

Mill Branch Stream Restoration Project Columbus County North Carolina

**CU: 03040206
SCO# 020611301A
EEP Project No. 251**



**3rd Year Monitoring Report
November 15, 2009**

Prepared for:



North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Parker Lincoln Building
2728 Capital Boulevard, Suite 1H-103
Raleigh, NC 27606

**Mill Branch Stream Restoration Project
Columbus County
North Carolina**

**CU: 03040206
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EEP Project No. 251**

**3rd Year Monitoring Report
November 15, 2009**

Prepared by:



**Rummel, Klepper & Kahl, LLP
900 Ridgefield Drive
Suite 350
Raleigh, NC 27609**

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3.0 Executive Summary/Project Abstract

Project goals and objectives for the Mill Branch stream restoration project included:

- Improving water quality;
- Providing wildlife habitat through the creation of a riparian zone;
- Improving aquatic habitat with the use of natural material stabilization structures and a riparian buffer;
- Excluding cattle from the stream;
- Reducing nutrient loads from entering the stream via the buffer acting as a filter exclusion of cattle;
- Increasing the stream's access to its floodplain;
- Reducing erosion and sedimentation; and
- Protecting floral and biotic diversity via preservation.

Four (four) permanent vegetation plots were established and used in annual vegetation monitoring. Overall, the site is exceeding the minimum success requirements. As per the mitigation plan, the vegetative success criteria are based on the US Army Corps of Engineers Stream Mitigation Guidelines (USACE, 2003). The final vegetative success criteria will be the survival of 320 5-year old planted woody stems per acre at the end of the year 5 monitoring period. Monitoring for 2009 revealed that vegetation plots VP2 and VP3 fall below the minimum success requirements. Vegetation plots VP1 and VP4 meet or exceed minimum success requirements. Vegetation plot locations are identified in Appendix C.

Overall, the stream is functioning well and holding grade, however, the stream has areas of that are of concern. Channel dimension and pattern are similar to as-built conditions and currently meeting monitoring minimum success requirement thresholds. The channel profile appears to be holding grade and maintaining some bedform features. Since project construction, North Carolina has been in a moderate to severe drought. The drought has caused low flow periods resulting in vegetation growing within the stream channel. The vegetation has cause disruption of sediment transport resulting in aggradation on parts of the project.

Wetland restoration or enhancement was not a part of the East Tarboro Canal Stream Restoration Site therefore no wetland monitoring is required.

Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the mitigation and restoration plan documents available on EEP's website. All raw data supporting the tables and figures in the appendices is available from EEP upon request.

4.0 Methodology

Vegetative sample plots were quantitatively monitored during the growing season. Four 100m² plots were established for site monitoring. Species composition, density, vigor and survival were all monitored. Each plot corner is permanently located with rebar. Year 3 vegetation monitoring was completed in October 2009 utilizing the Carolina Vegetation Survey (CVS) – EEP protocol Level 1 (version 4.1).

Stream monitoring was completed by utilizing total station survey along with Rosgen Level II techniques to determine stream stability and performance. The annual cross-sectional survey included points surveyed at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features were present. Longitudinal profile survey was conducted for the entire length of the restored channel for stream reaches. Measurements included thalweg, water surface, and bankfull. Existing onsite benchmarks were used for survey control.

Photo monitoring was conducted by walking each stream reach and taking photos at each predetermined photo point location using a digital camera.

5.0 References

Harrelson, C.C., C.L. Rawlins and J.P. Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. United States Department of Agriculture, Fort Collins, CO.

NCEEP. 2006. Content, Format and Data Requirements for EEP Monitoring Reports. North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Raleigh, NC. Version 1.2 November 16, 2006.

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

6.0 Project Condition and Monitoring Data Appendices

APPENDIX A

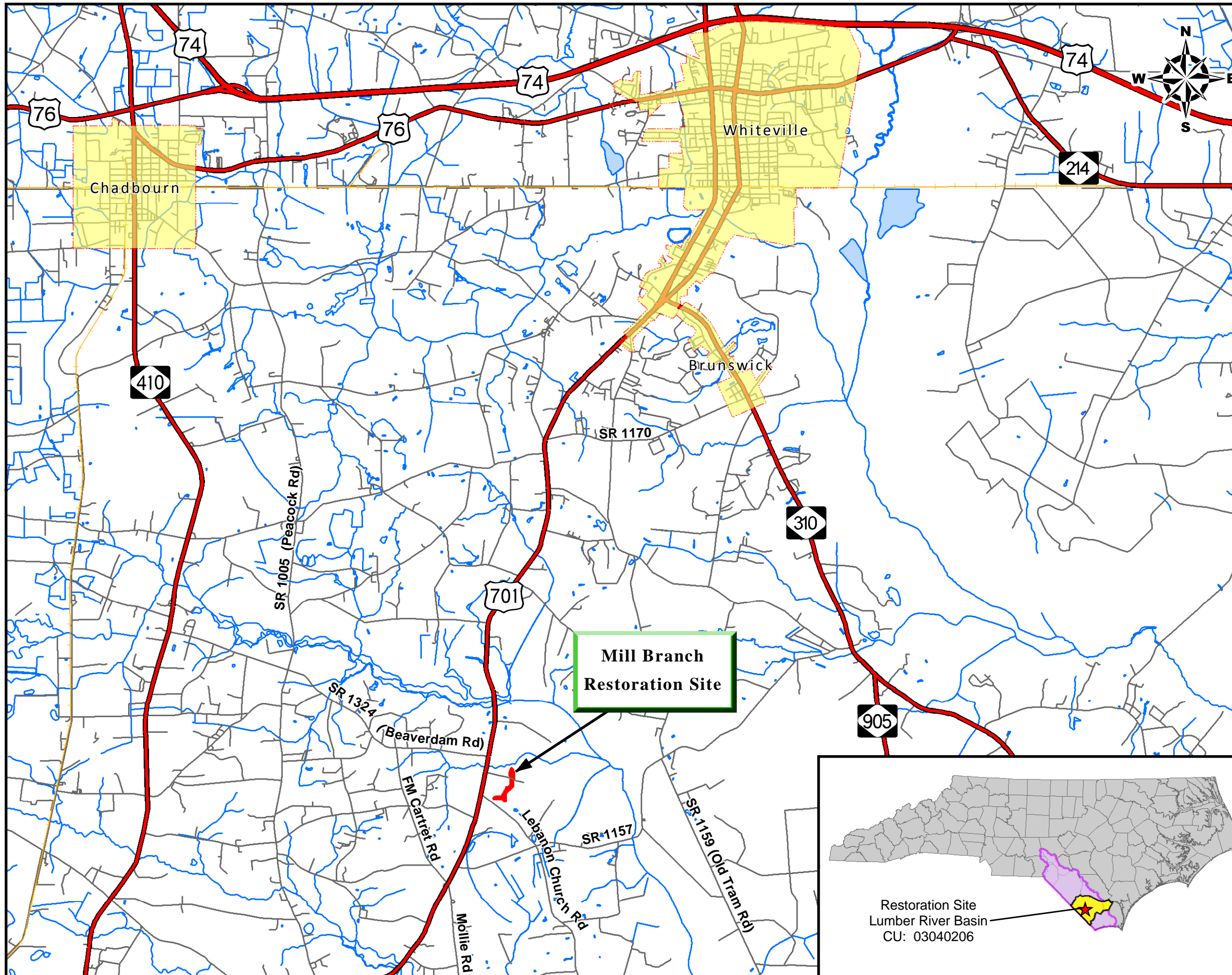
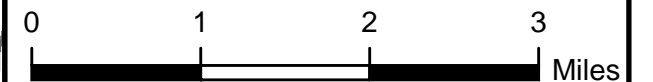


Figure 1
Location Map

Mill Branch
Stream Restoration Project
EEP No. 0251
Columbus County, North Carolina

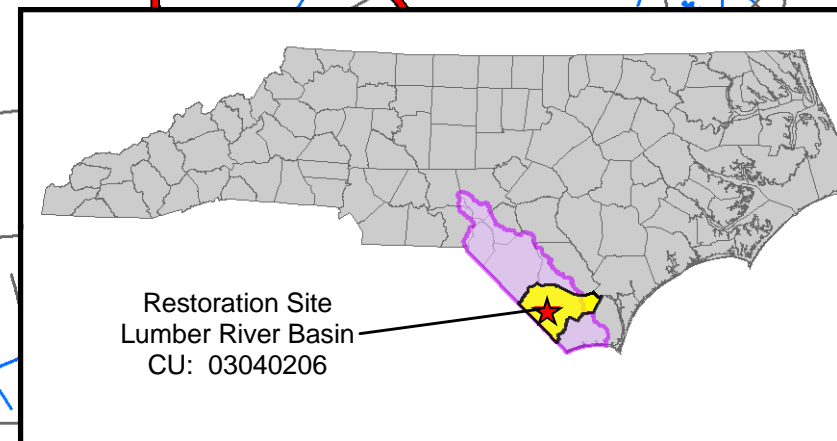
Monitoring Report
November 2009



Legend

- Highways
- Railroad
- Roads
- Streams
- Waterbodies
- Municipalities
- Project_boundary

Lat\ Long: 34.2222N, 78.7496W



Directions to Mill Branch Stream Restoration Site:
From Raleigh, take I-95 South to Exit 20 (NC 211). At the end of the ramp turn left to go east on NC 211. Stay on road as it becomes NC-72, follow for about 12 miles, then turn left onto US-74. In Whiteville, take US-701 Bypass south and follow for approximately 10 miles. Turn left onto Lebanon Church Road (SR 1141). The gated entrance into the pasture surrounding the project site is on the left just past Lebanon United Methodist Church.

FIGURE 2a

Mill Branch
Stream Restoration Site

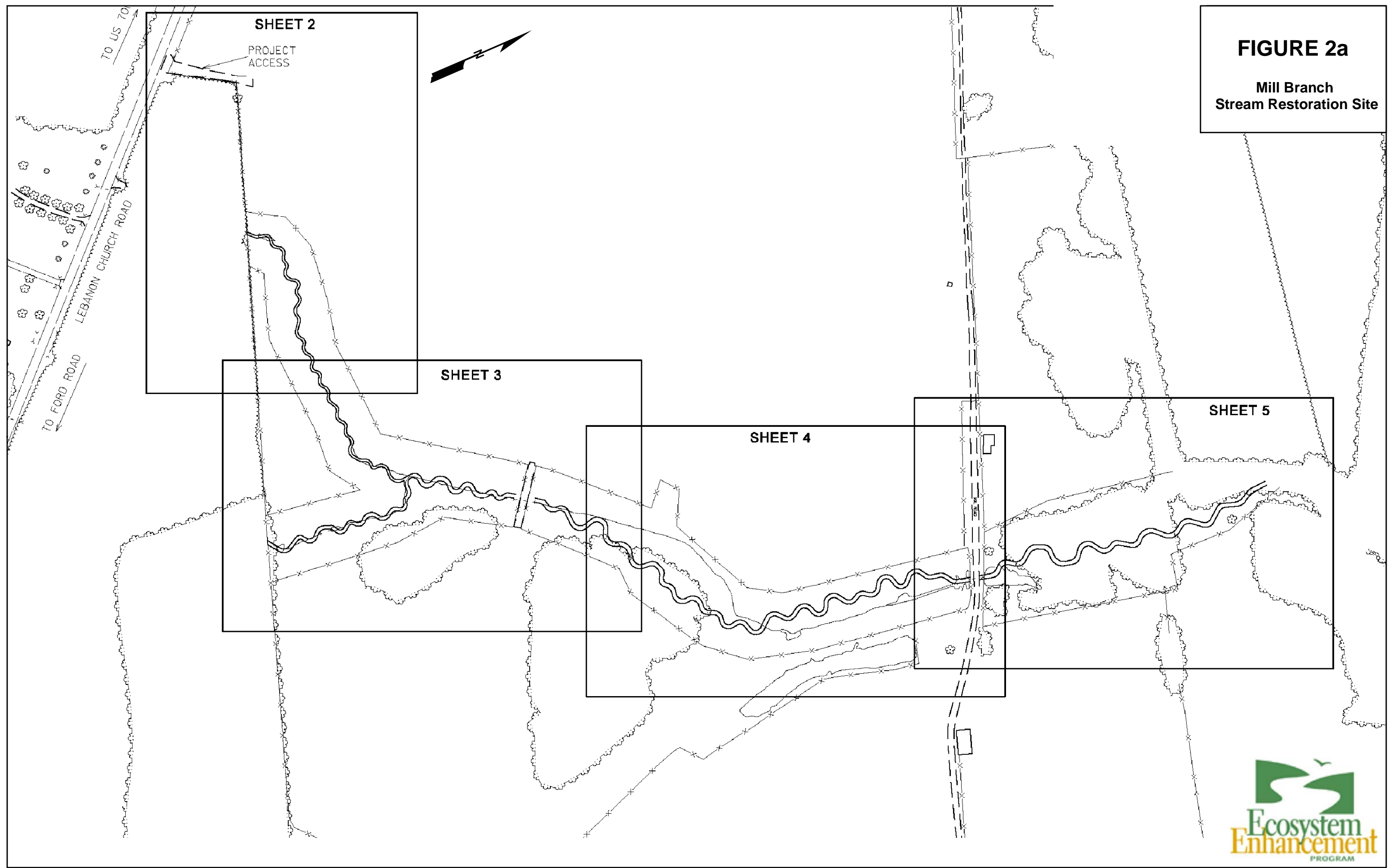


FIGURE 2b

Mill Branch Stream Restoration Site

VEG PLOT PIN COORDINATES		
PIN	X	Y
VP-1A	2074939.6552	170768.7832
VP-1B	2074937.5346	170815.1209

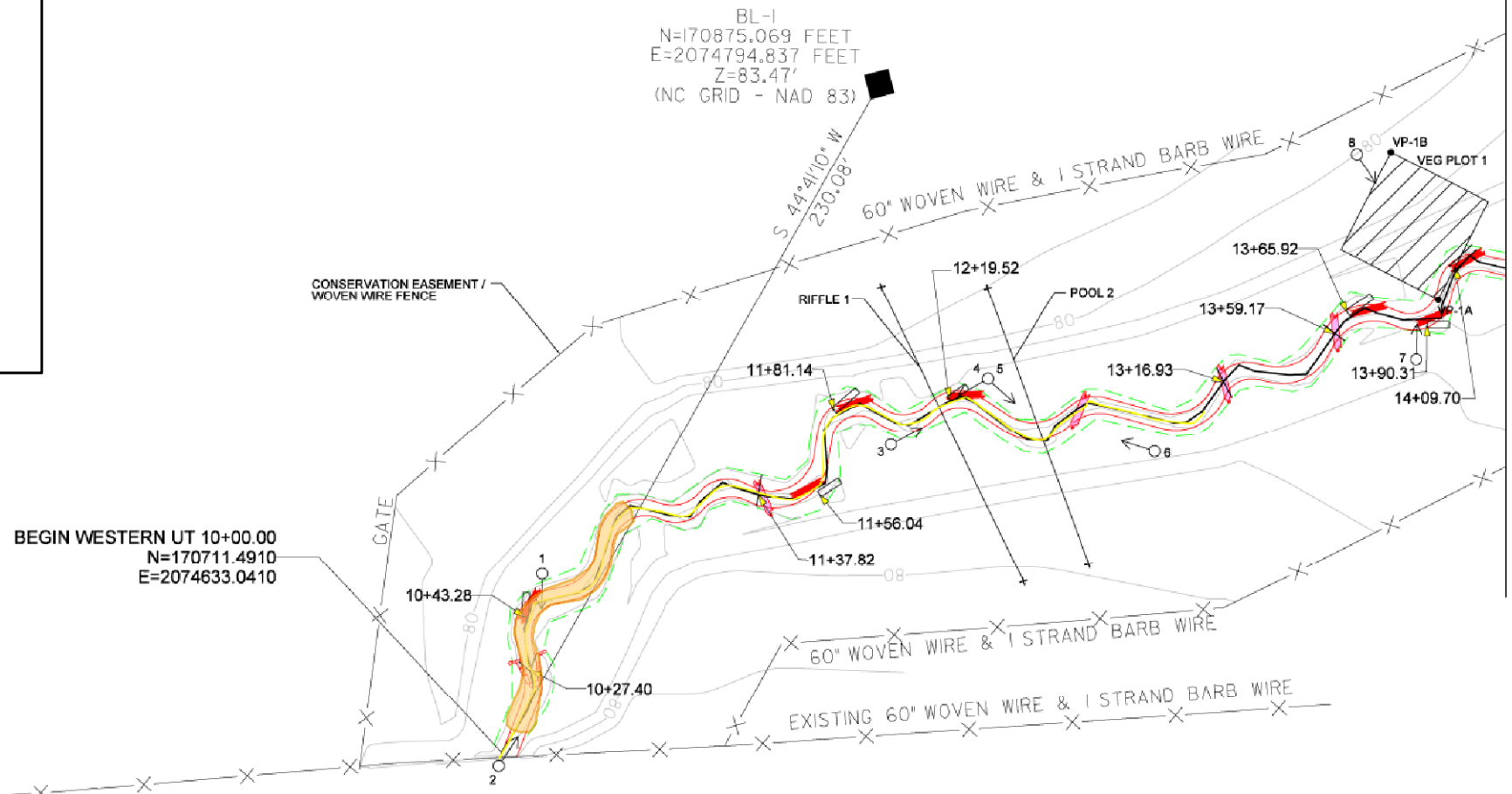
CROSS-SECTION COORDINATES				
CROSS-SECTION	LEFT		RIGHT	
	X	Y	X	Y
RIFFLE 1	2074779.4700	170816.2415	2074797.4519	170719.8073
POOL 2	2074810.1562	170807.4965	2074817.6790	170719.7804

