UT to BILLY'S CREEK
FINAL MONITORING REPORT
YEAR 3
2008

EEP Project # 36
Franklin County, North Carolina

Submitted to:

NCDENR-EEP
1652 Mail Service Center
Raleigh, NC 27699

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FINAL MONITORING REPORT
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EEP Project # 36
Franklin County, North Carolina

Original Design Firm:
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1600 Perimeter Road, Suite 400
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Submitted to:

NCDENR-EEP
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Raleigh, NC 27699

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Executive Summary

SEPI Engineering Group was retained by the North Carolina Ecosystem Enhancement Program to conduct year two monitoring at the Unnamed Tributary (UT) to Billy's Creek Stream Restoration Project, located northeast of Franklinton in Franklin County, North Carolina. The project reach is located in a sparsely developed agricultural watershed. The majority of the agricultural lands are used for cattle pasture.

Pre-construction conditions of the UT to Billy's Creek included a 1,878 linear foot section of degraded, perennial channel and several ditch-like tributaries. The upstream portions of the project reach retained an active floodplain area, whereas the downstream portions were severely incised (4 to 6 feet). The restoration of the UT to Billy's Creek was conducted as a Priority Level I restoration by returning the channel to an elevation such that the historic floodplain is utilized for above bankfull flows. The proposed stream classification for the project reach was a meandering E5 channel, with a total length of 2,101 linear feet.

Current monitoring for the site consists of evaluating both stream morphology and riparian vegetation. The stream monitoring included a longitudinal survey, cross section surveys, problem area identification, and photo documentation. A plan view featuring bankfull, edge of water, and thalweg lines as well as problem area locations was developed from the longitudinal survey. The vegetation assessment included a tally of planted vegetation in permanent vegetation plots, vegetation-specific problem area identification (i.e. bare areas and invasive species), and photo documentation. A vegetation problem area plan view was developed from the problem area identification. All morphological data, vegetation plot stem counts, cross section surveys, longitudinal profile, and plan view features were compared to previous monitoring years to assess project performance.

The majority of the UT Billys restoration reach remained stable through Monitoring Year 3, with the exception of a large section of sand deposition covering nearly the entire upper quarter of the reach. This deposition has changed the channel dimension significantly in this area. The aggradation does appear to be slowing as the rise in the streambed elevations of cross section 1 was less in Monitoring Year 3 than in Monitoring Year 2. However, this aggradation may be spreading downstream as Cross Section 3. Cross Section 2 had a significant rise in channel bed elevation between Monitoring Years 2 and 3. Other than aggradation, other problem areas found were associated with bank erosion. Bank erosion does not appear to be a major problem in the reach because it has impacted a low percentage of the total banks. However, there were two areas of severe concern where major slumping of both banks has occurred. These two areas are located at Station 18+72 and at Station 20+19. All structures appeared to be in good physical condition, except for one stone grade control structure, located at Station 15+90, that had water piping around the right side causing some bank scour.

Good planted stem densities were found for all the vegetation plots for UT to Billy's Creek. Stem densities were above the final Monitoring Year 5 goal of 260 stems per acre for all plots. The overall stem density (excluding livestakes) across all vegetation plots was 372 stems per acre.

UNNAMED TRIBUTARY TO BILLY'S CREEK STREAM RESTORATION MONITORING YEAR 3 REPORT

CONDUCTED FOR:
NCDENR ECOSYSTEM ENHANCEMENT PROGRAM

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1.0 PROJECT BACKGROUND

1.1 Project Objectives

The goals and objectives of the UT to Billy's Creek Stream Restoration Project were listed in the 2006 Final Mitigation As-Built Report (URS 2006) as:

- Restore the project reach to a more natural dimension, pattern, and profile so that the stream will be able to efficiently transport water and sediment loads provided by the watershed;
- Reconnect the project reach's channel to its historic floodplain where feasible;
- Eliminate the excessive sediment contribution to the system by the mass wasting and erosion of the stream banks along the project reach; and,
- Repair and restore the riparian corridor along the project reach in order to improve habitat and protect the stream from further erosion.

1.2 Project Structure, Restoration Type, and Approach

The restoration of the UT to Billy's Creek was conducted as a Priority Level I restoration by returning the channel to an elevation such that the historic floodplain is utilized for above-bankfull flows. Rock crossvanes, step pools, rootwads, and plantings were installed to establish and stabilize a profile with riffle and pool sequences and to provide habitat and stable streambanks. Plantings included live stakes on the floodplain as well as bare root throughout the conservation easement. Table I provides the project restoration components of the UT to Billy's Creek stream restoration project.

Table I. Project Restoration Components
UT to Billy's Creek/EEP Project Number 36

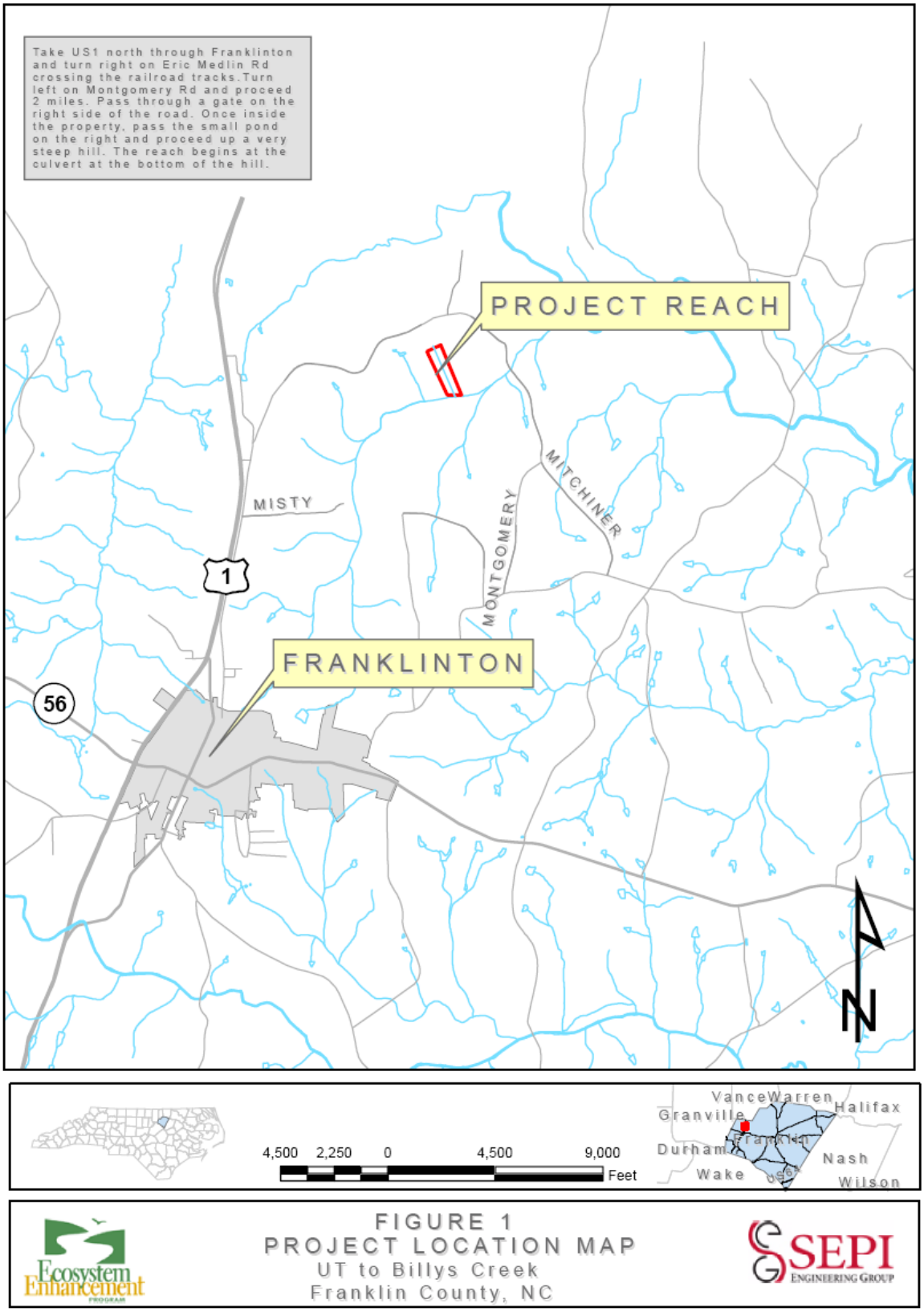
Project Segment or Reach ID	Pre-Existing Footage	Type	Approach	As-Built Footage	As-Built Stationing	Monitoring Year 4 Stationing	Comments
UT to Billy's Creek	1,878	Restoration	PI/PII	2,101	0+00 – 21+01	10+00 – 30+92	Includes 2,101 linear feet per As-Built. The first 100 ft and the last 100 ft of project reach) is PII.

1.3 Project Location and Setting

The UT to Billy's Creek Stream Restoration Project is located northeast of Franklinton in an agricultural and low density residential watershed (Figure 1). A ridge approximately 800 feet north of Montgomery Road forms the northern boundary of the project watershed. Montgomery Road runs east-west through the northern third of the watershed. The watershed is roughly divided in half by the unpaved farm road that crosses east-west at the northern end of the project reach. Ridges from the northern most point form the watershed's western and eastern edges as they slope down towards Billy's Creek. The southern end of the project watershed is at the point where an unpaved farm road crosses the project reach approximately 300 feet upstream of the

confluence with Billy's Creek. To travel to the site from the Raleigh-area, take US-1 North towards Franklinton. Turn right on SR 1210 (Montgomery Road). The project reach is located south of Montgomery Road, approximately three miles east of US 1 to the northeast of Franklinton on property privately held by the Grove family.

Figure 1. UT to Billy's Creek Vicinity Map



1.4 History and Background

The UT to Billy's Creek Stream Restoration was completed in the summer of 2005 and planted in the winter of 2005. The site was originally secured by the NC Wetlands Restoration Program. The Stream Restoration Plan was submitted by URS in 2003. The project reach is located on a cattle farm. The project reach is framed by 30-inch diameter culverts under unpaved farm roads at the north and south ends and pastured slopes to the east and west. There is at least one intermittent and four or more ephemeral tributary channels that flow into the project reach. Historically, the ephemeral channels were created to provide drainage within the floodplain. Approximately 600 feet south of the northern end of the project, the stream ran through an area of fairly active floodplain. Here, wetlands developed in the relict channels and floodplain adjacent to the main channel. Downstream of the wetland areas, severe incision (4 to 6 feet) and erosion was occurring following a major grade control point. Downstream of the grade control, the floodplain and stream system had been modified by the landowner. Tables II, III, and IV provide the project history, contact information for the contractors on the project, and the project background/setting, respectively.

Table II. Project Activity and Reporting History

UT to Billy's Creek/EEP Project No. 36

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	4/15/2003	NA	August 2003
Final Design - 90%	5/31/2003	NA	8/11/2004
Construction	7/31/2003	NA	June 2005
Planting	Fall 2004	NA	December 2005
Mitigation Plan/ As-built	Fall 2005	Winter 2006	April 2006
Year 1 monitoring	September 2006	September 2006	November 2006
Year 2 monitoring	Fall 2007	October 2007	December 2007
Year 3 monitoring	Fall 2008	October 2008	November 15, 2008
Year 4 monitoring	Fall 2009		
Year 5 monitoring	Fall 2010		
Year 5+ monitoring	Not scheduled		

Table III. Project Contact Table	
UT to Billy's Creek/EEP Project No. 36	
Designer	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560
Construction Contractor	McQueen Construction Inc. 619 Patrick Road Bahama, NC 27503
Planting Contractor	Carolina Environmental PO Box 1905 Mt. Airy, NC 27030
Seeding and Matting Contractor	Erosion Control Solutions 5508 Peakton Road Raleigh, NC 27604
Monitoring Year 1 (2006) Monitoring Performers	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560
Monitoring Year 2 & 3 (2007 & 2008) Monitoring Performers	SEPI Engineering Group 1025 Wade Avenue Raleigh, NC 27607 Phillip Todd (919) 789-9977
Stream Monitoring POC	Ira Poplar-Jeffers (919) 573-9914
Vegetation Monitoring POC	Phil Beach (919) 573-9936
Wetland Monitoring POC	N/A

Table IV. Project Background Table	
UT to Billy's Creek/EEP Project No. 36	
Project County	Franklin County, NC
Drainage Area	0.22 square miles
Drainage impervious cover estimate (%)	< 10%
Stream Order	1
Physiographic Region	Piedmont
Ecoregion	Northern Outer Piedmont (45f)
Rosgen Classification of As-built	E5
Dominant soil types	Chewcala, Altavista
Reference site ID	N/A
USGS HUC for Project and Reference	03020101
NCDWQ Sub-basin for Project and Reference	03-03-01
NCDWQ classification for Project and Reference	WS-IV; 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
% of project easement demarcated with bollards (if fencing absent)	N/A

2.0 PROJECT MONITORING METHODOLOGY

2.1 Vegetation Methodology

The following methodology was used for the stem count. The configuration of the five (5) 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. Plot inventories were conducted per the 2006 CVS-EEP Level II Protocol for Recording Vegetation (EEP 2006).

2.2 Stream Methodology

The project monitoring for the stream channel included a longitudinal survey, cross-sectional surveys, problem area identification, and photo documentation. The specific methodology for each portion of the stream monitoring is described in detail below.

2.2.1 Longitudinal Profile and Plan View

A longitudinal profile was surveyed with a Nikon DTM-520 Total Station, prism, and a TDS Recon Pocket PC. The heads of features (i.e., riffles, runs, pools, and glides) were surveyed, as well as the point of maximum depth of each pool, boundaries of problem areas, and any other significant slope-breaks or points of interest. At the head of each feature and at the maximum pool depth, thalweg, water surface, edge of water, left and right bankfull, and left and right top of bank (if different than bankfull) were surveyed. All profile measurements were extracted from this survey, including channel and valley length and length of each feature, water surface slope for each reach and feature, bankfull slope for the reach, and pool spacing. This survey also was used to draw plan view figures with Microstation v8 (Bentley Systems, Inc., Exton, PA). All pattern measurements (i.e. meander length, radius of curvature, belt width, meander width ratio, and sinuosity) were extracted from the plan view. Stationing was calculated along the thalweg.

