WELLS CREEK
FINAL MONITORING REPORT
YEAR 2 OF 5
2006

EEP Project # 414
Alamance County, North Carolina

Original Design Firm:
ARCADIS G&M of North Carolina, Inc.
801 Corporate Center Drive, Suite 300
Raleigh, NC 27607

Submitted to:

NCDENR-EEP
1652 Mail Service Center
Raleigh, NC 27699

Monitoring Firm:

1025 Wade Avenue
Raleigh, NC 27605
Phone: (919)789-9977
Project Manager:
Phillip Todd
ptodd@sepiengineering.com

Executive Summary

The North Carolina Ecosystem Enhancement Program (EEP) restored two reaches along Wells Creek and an unnamed tributary in 2004. This project is located in Alamance County, NC. The three different reaches flow through pasture areas and wooded sections. Prior to restoration, cattle and horses had unlimited access to the stream channels which created areas of severe bank erosion and loss of vegetation. Since the restoration has been complete, the livestock have been fenced out of the stream with the exception of a few crossings that are used throughout the year to move the cattle from one field to another.

There were several goals for this stream and buffer restoration project. Goals of the stream project included: reducing the bank erosion; reducing nutrient runoff on the site; stabilizing stream channel banks by planting vegetation; and, helping the stream reach its equilibrium through the proper design ratios for dimension, pattern, and profile.

This report documents the data collected for Year 2 monitoring. The data includes geomorphic and vegetative components. The geomorphic data collected includes: longitudinal profiles, cross-sections, pebble counts, and photo points along all three reaches. The vegetation data collected includes: stem count species and numbers for all of the vegetative plots throughout the project. The geomorphic and vegetative data collected for Year 2 was compared to previous data collected in Year 1. For the geomorphic data, graphs for the longitudinal and cross-section surveys were created by overlaying Year 1 and Year 2 data for comparisons.

Stakes used to mark the cross-section locations had to be replaced in Year 2 since a majority of them had either broken off, rotted, or were missing. Global Positioning System coordinates were used to locate the cross-sections, and metal conduit was used to mark the locations. Uncertainty in the location of some monitoring features and benchmarks has now been eliminated; therefore, subsequent annual comparisons will be fully consistent with the data collection in this report. Despite the problems with locating the cross-sections for monitoring, the two years of data overlaid with no major changes in dimensions. The exceptions to this were with Cross-Section #7 and #8 in which Year 1 data, was “bad” so Year 2 data could not be compared to show any changes. The longitudinal profiles between the two years did not change enough to warrant any immediate repairs. Some of the structures, noted in the report, need to be monitored closely over the next year and may need to be repaired.

1.0 PROJECT BACKGROUND

1.1 Project Location

This project is near Snow Camp, North Carolina in south-central Alamance County. To reach the site from Raleigh, go west on US 64 to Siler City. In Siler City, go north on Martin Luther King Boulevard; the North Carolina Atlas and Gazetteer (DeLorme 1997) labels the road as Snow Camp Road. Continue north toward the community of Snow Camp (approximately 12 miles). Just before Snow Camp, take a left on SR 2360 (Sylvan School Road). Continue on Sylvan School Road approximately 2 miles then take a right on Bass Mountain Road. Continue on Bass Mountain Road for approximately ½ mile and take a left on Beale Road. Continue on Beale Road for approximately 1 mile, then turn right on Longest Acre Road (Wright Road in the NC Gazetteer). Reach 1 is at the end of Longest Acre Road. All three reaches are located in the triangle created by Bass Mountain Road, Beale Road, and Thompson Road. Figure 1 shows the location of the three reaches.

1.2 Project Setting

The site is located in a rural portion of Alamance County on a working livestock farm. The stream reaches flow through pasture areas and wooded sections. Prior to restoration, the cattle and horses had unlimited access to portions of the channel while in certain fields. Since completion of the restoration project, the stream has been fenced off from the livestock. The surrounding topography has gently sloping hills.

1.3 Project Objectives

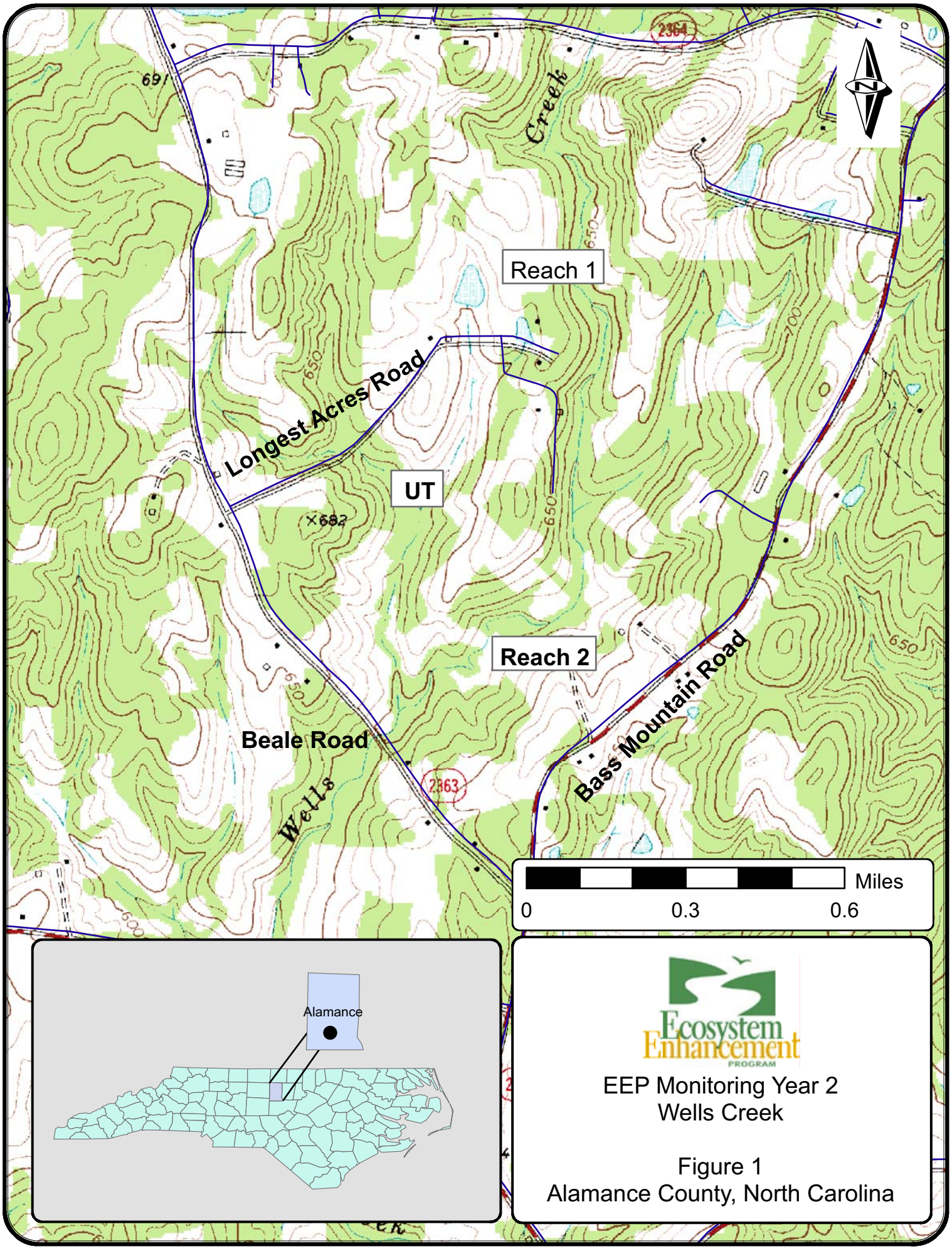
The goal of this stream restoration project is to improve the water quality in the Cape Fear River Basin. Wells Creek and its unnamed tributary (UT) at this project site are typical of streams within this and surrounding watersheds. Prior to restoration, the channels were exhibiting instability and degradation in response to the current and historical land use practices. Nutrient input should decrease with the establishment of a riparian buffer and fencing the cattle out of the streams. In time, the buffer will provide shade to the stream which will encourage wildlife diversity in the area (both aquatic and non-aquatic).

Reach 1, in the northernmost section, is the longest covering approximately 1,246 linear feet. Reach 2 includes 1,140 linear feet of Wells Creek and is located south of Reach 1. The UT to Wells Creek is approximately 1,014 linear feet and lies west of Reach 2. Figure 2 shows the location of the three reaches relative to each other.

Priority Level I, II and III restoration were implemented to restore the streams to a more stable condition. Boulder structures were constructed and installed at strategic locations to provide stream bed and bank stability. Root wads were installed to provide bank protection and increase habitat diversity.

Table I. Project Mitigation Structure and Objectives Table				
Wells Creek/EEP Project Number 414				
Project Segment or Reach ID	**Mitigation Type**	**Approach***	**Linear Footage or Acreage Stationing#**	**Comment#**
Reach 1	R	P I	756	New channel constructed
	E (I)	P II &P III	2,142	Modified profile and dimension
Reach 2	R	P I	840	New channel constructed
	E (I)	P II & P III	404	Modified profile and dimension
Unnamed Tributary	R	P I	1,161	New channel constructed
	E (I)	P II & P III	332	Modified profile and dimension

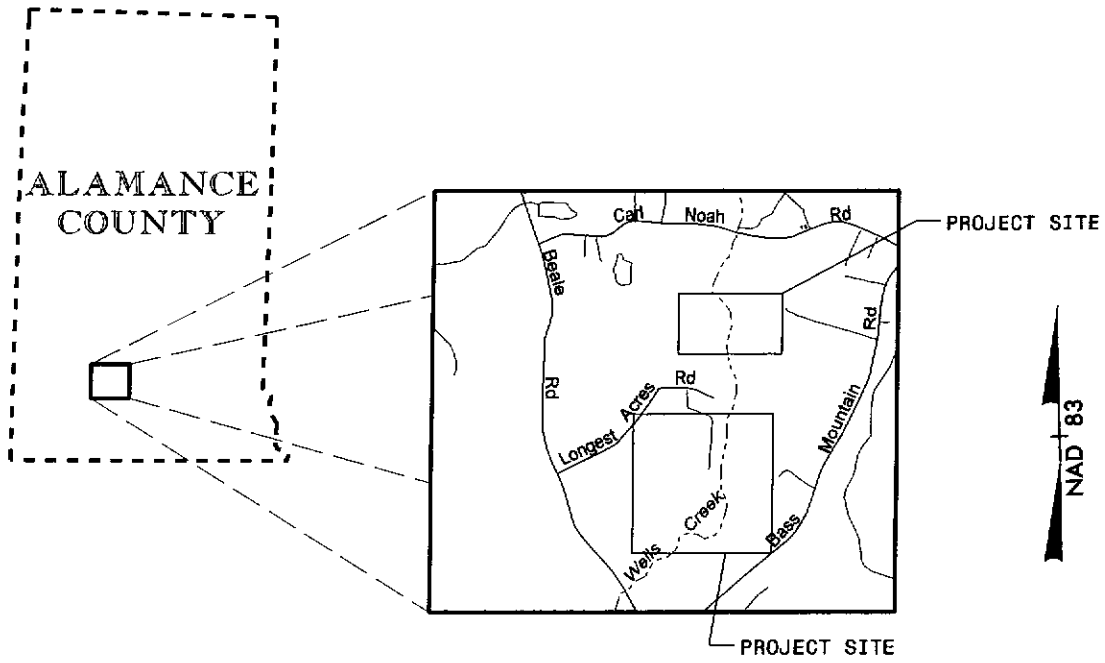
Note: "R" and "E (I)" in the Mitigation Type column refer to Restoration and Enhancement Level I.
"P" in the Approach column refers to Priority Level.
"*" – The Monitoring Year 1 report does not designate the Priority Level for each project reach. The noted approach is inferred based on comments in Table 2 of Monitoring Year 1 for the project.
"#" – information taken from Table 2 of Monitoring Year 1 for the project.

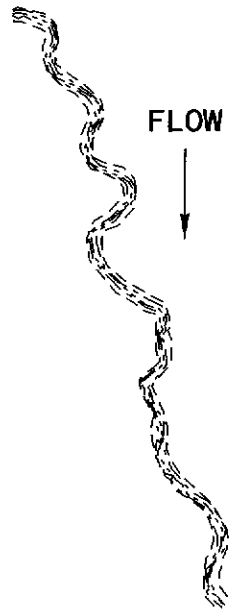


Ecosystem Enhancement Program

EEP Monitoring Year 2
Wells Creek

Figure 1
Alamance County, North Carolina

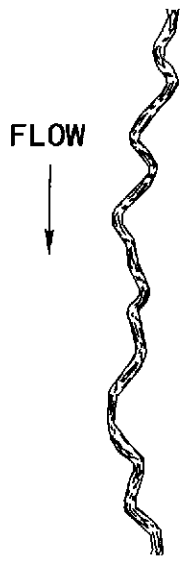


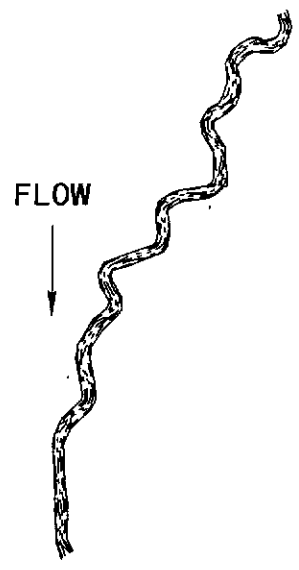


WELLS CREEK

REACH 1

UT TO WELLS CREEK





REACH 2

WELLS CREEK
FIGURE 2

SEPI
ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

Ecosystem Enhancement PROGRAM

LOCATION:
WELLS CREEK
STREAM MONITORING - YEAR 2

PROJ #: 414
COUNTY: ALAMANCE
PREPARED BY: WDY
CHECKED BY: ATW
DATE: 11/17/06

1.4 History and Background

Wells Creek and its tributary were in an active cattle pasture prior to restoration. The current land owner cleared the land for pasture in the 1970's when it was purchased. Prior to the 1970's the land was forested. According to the owner, there was a mill on site. An old rock dam is located upstream of Reach 2, and an old breached rock dam is at the downstream end of Reach 1. Prior to restoration the streams lacked sinuosity and they were likely altered for agricultural reasons. Tables II- IV provide background information on the site and the restoration project.

Table II. Project Activity and Reporting History

Wells Creek/EEP Project Number 414

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration Plan			August 1, 2002
Final Design - 90%			unknown
Construction			August 2003-April 2004
Temporary S&E mix applies to entire project area			August 2003-April 2004
Permanent seed mix applies to reach/segments 1&2			August 2003-April 2005
Containerized and B&B plantings for reach/segments 1&2			August 2003-April 2006
Mitigation Plan/ As-built (Year 0 Monitoring - baseline)		Dec-04	December 2004/July 2004
Year 1 monitoring			Sep-05
Year 2 monitoring		Apr-06	Nov-06
Year 3 monitoring	Apr-07		
Year 4 monitoring	Apr-08		
Year 5 monitoring	Apr-09		
Year 5+ monitoring			

Table III. Project Contract Table	
Wells Creek/EEP Project Number 414	
Designer	ARCADIS G&M of North Carolina 801 Corporate Center Drive, Suite 300 Raleigh, NC 27607
Construction Contractor	A&D Environmental and Industrial Services, Inc. Gerald Walker 2718 Uwharrie Road Archdale, NC 27263 336-434-7750
Planting Contractor	Seal Brothers Contracting Eddie Tobler PO BOX 86 Dobson, NC 27017 336-786-8863
Seeding Contractor	A&D Environmental and Industrial Services, Inc. Gerald Walker 2718 Uwharrie Road Archdale, NC 27263 336-434-7750
Monitoring Performers	SEPI Engineering Group 2300 Rexwoods Drive, Suite 370 Raleigh, NC 27607
Stream Monitoring POC	Amanda Todd (919) 789-9977
Vegetation Monitoring POC	Phillip Todd (919) 789-9977
Wetland Monitoring POC	N/A

Table IV. Project Background Table	
Wells Creek/EEP Project Number 414	
Project County	Alamance
Drainage Area	Reach 1: 1.63 sq mi Reach 2: 2.23 sq mi and UT: 0.71 sq. mi
Drainage impervious cover estimate (%) For example	Wells Creek Reach 1 & 2 ~3%; Unnamed Tributary <1%
Stream Order	Wells Creek Reach 1: 2nd Order
	Wells Creek Reach 2: 3rd Order
	Unnamed Tributary: 1st Order
Physiographic Region	Piedmont
Ecoregion	Southern Outer Piedmont Carolina Slate Belt
Rosgen Classification of As-built	C 4/1
Cowardin Classification	Disturbed Cattle Pasture
Dominant soil types	Colfax, Lignum, Georgeville, Tarrus, Herndon, Local Alluvial Land, and Vance
Reference site ID	UT to Wells Creek, Cane Creek Mountains, Alamance County and UT to Varnals Creek
USGS HUC for Project and Reference	03030002 Haw River
NCDWQ Sub-basin for Project and Reference	03-06-04
NCDWQ classification for Project and Reference	Project and reference are Class C, NSW
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	N/A
% of project easement fenced	100%

2.0 PROJECT MONITORING METHODOLOGY

2.1 Vegetation Methodology

The following methodology was used for the stem count. The configuration of the vegetation plots was marked out with tape to measure 10 meters by 10 meters (or equivalent to 100 square meters) depending on buffer width. The planted material, in the plot was marked with flagging. The targeted vegetation was then identified by species and the number of each species was recorded in a field book.