NOTE: ALL STATIONS REFERENCE THALWEG LOCATED FOR AS-BUILT SURVEY



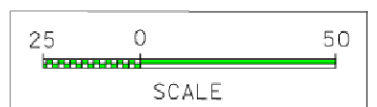
Problem Areas

- AGGRADATION
- CATTAILS
- BARE GROUND
- RILL EROSION



LEGEND

	AS-BUILT ROCK CROSS VANE		DESIGN ROCK CROSS VANE
	AS-BUILT LOG VANE WITH ROCK SILL		DESIGN LOG VANE
	AS-BUILT LOG SILL		DESIGN LOG SILL
	AS-BUILT LOG VANE		INVERT
	AS-BUILT THALWEG		FENCE LINE
	AS-BUILT BANKFULL		LIMITS OF DISTURBANCE
	DESIGN BANKFULL		VEG PLOT PINS
	MONITORING LONGITUDINAL PROFILE		VEG PLOTS
			CROSS-SECTIONS
			PHOTO POINTS



LOCATION: SITE LOCATED OFF HIGHWAY 701 AND LEBANON CHURCH ROAD SOUTH OF WHITEVILLE

PROJECT NO.: SCO# 02-06113-01A COUNTY: COLUMBUS

DESIGNED BY: DATE: CGM

CHECKED BY: DATE: NEJ

MATCH LINE - SEE SHEET 3

6/25/2021 10:50:46 AM L:\PROJECTS\2021\06113\01A\02\FIGURE 2B.DWG

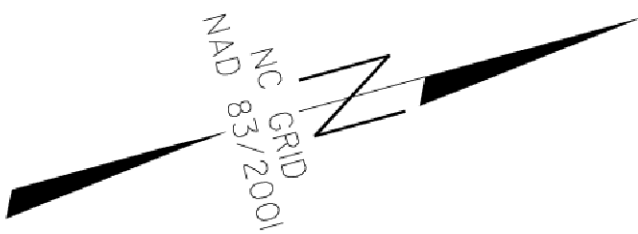
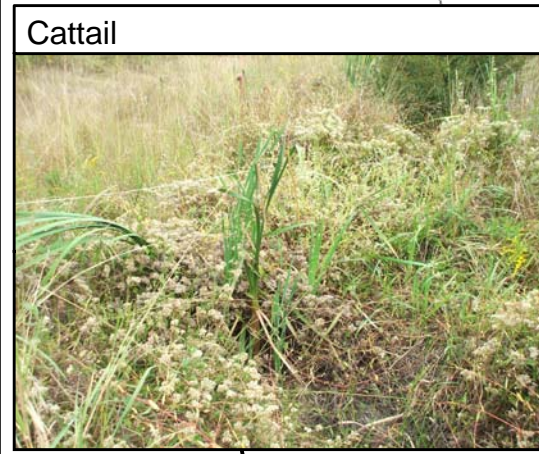
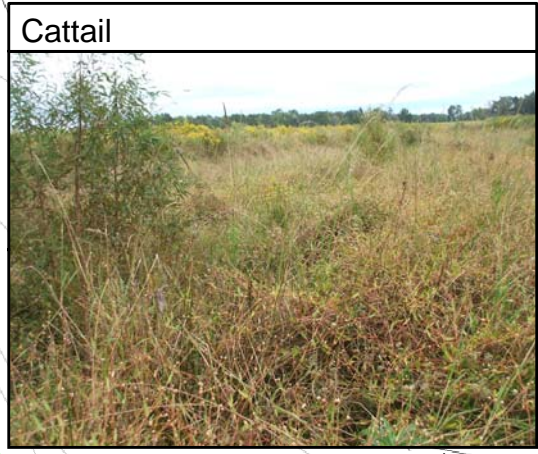
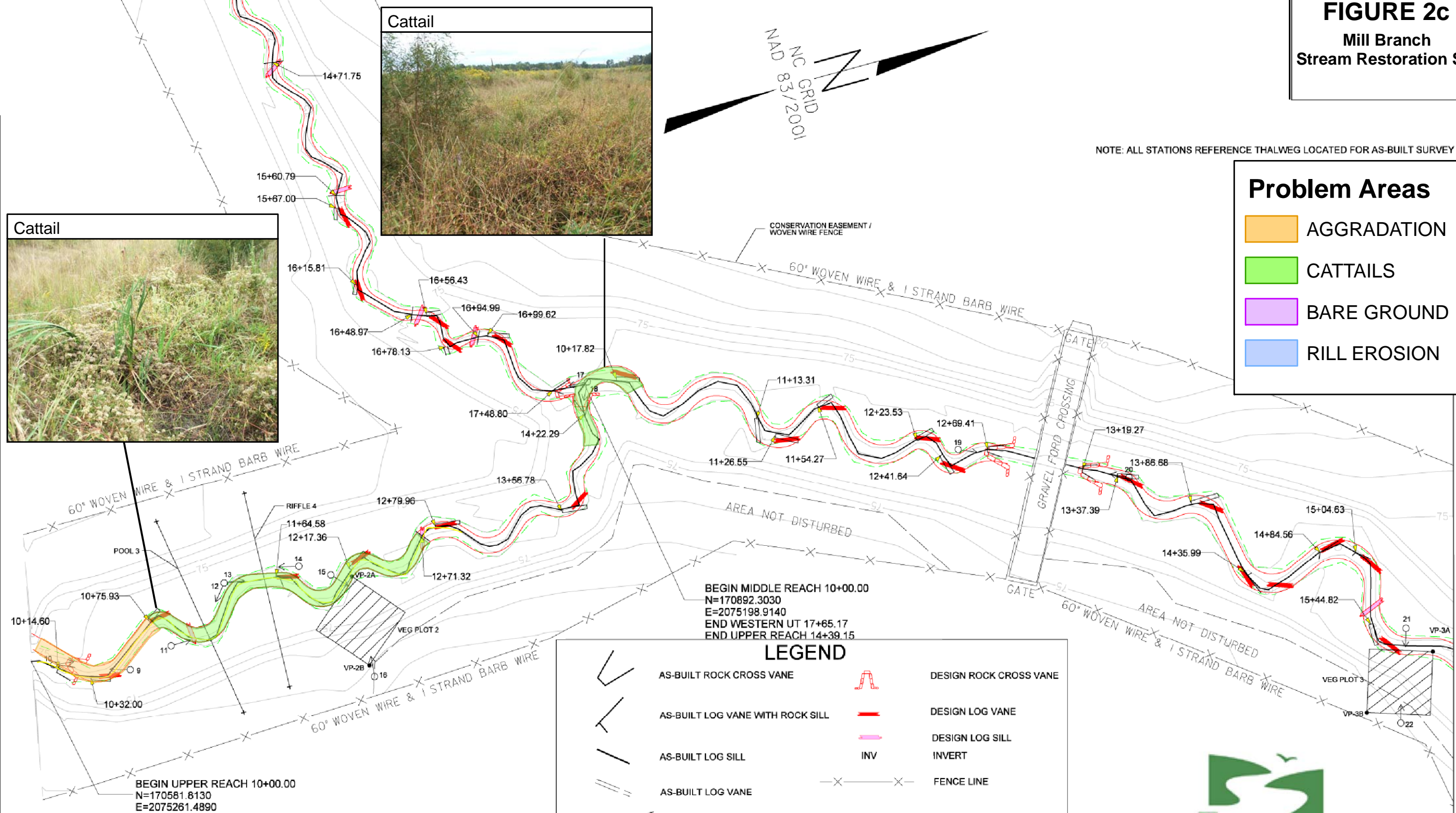
MATCH LINE - SEE SHEET 2

FIGURE 2c
Mill Branch
Stream Restoration Site

NOTE: ALL STATIONS REFERENCE THALWEG LOCATED FOR AS-BUILT SURVEY

Problem Areas

- AGGRADATION
- CATTAILS
- BARE GROUND
- RILL EROSION



LEGEND

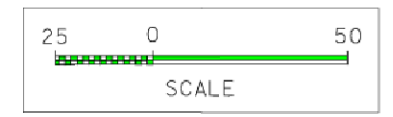
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	AS-BUILT LOG VANE WITH ROCK SILL		DESIGN LOG VANE
	AS-BUILT LOG SILL		DESIGN LOG SILL
	AS-BUILT LOG VANE		INV
	AS-BUILT THALWEG		FENCE LINE
	AS-BUILT BANKFULL		LIMITS OF DISTURBANCE
	DESIGN BANKFULL		VEG PLOT PINS
	MONITORING LONGITUDINAL PROFILE		VEG PLOTS
			CROSS-SECTIONS
			PHOTO POINTS

VEG PLOT PIN COORDINATES

PIN	X	Y
VP-2A	2075262.6162	170751.6045
VP-2B	2075308.8812	170748.2524

CROSS-SECTION COORDINATES

CROSS-SECTION	LEFT		RIGHT	
	X	Y	X	Y
POOL 3	2075209.2535	170662.4179	2075315.2216	170679.9107
RIFFLE 4	2075207.3409	170709.5291	2075308.6113	170705.9738



LOCATION:
SITE LOCATED OFF HIGHWAY 701
AND LEBANON CHURCH ROAD
SOUTH OF WHITEVILLE

PROJECT NO. SCO# 02-06113-01A COUNTY: COLUMBUS
DESIGNED BY: DEAN: ET: CGM
CHECKED BY: DATE: NEJ

MATCH LINE - SEE SHEET 4

6/25/2007
D:\PROJECTS\02-06113-01A\02-06113-01A_SHEETS.dwg

FIGURE 2d
Mill Branch
Stream Restoration Site

VEG PLOT PIN COORDINATES		
PIN	X	Y
VP-3A	2075466.5710	171234.5650
VP-3B	2075445.3470	171275.3682

CROSS-SECTION COORDINATES				
CROSS-SECTION	LEFT		RIGHT	
	X	Y	X	Y
RIFFLE 5	2075637.4170	171554.0230	2075730.5940	171632.4420
POOL 6	2075830.4130	171658.7970	2075722.6770	171696.2110

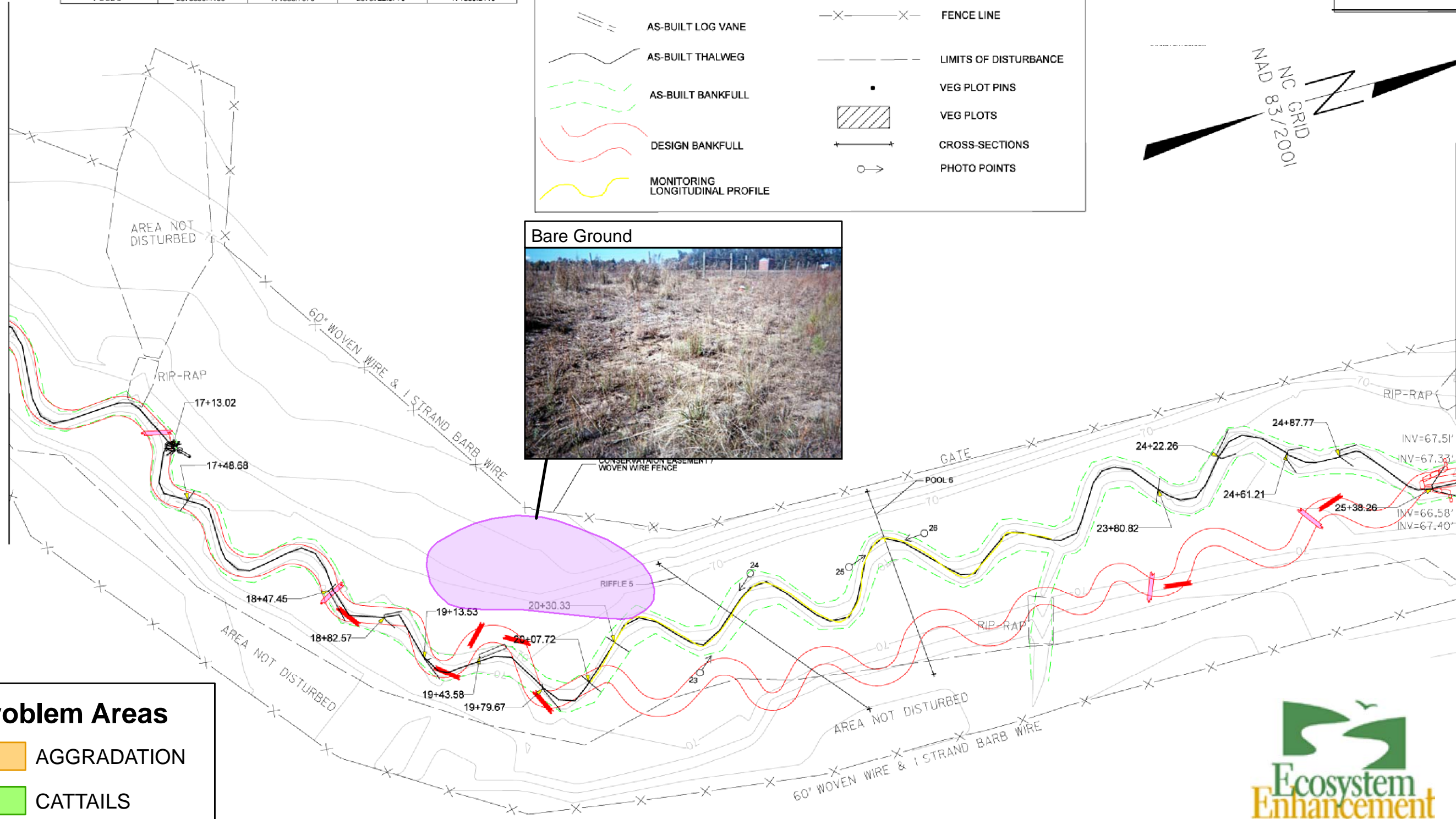
LEGEND

	AS-BUILT ROCK CROSS VANE		DESIGN ROCK CROSS VANE
	AS-BUILT LOG VANE WITH ROCK SILL		DESIGN LOG VANE
	AS-BUILT LOG SILL		DESIGN LOG SILL
	AS-BUILT LOG VANE		INVERT
	AS-BUILT THALWEG		FENCE LINE
	AS-BUILT BANKFULL		LIMITS OF DISTURBANCE
	DESIGN BANKFULL		VEG PLOT PINS
	MONITORING LONGITUDINAL PROFILE		VEG PLOTS
			CROSS-SECTIONS
			PHOTO POINTS



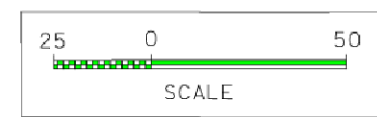
MATCH LINE - SEE SHEET 3

MATCH LINE - SEE SHEET 5



Problem Areas

- AGGRADATION
- CATTAILS
- BARE GROUND
- RILL EROSION



NOTE: ALL STATIONS REFERENCE THALWEG LOCATED FOR AS-BUILT SURVEY

LOCATION: SITE LOCATED OFF HIGHWAY 701 AND LEBANON CHURCH ROAD SOUTH OF WHITEVILLE	
PROJECT NO. SCO# 02-06113-01A	COUNTY: COLUMBUS
DESIGNED BY: CGM	CHECKED BY: NEJ

