



**HORSE CREEK (WAKE FOREST COUNTRY CLUB)
FINAL MONITORING REPORT
YEAR 4 OF 5
2009**

EEP Project # 409
Wake County, North Carolina

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

TABLE OF CONTENTS

Monitoring Summary 1
 Methodology 3
 Vegetation Methodology 3
 Stream Methodology 3
 Longitudinal Profile and Plan View 3
 Permanent Cross Sections 3
 Pebble Counts 4
 Photo Documentation 4
 References..... 5

APPENDICES

Appendix A: General Figures and Plan Views

Figure 1 – Project Location Map
 Current Condition Plan Views (Stream Problem Areas)Sheets 1-3
 Current Condition Plan Views (Vegetation Problem Areas)Sheets 1-3

Appendix B: General Project Tables

Table 1. Project Restoration Components B-1
 Table 2. Project Activity and Reporting History B-1
 Table 3. Project Contact Table B-2
 Table 4. Project Background Table B-3

Appendix C: Vegetation Assessment Data

Table 5: Vegetation Plot Mitigation Success Summary Table
 Plotolog: Vegetation Plot Photolog
 Table 6: Vegetation Metadata Table
 Table 7: Stem Count Total by Plot and Species.....To be included in Final Report.

Appendix D: Stream Assessment Data

Cross Sections & Photo Point Photolog
 Table B2. Visual Morphological Stability Assessment
 Table V. Verification of Bankfull Events
 Cross Section Annual Overlay Plots
 Longitudinal Profile Annual Overlay Plots

MONITORING SUMMARY

The Horse Creek (Wake Forest Country Club) stream restoration project includes 2,825 linear feet (lf) of Horse Creek and 550 lf of an Unnamed Tributary (UT) to Horse Creek. Prior to restoration the stream was classified as a Rosgen C/E5 stream. The majority of the pre-construction stream bank lacked natural vegetation which resulted in increased bank erosion and reduced buffer filtration rates. Restoration of Horse Creek called for a Rosgen C5 stream, reconnected the stream to its original floodplain in a new alignment, and increased stream length and sinuosity. The UT was an entrenched, straight, G5e. The design for the UT called for a Rosgen E5 channel, raised the profile, and reconnected the stream to its floodplain along a new alignment. In General, the restoration supports the EEP goal of the protection and improvement of water quality by restoring wetland, stream and riparian area functions and values lost through historic, current, and future impacts. Specifically, the stream restoration has the following objectives:

- Reduction of downstream sedimentation by stabilizing eroding stream banks within the WFCC property;
- Replacement of a degraded stream reach with a stabilized stream which supports natural stream processes;
- Reduction in property loss within the WFCC property;
- Improved aquatic habitat, including pools for fish, woody debris for habitat, and reduction in water temperature from shading of riparian trees; and
- Improved aesthetics of the restored stream reach.
- Nitrogen reduction to Falls Lake and the Neuse River by establishing new riparian buffer to filter nutrients along the denuded reach within the WFCC;
- Additional source water protection for Falls Lake, the City of Raleigh's water supply through buffer establishment; and
- Establishment of riparian corridor for wildlife between existing wooded areas.

The most notable vegetation problems were long sections of floodplain that had been mowed as part of regular fairway maintenance before the country club closed. These areas are located along the upper two thirds of the Horse Creek mainstem and along the entire UT section (see Vegetation Problem Area Plan Views; Appendix A). These areas have started to fill in with vegetation since closing of the golf course (fall of 2007), but still appear to lack diversity. In addition, the lower portion of Horse Creek has intact stands of invasive Chinese privet (*Ligustrum sinense*) which appear to be spreading North along the project. The vegetation plots (VP) impacted by past-mowing (i.e., VP C, E, I, and O) have stem densities below 260 stems/acre (Monitoring Year 5 goal). However, planted stems across all plots were measured at 468 stems/acre. Therefore, planted stem densities of less than the Monitoring Year 5 goal should not be interpreted as an indication of the planted species being completely inappropriate, or the growing conditions being severely inhospitable. In fact, the evidence of naturalization of volunteer stems suggests the growing conditions are suitable for good herbaceous and woody vegetative growth without supplemental plantings. However, supplemental plantings should not be ruled out for several areas.

Year 4 monitoring showed that the Horse Creek mainstem has significant instabilities in the form of bank erosion in the form of slumping. The bank slumping areas were concentrated downstream of Station 28+00. The actual cause of these erosional areas is unknown, but it appears to be related to the combination of steep banks, a lack of soil stability, and/or a lack of deeply rooted vegetation in these areas. Overall, 9% of banks were impacted by bank erosion along the Horse Creek mainstem. Also, there were problems regarding structures. Two cross

vanes and two J-hooks that have piping and/or backarm scour that may warrant review to see if repair is needed. All four of these problem structures are located between Station 34+00 and 37+00. The Beaver dams along the mainstem, noted during Monitoring Year 4, were noted to no longer be present as of August 17, 2009.

The UT Horse Creek reach has remained stable for Monitoring year 4. The headcut observed in Monitoring Years 2 and 3 has progressed upstream only a couple of inches, but will be observed closely during Monitoring Year 5. The channel bed appears to have risen significantly along one section toward the downstream end of the UT reach during Monitoring Year 4 (see longitudinal profile overlay figure; Appendix D). It should be noted that the UT reach was essentially dry at the time of surveying, and appeared to have been dry for a while as grass was growing in the channel along nearly the entire reach. Only the upstream portion of the channel, from the culvert outlet at the upstream end to the headcut (Station 10+59), had water in the channel. This grass growth and resulting soil development within the channel may have contributed to the observed streambed rise in the downstream aggradational area. In addition, all three cross vanes had water piping around and/or under some part of the structure.

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

METHODOLOGY

Vegetation Methodology

The following methodology was used for the stem count. The configuration of the seven (7) 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 and naturalized woody material in the plot was marked with flagging. Plot inventories were conducted per the 2006 CVS-EEP Level II Protocol for Recording Vegetation (EEP 2007). In 2007, EEP requested that only vegetation plots C, E, F, I, K, L, and O be monitored. These plots were carried forward for the 2009 monitoring year.

Stream Methodology

The project monitoring for the stream channel included a longitudinal survey, cross-sectional surveys, 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.

Longitudinal Profile and Plan View

A longitudinal profile was surveyed for both reaches with a Nikon DTM-520 Total Station, prism, and a TDS Recon Pocket PC. The heads of features (i.e., riffles, runs, and pools) 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 maximum pool depth, the 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) for each reach, and 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.

Permanent Cross Sections

Six permanent cross sections (three riffles and three pools) were surveyed along Horse Creek and two permanent cross sections (one riffle and one pool) were surveyed along the UT. The beginning (i.e., left bank facing downstream) and end of each permanent cross section were originally marked with a wooden stake and metal conduit. Cross sections were installed perpendicular to the stream flow. Each survey noted all changes in slope, tops of both banks, 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 Monitoring Years 0 and 2 for comparison. Monitoring Year 1 cross sections were not included per a 2007 EEP comment asking SEPI to remove these from the overlay figures based on the low survey accuracy. All dimension parameters (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 data from all previous monitoring years.

Pebble Counts

Based on the fact that Horse Creek and UT to Horse Creek are sandbed streams, 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.

Photo Documentation

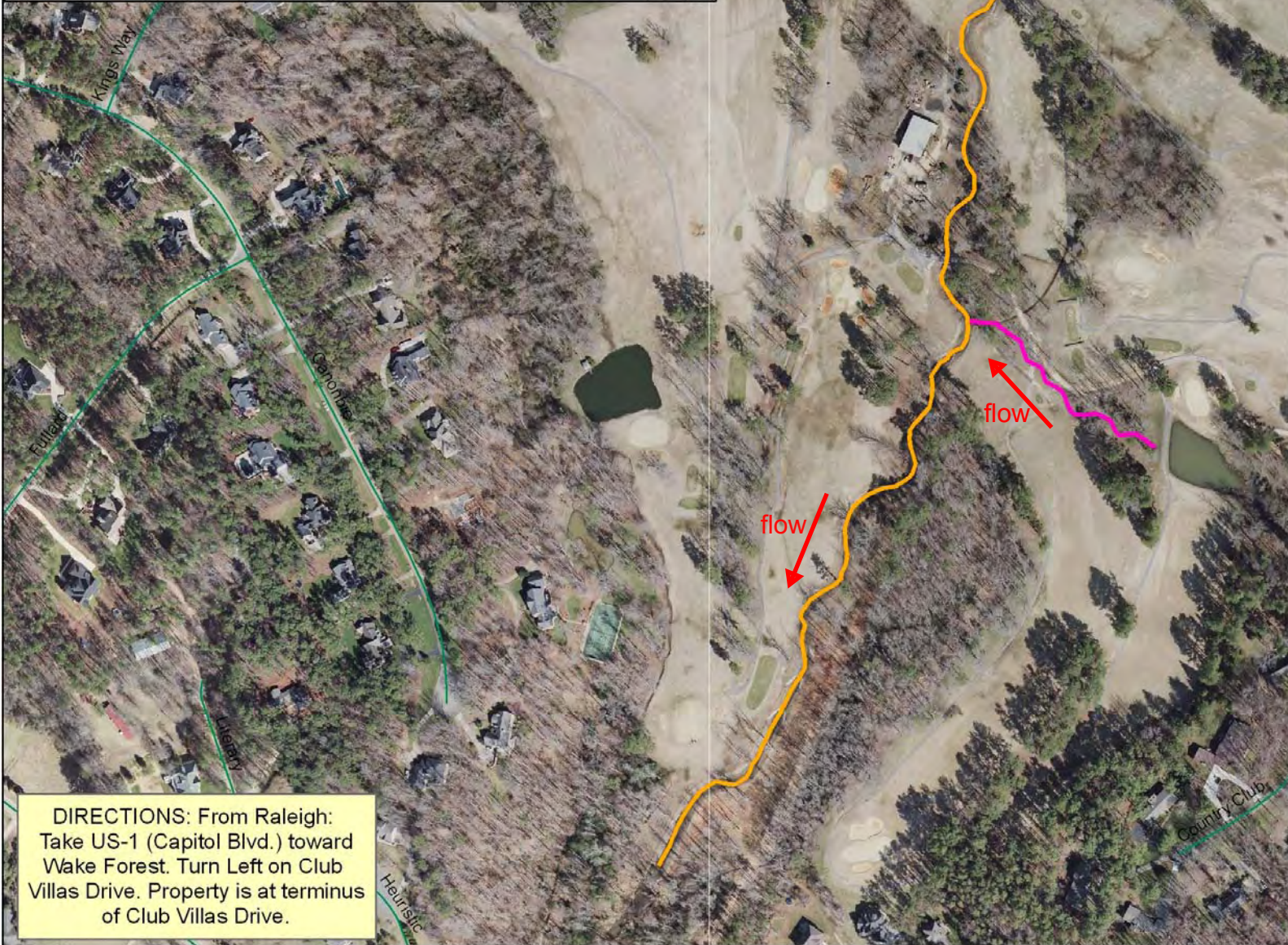
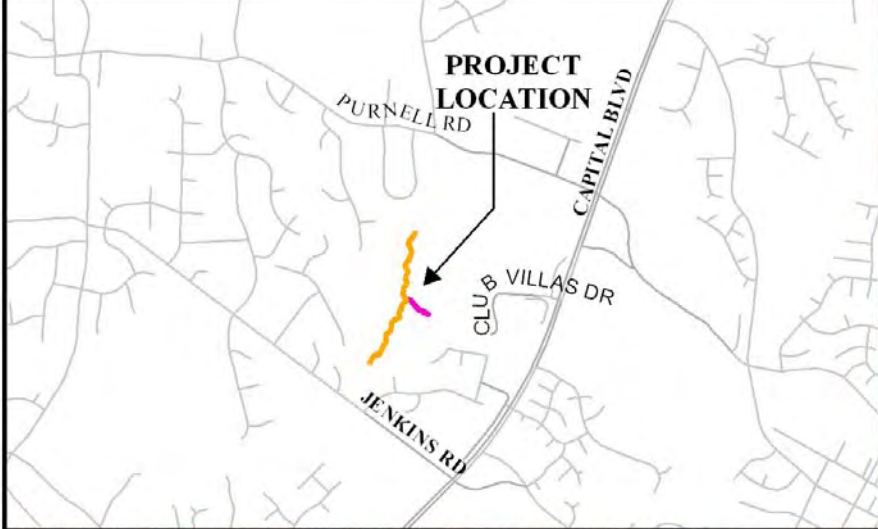
Permanent photo points were established during Monitoring Year 1. A set of three photographs (facing upstream, facing downstream, and facing the channel) were taken at each photo point with a digital camera. Two photographs were taken at each cross-section (facing upstream and downstream). A representative photograph of each vegetation plot was taken southern-most corner closest to the channel.

