CONOCONNARA MITIGATION SITE

RESTORATION PLAN REPORT

Prepared for

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List of Figures

List of Tables

Appendices

I. INTRODUCTION

This report supports the stream and wetland mitigation design to restore 5,073 linear feet of Looking Glass Run, restore 69 acres of non-riverine wetland, enhance eight acres of non-riverine wetland, and preserve 71 acres non-riverine wetland in Halifax County, North Carolina (Table 1). The project is being developed to provide full delivery mitigation to the North Carolina Ecosystem Enhancement Program (EEP) for impacts in hydrologic unit 03010107 of the Roanoke River Basin. The proposed stream restoration reach was disturbed by historic channelization and the proposed wetland restoration area is prior-converted (PC) cropland that was ditched and drained. The Conoconnara Site has a history of agriculture and timber production. The site currently supports agricultural production (primarily cotton), woodlands, and pine plantation.

The Conoconnara site is located in Halifax County, North Carolina just outside of Tillery, approximately seventeen miles southeast of Roanoke Rapids (Figure 1). The property is 567 acres located immediately south of NC 561 and is accessed via a farm road 1.1 miles east of Tillery.

The objective of this project is to produce a minimum of 5,000 stream mitigation units (SMU), 87 non-riverine wetland mitigation units (WMU), and maximize the improvement of riparian and aquatic habitats and water quality through ecological restoration and preservation practices. The proposed wetland and stream restoration project will provide multiple ecological and water quality benefits within the Roanoke River Basin. Benefits include nutrient removal, sediment reduction, water storage, improved groundwater recharge, enhanced in-stream habitat, and enhanced and restored wetland habitat.

Table 1. Conoconnara Mitigation Summary

Mitigation Practice	Size	Ratio	Mitigation Units
Wetland			
Non-riverine wetland preservation	71 ac	1:5	14
Non-riverine wetland enhancement	8 ac	1:2	4
Non-riverine wetland restoration	69 ac	1:1	69
		Total:	87 WMU's
Stream			
Stream Restoration (Looking Glass Run)	5073 lf	1:1	5,073
		Total:	5,073 SMU's

II. STUDY AREA

PHYSIOGRAPHY, TOPOGRAPHY, AND DRAINAGE

The Conoconnara site is in the Roanoke River Basin within NC Division of Water Quality (NCDWQ) sub-basin 03-02-08. The stream restoration area is in targeted local watershed unit 03010107090020. The site is in the Coastal Plain Physiographic Province and is underlain by the Yorktown geologic formation. The Yorktown formation is predominantly fossiliferous clay that contains varying amounts of fine-grained sand with concentrated lenses of bluish grey shell material (NCGS 1985). This formation is common for locations in the upper to mid-Coastal Plain province of North Carolina. The area surrounding the project reach is located on the western edge of a geologic feature known as Albemarle Embayment. Upstream of the project area is an escarpment that correlates to the previous

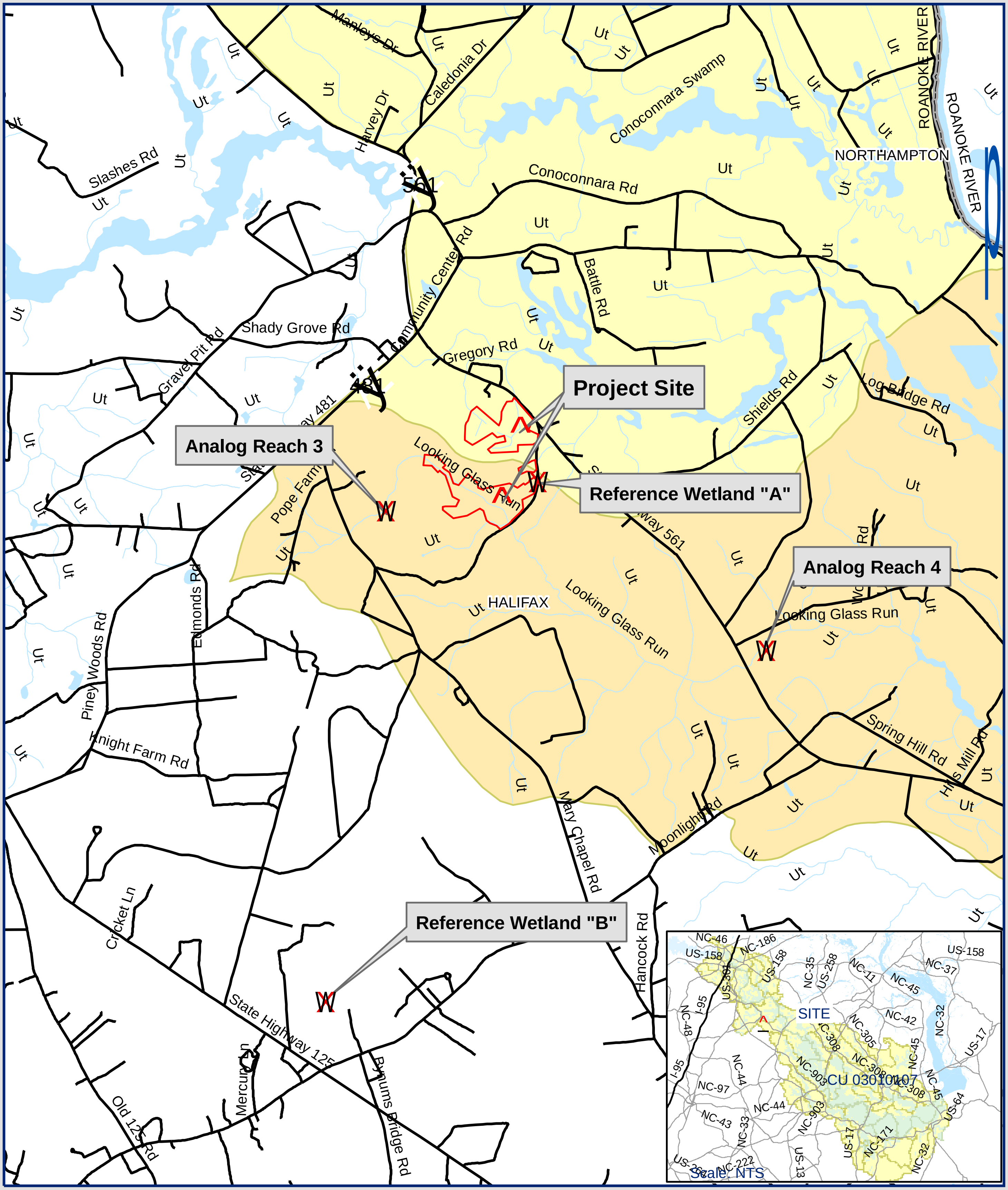
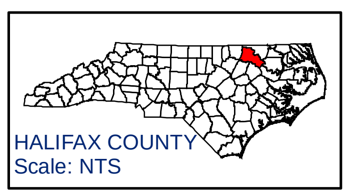


Figure 1.
Site Location Map
Conoconarra

SOURCES: NCDOT, NRCS, USGS

0 0.25 0.5 1 1.5 2 Miles

LEGEND
- Road
- Existing Waterbody
- HUC 03010107090020
- HUC 03010107090030



westward encroachment of the Atlantic Ocean. West of this feature elevations are higher and slopes are somewhat steeper. The local topography is very flat with elevations ranging from 69 to 62 feet above mean sea level (NAD 27) based upon USGS mapping (Figure 2) and recent topographic survey data.

The project will involve the wetland restoration of PC cropland that drains to Conoconnara Swamp and restoration of Looking Glass Run, both of which are tributaries to the Roanoke River. Conoconnara Swamp and Looking Glass Run are listed as Class "C" waters, indicating that the streams are considered to support aquatic life and secondary recreational uses. In the 1996 NCDWQ Basinwide Plan for the Roanoke River Basin, Conoconnara Swamp was listed as impaired based on fish community data. In the 2001 Basinwide Plan, Conoconnara Swamp was not rated due to the lack of sampling data. Restoration of the site will restore wetland and stream functions and reduce the amount of sediment, nutrients, and agricultural chemicals (e.g., pesticides and fertilizers) flowing from the site, providing functional uplift to water quality of the streams and the Roanoke River Basin.

GENERAL WATERSHED INFORMATION

Looking Glass Run has a drainage area of 562 acres (0.88 mi^2) at the downstream end of the restoration project. The 63.64 acre wetland restoration area has a drainage area of 130 acres (0.20 mi^2). The 5.36 acre wetland restoration area has a drainage area of 13.73 acres (0.02 mi^2). The dominant land use is agricultural production of cotton and soybeans, pine plantation, and woodland. Local drainage patterns have been altered in the past to drain wetlands and promote agricultural production. The USGS Scotland Neck, NC topographic quadrangle (Figure 2) shows that drainage from the site flows in two directions. The northern portion of the site flows primarily to Conoconnara Swamp, while the southern portion of the site drains to Looking Glass Run. There are numerous agricultural ditches and swales on the project property that are used to promote drainage. The ditches and swales were constructed to route water off the site, draining areas that were once wetland. On-site topography, soils, and existing wetland areas demonstrate that the site historically supported both riverine and non-riverine wetland areas. The restoration and preservation areas will be protected by a conservation easement. Areas of the property outside the conservation easement may continue to be used as woodland, pine plantation, agriculture, or wildlife food plots.

SOIL MAPPING

The property is located within the Roanoke-Dogue soil association. This association is found on nearly level, poorly drained and moderately well-drained soils that have a loamy surface layer and a clayey subsoil; on fluvial terraces. The landscape is characterized by broad, smooth flats and depressions and may be occasionally flooded for brief periods. The NRCS soil map is shown in Figure 3. Soils are described in detail in Section III Existing Conditions.

WETLAND DELINEATION

A wetland delineation was performed by Wetland and Natural Resource Consultants utilizing the routine on-site determination method. This delineation found that the wetland restoration area was non-jurisdictional due to subsurface drainage. Onsite wetlands include riverine wetlands along Looking Glass Run and adjacent non-riverine wetlands immediately upgradient and in the Looking Glass Run headwaters area. Generally, the wetland preservation area follows the wetland boundary. Riverine wetlands are not

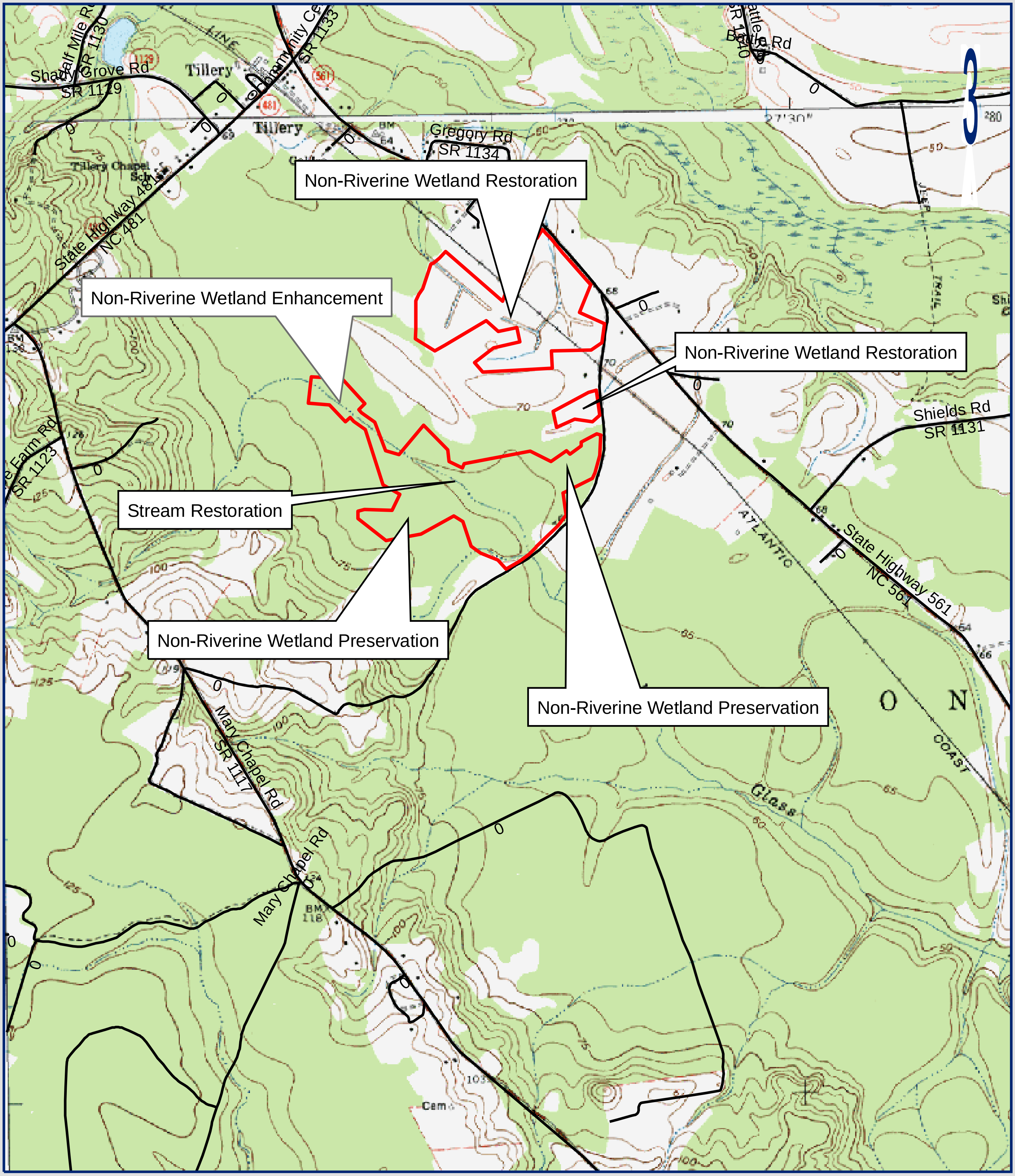


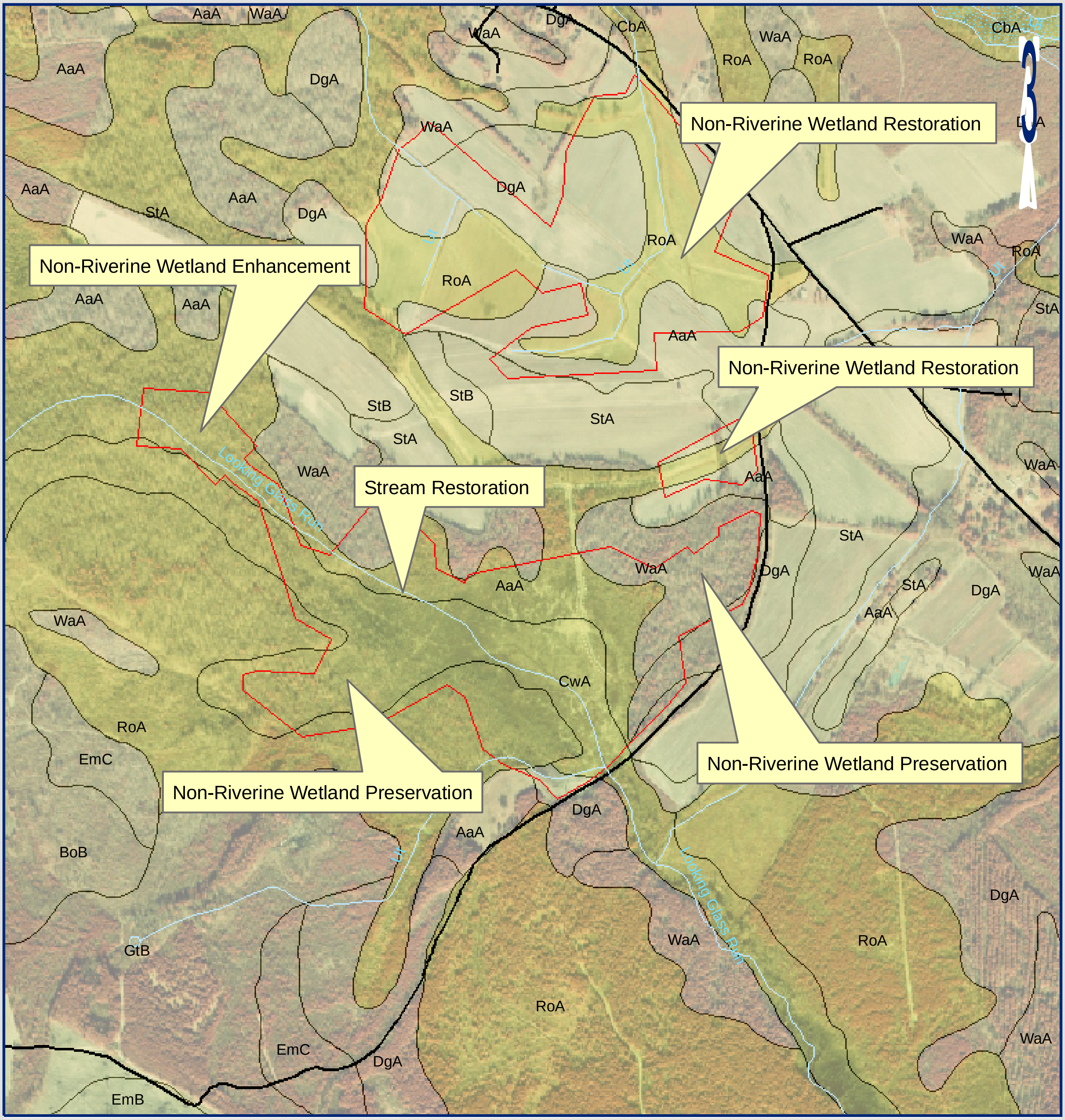
Figure 2.
USGS Quad Map
Conoconnara, Halifax County, NC

0 500 1,000 2,000 3,000 4,000 Feet

LEGEND

- Proposed Conservation Easement
- Road
- Stream

SOURCES: USGS, Scotland Neck, NC, Quadrangle, 1962
Dawson Crossroads, NC, Quadrangle, 1960



SOIL SERIES LEGEND

Non-Hydric Soils
BoB *Bonneau loamy fine sand, 0 to 4% slopes*
EmC *Emporia fine sandy loam, 6 to 10% slopes*
GtB *Gritney fine sandy loam, 2 to 6% slopes*
StA *State fine sandy loam, 0 to 2% slopes*
StB *State fine sandy loam, 2 to 6% slopes*

Hydric Soils
CwA *Chewacla and Wehadkee soils, 0 to 1% slopes, occasionally flooded*
RoA *Roanoke loam, 0 to 2% slopes, occasionally flooded*

Soils With Hydric Inclusions
AaA *Altavista fine sandy loam, 0 to 3% slopes, rarely flooded*
DgA *Dogue silt loam, 0 to 3% slopes*
WaA *Wahee silt loam, 0 to 2% slopes, rarely flooded*

0 250 500 1,000 1,500 2,000 Feet

Figure 3.
Soils Map
Conoconnara

SOURCES: NCDOT, NRCS

LEGEND
Proposed Conservation Easement
Road
Stream
StA Soil Type
DgA Hydric Soils

included in the wetland preservation area. Wetlands are described in detail in Section III Existing Conditions.

PROTECTED SPECIES

Table 2 lists the species native to Halifax County that are protected under the Federal Endangered Species Act. No suitable habitat exists within the project area for the listed federally protected species. Further, a review of the Natural Heritage Program database and maps did not reveal the presence of any known occurrences of protected species within the project vicinity. No further protected species surveys are anticipated.

Table 2. Protected Species in Halifax County

Scientific Name	Common Name	Federal Status
Alasmidonta heterodon	Dwarf Wedgemussel	Endangered
Elliptio steinstansana	Tar River Spinymussel	Endangered
Haliaeetus leucocephalus	Bald Eagle	Threatened
Picoides borealis	Red-cockaded Woodpecker	Endangered

III. EXISTING CONDITIONS

STREAM CHANNEL

Looking Glass Run flows across the property in a southeasterly direction and has been straightened and channelized for the entire length. The existing project reach has a very flat gradient with an overall measured slope of 0.0018 ft/ft. The valley gradient gradually decreases downstream until a distinct but slight slope discontinuity causes it to become essentially flat near the lower end of the project. This especially flat section of valley is part of an historic pond bottom. Bedforms are generally indistinct as is typical of Coastal Plain sand bed channels. There are accumulations of fine sediment throughout the reach. The stream bed and banks are comprised almost entirely of sand and silt and the width to depth ratios range from 6.7 to 20.2. The floodplain is a broad expanse of riparian wetlands so that the entrenchment ratio is very large (> 2.2). It has typical bank height ratios nearly 1, indicating little incision, although in some sections it is slightly higher. The stream has been classified as a predominantly E5 stream type with sections of C5 using the Rosgen stream classification system (Rosgen, 1994). The sections of C5 channel are likely a result of channelization. The natural stream type would likely most resemble E5 and DA using the Rosgen system. The design reach has been separated into three distinct sections which are described below and shown in Figure 4. Channel characteristics are summarized in Table 3.

Table 3. Summary of Existing Channel Characteristics

Reach	Drainage Area (Ac)	Cross Sect. Area (ft^2)	Width:Depth Ratio	Bank Height Ratio	Sinuosity	Slope (ft/ft)	D_{50} (mm)
Reach 1 (Upper)		8	7	1.4	1.05	0.0012	0.063
Reach 1 (Lower)	142	14	7	1	1.05	0.0012	0.063
Reach 2 (Upper)		6	17	1	1	0.002	0.25
Reach 2 (Lower)	373	6	48	1	1	0.002	1
Reach 3	562	8	22.2	1	1.03	0.002	0.063

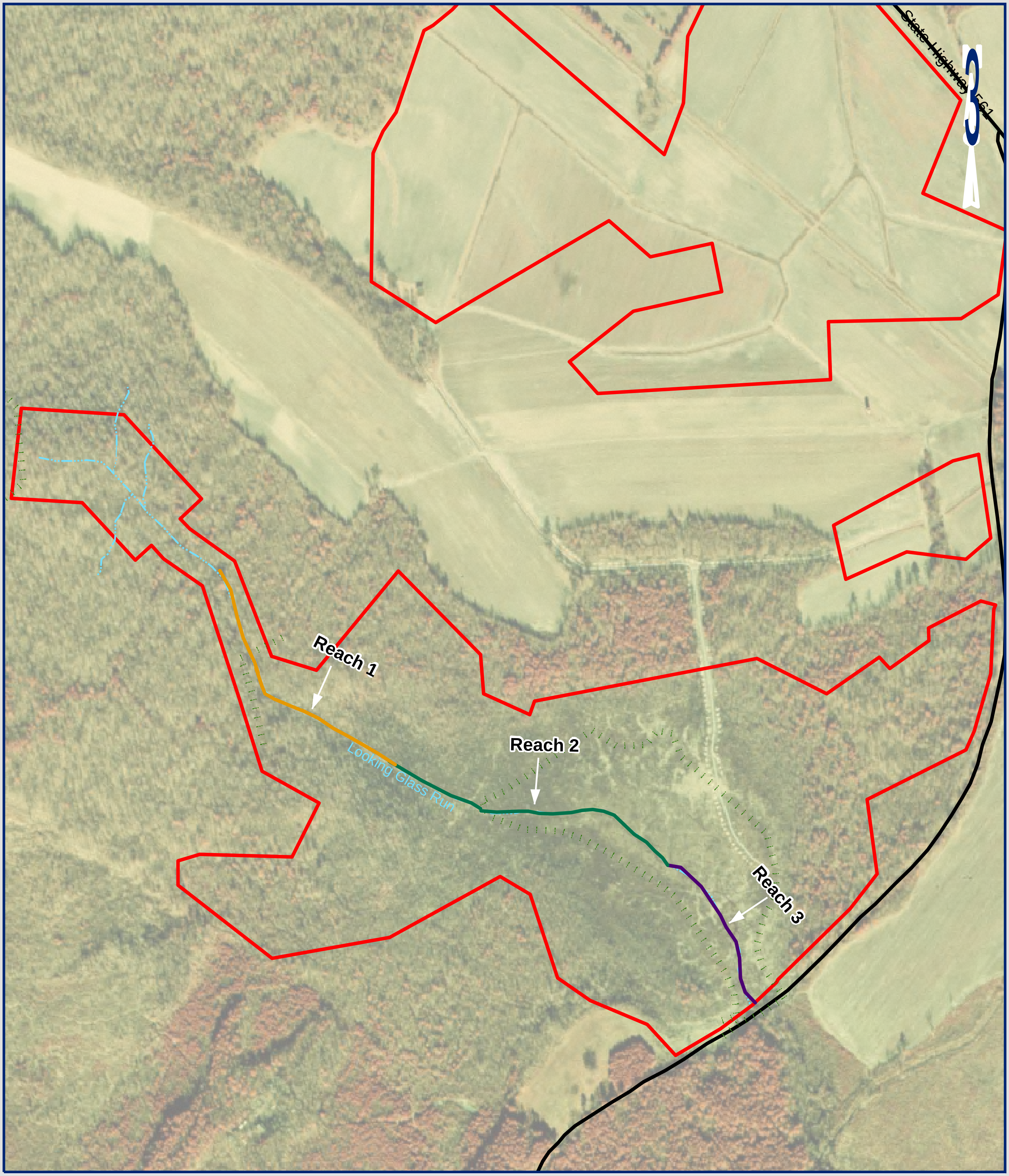


Figure 4.
Existing Stream Conditions
Conoconnara

0 300 600 1,200
Feet

SOURCES: NCDOT, USGS

LEGEND
Existing Centerline
DOT Roads
Current Woodline
Reach 1
Reach 2
Reach 3
Proposed Conservation Easement

Reach 1

The upstream section of the stream restoration design, Reach 1, begins approximately 800 feet downstream of the origin of the channel. It has a drainage area of 142 acres (0.22 mi^2) at the downstream end which includes three tributaries. This 1,500 foot section of channel is very straight (sinuosity = 1.05) and has a low gradient (0.0012 ft/ft). The 700 foot upstream section of Design Reach 1 has been clear-cut. This portion of the stream has a cross-sectional area of approximately 8 ft^2. The width to depth ratio is approximately 7 and the bank height ratio is 1.4. The lower 840 foot section of this reach runs through a mid-successional forested wetland. Channel cross sections are larger through this section (approximately 14 ft^2) and have a width to depth ratio of approximately 7 and a bank height ratio of nearly 1. The bed material along Reach 1 is fine sand (D_{50} = 0.063 mm). This reach would be classified as a E5.


Existing Condition of Reach 1

Reach 2

Reach 2 is very straight (sinuosity = 1.0) and has a low gradient (0.002 ft/ft). This reach flows through bottomland hardwood forest for approximately 515 feet before it enters the old pond bottom area. This portion of Reach 2 has a cross-sectional area of approximately 6 ft^2. The width to depth ratio is approximately 17 and the bank height ratio is approximately 1. The bed material along the upper portion is medium sand (D_{50} = 0.25 mm). The lower portion of Reach 2 flows through the pond bottom for approximately 1,000 feet. The pond bottom is covered by herbaceous vegetation with very few trees. The pond dam has been breached in-line with the stream channel. The lower portion of Reach 2 has a cross-sectional area of approximately 6 ft^2, a width to depth ratio of approximately 48, and a bank height ratio of nearly 1. The bed material along the lower portion of the reach is coarse sand (D_{50} = 1 mm). Reach 2 has a drainage area of 373 acres (0.58 mi^2). This reach would be classified as a C5.

Reach 3

The lower reach of the project, Reach 3, flows through the most downstream portion of the pond bottom for approximately 770 feet. It is very straight (sinuosity = 1.03) and has a low gradient (0.002 ft/ft). This reach has a cross-sectional area of 8 ft^2, a width to depth ratio of 22.2, and a bank height ratio of nearly 1. The bed material along the lower portion of the reach is fine sand (D_{50} = 0.0063 mm). Reach 3 has a drainage area of 562 acres (0.88 mi^2). This reach is classified as a C5.

STREAM HYDROLOGY

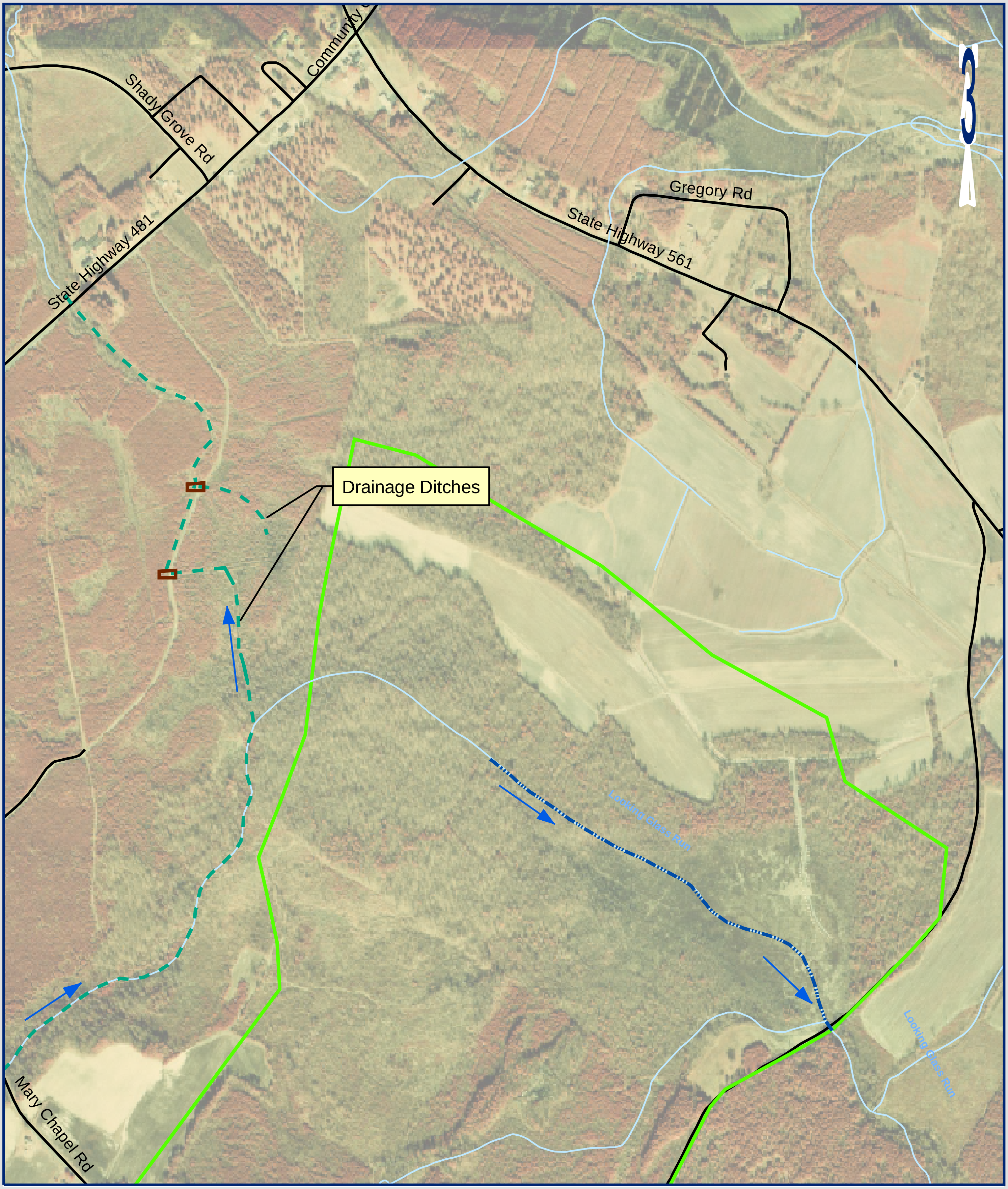
The hydrology of the project reach is complex. The lack of relief at the site has a significant impact on the hydrology of the natural system. The stream was historically surrounded by bottomland hardwood swamp. Much of the project watershed remains forested swamp land and is, therefore, slow to respond hydrologically. The swamp areas provide flood storage and attenuate peak flows.

The drainage patterns of the watershed have been altered by landowners. The USGS quadrangle map for Scotland Neck, NC (and GIS layers based on the quadrangle) indicates that Looking Glass Run originates on top of an escarpment and flows in a northeasterly direction before taking a sharp turn and continuing on in a southeasterly direction through the project reach. Field investigations of the site have revealed that the mapping is incorrect. The stream that originates on the escarpment flows to the northeast into a bottomland hardwood swamp which is drained from at least two locations into a network of ditches which outfalls to the north into an unnamed tributary to Conoconnara Swamp (Figure 5). Looking Glass Run originates below the bottomland hardwood swamp and flows southward through the project site. Originally, based on the USGS mapping, the project reach was determined to have a drainage area of 1,408 acres (2.2 mi^2) at the downstream end of the project. In actuality, the drainage area at that point is 563 acres (0.88 mi^2).

VEGETATION


Existing Vegetation Reach 2

The stream restoration site can be broken into three distinct vegetative communities (Figure 6). The upper portion of the design reach flows through a disturbed shrub-scrub area that has been recently clear cut. Along this section of the channel a few mature trees remain. These trees are primarily successional species such as red maple (*Acer rubrum*) and sweetgum (*Liquidambar styraciflua*). A variety of herbaceous wetland species also persist along this section of the stream including blackberry (*Rubus argutus*), greenbriar (*Smilax rotundifolia*), sedge (*Carex sp*.), giant cane (*Arundinaria gigantea*), soft rush (*Juncus effusus*), and Japanese honeysuckle (*Lonicera japonica*). The middle section of the design reach flows through a mid-successional bottomland hardwood forest. The canopy is comprised of tree species such as red maple, swamp chestnut oak (*Quercus michauxii*), and blackgum (*Nyssa sylvatica*). The sub-canopy is comprised mostly of sweetbay (*Magnolia virginiana*) and herbaceous species include sedge and giant cane. The lower portion of the design reach is located in an herbaceous-dominated historic pond bottom. The drained pond bottom is now covered primarily with species such as soft rush, woolgrass (*Scirpus cyperinus*), and smartweed (*Polygonum pennsylvanicum*).



EBX

Figure 5.
Stream Drainage Patterns
Conoconnara

0 250 500 1,000 1,500 2,000
Feet

SOURCES: NCDOT, USGS

LEGEND
- Project Watershed
- DOT Roads
- USGS Hydrography
- Actual Flow Pattern
- Looking Glass Run-Existing Stream
- Culverts

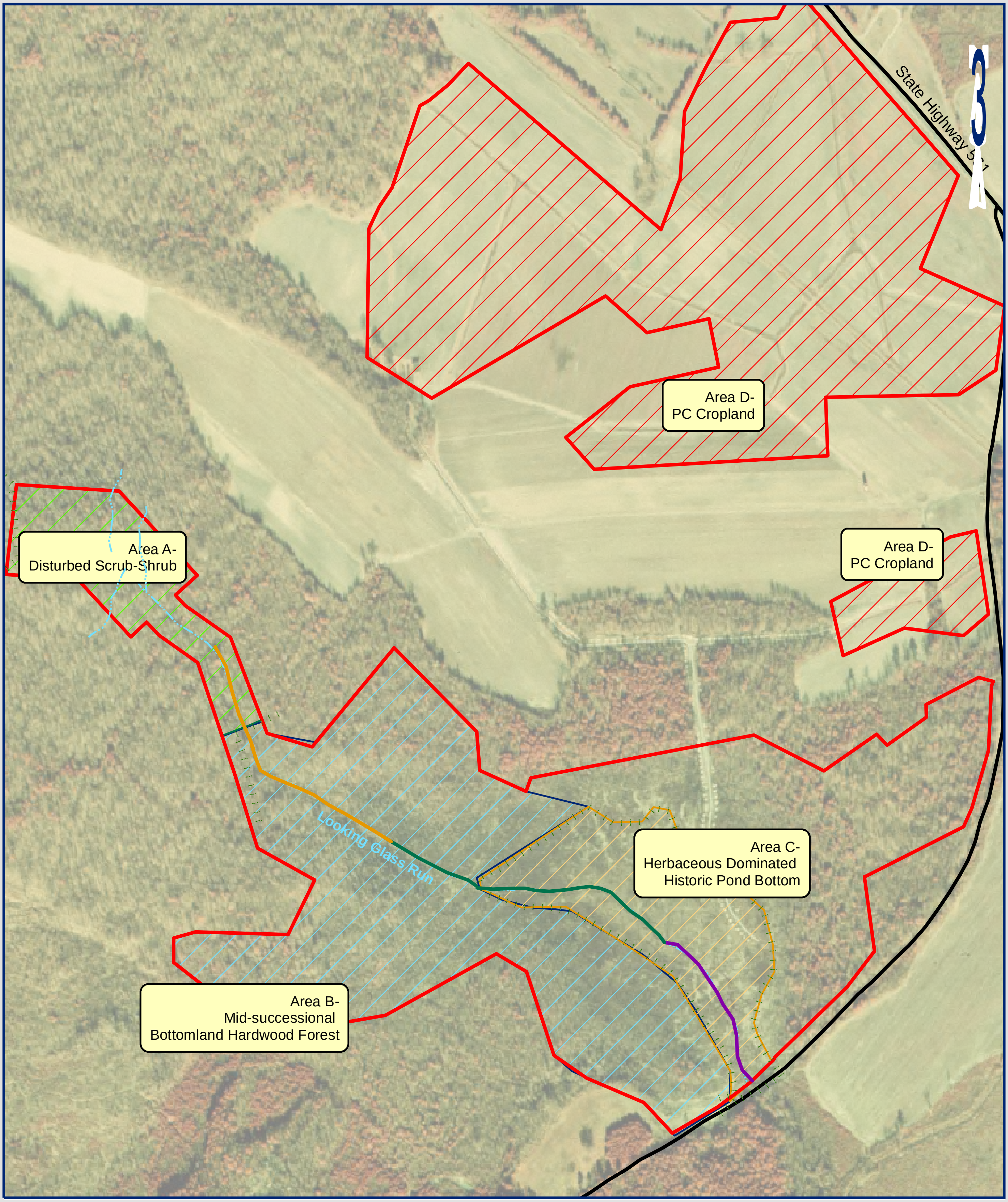


Figure 6.
Existing Plant Communities
Conoconnara

0 150 300 600 900 1,200 Feet

SOURCES: NCDOT, USGS

LEGEND
- Existing Centerline
- DOT Roads
- Current Woodline
- Reach 1
- Reach 2
- Reach 3
- Proposed Conservation Easement

The wetland restoration areas are composed of 69 acres of PC cropland. A few scattered trees are found along the drainage ditches and include red maple, sweetgum, water oak (*Quercus nigra*), and loblolly pine (*Pinus taeda*). In the ditches soft rush and cattail (*Typha latifolia*) were found. During the past year, the PC farm fields were planted with both cotton and soybeans.

The wetland enhancement area is similar to the disturbed shrub-scrub community described above. It is composed of eight acres of clear-cut non-riverine headwaters wetland immediately upstream of the restoration reach. Existing vegetation in this area is composed of early successional Facultative species such as sweetgum, red maple, and loblolly pine. Other species present include tulip poplar (*Liriodendron tulipifera*), greenbriar, giant cane, and blackberry. The vegetative community is extremely dense and lacks typical bottomland hardwood species.

Wetland preservation areas include approximately 71 acres (.11 mi^2) of non-riverine wetland upgradient from Looking Glass Run, as delineated by others. Vegetation in the non-riverine wetland consists primarily of willow oak (*Quercus phellos*), sweetgum, red maple, cherrybark oak (*Quercus pagodifolia*), and tulip poplar. Also present are loblolly pine and white oak (*Quercus alba*). The understory is composed of American holly (*Ilex opaca*) and pepperbush (*Clethra alnifolia*). This community is a mid-successional forest that shows signs of previous disturbance such as the presence of loblolly pine and numerous tractor/logging tire ruts.

SOILS

The property is located within the Roanoke-Dogue soil association. This association is found on nearly level, poorly drained and moderately well drained soils that have a loamy surface layer and a clayey subsoil; on fluvial terraces. The landscape is characterized by broad, smooth flats and depressions and may be occasionally flooded for brief periods.

The soils mapped along the stream restoration corridor are Chewacla and Wehadkee and Roanoke loam (Figure 3). Both of these map units are hydric soils. Chewacla and Wehadkee soils are nearly level, poorly drained, and found along floodplains. The seasonal high water table is within one foot of the ground surface. Roanoke soils are nearly level, poorly drained, and found on broad smooth flats, depressions, terraces, and drainageways. The seasonal high water table is within one foot of the ground surface. Both of these map units are primarily used as woodland and are limited by wetness and flooding.

Several soil borings were installed along the stream restoration corridor and wetland enhancement area to characterize on-site conditions. Soil borings verified hydric soils and typically had a dark gray loam or clay loam surface horizon (0-6 inches) underlain by a mottled dark gray sandy clay horizon. Gray clay soil was found from approximately 12 inches to greater than 36 inches.

Soils mapped on the wetland restoration areas are Roanoke loam (hydric), Altavista fine sandy loam and Dogue silt loam (soils with hydric inclusions). Roanoke soils are described above. Altavista soils are nearly level, moderately well drained, and occur on broad smooth flats, depressions, and drainageways. The seasonal high water table is typically at a depth of 1.5 to 2.5 feet below the ground surface. Dogue soils are nearly level, moderately well drained, and occur on broad smooth flats, depressions, and drainageways. The seasonal high water table is typically at a depth of 1.5 to 3.0 feet below the ground surface. Both of these map units are primarily used in agricultural production and limited by wetness and rare flooding.

A series of soil borings were described to verify hydric soil mapping (Figure 7). Soil borings indicated that hydric soils present in the PC areas closely matched the Roanoke series. These soil borings indicated hydric soils are present within 12 inches in the PC areas and the descriptions recorded indicate soil in this area closely resembles the Roanoke series and clearly distinguishes it from the Altavista and Dogue soils. The boring descriptions do not contain adequate detail to clearly distinguish between the Altavista and Dogue soils due to their similarities These soils typically had a plow layer 10-12 inches thick of brown clay loam or sandy loam; and mottled subsurface horizons of dark brown/gray clay and sandy clay. The complete soil boring logs are located in Appendix A.

WETLAND HYDROLOGY

The existing wetland areas on-site include riverine and non-riverine wetlands, and proposed non-riverine wetland restoration. The existing riverine wetlands are immediately adjacent to Looking Glass Run and have groundwater elevations within one foot of the ground surface for most or all of the growing season. Field indicators of wetland hydrology include, water stained leaves, saturated soil within 12 inches of the surface, crayfish burrows, positive fac-neutral test, and mapped hydric soils. The existing non-riverine wetlands have a water table within one foot of the surface during the early and late growing season, with a mid-growing season drawdown. The proposed wetland restoration area is on PC cropland. An extensive ditch network and agricultural surface modifications have effectively removed the wetland hydrology. Ditch depths range from two feet to four feet. Outside of the growing season water is frequently ponded in tire ruts and plant rows. No drainage tile was found in the course of field studies. No wetland hydrology was observed in the restoration area during the growing season; although hydric soil is present.

Existing Condition PC Cropland

IV. STREAM RESTORATION PLAN

The goal of the stream restoration portion of the project is to restore 3,785 linear feet of existing stream channel to an approximation of its natural condition while providing for channel stability, improved habitat, and appropriate hydraulic and sediment transport function. Once constructed, the restoration will increase the planform sinuosity of the channel; restore appropriate cross-sectional dimensions; provide in-stream habitat in the form of woody debris, pools, and bank vegetation; and create a forested riparian buffer. Forested riparian buffers will be established to have widths of at least 50 feet on each side of all restored channels. The result will be 5,073 linear feet of stream restoration.

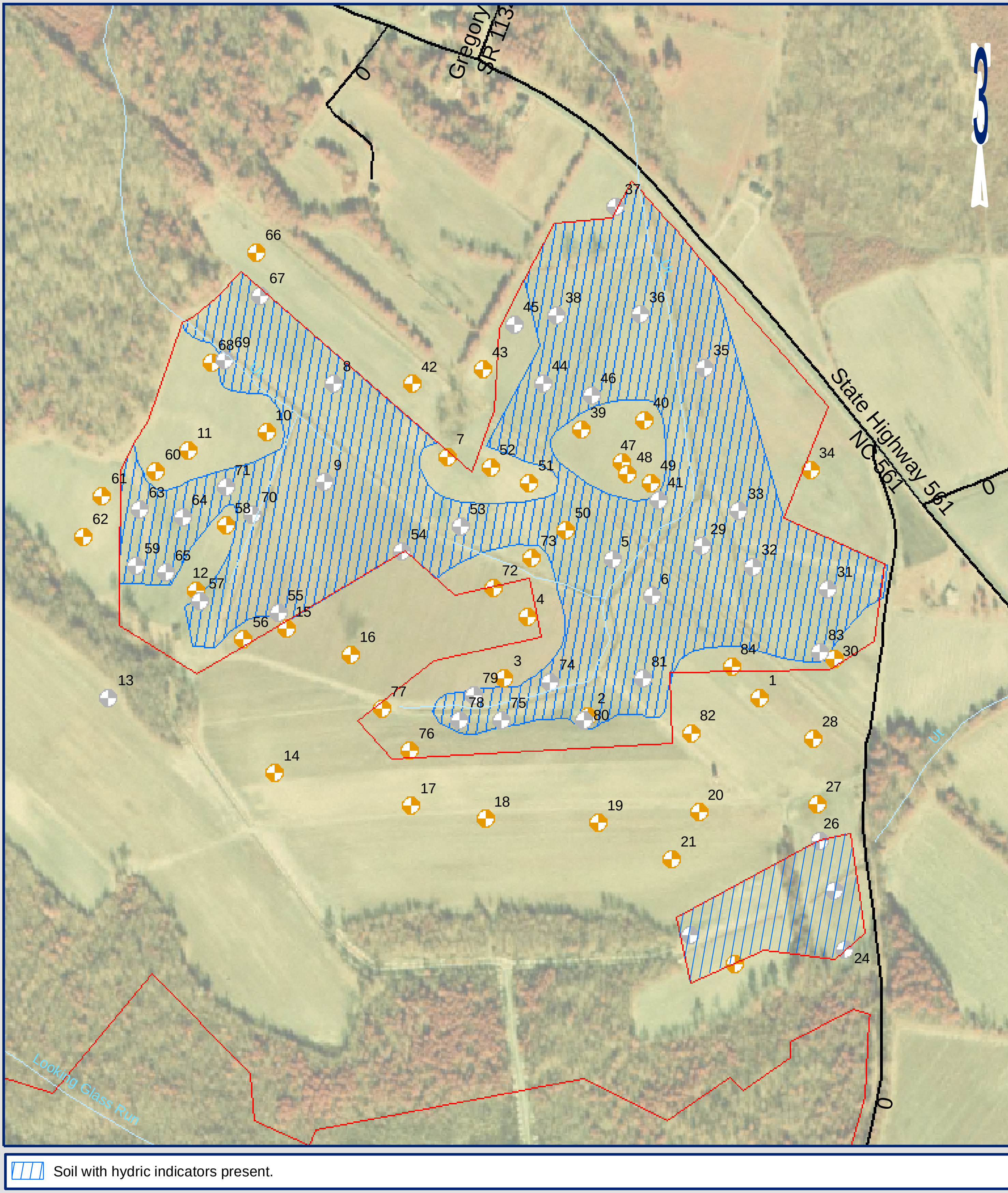


Figure 7.
Soil Borings Map
Conoconnara

SOURCES: NCDOT, USGS

LEGEND

- Proposed Conservation Easement
- Road
- Stream
- Hydric Soils
- Non-Hydric Soils

Appendix D contains the proposed stream design in plan form and the forested buffer restoration areas.

RESTORATION SUMMARY

Natural channel design techniques have been used to develop the restoration design described in this document. The analog stream design method was determined to be the most appropriate for this project. Multiple analog reaches were evaluated for use in this design. Two were selected, a single-thread channel near the design reach and a multiple-thread reach downstream of the project site on Looking Glass Run. The multi-thread channel is similar to those observed throughout the bottomlands of the North Carolina Coastal Plain.

Design parameters have been developed from analog reach data and applied to the subject stream. The designs presented herein provide for stable cross-sectional geometry, an increase in planform sinuosity, and restoration of sand-bed channel features and stream bed diversity to improve benthic habitat. The proposed design would allow flows that exceed the design bankfull stage to spread out over the floodplain. The proposed stream crosses the existing channel in several locations, and some segments of the restoration consist of hydraulic geometry modifications to the existing channel.

As presently envisioned, a large portion of the existing stream would be filled using material excavated from the restoration channel. However, many segments will be left unfilled to provide habitat diversity and flood storage. Native woody material will be installed throughout the restored reach to reduce bank stress, provide grade control, and increase habitat diversity. The primary analog reach has tremendous amounts of woody debris throughout the channel forcing scour pools and providing habitat for aquatic organisms. The size and spacing of the woody debris has been carefully replicated in the design reach.

Woody Debris in Analog Reach 3

Forested riparian buffers will be established along much of the project reach to have widths of at least fifty feet on both sides of all restored streams. An appropriate riparian plant community will be established to include multiple strata and a diverse mix of species. Replanting of native species will occur where the existing buffer is impacted during construction of the downstream end of the project.

The proposed stream and buffer restoration will prevent excessive erosion. By reducing the supply of fine sediments from the banks, restored bedforms will remain stable. In addition, the reductions in nutrients and other pollutant loadings that will be achieved with the

Conoconnara restoration work provide substantial benefits to the watershed. Incidental to the stream restoration, riverine wetlands may be restored or enhanced. No effort has been made to quantify these wetland areas.

HYDROLOGIC ANALYSIS

Hydrologic evaluations were performed for the subwatershed of each of the three design reaches to validate the design bankfull discharge and channel geometry. Peak flows and corresponding channel cross-sectional areas were determined through standard hydrologic methods for comparison to design parameters. Peak flows in this study were determined using the following methods:

- Flood frequency analysis for USGS gauge stations
- USGS regional regression equations for rural conditions in the Coastal Plain
- NC Regional Curves

Evaluations were made at the downstream limits of Design Reach 1, Design Reach 2, and Design Reach 3. Flood frequency analysis was developed for the study region using historic gauge data on all nearby USGS gauges with drainage areas less than 6,400 acres (10 mi^2) which passed the Dalrymple homogeneity test (Dalrymple, 1960). Flood frequency equations were developed for the 1-, 1.5-, and 2-year peak discharges based on the gauge data. Discharges were then computed for each analog and design reach. These discharges were compared to those predicted by the discharge regional curve and the USGS regional regression 2-year discharge equations (Pope, et al., 2001). For the analog reaches, they were compared to the bankfull discharge calculated using Manning's equation based on the surveyed bankfull cross-sectional geometry and slope. The hydrologic analysis is summarized in Table 4.

The discharge regional curve predicted flows that are very similar to those predicted by the 1-year flood frequency equation. The 1.5-year flood frequency equation predicted considerably higher discharges. The bankfull discharge of Analog Reach 3 calculated with Manning's equation is slightly higher than the regional curve predicted discharge and flood frequency equation predicted discharge. For Analog Reach 4 the Manning's equation discharge is considerably lower. This result for Analog Reach 4 is not surprising considering that there are multiple large natural swamp impoundments upstream of the analog site, which likely attenuate peak flows. None of the Regional curve sites were downstream of impoundments (Doll, et al., 2003).

The fact that the regional curves predict flows similar to the 1-year flood frequency analysis indicates that bankfull flows occur in the region with a frequency of approximately one year. The developers of the Coastal Plain regional curves report an average recurrence interval of 1.12 years for the gauged streams included in their study (Doll et al., 2003). Based on this hydrologic analysis, the design discharge for each reach was based on the regional curves with an expected recurrence interval of approximately one year.

Table 4. Summary of Hydrologic Analysis

Reach	Drainage Area (Ac)	NC Regional Curve Q	Flood Freq. Analysis Q_1	Flood Freq. Analysis $Q_{1.5}$	Flood Freq. Analysis Q_2	Regional Regression Eqns. Q_2	Surveyed Bankfull Indicator Q	Design Q
Analog 3	500	14.0	15.2	41.6	60.4	55.7	19.3	---
Analog 4	3963	61.6	55.5	151.9	220.3	220.9	27.7	---
Reach 1	142	5.6	6.7	18.4	26.7	23.4	---	6.0
Reach 2	373	11.2	12.4	34.0	49.3	44.8	---	11.0
Reach 3	562	15.1	16.1	44.2	64.0	59.3	---	15.0

All discharge values are in cubic feet per second

ANALOG REACH ANALYSIS

The analog method of natural channel design involves the use of a "template" stream adjacent to, nearby, or previously in the same location as the design reach. The template parameters of the analogs are replicated to create the features of the design reach. The analog approach is useful when watershed and boundary conditions are similar between the design and analog reaches (Skidmore et al., 2001). For this project, four analog reaches were studied. Two were eventually used in the design based on their apparent stability, proximity to the project, and similar hydro-geomorphic setting. The primary analog reach is a single thread channel adjacent to the design reach (0.45 miles away). The second analog reach used in the design is a multiple-thread channel downstream of the project site on Looking Glass Run. Both reaches were surveyed with total station equipment using standard field methods to collect data on the planform patterns, cross-sectional dimensions, and longitudinal profiles of the streams. Bulk sediment samples were collected and analyzed. Woody debris was mapped in order to replicate its occurrence in the design. Woody debris in a sand bed channel is important not only for habitat diversity but also as a forcing mechanism for pool creation and maintenance.

Analog Reach 3

Analog Reach 3 was determined to be the most suitable for the majority of the project and exhibits the following characteristics:

- Undisturbed stable reach on an adjacent stream;
- A geomorphically active floodplain that is hydrologically connected to the stream;
- Sinuosity of 1.47;
- Healthy riparian forest buffer;
- Location within the same geographical and meteorological region as the Conoconnara Site;
- Channel bed and bank materials of fine sand and silt comparable to the Conoconnara Site. The soils at both locations are Roanoke and Chewacla.

Analog Reach 4

Analog Reach 4 was identified as an appropriate analog to apply to the downstream portion of the project. This reach is a multi-thread channel flowing through and hydrologically connected to a riverine wetland system. This is the likely historic condition of the lower portion of the design reach and Analog Reach 4 exhibits the following characteristics:

- Undisturbed stable reach on the same stream;
- A geomorphically active floodplain that is hydrologically connected to the stream;
- Appropriate multi-thread pattern;
- Location within the same geographical and meteorological region as the Conoconnara Site;
- Channel bed and bank materials of fine sand and silt comparable to the Conoconnara Site. The soils at Analog Reach 4 and the Design Reach 3 are both Chewacla.

Side Channel Habitat in Analog Reach 4

ANALOG DESIGN APPROACH

The planform pattern, cross-sectional dimensions and shape, longitudinal profile, and locations of woody debris in the channel of the analog reaches were replicated in order to develop design parameters for the subject stream. A scaling factor was developed to size the design parameters for the project site. The scaling factor for each design reach (Reaches 1 through 3) was derived from the design cross-sectional area of each reach as follows:

1. The appropriate bankfull cross-sectional area (CSA) of each design reach was determined based on the drainage area of the site and the North Carolina Coastal Plain regional curve equations (Doll et al., 2003). The Coastal Plain regional curves were deemed appropriate for this use because they predicted bankfull cross-sectional geometry of most reaches studied for this project with reasonable accuracy. As described in the Hydrologic Analysis section, the regional curve discharge will be the design discharge.

2. The bankfull cross-sectional area predicted by the regional curves for each design reach was divided by the typical cross-sectional area of the respective analog reach. Analog Reach 3 was used to design Reaches 1 and 2 and the multiple-thread channel Analog Reach 4 was used to design Reach 3 (Table 5).

3. Once the scaling factors were determined, they were used to scale down the design parameters of the analogs to the appropriate size to design Reaches 1 through 3.

Table 5 describes the stream restoration design parameters derived from the analog reaches.

Table 5. Scaling Factors for Sizing Design Channel Parameters

Reach	Drainage Area (Ac)	Predicted Bankfull CSA (ft^2)	CSA Used in Scaling Factor (ft^2)	Analog Reach	Typical Analog CSA (ft^2)	Scaling Factor
Reach 1	142	5.4	6	AR3	11.6	0.52
Reach 2	373	10.2	11	AR3	11.6	0.95
Reach 3	562	13.32	14	AR4	25.6	0.55

TYPICAL DESIGN SECTIONS

Typical cross sections for shallows and pools are shown on the design plan sheets in Appendix D. The cross-section dimensions were developed for the three design reaches by multiplying the surveyed cross sections from the respective reference reaches by the scaling factors described in Table 5. The cross sections were altered slightly to facilitate constructability, however, the cross-sectional area, width to depth ratio, and side slopes were preserved. Typical pool sections include pools located on straight reaches and pools on meander bends.

TYPICAL MEANDER PATTERN

The plans showing the design channel alignment are provided in Appendix D. The design meander pattern was derived directly from the analog reaches. It was also sized using the scaling factors. At some locations, the analog meander pattern was altered to provide variability in pattern, to fit the channel within the available conservation easement, to follow the valley pattern, and to make the channel more constructible. In these cases the morphologic parameters summarized in Table 6 were applied.

LONGITUDINAL PROFILES

The design profiles are shown in Appendix D. These profiles extend throughout the entire project for the proposed channel alignment. The profiles were designed using the analog reach bed features which were sized with the scaling factors. The bed slopes and bankfull energy gradients were set for each design reach based on the existing valley slope and the sinuosity of the design reach.

MULTIPLE-THREAD CHANNEL

The multiple-thread, or anastomosed, channel design was completed in the same fashion as the single-thread reaches. Scaling factors were applied to surveyed dimensions for planform pattern, cross-sectional dimension, and bed features to size the channel dimensions. This was done for the main channel as well as the side channels. The side channel beds are hydraulically connected at both ends to the main channel and are typically located at an elevation above the main channel bed but below the floodplain surface. Side channels PCS2 and PCS4 (see Appendix D, Sheet 11) flow in the downstream direction of the main channel at all times. Side channels PCS1, PCS3, and PCS5 (see Appendix D, Sheet 11) have been designed to flow in both directions at low flow but in the downstream direction of the main channel at higher stages. This was accomplished by designing the profiles of these three side channels to closely mimic the analog. Rills were also surveyed at the analog site and incorporated into the design. Unconnected oxbow features were added to the design to provide additional and diverse aquatic habitat.

Table 6. Summary of Morpholgic Design Parameters

Parameter	Analog Reach 3	Analog Reach 4	Design Reach 1	Design Reach 2	Design Reach 3
Stream Type	E5	DA	E5	E5	DA
Drainage Area (Ac)	500	3963	142	373	562
Bankfull Xsec Area, Abkf (sq ft)	11.3	25.6	6.0	11.0	14.1
Avg. Bankfull Width, Wbkf (ft)	8.9	23.8	4.6	8.5	13.1
Bankfull W/D	7.1	18.3	7.1	7.1	18.3
Bankfull Mean Depth, Dbkf (ft)	1.3	1.3	0.7	1.2	0.7
Bankfull Max Depth, Dmax (ft)	2.2	2.4	1.1	2.0	1.3
Meander Length, Lm (ft)	33.9	105.0	17.6	32.2	57.8
Radius of Curvature, Rc (ft)	15.4	78.0	8.0	14.6	42.9
Belt Width, Wblt (ft)	32.1	34.0	16.7	30.5	18.7
Sinuosity, K	1.5	1.2	1.5	1.5	1.2
Valley Slope, Sval (ft/ft)	0.0074	0.0012	0.0019	0.0012	-0.0001
WS Slope	0.0050	0.0009	0.0096	0.0080	0.0080
Channel Slope, Schan=Sval/K (ft/ft)	0.0050	0.0010	0.0096	0.0080	0.0080
D50	0.50	0.05	0.06	0.25	0.063
D84	1.00	1.00	0.25	2.00	1.00
Velocity (u) (fps)	1.24	32.30	1.10	1.20	1.20
Discharge (Q)	13.98	61.50	6.00	11.00	15.00

SEDIMENT TRANSPORT ANALYSIS

A sediment transport analysis was performed to confirm that the restoration design creates a stable sand bed channel that neither aggrades nor degrades over time. Several stable channel design functions relating channel dimension, slope, and materials were utilized to verify cross-section dimensions as calculated by the analog design approach.

Sediment transport is typically assessed to determine a stream's ability to move a specific grain size at a given flow. Methods include analysis of shear stress, tractive force, and critical dimensionless shear stress. While these equations are important in estimating entrainment for gravel bed streams, the equations are not as effectively applied to sand bed channels in which the entire bed becomes mobile during geomorphically significant flows including the bankfull discharge. The following methods and functions were employed during the sediment transport analysis:

- Stable channel Analytical Model (SAMwin) -- Copeland Method
- Shear stress
- Velocity

<u>SAMwin (Copeland Method)</u>

Design cross-section dimensions as determined from the analog approach were evaluated using the stable channel design functions within the SAMwin Model (Version 1.0). These functions are based upon the methods used in the SAM Hydraulic Design Package for Channels developed by the USACE Waterways Experiment Station. The Copeland Method was developed specifically for sand bed channels (median grain size restriction of 0.0625 mm to 2 mm), and was therefore selected for application at the Conoconnara site. The method sizes stable dimensions as a function of slope, discharge, roughness, side slope, bed material gradation, and the inflowing sediment discharge. Results are presented as a range of widths and slopes, and their unique solution for depth, making it easy to adjust channel dimensions to achieve stable channel configurations (Appendix B). See Table 7 below for the SAMwin output.

Table 7. SAMwin Stable Channel Design Output

Reach	Bottom Width (ft)	Depth (ft)	Slope (ft/ft)	Shear Stress (lb/ft^2)
Reach 1	4.0	1.0	0.00083	0.06
Reach 2	5.0	1.3	0.00095	0.07
Reach 3	7.0	1.3	0.00077	0.06

Velocity Approach

Published data are readily available that provide entrainment velocities for different bed and bank materials. A comparison of calculated velocities to these permissible velocities is a simple method to aid the verification of channel stability. Table 8 compares the proposed velocities calculated using Manning's equation with the allowable velocities presented in the USACE's Hydraulic Design of Flood Control Channels manual (USACE, 1991). Results from sieve analyses determined that the project stream has a bed composed primarily of medium to fine grain sand.

Table 8. Comparison of Proposed and Allowable Velocities

Reach	Design Velocity (ft/s)	*Allowable Velocity (ft/s)	
		fine sand	coarse sand
Reach 1	1.2	2.0	4.0
Reach 2	1.3	2.0	4.0
Reach 3	1.2	2.0	4.0

*(USACE, 1991)

Shear Stress Approach

Shear stress is a commonly used tool for assessing channel stability. Allowable channel shear stresses are a function of bed slope, channel shape, flows, bed material (shape, size and gradation), cohesiveness of bank materials and vegetative cover. The shear stress approach compares calculated shear stresses to those found in literature. Shear stress is the force exerted on a boundary during the resistance of motion as calculated using the following formula:

(1) $\tau = \gamma RS$

τ = shear stress (lb/ft^2)

γ = specific gravity of water (62.4 lb/ft^3)

R = hydraulic radius (ft)

S = average channel slope (ft/ft)

Table 9. Comparison of Proposed and Allowable Shear Stresses

Reach	Proposed Shear Stress at Bankfull Stage (lb/ft^2)	Shields Diagram Critical Shear Stress (lb/ft^2)	Allowable Shear Stress	
			*Sand/Silt/Clay (lb/ft^2)	**Vegetation (lb/ft^2)
Reach 1	0.06	0.002	0.4 to 2.5	0.32 to 0.43
Reach 2	0.07	0.004	0.4 to 2.5	0.32 to 0.43
Reach 3	0.06	0.002	0.4 to 2.5	0.32 to 0.43

*(Chow 1959)
** (Fischenich, 2001)

Review of the above table shows that the proposed shear stresses for Conoconnara fall between the critical shear stress (shear stress required to initiate motion) and the allowable limits. Therefore, the proposed channel should neither degrade nor aggrade.

RIPARIAN BUFFER RESTORATION

Two restoration plant communities are delineated within the riparian buffer: the single thread channel buffer will be restored to a Coastal Plain small stream swamp and the multiple-thread channel buffer to a cypress-gum swamp. Species to be planted in each area are listed in Table 10, and are intended to restore communities comparable to those described by Schafale and Weakley (1990). Species selection was based on reference wetland vegetation and literature. Plant materials will be primarily container grown stock with supplemental bare root stock as needed. The planting plan results in a minimum density of 363 trees per acre (TPA). A final density of 260 TPA is desired.

Table 10. Riparian Buffer Planting Plan

Species	Common Name
Coastal Plain Small Stream Swamp (single thread channel)	
Fraxinus pennsylvanica	Green ash
Platanus occidentalis	Sycamore
Nyssa biflora	Swamp blackgum
Taxodium distichum	Bald cypress
Quercus nigra	Water oak
Quercus phellos	Willow oak
Cypress-gum Swamp (multiple-thread channel)	
Taxodium distichum	Bald cypress
Nyssa aquatica	Water tupelo
Quercus lyrata	Overcup oak
Betula nigra	River birch
Fraxinus pennsylvanica	Green ash
Quercus laurifolia	Laurel oak

STRUCTURES

Structures will be incorporated into the channel design to provide additional bank stability and in-stream habitat. Native materials and vegetation will be used for revetments and grade control structures when applicable. In addition, woody debris will be placed throughout the channel in locations similar to those mapped in the analog reaches. Analog Reach 3 has a large amount of woody debris throughout the length at the channel providing grade control for shallows and forcing scour pools. Grade control for shallows was also frequent in Analog Reach 4, however there was far less woody debris observed in that channel. Other habitat features installed will include leaf packs, dead brush, and waddles. During construction, new stream banks will be stabilized with sod mats harvested onsite if possible. Other bank stability measures include the installation of cuttings bundles at three to five foot intervals along the tops of banks, root wads, and log toes. Typical details for proposed structures and revetments are in Appendix D.

V. WETLAND RESTORATION PLAN

REFERENCE WETLAND STUDIES

Non-riverine wet hardwood forests (target natural community) are typically dominated by wetland oak species and swamp blackgum (*Nyssa biflora*) (Schafale and Weakley, 1990). The hydrologic regime is seasonally saturated or flooded. They experience periods of groundwater drawdown during the summer months due to increased evapotranspiration and reduced precipitation.

Two reference wetlands were identified and studied in the course of project design. Reference Wetland A is the on-site wetland preservation area. Reference Wetland B is the Hale Tract and is located approximately 4.3 miles south of the project area near NC Highway 903 (Figure 1). These two reference wetlands are both non-riverine wet hardwood forests but encompass distinct vegetative and hydrological conditions.