DATE PLOTTED: 11/11/2011 10:58:38 AM

FIGURE 2e
Mill Branch
Stream Restoration Site

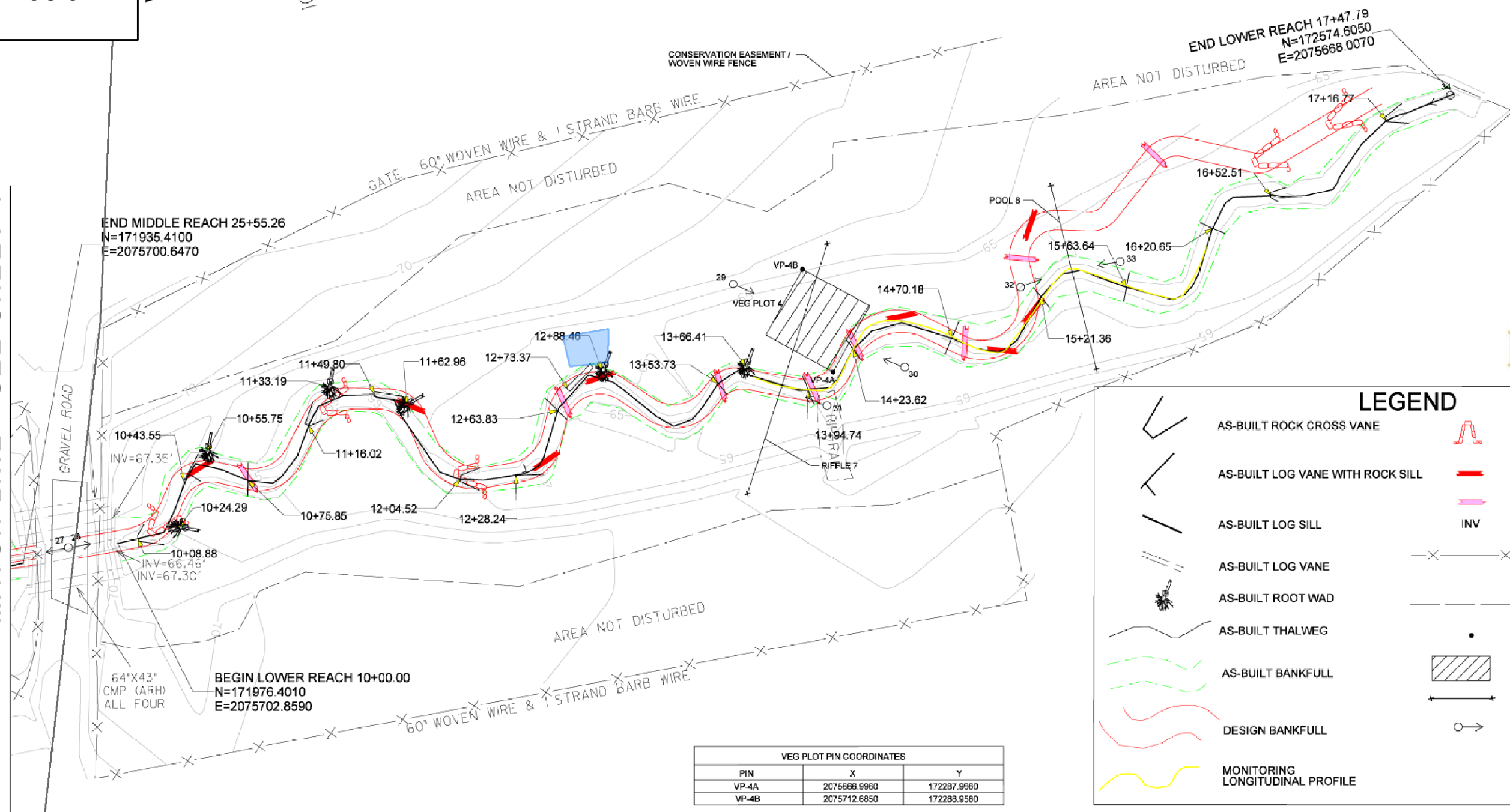
Problem Areas

- AGGRADATION
- CATTAILS
- BARE GROUND
- RILL EROSION



NOTE: ALL STATIONS REFERENCE THALWEG LOCATED FOR AS-BUILT SURVEY

MATCH LINE - SEE SHEET 4



LEGEND

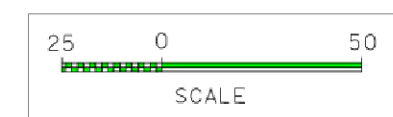
	AS-BUILT ROCK CROSS VANE		DESIGN ROCK CROSS VANE
	AS-BUILT LOG VANE WITH ROCK SILL		DESIGN LOG VANE
	AS-BUILT LOG SILL		DESIGN LOG SILL
	AS-BUILT LOG VANE		INVERT
	AS-BUILT ROOT WAD		FENCE LINE
	AS-BUILT THALWEG		LIMITS OF DISTURBANCE
	AS-BUILT BANKFULL		VEG PLOT PINS
	DESIGN BANKFULL		VEG PLOTS
	MONITORING LONGITUDINAL PROFILE		CROSS-SECTIONS
			PHOTO POINTS

VEG PLOT PIN COORDINATES

PIN	X	Y
VP-4A	2075688.9960	172287.9660
VP-4B	2075712.6850	172288.9580

CROSS-SECTION COORDINATES

CROSS-SECTION	LEFT				RIGHT			
	X	Y	X	Y	X	Y	X	Y
RIFFLE 7	2075659.3700	172300.9220	2075753.1770	172240.1770				
POOL 8	2075660.5780	172398.0200	2075740.8880	172397.2830				



LOCATION: SITE LOCATED OFF HIGHWAY 701 AND LEBANON CHURCH ROAD SOUTH OF WHITEVILLE
 COUNTY: COLUMBUS
 PROJECT NO.: SCO# 02-06113-01A
 DESIGNED BY: CGM
 CHECKED BY: NEJ
 DATE:

1/28/2007
 10:52:52 AM
 I:\PROJECTS\02-06113-01A\02-06113-01A_SHEETS\02-06113-01A_SHEETS.dwg
 User: jcm
 Plot: 02-06113-01A_SHEETS.dwg

APPENDIX B

Appendix B – General Project Tables

Table 1. Project Restoration Components Mill Branch Stream Restoration Project (EEP 0251)								
Reach ID	Existing Feet/Acres	Type	Approach	Footage or Acreage	Mitigation Ratio	Mitigation Units	Stationing	Comment
Western	660	R	P2	765.2	1.0	765.2	10+00.0 to 17+65.2	Smaller tributary
Upper	340	R	P2	439.2	1.0	439.2	10+00.0 to 14+39.2	Above confluence with trib
Middle	1265	R	P2	1555.3	1.0	1555.3	10+00.0 to 25+55.3	Between confluence and road crossing (includes ford crossing)
Lower	670	R	P2	747.8	1.0	747.8	10+00.0 to 17+47.8	Below road crossing
<i>Restoration Summary</i>	2935			3507.5				
Mill Branch	1750	P	-	1750.0	5.0	350.0		Downstream of restoration project
Riparian Wetlands	35.8	P	-	35.8	5.0	7.2		Downstream of restoration project
Non-Riparian Wetlands	1.5	P	-	1.5	5.0	0.3		Downstream of restoration project
Mitigation Unit Summations								
Stream (lf)	Riparian Wetland (ac)	Nonriparian Wetland (ac)	Total Wetland (ac)	Buffer (ac)	Comment			
3857.5	7.2	0.3	7.5	0.0				

R = Restoration
P2 = Priority 2
P = Preservation

**Table 2. Project Activity and Reporting History
Mill Branch Stream Restoration - EEP Project No. 251**

Activity or Report	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	NA	Jan 2005
Final Design - 90%	NA	Sept 2005
Construction	Jan 2007	Jan 2007
Temporary S&E mix applied to entire project area	Jan 2007	Jan 2007
Permanent seed mix applied to entire project area	Jan 2007	Jan 2007
Containerized and B&B plantings	Jan 2007	Jan 2007
Mitigation Plan / As-built (Year 0 Monitoring - baseline)	April 2007	June 2007
Year 1 Monitoring	Nov 2007	Dec 2007
Year 2 Monitoring	Nov 2008	Jan 2009
Year 3 Monitoring	Nov 2009	NA
Year 4 Monitoring	NA	NA
Year 5 Monitoring	NA	NA

**Table 3. Project Contacts Table
Mill Branch Stream Restoration - EEP Project No. 251**

Designer	Stantec Consulting Services, Inc. 801 Jones Franklin Road Suite 300 Raleigh, NC 27606 Brad Fairley, (919) 851-6866
Primary project design POC	
Construction Contractor	North State Environmental, Inc 2889 Lowery St. Suite B Winston-Salem, NC 27101 Darrell Westmoreland (336) 725-2405
Construction contractor POC	
Planting Contractor	North State Environmental, Inc 2889 Lowery St. Suite B Winston-Salem, NC 27101 Darrell Westmoreland (336) 725-2405
Planting Contractor POC	
Seeding Contractor	North State Environmental, Inc 2889 Lowery St. Suite B Winston-Salem, NC 27101 Darrell Westmoreland (336) 725-2405
Seeding Contractor POC	
Seed Mix Sources	contact North State Environmental, Inc
Nursery Stock Suppliers	Dykes & Son Nursery 825 Maude Etter Rd McMinnville, TN 37110 North State Environmental, Inc 2889 Lowery St. Suite B Winston-Salem, NC 27101 Stephen C. Joyce (336) 725-2405
Monitoring Performers (Year 3)	Rummel, Klepper, and Kahl, LLP 900 Ridgefield Drive Suite 250 Raleigh, NC 27609
Stream Monitoring POC	Pete Stafford (919)878-9560
Vegetation Monitoring POC	Pete Stafford (919)878-9560
Wetland Monitoring POC	NA

**Table 4. Project Attribute Table
Mill Branch Stream Restoration Site/EEP Project No. 0251**

Project County	Columbus
Drainage Area	178 acres
Drainage impervious cover estimate (%)	< 1 percent
Stream Order (from Soil Survey)	1 st order: Western & Upper Reaches 2 nd order: Middle & Lower Reaches
Physiographic Region	Coastal Plain
Ecoregion	Atlantic Southern Loam Plains (651)
Rosgen Classification of As-built	C
Cowardin Classification	Preservation Areas: PFO4/1A; PFO1C; PFO1A; PSS1/3A
Dominant soil types	Muckalee: Lower, Middle, and Western Reaches Goldsboro, Wagram: Upper Reach
Reference site ID	UT to Hog Swamp, UT to Ironhill Branch, Muddy Creek, Mill Creek
USGS HUC for Project	03040206060020
USGS HUC for Reference	UT to Hog Swamp: 03040203180030 UT to Ironhill Branch: 03040206060040 Muddy Creek: 03030004080090 Mill Creek: 03030004070060
NCDWQ Subbasin for Project	03-07-57
NCDWQ Subbasin for Reference	UT to Hog Swamp: 03-07-54 UT to Ironhill Branch: 03-07-57 Muddy Creek: 03-06-14 Mill Creek: 03-06-14
NCDWQ Classification for Project	C SW
NCDWQ Classification for Reference	C - Muddy Creek C SW - UT to Hog Swamp; UT to Ironhill Branch WS-III - Mill Creek
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	No
Percent of project easement fenced	100%

APPENDIX C

Appendix C – Vegetation Assessment Data

Table 5. Vegetation Plot Mitigation Success Summary Table			
Tract	Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean
Reach 1	VP1	Y	50%
Reach 2	VP2	N	
Reach 3	VP3	N	
Reach 4	VP4	Y	

Appendix C – Vegetation Monitoring Plot Photos (all photos recorded on October 1, 2009)



Vegetation Plot 1



Vegetation Plot 2

All photos recorded on October 1, 2009



Vegetation Plot 3



Vegetation Plot 4

All photos recorded on October 1, 2009

Appendix C – Vegetation Metadata

Table 6. Vegetation Metadata Table Mill Branch Restoration Site EEP No: 251	
Report Prepared By	William (Pete) Stafford
Date Prepared	11/6/2009 10:47
Database Name	cvs-eep-entrytool-v2.2.6.mdb
Database Location	C:\Documents and Settings\pstafford\Desktop\CVS Veg Data
Computer Name	STAFFORDP
Description Worksheets In This Document	
Metadata	This worksheet, wich is a summary of the project data.
Planted	Each project is listed with its PLANTED stems, for each year. This excludes live stakes and lists stems per acre.
Total Stems	Each Project is listed with its total stems for each year. This includes live stakes, all planted stems, and all natural/volunteer stems. Listed in stems per acre.
Plots	List of Plots surveyed
Vigor	Frequency distribution of vigor classes
Vigor by Species	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 Species	Damage values tallied by type for each species
Damage by Plot	Damage values tallied by type for each plot
Planted Stems by Plot	Count of planted living stems of each species for each plot; dead and missing stems are excluded
Project Summary	
EEP Project Number	251
Project Name	Mill Branch
Description	Stream Restoration
River Basin	Lumber
Length (ft)	
Stream to Edge width (ft)	
Area (sq. m)	
Required Plots (calculated)	
Sampled Plots	4

Appendix C - Stem Count Total and Planted Species by Plot and Species

		CURRENT DATA (MY3 2009)										ANNUAL MEANS							
		Plot 1		Plot 2		Plot 3		Plot 4		Current Mean		MY2 (2008)		MY1 (2007)		AB (2007)			
Scientific Name	Common Name	Type	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	
<i>Betula nigra</i>	River Birch	T	1	1	1	1	1				3	2	3	2	3	3	3	3	
<i>Carpinus caroliniana var. caroliniana</i>	American Hornbeam	T	2		1				2	1	5	1	5	2	5	5	5	5	
<i>Cephalanthus occidentalis</i>	Buttonbush	S								1	0	1	0	1	0	0	0	0	
<i>Cornus amomum</i>	Silky Dogwood	T	1		2	1	4	2	1		8	3	8	5	8	8	8	8	
<i>Liriodendron tulipifera var. tulipifera</i>	Tulip Poplar	T	2	2							2	2	2	2	2	2	2	2	
<i>Platanus occidentalis var. occidentalis</i>	Sycamore	T	1	1	1	1	1	1	1		4	3	4	3	4	4	4	4	
<i>Quercus lyrata</i>	Overcup Oak	T	1	1	3	2	1	2			5	5	5	4	5	5	5	5	
<i>Quercus pagoda</i>	Cherrybark Oak	T							1	1	1	1	1	1	1	1	1	1	
<i>Quercus phellos</i>	Willow Oak	T	2	2			1		3	3	6	5	6	6	6	6	6	6	
<i>Quercus nigra</i>	Water Oak	T							1		1	0	1	1	1	1	1	1	
<i>Salix sericea</i>	Willow	T			3		1	1	4	2	8	3	8	4	8	8	8	8	
		Plot Area	0.025 acre		0.025 acre		0.025 acre		0.025 acre										
*No baseline data for this project		Species Count	5		4		4		5		10		11		11		11		
Type = Tree or Shrub		Stem Count	7		5		6		8		26		31		43		43		
P = Planted, T = Total		Stems/Acre	280		200		240		320		260		310		430		430		

Appendix C – Vegetation Problem Areas Photos (photos recorded on 10/1/09)



VPA 1 – Cattail – Throughout the project site

All pictures recorded on 10/1/09

Appendix C – Vegetation Problem Area inventory Table

	Species	Total Planted Stems	# plots	Avg # stems	VP2	VP3
	<i>Betula nigra</i>	1	1	1	1	
	<i>Carpinus caroliniana</i> var. <i>caroliniana</i>					
	<i>Cephalanthus occidentalis</i>					
	<i>Cornus amomum</i>	3	2	1.5	1	2
	<i>Liriodendron tulipifera</i> var. <i>tulipifera</i>					
	<i>Platanus occidentalis</i> var. <i>occidentalis</i>	2	2	1	1	1
	<i>Quercus lyrata</i>	4	2	2	2	2
	<i>Quercus pagoda</i>					
	<i>Quercus phellos</i>					
	<i>Salix sericea</i>	1	1	0.5		1
TOT:	10	11	8	3	5	6

APPENDIX D

Appendix D - Stream Photo Station Photos (all photos recorded on October 1, 2009)



