

**UT ROCKY RIVER (SMITH TRACT) STREAM RESTORATION – NCEEP
Project #402**

2008 FINAL MONITORING REPORT – YEAR 2

**CONDUCTED FOR THE NORTH CAROLINA DEPARTMENT OF ENVIRONMENT
AND NATURAL RESOURCES**



Submitted on January 30, 2009 to:



North Carolina Department of
Environment and Natural Resources
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

**UT ROCKY RIVER (SMITH TRACT) STREAM RESTORATION – NCEEP
Project #402
2008 FINAL MONITORING REPORT – YEAR 2**

CONDUCTED FOR THE NORTH CAROLINA DEPARTMENT OF ENVIRONMENT
AND NATURAL RESOURCES

Table of Contents

1.0 Executive Summary	1
2.0 Project Background.....	2
2.1. Project Objectives	2
2.2. Project Structure, Mitigation Type, and Approach	2
2.3 Location and Setting	2
2.4. History and Background	4
2.5. Monitoring Plan View.....	6
3.0 Project Conditions and Monitoring Results.....	7
3.1 . Vegetation Assessment	7
3.1.1. Vegetation Problem Areas	7
3.1.2. Current Conditions Plan View	7
3.2. Stream Assessment	7
3.2.1. Procedural Items	7
3.2.1. Current Conditions Plan View	8
3.2.3. Problem Areas Table.....	8
3.2.4 Numbered Issue Photo Section	9
3.2.5. Fixed Station Photos	9
3.2.6. Stability Assessment Table	9
IV. Methodology.....	15
4.1. Stream Methodology.....	15
4.2. Vegetation Methodology	15
References.....	16

LIST OF FIGURES

Figure 1 Vicinity Map.....	3
Figure 2 Monitoring Plan View.....	6

Tables

Exhibit Table I. Project Mitigation Structure and Objectives.....	4
Exhibit Table II. Project Activity and Reporting History.....	4
Exhibit Table III. Project Contact Table.....	5
Exhibit Table IV. Project Background Table.....	5
Exhibit Table V. Verification of Bankfull Events	9
Exhibit Table VI. Categorical Stream Feature Visual Stability Assessment.....	10
Exhibit Table VII. Baseline Morphology and Hydraulic Summary.....	11
Exhibit Table VIII. Morphology and Hydraulic Monitoring Summary.....	13

APPENDICES

Appendix A Vegetation Data

A1. Vegetation Data Tables

Table 1. Vegetation Metadata

Table 2. Vegetation Vigor by Species

Table 3. Damage by Species

Table 4. Damage by Plot

Table 5. Stem Count by Plot and Species

Table 6. Vegetation Problem Areas

A2. Vegetation Problem Area Photo

A3 Vegetation Monitoring Plot Photos

Figure A1. Current Conditions Plan View

Appendix B Geomorphologic Raw Data

B1. Current Conditions Plan View

B2. Stream Problem Areas Table

B3. Representative Stream Problem Area Photos

B4. Stream Photo-station Photos

B5. Qualitative Visual Stability Assessment Table

B6. Cross section Plots and Raw Data Tables

B7. Longitudinal Plots and Raw Data Tables

B8. Pebble Counts

1.0 Executive Summary

From 2006 to 2007, a total of 2,206 linear feet of stream was enhanced or restored on two unnamed tributaries to Rocky River on the Smith property in Chatham County. The goals in Reach 1 were designed to eliminate cattle access to the stream and stabilize damaged banks to prevent further sediment input (Enhancement I), and to realign a section of the stream to incorporate a stable livestock crossing (Enhancement II). The goals for Reach 2 were to reconnect the incised channel to the floodplain and correct the reach's pattern, profile, and dimension (Restoration). First year monitoring was completed in December 2007.

The 2008 Initial Assessment was conducted by RJG&A in 14 April. Second annual vegetation and geomorphologic monitoring data were collected during October 2008. The restoration was also qualitatively evaluated during those visits.

Overall, the restoration project appears to have met its design goals. The enhanced sections of Reach 1 are stable and several of the problem areas discussed in the monitoring year one report have stabilized. There are several small areas of scour and incision in Reach 2 that do not currently need remedial action, but should be monitored. The introduction of new substrate to a number of riffles in Reach 2, post-construction and presumably in response to damage from a major storm event, appears to have helped stabilize the armor and facet grade in those areas.

The average live planted woody stem density (594 live stems per acre) has exceeded the vegetation success criteria (320 live stems per acre) by 86 percent. As was noted in the year one monitoring, invasive exotics continue to be present in both reaches, but no remedial action is recommended at this time. During one site visit it was noted that cattle had recently had access to both reaches. The landowner indicated that the neighbor's cattle had broken through the fence and were rounded up the next day.

2.0 Project Background

2.1. Project Objectives

Although the goals and objectives are combined the 2007 Mitigation Plan (Ward Consulting 2007), the last three bullet points list what we interpret to be the goals of the project including:

- Improve water quality and reduce erosion through restricting cattle access and improved riparian buffers
- Improve aquatic habitat using natural material stabilization structures
- Provide aesthetic value, wildlife habitat, and bank stability through restoration/enhancement of the riparian zone

In the following section, this document outlines that the stream restoration project's goals (or possibly objectives) were to:

- Reconnect Reach 2 to its floodplain
- Enhance approximately 150 feet of Reach 1 and stabilize an additional 955 feet of the same reach
- Provide a stable channel for both reaches in terms of pattern, profile, and dimension
- Provide a conservation easement and enhance/restore portions of the buffer for both reaches
- Exclude cattle from Reach 1

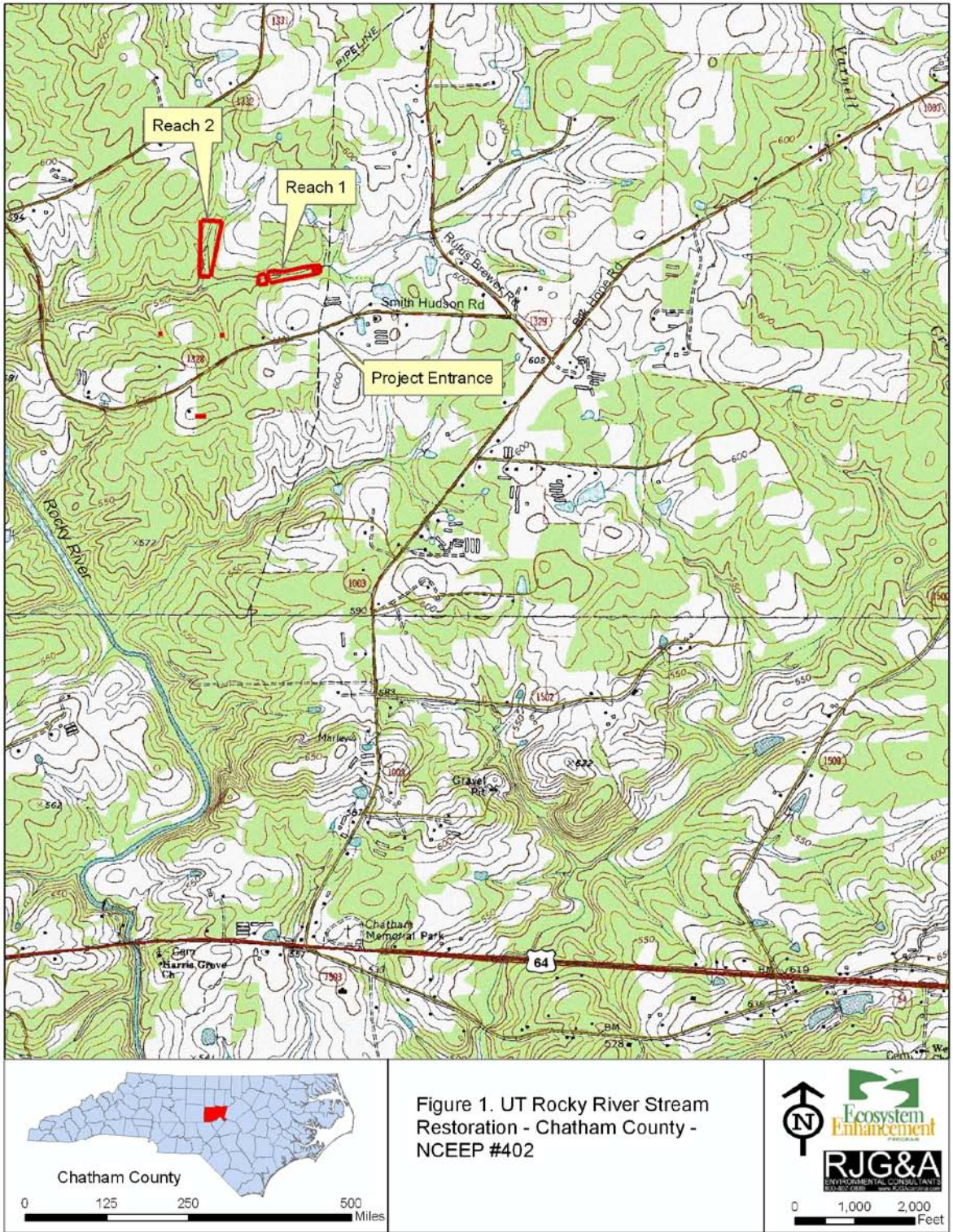
2.2. Project Structure, Mitigation Type, and Approach

Reach 1 is 1,095 linear feet in length. An Enhancement I stream mitigation approach was used to restore the stream pattern and profile design on the downstream most 208 linear feet of the reach. The banks were stabilized along the remaining upstream portion of Reach 1 as part of an Enhancement II. For Reach 2, a priority-one stream restoration was performed and the channels pattern, profile, and dimension were all restored.

2.3 Location and Setting

The entire restoration site is located on the Smith property off Smith Hudson Road in Chatham County. To get to the site from U.S. Highway 64, head north on Silk Hope Road (Figure 1). After approximately 2.1 miles, take a left on Rufus Brewer Road, then the first left on to Smith Hudson Road. Access to the site is approximately 0.6 miles down Smith Hudson on the right. Look for a farm pond on the left and a gravel/dirt road on the right.

The drainage area is approximately 820 acres for Reach 1 and approximately 135 acres for Reach 2. Land use for the Reach 1 drainage area is principally rural agricultural. Reach 2's land use is a combination of agriculture and forest. The property falls under the planning and zoning restrictions of Chatham County. The site is located in the 03030003 Cape Fear Cataloging Unit.



2.4. History and Background

The North Carolina Department of Transportation (NCDOT) identified two unnamed tributaries to Nick Creek in Chatham County, North Carolina, as stream mitigation sites in 2001. The tributaries are on a tract that was referred to as the Smith Tract Mitigation Site. The two unnamed tributaries have been designated Reach 1 and Reach 2. Ward Engineering began working on the project in 2003. The Restoration Plan was delivered in 2005, construction was completed in October 2006, and woody species were planted in late November to early December. The Mitigation Report was delivered in March 2007 and the final First Year Monitoring Report was delivered in December 2007. On-site observations and differences in the CCPVs included in the draft and final MY-1 reports, indicate that repair work was completed in Reach 2, presumably between December 2007 and 15 February 2008.

Exhibit Table I. Mitigation Structure and Objectives - UT Rocky River (Smith Tract) Stream Restoration – EEP Project #402 – Chatham, NC

Reach ID	Mitigation Type	Approach	Linear Feet	Stationing	Comment
Reach 1	EII	SS	887	00+00 – 08+87	Bank stabilization, fence out cattle
Reach 1	EI	P1	208	08+87 – 10+95	Relocation, improve cattle/equipment crossing, re-establish stream pattern and dimension
Reach 2	R	P1	1,111	-00+03 – 11+08	Reconnect to floodplain, adjust stream pattern, profile and dimension, install structures and vegetation

Exhibit Table II. Activity and Reporting History - UT Rocky River (Smith Tract) Stream Restoration – EEP Project #402– Chatham, NC

Activity or Report	Data Collection	Completion
Restoration Plan	2003	April 2005
Construction	NA	October 2006
Temporary S&E mix applied	NA	July 2006 (Reach 1); September 2006 (Reach 2)
Permanent seed mix applied	NA	July 2006 (Reach 1); September 2006 (Reach 2)
Containerized and B&B plantings	NA	December 2006
Mitigation Plan	NA	March 2007 (report date)
As-built	March 2005	December 2005 (report date)
Year 1 Monitoring		December 2007 (report date)
	Vegetation	November 2007
	Geomorphological	November 2007
Year 2 Monitoring		November 2008 (report date)
	Vegetation	October 2008
	Geomorphological	October 2008

Exhibit Table III. Project Contacts - UT Rocky River (Smith Tract) Stream Restoration – EEP Project #402	
Design:	Ward Consulting Engineers 8386 Six Forks Road, Suite 101 Raleigh, NC 27615-5088 Becky Ward (919) 870-0526
Construction Contractor:	McQueen Construction 619 Patrick Road Bahama, NC 27503 Harvey McQueen (919) 697-0614
Planting Contractor:	Southern Garden Inc. P.O. Box 808 Apex, NC 27502 (919) 362-1050
Seed Contractor:	McQueen Construction 619 Patrick Road Bahama, NC 27503 Harvey McQueen (919) 697-0614
Seed Mix Sources:	Evergreen Seed (919) 567-1333
Nursery Stock Suppliers:	Coastal Plain Conserv. Nursery, Inc. (Edenton, NC) Ellen Colodney (252) 482-5707 Cure Nursery (Pittsboro, NC) Bill and Jennifer Cure (919) 542-6186 Brook Run Nursery (Blackstone, VA) Howard Malinski (919) 422-8727
Monitoring Performers (2008 - 2009):	RJG&A 1221 Corporation Parkway, Suite 100 Raleigh, NC 27616 Ms. Jessi O’Neal (919) 872-1174

Exhibit Table IV. Project Background - UT Rocky River (Smith Tract) Stream – EEP Project #402	
County	Chatham
Drainage Area	Reach 1: 820 acres (1.28 square miles) Reach 2: 135 acres (0.21 square miles)
Drainage Impervious Cover Estimate (%)	Reach 1: 2% Reach 2: 1%
Stream Order	Reach 1: 2 Reach 2: 2
Physiographic Region	Piedmont
Ecoregion	45c Carolina Slate Belt
Rosgen Classification of As-built	Reach 1: C4/E4 Reach 2: C4
Dominant Soil Types	Reach 1: cid-Lignum Complex, Nanford-Baden Complex Reach 2: Riverview Silt Loam
Reference Site ID	North Prong Creek
USGS HUC for Project and Reference	03030003
NCDWQ Sub-basin for Project and Reference	03-06-12
NCDWQ Classification for Project and Reference	Reach 1: C Reach 2: C
Any portion of the project segment 303d listed?	No
Any portion of the project segment upstream of a 303d listed segment?	No
Reasons for 303d Listing or Stressor	NA
% of Project Easement Fenced	Reach 1: 13% Reach 2: 41%

2.5. Monitoring Plan View

See Figure 2.1 and 2.2 for the Monitoring Plan View.