2.2 Stream Methodology

The project monitoring for the stream channel included a longitudinal survey, cross-sectional surveys, pebble counts and photo documentation. These measurements were taken at each reach. The stationing was based on thalweg. The methodology for each portion of the stream monitoring is described in detail below.

2.2.1 Longitudinal Profile

The longitudinal profiles of the restored streams were surveyed at each reach. The heads of features, such as riffles, runs, pools, maximum pool, and glide, were surveyed in the longitudinal profile. At the head of each feature, thalweg, water surface, edge of water, left and right bankfull, and left and right top of bank were surveyed. The Average water-surface slope for each feature, pool length, and pool to pool spacing were calculated from this survey. The surveyed features also assisted in drawing out the plan view of the restored stream. Stream pattern data (i.e., meander length, radius of curvature, belt width, and sinuosity) were measured from the plan view.

The pool to pool spacing represented the spacing between the head of the pool feature in each meander bend. In addition, the pool to pool spacing included the pools that were constructed downstream of where the cross vanes were surveyed since they were included in Year 1 monitoring from the previous years data collection. These pools were grouped in to calculate the pool-to-pool spacing and the pool-to-pool spacing to bankfull width ratio calculations. The longitudinal profile for Year 2 was overlain on Year 1 data to note any changes.

2.2.2 Permanent Cross Sections

Four permanent cross sections (two riffles and two pools) were surveyed at each reach. The beginning and end of each permanent cross section were originally marked with a wooden stake. During the time since the initial installations and survey, the wooden stakes have either rotted, fallen over, broken off, or washed away. During Year 2 monitoring, metal conduit was installed at each beginning and end locations with the GPS coordinates provided by ARCADIS, the monitors for Year 1. Cross sections were established perpendicular to the stream flow with 0 feet on the left bank looking downstream. The survey noted all changes in slopes, tops of both banks, left and right bankfull, edges of water, thalweg and water surface. The bankfull cross sectional areas were calculated for each cross section. The cross sections were plotted and Year 1 monitoring data was overlain on top of Year 2 for comparison. The bankfull mean depth, cross-sectional area, width-to-depth ratios and entrenchment ratios were also compared from Year 1 to Year 2. Bank Height Ratio (BHR) was calculated and included in the morphology tables for each reach.

2.2.3 Pebble Counts

A modified Wolman pebble count (Rosgen 1993) consisting of 50 samples was taken at each permanent cross section. The cumulative percent was graphed, and the D50 and D84 were calculated.

2.3 Photo Documentation

Permanent photo points were established during Year 1 monitoring. A representative photograph of each vegetation plot was taken at the designated corner of the vegetation plot, and the corner was marked on the plan view sheets to document the corner and direction of the photograph it was taken from. Photographs were taken at these same corner points during the field surveys for Year 2 as noted from the monitoring Year 1 report. Directions of the photo points were followed from what was drawn on the Year 1 monitoring plan view sheets.

3.0 PROJECT CONDITIONS AND RESULTS

3.1 Vegetation

3.1.1 Soils Data

Table V. Preliminary Soil Data

Series	Max Depth (in.)	% Clay on Surface	K	T	OM %
Colfax (Ce)	67	5.0 - 20.0	0.45	*	1.0 - 3.0
Colfax (Cf)	67	7.0 - 25.0	0.36	*	1.0 - 3.0
Efland (EaC)	86	<<<<<<< Information unavailable >>>>>>>			
Efland (EaC2)	86	<<<<<<< Information unavailable >>>>>>>			
Efland (EbC3)	86	<<<<<<< Information unavailable >>>>>>>			
Georgeville (GaC2)	63	5.0 - 20.0	0.48	*	0.5 - 2.0
Georgeville (GaD2)	63	5.0 - 20.0	0.48	*	0.5 - 2.0
Local alluvial (Ld)		<<<<<<< High variability of data >>>>>>>			
Starr (Sb)	70	10.0 - 25.0	0.34	*	0.5 - 2.0
Vance (VcC2)	72	8.0 - 20.0	0.55	*	0.5 - 2.0

* The soils information was not available from the Natural Resources Conservation Service (NRCS)

3.1.2 Vegetative Problem Area Plan View

All three monitoring reaches have good herbaceous vegetative cover. However, bare root trees are not as prevalent in Reach 1 when compared to Reach 2 and the UT. Table VI in Appendix A3 describes the feature/issue with vegetation problem areas, the station, probable cause and photo number. The photos are in Appendix A1.

There are also extensive stands of Japanese grass (*Microstegium vimenium*) in all of the monitored reaches. This grass is very prevalent in Vegetation Plot (VP) #3 and #7 with some of the grass in VP #5. The grass is likely impeding bare root growth in VP #3; however, it is not affecting the growth of trees in VP #7. The largest areas of the grass are noted on the plan view sheets in Appendix C.

Red maple and sweet-gum were noted in several vegetation plots, particularly VP #4, 5 and 6 (all along UT) as well as VP #8. These volunteer species do not appear to be affecting the growth of the planted species.

3.1.3 Stem Counts

The stem counts on Reaches 2 and the UT are good. The number of stems per acre is well above the required stems/acre requirement at year five (260 stems/acre).

The stem counts on Reach 1 were not as good as Reach 2 and the UT. The number of stems per acre is well below the stems per acre requirement at year five (260 stems/acre).

Overall, there was a survival rate of 83% between Year 1 and Year 2. This rate is good considering 2005 was a drought year. Photos of the vegetation plots are in Appendix A2 and the raw data tables are located in Appendix A3.

3.2 Stream

3.2.1 Longitudinal Profile

From the review of overlaying the longitudinal survey data from Year 2 on Year 1, no conclusion can be made at this time as to whether the stream has changed significantly within any of the reaches surveyed. As shown within the longitudinal profiles (in Appendix B5), the profiles appear to be the same between the years. For Wells Creek Reach 2, the longitudinal profile in two areas shows a change in elevation at Station No. 06+00 and 07+60. Upon closer investigation, it looks like the station numbering may be off between the two years. A review of the general profile in this area shows the station numbers have moved; however, the general profile "shape" is similar. There have been very small changes in each of the profiles, but these changes may have been adjustments in sediment load and/or the channel adjusting after construction.

3.2.2 Permanent Cross Sections

From a review of the cross-sectional survey data from Year 2 overlain on Year 1, it can be concluded that some of the cross-sections have changed, but the change is only slight. It is hard to infer if the cross-sections that showed changes/variations between the two years in dimensions were actual changes or just differences in surveying data analysis. A few of the cross-sections (in particular, Cross-Sections 7 and 8 for the UT) had "bad" data collected in Year 1. This "bad" data prohibited a comparison between the two years. It is not known as to why the data from that year was "off" or not consistent between the years at the two sections as the other cross sections matched reasonably well. At this time, no conclusions on the stream data from Year 2 can be made. Once Year 3 data is collected, a better comparison of problem areas can be made since the Year 2 and Year 3 data will be collected using the same equipment and people. The cross-section plots are located in Appendix B4.

3.2.3 Pebble Counts

There is only pebble count data at cross sections #2, 3, 6, 7 9 and 11 to compare between Year 1 and Year 2. These overlays are located in Appendix B6 along with the pebble count data from Year 2.

At cross sections #2, 3 and 11, the stream material shows more fines in Year 2 than in Year 1. Cross sections #2 and 3 are located on Reach 1, and cross section #11 is on Reach 2 and downstream of cross section #9.

For cross sections #6, 7 and 9, the stream material shows a trend toward becoming more coarse material. Cross sections #6 and 7 are located on UT to Wells Creek, and cross section #9 is located on Reach 2.

3.3 Photo Documentation

Photos taken at the photo points and at the cross-sections are provided in Appendix A. Comparisons from Year 1 to Year 2 can be made by referring back to the Year 1 Monitoring report.

3.4 Problem Areas

Problem areas were noted throughout all three reaches in regards to structure problems, bank erosion, aggradation and bar formation. The plan view sheets (Figures 8-13 in Appendix C) show the location of the problem areas. The figures also show the structures on them, and the structures are color coded for the degree of instability or if the structure is in good condition. Table B1 in Appendix B is broken down for each reach with the feature issue, station number, and suspected cause.

4.0 OVERALL CONCLUSIONS FOR YEAR 2 MONITORING

The conclusion regarding vegetation at the end of Year 2 monitoring is that bare root trees need to be planted along Reach 1 because the stems/acre at Year 2 are below the requirement for Year 5. No other conclusions can be made in regards to the vegetation monitoring at this time.

The stream monitoring showed that the longitudinal profiles for all three reaches had not changed enough to warrant any concern at this time. No conclusions could be made at this time from the cross-sectional data collected due to poor data from Year 1 and/or there were no changes with the dimensions at the cross-sections. Uncertainty in the location of monitoring features and benchmarks has now been eliminated; therefore, subsequent annual comparisons will be fully consistent with the data collection in this report and conclusions from the Year 3 monitoring data can then be made.

REFERENCES

ARCADIS G&M of North Carolina, Inc (ARCADIS). September 2004. *Mitigation Plan, Wells Creek at Syndor Property*.

ARCADIS G&M of North Carolina, Inc (ARCADIS). December 2005. *Year One Monitoring Report, Wells Creek at Syndor Property*.

DeLorme. 1997. *The North Carolina Atlas and Gazateer*.

Harman, W.H., et al. 1999. *Bankfull Hydraulic Geometry Relationships for North Carolina Streams*. AWRA Wildland Hydrology Symposium Proceedings. Edited by D.S. Olson and J.P. Potyondy. AWRA Summer Synposium. Bozeman, MT.

North Carolina Ecosystem Enhancement Program. November 2006. *Content, Format and Data Requirements for EEP Monitoring Reports, Version 1.2*.

Rosgen, D.L. 1994. *A Classification of Natural River*. Catena, Volume 22: 166-169, Elsevier Science, B.V. Amsterdam.

U.S. Department of Agriculture, Soil Conversation Service. April 1960. *Soil Survey Alamance County, North Carolina*.

U.S. Department of Army, Corps of Engineers. 2003. *Stream Mitigation Guidelines*. http://www.saw.usace.army.mil/wetlands/Mitigation/stream_mitigation.html

APPENDIX A1

PHOTOLOG VEGETATION PROBLEM AREAS

APPENDIX A1
PHOTOLOG WELLS CREEK VEGETATION PROBLEM AREAS


Photo 1: Reach 1 Japanese Grass Right Bank


Photo 4: UT 14+20 Left Bank barren terrace


Photo 2: UT 18+50 Right bank bare floodplain


Photo 5: UT 12+50 Left Bank barren terrace


Photo 3: UT 19+00 Right Bank Japanese grass


Photo 6: UT 11+80 Left bank barren floodplain

Photo 7: Japanese grass

Photo 8: Japanese grass

APPENDIX A2

PHOTOLOG VEGETATION PLOTS

APPENDIX A2
PHOTOLOG WELLS CREEK VEGETATION PLOTS


Vegetation Plot 1


Vegetation Plot 2


Vegetation Plot 3


Vegetation Plot 4


Vegetation Plot 5


Vegetation Plot 6

Vegetation Plot 7

Vegetation Plot 8

Vegetation Plot 9

APPENDIX A3

VEGETATION DATA TABLES

Table VI. Vegetative Problem Areas			
Feature/Issue	**Station # / Range**	**Probable Cause**	**Photo #**
Bare Flood Plain	UT - Station 11+80	area washed from storm events	6
	UT - Station 12+50	area washed from storm events	5
	UT - Station 14+20	area washed from storm events	4
	UT - Station 18+50	area washed from storm events	2
Invasive/Exotic Populations	Reach 1 - Station # 20+50 Lt	Japanese grass overtaking area - from off site	8
	Reach 1 - down from Crest Gauge	Japanese grass overtaking area - from off site	1
	Reach 2 - Station #11-13	Japanese grass overtaking area - from off site	7

Weus Creek

Appendix A3

Table VII. Stem counts for each species arranged by plot

Species	Plots									Year 1 Totals	Year 2 Totals	Survival %
	1	2	3	4	5	6	7	8	9			
Shrubs												
Cornus ammomum			///	/					/			
Trees												
Betula nigra					///	//		//	//			
Carpinus caroliniana					///	///	/	///				
Diospyros virginiana												
Fraxinus pennsylvanica						///	/		//			
Juglans nigra	/	//	/	//	/	//	/		///			
Nyssa sylvatica												
Platanus occidentalis	/	/		/		///	/	////	////			
Salix nigra							///// ///// //					
Sambucus canandensis												
Quercus michauxii			/	///		/	///		/			
Quercus rubra			//									
Quercus alba		/		/	//							
Quercus marilandica			/									
Total including live stake												
Stems per acre												
Total exluding live stake												
Stems per acre												

Appendix A3

Table VII. Stem counts for each species arranged by plot

Species	Plots									Year 1 Totals	Year 2 Totals	Survival %
	1	2	3	4	5	6	7	8	9			
Shrubs												
Cornus ammomum			3	1	(7 LS)	(5 LS)	(1 LS)		1	11 (12 LS)	4 (13 LS)	36 (100)
Trees												
Betula nigra					3	2		2	2	10	9	90
Carpinus caroliniana					3	3	1	3		11	10	91
Diospyros virginiana										0	2	n/a
Fraxinus pennsylvanica						3	1		2	2	6	300
Juglans nigra	1	2	1	2	1	2	1		3	12	13	108
Nyssa sylvatica										1	0	0
Platanus occidentalis	1	1		1		3	1	5	4	22	16	73
Salix nigra							17			13	17	131
Sambucus canandensis										1	0	0
Quercus michauxii			1	3		1	3		1	16	9	56
Quercus rubra			2							2	2	100
Quercus alba		1		1	2					5	4	80
Quercus marilandica			1							1	1	100
Total including live stake	2	4	8	8	20	19	25	10	14	119	102	86
Stems per acre	95	190	381	364	1000	865	1190	500	667			
Total exluding live stake	2	4	8	9	14	11	21	10	17	107	89	83
Stems per acre	95.2	190.4	380.8	409.5	700	500.5	999.6	500	809.2			

APPENDIX B1

PHOTOLOG STREAM PROBLEM AREAS

APPENDIX B1
PHOTOLOG STREAM PROBLEM AREAS


Photo 1:


Photo 2:


Photo 3:


Photo 4:


Photo 5:


Photo 6:

Photo 7:

Photo 8:

Photo 9:

Photo 10:

Photo 11:

Photo 12:

Photo 13:

Photo 14:

Photo 15:

Photo 16:

Photo 17:

Photo 18:

Photo 19:

Photo 20:

APPENDIX B2

PHOTOLOG OF CROSS-SECTIONS AND PHOTO POINTS

APPENDIX B2
PHOTOLOG REACH 1


Cross-Section 1: Looking Downstream


Cross-Section 1: Looking Upstream


Cross-Section 2: Looking Downstream


Cross-Section 2: Looking Upstream


Cross-Section 3: Looking Downstream


Cross-Section 3: Looking Upstream

Cross Section 4: Looking Downstream

Cross Section 4: Looking Upstream

Photo point 1: Looking Upstream

Photo Point 1: Looking Downstream

Photo point 2: Looking Upstream

Photo point 2: Looking Downstream

Photo point 3: Looking Upstream

Photo point 3: Looking Downstream

Photo point 4: Looking Downstream

Photo point 4: Looking Upstream

Photo point 5: Looking Upstream

Photo point 5: Looking Downstream

Problems

APPENDIX B2
PHOTOLOG WELLS CREEK REACH 2


Cross-Section 9: Looking Downstream


Cross-Section 9: Looking Upstream


Cross-Section 10: Looking Downstream


Cross-Section 10: Looking Upstream


Cross-Section 11: Looking Downstream


Cross-Section 11: Looking Upstream

Cross-Section 12: looking Downstream

Cross-Section 12: looking upstream

Photo point 5: Looking Downstream

Photo point 6: Looking Downstream

Photo point 5: Looking Upstream

Photo point 6: Looking Upstream

Photo point 5: Looking at Channel

Photo point 6: Looking at Channel


Photo point 7: Looking Downstream


Photo point 8: Looking Downstream


Photo point 7: Looking Upstream


Photo point 8: Looking Upstream


Photo point 7: Looking at Channel

Photo point 9: Looking Downstream

Photo point 9: Looking Upstream

APPENDIX B2
PHOTOLOG WELLS CREEK UT


Cross-Section 5: Looking Downstream


Cross-Section 5: Looking Upstream


Cross-Section 6: Looking Downstream


Cross-Section 6: Looking Upstream


Cross-Section 7: Looking Downstream


Cross-Section 7: Looking Upstream

Cross-Section 8: Looking Downstream

Cross-Section 8: Looking Upstream


Photo point 10: Looking Downstream


Photo point 11: Looking Downstream


Photo point 10: Looking Upstream


Photo point 11: Looking Upstream


Photo point 10: Looking at Channel

Photo point 12: Looking Downstream

Photo point 12: Looking Upstream

APPENDIX B3

STREAM DATA TABLES

Table VIII. Verification of Bankfull Events - Wells Creek			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo # (if available)**
7/19/2006	Unknown	Bankfull event recorded: evident by crest stage gauge (0.6 inches wet on the measuring stick)	none
1/9/2007	Unknown	Bankfull event recorded: evident by crest stage gauge (7.0" inches wet on the measuring stick)	none