Photo Station 1. Beginning of Western Reach – Upstream



Photo Station 2. Beginning of Western Reach – Downstream

All photos recorded on October 1, 2009



Photo Station 3. Riffle Cross-section 1 – Downstream – Western Reach



Photo Station 4 Riffle Cross-section 1 – Upstream – Western Reach

All photos recorded on October 1, 2009



Photo Station 5. Pool Cross-section 2 - Downstream – Western Reach



Photo Station 6. Pool Cross-section – Upstream – Western Reach

All photos recorded on October 1, 2009



Photo Station 9. Beginning of Upper Reach – Upstream



Photo Station 10. Beginning of Upper Reach – Downstream

All photos recorded on October 1, 2009



Photo Station 11. Pool Cross-section 3 – Downstream – Upper Reach



Photo Station 12. Pool Cross-section 3 – Upstream – Upper Reach

All photos recorded on October 1, 2009



Photo Station 13. Riffle Cross-section 4 – Downstream – Upper Reach



Photo Station 14. Riffle Cross-section 4 – Upstream – Upper Reach

All photos recorded on October 1, 2009



Photo Station 17. Confluence of Western and Upper Reaches – Western Reach



Photo Station 18. Confluence of Western and Upper Reaches – Upper Reach

All photos recorded on October 1, 2009



Photo Station 19. Ford Crossing – Downstream – Middle Reach



Photo Station 20. Ford Crossing – Upstream – Middle Reach

All photos recorded on October 1, 2009



Photo Station 23. Riffle Cross-section 5 - Downstream – Middle Reach



Photo Station 24. Riffle Cross-section 5 - Upstream – Middle Reach

All photos recorded on October 1, 2009



Photo Station 25. Pool Cross-section 6 - Downstream – Middle Reach



Photo Station 26. Pool Cross-section 6 - Upstream – Middle Reach

All photos recorded on October 1, 2009



Photo Station 31. Riffle Cross-section 7 – Upstream – Lower Reach



Photo Station 32. Riffle Cross-section 7 – Downstream – Lower Reach

All photos recorded on October 1, 2009



Photo Station 33. Pool Cross-Section 8 – Upstream – Lower Reach



Photo Station 34. End of Project – Upstream – Lower Reach

All photos recorded on October 1, 2009

**Table 8A. Visual Morphological Stability Assessment
Mill Branch Stream Restoration Site/EEP Project No. 0251
Western Reach**

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?	29	29	0.00	100.00	
	2. Armor stable (eg no displacement?)	NA	NA	NA	NA	
	3. Facet grade appears stable?	29	29	0.00	100.00	
	4. Minimal evidence of embedding/fining?	29	29	0.00	100.00	
	5. Length appropriate?	29	29	0.00	100.00	100
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	30	30	0.00	100.00	
	2. Sufficiently deep (Max Pool D:Mean Bkf > 1.6?)	30	30	0.00	100.00	
	3. Length appropriate?	30	30	0.00	100.00	100
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	NA	NA	NA		
	2. Downstream of meander (glide/inflection) centering?	NA	NA	NA		NA
D. Meanders	1. Outer bend in state of limited/controlled erosion?	30	30	0.00	100.00	
	2. Of those eroding, # w/concomitant point bar formation?	30	30	0.00	100.00	
	3. Apparent Rc within spec?	30	30	0.00	100.00	
	4. Sufficient floodplain access and relief?	30	30	0.00	100.00	100
E. Bed General	1. General channel bed aggradation areas (bar formation)	1765	1765	0.00	100.00	
	2. Channel bed degradation - areas of increasing down-cutting or head-cutting?	1765	1765	0.00	100.00	0
F. Bank	1. Actively eroding, wasting, or slumping bank?	1765	1765	0.00	100.00	0
G. Vanes	1. Free of back or arm scour?	8	8	0.00	100.00	
	2. Height appropriate?	8	8	0.00	100.00	
	3. Angle and geometry appear appropriate?	8	8	0.00	100.00	
	4. Free of piping or other structural failures?	8	8	0.00	100.00	100
H. Wads/Boulders	1. Free of scour?	NA	NA	NA	NA	
	2. Footing stable?	NA	NA	NA	NA	NA

**Table 8B. Visual Morphological Stability Assessment
Mill Branch Stream Restoration Site/EEP Project No. 0251
Upper Reach**

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?	15	15	0.00	100.00	
	2. Armor stable (eg no displacement?)	NA	NA	0.00	NA	
	3. Facet grade appears stable?	15	15	0.00	100.00	
	4. Minimal evidence of embedding/fining?	15	15	0.00	100.00	
	5. Length appropriate?	15	15	0.00	100.00	100
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	15	15	0.00	100.00	
	2. Sufficiently deep (Max Pool D:Mean Bkf > 1.6?)	15	15	0.00	100.00	
	3. Length appropriate?	15	15	0.00	100.00	100
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	NA	NA	NA		
	2. Downstream of meander (glide/inflection) centering?	NA	NA	NA		NA
D. Meanders	1. Outer bend in state of limited/controlled erosion?	15	15	0.00	100.00	
	2. Of those eroding, # w/concomitant point bar formation?	15	15	0.00	100.00	
	3. Apparent Rc within spec?	15	15	0.00	100.00	
	4. Sufficient floodplain access and relief?	15	15	0.00	100.00	100
E. Bed General	1. General channel bed aggradation areas (bar formation)	1439	1439	0.00	100.00	
	2. Channel bed degradation - areas of increasing down-cutting or head-cutting?	1439	1439	0.00	100.00	100
F. Bank	1. Actively eroding, wasting, or slumping bank?	1439	1439	0.00	100.00	100
G. Vanes	1. Free of back or arm scour?	7	7	0.00	100.00	
	2. Height appropriate?	7	7	0.00	100.00	
	3. Angle and geometry appear appropriate?	7	7	0.00	100.00	
	4. Free of piping or other structural failures?	7	7	0.00	100.00	100
H. Wads/Boulders	1. Free of scour?	NA	NA	NA	NA	
	2. Footing stable?	NA	NA	NA	NA	NA

**Table 8C. Visual Morphological Stability Assessment
Mill Branch Stream Restoration Site/EEP Project No. 0251
Middle Reach**

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?	42	42	0	100.00	
	2. Armor stable (eg no displacement?)	NA	NA	NA	NA	
	3. Facet grade appears stable?	42	42	0	100.00	
	4. Minimal evidence of embedding/fining?	42	42	0	100.00	
	5. Length appropriate?	42	42	0	100.00	100
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	41	42	1	97.62	
	2. Sufficiently deep (Max Pool D:Mean Bkf > 1.6?)	41	42	1	97.62	
	3. Length appropriate?	42	42	0	100.00	98
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	NA	NA	NA		
	2. Downstream of meander (glide/inflection) centering?	NA	NA	NA		NA
D. Meanders	1. Outer bend in state of limited/controlled erosion?	41	42	1	97.62	
	2. Of those eroding, # w/concomitant point bar formation?	41	42	1	97.62	
	3. Apparent Rc within spec?	42	42	0	100.00	
	4. Sufficient floodplain access and relief?	39	42	3	92.86	97
E. Bed General	1. General channel bed aggradation areas (bar formation)	2535	2555	20	99.22	
	2. Channel bed degradation - areas of increasing down-cutting or head-cutting?	2540	2555	15	99.41	99
F. Bank	1. Actively eroding, wasting, or slumping bank?	2545	2555	10	99.61	100
G. Vanes	1. Free of back or arm scour?	19	20	1	95.00	
	2. Height appropriate?	18	20	2	90.00	
	3. Angle and geometry appear appropriate?	18	20	2	90.00	
	4. Free of piping or other structural failures?	17	20	3	85.00	90
H. Wads/Boulders	1. Free of scour?	1	1	0	100.00	
	2. Footing stable?	1	1	0	100.00	100

**Table 8D. Visual Morphological Stability Assessment
Mill Branch Stream Restoration Site/EEP Project No. 0251**

Lower Reach

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?	19	19	0	100.00	
	2. Armor stable (eg no displacement?)	NA	NA	NA	NA	
	3. Facet grade appears stable?	19	19	0	100.00	
	4. Minimal evidence of embedding/fining?	19	19	0	100.00	
	5. Length appropriate?	19	19	0	100.00	100
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	18	18	0	100.00	
	2. Sufficiently deep (Max Pool D:Mean Bkf > 1.6?)	18	18	0	100.00	
	3. Length appropriate?	18	18	0	100.00	100
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	NA	NA	NA		
	2. Downstream of meander (glide/inflection) centering?	NA	NA	NA		NA
D. Meanders	1. Outer bend in state of limited/controlled erosion?	17	18	1	94.44	
	2. Of those eroding, # w/concomitant point bar formation?	18	18	0	100.00	
	3. Apparent Rc within spec?	18	18	0	100.00	
	4. Sufficient floodplain access and relief?	16	18	2	88.89	96
E. Bed General	1. General channel bed aggradation areas (bar formation)	1748	1748	0	100.00	
	2. Channel bed degradation - areas of increasing down-cutting or head-cutting?	1748	1748	0	100.00	100
F. Bank	1. Actively eroding, wasting, or slumping bank?	1728	1748	20	98.86	99
G. Vanes	1. Free of back or arm scour?	16	17	1	94.12	
	2. Height appropriate?	15	17	2	88.24	
	3. Angle and geometry appear appropriate?	15	17	2	88.24	
	4. Free of piping or other structural failures?	17	17	0	100.00	93
H. Wads/Boulders	1. Free of scour?	1	1	0	100.00	
	2. Footing stable?	1	1	0	100.00	100

Appendix D – Verification of Bankfull Events

Table 9. Verification of Bankfull Events			
East Tarboro Canal Stream Restoration Site - EEP Project No. 123			
Date of Data Collection	Date of Occurrence	Method	Photo
October 1, 2009	September/October 2009	Visual Observation	Stream Photos 33

Project Name	Mill Branch
Cross Section	Cross-Section 1 - Western Reach
Feature	Riffle
Date	8/1/09
Crew	Tutt, Stafford

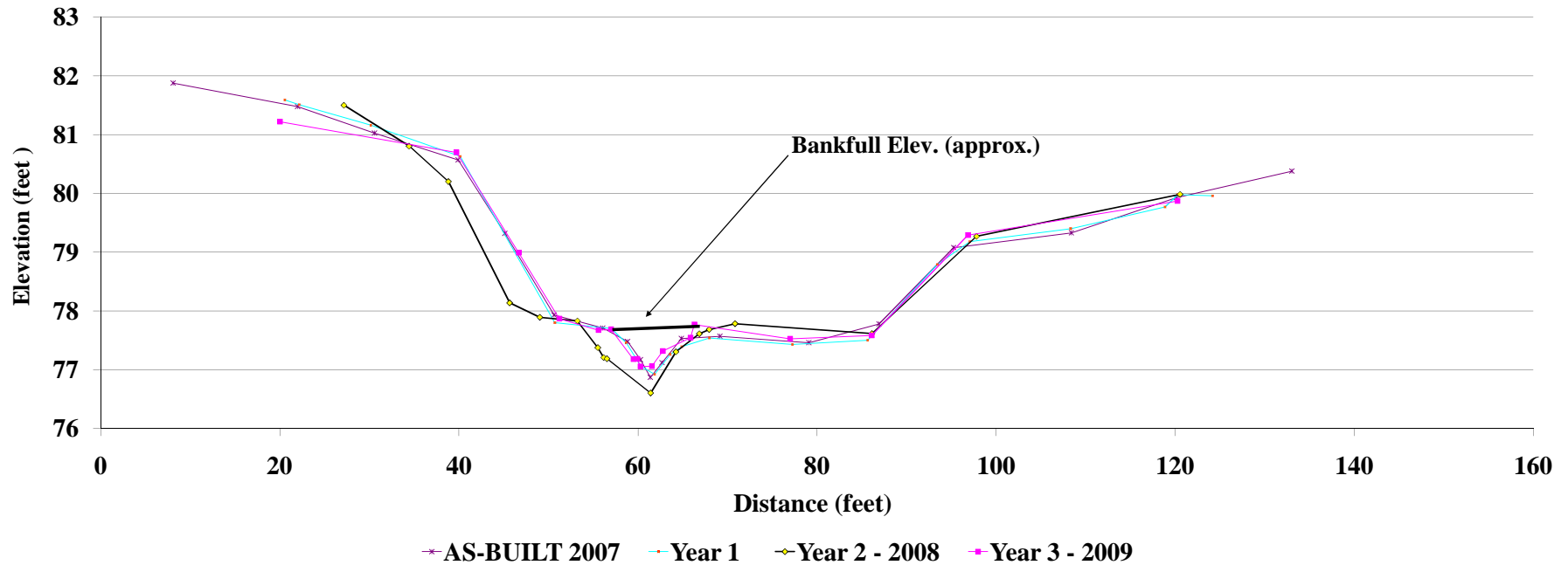
Year 5 - 2012 2012 Survey			Year 4 - 2011 2011 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 2007 Survey			AS-BUILT 2007 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
						20	81.223		27.2	81.5		20.54	81.59		8.1	81.9	
						39.72	80.6988		34.4	80.8		22.12	81.51		22.0	81.5	LPIN
						46.69	78.9918		38.8	80.2		30.12	81.16		30.6	81.03	
						51.21	77.869		45.7	78.1		40.13	80.63		39.9	80.6	
						55.58	77.6746		49.0	77.9		50.7	77.8		45.1	79.3	
						57	77.6874		53.2	77.8		57.01	77.7		50.6	77.9	
						59.49	77.1795		55.5	77.4		58.64	77.46		56.1	77.7	
						59.92	77.1808		56.2	77.2		60.3	77.06		58.9	77.5	LBKF
						60.25	77.0541		56.5	77.2		61.85	76.92		60.3	77.2	
						61.55	77.0577		61.4	76.6		63.6	77.26		61.4	76.9	
						62.75	77.314		64.2	77.3		64.88	77.39		62.7	77.1	
						65.86	77.5454		66.8	77.6		67.97	77.54		64.8	77.5	RBKF
						66.28	77.7664		67.9	77.7		77.23	77.43		69.1	77.6	
						76.98	77.5233		70.8	77.8		85.63	77.5		79.1	77.5	
						86.11	77.5823		86.1	77.6		93.42	78.79		86.9	77.8	
						96.84	79.2929		97.8	79.3		97.04	79.18		95.2	79.1	
						120.24	79.8711		120.5	80.0		108.31	79.4		108.4	79.33	
												118.85	79.77		120.1	79.9	RPIN
												120.29	79.98				
												124.16	79.96				



Photo of Cross-Section 1 - Looking Downstream @ STA 2+15

	Year 5 - 2012	Year 4 - 2011	Year 3 - 2009	Year 2 - 2008	Year 1	AS-BUILT 2007
Area			4.1	4.0	2.3	1.8
Width			23.4	19.5	8.7	6.0
Mean Depth			0.2	0.2	0.3	0.3
Max Depth			0.6	1.1	0.6	0.6
W/D			133.0	96.0	33.5	19.8

Mill Branch 2009 - Riffle Cross Section 1- Western Reach STA: 2+15



Project Name	Mill Branch
Cross Section	Cross-Section 2 - Western Reach
Feature	Riffle
Date	8/1/09
Crew	Tutt, Stafford