REFERENCES

- Dewberry & Davis. September 2002. *Stream Restoration Plan Horse Creek at Wake Forest Country Club*. November 2003
- Dewberry & Davis. *Horse Creek Stream Restoration Monitoring Report EEP Project Number 71082 Monitoring Year – 01 200*. September 2006
- 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.
- Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2006. *CVS-EEP Protocol for Recording Vegetation*. Available at < http://cvs.bio.unc.edu/protocol/cvs-EEP-manual-v4_lev1-2.pdf>. 11 pp.
- North Carolina Ecosystem Enhancement Program. September 2005. *Content, Format and Data Requirements for EEP Monitoring Reports*.
- Rosgen, D.L. 1994. *A Classification of Natural River*. Catena, Volume 22: 166-169.
- SEPI Engineering Group. January 2008. *Horse Creek (Wake Forest Country Club) Final Monitoring Report Year 2 of 5 2007*.
- SEPI Engineering Group. February 2009. *Horse Creek (Wake Forest Country Club) Final Monitoring Report Year 3 of 5 2007*.
- U.S. Department of Army, Corps of Engineers. 2003. *Stream Mitigation Guidelines*. http://www.saw.usace.army.mil/wetlands/Mitigation/stream_mitigation.html

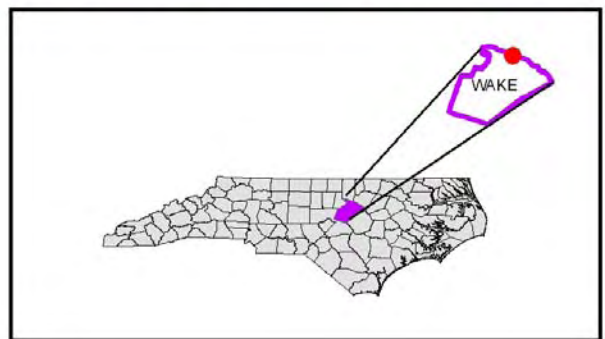
APPENDIX A

GENERAL FIGURES AND PLAN VIEWS



DIRECTIONS: From Raleigh:
 Take US-1 (Capitol Blvd.) toward
 Wake Forest. Turn Left on Club
 Villas Drive. Property is at terminus
 of Club Villas Drive.

**UT HORSE CREEK
 WAKE FOREST COUNTRY CLUB
 SITE VICINITY MAP**

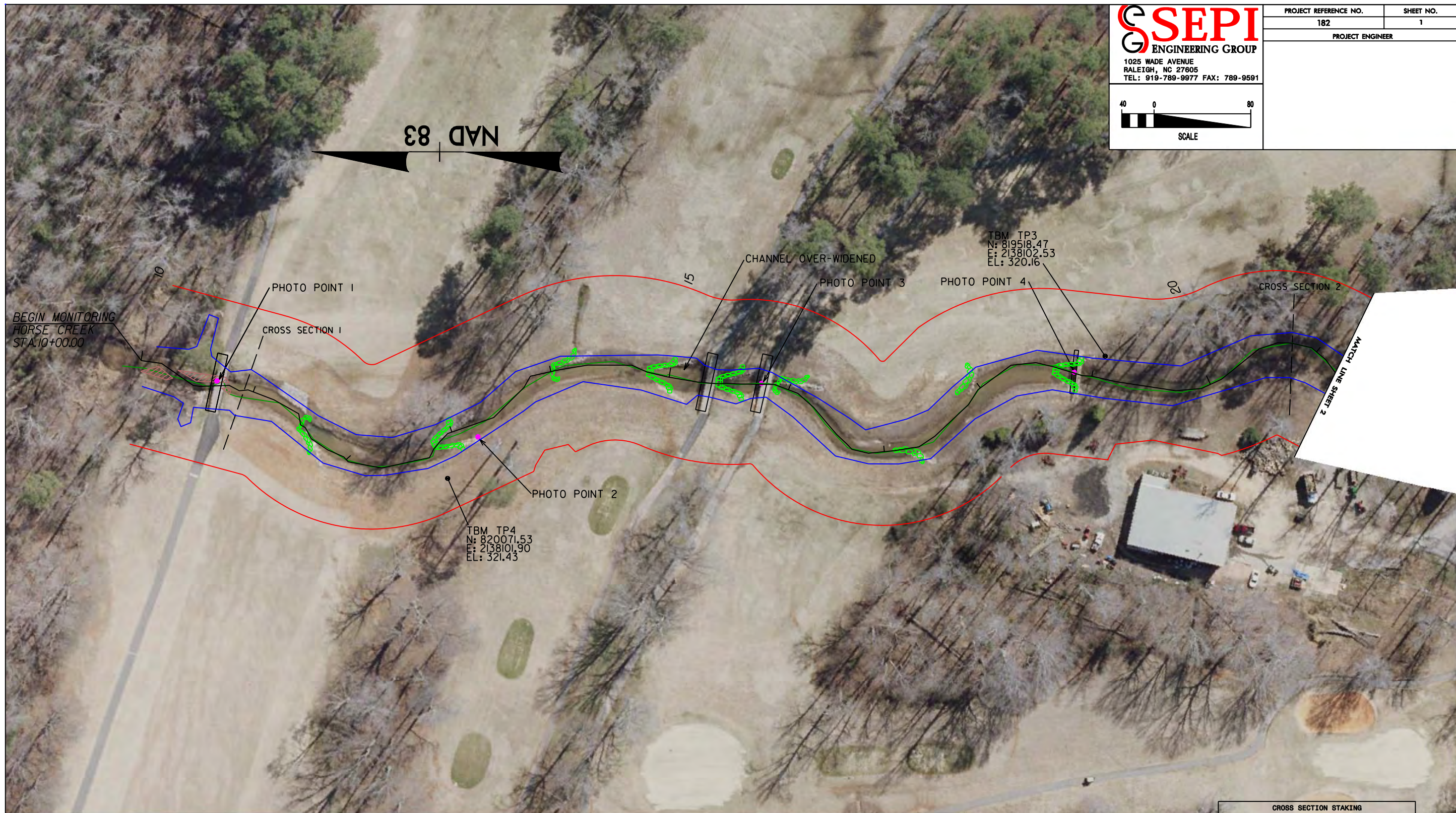
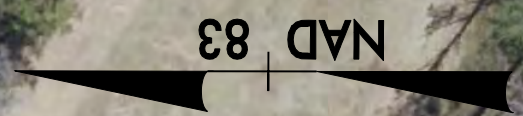
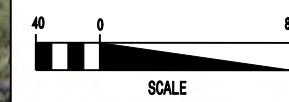


**FIGURE 1
 WAKE COUNTY NC**

300 150 0 300 Feet



- Horse Creek
- UT Horse Creek



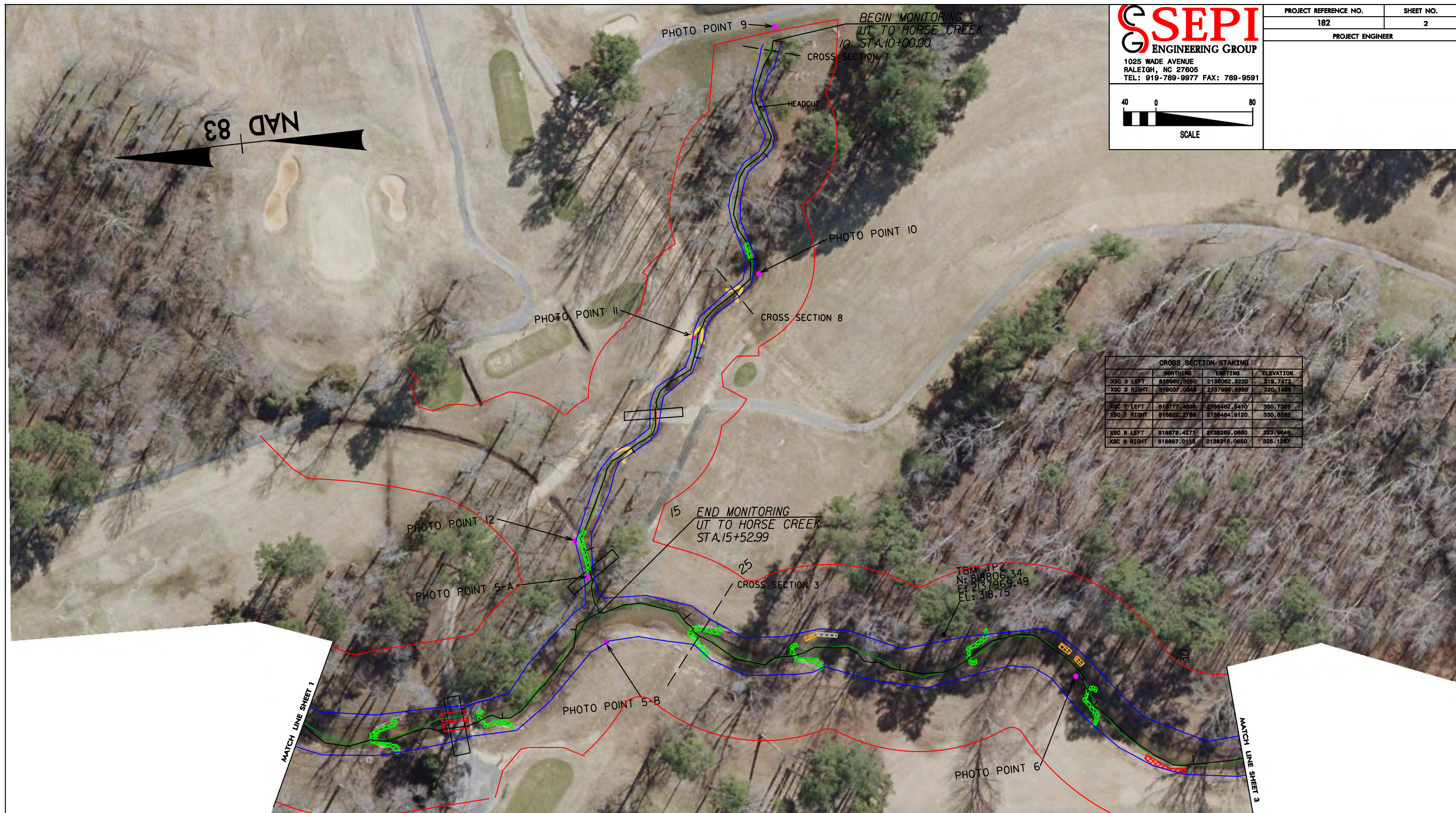
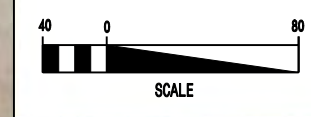
LEGEND

STREAM FEATURES		PROJECT ELEMENTS		STRUCTURE TYPES		COLOR CODE FOR STRUCTURES	
	THALWEG 2008		CROSS-SECTIONS		ROCK CROSS VANE		GOOD STRUCTURE
	THALWEG 2009		PHOTO POINT		J-HOOK VANE		STRUCTURE WITH POTENTIAL PROBLEM
	BANKFULL 2009		CONTROL POINT / BENCHMARK (TBM)		ROCK VANE		FAILING STRUCTURE
	BANK EROSION		EASEMENT BOUNDARY		CULVERT		
	SEVERE BANK EROSION		BRIDGE				
	AGGRADATION						
	BAR FORMATION						
	UNDERCUT BANK						

CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 1 LEFT	820200.0087	2138245.7540	322.0308
XSC 1 RIGHT	820249.8363	2138159.1450	324.1086
XSC 2 LEFT	819356.1645	2138122.9400	320.4503
XSC 2 RIGHT	819377.4254	2138026.7440	320.8482



LOCATION:	HORSE CREEK	
	CURRENT CONDITIONS PLAN VIEW	
	FINAL STREAM - YEAR 4	
PROJ #:	182	COUNTY: WAKE
PREPARED BY:	IPJ	
CHECKED BY:	PDB	DATE: 3/01/2010



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 3 LEFT	818860.3250	2138062.3220	319.7473
XSC 3 RIGHT	819037.0548	2137999.6980	320.1486
XSC 7 LEFT	818777.4858	2138462.5410	330.7385
XSC 7 RIGHT	818822.2789	2138484.9120	330.8282
XSC 8 LEFT	818878.4271	2138269.0650	323.9846
XSC 8 RIGHT	818897.0118	2138315.0650	325.1267

