Snow Creek Stream Restoration
2009 Final Monitoring Report
Monitoring Year Five

Ecosystem Enhancement Program Project Number 00344

Submitted to:

NCDENR-Ecosystem Enhancement Program
1652 Mail Service Center
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Submitted: April 23, 2010

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2009 Final Monitoring Report
Monitoring Year Five

Ecosystem Enhancement Program Project Number 00344

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April 23, 2010

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1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

The overarching goal of the project was to re-establish a stable channel dimension, pattern, and profile. Per EcoLogic's Stream Restoration Design Report (EcoLogic 2002), specific project objectives of the Snow Creek Stream Restoration were to:

- Improve water quality by reducing the sediment load generated by eroding banks and by restoring a riparian buffer;
- Restore a functioning floodplain;
- Enhance aquatic and terrestrial habitat in the stream corridor;
- Provide a stable ford across the main channel for tractor access;
- Provide two pedestrian bridges across the main channel for access to the temple property and agricultural fields; and
- Enhance habitat in the main channel and tributary for small-anthered bittercress (*Cardamine micranthera*), a federally endangered plant that occurs in the Snow Creek channel.

Vegetation survival at the site is excellent. Planted live-stakes, namely silky dogwood (*Cornus amomum*), are thriving and reproducing along the project buffer. In general, vegetative problem areas are improving. Beaver presence has been noted at the site for the last several years. During 2009 (MY5) monitoring several areas affected by recent beaver activity were observed. However, no beaver dams were present and the damaged areas were not void of woody vegetation. Beaver do not appear to be causing detrimental damage at this time. Vegetation along Snow Creek continues to recover from the storm events experienced by the site in 2007 (MY3), and volunteer species are populating previously bare areas. Evidence of recent storm events (sedimentation in the channel and on the banks and wrack lines) was observed during 2009 (MY5). Japanese stilt grass (*Microstegium vimineum*) continues to spread along the project buffer but remains concentrated at the constructed stream crossing. While the current infestation is not severe, Japanese stilt grass is known to be an aggressive plant and prolific seed producer and could expand rapidly throughout the project site. As with other invasive species, eradication is far less expensive and more successful if conducted at early stages, before the plant is allowed to take over a large area. Ten of the 12 inventoried monitoring plots are meeting the success criteria of 260 stems per acre, or at least seven stems per plot. Plot 15 has 6 planted stems remaining; however, volunteer stems were also present in the plot. With the inclusion of volunteer stems, the plot is meeting the success criteria. Plot 10 was found extremely disturbed during 2009 (MY5). No planted stems were located. It appeared the plot area had been destroyed by machinery of some type. Streambanks and floodplain areas around Plot 10 were stable and will likely populate the disturbed area.

Overall, the Snow Creek Stream Restoration Project is in very good condition. Several of the cross vanes continue to show signs that boulder(s) have slipped; however, most continue to hold grade and are filling behind the vane arms. In general, this project has a notable lack of bank erosion, attributable to extremely low bank angles and well established streamside vegetation. Pool development is excellent throughout the project reach. Up until the 2007 monitoring event, the problem areas listed in the initial monitoring reports, 2004 (As-built/MY1) were improving. During 2007 (MY3) monitoring, it was noted that the large storm events that occurred in January and March of 2007 coupled with the large beaver population had caused damage to the site. The rain event(s) caused bank erosion, mid channel bars, and some structure failure. The site appears to have stabilized significantly since 2007 (MY3), and many of the problem areas have been removed. Mid channel bars are transitioning to point bars, American sycamore (*Platanus occidentalis*) are vegetating the bars, and the previously unstable banks are now vegetated. Evidence of other (smaller) storm events have been noted in subsequent years, 2008 (MY4) and 2009 (MY5). Adjacent landowners have confirmed that sediment pulses regularly move through the channel. The channel seems to be narrowing and has used the sand deposition from the 2007 storm(s), 2008

storms, and most recently, the 2009 storms to aid in the process (*e.g.*, Snow Creek's cross section 1 has reduced bankfull width from 68 ft to 54 ft). No crest gages are installed at this site to document bankfull events. Therefore, potential occurrence was extrapolated based on USGS stream gage discharge data for the Little Yadkin River at Dalton, NC (USGS 2009) and on-site evidence such as sediment on the banks and floodplains and the height of recent wrack lines. The gage is located about 25 miles from the project site and has a drainage area of 43 square miles. An estimate of the number of bankfull events in 2009 was made by comparing the stream discharges from the USGS data in cubic feet per second (cfs) against the bankfull discharge estimated from the drainage area on the Rural Piedmont Regional Curve. According to the regional curve, a bankfull event occurs on a stream with a 43-square mile drainage area when the discharge is about 1,300 cfs. This discharge was exceeded in December of 2008 and January, June, July, and most recently in early November 2009, indicating that the Little Yadkin River has had five bankfull events since the previous year monitoring event (as of December 2, 2009). Snow Creek is in proximity to the Little Yadkin River and it is likely that the project site also experienced five bankfull events during the past monitoring year.

Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to the 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 the Ecosystem Enhancement Program's (EEP) website. All raw data supporting the tables and figures in the appendices is available from EEP upon request.

2.0 METHODOLOGY SECTION

All monitoring methodologies follow the 2006 templates and guidelines provided by EEP (EEP 2006). Photographs were taken at high resolution using a Sealife EcoShot 6.0 megapixel digital camera. GPS location information was collected in 2006 (MY2) using a Trimble Geo XT handheld mapping grade GPS unit. GPS locations were collected on both banks of each cross section and on all four corners of each vegetation plot. Stream and vegetation problem areas were noted in the field on As-Built Plan Sheets (EcoLogic Associates 2005). Permanent photo station photographs were taken from locations marked in the 2005 (As-built/MY1) Monitoring Report, prepared by EcoLogic Associates (2006).

2.1 STREAM METHODOLOGY

The methods used to generate the data in this report are standard fluvial geomorphology techniques as described in *Applied River Morphology* (Rosgen 1996) and related publications from US Forest Service and the interagency Stream Mitigation Guidelines (USACE 2003). URS' field morphology survey was conducted using a Nikon Total Station and the data were analyzed and displayed using the Reference Reach Spreadsheet, Version 4.1T (Mecklenburg 2006). Pebble counts were conducted by sampling a total of 100 pebbles from the feature of the cross section (the entire riffle or pool). According to the most recent guidance issued in Rosgen courses, the pebble count was concentrated within the wetted perimeter of the channel and did not include the banks. Photographs were taken at each cross section. A photo was taken from the left bank towards the right bank, and from the right bank towards the left bank.

2.2 VEGETATION METHODOLOGY

Twenty-three vegetation plots were established by EcoLogic in 2005. The plots are 10-meter by 10-meter in size. These 23 plots were evaluated in 2005 (As-built/MY1). According to the new CVS-EEP Protocol for Recording Vegetation (Lee *et al.* 2006), the Snow Creek Stream Restoration Project requires monitoring of 12 vegetation plots. The new CVS-EEP Protocol (http://cvs.bio.unc.edu/methods.htm) for Recording Vegetation was used to inventory 12 (3, 5, 7, 8, 10, 11, 13, 15, 16, 17, 18, and 21) of the 23 vegetation plots previously established by EcoLogic. Ecologic used rebar to mark all four corners of the

vegetation plots and the upstream, outside corner was marked with a 4-foot PVC pipe flagged with orange. The remaining three corners were marked with blue flagging. Planted stems were marked with white flagging. A reference photograph was taken from the outside, upstream corner of each plot. The new protocol was used to inventory the plots for the 2006 (MY2) stem counts. All planted stems were marked with white flagging. If flagging from the previous year was present, the old flagging was not removed. New flags were hung adjacent to old flags. Natural regeneration stems were recorded but not flagged. Reference photographs and GPS coordinates were taken at the southwest corner, facing the northeast corner, for each plot. Due to the large quantity of livestakes present in the vegetation plots, a sampling method was devised for planted stem counts based on the sub-sample methodology described in the CVS-EEP Protocol. The sub-sample method was only used for silky dogwood and black willow (*Salix nigra*). Over 200 stems of these species were observed in several vegetation plots (URS 2007). Monitoring taxonomy follows 'Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas' (Weakley 2007). Sand deposition at Snow Creek was first noted during the March 2007 initial site assessment. URS reported that:

> "As a result of the sand deposition, it will be extremely difficult to measure the diameter at decimeter height of the planted stems and/or accurately count the number of stems. The majority of the vegetation plots are buried in more than two feet of sand, leaving many live stakes and the majority of the small volunteer species that were counted in 2006 (MY2) inaccessible. In addition, many of the flags hung during 2006 (MY2) to identify counted, planted stems are also buried, making it difficult to discern between planted and volunteer stems. The methodologies used to inventory vegetation plots during 2007 (MY3) will need to be altered from the current protocol in order to conduct sampling. Since diameter at decimeter height measurements will not be possible for many stems, and the true height of the stem may not be measurable, it may be preferable to simply count and identify stems in each plot."