**Figure 2.1. Monitoring Plan View. Rocky River (Reach 1) - 2008
Chatham County, NC - EEP Project #402**

Thalweg Monitoring Year 2
10/16/2008

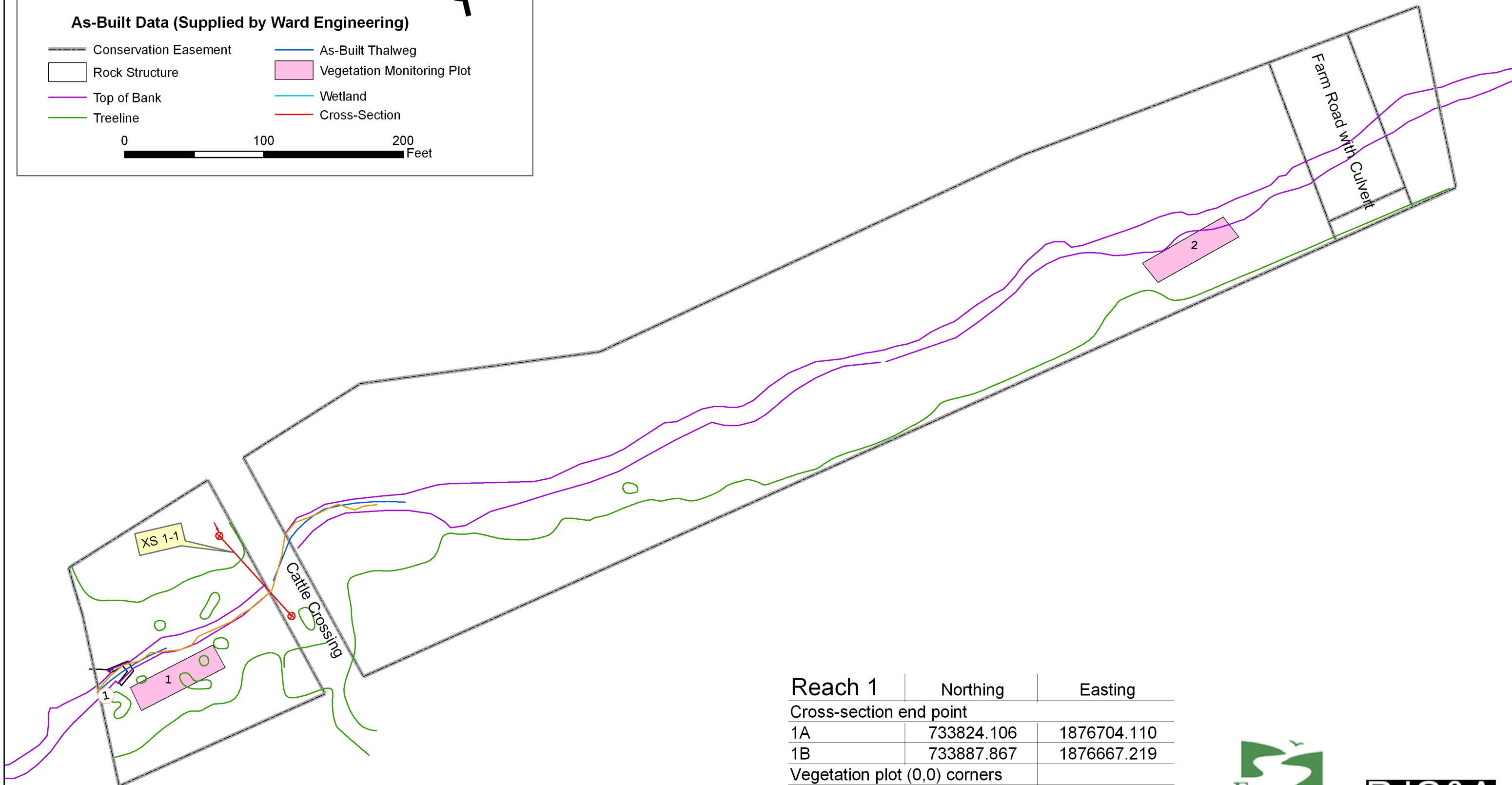
Photopoints



As-Built Data (Supplied by Ward Engineering)

- Conservation Easement
- As-Built Thalweg
- Rock Structure
- Vegetation Monitoring Plot
- Top of Bank
- Wetland
- Treeline
- Cross-Section

0 100 200 Feet



Reach 1	Northing	Easting
Cross-section end point		
1A	733824.106	1876704.110
1B	733887.867	1876667.219
Vegetation plot (0,0) corners		
1	733921.773	1877367.424
2	733786.687	1876587.837



**Figure 2.2. Monitoring Plan View. Rocky River (Reach 2) - 2008
Chatham County, NC - EEP Project #402**



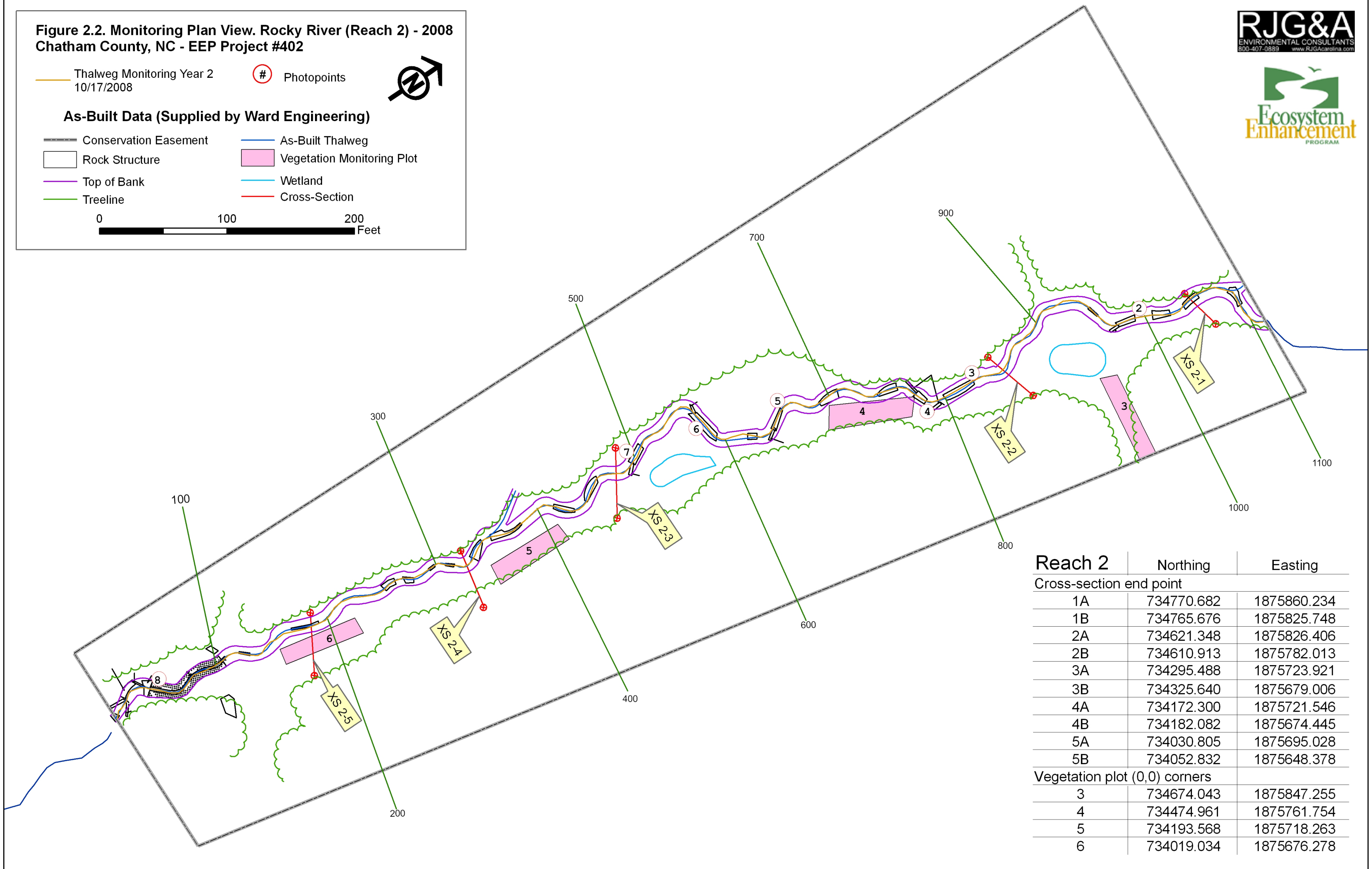
Thalweg Monitoring Year 2
10/17/2008

Photopoints

As-Built Data (Supplied by Ward Engineering)

- Conservation Easement
- Rock Structure
- Top of Bank
- Treeline
- As-Built Thalweg
- Vegetation Monitoring Plot
- Wetland
- Cross-Section

0 100 200 Feet



Reach 2	Northing	Easting
Cross-section end point		
1A	734770.682	1875860.234
1B	734765.676	1875825.748
2A	734621.348	1875826.406
2B	734610.913	1875782.013
3A	734295.488	1875723.921
3B	734325.640	1875679.006
4A	734172.300	1875721.546
4B	734182.082	1875674.445
5A	734030.805	1875695.028
5B	734052.832	1875648.378
Vegetation plot (0,0) corners		
3	734674.043	1875847.255
4	734474.961	1875761.754
5	734193.568	1875718.263
6	734019.034	1875676.278

3.0 Project Conditions and Monitoring Results

RJG&A's 2008 initial assessment was completed 14 April. The site was again qualitatively evaluated during October 16, 17, and 23, 2008 at the same time that quantitative vegetation and geomorphologic data were collected. Water was present in both Reach 1 and Reach 2 in April, however there was no water in the Reach 2 channel in October. Overall, the project appears to be meeting its design functions/goals.

3.1 . Vegetation Assessment

Overall planted woody vegetation appeared to be successful when qualitatively evaluated during April and October 2008. The average live, planted, woody stem density (594 live stems per acre) has exceeded the vegetation success criteria (320 live stems per acre) by 86 percent. This number is down from 905 stems per acre in 2007. This 2008 density exceeds the required 320 live stems per acre by 173 percent. Stem density is highest for *Fraxinus pennsylvanica* (Table 5, Appendix A). A number of planted stems identified during Monitoring Year 1 were identified as either dead or missing during this year's monitoring. Last year's record drought may have been partially responsible for a die-off.

Monitoring plot photos are located in Appendix A.

3.1.1. Vegetation Problem Areas

Three vegetation problem areas were identified in Reach 2 and four in Reach 1. In Reach 2, the area of bare soil that was identified last year is smaller but still present. Two areas of low planted stem density, identified in May 2008, persist in the downstream buffer restoration areas. In Reach 1, microstegium (*Microstegium vimineum*) has spread into three large problem areas on the left floodplain where there are more canopy openings for sunlight.

Throughout the forest edge of riparian buffer enhancement or preservation, sparsely located individuals of autumn olive (*Elaeagnus umbellata*), Chinese privet (*Ligustrum sinensis*), blackberry (*Rubus argutus*), and multiflora rose (*Rosa multiflora*) do occur. They are not out-competing any planted stems or native vegetation and therefore were not considered vegetation problem areas.

See Appendix A. Table 6, Appendix A, Vegetation Problem Area Photos and Figure B.1. Current Conditions Plan View.

3.1.2. Current Conditions Plan View

The Current Conditions Plan View may be found in Appendix B.1.

3.2. Stream Assessment

3.2.1. Procedural Items

3.2.1.1. Morphometric Criteria

RJG&A personnel qualitatively evaluated the site during April and October 2008. In October 2008 the second annual cross section, pattern, and longitudinal profile data were collected based on the 2003 Stream Mitigation Guidelines (USACE 2003). Six cross-sections were surveyed and longitudinal profiles of approximately 200 linear feet of Reach 1 and 1,100 feet of Reach 2 were surveyed. Photographs were taken at the six cross sections and at the 8 permanent in-stream structures (one in Reach 1, seven in Reach 2).

3.2.1.2. Hydrologic Criteria

A crest gauge with granulated cork is located along the left bank at station 2+90. The crest gauge was evaluated during the initial assessment visit in April 2008. The presence of cork above the bankfull line indicates that at least one bankfull storm event had occurred in between November 2007 and April 2008. There was also evidence of wrack and drift lines and downed vegetation throughout the restoration. After this evaluation, the gauge was re-filled with approximately five cubic inches of ground cork. The gauge was again evaluated on 17 October 2008 and cork was present above the bankfull line, indicating that at least one bankfull event had occurred since 14 April 2008.

The evaluation of UT Rocky River (Smith Tract) clearly indicates that at least two storm events resulted in flows over the designed/built bankfull elevation. According to NC CRONOS data and USGS gauge data from Siler City, dates of potential bankfull events include 05 March, 05 April, 27 August, and 06 September.

Date of Data Collection	Date of Occurrence	Method	Photo # (if available)
15 November 2007	October 26, 2007	Crest gauge evaluation, evaluation of USGS rain gauge data	NA
14 April 2008	March 5, 2008, April 5, 2008	Crest gauge evaluation, presence of wrack and drift lines, evaluation of NC CRONOS data	NA
17 October 2008	August 27, 2008, September 6, 2008	Crest gauge evaluation, presence of wrack and drift lines, evaluation of NC CRONOS data	NA

3.2.1. Current Conditions Plan View

The Current Conditions Plan View (Streams) can be found in Appendix B.1.

3.2.3. Problem Areas Table

Overall, the site is maintaining its as-built dimension, pattern, and profile. There are no problem areas in Reach 1. In Reach 2 there are several areas of scour that should be monitored, but no remedial action is currently recommended. As noted in last year’s monitoring report, there continues to be aggradation in the pools at the bottom of Reach 2 due to an undersized pipe (Photo SP2). The introduction of new substrate to a number of riffles in Reach 2 appears to have helped stabilize the armor and facet grade in those areas.

Appendix B.2. outlines problem areas by station, along with suspected causes and representative photos.

3.2.4 Numbered Issue Photo Section

Representative problem area photos are located in Appendix B.3.

3.2.5. Fixed Station Photos

Permanent photopoint images are located in Appendix B.4.