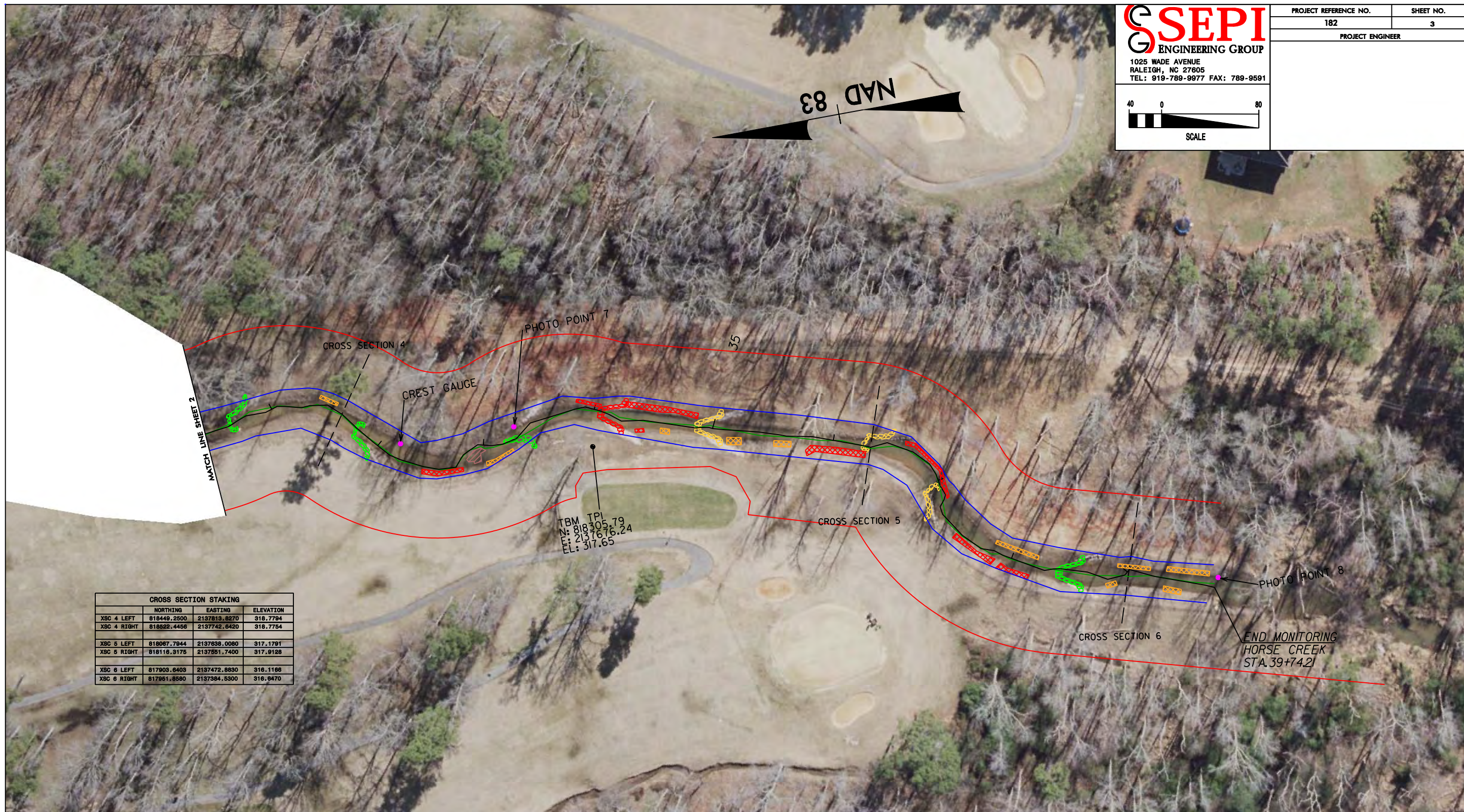
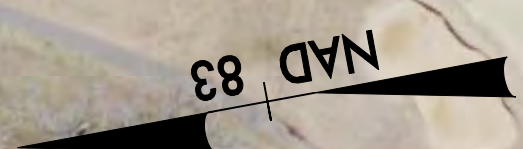
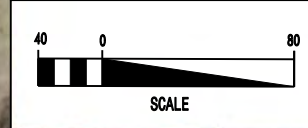
TBM TP2
N: 818806.34
E: 2137969.49
EL: 318.75

LEGEND

STREAM FEATURES	PROJECT ELEMENTS	STRUCTURE TYPES	COLOR CODE FOR STRUCTURES
THALWEG 2008	CROSS-SECTIONS	ROCK CROSS VANE	GOOD STRUCTURE
THALWEG 2009	PHOTO POINT	J-HOOK VANE	STRUCTURE WITH POTENTIAL PROBLEM
BANKFULL 2009	CONTROL POINT/BENCHMARK (TBM)	ROCK VANE	FAILING STRUCTURE
BANK EROSION	EASEMENT BOUNDARY		
SEVERE BANK EROSION	CULVERT		
AGGRADATION	BRIDGE		
BAR FORMATION			
UNDERCUT BANK			



LOCATION:	HORSE CREEK	
	CURRENT CONDITIONS PLAN VIEW	
	FINAL STREAM - YEAR 4	
PROJ #:	182	COUNTY: WAKE
PREPARED BY:	IPJ	
CHECKED BY:	PDB	DATE: 3/01/2010



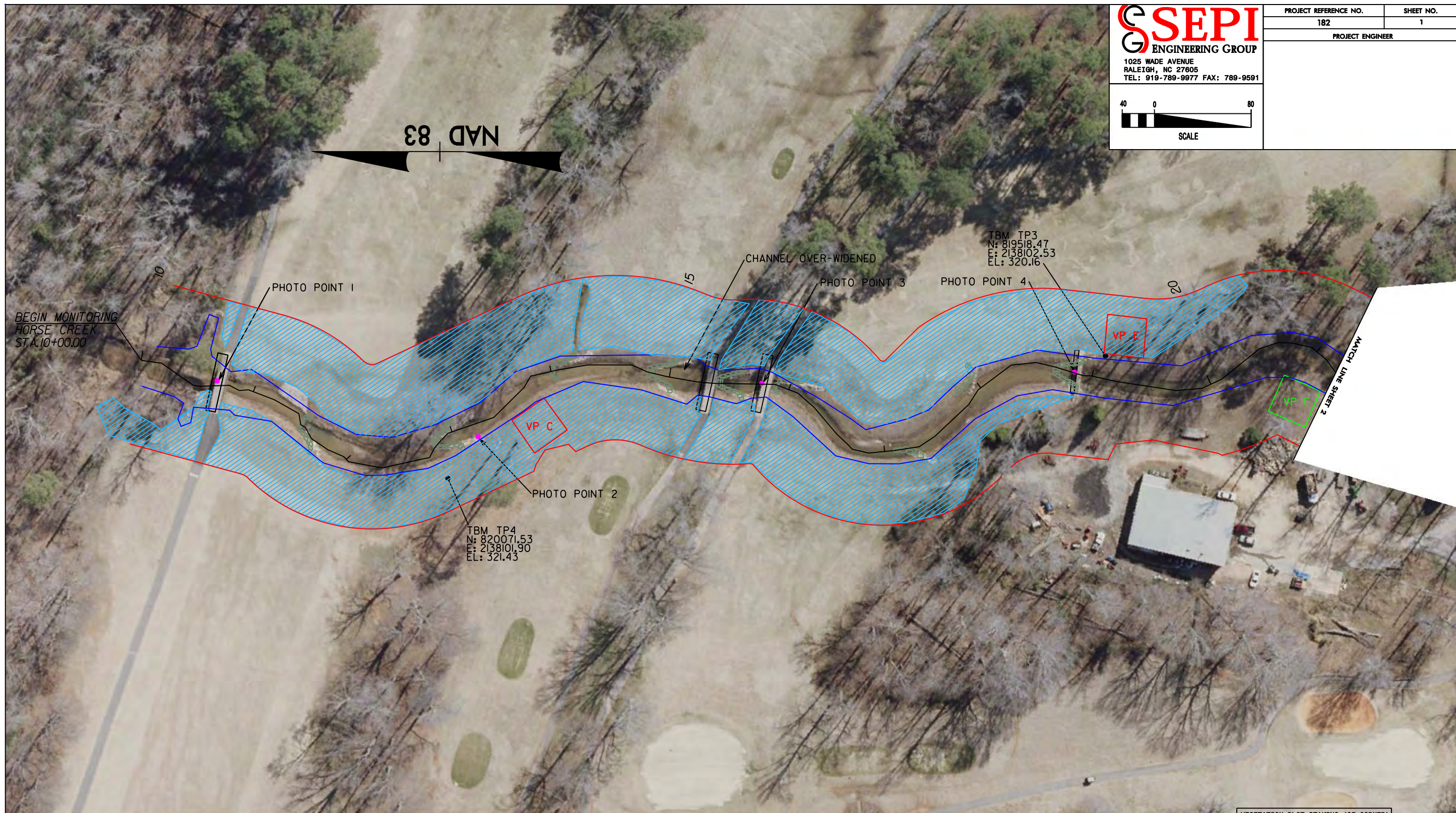
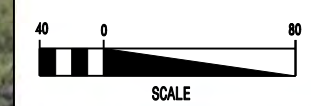
CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 4 LEFT	818449.2500	2137813.8270	318.7794
XSC 4 RIGHT	818522.4456	2137742.8420	318.7754
XSC 5 LEFT	818067.7944	2137838.0080	317.1791
XSC 5 RIGHT	818118.3175	2137851.7400	317.9128
XSC 6 LEFT	817903.6403	2137472.8830	316.1166
XSC 6 RIGHT	817951.6580	2137384.5300	316.8470

LEGEND

STREAM FEATURES	PROJECT ELEMENTS	STRUCTURE TYPES	COLOR CODE FOR STRUCTURES
THALWEG 2008	CROSS-SECTIONS	ROCK CROSS VANE	GOOD STRUCTURE
THALWEG 2009	PHOTO POINT	J-HOOK VANE	STRUCTURE WITH POTENTIAL PROBLEM
BANKFULL 2009	CONTROL POINT/BENCHMARK (TBM)	ROCK VANE	FAILING STRUCTURE
BANK EROSION	EASEMENT BOUNDARY	CULVERT	
SEVERE BANK EROSION	BRIDGE		
AGGRADATION			
BAR FORMATION			
UNDERCUT BANK			



LOCATION:	HORSE CREEK	
	CURRENT CONDITIONS PLAN VIEW FINAL STREAM - YEAR 4	
PROJ #:	182	COUNTY: WAKE
PREPARED BY:	IPJ	
CHECKED BY:	PDB	DATE: 3/01/2010



LEGEND

	THALWEG 2008		ROCK CROSS VANE		BARE BENCH/BANK
	BANKFULL 2008		J-HOOK VANE		PAST MOWING/MAINTENANCE IN EASEMENT (PRIOR TO SUMMER 2008)
	PHOTO POINT		ROOTWAD		LIGUSTRUM SINENSE PRESENT
	VEGETATION PLOT		ROCK VANE		ROSA MULTIFLORA PRESENT
	VEGETATION PLOT NOT MEETING SUCCESS REQUIREMENTS				

	NORTHING	EASTING
PLOT C	819981.3041	2138152.7109
PLOT E	819479.2526	2138126.8801
PLOT F	819349.1988	2138041.6765

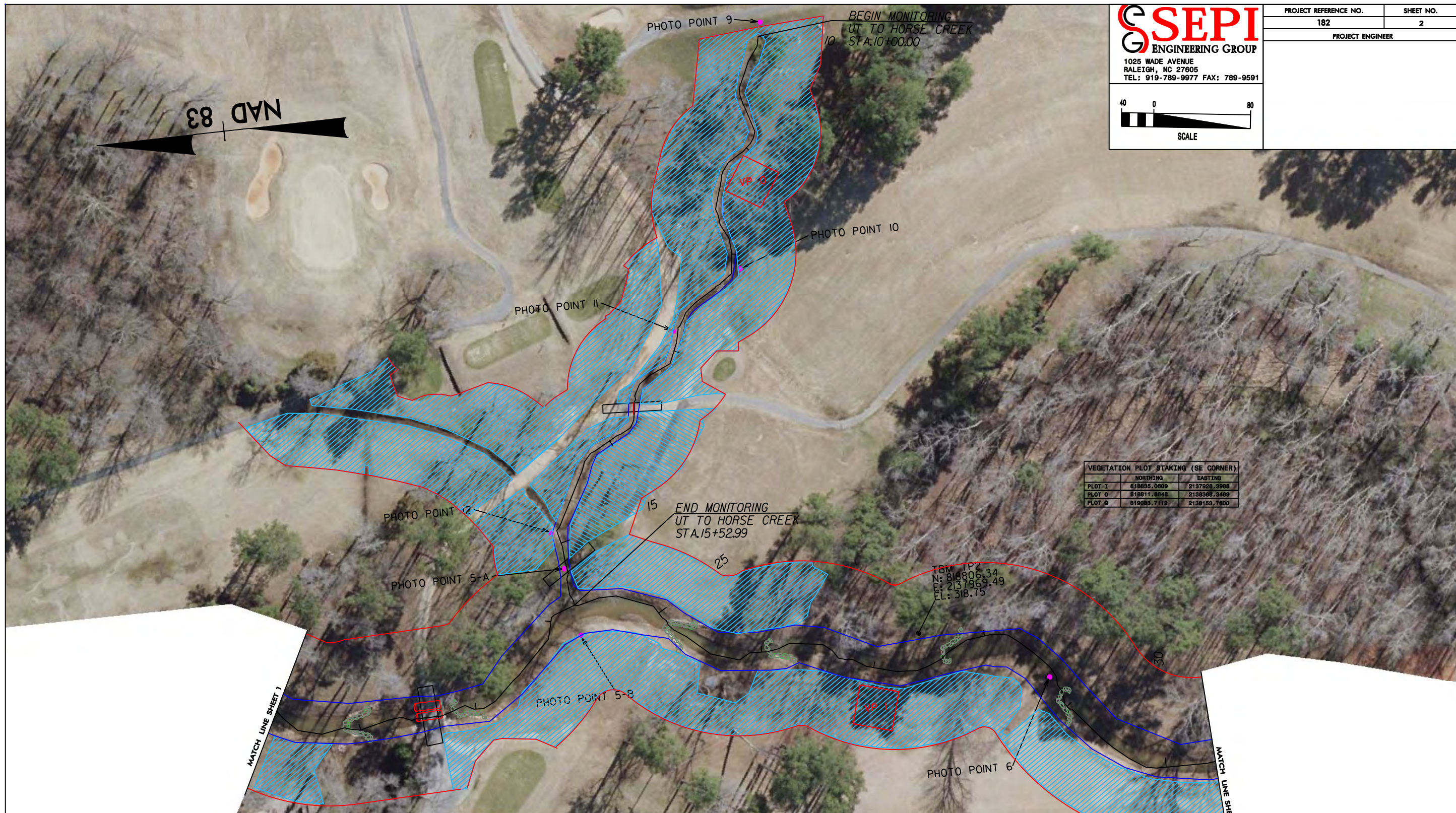


LOCATION:	HORSE CREEK	
	CURRENT CONDITIONS PLAN VIEW	
	FINAL VEGETATION- YEAR 4	
PROJ #:	182	COUNTY: WAKE
MONITORED BY:	IPJ	
CHECKED BY:	PDB	DATE: 3/01/2010

