STREAM RESTORATION PLAN

East Tarboro Canal
Edgecombe County, North Carolina

Ecosystem Enhancement PROGRAM

January 2005

EarthTech
A Tyco International Ltd. Company

701 Corporate Center Drive, Suite 475
Raleigh, NC 27607

John D.R. Nichols
1/12/2005

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

The North Carolina Ecosystem Enhancement Program (NCEEP) has identified two portions of the East Tarboro Canal as potential stream restoration sites. The East Tarboro Canal is located in the town of Tarboro in Edgecombe County, North Carolina (Figure 1). The most upstream segment (Reach 1) begins at the outlet of the culvert under Forest Acres Drive and proceeds downstream to the town property line crossing the creek adjacent to the end of the Rosewood Drive cul-de-sac (~1,900 linear feet). The work in this section will consist of stream enhancement. The downstream segment (Reach 2) begins at the outlet of the culvert under Martin Luther King Jr. Drive and proceeds downstream for approximately 2,900 linear feet to the inlet of the St. James Street cross pipes. Stream restoration is proposed for this Reach. Patillo Elementary School is immediately to the west of the Canal on Reach 2.

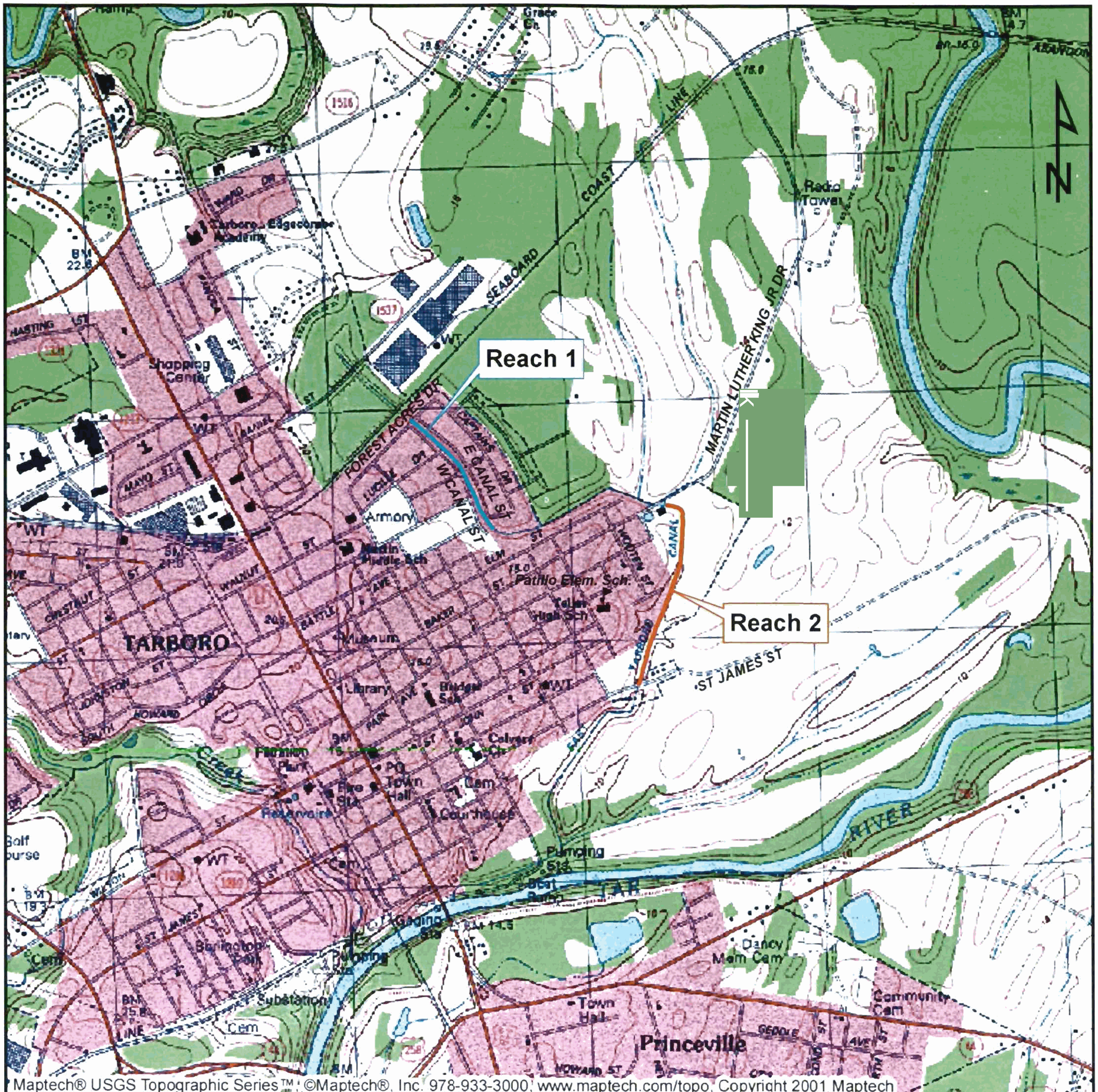
The town actively maintains East Tarboro Canal by dredging and cleaning debris out of both reaches. According to the town, this maintenance work is being done for flood control purposes. Appendix A contains a photo log of the site depicting existing conditions of the canal.

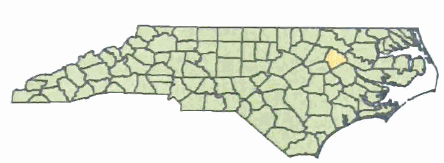
Vegetation throughout the majority of the site is minimal due to channel degradation and maintenance. Along Reach 1, there are row plantings of alternating loblolly pines (*Pinus taeda*) and crapemyrtles (*Lagerstroemia indica*) situated on the roadway shoulders that flank both sides of the canal. A majority of Reach 2 runs through a grassed park area. In Reach 2, there are no trees nor shrubs until the most downstream 300 feet where the town does not maintain the channel on both sides. There is a woody buffer along the left bank. The combination of extreme streambank erosion, lack of vegetation, and the cooperation of property owners make this an excellent potential restoration site.

Restoration and/or enhancement requires determining how far the stream has departed from its natural stability and then establishing the stable form of the stream under the current and future hydrologic conditions within the drainage area. The proposed enhancement on Reach 1 will involve raising the streambed in a few locations, vegetation planting, and the placement of structures to create a riffle-pool sequence that is currently lacking. The proposed restoration on Reach 2 will involve construction of stable meander geometry, modification of the channel cross-sections, and establishment of a floodplain at the existing stream elevation, thus, restoring a stable dimension, pattern, and profile. This restoration is based on analysis of current watershed hydrologic conditions, field evaluation of the project site, and the assessment of a stable reference reach. The following recommendations are included in this restoration plan:

- Form a stable channel with the proper dimension, pattern, and profile;
- Establish a floodplain along the stream channel where possible;
- Place natural material structures in the stream to improve stability and enhance aquatic habitat;
- Stabilize streambanks with herbaceous and woody vegetation; and
- Restore/enhance the streams riparian zone.

Q:\79457\GIS\FigsFeasPlan\F1_LocMap.mxd 11/04





Source: USGS Quadrangle, Tarboro, NC, 1981.

0 1,000 2,000 Feet

FIGURE 1
PROJECT LOCATION MAP

East Tarboro Canal
Tarboro, North Carolina

1.1 PROJECT DESCRIPTION

For purposes of this report, the restoration site is broken into two segments or reaches: Reach 1 lies between Forest Acres Drive and Rosewood Drive (1,917 linear feet) and Reach 2 extends 2,887 linear feet between Martin Luther King Jr. Drive and St. James Street. In reach 1, the East Tarboro Canal flows to the south and then to the southeast at the reach 1 terminus of construction. In Reach 2, the East Tarboro Canal flows southwesterly to the Tar River. Through both reaches the Town of Tarboro and Edgecombe Board of Education are the primary landowners. Several storm drainage pipes flow into the East Tarboro Canal along Reach 1. Two small drainage ditches, one swale, and several drainage pipes enter the canal downstream of Martin Luther King Jr. Drive in Reach 2.

1.2 GOALS AND OBJECTIVES

There are five overall goals for the project in its entirety. Each reach also has specific objectives to address particular problems within in each. The following are the overall goals:

1. Provide a stable stream channel that neither aggrades nor degrades while maintaining its dimension, pattern, and profile with the capacity to transport its watershed's water and sediment load.
2. Reconnect the canal to its floodplain and/or establish a new floodplain at a lower elevation.
3. Improve aquatic habitat with the use of natural material stabilization structures such as root wads, cross-vanes, woody debris, and riparian buffers.
4. Provide aesthetic value, wildlife habitat, and bank stability through the creation of a riparian zone.
5. Stabilize and enhance the small drainages that enter the site.

In addition to the above goals, Reach 1 has the following specific objectives that will be met for an Enhancement Level 1:

- Reducing erosion;
- Providing in-stream habitat;
- Protecting sewer and water lines from channel down-cutting;
- Planting native urban landscaping species; and
- Installing structures for adding in a riffle-pool system.

The following goals and objectives must be met to obtain full restoration credits for Reach 2:

- Reducing flooding problems;
- Planting native urban landscaping species; and
- Enhancing habitat through a wildlife corridor.

1.3 STREAM SURVEY METHODOLOGY

The US Forest Service General Technical Report RM-245, Stream Channel Reference Sites: An Illustrated Guide to Field Technique is used as a guide when taking field measurements (Harrelson et al 1994). Accurate field measurements are critical to determine the present condition of the existing channel, conditions of the floodplain, and watershed drainage patterns.

Earth Tech contracted with 4D Site Solutions, Inc. to conduct a topographic survey of the restoration site in September 2004. This mapping is used to evaluate present conditions, new channel alignment, and grading volumes. Mapping also provides locations of property lines, large trees, vegetation lines, culverts, roads, and elevations.

A stream survey of the property was conducted to better evaluate the drainage properties of the area surrounding the restoration site on August 21-22, 2004. A windshield survey was also conducted to determine the existing conditions within the watershed. During the site visit, three cross-sections on Reach 1 and eight cross-sections on Reach 2 were taken using standard differential leveling techniques. These cross-sections were used to gather details on the present dimension and condition of the channel. Due to recent channel disturbances, a bankfull feature was not reliably identified in the field. Cross-sectional area was calculated using the best estimate of the bankfull feature identified in the field. See Appendix B for a copy of the existing condition survey for the East Tarboro Canal.

1.3.1 Stream Delineation Criteria - Classification

Dave Rosgen developed his stream classification system in order to accomplish the following:

1) Predict a river's behavior;
2) Develop specific hydraulic and sediment relationships for a given stream type and its state;
3) Provide a mechanism to extrapolate site-specific data to stream reaches having similar characteristics; and
4) Provide a consistent frame of reference for communicating stream morphology and condition among a variety of disciplines and interested parties.

The Rosgen Stream Classification System is based on five criteria: width/depth ratio, entrenchment ratio, slope, sinuosity, and channel materials (1996). The cross-sections were classified using this system based on the few bankfull features present in the existing channel.

1.3.2 Bankfull Verification

The foundation of Dave Rosgen's classification system is the concept of bankfull stage, which is the point of incipient flooding. The classification depends on the correct assessment of bankfull. It is important to verify the physical indicators observed in the field with either gage data or a regional curve to ensure the correct assessment of the bankfull stage.

The bankfull stage is determined in the field using physical indicators. The following is a list of commonly used indicators that define bankfull (Rosgen, 1996):

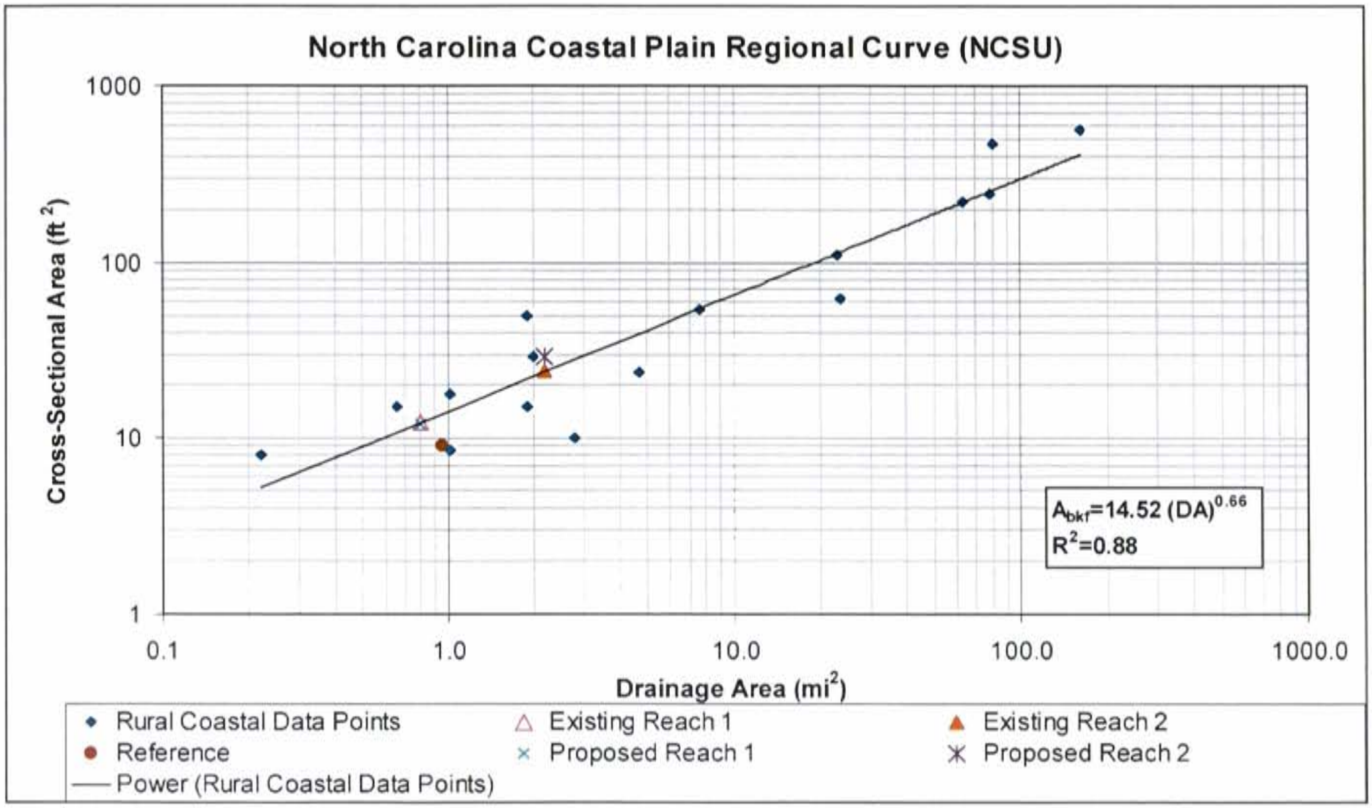
- The presence of a floodplain at the elevation of incipient flooding;
- The elevation associated with the top of the highest depositional feature (*e.g.* point bars, central bars within the active channel). These depositional features are especially good stage indicators for channels in the presence of terrace or adjacent colluvial slopes;
- A break in slope of the bank and/or a change in the particle size distribution, since finer material is associated with deposition by overflow, rather than deposition of coarser material within the active channel;
- Evidence of an inundation feature such as small benches below bankfull; and
- Staining of rocks.

Bankfull indicators were weak throughout both reaches of East Tarboro Canal. In Reach 1, there was a break in slope where a small bench has formed. In Reach 2, the channel had developed sinuosity and perhaps an inner berm where the town had not recently excavated the channel. Where the channel was recently excavated, there were no bankfull indicators due to the trapezoidal characteristics of the canal. In the lower section of Reach 2 where there were less human disturbances, a relatively consistent bankfull indicator was located along the left bank.

In ungauged areas like the East Tarboro Canal, Dave Rosgen recommends verifying bankfull with the development of regional curves. The regional curves normally plot bankfull discharge (Q_{bkf}), cross-sectional area, width, and depth as a function of drainage area. The cross-sectional areas of both reaches of the East Tarboro Canal, the reference reach, and the proposed design area are plotted on the North Carolina Coastal Plain Regional Curve developed by the North Carolina State University (NCSU) Water Quality Group, 2003 (Figure 2).

Data obtained from field surveys described in Section 2.2.2 were used to compute the morphological characteristics shown on the graph. The cross-sectional area for both reaches of East Tarboro Canal plot just above the trend line on the NC Coastal Plain Regional Curve (Figure 2).

Q:\79457\GIS\FigsFeasPlan\F2_RegCurve.mxd 11/04



Ecosystem Enhancement Program

FIGURE 2
NORTH CAROLINA COASTAL PLAIN BANKFULL CROSS-SECTIONAL AREA REGIONAL CURVE
East Tarboro Canal
Tarboro, North Carolina

2.0 EXISTING CONDITIONS

2.1 WATERSHED

2.1.1 General Description of the Watershed

East Tarboro Canal, a perennial stream, is located within the Coastal Plain Physiographic Province of the Tar River Basin (USGS Cataloging Unit 03020103). The watershed is located to the northeastern section of the Town of Tarboro in Edgecombe County, North Carolina. From the headwaters, the East Tarboro Canal flows for approximately 2.5 miles before entering the Tar River. Several small drainages enter the East Tarboro Canal along its extent.

The watershed for East Tarboro Canal is approximately 2.19 square miles (1,402 acres) at the end of Reach 2 (Figure 3). The watershed is oriented north to northeast. The topography of the watershed is relatively flat with wide floodplains. Land surface elevations range from approximately 16 to 72 feet above mean sea level. There are approximately 690 acres in the headwaters of this watershed that are currently undeveloped. Due to the relative proximity to the Town of Tarboro, it is likely that these parcels of land may be developed in the future.

2.1.2 Surface Waters Classification

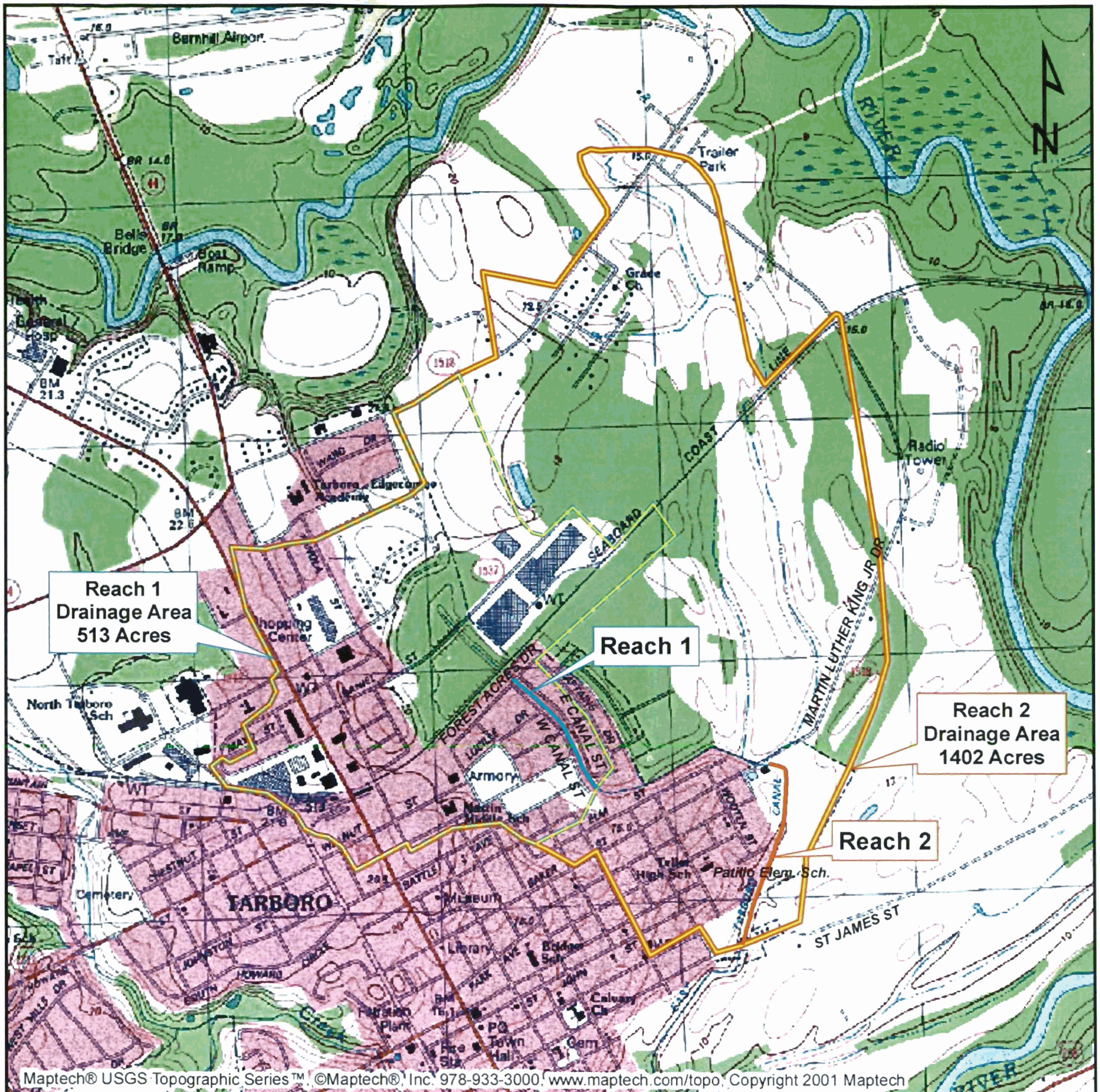
Surface waters in North Carolina are assigned a classification by the Division of Water Quality that is designed to maintain, protect, and enhance water quality within the state. The East Tarboro Canal is classified as Class C; NSW (28-(80)). *Class C* waters are freshwaters protected for secondary recreation, fishing, and aquatic life including propagation and survival, and wildlife.) The NSW classification is for waters that need additional nutrient management strategies for both point and non-point source pollution.

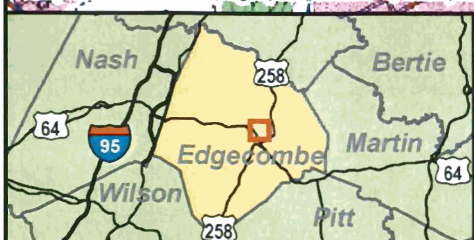
2.1.3 Land Use of the Watershed

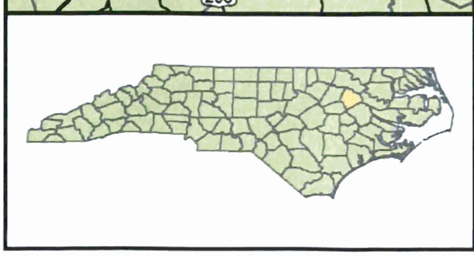
Land use within the watershed consists of commercial, residential, forested, and disturbed areas (sand quarry). Approximately 49% of the watershed is classified as agricultural/forested, 25% residential, 16% is a combination of commercial, industrial and institutional, and the remaining 11% is maintained (i.e. roads). Evaluation of a USGS topographic map reveals that approximately 18% of the watershed is impervious.

Based on conversations with town officials, the East Tarboro Canal has been actively maintained for at least 30 years. The channel maintenance was conducted to relieve flooding issues in the area.

Q:\79457\GIS\FigsFeasPlan\F3_WShed.mxd 11/04







Source: USGS Quadrangle,
Tarboro, NC, 1981.

0 1,000 2,000 Feet

Ecosystem Enhancement Program

FIGURE 3
EAST TARBORO CANAL
WATERSHED MAP

East Tarboro Canal
Tarboro, North Carolina

2.2 RESTORATION SITE

The following sections provide a description of existing site conditions. This includes the current stream conditions, soils, and surrounding plant communities.

2.2.1 Site Description

The project site begins downstream of Forest Acres Drive and flows for approximately 1,900 ft. in Reach 1. Reach 2 begins downstream of Martin Luther King Jr. Drive and continues downstream for approximately 2,900 linear ft. to Saint James Street. The project is located primarily on Town of Tarboro and the Edgecombe County Board of Education properties. Channel sinuosity for the entire reach is 1.02, with long straight stretches. High banks and areas of severe bank erosion can be found throughout both project reaches due to high in-stream shear stress and lack of streambank vegetation.

The causes of impairment throughout the restoration site are:

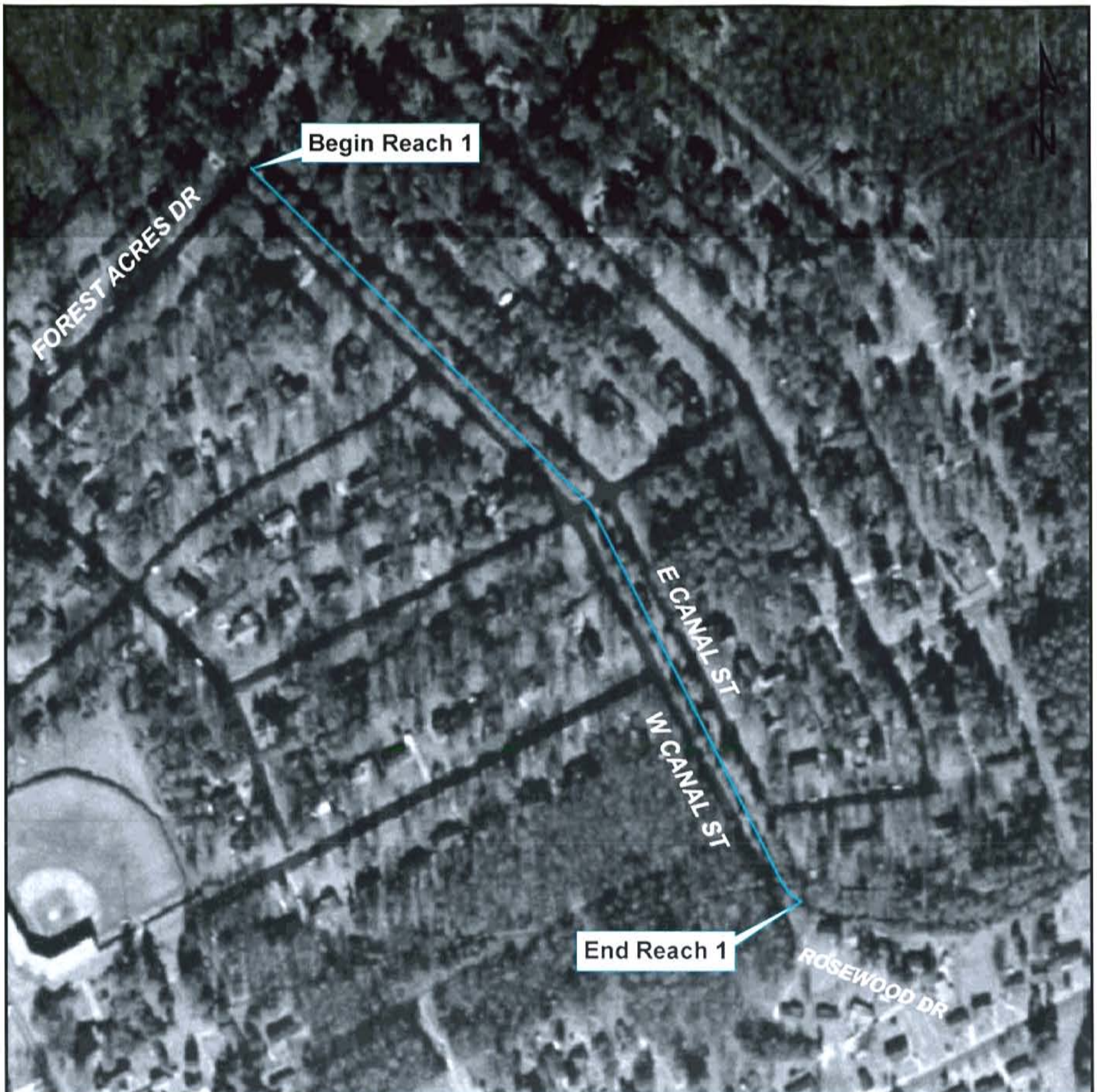
- Upstream development
- Road embankments adjacent to the streambanks on Reach 1;
- Previous channelization;
- Removal of riparian vegetation;
- Sedimentation on both reaches;
- Maintenance by the Town of Tarboro Public Works Department for flood control, and
- Recent channel modifications due to utility work and flood control.

2.2.2 Existing Stream Characteristics

Field surveys of the existing stream channels and surrounding floodplains were conducted to determine the potential for stream restoration on-site. The stream measurements are critical to the classification and assessment of the existing stream type. These measurements provide data to classify the stream using the Rosgen classification method, Levels I and II (Rosgen 1996).

Photographs of the site were taken and are provided in Appendix A. The channel can be typically described as a canal maintained by the Town of Tarboro for flood control (Figure 4). Although the channel is deeply incised and both reaches classify as G5c, Reach 2 is currently attempting to meander at a lower elevation by establishing a stable dimension, pattern, and profile within the new floodplain. Streambank erosion throughout the site is a result from pattern modifications and the lack of stream bank vegetation. An erosion assessment using the Bank Erosion Hazard Index was performed at each cross-section. Overall the banks of the canal in Reach 1 have high erosion potential while Reach 2 erosion potential varies from low to very high. Heavy rains, sandy soils, and a lack of vegetation have left unprotected soil on the streambanks vulnerable to erosion.

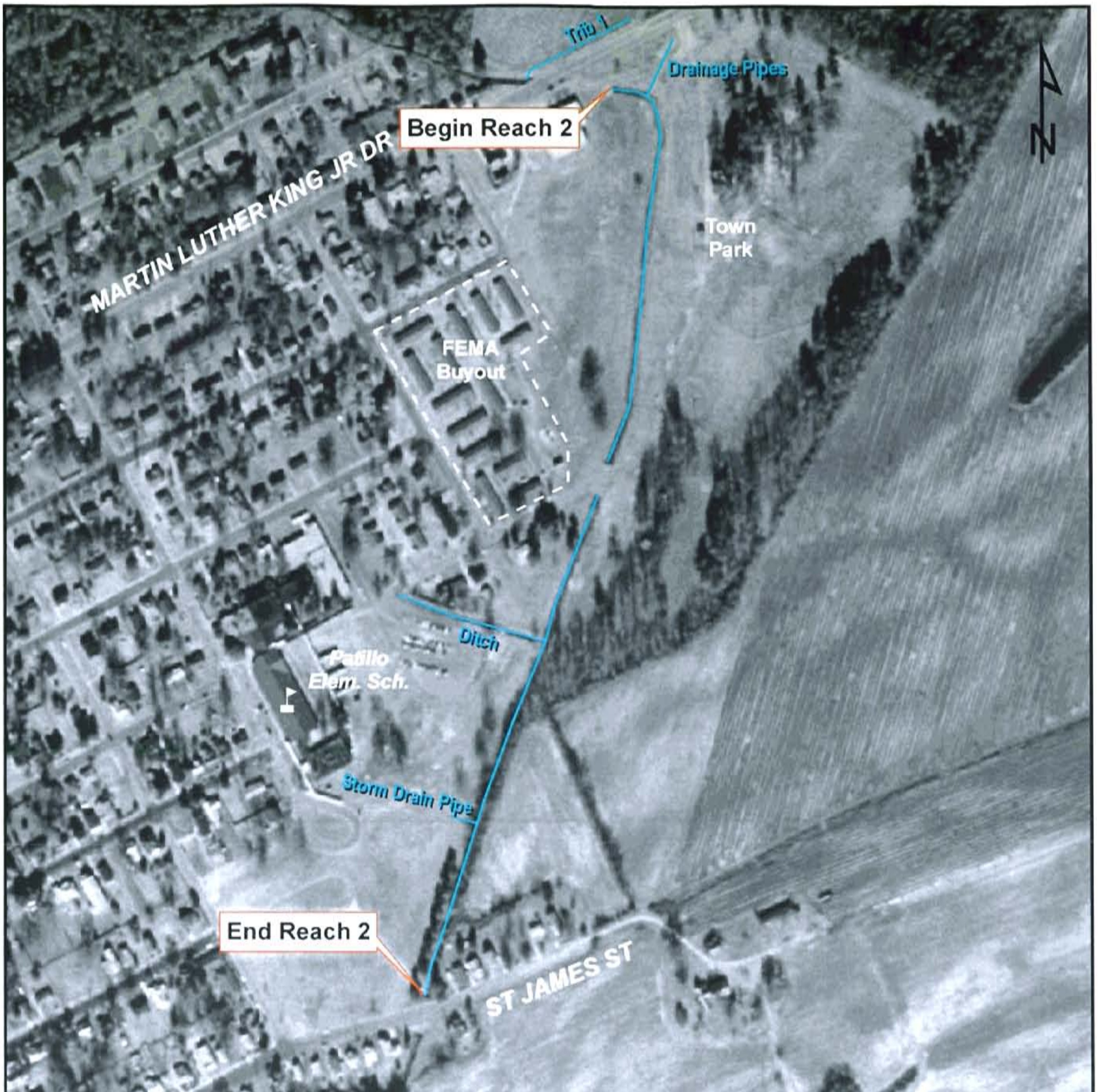
Q:\79457\GIS\FigsFeasPlan\F4A_ExCond.mxd 11/04



0 150 300 Feet

FIGURE 4A
EXISTING CONDITIONS
REACH 1

East Tarboro Canal
Tarboro, North Carolina



0 200 400 Feet

Ecosystem

FIGURE 4B
EXISTING CONDITIONS
REACH 2

East Tarboro Canal
Tarboro, North Carolina

Cross-Sections along Reach 1 and 2 were taken as well as a longitudinal profile in each reach. Since the bed material is sand, a pebble count was not performed on either reach nor was a pavement/subpavement sample taken. Figure 4 shows existing conditions for each reach. Detailed information on each reach may be found in Table 1. The survey information used to calculate the information for the existing conditions is included in Appendix B.

2.2.3 Soils of the Restoration Site

According to the Edgecombe County Soil Survey (USDA-SCS, 1979) several soil types are present in the project area (Figure 5). The soils mapped along the floodplain of the East Tarboro Canal in Reach 1 are Roanoke loam and Grantham-Urban land complex. The soils mapped along the floodplain of the East Tarboro Canal in Reach 2 are Portsmouth fine sandy loam and Roanoke loam. Surface runoff from these soils is slow to very slow and sometimes ponded in Portsmouth soil. Grantham, Portsmouth, and Roanoke soils are considered to be hydric by the NRCS. Soil units mapped by the NRCS along the floodplain at the site are briefly described below.

Grantham-Urban land complex (Gt). This unit is a poorly drained soil formed in Coastal Plain sediments and is found on nearly level broad interstream divides and shallow depressions in the uplands. The seasonal high water table is at the surface to 1 foot below the surface from December through March.

Portsmouth fine sandy loam (Pu). This unit is a very poorly drained soil formed in fluvial sediments and is found on nearly level broad flats and depressions on stream terraces. The seasonal high water table is at the surface to 1 foot below the surface throughout the year. A few small areas are subject to flooding.

Roanoke loam (Ro). This unit is a poorly drained soil formed in fluvial sediments and is found on nearly level broad flats and depressional areas along stream terraces. The seasonal high water table is at the surface to 1 foot below the surface from November through May. This soil is typically frequently flooded for brief periods.

The uplands immediately adjacent to the channel in Reach 2 are mapped as State loamy sand and Norfolk-Urban land complex. Land use and management of these soils may impact the soils in the project area.