2.2.2 Permanent Cross Sections

Four permanent cross sections (two riffles and two pools) were surveyed. The beginning and end of each permanent cross section were originally marked with a long PVC tube. Cross sections were installed perpendicular to the stream flow. Each cross section survey noted all changes in slopes, tops of both banks (if different from bankfull), left and right bankfull, edges of water, thalweg and water surface. The cross sections were then plotted, and Monitoring Year 3 data was overlain on data from all previous monitoring years for comparison. All dimension measurements (i.e. bankfull width, floodprone width, bankfull mean depth, cross sectional area, width-to-depth ratio, entrenchment ratio, bank height ratio, wetted perimeter, and hydraulic radius) were extracted from these plots and compared to the Monitoring Year 1 data.

2.2.3 Pebble Counts

Based on the fact that UT Billys is a sandbed stream, it was determined that pebble counts were unnecessary as they would fail to detect increases in fine sediments. Therefore, pebble counts were not performed for Monitoring Year 3.

2.3 Photo Documentation

Permanent photo points were established during Monitoring Year 1. A set of three photographs (facing upstream, facing downstream, and facing the channel) were taken at each photo point with a digital camera. Two photographs were taken at each cross-section (facing upstream and downstream). A representative photograph of each vegetation plot was taken at the designated corner of the vegetation plot and in the same direction as the Monitoring Year 1 photograph. An arrow was placed on the designated corner of each vegetation plot on the plan view sheets to

document the corner and direction of each photograph. Photos were also taken of all significant stream and vegetation problem areas.

3.0 PROJECT CONDITIONS AND MONITORING RESULTS

3.1 Vegetation Assessment

3.1.1 Soils Data

The UT to Billy's Creek watershed is in the Northern Outer Piedmont Ecoregion of North Carolina in the Felsic Crystalline System of the Piedmont Soil Region. The bedrock in the region is granite, granite gneiss, mica gneiss, and mica schist. Soils around the UT to Billy's Creek are primarily Chewacla and Altavista. Chewacla soils are Fluvaquentic Dystrudepts consisting of nearly level (0-3 percent slopes), somewhat poorly drained soils found on floodplains that form in recent alluvium. Chewacla soils are hydric and frequently flooded. Altavista soils are Aquic Hapludults consisting of typically sandy or loamy sediment. The soils are moderately well drained, nearly level and gently sloping (0-3 percent slopes), and are found on stream terraces. Altavista soils are not hydric and are rarely flooded. Preliminary soil data for the series are listed in Preliminary Soil Data table below.

Preliminary Soil Data

Series	Max Depth (in.)	% Clay on Surface	K	T	OM %
Chewacla	62	10 - 35	0.28-0.32	5	1-4
Altavista	62	10 - 24	0.24	5	0.5-3

3.1.2 Vegetative Problem Area Plan View

Overall, there appears to be good vegetation along the stream channel. There were some areas of bare floodplain and bare bank identified in the first two monitoring years where the vegetation was sparse. Several of these areas were listed again in Monitoring Year 3, however it should be noted that these areas are starting to fill in with vegetation as the project matures. The bare floodplain and bare bank areas are noted on the vegetation problem area plan view and problem area list.

Several populations of invasive *Ligustrum sinense* (Chinese privet) were noted along the project corridor during Monitoring Year 3. These areas occur along the length of the project and are noted on the problem area plan view as well as the vegetative problem area list. There is a small population of *Microstegium virmineum* that was discovered during Monitoring Year 3 (Station 13+75 to 15+13). Although not considered a 'problem,' it should be noted that cattails, which are sometimes considered to be invasive, were noted near the upper end of the reach.

3.1.3 Stem Counts

Good planted stem survival was noted for all the Vegetation Plots (VP) at UT to Billy's Creek. All of the plots are well above the Monitoring Year 5 stem density goal of 260 stems/acre. The plot densities ranged from 405 stems/acre for VP #5 to 567 stems/acre in VP #3. The overall stem density (excluding livestakes) across all vegetation plots was 372 stems per acre, and if livestakes and volunteers are included, the overall density is 461 stems per acre. These densities

indicate good performance of all vegetation plots. These plots are on their way to meeting the Monitoring Year 5 density goal.

3.2 Stream Assessment

Considering the 5 year timeframe of standard mitigation monitoring, restored streams should demonstrate morphologic stability in order to be considered successful. Stability does not equate to an absence of change, but rather to sustainable rates of change or stable patterns of variation. Restored streams often demonstrate some level of initial adjustment in the several months that follow construction and some change/variation subsequent to that is to also be expected. However, the observed change should not indicate a high rate or be unidirectional over time such that a robust trend is evident. If some trend is evident, it should be very modest or indicate migration to another stable form. Examples of the latter include depositional processes resulting in the development of constructive features on the banks and floodplain, such as an inner berm, slight channel narrowing, modest natural levees, and general floodplain deposition. Annual variation is to be expected, but over time this should demonstrate maintenance around some acceptable central tendency while also demonstrating consistency or a reduction in the amplitude of variation. Lastly, all of this must be evaluated in the context of hydrologic events to which the system is exposed over the monitoring period.

For channel dimension, cross-sectional overlays and key parameters such as cross-sectional area and the channel's width to depth ratio should demonstrate modest overall change and patterns of variation that are in keeping with above. For the channels' profile, the reach under assessment should not demonstrate any consistent trends in thalweg aggradation or degradation over any significant continuous portion of its length. Over the monitoring period, the profile should also demonstrate the maintenance or development of bedform (facets) more in keeping with reference level diversity and distributions for the stream type in question. It should also provide a meaningful contrast in terms of bedform diversity against the pre-existing condition. Bedform distributions, riffle/pool lengths and slopes will vary, but should do so with maintenance around design/As-built distributions. This requires that the majority of pools are maintained at greater depths with lower water surface slopes and riffles are shallow with greater water surface slopes. Substrate measurements should indicate the progression towards, or the maintenance of, the known distributions from the design phase.

In addition to these geomorphic criteria, a minimum of two bankfull events must be documented during separate monitoring years within the five year monitoring period for the monitoring to be considered complete. Table VIII documents all bankfull events recorded since the start of Monitoring Year 1.

Table V. Verification of Bankfull Events			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo # (if available)**
6/28/2006	6/14/2006	Per NOAA staff member, Jonathan Blaes, Tropical Storm Alberto produced a 50-year storm event in the Franklinton/Louisburg area. The storm produced approximately 5.55 inches of rain on 6/14.	
6/4/2007	6/3/2007	Result of 1.5' rainfall event. Wrack lines noted.	None
10/15/2008	4/27/2008	According to NCDC Station Coop ID 313123 - Louisburg NC, 2.15 inches of precipitation fell over this 24 hour period. It was assumed, but not verified, that this rainfall produced a bankfull event.	None
10/15/2008	9/6/2008	According to NCDC Station Coop ID 313123 - Louisburg NC, 3.27 inches of precipitation fell over this 24 hour period. It was assumed, but not verified, that this rainfall produced a bankfull event.	None

3.2.1 Longitudinal Profile and Plan View

The overall water surface slope and all other profile parameters were consistent through Monitoring Year 3. However, the channel bed has continued to aggrade with sand between stations 10+00 and 15+40 in Monitoring Year 3. Through observation of the longitudinal profile between monitoring years, it is apparent that the channel bed has continued rising (although at a slower rate) through Monitoring Year 3 along this section. The result has been a homogenization of the streambed profile throughout all channel features (including pools) along this section into one long run feature. This inundation of sediment is easily observed on-site as the bed appears to be overloaded with sand and has high densities of soft rush (*Juncus effuses*) growing directly in the channel. It can be difficult to find the channel in this area. This area is noted on the problem area plan view as aggradation. All pattern parameters remained consistent with Monitoring Year 2 values.

3.2.2 Permanent Cross Sections

The widespread deposition along the upper end of the project is apparent in cross section #1, where the stream bottom has risen during each consecutive monitoring year. However, the rate of aggradation may be slowing down as the rise of the streambed this monitoring year was less than the rise observed between Monitoring Years 1 and 2. There is evidence that this problem may be spreading downstream as far as cross section #3, Cross section #2 displayed a larger rise in the streambed elevations than cross section #1, and although cross section three did not show as much of a rise in streambed during the current monitoring year, the streambed has risen significantly at this location since construction. This aggradation problem area was not documented as extending all the way to cross section #2 during this years' on-site observations because the deposition is not as visually apparent downstream of the current documented limits. Nevertheless, this trend represents evidence that this depositional area needs close attention during Monitoring Year 4 so that the limits are accurately reported. Alternatively, very little change in dimension was observed between Monitoring Years 2 and 3 on cross sections 3 and 4. Aggradation of the streambed was observed during Monitoring Year 2 at cross section 3, but it is apparent that this has stabilized for as no change was observed during Monitoring Year 3.

3.2.3 Pebble Counts

Based on the fact that UT Billys is a sandbed stream, it was determined that pebble counts were unnecessary as they would fail to detect increases in fine sediments. Therefore, pebble counts were not performed for Monitoring Year 3.

Table VI. BEHI and Sediment Export Estimates

UT Billys Creek

Time Point	Segment / Reach	Linear Footage or Acreage	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%	Ton/y
MY1	Hoof Shear@XS 4	20					20	100							0.16
MY1	Remaining Channel	4030									4030	100			3.3
	Project Total	4050					20	100				100			3.46

3.2.4 Stream Problem Areas

Sand deposition (noted as aggradation on the problem area plan view) has "blanketed" the entire upper quarter of the project reach effect of homogenizing channel units into long run sections. Soft rush has "choked" the entire channel in this area, making it very difficult to locate channel features. These areas now look much more like linear wetland than stream channel. The sediment source is presumably upstream of the project. There are three bank erosion areas to keep an eye on, as noted on the problem area plan views (Appendix C). Although bank erosion does not appear to be a major problem of concern (bank condition of 98% in the Visual Morphological Stability Estimate), there are two specific erosion areas rated severe that should be watched closely in the future. These two areas, located at Station 18+72 and at Station 20+19 along the thalweg, have major slumping of both banks. Repair assessment may be warranted at these locations. All structures appeared to be in good physical condition, except for one stone grade control structure, located at Station 15+90 along the thalweg, that had water piping around the right side that caused some bank scour.

Table VII. Categorical Stream Feature Visual Stability Assessment

UT to Billy's Creek

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles*	100%	97%	73%	71%		
B. Pools*	100%	99%	75%	83%		
C. Thalweg	100%	97%	90%	91%		
D. Meanders	100%	100%	77%	67%		
E. Bed General	100%	97%	81%	84%		
F. Bank Condition	Unkown	Unknown	97%	98%		
G. Vanes / J Hooks etc.	100%	100%	98%	91%		
H. Wads and Boulders	100%	100%	100%	91%		

*Total As-built riffles and pools were revised per EEP comments; MY-2 performance percentages for riffles and pools were revised accordingly.

3.3 Photo Documentation

Photos taken of the vegetation problem areas are found in Appendix A1 and photos of the vegetation plots are in Appendix A2. Stream problem area photographs are provided in Appendix B1. The photographs taken at the marked photo point locations and at the cross-sections are provided in Appendix B2.

4.0 RECOMMENDATIONS AND CONCLUSIONS

The majority of the UT Billys restoration reach remained stable through Monitoring Year 3, with the exception of a large sections of sand deposition covering nearly the entire upper quarter of the reach. This deposition has changed the channel dimension significantly in this area. The aggradation does appear to be slowing as the rise in the streambed elevations of cross section 1 were less in Monitoring Year 3 than it was in Monitoring Year 2. However, this aggradation may be spreading downstream as Cross Section 2 had a significant rise in channel bed elevation between Monitoring Years 2 and 3. Other than aggradation, other problem areas found were associated with bank erosion. Even though bank erosion does not appear to be a major problem in the reach because it has impacted a low percentage of the total banks, there were two areas of severe concern where major slumping of both banks has occurred. These two areas are located at Station 18+72 and at Station 20+19. All structures appeared to be in good physical condition, except for one stone grade control structure, located at Station 15+90, that had water piping around the right side causing some bank scour.

Good planted stem densities were found for all the vegetation plots for UT to Billy's Creek. Stem densities were above the final Monitoring Year 5 goal of 260 stems per acre for all plots. The overall stem density (excluding livestakes) across all vegetation plots was 372 stems per acre.

