication Map
Appendix 10. Categorical Exclusion Approved Check List

2.0 Watershed Characterization

2.1 Drainage Area

The drainage area for this project is approximately 5.24 square miles at the down stream limit, approximately ½ mile (2,640 feet) upstream of where Mount Pleasant Creek crosses Ramseur Julian Road (Section 9, Figure 3). The watershed consists mainly of forested land with some land cleared for agriculture and livestock. This area is seeing more residential development but remains predominantly rural in nature. The watershed is bounded on the south by Whites Chapel Road, to the east by Highway 49, to the north by Sandy Creek Church Road and then the boundary heads southwest along the ridgeline, crossing Ramseur Julian Road before turning back towards the southeast, crossing Ramseur Julian Road again, towards the down stream limit of the project.

2.2 Surface Water Classification / Water Quality

Best Usage Classifications are ranks assigned to each surface water body by the NCDWQ in accordance with *Procedures for Assignment of Water Quality Standards* (15A NCAC 2B .0100) and *Classifications and Water Quality Standards Applicable to the Surface Waters of North Carolina* (15A NCAC 2B .0200). These classifications serve to protect water quality by governing the uses of the water resource.

Mount Pleasant Creek is the only perennial stream located within the project area (DWQ Stream Index Number 17-16-3), (Section 9.0, Figure 5). DWQ classifies Mount Pleasant Creek as **WS-III**. The "**WS-III**" classification indicates waters used as sources of potable water where a more protective WS-I or II classification is not feasible. These waters are also protected for Class C uses. WS-III waters are generally in *low to moderately developed* watersheds. General discharge permits only are allowed near the water supply intake whereas domestic and non-process industrial discharges are allowed in the rest of the water supply watershed. Mount Pleasant Creek leaves the project area and flows into Sandy Creek approximately 2.5 river miles (RM) past the downstream project limits. Sandy Creek flows into the Deep River approximately 4 RM downstream of its confluence with Mount Pleasant Creek, under Highways 64/49 just west of the town of Ramseur.

A stream evaluation of Mount Pleasant Creek determined it to be a perennial stream (Appendix 2). Therefore, surface waters within the embankments of Mount Pleasant Creek are subject to jurisdictional consideration under Section 404 of the Clean Water Act as waters of the U.S. (33 CFR Section 328.3).

2.3 Physiography, Geology and Soils

Slopes within the watershed range from 23% along some of the ridgelines to 4% in the valleys near the streams. The majority of land use in the watershed is upland forest (65%), with some land cleared for agriculture (30%) and the rest of the land either open water such as ponds, wetlands, and roadways. The highest elevations are in the interior ridgelines in the watershed, with elevations above 820 feet above sea level in some locations. The lowest elevation occurs along Mount Pleasant Creek near the downstream limit of the project and is approximately 540 feet above sea level, for a difference of 280 feet within the watershed.

The geology of this area is characterized by the Carolina Slate Belt soil system (Daniels, Buol, Kleiss, & Ditzler, 1999). The major rocks are volcanic argillites, basic and acid tuffs, breccias and flows. Volcanic igneous rocks rise above the surrounding slates as high rolling hills and small mountains. The topography of the Carolina Slate Belt has both similarities to and differences from the rest of the Piedmont. The interfluves are irregular, and sharp topographic breaks such as knolls and saddles are common. The valley sides are relatively short. Thick soils tend to occur on the smoother parts of the Slate Belt and thin soils occur on the broken or sharply irregular landscapes. Alluvial fills in the small streams draining the Slate Belt are narrow, shallow to hard rock, and contain an abundance of slate fragments. The small first and second order ephemeral streams or drainage ways are short and stubby with high angle junctions. Alignment of tributaries across the main stream is common and probably related to the underlying rock structures. Right angle turns are also common in the main channels (Daniels, Buol, Kleiss, & Ditzler, 1999).

Most of the non-eroded or moderately eroded soils have silt loam surfaces and over 30 percent silt plus have fine sand in the B horizon. Soils formed in the Carolina Slate Belt have relatively high silt contents and overlie relatively thin saprolite compared to soils formed in the felsic crystalline areas. Soils in the Slate system have more slowly permeable B horizons and saprolite than their felsic crystalline counterparts.

A detailed soil delineation was performed on the site utilizing numerous auger borings. Appendix 8 includes a soil boring location map and logs. The borings confirmed that the majority of the project area is dominated by variations of the Georgeville soil series as mapped by NRCS. Table 2.3.1 below presents a typical profile description for the Georgeville series

Table 2.3: Typical Profile for the Georgeville Soil Series

Horizon Name	Depth	Soil Color	Texture/Structure
Soil Unit 1:			
Ap	0-8	2.5 YR4/6	Silt loam/gr
Bt	8-30	2.5 YR4/8	Clay/sbk
BC	30-44	2.5 YR4/8	Sandy clay loam/sbk

2.4 Historical Land Use and Development Trends

There are no identified archeological or historical preservation sites located within the project area as determined in the feasibility study prepared by The North Carolina Department of Transportation and Kimley-Horn and Associates, Inc. The land is used by the Bowman's for growing crops, grazing cattle, and raising chickens. Cattle have not been totally fenced out of the stream and therefore a portion of the stream banks have been impacted by these large animals. The riparian area adjacent to the bank has a small buffer of vegetation that extends approximately 10 to 15 feet beyond the stream banks. Steep slopes to the south and east of the stream have prevented much clearing. West and north of the stream bank the land has been cleared and has been used for grazing cattle. Most of the current cleared area is outside of the conservation easement and will remain open for grazing cattle. Watershed land use is shown in Table 3. The watershed development is primarily farming and residential. No extensive development is expected within this watershed within the near future.

2.5 Endangered/Threatened Species

Some populations of fauna and flora have been in, or are in, the process of decline due to either natural forces or their inability to coexist with human activities. Federal law requires that any action, which has the potential to have a detrimental impact to the survival and well being of any species classified as federally protected, is subject to review by the US Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service (NMFS), under the provisions of the Endangered Species Act (ESA) of 1973, as amended. Endangered species may receive additional protection under separate state statutes. In North Carolina, protection of plant species falls under N.C. General Statutes (G.S.) 106 202.12 to 106-202.19 of 1979. Wildlife protection falls under G.S. 113-331 to 113-337 of 1987.

2.6 Federally Protected Species

Plants and animals with federal classifications of Endangered, Threatened, Proposed Endangered, and Proposed Threatened are protected under provisions of Sections 7 and 9 of the Endangered Species Act of 1973, as amended. As of January 17, 2007, the USFWS lists two species of plants and animals as federally protected species for Randolph County (Table 2.6.1).

Table 2.6: Federally Endangered Species Listed for Randolph County, NC.

Common Name	Scientific name	Status
Cape Fear shiner	*Notropis mekistocholas*	E
Schweinitz's sunflower	*Helianthus schweinitzii*	E

Cape Fear shiner ***Notropis mekistocholas***
Status: Endangered
Famliy: Cyprinidae
Listed: September 26, 1987
The Cape Fear shiner is a small, moderately stocky Cyprinid described by Snelson (1971). The fish's body is flushed, pale, silvery, yellow, with a black band running along the side. The fins are yellowish and somewhat pointed. The upper lip is black and the lower lip bears a thin black bar along its margin.

The Cape Fear shiner is distinguished from all other *Notropis* by having an elongated alimentary tract with two convolutions crossing the intestinal bulb. This is believed to be an adaptation for herbivorous feeding (Snelson 1971, USFWS 1988).

Current distribution of the Cape Fear shiner is limited mainly to small stretches of the Deep, Haw, and Rocky Rivers of the Cape Fear River basin. It is possible that it has always been rare and restricted in range; however a reduction in the historical range has been demonstrated (USFWS 1988). Approximately 17 RM of the Deep, Haw, and Rocky Rivers have been designated as federal Critical Habitat for the Cape Fear shiner (50 CFR Vol. 52 No. 186).

Typical habitat for the Cape Fear shiner has been described as slow pools, riffles, and slow runs over gravel, cobble, and boulder substrates (Snelson 1971, Pottern and Huish 1985). It has been suggested that essential spawning habitat for this species is associated with water willow (*Justicia americana*) beds, as Catch per Unit Effort (CPUE) were higher in water willow beds (NCWRC 1995), however recent micro-habitat studies did not support an association with water

willow during the spawning season (Howard 2003). Water willow may still provide protection from predators as well as water velocity refugia for depositing eggs (Howard 2003).

The restricted range and small population sizes make this species vulnerable to catastrophic events, such as toxic chemical spills (USFWS 1988). Inundation of habitat and restriction of flow regimes, which have resulted from multiple dam construction projects in the Cape Fear system, is likely the most significant factor that contributed to the species decline (USFWS 1988). Sedimentation of habitat, particularly that of water willow beds, also threatens the species.

Biological Conclusion **No Effect**

The Cape Fear Shiner is limited primarily to small stretches of the Deep, Haw, and Rocky Rivers of the Cape Fear River basin (USFWS 1988). The most recent data on the Cape Fear shiner population in the Deep River indicate that it is not currently known upstream of the Coleridge dam on the Deep River. Mount Pleasant Creek, a tributary in the Deep River watershed above Coleridge dam, flows through the Bowman site. This portion of the stream is fairly narrow and shallow and does not contain habitat elements (shallow rocky shoals) typical of the water bodies where the Cape Fear Shiner is currently known to occur. Mount Pleasant Creek flows into Sandy Creek which is dammed shortly before its confluence with the Deep River. There is an additional dam on the Deep River in Ramseur, upstream of the Coleridge dam. Although the Cape Fear shiner is reported to utilize smaller tributaries during high water periods in winter months (http://www.fws.gov/nc-es/fish/CFS_Fact_Sheet1.pdf), the presence of the dam on Sandy Creek, as well as the two dams on the Deep River (Ramseur and Coleridge) would restrict the species from utilizing the stream in the project area. Based on the lack of typical habitat and the presence of barriers between occupied habitat and the project area, it can be concluded that the proposed stream mitigation project will have "**No Effect**" on the Cape Fear shiner. Additionally, strict erosion control measures and BMPs should be utilized during construction to protect downstream aquatic habitats.

Schweinitz's Sunflower ***Helianthus schweinitzii***

Status: Endangered
Family: Asteraceae
Listed: 05/07/91
Flowers: Late August – first frost

Schweinitz's sunflower is a perennial herb endemic to the piedmont of North and South Carolina. The species can grow to six feet in height, but can be substantially shorter. The stem is usually unbranched in its lower portion, while the terminal one-third of the stem is freely branched. The stem is usually pubescent but can be nearly glabrous and it is often purple. The leaves are sessile to short-petiolate, lanceolate, 5 to 10 times as long as wide, scabrous above, with dense soft white hairs below. Schweinitz's sunflower has relatively small heads; the disk is 6 to 15 millimeters across and the flowers are yellow. Schweinitz's sunflower has thickened, tuberous rhizomes which store starch (USFWS 1994).

Schweinitz's sunflower is known to occur along roadsides, power line clearings, old pastures, woodland openings, and other sun-exposed areas. It is typically located on poor, clayey, or rocky

soils, especially those derived from mafic parent materials. The species historically occurred in prairielike habitats or oak savannas maintained by fires. Fire suppression and urbanization have resulted in the species decline (USFWS 1994).

Schweinitz's sunflower is presently believed to occur only in the lower Piedmont of south-central North Carolina and north-central South Carolina. The species is currently known from Anson, Cabarrus, Davidson, Gaston, Mecklenburg, Montgomery, Randolph, Rowan, Stanly, Stokes, Surry and Union counties in North Carolina (USFWS 1994).

Biological Conclusion **No Effect**

Potential habitat exists for Schweinitz's sunflower on the Bowman property along pasture and road edges but not in the proposed area of impact of steam restoration activities. Surveys were conducted on September 24, 2007, by Kate Montieth and Jennifer Logan of The Catena Group and no plants were found. The nearest known population of Schweinitz's sunflower is over eight miles away, northeast of Asheboro. Given the fact that potential habitat on the site is outside of the area of impact and the fact that no individuals were found during surveys, it can be concluded that the proposed stream mitigation project will have "**No Effect**" on Schweinitz's sunflower.

2.7 Federal Species of Concern

There are 10 Federal Species of Concern (FSC) listed by the USFWS for Randolph County (Table 2.7.1). FSC are not afforded federal protection under the Endangered Species Act of 1973, as amended, and are not subject to any of its provisions, including Section 7, until they are formally proposed or listed as Threatened or Endangered. FSC species are those under consideration for listing or for which there is insufficient information to support listing. In addition, FSCs which are listed as Endangered, Threatened, or Special Concern by the NCNHP list of Rare Plant and Animal Species are afforded state protection under the NC State Endangered Species Act and the NC Plant Protection and Conservation Act of 1979, as amended. Table 2.7.1 summarizes federal species of concern listed for Randolph Counties (January 17, 2007 USFWS list)

Table 2.7: Federal Species of Concern Listed for Randolph County, NC.

Common Name	Scientific name	Record
Vertebrate:		
American eel	*Anguilla rostrata*	FSC
Carolina darter	*Etheostoma collis collis*	FSC
Carolina redhorse	*Moxostoma sp. 2*	FSC
Invertebrate:		
Atlantic pigtoe	*Fusconaia masoni*	FSC
brook floater	*Alasmidonta varicosa*	FSC
Carolina creekshell	*Villosa vaughaniana*	FSC
Savannah lilliput	*Toxolasma pullus*	FSC
yellow lampmussel	*Lampsilis cariosa*	FSC
Vascular Plant:		
Georgia aster	*Symphyotrichum georgianum*	C
birdsfoot-trefoil	*Lotus unifoliolatus var. Helleri*	FSC

2.8 Cultural Resources

NCDOT Project Development and Environmental Analysis Branch conducted a feasibility study for the Bowman Site in 2004. The report states that files were reviewed at both the North Carolina Archeology Office and the North Carolina State Historical Preservation Office on December 12, 2003, and all records indicated no known archeological or historically relevant site within the project area.

2.9 Potential Constraints

2.9.1 Property Ownership and Boundary

The restoration segment of Mt. Pleasant Creek is located on a 5.26 square mile tract of land located approximately 3 miles north of the Town of Ramseur in Randolph County, North Carolina. The Tax ID of the Bowman property that will undergo restoration is 8714143409. Mt. Pleasant Creek enters the Bowman property on the northern end and flows approximately 1750 feet before exiting the property at the southwestern corner. The restoration project is contained entirely on this property and a conservation easement has been agreed upon with the owner and recorded.

2.9.2 Site Access

Entry to the site will be through an access easement described as a part of the conservation easement set by the North Carolina Department of Transportation. The access to the site begins on the north side of Whites Chapel Road to the east of its intersection with Ramseur Julian Road on an existing dirt roadway that travels along the western border of a parcel (ID #8714322622) owned by Hampton L. Kivett. The access road has a twenty-foot easement on the Kivett property. It continues north along the west border of the next property (ID #8714243166), which is owned by the Bowman's. The access road then enters the restoration site at the southeast corner. The existing roadway runs west between the chicken barns and the existing residence. This roadway turns to the north at a distance of approximately 300 feet. At this location the alignment for the road that will serve as the construction and future permanent access continues to the west. A ford crossing the stream will be established on this alignment and will tie into an existing dirt roadway on the west side of the stream. This road runs parallel to Mt. Pleasant creek offset at a distance of approximately 50 feet north of the right bank to the end of the project area. The existing stream crossing will be removed in the restoration. This proposed site access road is shown in Section 9, Figure 2 and in Appendix 9.

2.9.3 Utilities

No utilities exist within the project area.

2.9.4 FEMA/Hydrologic Trespass

Mt. Pleasant Creek is a Federal Emergency Management Agency (FEMA) regulated stream and is located on FIRM Panel 8714, community number 370195 within Randolph County unincorporated areas, North Carolina. The North Carolina Flood Mapping Program completed a limited detailed study with the new mapping preliminarily released November 30, 2006, which established base 100-year flood elevations and non-encroachment limits for this stream. FEMA cross-sections 14000, 14500, 15000, and 15500 fall within the restoration area. Cross section 14000 is located approximately 52 feet upstream of the downstream limit of the project. FEMA requires that no rise in 100-year water surface elevations occur on Mt. Pleasant Creek due to the

stream restoration project. A no rise certification package will be submitted to the Randolph County Floodplain Administrator for approval. A Letter of Map Revision (LOMR) will be required to be submitted to FEMA after construction is complete

Project Site Streams

3.1 Channel Classification

The existing Mount Pleasant Creek classifies as a "G4" channel. The "G" or "gully" stream type is an entrenched, narrow, and deep, step/pool channel with a low to moderate sinuosity. The "G" stream types typically have very high erosion rates and a high sediment supply (Rosgen, 1996). The "4" in the classification describes the channel further as a gravel bed stream.

3.2 Discharge

The drainage area to the end of the project limits is approximately 5.26 square miles and consists of moderate to steeply sloping terrain. The estimated bankfull discharge is approximately 300 cubic feet per second (cfs). The watershed discharge is based on the measured channel bankfull field cross sections. The TR-55 methodology is applied to the watershed to assist in the validation of these bankfull discharges. Bankfull is located within the incised channel banks approximately 1.2 feet below the existing top of bank and floodplain along the entire reach. A large natural rock waterfall is located approximately 125 feet upstream of the project site. At this location the channel rises in elevation approximately 1.5 feet and the top of the existing bank is at bankfull. The existing channel between the rock waterfall and the beginning of the project is very wooded and is in good condition. The owner of the upstream property was approached for inclusion into a stream restoration project in the past and declined any participation.

Almost the entire stream is in a broad floodplain. The valley narrows within the last two hundred and twenty feet of stream and the stream straightens. At this location, a long riffle covers most of the channel bottom length.

3.3 Channel Morphology

The morphological characteristics of the seven (7) cross sections surveyed on Mount Pleasant Creek are shown in Table 4. The restoration plans sheets 1-4, located in Section 10, show the existing channel conditions of Mt. Pleasant Creek and the locations of the seven (7) surveyed cross sections. The table compares the Creek with the morphological characteristics of the reference reach.

On the restoration site, Mt. Pleasant Creek is located at the edge of a broad floodplain. The land to the north and west of the stream is pasture on gentle slopes and the land to the east and south is primarily woods located on steeper slopes. The stream has sinuosity and an established riffle pool sequence. The riffle and pool locations within the pattern however do not correspond with typical locations for these features. The riffles often extend into or through the bends in the stream where pools are typically found. The riffles are, in some instances, very short and the pools extensively long.