3.2.6. Stability Assessment Table

Exhibit Table VII. Categorical Stream Feature Visual Stability Assessment UT Rocky River (Smith Tract) Stream Restoration – EEP Project #402						
Reach 1 (1,095 Feet)						
Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles	100%	80%	90%			
B. Pools	100%	100%	100%			
C. Thalweg	100%	100%	100%			
D. Meanders	100%	100%	100%			
E. Bed General	100%	100%	100%			
F. Bank	100%	NA	100%			
G. Vanes/J Hooks, etc.	100%	100%	100%			
H. Wads and Boulders	NA	NA	NA			
Reach 2 (1,111 Feet)						
A. Riffles	100%	92%	83%			
B. Pools	100%	91%	65%			
C. Thalweg	100%	95%	95%			
D. Meanders	100%	96%	77%			
E. Bed General	100%	100%	99%			
F. Bank	100%	NA	98%			
F. Vanes/J Hooks, etc.	100%	100%	100%			
G. Wads and Boulders	100%	NA	NA			

Exhibit Table VIII. Baseline Morphology and Hydraulic Summary – UT Rocky River Stream Restoration– EEP Project #402 – Reach 1

Parameter	USGS Gage Data			Regional Curve Data			Pre-Existing Condition (208')			Project Reference Stream			Design (208')			As-built (208')		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																		
BF Width (ft)	NA			8.1	28.0	14.0	17.0	22.3	19.9	12.7	13.9	13.3	-	-	24.0	-	-	24.0
Floodprone width (ft)	NA			NA			95	196	153	27	45	35.3	125	155	140	125	155	140
BF Cross Sectional Area (sq. ft)	NA			13.0	50.0	25.0	31.4	36.0	34.0	11.0	12.0	11.6	38.0	53.0	38.4	-	-	34.4
BF Mean depth (ft)	NA			1.03	2.60	1.60	1.50	2.08	1.74	0.85	0.91	0.88	-	-	1.60	-	-	1.44
BF Max Depth (ft)	NA			NA			2.45	3.00	2.62	1.26	1.44	1.34	2.30	2.60	2.45	2.30	2.60	2.80
Width/Depth Ratio	NA			NA			8.17	14.87	11.75	14.50	16.35	15.15	-	-	15.00	-	-	16.60
Entrenchment Ratio	NA			NA			4.80	7.00	6.00	2.13	3.24	2.65	5.20	6.45	5.8	5.23	6.48	5.85
Bank Height Ratio	NA			NA			1.00	1.30	1.20	0.84	1.80	1.19	1.00	1.20	1.10	1.00	1.20	1.15
Wetted Perimeter (ft)	NA			NA			-			-			-	-	24.9	-	-	26.0
Hydraulic Radius (ft)	NA			NA			1.50	1.74	1.50	0.79	0.81	0.80	-	-	1.54	-	-	1.32
Pattern																		
Channel Beltwidth (ft)	NA			NA			40	80	60	15	32	22	40	70	50	40	70	50
Radius of Curvature (ft)	NA			NA			15	70	40	12	36	22	55	70	60	55	70	62
Meander Wavelength (ft)	NA			NA			65	160	112	35	58	46	100	110	105	100	110	105
Meander Width Ratio	NA			NA			2.35	3.58	3.01	1.13	2.41	1.63	1.60	2.90	2.00	1.67	2.93	2.10
Profile																		
Riffle length (ft)	NA			NA			8	45	25	5	24	16	10	60	30	7	53	24
Riffle slope (ft/ft)	NA			NA			0.003	0.036	0.015	0.0156	0.149	0.026	0.033	0.037	0.034	0.012	0.032	0.030
Pool length (ft)	NA			NA			7	46	23	5	19	19	19	55	40	19	50	36
Pool spacing (ft)	NA			NA			26	58	44	23	64	40	27	60	53	24	60	46
Substrate																		
d50 (mm)	NA			NA			-	-	37.00	-	-	3.00	-	-	36.00	10.00		
d84 (mm)	NA			NA			-	-	79.00	-	-	31.00	-	-	74.00	33.00		
Additional Reach Parameters																		
Valley Length (ft)	NA			NA			-	-	185	-	-	312	-	-	185	-	-	185
Channel Length (ft)	NA			NA			-	-	222	-	-	397	-	-	208	-	-	208
Sinuosity	NA			NA			-	-	1.20	-	-	1.27	-	-	1.12	-	-	1.12
Water Surface Slope (ft/ft)	NA			NA			-	-	0.0088	-	-	0.0078	-	-	0.0103	-	-	0.0093
BF slope (ft/ft)	NA			NA			-	-	0.0103	-	-	0.0079	-	-	0.0105	-	-	0.0105
Rosgen Classification	NA			NA			-	-	C4/E4	-	-	C4	-	-	C4	-	-	C4

*Data could not be collected for base line data directly after construction due to stream matting covering the substrate

Exhibit Table VIII. Baseline Morphology and Hydraulic Summary – UT Rocky River Stream Restoration– EEP Project #402 – Reach 2

Parameter	USGS Gage Data			Regional Curve Data			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																		
BF Width (ft)	NA			3.7	14.0	7.6	7.7	8.7	8.13	12.7	13.9	13.3	-	-	11.0	9.9	14.6	11.2
Floodprone width (ft)	NA			NA			11	12	11.33	27	45	35	100	200	144	104	200	141
BF Cross Sectional Area (sq. ft)	NA			3.4	15.0	7.5	6.0	7.0	6.7	11.0	12.0	11.6	8.2	9.2	8.2	8.0	14.9	9.9
BF Mean depth (ft)	NA			0.59	1.55	1.02	0.75	0.91	0.82	0.85	0.91	0.88	0.74	0.84	0.74	0.77	1.02	0.87
BF Max Depth (ft)	NA			NA			1.20	1.37	1.26	1.26	1.44	1.34	1.05	1.33	1.16	1.34	1.64	1.51
Width/Depth Ratio	NA			NA			8.42	10.90	10.00	14.50	16.35	15.15	13.00	16.35	15.00	11.16	14.30	12.75
Entrenchment Ratio	NA			NA			1.26	1.56	1.40	2.13	3.24	2.65	9.90	18.00	13.00	7.90	21.90	13.56
Bank Height Ratio	NA			NA			1.46	1.83	1.66	0.84	1.18	1.02	0.84	1.15	1.00	1.00	1.12	1.04
Wetted Perimeter (ft)	NA			NA			-			-			-			10.4	15.1	11.8
Hydraulic Radius (ft)	NA			NA			0.75	0.91	0.82	0.79	0.81	0.80	-			0.73	0.98	0.83
Pattern																		
Channel Beltwidth (ft)	NA			NA			13	35	20	15	32	22	13	27	18	14	35	21
Radius of Curvature (ft)	NA			NA			8	21	12	12	36	22	10	20	14	10	20	14
Meander Wavelength (ft)	NA			NA			35	85	57	35	58	46	24	65	38	24	65	37
Meander Width Ratio	NA			NA			1.60	4.30	2.46	1.13	2.41	1.63	1.13	2.41	1.63	1.30	2.70	1.98
Profile																		
Riffle length (ft)	NA			NA			4	118	23	5	24	16	4	26	10	3	26	9
Riffle slope (ft/ft)	NA			NA			0.005	0.072	0.030	0.016	0.149	0.026	0.020	0.083	0.035	0.012	0.060	0.033
Pool length (ft)	NA			NA			6	13	10	5	19	10	13	27	16	8	30	16
Pool spacing (ft)	NA			NA			14	139	40	23	64	40	17	51	28	12	63	28
Substrate																		
d50 (mm)	NA			NA			-	-	29.00	-	-	3.00	-	-	29.00	*		
d84 (mm)	NA			NA			-	-	110.00	-	-	31.00	-	-	110.00	*		
Additional Reach Parameters																		
Valley Length (ft)	NA			NA			-	-	950	-	-	312	-	-	950	-	-	950
Channel Length (ft)	NA			NA			-	-	1011	-	-	397	-	-	1165	-	-	1111
Sinuosity	NA			NA			-	-	1.06	-	-	1.27	-	-	1.23	-	-	1.20
Water Surface Slope (ft/ft)	NA			NA			-	-	0.015	-	-	0.008	0.009	0.016	0.013	-	-	-
BF slope (ft/ft)	NA			NA			-	-	0.014	-	-	0.008	0.009	0.016	0.013	0.009	0.02	0.009/ 0.014 **
Rosgen Classification	NA			NA			-	-	G4	-	-	C4	-	-	C4	-	-	C4

**Upstream/Downstream Portions
 UT Rocky River (Smith Tract) Stream Restoration
 EEP Project #402
 RJG&A

Table IX a. Morphology and Hydraulic Monitoring Summary
Smith Tract / Number 046107
Reach 1: 1095 feet

Parameter	Cross Section 1 Riffle																	
	MY1	MY2	MY3	MY4	MY5	MY+												
Dimension																		
BF Width (ft)	18.2	25.3																
Floodprone Width (ft)	158	157																
BF Cross Sectional Area (sq.ft)	27.8	33.9																
BF Mean Depth (ft)	1.53	1.34																
BF Max Depth (ft)	2.48	2.90																
Width/Depth Ratio	11.89	18.81																
Entrenchment Ratio	8.44	6.20																
Bank Height Ratio	1.25	1.31																
Wetted Perimeter (ft)	19.1	26.4																
Hydraulic Radius (ft)	1.46	1.29																
Substrate																		
d50 (mm)	10.00	11.30																
d84 (mm)	33.00	59.25																

Parameter	MY-01 (2007)			MY-02 (2008)			MY-03 (2009)			MY-04 (2010)			MY-05 (2011)			MY-06 (2012)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	27	58	39	6	24	13												
Radius of Curvature (ft)	21	65	39	27	70	32												
Meander Wavelength (ft)	63	104	84			176												
Meander Width Ratio	1.23	2.04	1.63			1.15												
Profile																		
Riffle length (ft)	4	18	7	8	26	14												
Riffle slope (ft/ft)	0.020	0.040	0.034	-0.020	0.030	0.010												
Pool length (ft)	13	18	14	19	37	27												
Pool spacing (ft)	17	36	22	11	26	16												
Additional Reach parameters				**For the surveyed section only														
Valley Length (ft)	1060			245														
Channel Length (ft)	1139			266														
Sinuosity	1.07			1.08														
Water Surface Slope (ft/ft)	*			0.0130														
BF Slope (ft/ft)	0.0093			0.0055														
Rosgen Classification	C4			C4														

* No Data - Stream was dry at time of survey

Table IX b. Morphology and Hydraulic Monitoring Summary
Smith Tract / Number 046107
Reach 2: 1111 feet

Parameter	Cross Section 1 Riffle						Cross Section 2 Pool						Cross Section 3 Riffle					
	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Dimension																		
BF Width (ft)	13.2	15.0					9.9	13.2					9.2	10.3				
Floodprone Width (ft)	104	104					112	112					200	200				
BF Cross Sectional Area (sq.ft)	12.6	14.8					8.6	9.8					7.2	8.2				
BF Mean Depth (ft)	0.95	0.98					0.87	0.74					0.78	80.00				
BF Max Depth (ft)	1.59	1.83					1.35	1.63					1.30	1.55				
Width/Depth Ratio	13.81	15.28					11.45	17.70					11.72	12.94				
Entrenchment Ratio	7.90	6.90					11.27	8.50					21.85	19.40				
Bank Height Ratio	2.13	1.28					1.26	1.07					1.15	1.13				
Wetted Perimeter (ft)	13.7	15.6					10.5	13.8					9.7	11.0				
Hydraulic Radius (ft)	0.92	0.95					0.82	0.71					0.74	0.75				
Substrate																		
d50 (mm)	22.00	0.04					0.18	0.04					0.25	0.04				
d84 (mm)	110.00	90.00					11.00	1.67					11.00	0.06				
Parameter	MY-01 (2007)			MY-02 (2008)			MY-03 (2009)			MY-04 (2010)			MY-05 (2011)			MY-06 (2012)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	13	27	18	6	24	13												
Radius of Curvature (ft)	10	30	18	8	33	11												
Meander Wavelength (ft)	29	48	38	28	64	46												
Meander Width Ratio	1.13	2.41	1.63			3.72												
Profile																		
Riffle length (ft)	3	26	10	4	45	13												
Riffle slope (ft/ft)	-0.020	0.060	0.030	-0.017	0.098	0.029												
Pool length (ft)	7	29	14	8	31	16												
Pool spacing (ft)	12	47	26	0	89	22												
Additional Reach parameters																		
Valley Length (ft)	950			950														
Channel Length (ft)	1200			1111														
Sinuosity	1.26			1.17														
Water Surface Slope (ft/ft)	*			*														
BF Slope (ft/ft)	0.009 / 0.014**			0.014***														
Rosgen Classification	C4			C														

*No water in the channel at the time of the survey; **Upper portion of reach2/Lower portion of reach 2; *** I don't know where they broke the stream btwn "upper" and "lower" portions.

Table IX b. Morphology and Hydraulic Monitoring Summary (cont.)												
Smith Tract / Number 046107												
Reach 2: 1090 feet												
Parameter	Cross Section 4 Pool						Cross Section 5 Riffle					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	11.0	10.9					10.6	13.1				
Floodprone Width (ft)	160	160					130	130				
BF Cross Sectional Area (sq.ft)	11.0	10.9					10.3	11.3				
BF Mean Depth (ft)	1.00	1.00					0.97	0.86				
BF Max Depth (ft)	1.77	1.75					1.83	1.98				
Width/Depth Ratio	10.95	10.91					10.96	15.18				
Entrenchment Ratio	14.55	14.68					12.22	9.90				
Bank Height Ratio	1.46	1.01					0.61	1.20				
Wetted Perimeter (ft)	11.8	11.6					11.6	8.8				
Hydraulic Radius (ft)	0.93	0.94					0.89	0.98				
Substrate												
d50 (mm)	0.20	0.04					0.23	39.80				
d84 (mm)	16.00	0.06					90.00	120.90				

Parameter	MY+ (2013)			MY+ (2014)			MY+ (2015)			MY+ (2016)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)												
Radius of Curvature (ft)												
Meander Wavelength (ft)												
Meander Width Ratio												
Profile												
Riffle length (ft)												
Riffle slope (ft/ft)												
Pool length (ft)												
Pool spacing (ft)												
Additional Reach parameters												
Valley Length (ft)												
Channel Length (ft)												
Sinuosity												
Water Surface Slope (ft/ft)												
BF Slope (ft/ft)												
Rosgen Classification												

IV. Methodology

Monitoring methodologies follow the current EEP-provided templates and guidelines (Lee *et al* 2006). Photographs were taken digitally. A Trimble Geo XT handheld mapping-grade unit was used to collect cross section, vegetation corner, photopoint, and problem area locations. All problem areas identified on the spring 2008 versions of the CCPV were re-evaluated.