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

40 0 80
SCALE

PROJECT REFERENCE NO.	SHEET NO.
182	2
PROJECT ENGINEER	



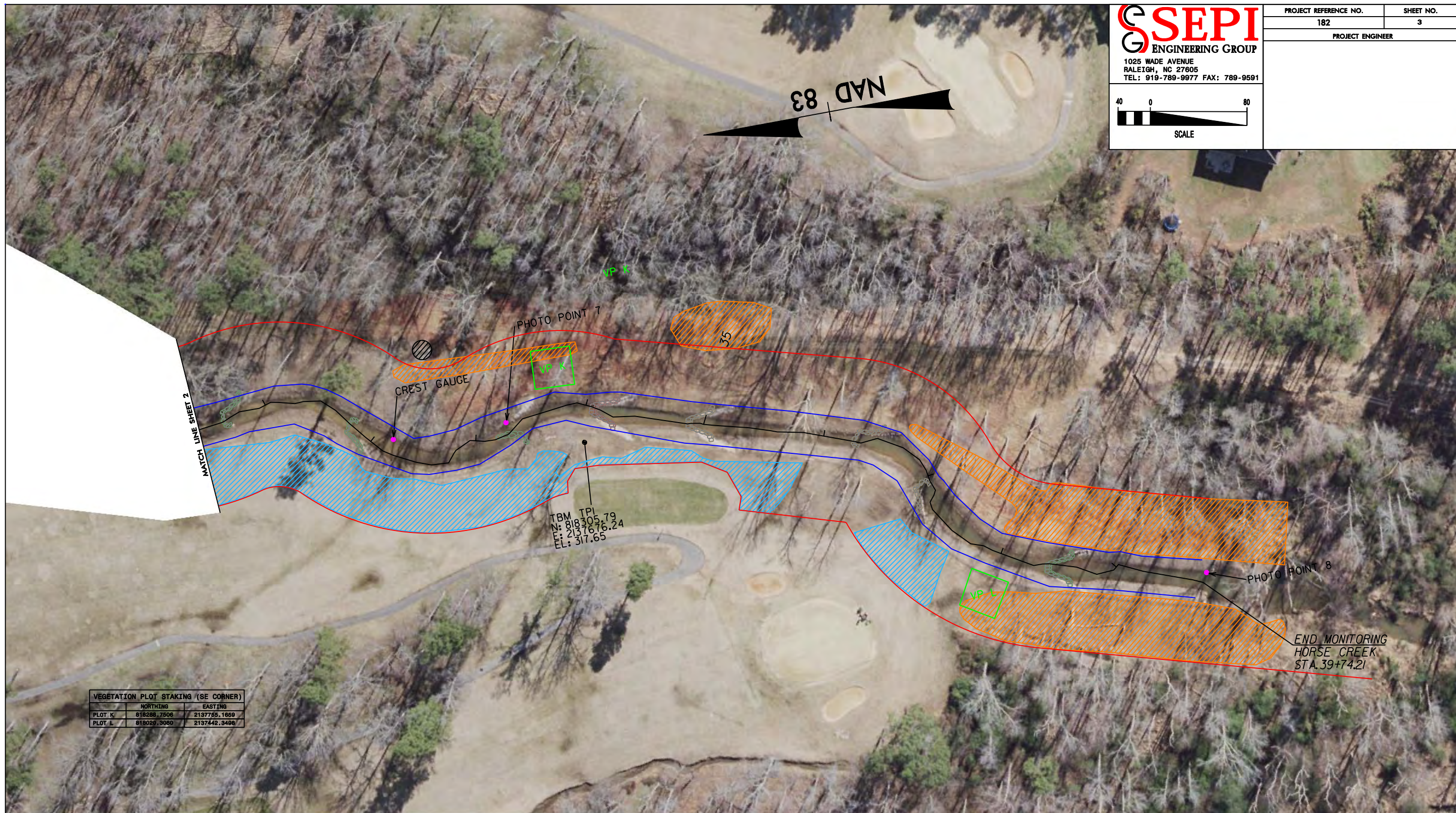
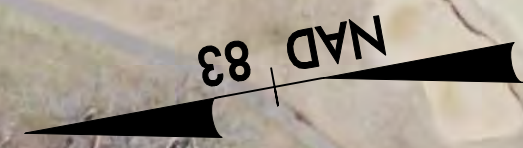
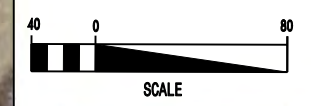
	NORTHING	EASTING
PLOT 1	818835.0609	2137928.3988
PLOT 0	818811.8648	2138368.3469
PLOT 0	819089.7112	2138153.7600

LEGEND

	THALWEG 2008		BARE BENCH/BANK
	BANKFULL 2008		PAST MOWING/MAINTENANCE IN EASEMENT (PRIOR TO SUMMER 2008)
	PHOTO POINT		LIGUSTRUM SINENSE PRESENT
	VEGETATION PLOT		ROSA MULTIFLORA PRESENT
	VEGETATION PLOT NOT MEETING SUCCESS REQUIREMENTS		ROCK CROSS VANE
			J-HOOK VANE
			ROCK VANE
			ROOTWAD



LOCATION:	HORSE CREEK	
	CURRENT CONDITIONS PLAN VIEW	
	FINAL VEGETATION- YEAR 4	
PROJ #:	182	COUNTY: WAKE
MONITORED BY:	IPJ	
CHECKED BY:	PDB	DATE: 3/01/2010



	NORTHING	EASTING
PLOT K	818288.7506	2137755.1859
PLOT L	818029.3080	2137442.3498

LEGEND

	THALWEG 2008		ROCK CROSS VANE		BARE BENCH/BANK
	BANKFULL 2008		J-HOOK VANE		PAST MOWING/MAINTENANCE IN EASEMENT (PRIOR TO SUMMER 2008)
	PHOTO POINT		ROOTWAD		LIGUSTRUM SINENSE PRESENT
	VEGETATION PLOT		ROCK VANE		ROSA MUL TIFLORA PRESENT
	VEGETATION PLOT NOT MEETING SUCCESS REQUIREMENTS				



LOCATION:	HORSE CREEK	
	CURRENT CONDITIONS PLAN VIEW	
	FINAL VEGETATION- YEAR 4	
PROJ #:	182	COUNTY: WAKE
MONITORED BY:	IPJ	
CHECKED BY:	PDB	DATE: 3/01/2010

APPENDIX B

GENERAL PROJECT TABLES

**Table 1. Project Restoration Components
Horse Creek/EEP Project Number 409**

Project Segment or Reach ID	Pre-Existing Footage	Type	Approach	As-Built Footage	As-Built Stationing	Monitoring Year 4 Stationing	Comments
Horse Creek	2,890	R^	PI & PII*	2,899	0+00 – 28+99	10+00 – 39+69	Channel relocation.
UT to Horse Creek	612	R^	PI	548	0+00 – 5+48	10+00 – 15+52	Channel relocation.

* denotes that the Restoration Plan states Priority 1 for the stream, except “at the intersections, the proposed reach will be Priority 2”.

“P” in the Approach column refers to Priority Level.

^ denotes that the Restoration Plan states the stream channel was elevated and reattached to its flood plain.

PI denotes Priority I

PII denotes Priority II

R denotes Restoration

Table 2. Project Activity and Reporting History

Horse Creek Stream Restoration/EEP Project Number 409

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	2002		November 22, 2002
Final Design - 90%	2003		March 27, 2003
Construction	2003		April 1, 2005
Temporary S&E mix applies to entire project area	2003		April 1, 2005
Permanent seed mix applies to reach/segments 1&2	2003		April 1, 2005
Containerized and B&B plantings for reach/segments 1&2	2003		April 1, 2005
Mitigation Plan/ As-built (Year 0 Monitoring - baseline)	2003		
Year 1 monitoring	December 2006	August 2006	August 1, 2006
Year 2 monitoring	December 2007	November 2007	December 21, 2007
Year 3 monitoring	December 2008	November 2008	December 5, 2008
Year 4 monitoring	December 2009	October 2009	November 20, 2009
Year 5 monitoring	December 2010	NA	

*Wake Forest Country Club closed in 2007 (Monitoring Year 2) and, as a result, golf course maintenance was discontinued at that time.

Table 3. Project Contact Table	
Horse Creek (Wake Forest Country Club) /EEP Project Number 71082	
Designer Kenneth Ashe, PE	Dewberry & Davis, Inc 2301 Rexwoods Drive, Suite 200 Raleigh, NC 27607 919-881-9939
Construction Contractor Allen Eudy	Contaminant Control, Inc 438-C Robeson Street Fayetteville, NC 28301 910-484-7000
Planting Contractor Jim Matthews, Ph.D.	HARP 9305-D Monroe Road Charlotte, NC 28270 704-687-4061
Seeding Contractor Andrew Van Vlack	705 Comphrey Court Wake Forest, NC 27587 919-570-6163
Seed Source	Mellow Marsh Farm 1312 Woody Store Road Siler City, NC 27344 919-742-1200
Nursery Stock Suppliers	Mellow Marsh Farm 1312 Woody Store Road Siler City, NC 27344 919-742-1200
2006 (Year 1) Monitoring Performers Kenneth Ashe, PE	Dewberry & Davis, Inc 2301 Rexwoods Drive, Suite 200 Raleigh, NC 27607 919-881-9939
2007-2009 (Year 2 - 4) Monitoring Performers Phillip Todd	SEPI Engineering Group 1025 Wade Avenue Raleigh, NC 27605 919-789-9977
2009 Stream Monitoring POC	Ira Poplar-Jeffers (919) 789-9977
2009 Vegetation Monitoring POC	Phil Beach (919) 789-9977
Wetland Monitoring POC	N/A

Table 4. Project Background Table		
Horse Creek (Wake Forest Country Club) /EEP Project Number 71082		
	Horse Creek	UT to Horse Creek
Project County	Wake	Wake
Drainage Area	7.9 square miles	1.6 square miles
Drainage impervious cover estimate (%)	7.8%	<5%
Stream Order	3 rd	1 st
Physiographic Region	Piedmont	Piedmont
Ecoregion	45f	45f
Rosgen Classification of As-built	C5	E5
Cowardin Classification	N/A	N/A
Dominant soil types	Chewacla	Chewacla
Reference site ID	Little Beaver Dam	UT to Barton Creek
USGS HUC for Project and Reference	03020102	03020102
NCDWQ Sub-basin for Project and Reference	03-04-01	03-04-01
NCDWQ classification for Project and Reference	WS-IV	WS-IV
Any portion of any project segment 303d listed?	No	No
Any portion of any project segment upstream of a 303d listed segment?	No	No
Reasons for 303d listing or stressor	N/a	N/A
% of project easement fenced	0	0
% of project easement demarcated with bollards (if not fenced)	0	0

APPENDIX C

VEGETATION ASSESSMENT DATA

Table 5. Vegetation Plot Mitigation Success Summary Table

Tract	Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean (Stems per Acre)
Wake Forest Country Club	C	No	468
	E	No	
	F	Yes	
	I	No	
	K	Yes	
	L	No	
	O	No	

**APPENDIX C
PHOTOLOG HORSE CREEK (WAKE FOREST COUNTRY CLUB)**

VEGETATION PLOTS



Photo 1: Vegetation Plot C (9-29-2009).



Photo 2: Vegetation Plot E (9-29-2009).



Photo 3: Vegetation Plot F (9-29-2009).



Photo 4: Vegetation Plot I (9-29-2009).



Photo 5: Vegetation Plot K (10-1-2009).



Photo 6: Vegetation Plot L (9-29-2009).



Photo 7: Vegetation Plot O (10-1-2009).