The dimensions of the existing channel are narrower and deeper due to the head cut that has occurred through this area. The channel has lowered approximately 1.2 feet beyond the floodplain and has increased the channels cross sectional area and therefore its capacity to carry

larger storm events. The existing stream banks are generally steep in slope. The pool widths and cross sectional areas are not very much larger than the riffle sections with a ratio of pool area to bankfull area of only 1.1. Some of the stream widths in the upper section of the restoration reach have been enlarged due to severe erosion on the banks. This erosion is primarily due to lack of bank vegetation and prior cattle access.
The profile of the stream shows an inconsistent pattern of many short small pools between short and sometimes very long stretches of riffles. The lower portion of the stream slope is at a steeper slope than the upper 1/3 of the stream, which shows a flatter gradient. This change in grade occurs at the existing ford in the stream.

3.4 Channel Stability Assessment

The channel stability assessment was based on observations made in evaluating bank erosion potential with the Rosgen method of completing a Bank Erosion Hazard Index (BEHI). BEHI indexes were evaluated along each side of the stream bank for the entire restoration length of Mt. Pleasant Creek. The stability assessment showed that 64 % of the stream length had banks that classified with moderate to high bank erosion potential. The bank erosion rate for the restoration segment of Mt. Pleasant Creek was estimated to be 35.5 tons per year based on the current bank conditions. The channel stability assessment for Mount Pleasant Creek is listed in Table 5.

3.5 Bankfull Verification

Bankfull Verification on Mount Pleasant Creek was completed with a comparison of field surveyed cross sections along the steam to typical bankfull width, area, depth, and discharge relationships. The watershed predicted discharges were compared with the bankfull channel capacities for verification. The Rural Piedmont Regional Curves developed by the North Carolina State University (NCSU) Water Quality Group were used to verify acceptable limits of morphological characteristics based on a hydro-physiographic region and drainage area. The average bankfull cross sectional area, width, and depth for Mount Pleasant Creek fell within the confidence limits of the North Carolina Rural Regional curves.

3.6 Vegetation

Plant community classifications follow those presented by Schafale and Weakley (1990) where possible. The dominant flora observed, or likely to occur, in each community are described and discussed.

Scientific nomenclature and the common names (when applicable) are provided. Plant taxonomy typically follows Radford et al. (1968), Petrides (1998), and Thieret et.al. (2001). All subsequent references to the same organism will include the common name only. Published range distributions and habitat analysis are used in estimating flora expected to be present within the project area.

The restoration site vegetative communities as described below are shown in Figure 6.

Piedmont/ Low Mountain Alluvial Forest

This community is located along Mount Pleasant Creek which transitions into Pasture/Disturbed community in adjacent cleared areas and Dry-Mesic-Oak-Hickory Forest in more upland forested areas on the property. The canopy consists of tulip poplar (*Liriodendron tulipifera*),

forested areas on the property. The canopy consists of tulip poplar (*Liriodendron tulipifera*), sweet gum (*Liquidambar styraciflua*), sycamore (*Platanus occidentalis*), hackberry (*Celtis laevigata*), box elder (*Acer negundo*), American elm (*Ulmus americana*), red maple (*Acer rubrum*), and black walnut (*Juglans nigra*). Sub-canopy and shrub species include ironwood (*Carpinus caroliniana*), pawpaw (*Asimina triloba*), box elder, tag alder (*Alnus serrulata*), elderberry (*Sambucus canadensis*), and painted buckeye (*Aesculus sylvatica*). The herbaceous layer includes Christmas fern (*Polystichum acrostichoides*), poison ivy (*Toxicodendron radicans*), greenbriars (*Smilax spp.*), violets (*Viola spp.*), Southern trout lily (*Erythronium umbilicatum spp. umbilicatum*), and spring beauty (*Claytonia virginica*).

Dry-Mesic-Oak-Hickory Forest

This was historically one of the predominant community types of the piedmont, occurring on mid slopes and upland flats. Much of these areas have been converted to agricultural/forestry lands, or urban development. This community type is fairly common in the project physiographic region, although much of the tracts have been fragmented and are not of significant size, or quality, which is the case within the areas observed on the Bowman property. The moisture regime of this community type ranges from dry to mesic, and is dependent on topographic position and level of canopy disturbance. This community gradates into the Pastureland/Disturbed community and the Piedmont/Low Mountain Alluvial Forest along Mount Pleasant Creek.

White oak (*Quercus alba*) is the most dominate canopy species, with red oak (*Q. rubra*), loblolly pine (*Pinus taeda*), mockernut hickory (*Carya tomentosa*), and sweetgum comprising the remainder of the canopy. More mesophytic species such as yellow poplar and red maple are dominant in lower topographic areas. Subcanopy species include flowering dogwood (*Cornus florida*), sourwood (*Oxydendron arboreum*), red maple, black gum (*Nyssa sylvatica*), American holly (*Ilex opaca*) and black cherry (*Prunus serotina*). The herbaceous component is generally sparse with Christmas fern (*Polystichium acrosticoides*), spotted wintergreen (*Chimaphila maculata*), cranefly orchid (*Tipularia discolor*) being common species.

Pasture/Disturbed Community

The pasture/disturbed community on the Bowman site is intermittently used as pastureland and as a result is undergoing various stages of succession. The plant community is dominated by fescue (*Festuca spp.*), little bluestem (*Schizachyrium spp.*), and other grasses. There is the sparse scattering of immature canopy species such as loblolly pine (*Pinus taeda*), sweet gum, box elder, and Eastern red cedar (*Juniperus virginiana*) in these open areas. Shrub and herbaceous species such as multiflora rose (*Rosa multiflora*), blackberry (*Rubus spp.*), and the invasive exotic Chinese privet (*Ligustrum sinense*) are present especially along fence lines and transitional margins.

3.0 Reference Streams

3.1 Watershed Characterization

Little Brush Creek located in the mid-western part of Chatham County, North Carolina, was used for the reference reach for this project, Figure 7. The reference reach is located south of the Oakley Church Rd and Airport Rd intersection and is approximately 3.5 miles south and 3 miles west of Siler City, NC. The drainage area is approximately 3.98 square miles and consists

mostly of woods and grazing areas along with some residential areas and a small airport in the northern part of the watershed. The soils surrounding Little Brush Creek consist mostly of Riverview Silt Loam and Georgeville Silt Loam. Riverview Silt Loam is described as a well-drained soil that is frequently flooded and has 0 to 3 percent slopes. Georgeville Silt Loam is described as a well-drained soil on uplands with 2 to 6 percent slopes and a loamy surface layer with clayey subsoil. Other soils present in the watershed include Georgeville Silty Clay Loam, Georgeville-Badin complex, Herndon Silt Loam, Nanford-Badin complex, Riverview Silt Loam, Callison-Lignum complex, Callison-Misenheimer complex, and Cid-Lignum complex. The Georgeville-Badin complex soil type has the Hydrologic soil properties of both a B and C type, but due to all of the surrounding soil types being of B hydrologic soil type it was assumed to be B type for purposes of modeling.

3.2 Channel Classification

Little Brush Creek is located in a primarily wooded area. The stream classifies as a C4 stream type. The "C" stream types are located in narrow to wide valleys, constructed from alluvial deposition. They have a well developed floodplain that is slightly entrenched, are relatively sinuous with a channel slope of 2% or less and a bedform morphology indicative of a riffle/pool configuration. The C-type streams also exhibit a sequencing of steps (riffles) and flats (pools) that are linked to the meander geometry of the river where the riffle/pool sequence or spacing is approximately 5-7 bankfull channel widths. The primary morphological features of the "C" stream type are the sinuous, low relief channel, the well developed floodplains built by the river, and characteristic "point bars" within the active channel. The channel aggradation/degradation and lateral extension processes, notably active in "C" stream types, are dependent on the natural stability of streambank, the existing upstream watershed conditions and flow and sediment regime. These channels can be significantly altered and rapidly de-stabilized when the effects of imposed changes in bank stability, watershed conditions, or flow regime are combined to cause an exceedance of a channel stability threshold (Rosgen, 1996).

3.3 Discharge

The drainage area at the downstream limit of the reference reach is approximately 3.98 square miles and the discharge is approximately 315 cfs. The stream discharge was predicted with the SCS TR55 methodology to evaluate the watershed. The discharge amounts were compared to discharges generated from field-surveyed bankfull cross section areas. Bankfull is located at the top or very close to the top of the channel.

3.4 Channel Morphology (pattern, dimension, profile)

The morphological characteristics of the six (6) cross sections surveyed on Little Brush Creek are shown in Table 4 with those from Mount Pleasant Creek. Little Brush Creek is a C4 stream type. The stream is located in the same physiographic region as Mount Pleasant Creek. The channel has a high bankfull width/depth ratio and a low bank height that allows floodwater to access the floodplain. The profile consists of an adequately developed riffle pool sequence located appropriately within the stream's sinuous pattern.

3.5 Channel Stability Assessment

The channel stability was assessed with observations made in evaluating bank erosion potential with the Rosgen method of completing a Bank Erosion Hazard Index (BEHI). BEHI indexes

were completed on stream channel cross sections on Little Brush Creek. Visual observations and computed BEHI's of Little Brush Creek show that the stream has adequate root depth and density, moderate bank slopes, low bank heights and good vegetative surface protection. The channel stability assessment determined that Little Brush Creek has "low" bank erosion potential.

3.6 Bankfull Verification

Bankfull verification on Little Brush Creek was completed with a comparison of field surveyed stream cross sections for typical bankfull width, area, depth and discharge relationships. The watershed predicted discharges were compared with the bankfull channel capacities generated from field cross sections for verification. The Rural Piedmont Curves developed by the North Carolina State University (NCSU) Water Quality Group were used to verify acceptable limits of morphological characteristics based on a hydro-physiographic region and drainage area. The average cross sectional areas for Little Brush Creek fell within the confidence limits for the bankfull area, width, and depth fell within the confidence limits of the North Carolina Rural Regional Curve.

3.7 Vegetation

Plant community classifications follow those presented by Schafale and Weakley (1990) where possible. The dominant flora observed, or likely to occur, in each community are described and discussed.

Scientific nomenclature and the common names (when applicable) are provided. Plant taxonomy typically follows Radford et al. (1968), Petrides et.al. (1998), and Niering et.al. (2001). All subsequent references to the same organism will include the common name only. Published range distributions and habitat analysis are used in estimating flora expected to be present within the project area.

The reference site was classified as a piedmont bottomland forest as described below and as shown on Figure10.

Piedmont Bottomland Forest

This community is located along both banks of the UT to Little Brush Creek. Common canopy species include cherrybark oak (*Quercus falcate* var. *pagodifolia*), green ash (*Fraxinus pennsylvanica*), sweet gum (*Liquidambar styraciflua*), and tulip poplar (*Liriodendron tulipifera*). Less common, but also present in the canopy are black gum (*Nyssa sylvatica*), mockernut hickory (*Carya tomentosa*), shagbark hickory (*C. ovata*), and white oak (*Q. alba*). The sub-canopy is dominated by musclewood (*Carpinus caroliniana*). Also present are American elm (*Ulmus americana*), black cherry (*Prunus serotina*), black walnut (*Juglans nigra*), eastern redbud (*Cercis canadensis*), red maple (*Acer rubrum*), and witch hazel (*Hamamelis virginiana*). The shrub layer is dominated by American hazelnut (*Corylus americana*). Also present are American holly (*Ilex opaca*), silverbell (*Halesia tetraptera*), black haw (*Viburnum prunifolium*), American dogwood (*Cornus florida*), Chinese privet (*Ligustrum sinense*), and red cedar (*Juniperus virginiana*). The herbaceous layer contained aster (*Aster* sp.), American hog peanut (*Amphicarpaea bracteata*), Christmas fern (*Polystichum acrostichoides*), *Hexastylis* sp.,

Japanese honeysuckle (*Lonicera japonica*), jewelweed (*Impatiens capensis*), Nepal microstegium (*Eulalia viminea*), poison ivy (*Toxicodendron radicans*), sedges (*Carex* sp.), swamp Jack-in-the-pulpit (*Arisaema triphyllum*), switch cane (*Arundinaria tecta*), Virginia creeper (*Parthenocissus quinquefolia*), wild grape (*Vitus* sp.), and violet (*Viola* sp.).

4.0 Project Site Restoration Plan

4.1 Restoration Project Goals and Objectives

The restoration goals for this project are to improve water quality with the construction of stable stream banks, removal of cattle access, and the establishment of a protective buffer. To control sediment transport due to the clearing of adjacent floodplains. Improve the stream function and habitat with the connection of the channelized and incised stream back to its floodplain. Restore long-term stability with the restoration of channel pattern, profile and dimension. Improve in-stream habitat with the installation of rootwads, constructed riffles and single wing rock vanes to enhance pool depths.

The project objectives will include the restoration of 827 linear feet of stream with a Priority II Restoration and 657 linear feet of Priority I restoration in order to raise the stream elevation, reconnect the floodplain, restore pattern, and re-establish channel dimension. Enhance 173 liner feet through Priority II enhancement. Preserve 50 linear feet of stream. Establish a riparian buffer of a minimum of 15 linear feet from the stream bank with an average distance of 80 feet. Buffer enhancement of 3.76 acres along the stream length will be established with the planting of riparian vegetation and 4.72 acres of wooded buffer will be preserved. The total restoration stream length is 1,707 linear feet. The proposed restoration plans are included in Section 10 plan sheets 4-8.

4.1.1 Designed Channel Classification

The classification of the proposed stream is a C4 stream type. The currently incised stream will be reconnected to its floodplain by raising the channel up in elevation approximately 1.2 feet. The stream pattern, profile, and dimension will be adjusted to allow the stream to efficiently transport its water and sediment load through a combination of changes to the channel dimension, pattern, and profile. The channel dimension will be modified to provide for a shallower wider stream that is designed for the bankfull cross sectional area. The new stream channel will have access to the floodplain for storm events greater than the bankfull return period. The pattern of the stream will also be adjusted. A new stream alignment outside of the existing channel is designed for a distance of approximately 657 linear feet at the top of the channel. In this area the new channel will be realigned outside of the existing channel in order to establish the correct pattern and tie into the existing channel at the upstream property limits. The remaining 1000 linear feet of stream will modify the pattern staying mostly within the existing channel alignment. The existing alignment will be modified to provide a corrected pattern with better radius of curvatures and riffle lengths. The pattern will also be modified in that the riffles and pools will be constructed in the proper locations.

The installation of structures and vegetation will be an important part of the restoration plan to lend long-term stabilization. At the downstream end of the project a series of rock cross vanes / step pool type structures will be constructed to transition the channel elevation approximately 1.2

feet. Single wing rock vanes, root wads and clay plugs will also be utilized throughout the reach to add stabilization to the design.

Grading of the floodplain bench will provide additional flood capacity to compensate for the change in channel configuration during the 100-year storm event for this FEMA regulated stream. The grading has been completed to not only preserve the existing floodplain water surface elevations but also to preserve as many trees as possible along the corridor that is to be graded.

4.2 Sediment Transport Analysis

4.2.1 Methodology

A stable stream has the capacity to move its sediment load without aggrading or degrading. The total load of sediment can be divided into wash load and bed load. Wash load is normally composed of fine sands, silts and clay and transported in suspension at a rate that is determined by availability and not hydraulically controlled by the size and nature of the bed material and hydraulic conditions (Hey 1997).

The critical shear stress for the proposed channels has to be sufficient to move the particle size diameter value at the 84th percentile (D84) of the bed material. Shear stress was computed using the shear stress equation below and compared to the Shield's Curve of the threshold of grain diameter motion.

$$\mathcal{T} = \mathcal{Y}\, R s$$

Where:
$\mathcal{T}$ = shear stress (lb/sqft)
$\mathcal{Y}$ = specific gravity of water (62.4 lb/cubic ft.)
R = hydraulic radius (ft)
s = water surface slope (ft/ft)

Additional sediment transport analysis was completed using the Rosgen method of using bed materials and sub surface material D50 particle sizes to determine the critical dimensionless shear stress. The critical shear stress along with the channel slope and largest sub-pavement moving particle made available by the watershed as measured on a depositional feature were used to predict the mean depth for the design channel at bankfull. If the channel design depth is too small the channel sediment will be deposited. If the depth is too large the channel will need energy deposition.

$$\mathcal{Y}ci = 0.0834\left(\frac{di}{\mathcal{D}\hat{}50}\right)\hat{} - 0.872$$

$$Depth = \frac{(\mathcal{T}ci)\ 1.65\ (\mathcal{D})}{slope}$$

Where:
$\mathcal{T}ci$ = critical shear stress (lb/sqft)
di = D50 pavement bed material

$d^{\wedge}50$ = D50 sub-pavement
D = Largest sub-pavement particle (ft)
$Depth$ = Mean depth at bankfull (ft)
$Slope$ = Average water surface slope at bankfull (ft/ft)

4.2.2 Calculations and Discussion

The shear stress calculated for sediment samples in Mount Pleasant Creek 0.70 lbs/sq ft when entered into Shield's Curve, predicted a range of particle motion of 3.74 inches small cobble. The D84 in Mount Pleasant Creek is small cobble and therefore will move as a bed load. The existing stream shows evidence of down cutting over time to the current stream slope. The existing stream slope average is 0.0049 ft/ft in a valley slope of 0.0055 ft/ft. The proposed project will reconnect the existing channel with its floodplain and in doing so will shorten the channel length. The proposed channel relocation will increase the overall elevation but with the shortened channel length and rock outfall transition the resulting proposed slope will be 0.0041 ft/ft.

The Rosgen analysis showed that with the mean channel depth designed, a particle between 120 mm to approximately 130 mm (small cobble) will pass through the system. This is consistent with the shields diagram analysis of the range of particle motion in the system of small cobbles. The bankfull depth of 2.2 feet for the proposed stream was designed to pass the small cobble sediment that is moving through Mount Pleasant Creek.

4.2.3 No-rise, LOMR, CLOMR

Mt. Pleasant Creek is a FEMA regulated stream. The limited detailed study models were obtained from the North Carolina Flood Mapping Program. This model consisted of a 100 year natural and encroachment profile. Four FEMA existing model cross sections were located within the project area at river stations 14000, 14500, 15000, and 15500. The stream restoration project falls within the limits of river station 13945 and 15780 on Mt. Pleasant Creek.

The Corps of Engineers step backwater computer model HEC-RAS was used to perform the flood study analysis. Copying the effective limited detailed model to a pre-project model created a pre-project model. The pre-project model was truncated to begin at river station 13000 and end at station 18000. The pre-project model was modified further to include additional cross sections to describe the restoration channel length in detail. A post project model was created in which the existing channel cross sections within the restoration length were modified to show the proposed channel sections. A comparison of the pre-project and post-project models shows that there is no rise in water surface elevation within the restoration project area. A decrease in water surface elevation does occur with a maximum difference of –0.34 feet. HEC-RAS model flood study map and output model data is included in Appendix 7.

A no-rise report will be sent to Randolph County for approval. Although no rise was determined for this study the decrease in water surface elevation is greater than -0.1 ft., therefore a LOMR will be required to be submitted to FEMA upon the completion of the project.