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APPENDIX A1

VEGETATION DATA TABLES

Report Prepared By	PHILIP BEACH
Date Prepared	11/24/2008 9:39

database name	UT Billys Creek CVS Data 2008.mdb
database location	G:\Environmental\EN08.004 - EEP Monitoring 2008-09\CVS-EEP DATABASE - 2008 VERSION
computer name	W08

DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------

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

PROJECT SUMMARY----------

Project Code	EEP Project Number 36
project Name	UTBILLY08
Description	UTTAR MONITORING 08
River Basin	Tar-Pamlico
length(ft)	2,101 (as-built)
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	5
Sampled Plots	5

Vigor By Species - UT Billys Creek (Monitoring Year 3)

	Species	4	3	2	1	0	Missing	Unknown
	Alnus serrulata		1	1				
	Aronia arbutifolia	1	3				2	
	Betula nigra		2	1			5	
	Celtis laevigata		1				2	
	Cornus amomum	2	8	3			11	
	Cornus florida		1					
	Fraxinus pennsylvanica		2	1			1	
	Nyssa sylvatica		1				1	
	Pinus taeda		1					
	Quercus falcata	1					4	
	Quercus phellos	5	6	1			5	
	Salix nigra		5				1	
	Sambucus canadensis		1				2	
	Viburnum nudum	1						
	Viburnum dentatum	1	1				1	
	Rhus copallinum	3	2				1	
	Carpinus caroliniana						2	
	Liriodendron tulipifera	1						
TOT:	**18**	**15**	**35**	**7**			**38**	

Damage By Plot - UT Billys Creek (Monitoring Year 3)

	plot	All Damage Categories	(no damage)	Insects	Unknown
	UTBILLY08-01-0001-year:3	14	12	1	1
	UTBILLY08-01-0002-year:3	22	19	3	
	UTBILLY08-01-0003-year:3	26	19	6	1
	UTBILLY08-01-0004-year:3	18	15	3	
	UTBILLY08-01-0005-year:3	15	11	4	
TOT:	**5**	**95**	**76**	**17**	**2**

Damage By Species - UT Billys Creek (Monitoring Year 3)

	Species	All Damage Categories	(no damage)	Insects	Unknown
	Alnus serrulata	2	1	1	
	Aronia arbutifolia	6	5	1	
	Betula nigra	8	6	2	
	Carpinus caroliniana	2	2		
	Celtis laevigata	3	3		
	Cornus amomum	24	19	4	1
	Cornus florida	1		1	
	Fraxinus pennsylvanica	4	3	1	
	Liriodendron tulipifera	1	1		
	Nyssa sylvatica	2	1	1	
	Pinus taeda	1	1		
	Quercus falcata	5	5		
	Quercus phellos	17	14	2	1
	Rhus copallinum	6	6		
	Salix nigra	6	3	3	
	Sambucus canadensis	3	3		
	Viburnum dentatum	3	3		
	Viburnum nudum	1		1	
TOT:	**18**	**95**	**76**	**17**	**2**

Stem Count by Plot and Species - UT Billys Creek (Monitoring Year 3)

	Species	Total Planted Stems	# plots	avg# stems	plot UTBILLY08-01-0001-year:3	plot UTBILLY08-01-0002-year:3	plot UTBILLY08-01-0003-year:3	plot UTBILLY08-01-0004-year:3	plot UTBILLY08-01-0005-year:3
	Alnus serrulata	2	2	1		1		1	
	Aronia arbutifolia	4	2	2		1		3	
	Betula nigra	3	1	3		3			
	Celtis laevigata	1	1	1	1				
	Cornus amomum	13	4	3.25	5		4	2	2
	Cornus florida	1	1	1		1			
	Fraxinus pennsylvanica	3	3	1	1	1	1		
	Liriodendron tulipifera	1	1	1	1				
	Nyssa sylvatica	1	1	1			1		
	Pinus taeda	1	1	1		1			
	Quercus falcata	1	1	1					1
	Quercus phellos	12	5	2.4	3	1	2	2	4
	Rhus copallinum	5	3	1.67			2	2	1
	Salix nigra	5	2	2.5			4		1
	Sambucus canadensis	1	1	1		1			
	Viburnum dentatum	2	2	1		1		1	
	Viburnum nudum	1	1	1					1
TOT:	**17**	**57**	**17**		**11**	**11**	**14**	**11**	**10**

Table 6. Vegetative Problem Areas

Feature/Issue	Station # / Range	Probable Cause	Photo #
Bare floodplain (Right Bank)	10+09 to 12+24	Previous livestock trampling / soil texture amenable to erosion	
	12+59 to 13+45	Previous livestock trampling / soil texture amenable to erosion	
Microstegium virmineum (Right Bank)	13+75 to 15+13	Invasive vegetative opportunism.	
Ligustrum sinense (Left Bank)	18+47 to 19+71	Invasive vegetative opportunism.	
Ligustrum sinense (Left Bank)	18+50 to 22+28	Invasive vegetative opportunism.	
Ligustrum sinense (Right Bank)	19+11 to 21+02	Invasive vegetative opportunism.	
Bare Bench/Bank (Left)	21+02 to 21+27	Vegetation scarce/absent.	1
Bare Bench/Bank (Right)	21+05 to 21+20	Vegetation scarce/absent.	1
Ligustrum sinense (Right Bank)	21+92 to 27+04	Invasive vegetative opportunism.	
Bare Bench/Bank (Right)	23+02 to 23+21	Previous livestock trampling / soil texture amenable to erosion	
Bare Bench/Bank (Right)	24+74 to 25+37	Previous livestock trampling / soil texture amenable to erosion	
Bare Bench/Bank (Left)	25+66 to 26+22	Previous livestock trampling / soil texture amenable to erosion	
Ligustrum sinense (Left Bank)	24+98 to 25+06	Invasive vegetative opportunism.	
Ligustrum sinense (Left Bank)	25+64 to 27+99	Invasive vegetative opportunism.	
Bare Bench/Bank (Right)	28+15 to 28+30	Previous livestock trampling / soil texture amenable to erosion	
Ligustrum sinense (Right Bank)	27+34 to 29+08	Invasive vegetative opportunism.	2
Bare Bench/Bank (Right)	29+45 to 29+58	Previous livestock trampling / soil texture amenable to erosion	
Bare Bench/Bank (Left)	29+51 to 30+05	Previous livestock trampling / soil texture amenable to erosion	

* Populations of Ligustrum sinense are scattered along the project from approximately Station 18+00 to 30+82. Only the substantial populations of Ligustrum are noted in Table VI above.

APPENDIX A2

PHOTOLOG VEGETATION PROBLEM AREAS

APPENDIX A2
PHOTOLOG - UT to Billy's Creek

PROBLEM AREAS (Vegetation)

Photo 1. Representative bare bank problem area (Station No. 21+02; view from left bank; 9-14-2008).

Photo2. Representative Chinese privet (*Ligustrum sinense)* growth (Station No. 27+34; view from left bank; 9-14-2008).

APPENDIX A3

PHOTOLOG VEGETATION PLOTS

APPENDIX A3
PHOTOLOG UT to Billy's Creek

VEGETATION PLOTS


Photo 1: Vegetation Plot 1 (10-14-2008).


Photo 2: Vegetation Plot 2 (10-14-2008).


Photo 3: Vegetation Plot 3 (10-14-2008).


Photo 4: Vegetation Plot 4 (10-14-2008).


Photo 5: Vegetation Plot 5 (10-14-2008).

APPENDIX B1

PHOTOLOG STREAM PROBLEM AREAS

APPENDIX B1
PHOTOLOG UT to Billy's Creek

STREAM PROBLEM AREAS

Photo 1: Representative sand/gravel aggradation and bar formation problem area (Station No. 10+00; view downstream; 2-27-2008).

Photo 2: Representative crossvane problem area (Station No. 14+53; view upstream; crossvane is covered in photo; 2-27-2008).

Photo 3: Representative bank erosion problem area (Station No. 18+72; view of right bank; 6-30-2008).

APPENDIX B2

PHOTOLOG OF CROSS-SECTIONS AND PHOTO POINTS

APPENDIX B2
PHOTOLOG UT Billy's Creek

Cross Sections/Photo Points

Cross-Section/Photo Point 1: View Upstream (6-24-2008).

Cross-Section/Photo Point 1: View Downstream (6-24-2008).

Cross-Section/Photo Point 1: Facing Channel (6-24-2008).

Cross-Section/Photo Point 2: View Upstream (6-26-2008).

Cross-Section/Photo Point 3: View Upstream (6-30-2008).

Cross-Section/Photo Point 2: View Upstream (6-26-2008).

Cross-Section/Photo Point 3: View Downstream (6-26-2008).

Cross-Section/Photo Point 2: Facing Channel (6-26-2008).

Cross-Section/Photo point 3: Facing Channel (6-26-2008).

Cross-Section/Photo Point 4: View Upstream (7-01-2008).

Cross-Section/Photo Point 4: View Downstream (7-01-2008).

Cross-Section/Photo Point 4:Facing Channel (7-01-2008).

APPENDIX B3

STREAM DATA TABLES

Table VIII. Baseline Morphology and Hydraulic Summary

UT Billys Creek

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																		
BF Width (ft)				3.5	15	8	6.5	8.7		6.2	6.3	6.3			9	8	14	10
Floodprone Width (ft)							8.3	25.3		33	39	36	20	105	63	50	100	75
BF Cross Sectional Area (ft)				3.5	15	7	7.3	8.2		4.2	4.7	4.5	8	8	8	6.9	8.5	7.7
BF Mean Depth (ft)				0.55	1	1.75	0.8	1.3		0.68	0.74	0.71	0.9	0.9	0.9	0.8	0.9	0.9
Max Depth (ft)							1.2	1.8		1	1.1	1.05	1.3	1.3	1.3	1.2	1.3	1.2
Width/Depth Ratio							5.2	10.4		8.6	9.3	8.9	10.1	10.1	10.1	10.6	11.7	10.9
Entrenchment Ratio							1.3	2.9		5.3	6.2	5.7	2.2	11.6	6.9	5	6.2	5.6
Bank Heigh Ratio							1.3	3.0										
Wetted Perimeter (ft)													9.6	9.6	9.6	9.4	10.1	9.7
Hydraulic Radius (ft)													0.8	0.8	0.8	0.7	0.8	0.8
Pattern																		
Channel Belthwidth (ft)							14	34		13.2	21.5	17.1	16	35	25	14	30	20
Radius of Curvature (ft)							18	21		10.2	29	16.4	12.5	34.5	21	18	26	24
Meander Wavelength (ft)							35	36		28.7	48.7	40.1	29	74	56	40	68	50
Meader Width Ratio							2.2	3.9		2.1	3.4	2.7	1.8	3.9	2.8	0.57	0.46	0.5
Profile																		
Riffle Length													1	29	8	1	30	10
Riffle Slope (ft/ft)													0.0080	0.02	0.01	0.0080	0.0200	0.0100
Pool Length (ft)													16	69	32	20	70	30
Pool Spacing (ft)									22	11.7	26.7	18	18.1	49.9	31.1	18	50	34
Substrate																		
d50 (mm)									1.3							0.062	0.16	0.11
d84 (mm)									4							0.16	0.75	0.53
Additional Reach Parameters																		
Valley Length (ft)									1580						1580			1580
Channel Length (ft)									1848			108			1969			2101
Sinuosity							1.11	1.32	1.17			1.2			1.25			1.33
Water Surface Slope (ft/ft)							0.56	1.5	1.0300			0.8000			1.1900			
BF Slope (ft/ft)																		0.0080
Rosgen Classification									E5/G5c			E5			E5			E5
*Habitat Index																		
*Macrobenthos																		

Table IX. Morphology and Hydraulic Monitoring Summary

UT Billys Creek

(EEP Project No. 36)

Parameter	Cross Section 1 Pool						Cross Section 2 Riffle						Cross Section 3 Pool						Cross Section 4 Riffle					
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)	29.3	16.6	27.6				12.9	11.1	11.1				16.1	14.3	17.0				9.8	8.6	10.4			
Floodprone Width (ft)	75	NA	NA				75	72+	72+				40	NA	NA				75	72+	72+			
BFCross Sectional Area (ft)	11.5	7.9	10.4				9.7	8.4	6.8				9.5	5.1	5.5				7.2	7.5	7.1			
BF Mean Depth (ft)	0.4	0.5	0.4				0.8	0.8	0.6				0.6	0.4	0.3				0.7	0.9	0.7			
Width/Depth Ratio	74.6	NA	NA				17	14.6	18.3				27.3	NA	NA				13.3	10.0	15.2			
Entrenchment Ratio	2.6	NA	NA				5.8	6.6+	6.5+				2.5	NA	NA				7.7	8.4+	6.9+			
Bank Height Ratio	*	NA	NA				*	1	1.1				*	NA	NA				*	1.08	1.11			
Wetted Perimeter (ft)	29.9	17.4	27.9				13.3	11.5	12.1				16.8	14.9	17.3				10.8	11.5	11.5			
Hydraulic radius (ft)	0.4	0.5	0.4				0.7	0.7	0.6				0.6	0.3	0.3				0.7	0.7	0.6			
Substrate																								
d50 (mm)	1.1	1.7	NA				1.5	0.5	NA				1.4	1.4	NA				1.2	1.4	NA			
d84 (mm)	1.7	3.1	NA				8	1	NA				1.8	1.9	NA				1.7	1.9	NA			

*Data was not provided in 2006 monitoring report

Parameter	MY-01 (2006)			MY-02 (2007)			MY-03 (2008)			MY-04 (2009)			MY-05 (2010)			MY+ (2009)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	14	30	20	14.9	39.9	26.8	12.66	41.69	25.11									
Radius of Curvature (ft)	18	26	24	6.8	30.1	16.0	7.14	37.93	14.57									
Meander Wavelength (ft)	40	60	50	34.5	73.0	55.9	36.89	73.71	56.26									
Meander Width Ratio	1.2	2.6	1.8	1.5	4.1	2.7	1.2	4.0	2.4									
Profile																		
Riffle length (ft)	2	64	16	2.2	66.0	16.4	3.2	65.4	19.9									
Riffle slope (ft/ft)	0.001	0.036	0.015	0.003	0.122	0.013	0.002	0.085	0.017									
Pool length (ft)	2	38	13	2.3	34.2	10.5	4.1	36.5	11.7									
Pool spacing (ft)	10	66	31	13.2	94.5	29.8	12.4	83.6	31.3									
Additional Reach Parameters																		
Valley Length (ft)	1580			1564.3			1564.30											
Channel Length (ft)	2025			2091.9			2082.41											
Sinuosity	1.28			1.34			1.33											
Water Surface Slope (ft/ft)	0.014			0.012			0.013											
BF slope (ft/ft)	0.040			0.012			0.013											
Rosgen Classification	C5			C/E5			C5											
*Habitat Index	NA			NA			NA											
*Macrobenthos	NA			NA			NA											