Table B1. Stream Problem Areas		
Wells Creek Reach 1		
Feature Issue	**Station numbers**	**Suspected Cause**
Aggradation	10+19.45	
	10+49.06	Channel built too wide; narrowing to a more stable dimension
Rootwad	10+86.31	
Rootwad	10+90.81	Location of rootwads upstream creating backeddys around downstream rootwads
Rootwad	10+95.99	
Bank Erosion (left bank)	10+96.92	
	11+18.70	Location of rootwads upstream creating backeddys downstream
Rootwad	12+56.46	
		Location of upstream rootwad creating backeddys downstream; possibly angl
Cross-Vane	12+74.24	
		Piping around structure on right side
Bank Erosion (left bank)	12+96.27	Flow direction coming from upstream cross-vane and backwater affect of
	13+15.91	downstream J-Hook; also lack of vegetation
Aggradation (grass)	17+47.84	Downstream J-hook elevation higher which created deposition upstream;
	17+67.01	eventually built up so grasses growing in channel
Aggradation (grass)	17+86.54	
	17+95.15	
Central Bar (grass)	17+95.15	Downstream rootwads and cross-vane causing deposition upstream and
	18+33.68	creation of a central bar with grasses growing on it.
Aggradation	18+71.27	
	18+75.95	Cattails
Aggradation	19+14.42	
	19+28.32	Channel narrows in this area possibly from upstream vane
Central Bar	21+72.75	
	21+81.44	Channel narrow upstream of this area
Bank Erosion (right bank)	22+20.23	
	22+41.71	Direction of flow, unstable soils, lack of vegetation

Table B1. Stream Problem Areas

Wells Creek Reach 2

Feature Issue	Station numbers	Suspected Cause	Photo number
Bank Erosion (left bank)	10+23.43	Possibly due to upstream structure placement, soil type, lack of bank	
	10+51.20	vegetation for a significant amount of time after construction, and/or radius of	1
Bank Erosion (left bank)	10+77.55		
	11+43.84	Toe Erosion along left bank and some slumping and erosion along right bank;	
Bank Erosion (right bank)	10+82.65	possibly due to soil type, lack of vegetation immediately after construction,	
	11+73.21	and/or channel built wider than designed.	2
Bank Erosion (left bank)	11+85.04	Bank Erosion upstream of rootwad; possibly caused by back eddy from	
	11+90.79	rootwad	
Rootwad	11+94.19		
		Angle of rootwad to flow and size	
Bank Erosion (left bank)	11+98.26		
	12+08.84		3
Aggradation (grass-lateral bar)	12+17.11	Channel might have been built too wide in which the channel is narrowing up	
	12+55.50	to a more stable dimension.	4
Bank Erosion (right bank)	12+55.57	Bank Erosion downstream of rootwad; possibly caused by back eddy from	
	12+58.04	rootwad	
Rootwad	12+80.32		
		Angle of rootwad to flow and size	
Bank Erosion (right bank)	12+82.72		
	12+91.37	Possibly due to rootwad upstream creating back eddy.	
Aggradation (grass)	12+91.37	Channel might have been built too wide in which the channel is narrowing up	
	13+35.93	to a more stable dimension.	
Bank Erosion (left bank)	13+60.32		
	13+67.30	Probably from radius of curvature	
Debris Jam	14+23.09		
		Natural	5
Bank Erosion (right bank)	14+60.81	Soil Type or lack of vegetation	
	14+95.15		
J-hook	15+02.51	Angle and placement of J-hook	
Bank Erosion (right bank)	15+15.42		
	15+94.29	Soil Type or lack of vegetation. Channel may have been built too wide and is	
Bank Erosion (left bank)	15+17.73	narrowing up.	
	15+80.06		7 and 8
J-hook	15+99.16	Angle and placement of J-hook	
			12
Bank Erosion (right bank)	16+10.02	Probably due from flow directing into bank from usptream J-hook.	
	16+19.74		
Aggradation (grass)	16+19.74	Channel might have been built too wide in which the channel is narrowing up	
	16+63.46	to a more stable dimension.	10
Bank Erosion (right bank)	16+81.79	Cross-Vane Upstream impacting erosion area	
	16+93.83		
Bank Erosion (left bank)	16+94.37	Channel might have been built too wide in which the channel is narrowing up	
	17+32.53	to a more stable dimension. Soils and lack of vegetation may also be factors.	9
Aggradation (grass)	17+02.97		
	17+42.82	Channel narrowing up.	14
Debris Jam	17+43.40		
		Natural	
Aggradation (grass)	17+81.00		
	18+47.51	Channel narrowing up.	15
Bank Erosion (left bank)	18+78.02		
	18+85.02	Due to upstream J-hook structure (back eddy)	19
Aggradation (grass)	20+25.86		
	20+45.05	Placement of downstream rootwad and exiting meander bend	20

Table B1. Stream Problem Areas		
Wells Creek Reach UT		
Feature Issue	**Station numbers**	**Suspected Cause**
J-Hook	10+01.12	Angle and placement of J-hook
Bank Erosion (left bank)	10+12.06	Possibly due to flow directed to bank from the J-hook upstream
	10+25.72	
Aggradation (grass)	10+35.95	Channel is narrowing
	10+59.41	
Aggradation (grass)	11+03.53	Channel is narrowing
	11+18.18	
Bank Erosion (left bank)	11+34.93	Possibly due to flow directed to bank from the J-hook upstream
	11+47.68	
Aggradation (grass)	11+45.40	Channel perhaps built too wide and is trying to narrow up
	12+23.77	
Aggradation (grass)	12+55.97	Channel perhaps built too wide and is trying to narrow up
	12+90.57	
Cross-Vane	13+24.20	
Aggradation (filling in lateral bar)	13+43.70	Channel is narrowing
	13+66.80	
Aggradation (grass)	13+36.94	Channel is narrowing itself. This is further evidenced by the formation of a
	13+66.19	lateral bar beside it on the right bank
Aggradation (grass)	14+28.98	Channel perhaps built too wide and is trying to narrow up
	14+47.38	
Aggradation (grass)	14+81.82	Channel perhaps built too wide and is trying to narrow up
	15+25.40	
J-Hook	16+31.95	Angle and placement of J-hook
Bank Erosion (left bank)	16+43.74	Possibly due to flow directed to bank from the J-hook upstream
	16+61.60	
Aggradation (grass)	16+60.00	Channel perhaps built too wide and is trying to narrow up
	16+96.87	
Bank Erosion (right bank)	17+11.03	Possibly caused lack of bank protection to redirect flow directed onto bank
	17+21.01	
Bank Erosion (right bank)	17+29.05	Angle and placement of Vane
	17+70.00	
Bank Erosion (left bank)	17+52.04	Possibly due to lack of vegetation
	17+73.83	
Bank Erosion (right bank)	17+74.82	Possibly cause by flow directed to the bank from the Vane upstream
	17+94.03	
Rootwad	18+04.93	Placement of rootwad too high. Dried out.
Rootwad	18+08.00	Placement of rootwad too high. Dried out.
Rootwad	18+14.62	Placement of rootwad too high. Dried out.
Bank Erosion (right bank)	18+44.89	Possibly due to lack of vegetation
	18+52.10	
Aggradation (grass)	18+75.29	Channel perhaps built too wide and is trying to narrow up
	19+02.00	
Rootwad	19+18.75	
Rootwad	19+28.39	
Bank Erosion (right bank)	19+19.71	Possibly caused by flow directed onto bank from Vane immediately
	19+23.76	upstream
Aggradation (grass)	19+34.67	Channel is narrowing
	19+51.23	
Bank Erosion (left bank)	19+60.23	Possibly due to lack of bank protection/vegetation
	19+86.81	

Table B2. Visual Morphological Stability Assessment

Wells Creek

Segment/Reach: 1 (1247 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	% Performing in Stable Condition	Feature Performance Mean or Total
A. Riffles	1. Present	16	16	NA	100%	
	2. Armor stable	14	16	NA	88%	
	3. Facet grade appears stable	16	16	NA	100%	
	4. Minimal evidence of embedding/fining	15	16	NA	94%	
	5. Length appropriate	15	16	NA	94%	**95%**
B. Pools	1. Present	20	20	NA	100%	
	2. Sufficiently deep	18	20	NA	90%	
	3. Length appropriate	19	20	NA	95%	**95%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	6	6	NA	100%	
	2. Downstream of meander (glide/inflection) centering	5	6	NA	83%	**92%**
D. Meanders	1. Outer bend in state of limited/controlled erosion	10	13	NA	77%	
	2. Of those eroding, # w/concomitant point bar formation	2	3	NA	67%	
	3. Apparent Rc within specifications	10	13	NA	77%	
	4. Sufficient floodplain access and relief	10	13	NA	77%	**74%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	7/112	91%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting	NA	NA	0/0	100%	**96%**
F. Bank Condition	1. Actively eroding, wasting, or slumping bank	NA	NA	3/57	95%	**95%**
G. Vanes / J Hooks etc.	1. Free of back or arm scour	17	18	NA	94%	
	2. Height appropriate	17	18	NA	94%	
	3. Angle and geometry appear appropriate	17	18	NA	94%	
	4. Free of piping or other structural failures	17	18	NA	94%	**94%**
H. Wads and Boulders	1. Free of scour	12	16	NA	75%	
	2. Footing stable	16	16	NA	100%	**88%**

Table B2. Visual Morphological Stability Assessment

Wells Creek

Segment/Reach: 2 (1141 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	% Performing in Stable Condition	Feature Performance Mean or Total
A. Riffles	1. Present	8	8	NA	100%	
	2. Armor stable	6	8	NA	75%	
	3. Facet grade appears stable	6	8	NA	75%	
	4. Minimal evidence of embedding/fining	6	8	NA	75%	
	5. Length appropriate	6	8	NA	75%	**80%**
B. Pools	1. Present	13	13	NA	100%	
	2. Sufficiently deep	10	13	NA	77%	
	3. Length appropriate	10	13	NA	77%	**85%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	5	6	NA	83%	
	2. Downstream of meander (glide/inflection) centering	5	6	NA	83%	**83%**
D. Meanders	1. Outer bend in state of limited/controlled erosion	7	13	NA	54%	
	2. Of those eroding, # w/concomitant point bar formation	2	6	NA	33%	
	3. Apparent Rc within specifications	9	13	NA	69%	
	4. Sufficient floodplain access and relief	7	13	NA	54%	**53%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	6/235	79%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting	NA	NA	0/0	100%	**90%**
F. Bank Condition	1. Actively eroding, wasting, or slumping bank	NA	NA	13/337	70%	**70%**
G. Vanes / J Hooks etc.	1. Free of back or arm scour	12	14	NA	86%	
	2. Height appropriate	12	14	NA	86%	
	3. Angle and geometry appear appropriate	12	14	NA	86%	
	4. Free of piping or other structural failures	12	14	NA	86%	**86%**
H. Wads and Boulders	1. Free of scour	5	7	NA	71%	
	2. Footing stable	5	7	NA	71%	**71%**

Table B2. Visual Morphological Stability Assessment

Wells Creek

Segment/Reach: UT (1013 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	% Performing in Stable Condition	Feature Performance Mean or Total
A. Riffles	1. Present	15	15	NA	100%	
	2. Armor stable	12	15	NA	80%	
	3. Facet grade appears stable	12	15	NA	80%	
	4. Minimal evidence of embedding/fining	12	15	NA	80%	
	5. Length appropriate	11	15	NA	73%	**83%**
B. Pools	1. Present	17	17	NA	100%	
	2. Sufficiently deep	14	17	NA	82%	
	3. Length appropriate	14	17	NA	82%	**88%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	7	8	NA	88%	
	2. Downstream of meander (glide/inflection) centering	6	7	NA	86%	**87%**
D. Meanders	1. Outer bend in state of limited/controlled erosion	9	15	NA	60%	
	2. Of those eroding, # w/concomitant point bar formation	5	6	NA	83%	
	3. Apparent Rc within specifications	14	15	NA	93%	
	4. Sufficient floodplain access and relief	13	15	NA	87%	**81%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	10/329	68%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting	NA	NA	0/0	100%	**84%**
F. Bank Condition	1. Actively eroding, wasting, or slumping bank	NA	NA	9/172	83%	**83%**
G. Vanes / J Hooks etc.	1. Free of back or arm scour	12	13	NA	92%	
	2. Height appropriate	10	13	NA	77%	
	3. Angle and geometry appear appropriate	10	13	NA	77%	
	4. Free of piping or other structural failures	12	13	NA	92%	**85%**
H. Wads and Boulders	1. Free of scour	11	16	NA	69%	
	2. Footing stable	11	16	NA	69%	**69%**

Table XI. Categorical Stream Feature Visual Stability Assessment						
Wells Creek						
Segment/Reach: 1						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	Unknown	Unknown	95%			
B. Pools			95%			
C. Thalweg			92%			
D. Meanders			74%			
E. Bed General			96%			
F. Bank Condition			95%			
G. Vanes / J Hooks etc.			94%			
H. Wads and Boulders			88%			

Table XI. Categorical Stream Feature Visual Stability Assessment						
Wells Creek						
Segment/Reach: 2						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	Unknown	Unknown	80%			
B. Pools			85%			
C. Thalweg			83%			
D. Meanders			53%			
E. Bed General			90%			
F. Bank Condition			70%			
G. Vanes / J Hooks etc.			86%			
H. Wads and Boulders			71%			

Table XI. Categorical Stream Feature Visual Stability Assessment						
Wells Creek						
Segment/Reach: UT						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	Unknown	Unknown	83%			
B. Pools			88%			
C. Thalweg			87%			
D. Meanders			81%			
E. Bed General			84%			
F. Bank Condition			83%			
G. Vanes / J Hooks etc.			85%			
H. Wads and Boulders			69%			