4.1. Stream Methodology

Methods employed were a combination those specified in the Mitigation Plan, the First Annual Monitoring Report, and standard regulatory guidance and procedures documents. Stream monitoring data was collected using the techniques described in US ACE Stream Mitigation Guidelines, US Forest Service's Stream Channel Reference Sites, and Applied River morphology (USACE, 2003; Harrelson et al., 1994; Rosgen, 1996). A South Total Station and Nikon automatic level were used for collecting all geomorphic data. Photographs facing upstream were taken at each cross section.

4.2. Vegetation Methodology

A total of six representative vegetation survey plots were selected and installed in the Reaches 1 and 2 by Ward Engineering in 2007. All plots measure 100 square meters in area and are five meters by 20 meters. Pursuant to the guidelines, the four corners of each plot (e.g. 0,0; 0,10; 10,0; and 10,10; or 0,0; 0,20; 5,0; and 5,20.) are marked with metal pipe.

Level 1 (planted woody stems) and Level 2 (volunteer woody stems) data collection was performed in all plots, pursuant to the most recent CVS/EEP protocol (Lee *et al* 2006). Within each plot, each planted woody stem location (x and y) was recorded, and height and live stem diameter were recorded for each stem location. All planted stems were identified with pink flagging. Vegetation was identified using Weakley (Weakley 2007). Photos were taken of each vegetation plot from the 0,0 corner.

Tables 1 through 5 in Appendix A contain the data from the vegetation monitoring. Monitoring plot photos can also be found in Appendix A.

References

- Harrelson, Cheryl, C. L. Rawlins, and John Potpondy. (1994). *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*. USDA, Forest Service. General Technical Report RM-245.
- Lee, Michael T., Peet, Robert K., Roberts, Steven D., Wentworth, Thomas R. (2006). *CVS-EEP Protocol for Recording Vegetation Version 4.0*. Retrieved October 30, 2006, from: <http://www.nceep.net/business/monitoring/veg/datasheets.htm>.
- Radford, A.E., H.E. Ahles, and C.R. Bell (1968). *Manual of the Vascular Flora of the Carolinas*. University of North Carolina Press. Chapel Hill, NC.
- Rosgen, D L. (1996) *Applied River Morphology*. Wildland Hydrology Books, Pagosa Springs, CO.
- Rosgen, DL. (1997). "A Geomorphological Approach to Restoration of Incised Rivers. In *Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision*, ed. S.S.Y. Wang, E.J. Langendoen and F.B. Shields, Jr. University of Mississippi Press, Oxford, MS.
- USACOE (2003) *Stream Mitigation Guidelines*. USACOE, USEPA, NCWRC, NCDENR-DWQ
- Ward Consulting Engineering (2007). *UT to Rocky River (Smith Tract) Stream and Buffer Restoration, Enhancement, and Preservation, Chatham County, North Carolina Mitigation Report*. March 20, 2007.
- Ward Consulting Engineering (2008). *UT to Rocky River (Smith Tract) Stream and Buffer Restoration, Enhancement, and Preservation, Chatham County, North Carolina Final Monitoring Report*. February 15, 2008.
- Weakley, Alan (2007). *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas*. Retrieved March 27, 2007 from: <http://www.herbarium.unc.edu/flora.htm>.

Appendix A. Vegetation Data
UT Rocky River (Smith Tract) Stream Restoration – Project #402

Table A1. Vegetation Data Tables

Table 1. Vegetation Metadata

Table 2. Vegetation Vigor by Species

Table 3. Vegetation Damage by Species

Table 4. Vegetation Damage by Plot

Table 5. Stem Count by Plot and Species

Table 6. Vegetation Problem Areas

Table A2. Vegetation Problem Area Photos

Table A3. Vegetation Monitoring Plot Photos

Appendix A.1.

Table 1. Vegetation Metadata - UT Rocky River (Smith Tract) Stream Restoration – EEP Project #402

Report Prepared By Sean Doig

Date Prepared

10/29/2008 8:57

database name project402-2008vmd-cvs-eeep-entrytool-v2.2.5.mdb

database location D:

computer name

DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----

Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.

PROJECT SUMMARY-----

Project Code	402
project Name	UT Rocky River Smith Tract
Description	Stream restoration, enhancement and preservation
River Basin	Cape Fear
length(ft)	Reach 1: 1,095 ; Reach 2: 1,111
stream-to-edge width (ft)	Reach 1: 25' - 64'; Reach 2: 0' - 125'
area (sq m)	Reach 1: 3,830; Reach 2: 4,660
Required Plots (calculated)	6
Sampled Plots	6

Appendix A.1.

Table 2. Vigor by Species- UT Rocky River (Smith Tract) Stream Restoration – EEP Project #402

	Species	4	3	2	1	0	Missing	Unknown
	<i>Alnus serrulata</i>	4					3	
	<i>Betula nigra</i>	8	1				2	
	<i>Carya cordiformis</i>	2	3	2		3	11	
	<i>Celtis laevigata</i>	4	2	1	1		4	
	<i>Fraxinus pennsylvanica</i>	12		1			4	
	<i>Ilex verticillata</i>	2	2			1	1	
	<i>Nyssa sylvatica</i>	1	1			1	3	
	<i>Quercus alba</i>	4		1		2		
	<i>Quercus pagoda</i>	4				2	2	
	<i>Quercus phellos</i>	5				1	4	
	<i>Sambucus canadensis</i>	3	2				1	
	<i>Viburnum nudum</i>		2					
	<i>Quercus rubra</i>		2			2		
	<i>Lindera benzoin</i>	2	2				3	
	<i>Liriodendron tulipifera</i>	2				3	6	
	<i>Platanus occidentalis</i>	4	1					
	<i>Ulmus americana</i>	6		1				
TOT:	17	63	18	6	1	15	44	

Appendix A.1.

Table 3. Damage by Species- UT Rocky River (Smith Tract) Stream Restoration – EEP Project #402

Species	All Damage Categories	(no damage)	Human Trampled	Insects
Alnus serrulata	7	7		
Betula nigra	11	11		
Carya cordiformis	21	21		
Celtis laevigata	12	12		
Fraxinus pennsylvanica	17	16		1
Ilex verticillata	6	6		
Lindera benzoin	7	7		
Liriodendron tulipifera	11	11		
Nyssa sylvatica	6	6		
Platanus occidentalis	5	5		
Quercus alba	7	6	1	
Quercus pagoda	8	8		
Quercus phellos	10	10		
Quercus rubra	4	3	1	
Sambucus canadensis	6	6		
Ulmus americana	7	7		
Viburnum nudum	2	2		
TOT: 17	147	144	2	1

Appendix A.1.

Table 4. Damage by Plot- UT Rocky River (Smith Tract) Stream Restoration – EEP Project #402

	<i>plot</i>	<i>All Damage Categories</i>	<i>(no damage)</i>	<i>Human Trampled</i>	<i>Insects</i>
	402-01-0001-year:2	18	17		1
	402-01-0002-year:2	21	21		
	402-01-0003-year:2	22	20	2	
	402-01-0004-year:2	34	34		
	402-01-0005-year:2	23	23		
	402-01-0006-year:2	29	29		
TOT:	6	147	144	2	1

Appendix A.1.

Table 5. Planted Stems by Plot and Species- UT Rocky River (Smith Tract) Stream Restoration – EEP Project #402

Species	Total Planted Stems			Plot					
	# plots	avg# stems		402-01-0001-year:2	402-01-0002-year:2	402-01-0003-year:2	402-01-0004-year:2	402-01-0005-year:2	402-01-0006-year:2
Alnus serrulata	4	2	2				1		3
Betula nigra	9	2	4.5				4	5	
Carya cordiformis	7	4	1.75	1	2	1			3
Celtis laevigata	8	3	2.67	3	1		4		
Fraxinus pennsylvanica	13	5	2.6	1	1		5	5	1
Ilex verticillata	4	2	2				1		3
Lindera benzoin	4	2	2				2		2
Liriodendron tulipifera	2	2	1		1			1	
Nyssa sylvatica	2	1	2		2				
Platanus occidentalis	5	3	1.67	2				2	1
Quercus alba	5	1	5			5			
Quercus pagoda	4	2	2				2	2	
Quercus phellos	5	3	1.67	1				3	1
Quercus rubra	2	1	2		2				
Sambucus canadensis	5	2	2.5				1		4
Ulmus americana	7	3	2.33				4	1	2
Viburnum nudum	2	1	2						2
TOT:	17	88	17	7	4	11	25	19	22

A.1. Table 6. 2008 Vegetation Problem Areas – Rocky River Stream Restoration – NCEEP #402

Problem	Station	Suspected Cause	Photo
Reach 1			
Non-native species (<i>Microstegium vimineum</i>)	175-235	Wet floodplain soils in the less shady areas	VP1
Bare soil on floodplain	300-325	Area of compacted soil near stream	VP2
Non-native species (<i>Microstegium vimineum</i>)	400-625	Wet floodplain soils in the less shady areas	VP1
Non-native species (<i>Microstegium vimineum</i>)	735-1010	Wet floodplain soils in the less shady areas	VP1
Reach 2			
Low planted stem density	75-125	Area on terrace, less contact with water table during drought	
Bare soil	100-120	Area of compacted soil near stream	VP2
Low planted stem density	100-130	Area on terrace, less contact with water table during drought	

A2. Vegetation Problem Area Photographs - 2008 - Rocky River Stream Restoration



VP1. *Microstegium vimineum* (10/23/08)



VP2. Bare soil on floodplain(10/23/08)



VP3. Low planted stem density(10/23/08)

Appendix A.3. Vegetation Monitoring Plot Photos

A.3. Vegetation Monitoring Plot Photographs - Year 2 - 2008 - UT Rocky River Stream Restoration (EEP Project #402)



Plot 1 (10/16/08)



Plot 2 (11/11/08)



Plot 3 (10/23/08)



Plot 4 (10/17/08)

Appendix A.3. Vegetation Monitoring Plot Photos

A.3. Vegetation Monitoring Plot Photographs - Year 2 - 2008 - UT Rocky River Stream Restoration (EEP Project #402)



Plot 5 (10/23/08)

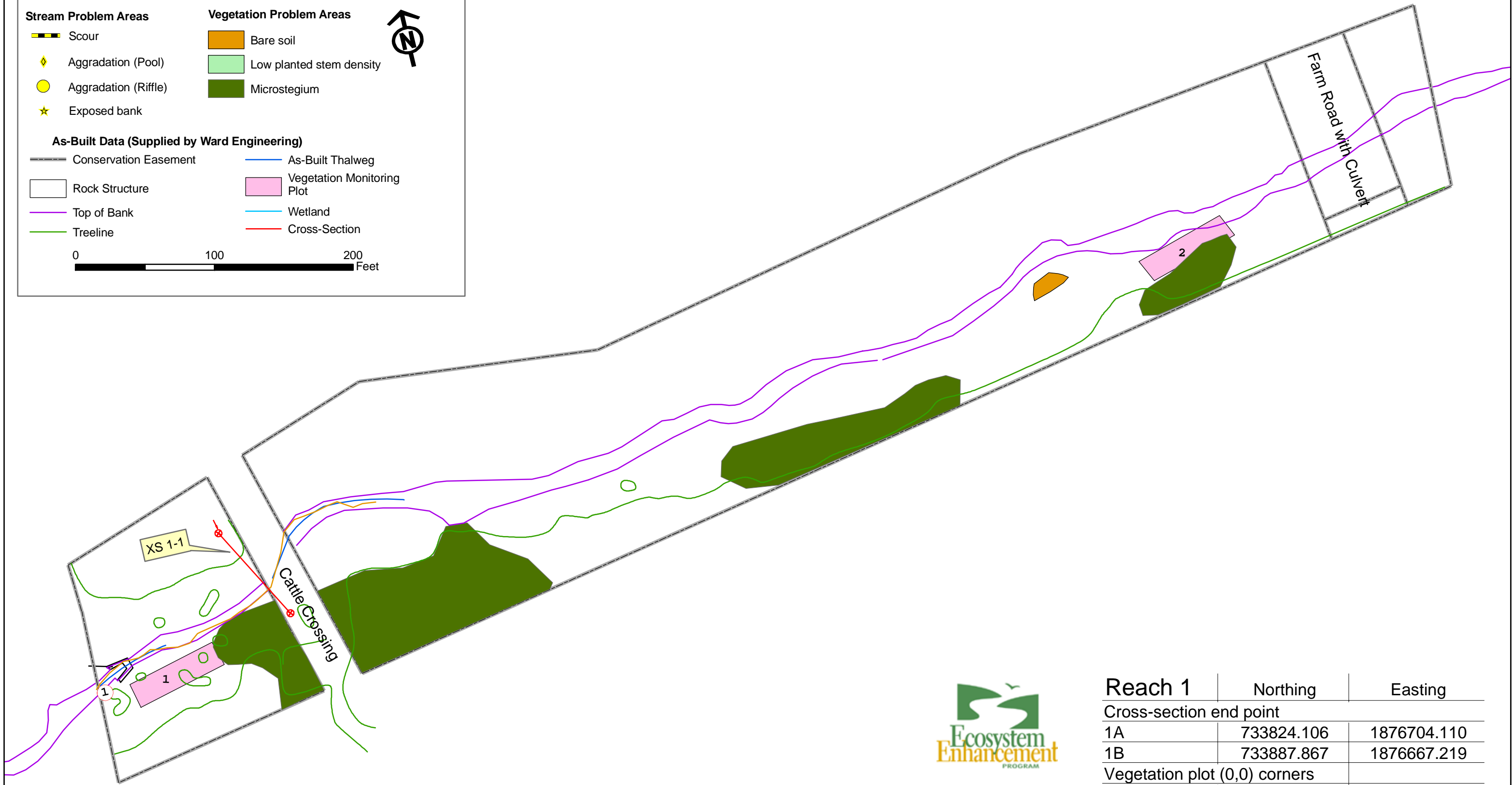
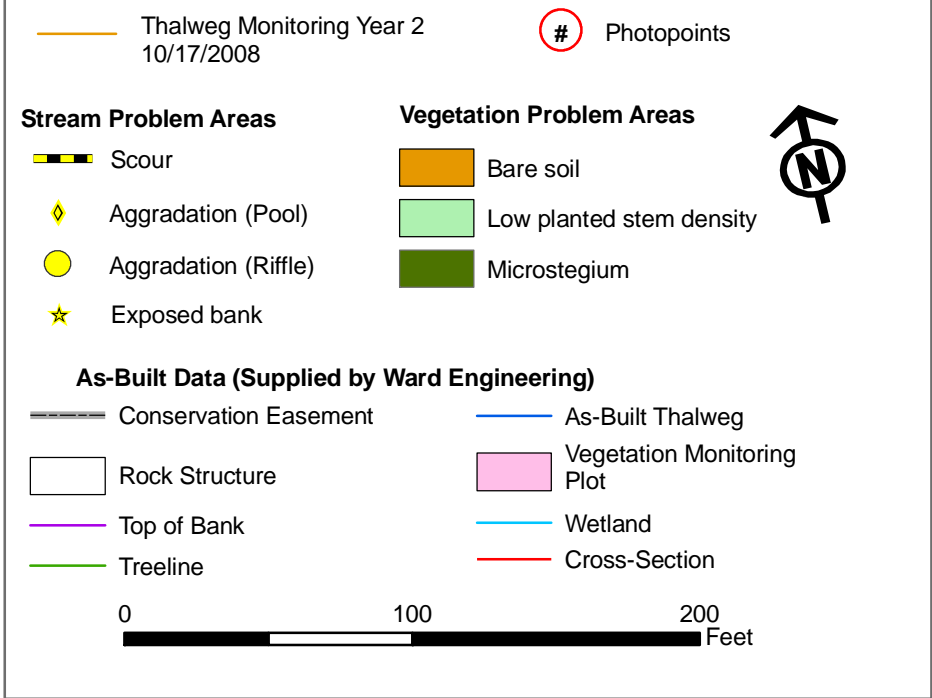