URS met with EEP staff onsite in June of 2007 to discuss how to monitor vegetation at Snow Creek during subsequent monitoring. It was decided that due to the amount of deposition and the number of livestakes present onsite, 2007 (MY3) vegetation monitoring would consist of a presence/absence (stem count) assessment and that ddh (diameter at decimeter height) and dbh (diameter at breast height) measurements would not be taken. Planted stems were not re-flagged during 2007 (MY3) monitoring. Since much of the sand deposited during the 2006-2007 storm event(s) remained, the same basic methodologies used for vegetation sampling in 2007 (MY3) were used in 2008 (MY4). During 2008 (MY4) monitoring URS recorded approximate height and dbh for planted stems listed on data sheets during 2007 (MY3) and reflagged planted stems. During 2009 (MY5), URS recorded approximate height and measured dbh for planted stems. Planted stems were reflagged.

3.0 REFERENCES

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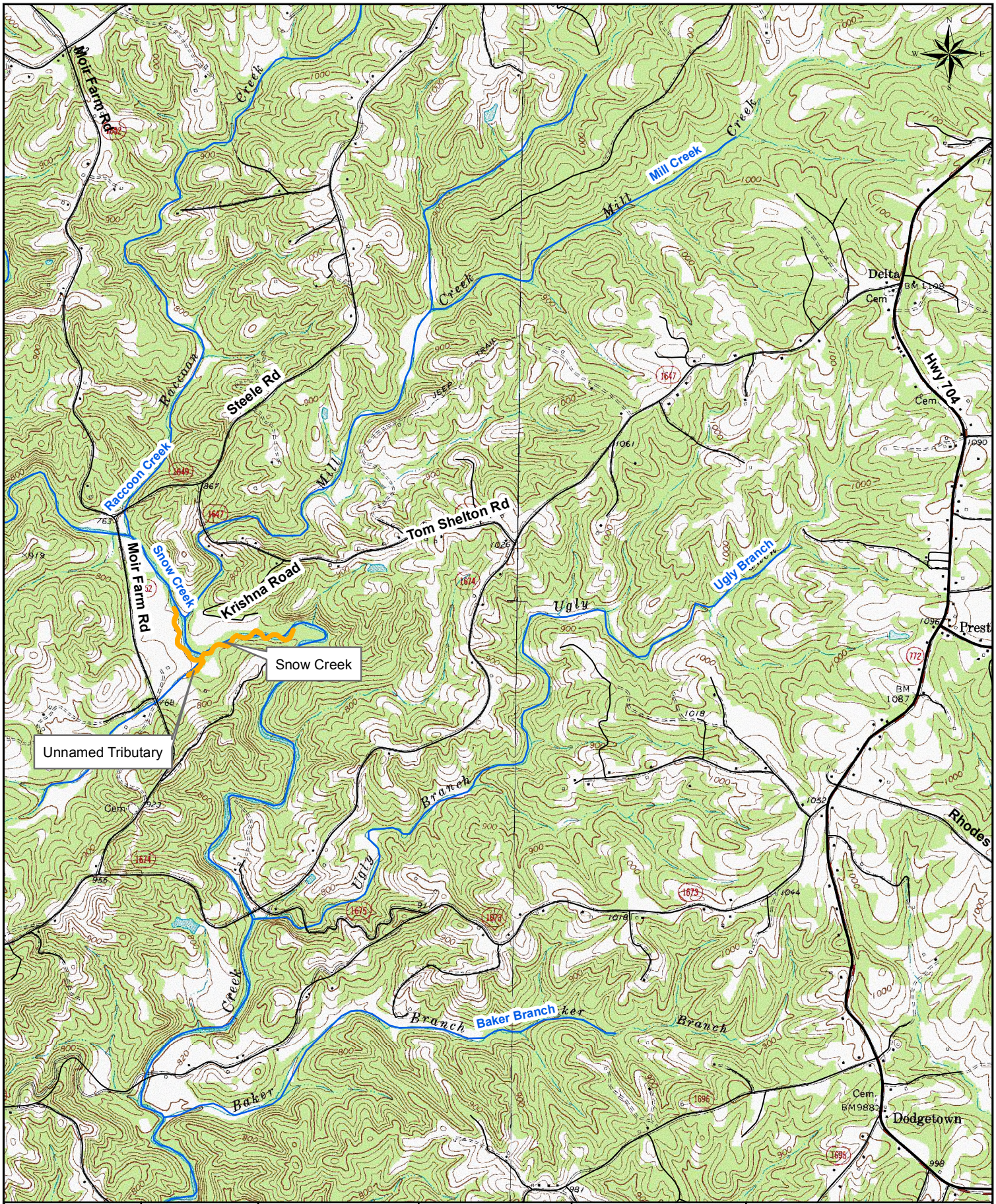
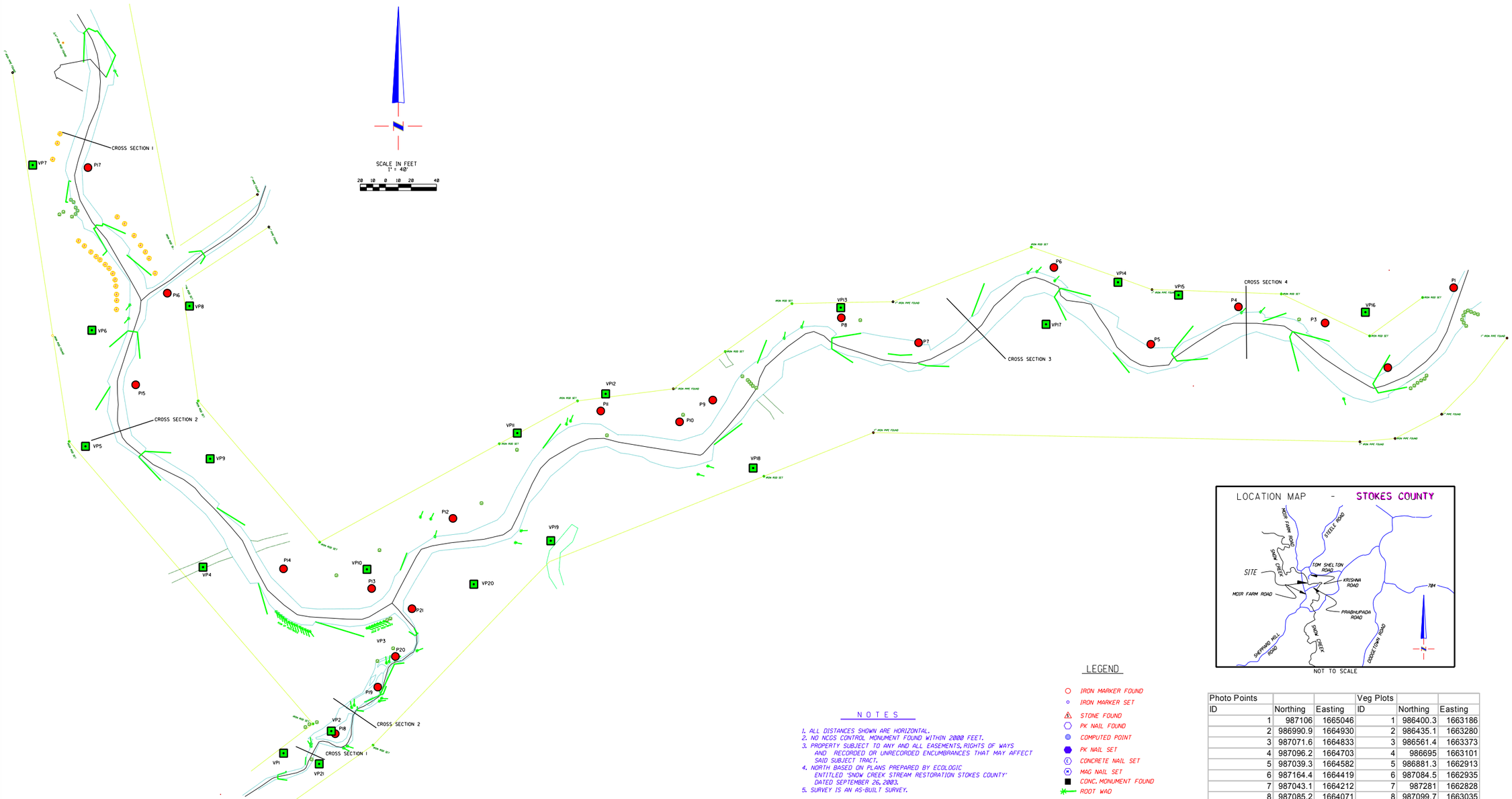
Project Condition and Monitoring Data Appendices

