MILL BRANCH

FINAL STREAM AND WETLAND RESTORATION PLAN

Columbus County,
North Carolina

North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program

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EXECUTIVE SUMMARY

The Mill Branch Restoration Site was discovered during the Lumber River Basin Wetland and Stream Mitigation Site Search in 2002. This document details a plan to restore two unnamed tributaries (Main UT and Western UT), preserve and enhance riverine and non-riverine wetlands adjacent to both Mill Branch and the Main UT, and preserve portions of Mill Branch that flow through the forested wetlands on the northern portions of the property. The Site will be used to compensate for impacts within the Lumber River Basin.

Restoration of a degraded stream and wetland system to a stable condition leads to improvements in the aquatic and terrestrial communities that depend on it. The proposed plan will provide important benefits by improving the biological integrity of the stream and wetland system, reducing toxicity from surrounding nutrient runoff, increasing dissolved oxygen, moderating pH levels, and moderating water temperatures of the stream through shading by the surrounding buffer. The following table provides acreages and footages for proposed restoration, preservation, creation and enhancement on-site.

RESOURCE	RESTORATION	PRESERVATION	CREATION	ENHANCEMENT
Main UT (l.f.)	2,663	--	--	--
Western UT (l.f.)	739	--	--	--
Mill Branch (l.f.)	--	1,750	--	--
Riverine Wetlands (ac.)	--	35.8	0.25	0.44
Non-Riverine Wetlands (ac)	--	1.5	--	--

The Mill Branch Restoration Site will restore a considerably altered stream segment in a region where unaltered or restored streams are rare. The existing channel is classified as a G5 stream type, which is narrow and deep, using the Rosgen classification (Rosgen, 1996) system. The Main UT and the Western UT have and will continue to degrade because the channel has been straightened, cattle are accessing the stream, and there is relatively no woody vegetation within the riparian buffer. These factors have led to increased incision of the channel, increased nutrient loading into the channel, temperature increases of water in the channel, and a severe degradation of aquatic habitat. Stream restoration using Natural Channel Design will help to reduce the amount of sediment and nutrients from adjacent and upstream agricultural practices both entering and leaving the system. Riparian buffer plantings will jumpstart vegetation growth that will shade the channel and lower water temperatures, filter nutrients from entering the channel, provide woody debris for aquatic habitat, and grow root masses that will help stabilize the channel's banks.

Wetland pockets will be incorporated into the restoration of the entire system. These wetland pockets will be utilized in areas where the channel has been completely abandoned, where seeps are flowing into the newly constructed floodplain, and where a drainage swale from an adjacent irrigation pond intersects the channel.

Portions of Mill Branch and wetlands adjacent to Mill Branch, both Coastal Plain Small Stream Swamp and Coastal Plain Bottomland Hardwood wetlands, will be preserved in

perpetuity. An extensive beaver dam complex dams much of Mill Branch on the Jones Property, therefore the entire length of Mill Branch will not be preserved. The large majority of the wetlands to be preserved are classified as a Coastal Plain Small Stream Swamp. Most of the Swamp has been clear-cut within the last five to 10 years. Standing water approximately 1.5 feet deep was observed on every site inspection in the majority of the Swamp.

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1.0 INTRODUCTION

The Mill Branch Restoration Site was discovered during the Lumber River Basin Wetland and Stream Restoration Site Search in 2002. This document details a plan to restore two unnamed tributaries on-site (Main UT and Western UT), preserve wetlands adjacent to Mill Branch, preserve portions of Mill Branch itself, and to enhance and create wetlands in abandoned sections of the existing channel and wet seeps adjacent to the channel. The Site is being acquired through Mr. James P. Jones of Tabor City, NC.

The Main UT flows directly into Mill Branch at the downstream end of the Site. Mill Branch (Stream Index Number 15-17-1-12-1-6-1) is a tributary to Beaver Dam Swamp (Stream Index Number 15-17-1-12-1) (NCDWQ, 2004). The Main and Western UTs, Mill Branch, and Beaver Dam Swamp are all classified as C; SW as assigned by the North Carolina Division of Water Quality. Class C classifications indicate freshwaters protected for secondary recreation, fishing, and aquatic life including propagation and survival, and wildlife. Swamp Waters (SW) are waters which have low velocities and other natural characteristics which are different from adjacent streams.

The proposed Site will provide 3,402 linear feet of stream restoration on unnamed tributaries to Mill Branch, 1,750 linear feet of stream preservation on Mill Branch, 0.44 acres of riverine wetland enhancement, 0.25 acres of riverine wetland creation, 35.8 acres of riverine wetland preservation adjacent to Mill Branch and 1.5 acres of non-riverine wetland preservation.

2.0 GOALS AND OBJECTIVES

The Mill Branch Restoration Site consists of the following main components: stream restoration, stream preservation, wetland preservation, wetland enhancement, and wetland creation on a single property. The Main UT and a small tributary to the Main UT that flows from the southwestern portion of the Site will be restored. The small tributary flowing from the southwestern portion of the Site will be referred to as the Western UT throughout the document. Both the Main UT and the Western UT have been altered and moved from their original landscape position. Additionally, both channels have been straightened, cleared of woody vegetation, and have cattle accessing the channel. These impacts have degraded biologic, chemical, hydrologic, and geomorphic aspects within the channel and consequently Mill Branch's watershed. The proposed stream restoration will include: re-establishing a more stable and natural dimension, pattern and profile, establishing grade control points, creating a bankfull bench and floodplain, increasing sinuosity, and planting a riparian buffer.

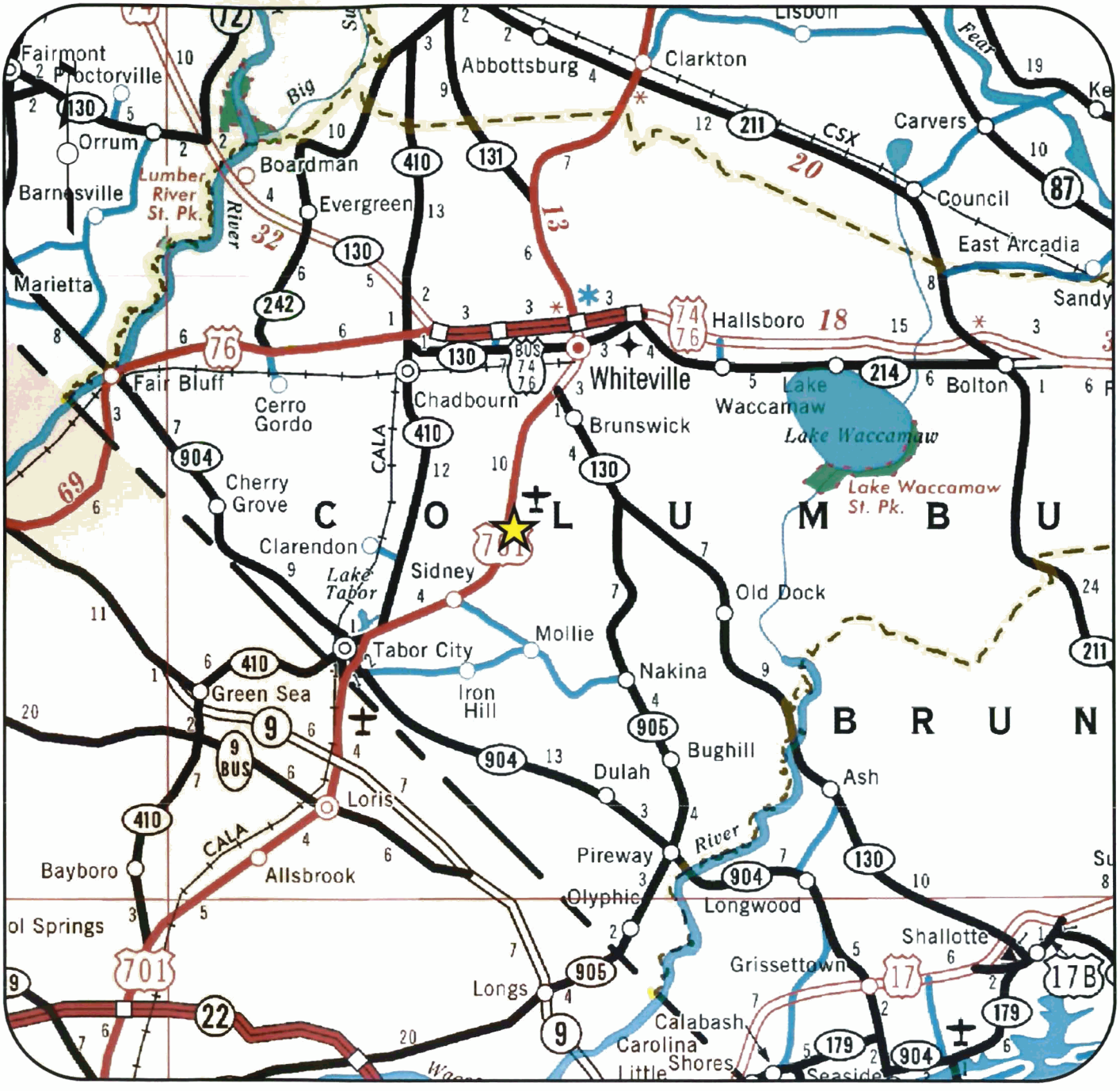
Mill Branch and wetlands associated with Mill Branch on the northern portions of the property will be preserved and will provide a permanent vegetated riparian buffer and wildlife corridor. A large beaver dam complex in the downstream half of Mill Branch has blocked flow, which has inundated the floodplain with over 1.5 feet of water. For this reason the lower half of Mill Branch will not be preserved, but the surrounding land will be preserved for its wetlands. The preservation of both Mill Branch and its associated wetlands will ensure floral and biotic diversity on-site and will enhance chemical, biological, and thermal conditions within Mill Branch's watershed.

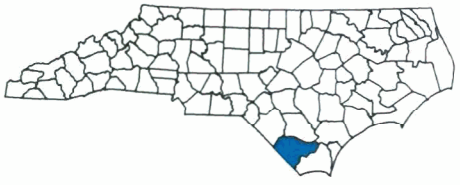
Sections of the existing channel that are abandoned after restoration will be converted into wetland pockets. These pockets will aid in filtering nutrients and excess sediment from the adjacent landscape, and will provide habitat for both terrestrial and aquatic fauna and biota. Other small wetland pockets, such as a wet seep draining out of a watering pond for cattle near the Main UT, that are currently adjacent to restoration reaches will be enhanced with vegetative plantings and minor earthwork to direct drainage.

Vegetation will be planted on the banks, floodplain, wetland pockets, and riparian buffer to help the establishment of a vibrant overall vegetated buffer to the restored channels. These plantings will help to stabilize the soil, uptake nutrients, decrease sedimentation, and provide habitat for fauna.

3.0 PROJECT LOCATION

The Mill Branch Site is approximately six miles south of the Town of Whiteville in Columbus County (Figure 1). The Site is located off of HWY 701 just northeast of its intersection with Lebanon Road (SR 1141) (Figure 2). Both Mill Branch and the Main UT are located within United States Geological Survey (USGS) hydrologic unit 03040206 and NCDWQ subbasin 03-07-57 of the Lumber River Basin. The Main UT is classified as C; SW as previously detailed in Section 1.0.





Legend

★ Mitigation Site
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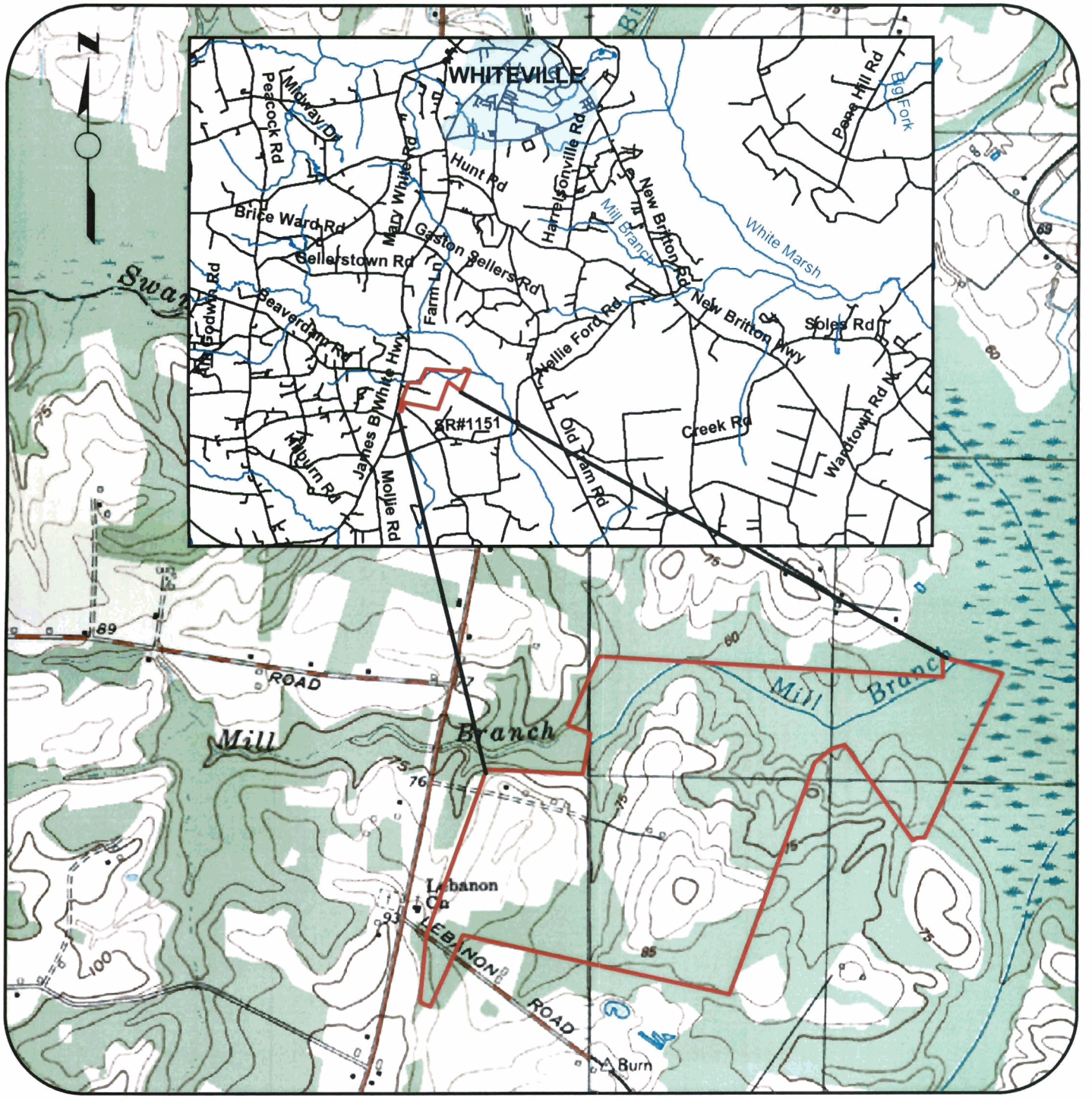
Vicinity Map

1" = 33,000'

Figure 1



Legend

- Jones Property
- Columbus County

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Location Map

Not to Scale

Figure 2

4.0 WATERSHED

The Site is located in the Middle Atlantic Coastal Plain, Carolina Flatwoods region of North Carolina (Griffith *et al.*, 2002). Broad, flat, interstream divides are the dominant topographic feature of this area. Terraces created by coastal waters during the Pleistocene era are covered by fine-loamy and coarse-loamy soils. Figure 3 depicts the watershed area and dominant land uses of the Main and Western UT's watershed. The watershed area encompasses approximately 178 acres. Elevations of the watershed range between approximately 65 to 100 feet above mean sea level (msl).

4.1 LAND USE

Land use within the watershed is dominated by a mixture of agriculture (pasture land and row crops), forested lands, and scattered single residency family homes. Agriculture comprises approximately 147 acres (83 percent), forested lands approximately 21 acres (12 percent), and single residency family homes approximately 9 acres (5 percent) of the total watershed area. A field verification of the watershed area was conducted on February 2, 2004.

Pasture land with scattered patches of trees surrounds the Main UT within the Site. Additionally, pasture land and row crops surround the Main UT upstream of the Site. State Road (SR) 1141, oriented east to west, bisects the watershed. The Site is located downstream (north) of SR 1141. One additional paved road, Highway (HWY) 701, intersects the western portions of the watershed in a north to south direction.

4.2 FUTURE WATERSHED IMPACTS

According to the Columbus County Manager's Office, the County has no zoning ordinances except in the town of Whiteville, Columbus County Community College, and within the Riegelwood Sanitary District. Therefore, land within the Site and within the Mill Branch watershed is not zoned.

No development within the Mill Branch watershed is planned according to the Columbus County Economic Development Commission. Therefore, the watershed land use upstream of and within the Site should not change significantly in the near future.

Legend

- Watershed Area
- Agriculture
- Forested
- Residential
- Hydrography
- Pond
- Jones Property

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Watershed and Land Use

Scale: 1" = 1,000' Figure 3

5.0 EXISTING CONDITIONS

5.1 HYDROLOGIC FEATURES

This section details all hydrologic features on-site. The Site contains three stream reaches, one pond, and numerous wetlands. All of these features are further described below and are graphically depicted on Figure 4.

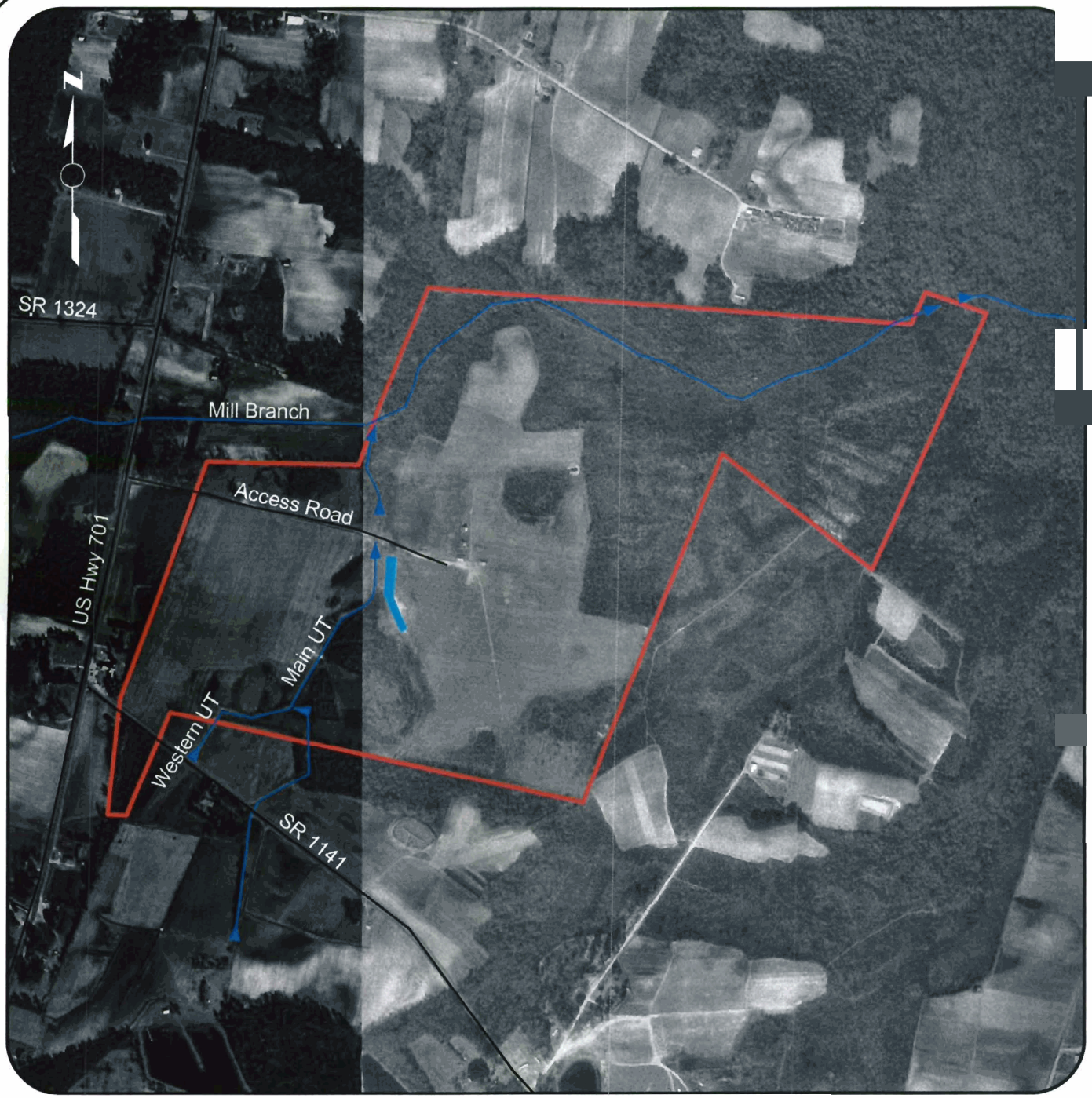
5.1.1 Streams

The three streams found on-site are Mill Branch, the Main UT to Mill Branch and the Western UT. Mill Branch is represented as an intermittent stream on the Tabor City East 7.5-minute topographic quadrangle (USGS, 1962) and as a perennial stream on the Nakina 7.5-minute topographic quadrangle (USGS, 1990). Additionally Mill Branch is represented as an intermittent channel in the *Columbus County Soil Survey (Spruill, 1990)*. Mill Branch is the collector stream for both the Main and Western UTs. Mill Branch flows generally from west to east across the northern portions of the Jones Property. Past channel alterations have left Mill Branch a channelized stream flowing through a Coastal Plain Small Stream Swamp (Schafale, 1990). A straight channel and spoil piles acting as berms are the primary evidence of past channel alterations. Mature vegetation is growing off of both the left and right banks on the upstream half of the length of the channel on the Jones Property. Additionally, mature trees, estimated to be over 40 years old, are growing from the spoil piles indicating Mill Branch was channelized many years ago. A large beaver dam complex is located in the channel near its midpoint on the Jones Property. This beaver dam complex has blocked the flow of Mill Branch, which has inundated wetlands with standing water on the floodplain. Mill Branch loses a defined channel from the beaver dam complex to near the end of the Jones' eastern property boundary.

Both the Main and Western UTs are represented as intermittent streams in the *Columbus County Soil Survey*; however, both reaches are not represented as a jurisdictional stream on the Nakina and Tabor City East 7.5-minute topographic quadrangles. The Main UT may have been moved out of its original valley and relocated west on-site into the adjacent valley. This observation was made while examining the *Columbus County Soil Survey* and topographic information. This valley may be the natural valley for the Western UT, but now the Western UT flows into the Main UT and both drain the same valley.

Both the Main UT and the Western UT have been channelized, lack woody vegetation, and have cattle accessing the stream on a consistent basis. This has severely altered the natural dimension, pattern, and profile of both streams, which led to their degradation. Downcutting (incision) and widening processes in each stream have resulted in bed instability and bank failure in places, both of which contribute increased amounts of sediment to the channel. Additional degradation comes from cattle access to the channel and the absence of mature vegetation on and adjacent to the banks of the channel. These factors have lead to increased sediment loss from the banks and chemical and thermal degradation of the channel's water.

The Main UT has three culverted crossings on-site. Two of three crossings are rarely used because they are located in the pasture in which the Main UT flows. The crossing that is used the most is located under the access road. The Western UT has one



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Legend

- Hydrography
- Pond
- Jones Property

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Hydrologic Features

Scale: 1" = 1,000'

Figure 4

culverted crossing as it enters the Site on the southwestern portion of the property. The landowner has indicated a willingness to replace culverts on his property that are required to restore the stream.

Both the Main and Western UT's banks are sparsely vegetated. The dominant vegetation found on the banks includes dog fennel (*Eupatorium compositifolium*), Chinese privette (*Ligustrum sinense*), blackberry (*Rubus* sp.), and fescue (*Festuca* spp.). No mature vegetation is found on or directly adjacent to the banks of the channel until the Main UT flows under the access road in the northern (downstream) portions of the Site. The lower 800 feet of the Main UT's bank, located just upstream of Mill Branch, is vegetated with widely scattered sweetgum (*Liquidambar styraciflua)* and red maple (*Acer rubrum*). This riparian area, however, has been impacted by cattle using it to access a ponded portion of the Main UT located directly north of the access road.

Aquatic fauna observed in the channel during field investigations included various minnow species and crayfish. No other macroinvertebrates were observed in either the Main or Western UTs. In-stream water quality is poor due to cattle accessing the channels, the lack of a vegetated riparian buffer, row crops directly upstream of the Site, and runoff from paved roads in the watershed. Large amounts of nutrient runoff combined with little canopy cover to shade the stream, will result in higher water temperatures and lower dissolved oxygen, particularly in the summertime. Frequent algal blooms, and the absence of riffle pool sequences reduce the availability of suitable habitat for macroinvertebrates and other aquatic species.

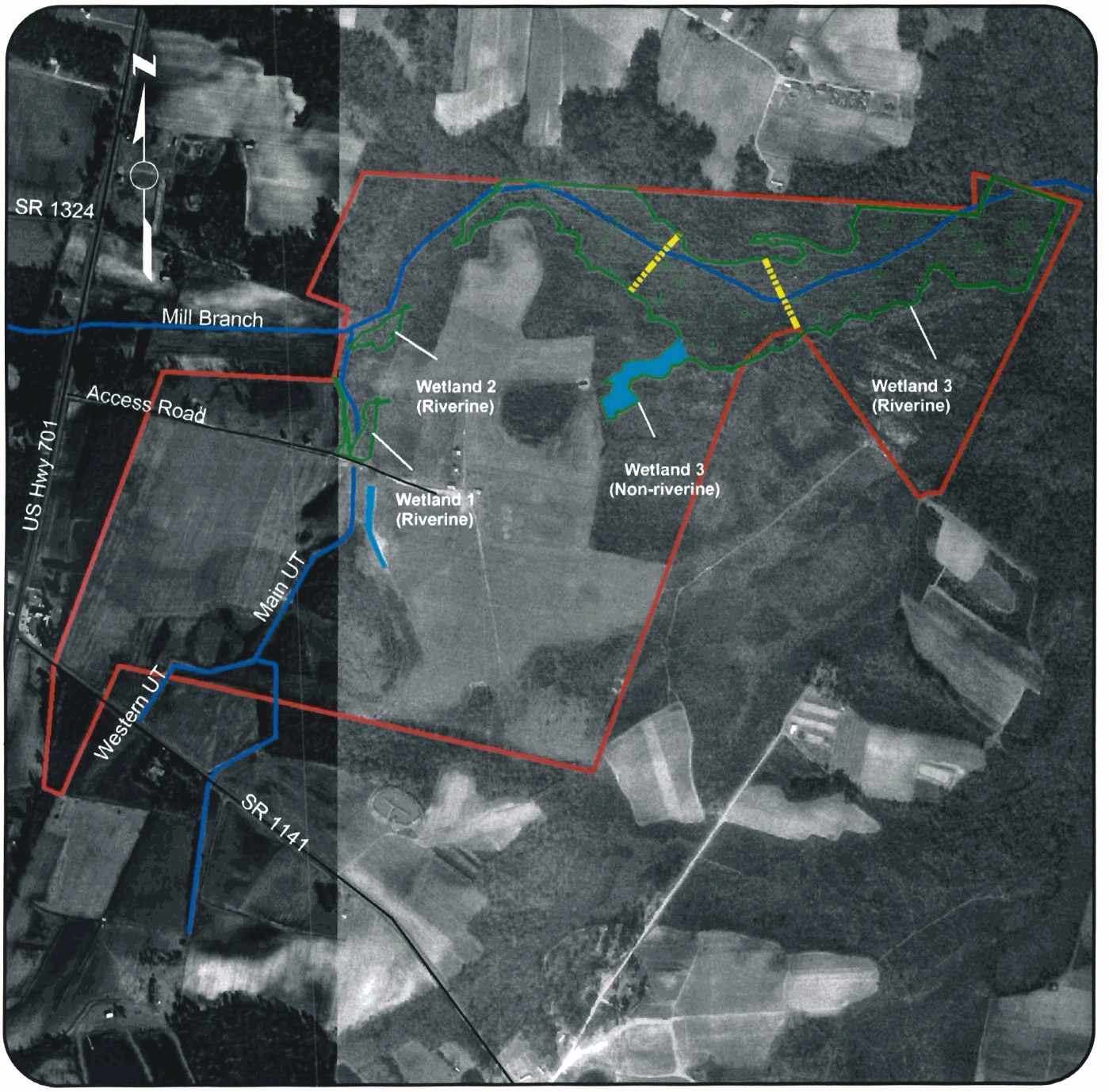
The NCDWQ Stream Classification Form (NCDWQ, 1999) for determining ephemeral, intermittent, and perennial channels was used to evaluate both restoration reaches. Forms were completed for both the Main and Western UTs. The Main UT received a numerical value of 24.75 and the Western UT received a numerical value of 20.25, indicating both are at least an intermittent streams. The completed NCDWQ forms can be found in Appendix A. Minnows were observed on numerous site inspections in the Main UT, suggesting a small perennial stream.

The Main UT received a 41 of 100 possible points on the Habitat Assessment Form (NCDWQ, 2001). The Western UT received a 37 of 100 possible points on the Habitat Assessment Form. Both of these ratings suggest poor habitat quality. The Stream Visual Assessment Protocol worksheet (USDA, 1998) resulted in a score of 2.67 for the Main UT and 3.2 for the Western UT, indicating both streams display poor habitat conditions. The completed forms can be found in Appendix A.

5.1.2 Wetlands

Three wetlands were delineated on-site in February 2004 and are displayed in Figure 5. Descriptions of the delineated wetlands, as well as NWI mapped wetlands, are detailed below.

The first wetland (Wetland 1) is a riverine wetland located immediately north of the access road to the Jones Property. Wetland 1 is approximately 0.8 acres. Cattle have access to this wetland, which is best described as a disturbed headwater forest. The Main UT flows through this wetland as both a braided and meandering stream, which has been dammed in the past in order to provide a watering source for cattle. The depth of surface water averages 2 inches and soils have a clay loam to loam texture with a



Legend

- Jones Property
- Riverine Jurisdictional Wetlands
- Non-riverine Jurisdictional Wetlands
- Beaverdam Complex
- Pond
- Hydrography

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Delineated Wetlands

Scale: 1" = 850' **Figure 5**

chroma of 1. Vegetation consists mostly of opportunistic and invasive species. The canopy is dominated by red maple and sweetgum. Other canopy and understory vegetation within the wetland includes black willow (*Salix nigra*), tearthumb (*Polygonum sagittatum*), Chinese privet, needlerush (*Juncus* spp.), and Carex (*Carex* spp).

A second wetland (Wetland 2) is a riverine wetland that occurs near the confluence of the Main UT and Mill Branch and is representative of a Coastal Plain Bottomland Hardwood Forest. Wetland 2 is approximately 0.8 acre and occurs south of the berm located along the right bank of Mill Branch. The depth of surface water varied from ground surface to 1.5 feet, with an average of approximately 6 inches the day of inspection. Soils are characterized as silty to sandy loam in texture with a chroma of 1. Canopy species include sweetgum, red maple, yellow poplar (*Liriodendron tulipifera*), and swamp chestnut oak (*Quercus michauxii*). Understory and herbaceous species include Chinese privet, ebony spleenwort (*Asplenium platyneuron*), and Carex.

The third delineated wetland (Wetland 3) is 36.5 acres. Wetland 3 is comprised of two wetland types, Coastal Plain Small Stream Swamp and Coastal Plain Bottomland Hardwood Forest (Schafale, 1990). The Coastal Plain Small Stream Swamp, a riverine wetland, is approximately 35.0 acres. The Coastal Plain Bottomland Hardwood Forest, a non-riverine wetland, is approximately 1.5 acres and is located on the southwestern portion of Wetland 3. The main hydrologic factor in the Coastal Plain Bottomland Hardwood Forest is groundwater seep from a pond upslope of the wetland. Wetland 3 is located along Mill Branch just inside the property boundary. The western part of this wetland, upstream of the beaver dam, consists of a mature swamp forest system. Watermarks on trees and water-stained leaves are common and the depth of surface water averages 6 inches. Soils consist of a silty clay loam with a chroma of less than 2. Canopy vegetation is dominated by water tupelo (*Nyssa aquatica*) and red maple. Other canopy and understory vegetation within Wetland 3 includes water oak (*Quercus nigra*), yellow poplar, loblolly pine (*Pinus taeda*), American holly (*Ilex opaca*), Chinese privet, and horse sugar (*Symplocos tinctoria*).

Most of the eastern portion of Wetland 3, which is largely influenced by the beaver dam complex, consists of a five to 10 year old clear cut, which consequently does not have the diverse, mature vegetation evident upstream of the beaver dam. Watermarks on trees are common and the depth of surface water averages approximately 1.5 feet. The A horizon (0 to 4 inches) consists of an organic muck and has a chroma of 2. Below 4 inches, the soil consists more of a sandy loam with a chroma of 1. Red maple is the dominant canopy species within the clear-cut portion of Wetland 3. Other canopy species include sweetgum and water tupelo. Vegetation in the understory is composed of American holly, titi (*Cyrilla racemiflora*), swamp red bay (*Persea palustris*), greenbrier (*Smilax* sp.) and inkberry (*Ilex coriacea*). Wetland delineation forms are included in Appendix B. Approximately 1.5 acres of wetlands in the eastern portion of Wetland 3 are non-riverine wetlands that are located in a Coastal Plain Small Bottomland Hardwood Forest.

5.1.3 NWI Wetlands

National Wetland Inventory (NWI) mapping indicates approximately 120 acres of wetlands on the Site (Figure 6). The majority of the NWI mapped wetlands occur along Mill Branch. Many of these wetlands are represented in the delineated wetlands detailed previously in Section 3.5.2. Much of the 120 acres of mapped NWI wetlands did not

Legend

- NWI
- Hydrography
- Pond
- Jones Property

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NWI Wetlands

Scale: 1" = 850' Figure 6

meet all three wetland parameters (hydrology, vegetation, and soils) and therefore were not delineated as wetlands in the field. The wetlands mapped along the northern property boundary are classified as Palustrine, Forested, Broad-Leaved Deciduous/Needle-Leaved Evergreen, Seasonally Flooded (PFO1/4C) wetlands. Wetlands located south of Mill Branch along the eastern portion of the Site consist of Palustrine, Forested, Broad-Leaved Deciduous, Seasonally Flooded (PFO1C) wetlands. Areas along the eastern property boundary are mapped as Palustrine, Forested, Needle-Leaved Evergreen/Broad-Leaved Deciduous, Temporarily Flooded (PFO4/1A). It is predominantly the PFO4/1A wetlands that appear to have been impacted by timber and cattle activities.

5.2 POND AND WET SWALES

A pond is located approximately 60 feet off of the right bank of the Main UT, just south of the access road. The pond is approximately 450 feet in length and is used as a watering source for cattle. A small drainage swale has formed on the northwestern side of the pond and drains to the Main UT. The swale directs overflow from the pond towards the Main UT. No defined channel is present, but the swale was inundated with approximately 1 inch of water on many site visits, especially after large rainfall events.

A second wet swale is located just upstream of the pond. This swale comes from a forested patch of woods located just south of the Main UT. The swale looks to be an old drainage channel that may have been filled in the past. The swale does not show signs of sheet flow. Water approximately 1 inch deep was observed to be standing in the swale during site visits.

5.3 SOILS

The Columbus County Soil Survey maps several hydric and nonhydric soils on the Site. Nonhydric soils include: Norfolk loamy fine sand, Wagram loamy fine sand, Goldsboro fine sandy loam, Lynchburg fine sandy loam, Stallings sandy loam, and Johns fine sandy loam. Hydric soils include Grifton fine sandy loam, Meggett fine sandy loam, Muckalee sandy loam, and Rains fine sandy loam (Figure 7).

5.3.1 Nonhydric Soils

Goldsboro fine sandy loam is a moderately well drained soil found on smooth uplands. Permeability and runoff are moderate. The seasonal high water table is below 2.0 feet. Pockets of Goldsboro soils are located throughout the Site, most commonly located just upslope from hydric Muckalee soils.

Johns fine sandy loam is a moderately well to somewhat poorly drained soil often found along stream terraces of the Lumber River. Johns soils have moderate permeability and moderate to high runoff potential. The seasonal high water table is between 1.5 to 3.0 feet from December to April. Johns soils are mapped along the easternmost property boundary of the Site.

Lynchburg fine sandy loam is a somewhat poorly drained soil located on broad upland flats. Lynchburg soils have moderate permeability and moderate to high runoff potential. The water table is typically at a depth of 0.5 to 1.5 feet from November to April. Lynchburg soils are located along the western boundary of the Site.

Legend

- Hydric Soils
- Nonhydric Soils
- Hydrography
- Pond
- Jones Property

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Soils

Scale: 1" = 850' Figure 7

Norfolk loamy fine sand is a well-drained soil found on broad, smooth flats of uplands. Permeability is moderate and surface runoff is medium. The seasonal high water table remains below 4.0 feet. Norfolk loamy sand is the predominant soil found within the central portions of the Site used for pasture.

Stallings sandy loam is a somewhat poorly drained soil located on broad upland flats. Stallings soils have slow infiltration rates and moderate to high runoff potential. The seasonal high water table is between 1.0 to 2.5 feet during December to April. A small pocket of Stallings soils is located within the northeastern portion of the Site.

Wagram loamy fine sand is a well-drained soil located along side slopes and upland flats. Wagram soils have moderate permeability and low surface runoff potential. The seasonal high water table is below 6.0 feet. Small pockets of Wagram soils are located within forested areas along the eastern portion of the Site.

5.3.2 Hydric Soils

Muckalee sandy loam, frequently flooded, is a poorly drained soil found along small stream floodplains. Infiltration is very slow and runoff potential is high. The water table is at a depth of 0.5 to 1.5 feet from December to March. Muckalee loam is the predominant hydric soil found on the Site and comprises the majority of the wetland preservation area.

Meggett fine sandy loam, frequently flooded, is a poorly drained soil located along floodplains and along stream terraces. Infiltration is very slow and runoff potential is high. The water table is at the surface to a depth of 1.0 foot between November and April. A small area of Meggett soils is mapped in the most northeastern corner of the Site, within the wetland preservation area.

Rains fine sandy loam is a poorly drained soil located on broad flats and shallow depressions of uplands. In areas that have not been altered by drainage, Rains soils have very slow infiltration and high runoff potential. The water table ranges from surface to a depth of 1.0 foot between November and April. A small area of Rains soils is located along the southwestern most portion of the Site.

Grifton fine sandy loam is a poorly drained soil found on broad interstream areas. Infiltration is very slow and the runoff potential is high. The water table is at a depth of 0.5 to 1.0 feet from December to May. This hydric soil is found on the southeastern corner of the Site. Portions of the areas mapped as Grifton soils have been cleared for pasture.

5.4 VEGETATIVE COMMUNITIES

Cattle pasture is the dominant land use on the Site and comprises approximately 50 percent of the total 245 acres. The remaining land is mostly forested. Restoration of the stream channel, excluding cattle from the channel, and establishment of a vegetated riparian buffer will provide additional wildlife habitat for terrestrial and aquatic species where minimal habitat exists now. The Site may potentially provide habitat for some Federal Species of Concern such as the Pee Dee lotic crayfish (*Procmabarus lepidodactylus*) and Savannah lilliput (*Toxolasma pullus*).

Vegetative community descriptions are based on the natural communities described in *Classification of the Natural Communities of North Carolina* and *A Field Guide to North Carolina Wetlands* (NCDENR, 1994). Vegetative communities present on the Site include Wet Flats, Headwater Forests, Coastal Plain Bottomland Hardwood Forest (Blackwater Subtype) and Coastal Plain Small Stream Swamp (Blackwater Subtype) (Figure 8). In addition, a pine plantation consisting mostly of loblolly pine is located upslope of the Coastal Plain Small Stream Swamp.

Several small, forested stands occur on the Jones Property. Located within an interstream divide, the forested area south of Lebanon Road (SR 1141) on the Jones Property is best described as a Wet Flat. The remaining forested pockets located along the Main UT and northeast of the access road most closely resemble Headwater Forests. Mature vegetation located just beyond the right bank of the Main UT consists mostly of early successional species such as sweetgum, red maple, and loblolly pine. These areas are accessible to cattle and are therefore susceptible to grazing and erosion impacts. In addition, downcutting of the stream has resulted in draining many of these areas that may have at once been jurisdictional wetlands. A third small pocket representing a Headwater Forest occurs southeast of the access road. This area is also accessible to cattle and consists largely of sweetgum, red maple and loblolly pine.

A disturbed Coastal Plain Bottomland Hardwood Forest (Blackwater Subtype) is located just north of the access road entering the Jones Property. Much of this forest is a jurisdictional wetland. Hydrology is maintained by ponding of the Main UT in this area. Historically, this area likely contained much greater vegetation diversity, however, the Main UT has been altered in the recent past to provide a watering source for cattle. Consequently, the area now consists of a ponded channel with wet pockets. Vegetation within this area consists predominantly of sweetgum, red maple, Chinese privet, *Polygynum* spp., *Juncus* spp., and *Carex* spp.

An additional, larger area of Coastal Plain Bottomland Hardwood Forest (Blackwater Subtype) is located just downstream of the confluence of the Main UT and Mill Branch. A small wetland is included in this community. Vegetation consists of species such as swamp chestnut oak and yellow poplar. Understory and herbaceous species include Japanese honeysuckle (*Lonicera japonica*), greenbrier, and *Carex* spp. This community transitions to the more extensive Coastal Plain Small Stream Swamp forest to the east.

The Coastal Plain Small Stream Swamp (Blackwater Subtype) is the predominant community located in the wetland preservation area located along Mill Branch in the northern portion of the property. An extensive beaver dam complex occurs within this portion of the Site. The beaver dams are backing water in Mill Branch and inundating this area. The wetland area located upstream of the beaver dams has a diverse vegetative community and is representative of a maturing Coastal Plain Small Stream Swamp. Canopy species are dominated by water tupelo and red maple. Other species present include yellow poplar, sweetgum, and water oak. The understory consists of American holly, horse sugar, titi, swamp red bay, sweet bay (*Magnolia virginiana*) and Chinese privet.

Legend

- Wet Flat
- Cattle Pasture
- Headwater Forest
- Pine Plantation
- Bottomland Hardwood Forest
- Small Stream Swamp Forest
- Hydrography
- Pond
- Jones Property

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Vegetative Communities

Scale: 1" = 850' **Figure 8**

Clearcutting has occurred within the last five to 10 years in portions of the swamp of the beaver dam complex. Dominant vegetation consists of red maple, water tupelo, and sweetgum. Understory vegetation includes titi, swamp red bay, sweet bay, American holly, and inkberry. The vegetative community located upslope of the wetland preservation area consists mostly of loblolly pine plantation.

5.5 RARE, THREATENED AND ENDANGERED SPECIES AND COMMUNITIES

The North Carolina Natural Heritage Program (NHP) was contacted to determine the presence of, or potential for rare, threatened and/or endangered species to occur on the subject properties and any listings of unique or rare natural community types in surrounding areas. Additionally, the United States Fish and Wildlife Service (USFWS) was contacted to request comments on the Site. A response phone call from Mr. Howard Hall of the USFWS on October 7, 2002 yielded no concerns regarding the Mill Branch Site.

5.5.1 Federal Listings

The USFWS protects plants and animals with the federal status designations of Endangered, Threatened, Proposed, or Experimental (either essential or non-essential) under the 1973 Endangered Species Act. Six federally protected species are listed by the USFWS (Table 1) as occurring in Columbus County (http://web.ncusfws.org/es/cntylist/columbus.html). A letter of response (Appendix C) from NHP indicates that there is no record of federally listed rare species, significant natural communities or priority natural areas, neither at the site nor within one mile of the site.

TABLE 1 Federally Listed Species and Species of Concern for Columbus County

SCIENTIFIC NAME	COMMON NAME	STATUS	HABITAT
	Vertebrates		
Alligator mississippiensis	American alligator	T(S/A)	Yes
Aimophila aestivalis	Bachman's sparrow	FSC	No
Elassoma boehlkei	Carolina pygmy sunfish	FSC	Yes
Ammodramus henslowii	Henslow's sparrow	FSC	No
Ophisaurus mimicus	Mimic glass lizard	FSC	No
Corynorhinus rafinesquii	Rafinesque's big-eared bat	FSC	Yes
Picoides borealis	Red-cockaded woodpecker	E	No
Acipenser brevirostrum	Shortnose sturgeon	E	No
Fundulus waccamensis	Waccamaw killifish	FSC	No
Menidia extensa	Waccamaw silverside	T	No
	Invertebrates		
Triodopsis soelneri	Cape Fear threetooth	FSC	Yes
Procambarus lepidodactylus	Pee Dee lotic crayfish	FSC	Yes
Toxolasma pullus	Savannah lilliput	FSC	Yes
Lampsilis fullerkati	Waccamaw fatmucket	FSC	No
Elliptio Sp. 5	Waccamaw lance pearlymussel	FSC	Yes
Elliptio waccamawensis	Waccamaw spike	FSC	No
	Vascular Plants		
Tofieldia glabra	Carolina asphodel	FSC	No
Macbridea caroliniana	Carolina bogmint	FSC	Yes
Parnassia caroliniana	Carolina grass-of-parnassus	FSC	No
Carex chapmanii	Chapman's sedge	FSC	Yes
Thalictrum cooleyi	Cooley's meadowrue	E	No
Fimbristylis perpusilla	Harper's fimbry	FSC	Yes
Plantago sparsiflora	Pineland plantain	FSC	No
Eupatorium resinosum	Resinous boneset	FSC	Yes
Lysimachia asperulaefolia	Rough-leaved loosestrife	E	No
Oxypolis ternata	Savannah cowbane	FSC	No
Amorpha georgiana var. confusa	Savanna indigo-bush	FSC	No
Solidago verna	Spring-flowering goldenrod	FSC	No
Rhynchospora decurrens	Swamp forest beaksedge	FSC	Yes
Dionaea muscipula	Venus flytrap	FSC	Yes
Sporobolus teretifolius sensu stricto	Wireleaf dropseed	FSC	No

"E"-- An Endangered species is one, which is in danger of extinction throughout all or a significant portion of its range.

"**FSC**"-- A Special Concern species is one, which requires monitoring but may be taken or collected and sold under regulations adopted under the provisions of Article 25 of Chapter 113 of the General Statutes (animals) and the Plant Protection and Conservation Act (plants). Only propagated material may be sold of Special Concern plants that are also listed as Threatened or Endangered.

"**T**"-- A Threatened species is one, which is likely to become endangered species within the foreseeable future throughout all or a significant portion of its range.

5.5.2 State Rare and Protected Species

Plants and animals with state designations of Endangered (E), Threatened (T), Candidate (C) or Special Concern (SC) are protected under the State Endangered Species Act (G.S. 113-331 to 113-337) (administered and enforced by the NC Wildlife Resources Commission) and the State of North Carolina Plant Protection and Conservation Act of 1979 (G.S. 196: 106-202.12 to 106-202.19) administered and enforced by the NC Department of Agriculture. As noted in section 5.5.1, a letter of response (Appendix C) from NHP indicates that there is no record of state listed rare species, significant natural communities or priority natural areas, either at the site nor within one mile of the site.

5.6 STREAM CLASSIFICATION AND SUBSTRATE ANAYLSIS

Both the Main and Western UTs were surveyed on Jan 20, 2004. The Main UT and the Western UT are classified as G5 type channels using the Rosgen classification system. Typically a G type channel is entrenched, and displays a low width-to-depth ratio and a low sinuosity. Both the Main UT and Western UT display channels with width-to-depth ratios ranging between 4.0 and 8.7, and sinuosities of 1.05 (Upper Reach), 1.09 (Middle and Lower Reaches), and 1.01 (Western Reach). The low sinuosity on both the Main and Western UTs is further evidence that they have been channelized in the past. Neither the Main nor Western UT shows any natural meanders in their respective patterns.

The Main UT displays bankfull channel widths between 2.9 and 6.5 feet and average bankfull depths of 0.72 to 0.86 feet. The Western UT generally displays a bankfull channel width of 2.8 feet and an average bankfull depth of 0.32 feet. However, the Main UT displays entrenchment ratios that are somewhat higher than Rosgen's classification system suggests for G type channels. Entrenchment ratios vary from 2.3 to 10.8 in cross-sections completed on the Main UT. Rosgen's classification system indicates that G type channels typically display entrenchment ratios of 1.4 (+/- 0.2). It is believed that the Main UT functions more like a G type channel than any other channel type because of the lack of meander geometry and the lack of a riffle pool sequence (displays poor bed form diversity), both of which aid in the dissipation of energy during high flows. The Main UT could be transitioning from an unstable C type channel to a G type channel. The Western UT displays entrenchment ratios of 1.0, which fall within the typical category of a G type channel.

The '5' classification signifies that both the Main UT and the Western UT contain sand as the predominant channel material. The D50 cumulative particle size of the Main UT is 0.1 mm. This places the dominant particle size in the Very Fine (0.62 to 0.125 mm) sand category. The D50 cumulative particle size of the Western UT is 0.2 mm. This places the dominant particle size in the Fine (0.125 to 0.25 mm) sand category. Small areas of clay in the bed exposed from the incision of the channel are apparent through small portions of the Main UT in its downstream extents. Existing channel data and photographs for both the Main and Western UTs are presented in Appendix A.

6.0 REFERENCE CONDITIONS

6.1 EXISTING CHANNEL

The existing channel does not provide a stable dimension, pattern, and profile that can be used to design the proposed restored channel. Neither the upstream nor the downstream portions of the Main or Western UT demonstrate stable reaches that would provide adequate reference information. This is largely the result of stream channelization and agricultural impacts. The existing channels are classified as G5 type streams. G5 type streams typically signify unstable, narrow, incised channels with very low sinuosity and low entrenchment ratios in sand bed systems.

6.2 REFERENCE REACHES

Sixty-two potential reference reaches were identified in the Lumber River Basin using available mapping, photography, and soils information. Each potential reference reach was located either in the same or adjacent 6-digit hydrologic unit code as the Site, and was reviewed in the field. Two of the 62 streams were determined to be suitable reference reaches. The lack of suitable reference reaches further indicates the degree of stream degradation in southeastern North Carolina.

The two primary reference reaches, an Unnamed Tributary (UT) to Hog Swamp located in Robeson County and an Unnamed Tributary (UT) to Ironhill Branch located in Columbus County, were identified in the Lumber River Basin and were used as the primary reference reaches (Figure 9). These reference reaches were surveyed on February 19, 2004 and March 9, 2004.

