

**Camp Branch Stream Restoration**  
**Project No. 92350**  
**2008 Monitoring Report (Final): Year 2 of 5**



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# Table of Contents

## EXECUTIVE SUMMARY

## SECTION 1 – PROJECT BACKGROUND

1.1 Location and Setting .....	1-1
1.2 Mitigation Structure and Objectives .....	1-1
1.3 Project History and Background .....	1-3
1.4 Monitoring Plan View.....	1-5

## SECTION 2 – PROJECT CONDITION AND MONITORING RESULTS

2.1 Vegetation Assessment .....	2-1
2.1.1 Soil Data.....	2-1
2.1.2 Vegetative Current Condition .....	2-2
2.1.3 Vegetative Current Condition Plan View .....	2-2
2.1.4 Stem Counts .....	2-2
2.1.5 Vegetation Plot Photos.....	2-3
2.2. Stream Assessment .....	2-3
2.2.1 Stream Current Condition Plan View .....	2-3
2.2.2 Stream Current Condition Table .....	2-3
2.2.3 Numbered Issues Photo Section.....	2-3
2.2.4 Stability Assessment .....	2-3
2.2.5 Quantitative Measures Tables.....	2-5
2.2.6 Hydrologic Criteria .....	2-10

## SECTION 3 – METHODOLOGY

3.1 Methodology .....	3-1
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## SECTION 4 – REFERENCES

## SECTION 5 – FIGURES

## SECTION 6 – APPENDICES

### List of Tables

Table 1.1	Project Mitigation Structure and Objectives.....	1-3
Table 1.2	Project Activity and Reporting History .....	1-4
Table 1.3	Project Contacts .....	1-4
Table 1.4	Project Background.....	1-5
Table 2.1	Categorical Stream Feature Visual Stability Assessment.....	2-4
Table 2.2	Baseline Morphology and Hydraulic As-Built Summary.....	2-6
Table 2.3	Morphology and Hydraulic Monitoring Summary.....	2-8
Table 2.4	Verification of Bankfull Events .....	2-10

### List of Figures

Figure 1.1	Project Location Map
Figure 1.2	Monitoring Plan View Map

### List of Appendices

Appendix 1	Vegetation Raw Data
Appendix 2	Geomorphic and Stream Stability Data
Appendix 3	Current Condition Plan View (Integrated)



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## **EXECUTIVE SUMMARY**

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## Executive Summary

The Camp Branch Stream Restoration Project (Site) is located in Anson County, North Carolina on property owned by Mr. John Bishop. The Site is one of three separate Ecosystem Enhancement Program (EEP) projects located on the 200-acre Bishop Property, each confined within a North Carolina Department of Transportation (NCDOT)-owned conservation easement. Primary goals for the Site were to restore stable dimension, pattern, and profile for impacted on-site stream reaches. Secondary Site restoration goals included stream channel enhancement and preservation. The following restoration goals were established for the Site.

1. Priority II stream restoration (including all attendant benefits outlined in Rosgen 1996) via excavation of approximately 1,767 linear feet of a designed E/C-type stream of the main Camp Branch channel on new location, including adjacent floodplain excavation to achieve an entrenchment ratio characteristic of E/C-type streams.
2. Priority I stream restoration (including all attendant benefits outlined in Rosgen 1996) of approximately 403 linear feet and Priority II restoration of approximately 143 linear feet of a designed E/C-type stream of a UT to Camp Branch, including floodplain excavation along the UT upstream of Camp Branch to achieve a stable confluence.
3. Level II stream enhancement of approximately 945 linear feet of Camp Branch upstream of its confluence with the UT via riparian plantings adjacent to the Camp Branch stream banks.
4. Re-establishment of the characteristic, pre-disturbance Piedmont Bottomland Forest (Schafale and Weakley 1990) community adjacent to restoration reaches using bare root seedling plantings.

Site construction activities were completed in October 2006, and the riparian and floodplain area was planted in February 2007. As-built surveys for the Site were performed in May 2007. First year monitoring was conducted in October 2007. In order to be considered successful, the Site must achieve vegetative, groundwater, and stream channel success criteria for a minimum of five years (or until success criteria are achieved). Crest gauges were also installed to monitor for the occurrence of bankfull events. This report serves as the 2<sup>nd</sup> year of the 5 year monitoring plan for the Site.

The 2008 vegetation monitoring results indicated that the Site appears to be meeting vegetation success criteria. Vegetative monitoring success criteria as stated in the 2007 mitigation plan requires an average number of planted stems per acre exceeding 320 stems/acre after the third year of monitoring and 260 stems/acre after the fifth and final year of project monitoring. The survival rate for the woody vegetation monitored for 2008 is 92%. The site density is approximately 891 planted stems per acre, which exceeds the year 3 goal of 320 planted stems per acre. However, the first year monitoring reported there were 1,047 planted stems per acre. Planted stem mortality within the plots is most likely due to the severe drought experienced during the 2007 growing season; however, based on visual assessment of the planted vegetation, it may also be due to wildlife grazing or insects.

Results from the 2008 stream monitoring effort indicate that Camp Branch and its tributary are maintaining vertical and lateral stability with minimal bank erosion. Although some areas are illustrating minor erosion, visual assessments along the channel indicated that there are no major advancements towards instability within the reach. Areas with in-stream vegetation growth could potentially result in localized areas of aggradation, and lead to lateral and/or vertical shifts in the stream. These areas will continue to be monitored closely for significant adjustments in the bed features and the channel thalweg. High sedimentation is evident at the lower end of the main channel, immediately upstream of the transition point from the restoration reach to the preservation reach. The shift in bankfull elevation and dimension from the restoration reach to the preservation reach may have resulted in high silt deposition upstream of the convergence point.

Overall, the Camp Branch Stream Restoration Site appears to be stable and has met stream and vegetation mitigation goals for monitoring year 2.



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**SECTION 1**  
**PROJECT BACKGROUND**

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# SECTION 1

## PROJECT BACKGROUND

The background information provided in this report is referenced from the mitigation plan and previous monitoring reports prepared by EcoScience (2007).

### 1.1 Location and Setting

The Site is located north of the Town of Wadesboro in Anson County, North Carolina, immediately northwest (upstream) of the Rocky River's confluence with the Pee Dee River (Figure 1.1). The Site is one of three separate Ecosystem Enhancement Program (EEP) projects located on the 200-acre Bishop Property, each confined within a North Carolina Department of Transportation (NCDOT)-owned conservation easement. Based on information provided by EEP, the Site consisted of restoring/enhancing/ preserving 16,176 lf of Camp Branch and an UT to Camp Branch using both Priority 1 and 2 approaches. There are also 12,918 lf of stream of preservation and 11.6 acres of restored/enhanced/preserved wetland areas within the 200-acre Bishop Property.

To access the site from Charlotte, take US-74 east towards Wadesboro. Approximately 7.6 miles after the Town of Polkton, turn left onto US-52 north. Follow US-52 north through Ansonville until you reach Carpenter Road and turn right. Continue straight on gravel road until you reach the second gated access road. Follow this gravel road to the bottom of the hill where it crosses the stream restoration project. The stream restoration begins upstream of this gravel road.

### 1.2 Mitigation Structure and Objectives

The Site is located within the Piedmont Eco-Region of the Yadkin River Basin (USGS Subbasin HUC 03040105). Prior to restoration, the site was predominantly utilized for row cropping and recreational activities, such as hunting and wildlife viewing. Historically, drainage features and wetland areas were dredged, straightened, and filled in to provide land for agricultural purposes. These activities are thought to have inhibited stream channel stability and water quality; therefore, producing an incised, eroded stream. Primary goals for the site were to restore stable dimension, pattern, and profile for impacted on-site stream reaches. Secondary Site restoration goals included stream channel enhancement and preservation. These goals were achieved via planting bare root seedlings to recreate pre-disturbance vegetative communities within their appropriate landscape contexts.

The following specific restoration goals were established for the Camp Branch Stream Restoration Project.

1. Priority II stream restoration (including all attendant benefits outlined in Rosgen 1996) via excavation of approximately 1,767 linear feet of a designed E/C-type stream of the main Camp Branch channel on new location, including adjacent floodplain excavation to achieve an entrenchment ratio characteristic of E/C-type streams.