Appendix A: General Figures and Plan Views



Prepared By: URS Corporation - North Carolina 1600 Perimeter Park Drive Suite 400 Morrisville, NC 27560 Phone: 919-461-1100 Fax: 919-461-1415 URS	**Prepared For:** NC Ecosystem Enhancement Program Ecosystem Enhancement Program	**Project:** Snow Creek Stream Restoration Stokes County, NC	**Monitoring Year:** 5(2009)	**Legend** Project Reach	Figure 1 Vicinity Map 0 0.25 0.5 Miles
		Project Number: 00344	**Date:** December 2009		



NOTES

1. ALL DISTANCES SHOWN ARE HORIZONTAL.
2. NO NCGS CONTROL MONUMENT FOUND WITHIN 2000 FEET.
3. PROPERTY SUBJECT TO ANY AND ALL EASEMENTS, RIGHTS OF WAYS AND RECORDED OR UNRECORDED ENCUMBRANCES THAT MAY AFFECT SAID SUBJECT TRACT.
4. NORTH BASED ON PLANS PREPARED BY ECOLOGIC ENTITLED 'SNOW CREEK STREAM RESTORATION STOKES COUNTY' DATED SEPTEMBER 26, 2003.
5. SURVEY IS AN AS-BUILT SURVEY.

LEGEND

- IRON MARKER FOUND
- IRON MARKER SET
- STONE FOUND
- PK NAIL FOUND
- COMPUTED POINT
- PK NAIL SET
- CONCRETE NAIL SET
- MAG NAIL SET
- CONC. MONUMENT FOUND
- ROOT WAD
- CROSS VANE
- VANE
- ROCK OR STONE
- ROW OF STONES
- ROCK VANE
- CONTOUR LINE
- VEGETATION PLOTS
- PHOTO POINTS
- THALWEG (2/05)
- TOP OF BANK (2/05)

Photo Points			Veg Plots		
ID	Northing	Easting	ID	Northing	Easting
1	987106	1665046	1	986400.3	1663186
2	986990.9	1664930	2	986435.1	1663280
3	987071.6	1664833	3	986561.4	1663373
4	987096.2	1664703	4	986695	1663101
5	987039.3	1664582	5	986881.3	1662913
6	987164.4	1664419	6	987084.5	1662935
7	987043.1	1664212	7	987281	1662828
8	987085.2	1664071	8	987099.7	1663035
9	986935.1	1663889	9	986861.7	1663116
10	986889.5	1663835	10	986674.2	1663331
11	986925	1663712	11	986908.3	1663590
12	986756.8	1663472	12	986950.4	1663730
13	986642.6	1663354	13	987104.2	1664071
14	986665.7	1663210	14	987135.6	1664514
15	986982.5	1662972	15	987109.8	1664612
16	987115.6	1663015	16	987063.2	1664886
17	987291.1	1662893	17	987074.4	1664386
18	986431.9	1663286	18	986851.6	1663921
19	986490.8	1663356	19	986747.7	1663620
20	986553.4	1663394	20	986688.8	1663528
21	986623.6	1663401	21	986382.9	1663269

40 20 0 40 80
1" = 80'

I, KEITH P. GARRISON, CERTIFY THAT THIS PLAT WAS DRAWN BY ME FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION (SEE REFERENCES ON PLAT); THAT THE BOUNDARIES NOT SURVEYED ARE CLEARLY INDICATED AS DRAWN FROM INFORMATION FOUND IN DEED REFERENCES SHOWN; THAT THE RATIO OF PRECISION AS CALCULATED IS 1:10,000; THAT THIS PLAT WAS PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED; THAT THIS SURVEY IS OF AN EXISTING BUILDING OR OTHER STRUCTURE, OR NATURAL FEATURE, SUCH AS A WATERCOURSE.

WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER AND SEAL THIS

DAY OF A.D., 20

KEITH P. GARRISON
NORTH CAROLINA PROFESSIONAL LAND SURVEYOR *L-4434

This document originally issued and sealed by KEITH P. GARRISON, PLS NC Registration No. L-4434 ON MARCH 30, 2005
This media should not be considered a certified document.

REVISIONS

NO.	DATE

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PROJECT: SNOW CREEK STREAM RESTORATION 2009 MONITORING REPORT

TITLE: MONITORING PLAN VIEW

CLIENT: NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Ecosystem Enhancement Program

DATE: APRIL 2010

TECHNICIAN: EHJ

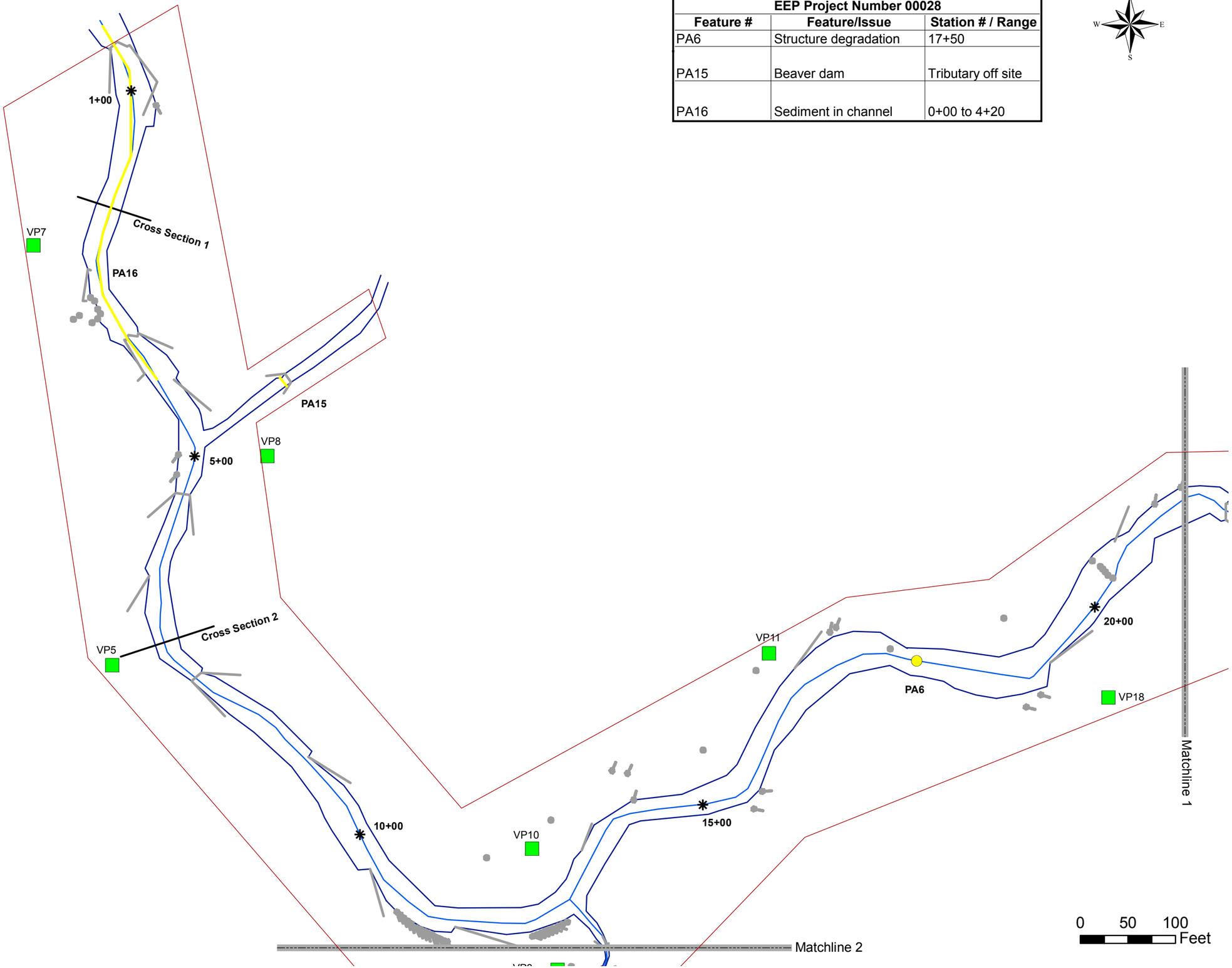
CHECKED BY: KM

MONITORING YEAR 5

EEP PROJECT NO. 00344

SHEET NO.