Reference Wetland A

Vegetation in Wetland A consists primarily of willow oak, sweetgum, red maple, cherrybark oak, and tulip poplar. Also present are loblolly pine and white oak. The understory is composed of American holly and pepperbush. This community is a mid-successional forest that shows signs of previous disturbance such as the presence of loblolly pine and numerous tractor/logging tire ruts. Wetland B is composed of a more intact non-riverine hardwood forest. Overstory species include red maple, willow oak, laurel oak (*Quercus laurifolia*), swamp blackgum, and sweetgum. Understory species include spicebush (*Lindera benzoin*), highbush blueberry (*Vaccinium corymbosum*), and huckleberry (*Gaylussacia frondosa*). Herbaceous species include Virginia chainfern (*Woodwardia virginica*) and sedge. Neither reference wetland represents a climax non-riverine wet hardwood community as defined by Schafale and Weakley. The dominance of red maple and sweetgum indicates past disturbance and a mid-successional community. The proposed restoration will incorporate species found within the reference wetlands but also will include more climax species.

Hydrology was assessed within the two reference wetlands through auger borings and observations of hydrology indicators. Both reference wetlands had a water table within 12 inches of the surface during the early growing season. Wetland B also had standing water in several depressional areas. Water table elevations within this wetland type fluctuate greatly throughout the growing season with saturated soil in the Spring and Fall and a significant summer drawdown. It is believed that the restoration area will behave similarly. Monitoring wells will be installed within Wetland A for comparison to the restoration hydrology. A key component to the reference wetland hydrology is complexes of shallow depressions and pools. These depressions varied in size and depth between the sites but typically were 6 - 12 inches deep, and 40 - 300 feet long. These depressions offer increased surface storage and infiltration.

Soils on the reference wetlands are mapped as Roanoke loam and Grantham loam; both hydric soils. Auger borings confirmed that hydric soils are present on the reference wetlands. These Roanoke and Grantham soil series typically occupy broad smooth flats, depressions, and drainageways. The proposed restoration site closely matches these landforms.

DESIGN NARRATIVE

The primary wetland restoration activity will be construction of ditch plugs throughout the PC areas. A typical ditch plug will be 15 feet wide and extend above the top of the ditch bank elevation approximately 6 inches. Plugs are to be constructed of compacted fill (clay or sandy clay) placed in 12-inch lifts with the upper 18 inches minimally compacted to allow for plant growth. Plugs are spaced such that successive plugs are no more than 6 inches in elevation below one another. Three ditches leave the 60 acre restoration area and one ditch leaves the nine acre restoration area. These ditches empty into existing drainage networks that will remain in their current condition. At the point of departure from the conservation easement, a ditch plug with a geotextile-lined spillway will be constructed to protect against erosion during high-flow events. Ditch plugs will be constructed using excavated material from the stream restoration construction and excavation of wetland pools. Any excess fill material will be used to construct additional plugs or to entirely fill smaller ditches, as needed.

Limited areas of fill material in the 60 acre restoration area will be removed to access the historic hydric soil elevation. Fill areas are principally side cast ditch spoil and low field crowns.

Existing Railroad Bed

The abandoned railroad bed will be removed and the adjacent ditches filled to create a seamless transition between the northern and southern portions of the wetland restoration site. Also, the overhead power line adjacent to the railroad bed will be rerouted to the north of the conservation easement (along NC 561) to allow a full conversion to wet hardwood forest. Dominion Power Corporation will be responsible for demolition and relocation of the overhead power line. Several of the existing power line poles will be left standing and converted to raptor perches with the addition of crossbars. A farm path near the southern boundary of the conservation easement will be regraded to match surrounding contours, disked, and planted. A new farm path will be established outside of the conservation easement.

At the west end of the abandoned railroad bed (within the conservation easement) the existing ditches continue to flow into the conservation easement. When the bed is regraded these ditches will be re-directed to drain to the west. Approximately 350 feet of each ditch will need to be regraded; the maximum depth of cut will be approximately 0.5 feet.

Reference Wetland B Depression

Microtopography and surface roughness are key components to promoting infiltration of precipitation and recharge of the shallow water table. The proposed restoration site is very gently sloping (less than one percent) but does contain approximately seven feet of elevation difference across the site. Several decades of agricultural management has eliminated microtopography across the site. As part of the restoration effort 54 shallow depressions will be excavated on the upper elevations of the restoration area (outside of the immediate vicinity of the ditches). These depressions will be typically 80 feet long, 40 feet wide, 0.8 feet deep, and an elliptical shape. The total excavated area will cover approximately three percent of the conservation easement area. They will be constructed in groups of three with the long axis parallel with the contour. These depressions replicate those found in the reference wetlands and will be constructed with slight irregularities for a diversity of habitat. During construction of the depressions the surface horizon (upper eight inches) will be removed and stockpiled, approximately 0.8 feet of subsoil will be removed, and then the topsoil will be replaced. This approach will retain the nutrient rich sandy loam topsoil and provide clay subsoil for ditch plug construction. The depressions will offer increased surface storage, infiltration, and enhanced hydroperiod outside of the ditch corridors. The entire conservation easement will be heavily disked to breakup the plow layer, increase surface roughness, and promote infiltration.

HYDROLOGY ASSESSMENT

In order to determine suitable hydrology for the proposed 63.64 acre wetland restoration site, existing hydrologic conditions were evaluated through a water budget analysis. This water budget is a model for groundwater availability and potential drawdown for the proposed wetland. A watershed approach was applied and methods outlined in *Planning Hydrology for Constructed Wetlands* (Pierce, 1993) were followed.

The water budget presented in this report was determined from the following equation:

(2) $$S = P + R - ET - I.$$

Where S is storage, P is precipitation, R is runoff, ET is evapotranspiration, and I is infiltration (Pierce, 1993).

Precipitation

Daily precipitation data from the Enfield weather station has been compiled for a 31-year period of record from January 1, 1975 through December 31, 2005 (North Carolina State Climatologist). Average monthly precipitation values were then calculated from these data and applied to the water budget calculations.

Evapotranspiration

Three years of evapotranspiration data from the Peanut Belt Research Station (Lewiston) weather station was also compiled for this analysis (North Carolina State Climatologist). The Peanut Belt Research Station was used, as it is the closest station to the site with evapotranspiration records available.

Runoff Calculations

Runoff onto the wetland restoration area was determined by using the TR-55 Curve Number Method as described by Pierce 1993. This was done by first determining the amount of rainfall required over a 24-hour period to produce runoff (Q) for the drainage area. The drainage area was delineated using NCDOT topographic data for Halifax County, North Carolina.

The value of Q for the drainage area was then subtracted from daily precipitation values over the period of record. Those days that returned positive values (i.e. runoff occurred) were then summed to return the total amount of *runoff* (*R*) produced within the watershed area. The equation or equations for calculating runoff is as follows:

(3) $$Q = \frac{(P_{24} - 0.2S)^2}{(P_{24} + 0.8S)}$$

(4) $$S = \left(\frac{1000}{CN}\right) - 10$$

(5) $$Q = \frac{\left[P_{24} - 0.2\left(\left(\frac{1000}{CN}\right) - 10\right)\right]^2}{\left[P_{24} + 0.8\left(\left(\frac{1000}{CN}\right) - 10\right)\right]}$$

Where P_{24} is the maximum rainfall occurring in a 24-hour period (over the period of record), CN is the composite curve number, and S is the storage capacity of the soil. A composite curve was calculated by subdividing the watershed with respect to soil hydrologic group and land use then determining the appropriate curve number for each subdivision using tables published by the USDA (1986). The area and curve number was multiplied, summed and divided by the total watershed area to calculate the composite curve number as described below.

(6) $$CN = \frac{\sum(CN * SubdividedArea)}{(WatershedArea)}$$

By this method the composite curve number for the proposed wetland creation/enhancement site was 78.2.

A 24-hour rainfall record was determined using precipitation data. The maximum climatological-day precipitation (non-hurricane related) over the 30-year period of record occurred on June 16, 2001, with 3.67 inches of rainfall. Therefore P_{24} = 3.67 in.

The minimum rainfall needed to produce runoff (*Q*) was calculated using the above equation. As calculated: Q = 1.42

Using this value, the runoff produced by each rain event was calculated by subtracting the minimum 24-hour rainfall amount needed to produce runoff (Q) from the amount of precipitation (P) on each day. Those events that return positive values (i.e. runoff occurred) are then summed to return the amount of *runoff* (*R*) produced by each acre in the watershed. These values are then averaged by month for the entire period to give the average monthly runoff for the watershed. Once runoff values were calculated for the drainage area, it was necessary to adjust these values to reflect the amount of water seen on the site as follows:

(7) *R = (Watershed Runoff) * (Watershed Area) / (Site Area)*

Infiltration

The proposed wetland creation / enhancement area contains primarily Roanoke soils. Field investigations revealed that the existing soils have clay and sandy clay subsurface. Infiltration through the column will be minimal due to the clay texture and inherently difficult to estimate. For the purposes of this hydrologic evaluation it was assumed to be zero.

Hydrograph

The calculated data have been compiled and a hydrograph has been plotted illustrating the flow of water in and out of the proposed wetland construction area (Figure 8). These values are represented in acre-inches. Results of this analysis indicate that there is a period of drawdown during the months of April through July, similar to natural wet hardwood forest systems. These results also indicate that runoff will provide minimal inputs to the restoration area. However, direct precipitation and retention of water onsite will provide adequate wetland hydrology to the restored wetland area.

Ponded water in PC cropland

This water budget analysis was conducted to evaluate the existing hydrology of the proposed wetland restoration area and to determine if the proposed wetland design is appropriate for this site. The modeling presented in this report indicates that there is sufficient hydrology during the growing season (April 9 to October 23, NRCS 2001) to support wetland vegetation.

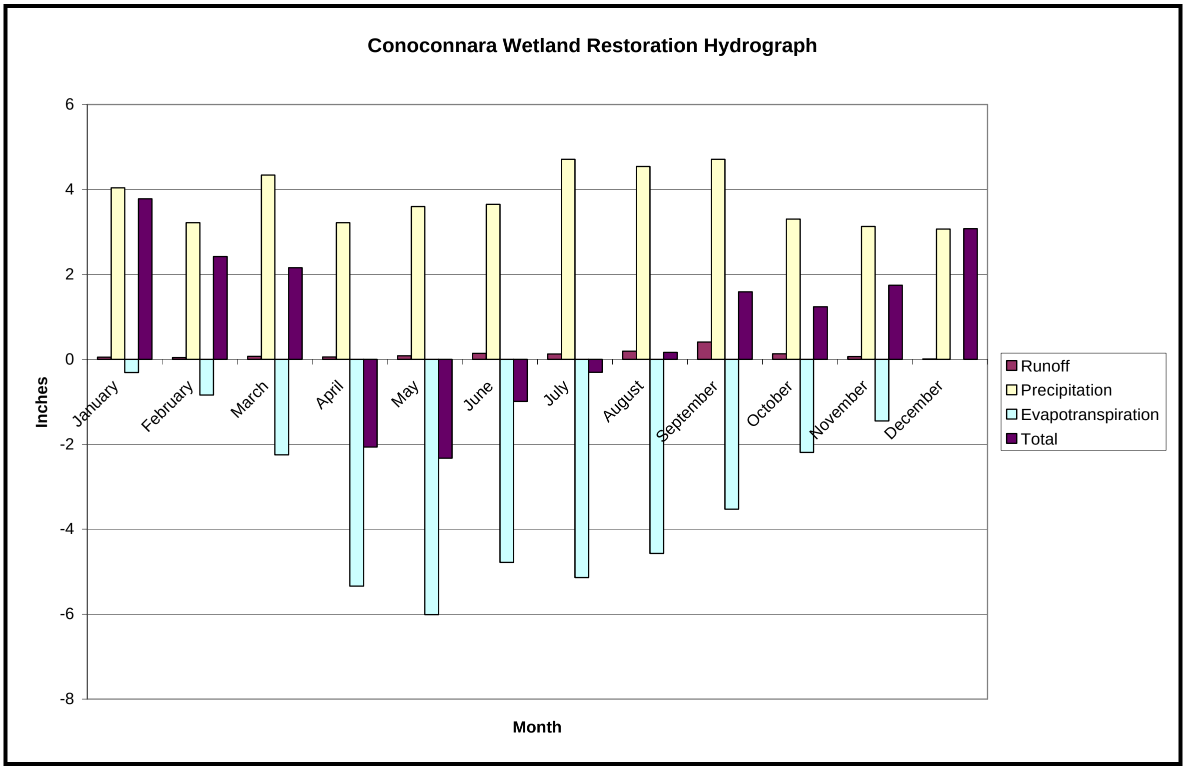


Figure 8. Wetland Restoration Hydrograph

PLANTING PLAN

Two planting areas will be delineated: an area of potential standing water or prolonged saturation near the plugged ditches and topographical lows; and adjacent upgradient wetland areas that may experience greater drawdown during dry periods (Figure 9). Species to be planted in each area are listed in Table 11, and are intended to restore communities comparable to the non-riverine wet hardwood forest as described by Schafale and Weakley (1990). Species selection was based on reference wetland vegetation, literature, and commercial availability. Plant materials will be primarily container-grown stock with supplemental bare-root stock as needed. The planting plan results in a minimum density of 435 trees per acre (TPA). A final density of 260 TPA is desired. Invasive species will be monitored and subsequent invasive species control will be undertaken as needed.

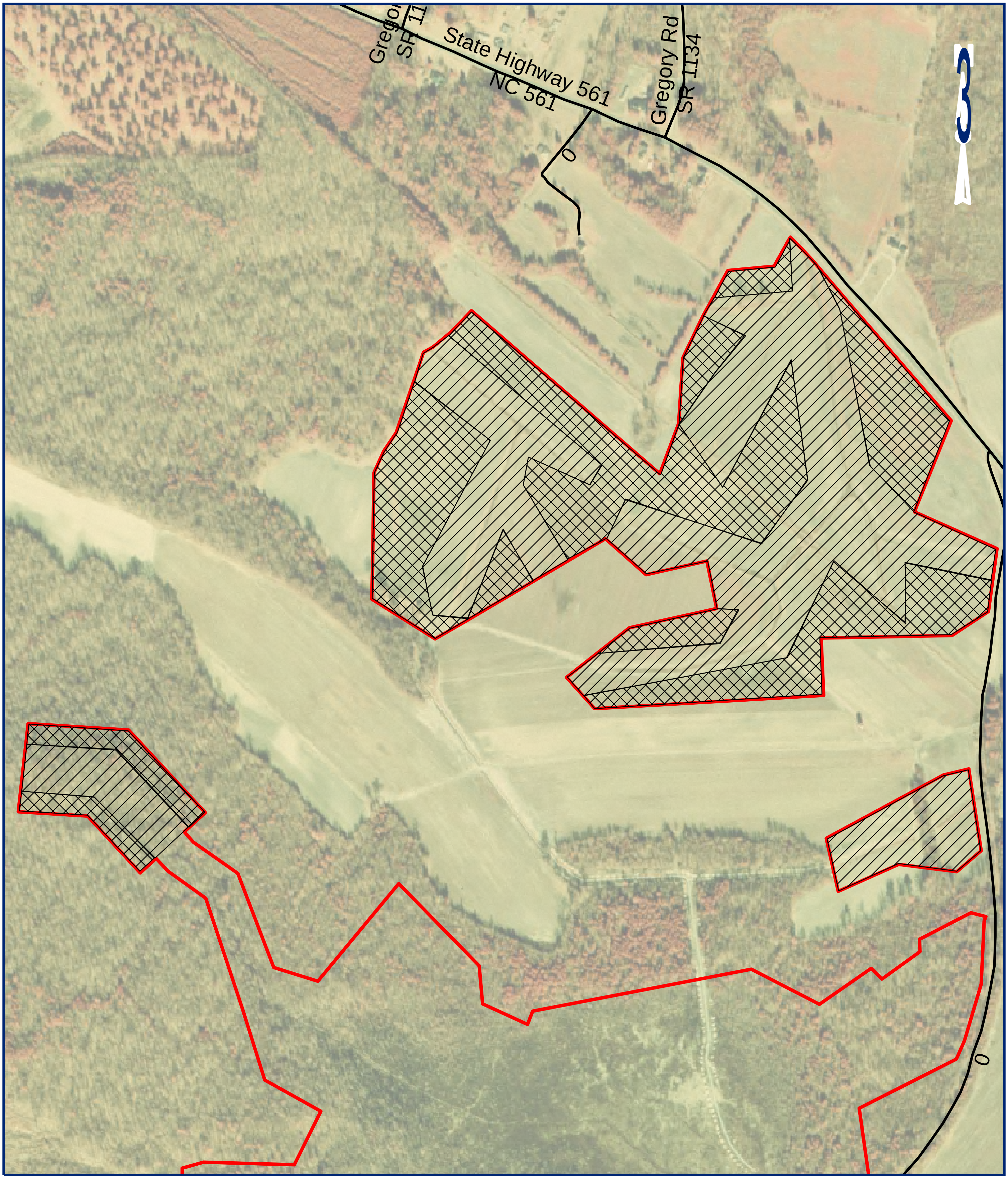


Figure 9.
Wetland Planting Zones
Conoconnara

0 150 300 600 900 1,200
Feet

SOURCES: NCDOT, USGS

LEGEND

Proposed Conservation Easement
Road
Zone 1 (saturated/inundated)
Zone 2 (saturated)

Table 11. Wetland Planting Plan

Species	Common Name
Zone 1 (saturated/inundated)	
Quercus phellos	Willow oak
Quercus nigra	Water oak
Platanus occidentalis	Sycamore
Fraxinus pennsylvanica	Green ash
Quercus laurifolia	Laurel oak
Nyssa biflora	Swamp blackgum
Carpinus caroliniana	Musclewood
Zone 2 (saturated)	
Liriodendron tulipifera	Tulip-poplar
Ulmus Americana	American elm
Quercus nigra	Water oak
Quercus pagodafolia	Cherrybark oak
Quercus phellos	Willow oak
Asimina triloba	Pawpaw
Nyssa sylvatica	Blackgum

A minimum of six raptor poles will be installed across the wetland restoration site to encourage predation of tree damaging rodents. The poles will be retrofitted power line poles or newly installed. The poles will be installed such that the entire area will be visible from a minimum of two poles or adjacent trees.

SOILS

As previously mentioned, WK Dickson performed 84 soil borings (Figure 4 and Appendix A) across the proposed restoration area and adjacent fields to verify soils mapping, quantify any fill material, and generally evaluate soil conditions. Soils were found to have both hydrological and soil modifications. Ditching and contouring from repeated agricultural tillage have modified the soils across the site. These modifications have resulted in increased surface drainage, increased lateral subsurface drainage, soil mixing, and dredge spoil spread across areas adjacent to the ditches. Hydric soil exists through a large portion of the proposed conservation easement. Subsurface textures were typically found to be sandy clay or clay. Soil profiles were evaluated for morphologic characteristics and divided into four mapping units for the site. These map units are;

- Soils currently showing hydric characteristics;
- Soils that will likely develop hydric characteristics after extended saturation;
- Soils that may develop hydric characteristics after extended saturation; and,
- Soil lacking hydric characteristics and that will most likely not develop hydric characteristics

Restoration of wetlands includes restoring saturated conditions to existing hydric soils. Using criteria based on "Field Indicators of Hydric Soils in the United States" (USDA, NRCS, 2006), 69 acres have been identified that currently show hydric characteristics within the easement boundary. These soils have soil matrix colors of 2 or less and common to many yellowish red to yellowish brown (5-YR 4/6 to 10-YR 5/8) mottles within the top 12 inches. These soils occupy the lowest part of the landscape and are often located around the current ditch system. These soils will be restored to wetlands when natural hydrology has been returned to the site.

The total wetland restoration easements are 82.85 acres and 5.36 acres (88.21 acres total). The total wetland restoration area is 69 acres. The 19.21 acres of non-hydric soil area are not proposed for restoration due to a lack of existing hydric soil. These non-hydric soil areas are located on the highest landscape positions and will serve as a buffer to the restored areas.

ENHANCEMENT SUMMARY

The proposed eight acres of non-riverine wetland enhancement will provide a forested non-riverine wet hardwood forest in the Looking Glass Run headwaters area immediately upstream of the stream restoration corridor. This area is currently a disturbed scrub-shrub community dominated by invasive early successional facultative species. The wetland enhancement will improve wildlife habitat by providing mast producing species and enhance water quality functions. The proposed enhancement treatments include applying a suitable broad spectrum foliar herbicide (i.e. Rodeo), allowing the herbicide to translocate to the root systems, and then clearing the standing vegetation at ground level. Stumps will be left in place to provide soil stabilization and organic matter. The wetland enhancement area will planted following the wetland restoration planting plan given above. Invasive species will be monitored and subsequent invasive species control will be undertaken as needed.

PRESERVATION SUMMARY

The proposed 71 acres of non-riverine wetland preservation will provide a continuous non-riverine wetland system grading into riverine wetlands and the stream restoration site. This approach will enhance wildlife habitat, wildlife passage, and water quality functions. The preservation area also serves as a reference wetland and is described in SECTION III EXISTING CONDITIONS and in SECTION V WETLAND RESTORATION PLAN REFERENCE WETLAND STUDIES.

VI. SUCCESS CRITERIA

The success criteria components will adhere to EEP and USACE guidelines. Specific success criteria are presented below.

STREAM RESTORATION SUCCESS CRITERIA

Bankfull Events

Two bankfull flow events must be documented within the 5-year monitoring period. The two bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years.

Cross Sections

There should be little change in as-built cross-sections. If changes do take place they should be evaluated to determine if they represent a movement toward a more unstable condition (for example down-cutting or erosion) or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross sections shall be classified using the Rosgen stream classification method and all monitored cross sections should fall within the quantitative parameters defined for channels of the design stream type. It should be noted that in sand bed channels, more variability in cross-sectional dimensions over time is expected than in channels with coarser boundary conditions.

Longitudinal Profiles

The longitudinal profiles should show that the bedform features remain generally stable, e.g. they are not aggrading or degrading. The pools should remain deep and the riffles should remain shallower than the pools. Bedforms observed should be consistent with those observed for channels of the design stream type. However, since the stream is a sand bed channel, all bedforms are expected to be dynamic.

Stream Vegetative Success Criteria

Specific and measurable success criteria for plant density within the riparian buffer on the site will be based on the recommendations found in the WRP Technical Note and correspondence from review agencies on mitigation sites approved under the Neu-Con Mitigation Banking Instrument.

The interim measure of vegetative success for the site will be the survival of at least 320 3-year old planted trees per acre at the end of year three of the monitoring period. The final vegetative success criteria will be the survival of 260 5-year old planted trees per acre at the end of year five of the monitoring period.

Digital Image Stations

Digital images will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation and effectiveness of erosion control measures. Longitudinal images should not indicate the absences of developing bars within the channel or an excessive increase in channel depth. Lateral images should not indicate excessive erosion or continuing degradation of the banks over time. A series of images over time should indicate successional maturation of riparian vegetation.

WETLAND RESTORATION SUCCESS CRITERIA

Hydrology

Successful establishment of wetland hydrology will be demonstrated by a wetland hydroperiod in excess of seven percent of one growing season at each groundwater gauge location. Gauge data will be compared to reference wetland well data in growing seasons with less than normal rainfall. In periods of low rainfall, if a restoration gauge hydroperiod exceeds the reference gauge hydroperiod and both exceed five percent of the growing season, then the gauge will be deemed successful.

If a gauge location fails to meet these success criteria in the five year monitoring period then monitoring may be extended, remedial actions may be undertaken, or groundwater modeling may be used to demonstrate the limits of wetland restoration.

Vegetation

Successful establishment of wetland vegetation will be the survival of 320 planted trees following year three monitoring and 260 planted trees following year five monitoring.

Digital Image Stations

Digital images will be used to subjectively evaluate the restoration site over time. A series of images over the five year monitoring period should demonstrate maturation of planted vegetation and volunteer hydrophytic species.

WETLAND ENHANCEMENT SUCCESS CRITERIA

Vegetation

Successful establishment of wetland vegetation will be the survival of 320 planted trees following year three monitoring and 260 planted trees following year five monitoring.

Digital Image Stations

Digital images will be used to subjectively evaluate enhancement site over time. A series of images over the five year monitoring period should demonstrate maturation of planted vegetation.

VII. MONITORING

Monitoring will follow current EEP guidelines and will be presented in annual reports. An as-built report (Mitigation Plan) documenting the entire project will be developed following completion of planting. The report will include elevations, photographs, sampling plot locations, and a description of initial species composition by community type, and gauge locations. The report will also include a list of the species planted and the associated densities.

STREAM RESTORATION MONITORING

The stream monitoring program will be implemented to document system development and progress toward achieving the success criteria. The monitoring program will be undertaken for 5 years or until the final success criteria are achieved, whichever is longer.

Bankfull Events

The occurrence of bankfull events within the monitoring period will be documented by the use of a crest gauge and photographs. The crest gauge will record the highest watermark between site visits, and the gauge will be checked each time there is a site visit to determine if a bankfull event has occurred. Digital images will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits. All crest gauges will be checked monthly.

Cross Sections

Two permanent cross sections will be installed per 1,000 linear feet of stream restoration work, with one located at a riffle cross section and one located at a pool cross section. Each cross section will be marked on both banks with permanent pins to establish the exact transect used. A common benchmark will be used for cross sections and consistently used to facilitate easy comparison of year-to-year data. The annual cross-section survey will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross sections will be classified using the Rosgen stream classification system.

Bed Material Analyses

The project stream reach is composed of bedforms in the sand size sediment fraction. Since the median grain size (D50) is similar to the analog reaches studied, it is unexpected that a substantial change will occur. Bulk samples will be collected and analyzed to determine any changes in substrate. Composite samples will be taken across the channel bottom at no less than 6 cross sections.

Longitudinal Profiles

A longitudinal profile will be completed in years one, three, and five of the monitoring period. The profile will be conducted for a representative length of restored channel. Measurements will include thalweg, water surface, bankfull, and top of low bank. Each of these measurements will be taken at the head of each feature, for example, shallow, pool, and the max pool depth. The survey will be tied to a permanent benchmark.

Vegetative Monitoring

In order to determine if the success criteria are achieved, vegetation-monitoring stations will be installed on approximately 2 percent of the restoration site. The size of individual monitoring plots will be $100m^2$. Vegetation monitoring will occur in spring after leaf-out has occurred. Individual plot data for woody species will be provided. Permanent plots for the sampling of planted species will be systematically distributed across the restoration area with the specific plot location and orientation assigned randomly. The enumeration of the density of planted species will equal the number of remaining stems in the plot divided by the plot size in acres. Individual planted trees will be marked with a 4-foot PVC stake and aluminum tag such that they can be identified in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living planted seedlings and the current year's living planted seedlings.

At the end of the first growing season, species composition, density, and survival will be evaluated. For each subsequent year, until the final success criteria is achieved, the restored site will be evaluated between July and November.

Digital Image Stations

Digital images will be used to visually document restoration success. Reference stations will be imaged before construction and continued for at least five years following construction. Reference images will be taken once a year. After construction has taken place, reference stations will be marked with wooden stakes.

Lateral reference images. Reference image transects will be taken at each permanent cross section. Images will be taken of both banks at each cross section. The survey tape will be centered in the images of the bank. The water line will be located in the lower edge of the frame and as much of the bank as possible included in each image. Survey personnel should make an effort to consistently maintain the same area in each image over time.

Structure images. Images will be taken at each grade control structure along the restored stream. Survey personnel should make every effort to consistently maintain the same area in each image over time.

Benthic Macroinvertebrates and Fish Sampling

No benthic macro-invertebrate or fish sampling is required on the restored site at this time. Should sampling eventually be required by the review agencies, appropriate sampling methodologies and success criteria will be implemented based on those accepted and approved by the review agencies.

WETLAND RESTORATION MONITORING

The wetland monitoring program will be implemented to document system development and progress toward achieving the success criteria. The monitoring program will be undertaken for 5 years or until the final success criteria are achieved, whichever is longer.

Hydrology Monitoring

Hydrology monitoring will consist of automatic recording groundwater gauges, manual groundwater gauges, on-site rain gauge, and reference wetland automatic recording groundwater gauge. The groundwater gauges will be installed to provide uniform coverage over the restoration site. Manual gauges will be correlated to adjacent automatic gauges with regression equations to determine daily water table elevations. All groundwater gauges and rain gauges will be visited monthly to download data, record water table elevation, and perform routine maintenance.

Following each growing season all gauge data will be compiled into hydroperiod charts and included in the annual monitoring report. The monthly rainfall data will be compared with the 30-year average to determine abnormally high or low rainfall, and presented in the annual monitoring report.

Vegetative Monitoring

In order to determine if the success criteria are achieved, vegetation-monitoring stations will be installed on approximately 2 percent of the restoration site. The size of individual monitoring plots will be 100m^2. Vegetation monitoring will occur in spring after leaf-out has occurred. Individual plot data for woody species will be provided. Permanent plots for the sampling of planted species will be systematically distributed across the restoration area with the specific plot location and orientation assigned randomly. The enumeration of the density of planted species will equal the number of remaining stems in the plot divided by the plot size in acres. Individual planted trees will be marked with a 4-foot PVC stake and aluminum tag such that they can be identified in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living planted seedlings and the current year's living planted seedlings.

At the end of the first growing season, species composition, density, and survival will be evaluated. For each subsequent year, until the final success criteria is achieved, the restored site will be evaluated between July and November.

Digital Image Stations

Digital images will be used to visually document restoration success. Reference stations will be imaged before construction and continued for at least five years following construction. Reference images will be taken once a year. After construction has taken place, reference stations will be marked with wooden stakes.

WETLAND ENHANCEMENT MONITORING

The wetland enhancement monitoring program will be undertaken for 5 years or until the final success criteria are achieved, whichever is longer.

Vegetative Monitoring

In order to determine if the success criteria are achieved, vegetation-monitoring stations will be installed on approximately 2 percent of the enhancement area. The size of individual monitoring plots will be $100m^2$. Vegetation monitoring will occur in spring after leaf-out has occurred. Individual plot data for woody species will be provided. Permanent plots for the sampling of planted species will be systematically distributed across the enhancement area with the specific plot location and orientation assigned randomly. The enumeration of the density of planted species will equal the number of remaining stems in the plot divided by the plot size in acres. Individual planted trees will be marked with a 4-foot PVC stake and aluminum tag such that they can be identified in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living planted seedlings and the current year's living planted seedlings.

At the end of the first growing season, species composition, density, and survival will be evaluated. For each subsequent year, until the final success criteria is achieved, the restored site will be evaluated between July and November.

Digital Image Stations

Digital images will be used to visually document enhancement success. Reference stations will be imaged before construction and continued for at least five years following construction. Reference images will be taken once a year. After construction has taken place, reference stations will be marked with wooden stakes.

REMEDIAL ACTIONS

In the event that the site or a specific component of the site fails to achieve the defined success criteria, EBX will develop necessary adaptive management plans and/or implement appropriate remedial actions for the site in coordination with the review agencies. Remedial action required by the review agencies will be designed to achieve the success criteria specified previously, and shall include a work schedule and monitoring criteria that will take into account physical and climactic conditions.

VIII. CONCLUSIONS

As originally conceived, the Conoconnara Restoration Project was intended to provide 5,000 stream mitigation units and 87 wetland mitigation units. The stream mitigation design presented herein provides a total of 5,073 linear feet of stream restoration. The wetland mitigation design presented herein provides 69 acres of restoration, eight acres of enhancement, and 71 acres of preservation (87 wetland mitigation units). Additional wetland mitigation units may be available through preservation and additional restoration. EBX-Neuse I, LLC has purchased conservation easement on the restoration, enhancement, and preservation sites. The easement includes a minimum 50-foot buffer on the stream restoration site outside of the total belt width. The easement limits will be clearly marked with marker posts, signage, or other appropriate means. No fencing is anticipated as no livestock operations are located on the property. Crossings shown on the plans will be retained as assets within the easement.

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Boring	Start Depth	End Depth	Matrix	Mottle	Mottle Description	Texture	Hydric
1	0	8	10YR5/8			Sandy Loam	No
	8	20	10YR6/6	7.5YR5/8		Clay Loam	
	20	30	10YR5/8	10YR6/3		Clay Loam	
2	0	2	10YR4/4			Organic	No
	2	8	10YR4/4	10YR6/3		Sandy Loam	
	8	16	2.5Y7/4	10YR6/8		Sandy Loam	
	16	20	10YR6/8	2.5Y7/4		Clay	
3	0	4	2.5Y5/3			Sandy Loam	No
	4	8	2.5Y5/3	10YR5/8		Sandy Loam	
	8	14	2.5Y6/4	10YR5/8		Sandy Clay	
	14	24	2.5Y7/3	10YR5/8		Clay	
4	0	4	2.5Y5/3			Sandy Loam	No
	4	18	2.5Y6/4	10YR5/8		Clay Loam	
	18	20	10YR6/2	10YR5/8		Clay	
5	0	8	2.5Y5/3			Clay	Yes
	8	24	2.5Y7/1	10YR5/8		Clay	
6	0	8	2.5Y5/3			Sandy Loam	Yes
	8	24	2.5Y7/1	10YR5/8		Clay	
7	0	8	2.5Y5/3			Sandy Loam	No
	8	20	2.5Y7/3	10YR5/8		Sandy Clay	
	20	24	2.5Y7/2	10YR5/8		Sandy Clay	
8	0	8	2.5Y5/3			Clay Loam	Yes
	8	24	2.5Y6/1	10YR5/8		Clay	
9	0	8	2.5Y5/3			Sandy Loam	Yes
	8	24	2.5Y6/1	10YR5/8		Clay	
10	0	4	2.5Y5/3			Sandy Loam	No
	4	16	2.5Y6/4	10YR5/8	Large, many	Clay	
	16	30	2.5Y7/2	10YR5/8	Large, many	Clay	
11	0	8	2.5Y5/3			Sandy Loam	No
	8	16	2.5Y6/4	10YR5/8	Small, Few	Sandy Clay	
	16	28	10YR6/4	10YR5/8	Large, many	Sandy Clay	
	28	30	2.5Y6/1	10YR5/8	Large, many	Clay	
12	0	6	2.5Y5/3			Sandy Loam	No
	6	16	2.5Y6/4	10YR5/8	Small, Few	Sandy Clay	
	16	24	2.5Y6/1	10YR5/8	Small, Few	Clay	
13	0	8	2.5Y5/3			Sandy Loam	Yes
	8	24	2.5Y6/1	5YR4/6	Small, Few	Clay	
14	0	6	10YR4/4			Sandy Loam	No
	6	24	10YR4/4			Clay	
15	0	8	2.5Y5/3			Sandy Loam	No
	8	24	2.5Y6/3	10YR5/8	Large, many	Clay	
16	0	8	2.5Y5/3			Sandy Loam	No
	8	24	2.5Y6/3	10YR5/8	Large, many	Clay	
17	0	8	10YR4/4			Sandy Loam	No
	8	24	10YR4/4			Clay	
18	0	8	10YR4/4			Sandy Loam	No
	8	35	10YR4/4			Clay	

Boring	Start Depth	End Depth	Matrix	Mottle	Mottle Description	Texture	Hydric
19	0	10	2.5Y5/3			Sandy Loam	No
	10	24	2.5Y4/4			Sandy Loam	
	24	30	2.5Y6/4			Sandy Loam	
20	0	24	10YR4/4			Sandy Loam	No
21	0	30	7.5YR5/6			Clay Loam	
22	0	12	10YR6/2	10YR5/8	Medium, many	Clay	Yes
	12	18	10YR6/2	10YR5/8	Medium, many	Sandy Clay	
	18	24	2.5Y7/1	10YR5/8	Medium, many	Sandy Clay	
23	0	8	10YR5/6			Sandy Loam	No
	8	30	10YR5/6			Sandy Clay	
24	0	15	10YR6/2	10YR5/8	Medium, many	Sandy Clay	Yes
	15	30	10YR6/2	10YR5/8	Medium, many	Clay	
25	0	6	2.5Y5/3			Sandy Loam	Yes
	6	30	10YR6/1	10YR5/8	Medium, many	Clay	
26	0	6	2.5Y5/3			Sandy Loam	Yes
	6	24	10YR6/1	10YR5/8		Clay	
27	0	4	2.5Y5/3			Sandy Loam	No
	4	15	2.5Y6/6			Sandy Clay	
	15	24	2.5Y6/6	10YR5/8	Large, many	Clay	
28	0	4	2.5Y5/3			Sandy Loam	No
	4	15	2.5Y6/6			Sandy Clay	
	15	24	2.5Y6/6	10YR5/8	Large, many	Clay	
29	0	8	2.5Y5/3			Sandy Clay	Yes
	8	10	2.5Y5/3	10YR5/8	Medium, many	Clay	
	10	24	10YR6/2	10YR5/8	Medium, many	Clay	
30	0	7	10YR4/3			Sandy Clay Loam	No
	7	14	10YR5/3	10YR5/8	Small, few	Sandy Clay	
	14	30	10YR6/1	5YR5/8	Medium, many	Clay	
31	0	6	10YR4/3			Sandy Clay	Yes
	6	9	10YR5/2	7.5YR4/6	Small, common	Clay	
	9	20	10YR5/1	7.5YR5/8	Medium, common	Clay	
32	0	9	10YR4/3	7.5YR5/8	Small, few	Sandy Clay	Yes
	9	20	10YR6/1	10YR5/8	Medium, common	Clay	
33	0	5	10YR4/3	10YR5/8	Small, few	Sandy Clay	Yes
	5	10	10YR4/3	10YR5/8	Small, many	Clay	
	10	20	10YR5/1	7.5YR5/8	Medium, common	Clay	
34	0	8	10YR4/3			Sandy Clay Loam	No
	8	16	10YR5/3	10YR5/8	Medium, common	Clay	
	16	30	7.5YR5/8	10YR5/1	Medium, many	Clay	
	30	34	10YR5/1	7.5YR5/8	Medium, many	Clay	
35	0	8	10YR4/3			Clay Loam	Yes
	8	18	10YR6/1	7.5YR5/8	Medium, many	Clay	
36	0	7	10YR4/3	7.5YR5/8	Medium, common	Sandy Clay	Yes
	7	14	10YR5/2	7.5YR5/8	Medium, many	Clay	
	14	20	10YR6/1			Clay	

Boring	Start Depth	End Depth	Matrix	Mottle	Mottle Description	Texture	Hydric
37	0	6	10YR5/6			Sandy Clay	Yes
	6	16	10YR5/2	10YR5/8	Small, many	Clay	
	16	24	10YR5/1	10YR5/8	Medium, common	Clay	
38	0	8	10YR4/3			Sandy Clay Loam	Yes
	8	20	10YR5/1	10YR5/4	Medium, many	Sandy Clay	
	20	30	10YR5/1	10YR5/8	Medium, many	Clay	
39	0	7	10YR4/4			Sandy Loam	No
	7	20	10YR5/3	7.5YR5/8	Medium,common	Sandy Clay	
40	0	8	10YR4/3			Sandy Clay	No
	8	14	10YR5/3	10YR5/8	Medium, few	Sandy Clay	
	14	20	10YR5/1	10YR5/8	Medium, common	Clay	
41	0	9	10YR4/3			Sandy Clay	Yes
	9	20	10YR5/1	7.5YR5/8	Medium, common	Clay	
42	0	11	7.5YR 5/4			Sandy Loam	No
	11	18	10YR 5/4	10YR 6/2	Medium, 25%	Sandy Clay	
	18	22	10YR 5/4	7.5YR 5/8	40%	Clay	
43	0	12	7.5YR 4/3			Sandy Loam	No
	12	35	10YR 6/3	7.5YR 5/8	35%	Sandy Clay Loam	
				7.5YR 2.5/1	5%		
	35	37	10YR 7/1	10YR 5/8	Fine, Medium, 20%	Clay	
44	0	10	10YR 6/1	10YR 6/3	Fine, Medium, 15%	Sandy Clay Loam	Yes
	10	24	10YR 6/1	10YR 5/8	Fine, Medium, 15%	Sandy Clay	
45	0	11	10YR 4/3			Sandy Loam	Yes
	11	18	7.5YR 6/2	7.5YR 5/6	Fine, Medium,45%	Clay	
	18	28	7.5YR 6/1	7.5YR 5/8	Medium, 30%	Sandy Clay	
46	1	10	10YR 4/3			Sandy Clay Loam	Yes
	10	25	7.5YR 6/1	7.5YR 5/6	Fine, Medium, 30%	Clay	
47	0	12	10YR 5/3			Sandy Loam	No
	12	18	7.5YR 5/3	7.5YR 5/2	Fine, Medium, 20%	Clay	
				7.5YR 5/6	Fine, Medium, 25%		
	18	27	7.5YR 5/8	7.5YR 7/1	Fine, 35%	Clay	
48	0	7				Sandy Loam	No
	7	15	10YR 5/6			Clay	
49	0	9				Sandy Loam	No
	9	18	10YR 5/6	10YR 5/3			
				10YR 6/3			
50	0	8	7.5YR 5/3			Sandy Loam	No
	8	13	7.5YR 5/6	7.5YR 4/6	Fine, 3%	Sandy Clay Loam	
				7.5YR 6/2	Fine, 5%		
	13	24	7.5YR 7/1	7.5YR 5/8	Fine, Medium, 10%	Clay	
				7.5YR 5/6	Fine, Medium, 15%		
51	0	10	10YR 4/3			Sandy Loam	No
	10	20	10YR 4/6	10YR 5/6	Medium, 30%	Sandy Loam	
52	0	10	10YR 5/4			Sandy Loam	No
	10	23	7.5YR 5/6	10YR 5/6	Medium, 5%	Sand	
	23	27	7.5YR 7/3	7.5YR 5/8	Fine, Medium, 15%	Sandy Clay Loam	
53	0	9	10YR 5/3			Sandy Loam	Yes
	9	23	7.5YR 6/1	7.5YR 5/8	Fine, 20%	Sandy Clay Loam	

Boring	Start Depth	End Depth	Matrix	Mottle	Mottle Description	Texture	Hydric
54	0	9	7.5YR 5/3	7.5YR 6/3	Fine, 20%	Sandy Loam	Yes
	9	24	7.5YR 6/1	7.5YR 5/8	Fine, Medium, 40%	Clay	
55	0	8	10YR 5/4	10YR 2/1	Fine, 3%	Sandy Loam	Yes
	8	12	7.5YR 6/3	7.5YR 6/6	Fine, 8%	Sandy Loam	
	12	18	7.5YR 6/1	7.5YR 4/6	Medium, 45%	Sandy Clay	
	18	23	7.5YR 6/1	7.5YR 5/8	Medium, Coarse, 45%	Sandy Clay	
56	0	7	7.5YR 4/3			Sandy Loam	No
	7	16	7.5YR 4/3	7.5YR 6/2	Medium, 30%	Sandy Loam	
				7.5YR 5/6	Fine, 5%		
	16	23	7.5YR 6/2	7.5YR 5/3	Fine, Medium, 25%	Sandy Loam	
				7.5YR 5/8	Fine, 5%		
57	0	9	7.5YR 4/2			Sandy Loam	Yes
	9	15	7.5YR 5/1	7.5YR 4/2	Fine, 5%	Sandy Loam	
	15	24	7.5YR 5/8	7.5YR 6/1	Medium, 45%	Sandy Clay	
58	0	10	7.5YR 5/3			Sandy Loam	No
	10	20	7.5YR 5/6	7.5YR 6/4	Medium, 20%	Sandy Loam	
	20	25	7.5YR 5/6	7.5YR 4/6	Medium, 10%	Sandy Clay Loam	
				7.5YR 6/1	Fine, Medium, 25%		
				7.5YR 2.5/1	Coarse, 10%		
59	0	9	7.5YR 5/2	7.5YR 5/8	Fine, Medium, 15%	Sandy Loam	Yes
	9	16	7.5YR 6/1	7.5YR 5/8	Medium, 20%	Sandy Clay Loam	
	16	23	7.5YR 7/1	7.5YR 5/8	Medium, 20%	Sandy Clay	
60	0	7	10YR 5/4			Sandy Loam	No
	7	14	7.5YR 5/6	7.5YR 4/6	Fine, 10%	Sandy Loam	
	14	19	7.5YR 5/6	7.5YR 6/1	Medium, 45%	Sandy Clay	
61	0	7	10YR 5/3			Sandy Loam	No
	7	17	10YR 5/3	7.5YR 5/8	Fine, 10%	Sandy Clay Loam	
	17	22	7.5YR 5/8	7.5YR 6/1	Medium, 30%	Sandy Clay	
62	0	6	10YR 4/3			Sandy Loam	No
	6	15	10YR 4/4	10YR 4/3	Fine, 10%	Sandy Loam	
	15	25	10YR 5/1	10YR 5/6	Fine, Medium, 35%	Sandy Clay	
63	0	8	10YR 5/1	10YR 4/3	Fine, 10%	Sandy Loam	Yes
				7.5YR 4/6	Medium, 5%		
	8	15	7.5YR 5/1	7.5YR 4/6	Medium, 40%	Clay	
	15	24	7.5YR 6/1	7.5YR 5/8	Fine, Medium, 20%	Clay	
64	0	9	7.5YR 4/2	7.5YR 5/6	Fine, 2%	Sandy Loam	Yes
	9	19	7.5YR 6/2	7.5YR 5/8	Medium, 35%	Sandy Clay Loam	
	19	25	7.5YR 7/1	7.5YR 5/8	Fine, Medium, 40%	Sandy Clay	
65	0	7	7.5YR 5/2			Sandy Loam	Yes
	7	16	7.5YR 5/2	7.5YR 5/8	Medium, 35%	Sandy Clay Loam	
	16	24	7.5YR 6/1	7.5YR 5/6	Fine, Medium, Coarse, 40%	Sandy Clay	
66	0	7	10YR 5/3	7.5YR 4/6	Fine, Medium, 20%	Sandy Clay Loam	No
	7	16	7.5YR 5/6	7.5YR 7/1	Fine, Medium, 20%	Sandy Clay	
	16	27	7.5YR 6/1	7.5YR 5/8	Fine, Medium, 40%	Sandy Clay	
67	0	8	7.5YR 4/2	7.5YR 3/4	Fine, Medium, 10%	Clay	Yes
				7.5YR 2.5/1	Fine, 5%		
	8	19	7.5YR 6/1	7.5YR 5/6	Fine, 10%	Clay	
				7.5YR 2.5/1	Fine, Medium, 10%		
	19	27	7.5YR 5/1	7.5YR 5/6	Fine, 10%	Clay	
				7.5YR 2.5/1	Fine, 3%		

Boring	Start Depth	End Depth	Matrix	Mottle	Mottle Description	Texture	Hydric
68	0	13	10YR 4/3			Sandy Loam	No
	13	18	7.5YR 5/6	7.5YR 7/2	Medium, 40%	Sandy Clay	
	18	23	7.5YR 4/6	7.5YR 7/1	Fine, Medium, 15%	Sandy Clay	
				7.5YR 3/4	Fine, Medium, 10%		
69	0	8	7.5YR 6/3	7.5YR 5/6	Fine, Medium, 20%	Sandy Clay	Yes
				7.5YR 6/1	Fine, 5%		
	8	24	7.5YR 6/2	7.5YR 5/8	Fine, Medium, 45%	Clay	
70	0	7	7.5YR 5/2			Sandy Loam	Yes
	7	15	7.5YR 6/2	7.5YR 5/6	Medium, 30%	Sandy Clay	
	15	24	7.5YR 6/1	7.5YR 5/6	Medium, 25%	Clay	
71	0	9	7.5YR 4/4	7.5YR 5/8	Fine, 15%	Clay Loam	Yes
	9	21	7.5YR 7/2	7.5YR 5/6	Fine, Medium, 45%	Clay	
72	0	9	7.5YR 5/4			Sandy Loam	No
	9	17	7.5YR 6/3	7.5YR 5/6	Medium, 5%	Sandy Clay Loam	
				7.5YR 4/3	Fine, Medium, 15%		
				7.5YR 2.5/1	Fine, 3%		
	17	29	7.5YR 7/1	7.5YR 5/8	Fine, Medium, 25%	Sandy Clay	
				7.5YR 5/6	Medium, 10%		
				7.5YR 2.5/1	Medium, Coarse, 10%		
73	0	6	7.5YR 5/3			Sandy Loam	No
	6	12	7.5YR 5/3	7.5YR 5/6	Fine, Medium, 20%	Clay Loam	
	12	19	7.5YR 6/3	7.5YR 5/6	Fine, Medium, 35%	Clay	
				7.5YR 2.5/1	Medium, 5%		
	19	24	7.5YR 6/3	7.5YR 7/2	Medium, 15%	Clay	
				7.5YR 5/8	Fine, Medium, 25%		
				7.5YR 2.5/1	Medium, 10%		
74	0	6	7.5YR 5/2	7.5YR 6/2	Fine, 10%	Sandy Loam	Yes
				7.5YR 5/6	Fine, 15%		
	6	15	7.5YR 6/2	7.5YR 5/8	Fine, Medium, 15%	Clay	
	15	28	7.5YR 6/1	7.5YR 5/8	Fine, Medium, 40%	Clay	
				7.5YR 2.5/1	Medium, Coarse, 5%		
75	0	6	7.5YR 5/4			Sandy Loam	Yes
	6	15	7.5YR 7/1	7.5YR 5/8	Medium, 5%	Sandy Clay Loam	
	15	26	7.5YR 6/1	7.5YR 5/8	Medium, 40%	Sandy Clay	
76	0	8	7.5YR 5/4			Sandy Loam	No
	8	17	7.5YR 5/6			Sandy Clay Loam	
77	0	6	7.5YR 4/3			Sandy Loam	No
	6	24	7.5YR 5/6	7.5YR 5/8	Fine, 10%	Clay	
				7.5YR 6/2	Fine, Medium, 30%		
78	0	10	7.5YR 5/4			Sandy Clay Loam	Yes
	10	23	7.5YR 6/1	7.5YR 5/6	Medium, 45%	Sandy Clay	
79	0	7	7.5YR 4/4			Sandy Loam	Yes
	7	24	7.5YR 6/1	7.5YR 5/8	Fine, Medium, 35%	Clay	
80	0	8	7.5YR 5/3			Sandy Loam	Yes
	8	12	7.5YR 6/1	7.5YR 5/6	Medium, 40%	Sandy Clay	
	12	24	7.5YR 5/6	7.5YR 6/1	Medium, 40%	Clay	
				7.5YR 5/8	Fine, 5%		
81	0	6	7.5YR 4/3			Clay Loam	Yes
	6	17	7.5YR 7/1	7.5YR 5/8	Fine, Medium, 25%	Clay	

Boring	Start Depth	End Depth	Matrix	Mottle	Mottle Description	Texture	Hydric
82	0	12	7.5YR 5/4			Sandy Loam	No
	12	17	7.5YR 5/6	7.5YR 5/8	Fine, 5%	Sandy Clay Loam	
83	0	6	10YR 4/3			Clay Loam	Yes
	6	26	10YR 6/1	7.5YR 5/6	Fine, 20%	Clay	
84	0	6	7.5YR 5/4			Clay Loam	No
	6	24	7.5YR 6/4	7.5YR 5/8	Fine, Medium, 25%	Clay	
				7.5YR 2.5/1	Medium, Coarse, 12%		
				7.5YR 6/2	Fine, 5%		
				7.5YR 5/6	Fine, Medium, 15%		

USGS Gages in Conoconarra Vicinity with Drainage Area Less Then 10 Square Miles

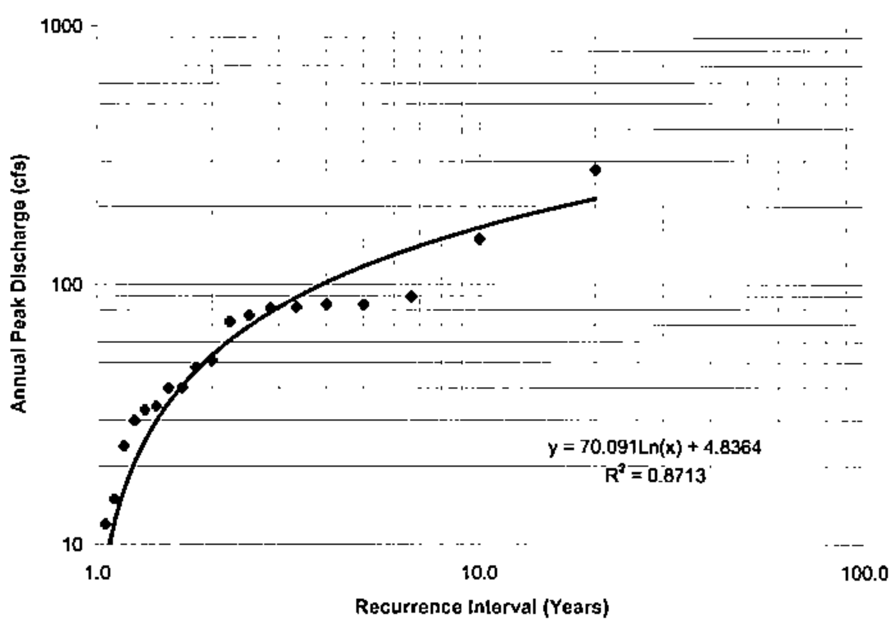
Site Number	Site Name	County	HUC	Drainage	Peak flow data begin date	Peak flow data end date	Peak flow data count
2053110	WILDCAT SWAMP NEAR JACKSON, NC	131	3010204	0.69	3/2/1953	1/5/1971	19
2083090	BEAVERDAM SWAMP NEAR HEATHSVILLE, NC	83	3020102	9.44	4/13/1953	2/9/1971	19
2053510	AHOSKIE CREEK TRIBUTARY AT POORTOWN, NC	91	3010203	2.6	9/13/1964	2/2/1973	10
2053550	CHINKAPIN CREEK NEAR COLERAIN, NC	15	3010203	8.9	6/15/1953	2/13/1971	19
2081060	SMITHWICK CREEK TRIBUTARY NR WILLIAMSTON, NC	117	3010107	0.92	1953-03-00	3/3/1971	19
2082630	HARTS MILL RUN NEAR TARBORO, NC	65	3020101	8.58	6/23/1953	3/4/1971	19
2084070	GREEN MILL RN AT ARLINGTON BLVD AT GREENVILLE, NC	147	3020103	9.1	8/10/1951	2/12/1985	35
2084164	JUNIPER BRANCH AT SR1766 NR SIMPSON, NC	147	3020103	7.5	1/28/1976	11/30/1985	11
2088210	HANNAH CREEK NEAR BENSON, NC	101	3020201	2.59	1953-06-00	3/4/1971	19
2088420	LONG BRANCH NEAR SELMA, NC	101	3020201	7.64	3/12/1953	3/4/1971	19
2090560	LEE SWAMP TRIBUTARY NR LUCAMA, NC	195	3020203	2.83	6/22/1953	3/4/1971	19
2090780	WHITEOAK SWAMP TRIBUTARY NR WILSON, NC	195	3020203	2.6	5/7/1953	3/4/1971	19
2091430	SHEPHERD RUN NEAR SNOW HILL, NC	79	3020203	1.47	1953-04-00	3/4/1971	19

Agency	Site Number	Site Name	From	To	Count
USGS	2053110	WILDCAT SWAMP NEAR JACKSON, NC	3/2/1953	1/5/1971	19

Northampton County, North Carolina
Hydrologic Unit Code 03010204
Latitude 36°25'48", Longitude 77°22'24" NAD27
Drainage area 0.69 square miles

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1958	7-May-58	25.97	1	278	20.0
1960	Sep. 12, 1960	25.8	2	150	10.0
1965	Dec. 27, 1964	24.93	3	90	6.7
1957	Feb. 05, 1957	24.61	4	84	5.0
1968	Jan. 14, 1968	24.64	5	84	4.0
1971	Jan. 05, 1971	24.54	6	82	3.3
1954	24-May-54	24.44	7	81	2.9
1962	Jul. 16, 1962	24.27	8	76	2.5
1969	Aug. 05, 1969	24.17	9	72	2.2
1956	6-May-56	23.27	10	51	2.0
1963	21-May-63	23.17	11	48	1.8
1964	Sep. 13, 1964		12	40.02	1.7
1961	Aug. 20, 1961	22.94	13	40	1.5
1959	Apr. 13, 1959	22.75	14	34	1.4
1955	Aug. 12, 1955	22.73	15	33	1.3
1966	Feb. 24, 1966	22.66	16	30	1.3
1970	Apr. 14, 1970	22.46	17	24	1.2
1967	Aug. 22, 1967	22.16	18	15	1.1
1953	Mar. 02, 1953	22.04	19	12	1.1

n= 19
$Q_{2.33}$ = 64 cfs

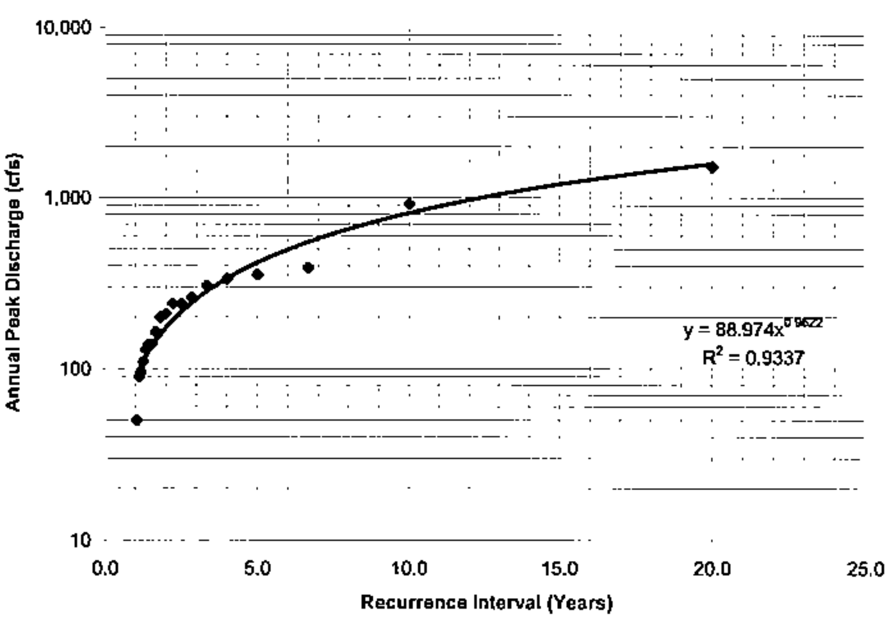


Agency	Site Number	Site Name	From	To	Count
USGS	2083090	BEAVERDAM SWAMP NEAR	4/13/1953	2/9/1971	19

Halifax County, North Carolina
Hydrologic Unit Code 03020102
Latitude 36°16'49", Longitude 77°41'48" NAD27
Drainage area 9.44 square miles

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1958	6-May-58	23.14	1	1,520	20.0
1960	Sep. 12, 1960	21.87	2	920	10.0
1956	Mar. 16, 1956	20.34	3	390	6.7
1954	Jan. 26, 1954	20.23	4	355	5.0
1965	Aug. 01, 1965	20.18	5	335	4.0
1968	Jun. 11, 1968	20.06	6	305	3.3
1967	Aug. 24, 1967	19.88	7	260	2.9
1955	Sep. 19, 1955	19.79	8	240	2.5
1962	Jan. 06, 1962	19.78	9	240	2.2
1959	Dec. 29, 1958	19.64	10	210	2.0
1961	11-May-61	19.62	11	200	1.8
1969	Aug. 05, 1969	19.43	12	164	1.7
1971	Feb. 09, 1971	19.31	13	140	1.5
1966	Feb. 28, 1966	19.29	14	138	1.4
1964	Sep. 13, 1964	19.25	15	130	1.3
1970	Apr. 14, 1970	19.12	16	110	1.3
1957	1957	19	17	95	1.2
1963	Mar. 17, 1963	19.02	18	90	1.1
1953	Apr. 13, 1953	18.61	19	50	1.1

n= 19
$Q_{2.33}$ = 201 cfs

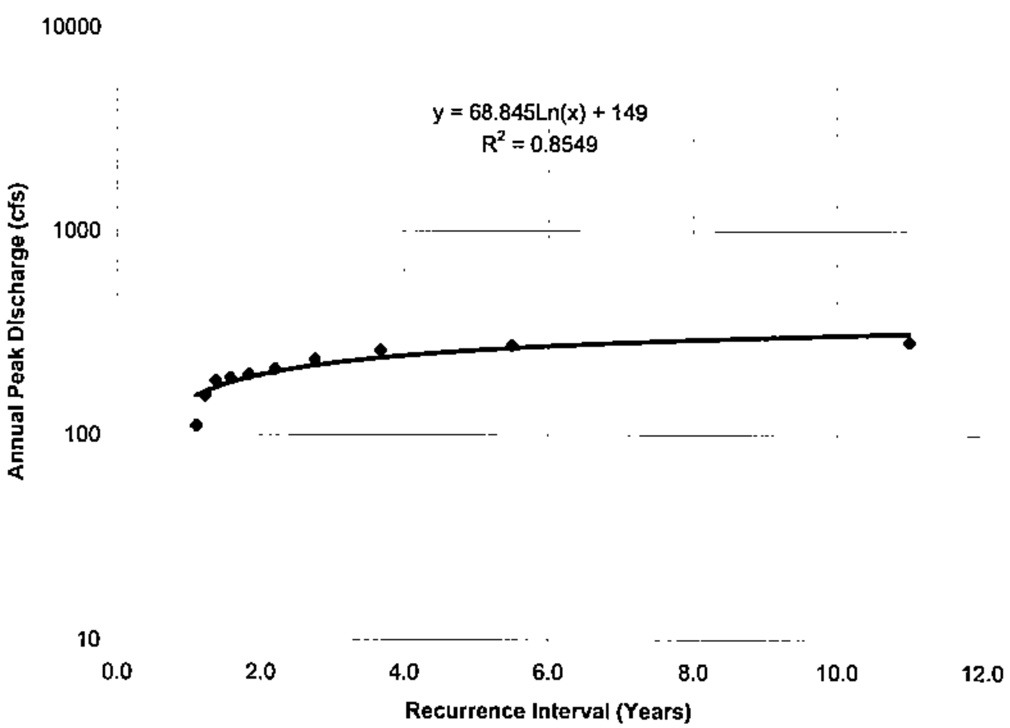


Agency	Site Number	Site Name	From	To	Count
USGS	2053510	AHOSKIE CREEK TRIBUTAR	9/13/1964	2/2/1973	10

Hertford County, North Carolina
Hydrologic Unit Code 03010203
Latitude 36°16'29", Longitude 77°00'38" NAD27
Drainage area 2.60 square miles
Gage datum 30.86 feet above sea level NGVD29

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1972	Jun. 17, 1972	9.41	1	286	11.0
1966	30-May-66	9.1	2	274	5.5
1970	Oct. 02, 1969	8.73	3	259	3.7
1973	Feb. 02, 1973	8.11	4	234	2.8
1968	Jan. 14, 1968	7.67	5	210	2.2
1965	Oct. 05, 1964	7.2	6	197	1.8
1967	Aug. 22, 1967	7.02	7	190	1.6
1969	Jul. 06, 1969	6.84	8	184	1.4
1971	Sep. 30, 1971	6.61	9	156	1.2
1964	Sep. 13, 1964	4.92	10	111	1.1

n= 10
$Q_{2.33}$ = 207 cfs

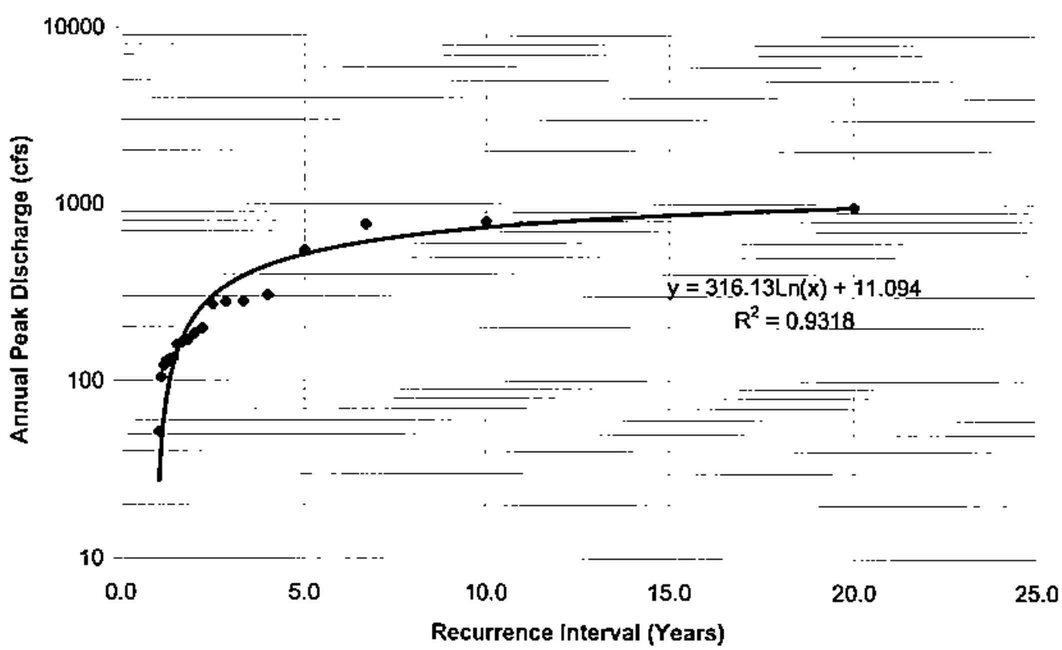


Agency	Site Number	Site Name	From	To	Count
USGS	2053550	CHINKAPIN CREEK NEAR COLERAIN, NC	6/15/1953	2/13/1971	19

Bertie County, North Carolina
Hydrologic Unit Code 03010203
Latitude 36°11'52", Longitude 76°47'14" NAD27
Drainage area 8.90 square miles
Gage datum 14.29 feet above sea level NGVD29