Plot 6 (10/23/08)

Appendix B. Stream Data
UT Rocky River (Smith Tract) Stream Restoration – Project #402

- B.1. Stream Current Condition Plan View
- B.2. Stream Problem Areas
- B.3. Stream Problem Area Photos
- B.4. Stream Photo-station Photos
- B.5. Table B2. Qualitative Visual Stability Assessment
- B.6. Cross section Plots
- B.7. Longitudinal Plots
- B.8. Pebble Count Frequency Distribution Plot

Figure B.1.2. Current Conditions Plan View. Rocky River (Reach 2) - 2008 Chatham County, NC - EEP Project #402



Reach 1	Northing	Easting
Cross-section end point		
1A	733824.106	1876704.110
1B	733887.867	1876667.219
Vegetation plot (0,0) corners		
1	733921.773	1877367.424
2	733786.687	1876587.837

Figure B.1.2. Current Conditions Plan View. Rocky River (Reach 2) - 2008 Chatham County, NC - EEP Project #402



Thalweg Monitoring Year 2
10/17/2008

Photopoints

Stream Problem Areas

- Scour
- Aggradation (Pool)
- Aggradation (Riffle)
- Exposed bank

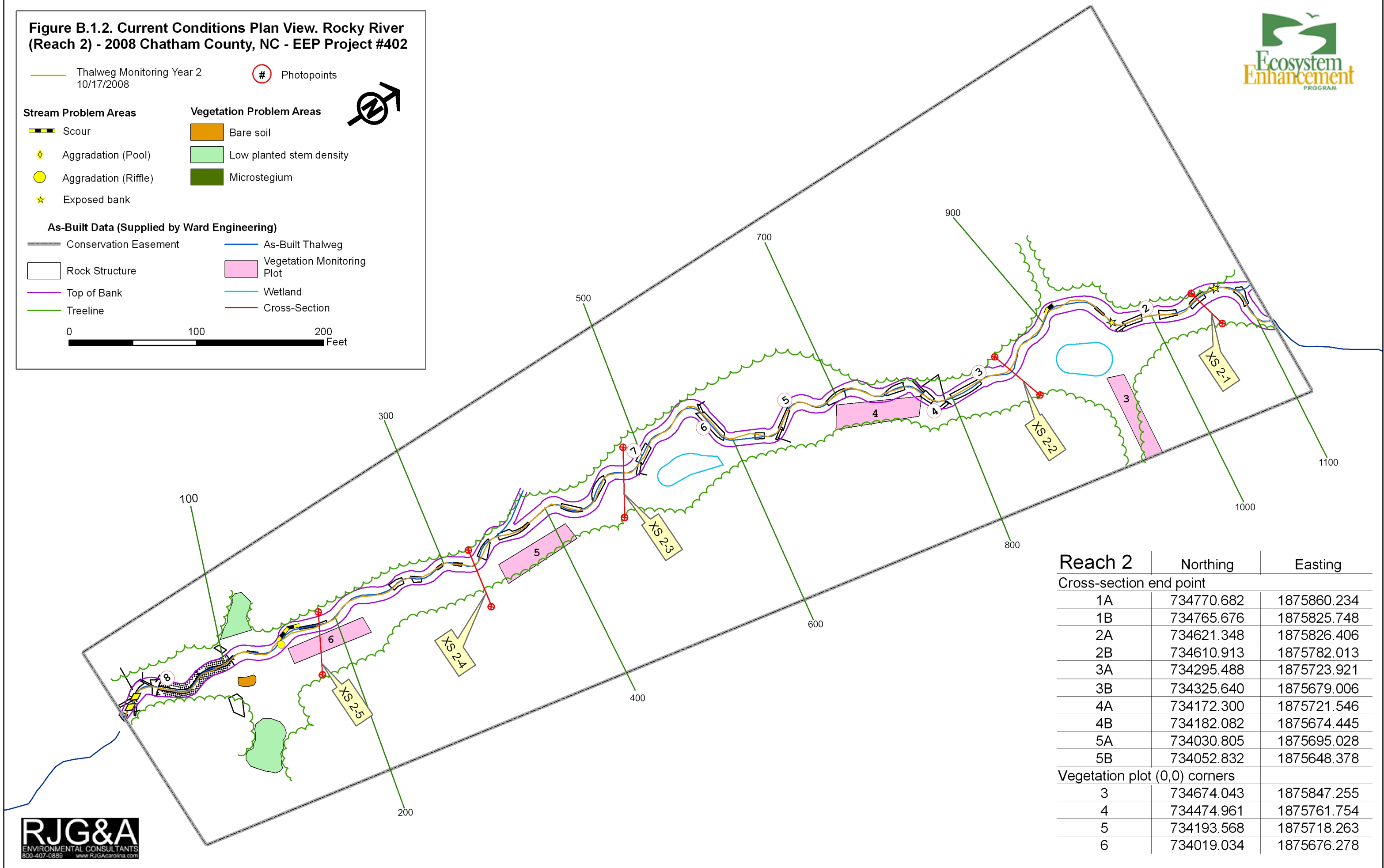
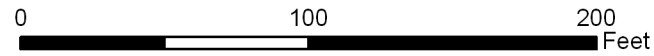
Vegetation Problem Areas

- Bare soil
- Low planted stem density
- Microstegium



As-Built Data (Supplied by Ward Engineering)

- Conservation Easement
- Rock Structure
- Top of Bank
- Treeline
- As-Built Thalweg
- Vegetation Monitoring Plot
- Wetland
- Cross-Section



Reach 2	Northing	Easting
Cross-section end point		
1A	734770.682	1875860.234
1B	734765.676	1875825.748
2A	734621.348	1875826.406
2B	734610.913	1875782.013
3A	734295.488	1875723.921
3B	734325.640	1875679.006
4A	734172.300	1875721.546
4B	734182.082	1875674.445
5A	734030.805	1875695.028
5B	734052.832	1875648.378
Vegetation plot (0,0) corners		
3	734674.043	1875847.255
4	734474.961	1875761.754
5	734193.568	1875718.263
6	734019.034	1875676.278

Appendix B.2. Stream Problem Areas Table - Year 2 - 2008 - UT Rocky River Stream Restoration (EEP Project #402)

Feature/Issue	Station	Suspected Cause	Photo #
Reach 1			
No problem areas in fall 2008			
Reach 2			
Aggradation (Pool)	15-18	Above and below last structure, deposition due to previously existing pipe restriction	SP2
Bank Scour	147-165	Un-armored bank	SP4 & SP5
Bank Scour	910-918	Un-armored bank	SP4 & SP5
Exposed Bank	968	Loss of vegetation and resulting erosion	SP6
Exposed Bank	1057	Loss of vegetation and resulting erosion	SP6

B.3. Representative Stream Problem Photos - Year 2 - 2008 - UT Rocky River Stream Restoration (EEP Project #402)



SP2 - Aggradation below Cross Vane, Reach 2 (10/23/08)



SP4 - Scour, Reach 2 (10/23/08)

B.3. Representative Stream Problem Photos - Year 2 - 2008 - UT Rocky River Stream Restoration (EEP Project #402)



SP5 - Scour, Reach 2 (10/23/08)



SP6 - Exposed Bank, Reach 2 (10/23/08)

Appendix B.4. 2008 Stream Photo-station Photos - Rocky River Stream Restoration #402



PP #1 - Reach 1 - (05/14/08)



PP #2 - Reach 2 - (05/14/08)



PP #3 - Reach 2 - (05/14/08)



PP #4 - Reach 2 - (05/14/08)

Appendix B.4. 2008 Stream Photo-station Photos - Rocky River Stream Restoration #402



PP #5 - Reach 2 - (05/14/08)



PP #6 - Reach 2 - (05/14/08)



PP #7 - Reach 2 - (05/14/08)



PP #8 - Reach 2 - (05/14/08)

B.1. a. Visual Morphological Stability Assessment

Smith Tract / Number 046107

Reach 1: 1095 feet (reconstructed channel: sta. 8+87 to 10+95)

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature perform Mean or Total
A. Riffles	1. Present?	4	4	NA	100	
	2. Armor stable (e.g.no displacement?)	4	4	NA	100	
	3. Facet grade appears stable?	3	4	NA	75	
	4. Minimal evidence of embedding/fining?	4	4	NA	100	
	5. Length appropriate?	3	4	NA	75	90%
B. Pools	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	3	3	NA	100	
	2. Sufficiently deep (Max. Pool D:Mean Bkf>1.6?)	3	3	NA	100	
	3. Length appropriate?	3	3	NA	100	100%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	3	3	NA	100	
	2. Downstream of meander (glide/inflection) centering?	3	3	NA	100	100%
D. Meanders	1. Outer bend in state of limited/controlled erosion?	3	3	NA	100	
	2. Of those eroding, # w/concomitant point bar formation?	3	3	NA	100	
	3. apparent Rc within spec?	3	3	NA	100	
	4. Sufficient floodplain access and relief?	3	3	NA	100	100%
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	NA	NA	
	2. Channel bed degradation-areas of increasing downcutting of head cutting?	NA	NA	NA	NA	100%
F. Bank	1. Actively eroding, wasting, or slumping bank	NA	NA	NA	100	100%
F. Vanes	1. Free of back or arm scour?	1	1	NA	100	
	2. Height appropriate?	1	1	NA	100	
	3. Angle and geometry appear appropriate?	1	1	NA	100	
	4. Free of piping or other structural failures?	1	1	NA	100	100%
G. Wads/ Boulders	1. Free of scour?	NA	NA	NA	NA	
	2. Footing stable?	NA	NA	NA	NA	NA

**B.2. b. Visual Morphological Stability Assessment
Smith Tract / Number 046107
Reach 2: 1111 feet**

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature perform Mean or Total
A. Riffles	1. Present?	35	41	NA	85	
	2. Armor stable (e.g.no displacement?)	35	41	NA	85	
	3. Facet grade appears stable?	35	41	NA	85	
	4. Minimal evidence of embedding/fining?	35	41	NA	85	
	5. Length appropriate?	31	41	NA	76	83%
B. Pools	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	28	42	NA	67	
	2. Sufficiently deep (Max. Pool D:Mean Bkf>1.6?)	28	42	NA	67	
	3. Length appropriate?	26	42	NA	62	65%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	38	41	NA	93	
	2. Downstream of meander (glide/inflection) centering?	40	41	NA	98	95%
D. Meanders	1. Outer bend in state of limited/controlled erosion?	38	42	NA	90	
	2. Of those eroding, # w/concomitant point bar formation?	1	4	NA	25	
	3. apparent Rc within spec?	42	42	NA	100	
	4. Sufficient floodplain access and relief?	39	42	NA	93	77%
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	1/15	98	
	2. Channel bed degradation-areas of increasing downcutting or head cutting?	NA	NA	0/0	100	99%
F. Bank	1. Actively eroding, wasting, or slumping bank	NA	NA	2/25	98	98%
F. Vanes	1. Free of back or arm scour?	8	8	NA	100	
	2. Height appropriate?	8	8	NA	100	
	3. Angle and geometry appear appropriate?	8	8	NA	100	
	4. Free of piping or other structural failures?	8	8	NA	100	100%
G. Wads/ Boulders	1. Free of scour?	NA	NA	NA	NA	
	2. Footing stable?	NA	NA	NA	NA	NA

B6. Cross Section Plots, Photos, and Raw Data Tables - Year 2 - 2008 - Rocky River Stream Restoration

River Basin: Cape Fear
 Watershed: UT Rocky River
 XS ID: Reach 1, XS-1
 Reach: 1
 Date: 10/16/2008
 Field Crew: J.O. and S.D.