Table 6. Vegetation Metadata

Report Prepared By	PHILIP BEACH
Date Prepared	11/11/2009 11:09
database name	SEPI-2009-B.mdb.mdb
database location	G:\Environmental\EN08.004 - EEP Monitoring 2008-09\CVS-EEP DATABASE\CVS Database - 2009 Version (WFCC a
computer name	W47
file size	64946176

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
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.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
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

PROJECT SUMMARY-----

Project Code	WFGC 08
project Name	WFGC
Description	WFGC CVS MONITORING 2008
River Basin	Neuse
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	7

APPENDIX D

STREAM ASSESSMENT DATA

**APPENDIX D
PHOTOLOG –HORSE CREEK (WAKE FOREST COUNTRY CLUB)**

CROSS-SECTIONS & PHOTOPOINTS



Cross-Section 1: View downstream. Horse Creek (8-19-2009).



Cross-Section 1: View upstream. Horse Creek (8-19-2009).



Cross-Section 2: View Downstream. Horse Creek (8-19-2009).



Cross-Section 2: View upstream. Horse Creek (8-19-2009).



Cross-Section 3: View downstream. Horse Creek (8-24-2009).



Cross-Section 3: View upstream. Horse Creek (8-24-2009).



Cross-Section 4: View downstream. Horse Creek (8-24-2009).



Cross-Section 4: View upstream. Horse Creek (8-24-2009).



Cross-Section 5: View downstream. Horse Creek (11-23-2009).



Cross-Section 5: View upstream. Horse Creek (11-23-2009).



Cross-Section 6: View downstream. Horse Creek (11-23-2009).



Cross-Section 6: View upstream. Horse Creek (11-23-2009).



Cross-Section 7: View downstream. UT Horse Creek (11-23-2009).



Cross-Section 7: View upstream. UT Horse Creek (11-23-2009).



Cross-Section 8: View downstream. UT Horse Creek (11-23-2009).



Cross-Section 8: View upstream. UT Horse Creek (11-23-2009).



Photo-Point 1: View downstream. Horse Creek (8-19-2009).



Photo-Point 1: View upstream. Horse Creek (8-19-2009).



Photo-Point 2: View downstream. Horse Creek (8-19-2009).



Photo-Point 2: View upstream. Horse Creek (8-19-2009).



Photo-Point 3: View downstream Horse Creek (8-19-2009).



Photo-Point 3: View upstream Horse Creek. (8-19-2009).



Photo-Point 4: View downstream. Horse Creek (8-19-2009).



Photo-Point 4: View upstream. Horse Creek (8-19-2009).



Photo-Point 5a: View downstream. UT Horse Creek (8-24-2009).



Photo-Point 5a: View upstream. UT Horse Creek (8-24-2009).



Photo-Point 5b: View downstream. Horse Creek (8-24-2009).



Photo-Point 5b: View upstream. Horse Creek (8-24-2009).



Photo-Point 6: View downstream. Horse Creek (8-24-2009).



Photo-Point 6: View upstream. Horse Creek (8-24-2009).



Photo-Point 7: View downstream. Horse Creek (8-24-2009).



Photo-Point 7: View upstream. Horse Creek (8-24-2009).



Photo-Point 8: View downstream. Horse Creek (11-23-2009).



Photo-Point 8: View upstream. Horse Creek (11-23-2009).



Photo-Point 9: View downstream. UT Horse Creek (11-23-2009).



Photo-Point 9: View upstream. UT Horse Creek (11-23-2009).



Photo-Point 10: View downstream. UT Horse Creek (11-23-2009).



Photo-Point 10: View upstream. UT Horse Creek (11-23-2009).



Photo-Point 11: View downstream. UT Horse Creek (11-23-2009).



Photo-Point 11: View upstream. UT Horse Creek (11-23-2009).



Photo-Point 12: View downstream. UT Horse Creek (11-23-2009).



Photo-Point 12: View upstream. UT Horse Creek (11-23-2009).

Table B2. Visual Morphological Stability Assessment

Horse Creek

Segment/Reach: Mainstem

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	23	31	NA	74%	
	2. Armor stable	19	31	NA	61%	
	3. Facet grade appears stable	20	31	NA	65%	
	4. Minimal evidence of embedding/fining	19	31	NA	61%	
	5. Length appropriate	20	31	NA	65%	65%
B. Pools	1. Present	26	30	NA	87%	
	2. Sufficiently deep	26	30	NA	87%	
	3. Length appropriate	15	30	NA	50%	74%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	9	9	NA	100%	
	2. Downstream of meander (glide/inflection) centering	9	9	NA	100%	100%
D. Meanders	1. Outer bend in state of limited/controlled erosion	10	18	NA	56%	
	2. Of those eroding, # w/concomitant point bar formation	5	8	NA	63%	
	3. Apparent Rc within specifications	11	18	NA	61%	
	4. Sufficient floodplain access and relief	18	18	NA	100%	70%
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	2/104.5	96%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting	NA	NA	0/0	100%	98%
F. Bank Condition	1. Actively eroding, wasting, or slumping bank	NA	NA	22/534.5	91%	91%
G. Vanes / J Hooks etc.	1. Free of back or arm scour	21	24	NA	88%	
	2. Height appropriate	24	24	NA	100%	
	3. Angle and geometry appear appropriate	24	24	NA	100%	
	4. Free of piping or other structural failures	20	24	NA	83%	93%
H. Wads and Boulders	1. Free of scour	NA	NA	NA	NA	
	2. Footing stable	NA	NA	NA	NA	NA

Table B2. Visual Morphological Stability Assessment

Horse Creek

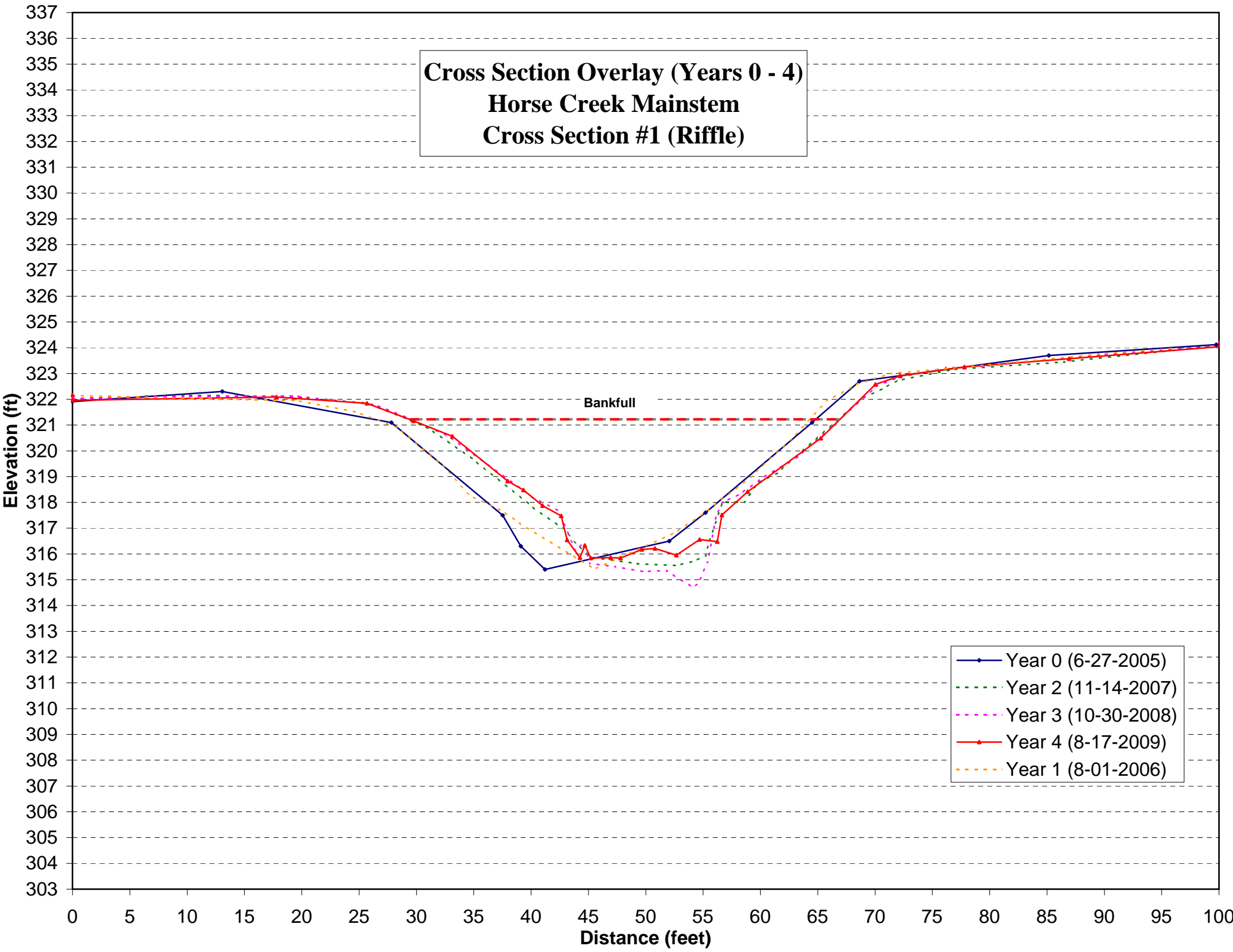
Segment/Reach: Unnamed Tributary

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	12	12	NA	100%	
	2. Armor stable	9	12	NA	75%	
	3. Facet grade appears stable	11	12	NA	92%	
	4. Minimal evidence of embedding/fining	10	12	NA	83%	
	5. Length appropriate	4	12	NA	33%	77%
B. Pools	1. Present	10	12	NA	83%	
	2. Sufficiently deep	10	12	NA	83%	
	3. Length appropriate	6	12	NA	50%	72%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	5	5	NA	100%	
	2. Downstream of meander (glide/inflection) centering	5	5	NA	100%	100%
D. Meanders	1. Outer bend in state of limited/controlled erosion	9	9	NA	100%	
	2. Of those eroding, # w/concomitant point bar formation	0	0	NA	100%	
	3. Apparent Rc within specifications	5	9	NA	56%	
	4. Sufficient floodplain access and relief	9	9	NA	100%	89%
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	2/39	96%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting	NA	NA	1/14.7	97%	97%
F. Bank Condition	1. Actively eroding, wasting, or slumping bank	NA	NA	0/0	100%	100%
G. Vanes / J Hooks etc.	1. Free of back or arm scour	3	3	NA	100%	
	2. Height appropriate	2	3	NA	67%	
	3. Angle and geometry appear appropriate	3	3	NA	100%	
	4. Free of piping or other structural failures	0	3	NA	0%	67%
H. Wads and Boulders	1. Free of scour	NA	NA	NA	NA	
	2. Footing stable	NA	NA	NA	NA	NA

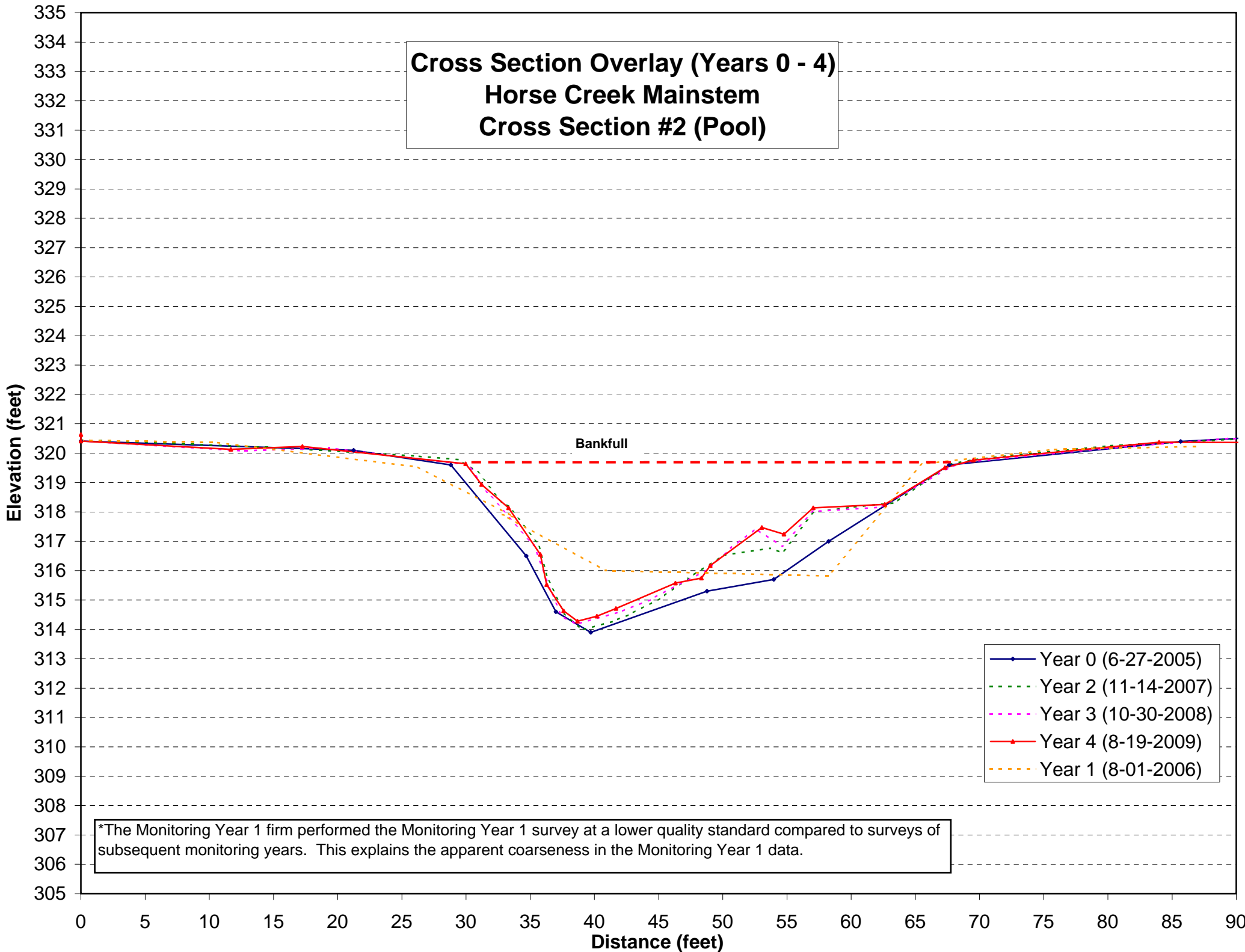
Table V. Verification of Bankfull Events - Horse Creek