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1961	11-May-61	23.71	1	960	20.0
1960	Sep. 12, 1960	23.25	2	795	10.0
1955	Sep. 20, 1955	23.17	3	770	6.7
1968	Jan. 24, 1968	22.42	4	550	5.0
1971	Feb. 13, 1971	21.46	5	305	4.0
1965	Oct. 06, 1964	21.36	6	282	3.3
1958	7-May-58	21.42	7	280	2.9
1954	Jan. 1954	21.38	8	270	2.5
1969	Aug. 05, 1969	20.95	9	198	2.2
1970	Feb. 03, 1970	20.88	10	185	2.0
1953	Jun. 15, 1953	20.91	11	170	1.8
1967	Aug. 22, 1967	20.79	12	166	1.7
1959	Apr. 1959	20.75	13	160	1.5
1962	Jun. 03, 1962	20.61	14	135	1.4
1956	6-May-56	20.79	15	133	1.3
1964	Sep. 13, 1964	20.58	16	130	1.3
1966	Feb. 24, 1966	20.54	17	122	1.2
1957	Feb. 1957	20.51	18	105	1.1
1963	Jun. 03, 1963	20.13	19	52	1.1

n= 19
$Q_{2.33}$ = 278 cfs

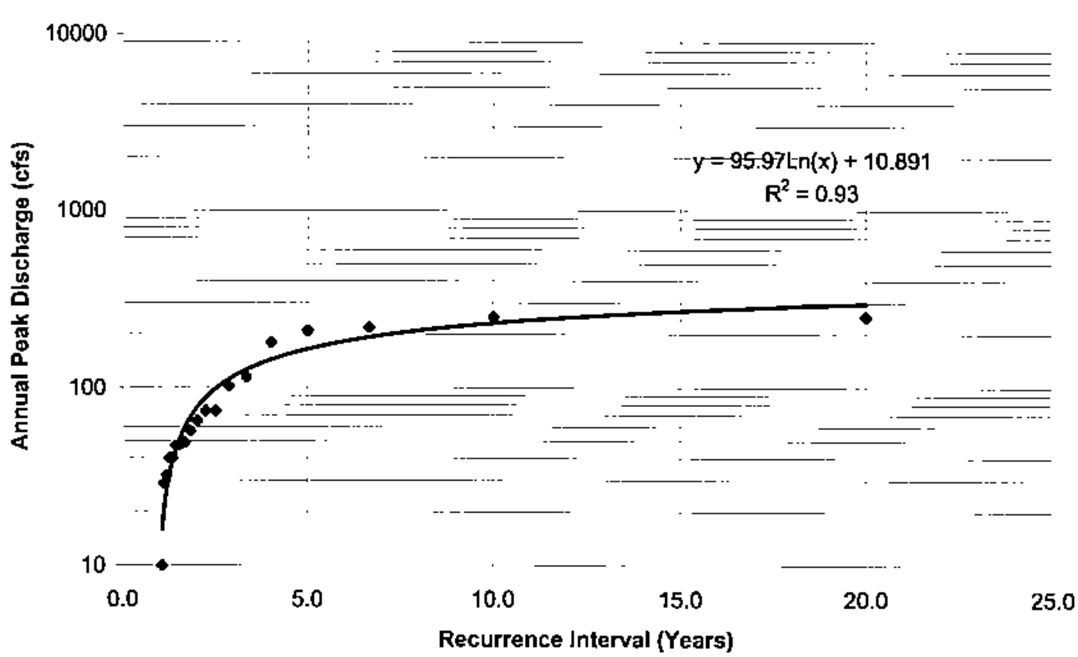


Agency	Site Number	Site Name	From	To	Count
USGS	2081060	SMITHWICK CREEK TRIBUTARY NR WILLIAI	1953-03-	3/3/1971	19

Martin County, North Carolina
Hydrologic Unit Code 03010107
Latitude 35°43'51", Longitude 77°04'42" NAD27
Drainage area 0.92 square miles

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1965	Oct. 05, 1964	23.9	1	252	20.0
1955	Sep. 20, 1955	23.86	2	250	10.0
1971	Mar. 03, 1971	23.65	3	220	6.7
1956	Sep. 26, 1956	23.56	4	210	5.0
1962	Jul. 04, 1962	23.3	5	180	4.0
1960	Sep. 12, 1960	22.65	6	115	3.3
1966	30-May-66	22.5	7	102	2.9
1959	Apr. 1959	22.11	8	74	2.5
1961	11-May-61	22.11	9	74	2.2
1968	Mar. 13, 1968	21.91	10	65	2.0
1969	Mar. 19, 1969	21.82	11	57	1.8
1954	Jul. 1954	21.68	12	49	1.7
1958	Aug. 26, 1958	21.67	13	48	1.5
1964	Mar. 15, 1964	21.62	14	47	1.4
1967	Sep. 10, 1967	21.5	15	40	1.3
1970	Nov. 02, 1969	21.5	16	40	1.3
1963	Jan. 21, 1963	21.32	17	32	1.2
1957	Oct. 1956	21.25	18	29	1.1
1953	Mar. 1953	20.7	19	10	1.1

n= 19
$Q_{2.33}$ = 92 cfs

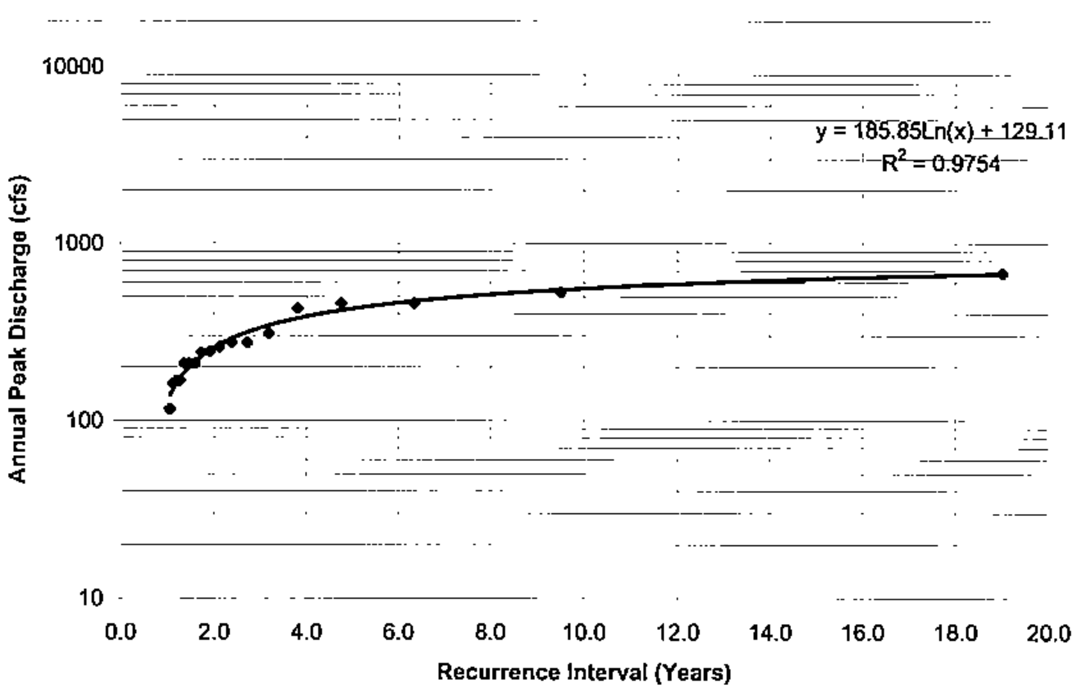


Agency	Site Number	Site Name	From	To	Count
USGS	2082630	HARTS MILL RUN NEAR TARBORO, NC	6/23/1953	3/4/1971	19

Martin County, North Carolina
Hydrologic Unit Code 03010107
Latitude 35°43'51", Longitude 77°04'42" NAD27
Drainage area 0.92 square miles

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1960	Sep. 12, 1960	21.81	1	680	19.0
1965	Oct. 05, 1964	21.46	2	530	9.5
1955	Sep. 03, 1955	21.94	3	460	6.3
1970	Oct. 02, 1969	21.23	4	460	4.8
1967	Aug. 21, 1967	21.37	5	430	3.8
1958	Aug. 25, 1958	20.78	6	310	3.2
1954	Jan. 22, 1954	21.15	7	275	2.7
1957	Jun. 09, 1957	21.17	8	275	2.4
1953	Jun. 23, 1953	21.11	9	260	2.1
1968	Jan. 14, 1968	20.34	10	245	1.9
1966	Mar. 04, 1966	20.35	11	242	1.7
1961	Feb. 25, 1961	20.18	12	210	1.6
1964	Mar. 15, 1964	20.14	13	210	1.5
1971	Mar. 04, 1971	20.15	14	210	1.4
1962	Jul. 04, 1962	19.86	15	168	1.3
1969	Jun. 19, 1969	19.87	16	168	1.2
1959	Oct. 1958	19.73	17	161	1.1
1956	Sep. 26, 1956	20.18	18	116	1.1
1963	1963	19.86			

n= 18
$Q_{2.33}$ = 286 cfs

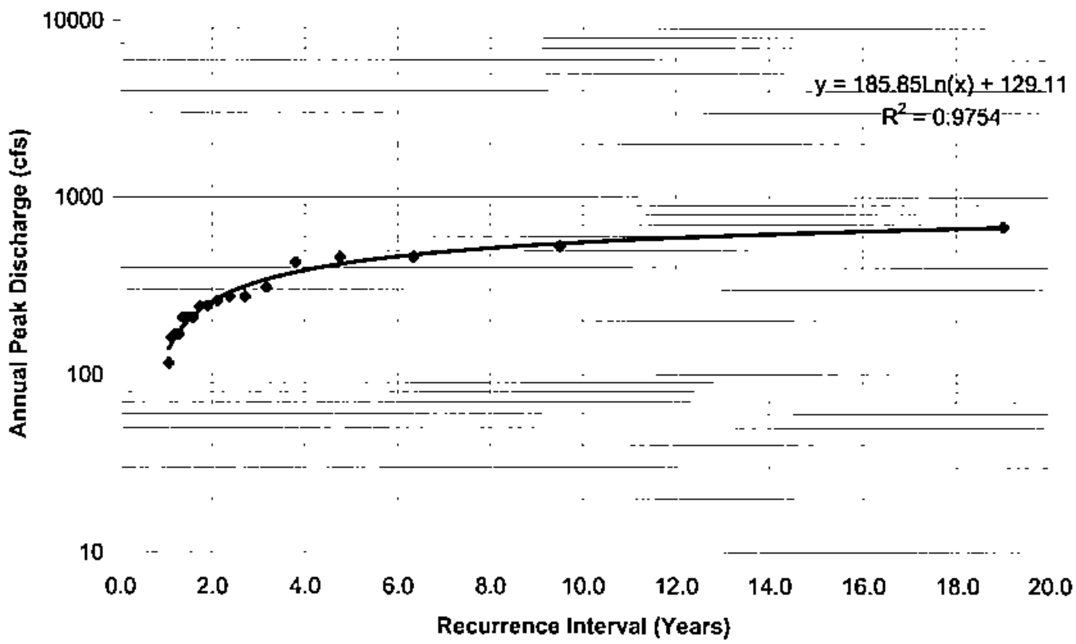


Agency	Site Number	Site Name	From	To	Count
USGS	2082630	HARTS MILL RUN NEAR TARBORO, NC	6/23/1953	3/4/1971	19

Martin County, North Carolina
Hydrologic Unit Code 03010107
Latitude 35°43'51", Longitude 77°04'42" NAD27
Drainage area 0.92 square miles

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1960	Sep. 12, 1960	21.81	1	680	19.0
1965	Oct. 05, 1964	21.46	2	530	9.5
1955	Sep. 03, 1955	21.94	3	460	6.3
1970	Oct. 02, 1969	21.23	4	460	4.8
1967	Aug. 21, 1967	21.37	5	430	3.8
1958	Aug. 25, 1958	20.78	6	310	3.2
1954	Jan. 22, 1954	21.15	7	275	2.7
1957	Jun. 09, 1957	21.17	8	275	2.4
1953	Jun. 23, 1953	21.11	9	260	2.1
1968	Jan. 14, 1968	20.34	10	245	1.9
1966	Mar. 04, 1966	20.35	11	242	1.7
1961	Feb. 25, 1961	20.18	12	210	1.6
1964	Mar. 15, 1964	20.14	13	210	1.5
1971	Mar. 04, 1971	20.15	14	210	1.4
1962	Jul. 04, 1962	19.86	15	168	1.3
1969	Jun. 19, 1969	19.87	16	168	1.2
1959	Oct. 1958	19.73	17	161	1.1
1956	Sep. 26, 1956	20.18	18	116	1.1
1963	1963	19.86			

n= 18
$Q_{2.33}$ = 286 cfs

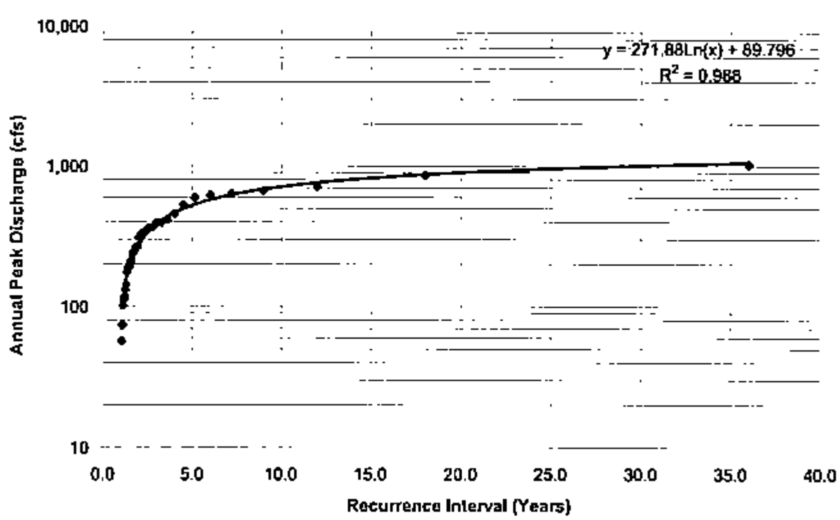


Agency	Site Number	Site Name	From	To	Count
USGS	2084070	GREEN MILL RN AT ARLINGTON BLVD AT G	8/10/1951	2/12/1985	35

Pitt County, North Carolina
Hydrologic Unit Code 03020103
Latitude 35°37'04", Longitude 77°22'17" NAD27
Drainage area 9.10 square miles
Gage datum 27.12 feet above sea level NGVD29

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1953	Jun. 23, 1953		1	1,030	36.0
1981	Aug. 12, 1981	10.56	2	864	18.0
1984	Jul. 17, 1984	9.88	3	714	12.0
1982	Aug. 01, 1982	9.65	4	669	9.0
1983	Jun. 08, 1983	9.48	5	637	7.2
1974	Aug. 06, 1974		6	624	6.0
1978	Nov. 06, 1977		7	598	5.1
1973	Jun. 09, 1973		8	529	4.5
1971	Jul. 10, 1971		9	458	4.0
1976	Jun. 27, 1976		10	416	3.6
1985	Feb. 12, 1985	8.1	11	398	3.3
1962	Jul. 04, 1962		12	397	3.0
1951	Aug. 10, 1951		13	368	2.8
1952	Mar. 04, 1952		14	366	2.6
1960	Jul. 29, 1960		15	351	2.4
1980	Mar. 18, 1980	7.63	16	338	2.3
1966	Jul. 06, 1966		17	330	2.1
1955	Aug. 17, 1955		18	310	2.0
1968	Aug. 11, 1968		19	266	1.9
1959	Jul. 13, 1959		20	264	1.8
1965	Oct. 05, 1964		21	245	1.7
1972	Aug. 18, 1972		22	237	1.6
1961	Jun. 26, 1961		23	213	1.6
1963	Aug. 08, 1963		24	200	1.5
1964	Aug. 31, 1964		25	190	1.4
1967	Aug. 11, 1967		26	189	1.4
1956	Jul. 10, 1956		27	176	1.3
1958	Aug. 26, 1958		28	144	1.3
1970	Oct. 03, 1969		29	132	1.2
1957	Feb. 28, 1957		30	119	1.2
1954	Aug. 27, 1954		31	113	1.2
1969	Aug. 04, 1969		32	102	1.1
1975	Dec. 01, 1974		33	75	1.1
1977	25-May-77		34	74	1.1
1979	Jun. 11, 1979		35	57	1.0

n= 35
$Q_{2.33}$ = 320 cfs

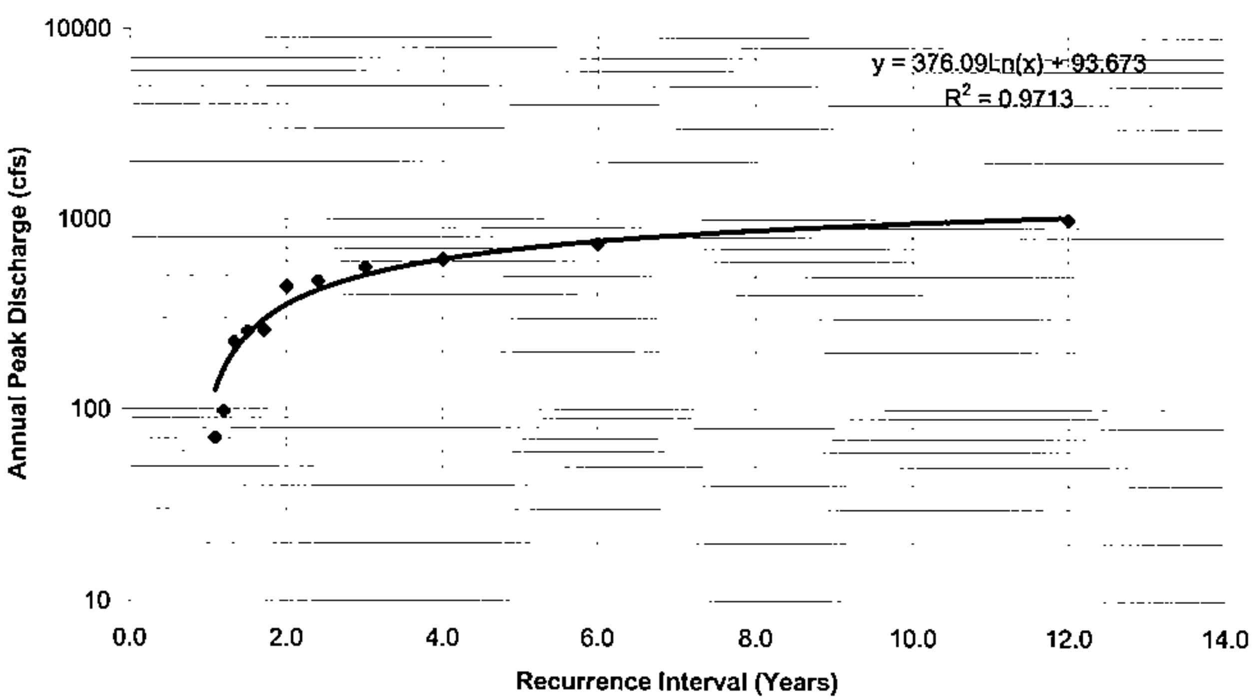


Agency	Site Number	Site Name	From	To	Count
USGS	2084164	JUNIPER BRANCH AT SR1766 NR SIMPSON	1/28/1976	########	11

Pitt County, North Carolina
Hydrologic Unit Code 03020103
Latitude 35°33'55", Longitude 77°14'43" NAD27
Drainage area 7.50 square miles

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1978	5-May-78	16.83	1	996	12.0
1979	Jun. 11, 1979	16.63	2	740	6.0
1981	Jun. 06, 1981	16.43	3	614	4.0
1982	Aug. 01, 1982	16.33	4	557	3.0
1980	21-May-80	16.16	5	470	2.4
1984	Jul. 17, 1984	16.09	6	441	2.0
1985	Aug. 02, 1985	15.48	7	260	1.7
1983	Oct. 25, 1982	15.46	8	256	1.5
1986	Nov. 30, 1985	15.3	9	225	1.3
1977	24-May-77	14.7	10	98	1.2
1976	Jan. 28, 1976	14.64	11	71	1.1

n= 11
$Q_{2.33}$ = 412 cfs

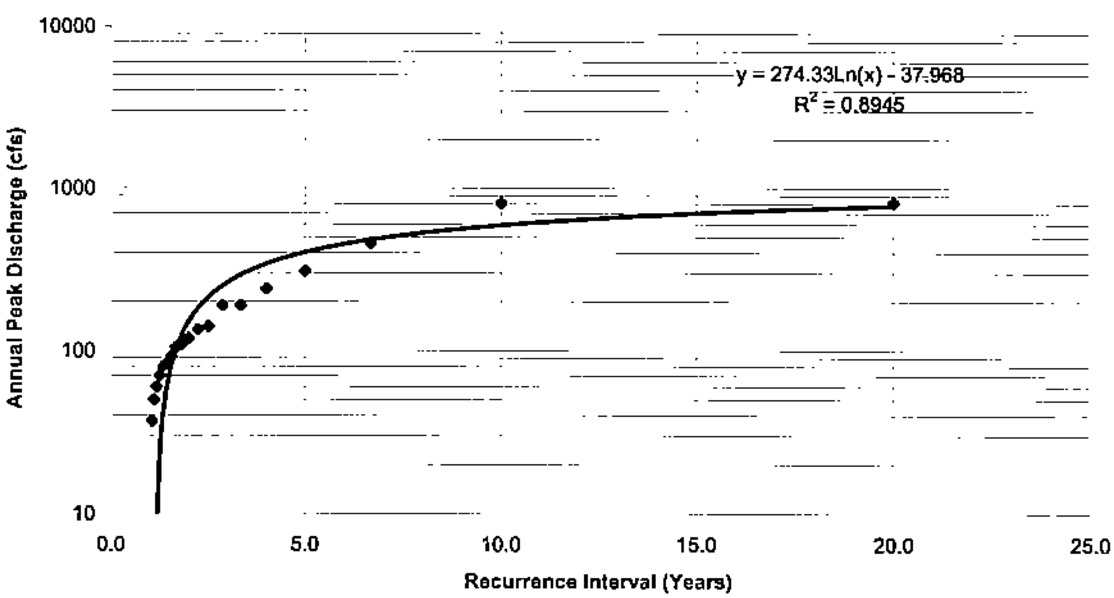


Agency	Site Number	Site Name	From	To	Count
USGS	2088210	HANNAH CREEK NEAR BENSON, NC	1953-06-	3/4/1971	19

Johnston County, North Carolina
Hydrologic Unit Code 03020201
Latitude 35°23'36", Longitude 78°31'48" NAD27
Drainage area 2.59 square miles

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1965	Oct. 05, 1964	23.19	1	820	20.0
1959	Jun. 05, 1959	23.17	2	808	10.0
1962	Jul. 04, 1962	22.44	3	460	6.7
1964	Sep. 13, 1964	21.79	4	310	5.0
1960	Sep. 12, 1960	21.65	5	240	4.0
1953	Jun. 1953	21.68	6	190	3.3
1956	Sep. 26, 1956	21.63	7	190	2.9
1957	Nov. 22, 1956	21.3	8	141	2.5
1961	11-May-61	20.96	9	135	2.2
1966	Feb. 28, 1966	20.48	10	120	2.0
1969	Jun. 10, 1969	20.75	11	110	1.8
1955	Aug. 12, 1955	20.69	12	105	1.7
1954	Jan. 22, 1954	20.52	13	92	1.5
1958	Feb. 27, 1958	20.36	14	83	1.4
1971	Mar. 04, 1971	20.38	15	80	1.3
1963	Nov. 09, 1962	20.2	16	70	1.3
1970	Aug. 24, 1970	19.97	17	60	1.2
1967	Sep. 10, 1967	19.79	18	50	1.1
1968	Jan. 12, 1968	19.48	19	37	1.1

n= 19
$Q_{2.33}$ = 101 cfs

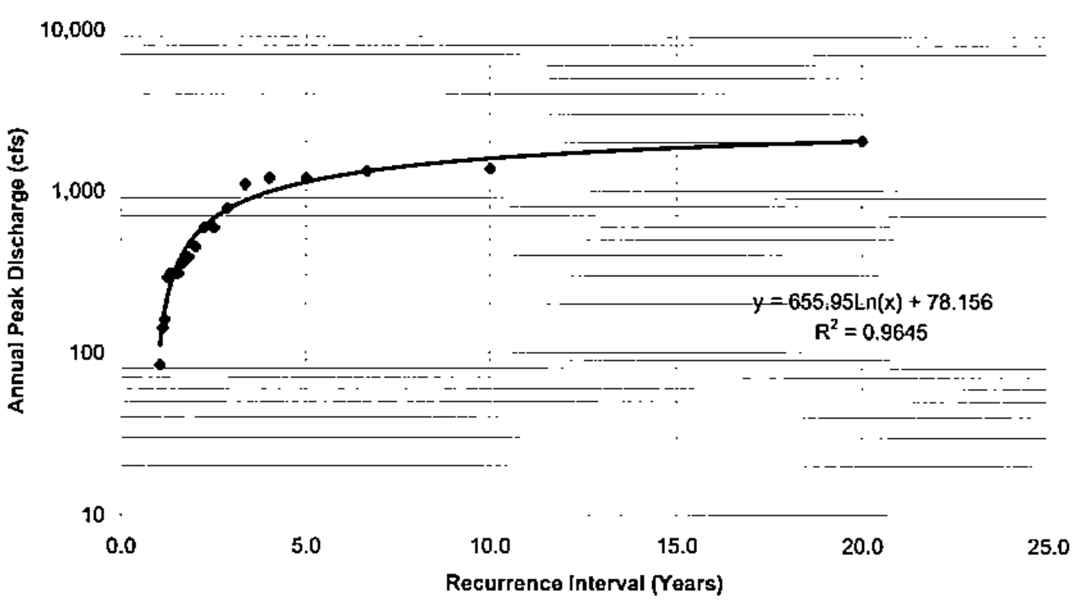


Agency	Site Number	Site Name	From	To	Count
USGS	2088420	LONG BRANCH NEAR SELMA, NC	3/12/1953	3/4/1971	19

Johnston County, North Carolina
Hydrologic Unit Code 03020201
Latitude 35°38'11", Longitude 78°15'06" NAD27
Drainage area 7.64 square miles
Gage datum 155.19 feet above sea level NGVD29

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1960	Oct. 24, 1959	24.96	1	2,050	20.0
1965	Oct. 06, 1964	22.96	2	1,370	10.0
1962	Jul. 04, 1962	23.13	3	1,330	6.7
1954	Jan. 1954	22.86	4	1,200	5.0
1957	Jun. 09, 1957	22.78	5	1,200	4.0
1953	Mar. 12, 1953	22.65	6	1,100	3.3
1956	Mar. 16, 1956	22.57	7	780	2.9
1961	Jun. 27, 1961	22.46	8	590	2.5
1964	Mar. 15, 1964	22.46	9	590	2.2
1955	Aug. 1955	22.34	10	450	2.0
1958	Aug. 26, 1958	22.25	11	390	1.8
1966	Mar. 04, 1966	22.18	12	360	1.7
1959	Apr. 1959	21.97	13	310	1.5
1967	Sep. 10, 1967	22.11	14	310	1.4
1971	Mar. 04, 1971	22.1	15	310	1.3
1963	Jan. 19, 1963	22.06	16	290	1.3
1970	Apr. 15, 1970	21.6	17	160	1.2
1969	Apr. 19, 1969	21.5	18	142	1.1
1968	Jun. 10, 1968	20.98	19	84	1.1

n= 19
$Q_{2.33}$ = 633 cfs

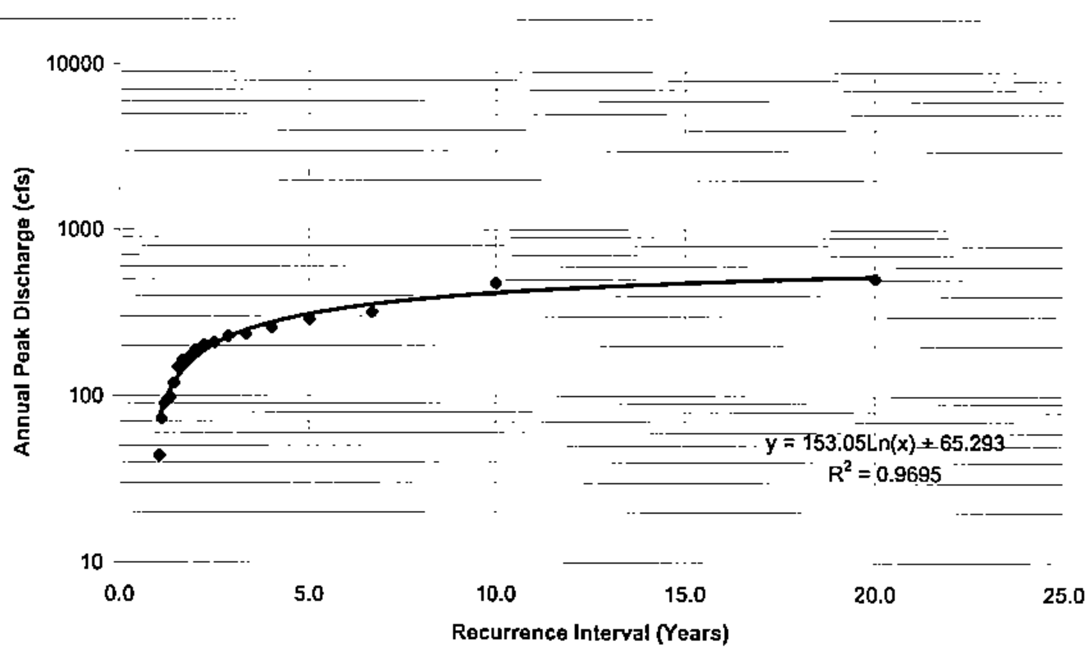


Agency	Site Number	Site Name	From	To	Count
USGS	2090560	LEE SWAMP TRIBUTARY NR LUCAMA, NC	6/22/1953	3/4/1971	19

Wilson County, North Carolina
Hydrologic Unit Code 03020203
Lalilude 35°38'21", Longitude 78°01'37" NAD27
Drainage area 2.83 square miles

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1960	Jul. 30, 1960	25.96	1	508	20.0
1965	Oct. 05, 1964	27	2	476	10.0
1955	Sep. 19, 1955	23.49	3	320	6.7
1964	Mar. 15, 1964	23.4	4	290	5.0
1967	Aug. 11, 1967	23.27	5	260	4.0
1954	Jan. 22, 1954	23.1	6	236	3.3
1958	7-May-58	22.98	7	230	2.9
1961	Feb. 24, 1961	22.8	8	210	2.5
1959	Feb. 06, 1959	22.79	9	204	2.2
1971	Mar. 04, 1971	22.7	10	190	2.0
1969	Aug. 05, 1969	22.58	11	172	1.8
1966	Mar. 05, 1966	22.5	12	165	1.7
1968	Jan. 14, 1968	22.4	13	150	1.5
1962	Jul. 04, 1962	22.07	14	120	1.4
1957	Feb. 28, 1957	21.94	15	98	1.3
1963	Jan. 21, 1963	21.74	16	95	1.3
1956	Mar. 16, 1956	21.86	17	90	1.2
1970	Oct. 02, 1969	21.42	18	73	1.1
1953	Jun. 22, 1953	21.09	19	44	1.1

n= 19
$Q_{2.33}$ = 195 cfs

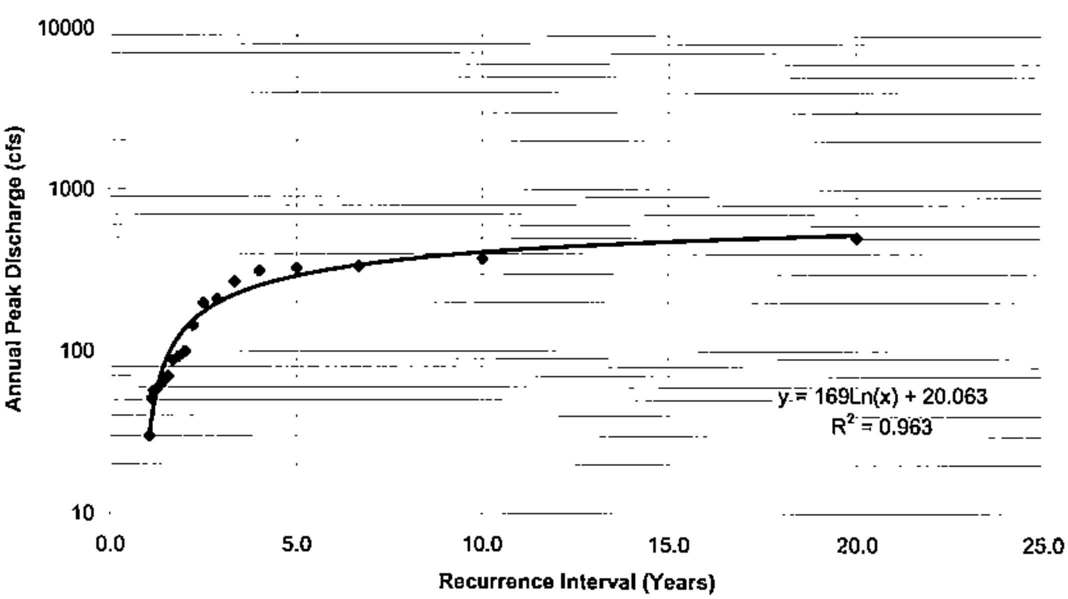


Agency	Site Number	Site Name	From	To	Count
USGS	2090780	WHITEOAK SWAMP TRIBUTARY NR WILSON	5/7/1953	3/4/1971	19

Wilson County, North Carolina
Hydrologic Unit Code 03020203
Latitude 35°42'24", Longitude 77°47'11" NAD27
Drainage area 2.60 square miles

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1965	Oct. 05, 1964	23.37	1	505	20.0
1960	Sep. 12, 1960	22.65	2	375	10.0
1966	Mar. 04, 1966	22.4	3	335	6.7
1955	Sep. 04, 1955	22.32	4	327	5.0
1964	Aug. 10, 1964	22.25	5	313	4.0
1954	Jan. 1954	21.82	6	270	3.3
1967	Aug. 11, 1967	21.57	7	210	2.9
1961	11-May-61	21.57	8	198	2.5
1971	Mar. 04, 1971	21.3	9	145	2.2
1968	Jan. 13, 1968	21.12	10	100	2.0
1953	7-May-53	21	11	92	1.8
1959	Mar. 06, 1959	20.98	12	88	1.7
1970	Feb. 03, 1970	20.8	13	70	1.5
1958	Nov. 23, 1957	20.76	14	66	1.4
1963	Jan. 21, 1963	20.7	15	62	1.3
1956	Sep. 26, 1956	20.61	16	58	1.3
1969	Mar. 19, 1969	20.65	17	57	1.2
1957	Nov. 22, 1956	20.58	18	51	1.1
1962	Jul. 04, 1962	20.2	19	30	1.1

n= 19
$Q_{2.33}$ = 163 cfs

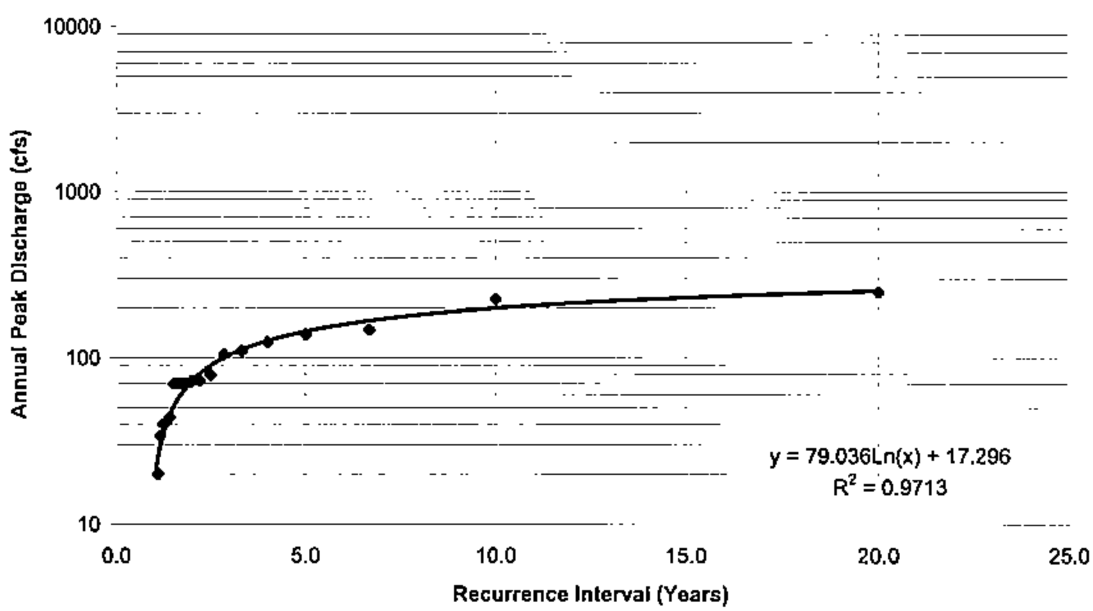


Agency	Site Number	Site Name	From	To	Count
USGS	2091430	SHEPHERD RUN NEAR SNOW HILL, NC	1953-04-	3/4/1971	19

Greene County, North Carolina
Hydrologic Unit Code 03020203
Latitude 35°26'06", Longitude 77°38'42" NAD27
Drainage area 1.47 square miles

Water Year	Date	Gage Height (feet)	Rank	Stream-flow (cfs)	Recurrence Interval
1960	Sep. 12, 1960	21.69	1	250	20.0
1965	Jul. 06, 1965	21.5	2	225	10.0
1955	Sep. 19, 1955	20.81	3	148	6.7
1964	Sep. 13, 1964	20.8	4	138	5.0
1969	20-May-69	20.66	5	124	4.0
1970	Nov. 02, 1969	20.53	6	110	3.3
1962	Jul. 04, 1962	20.47	7	105	2.9
1971	Mar. 04, 1971	20.15	8	79	2.5
1959	Mar. 1959	20.06	9	73	2.2
1966	Apr. 29, 1966	20.06	10	72	2.0
1954	1954		11	70	1.8
1956	1956		12	70	1.7
1957	1957		13	70	1.5
1961	11-May-61	19.63	14	44	1.4
1963	Jan. 21, 1963	19.53	15	41	1.3
1968	Nov. 25, 1967	19.52	16	40	1.3
1958	Oct. 01, 1957	19.35	17	34	1.2
1967	Dec. 13, 1966	19	18	20	1.1
1953	Apr. 1953	17.71	19	5	1.1

n= 19
$Q_{2.33}$ = 84 cfs



Dalrymple Homogeneity Test

Gage Station	$Q_{2.33}$	Q_{10}	Ratio Q_{10} / $Q_{2.33}$	$Q_{2.33}$ X Avg 10-yr ratio	Recurrence Interval for $Q_{2.33}$ X Avg 10-yr ratio	Period of Record
WILDCAT	64	166	2.59	150	7.9	19
CHINKAPIN	278	739	2.65	651	7.6	19
SMITHWICK	92	232	2.52	215	8.4	19
HARTS	286	557	1.95	669	18.3	19
GREEN	320	716	2.24	747	11.2	35
JUNIPER	412	960	2.33	963	10.1	11
HANNAH	101	209	2.07	236	14.3	19
LEE	195	418	2.14	455	12.8	19
WHITEOAK	163	409	2.51	381	8.5	19
SHEPHERD	84	199	2.37	197	9.7	19
AHOSKIE	207	308	1.48	484	130.6	19
BEAVERDAM	201	816	4.06	469	5.6	19
LONG	633	1589	2.51	1480	8.5	19
Average 10-YR Ratio			2.34			

fails homogeniety test

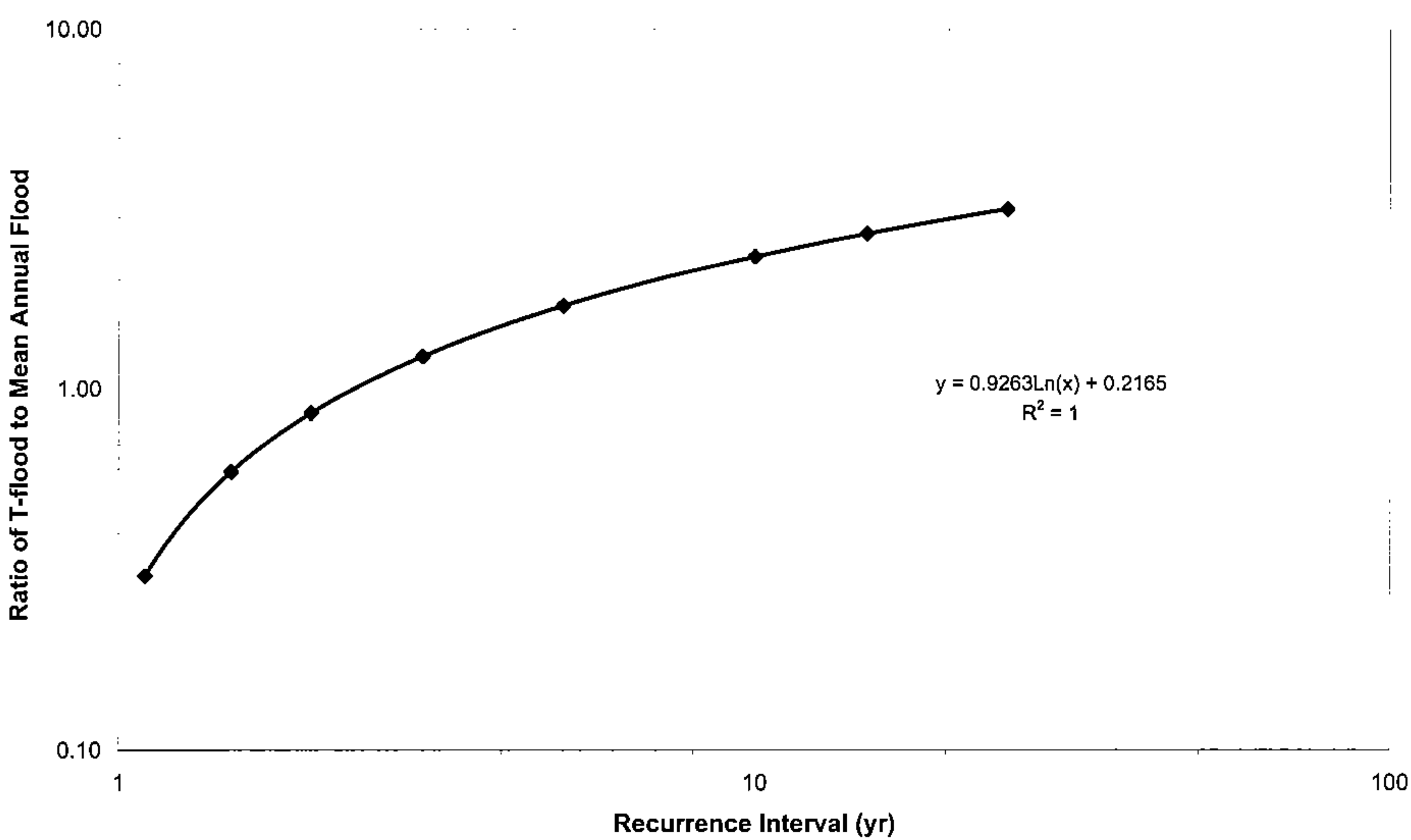
T-year flood (cfs) from flood-frequency equations

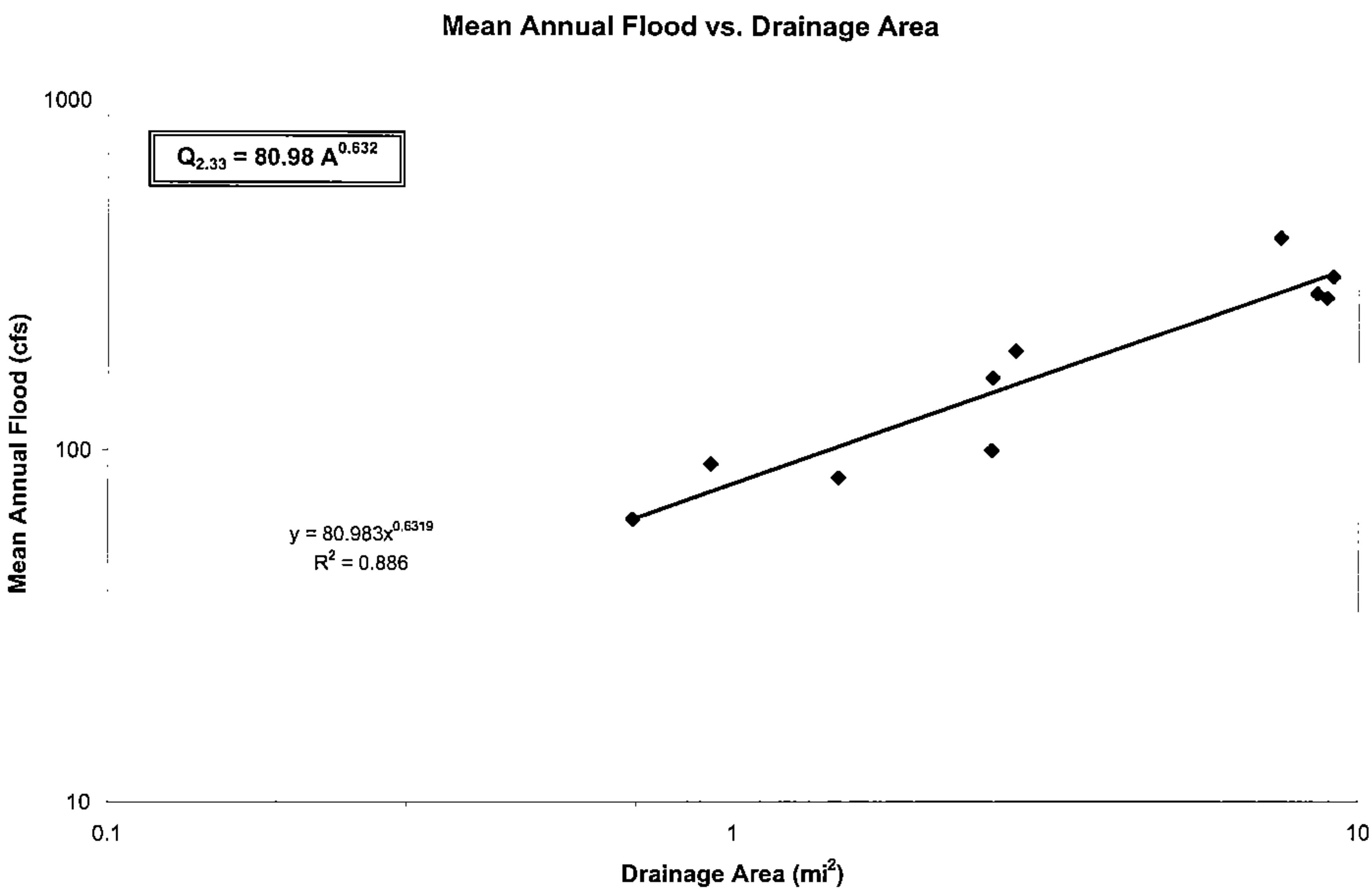
	WILDCAT	CHINKAPIN	SMITHWICK	HARTS	GREEN	JUNIPER	HANNAH	LEE	WHITEOAK	SHEPHERD
Area (sqmi)	0.69	8.9	0.92	8.58	9.1	7.5	2.59	2.83	2.6	1.47
2.33	64	278	92	286	320	412	101	195	163	84
1.1	12	41	20	147	116	130	45	80	36	25
1.5	33	139	50	204	200	246	68	127	89	49
2	53	230	77	258	278	354	89	171	137	72
3	82	358	116	333	388	507	120	233	206	104
5	118	520	165	428	527	699	158	312	292	144
10	166	739	232	557	716	960	209	418	409	199
15	195	867	271	632	826	1112	239	480	478	231
25	230	1029	320	727	965	1304	277	558	564	272

Ratio of T-year flood to mean annual flood

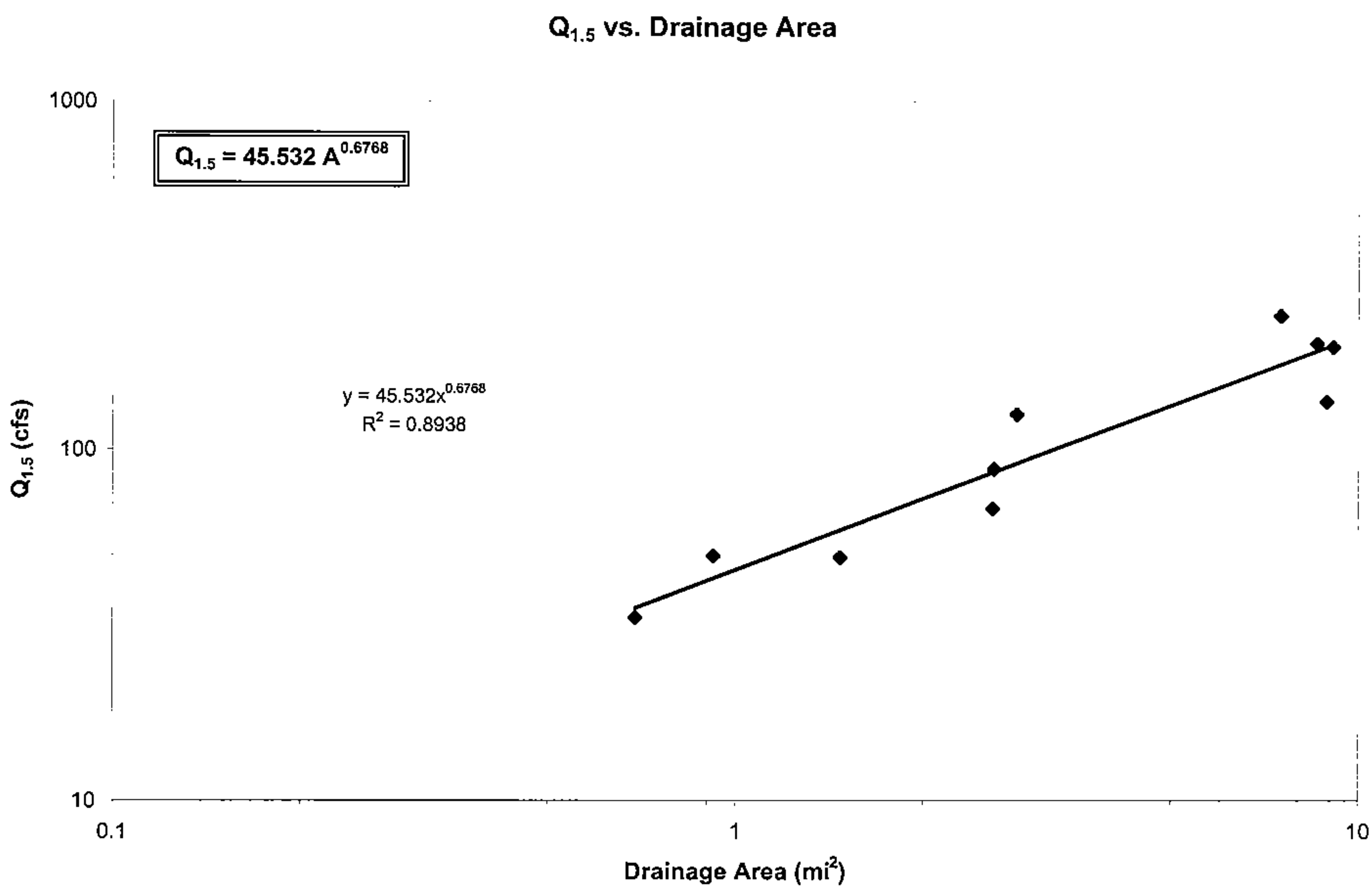
	WILDCAT	CHINKAPIN	SMITHWICK	HARTS	GREEN	JUNIPER	HANNAH	LEE	WHITEOAK	SHEPHERD	median
1.1	0.18	0.15	0.22	0.51	0.36	0.31	0.45	0.41	0.22	0.30	0.30
1.5	0.52	0.50	0.54	0.71	0.63	0.60	0.68	0.65	0.54	0.59	0.59
2	0.83	0.83	0.84	0.90	0.87	0.86	0.89	0.88	0.84	0.86	0.86
3	1.28	1.29	1.26	1.16	1.21	1.23	1.19	1.20	1.26	1.24	1.23
5	1.83	1.87	1.80	1.50	1.65	1.70	1.56	1.60	1.79	1.72	1.71
10	2.59	2.65	2.52	1.95	2.24	2.33	2.07	2.14	2.51	2.37	2.35
15	3.04	3.11	2.94	2.21	2.58	2.70	2.37	2.46	2.93	2.75	2.72
25	3.59	3.69	3.47	2.54	3.02	3.17	2.75	2.86	3.46	3.23	3.20

Ratio of T-flood to $Q_{2.33}$ vs. Recurrence Interval





Mean Annual Flood vs. Drainage Area
$Q_{2.33} = 80.98\ A^{0.632}$
$y = 80.983x^{0.6319}$
$R^2 = 0.886$
1000
100
10
0.1
1
10
Mean Annual Flood (cfs)
Drainage Area (mi²)


$Q_{1.5}$ vs. Drainage Area
$Q_{1.5} = 45.532\ A^{0.6768}$
$y = 45.532x^{0.6768}$
$R^2 = 0.8938$
$Q_{1.5}$ (cfs)
1000
100
10
0.1
1
10
Drainage Area (mi^2)

Conoconnara Design Q Summary

Reach 1

Flood Frequency Analysis

$Q_{2.33}$ = 80.98 A^0.632
Ratio = 0.9263*Ln(T-year) + 0.2165

DA	0.22	mi^2
$Q_{2.33}$	31.1	ft^3/s
Q_1	6.7	ft^3/s
$Q_{1.5}$	18.4	ft^3/s
Q_2	26.7	ft^3/s

Regional Regression Eqns

Rural Coastal Q_2	23.4	ft^3/s
Rural Piedmont Q_2	46.6	ft^3/s

Regional Curves

Rural Coastal Q_{BKF}	5.6	ft^3/s
Rural Piedmont Q_{BKF}	31.3	ft^3/s

Flood Frequency Analysis (1.5 yr)

$Q_{1.5}$ = 45.532 A^0.6768

$Q_{1.5}$	16.3	ft^3/s

Reach 2

Flood Frequency Analysis

$Q_{2.33}$ = 80.98 A^0.632
Ratio = 0.9263*Ln(T-year) + 0.2165

DA	0.58	mi^2
$Q_{2.33}$	57.4	ft^3/s
Q_1	12.4	ft^3/s
$Q_{1.5}$	34.0	ft^3/s
Q_2	49.3	ft^3/s

Regional Regression Eqns

Rural Coastal Q_2	44.8	ft^3/s
Rural Piedmont Q_2	92.1	ft^3/s

Regional Curves

Rural Coastal Q_{BKF}	11.2	ft^3/s
Rural Piedmont Q_{BKF}	62.2	ft^3/s

Flood Frequency Analysis (1.5 yr)

$Q_{2.33}$ = 45.532 A^0.6768

$Q_{1.5}$	16.3	ft^3/s

Reach 3

Flood Frequency Analysis

$Q_{2.33}$ = 80.98 A^0.632
Ratio = 0.9263*Ln(T-year) + 0.2165

DA	0.878	mi^2
$Q_{2.33}$	74.6	ft^3/s
Q_1	16.1	ft^3/s
$Q_{1.5}$	44.2	ft^3/s
Q_2	64.0	ft^3/s

Regional Regression Eqns

Rural Coastal Q_2	59.3	ft^3/s
Rural Piedmont Q_2	123.2	ft^3/s

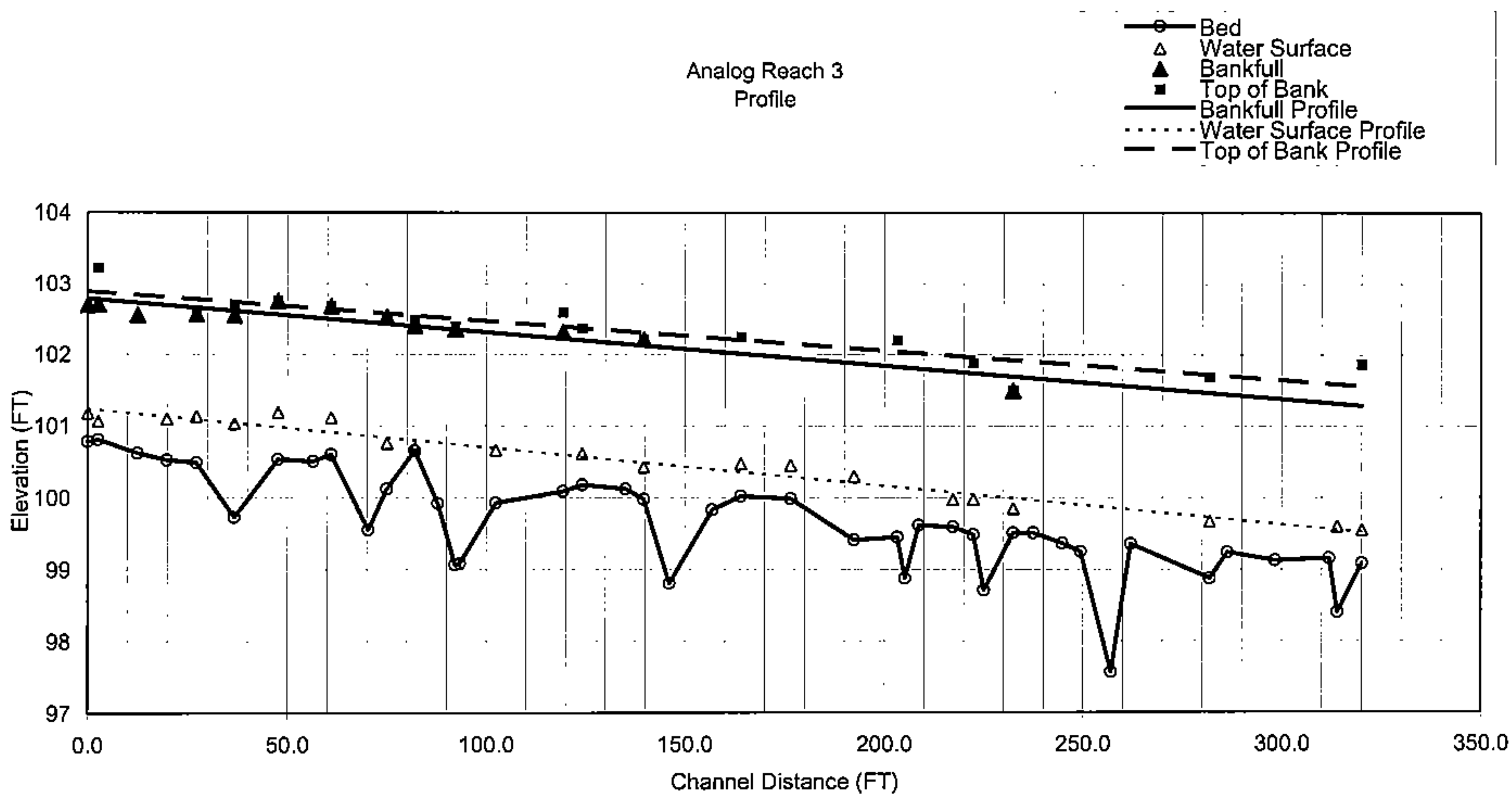
Regional Curves

Rural Coastal Q_{BKF}	15.1	ft^3/s
Rural Piedmont Q_{BKF}	83.5	ft^3/s

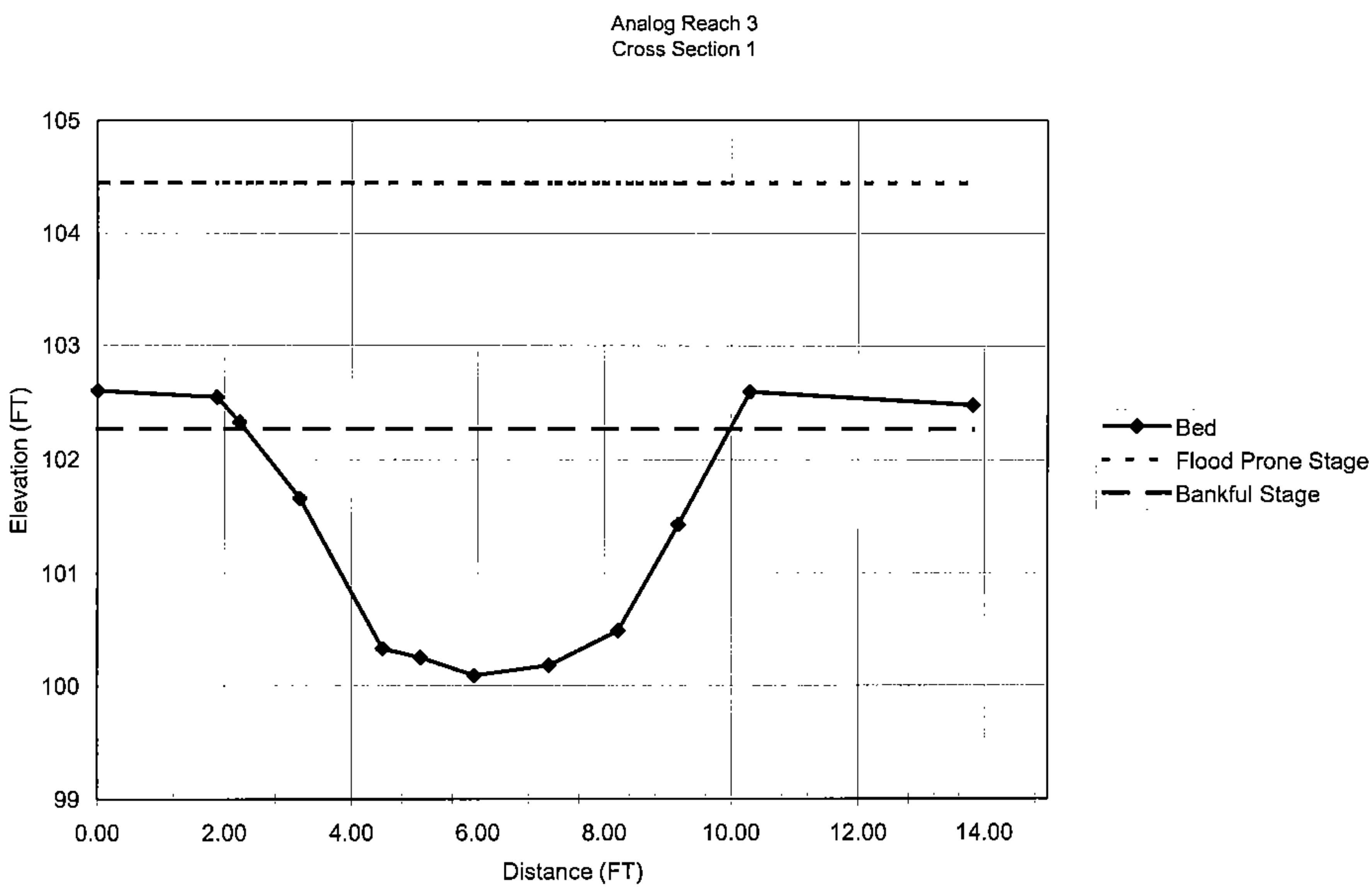
Flood Frequency Analysis (1.5 yr)