4.2.4 Hydrologic Trespass

As a result of the stream channel relocation and benching, the water surface elevations predicted by the effective FEMA model will not cause a rise in water surface elevations within the stream relocation segment of Mt. Pleasant Creek.

4.3 Soil Restoration

4.3.1 Narrative & Soil Preparation and Amendment

Soil samples were collected and sent to the North Carolina Department of Agriculture & Consumer Services (NCDA & CS) Agronomic Division for a predictive soil test. The soil test is a measure of the elements essential to plant nutrition and also measures the soil acidity and pH. These factors are indicators of lime requirements, nutrient availability and the potential of the soil to produce crops.

The soil test reports up twenty-two (22) factors, with the first seven (7) describing the soil and its degree of acidity. The other fifteen (15) indicate levels of plant nutrients or other fertility measurements. Attached is a copy of the soil test result for each sample.

Many of the nutrient results are reported as indices. This index relates to general nutrient availability and indicates the likelihood of crop response to fertilization. The lower the test result index, the more likely there will be a response to an application of that nutrient.

Based on the soil test results, the soil pH and Cation Exchange Capacity (CEC) is typical of mineral soils. As shown in the soil test results, the site sample shows a low phosphorus index (P-I) and vegetation response to application of phosphorus would be high. The Potassium index (K-I) for the soil sample indicates that the soils have a medium to high status and that application of potassium to the soil would either have a low response or no response.

4.4 Natural Plant Community Restoration

4.4.1 Narrative & Plant Community Restoration

Typically, a restoration site will be planted according to the vegetation found at the reference site. However, due to the difficulty finding a reference stream that was appropriate and undisturbed, the plant community at the reference site was not appropriate to the restoration site. Instead the restored floodplain will be planted with canopy and understory plant species typical of a Piedmont/ Low Mountain Alluvial Forest as defined by Shafale and Weakley (1990). To see a list of species that will be planted within the restored floodplain area see Table 7.

4.4.2 On-site Invasive Species Management

A variety of plant species inhabit the project study area. While the majority of those species are native to the region there are a few invasive exotic species found within the project study area. Within the project study area, there are 6 invasive exotic plant species; Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), and multiflora rose (*Rosa multiflora*). Where ground-disturbing activities occur within the project study area, invasive exotic species management strategies will be conducted. Manual or mechanical removal of invasive exotic plants should always be considered as the first method of control where feasible. Alternative management strategies that are species specific are presented below.

Chinese privet: This shrub was introduced from China and Europe in the early to mid 1800's and used as an ornamental shrub and has spread throughout and invaded woodlands in the southeastern United States. This aggressive thicket forming shrub can out-compete native vegetation and become the dominant shrub layer of an invaded habitat resulting in a lower species composition and an alteration in the natural community structure. It can shade out the herbaceous layer of the community it inhabits. This evergreen shrub is shade tolerant and colonizes by root and stump sprouts and the seeds are spread widely by wildlife such as birds. It has commonly been used as a hedge and has escaped and invaded adjacent areas to form dense thickets. Control efforts during early stages of colonization have a higher potential for successful management. A foliar herbicidal application of glyphosate as a 3 percent solution in water should be applied between August and December. For stem to tall for a foliar spray, an application of Garlon 4 as a 20 percent solution in a basal oil, diesel fuel, or kerosene with a penetrant to the bark as a basal spray. The cut stump method, which entails cutting large stems and immediately treating the stumps with Velpar L as a 10 percent solution in water with a surfactant. This method may harm non-target plants by root uptake. A safer method when considering surrounding vegetation is through treating the cut stump and stem with a glyphosate or Garlon 3A herbicide as a 20 percent solution in water with a surfactant.

Japanese Honeysuckle: Japanese honeysuckle occurs as dense infestations along forest margins, rights-of-ways, and under canopies. This vine is shade tolerant and spreads from a large root stock, rooting at vine nodes, and seeds are dispersed by animals. Manual or mechanical removal should be considered as the first step in eradication. Other control procedures to consider should include cutting the larger vines just above the soil surface and immediately treat the freshly cut stem with with a glyphosate herbicide or Garlon 3A as a 20 percent solution in water from July to October. Foliar treatments with a glyphosate herbicide as a 2 percent solution in water should be applied between July and October.

Multiflora rose: This shrub thrives in sunny locations and well-drained soils. This shrub forms dense thickets that out compete native herbaceous and shrub species. The seeds of this shrub are bird and mammal dispersed. Due to bird dispersal, this shrub can colonize the gaps in late-successional forests. It may not be a long-term threat in mature forests and may be likely to be shaded out by surrounding trees and shade tolerant shrubs. Recommended control procedures for this shrub include a foliar application of Arsenal AC as a 1 percent solution between August and October. This method may harm surrounding non-target plants through root uptake. A less effective treatment of a glyphosate herbicide as a 4 percent solution in water with a surfactant should be applied from May to October. This method would have no soil activity to damage surrounding plants.

Areas of the restoration site that are currently vegetated with native, non-invasive species will not be disturbed, outside the limits of necessary construction activities. Succession in these areas should be allowed to proceed naturally. In areas where exotic species are located removal should be undertaken by hand or by herbicide application.

5.0 Performance Criteria

To demonstrate mitigative success, baseline conditions will be established in the form of as-built drawings. The as-built drawings will include profile and plan views of the completed stream project. At the conclusion of the construction activities, the channel modifications and planted vegetation based on a 1.4 – 1.7 year bankfull return period will be monitored annually for a minimum of five years. Monitoring reports will be prepared at the end each year and made available to the resource agencies.

5.1 Streams

The proposed success criteria for stream mitigation will be based on the stability of the stream. The geomorphology of the stream will be monitored as follows:

- Dimension: Permanent cross sections (surveyed or GPS'd) will be established in the frequency of one for every 20 bankfull widths along the length of the reach. Cross section sites will be selected such that approximately half are placed in riffles and half placed in pools. Measurements of W/D ratio, entrenchment ratio, and low bank height ratio will be monitored yearly.
- Pattern: Pattern measurements will include sinuosity and meander width ratio and will be performed yearly. Measurements of radius of curvature will be monitored on newly constructed meanders for the first year only.
- Profile: Longitudinal profile will be surveyed and measurements collected on slope (average, pool, riffle) and pool-to-pool spacing.
- Materials: Pebble counts in pools and riffles will be measured. The D50 and D84 particle size diameter percentiles will be monitored to assure an increase in coarseness in riffles and an increase in fineness in pools.
- Photo Reference Points: Photo reference points will be established at all cross sections showing banks and channel. Additional photos will be taken at selected structures on the project to monitor their structural stability.
- Vegetation: Vegetation plots will be established to monitor the plant survival in the planted areas of the conservation easement and stream bank. The vegetation plots will be 10 meters by 10 meters and will be established based on site conditions. Vegetative sampling will be undertaken on a yearly basis. The survival rate will be based on 320 stems/acre for trees after five years of planting.

During the annual review the entire stream reach will be evaluated for any potential problem areas and photographs taken to document the degree and severity. Potential problem areas may include bank instability, in-stream structure failure or unsuccessful vegetation establishment. If a failure area is noted, corrective actions will be evaluated to resolve the problem. Remedial actions will be undertaken considering any seasonal limitations. Any remedial actions will be documented on the as-built plans.

5.2 Vegetation

The vegetation monitoring will be conducted according to the Carolina Vegetation Survey (CVS) – EEP protocol. Vegetation monitoring plots will be 100 square meters in size and will be conducted according to the Level I protocol which has a focus of planted stems only. The purpose of this level of monitoring is to determine the pattern of installation of plant material

with respect to species, spacing, density, and to monitor the survival and growth of those installed species. The success criteria for the preferred species in the restoration areas will be based on annual and cumulative survival and growth over five (5) years. Survival on preferred species must be at a minimum 320 stems/acre at the end of the five years of monitoring. Determining sampling strategy for woody trees and shrubs depends on the size and uniformity of the plants. According to the CVS-EEP protocol, the total area of all the sampling plots must be equal to or greater than 5% of the total area of the mitigation site.

5.3 Schedule/Reporting

The Mount Pleasant Creek Stream Restoration Project will be determined to be successful once vegetation success criteria have been met within the restoration and enhancement areas. During vegetation monitoring, planted and volunteer stem densities will be measured in addition to the relative abundance and diversity of herbaceous vegetation within the monitoring plots. Species will be listed and identified by wetland indicator status. Planting locations and methods will be completed in the first year Annual Report. Survival, numbers per acre by species, and tree height will be measured at the end of each growing season just prior to leaf fall.

Monitoring data will be collected for a period of five years or until all success criteria are achieved, whichever is longer. Annual Reports will be submitted to the EEP prior to the end of each calendar year, documenting plant community conditions within the restoration areas and documenting hydrologic data within these areas and reference plots. The project areas will be photographed from permanent photo stations and changes in any of the above variables will be recorded and included in each annual report. The Annual Report will also include a proposed plan of action for the following year including maintenance activities.

6.0 References

Daniels, Buol, Kleiss, & Ditzler, 1999

Howard, A. K. (2003). Influence of in stream physical habitat and water quality on the survival and occurrence of the endangered Cape Fear shiner. Raleigh, North Carolina, North Carolina State University. M.S.: 133.

Malcom, H. Rooney P.E/, Elements of Urban Stormwater Design, North Carolina State University, 1989.

Natural Resource Conservation Service (NRCS). Issued 2002. Soil Survey of Randolph County, North Carolina. US Department of Agriculture. Soil Conservation Service.

North Carolina Department of Transportation and Kimley-Horn and Associates, Inc. Stream and Wetland Mitigation Feasibility Study Bowman Property, Randolph County, North Carolina, TIP Project No. R-0609WM, December 9, 2004

North Carolina Wildlife Resources Commission (NCWRC). 1995. Annual Performance Report, Non-game and Endangered Wildlife Program, Vol. III, July 1993-June 1994.

North Carolina Department of Water Quality (NCDWQ). 2005. Basinwide Information Management System (BIMS) (http://h2o.enr.state.nc.us/bims/reports/reportsWB.html). North Carolina Department of Environment, Health and Natural Resources, Raleigh, North Carolina.

North Carolina State Flood Mapping Program website: www.ncfloodmaps.com, Mt. Pleasant Creek Floodplain and Floodway Shape files.

Petrides, G. A. 1988. A field guide to eastern trees: eastern United States and Canada, including the Midwest.

Pottern, G. B. and M. T. Huish. 1985. Status Survey of the Cape Fear Shiner (Notropis mekistocholas), U.S. Fish and Wildlife Service Contract No. 14-16-0009-1522.

Radford, A.E., H.E. Ahles, and C.R. Bell. 1964. Guide to the vascular flora of the Carolinas, with distribution in the Southeastern States. University of North Carolina Press: Chapel Hill, North Carolina.

Randolph County North Carolina GIS Information August 18, 2006

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

Schafale, M.P., and A.S. Weakley. 1990. Classification of the natural communities of North Carolina, third approximation. N.C. Natural Heritage Program, Raleigh, N.C. 325 pp.

Snelson, F. F. 1971. *Notropis mekistocholas*, A New Cyprinid Fish Endemic to the Cape Fear River Basin, North Carolina. Copeia 1971: 449-462.

Thieret, J. W., W. A. Niering, N. C. Olmstead. 2001. National Audubon Society: Field Guide to North American Wildflowers: Eastern Region.

US Army Corps of Engineers, HEC-1 Flood Hydrograph Package 3.1, September 1990, Hydrologic Engineering Center.

US Geological Survey, Water-Resources Investigations Report 96-4084, Estimation of Flood-Frequency Characteristics of Small Urban Streams in North Carolina, 2001

U.S. Fish and Wildlife Service (USFWS). 1988. Cape Fear Shiner Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, GA. 18 pp.

U.S. Fish and Wildlife Service (USFWS). 1994. Schweinitz's Sunflower Recovery Plan. Atlanta, GA. 28 pp.

U.S. Geological Survey (USGS). 1974. Grays'Chapel quadrangle, North Carolina [map]. 1:24,000. 7.5 Minute Series. Washington D.C.

U.S. Geological Survey (USGS). 1968 Coleridge quadrangle, North Carolina [map]. 1:24,000. 7.5 Minute Series. Washington D.C.

Urban Hydrology for Small Watersheds, Soil Conservation Services, June 1986, Technical Release 55

US Geological Survey, Water-supply Paper 1898-B. Determination of the Manning Coefficient From measured Bed Roughness in Natural Channels, 1970.

U.S. Geological Survey (USGS). 2005. Water Resources of the United States. Hydrologic Unit Maps. Available URL: http://water.usgs.gov/GIS/huc.html.

Wolman, M.G., 1954. A Method of Sampling Course River-Bed Material, Transactions of American Geophysical Union 35:951-956.

NOAA's National Weather Service: Hydrometeorological Design Studies Center - Precipitation Frequency Data Server. Available URL: http://hdsc.nws.noaa.gov/hdsc/pfds/orb/nc_pfds.html

Patterson, J. M., D. R. Clinton, W. A. Harman, G. D. Jennings, and L. O. Slate. 1999. Development of streambank erodibility relationships for North Carolina streams. In *Wildland Hydrology, Proc. AWRA Specialty Conf.*, Bozeman, Montana, ed. D. S. Olson and J. P. Potyondy, 117-123. Middleburg, Va.: American Water Resources Association.

Doll, B. A., G. L. Grabow, K. R. Hall, J. Halley, W. A. Harman, G. D. Jennings, and D. E. Wise. Stream Restoration: A Natural Channel Design Handbook. North Carolina Stream Restoration Institute. North Carolina Sea Grant. State of North Carolina Department of Transportation. United States Environmental Protection Agency.

8.0 Tables

Table 1: Mount Pleasant Creek Restoration Structure and Objectives

Restoration Segment ID	Station Range	Restoration Type	Priority Approach	Existing Linear Footage	Designed Linear Footage	Comment
Reach 1	16+90 to 1+50	Restoration	P1	1550	1540	
Reach 2	1+50 to 0	Enhancement	P3	150	150	

Table 2: Drainage Areas

Stream	Drainage Area (Sq. Miles)
Mt. Pleasant Creek	5.26
Little Brush Creek	3.98

Table 3: Land Use of the Mount Pleasant Creek Watershed

Land Use	Square Miles	Percentage
Parking lots, roads, roofs, driveways	0.504	10%
Residential area with 1 acre lots	2.854	54%
Pasture, grassland or range with 50 to 75% ground cover	1.814	34%
Woods – some grazing, some forest litter	0.034	1%
Woods – no grazing, forest litter	0.064	1%

Table 4: Morphological Table

Variables	Existing Channel Mt. Pleasant Creek - Upper Section	Existing Channel Mt. Pleasant Creek - Lower	Proposed Channel Mt. Pleasant Crk.	Little Brush Creek Reference Reach
Stream type	G4	G4	C4	C4
Drainage Area (Sq. Mile)	5.24	5.24	5.24	3.98
Bankfull width, LF (Wbkf)	28.25 (25.5-31)	28 (25-33)	31	32.2 (25.5-37.5)
Bankfull mean depth, LF (dbkf)	2.29 (2.03-2.55)	2.37 (1.94-2.61)	2.2	2.24 (1.9-2.64)
Width/depth ratio (Wbkf/dbkf)	12.63 (10.00-15.25)	12.26 (9.59-16.98)	14.1	14.68 (9.65-19.91)
Bankfull Cross Sectional Area, ft^2 (Abkf)	64 (63-65)	65.18 (64.15-66.20)	68	71.35 (67.4-76.84)
Bankfull Mean Velocity, ft/s (Vbkf)	4.84 (4.41-5.28)	4.66 (4.22-5.36)	4.63	4.73 (3.82-5.97)

Bankfull Discharge, cfs (Qbkf)	310.45 (278-343)	303.61 (279-349)	300	315 (273-340)
Bankfull Maximum depth, LF (dmax)	3.45 (3.25-3.65)	3.36 (3.20-3.49)	3	3.45 (3.0-3.78)
Max driff/dbkf ratio	1.51 (1.42-1.59)	1.42 (1.35-1.48)	1.5 (1.34-1.68)	1.54 (1.34-1.68)
Low Bank Height Ft	4.56 (3-5.5)	5.53 (3.7-6.7)	2.7 (1.95-3.58)	2.86 (1.7-3.53)
Low bank Height to max dbkf	1.3 (0.9-1.58)	1.48 (1.02-2.53)	0.83 (.6-1.1)	0.83 (0.55-1.13)
Width of flood prone area, LF (Wfpa)	287.5 (280-295)	176 (83-285)	90	129.8 (92-170)
Entrenchment ratio (Wfpa/Wbkf)	10.25 (9.52-10.98)	6.08 (3.19-8.64)	2.9 (1.77-3.55)	4 (2.88-5.16)
Meander length, LF (Lm)	117 (47-200)	199 (110-310)	155 (62-310)	162 (65-330)
Ratio of meander length to bankfull width (Lm/Wbkf)	4.16 (1.66-7.08)	7.09 (3.93-11.07)	5 (2.0-10)	5 (2.0-10.25)
Radius of Curvature, LF (Rc)	140.5 (43-straight)	242.83 (29-straight)	93 (39-192)	97 (41-200)
Ratio of radius of curvature to bankfull width (Rc/Wbkf)	4.97 (1.5-14.76)	8.67 (1-19.39)	3 (1.27-6.2)	3 (1.27-6.2)
Belt width, LF (Wblt)	41.43 (33-60)	75 (30-140)	87 (67-115)	90 (70-120)
Meander width ratio (Wblt/Wbkf)	1.47 (1.17-2.12)	2.68 (1.07-5)	2.8 (2.17-3.7)	2.8 (2.17-3.73)
Sinuosity (stream length /valley distance) (k)	1.39	1.24	1.18	1.19
Valley slope (ft/ft)	0.0038	0.0051	0.0046	0.0039
Average slope Savg= (Svalley /k)	0.0028	0.004	0.0039	0.0033
Pool Slope (Spool)	-0.0007 (-0.0004 - -0.0011)	0.0013 (0.0004-0.0019)	0.0012 (0-.0039)	0.001 (-0.0004-0.0032)
Ratio of pool slope to average slope spool/Sbkf)	-0.15 (-0.05 - -0.24)	0.28 (0.09-0.41)	0.3 (0-.94)	0.3 (0-0.94)