2. Priority I stream restoration (including all attendant benefits outlined in Rosgen 1996) of approximately 403 linear feet and Priority II restoration of approximately 143 linear feet of a designed E/C-type stream of a UT to Camp Branch, including floodplain excavation along the UT upstream of Camp Branch to achieve a stable confluence.
3. Level II stream enhancement of approximately 945 linear feet of Camp Branch upstream of its confluence with the UT via riparian plantings adjacent to the Camp Branch stream banks.
4. Re-establishment of the characteristic, pre-disturbance Piedmont Bottomland Forest (Schafale and Weakley 1990) community adjacent to restoration reaches using bare root seedling plantings.

The main reach of Camp Branch was restored by relocating approximately 1,767 lf of the existing channel (Restoration, Priority 2) and restoring approximately 403 lf (Restoration, Priority 1) and 143 lf (Restoration, Priority 2) of its tributary. Camp Branch (Reach 1) and its tributary (Reach 4) were designed as an E/C-type stream (Table 1.1). Bankfull benches were created along Reach 1 and 4 to re-establish floodplain connection at the existing stream elevation. Along Reach 3, the tributary's streambed was raised to re-attach the channel with its floodplain at a higher elevation. The Site's riparian areas were planted to improve habitat and stabilize streambanks via planting bare root seedlings to recreate pre-disturbance vegetative communities within their appropriate landscape contexts.

**Table 1.1  
Project Mitigation Structure and Objectives  
Camp Branch/Project No. 92350**

Segment/Reach	Mitigation Type	Approach	Linear Footage or Acres	Stationing (ft)	Comments	
Reach 1-Camp Branch	R	P2	1,767 lf	0+00 – 17+94	Channel restoration, relocation. Total lf includes 27 lf gap in easement at channel ford.	
Reach 2-Camp Branch	E2	N/A	945 lf	N/A*	Channel enhancement. Enhancement reaches not stationed	
Reach 3-UT Camp Branch	R	P1	403 lf	0+00 – 4+33	Channel restoration, relocation. Total lf does not include 30 lf gap in easement at channel ford.	
Reach 4-UT Camp Branch	R	P2	143 lf	4+33 – 5+76		
Stream Preservation**	P	N/A	6,563 lf	N/A*		
Wetland Preservation	P	N/A	5.2 ac	N/A		
Component Summations						
Restoration Level	Stream (lf)	Wetland (ac)		Upland (ac)	Buffer (ac)	BMP
		Riparian	Non-Riparian			
Restoration (R)	2,313	N/A	N/A	N/A	N/A	N/A
Enhancement (E)	N/A	N/A	N/A	N/A	N/A	N/A
Enhancement I (E)	N/A	N/A	N/A	N/A	N/A	N/A
Enhancement II (E)	945	N/A	N/A	N/A	N/A	N/A
Creation (C)	N/A	N/A	N/A	N/A	N/A	N/A
Preservation (P)	6,563	N/A	5.2	N/A	N/A	N/A
HQ Preservation (P)	N/A	N/A	N/A	N/A	N/A	N/A
<b>Totals</b>	<b>9,821</b>	<b>N/A</b>	<b>5.2</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>

\*Stationing was not provided for the enhancement and preservation reach.

### 1.3 Project History and Background

The stream preservation/enhancement/restoration plan was designed by EcoScience Corporation and constructed by Vaughn Construction, Inc. Construction and planting activities were completed in February 2007. As-built surveys for the Site were performed in May 2007. The first annual monitoring activities were conducted in October 2007. This report serves as the 2<sup>nd</sup> year of the 5 year monitoring plan for the Camp Branch project. Tables 1.2 and 1.3 provide detailed project activity, history, and contact information for this project. Table 1.4 provides more in-depth watershed/site background for the project.

**Table 1.2**  
**Project Activity and Reporting History**  
**Camp Branch/Project No. 92350**

Activity or Report	Data Collection Completed	Actual Completion or Delivery
Restoration Plan	August 2004	September 2004
Final Design (90%)	March 2005	June 2005
Construction	N/A	February 2007
Temporary S&E mix applied to entire project area *	N/A	Throughout construction
Permanent seed mix applied to reach/segments	N/A	October 2006
Bare Root Seedling Installation	N/A	February 2007
Mitigation Plan	June 2007	October 2007
Final Report	June 2007	October 2007
Year 1 Monitoring	October 2007 /December2007	October 2007 /December2007
Year 2 Monitoring	May 2008/September 2008	November 2008
Year 3 Monitoring	TBD	TBD
Year 4 Monitoring	TBD	TBD
Year 5 Monitoring	TBD	TBD

\*Seed and mulch is added as each section of construction is completed.

**Table 1.3**  
**Project Contacts**  
**Camp Branch/Project No. 92350**

<b>Designer</b>	EcoScience Corporation 1101 Haynes Street, Suite 101 Raleigh, NC 27604 919- 828-3433
<b>Construction</b>	Vaughn Construction, Inc. Tommy Vaughn and Spencer Walker (Foremen) P.O. Box 796 Wadesboro, NC 28170 704- 694-6450
<b>Planting Contractor</b>	Kiker Forestry and Realty P.O. Box 933 Wadesboro, NC 28170 704- 694-6436
<b>Seeding Contractor</b>	N/A
<b>Monitoring Performers</b>	
<b>Year 1</b>	EcoScience Corporation 1101 Haynes Street, Suite 101 Raleigh, NC 27604 919- 828-3433
<b>Year 2-present</b>	Jordan, Jones, & Goulding 9101 Southern Pine Blvd., Suite 160 Charlotte, NC 28273
<b>Stream Monitoring, POC</b>	Kirsten Young, 704-527-4106 ext.246
<b>Vegetation Monitoring, POC</b>	

**Table 1.4**  
**Project Background**  
**Camp Branch/Project No. 92350**

Project County	Anson County, North Carolina
Drainage Area	2.9 square miles
Impervious cover estimate (%)	<1 percent
Stream Orders (per USGS Topo Quad Map): Camp Branch/UT to Camp Branch	2nd/1st
Physiographic Region	Piedmont
EcoRegion (Griffith and Omernik)	Triassic Basins
Rosgen Classifications of As-built: Camp Branch/UT to Camp Branch	C4 E/C4
Cowardin Classification Camp Branch/UT to Camp Branch	Streams: R2UB12/R4SB23
Dominant soil types	Badin Channery Silt Loam (BaB, BaC) Badin-Goldston Complex (BgD) McQueen (MrB) Shellbluff (ShA) Tetotum (ToA) Chewacla (ChA)
Reference Site ID	N/A* (reference areas established on-Site)
USGS HUCs for Project and Reference	03040105
NCDWQ Sub-basins for Project and Reference	03-07-14
NCDWQ classification for Project and Reference	C
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	N/A
Percent of project easement fenced	No fencing along easement

\*N/A – Not Applicable

## 1.4 Monitoring Plan View

The monitoring plan view map (Figure 1.2) illustrates the location of the longitudinal profile stations, cross-section stations, vegetation plots, and gauges. A total of eight cross-sections were established within the main reach and its tributary by EcoScience in 2007. Approximately 2,311 lf of longitudinal profile were monitored along the main channel and its tributary. Seven previously established vegetative plots in the riparian zone adjacent to Camp Branch were identified and monitored. Photographs were taken at each cross-section, vegetation plot, and current condition areas.



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**SECTION 2**  
**PROJECT CONDITION AND MONITORING RESULTS**

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## SECTION 2

### PROJECT CONDITION AND MONITORING RESULTS

The following monitoring results are from the 2008 (year 2 of 5) survey.

#### 2.1 Vegetation Assessment

##### 2.1.1 Soil Data

The Site is underlain by the Carolina Slate Belt geologic formation, immediately adjacent to the Chatham Group of the Triassic Basin geologic formation, within the Piedmont physiographic province of North Carolina. The hydrophysiographic region is characterized by dissected irregular plains, some hills, linear ridges, and isolated monadnocks (*Griffith 2002* in *EcoScience*, 2007). This region is characterized by moderate rainfall with precipitation averaging approximately 47 inches per year (*NRCS 2000* in *EcoScience*, 2007).