$Q_{2.33}$ = 45.532 A^0.6768

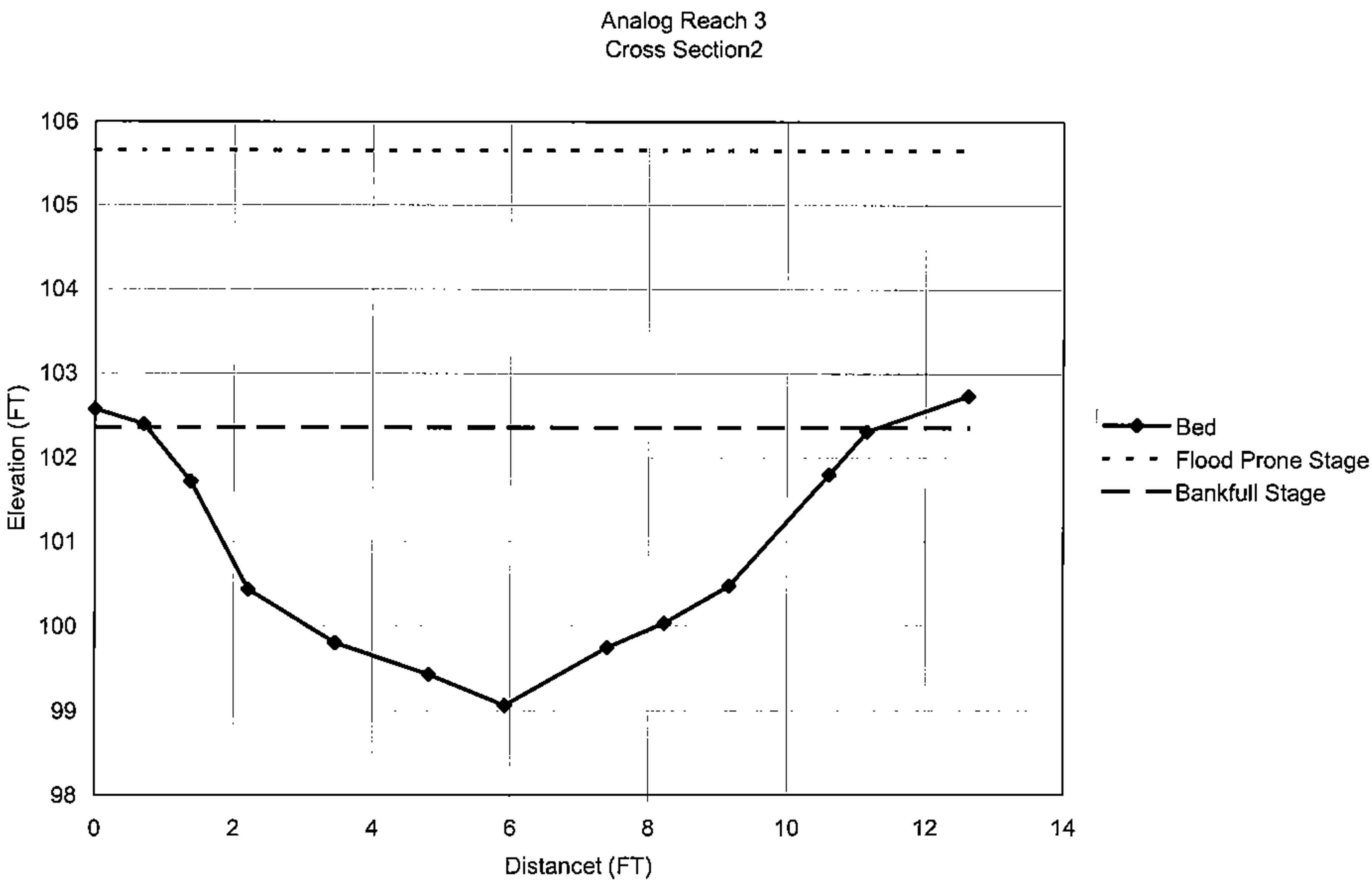
$Q_{1.5}$	16.3	ft^3/s



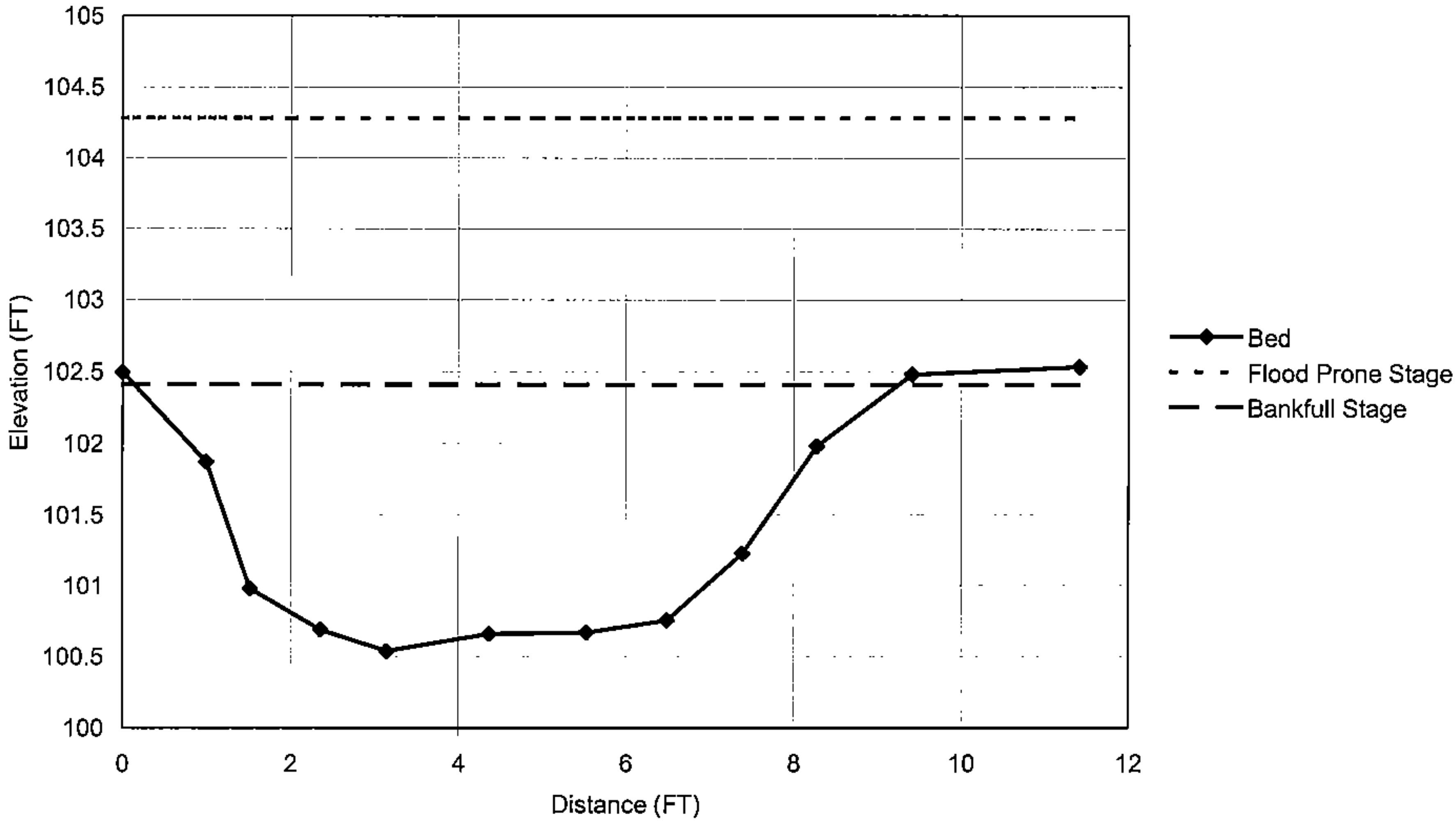
Analog Reach 3
Profile
Bed
Water Surface
Bankfull
Top of Bank
Bankfull Profile
Water Surface Profile
Top of Bank Profile
104
103
102
101
100
99
98
97
Elevation (FT)
0.0
50.0
100.0
150.0
200.0
250.0
300.0
350.0
Channel Distance (FT)



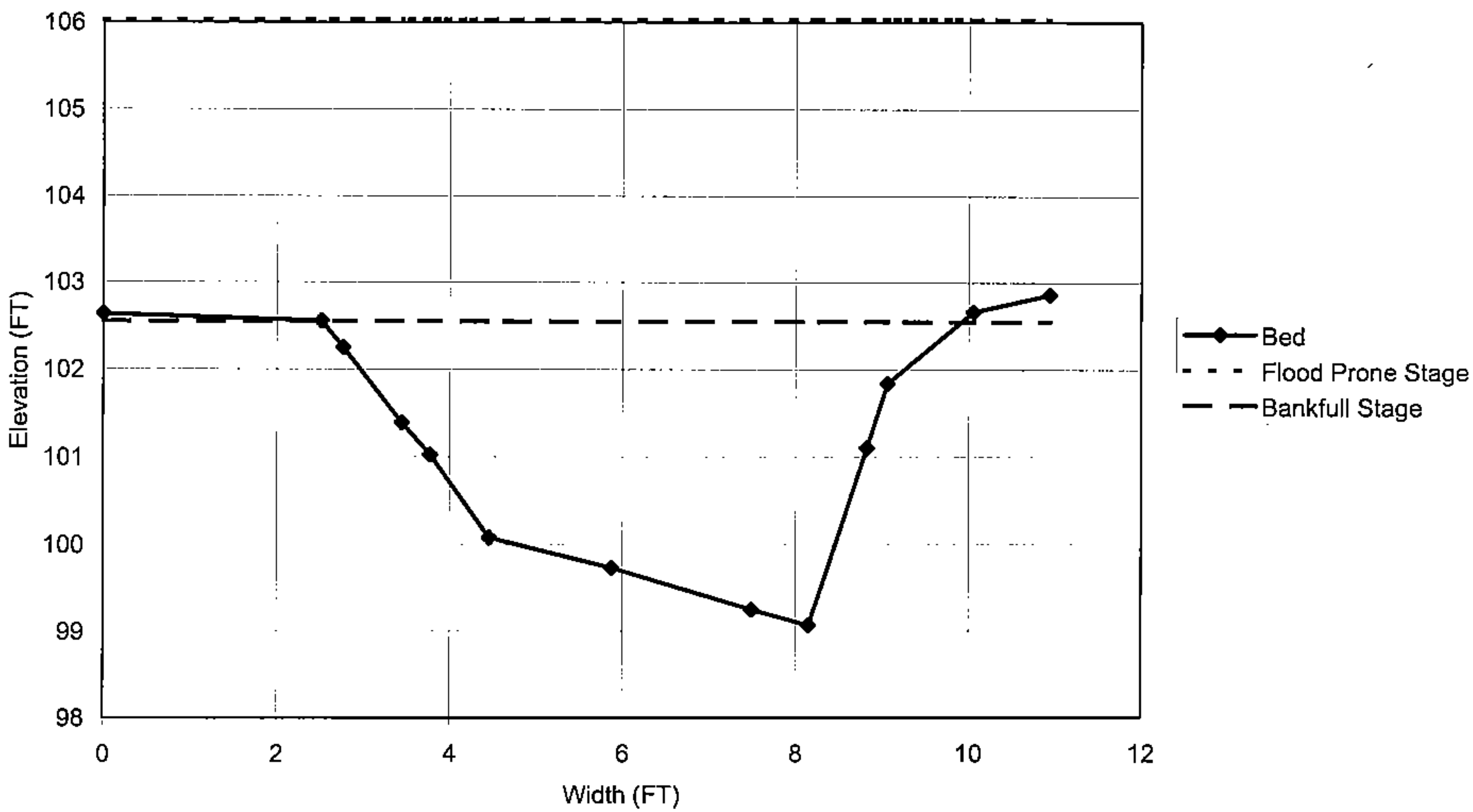
Analog Reach 3
Cross Section 1
105
104
103
102
101
100
99
Elevation (FT)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
Distance (FT)
Bed
Flood Prone Stage
Bankful Stage


Analog Reach 3
Cross Section2
106
105
104
103
102
101
100
99
98
Elevation (FT)
0
2
4
6
8
10
12
14
Distancet (FT)
Bed
Flood Prone Stage
Bankfull Stage

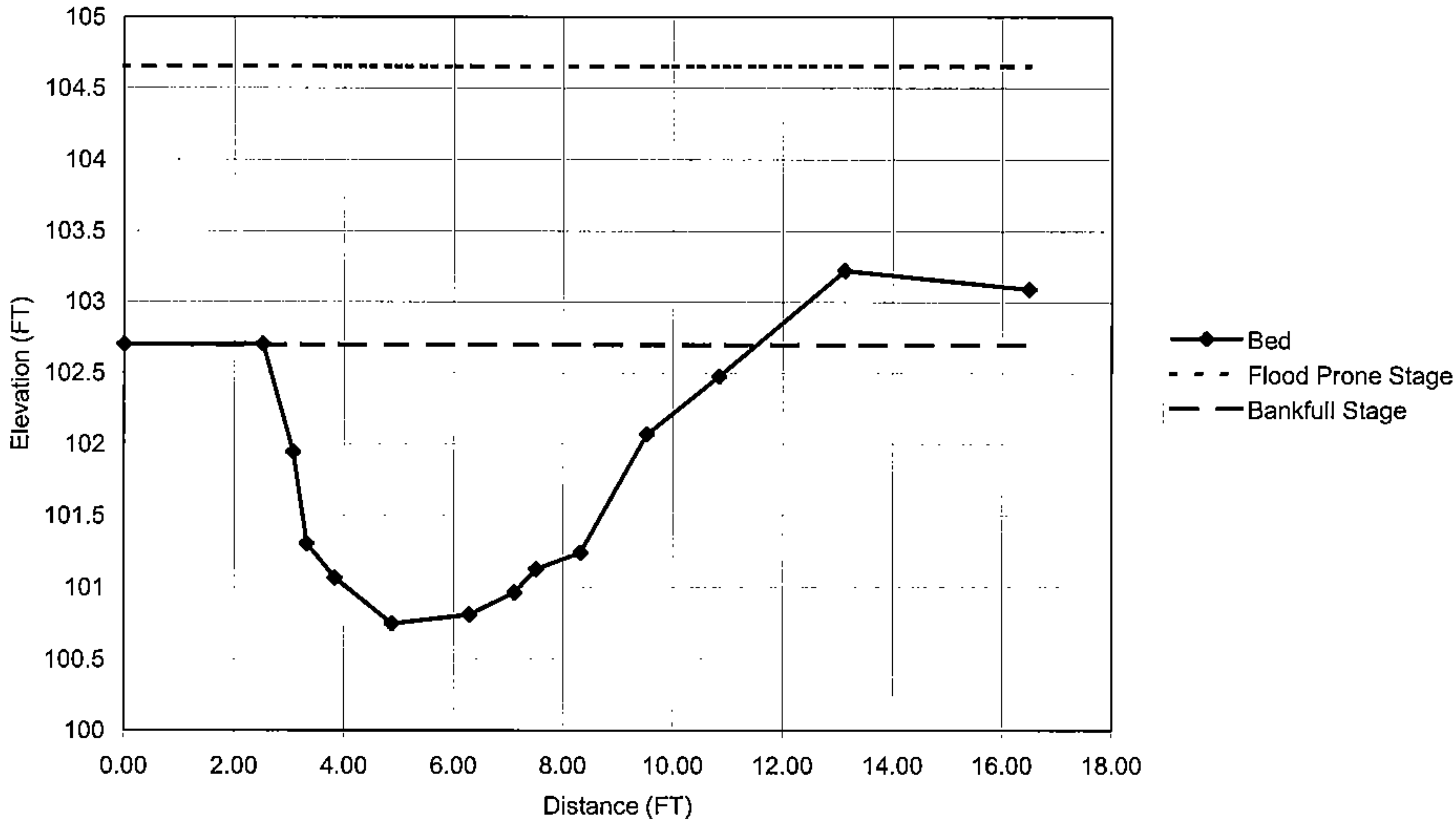
Analog Reach 3
Cross Section 3



Analog Reach 3
Cross Section 4



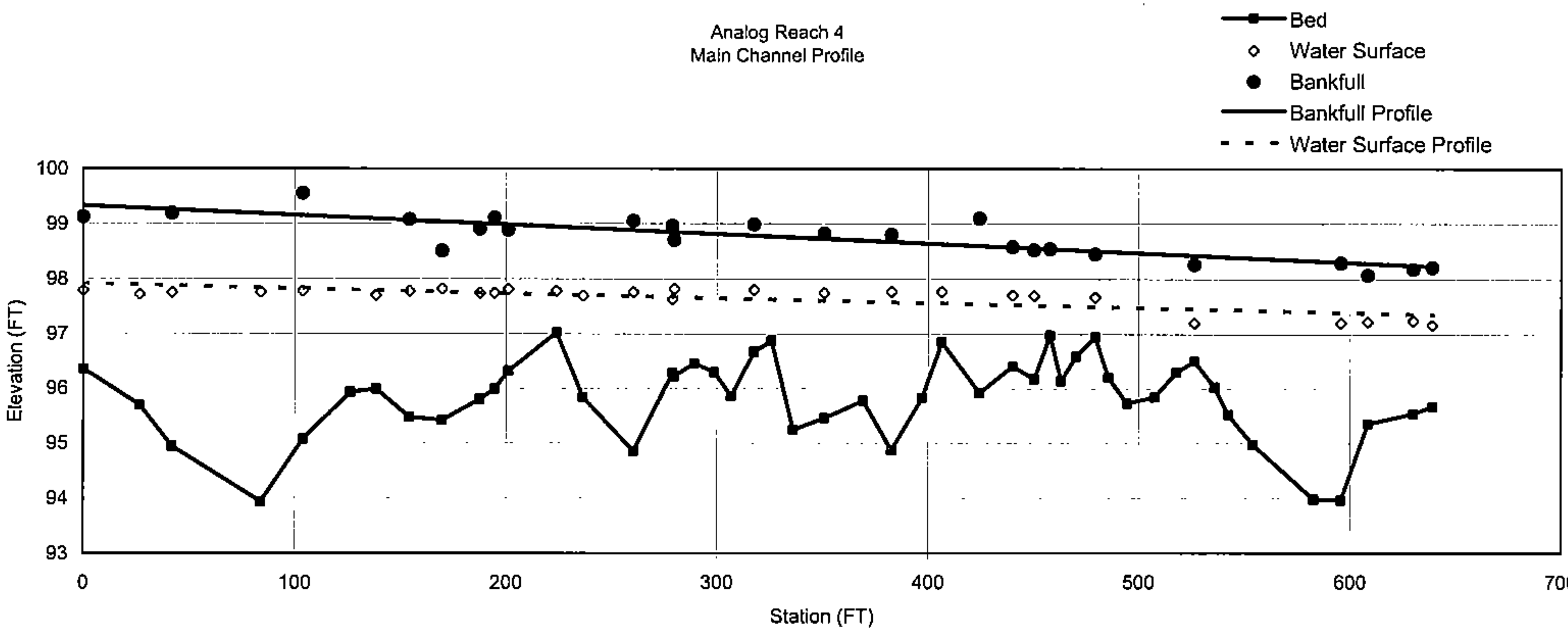
Analog Reach 3
Cross Section 5



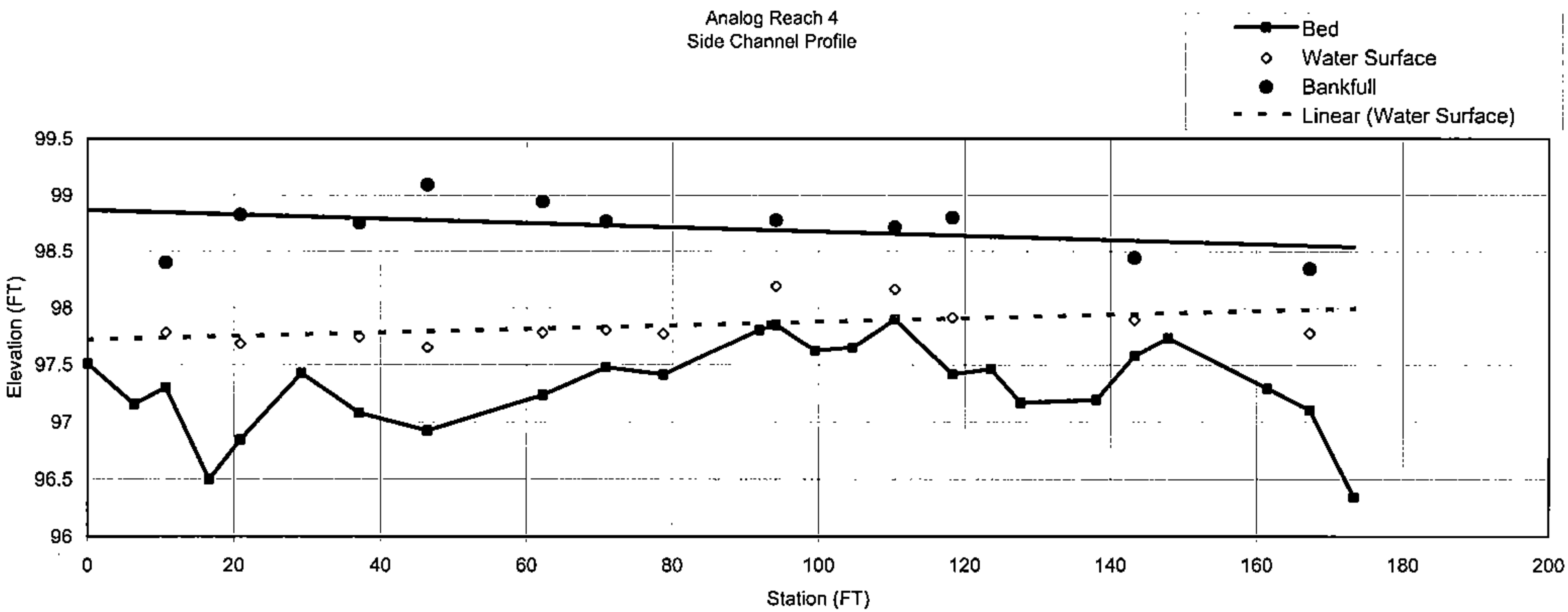
Site Name: Conoconnara
Data Point: Analog Reach 3
Sample taken by: JK
Date:

Sieve Analysis by: BH

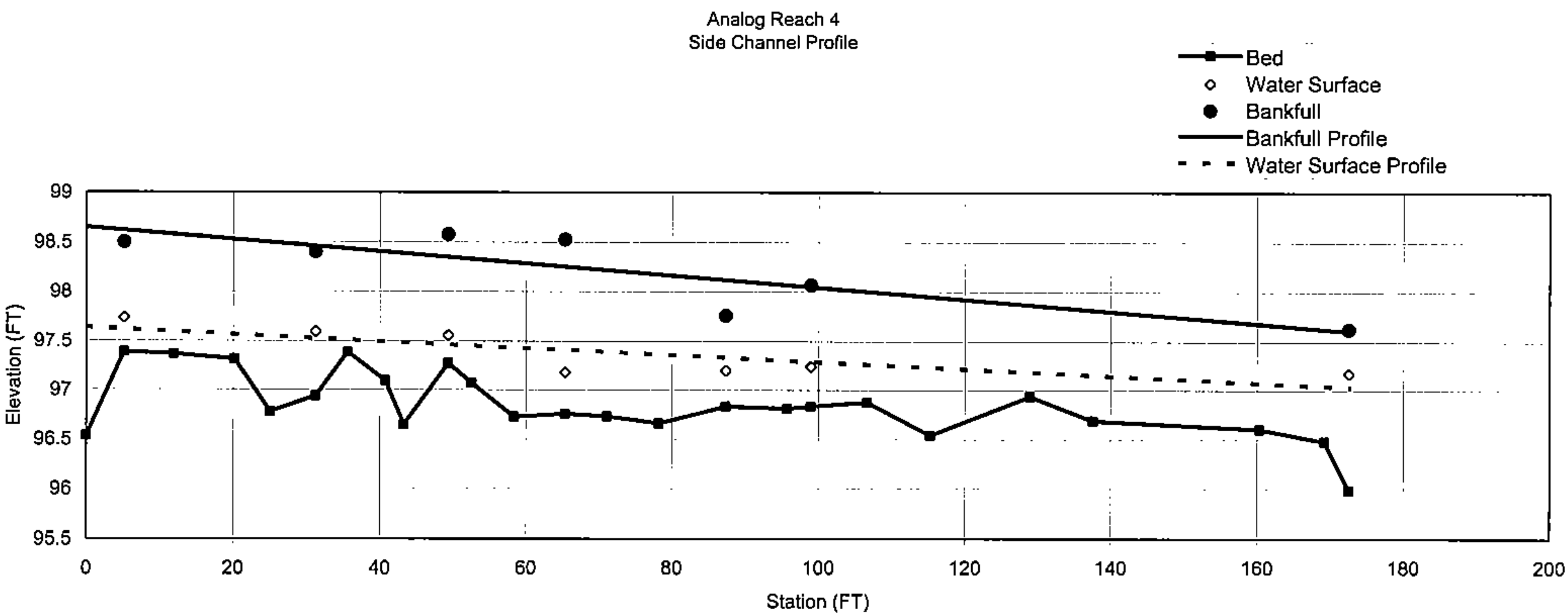
SIEVE OPENING SIZE (MM)	GROSS WT.	SIEVE WT.	NET WT. (Kg)	% OF TOTAL SAMPLE	CUMULATIVE % OF TOTAL SAMPLE	GRAMS
Less than 0.053			0.00	0.00	0.00	0.00
0.053			0.00	0.00	0.00	0.00
0.063			0.06	6.78	6.78	60.00
0.25			0.31	35.03	41.81	310.00
0.5			0.31	34.46	76.27	305.00
1			0.14	15.82	92.09	140.00
2			0.07	7.34	99.44	65.00
4			0.01	0.56	100.00	5.00
8			0.00	0.00	100.00	0.00
16			0.00	0.00	100.00	0.00
31.5			0.00	0.00	100.00	0.00
63			0.00	0.00	100.00	0.00
Total =	0	0	0.89	100.00	816.38	885.00



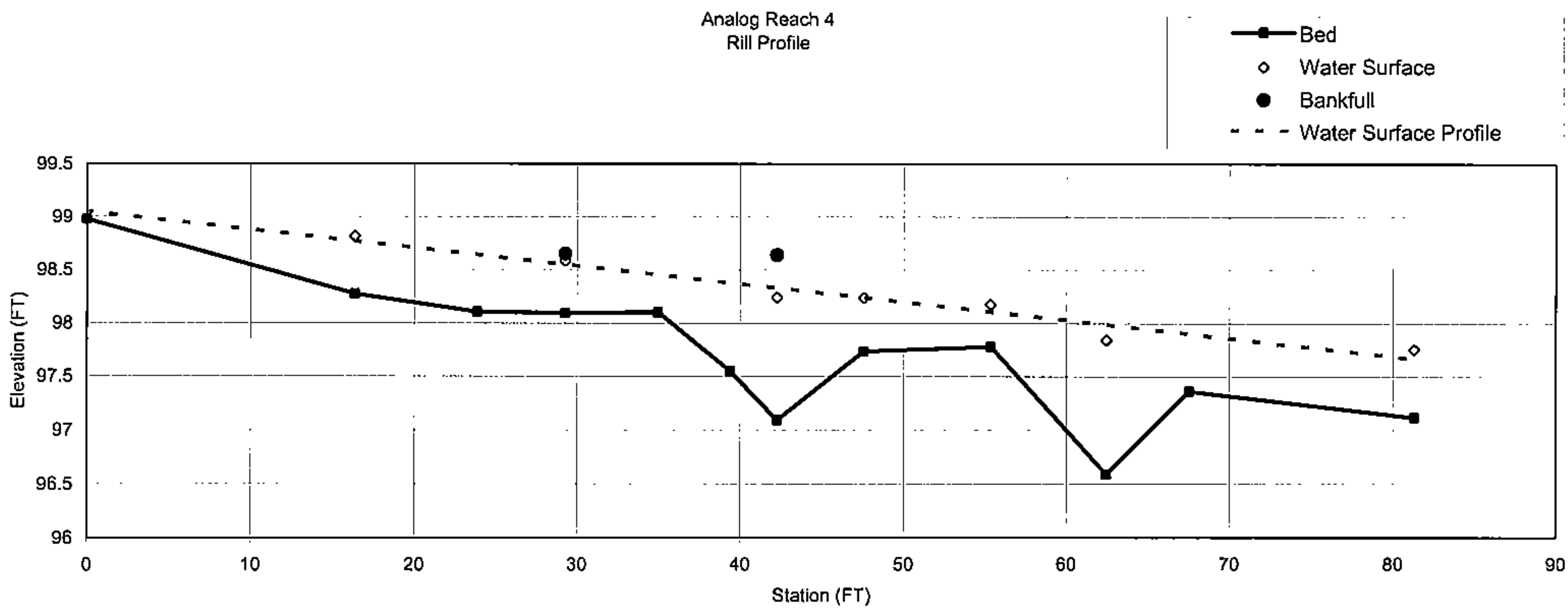
Analog Reach 4
Main Channel Profile
Bed
Water Surface
Bankfull
Bankfull Profile
Water Surface Profile
Elevation (FT)
100
99
98
97
96
95
94
93
0
100
200
300
400
500
600
700
Station (FT)



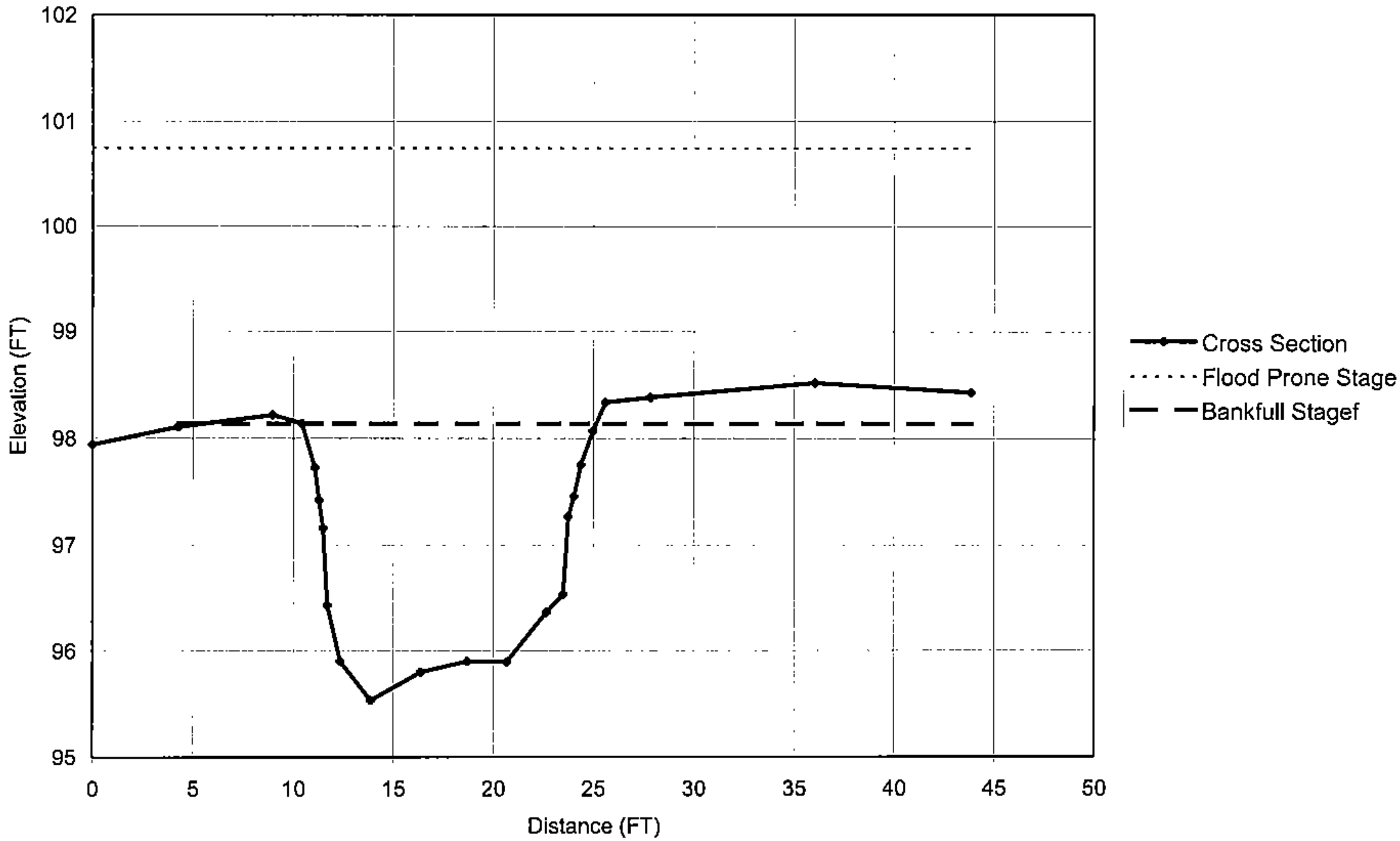
Analog Reach 4
Side Channel Profile
Bed
Water Surface
Bankfull
Linear (Water Surface)
99.5
99
98.5
98
97.5
97
96.5
96
Elevation (FT)
0
20
40
60
80
100
120
140
160
180
200
Station (FT)

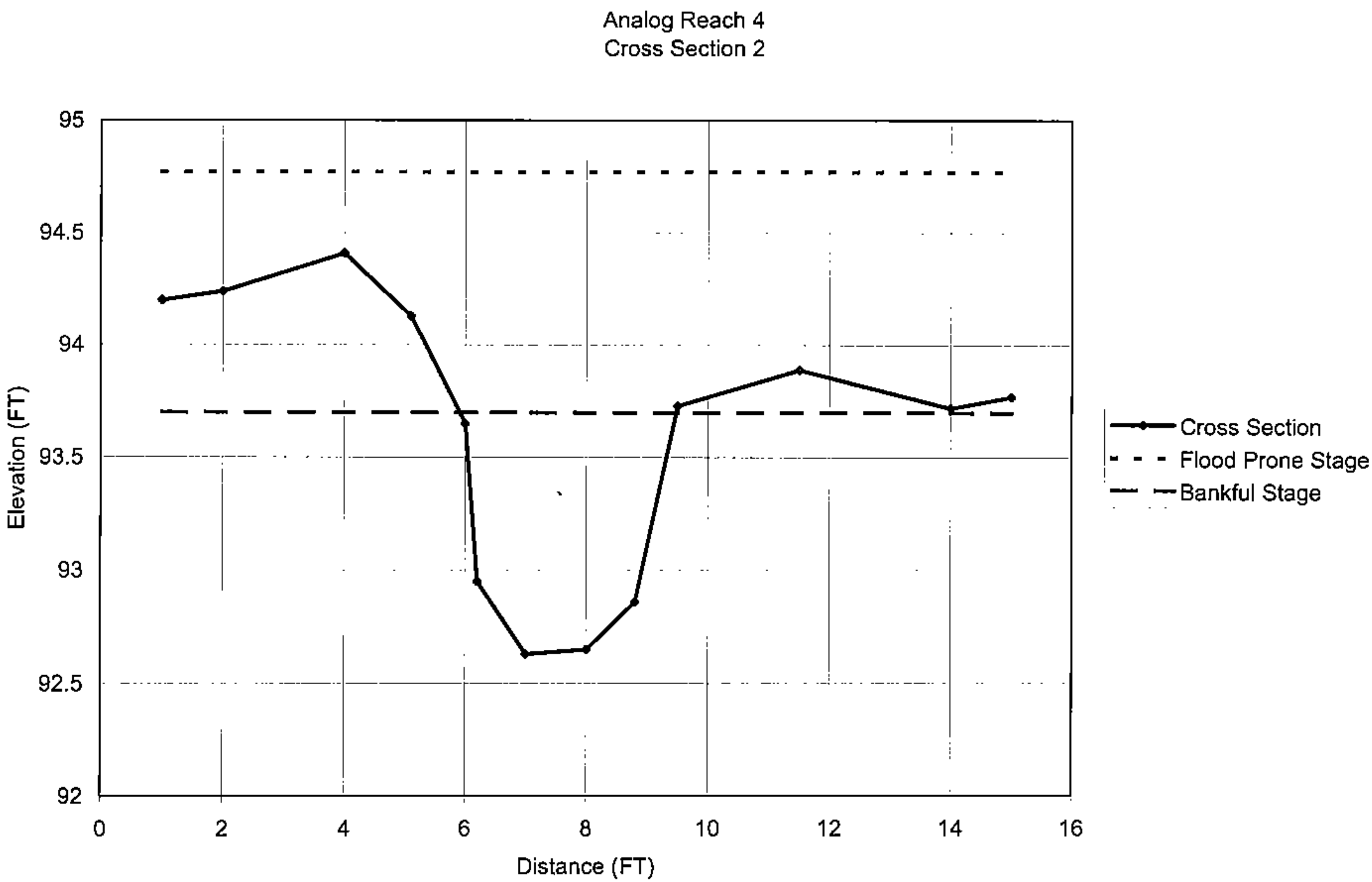


Analog Reach 4
Side Channel Profile
Bed
Water Surface
Bankfull
Bankfull Profile
Water Surface Profile
Elevation (FT)
99
98.5
98
97.5
97
96.5
96
95.5
0
20
40
60
80
100
120
140
160
180
200
Station (FT)

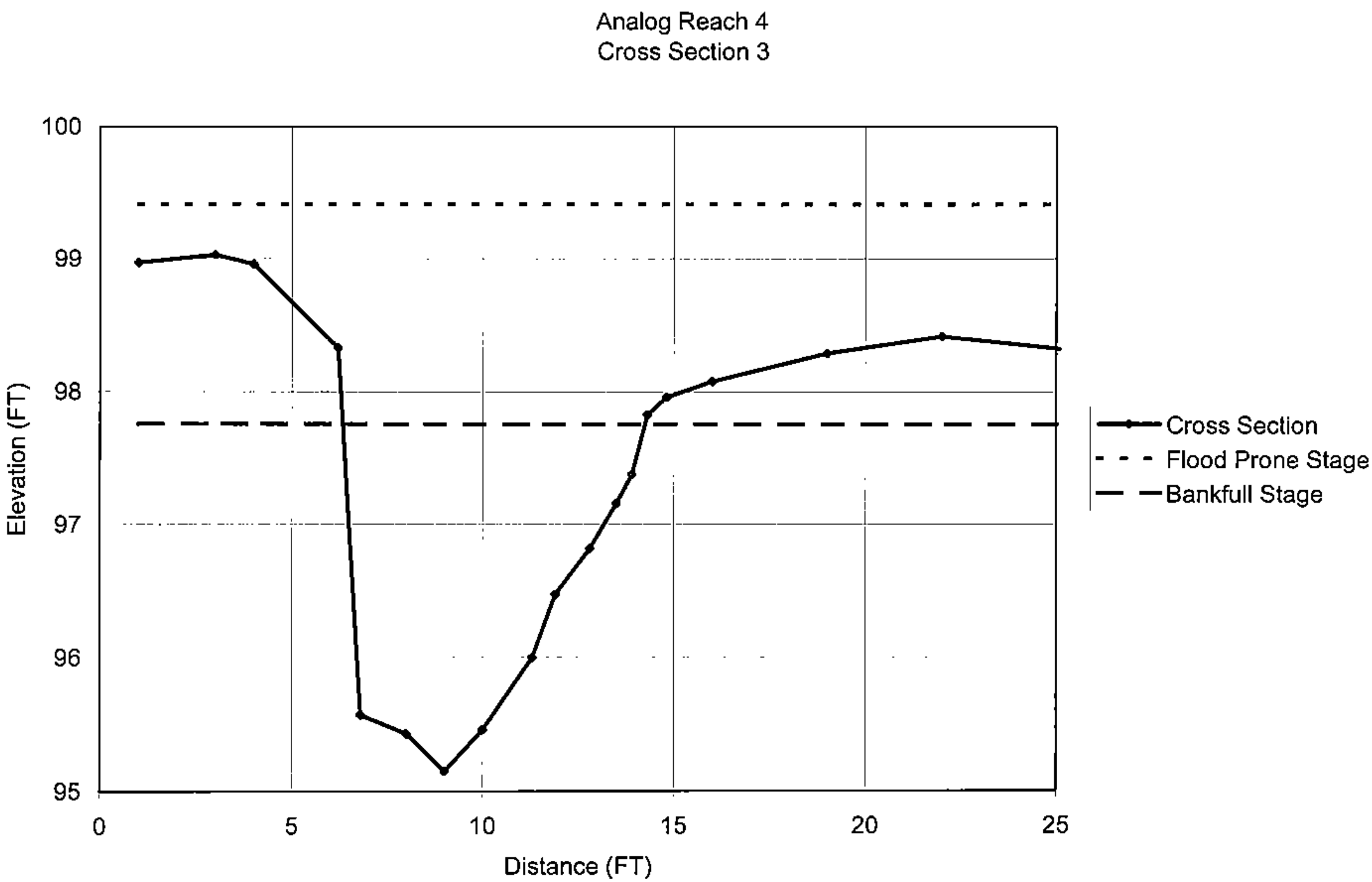

Analog Reach 4
Rill Profile
Bed
Water Surface
Bankfull
Water Surface Profile
Elevation (FT)
99.5
99
98.5
98
97.5
97
96.5
96
0
10
20
30
40
50
60
70
80
90
Station (FT)

Analog Reach 4
Cross Section 6



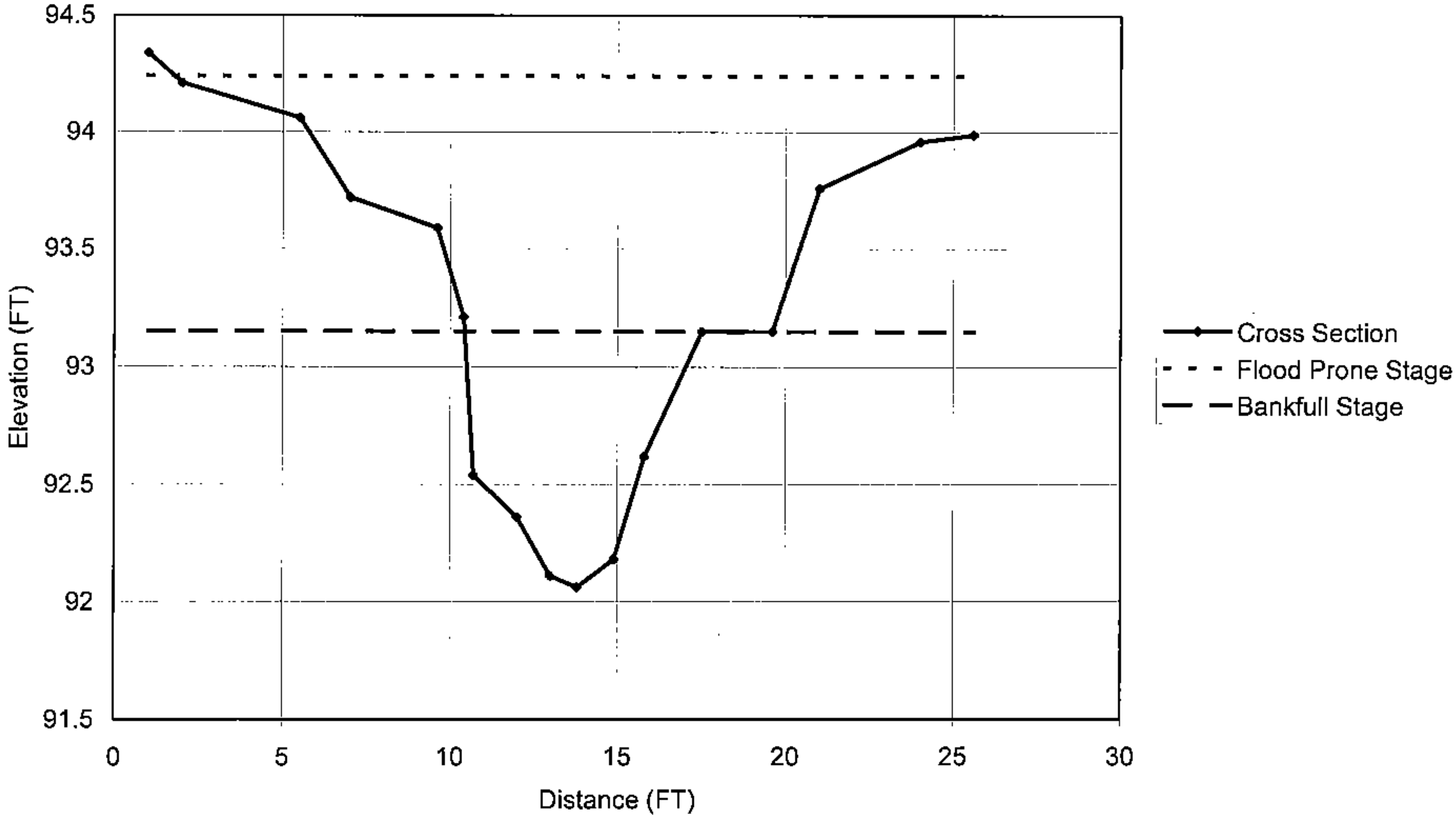


Analog Reach 4
Cross Section 2
95
94.5
94
93.5
93
92.5
92
Elevation (FT)
0
2
4
6
8
10
12
14
16
Distance (FT)
Cross Section
Flood Prone Stage
Bankful Stage

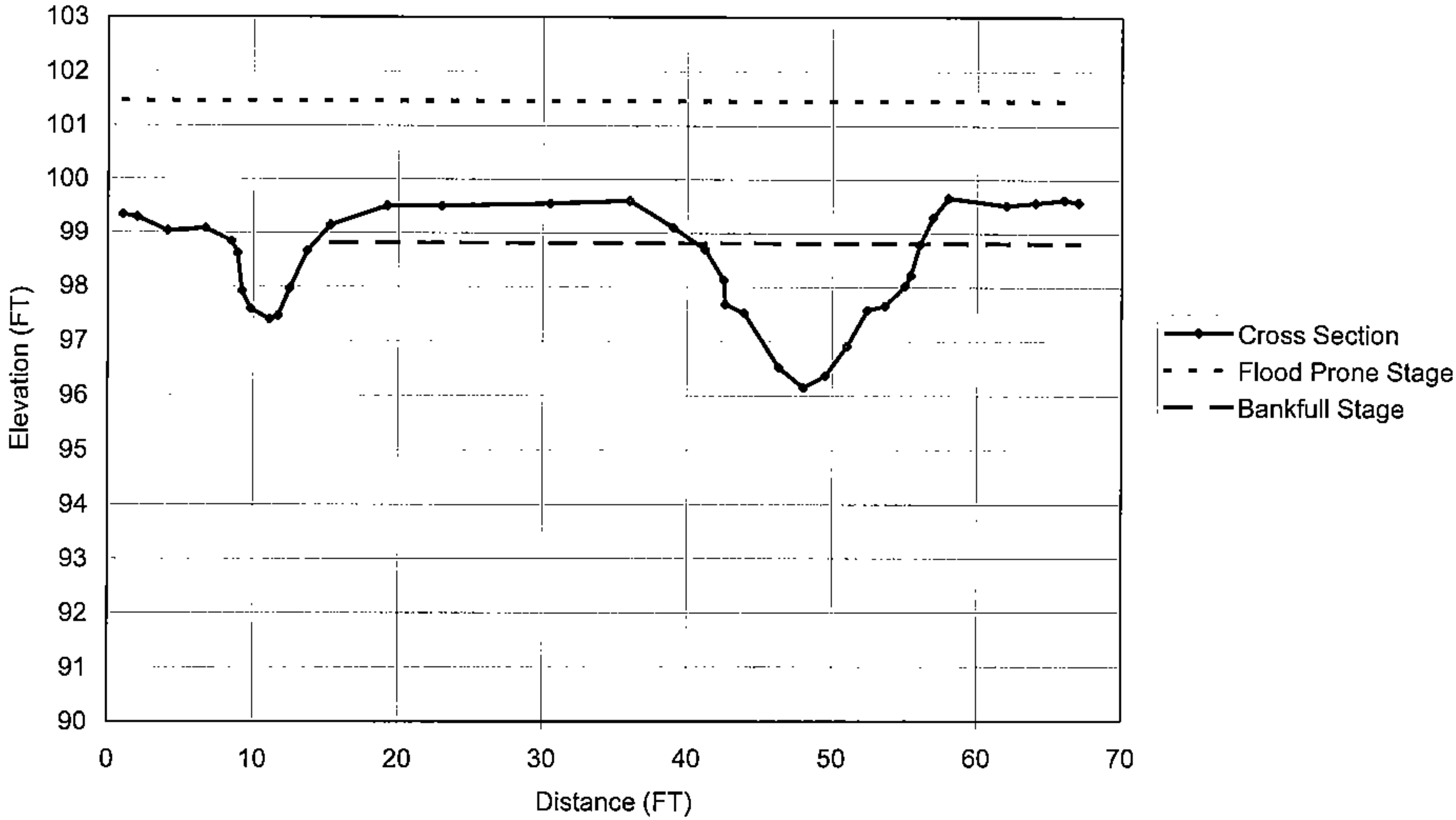


Analog Reach 4
Cross Section 3
100
99
98
97
96
95
Elevation (FT)
0
5
10
15
20
25
Distance (FT)
Cross Section
Flood Prone Stage
Bankfull Stage

Analog Reach 4
Cross Section 4



Analog Reach 4
Cross Section 5



Site Name: Looking Glass Run Analog 4
Data Point: Side Channel Pool
Sample taken by: JK, BH
Date: 5/24/2006

Sieve Analysis by: BH 6/7/06

SIEVE OPENING SIZE (MM)	GROSS WT.	SIEVE WT.	NET WT. (Kg)	% OF TOTAL SAMPLE	CUMULATIVE % OF TOTAL SAMPLE	GRAMS
Less than 0.053			0.00	0.00	0.00	0.00
0.053			0.01	1.64	1.64	5.00
0.063			0.09	27.87	29.51	85.00
0.25			0.09	29.51	59.02	90.00
0.5			0.08	26.23	85.25	80.00
1			0.05	14.75	100.00	45.00
2			0.00	0.00	100.00	0.00
4			0.00	0.00	100.00	0.00
8			0.00	0.00	100.00	0.00
16			0.00	0.00	100.00	0.00
31.5			0.00	0.00	100.00	0.00
63			0.00	0.00	100.00	0.00
Total =	0	0	0.31	100.00	875.41	305.00

Site Name: Looking Glass Run Analog 4
Data Point: Side Channel
Sample taken by: JK, BH
Date: 5/24/2006

Sieve Analysis by: BH 6/7/06

SIEVE OPENING SIZE (MM)	GROSS WT.	SIEVE WT.	NET WT. (Kg)	% OF TOTAL SAMPLE	CUMULATIVE % OF TOTAL SAMPLE	GRAMS
Less than 0.053			$0.00	$0.00	$0.00	$0.00
0.053			$0.00	$0.00	$0.00	$0.00
0.063			$0.05	$12.50	$12.50	$45.00
0.25			$0.16	$44.44	$56.94	$160.00
0.5			$0.10	$27.78	$84.72	$100.00
1			$0.05	$12.50	$97.22	$45.00
2			$0.01	$2.78	$100.00	$10.00
4			$0.00	$0.00	$100.00	$0.00
8			$0.00	$0.00	$100.00	$0.00
16			$0.00	$0.00	$100.00	$0.00
31.5			$0.00	$0.00	$100.00	$0.00
63			$0.00	$0.00	$100.00	$0.00
Total =	0	0	$0.36	$100.00	$851.39	$360.00

Site Name: Looking Glass Run Analog 4
Data Point: Main Channel Pool
Sample taken by: JK, BH
Date: 5/24/2006

Sieve Analysis by: BH 6/7/06

SIEVE OPENING SIZE (MM)	GROSS WT.	SIEVE WT.	NET WT. (Kg)	% OF TOTAL SAMPLE	CUMULATIVE % OF TOTAL SAMPLE	GRAMS
Less than 0.053			0.00	0.00	0.00	0.00
0.053			0.00	0.00	0.00	0.00
0.063			0.06	6.74	6.74	60.00
0.25			0.29	32.58	39.33	290.00
0.5			0.22	24.72	64.04	220.00
1			0.17	18.54	82.58	165.00
2			0.13	14.04	96.63	125.00
4			0.03	3.37	100.00	30.00
8			0.00	0.00	100.00	0.00
16			0.00	0.00	100.00	0.00
31.5			0.00	0.00	100.00	0.00
63			0.00	0.00	100.00	0.00
Total =	0	0	0.89	100.00	789.33	890.00

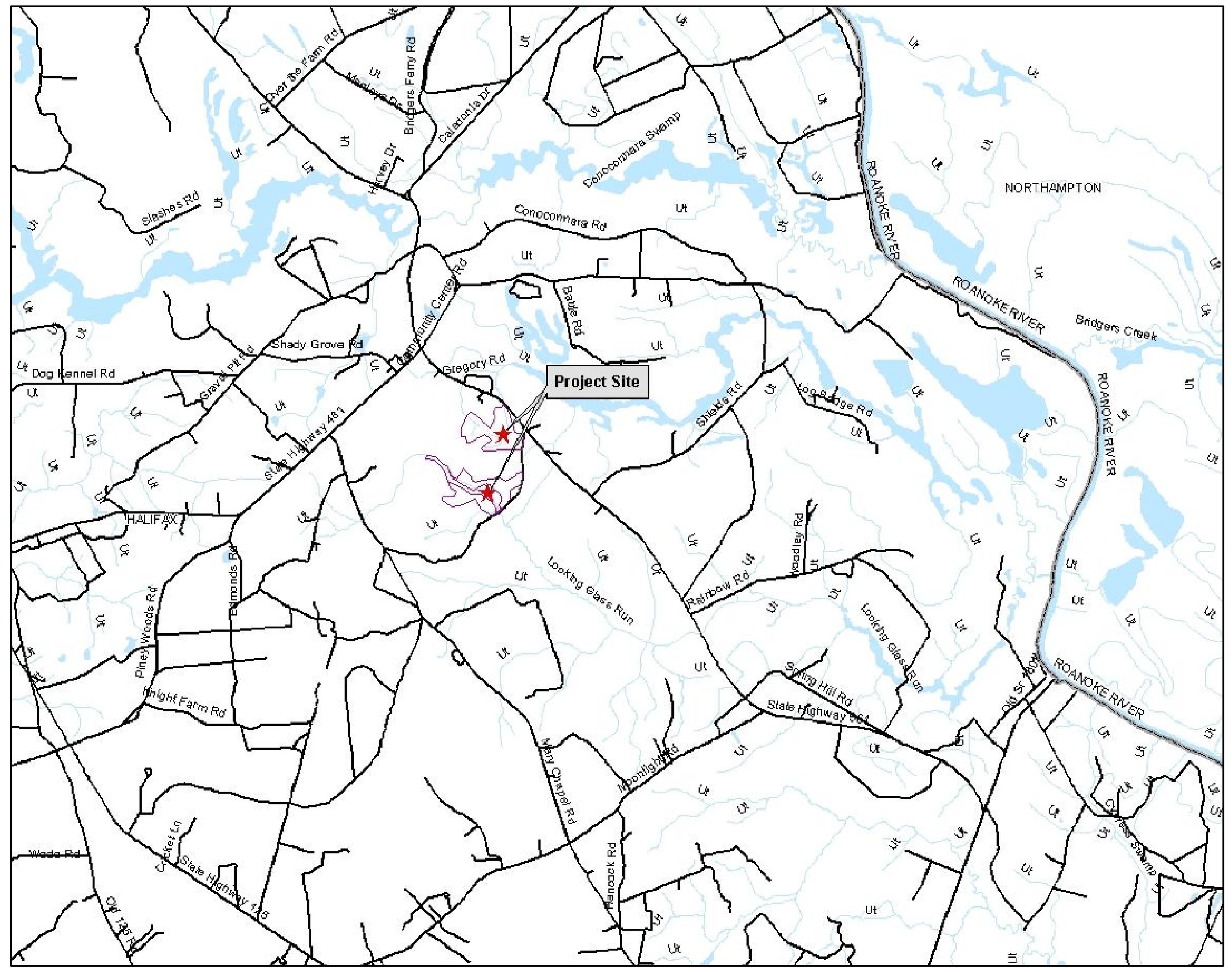
Site Name: Looking Glass Run Analog 4
Data Point: Main Channel
Sample taken by: JK, BH
Date: 5/24/2006

Sieve Analysis by: BH 6/7/06

SIEVE OPENING SIZE (MM)	GROSS WT.	SIEVE WT.	NET WT. (Kg)	% OF TOTAL SAMPLE	CUMULATIVE % OF TOTAL SAMPLE	GRAMS
Less than 0.053			0.00	0.00	0.00	0.00
0.053			0.00	0.00	0.00	0.00
0.063			0.04	3.78	3.78	35.00
0.25			0.23	24.86	28.65	230.00
0.5			0.36	38.92	67.57	360.00
1			0.21	22.16	89.73	205.00
2			0.05	4.86	94.59	45.00
4			0.05	5.41	100.00	50.00
8			0.00	0.00	100.00	0.00
16			0.00	0.00	100.00	0.00
31.5			0.00	0.00	100.00	0.00
63			0.00	0.00	100.00	0.00
Total =	0	0	0.925	100	784.3243243	925

CONOCONNARA MITIGATION PROJECT

JUNE 2006



VICINITY MAP
NTS

ENVIRONMENTAL BANC & EXCHANGE, LLC

MANAGERS, BANKERS AND TRADERS OF
ENVIRONMENTAL RIGHTS

2530 MERIDIAN PARKWAY SUITE 200
DURHAM, NC 27713
919-545-2929

WK DICKSON
community infrastructure consultants

3101 JOHN HUMPHRIES WYND
RALEIGH, NC 27612
(919) 782-0495

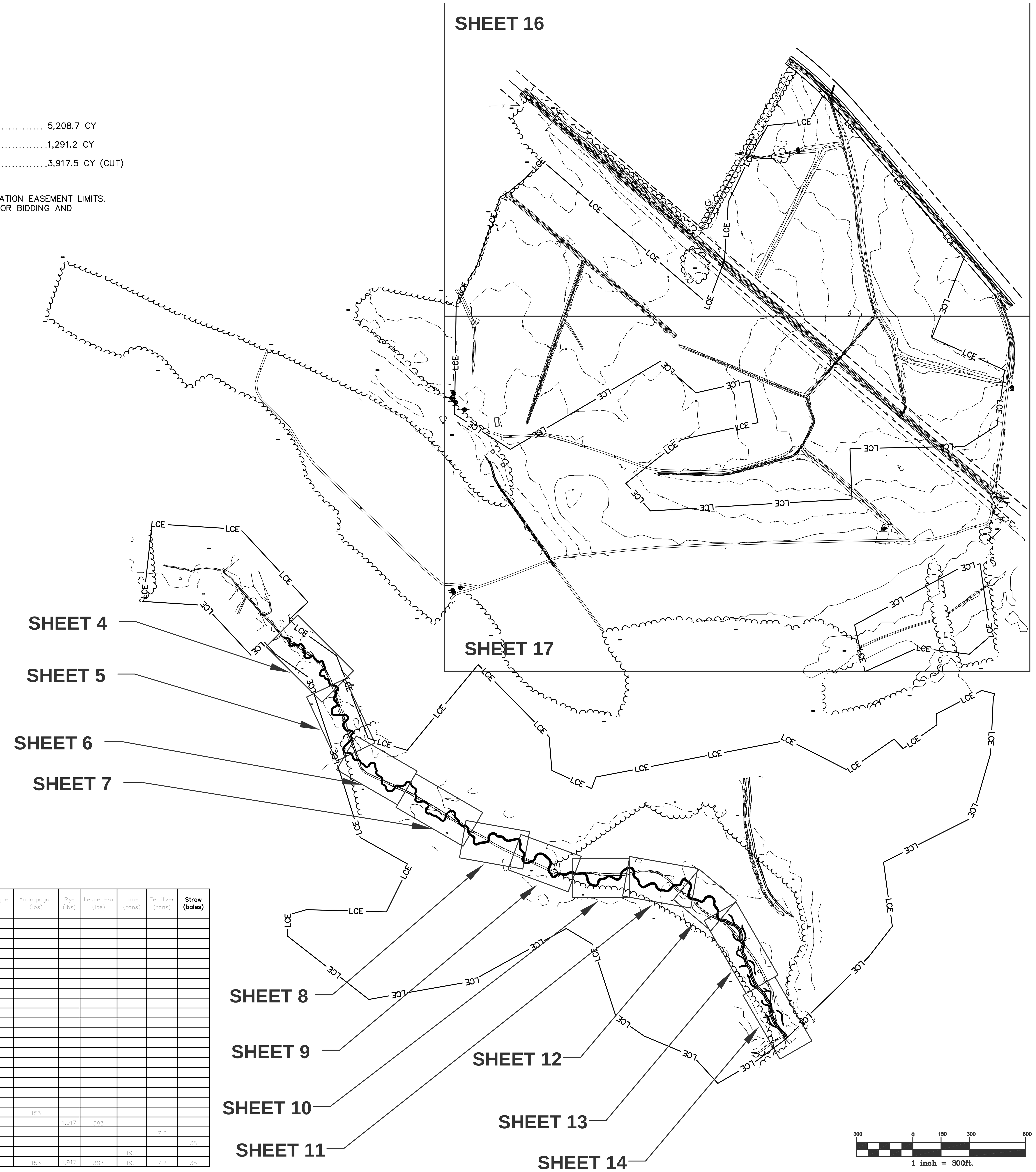
EBX

SHEET INDEX

EARTHWORK QUANTITY ESTIMATE

CUT .... 5,208.7 CY
FILL .... 1,291.2 CY
NET .... 3,917.5 CY (CUT)

NOTE:
1. EXCESS SOIL IS TO BE DISTRIBUTED IN AREAS WITHIN THE CONSERVATION EASEMENT LIMITS.
2. THESE QUANTITIES ARE ONLY ESTIMATES, CONTRACTOR TO VERIFY FOR BIDDING AND CONSTRUCTION PURPOSES.



QUANTITY ESTIMATE

Structure	Quantity Needed	Cuttings Bundle (ea)	Wattle Cuttings (ea)	Coir Fiber Matting (SY)	Silt Fence (LF)	Root Wads (ea)	Filter Fabric (SY)	Class A Stone (tons)	Class B Stone (tons)	#5 Stone (tons)	2-3" Stone (tons)	15' Long 8" Dia logs	12' Long 16" Dia logs (ea)	10' Long 8" Dia logs (ea)	4' Long 8" Dia logs (ea)	Raptor Pole (ea)	Backfill (yd3)	Wooden Stakes	Duckbill Anchors	4' x 5/8" Rebar	Concrete (CY)	Panicum Sp. (lbs)	Deertongue (lbs)	Andropogon (lbs)	Rye (lbs)	Lespedeza (lbs)	Lime (tons)	Fertilizer (tons)	Straw (bales)
Root Wad	67					67																							
Large Woody Debris	15												8		8				30										
Small Woody Debris	221																												
Wattle	74		74															294											
Dead Brush	74																	74											
Woody Debris Bundle	74																		74										
Leaf Pack	8			7																									
Log Ramp	3						30					30		6						30									
Raptor Pole	4															4					1								
Cuttings Bundle	52	52																											
Stream Channel Plug	19													19			291		76										
Wetland Channel Plug	48																736												
Log Grade Control	41						456						123	82					492										
Log Toe Protection	74						822							74					296										
Ford Crossing *	1						58	17																					
Coir Matting	1,765			1,765																									
Rock Check Dam	3								114	7																			
Construction Entrance	1						292				88																		
Silt Fence	1,404				1,404																								
Permanent Seeding	441																					153	134	153					
Temporary Seeding	2,300																								1,917	383			
Fertilizer	7.2																											7.2	
Straw	38.3																												38
Lime	19.2																										19.2		
Total	–	52	74	1,772	1,404	67	1,658	17	114	7	88	30	131	181	8	4	1,027	368	968	30	1	153	134	153	1,917	383	19.2	7.2	38

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER: DPI	DRAWING SCALE: 1" = 300'	RELEASED FOR	DATE
DRAWN BY: TRS	PROJECT DATE: 06/2006	APPROVALS	
APPROVED BY: ME	PROJECT NUMBER: 6002000RA	BIDDING	
FILE NAME: wetland.dwg	PLOT DATE: 11/10/2006	CONSTRUCTION	
		RECORD DWG.	

WK DICKSON
community infrastructure consultants

3101 JOHN HUMPHRIES WYND
RALEIGH, NC 27612
(919) 782-0495

Office Locations:
North Carolina Georgia
South Carolina Florida

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ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

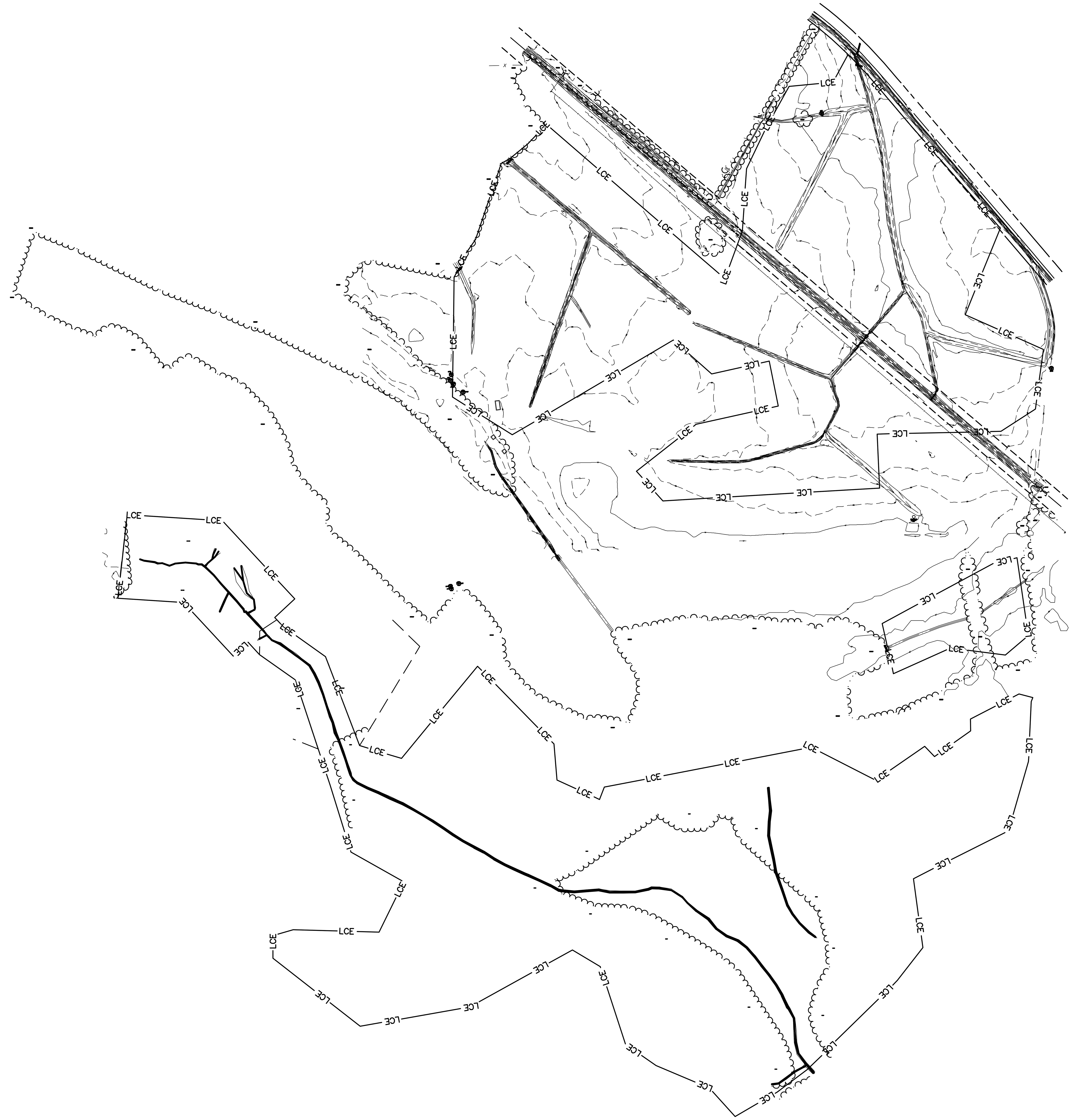
DESIGN PLANS
INDEX SHEET

LEGEND

TREE LINE

EXISTING CONTOURS

LIMITS OF CONSERVATION EASEMENT —— LCE ——



300 0 150 300 600

1 inch = 300ft.