Table B1. Stream Problem Areas

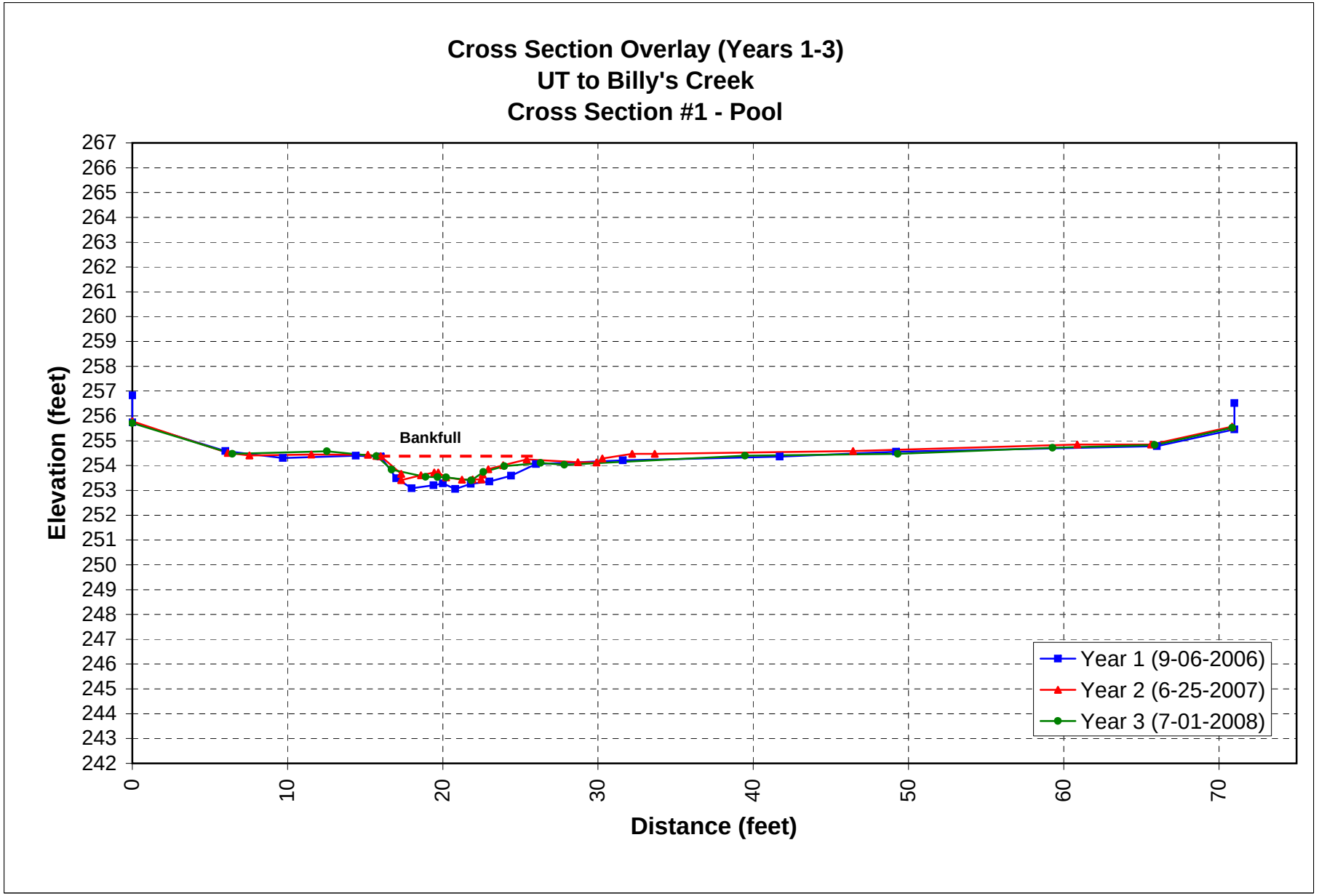
UT Billys Creek

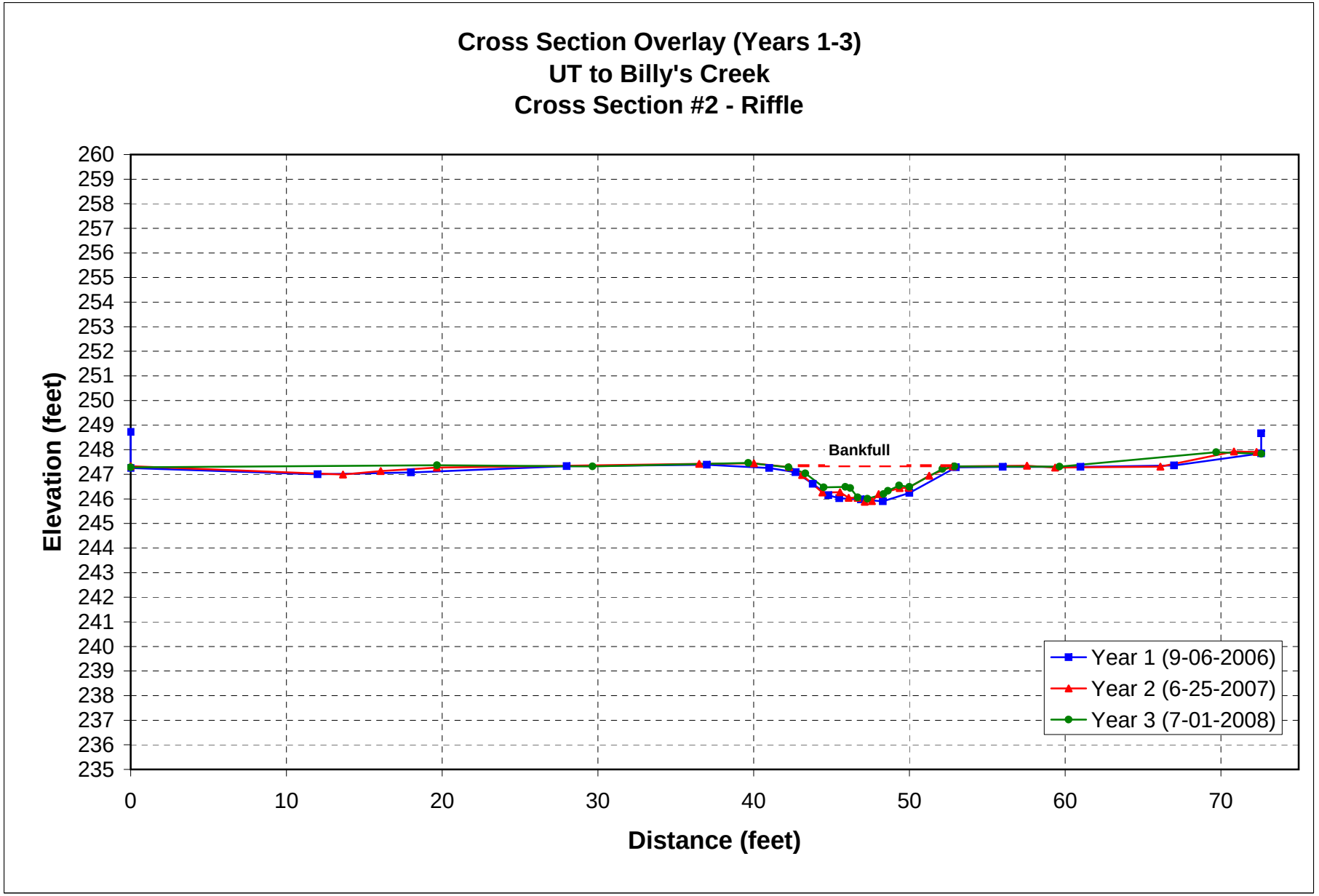
Feature Issue	Station numbers	Suspected Cause	Photo number
Aggradation	10+00	An upstream source has deposited significant amounts of fine sediment (i.e. sand) during high flow events, resulting in long sections of fine sediment aggradation.	1
	15+40.55		
Cross Vane	10+12.50	Buried under sediment; cannot find; not forming pool.	
Cross Vane	12+02.37	Buried under sediment; cannot find; not forming pool.	
Cross Vane	14+53.42	Buried under sediment; not forming pool.	2
Central Bar Formation	14+53.52	Sediment aggradatio has filled in pool.	2
	14+67.58		
Stone Step Structure	15+90	Piping/scour around right side of structure.	
Bank Erosion (both banks, severe)	18+72	Major slumping, possibly due to lack of protective vegetation and/or soil instability. Also exposure/undercutting of matting.	4
	19+05		
Central Bar Formation	19+05.5	Sediment aggradatio has filled in pool.	
	19+11		
Bank Erosion (right bank)	19+37	Soil instability or lack of protective vegetation.	
	19+46		
Bank Erosion (both banks, severe)	20+19	Major slumping, possibly due to lack of protective vegetation and/or soil instability. Also exposure/undercutting of matting.	
	20+26		
Aggradation	23+36	An upstream source has deposited significant amounts of fine sediment (i.e. sand) during high flow events, resulting in long sections of fine sediment aggradation.	
	24+34		
Central Bar Formation	23+88	Aggradation forming bar in middle of stream & filling in pool.	3
	23+93		

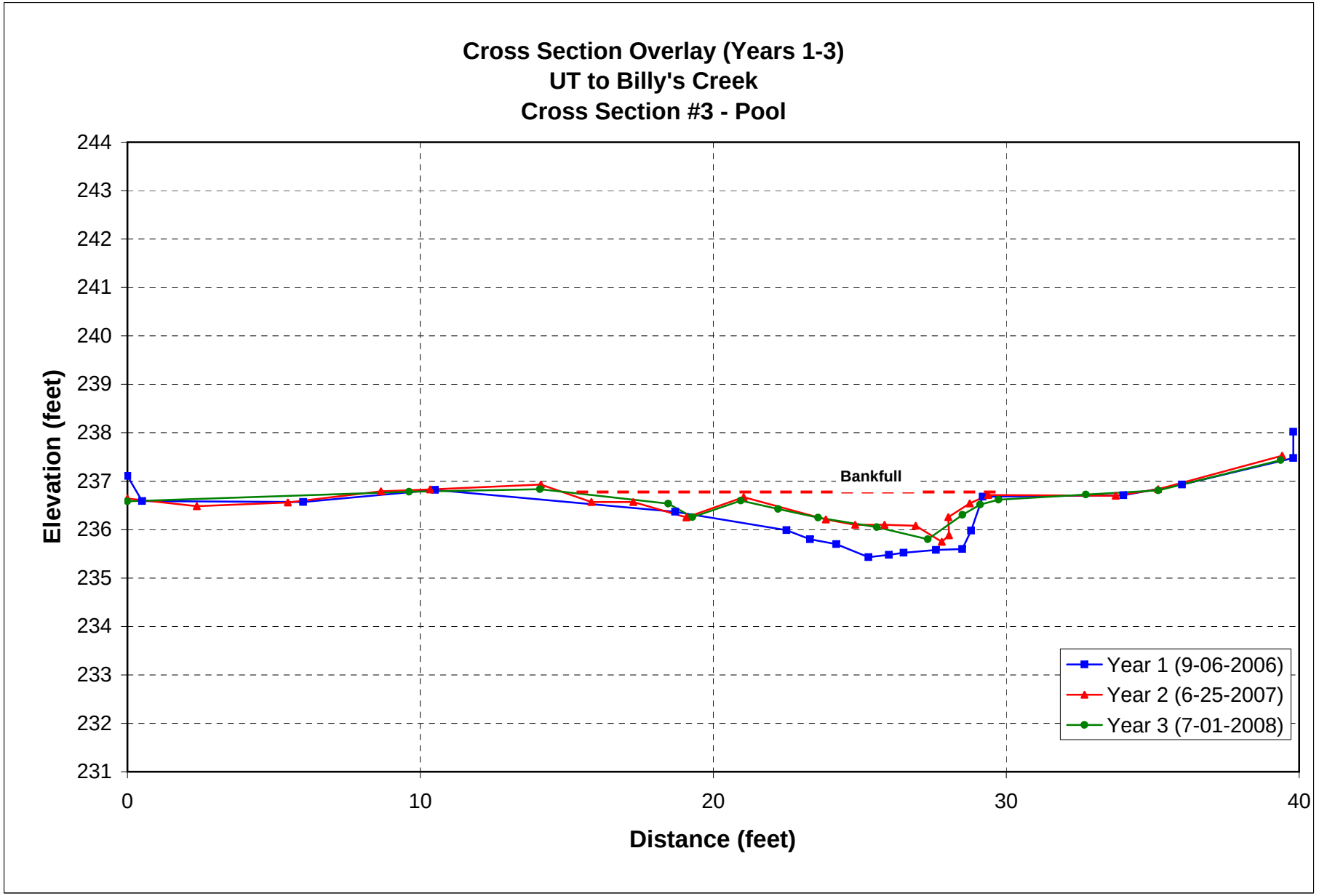
Table B2. Visual Morphological Stability Assessment UT Billys Creek						
Feature Category	**Metric (per As-built and reference baselines)**	**(#Stable) Number Performing as Intended**	**Total Number per As-built**	**Total Number / feet in unstable state**	**% Performing in Stable Condition**	**Feature Performance Mean or Total**
A. Riffles	1. Present	39	49	NA	80%	
	2. Armor stable	34	49	NA	69%	
	3. Facet grade appears stable	34	49	NA	69%	
	4. Minimal evidence of embedding/fining	34	49	NA	69%	
	5. Length appropriate	34	49	NA	69%	**71%**
B. Pools	1. Present	42	48	NA	88%	
	2. Sufficiently deep	41	48	NA	85%	
	3. Length appropriate	36	48	NA	75%	**83%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	28	29	NA	97%	
	2. Downstream of meander (glide/inflection) centering	24	28	NA	86%	**91%**
D. Meanders	1. Outer bend in state of limited/controlled erosion	53	56	NA	95%	
	2. Of those eroding, # w/concomitant point bar formation	0	3	NA	0%	
	3. Apparent Rc within specifications	40	56	NA	71%	
	4. Sufficient floodplain access and relief	56	56	NA	100%	**67%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	5/663.1	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	5/89	98%	**98%**
G. Vanes / J Hooks	1. Free of back or arm scour	24	26	NA	92%	
	2. Height appropriate	23	26	NA	88%	
	3. Angle and geometry appear appropriate	23	26	NA	88%	
	4. Free of piping or other structural failures	25	26	NA	96%	**91%**
H. Wads and Boulders	1. Free of scour	9	11	NA	82%	
	2. Footing stable	11	11	NA	100%	**91%**