Table 1. Morphological Characteristics

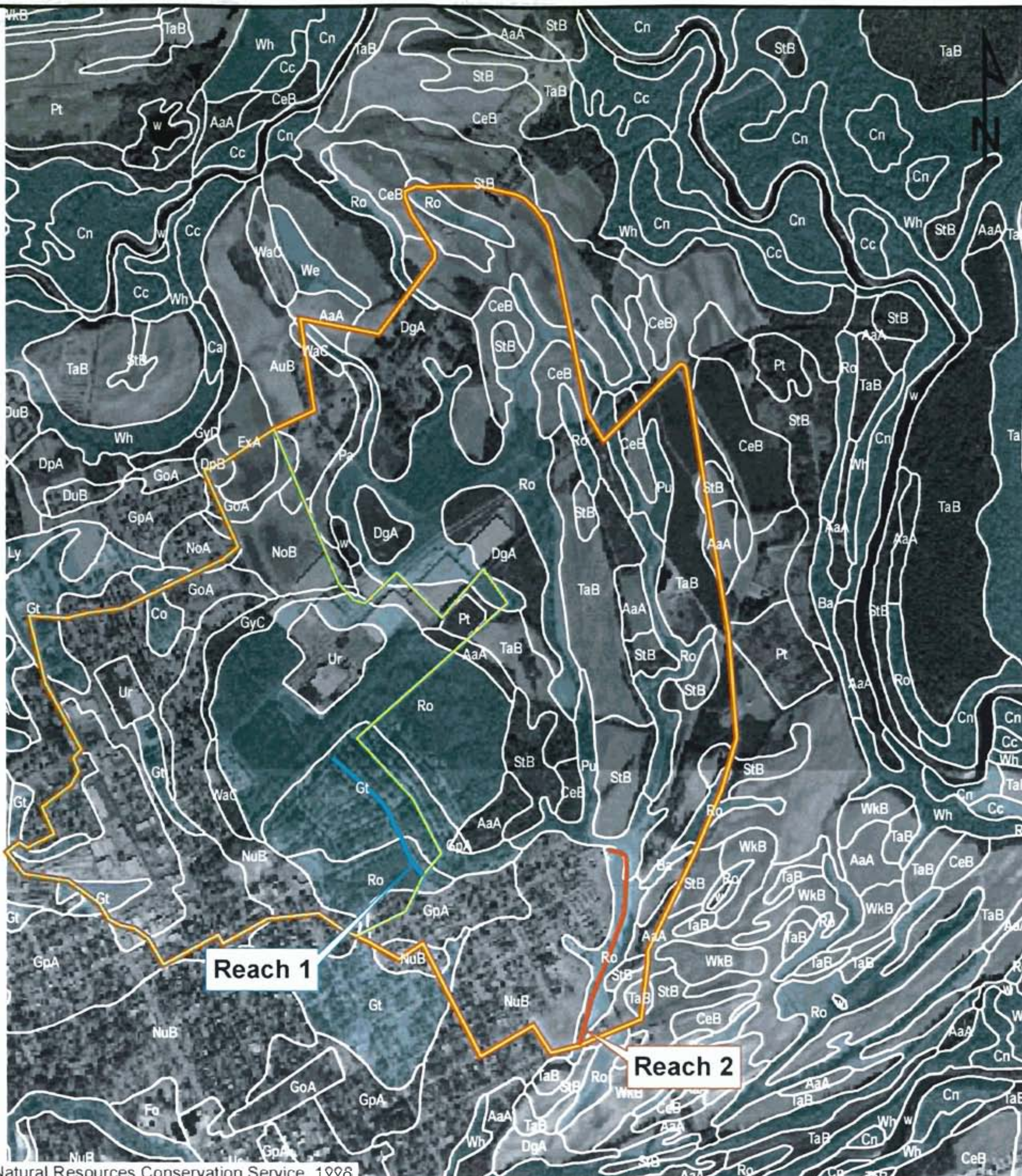
Variables	Existing East Tarboro Canal (Canal Street Section)	Existing East Tarboro Canal (ML King Dr. to St. James St.)	Reference Reach - (Trib. To Westbrook Mill Creek)	Proposed East Tarboro Canal (Canal Street Section)	Proposed East Tarboro Canal (ML King Dr. to St. James St.)
Stream Type (Rosgen)	G5c	G5c	C5	C5	C5
Drainage Area (sq. mi.)	0.80	2.19	0.95	0.80	2.19
Bankfull Width (W_{bkf}, ft)	7.3 - 9.8	14.0 - 17.0	10.8 - 11.0	12.0	20.0
MEAN	7.3	15.0	10.9		
Bankfull Mean Depth (d_{bkf}, ft)	1.23 - 2.02	1.50 - 1.72	0.77 - 0.87	1.00	1.46
MEAN	1.5	1.61	0.82		
Width/depth Ratio (W_{bkf}/d_{bkf})	3.6 - 8.0	8.2 - 11.4	12.6 - 14.1	12.0	13.7
MEAN	5.6	9.4	13.4		
Bankfull Cross-sectional Area (A_{bkf} sq. ft.)	10.1 - 14.7	22.8 - 25.4	8.3 - 9.6	12.0	29.25
MEAN	12.3	24.1	9.0		
Bankfull Maximum Depth (d_{max} ft)	1.54 - 2.92	2.20 - 2.37	1.24 - 1.45	1.60	2.50
MEAN	2.0	2.32	1.34		
Ratio Bankfull Maximum Depth to Mean Bankfull Depth (d_{max}/d_{bkf})	1.3	1.4	1.63	1.6	1.71
Low Bank Height to Bankfull Maximum Depth Ratio	2.06 - 5.54	2.16 - 3.15	1.07 - 1.00	1.0	1.0
Width of Flood Prone Area (W_{fpa} ft)	11 - 21	23 - 25	>100 - >100	N/A	44-120+
MEAN	15	24	>100		
Entrenchment Ratio (W_{fpa}/W_{bkf})	1.3 - 2.9	1.5 - 1.7	>9.1 - >9.3	2.2	2.2 - 6.0
Meander Length (L_m ft)	No Meander	154 - 226	39 - 64	N/A	72 - 170
MEAN	N/A	190	50.4		
Ratio of Meander Length to Bankfull Width	N/A	10.3 - 15.1	3.6 - 5.9	N/A	3.6 - 8.5
(L_m/W_{bkf}) MEAN	N/A	12.7	4.6	N/A	4.8
Radius of Curvature (R_c ft)	No Curves	75 - 560	14.4 - 39.8	N/A	40 - 72
MEAN	N/A	220	23.3	N/A	56
Ratio of Radius of Curvature to Bankfull Width	N/A	5.0 - 37.3	1.3 - 3.6 ***	N/A	2.0 - 3.6
(R_c/W_{bkf}) MEAN	N/A	14.7	2.1	N/A	2.8
Belt Width (W_{blt} ft)	N/A	29 - 47	12.5 - 25.0	N/A	22 - 46
MEAN	N/A	39	18.8	N/A	34
Meander Width Ratio (W_{blt}/W_{bkf})	N/A	1.9 - 3.1	1.1 - 2.3	N/A	1.1 - 2.3
MEAN	N/A	2.6	1.7	N/A	1.7
Sinuosity (Stream Length/Valley Length, k - ft/ft)	1.01	1.03	1.3	N/A	1.2 - 1.4
Valley Slope (S_{valley}) ft/ft	0.0022	0.0022	0.0038	0.0022	0.0022
Average Water Surface Slope (S_{avg})	0.0001 *	0.0007 **	0.0030	0.0022	0.0018
Pool Slope (S_{pool})	No Sequence	0.0000 - 0.0004	0.0000 - .0117	0.0000 - 0.0010	0.0000 - 0.0010
MEAN	N/A	0.0002	0.0034		
Ratio of Pool Slope to Average Slope (S_{pool}/S_{avg})	N/A	0.3	1.1	0.0 - 0.5	0.0 - 0.6
Riffle Slope (S_{riff} ft/ft)	No Sequence	0.0002 - 0.0044	0.0000 - 0.0055	0.0000 - 0.0040	0.0000 - 0.0036
MEAN	N/A	0.0022	0.0022		
Ratio of Riffle Slope to Average Slope (S_{riff}/S_{avg})	N/A	0.3 - 6.3	0.0 - 1.8	0.0 - 1.8	0.0 - 2.0
MEAN	N/A	3.1	0.7		
Maximum Pool Depth (d_{pool} ft)	No Sequence	3.02 - 3.81	1.43 - 2.06	2.00	3.33
Ratio of pool depth to mean bankfull depth (d_{pool}/d_{bkf})	N/A	2.1	2.0	2.0	2.3
Pool Area (Parea S.F.)	N/A	27.1	11.9	16.0	38.5
Ratio of Pool Area to Riffle Area (A_{pool} S.F.)	N/A	1.1	1.3	1.3	1.3
Pool Width (W_{pool} ft)	N/A	23.3	13.0	15.0	24.0
Ratio of Pool Width to Bankfull Width (W_{pool}/W_{bkf})	N/A	1.6	1.2	1.3	1.2
Pool to Pool Spacing (P-P ft)	N/A	44 - 133	16 - 45	18 - 50	32 - 86
MEAN	N/A	90	32.3	34	59
Ratio of P-P to Bankfull Width (P-P/W_{bkf})	N/A	2.9 - 8.9	1.5 - 4.1	1.5 - 4.1	1.5 - 4.1
MEAN	N/A	6.0	3.0	2.8	3.0

* Slope of .0022 between culvert inverts will likely better approximate the bankfull discharge water surface slope. Slope of .0001 is at low flow and due to ponding in downcut channel.

** Slope of .0021 between culvert inverts will likely better approximate the bankfull discharge water surface slope. Slope of .0007 is at low flow and due to ponding in downcut channel.

*** Rosgen recommends keeping the Rc/Wbkf >2.0 for stability.

Q:\79457\GIS\FigsFeasPlan\F5_Soils.mxd 11/04



Source: USDA - Natural Resources Conservation Service, 1998

Name	Description
AaA	Altavista fine sandy loam. 0 to 3 percent slopes
AuB	Autryville loamy sand 0 to 6 percent slopes
Ba	Ballahack fine sandy barn'
CeB	Conetoe loamy sand 0 lo 4 percent slopes
DgA	Dogue fine sandy loam 0 to 3 p a w n slopes
GoA	Goldsboro fine sandy s a n 0 to 2 percent slopes
GpA	Goldsboro-Urban land complex, 0 to 2 percent slopes
Gt	Grantham-Urban land complex*
GyC	Gritney fine sandy loam 6 to 10 percent slopes
NoA	Norfolk loamy sand 0 to2 percent slopes
NoB	Norfolk loamy sand, 2 to6 percent slopes
Pa	Pactolus loamy sand
Pt	Pits
Pu	Portsmouth fine sandy loam'
Ro	Roanoke loam*
StB	State loamy sand, 0 to 4 percent slopes
TaB	Tarboro loamy sand 0 to 6 percent slopes
Ur	Urban land
w	Water
WaC	Wagram loamy sand 6 to 10 percent slopes
We	Wahee fine sandy loam. 0 to 4 percent slopes*
WkB	Wickham sandy loam, 0 to 4 percent slopes

Hydric Soil

0 1,000 2,000 Feet

Ecosystem Enhancement

FIGURE 5
SOILS

East Tarboro Canal
Tarboro, North Carolina

2.2.4 Geotechnical Investigations

Froehling & Robertson, Inc. has performed Geotechnical investigations for both stream reaches. The report is located in Appendix D. A total of five soil test borings were performed. Soils encountered are predominately loose sands, soft clays, and stiff silts. Due to the loose and soft condition of the native sand, Froehling & Robertson, Inc recommend that stream banks be graded no steeper than 3 Horizontal to 1 Vertical (3H:1V) for slope stability. In some locations, slopes of 2.5H:1V may be used.

2.2.5 Terrestrial Plant Communities

The following sections describe the existing plant communities on and adjacent to the restoration site (Figure 4). Historically the entire floodplain of the East Tarboro Canal was most likely a continuous bottomland hardwood ecosystem connecting, flooding, and draining numerous adjacent wetlands. This ecosystem is now altered and fragmented by various land uses. The previous floodplain is no longer available for overbank flows because of filling of the floodplain and channel incision. The communities that now exist along the East Tarboro Canal are drier, well drained urban landscapes that no longer resemble the original plant communities. Nomenclature follows Radford et al (1968) and the National Plants Database (USDA-NRCS 2004).

2.2.5.1 Street Scape

The upper reach of this project is located between two urban residential streets, East Canal Street and West Canal Street. Within this reach the banks are steep to nearly vertical and lack woody vegetation. Herbaceous vegetation is reduced because of the frequent mowing. The area between the top of the banks and the edge of pavement is frequently maintained. Vegetation consists of a row on each bank consisting of loblolly pines (*Pinus taeda*) that alternate with crapemyrtle (*Lagerstroemia indica*) and photinia (*Photinia* sp.). The closely mowed grass is centipede grass (*Eremochloa ophiuroides*). Although overbank flooding occurs on occasions, this area is relatively dry because of the deeply incised channel and well-drained, sandy soil surrounding the channel.

2.2.5.2 Maintained Grass Field

An area consisting of an open grass field, parking lot, and picnic area is located in the middle and lower reaches near Patillo Elementary School. The area surrounding the stream is herbaceous and is maintained regularly through mowing, often to the edge of the channel. Species within the open field include Bermudagrass (*Cynodon dactylon.*), centipede grass, crab grass (*Digitaria* sp.), bahiagrass (*Paspalum notatum*), Carolina horsenettle (*Solanum carolinense*), and buckhorn plantain (*Plantago lanceolata*). Vegetation in the channel included a few other species including soft rush (*Juncus effusus*) and sedges.

2.2.5.3 Wooded Buffer

A narrow wooded buffer is located in the lower reach along the east side of the canal. Beyond this buffer is a field with agricultural row crops. The woody species found within the buffer include sweet gum (*Liquidambar styriciflua*), water oak (*Quercus nigra*), river birch (*Betula nigra*), common elderberry (*Sambucus nigra* ssp. *Canadensis*), Japanese honeysuckle (*Lonicera japonica*), and privet (*Ligustrum sinense*). The canal is wider and less maintained in this section. Much of the vegetation canopies the a portion of the channel. Within this reach, additional herbaceous species are found including deertongue (*Dichanthelium clandestinum*), Virginia dayflower (*Commelina virginica*), and eastern gamagrass (*Tripsacum dactyloides*). Within the channel, wartremoving herb (also called Asian dayflower) (*Murdannia keisak*) is also present.

2.2.6 Wildlife Observations and Protected Species

Wildlife and signs of wildlife were noted during on-site visits; however, a formal wildlife survey was not performed. Tracks of white tailed deer (Odocoileus virginianus) and raccoon (Procyon lotor) were observed along the stream banks.

The USFWS lists two species under federal protection and seven species of federal concern for Edgecombe County (list updated February 13 2003 - USFWS 2004). These species are listed in Table 2.

Table 2. Federally Protected Species in Edgecombe County, NC

Common Name	Scientific Name	Status
Vertebrates		
"Carolina" madtom	*Noturus furiosuspopulation 2*	FSC
Eastern Henslow's sparrow	*Ammodramus henslowii*	FSC
Pinewoods shiner	*Lythrurus matutinus*	FSC
Red-cockaded woodpecker	*Picoides borealis*	Endangered
Southern hognose snake	*Heterodon simus*	FSC*
Invertebrates		
Atlantic pigtoe	*Fusconaia masoni*	FSC
Tar spinymussel	*Elliptio steinstansana*	Endangered
Yellow lampmussel	*Lampsilis cariosa*	FSC
Yellow lance	*Elliptio lanceolata*	FSC

Notes:
FSC Federal Species of Concern
* Historic record–the species was last observed in the county more than 50 years ago.
USFWS – List updated February 13, 2003

3.0 REFERENCE REACHES

3.1 Unnamed Tributary to Mill Creek

The Unnamed Tributary to Mill Creek (UT Mill Creek) is a first order stream flowing into the Neuse River in Bentonville located in Johnston County, NC (Figure 6). The watershed area is approximately 608 acres (0.95 square miles), most of which is rural farmland.

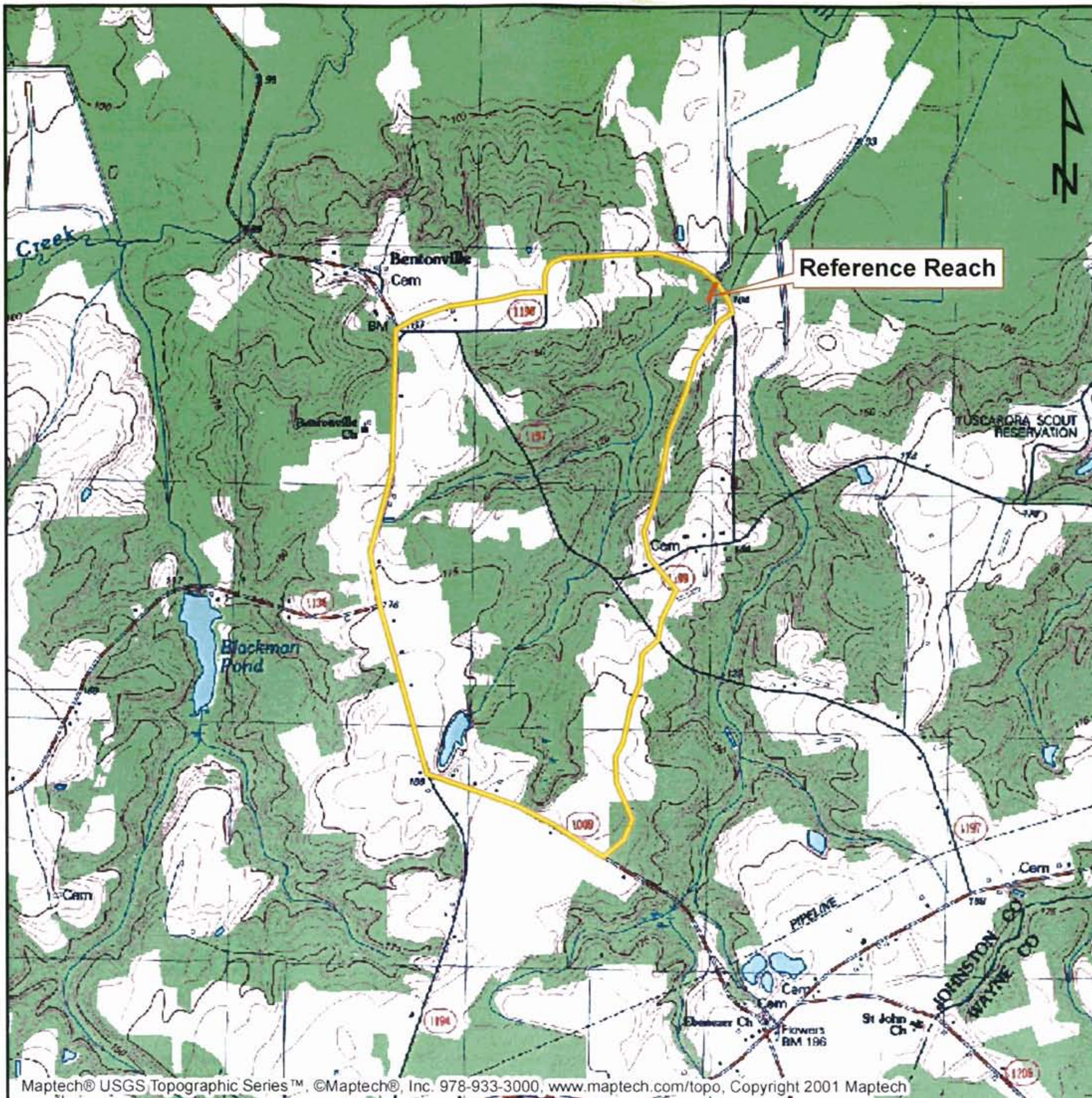
The watershed boundary to the east is NC 1197 (Bentonville Road), to the south SR 1009 (Devils Racetrack Road), and then follows the ridgelines to the reference reach site. The watershed is predominately comprised of single-family residences, forested areas, and farms.

Approximately 280 linear feet of this stream was surveyed on September 13, 2004 to obtain the morphological data. This length of channel was determined from the bankfull width of the first cross-section that was taken (10.8 ft. wide). The reference reach length falls within that recommended by Rosgen; a range of 20 to 30 bankfull widths.

The streambed is composed of sand with some small gravel in the riffle cross-sections. Signs of recent overbank storm flows are evident by the amount of debris on the upstream side of trees in the floodplain. This reference classifies as a C5 stream type with a mean width-to-depth ratio of 13.4 and a sinuosity of 1.28. The complete data set for this reference reach can be found in Appendix C and a summary can be found in Table 2.

The vegetation is of fairly good reference quality, given the difficulty of finding undisturbed stands of forest. The canopy trees are a mixture of age classes, but very few are of large diameter. Pines are a minor component, indicating that the stand is approaching maturity. The canopy is relatively dense, reaching approximately 60 feet in height with the mid-canopy still developing. A few trees appeared to be older and may have been established along the buffer prior to the existing forest development. Canopy and subcanopy trees include sweetgum, red maple (*Acer rubrum*), yellow poplar (*Liriodendron tulipifera*), swamp chestnut oak (*Quercus michauxii*), loblolly pine, and swamp tupelo (*Nyssa biflora*). Shrubs and vines are abundant but not dense and include coastal doghobble (*Leucothoe axillaris*), sweet pepper bush (*Clethra alnifolia*), swamp greenbriar (*Smilax laurifolia*), grape (*Vitis* sp.), American holly (*Ilex opaca*), and greenbriar (*Smilax rotundifolia*). The herbaceous layer includes Nepalese browntop (*Microstegium vimineum*), cinnamon fern (*Osmunda cinnamomea*), and giant cane (*Arundinaria gigantea*). Wetter areas on the floodplain and along the stream also included netted chain fern (*Woodwardia areolata*) and jewel weed (*Impatiens capensis*). This community appears to be a marginal example of a *Quercus michauxii* - *Quercus pagoda* Saturated Forest Alliance (I.B.2.N.g.7).

Q:\79457\GIS\FigsFeasPlan\F6_RefReach.mxd 11/04



Source: USGS Quadrangle, Newton Grove North, NC, 1986.

0 1,000 2,000 **Feet**

Ecosystem Enhancement

FIGURE 6
REFERENCE REACH
UNNAMED TRIBUTARY TO MILL CREEK
East Tarboro Canal
Tarboro, North Carolina

4.0 STREAM CHANNEL DESIGN

The proposed design is based upon Dave Rosgen's natural channel design methodology. As described in Section 3.0, UT to Mill Creek was utilized as a reference reach on which the morphological characteristics were measured to determine a range of values for the stable dimension, pattern, and profile of the proposed channel. The existing, reference, and proposed morphological characteristics are shown in Table 1.

Reach 1 will be modified to improve the bedform and to increase the vegetation on the streambanks. The two roads that bound the project, East and West Canal Street, restrict any pattern adjustment. However, bankfull benches and grading of the slope will be performed in order to improve the stream's dimensional characteristics. This design will be classified as Enhancement due to the fact that only the profile and dimension will be modified in addition to the vegetation.

The design of Reach 2 will include dimension, pattern and profile adjustments in addition to vegetation and buffer establishment. Therefore, this reach will qualify for Restoration credits. The proposed stream will include a meandering plan form that incorporates in-stream natural material structures for stability and habitat value. The drainages that enter the canal in this reach will be incorporated into the design, which will integrate a stable tie-in with the East Tarboro Canal. There will be no natural channel design of these minor drainage ways, other than in-stream structures at the tie-in with the main channel.

A conceptual design was developed from the range of values listed in Table 1. This project will enhance approximately 1,833 linear feet in Reach 1 and restore approximately 2,946 linear feet of Reach 2 as measured along the proposed centerline of East Tarboro Canal (excluding culvert lengths). The plan view of the proposed restoration design can be seen in Figure 7.

4.1 RESTORATION TECHNIQUES

Stream dimension, pattern, and profile will be adjusted so the new stream channel can maintain stability while transporting its water and sediment load. Enhancement will involve adjusting the profile and dimension of Reach 1 while the dimension, pattern and profile of Reach 2 will be modified to qualify as restoration of the East Tarboro Canal (Figure 7).

Vegetation will be used to provide stability and provide habitat along the streambanks and in the riparian area. In Reach 1, primarily low growing shrubs and herbaceous vegetation will be planted due to the limited width of the buffer, adjacent landowner concerns, and sight constraints for traffic. Reach 2 will include the addition of more woody vegetation in the form of trees and shrubs in addition to herbaceous vegetation. Reach 2 has a wide floodplain available for buffer establishment. The main landowner in this reach is the Town of Tarboro, which is a great advantage to this project.

Note: Not to Scale

***S.U.E. = Subsurface Utility Engineering**

CONVENTIONAL PLAN SHEET SYMBOLS

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

RAILROADS:
- Standard Guage (CSX TRANSPORTATION)
- RR Signal Milepost (MILEPOST 35)
- Switch (SWITCH)
- RR Abandoned
- RR Dismantled

BOUNDARIES AND PROPERTY:
- Property Line
- Existing Iron Pin
- Property Corner
- Property Monument
- Existing Fence Line
- Proposed Woven Wire Fence
- Proposed Chain Link Fence
- Proposed Barbed Wire Fence
- Existing Wetland Boundary
- Proposed Wetland Boundary
- Existing High Quality Wetland Boundary
- Existing Endangered Animal Boundary
- Existing Endangered Plant Boundary

BUILDINGS AND OTHER CULTURE:
- Gas Pump Vent or U/G Tank Cap
- Sign
- Well
- Small Mine
- Foundation
- Area Outline
- Cemetery
- Building
- School
- Church
- Dam

HYDROLOGY:
- Stream or Body of Water
- Hydro, Pool or Reservoir
- River Basin Buffer (RBB)
- Flow Arrow
- Disappearing Stream
- Spring
- Swamp Marsh
- Proposed Lateral, Tail, Head Ditch (FLOW)

RIGHT OF WAY:
- Existing Right of Way Marker
- Existing Right of Way Line
- Existing Easement Line (E)
- Proposed Temporary Construction Easement (E)
- Proposed Temporary Drainage Easement (TDE)
- Conservation Easement (CE)

ROADS AND RELATED FEATURES:
- Existing Edge of Pavement
- Existing Curb
- Proposed Slope Stakes Cut (C)
- Proposed Slope Stakes Fill (F)
- Existing Metal Guardrail
- Proposed Guardrail
- Existing Cable Guiderail
- Proposed Cable Guiderail

VEGETATION:
PN = PINE
HW = HARDWOOD
ORN = ORNAMENTAL

- Single Tree
- Single Shrub
- Hedge
- Woods Line
- Orchard
- Vineyard (Vineyard)

STREAM RESTORATION
- Root Wad Area
- Rock Sill
- Rock Grade Control Vane
- Rock Cross Vane
- J-Hook
- Channel Plug
- Rock Stone Toe protection

EXISTING STRUCTURES:
MAJOR:
- Bridge, Tunnel or Box Culvert (CONC)
- Bridge Wing Wall, Head Wall and End Wall (CONC WW)

MINOR:
- Head and End Wall (CONC HW)
- Pipe Culvert
- Footbridge
- Drainage Box: Catch Basin, DI or JB (CB)
- Paved Ditch Gutter
- Storm Sewer Manhole
- Storm Sewer (S)

UTILITIES:
POWER:
- Existing Power Pole
- Proposed Power Pole
- Existing Joint Use Pole
- Proposed Joint Use Pole
- Power Manhole
- Power Line Tower
- Power Transformer
- U/G Power Cable Hand Hole
- H-Frame Pole
- Recorded U/G Power Line (P)
- Designated U/G Power Line (S.U.E.*) (P)

TELEPHONE:
- Existing Telephone Pole
- Proposed Telephone Pole
- Telephone Manhole
- Telephone Booth
- Telephone Pedestal
- Telephone Cell Tower
- U/G Telephone Cable Hand Hole
- Recorded U/G Telephone Cable (T)
- Designated U/G Telephone Cable (S.U.E.*) (T)
- Recorded U/G Telephone Conduit (TC)
- Designated U/G Telephone Conduit (S.U.E.*) (TC)
- Recorded U/G Fiber Optics Cable (T FO)
- Designated U/G Fiber Optics Cable (S.U.E.*) (T FO)

WATER:
- Water Manhole
- Water Meter
- Water Valve
- Water Hydrant
- Recorded U/G Water Line
- Designated U/G Water Line (S.U.E.*)
- Above Ground Water Line (A/G Water)

TV:
- TV Satellite Dish
- TV Pedestal
- TV Tower
- U/G TV Cable Hand Hole
- Recorded U/G TV Cable (TV)
- Designated U/G TV Cable (S.U.E.*) (TV)
- Recorded U/G Fiber Optic Cable (TV FO)
- Designated U/G Fiber Optic Cable (S.U.E.*) (TV FO)

GAS:
- Gas Valve
- Gas Meter
- Recorded U/G Gas Line (G)
- Designated U/G Gas Line (S.U.E.*) (G)
- Above Ground Gas Line (A/G Gas)

SANITARY SEWER:
- Sanitary Sewer Manhole
- Sanitary Sewer Cleanout
- U/G Sanitary Sewer Line (SS)
- Above Ground Sanitary Sewer (A/G Sanitary Sewer)
- Recorded SS Forced Main Line (FSS)
- Designated SS Forced Main Line (S.U.E.*) (FSS)

MISCELLANEOUS:
- Utility Pole
- Utility Pole with Base
- Utility Located Object
- Utility Traffic Signal Box
- Utility Unknown U/G Line (?UTL)
- U/G Tank; Water, Gas, Oil
- A/G Tank; Water, Gas, Oil
- U/G Test Hole (S.U.E.*)
- Abandoned According to Utility Records — AATUR
- End of Information — E.O.I.

SCALE 50 0 50 100

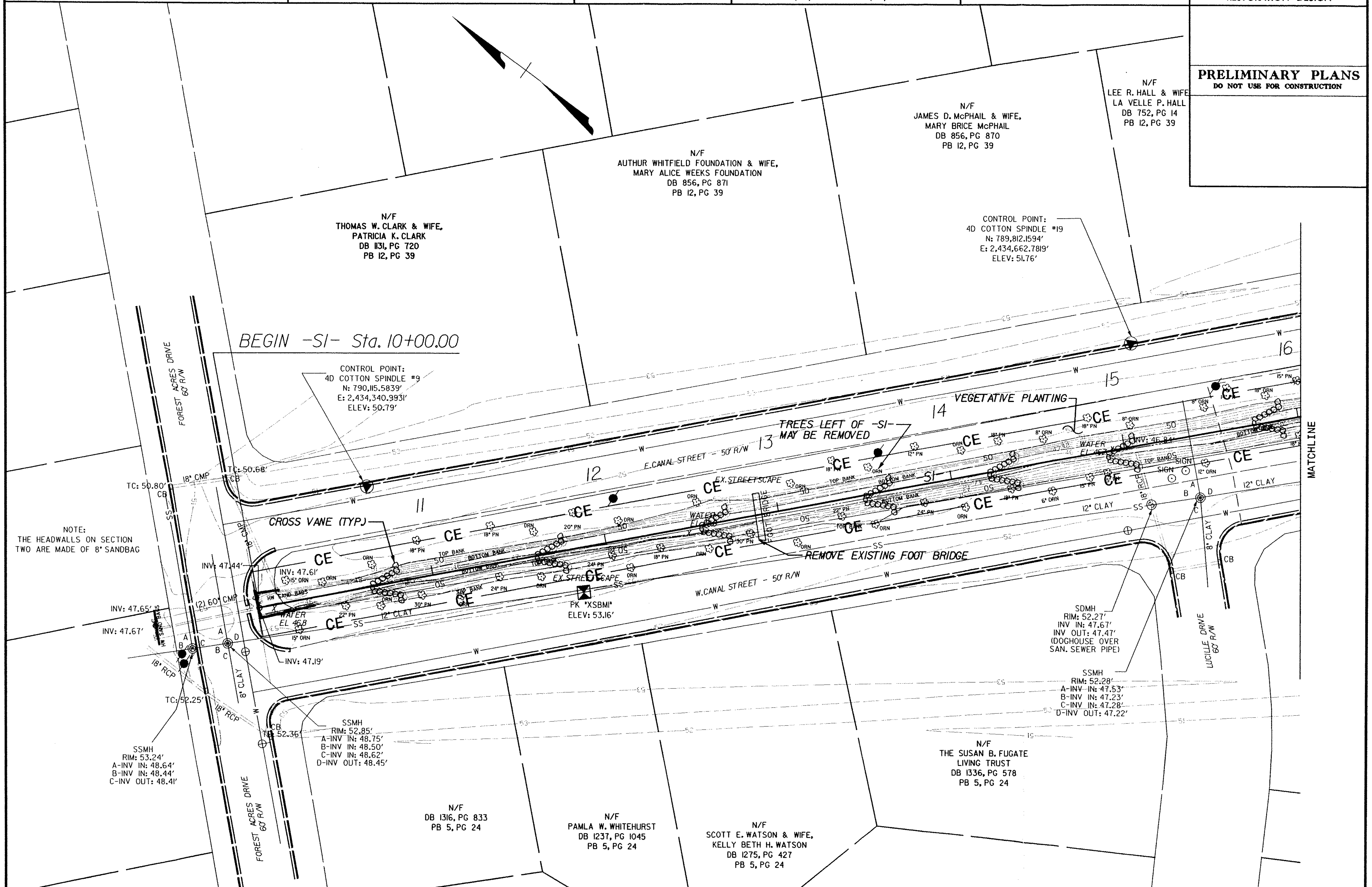
EarthTech
A Tyco International Ltd. Company
701 Corporate Center Drive, Suite #475; Raleigh, NC 27607
Phone: (919) 854-6200 Fax: (919) 854-6259

EAST TARBORO CANAL STREAM RESTORATION
EDGECOMBE COUNTY
ECOSYSTEM ENHANCEMENT PROGRAM

PROJECT NO.	SHEET NO.
	FIGURE 7-B

PROPOSED STREAM RESTORATION DESIGN

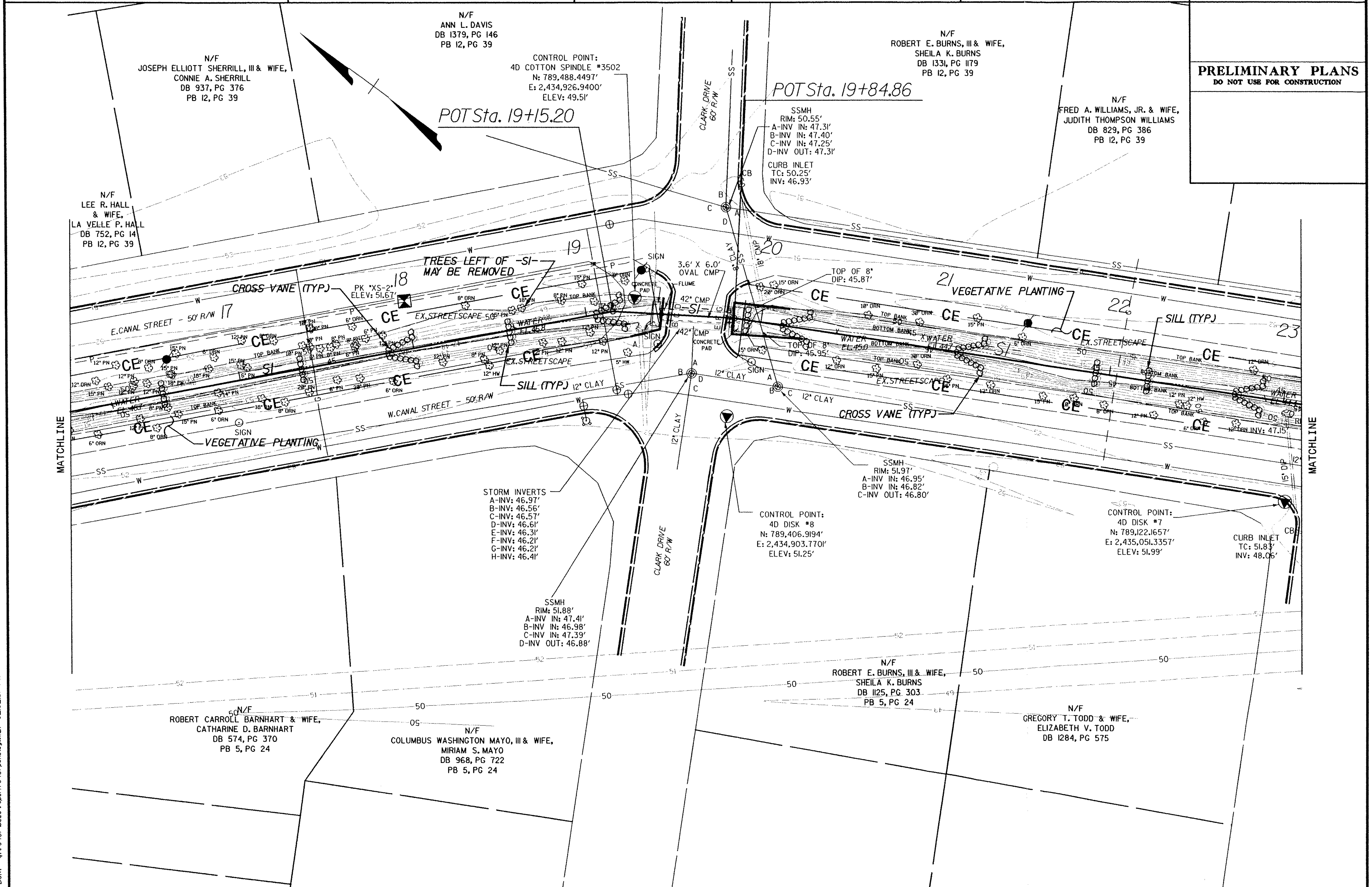
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION



USER: el DATE: 01/12/2005
DGN: q:\79457\cadd\report\79457psht8.dgn TIME: 02:32:56 PM

SCALE 50 0 50 100	EarthTech A Tyco International Ltd. Company 701 Corporate Center Drive, Suite #475; Raleigh ,NC 27607 Phone: (919) 854-6200 Fax: (919) 854-6259	EAST TARBORO CANAL STREAM RESTORATION EDGECOMBE COUNTY ECOSYSTEM ENHANCEMENT PROGRAM	PROJECT NO.	SHEET NO. FIGURE 7-C
			PROPOSED STREAM RESTORATION DESIGN	

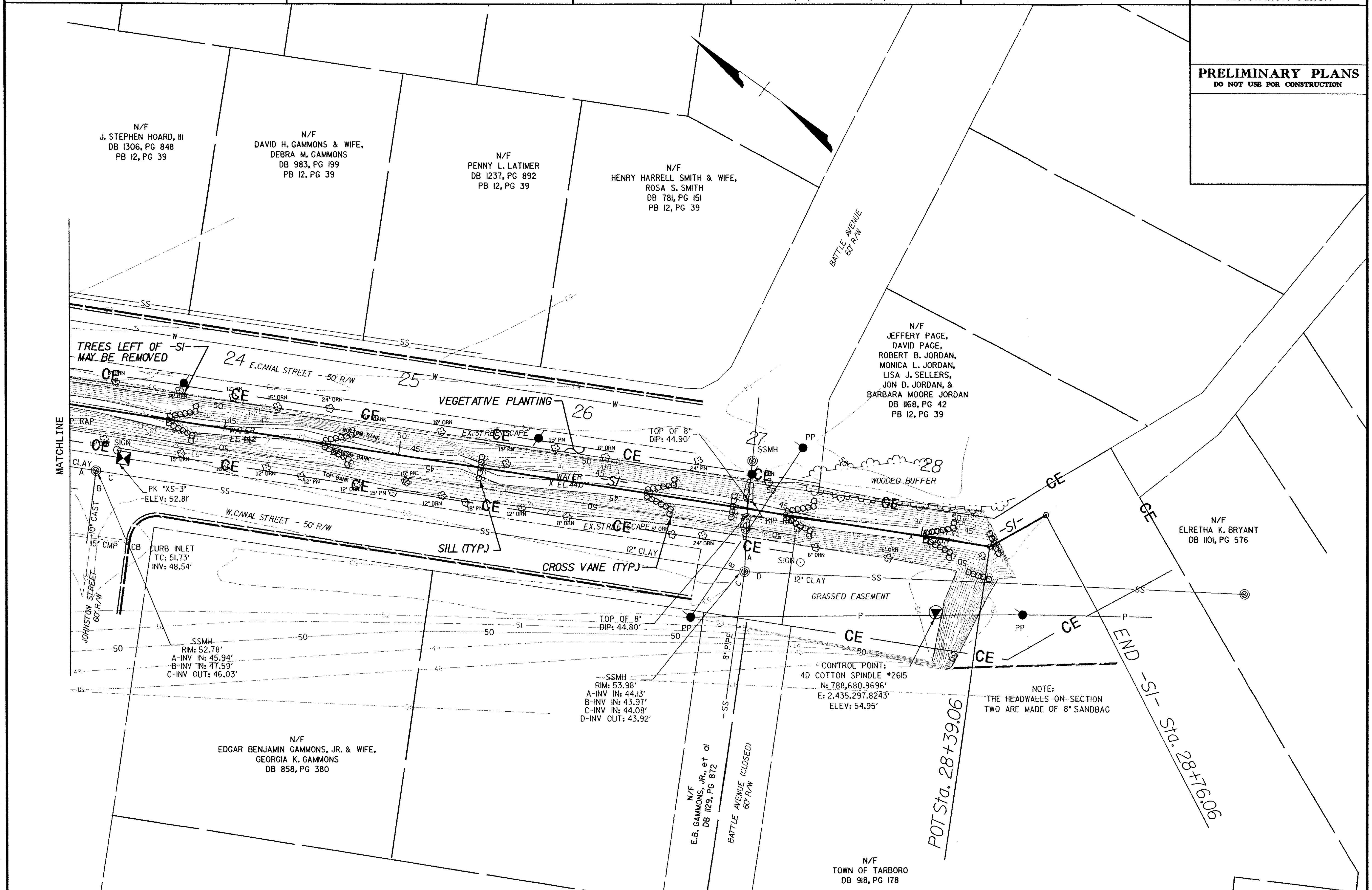
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION



USER: ej DATE: 01/12/2005
DGN: q:\79457\cadd\report\79457pst9.dgn TIME: 02:32:57 PM

SCALE	EarthTech	EAST TARBORO CANAL STREAM RESTORATION	PROJECT NO.	SHEET NO.
50 0 50 100	A Tyco International Ltd. Company 701 Corporate Center Drive, Suite #475; Raleigh ,NC 27607 Phone: (919) 854-6200 Fax: (919) 854-6259	EDGECOMBE COUNTY ECOSYSTEM ENHANCEMENT PROGRAM		FIGURE 7-D
			PROPOSED STREAM RESTORATION DESIGN	

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION



USER: ej DGN: q:\79457\cadd\report\79457psh10.dgn DATE: 01/12/2005 TIME: 02:32:57 PM