Date of Data Collection	Date of Occurrence	Method	Photo # (if available)
7/31/2006	6/14/2006	Large amount of fresh sediment observed on floodplain. Event observed by golf course personnel.	None
6/3/2007	6/3/2007	Result of approximate 1.5" rainfall event. Wrack lines observed.	None
6/30/2008	7/1/2008	According to NCDC Station Coop ID 312993 - FALLS LAKE, NC , 2.08 inches of precipitation fell over this 24 hour period. It was assumed, but not verified, that this rainfall produced a bankfull event.	None
9/6/2008	9/7/2008	According to NCDC Station Coop ID 312993 - FALLS LAKE, NC , 4.37 inches of precipitation fell over this 24 hour period. It was assumed, but not verified, that this rainfall produced a bankfull event.	None
2/16/2009	Unknown; but probably between the dates of January 20 and January 21, 2009.	Crest gauge reading of 40" on stick. Base of crest gauge (measuring stick) located at bankfull elevation. Date of bankfull flow unknown, but a 4+ inch precipitation event occurred between January 20 and January 21, 2009. Presumably, this event caused the over-bank flow.	None

Cross Section Overlay (Years 0 - 4)
Horse Creek Mainstem
Cross Section #1 (Riffle)

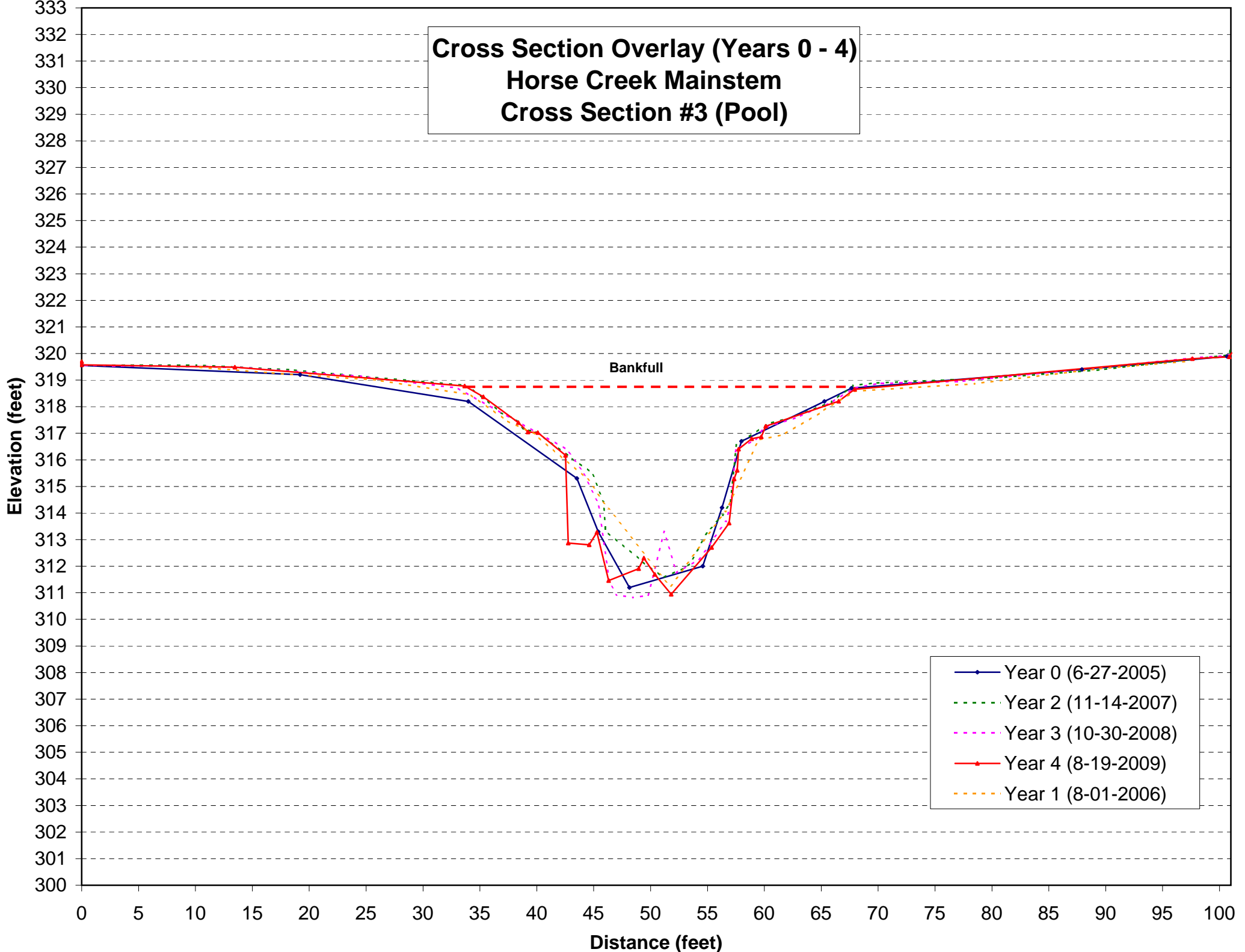


Cross Section Overlay (Years 0 - 4)
Horse Creek Mainstem
Cross Section #2 (Pool)

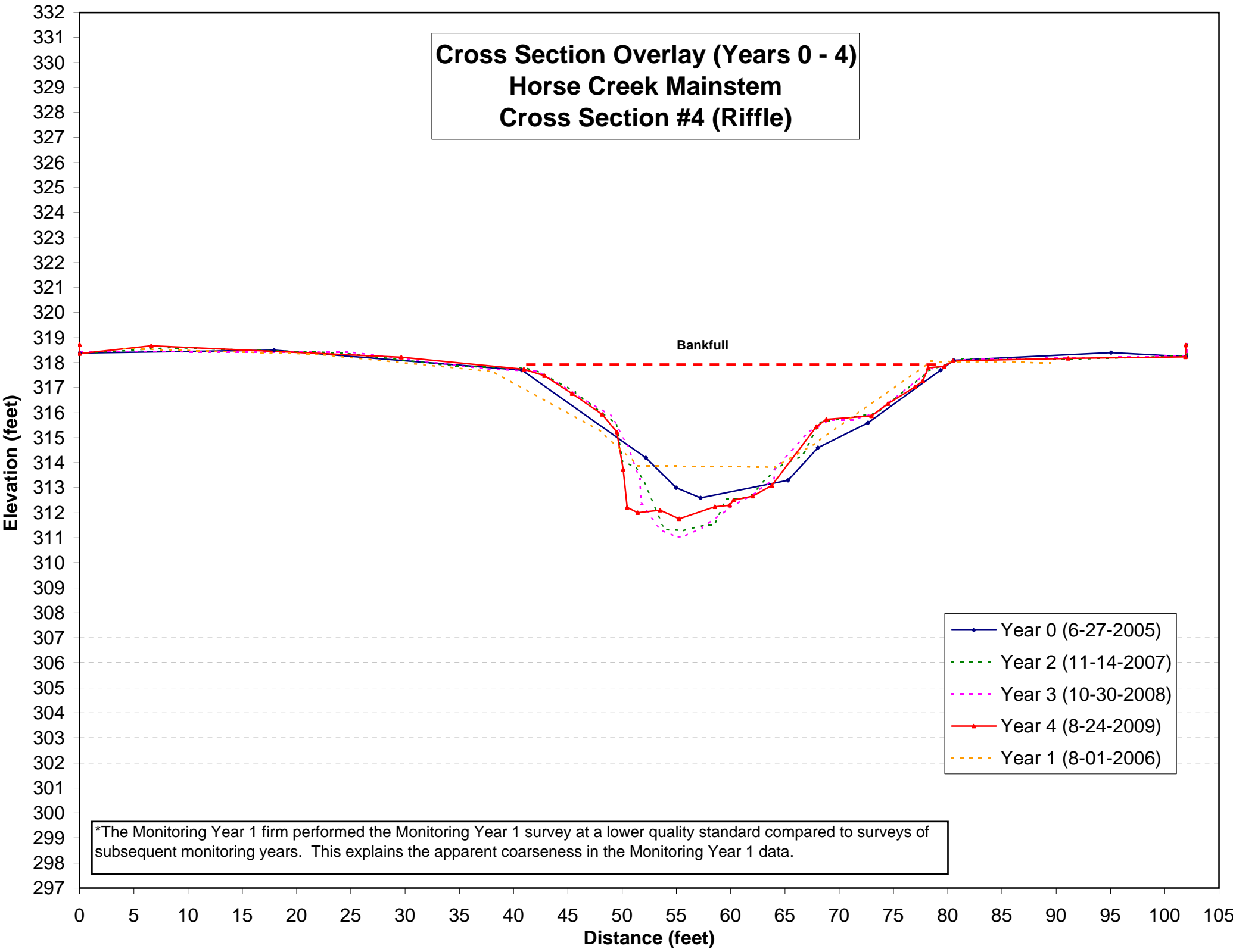


*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.

Cross Section Overlay (Years 0 - 4)
Horse Creek Mainstem
Cross Section #3 (Pool)