Snow Creek		
EEP Project Number 00028		
Feature #	**Feature/Issue**	**Station # / Range**
PA6	Structure degradation	17+50
PA15	Beaver dam	Tributary off site
PA16	Sediment in channel	0+00 to 4+20



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Prepared For:
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Enhancement Program

Project:
Snow Creek
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Stokes County, NC

Monitoring Year:
5 (2009)

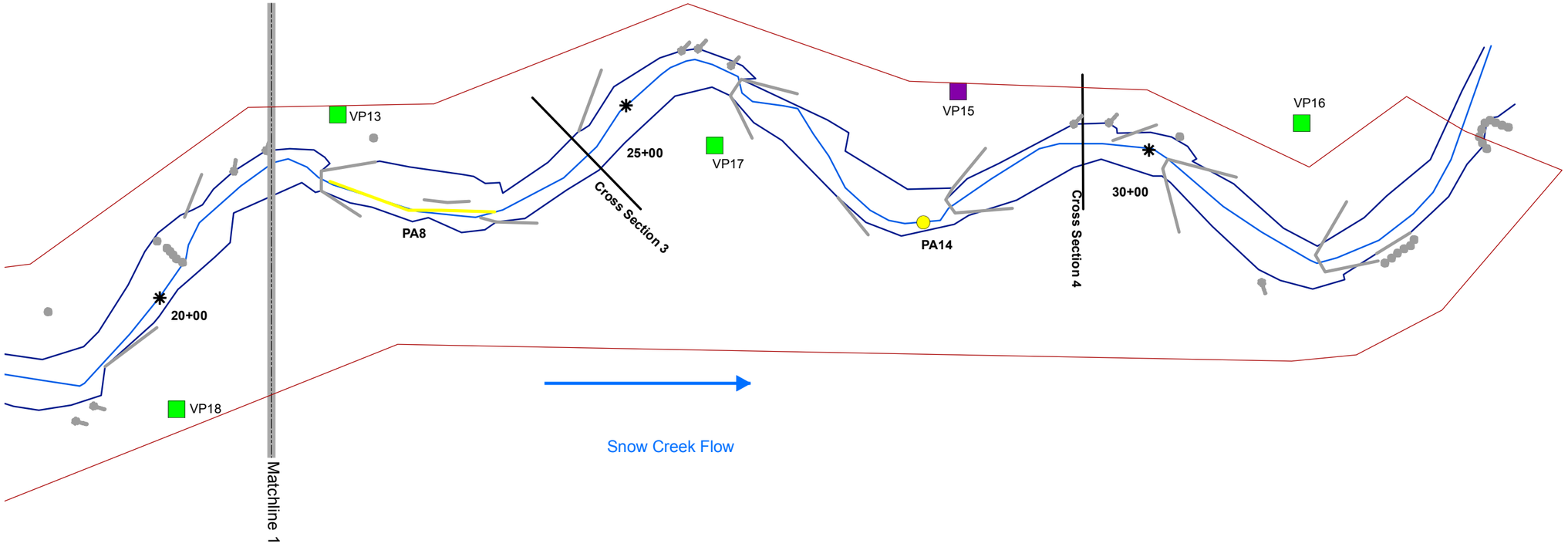
Project Number:
00344

Date:
April 2010

Legend
- Conservation Easement
- Problem Area Concern
- Problem Area Concern
- Vegetation Plot Meeting Success Criteria
- Vegetation Plot Not Meeting Success Criteria
- Matchlines
- Structures
- Stations
- Cross Section
- As-Built Centerline
- As-Built Streambank

Stream
Current Condition
Plan View

Snow Creek		
EEP Project Number 00028		
Feature #	**Feature/Issue**	**Station # / Range**
PA8	Mid channel bar / aggradation	22+00 to 23+10
PA14	Structure failure	28+80



0 50 100 Feet

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Stream
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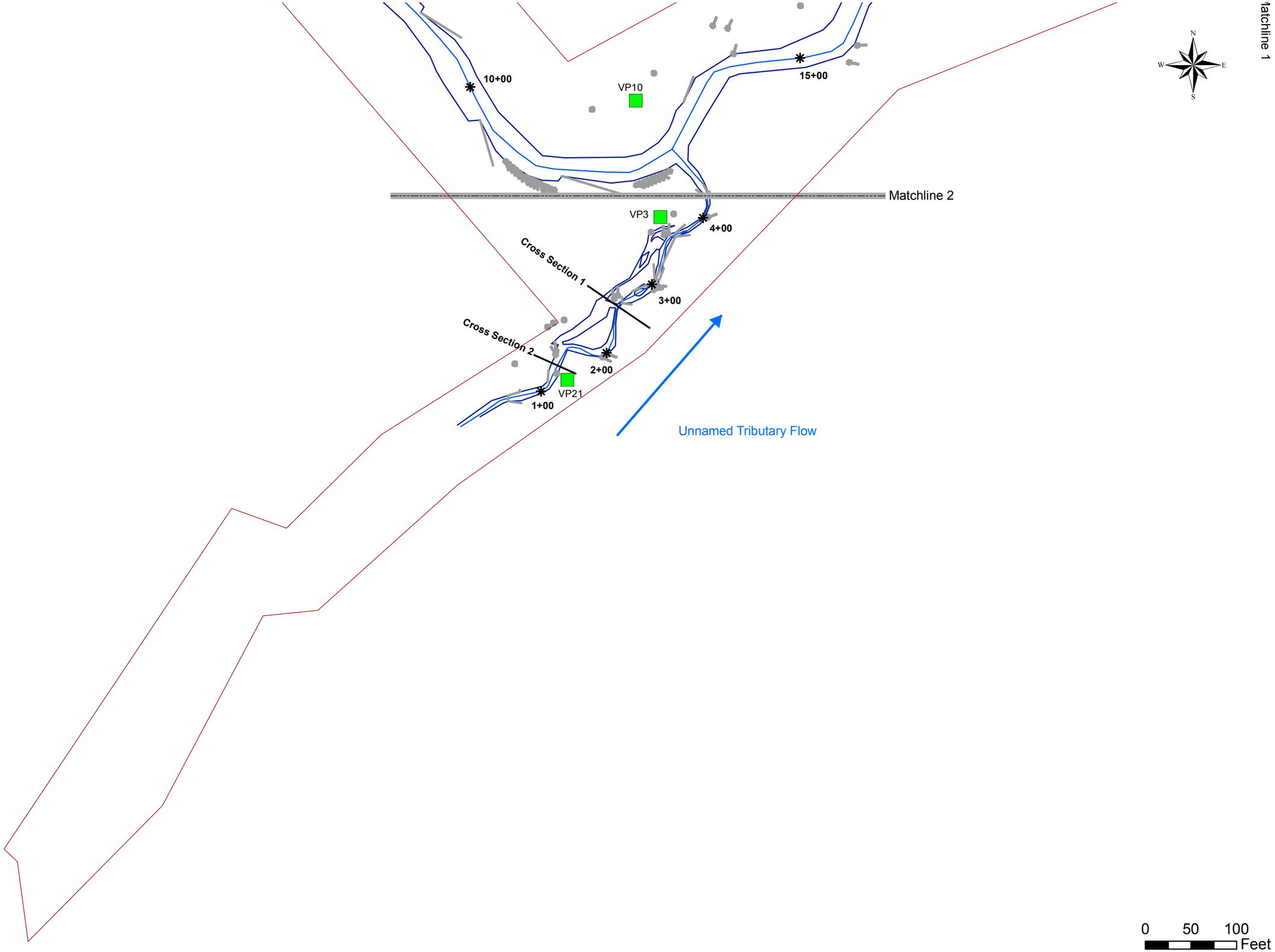