SCALE 50 0 50 100

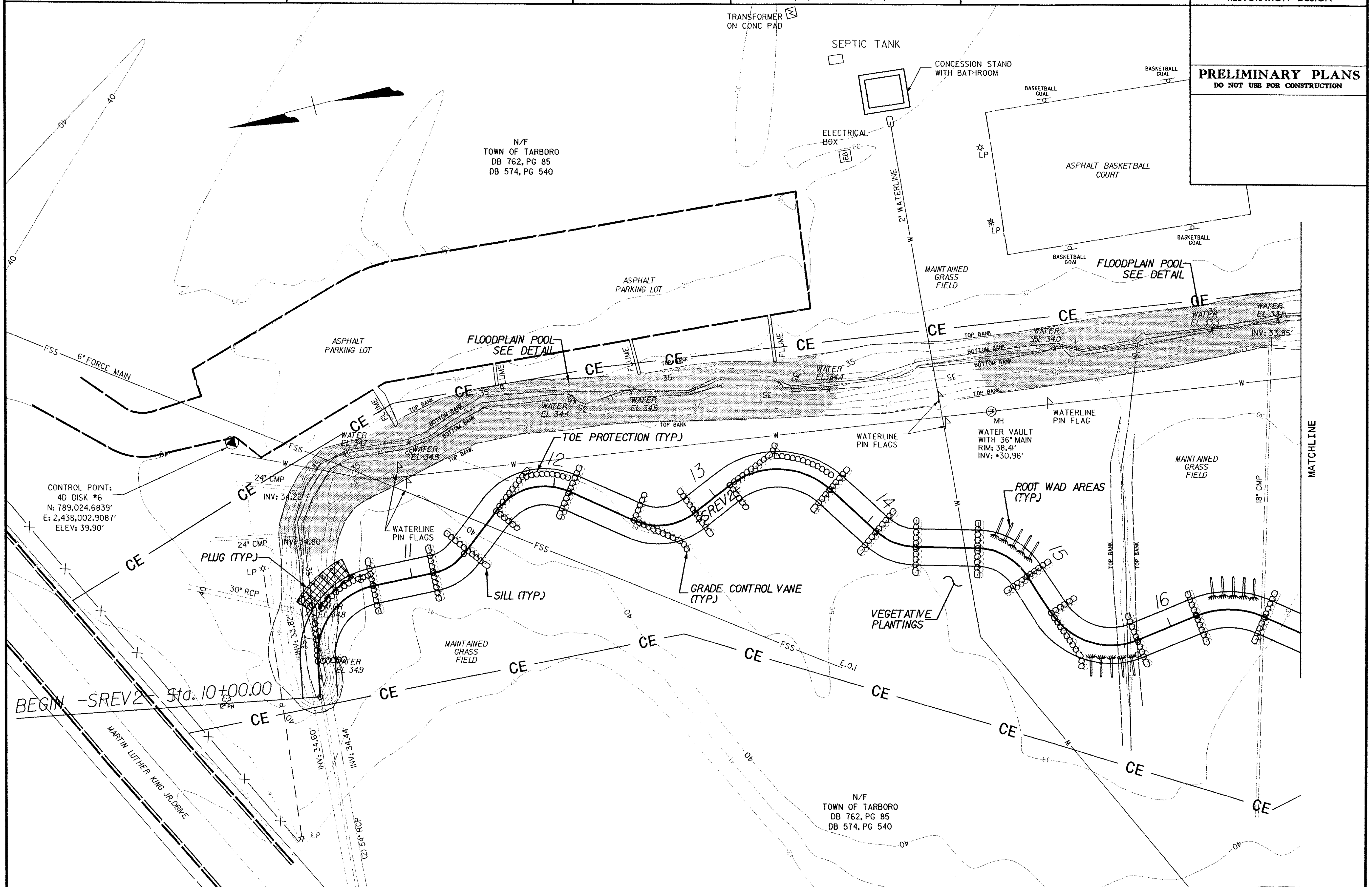
EarthTech
A Tyco International Ltd. Company
701 Corporate Center Drive, Suite #475; Raleigh, NC 27607
Phone: (919) 854-6200 Fax: (919) 854-6259

EAST TARBORO CANAL STREAM RESTORATION
EDGECOMBE COUNTY
ECOSYSTEM ENHANCEMENT PROGRAM

PROJECT NO.	SHEET NO.
	FIGURE 7-E

PROPOSED STREAM RESTORATION DESIGN

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

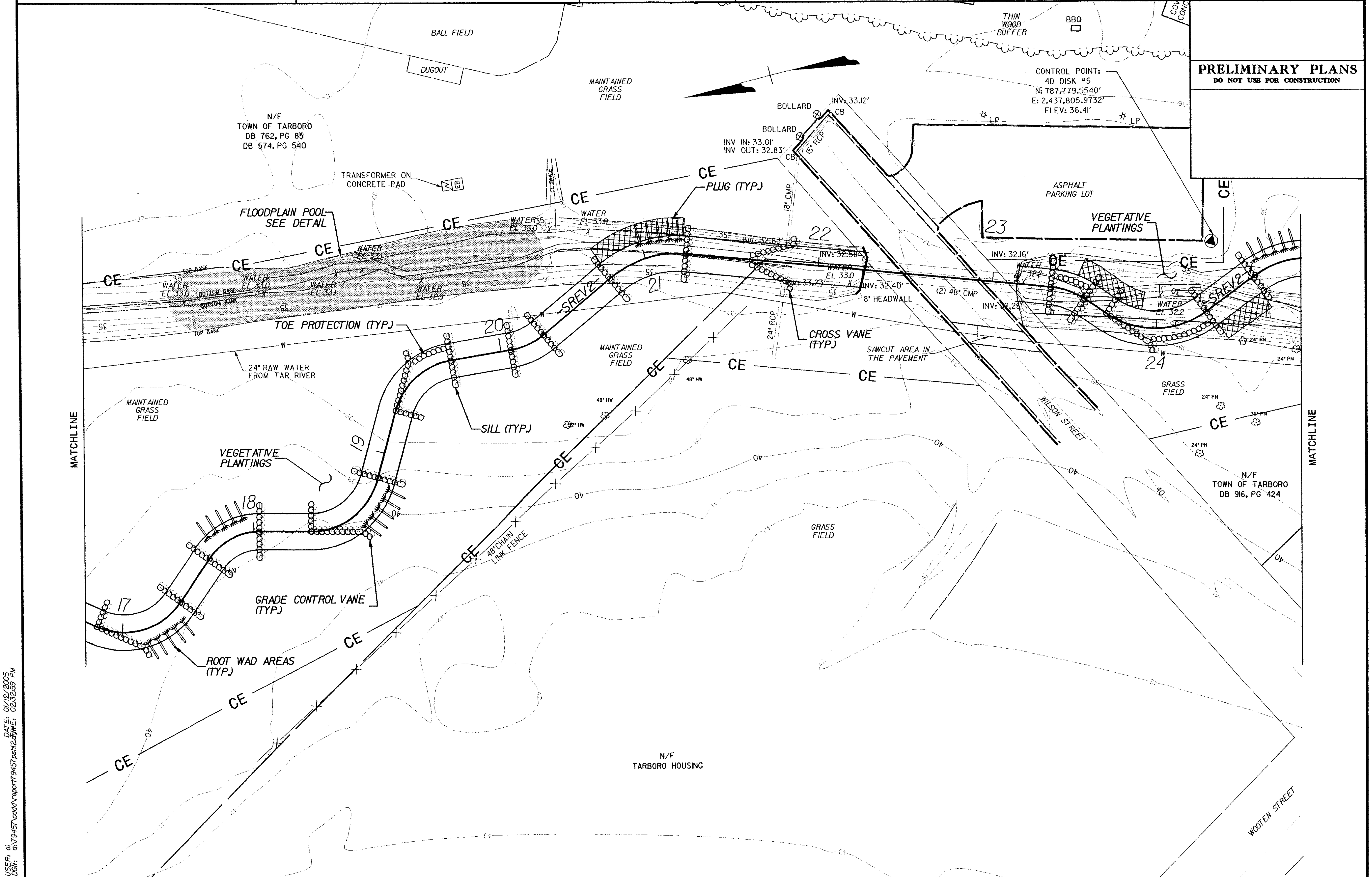


USER: e)
DGN: q:\79457\cadd\report\79457psh1.dgn
DATE: 01/12/2005
TIME: 02:32:58 PM

SCALE	EarthTech	EAST TARBORO CANAL STREAM RESTORATION	PROJECT NO.	SHEET NO.
50 0 50 100	A Tyco International Ltd. Company 701 Corporate Center Drive, Suite #475; Raleigh ,NC 27607 Phone: (919) 854-6200 Fax: (919) 854-6259	EDGECOMBE COUNTY ECOSYSTEM ENHANCEMENT PROGRAM		FIGURE 7-F

PROPOSED STREAM RESTORATION DESIGN

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION



USER: ej
DGN: q:\79457\cadd\report\79457psht2.dgn
DATE: 01/12/2005
TIME: 02:32:59 PM

SCALE 50 0 50 100

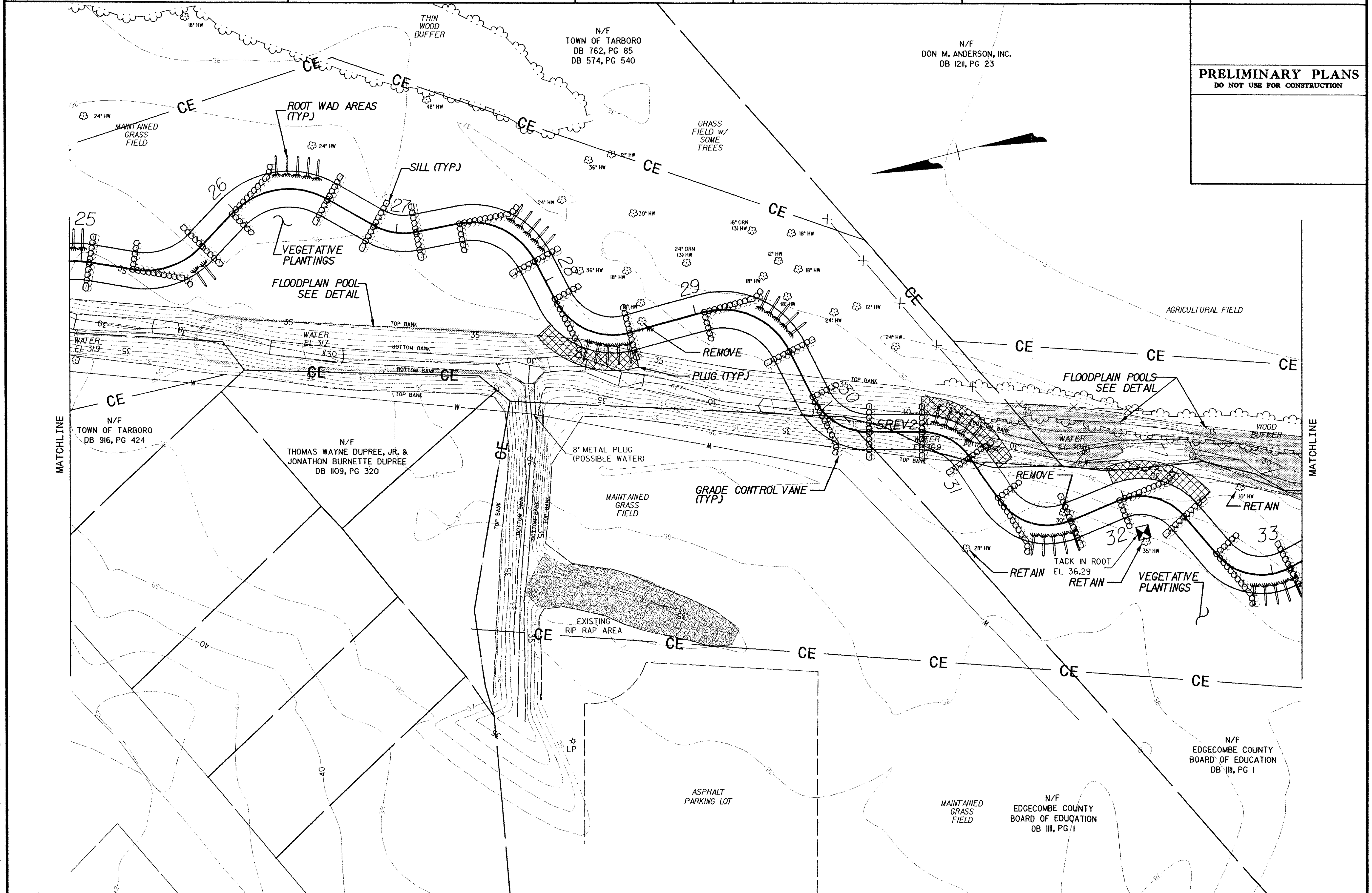
EarthTech
A Tyco International Ltd. Company
701 Corporate Center Drive, Suite #475; Raleigh, NC 27607
Phone: (919) 854-6200 Fax: (919) 854-6259

EAST TARBORO CANAL STREAM RESTORATION
EDGECOMBE COUNTY
ECOSYSTEM ENHANCEMENT PROGRAM

PROJECT NO.	SHEET NO.
	FIGURE 7-G

PROPOSED STREAM RESTORATION DESIGN

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION



USER: el DGN: q:\79457\cadd\report\79457psh3.dgn
DATE: 01/12/2005 TIME: 02:33:00 PM

SCALE
50 0 50 100

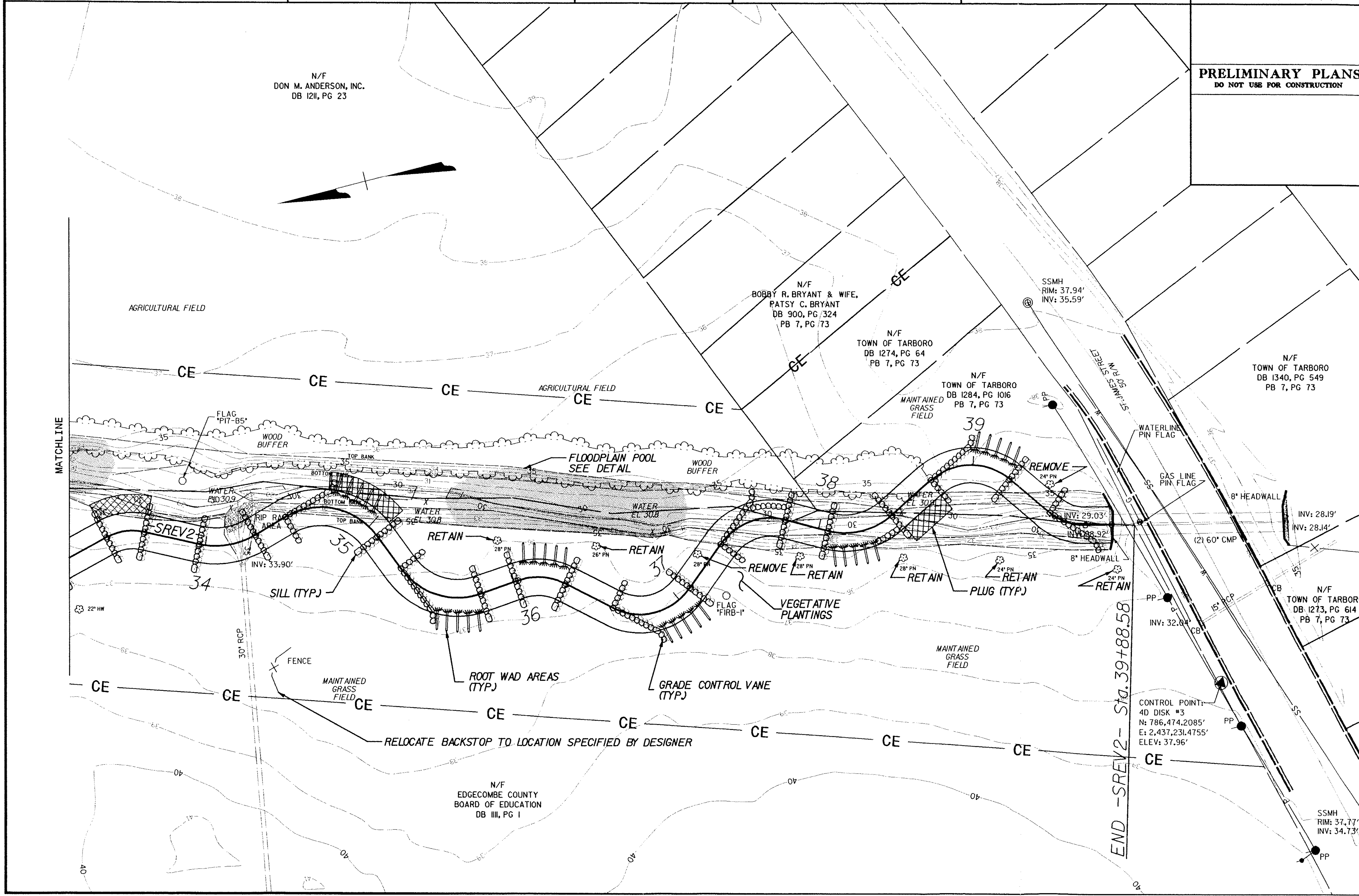
EarthTech
A Tyco International Ltd. Company
701 Corporate Center Drive, Suite #475; Raleigh, NC 27607
Phone: (919) 854-6200 Fax: (919) 854-6259

EAST TARBORO CANAL STREAM RESTORATION
EDGECOMBE COUNTY
ECOSYSTEM ENHANCEMENT PROGRAM

PROJECT NO.	SHEET NO.
	FIGURE 7-H

PROPOSED STREAM RESTORATION DESIGN

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION



USER: el
DATE: 01/12/2005
TIME: 02:33:00 PM
DGN: q:\79457\cadd\report79457psh14.dgn

4.1.1 Dimension

The present bankfull channel width for East Tarboro Canal ranges from 7.3 to 9.8 ft. in Reach 1 with a cross-sectional area ranging from 10.1 to 14.7 ft^2. Reach 2 currently has a bankfull width of 14.0 to 17.0 ft. with a 22.8 to 25.4 ft^2 bankfull cross-sectional area. The bankfull cross-sectional area for the design channel was determined from evaluating the North Carolina Coastal Regional Curve relationships and comparing them to the existing cross-sectional area. Forty-nine percent of the watershed remains agricultural/undeveloped. Therefore, this land has the potential for development due to its proximity to the main town of Tarboro. This also was taken into account in the selection of the final cross-sectional area. HEC-RAS will be used to verify the design cross-sectional area for the project and estimate in-channel shear stress. This assessment will not be conducted until the design phase of the project. Typical cross-sections can be seen in Figure 8.

The dimension on Reach 1 will be widened from an average of 7.3 ft. to 12.0 ft to allow for a c-type width-to-depth ratio of 12.0. This modification will help the channel stability by decreasing the shear stress on the streambanks. Bankfull benches will be incorporated into the design where possible to increase the floodprone width and area since flood storage is a concern in this watershed. The current bank height ratio of between 2.1 and 5.5 will be decreased to a target value of 1.0 in this reach.

A design width of 20.0 ft. for Reach 2 of the East Tarboro Canal will be applied to the proposed stream. This width was back calculated from the cross-sectional area taken from the existing conditions and a width-to-depth ratio of 13.7 from the reference reach. These characteristics will provide a stream channel that classifies as a C-type channel for the East Tarboro Canal according to the Rosgen classification system.

The existing channel, with bank height ratio's ranging from 2.2 to 3.2 in Reach 2, will have benches cut at the bankfull elevation so that the entrenchment ratio for the design channel is 6.0 on average and therefore, bank height ratios are 1.0. Where constraints such as utilities and road crossings are prohibitive, a minimum of a 2.2 entrenchment ratio will be obtained. With the proposed channel cross-section, a total of 20.0 feet of benches (minimum) are necessary to obtain an entrenchment ratio appropriated for a C-type channel. The bench on the outside of the meanders will be raised by 0.5 ft. and the pointbar on the inside of the meander will be lowered by 0.5 ft. to encourage the water to cut across the pointbar. Benches in excess of 20.0 feet (combined left and right bank) will be obtained where the conservation easement and constraints allow increasing the entrenchment ratio beyond a minimum of 2.2. Unlike the existing channel, the proposed channel will be able to access a floodplain and effectively transport the sediment load.

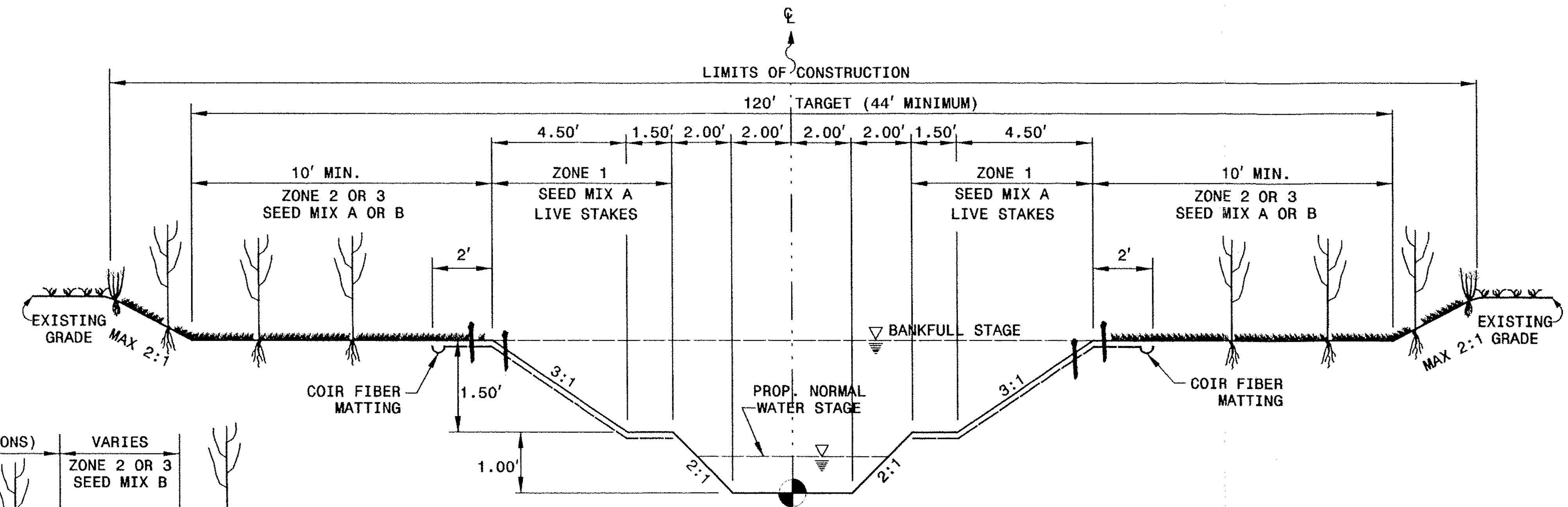
The proposed channel is sized to accommodate the existing watershed characteristics. The floodplain shall be built adjacent to the proposed channel to accommodate additional stormwater input from future development in the headwaters.

EarthTech
A Tyco International Ltd. Company
701 Corporate Center Drive, Suite #475; Raleigh ,NC 27607
Phone: (919) 854-6200 Fax: (919) 854-6259

EAST TARBORO CANAL STREAM RESTORATION
EDGECOMBE COUNTY
ECOSYSTEM ENHANCEMENT PROGRAM

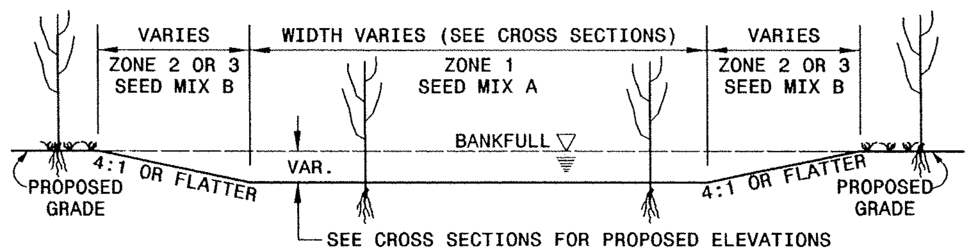
PROJECT NO.	SHEET NO.
	FIGURE 8-A

TYPICAL SECTIONS

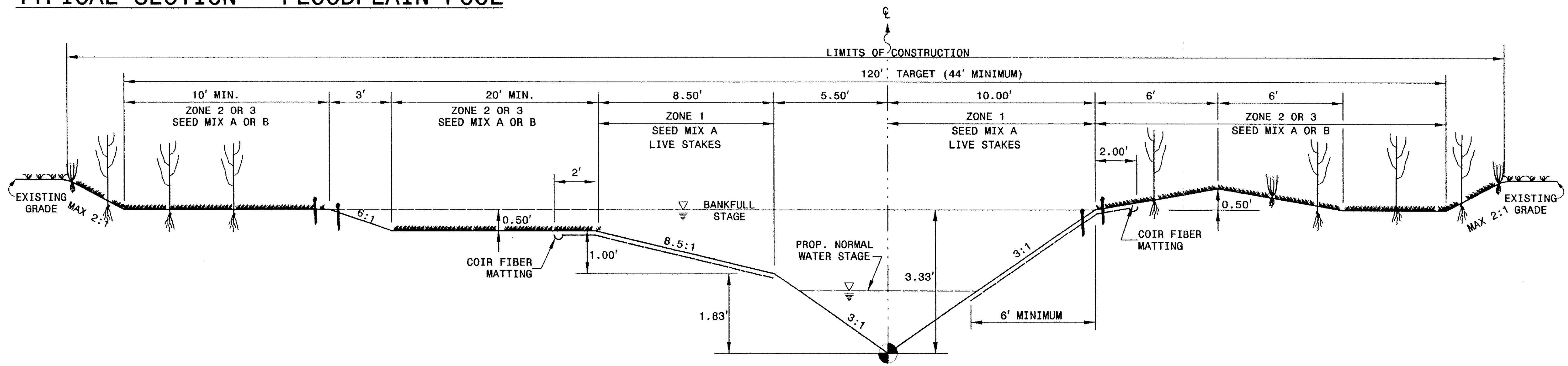


TYPICAL SECTION - RIFFLE

-SREV2-



TYPICAL SECTION - FLOODPLAIN POOL



TYPICAL SECTION - POOL RIGHT

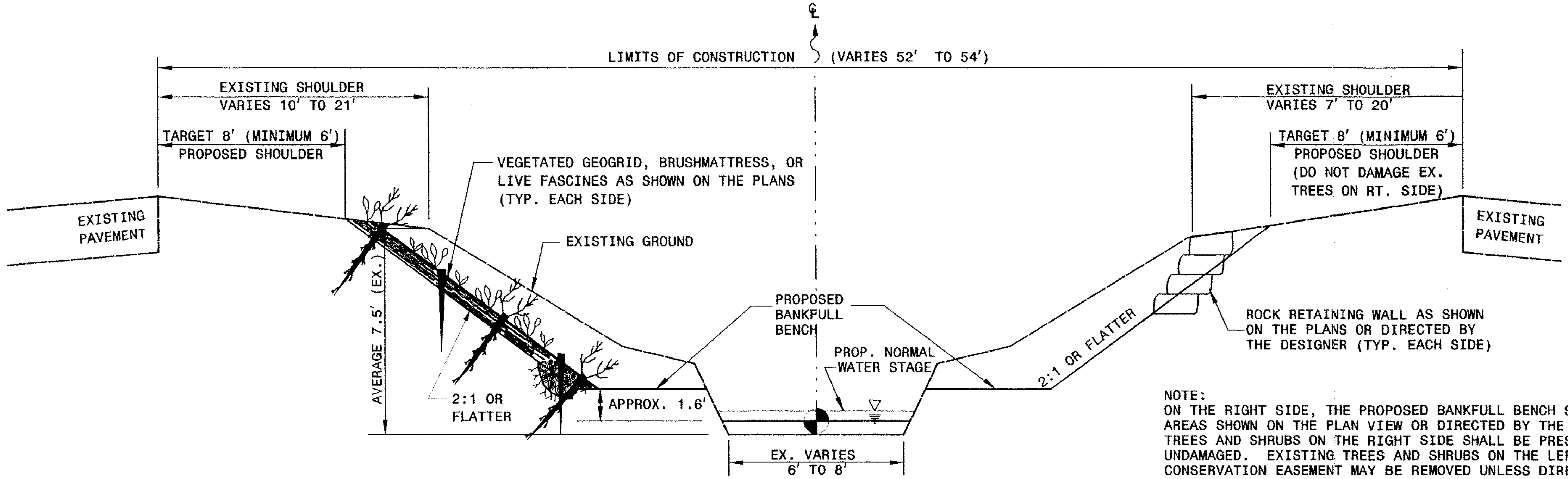
(REVERSE FOR POOL LEFT)

-SREV2-

IN A RIFFLE THE THALWEG (DEEPEST POINT IN CROSS SECTION) IS LOCATED IN CENTER OF CHANNEL
POOL BANK - TO - BANK SPACING IS ADJUSTED THROUGHOUT THE CURVE.
POOL BANK - TO - BANK DIMENSIONS SHOWN ARE AT THE CENTER OF THE CURVE.
SCALE : NTS

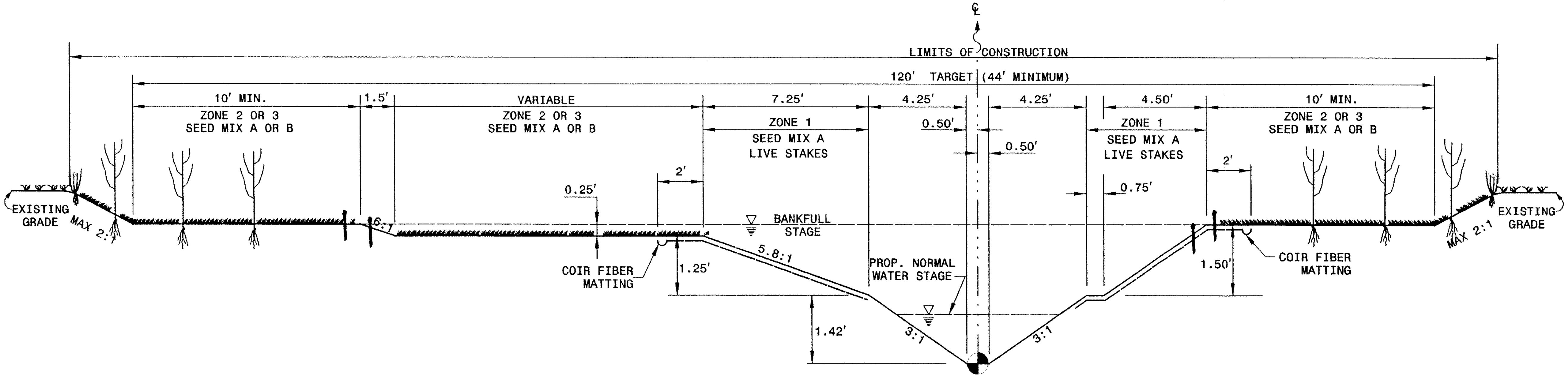
USER: ej
DGN: q:\79457\cadd\report\79457typ.dgn
DATE: 01/12/2005
TIME: 02:33:05 PM

			EarthTech A Tyco International Ltd. Company 701 Corporate Center Drive, Suite #475; Raleigh ,NC 27607 Phone: (919) 854-6200 Fax: (919) 854-6259	EAST TARBORO CANAL STREAM RESTORATION EDGECOMBE COUNTY ECOSYSTEM ENHANCEMENT PROGRAM	PROJECT NO.	SHEET NO. FIGURE 8-B TYPICAL SECTIONS



NOTE:
ON THE RIGHT SIDE, THE PROPOSED BANKFULL BENCH SHALL BE CUT ONLY IN AREAS SHOWN ON THE PLAN VIEW OR DIRECTED BY THE DESIGNER. EXISTING TREES AND SHRUBS ON THE RIGHT SIDE SHALL BE PRESERVED AND LEFT UNDAMAGED. EXISTING TREES AND SHRUBS ON THE LEFT SIDE IN THE CONSERVATION EASEMENT MAY BE REMOVED UNLESS DIRECTED OTHERWISE BY THE DESIGNER.

TYPICAL SECTION
-S1-



TYPICAL SECTION - INTERMEDIATE RIGHT
(REVERSE FOR INTERMEDIATE LEFT)
-SREV2-

SCALE : NTS

USER: el DATE: 01/12/2005
DGN: q:\79457\cadd\report\79457typ.dgn TIME: 02:33:04 PM

4.1.2 Pattern Geometry

The existing pattern of the East Tarboro Canal can be described as long straight reaches followed by sparse meanders. The current sinuosity in Reach 1 is 1.01 and 1.03 in Reach 2. Design sinuosity for the East Tarboro Canal is 1.20 to 1.35 in Reach 2. The pattern in Reach 1 will remain unchanged due to lateral constraints. The proposed pattern in Reach 2 is limited in a few places due to utility crossings, property lines, and road crossings.

A stable pattern will be achieved by introducing meanders into the stream with appropriate radius of curvatures and lengths based on reference reach data from the Tributary to Westbrook Mill Creek and existing constraints. Introduction of these meanders will improve habitat while lowering shear stress.

Multiple pipe and ditch systems enter the main stream along both reaches. These will be tied to the main channel using a combination of ditch realignment, augmentation of piping systems, and dissipater basins. Floodplain pools will be used to collect storm water and treat it to enhance water quality. Tie-ins will typically be done downstream of pool forming structures to minimize the risk of erosion at stream confluences.

4.1.3 Bedform

The existing bedform along the East Tarboro Canal is fairly uniform. Long, straight sections of the channel consist of predominantly run bedform features. The design channel will incorporate riffles and pools to provide bedform common to C-stream types with sand substrate. Pools will be located in the outside of meander bends with riffles in the inflection points between meanders. Riffles in Reach 1 will have a mean depth of 1.00 ft. and a thalweg depth of 1.60 ft. while the pools will be deeper with a maximum depth of 2.00 ft. Reach 2 will have a mean riffle depth of 1.46 ft, a maximum depth of 2.50, and a pool depth of 3.33 ft. The proposed longitudinal profile is shown in Figure 9 for Reach 2.

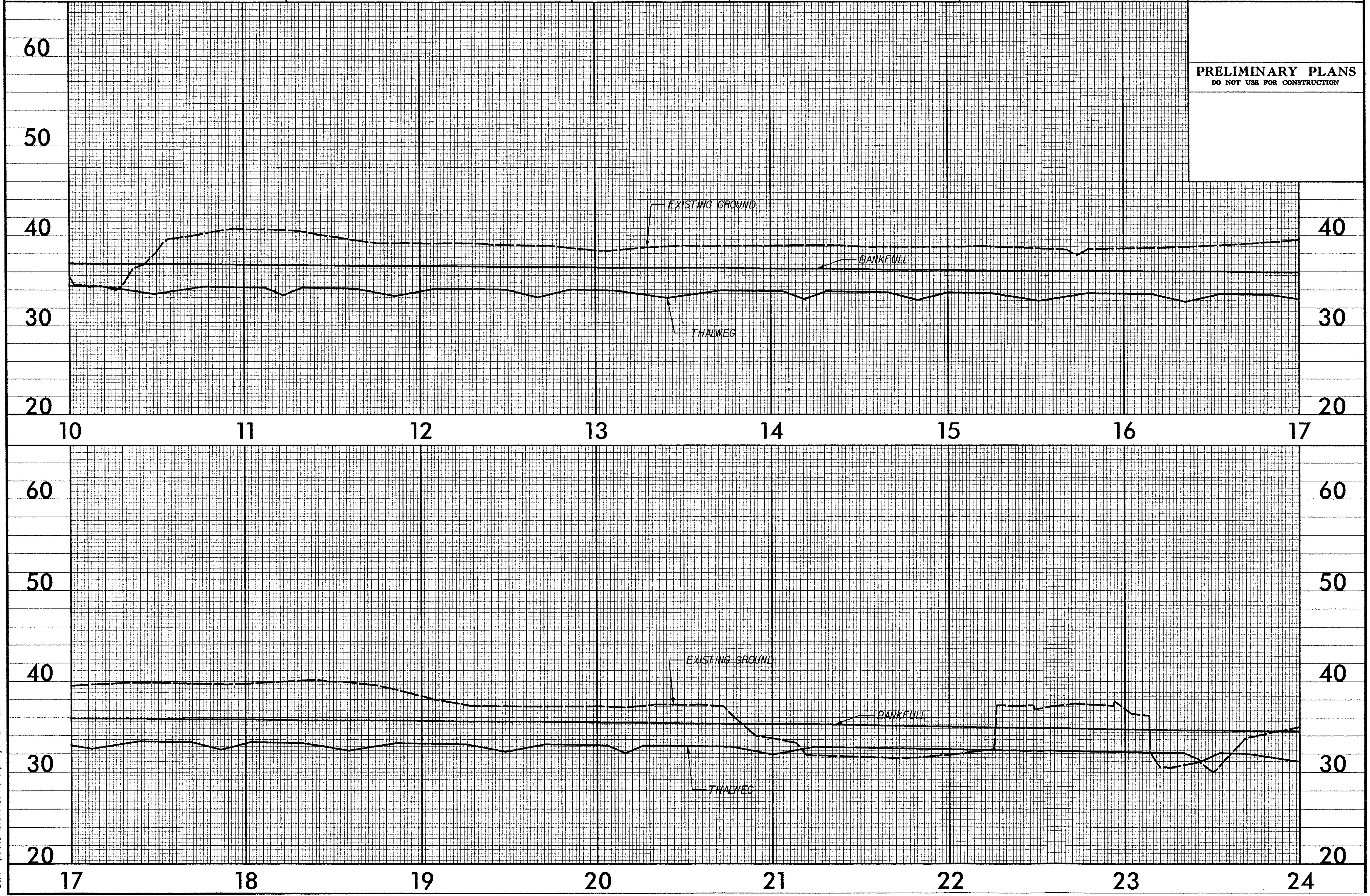
The existing pool-to-pool spacing on the East Tarboro Canal, Reach 2 is 44 to 133. The proposed spacing is 32 to 86 ft., which is within the range of 1.5 and 4.1 bankfull widths as determined from the reference reach data. To accomplish this, pools will be realigned or constructed such that they will be located in the outside of the meander bends. Bedform will also be addressed through the strategic placement of natural material structures such as cross vanes, grade control vanes, root wads, and stone sills. Modifications to the bedform will provide stability and habitat to the channel.

4.1.4 Riparian Areas

A riparian zone will be created around the new proposed stream channel to enhance both aquatic and terrestrial habitat as well as stabilize the stream channel. The riparian zone will extend from the top of bank to the conservation easement boundaries (Figure 7& 8). These areas will be planted with appropriate riparian vegetation as described in Section 5.0 Habitat Restoration.