Site soils have been mapped by the NRCS and include the Badin – Goldston complex (BgD), as well as the McQueen (MrB), Shellbluff (ShA), Tetotum (ToA), and Chewacla series (ChA) (*NRCS 2000* in *EcoScience*, 2004). A general description of each soil and its hydric/non-hydric status is included below.

Badin-Goldston Complex BgD: This series shares many characteristics with the Badin Channery Silt Loam described above; however, the addition of Goldston in the complex produces additional ranges for some values. These soils are also found in the Piedmont on slopes of 15 to 25 percent. Depths can range from shallow to moderately deep, and permeability can be moderate to moderately rapid, though typically well-drained. Depth to the seasonal high water table is greater than 6.0 feet, and depth to bedrock varies from 10 to 20 inches and 20 to 40 inches to soft bedrock. Depth to hard bedrock is between 10 to 20 inches and greater than 40 inches.

McQueen MrB: This series, found in the Piedmont, Upper Coastal Plain, and Sandhills along major streams and rivers, is very deep and well-drained. Permeability is slow, and the seasonal high water table through the months of January through March is at a depth of 4 to 6 feet. Depth to bedrock is greater than 60 inches. McQueen soils occur in floodplains adjacent to the Rocky River and Camp Branch.

Shellbluff (ShA): This soil series is also found in floodplains of the Piedmont, Upper Coastal Plain, and Sandhills landscapes. Shellbluff soils are typically very deep and well drained with moderate permeability. Slopes are quite flat, ranging between 0 and 2 percent. From December to March the seasonal high water table can vary between 3 and 5 feet, and depth to bedrock is more than 60 inches. Shellbluff soils occur in crowned agricultural fields within the Rocky River floodplain.

Tetotum (ToA): These soils are located on low stream terraces in the Piedmont, Upper Coastal Plain, and Sandhills landscapes. Tetotum soils are classified as very deep and moderately well-

drained with moderate permeability. These soils are found in low slope areas with slopes ranging from 0 to 3 percent. Seasonal high water tables in the months of December to April are between 1.5 and 2.5 feet. Bedrock can be found at depths greater than 60 inches. Tetotum soils occur in low elevation depressions downstream from a man-made pond in the UT to Camp Branch.

Chewacla ChA: These frequently flooded soils can be found in floodplains of the Piedmont, Upper Coastal Plains, and Sandhills. Soils are very deep and somewhat poorly-drained with moderate permeability. During the months of November through April the seasonal high water table can be at a depth of 0.5 to 1.5 feet. Depth to bedrock is more than 60 inches. Chewacla soils occur in low elevation depressions within the Rocky River floodplain.

### **2.1.2 Vegetative Current Condition**

Herbaceous seeding appears to provide adequate soil cover along the streambanks; however, areas along the floodplain have barren areas of little to no vegetative cover. Please refer to Appendix 1.1 and 1.2 for more details on vegetative problem areas and photos.

### **2.1.3 Vegetative Current Condition Plan View**

Please refer to Appendix 3 for location of vegetative current conditions onsite and Appendix 1.2 for representative vegetation current condition photos.

### **2.1.4 Stem Counts**

JJG conducted the 2008 (year 2 of 5) vegetative assessment and vegetative plot analysis in September 2008 per the 2006 CVS-EEP Level 2 protocol (Lee et al., 2006). The seven vegetative plots previously established in the design phase were selected randomly and represent the riparian buffer zone. Vegetative monitoring success criteria as stated in the 2007 mitigation plan requires an average number of planted stems per acre exceeding 320 stems/acre after the third year of monitoring and 260 stems/acre after the fifth and final year of project monitoring. Please refer the vegetation summary below and to Appendix 1.1 for a summary of stem counts.

The survival rate for the woody vegetation monitored for 2008 is 92%. The monitoring data recorded an average of 22 planted live stems per plot. The site density is approximately 891 planted stems per acre, which exceeds the year 3 goal of 320 planted stems per acre. However, the first year monitoring reported there were 1,047 planted stems per acre. The site density was calculated by dividing the average number of stems by the plot size (0.025 ac). Planted stem mortality within the plots is most likely due to the drought like conditions that occurred throughout North Carolina in the 2007 monitoring year; however, based on visual assessment of the planted vegetation, it may also be due to wildlife grazing or insects. The vigor of the live planted stems within the plots also appears to have been affected by wildlife activity and drought. Approximately 14 percent of the planted stems scored a vigor level of 2 and 35 percent of the planted stems scored a vigor level of 3. Thus, as recommended by EcoScience, supplemental plantings may be warranted within planted areas along Camp Branch if the planted stems vigor continues to decline to ensure the site meets vegetation success criteria in monitoring year 5.

In conclusion, the vegetation throughout the stream and riparian restoration project meets the success requirements. Although some loss of vegetation has occurred, the overall growth of the riparian buffer is good. Per the success criterion for the 2008 monitoring year, the site has exceeded 320 stems per acre.

### **2.1.5 Vegetation Plot Photos**

Please refer to Appendix 1.3 for photographs of the vegetation monitoring plots.

## **2.2 Stream Assessment**

Stream dimension, pattern, profile, and substrate were evaluated within 2,311 lf of the Site. Please refer to Table 2.1 for a summary of the visual stability assessment, Table 2.2 for the as-built morphology and hydraulic summary, Table 2.3 for monitoring years 2007-2008 morphology and hydraulic summary, Table 2.4 for hydrologic criteria, and Appendix 2 for more detailed stream data tables and plots.

### **2.2.1 Stream Current Condition Plan View**

Please refer to Appendix 3 for the location of the stream current conditions onsite.

### **2.2.2 Stream Current Condition Table**

Please refer to Appendix 2.1 for the stream current condition table.

### **2.2.3 Numbered Issues Photo Section**

Please refer to Appendix 2.2 for representative stream current condition photos.

### **2.2.4 Stability Assessment**

The majority of the project conditions reflected the as-built drawings. The following general observations were noted.

- The pattern, profile, and dimension of the restored main channel and its tributary appear stable.
- Along the main channel there are areas of poor streambank and floodplain cover due to the lack of vegetative growth. The lack of vegetative growth could be due to the drought like conditions experienced after planting occurred on this site.
- Heavy in-stream sediment deposition is occurring at the downstream end of the main channel where the restoration reach converges with the preservation reach.
- Rill formations along the slope between the terrace and floodplain were observed along the main channel. Based on photographs from the previous monitoring firm, these rills do not appear to have advanced since last year's monitoring observations.

- There are sporadic patches of in-stream vegetation occurring along the thalweg of the main channel and its tributary.
- A few riffles along the tributary were dry during the 2008 assessment.

### *Main Channel*

Overall, the present channel is maintaining both lateral and vertical stability with minimal bank erosion. Although some areas are illustrating minor erosion, visual assessments along the channel indicated that there are no major advancements towards instability within the reach. The average bankfull width (22.5 ft) of the surveyed cross-sections is slightly higher than the proposed 16-22 ft. Cross-section 6, which is a riffle, appears to have some minor changes along the right bank. This change has caused an increase in the channels bankfull width from the previous monitoring year. The thalweg profile appears to be stable, and is characterized by well-defined riffle and pool features. The average water surface slope and the average bankfull slope were very similar for the surveyed reach, 0.0039 ft/ft and 0.0036 ft/ft, respectively.

High sedimentation rates are evident at the lower end of the main channel, immediately upstream of the transition point from the restoration reach to the preservation reach. The shift in bankfull elevation and dimension from the restoration reach to the preservation reach could have resulted in high sediment deposition upstream of the convergence point. Areas with in-stream vegetation growth could potentially result in localized areas of aggradation, and lead to lateral and/or vertical shifts in the stream. These areas will continue to be monitored closely for significant adjustments in the bed features and the channel thalweg.

### *Tributary*

Based on current monitoring data and the visual inspection, the channel appears to be functioning properly and maintaining stability. No erosional failure was observed along this reach. In-stream vegetation was observed and noted in the Current Condition Plan View (CCPV) (Appendix 3).