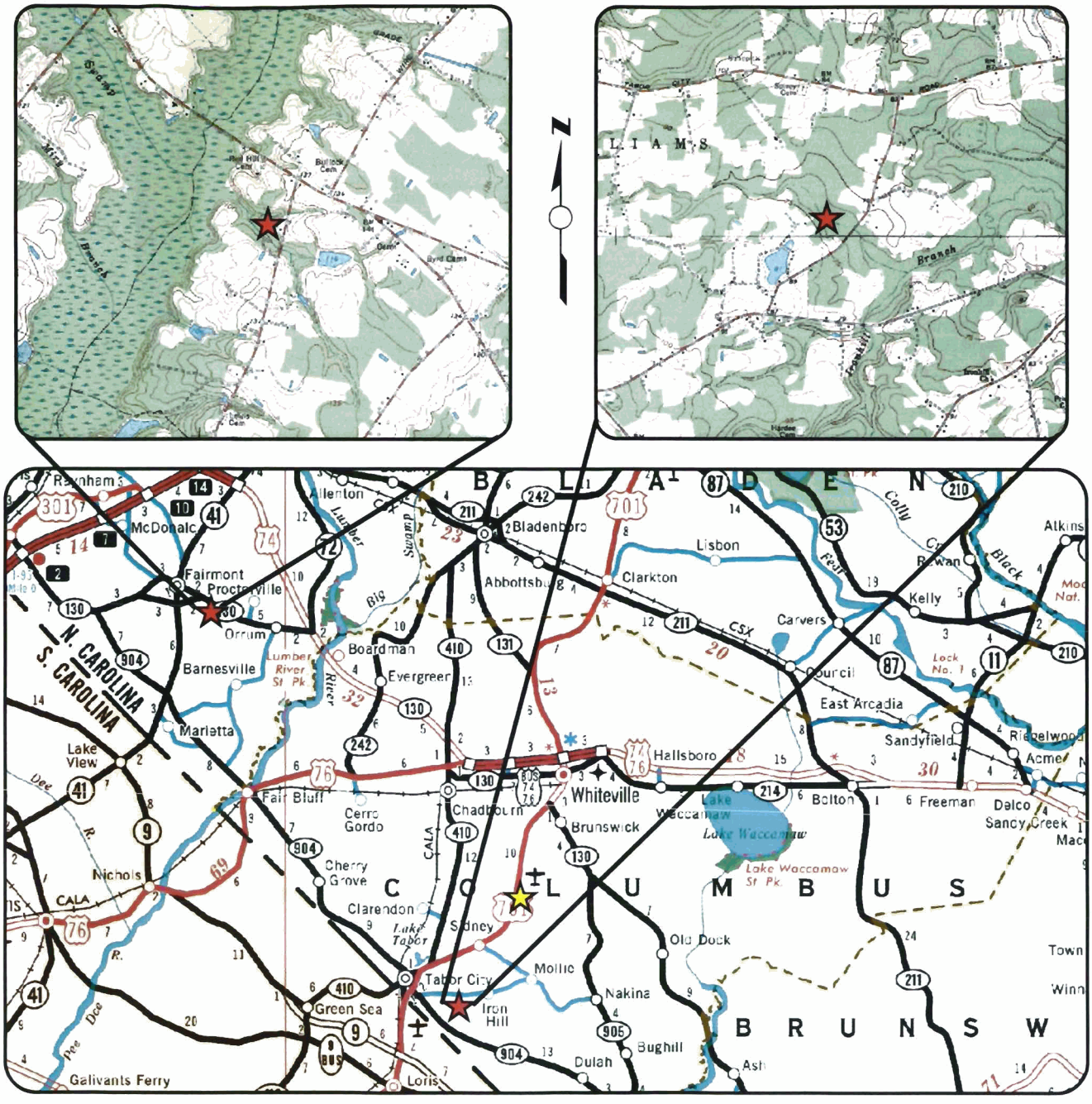
Additional stream reference information was deemed necessary to supplement the reference information collected on the primary reference reaches because the Site has numerous (four) design reaches (discussed in Section 7). Two additional (secondary) reference reaches from the Cape Fear River Basin were utilized because no other suitable reference reaches could be located near the Site within the Lumber River Basin. These two reference reaches, Muddy Creek in Harnett County and Mill Creek in Moore County, were surveyed on March 3, 2004 and February 23, 2004 respectively (Figure 10). Although the secondary reference reaches are located outside of the Lumber River Basin, both represent channel and valley types similar to those that will be restored on the Site.

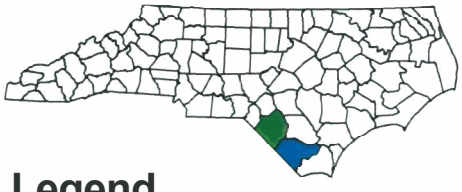
6.2.1 UT to Hog Swamp (Primary)

The UT to Hog Swamp reference reach is a first order, perennial tributary flowing west into Hog Swamp in Robeson County, North Carolina. The UT to Hog Swamp is represented as an intermittent blue line stream on the Fairmont 7.5-minute topographic quadrangle (USGS, 1962) and has a watershed area of approximately 48 acres. Land use within the watershed consists of predominately agricultural with some residential, small commercial, and forest. There is a mature forested buffer along most of the channel and the entire surveyed reach.

UT to Hog Swamp

UT to Ironhill Branch





Legend

- ★ Reference Site
- ☆ Mitigation Site
- Robeson County (UT to Hog Swamp)
- Columbus County (UT to Ironhill Branch)

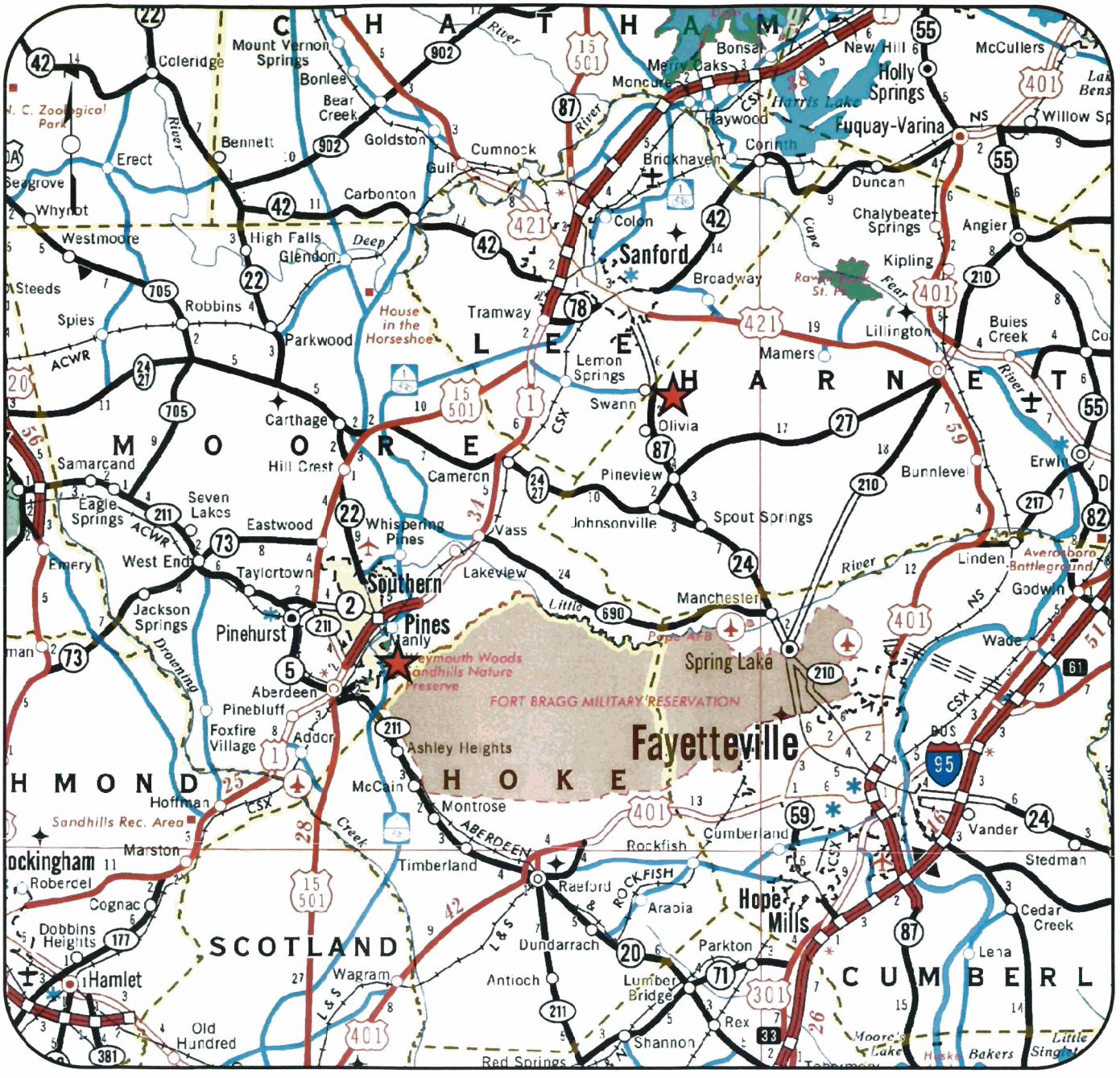
North Carolina Ecosystem Enhancement Program

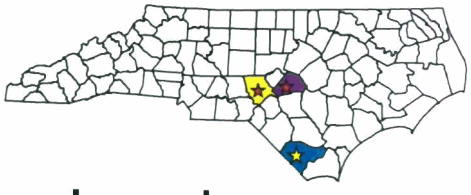
Mill Branch
Stream and Wetland Restoration Plan
Columbus County
North Carolina

Primary Reference Reach Locations

Not to Scale

Figure 9





Legend

- ★ Secondary Reference Reaches
- ☆ UT to Mill Branch
- Columbus County
- Moore County (Mill Creek)
- Harnett County (Muddy Creek)

North Carolina Ecosystem Enhancement Program

Mill Branch
Stream and Wetland Restoration Plan
Columbus County
North Carolina

Secondary Reference Reach Locations

Not to Scale

Figure 10

The reference reach was surveyed downstream (west) of the SR 2225 (Leggett Road) crossing. The reach used for the survey was 187 feet in length. The survey included a longitudinal profile, cross-sections, and an evaluation of the bed material, buffer, and system stability. The bankfull area of 1.8 ft^2 is 0.8 ft^2 lower than the Stream Restoration Institute's regional curve for the watershed area. Bankfull width of the channel is 3.8 feet and bankfull depth is 0.48 feet. The reference reach exhibits a sinuosity of 1.24 with a radius of curvature of 4.4 to 45.6 feet, a meander length of 12.0 to 70.0 feet, and a belt width of 5.7 to 16.0 feet. The UT to Hog Swamp has a width-to-depth ratio of 7.9 and an entrenchment ratio of 26.6, indicating it is slightly entrenched as defined by Rosgen's classification system. The streambed material is dominated by sand. The UT to Hog Swamp reference reach is characterized as an E5 stream type from the data collected. All morphological information for the UT to Hog Swamp can be found in Table 2. The reach is transporting its sediment supply without aggrading or degrading while maintaining its dimension, pattern, and profile. The UT to Hog Swamp received a rating of 40.5 on the NCDWQ Stream Classification Form, signifying perennial flow, and received an 84 out of a possible 100 points on the Habitat Assessment Form indicating good aquatic habitat. The Stream Visual Assessment Protocol resulted in a score of 8.7, indicating the stream is in good condition. Reference reach data, stream forms, and photographs of the UT to Hog Swamp are presented in Appendix D.

The UT to Hog Swamp reference reach flows through a Coastal Plain Bottomland Hardwood Forest. The canopy is dominated by sweetgum, water oak, swamp black gum (*Nyssa biflora*), yellow poplar, river birch (*Betula nigra*) and American holly. Understory species include wax myrtle (*Myrica cerifera*), swamp red bay, Chinese privet, and giant cane (*Arundinaria gigantea*). Chinese privet is an invasive species but is not dominating the vegetative composition of the riparian buffer. The shrub and herbaceous layers are minimal because of a mature, closed canopy. The channel has a variety of habitat for marcroinvertebrates including leaf packs, root wads, and woody debris.

6.2.2 UT to Ironhill Branch (Primary)

The Unnamed Tributary (UT) to Ironhill Branch reference reach is a first order, perennial tributary that flows east to Ironhill Branch in Columbus County, North Carolina. The UT to Ironhill Branch is shown as an intermittent blue line stream on the Tabor City East 7.5-minute topographic quadrangle (USGS, 1962). The 1,030-acre watershed consists of forested, agricultural, and residential land uses. No impoundments were located within the watershed.

Flow within the UT to Ironhill Branch was near bankfull elevation on the day of the reference reach survey. The reference reach survey was conducted upstream (west) of SR 1131 (Kenny Jordan Road). The reach used for the detailed survey was 271 feet long. The survey included a longitudinal profile, cross-sections, and an evaluation of the bed material, buffer, and system stability. The bankfull area of 13.3 ft^2 corresponds with the coastal plain regional curve presented by NC Stream Restoration Institute. Bankfull width of the reach is 14.2 feet and bankfull depth is 0.94 feet. The reference reach exhibits a sinuosity of 1.30 with a radius of curvature of 13.7 to 20.8 feet, a meander length of 42.0 to 72.0 feet, and a belt width of 30.0 to 59.0 feet. The width-to-depth ratio of 15.2 is moderate to high and the entrenchment ratio of 20.4 is slightly entrenched as defined by Rosgen's classification system. Both the reference reach and the restoration reach's streambed material are dominated by sand. The UT to Ironhill Branch reference reach is classified as a C5 stream type using the data collected and field observations.

All morphological information for Ironhill Branch can be found in Table 2. The reach is transporting its sediment supply without aggrading or degrading while maintaining its dimension, pattern, and profile. The UT to Ironhill Branch received a rating of 45.5 on the NCDWQ Stream Classification Form, signifying perennial flow. Additionally, the UT to Ironhill Branch received an 87 out of a possible 100 points on the Habitat Assessment Form indicating good aquatic habitat. The Stream Visual Assessment Protocol resulted in a score of 8.8, indicating the stream is in good condition. Reference reach data, stream forms, and photographs of the UT to Ironhill Branch are presented in Appendix E.

The reach of the UT to Ironhill Branch used as a reference flows through a well-established buffer. The buffer most closely resembled a Coastal Plain Bottomland Hardwood Forest as described by Schafale and Weakley (1990). The canopy is dominated by red maple, water tupelo, sweetgum and American holly. Understory species include Chinese privet, titi, giant cane, poison ivy (*Toxicodendron radicans*), and greenbrier. Chinese privet is an invasive species but is not dominating the vegetative composition of the riparian buffer. The shade provided by the canopy as well as a variety of leaf packs and debris located within the stream create excellent habitat for macroinvertebrates.

6.2.3 Muddy Creek (Secondary)

Muddy Creek is located northwest of Fort Bragg, NC. The reference reach flows west to southeast through a forested area managed by Fort Bragg. Muddy Creek eventually flows into the Little River, which continues into the Cape Fear River.

The reach used for the survey totaled 236.9 feet in length. This reference reach is represented as a second order stream with a watershed area of 544 acres on the Overhills 7.5 minute topographic quadrangle (USGS, 1971). The survey included a longitudinal profile, cross-sections, bed material evaluation, buffer assessments, and system stability evaluation. The bankfull width of the reach is 11.5 feet and the bankfull depth is 1.03 feet. The reference reach exhibits a sinuosity of 1.13 with a radius of curvature of 10.4 to 21.9 feet, a meander length of 55.0 to 97.0 feet, and a belt width of 30.0 to 49.0 feet. Muddy Creek has a moderate width-to-depth ratio of 10.8 and an entrenchment ratio of 22.0, indicating it is slightly entrenched as defined by Rosgen's classification system. The streambed material is dominated by sand. The reference reach was classified as a C5 stream type based upon the survey data. All morphological information for Muddy Creek can be found in Table 2. The reference reach is transporting its sediment supply without aggrading or degrading while maintaining its dimension, pattern, and profile. Muddy Creek received a rating of 47 on the NCDWQ Stream Classification Form, signifying perennial flow, at the time of the survey and received a 91 out of a possible 100 points on the Habitat Assessment Form indicating good aquatic habitat. The Stream Visual Assessment Protocol resulted in a score of 9, indicating the stream is in excellent condition. Reference reach data, stream forms, and photographs of Muddy Creek are presented in Appendix F.

There is evidence of recent bankfull events throughout the reach (debris lines). The stream channel has abundant woody debris, leaf packs, and undercut banks with exposed roots, which all provide excellent habitat for benthic macroinvertebrates and other aquatic life.

The stream flows through a mature Coastal Plain Bottomland Hardwood Forest with well-developed layers of vegetation. The canopy is dominated red maple, yellow poplar, sweetgum, and water tupelo. Notably missing from canopy are oaks, which may have been eliminated through historic logging operations. No other noticeable signs of recent logging were noticed during the site inspection. The understory contains many of the canopy species as well as American holly, swamp red bay, and sweet bay. The shrub layer is dominated by fetterbush (*Lyonia lucida*), dog-hobble (*Leucothoe racemosa*), titi, and giant cane. The sparse herbaceous layer includes cinnamon fern (*Osmunda cinnamomea*) and a few sedges.

6.2.4 Mill Creek (Secondary)

Mill Creek is located in Southern Pines, NC. The reference reach flows west to northeast into James Creek, which flows to the Little River. The reach used for the survey was 434 feet in length. This reference reach is represented as a third order stream with a watershed area of 1,229 acres on the Niagra 7.5 minute topographic quadrangle (USGS, 1983). The survey included a longitudinal profile, cross-sections, bed material evaluation, buffer assessments, and system stability evaluation. The bankfull width of the reach is 11.3 feet and the bankfull depth is approximately 1.85 feet. The reference reach exhibits a sinuosity of 1.18 with a radius of curvature of 9.7 to 29.8 feet, a meander length of 37.7 to 72.6 feet, and a belt width of 15.1 to 27.0 feet. Mill Creek has a width-to-depth ratio of 6.1 and an entrenchment ratio of 26.5, indicating it is slightly entrenched as defined by Rosgen's classification system. The streambed material is dominated by sand. Mill Creek is classified as an E5 stream type from the data collected in the field. All morphological information for Mill Creek can be found in Table 2. The reference reach is transporting its sediment supply without aggrading or degrading while maintaining its dimension, pattern, and profile. Mill Creek received a rating of 48.5 on the NCDWQ Stream Classification Form, signifying perennial flow, and received an 83 out of a possible 100 points on the Habitat Assessment Form indicating good aquatic habitat. The Stream Visual Assessment Protocol resulted in a score of 8.2, indicating the stream is in good condition. Reference reach data, stream forms, and photographs of Mill Creek are presented in Appendix G.

There is evidence of recent bankfull events throughout the reach (debris lines). The stream channel has an abundant amount of woody debris, leaf packs, and undercut banks with exposed roots, which all provide excellent habitat for benthic macroinvertebrates and other aquatic life. The reference reach has a well-developed riffle-pool sequence with 2.5 to 3-foot high, stable banks.

The stream flows through a mature Coastal Plain Bottomland Hardwood Forest with well-developed layers of vegetation. The canopy is dominated by red maple, yellow poplar, sweetgum, swamp black gum, and water tupelo. There are also scattered specimens of loblolly pine and Atlantic white cedar (*Chamaecyparis thyoides*). Notably missing from canopy are oaks, which may have been eliminated through historic logging operations. The understory contains many of the canopy species as well as American holly, swamp red bay, and sweet bay. The shrub layer is dominated by fetterbush, dog-hobble, inkberry, titi, and giant cane. The sparse herbaceous layer includes cinnamon fern and *Carex* spp.

Table 2. Reference Morphological Characteristics

Restoration Plan: **UT to Mill Branch**
Watershed: **Lumber River**
County: **Columbus**
Design by: **RVS**
Checked by: **KMM/RKW**

ITEM	Reference Reach	Reference Reach	Reference Reach	Reference Reach
LOCATION	UT to Hog Swamp	UT to Ironhill Branch	Muddy Creek	Mill Creek
STREAM TYPE	E5	C5	C5	C5
DRAINAGE AREA, Ac - Sq Mi	48.00 Ac - 0.08 Sq Mi	1030.40 Ac - 1.61 Sq Mi	544.00 Ac - 0.85 Sq Mi	1228.80 Ac - 1.92 Sq Mi
BANKFULL WIDTH (W_{bkf}), ft	3.8 ft	14.2 ft	11.2 ft	11.3 ft
BANKFULL MEAN DEPTH (d_{bkf}), ft	0.48 ft	0.94 ft	1.03 ft	1.85 ft
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	7.9	15.2	10.8	6.1
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	1.8 ft^2	13.3 ft^2	11.5 ft^2	21.0 ft^2
BANKFULL MEAN VELOCITY, fps	1.5 fps	1.8 fps	1.3 fps	1.3 fps
BANKFULL DISCHARGE, cfs	2.7 cfs	24.1 cfs	14.7 cfs	26.5 cfs
BANKFULL MAX DEPTH (d_{max}), ft	0.72 ft	1.56 ft	1.72 ft	2.58 ft
WIDTH Flood-Prone Area (W_{fpa}), ft	100.0 ft	290.0 ft	245.0 ft	300.0 ft
ENTRENCHMENT RATIO (ER)	26.6	20.4	22.0	26.5
MEANDER LENGTH (Lm), ft	12.0 - 70.0 ft	42.0 - 72.0 ft	55.0 - 97.0 ft	37.7 - 72.6 ft
RATIO OF Lm TO W_{bkf}	3.2 - 18.6	3.0 - 5.1	4.9 - 8.7	3.3 - 6.4
RADIUS OF CURVATURE, ft	4.4 - 45.6 ft	13.7 - 20.8 ft	10.4 - 21.9 ft	9.7 - 29.8 ft
RATIO OF Rc TO W_{bkf}	1.2 - 12.1	1.0 - 1.5	0.9 - 2.0	0.9 - 2.6
BELT WIDTH, ft	5.7 - 16.0 ft	30.0 - 59.0 ft	30.0 - 49.0 ft	15.1 - 27.0 ft
MEANDER WIDTH RATIO	1.5 - 4.2	2.1 - 4.2	2.7 - 4.4	1.3 - 2.4
SINUOSITY (K)	1.24	1.30	1.13	1.18
VALLEY SLOPE, ft/ft	0.0084 ft/ft	0.0026 ft/ft	0.0042 ft/ft	0.0070 ft/ft
AVERAGE SLOPE (S), ft/ft	0.0068 ft/ft	0.0020 ft/ft	0.0037 ft/ft	0.0059 ft/ft
POOL SLOPE, ft/ft	0.0000 ft/ft	0.0015 - 0.0065 ft/ft	0.0000 - 0.0009 ft/ft	0.0000 - 0.0080 ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE	0.0 - 0.9	0.8 - 3.3	0.0 - 0.2	0.0 - 1.4
MAX POOL DEPTH, ft	1.10 ft	1.50 ft	1.77 ft	3.12 ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	2.3	1.6	1.7	1.7
POOL WIDTH, ft	3.80 ft	16.10 ft	17.23 ft	11.85 ft
RATIO OF POOL WIDTH TO BANKFULL WIDTH	1.01	1.13	1.54	1.05
POOL TO POOL SPACING, ft	9.0 - 23.0 ft	40.0 - 65.0 ft	18.0 - 67.7 ft	11.4 - 61.0 ft
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH	2.4 - 6.1	2.8 - 4.6	1.6 - 6.1	1.0 - 5.4

7.0 PROPOSED CONDITIONS

The Mill Branch Restoration Plan addresses how streams on-site will be restored and preserved, how wetlands will be preserved; created, and enhanced; and, how vegetation will be introduced to provide bank stability, habitat and food sources to wildlife.

7.1 STREAMS

The Mill Branch Restoration Plan addresses three streams: Mill Branch, Main UT, and Western UT. These three streams are all located on the Jones Property and discussed further below.

7.1.1 Stream Restoration (Natural Channel Design)

The proposed restoration of the Main UT starts at the fence line of the southern Jones Property boundary to a point that is approximately 110 feet upstream of the confluence of the Main UT and Mill Branch (Figure 11). This point was chosen as the ending point of the restoration for the following two reasons: 1) this represents a point at which the property boundary of the Jones Property and the adjacent property (Hall/Sellers Property) comes close to meeting and, 2) Mill Branch has a back water effect on the Main UT for much of the year from beaver dams that block the stream. The property lines will need to be surveyed to determine their exact locations prior to construction. The Western UT will be restored from the fence line at the southern Jones Property line to its convergence with the Main UT.

The existing channel of the Main UT is unstable, incised and has a bank height ratio greater than 2 in most places. The stream slope for the entire reach is slightly less than 0.6 percent while the valley slope for the entire reach is slightly greater than 0.6 percent. The majority of elevation drop in the Main UT is lost downstream (north) of the access road through the Site. The remaining length of the Main UT, south of the access road is much flatter (much lower slope).

The Main UT is designed as a Priority II restoration (Rosgen, 1997). Two main factors led to the Priority II design. First, the stream has a lot of elevation change throughout the Site to reach the bed elevation of Mill Branch at its convergence with the Main UT. The steepest slope of the channel is downstream of the access road. If the bankfull elevation were raised to top of bank (Priority I restoration) throughout the entire Site, eventually the channel's design slope would be much steeper than the existing channel slope to reach the elevation at the projects end point. Second, if the channel's bed were "raised" so that bankfull were at top of bank, the base flow of the stream could be lost. The stream has a relatively small drainage area, low base flow discharge, and flows through soils with a very high sand content. If the bankfull elevation is raised to top of bank the base flow could perk down through the sand and remain at the current streambed elevation for the foreseeable future.

The Western UT is designed as a Priority II restoration. A Priority II restoration is utilized for the Western UT because the UT will have to reach the grade of the Main UT in a relatively short distance not allowing the channel to be "raised" throughout the reach.

Stantec
Stantec Consulting Services Inc.
Suite 300, 801 Jones Franklin Road
Raleigh, NC
27606
Tel. 919.851.6866
Fax. 919.851.7024
www.stantec.com

FIGURE 12

FIGURE 13

FIGURE 14

STAGING/STOCKPILE AREA = 1AC.

BEGIN WESTERN UT 10+00.00

12' ACCESS ROAD

WESTERN UT

MIDDLE REACH

BEGIN UPPER REACH 10+00.00
N= 1705867.798
E= 2075253.3872

UPPER REACH

BEGIN MIDDLE REACH 10+00.00
END UPPER REACH 14+34.04
END WESTERN UT 17+70.28

STAGING/STOCKPILE AREA = 1AC.

LOWER REACH

END MIDDLE REACH 18+13.20
N= 1705594.3686
E= 2075655.8153

BEGIN LOWER REACH 10+00.00
END MIDDLE REACH 25+60.75
N= 1705594.1703
E= 2075655.9920

POND

Mill Branch Stream and Wetland Restoration Plan

Columbus County, North Carolina

Plan View

Scale: 1"= 80'

Figure 11

All restoration reaches will be designed as low width-to-depth (12.0) C5 type channels, although over time, it is expected that the channels may naturally evolve into a lower width-to-depth channel that could be classified as an E5. Restoration will include establishing the proper dimension, pattern, profile, and riparian buffer. A floodplain will be constructed because the existing channels are incised, and display little to no floodplain at the bankfull discharge. A more natural and stable channel geometry will be constructed for each reach, which will increase sinuosity in the channel's pattern. The proposed channel will be slightly entrenched with a moderate width-to-depth ratio and moderate sinuosity. The morphological characteristics of the proposed channels, and reference reaches are shown in Table 3. The channel's riparian buffer is based upon a 50-foot zone from the outside of the meander bend. The buffer planting is discussed in Section 9.

Four stream designs were incorporated into the Restoration Plan (Figure 11). Three designs, the Upper Reach, Middle Reach, and Lower Reach, were used for the Main UT. A fourth design was used for the Western UT. Design bankfull width-to-depth ratio for the Upper Reach is 12.0 with a bankfull width of 6.9 feet and bankfull mean depth of 0.58 feet (Figure 12). The bank height ratio will be reduced from 2.0 to 1.0 indicating the channel will access its floodplain during bankfull and larger flows. Sinuosity will be increased from 1.05 to 1.20. The design channel utilizes as much of the existing channel as possible to minimize grading. The flood-prone width will range between 31.1 and 31.7 feet. The flood-prone width will vary throughout the channel depending on meander width (flood-prone will always be wider than meander width) and the location of the design channel in relation to the existing channel (existing channel will increase flood-prone width without further excavation in some areas). The entrenchment ratio will vary between 4.5 and 4.6. The proposed restored channel will be approximately 411 feet long, which is more than the existing 360 feet.

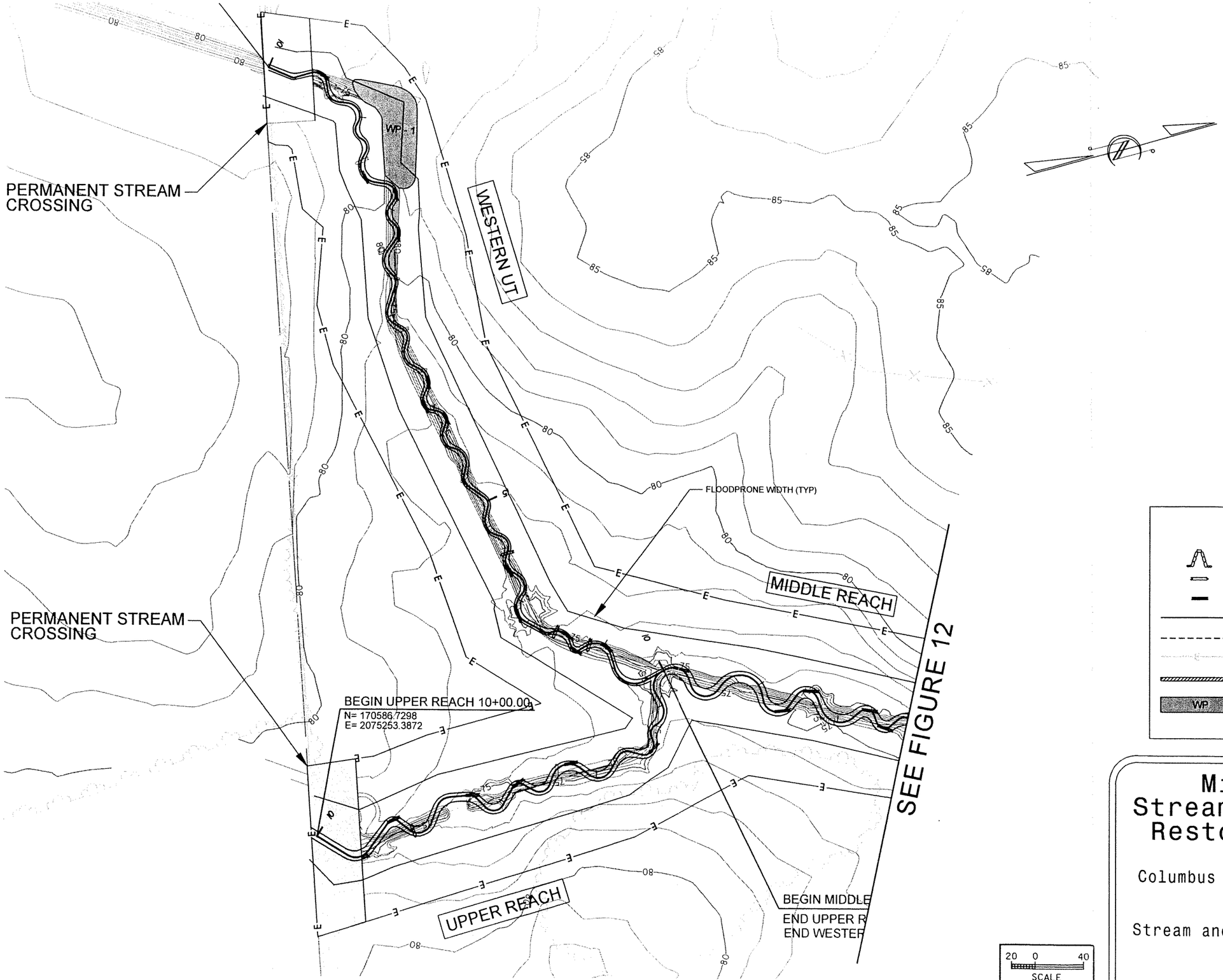
The Middle Reach and Lower Reach were designed like the Upper Reach to utilize the existing channel to lower the amount of excavation that will be required to restore the channels. The Middle reach has a design bankfull width-to-depth ratio of 12.0 with a bankfull width of 8.3 feet and a mean bankfull depth of 0.69 feet (Figure 12 and 13). The bank height ratio will be reduced from greater than 2.0 to 1.0. Sinuosity will be increased from 1.03 to 1.22. The existing sinuosity of the Middle and Lower Reach as shown in Table 3 is 1.09. This existing sinuosity is not reach specific and therefore should be viewed as an overall average sinuosity for current conditions on the Middle and Lower Reaches combined. The flood-prone width will range between 29.9 and 38.2 feet, which will provide an entrenchment ratio ranging between 3.6 and 4.6. The proposed restored channel will be approximately 1,474 feet long, which is more than the existing 1,277 feet.

The Lower Reach has a design bankfull width-to-depth ratio of 12.0 with a bankfull width of 8.6 feet and a mean bankfull depth of 0.72 feet (Figure 14). The bank height ratio will be reduced from greater than 2.0 to 1.0. Sinuosity will be increased from 1.04 to 1.33. The flood-prone width will range between 26.7 and 42.1 feet, which would provide an entrenchment ratio ranging between 3.1 and 4.9. The proposed restored channel will be approximately 778 feet long, which is more than the existing 655 feet.

Table 3. Morphological Characteristics of Project Stream Channel

Restoration Plan: **UT to Mill Branch**
Watershed: **Lumber River**
County: **Columbus**
Design by: **RVS**
Checked by: **KMM/RKW**

ITEM	Existing Conditions	Existing Conditions	Existing Conditions	Proposed Conditions	Proposed Conditions	Proposed Conditions	Proposed Conditions	Reference Reach	Reference Reach	Reference Reach	Reference Reach
LOCATION	Western Reach	Upper Reach	Middle and Lower Reach	Western UT	UT to Mill Branch Main Trib Upper Reach	UT to Mill Branch Main Trib Middle Reach	UT to Mill Branch Main Trib Lower Reach	UT to Hog Swamp	UT to Ironhill Branch	Muddy Creek	Mill Creek
STREAM TYPE	G5	0	G5	C5	C5	C5	C5	E5	C5	C5	C5
DRAINAGE AREA, Ac - Sq Mi	20 Ac - 0.03 Sq Mi	97 Ac - 0.15 Sq Mi	137 Ac - 0.21 Sq Mi	25 Ac - 0.04 Sq Mi	91 Ac - 0.14 Sq Mi	159 Ac - 0.25 Sq Mi	178 Ac - 0.28 Sq Mi	48 Ac - 0.08 Sq Mi	1030 Ac - 1.61 Sq Mi	544 Ac - 0.85 Sq Mi	1229 Ac - 1.92 Sq Mi
BANKFULL WIDTH (W_{bkf}), ft	2.8 ft	2.9 ft	6.5 ft	4.5 ft	6.9 ft	8.3 ft	8.6 ft	3.8 ft	14.2 ft	11.2 ft	11.3 ft
BANKFULL MEAN DEPTH (d_{bkf}), ft	0.32 ft	0.72 ft	0.86 ft	0.38 ft	0.58 ft	0.69 ft	0.72 ft	0.48 ft	0.94 ft	1.03 ft	1.85 ft
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	8.7	4.0	7.5	12.0	12.0	12.0	12.0	7.9	15.2	10.8	6.1
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	0.9 ft^2	2.1 ft^2	5.6 ft^2	1.7 ft^2	4.0 ft^2	5.7 ft^2	6.2 ft^2	1.8 ft^2	13.3 ft^2	11.5 ft^2	21.0 ft^2
BANKFULL MEAN VELOCITY, fps	1.6 fps	2.0 fps	1.0 fps	1.0 fps	1.2 fps	1.2 fps	1.2 fps	1.5 fps	1.8 fps	1.3 fps	1.3 fps
BANKFULL DISCHARGE, cfs	1.4 cfs	4.2 cfs	5.5 cfs	1.6 cfs	4.1 cfs	6.1 cfs	6.6 cfs	2.7 cfs	24.1 cfs	14.7 cfs	26.5 cfs
BANKFULL MAX DEPTH (d_{max}), ft	0.46 ft	1.17 ft	2.02 ft	0.53 ft	0.75 ft	0.90 ft	0.93 ft	0.72 ft	1.56 ft	1.72 ft	2.58 ft
WIDTH Flood-Prone Area (W_{fpa}), ft	2.9 ft	6.8 ft	70.0 ft	11.8 - 24.1 ft	31.1 31.7 ft	29.9 - 38.2 ft	26.7 - 42.1 ft	100.0 ft	290.0 ft	245.0 ft	300.0 ft
ENTRENCHMENT RATIO (ER)	1.0	2.3	10.8	2.6 - 5.3	4.5 - 4.6	3.6 - 4.6	3.1 - 4.9	26.6	20.4	22.0	26.5
MEANDER LENGTH (Lm), ft	220.00 ft	210.0 ft	260.0 ft	19.4 - 40.9 ft	20.7 - 62.1 ft	24.9 - 74.7 ft	25.8 - 77.4 ft	12.0 - 70.0 ft	42.0 - 72.0 ft	55.0 - 97.0 ft	37.7 - 72.6 ft
RATIO OF Lm TO W_{bkf}	78.6	72.4	40.0	4.3 - 9.0	3.0 - 9.0	3.0 - 9.0	3.0 - 9.0	3.2 - 18.6	3.0 - 5.1	4.9 - 8.7	3.3 - 6.4
RADIUS OF CURVATURE, ft	15.0 ft	10.0 ft	25.0 ft	5.4 - 21.8 ft	6.9 - 20.7 ft	8.3 - 24.9 ft	8.6 - 25.8 ft	4.4 - 45.6 ft	13.7 - 20.8 ft	10.4 - 21.9 ft	9.7 - 29.8 ft
RATIO OF Rc TO W_{bkf}	5.4	3.4	3.8	1.2 - 4.8	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0	1.2 - 12.1	1.0 - 1.5	0.9 - 2.0	0.9 - 2.6
BELT WIDTH, ft	85.0 ft	55.0 ft	50.0 ft	6.8 - 19.1 ft	14.5 - 29.0 ft	17.4 - 34.9 ft	18.1 - 36.1 ft	5.7 - 16.0 ft	30.0 - 59.0 ft	30.0 - 49.0 ft	15.1 - 27.0 ft
MEANDER WIDTH RATIO	30.36	19.0	7.7	1.5 - 4.2	2.1 - 4.2	2.1 - 4.2	2.1 - 4.2	1.5 - 4.2	2.1 - 4.2	2.7 - 4.4	1.3 - 2.4
SINUOSITY (K)	1.01	1.05	1.09	1.23	1.27	1.24	1.26	1.24	1.30	1.13	1.18
VALLEY SLOPE, ft/ft	0.0087 ft/ft	0.0077 ft/ft	0.0011 ft/ft	0.0099 ft/ft	0.0054 ft/ft	0.0037 ft/ft	0.0131 ft/ft	0.0084 ft/ft	0.0026 ft/ft	0.0042 ft/ft	0.0070 ft/ft
AVERAGE SLOPE (S), ft/ft	0.0086 ft/ft	0.0073 ft/ft	0.0010 ft/ft	0.0022 ft/ft	0.0019 ft/ft	0.0020 ft/ft	0.0022 ft/ft	0.0068 ft/ft	0.0020 ft/ft	0.0037 ft/ft	0.0059 ft/ft
POOL SLOPE, ft/ft	0.0022 ft/ft	0.0000	0.0009 ft/ft	0.0008 ft/ft	0.0007 ft/ft	0.0007 ft/ft	0.0008 ft/ft	0.0000 ft/ft	0.0015 - 0.0065 ft/ft	0.0000 - 0.0009 ft/ft	0.0000 - 0.0080 ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE	0.3	0.0 -	0.9	0.4	0.4	0.4	0.4	0.0 - 0.9	0.8 - 3.3	0.0 - 0.2	0.0 - 1.4
MAX POOL DEPTH, ft	0.70 ft	1.20 ft	1.70 ft	0.95 ft	1.44 ft	1.73 ft	1.79 ft	1.10 ft	1.50 ft	1.77 ft	3.12 ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	2.2	1.7	2.0	2.5	2.5	2.5	2.5	2.3	1.6	1.7	1.7
POOL WIDTH, ft	N/A	3.9	N/A	5.22 ft	7.94 ft	9.55 ft	9.89 ft	3.80 ft	16.10 ft	17.23 ft	11.85 ft
RATIO OF POOL WIDTH TO BANKFULL WIDTH	N/A	1.3	N/A	1.15	1.15	1.15	1.15	1.01	1.13	1.54	1.05
POOL TO POOL SPACING, ft	N/A	99.0	120.0 ft	9.5 - 24.5 ft	16.6 - 38.0 ft	17.4 - 44.8 ft	18.1 - 46.4 ft	9.0 - 23.0 ft	40.0 - 65.0 ft	18.0 - 67.7 ft	11.4 - 61.0 ft
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH	N/A	34.1	18.5	2.1 - 5.4	2.4 - 5.5	2.1 - 5.4	2.1 - 5.4	2.4 - 6.1	2.8 - 4.6	1.6 - 6.1	1.0 - 5.4



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LEGEND

- CROSS-VANE
- LOG SILL
- LOG VANE
- FLOODPRONE WIDTH
- WETLAND PRESERVATION
- CONSERVATION EASEMENT
- CHANNEL PLUG
- WP — WETLAND POCKETS

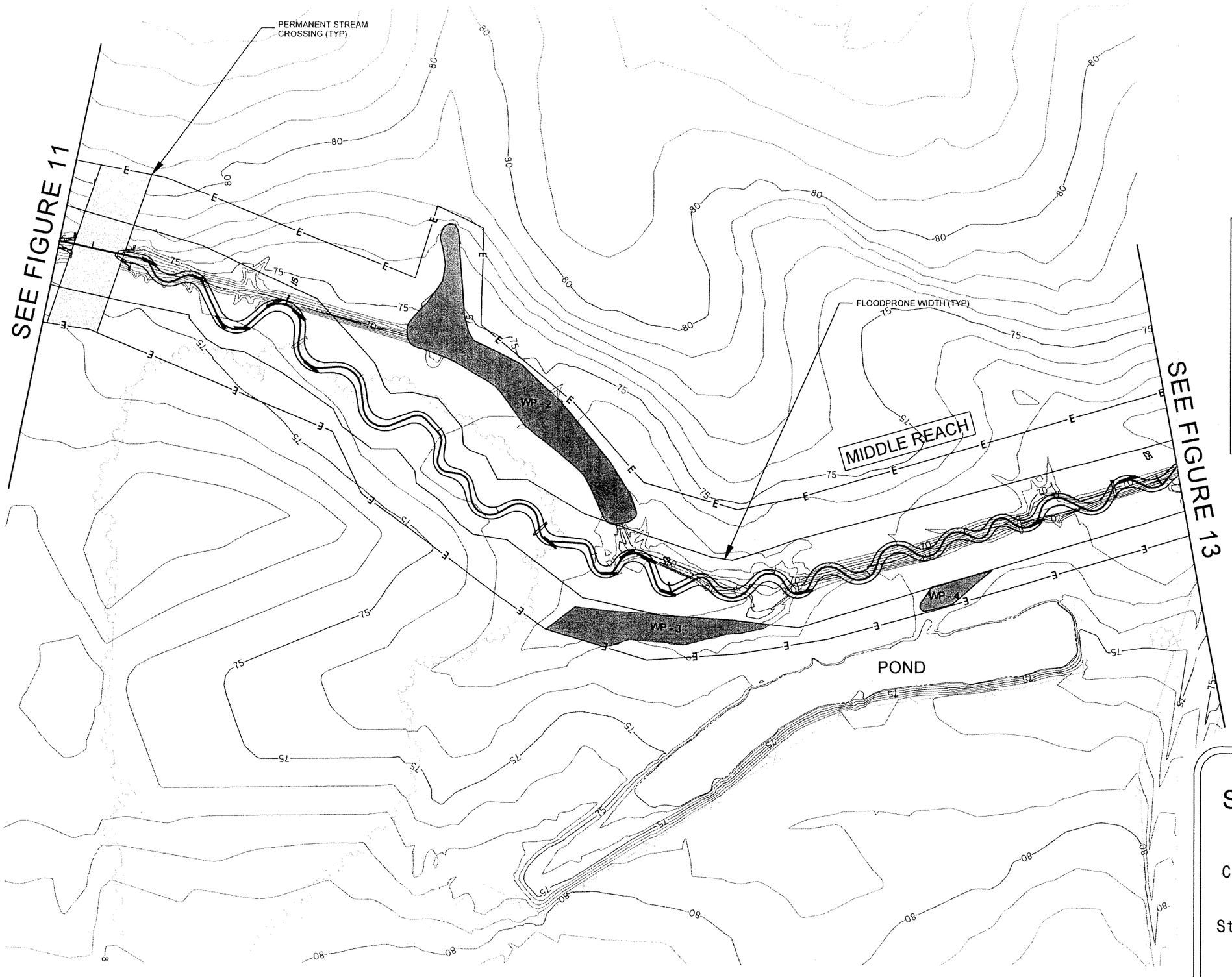
20 0 40
SCALE

Mill Branch Stream and Wetland Restoration Plan

Columbus County, North Carolina

Stream and Wetland Restoration:
Close-up 1

Figure 12



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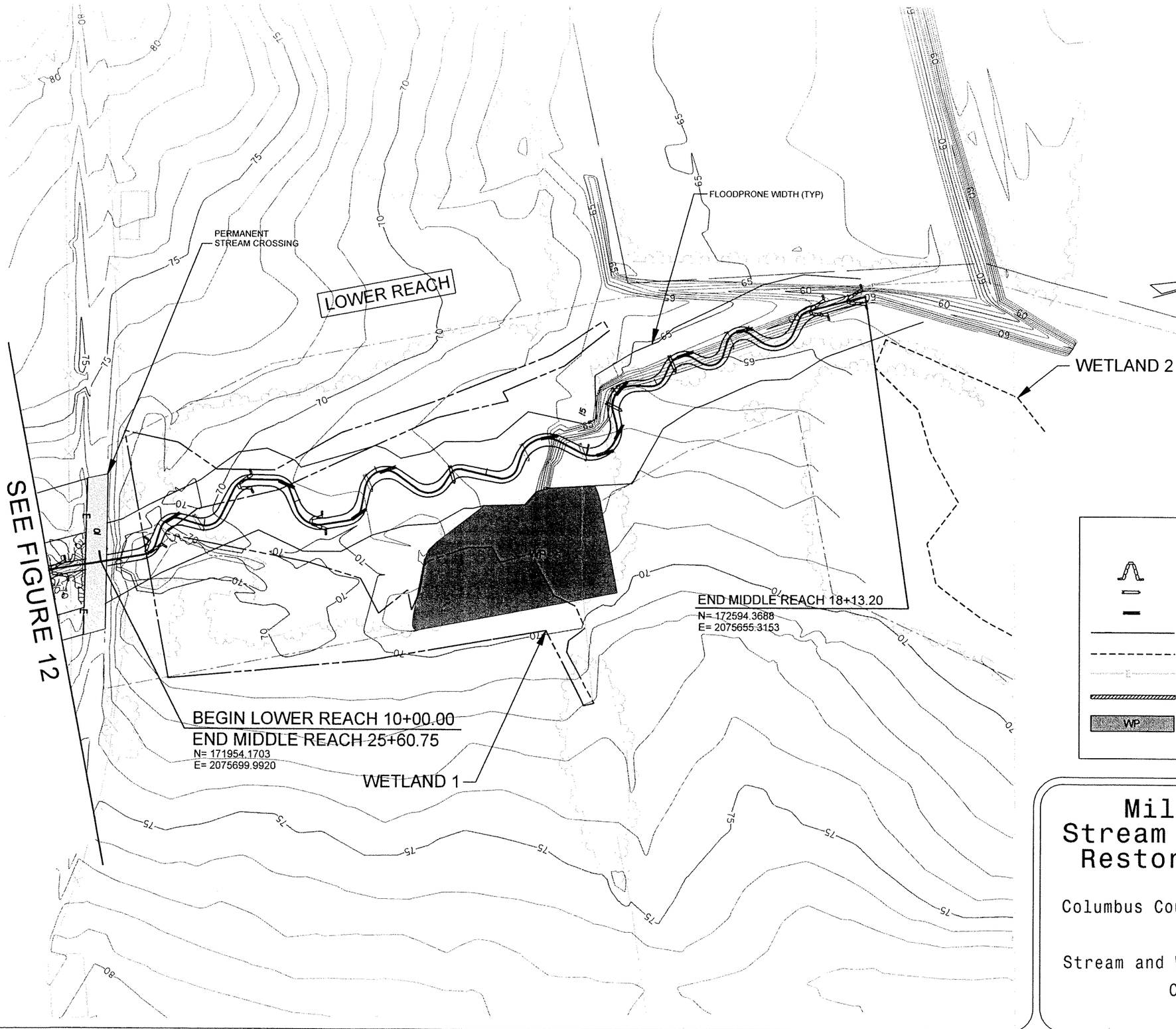
20 0 40
SCALE

Mill Branch Stream and Wetland Restoration Plan

Columbus County, North Carolina

Stream and Wetland Restoration: Close-up 2

Figure 13



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- WP — WETLAND POCKETS

Mill Branch Stream and Wetland Restoration Plan

Columbus County, North Carolina

Stream and Wetland Restoration:
Close-up 3

Figure 14

The Western Reach was designed to use the existing channel as much as possible, because the existing channel is so entrenched as evidenced by a bank height ratio greater than four (Figure 12). The entrenchment ratio was lowered to the lower limits of a C type channel (as close to a 2.2 entrenchment ratio as possible) to decrease the amount of excavation required to cut the design channel. This will allow for a bankfull bench and floodplain during high flows but will minimize the amount of earth to be moved to restore the channel. The Western Reach has a design bankfull width-to-depth ratio of 12.0 with a bankfull width of 4.5 feet and a mean bankfull depth of 0.38 feet. The bank height ratio will be reduced from greater than 4 to 1.0. Sinuosity will be increased from 1.06 to 1.17. The flood-prone width will range between 19.4 and 40.9 feet, which would provide an entrenchment ratio ranging between 2.6 and 5.3. The proposed restored channel will be approximately 739 feet long, which is more than the existing 663 feet.

The bankfull channel for each designed channel will have a meandering pattern through a well-developed floodplain. The proposed longitudinal profiles for all reaches are depicted in Figures 15, 16, 17, and 18. Bankfull and larger flows will be able to access the newly excavated floodplain. The hydrologic, sediment and flood analyses are discussed in 7.1.2, 7.1.3, and 7.1.4, respectively. Structures to be used in the final design are detailed and discussed in Section 8.

7.1.2 Hydrologic Analysis

Discharge rates for the design have been evaluated with the Coastal Plain regional curve. The bankfull discharge for the Upper Reach is 4.1 ft^3/s. The bankfull discharge for the Middle Reach is 6.1 ft^3/s. The bankfull discharge for the Lower Reach is 6.6 ft^3/s. The bankfull discharge for the Western Reach is 1.6 ft^3/s. The existing and proposed geometries were evaluated at the bankfull discharge rates using HEC-RAS (USACE, 2004). The analysis supports the field identification of the existing bankfull area with a close approximation and confirms the proposed channel will adequately carry the discharge at bankfull stage.

7.1.3 Sediment Analysis

Standard practice of evaluating a predominantly sandbed stream's capacity is to evaluate the stream power of the channel. Stream power is the product of the shear stress and the bankfull flow velocity. The current stream power in both the Main UT and the Western UT is generally too high (with the exception of near the access road where the culvert causes a backwater effect) and consequently is downcutting the existing streambed. This is typical for G type channels. The designed stream power for both the Main UT and the Western UT has been lowered, as shown in Tables 4 and 5 below, so that the channel will transport its flow without aggrading or degrading.