Maximum pool depth, LF (dpool)	4.4 (4.1-4.8)	4.13 (3.8-4.7)	4 (3.39-4.1)	3.7 (3.46-4.12)
Ratio of pool depth to average bankfull depth (dpool/dbkf)	1.92 (1.79-1.92)	1.74 (1.61-1.99)	1.8 (1.54-1.84)	1.65 (1.54-1.84)
Pool width, LF (Wpool)	33.6 33.6	24.6 (23-26.2)	31 (24.5-31)	27.95 (25.5-30.4)
Ratio of pool width to bankfull width (Wpool/Wbkf)	1.19 1.19	0.88 (0.82-0.94)	0.87 (0.79-1.0)	0.87 (0.79-0.94)
Pool Cross Sectional Area, ft^2	78.04 78.04	69.81 (65.21-74.42)	81.6 (78-92)	89 (81.04-96.65)
Ratio of pool area to bankfull area	1.22 1.22	1.07 (1 – 1.14)	1.2 (1.15-1.35)	1.25 (1.14-1.35)
Pool to pool spacing, LF (p-p)	82.33 (52-141)	142.29 (65-293)	195 (189-205)	204 (197-211)
Ratio of p-p spacing to bankfull width (p-p/Wbkf)	2.91 (1.84-4.99)	5.08 (2.32-10.46)	6.3 (6.1-6.6)	6.34 (6.12-6.55)

Table 5: BEHI/NBS and Sediment Export Estimate for Mt. Pleasant Creek

Time Point	Segment	Linear Footage	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export
Pre-Construction			Ft.	%	Ft.	%	Ft.	%	Ft.	%	Ft.	%	Ft.	%	Ton/y
	Entire Reach	3316					271	8	1869	56	1176	36			35.5

Table 6: BEHI/NBS and Sediment Export Estimate for Little Brush Creek

Time Point	Segment	Linear Footage	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export
Pre-Construction			Ft.	%	Ft.	%	Ft.	%	Ft.	%	Ft.	%	Ft.	%	Ton/y
	Entire Reach	674							121	18	553	82			1.2

Table 7. Planting Plan Species List

Botanical Name	Common Name
Canopy Species:	
Betula nigra	River Birch
Carya cordiformis	Bitternut Hickory
Carya ovata	Shagbark Hickory
Celtis laevigata	Hackberry
Fraxinus pennsylvanica	Green Ash
Liriodendron tulipifera	Tulip Poplar
Platanus occidentalis	Sycamore
Ulmus americana	American Elm
Understory/Shrub Species:	
Aesculus aestivalis	Painted Buckeye
Asimina triloba	Common Pawpaw
Carpinus caroliniana	Ironwood
Calycanthus floridus	Sweet-shrub
Cornus ammomum	Silky Dogwood
Euonymus americanus	Strawberry Bush
Lindera benzoin	Spicebush
Herbaceous Species:	
Arisaema triphyllum	Jack-in-the-Pulplit
Eurybia divaricatus	Heartleaf Aster
Boehmeria cylindrica	False Nettle
Carex laxiflora	Broad Loose-flower Sedge
Chasmantheum latifolia	River Oats
Corydalus flavula	Yellow Fumewort
Impatiens capensis	Orange Jewelweed
Senecio aureus	Golden Ragwort
Solidago caesia	Bluestem Goldenrod
Verbesina alternifolia	Wingstem

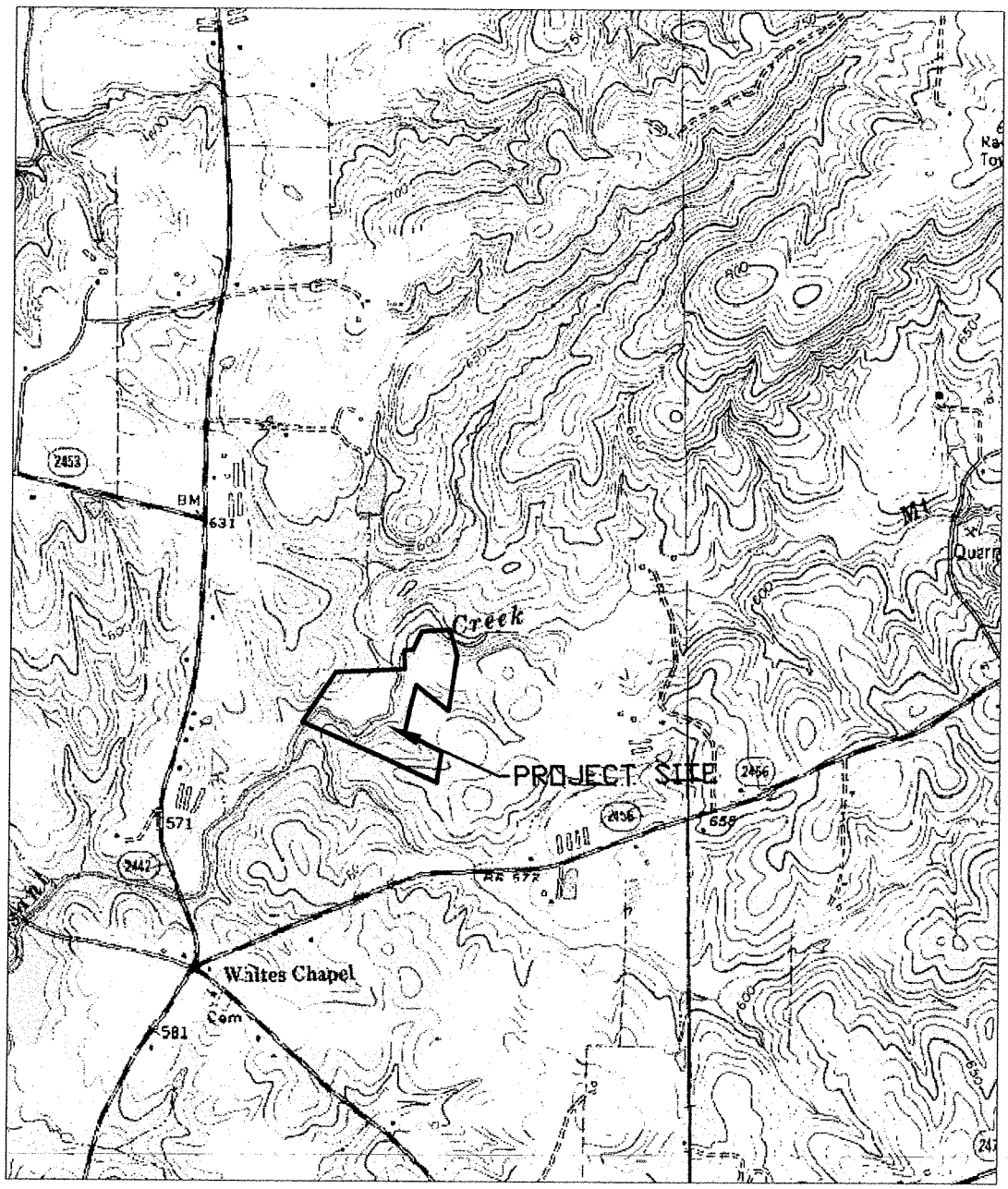
Table 8. Particle Size Distribution

Materials:	Existing	Proposed	Reference
Particle Size distribution of channel material			
D16	1.0	1.0	0.5
D35	11	11	9
D50	30	30	13.5
D84	100	100	110
D95	200	200	160
Particle Size distribution of bar material			
D16	0.72	0.72	1.3
D35	1.6	1.6	6
D50	3.2	3.2	17
D84	12.5	12.5	58
D95	29	29	100
Largest size particle at the toe (lower third) of bar	5.0-5.5	5.0-5.5	4.0-5.0

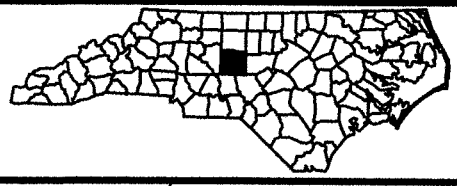
Table 9. Sediment Transport Validation

Sediment Transport Validation (Based on Bankfull shear Stress)	Existing	Proposed
Calculated value	0.70	0.6
Value from Shield Diagram (lb/sq.ft.)	0.7 – 0.8	0.7 –0.8
Critical dimensionless shear stress	0.012	0.012
Miminum mean dbkf calculated using critical dimensionless shear stress equations	1.85	2.2

9.0 Figures



USGS Quadrangle Map Gray's Chapel from www.topozone.com



North Carolina - Ecosystem Enhancement Program

Mt. Pleasant Creek Stream Restoration Project
Randolph County, NC
SCO #060678701

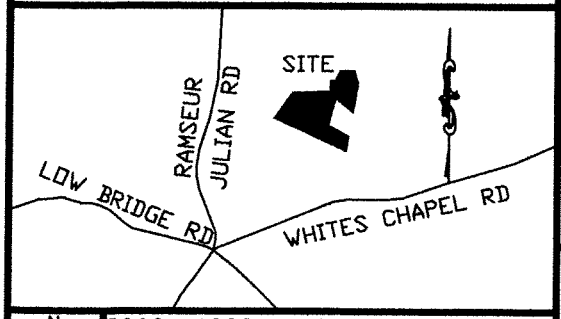
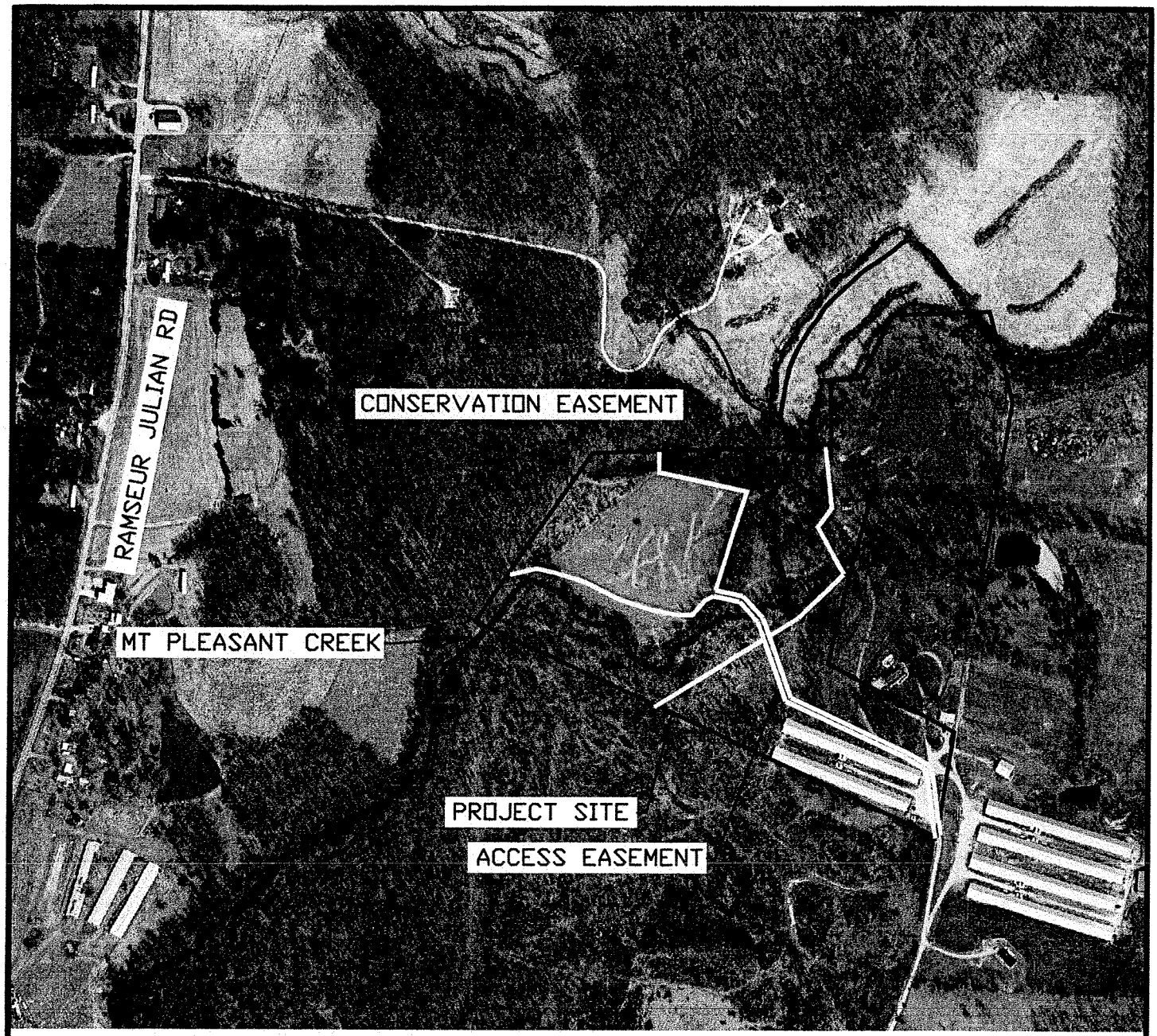


FIGURE 1
BOWMAN PROPERTY
VICINITY MAP

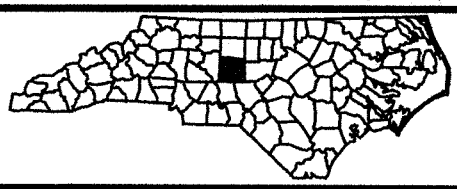
DATE: MARCH 16, 2007

WARD CONSULTING ENGINEERS, PC

8386 Six Forks Rd. Suite 101 (919) 870-0526
Raleigh, NC 27615-5088 FAX (919) 870-5359



Aerial provided by Randolph County Computer Services, June 9, 2006



Ecosystem Enhancement PROGRAM

North Carolina - Ecosystem Enhancement Program

Mt. Pleasant Creek Stream Restoration Project
Randolph County, NC
SCO #060678701

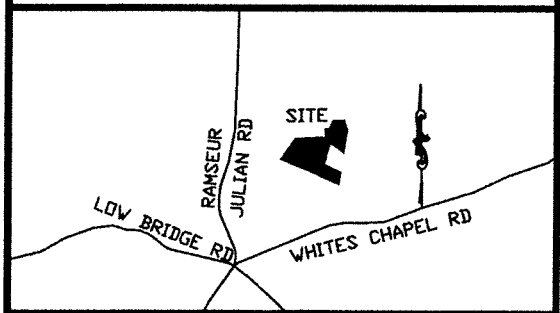
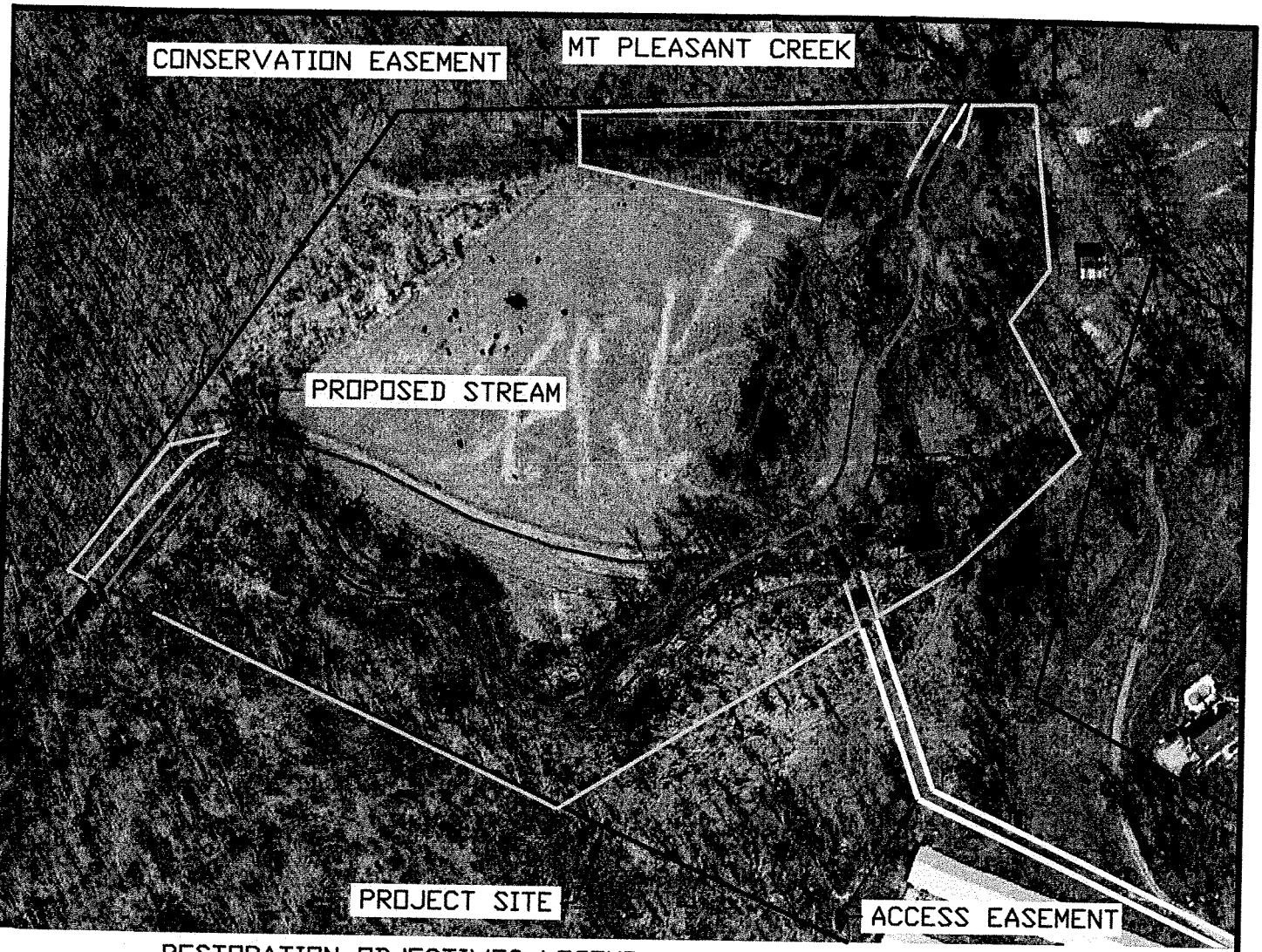


FIGURE 2
BOWMAN PROPERTY
AERIAL VICINITY MAP

DATE: MARCH 16, 2007

WARD CONSULTING ENGINEERS, PC

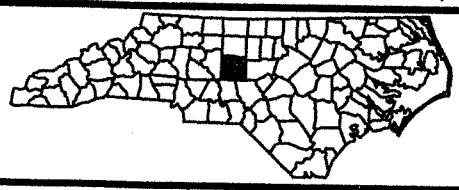
8386 Six Forks Rd. Suite 101 (919) 870-0526
Raleigh, NC 27615-5088 FAX (919) 870-5359