		SCALE 50 0 50 100	EarthTech A Tyco International Ltd. Company 701 Corporate Center Drive, Suite #475; Raleigh ,NC 27607 Phone: (919) 854-6200 Fax: (919) 854-6259	EAST TARBORO CANAL STREAM RESTORATION EDGECOMBE COUNTY ECOSYSTEM ENHANCEMENT PROGRAM	PROJECT NO.	SHEET NO. FIGURE 9-A -SREV2- PROFILE

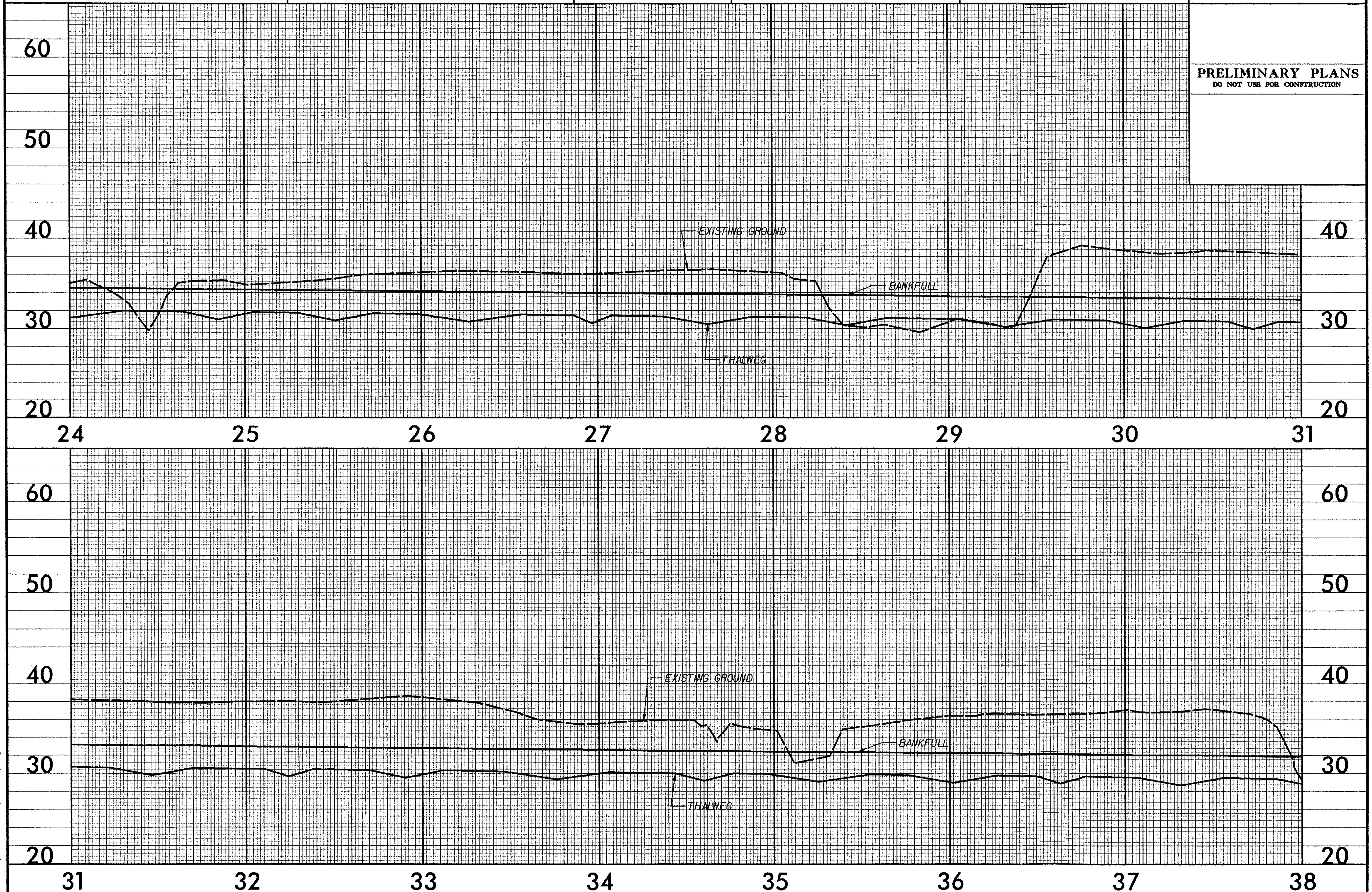
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION



USER: ej
DGN: q:\79457\cadd\report\79457pf1.dgn
DATE: 01/12/2005
TIME: 02:33:07 PM

SCALE	EarthTech	EAST TARBORO CANAL STREAM RESTORATION	PROJECT NO.	SHEET NO.
50 0 50 100	A Tyco International Ltd. Company 701 Corporate Center Drive, Suite #475; Raleigh ,NC 27607 Phone: (919) 854-6200 Fax: (919) 854-6259	EDGECOMBE COUNTY ECOSYSTEM ENHANCEMENT PROGRAM		FIGURE 9-B
			-SREV2- PROFILE	

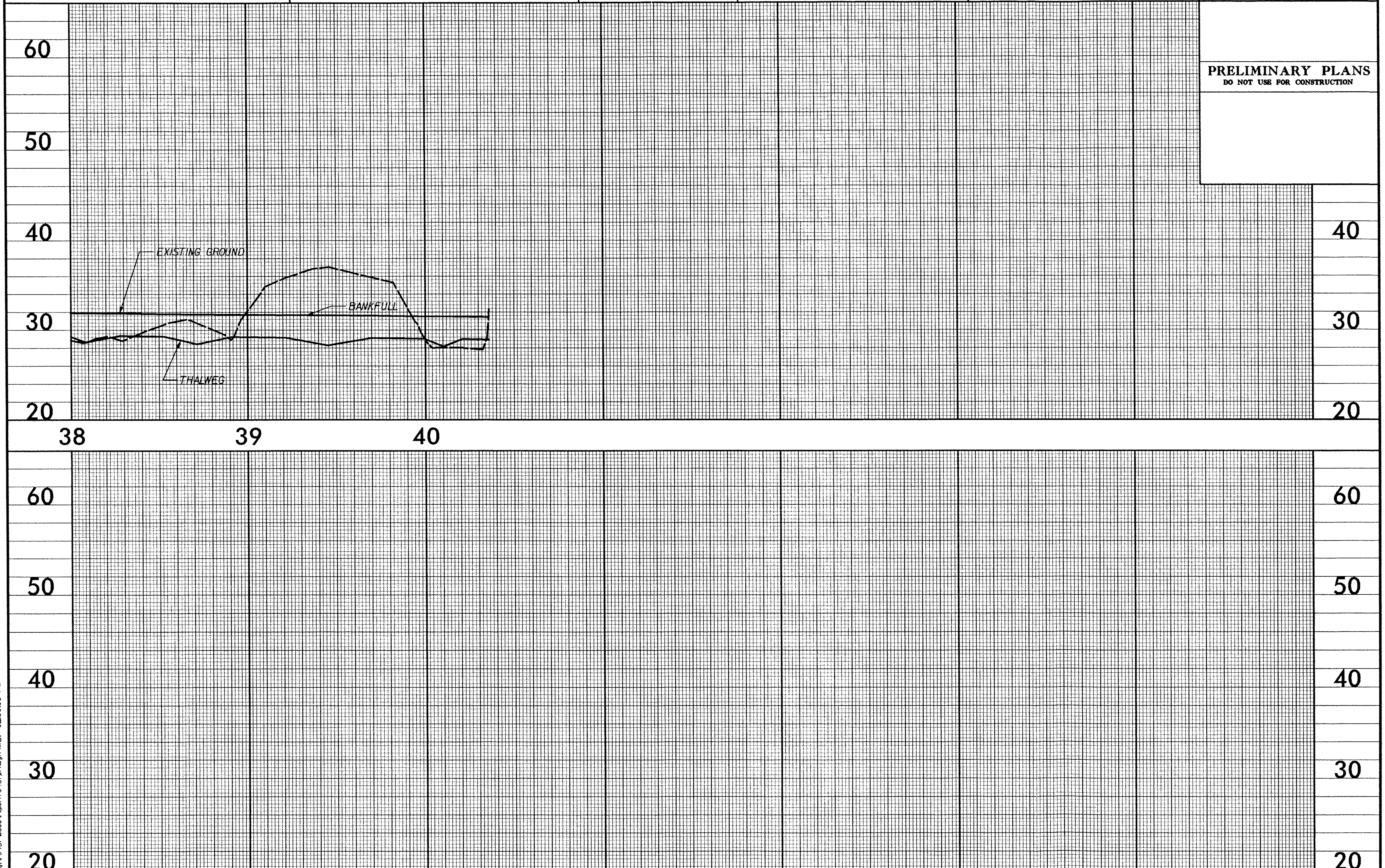
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION



USER: ej
DGN: q:\79457\cadd\report\79457pf1.dgn
DATE: 01/12/2005
TIME: 02:33:07 PM

SCALE	EarthTech	EAST TARBORO CANAL STREAM RESTORATION	PROJECT NO.	SHEET NO.
50 0 50 100	A Tyco International Ltd. Company	EDGECOMBE COUNTY		FIGURE 9-C
	701 Corporate Center Drive, Suite #475; Raleigh ,NC 27607 Phone: (919) 854-6200 Fax: (919) 854-6259	ECOSYSTEM ENHANCEMENT PROGRAM	-SREV2- PROFILE	

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION



USER: el DATE: 01/12/2005
DGN: q:\79457\cadd\report\79457pf1.dgn TIME: 02:33:08 PM

4.2 SEDIMENT TRANSPORT

A stable stream has the capacity to move its sediment load without aggrading or degrading. The total load of sediment can be divided into bedload and wash load. Wash load is normally composed of fine sands, silts and clay and transported in suspension at a rate that is determined by availability and not by stream hydraulics. Bedload is transported by rolling, sliding, or hopping (saltating) along the bed. At higher discharges, some portion of the bedload can be suspended, especially if there is a sand component in the bedload. Bed material transport rates are essentially controlled by the size and nature of the bed material and hydraulic conditions (Hey 1997).

Critical dimensionless shear stress can be calculated for gravel and cobble bed streams using sediment entrainment calculations. However, the bed material of both Reach 1 and 2 of the East Tarboro Canal classifies as sand. All particles in a sand bed channel have the potential to become mobilized during bankfull events.

Shear stress at the riffle was also checked using Shield's Curve. The shear stress placed on the sediment particles is the force that entrains and moves the particles, given by:

$$\tau = \gamma R s$$

where, τ=shear stress (lb/ft^2)
γ=specific gravity of water (62.4 lb/ft^3)
R=hydraulic radius (ft)
s=average bankfull slope (ft/ft)

Hydraulic radius is calculated by:

$$R = \frac{A}{P}$$

where, R=hydraulic radius
A=cross-sectional area (ft^2)
P=wetted perimeter (ft)

Thus,

$$\mathrm{Re}\,ach1 : R = \frac{12.0 ft^2}{12.6 ft} = 0.95 ft$$

$$\mathrm{Re}\,ach2 : R = \frac{29.25 ft^2}{20.96 ft} = 1.40 ft$$

Wetted perimeter and cross-sectional area were measured off of a CADD file of the typical riffle cross-section drawn to scale.

Therefore,

$$\text{Reach1}: \tau = (62.4\frac{lb}{ft^3})(0.95\,ft)(0.0022\frac{ft}{ft}) = 0.13\,lb/ft^2$$

$$\text{Reach2}: \tau = (62.4\frac{lb}{ft^3})(1.40\,ft)(0.0018\frac{ft}{ft}) = 0.16\,lb/ft^2$$

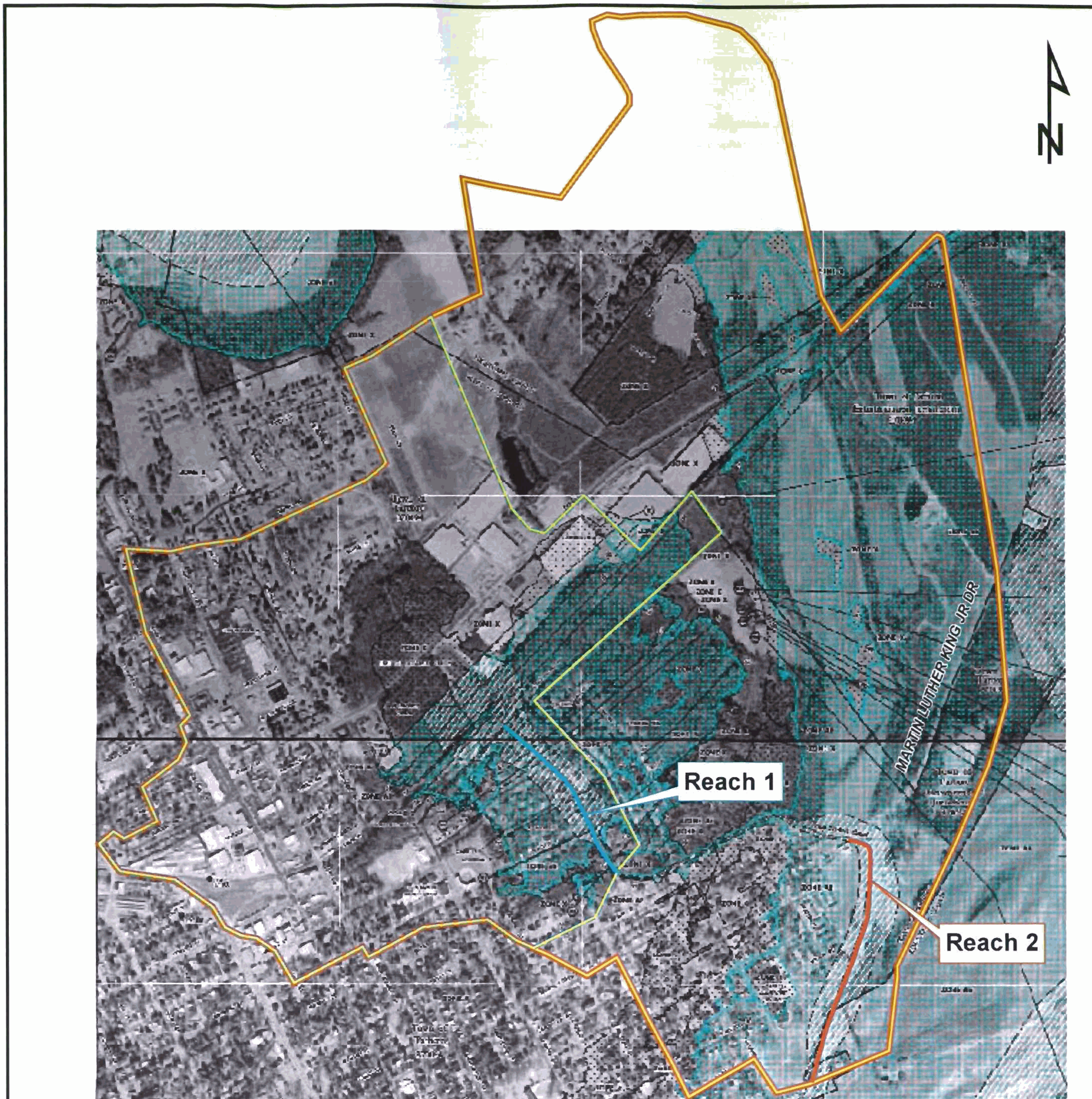
The critical shear stress for the proposed channel has to be sufficient to move the D_{84} of the riffle bed material, which is sand for both reaches of East Tarboro Canal. Based on a shear stress of 0.13 or 0.16 lb/ft^2, Shield's Curve predicts that this stream can move a particle that is, on average, greater than 10 mm (medium gravel). Since the D_{84} was less than 2 mm and Shield's Curve predicts, on average, 10 mm, the proposed stream has the competency to move its bedload. Rosgen has also generated a curve that piggybacks Shields Curve (Appendix B). Rosgen recommends using this curve when the critical shear stress falls below 1.0 lb/ft^2 and Shield's Curve above 1.0 lb/ft^2. This curve predicts that a 35 mm particle will be moved based on the critical shear stress of 0.13 to 0.16 lb/ft^2. The largest particle measured during the pebble count was less than 2 mm. These particles would be moved as predicted by either curve.

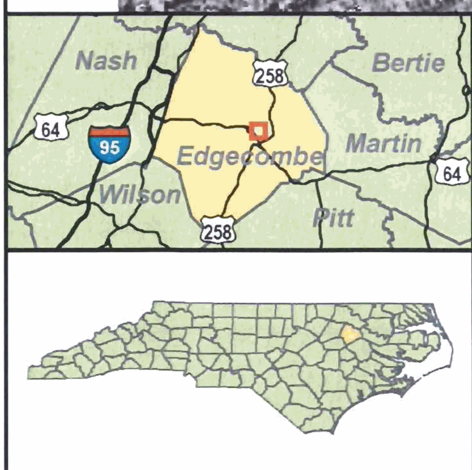
4.3 FLOODING ANALYSIS

The East Tarboro Canal is a Federal Emergency Management Agency (FEMA) regulated stream with a detailed study. The proposed stream restoration project is located within a zone AE flood hazard area (Figure 10). Zone AE indicates areas inundated by the 100-year recurrence storm event. Along the downstream reach, work shall be performed both in the floodplain and in the floodway. A new floodplain will be excavated so that the active stream will be able to access it during larger storm events. Additionally, the stream profile will be altered somewhat and the stream channel form will change radically. This will likely necessitate adjustments to the FEMA FIRM (Flood Insurance Rate Map). Therefore, requests for both Conditional Letter of Map Revision (CLOMR) and follow-up Letter of Map Revision (LOMR) will be required. Since the floodplain is to be lowered, consequently decreasing cross sectional area, it is believed that the stream restoration will lower flood elevations in this reach. During Hurricane Floyd, most of the structures located in the floodplain in this area received substantial damage and were demolished. The majority of these properties were "bought-out" by FEMA and, as a result, the property in the 100-year floodplain is generally structure-free and Town-owned.

Work to be performed on the upper reach involves mainly the placement of structures, planting, minimal channel bed re-profiling, minimal grading and re-shaping of the dimensional characteristics. All work shall be done in the existing floodway. During the design process, it will be endeavored to maintain flood elevations at or below existing flood elevations. Unless a FEMA FIRM adjustment is to be done, FEMA regulations require (section 60.3 (b) 7) that communities assure that the flood carrying capacity within the altered or relocated portion of watercourses be maintained. Consultation with

Q:\79457\GIS\FigsFeasPlan\F10_FIRM.mxd 11/04





Source: FIRM Panel Numbers: 3720473800 J and 3720473900 J

0 750 1,500 Feet

Ecosystem Enhancement

FIGURE 10
FLOOD INSURANCE RATE MAP

East Tarboro Canal
Tarboro, North Carolina

the local floodplain administrator and hydraulic analysis shall be performed during final design to determine the relevance of CLOMR/LOMR submittals for this reach.

In order to meet FEMA requirements and assess the flooding effects of the proposed project, a hydraulic analysis will be performed using FEMA accepted modeling software (HEC-RAS, HEC-2) for both the existing conditions and the proposed conditions. This analysis will aid in taking the necessary action to protect structures, if any, impacted by changes to the hydraulic environment and will verify assumptions made during the design process.

4.4 STRUCTURES

Several different structures made of natural materials will be installed along the East Tarboro Canal. These structures include cross vanes, root wads, and sills. Vegetated geogrids and brush layering may also be used on a limited basis. Figures 11 contain the details for the proposed structures. Natural materials such as boulders, logs, root wads, and vegetation cuttings will be used to create these structures from both off-site and on-site sources.

4.4.1 Cross Vane

A cross vane structure serves to maintain the grade of the stream. The design shape is roughly that of the letter "U" with the apex located on the upstream side. Footer rocks are placed in the channel bottom for stability. Rocks are then placed on these footer rocks in the middle of the channel at approximately the same elevation as the thalweg. On either side of the channel, rocks are placed at an angle to the streambank, gradually inclining in elevation until they are located above the bankfull surface directly adjacent to the streambank. Water flowing downstream is directed over the vane towards the middle of the channel. Rocks placed at the apex determine the bed elevation upstream. A cross vane is primarily used for grade control and to protect the streambanks.

4.4.2 Root Wads

Root wads provide the following benefits: (1) protect the streambank from erosion; (2) provide in-stream and overhead cover for fish; (3) provide shade, detritus, and terrestrial insect habitat; (4) look natural, and (5) provide diversity of habitats (Rosgen 1996). A footer log and boulder are placed on the channel bottom abutting the streambank along an outside meander that will provide support for the root wad and additional stability to the bank. A large tree root wad is then placed on the streambank with additional boulders and rocks on either side for stability. Flowing water is deflected away from the bank and towards the center of the channel. Specific location of these structures and types of structures will be determined during final design.

4.4.3 Vegetated Geogrids/Brush Mattresses

Vegetated geogrids may be used in locations where space for root wads and other structures is limited and where slopes are very steep. The primary application of vegetated geogrids will likely be along Canal Street. Vegetated geogrids use a hardened structure, such as a gabion basket or rock toe, for their base. Lifts of soil are wrapped in a geotextile fabric and live cuttings are placed in-between individual lifts. The vegetative stabilization provides soil reinforcement and aquatic habitat. Unlike a typical retaining wall, the hardened look of this structure disappears once the overhanging vegetation is established.

Brush mattresses are used to create a system of living branches that form a cover over the streambank, providing immediate protection from erosion. These live stakes, cuttings, and fascines root and grow into an excellent natural riparian zone habitat that works to stabilize the banks. Brush mattresses will be used primarily on the steep banks along Canal Street.

4.4.4 Stone Sills

A stone sill consists of boulders aligned perpendicular to the stream's flow so that the header rock's top elevations are at the elevation of the proposed channel. The sill length includes the bankfull to bankfull distance plus a portion embedded into each bank. Individual rocks shall be fitted tightly such that water flows over the device and not through the individual rocks. The header and footer boulders must be placed such that the ends butt up against each other. No gaps between boulders will be accepted. However, where voids occur between boulders due to the jagged surfaces, Structure Stone, Class A shall be hand placed from both the upstream and downstream sides of the structure to fill the voids.

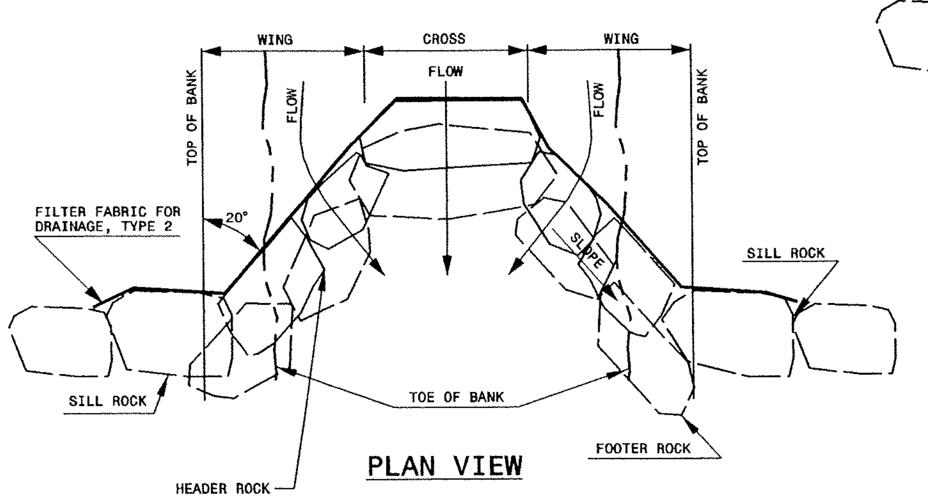
After the structure is constructed, a trench shall be dug upstream along the outline of the vane and sill rock. The trench shall extend to the bottom of the footer rocks. A non-woven geotextile fabric shall be placed in the trench and backfilled with No. 57 Stone (Sediment Control Stone). Fabric that overlaps the header rocks must be trimmed after backfilling with stone, so that a maximum of 2 inches is exposed. Vegetation transplants or live stakes shall be placed along the channel bank around the structure as detailed in the Landscape Plans. Minor modifications to the structure may be necessary after water has been returned to the channel.

4.4.5 Grade Control Vane

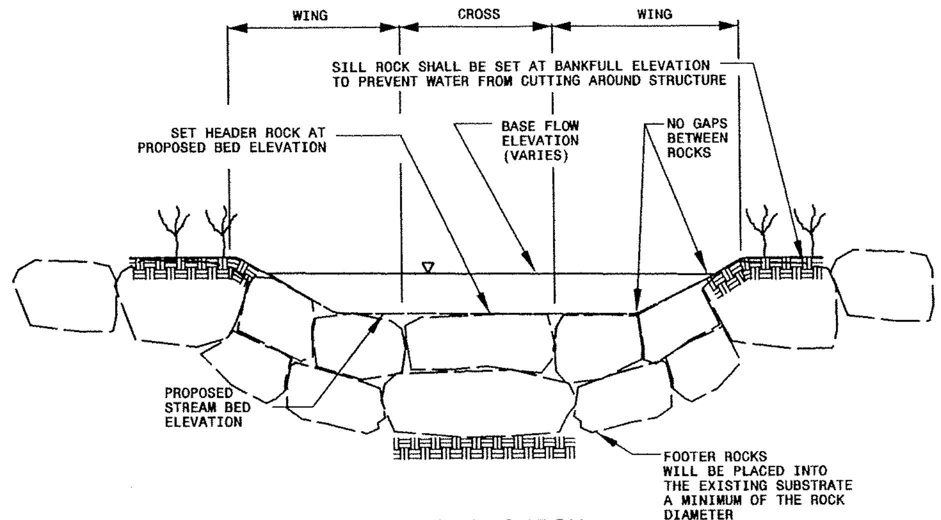
A grade control vane is essentially half of a cross-vane with the cross portion of the vane extended into a sill. It redirects water in the downstream direction, thus reducing the near-bank stresses. A grade control vane can be built in combination with rootwads and can be built out of boulders or logs. Grade control vanes will be placed near the beginning of meander bends to protect the steeper sloped banks along the outside of pools. Specific location of these structures will be determined during final design.

Figure 11. Details

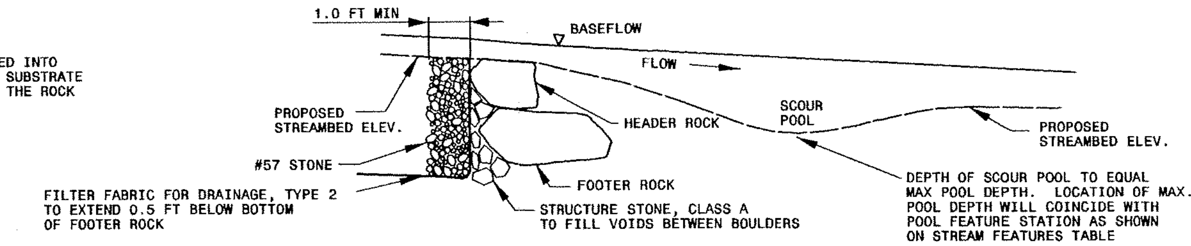
			EarthTech A Tyco International Ltd. Company 701 Corporate Center Drive, Suite #475; Raleigh ,NC 27607 Phone: (919) 854-6200 Fax: (919) 854-6259	EAST TARBORO CANAL STREAM RESTORATION EDGECOMBE COUNTY ECOSYSTEM ENHANCEMENT PROGRAM	PROJECT NO. / SHEET NO. FIGURE 11-A DETAILS



PLAN VIEW



CROSS SECTION



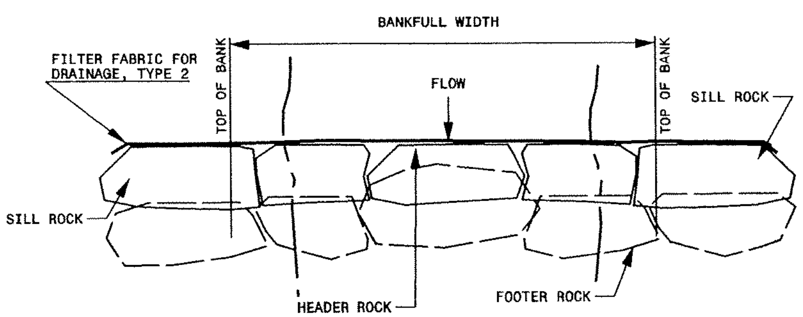
PROFILE VIEW

NOTES:

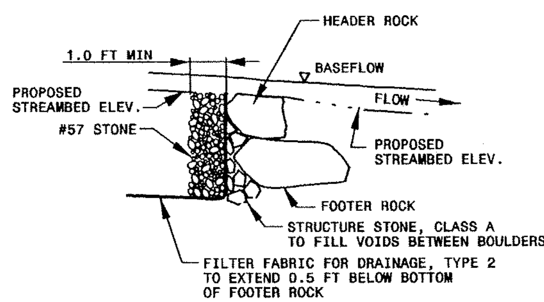
1. SCOUR POOL TO BE LOCATED PER STREAM FEATURES TABLE.
2. HEADER, FOOTER, AND SILL ROCKS TO BE STRUCTURE STONE, CLASS BOULDER.

ROCK CROSS VANE

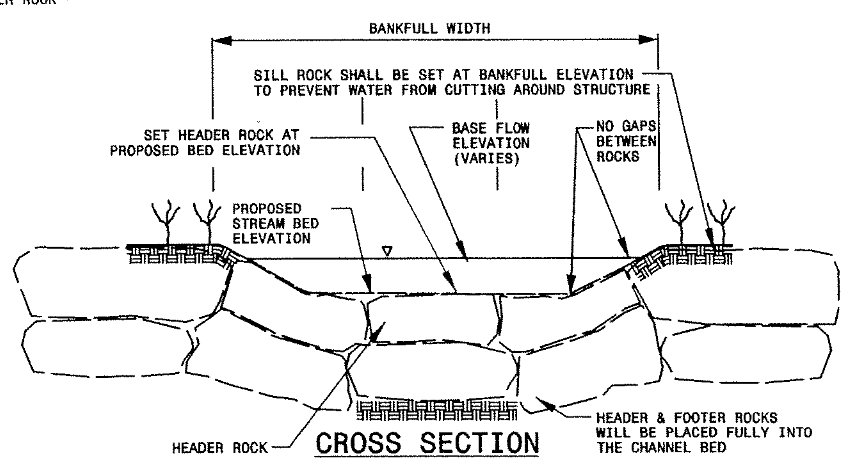
SCALE: NTS



PLAN VIEW



PROFILE VIEW



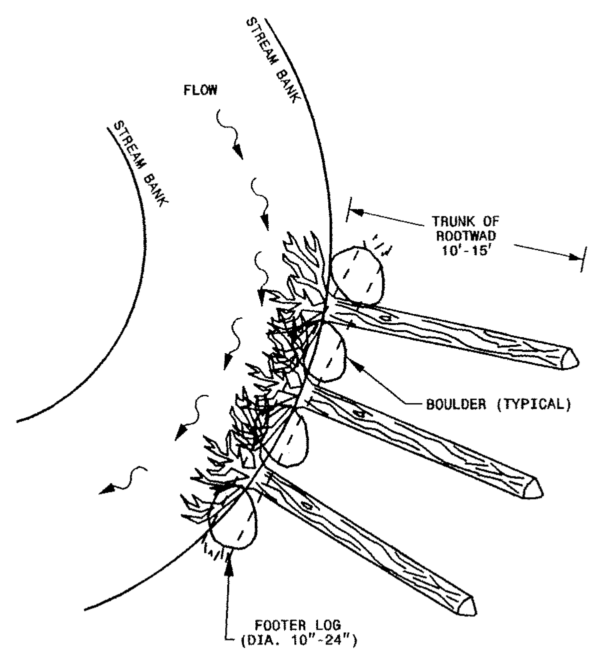
CROSS SECTION

NOTES:

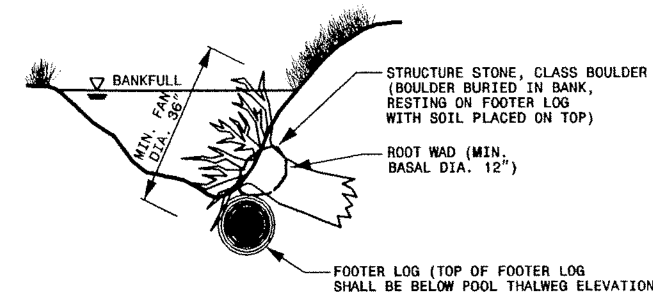
HEADER, FOOTER, AND SILL ROCKS TO BE STRUCTURE STONE, CLASS BOULDER

ROCK SILL

SCALE: NTS



PLAN



CROSS-SECTION

ROOT WAD

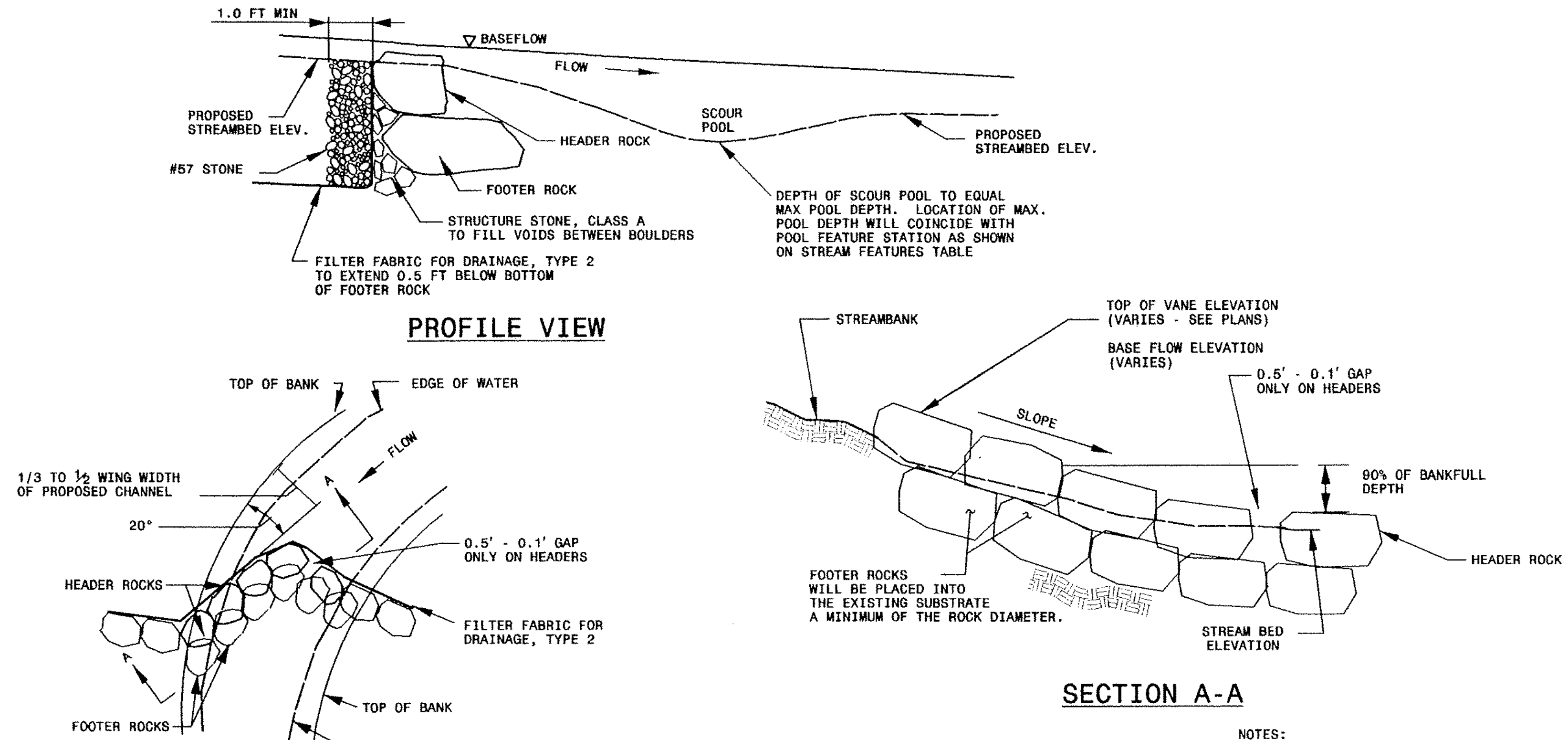
SCALE: NTS

USER: e) DATE: 01/12/2005
DGN: q:\79457\cadd\report\79457det.dgn TIME: 02:33:0 PM

EarthTech
A Tyco International Ltd. Company
701 Corporate Center Drive, Suite #475; Raleigh ,NC 27607
Phone: (919) 854-6200 Fax: (919) 854-6259

EAST TARBORO CANAL STREAM RESTORATION
EDGECOMBE COUNTY
ECOSYSTEM ENHANCEMENT PROGRAM

PROJECT NO.	SHEET NO.
	FIGURE 11-B
DETAILS	

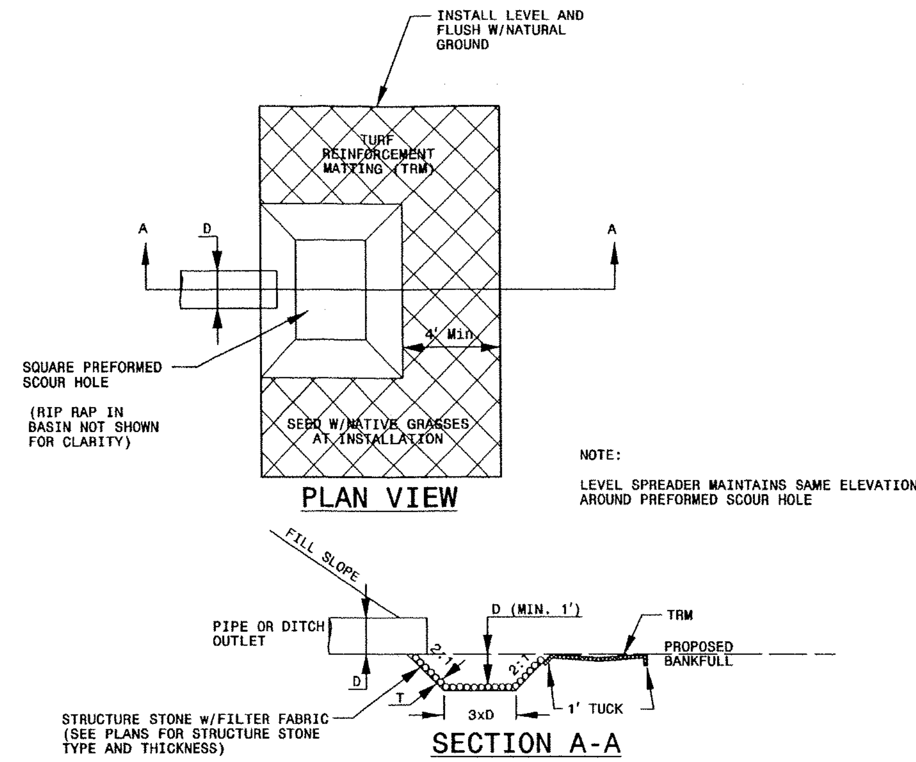


NOTES:

1. SCOUR POOL TO BE LOCATED PER STREAM FEATURES TABLE.
2. HEADER, FOOTER, AND SILL ROCKS TO BE STRUCTURE STONE, CLASS BOULDER.