TABLE 4. Main UT Stream Power Analysis

PARAMETER	*EXISTING*	*PROPOSED*
Velocity (ft/s)	1.0 – 2.0	1.2
Stream Power (lbs/s)	0.3 – 1.9	0.5 – 0.9

Figure 15 Proposed Longitudinal Profile: Upper Reach

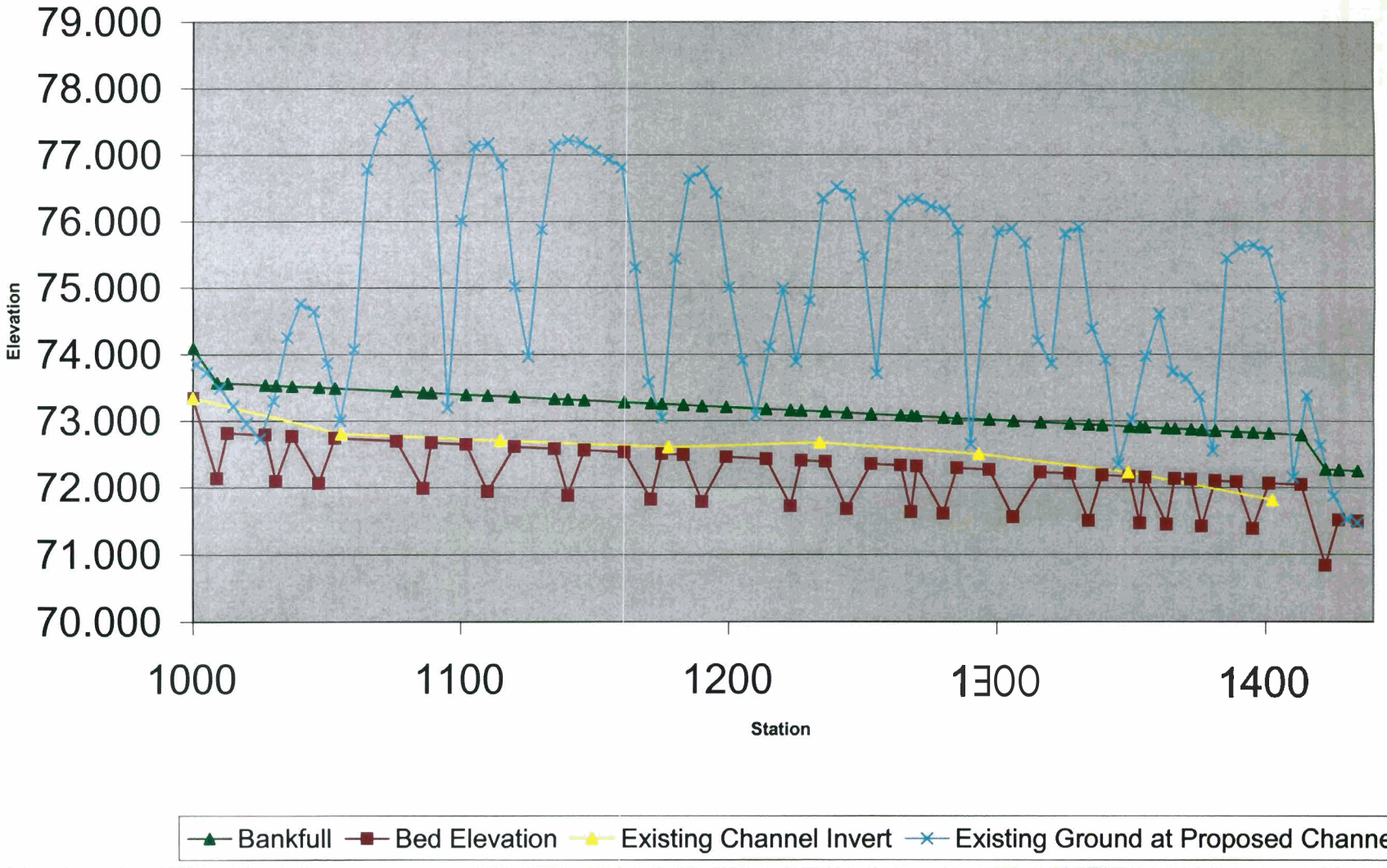


Figure 16 Proposed Longitudinal Profile: Middle Reach

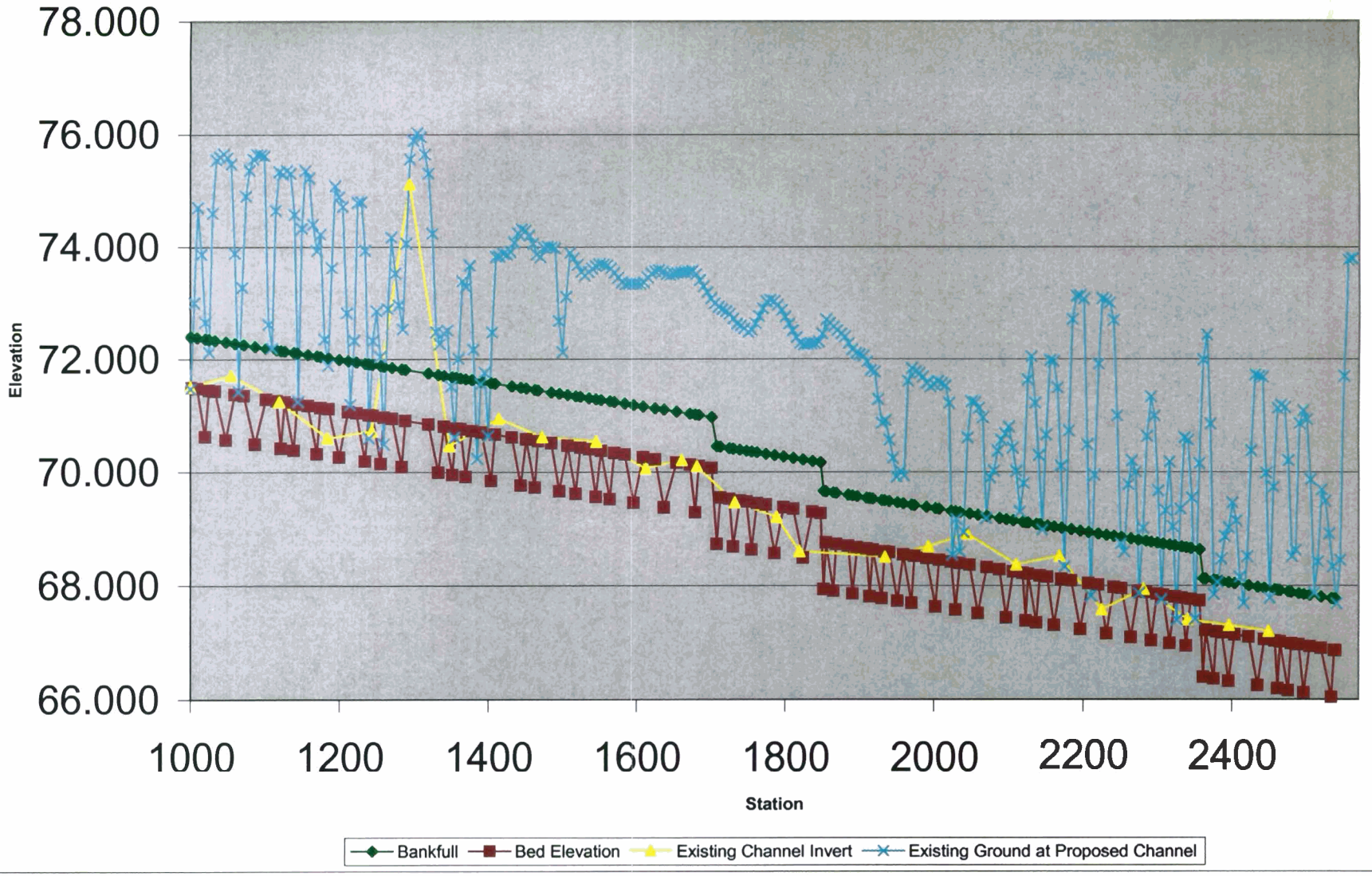


Figure 17 Proposed Longitudinal Profile: Lower Reach

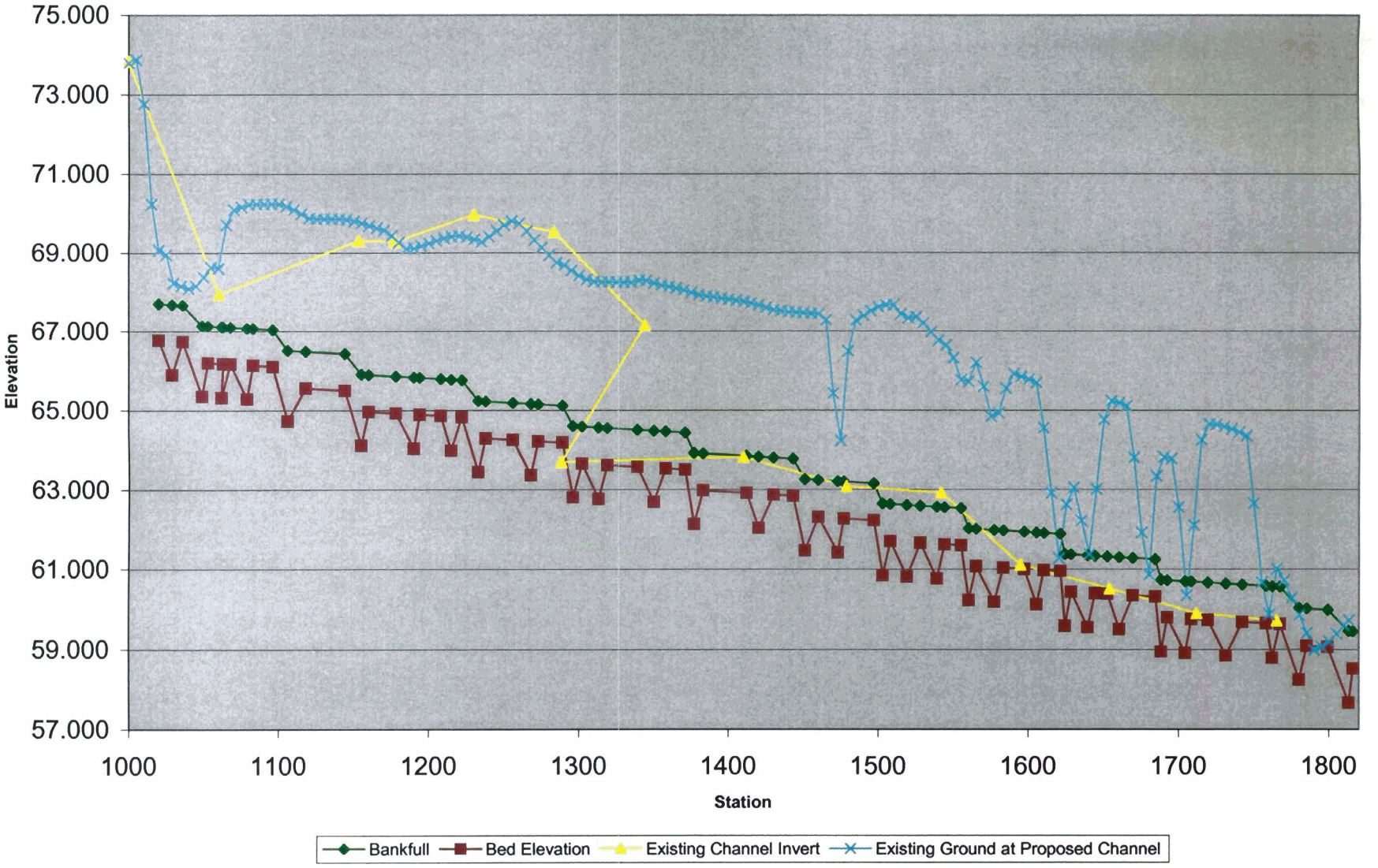


Figure 18 Proposed Longitudinal Profile: Western Reach

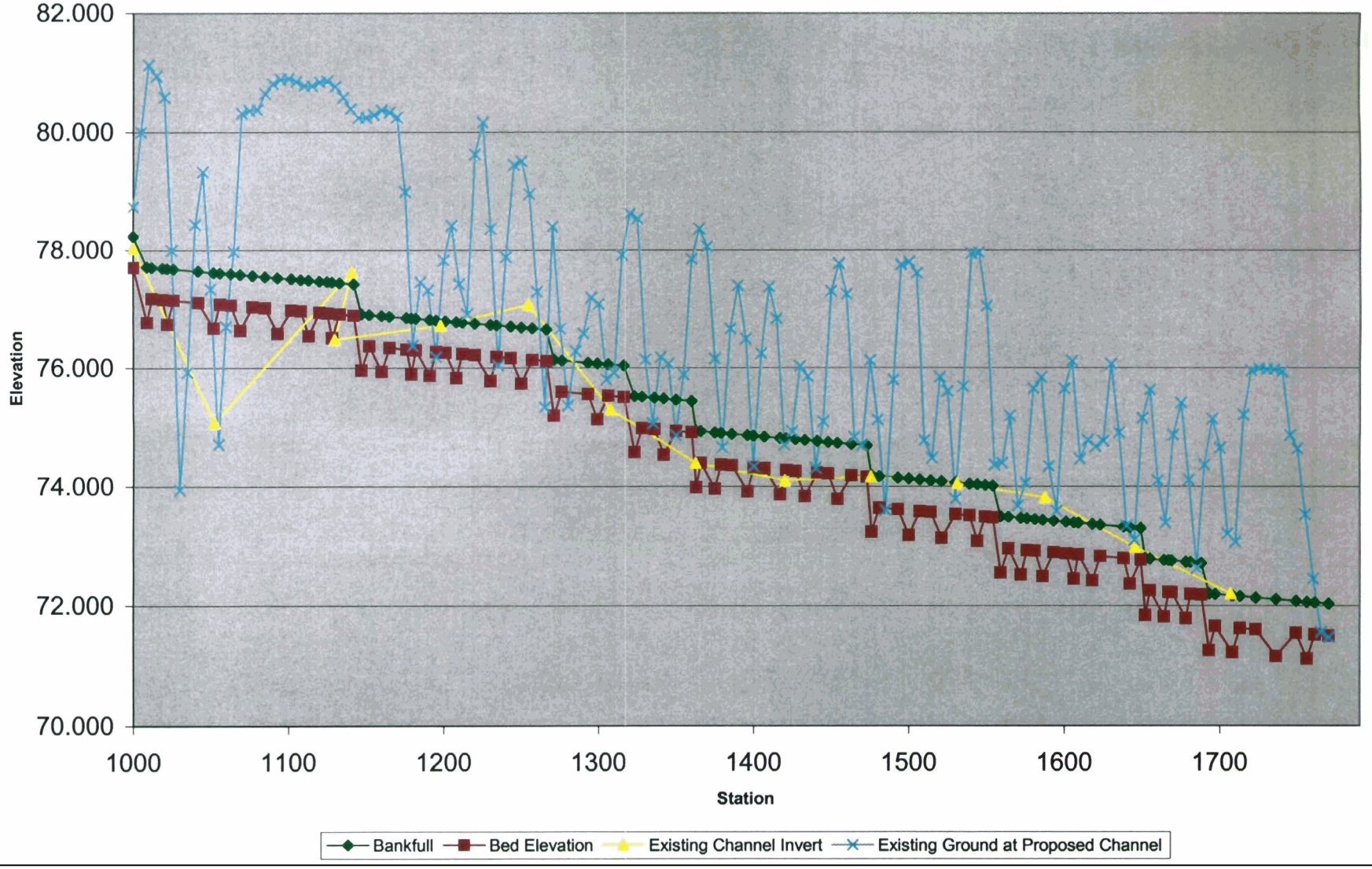


TABLE 5. Western UT Stream Power Analysis

PARAMETER	EXISTING	PROPOSED
Velocity (ft/s)	1.6	1.0
Stream Power (lbs/s)	0.7	0.2

The existing velocity and stream power of 1.0 ft/s and 0.3 lbs/s in the Main UT (Table 4) were taken from a point in the Middle Reach that is strongly affected by backwater from the culvert under the access road. These data are presented to show the effect of the culvert on this section of the channel, but these calculations are not considered typical of the Main UT. The existing velocity and stream power of 2.0 ft/s and 1.9 lbs/s are considered more typical of the Main UT as a whole and should be used to compare with proposed conditions.

The designed velocity and stream power are based off of restoring sandbed systems with relatively low width-to-depth ratios to a channel slope that corresponds closely to 0.2 percent. This evaluation is based off of observing previously restored sandbed streams and experiences of the stream restoration "community." The proposed design lowers both the velocity and stream power in the Main and Western UTs, which are currently down cutting because the channel's velocity and stream power are too high. The proposed dimension, pattern, and profile will combine together to form an effective, stable channel with the capacity to transport its sediment.

7.1.4 Flood Analysis

Analyses were performed for the existing and proposed conditions for the bankfull, 2, 10, and 100-year discharges. Geometric data and steady flow data are both required to run HEC-RAS. The 2, 10, and 100-year discharges were determined using the USGS Coastal Plain Rural Regression Equations (USGS *et al.*, 1996).

Geometric data consists of establishing the connectivity of the river system. Such data includes: cross-sectional data, reach lengths, energy loss coefficients (friction losses, contraction and expansion losses), and stream junction information.

The analysis indicates that the proposed channel geometry will not increase the 100-year flood elevations within the project area. Results are presented in Appendix H.

7.1.5 Stream Preservation

Approximately 1,750 linear feet of Mill Branch located in the northern portion of the Jones Property will be preserved. Mill Branch is shown as flowing well over 1,750 linear feet on the Jones Property on several forms of mapping that have been reviewed. However, a large beaver dam complex was found in Mill Branch upon inspection of the channel, which has blocked the flow of Mill Branch. The dam complex has backed water up in Mill Branch above the top of bank, which has created a wetland system in the downstream portions of Mill Branch on the Jones Property. Consequently, Mill Branch has lost any resemblance of a flowing stream in this portion of the Property because water has topped the banks and is inundating the floodplain with over a foot of water. For this reason only 1,750 linear feet of Mill Branch upstream of the beaver dam complex is proposed for inclusion into preservation calculations.

7.1.6 Stream Crossings

Two stream crossings are proposed for the Site. The current culverted crossing located at the access road will be replaced with a culvert and floodplain culverts capable of passing a 10-year storm flow (Figure 14). One crossing (in the Middle Reach) will be left intact but will be replaced with a ford crossing to allow the owner to access both sides of his pasture (Figure 13).

7.1.7 Stream Summary

Approximately 3,402 linear feet of channel is designed to restore both the Main and Western UTs. The Main UT is separated into thee reaches, the Upper Reach, Middle Reach, and Lower Reach, which have a combined restored length of 2,663 linear feet. The Western UT restored length is 739 linear feet. Additionally, approximately 1,750 linear feet of Mill Branch will be preserved on the northern portions of the Jones Property. Table 6 lists a summary of stream restoration and preservation on-site.

TABLE 6. Stream Summary

STREAM	EXISTING LENGTH (ft)	RESTORED LENGTH (ft)	PRESERVED LENGTH (ft)
Mill Branch	1,750	--	1,750
Upper Reach Main UT	360	411	--
Middle Reach Main UT	1,277	1,474	--
Lower Reach Main UT	655	778	--
Western UT	663	739	--
TOTAL	4,705	3,402	1,750

7.2 WETLANDS

The Mill Branch Restoration Plan addresses wetlands that are currently jurisdictional wetlands on-site, proposed pocket wetlands created in abandoned sections of the existing channel after restoration, and wet swales.

7.2.1 Impacted Wetlands

Wetland 1 is a 0.8-acre riverine wetland that will be impacted by the restoration of the Main UT (Figure 11). The Main UT will flow west of its current location after restoration. Currently, the Main UT is blocked to form a watering source for cattle, which consequently backs up water that supplies much of the hydrology to Wetland 1. It is believed that the water table in the area forming Wetland 1 will lower dramatically when the Main UT is relocated and no longer blocked. For this reason it is believed that Wetland 1 may substantially decrease in size when the Main UT is relocated from its current position.

7.2.2 Wetland Preservation

Approximately 37.3 acres of wetlands (previously described as Wetlands 2 and 3 in Section 5.1.2) will be preserved on-site (Figure 11). The preserved wetlands are located along the northern boundary of the Jones Property. The majority of the wetlands, approximately 35.8 acres, are riverine wetlands located within the floodplain of Mill

Branch (Figure 5). Approximately 1.5 acres are non-riverine wetlands located adjacent to Mill Branch's floodplain in a Coastal Plain Bottomland Hardwood Forest. These wetland areas will serve as a good native seed source for the floodplain and buffer areas along the restored channel, habitat and a wildlife corridor for both aquatic and terrestrial biota and fauna, and to filter nutrients from upstream pollution sources such as row cropping, and cattle production. Photographs of wetland areas are included in Figure 19.

7.2.3 Wetland Pockets and Pond

Linear sections of the existing channel will be abandoned following the restoration of the Main and Western UTs. These abandoned sections of the existing channels will be used as wetland pockets (Figures 12, and 13; WP 1 and WP 2). Overbank flooding from the proposed channels, rainfall, groundwater, and sheet flow from adjacent slopes will be the major hydrologic contributors. Vegetation to be planted is found in Section 9.4 (Zone D, Wetland Pockets). Both the wet swale and wetland pockets will improve water quality within Mill Branch's watershed by trapping excess sediment from runoff, and by trapping excess nutrients from the adjacent cattle operation and upstream row cropping.

An additional wet swale located upstream of the pond will be planted with vegetation found in Section 9.2 (Zone B, Floodplain Zone) (Figure 13, WP 3). Currently the swale contains tufts of *Juncus* species but is relatively low in plant species diversity. Supplemental vegetation will increase the ability of the swale to filter nutrients and provide aquatic habitat.

There is currently a wet swale that drains overflow from an irrigation pond that is located approximately 60 feet off of the right bank of the Main UT (Figure 13, WP 4). This swale will be enhanced during construction to provide a stable overflow from the pond into the Main UT. This swale will have to be stabilized before entering the channel so as to protect the channel's banks from saturation and collapse. This swale will be graded into a more defined linear wetland that will enable sediment and excess nutrients to settle out or be absorbed prior to entering the restored channel. Additionally, wetland vegetation, as found in Section 9.4 (Zone D, Wetland Pockets) will be planted within the swale to decrease nutrients that flow to the Main UT and supplement the aquatic habitat of the channel. A floodplain interceptor will be placed at the toe of the bank of the newly constructed swale at the channel to ensure bank stability.

The pond will not be impacted by construction of the stream channel or enhancement of the wet swale flowing from the pond. The easement boundary for the restored channel is placed approximately 12 feet off of the left (west) bank of the pond. This will allow the owner access to the pond's banks without impacting or crossing into the easement bounds.

A portion of Wetland 1 will be enhanced by filling the existing channel with a clay plug, capturing flow from the surrounding landscape, and planting it with vegetation found in Section 9.4 (Zone D, Wet Pockets) (Figure 14, WP 5). A photograph of Wetland 1 is found in Figure 19. A small seep was flagged as part of Wetland 1. This seep drains into the area that is listed as WP 5 in the plans. It is believed that the seep along with sheet flow from the surrounding terrain will allow WP 5 to maintain wetland hydrology, although much of Wetland 1 may lose hydrology when the Main UT is relocated.

Looking north at Wetland 1 from access road.

Standing water located in Wetland 2.

Clearcut located in Wetland 3.

Eastern extent of Wetland 3.

Standing water located in Wetland 3.

Vegetative diversity in Wetland 3.

Figure 19. Wetland Photographs.

7.2.4 Wetland Summary

Wetlands will be preserved, enhanced and created. Both Wetland 2 and 3 will be preserved on the northern portions of the Jones Property. Both wetlands combine to provide approximately 37.3 acres of wetland preservation on-site. Of the 37.3 acres to be preserved, approximately 35.8 acres are categorized as riverine wetlands and approximately 1.5 acres are categorized as non- riverine wetlands. Wetland pockets 1 and 2 will combine to provide approximately 0.25 acres of riverine wetland creation. Wetland pockets 3, 4, and 5 will be enhanced by plantings and grading to provide 0.44 acres of riverine wetlands. Table 7 lists a summary of wetland creation, enhancement and preservation on-site.

Wetlands could be established in the floodplain of the restored channel if the water table and over bank floods provide sufficient hydrology to meet wetland criteria. It is suggested that monitoring gauges be placed throughout the floodplain after construction to monitor the water table for wetland hydrology. No potential floodplain wetland acreage amounts are included in the document because monitoring hydrology will be necessary to determine wetland extents.

Wetland 1 will be negatively impacted through restoration of the Main UT. The main UT will create a drainage effect on Wetland 1, which may drain much of the existing wetland area.

TABLE 7. Wetland Summary

WETLAND	WETLAND TYPE	SIZE (ac)	TYPE
WP 1	Riverine	0.06	Creation
WP 2	Riverine	0.19	Creation
WP 3	Riverine	0.10	Enhancement
WP 4	Riverine	0.04	Enhancement
WP 5	Riverine	0.30	Enhancement
Wetland 2	Riverine	0.8	Preservation
Wetland 3	Riverine	35.0	Preservation
Wetland 3	Non-Riverine	1.5	Preservation

8.0 TYPICALS (STRUCTURES, CHANNEL PLUGS, AND CROSS-SECTIONS)

8.1 STRUCTURES AND CHANNEL PLUGS

A number of different structures will be used to control grade, stabilize the pattern, profile and dimension, and enhance aquatic habitat. These structures may include but are not limited to: rock cross vanes, log vanes, log vane/root wad combos, log sills, and floodplain interceptors. Some rocks and boulders will be used for grade control, but the use of rock and boulder will be minimized because they are not commonly found in this physiographic region. Few woody materials for structures will come from on-site because of the lack of suitable, mature, available trees.

Cross vanes direct the flow away from the stream banks towards the middle of the channel (Rosgen, 2002) (Figure 20). This structure creates a scour pool below, while maintaining the grade for the upstream portion. Rock cross vanes will be used at the top and bottom of the Site, near the convergence point of the Main and Western UTs, and at drop structures where a stable grade control point is required. These structures will imitate many of the natural drops, such as large roots crossing the channel that act as grade stabilization, that were found in the reference reaches.

Log vanes will be used to direct the flow away from the bank and toward the center of the channel (Figure 21). Log vanes will be used to introduce woody material into the channel to provide habitat and a food source for aquatic life. Without this introduction it would be many years before the planted saplings would be able to provide the stream with this habitat feature.

Log Sills will be used in the channel as grade control (Figure 22). The log sills will be placed at an angle bisecting the channel at the head of pool near the beginning of the meander bend. The sill will be inserted so that the top of the sill will be at the same elevation as the channel bed. Bundle cuttings, using a species that roots quickly such as black willow (*Salix nigra*), will be planted on the edges of the sill to act as a deterrent to lateral expansion (Figure 23).

Floodplain interceptors will be used where wet seeps intersect the channel (Figure 24). A floodplain interceptor uses riprap, filter fabric and vegetative plantings to stabilize banks where sheet flow or other forms of saturation enter the stream.

Channel plugs will be used where the proposed channel intersects the existing channel (Figure 25). The plug will be composed of impervious select material that will deter channel avulsions and bank failures.

8.2 TYPICAL CROSS-SECTIONS

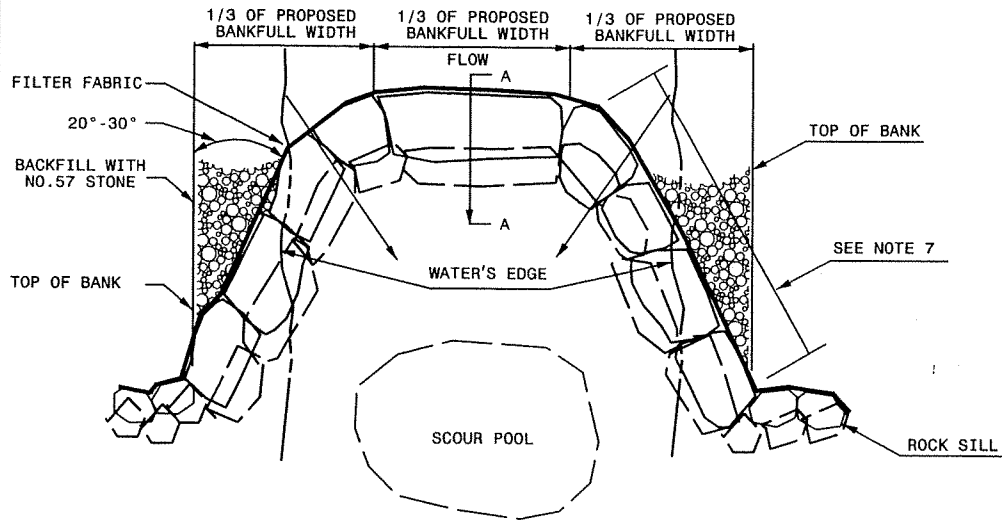
Typical proposed cross-sections of both a riffle and pool are depicted in Figures 26 through 33 for the Upper, Middle, Lower, and Western Reaches. Existing ground is shown in each cross-section.

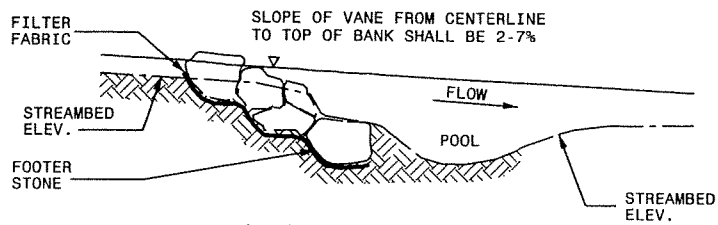
ROCK CROSS VANE

SCALE:NTS

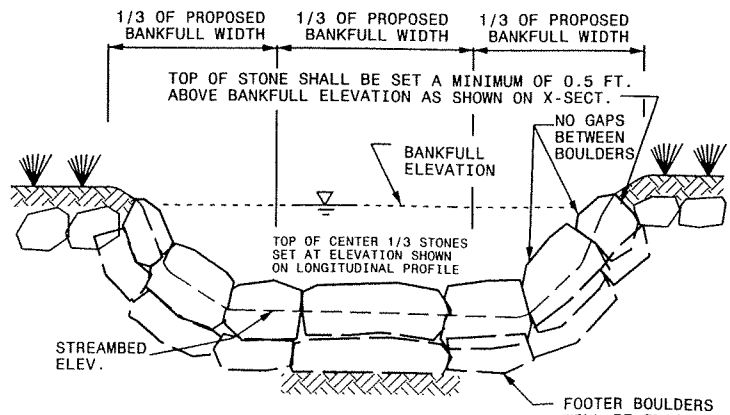
NOTES:
1. ALL STONES ARE TO BE STRUCTURE STONE.
2. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER, PLUGGING WITH STRUCTURE STONE CLASS A AND NO.57 AND LINING WITH FILTER FABRIC.
3. DIMENSIONS AND SLOPES MAYBE ADJUSTED TO FIT BY THE ENGINEER.
4. A DOUBLE FOOTER BOULDER SHALL BE UTILIZED IN SAND BED MATERIAL.
5. CONTRACTOR WILL BE REQUIRED TO FIT BOULDERS TIGHTLY.
6. FOOTER BOULDERS AND VANE BOULDERS SHALL BE NATIVE STONE OR SHOT ROCK, CUBICAL OR RECTANGULAR IN NATURE.
7. SLOPE OF VANE FROM CENTERLINE TO TOP OF BANK SHALL BE 2-7%.

FILTER FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF STRUCTURE.





SECTION A-A



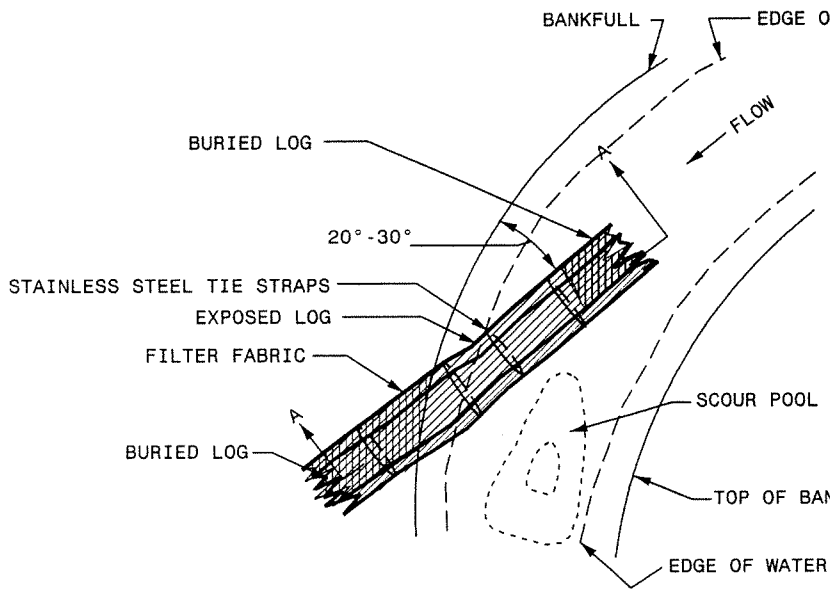
CROSS-SECTION

FIGURE 20

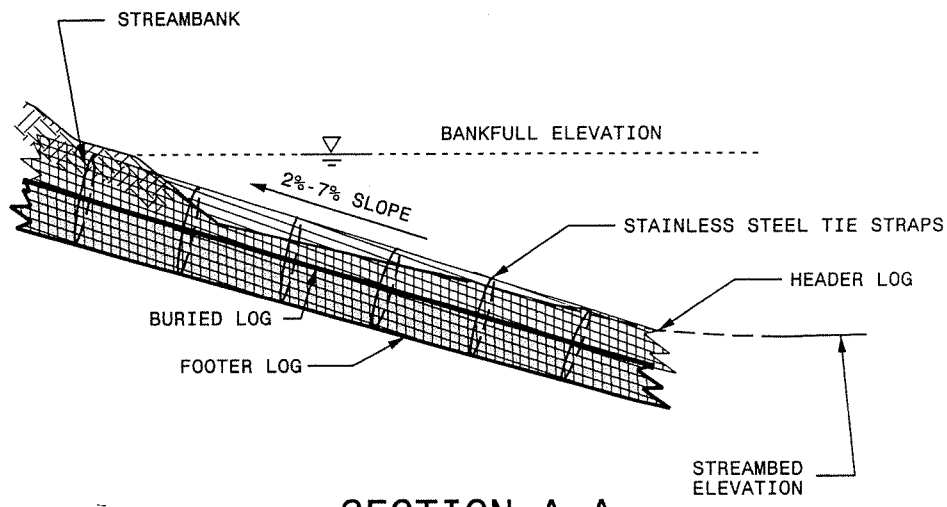
LOG VANE

SCALE: NTS

FILTER FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE ¼ DIAMETER FROM THE TOP OF THE LOG. FILTER FBARIC SHALL BE NAILED TO LOG VANE. THE NAILS SHALL BE ON 12 INCH CENTERS. FILTER FABRIC SHALL BE BURIED IN THE BOTTOM OF THE CHANNEL AND SHALL BE PLACED THE ENTIRE LENGTH OF STRUCTURE.



PLAN VIEW



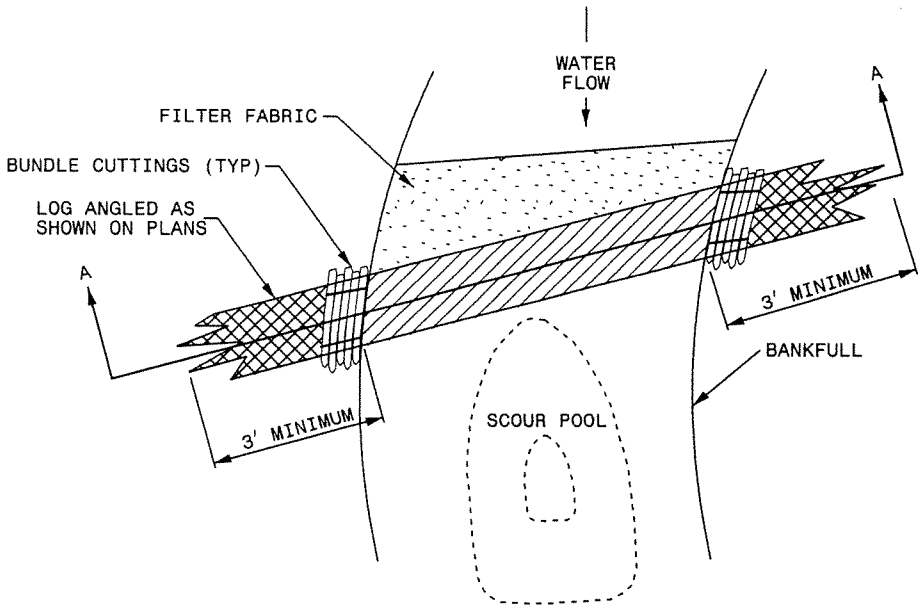
SECTION A-A

NOTE: LOG IS HARDWOOD MINIMUM DIAMETER OF 12". LOG IS BURIED MINIMUM OF 3 FT. ON BOTH ENDS.

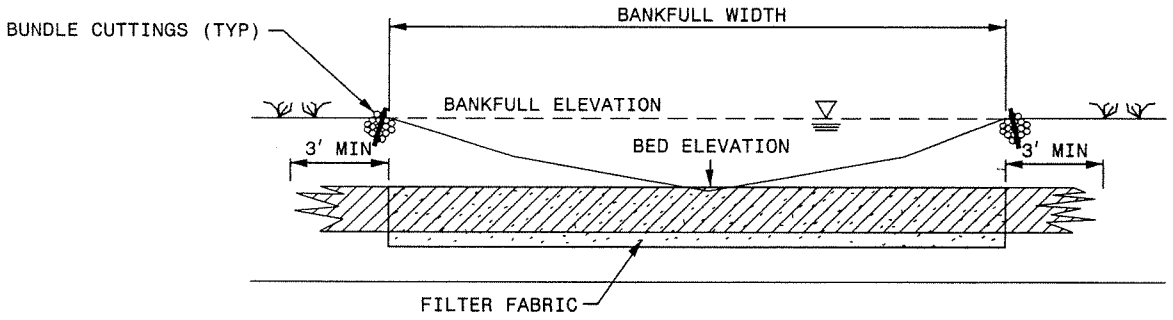
FIGURE 21

LOG SILL

SCALE: NTS



PLAN VIEW



SECTION A-A

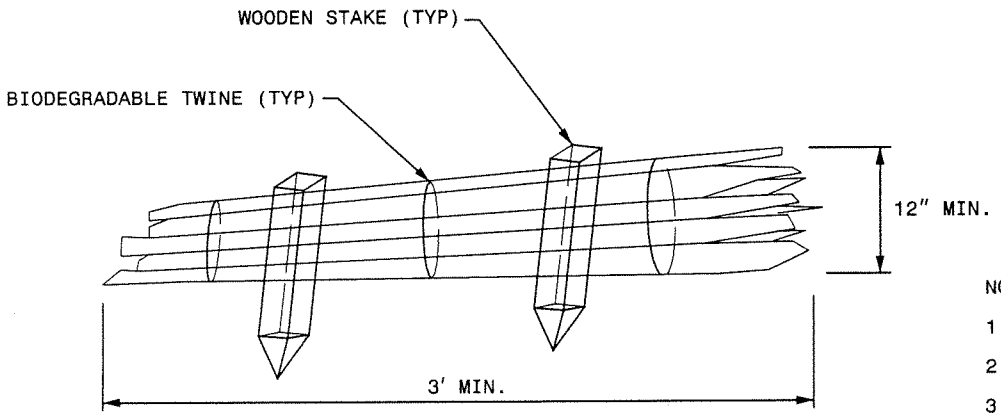
NOTES:

1. LOG SILL SHALL BE OF A HARDWOOD SPECIES, AND SHALL BE AT LEAST 24" IN DIAMETER.
2. ANGLE OF LOG IN CHANNEL SHALL MATCH THE ANGLE OF THE LOG AS SHOWN ON THE PLAN VIEW IN THE PLANS.
3. BUNDLE CUTTINGS SHALL BE PLACED AT THE CHANNEL EDGE ABOVE THE SILL ON BOTH THE LEFT AND RIGHT BANKS.
4. FILTER FABRIC SHALL BE WRAPPED AROUND THE SILL LOG AND PLACED UPSTREAM OF THE SILL TO PREVENT UNDERCUTTING OF THE SILL. FILTER FABRIC SHALL BE BACK FILLED AND COMPACTED WITH MATERIAL EXCAVATED ON-SITE.

FIGURE 22

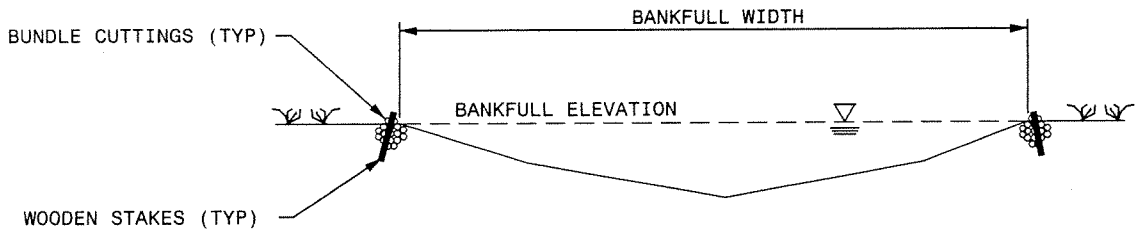
BUNDLE CUTTINGS

SCALE: NTS



NOTES:

1. BUNDLE CUTTINGS SHALL BE COMPOSED OF CUTTINGS FROM VEGETATION USED FOR LIVE STAKING.
2. THE BUNDLE SHALL BE A MINIMUM OF 12" IN DIAMETER AND A MINIMUM OF 3' LONG.
3. TWO WOODEN STAKES SHALL BE DRIVEN THROUGH THE BUNDLE TO ANCHOR THE BUNDLES TO THE GROUND.
4. APPROXIMATELY 2" OF TOP SOIL SHALL BE FILLED ON TOP OF THE BUNDLE CUTTINGS AFTER INSTALLATION.

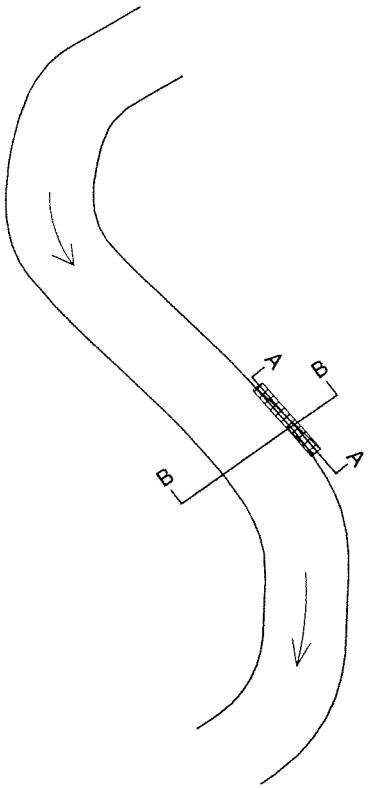


TYPICAL SECTION

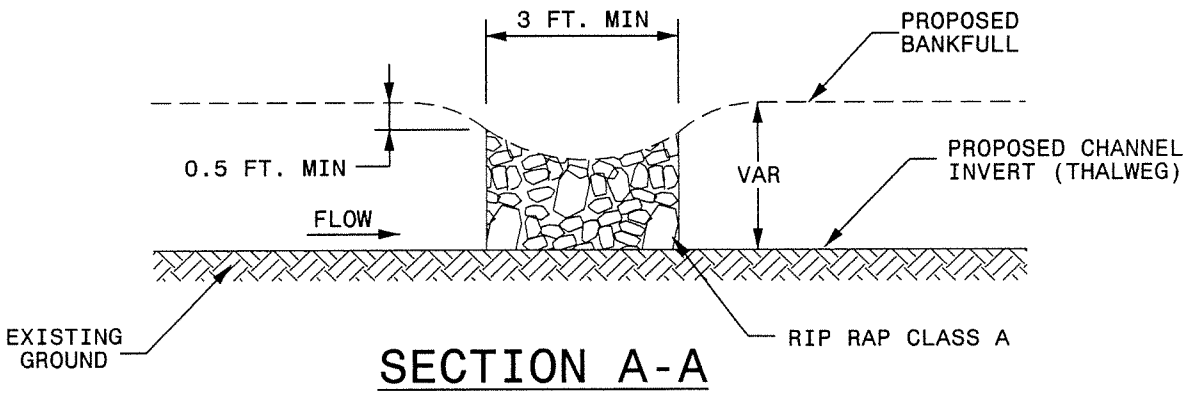
FIGURE 23

FLOODPLAIN INTERCEPTOR

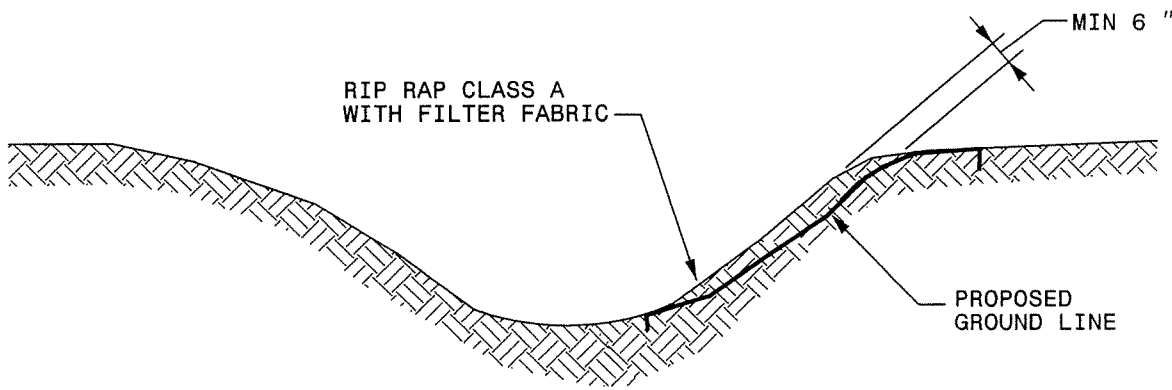
SCALE: NTS



PLAN VIEW



SECTION A-A



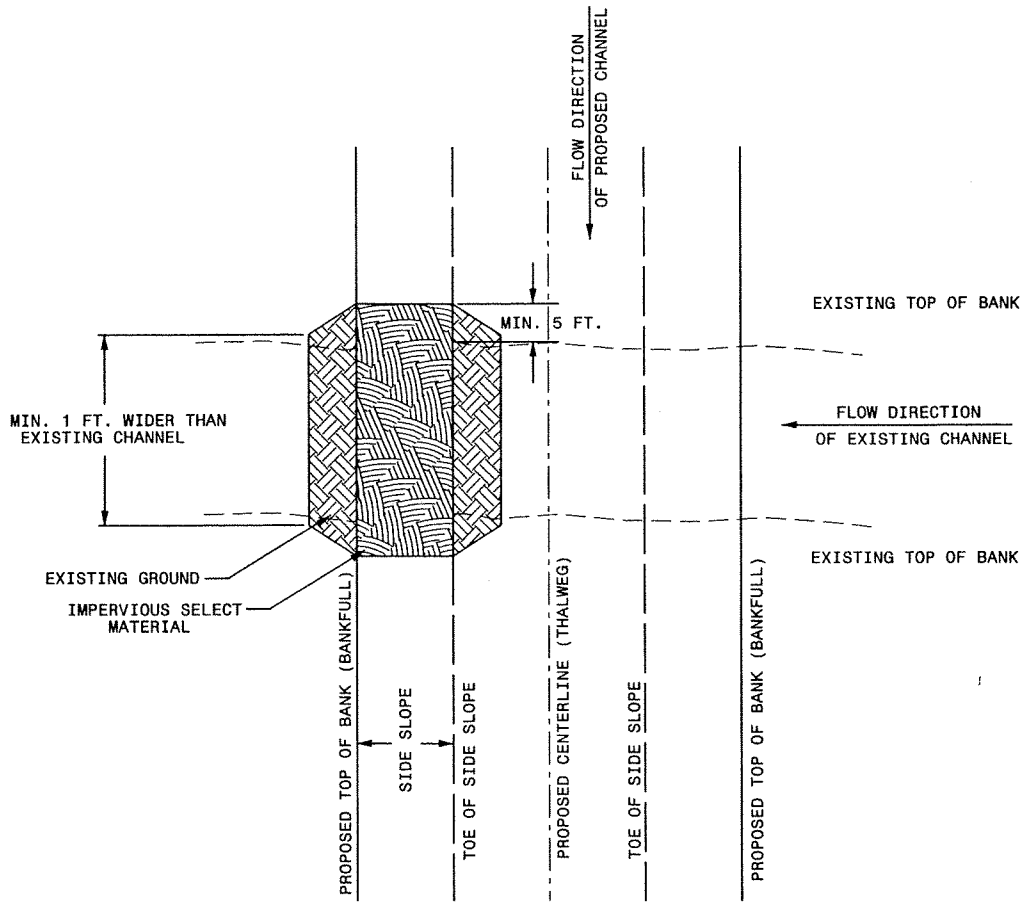
RIP RAP SHALL BE A
MINIMUM OF 1 FT
IN DEPTH.