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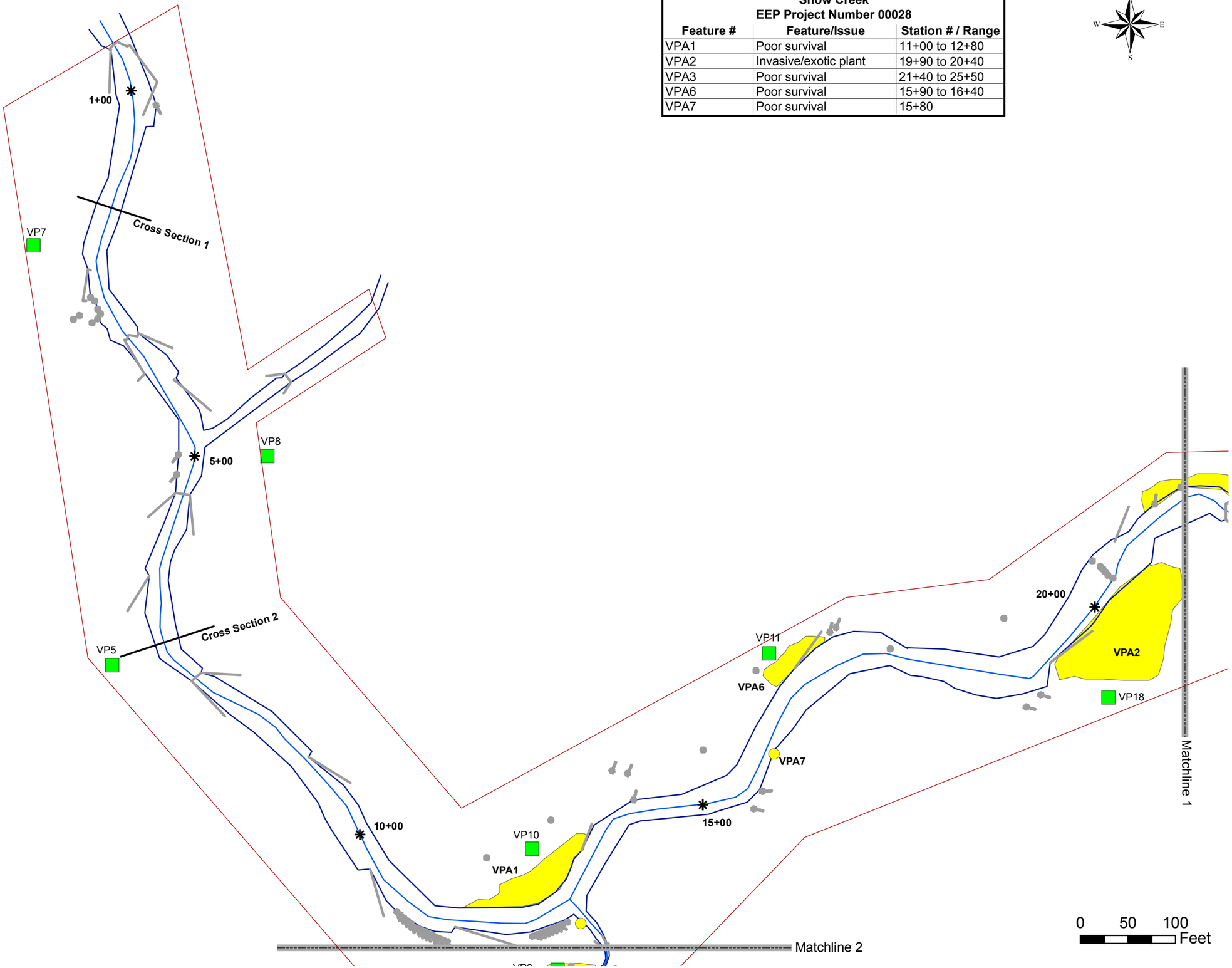
Stream
Current Condition
Plan View

Sheet 3 of 3

Snow Creek EEP Project Number 00028		
Feature #	**Feature/Issue**	**Station # / Range**
VPA1	Poor survival	11+00 to 12+80
VPA2	Invasive/exotic plant	19+90 to 20+40
VPA3	Poor survival	21+40 to 25+50
VPA6	Poor survival	15+90 to 16+40
VPA7	Poor survival	15+80



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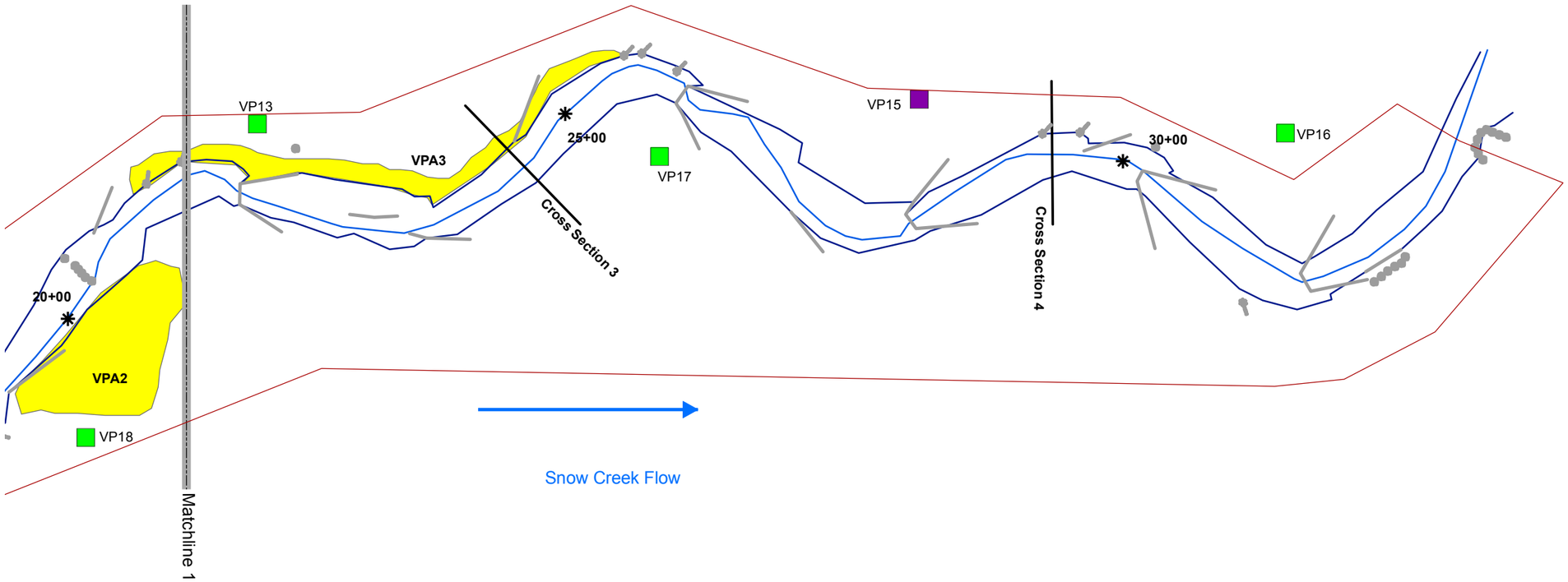
Vegetation Current Condition Plan View

Snow Creek EEP Project Number 00028		
Feature #	**Feature/Issue**	**Station # / Range**
VPA2	Invasive/exotic plant	19+90 to 20+40
VPA3	Poor survival	21+40 to 25+50



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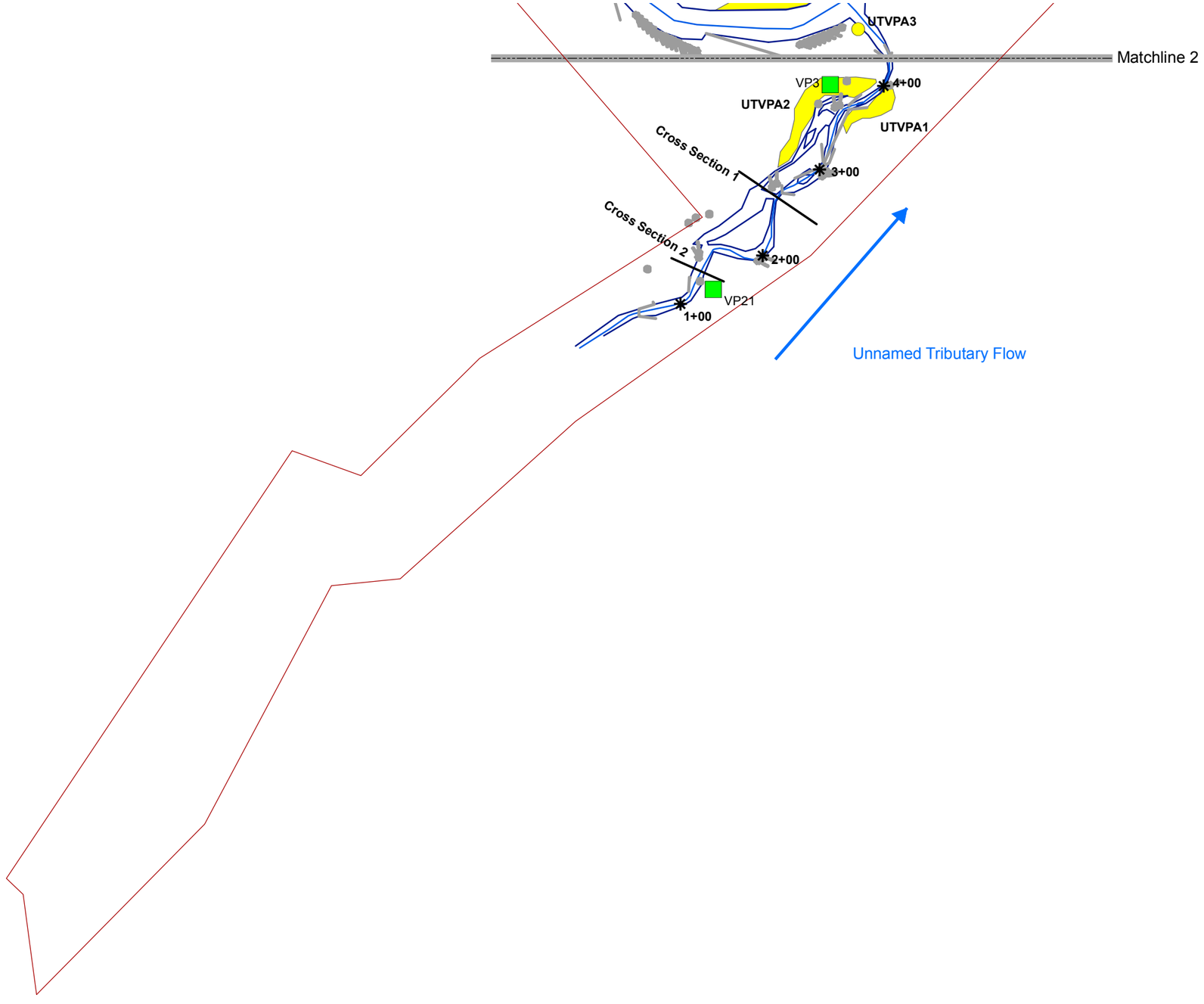
0 50 100 Feet