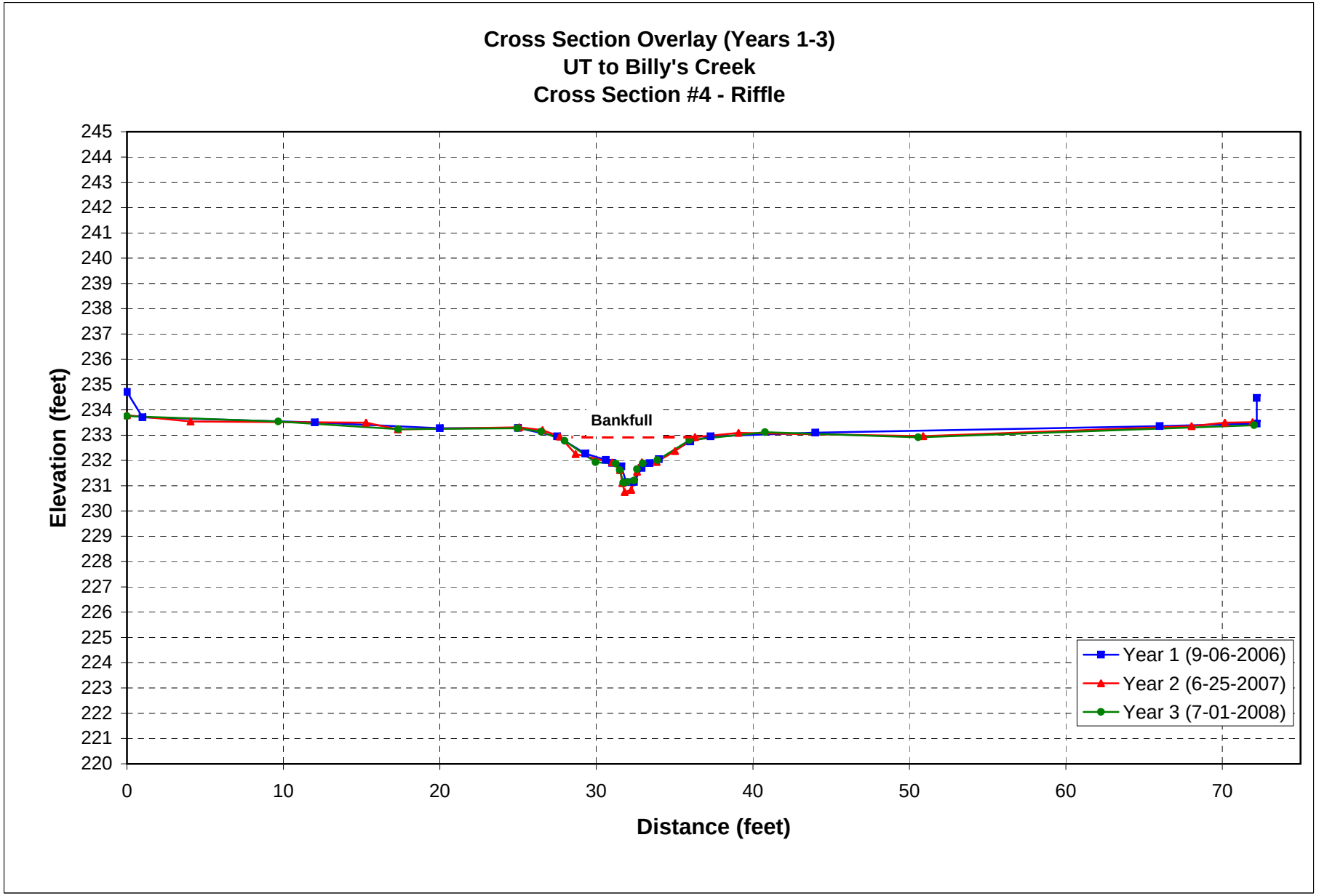
APPENDIX B4

STREAM CROSS-SECTIONS


Cross Section Overlay (Years 1-3)
UT to Billy's Creek
Cross Section #1 - Pool
Elevation (feet)
267
266
265
264
263
262
261
260
259
258
257
256
255
254
253
252
251
250
249
248
247
246
245
244
243
242
Bankfull
0
10
20
30
40
50
60
70
Distance (feet)
Year 1 (9-06-2006)
Year 2 (6-25-2007)
Year 3 (7-01-2008)


Cross Section Overlay (Years 1-3)
UT to Billy's Creek
Cross Section #2 - Riffle
Elevation (feet)
260
259
258
257
256
255
254
253
252
251
250
249
248
247
246
245
244
243
242
241
240
239
238
237
236
235
0
10
20
30
40
50
60
70
Distance (feet)
Bankfull
Year 1 (9-06-2006)
Year 2 (6-25-2007)
Year 3 (7-01-2008)


Cross Section Overlay (Years 1-3)
UT to Billy's Creek
Cross Section #3 - Pool
Elevation (feet)
244
243
242
241
240
239
238
237
236
235
234
233
232
231
0
10
20
30
40
Distance (feet)
Bankfull
Year 1 (9-06-2006)
Year 2 (6-25-2007)
Year 3 (7-01-2008)


Cross Section Overlay (Years 1-3)
UT to Billy's Creek
Cross Section #4 - Riffle
Elevation (feet)
245
244
243
242
241
240
239
238
237
236
235
234
233
232
231
230
229
228
227
226
225
224
223
222
221
220
0
10
20
30
40
50
60
70
Distance (feet)
Bankfull
Year 1 (9-06-2006)
Year 2 (6-25-2007)
Year 3 (7-01-2008)

Field Crew:	IPJ and KC
Stream Reach:	UT to Billy's Creek
Drainage Area:	0.22
Date:	Jul-08
Monitoring Year	3

STATION (Feet)	ELEVATION (Feet)	NOTES
0.00	255.71	
6.45	254.48	
12.54	254.58	TOB
15.73	254.38	
16.71	253.83	LEW
18.89	253.54	
19.66	253.53	
20.22	253.53	Thalweg
21.84	253.41	
22.62	253.74	REW
23.96	253.97	
26.31	254.10	
27.84	254.03	
39.47	254.40	
49.31	254.48	
59.28	254.71	
65.87	254.83	
70.86	255.53	

Bankfull/Top of Bank Hydraulic Geometry

	Width (Feet)	Depth (Feet)	Perimeter (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.00	0.0
	0.7	0.1	0.73	0.0
	1.0	0.6	1.12	0.3
	2.2	0.9	2.20	1.6
	0.8	0.9	0.77	0.7
	0.6	0.9	0.56	0.5
	1.6	1.0	1.62	1.6
	0.8	0.7	0.85	0.7
	1.3	0.5	1.36	0.8
	2.4	0.3	2.35	0.9
	1.5	0.4	1.53	0.6
	11.6	0.0	11.64	2.6
	3.1		3.13	0.1
TOTALS	27.6		27.9	10.4

SUMMARY DATA

A(BKF)	10.4
W(BKF)	27.6
Max d	1.0
Mean d	0.4
Wet. P	27.87
Hyd. R	0.37

Bankfull datum* = 254.44

*Datum reset during Monitoring Year 2.

Field Crew:	IPJ and KC
Stream Reach:	UT to Billy's Creek
Drainage Area:	0.22
Date:	Jul-08
Monitoring Year	3

STATION (Feet)	ELEVATION (Feet)	NOTES
0.00	247.28	
19.67	247.36	
29.66	247.32	
39.66	247.46	TOB
42.25	247.28	
43.32	247.03	
44.51	246.47	
45.90	246.49	
46.21	246.44	LEW
46.69	246.06	
47.32	246.01	Thalweg
48.34	246.19	
48.63	246.33	REW
49.35	246.55	
50.00	246.48	
52.13	247.21	
52.91	247.32	BKF
59.64	247.31	
69.71	247.89	
72.61	247.83	

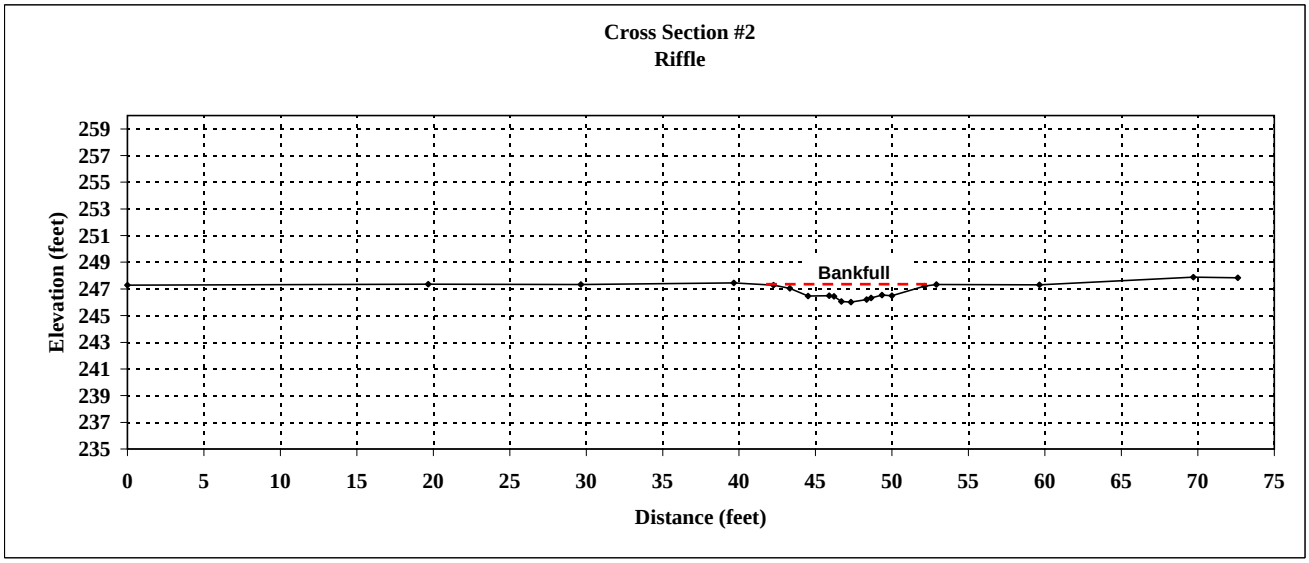
Bankfull Hydraulic Geometry

	Width (Feet)	Depth (Feet)	Perimeter (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.00	0.0
	0.5	0.9	0.96	0.2
	1.1	0.8	1.07	0.9
	1.2	0.9	1.19	1.0
	1.4	1.3	1.44	1.5
	0.3	1.3	0.31	0.4
	0.5	1.1	0.51	0.6
	0.6	1.0	0.64	0.7
	1.0	0.8	1.04	0.9
	0.3	0.8	0.30	0.2
	0.7	0.1	1.02	0.3
	0.6	0.0	0.66	0.0
	2.1	0.0	2.13	0.0
	0.8		0.78	0.0
TOTALS	11.1		12.1	6.8

SUMMARY DATA (BANKFULL)

A(BKF)	6.8	W(FPA)	72+
W(BKF)	11.1	WP	12.1
Max d	1.3	Hydraulic Radius	0.56
Mean d	0.6	Wetted Perimeter=	WP
W/D	18.3	Area=	A
Bank Height	1.45	Width=	W
Entrenchment	6.5+	Depth=	D
Stream Type	C	Bankfull=	BKF
Area from Rural Regional Curve			15.8

Bankfull datum* = 247.32
*Datum reset during Monitoring Year 2.



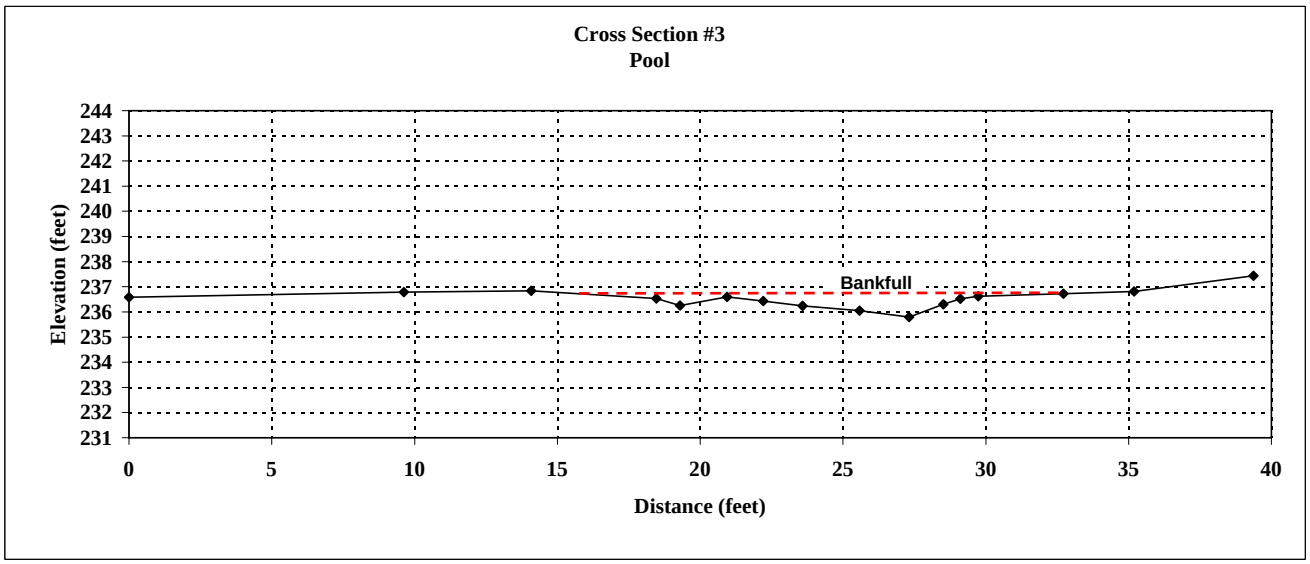
Field Crew:	IPJ and KC
Stream Reach:	UT to Billy's Creek
Drainage Area:	0.22
Date:	Jul-08
Monitoring Year	3

STATION (Feet)	HI (Feet)	NOTES
0.00	236.58	
9.62	236.78	
14.08	236.83	TOB
18.46	236.53	
19.29	236.26	
20.94	236.60	
22.21	236.43	
23.58	236.25	LEW
25.58	236.05	
27.32	235.80	Thalweg
28.51	236.31	REW
29.11	236.52	
29.74	236.62	
32.72	236.72	BKF
35.19	236.81	
39.37	237.44	

Bankfull Hydraulic Geometry			
Width (Feet)	Depth (Feet)	Perimeter (Feet)	Area (Sq. Ft.)
0.0	0.0	0.00	0.0
2.8	0.2	2.77	0.2
0.8	0.5	0.87	0.3
1.7	0.1	1.68	0.5
1.3	0.3	1.28	0.3
1.4	0.5	1.38	0.5
2.0	0.7	2.01	1.1
1.7	0.9	1.76	1.4
1.2	0.4	1.29	0.8
0.6	0.2	0.64	0.2
0.6	0.1	0.64	0.1
3.0		2.98	0.1
TOTALS 17.0		17.3	5.5

SUMMARY DATA	
A(BKF)	5.5
W(BKF)	17.0
Max d	0.9
Mean d	0.3
Wet. P	17.3
Hyd. R	0.32

Bankfull datum* = 236.72
*Datum reset during Monitoring Year 2.