SECTION B-B

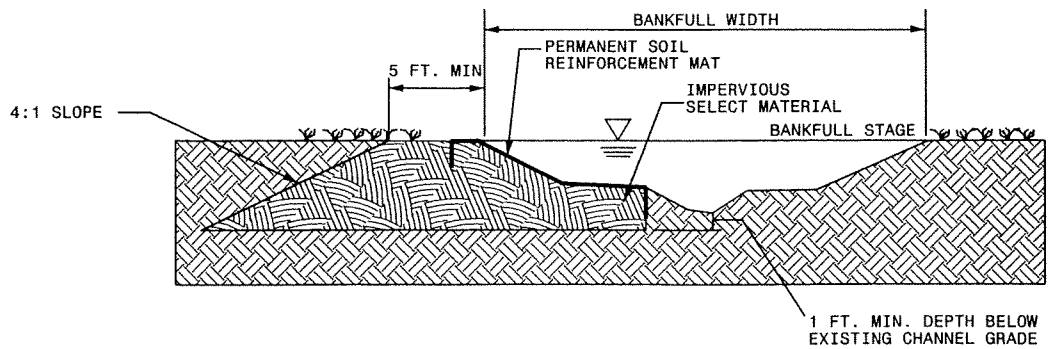
FIGURE 24

IMPERVIOUS STREAM CHANNEL PLUG

SCALE: NTS



PLAN VIEW



CROSS-SECTION

FIGURE 25

REVISIONS

PROJECT REFERENCE NO.	SHEET NO.
R513WM	

UPPER REACH: TYPICAL RIFFLE CROSS SECTION

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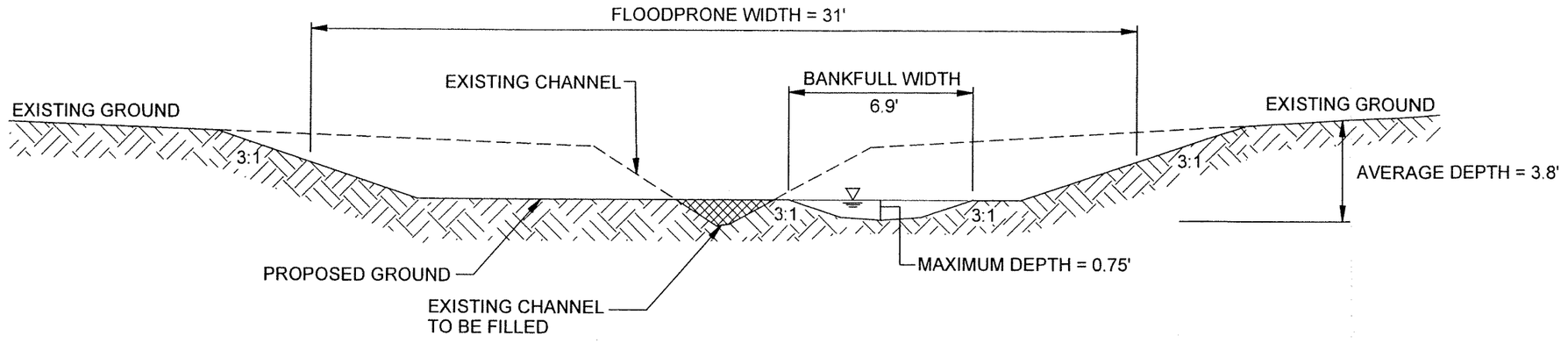
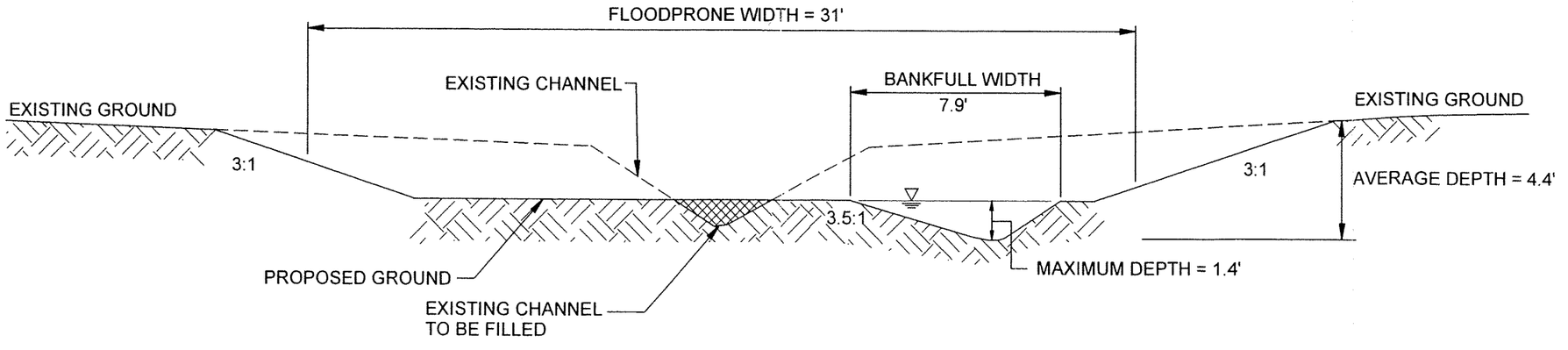


2 0 5
SCALE

FIGURE 26

UPPER REACH: TYPICAL POOL CROSS SECTION



2 0 5
SCALE

FIGURE 27

PROJECT REFERENCE NO.	SHEET NO.
R513WM	

MIDDLE REACH: TYPICAL RIFFLE CROSS SECTION

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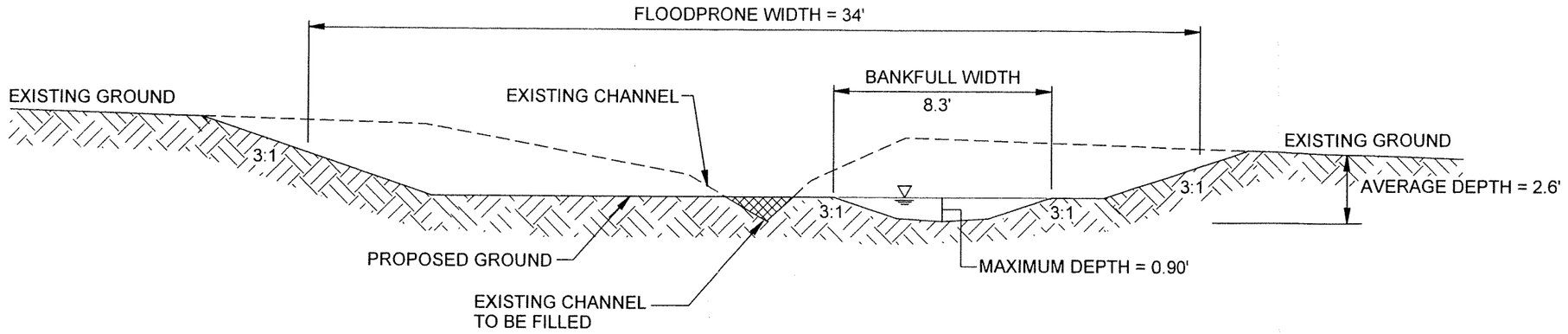
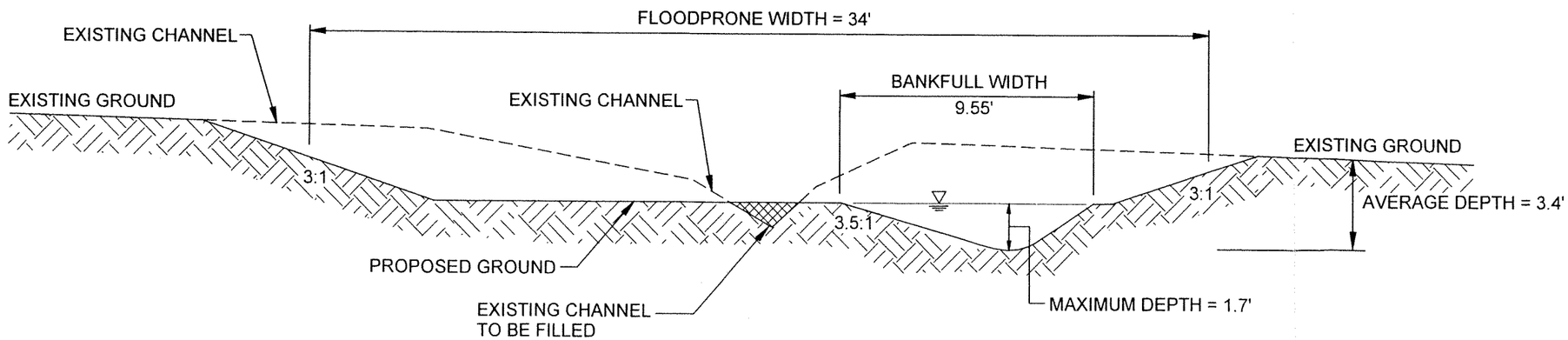


2 0 5
SCALE

FIGURE 28

MIDDLE REACH: TYPICAL POOL CROSS SECTION



2 0 5
SCALE

FIGURE 29

REVISIONS

PROJECT REFERENCE NO.	SHEET NO.
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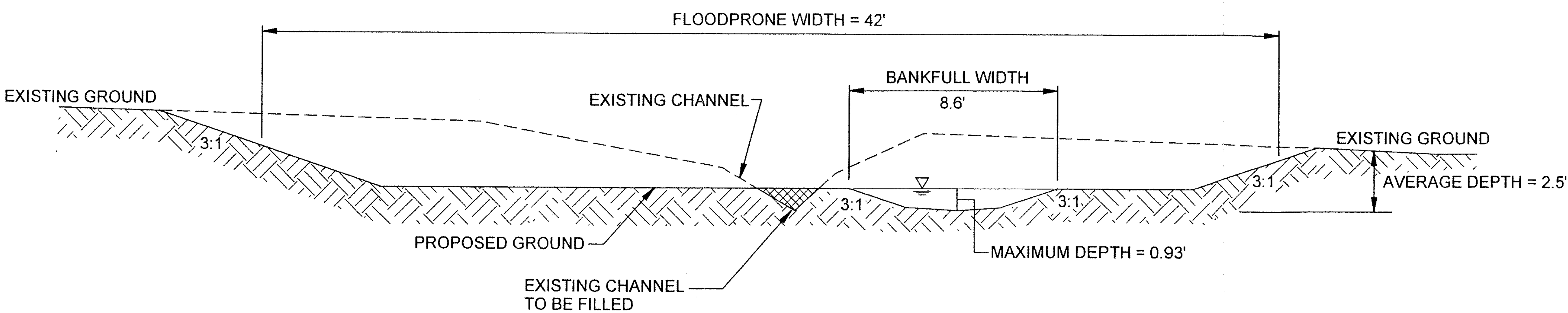
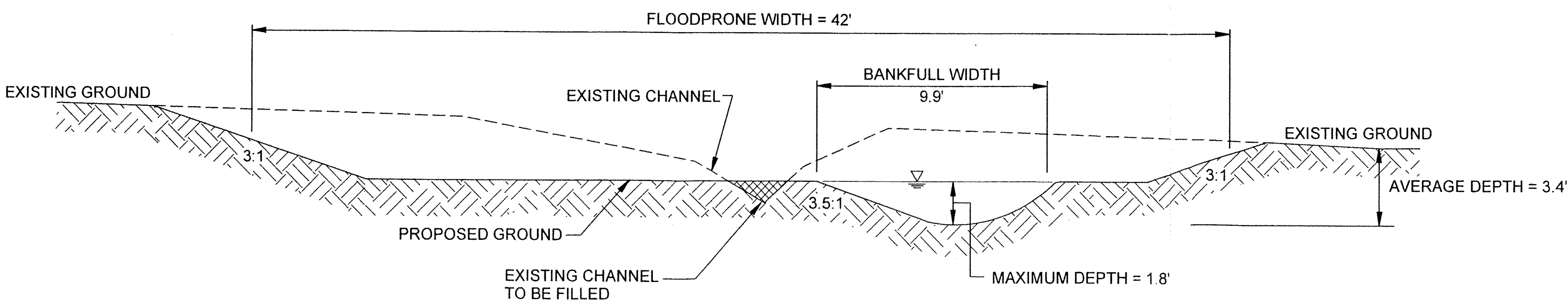
LOWER REACH: TYPICAL RIFFLE CROSS SECTION



2 0 5
SCALE

FIGURE 30

LOWER REACH: TYPICAL POOL CROSS SECTION



2 0 5
SCALE

FIGURE 31

REVISIONS

PROJECT REFERENCE NO.	SHEET NO.
R513WM	

WESTERN UT: TYPICAL RIFFLE CROSS SECTION

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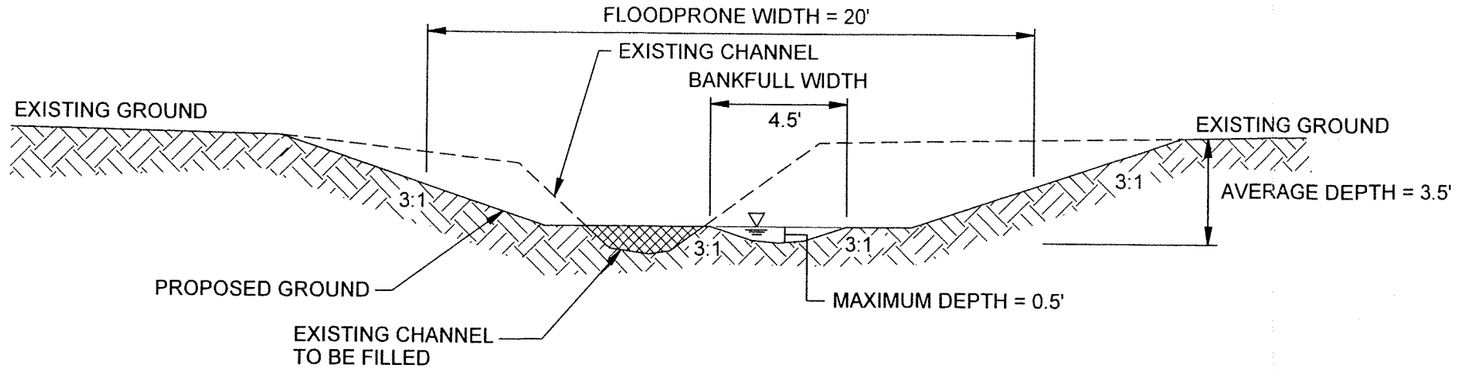
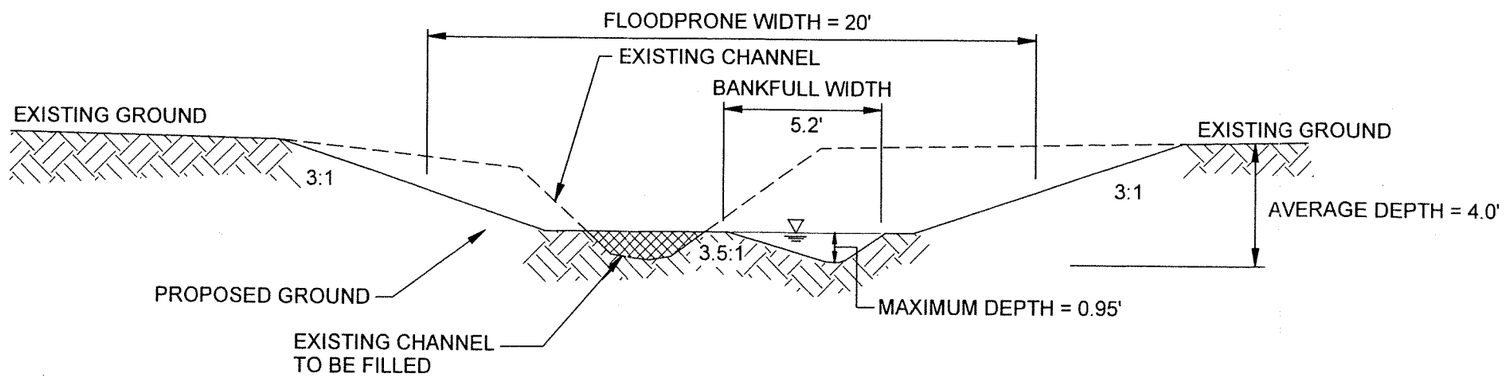


2 0 5
SCALE

FIGURE 32

WESTERN UT: TYPICAL POOL CROSS SECTION



2 0 5
SCALE

FIGURE 33

9.0 PLANTING PLAN

Seeding, mulching, live staking, and vegetation planting will be utilized to stabilize the restored streambanks and buffer. All disturbed areas will be seeded with a non-invasive grass species and either mulched or matted. Biodegradable matting will provide immediate protection for the streambanks against shear stress while the plantings develop a root mass. In time, the plantings will replace the matting in providing stability.

Plantings will be used for streambank stabilization and buffer establishment and will eventually provide shade and wildlife habitat along the restored stream. Plantings will quickly develop a root mass and help protect streambanks and floodplains from erosive forces while absorbing nutrients. Approximately 50 feet from the outside of a meander bend will be planted on either side of the channel. The Coastal Plain Swamp Forest Community located within the wetland preservation area has a good diversity of vegetation and will be used as a reference community for vegetative plantings along the restored stream channel. The restored buffer will also be supplemented with vegetation found along the stream reference reaches and species listed in representative communities of Schafale and Weakley (1990) and *Recommended Native Plant Species for Stream Restoration in North Carolina* (Hall, 2001). All plantings will be dependent on species availability and agency approval. Planting techniques may include live staking, containerized, and bare root plantings. In addition, it can be expected that natural recruitment from on-site woody and herbaceous material will occur.

Four planting zones are proposed as follows: Zone A – Streambank Zone, Zone B - Floodplain Zone, Zone C – Riparian Buffer, Zone D – Wetland Pockets. A list of tree and shrub species to be included in each zone is included as Table 8. A variety of species are included on each list to account for diversity in the planted zones and to provide a wide species selection to the contractor. Some species may not be available when the Site is planted therefore the larger variety of species should allow the contractor to acquire enough species for each zone to ensure diversification during planting. At least three different species should be planted in each zone to provide diversity. Details of the vegetative communities within each zone are provided below and displayed in Figure 34.

TABLE 8. Proposed Planting by Zones

Zone	Vegetative Community Type	Common Name	*Scientific Name*	Southeast Region Indicator Status
A	Streambank	Swamp Dogwood	*Cornus stricta*	FACW-
		Virginia Willow	*Itea virginica*	FACW+
		Elderberry	*Sambucus canadensis*	FACW-
		River Birch	*Betula nigra*	FACW
		Ironwood	*Carpinus caroliniana*	FAC
B	Floodplain	Laurel Oak	*Quercus laurifolia*	FACW
		Water Oak	*Quercus nigra*	
		Swamp Chestnut Oak	*Quercus michauxii*	FACW-
		Overcup Oak	*Quercus lyrata*	OBL
		Swamp Blackgum	*Nyssa biflora*	OBL
		Swamp Cottonwood	*Populus heterophylla*	OBL
		Swamp Red Bay	*Persea palustris*	FACW
		Titi	*Cyrilla racemiflora*	FACW
		Inkberry	*Ilex coriacea*	FACW
		Coastal Dog-Hobble	*Leucothoe axillaris*	FACW
C	Riparian Buffer	Water Oak	*Quercus nigra*	FAC
		Willow Oak	*Quercus phellos*	FACW-
		Swamp Chestnut Oak	*Quercus michauxii*	FACW-
		Cherrybark Oak	*Quercus falcata var. pagodaefolia*	FAC+
		Yellow Poplar	*Liriodendron tulipifera*	FAC
		American Sycamore	*Platanus occidentalis*	FACW-
		Green Ash	*Fraxinus pennslyvanica*	FACW
		Wax Myrtle	*Myrica cerifera*	FAC+
		Sweet Pepperbush	*Clethra alnifolia*	FACW
D	Wetland Pockets	Swamp Blackgum	*Nyssa Biflora*	OBL
		Bald Cypress	*Taxodium distichum*	OBL
		Swamp Dogwood	*Cornus stricta*	FACW-
		Buttonbush	*Cephalanthus occidentalis*	OBL
		Lizard's Tail	*Saururus cernuus*	OBL
		Pickerelweed	*Pontederia cordata*	OBL

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BEGIN WESTERN UT 10+00.00
N= 170586.7298
E= 2075253.3872

WESTERN UT

FLOODPRONE WIDTH (TYP)

PERMANENT STREAM CROSSING (TYP)

MIDDLE REACH

BEGIN UPPER REACH 10+00.00
N= 170586.7298
E= 2075253.3872

UPPER REACH

BEGIN MIDDLE REACH 10+00.00
END UPPER REACH 14+34.04
END WESTERN UT 17+70.28

FLOODPRONE WIDTH (TYP)

MIDDLE REACH

POND

PERMANENT STREAM CROSSING

LOWER REACH

FLOODPRONE WIDTH (TYP)

WETLAND 2

END MIDDLE REACH 18+13.20
N= 172594.3688
E= 2075655.3153

BEGIN LOWER REACH 10+00.00
END MIDDLE REACH 25+60.75
N= 177554.1203
E= 2075696.9920

WETLAND 1

40 0 80
SCALE

LEGEND

- WETLAND NOT PRESERVED
- WETLAND PRESERVATION
- PLANTING LIMITS
- FLOODPRONE WIDTH

ZONE A — STREAMBANK ZONE
ZONE B — FLOODPLAIN ZONE
ZONE C — RIPARIAN BUFFER
ZONE D (WP) — WETLAND POCKETS

Mill Branch Stream and Wetland Restoration Plan

Columbus County, North Carolina

Planting Plan

FIGURE 34

9.1 ZONE A – STREAMBANK ZONE

Streambank plantings will consist of quick-growing trees and shrubs, which will provide stability and reinforcement. Streambank plantings may include the following species: swamp dogwood (*Cornus stricta*), elderberry (*Sambucus canadensis)*, buttonbush (*Cephalanthus occidentalis*), Virginia willow (*Itea virginica*), river birch, and ironwood (*Carpinus caroliniana*). These rapid growing species will begin to provide shading for the newly restored channel. These species will also provide food and habitat for a variety of songbirds, butterflies, and other wildlife. The streambed and point bars will not be matted or planted so the natural dynamics associated with sediment transport and flow may occur within the channel.

9.2 ZONE B – FLOODPLAIN ZONE

Vegetative plantings within the new floodplain will consist of those woody species native to the Coastal Plain physiographic region, predominantly Coastal Plain Bottomland Hardwood species. The floodplain zone will extend from the edge of the Streambank Zone to the base of the upland slope on each side of the channel. The following woody species are proposed within Zone B dependent upon species availability at the time of construction: laurel oak (*Quercus laurifolia*), water oak, swamp chestnut oak, overcup oak (*Quercus lyrata*), swamp blackgum, swamp cottonwood (*Populus heterophylla*), swamp red bay, titi, inkberry and coastal dog-hobble (*Leucothoe axillaris*). The nuts and fruits from these plantings will provide food for a variety of mammal and bird species. It is expected that flooding and groundwater seepage from side slopes may raise the water table enough to meet wetland hydrology parameters. Wetlands could be restored in the Floodplain Zone if hydrology parameters are met. Installation of monitoring gauges is recommended to aid in determining which portions of the Floodplain Zone will become wetlands.

9.3 ZONE C – RIPARIAN BUFFER

Zone C will extend from the edge of the floodplain, Zone B, and encompass the remainder of the riparian buffer. Plantings within the buffer will include species that are adaptable to both wet and dry conditions and include species representative of Coastal Plain Bottomland Hardwood and Coastal Plain Mesic Mixed Hardwood Forest communities. Many of the species in Zone B will also be planted in Zone C. Based on species availability, the proposed woody species will include: water oak, willow oak (*Quercus phellos*), swamp chestnut oak, cherrybark oak (*Quercus falcata var. pagodaefolia*), yellow poplar, American sycamore (*Platanus occidentalis*), green ash (*Fraxinus pennsylvanica*), wax myrtle, and sweet pepperbush (*Clethra alnifolia*). It is anticipated that additional species such as horse sugar and American holly, both present within the downstream wetland preservation area, will self-colonize.

9.4 ZONE D – WETLAND POCKETS

Wet pockets will be incorporated into the design in order to filter excessive nutrient runoff from the adjacent cattle operation prior to its entry into the Main UT and downstream Mill Branch. Areas where the channel has been abandoned, wet seeps currently on-site, and a wet swale presently draining the watering pond approximately 50 feet off the right bank of the Main UT fall within the Wetland Pocket category for plantings. *Juncus* sp. presently occurs within many of these areas and will be supplemented with the following

species: swamp blackgum, bald cypress (*Taxodium distichum*), swamp dogwood, buttonbush, lizard's tail (*Saururus cernuus*), and pickerelweed (*Pontederia cordata).*

10.0 MONITORING PLAN

10.1 STREAM RESTORATION MONITORING

The stability of the stream channel will be monitored annually for five years or until success criteria are satisfied. Monitoring protocols will be based upon the Stream Mitigation Guidelines (USACE et al., 2003) and include photo documentation, channel stability, and ecological function of the restored stream.

10.2 WETLAND MONITORING

Monitoring of the restored wetland will be conducted for five years. Hydrologic monitoring gauges will be installed in the wetland pockets as well as a reference wetland. Hydrology will be conducted through continuously monitoring gauges programmed to read once every twelve hours. Monitoring gauges will be downloaded, at a minimum, once every three months.

Vegetation monitoring will adhere to the specifications established in the Ecosystem Enhancement Program's (EEP) vegetation monitoring guidelines.

11.0 SUCCESS CRITERIA

11.1 STREAM RESTORATION SUCCESS CRITERIA

Success of the restored stream will be based upon criteria established in the 2003 Stream Mitigation Guidelines (USACE *et al.*).

11.2 WETLAND RESTORATION SUCCESS CRITERIA

Hydrologic success will be based upon hydroperiods measured in the reference wetland. A hydroperiod within ten percent of the reference wetland will be considered successful. In addition, hydrology within the restored wetland will be compared to the USACE wetland guidance defining wetland hydrology as water within 12 inches of the surface for 5 - 12.5% of the growing season.

Vegetation within the restored wetland will be considered successful if it meets 260 stems per acre in the first year of monitoring as stated in EEP's draft vegetation monitoring guidelines.

12.0 REFERENCES

Doll, Barbara, A. Dobbins, J. Spooner, D. Clinton, and D. Bidelspach. 2004. Hydraulic Geometry Relationships for Rural North Carolina Coastal Plain Streams. Raleigh, NC. http://www.bae.ncsu.edu/programs/extension/wqg/sri/append_a.pdf

Griffith, G.E., Omernik, J.M. Comstock, J.A., Schafale, M.P., McNab, W.H., Lenat, D.R., MacPherson, T.F., Glover, J.B., and Shelburne, V.B. 2002. Ecoregions of North Carolina and South Carolina, (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

Hall, Karen. 2001. Recommended Native Plant Species for Stream Restoration in North Carolina. North Carolina Stream Restoration Institute. North Carolina State University.

Harrelson, Cheryl C., Rawlins, C. L., and Potyondy, John P. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique, General Technical Report RM-245. Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

NCDOT. 1999. Guidelines for Drainage Studies and Hydraulic Design, Appendix C. Hydraulic Charts C200.1 and C200.2. NCDOT, Division of Highways, Highway Design Branch, Hydraulics Unit.

NCDOT. 2003. Mill Branch Stream and Wetland Mitigation Feasibility Study. NCDOT, PD&EA Branch.

NCDENR. 1994. A Field Guide to North Carolina Wetlands. EPA #904/B-94/001. DEM Report No. 94-03. Division of Environmental Management. Water Quality Section. Raleigh, NC

NCDWQ. 1999. Internal Guidance Manual, NC Division of Water Quality Stream Classification Method, Version 2.0. North Carolina Department of Environment and Natural Resources, Division of Water Quality. Raleigh, NC.

NCDWQ. 2001. Internal Technical Guide for Stream Work in North Carolina. North Carolina Department of Environmental and Natural Resources, Division of Water Quality, Raleigh, NC.

NCDWQ. 2004. North Carolina Waterbodies Reports. Basinwide Information Management System, North Carolina Division of Water Quality, North Carolina Department of Environmental and Natural Resources. http://h2o.enr.state.nc.us/bims/reports/basinsandwaterbodies/hydroLumber.pdf

Rosgen, David L. 2002. The Cross vane, W-Weir, and J-hook Vane Structures...Their Description, Design, and Application for Stream Stabilization and River Restoration. Proceedings from the American Society of Civil Engineers.

Rosgen, David L. 1997. A Geomorphological Approach to Restoration of Incised Rivers. Proceedings of the conference on Management of Landscapes Disturbed by Channel Incision.

Rosgen, David 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. North Carolina Natural Heritage Program, Raleigh, NC.

Spruill, William E. 1990. Soil Survey, Columbus County, North Carolina. Soil Conservation Service, USDA.

USACE. 2003. HEC-RAS River Analysis System, Version 3.1.1. USACE, Hydrologic Engineering Center, Davis, California.

USACE, USEPA, NCWRC, NCDWQ. 2003. Stream Mitigation Guidelines.

USDA. 1998. Natural Resources Conservation Service. Stream Visual Assessment Protocol. NWCC Technical Note 99-1.

USFWS, 2003. http://web.ncusfws.org/es/cntylist/columbus.html. World Wide Web.

USGS. Robbins, Jeanne C. and Pope, Benjamin F. 1996. Estimation of Flood-Frequency Characteristics of Small Urban Streams in North Carolina. Water-Resources Investigations Report 96-4084. Raleigh, NC.

USGS. Fairmont Quadrangle, North Carolina, 7.5 Minute Series (Topographic). 1962. Denver, Colorado or Reston, Virginia.

USGS. Nakina Quadrangle, North Carolina – Columbus Co., 7.5 Minute Series (Topographic). 1990. Denver, Colorado or Reston, Virginia.

USGS. Niagra Quadrangle, North Carolina, 7.5 Minute Series (Topographic). 1983. Denver, Colorado or Reston, Virginia.

USGS. Overhills Quadrangle, North Carolina, 7.5 Minute Series (Topographic). 1971. Denver, Colorado or Reston, Virginia.

USGS. Tabor City East Quadrangle, North Carolina – South Carolina, 7.5 Minute Series (Topographic). 1962. Denver, Colorado or Reston, Virginia.

APPENDIX A

Main UT and Western UT Stream Information

Upstream extent of Main UT along Jones property boundary.

Looking downstream on Upper Reach of Main UT.

Wet swale draining into Main UT

Looking upstream from access road on Main

Looking upstream of Lower Reach of Main UT.

Looking upstream of Western UT.

Appendix A. Existing Conditions along Mill Branch

Existing Data

Basin:	LUMBER RIVER	Channel Slope:	0.73 %
Reach:	Main UT-Upper Reach	Stream Length:	368 ft
Observers:	RS, ND, PC, Ed Hajnos (DOT)	Valley Length:	350 ft
Channel Type:	G5	Sinousity:	1.05
Drainage Area (sq mi):	0.15	Meander Length:	210
		Belt Width:	55
		Radius of Curvature:	10

Longitudinal Data

Station	Elevation Streambed	Elevation Water Surface	Top of Bank	Bench
3	73.72	74.57		
12	75.21		78.23	
27	71.97	74.20		
32	73.29	74.21		
33	73.95	74.20	78.06	74.76
51	74.04	74.14	77.79	
76	73.57	73.96	77.14	74.65
85	73.64	73.92	76.75	
87	73.47	73.98		74.74
99	73.66	73.91		74.59
101	73.72	73.92		74.55
102	73.54	73.76		
108	73.39	73.71		
122	73.02	73.73		
142	72.59	73.73		
161	73.56	73.74		
166	73.59	73.72	77.17	74.33
195	72.80	73.24		
209	72.68	73.23	75.90	73.84
241	72.64	73.10	75.49	74.19
255	72.71	73.11		
262	72.95	73.09	75.60	73.86
282	72.76	72.98		
300	72.43	72.63		
318	72.16	72.52		
327	72.33	72.52		
338	71.89	72.08	75.99	72.81
368	71.59	71.71		

Existing Data

Basin:	LUMBER RIVER
Reach:	Main UT-Upper Reach
Observers:	RS, ND, PC, Ed Hajnos (DOT)
Channel Type:	G5
Drainage Area (sq mi):	0.15

Riffle - Station 209

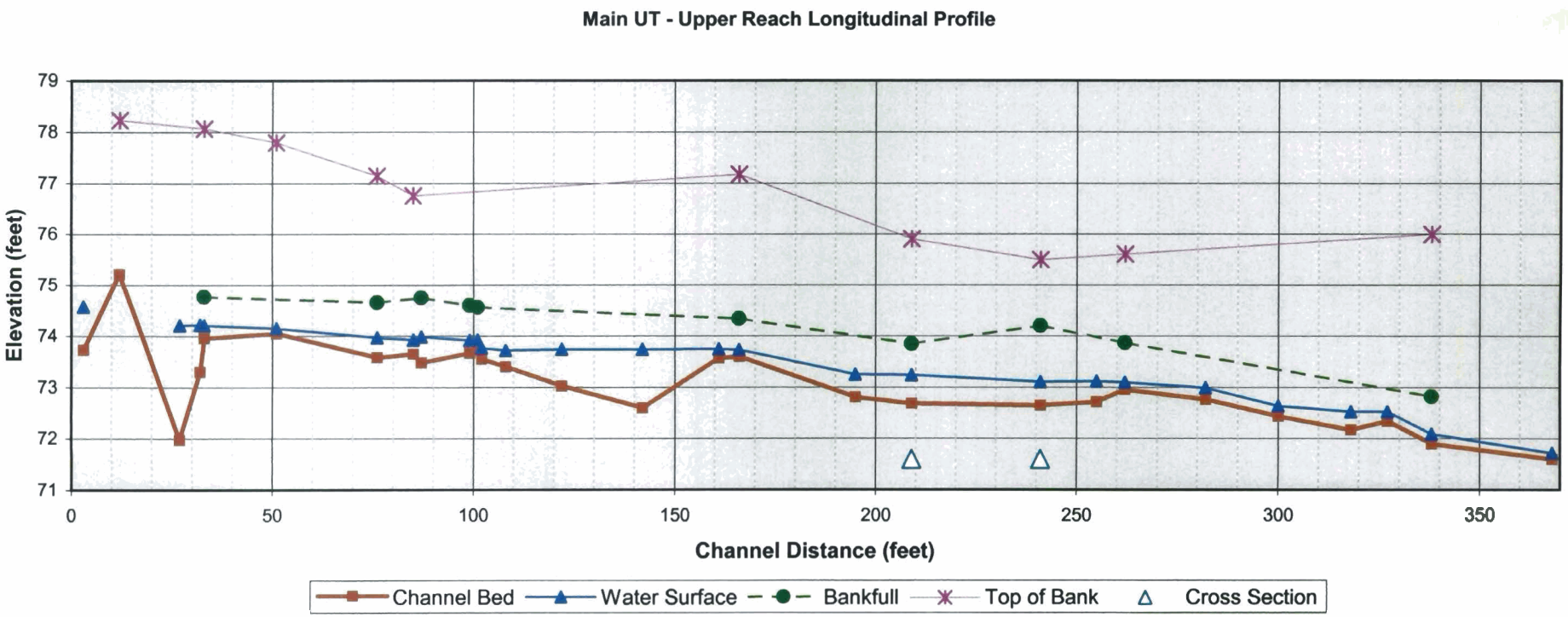
Station	Elevation
0	77.15
32.0	75.94
34.5	74.32
35.0	74.32
36.0	73.23
36.6	72.75
37.1	72.81
37.8	73.24
38.4	74.18
39.5	74.91
42.4	75.93
65.0	77.47
95.0	79.99

Bankfull Area	2.1 sq.ft
Bankfull Width	2.9 ft
Max depth	1.2 ft
Mean depth	0.7 ft
Width/Depth Ratio	3.9
Flood Prone Width	6.8 ft
Entrenchment Ratio	2.4

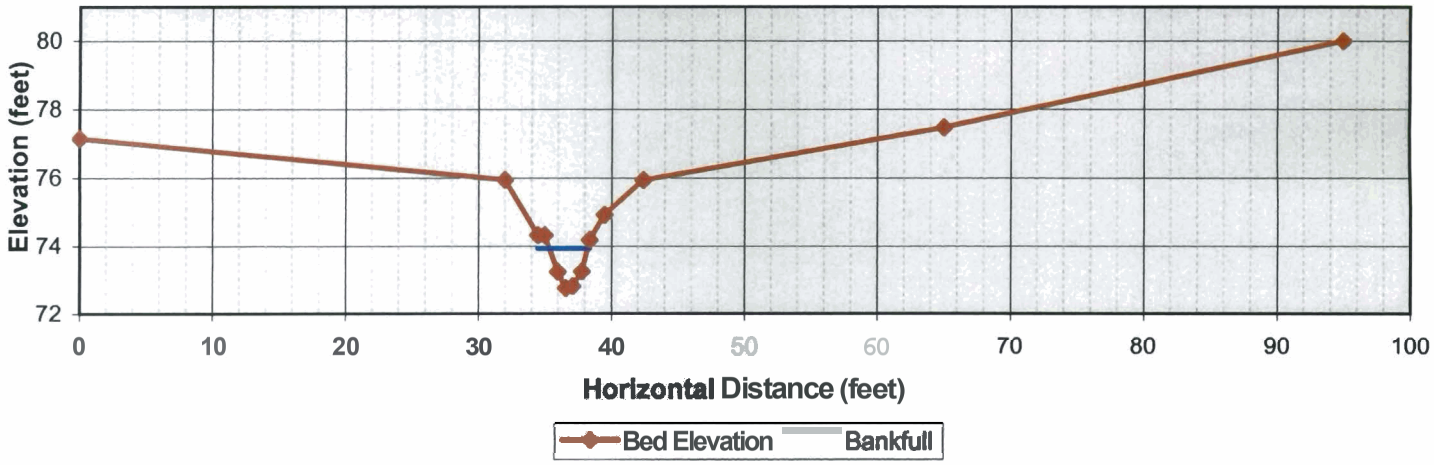
Pool - Station 241

Station	Elevation
0.0	76.99
44.0	75.52
44.5	74.94
46.2	74.41
47.9	72.81
48.4	72.61
49.3	72.64
49.8	72.99
50.7	73.82
51.8	74.7
53.1	75.48
66.0	76.65
91.8	79.29

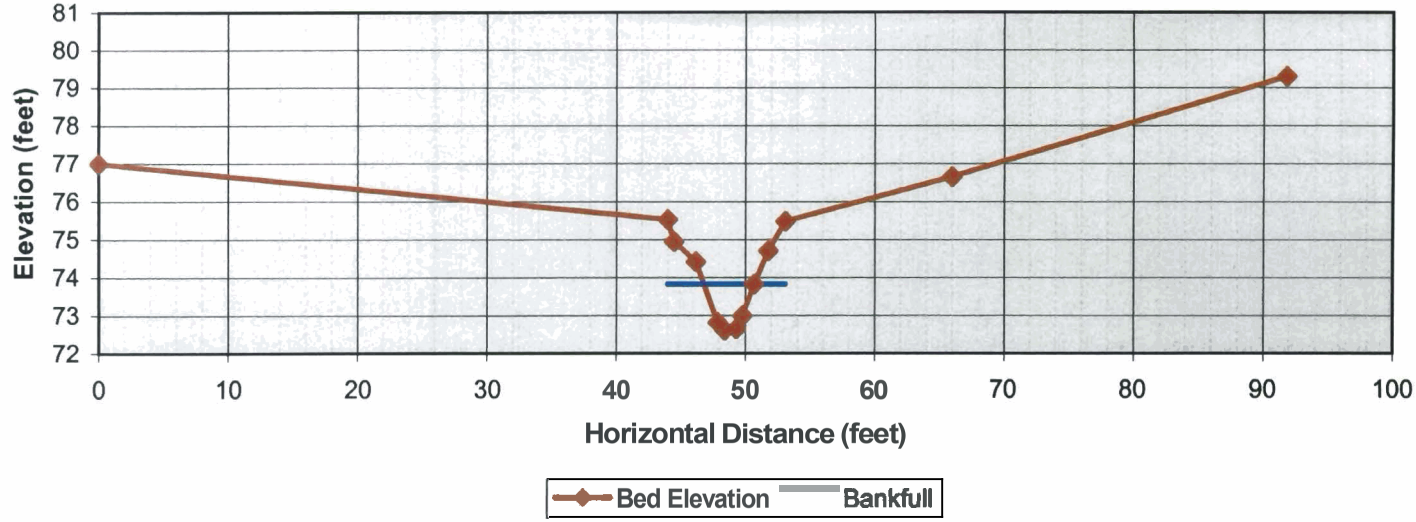
Bankfull Area	3.0 sq.ft
Bankfull Width	3.9 ft
Max depth	1.2 ft
Mean depth	0.8 ft


Main UT - Upper Reach Longitudinal Profile
Elevation (feet)
79
78
77
76
75
74
73
72
71
0
50
100
150
200
250
300
350
Channel Distance (feet)
Channel Bed
Water Surface
Bankfull
Top of Bank
Cross Section

Main UT - Upper Reach Riffle Cross Section



East Tributary Pool Cross-Section



Existing Data

Basin:	LUMBER RIVER	Channel Slope:	0.10 %
Reach:	Main UT-Middle and Lower Reach	Stream Length:	300 ft
Observers:	RS, ND, PC, Ed Hajnos (DOT)	Valley Length:	275 ft
Channel Type:	G5	Sinousity:	1.09
Drainage Area (sq mi):	0.21	Meander Length:	260
		Belt Width:	50
		Radius of Curvature:	25

Longitudinal Data

Station	Elevation Streambed	Elevation Water Surface	Top of Bank	Bench
0	69.67	69.86	72.94	70.94
7	69.31	69.80		
20	69.29	69.81		
25	69.43	69.82	71.21	
44	69.37	69.79	71.09	
49	69.21	69.80		
66	69.76	69.79	72.05	70.50
83	68.88	69.79		
91	69.30	69.75		
105	68.67	69.75	71.60	70.60
142	69.26	69.65	71.47	70.40
148	68.94	69.66		70.03
150	68.07	69.63		
168	68.57	69.64	71.18	69.92
177	68.46	69.63		
202	68.12	69.62		
218	68.81	69.60		
226	69.43	69.64		
263	69.02	69.55	71.97	69.73
282	67.92	69.55		
300	67.32	69.53	71.75	69.93

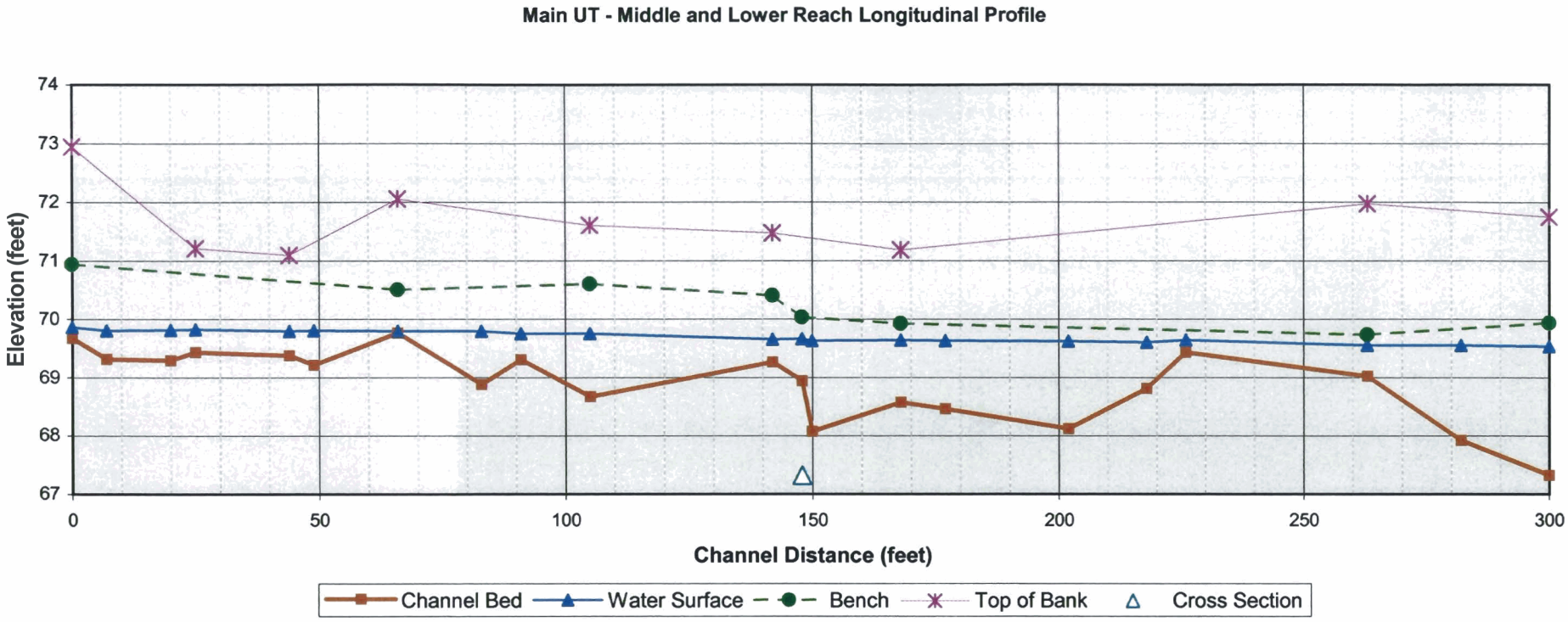
Existing Data

Basin:	LUMBER RIVER
Reach:	Main UT-Middle and Lower Reach
Observers:	RS, ND, PC, Ed Hajnos (DOT)
Channel Type:	G5
Drainage Area (sq mi):	0.21

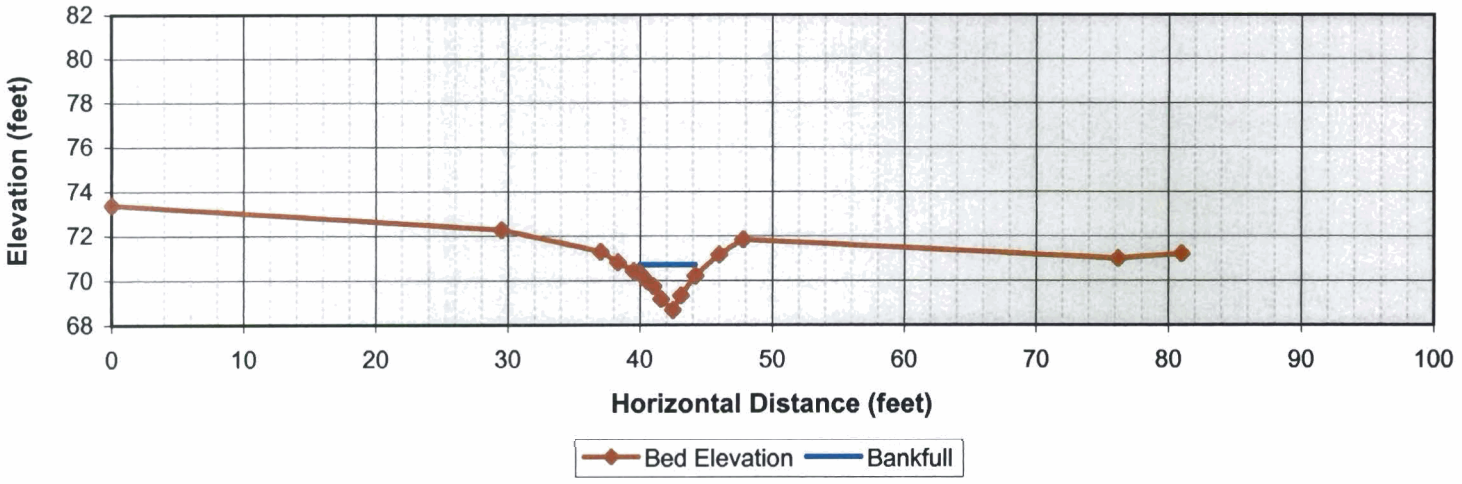
Riffle - Station 148

Station	Elevation
0	73.37
29.5	72.26
37	71.28
38.3	70.8
39.5	70.41
40	70.31
40.5	69.98
41	69.74
41.6	69.16
42.5	68.67
43.1	69.31
44.2	70.2
46	71.15
47.8	71.83
76.2	70.97
81	71.2

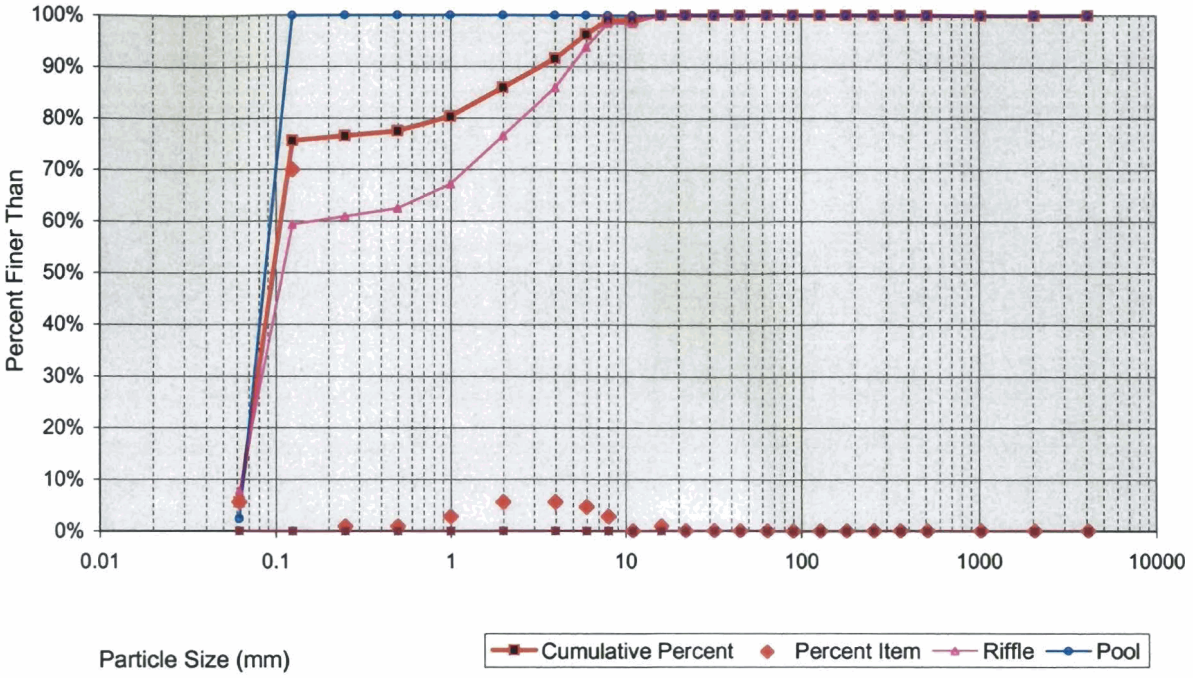
Bankfull Area	5.6 sq.ft
Bankfull Width	6.5 ft
Max depth	2.0 ft
Mean depth	0.86 ft
Width/Depth Ratio	7.5
Flood Prone Width	70.0 ft
Entrenchment Ratio	10.8


Main UT - Middle and Lower Reach Longitudinal Profile
Elevation (feet)
74
73
72
71
70
69
68
67
0
50
100
150
200
250
300
Channel Distance (feet)
Channel Bed
Water Surface
Bench
Top of Bank
Cross Section

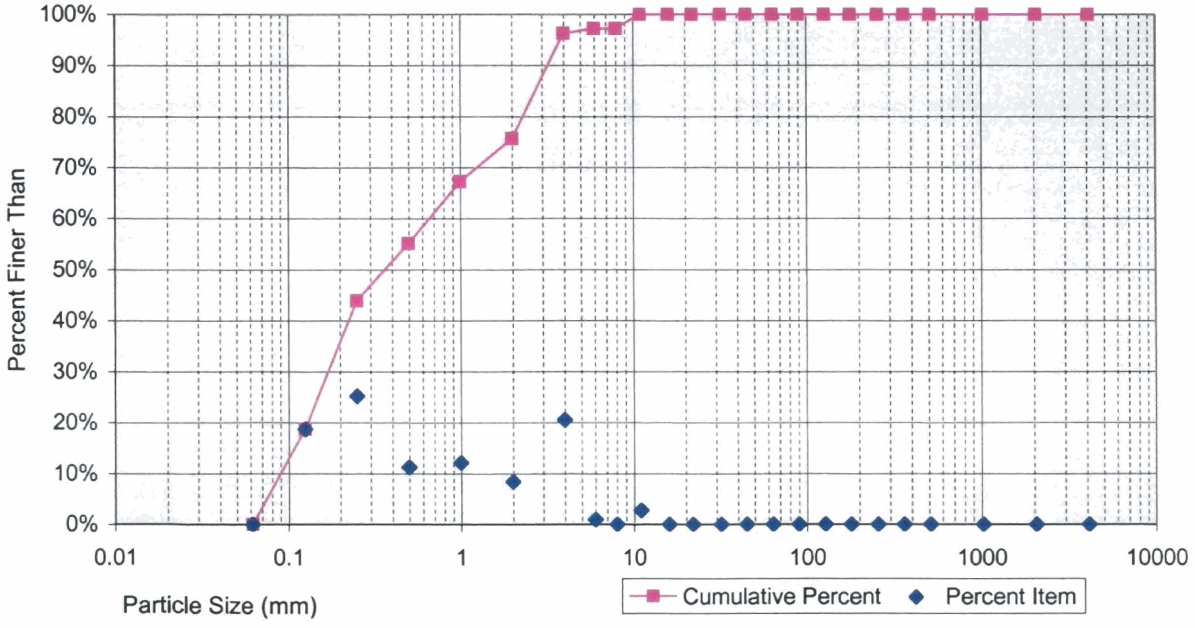
Main UT - Middle and Lower Reach Riffle Cross Section



Main UT Cumulative Pebble Count



Main UT Pebble Count
Riffle Cross Section



NCDWQ Stream Classification Form S500

Project Name: Mill Branch Western UT | River Basin: Lumber | County: Columbus | Evaluator: RVS

DWQ Project Number: N/A | Nearest Named Stream: Mill Branch | Latitude: 34°13'13.16"N | Signature:

Date: 2/11/04 | USGS QUAD: Nakina/Tabor City East | Longitude: 78°45'13.48W

Location/Directions: East of US 701, north of SR 1141.