Table XII Baseline Morphologyand Hydraulic Summary
Wells Creek/EEP Number 414

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design (SR#1)			As-built (SR#1)			Design (SR#2)			As-built (SR#2)			Design (UT)			As-built (UT)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																														
BF Width (ft)	28	30	29			14.77	15.4	28.9	22.75	6.5	10	8			25	20.1	27.4	23.7			20	19.3	31.6	25.4			15	13.5	16	14.9
Floodporne Width (ft)	40	100	70				24.5	50	40.7	16	22	18.8			>55	48	66	57			>50			100			>33	50	77	63.5
BFCross Sectional Area (ft)	58.6	58.9	58			29.9	22.2	34.8	31	3.9	6.3	5.3			33	25.2	42.8	34	32.2	36	34.1	44.2	47.1	45.6			17	13.5	16	14.7
BF Mean Depth (ft)	2	2.1	2			1.75	0.8	1.9	1.4	0.4	1	0.7			1.3	1.3	1.6	1.4			1.8	1.5	2.3	1.9			1.1			1
Max Depth (ft)	2.7	3	2.9				1.3	3.1	2.1	0.9	1.4	1.1	1.7	2.6	2.1	1.6	3.1	2.3	2.3	3.6	2.9	2.5	3.5	3	1.4	2.2	1.8	1.4	2.1	1.6
Width/Depth Ratio	13	15	14				8	38	18.3	7	26	13.5			19	16.1	17.6	16.8			11	8.4	21.2	14.8			12.5	14.8	15.3	15
Entrenchment Ratio	1.3	3.6	2.4				1	3.2	1.9	2	3.4	2.4			>2.2			2.4			>2.2	3.2	5.2	4.2			>2.2	3.5	4.9	4.2
Wetted Perimeter (ft)	33.6	33.7	33.65				16.8	29.2	24.1	7.2	11.7	9			27.6	21.5	28.2	24.9			23.6	21	33.1	27			17.2	14.7	16.2	15.5
Hydraulic radious (ft)	1.7	1.7	1.7				1	1.8	1.4	0.3	0.9	0.7			1.2	1.2	1.5	1.35			1.4	1.4	2.1	1.8			1	0.9	1	0.95
Pattern																														
Channel Beltwidth (ft)							6	271	69.4	10	35	20.9	33	110	65	29.5	105.6	55.9	26	88	52	32.5	81.8	57.2	19.5	66	39	17.8	71.7	45.4
Radius of Curvature (ft)							2.5	641	81.9	2.3	31.8	13.5	8	100	40	10	80	44.6	6	80	32	40	130	69.2	4.5	60	24	20	150	70.7
Meander Wavelenght (ft)							56	360	182.2	35	70	50	110	220	157	49.3	232.4	137.5	88	176	126	113	151.3	129.5	66	132	94.5	55	184.3	116.5
Meander Width Ratio							3.2	9.1	5.3	1.3	4.4	2.6	1.3	4.4	2.6	1.2	4.4	2.3	1.3	4.4	2.6	1.3	3.2	2.2	1.3	4.4	2.6	1.2	4.8	3
Profile																														
Riffle length (ft)							3.4	108.5	40.2	2	25	13.9	6.3	77.5	42.5	20.1	110.8	41.1	5	62	34	14.3	128.3	38.2	3.8	46.5	25.5	5.6	89.5	26.7
Riffle slope (ft/ft)							0.0006	0.041	0.0208	0.0173	0.078	0.039	0.0042	0.019	0.011	0.002	0.019	0.007	0.006	0.0276	0.017	0	0.0228	0.0107	0.0058	0.0256	0.0154	0.0027	0.0483	0.02
Pool length (ft)							3.5	218.6	43.8	7	27	14.5	22.5	85	45	7.4	93.9	27.2	18	68	36	4.6	84.8	43.6	13.5	51	27	8	61.1	36.8
Pool spacing (ft)							10.2	258.1	90.4	17	63	36.5	30	197.5	115	31	176.5	66.2	42	158	92	22.4	170.6	79.9	31.5	118.5	69	29.8	139.6	59.9
Substrate																														
d50 (mm)									0.9			4.5						0.1						0.5						0.6
d84 (mm)									68			53						9						17						13
Additional Reach Parameters																														
Valley Length (ft)							2850			337			945			960			1010			1010			1415			859		
Channel Length (ft)							3714			447			1127			1193			1244			1127			1696			1083		
Sinuosity							1.3			1.3			1.2			1.2			1.3			1.1			1.2			1.3		
Water Surface Slope (ft/ft)	0.0016						0.0084			0.0197			0.0047			0.0049			0.0069			0.0062			0.0064			0.0053		
BF slope (ft/ft)							0.79			0.0199			0.0047			0.0049			0.0069			0.0062			0.0064			0.0053		
Rosgen Classification	B/C						E5, B5, F5, and G5			C4/1			C4/1			C5/1			C4/1			C/E4/1			C4/1			C5/1		
*Habitat Index							N/A																							
*Macrobenthos							N/A																							

Table XIII. Morphology and Hydraulic Monitoring Summary
Wells Creek
Segment/Reach: 1

Parameter	Cross Section 1 Pool						Cross Section 2 Riffle						Cross Section 3 Riffle						Cross Section 4 Pool					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	36.9	26.4					19.6	20.4					33	28.8					30.4	26.1				
Floodporne Width (ft)	>100.0	NA					>100	>85					>70	43					>100	NA				
BFCross Sectional Area (ft)	66.9	46.9					32.9	38.7					41.7	40.7					36.3	40.3				
BF Mean Depth (ft)	1.8	1.8					1.7	1.9					1.3	1.4					1.2	1.5				
Width/Depth Ratio	20.5	NA					11.5	10.7					25.4	20.5					25.3	NA				
Entrenchment Ratio	2.7	NA					>5.1	>3.3					>2.1	1.5					3.3	NA				
Bank Height Ratio	NA	NA					1	1					1	1					NA	NA				
Wetted Perimeter (ft)	39.2	44.7					21.7	23.4					33.5	49.7					31.6	30.9				
Hydraulic radious (ft)	1.7	1.6					1.5	1.7					1.2	2					1.1	1.3				
Substrate																								
d50 (mm)	NA	0.25					8.3	0.25					8	0.125					NA	0.25				
d84 (mm)	NA	11.3					41	18					19	11.3					NA	11.3				

Parameter	MY-01 (2001)			MY-02 (2002)			MY-03 (2003)			MY-04 (2004)			MY-05 (2005)			MY+ (2006)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	29	101.7	63.4	37.45	107.3	67.26												
Radius of Curvature (ft)	20	100	52.7	15	120	40												
Meander Wavelenght (ft)	123	246	465.1	136.45	324.8	198.5												
Meander Width Ratio	0.8	2.8	1.7	1.34	2.95	1.88												
Profile																		
Riffle length (ft)	6.8	46.7	24.6	1.5	38.8	12.8												
Riffle slope (ft/ft)	0	0.032	0.012	0	0.473	0.069												
Pool length (ft)	5.9	128.9	36.5	6.2	108.0	29.1												
Pool spacing (ft)	20.5	169.5	66.2	25.1	239.4	63.0												
Additional Reach Parameters																		
Valley Length (ft)	952			995														
Channel Length (ft)	1213			1244														
Sinuosity	1.3			1.2														
Water Surface Slope (ft/ft)	0.005			0.0052														
BF slope (ft/ft)	0.0055			0.0042														
Rosgen Classification	C 4/1			C 4														
*Habitat Index																		
*Macrobenthos																		

Table XIII. Morphology and Hydraulic Monitoring Summary
Wells Creek
Segment/Reach: 2

Parameter	Cross Section 9 Riffle						Cross Section 10 Pool						Cross Section 11 Riffle						Cross Section 12 Pool					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	23.1	19.5					27	20.8					20.9	18.8					22.1	22.1				
Floodporne Width (ft)	>100	>45					>100	NA					>100	38					>100.0	NA				
BFCross Sectional Area (ft)	44	41.6					54.8	51.4					40.9	47					35.5	52				
BF Mean Depth (ft)	1.9	2.1					2	2.4					2	2.5					1.6	2.3				
Width/Depth Ratio	12.1	10.8					13.5	NA					10.5	7.5					13.8	NA				
Entrenchment Ratio	4.3	>2.3					>3.7	NA					>4.8	2					>4.5	NA				
Bank Height Ratio	1	1					NA	NA					1	1					NA	NA				
Wetted Perimeter (ft)	24.9	22.4					28.6	23.7					22.5	22.9					23.4	31.9				
Hydraulic radious (ft)	1.8	1.9					1.9	2.2					1.8	2.1					1.5	1.7				
Substrate																								
d50 (mm)	12.5	8					NA	0.45					13.5	0.45					NA	0.25				
d84 (mm)	43	44					NA	32					23	32					NA	1				

Parameter	MY-01 (2001)			MY-02 (2002)			MY-03 (2003)			MY-04 (2004)			MY-05 (2005)			MY+ (2006)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	13.1	85.4	55	38.52	85.07	54.16												
Radius of Curvature (ft)	15	120	39.4	22	70	31.5												
Meander Wavelenght (ft)	105	180	134.8	115.79	149.8	127												
Meander Width Ratio	0.6	3.9	2.5	1.98	4.36	2.78												
Profile																		
Riffle length (ft)	3.8	53.9	26	13	53	27												
Riffle slope (ft/ft)	0.0018	0.039	0.014	0	0.04	0.01												
Pool length (ft)	17	128.4	42.9	5.8	208.8	52.5												
Pool spacing (ft)	46.4	184.3	87	23	117	74												
Additional Reach Parameters																		
Valley Length (ft)	906			902.92														
Channel Length (ft)	1127			1140														
Sinuosity	1.24			1.26														
Water Surface Slope (ft/ft)	0.0053			0.005														
BF slope (ft/ft)	0.0058			0.005														
Rosgen Classification	C4/1			E														
*Habitat Index	NA			NA														
*Macrobenthos	NA			NA														

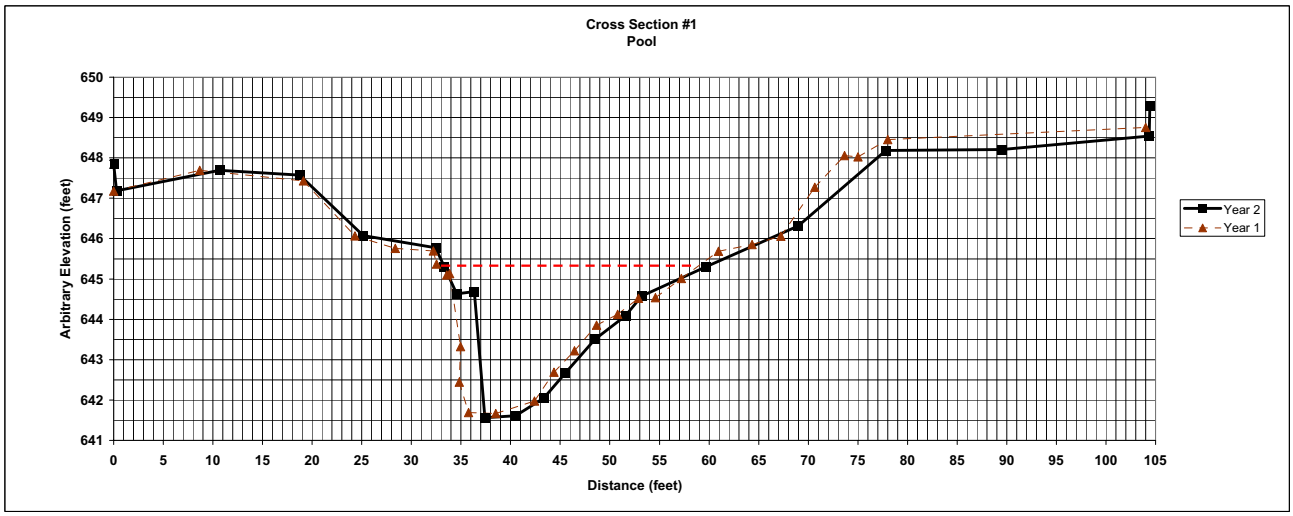
Table XIII. Morphology and Hydraulic Monitoring Summary
Wells Creek
Segment/Reach: UT

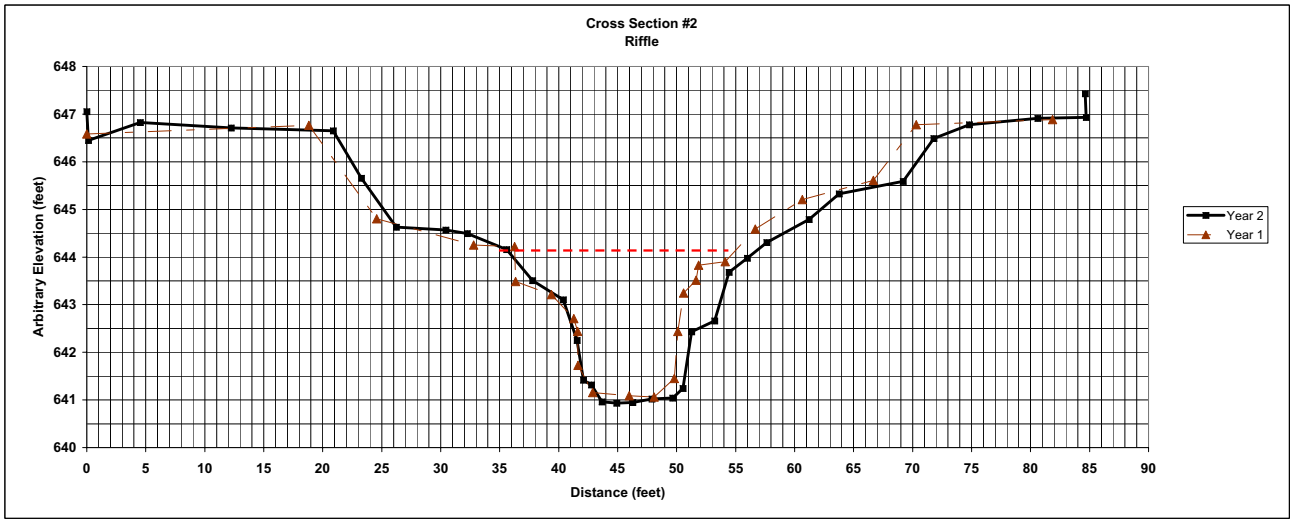
Parameter	Cross Section 5- Pool						Cross Section 6 -Riffle						Cross Section 7 - Riffle						Cross Section 8 - Pool					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	17	14.4					18.2	20.4					17.8	9.2					15.8	18.9				
Floodporne Width (ft)	67	NA					72	67					50	67					50	NA				
BFCross Sectional Area (ft)	18.3	21.9					12.8	14.4					13.1	13.6					22.3	23				
BF Mean Depth (ft)	1.1	1.5					0.7	0.7					0.7	1.5					1.4	1.2				
Width/Depth Ratio	15.5	NA					26	26.9					25.4	6.2					11.3	NA				
Entrenchment Ratio	3.9	NA					4	3.4					2.8	7.2					3.2	NA				
Bank Height Ratio	NA	NA					1	1					1	1					NA	NA				
Wetted Perimeter (ft)	18.1	19.9					18.5	21.6					18.2	39.6					17.2	26.2				
Hydraulic radious (ft)	1	1.1					1	0.7					0.7	0.8					1.3	1.1				
Substrate																								
d50 (mm)	NA	0.5					0.2	1					0.1	0.5					NA	0.5				
d84 (mm)	NA	23					22	32					35	18					NA	18				

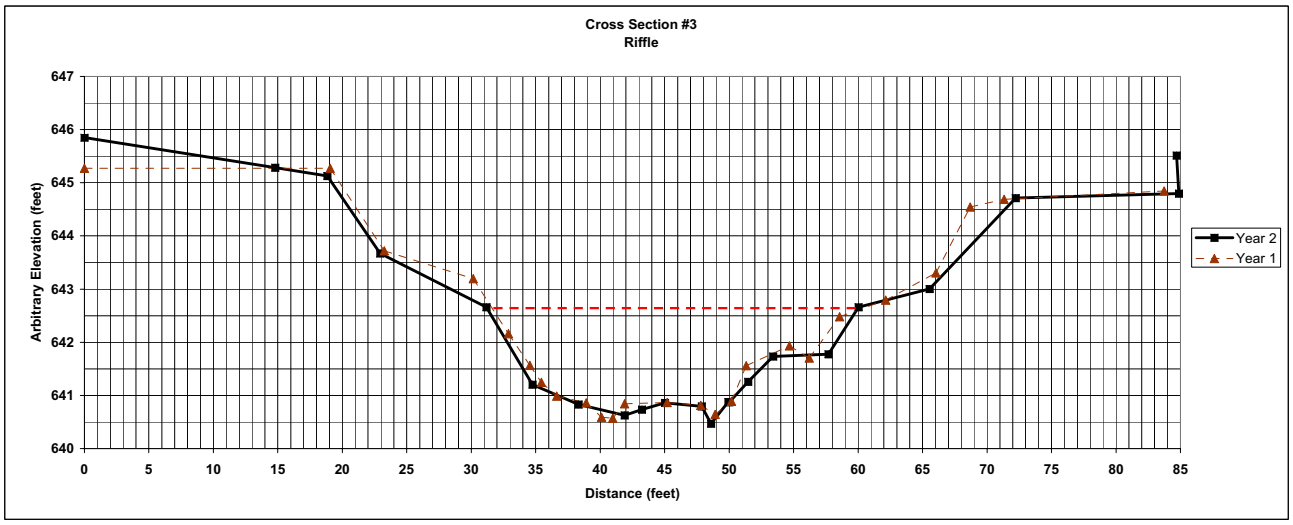
Parameter	MY-01 (2001)			MY-02 (2002)			MY-03 (2003)			MY-04 (2004)			MY-05 (2005)			MY+ (2006)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	9.4	67.7	42.4	27.33	72.73	56.87												
Radius of Curvature (ft)	8	110	40.1	18.63	79.72	28.26												
Meander Wavelenght (ft)	71	176	116.7	91.3	191.7	136.7												
Meander Width Ratio	0.5	3.8	2.4	1.85	4.9	3.8												
Profile																		
Riffle length (ft)	8.2	49.8	21.8	3.3	69.3	22.5												
Riffle slope (ft/ft)	0.0003	0.045	0.016	0	0.04	0.01												
Pool length (ft)	7.6	57.2	27	4.8	39.1	23.4												
Pool spacing (ft)	22	125.4	64	35.3	100.6	59.3												
Additional Reach Parameters																		
Valley Length (ft)	841.4			853.46														
Channel Length (ft)	1014.2			1012.3														
Sinuosity	1.2			1.2														
Water Surface Slope (ft/ft)	0.006			0.006														
BF slope (ft/ft)	0.006			0.006														
Rosgen Classification	C4/1			C 4														
*Habitat Index																		
*Macrobenthos																		