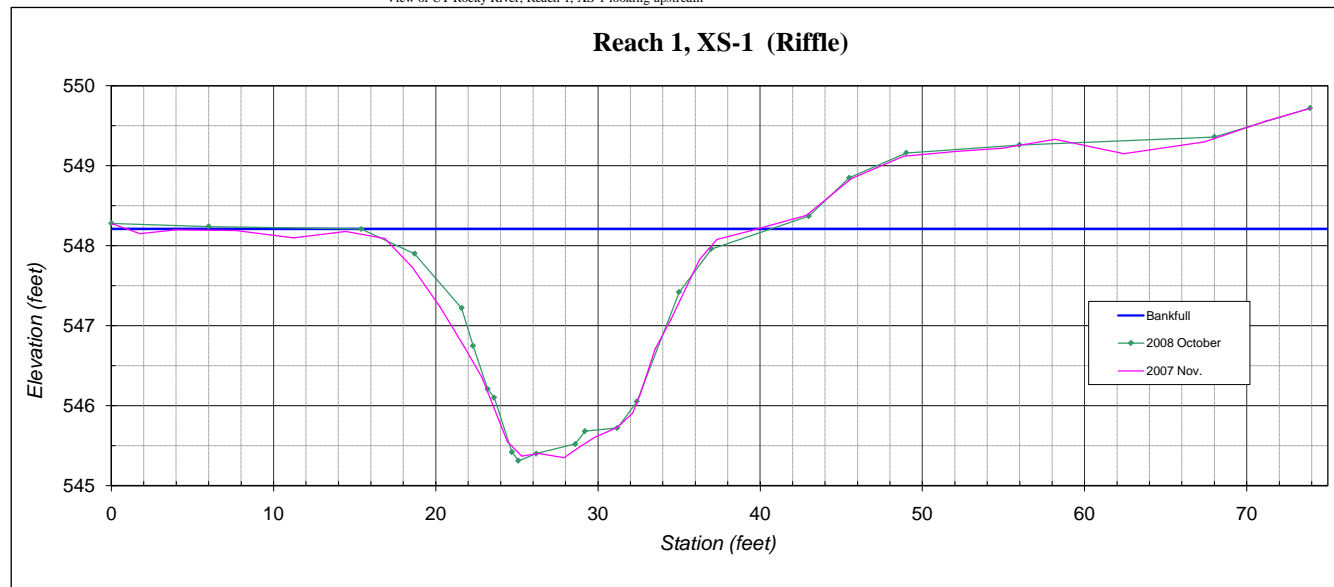
Station	Elevation
0	548.28
6	548.24
15.4	548.21
18.7	547.9
21.6	547.22
22.3	546.75
23.2	546.21
23.6	546.1
24.7	545.42
25.1	545.31
26.2	545.4
28.6	545.52
29.2	545.68
31.2	545.72
32.4	546.05
35	547.42
37	547.96
43	548.37
45.5	548.85
49	549.16
56	549.26
68	549.36
73.9	549.72

SUMMARY DATA
 Floodprone Elevation (ft) 551.11
 Bankfull Elevation (ft) 548.21
 Floodprone Width (ft) 157.00
 Bankfull Width (ft) 25.26
 Entrenchment Ratio 6.20
 Mean Depth (ft) 1.34
 Maximum Depth (ft) 2.90
 Width/Depth Ratio 18.81
 Bankfull Area (sq ft) 33.91
 Wetted Perimeter (ft) 26.36
 Hydraulic Radius (ft) 1.29

Stream Type: C



View of UT Rocky River, Reach 1, XS-1 looking upstream



B6. Cross Section Plots, Photos, and Raw Data Tables - Year 2 - 2008 - Rocky River Stream Restoration

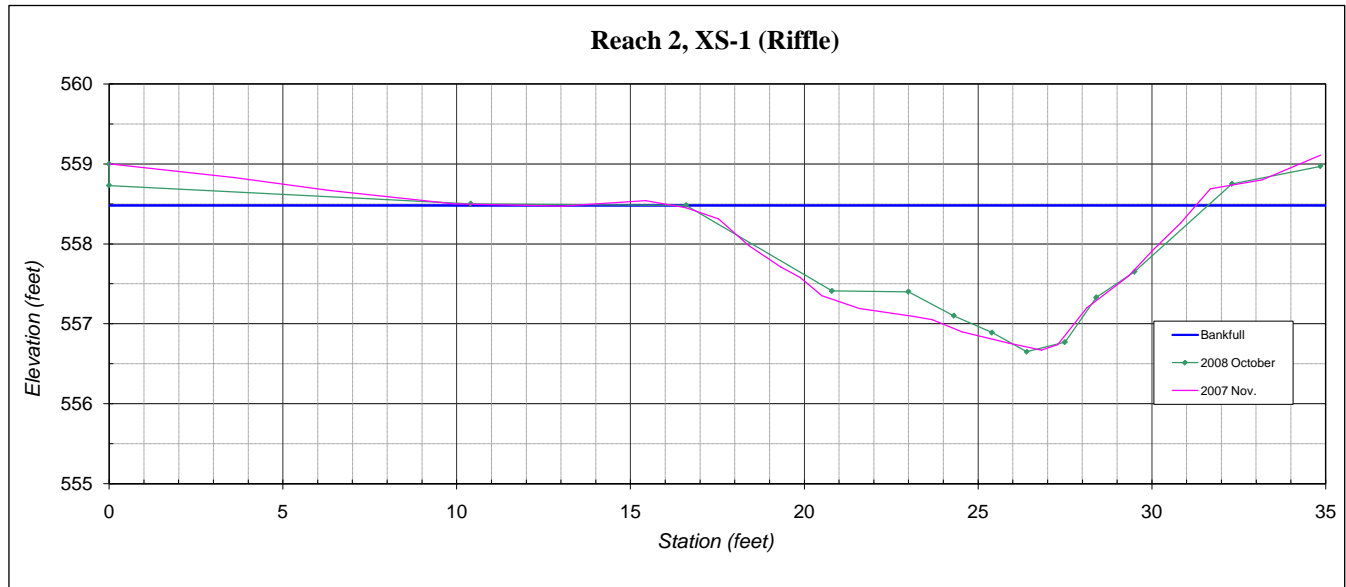
River Basin: Cape Fear
 Watershed: UT Rocky River
 XS ID: Reach 2, XS-1
 Reach: 2
 Date: 10/17/2008
 Field Crew: J.O. and A.W.

Station	Rod Ht.	Elevation
0	4.4	559.00
0	4.67	558.73
10.4	4.9	558.50
16.6	4.92	558.48
20.8	5.99	557.41
23	6	557.40
24.3	6.3	557.10
25.4	6.51	556.89
26.4	6.75	556.65
27.5	6.63	556.77
28.4	6.07	557.33
29.5	5.75	557.65
32.3	4.65	558.75
34.85	4.43	558.97

SUMMARY DATA
 Floodprone Elevation (ft) 560.31
 Bankfull Elevation (ft) 558.48
 Floodprone Width (ft) 104.00
 Bankfull Width (ft) 15.01
 Entrenchment Ratio 6.93
 Mean Depth (ft) 0.98
 Maximum Depth (ft) 1.83
 Width/Depth Ratio 15.28
 Bankfull Area (sq ft) 14.75
 Wetted Perimeter (ft) 15.60
 Hydraulic Radius (ft) 0.95

Stream Type: C

photo out of focus



B6. Cross Section Plots, Photos, and Raw Data Tables - Year 2 - 2008 - Rocky River Stream Restoration

River Basin: Cape Fear
 Watershed: UT Rocky River
 XS ID: Reach 2, XS-2
 Reach: 2
 Date: 10/17/2008
 Field Crew: J.O. and A.W.

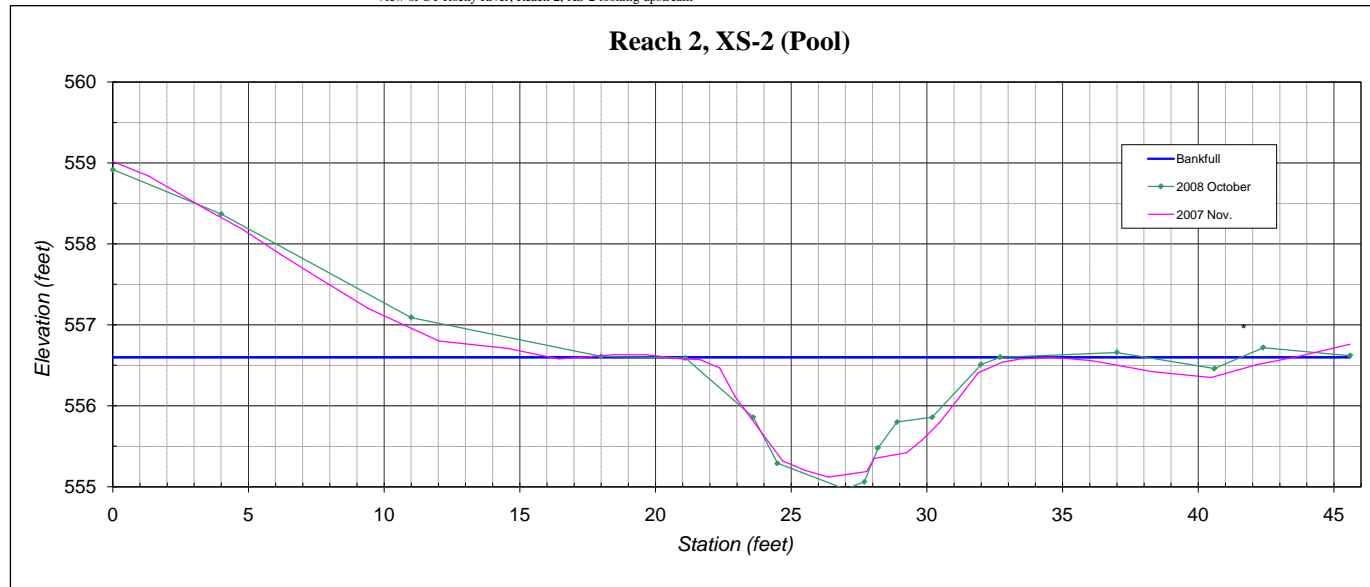
Station	Rod Ht.	Elevation
0	2.64	558.92
4	3.19	558.37
11	4.47	557.09
18	4.95	556.61
21.1	4.97	556.59
23.6	5.7	555.86
24.5	6.27	555.29
27	6.59	554.97
27.7	6.5	555.06
28.2	6.08	555.48
28.9	5.76	555.80
30.2	5.7	555.86
32	5.05	556.51
32.7	4.96	556.60
37	4.9	556.66
40.6	5.1	556.46
42.4	4.84	556.72
45.6	4.94	556.62

SUMMARY DATA
 Floodprone Elevation (ft) 558.23
 Bankfull Elevation (ft) 556.60
 Floodprone Width (ft) 112.00
 Bankfull Width (ft) 13.15
 Entrenchment Ratio 8.52
 Mean Depth (ft) 74.00
 Maximum Depth (ft) 1.63
 Width/Depth Ratio 17.70
 Bankfull Area (sq ft) 9.77
 Wetted Perimeter (ft) 13.79
 Hydraulic Radius (ft) 0.71

Stream Type: C



View of UT Rocky River, Reach 2, XS-2 looking upstream



B6. Cross Section Plots, Photos, and Raw Data Tables - Year 2 - 2008 - Rocky River Stream Restoration

River Basin: Cape Fear
 Watershed: UT Rocky River
 XS ID: Reach 2, XS-3
 Reach: 2
 Date: 10/17/2008
 Field Crew: J.O. and A.W.

Station	Rod Ht.	Elevation
0	4.43	552.38
9.4	4.81	552.00
20.5	5.25	551.56
26.2	5.4	551.41
28	5.27	551.54
29.6	5.26	551.55
30.4	5.3	551.51
31	5.84	550.97
32.7	6.28	550.53
33.6	6.81	550.00
35.4	6.66	550.15
36.4	6.28	550.53
37.5	5.76	551.05
38.7	5.67	551.14
40.5	5.06	551.75
44.8	5.09	551.72
50.2	5.1	551.71
54.1	4.95	551.86

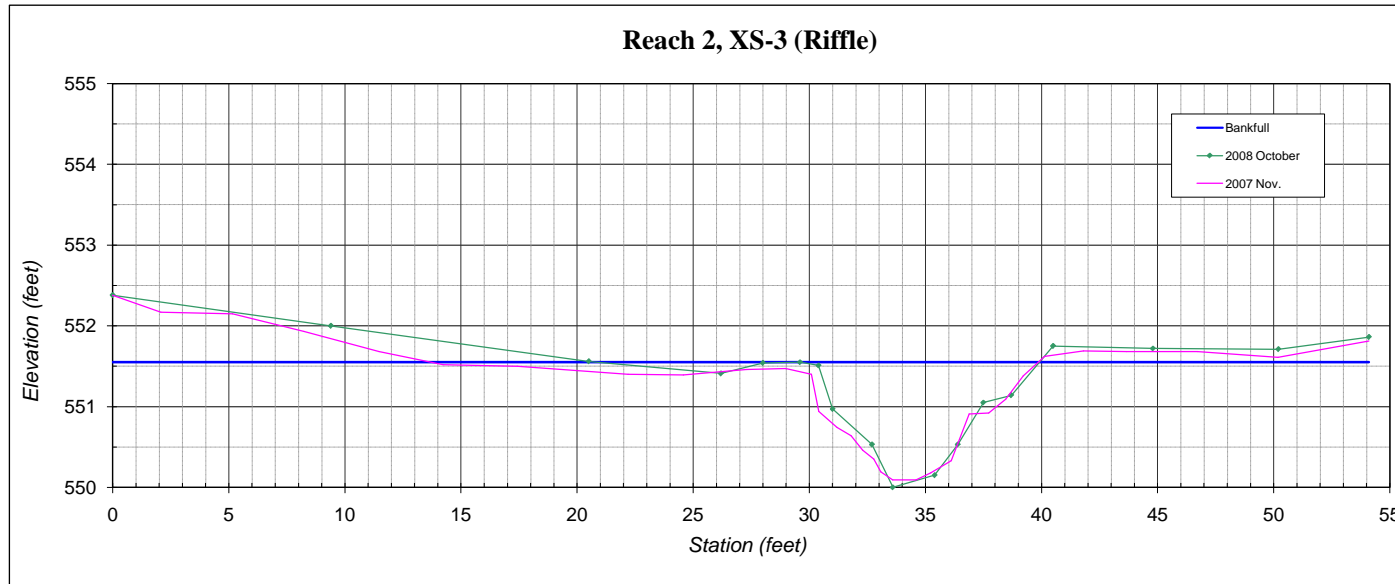
SUMMARY DATA

Floodprone Elevation (ft)	553.10
Bankfull Elevation (ft)	551.55
Floodprone Width (ft)	200.00
Bankfull Width (ft)	10.31
Entrenchment Ratio	19.40
Mean Depth (ft)	0.80
Maximum Depth (ft)	1.55
Width/Depth Ratio	12.94
Bankfull Area (sq ft)	8.21
Wetted Perimeter (ft)	10.98
Hydraulic Radius (ft)	0.75

Stream Type: C



View of UT Rocky River, Reach 2, XS-3 looking upstream



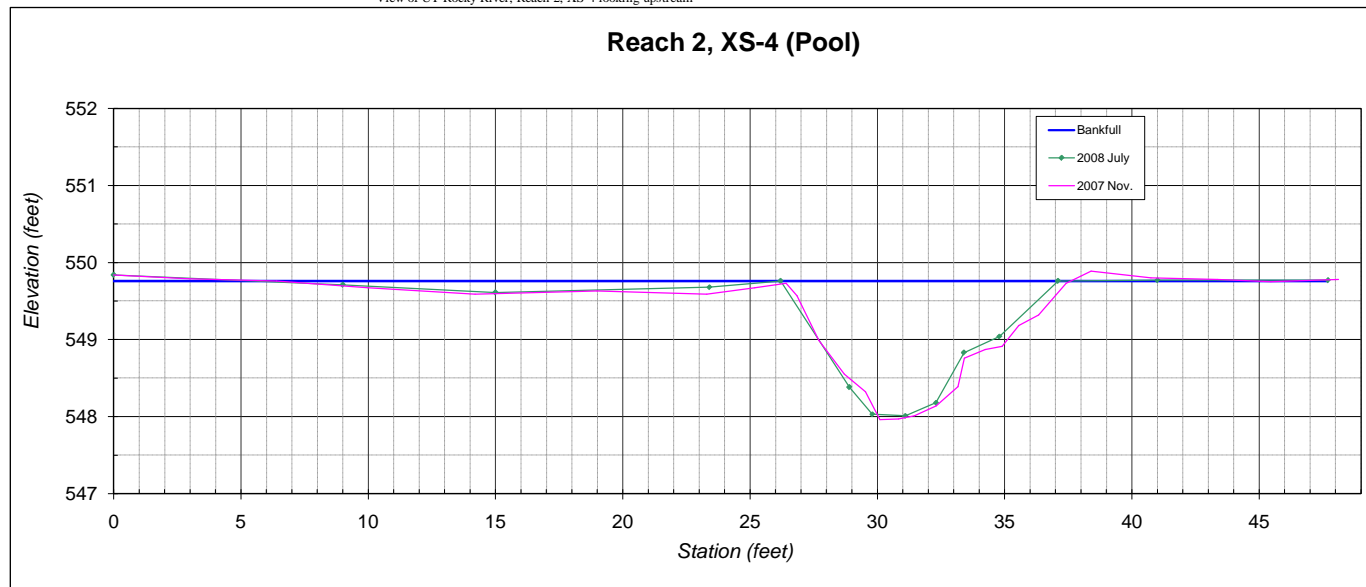
River Basin: Cape Fear
 Watershed: UT Rocky River
 XS ID: Reach 2, XS 4
 Reach: 2
 Date: 10/17/2008
 Field Crew: J.O. and A.W.