ROCK J-HOOK VANE

SCALE: NTS



NOTE:

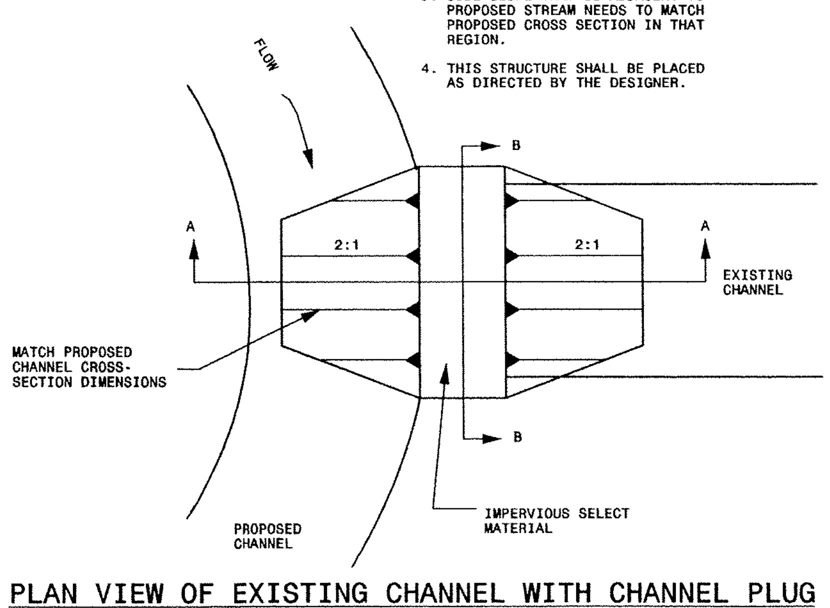
LEVEL SPREADER MAINTAINS SAME ELEVATION AROUND PREFORMED SCOUR HOLE

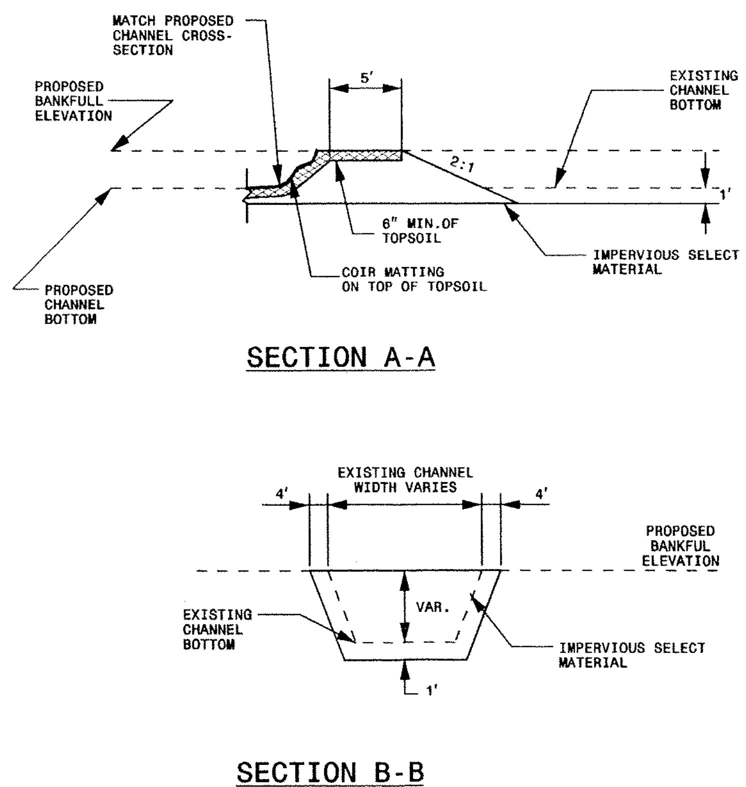
PRE-FORMED SCOUR HOLE WITH LEVEL SPREADER

SCALE: NTS

NOTES:

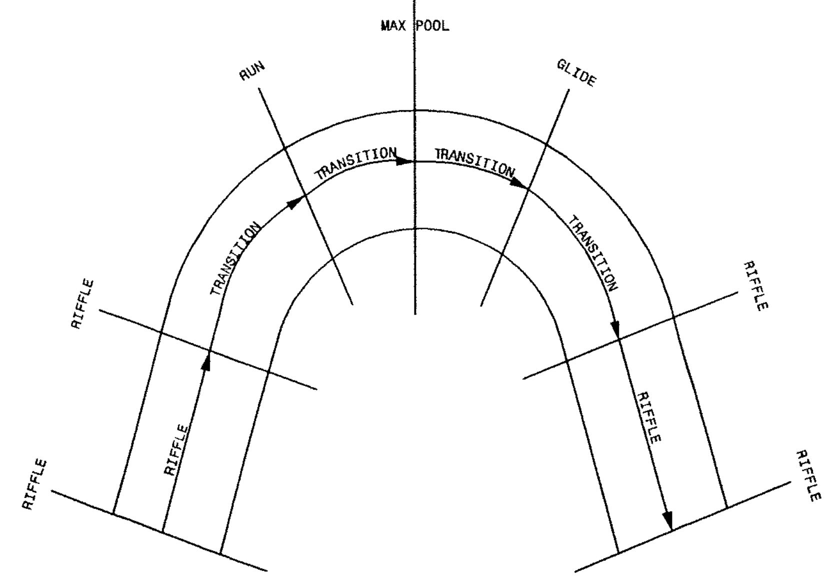
1. CHANNEL PLUGS TO BE LOCATED AS SHOWN ON THE PLANS AND AT OTHER LOCATIONS AS DIRECTED BY THE DESIGNER.
2. 90% COMPACTION RATE IS REQUIRED ON CHANNEL PLUG OR AS APPROVED BY THE DESIGNER.
3. SIDE SLOPE THAT IS ADJACENT TO PROPOSED STREAM NEEDS TO MATCH PROPOSED CROSS SECTION IN THAT REGION.
4. THIS STRUCTURE SHALL BE PLACED AS DIRECTED BY THE DESIGNER.





CHANNEL PLUG

SCALE: NTS



NOTES:

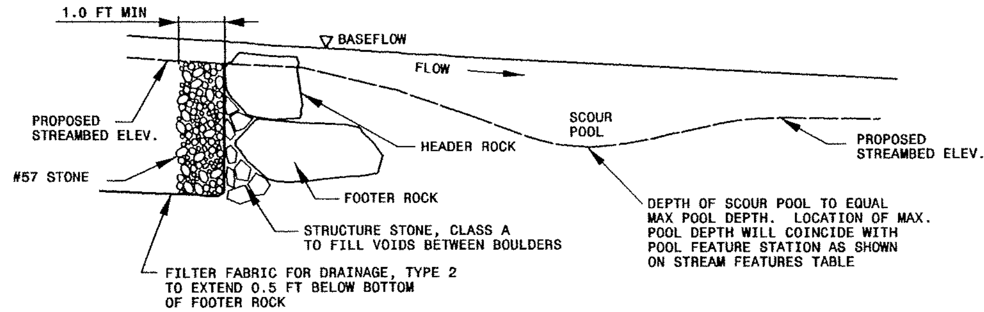
1. AREAS IN BETWEEN LABELED FEATURES ARE TRANSITION AREAS.
2. SEE TYPICALS AND STATIONING FOR MORE DETAIL.
3. THE AREA BETWEEN THE CONCURRENT RIFFLE CROSS-SECTIONS ARE CONSIDERED THE RIFFLE SECTION.
4. THE AREA BETWEEN THE DOWNSTREAM RIFFLE AND RUN CROSS-SECTION IS CONSIDERED THE RUN SECTION.
5. THE AREA BETWEEN THE RUN AND GLIDE CROSS-SECTION IS CONSIDERED THE POOL SECTION.
6. THE AREA BETWEEN THE GLIDE AND THE UPSTREAM RIFFLE CROSS-SECTION IS CONSIDERED THE GLIDE SECTION.

CROSS SECTION TRANSITION LOCATIONS

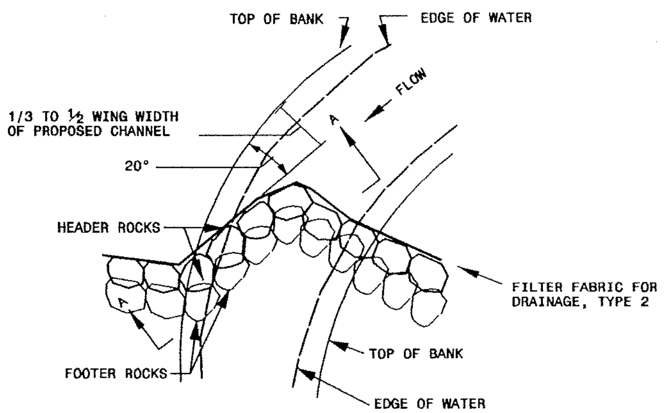
SCALE: NTS

USER: el DATE: 01/12/2005
DGN: q:\79457\cadd\report79457det.dgn TIME: 02:33:11 PM

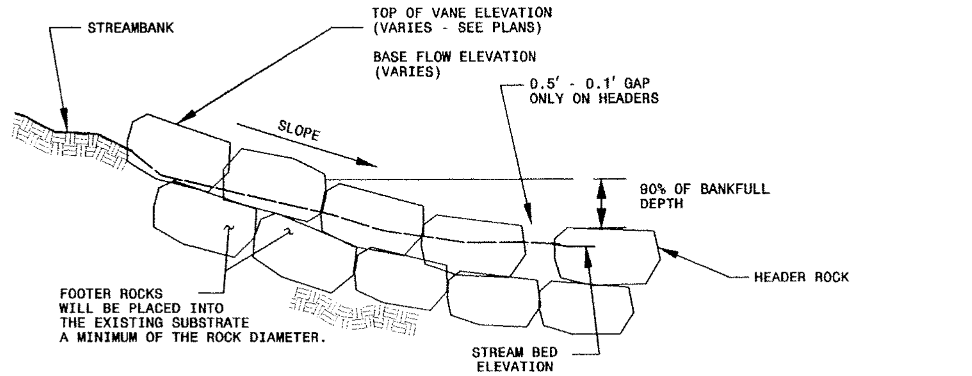
			EarthTech A Tyco International Ltd. Company 701 Corporate Center Drive, Suite #475; Raleigh ,NC 27607 Phone: (919) 854-6200 Fax: (919) 854-6259	EAST TARBORO CANAL STREAM RESTORATION EDGECOMBE COUNTY ECOSYSTEM ENHANCEMENT PROGRAM	PROJECT NO. / SHEET NO. FIGURE 11-C DETAILS



PROFILE VIEW



PLAN VIEW



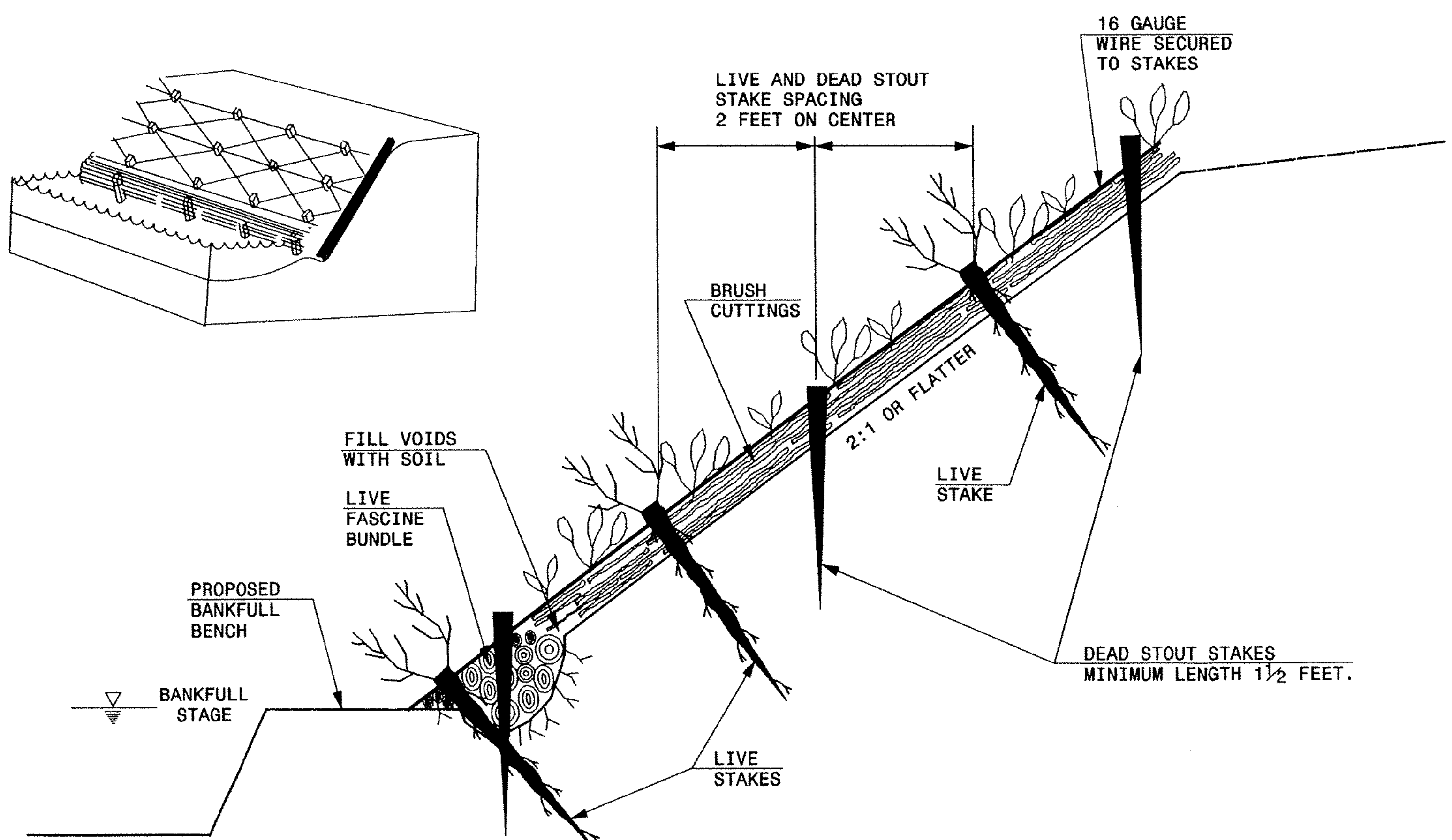
SECTION A-A

NOTES:

1. SCOUR POOL TO BE LOCATED PER STREAM FEATURES TABLE.
2. HEADER, FOOTER, AND SILL ROCKS TO BE STRUCTURE STONE, CLASS BOULDER.

GRADE CONTROL VANE

SCALE: NTS



BRUSH MATTRESS DETAIL

USER: ej DATE: 01/12/2005
DGN: q:\9457\cadd\report\9457det.dgn TIME: 02:33:11 PM

5.0 HABITAT RESTORATION

5.1 Vegetation

Vegetation that quickly develops a canopy, has an extensive root system, and a substantial aboveground plant structure is needed to help stabilize the banks of a restored stream channel in order to reduce scour and runoff erosion. In natural riparian environments, pioneer plants that often provide these functions are alder, river birch, silky dogwood, and various willow species. Once established, these trees and shrubs create an environment that allows for the succession of other riparian species including ashes, red maples, sycamores, and oaks.

In the newly restored stream channel, revegetation will be vital to help stabilize the stream banks and establish a riparian zone around the restored channel. Revegetation efforts on this project will emulate natural vegetation communities found along relatively undisturbed stream corridors in ecologically similar settings. To quickly establish dense root mass along the channel bank, a native herb/grass mixture will be planted on the streambed and bank. Shrubs, vines, and live stakes will be utilized on the stream bank and along the floodplain to provide additional root mass. Extra care will be given to the outside of the meander bends to ensure a dense root mass in those areas of high stress. Coir matting will be used to provide erosion protection until vegetation becomes established. Trees, shrubs and a native grass mixture will be planted along the tops of the channel banks.

In addition to the plantings to help stabilize the newly excavated stream banks, a characteristic floodplain forest community will be reestablished in a riparian buffer zone along each stream bank. Where possible the buffer will be 50 feet. Due to the urban constraints in Reach 1, the buffer will extend from the top of bank to the road shoulder, which is less than 50 feet on each side.

All plant material should be native species collected and propagated from material within the Upper Coastal Plain physiographic province and within 200 miles north or south latitude. The use of material that is genetically adapted to specific site conditions enhances long-term growth and survival and avoids contaminating the gene pool of the surrounding vegetation with non-adapted ecotypes. Vigorous growth of well-adapted ecotypes can also minimize problems with exotic invasive plants. Appropriate plant material is usually available upon request and can be obtained with planning and foresight.

Woody vegetation will be planted between November and March to allow plants to stabilize during the dormant period and set roots during the spring season. A non-aggressive, rapidly germinating grass will be used for immediate temporary erosion control on all newly excavated surfaces. A seed mix consisting of native graminoids and forbs will be applied during the appropriate season to ensure optimal germination and survival. Removal or control of nuisance vegetation will be implemented as necessary to promote survival of target plants.

The floodplain community recommended for this project is modeled after the *Nyssa* (*aquatica, biflora, ogeche*) Floodplain Seasonally Flooded Forest Alliance (I.B.2.N.e.8) as described in International Classification of Ecological Communities: Terrestrial Vegetation (NatureServe 2002). This community is similar to the Coastal Plain Small Stream Swamp (Blackwater Type) (Schafale and Weakley. 1990). Few indicator species of this community are present on the site because of longstanding anthropogenic alterations such as development and cultivation. However, the geography and topography of the site match the characteristics of the target community. Recommended plantings for this floodplain community are listed in the following sections. Dryer species are recommended for the top of bank areas.

This restoration can be divided into two main types of restoration communities. The upstream reach will require consideration of its location within a residential community and the types of plantings that will be appropriate in this setting. The lower reach is in an area with sufficient land to establish adequate buffers. This is also near a school and may be used as a teaching tool for teachers, students, and community leaders.

5.1.1 Site Preparation

This restoration occurs within an urban setting and raising the streambed elevation to its original elevation is not practical. Because a new floodplain will need to be excavated, the underlying soil will need to be considered for fertility and compaction in relation to establishing a vegetative cover. Existing topsoil shall be stockpiled on-site for later use. It is recommended that topsoil be added to the newly excavated surface to provide more favorable growing conditions that will allow quick establishment and growth of the desired vegetation. Topsoil should be loamy and contain higher amounts of organic material. The upper reach does not currently appear to have appropriate topsoil. Therefore, topsoil from the lower reach or from an outside source may be required in this area.

Liming and fertilizing are probably not necessary on this site, given the long history of these treatments. Addition of nutrients and a pH greater than 6.0 will favor the growth of ruderal opportunists over the desired native species. However, a soil analysis should be performed to confirm nutrient status on the site. Any required soil amendments shall be disked in.

Although exotics species are limited within the restoration reaches, these species are upstream and adjacent to the site. Care should be taken to prevent invasion of these species as most are relatively mobile and can establish rapidly under favorable conditions.

All planting areas to be planted shall be ripped on contour to a minimum depth of 18 inches. A 2-inch layer of organic matter and other soil amendments, including topsoil, fertilizer, and possibly lime, should be incorporated into the soil surface of planting areas by disking. Addition of organic matter during site preparation is a fast, easy way to shorten the time it will take for the soil to revert to a characteristic pre-disturbance structure and chemistry supportive of bottomland forests. Well-seasoned hardwood chips or leaf compost may be used as a source of organic matter. Including organic matter on the entire site may not be practical. However, it is recommended in the areas adjacent to and including the newly built channel. The surface should be left rough and irregular to emulate natural microtopography except where coir matting is to be placed which requires a smooth surface free of irregularities for optimum performance.

5.1.2 Streambank Vegetation

A combination of seeds, live stakes, and bare root nursery stock will be utilized to stabilize the banks. Species proposed for planting are listed below. Any of the listed species may also be salvaged from construction areas and transplanted on the streambanks.

Live stakes
Black willow (*Salix nigra*) (limited use-maximum of 20%)
Elderberry (*Sambucus canadensis*)
Silky dogwood (*Cornus amomum*)
Common buttonbush (*Cephalanthus occidentalis*)

Shrubs (bare root or container)
Possumhaw (*Ilex decidua*)
Spicebush (*Lindera benzoin*)
Tag alder (*Alnus serrulata*)
Wild raisin (*Viburnum nudum*)
Coastal doghobble (*Leucothoe axillaris*)
Swamp titi (*Cyrilla racemiflora*)

Graminoids and Forbs (seeds or plugs)
Fringed sedge (*Carex crinita*)
Shallow sedge (*Carex lurida*)
Indian woodoats (*Chasmanthium latifolium*)
Common rush (*Juncus effusus*)

5.1.3 Riparian Buffer

In Reach 2, a target 50 ft. riparian buffer will be established in the floodplain from the top of the banks of the proposed stream channel. Bare-root seedlings of canopy and subcanopy tree species will be planted on 8-foot centers for a planting density of 680 trees/acre of the finest quality 1/0 seedlings. Hardwood bare-root seedlings that will form the canopy must have a minimum root collar diameter (RCD) of 3/8-inch. It is recommended that seedlings be at least 12 to 18 inches in height. Proposed species to be planted in these areas include the following:

Trees (bare root)
Swamp tupelo (*Nyssa biflora*)
Bald cypress (*Taxodium distichum*)
Green ash (*Fraxinus pennsylvanica*)
Oaks (*Quercus laurifolia, Q. nigra, Q. phellos, Q. pagoda*)
Ironwood (*Carpinus caroliniana*)
Bitternut hickory (*Carya cordiformis*)

Shrubs should be concentrated along the outer edges of the buffer as a possible barrier to opportunistic invasions of exotic species.

Shrubs (bare root or container)
American beautyberry (*Callicarpa americana*)
American hazelnut (*Corylus americana*)
Flowering dogwood (*Cornus florida*)

Graminoids and Forbs
Deertongue (*Panicum clandestinum*)
Little blue stem (*Schizachyrium scoparium*)
Virginia wildrye (*Elymus virginicus*)

6.0 MONITORING

The following monitoring criteria are taken from the Stream Mitigation Guidelines (USACE, 2003) for Level 1 Restoration and Enhancement sites.

Monitoring of the stability of the channel is recommended to occur after the first growing season and should continue annually for a period of 5 years or until two bankfull events have been documented. Bankfull events must be documented during separate monitoring years.

The following monitoring practices are recommended at all Level 1 Restoration and Enhancement sites: reference photos, plant survival analysis, channel stability analysis, and biological data if required by permit conditions. Channel stability analysis will consist of a representative longitudinal profile, cross-sections, pebble counts at each cross-section, and pattern measurements if altered since construction. The purpose of monitoring is to determine bank stability, bed stability, morphological stability, overall channel stability, and mortality of vegetation. If biological sampling is required, it will be used to evaluate secondary impacts of the restoration project.

The monitoring report shall contain a general description of the site and the goals of the project. The report will discuss the current years' results and a discussion of any changes that have occurred on the restoration site. The relative significance of these changes will be discussed in detail and a maintenance plan will be recommended if applicable. The current data overlaid over the previous data and a photo log showing successive photos will be included in the appendix.

7.0 SUCCESS CRITERIA

The following success criteria are recommended for the East Tarboro Canal Project. These criteria are taken from the Stream Mitigation Guidelines (USACE, 2003).

7.1 Channel Stability

7.1.1 Dimension, Pattern, and Profile

The dimension, pattern, and profile of the stream should show no radical change during the 5-year monitoring period. To determine this, the longitudinal profile and cross-sections will be re-surveyed annually. Cross-sections will be overlaid to verify no significant change in the dimension from year to year. Similarly, the longitudinal profile will be overlaid to confirm a stable bed profile, i.e. riffle pool spacing should remain fairly constant and there should be a general lack of aggradation and degradation. Due to the number of rootwads located in the majority of the meanders, the pattern may be confirmed through visual observation. If a rootwad has washed out or there are signs of erosion, the radius of curvature will be measured and compared to the as-built mapping.

7.1.2 Bed Material

A Modified Wolman Pebble Count will be taken at each cross-section to determine the change in the surface material below bankfull. The pools should contain a finer material than the riffles. In general, the pebble count should show a change in the size of bed material toward the desired composition. The pebble count will be taken once a year during the annual monitoring period. The consecutive pebble counts will be plotted on the same graph. In addition, the D50 and D84 will be compared to determine changes in the surface material of the cross-section.

7.2 Photograph Documentation

Photographs will be taken as described by the permit conditions and compared to the as-built photos. The photos will be used to make a qualitative assessment of channel aggradation or degradation, bank erosion, success of riparian vegetation, effectiveness of erosion control measures, and the presence or absence of developing in-stream bars. Any significant changes from the as-built conditions will be discussed and highlighted in the report.

7.3 Ecological Function

Ecological function will be assessed to determine the health and survival of the vegetation and to determine if the restored section mimics the reference reach. The success criteria for tree seedlings in the riparian buffer zones are defined by the Division of Water Quality to be 80 % survival of planted species or 260 trees/acre after five years. Vegetation will be monitored annually.

8.0 REFERENCES

Doll, B.A., A.D. Dobbins, J. Spooner, D.R. Clinton and D.A. Bidelspach. 2003. Hydraulic Geometry Relationships for Rural North Carolina Coastal Plain Streams. Report to NC Division of Water Quality (EPA 319).

Harrelson, Cheryl, C.L. Rawlins and John Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. United States Department of Agriculture, Forest Service. General Technical Report RM-245.

NatureServe. 2002. International Classification of Ecological Communities: Terrestrial Vegetation. Natural Heritage Central Databases. NatureServe, Arlington, VA.

NCDENR. "Water Quality Stream Classifications for Streams in North Carolina." *Water Quality Section.* http://h2o.enr.state.nc.us/wqhome.html (12 March 2002).

Radford, A.E., H.E. Ahles and G.R. Bell. 1968. *Manual of the Vascular Flora of the Carolinas.* The University of North Carolina Press, Chapel Hill, North Carolina.

Rosgen, Dave. 1997. A Geomorphological Approach to Restoration of Incised Rivers. Wildland Hydrology. Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision.

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

USDA-SCS. 1979. Soil Survey of Edgecombe County, North Carolina.

USACE. 2003. Stream Mitigation Guidelines, April 2003 (http://www.saw.usace.army.mil/wetlands/Mitigation/stream_mitigation.html).

USDA, NRCS. 2004. *The PLANTS Database, Version 3.5* (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

USDA-NRCS Soil Survey Division. Hydric Soils Series Lists by States. *Hydric soils of North Carolina.* http://soils.usda.gov/soil_use/main.htm. Revised December 15, 1995 (Accessed October 2004).

Photo Log

East Tarboro Canal

Reach 1

1. Looking downstream from Forest Acres Drive

2. Looking upstream at Forest Acres Drive culvert

3. Looking downstream from point approximately 150' downstream of Forest Acres Drive culvert

4. Looking downstream from point just downstream of Clark Drive culvert

Reach 2

5. Looking upstream from point just upstream of Wilson Street

6. Looking downstream from point approximately 400' upstream from Wilson Street culvert

7. Looking upstream from Wilson Street during Town "maintenance" of canal

8. Looking downstream from point approximately 650' upstream from St. James Street

9. Looking downstream at Wilson Street culvert

10. Looking upstream from St. James Street

East Tarboro Canal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Tar
Watershed:	East Tarboro Canal
Stream Reach:	Reach 1-Canal Street (Forest Acres Dr. to Rosewood Dr.)
DA upstream point (sq mi):	0.66
DA downstream point (sq mi):	0.80
Date:	9/21/2004
Longitudinal Profile	
Reference	1+83.0 XS 1 Profile Station (0+00 @ Forest Acres Dr. D/S PIPE INVERT)
	ABOVE FOREST ACRES DRIVE

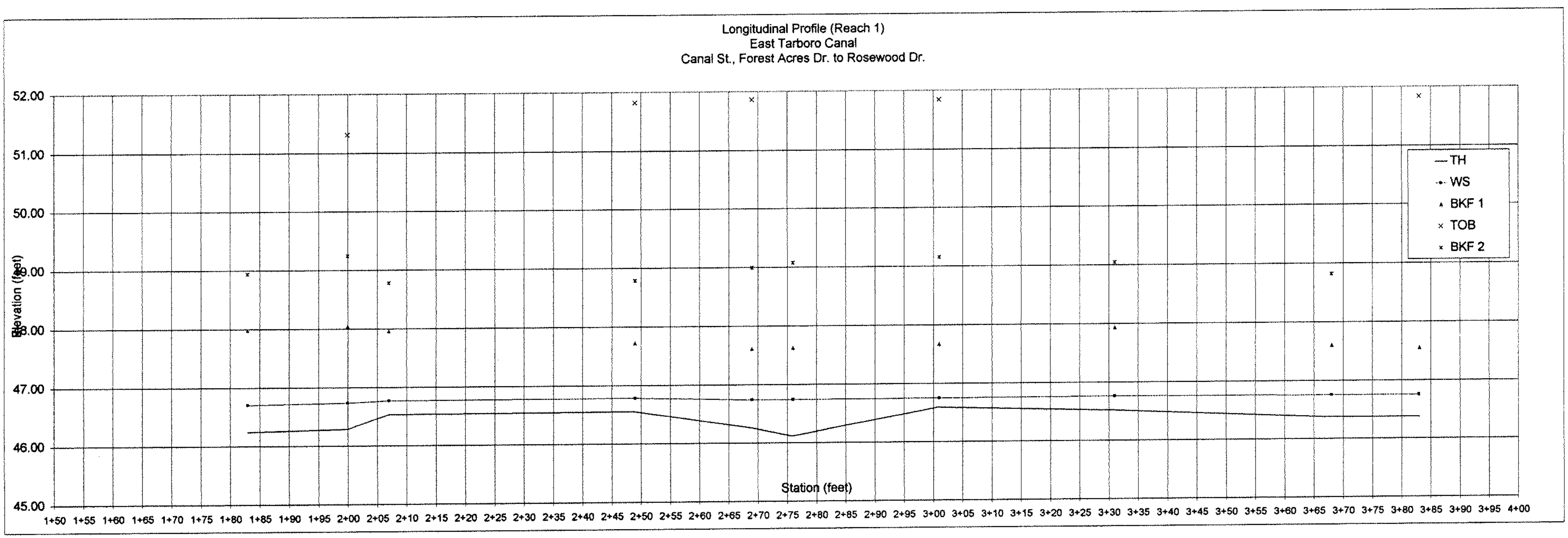
Dist. From Reference	PROFILE STATION	FEATURE	THALWEG LEVEL	WS LEVEL	BKF 1 LEVEL	BKF 2 LEVEL	LOW TOB LEVEL	BM LEVEL	BM ELEV.	HI
0.0	1+83.0	RIFFLE	8.18	7.72	6.44			1.26	53.16	54.42
17.0	2+00.0	POOL	8.14	7.69	6.38	5.48	3.10	1.26	53.16	54.42
24.0	2+07.0	RIFFLE	7.89	7.65	6.46	5.17		1.26	53.16	54.42
66.0	2+49.0	POOL	7.87	7.64	6.70	5.64	2.59	1.26	53.16	54.42
86.0	2+69.0	RIFFLE	8.16	7.68	6.81	5.63	2.55	1.26	53.16	54.42
93.0	2+76.0	POOL	8.30	7.68	6.80	5.42		1.26	53.16	54.42
118.0	3+01.0	RIFFLE	7.83	7.67	6.75	5.34	2.57	1.26	53.16	54.42
148.0	3+31.0	POOL	7.90	7.66	6.49	5.26		1.26	53.16	54.42
185.0	3+68.0	RIFFLE	8.05	7.67	6.82	5.37		1.26	53.16	54.42
200.0	3+83.0	POOL	8.05	7.67	6.87	5.60	2.58	1.26	53.16	54.42

THALWEG ELEV.	WS ELEV.	BKF 1 ELEV.	BKF 2 ELEV.	LOW TOB ELEV.	Notes
46.24	46.70	47.98			XS 1
46.28	46.73	48.04	48.94	51.32	
46.53	46.77	47.96	49.25		
46.55	46.78	47.72	48.78	51.83	
46.26	46.74	47.61	48.79	51.87	
46.12	46.74	47.62	49.00		
46.59	46.75	47.67	49.08	51.85	
46.52	46.76	47.93	49.16		
46.37	46.75	47.60	49.05		
46.37	46.75	47.55	48.82	51.84	

BHR Low Bank Ht/ BKF Ht.	P-P	Pool Length	Max Pool Depth	Pool Slope	Riffle Length	Riffle Slope	Glide Length	Glide Slope	Run Length	Run Slope
-26.57	N/A	N/A	N/A	N/A	17.0	-0.0018	N/A	N/A	N/A	N/A
N/A	N/A	7.0	N/A	-0.0057	N/A	N/A	N/A	N/A	N/A	N/A
-32.54	N/A	N/A	N/A	N/A	42.0	-0.0002	N/A	N/A	N/A	N/A
N/A	N/A	20.0	N/A	0.0020	N/A	N/A	N/A	N/A	N/A	N/A
4.16	N/A	N/A	N/A	N/A	7.0	0.0000	N/A	N/A	N/A	N/A
N/A	N/A	25.0	N/A	-0.0004	N/A	N/A	N/A	N/A	N/A	N/A
4.87	N/A	N/A	N/A	N/A	30.0	-0.0003	N/A	N/A	N/A	N/A
N/A	N/A	37.0	N/A	0.0003	N/A	N/A	N/A	N/A	N/A	N/A
-37.70	N/A	N/A	N/A	N/A	15.0	0.0000	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Thalweg Slope	-0.0007
WS Slope	-0.0003
BKF Slope	0.0021

	Riffle BKF Width	Riffle BKF Mean Depth	Riffle BKF Max. Depth	Bk Ht/ Bkf Ht.	P-P	Pool Length	Max Pool Depth	Pool Slope	Riffle Length	Riffle Slope	Glide Length	Glide Slope	Run Length	Run Slope	
MIN	7.3	1.4	1.7	-37.70	0.0	7.0	0.00	-0.0057	7.0	-0.0018	0.0	0.0000	0.0	0.0000	
MAX	7.3	2.0	2.9	4.87	0.0	37.0	0.00	0.0020	42.0	0.0000	0.0	0.0000	0.0	0.0000	
AVG	7.3	1.7	2.3	-17.56	#DIV/0!	22.3	#DIV/0!	-0.0010	22.2	-0.0005	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	
Min ratio				-22.8	0.0		0.0	21.1		6.5		0.0		0.0	
Max ratio				1.7	0.0		0.0	-7.4		0.0		0.0		0.0	
Avg ratio				-7.7	#DIV/0!		#DIV/0!	3.6		1.7		#DIV/0!		#DIV/0!	
						89			111		0		0		200



East Tarboro Canal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Tar
Watershed:	East Tarboro Canal
Stream Reach:	Reach 1-Canal Street (Forest Acres Dr. to Rosewood Dr.)
DA upstream point (sq mi):	0.68
DA downstream point (sq mi):	0.80
Date:	9/21/2004
Benchmark:	XSBM1 (Nail in Pavement Edge)
Benchmark Elev:	53.16
Benchmark Level:	1.25
Benchmark HI:	54.41
Station:	1+83.0 (0+00 @ Forest Acres Dr. D/S PIPE INVERT)
Cross Section:	1
Feature:	Straight Ditch (No Riffle/Pool Sequence noted)

ABBREVIATIONS

TH	THALWEG
WS	WATER SURFACE
LEW	LEFT EDGE OF WATER
REW	RIGHT EDGE OF WATER
LBKF	LEFT BANKFULL
RBKF	RIGHT BANKFULL
LTOB	LEFT TOP OF BANK
RTOB	RIGHT TOP OF BANK
A	AREA
W	WIDTH
D	DEPTH
BKF	BANKFULL

Bank Erosion Hazard Index (BEHI)

Criteria	Value	Index	Bank Erosion Potential
Bank Ht/Bkf Ht	3.21	10	Extreme
Root Depth/Bank Ht	0.92	1.8	Very Low
Root Density (%)	10	N/A	N/A
Weighted Root Density	9.2	8.5	Very High
Bank Angle (Degrees)	8	3.6	Low
Surface Protection (%)	20	7.4	High
Bank Materials	silt loam	0	
Stratification		0	
		31.3	High

XS STATION (Feet)	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
0+00.0	54.41	2.15	52.26	
0+08.0	54.41	1.96	52.45	
0+11.0	54.41	2.30	52.11	
0+17.0	54.41	2.75	51.66	LTOB
0+19.0	54.41	3.18	51.23	
0+20.0	54.41	3.51	50.90	
0+21.4	54.41	4.07	50.34	
0+22.5	54.41	5.90	48.51	
0+23.1	54.41	6.43	47.98	LBKF
0+24.0	54.41	7.16	47.25	
0+24.2	54.41	7.83	46.58	LEW
0+25.0	54.41	7.92	46.49	
0+26.5	54.41	8.00	46.41	
0+28.4	54.41	8.08	46.33	TH
0+29.3	54.41	8.03	46.38	
0+30.2	54.41	7.95	46.46	REW
0+30.4	54.41	6.43	47.98	RBKF
0+31.0	54.41	5.43	48.98	
0+32.5	54.41	4.88	49.53	
0+34.7	54.41	4.12	50.29	
0+38.2	54.41	2.78	51.63	RTOB
0+41.5	54.41	2.23	52.18	
0+46.0	54.41	1.84	52.57	
0+49.0	54.41	1.65	52.76	
0+52.5	54.41	1.40	53.01	
0+53.0	54.41	1.25	53.16	

0+23.1

0+30.4

OTHER LEVELS Description	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
WS	54.41	7.68	46.73	Water Depth at TH = 0.40'

BANKFULL Hydraulic Geometry

Bankfull Elevation = 47.98

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	-4.28	N/A	N/A
8.0	-4.47	N/A	N/A
3.0	-4.13	N/A	N/A
6.0	-3.68	N/A	N/A
2.0	-3.25	N/A	N/A
1.0	-2.92	N/A	N/A
1.4	-2.36	N/A	N/A
1.1	-0.53	N/A	N/A
0.6	0.00	N/A	N/A
0.9	0.73	0.3	1.2
0.2	1.40	0.2	1.4
0.8	1.49	1.2	1.7
1.5	1.57	2.3	2.2
1.9	1.65	3.1	2.5
0.9	1.60	1.5	1.8
0.9	1.52	1.4	1.8
0.2	0.00	0.2	0.2
0.6	-1.00	N/A	N/A
1.5	-1.55	N/A	N/A
2.2	-2.31	N/A	N/A
3.5	-3.65	N/A	N/A
3.3	-4.20	N/A	N/A
4.5	-4.59	N/A	N/A
3.0	-4.78	N/A	N/A
3.5	-5.03	N/A	N/A
0.5	-5.18	N/A	N/A

SUMMARY DATA (BANKFULL)

A(BKF)	10.1
W(BKF)	7.3
Max d	1.65
Mean d	1.38
ELEV. (FPA)	49.63
W(FPA)	10.5
Slope	0.0007
W/D	5.29
Entrenchment	1.44
Stream Type	G5c
Wetted Perimeter	12.8
Manning's "n"	0.030
Manning's Discharge	11.3