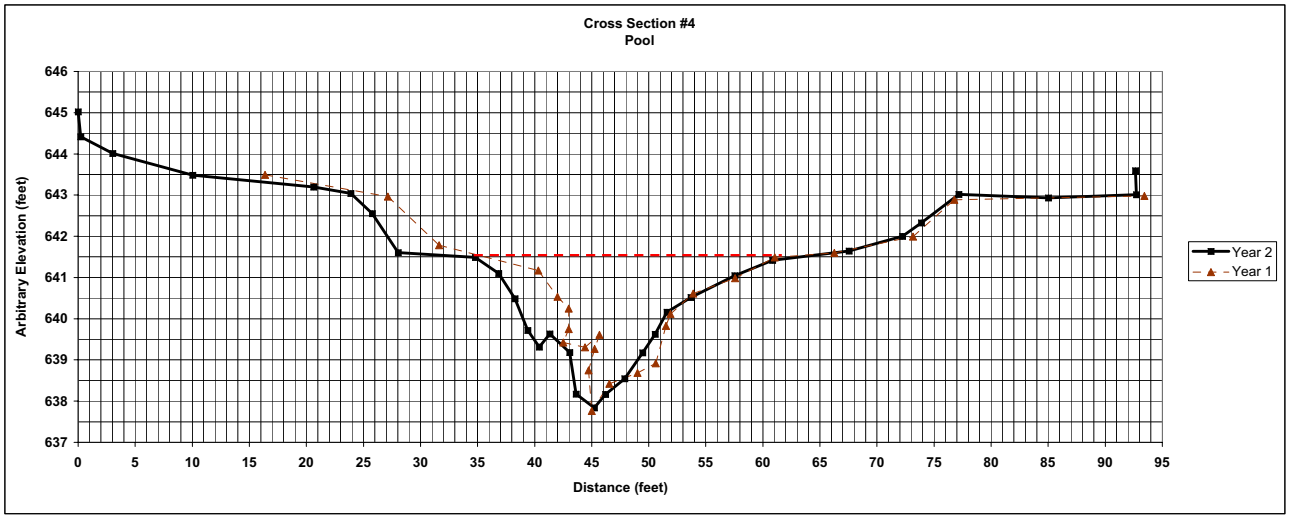
APPENDIX B4

STREAM CROSS-SECTIONS

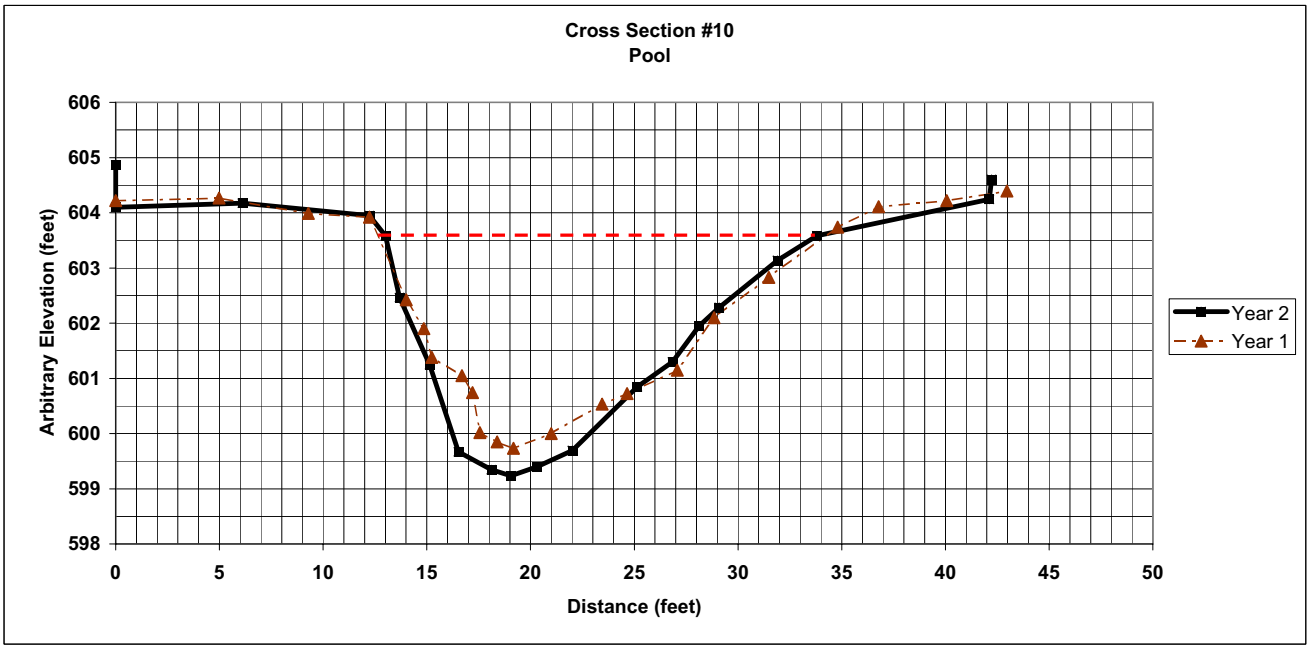

Cross Section #1
Pool
Arbitrary Elevation (feet)
650
649
648
647
646
645
644
643
642
641
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105
Distance (feet)
Year 2
Year 1


Cross Section #2
Riffle
Arbitrary Elevation (feet)
648
647
646
645
644
643
642
641
640
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
Distance (feet)
Year 2
Year 1

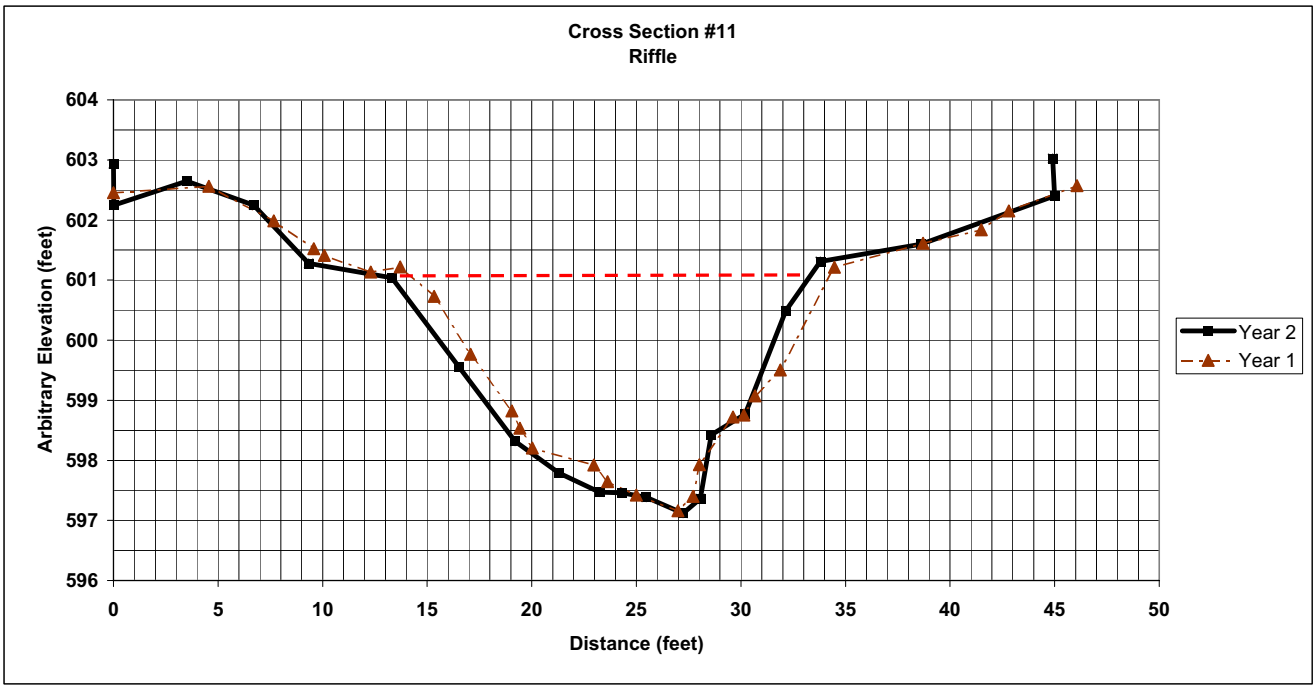

Cross Section #3
Riffle
Arbitrary Elevation (feet)
647
646
645
644
643
642
641
640
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Distance (feet)
Year 2
Year 1

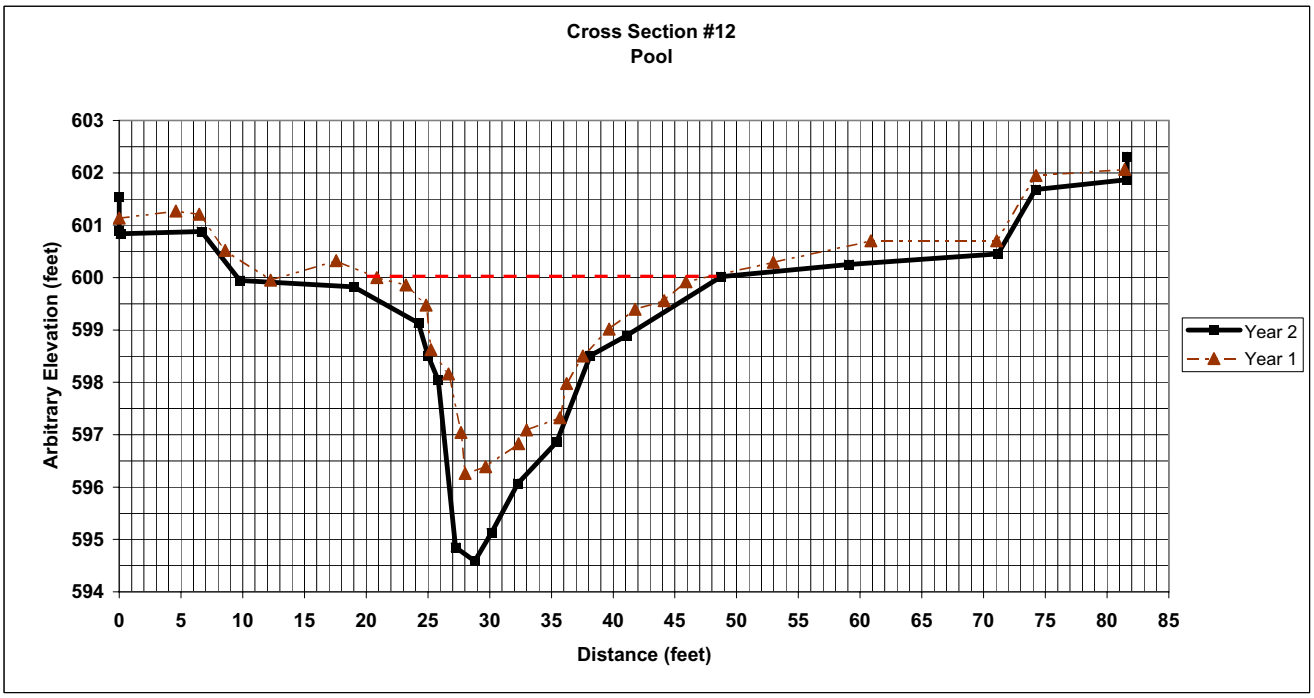

Cross Section #4
Pool
Arbitrary Elevation (feet)
646
645
644
643
642
641
640
639
638
637
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95
Distance (feet)
Year 2
Year 1

Appendix B4
Reach 2 Cross-Sections
Year 1 and 2 Comparisons

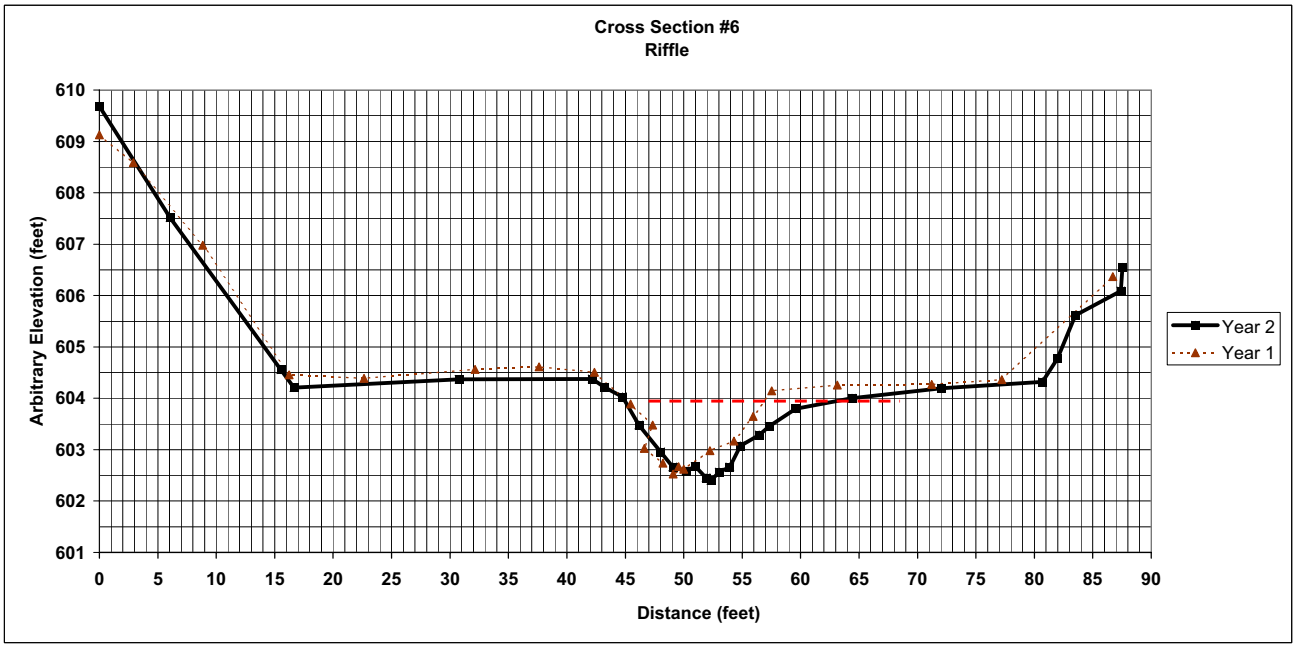


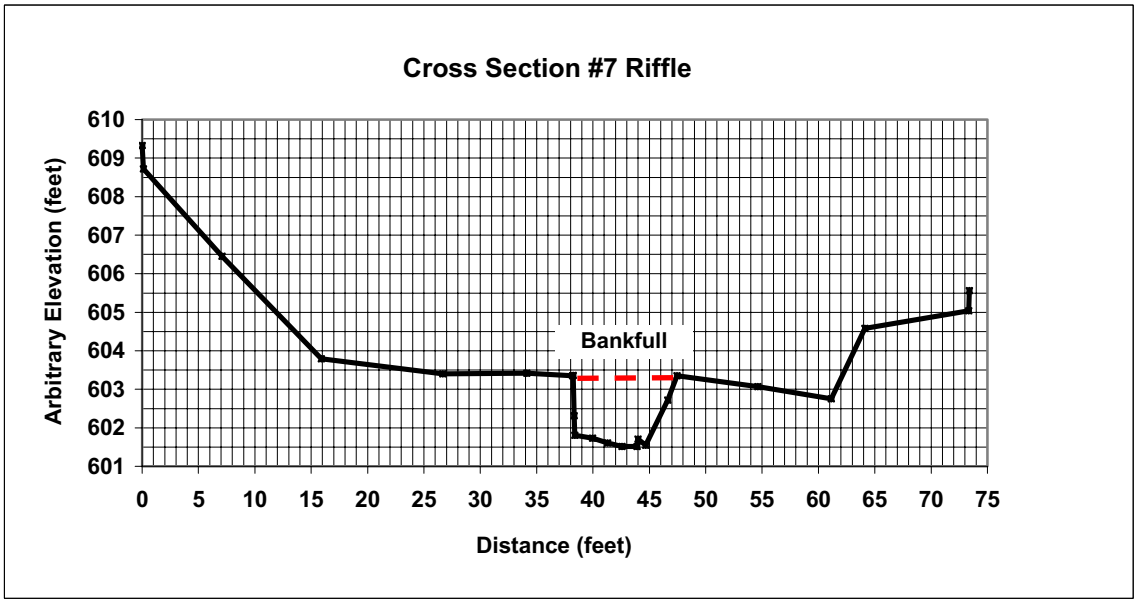
Appendix B4
Reach 2 Cross-Sections
Year 1 and 2 Comparisons