**Table 2.1**  
**Categorical Stream Feature Visual Stability Assessment**  
**Camp Branch/Project No. 92350**

#### **Main Channel**

<b>Feature</b>	<b>Initial-2006</b>	<b>MY1-2007</b>	<b>MY2-2008</b>	<b>MY3-2009</b>	<b>MY4-2010</b>	<b>MY5-2011</b>
A. Riffles	100%	88%	90%			
B. Pools	100%	79%	79%			
C. Thalweg	100%	100%	100%			
D. Meanders	100%	100%	100%			
E. Bed General	100%	95%	100%			
F. Bank	N/A	N/A	100%			
G. Vanes	N/A	N/A	N/A			
H. Wads/ Boulders	N/A	N/A	N/A			

**Table 2.1 cont.**  
**Categorical Stream Feature Visual Stability Assessment**  
**Camp Branch/Project No. 92350**

**Tributary**

<b>Feature</b>	<b>Initial- 2006</b>	<b>MY1- 2007</b>	<b>MY2- 2008</b>	<b>MY3- 2009</b>	<b>MY4- 2010</b>	<b>MY5- 2011</b>
A. Riffles	100%	100%	100%			
B. Pools	100%	100%	100%			
C. Thalweg	100%	100%	100%			
D. Meanders	100%	100%	100%			
E. Bed General	100%	100%	100%			
F. Bank	N/A	N/A	100%			
G. Vanes	N/A	N/A	N/A			
H. Wads/ Boulders	N/A	N/A	N/A			

### 2.2.5 Quantitative Measures Tables

Tables 2.2 and 2.3 display morphological summary data for baseline as-built conditions and the 2007 and 2008 monitoring year. Please refer to Appendix 2 for morphological plots and raw data tables.

**Table 2.2  
Baseline Morphology and Hydraulic As-Built Summary  
Camp Branch/Project No. 92350  
Main Channel**

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built/Year-1		
	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
<b>Dimension</b>																		
Bankfull Width (ft)	N/A*	N/A	N/A	N/A	18.8	N/A	16.0	17.8	19.5	21.3	21.3	21.3	16.0	19.0	22.0	18.1	20.4	22.8
Floodprone Width (ft)	N/A	N/A	N/A	N/A	N/A	N/A	17.2	20.8	24.3	NA	NA	NA	70.0	90.0	300.0	91.3	95.2	99.9
Bankfull Cross-sectional Area	N/A	N/A	N/A	N/A	44.2	N/A	42.0	42.0	42.0	38.7	38.7	38.7	30.0	30.0	30.0	24.0	27.8	31.6
Bankfull Mean Depth	N/A	N/A	N/A	N/A	2.1	N/A	2.2	2.4	2.6	1.8	1.8	1.8	1.4	1.6	1.9	1.3	1.4	1.4
Bankfull Max Depth	N/A	N/A	N/A	N/A	N/A	N/A	2.5	2.8	3.0	2.7	2.7	2.7	1.8	2.0	2.3	1.8	1.9	2.0
Width/Depth Ratio	N/A	N/A	N/A	N/A	9.0	N/A	6.2	7.6	8.9	11.8	11.8	11.8	10.0	11.9	13.8	13.6	14.9	16.3
Entrenchment Ratio	N/A	N/A	N/A	N/A	N/A	N/A	1.1	1.1	1.2	NA	NA	NA	3.7	4.7	15.8	4.5	4.7	4.9
Wetted Perimeter (ft)	N/A	N/A	N/A	N/A	23.0	N/A	20.8	22.6	24.3	24.9	24.9	24.9	21.8	22.2	22.8	23.0	23.2	23.2
Hydraulic Radius (ft)	N/A	N/A	N/A	N/A	1.9	N/A	1.7	1.9	2.0	1.6	1.6	1.6	1.3	1.4	1.4	1.2	1.2	1.2
Bank Height Ratio																		
<b>Pattern</b>																		
Channel Beltwidth (ft)	N/A	N/A	N/A	N/A	N/A	N/A	19	37	79	NA	NA	NA	45.0	62.0	77.0	45.0	62.0	80.0
Radius of Curvature (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	40.0	51.1	76.0	40.0	51.1	76.0
Meander Wave Length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	102.0	137.8	171.0	102.0	137.8	171.0
Meander Width Ratio	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	2.4	3.3	4.1	2.2	3.0	3.9
<b>Profile</b>																		
Riffle Length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	9.0	21.9	37.0	10.2	23.4	43.3
Riffle Slope (ft/ft)	N/A	N/A	N/A	N/A	N/A	N/A	0.001	0.01	0.06	0.008	NA	0.02	0.003	0.005	0.009	0	0.01	0.02
Pool Length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	23.0	29.5	38.0	11.6	23.0	37.0
Pool to Pool Spacing (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	48.0	72.5	122.0	44.8	86.5	173.4
<b>Substrate</b>																		
D50 (mm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.8	N/A	7.2	7.2	7.2	gravel	gravel	gravel	0.4	14.7	31.0
D84 (mm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	39.0	N/A	NA	NA	NA	gravel	gravel	gravel	16.0	31.5	45.0
<b>Additional Reach Parameters</b>																		
Valley Length (ft)	N/A			N/A			1,640			NA			1,640			1,640		
Channel Length (ft)	N/A			N/A			1,722			NA			1807			1,810		
Sinuosity	N/A			N/A			1.05			1.18			1.1			1.1		
Water Surface Slope (ft/ft)	N/A			N/A			0.0041			0.0029			N/A			N/A		
Bankfull Slope (ft/ft)	N/A			N/A			NA			0.0029			0.004 (0.0035-0.0055)			0.0034		
Rosgen Classification	N/A			N/A			G4			E/C4			C4			C4		

**Table 2.2 cont.**  
**Baseline Morphology and Hydraulic As-Built Summary**  
**Camp Branch/Project No. 92350**  
**Tributary**

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built/Year-1		
	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
<b>Dimension</b>																		
Bankfull Width (ft)	N/A*	N/A	N/A	N/A	6.0	N/A	NA	NA	NA	NA	NA	NA	5.0	6.0	7.0	6.8	7.9	8.0
Floodprone Width (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	35.0	200.0	500.0	35.0	200.0	500.0
Bankfull Cross-sectional Area	N/A	N/A	N/A	N/A	7.2	N/A	NA	NA	NA	NA	NA	NA	6.4	6.4	6.4	3.0	4.4	5.8
Bankfull Mean Depth	N/A	N/A	N/A	N/A	0.9	N/A	NA	NA	NA	NA	NA	NA	0.5	0.6	0.7	0.4	0.6	0.7
Bankfull Max Depth	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	0.7	0.8	1.0	0.6	0.8	1.0
Width/Depth Ratio	N/A	N/A	N/A	N/A	6.7	N/A	NA	NA	NA	NA	NA	NA	8.6	10.0	12.0	11.2	13.1	19.8
Entrenchment Ratio	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	5.8	33.0	83.0	4.4	25.3	63.3
Wetted Perimeter (ft)	N/A	N/A	N/A	N/A	7.8	N/A	NA	NA	NA	NA	NA	NA	7.0	7.2	7.4	8.7	9.1	9.3
Hydraulic Radius (ft)	N/A	N/A	N/A	N/A	0.8	N/A	NA	NA	NA	NA	NA	NA	0.9	0.9	0.9	0.5	0.5	0.5
Bank Height Ratio																		
<b>Pattern</b>																		
Channel Beltwidth (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	32.0	37.0	42.0	32.0	37.0	42.0
Radius of Curvature (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	14.0	18.0	30.0	14.0	18.0	30.0
Meander Wave Length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	59.0	60.6	62.0	59.0	60.6	62.0
Meander Width Ratio	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	5.3	6.2	7.0	4.1	4.7	5.3
<b>Profile</b>																		
Riffle Length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	7.0	11.3	18.0	NA	NA	NA
Riffle Slope (ft/ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	0.007	0.01	0.02	NA	NA	NA
Pool Length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	8.0	14.8	24.0	NA	NA	NA
Pool to Pool Spacing (ft)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	21.0	37.2	46.8	NA	NA	NA
<b>Substrate</b>																		
D50 (mm)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	gravel	gravel	gravel	0.4	21.2	69.0
D84 (mm)	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	gravel	gravel	gravel	0.5	45.7	110.0
<b>Additional Reach Parameters</b>																		
Valley Length (ft)	N/A			N/A			NA			NA			749			667		
Channel Length (ft)	N/A			N/A			NA			NA			624			556		
Sinuosity	N/A			N/A			NA			NA			1.2			1.2		
Water Surface Slope (ft/ft)	N/A			N/A			NA			NA			N/A			N/A		
Bankfull Slope (ft/ft)	N/A			N/A			NA			NA			0.01 (0.004-0.013)			0.01		
Rosgen Classification	N/A			N/A			NA			NA			E4/5			C4/5		