Vegetation
Current Condition
Plan View



Unnamed Tributary EEP Project Number 00028		
UTVPA1	Poor survival	3+50 to 4+00
UTVPA2	Poor survival	2+80 to 4+00
UTVPA3	Poor survival	4+90

0 50 100 Feet

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Vegetation
Current Condition
Plan View

Sheet 3 of 3

Appendix B: General Project Tables

Table 1: Project Restoration Components

Snow Creek EEP Project Number 00344						
Project Segment or Reach	**Existing Feet**	**Mitigation Type**	**Approach**	**Linear Footage**	**Stationing**	**Comment**
Snow Creek – Reach 1	3,310	R	PII	1,200*	0+00 to 12+00*	Portion of reach is new channel
Snow Creek – Reach 2		R	PII	2,359*	12+00 to 35+59*	Modify profile, dimension, pattern
UT to Snow Creek	1,355	R	PII	450*	0+00 to 4+50*	New pattern, profile, dimension, and structures
UT to Snow Creek		E	EI	855*	N/A	Cattle exclusion and easement

*Per 2005 As-Built Plan.

R = Restoration
EI = Enhancement
EII = Enhancement II
S = Stabilization
PI = Priority I
PII = Priority II
PIII = Priority III
SS = Stream Bank Stabilization

Table 2: Project Activity and Reporting History

Snow Creek EEP Project Number 00344			
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan	Unknown	Unknown	September 2002
Final Design 90%	Unknown	Unknown	Unknown
Construction (began July 2004)	Unknown	Unknown	January 2005
Permanent seed mix applied	Unknown	Unknown	July 2004 – January 2005
Live stakes and woody plants	Unknown	Unknown	January 2005 – March 2005
Storm Damage Repairs	2005	Unknown	April 2005
Final Walk Through	Unknown	Unknown	July 2005
As-Built Report	Unknown	Unknown	December 2005
Year 1 Monitoring	2005	July 2005	April 2006
Year 2 Monitoring	2006	October 2006	December 2006
Year 3 Monitoring	2007	November 2007	December 2007
Year 4 Monitoring	2008	November 2008	December 2008
Year 5 Monitoring	2009	December 2009	December 2009

Table 3: Project Contacts Table

Snow Creek EEP Project Number 00344	
Designer	EcoLogic Associates, P.C. 4321-A South Elm-Eugene Street Greensboro, NC 27406
Primary project design POC	Ken Bridle 336-355-8108
Construction Contractor	Shamrock Environmental PO Box 14987 Greensboro, NC 27415
Construction contractor POC	Mike Granson 336-375-1989
Planting Contractor	Wheat Swamp Landscaping 4675 Ben Dail Road LaGrange, NC 28551-8038
Planting contractor POC	Charles Hughes 252-566-5030
Seeding Contractor	Shamrock Environmental PO Box 14987 Greensboro, NC 27415
Seeding contractor POC	Mike Granson 336-375-1989
Seed Mix Sources	Earnst Seed/Monitor Roller Mill 109 E 4th Street Walnut Cove, NC 27052 336-591-4126
Nursery Stock Suppliers	Wheat Swamp Landscaping 4675 Ben Dail Road LaGrange, NC 28551-8038 252-566-5030
Monitoring Performers – 2005	EcoLogic Associates, P.C. 4321-A South Elm-Eugene Street Greensboro, NC 27406
Monitoring POC	Ken Bridle 336-335-1108
Monitoring Performers – 2006	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560
Monitoring POC	Kathleen McKeithan 919-461-1597
Monitoring Performers – 2007	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560
Monitoring POC	Kathleen McKeithan 919-461-1597
Monitoring Performers – 2008	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560
Monitoring POC	Kathleen McKeithan 919-461-1597
Monitoring Performers – 2009	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560
Monitoring POC	Kathleen McKeithan 919-461-1597

Table 4: Project Attribute Table

Snow Creek EEP Project Number 00344		
Project County		Stokes
Drainage Area	Snow Creek	28 square miles
	Unnamed Tributary	0.9 square miles
Drainage impervious cover estimate (%)		1% or less
Stream Order	Snow Creek	4th
	Unnamed Tributary	2nd
Physiographic Region		Piedmont
Ecoregion		Northern Inner Piedmont (45e)
Rosgen Classification of As-Built		C4
Dominant soil types		Toccoa and Riverview
Reference site ID		Long Creek in VA
USGS HUC for Project and Reference		03010103 – Project
NCDWQ Sub-basin for Project and Reference		ROA01 22-20 – Project
NCDWQ classification for Project and Reference		C – Project
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		NA
% of project easement fenced		100

Appendix C: Vegetation Assessment Data

Appendix C-I: Vegetation Monitoring Plot Photos


VP3


VP5


VP7


VP8


VP10


VP11


VP13


VP15


VP16


VP17


VP18


VP21

Appendix C-II: Vegetation Data Tables

Table 5: Vegetation Metadata Table

Report Prepared By	Susan Shelingoski
Date Prepared	12/7/2009 7:34
Database Name	URS-2009-A.mdb
Database Location	C:\Documents and Settings\susan_shelingoski\MyDocuments\PROJECT FILES\Monitoring
Computer Name	RDUXPL160
File Size	57880576
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.
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 and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	344
Project Name	Snow Creek
Description	Stream Restoration
River Basin	Upper Roanoke River Basin
Length(ft)	5,394
Stream-to-Edge Width (ft)	30
Area (sq m)	7.4 acres
Required Plots (calculated)	12
Sampled Plots	12