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER DPI	DRAWING SCALE 1" = 300'
DRAWN BY TRS	PROJECT DATE 06/2006
APPROVED BY ME	PROJECT NUMBER 6002000RA
FILE NAME wetland.dwg	PLOT DATE 11/10/2006

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Office Locations:
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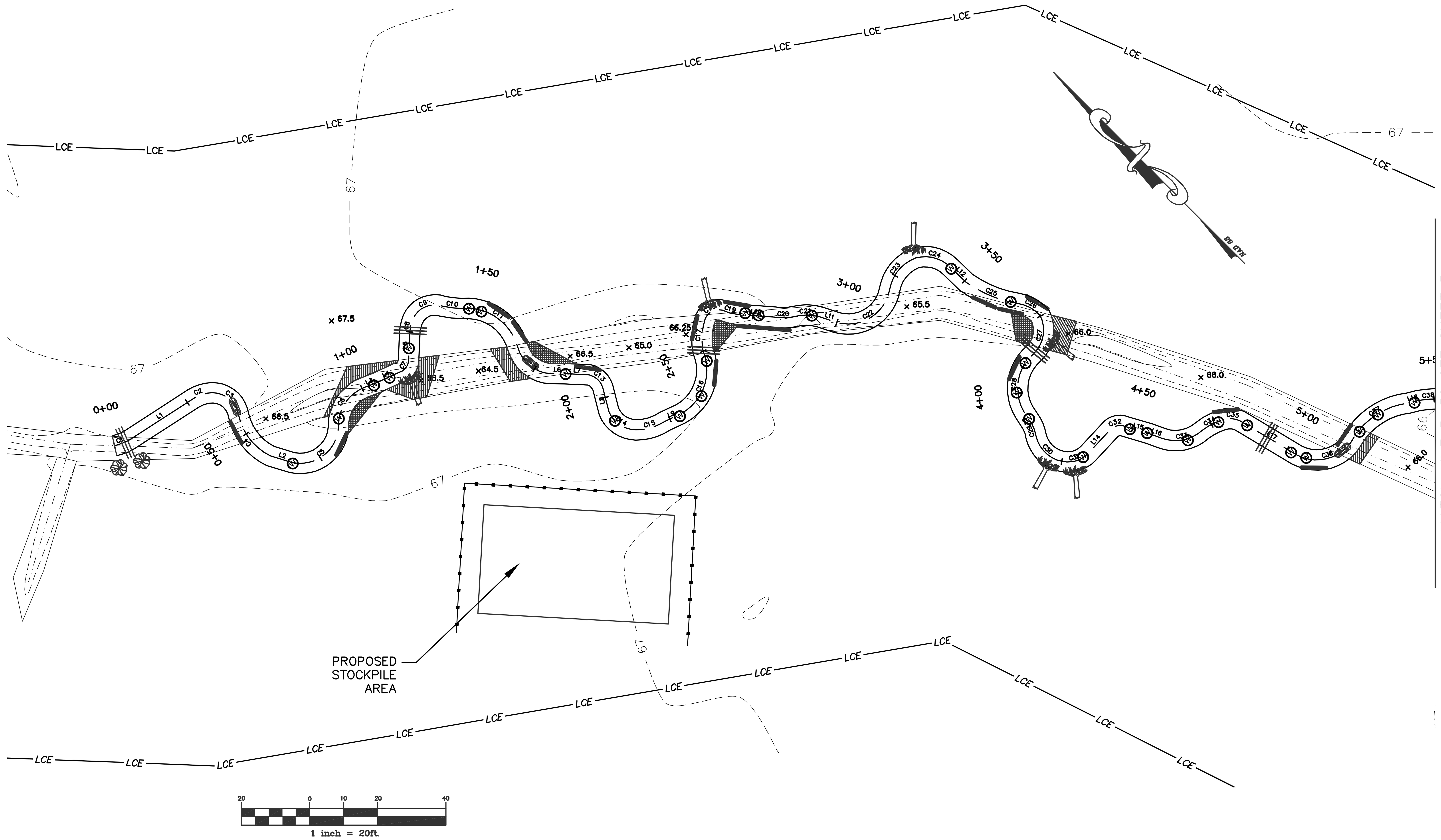
South Carolina Florida

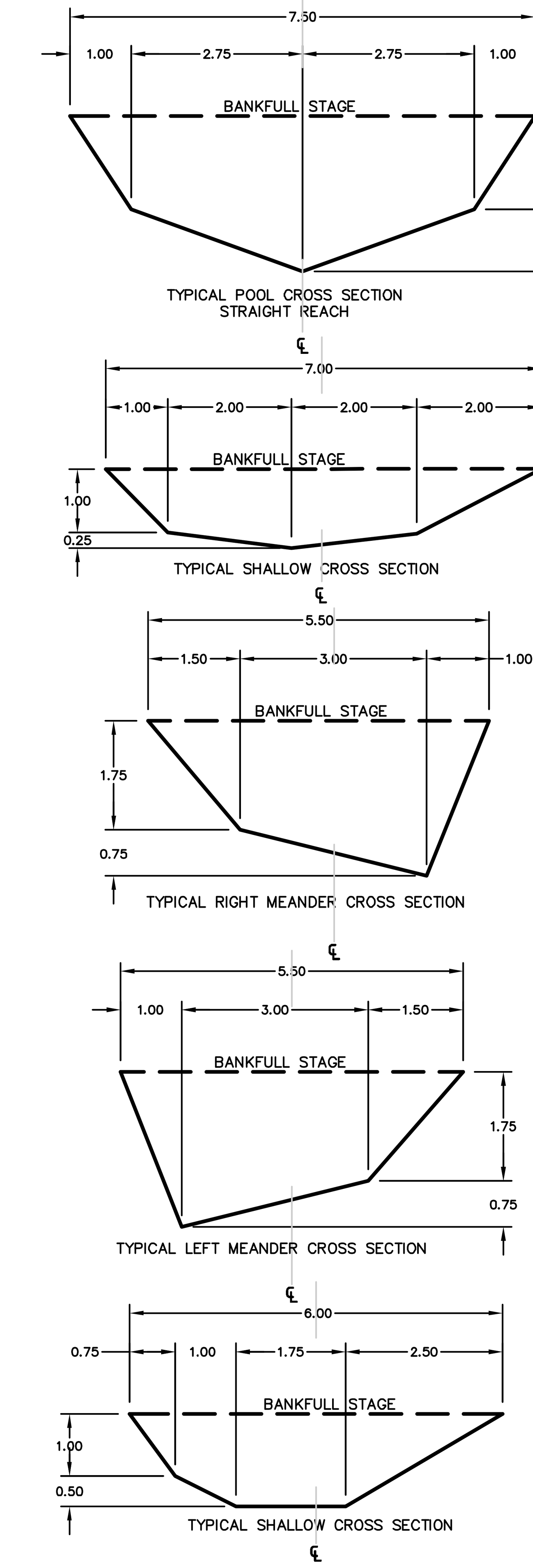
RELEASED FOR	DATE
APPROVALS	
BIDDING	
CONSTRUCTION	
RECORD DWG.	

EBX

ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

EXISTING CONDITIONS





NOT TO SCALE

LEGEND

- WOODS LINE
- EXISTING CONTOURS
- EXISTING DITCH
- PROPOSED CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- LIMITS OF CONSERVATION EASMENT — LCE
- SILT FENCE
- LOG RAMP
- SMALL WOODY DEBRIS
- LARGE WOODY DEBRIS
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- FORD CROSSING
- ROOT WAD
- CUTTINGS BUNDLE
- CHANNEL PLUG
- COIR MATTING
- PROPOSED SPOT ELEVATIONS +64.0

STRUCTURE	FROM		TO		*BANK
	STA	ELEV	STA	ELEV	
CUTTINGS BUNDLE	0+0	66.38	----	----	R
LOG GRADE CONTROL	0+01	65.18	----	----	----
CUTTINGS BUNDLE	0+05	66.40	----	----	R
LOG TOE	0+45	65.54	0+53	65.52	R
LOG TOE	0+78	65.55	0+86	64.89	R
ROOT WAD	1+13	66.16	----	----	R
LOG GRADE CONTROL	1+24	64.96	----	----	----
LOG TOE	1+52	65.42	1+60	64.94	L
LOG TOE	1+60	64.94	1+68	65.27	L
LOG TOE	1+87	65.40	1+96	65.36	L
LOG TOE	2+40	65.10	2+48	65.37	R
LOG GRADE CONTROL	2+49	64.91	----	----	----
LOG TOE	2+53	65.29	2+61	65.35	L
ROOT WAD	2+63	66.61	----	----	L
LOG TOE	2+66	65.19	2+74	65.40	L
LOG TOE	2+70	65.33	2+78	65.15	R
LOG TOE	2+78	65.27	2+86	65.20	R
ROOT WAD	3+28	66.30	----	----	L
LOG TOE	3+54	65.35	3+62	65.15	R
LOG TOE	3+62	65.15	3+70	65.35	R
LOG TOE	3+70	65.35	3+78	65.25	L
ROOT WAD	3+82	66.60	----	----	L
LOG GRADE CONTROL	3+86	64.76	----	----	----
LOG TOE	3+90	65.05	3+98	65.26	R
ROOT WAD	4+22	66.50	----	----	R
ROOT WAD	4+29	65.98	----	----	R
LOG TOE	4+77	65.23	4+85	64.90	L
LOG GRADE CONTROL	4+92	64.65	----	----	----
LOG TOE	5+05	64.97	5+13	65.11	R
LOG TOE	5+18	65.31	5+26	65.05	L

*RIGHT (R) AND LEFT (L) BANK LOCATIONS ARE REFERENCED LOOKING DOWNSTREAM

NOTES:

IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.

ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.

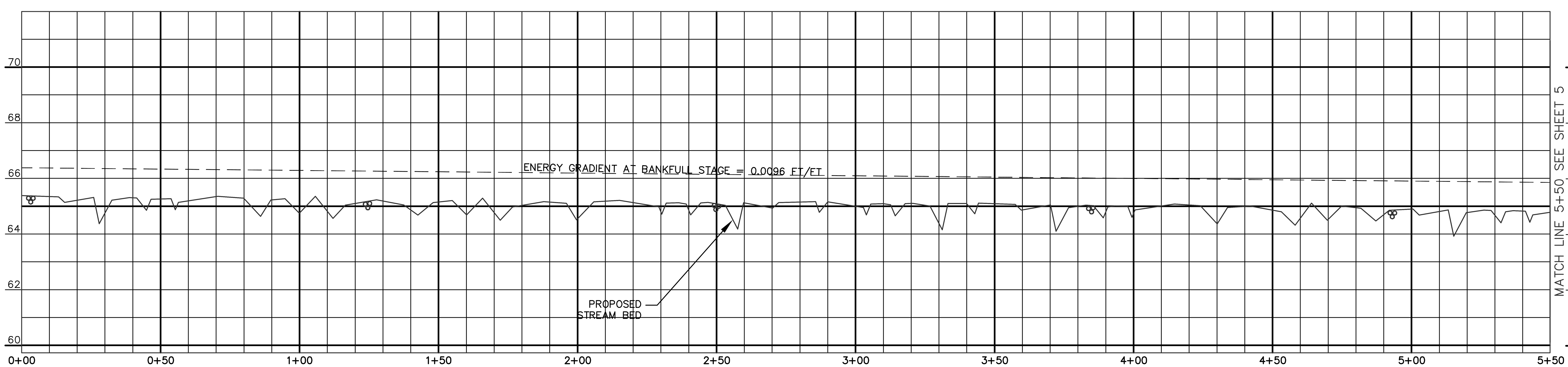
ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.

REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.

CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.

LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.

SOD MATS MAY BE SUBSTITUTED FOR COIR FIBER MATTING.



Horizontal Scale: 1 inch = 20ft.
Vertical Scale: 1 inch = 2ft.

LOG GRADE CONTROL
LOG RAMP

CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C1	16.11	4.74
C2	11.14	4.40
C3	7.84	12.67
C4	17.43	15.55
C5	11.22	19.27
C6	12.05	15.04
C7	3.98	5.44
C8	12.30	3.82
C9	7.09	10.73
C10	25.13	5.61
C11	15.56	21.78
C12	10.59	12.97
C13	5.47	5.50
C14	8.64	10.09
C15	15.27	9.12
C16	14.56	21.54
C17	18.74	9.70
C18	4.28	5.98
C19	14.78	4.77

CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C20	15.17	5.67
C21	14.43	7.68
C22	12.36	20.62
C23	12.11	12.55
C24	10.53	11.11
C25	35.23	16.47
C26	11.23	7.78
C27	9.58	11.95
C28	13.50	20.93
C29	9.92	3.84
C30	9.74	11.36
C31	8.13	8.38
C32	3.98	5.44
C33	11.89	12.88
C34	18.20	6.62
C35	6.58	6.48
C36	12.28	19.45
C37	22.09	19.52
C38	56.54	6.14

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER: DPI	DRAWING SCALE: 1" = 20'
DRAWN BY: TRS	PROJECT DATE: 06/2006
APPROVED BY: ME	PROJECT NUMBER: 6002000RA
FILE NAME: design_layout.dwg	PLOT DATE: 11/10/06

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RALEIGH, NC 27612
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Office Locations:
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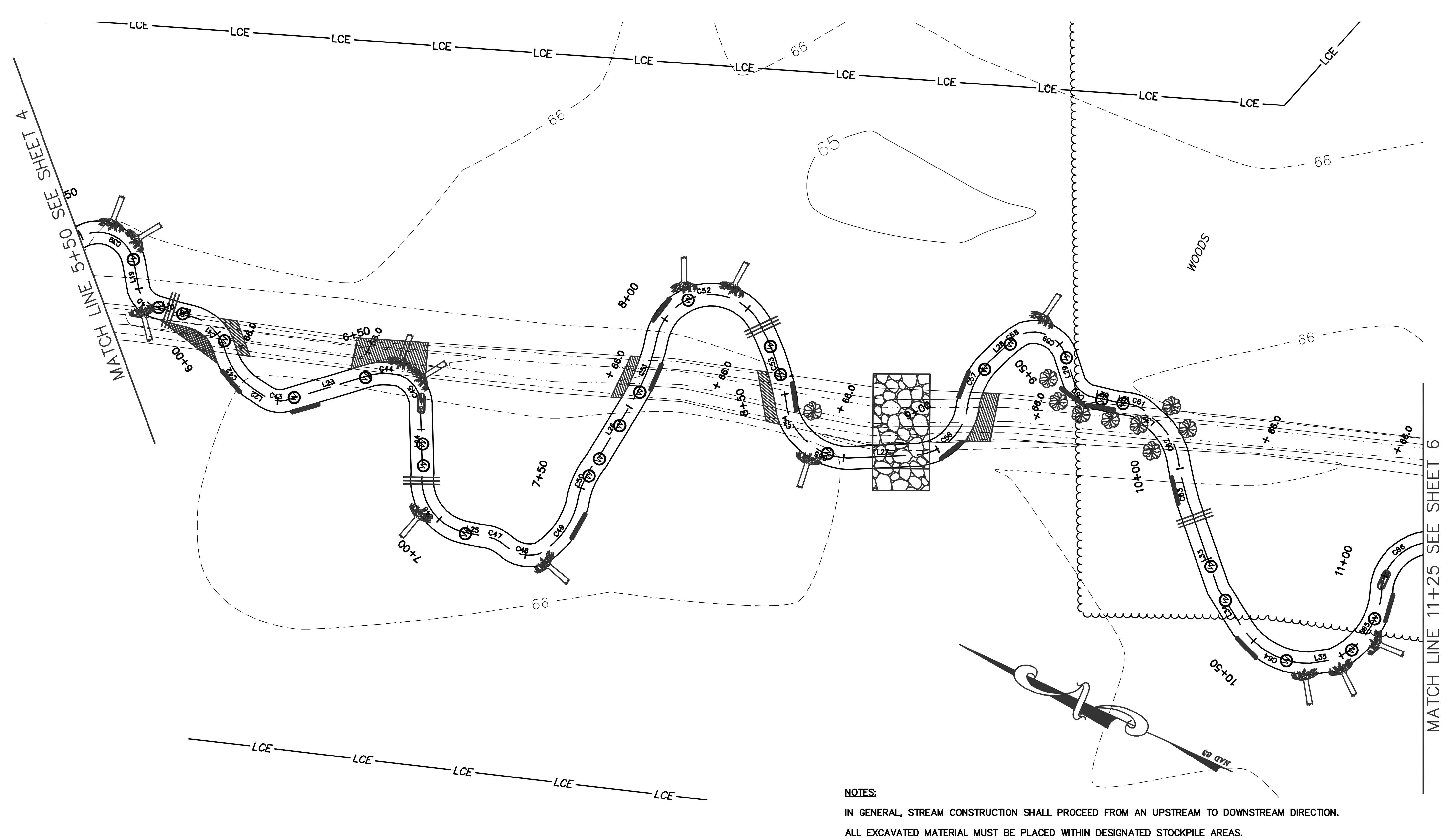
South Carolina — Florida

RELEASED FOR	DATE
APPROVALS	
BIDDING	
CONSTRUCTION	
RECORD DWG.	

EBX

ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN
STA. 0+00 TO STA. 5+50



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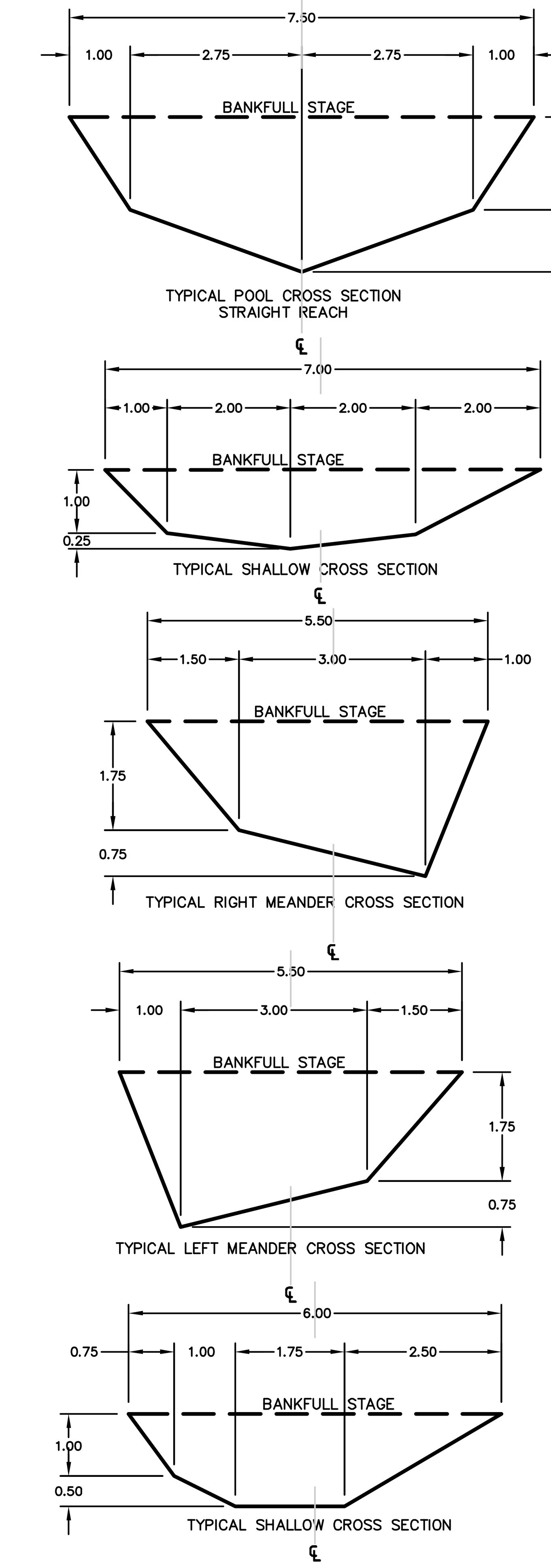


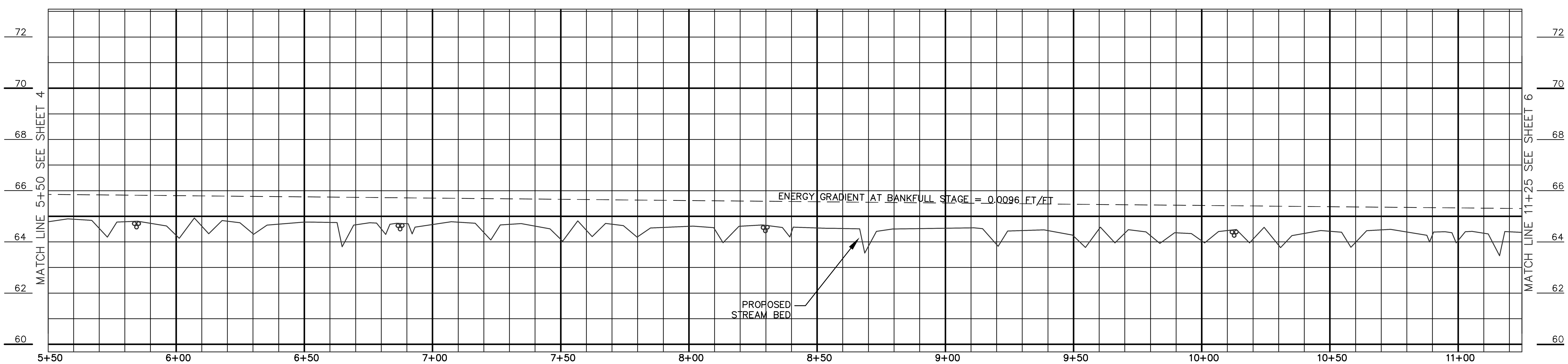
NOT TO SCALE

LEGEND

- WOODS LINE
- EXISTING CONTOURS
- EXISTING DITCH
- PROPOSED CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- LIMITS OF CONSERVATION EASMENT — LCE
- SILT FENCE
- LOG RAMP
- SMALL WOODY DEBRIS — W
- LARGE WOODY DEBRIS
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- FORD CROSSING
- ROOT WAD
- CUTTINGS BUNDLE
- CHANNEL PLUG
- COIR MATTING
- PROPOSED SPOT ELEVATIONS — +64.0

STRUCTURE	FROM		TO		*BANK
	STA	ELEV	STA	ELEV	
ROOT WAD	5+57	66.39	----	----	L
ROOT WAD	5+64	66.36	----	----	L
ROOT WAD	5+81	66.3	----	----	R
LOG GRADE CONTROL	5+84	64.60	----	----	----
LOG TOE	6+09	64.97	6+17	64.99	R
LOG TOE	6+37	64.92	6+45	64.98	R
ROOT WAD	6+58	66.26	----	----	L
ROOT WAD	6+63	66.13	----	----	L
LOG GRADE CONTROL	6+88	64.52	----	----	----
ROOT WAD	7+04	66.24	----	----	R
ROOT WAD	7+29	66.18	----	----	R
LOG TOE	7+36	64.94	7+44	64.79	R
LOG TOE	7+81	64.52	7+89	64.81	R
LOG TOE	7+93	64.83	9+01	64.86	L
ROOT WAD	8+10	66.00	----	----	L
ROOT WAD	8+20	66.11	----	----	L
LOG GRADE CONTROL	8+30	64.45	----	----	----
LOG TOE	8+47	64.8	8+55	64.78	L
CUTTINGS BUNDLE	8+57	65.56	----	----	L
ROOT WAD	8+68	65.34	----	----	R
FORD	8+82	65.01	8+97	65.03	----
LOG TOE	8+99	64.78	9+07	64.79	R
LOG TOE	9+15	64.71	9+23	64.46	L
ROOT WAD	9+45	65.85	----	----	L
CUTTINGS BUNDLE	9+58	65.46	----	----	R
LOG TOE	9+61	64.77	9+69	64.49	R
CUTTINGS BUNDLE	9+63	65.46	----	----	R
CUTTINGS BUNDLE	9+66	65.46	----	----	R
LOG TOE	9+66	64.23	9+74	64.69	R
CUTTINGS BUNDLE	9+73	65.45	----	----	R
CUTTINGS BUNDLE	9+84	65.44	----	----	R
CUTTINGS BUNDLE	9+85	65.44	----	----	L
CUTTINGS BUNDLE	9+92	65.43	----	----	L
CUTTINGS BUNDLE	9+93	65.43	----	----	R
LOG TOE	10+01	64.22	10+09	64.68	R
LOG GRADE CONTROL	10+13	64.28	----	----	----
LOG TOE	10+46	64.69	10+54	64.63	R
ROOT WAD	10+66	65.95	----	----	R
ROOT WAD	10+74	65.98	----	----	R
ROOT WAD	10+83	65.84	----	----	R
LOG TOE	10+88	64.45	10+96	64.63	R

*RIGHT (R) AND LEFT (L) BANK LOCATIONS ARE REFERENCED LOOKING DOWNSTREAM



Horizontal Scale: 1 inch = 20ft.
Vertical Scale: 1 inch = 2ft.

LOG GRADE CONTROL
LOG RAMP

CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C39	9.65	16.26
C40	6.92	6.57
C41	11.89	12.88
C42	17.58	12.67
C43	6.77	5.39
C44	17.58	7.20
C45	8.57	11.18
C46	14.12	20.68
C47	10.41	7.15
C48	9.07	9.72
C49	22.03	16.38
C50	23.88	13.23
C51	52.14	18.84
C52	14.65	35.31
C53	65.70	21.26
C54	14.18	10.22
C55	17.02	13.99
C56	14.69	18.46
C57	21.54	16.68
C58	19.74	4.83
C59	8.95	14.73
C60	7.15	5.14
C61	6.69	3.91
C62	17.58	12.67
C63	80.23	14.91
C64	21.09	20.84
C65	21.00	25.04
C66	13.89	20.69

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER DPI	DRAWING SCALE 1" = 20'
DRAWN BY TRS	PROJECT DATE 06/2006
APPROVED BY ME	PROJECT NUMBER 6002000RA
FILE NAME design_layout.dwg	PLOT DATE 11/10/06

WK DICKSON
community infrastructure consultants

3101 JOHN HUMPHRIES WYND
RALEIGH, NC 27612
(919) 782-0495

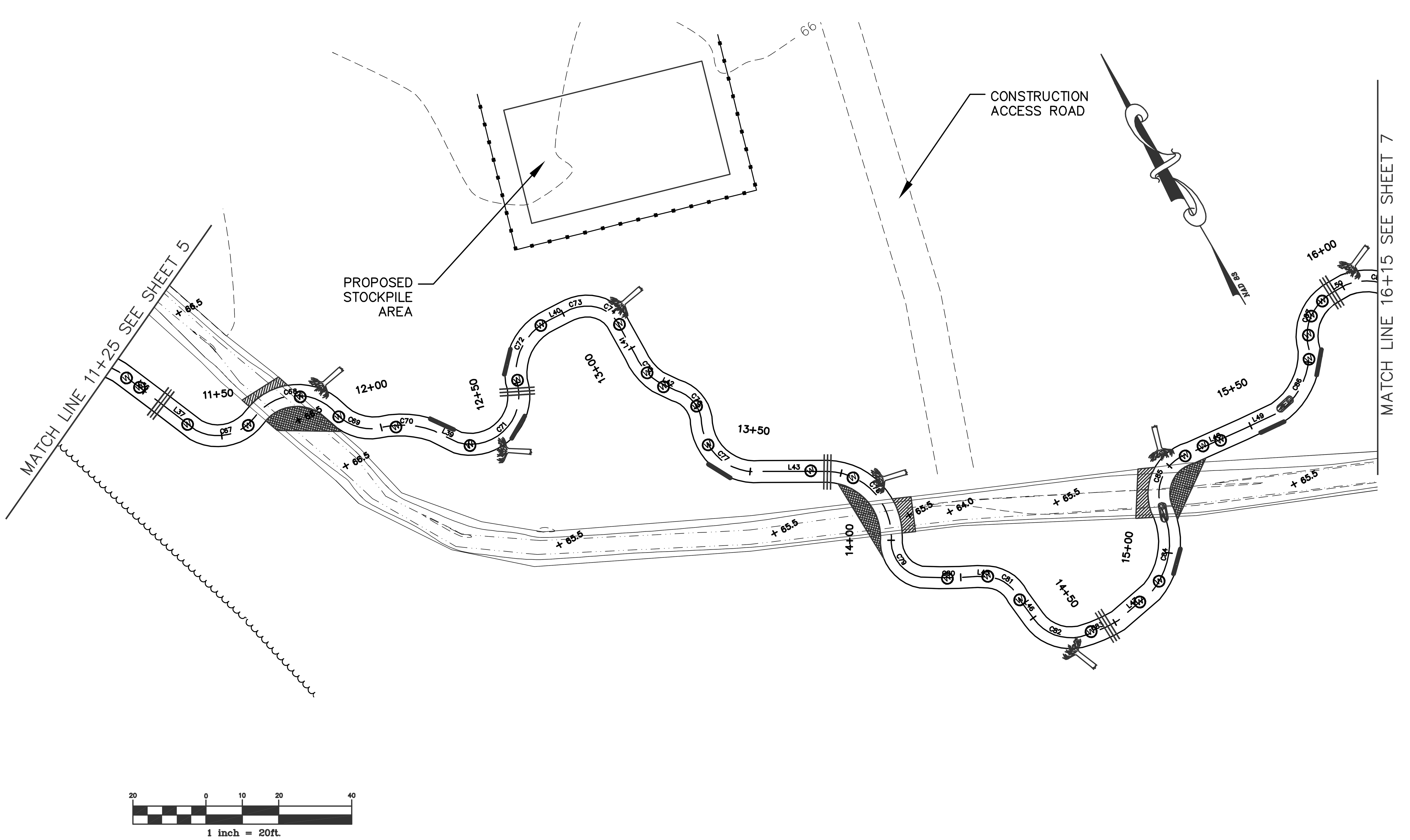
Office Locations:
North Carolina Georgia
South Carolina Florida

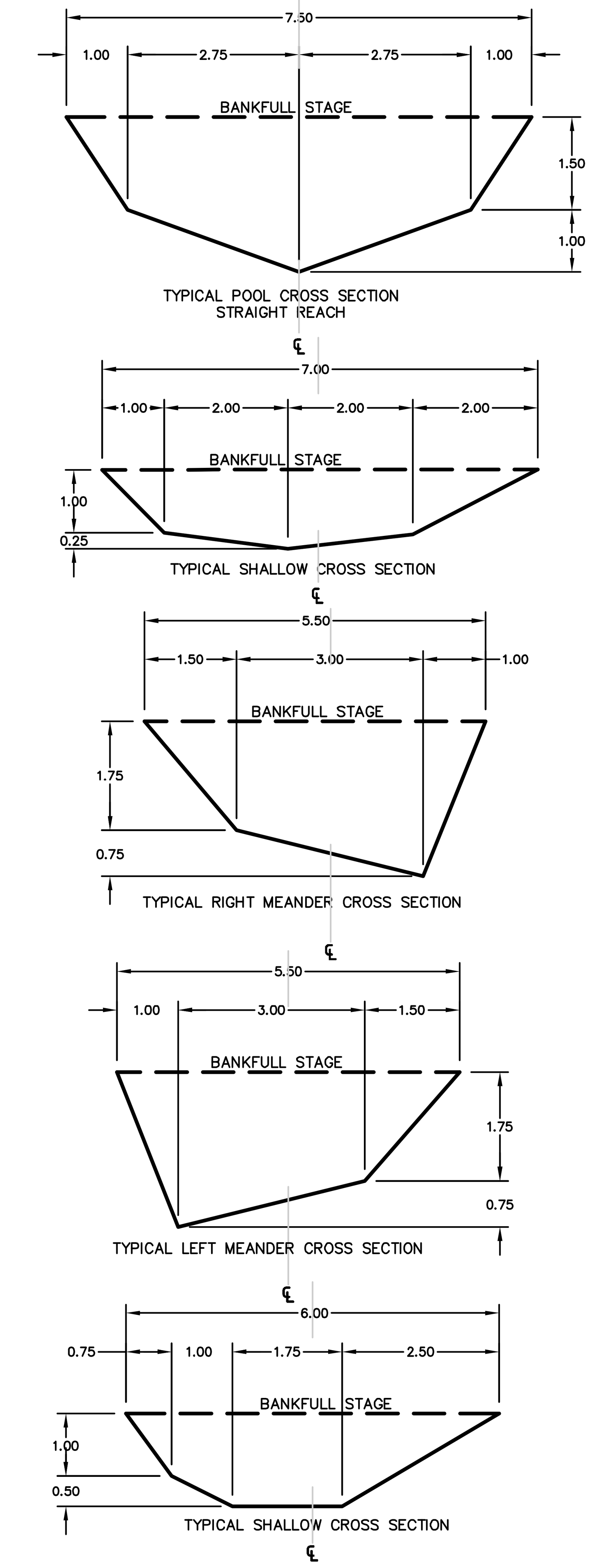
RELEASED FOR	DATE
APPROVALS	
BIDDING	
CONSTRUCTION	
RECORD DWG.	

EBX

ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN
STA. 5+50 TO STA. 11+25





NOT TO SCALE

LEGEND

WOODS LINE	
EXISTING CONTOURS	
EXISTING DITCH	
PROPOSED CENTER OF CHANNEL	
LIMITS OF BANKFULL CHANNEL	
LIMITS OF CONSERVATION EASMENT	LCE
SILT FENCE	
LOG RAMP	
SMALL WOODY DEBRIS	W
LARGE WOODY DEBRIS	
LOG GRADE CONTROL	
LOG TOE PROTECTION	
FORD CROSSING	
ROOT WAD	
CUTTINGS BUNDLE	
CHANNEL PLUG	
COIR MATTING	
PROPOSED SPOT ELEVATIONS	+64.0

NOTES:

IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.

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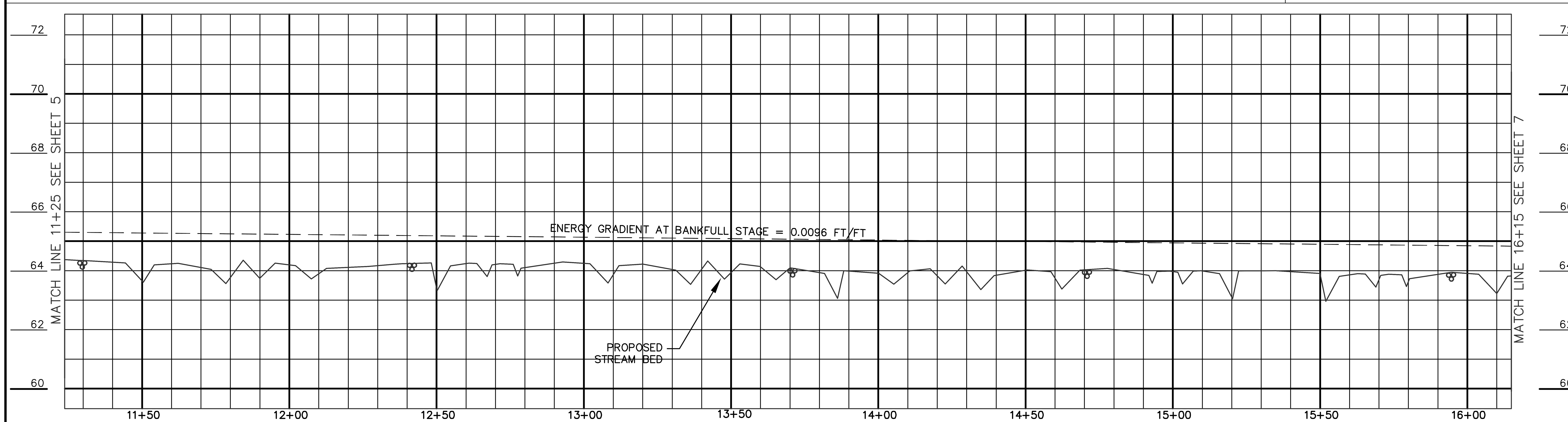
LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.

STRUCTURE	FROM		TO		*BANK
	STA	ELEV	STA	ELEV	
LOG GRADE CONTROL	11+29	64.15	----	----	----
ROOT WAD	11+81	65.41	----	----	L
LOG TOE	12+12	64.28	12+20	64.36	L
ROOT WAD	12+33	65.69	----	----	R
LOG TOE	12+35	64.46	12+43	64.5	R
LOG GRADE CONTROL	12+40	64.04	----	----	----
LOG TOE	12+52	63.91	12+60	64.49	L
ROOT WAD	12+89	65.74	----	----	L
LOG TOE	13+38	64.02	13+46	64.15	R
LOG GRADE CONTROL	13+70	63.90	----	----	----
ROOT WAD	13+86	64.59	----	----	L
ROOT WAD	14+61	65.08	----	----	R
LOG GRADE CONTROL	14+72	63.81	----	----	----
LOG TOE	14+95	64.22	15+03	63.88	R
ROOT WAD	15+26	65.49	----	----	L
LOG TOE	15+52	63.22	15+60	64.11	R
LOG TOE	15+72	64.11	15+80	63.88	R
LOG GRADE CONTROL	15+93	63.72	----	----	----
ROOT WAD	16+04	65.36	----	----	L

*RIGHT (R) AND LEFT (L) BANK LOCATIONS ARE REFERENCED LOOKING DOWNSTREAM

CURVE TABLE		
CURVE	ARC LENGTH	RADIUS
C67	12.52	17.99
C68	14.35	24.18
C69	13.21	14.64
C70	24.84	15.36
C71	13.26	28.55
C72	16.07	20.50
C73	12.45	7.83
C74	9.50	10.01
C75	16.73	9.69
C76	9.61	12.54
C77	14.74	23.16
C78	17.94	27.68
C79	10.19	15.12
C80	131.77	15.57
C81	9.64	10.27
C82	12.35	14.31
C83	41.48	11.35
C84	21.12	22.61
C85	11.56	21.08
C86	19.89	20.39
C87	13.58	18.50



Horizontal Scale: 1 inch = 20ft.
Vertical Scale: 1 inch = 2ft.

LOG GRADE CONTROL
LOG RAMP

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER DPI	DRAWING SCALE 1" = 20'
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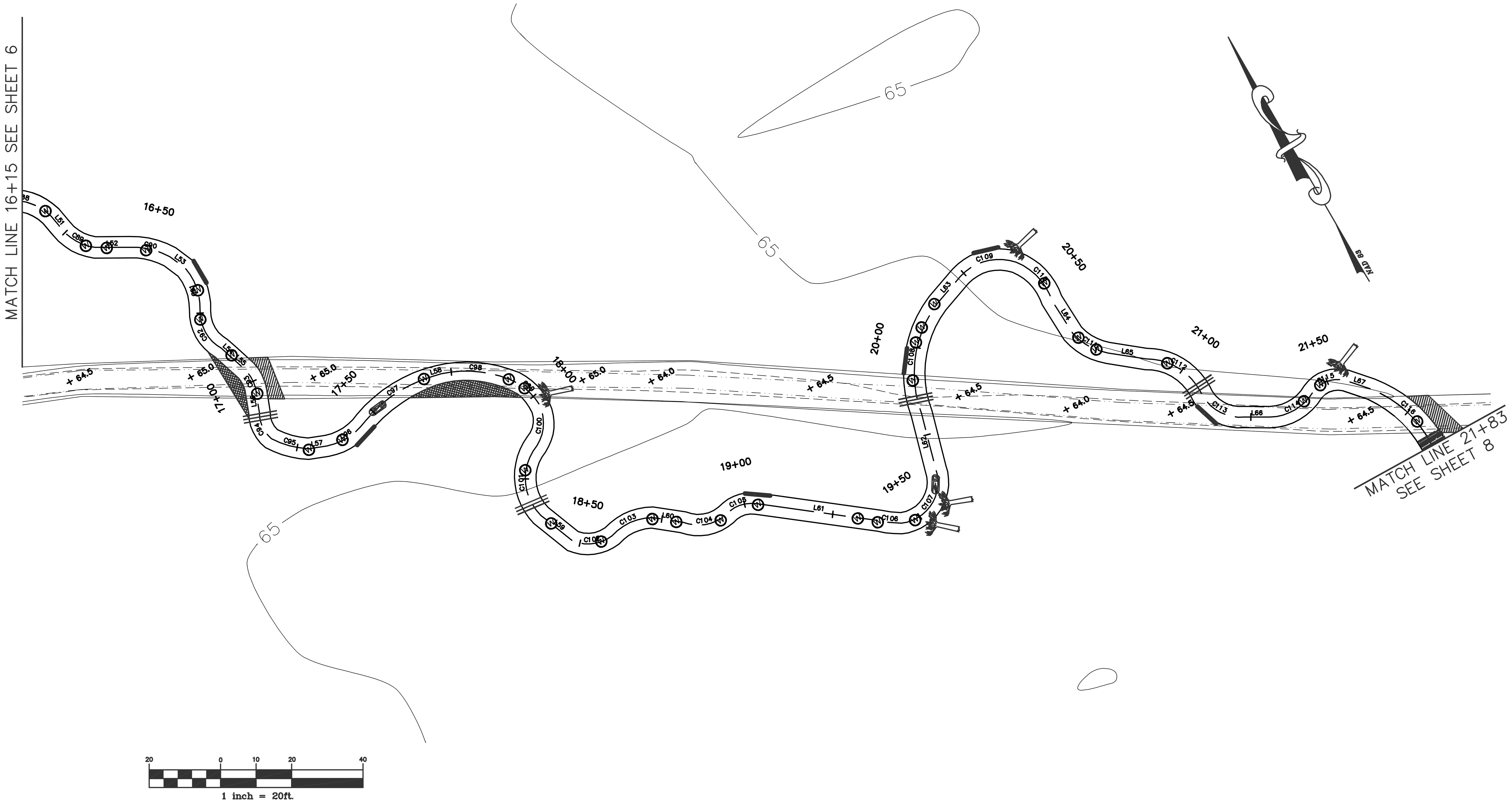
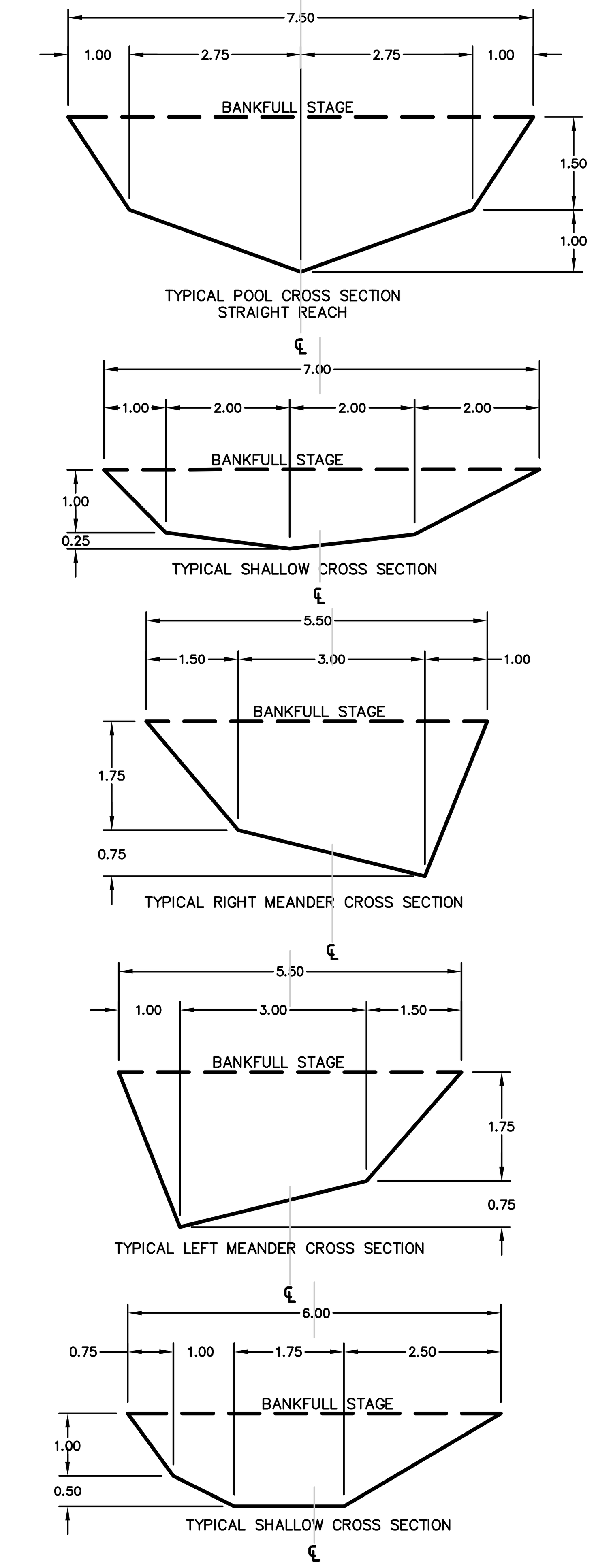
EBX

ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN
STA. 11+25 TO STA. 16+15





NOT TO SCALE

LEGEND

- WOODS LINE
- EXISTING CONTOURS
- EXISTING DITCH
- PROPOSED CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- LIMITS OF CONSERVATION EASMENT — LCE —
- SILT FENCE
- LOG RAMP
- SMALL WOODY DEBRIS
- LARGE WOODY DEBRIS
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- FORD CROSSING
- ROOT WAD
- CUTTINGS BUNDLE
- CHANNEL PLUG
- COIR MATTING
- PROPOSED SPOT ELEVATIONS +64.0

NOTES:

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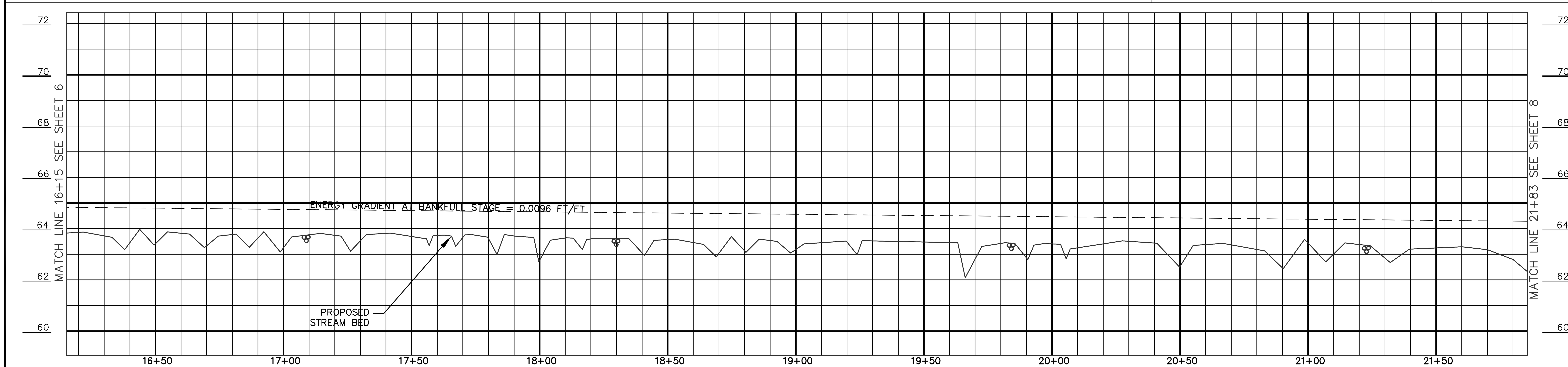
STRUCTURE	FROM		TO		*BANK
	STA	ELEV	STA	ELEV	
LOG TOE	16+69	63.52	16+77	63.99	L
LOG GRADE CONTROL	17+09	63.55	----	----	----
LOG TOE	17+40	64.07	17+48	63.97	R
ROOT WAD	18+02	64.64	----	----	L
LOG GRADE CONTROL	18+31	63.41	----	----	----
LOG TOE	19+00	63.44	19+08	63.69	L
ROOT WAD	19+52	64.97	----	----	R
ROOT WAD	19+57	64.96	----	----	R
LOG GRADE CONTROL	19+85	63.23	----	----	----
LOG TOE	19+90	63.12	19+98	63.66	L
LOG TOE	20+30	63.76	20+38	63.7	L
ROOT WAD	20+41	64.92	----	----	L
LOG GRADE CONTROL	21+06	63.13	----	----	----
LOG TOE	21+10	63.26	21+18	63.65	R
ROOT WAD	21+54	64.77	----	----	L
LOG RAMP	21+82	62.63	21+86	62.29	----

*RIGHT (R) AND LEFT (L) BANK LOCATIONS ARE REFERENCED LOOKING DOWNSTREAM



Horizontal Scale: 1 inch = 20ft.
Vertical Scale: 1 inch = 2ft.

CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C88	15.44	17.97
C89	14.63	10.97
C90	22.10	11.76
C91	17.58	12.67
C92	11.89	12.88
C93	11.61	5.55
C94	9.44	8.31
C95	25.36	10.83
C96	17.19	13.18
C97	38.41	23.04
C98	32.98	19.58
C99	17.14	11.11
C100	12.00	12.00
C101	14.56	21.54
C102	11.31	11.57
C103	15.60	12.76
C104	11.89	12.88
C105	9.55	9.59
C106	26.99	6.26
C107	11.60	20.78
C108	32.62	32.70
C109	14.84	17.01
C110	17.38	15.13
C111	17.19	11.37
C112	17.15	18.57
C113	12.32	15.32
C114	14.55	14.72
C115	8.56	10.17
C116	32.13	23.15

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER: DPI	DRAWING SCALE: 1" = 20'
DRAWN BY: TRS	PROJECT DATE: 06/2006
APPROVED BY: ME	PROJECT NUMBER: 6002000RA
FILE NAME: design_layout.dwg	PLOT DATE: 11/10/06

WK DICKSON
community infrastructure consultants

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Office Locations:
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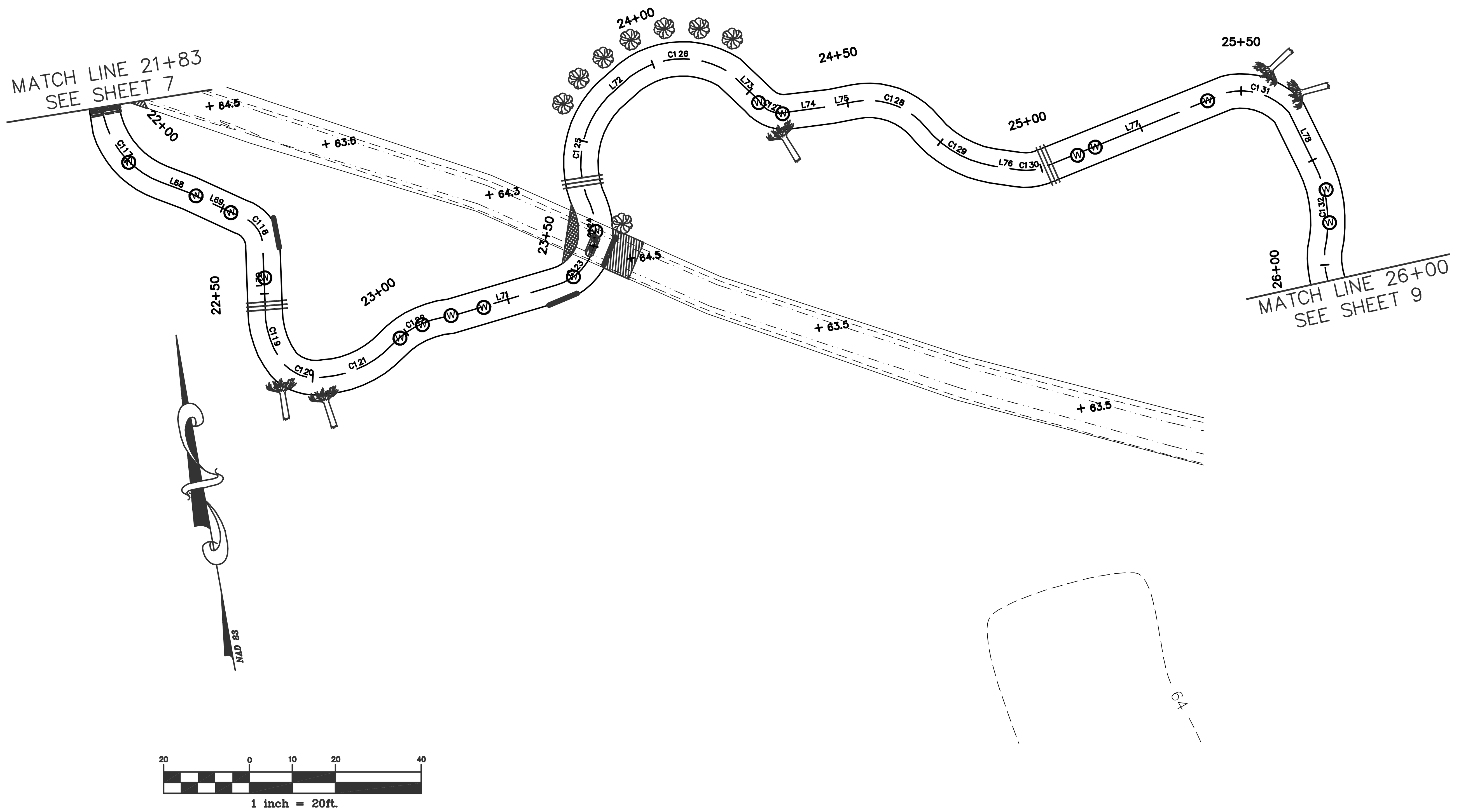
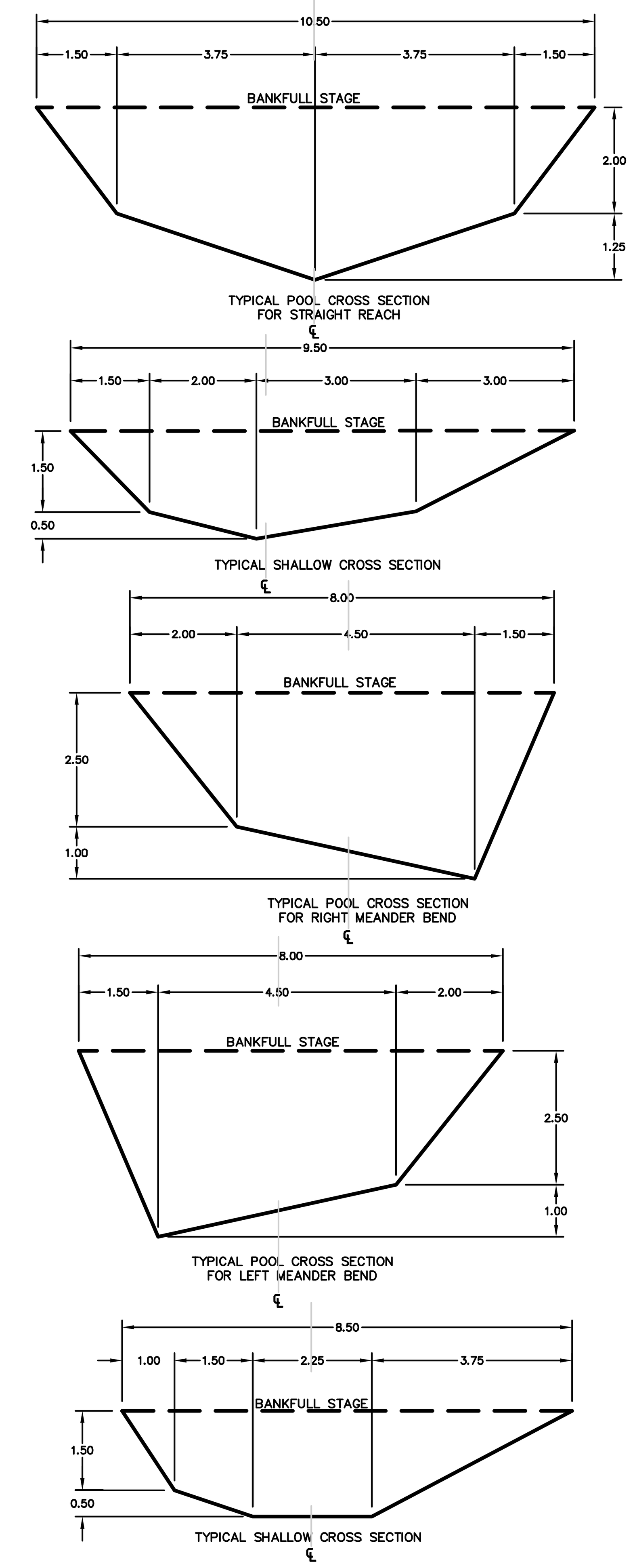
CONSTRUCTION	
RECORD DWG.	

EBX

ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN
STA. 16+15 TO STA. 21+83





NOT TO SCALE

LEGEND

- WOODS LINE
- EXISTING CONTOURS
- EXISTING DITCH
- PROPOSED CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- LIMITS OF CONSERVATION EASMENT — LCE —
- SILT FENCE
- LOG RAMP
- SMALL WOODY DEBRIS
- LARGE WOODY DEBRIS
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- FORD CROSSING
- ROOT WAD
- CUTTINGS BUNDLE
- CHANNEL PLUG
- COIR MATTING
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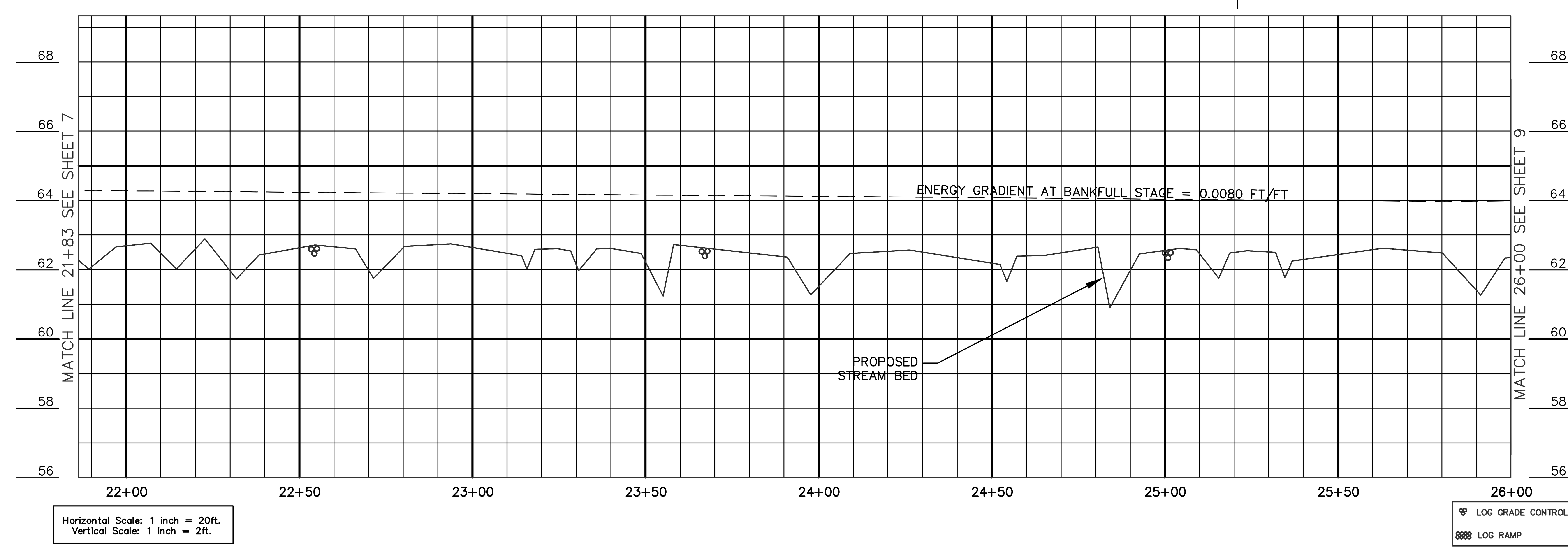
STRUCTURE	FROM		TO		*BANK
	STA	ELEV	STA	ELEV	
LOG TOE	22+34	62.21	22+42	62.73	L
LOG GRADE CONTROL	22+52	62.51	----	----	----
ROOT WAD	22+70	63.48	----	----	R
ROOT WAD	22+77	63.82	----	----	R
LOG TOE	23+30	62.39	23+38	62.86	R
LOG TOE	23+41	62.85	23+49	62.66	R
CUT BUNDLE	23+55	64.15	----	----	R
LOG GRADE CONTROL	23+65	62.43	----	----	----
CUT BUNDLE	23+77	64.14	----	----	L
CUT BUNDLE	23+82	64.13	----	----	L
CUT BUNDLE	23+88	64.13	----	----	L
CUT BUNDLE	23+94	64.12	----	----	L
CUT BUNDLE	24+00	64.12	----	----	L
CUT BUNDLE	24+06	64.11	----	----	L
CUT BUNDLE	24+12	64.11	----	----	L
ROOT WAD	24+35	63.93	----	----	R
LOG GRADE CONTROL	25+00	62.35	----	----	----
ROOT WAD	25+56	64.01	----	----	L
ROOT WAD	25+60	64.08	----	----	L

*RIGHT (R) AND LEFT (L) BANK LOCATIONS ARE REFERENCED LOOKING DOWNSTREAM



CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C117	21.73	23.53
C118	7.27	9.94
C119	19.33	13.99
C120	9.86	10.17
C121	23.69	17.52
C122	21.51	15.77
C123	12.61	12.51
C124	15.91	10.56
C125	22.17	27.13
C126	20.18	24.35
C127	5.74	7.85
C128	17.15	18.57
C129	25.36	18.27
C130	12.57	5.62
C131	14.82	15.99
C132	30.37	20.97

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER: DPI
DRAWN BY: TRS
APPROVED BY: ME
FILE NAME: design_layout.dwg
DRAWING SCALE: 1" = 20'
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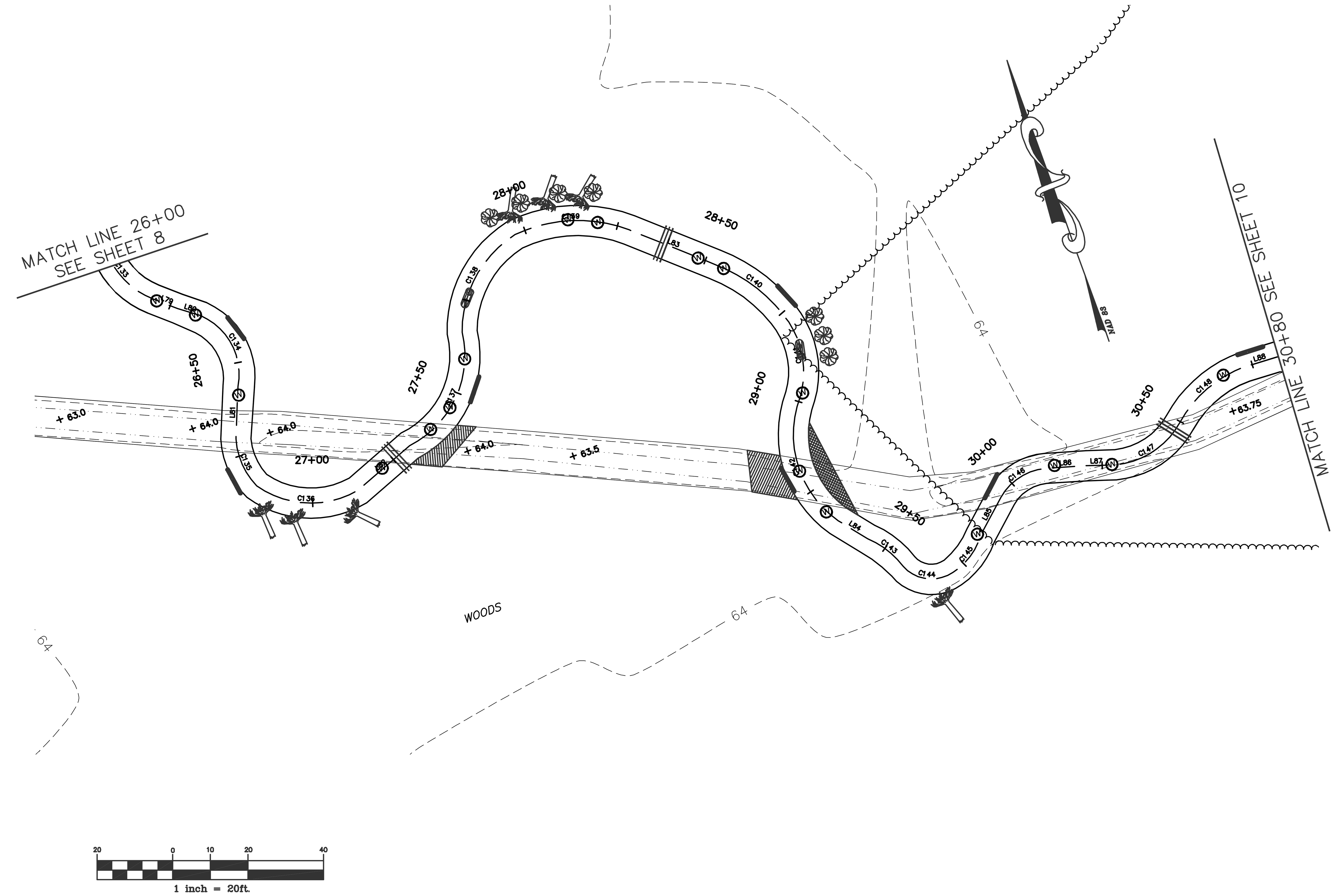
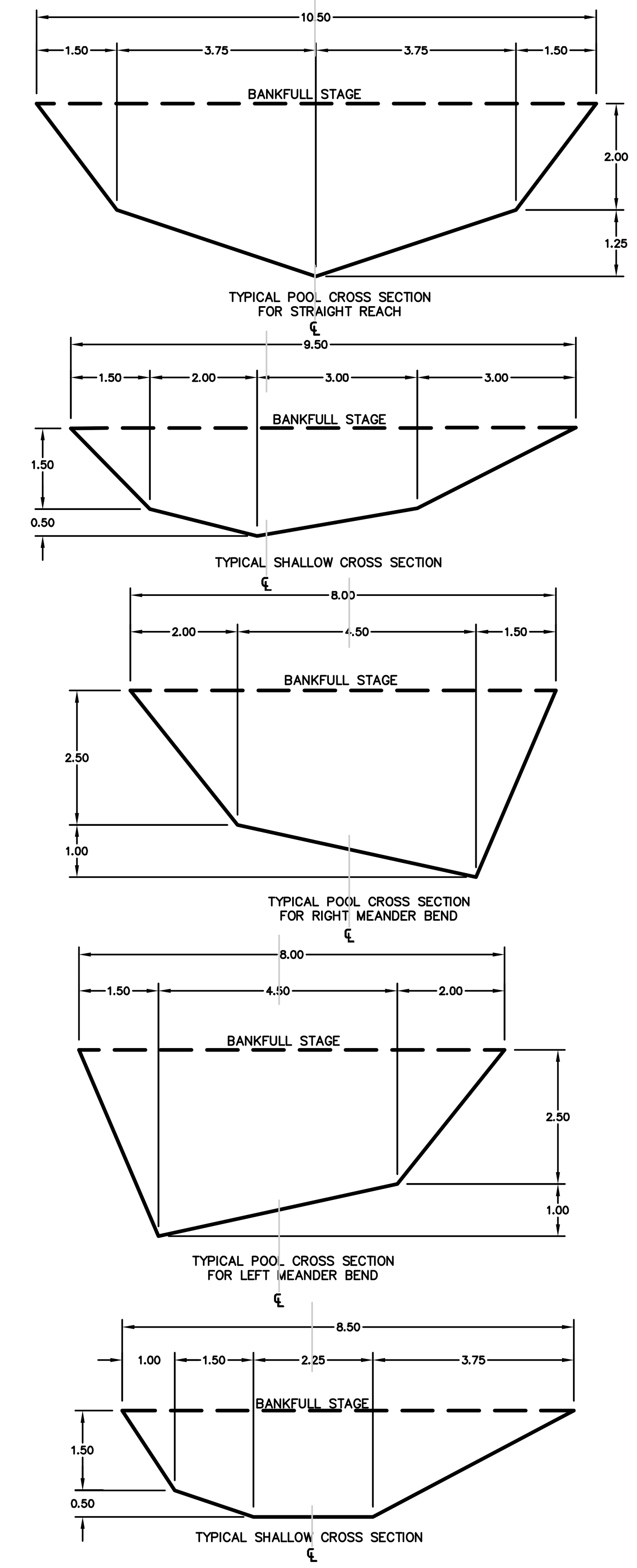
EBX

ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN
STA. 21+83 TO STA. 26+00





NOT TO SCALE

LEGEND

- WOODS LINE
- EXISTING CONTOURS
- EXISTING DITCH
- PROPOSED CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- LIMITS OF CONSERVATION EASMENT — LCE
- SILT FENCE
- LOG RAMP
- SMALL WOODY DEBRIS — W
- LARGE WOODY DEBRIS
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- FORD CROSSING
- ROOT WAD
- CUTTINGS BUNDLE
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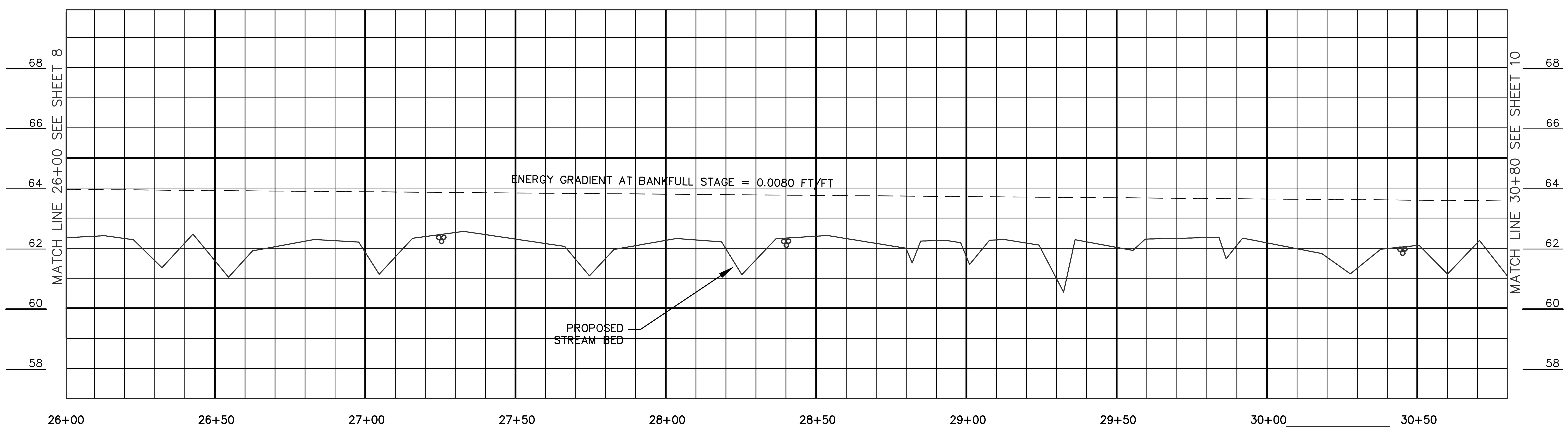
STRUCTURE	FROM STA	FROM ELEV	TO STA	TO ELEV	*BANK
LOG TOE	26+39	62.32	26+47	0.25	L
LOG TOE	26+76	62.41	26+84	62.54	R
ROOT WAD	26+89	63.76	----	----	R
ROOT WAD	26+97	63.71	----	----	R
ROOT WAD	27+10	63.20	----	----	R
LOG GRADE CONTROL	27+25	62.25	----	----	----
LOG TOE	27+48	62.52	27+56	62.43	R
CUT BUNDLE	27+95	63.80	----	----	L
ROOT WAD	27+99	63.74	----	----	L
CUT BUNDLE	28+01	63.78	----	----	L
ROOT WAD	28+07	63.79	----	----	L
CUT BUNDLE	28+10	63.79	----	----	L
ROOT WAD	28+15	63.74	----	----	L
CUT BUNDLE	28+17	63.78	----	----	L
LOG GRADE CONTROL	28+37	62.12	----	----	----
LOG TOE	28+69	62.42	28+77	62.29	L
CUT BUNDLE	28+80	63.73	----	----	L
CUT BUNDLE	28+85	63.73	----	----	L
CUT BUNDLE	28+89	63.73	----	----	L
LOG TOE	29+15	62.50	29+23	62.37	R
ROOT WAD	29+68	63.82	----	----	----
LOG TOE	29+92	62.58	30+00	62.43	L
LOG GRADE CONTROL	30+46	61.85	----	----	----
LOG TOE	30+72	62.34	30+80	61.33	L

*RIGHT (R) AND LEFT (L) BANK LOCATIONS ARE REFERENCED LOOKING DOWNSTREAM

CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C133	21.73	23.53
C134	16.93	22.93
C135	19.71	13.86
C136	24.77	28.35
C137	26.73	35.72
C138	30.06	30.80
C139	38.81	31.07
C140	42.47	22.66
C141	24.01	23.11
C142	28.10	37.13
C143	23.19	12.10
C144	10.10	14.46
C145	17.70	12.57
C146	15.17	14.59
C147	21.73	23.53
C148	32.13	23.15



Horizontal Scale: 1 inch = 20ft.
Vertical Scale: 1 inch = 2ft.