PLEASE NOTE:** ***If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used*

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Riffle-Pool Sequence?	0	1	2	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	1	2	3
3) Are Natural Levees Present?	0	1	2	3
4) Is The Channel Sinuous?	0	1	2	3
5) Is There An Active (Or Relic) Floodplain Present?	0	1	2	3
6) Is The Channel Braided?	0	1	2	3
7) Are Recent Alluvial Deposits Present?	0	1	2	3
8) Is There A Bankfull Bench Present?	0	1	2	3
9) Is A Continuous Bed & Bank Present?	0	1	2	3
*(*NOTE: If Bed & Bank Caused By Ditching And WITHOUT Sinuosity Then Score=0*)*				
10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map *And/Or* In Field) Present?	*Yes*=3		*No*=0	

PRIMARY GEOMORPHOLOGY INDICATOR POINTS: 8

II. Hydrology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Groundwater Flow/Discharge Present?	0	1	2	3

PRIMARY HYDROLOGY INDICATOR POINTS: 1

III. Biology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Are Fibrous Roots Present In Streambed?	3	2	1	0
2) Are Rooted Plants Present In Streambed?	3	2	1	0
3) Is Periphyton Present?	0	1	2	3
4) Are Bivalves Present?	0	1	2	3

PRIMARY BIOLOGY INDICATOR POINTS: 5

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Head Cut Present In Channel?	0	.5	1	1.5
2) Is There A Grade Control Point In Channel?	0	.5	1	1.5
3) Does Topography Indicate A Natural Drainage Way?	0	.5	1	1.5

SECONDARY GEOMORPHOLOGY INDICATOR POINTS: 1

II. Hydrology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is This Year's (Or Last's) Leaf litter Present In Streambed?	1.5	1	.5	0
2) Is Sediment On Plants (Or Debris) Present?	0	.5	1	1.5
3) Are Wrack Lines Present?	0	.5	1	1.5
4) Is Water In Channel *And* >48 Hrs. Since Last *Known* Rain? *(*NOTE: If Ditch Indicated In #9 Above Skip This Step And #5 Below*)*	0	.5	1	1.5
5) Is There Water In Channel During Dry Conditions *Or* In Growing Season)?	0	.5	1	1.5
6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)?	*Yes=1.5*		*No*=0	

SECONDARY HYDROLOGY INDICATOR POINTS: 3.5

III. Biology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Are Fish Present?	0	.5	1	1.5
2) Are Amphibians Present?	0	.5	1	1.5
3) Are AquaticTurtles Present?	0	.5	1	1.5
4) Are Crayfish Present?	0	.5	1	1.5
5) Are Macrobenthos Present?	0	.5	1	1.5
6) Are Iron Oxidizing Bacteria/Fungus Present?	0	.5	1	1.5
7) Is Filamentous Algae Present?	0	.5	1	1.5

8) Are Wetland Plants In Streambed? N/A	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(NOTE: If Total Absence Of All Plants In Streambed As Noted Above Skip This Step UNLESS SAV Present*).*	2	1	.75	.5	0	0

SECONDARY BIOLOGY INDICATOR POINTS: 1.75

TOTAL POINTS (Primary + Secondary)= 20.25 *(If Greater Than Or Equal To 19 Points The Stream Is At Least Intermittent)*

Habitat Assessment Field Data Sheet
Coastal Plain Streams

Directions for use of this Assessment: The observer is to survey a minimum of 100 meters of stream, preferably in an upstream direction starting above the bridge pool and the road right-of-way. The stream segment which is assessed should represent average stream conditions. In order to perform a proper habitat evaluation the observer needs to get into the stream. All meter readings need to be performed prior to walking the stream. When working the habitat index, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. There are seven different metrics in this index and a final habitat score is determined by adding the results from the different metrics.

Stream Westeca JT to Mill Branch Location/Road East of US701 County Columbus Date 2/11/04
CC#_____ Subbasin 3-7-57 Basin Lumber

Observer(s): NND Office Location Raleigh, NC Agency _____

Type of Study: Fish Benthos Basinwide Special Study (Describe) Stream Restoration

Latitude _____ Longitude _____ Ecoregion (circle one) CA CB Swamp Distance Surveyed 670 meters
34°13'13.16"N 78°45'13.48"W

Physical Characterization: Land use refers to immediate area that you can see from sampling location - include what you see driving thru the watershed in the remarks section.

Land use: Forest 5 % Active Pasture 95 % Active Crops ____% Fallow Fields ____% Commercial ____%
Industrial ____% Residential ____% Other ____%. Describe:_____

Width: (meters) Stream 3 ft Channel _____ Average Stream Depth: (m) 0.5 ft Velocity _____ m/sec

Flow conditions (circle one): High (Normal) Low

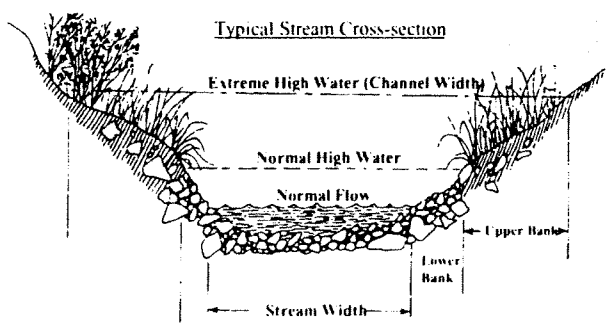
Manmade Stabilization: Y[ ] N[ ] Describe:_____

Water Quality: Temperature ____°C Dissolved Oxygen ____mg/l Conductivity _____µmhos/cm pH _____

Turbidity: (circle) Clear Slightly Turbid Turbid Tannic

Weather Conditions:_____ **Photo #**_____

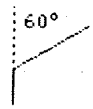
Remarks: Channelized stream.



I. Channel Modification (Use topo map as an additional aid for this parameter)

	Natural Channel Score	Modified Channel Score
A. Frequent bends		
1. bends > 60°.....	15.....	12
2. bends < 60°.....	13.....	10
B. Infrequent bends		
1. bends > 60°.....	11.....	7
2. bends < 60°.....	8.....	(5)

Remarks_____ Subtotal 5



II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover.

Circle the habitats which occur- **(Rocks) (Macrophytes) (sticks and leaf packs) (snags and logs) (undercut banks or root mats)** Definition: leafpacks consist of older leaves that are packed together and have begun to decay. Piles of leaves in pool areas are not considered leaf packs. EXAMPLE: If >70% of the reach is rocks, 1 type is present, circle the score of 17.

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>50% Score	30-50% Score	10-30% Score	<10% Score
4 or 5 types present.....	20	16	12	8
3 types present.....	19	15	11	7
2 types present.....	18	14	10	6
1 type present.....	17	(13)	9	5
No types present.....	0			

Remarks_____ Subtotal 13

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) look at entire reach for substrate scoring, but only look at riffle for embeddedness.

	Score
A. substrate types mixes	
1. gravel/rock dominant.....	15
2. sand dominant.....	13
3. detrirus dominant.....	7
4. silt/clay dominant.....	4
B. substrate homgeneous	
1. substrate nearly all gravel.....	12
2. substrate nearly all sand	(7)
3. substrate nearly all detritus.....	4
4. substrate nearly all silt/ clay.....	1

Remarks_____ Subtotal 7

VII. Riparian Vegetative Zone Width

Definition: A break in the riparian zone is any area which allows sediment to enter the stream. Breaks refer to the near-stream portion of the riparian zone (banks): places where pollutants can directly enter the stream.

	Left Bank	Right Bank
A. Riparian zone **intact** (no breaks)		
1. zone width > 18 meters	5	5
2. zone width 12-18 meters	4	4
3. zone width 6-12 meters	3	3
4. zone width < 6 meters	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. zone width > 18 meters	4	4
b. zone width 12-18 meters	3	3
c. zone width 6-12 meters	2	2
d. zone width < 6 meters	1	1
2. breaks common		
a. zone width > 18 meters	3	3
b. zone width 12-18 meters	2	2
c. zone width 6-12 meters	1	1
d. zone width < 6 meters	(0)	(0)

Total (0)

Remarks _____

TOTAL SCORE 37

COMMENTS, DRAWINGS:

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams.

	Score
A. Pools present	
1. Pools Frequent (>30% of 100m area surveyed)	
a. variety of pool sizes	10
b.pools same size	8
2. Pools Infrequent (<30% of the 100m area surveyed)	
a. variety of pool sizes	(6)
b.pools same size	4
B. Pools absent	
1. Runs present	3
2. Runs absent	0

Remarks_____ Total (6)

V. Bank Stability and Vegetation

	Left Bank	Right Bank
A. Banks stable		
1. no evidence of erosion or bank failure, little potential for erosion	10	10
B. Erosion areas present		
1. diverse trees, shrubs, grass; plants healthy with good root systems	9	9
2. few trees or small trees and shrubs; vegetation appears generally healthy	7	7
3. sparse vegetation; plant types and conditions suggest poorer soil binding	4	4
4. mostly grasses, few if any trees and shrubs, high ersosion and failure potential at high flow	(2)	(2)
5. no bank vegetation, mass erosion and bank failure evident	0	0

Total 4

Remarks_____

VI. Light Penetration (Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead).

	Score
A. Stream with **good** shading with some breaks for light penetration	10
B. Stream with **full canopy** - breaks for light penetration absent	8
C. Stream with **partial** shading - sunlight and shading are essentially equa	7
D. Stream with **minimal** shading - full sun in all but a few areas	(2)
E. **No shading**	0

Remarks_____ 2

Stream Visual Assessment Protocol

Owners name J.P. Jones Evaluator's name N. Daly Date 2/11/04

Stream name Western UT to Mill Branch Waterbody ID number 15-17-1-12-1-6-1 (Mill Branch

Reach location ≈6 m. South of Whiteville, NC

Ecoregion Coastal Plain Drainage area 0.035 sq. mi. Gradient 0.86%

Applicable reference site

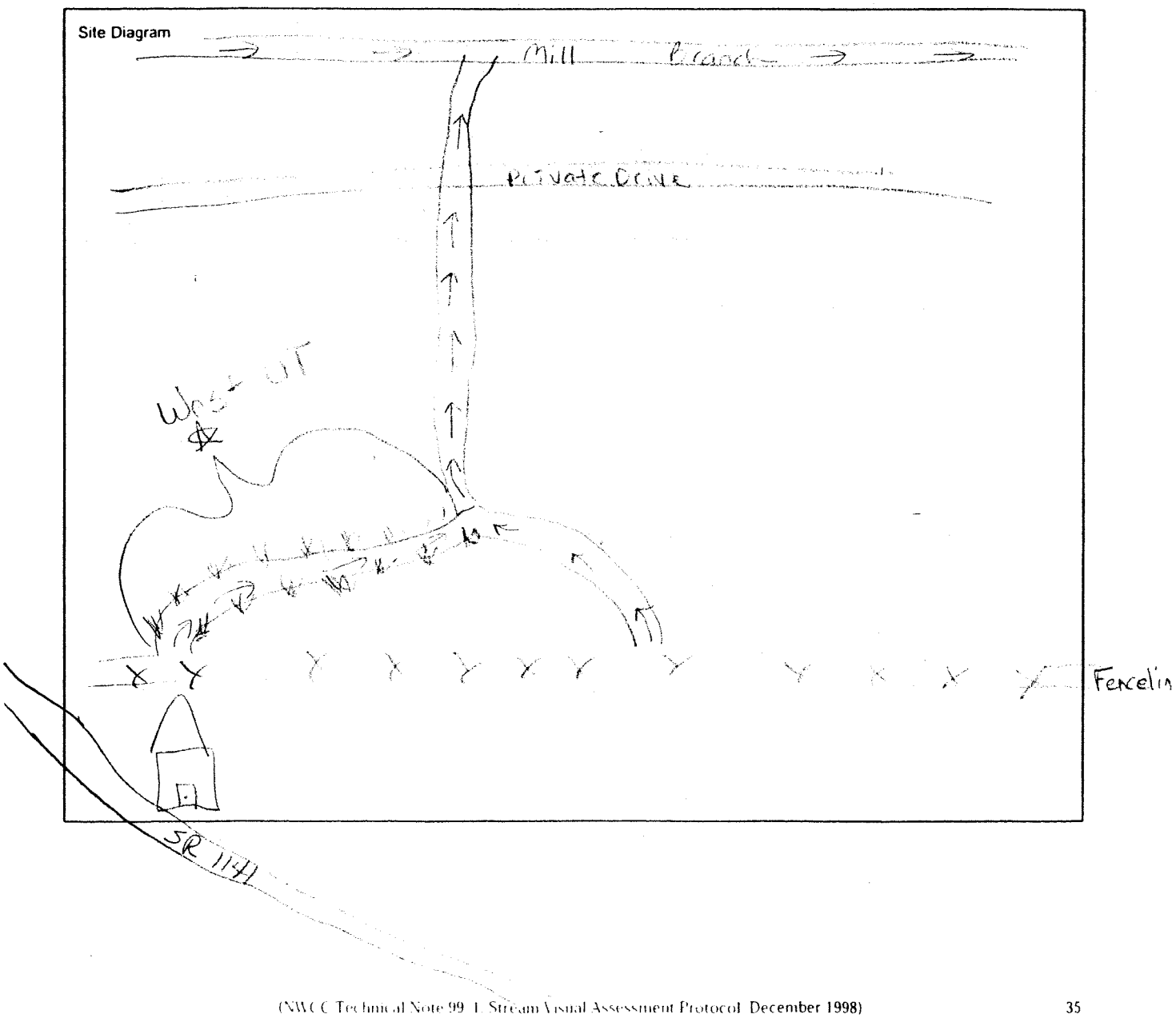
Land use within drainage (%): row crop 20 hayland ____ grazing/pasture 65 forest 15 residential ____

confined animal feeding operations ____ Cons. Reserve ____ industrial ____ Other: ____

Weather conditions-today ____ Past 2-5 days ____

Active channel width ≈3 ft Dominant substrate: boulder ____ gravel ____ sand ✓ silt ____ mud ____

Site Diagram



Assessment Scores

Channel condition	1
Hydrologic alteration	2
Riparian zone	3
Bank stability	3
Water appearance	5
Nutrient enrichment	6
Barriers to fish movement	3
Instream fish cover	3
Pools	3
Invertebrate habitat	1

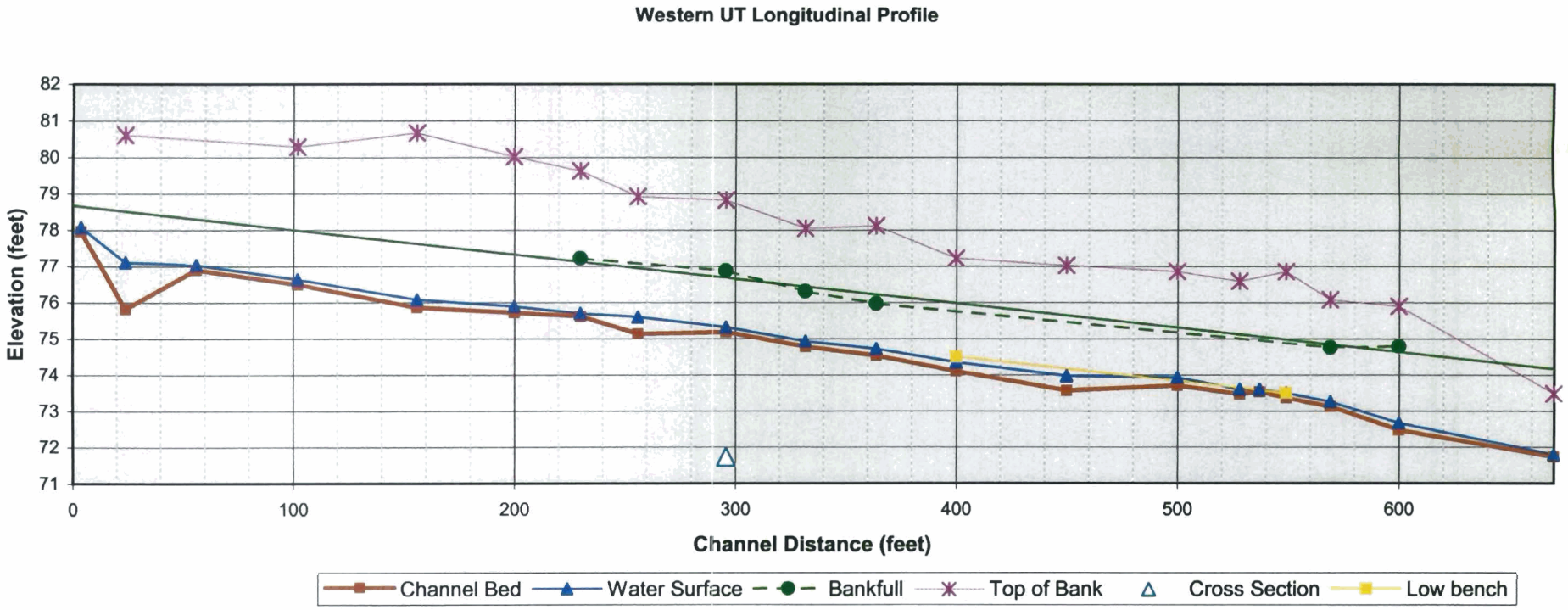
Score only if applicable

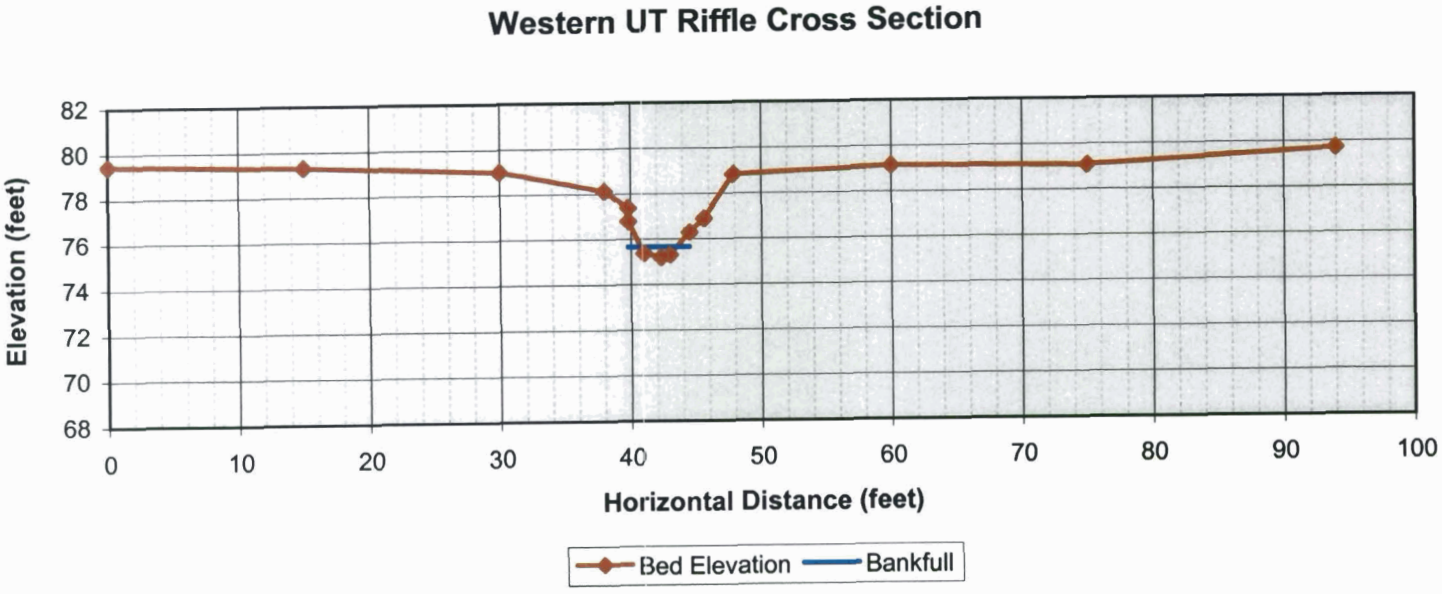
Canopy cover	
Manure presence	3
Salinity	
Riffle embeddedness	
Marcroinvertebrates Observed (optional)	

Overall score (Total divided by number scored)	3.2	<6.0	**Poor**
		6.1-7.4	**Fair**
		7.5-8.9	**Good**
		>9.0	**Excellent**

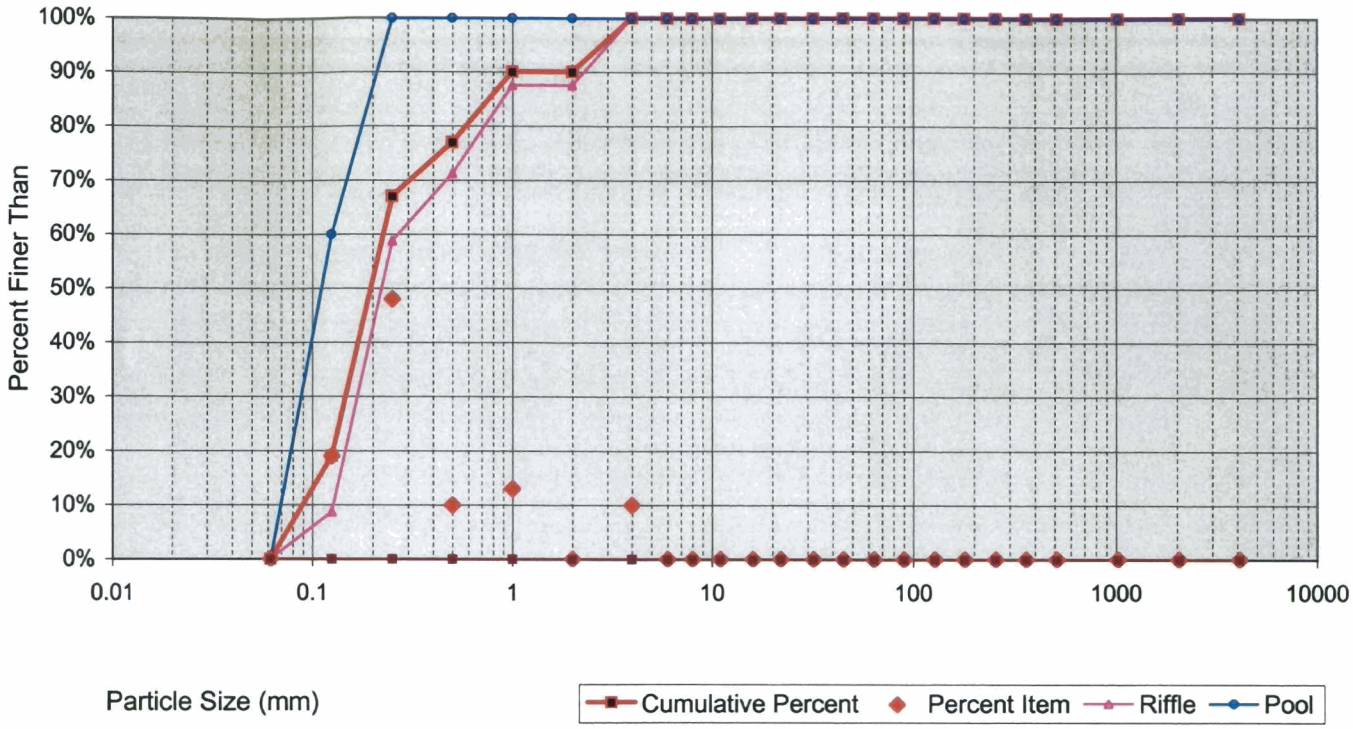
Suspected causes of observed problems Active cattle pasture leading to erosion + excess nutrient input. Past channelization of stream.

Recommendations Restore dimension/pattern/profile based on reference reach conditions. Fence off cattle + establish buffer

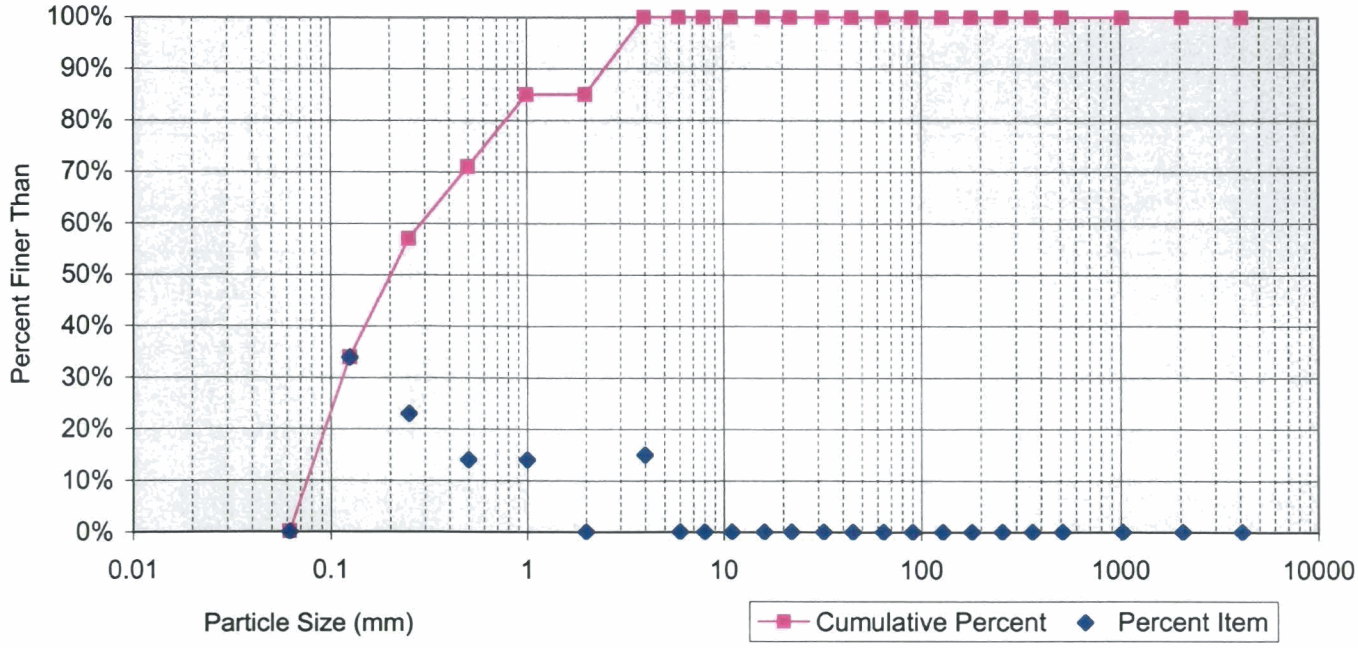

Western UT Longitudinal Profile
Elevation (feet)
82
81
80
79
78
77
76
75
74
73
72
71
0
100
200
300
400
500
600
Channel Distance (feet)
Channel Bed
Water Surface
Bankfull
Top of Bank
Cross Section
Low bench


Western UT Riffle Cross Section
Elevation (feet)
82
80
78
76
74
72
70
68
0
10
20
30
40
50
60
70
80
90
100
Horizontal Distance (feet)
Bed Elevation
Bankfull

Western UT Cumulative Pebble Count



Western UT Pebble Count
Riffle Cross Section



NCDWQ Stream Classification Form **S500**

Project Name: Mill Branch Main UT | River Basin: Lumber | County: Columbus | Evaluator: RVS

DWQ Project Number: N/A | Nearest Named Stream: Mill Branch | Latitude: 34°13'11.88"N | Signature:

Date: 2/11/04 | USGS QUAD: Nakina/Tabor City East | Longitude: 78°44'55.12"W

Location/Directions: East of US 701, north of SR 1141.

PLEASE NOTE:** ***If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used*

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Riffle-Pool Sequence?	0	1	2	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	1	2	3
3) Are Natural Levees Present?	0	1	2	3
4) Is The Channel Sinuous?	0	1	2	3
5) Is There An Active (Or Relic) Floodplain Present?	0	1	2	3
6) Is The Channel Braided?	0	1	2	3
7) Are Recent Alluvial Deposits Present?	0	1	2	3
8) Is There A Bankfull Bench Present?	0	1	2	3
9) Is A Continuous Bed & Bank Present?	0	1	2	3

*(*NOTE: If Bed & Bank Caused By Ditching And WITHOUT Sinuosity Then Score=0*)*

10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map *And/Or* In Field) Present? *Yes*=3 *No*=0

PRIMARY GEOMORPHOLOGY INDICATOR POINTS: 11

II. Hydrology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Groundwater Flow/Discharge Present?	0	1	2	3

PRIMARY HYDROLOGY INDICATOR POINTS: 1

III. Biology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Are Fibrous Roots Present In Streambed?	3	2	1	0
2) Are Rooted Plants Present In Streambed?	3	2	1	0
3) Is Periphyton Present?	0	1	2	3
4) Are Bivalves Present?	0	1	2	3

PRIMARY BIOLOGY INDICATOR POINTS: 6

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Head Cut Present In Channel?	0	.5	1	1.5
2) Is There A Grade Control Point In Channel?	0	.5	1	1.5
3) Does Topography Indicate A Natural Drainage Way?	0	.5	1	1.5

SECONDARY GEOMORPHOLOGY INDICATOR POINTS: 1

II. Hydrology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is This Year's (Or Last's) Leaf litter Present In Streambed?	1.5	1	.5	0
2) Is Sediment On Plants (Or Debris) Present?	0	.5	1	1.5
3) Are Wrack Lines Present?	0	.5	1	1.5
4) Is Water In Channel *And* >48 Hrs. Since Last *Known* Rain? *(*NOTE: If Ditch Indicated In #9 Above Skip This Step And #5 Below*)*	0	.5	1	1.5
5) Is There Water In Channel During Dry Conditions *Or* In Growing Season)?	0	.5	1	1.5

6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)? *Yes=1.5* *No*=0

SECONDARY HYDROLOGY INDICATOR POINTS: 4

III. Biology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Are Fish Present?	0	.5	1	1.5
2) Are Amphibians Present?	0	.5	1	1.5
3) Are AquaticTurtles Present?	0	.5	1	1.5
4) Are Crayfish Present?	0	.5	1	1.5
5) Are Macrobenthos Present?	0	.5	1	1.5
6) Are Iron Oxidizing Bacteria/Fungus Present?	0	.5	1	1.5
7) Is Filamentous Algae Present?	0	.5	1	1.5

8) Are Wetland Plants In Streambed? N/A	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(NOTE: If Total Absence Of All Plants In Streambed As Noted Above Skip This Step UNLESS SAV Present*).*	2	1	.75	.5	0	0

SECONDARY BIOLOGY INDICATOR POINTS: 1.75

TOTAL POINTS (Primary + Secondary)= 24.75 *(If Greater Than Or Equal To 19 Points The Stream Is At Least Intermittent)*

V. Bank Stability and Vegetation

	Lft Bank Score	Rt Bank Score
A. Banks stable		
1. no evidence of erosion or bank failure, little potential for erosion	10	10
B. Erosion areas present		
1. diverse trees, shrubs, grass; plants healthy with good root systems	9	9
2. few trees or small trees and shrubs; vegetation appears generally healthy	7	7
3. sparse vegetation; plant types and conditions suggest poorer soil binding	4	4
4. mostly grasses, few if any trees and shrubs, high ersosion and failure potential at high flow	(2)	(2)
5. no bank vegetation, mass erosion and bank failure evident	0	0

Total 11

Remarks bank vegetation dominated by Carex sp., Rosa palustris, privet = very little vegetation on banks

VI. Light Penetration (Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead).

	Score
A. Stream with good shading with some breaks for light penetration	10
B. Stream with full canopy - breaks for light penetration absent	8
C. Stream with partial shading - sunlight and shading are essentially equa	7
D. Stream with minimal shading - full sun in all but a few areas	(2)
E. No shading	0

Remarks Very little bank vegetation 2

VII. Riparian Vegetative Zone Width

Definition: A break in the riparian zone is any area which allows sediment to enter the stream. Breaks refer to the near-stream portion of the riparian zone (banks): places where pollutants can directly enter the stream.

	Lft Bank Score	Rt Bank Score
A. Riparian zone intact (no breaks)		
1. zone width > 18 meters	5	5
2. zone width 12-18 meters	4	4
3. zone width 6-12 meters	3	3
4. zone width < 6 meters	2	2
B. Riparian zone not intact (breaks)		
1. breaks rare		
a. zone width > 18 meters	4	4
b. zone width 12-18 meters	3	3
c. zone width 6-12 meters	2	2
d. zone width < 6 meters	1	1
2. breaks common		
a. zone width > 18 meters	3	3
b. zone width 12-18 meters	2	2
c. zone width 6-12 meters	1	1
d. zone width < 6 meters	(0)	(0)

Total 0

Remarks

TOTAL SCORE 41

Stream Visual Assessment Protocol

Owners name J.P. Jones Evaluator's name RVS Date 11-1-02

Stream name Main UT to Mill Branch Waterbody ID number 15-17-1-12-1-6-1)

Reach location ~6 mi South of Whiteville, NC on HW 701

Ecoregion Coastal Plain Drainage area 0.21 sq. mi. Gradient 0.10%

Applicable reference site

Land use within drainage (%): row crop ___ hayland ___ grazing/pasture 83% forest 12% residential 5%

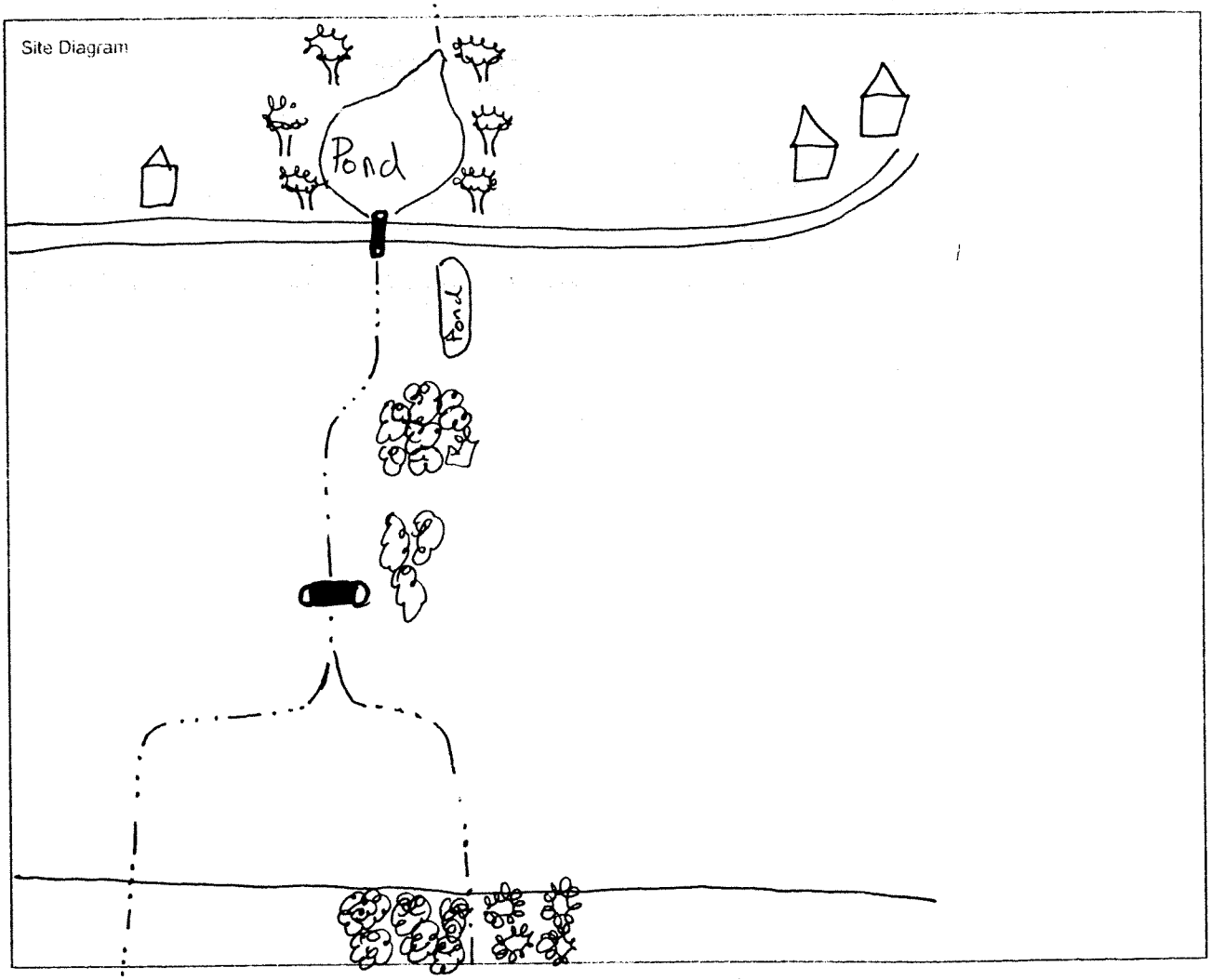
confined animal feeding operations ___ Cons. Reserve ___ industrial ___ Other: ___

Weather conditions-today ___ Past 2-5 days ___

Active channel width ___ Dominant substrate: boulder ___ gravel ___ sand ✓ silt ___ mud ___

Mill Branch ═══ Mill Branch

Site Diagram



Assessment Scores

Channel condition	3
Hydrologic alteration	3
Riparian zone	1
Bank stability	1
Water appearance	7
Nutrient enrichment	3
Barriers to fish movement	5
Instream fish cover	1
Pools	3
Invertebrate habitat	1

Score only if applicable

Canopy cover	1
Manure presence	3
Salinity	–
Riffle embeddedness	–
Marcroinvertebrates Observed (optional)	–

Overall score
(Total divided by number scored)
32/12 2.67

<6.0	**Poor**
6.1-7.4	**Fair**
7.5-8.9	**Good**
>9.0	**Excellent**

Suspected causes of observed problems

Recommendations

Habitat Assessment Field Data Sheet
Coastal Plain Streams

Directions for use of this Assessment. The observer is to survey a minimum of 100 meters of stream, preferably in an upstream direction starting above the bridge pool and the road right-of-way. The stream segment which is assessed should represent average stream conditions. In order to perform a proper habitat evaluation the observer needs to get into the stream. All meter readings need to be performed prior to walking the stream. When working the habitat index, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. There are seven different metrics in this index and a final habitat score is determined by adding the results from the different metrics.

Stream Main UT to Mill Branch Location/Road Jones Property County Columbus

Date 11-1-02 CC# _____ Subbasin 3-7-57 Basin Lumber

Observer(s): RVS Office Location Raleigh Agency —

Type of Study: Fish Benthos Basinwide Special Study (Describe) Stream Restoration

Latitude _____ Longitude _____ Ecoregion (circle one) CA CB Swamp Distance Surveyed 668 ft meters

34° 13' 11.88" N 78° 44' 55.12" W

Physical Characterization: Land use refers to immediate area that you can see from sampling location - include what you see driving thru the watershed in the remarks section.

Land use: Forest 5 % Active Pasture 95 % Active Crops ____ % Fallow Fields ____ % Commercial ____ %
Industrial ____ % Residential ____ % Other ____ %. Describe _____

Width: (~~meters~~ ft) Stream 40 Channel _____ Average Stream Depth (~~m~~ ft) 0.75 Velocity _____ m/sec

Flow conditions (circle one) High Normal Low

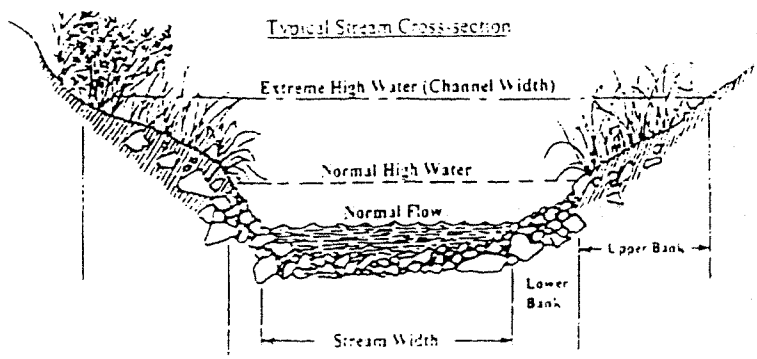
Manmade Stabilization: Y[ ] N[✓] Describe: _____

Water Quality: Temperature ____ °C Dissolved Oxygen _____ mg/l Conductivity _____ umhos/cm pH _____

Turbidity: (circle) Clear Slightly Turbid Turbid Tannic

Weather Conditions: _____ Photo # _____

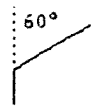
Remarks: Channelized stream impacted by cattle.



I. **Channel Modification** (Use topo map as an additional aid for this parameter)

	Natural Channel Score	Modified Channel Score
(channelized)		
A. Frequent bends		
1. bends > 60°	15	12
2. bends < 60°	13	10
B. Infrequent bends		
1. bends > 60°	11	(7)
2. bends < 60°	8	5

Remarks Has been channelized Subtotal 7



II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover Circle the habitats which occur- (Rocks) (Macrophytes) (sticks and leaf packs) (snags and logs) (undercut banks or root mats) Definition: leafpacks consist of older leaves that are packed together and have begun to decay. Piles of leaves in pool areas are not considered leaf packs. EXAMPLE: If >70% of the reach is rocks, 1 type is present, circle the score of 17.

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>50% Score	30-50% Score	10-30% Score	<10% Score
4 or 5 types present	20	16	12	8
3 types present	19	15	11	7
2 types present	18	14	10	6
1 type present	17	13	(9)	5
No types present	0			

Remarks Subtotal 9

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) look at entire reach for substrate scoring, but only look at riffle for embeddedness.

	Score
A. substrate types mixes	
1. gravel/rocks dominant	15
2. sand dominant	(13)
3. detritus dominant	7
4. silt/clay dominant	4
B. substrate homgeneous	
1. substrate nearly all gravel	12
2. substrate nearly all sand	7
3. substrate nearly all detritus	4
4. substrate nearly all silt/clay	1

Remarks Subtotal 13

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams.

	Score
A. Pools present	
1. Pools Frequent (>30% of 100m area surveyed)	
a. variety of pool sizes	10
b.pools same size	8
2. Pools Infrequent (<30% of the 100m area surveyed)	
a. variety of pool sizes	(6)
b.pools same size	4
B. Pools absent	
1. Runs present	3
2. Runs absent	0

Remarks Page Total 6

Existing Data

Basin:	LUMBER RIVER	Channel Slope:	0.86 %
Reach:	Western UT	Stream Length:	670 ft
Observers:	RS, ND, PC, Ed Hajnos (DOT)	Valley Length:	663 ft
Channel Type:	G5	Sinousity:	1.01
Drainage Area (sq mi):	0.03	Meander Length:	220
		Belt Width:	85
		Radius of Curvature:	15

Longitudinal Data

Station	Elevation Streambed	Elevation Water Surface	Top of Bank	Bench
4	77.95	78.07		
24	75.81	77.10	80.60	
56	76.89	77.03		
102	76.49	76.63	80.28	
156	75.85	76.07	80.66	
200	75.71	75.88	80.01	
230	75.61	75.69	79.62	77.21
256	75.12	75.59	78.92	
296	75.17	75.31	78.82	76.87
332	74.77	74.92	78.04	76.30
364	74.52	74.71	78.11	75.96
400	74.09	74.34	77.21	
450	73.56	73.96	77.02	
500	73.69	73.92	76.85	
528	73.46	73.59	76.58	
537	73.52	73.59		
549	73.36	73.49	76.85	
569	73.12	73.25	76.07	74.75
600	72.47	72.66	75.89	74.78
670	71.72	71.78	73.47	

Existing Data

Basin:	LUMBER RIVER
Reach:	Western UT
Observers:	RS, ND, PC, Ed Hajnos (DOT)
Channel Type:	G5
Drainage Area (sq mi):	0.03

Riffle - Station 296

Station	Elevation
0	79.434
15	79.294
30	78.994
38	78.114
39.8	77.374
39.8	76.784
41	75.354
42.3	75.174
43	75.284
44.5	76.284
45.6	76.884
47.9	78.824
60	79.134
75	79.064
94	79.704

Bankfull Area	0.9 sq.ft
Bankfull Width	2.8 ft
Max depth	0.5 ft
Mean depth	0.3 ft
Width/Depth Ratio	8.7
Flood Prone Width	2.9 ft
Entrenchment Ratio	1.1

APPENDIX B

Routine Wetland Determination Data Forms

DATA FORM

ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Mill Branch Mitigation Site			Date: 2/3/04
Applicant / Owner: J. P. Jones			County: Columbus
Investigator: Ryan Smith, Nancy Daly			State: NC
Do Normal Circumstances exist on the site?	YES	NO	Community ID: Wetland
Is the site significantly disturbed (Atypical Situation)?	YES	NO	Transect ID: Flags 101-136
Is the area a potential Problem Area? (If needed, explain on reverse)	YES	NO	Plot ID: Wetland 1

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1) *Juncus* sp.	Grass	FACW	9)		
2) *Carex* sp.	Grass	FAC	10).		
3) *Liquidambar styraciflua*	Canopy	FAC+	11)		
4) *Polygonum sagittatum*	Herb	OBL	12)		
5) *Acer rubrum*	Canopy	FACW-	13)		
6) *Ligustrum sinense*	Shrub	FAC			
7) Salix nigra	Canopy	OBL			
8)					
Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-): 100%					
Remarks:					

HYDROLOGY

[ ] Recorded Data (Describe in Remarks)
- [ ] Stream, Lake, or Tide Guage
- [ ] Aerial Photographs
- [ ] Other

[X] No Recorded Data Available

FIELD OBSERVATIONS

Depth of Surface Water	2	(in)
Depth of Free Water in Pit		(in)
Depth to Saturated Soil		(in)

WETLAND HYDROLOGY INDICATORS

Primary Indicators:
- [X] Inundated
- [X] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [X] Drainage Patterns in Wetlands

Secondary Indicators (2 or more Required)
- [X] Oxidized Root Channels in Upper 12 inches
- [ ] Water-stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase): Muckalee					Drainage Class: Poorly drained
Taxonomy (Subgroup): Typic Fluvaquents				Field Observations Confirm Mapped Type? YES NO	
PROFILE DESCRIPTION					
Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-6		7.5YR3/1			Clay loam
6-15		10YR3/1			Loam

HYDRIC SOIL INDICATORS:

[ ] Histosol	[ ] Concretions
[ ] Histic Epipedon	[ ] High Organic Content in Surface Layer in Sandy Soils
[ ] Sulfidic Odor	[ ] Organic Streaking in Sandy Soils
[X] Aquic Moisture Regime	[ ] Listed on Local Hydric Soils List
[X] Reducing Conditions	[ ] Listed on National Hydric Soils List
[X] Gleyed or Low-Chroma Colors	[ ] Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

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

Remarks:
Area has been previously modified to create a watering hole for cattle.

DATA FORM

ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Mill Branch Mitigation Site			Date: 2/3/04
Applicant / Owner: J. P. Jones			County: Columbus
Investigator: Ryan Smith, Nancy Daly			State: NC
Do Normal Circumstances exist on the site?	YES	NO	Community ID: Upland
Is the site significantly disturbed (Atypical Situation)?	YES	NO	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse)	YES	NO	Plot ID: Upland 1

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1) *Festuca* spp.	Grass	FAC	9)		
2)			10).		
3)			11)		
4)			12)		
5)			13)		
6)					
7)					
8)					
Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-):					
Remarks:					

HYDROLOGY

[ ] Recorded Data (Describe in Remarks)
- [ ] Stream, Lake, or Tide Guage
- [ ] Aerial Photographs
- [ ] Other

[X] No Recorded Data Available

FIELD OBSERVATIONS		
Depth of Surface Water	N/A	(in)
Depth of Free Water in Pit	N/A	(in)
Depth to Saturated Soil	N/A	(in)

WETLAND HYDROLOGY INDICATORS

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more Required)
- [ ] Oxidized Root Channels in Upper 12 inches
- [ ] Water-stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase): Goldsboro Series				Drainage Class: Moderately well	
Taxonomy (Subgroup): Aquic Paleudults				Field Observations Confirm Mapped Type? YES NO	
PROFILE DESCRIPTION					
Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-8	10YR3/2				Loam
8-14	10YR6/6				Loam

HYDRIC SOIL INDICATORS:

[ ] Histosol
[ ] Histic Epipedon
[ ] Sulfidic Odor
[ ] Aquic Moisture Regime
[ ] Reducing Conditions
[ ] Gleyed or Low-Chroma Colors
[ ] Concretions
[ ] High Organic Content in Surface Layer in Sandy Soils
[ ] Organic Streaking in Sandy Soils
[ ] Listed on Local Hydric Soils List
[ ] Listed on National Hydric Soils List
[ ] Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

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

Remarks:

DATA FORM

ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Mill Branch Mitigation Site			Date: 2/11/04
Applicant / Owner: J. P. Jones			County: Columbus
Investigator: Ryan Smith, Nancy Daly			State: NC
Do Normal Circumstances exist on the site?	YES	NO	Community ID: Wetland
Is the site significantly disturbed (Atypical Situation)?	YES	NO	Transect ID: Flags 201-222
Is the area a potential Problem Area? (If needed, explain on reverse)	YES	NO	Plot ID: Wetland 2

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1) *Liquidambar styraciflua*	Canopy	FAC+	9)		
2) *Acer rubrum*	Canopy	FACW-	10).		
3) *Lonicera japonica*	Vine	FAC-	11)		
4) *Asplenium playtneuron*	Herb	FACU	12)		
5) *Ligustrum sinense*	Shrub	FAC	13)		
6) *Quercus michauxii*	Canopy	FACW-			
7) *Liriodendron tulipifera*	Canopy	FACW			
8) Carex sp.	Grass	FAC			
Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-): 75%					
Remarks:					

HYDROLOGY

[ ] Recorded Data (Describe in Remarks)
- [ ] Stream, Lake, or Tide Guage
- [ ] Aerial Photographs
- [ ] Other

[X] No Recorded Data Available

FIELD OBSERVATIONS		
Depth of Surface Water	6	(in)
Depth of Free Water in Pit		(in)
Depth to Saturated Soil		(in)

WETLAND HYDROLOGY INDICATORS

Primary Indicators:
- [X] Inundated
- [X] Saturated in Upper 12 Inches
- [X] Water Marks
- [X] Drift Lines
- [X] Sediment Deposits
- [X] Drainage Patterns in Wetlands

Secondary Indicators (2 or more Required)
- [X] Oxidized Root Channels in Upper 12 inches
- [X] Water-stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase): Muckalee					Drainage Class: Poorly drained
Taxonomy (Subgroup): Typic Fluvaquents				Field Observations Confirm Mapped Type? YES NO	
PROFILE DESCRIPTION					
Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-6		10YR2/1			Silty loam
6-15		7.5YR3/1			Sandy loam

HYDRIC SOIL INDICATORS:

[ ] Histosol	[ ] Concretions
[ ] Histic Epipedon	[ ] High Organic Content in Surface Layer in Sandy Soils
[X] Sulfidic Odor	[ ] Organic Streaking in Sandy Soils
[X] Aquic Moisture Regime	[ ] Listed on Local Hydric Soils List
[X] Reducing Conditions	[ ] Listed on National Hydric Soils List
[X] Gleyed or Low-Chroma Colors	[ ] Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

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

Remarks:

DATA FORM

ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Mill Branch Mitigation Site			Date: 2/3/04
Applicant / Owner: J. P. Jones			County: Columbus
Investigator: Ryan Smith, Nancy Daly			State: NC
Do Normal Circumstances exist on the site?	YES	NO	Community ID: Upland
Is the site significantly disturbed (Atypical Situation)?	YES	NO	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse)	YES	NO	Plot ID: Upland 2

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1) *Festuca* spp.	Grass	FAC	9)		
2) Pinus taeda	Canopy	FAC	10).		
3)			11)		
4)			12)		
5)			13)		
6)					
7)					
8)					

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-): 100%

Remarks:

HYDROLOGY

[ ] Recorded Data (Describe in Remarks)
- [ ] Stream, Lake, or Tide Guage
- [ ] Aerial Photographs
- [ ] Other

[X] No Recorded Data Available

FIELD OBSERVATIONS		
Depth of Surface Water	N/A	(in)
Depth of Free Water in Pit	N/A	(in)
Depth to Saturated Soil	N/A	(in)

WETLAND HYDROLOGY INDICATORS

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more Required)
- [ ] Oxidized Root Channels in Upper 12 inches
- [ ] Water-stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase): Norfolk				Drainage Class: Well drained	
Taxonomy (Subgroup): Typic Paludults				Field Observations Confirm Mapped Type? YES NO	
PROFILE DESCRIPTION					
Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-8		10YR2/1			Loam
8-12		10YR6/3	10YR6/8	Common/Distinct	Sandy loam

HYDRIC SOIL INDICATORS:

[ ] Histosol
[ ] Histic Epipedon
[ ] Sulfidic Odor
[ ] Aquic Moisture Regime
[ ] Reducing Conditions
[ ] Gleyed or Low-Chroma Colors
[ ] Concretions
[ ] High Organic Content in Surface Layer in Sandy Soils
[ ] Organic Streaking in Sandy Soils
[ ] Listed on Local Hydric Soils List
[ ] Listed on National Hydric Soils List
[ ] Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

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

Remarks:

DATA FORM

ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Mill Branch Mitigation Site			Date: 2/11/04
Applicant / Owner: J. P. Jones			County: Columbus
Investigator: Ryan Smith, Nancy Daly			State: NC
Do Normal Circumstances exist on the site?	YES	NO	Community ID: Wetland cutover
Is the site significantly disturbed (Atypical Situation)?	YES	NO	Transect ID: Eastern portion Wetland 3
Is the area a potential Problem Area? (If needed, explain on reverse)	YES	NO	Plot ID: Wetland 3 cutover

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1) *Nyssa aquatica*	Canopy	OBL	9) *Ilex opaca*	Understory	FAC-
2) *Acer rubrum*	Canopy	FACW-	10).		
3) *Ilex coriacea*	Shrub	FACW	11)		
4) *Cyrilla racemiflora*	Shrub	FACW	12)		
5) *Persea borbonia*	Understory	FACW	13)		
6) Pinus taeda	Canopy	FAC			
7) *Liquidambar styraciflua*	Canopy	FAC+			
8) *Smilax* spp.	Vine	FACW+			
Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-): 89%					
Remarks:					

HYDROLOGY

[ ] Recorded Data (Describe in Remarks)
- [ ] Stream, Lake, or Tide Guage
- [ ] Aerial Photographs
- [ ] Other

[X] No Recorded Data Available

FIELD OBSERVATIONS		
Depth of Surface Water	12	(in)
Depth of Free Water in Pit		(in)
Depth to Saturated Soil		(in)

WETLAND HYDROLOGY INDICATORS

Primary Indicators:
- [X] Inundated
- [X] Saturated in Upper 12 Inches
- [X] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [X] Drainage Patterns in Wetlands

Secondary Indicators (2 or more Required)
- [ ] Oxidized Root Channels in Upper 12 inches
- [X] Water-stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase): Muckalee					Drainage Class: Poorly drained
Taxonomy (Subgroup): Typic Fluvaquents				Field Observations Confirm Mapped Type? YES NO	
PROFILE DESCRIPTION					
Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		2.5Y3/2			Muck
4-16		10YR4/1			Sandy loam

HYDRIC SOIL INDICATORS:

[ ] Histosol	[ ] Concretions
[ ] Histic Epipedon	[ ] High Organic Content in Surface Layer in Sandy Soils
[ ] Sulfidic Odor	[ ] Organic Streaking in Sandy Soils
[X] Aquic Moisture Regime	[ ] Listed on Local Hydric Soils List
[X] Reducing Conditions	[ ] Listed on National Hydric Soils List
[X] Gleyed or Low-Chroma Colors	[ ] Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

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

Remarks:
Wetland swamp forest community was clear cut in the last 5-10 years.