Table 6: Stem Count Total and Planted by Plot and Species

Scientific Name	Common Name	Species Type	Current Plot Data (MY5 2009)																																			Annual Means											
			344-01-0003			344-01-0005			344-01-0007			344-01-0008			344-01-0011			344-01-0013			344-01-0015			344-01-0016			344-01-0017			344-01-0018			344-01-0021			MY5 (2009)			MY4 (2008)			MY3 (2007)			MY2 (2006)		
			P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T
Acer negundo	boxelder	Tree																																													7
Ailanthus altissima	tree of heaven	Tree																																											5			2
Alnus	alder	Shrub Tree																														1	1		1	1		1	1		1	1		1	1		1	1
Alnus serrulata	hazel alder	Shrub Tree					1	1																								1	1		2	2		2	2	1	6	8	1	8	12
Aronia arbutifolia	Red Chokeberry	Shrub					1	1																											1	1		2	2		6	6		7	10
Betula nigra	river birch	Tree																														1	1		1	1		1	1			24			88
Cercis canadensis	eastern redbud	Shrub Tree																																								1	1		2	2
Cornus amomum	silky dogwood	Shrub	51	51	51		1	45	15	15	27	3	3	33	57	57	61	38	38	38	3	3	3	13	13	13	10	11	11	18	19	19	18	18	18	226	229	319	238	242	503	324	330	330	340	346	351
Cornus florida	flowering dogwood	Shrub Tree																												4	4					4	4		5	5		16	16		16	16
Crataegus	hawthorn	Shrub Tree																																							3	3		6	6
Diospyros virginiana	common persimmon	Tree																																											1
Liriodendron tulipifera	tuliptree	Tree																																									2			9
Nyssa sylvatica	blackgum	Tree											2	2																										2	2		2	2		3	3		6	9
Pinus virginiana	Virginia pine	Tree												7																												7			3					
Platanus occidentalis	American sycamore	Tree																												2	2		6	6		8	8		9	80		5	88		5	167
Prunus	plum	Shrub Tree																																													2
Prunus serotina	black cherry	Shrub Tree																												1	1					1	1		1	1		1	9		1	32
Quercus rubra	northern red oak	Tree											1	1																						1	1		1	3		2	2		2	2
Quercus velutina	black oak	Tree		1	1																															1	1		1	1		1	1		1	1
Rhus glabra	smooth sumac	Shrub Tree																																						1							8
Salix nigra	black willow	Tree	5	5	5	10	10	10	2	7	23	19	20	20	16	16	34	6	6	6	2	2	2	13	13	13	5	5	5	2	2	2	17	17	17	97	103	137	120	130	130	181	189	189	187	197	201
Sambucus canadensis	Common Elderberry	Shrub Tree																			1	1	1											3	3	1	4	4	1	7	7	4	10	10	4	10	10
Unknown		unknown																																											2	2
Stem count			56	57	57	10	13	57	17	22	50	22	26	63	73	73	95	44	44	44	6	6	6	26	26	26	15	16	16	20	28	28	35	47	47	324	358	489	359	404	742	510	574	698	532	610	939
size (ares)			1			1			1			1			1			1			1			1			1			1			1			12			12			12			12		
size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.30			0.30			0.30			0.30		
Species count			2	3	3	1	4	4	2	2	2	2	4	5	2	2	2	2	2	2	3	3	3	2	2	2	2	2	2	2	5	5	2	7	7	3	13	14	3	13	15	4	14	17	4	15	22
Stems per ACRE			2266	2307	2307	404.7	526.1	2307	688	890.3	2023	890.3	1052	2550	2954	2954	3845	1781	1781	1781	242.8	242.8	242.8	1052	1052	1052	607	647.5	647.5	809.4	1133	1133	1416	1902	1902	1093	1207	1649	1211	1362	2502	1720	1936	2354	1794	2057	3167

Appendix D: Stream Assessment Data

Appendix D-I: Stream Photo Station Photos


P1 facing upstream


P2 facing upstream


P3 facing upstream


P4 facing upstream


P5 facing right bank


P6 facing upstream


P7 facing upstream


P8 facing upstream


P9 facing upstream


P10 facing upstream


P11 facing upstream


P12 facing upstream


P13 facing upstream


P14 facing upstream


P15 facing upstream


P16 facing downstream


P17 facing downstream


P18 facing upstream


P19 facing upstream


P20 facing upstream


P21 facing upstream

Appendix D-II: Stream Data Tables

Table 7: Visual Morphological Stability Assessment

Snow Creek (4,085 ft) EEP Project Number 00344						
Feature Category	Metric (per As-Built and Reference Baselines)	(# Stable) Number Performing as Intended	Total Number per As-Built	Total Number/Feet in Unstable State	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	Present?	10	16	6	63	
	Armor stable (no displacement)?	9	16	7	56	
	Facet grade appears stable?	10	16	6	63	
	Minimal evidence of embedding/fining?	8	16	8	50	
	Length appropriate?	9	16	7	56	
						58
B. Pools	Present (not subject to severe aggrad. or migration)?	22	19	0	100	
	Sufficiently deep (max pool D:mean Bkf >1.6)	20	19	0	100	
	Length appropriate?	20	19	0	100	
						100
C. Thalweg	Upstream of meander bend (run/inflection) centering?	4085	4085	0	100	
	Downstream of meander (glide/inflection) centering?	4085	4085	0	100	
						100
D. Meanders	Outer bend in state of limited/controlled erosion?	19	19	0	100	
	Of those eroding, # w/concomitant point bar formation?	19	19	0	100	
	Apparent Rc within spec?	19	19	0	100	
	Sufficient floodplain access and relief?	19	19	0	100	
						100
E. Bed General	General channel bed aggradation areas (bar formation)	N/A	N/A	1/500	88	
	Channel bed degradation–areas of increasing downcutting/headcutting?	N/A	N/A	0	100	
						94
F. Bank	Actively eroding, wasting, or slumping bank	N/A	N/A	0	100	
						100
G. Vanes	Free of back or arm scour?	23	25	2	92	
	Height appropriate?	24	25	1	96	
	Angle and geometry appear appropriate?	24	25	1	96	
	Free of piping or other structural failures?	23	25	2	92	
						94
H. Wads/ Boulders	Free of scour?	1	1	0	100	
	Footing stable?	1	1	0	100	
						100

Unnamed Tributary (454 ft) EEP Project Number 00344						
Feature Category	Metric (per As-Built and Reference Baselines)	(# Stable) Number Performing as Intended	Total Number per As-Built	Total Number/Feet in Unstable State	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	Present?	4	6	2	67	
	Armor stable (no displacement)?	4	6	2	67	
	Facet grade appears stable?	4	6	2	67	
	Minimal evidence of embedding/fining?	4	6	2	67	
	Length appropriate?	4	6	2	67	
						67
B. Pools	Present (not subject to severe aggrad. or migration)?	9	9	0	100	
	Sufficiently deep (max pool D:mean Bkf >1.6)	9	9	0	100	
	Length appropriate?	8	9	1	89	
						96
C. Thalweg	Upstream of meander bend (run/inflection) centering?	454	454	0	100	
	Downstream of meander (glide/inflection) centering?	454	454	0	100	
						100
D. Meanders	Outer bend in state of limited/controlled erosion?	8	8	0	100	
	Of those eroding, # w/concomitant point bar formation?	8	8	0	100	
	Apparent Rc within spec?	7	8	1	88	
	Sufficient floodplain access and relief?	8	8	0	100	
						97
E. Bed General	General channel bed aggradation areas (bar formation)	N/A	N/A	3/60	87	
	Channel bed degradation–areas of increasing downcutting/headcutting?	N/A	N/A	0	100	
						94
F. Bank	Actively eroding, wasting, or slumping bank	N/A	N/A	0	100	
						100
G. Vanes	Free of back or arm scour?	7	7	0	100	
	Height appropriate?	7	7	0	100	
	Angle and geometry appear appropriate?	7	7	0	100	
	Free of piping or other structural failures?	7	7	0	100	
						100
H. Wads/ Boulders	Free of scour?	7	7	0	100	
	Footing stable?	7	7	0	100	
						100

Table 8: Verification of Bankfull Events

Snow Creek EEP Project Number 00344		
Date of Data Collection	Date of Occurrence	Method
11/2/2006	Mid-January 2006	Proximal USGS Gage Resource
11/30/07	January 2007	Proximal USGS Gage Resource
11/30/07	March 2007	Proximal USGS Gage Resource
11/14/08	May 2008	Proximal USGS Gage Resource
11/14/08	September 2008	Proximal USGS Gage Resource
12/2/09	December 2008	Proximal USGS Gage Resource
12/2/09	January 2009	Proximal USGS Gage Resource
12/2/09	June 2009	Proximal USGS Gage Resource
12/2/09	July 2009	Proximal USGS Gage Resource
12/2/09	November 2009	Proximal USGS Gage Resource, presence of recent sediment and wrack lines

2009 wrack lines above bankfull

Appendix D-III: Cross Section Photos and Plots

Elevation data were not provided to URS. However, elevation data were used by EcoLogic in plotting Year 1 cross section data. URS was unable to locate benchmarks in the field to establish elevations for 2006 and 2007 cross sections. Cross section data were hand manipulated to match elevation data used in Year 1 cross sections.

In 2006, cross section pins were located for all plots with the exception of cross section 2 on the Unnamed Tributary, where the left bank was not found. URS reestablished the left bank pin in the field. In 2008, the left bank pin for cross section 1 on the Unnamed Tributary was not located. URS reestablished the left bank pin in the field. Data from cross sections 1 and 2 on the Unnamed Tributary from 2006, 2007, 2008, and 2009 are not comparable to Year 1 data. The reestablishment of pins effectively relocates the cross sections.