**Table 2.3  
Morphology and Hydraulic Monitoring Summary  
Camp Branch/Project No. 92350  
Main Channel**

PARAMETER	Cross-Section 5 Pool					Cross-Section 6 Riffle					Cross-Section 7 Pool					Cross-Section 8 Riffle				
	MY1-2007	MY2-2008	MY3-2009	MY4-2010	MY5-2011	MY1-2007	MY2-2008	MY3-2009	MY4-2010	MY5-2011	MY1-2007	MY2-2008	MY3-2009	MY4-2010	MY5-2011	MY1-2007	MY2-2008	MY3-2009	MY4-2010	MY5-2011
<b>DIMENSION</b>																				
Bankfull Width (ft)	21.0	20.0				18.1	22.7				23.9	23.6				22.8	23.8			
Floodprone Width (ft)	97.2	101.7				99.9	100.5				85.2	97.9				91.3	89.3			
Bankfull Cross-sectional Area	37.8	37.3				24.0	27.0				47.4	46.7				31.6	28.5			
Bankfull Mean Depth	1.8	1.9				1.3	1.2				2.0	2.0				1.4	1.2			
Bankfull Max Depth	2.5	2.8				1.8	2.0				3.3	3.3				2.0	1.9			
Width/Depth Ratio	11.6	10.8				13.6	19.1				12.0	11.9				16.3	19.8			
Entrenchment Ratio	4.6	5.1				5.5	4.4				3.6	4.2				4.0	3.8			
Wetted Perimeter (ft)	24.6	21.2				20.7	23.6				27.9	24.8				25.6	24.2			
Hydraulic Radius (ft)	1.4	1.8				1.2	1.2				1.7	1.9				1.2	1.2			
Bank Height Ratio	*	1.0				*	1.0				*	1.0				*	1.0			
<b>SUBSTRATE (Reachwide)</b>	<b>MY1-2007</b>	<b>MY2-2008**</b>	<b>MY3-2009</b>	<b>MY4-2010</b>	<b>MY5-2011</b>	<b>MY1-2007</b>	<b>MY2-2008**</b>	<b>MY3-2009</b>	<b>MY4-2010</b>	<b>MY5-2011</b>	<b>MY1-2007</b>	<b>MY2-2008**</b>	<b>MY3-2009</b>	<b>MY4-2010</b>	<b>MY5-2011</b>	<b>MY1-2007</b>	<b>MY2-2008**</b>	<b>MY3-2009</b>	<b>MY4-2010</b>	<b>MY5-2011</b>
D50 (mm)	0.4					31					0.4					27				
D84 (mm)	16					45					20					45				
<b>PROFILE</b>	<b>MY1-2007</b>		<b>MY2-2008</b>			<b>MY3-2009</b>			<b>MY4-2010</b>			<b>MY5-2011</b>								
	<b>Min</b>	<b>Max</b>	<b>Med</b>	<b>Min</b>	<b>Max</b>	<b>Med</b>	<b>Min</b>	<b>Max</b>	<b>Med</b>	<b>Min</b>	<b>Max</b>	<b>Med</b>	<b>Min</b>	<b>Max</b>	<b>Med</b>					
Riffle Length (ft)	10.20	43.30	23.40	9.48	39.32	21.39														
Riffle Slope (ft/ft)	0.0000	0.0200	0.0100	0.0019	0.0327	0.0185														
Pool Length (ft)	11.60	37.00	23.00	19.35	72.39	46.59														
Pool to Pool Spacing (ft)	44.90	94.00	74.70	45.68	117.05	75.65														
<b>ADDITIONAL REACH PARAMETERS</b>																				
Valley Length (ft)	1,640		1,640																	
Channel Length (ft)	1,810		1,810																	
Sinuosity	1.1		1.1																	
Water Surface Slope (ft/ft)	N/A		0.0039																	
Bankfull Slope (ft/ft)	0.0034		0.0036																	
Rosgen Classification	C4		C4																	

\* Data was not reported

\*\*Reachwide Pebble Count was conducted for MY-2008

**Table 2.3 cont.**  
**Morphology and Hydraulic Monitoring Summary**  
**Camp Branch/Project No. 92350**  
**Tributary**

PARAMETER	Cross-Section 1 Riffle					Cross-Section 2 Pool					Cross-Section 3 Riffle					Cross-Section 4 Pool				
	MY1-2007	MY2-2008	MY3-2009	MY4-2010	MY5-2011	MY1-2007	MY2-2008	MY3-2009	MY4-2010	MY5-2011	MY1-2007	MY2-2008	MY3-2009	MY4-2010	MY5-2011	MY1-2007	MY2-2008	MY3-2009	MY4-2010	MY5-2011
Bankfull Width (ft)	8.00	8.97				6.80	6.80				7.90	5.44				5.90	6.14			
Floodprone Width (ft)	>55	55.20				>66	65.72				35.00	39.52				38.00	37.48			
Bankfull Cross-sectional Area	5.80	6.33				5.90	5.68				3.00	2.16				3.50	2.94			
Bankfull Mean Depth	0.70	0.71				0.90	0.84				0.40	0.42				0.60	0.48			
Bankfull Max Depth	1.00	1.26				1.40	1.35				0.60	0.65				1.10	1.10			
Width/Depth Ratio	11.40	12.63				7.60	8.10				19.80	12.17				9.80	12.79			
Entrenchment Ratio	>6.9	6.15				>9.7	9.66				4.40	7.73				6.40	6.10			
Wetted Perimeter (ft)	9.40	9.40				8.60	7.58				8.70	5.51				7.10	6.73			
Hydraulic Radius (ft)	0.60	0.67				0.70	0.75				0.30	0.39				0.50	0.44			
Bank Height Ratio	*	1.00				*	1.00				*	1.00				*	1.00			
<b>SUBSTRATE (Reachwide)</b>	<b>MY1-2007</b>	<b>MY2-2008**</b>	<b>MY3-2009</b>	<b>MY4-2010</b>	<b>MY5-2011</b>	<b>MY1-2007</b>	<b>MY2-2008**</b>	<b>MY3-2009</b>	<b>MY4-2010</b>	<b>MY5-2011</b>	<b>MY1-2007</b>	<b>MY2-2008**</b>	<b>MY3-2009</b>	<b>MY4-2010</b>	<b>MY5-2011</b>	<b>MY1-2007</b>	<b>MY2-2008**</b>	<b>MY3-2009</b>	<b>MY4-2010</b>	<b>MY5-2011</b>
D50 (mm)	69					0.4					15					0.4				
D84 (mm)	110					0.5					72					0.5				
<b>PROFILE</b>	<b>MY1-2007</b>			<b>MY2-2008</b>			<b>MY3-2009</b>			<b>MY4-2010</b>			<b>MY5-2011</b>							
	<b>Min</b>	<b>Max</b>	<b>Med</b>	<b>Min</b>	<b>Max</b>	<b>Med</b>	<b>Min</b>	<b>Max</b>	<b>Med</b>	<b>Min</b>	<b>Max</b>	<b>Med</b>	<b>Min</b>	<b>Max</b>	<b>Med</b>					
Riffle Length (ft)	N/A	N/A	N/A	5.16	27.10	9.46														
Riffle Slope (ft/ft)	N/A	N/A	N/A	0.0060	0.1003	0.02														
Pool Length (ft)	N/A	N/A	N/A	11.18	29.25	21.08														
Pool to Pool Spacing (ft)	N/A	N/A	N/A	7.84	72.26	36.13														
<b>ADDITIONAL REACH PARAMETERS</b>																				
Valley Length (ft)	667			667																
Channel Length (ft)	556			556																
Sinuosity	1.2			1.2																
Water Surface Slope (ft/ft)	N/A			0.0102																
Bankfull Slope (ft/ft)	0.0100			0.0105																
Rosgen Classification	C4			C4																

\* Data was not reported

\*\*Reachwide Pebble Count was conducted for MY-2008

### 2.2.7 Hydrologic Criteria

Two crest gauges are located on the Camp Branch Site. One is located on the main channel upstream of cross-section 1 and the second is located on the UT upstream of cross-section 5. Table 2.4 below verifies that one bankfull or greater event occurred within the Camp Branch restoration project in 2008 monitoring year.