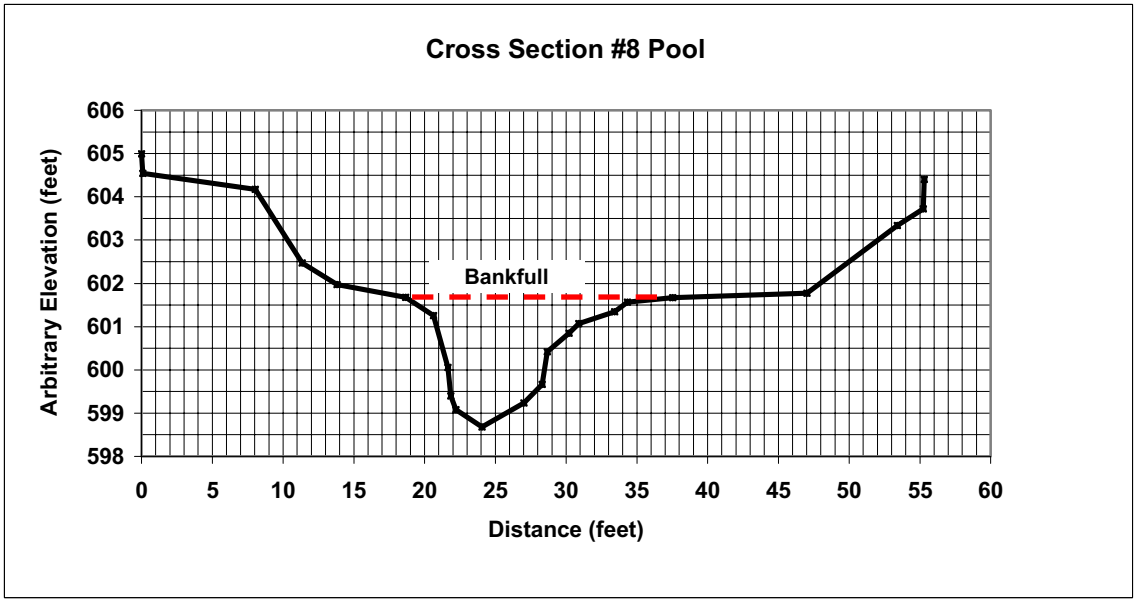




Appendix B4
UT to Wells Creek Cross-Sections
Year 1 and 2 Comparisons





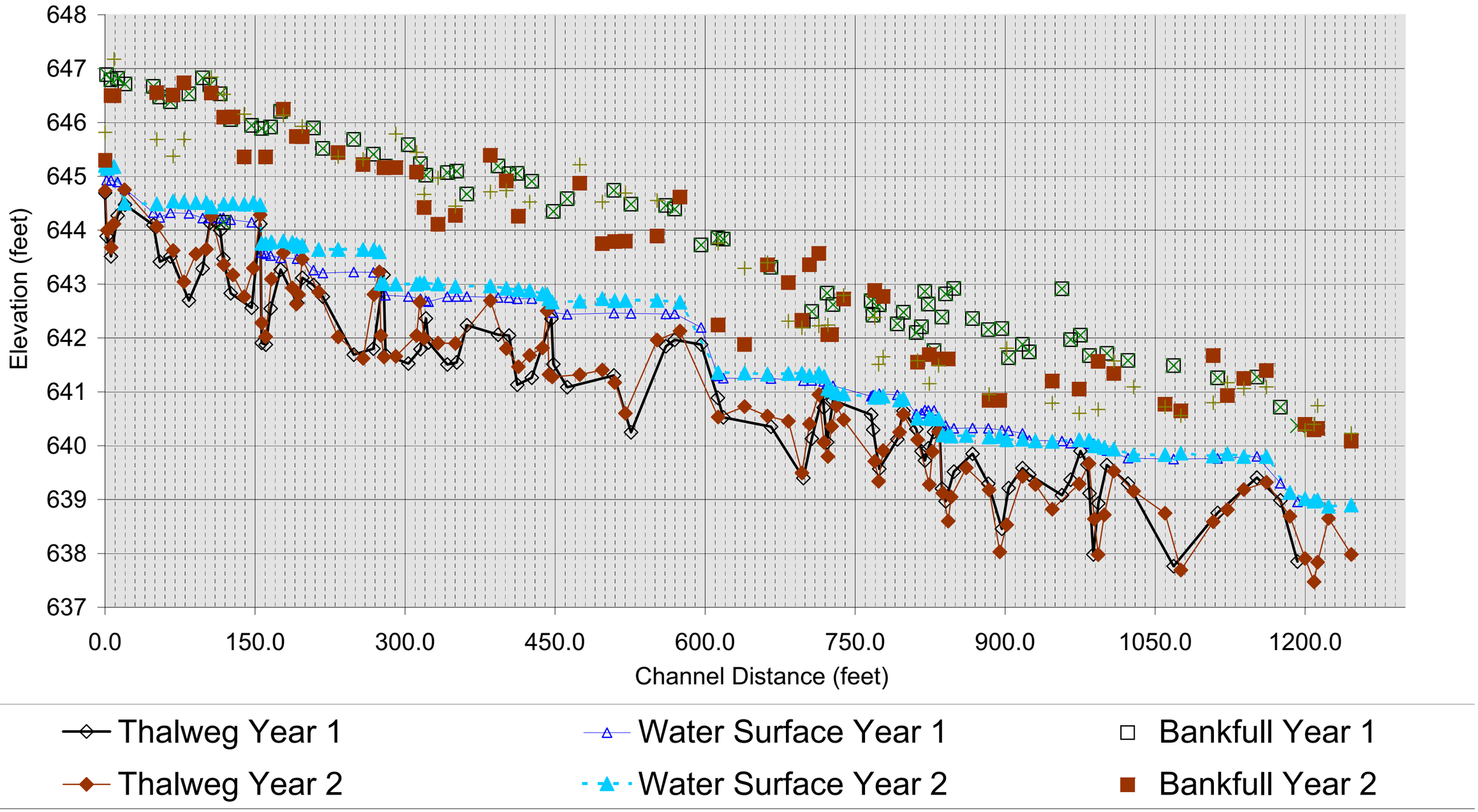


*2005 raw data was corrupted and therefore excluded from cross section 7 and 8 comparisons. Cross sections shown are from monitoring year 2.

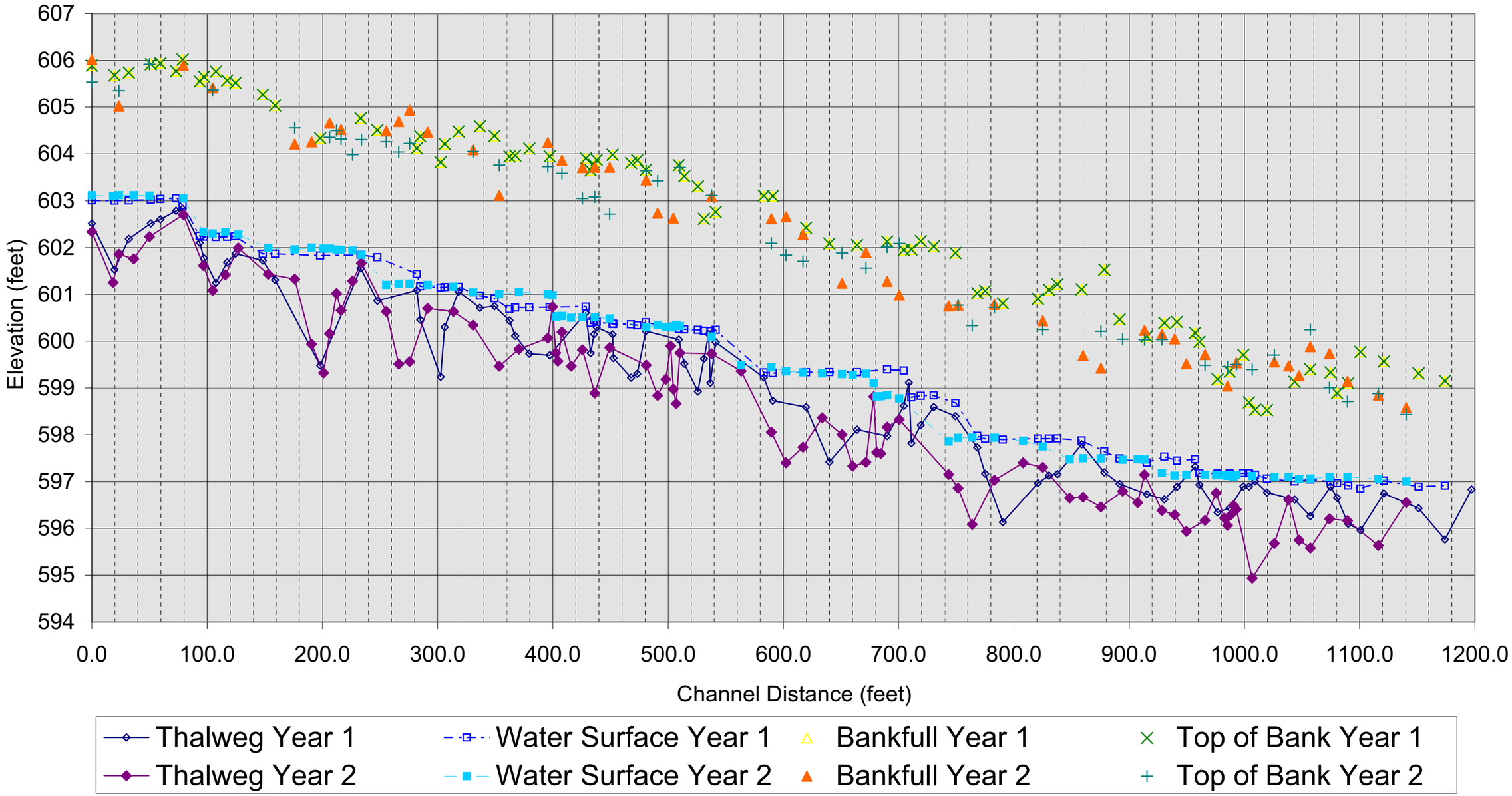
APPENDIX B5

STREAM LONGITUDINAL PROFILE

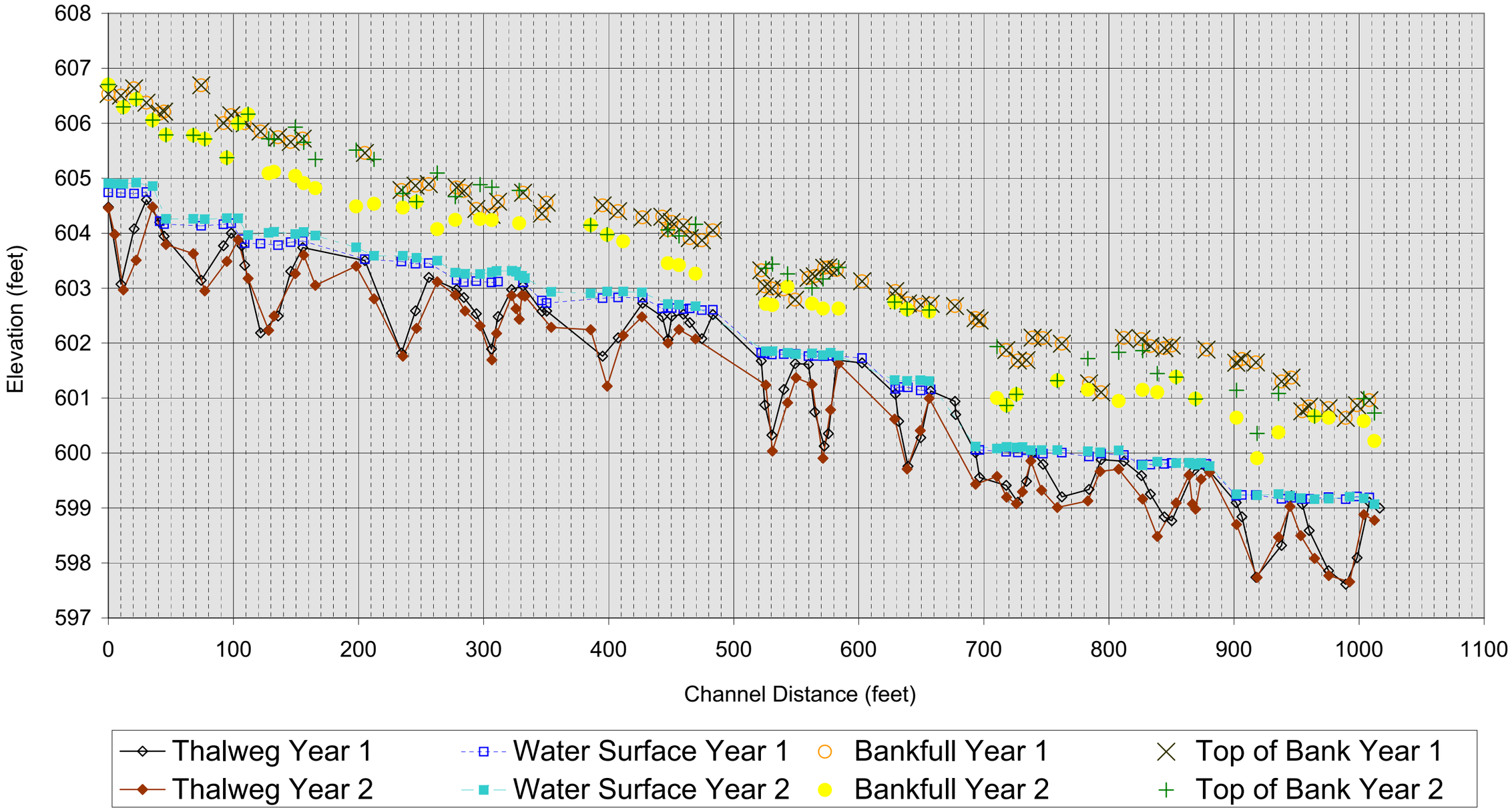
Appendix B5: Longitudinal Profile Wells Creek Reach 1; Year 1 and 2 Comparisons



Appendix B5: Longitudinal Profile for Wells Creek Reach 2; Year 1 and 2 Comparisons



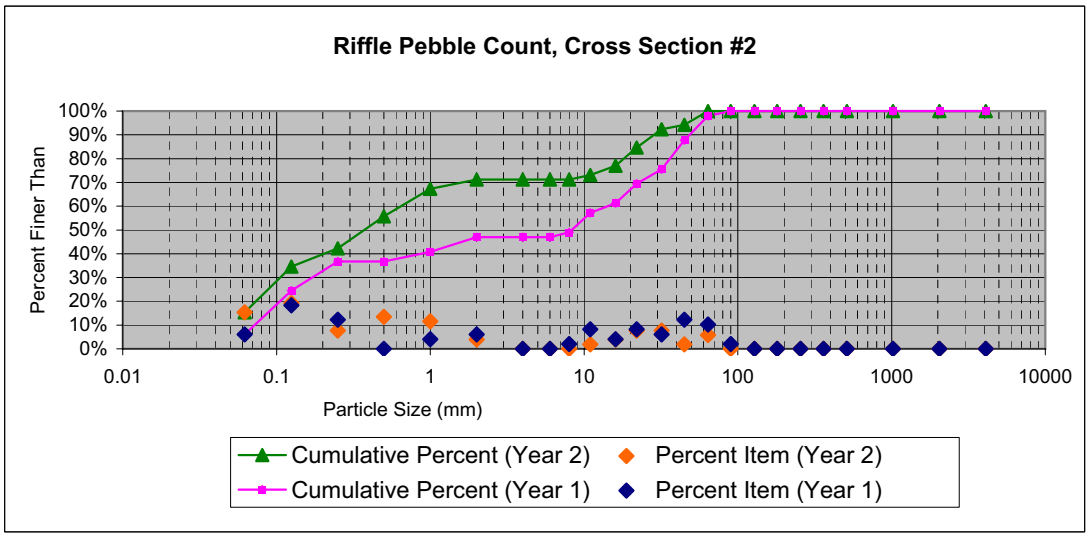
Appendix B5: Longitudinal Profile for UT to Wells Creek; Year 1 and 2 Comparisons