DATA FORM

ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Mill Branch Mitigation Site			Date: 2/11/04
Applicant / Owner: J. P. Jones			County: Columbus
Investigator: Ryan Smith, Nancy Daly			State: NC
Do Normal Circumstances exist on the site?	YES	NO	Community ID: Upland (cutover)
Is the site significantly disturbed (Atypical Situation)?	YES	NO	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse)	YES	NO	Plot ID: Upland 3 (cutover)

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1) *Festuca* spp.	Grass	FAC	9)		
2)			10).		
3)			11)		
4)			12)		
5)			13)		
6)					
7)					
8)					

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-): 100%

Remarks:
Agricultural field.

HYDROLOGY

[ ] Recorded Data (Describe in Remarks)
- [ ] Stream, Lake, or Tide Guage
- [ ] Aerial Photographs
- [ ] Other

[X] No Recorded Data Available

FIELD OBSERVATIONS		
Depth of Surface Water	N/A	(in)
Depth of Free Water in Pit	N/A	(in)
Depth to Saturated Soil	N/A	(in)

WETLAND HYDROLOGY INDICATORS

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more Required)
- [ ] Oxidized Root Channels in Upper 12 inches
- [ ] Water-stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase): Muckalee				Drainage Class: Well drained	
Taxonomy (Subgroup): Typic Fluvaquents				Field Observations Confirm Mapped Type? YES NO	
PROFILE DESCRIPTION					
Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-5		7.5YR3/2			Loamy sand
5-12		10YR3/2			Sandy loam
12+		10YR7/3			Sand

HYDRIC SOIL INDICATORS:

[ ] Histosol	[ ] Concretions
[ ] Histic Epipedon	[ ] High Organic Content in Surface Layer in Sandy Soils
[ ] Sulfidic Odor	[ ] Organic Streaking in Sandy Soils
[ ] Aquic Moisture Regime	[ ] Listed on Local Hydric Soils List
[ ] Reducing Conditions	[ ] Listed on National Hydric Soils List
[ ] Gleyed or Low-Chroma Colors	[ ] Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

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

Remarks:

DATA FORM

ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Mill Branch Mitigation Site			Date: 2/11/04
Applicant / Owner: J. P. Jones			County: Columbus
Investigator: Ryan Smith, Nancy Daly			State: NC
Do Normal Circumstances exist on the site?	YES	NO	Community ID: Wetland forested
Is the site significantly disturbed (Atypical Situation)?	YES	NO	Transect ID: Western portion Wetland 3
Is the area a potential Problem Area? (If needed, explain on reverse)	YES	NO	Plot ID: Wetland 3 forested

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1) *Nyssa aquatica*	Canopy	OBL	9) *Ligustrum sinense*	Shrub	FAC
2) *Acer rubrum*	Canopy	FACW-	10).		
3) *Ilex opaca*	Understory	FAC-	11)		
4) *Symplocos tinctoria*	Understory	FAC	12)		
5) *Liriodendron tulipifera*	Canopy	FACW	13)		
6) *Pinus taeda*	Canopy	FAC			
7) *Liquidambar styraciflua*	Canopy	FAC+			
8) *Quercus nigra*	Canopy	FAC			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-): 89%

Remarks:

HYDROLOGY

[ ] Recorded Data (Describe in Remarks)
- [ ] Stream, Lake, or Tide Guage
- [ ] Aerial Photographs
- [ ] Other

[X] No Recorded Data Available

FIELD OBSERVATIONS		
Depth of Surface Water	6	(in)
Depth of Free Water in Pit		(in)
Depth to Saturated Soil		(in)

WETLAND HYDROLOGY INDICATORS

Primary Indicators:
- [X] Inundated
- [X] Saturated in Upper 12 Inches
- [X] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [X] Drainage Patterns in Wetlands

Secondary Indicators (2 or more Required)
- [X] Oxidized Root Channels in Upper 12 inches
- [X] Water-stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase): Muckalee				Drainage Class: Poorly drained	
Taxonomy (Subgroup): Typic Fluvaquents				Field Observations Confirm Mapped Type? YES NO	
PROFILE DESCRIPTION					
Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10YR3/1			Silty clay loam
4-12		10YR4/1			Silty clay loam
12-15		10YR6/2	7.5YR5/8	Prominent/Abundant	Silty clay loam

HYDRIC SOIL INDICATORS:

[ ] Histosol	[ ] Concretions
[ ] Histic Epipedon	[ ] High Organic Content in Surface Layer in Sandy Soils
[ ] Sulfidic Odor	[ ] Organic Streaking in Sandy Soils
[X] Aquic Moisture Regime	[ ] Listed on Local Hydric Soils List
[X] Reducing Conditions	[ ] Listed on National Hydric Soils List
[X] Gleyed or Low-Chroma Colors	[ ] Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

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

Remarks:

DATA FORM

ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Mill Branch Mitigation Site			Date: 2/11/04
Applicant / Owner: J. P. Jones			County: Columbus
Investigator: Ryan Smith, Nancy Daly			State: NC
Do Normal Circumstances exist on the site?	YES	NO	Community ID: Upland (forested)
Is the site significantly disturbed (Atypical Situation)?	YES	NO	Transect ID:
Is the area a potential Problem Area? (If needed, explain on reverse)	YES	NO	Plot ID: Upland 3 (forested)

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1) *Ilex opaca*	Understory	FAC-	9)		
2) *Liriodendron tulipifera*	Canopy	FAC	10).		
3) *Vitis rotundifolia*	Vine	FAC	11)		
4) *Prunus serotina*	Understory	FACU	12)		
5) *Smilax rotundifolia*	Vine	FAC	13)		
6) *Symplocos tinctoria*	Understory	FAC			
7) *Ligustrum sinense*	Shrub	FAC			
8) *Acer rubrum*	Canopy	FACW-			
Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-): 75%					
Remarks:					

HYDROLOGY

[ ] Recorded Data (Describe in Remarks)
- [ ] Stream, Lake, or Tide Guage
- [ ] Aerial Photographs
- [ ] Other

[X] No Recorded Data Available

FIELD OBSERVATIONS		
Depth of Surface Water	N/A	(in)
Depth of Free Water in Pit	N/A	(in)
Depth to Saturated Soil	N/A	(in)

WETLAND HYDROLOGY INDICATORS

Primary Indicators:
- [ ] Inundated
- [ ] Saturated in Upper 12 Inches
- [ ] Water Marks
- [ ] Drift Lines
- [ ] Sediment Deposits
- [ ] Drainage Patterns in Wetlands

Secondary Indicators (2 or more Required)
- [ ] Oxidized Root Channels in Upper 12 inches
- [ ] Water-stained Leaves
- [ ] Local Soil Survey Data
- [ ] FAC-Neutral Test
- [ ] Other (Explain in Remarks)

SOILS

Map Unit Name (Series and Phase): Goldsboro					Drainage Class: Moderately well
Taxonomy (Subgroup): Aquic Paleudults				Field Observations Confirm Mapped Type? YES NO	
PROFILE DESCRIPTION					
Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-5		10YR2/1			Sandy loam
5-10		10YR5/2			Sandy loam
10-15		10YR6/6			Sandy loam

HYDRIC SOIL INDICATORS:

[ ] Histosol	[ ] Concretions
[ ] Histic Epipedon	[ ] High Organic Content in Surface Layer in Sandy Soils
[ ] Sulfidic Odor	[ ] Organic Streaking in Sandy Soils
[ ] Aquic Moisture Regime	[ ] Listed on Local Hydric Soils List
[ ] Reducing Conditions	[ ] Listed on National Hydric Soils List
[ ] Gleyed or Low-Chroma Colors	[ ] Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

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

Remarks:

APPENDIX C

Agency Response Letter

NCDENR

North Carolina Department of Environment and Natural Resources
Division of Parks and Recreation

Michael F. Easley, Governor | William G. Ross, Jr., Secretary | Philip K. McKnelly, Director

September 16, 2002

Mr. Ryan Smith
Stantec Consulting Services Inc
801 Jones Franklin Road, Suite 300
Raleigh, NC 27606

Subject: Mill Branch Stream Restoration Feasibility Study; Columbus County

Dear Mr. Smith:

The Natural Heritage Program has no record of rare species, significant natural communities, or priority natural areas at the site nor within a mile of the site.

You may wish to check the Natural Heritage Program database website at <www.ncsparks.net/nhp/search.html> for a listing of rare plants and animals and significant natural communities in the county and on the topographic quad map. Please do not hesitate to contact me at 919-715-8687 if you have questions or need further information.

Sincerely,

Harry E. LeGrand Jr.

Harry E. LeGrand, Jr., Zoologist
Natural Heritage Program

HEL/hel

1615 Mail Service Center, Raleigh, North Carolina 27699-1615
Phone: 919-733-4181 \ Fax: 919-715-3085 \ Internet: www.ncsparks.net

APPENDIX D

UT to Hog Swamp Stream Information

Straight reach located along longitudinal profile.

Pool cross section.

Debris jam located in channel.

Meander bends within channel.

R i e cross section.

Pool located along upstream portion of profile.

Appendix D. Existing Conditions along UT to Hog Swamp

Existing Data

Basin:	LUMBER RIVER (03040203)	Channel Slope:	0.68 %
Reach:	UT to Hog Swamp	Stream Length:	187 ft
Observers:	RS, KM, ND	Valley Length:	151 ft
Channel Type:	E5	Sinousity:	1.24
Drainage Area (sq mi):	0.08	Meander Length:	12.0 - 70.0 ft
		Belt Width:	5.7 - 16.0 ft
		Radius of Curvature:	4.4 - 45.6 ft

Longitudinal Data

Station	Elevation Streambed	Elevation Water Surface	High Bench	Bankfull	Top of Bank	Station	Elevation Streambed	Elevation Water Surface	High Bench	Bankfull	Top of Bank
0	94.28	94.44			95.5	105.90	93.51	93.77			
3	94.22	94.44				107.00	93.57	93.77	94.22	94.55	94.55
4	94.17	94.44				117.70	93.53	93.75			
6.6	94.26	94.44				118.80	93.24	93.74			
10	94.24	94.42				121.30	93.48	93.74			
12.8	94.15	94.40		95.14	95.14	130.00	93.55	93.74	94.08	94.52	94.52
13.8	94.16	94.40				132.80	93.40	93.56			
15.5	94.08	94.39				139.00	93.22	93.47			
17.3	94.07	94.39	94.76		95.55	144.70	93.11	93.44			
18.3	94.16	94.39				147.40	93.11	93.44			
19	93.98	94.39				149.00	93.17	93.43		93.99	93.99
19.4	94.17	94.38				152.80	93.12	93.36		93.97	93.97
24.3	94.15	94.36	94.52		95.49	157.00	93.07	93.35			
32.5	94.11	94.32				159.00	93.01	93.35			
34.7	94.12	94.31				159.20	93.13	93.33			
38.6	93.86	94.31				161.80	93.06	93.30			
40.3	93.97	94.30				162.60	92.96	93.31			
42	94.16	94.27				167.40	92.91	93.28	93.60		93.60
42.8	93.92	94.27				169.60	93.02	93.27			
43.2	93.97	94.26				187.00	93.01	93.17	93.63	93.63	93.63
45.6	94.15	94.26	94.43		95.29						
46.4	94.09	94.25									
47	93.88	94.26									
47.4	93.96	94.26									
48.6	94.02	94.26	94.44	95.05	95.05						
57	93.98	94.22	94.42	94.82	94.82						
60.8	93.95	94.18									
62.2	93.93	94.19									
63	93.85	94.19									
68.3	93.98	94.18	94.47		94.47						
72.2	94.00	94.18									
74	94.03	94.15	94.29	94.88	94.88						
76.1	93.97	94.14									
79	93.80	94.09									
80	93.61	94.07									
81.3	93.61	94.08									
83.7	93.80	94.08									
85.3	93.83	94.08									
86	93.79	93.95									
88.4	93.74	93.91	94.16	94.74	94.74						
90.2	93.55	93.85									
96.2	93.65	93.80	94.17		94.88						
97.5	93.57	93.78									
98.2	93.54	93.79									
100.5	93.46	93.79									
104	93.46	93.78									

Existing Data

Basin:	LUMBER RIVER (03040203)
Reach:	UT to Hog Swamp
Observers:	RS, KM, ND
Channel Type:	E5
Drainage Area (sq mi):	0.08

Riffle -Station 132.8

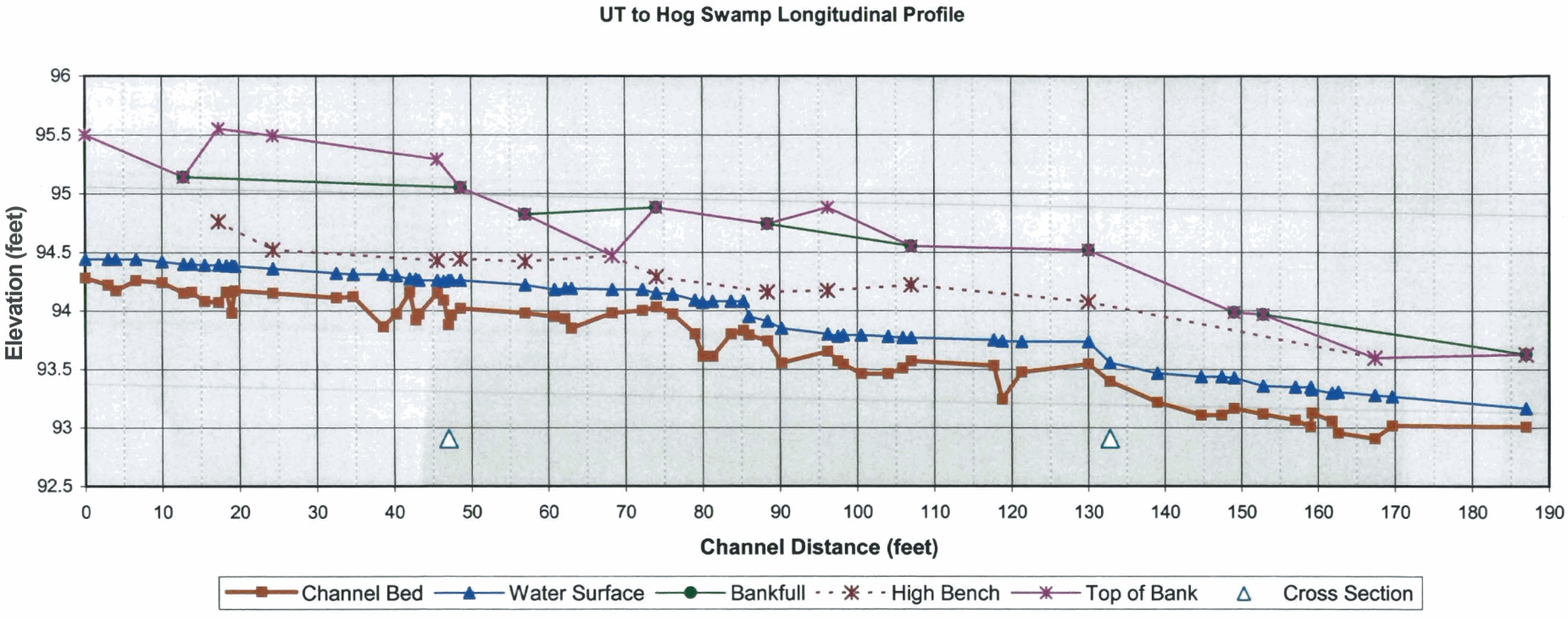
Station	Elevation
0	96.29
15.3	96.09
21	95.67
26.5	95.62
33	95.89
39.3	95.56
43.4	95.66
43.7	95.55
44	95.35
44.1	95.13
44.25	94.92
44.5	94.87
44.9	94.81
45	94.77
45.2	94.74
45.7	94.74
46	94.83
46.3	94.91
46.6	94.99
46.8	95.12
47	95.25
47.4	95.35
47.6	95.46
48	95.56
48.6	95.76

Bankfull Area	1.8	sq.ft
Bankfull Width	3.8	ft
Max depth	0.7	ft
Mean depth	0.5	ft
Width/Depth Ratio	7.9	
Flood Prone Width	100.0	ft
Entrenchment Ratio	26.6	

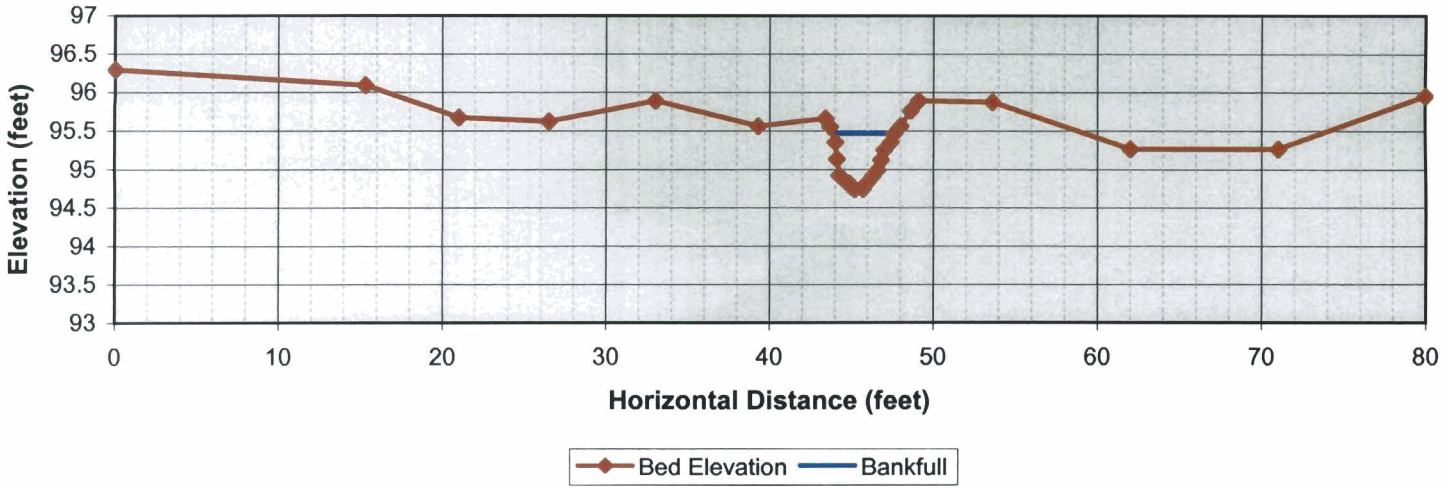
Pool - Station 47

Station	Elevation
0	95.46
17.3	95.32
19	95.03
19.7	94.61
19.9	94.27
20.5	94.16
21.2	94.055
21.5	93.95
21.9	93.85
22.2	93.86
22.6	93.73
22.9	93.81
23	93.98
23.1	94.22
23.5	94.5
24	95.05
24.8	95.14
34	95.77
45	95.89

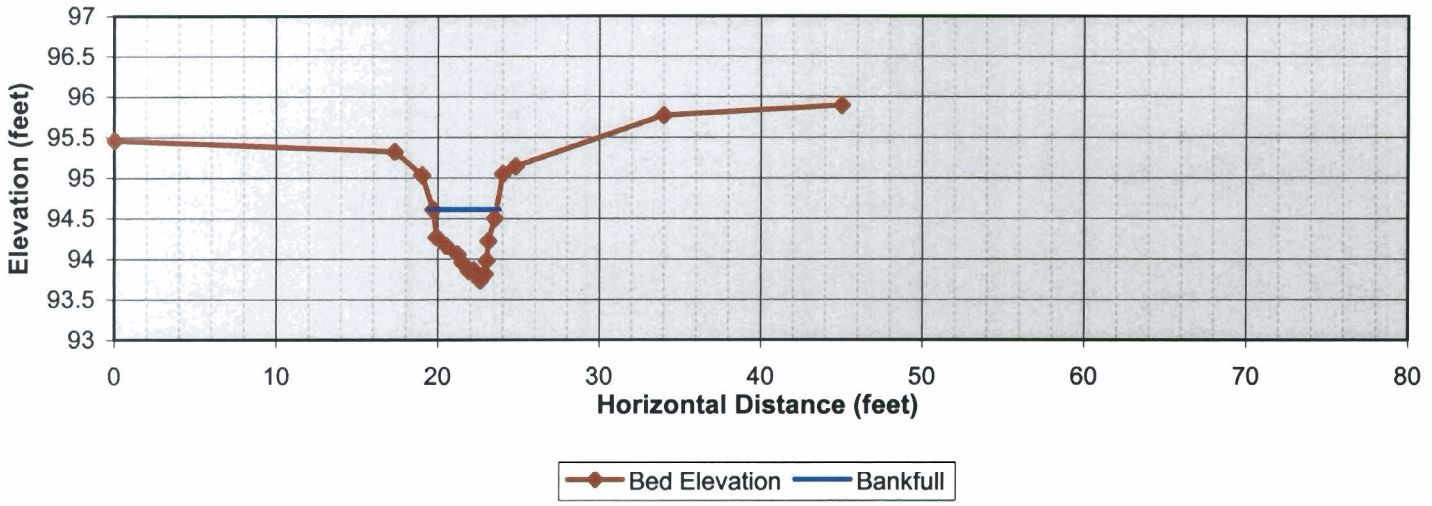
Bankfull Area	2.1	sq.ft
Bankfull Width	3.8	ft
Max depth	0.9	ft
Mean depth	0.6	ft


UT to Hog Swamp Longitudinal Profile
Elevation (feet)
96
95.5
95
94.5
94
93.5
93
92.5
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
Channel Distance (feet)
Channel Bed
Water Surface
Bankfull
High Bench
Top of Bank
Cross Section

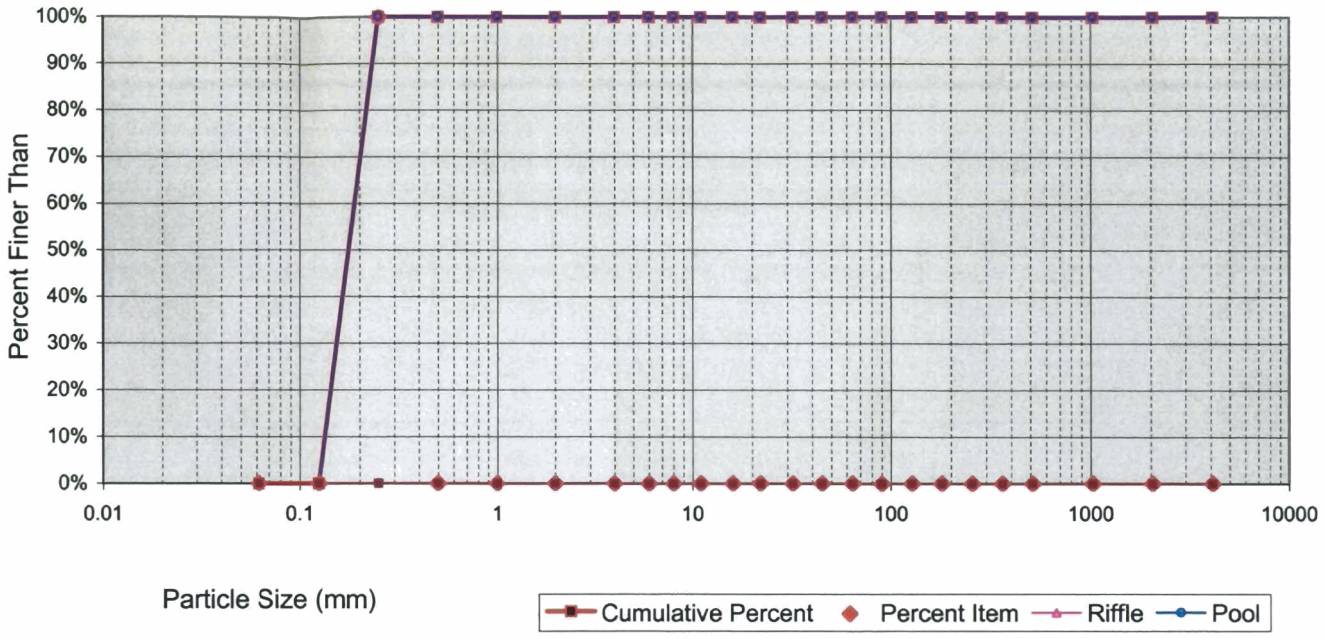
UT to Hog Swamp Riffle Cross Section



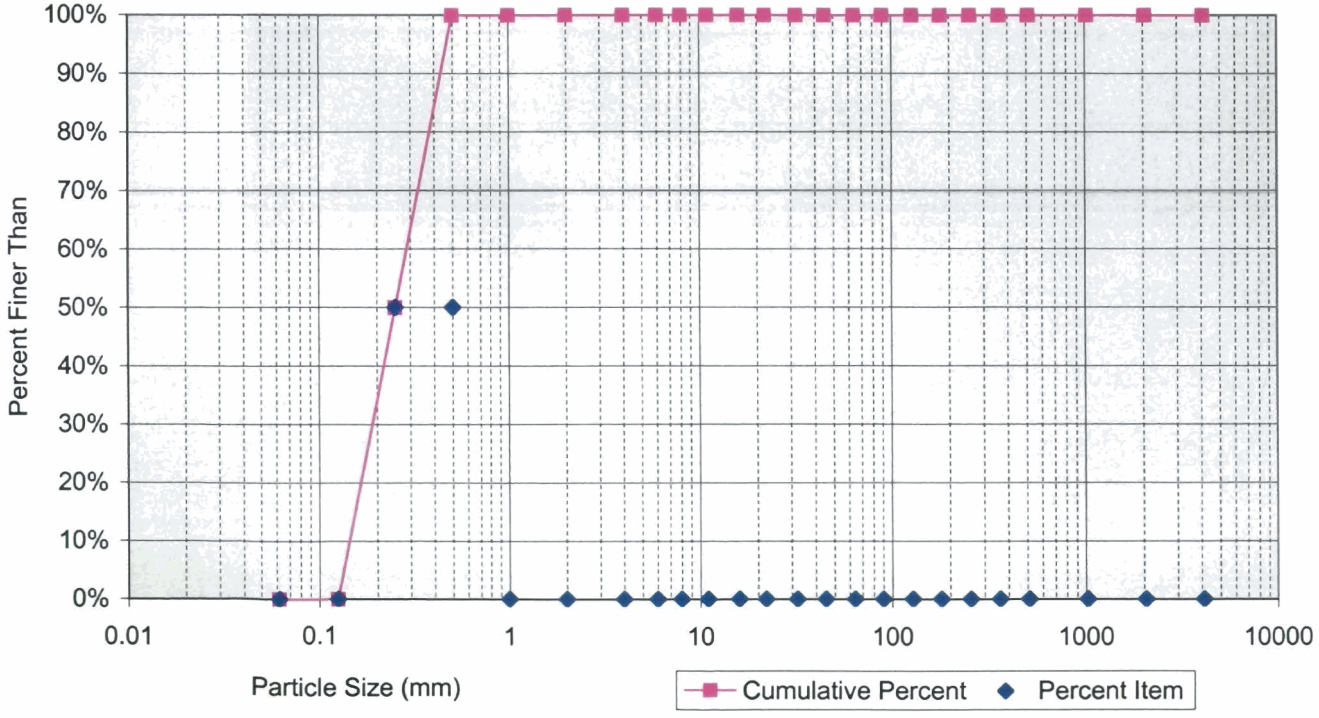
UT to Hog Swamp Pool Cross Section



UT to Hog Swamp Cumulative Pebble Count



UT to Hog Swamp Pebble Count
Riffle Cross Section



NCDWQ Stream Classification Form **S500**

Project Name: Hog Swamp River Basin: Lumber County: Robeson Evaluators: R. Smith, N. Daly, K. McKeithan

DWQ Project Number: N/A Nearest Named Stream: Hog Swamp Latitude: 34°28'19.39"N Signature:

Date: 3/9/04 USGS QUAD: Farimont Longitude: 79°04'40.54W

Location/Directions: UT to Hog Swamp located west of SR 2225

PLEASE NOTE:** ***If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used*

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Riffle-Pool Sequence?	0	1	2	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	1	2	3
3) Are Natural Levees Present?	0	1	2	3
4) Is The Channel Sinuous?	0	1	2	3
5) Is There An Active (Or Relic) Floodplain Present?	0	1	2	3
6) Is The Channel Braided?	0	1	2	3
7) Are Recent Alluvial Deposits Present?	0	1	2	3
8) Is There A Bankfull Bench Present?	0	1	2	3
9) Is A Continuous Bed & Bank Present?	0	1	2	3

*(*NOTE: If Bed & Bank Caused By Ditching And WITHOUT Sinuosity Then Score=0*)*

10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map *And/Or* In Field) Present? *Yes*=3 *No*=0

PRIMARY GEOMORPHOLOGY INDICATOR POINTS: 18

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is There A Groundwater Flow/Discharge Present?	0	1	2	3

PRIMARY HYDROLOGY INDICATOR POINTS: 2

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fibrous Roots Present In Streambed?	3	2	1	0
2) Are Rooted Plants Present In Streambed?	3	2	1	0
3) Is Periphyton Present?	0	1	2	3
4) Are Bivalves Present?	0	1	2	3

PRIMARY BIOLOGY INDICATOR POINTS: 6

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	Absent	Weak	Moderate	Strong
1) Is There A Head Cut Present In Channel?	0	.5	1	1.5
2) Is There A Grade Control Point In Channel?	0	.5	1	1.5
3) Does Topography Indicate A Natural Drainage Way?	0	.5	1	1.5

SECONDARY GEOMORPHOLOGY INDICATOR POINTS: 2

II. Hydrology	Absent	Weak	Moderate	Strong
1) Is This Year's (Or Last's) Leaf litter Present In Streambed?	1.5	1	.5	0
2) Is Sediment On Plants (Or Debris) Present?	0	.5	1	1.5
3) Are Wrack Lines Present?	0	.5	1	1.5
4) Is Water In Channel *And* >48 Hrs. Since Last *Known* Rain? *(*NOTE: If Ditch Indicated In #9 Above Skip This Step And #5 Below*)*	0	.5	1	1.5
5) Is There Water In Channel During Dry Conditions *Or* In Growing Season)?	0	.5	1	1.5

6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)? *Yes*=1.5 *No*=0

SECONDARY HYDROLOGY INDICATOR POINTS: 6.5

III. Biology	Absent	Weak	Moderate	Strong
1) Are Fish Present?	0	.5	1	1.5
2) Are Amphibians Present?	0	.5	1	1.5
3) Are AquaticTurtles Present?	0	.5	1	1.5
4) Are Crayfish Present?	0	.5	1	1.5
5) Are Macrobenthos Present?	0	.5	1	1.5
6) Are Iron Oxidizing Bacteria/Fungus Present?	0	.5	1	1.5
7) Is Filamentous Algae Present?	0	.5	1	1.5

8) Are Wetland Plants In Streambed? N/A	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(NOTE: If Total Absence Of All Plants In Streambed As Noted Above Skip This Step UNLESS SAV Present*).*	2	1	.75	.5	0	0

SECONDARY BIOLOGY INDICATOR POINTS: 6

TOTAL POINTS (Primary + Secondary)= 40.5 *(If Greater Than Or Equal To 19 Points The Stream Is At Least Intermittent)*

Habitat Assessment Field Data Sheet
Coastal Plain Streams

Directions for use of this Assessment: The observer is to survey a minimum of 100 meters of stream, preferably in an upstream direction starting above the bridge pool and the road right-of-way. The stream segment which is assessed should represent average stream conditions. In order to perform a proper habitat evaluation the observer needs to get into the stream. All meter readings need to be performed prior to walking the stream. When working the habitat index, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. There are seven different metrics in this index and a final habitat score is determined by adding the results from the different metrics.

Stream UT to Hog Swamp Location/Road West of SR 2225 County Robeson Date 3/9/04
CC#_____ Subbasin_____ Basin Lumber
Observer(s): Katie McKeithan, Ryan Smith, Nancy Daly Office Location Raleigh Agency _____
Type of Study: Fish Benthos Basinwide Special Study (Describe) Reference Reach for Stream Restoration
Latitude 34°28'19.39"N Longitude 79°04'40.54W Ecoregion (circle one) CA CB Swamp Distance Surveyed 280 meters/ft

Physical Characterization: Land use refers to immediate area that you can see from sampling location - include what you see driving thru the watershed in the remarks section.

Land use: Forest 70 % Active Pasture_____% Active Crops_____% Fallow Fields_____% Commercial_____% Industrial_____% Residential 30 % Other _____%. Describe:_____

Width: (~~meters~~ ft) Stream 3.8 Channel_____ Average Stream Depth: (~~m~~) 0.4 ft Velocity 1.6 ~~m/sec~~ ft/sec

Flow conditions (circle one): High (Normal) Low

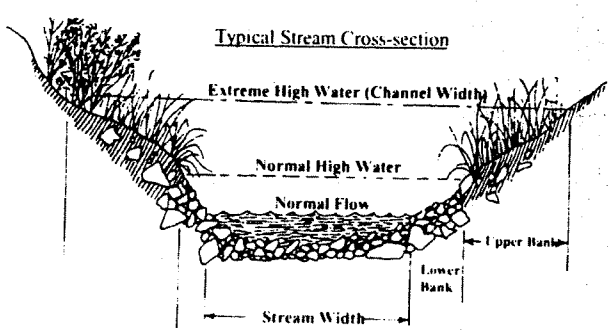
Manmade Stabilization: Y[ ] N[✓] Describe:_____

Water Quality: Temperature____°C Dissolved Oxygen ____mg/l Conductivity _____µmhos/cm pH ____

Turbidity: (circle) (Clear) Slightly Turbid Turbid Tannic

Weather Conditions: Sunny/Cool **Photo #**_____

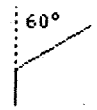
Remarks:_____



I. Channel Modification (Use topo map as an additional aid for this parameter)

	Natural Channel	Modified Channel
	Score	Score
A. Frequent bends		
1. bends > 60°	15	12
2. bends < 60°	(13)	10
B. Infrequent bends		
1. bends > 60°	11	7
2. bends < 60°	8	5

Remarks_____ Subtotal 13



II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover.

Circle the habitats which occur- **(Rocks) (Macrophytes) (sticks and leaf packs) (snags and logs) (undercut banks or root mats)** Definition: leafpacks consist of older leaves that are packed together and have begun to decay. Piles of leaves in pool areas are not considered leaf packs. EXAMPLE: If >70% of the reach is rocks, 1 type is present, circle the score of 17.

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>50%	30-50%	10-30%	<10%
	Score	Score	Score	Score
4 or 5 types present	20	16	12	8
3 types present	(19)	15	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

Remarks_____ Subtotal 19

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) look at entire reach for substrate scoring, but only look at riffle for embeddedness.

	Score
A. substrate types mixes	
1. gravel/rock dominant	15
2. sand dominant	13
3. detrirus dominant	7
4. silt/clay dominant	4
B. substrate homgeneous	
1. substrate nearly all gravel	12
2. substrate nearly all sand	(7)
3. substrate nearly all detritus	4
4. substrate nearly all silt/ clay	1

Remarks_____ Subtotal 7

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams.

	Score
A. Pools present	
1. Pools Frequent (>30% of 100m area surveyed)	
a. variety of pool sizes	10
b.pools same size	8 (9)
2. Pools Infrequent (<30% of the 100m area surveyed)	
a. variety of pool sizes	6
b.pools same size	4
B. Pools absent	
1. Runs present	3
2. Runs absent	0

Remarks_____ Total 9

V. Bank Stability and Vegetation

	Left Bank	Right Bank
A. Banks stable		
1. no evidence of erosion or bank failure, little potential for erosion	10	10
B. Erosion areas present		
1. diverse trees, shrubs, grass; plants healthy with good root systems	(9)	(9)
2. few trees or small trees and shrubs; vegetation appears generally healthy	7	7
3. sparse vegetation; plant types and conditions suggest poorer soil binding	4	4
4. mostly grasses, few if any trees and shrubs, high ersosion and failure potential at high flow	2	2
5. no bank vegetation, mass erosion and bank failure evident	0	0

Total 18 18

Remarks_____

VI. Light Penetration (Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead).

	Score
A. Stream with **good** shading with some breaks for light penetration	(10)
B. Stream with **full canopy** - breaks for light penetration absent	8
C. Stream with **partial** shading - sunlight and shading are essentially equa	7
D. Stream with **minimal** shading - full sun in all but a few areas	2
E. **No shading**	0

Remarks_____ 10

VII. Riparian Vegetative Zone Width

Definition: A break in the riparian zone is any area which allows sediment to enter the stream. Breaks refer to the near-stream portion of the riparian zone (banks); places where pollutants can directly enter the stream.

	Left Bank	Right Bank
A. Riparian zone **intact** (no breaks)		
1. zone width > 18 meters	5	5
2. zone width 12-18 meters	4	4
3. zone width 6-12 meters	3	3
4. zone width < 6 meters	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. zone width > 18 meters	(4)	(4)
b. zone width 12-18 meters	3	3
c. zone width 6-12 meters	2	2
d. zone width < 6 meters	1	1
2. breaks common		
a. zone width > 18 meters	3	3
b. zone width 12-18 meters	2	2
c. zone width 6-12 meters	1	1
d. zone width < 6 meters	0	0

Total 8

Remarks _____

TOTAL SCORE 84

COMMENTS, DRAWINGS:

Stream Visual Assessment Protocol

Owners name _____ Evaluator's name Ryan Smith, Katie McKeithan, Nancy Daly Date 3/9/04

Stream name UT to Hog Swamp Waterbody ID number 14-30-7

Reach location West of SR 2225 - Robeson County

Ecoregion Coastal Plain Drainage area 0.08 sq.mi Gradient 0.68% slope

Applicable reference site Reference Site for UT to Mill Branch

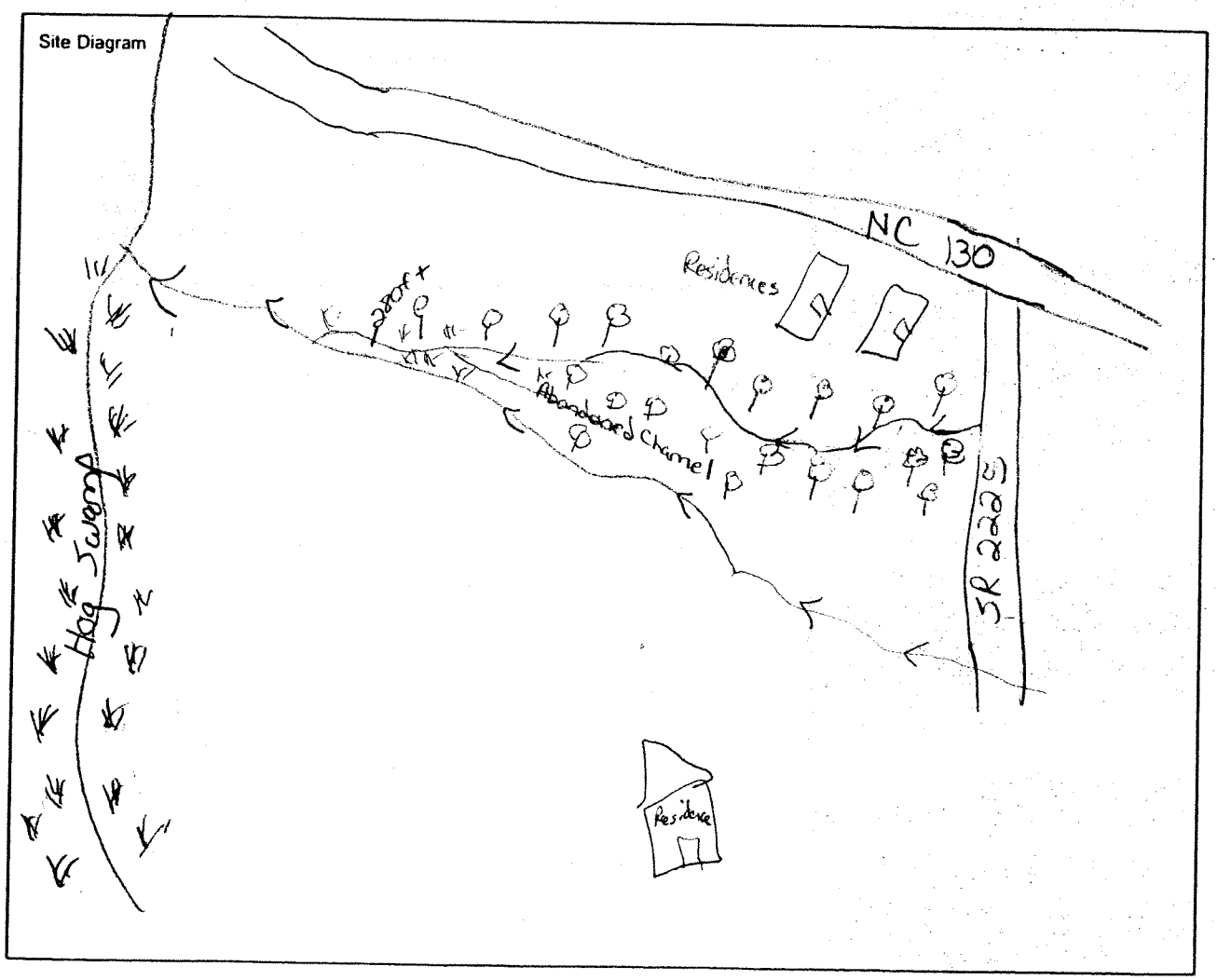
Land use within drainage (%): row crop 50 hayland _____ grazing/pasture _____ forest 35 residential 15

confined animal feeding operations _____ Cons. Reserve _____ industrial _____ Other: _____

Weather conditions-today Sunny/Cool Past 2-5 days _____

Active channel width 3.8 ft Dominant substrate: boulder _____ gravel _____ sand ✓ silt _____ mud _____

Site Diagram



Assessment Scores

Channel condition	9
Hydrologic alteration	10
Riparian zone	10
Bank stability	7
Water appearance	10
Nutrient enrichment	9
Barriers to fish movement	10
Instream fish cover	8

Pools	8
Invertebrate habitat	7

Score only if applicable

Canopy cover	8
Manure presence	
Salinity	
Riffle embeddedness	
Marcroinvertebrates Observed (optional)	

Overall score (Total divided by number scored)	8.7	<6.0	**Poor**
		6.1-7.4	**Fair**
		7.5-8.9	**Good**
		>9.0	**Excellent**

Suspected causes of observed problems_____

Recommendations_____

APPENDIX E

UT to Ironhill Branch Stream Information

Looking downstream along longitudinal profile.

Looking upstream along longitudinal profile.

Straight reach along profile.

Looking upstream. Riffle cross section in background.

Upstream extent of longitudinal profile.

Looking downstream along longitudinal profile.