**Table 2.4**  
**Verification of Bankfull Events**  
**Camp Branch/Project No. 92350**

<b>Date of Collection</b>	<b>Date of Occurrence</b>	<b>Method</b>	<b>Photo # (if available)</b>
12/2007	N/A*	Crest Gauge (Main Channel and Tributary)	N/A
8/2008	Unknown	Crest Gauge (Main Channel and Tributary)	N/A

\*Note from previous monitoring report: No bankfull events were observed to have occurred during the Year-1 (2007) monitoring period.



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**SECTION 3**  
**METHODOLOGY**

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## SECTION 3

### METHODOLOGY

#### 3.1 Methodology

Methods employed for the Camp Branch Stream Restoration Project were a combination of those established by standard regulatory guidance and procedures documents and as well as previous monitoring reports completed by EcoScience. Geomorphic and stream assessments were performed following guidelines outlined in the Stream Channel Reference Sites: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in the Stream Restoration a Natural Channel Design Handbook (Doll et al, 2003). Vegetation assessments were performed following the Carolina Vegetation Survey-NCEEP Level 2 Protocol (Lee et al., 2006). JYG used the *Flora of the Carolinas, Virginia, Georgia, and surrounding areas* by Alan S. Weakley as the taxonomic standard for vegetation nomenclature for this report.



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**SECTION 4**  
**REFERENCES**

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## SECTION 4

### REFERENCES

Doll, B.A., Grabow, G.L., Hall, K.A., Halley, J., Harman, W.A., Jennings, G.D., and Wise, D.E., 2003. *Stream Restoration A Natural Channel Design Handbook*.

EcoScience Corporation. 2007. *Bishop Site Stream and Wetland Restoration 2007 Annual Monitoring Report (Year 1)*. Raleigh, NC.

Harrelson, Cheryl C; Rawlins, C.L.; Potyondy, John P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Lee, Michael T., R. K. Peet, S. D. Roberts, and T. R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0 (<http://cvs.bio.unc.edu/methods.htm>).

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

Weakley, A.S. 2008. *Flora of the Carolinas, Virginia, Georgia, Northern Florida, and Surrounding Areas* (Draft April 2008). University of North Carolina at Chapel Hill: Chapel Hill, NC.



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**SECTION 5**  
**FIGURES**

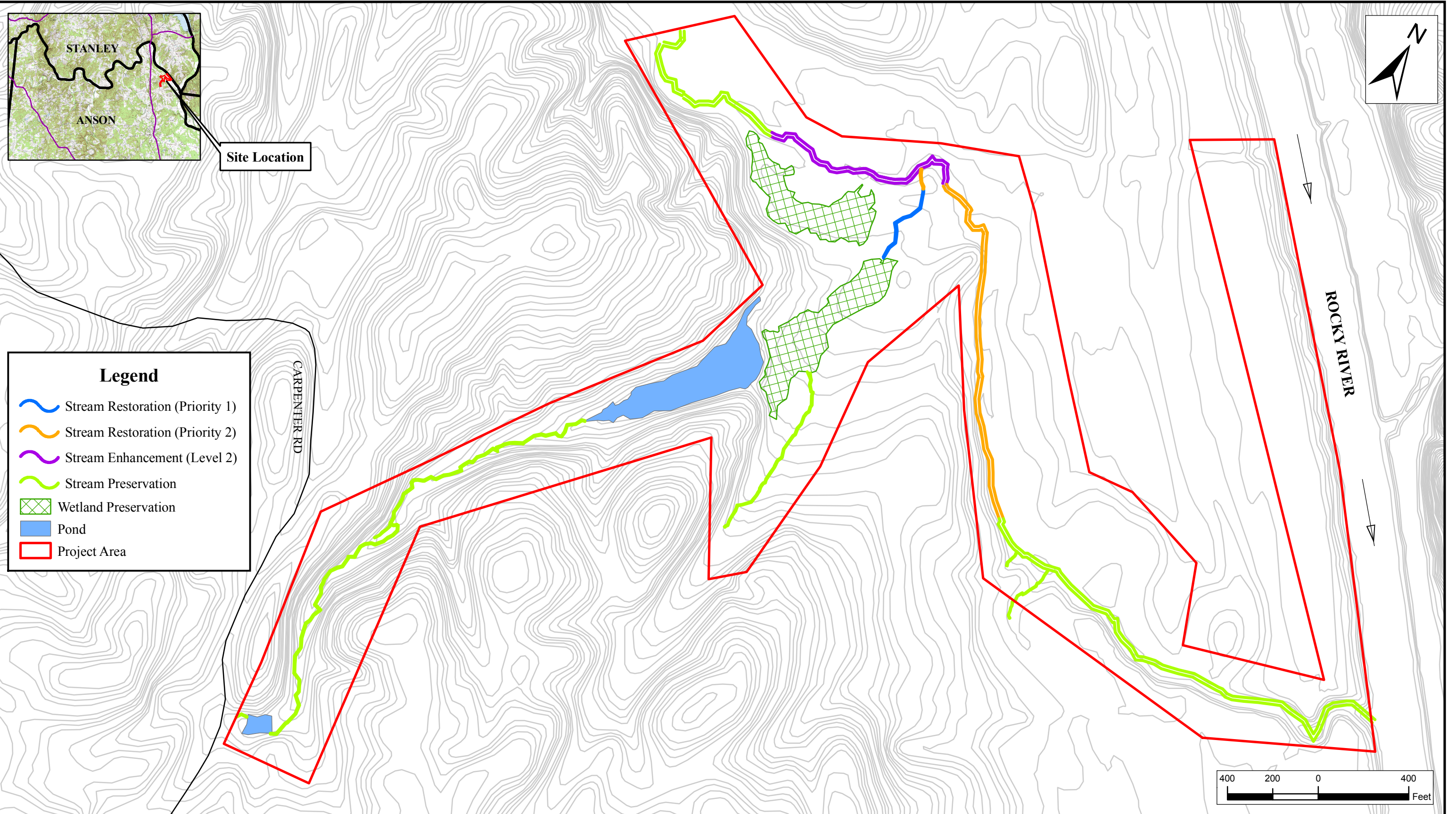
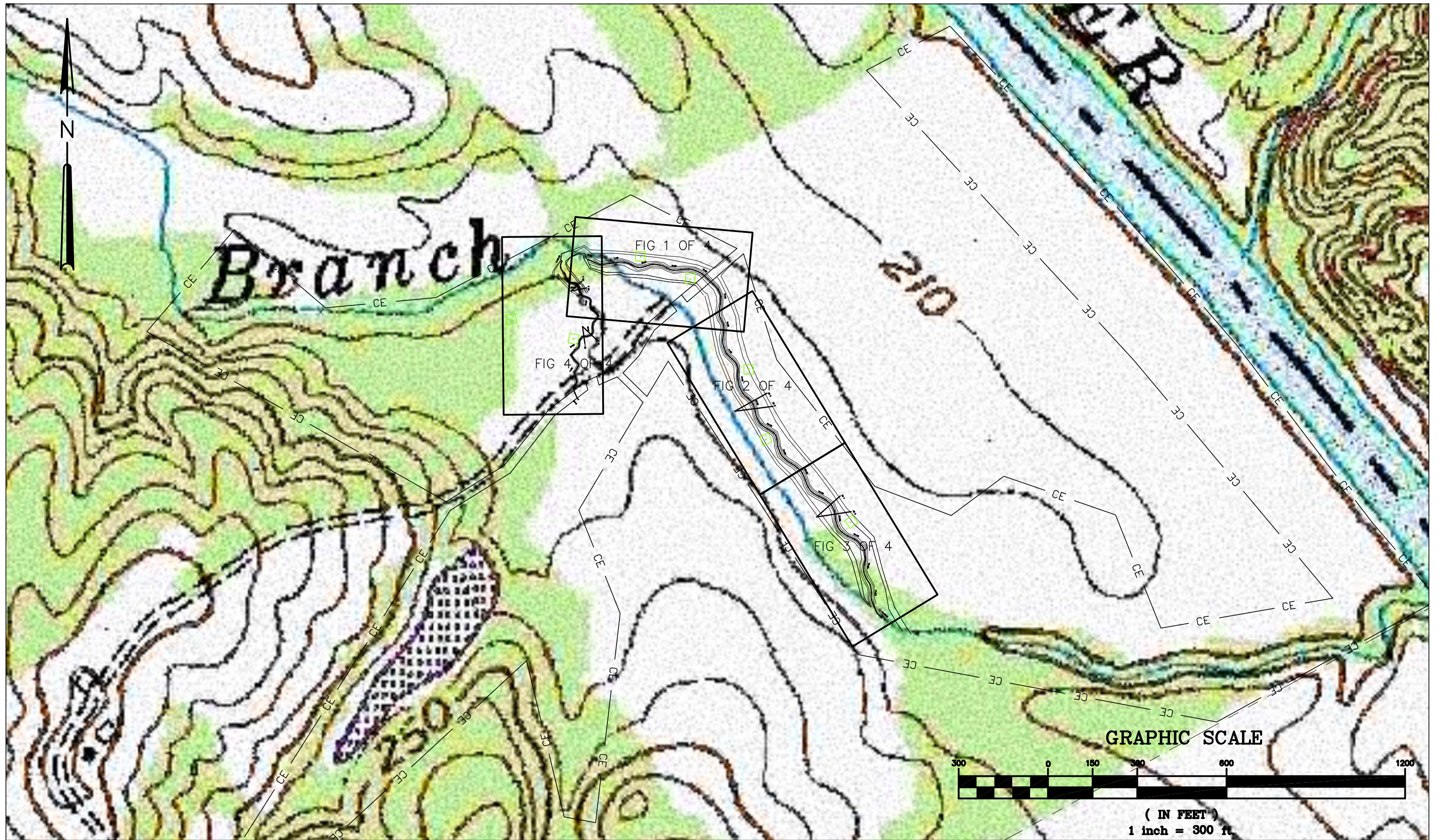