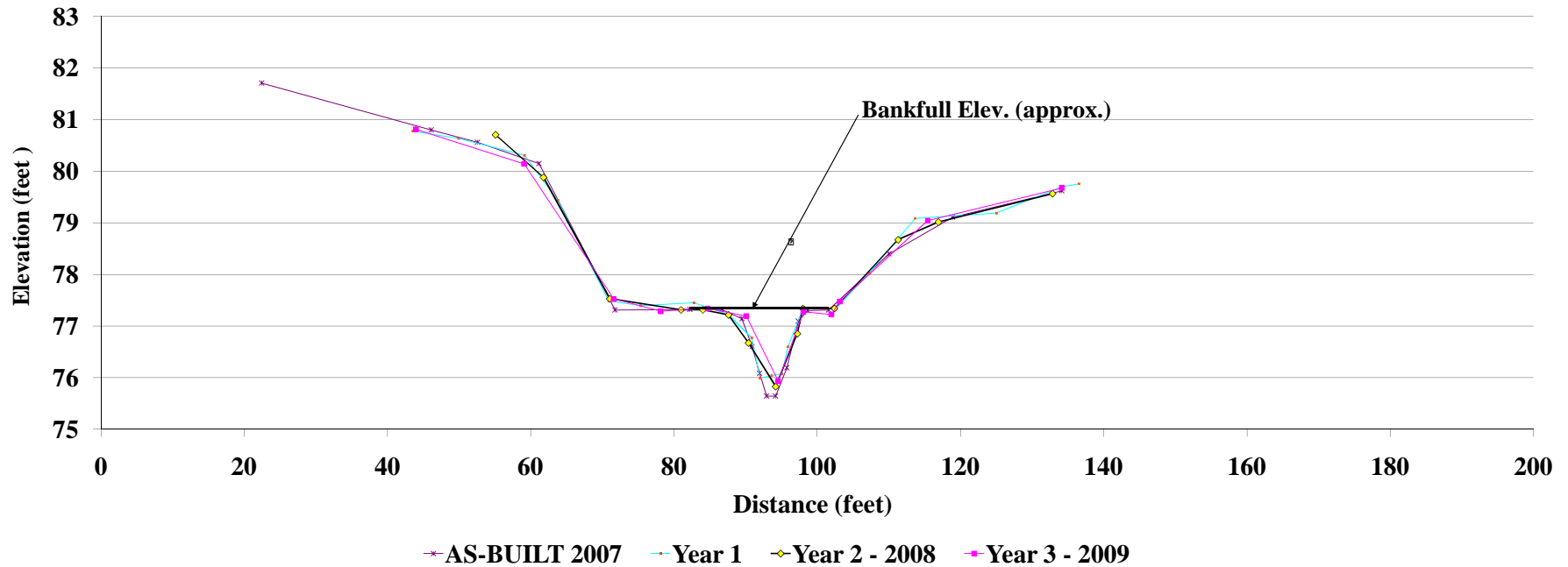
Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 2007 Survey			AS-BUILT 2007 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
						44	80.8122		55.10	80.71		43.56	80.78		22.5	81.7	
						59.09	80.1417		61.79	79.88		49.95	80.64		46.1	80.8	LPIN
						71.59	77.5265		71.05	77.53		59.14	80.31		52.6	80.56	
						78.17	77.2856		80.99	77.31		63.79	79.44		61.2	80.2	
						84.7	77.3397		84.05	77.32		70.9	77.49		71.8	77.3	
						90.13	77.1907		87.63	77.22		75.34	77.4		82.3	77.3	LBKF
						94.53	75.9317		90.42	76.67		82.81	77.45		86.7	77.3	
						98.08	77.2774		94.20	75.83		87.69	77.22		89.5	77.1	
						101.98	77.2239		97.23	76.85		90.87	76.77		90.9	76.6	
						103.17	77.4773		97.99	77.34		92.02	75.99		92.0	76.1	
						115.44	79.0432		102.41	77.34		93.64	76.04		92.9	75.6	
						134.15	79.6761		111.29	78.67		95.07	76.07		94.2	75.6	
									116.92	79.02		95.93	76.6		95.8	76.2	
									132.86	79.57		98.1	77.37		97.4	77.1	
												102.53	77.32		98.7	77.3	
												107.26	78.03		101.6	77.31	RBKF
												113.67	79.09		110.0	78.4	
												125.03	79.19		118.9	79.1	
												134.13	79.7		134.2	79.6	RPIN
												136.53	79.76		150.8	80.1	



Photo of Cross-Section 2 - Looking Upstream @ STA 2+50

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1	AS-BUILT 2007
Area			6.7	8.2	7.5	8.7
Width			23.7	17.4	11.2	11.7
Mean Depth			0.3	0.5	0.7	0.7
Max Depth			1.4	1.3	1.3	1.7
W/D			83.2	37.1	16.7	15.7

Mill Branch 2009 - Pool Cross Section 2 - Western Reach STA: 2+50



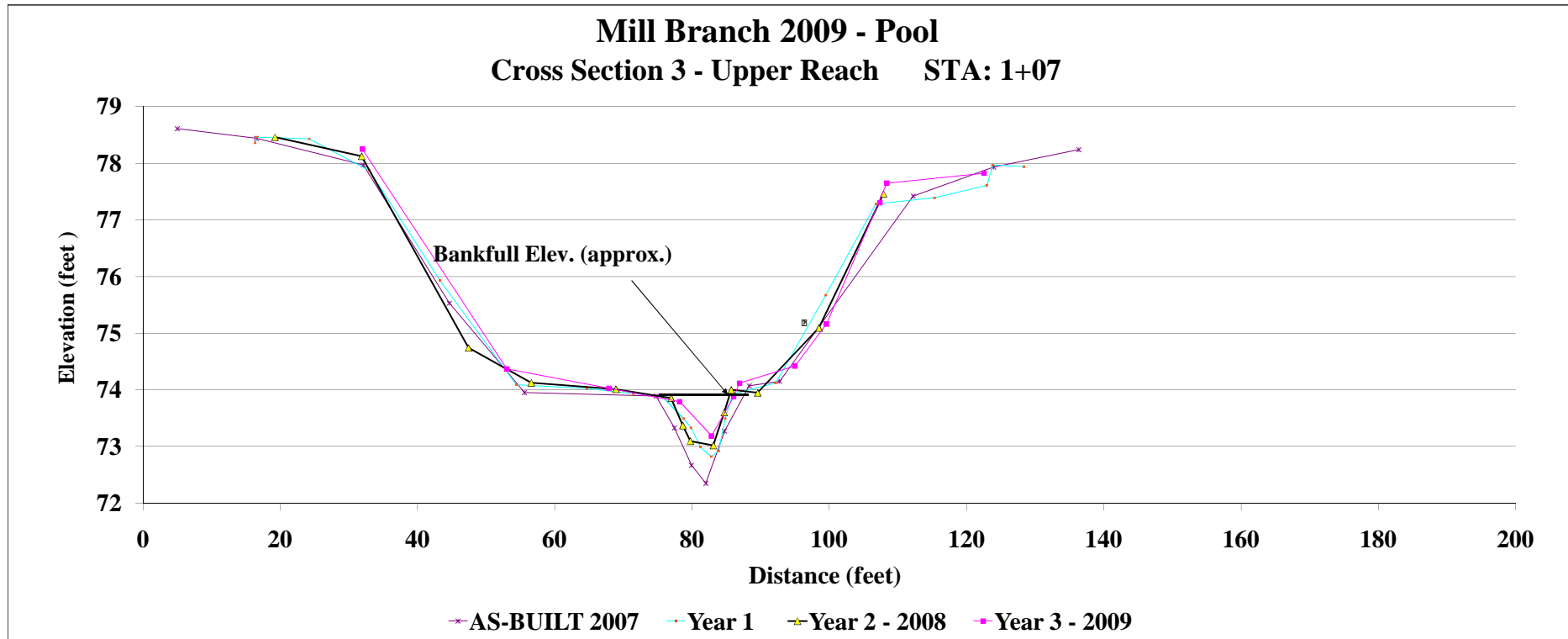
Project Name	Mill Branch
Cross Section	Cross-Section 3 - Upper Reach
Feature	Pool
Date	Aug-09
Crew	Tutt, Stafford

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 2007 Survey			AS-BUILT 2007 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
						32	78.2458		19.25	78.46		16.37	78.36		5.0	78.6	
						53.03	74.3698		31.88	78.12		16.57	78.46		16.5	78.4	
						67.89	74.027		47.44	74.74		24.25	78.43		32.1	77.97	LPIN
						78.2	73.7915		56.58	74.13		33.02	77.87		44.7	75.5	
						82.83	73.1871		68.91	74.01		43.29	75.93		55.6	74.0	
						86.07	73.8822		76.96	73.85		54.4	74.09		74.8	73.9	LBKF
						86.92	74.1171		78.67	73.37		64.66	74.02		77.4	73.3	
						95.02	74.4213		79.76	73.09		71.46	73.93		79.9	72.7	
						99.58	75.1633		83.12	73.02		75.54	73.89		82.0	72.4	
						108.39	77.6479		84.69	73.60		78.79	73.49		84.8	73.3	RBKF
						122.55	77.8251		85.72	74.00		79.85	73.33		88.3	74.1	
									89.58	73.95		81.23	72.99		92.8	74.2	
									107.4	77.3		82.8	72.82		112.2	77.4	
												83.89	72.92		123.9	77.9	RPIN
												84.85	73.49		136.4	78.2	
												85.92	73.92				
												92.18	74.12				
												99.48	75.67				
												106.77	77.28				
												115.33	77.39				
												122.93	77.61				
												123.83	77.97				
												128.35	77.94				



Photo of Cross-Section 3 - Looking Downstream @ STA 1+07

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1	AS-BUILT 2007
Area			2.6	2.0	5.8	9.8
Width			8.4	7.3	11.1	12.7
Mean Depth			0.3	0.3	0.5	0.8
Max Depth			0.8	1.0	1.1	1.5
W/D			27.6	26.9	21.2	16.6



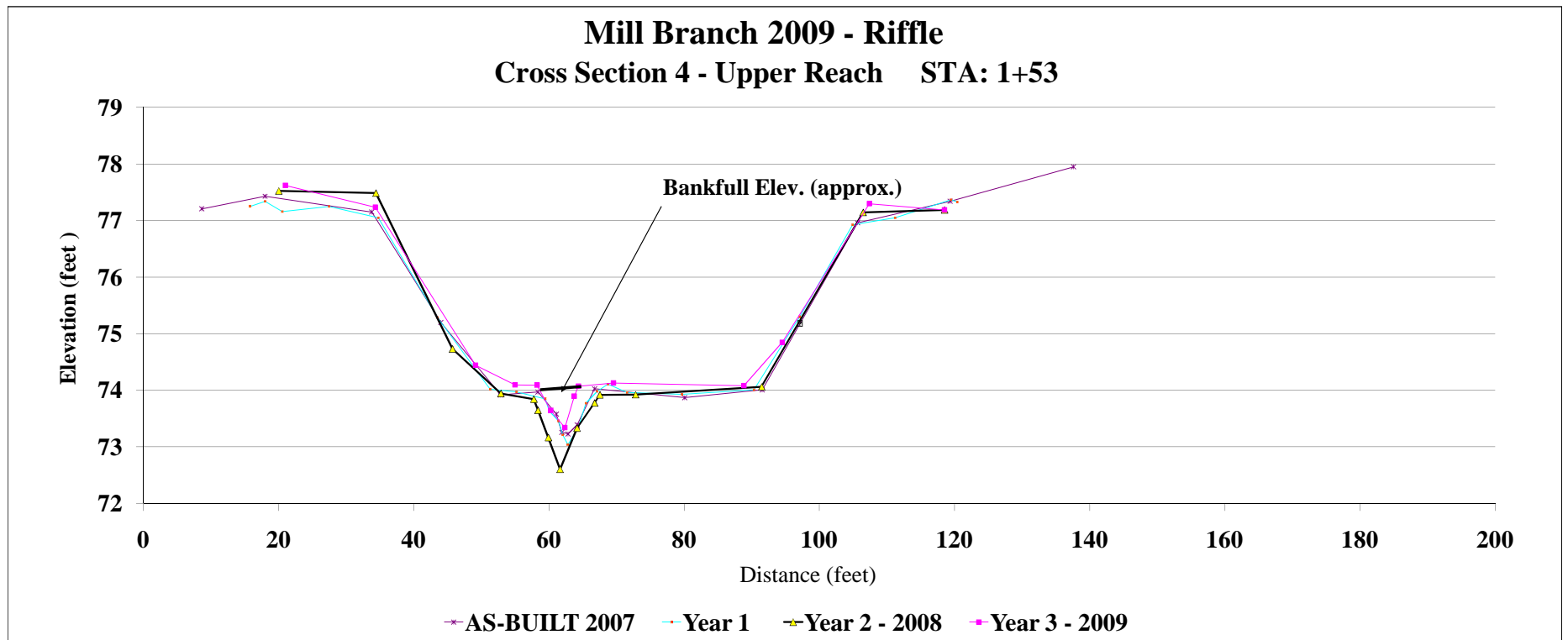
Project Name	Mill Branch
Cross Section	Cross-Section 4 - Upper Reach
Feature	Riffle
Date	Aug-09
Crew	Tutt Stafford

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 2007 Survey			AS-BUILT 2007 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
						21	77.5216		20.00	77.53		15.71	77.26		8.63	77.21	
						34.31	77.2356		34.38	77.49		15.74	77.25		18.00	77.43	LPIN
						49.14	74.4418		45.71	74.73		17.97	77.34		33.76	77.15	
						54.99	74.0989		52.87	73.95		20.51	77.16		43.99	75.20	
						58.22	74.0938		57.74	73.85		27.45	77.25		52.83	73.92	
						60.25	73.6464		58.36	73.65		34.71	77.05		58.36	73.97	LBKF
						62.34	73.3414		59.89	73.17		43.48	75.29		61.09	73.58	
						63.73	73.8989		61.62	72.61		51.28	74.02		61.89	73.26	
						64.36	74.0738		64.14	73.33		55.19	73.97		62.82	73.23	
						69.53	74.1309		66.74	73.78		59.44	73.85		64.17	73.39	
						88.85	74.0824		67.52	73.92		80.02	73.63		66.74	74.03	RBKF
						94.5	74.8464		72.80	73.92		61.39	73.46		80.08	73.87	
						107.4	77.3		91.46	74.06		62.01	73.21		91.55	74.01	
						118.5	77.2		106.47	77.15		62.76	73.04		105.64	76.96	
									118.51	77.19		64.31	73.33		119.34	77.34	RPIN
												65.45	73.77		137.60	77.95	
												67.1	73.98				
												68.7	74.11				
												71.52	73.96				
												79.67	73.93				
												90.3	74.0				
												97.1	75.30				
												104.9	76.9				
												111.2	77.1				
												119.5	77.4				
												120.4	77.3				



Photo of Cross-Section 1 - Looking Downstream @ STA 1+53

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1	AS-BUILT 2007
Area			1.7	2.4	3.7	3.2
Width			6.7	8.5	8.4	8.1
Mean Depth			0.3	0.3	0.4	0.4
Max Depth			0.8	1.3	0.9	0.7
W/D			26.8	30.6	18.9	20.6



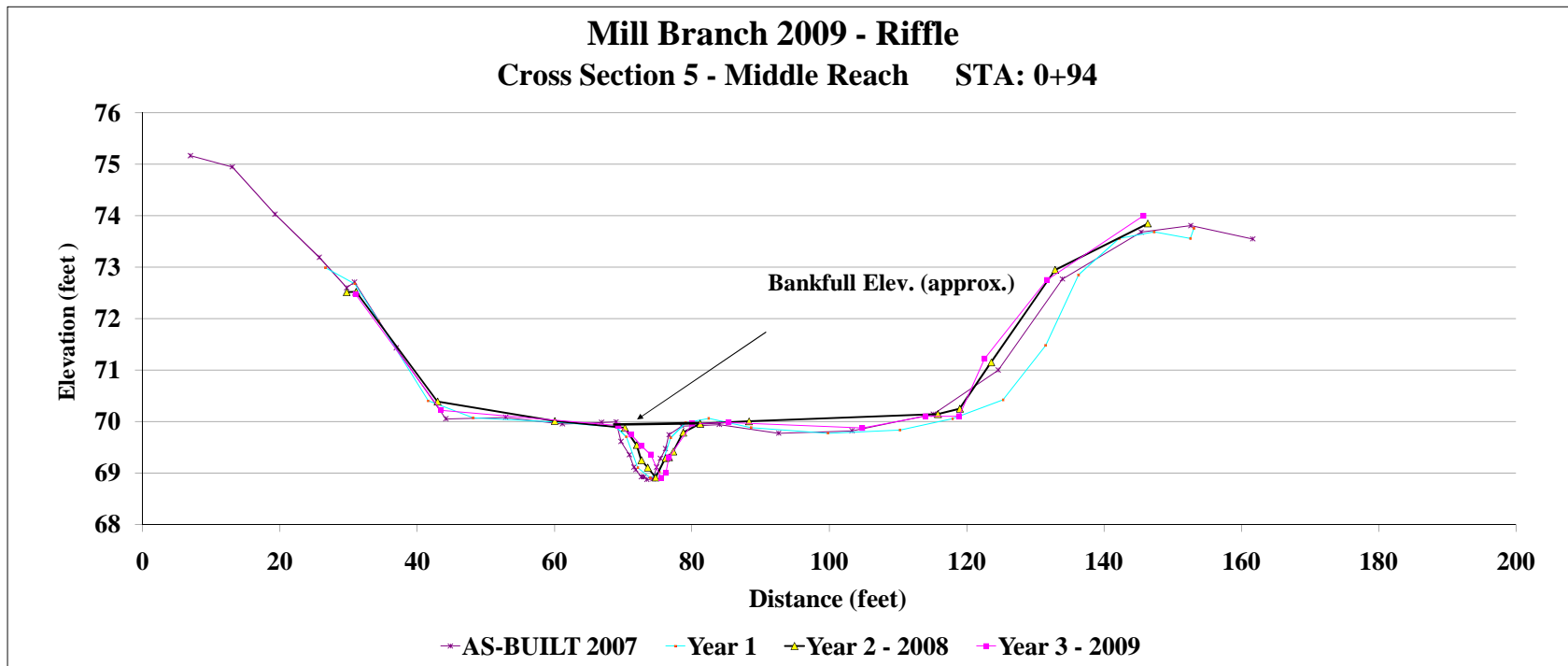
Project Name	Mill Branch
Cross Section	Cross-Section 5 - Middle Reach
Feature	Riffle
Date	Aug-09
Crew	Tutt, Stafford