LOG GRADE CONTROL
LOG RAMP

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

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EBX

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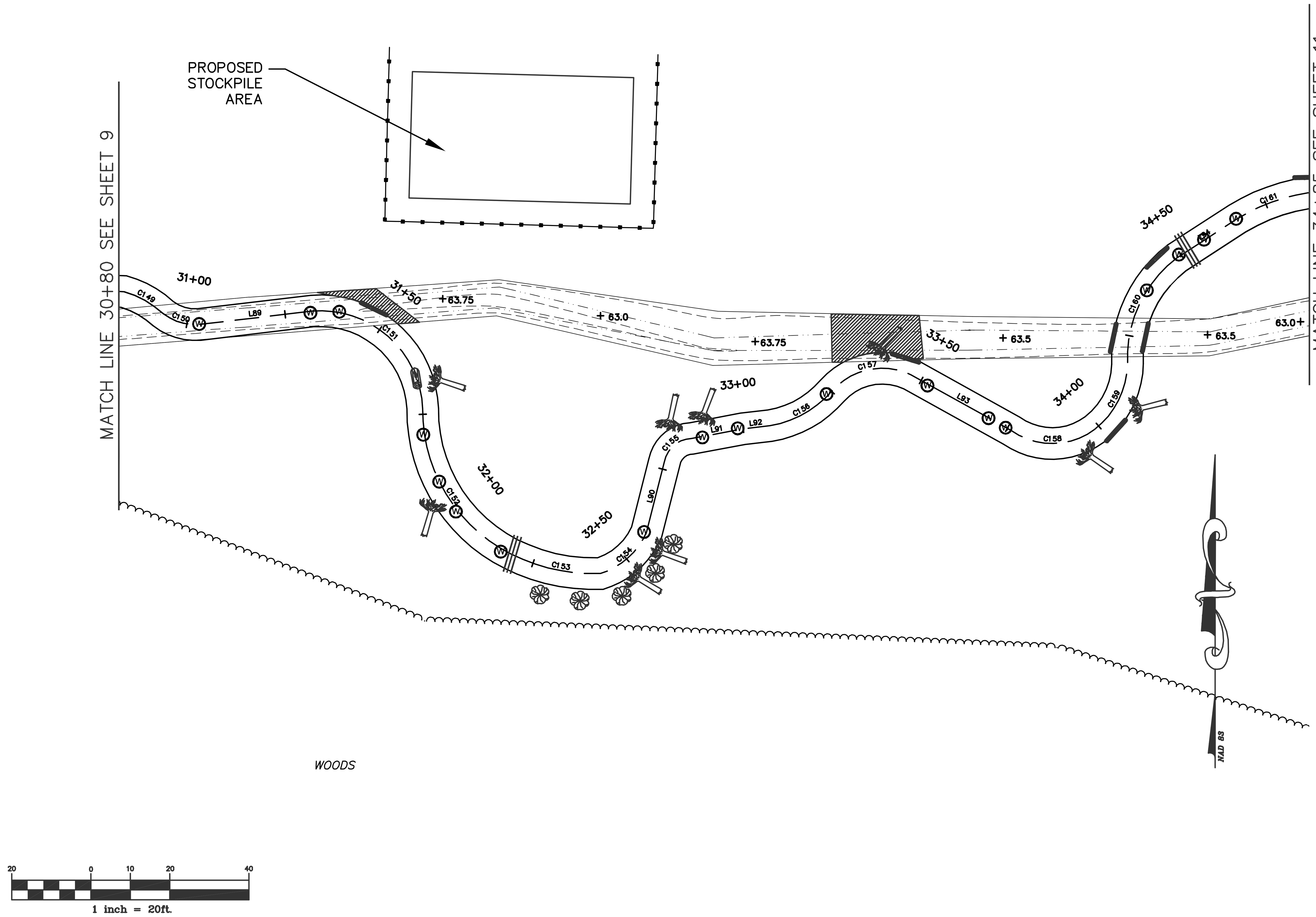
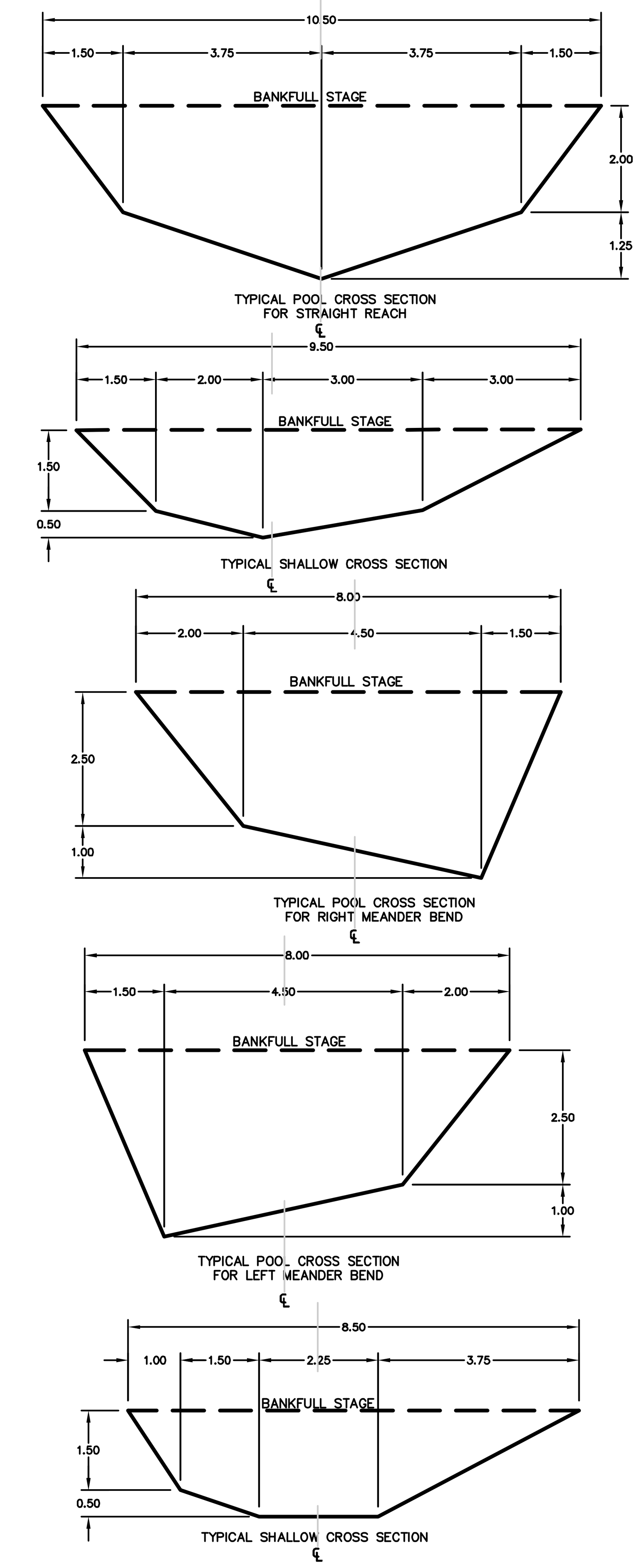
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN
STA. 26+00 TO STA. 30+80





LEGEND

- WOODS LINE
- EXISTING CONTOURS
- EXISTING DITCH
- PROPOSED CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- LIMITS OF CONSERVATION EASMENT — LCE —
- SILT FENCE
- LOG RAMP
- SMALL WOODY DEBRIS
- LARGE WOODY DEBRIS
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- FORD CROSSING
- ROOT WAD
- CUTTINGS BUNDLE
- CHANNEL PLUG
- COIR MATTING
- PROPOSED SPOT ELEVATIONS +64.0

NOTES:

IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.

ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.

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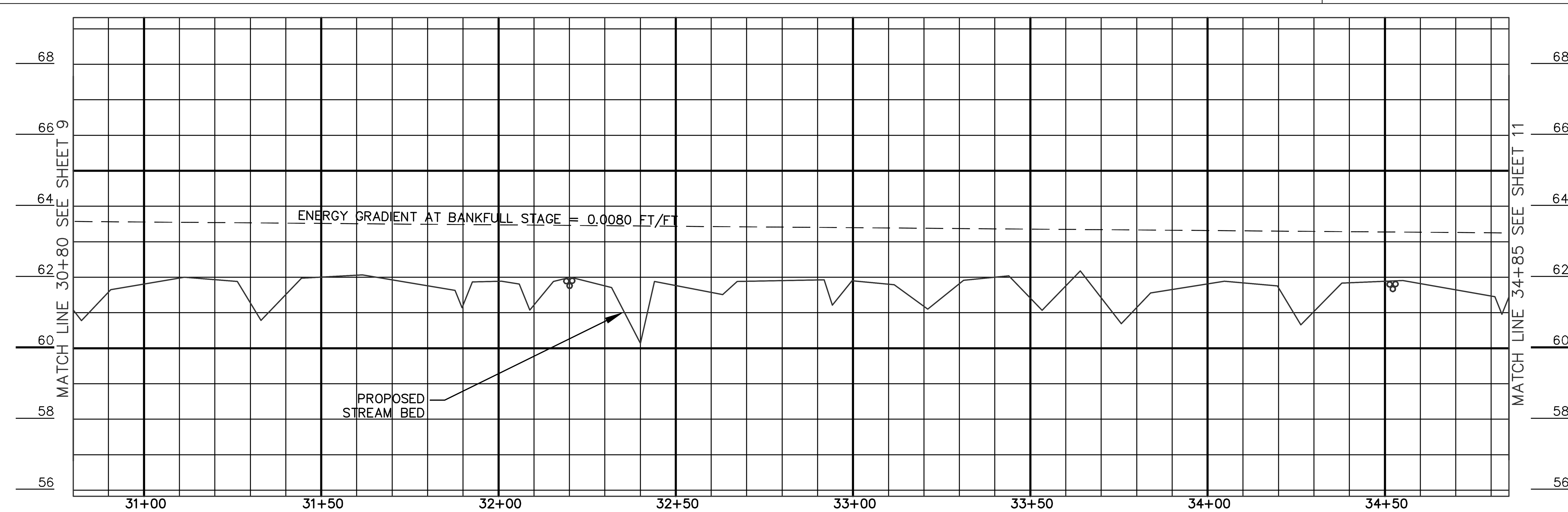
LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.

STRUCTURE	FROM		TO		*BANK
	STA	ELEV	STA	ELEV	
LOG TOE	31+42	61.97	31+50	62.25	L
ROOT WAD	31+68	63.46	----	----	L
ROOT WAD	31+98	63.38	----	----	R
LOG GRADE CONTROL	32+18	61.75	----	----	----
CUT BUNDLE	32+29	63.45	----	----	R
CUT BUNDLE	32+38	63.45	----	----	R
CUT BUNDLE	32+45	63.44	----	----	R
ROOT WAD	32+49	63.28	----	----	R
CUT BUNDLE	32+52	63.43	----	----	R
ROOT WAD	32+56	63.15	----	----	R
CUT BUNDLE	32+57	63.43	----	----	R
ROOT WAD	32+84	63.41	----	----	L
ROOT WAD	32+92	63.38	----	----	L
ROOT WAD	33+39	63.49	----	----	L
LOG TOE	33+40	62.25	33+48	61.80	L
ROOT WAD	33+95	63.23	----	----	R
LOG TOE	33+99	62.04	34+07	62.12	R
ROOT WAD	34+09	63.35	----	----	R
LOG TOE	34+20	61.96	34+28	61.08	L
LOG TOE	34+21	61.79	34+29	61.18	R
LOG TOE	34+40	62.09	34+48	62.13	L
LOG GRADE CONTROL	34+51	61.69	----	----	----
LOG TOE	34+83	61.25	34+91	61.94	L

*RIGHT (R) AND LEFT (L) BANK LOCATIONS ARE REFERENCED LOOKING DOWNSTREAM

CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C149	24.65	11.53
C150	13.45	9.72
C151	25.94	41.72
C152	40.70	48.62
C153	46.68	20.15
C154	18.90	16.16
C155	7.27	9.94
C156	26.28	18.55
C157	16.90	21.70
C158	17.94	22.52
C159	21.71	19.11
C160	31.80	30.75
C161	48.65	19.21



Horizontal Scale: 1 inch = 20ft.
Vertical Scale: 1 inch = 2ft.

LOG GRADE CONTROL
LOG RAMP

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER	DRAWING SCALE
DPI	1" = 20'
DRAWN BY	PROJECT DATE
TRS	06/2006
APPROVED BY	PROJECT NUMBER
ME	6002000RA
FILE NAME	PLOT DATE
design_layout.dwg	11/10/06

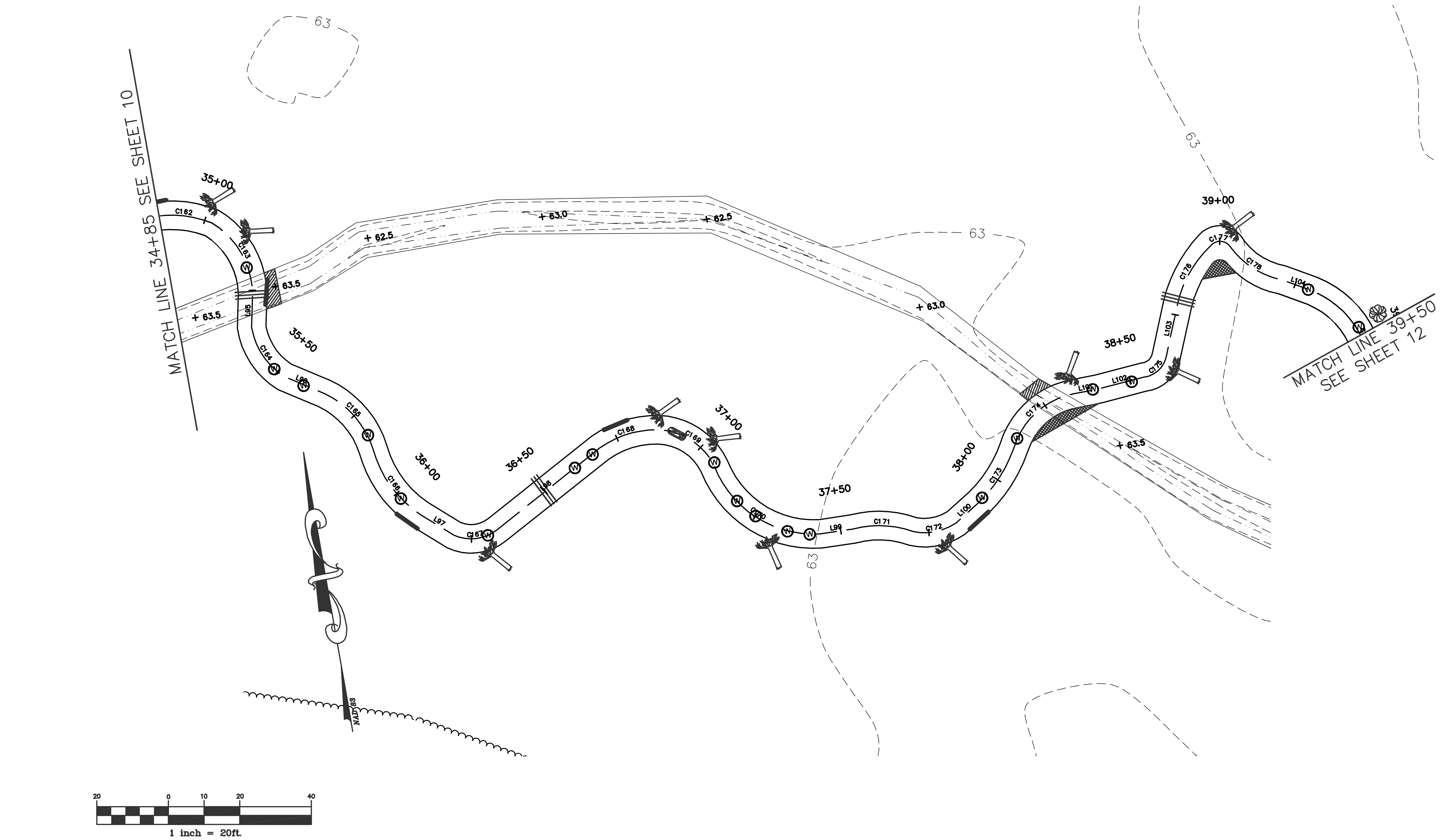
WK DICKSON
community infrastructure consultants
3101 JOHN HUMPHRIES WYND
RALEIGH, NC 27612
(919) 782-0495
Office Locations:
North Carolina Georgia
South Carolina Florida

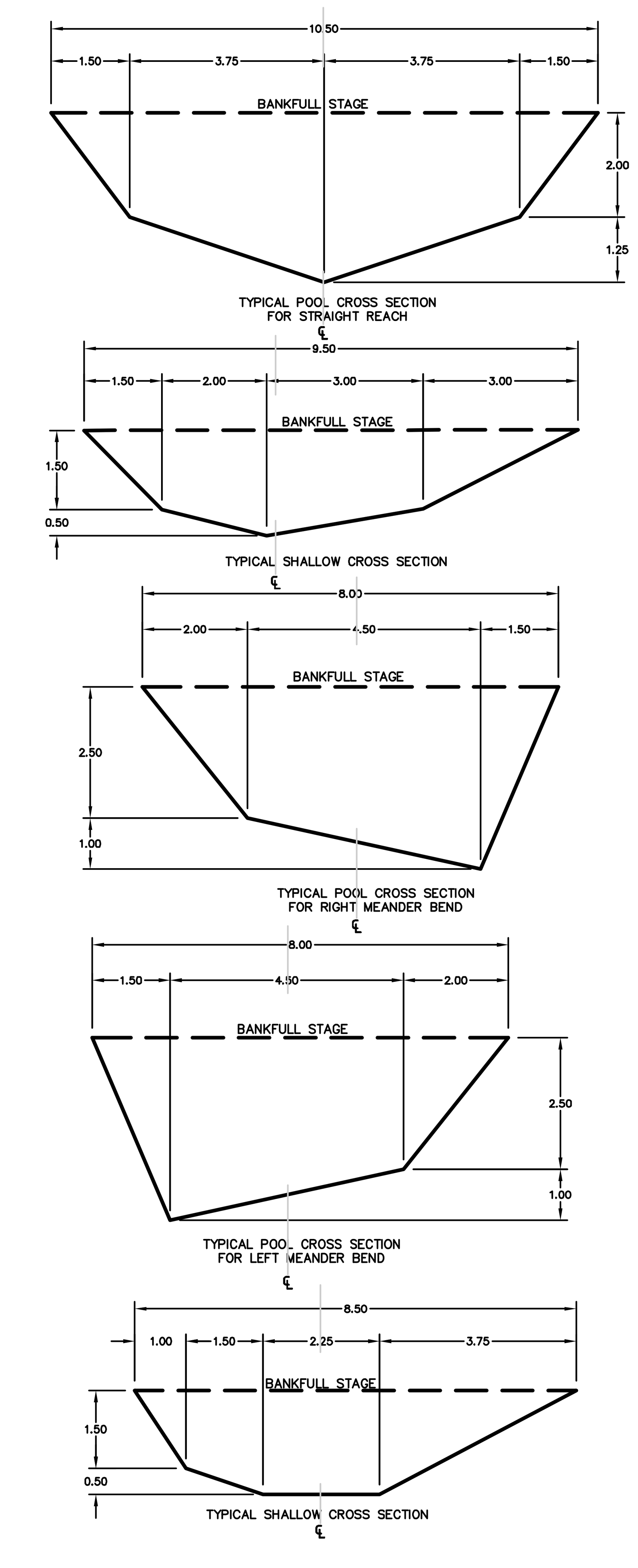
RELEASED FOR	DATE
APPROVALS	
BIDDING	
CONSTRUCTION	
RECORD DWG.	

EBX

ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN
STA. 30+80 TO STA. 34+85





LEGEND

- WOODS LINE
- EXISTING CONTOURS
- EXISTING DITCH
- PROPOSED CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- LIMITS OF CONSERVATION EASMENT — LCE —
- SILT FENCE
- LOG RAMP
- SMALL WOODY DEBRIS
- LARGE WOODY DEBRIS
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- FORD CROSSING
- ROOT WAD
- CUTTINGS BUNDLE
- CHANNEL PLUG
- COIR MATTING
- PROPOSED SPOT ELEVATIONS +64.0

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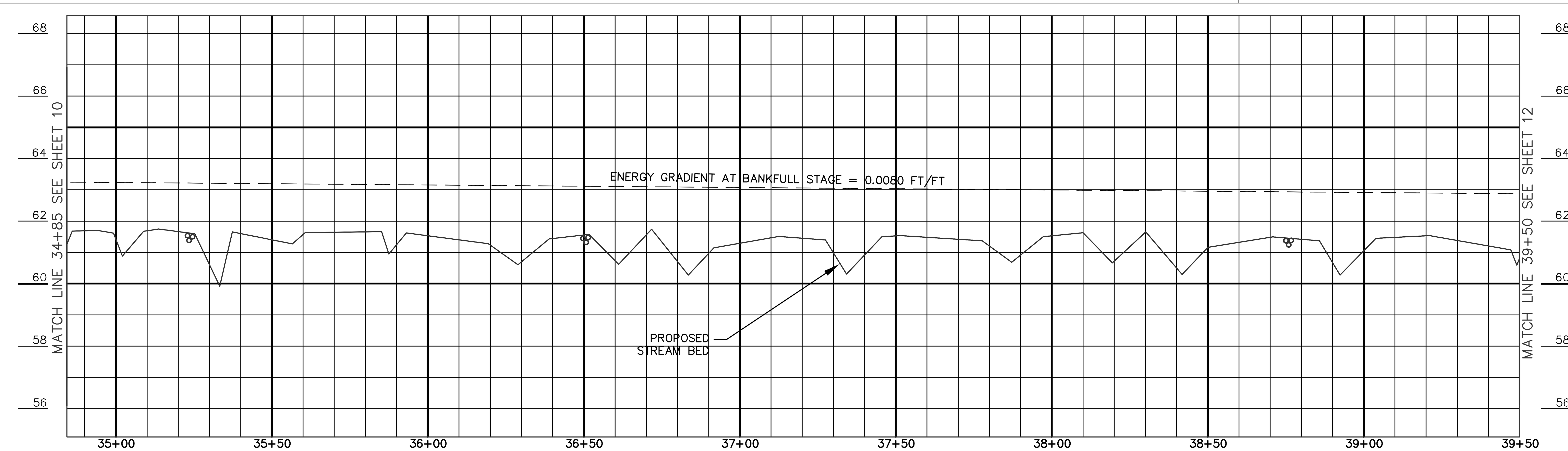
STRUCTURE	FROM		TO		*BANK
	STA	ELEV	STA	ELEV	
ROOT WAD	35+01	62.66	----	----	L
ROOT WAD	35+11	63.19	----	----	L
LOG TOE	35+23	61.78	35+31	60.61	L
LOG GRADE CONTROL	35+25	61.40	----	----	----
LOG TOE	36+04	61.73	36+12	0.25	R
ROOT WAD	36+29	62.12	----	----	R
LOG GRADE CONTROL	36+49	61.34	----	----	----
LOG TOE	36+73	61.83	36+81	60.83	L
ROOT WAD	36+87	62.14	----	----	L
ROOT WAD	37+02	62.83	----	----	L
ROOT WAD	37+32	62.16	----	----	R
ROOT WAD	37+79	62.78	----	----	R
LOG TOE	37+85	61.09	37+93	61.41	R
ROOT WAD	38+33	62.82	----	----	L
ROOT WAD	38+61	62.84	----	----	R
LOG GRADE CONTROL	38+78	61.21	----	----	----
ROOT WAD	39+02	62.76	----	----	L
CUT BUNDLE	39+47	62.88	----	----	L

*RIGHT (R) AND LEFT (L) BANK LOCATIONS ARE REFERENCED LOOKING DOWNSTREAM

CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C162	30.67	16.03
C163	23.81	23.77
C164	20.33	17.06
C165	26.13	23.91
C166	32.13	23.15
C167	11.64	12.74
C168	27.20	17.59
C169	18.06	19.47
C170	29.94	37.66
C171	28.49	17.19
C172	15.67	12.58
C173	40.30	18.71
C174	21.73	23.53
C175	7.27	9.94
C176	31.62	19.12
C177	3.41	5.91
C178	23.93	18.12



Horizontal Scale: 1 inch = 20ft.
Vertical Scale: 1 inch = 2ft.

LOG GRADE CONTROL
LOG RAMP

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER: DPI
DRAWN BY: TRS
APPROVED BY: ME
FILE NAME: design_layout.dwg
DRAWING SCALE: 1" = 20'
PROJECT DATE: 06/2006
PROJECT NUMBER: 6002000RA
PLOT DATE: 11/10/06

WK DICKSON
community infrastructure consultants

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RALEIGH, NC 27612
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Office Locations:
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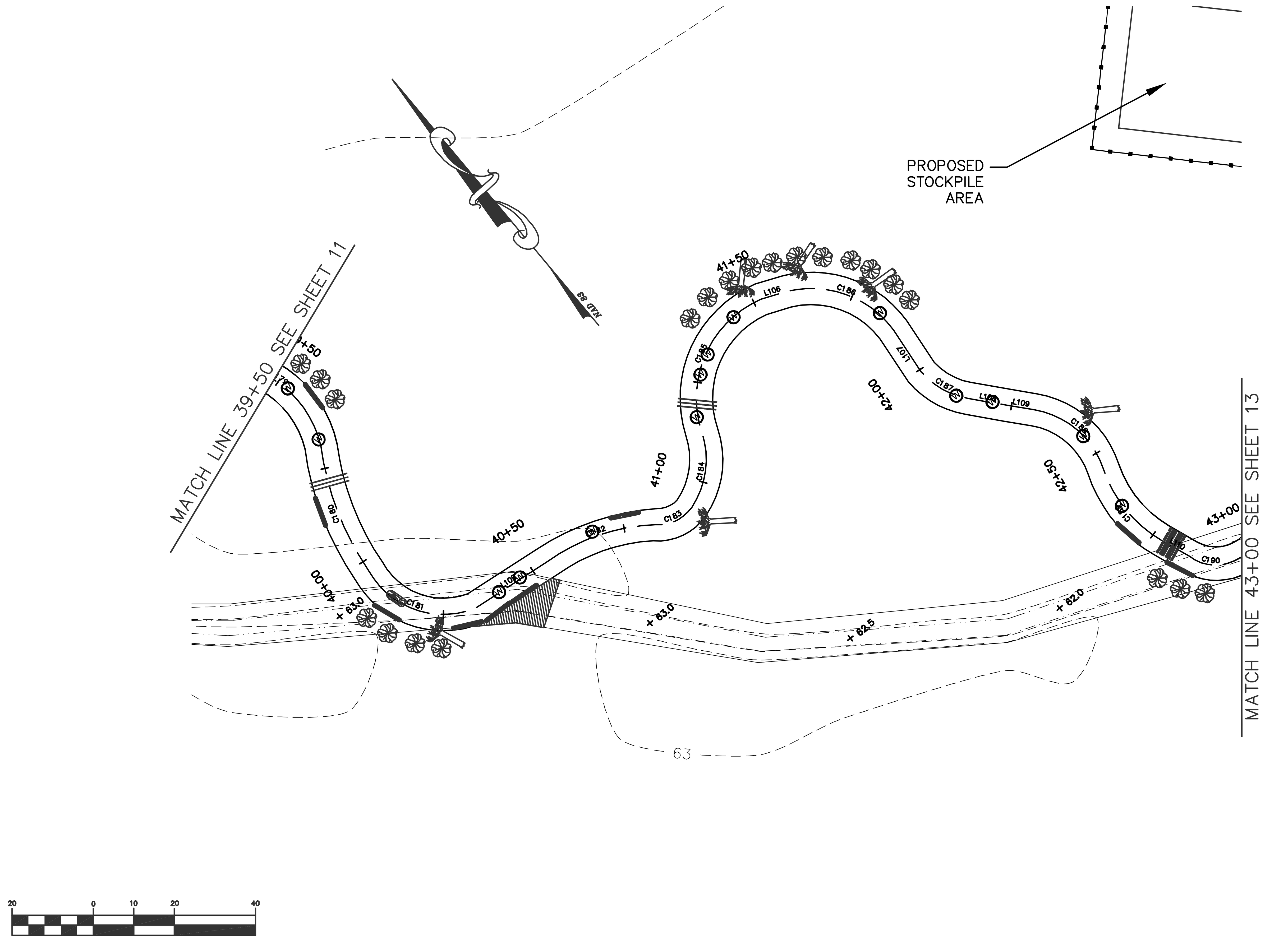
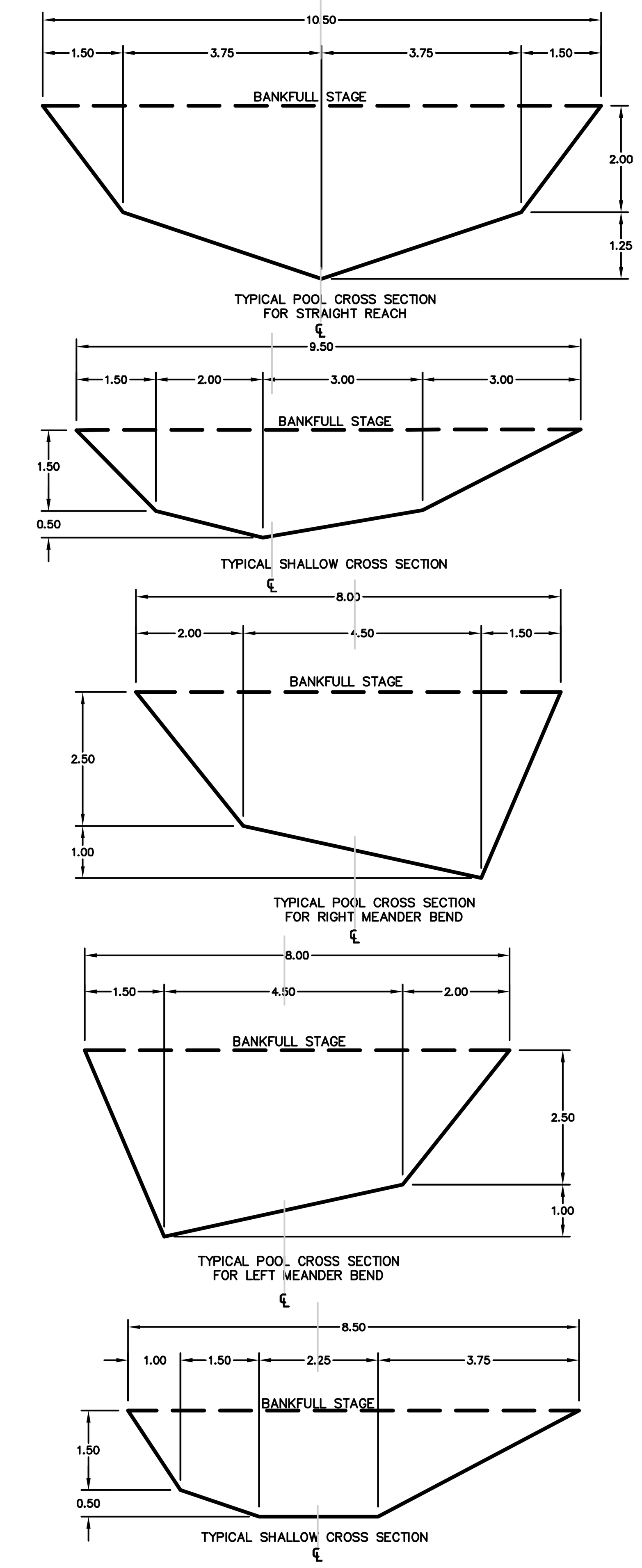
RELEASED FOR	DATE
APPROVALS	
BIDDING	
CONSTRUCTION	
RECORD DWG.	

EBX

ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN
STA. 34+85 TO STA. 39+50





LEGEND

WOODS LINE
EXISTING CONTOURS
EXISTING DITCH
PROPOSED CENTER OF CHANNEL
LIMITS OF BANKFULL CHANNEL
LIMITS OF CONSERVATION EASMENT — LCE —
SILT FENCE
LOG RAMP
SMALL WOODY DEBRIS
LARGE WOODY DEBRIS
LOG GRADE CONTROL
LOG TOE PROTECTION
FORD CROSSING
ROOT WAD
CUTTINGS BUNDLE
CHANNEL PLUG
COIR MATTING
PROPOSED SPOT ELEVATIONS +64.0

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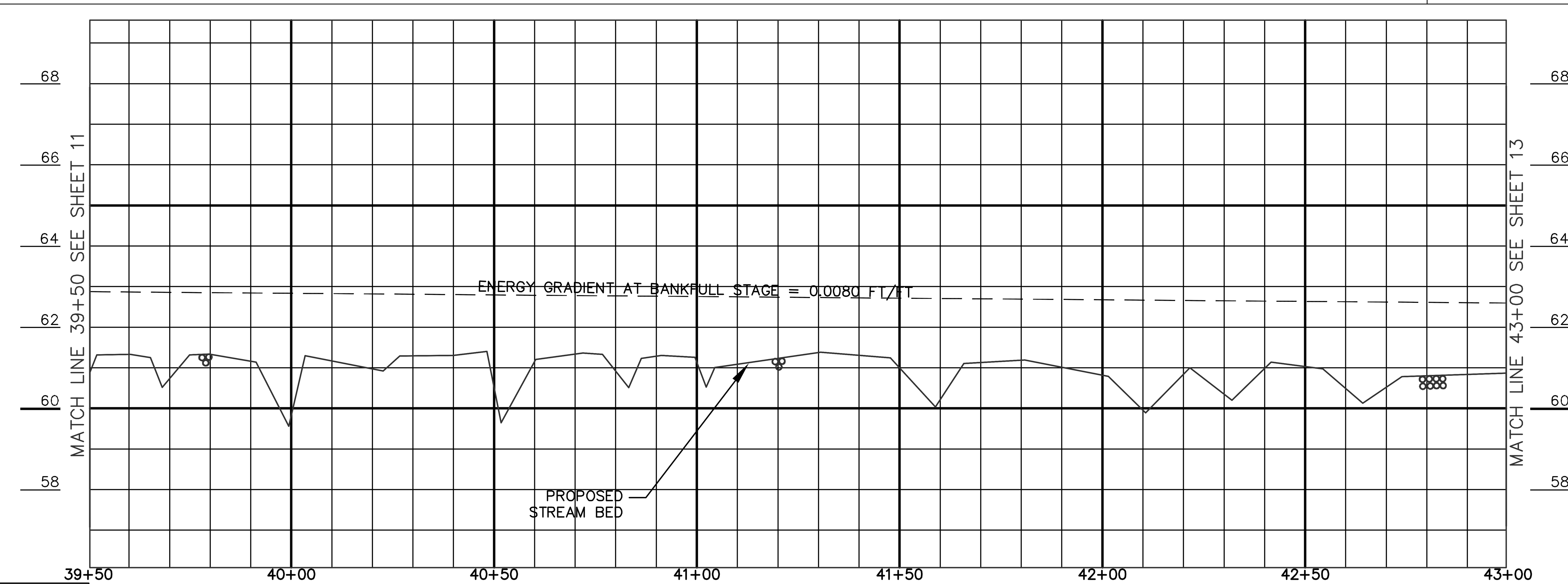
STRUCTURE	FROM		TO		*BANK
	STA	ELEV	STA	ELEV	
CUT BUNDLE	39+53	62.87	----	----	L
LOG TOE	39+56	61.57	39+64	61.52	L
CUT BUNDLE	39+58	62.87	----	----	L
CUT BUNDLE	39+64	62.86	----	----	L
LOG GRADE CONTROL	39+78	61.13	----	----	----
LOG TOE	39+79	61.43	39+87	60.28	R
LOG TOE	40+10	61.42	40+18	61.27	R
CUT BUNDLE	40+11	62.83	----	----	R
CUT BUNDLE	40+16	62.82	----	----	R
CUT BUNDLE	40+21	62.82	----	----	R
ROOT WAD	40+25	62.63	----	----	R
CUT BUNDLE	40+26	62.82	----	----	R
LOG TOE	40+28	61.54	40+36	61.55	R
LOG TOE	40+36	61.55	40+44	61.6	R
LOG TOE	40+44	61.60	40+52	59.95	R
LOG TOE	40+72	61.62	40+80	61.16	L
ROOT WAD	40+95	62.78	----	----	R
LOG GRADE CONTROL	41+19	61.01	----	----	----
CUT BUNDLE	41+37	62.73	----	----	L
CUT BUNDLE	41+42	62.72	----	----	L
CUT BUNDLE	41+48	62.72	----	----	L
ROOT WAD	41+50	62.50	----	----	L
CUT BUNDLE	41+52	62.71	----	----	L
CUT BUNDLE	41+57	62.71	----	----	L
CUT BUNDLE	41+62	62.71	----	----	L
ROOT WAD	41+62	62.02	----	----	L
CUT BUNDLE	41+67	62.70	----	----	L
CUT BUNDLE	41+72	62.70	----	----	L
CUT BUNDLE	41+76	62.69	----	----	L
ROOT WAD	41+78	62.68	----	----	L
CUT BUNDLE	41+81	62.69	----	----	L
CUT BUNDLE	41+86	62.69	----	----	L
ROOT WAD	41+85	62.61	----	----	L
LOG TOE	42+67	60.57	42+75	61.04	R
LOG RAMP	42+79	60.80	42+83	60.81	----
LOG TOE	42+82	61.06	42+90	61.09	R
CUT BUNDLE	42+83	62.61	----	----	R
CUT BUNDLE	42+89	62.60	----	----	R
CUT BUNDLE	42+92	62.60	----	----	R

*RIGHT (R) AND LEFT (L) BANK LOCATIONS ARE REFERENCED LOOKING DOWNSTREAM

CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C179	26.61	39.36
C180	70.46	33.11
C181	21.07	30.38
C182	48.58	28.48
C183	10.20	10.44
C184	21.26	19.37
C185	26.61	39.36
C186	25.14	29.66
C187	20.02	13.50
C188	21.73	23.53
C189	32.13	23.15
C190	10.48	11.76



Horizontal Scale: 1 inch = 20ft.
Vertical Scale: 1 inch = 2ft.

LOG GRADE CONTROL
LOG RAMP

REV. NO.	DESCRIPTION	DATE

REVISIONS

PROJECT MANAGER DPI	DRAWING SCALE 1" = 20'
DRAWN BY TRS	PROJECT DATE 06/2006
APPROVED BY ME	PROJECT NUMBER 6002000RA
FILE NAME design_layout.dwg	PLOT DATE 11/10/06

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Office Locations:
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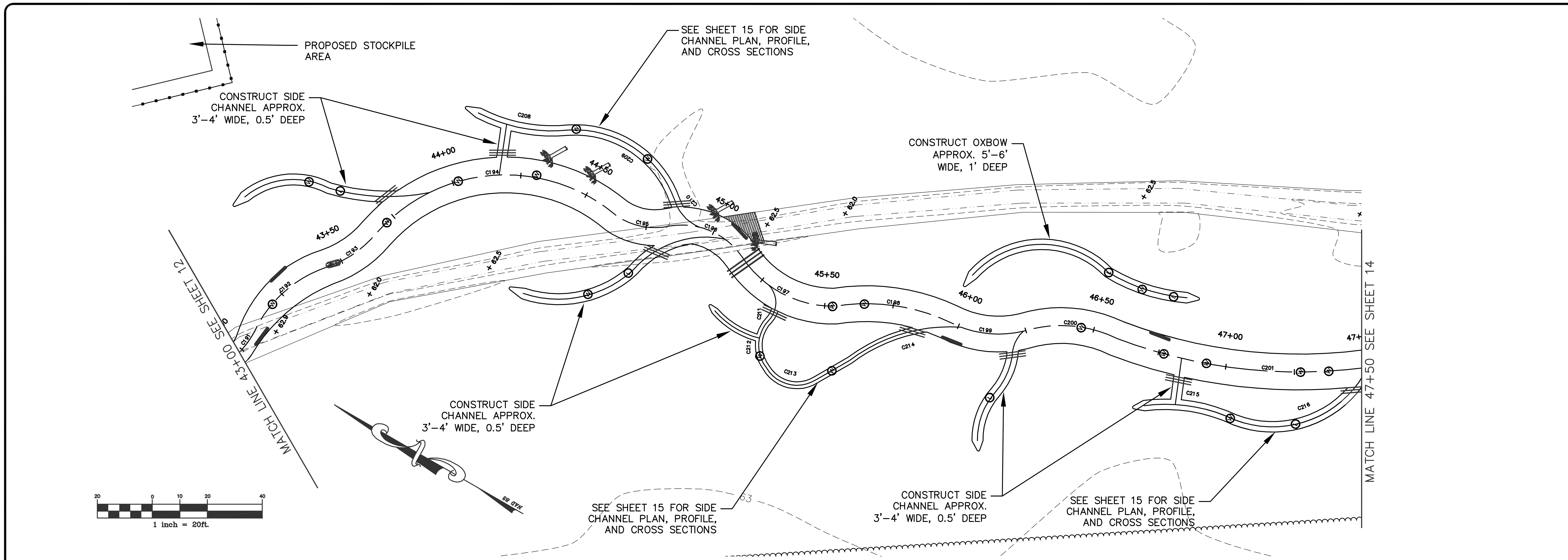
RELEASED FOR	DATE
APPROVALS	
BIDDING	
CONSTRUCTION	
RECORD DWG.	

EBX

ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN
STA. 39+50 TO STA. 43+00



LEGEND

- WOODS LINE
- EXISTING CONTOURS
- EXISTING DITCH
- PROPOSED CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- LIMITS OF CONSERVATION EASMENT — LCE
- SILT FENCE
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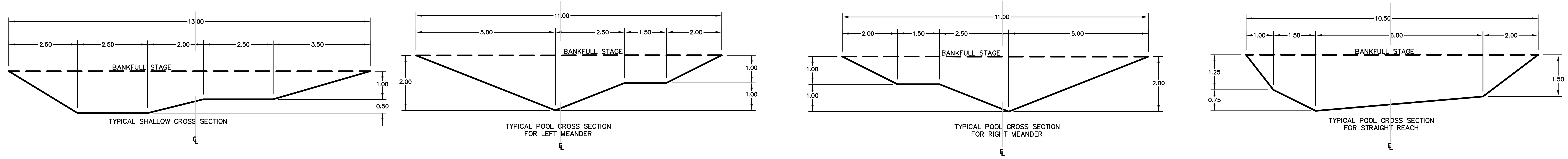
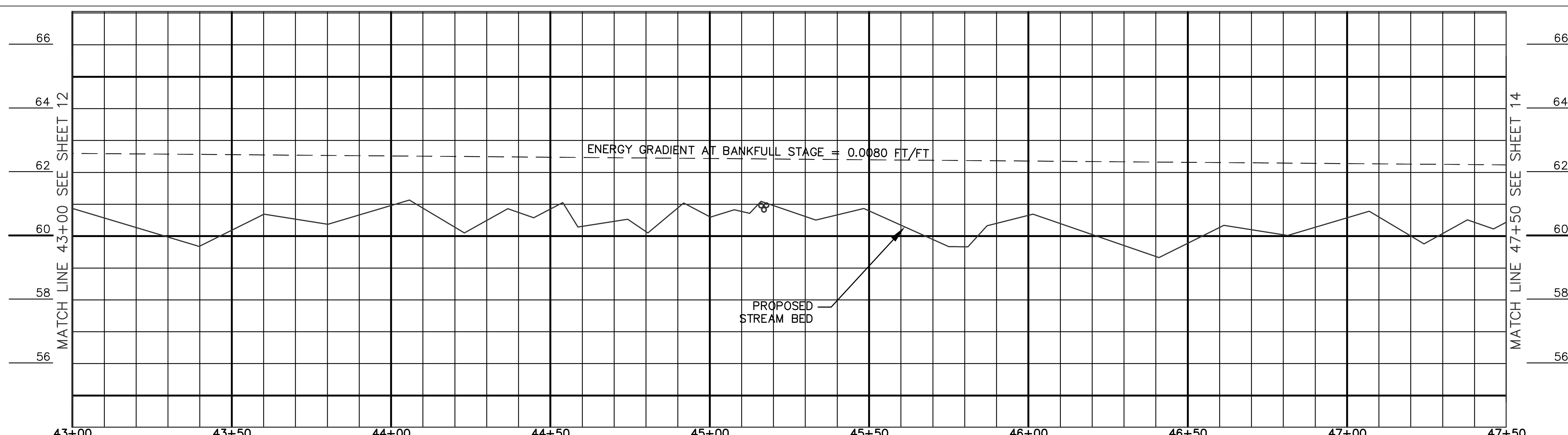
- COIR MATTING
- PROPOSED SPOT ELEVATIONS +64.0





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STRUCTURE	FROM		TO		*BANK
	STA	ELEV	STA	ELEV	
LOG TOE	43+04	61.00	43+12	60.76	R
LOG TOE	43+25	60.37	43+33	60.13	L
LOG GRADE CONTROL	43+78	61.83	----	----	L
LOG GRADE CONTROL	44+17	61.80	----	----	L
ROOT WAD	44+34	62.22	----	----	L
ROOT WAD	44+49	62.30	----	----	L
LOG GRADE CONTROL	44+79	61.75	----	----	R
LOG GRADE CONTROL	44+87	61.45	----	----	L
ROOT WAD	44+98	62.21	----	----	L
LOG TOE	45+04	60.96	45+12	60.98	L
ROOT WAD	45+13	62.27	----	----	L
LOG GRADE CONTROL	45+15	60.78	----	----	----
LOG GRADE CONTROL	45+34	62.00	----	----	R
LOG GRADE CONTROL	45+84	61.97	----	----	R
LOG TOE	45+96	60.80	46+04	60.85	R
LOG GRADE CONTROL	46+31	61.63	----	----	R
LOG TOE	46+69	60.47	46+77	60.34	L
LOG GRADE CONTROL	46+84	61.59	----	----	R
LOG GRADE CONTROL	47+46	62.65	----	----	R

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CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C191	35.10	13.98
C192	44.92	33.36
C193	39.38	21.83
C194	62.49	97.24
C195	24.61	20.13
C196	26.48	30.12
C197	39.40	40.04
C198	71.53	42.67
C199	38.47	27.60
C200	46.21	34.91
C201	185.72	113.24
C208	58.43	33.92
C209	38.41	49.85
C210	15.54	13.47
C211	9.22	14.05
C212	13.19	18.81
C213	12.91	20.82
C214	60.30	43.17
C215	58.95	34.01
C216	38.47	56.88

REV. NO.	DESCRIPTION	DATE

REVISIONS

PROJECT MANAGER DPI	DRAWING SCALE 1" = 20'
DRAWN BY TRS	PROJECT DATE 06/2006
APPROVED BY ME	PROJECT NUMBER 6002000RA
FILE NAME design_layout.dwg	PLOT DATE 11/10/06

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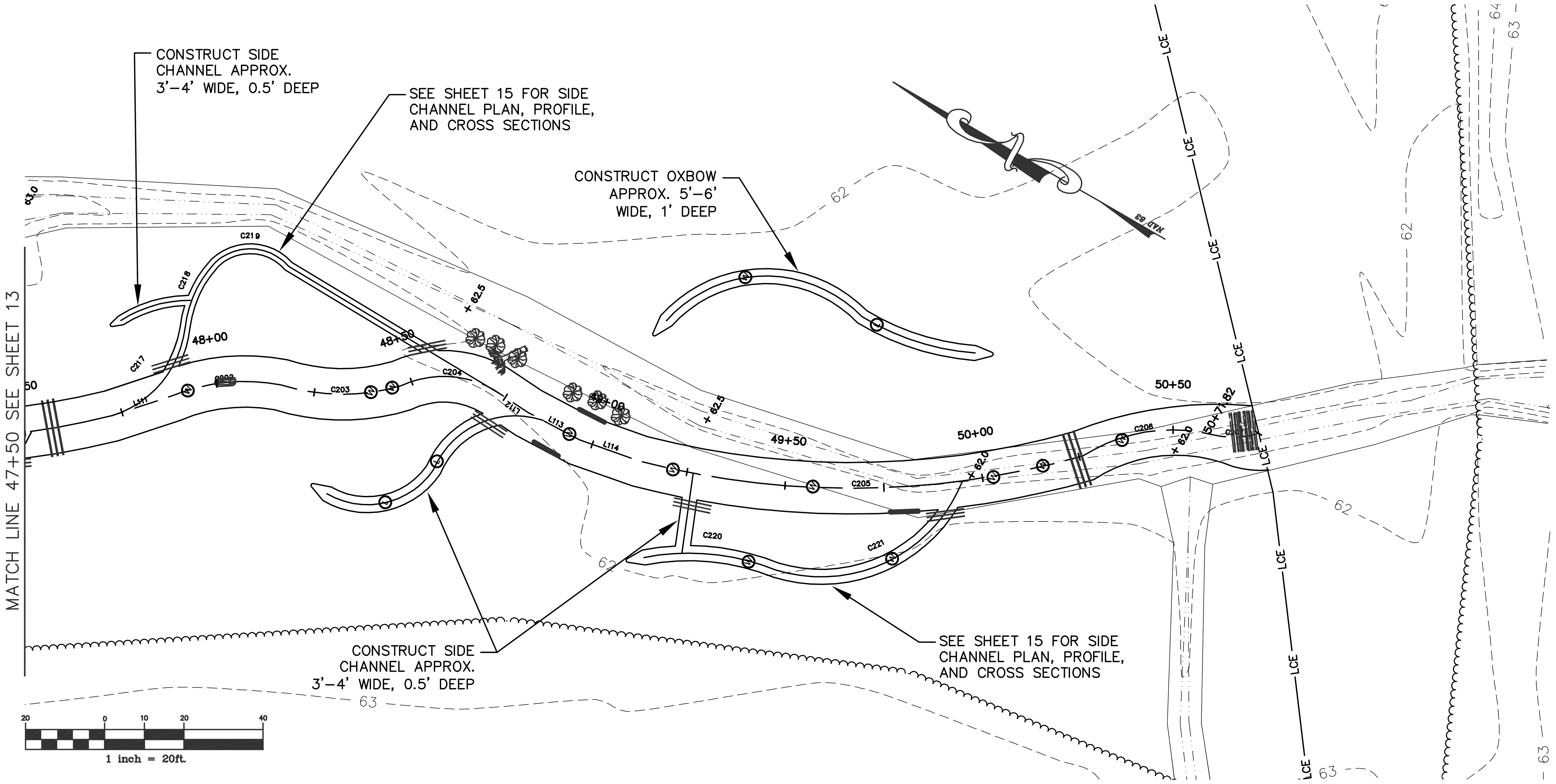
EBX

ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN
STA. 43+00 TO STA. 47+50



LEGEND

WOODS LINE
EXISTING CONTOURS
EXISTING DITCH
PROPOSED CENTER OF CHANNEL
LIMITS OF BANKFULL CHANNEL
LIMITS OF CONSERVATION EASMENT — LCE
SILT FENCE
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LEAF PACK
SMALL WOODY DEBRIS
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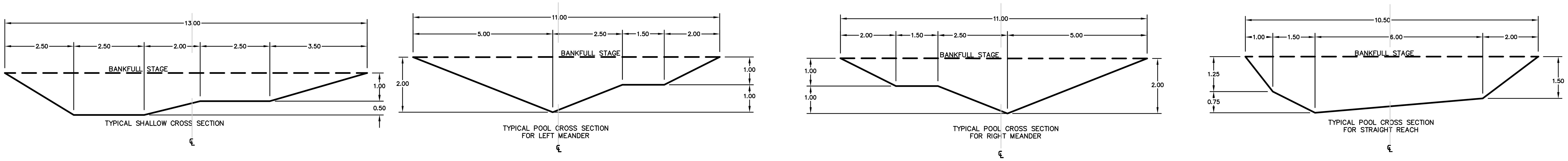
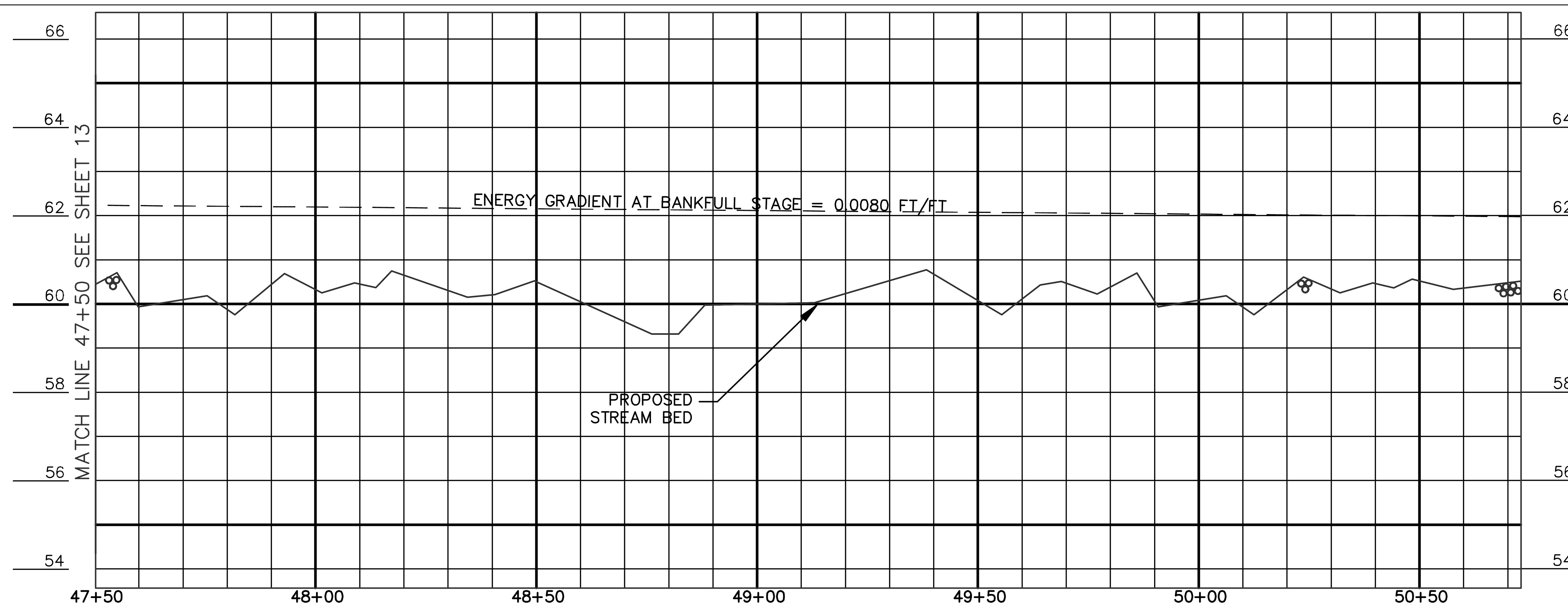


STRUCTURE	FROM		TO		*BANK
	STA	ELEV	STA	ELEV	
LOG GRADE CONTROL	47+55	60.51	----	----	----
LOG GRADE CONTROL	47+90	61.43	----	----	L
LOG GRADE CONTROL	48+56	61.46	----	----	L
CUT BUNDLE	48+64	62.14	----	----	L
CUT BUNDLE	48+68	62.14	----	----	L
ROOT WAD	48+70	61.10	----	----	L
CUT BUNDLE	48+72	62.14	----	----	L
LOG GRADE CONTROL	48+75	61.44	----	----	R
LOG TOE	48+86	59.99	48+94	0.25	R
CUT BUNDLE	48+90	62.12	----	----	L
LOG TOE	48+92	60.23	49+00	0.25	L
CUT BUNDLE	48+96	62.12	----	----	L
CUT BUNDLE	49+04	62.11	----	----	L
LOG GRADE CONTROL	49+27	61.39	----	----	R
LOG TOE	49+76	60.51	49+84	60.84	R
LOG GRADE CONTROL	49+90	61.76	----	----	R
LOG GRADE CONTROL	50+23	60.41	----	----	----
LOG RAMP	50+68	60.29	50+72	60.47	----

*RIGHT (R) AND LEFT (L) BANK LOCATIONS ARE REFERENCED LOOKING DOWNSTREAM



Horizontal Scale: 1 inch = 20ft.
Vertical Scale: 1 inch = 2ft.

LOG GRADE CONTROL
LOG RAMP

CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C202	48.57	28.02
C203	51.96	30.88
C204	25.25	26.66
C205	212.95	113.20
C206	42.48	33.95
C207	21.61	11.86
C217	26.57	30.67
C218	28.84	18.25
C219	12.91	20.82
C220	58.95	34.01
C221	38.47	57.36

REV. NO.	DESCRIPTION	DATE

REVISIONS

PROJECT MANAGER DPI	DRAWING SCALE 1" = 20'
DRAWN BY TRS	PROJECT DATE 06/2006
APPROVED BY ME	PROJECT NUMBER 6002000RA
FILE NAME design_layout.dwg	PLOT DATE 11/10/06

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CONSTRUCTION	
RECORD DWG.	