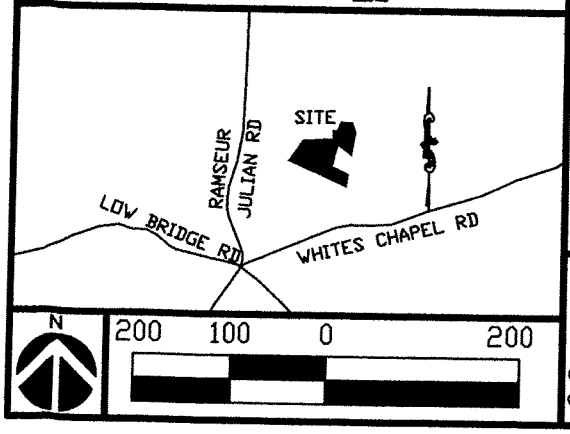


RESTORATION OBJECTIVES LEGEND

	STREAM ENHANCEMENT II	173 LF
	STREAM PRIORITY 1 RESTORATION	657 LF
	STREAM PRIORITY 2 RESTORATION	827 LF
	STREAM PRESERVATION	50 LF
	BUFFER ENHANCEMENT	3.76 AC
	BUFFER PRESERVATION	4.72 AC

Aerial provided by Randolph County Computer Services, June 9, 2006





Ecosystem Enhancement Program

North Carolina - Ecosystem Enhancement Program

Mt. Pleasant Creek Stream Restoration Project
Randolph County, NC
SCO #060678701

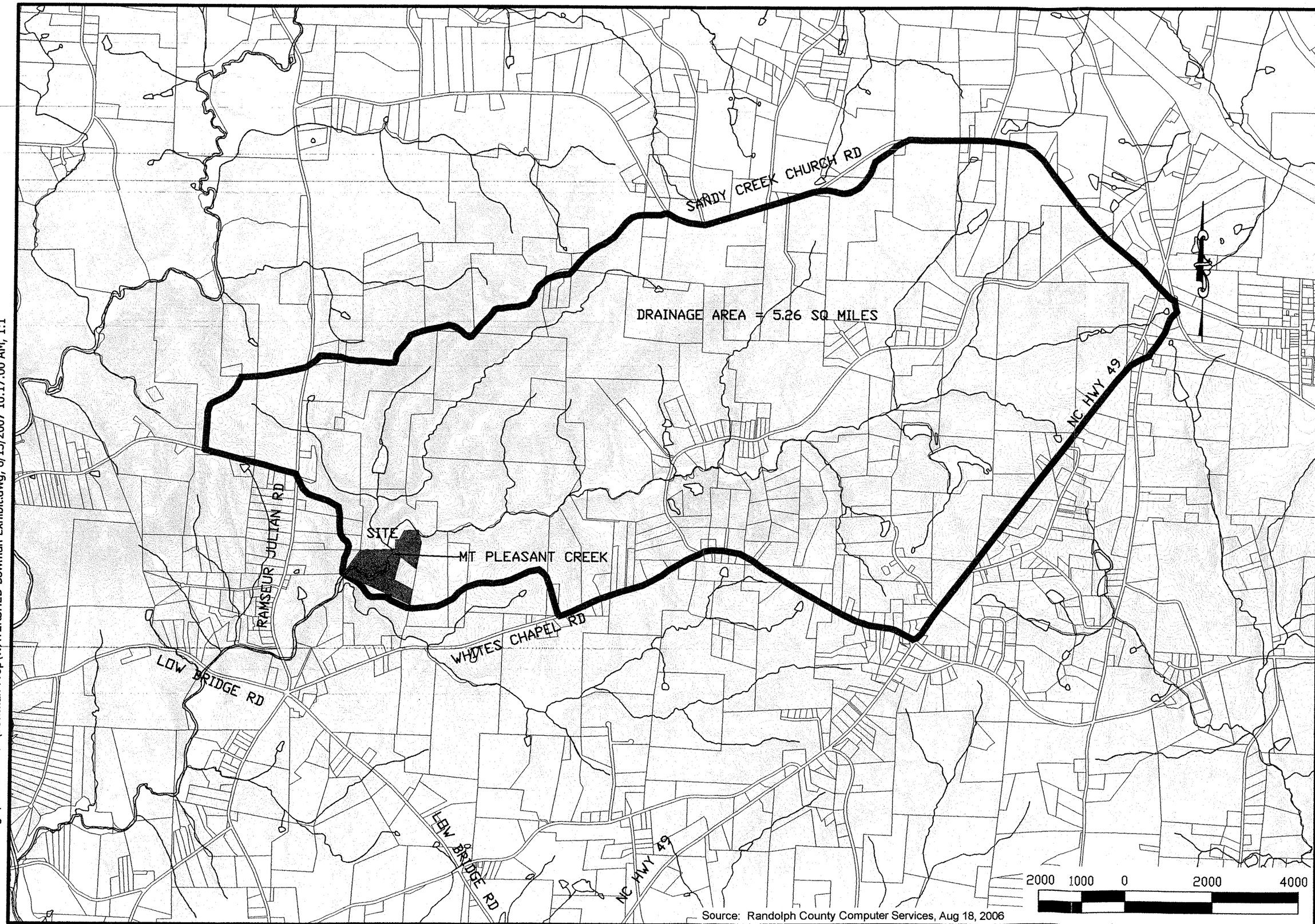
FIGURE 2A
BOWMAN PROPERTY
RESTORATION OBJECTIVES

DATE: MARCH 16, 2007

WARD CONSULTING ENGINEERS, PC

8386 Six Forks Rd. Suite 101 (919) 870-0526
Raleigh, NC 27615-5088 FAX (919) 870-5359

C:\...\cad\...\Bowman\Bowman Prop\Exhibits Bowman.dwg, 11/7/2007 3:36:18 PM, 1:1



Source: Randolph County Computer Services, Aug 18, 2006

WARD CONSULTING ENGINEERS, PC
8386 Six Forks Rd, Suite 101 (919) 870-0626
Raleigh, NC 27613 FAX (919) 870-6359

Ecosystem Enhancement PROGRAM

MT PLEASANT CREEK WATERSHED MAP

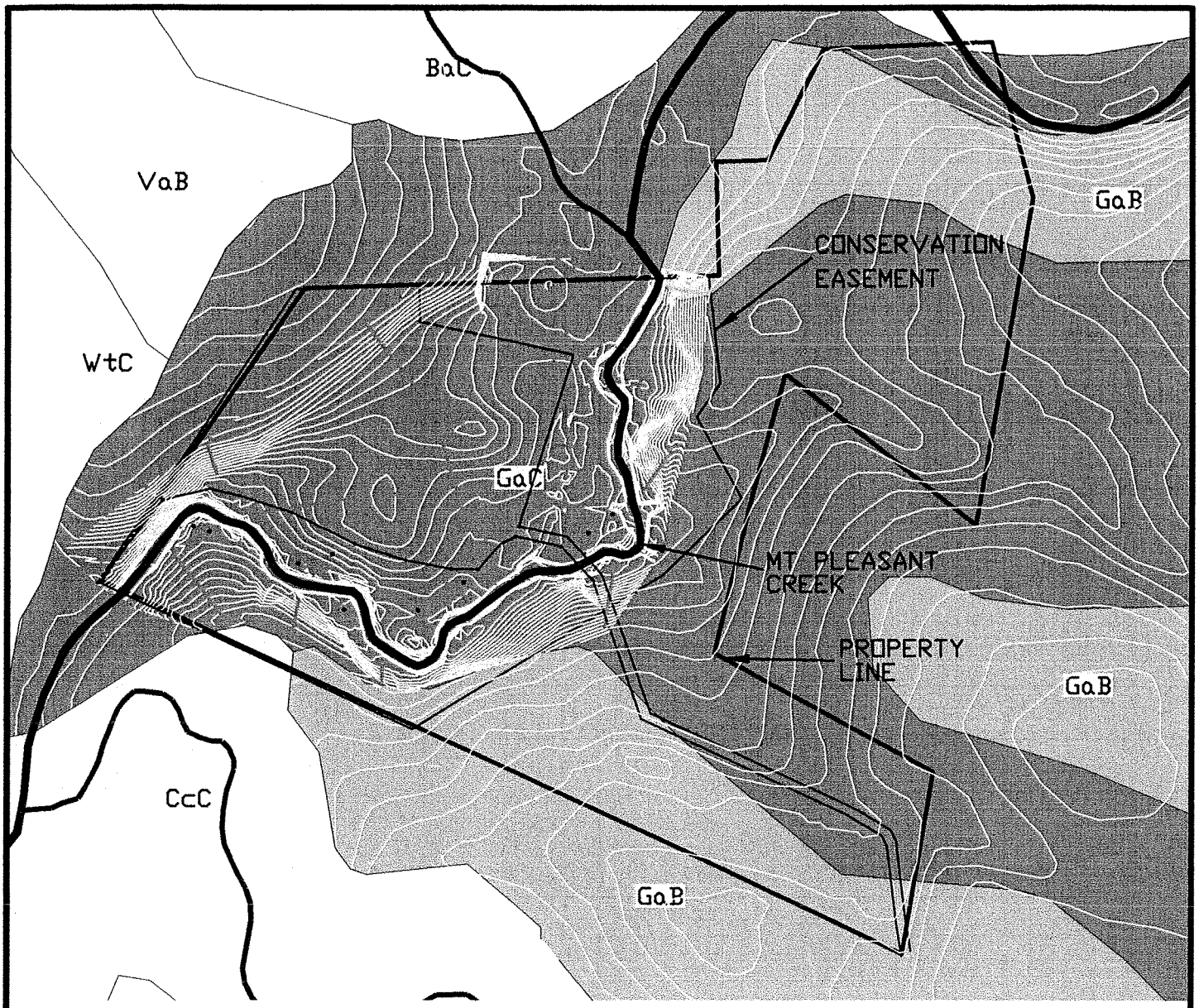
RANDOLPH COUNTY, NORTH CAROLINA

DATE: 16 March 2007

PROJ./DWG. NAME: Cox-Bowman/Exhibits Watershed

SCALE: 1"=2000'

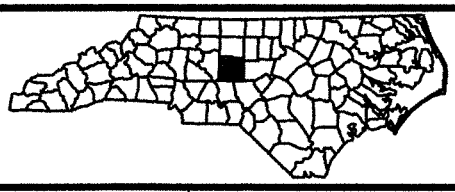
FIGURE 3



SOILS LEGEND

GaC - GEORGEVILLE SILT LOAM 8-15% SLOPES

GaB - GEORGEVILLE SILT LOAM 2-8% SLOPES



North Carolina - Ecosystem Enhancement Program

Mt. Pleasant Creek Stream Restoration Project
Randolph County, NC
SCO #060678701

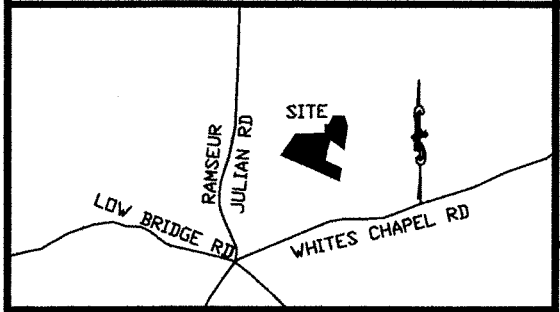
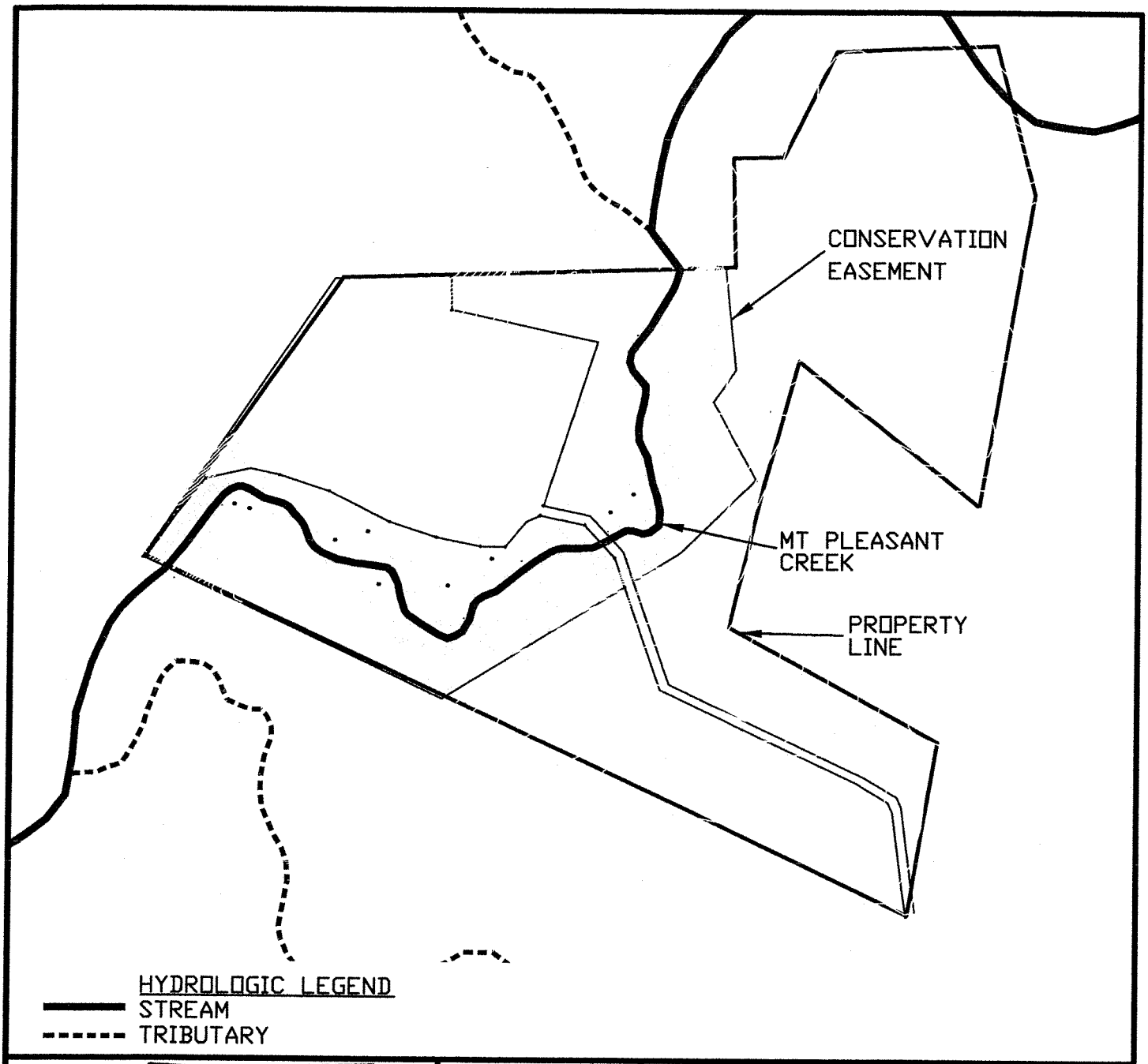


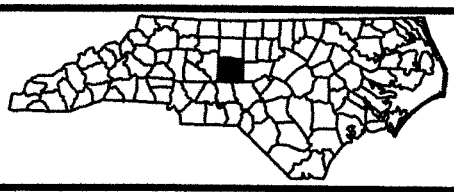
FIGURE 4
BOWMAN PROPERTY
NRCS SOIL SURVEY

DATE: MARCH 16, 2007

WARD CONSULTING ENGINEERS, PC

8386 Six Forks Rd. Suite 101 (919) 870-0526
Raleigh, NC 27615-5088 FAX (919) 870-5359





Ecosystem Enhancement PROGRAM

North Carolina - Ecosystem Enhancement Program

Mt. Pleasant Creek Stream Restoration Project
Randolph County, NC
SCO #060678701

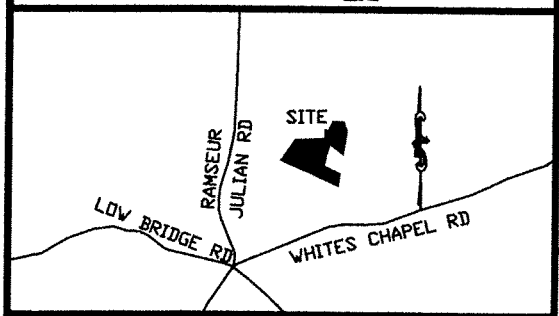
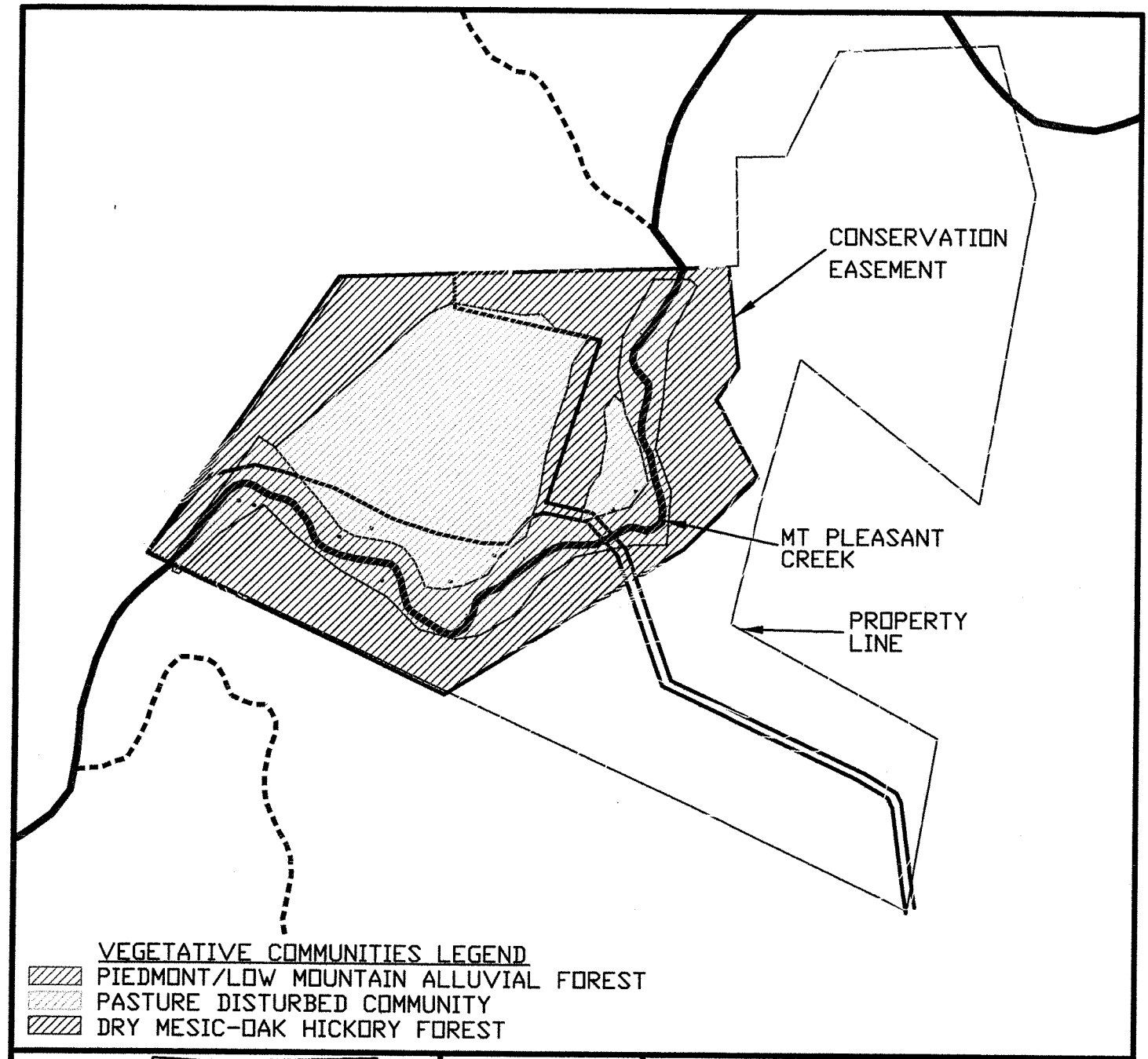