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 2007 Survey			AS-BUILT 2007 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
						31	72.473		29.70	72.52		26.63	72.99		7.0	75.2	
			43.4	70.2199		43.4	70.2199		31.08	72.52		30.9	72.68		13.1	75.0	
			69.2	69.919		69.2	69.919		42.94	70.39		34.38	71.95		19.3	74.0	
			71.15	69.741		71.15	69.741		60	70.01		41.58	70.4		25.8	73.2	
			72.6	69.5243		72.6	69.5243		70.22	69.88		48.12	70.07		29.7	72.6	
			74.01	69.352		74.01	69.352		71.95	69.54		59.86	69.99		30.9	72.7	
			75.51	68.8994		75.51	68.8994		72.63	69.25		68.98	69.89		37.0	71.4	LPIN
			76.19	68.9999		76.19	68.9999		73.55	69.10		70.44	69.7		44.2	70.1	
			76.61	69.3021		76.61	69.3021		74.69	68.91		72.13	69.1		52.9	70.1	
			80.02	69.9571		80.02	69.9571		76.15	69.29		73.93	68.9		61.1	70.0	
			85.32	69.9822		85.32	69.9822		76.65	69.30		75.27	69.02		66.9	70.0	LBKF
			104.81	69.8731		104.81	69.8731		77.27	69.42		78.9	69.68		69.0	70.0	
			114.0	70.1		114.0	70.1		78.72	69.78		79.08	69.97		69.7	69.6	
			118.9	70.1		118.9	70.1		81.18	69.96		82.45	70.06		70.9	69.4	
			122.6	71.2		122.6	71.2		88.29	70.00		88.6	69.88		71.6	69.1	
			131.7	72.8		131.7	72.8		115.81	70.14		99.81	69.77		71.8	69.1	
			145.8	74.0		145.8	74.0		119	70.25		110.3	69.83		72.6	68.9	
									123.58	71.15		117.95	70.05		73.0	68.9	
									132.88	72.95		125.31	70.42		73.4	68.9	
									146.38	73.85		131.5	71.48		74.3	68.9	
												136.29	72.85		74.8	69.1	
												142.21	73.56		75.4	69.3	
												147.31	73.69		76.1	69.5	
												152.59	73.56		76.7	69.7	
												153.1	73.76		78.5	69.9	RBKF
															81.3	69.9	
															84.0	69.9	
															92.6	69.8	
															103.3	69.8	
															115.1	70.1	
															124.6	71.0	
															133.9	72.8	
															145.4	73.7	
															152.6	73.8	RPIN
															161.7	73.6	



Photo of Cross-Section 5 - Looking Downstream @ STA 0+94

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1	AS-BUILT 2007
Area			4.0	3.9	5.1	5.2
Width			15.8	8.6	9.7	9.5
Mean Depth			0.3	0.5	0.5	0.6
Max Depth			1.0	1.0	1.0	1.0
W/D			61.9	19.0	18.8	17.2



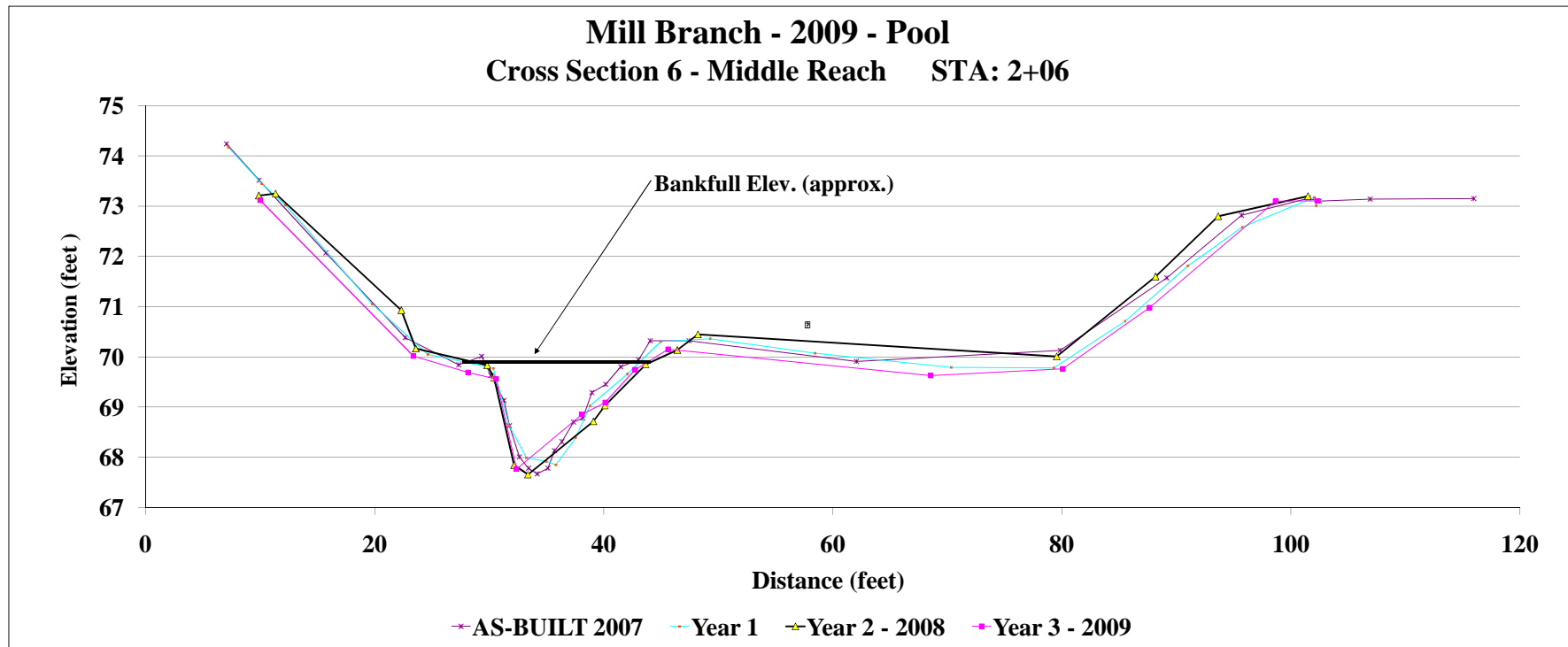
Project Name Mill Branch
 Cross Section Cross-Section 6 - Middle Reach
 Feature Pool
 Date Aug-09
 Crew Tutt, Stafford

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 2007 Survey			AS-BUILT 2007 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
						10	73.119		9.90	73.21		7.23	74.17		7.1	74.24	
						23.38	70.0153		11.37	73.25		10.15	73.44		9.9	73.52	LPIN
						28.16	69.6893		22.34	70.93		12.22	73.02		15.8	72.07	
						30.61	69.5584		23.60	70.17		19.78	71.05		22.7	70.38	
						32.38	67.7646		29.84	69.84		24.65	70.05		27.3	69.84	LBKF
						38.1	69.3541		30.42	69.59		30.36	69.77		29.4	70.01	
						40.14	69.0907		32.19	67.85		31.75	68.63		30.2	69.63	
						42.75	69.7453		33.39	67.66		33.25	67.99		31.3	69.13	
						45.63	70.1485		39.12	68.72		34.99	67.92		31.8	68.63	
						68.55	69.6246		40.12	69.04		35.82	67.85		32.6	68.01	
						80.09	69.7603		43.68	69.85		37.55	68.39		33.4	67.78	
						87.65	70.983		46.44	70.14		38.81	69.02		34.2	67.67	
						98.7	73.1		48.24	70.45		42.08	69.66		35.1	67.78	
						102.3	73.1		70.56	70.01		44.99	70.3		35.7	68.13	RBKF
									88.20	71.60		49.3	70.36		36.4	68.31	
									93.65	72.80		58.47	70.07		37.4	68.70	
									101.50	73.20		70.35	69.79		38.2	68.78	
												79.29	69.78		39.0	69.29	
												85.54	70.71		40.2	69.45	
												91.02	71.81		41.5	69.80	
												95.76	72.58		43.1	69.94	RBKF
												102.06	73.17		44.1	70.32	
												102.23	73.01		47.5	70.32	
															62.1	69.91	
															79.9	70.13	
															89.2	71.57	
															95.7	72.82	
															101.5	73.16	RPIN
															102.5	73.10	
															106.9	73.14	
															116.0	73.15	



Photo of Cross-Section 6 - Looking Downstream @ STA 2+06

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1	AS-BUILT 2007
Area						
Width			11.0	14.8	16.6	15.5
Mean Depth			20.6	19.0	14.2	13.7
Max Depth			0.5	0.8	1.2	1.1
W/D			2.2	2.5	2.2	2.3
			38.6	24.4	12.2	12.1



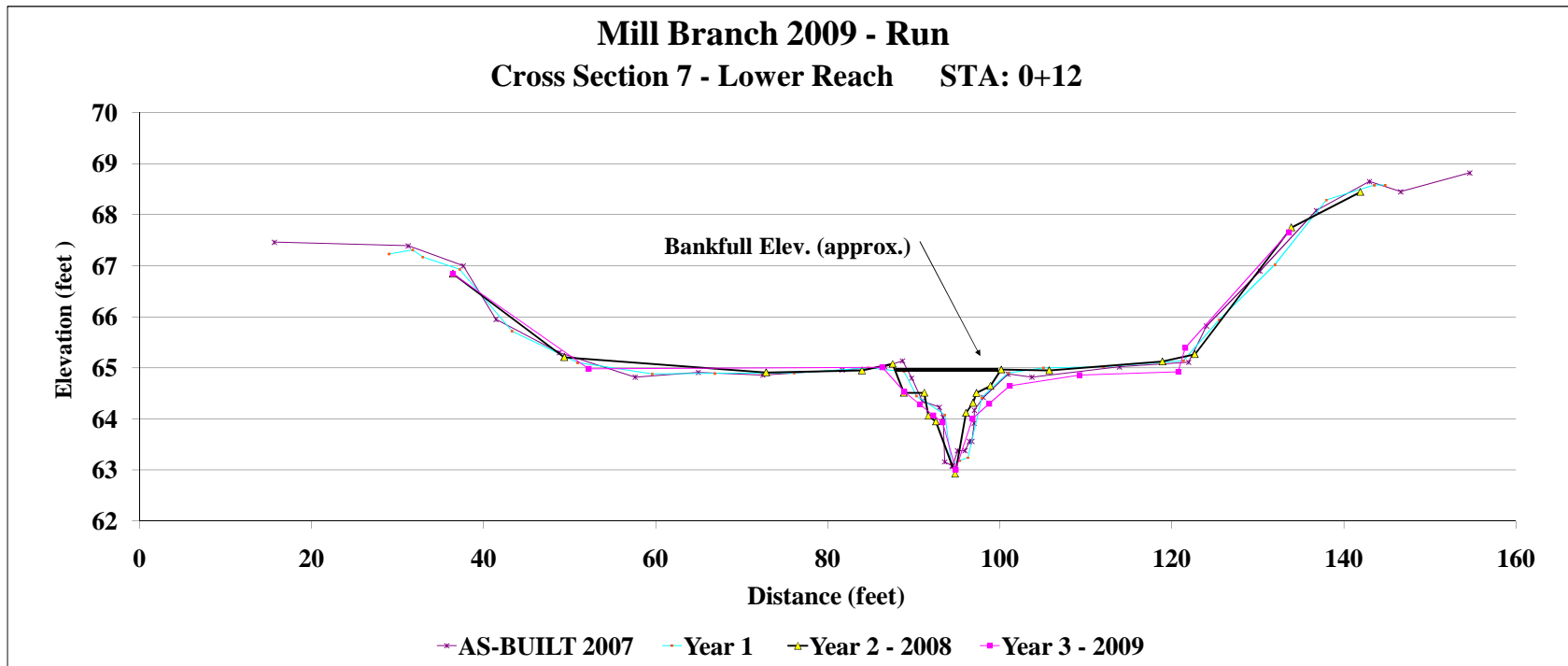
Project Name	Mill Branch
Cross Section	Cross-Section 7 - Lower Reach
Feature	Riffle
Date	Aug-09
Crew	Tutt, Stafford

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 2007 Survey			AS-BUILT 2007 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
						36.40	66.85		36.40	66.85		29.01	67.23		15.7	67.5	
						52.22	64.98		49.36	65.21		31.77	67.31		31.2	67.4	LPIN
						86.33	65.01		72.83	64.91		32.93	67.17		37.6	67.00	
						88.89	64.5312		83.97	64.95		37.21	66.93		41.4	66.0	
						90.72	64.287		87.54	65.08		43.28	65.72		48.8	65.3	
						92.28	64.066		88.83	64.51		50.94	65.1		57.6	64.8	
						93.34	63.932		91.22	64.51		59.6	64.88		64.9	64.9	
						94.88	63.0065		91.70	64.06		66.87	64.89		72.4	64.9	
						96.84	64.0023		92.57	63.95		76.08	64.9		81.7	65.0	
						98.77	64.2934		94.80	62.93		84.71	65		86.6	65.0	
						101.17	64.6467		96.06	64.12		88.86	64.93		88.7	65.1	
						109.28	64.8596		96.88	64.32		90.3	64.45		89.7	64.8	
						120.74	64.9239		97.28	64.51		93.6	64.08		91.0	64.4	
						121.58	65.39		98.90	64.65		94.34	63.13		92.9	64.2	LBKF
						133.62	67.66		100.16	64.97		95.31	63.18		93.4	64.0	
						142.05	68.05		105.74	64.95		96.29	63.24		93.6	63.2	
									118.90	65.13		97.89	64.41		94.4	63.08	
									122.66	65.27		100.96	64.9		94.5	63.1	
									133.88	67.75		105.06	65		95.1	63.4	
									141.91	68.45		112.02	65.02		95.9	63.4	
												121.33	65.14		96.5	63.6	
												125.49	65.94		96.7	63.6	
												131.95	67.02		97.0	63.9	
												137.94	68.29		97.0	64.2	RBKF
												143.52	68.58		98.1	64.4	
												144.78	68.58		101.0	64.9	
															103.7	64.8	
															113.9	65.0	
															121.9	65.1	
															124.0	65.8	
															130.3	66.9	
															136.8	68.1	
															143.0	68.7	RPIN
															146.6	68.5	
															154.6	68.8	



Photo of Cross-Section 7 - Looking Upstream @ STA 0+12

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1	AS-BUILT 2007
Area			11.8	8.4	8.9	8.9
Width			20.4	14.7	11.8	10.8
Mean Depth			0.6	0.6	0.8	0.8
Max Depth			1.9	2.0	1.7	1.8
W/D			35.2	25.1	15.6	13.1