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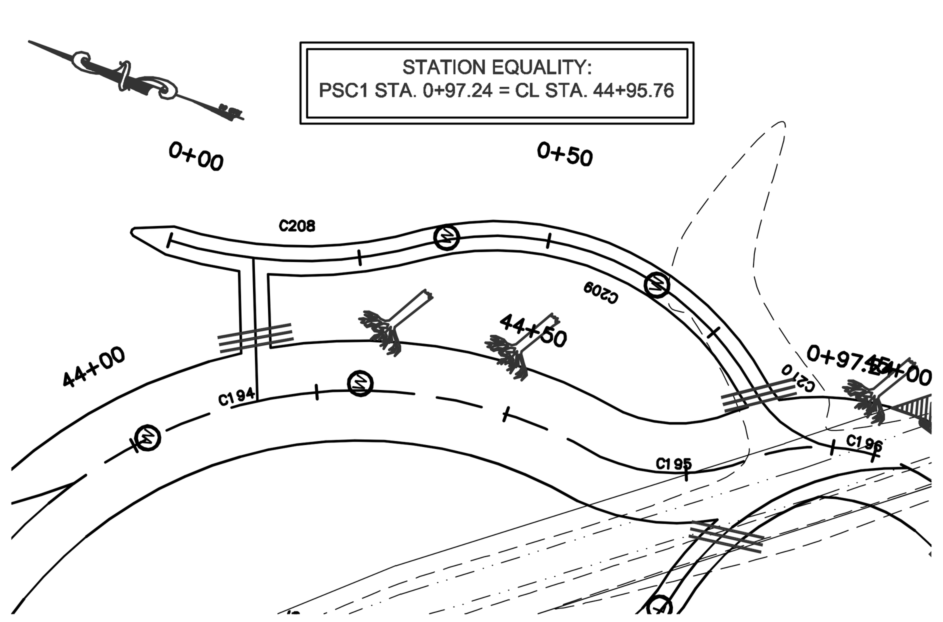
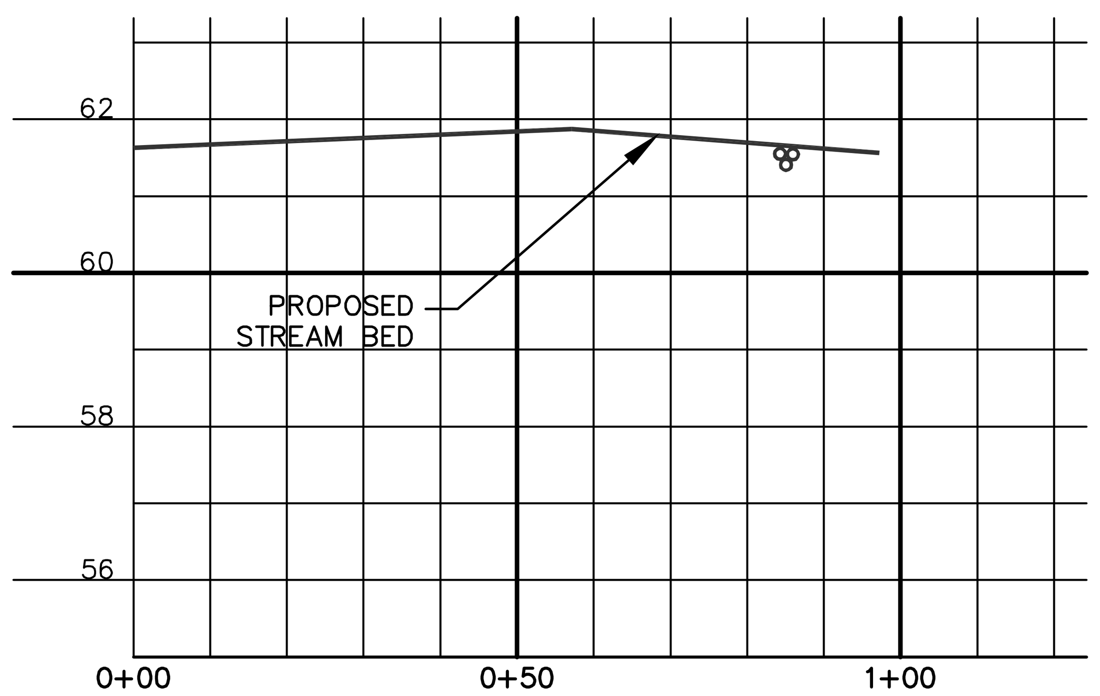
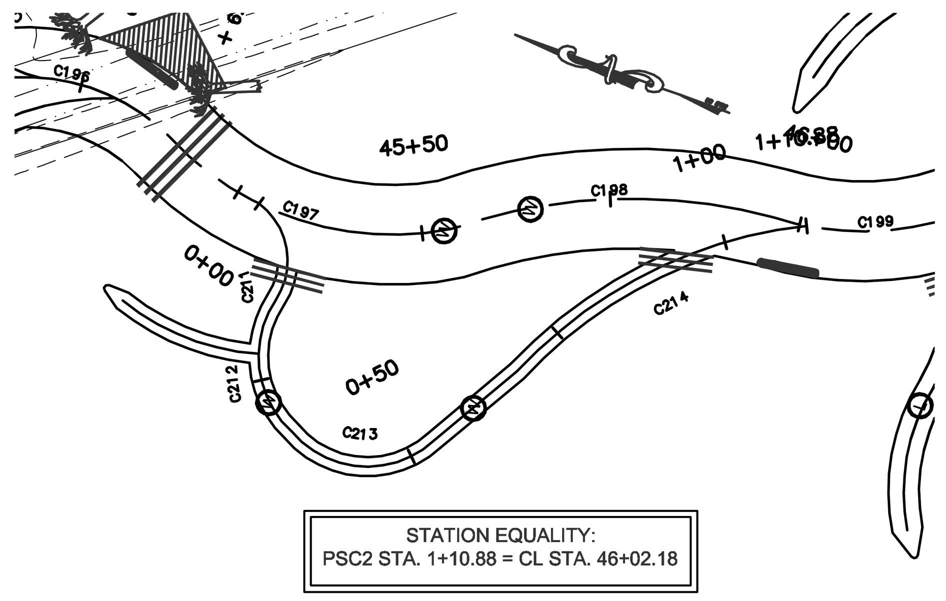
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN
STA. 47+50 TO STA. 50+73.05

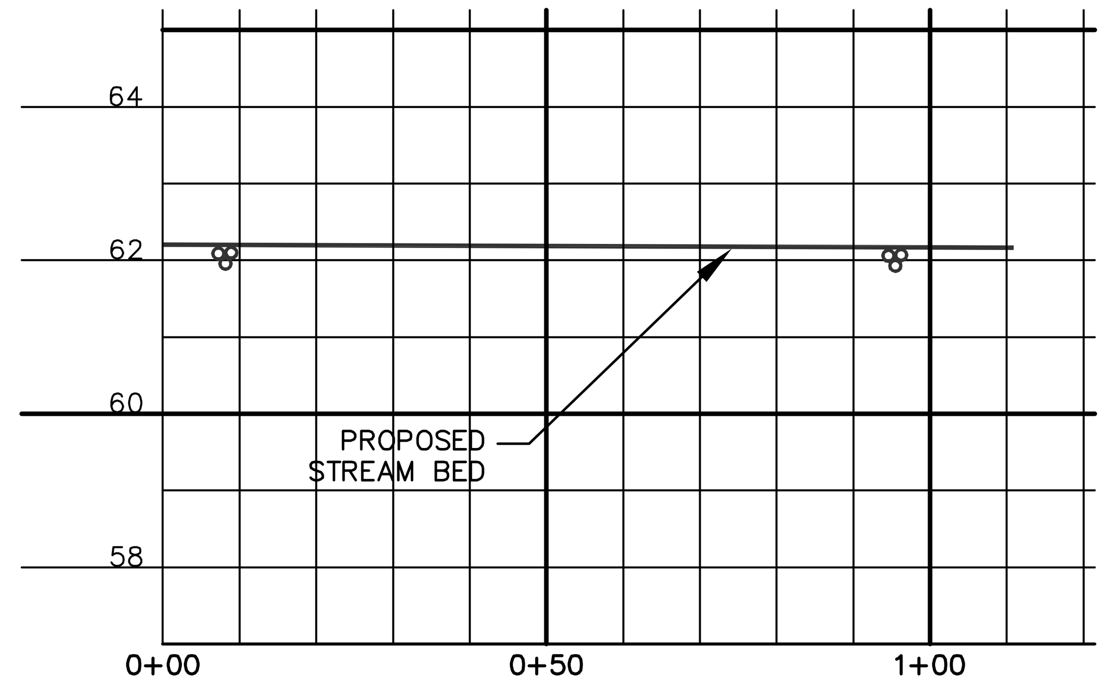


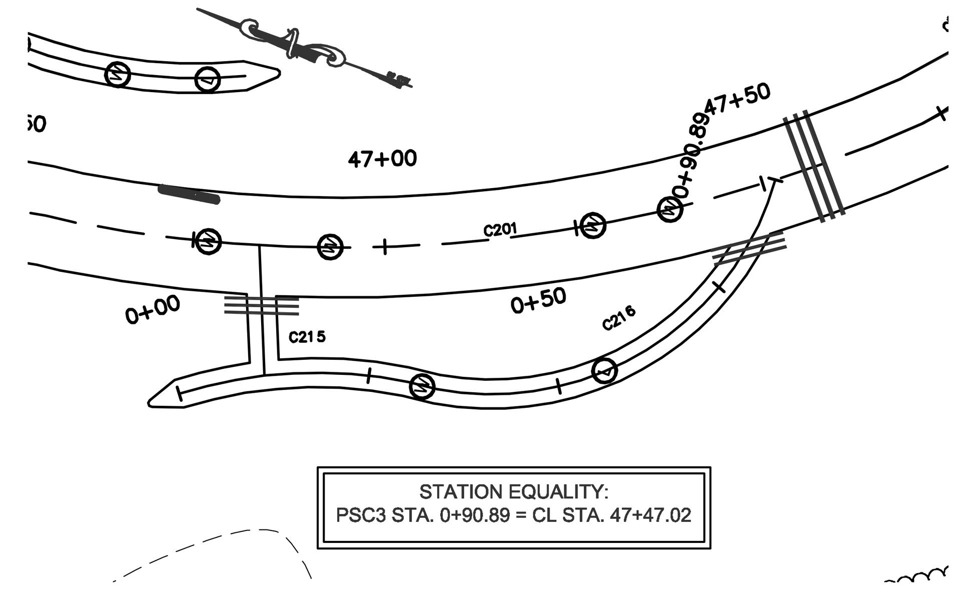
PSC1



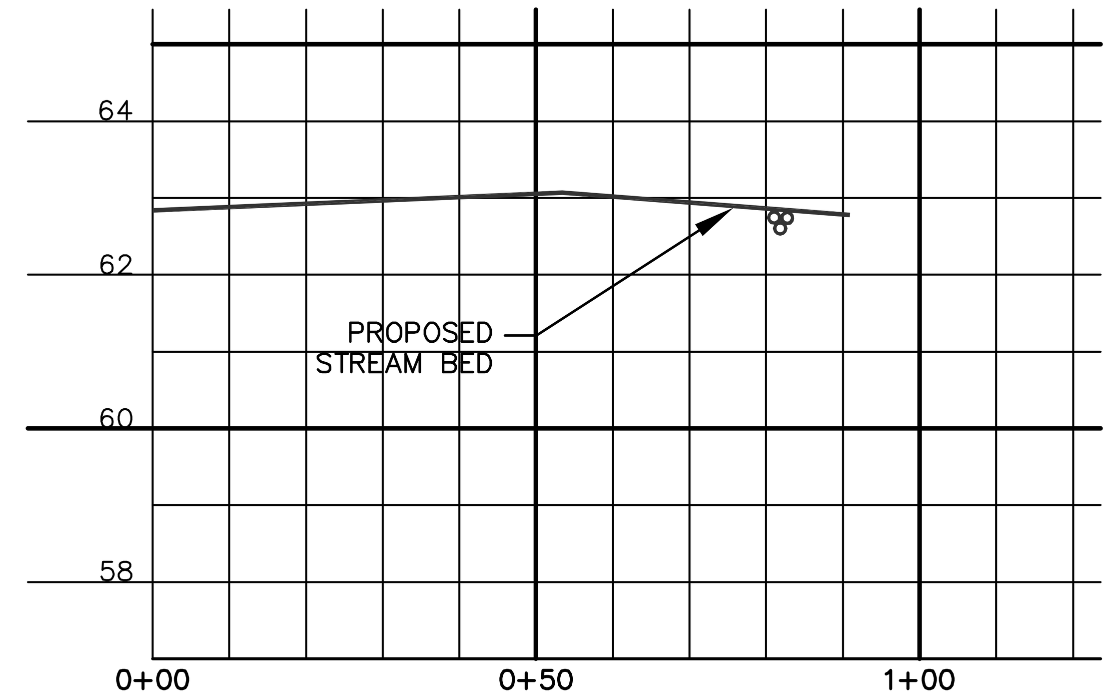


PSC2



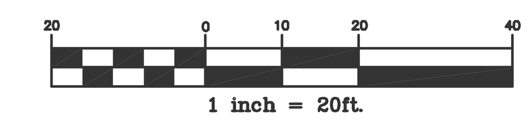


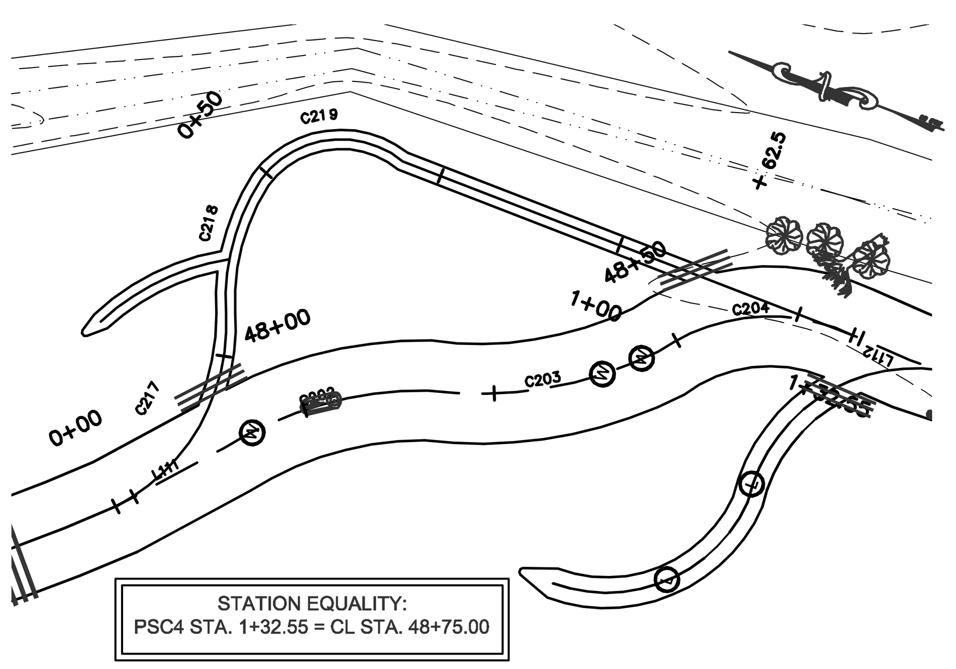
PSC3



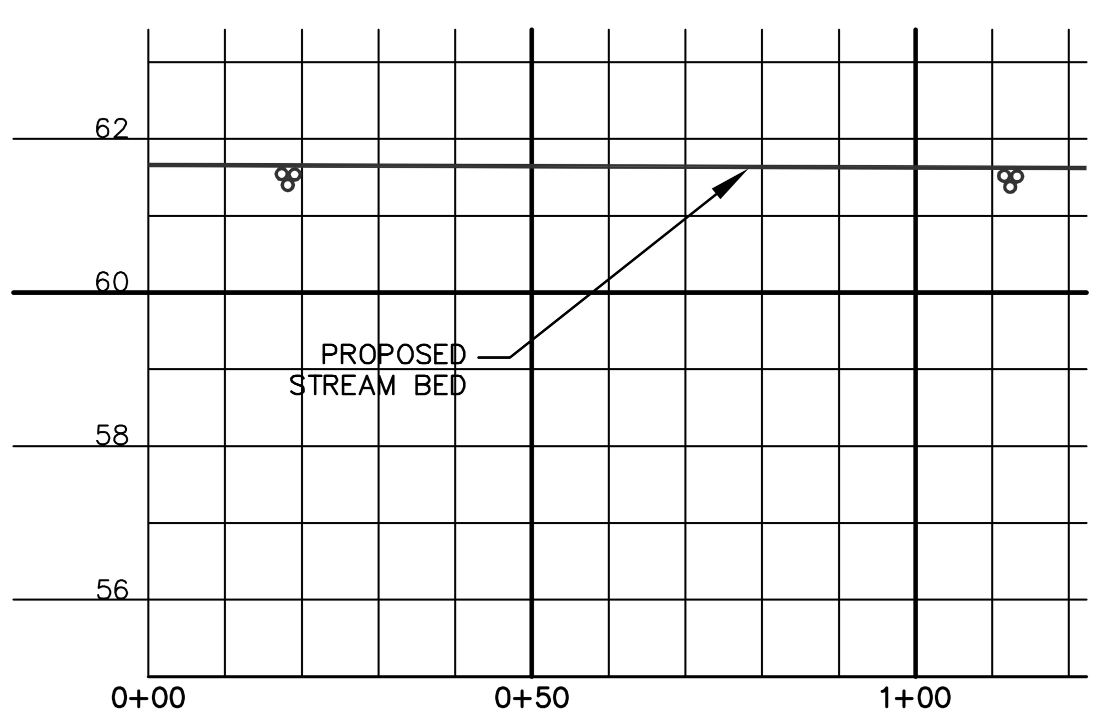
LEGEND

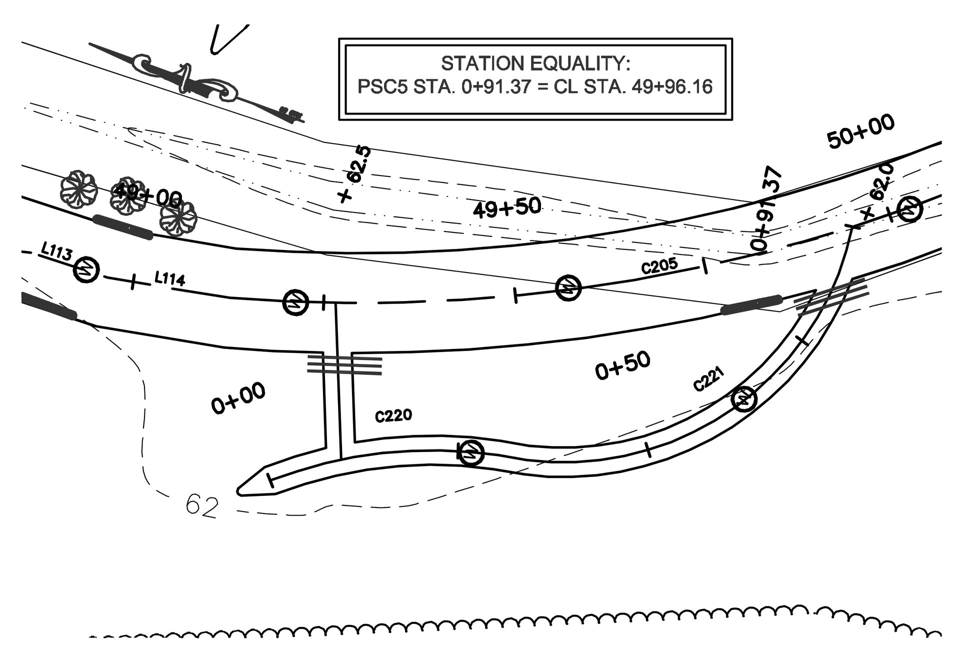
WOODS LINE	
EXISTING CONTOURS	
EXISTING DITCH	
PROPOSED CENTER OF CHANNEL	
LIMITS OF BANKFULL CHANNEL	
LIMITS OF CONSERVATION EASMENT	LCE
SILT FENCE	
LOG RAMP	
LEAF PACK	L
SMALL WOODY DEBRIS	W
LARGE WOODY DEBRIS	
LOG GRADE CONTROL	
LOG TOE PROTECTION	
FORD CROSSING	
ROOT WAD	
CUTTINGS BUNDLE	
CHANNEL PLUG	
PROPOSED SPOT ELEVATIONS	+64.0



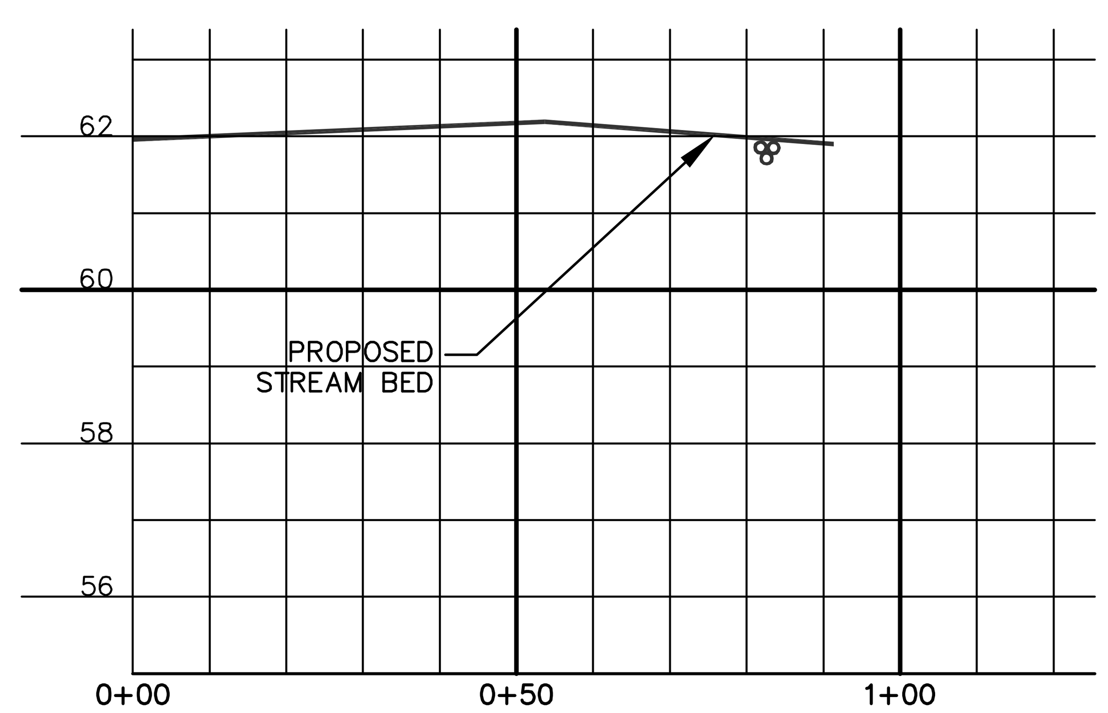


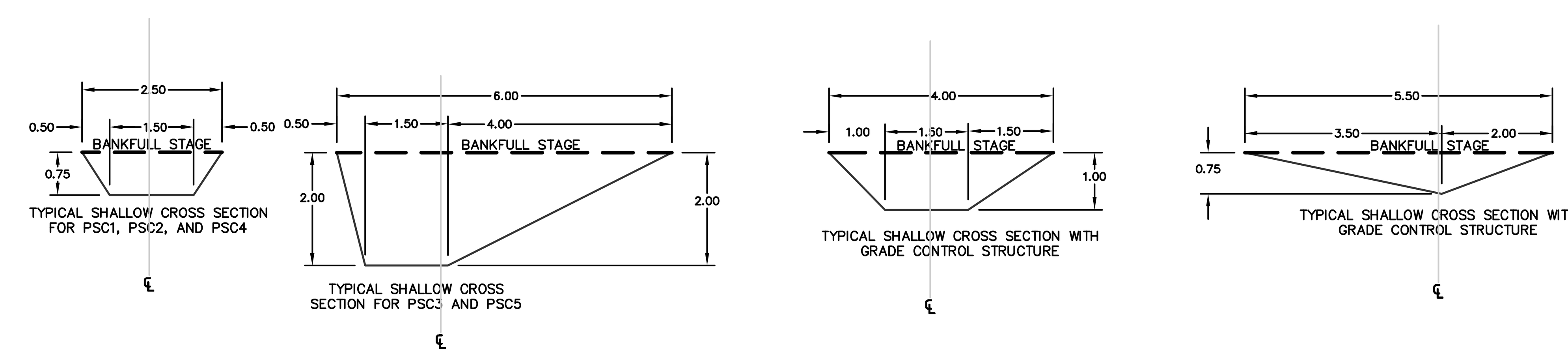
PSC4





PSC5





CURVE TABLE

CURVE	ARC LENGTH	RADIUS
C208	58.43	33.92
C209	38.41	49.85
C210	15.54	13.47
C211	9.22	14.05
C212	13.19	18.81
C213	12.91	20.82
C214	60.30	43.17
C215	58.95	34.01
C216	38.47	56.88
C217	26.57	30.67
C218	28.84	18.25
C219	12.91	20.82
C220	58.95	34.01
C221	38.47	57.36

NOTES:

IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.

ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.

ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.

REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.

CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.

LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER: DPI	DRAWING SCALE: 1" = 20'
DRAWN BY: TRS	PROJECT DATE: 06/2006
APPROVED BY: ME	PROJECT NUMBER: 6002000RA
FILE NAME: design_layout.dwg	PLOT DATE: 11/10/06

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ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

STREAM RESTORATION DESIGN

LEGEND
CHANNEL PLUG
CHANNEL PLUG WITH SPILLWAY
WETLAND DEPRESSION
TREE LINE
EXISTING CONTOURS
LIMITS OF CONSERVATION EASEMENT
LCE
PROPOSED SPOT ELEVATIONS
+ 66.50'
ROCK CHECK DAM
SEABOARD COASTLINE RAILROAD 130' (ABANDONED) R/W
OVERHEAD UTILITY TO BE RELOCATED OUTSIDE OF CONSERVATION EASEMENT BY OTHERS
PROPOSED STOCKPILE AREA
EXIST. OVERHEAD UTILITY TO BE REMOVED BY OTHERS
REGRADE CHANNEL TO REVERSE FLOW
RAPTOR POLE
EXIST. CULVERT TO BE REMOVED
TEMPORARY CONSTRUCTION ENTRANCE SEE DETAIL SHEET 22
TOP ELEV. = 62.0'
SPILLWAY = 61.0'
TOP ELEV. = 62.5'
TOP ELEV. = 63.0'
TOP ELEV. = 63.5'
TOP ELEV. = 64.0'
TOP ELEV. = 64.5'
TOP ELEV. = 65.0'
TOP ELEV. = 65.5'
TOP ELEV. = 66.0'
SPILLWAY = 65.1'
TOP ELEV. = 66.5'
TOP ELEV. = 67.0'
TOP ELEV. = 67.5'
TOP ELEV. = 68.0'
SPILLWAY = 67.3'
PROP. INV. = 65.8'
PROP. INV. = 66.9'
NAD 83
MATCH LINE SEE SHEET 17
1 inch = 100ft.

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER: DPI	DRAWING SCALE: 1" = 100'
DRAWN BY: TRS	PROJECT DATE: 06/2006
APPROVED BY: ME	PROJECT NUMBER: 6002000RA
FILE NAME: wetland.dwg	PLOT DATE: 11/10/06

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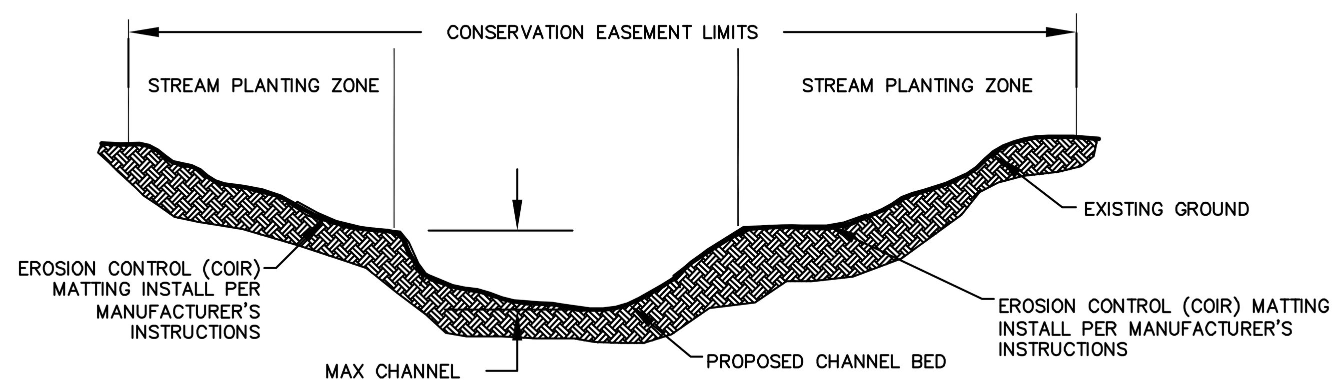
ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

WETLAND DESIGN PLANS

17 / 24

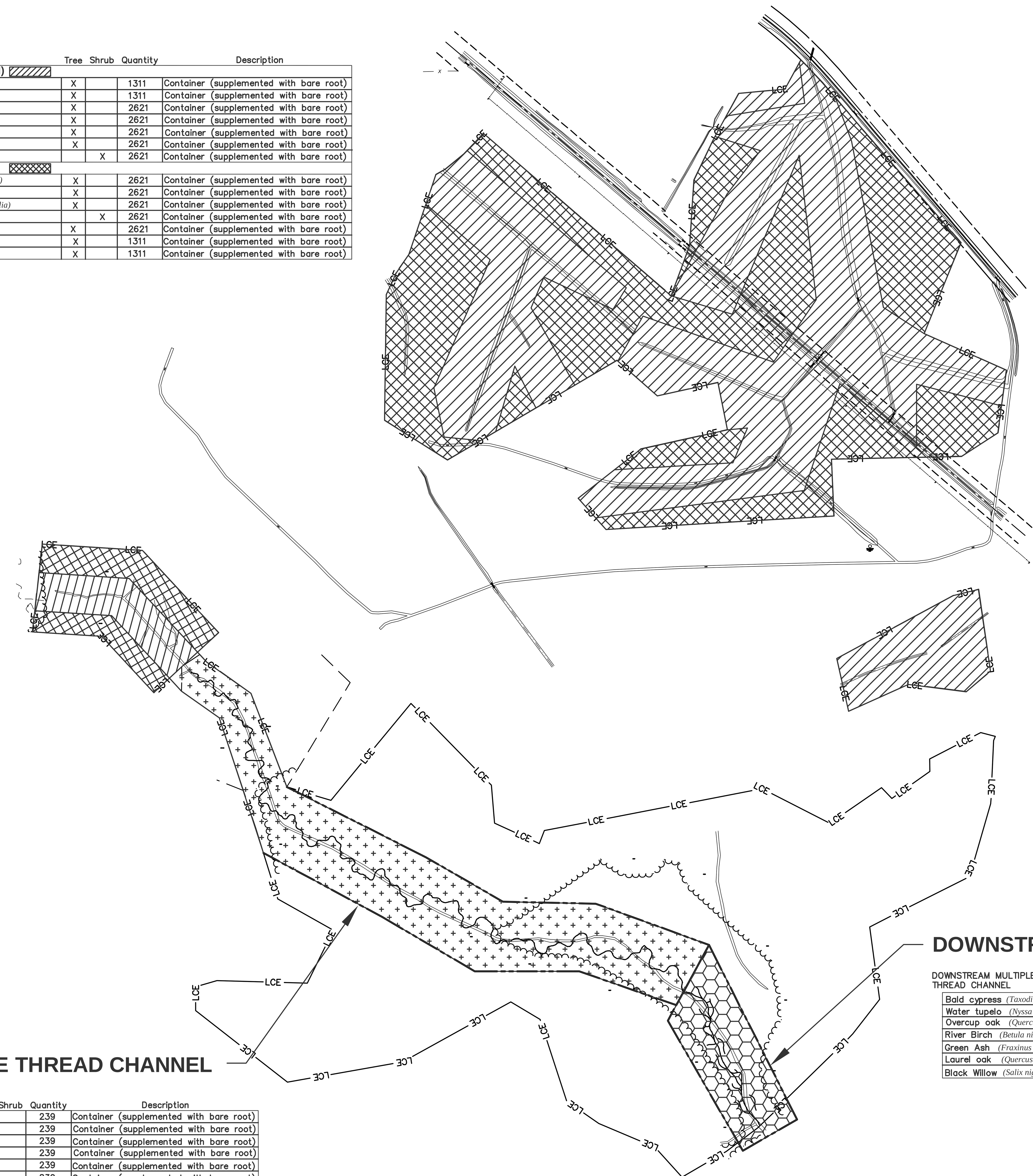
WETLAND PLANTING PLAN

	Tree	Shrub	Quantity	Description
Zone 1 (saturated/inundated)				
Willow oak *(Quercus phellos)*	X		1311	Container (supplemented with bare root)
Water oak *(Quercus nigra)*	X		1311	Container (supplemented with bare root)
Sycamore *(Platanus occidentalis)*	X		2621	Container (supplemented with bare root)
Green Ash *(Fraxinus pennsylvanica)*	X		2621	Container (supplemented with bare root)
Laurel oak *(Quercus laurifolia)*	X		2621	Container (supplemented with bare root)
Swamp blackgum *(Nyssa biflora)*	X		2621	Container (supplemented with bare root)
Musclewood *(Carpinus caroliniana)*		X	2621	Container (supplemented with bare root)
Zone 2 (saturated)				
Yellow poplar *(Liriodendron tulipifera)*	X		2621	Container (supplemented with bare root)
American elm *(Ulmus americana)*	X		2621	Container (supplemented with bare root)
Cherrybark oak *(Quercus pagodafolia)*	X		2621	Container (supplemented with bare root)
Pawpaw *(Asimina triloba)*		X	2621	Container (supplemented with bare root)
Blackgum *(Nyssa sylvatica)*	X		2621	Container (supplemented with bare root)
Willow oak *(Quercus phellos)*	X		1311	Container (supplemented with bare root)
Water oak *(Quercus nigra)*	X		1311	Container (supplemented with bare root)



NOTE:
INSTALL EROSION CONTROL MATTING PER MANUFACTURER'S INSTRUCTIONS ALONG PROPOSED CHANNEL BANKS.

PLANTING ZONE
NOT TO SCALE



PLANTING NOTES

ALL PLANTING AREAS
1. EROSION CONTROL MEASURES SHALL BE PROPERLY MAINTAINED UNTIL PERMANENT VEGETATION IS ESTABLISHED. THE CONTRACTOR SHALL INSPECT EROSION CONTROL MEASURES AT THE END OF EACH WORKING DAY TO ENSURE MEASURES ARE FUNCTIONING PROPERLY.
2. DISTURBED AREAS NOT AT FINAL GRADE SHALL BE TEMPORARILY VEGETATED WITHIN 10 WORKING DAYS. UPON COMPLETION OF FINAL GRADING, PERMANENT VEGETATION SHALL BE ESTABLISHED FOR ALL DISTURBED AREAS WITHIN 10 WORKING DAYS. SEEDING SHALL BE IN ACCORDANCE WITH EROSION CONTROL PLAN.
3. ALL DISTURBED AREAS SHALL BE PREPARED PRIOR TO PLANTING BY DISC OR SPRING-TOOTH CHISEL PLOW TO MINIMUM DEPTH OF 12 INCHES. MULTIPLE PASSES SHALL BE MADE ACROSS PLANTING AREAS WITH THE IMPLEMENT AND THE FINAL PASS SHALL FOLLOW TOPOGRAPHIC CONTOURS.
4. COIR FABRIC MATERIALS SHALL NOT BE CUT WITH PLANTING IMPLEMENTS. THE SMALLEST OPENING NECESSARY TO ACCOMMODATE EACH PLANT SHALL BE CUT INTO COIR FABRIC USING A SHARP KNIFE OR SHEARS. NO HOLES LARGER THAN 12 INCHES SHALL BE MADE.
5. SPECIES SHALL BE DISTRIBUTED SUCH THAT 3 TO 6 PLANTS OF THE SAME SPECIES ARE GROUPED TOGETHER.

PERMANENT SEEDING FOR ALL DISTURBED AREAS OF THE CONSERVATION EASEMENT LIMITS SHALL BE AS FOLLOWS (RATE IS PURE LIVE SEED).

SEED TYPE	RATE (POUNDS/ACRE)	QUANTITY
PANICUM SP.	6	5
DEERTONGUE	6	5
ANDROPOGON SP.	6	5

DOWNSTREAM MULTIPLE THREAD CHANNEL

DOWNSTREAM MULTIPLE THREAD CHANNEL

	Tree	Shrub	Quantity	Description
Bald cypress *(Taxodium distichum)*	X		456	Container (supplemented with bare root)
Water tupelo *(Nyssa aquatica)*	X		456	Container (supplemented with bare root)
Overcup oak *(Quercus lyrata)*	X		852	Bare root
River Birch *(Betula nigra)*	X		456	Container (supplemented with bare root)
Green Ash *(Fraxinus pennsylvanica)*	X		456	Container (supplemented with bare root)
Laurel oak *(Quercus laurifolia)*	X		456	Container (supplemented with bare root)
Black Willow *(Salix nigra)*	X		1579	Live Stake

UPSTREAM SINGLE THREAD CHANNEL

STREAM PLANTING PLAN

UPSTREAM SINGLE-THREAD CHANNEL

	Tree	Shrub	Quantity	Description
Green Ash *(Fraxinus pennsylvanica)*	X		239	Container (supplemented with bare root)
Sycamore *(Platanus occidentalis)*	X		239	Container (supplemented with bare root)
Swamp blackgum *(Nyssa biflora)*	X		239	Container (supplemented with bare root)
Bald cypress *(Taxodium distichum)*	X		239	Container (supplemented with bare root)
Water oak *(Quercus nigra)*	X		239	Container (supplemented with bare root)
Willow oak *(Quercus phellos)*	X		239	Container (supplemented with bare root)
Black Willow *(Salix nigra)*	X		1314	Live Stake

300 0 150 300 600
1 inch = 300ft.

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APPROVED BY ME	PROJECT NUMBER 6002000RA	BIDDING	
FILE NAME wetland.dwg	PLOT DATE 11/10/2006	CONSTRUCTION	
		RECORD DWG.	

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HALIFAX COUNTY, NORTH CAROLINA

PLANTING PLAN

TEMPORARY SEEDING FOR FALL AND LATE WINTER

	GENTLE SLOPES	STEEP SLOPES
SEEDING MIXTURE	80 lbs/acre of rye grain seed mix	100 lbs/acre tall fescue 30 lbs/acre Sericea lespedeza (unscarified after August 15) 10 lbs/acre Kobe lespedeza
SEEDING DATES	FALL: August 25 – October 15 Late winter: February 15 – April 15 To extend spring seeding into June, add 15 lbs/acre hulled Bermudagrass.	FALL: August 25 – October 15 Late winter: February 15 – April 15 To extend spring seeding into June, add 15 lbs/acre hulled Bermudagrass.
SEEDING AMENDMENTS	Follow recommendations of soil tests or apply 2,000 lb/acre ground agricultural limestone and 750 lb/acre 10-10-10 fertilizer. Apply 4,000 lb/acre straw. Anchor straw with netting or a mulch anchoring tool. Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.	Follow recommendations of soil tests or apply 2,000 lb/acre ground agricultural limestone and 750 lb/acre 10-10-10 fertilizer. Apply 4,000 lb/acre straw. Anchor straw with netting or a mulch anchoring tool. Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.

TEMPORARY SEEDING FOR WARM AND COOL SEASON

	GENTLE SLOPES	STEEP SLOPES
SEEDING MIXTURE	40 lbs/acre of German millet 80 lbs/acre of tall fescue	100 lbs/acre Rye (grain) 30 lbs/acre Sericea lespedeza
SEEDING DATES	May 1 – August 15 Refertilize if growth is not fully adequate. Apply 4000 lbs/acre straw or equivalent hydroseeding.	October 25 – December 30 Between December 30 – February 15, add 50 lbs/acre of annual Kobe lespedeza. Apply 4000 lbs/acre straw or equivalent hydroseeding.
SEEDING AMENDMENTS	Follow recommendations of soil tests or apply 2,000 lb/acre ground agricultural limestone and 750 lb/acre 10-10-10 fertilizer. Apply 4,000 lb/acre straw. Anchor straw with netting or a mulch anchoring tool. Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.	Follow recommendations of soil tests or apply 2,000 lb/acre ground agricultural limestone and 750 lb/acre 10-10-10 fertilizer. Apply 4,000 lb/acre straw. Anchor straw with netting or a mulch anchoring tool. Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.

EROSION CONTROL:
GENERAL NOTES

1. REVIEW CONSTRUCTION SEQUENCE FOR ADDITIONAL EROSION CONTROL MEASURES. ALL PERMANENT AND TEMPORARY EROSION CONTROL STRUCTURES (I.E ROCK CHECK DAMS, SILT FENCE AND TEMPORARY CONSTRUCTION ENTRANCES) SHALL BE INSTALLED PRIOR TO THE START OF CONSTRUCTION OF THE LAND-DISTURBING ACTIVITY.

2. CONSTRUCTION ACCESS AREAS SHOWN ARE TO GUIDE CONTRACTOR DURING CONSTRUCTION. CONTRACTOR SHALL COORDINATE WITH ENGINEER IF ALTERNATIVE CONSTRUCTION ACCESS ROUTES WILL IMPROVE EFFICIENCY OF CONSTRUCTION.

3. ALL AREAS DISTURBED BY THE CONTRACTOR SHALL BE SEEDED PER THE SPECIFICATIONS IN THE SEEDING SCHEDULE.

4. MULCH: APPLY 2 TONS/ACRE GRAIN STRAW AND ANCHOR STRAW ON ALL OTHER DISTURBED AREAS.

5. EROSION CONTROL:

A. INSTALL PERMANENT VEGETATIVE COVER AND THE LONG-TERM EROSION PROTECTION MEASURES OR STRUCTURES AS DIRECTED BY ENGINEER UPON CONSTRUCTION COMPLETION. APPROPRIATE EROSION CONTROL MEASURES MUST BE PLACED BETWEEN THE DISTURBED AREA AND AFFECTED WATERWAY AND MAINTAINED UNTIL PERMANENTLY VEGETATED.

B. PROVIDE FOR HANDLING THE INCREASED RUNOFF CAUSED BY CHANGED SOIL AND SURFACE CONDITIONS. USE EFFECTIVE MEANS TO CONSERVE EXISTING ON-SITE SOIL CONDITIONS.

C. DURING CONSTRUCTION ACTIVITIES, ALL DISTURBED AREAS SHALL BE STABILIZED AT THE END OF EACH WORKING DAY. USE TEMPORARY PLANT COVER, MULCHING, AND/OR STRUCTURES TO CONTROL RUNOFF AND PROTECT AREAS SUBJECT TO EROSION DURING CONSTRUCTION.

D. ALL SEDIMENT AND EROSION CONTROLS ARE TO BE INSPECTED AT LEAST ONCE EVERY SEVEN CALENDAR DAYS AND AFTER ANY STORM EVENT OF GREATER THAN 0.5 INCHES OF PRECIPITATION DURING ANY 24-HOUR PERIOD. MAINTENANCE OF SEDIMENT TRAPPING STRUCTURES SHALL BE PERFORMED AS NECESSARY PER THESE INSPECTIONS. SILT FENCING SHALL BE INSTALLED AS SHOWN ON PLANS.

E. STABILIZATION MEASURES SHALL BE INITIATED AT THE END OF EACH DAY IN PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED. EXCEPT WHERE CONSTRUCTION ACTIVITIES SHALL BE REINITIATED WITHIN 21 CALENDAR DAYS. ALL AREAS WHERE FINAL GRADE HAS BEEN ESTABLISHED SHALL BE PERMANENTLY STABILIZED WITHIN 2 CALENDAR DAYS.

F. CONTRACTOR MUST TAKE THE NECESSARY ACTION TO MINIMIZE THE TRACKING OF MUD ONTO THE PAVED ROADWAY FROM CONSTRUCTION AREAS. DAILY REMOVAL OF MUD/SOIL MAY BE REQUIRED.

G. ALL EROSION CONTROL DEVICES SHALL BE PROPERLY MAINTAINED DURING ALL PHASES OF CONSTRUCTION UNTIL THE COMPLETION OF ALL CONSTRUCTION ACTIVITIES AND ALL DISTURBED AREAS HAVE BEEN STABILIZED. ADDITIONAL CONTROL DEVICES MAY BE REQUIRED DURING CONSTRUCTION IN ORDER TO CONTROL EROSION AND/OR OFF SITE SEDIMENTATION. CONTRACTOR SHALL REMOVE ALL TEMPORARY CONTROL DEVICES ONCE CONSTRUCTION IS COMPLETE AND THE SITE IS STABILIZED. A MAXIMUM OF 1000 LINEAR FEET OF STREAM MAY BE DISTURBED AT ANY ONE TIME.

H. SILT FENCING TO BE INSTALLED AROUND INDICATED STOCKPILE AREAS TO PREVENT LOSS OF SEDIMENT. STOCKPILE AREAS MAY BE RELOCATED UPON APPROVAL FROM ENGINEER.

I. ASPHALT TACKIFIER SHALL NOT BE USED.

J. ALL NECESSARY MEASURES MUST BE TAKEN TO PREVENT OIL, TAR, TRASH, AND OTHER POLLUTANTS FROM ENTERING THE ADJACENT OFF SITE AREAS.

K. WETLANDS/STREAMS CANNOT BE ENCROACHED UNDER ANY CIRCUMSTANCES IF NOT APPROVED AS DESIGNATED IMPACT AREAS.

L. ACTIVITIES MUST AVOID DISTURBANCE OF WOODY RIPARIAN VEGETATION WITHIN THE PROJECT AREA TO THE GREATEST EXTENT PRACTICABLE. REMOVAL OF VEGETATION MUST BE LIMITED TO ONLY THAT NECESSARY FOR CONSTRUCTION OF THE CHANNEL.

M. NO ONSITE BURIAL OR BURNING OF VEGETATION OR CONSTRUCTION DEBRIS WILL BE PERMITTED. VEGETATIVE DEBRIS SHALL BE STOCKPILED AND DISPOSED OF ONSITE PER DIRECTION OF ENGINEER.

N. ANY GRADING BEYOND THE CONSTRUCTION LIMITS SHOWN ON THE PLAN IS A VIOLATION OF THE NORTH CAROLINA EROSION CONTROL ORDINANCE, AND IS SUBJECT TO A FINE.

O. PLEASE REFERENCE PLAN SHEET DETAILS AND NCDENR STANDARDS FOR CONSTRUCTION OF EROSION CONTROL MEASURES.

P. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ALL EROSION CONTROL MEASURES RELATED TO THE CONSTRUCTION SITE.

Q. THE LOCATIONS OF SOME EROSION CONTROL MEASURES MAY HAVE TO BE ALTERED FROM THOSE SHOWN ON THE PLANS IF DRAINAGE PATTERNS CHANGE DURING CONSTRUCTION.

R. IF IT IS DETERMINED DURING THE COURSE OF CONSTRUCTION THAT SIGNIFICANT SEDIMENT IS LEAVING THE SITE (DESPITE THE PROPER IMPLEMENTATION AND MAINTENANCE OF EROSION CONTROL MEASURES), THE PERSON RESPONSIBLE FOR THE LAND DISTURBING ACTIVITY IS OBLIGATED TO TAKE ADDITIONAL PROTECTIVE ACTION.

STREAM CONSTRUCTION SEQUENCE:

1. CONDUCT PRE-CONSTRUCTION MEETING INCLUDING OWNER, ENGINEER, ASSOCIATED CONTRACTORS, AND OTHER AFFECTED PARTIES.

2. OBTAIN EROSION CONTROL PERMIT FROM NCDENR – LAND QUALITY SECTION AND ALL OTHER APPROVALS NECESSARY TO BEGIN AND COMPLETE THE PROJECT.

3. CONTRACTOR IS FULLY RESPONSIBLE FOR CONTACTING ALL APPROPRIATE PARTIES AND ASSURING THAT UTILITIES ARE LOCATED PRIOR TO THE COMMENCEMENT OF CONSTRUCTION. CALL NC ONE-CALL (PREVIOUSLY ULOCO) AT 1-800-632-4949 FOR UTILITY LOCATING SERVICES 48 HOURS PRIOR TO COMMENCEMENT OF ANY WORK. CONTRACTOR SHALL VERIFY LOCATION AND DEPTH OF ALL EXISTING UTILITIES PRIOR TO CONSTRUCTION.

4. PRIOR TO CONSTRUCTION, STABILIZED GRAVEL ENTRANCE/EXIT AND ROUTES OF INGRESS AND EGRESS SHALL BE ESTABLISHED AS SHOWN ON THE PLANS AND DETAILS.

5. PREPARE STAGING AND STOCKPILING AREAS IN LOCATIONS AS SHOWN ON THE CONSTRUCTION PLANS OR AS APPROVED BY THE ENGINEER. ANY EXCESS SPOIL FROM STREAM CONSTRUCTION SHALL BE USED TO CONSTRUCT WETLAND DITCH PLUGS AS SHOWN ON PLANS.

6. INSTALL PUMP AROUND APPARATUS AND IMPERVIOUS DIKES AT UPSTREAM END OF PROJECT. AS CONSTRUCTION PROGRESSES, MOVE PUMP AROUND OPERATION DOWNSTREAM. (SEE DETAILS ON SHEET 22)

7. CONSTRUCT UPSTREAM PORTION OF THE CHANNEL FIRST, WORKING IN AN UPSTREAM TO DOWNSTREAM DIRECTION.

8. ROUGH GRADING OF CHANNEL SHALL BE PERFORMED PRIOR TO INSTALLATION OF STRUCTURES.

9. INSTALL STRUCTURES AS SHOWN ON PLANS AND DETAILS. PRIOR TO FINE GRADING, OBTAIN APPROVAL OF THE ENGINEER ON INSTALLATION OF STRUCTURES.

10. UPON COMPLETION OF FINE GRADING, INSTALL EROSION CONTROL MATTING.

11. HYDRAULICALLY CONNECT MOST UPSTREAM REACH OF NEW CHANNEL TO THE EXISTING CHANNEL TO FLUSH OUT FINE SEDIMENT PRIOR TO MAKING CONNECTION TO NEW DOWNSTREAM CHANNEL (SEE DETAIL FOR ADDITIONAL INFORMATION).

12. FILL AND STABILIZE ABANDONED SEGMENTS OF THE EXISTING CHANNEL PER DIRECTION OF THE ENGINEER.

13. ALL IMPERVIOUS DIKES AND PUMPING APPARATUS SHALL BE REMOVED FROM THE STREAM AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.

14. DURING STREAM CONSTRUCTION ACTIVITIES, THE WORK AREA SHALL BE STABILIZED AT THE END OF EACH WORKING DAY.

15. INSTALL LIVE STAKE, BARE ROOT, AND CONTAINERIZED PLANTINGS AS SPECIFIED ON PLANTING PLANS.

WETLAND CONSTRUCTION SEQUENCE:

1. CONDUCT PRE-CONSTRUCTION MEETING INCLUDING OWNER, ENGINEER, ASSOCIATED CONTRACTORS, AND OTHER AFFECTED PARTIES.

2. OBTAIN EROSION CONTROL PERMIT FROM NCDENR – LAND QUALITY SECTION AND ALL OTHER APPROVALS NECESSARY TO BEGIN AND COMPLETE THE PROJECT.

3. CONTRACTOR IS FULLY RESPONSIBLE FOR CONTACTING ALL APPROPRIATE PARTIES AND ASSURING THAT UTILITIES ARE LOCATED PRIOR TO THE COMMENCEMENT OF CONSTRUCTION. CALL NC ONE-CALL (PREVIOUSLY ULOCO) AT 1-800-632-4949 FOR UTILITY LOCATING SERVICES 48 HOURS PRIOR TO COMMENCEMENT OF ANY WORK. CONTRACTOR SHALL VERIFY LOCATION AND DEPTH OF ALL EXISTING UTILITIES PRIOR TO CONSTRUCTION.

4. PRIOR TO CONSTRUCTION, STABILIZED GRAVEL ENTRANCE/EXIT AND ROUTES OF INGRESS AND EGRESS SHALL BE ESTABLISHED AS SHOWN ON THE PLANS AND DETAILS.

5. EXCESS SPOIL FROM STREAM CONSTRUCTION SHALL BE USED TO CONSTRUCT WETLAND DITCH PLUGS AS SHOWN ON PLANS.

6. PREPARE STAGING AND STOCKPILING AREAS IN LOCATIONS AS SHOWN ON THE CONSTRUCTION PLANS OR AS APPROVED BY THE ENGINEER.

7. ROUGH GRADING OF WETLAND SHALL BE PERFORMED PRIOR TO INSTALLATION OF STRUCTURES.

8. INSTALL STRUCTURES AS SHOWN ON PLANS AND DETAILS. PRIOR TO FINE GRADING, OBTAIN APPROVAL OF THE ENGINEER ON INSTALLATION OF STRUCTURES.

9. UPON COMPLETION OF DITCH PLUG CONSTRUCTION, THE SOIL SHALL BE DISKED IN THE WETLAND AS SPECIFIED BY THE ENGINEER.

10. DURING WETLAND CONSTRUCTION ACTIVITIES, THE WORK AREA SHALL BE STABILIZED AT THE END OF EACH WORKING DAY.

11. INSTALL CONTAINERIZED PLANTINGS AS SPECIFIED ON PLANTING PLAN.

CONSTRUCTION NOTES:

1. PLEASE REFERENCE PLAN SHEET DETAILS AND NCDENR STANDARDS FOR CONSTRUCTION OF EROSION CONTROL MEASURES. ALL PERMANENT AND TEMPORARY EROSION CONTROL STRUCTURES (I.E ROCK CHECK DAMS, SILT FENCE AND TEMPORARY CONSTRUCTION ENTRANCES) SHALL BE INSTALLED PRIOR TO THE START OF CONSTRUCTION OF THE LAND-DISTURBING ACTIVITY.

2. IN GENERAL, STREAM CONSTRUCTION SHALL PROCEED FROM AN UPSTREAM TO DOWNSTREAM DIRECTION.

3. DURING STREAM AND WETLAND CONSTRUCTION ACTIVITIES, THE WORK AREA SHALL BE STABILIZED AT THE END OF EACH WORKING DAY.

4. STOCKPILE AREAS MAY BE RELOCATED UPON THE APPROVAL OF THE ENGINEER. SILT FENCING MUST BE INSTALLED AROUND ALL STOCKPILE AREAS.

5. PROPOSED CHANNEL EXCAVATION AND GRADING SHALL BE PERFORMED USING EQUIPMENT FROM OUTSIDE OF THE EXISTING CHANNEL WHERE POSSIBLE. TEMPORARY CROSSINGS WILL BE USED AT LOCATIONS SPECIFIED ON THE PLANS. CROSSINGS MAY BE ADDED OR RELOCATED UPON APPROVAL FROM THE ENGINEER.

6. CONTRACTOR SHALL REMOVE ALL TEMPORARY CONTROL DEVICES ONCE CONSTRUCTION IS COMPLETE AND THE SITE IS STABILIZED. A MAXIMUM OF 1000 LINEAR FEET OF STREAM MAY BE DISTURBED AT ANY ONE TIME.

7. ALL EXCAVATED MATERIAL MUST BE PLACED WITHIN DESIGNATED STOCKPILE AREAS.

8. AT LOCATIONS IN WHICH THE EXISTING CHANNEL IS BEING MAINTAINED, TEMPORARY PUMP AROUND DAMS AND BYPASS PUMPING WILL BE USED TO DE-WATER THE WORK AREA AS DESCRIBED IN THE DETAILS.

9. WHEN THE PROPOSED CHANNEL HAS BEEN SUFFICIENTLY STABILIZED TO PREVENT EROSION, ALL TEMPORARY PUMP AROUND DAMS WILL BE REMOVED FROM THE ACTIVE STREAM CHANNEL AND NORMAL FLOW RESTORED. ACCUMULATED SEDIMENT SHALL BE DISPOSED OF IN DESIGNATED SPOILS AREAS PRIOR TO REMOVAL OF TEMPORARY PUMP AROUND DAM.

10. HYDRAULICALLY CONNECT MOST UPSTREAM REACH OF NEW CHANNEL TO THE EXISTING CHANNEL TO FLUSH OUT FINE SEDIMENT PRIOR TO MAKING CONNECTION TO NEW DOWNSTREAM CHANNEL (SEE DETAIL FOR ADDITIONAL INFORMATION).

11. FILL AND STABILIZE ABANDONED SEGMENTS OF THE EXISTING CHANNEL PER DIRECTION OF THE ENGINEER.

12. ALL IMPERVIOUS DIKES AND BYPASS PUMPING EQUIPMENT SHALL BE MODIFIED AT THE END OF EACH DAY TO RESTORE NORMAL FLOW BACK TO THE CHANNEL.

13. PRIOR TO FINE GRADING, THE CONTRACTOR MUST OBTAIN APPROVAL OF ENGINEER ON THE INSTALLATION OF ALL STRUCTURES.

14. REMOVE ALL LOOSE OR EXCESS DIRT FROM ROOT BALLS BEFORE INSTALLING ROOT WADS.

15. TEMPORARY AND PERMANENT STABILIZATION OF ALL DISTURBED GRASSED AREAS AT THE TOP OF THE CHANNEL BANKS WILL BE IN ACCORDANCE WITH THE SEEDING AND MULCHING SPECIFICATION AS SHOWN ON VEGETATION PLAN.

16. CONTRACTOR SHALL NOT COMPACT SOIL AROUND ROOTS OR TREES TO REMAIN, AND SHALL NOT DAMAGE SUCH TREES IN ANY WAY. EXCAVATED OR OTHER MATERIAL SHALL NOT BE PLACED, PILED OR STORED WITHIN THE CRITICAL ROOT ZONE AREA OF THE TREES TO BE SAVED.

17. IT SHALL BE UNDERSTOOD THAT FAILURE TO SPECIFICALLY MENTION ANY WORK THAT WOULD REASONABLY BE REQUIRED TO COMPLETE THIS PROJECT SHALL NOT RELIEVE THE CONTRACTOR OF HIS RESPONSIBILITY TO PERFORM SUCH WORK.

18. USE TIMBER MATS TO PROTECT EXISTING WETLAND AREAS FROM VEHICLES OR EQUIPMENT.

19. NO TREES WILL BE REMOVED WITHOUT DIRECTION FROM ENGINEER. REMOVAL OF TREES NOT INTENDED FOR USE AS ROOT WADS MUST BE FLUSH CUT.

20. CONTRACTOR SHALL BE RESPONSIBLE FOR DISPOSING OF EXCESS SOIL OFFSITE.

21. LOG VANES MAY BE SUBSTITUTED FOR ROOT WADS WITH APPROVAL OF ENGINEER.

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER: DPI	DRAWING SCALE: 1" = 200'
DRAWN BY: TRS	PROJECT DATE: 06/2006
APPROVED BY: ME	PROJECT NUMBER: 6002000RA
FILE NAME: design_layout.dwg	PLOT DATE: 11/10/06

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3101 JOHN HUMPHRIES WYND
RALEIGH, NC 27612
(919) 782-0495

Office Locations:
North Carolina Georgia
South Carolina Florida

RELEASED FOR	DATE
APPROVALS	06/09/06
BIDDING	
CONSTRUCTION	
RECORD DWG.	

EBX

ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA SWAMP RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

CONOCONNARA DESIGN PLANS
EROSION AND SEDIMENT CONTROL

LEGEND

- CONSTRUCTION ACCESS ROAD
- STOCKPILE AREA
- LIMITS OF CONSERVATION EASEMENT
- LIMITS OF DISTURBANCE
- SILT FENCING
- OVERHEAD UTILITY

TOTAL AREA OF DISTURBANCE = 19 AC

SEE SHEET 21 FOR ADDITIONAL WETLAND EROSION CONTROL PRACTICES

200 0 100 200 400

1 inch = 200ft.

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	REVISIONS	

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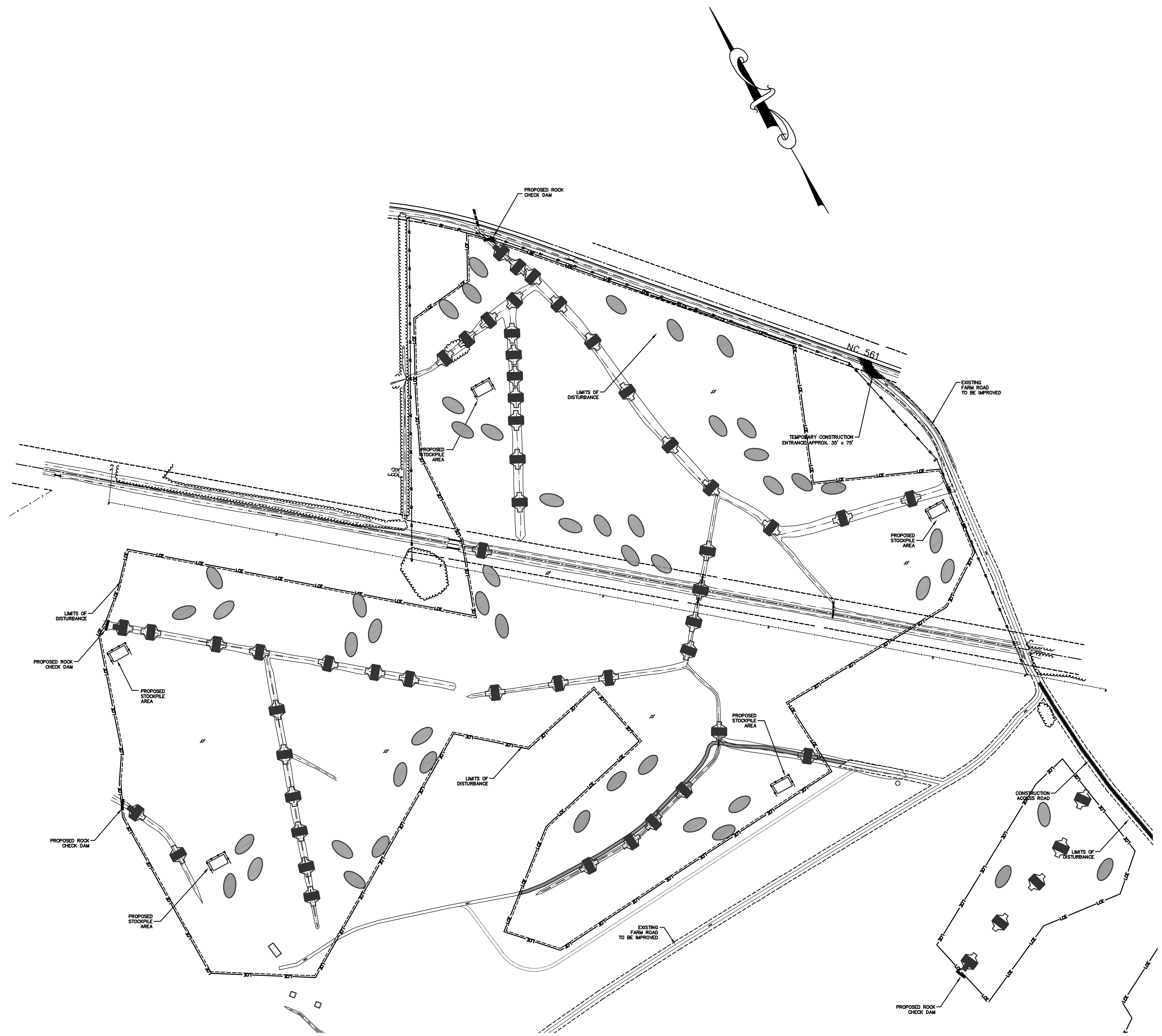
HALIFAX COUNTY, NORTH CAROLINA

CONOCONNARA DESIGN PLANS
EROSION AND SEDIMENT CONTROL



LEGEND

- CONSTRUCTION ACCESS ROAD
- STOCKPILE AREA
- LIMITS OF CONSERVATION EASEMENT
- LIMITS OF DISTURBANCE
- SILT FENCING
- OVERHEAD UTILITY
- ROCK CHECK DAM

TOTAL AREA OF DISTURBANCE = 82 AC

LIMITS OF DISTURBANCE AREA IS EQUAL TO LIMITS OF CONSERVATION EASEMENT

200 0 100 200 400

1 inch = 200ft.

REV. NO.	DESCRIPTION	DATE

REVISIONS

PROJECT MANAGER	DRAWING SCALE
DPI	1" = 200'
DRAWN BY	PROJECT DATE
TRS	06/2006
APPROVED BY	PROJECT NUMBER
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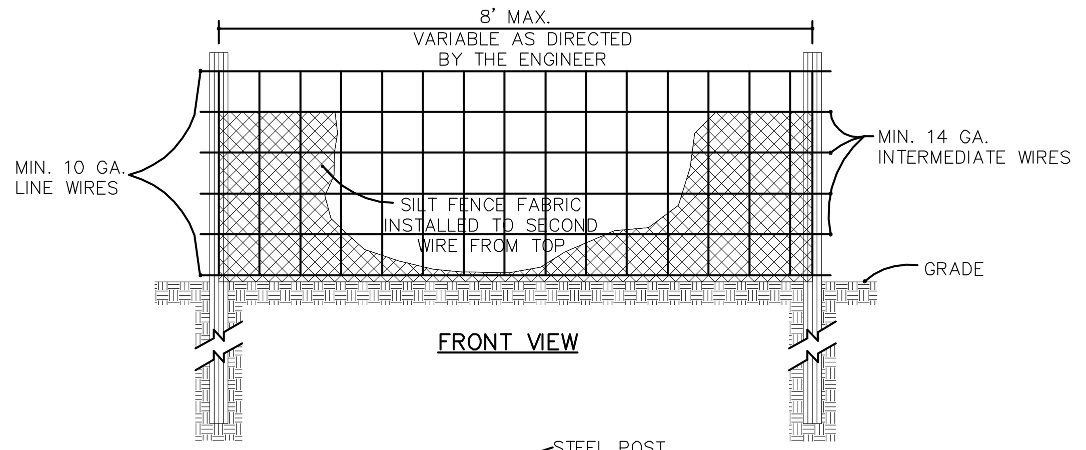
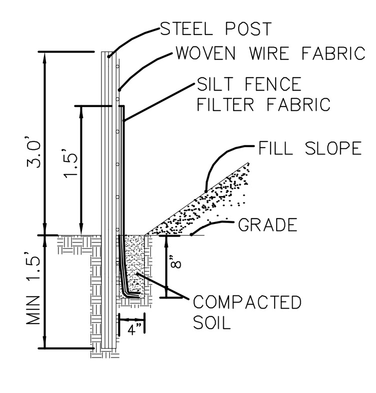
HALIFAX COUNTY, NORTH CAROLINA

CONOCONNARA DESIGN PLANS
EROSION AND SEDIMENT CONTROL

21/24



FRONT VIEW

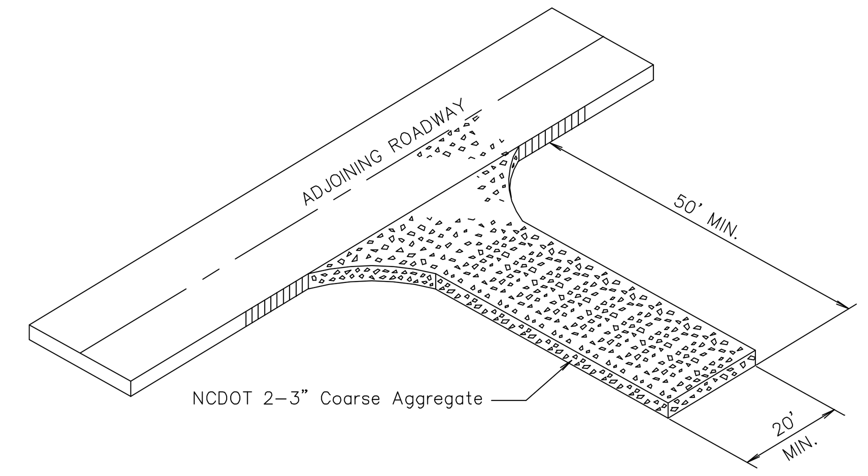


SIDE VIEW

NOTE:
1. USE SILT FENCE ONLY WHEN DRAINAGE AREA DOES NOT EXCEED 1/4 ACRE AND NEVER IN AREAS OF CONCENTRATED FLOW.
2. THE BOTTOM 1.0' OF THE SILT FENCE MUST BE BURIED.
3. THE WIRE MUST EXTEND A MINIMUM OF 6" BELOW THE GROUND SURFACE.
4. FILTER FABRIC USED SHALL BE NCDOT TYPE 3 ENGINEERING FABRIC OR EQUIVALENT.

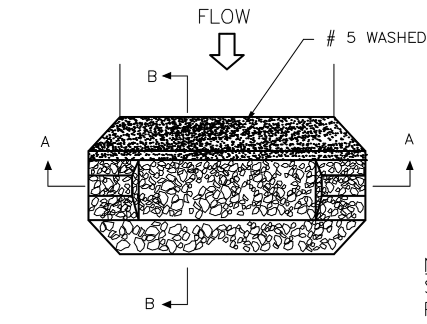
SILT FENCE MAINTENANCE:
1. FOR REPAIR OF SILT FENCE FAILURES, USE No. 57 WASHED STONE.
2. INSPECT FENCE PERIODICALLY AND AFTER EACH RAIN EVENT.
3. IF SILT FENCE BECOMES DAMAGED, REPLACE IMMEDIATELY.
4. REMOVE SEDIMENT DEPOSITS PROMPTLY.