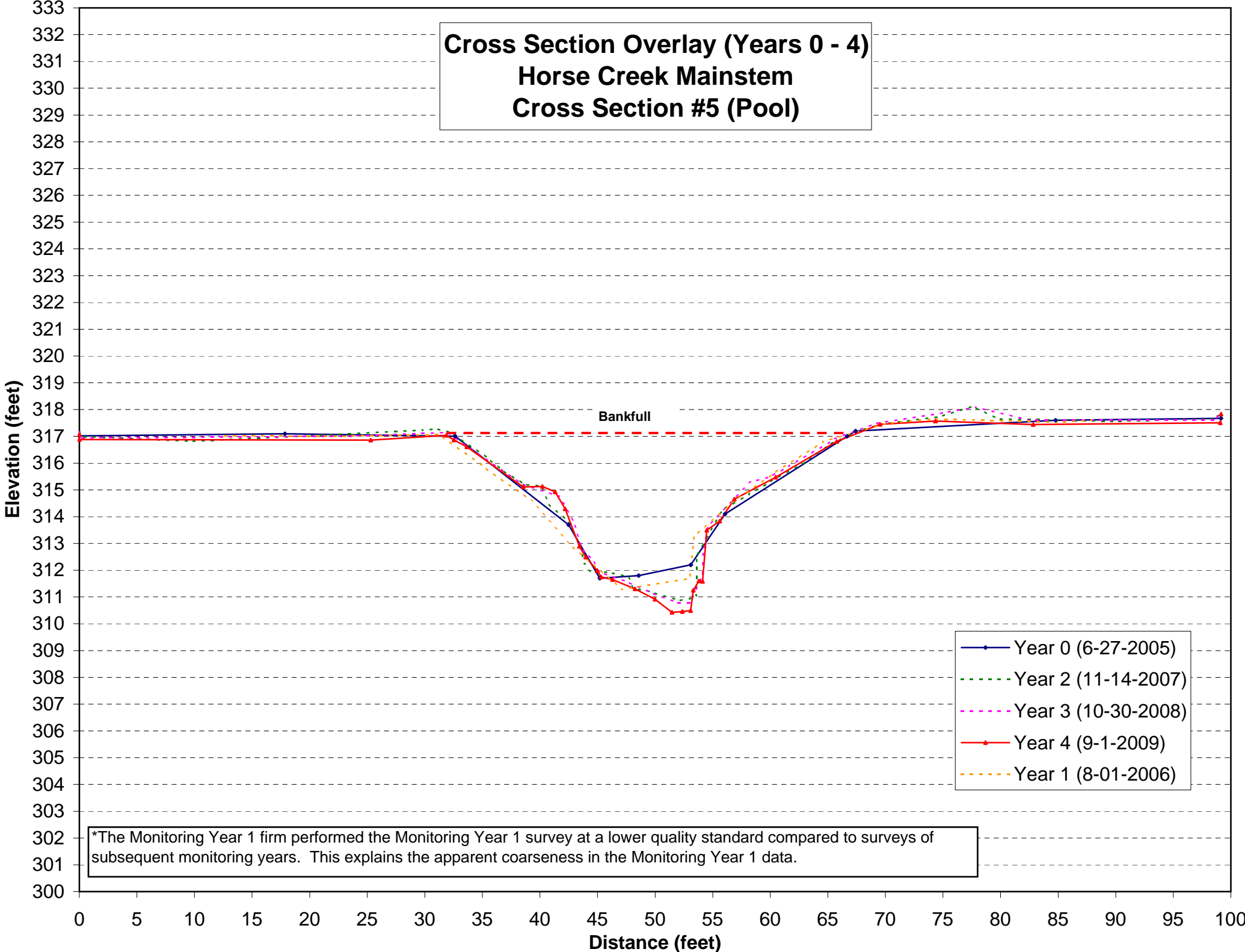


**Cross Section Overlay (Years 0 - 4)
Horse Creek Mainstem
Cross Section #4 (Riffle)**



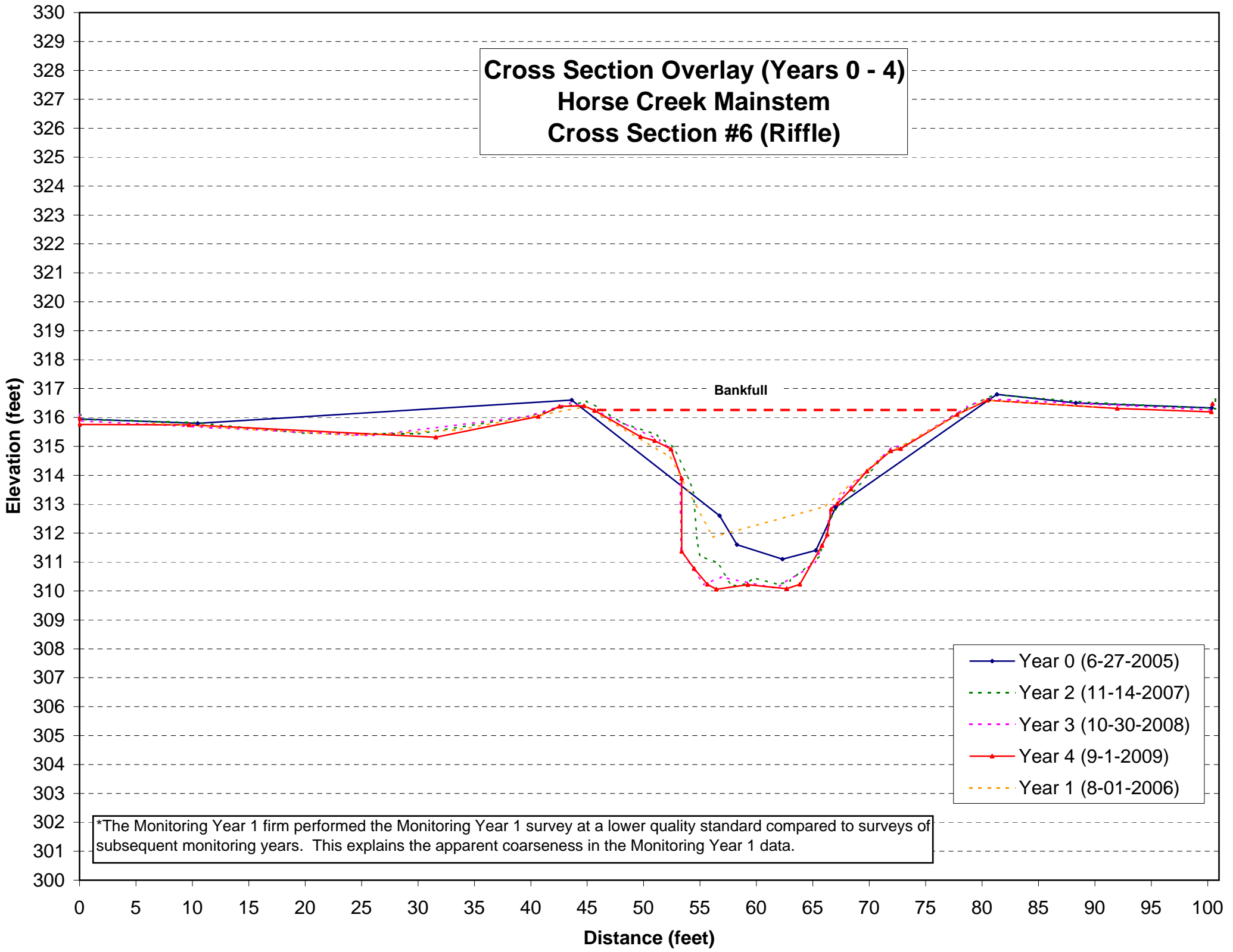
*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.

Cross Section Overlay (Years 0 - 4)
Horse Creek Mainstem
Cross Section #5 (Pool)

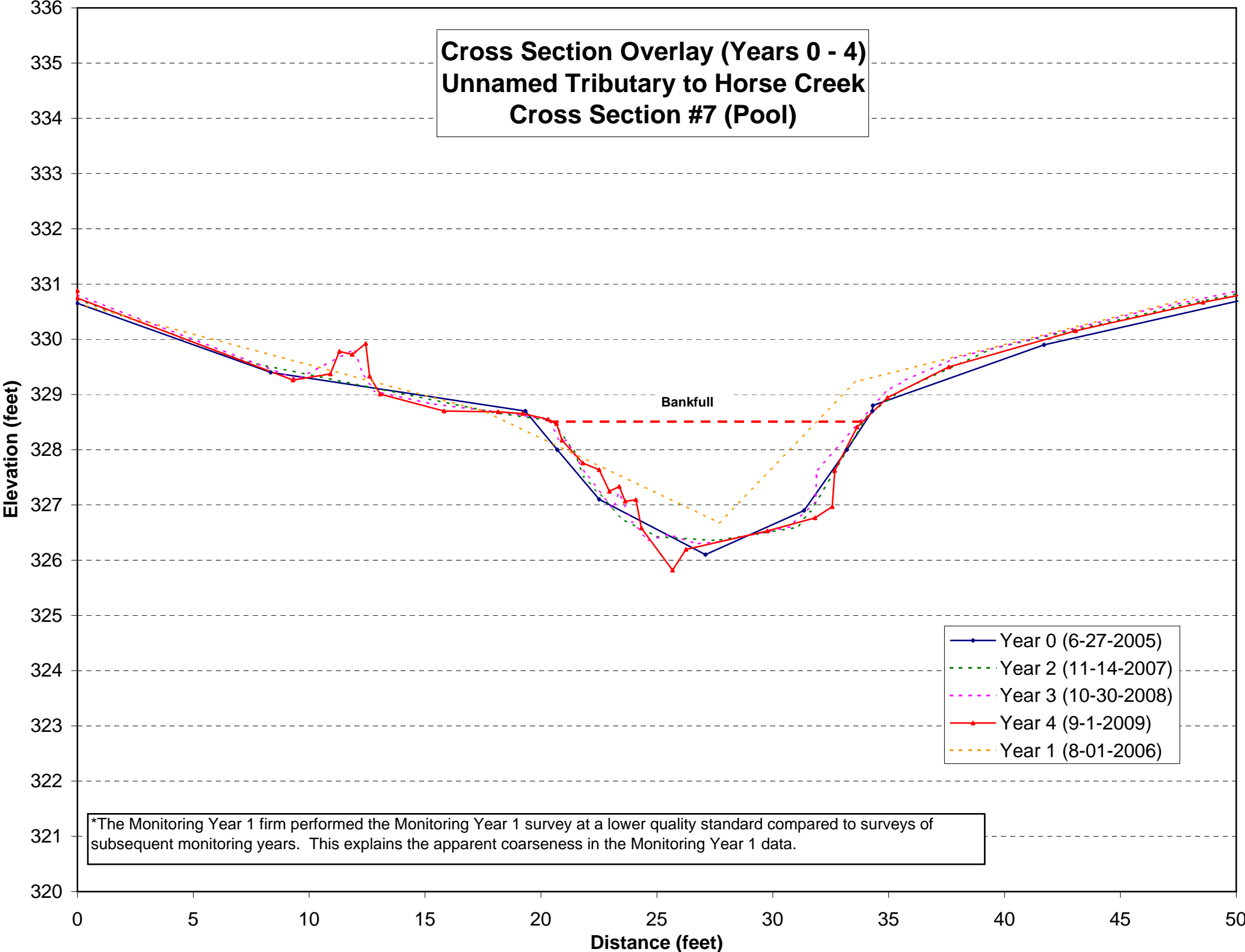


*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.

Cross Section Overlay (Years 0 - 4)
Horse Creek Mainstem
Cross Section #6 (Riffle)

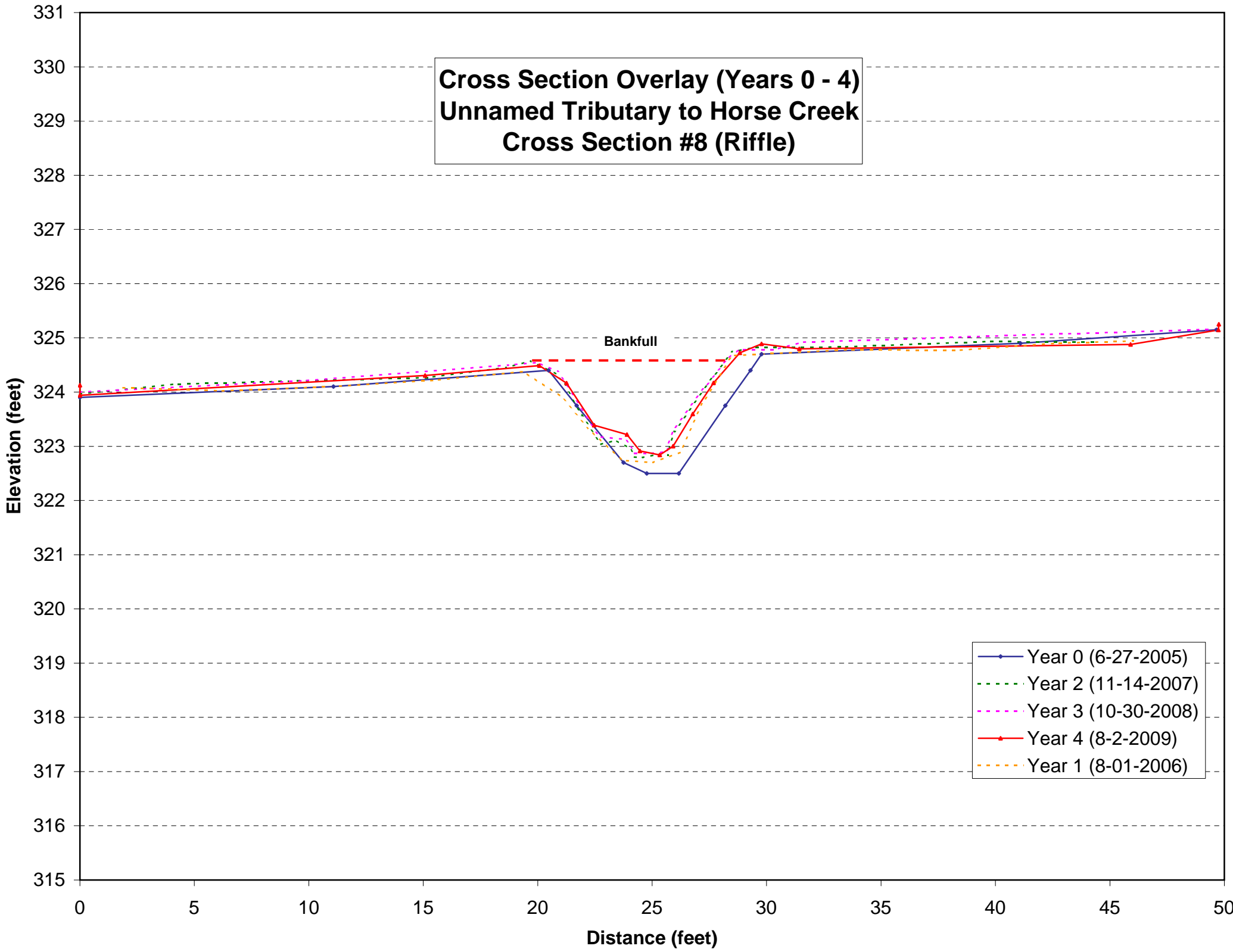


**Cross Section Overlay (Years 0 - 4)
Unnamed Tributary to Horse Creek
Cross Section #7 (Pool)**



*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.