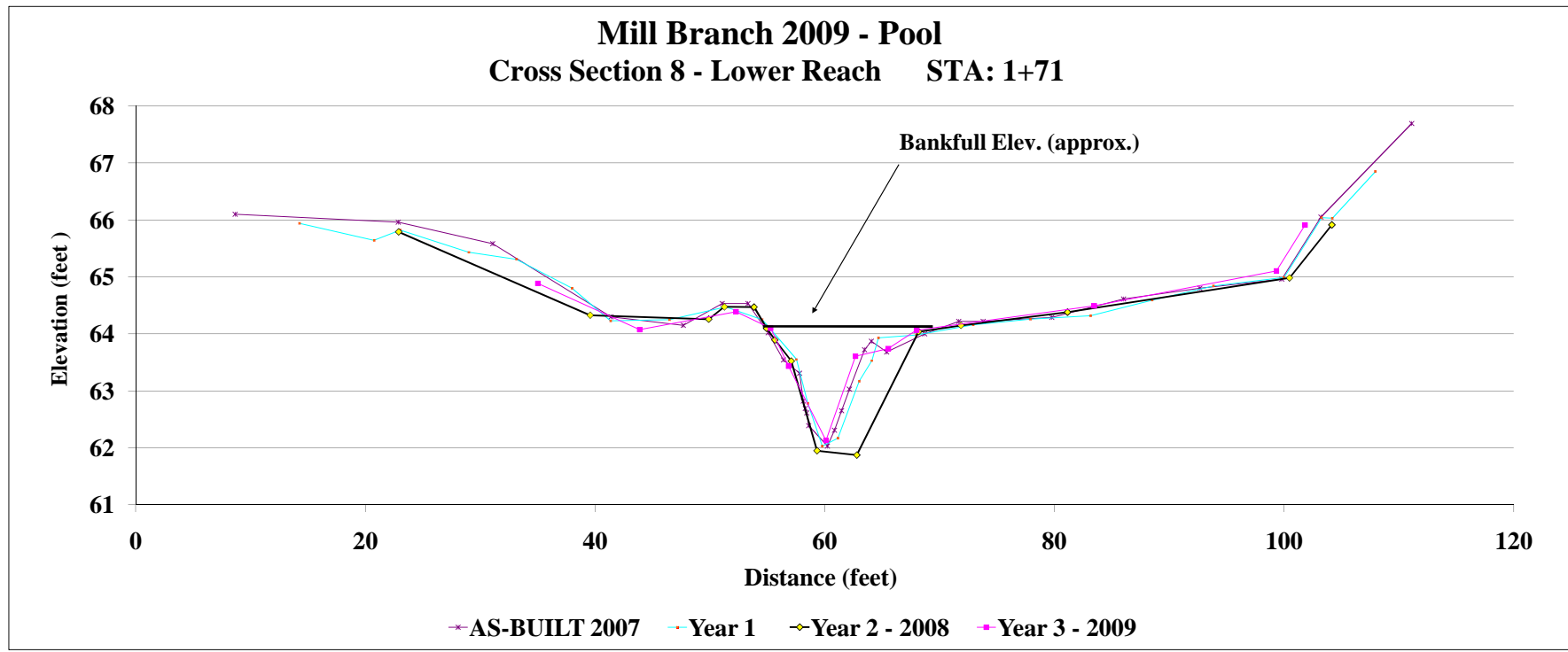
Project Name	Mill Branch
Cross Section	Cross-Section 8 - Lower Reach
Feature	Pool
Date	Aug-09
Crew	Tutt, Stafford

Year 5 - 2011 2011 Survey			Year 4 - 2010 2010 Survey			Year 3 - 2009 2009 Survey			Year 2 - 2008 2008 Survey			Year 1 2007 Survey			AS-BUILT 2007 AS-BUILT Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
						35	64.8848		22.90	65.79		14.25	65.94		8.7	66.1	
						43.87	64.0722		39.58	64.33		20.74	65.64		22.9	66.0	LPIN
						52.26	64.3871		49.89	64.26		23.03	65.82		31.1	65.58	
						55.28	64.0994		51.26	64.47		29	65.43		41.4	64.3	
						56.82	63.4339		53.84	64.47		33.14	65.31		47.7	64.2	
						60.1	62.1274		54.93	64.10		38	64.8		51.1	64.5	
						62.66	63.6054		55.66	63.89		41.35	64.23		53.3	64.5	
						65.51	63.7403		57.08	63.52		46.47	64.25		55.1	64.0	
						67.98	64.0635		59.33	61.95		51.39	64.47		56.4	63.5	LBKF
						83.44	64.4916		62.79	61.87		54.54	64.25		57.8	63.3	
						99.31	65.1068		68.17	64.04		57.52	63.55		58.1	62.8	
						101.8	65.9112		71.86	64.15		58.51	62.78		58.3	62.7	
									81.13	64.38		59.77	62.03		58.4	62.6	
									100.46	64.98		61.13	62.17		58.6	62.4	
												63	63.17		60.2	62.0	
												64.09	63.53		60.8	62.31	
												64.67	63.93		61.5	62.7	
												67.97	63.98		62.1	63.0	
												72.93	64.16		63.5	63.7	RBKF
												77.92	64.26		64.1	63.9	
												83.14	64.32		65.4	63.7	
												88.51	64.59		68.7	64.0	
												93.85	64.84		71.6	64.2	
												99.97	64.99		73.8	64.2	
												103.26	66.04		79.7	64.3	
												104.2	66.03		86.0	64.6	
												107.95	66.85		92.7	64.8	
															99.8	65.0	
															103.2	66.1	RPIN
															111.1	67.7	

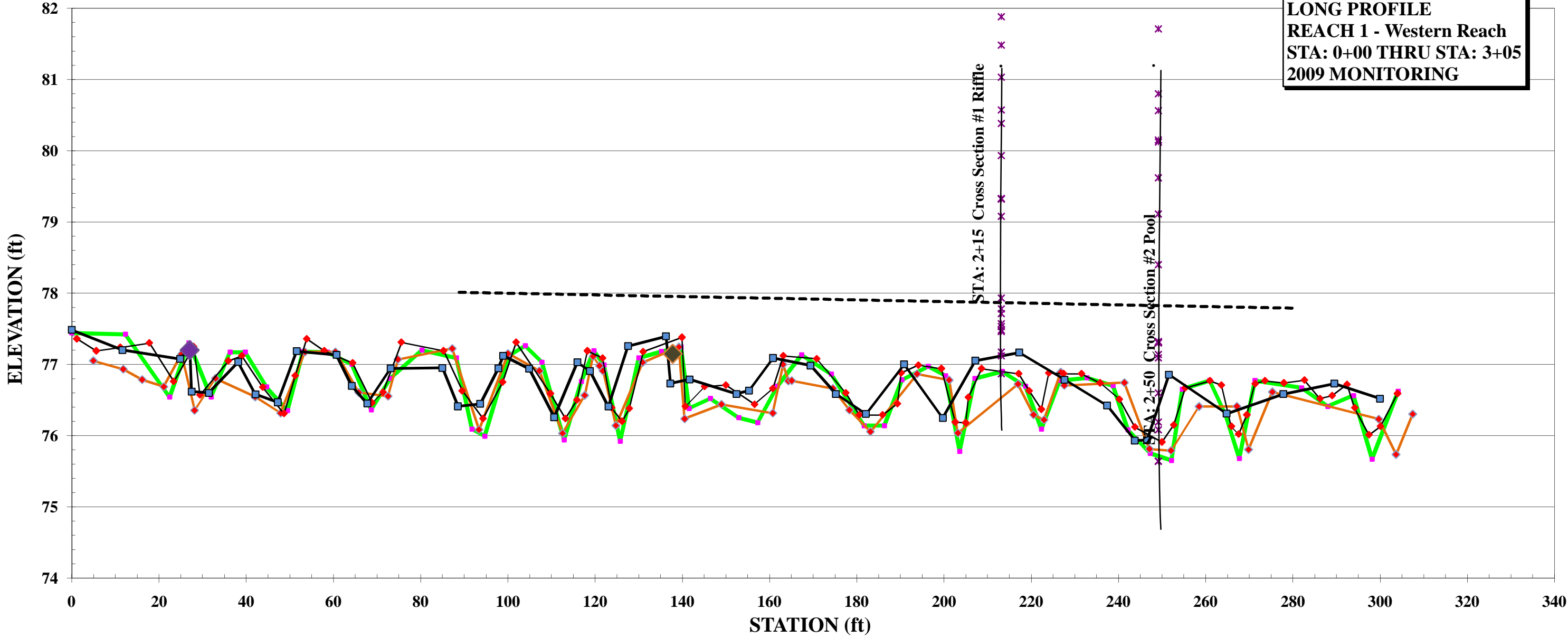


Photo of Cross-Section 8 - Looking Downstream @ STA 1+71

	Year 5 - 2011	Year 4 - 2010	Year 3 - 2009	Year 2 - 2008	Year 1	AS-BUILT 2007
Area			7.0	8.7	12.5	12.6
Width			15.4	11.2	16.9	17.0
Mean Depth			0.5	0.8	0.7	0.7
Max Depth			2.3	2.6	2.2	2.2
W/D			34.0	14.5	22.8	22.9

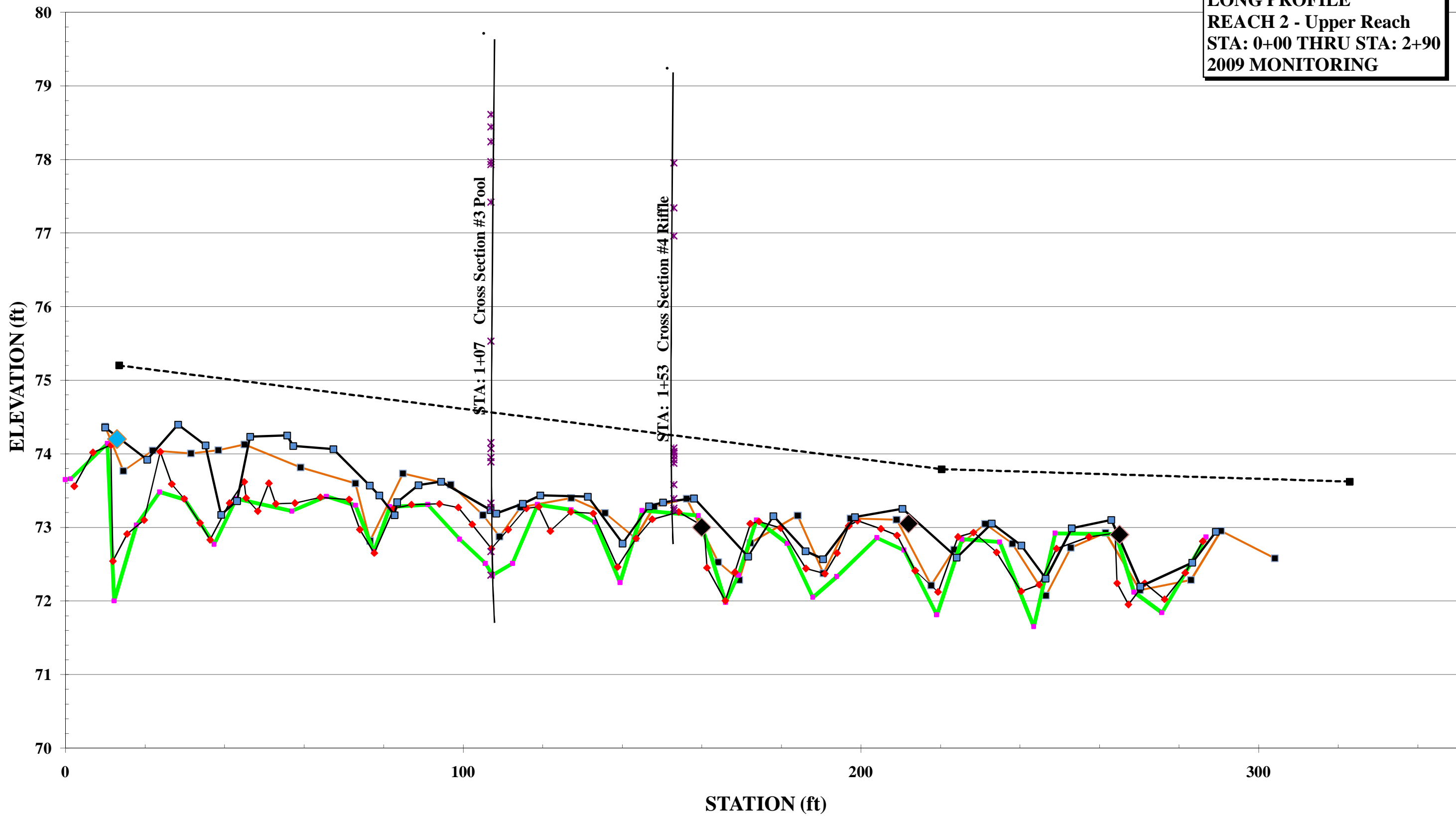


**MILL BRANCH
LONG PROFILE
REACH 1 - Western Reach
STA: 0+00 THRU STA: 3+05
2009 MONITORING**



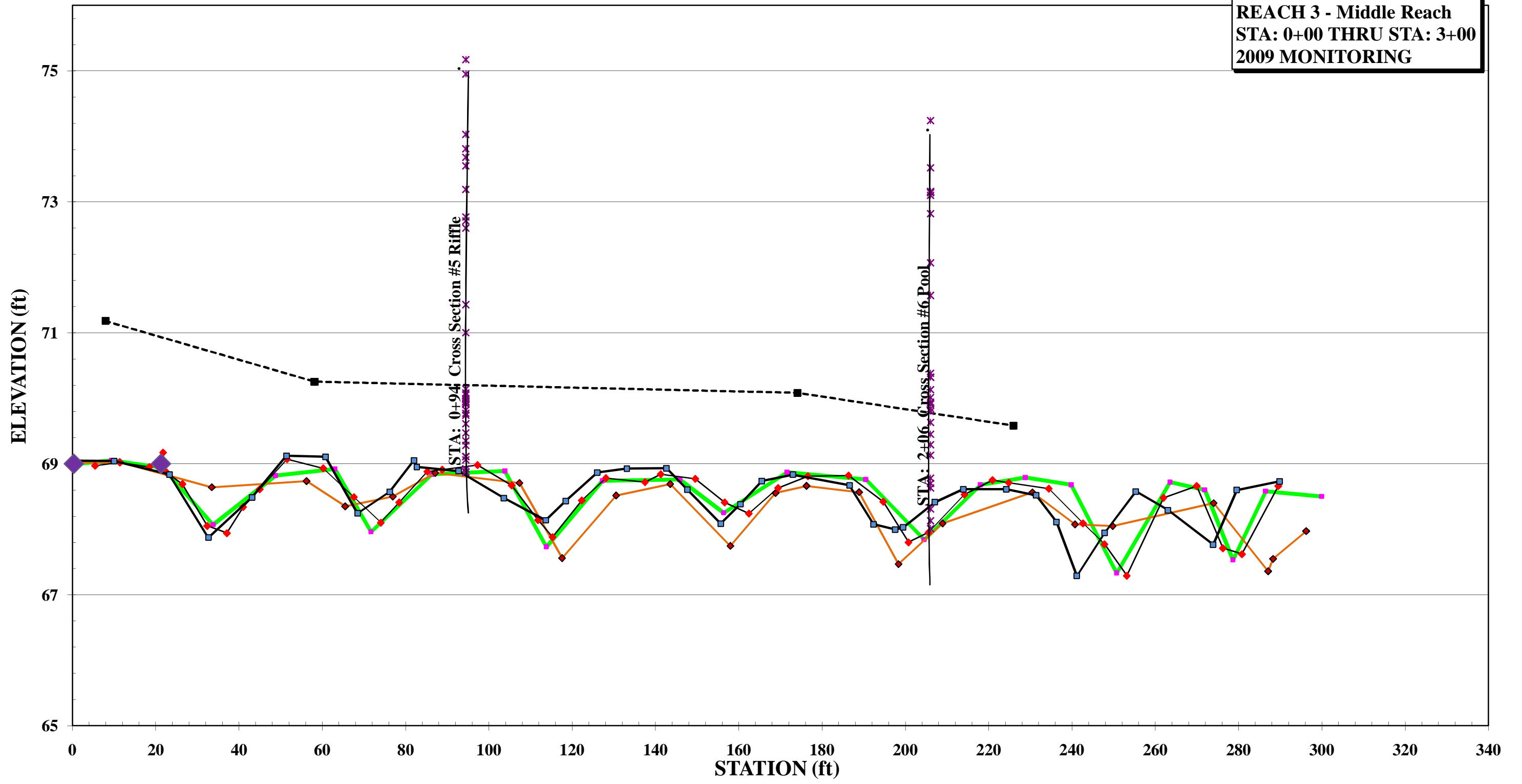
—■ 2007 As-Built Thalweg
—■ 2008 MY2 Thalweg
—■ 2007 MY1 Thalweg
× Cross Sections
◆ Log Vane
◆ Log Sill
—■ 2009 Thalweg
- - - - 2009 Bankfull