Station	Rod Ht.	Elevation
0	5.19	549.84
9	5.32	549.71
15	5.42	549.61
23.4	5.35	549.68
26.2	5.27	549.76
28.9	6.65	548.38
29.8	7	548.03
31.1	7.02	548.01
32.3	6.85	548.18
33.4	6.2	548.83
34.8	5.99	549.04
37.1	5.27	549.76
41	5.26	549.77
47.7	5.26	549.77

SUMMARY DATA
 Floodprone Elevation (ft) 551.51
 Bankfull Elevation (ft) 549.76
 Floodprone Width (ft) 160.00
 Bankfull Width (ft) 10.90
 Entrenchment Ratio 14.68
 Mean Depth (ft) 1.00
 Maximum Depth (ft) 1.75
 Width/Depth Ratio 10.91
 Bankfull Area (sq ft) 10.89
 Wetted Perimeter (ft) 11.61
 Hydraulic Radius (ft) 0.94
 Stream Type: C



View of UT Rocky River, Reach 2, XS-4 looking upstream



B6. Cross Section Plots, Photos, and Raw Data Tables - Year 2 - 2008 - Rocky River Stream Restoration

River Basin: Cape Fear
 Watershed: UT Rocky River
 XS ID: Reach 2, XS-5
 Reach: 2
 Date: 10/17/2008
 Field Crew: J.O. and A.W.

Station	Rod Ht.	Elevation
0	4.92	547.87
6.1	5.1	547.69
10	5.21	547.58
19.5	4.94	547.85
23.2	4.86	547.93
28.6	4.92	547.87
30	5.12	547.67
33.6	5.12	547.67
35.6	5.91	546.88
36.1	6.72	546.07
36.9	6.81	545.98
38.1	7.1	545.69
40	6.78	546.01
41	5.97	546.82
42.6	5.69	547.10
43.9	5.28	547.51
44.7	5.13	547.66
48.7	5.19	547.60
51.59	4.73	548.06

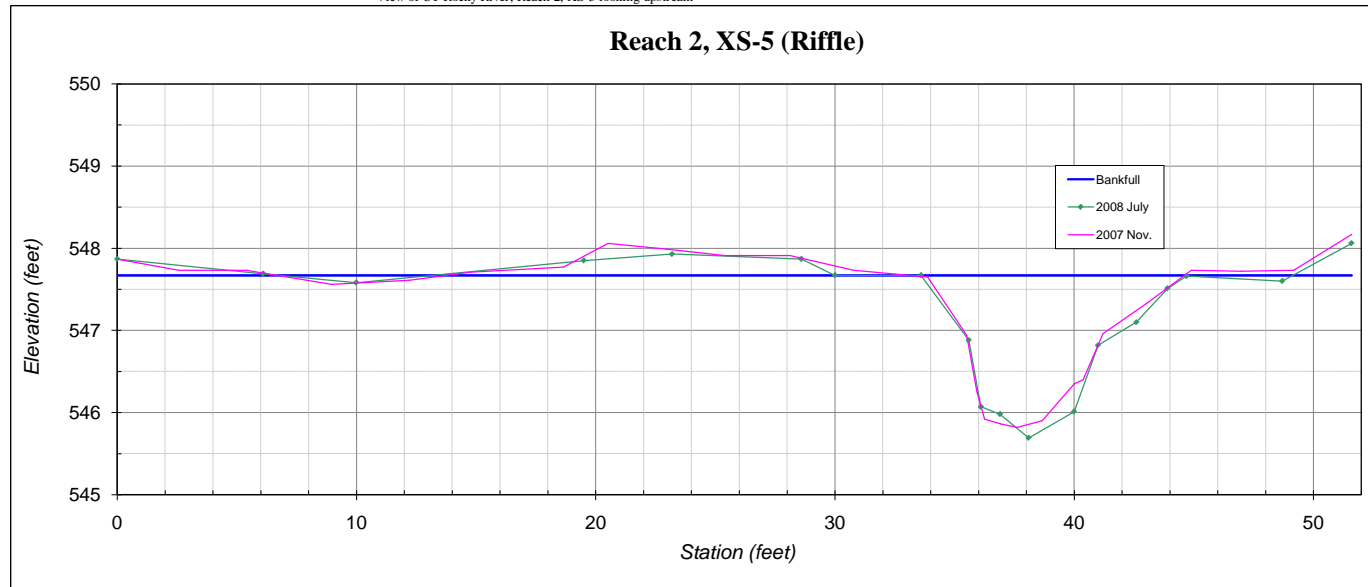
SUMMARY DATA

Floodprone Elevation (ft)	549.65
Bankfull Elevation (ft)	547.67
Floodprone Width (ft)	130.00
Bankfull Width (ft)	13.10
Entrenchment Ratio	9.92
Mean Depth (ft)	0.86
Maximum Depth (ft)	1.98
Width/Depth Ratio	15.18
Bankfull Area (sq ft)	11.31
Wetted Perimeter (ft)	14.16
Hydraulic Radius (ft)	0.80

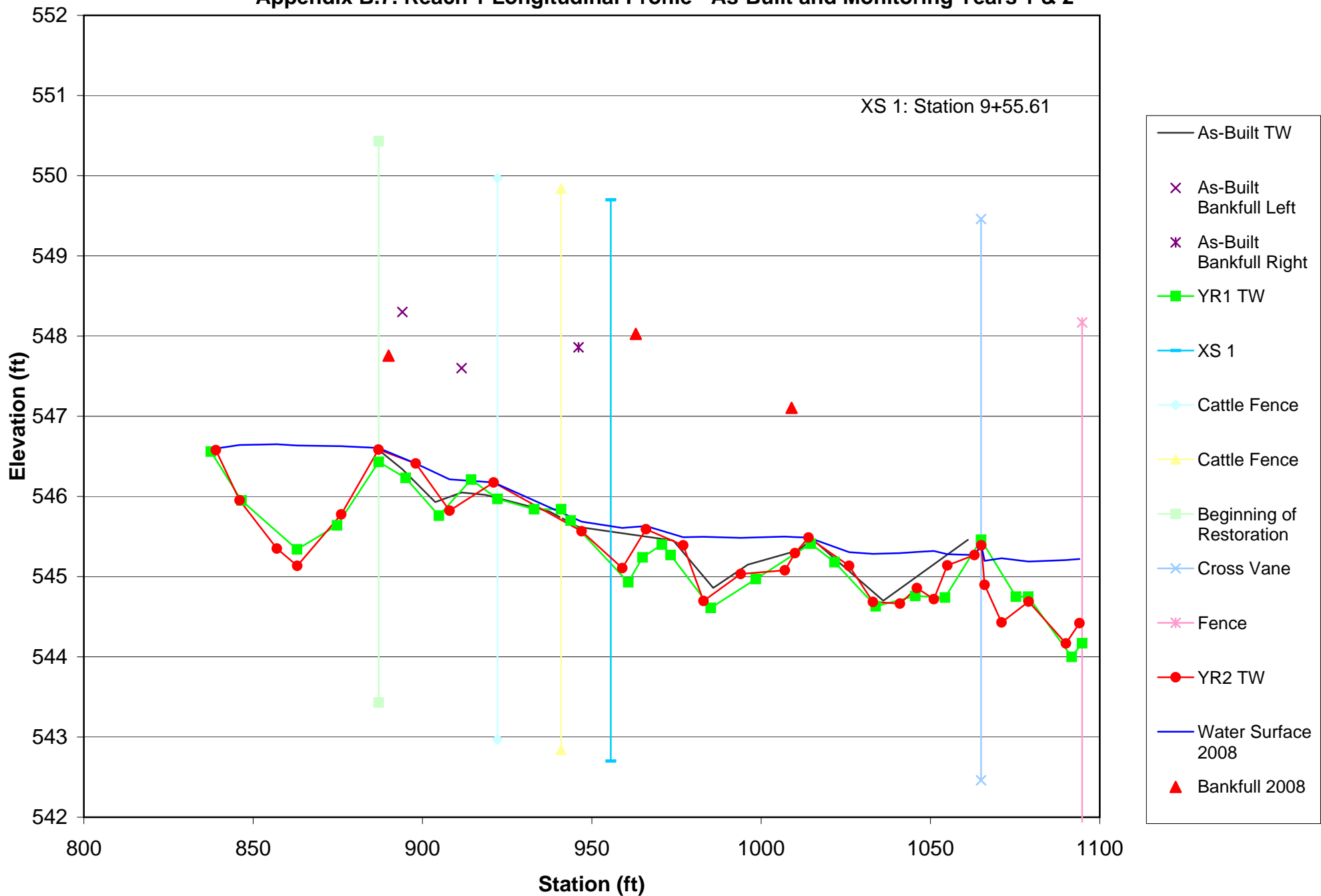
Stream Type: C



View of UT Rocky River, Reach 2, XS-5 looking upstream



Appendix B.7. Reach 1 Longitudinal Profile - As-Built and Monitoring Years 1 & 2



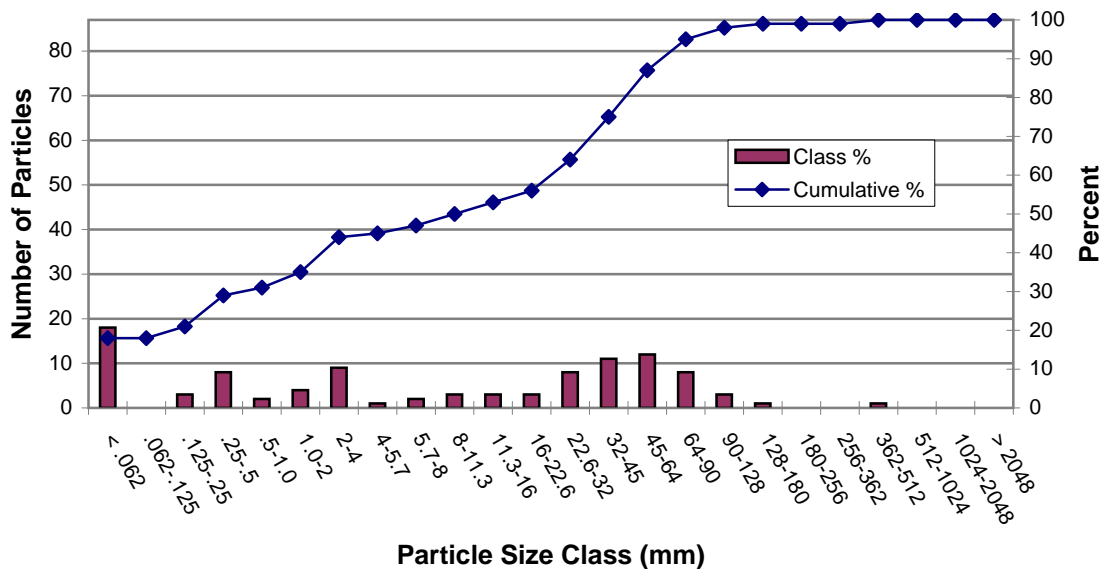
B8. Pebble Count - Rocky River Smith Tract Stream Restoration Monitoring Year - 2 (10/17/08)

Reach One, Cross Section One

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< .062	18	18	18
Sand	Very Fine Sand	.062-.125		0	18
	Fine Sand	.125-.25	3	3	21
	Medium Sand	.25-.5	8	8	29
	Coarse Sand	.5-1.0	2	2	31
	Very Course Sand	1.0-2	4	4	35
Gravel	Very Fine Gravel	2-4	9	9	44
	Fine Gravel	4-5.7	1	1	45
	Fine Gravel	5.7-8	2	2	47
	Medium Gravel	8-11.3	3	3	50
	Medium Gravel	11.3-16	3	3	53
	Coarse Gravel	16-22.6	3	3	56
	Coarse Gravel	22.6-32	8	8	64
	Very Course Gravel	32-45	11	11	75
	Very Course Gravel	45-64	12	12	87
Cobble	Small Cobble	64-90	8	8	95
	Small Cobble	90-128	3	3	98
	Medium Cobble	128-180	1	1	99
	Large Cobble	180-256		0	99
Boulder	Small Boulders	256-362		0	99
	Small Boulders	362-512	1	1	100
	Medium Boulders	512-1024		0	100
	Large Boulders	1024-2048		0	100
	Bedrock	> 2048		0	100

d₅₀ = 11.3 mm
d₈₄ = 59.25 mm

Total 100



B8. Pebble Count - Rocky River Smith Tract Stream Restoration Monitoring Year - 2 (10/17/08)