Field Crew:	IPJ and KC
Stream Reach:	UT to Billy's Creek
Drainage Area:	0.22
Date:	Jul-08
Monitoring Year	3

STATION (Feet)	ELEVATION (Feet)	NOTES
0.00	233.75	
9.67	233.54	
17.33	233.24	
24.95	233.27	
26.47	233.13	
27.97	232.78	
29.95	231.93	
31.24	231.87	
31.49	231.61	LEW
31.72	231.12	
31.97	231.14	Thalweg
32.41	231.20	
32.60	231.65	REW
32.97	231.89	
33.91	232.01	
35.95	232.80	
40.78	233.12	TOB
50.57	232.92	
72.04	233.40	

Bankfull Hydraulic Geometry

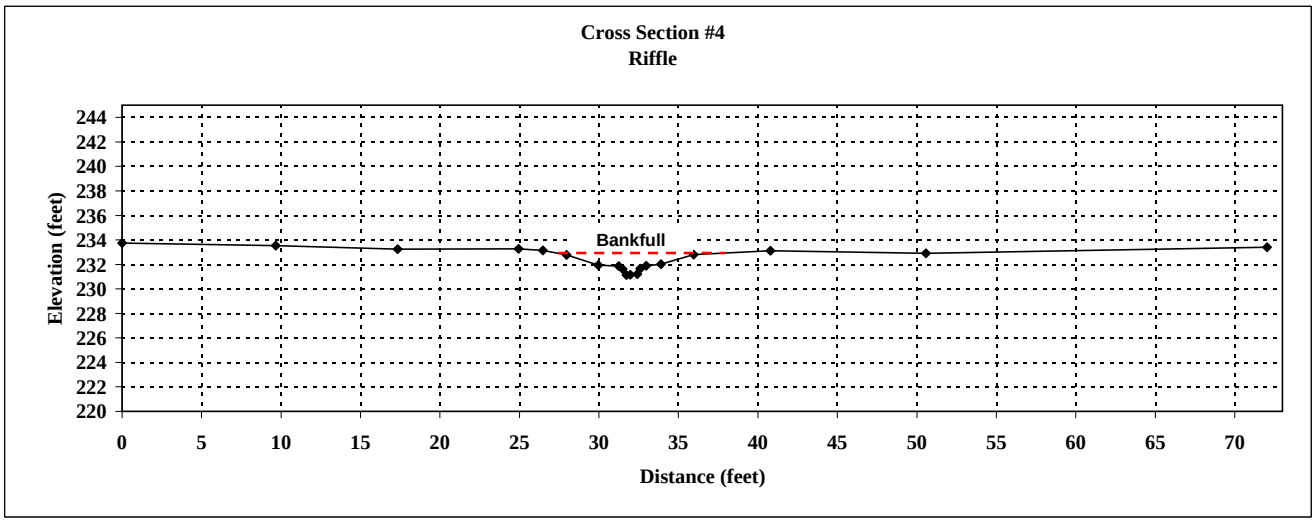
	Width (Feet)	Depth (Feet)	Perimeter (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.00	0.0
	0.6	0.1	0.64	0.0
	2.0	1.0	2.15	1.1
	1.3	1.1	1.29	1.3
	0.3	1.3	0.36	0.3
	0.2	1.8	0.54	0.4
	0.3	1.8	0.25	0.4
	0.4	1.7	0.44	0.8
	0.2	1.3	0.49	0.3
	0.4	1.0	0.44	0.4
	0.9	0.9	0.95	0.9
	2.0	0.1	2.19	1.1
	1.8		1.80	0.1
TOTALS	10.4		11.5	7.1

SUMMARY DATA (BANKFULL)

A(BKF)	7.1	W(FPA)	72+
W(BKF)	10.4	WP	11.5
Max d	1.8	Hydraulic Radius	0.62
Mean d	0.7	Wetted Perimeter=	WP
W/D	15.2	Area=	A
Bank Height	1.99	Width=	W
Entrenchment	6.9+	Depth=	D
Stream Type	C	Bankfull=	BKF
Area from Rural Regional Curve			8.7

Bankfull datum* = 232.92

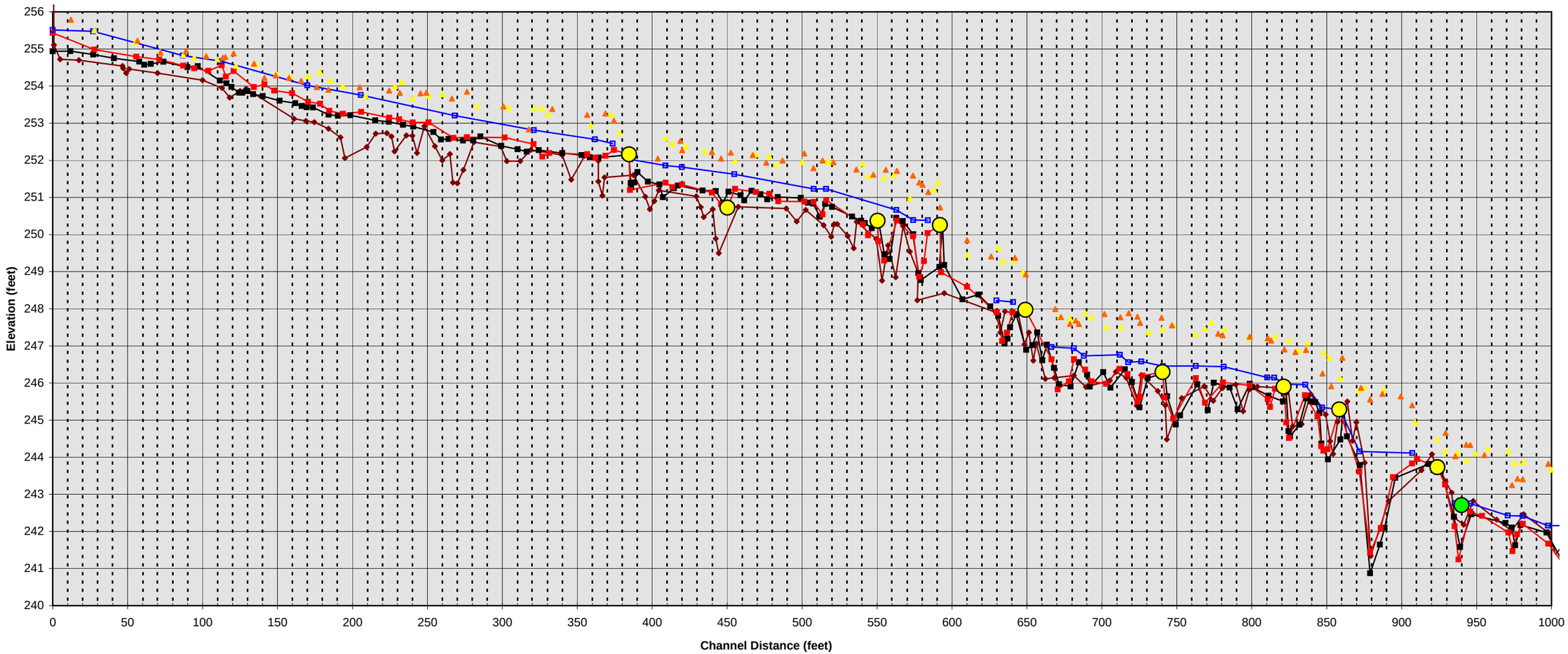
*Datum reset during Monitoring Year 2.



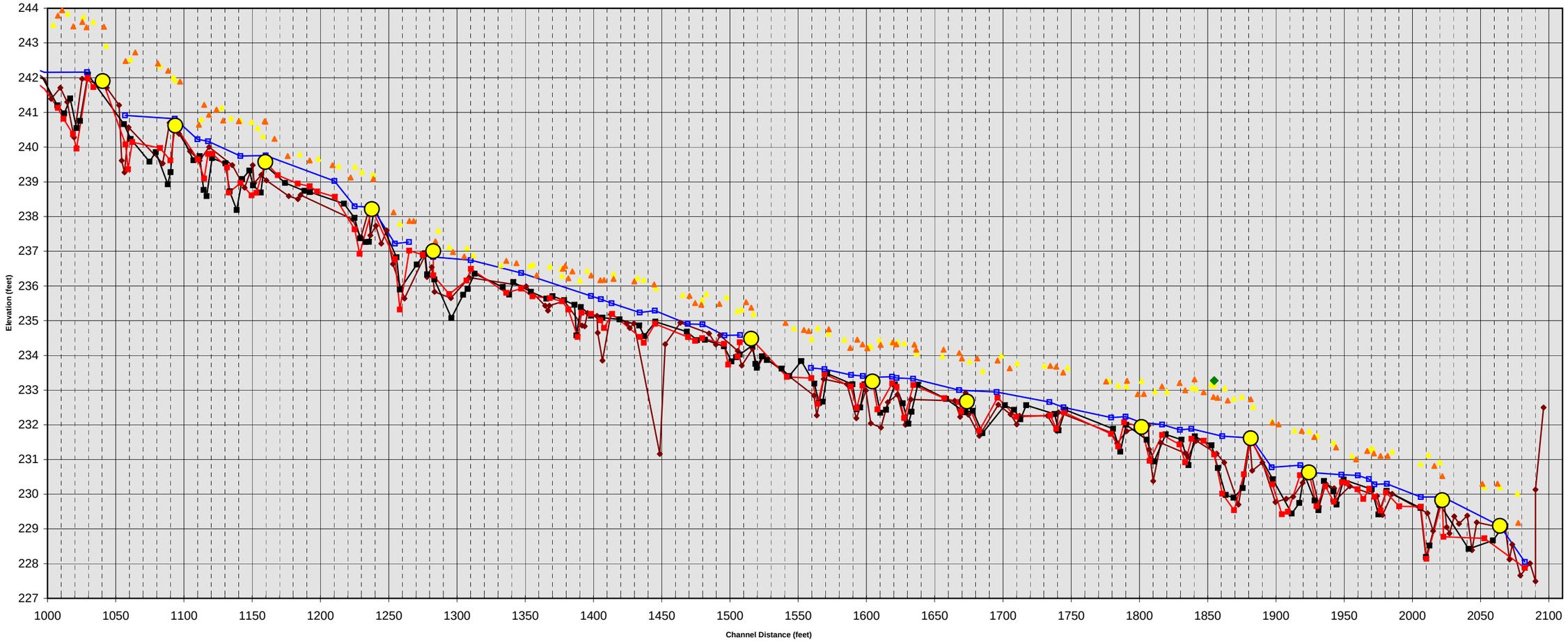
APPENDIX B5

STREAM LONGITUDINAL PROFILE

Longitudinal Profile Overlay (Years 1-3) Page 1 of 2
UT to Billy's Creek



Longitudinal Profile Overlay (Years 1-3) Page 2 of 2
UT to Billy's Creek



Thalweg Year 1 (9-06-2006)
Thalweg Year 2 (6-25-2007)
Thalweg Year 3 (7-01-2008)
Water Surface Year 3
Left Bankfull Year 3
Right Bankfull Year 3
Left Top of Bank Year 3
Right Top of Bank Year 3
Vane/structure

APPENDIX B6

STREAM PEBBLE COUNTS

At the request of EEP, pebble counts were not performed for UT Billy's Creek during Monitoring Year 3 because this is a sandbed stream.

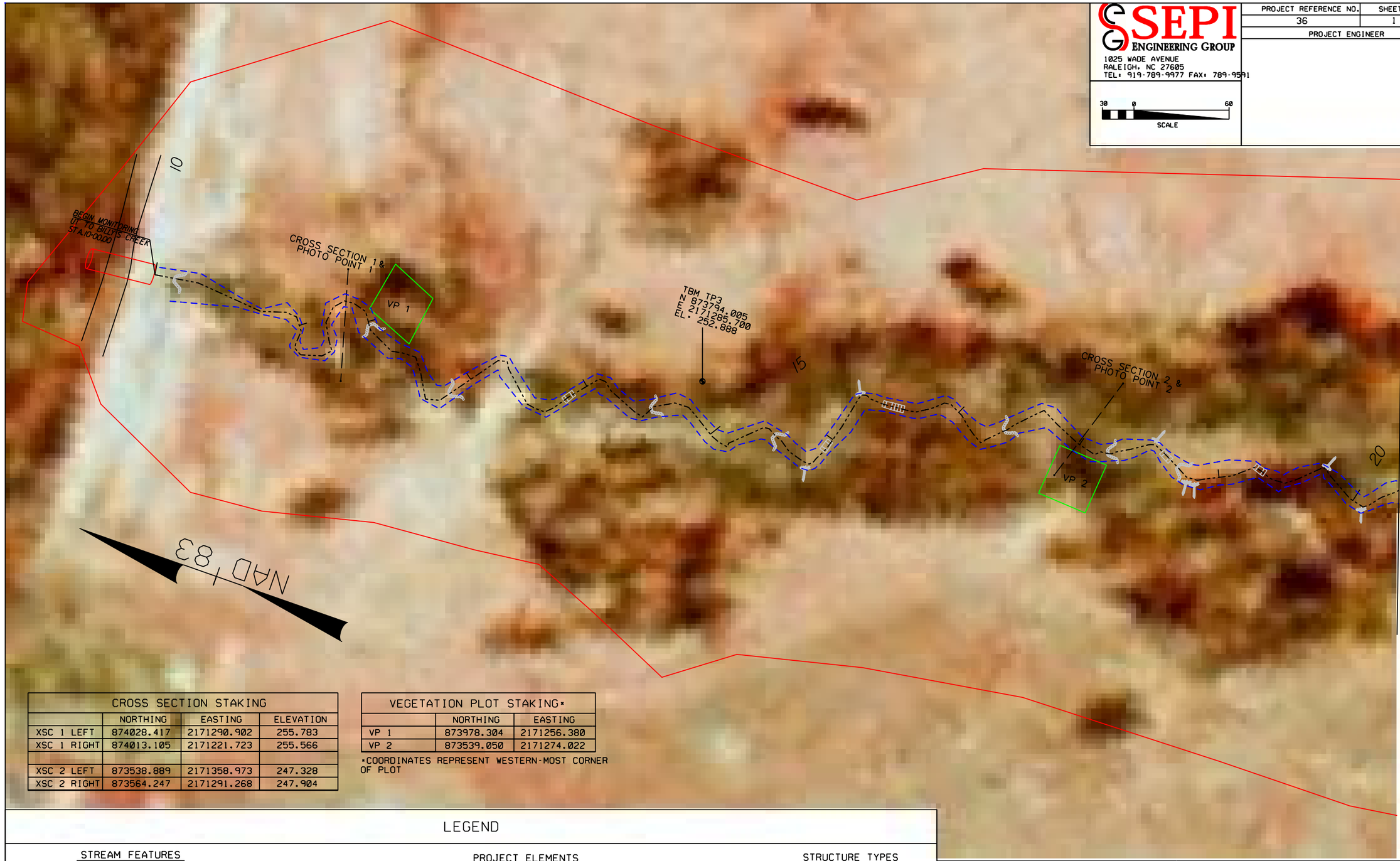
APPENDIX C

PLAN VIEW SHEETS

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

PROJECT REFERENCE NO.	SHEET NO.
36	1
PROJECT ENGINEER	

30 0 60
SCALE



CROSS SECTION STAKING

	NORTHING	EASTING	ELEVATION
XSC 1 LEFT	874028.417	2171290.902	255.783
XSC 1 RIGHT	874013.105	2171221.723	255.566
XSC 2 LEFT	873538.889	2171358.973	247.328
XSC 2 RIGHT	873564.247	2171291.268	247.904