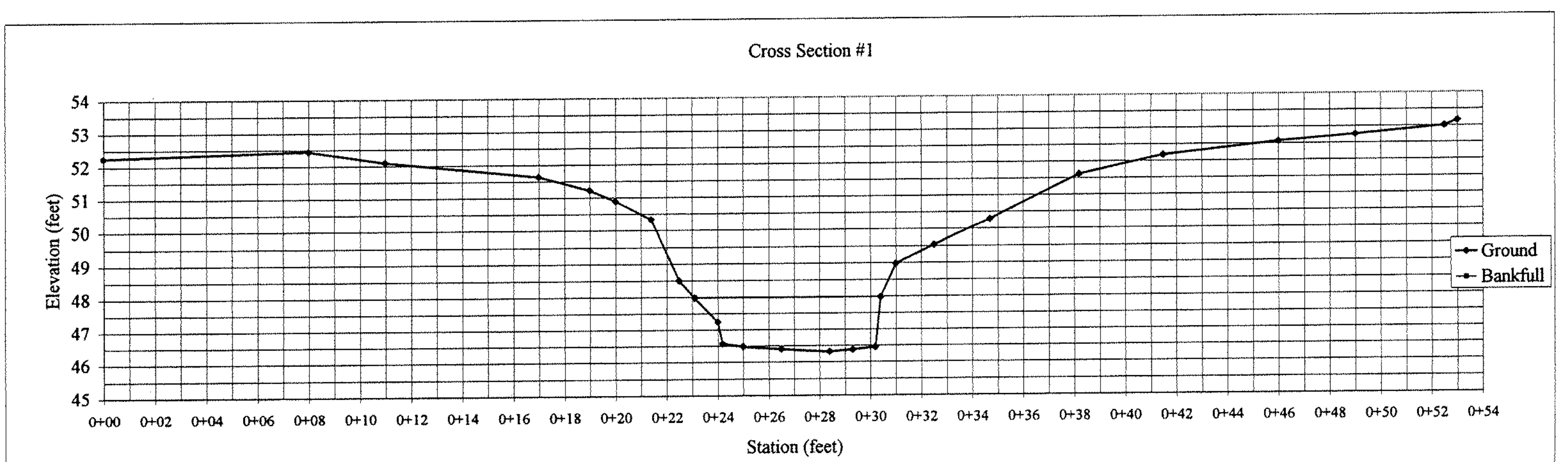
Low Top of Bank Hydraulic Geometry

Low Top of Bank Elev 51.63

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	-0.63	N/A	N/A
8.0	-0.82	N/A	N/A
3.0	-0.48	N/A	N/A
6.0	-0.03	N/A	N/A
2.0	0.40	N/A	N/A
1.0	0.73	0.6	1.2
1.4	1.29	1.4	1.9
1.1	3.12	2.4	3.3
0.6	3.65	2.0	3.7
0.9	4.38	3.6	4.5
0.2	5.05	0.9	5.1
0.8	5.14	4.1	5.2
1.5	5.22	7.8	5.4
1.9	5.30	10.0	5.6
0.9	5.25	4.7	5.3
0.9	5.17	4.7	5.2
0.2	3.65	0.9	3.7
0.6	2.65	1.9	2.7
1.5	2.10	3.6	2.6
2.2	1.34	3.8	2.8
3.5	0.00	2.3	3.5
3.3	-0.55	N/A	N/A
4.5	-0.94	N/A	N/A
3.0	-1.13	N/A	N/A
3.5	-1.38	N/A	N/A
0.5	-1.53	N/A	N/A

SUMMARY DATA (Low Top of Bank)

A	54.7
W	21.2
Max d	5.30
Mean d	2.58
Slope	0.0007
W/D	8.21
Wetted Perimeter	61.5
Manning's "n"	0.030
Manning's Discharge	66.3



East Tarboro Canal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Tar
Watershed:	East Tarboro Canal
Stream Reach:	Reach 1-Canal Street (Forest Acres Dr. to Rosewood Dr.)
DA upstream point (sq mi):	0.66
DA downstream point (sq mi):	0.80
Date:	9/21/2004
Benchmark:	CLARK ST. u/s LT. INV. (looking d/s)
Benchmark Elev:	46.56
Benchmark Level:	10.28
Benchmark HI:	56.84
Station:	7+96.0 (0+00 @ Forest Acres Dr. D/S PIPE INVERT)
Cross Section:	2
Feature:	Straight Ditch (No Riffle/Pool Sequence noted)

ABBREVIATIONS

TH	THALWEG
WS	WATER SURFACE
LEW	LEFT EDGE OF WATER
REW	RIGHT EDGE OF WATER
LBKF	LEFT BANKFULL
RBKF	RIGHT BANKFULL
LTOB	LEFT TOP OF BANK
RTOB	RIGHT TOP OF BANK
A	AREA
W	WIDTH
D	DEPTH
BKF	BANKFULL

Bank Erosion Hazard Index (BEHI)

Criteria	Value	Index	Bank Erosion Potential
Bank Ht/Bkf Ht	2.06	8	Very High
Root Depth/Bank Ht	0	10	Extreme
Root Density (%)	10	N/A	N/A
Weighted Root Density	0	10	Extreme
Bank Angle (Degrees)	90	7.9	High
Surface Protection (%)	60	3.5	Low
Bank Materials	Sandy Loar	0	
Stratification		0	
		39.4	High

XS STATION (Feet)	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
0+00.0	56.84	5.31	51.53	LT E/P
0+07.0	56.84	5.27	51.57	
0+14.0	56.84	5.94	50.90	LTOB
0+19.0	56.84	7.84	49.00	
0+20.7	56.84	8.16	48.68	
0+21.3	56.84	8.51	48.33	
0+22.2	56.84	9.03	47.81	LBKF
0+23.0	56.84	10.45	46.39	LEW
0+24.5	56.84	11.22	45.62	
0+26.0	56.84	11.60	45.24	
0+28.0	56.84	11.95	44.89	TH
0+28.5	56.84	11.24	45.60	REW
0+29.5	56.84	9.03	47.81	RBKF
0+30.5	56.84	8.51	48.33	
0+33.0	56.84	8.90	47.94	
0+39.5	56.84	4.05	52.79	RTOB
0+46.0	56.84	4.06	52.78	
0+52.0	56.84	4.52	52.32	RT E/P

0+22.2

0+29.5

OTHER LEVELS Description	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
WS	56.84	10.30	46.54	Water Depth at TH = 1.95'

BANKFULL Hydraulic Geometry
Bankfull Elevation = 47.81

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	-3.72	N/A	N/A
7.0	-3.76	N/A	N/A
7.0	-3.09	N/A	N/A
5.0	-1.19	N/A	N/A
1.7	-0.87	N/A	N/A
0.6	-0.52	N/A	N/A
0.9	0.00	N/A	N/A
0.8	1.42	0.6	1.6
1.5	2.19	2.7	2.7
1.5	2.57	3.6	3.0
2.0	2.92	5.5	3.5
0.5	2.21	1.3	2.3
1.0	0.00	1.1	1.0
1.0	-0.52	N/A	N/A
2.5	-0.13	N/A	N/A
6.5	-4.98	N/A	N/A
6.5	-4.97	N/A	N/A
6.0	-4.51	N/A	N/A

SUMMARY DATA (BANKFULL)

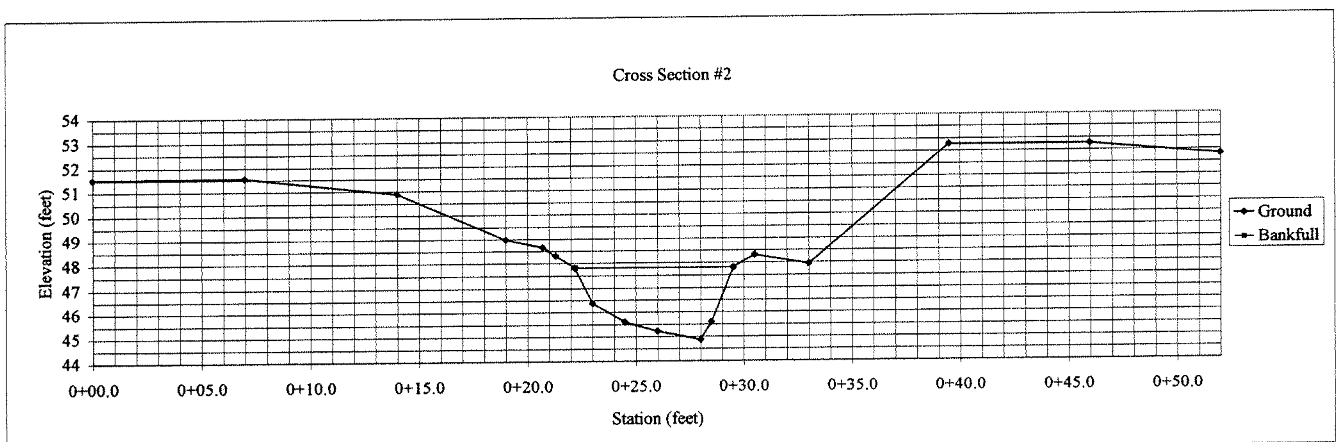
A(BKF)	14.7
W(BKF)	7.3
Max d	2.92
Mean d	2.02
ELEV. (FPA)	50.73
W(FPA)	21
Slope	0.0007
W/D	3.62
Entrenchment	2.88
Stream Type	E5
Wetted Perimeter	14.1
Manning's "n"	0.030
Manning's Discharge	19.9

Low Top of Bank Hydraulic Geometry
Low Top of Bank Elev. = 52.79

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	1.26	N/A	N/A
7.0	1.22	8.7	7.1
7.0	1.89	10.9	7.3
5.0	3.79	14.2	6.3
1.7	4.11	6.7	4.4
0.6	4.46	2.6	4.5
0.9	4.98	4.2	5.1
0.8	6.40	4.6	6.4
1.5	7.17	10.2	7.3
1.5	7.55	11.0	7.7
2.0	7.90	15.5	8.1
0.5	7.19	3.8	7.2
1.0	4.98	6.1	5.1
1.0	4.46	4.7	4.6
2.5	4.85	11.6	5.5
6.5	0.00	15.8	6.5
6.5	0.01	0.0	6.5
6.0	0.47	1.4	6.0

SUMMARY DATA (Low Top of Bank)

A	132.0
W	70.0
Max d	7.90
Mean d	1.89
Slope	0.0007
W/D	37.13
Wetted Perimeter	105.6
Manning's "n"	0.030
Manning's Discharge	200.7



East Tarboro Canal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Tar
Watershed:	East Tarboro Canal
Stream Reach:	Reach 1-Canal Street (Forest Acres Dr. to Rosewood Dr.)
DA upstream point (sq mi):	0.66
DA downstream point (sq mi):	0.80
Date:	9/21/2004
Benchmark:	CLARK ST. d/s RT. INV. (looking d/s)
Benchmark Elev:	46.31
Benchmark Level:	11.62
Benchmark HI:	57.93
Station:	13+52.0 (0+00 @ Forest Acres Dr. D/S PIPE INVERT)
Cross Section:	3
Feature:	Riffle?

XS STATION (Feet)	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
0+00.0	57.93	4.96	52.97	LT ROAD E/P
0+12.0	57.93	4.77	53.16	LTOB
0+16.0	57.93	7.22	50.71	
0+19.0	57.93	10.12	47.81	
0+19.7	57.93	11.18	46.75	
0+20.5	57.93	12.28	45.65	LBKF
0+20.8	57.93	12.70	45.23	
0+21.5	57.93	13.50	44.43	
0+22.0	57.93	13.82	44.11	TH
0+26.0	57.93	13.70	44.23	
0+29.0	57.93	13.48	44.45	
0+30.0	57.93	12.70	45.23	
0+30.3	57.93	12.28	45.65	RBKF
0+31.0	57.93	11.18	46.75	
0+33.0	57.93	10.31	47.62	
0+36.0	57.93	8.73	49.20	
0+39.0	57.93	7.51	50.42	
0+42.0	57.93	5.28	52.65	RTOB
0+46.0	57.93	4.85	53.08	
0+51.0	57.93	5.10	52.83	RT ROAD E/P

0+20.5

0+30.3

OTHER LEVELS Description	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES

ABBREVIATIONS

TH	THALWEG
WS	WATER SURFACE
LEW	LEFT EDGE OF WATER
REW	RIGHT EDGE OF WATER
LBKF	LEFT BANKFULL
RBKF	RIGHT BANKFULL
LTOB	LEFT TOP OF BANK
RTOB	RIGHT TOP OF BANK
A	AREA
W	WIDTH
D	DEPTH
BKF	BANKFULL

Bank Erosion Hazard Index (BEHI)

Criteria	Value	Index	Bank Erosion Potential
Bank Ht/Bkf Ht			
Root Depth/Bank Ht			
Root Density (%)			
Weighted Root Density			
Bank Angle (Degrees)			
Surface Protection (%)			
Bank Materials			
Stratification			
		0	

BANKFULL Hydraulic Geometry

Bankfull Elevation = 45.65

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	-7.32	N/A	N/A
12.0	-7.51	N/A	N/A
4.0	-5.06	N/A	N/A
3.0	-2.16	N/A	N/A
0.7	-1.10	N/A	N/A
0.8	0.00	N/A	N/A
0.3	0.42	0.1	0.5
0.7	1.22	0.5	1.4
0.5	1.54	0.7	1.6
4.0	1.42	5.9	4.2
3.0	1.20	3.9	3.2
1.0	0.42	0.8	1.1
0.3	0.00	0.1	0.3
0.7	-1.10	N/A	N/A
2.0	-1.97	N/A	N/A
3.0	-3.55	N/A	N/A
3.0	-4.77	N/A	N/A
3.0	-7.00	N/A	N/A
4.0	-7.43	N/A	N/A

SUMMARY DATA (BANKFULL)

A(BKF)	12.0
W(BKF)	9.8
Max d	1.54
Mean d	1.23
ELEV. (FPA)	47.19
W(FPA)	12.7
Slope	0.0004
W/D	7.99
Entrenchment	1.30
Stream Type	G5c
Wetted Perimeter	12.4
Manning's "n"	0.030
Manning's Discharge	11.7

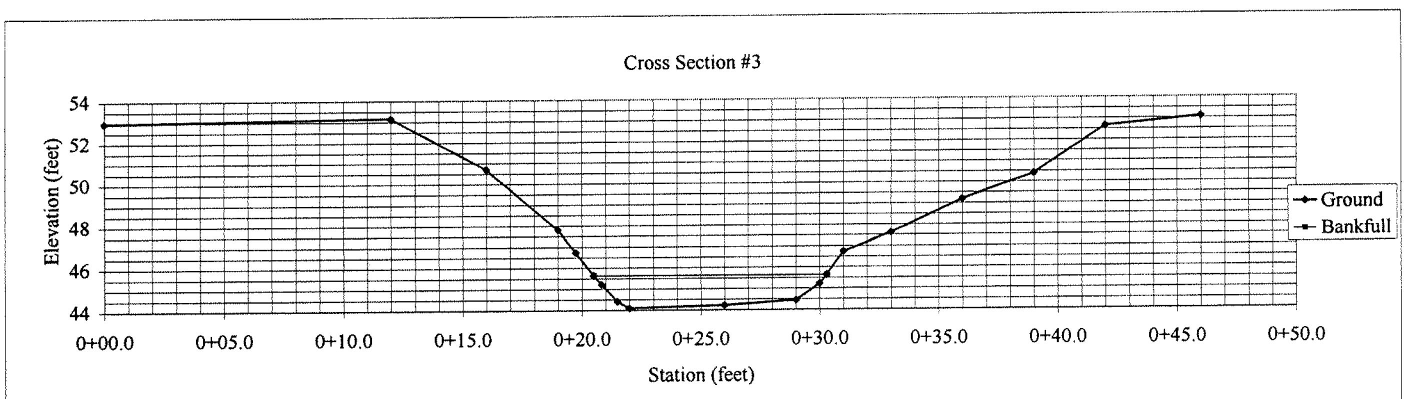
Low Top of Bank Hydraulic Geometry

Low Top of Bank Elev. = 52.65

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	-0.32	N/A	N/A
12.0	-0.51	N/A	N/A
4.0	1.94	N/A	N/A
3.0	4.84	10.2	5.7
0.7	5.90	4.0	5.9
0.8	7.00	4.9	7.0
0.3	7.42	2.5	7.4
0.7	8.22	5.2	8.2
0.5	8.54	4.2	8.6
4.0	8.42	33.9	9.3
3.0	8.20	24.9	8.7
1.0	7.42	7.8	7.5
0.3	7.00	2.2	7.0
0.7	5.90	4.5	5.9
2.0	5.03	10.9	5.4
3.0	3.45	12.7	4.6
3.0	2.23	8.5	3.7
3.0	0.00	3.3	3.0
4.0	-0.43	N/A	N/A

SUMMARY DATA (Low Top of Bank)

A	139.7
W	30.0
Max d	8.54
Mean d	4.66
Slope	0.0004
W/D	6.44
Wetted Perimeter	98.1
Manning's "n"	0.030
Manning's Discharge	175.2



East T[illegible]anal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Tar
Watershed:	East Tarboro Canal
Stream Reach:	Reach 2 - Martin Luther King Drive to St. James Street
DA upstream point (sq mi):	1.96
DA downstream point (sq mi):	2.19
Date:	9/8/2004
Longitudinal Profile	
Reference	19+18.0 XS 14 Profile Station (0+00 @ ML King D/S PIPE INVERT)

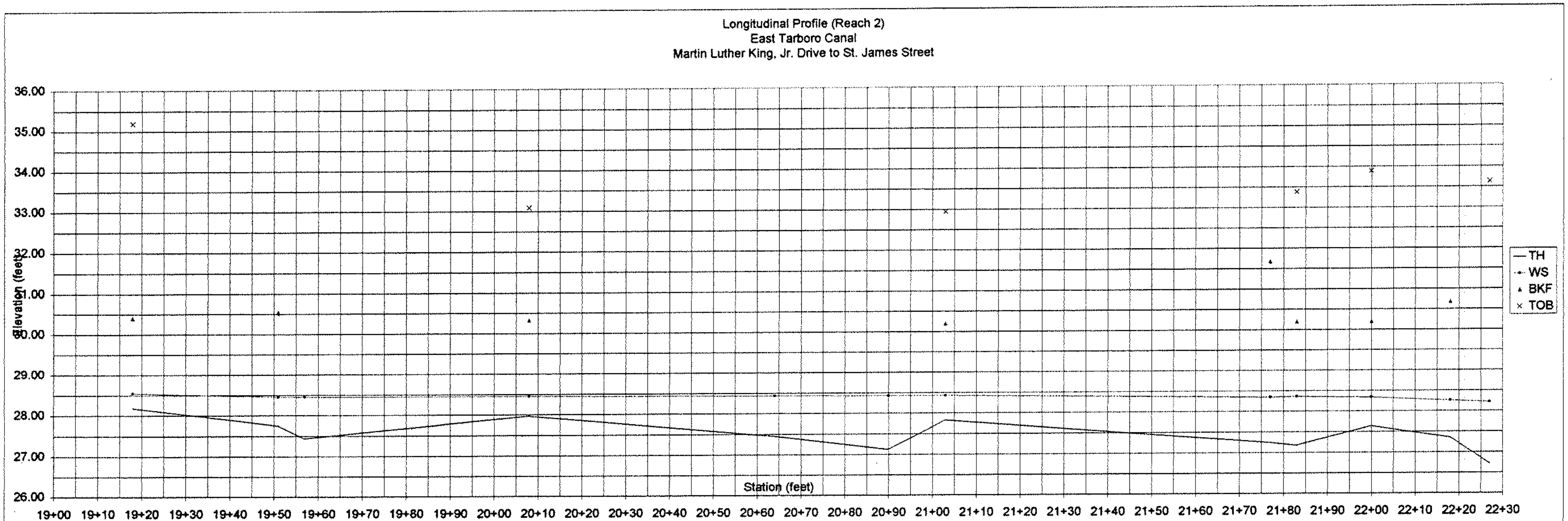
Dist. From Reference	PROFILE STATION	FEATURE	THALWEG LEVEL	WS LEVEL	LBKF LEVEL	RBKF LEVEL	LOW TOB LEVEL	BM LEVEL	BM ELEV.	HI
0.0	19+18.0	RIFFLE	12.51	12.14	10.29	10.29	5.51	4.40	36.29	40.69
33.0	19+51.0	POOL	12.33	11.63	9.55			3.79	36.29	40.08
39.0	19+57.0	MAX. POOL	12.64	11.63				3.79	36.29	40.08
90.0	20+08.0	RIFFLE	11.33	10.85	8.97	8.97	6.22	3.01	36.29	39.30
146.0	20+64.0	POOL	12.62	11.64		9.55		3.79	36.29	40.08
172.0	20+90.0	MAX. POOL	12.95	11.65				3.79	36.29	40.08
185.0	21+03.0	RIFFLE	11.72	11.12	9.35	9.35	6.61	3.26	36.29	39.55
259.0	21+77.0	POOL	12.83	11.73	8.41			3.79	36.29	40.08
265.0	21+83.0	MAX. POOL	12.22	11.04	9.20	9.20	6.03	3.11	36.29	39.40
282.0	22+00.0	RIFFLE	12.44	11.74	9.88		6.20	3.79	36.29	40.08
300.0	22+18.0	POOL	12.72	11.82	9.40			3.79	36.29	40.08
309.0	22+27.0	MAX. POOL	13.36	11.86		9.55	6.46	3.79	36.29	40.08

Dist. From Reference	THALWEG ELEV.	WS ELEV.	LBKF ELEV.	RBKF ELEV.	LOW TOB ELEV.	Notes
0.0	28.18	28.55	30.40	30.40	35.18	XS 14
33.0	27.75	28.45	30.53			
39.0	27.44	28.45				
90.0	27.97	28.45	30.33	30.33	33.08	XS 15
146.0	27.46	28.44		30.53		
172.0	27.13	28.43				
185.0	27.83	28.43	30.20	30.20	32.94	XS 16
259.0	27.25	28.35	31.67			
265.0	27.18	28.36	30.20	30.20	33.37	XS 17
282.0	27.64	28.34	30.20		33.88	
300.0	27.36	28.26	30.68			
309.0	26.72	28.22		30.53	33.62	

Dist. From Reference	BHR Low Bank Ht/ BKF Ht.	P-P	Pool Length	Max Poo Depth	Pool Slope	Riffle Length	Riffle Slope	Glide Length	Glide Slope	Run Length	Run Slope
0.0	3.15	N/A	N/A	N/A	N/A	33.0	0.0030	N/A	N/A	N/A	N/A
33.0	N/A	N/A	57.0	N/A	0.0000	N/A	N/A	N/A	N/A	N/A	N/A
39.0	N/A	133.0	N/A	-27.44	N/A	N/A	N/A	N/A	N/A	N/A	N/A
90.0	2.17	N/A	N/A	N/A	N/A	56.0	0.0002	N/A	N/A	N/A	N/A
146.0	N/A	N/A	39.0	N/A	0.0003	N/A	N/A	N/A	N/A	N/A	N/A
172.0	N/A	93.0	N/A	3.07	N/A	N/A	N/A	N/A	N/A	N/A	N/A
185.0	2.16	N/A	N/A	N/A	N/A	74.0	0.0011	N/A	N/A	N/A	N/A
259.0	N/A	N/A	23.0	N/A	0.0004	N/A	N/A	N/A	N/A	N/A	N/A
265.0	N/A	44.0	N/A	3.02	N/A	N/A	N/A	N/A	N/A	N/A	N/A
282.0	2.44	N/A	N/A	N/A	N/A	18.0	0.0044	N/A	N/A	N/A	N/A
300.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
309.0	N/A	N/A	N/A	-26.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Thalweg Slope	0.0019
WS Slope	0.0007
BKF Slope	0.0007

	Riffle BKF Width	Riffle BKF Mean Depth	Riffle BKF Max. Depth	Bk Ht/ Bkf Ht.	P-P	Pool Length	Max Poo Depth	Pool Slope	Riffle Length	Riffle Slope	Glide Length	Glide Slope	Run Length	Run Slope	
MIN	14.0	1.5	2.2	2.16	44.0	23.0	-27.44	0.0000	18.0	0.0002	0.0	0.0000	0.0	0.0000	
MAX	17.0	1.7	2.4	3.15	133.0	57.0	3.07	0.0004	74.0	0.0044	0.0	0.0000	0.0	0.0000	
AVG	15.0	1.6	2.3	2.48	90.0	39.7	-12.02	0.0002	45.3	0.0022	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	
Min ratio				1.0	3.1		-18.4	0.0		0.2		0.0		0.0	
Max ratio				1.3	7.8		1.8	0.6		6.0		0.0		0.0	
Avg ratio				1.1	6.0		-7.5	0.3		2.9		#DIV/0!		#DIV/0!	
						119			181		0		0		300



East Tarboro Canal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Tar
Watershed:	East Tarboro Canal
Stream Reach:	Reach 2 - Martin Luther King Drive to St. James Street
DA upstream point (sq mi):	1.96
DA downstream point (sq mi):	2.19
Date:	#####
Benchmark:	Nail in Oak Root (Sta 20+35 ex.; 50.5 rt.)
Benchmark Elev:	36.29
Benchmark Level:	4.40
Benchmark HI:	40.69
Station:	19+18.0 (0+00 @ ML King D/S PIPE INVERT)
Cross Section:	14
Feature:	Riffle

ABBREVIATIONS

TH	THALWEG
WS	WATER SURFACE
LEW	LEFT EDGE OF WATER
REW	RIGHT EDGE OF WATER
LBKF	LEFT BANKFULL
RBKF	RIGHT BANKFULL
LTOB	LEFT TOP OF BANK
RTOB	RIGHT TOP OF BANK
A	AREA
W	WIDTH
D	DEPTH
BKF	BANKFULL

Bank Erosion Hazard Index (BEHI)

Criteria	Value	Index	Bank Erosion Potential
Bank Ht/Bkf Ht	3.15	10	Extreme
Root Depth/Bank Ht	0.33	5.7	Moderate
Root Density (%)	40	N/A	N/A
Weighted Root Density	13	8.1	Very High
Bank Angle (Degrees)	75	5.4	Moderate
Surface Protection (%)	60	3.5	Low
Bank Materials	Sand/Silt	5	
Stratification		0	
		37.7	High

XS STATION (Feet)	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
0+00.0	40.69	5.09	35.60	
0+03.0	40.69	5.30	35.39	LTOB
0+07.0	40.69	8.50	32.19	
0+10.5	40.69	9.34	31.35	
0+12.3	40.69	10.29	30.40	LBKF
0+13.5	40.69	10.94	29.75	
0+14.0	40.69	12.34	28.35	LEW
0+17.0	40.69	12.51	28.18	TH
0+23.5	40.69	12.13	28.56	
0+24.0	40.69	11.36	29.33	
0+26.0	40.69	10.55	30.14	
0+26.4	40.69	10.29	30.40	RBKF
0+28.0	40.69	9.34	31.35	
0+32.0	40.69	6.87	33.82	
0+36.0	40.69	5.51	35.18	RTOB
0+68.0	40.69	4.42	36.27	
1+00.0	40.69	4.90	35.79	

0+12.3
0+26.4

OTHER LEVELS Description	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
WS	40.69	12.14	28.55	Water Depth at TH = 0.37'
TP2	40.69	4.40	36.29	

BANKFULL Hydraulic Geometry
Bankfull Elevation 30.40

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	-5.20	N/A	N/A
3.0	-4.99	N/A	N/A
4.0	-1.79	N/A	N/A
3.5	-0.95	N/A	N/A
1.8	0.00	N/A	N/A
1.2	0.65	0.4	1.4
0.5	2.05	0.7	2.1
3.0	2.22	6.4	3.7
6.5	1.84	13.2	6.8
0.5	1.07	0.7	1.2
2.0	0.26	1.3	2.0
0.4	0.00	0.1	0.4
1.6	-0.95	N/A	N/A
4.0	-3.42	N/A	N/A
4.0	-4.78	N/A	N/A
32.0	-5.87	N/A	N/A
32.0	-5.39	N/A	N/A

SUMMARY DATA (BANKFULL)

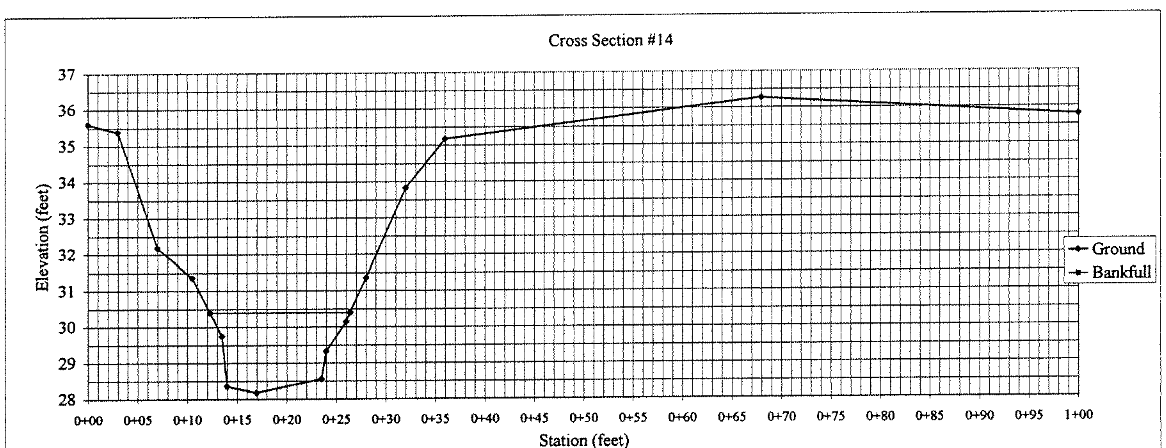
A(BKF)	22.8
W(BKF)	14.1
Max d	2.22
Mean d	1.62
ELEV. (FPA)	32.62
W(FPA)	24
Slope	0.0021
W/D	8.73
Entrenchment	1.70
Stream Type	G5c
Wetted Perimeter	17.6
Manning's "n"	0.050
Manning's Discharge	36.9

Low Top of Bank Hydraulic Geometry
Low Top of Bank I 35.18

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	-0.42	N/A	N/A
3.0	-0.21	N/A	N/A
4.0	2.99	N/A	N/A
3.5	3.83	11.9	5.2
1.8	4.78	7.7	5.1
1.2	5.43	6.1	5.6
0.5	6.83	3.1	6.8
3.0	7.00	20.7	7.6
6.5	6.62	44.3	9.3
0.5	5.85	3.1	5.9
2.0	5.04	10.9	5.4
0.4	4.78	2.0	4.8
1.6	3.83	6.9	4.2
4.0	1.36	10.4	4.2
4.0	0.00	2.7	4.0
32.0	-1.09	N/A	N/A
32.0	-0.61	N/A	N/A

SUMMARY DATA (Low Top of Bank)

A	129.8
W	33.0
Max d	7.00
Mean d	3.93
Slope	0.0021
W/D	8.39
Wetted Perimeter	68.1
Manning's "n"	0.050
Manning's Discharge	272.0



East Tarboro Canal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Tar
Watershed:	East Tarboro Canal
Stream Reach:	Reach 2 - Martin Luther King Drive to St. James Street
DA upstream point (sq mi):	1.96
DA downstream point (sq mi):	2.19
Date:	######
Benchmark:	Nail in Oak Root (Sta 20+35 ex; 50.5 rt.)
Benchmark Elev:	36.29
Benchmark Level:	3.01
Benchmark HI:	39.30
Station:	20+20.0 (0+00 @ ML King D/S PIPE INVERT)
Cross Section:	15
Feature:	Riffle

ABBREVIATIONS

TH	THALWEG
WS	WATER SURFACE
LEW	LEFT EDGE OF WATER
REW	RIGHT EDGE OF WATER
LBKF	LEFT BANKFULL
RBKF	RIGHT BANKFULL
LTOB	LEFT TOP OF BANK
RTOB	RIGHT TOP OF BANK
A	AREA
W	WIDTH
D	DEPTH
BKF	BANKFULL

Bank Erosion Hazard Index (BEHI)

Criteria	Value	Index	Bank Erosion Potential
Bank Ht/Bkf Ht	2.16	8.2	Very High
Root Depth/Bank Ht	0.91	1.9	Very Low
Root Density (%)	40	N/A	N/A
Weighted Root Density	36	5.5	Moderate
Bank Angle (Degrees)	35	2.9	Low
Surface Protection (%)	60	3.5	Low
Bank Materials	Silt/Clay	0	
Stratification		0	
		22	Moderate

XS STATION (feet)	HI (feet)	LEVEL (feet)	ELEV. (feet)	NOTES	
0+00.0	39.30	4.01	35.29		•
0+03.0	39.30	4.28	35.02	LTOB	•
0+07.0	39.30	7.39	31.91		•
0+09.0	39.30	8.09	31.21		•
0+14.0	39.30	8.45	30.85		•
0+15.0	39.30	8.97	30.33	LBKF	0+15.0
0+16.5	39.30	9.45	29.85		•
0+17.0	39.30	11.33	27.97	TH/LEW	•
0+20.0	39.30	11.31	27.99		•
0+23.0	39.30	10.72	28.58		•
0+27.5	39.30	10.92	28.38		•
0+29.0	39.30	8.97	30.33	RBKF	0+29.0
0+34.0	39.30	6.22	33.08	RTOB	•
0+50.0	39.30	4.58	34.72		•
0+82.0	39.30	3.37	35.93		•
1+00.0	39.30	3.50	35.80		•

OTHER LEVELS Description	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
WS	39.30	10.85	28.45	Water Depth at TH = 0.48'
TP2	39.30	3.01	36.29	

BANKFULL Hydraulic Geometry
Bankfull Elevation 30.33

Width (feet)	Depth (feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (feet)
N/A	-4.96	N/A	N/A
3.0	-4.69	N/A	N/A
4.0	-1.58	N/A	N/A
2.0	-0.88	N/A	N/A
5.0	-0.52	N/A	N/A
1.0	0.00	N/A	N/A
1.5	0.48	0.4	1.6
0.5	2.36	0.7	2.4
3.0	2.34	7.1	3.8
3.0	1.75	6.1	3.5
4.5	1.95	8.3	4.9
1.5	0.00	1.5	1.5
5.0	-2.75	N/A	N/A
16.0	-4.39	N/A	N/A
32.0	-5.60	N/A	N/A
18.0	-5.47	N/A	N/A

SUMMARY DATA (BANKFULL)

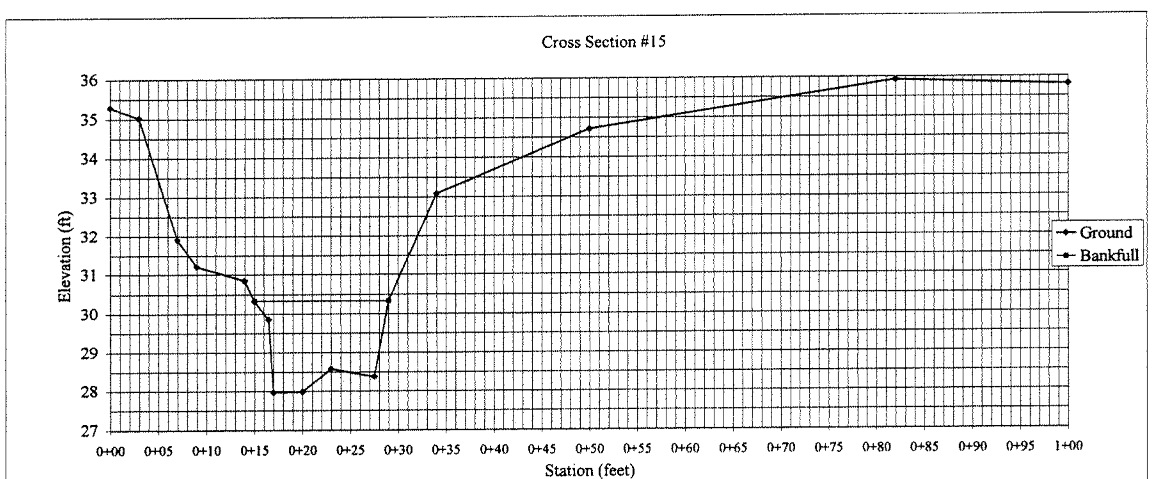
A(BKF)	24.0
W(BKF)	14.0
Max d	2.36
Mean d	1.72
ELEV. (FPA)	32.69
W(FPA)	23
Slope	0.0021
W/D	8.15
Entrenchment	1.64
Stream Type	G5c
Wetted Perimeter	17.7
Manning's "n"	0.050
Manning's Discharge	40.2

Low Top of Bank Hydraulic Geometry
Low Top of Bank I 33.08

Width (feet)	Depth (feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (feet)
N/A	-2.21	N/A	N/A
3.0	-1.94	N/A	N/A
4.0	1.17	N/A	N/A
2.0	1.87	3.0	2.7
5.0	2.23	10.3	5.5
1.0	2.75	2.5	2.9
1.5	3.23	4.5	3.6
0.5	5.11	2.1	5.1
3.0	5.09	15.3	5.9
3.0	4.50	14.4	5.4
4.5	4.70	20.7	6.5
1.5	2.75	5.6	3.1
5.0	0.00	6.9	5.0
16.0	-1.64	N/A	N/A
32.0	-2.85	N/A	N/A
18.0	-2.72	N/A	N/A

SUMMARY DATA (Low Top of Bank)

A	85.2
W	31.0
Max d	5.11
Mean d	2.75
Slope	0.0021
W/D	11.28
Wetted Perimeter	45.8
Manning's "n"	0.050
Manning's Discharge	175.5



East Tarboro Canal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Tar
Watershed:	East Tarboro Canal
Stream Reach:	Reach 2 - Martin Luther King Drive to St. James Street
DA upstream point (sq mi):	1.96
DA downstream point (sq mi):	2.19
Date:	9/8/2004
Benchmark:	Nail in Oak Root (Sta 20+35 ex.; 50.5 rt.)
Benchmark Elev:	36.29
Benchmark Level:	3.26
Benchmark HI:	39.55
Station:	21+09.0 (0+00 @ ML King D/S PIPE INVERT)
Cross Section:	16
Feature:	Riffle

ABBREVIATIONS

TH	THALWEG
WS	WATER SURFACE
LEW	LEFT EDGE OF WATER
REW	RIGHT EDGE OF WATER
LBKF	LEFT BANKFULL
RBKF	RIGHT BANKFULL
LTOB	LEFT TOP OF BANK
RTOB	RIGHT TOP OF BANK
A	AREA
W	WIDTH
D	DEPTH
BKF	BANKFULL

Bank Erosion Hazard Index (BEHI)

Criteria	Value	Index	Bank Erosion Potential
Bank Ht/Bkf Ht	2.16	8.2	Very High
Root Depth/Bank Ht	0.88	2	Low
Root Density (%)	95	N/A	N/A
Weighted Root Density	84	1.7	Very Low
Bank Angle (Degrees)	40	3	Low
Surface Protection (%)	90	1.45	Very Low
Bank Materials	Silt/Clay	0	
Stratification		0	
		16.35	Low

XS STATION (Feet)	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
0+00.0	39.55	4.25	35.30	TOP BERM
0+06.0	39.55	3.32	36.23	
0+08.4	39.55	6.61	32.94	lintltob/~fpa Added Point (Not Surveyed)
0+10.0	39.55	8.78	30.77	
0+11.0	39.55	9.49	30.06	
0+14.0	39.55	9.35	30.20	LBKF
0+17.0	39.55	9.98	29.57	
0+19.0	39.55	11.18	28.37	LEW
0+24.0	39.55	11.42	28.13	
0+25.0	39.55	11.61	27.94	
0+27.0	39.55	11.72	27.83	TH
0+28.0	39.55	11.59	27.96	REW
0+29.0	39.55	10.57	28.98	
0+31.0	39.55	9.35	30.20	RBKF
0+32.0	39.55	8.78	30.77	
0+34.0	39.55	6.61	32.94	RTOB/~fpa
0+48.0	39.55	5.65	33.90	
1+00.0	39.55	4.75	34.80	

0+14.0

0+31.0

OTHER LEVELS Description	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
WS	39.55	11.12	28.43	Water Depth at TH = 0.60'
TP2	39.55	3.26	36.29	