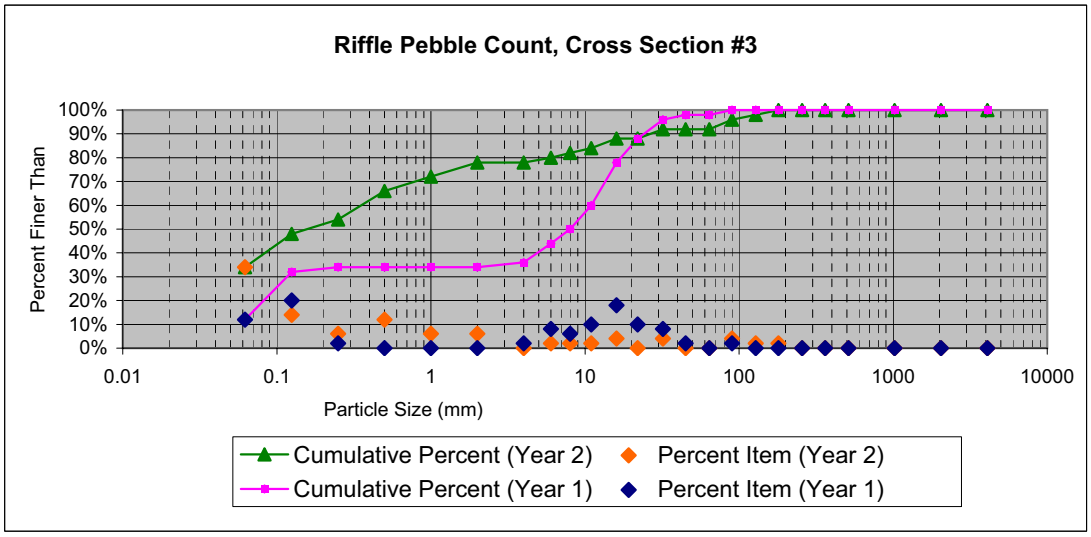


APPENDIX B6

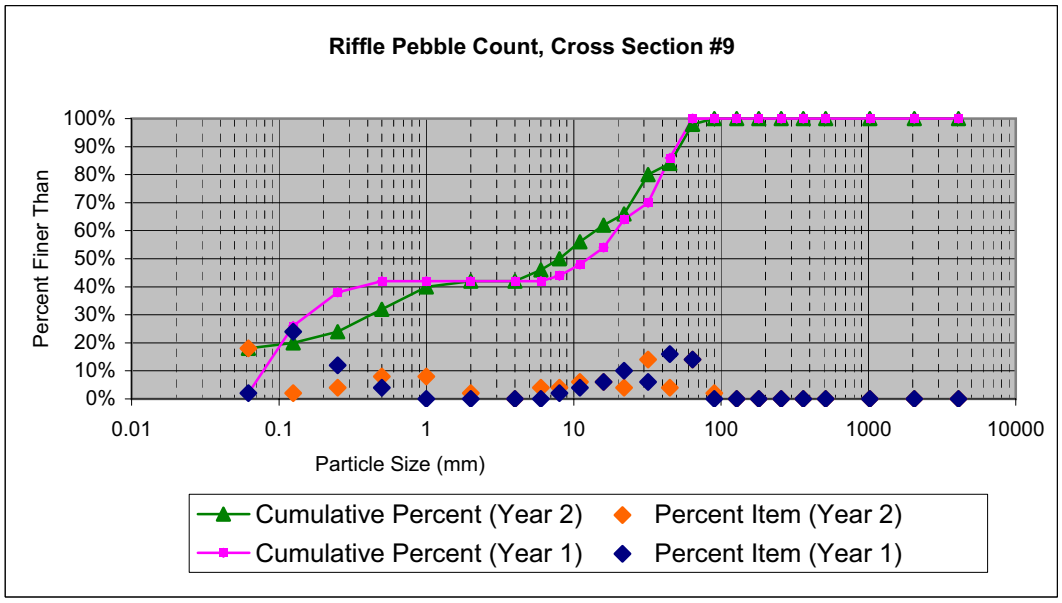
STREAM PEBBLE COUNTS

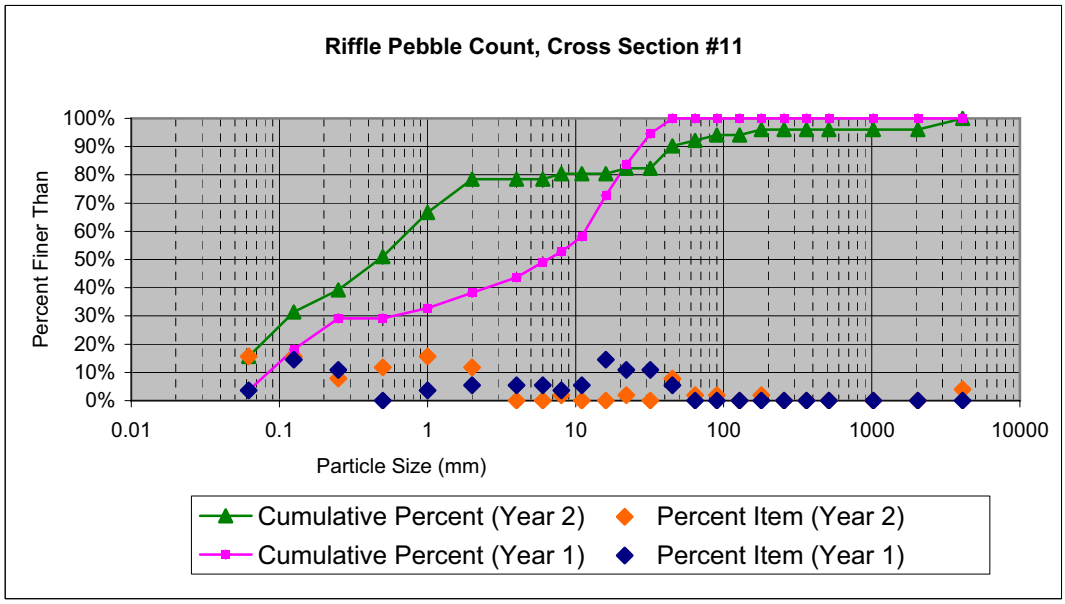
Wells Creek Reach 1
Pebble Count Comparison
Year 1 and Year 2



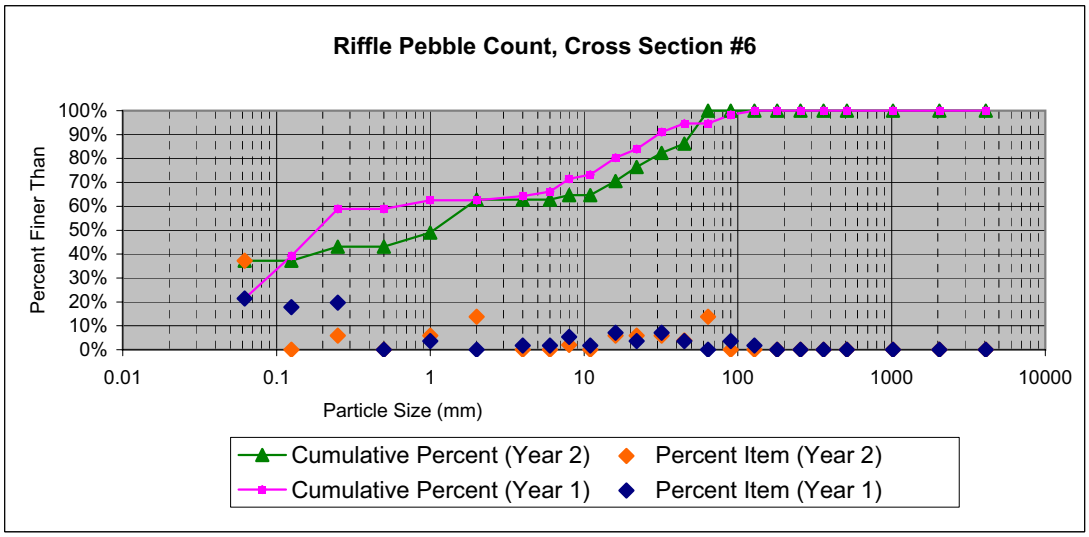


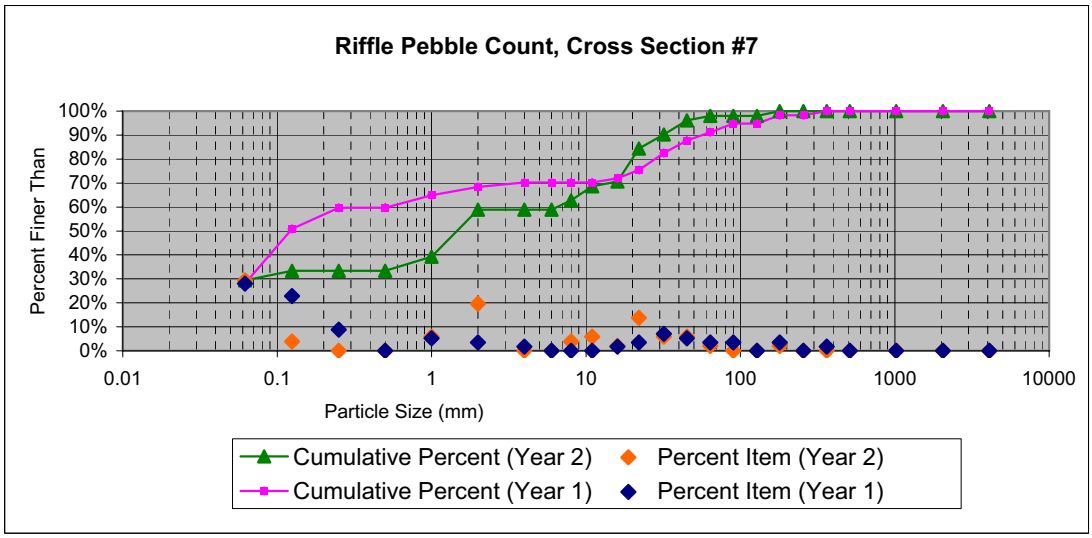
Wells Creek Reach 2
Pebble Count Comparison
Year 1 and Year 2





UT to Wells Creek
Pebble Count Comparison
Year 1 and Year 2





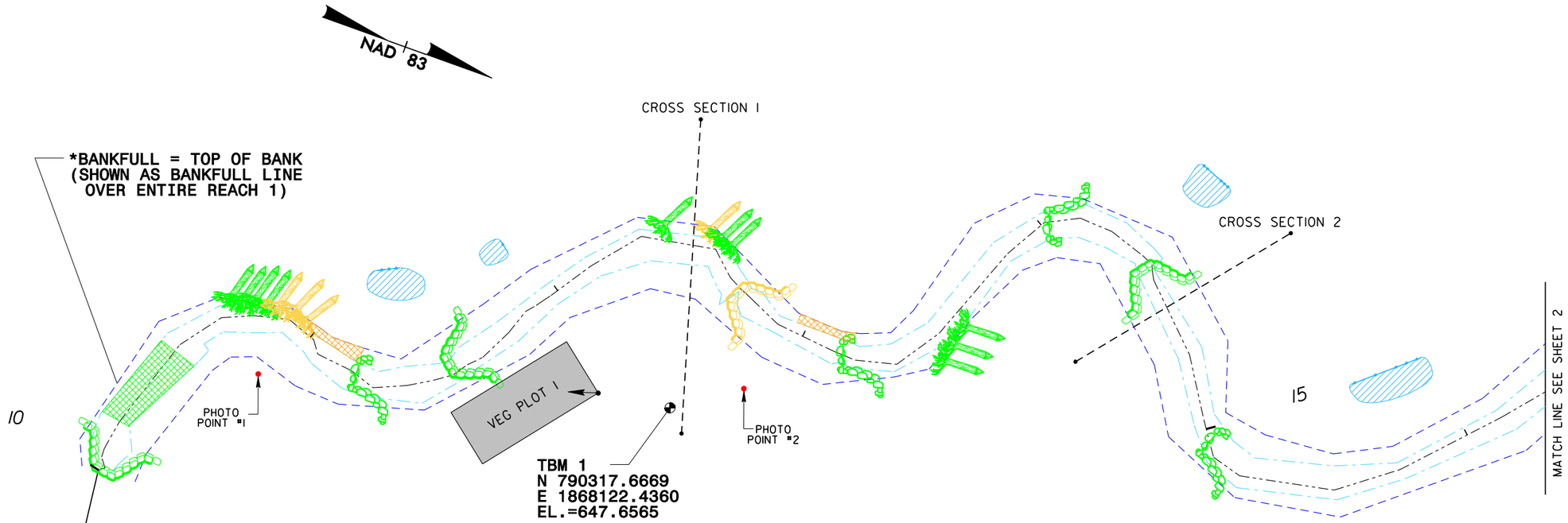
APPENDIX C

PLAN VIEW SHEETS

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
414	1
PROJECT ENGINEER	

10 0 20
SCALE



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 1 LEFT	790305.5148	1868218.0170	647.6658
XSC 1 RIGHT	790314.0373	1868113.8230	649.1659
XSC 2 LEFT	790110.5344	1868176.2530	647.0516
XSC 2 RIGHT	790182.8344	1868135.0260	647.4296

LEGEND

- THALWEG 2006
- EDGE OF WATER 2006
- BANKFULL 2006
- TOP OF BANK 2006
- CROSS-SECTIONS
- PHOTO POINT

- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION (GRASSES)
- AGGRADATON (CATTAILS)
- BARE BENCH
- BARE FLOODPLAIN
- INVASIVE/EXOTIC (MICROSTEGIUM)

STRUCTURE TYPES
- ROCK CROSS VANE
- J-HOOK VANE
- ROOTWAD
- ROCK VANE

COLOR CODE FOR STRUCTURES
- GOOD STRUCTURE
- STRUCTURE WITH POTENTIAL PROBLEM
- FAILING STRUCTURE

WELLS CREEK - REACH 1

Ecosystem Enhancement PROGRAM

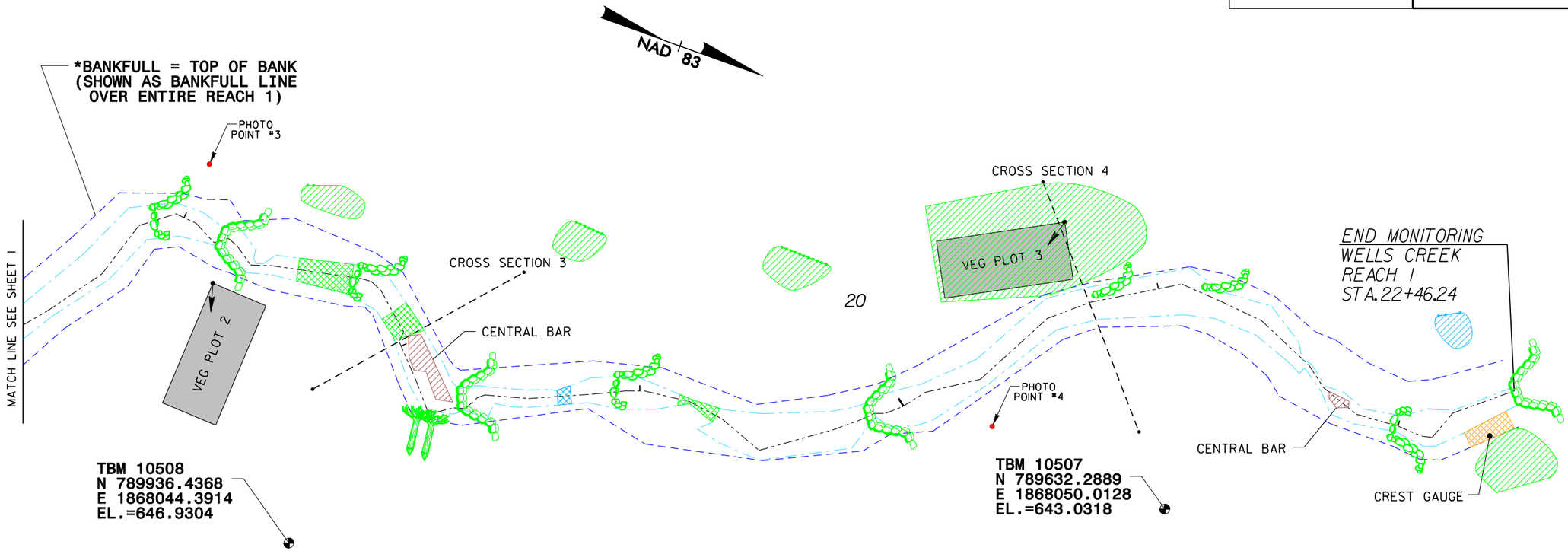
LOCATION:
WELLS CREEK
STREAM MONITORING - YEAR 2

PROJ #:	COUNTY:
414	ALAMANCE
PREPARED BY: WDY	
CHECKED BY: ATW	DATE: 11/17/06

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
414	2
PROJECT ENGINEER	

10 0 20
SCALE



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 3 LEFT	789852.9624	1868136.6510	645.8511
XSC 3 RIGHT	789927.1424	1868097.5820	645.5129
XSC 4 LEFT	789672.2703	1868164.3220	645.0177
XSC 4 RIGHT	789640.7034	1868076.9910	643.5958

LEGEND

- THALWEG 2006
- EDGE OF WATER 2006
- BANKFULL 2006
- TOP OF BANK 2006
- CROSS-SECTIONS
- PHOTO POINT
- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION (GRASSES)
- AGGRADATON (CATTAILS)
- BARE BENCH
- BARE FLOODPLAIN
- INVASIVE/EXOTIC (MICROSTEGIUM)