VEGETATION PLOT STAKING*

	NORTHING	EASTING
VP 1	873978.304	2171256.380
VP 2	873539.050	2171274.022

*COORDINATES REPRESENT WESTERN-MOST CORNER OF PLOT

LEGEND

STREAM FEATURES
- THALWEG 2008
- BANKFULL 2008

PROJECT ELEMENTS
- CROSS-SECTION/PHOTO POINT
- CONTROL POINT/BENCHMARK (TBM)
- VEGETATION PLOT
- EASEMENT BOUNDARY
- FARM ROAD/SITE ACCESS
- CULVERT

STRUCTURE TYPES
- ROCK CROSS VANE
- ROCK STEP STRUCTURE
- ROOTWAD

Ecosystem Enhancement PROGRAM

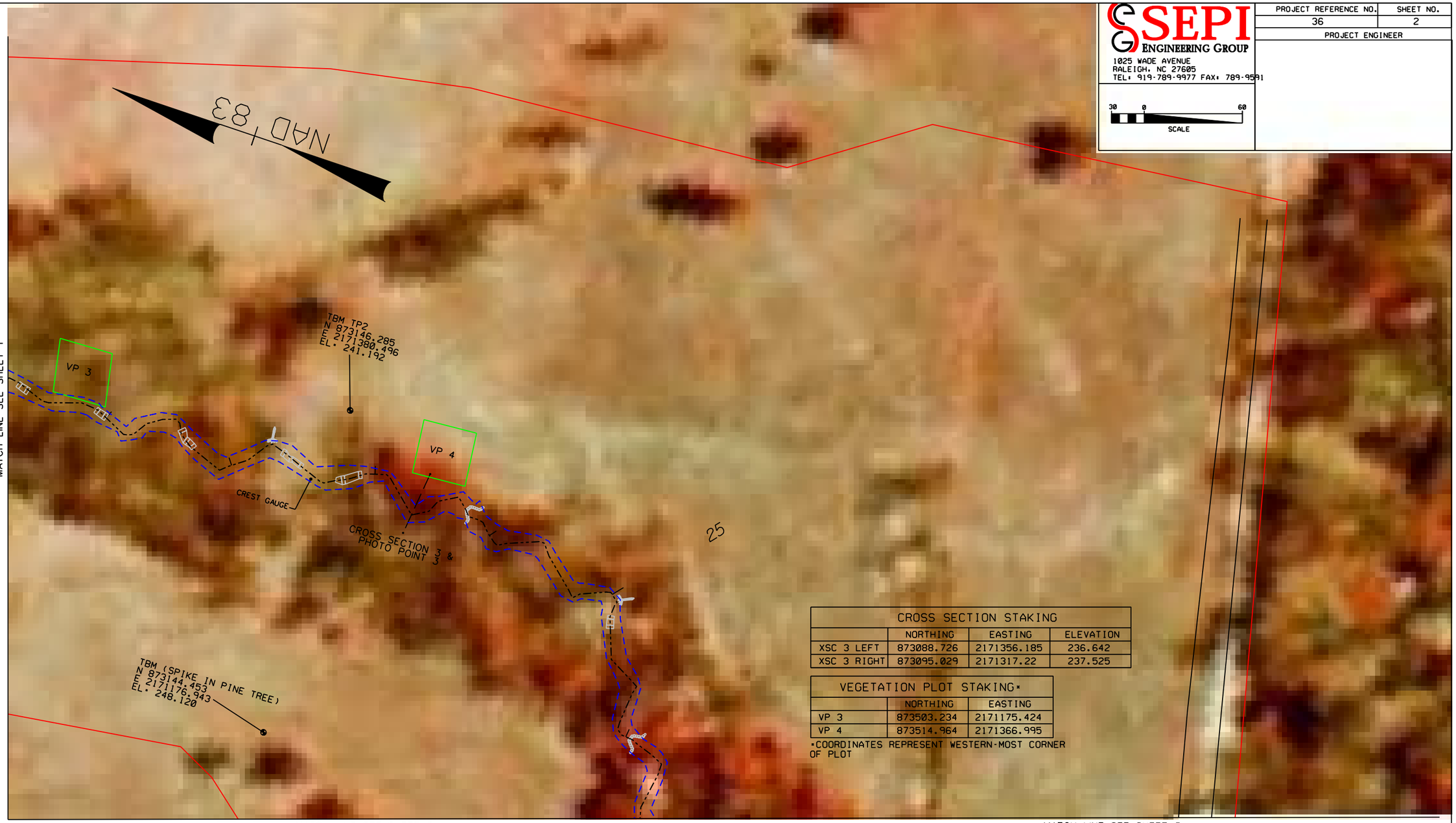
LOCATION:
UT TO BILLY'S CREEK
MONITORING PLAN VIEW
MONITORING YEAR 3

PROJ #:	COUNTY:
36	FRANKLIN
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 2/2/08

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

PROJECT REFERENCE NO.	SHEET NO.
36	2
PROJECT ENGINEER	

30 0 60
SCALE



CROSS SECTION STAKING

	NORTHING	EASTING	ELEVATION
XSC 3 LEFT	873088.726	2171356.185	236.642
XSC 3 RIGHT	873095.029	2171317.22	237.525

VEGETATION PLOT STAKING*

	NORTHING	EASTING
VP 3	873503.234	2171175.424
VP 4	873514.964	2171366.995

*COORDINATES REPRESENT WESTERN-MOST CORNER OF PLOT

LEGEND

STREAM FEATURES
- THALWEG 2008
- BANKFULL 2008

PROJECT ELEMENTS
- CROSS-SECTION/PHOTO POINT
- CONTROL POINT/BENCHMARK (TBM)
- VEGETATION PLOT
- EASEMENT BOUNDARY
- FARM ROAD/SITE ACCESS
- CULVERT

STRUCTURE TYPES
- ROCK CROSS VANE
- ROCK STEP STRUCTURE
- ROOTWAD

Ecosystem Enhancement PROGRAM

LOCATION:
UT TO BILLY'S CREEK
MONITORING PLAN VIEW
MONITORING YEAR 3

PROJ #:	COUNTY:
36	FRANKLIN
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 2/2/08

VEGETATION PLOT STAKING*		
	NORTHING	EASTING
VP 5	873257.591	2171797.134

*COORDINATES REPRESENT WESTERN-MOST CORNER OF PLOT

CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 4 LEFT	872773.671	2171195.536	233.787
XSC 4 RIGHT	872746.677	2171128.852	233.510

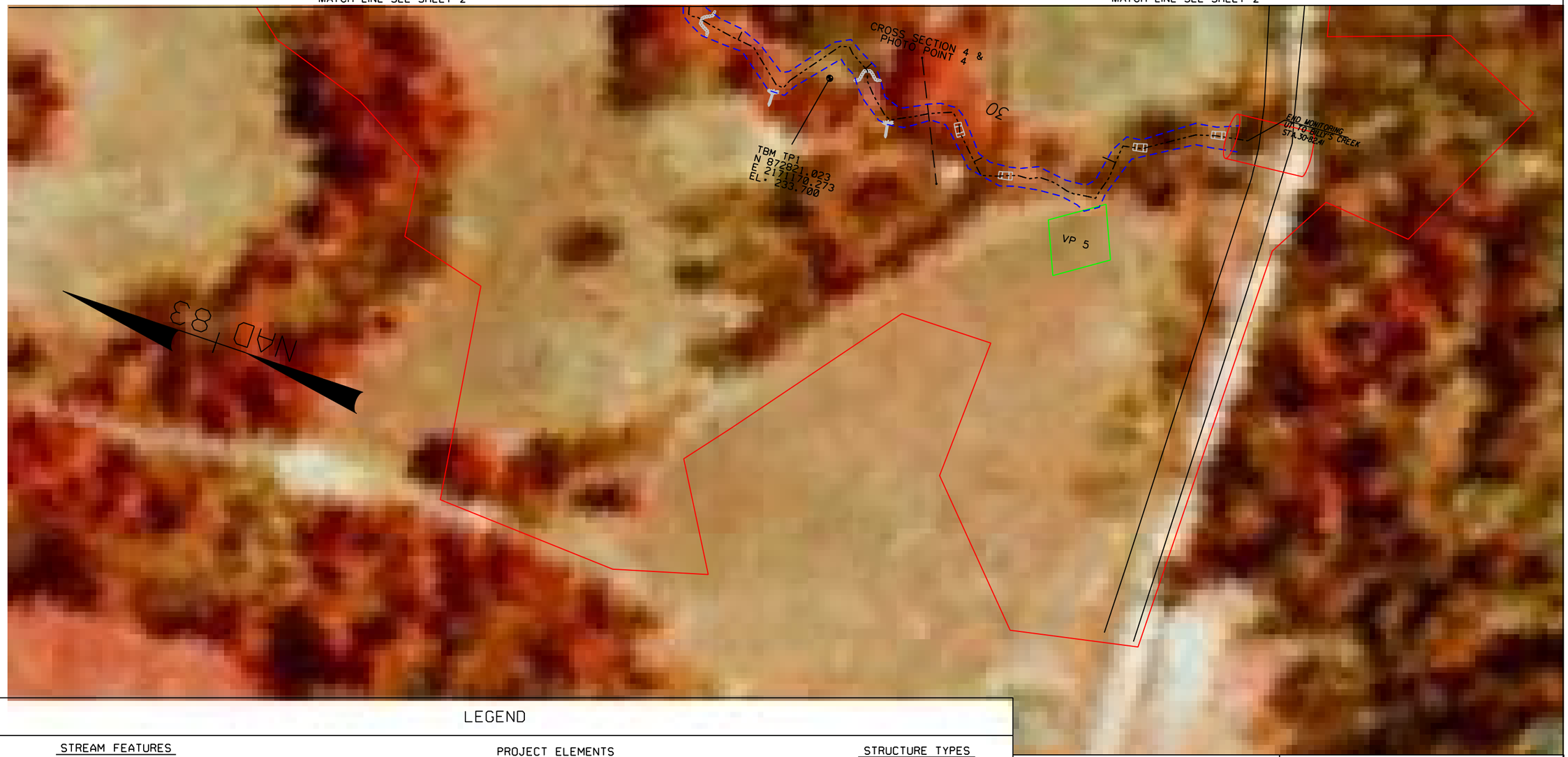
SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
36	3
PROJECT ENGINEER	

30 0 60
SCALE

MATCH LINE SEE SHEET 2

MATCH LINE SEE SHEET 2



LEGEND

STREAM FEATURES
- THALWEG 2008
- BANKFULL 2008

PROJECT ELEMENTS
- CROSS-SECTION/PHOTO POINT
- CONTROL POINT/BENCHMARK (TBM)
- VEGETATION PLOT
- EASEMENT BOUNDARY
- FARM ROAD/SITE ACCESS
- CULVERT

STRUCTURE TYPES
- ROCK CROSS VANE
- ROCK STEP STRUCTURE
- ROOTWAD

Ecosystem Enhancement PROGRAM

LOCATION:
UT TO BILLY'S CREEK
MONITORING PLAN VIEW
MONITORING YEAR 3

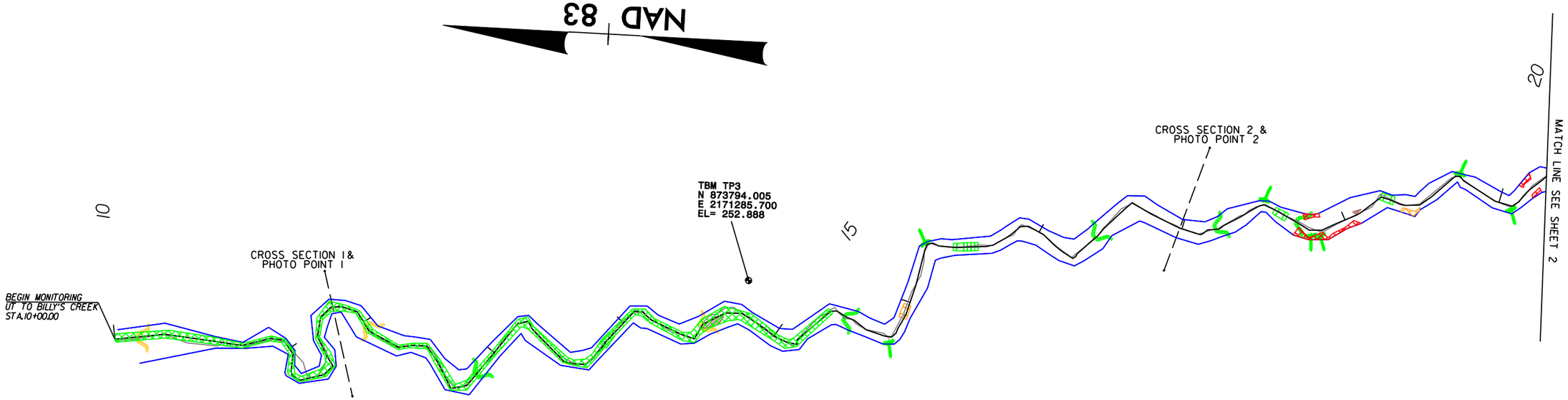
PROJ #:	COUNTY:
36	FRANKLIN
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 2/2/08

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

PROJECT REFERENCE NO.	SHEET NO.
36	1
PROJECT ENGINEER	

30 0 60
SCALE

NAD 83



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 1 LEFT	874028.417	2171290.902	255.783
XSC 1 RIGHT	874013.105	2171221.723	255.566
XSC 2 LEFT	873538.889	2171358.973	247.328
XSC 2 RIGHT	873564.247	2171291.268	247.904