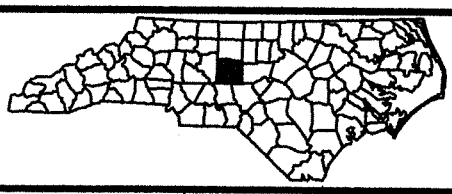
FIGURE 5
BOWMAN PROPERTY
HYDROLOGIC FEATURES

DATE: MARCH 16, 2007

WARD CONSULTING ENGINEERS, PC

8386 Six Forks Rd. Suite 101 (919) 870-0526
Raleigh, NC 27615-5088 FAX (919) 870-5359





Ecosystem Enhancement PROGRAM

North Carolina - Ecosystem Enhancement Program

Mt. Pleasant Creek Stream Restoration Project
Randolph County, NC
SCO #060678701

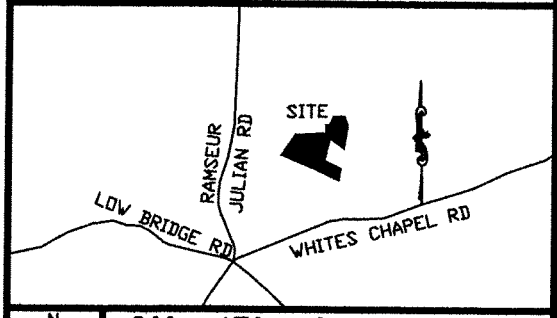
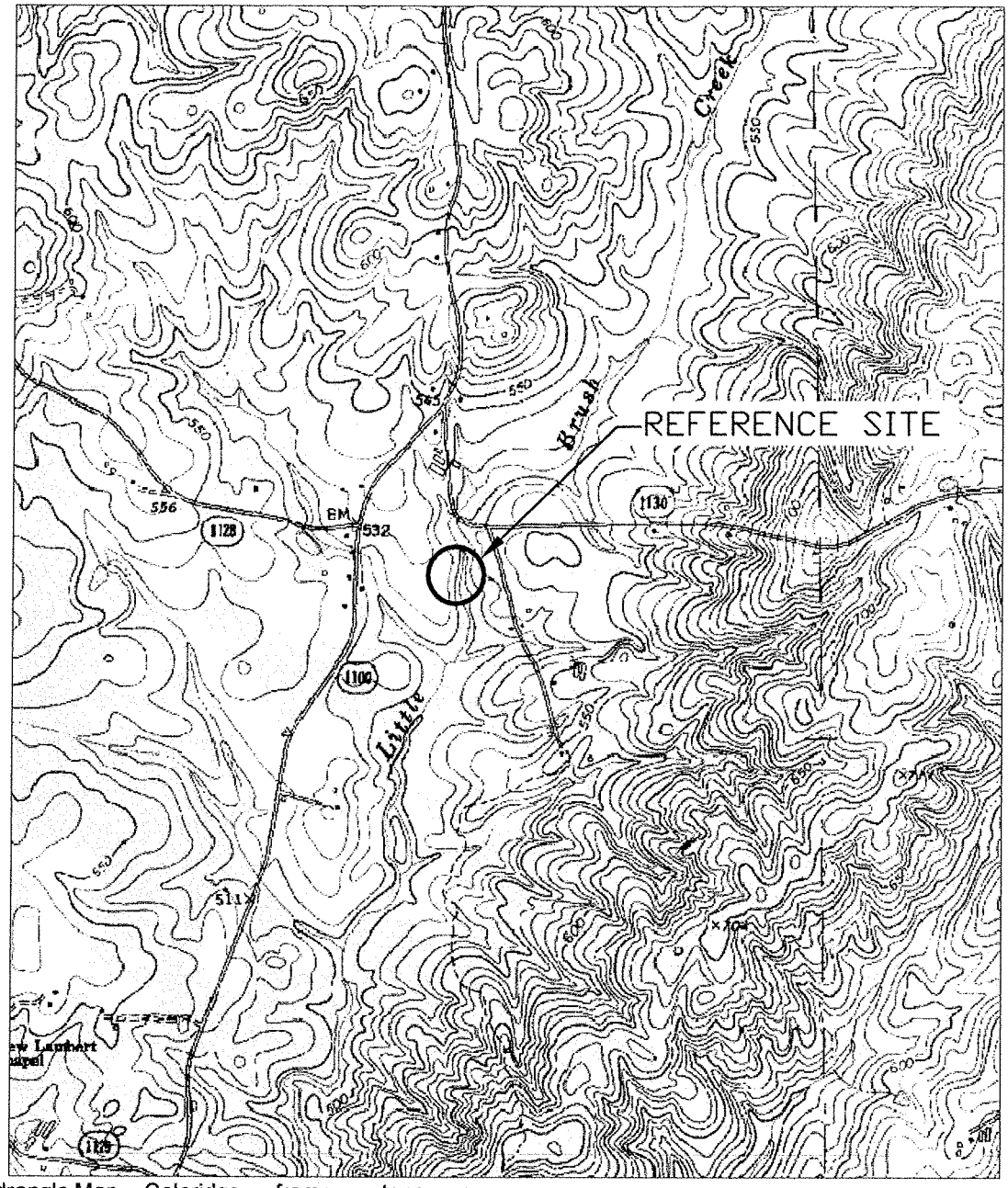


FIGURE 6
BOWMAN PROPERTY
VEGETATIVE COMMUNITIES

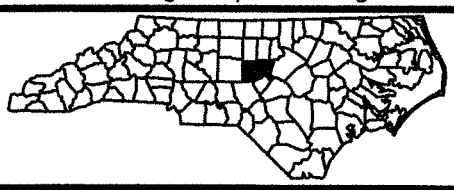
DATE: MARCH 16, 2007

WARD CONSULTING ENGINEERS, PC

8386 Six Forks Rd. Suite 101 (919) 870-0526
Raleigh, NC 27615-5088 FAX (919) 870-5359



USGS Quadrangle Map Coleridge from www.topozone.com



Ecosystem Enhancement PROGRAM

North Carolina - Ecosystem Enhancement Program

Mt. Pleasant Creek Stream Restoration Project
Randolph County, NC
SCO #060678701

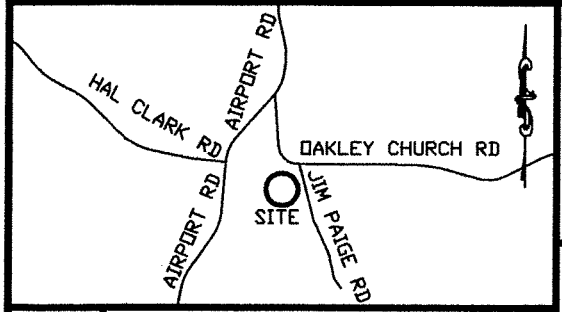
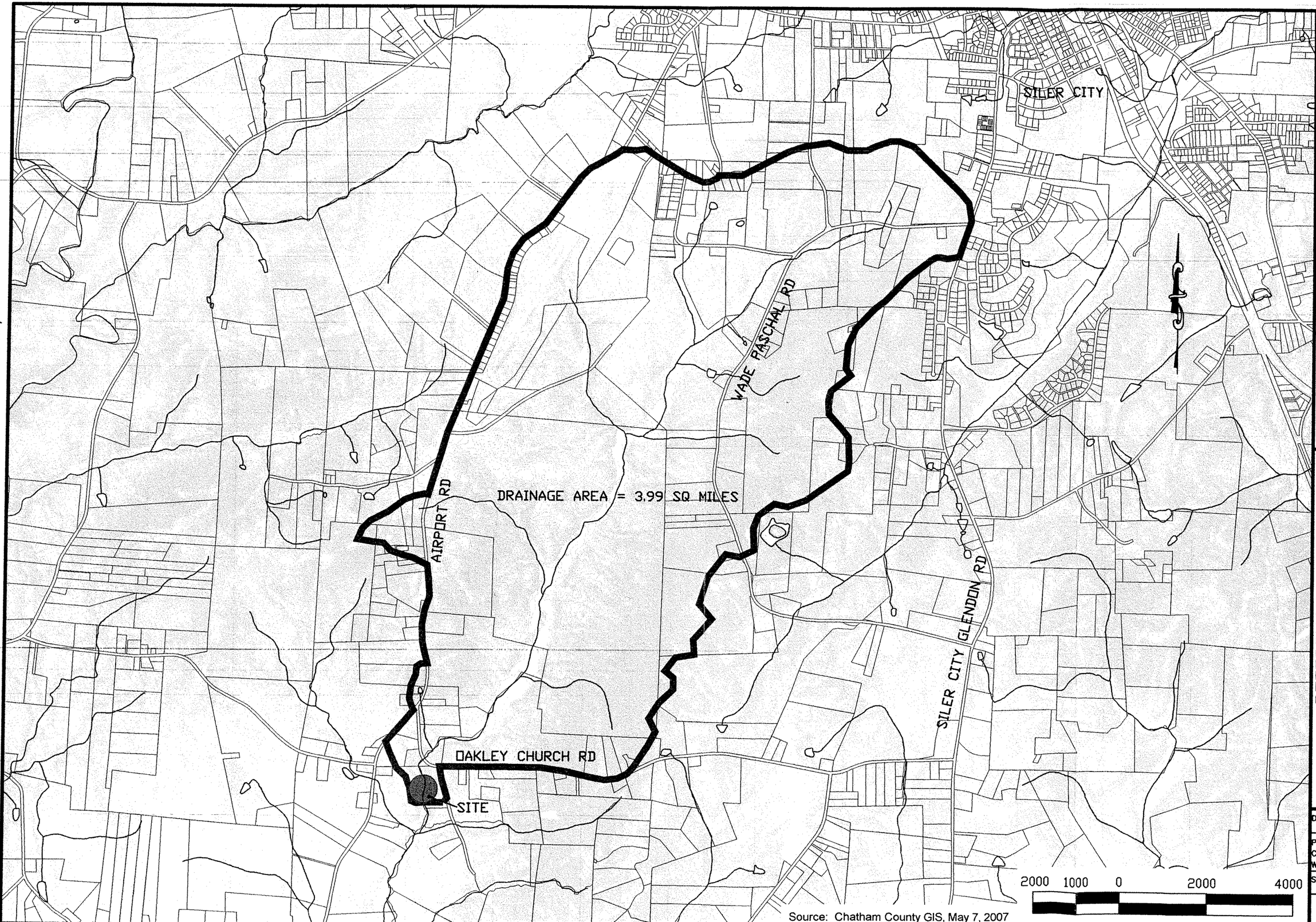


FIGURE 7
REFERENCE SITE
LITTLE BRUSH CREEK
VICINITY MAP

DATE: MARCH 16, 2007

WARD CONSULTING ENGINEERS, PC

8386 Six Forks Rd. Suite 101 (919) 870-0526
Raleigh, NC 27615-5088 FAX (919) 870-5359



Source: Chatham County GIS, May 7, 2007

WARD CONSULTING ENGINEERS, PC
8386 Six Forks Rd, Suite 101 (919) 870-0626
Raleigh, NC 27613 FAX (919) 870-5369

Ecosystem Enhancement PROGRAM

REFERENCE SITE
LITTLE BRUSH CREEK
WATERSHED MAP

CHATHAM COUNTY, NORTH CAROLINA

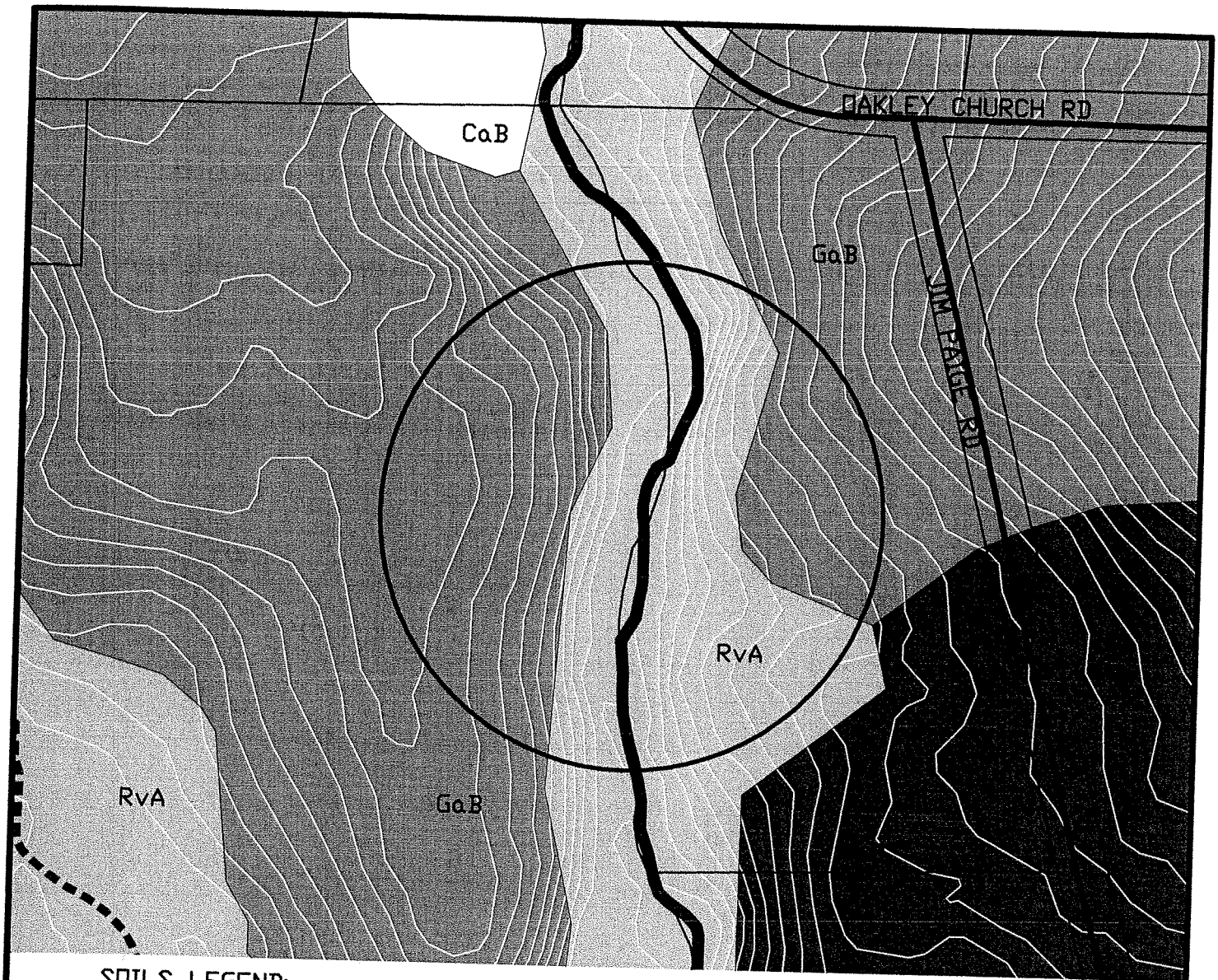
DATE: 16 March 2007

PROJ./DWG. NAME: Cox-Bowman/Exhibits Watershed

SCALE: 1"=2000'

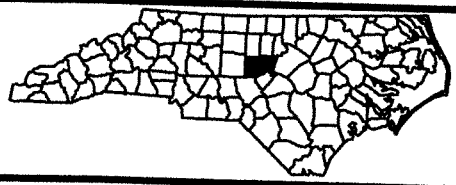
FIGURE 8

C:\Autocad Drawings\Cox-Bowman\Bowman Prop\WATERSHED Brush Creek Exhibit.dwg, 8/13/2007 10:15:17 AM, 1:1



SOILS LEGEND:

RvA - RIVERVIEW SILT LOAM 0-3% SLOPES
GaB - GEORGEVILLE SILT LOAM 2-6% SLOPES
NaB - NANFORD-BEDIN COMPLEX 2-6% SLOPES



Ecosystem Enhancement PROGRAM

North Carolina - Ecosystem Enhancement Program

Mt. Pleasant Creek Stream Restoration Project
Randolph County, NC
SCO #060678701

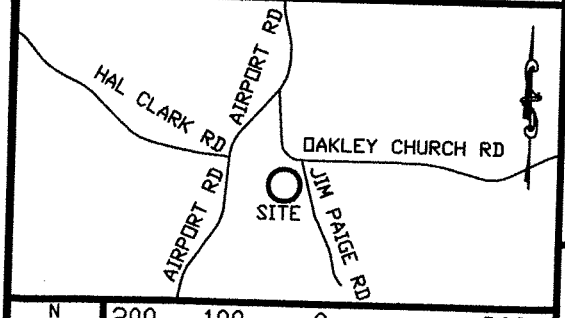
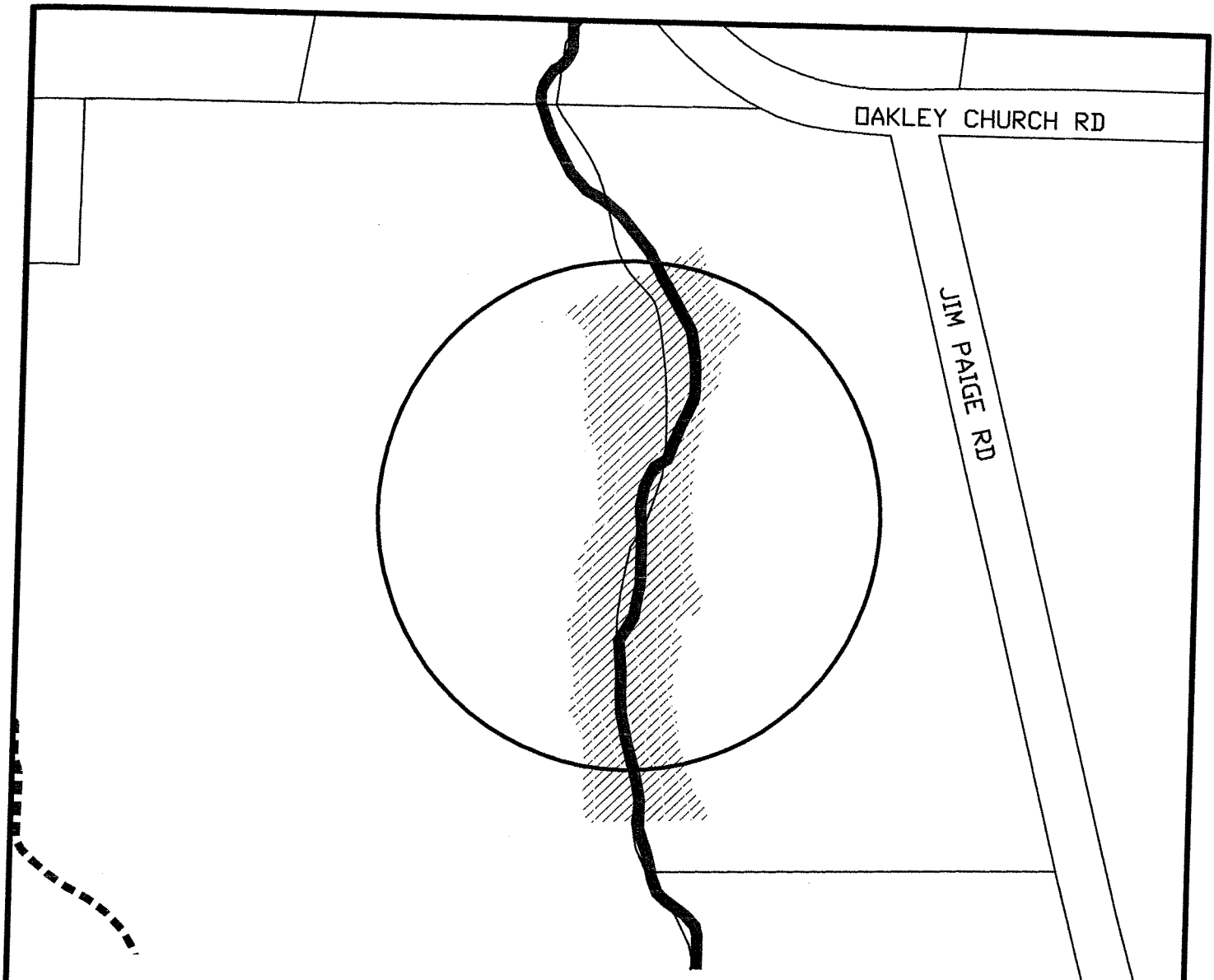


FIGURE 9
REFERENCE SITE
LITTLE BRUSH CREEK
NRCS SOIL SURVEY

DATE: MARCH 16, 2007

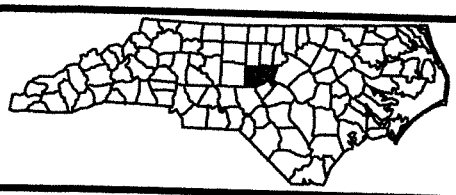
WARD CONSULTING ENGINEERS, PC

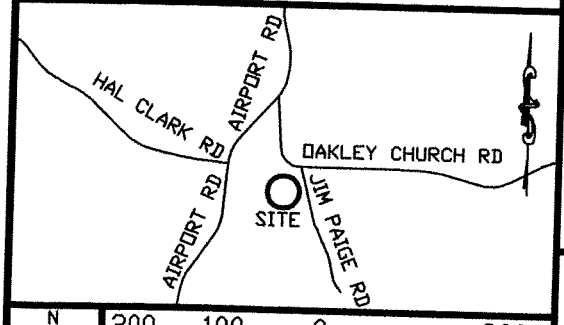
8386 Six Forks Rd. Suite 101 (919) 870-0526
Raleigh, NC 27615-5088 FAX (919) 870-5359



VEGETATIVE COMMUNITIES LEGEND:

PIEDMONT BOTTOMLAND FOREST





Ecosystem Enhancement PROGRAM

North Carolina - Ecosystem Enhancement Program

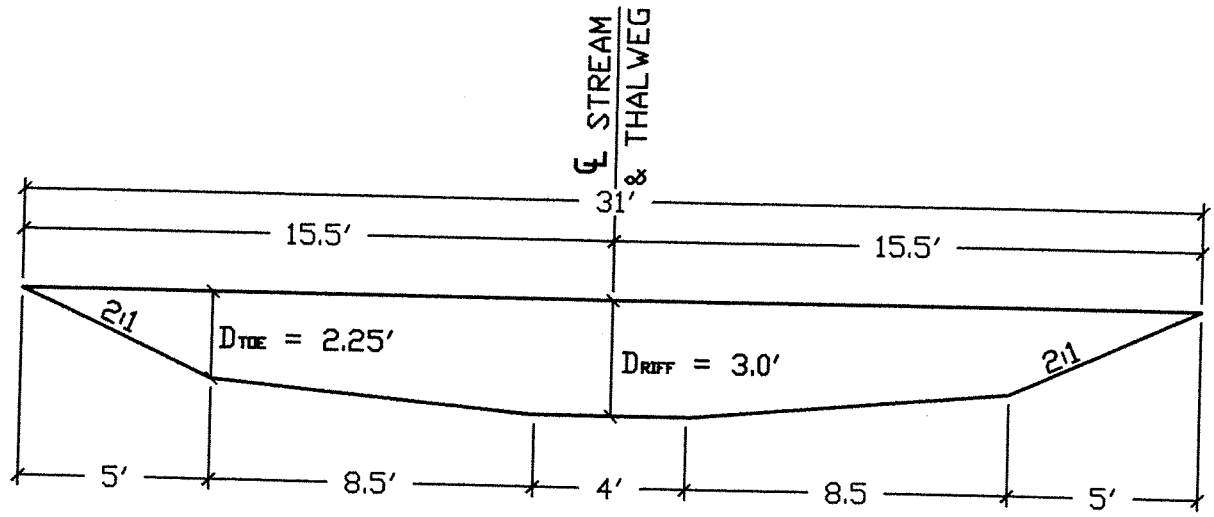
Mt. Pleasant Creek Stream Restoration Project
Randolph County, NC
SCO #060678701

FIGURE 10
REFERENCE SITE
LITTLE BRUSH CREEK
VEGETATIVE COMMUNITIES

DATE: MARCH 16, 2007

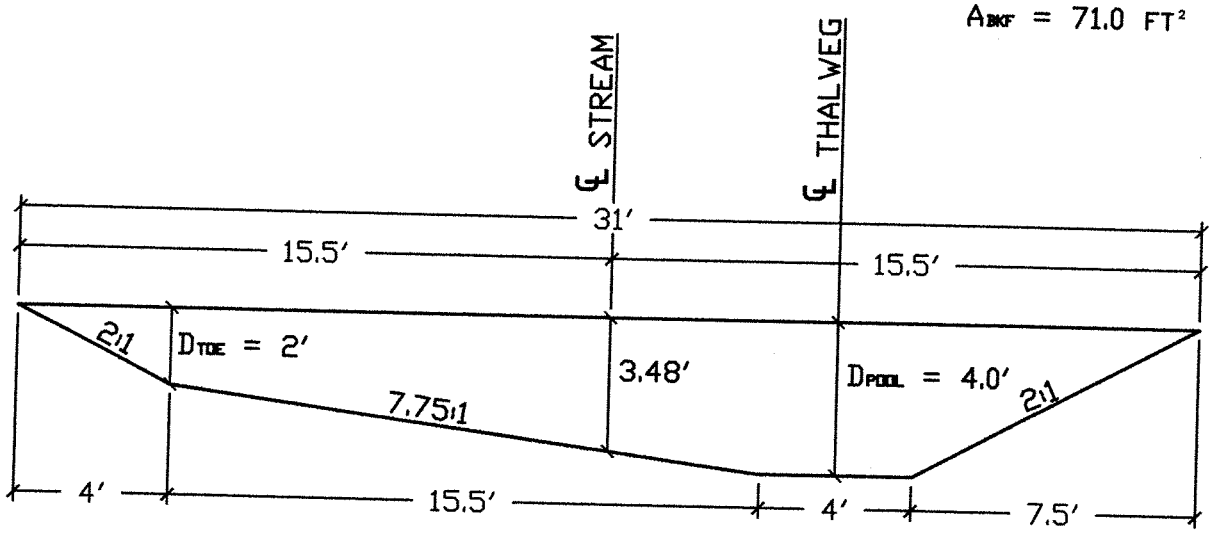
WARD CONSULTING ENGINEERS, PC

8386 Six Forks Rd. Suite 101 (919) 870-0526
Raleigh, NC 27615-5088 FAX (919) 870-5359



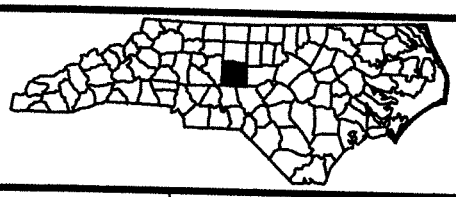
RIFFLE SECTION

W_{BKF} = 31.0 FT
A_{BKF} = 71.0 FT²



POOL SECTION

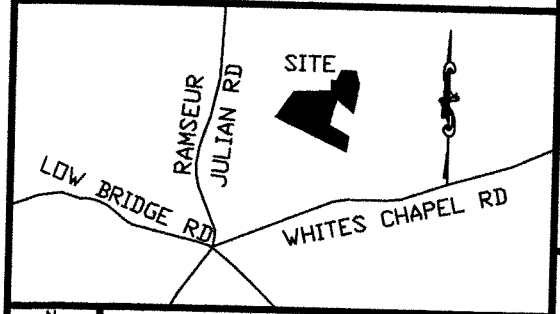
W_{BKF} = 31.0 FT
A_{BKF} = 82.6 FT²



Ecosystem Enhancement PROGRAM

North Carolina - Ecosystem Enhancement Program

Mt. Pleasant Creek Stream Restoration Project
Randolph County, NC
SCO #060678701



NOT TO SCALE

FIGURE 11
BOWMAN PROPERTY
TYP. CROSS SECTIONS

DATE: MARCH 16, 2007

WARD CONSULTING ENGINEERS, PC

8386 Six Forks Rd. Suite 101 (919) 870-0526
Raleigh, NC 27615-5088 FAX (919) 870-5359

10.0 Restoration Plans

Sheet 1. Existing Conditions

Sheet 2. Existing Conditions

Sheet 3. Existing Conditions

Sheet 4. Existing Conditions

Sheet 5. Restoration Plan Station 0 to 5+43

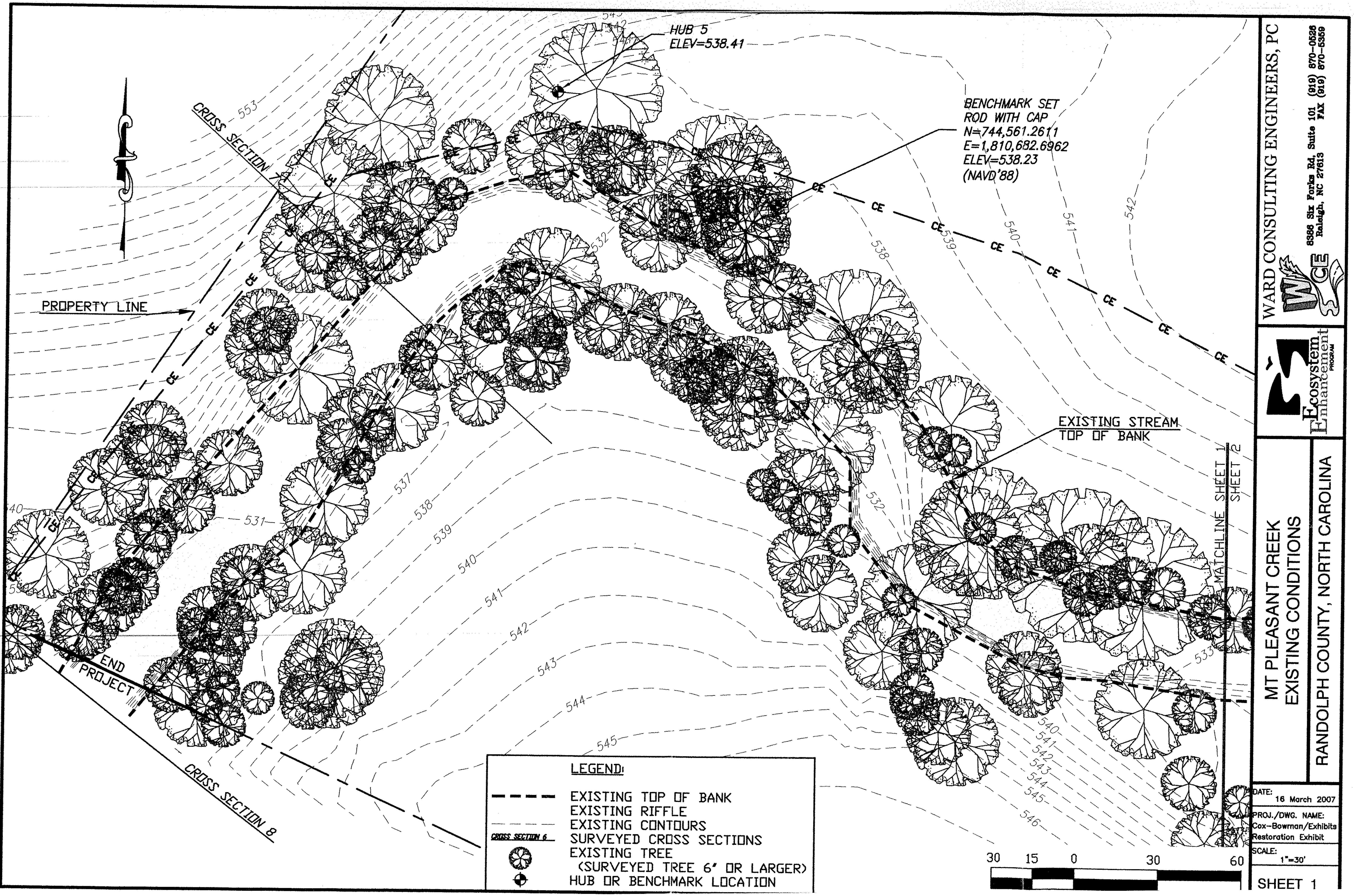
Sheet 6. Restoration Plan Station 5+43 to 10+50

Sheet 7. Restoration Plan Station 10+50 to 14+75

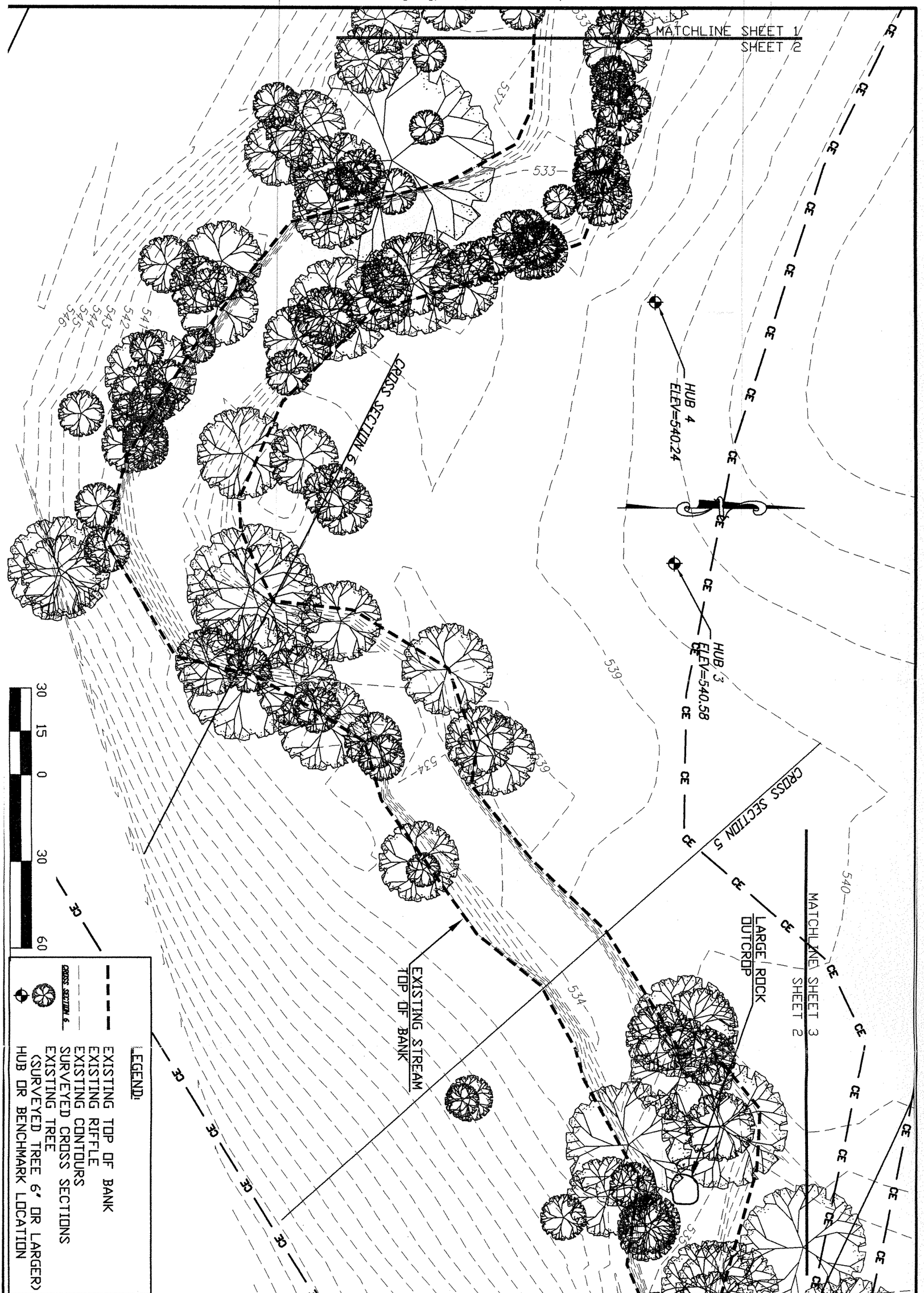
Sheet 8. Restoration Plan Station 14+75 to 17+74

Sheet 9. Proposed Profile

C:\Autocad Drawings\Cox-Bowman\Bowman Prop\Exhibit Restoration Existing.dwg, 11/9/2007 4:48:20 PM, 1:1



:\Autocad Drawings\Cox-Bowman\Bowman Prop\Exhibit Restoration Existing.dwg, 11/9/2007 4:48:57 PM, 1:1