Appendix E. Existing Conditions along UT to Ironhill Branch

Existing Data

Basin:	LUMBER RIVER (03040206)	Channel Slope:	0.20 %
Reach:	UT to Ironhill Branch	Stream Length:	271 ft
Observers:	RS, KM, ND	Valley Length:	208 ft
Channel Type:	C5	Sinousity:	1.30
Drainage Area (sq mi):	1.61	Meander Length:	46 ft
		Belt Width:	45 ft
		Radius of Curvature:	14.4 ft

Longitudinal Data

Station	Elevation Streambed	Elevation Water Surface	TOB / Bankfull
7	98.59	99.83	99.91
11.7	98.47	99.82	
25.5	98.19	99.82	
30	98.44	99.79	
33	98.41	99.79	
37.5	98.54	99.76	99.87
41	98.19	99.74	
46.2	97.81	99.66	
50	97.82	99.66	
54	97.79	99.65	
56	98.25	99.64	99.73
62	98.24	99.66	
68	98.53	99.63	
78	98.55	99.64	99.77
80	98.47	99.65	
81	98.25	99.64	
88	98.09	99.64	
91	98.36	99.62	
97	98.22	99.62	99.71
105	98.50	99.61	
113	98.41	99.60	
120	98.49	99.60	
128	98.35	99.59	
136	98.19	99.58	
142	98.18	99.57	99.57
152	97.92	99.55	
162	98.33	99.54	
171	98.47	99.49	
185	98.20	99.48	
193	98.30	99.45	
204	98.12	99.44	99.73
214	97.98	99.45	
221	98.11	99.44	
228	98.08	99.43	
237	97.98	99.40	
242	97.66	99.42	
245	98.12	99.39	
254	97.71	99.38	99.46
255.5	97.64	99.38	
257	98.02	99.36	
265	98.23	#N/A	
271	98.32	99.30	99.33

Existing Data

Basin:	LUMBER RIVER (03040206)
Reach:	UT to Ironhill Branch
Observers:	RS, KM, ND
Channel Type:	C5
Drainage Area (sq mi):	1.61

Riffle - Station 204

Station	Elevation
0	94.84
2.5	94.75
5	94.72
10	94.48
14	94.54
20	94.9
27	94.68
30	94.8
32	94.58
37	94.83
40.5	95.02
41.6	94.75
43	94.62
43.7	94.62
45	94.1
46	93.77
47.4	93.5
48.3	93.49
49.4	93.46
51	93.59
52.4	93.7
53.7	94.8
55	95.08
62	94.8
66.6	94.87

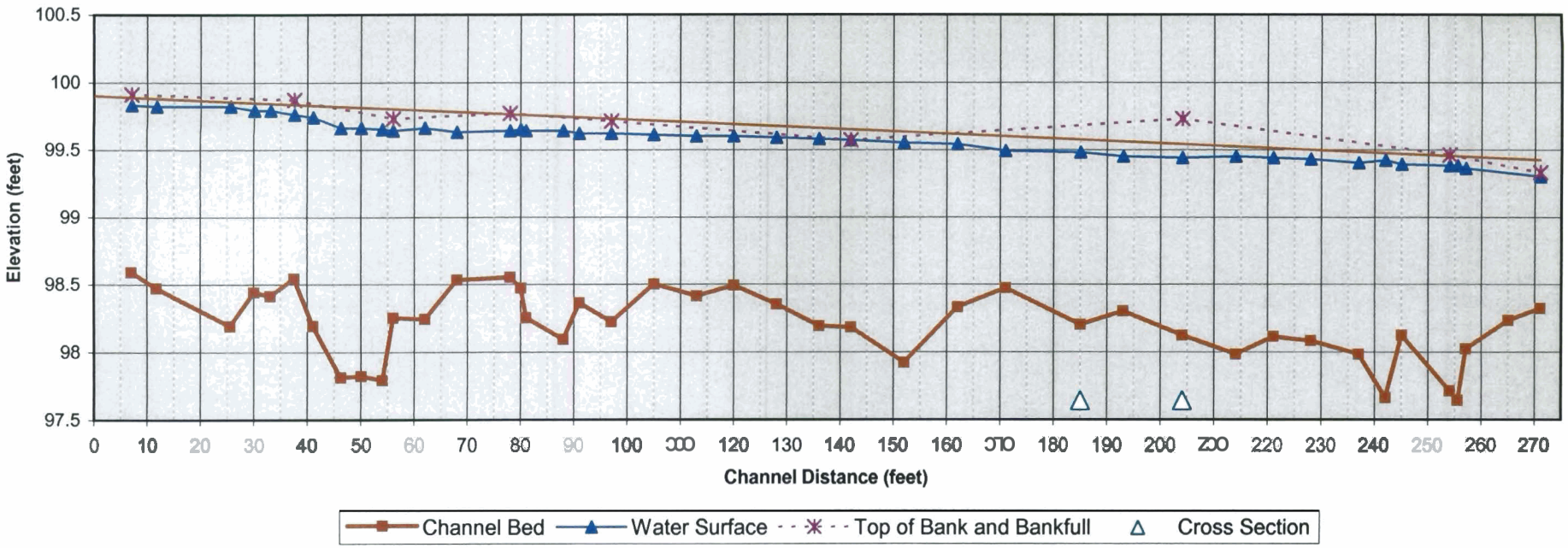
Bankfull Area	13.3 sq.ft
Bankfull Width	14.2 ft
Max depth	1.6 ft
Mean depth	0.9 ft
Width/Depth Ratio	15.2
Flood Prone Width	290.0 ft
Entrenchment Ratio	20.4

Pool - Station 185

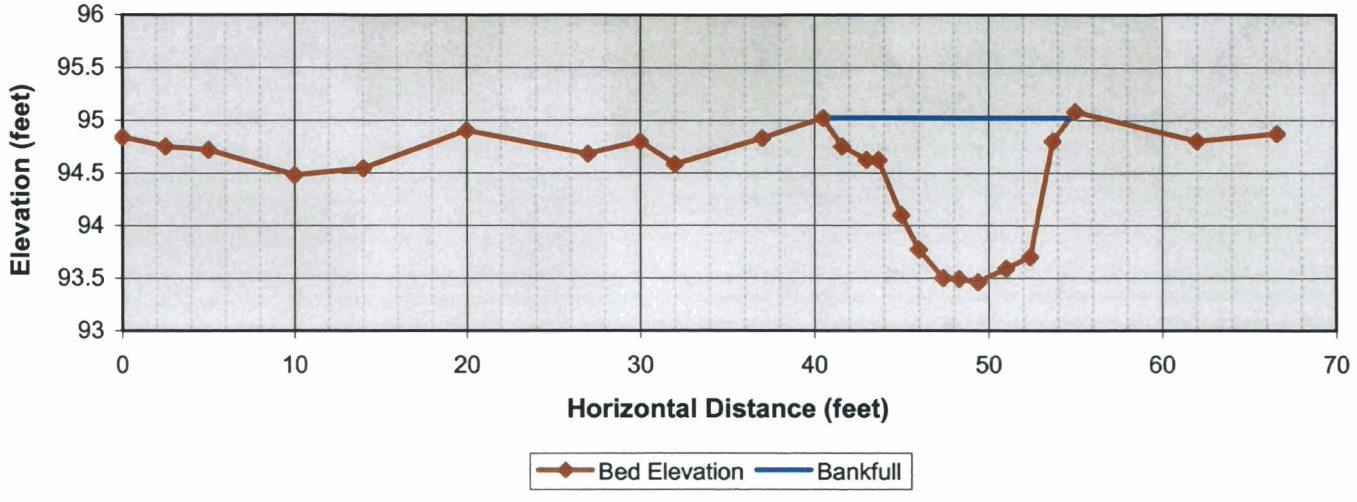
Station	Elevation
0	95.37
13	94.67
19	94.67
22.3	95.15
27.2	95.16
27.8	94.77
28	94.45
28.4	93.7
29.2	93.37
30.3	93.48
31.3	93.56
32.3	93.75
33.3	93.91
34	94
35.3	94.06
36.3	94.17
37.3	94.13
38.3	94.35
39.3	94.4
40.3	94.36
41.8	94.55
43.4	94.61
43.9	94.89
55.3	94.77

Bankfull Area	12.9 sq.ft
Bankfull Width	16.1 ft
Max depth	1.5 ft
Mean depth	0.8 ft

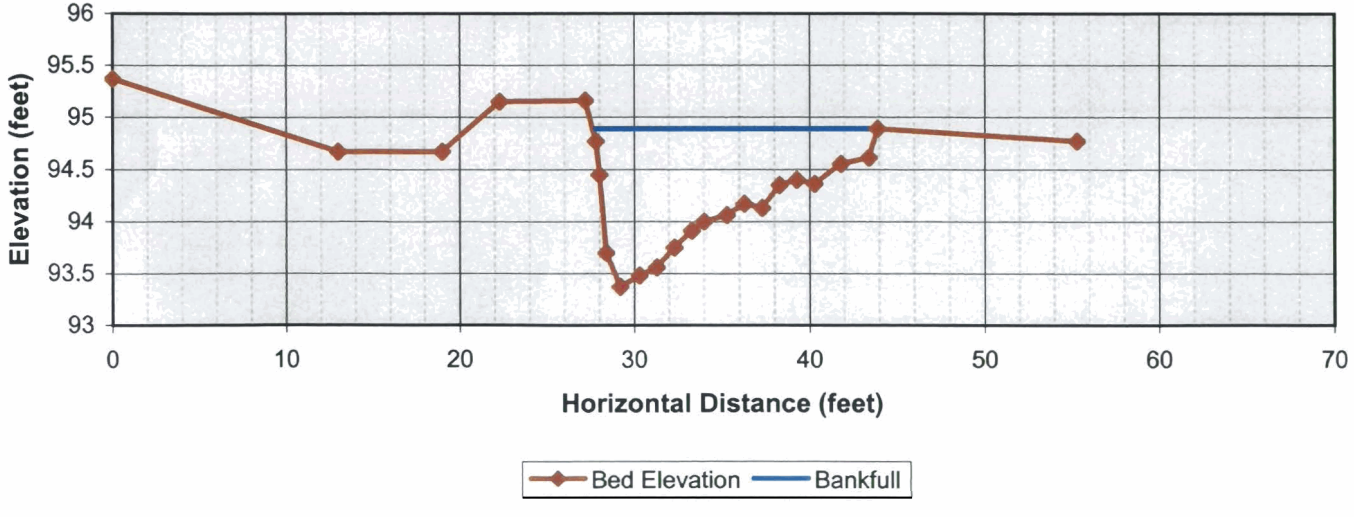
UT to Ironhill Branch Longitudinal Profile



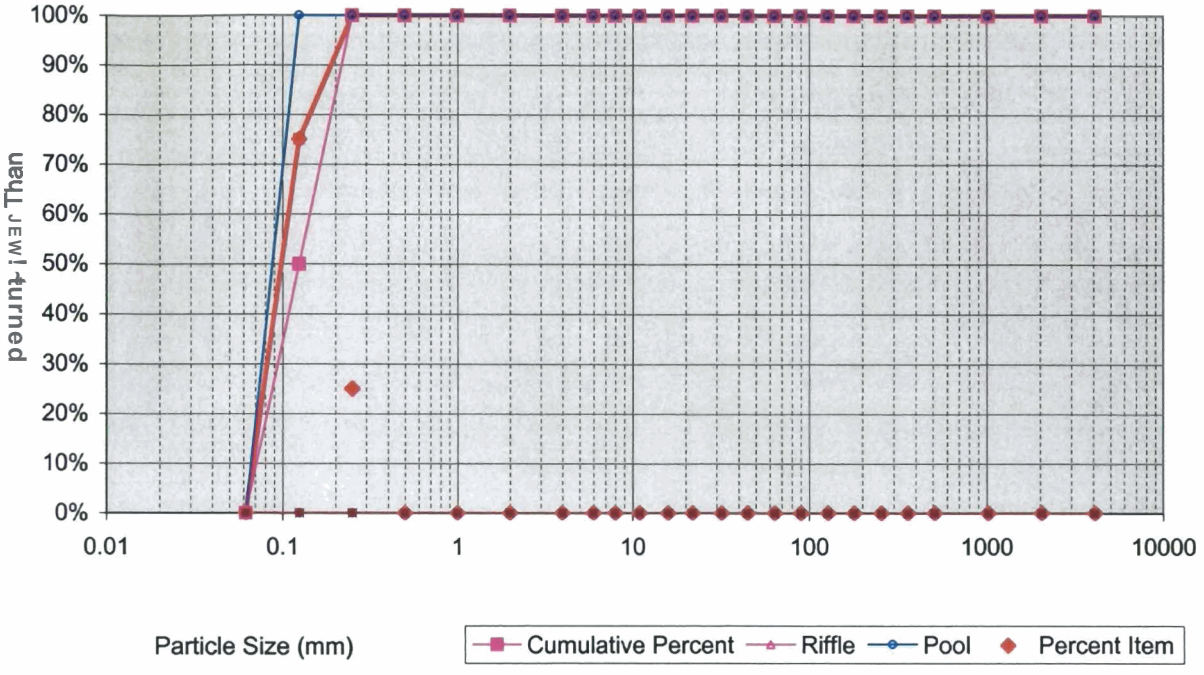
UT to Ironhill Branch Riffle Cross Section



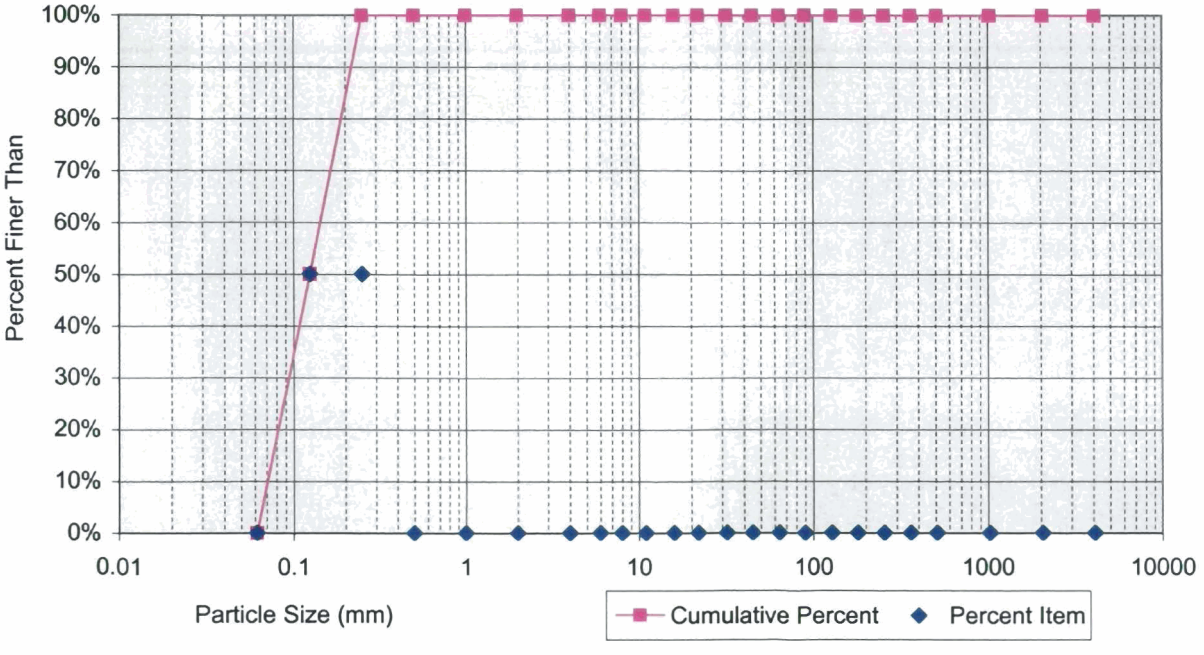
UT to Ironhill Branch Pool Cross Section



UT to Ironhill Branch Cumulative Pebble Count



UT to Ironhill Branch Pebble Count
Riffle Cross Section



NCDWQ Stream Classification Form **S500**

Project Name: Ironhill Branch River Basin: Lumber County: Columbus Evaluators: R. Smith, N. Daly, K. McKeithan

DWQ Project Number: N/A Nearest Named Stream: Ironhill Branch Latitude: 34°07'33.18" Signature:

Date: 2/20/03 USGS QUAD: Tabor City East Longitude: 78°48'55.13"W

Location/Directions: UT to Ironhill Branch located West of SR 1131

PLEASE NOTE:** ***If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used*

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Riffle-Pool Sequence?	0	1	**2**	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	1	2	**3**
3) Are Natural Levees Present?	**0**	1	2	3
4) Is The Channel Sinuous?	0	1	2	**3**
5) Is There An Active (Or Relic) Floodplain Present?	0	1	2	**3**
6) Is The Channel Braided?	0	**1**	2	3
7) Are Recent Alluvial Deposits Present?	0	1	2	**3**
8) Is There A Bankfull Bench Present?	0	1	2	**3**
9) Is A Continuous Bed & Bank Present?	0	1	2	**3**

*(*NOTE: If Bed & Bank Caused By Ditching And WITHOUT Sinuosity Then Score=0*)*

10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map *And/Or* In Field) Present? *Yes*=3 *No*=**0**

PRIMARY GEOMORPHOLOGY INDICATOR POINTS: **21**

II. Hydrology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Groundwater Flow/Discharge Present?	0	1	2	**3**

PRIMARY HYDROLOGY INDICATOR POINTS: **3**

III. Biology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Are Fibrous Roots Present In Streambed?	**3**	2	1	0
2) Are Rooted Plants Present In Streambed?	3	2	**1**	0
3) Is Periphyton Present?	**0**	1	2	3
4) Are Bivalves Present?	0	**1**	2	3

PRIMARY BIOLOGY INDICATOR POINTS: **5**

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Head Cut Present In Channel?	**0**	.5	1	1.5
2) Is There A Grade Control Point In Channel?	0	.5	**1**	1.5
3) Does Topography Indicate A Natural Drainage Way?	0	.5	1	**1.5**

SECONDARY GEOMORPHOLOGY INDICATOR POINTS: **2.5**

II. Hydrology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is This Year's (Or Last's) Leaf litter Present In Streambed?	1.5	**1**	.5	0
2) Is Sediment On Plants (Or Debris) Present?	0	.5	1	**1.5**
3) Are Wrack Lines Present?	0	.5	1	**1.5**
4) Is Water In Channel *And* >48 Hrs. Since Last *Known* Rain? *(*NOTE: If Ditch Indicated In #9 Above Skip This Step And #5 Below*)*	0	.5	**1**	1.5
5) Is There Water In Channel During Dry Conditions *Or* In Growing Season)?	0	.5	**1**	1.5

6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)? *Yes*=**1.5** *No*=0

SECONDARY HYDROLOGY INDICATOR POINTS: **7.5**

III. Biology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Are Fish Present?	0	.5	**1**	1.5
2) Are Amphibians Present?	0	.5	**1**	1.5
3) Are AquaticTurtles Present?	0	**.5**	1	1.5
4) Are Crayfish Present?	0	.5	**1**	1.5
5) Are Macrobenthos Present?	0	.5	**1**	1.5
6) Are Iron Oxidizing Bacteria/Fungus Present?	0	**.5**	1	1.5
7) Is Filamentous Algae Present?	0	**.5**	1	1.5

8) Are Wetland Plants In Streambed? N/A	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(NOTE: If Total Absence Of All Plants In Streambed As Noted Above Skip This Step UNLESS SAV Present*).*	2	**1**	.75	.5	0	0

SECONDARY BIOLOGY INDICATOR POINTS: **6.5**

TOTAL POINTS (Primary + Secondary)= **45.5** *(If Greater Than Or Equal To 19 Points The Stream Is At Least Intermittent)*

Habitat Assessment Field Data Sheet
Coastal Plain Streams

Directions for use of this Assessment: The observer is to survey a minimum of 100 meters of stream, preferably in an upstream direction starting above the bridge pool and the road right-of-way. The stream segment which is assessed should represent average stream conditions. In order to perform a proper habitat evaluation the observer needs to get into the stream. All meter readings need to be performed prior to walking the stream. When working the habitat index, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. There are seven different metrics in this index and a final habitat score is determined by adding the results from the different metrics.

Stream UT to Ironhill Branch Location/Road West of SR 1131 County Columbus Date 2/20/04
CC# _____ Subbasin 3-7-57 Basin Lumber

Observer(s): Ryan Smith, Katie McKeithan, Nancy Daly Office Location Raleigh Agency —

Type of Study: Fish Benthos Basinwide Special Study (Describe) Reference Reach for Stream Restoration ≈ 300 ft

Latitude _____ Longitude _____ Ecoregion (circle one) CA CB Swamp Distance Surveyed ____ meters
34°07'33.18N 78°48'55.13W

Physical Characterization: Land use refers to immediate area that you can see from sampling location - include what you see driving thru the watershed in the remarks section.

Land use: Forest 100 % Active Pasture _____ % Active Crops _____ % Fallow Fields _____ % Commercial _____ %
Industrial _____ % Residential _____ % Other _____ %. Describe: _____

Width: (~~meters~~ feet) Stream 142 Channel _____ Average Stream Depth: (~~m~~) 0.9 ft Velocity 1.8 ~~m/sec~~ ft/sec

Flow conditions (circle one): High Normal Low (Bankfull)

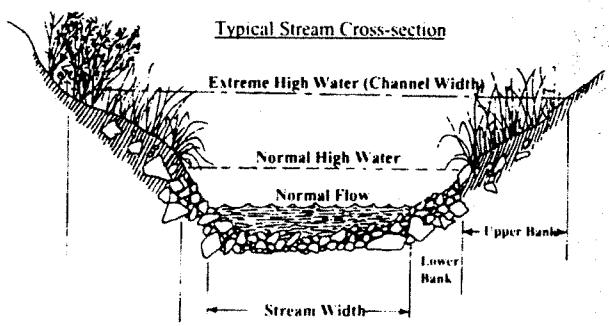
Manmade Stabilization: Y[ ] N[✓] Describe: _____

Water Quality: Temperature ____ °C Dissolved Oxygen ____ mg/l Conductivity _____ µmhos/cm pH _____

Turbidity: (circle) (Clear) Slightly Turbid Turbid Tannic

Weather Conditions: Sunny/Cool **Photo #** _____

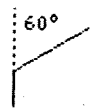
Remarks: Scattered agricultural fields throughout watershed. Recent ice storm resulted in many downed trees.



I. Channel Modification (Use topo map as an additional aid for this parameter)

	Natural Channel Score	Modified Channel Score
A. Frequent bends		
1. bends > 60°	15	12
2. bends < 60°	(13)	10
B. Infrequent bends		
1. bends > 60°	11	7
2. bends < 60°	8	5

Remarks_____ Subtotal 13



II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover.

Circle the habitats which occur- **(Rocks) (Macrophytes) (sticks and leaf packs) (snags and logs) (undercut banks or root mats)** Definition: leafpacks consist of older leaves that are packed together and have begun to decay. Piles of leaves in pool areas are not considered leaf packs. EXAMPLE: If >70% of the reach is rocks, 1 type is present, circle the score of 17.

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>50% Score	30-50% Score	10-30% Score	<10% Score
4 or 5 types present	20	16	12	8
3 types present	(19)	15	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

Remarks_____ Subtotal 19

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) look at entire reach for substrate scoring, but only look at riffle for embeddedness.

	Score
A. substrate types mixes	
1. gravel/rock dominant	15
2. sand dominant	13
3. detrirus dominant	7
4. silt/clay dominant	4
B. substrate homgeneous	
1. substrate nearly all gravel	12
2. substrate nearly all sand	(7)
3. substrate nearly all detritus	4
4. substrate nearly all silt/ clay	1

Remarks_____ Subtotal 7

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams.

	Score
A. Pools present	
1. Pools Frequent (>30% of 100m area surveyed)	
a. variety of pool sizes	(10)
b.pools same size	8
2. Pools Infrequent (<30% of the 100m area surveyed)	
a. variety of pool sizes	(6)
b.pools same size	4
B. Pools absent	
1. Runs present	3
2. Runs absent	0

Remarks_____ Total 10

V. Bank Stability and Vegetation

	Left Bank	Right Bank
A. Banks stable		
1. no evidence of erosion or bank failure, little potential for erosion	10	10
B. Erosion areas present		
1. diverse trees, shrubs, grass; plants healthy with good root systems	(9)	(9)
2. few trees or small trees and shrubs; vegetation appears generally healthy	7	7
3. sparse vegetation; plant types and conditions suggest poorer soil binding	4	4
4. mostly grasses, few if any trees and shrubs, high ersosion and failure potential at high flow	2	2
5. no bank vegetation, mass erosion and bank failure evident	0	0

Total_____

Remarks_____ 18

VI. Light Penetration (Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead).

	Score
A. Stream with **good** shading with some breaks for light penetration	(10)
B. Stream with **full canopy** - breaks for light penetration absent	8
C. Stream with **partial** shading - sunlight and shading are essentially equa	7
D. Stream with **minimal** shading - full sun in all but a few areas	2
E. **No shading**	0

Remarks_____ 10

VII. Riparian Vegetative Zone Width

Definition: A break in the riparian zone is any area which allows sediment to enter the stream. Breaks refer to the near-stream portion of the riparian zone (banks): places where pollutants can directly enter the stream.

	Left Bank	Right Bank
A. Riparian zone **intact** (no breaks)		
1. zone width > 18 meters	(5)	(5)
2. zone width 12-18 meters	4	4
3. zone width 6-12 meters	3	3
4. zone width < 6 meters	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. zone width > 18 meters	4	4
b. zone width 12-18 meters	3	3
c. zone width 6-12 meters	2	2
d. zone width < 6 meters	1	1
2. breaks common		
a. zone width > 18 meters	3	3
b. zone width 12-18 meters	2	2
c. zone width 6-12 meters	1	1
d. zone width < 6 meters	0	0

Total_____ 10

Remarks_____

TOTAL SCORE 187

COMMENTS, DRAWINGS:

Stream Visual Assessment Protocol

Owners name _____ Evaluator's name Ryan Smith, Katie McKeithan, Nancy Daly Date 2/20/04

Stream name UT to Ironhill Branch Waterbody ID number 15-17-1-10-1

Reach location West of SR 1131 in Columbus County

Ecoregion Coastal Plain Drainage area 1.61 sq. mi Gradient 0.2% slope

Applicable reference site Referese Site for UT to Mill Branch

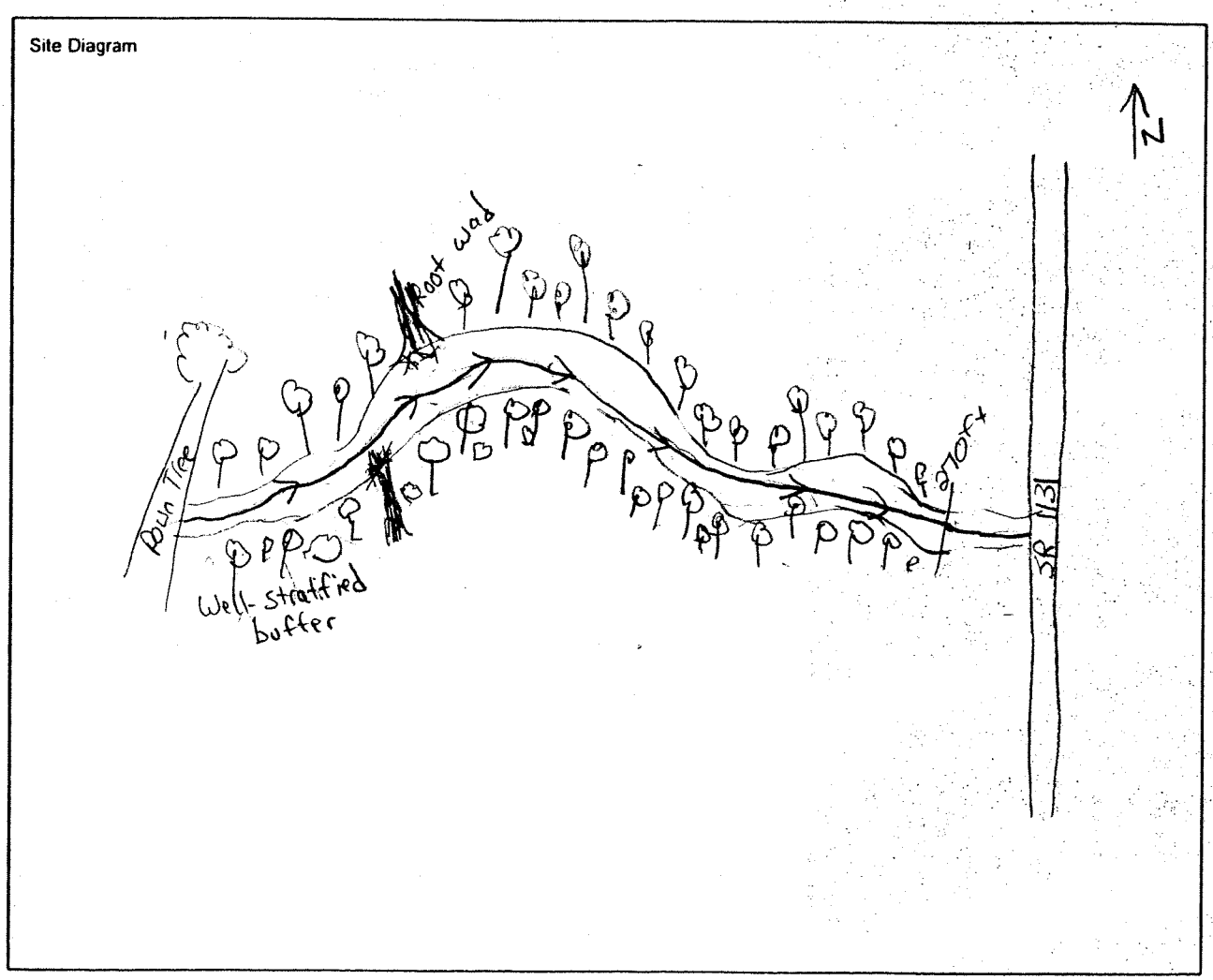
Land use within drainage (%): row crop 30 hayland _____ grazing/pasture _____ forest 70 residential _____

confined animal feeding operations _____ Cons. Reserve _____ industrial _____ Other: _____

Weather conditions-today Sunny/Cool Past 2-5 days _____

Active channel width 14.2ft Dominant substrate: boulder _____ gravel _____ sand V silt _____ mud _____

Site Diagram



Assessment Scores

Channel condition	9
Hydrologic alteration	10
Riparian zone	10
Bank stability	8
Water appearance	10
Nutrient enrichment	9
Barriers to fish movement	10
Instream fish cover	8

Pools	7
Invertebrate habitat	7

Score only if applicable

Canopy cover	9
Manure presence	
Salinity	
Riffle embeddedness	
Marcroinvertebrates Observed (optional)	

Overall score (Total divided by number scored)	8.8	<6.0	**Poor**
		6.1-7.4	**Fair**
		7.5-8.9	**Good**
		>9.0	**Excellent**

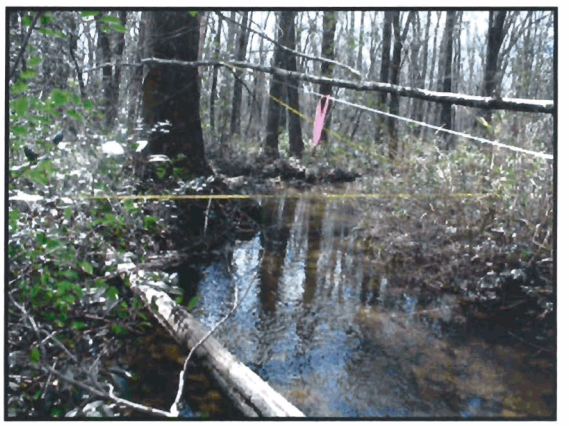
Suspected causes of observed problems_____

Recommendations_____

APPENDIX F

Muddy Creek Stream Information

Looking upstream from downstream limit.



Pool cross section.

Riffle cross section.

Debris jam in stream.

Looking upstream along longitudinal profile.

Looking upstream at culvert.

Appendix F. Existing Conditions along Muddy Creek

Muddy Creek Longitudinal Profile Data

Basin:	Cape Fear 03030004	Channel Slope:	0.37 %
Reach:	Muddy Creek	Stream Length:	236.9 ft
Observers:	KMM, ACB, RVS, SS	Valley Length:	210 ft
Channel Type:	C5	Sinousity:	1.13
Drainage Area (sq mi):	0.85	Meander Length:	55.0 - 97.0 ft
		Belt Width:	40.5 ft
		Radius of Curvature:	10.4 - 21.9 ft

Longitudinal Data

Station	Elevation Streambed	Elevation Water surface	Elevation Bankfull	Elevation Top of Bank	-----	Station	Elevation Streambed	Elevation Water surface	Elevation Bankfull	Elevation Top of Bank	-----
0.0	96.12					128.0	95.55		97.32		
1.2	95.67					128.3	95.56	97.18			
7.1	94.63					129.7				97.42	
13.0	94.44					131.0	95.67	97.18			
19.0	94.01	97.46		97.55		134.0	95.63	97.18			
25.6	95.12	97.45				138.0	96.00	97.17			
29.0	95.39	97.46		97.88		140.5	96.22	97.17		97.35	
32.0	95.20	97.46				143.0	96.42	97.17			
35.0	95.60	97.46				145.5	96.25	97.17			
40.0	95.87	97.46				147.6	96.25	97.17			
45.0	95.80	97.46		97.53		151.0	96.42	97.17			
46.0	95.81	97.46				155.0	96.41	97.17			
48.0	95.60					157.5	96.11	97.16			
50.0	95.81	97.46				163.0	96.10	97.16			
52.5	96.14			97.76		165.5	95.85	97.16			
55.0	95.99	97.46				168.0	96.06	97.16		97.47	
57.0	96.01	97.46				170.0	96.13	97.16			
60.5	96.17	97.46				173.0	96.12	97.16			
64.0	95.93		97.65			175.5	96.43	97.15			
65.0	96.34	97.47				178.7	95.93	96.87			
68.0	96.34	97.47				182.0	96.01	96.87			
72.0	95.91	97.47		97.57		186.0	95.99	96.86			
74.0	95.82	97.47				188.5	95.89	96.86			
77.0	95.90	97.45				190.0	96.04	96.85			
80.3	96.11	97.46				192.4	95.47	96.83			
84.0	96.10	97.46		97.53		194.7	95.61	96.82			
86.0	96.20	97.46				198.0	95.36	96.82			
88.0	96.05	97.24				200.0	95.21	96.81		97.25	
91.5	96.29	97.20				202.0	95.25	96.81			
92.7	96.27	97.22				203.0	95.72	96.81			
96.0	95.92	97.22				206.0	95.90	96.81			
98.5	96.28	97.21				208.5	95.91	96.81			
101.4	96.11	97.22				213.0	95.50	96.79			
104.0	96.08	97.21				217.0	95.34	96.79			
108.0	96.16	97.20				219.0	95.39	96.79		97.11	
111.0	96.28	97.20	97.65	97.71		222.0	95.76	96.79			
114.0	96.15	97.20				223.4	95.70	96.79			
115.6	96.02	97.20				227.0	95.65	96.79			
119.0	96.10	97.19				231.0	95.34	96.78			
121.5	96.13	97.20				234.0	95.00	96.77			
124.7	96.04	97.18				236.9	95.35	96.78			
126.0	95.83	97.18									

Muddy Creek Cross-Section Data

Basin:	Cape Fear 03030004
Reach:	Muddy Creek
Observers:	KMM, ACB, RVS, SS
Channel Type:	C5
Drainage Area (sq mi):	0.85

Riffle - Station 64

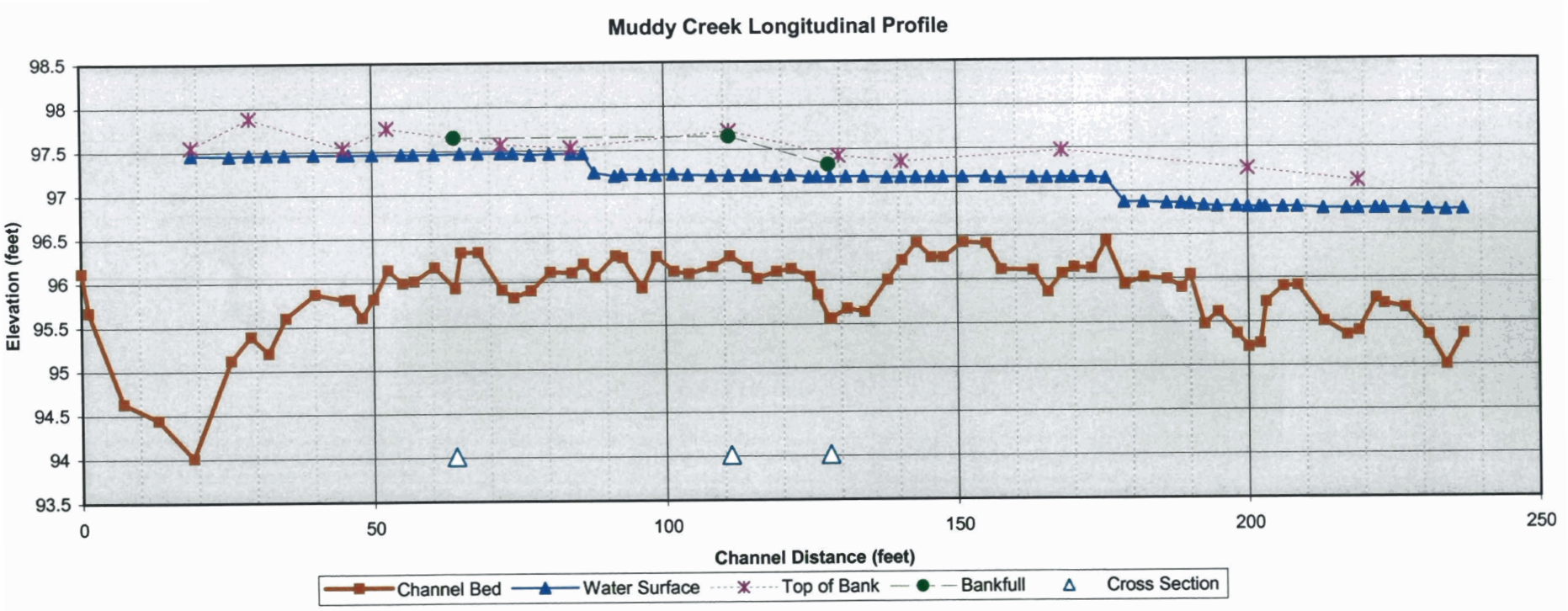
Station	Elevation Streambed	Elevation Bankfull
1.0	97.8	97.73
2.8	97.28	
3.5	97.17	
6.0	97.39	
8.8	97.61	
12.0	97.5	
15.0	97.35	
16.0	97.15	
17.5	97.13	
19.2	97.3	
21.0	97.38	
23.5	97.33	
25.4	97.3	
26.9	97.43	
29.9	97.82	
31.7	97.86	
32.2	97.76	
33.0	97.22	
34.4	96.34	
35.2	96.25	
36.7	96.26	
37.9	96.25	
39.2	96.01	
40	96.11	
40.5	97.14	
42	97.43	
43.4	97.73	
48	97.73	
59	97.49	
65.8	97.3	
79	97.3	
95	97.33	

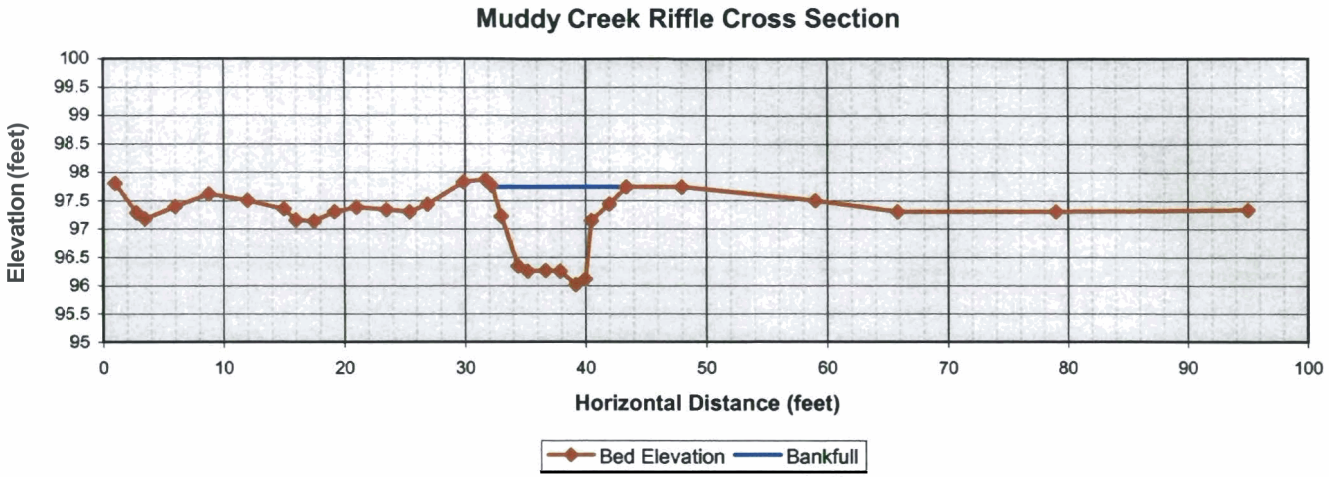
Bankfull Area	11.5 sq.ft
Bankfull Width	11.2 ft
Max depth	1.7 ft
Mean depth	1.03 ft
Width/Depth Ratio	10.8
Flood Prone Width	245.0 ft
Entrenchment Ratio	22.0

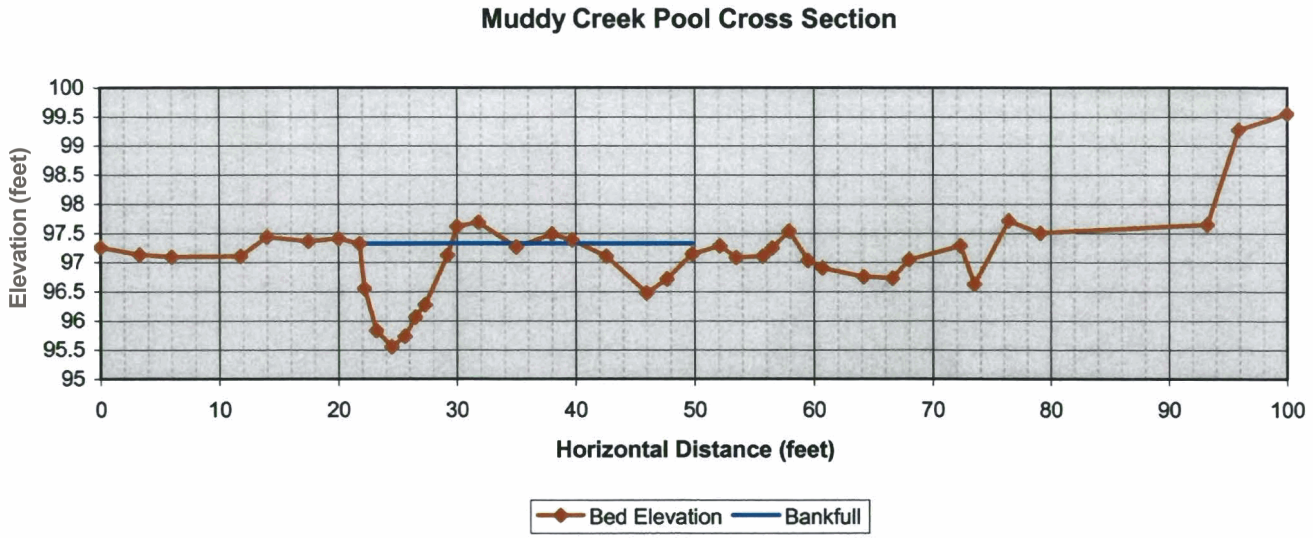
Pool - Station 128

Station	Elevation Streambed	Elevation Bankfull
0.0	97.25	97.32
3.3	97.13	
6.0	97.09	
11.8	97.1	
14.0	97.43	
17.5	97.36	
20.0	97.41	
21.8	97.32	
22.2	96.55	
23.2	95.83	
24.5	95.55	
25.6	95.73	
26.5	96.06	
27.3	96.27	
29.2	97.12	
30.0	97.61	
31.8	97.68	
35.0	97.26	
38.0	97.48	
39.7	97.38	
42.6	97.1	
46.0	96.47	
47.7	96.71	
49.8	97.14	
52.1	97.28	
53.5	97.08	
55.7	97.1	
56.5	97.24	
57.9	97.53	
59.5	97.03	
60.7	96.9	
64.2	96.75	
66.6	96.72	
68	97.04	
72.3	97.28	
73.5	96.62	
76.4	97.71	
79.1	97.5	
93.2	97.64	
95.9	99.27	
100	99.55	

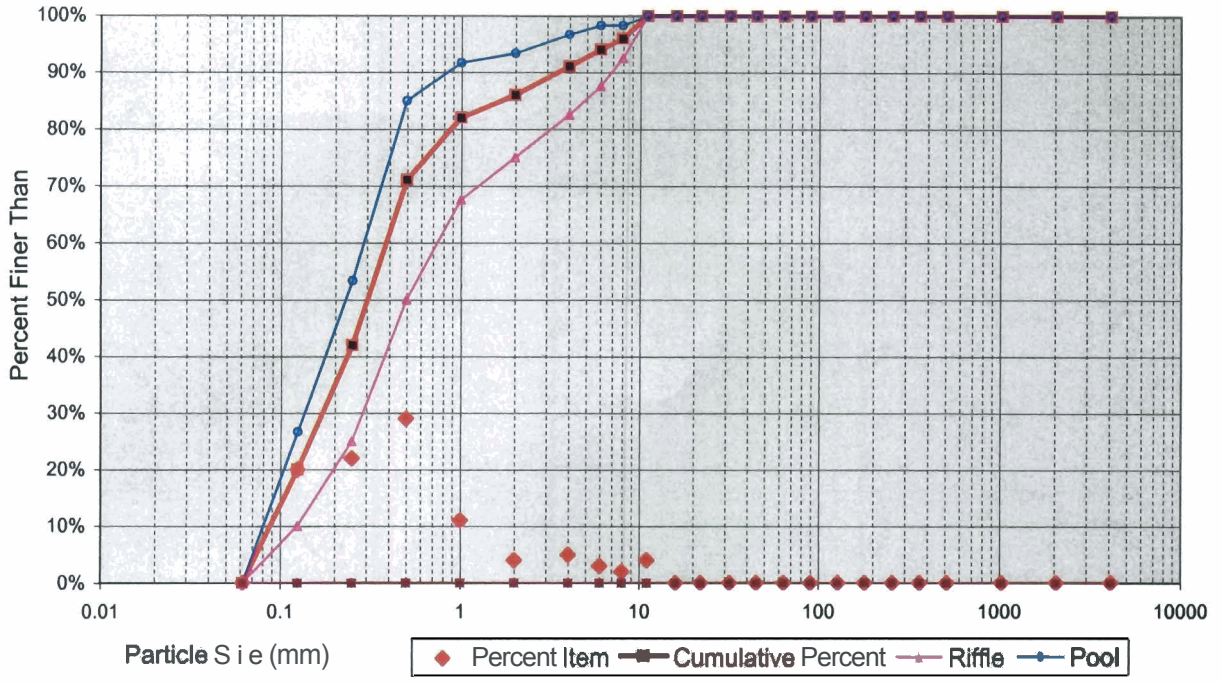
Bankfull Area	12.8 sq.ft
Bankfull Width	17.2 ft
Max depth	1.8 ft
Mean depth	0.7 ft


Muddy Creek Longitudinal Profile
Elevation (feet)
98.5
98
97.5
97
96.5
96
95.5
95
94.5
94
93.5
0
50
100
150
200
250
Channel Distance (feet)
Channel Bed
Water Surface
Top of Bank
Bankfull
Cross Section

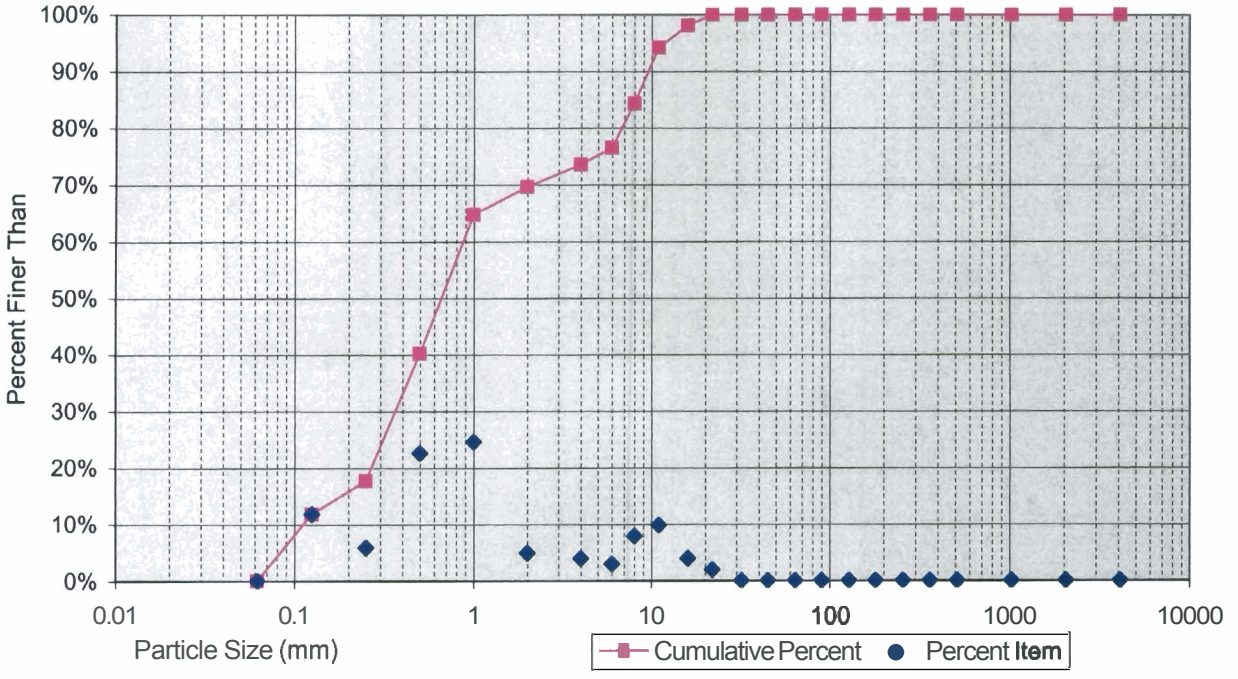

Muddy Creek Riffle Cross Section
Elevation (feet)
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
0
10
20
30
40
50
60
70
80
90
100
Horizontal Distance (feet)
Bed Elevation
Bankfull


Muddy Creek Pool Cross Section
Elevation (feet)
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
0
10
20
30
40
50
60
70
80
90
100
Horizontal Distance (feet)
Bed Elevation
Bankfull

Muddy Creek Cumulative Pebble Count



Muddy Creek Pebble Count
Riffle Cross Section



NCDWQ Stream Classification Form **S500**

Project Name: Muddy Creek River Basin: Cape Fear County: Harnett Evaluators: R. Smith

DWQ Project Number: N/A Nearest Named Stream: Muddy Creek Latitude: Signature:

Date: 3/3/04 USGS QUAD: Longitude:

Location/Directions: North of Little River, and west of Spout Springs

PLEASE NOTE:** ***If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used*

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Riffle-Pool Sequence?	0	1	2	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	1	2	3
3) Are Natural Levees Present?	0	1	2	3
4) Is The Channel Sinuous?	0	1	2	3
5) Is There An Active (Or Relic) Floodplain Present?	0	1	2	3
6) Is The Channel Braided?	0	1	2	3
7) Are Recent Alluvial Deposits Present?	0	1	2	3
8) Is There A Bankfull Bench Present?	0	1	2	3
9) Is A Continuous Bed & Bank Present?	0	1	2	3
*(*NOTE: If Bed & Bank Caused By Ditching And WITHOUT Sinuosity Then Score=0*)*				
10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map *And/Or* In Field) Present?	*Yes*=3		*No*=0	

PRIMARY GEOMORPHOLOGY INDICATOR POINTS: 22

II. Hydrology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Groundwater Flow/Discharge Present?	0	1	2	3

PRIMARY HYDROLOGY INDICATOR POINTS: 3

III. Biology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Are Fibrous Roots Present In Streambed?	3	2	1	0
2) Are Rooted Plants Present In Streambed?	3	2	1	0
3) Is Periphyton Present?	0	1	2	3
4) Are Bivalves Present?	0	1	2	3

PRIMARY BIOLOGY INDICATOR POINTS: 7

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Head Cut Present In Channel?	0	.5	1	1.5
2) Is There A Grade Control Point In Channel?	0	.5	1	1.5
3) Does Topography Indicate A Natural Drainage Way?	0	.5	1	1.5

SECONDARY GEOMORPHOLOGY INDICATOR POINTS: 1.5

II. Hydrology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is This Year's (Or Last's) Leaf litter Present In Streambed?	1.5	1	.5	0
2) Is Sediment On Plants (Or Debris) Present?	0	.5	1	1.5
3) Are Wrack Lines Present?	0	.5	1	1.5
4) Is Water In Channel *And* >48 Hrs. Since Last *Known* Rain? *(*NOTE: If Ditch Indicated In #9 Above Skip This Step And #5 Below*)*	0	.5	1	1.5
5) Is There Water In Channel During Dry Conditions *Or* In Growing Season)?	0	.5	1	1.5
6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)?	*Yes=1.5*		*No*=0	

SECONDARY HYDROLOGY INDICATOR POINTS: 8.5

III. Biology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Are Fish Present?	0	.5	1	1.5
2) Are Amphibians Present?	0	.5	1	1.5
3) Are AquaticTurtles Present?	0	.5	1	1.5
4) Are Crayfish Present?	0	.5	1	1.5
5) Are Macrobenthos Present?	0	.5	1	1.5
6) Are Iron Oxidizing Bacteria/Fungus Present?	0	.5	1	1.5
7) Is Filamentous Algae Present?	0	.5	1	1.5

8) Are Wetland Plants In Streambed? N/A	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(NOTE: If Total Absence Of All Plants In Streambed As Noted Above Skip This Step UNLESS SAV Present*).*	2	1	.75	.5	0	0

SECONDARY BIOLOGY INDICATOR POINTS: 5

TOTAL POINTS (Primary + Secondary)= 47 *(If Greater Than Or Equal To 19 Points The Stream Is At Least Intermittent)*

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Stream Muddy Creek Location/Road N. of Little River County Harnett

Date 3-3-04 CC# _____ Subbasin 03-06-14 Basin Cape Fear

Observer(s): RVS Office Location Raleigh Agency _____

Type of Study: Fish Benthos Basinwide Special Study (Describe) Reference for Stream Restoration

Latitude _____ Longitude _____ Ecoregion (circle one) CA CB Swamp Distance Surveyed 236.9 ~~meters~~ feet

Physical Characterization: Land use refers to immediate area that you can see from sampling location - include what you see driving thru the watershed in the remarks section.

Land use: Forest 100 % Active Pasture _____ % Active Crops _____ % Fallow Fields _____ % Commercial _____ %
Industrial _____ % Residential _____ % Other _____ %. Describe: _____

Width: (~~meters~~) ft Stream 11.2 Channel _____ Average Stream Depth: (~~m~~) ft 1.0 Velocity 1.3 ~~m/sec~~ ft/sec

Flow conditions (circle one): High (Normal) Low

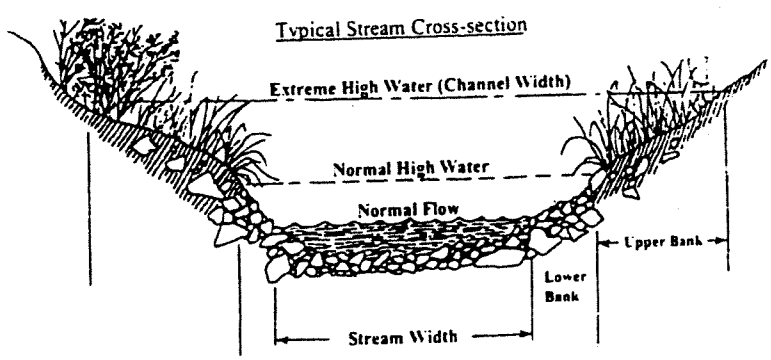
Manmade Stabilization: Y[ ] N[ ] Describe: _____

Water Quality: Temperature _____ °C Dissolved Oxygen _____ mg/l Conductivity _____ µmhos/cm pH _____

Turbidity: (circle) (Clear) Slightly Turbid Turbid Tannic

Weather Conditions: Sunny **Photo #** _____

Remarks: _____

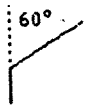


I. Channel Modification (Use topo map as an additional aid for this parameter)

(channelized)	Natural Channel Score	Modified Channel Score
A. Frequent bends		
1. bends > 60°	15	12
2. bends < 60°	(13)	10
B. Infrequent bends		
1. bends > 60°	11	7
2. bends < 60°	8	5

Subtotal 13

Remarks



II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. Circle the habitats which occur- **(Rocks) (Macrophytes) (sticks and leaf packs) (snags and logs) (undercut banks or root mats)** Definition: leafpacks consist of older leaves that are packed together and have begun to decay. Piles of leaves in pool areas are not considered leaf packs. EXAMPLE: If >70% of the reach is rocks, 1 type is present, circle the score of 17.