LEGEND

- THALWEG 2007
- THALWEG 2008
- BANKFULL 2008
- CROSS-SECTIONS
- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION
- UNDERCUT BANKS
- EXPOSED SEDIMENT BAR

STRUCTURE TYPES
ROCK CROSS VANE
ROCK STEP STRUCTURE
ROOTWAD

COLOR CODE FOR STRUCTURES
- GOOD STRUCTURE (ACTUAL LOCATION)
- STRUCTURE WITH POTENTIAL PROBLEM (ACTUAL LOCATION)
- FAILING STRUCTURE (ACTUAL LOCATION)

Ecosystem Enhancement PROGRAM

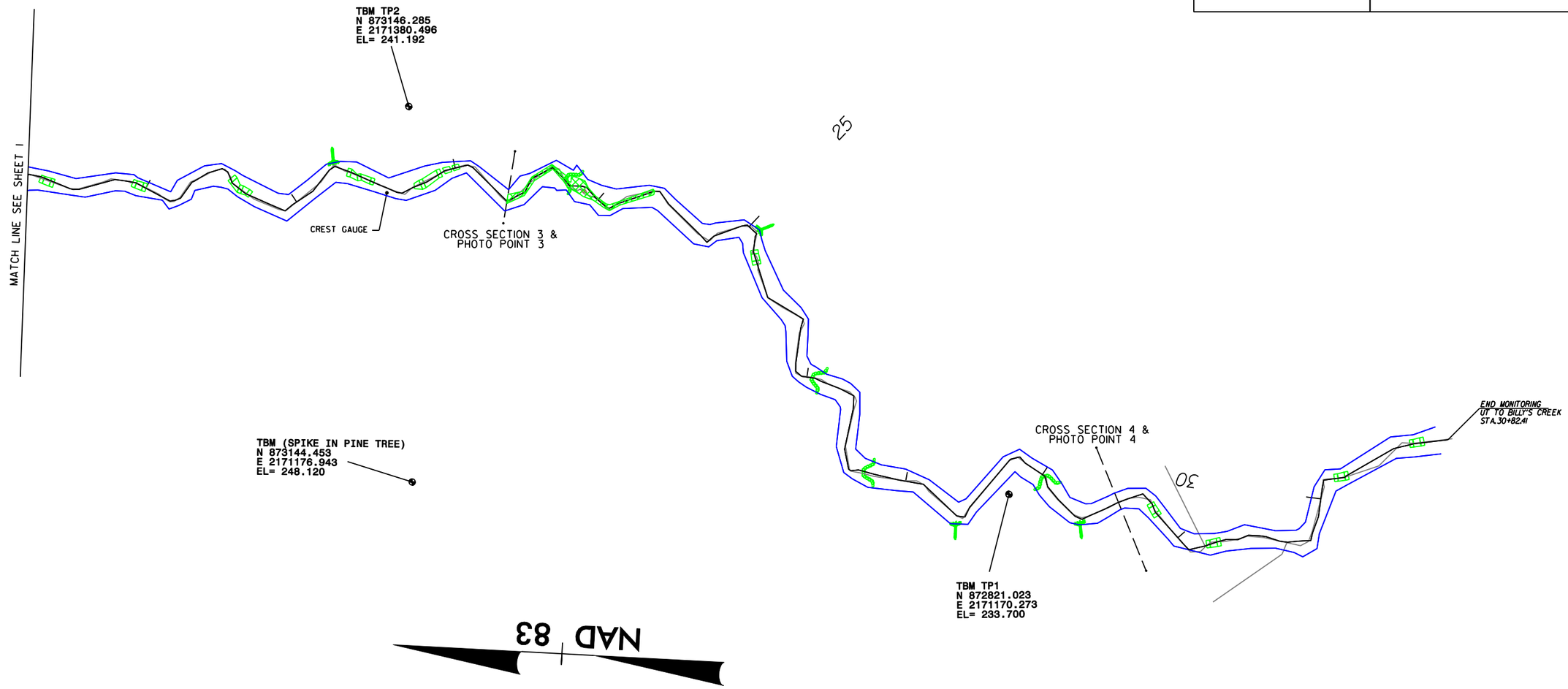
LOCATION:
UT TO BILLY'S CREEK
STREAM MONITORING - YEAR 3

PROJ #:	COUNTY:
36	FRANKLIN
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 2/10/09

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

PROJECT REFERENCE NO.	SHEET NO.
36	
PROJECT ENGINEER	
2	

30 0 60
SCALE



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 3 LEFT	873088.726	2171356.185	236.642
XSC 3 RIGHT	873095.029	2171317.22	237.525
XSC 4 LEFT	872773.671	2171195.536	233.787
XSC 4 RIGHT	872746.677	2171128.852	233.510

LEGEND

- THALWEG 2007
- THALWEG 2008
- BANKFULL 2008
- CROSS-SECTIONS
- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION
- UNDERCUT BANKS
- EXPOSED SEDIMENT BAR

STRUCTURE TYPES
ROCK CROSS VANE
ROCK STEP STRUCTURE
ROOTWAD

COLOR CODE FOR STRUCTURES
- GOOD STRUCTURE (ACTUAL LOCATION)
- STRUCTURE WITH POTENTIAL PROBLEM (ACTUAL LOCATION)
- FAILING STRUCTURE (ACTUAL LOCATION)

Ecosystem Enhancement PROGRAM

LOCATION:
UT TO BILLY'S CREEK
STREAM MONITORING - YEAR 3

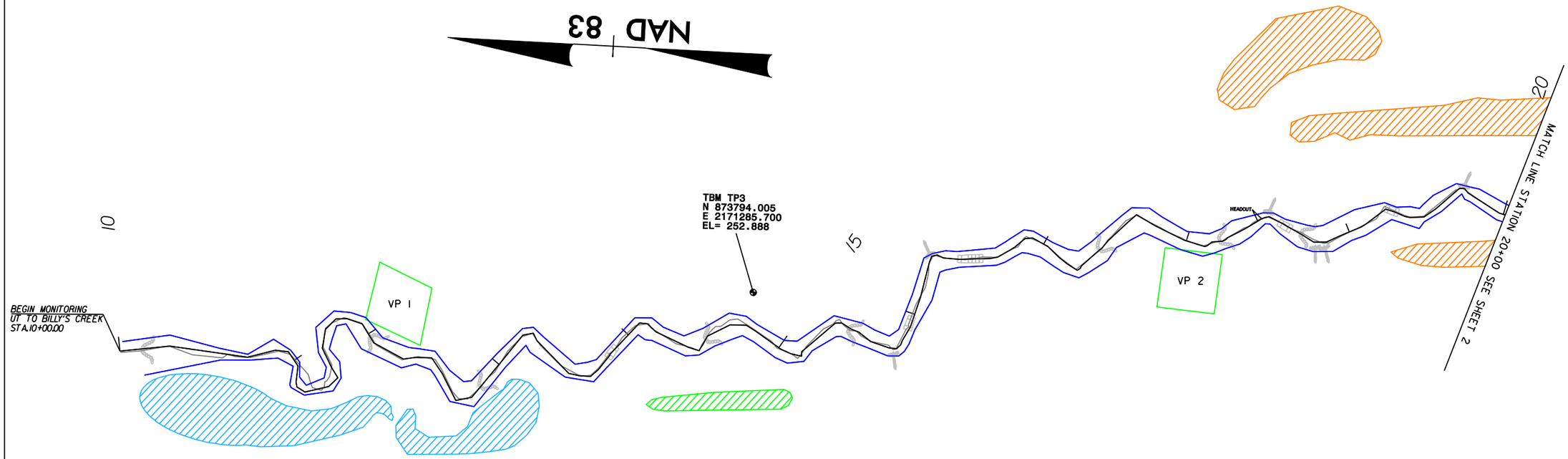
PROJ #:	COUNTY:
36	FRANKLIN
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 2/10/09

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

PROJECT REFERENCE NO.	SHEET NO.
36	1
PROJECT ENGINEER	

30 0 60
SCALE

NAD 83



*POPULATIONS OF *LIGUSTRUM SINENSE* ARE SCATTERED ALONG THE PROJECT FROM APPROXIMATELY STATION 18+00.00 TO THE END. ONLY THE MOST SUBSTANTIAL OF THESE AREAS ARE NOTED AS POLYGONS ON THIS PLAN VIEW.

VEGETATION PLOT STAKING*		
	NORTHING	EASTING
VP 1	873978.304	2171256.380
VP 2	873539.050	2171274.022

*COORDINATES REPRESENT WESTERN-MOST CORNER OF PLOT

LEGEND

- THALWEG 2007
- THALWEG 2008
- BANKFULL 2008
- VEGETATION PLOT WITH PHOTO CORNER
- VEGETATION PLOT NOT MEETING SUCCESS REQUIREMENTS
- BARE BENCH/BANK
- BARE FLOODPLAIN
- *MICROSTEGIUM VIRMINEUM* PRESENT
- *LIGUSTRUM SINENSE* PRESENT

STRUCTURE TYPES

- ROCK CROSS VANE
- ROCK STEP STRUCTURE
- ROOTWAD

Ecosystem Enhancement PROGRAM

LOCATION:
UT TO BILLY'S CREEK
VEGETATION MONITORING - YEAR 3

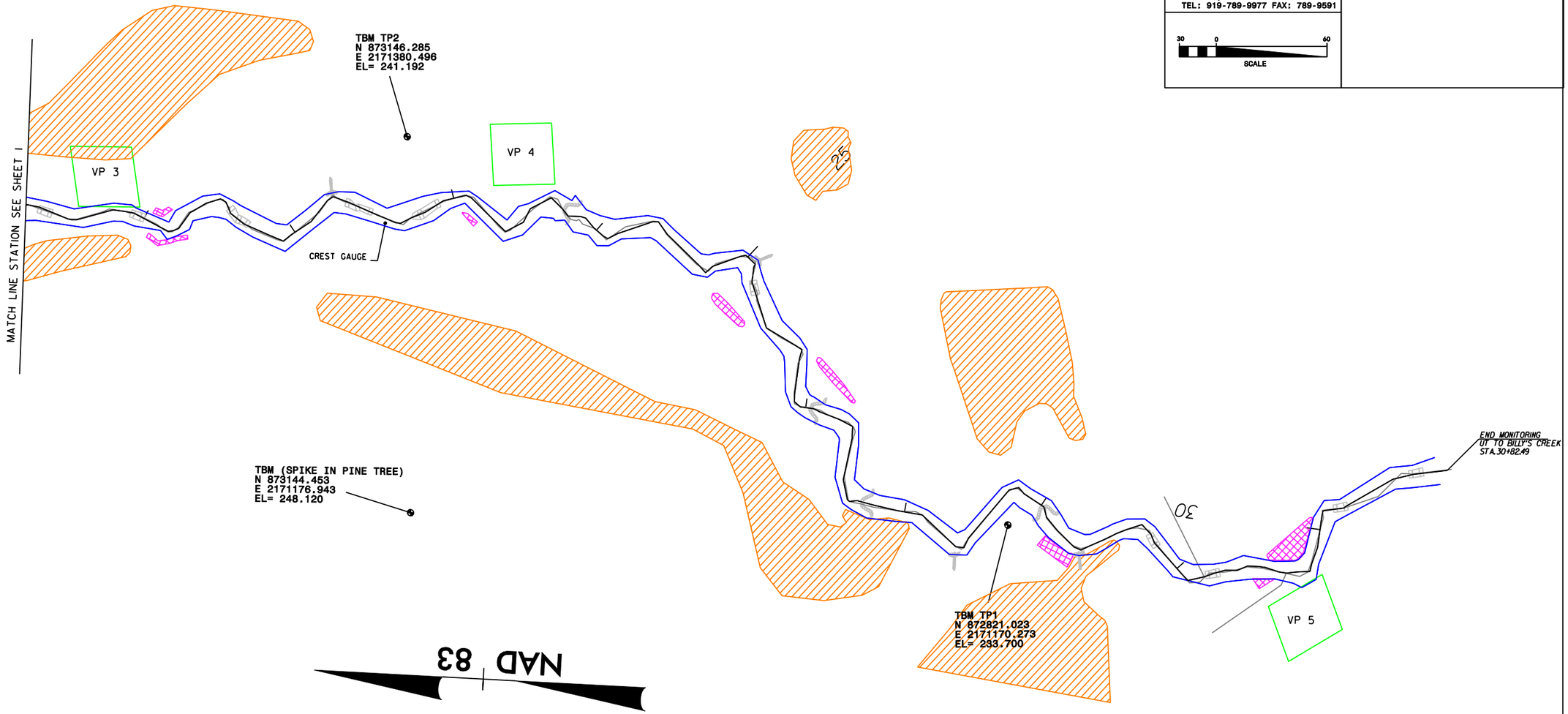
PROJ #:	COUNTY:
36	FRANKLIN
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 2/10/09

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

PROJECT REFERENCE NO.	SHEET NO.
36	2

PROJECT ENGINEER

30 0 60
SCALE



**POPULATIONS OF LIGUSTRUM SINENSE ARE SCATTERED ALONG THE PROJECT FROM APPROXIMATELY STATION 18+00.00 TO THE END. ONLY THE MOST SUBSTANTIAL OF THESE AREAS ARE NOTED AS POLYGONS ON THIS PLAN VIEW.*

VEGETATION PLOT STAKING*		
	NORTHING	EASTING
VP 3	873503.234	2171175.424
VP 4	873514.964	2171366.995
VP 5	873257.591	2171797.134

*COORDINATES REPRESENT WESTERN-MOST CORNER OF PLOT

LEGEND

- THALWEG 2007
- THALWEG 2008
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- VEGETATION PLOT WITH PHOTO CORNER
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- BARE FLOODPLAIN
- *MICROSTEGIUM VIMINEUM* PRESENT
- *LIGUSTRUM SINENSE* PRESENT

STRUCTURE TYPES

ROCK CROSS VANE
ROCK STEP STRUCTURE
ROOTWAD

Ecosystem Enhancement PROGRAM

LOCATION:
UT TO BILLY'S CREEK
VEGETATION MONITORING - YEAR 3

PROJ #:	COUNTY:
36	FRANKLIN
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 2/10/09