TEMPORARY SILT FENCE
NOT TO SCALE



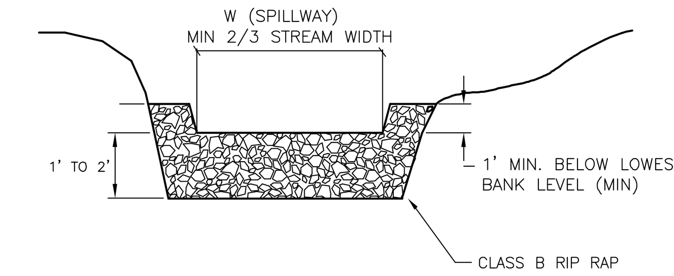
1. CONTRACTOR SHALL CONSTRUCT TIRE SCRUBBER AT ENTRANCE OF EACH CONSTRUCTION ACCESS TO STATE OR PUBLIC ROAD. NCDOT 2-3" COARSE AGGREGATE SHALL BE USED. PAD SHALL BE 50 FEET LONG BY 20 FEET WIDE BY 6 INCHES DEEP MINIMUM.
2. PROVIDE TURNING RADIUS SUFFICIENT TO ACCOMODATE LARGE (TANDUM) TRUCKS.
3. LOCATE ENTRANCES IN ORDER TO PROVIDE MAXIMUM UTILITY BY ALL CONSTRUCTION VEHICLES.
4. CONTRACTOR SHALL MAINTAIN CONSTRUCTION ENTRANCE IN CONDITION SUCH THAT TRUCKS ARE PREVENTED FROM TRACKING MUD ONTO STREETS AND MUD IS PREVENTED FROM FLOWING DIRECTLY ONTO STREETS. TOP-DRESS CONSTRUCTION ENTRANCE PERIODICALLY AS NEEDED.
5. LOCATE TEMPORARY CONSTRUCTION ENTRANCE ON BOTH SIDES OF CONSTRUCTION ROADWAYS WHERE THEY CROSS STATE OR PUBLIC ROADS.
6. REMOVE TEMPORARY ENTRANCE/EXIT AFTER AREA HAS BEEN STABILIZED.

TEMPORARY CONSTRUCTION ENTRANCE
NOT TO SCALE

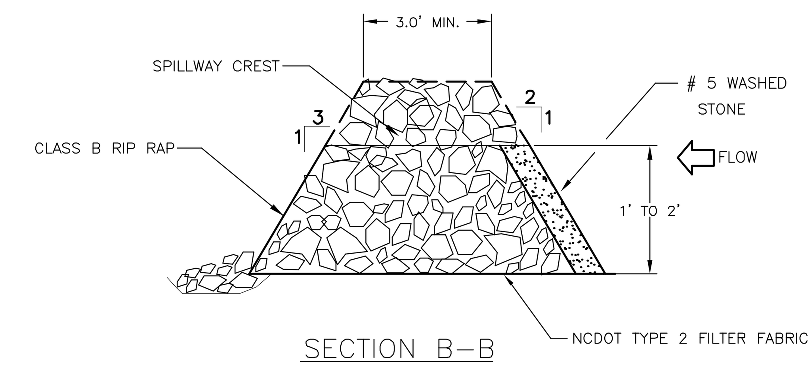


NOTE:
SAND BAGS WRAPPED IN 10 mm POLYPROPYLENE MAY BE SUBSTITUTED FOR STONE.

PLAN

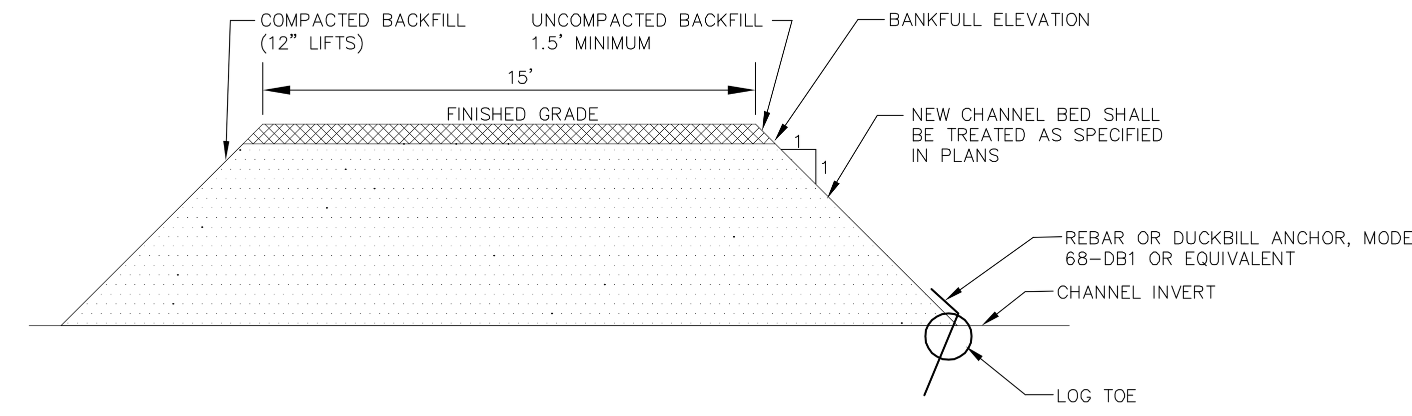


SECTION A–A

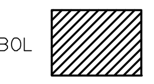


SECTION B–B

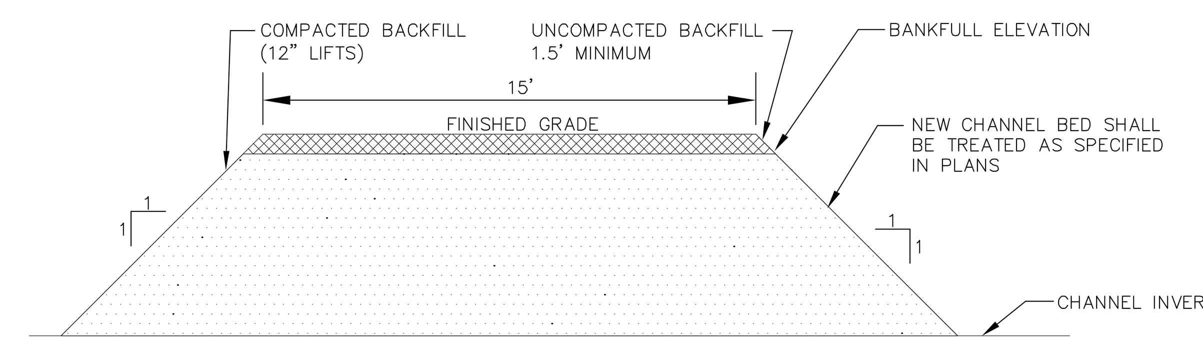
TEMPORARY ROCK CHECK DAM
NOT TO SCALE



PLAN VIEW SYMBOL



STREAM CHANNEL PLUG
NOT TO SCALE



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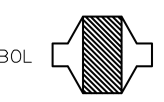
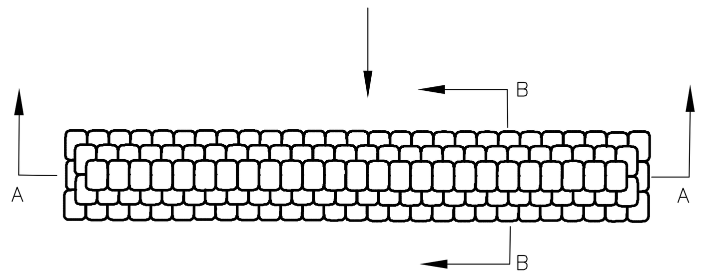
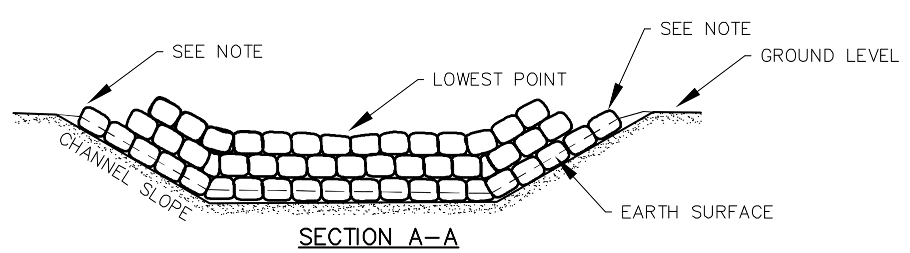


WETLAND CHANNEL PLUG
NOT TO SCALE

SANDBAG BARRIERS SHALL BE CONSTRUCTED OF THREE LAYERS OF SANDBAGS. THE BOTTOM LAYER SHALL CONSIST OF 3 ROWS OF BAGS, THE MIDDLE LAYER SHALL CONSIST OF 2 ROWS OF BAGS AND THE TOP LAYER SHALL CONSIST OF 1 ROW OF BAGS. THE RECOMMENDED DIMENSION OF A FILLED SANDBAG SHALL BE APPROXIMATELY 0.5 FT X 0.5 FT X 1.5 FT.

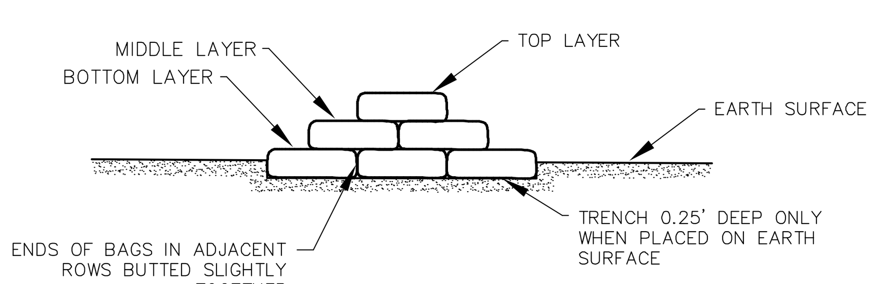


PLAN VIEW



SECTION A–A

NOTE: END OF DIKE AT GROUND LEVEL TO BE HIGHER THAN THE LOWEST POINT OF FLOW CHECK. SUFFICIENT SANDBAGS ARE TO BE PLACED TO PREVENT SCOURING.



SECTION B–B

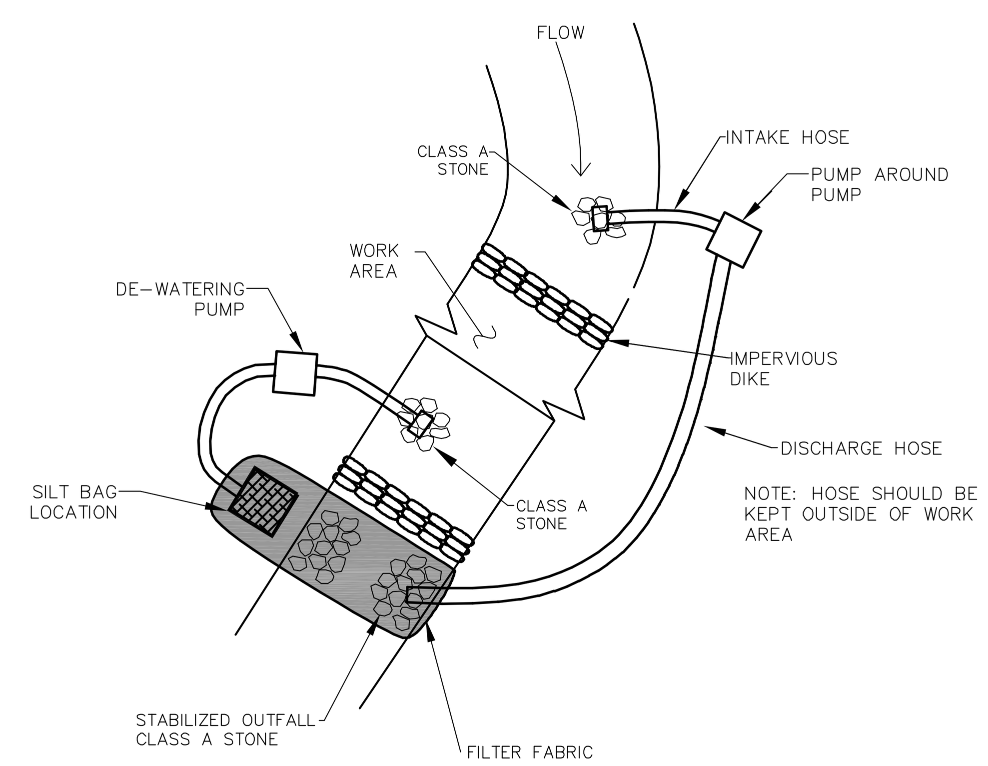
SANDBAG IMPERVIOUS DIKE
NOT TO SCALE

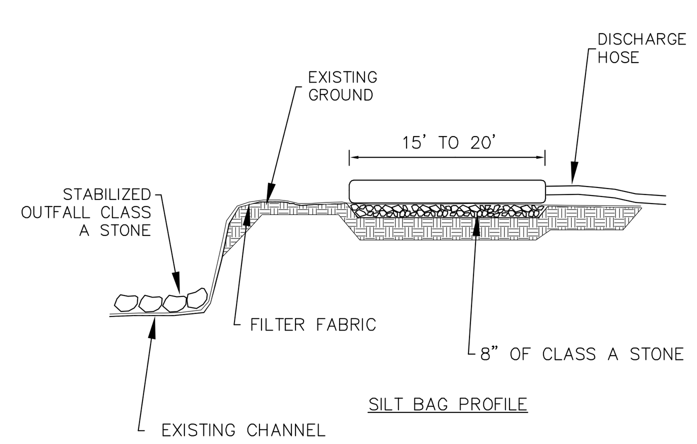
NOTES:

1. EXCAVATION SHALL BE PERFORMED ONLY IN DRY AND/OR ISOLATED SECTIONS OF CHANNEL.
2. IMPERVIOUS DIKES SHOULD BE USED TO ISOLATE WORK AREAS FROM STREAM FLOW.
3. THE CONTRACTOR SHALL NOT DISTURB MORE AREA THAN CAN BE STABILIZED IN ONE WORKING DAY. A MAXIMUM OF 1000 FEET MAY BE DISTURBED AT ANY ONE TIME.
4. THE PUMP-AROUND PUMP SHOULD ADEQUATELY CONVEY MINIMUM 450 GALLONS / MINUTE
5. PERFORMANCE q=450 GPM ONLY

SEQUENCE OF CONSTRUCTION FOR TYPICAL PUMP AROUND

1. INSTALL STILLING BASIN AND STABILIZED OUTFALL USING CLASS A RIP RAP AT THE DOWNSTREAM END OF THE DESIGNATED PROJECT WORKING AREA.
2. THE CONTRACTOR WILL INSTALL THE PUMP AROUND PUMP AND THE TEMPORARY PIPING THAT WILL CONVEY THE BASE FLOW FROM UPSTREAM OF THE WORK AREA TO THE STABILIZED OUTFALL.
3. INSTALL UPSTREAM IMPERVIOUS DIKE AND BEGIN PUMPING OPERATIONS FOR STREAM DIVERSION.
4. INSTALL THE DOWNSTREAM IMPERVIOUS DIKE AND DEWATERING PUMPING APPARATUS IF NEEDED TO DEWATER THE ENTRAPPED AREA. THE PUMP AND HOSE FOR THIS PURPOSE SHALL BE OF SUFFICIENT SIZE TO DEWATER THE WORK AREA. THIS WATER WILL ALSO BE PUMPED TO AN OUTFALL STABILIZED WITH CLASS A RIP RAP.
5. THE CONTRACTOR WILL PERFORM STREAM RESTORATION WORK IN ACCORDANCE WITH THE PLAN AND FOLLOWING THE GENERAL CONSTRUCTION SEQUENCE.
6. THE CONTRACTOR WILL EXCAVATE ANY ACCUMULATED SILT AND DEWATER BEFORE REMOVAL OF THE IMPERVIOUS DIKE. WHEN DEWATERING AREA, ALL DIRTY WATER MUST BE PUMPED THROUGH A SILT BAG. REMOVE IMPERVIOUS DIKES, PUMPS, AND TEMPORARY FLEXIBLE HOSE/PIPING STARTING WITH THE DOWNSTREAM DIKE FIRST.
7. ONCE THE WORKING AREA IS COMPLETED, REMOVE ALL RIP RAP AND IMPERVIOUS DIKES AND STABILIZE DISTURBED AREAS WITH SEED AND MULCH.

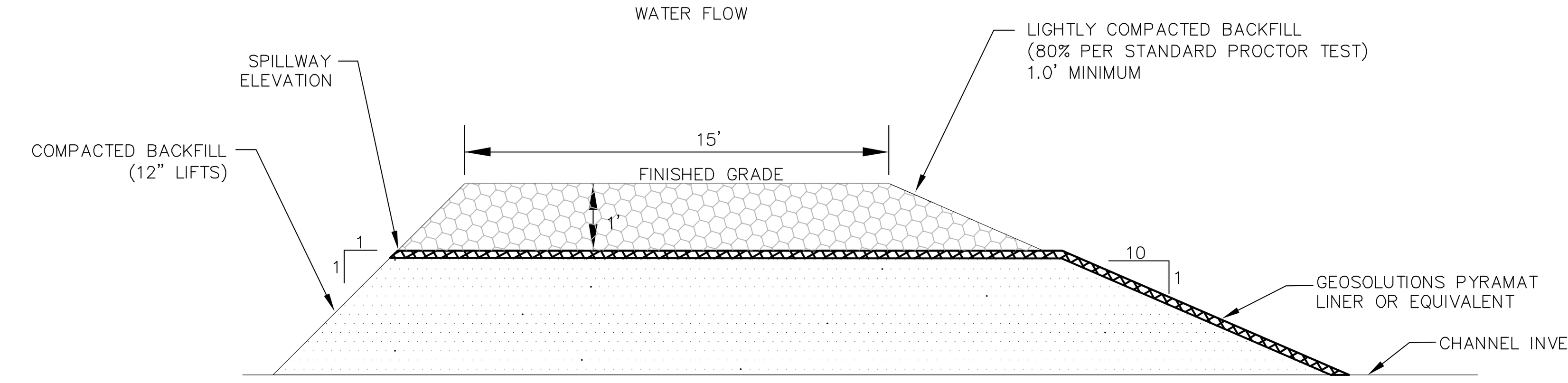




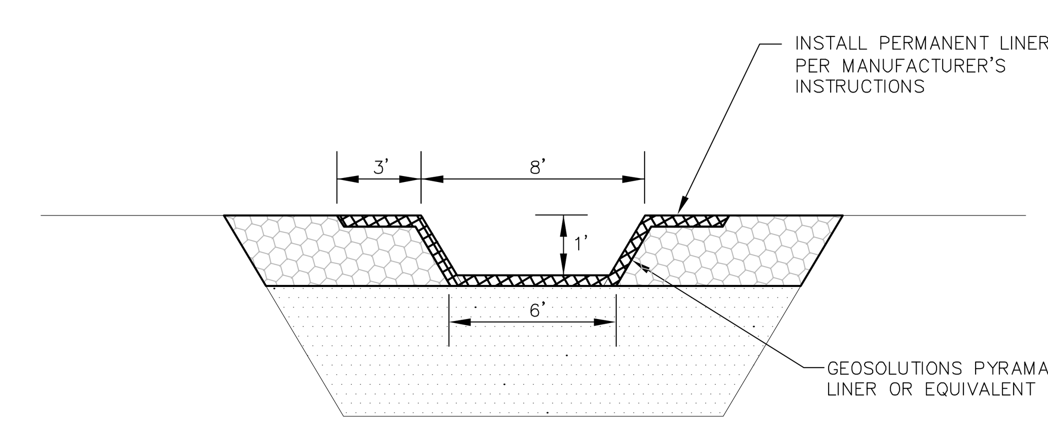
SILT BAG PROFILE

PUMP AROUND
NOT TO SCALE

WATER FLOW

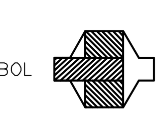


PROFILE VIEW



SECTION VIEW

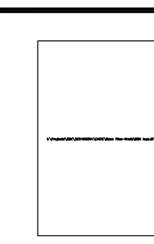
PLAN VIEW SYMBOL



WETLAND CHANNEL PLUG W/ SPILLWAY
NOT TO SCALE

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER DPI	DRAWING SCALE NTS
DRAWN BY TRS	PROJECT DATE 06/2006
APPROVED BY ME	PROJECT NUMBER 6002000RA
FILE NAME design_layout.dwg	PLOT DATE 11/10/06



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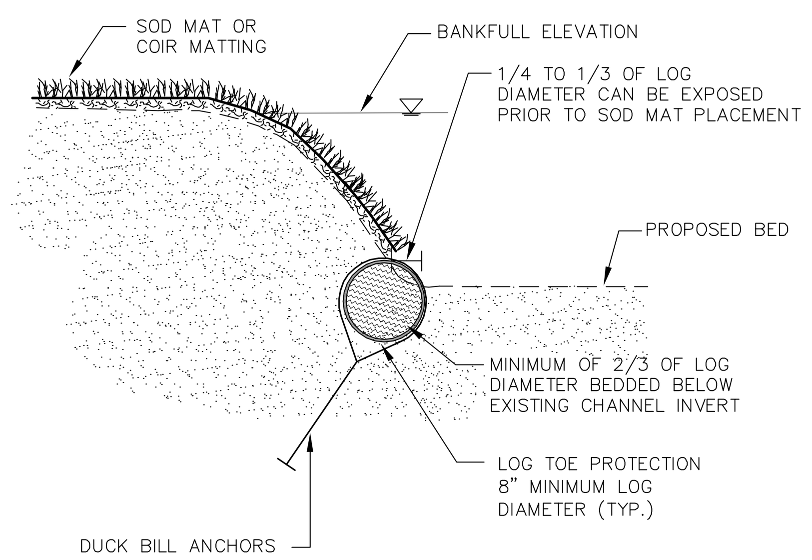
ENVIRONMENTAL BANC & EXCHANGE, LLC
CONOCONNARA RESTORATION
HALIFAX COUNTY, NORTH CAROLINA

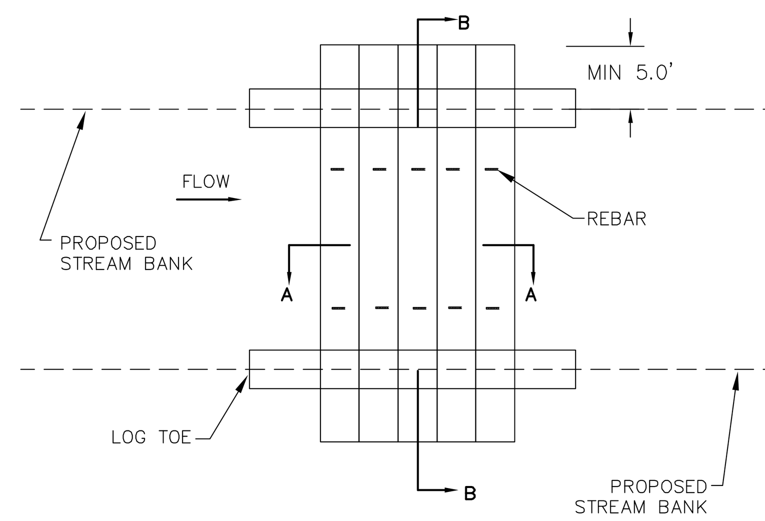
CONOCONNARA DESIGN PLANS
DETAILS

22/24

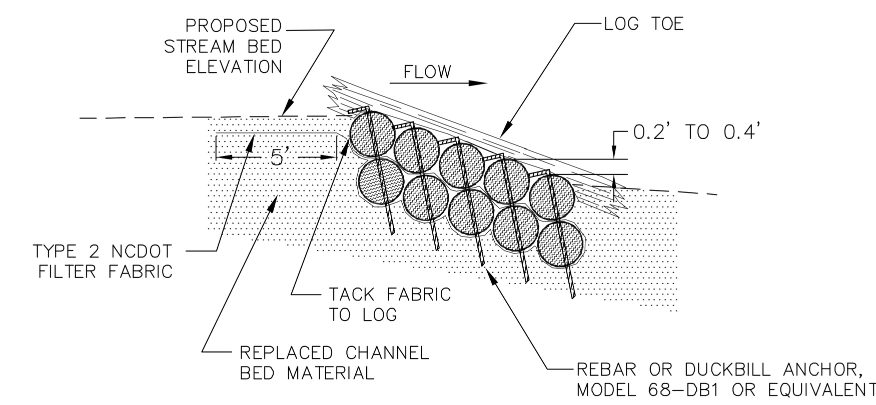


PLAN VIEW SYMBOL

LOG TOE PROTECTION
NOT TO SCALE

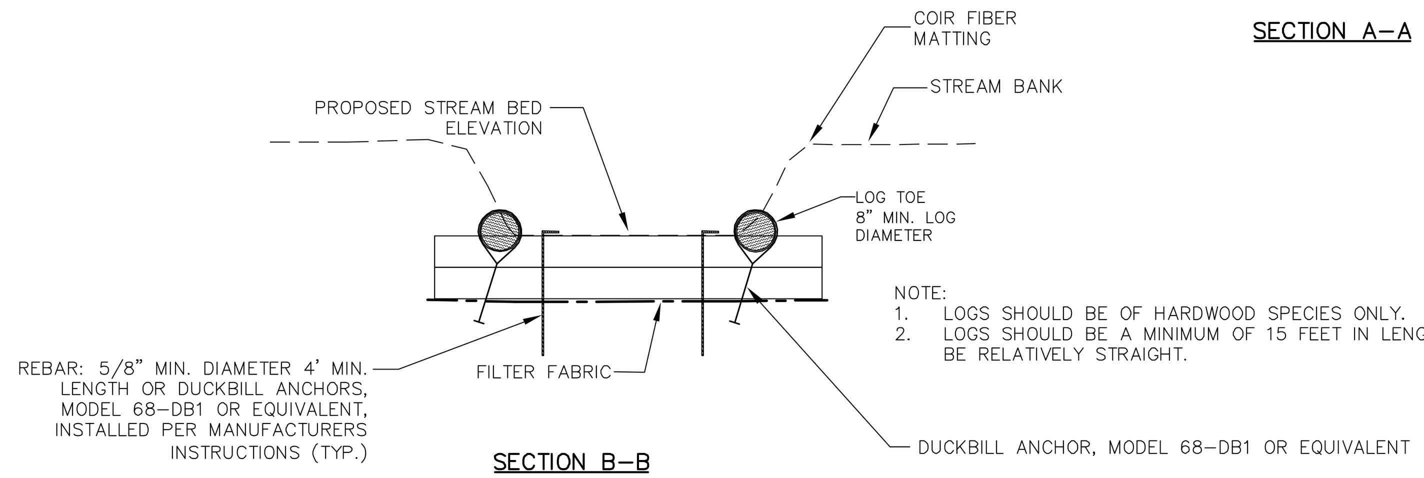


PLAN VIEW



NOTE:
1. LOGS SHOULD BE AT LEAST 6 INCHES IN DIAMETER AND RELATIVELY STRAIGHT.
2. NAIL FILTER FABRIC USING 3" 10D GALVANIZED COMMON NAIL EVERY 2' ALONG THE LOG.
3. FILTER FABRIC USED SHALL BE NCDOT TYPE 2 ENGINEERING FABRIC OR EQUIVALENT.

SECTION A-A



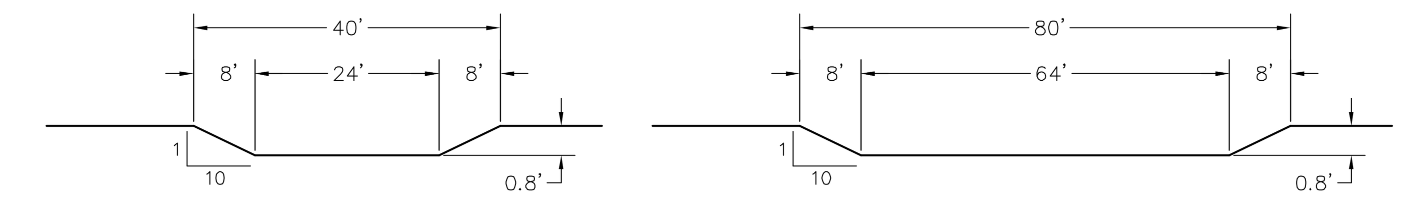
NOTE:
1. LOGS SHOULD BE OF HARDWOOD SPECIES ONLY.
2. LOGS SHOULD BE A MINIMUM OF 15 FEET IN LENGTH AND BE RELATIVELY STRAIGHT.

SECTION B-B

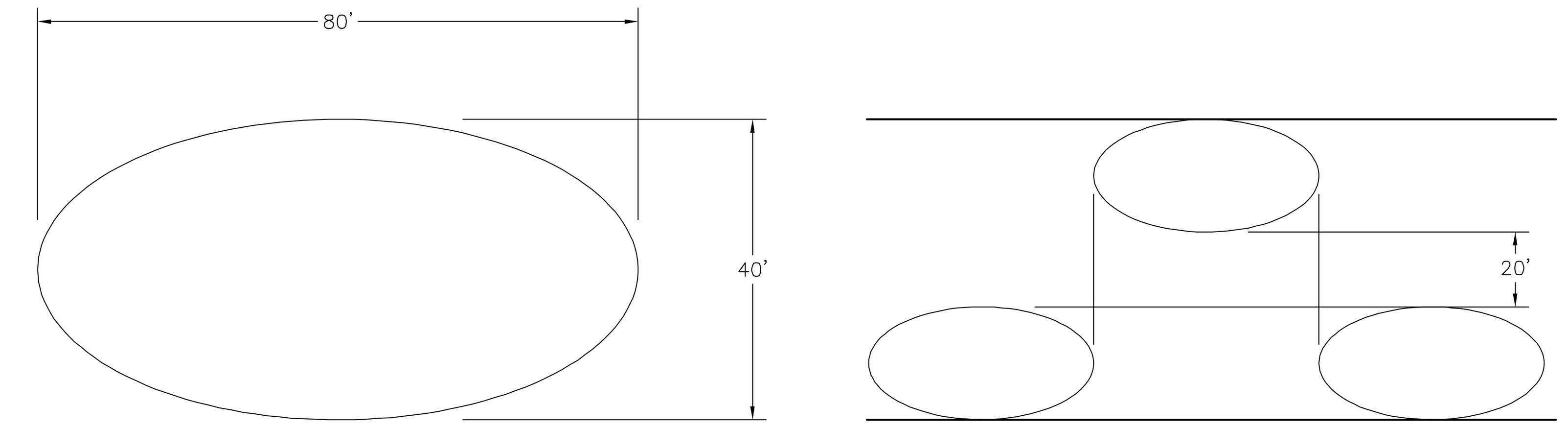
PLAN VIEW SYMBOL

LOG RAMP
NOT TO SCALE

NOTES
1. DEPRESSIONS ARE TO BE CONSTRUCTED WITH A MAXIMUM DEPTH OF 0.8'.
2. POSITION LONG AXIS OF DEPRESSION (80') PARALLEL TO CONTOURS.
3. USE A MAXIMUM SIDE SLOPE OF 10:1.
4. CUT MATERIAL TO BE USED IN CONSTRUCTION OF CHANNEL PLUGS.
5. DIMENSIONS ARE TYPICAL, ACTUAL DEPRESSION TO BE CONSTRUCTED WITH SLIGHT IRREGULARITIES.



PROFILE VIEWS

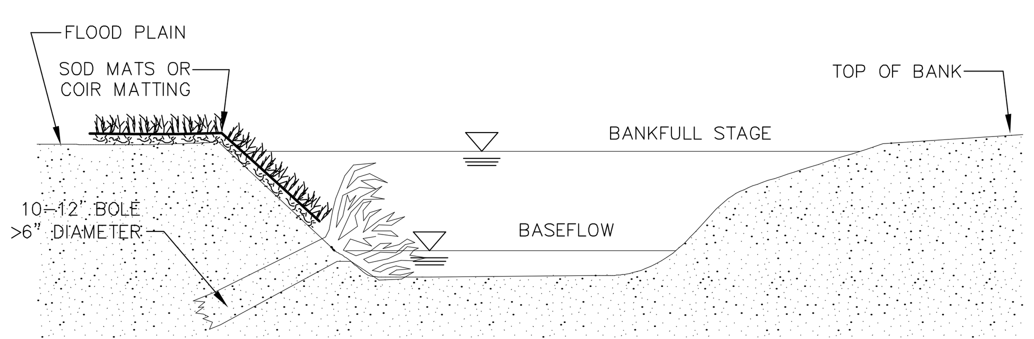


PLAN VIEW

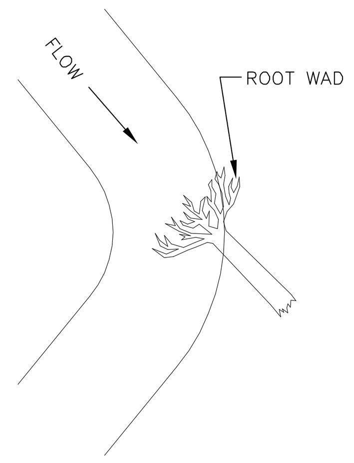
SPACING

PLAN VIEW SYMBOL

WETLAND DEPRESSION
NOT TO SCALE



CROSS SECTION VIEW



PLAN VIEW

DRIVE POINT METHOD:

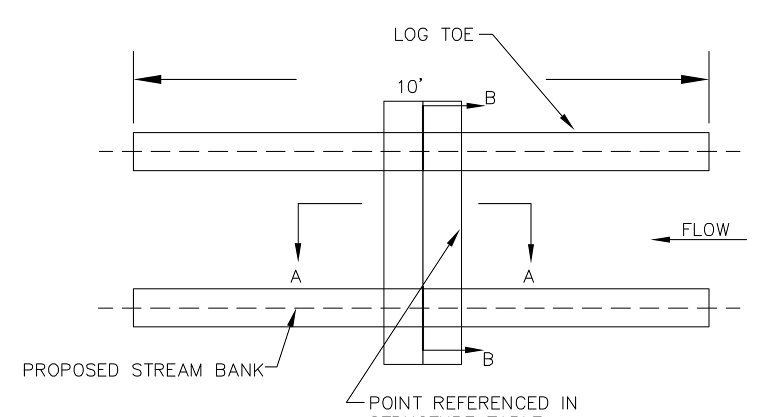
SHARPEN THE END OF THE LOG WITH A CHAINSAW BEFORE "DRIVING" IT INTO THE BANK. ORIENT ROOT WADS UPSTREAM SO THAT THE STREAM FLOW MEETS THE ROOT WAD AT A 90-DEGREE ANGLE, DEFLECTING THE WATER AWAY FROM THE BANK.

TRENCHING METHOD:

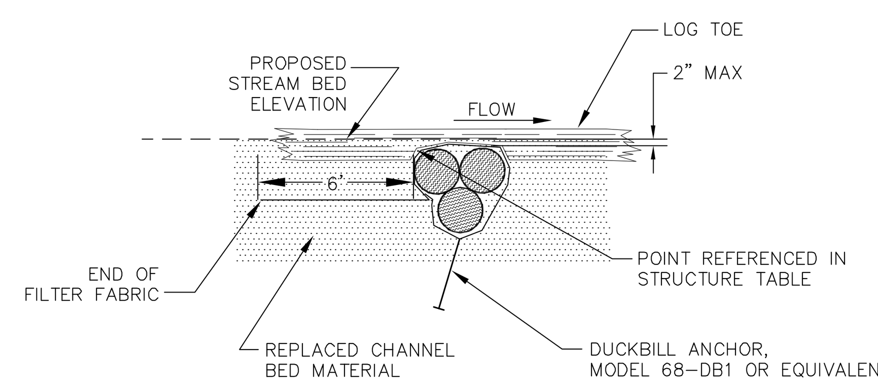
IF THE ROOT WAD CANNOT BE DRIVEN INTO THE BANK OR THE BANK NEEDS TO BE RECONSTRUCTED, THE TRENCHING METHOD SHOULD BE USED. THIS METHOD REQUIRES THAT A TRENCH BE EXCAVATED PARALLEL TO THE BANK AND WELL BELOW THE STREAMBED FOR THE LOG PORTION OF THE ROOT WAD. ONE-THIRD OF THE ROOT WAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS.

PLAN VIEW SYMBOL

ROOT WAD REVETMENT
NOT TO SCALE

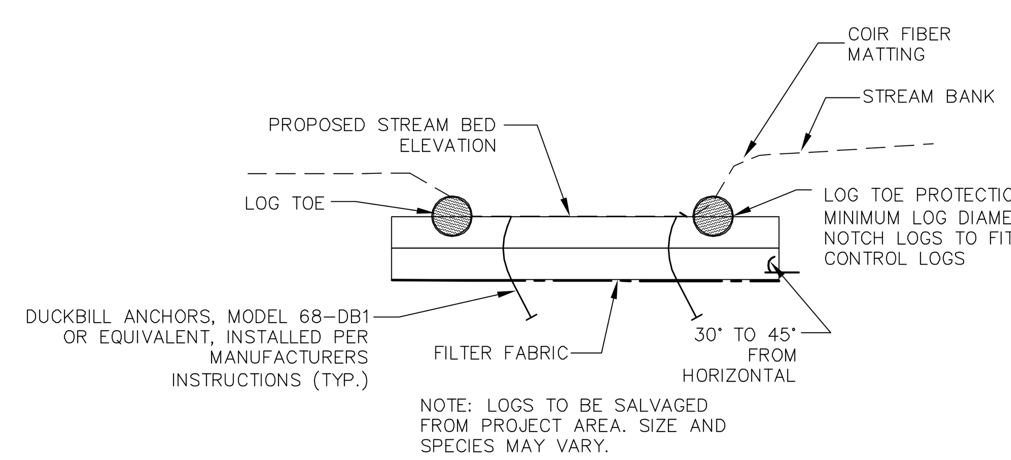


PLAN VIEW



SECTION A-A

1. LOGS SHOULD BE AT LEAST 8 INCHES IN DIAMETER, A MINIMUM OF 15 FEET IN LENGTH, AND RELATIVELY STRAIGHT.
2. NAIL FILTER FABRIC USING 3" 10D GALVANIZED COMMON NAIL EVERY 2' ALONG THE LOG.
3. FILTER FABRIC USED SHALL BE NCDOT TYPE 2 ENGINEERING FABRIC OR EQUIVALENT.

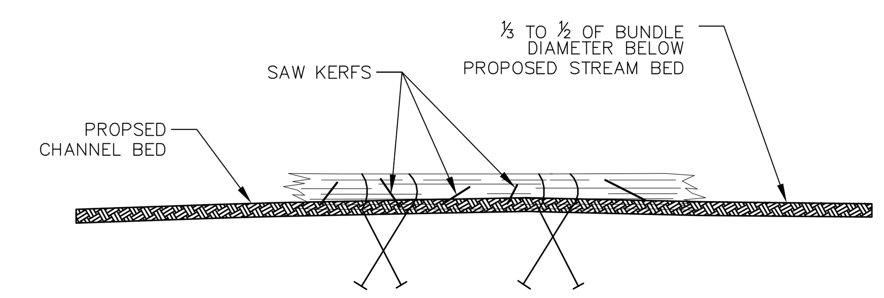


NOTE: LOGS TO BE SALVAGED FROM PROJECT AREA. SIZE AND SPECIES MAY VARY.

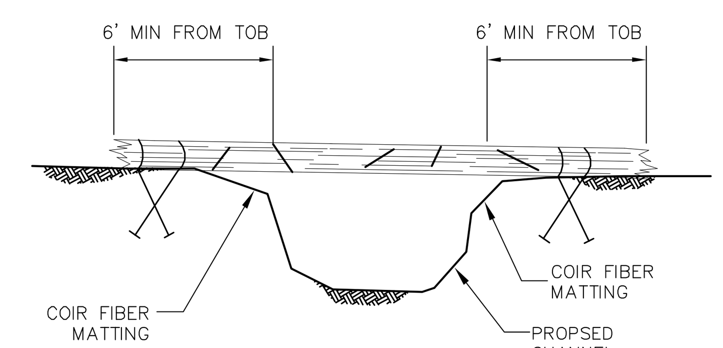
GRADE CONTROL STRUCTURE
SECTION B-B

PLAN VIEW SYMBOL

LOG GRADE CONTROL
NOT TO SCALE



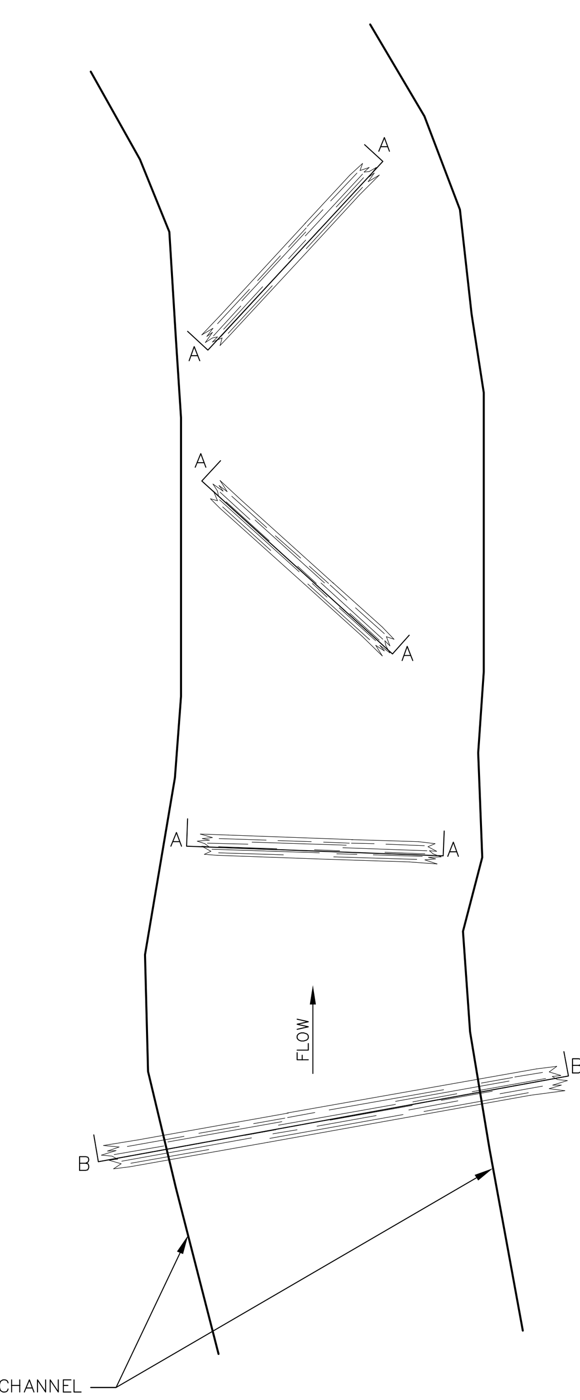
TYPICAL SECTION A-A



TYPICAL SECTION B-B

USE LOGS OF VARYING SIZES 9"-15" DIAMETER AND 4'-12' LONG. LOGS SHALL BE HELD IN PLACE WITH DUCKBILL ANCHORS, MODEL 68-DB1 OR EQUIVALENT, AND PLACED ACCORDING TO DESIGN PLANS AND AS DIRECTED BY ENGINEER.

ALL LOGS SHALL BE "ROUGHED UP" WITH A CHAINSAW PRIOR TO INSTALLATION. SAW KERFS SHALL BE 0.25" TO 2.0" IN DEPTH.



TYPICAL PLAN VIEW

LARGE WOODY DEBRIS
NOT TO SCALE

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER DPI	DRAWING SCALE NTS	RELEASED FOR	DATE
DRAWN BY TRS	PROJECT DATE 06/2006	APPROVALS	06/09/06
APPROVED BY ME	PROJECT NUMBER 6002000RA	BIDDING	
FILE NAME design_layout.dwg	PLOT DATE 11/10/06	CONSTRUCTION	
		RECORD DWG.	

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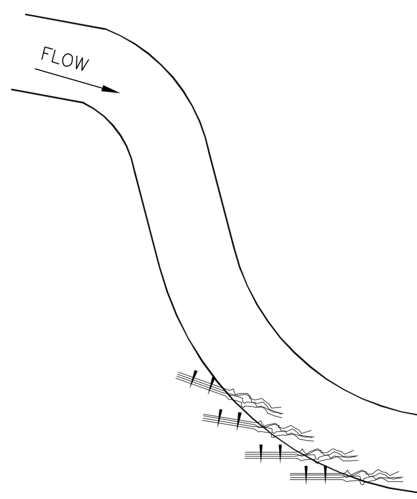
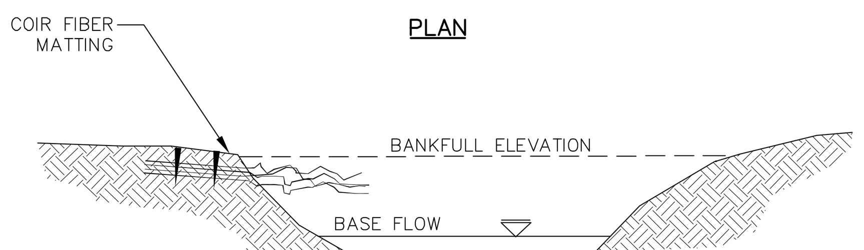
CONOCONNARA DESIGN PLANS

DETAILS



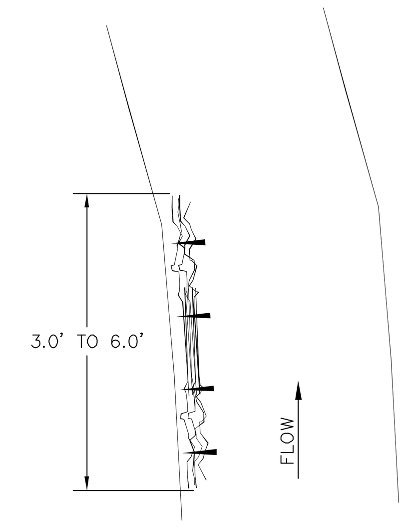
PLAN



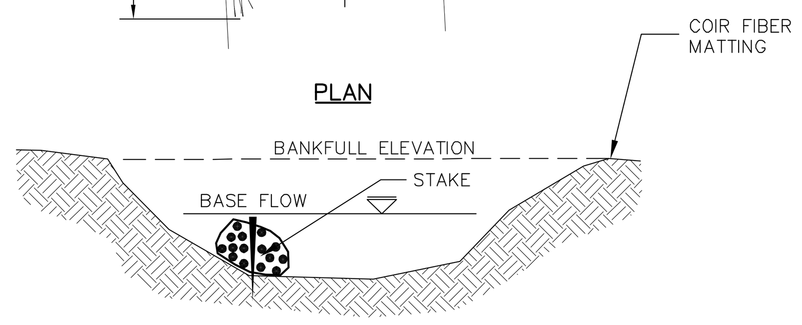
TYPICAL SECTION

NOTE:
WATTLES ARE TO BE INSTALLED 5' O.C. BY CUTTING AN APPROXIMATELY 4" WIDE TRENCH PERPENDICULAR TO THE STREAM BANK AT AN ELEVATION JUST BELOW BANKFULL. INSERT THE WATTLES, ANCHORING WITH STAKES, AND TIGHTLY BACKFILL WITH TOPSOIL. WATTLES SHALL CONSIST OF 6 TO 15 STEMS, 0.25" TO 0.75" IN DIAMETER. MINIMUM LENGTH IS 5.0 FEET. AT LEAST 3.0 FEET SHALL BE INSTALLED WITHIN THE BANK.

WATTLE



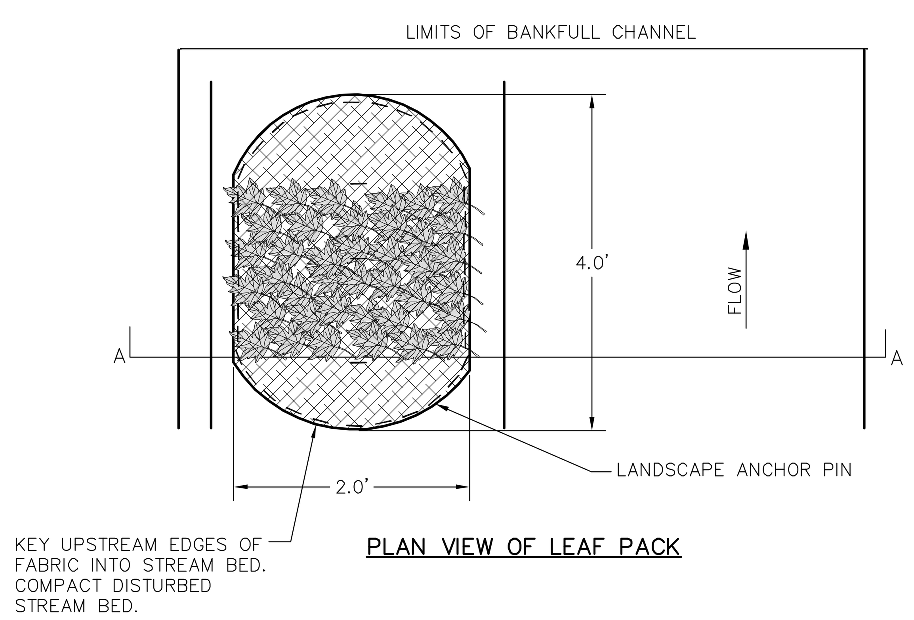
PLAN



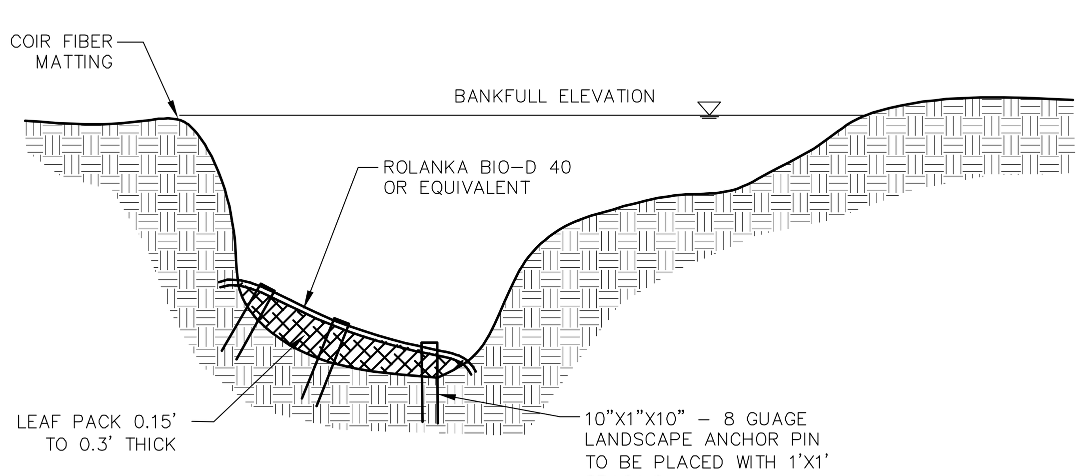
TYPICAL SECTION

NOTE: USE DEAD BRUSH AND TOPS 0.5 TO 3.0 INCHES IN DIAMETER. TIE BUNDLES WITH TWINE AND STAKE TO THE CHANNEL BED.

DEAD BRUSH

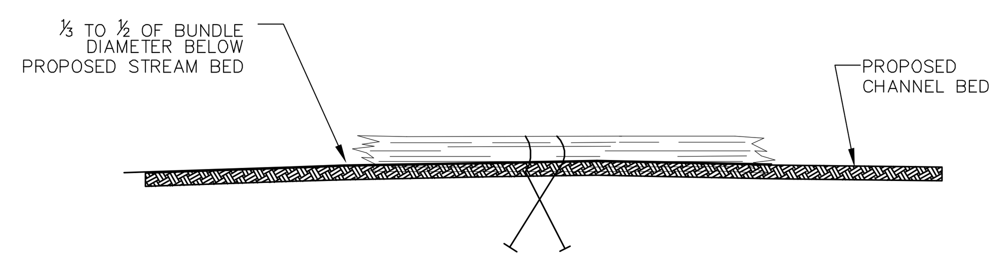


PLAN VIEW OF LEAF PACK



SECTION A-A

LEAF PACK



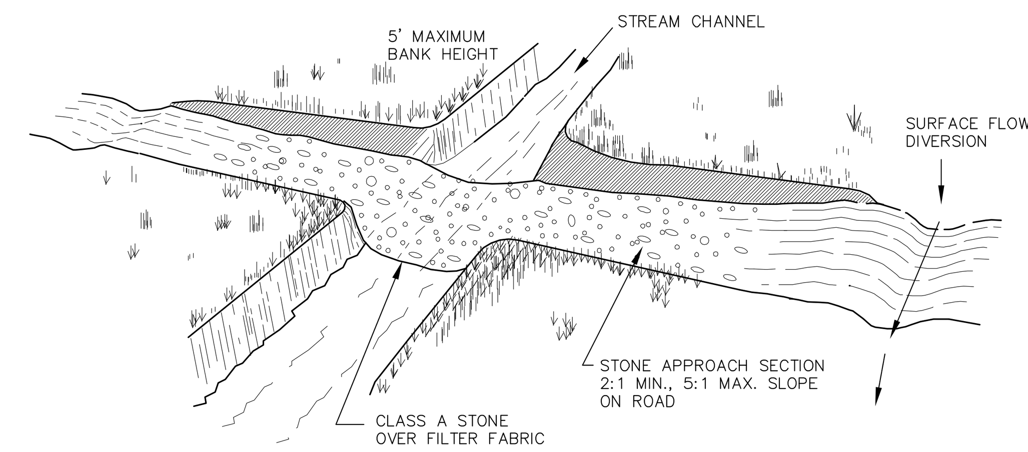
USE STICKS AND LOGS OF VARYING SIZES 2"-5" DIAMETER AND 2'-4' LONG. WOODY DEBRIS SHALL BE HELD IN PLACE DUCKBILL ANCHOR, MODEL 68-DB1 OR EQUIVALENTS AND PLACED ACCORDING TO DESIGN PLANS AND AS DIRECTED BY ENGINEER.

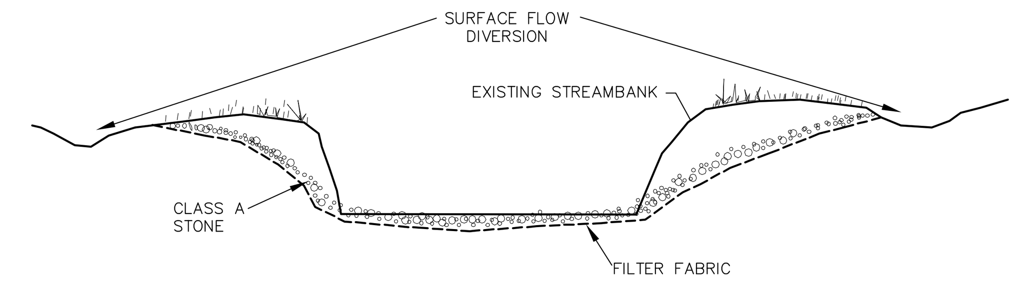
WOODY DEBRIS BUNDLE

NOTE:
WHEN INSTALLING SMALL WOODY DEBRIS STRUCTURES AS LOCATED ON THE PLAN SHEETS, CONTRACTOR SHALL ALTERNATE BETWEEN WATTLE, SMALL LOG, LEAF PACK, AND DEAD BRUSH STRUCTURES BASED ON READILY AVAILABLE MATERIALS AND PER DIRECTION OF THE ENGINEER.

SMALL WOODY DEBRIS AND HABITAT STRUCTURES

NOT TO SCALE

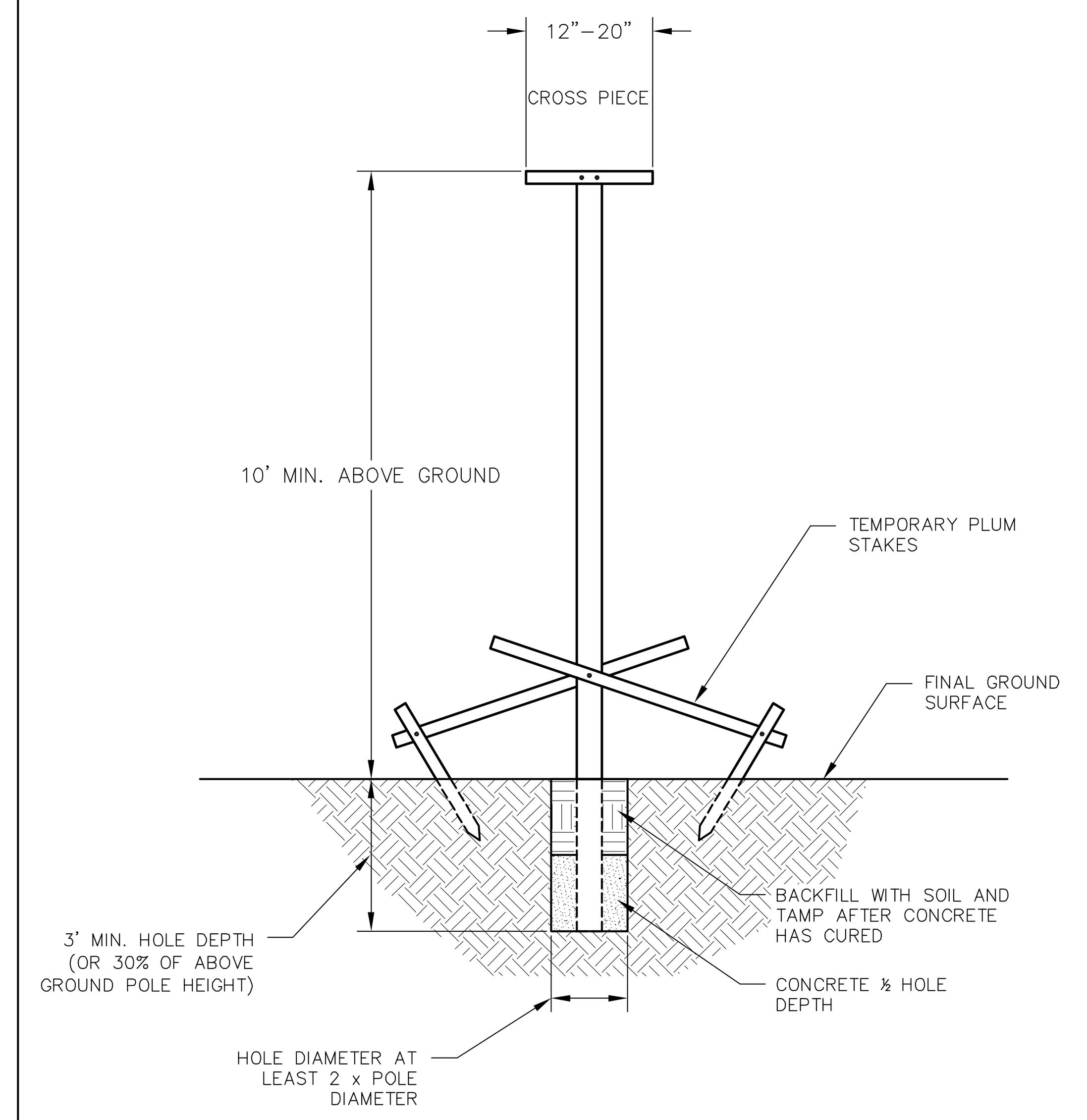




NOTES:
1. CONSTRUCT STREAM CROSSING WHEN FLOW IS LOW.
2. HAVE ALL NECESSARY MATERIALS AND EQUIPMENT ON-SITE BEFORE WORK BEGINS.
3. MINIMIZE CLEARING AND EXCAVATION OF STREAMBANKS. DO NOT EXCAVATE CHANNEL BOTTOM. COMPLETE ONE SIDE BEFORE STARTING ON THE OTHER SIDE.
4. INSTALL STREAM CROSSING PERPENDICULAR TO FLOW.
5. GRADE SLOPES TO A MINIMUM OF 2:1 SLOPE, MAXIMUM
6. MAINTAIN CROSSING SO THAT RUNOFF IN THE CONSTRUCTION ROAD DOES NOT ENTER EXISTING CHANNEL.
7. A STABILIZED PAD OF NATURAL CLASS A STONE, 6 INCHES THICK, LINED WITH FILTER FABRIC SHALL BE USED OVER THE BERM AND ACCESS SLOPES.
8. FILTER FABRIC USED SHALL BE NCDOT TYPE 2 ENGINEERING FABRIC OR EQUIVALENT.
9. WIDTH OF THE CROSSING SHALL BE SUFFICIENT (8' MIN.) TO ACCOMMODATE THE LARGEST VEHICLE CROSSING THE CHANNEL.
10. CONTRACTOR SHALL DETERMINE AN APPROPRIATE RAMP ANGLE ACCORDING TO EQUIPMENT UTILIZED.
11. TEMPORARY CROSSINGS ARE TO BE ABANDONED IN PLACE.

FORD AND TEMPORARY STREAM CROSSING

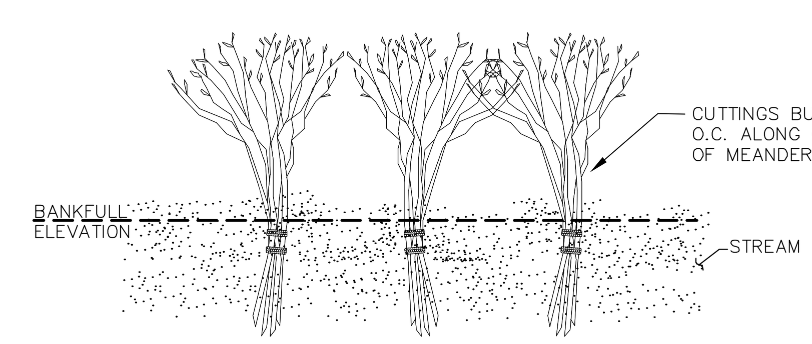
NOT TO SCALE



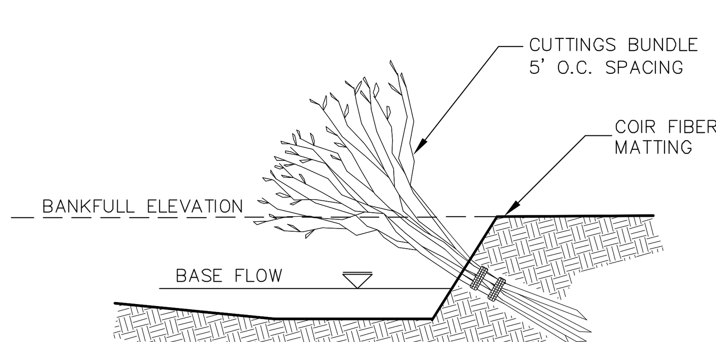
ACCEPTABLE POLE MATERIALS:
- 4"x4" PRESSURE TREATED SYP
- RED CEDAR LOG WITH 6" MIN. LARGE END DIA. AND 3" MIN. SMALL END DIA.

RAPTOR POLE

NOT TO SCALE



LIVE CUTTINGS BUNDLE TYPICAL PROFILE

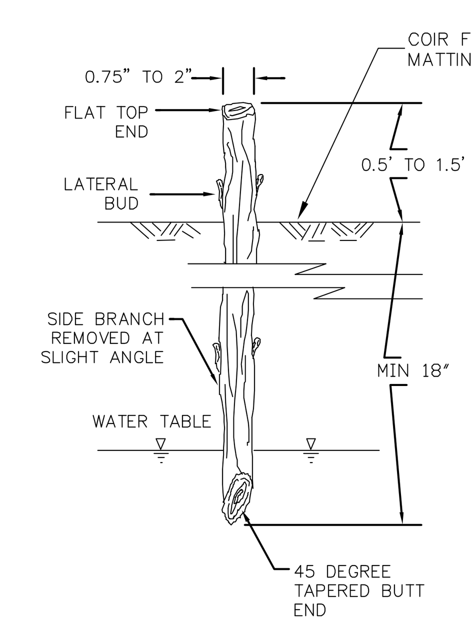


LIVE CUTTINGS BUNDLE TYPICAL SECTION

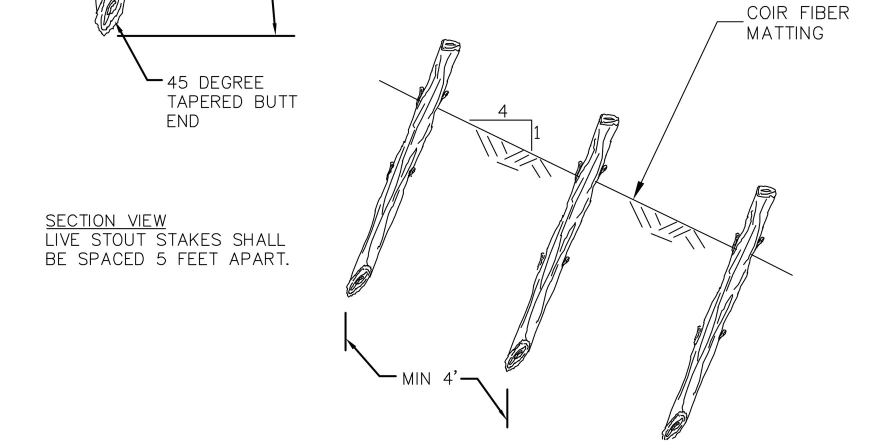
NOTE: ACCEPTABLE SPECIES INCLUDE BLACK WILLOW (SALIX NIGRA) AND SILKY DOGWOOD (CORNUS AMMOMUM). CUTTINGS BUNDLES ARE TO BE INSTALLED (AFTER SOD MAT HAS BEEN PLACED) BY DRILLING AN APPROXIMATE 4" DIAMETER HOLE INTO THE STREAM BANK FROM AN ELEVATION SLIGHTLY ABOVE BANKFULL ELEVATION, INSERTING THE CUTTINGS AND TIGHTLY BACKFILLING WITH TOPSOIL. WILLOW CUTTINGS SHOULD BE RINSED AT CUTTING POINT TO ALLOW BETTER ROOTING. ALDER TRANSPLANTS CAN BE SUBSTITUTED FOR CUTTINGS BUNDLES WITH APPROVAL OF ENGINEER

LIVE CUTTINGS BUNDLE

NOT TO SCALE



DETAIL
LIVE STAKES SHOULD BE LONG ENOUGH TO REACH BELOW THE GROUNDWATER TABLE. (GENERALLY, A LENGTH OF 2 TO 3 FEET IS SUFFICIENT.) ADDITIONALLY, THE STAKES SHOULD HAVE A DIAMETER IN THE RANGE OF 0.75 TO 2 INCHES.



SECTION VIEW
LIVE STOUT STAKES SHALL BE SPACED 5 FEET APART.

NOTE:
ACCEPTABLE SPECIES INCLUDE BLACK WILLOW (SALIX NIGRA) AND SILKY DOGWOOD (CORNUS AMMOMUM).

LIVE STAKE

NOT TO SCALE

REV. NO.	DESCRIPTION	DATE
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