Figure 1.1 Project Location Map  
 Camp Branch Stream Restoration  
 Anson County, NC  
 Year 2 of 5

Project No. 92350  
 February 2009





NOTES:  
 1. GENERAL SITE DATA PROVIDED BY NCEEP.  
 2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 92350  
 ANSON COUNTY  
 NORTH CAROLINA  
 MONITORING  
 YEAR 2 of 5



NC ECOSYSTEM ENHANCEMENT PROGRAM  
 CAMP BRANCH STREAM RESTORATION

DATE : FEBRUARY 2009  
 SCALE : 1"=300'  
 JOB NO.: 03060005

FIGURE 1.2  
 MONITORING PLAN VIEW

FIGURE KEY

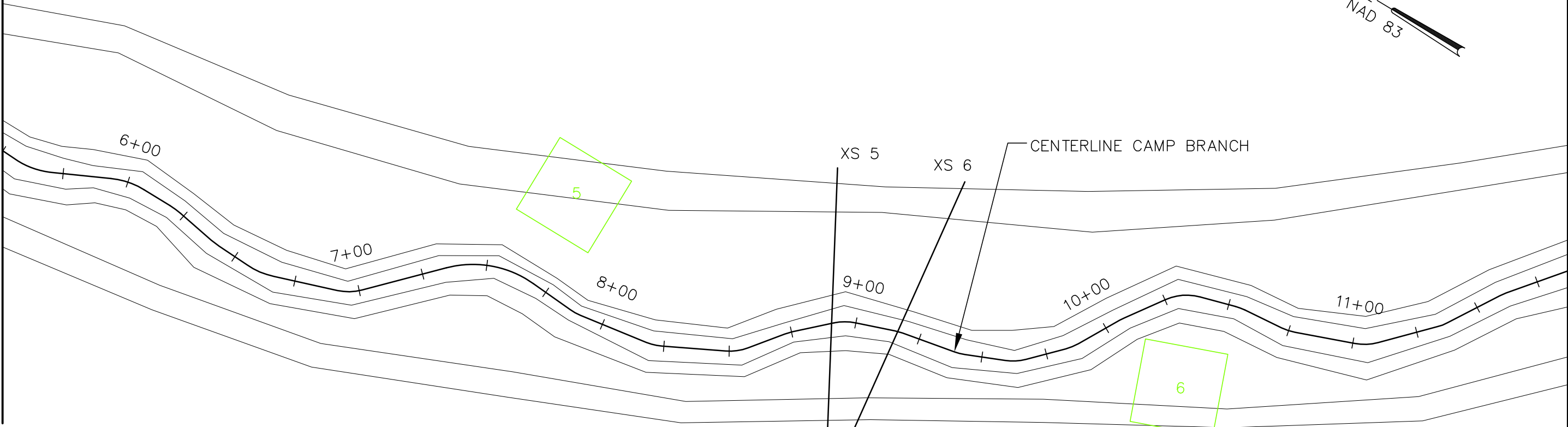
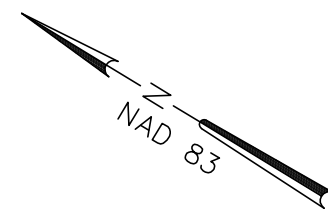








MATCHLINE SEE FIGURE 1 OF 4

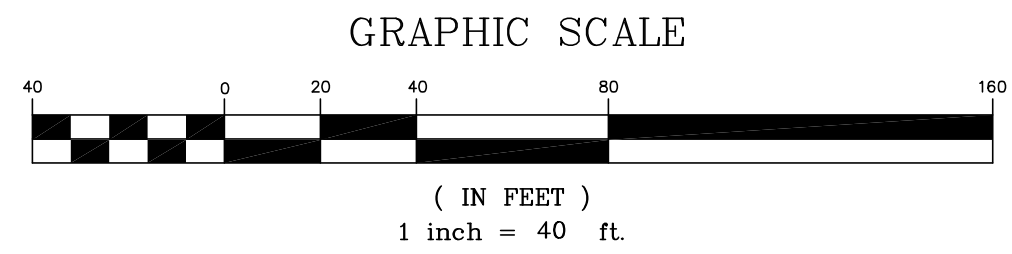
MATCHLINE SEE FIGURE 3 OF 4

CE CE CE CE CE CE CE CE CE CE CE CE CE CE CE CE



**LEGEND**

-  CHANNEL CENTERLINE
-  BANK FULL
-  CREST GAUGE
-  VEGETATION PLOT



**NOTES:**  
 1. GENERAL SITE DATA PROVIDED BY NCEEP.  
 2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 92350  
 ANSON COUNTY  
 NORTH CAROLINA  
 MONITORING  
 YEAR 2 of 5