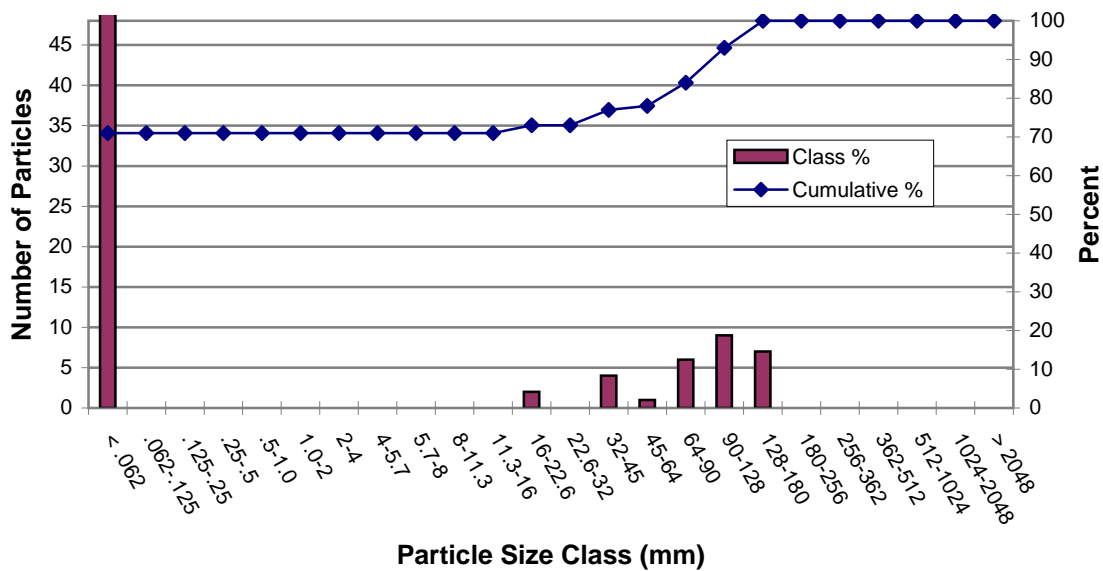
Reach Two, Cross Section One

S/C	Particle	Size Range (mm)	Total #	Class %	Cumulative %
	Silt/Clay	< .062	71	71	71
Sand	Very Fine Sand	.062-.125		0	71
	Fine Sand	.125-.25		0	71
	Medium Sand	.25-.5		0	71
	Coarse Sand	.5-1.0		0	71
	Very Course Sand	1.0-2		0	71
Gravel	Very Fine Gravel	2-4		0	71
	Fine Gravel	4-5.7		0	71
	Fine Gravel	5.7-8		0	71
	Medium Gravel	8-11.3		0	71
	Medium Gravel	11.3-16		0	71
	Coarse Gravel	16-22.6	2	2	73
	Coarse Gravel	22.6-32		0	73
	Very Course Gravel	32-45	4	4	77
	Very Course Gravel	45-64	1	1	78
Cobble	Small Cobble	64-90	6	6	84
	Small Cobble	90-128	9	9	93
	Medium Cobble	128-180	7	7	100
	Large Cobble	180-256		0	100
Boulder	Small Boulders	256-362		0	100
	Small Boulders	362-512		0	100
	Medium Boulders	512-1024		0	100
	Large Boulders	1024-2048		0	100
	Bedrock	> 2048		0	100

d₅₀ = 0.04 mm

d₈₄ = 90 mm

Total 100



B8. Pebble Count - Rocky River Smith Tract Stream Restoration Monitoring Year - 2 (10/17/08)

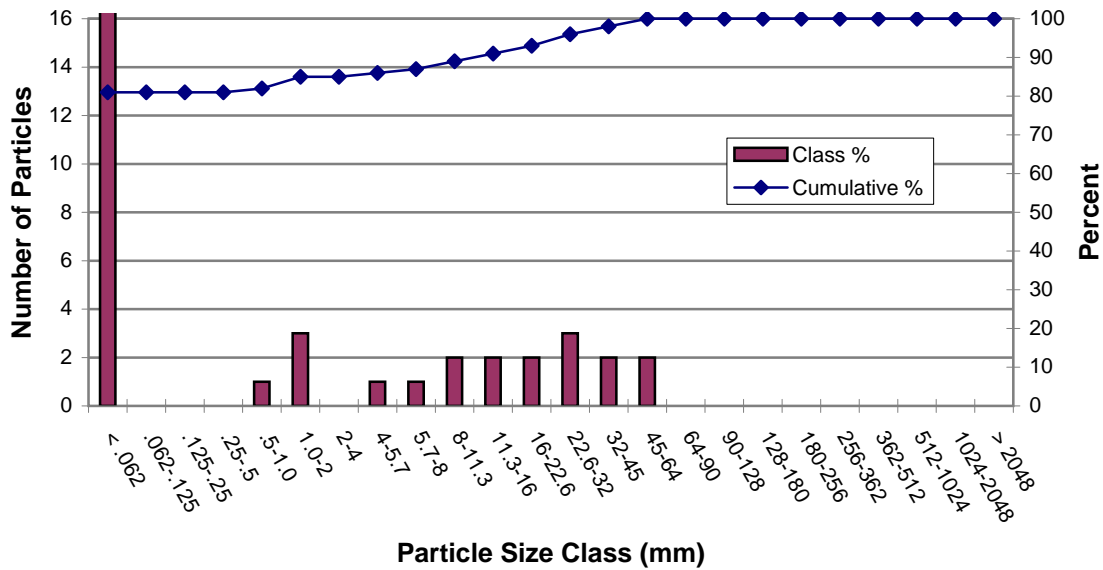
Reach Two, Cross Section Two

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< .062	81	81	81
Sand	Very Fine Sand	.062-.125		0	81
	Fine Sand	.125-.25		0	81
	Medium Sand	.25-.5		0	81
	Coarse Sand	.5-1.0	1	1	82
	Very Course Sand	1.0-2	3	3	85
Gravel	Very Fine Gravel	2-4		0	85
	Fine Gravel	4-5.7	1	1	86
	Fine Gravel	5.7-8	1	1	87
	Medium Gravel	8-11.3	2	2	89
	Medium Gravel	11.3-16	2	2	91
	Coarse Gravel	16-22.6	2	2	93
	Coarse Gravel	22.6-32	3	3	96
	Very Course Gravel	32-45	2	2	98
	Very Course Gravel	45-64	2	2	100
Cobble	Small Cobble	64-90		0	100
	Small Cobble	90-128		0	100
	Medium Cobble	128-180		0	100
	Large Cobble	180-256		0	100
Boulder	Small Boulders	256-362		0	100
	Small Boulders	362-512		0	100
	Medium Boulders	512-1024		0	100
	Large Boulders	1024-2048		0	100
	Bedrock	> 2048		0	100

d₅₀ = 0.04 mm

d₈₄ = 1.67 mm

Total 100



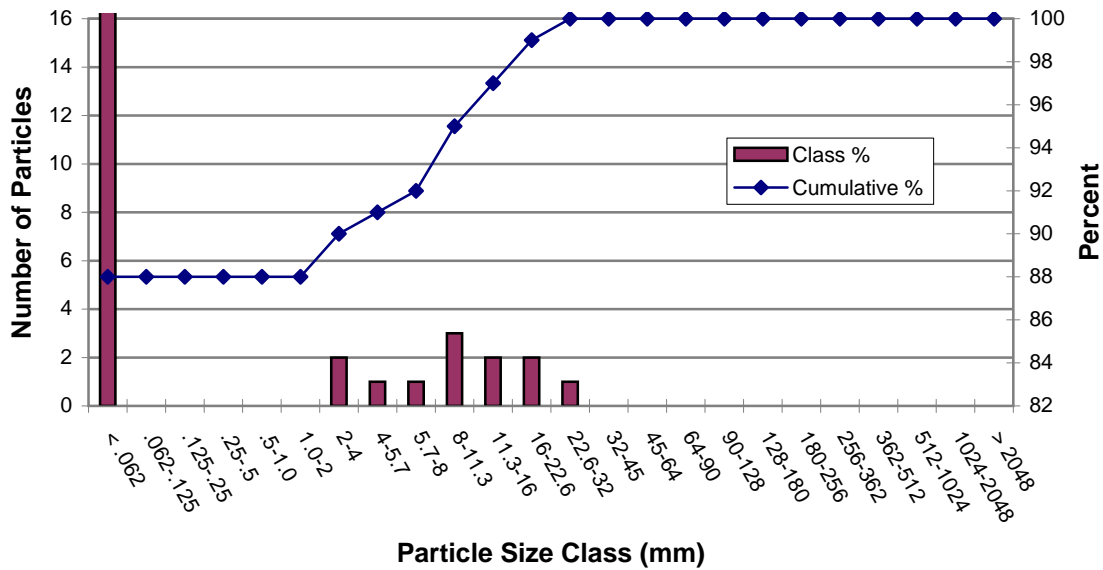
B8. Pebble Count - Rocky River Smith Tract Stream Restoration Monitoring Year - 2 (10/17/08)

Reach Two, Cross Section Three

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< .062	88	88	88
Sand	Very Fine Sand	.062-.125		0	88
	Fine Sand	.125-.25		0	88
	Medium Sand	.25-.5		0	88
	Coarse Sand	.5-1.0		0	88
	Very Course Sand	1.0-2		0	88
Gravel	Very Fine Gravel	2-4	2	2	90
	Fine Gravel	4-5.7	1	1	91
	Fine Gravel	5.7-8	1	1	92
	Medium Gravel	8-11.3	3	3	95
	Medium Gravel	11.3-16	2	2	97
	Coarse Gravel	16-22.6	2	2	99
	Coarse Gravel	22.6-32	1	1	100
	Very Course Gravel	32-45		0	100
	Very Course Gravel	45-64		0	100
Cobble	Small Cobble	64-90		0	100
	Small Cobble	90-128		0	100
	Medium Cobble	128-180		0	100
	Large Cobble	180-256		0	100
Boulder	Small Boulders	256-362		0	100
	Small Boulders	362-512		0	100
	Medium Boulders	512-1024		0	100
	Large Boulders	1024-2048		0	100
	Bedrock	> 2048		0	100

d₅₀ = 0.04 mm
d₈₄ = 0.06 mm

Total 100



B8. Pebble Count - Rocky River Smith Tract Stream Restoration Monitoring Year - 2 (10/17/08)

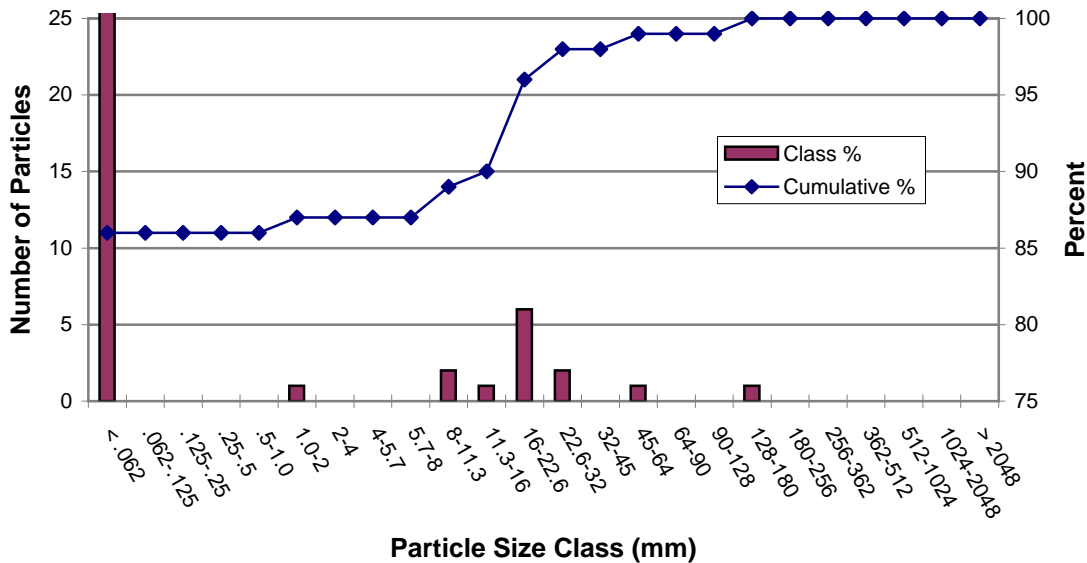
Reach Two, Cross Section Four

S/C	Particle	Size Range (mm)	Total #	Class %	Cumulative %
	Silt/Clay	< .062	86	86	86
Sand	Very Fine Sand	.062-.125		0	86
	Fine Sand	.125-.25		0	86
	Medium Sand	.25-.5		0	86
	Coarse Sand	.5-1.0		0	86
	Very Course Sand	1.0-2	1	1	87
Gravel	Very Fine Gravel	2-4		0	87
	Fine Gravel	4-5.7		0	87
	Fine Gravel	5.7-8		0	87
	Medium Gravel	8-11.3	2	2	89
	Medium Gravel	11.3-16	1	1	90
	Coarse Gravel	16-22.6	6	6	96
	Coarse Gravel	22.6-32	2	2	98
	Very Course Gravel	32-45		0	98
	Very Course Gravel	45-64	1	1	99
Cobble	Small Cobble	64-90		0	99
	Small Cobble	90-128		0	99
	Medium Cobble	128-180	1	1	100
	Large Cobble	180-256		0	100
Boulder	Small Boulders	256-362		0	100
	Small Boulders	362-512		0	100
	Medium Boulders	512-1024		0	100
	Large Boulders	1024-2048		0	100
	Bedrock	> 2048		0	100

d₅₀ = 0.04 mm

d₈₄ = 0.06 mm

Total 100



B8. Pebble Count - Rocky River Smith Tract Stream Restoration Monitoring Year - 2 (10/17/08)

Reach Two, Cross Section Five

S/C	Particle	Size Range (mm)	Total #	Class %	Cumulative %
	Silt/Clay	< .062	30	30	30
Sand	Very Fine Sand	.062-.125		0	30
	Fine Sand	.125-.25		0	30
	Medium Sand	.25-.5		0	30
	Coarse Sand	.5-1.0		0	30
	Very Course Sand	1.0-2		0	30
Gravel	Very Fine Gravel	2-4		0	30
	Fine Gravel	4-5.7		0	30
	Fine Gravel	5.7-8		0	30
	Medium Gravel	8-11.3		0	30
	Medium Gravel	11.3-16	1	1	31
	Coarse Gravel	16-22.6	7	7	38
	Coarse Gravel	22.6-32	6	6	44
	Very Course Gravel	32-45	10	10	54
	Very Course Gravel	45-64	9	9	63
Cobble	Small Cobble	64-90	8	8	71
	Small Cobble	90-128	16	16	87
	Medium Cobble	128-180	8	8	95
	Large Cobble	180-256		0	95
Boulder	Small Boulders	256-362	3	3	98
	Small Boulders	362-512	1	1	99
	Medium Boulders	512-1024	1	1	100
	Large Boulders	1024-2048		0	100
	Bedrock	> 2048		0	100

$d_{50} = 39.8 \text{ mm}$

$d_{84} = 120.88 \text{ mm}$

Total 100