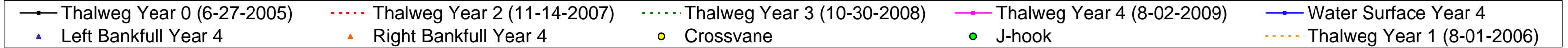
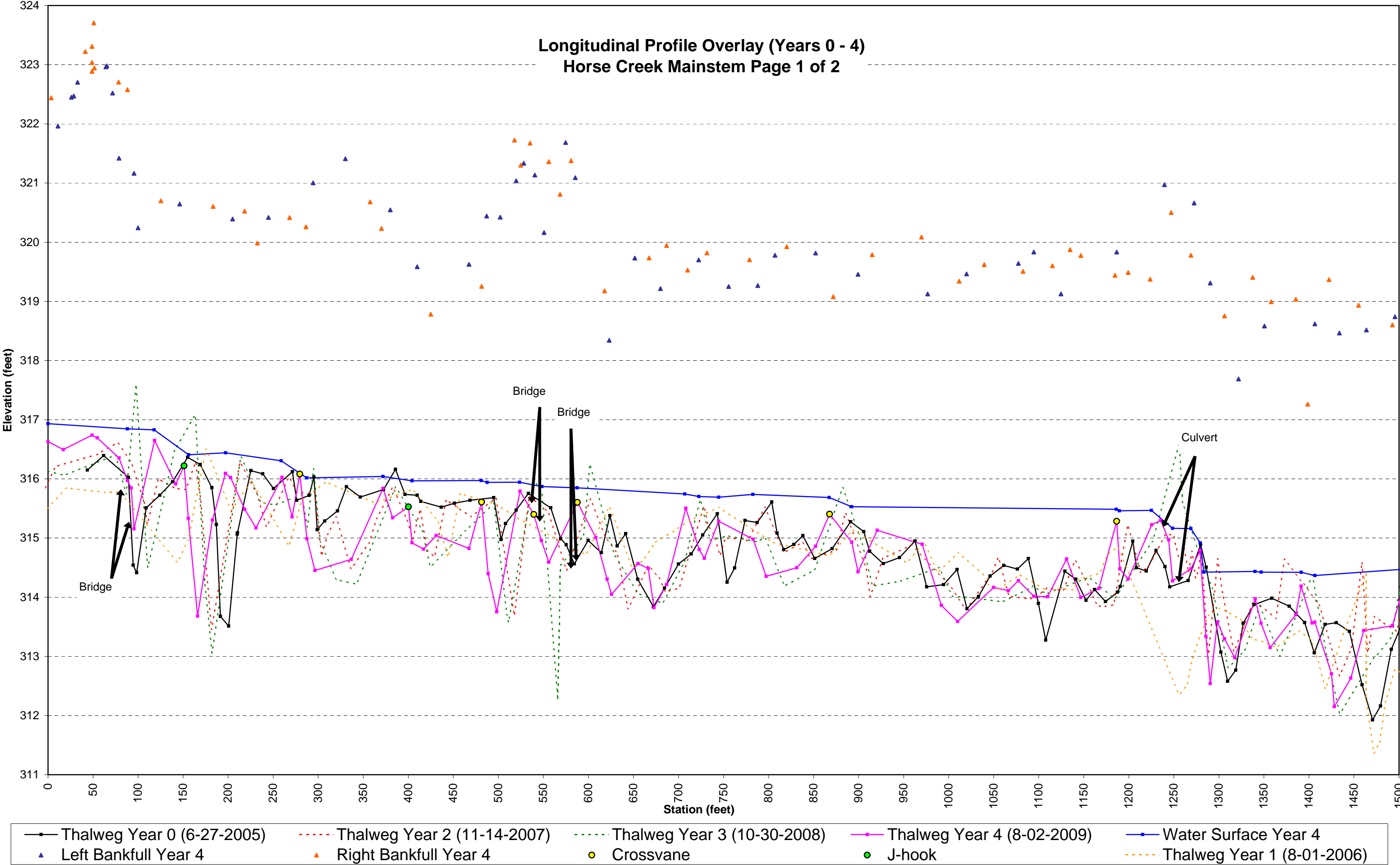
**Cross Section Overlay (Years 0 - 4)
Unnamed Tributary to Horse Creek
Cross Section #8 (Riffle)**



Bankfull

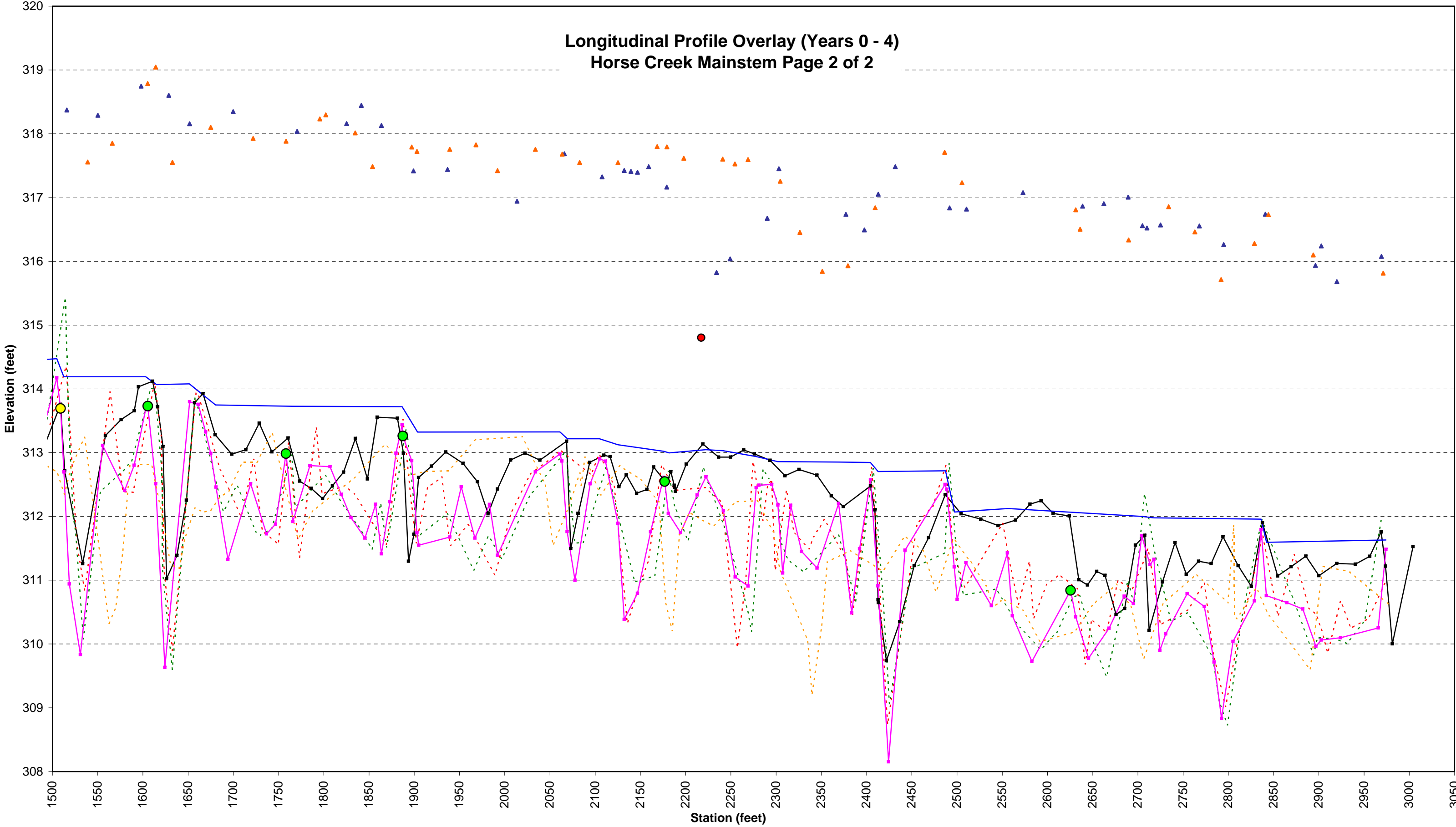
- Year 0 (6-27-2005)
- Year 2 (11-14-2007)
- Year 3 (10-30-2008)
- Year 4 (8-2-2009)
- Year 1 (8-01-2006)

Longitudinal Profile Overlay (Years 0 - 4) Horse Creek Mainstem Page 1 of 2



*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This

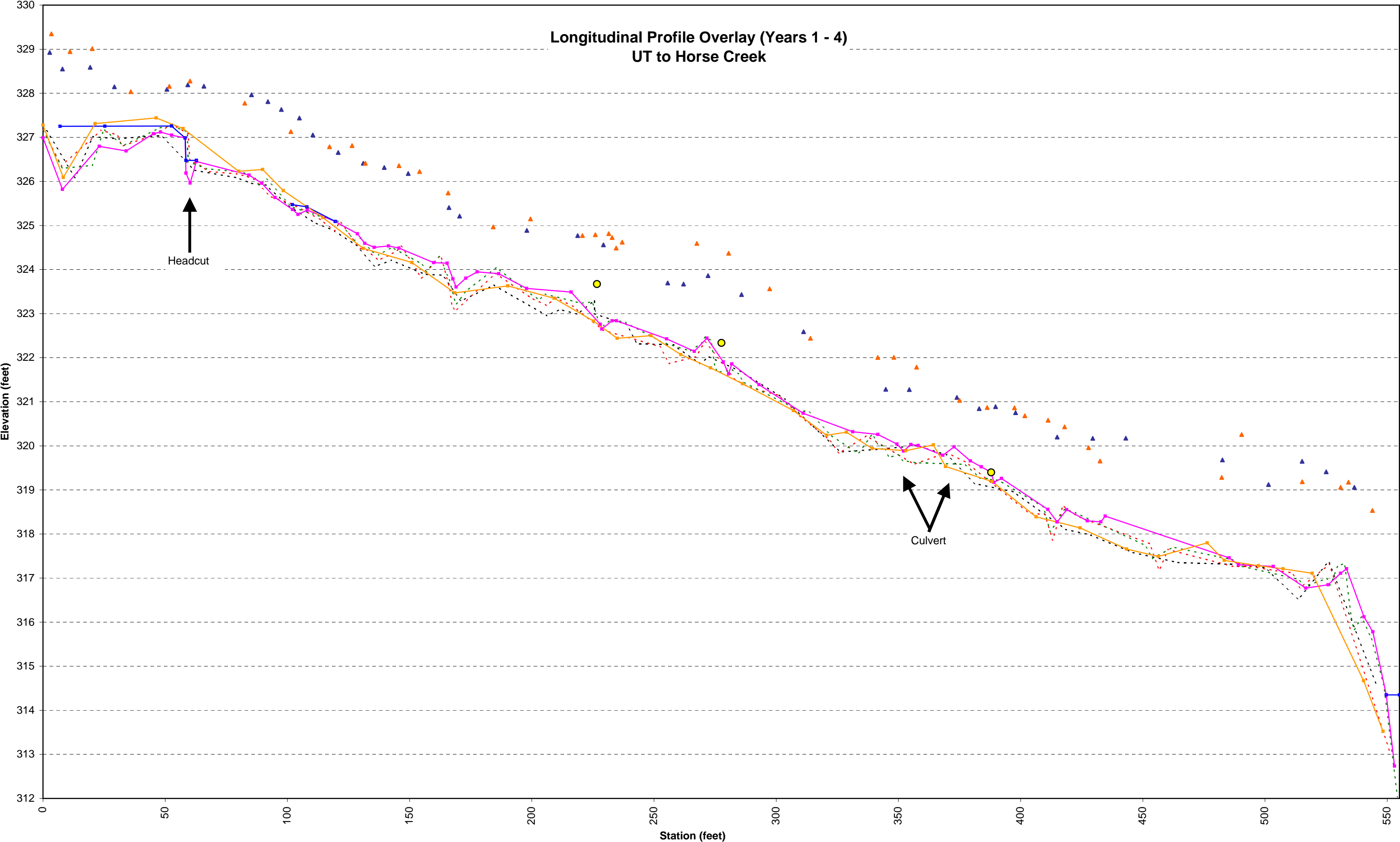
Longitudinal Profile Overlay (Years 0 - 4)
Horse Creek Mainstem Page 2 of 2



- | | | | |
|--------------------------------|---------------------------------------|---------------------------------------|--------------------------------|
| —●— Thalweg Year 0 (6-27-2005) | - - - - - Thalweg Year 2 (11-14-2007) | - · - · - Thalweg Year 3 (10-30-2008) | —■— Thalweg Year 4 (8-02-2009) |
| — Water Surface Year 4 | ▲ Left Bankfull Year 4 | ▲ Right Bankfull Year 4 | ● Crossvane |
| ● J-hook | ● Crest Gauge | - · - · - Thalweg Year 1 (8-01-2006) | |

*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This

Longitudinal Profile Overlay (Years 1 - 4) UT to Horse Creek



- Thalweg Year 1 (8-01-2006)
- Thalweg Year 2 (11-14-2007)
- Thalweg Year 3 (10-30-2008)
- Thalweg Year 4 (8-02-2009)
- Thalweg As-Built (8-31-2006)
- Water Surface Year 4
- ▲ Left Bankfull Year 4
- ▲ Right Bankfull Year 4
- Crossvane

Pebble counts were not performed for Horse Creek or UT to Horse Creek during Monitoring Year 4 because they are sandbed streams and the counts would not successfully detect changes in the amounts of fine sediments in the channel bed.