**MILL BRANCH
LONG PROFILE
REACH 2 - Upper Reach
STA: 0+00 THRU STA: 2+90
2009 MONITORING**

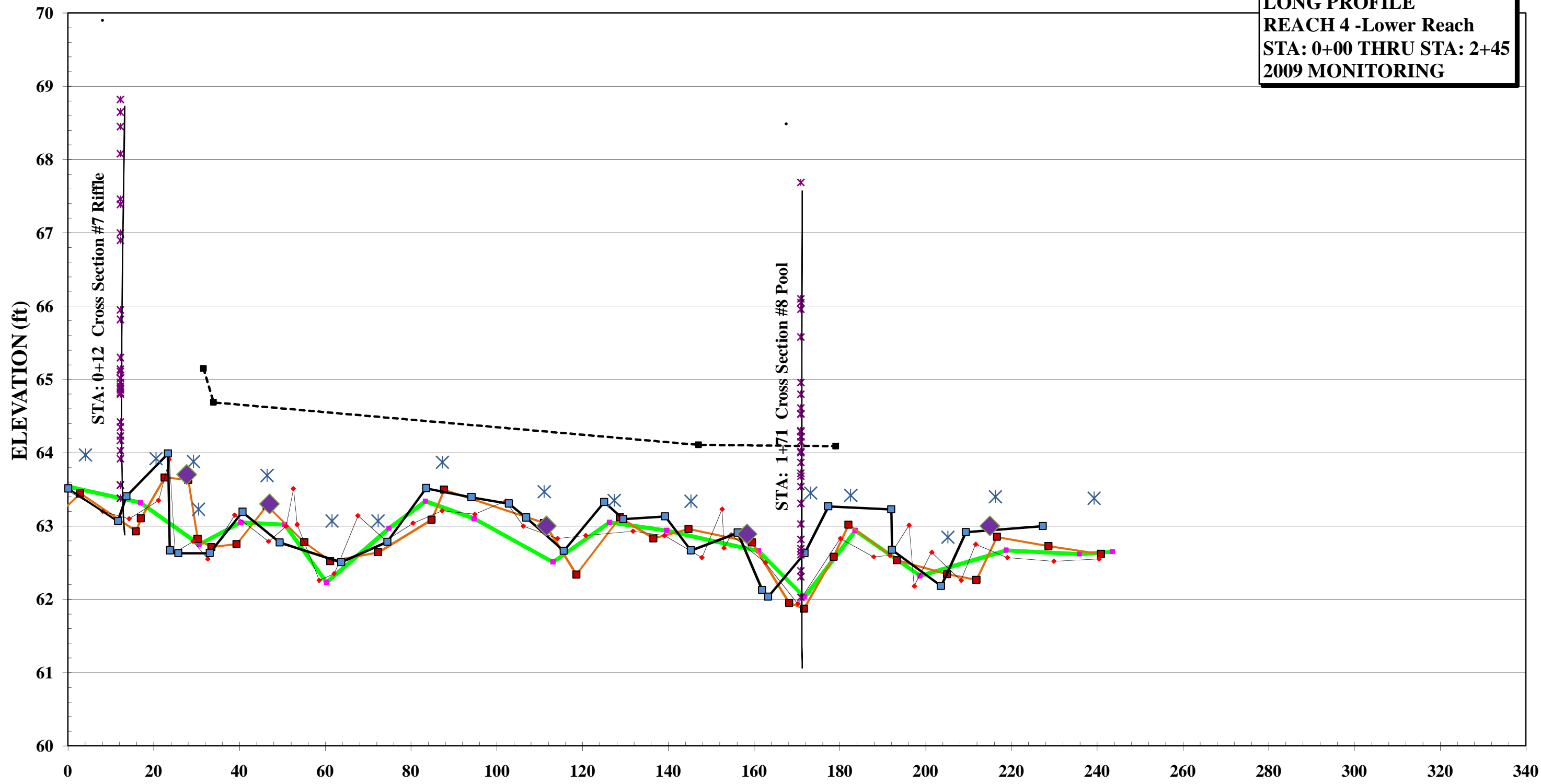


■ 2008 MY2 Thalweg
 ■ 2007 As-Built Thalweg
 ✕ Cross Sections
 ◆ 2007 MY1 Thalweg
 ◆ Rock Cross Vane
 ◆ Log Vane
 ■ 2009 Thalweg
 - - - 2009 Bankfull

**MILL BRANCH
LONG PROFILE
REACH 3 - Middle Reach
STA: 0+00 THRU STA: 3+00
2009 MONITORING**



**MILL BRANCH
LONG PROFILE
REACH 4 -Lower Reach
STA: 0+00 THRU STA: 2+45
2009 MONITORING**



—■— 2007 As- Built Thalweg
 —■— 2008 MY2 Thalweg
 * 2009 M32 Water Surface
 —◆— 2007 MY1 Thalweg
 * Cross Sections
 ◆ Log Sill
 —■— 2009 Thalweg
 - - -■ - - 2009 Bankfull

Morphology and Hydraulic Monitoring Summary
Mill Branch Stream Restoration Site/EEP Project No. 0251
Western Reach

Parameter	Cross Section 1				Cross Section 2													
	MY0	MY1	MY2	MY3	MY0	MY1	MY2	MY3										
Dimension																		
BF Width (ft)	6	8.7	28.1	23.4	11.7	11.2	17.4	23.7										
Floodprone Width (ft) (approx)	45	4.5	47	39.5	52	43	45.6	46										
BF Cross Sectional Area (ft ²)	1.8	2.3	6.5	4.1	8.7	7.5	8.2	6.7										
BF Mean Depth (ft)	0.3	0.3	0.2	0.2	0.7	0.7	0.5	0.3										
BF Max Depth (ft)	0.6	0.6	1.2	0.6	1.7	1.3	1.4	1.4										
Width/Depth Ratio	33.5	19.80	121.8	133	15.7	16.7	37.1	83.2										
Entrenchment Ratio	7.5	5.2	1.7	1.7	4.4	3.8	2.6	1.9										
Wetted Perimeter (ft)	-	-	28.5	23.6	-	-	17.9	24.1										
Hydraulic radius (ft)	-	-	0.2	0.2	-	-	0.5	0.3										
Substrate																		
d50 (mm)		0.12	0.11	0.18		0.12	0.11	0.18										
d84 (mm)		0.26	0.28	0.67		0.26	0.28	0.67										
Parameter	MY-00 (2007)			MY-01 (2007)			MY-02 (2008)			MY-03 (2009)			MY-04 (2010)			MY-05 (2011)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	16	26	20	15	25	19	14	27	20	14	28	21						
Radius of Curvature (ft)	8	15	11.3	7	16	11	7	17	12	7	17	13						
Meander Wavelength (ft)	32	42	36	31	44	37	32	44	38	32	44	38						
Meander Width Ratio	5.37	7.12	6.30	-	-	4.20	-	-	4.8	-	-	4.8						
Profile																		
Riffle Length (ft)	4	10	6	-	-	-												
Riffle Slope (ft)				-	-	-												
Pool Length (ft)	8	23	12	-	-	-												
Pool Spacing (ft)	19	40	27	18	40	25	17	40	18	17	40	18						
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)	304																	
Sinuousity	1.20																	
Water Surface Slope (ft/ft)																		
BF Slope (ft/ft)																		
Rosgen Classification	C5																	
*Habitat Index																		
*Macrobenthos																		

**Exhibit Table IXB. Morphology and Hydraulic Monitoring Summary
Mill Branch Stream Restoration Site/EEP Project No. 0251
Upper Reach**

Parameter	Cross Section 3				Cross Section 4														
	MY0	MY1	MY2	MY3	MY0	MY1	MY2	MY3											
Dimension	MY0	MY1	MY2	MY3	MY0	MY1	MY2	MY3											
BF Width (ft)	12.7	11.1	7.3	8.4	8.10	8.40	4.5	6.7											
Floodprone Width (ft) (approx)	57	48	23.1	24.8	47	45	23.8	14.1											
BF Cross Sectional Area (ft ²)	9.8	5.8	2.0	2.6	3.2	8.7	3.7	2.2	1.7										
BF Mean Depth (ft)	0.8	0.5	0.3	0.3	0.4	0.4	0.5	0.3											
BF Max Depth (ft)	1.50	1.10	1.0	0.8	0.7	0.9	1.3	0.8											
Width/Depth Ratio	16.6	21.2	26.9	27.6	20.3	18.9	9.0	26.8											
Entrenchment Ratio	4.5	4.30	6.2	2.9	5.8	5.4	5.3	2.1											
Wetted Perimeter (ft)	-	-	8.2	8.7	-	-	5.5	7.1											
Hydraulic radius (ft)	-	-	0.2	0.3	-	-	0.4	0.2											
Substrate																			
d50 (mm)		0.10	0.07				0.10	0.07	.086										
d84 (mm)		0.23	0.26				0.23	0.062	.2										
Parameter	MY-00 (2007)			MY-01 (2007)			MY-02 (2008)			MY-03 (2009)			MY-04 (2010)			MY-05 (2011)			
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	
Channel Beltwidth (ft)	23	29	26	22	28	26	21	27	25	20	27	24							
Radius of Curvature (ft)	11	18	14	11	19	13	11	18	13	11	18	14							
Meander Wavelength (ft)	39	59	46	40	59	45	38	59	45	38	59	45							
Meander Width Ratio	2.94	3.72	3	-	-	5.38	-	-	4.9	-	-	4.9							
Profile																			
Riffle Length (ft)	5	14	9	-	-	-	-	-	-	-	-	-							
Riffle Slope (ft)	0.001	0.013	0.005	-	-	-	-	-	-	-	-	-							
Pool Length (ft)	5	21	13	-	-	-	-	-	-	-	-	-							
Pool Spacing (ft)	23	40	29	22	38	31	20	28	30	20	28	30							
Additional Reach Parameters																			
Valley Length (ft)	233			233															
Channel Length (ft)	286			286															
Sinosity	1.23			1.23															
Water Surface Slope (ft/ft)	0.00260			n/a															
BF Slope (ft/ft)	0.0027			0.0033															
Rosgen Classification	C5			C5															
*Habitat Index																			
*Macrobenthos																			

**Exhibit Table IXC. Morphology and Hydraulic Monitoring Summary
Mill Branch Stream Restoration Site/EEP Project No. 0251
Middle Reach**

Parameter	Cross Section 5				Cross Section 6													
	MY0	MY1	MY2	MY3	MY0	MY1	MY2	MY3										
Dimension																		
BF Width (ft)	9.50	9.70	15.1	15.8	13.7	14.2	19	20.6										
Floodprone Width (ft) (approx)	88	93	79.5	61.9	77	75	31.5	28.5										
BF Cross Sectional Area (ft2)	5.20	5.10	4.8	4.0	15.5	16.6	14.8	11										
BF Mean Depth (ft)	0.60	0.50	0.3	0.3	1.1	1.2	0.8	0.5										
BF Max Depth (ft)	1.00	1.00	1.0	1.0	2.2	2.3	2.5	2.2										
Width/Depth Ratio	17.2	18.8	47.9	61.9	12.2	12.1	24.4	38.6										
Entrenchment Ratio	9.10	9.80	5.3	3.9	4.5	5.4	1.7	1.4										
Wetted Perimeter (ft)	-	-	15.4	16.1	-	-	21.1	22.5										
Hydraulic radius (ft)	-	-	0.3	0.3	-	-	0.7	0.5										
Substrate																		
d50 (mm)		0.09	0.062	.18		0.09	0.0622	.18										
d84 (mm)		0.20	0.2	.5		0.20	0.2	.5										
Parameter	MY-00 (2007)			MY-01 (2007)			MY-02 (2008)			MY-03 (2009)			MY-04 (2010)			MY-05 (2011)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	31	41	36	28	39	35	28	40	35	28	40	35						
Radius of Curvature (ft)	15	20	17	13	19	18	13	21	18	13	21	18						
Meander Wavelength (ft)	60	68	64	58	69	64	58	68	64	58	68	64						
Meander Width Ratio	8	4	6	-	-	7	-	-	7	-	-	7						
Profile																		
Riffle Length (ft)	7	17	13	-	-	-	-	-	-	-	-	-						
Riffle Slope (ft)	0.00	0.00	0.00	-	-	-	-	-	-	-	-	-						
Pool Length (ft)	10	23	18	-	-	-	-	-	-	-	-	-						
Pool Spacing (ft)	28	48	41	28	47	41	29	49	42	29	49	42						
Additional Reach Parameters																		
Valley Length (ft)	234			234														
Channel Length (ft)	299			299														
Sinosity	1.28			1.28														
Water Surface Slope (ft/ft)	0.0011			n/a														
BF Slope (ft/ft)	0.0011			0.0006														
Rosgen Classification	C5			C5														
*Habitat Index																		
*Macrobenthos																		

**Exhibit Table IXD. Morphology and Hydraulic Monitoring Summary
Mill Branch Stream Restoration Site/EEP Project No. 0251
Lower Reach**

Parameter	Cross Section 7				Cross Section 8													
	MY0	MY1	MY2	MY3	MY0	MY1	MY2	MY3										
Dimension																		
BF Width (ft)	10.8	11.8	18.3	10.3	17	16.9	11.2	15.4										
Floodprone Width (ft) (approx)	84	84	92.7	72.3	-	-	17.5	26.8										
BF Cross Sectional Area (ft2)	8.9	8.9	8.5	5.2	12.6	12.5	8.7	7										
BF Mean Depth (ft)	0.8	0.8	0.5	0.5	0.7	0.7	0.8	.5										
BF Max Depth (ft)	1.8	1.7	2.0	1.5	2.2	2.2	2.6	2.3										
Width/Depth Ratio	13.6	15.6	39.4	20.4	22.9	22.8	14.5	34										
Entrenchment Ratio	7.8	7.2	5.1	7	-	-	1.5	1.7										
Wetted Perimeter (ft)	-	-	19.4	10.9	-	-	15.3	17.3										
Hydraulic radius (ft)	-	-	0.4	0.5	-	-	0.6	.4										
Substrate																		
d50 (mm)		0.10	0.067	.1		0.10	0.067	.1										
d84 (mm)		0.23	0.21	.25		0.23	0.21	.25										
Parameter	MY-00 (2007)			MY-01 (2007)			MY-02 (2008)			MY-03 (2009)			MY-04 (2010)			MY-05 (2011)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	37	37	37	35	39	38	35	38	37	35	38	37						
Radius of Curvature (ft)	17	24	20	17	24	20	17	23	19	18	23	19						
Meander Wavelength (ft)	77	86	82	75	85	82	75	85	82	75	85	82						
Meander Width Ratio	7.1	8.1	7.6	-	-	7	-	-	7	-	-	7						
Profile																		
Riffle Length (ft)	4	11	8	-	-	-	-	-	-	-	-	-						
Riffle Slope (ft)	0.00	0.01	0.00	-	-	-	-	-	-	-	-	-						
Pool Length (ft)	28	53	41	-	-	-	-	-	-	-	-	-						
Pool Spacing (ft)	18	20	19	17	24	20	16	23	17	16	23	17						
Additional Reach Parameters																		
Valley Length (ft)	201			201														
Channel Length (ft)	243			243														
Sinosity	1.21			1.21														
Water Surface Slope (ft/ft)	0.0036			-														
BF Slope (ft/ft)	0.0042			0.0042														
Rosgen Classification	C5			C5														
*Habitat Index																		
*Macrobenthos																		

Appendix D – Stream Problem Area Photos (all photos recorder on 10/1/09)



SPA 1 - Dry stream bed. Western Reach and Lower Reach



SPA 2 - Cattail – Throughout project site

All pictures recorded on 10/1/09



SPA 3 - Vegetation growing in the channel bed. Throughout the project site

All pictures recorded on 10/1/09

Appendix D – Stream Problem Areas Inventory Table

Exhibit Table B.1 Stream Problem Areas Mill Branch Stream Restoration Site EEP Project No. 251				
Feature Issue	Reach	Station Number	Suspected Cause	Photo Number
Aggradation	Western	10+00 to 13+50	N/A	*
	Upper	10+00 to 12+50	N/A	*
Cattails	All	Throughout	Dry Conditions	SPA 2
Vegetation Growth in channel bed	All	Throughout	Dry Conditions	SPA 3

**Pictures for aggradation areas were not taken due to vegetation growing in the channel and blocking the view*