MT PLEASANT CREEK
EXISTING CONDITIONS
RANDOLPH COUNTY, NORTH CAROLINA

DATE: 16 March 2007
PROJ./DWG. NAME: Cox-Bowman/Exhibits Restoration Exhibit
SCALE: 1"=30'
SHEET 2

Ecosystem Enhancement PROGRAM

WARD CONSULTING ENGINEERS, PC
8386 Six Forks Rd, Suite 101 (919) 870-0526
Raleigh, NC 27613 FAX (919) 870-5359

MATCHLINE SHEET 4
SHEET 3

BENCHMARK SET
ROD WITH CAP
N=744,669.4884
E=1,811,318.4953
ELEV=542.51
(NAVD'88)

BENCHMARK SET
ROD WITH CAP
N=744,481.6138
E=1,811,284.2830
ELEV=540.15(NAVD'88)

HUB 2
ELEV=541.05

CROSS SECTION 6

EXISTING STREAM
TOP OF BANK

MATCHLINE SHEET 3
SHEET 2

LARGE ROCK
OUTCROP

LEGEND:

- EXISTING TOP OF BANK
- EXISTING RIFFLE
- EXISTING CONTOURS
- CROSS SECTION 6 — SURVEYED CROSS SECTIONS
- EXISTING TREE (SURVEYED TREE 6" OR LARGER)
- HUB OR BENCHMARK LOCATION

30 15 0 30 60

WARD CONSULTING ENGINEERS, PC
8586 Six Forks Rd, Suite 101 (919) 870-0525
Raleigh, NC 27613 FAX (919) 870-5369

Ecosystem Enhancement Program

MT PLEASANT CREEK
EXISTING CONDITIONS

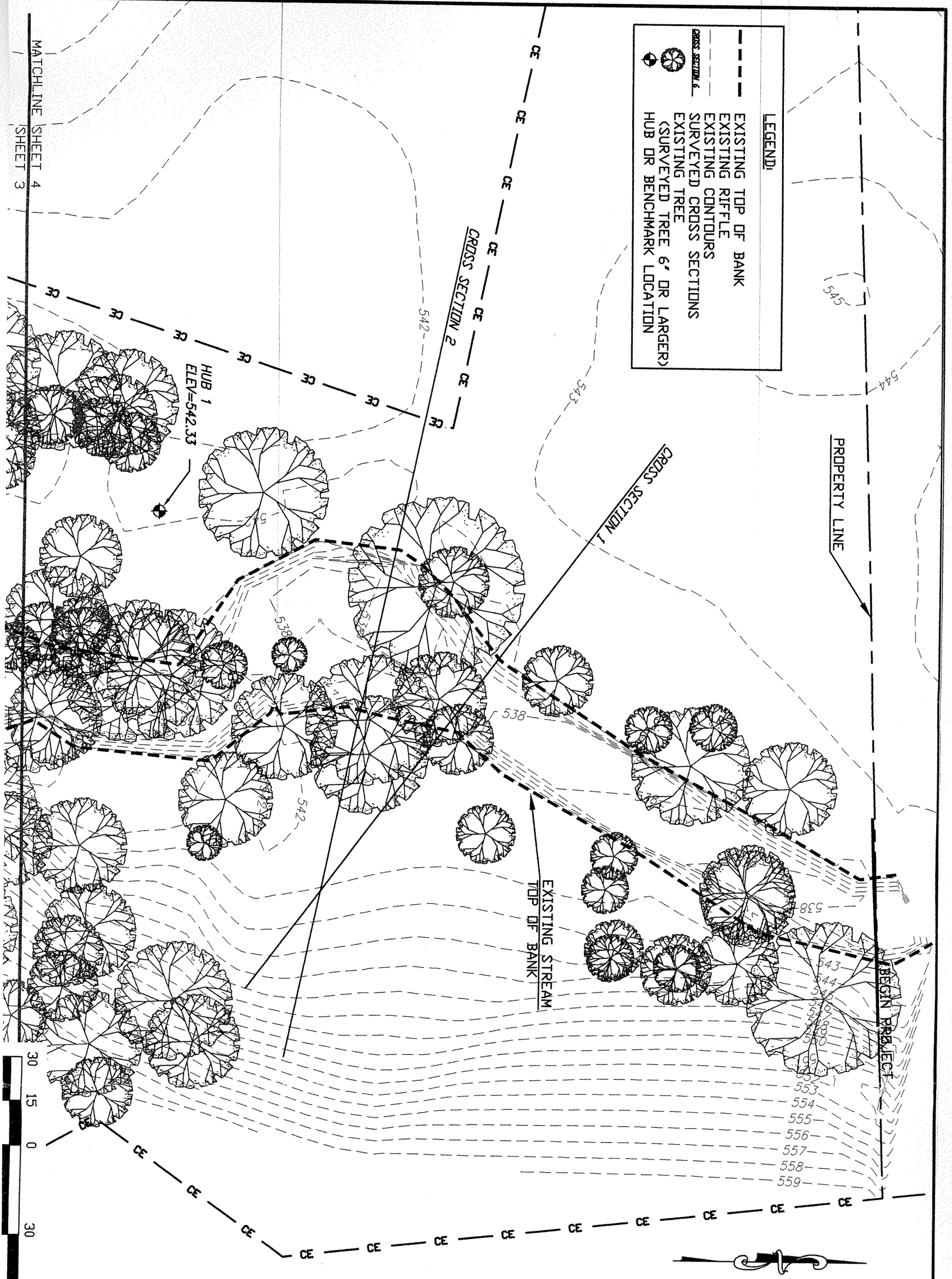
RANDOLPH COUNTY, NORTH CAROLINA

DATE: 16 March 2007
PROJ./DWG. NAME: Cox-Bowman/Exhibits Restoration Exhibit
SCALE: 1"=30'

SHEET 3

C:\Autocad Drawings\Cox-Bowman\Bowman Prop\Exhibit Restoration Existing.dwg, 11/9/2007 4:50:53 PM, 1:1

C:\Autocad Drawings\Cox-Bowman\Bowman Prop\Exhibit Restoration Existing.dwg, 11/9/2007 4:51:41 PM, 1:1



30 15 0 30 60

SHEET 4

DATE:	16 March 2007
PROJ./DWG. NAME:	Cox-Bowman/Exhibits Restoration Exhibit
SCALE:	1"=30'

MT PLEASANT CREEK
EXISTING CONDITIONS

RANDOLPH COUNTY, NORTH CAROLINA

Ecosystem Enhancement PROGRAM

WARD CONSULTING ENGINEERS, PC

8386 Six Forks Rd, Suite 101 (919) 870-0526
Raleigh, NC 27613 FAX (919) 870-5359

TIE PROPOSED TOB
INTO EXISTING TOB
TYP BOTH SIDES

ROOT WADS

FEMA 100 YR
FLOODPLAIN

SINGLE WING
ROCK VANE

ROCK CROSS VANE
(TYP-3) FOR VERTICAL
GRADE TRANSITION

PROPOSED
STREAM TOP
OF BANK

CONSTRUCTED
RIFFLE

EXISTING
STREAM TOP
OF BANK

PROPOSED STREAM
CENTERLINE

MATCHLINE SHEET 1
SHEET 2

END PROJECT

FEMA 100 YR
FLOODPLAIN

SINGLE WING
ROCK VANE

0+00
1+00
2+00
3+00
4+00
5+00

535
536
537
538
540

CE
TCE

LEGEND:

- FEMA 100 YR FLOODPLIAN
- PROPOSED STREAM CENTERLINE
- PROPOSED TOP OF BANK
- CONSTRUCTED RIFFLE
- EXISTING TOP OF BANK
- EXISTING RIFFLE
- EXISTING CONTOURS (SURVEYED)
- PROPOSED CONTOURS
- CONSERVATION EASEMENT
- PROPERTY LINE
- TEMPORARY CONSTRUCTION EASEMENT
- CLAY PLUG
- PROPOSED STREAM FORD

- ROOTWAD
- ROCKVANE
- TREE LINE
- TREES TO REMAIN

30 15 0 30 60

WARD CONSULTING ENGINEERS, PC
8386 Six Forks Rd, Suite 101 (919) 870-0526
Raleigh, NC 27613 FAX (919) 870-5359

Ecosystem Enhancement PROGRAM

MT PLEASANT CREEK STA 4+43 - 10+50
RESTORATION PLAN

RANDOLPH COUNTY, NORTH CAROLINA

DATE: 09 NOV 2007
PROJ./DWG. NAME: Cox-Bowman/Exhibits Restoration Exhibit
SCALE: 1"=30'

SHEET 5

C:\Autocad Drawings\Cox-Bowman\Bowman Prop\Exhibit Restoration Proposed.dwg, 11/9/2007 5:00:45 PM, 1:1

MATCHLINE SHEET 1
SHEET 2

MATCHLINE SHEET 3
SHEET 2

FEMA 100 YR
FLOODPLAIN

GABION BASKET FOUNDATION
WITH VEGETATED GEOGRIDS

LARGE ROCK
OUTCROP

SILL

SINGLE WING
ROCK VANE

CENTER OF
RESTORATION
PROJECT STA 8+50
LAT: 35°47'36.4"
LONG: 79°38'13.52"

PROPOSED STREAM
CENTERLINE

CONSTRUCTED
RIFFLE

EXISTING
STREAM TOP
OF BANK

PROPOSED
STREAM TOP
OF BANK

SINGLE WING
ROCK VANE

ROOT WADS

9+00
10+00
11+00
7+00
8+00

537
538
539
540
542

30 15 0 30 60

LEGEND:

- FEMA 100 YR FLOODPLIAN
- PROPOSED STREAM CENTERLINE
- PROPOSED TOP OF BANK
- CONSTRUCTED RIFFLE
- EXISTING TOP OF BANK
- EXISTING RIFFLE
- EXISTING CONTOURS (SURVEYED)
- PROPOSED CONTOURS
- CE — CONSERVATION EASEMENT
- PROPERTY LINE
- TCE — TEMPORARY CONSTRUCTION EASEMENT
- CLAY PLUG
- PROPOSED STREAM FORD
- ROOTWAD
- ROCKVANE
- TREE LINE
- TREES TO REMAIN

WARD CONSULTING ENGINEERS, PC
8386 Six Forks Rd, Suite 101 (919) 870-0626
Raleigh, NC 27613 FAX (919) 870-5359

Ecosystem Enhancement Program

MT PLEASANT CREEK STA 4+43 - 10+50
RESTORATION PLAN

RANDOLPH COUNTY, NORTH CAROLINA

DATE: 09 NOV 2007

PROJ./DWG. NAME: Cox-Bowman/Exhibits Restoration Exhibit

SCALE: 1"=30'

SHEET 6

C:\Autocad Drawings\Cox-Bowman\Bowman Prop\Exhibit Restoration Proposed.dwg, 11/9/2007 5:01:59 PM, 1:1

MATCHLINE SHEET 4
SHEET 3

LEGEND:

- FEMA 100 YR FLOODPLIAN
- PROPOSED STREAM CENTERLINE
- PROPOSED TOP OF BANK
- CONSTRUCTED RIFFLE
- EXISTING TOP OF BANK
- EXISTING RIFFLE
- EXISTING CONTOURS (SURVEYED)
- PROPOSED CONTOURS
- CE — CONSERVATION EASEMENT
- PROPERTY LINE
- TCE — TEMPORARY CONSTRUCTION EASEMENT
- CLAY PLUG
- PROPOSED STREAM FORD
- ROOTWAD
- ROCKVANE
- TREE LINE
- TREES TO REMAIN

CLAY PLUG

PROPOSED STREAM CENTERLINE

CONSTRUCTED RIFFLE

ABANDON EXISTING FORD

PROPOSED STREAM TOP OF BANK

EXISTING STREAM TOP OF BANK

PROPOSED 20' GATED STREAM FORD

GABION BASKET FOUNDATION WITH VEGETATED GEOGRIDS

ROCK FOR OFFSITE DRAINAGE EROSION CONTROL (TO NEW TOP OF BANK)

OFFSITE DRAINAGE

FEMA 100 YR FLOODPLAIN

MATCHLINE SHEET 3
SHEET 2

GABION BASKET FOUNDATION WITH VEGETATED GEOGRIDS

LARGE ROCK OUTCROP

TEMPORARY CONSTRUCTION EASEMENT & FUTURE PERMANENT ACCESS

13+00 12+00 10+00 1+00

540 541 542 539 538.5

30 15 0 30 60

WARD CONSULTING ENGINEERS, PC
8386 Six Forks Rd, Suite 101 (919) 870-0626
Raleigh, NC 27613 FAX (919) 870-5359

Ecosystem Enhancement Program

MT PLEASANT CREEK STA 10+50 - 14+75
RESTORATION PLAN

RANDOLPH COUNTY, NORTH CAROLINA

DATE: 09 NOV 2007

PROJ./DWG. NAME: Cox-Bowman/Exhibits Restoration Exhibit

SCALE: 1"=30'

SHEET 7

LEGEND:

- FEMA 100 YR FLOODPLIAN
- PROPOSED STREAM CENTERLINE
- PROPOSED TOP OF BANK
- CONSTRUCTED RIFFLE
- EXISTING TOP OF BANK
- EXISTING RIFFLE
- EXISTING CONTOURS (SURVEYED)
- PROPOSED CONTOURS
- CE — CONSERVATION EASEMENT
- PROPERTY LINE
- TCE — TEMPORARY CONSTRUCTION EASEMENT
- CLAY PLUG
- PROPOSED STREAM FORD
- ROOTWAD
- ROCKVANE
- TREE LINE
- TREES TO REMAIN

BEGIN PROJECT

PROPERTY LINE

NEW CHANNEL TIED TO EXISTING TOP OF BANK

16+66

PROPOSED STREAM CENTERLINE

16+00

CLAY PLUG

EXISTING STREAM TOP OF BANK

TO REMAIN AS EPHEMERAL POOL

PROPOSED STREAM TOP OF BANK

FEMA 100 YR FLOODPLAIN

CONSTRUCTED RIFFLE

540

541

15+00

542

544

546

CLAY PLUG

14+00

FEMA 100 YR FLOODPLAIN

MATCHLINE SHEET 4
SHEET 3

CE

30

30 15 0 30 60

WARD CONSULTING ENGINEERS, PC
8386 Six Forks Rd, Suite 101 (919) 870-0626
Raleigh, NC 27613 FAX (919) 870-5359

Ecosystem Enhancement Program

MT PLEASANT CREEK STA 14+75 - 17+74
RESTORATION PLAN

RANDOLPH COUNTY, NORTH CAROLINA

DATE: 09 NOV 2007

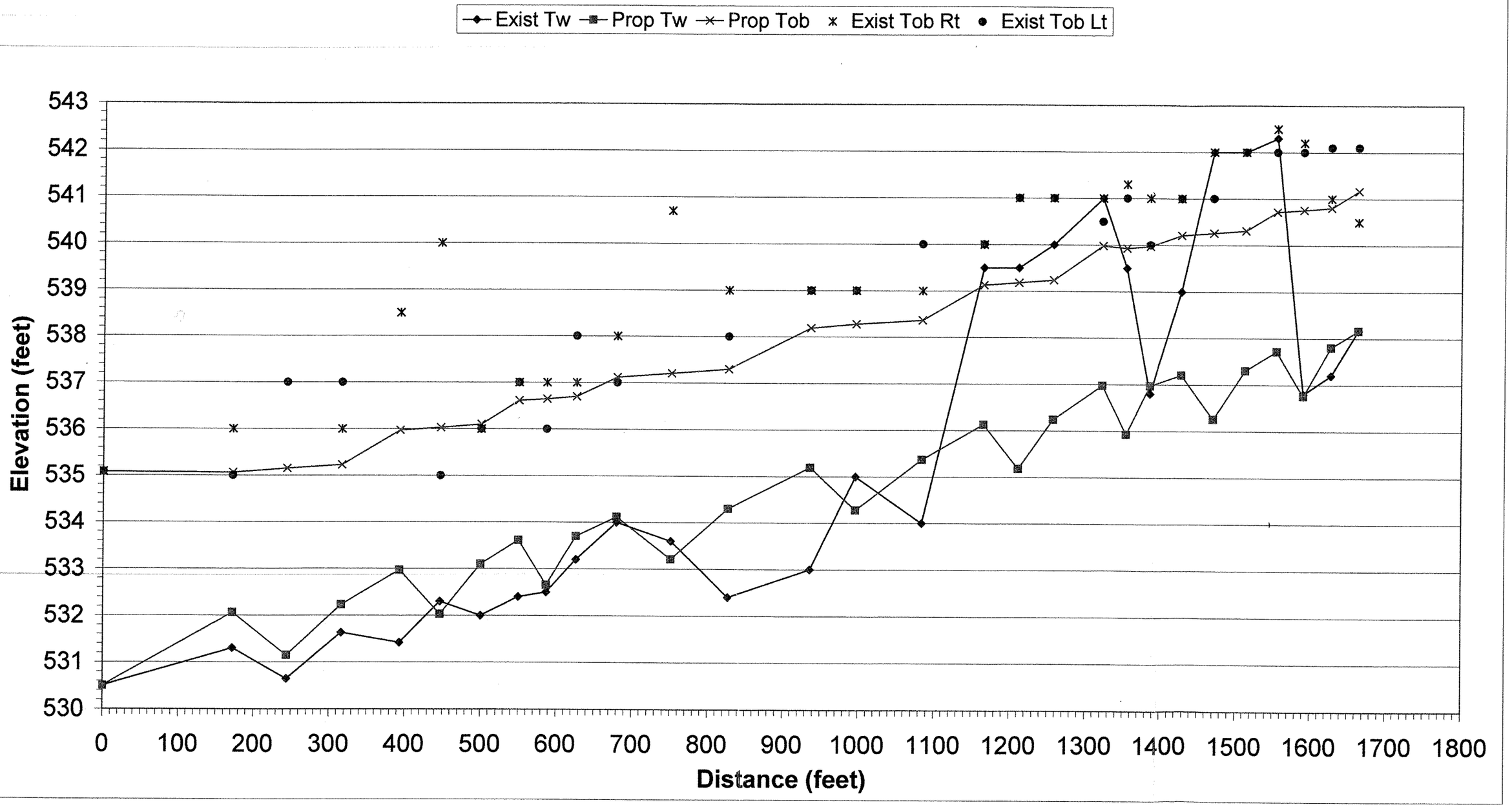
PROJ./DWG. NAME: Cox-Bowman/Exhibits Restoration Exhibit

SCALE: 1"=30'

SHEET 8

C:\Autocad Drawings\Cox-Bowman\Bowman Prop\Exhibit Restoration Proposed.dwg, 11/9/2007 5:04:02 PM, 1:1

Revised Proposed Profile November 2, 2007



Click on the Desired Link Below

Appendices