BANKFULL Hydraulic Geometry

Bankfull Elevation 30.20

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	-5.10	N/A	N/A
6.0	-6.03	N/A	N/A
2.4	-2.74	N/A	N/A
1.6	-0.57	N/A	N/A
1.0	0.14	N/A	N/A
3.0	0.00	0.2	3.0
3.0	0.63	0.9	3.1
2.0	1.83	2.5	2.7
5.0	2.07	9.8	5.4
1.0	2.26	2.2	2.5
2.0	2.37	4.6	3.1
1.0	2.24	2.3	2.5
1.0	1.22	1.7	1.6
2.0	0.00	1.2	2.0
1.0	-0.57	N/A	N/A
2.0	-2.74	N/A	N/A
14.0	-3.70	N/A	N/A
52.0	-4.60	N/A	N/A

SUMMARY DATA (BANKFULL)

A(BKF)	25.4
W(BKF)	17.0
Max d	2.37
Mean d	1.50
ELEV. (FPA)	32.57
W(FPA)	25
Slope	0.0021
W/D	11.37
Entrenchment	1.47
Stream Type	G5c
Wetted Perimeter	25.8
Manning's "n"	0.050
Manning's Discharge	34.3

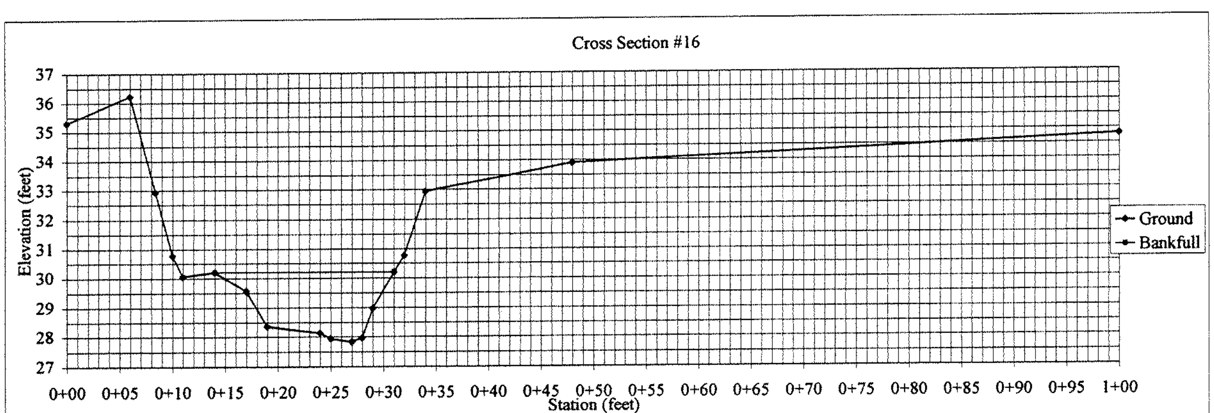
Low Top of Bank Hydraulic Geometry

Low Top of Bank Elev 32.94

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	-2.36	N/A	N/A
6.0	-3.29	N/A	N/A
2.4	0.00	N/A	N/A
1.6	2.17	1.7	2.7
1.0	2.88	2.5	3.0
3.0	2.74	8.4	4.1
3.0	3.37	9.2	4.5
2.0	4.57	7.9	5.0
5.0	4.81	23.5	6.9
1.0	5.00	4.9	5.1
2.0	5.11	10.1	5.5
1.0	4.98	5.0	5.1
1.0	3.96	4.5	4.1
2.0	2.74	6.7	3.4
1.0	2.17	2.5	2.4
2.0	0.00	2.2	2.0
14.0	-0.96	N/A	N/A
52.0	-1.86	N/A	N/A

SUMMARY DATA (Low Top of Bank)

A	89.1
W	26.0
Max d	5.11
Mean d	3.43
Slope	0.0021
W/D	7.59
Wetted Perimeter	53.8
Manning's "n"	0.050
Manning's Discharge	169.9



East Tarboro Canal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Tar
Watershed:	East Tarboro Canal
Stream Reach:	Reach 2 - Martin Luther King Drive to St. James Street
DA upstream point (sq mi):	1.96
DA downstream point (sq mi):	2.19
Date:	9/8/2004
Benchmark:	Nail in Oak Root (Sta 20+35 ex.; 50.5 ft.)
Benchmark Elev:	36.29
Benchmark Level:	3.11
Benchmark HI:	39.40
Station:	21+95.0 (0+00 @ ML King D/S PIPE INVERT)
Cross Section:	17
Feature:	Pool

ABBREVIATIONS

TH	THALWEG
WS	WATER SURFACE
LEW	LEFT EDGE OF WATER
REW	RIGHT EDGE OF WATER
LBKF	LEFT BANKFULL
RBKF	RIGHT BANKFULL
LTOB	LEFT TOP OF BANK
RTOB	RIGHT TOP OF BANK
A	AREA
W	WIDTH
D	DEPTH
BKF	BANKFULL

Bank Erosion Hazard Index (BEHI)

Criteria	Value	Index	Bank Erosion Potential
Bank Ht/Bkf Ht	2.05	8	Very High
Root Depth/Bank Ht	0.81	2.5	Low
Root Density (%)	10	N/A	N/A
Weighted Root Density	8	8.7	Very High
Bank Angle (Degrees)	45	3.2	Low
Surface Protection (%)	25	7.36	High
Bank Materials	Sand/Silt	5	
Stratification		0	
		34.76	High

XS STATION (feet)	HI (feet)	LEVEL (feet)	ELEV. (feet)	NOTES	
0+00.0	39.40	4.97	34.43	AT BARBWIRE FENCE	•
0+03.0	39.40	5.14	34.26	LTOB	•
0+08.0	39.40	7.48	31.92		•
0+12.0	39.40	8.41	30.99		•
0+17.0	39.40	8.85	30.55		•
0+19.9	39.40	9.20	30.20	LBKF	0+19.9
0+24.0	39.40	9.71	29.69		•
0+25.0	39.40	9.49	29.91		•
0+28.0	39.40	9.39	30.01		•
0+30.0	39.40	9.94	29.46		•
0+34.0	39.40	10.44	28.96		•
0+34.5	39.40	11.50	27.90	LEW	•
0+36.0	39.40	12.22	27.18	TH	•
0+38.0	39.40	11.94	27.46		•
0+40.5	39.40	11.51	27.89		•
0+41.0	39.40	11.01	28.39		•
0+43.0	39.40	9.39	30.01		•
0+43.2	39.40	9.20	30.20	RBKF	0+43.2
0+44.0	39.40	8.56	30.84		•
0+44.1	39.40	8.41	30.99		•
0+46.0	39.40	6.03	33.37	RTOB/~WFPA	•
1+00.0	39.40	4.08	35.32		•

OTHER LEVELS Description	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
WS	39.40	11.04	28.36	Water Depth at TH = 1.18'
TP2	39.40	3.11	36.29	

BANKFULL Hydraulic Geometry
Bankfull Elevation 30.20

Width (feet)	Depth (feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (feet)
N/A	-4.23	N/A	N/A
3.0	-4.06	N/A	N/A
5.0	-1.72	N/A	N/A
4.0	-0.79	N/A	N/A
5.0	-0.35	N/A	N/A
2.9	0.00	N/A	N/A
4.1	0.51	1.0	4.1
1.0	0.29	0.4	1.0
3.0	0.19	0.7	3.0
2.0	0.74	0.9	2.1
4.0	1.24	4.0	4.2
0.5	2.30	0.9	2.4
1.5	3.02	4.0	3.4
2.0	2.74	5.8	3.4
2.5	2.31	6.3	3.4
0.5	1.81	1.0	1.9
2.0	0.19	2.0	2.0
0.2	0.00	0.0	0.2
0.8	-0.64	N/A	N/A
0.1	-0.79	N/A	N/A
1.9	-3.17	N/A	N/A
54.0	-5.12	N/A	N/A

SUMMARY DATA (BANKFULL)

A(BKF)	27.1
W(BKF)	23.3
Max d	3.02
Mean d	1.16
ELEV. (FPA)	N/A
W(FPA)	N/A
Slope	0.0021
W/D	N/A
Entrenchment	N/A
Stream Type	N/A
Wetted Perimeter	31.1
Manning's "n"	0.050
Manning's Discharge	33.6

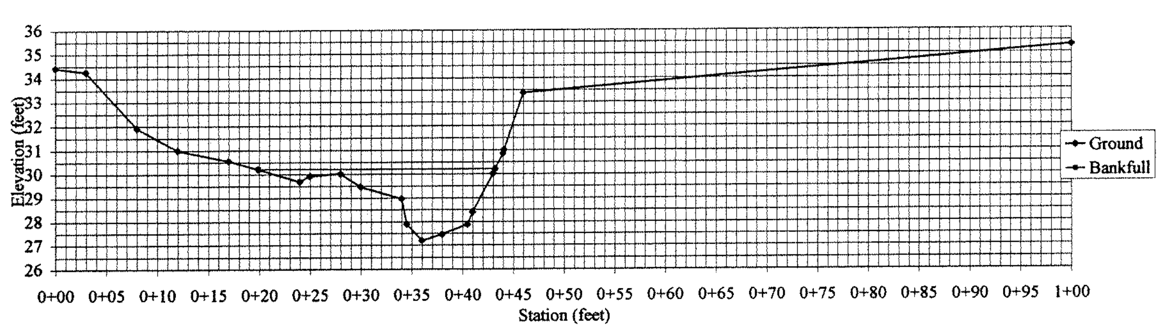
Low Top of Bank Hydraulic Geometry
Low Top of Bank Elev 33.37

Width (feet)	Depth (feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (feet)
N/A	-1.06	N/A	N/A
3.0	-0.89	N/A	N/A
5.0	1.45	N/A	N/A
4.0	2.38	7.7	4.7
5.0	2.82	13.0	5.7
2.9	3.17	8.7	4.3
4.1	3.68	14.0	5.5
1.0	3.46	3.6	3.6
3.0	3.36	10.2	4.5
2.0	3.91	7.3	4.4
4.0	4.41	16.6	6.0
0.5	5.47	2.5	5.5
1.5	6.19	8.7	6.4
2.0	5.91	12.1	6.2
2.5	5.48	14.2	6.0
0.5	4.98	2.6	5.0
2.0	3.36	8.3	3.9
0.2	3.17	0.7	3.2
0.8	2.53	2.3	2.7
0.1	2.38	0.2	2.4
1.9	0.00	2.3	1.9
54.0	-1.95	N/A	N/A

SUMMARY DATA (Low Top of Bank)

A	135.0
W	41.0
Max d	6.19
Mean d	3.29
Slope	0.0021
W/D	12.45
Wetted Perimeter	81.8
Manning's "n"	0.050
Manning's Discharge	256.9

Cross Section #17



East [illegible] anal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Neuse
Watershed:	Un-Named Tributary to Mill Creek
Stream Reach:	upstream of SR 1198
DA upstream point (sq mi):	0.95
DA downstream point (sq mi):	0.95
Date:	9/13/2004

Longitudinal Profile

Reference — 0+00.0 Profile Station (80' Upstream from Center Pipe D/S Invert)

Note: Profile goes d/s to u/s (non-standard stationing)

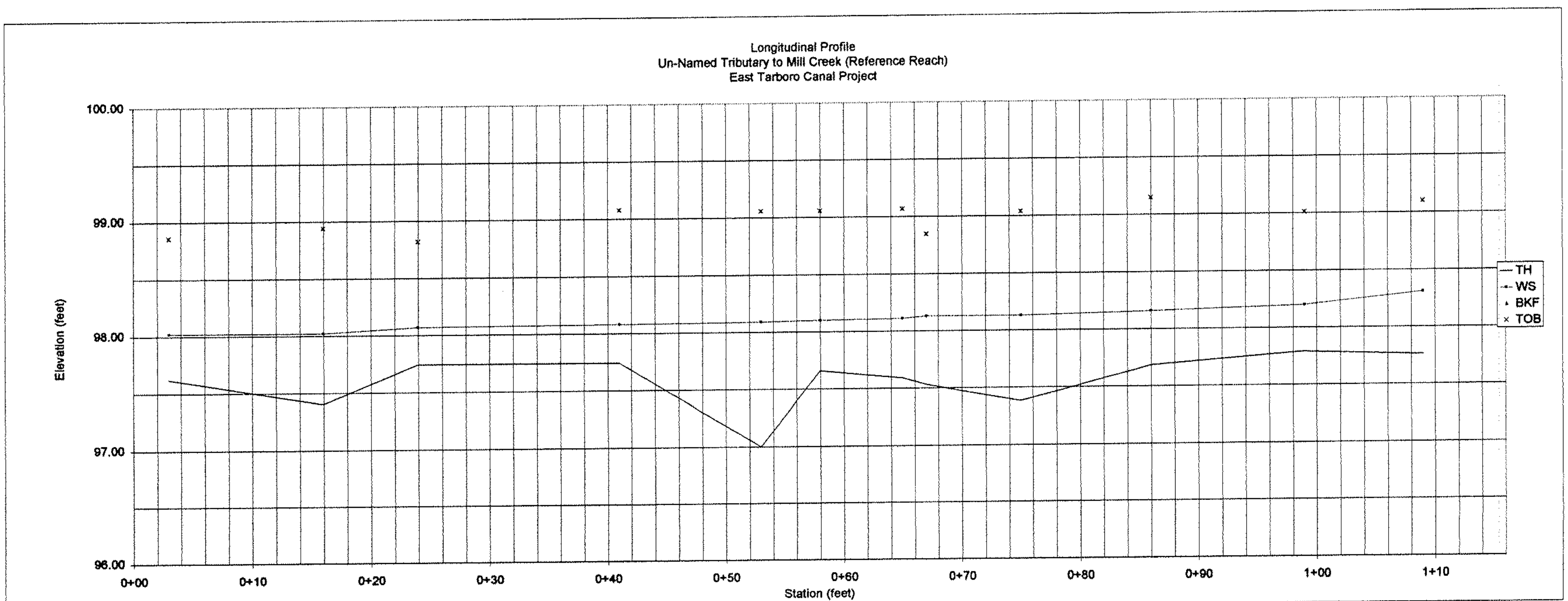
Dist. From Reference	PROFILE STATION	FEATURE	THALWEG LEVEL	WS DEPTH	BKF 1 LEVEL	BKF 2 LEVEL	LOW TOB LEVEL	BM LEVEL	BM ELEV.	HI
3.0	0+03.0	RIFFLE	6.20	0.40	4.96			3.82	100.00	103.82
16.0	0+16.0	MAX. POOL	6.42	0.62	4.88			3.82	100.00	103.82
24.0	0+24.0	POOL	6.08	0.33	5.00			3.82	100.00	103.82
41.0	0+41.0	RIFFLE	6.08	0.34	4.74			3.82	100.00	103.82
53.0	0+53.0	MAX. POOL	6.82	1.09	4.76			3.82	100.00	103.82
58.0	0+58.0	POOL	6.16	0.44	4.76			3.82	100.00	103.82
65.0	0+65.0	RIFFLE	6.23	0.52	4.75			3.82	100.00	103.82
67.0	0+67.0	GLIDE	6.29	0.60	4.97			3.82	100.00	103.82
75.0	0+75.0	MAX. POOL	6.44	0.75	4.78			3.82	100.00	103.82
86.0	0+86.0	POOL	6.14	0.48	4.67			3.82	100.00	103.82
99.0	0+99.0	RIFFLE	6.03	0.41	4.81			3.82	100.00	103.82
109.0	1+09.0	GLIDE	6.06	0.55	4.72			3.82	100.00	103.82
114.0	1+14.0	MAX. POOL	6.56	1.05	4.72			3.82	100.00	103.82
129.0	1+29.0	POOL	6.05	0.54	4.52			3.82	100.00	103.82
149.0	1+49.0	RIFFLE	5.86	0.46	4.60			3.82	100.00	103.82
159.0	1+59.0	MAX. POOL	5.88	0.52	4.45			3.82	100.00	103.82
166.0	1+66.0	POOL	6.71	0.44	5.54			4.81	99.96	104.77
178.0	1+78.0	RIFFLE	6.82	0.55	5.49			4.81	99.96	104.77
183.0	1+83.0	MAX. POOL	6.84	0.59	5.34			4.81	99.96	104.77
186.0	1+86.0	POOL	6.65	0.4	5.39			4.81	99.96	104.77
195.0	1+95.0	RIFFLE	6.62	0.37	5.42			4.81	99.96	104.77
196.0	1+96.0	GLIDE	6.82	0.57	5.42			4.81	99.96	104.77
199.0	1+99.0	MAX. POOL	6.97	0.72	5.42			4.81	99.96	104.77
202.0	2+02.0	POOL	6.48	0.3	5.54			4.81	99.96	104.77
229.0	2+29.0	RIFFLE	6.53	0.45	5.11			4.81	99.96	104.77
242.0	2+42.0	MAX. POOL	6.88	0.84	5.15			4.81	99.96	104.77
250.0	2+50.0	POOL	6.58	0.57	5.15			4.81	99.96	104.77
283.0	2+83.0	RIFFLE	6.44	0.53	5.10			4.81	99.96	104.77

PROFILE STATION	THALWEG ELEV.	WS ELEV.	BKF 1 ELEV.	BKF 2 ELEV.	LOW TOB ELEV.	Notes
0+03.0	97.62	98.02	98.86	BLANK	98.86	XS A
0+16.0	97.40	98.02	98.94	BLANK	98.94	
0+24.0	97.74	98.07	98.82	BLANK	98.82	
0+41.0	97.74	98.08	99.08	BLANK	99.08	
0+53.0	97.00	98.09	99.06	BLANK	99.06	XS C
0+58.0	97.66	98.10	99.06	BLANK	99.06	
0+65.0	97.59	98.11	99.07	BLANK	99.07	Near XS B
0+67.0	97.53	98.13	98.85	BLANK	98.85	
0+75.0	97.38	98.13	99.04	BLANK	99.04	
0+86.0	97.68	98.16	99.15	BLANK	99.15	
0+99.0	97.79	98.20	99.01	BLANK	99.01	
1+09.0	97.76	98.31	99.10	BLANK	99.10	
1+14.0	97.26	98.31	99.10	BLANK	99.10	
1+29.0	97.77	98.31	99.30	BLANK	99.30	
1+49.0	97.96	98.42	99.22	BLANK	99.22	
1+59.0	97.94	98.46	99.37	BLANK	99.37	
1+66.0	98.06	98.50	99.23	BLANK	99.23	
1+78.0	97.95	98.50	99.28	BLANK	99.28	
1+83.0	97.93	98.52	99.43	BLANK	99.43	
1+86.0	98.12	98.52	99.38	BLANK	99.38	
1+95.0	98.15	98.52	99.35	BLANK	99.35	
1+96.0	97.95	98.52	99.35	BLANK	99.35	
1+99.0	97.80	98.52	99.35	BLANK	99.35	
2+02.0	98.29	98.59	99.23	BLANK	99.23	
2+29.0	98.24	98.69	99.66	BLANK	99.66	
2+42.0	97.89	98.73	99.62	BLANK	99.62	
2+50.0	98.19	98.76	99.62	BLANK	99.62	
2+83.0	98.33	98.86	99.67	BLANK	99.67	

PROFILE STATION	BHR Low Bank Ht/ BKF Ht.	P-P	Pool Length	Max Poo Depth	Pool Slope	Riffle Length	Riffle Slope	Glide Length	Glide Slope	Run Length	Run Slope
0+03.0	1.00		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
0+16.0	N/A		N/A	1.54	N/A	N/A	N/A	N/A	N/A	N/A	N/A
0+24.0	N/A		21.0	N/A	0.0024	N/A	N/A	N/A	N/A	N/A	N/A
0+41.0	1.00		N/A	N/A	N/A	17.0	0.0006	N/A	N/A	N/A	N/A
0+53.0	N/A	37.0	N/A	2.06	N/A	N/A	N/A	N/A	N/A	N/A	N/A
0+58.0	N/A		17.0	N/A	0.0012	N/A	N/A	N/A	N/A	N/A	N/A
0+65.0	1.00		N/A	N/A	N/A	7.0	0.0014	N/A	N/A	N/A	N/A
0+67.0	N/A		N/A	N/A	N/A	N/A	N/A	2.0	0.0100	N/A	N/A
0+75.0	N/A	22.0	N/A	1.66	N/A	N/A	N/A	N/A	N/A	N/A	N/A
0+86.0	N/A		19.0	N/A	0.0016	N/A	N/A	N/A	N/A	N/A	N/A
0+99.0	1.00		N/A	N/A	N/A	13.0	0.0031	N/A	N/A	N/A	N/A
1+09.0	N/A		N/A	N/A	N/A	N/A	N/A	10.0	0.0110	N/A	N/A
1+14.0	N/A	39.0	N/A	1.84	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1+29.0	N/A		20.0	N/A	0.0000	N/A	N/A	N/A	N/A	N/A	N/A
1+49.0	1.00		N/A	N/A	N/A	20.0	0.0055	N/A	N/A	N/A	N/A
1+59.0	N/A	45.0	N/A	1.43	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1+66.0	N/A		17.0	N/A	0.0047	N/A	N/A	N/A	N/A	N/A	N/A
1+78.0	1.00		N/A	N/A	N/A	12.0	0.0000	N/A	N/A	N/A	N/A
1+83.0	N/A	24.0	N/A	1.50	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1+86.0	N/A		8.0	N/A	0.0025	N/A	N/A	N/A	N/A	N/A	N/A
1+95.0	1.00		N/A	N/A	N/A	9.0	0.0000	N/A	N/A	N/A	N/A
1+96.0	N/A		N/A	N/A	N/A	N/A	N/A	1.0	0.0000	N/A	N/A
1+99.0	N/A	16.0	N/A	1.55	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2+02.0	N/A		6.0	N/A	0.0117	N/A	N/A	N/A	N/A	N/A	N/A
2+29.0	1.00		N/A	N/A	N/A	27.0	0.0037	N/A	N/A	N/A	N/A
2+42.0	N/A	43.0	N/A	1.73	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2+50.0	N/A		21.0	N/A	0.0033	N/A	N/A	N/A	N/A	N/A	N/A
2+83.0	1.00		N/A	N/A	N/A	33.0	0.0030	N/A	N/A	N/A	N/A

	Riffle BKF Width	Riffle BKF Mean Depth	Riffle BKF Max. Depth	Bk Ht/ Bkf Ht.	P-P	Pool Length	Max Poo Depth	Pool Slope	Riffle Length	Riffle Slope	Glide Length	Glide Slope	Run Length	Run Slope	
MIN	10.8	0.8	1.2	1.00	16.0	6.0	1.43	0.0000	7.0	0.0000	1.0	0.0000	0.0	0.0000	
MAX	11.0	0.9	1.5	1.00	45.0	21.0	2.06	0.0117	33.0	0.0055	10.0	0.0110	0.0	0.0000	
AVG	10.9	0.8	1.3	1.00	32.3	16.1	1.66	0.0034	17.3	0.0022	4.3	0.0070	#DIV/0!	#DIV/0!	
Min ratio				0.8	1.5		1.9	0.0		0.0		0.0		0.0	
Max ratio				0.7	4.1		2.4	3.9		1.8		3.7		0.0	
Avg ratio				0.7	3.0		2.0	1.1		0.7		2.3		#DIV/0!	
						129			138		13		0		280

Thalweg Slope	0.0025
WS Slope	0.0030
BKF Slope	0.0029



East Tarboro Canal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Neuse
Watershed:	**Un-Named Tributary to Mill Creek**
Stream Reach:	**upstream of SR 1198**
DA upstream point (sq mi):	0.95
DA downstream point (sq mi):	0.95
Date:	9/13/2004
Benchmark:	1st Low Corrugation on top of Center Alum. Culvert (u/s)
Benchmark Elev:	100.00 (Assumed Elevation)
Benchmark Level:	3.82
Benchmark HI:	103.82
Station:	0+03.0 (0+00 is 80' U/S from Center Pipe U/S Invert)
Cross Section:	A
Feature:	Riffle

ABBREVIATIONS

TH	THALWEG
WS	WATER SURFACE
LEW	LEFT EDGE OF WATER
REW	RIGHT EDGE OF WATER
LBKF	LEFT BANKFULL
RBKF	RIGHT BANKFULL
LTOB	LEFT TOP OF BANK
RTOB	RIGHT TOP OF BANK
A	AREA
W	WIDTH
D	DEPTH
BKF	BANKFULL

XS STATION (Feet)	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
0+00.0	103.82	4.05	99.77	
0+10.0	103.82	4.43	99.39	
0+20.0	103.82	4.66	99.16	
0+30.0	103.82	4.85	98.97	
0+37.0	103.82	4.48	99.34	
0+40.0	103.82	4.75	99.07	
0+43.0	103.82	4.96	98.86	LBKF
0+44.0	103.82	5.10	98.72	
0+44.7	103.82	5.56	98.26	
0+45.2	103.82	5.98	97.84	LEW
0+45.8	103.82	6.20	97.62	TH
0+47.0	103.82	6.10	97.72	
0+48.0	103.82	6.15	97.67	
0+49.5	103.82	6.18	97.64	
0+50.6	103.82	6.14	97.68	
0+50.9	103.82	5.76	98.06	REW/WS
0+52.0	103.82	5.24	98.58	
0+53.8	103.82	4.96	98.86	RBKF
0+54.5	103.82	4.87	98.95	
0+60.0	103.82	5.34	98.48	
0+65.0	103.82	4.65	99.17	
0+72.0	103.82	4.68	99.14	
0+83.0	103.82	4.67	99.15	
1+00.0	103.82	4.86	98.96	

0+43.0

0+53.8

OTHER LEVELS Description	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
WS	103.82	5.80	98.02	Water Depth at TH = 0.40'

BANKFULL Hydraulic Geometry

Bankfull Elevation = 98.86

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seq. Leng. (Feet)
N/A	-0.91	N/A	N/A
10.0	-0.53	N/A	N/A
10.0	-0.30	N/A	N/A
10.0	-0.11	N/A	N/A
7.0	-0.48	N/A	N/A
3.0	-0.21	N/A	N/A
3.0	0.00	N/A	N/A
1.0	0.14	0.1	1.0
0.7	0.60	0.3	0.9
0.5	1.02	0.4	1.1
0.6	1.24	0.7	1.4
1.2	1.14	1.4	1.7
1.0	1.19	1.2	1.6
1.5	1.22	1.8	1.9
1.1	1.18	1.3	1.6
0.3	0.80	0.3	0.9
1.1	0.28	0.6	1.1
1.8	0.00	0.3	1.8
0.7	-0.09	N/A	N/A
5.5	0.38	N/A	N/A
5.0	-0.31	N/A	N/A
7.0	-0.28	N/A	N/A
11.0	-0.29	N/A	N/A
17.0	-0.10	N/A	N/A

SUMMARY DATA (BANKFULL)

A(BKF)	8.3	
W(BKF)	10.8	
Max d	1.24	
Mean d	0.77	
ELEV. (FPA)	100.10	
W(FPA)	100	Greater
Slope	0.0030	
W/D	14.09	
Entrenchment	9.26	Greater
Stream Type	C5	
Wetted Perimeter	15.0	
Manning's "n"	0.045	
Manning's Discharge	10.1	

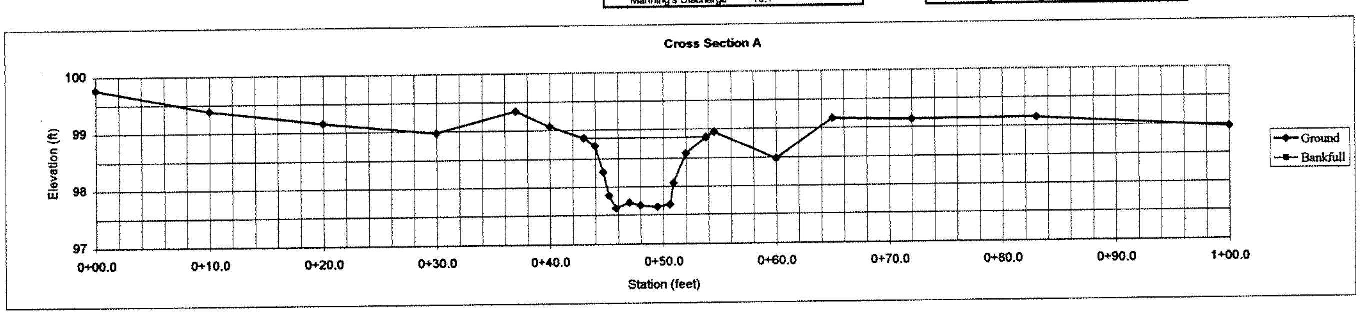
Low Top of Bank Hydraulic Geometry

Low Top of Bank Elev. = 98.95

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seq. Leng. (Feet)
N/A	-0.82	N/A	N/A
10.0	-0.44	N/A	N/A
10.0	-0.21	N/A	N/A
10.0	-0.02	N/A	N/A
7.0	-0.39	N/A	N/A
3.0	-0.12	N/A	N/A
3.0	0.09	N/A	N/A
1.0	0.23	0.2	1.0
0.7	0.69	0.3	1.0
0.5	1.11	0.5	1.2
0.6	1.33	0.7	1.5
1.2	1.23	1.5	1.7
1.0	1.28	1.3	1.6
1.5	1.31	1.9	2.0
1.1	1.27	1.4	1.7
0.3	0.89	0.3	0.9
1.1	0.37	0.7	1.2
1.8	0.09	0.4	1.8
0.7	0.00	0.0	0.7
5.5	0.47	1.3	5.5
5.0	-0.22	N/A	N/A
7.0	-0.19	N/A	N/A
11.0	-0.20	N/A	N/A
17.0	-0.01	N/A	N/A

SUMMARY DATA (Low Top of Bank)

A	10.6
W	10.8
Max d	1.33
Mean d	0.98
Slope	0.0030
W/D	11.03
Wetted Perimeter	21.8
Manning's "n"	0.045
Manning's Discharge	11.8



East Tarboro Canal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Neuse
Watershed:	**Un-Named Tributary to Mill Creek**
Stream Reach:	upstream of SR 1198
DA upstream point (sq mi):	0.95
DA downstream point (sq mi):	0.95
Date:	9/13/2004
Benchmark:	1st Low Corrugation on top of Center Alum. Culvert (u/s)
Benchmark Elev:	100.00 (Assumed Elevation)
Benchmark Level:	3.82
Benchmark HI:	103.82
Station:	0+60.0 (0+00 is 80' U/S from Center Pipe U/S Invert)
Cross Section:	B
Feature:	Riffle

ABBREVIATIONS

TH	THALWEG
WS	WATER SURFACE
LEW	LEFT EDGE OF WATER
REW	RIGHT EDGE OF WATER
LBKF	LEFT BANKFULL
RBKF	RIGHT BANKFULL
LTOB	LEFT TOP OF BANK
RTOB	RIGHT TOP OF BANK
A	AREA
W	WIDTH
D	DEPTH
BKF	BANKFULL

XS STATION (Feet)	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
0+00.0	103.82	4.56	99.26	
0+12.0	103.82	4.90	98.92	
0+18.0	103.82	4.74	99.08	
0+34.0	103.82	4.41	99.41	
0+38.0	103.82	4.53	99.29	
0+40.0	103.82	4.70	99.12	
0+43.0	103.82	4.75	99.07	LBKF
0+44.8	103.82	4.99	98.83	
0+45.8	103.82	5.36	98.46	
0+46.5	103.82	5.76	98.06	LEW
0+48.6	103.82	6.03	97.79	
0+51.0	103.82	6.20	97.62	TH
0+52.6	103.82	5.76	98.06	LEW
0+54.0	103.82	4.75	99.07	RBKF
0+58.0	103.82	4.19	99.63	
0+80.0	103.82	4.40	99.42	
1+00.0	103.82	4.68	99.14	

0+43.0

0+54.0

OTHER LEVELS Description	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
TP1	103.82	4.10	99.72	Notch in top of 14" Water Oak
WS	103.82	5.66	98.16	Water Depth at TH = 0.54'

BANKFULL Hydraulic Geometry

Bankfull Elevation = 99.07

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	-0.19	N/A	N/A
12.0	0.15	N/A	N/A
6.0	-0.01	N/A	N/A
16.0	-0.34	N/A	N/A
4.0	-0.22	N/A	N/A
2.0	-0.05	N/A	N/A
3.0	0.00	N/A	N/A
1.8	0.24	0.2	1.8
1.0	0.61	0.4	1.2
0.7	1.01	0.6	1.2
2.1	1.28	2.4	2.5
2.4	1.45	3.3	2.8
1.6	1.01	2.0	1.9
1.4	0.00	0.7	1.4
4.0	-0.56	N/A	N/A
22.0	-0.35	N/A	N/A
20.0	-0.07	N/A	N/A

SUMMARY DATA (BANKFULL)

A(BKF)	9.6	
W(BKF)	11.0	
Max d	1.45	
Mean d	0.87	
ELEV. (FPA)	100.52	
W(FPA)	100	Greater
Slope	0.0030	
W/D	12.65	
Entrenchment	9.09	Greater
Stream Type	C5	
Wetted Perimeter	12.8	
Manning's "n"	0.045	
Manning's Discharge	14.3	

Low Top of Bank Hydraulic Geometry

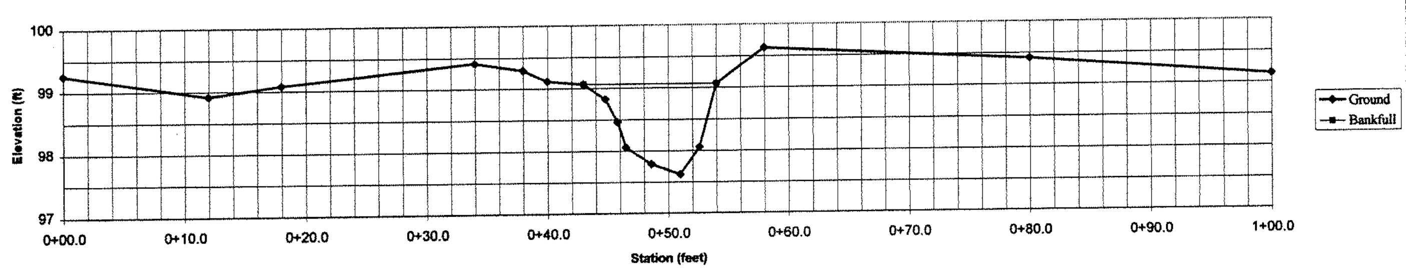
Low Top of Bank Elev. = 99.07

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seg. Leng. (Feet)
N/A	-0.19	N/A	N/A
12.0	0.15	N/A	N/A
6.0	-0.01	N/A	N/A
16.0	-0.34	N/A	N/A
4.0	-0.22	N/A	N/A
2.0	-0.05	N/A	N/A
3.0	0.00	N/A	N/A
1.8	0.24	0.2	1.8
1.0	0.61	0.4	1.2
0.7	1.01	0.6	1.2
2.1	1.28	2.4	2.5
2.4	1.45	3.3	2.8
1.6	1.01	2.0	1.9
1.4	0.00	0.7	1.4
4.0	-0.56	N/A	N/A
22.0	-0.35	N/A	N/A
20.0	-0.07	N/A	N/A

SUMMARY DATA (Low Top of Bank)

A	9.6
W	11.0
Max d	1.45
Mean d	0.87
Slope	0.0030
W/D	12.65
Wetted Perimeter	12.8
Manning's "n"	0.045
Manning's Discharge	14.3

Cross Section B



East Tarboro Canal
Tarboro, NC
Edgecombe County

Prepared By:	Amanda Todd, George Lankford, and John Nichols
River Basin:	Neuse
Watershed:	**Un-Named Tributary to Mill Creek**
Stream Reach:	**upstream of SR 1198**
DA upstream point (sq mi):	0.95
DA downstream point (sq mi):	0.95
Date:	9/13/2004
Benchmark:	1st Low Corrugation on top of Center Alum. Culvert (u/s)
Benchmark Elev:	100.00 (Assumed Elevation)
Benchmark Level:	3.82
Benchmark HI:	103.82
Station:	0+52.0 (0+00 is 80' U/S from Center Pipe U/S Invert)
Cross Section:	C
Feature:	Pool

ABBREVIATIONS

TH	THALWEG
WS	WATER SURFACE
LEW	LEFT EDGE OF WATER
REW	RIGHT EDGE OF WATER
LBKF	LEFT BANKFULL
RBKF	RIGHT BANKFULL
LTOB	LEFT TOP OF BANK
RTOB	RIGHT TOP OF BANK
A	AREA
W	WIDTH
D	DEPTH
BKF	BANKFULL

XS STATION (Feet)	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES	
0+00.0	103.82	5.07	98.75		
0+20.0	103.82	4.43	99.39		
0+28.0	103.82	4.44	99.38		
0+30.0	103.82	4.76	99.06	LBKF	0+30.0
0+34.2	103.82	5.00	98.82		
0+35.0	103.82	5.76	98.06	LEW	
0+37.0	103.82	5.94	97.88		
0+39.0	103.82	6.14	97.68		
0+40.0	103.82	6.28	97.54		
0+41.3	103.82	6.82	97.00	TH	
0+42.4	103.82	6.18	97.64	REW	
0+43.0	103.82	4.76	99.06	RBKF	0+43.0
0+44.5	103.82	4.58	99.24		
0+53.0	103.82	4.66	99.16		
0+78.0	103.82	4.64	99.18		
1+00.0	103.82	4.82	99.00		

OTHER LEVELS Description	HI (Feet)	LEVEL (Feet)	ELEV. (Feet)	NOTES
TP1	103.82	4.10	99.72	Notch in top of 14" Water Oak
WS	103.82	5.66	98.16	Water Depth at TH = 0.40'

BANKFULL Hydraulic Geometry
Bankfull Elevation = 99.06

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seq. Leng. (Feet)
N/A	0.31	N/A	N/A
20.0	-0.33	N/A	N/A
8.0	-0.32	N/A	N/A
2.0	0.00	N/A	N/A
4.2	0.24	0.5	4.2
0.8	1.00	0.5	1.3
2.0	1.18	2.2	2.3
2.0	1.38	2.6	2.4
1.0	1.52	1.5	1.8
1.3	2.06	2.3	2.4
1.1	1.42	1.9	1.8
0.6	0.00	0.4	0.6
1.5	-0.18	N/A	N/A
8.5	-0.10	N/A	N/A
25.0	-0.12	N/A	N/A
22.0	0.06	N/A	N/A

SUMMARY DATA (BANKFULL)

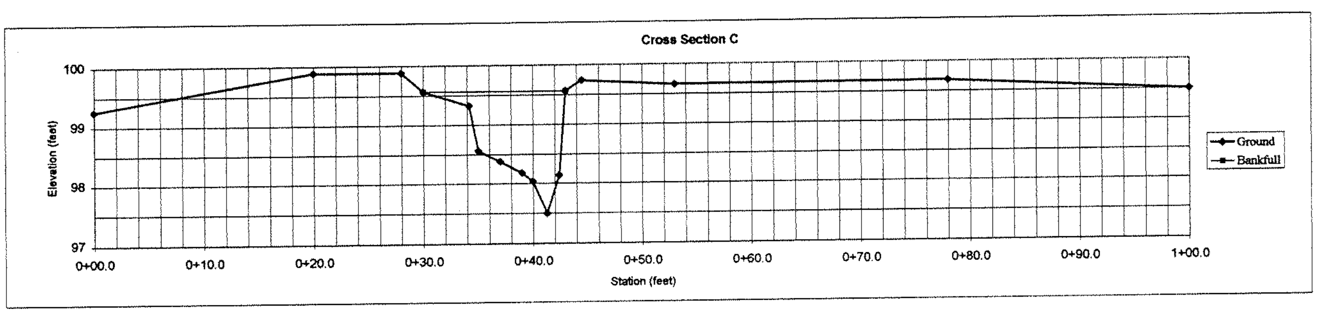
A(BKF)	11.9	
W(BKF)	13.0	
Max d	2.06	
Mean d	0.91	
ELEV. (FPA)	N/A	
W(FPA)	N/A	Greater
Slope	0.0030	
W/D	N/A	
Entrenchment	N/A	Greater
Stream Type	N/A	
Wetted Perimeter	16.9	
Manning's "n"	0.045	
Manning's Discharge	16.9	

Low Top of Bank Hydraulic Geometry
Low Top of Bank Elev. = 98.95

Width (Feet)	Depth (Feet)	Inc.Area (Sq. Ft.)	Seq. Leng. (Feet)
N/A	0.20	N/A	N/A
20.0	-0.44	N/A	N/A
8.0	-0.43	N/A	N/A
2.0	-0.11	N/A	N/A
4.2	0.13	N/A	N/A
0.8	0.89	0.4	1.2
2.0	1.07	2.0	2.3
2.0	1.27	2.3	2.4
1.0	1.41	1.3	1.7
1.3	1.95	2.2	2.3
1.1	1.31	1.8	1.7
0.6	-0.11	N/A	N/A
1.5	-0.29	N/A	N/A
8.5	-0.21	N/A	N/A
25.0	-0.23	N/A	N/A
22.0	-0.05	N/A	N/A

SUMMARY DATA (Low Top of Bank)

A	10.0
W	13.0
Max d	1.95
Mean d	0.77
Slope	0.0030
W/D	16.86
Wetted Perimeter	11.6
Manning's "n"	0.045
Manning's Discharge	16.4



REPORT OF SUBSURFACE EXPLORATION

EAST TARBORO CANAL REALIGNMENT
TARBORO, NORTH CAROLINA

F&R PROJECT NO. F66-165

Prepared For:

EARTH TECH
701 Corporate Center Drive, Suite 475
Raleigh, North Carolina 27607-5074

Prepared By:

FROEHLING & ROBERTSON, INC.
310 Hubert Street
Raleigh, North Carolina 27603
Phone: (919) 828-3441 • Fax: (919) 828-5751

September 2, 2004

SINCE 1881

FROEHLING & ROBERTSON, INC.

GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

310 HUBERT STREET • RALEIGH, NC 27603
PHONE: (919) 828-3441 • FAX: (919) 828-5751
WEB SITE: www.FandR.com

September 2, 2004

Earth Tech
Mr. John D.R. Nichols, P.E.
701 Corporate Center Drive, Suite 475
Raleigh, North Carolina 27607-5074

Re: Report of Subsurface Exploration
Proposed East Tarboro Canal Realignment
Tarboro, North Carolina
F&R Project No. F66-165

Dear Mr. Nichols:

Froehling and Robertson, Inc. (F&R) has completed the subsurface exploration at the above referenced project site. The scope of services presented for this study in our proposal (No. 0466-396G) was approved by Mr. John Nichols on behalf of Earth Tech. Authorization to proceed was provided by Earth Tech's contract form. This report contains a description of the project information provided to F&R and a discussion of the general subsurface conditions revealed during the exploration.

We have enjoyed working with you and appreciate the opportunity to serve as your geotechnical consultant on this project. If you need further information or if we can provide additional services, please do not hesitate to contact us.

Sincerely,
FROEHLING & ROBERTSON, INC.

NORTH CAROLINA PROFESSIONAL SEAL 029513 ENGINEER GARRETT J. KASTEN

Garrett J. Kasten, P.E.
Geotechnical Engineer

Daniel K. Schaefer, P.E.
Raleigh Branch Manager

HEADQUARTERS: 3015 DUMBARTON ROAD • BOX 27524 • RICHMOND, VA 23261-7524
TELEPHONE: (804) 264-2701 • FAX: (804) 264-1202

BRANCHES: ASHEVILLE, NC • BALTIMORE, MD • CHARLOTTE, NC • CHESAPEAKE, VA
CROZET, VA • FAYETTEVILLE, NC • FREDERICKSBURG, VA • GREENVILLE, SC
HICKORY, NC • RALEIGH, NC • ROANOKE, VA • STERLING, VA

SINCE 1881

TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE OF SERVICES

F&R has completed the subsurface exploration for the proposed East Tarboro Canal realignment in Tarboro, North Carolina. F&R completed the subsurface exploration at the project site on August 18, 2004. The purpose of this exploration was to evaluate the subsurface conditions near the existing canal and within the general area of the proposed realignment and to provide general recommendations with regards to creek bank stabilities. In order to achieve these purposes, we performed the following scope of work:

- Performed a site reconnaissance to complete geotechnical observations;
- Reviewed relevant, readily available published geologic maps;
- Advanced 5 soil test borings within the project area;
- Prepared typed Boring Logs and a Subsurface Profile;
- Assessed the collected information and prepared this report.

This report is organized to discuss the Project Data (Section 2.0), Exploration Procedures (Section 3.0), Geologic & Subsurface Conditions (Section 4.0), General Engineering Evaluation (Section 5.0). The drawings, and test boring logs are presented in the Appendices to this report.

2.0 PROJECT DATA

2.1 SITE DESCRIPTION

The subject property is located within the City of Tarboro, North Carolina (see Figure 1, Appendix I) along the existing East Tarboro Canal. The existing canal currently runs parallel to West Canal Street and then through a series of parks, open areas, and a school yard. In general, the nearby ground surface is covered with grass and scattered pine trees.

The site elevations range between 10 and 14 feet above mean seal level (see Figure 2 – Boring Location Plan). Large flat plains are typical topographic features of the surrounding area and the site itself is relatively flat. The project vicinity is developed with residential homes, parks, schools and small businesses.

2.2 PROPOSED CONSTRUCTION

The proposed project will consist of the realignment of the existing canal, creating a more natural meandering stream. Final grading plans and stream alignments were not available at the time of explorations or the preparation of this report. F&R is not aware of any structures or cuts and fills of significant depth associated with this project.

3.0 EXPLORATION PROCEDURES

A total of five (5) soil test borings (B-1 through B-5) were performed at the project site. The borings were advanced at the approximate locations shown on the attached Boring Location Plan included as Figure 2 in Appendix I. The boring locations were established in the field with the assistance of Mr. John Nichols of Earth Tech. Ground surface elevations at the boring locations have been interpolated from topographic map (USGS 7.5 Minute Series, Tarboro Quadrangle) and should only be considered approximate given the method of determination.

Each boring was advanced to a depth of 15 feet below the ground surface utilizing hollow stem auger boring techniques for borehole stabilization. Representative soil samples were obtained using a standard two-inch outside diameter (O.D.) split barrel sampler in general accordance with ASTM D 1586, Penetration Test and Split-Barrel Sampling of Soils (Standard Penetration Test). The number of blows required to drive the split barrel sampler three consecutive 6-inch increments is recorded and the blows of the last two 6-inch increments are added to obtain the Standard Penetration Test (SPT) N-values representing the penetration resistance of the soil. Standard Penetration Tests were performed at frequent intervals to evaluate the consistency and general engineering properties of the subsurface soils.

Representative portions of the soil samples obtained from each SPT interval were sealed in a container, labeled and transported to our laboratory for final classification by a geotechnical engineer. The soil samples were visually classified in general accordance with the Unified Soil Classification System (USCS), using visual-manual identification procedures (ASTM D 2488). The Boring Log for each test boring is presented in Appendix II of this report.

4.0 GEOLOGIC AND SUBSURFACE CONDITIONS

4.1 REGIONAL GEOLOGY

The project site is geologically located within the Coastal Plain Physiographic Province of North Carolina. The Coastal Plain of North Carolina is comprised of flat lying to very gently dipping sedimentary strata which overlay a "basement" of crystalline rocks. The site is specifically located within the Yorktown Formation (Tpy). This formation is described as fossiliferous clay with varying amounts of fine grained sand, bluish gray, shell material commonly concentrated in lenses, mainly in areas north of the Nuese River (Brown, 1985).

4.2 SUBSURFACE CONDITIONS

A Subsurface Profile has been prepared from the boring data to graphically illustrate the subsurface conditions encountered at the site and is presented as Figure 3. Strata breaks designated on the Boring Logs and Subsurface Profile represent approximate boundaries between soil types. The transition from one soil type to another may be gradual or occur between soil samples. This section of the report provides a general discussion of subsurface conditions encountered within areas of proposed construction at the project site during our subsurface exploration. More detailed descriptions of the subsurface conditions are presented on the Boring Logs in Appendix II.

Soil conditions in Borings B-1, B-2 and B-3 were similar to each other, while B-4 and B-5 were similar. Each boring encountered a relatively thin layer of organic topsoil, between 0.2 feet in thickness, consisting of dark brown loamy soils with roots and rootlets.

Underlying the topsoil, Borings B-1, B-2 and B-3 encountered loose to medium dense, mixed brown sand with varying amounts of silt to depths between 1.5 to 6.0 feet. SPT N-values ranged between 4 and 7 bpf (blows per foot). Beneath this layer, very loose to medium dense, mixed brown clayey sands were encountered to depths between 8.5 and 15.0 feet below the ground surface. SPT N-values ranged between 2 and 11 bpf, with typical values of 6 bpf. B-2 was terminated in this formation at a depth of 15.0 feet. Borings B-1 and B-3 then encountered loose, tan and gray, slightly silty sands beneath the sandy clay. SPT N-values ranged from 6 to 15 bpf, with typical values of 7 bpf.

Borings B-4 and B-5 encountered a slightly different soil profile from B-1, B-2 and B-3. B-4 penetrated a relatively thin layer of firm, mixed brown and gray, sandy silt to a depth of 1.5 feet. The blow counts in this layer were 6 bpf. From just below the topsoil layer in B-5, and underlying the sandy silt in B-4, each boring penetrated stiff, mixed gray clay with varying amounts of sand. SPT N-values ranged in this layer from 12 to 15 bpf with typical values of 12 bpf. A relatively thin layer of sandy clay underlies the silts which was found to be soft, gray and brown. SPT N-values within this soil layer were 3 bpf. Each boring was terminated in a very loose to medium dense gray and green sand which contains variable amounts of silt and clay. SPT N-values varied between 11 bpf in B-4 and 2 bpf in B-5.

4.3 GROUNDWATER CONDITIONS

Soil samples were generally found to be in a moist condition, however, all samples retrieved from below the groundwater table were saturated. Free-standing groundwater was encountered between approximately 4.0 to 7.0 feet below the ground surface in all borings. Measurements were taken immediately after drilling. Borings were backfilled upon completion of drilling. We note that the elevation of the groundwater table is dependent upon seasonal factors such as precipitation and temperature as well as the depth of water in the nearby canal. Therefore, the elevation of the groundwater table may be different at other times of the year from the elevation presented in this report.

5.0 GENERAL ENGINEERING EVALUATION

The soils encountered in the borings that will form the new stream banks predominantly consist of loose sands, soft clays, and stiff silts. Based on the estimated stream bed elevations, it is anticipated that the stream bed will consist of different combinations of these soils.

Due to the apparently loose and soft condition of the native sands and clays, F&R recommends that the stream banks within sandy areas generally be graded no steeper than 3 Horizontal to 1 Vertical (3H:1V) for slope stability considerations. In locations with the stiff silts (B-4 and B-5) the stream banks may be increased to 2.5 Horizontal to 1 Vertical (2H:1V) if required. However, it should be understood that minor sloughing may occur in areas of steeper slopes.

Following excavation, the slopes should be vegetated as soon as possible to stabilize the surface and prevent erosion and surface sloughing. It is our understanding that the type of vegetation and method of placement will be determined by Earth Tech. Slopes which are not adequately vegetated and stabilized may be more susceptible to sloughing and erosion, which may then require maintenance.

Please do not hesitate to contact us if you have any questions regarding this report or require additional geotechnical information.

6.0 LIMITATIONS

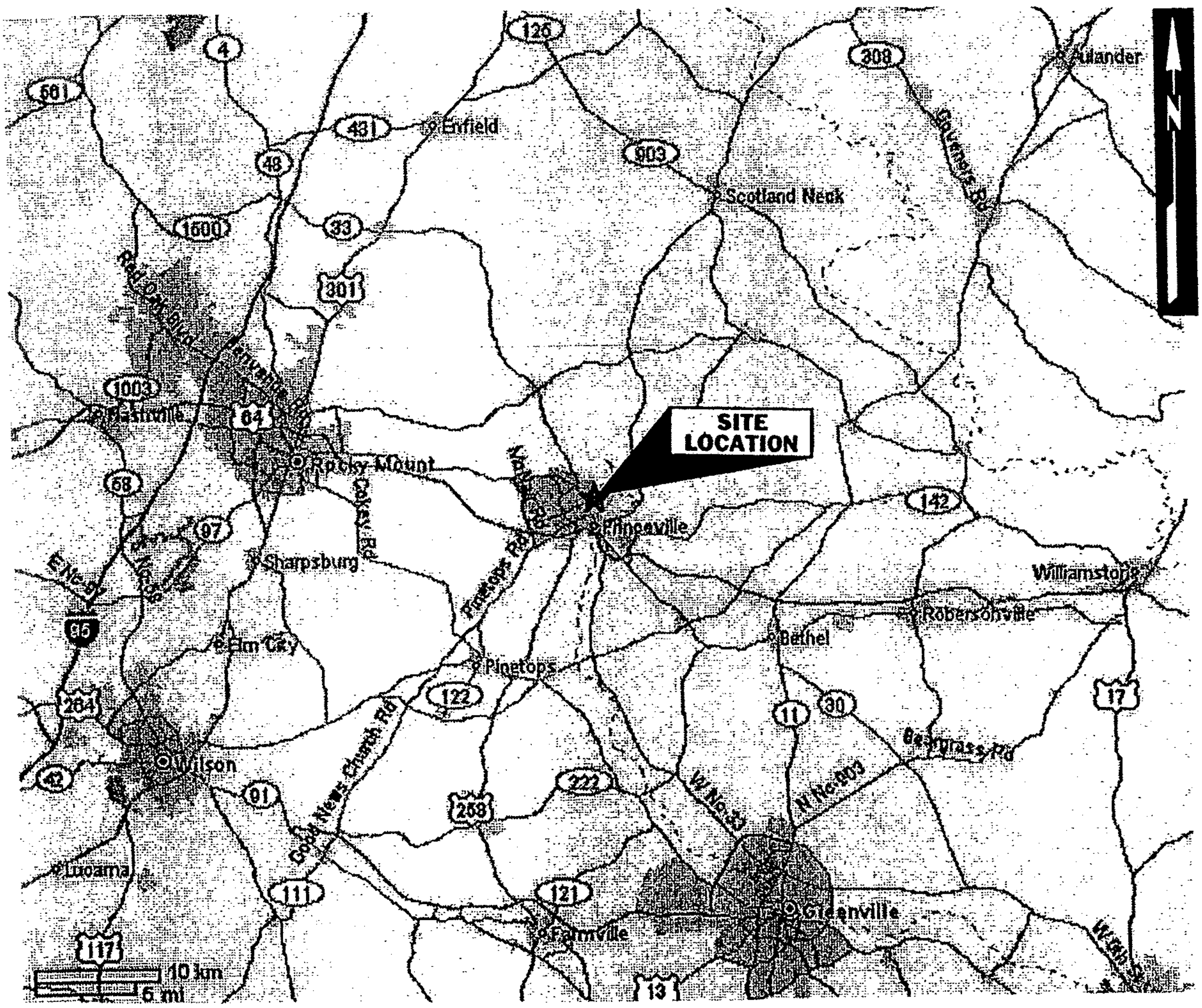
This report has been prepared for the exclusive use of Earth Tech for specific application to the referenced property in accordance with generally accepted soil and engineering practices. No other warranty, expressed or implied, is made. These conclusions and recommendations do not reflect variations in subsurface conditions that could exist intermediate of the boring locations or in unexplored areas of the site. Should such variations become apparent during construction, we reserve the right to re-evaluate our conclusions and recommendations based upon on-site observations of the conditions. In the event changes are made in the proposed construction plans, the recommendations presented in this report shall not be considered valid unless reviewed by our firm and conclusions of this report modified or verified in writing. Prior to final design, F&R should be afforded the opportunity to review the project plans and specifications to determine if additional or modified recommendations are necessary.

SINCE

F&R

1881

APPENDIX I



SITE VICINITY MAP

FROEHLING & ROBERTSON, INC. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS ENGINEERS • LABORATORIES 'OVER ONE HUNDRED YEARS OF SERVICE' 310 Hubert Street Raleigh, NC 27603 (919) 828-3441; Fax: (919) 828-5751 www.FandR.com	CLIENT: Earth Tech		
	PROJECT: East Tarboro Canal		
	LOCATION: Tarboro, NC		
	F&R PROJECT No.: F66-165		
	DATE: 8/2004	SCALE: As shown	FIGURE No.: 1

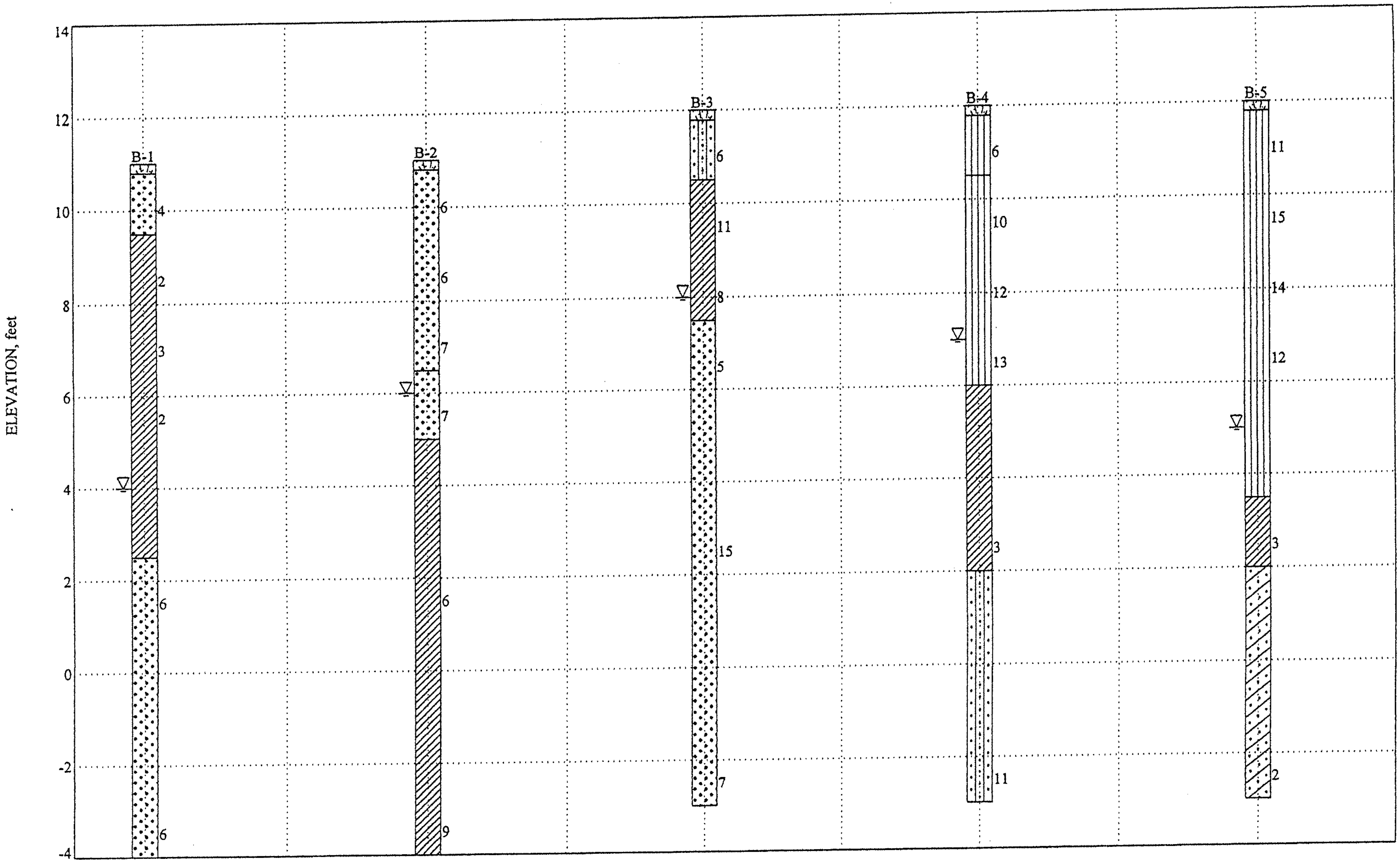
LEGEND

APPROX. F&R BORING LOCATION

BORING LOCATION PLAN

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"
310 Hubert Street Raleigh, NC 27603
(919) 828-3441; Fax: (919) 828-5751
www.FandR.com

CLIENT: Earth Tech		
PROJECT: East Tarboro Canal		
LOCATION: Tarboro, NC		
F&R PROJECT No.: F66-165		
DATE: 8/2004	SCALE: 1"=0.3 mi. approx.	FIGURE No.: 2



SINCE 1881 **FROEHLING & ROBERTSON, INC.** GEOTECHNICAL • ENVIRONMENTAL • MATERIALS ENGINEERS • LABORATORIES *"OVER ONE HUNDRED YEARS OF SERVICE"*	CLIENT : Earth Tech PROJECT : East Tarboro Canal LOCATION : Tarboro, NC DATE : August 24, 2004

SUBSURFACE PROFILE FIGURE No. 3

SINCE

1881

APPENDIX II

BORING LOG

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"
SINCE 1881

Report No.: **F66-165** Date: **August 2004**

Client: **Earth Tech**
Project: **East Tarboro Canal, Tarboro, NC**
Boring No.: **B-1** **(1 of 1)** Total Depth **15.0'** Elev: **11.0 ±** Location:
Type of Boring: **2.25" ID HSA** Started: **8/18/04** Completed: **8/18/04** Driller: **C. Clay**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
10.8	0.2	TOPSOIL	2-2-2	0.0	4	GROUNDWATER DATA: 0 Hrs.: 7.0'
		Loose, moist, brown, SAND (SW), with trace silt.				
9.5	1.5	Very loose, moist, brown & dark brown, clayey SAND (SC).	2-1-1	1.5	2	
			1-1-2	3.0	3	
			1-1-1	4.5	2	
				6.0		
2.5	8.5	Loose, saturated, mixed brown & gray, SAND (SW), with trace silt.	3-3-3	8.5	6	
				10.0		
			3-3-3	13.5	6	
-4.0	15.0	Boring terminated at 15.0 feet.		15.0		

BORING LOG F66-165.GPJ F&R.GDT 9/2/04

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

BORING LOG

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"
SINCE 1881

Report No.: **F66-165** Date: **August 2004**

Client: **Earth Tech**			
Project: **East Tarboro Canal, Tarboro, NC**			
Boring No.: **B-2** (1 of 1)	Total Depth **15.0'**	Elev: **11.0 ±**	Location:
Type of Boring: **2.25" ID HSA**	Started: **8/18/04**	Completed: **8/18/04**	Driller: **C. Clay**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
10.8	0.2	TOPSOIL	2-3-3	0.0	6	GROUNDWATER DATA: 0 Hrs.: 5.0'
		Loose to medium dense, moist, SAND (SW), with trace silt.	3-3-3	1.5	6	
			2-3-4	3.0	7	
6.5	4.5	Loose, saturated, brown, SAND (SW), with trace silt.	3-3-4	4.5	7	
5.0	6.0	Loose, moist, mixed brown, clayey SAND (SC).		6.0		
			3-3-3	8.5	6	
				10.0		
			3-4-5	13.5	9	
-4.0	15.0	Boring terminated at 15.0 feet.		15.0		

BORING LOG F66-165.GPJ F&R.GDT 9/2/04

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

BORING LOG

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"
SINCE 1881

Report No.: **F66-165** Date: **August 2004**

Client: **Earth Tech**

Project: **East Tarboro Canal, Tarboro, NC**

Boring No.: **B-3** **(1 of 1)** Total Depth **15.0'** Elev: **12.0 ±** Location:

Type of Boring: **2.25" ID HSA** Started: **8/18/04** Completed: **8/18/04** Driller: **C. Clay**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
11.8	0.2	TOPSOIL	2-3-3	0.0	6	GROUNDWATER DATA: 0 Hrs.: 4.0'
		Loose, moist, mixed brown, silty SAND (SM).				
10.5	1.5	Loose to medium dense, moist, dark brown, slightly silty, clayey SAND (SC).	5-6-5	1.5	11	
			4-4-4	3.0	8	
7.5	4.5	Loose, tan & gray, SAND (SW), with trace silt.	2-2-3	4.5	5	
				6.0		
			6-6-9	8.5	15	
				10.0		
			2-3-4	13.5	7	
-3.0	15.0	Boring terminated at 15.0 feet.		15.0		

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

Report No.: **F66-165** Date: **August 2004**

Client: **Earth Tech**

Project: **East Tarboro Canal, Tarboro, NC**

Boring No.: **B-4** **(1 of 1)** Total Depth **15.0'** Elev: **12.0 ±** Location:

Type of Boring: **2.25" ID HSA** Started: **8/18/04** Completed: **8/18/04** Driller: **C. Clay**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
11.8	0.2	TOPSOIL	2-3-3	0.0	6	GROUNDWATER DATA: 0 Hrs.: 5.0'
		Firm, moist, mixed brown & gray, sandy SILT (ML).				
10.5	1.5	Stiff, moist, gray, slightly sandy CLAY (CL).	4-4-6	1.5	10	
			4-6-6	3.0	12	
			4-6-7	4.5	13	
6.0	6.0	Soft, moist, gray, sandy CLAY (CL).		6.0		
			3-2-1	8.5	3	
2.0	10.0	Medium dense, saturated, gray, slightly silty SAND (SM).		10.0		
			6-6-5	13.5	11	
-3.0	15.0	Boring terminated at 15.0 feet.		15.0		

BORING_LOG F66-165.GPJ F&R.GDT 9/2/04

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.

BORING LOG

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"
SINCE 1881

Report No.: **F66-165** Date: **August 2004**

Client: **Earth Tech**

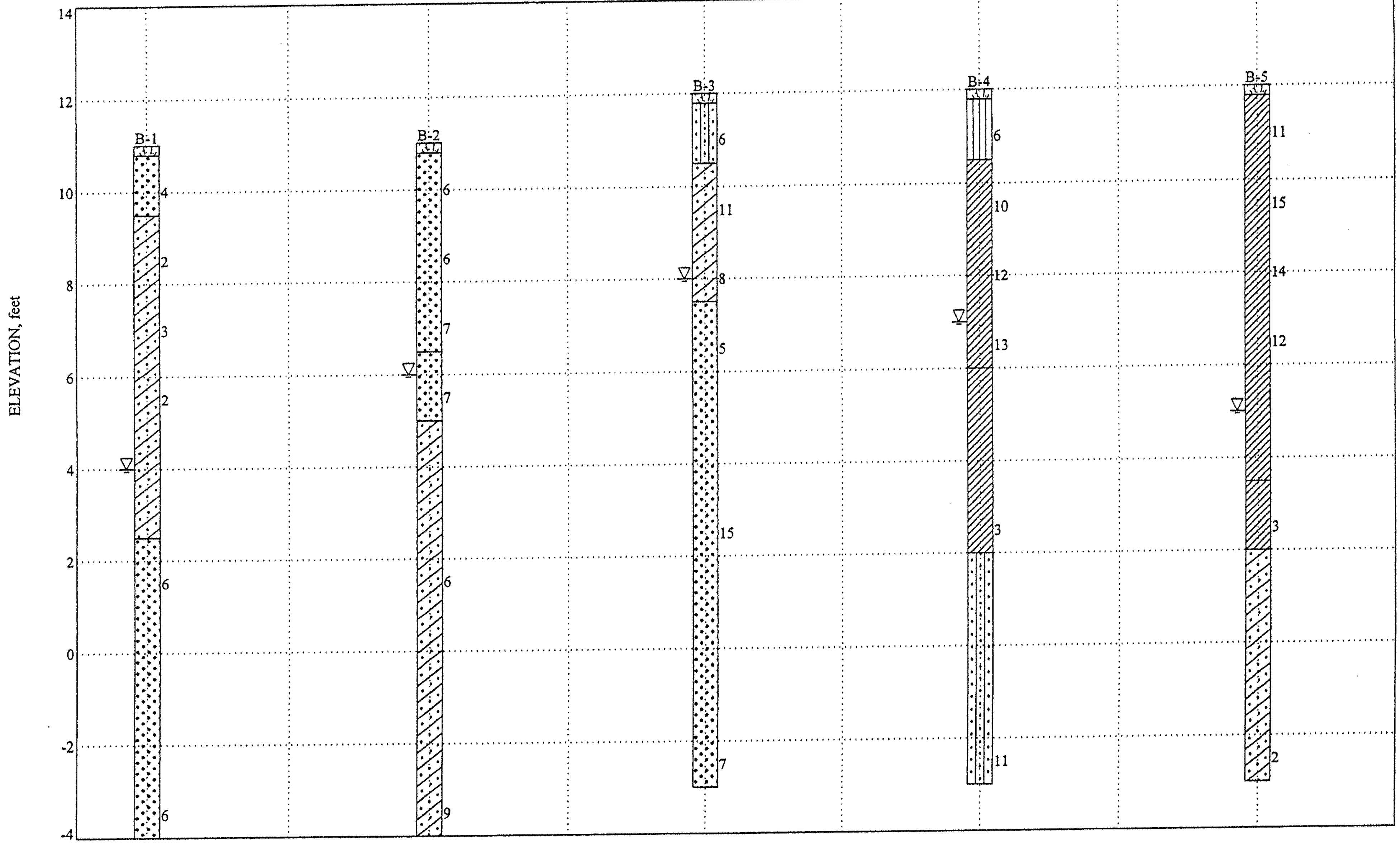
Project: **East Tarboro Canal, Tarboro, NC**

Boring No.: **B-5** **(1 of 1)** Total Depth **15.0'** Elev: **12.0 ±** Location:

Type of Boring: **2.25" ID HSA** Started: **8/18/04** Completed: **8/18/04** Driller: **C. Clay**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (feet)	N Value (blows/ft)	REMARKS
11.8	0.2	TOPSOIL	3-5-6	0.0	11	GROUNDWATER DATA: 0 Hrs.: 7.0'
		Stiff, moist, mixed gray & tan, CLAY (CL), with trace sand.	4-6-9	1.5	15	
			4-6-8	3.0	14	
			4-6-6	4.5	12	
				6.0		
3.5	8.5	Soft, moist, brown, CLAY (CL), with trace sand & silt.	1-1-2	8.5	3	
2.0	10.0	Very loose, saturated, gray & green, clayey SAND (SC).		10.0		
			1-1-1	13.5	2	
-3.0	15.0	Boring terminated at 15.0 feet.		15.0		

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N.



SINCE 1881

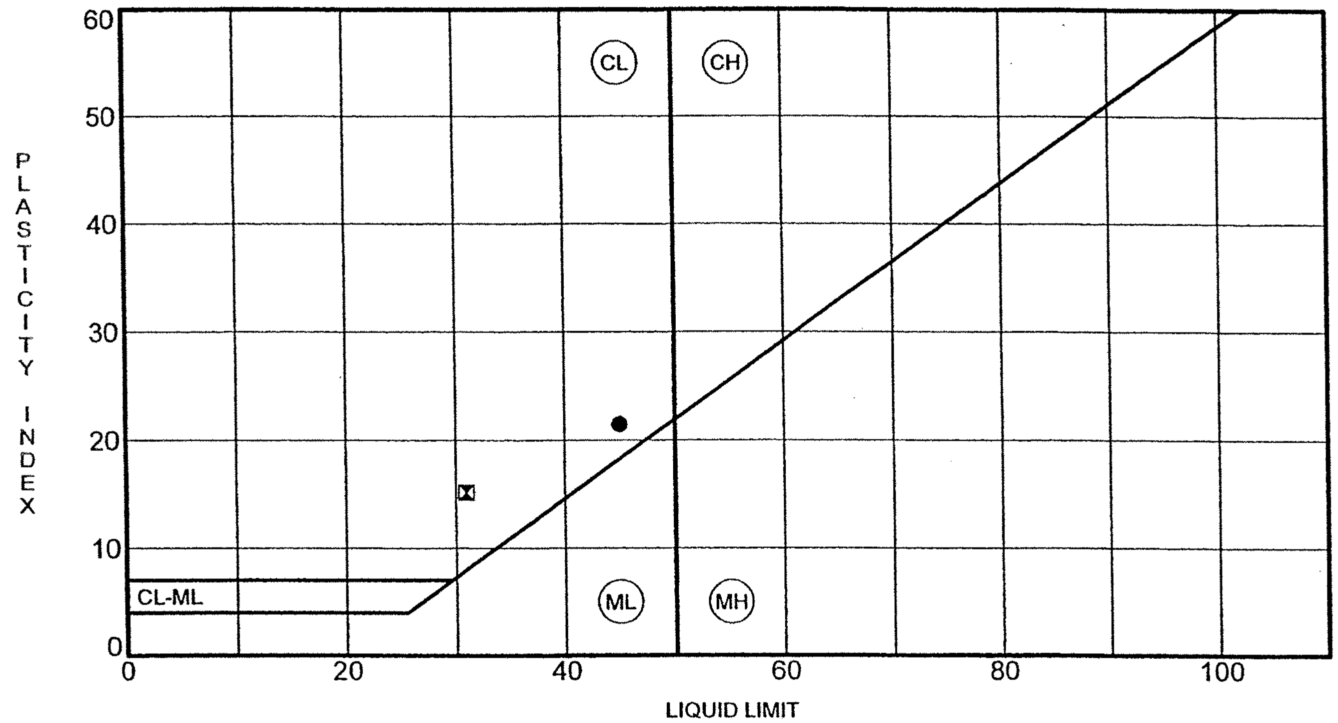
FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

CLIENT :	Earth Tech
PROJECT :	East Tarboro Canal
LOCATION :	Tarboro, NC
DATE :	September 2, 2004

SUBSURFACE PROFILE FIGURE No. 3

SINCE F&R 1881

APPENDIX III



Boring No.		Depth		LL	PL	PI	Fines	Classification	% Natural Moisture Content
●	B-1	at	3.0	45	24	21	43	CLAYEY SAND (SC)	27.4
⊠	B-4	at	4.5	31	16	15	68	SANDY LEAN CLAY (CL)	15.3

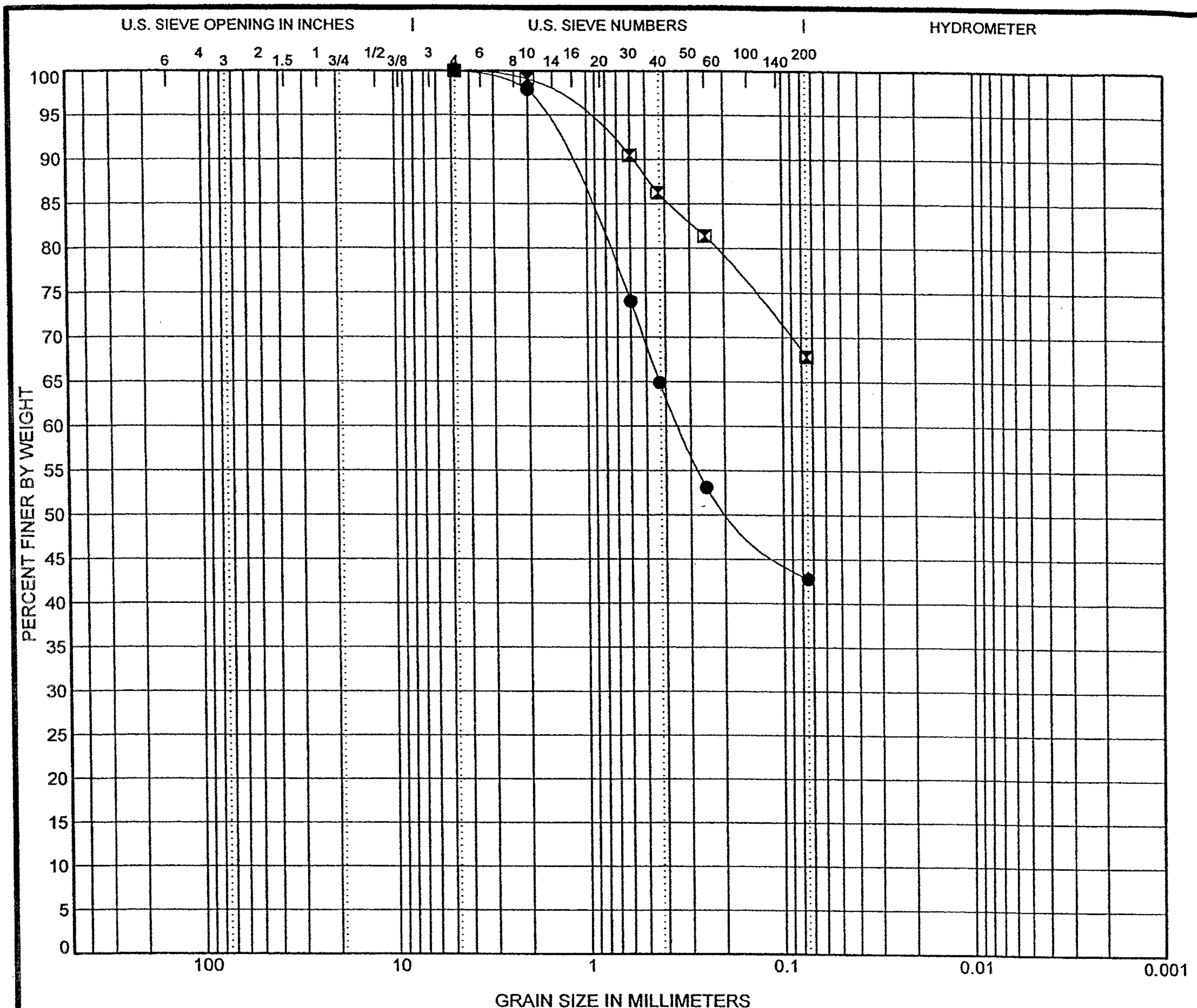
US ATTERBERG LIMITS F66-165.GPJ F&R.GDT 8/26/04

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: F66-165
Client: Earth Tech
Project: East Tarboro Canal
Location: Tarboro, NC
Date: August 2004



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	B-1	at	3.0	CLAYEY SAND (SC)	45	24	21		
⊠	B-4	at	4.5	SANDY LEAN CLAY (CL)	31	16	15		
		at							
		at							
		at							

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	at	3.0	4.76	0.343			0.0	57.2	42.8	
⊠	B-4	at	4.5	4.76				0.0	32.1	67.8	
		at									
		at									
		at									

US GRAIN SIZE F66-165.GPJ F&R.GDT 8/26/04

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: F66-165
Client: Earth Tech
Project: East Tarboro Canal
Location: Tarboro, NC
Date: August 2004