STRUCTURE TYPES
- ROCK CROSS VANE
- J-HOOK VANE
- ROOTWAD
- ROCK VANE

COLOR CODE FOR STRUCTURES
- GOOD STRUCTURE
- STRUCTURE WITH POTENTIAL PROBLEM
- FAILING STRUCTURE

WELLS CREEK - REACH 1

Ecosystem Enhancement PROGRAM

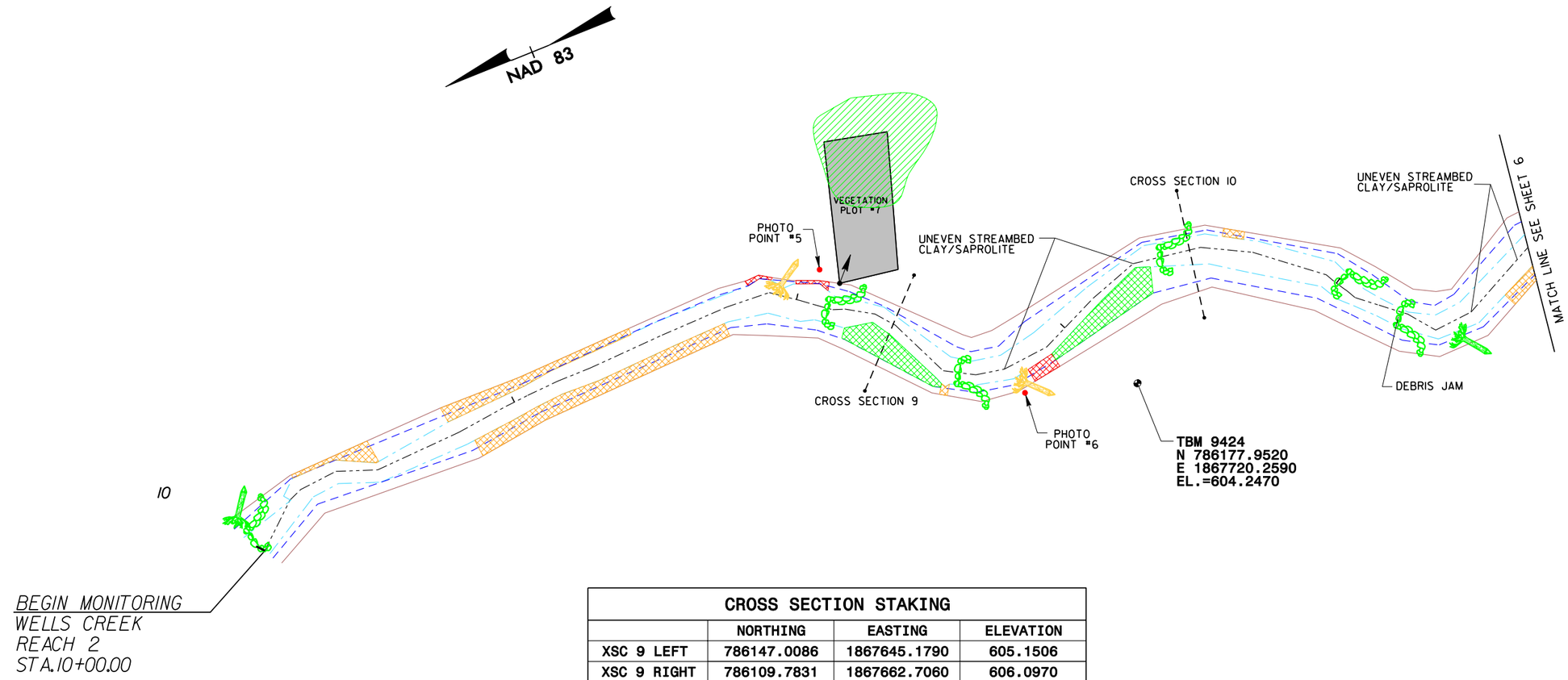
LOCATION:
WELLS CREEK
STREAM MONITORING - YEAR 2

PROJ #:	COUNTY:
414	ALAMANCE
PREPARED BY: WDY	
CHECKED BY: ATW	DATE: 11/17/06

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
414	5
PROJECT ENGINEER	

10 0 20
SCALE



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 9 LEFT	786147.0086	1867645.1790	605.1506
XSC 9 RIGHT	786109.7831	1867662.7060	606.0970
XSC 10 LEFT	786229.4962	1867681.8020	604.8637
XSC 10 RIGHT	786208.5385	1867718.8310	604.6050

LEGEND

- THALWEG 2006
- EDGE OF WATER 2006
- BANKFULL 2006
- TOP OF BANK 2006
- CROSS-SECTIONS
- PHOTO POINT
- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION (GRASSES)
- AGGRADATON (CATTAILS)
- BARE BENCH
- BARE FLOODPLAIN
- INVASIVE/EXOTIC (MICROSTEGIUM)

STRUCTURE TYPES
- ROCK CROSS VANE
- J-HOOK VANE
- ROOTWAD
- ROCK VANE

COLOR CODE FOR STRUCTURES
- GOOD STRUCTURE
- STRUCTURE WITH POTENTIAL PROBLEM
- FAILING STRUCTURE

WELLS CREEK - REACH 2

Ecosystem Enhancement PROGRAM

LOCATION:
WELLS CREEK
STREAM MONITORING - YEAR 2

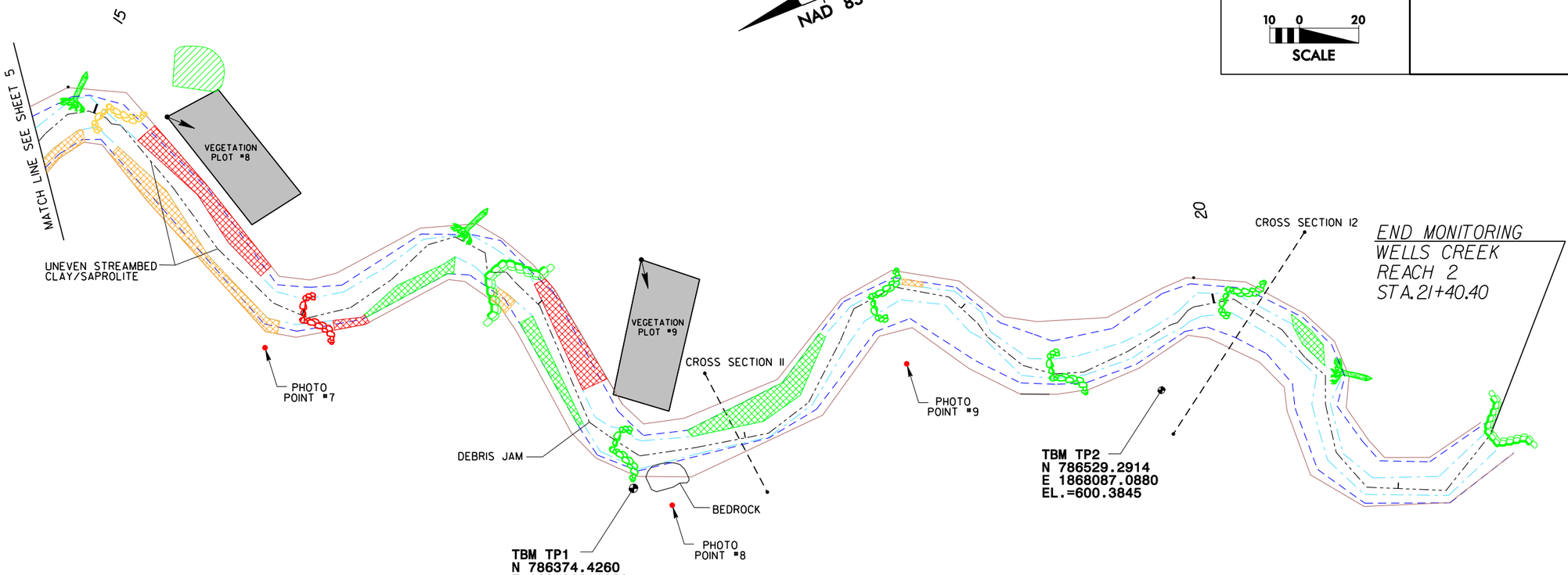
PROJ #: 414
COUNTY: ALAMANCE
PREPARED BY: WDY
CHECKED BY: ATW
DATE: 11/17/06

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
414	6
PROJECT ENGINEER	

10 0 20
SCALE

NAD 83



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 11 LEFT	786418.2249	1867980.2450	602.9365
XSC 11 RIGHT	786407.2489	1868024.1950	603.0278
XSC 12 LEFT	786600.8247	1868079.4820	601.5332
XSC 12 RIGHT	786522.4359	1868100.7920	602.3083

LEGEND

- THALWEG 2006
- EDGE OF WATER 2006
- BANKFULL 2006
- TOP OF BANK 2006
- CROSS-SECTIONS
- PHOTO POINT
- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION (GRASSES)
- AGGRADATON (CATTAILS)
- BARE BENCH
- BARE FLOODPLAIN
- INVASIVE/EXOTIC (MICROSTEGIUM)

STRUCTURE TYPES
- ROCK CROSS VANE
- J-HOOK VANE
- ROOTWAD
- ROCK VANE

COLOR CODE FOR STRUCTURES
- GOOD STRUCTURE
- STRUCTURE WITH POTENTIAL PROBLEM
- FAILING STRUCTURE

WELLS CREEK - REACH 2

Ecosystem Enhancement PROGRAM

LOCATION:
WELLS CREEK
STREAM MONITORING - YEAR 2

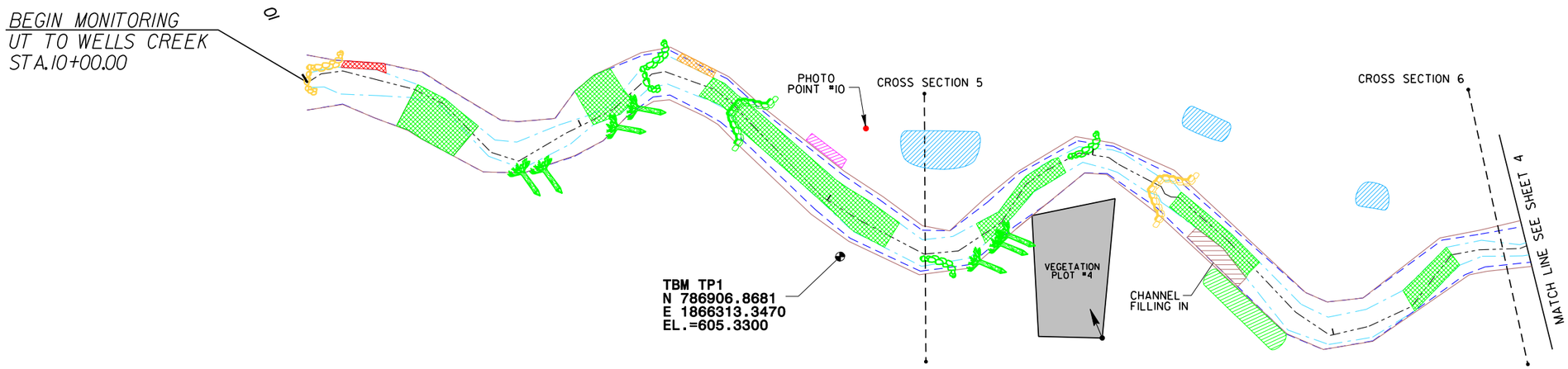
PROJ #:	COUNTY:
414	ALAMANCE
PREPARED BY: WDY	
CHECKED BY: ATW	DATE: 11/17/06

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
414	3
PROJECT ENGINEER	

10 0 20
SCALE

NAD 83



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 5 LEFT	786862.4549	1866351.6519	609.7649
XSC 5 RIGHT	786893.9555	1866271.9524	608.4476
XSC 6 LEFT	786700.8207	1866288.0700	609.6833
XSC 6 RIGHT	786715.8993	1866199.4730	606.5492

LEGEND

- THALWEG 2006
- EDGE OF WATER 2006
- BANKFULL 2006
- TOP OF BANK 2006
- CROSS-SECTIONS
- PHOTO POINT

- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION (GRASSES)
- AGGRADATON (CATTAILS)
- BARE BENCH
- BARE FLOODPLAIN
- INVASIVE/EXOTIC (MICROSTEGIUM)

STRUCTURE TYPES
- ROCK CROSS VANE
- J-HOOK VANE
- ROOTWAD
- ROCK VANE

COLOR CODE FOR STRUCTURES
- GOOD STRUCTURE
- STRUCTURE WITH POTENTIAL PROBLEM
- FAILING STRUCTURE

UT TO WELLS CREEK

Ecosystem Enhancement PROGRAM

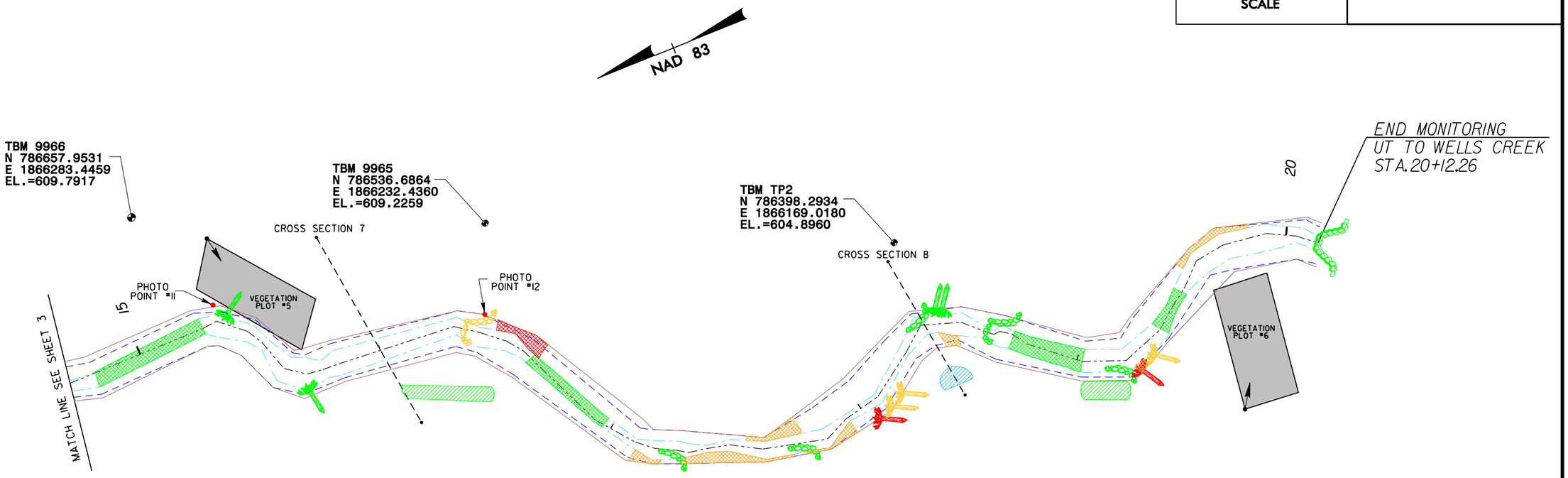
LOCATION:
WELLS CREEK
STREAM MONITORING - YEAR 2

PROJ #:	COUNTY:
414	ALAMANCE
PREPARED BY: WDY	
CHECKED BY: ATW	DATE: 11/17/06

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
414	4
PROJECT ENGINEER	

10 0 20
SCALE



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 7 LEFT	786596.8813	1866250.9420	609.3301
XSC 7 RIGHT	786586.2595	1866172.4990	605.5594
XSC 8 LEFT	786403.0018	1866163.2910	604.9927
XSC 8 RIGHT	786394.8939	1866106.6040	604.3983

LEGEND

- THALWEG 2006
- EDGE OF WATER 2006
- BANKFULL 2006
- TOP OF BANK 2006
- CROSS-SECTIONS
- PHOTO POINT
- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION (GRASSES)
- AGGRADATON (CATTAILS)
- BARE BENCH
- BARE FLOODPLAIN
- INVASIVE/EXOTIC (MICROSTEGIUM)

STRUCTURE TYPES
- ROCK CROSS VANE
- J-HOOK VANE
- ROOTWAD
- ROCK VANE

COLOR CODE FOR STRUCTURES
- GOOD STRUCTURE
- STRUCTURE WITH POTENTIAL PROBLEM
- FAILING STRUCTURE

UT TO WELLS CREEK

Ecosystem Enhancement PROGRAM

LOCATION:
WELLS CREEK
STREAM MONITORING - YEAR 2

PROJ #: 414
COUNTY: ALAMANCE
PREPARED BY: WDY
CHECKED BY: ATW
DATE: 11/17/06