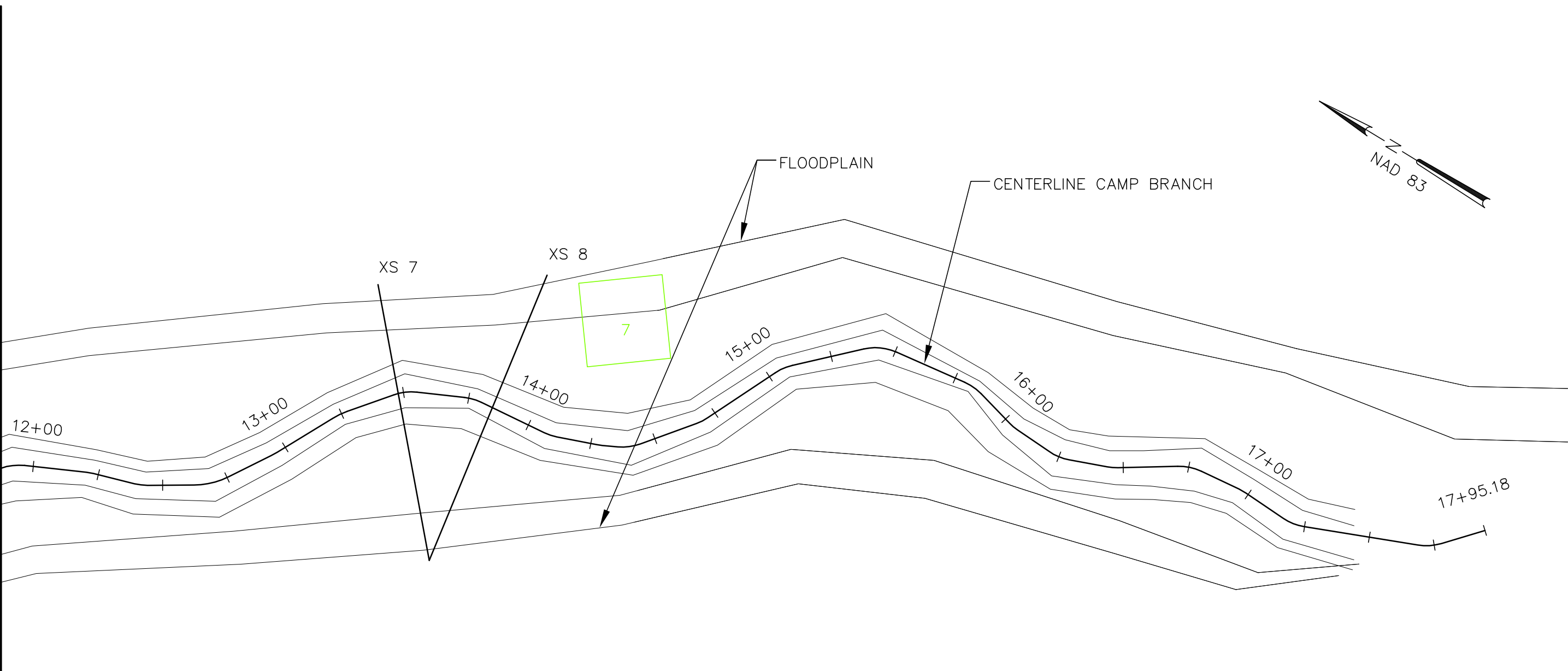
NC ECOSYSTEM ENHANCEMENT PROGRAM  
 CAMP BRANCH STREAM RESTORATION

**FIGURE 1.2  
 MONITORING PLAN VIEW**


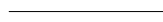


DATE : FEBRUARY 2009  
 SCALE : 1"=40'  
 JOB NO.: 03060005

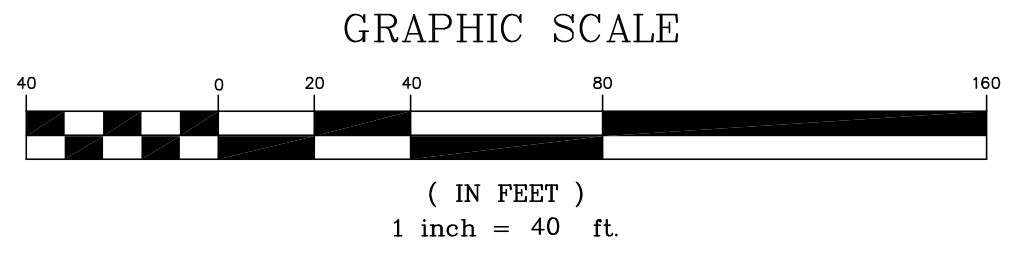
FIGURE 2 OF 4

MATCHLINE SEE FIGURE 2 OF 4



**LEGEND**

-  CHANNEL CENTERLINE
-  BANK FULL
-  CREST GAUGE
-  VEGETATION PLOT



NOTES:  
1. GENERAL SITE DATA PROVIDED BY NCEEP.  
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 92350  
ANSON COUNTY  
NORTH CAROLINA  
MONITORING  
YEAR 2 of 5



NC ECOSYSTEM ENHANCEMENT PROGRAM  
CAMP BRANCH STREAM RESTORATION

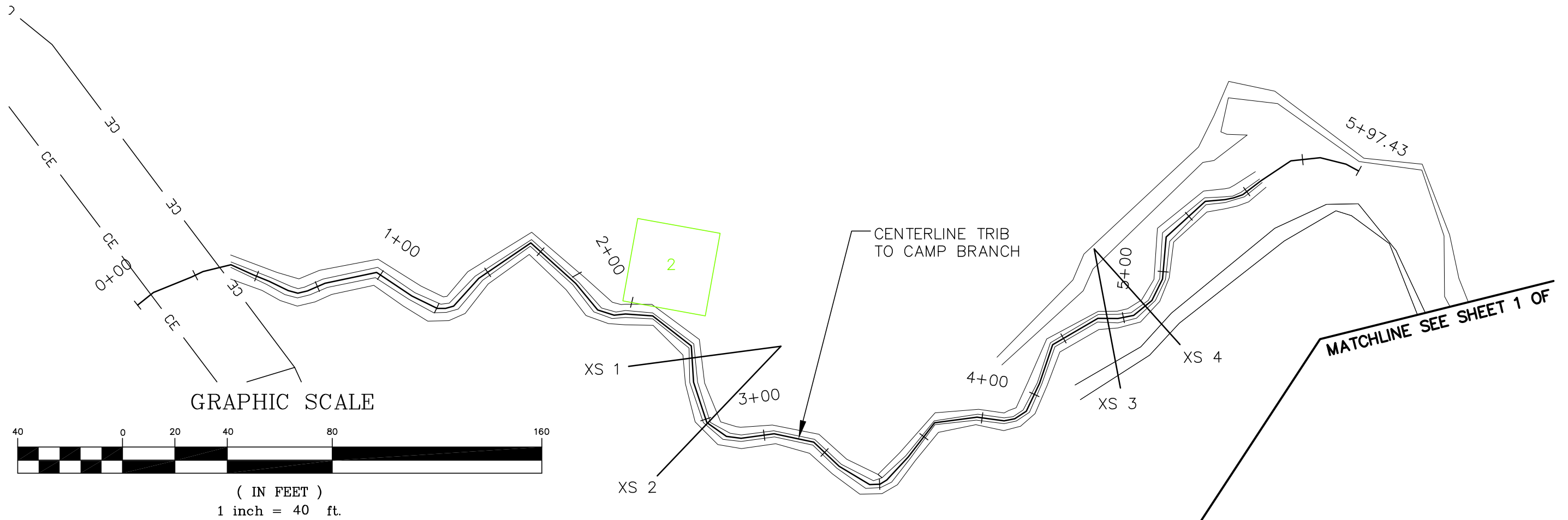
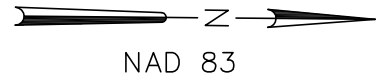
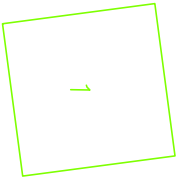
FIGURE 1.2  
MONITORING PLAN VIEW

DATE : FEBRUARY 2009  
SCALE : 1"=40'  
JOB NO.: 03060005

FIGURE 3 OF 4

**LEGEND**

- CHANNEL CENTERLINE
- BANK FULL
- CREST GAUGE
- # VEGETATION PLOT



NOTES:  
 1. GENERAL SITE DATA PROVIDED BY NCEEP.  
 2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 92350  
 ANSON COUNTY  
 NORTH CAROLINA  
 MONITORING  
 YEAR 2 of 5



NC ECOSYSTEM ENHANCEMENT PROGRAM  
 CAMP BRANCH STREAM RESTORATION

**FIGURE 1.2**  
**MONITORING PLAN VIEW**

DATE : FEBRUARY 2009  
 SCALE : 1"=40'  
 JOB NO.: 03060005

**Click on the Desired Link Below**

**Appendices**