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>50% Score	30-50% Score	10-30% Score	<10% Score
4 or 5 types present	20	16	12	8
3 types present	19	(15)	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

Subtotal 15

Remarks

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) look at entire reach for substrate scoring, but only look at riffle for embeddedness.

	Score
A. substrate types mixes	
1. gravel rocks dominant)	15
2. sand dominant	(13)
3. detrirus dominant	7
4. silt/clay dominant	4
B. substrate homgeneous	
1. substrate nearly all gravel	12
2. substrate nearly all sand	7
3. substrate nearly all detritus	4
4. substrate nearly all silt/ clay	1

Subtotal 13

Remarks

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams.

	Score
A. Pools present	
1. Pools Frequent (>30% of 100m area surveyed)	(10)
a. variety of pool sizes	8
b.pools same size	
2. Pools Infrequent (<30% of the 100m area surveyed)	6
a. variety of pool sizes	4
b.pools same size	
B. Pools absent	3
1. Runs present	0
2. Runs absent	

Page Total 10

Remarks

V. Bank Stability and Vegetation

	Lft. Bank Score	Rt. Bank Score
A. Banks stable		
1. no evidence of erosion or bank failure, little potential for erosion	(10)	(10)
B. Erosion areas present		
1. diverse trees, shrubs, grass; plants healthy with good root systems	9	9
2. few trees or small trees and shrubs; vegetation appears generally healthy	7	7
3. sparse vegetation; plant types and conditions suggest poorer soil binding	4	4
4. mostly grasses, few if any trees and shrubs, high ersosion and failure potential at high flow	2	2
5. no bank vegetation, mass erosion and bank failure evident	0	0

Total 20

Remarks_____

VI. Light Penetration (Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead).

	Score
A. Stream with **good** shading with some breaks for light penetration	(10)
B. Stream with **full canopy** - breaks for light penetration absent	8
C. Stream with **partial** shading - sunlight and shading are essentially equa	7
D. Stream with **minimal** shading - full sun in all but a few areas	2
E. **No shading**	0

Remarks_____ 10

VII. Riparian Vegetative Zone Width

Definition: A break in the riparian zone is any area which allows sediment to enter the stream. Breaks refer to the near-stream portion of the riparian zone (banks); places where pollutants can directly enter the stream.

	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. zone width > 18 meters	(5)	(5)
2. zone width 12-18 meters	4	4
3. zone width 6-12 meters	3	3
4. zone width < 6 meters	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. zone width > 18 meters	4	4
b. zone width 12-18 meters	3	3
c. zone width 6-12 meters	2	2
d. zone width < 6 meters	1	1
2. breaks common		
a. zone width > 18 meters	3	3
b. zone width 12-18 meters	2	2
c. zone width 6-12 meters	1	1
d. zone width < 6 meters	0	0

Total 10

Remarks_____

TOTAL SCORE 91

Stream Visual Assessment Protocol

Owners name _____ Evaluator's name RVS Date 3-30-04

Stream name Muddy Creek Waterbody ID number 18-23-2E

Reach location N. of Little River in Harnett County

Ecoregion Sand Hills (Coastal Plain) Drainage area 0.85 mi^2 Gradient 0.37%

Applicable reference site _____

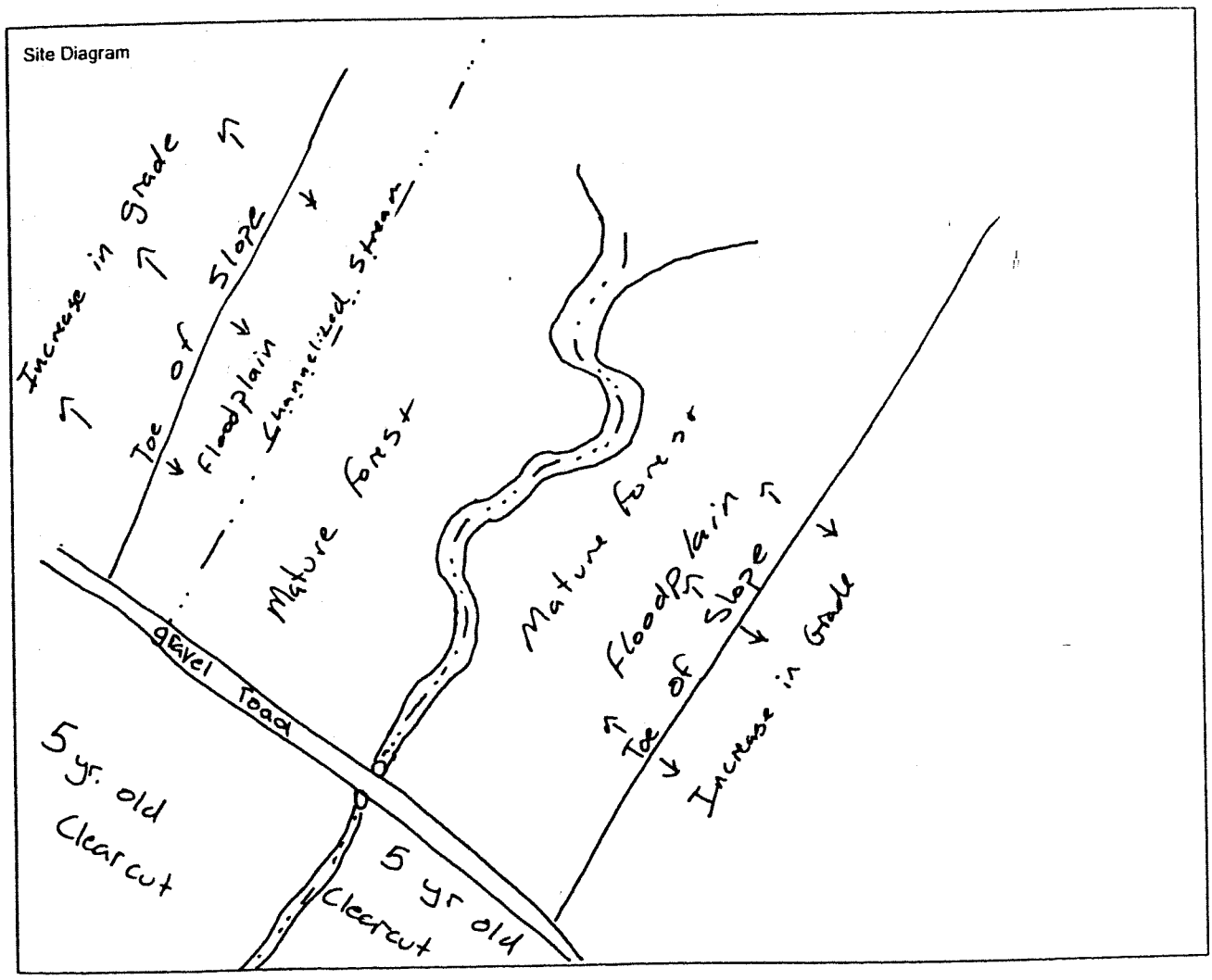
Land use within drainage (%): row crop _____ hayland _____ grazing/pasture _____ forest 100 residential _____

confined animal feeding operations _____ Cons. Reserve _____ industrial _____ Other: _____

Weather conditions-today Sunny Past 2-5 days _____

Active channel width 11.2 ft Dominant substrate: boulder _____ gravel _____ sand ✓ silt _____ mud _____

Site Diagram



Assessment Scores

Channel condition	10
Hydrologic alteration	10
Riparian zone	10
Bank stability	10
Water appearance	10
Nutrient enrichment	10
Barriers to fish movement	10
Instream fish cover	5
Pools	7
Invertebrate habitat	7

Score only if applicable

Canopy cover	10
Manure presence	
Salinity	
Riffle embeddedness	
Marcroinvertebrates Observed (optional)	

Overall score
(Total divided by number scored) 99/11 = 9

<6.0	**Poor**
6.1-7.4	**Fair**
7.5-8.9	**Good**
>9.0	**Excellent**

Suspected causes of observed problems_____

Recommendations_____

APPENDIX G

Mill Creek Stream Information

Riffle along mid-section of profile.

Meander bend and pool in mid-section of profile.

Log in stream channel.

Debris jam in stream channel.

Looking upstream along longitudinal profile.

Straight riffle length in lower portion of profile.

Mill Creek Longitudinal Profile Data

Basin:	Cape Fear	Channel Slope:	0.59 %
Reach:	Mill Creek (0303004)	Measured Stream Length:	479 ft
Observers:	KMM, ACB, RVS, SS	Stream Profile Length:	434 ft
Channel Type:	E5	Measured Valley Length:	405 ft
Drainage Area (sq mi):	1.92	Sinousity:	1.18
		Meander Length:	37.0- 73.0 ft
		Belt Width:	25 ft
		Radius of Curvature:	9.7 - 29.8 ft

Longitudinal Data

Station	Elevation Streambed	Elevation Water surface	Elevation Bankfull	Top of Bank	Berm
0.0	98.06	99.58		100.05	
3.8	97.70	99.60			
5.8	97.99	99.57			
7.2	99.47	99.58		100.14	
7.3	97.67				
8.0	96.01	98.15			
9.4	96.13	98.15			
11.3	96.94	97.95			
14.0	96.66	97.85		99.84	
15.5	96.55	97.85			
19.0	96.62	97.90		99.67	
22.3	96.74	97.85		99.72	98.44
25.3	96.67	97.85			
28.8	96.42	97.88			
31.0	96.53	97.85		98.90	
33.6	96.77	97.85			
34.6	96.67	97.85		99.36	
38.9	96.30	97.81			
41.4	96.12	97.77		99.42	
42.3	96.26	97.77			
46.4	96.11	97.77		99.48	
48.9	96.73	97.76			
52.0	96.70	97.75			
54.0	97.58	97.73			
55.0	96.02	97.55	98.71		
58.7	95.89	97.58			
61.0	95.70	97.53			
63.9	96.26	97.53			
66.4	95.79	97.43			
69.0	94.98	97.56	98.51		
73.0	94.49	97.56			
74.0	94.55	97.57			
75.0	94.72	97.56			
78.4	96.02	97.57	98.61		
80.6	96.03	97.53			
82.0	95.92	97.53			
84.5	95.36	97.53			
88.0	95.38	97.53			
92.0	95.24	#N/A	98.36		
94.0	95.47	97.55			
99.0	96.33	97.53			
102.0	96.11	97.47			
105.0	96.06	97.46			
112.0	96.13	97.42	98.79		
117.0	96.28	97.34			
128.0	96.32	97.34			
132.0	96.10	97.34			
137.0	96.15	97.34	98.27		
142.0	96.13	97.34			
145.0	95.87	97.33	98.19		
148.0	95.38	97.34			
155.0	95.71	97.30	98.52		
158.5	95.58	97.31			
160.0	95 82	97.22			
162.5	94.64	96.75			
168.0	94.29	96.79			
175.0	94.62	96.77			
179.0	95.30	96.78			
185.0	95.65	96.79			
190.0	95.31	96.79			
196.0	95.05	96.79	97.91		
200.0	95.31	96.77			
203.0	95.49	96.77			
206.4	95.5	96.8			
208.5	95.3		97.8		
212.5	95.1	96.8			
216.0	95.4	96.8			
221.0	95.1	96.8			
228.0	95.1	96.8	97.7		
235.0	94.8	96.8			
238.0	95.4	96.8	98.1		
242.0	95.4	96.8			
244.0	95.2		97.8	98.1	
249.0	95.6	96.8	98.0		
256.0	95.9	96.8			
257.0	95.5	96.8			
261.0	95.2	96.6			
264.0	95.4	96.6			
270.0	95.0	96.7			
276.0	95.2	96.7			
279.0	95.1	96.7			
282.0	95.5	96.7			
284.0	95.1	96.7			
287.5	95.2	96.7			
292.0	94.9	96.7			
297.0	95.0	96.6			
300.0	95.2	96.7			
304.0	94.8	96.6	97.7		
308.0	94.6	96.6	97.6		
311.0	94.7	96.6			
314.0	95.1	96.6	97.6		
319.0	95.1	96.6			
323.0	95.4	96.6	97.7		
324.0	94.9	96.6			
327.0	94.8	96.6			
330.0	95.3	96.6			
332.0	94.1		97.7	97.7	
334.0	94.5	96.6			
336.0	95.4	96.6			
338.0	95.2	96.6			
342.0	95.0	96.6			
344.0	95.4	96.6			
347.0	95.7	96.6			
349.0	96.5	96.6			
349.5	94.6	96.3		97.9	
352.0	94.3	96.3			
353.0	95.1	96.3			
354.0	94.9	96.1			
357.8	95.1	96.1			
361.0	95.1	96.1	97.6		
365.0	95.1	96.1			
369.0	95.0	96.1			
374.5	94.9	96.1	97.3		
379.0	95.0	96.1			
385.0	94.7	96.1			
392.0	94.3	96.1	97.2		96.6
398.0	94.3	96.07			
403.0	95.0	96.07	97.4		96.62
407.0	95.0	96.07			
410.5	94.71	96.06			
413	94.34	96.07			
419	94.43	96.06	97.0		
425	95.38	96.06			
428	95.04	96.04			
434	94.91	96.02	97.0		

Mill Creek - Cross Section Data

Basin:	Cape Fear
Reach:	Mill Creek (0303004)
Observers:	KMM, ACB, RVS, SS
Channel Type:	E5
Drainage Area (sq mi):	1.92

Riffle - Station 244

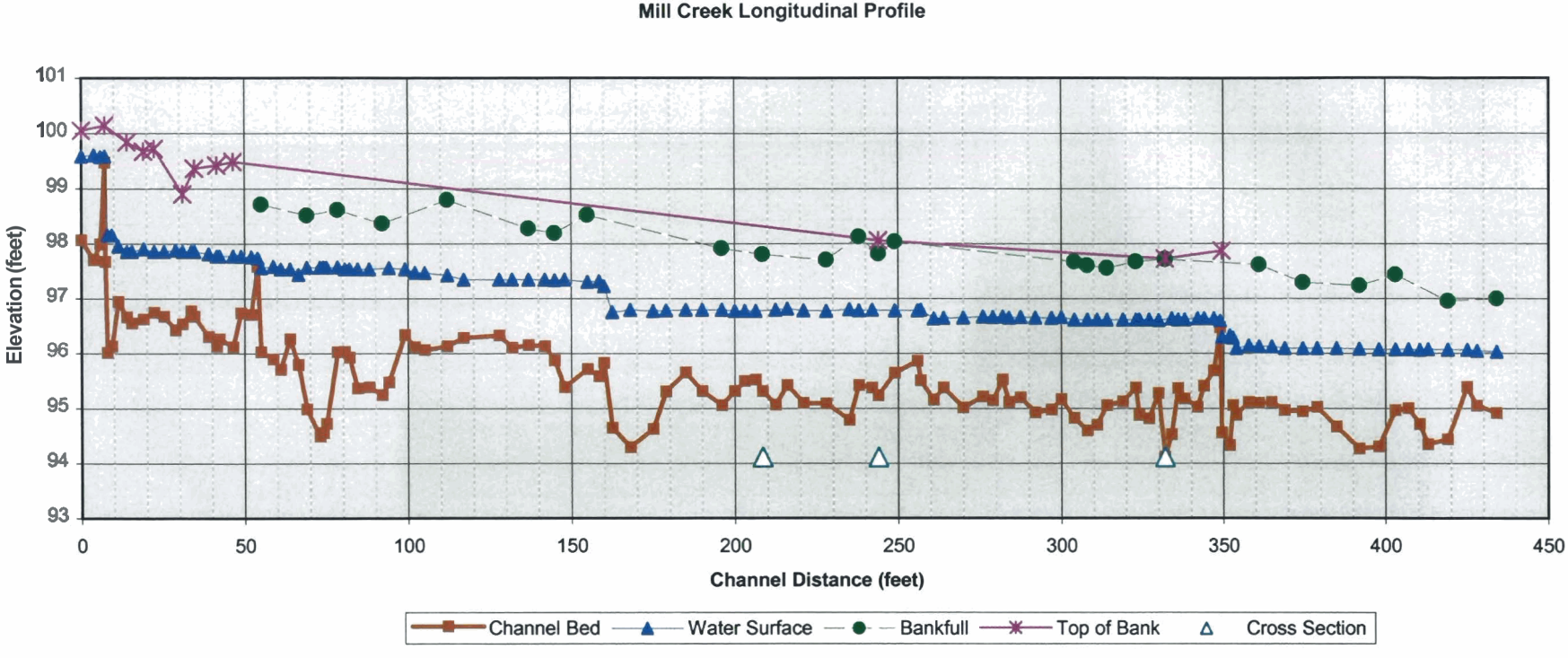
Station	Elevation Streambed	Elevation Bankfull
0.0	95.01	95.1
8.0	94.93	
10.0	95.20	
13.0	95.34	
13.2	94.08	
13.5	93.54	
14.9	92.72	
16.0	92.56	
17.0	92.52	
18.0	92.65	
18.8	92.70	
19.6	92.84	
20.3	93.05	
21.1	93.31	
22.0	93.54	
22.7	93.81	
22.9	94.51	
23.3	94.68	
25.0	95.35	
33.5	94.96	

Bankfull Area	21.0 sq.ft
Bankfull Width	11.3 ft
Max depth	2.6 ft
Mean depth	1.9 ft
Width/Depth Ratio	6.1
Flood Prone Width	300 ft
Entrenchment Ratio	26.5

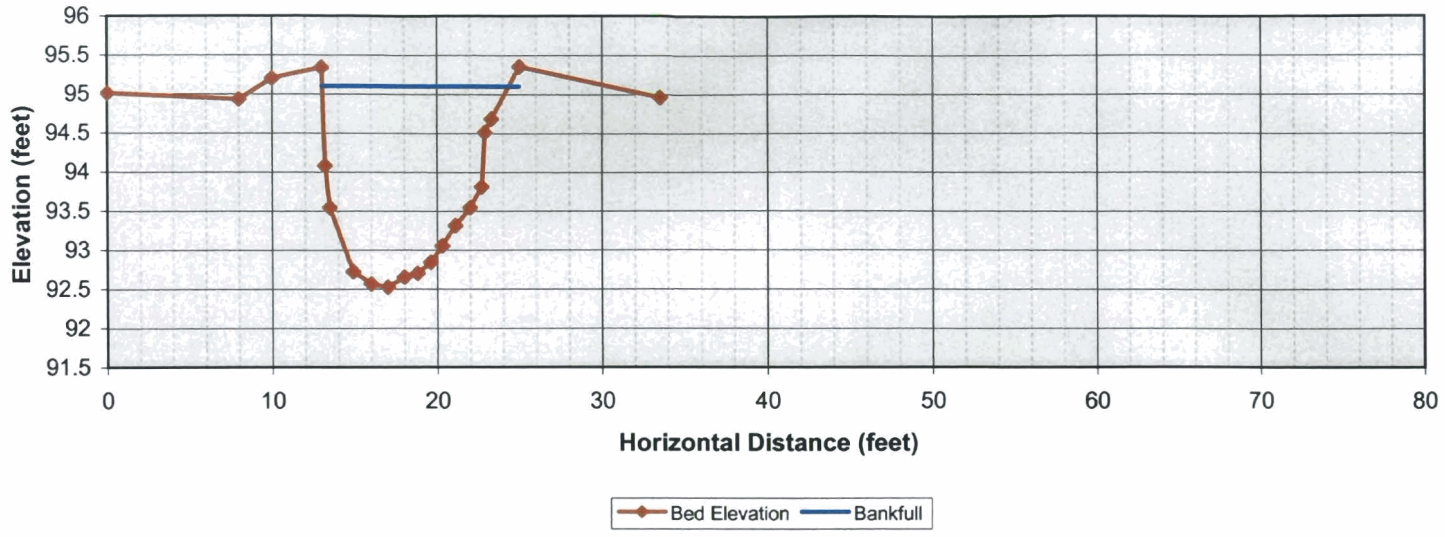
Pool - Station 332

Station	Elevation Streambed	Elevation Bankfull
0.0	95.51	95.20
2.0	95.06	
5.6	95.09	
10.2	95.13	
15.0	95.26	
16.5	95.21	
18.0	94.93	
19.0	94.65	
19.3	94.54	
19.4	94.25	
19.6	94.11	
20.0	93.75	
21.0	93.37	
22.0	92.95	
23.0	92.29	
24.0	92.95	
24.5	92.65	
25.2	92.71	
25.8	92.08	
26.0	92.78	
26.6	92.11	
26.8	94.65	
27.4	94.78	
28.4	95.17	
31.5	95.2	
33.4	95.15	
39.0	94.89	
40.0	94.26	
42.6	94.30	
44.0	94.41	
48.0	95.16	
52.0	95.28	
56.0	95.07	
58.0	94.99	
59.3	94.36	
60.5	93.58	
61.0	93.57	
63.0	93.72	
64.5	94.35	
65.9	94.84	
68.0	94.87	
79.0	94.98	

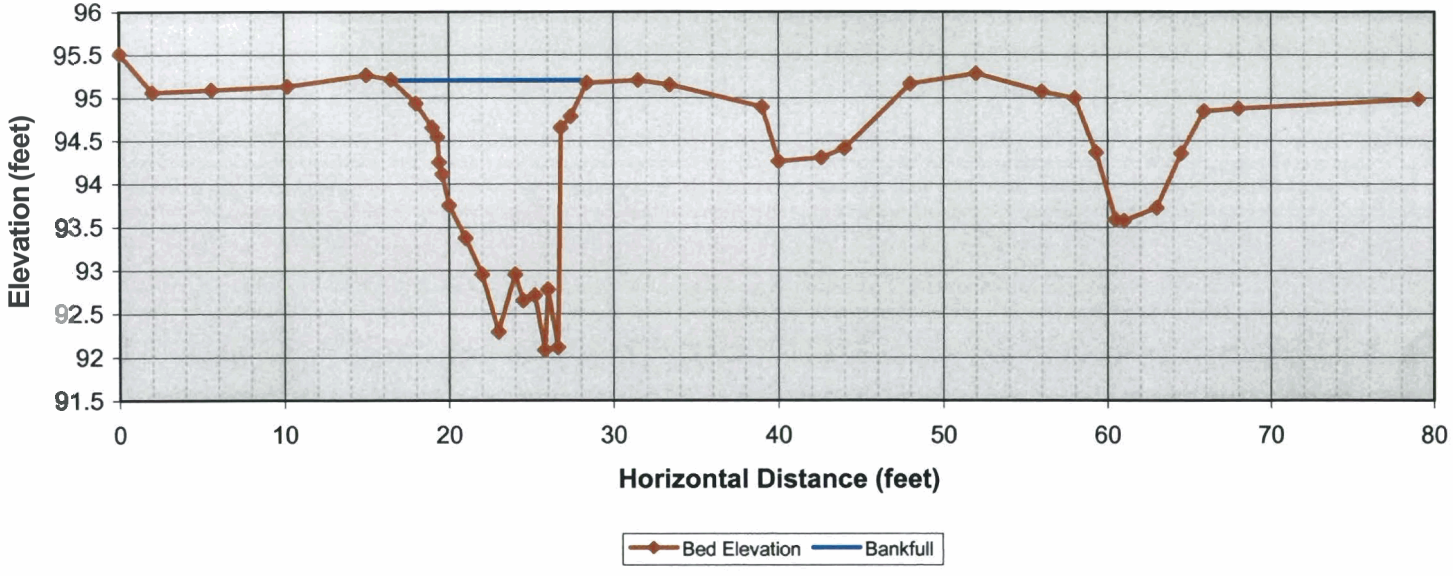
Bankfull Area	18.2 sq.ft
Bankfull Width	26.45 ft
Max depth	3.12 ft
Mean depth	1.5 ft


Mill Creek Longitudinal Profile
Elevation (feet)
101
100
99
98
97
96
95
94
93
0
50
100
150
200
250
300
350
400
450
Channel Distance (feet)
Channel Bed
Water Surface
Bankfull
Top of Bank
Cross Section

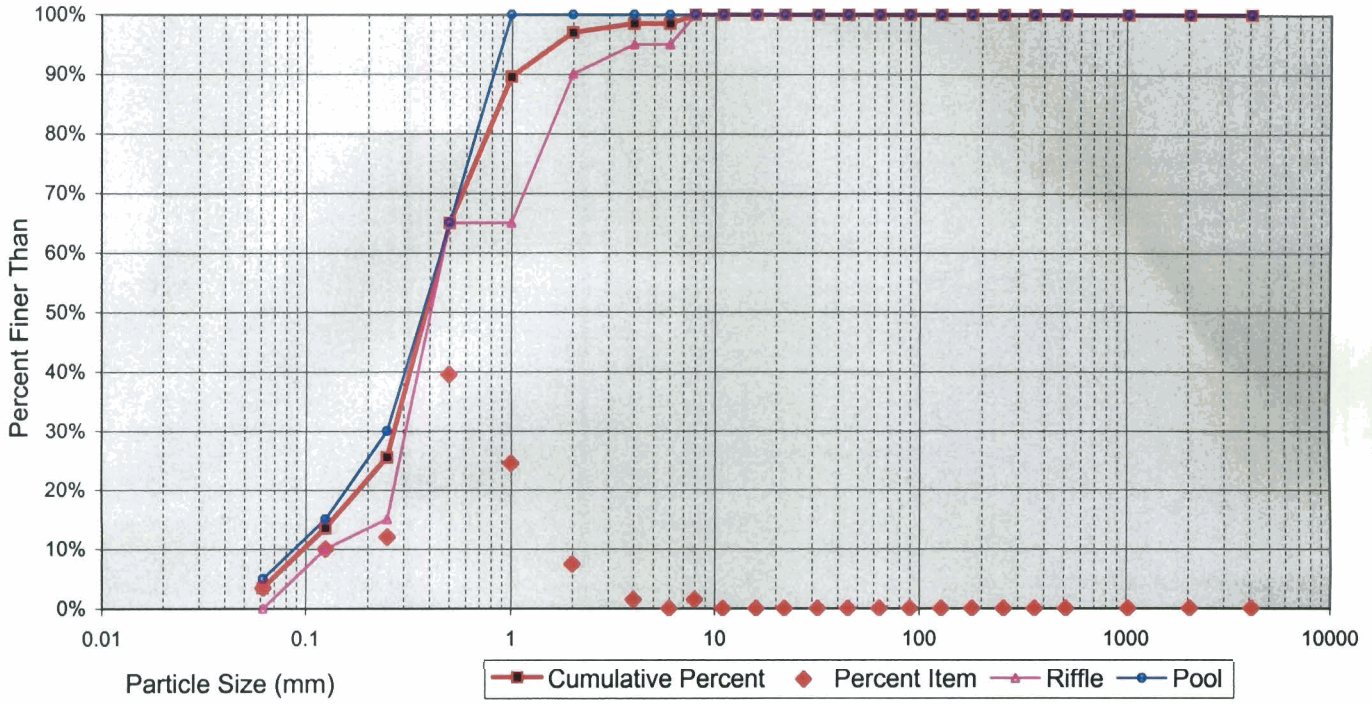
Mill Creek Riffle Cross Section



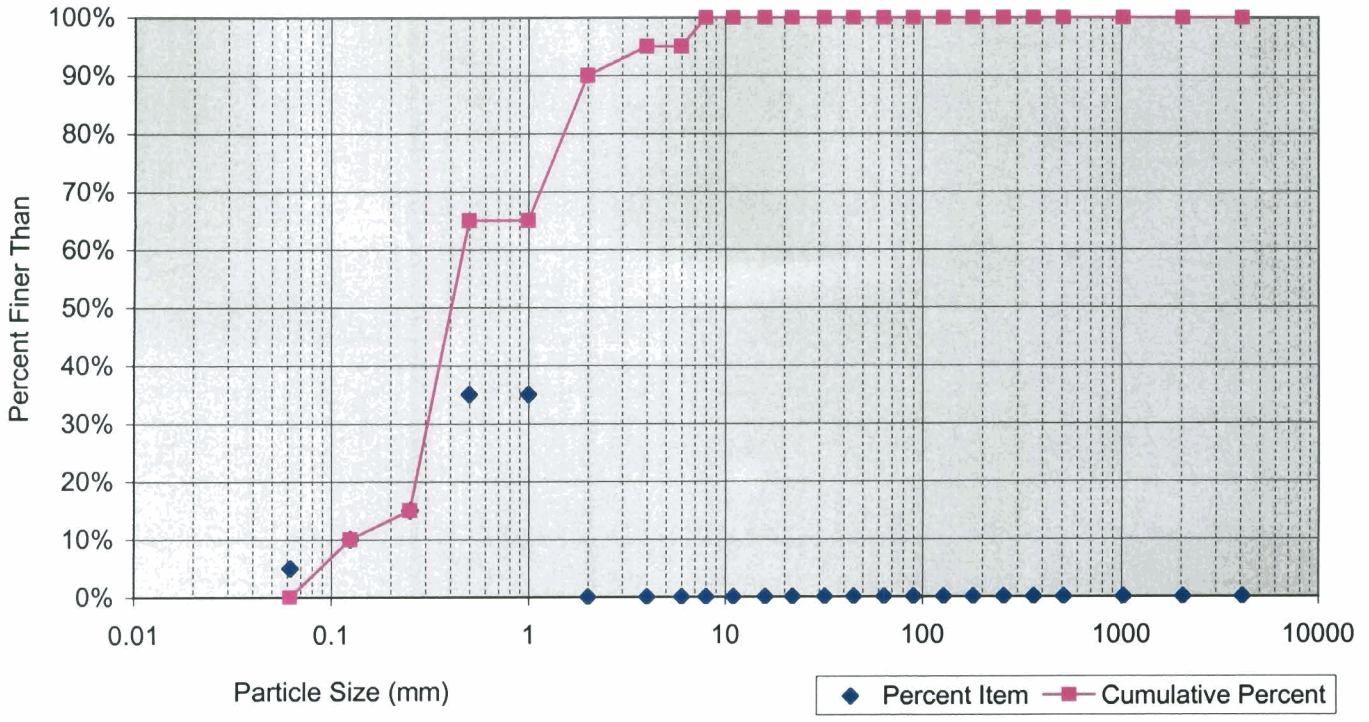
Mill Creek Pool Cross Section



Mill Creek Cumulative Pebble Count



Mill Creek Pebble Count
Riffle Cross Section



NCDWQ Stream Classification Form S500

Project Name: Mill Creek River Basin: Cape Fear County: Moore Evaluators: R. Smith

DWQ Project Number: N/A Nearest Named Stream: Mill Creek Latitude: Signature:

Date: 2/23/04 USGS QUAD: Longitude:

Location/Directions: Southern Pines, NC

PLEASE NOTE:** ***If evaluator and landowner agree that the feature is a man-made ditch, then use of this form is not necessary. Also, if in the best professional judgement of the evaluator, the feature is a man-made ditch and not a modified natural stream—this rating system should not be used*

Primary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Riffle-Pool Sequence?	0	1	2	3
2) Is The USDA Texture In Streambed Different From Surrounding Terrain?	0	1	2	3
3) Are Natural Levees Present?	0	1	2	3
4) Is The Channel Sinuous?	0	1	2	3
5) Is There An Active (Or Relic) Floodplain Present?	0	1	2	3
6) Is The Channel Braided?	0	1	2	3
7) Are Recent Alluvial Deposits Present?	0	1	2	3
8) Is There A Bankfull Bench Present?	0	1	2	3
9) Is A Continuous Bed & Bank Present?	0	1	2	3
*(*NOTE: If Bed & Bank Caused By Ditching And WITHOUT Sinuosity Then Score=0*)*				
10) Is A 2nd Order Or Greater Channel (As Indicated On Topo Map *And/Or* In Field) Present?	*Yes*=3		*No*=0	

PRIMARY GEOMORPHOLOGY INDICATOR POINTS: 22

II. Hydrology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Groundwater Flow/Discharge Present?	0	1	2	3

PRIMARY HYDROLOGY INDICATOR POINTS: 3

III. Biology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Are Fibrous Roots Present In Streambed?	3	2	1	0
2) Are Rooted Plants Present In Streambed?	3	2	1	0
3) Is Periphyton Present?	0	1	2	3
4) Are Bivalves Present?	0	1	2	3

PRIMARY BIOLOGY INDICATOR POINTS: 6

Secondary Field Indicators: *(Circle One Number Per Line)*

I. Geomorphology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is There A Head Cut Present In Channel?	0	.5	1	1.5
2) Is There A Grade Control Point In Channel?	0	.5	1	1.5
3) Does Topography Indicate A Natural Drainage Way?	0	.5	1	1.5

SECONDARY GEOMORPHOLOGY INDICATOR POINTS: 3

II. Hydrology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Is This Year's (Or Last's) Leaf litter Present In Streambed?	1.5	1	.5	0
2) Is Sediment On Plants (Or Debris) Present?	0	.5	1	1.5
3) Are Wrack Lines Present?	0	.5	1	1.5
4) Is Water In Channel *And* >48 Hrs. Since Last *Known* Rain? *(*NOTE: If Ditch Indicated In #9 Above Skip This Step And #5 Below*)*	0	.5	1	1.5
5) Is There Water In Channel During Dry Conditions *Or* In Growing Season)?	0	.5	1	1.5
6) Are Hydric Soils Present In Sides Of Channel (Or In Headcut)?	*Yes*=1.5		*No*=0	

SECONDARY HYDROLOGY INDICATOR POINTS: 8.5

III. Biology	**Absent**	**Weak**	**Moderate**	**Strong**
1) Are Fish Present?	0	.5	1	1.5
2) Are Amphibians Present?	0	.5	1	1.5
3) Are AquaticTurtles Present?	0	.5	1	1.5
4) Are Crayfish Present?	0	.5	1	1.5
5) Are Macrobenthos Present?	0	.5	1	1.5
6) Are Iron Oxidizing Bacteria/Fungus Present?	0	.5	1	1.5
7) Is Filamentous Algae Present?	0	.5	1	1.5

8) Are Wetland Plants In Streambed? N/A	SAV	Mostly OBL	Mostly FACW	Mostly FAC	Mostly FACU	Mostly UPL
(NOTE: If Total Absence Of All Plants In Streambed As Noted Above Skip This Step UNLESS SAV Present*).*	2	1	.75	.5	0	0

SECONDARY BIOLOGY INDICATOR POINTS: 8

TOTAL POINTS (Primary + Secondary)= 48.5 *(If Greater Than Or Equal To 19 Points The Stream Is At Least Intermittent)*

Habitat Assessment Field Data Sheet
Coastal Plain Streams

Directions for use of this Assessment: The observer is to survey a minimum of 100 meters of stream, preferably in an upstream direction starting above the bridge pool and the road right-of-way. The stream segment which is assessed should represent average stream conditions. In order to perform a proper habitat evaluation the observer needs to get into the stream. All meter readings need to be performed prior to walking the stream. When working the habitat index, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. There are seven different metrics in this index and a final habitat score is determined by adding the results from the different metrics.

Stream Mill Creek Location/Road Southern Pine County Moore

Date 2-23-04 CC# _____ Subbasin 03-06-14 Basin Cape Fear

Observer(s): RVS Office Location Raleigh Agency _____

Type of Study: Fish Benthos Basinwide Special Study (Describe) Reference for Stream Restoration

Latitude _____ Longitude _____ Ecoregion (circle one) CA CB Swamp Distance Surveyed 434 ~~meters~~ ft

Physical Characterization: Land use refers to immediate area that you can see from sampling location - include what you see driving thru the watershed in the remarks section.

Land use: Forest 65 % Active Pasture 5 % Active Crops ____% Fallow Fields ____% Commercial ____% Industrial ____% Residential 30 % Other ____%. Describe: _____

Width: (~~meters~~ ft) Stream 11.3 Channel 3.4 Average Stream Depth: (~~m~~ ft) 1.9 Velocity 1.3 ~~m/sec~~ ft/sec

Flow conditions (circle one): (High) Normal Low

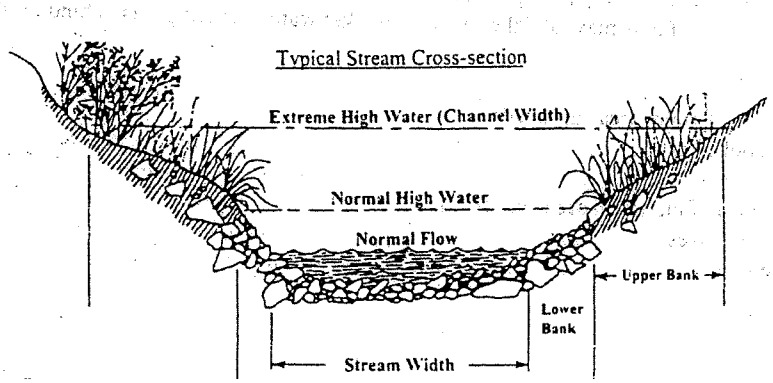
Manmade Stabilization: Y[ ] N[X] Describe: _____

Water Quality: Temperature ____ °C Dissolved Oxygen _____ mg/l Conductivity _____ µmhos/cm pH _____

Turbidity: (circle) (Clear) Slightly Turbid Turbid Tannic

Weather Conditions: Sunny **Photo #** _____

Remarks: _____

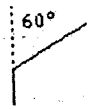


I. Channel Modification (Use topo map as an additional aid for this parameter)

	Natural Channel Score	Modified Channel Score
(channelized)		
A. Frequent bends		
1. bends > 60°	15	12
2. bends < 60°	(13)	10
B. Infrequent bends		
1. bends > 60°	11	7
2. bends < 60°	8	5

Subtotal 13

Remarks



II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. Circle the habitats which occur- **(Rocks) (Macrophytes) (sticks and leaf packs) (snags and logs) (undercut banks or root mats)** Definition: leafpacks consist of older leaves that are packed together and have begun to decay. Piles of leaves in pool areas are not considered leaf packs. EXAMPLE: If >70% of the reach is rocks, 1 type is present, circle the score of 17.

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>50% Score	30-50% Score	10-30% Score	<10% Score
4 or 5 types present	20	16	12	8
3 types present	19	(15)	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

Subtotal 15

Remarks

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) look at entire reach for substrate scoring, but only look at riffle for embeddedness.

	Score
A. substrate types mixes	
1. gravel/rocks dominant)	15
2. sand dominant	13
3. detrirus dominant	7
4. silt/clay dominant	4
B. substrate homgeneous	
1. substrate nearly all gravel	12
2. substrate nearly all sand	(7)
3. substrate nearly all detritus	4
4. substrate nearly all silt/ clay	1

Subtotal 7

Remarks

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams.

	Score
A. Pools present	
1. Pools Frequent (>30% of 100m area surveyed)	
a. variety of pool sizes	(10)
b.pools same size	8
2. Pools Infrequent (<30% of the 100m area surveyed)	
a. variety of pool sizes	6
b.pools same size	4
B. Pools absent	
1. Runs present	3
2. Runs absent	0

Page Total 10

Remarks

V. Bank Stability and Vegetation

	Lft. Bank Score	Rt. Bank Score
A. Banks stable		
1. no evidence of erosion or bank failure, little potential for erosion	10	10
B. Erosion areas present		
1. diverse trees, shrubs, grass; plants healthy with good root systems	(9)	(9)
2. few trees or small trees and shrubs; vegetation appears generally healthy	7	7
3. sparse vegetation; plant types and conditions suggest poorer soil binding	4	4
4. mostly grasses, few if any trees and shrubs, high ersosion and failure potential at high flow	2	2
5. no bank vegetation, mass erosion and bank failure evident	0	0

Total 18

Remarks

VI. Light Penetration (Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead).

	Score
A. Stream with **good** shading with some breaks for light penetration	(10)
B. Stream with **full canopy** - breaks for light penetration absent	8
C. Stream with **partial** shading - sunlight and shading are essentially equa	7
D. Stream with **minimal** shading - full sun in all but a few areas	2
E. **No shading**	0

10

Remarks

VII. Riparian Vegetative Zone Width

Definition: A break in the riparian zone is any area which allows sediment to enter the stream. Breaks refer to the near-stream portion of the riparian zone (banks); places where pollutants can directly enter the stream.

	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)	(5)	(5)
1. zone width > 18 meters	4	4
2. zone width 12-18 meters	3	3
3. zone width 6-12 meters	2	2
4. zone width < 6 meters		
B. Riparian zone **not intact** (breaks)		
1. breaks rare	4	4
a. zone width > 18 meters	3	3
b. zone width 12-18 meters	2	2
c. zone width 6-12 meters	1	1
d. zone width < 6 meters		
2. breaks common	3	3
a. zone width > 18 meters	2	2
b. zone width 12-18 meters	1	1
c. zone width 6-12 meters	0	0
d. zone width < 6 meters		

Total 10

Remarks

TOTAL SCORE 83

Stream Visual Assessment Protocol

Owners name _____ Evaluator's name RVS Date 2-23-04

Stream name Mill Creek Waterbody ID number 18-23-11-(2)

Reach location Southern Pines, Moore County

Ecoregion Sand Hills (Coastal Plain) Drainage area 1.92 mi² Gradient 0.59%

Applicable reference site _____

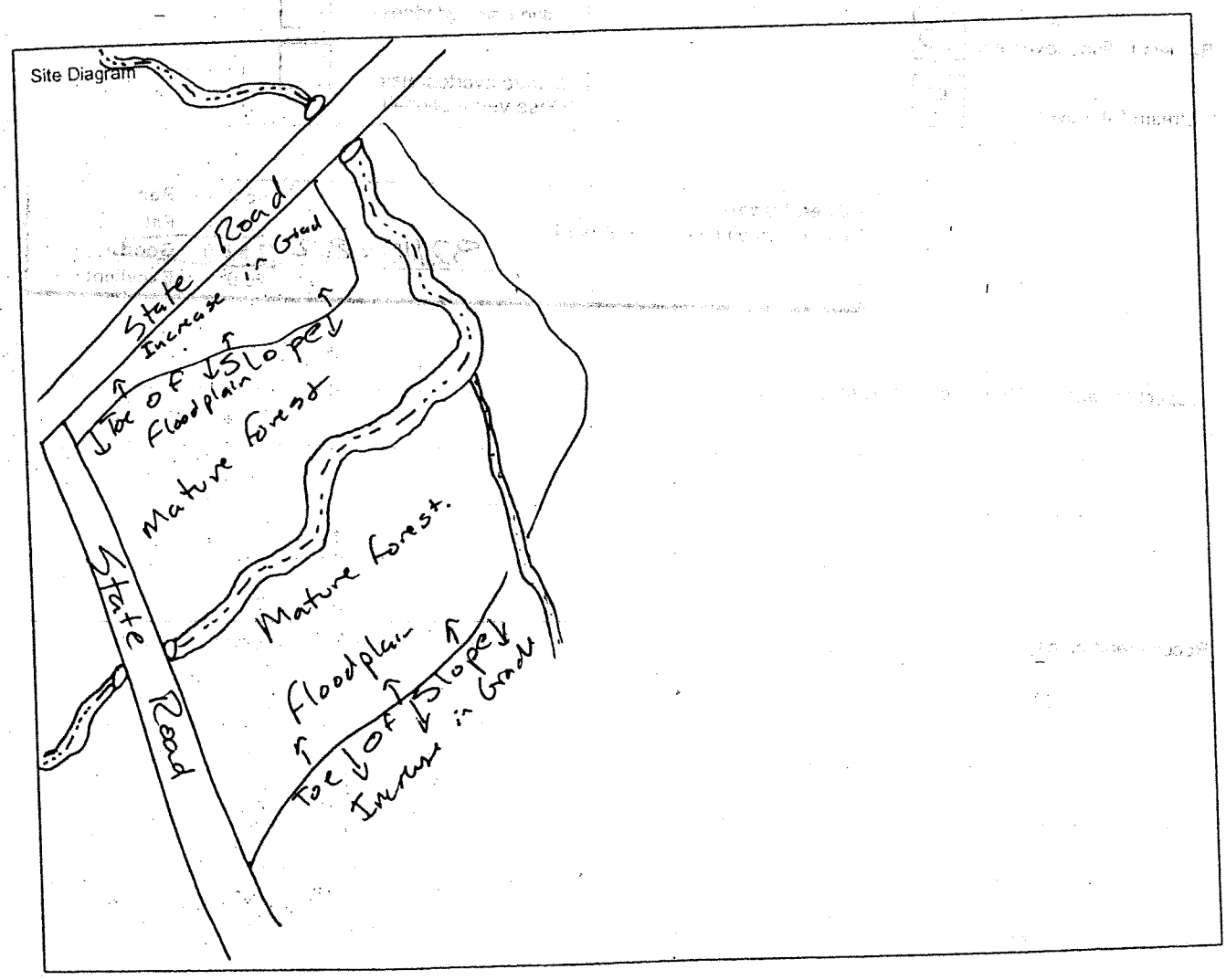
Land use within drainage (%): row crop _____ hayland _____ grazing/pasture 5 forest 65 residential 30

confined animal feeding operations _____ Cons. Reserve _____ industrial _____ Other: _____

Weather conditions-today Sunny Past 2-5 days _____

Active channel width 11.3ft Dominant substrate: boulder _____ gravel _ sand ✓ silt _____ mud _____

Site Diagram



Assessment Scores

Channel condition	8
Hydrologic alteration	10
Riparian zone	10
Bank stability	7
Water appearance	8
Nutrient enrichment	7
Barriers to fish movement	10
Instream fish cover	5

Pools	10
Invertebrate habitat	7

Score only if applicable

Canopy cover	
Manure presence	
Salinity	
Riffle embeddedness	
Marcroinvertebrates Observed (optional)	

Overall score
(Total divided by number scored)

82/10 = 8.2

<6.0	**Poor**
6.1-7.4	**Fair**
7.5-8.9	**Good**
>9.0	**Excellent**

Suspected causes of observed problems

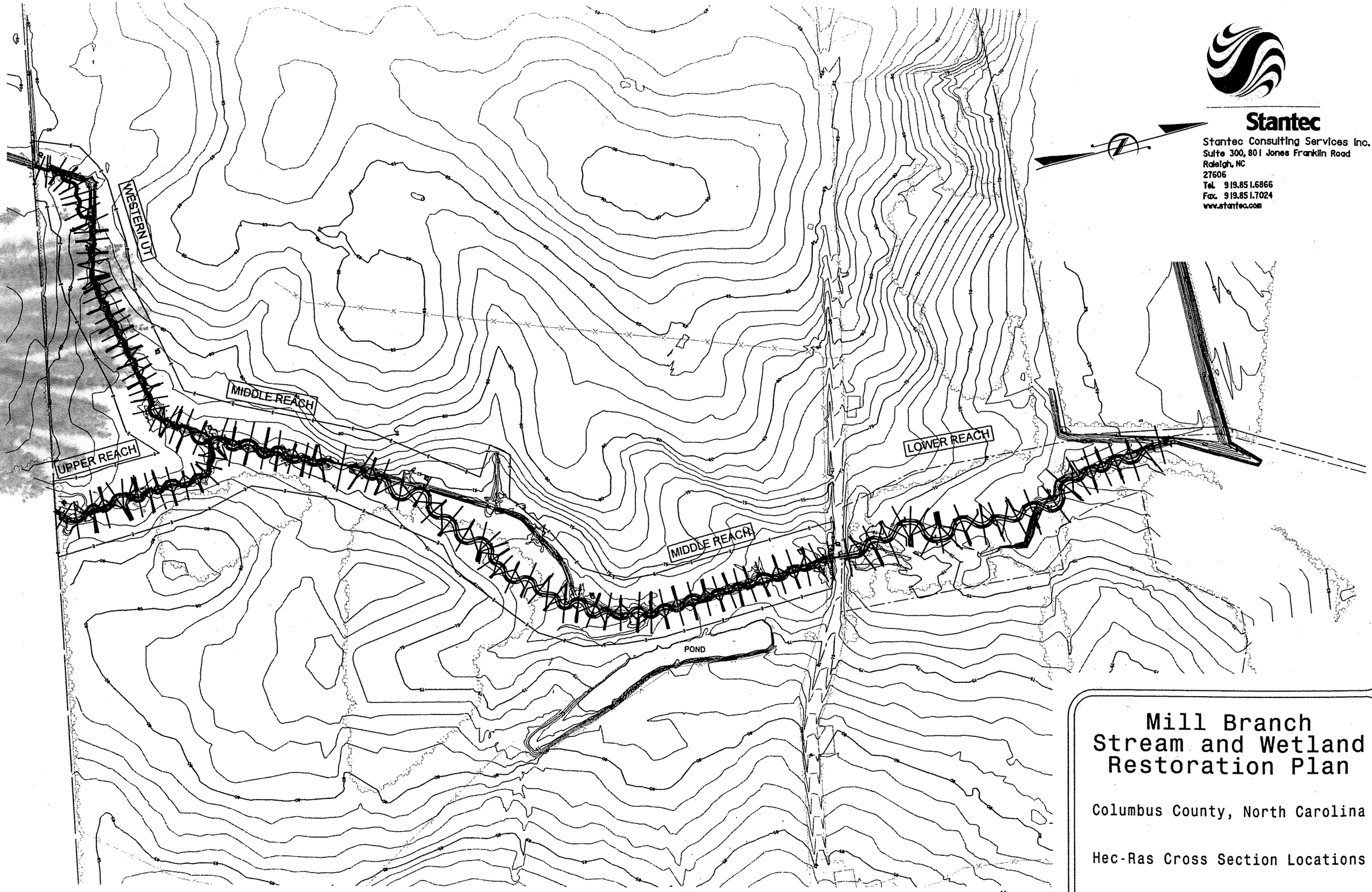
Recommendations

APPENDIX H

HEC - RAS Analysis

Appendix H. HEC-Ras Data for 100-yr Storm Event

Mill Branch HEC-RAS							
Reach	HEC-RAS Station-Existing	HEC-RAS Station - Proposed	Storm	Discharge	Proposed Water Surface Elevation	Existing Water Surface Elevation	Change in Water Surface Elevation
West	1650.00	1761.09	100 yr	130.22	79.89	81.06	-1.17
West	1450.00	1449.16	100 yr	130.22	77.11	79.81	-2.70
West	1250.00	1247.80	100 yr	130.22	75.83	78.35	-2.52
West	1000.00	1008.39	100 yr	130.22	75.84	77.22	-1.38
Upper	1349.32	1420.79	100 yr	247.51	76.77	78.42	-1.65
Upper	1250.00	1278.38	100 yr	247.51	76.72	77.98	-1.26
Upper	1150.00	1145.25	100 yr	247.51	76.46	77.68	-1.22
Upper	1000.00	1027.61	100 yr	247.51	75.84	77.22	-1.38
Middle	2250.00	2546.88	100 yr	326.55	75.84	77.22	-1.38
Middle	1900.00	1896.17	100 yr	326.55	73.77	75.30	-1.53
Middle	1300.00	1297.58	100 yr	326.55	71.88	74.11	-2.23
Middle	1000.00	1017.22	100 yr	326.55	69.49	73.85	-4.36
Lower	1700.00	1797.94	100 yr	345.62	69.43	73.85	-4.42
Lower	1550.00	1553.00	100 yr	345.62	67.44	71.06	-3.62
Lower	1200.00	1226.36	100 yr	345.62	63.99	66.12	-2.13
Lower	1000.00	1020.70	100 yr	345.62	63.11	65.76	-2.65



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Mill Branch Stream and Wetland Restoration Plan

Columbus County, North Carolina

Hec-Ras Cross Section Locations

Scale: 1"= 80'