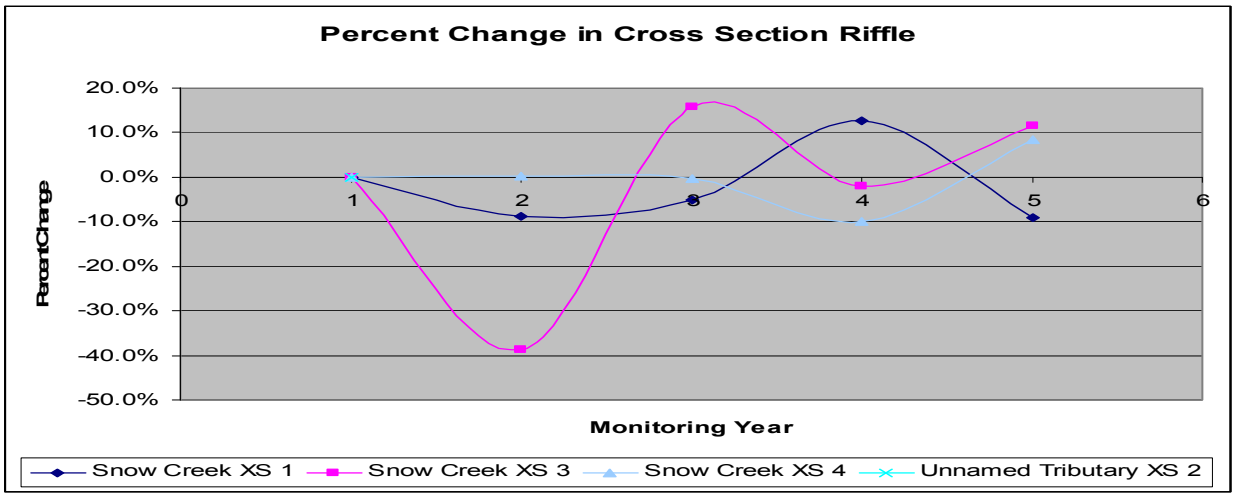
In 2007, the right bank pin of cross section 2 on the mainstem was not located. The southwest corner of vegetation plot 5 was used in its place. In 2008, the right bank pin was located. Therefore, 2007 cross section data are not comparable to Years 1, 2, 4, and 5. URS has plotted these data on the same graph for reference only. The data and/or graph should not be used to interpret channel change for cross section 2 of the Unnamed Tributary or the mainstem.

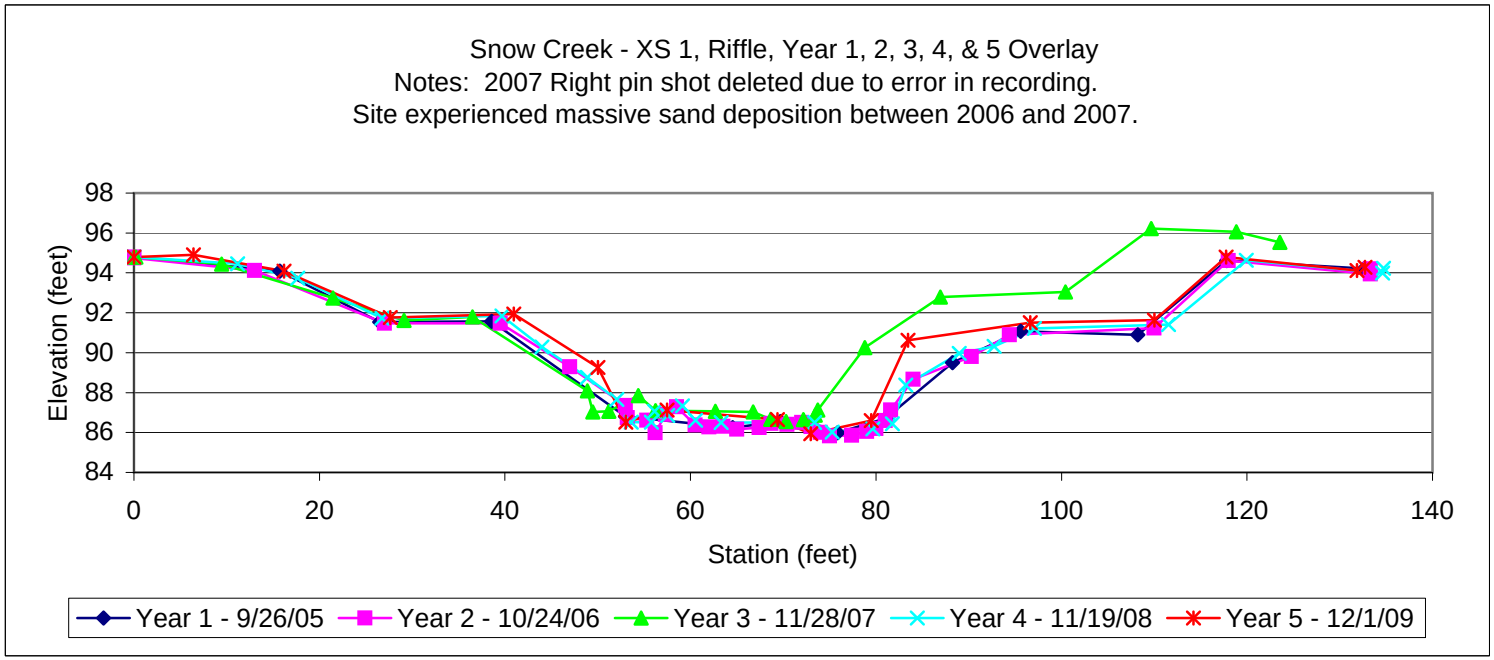
Table 9: Cross Section Pin Change Summary

Snow Creek EEP Project Number 00344		
Reach ID	Cross Section	Description of Change
Snow Creek	XS2	Right pin: vegetation plot corner was shot during 2007 instead of XS pin
Unnamed Tributary	XS1	Left pin: reestablished in 2008
Unnamed Tributary	XS2	Left pin: reestablished in 2006

Figure 5 summaries the percent changes in each riffle cross section monitored. The peaks and valleys beginning to reduce in size by monitoring year (remaining closer to zero) reveals a stabilizing trend as shown in each riffle cross section on-site.

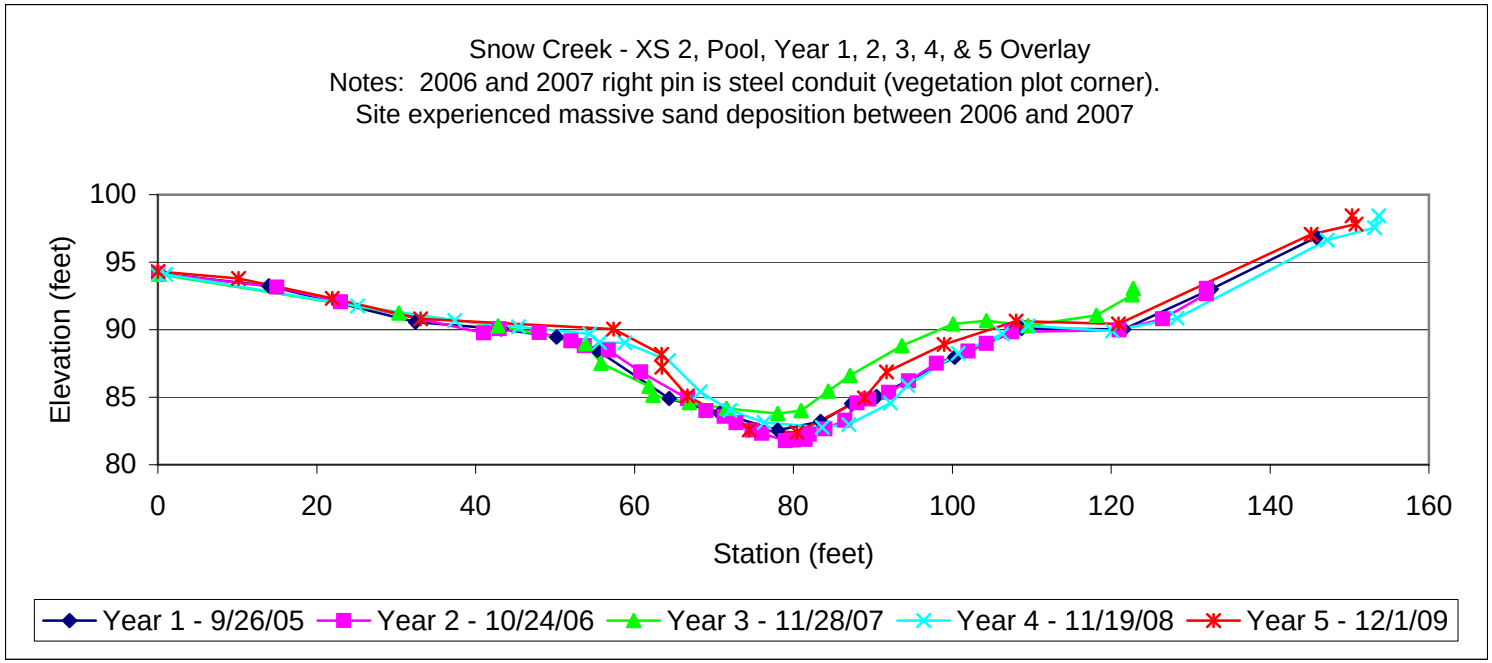
Figure 5: Percent Change in Cross Section Riffle





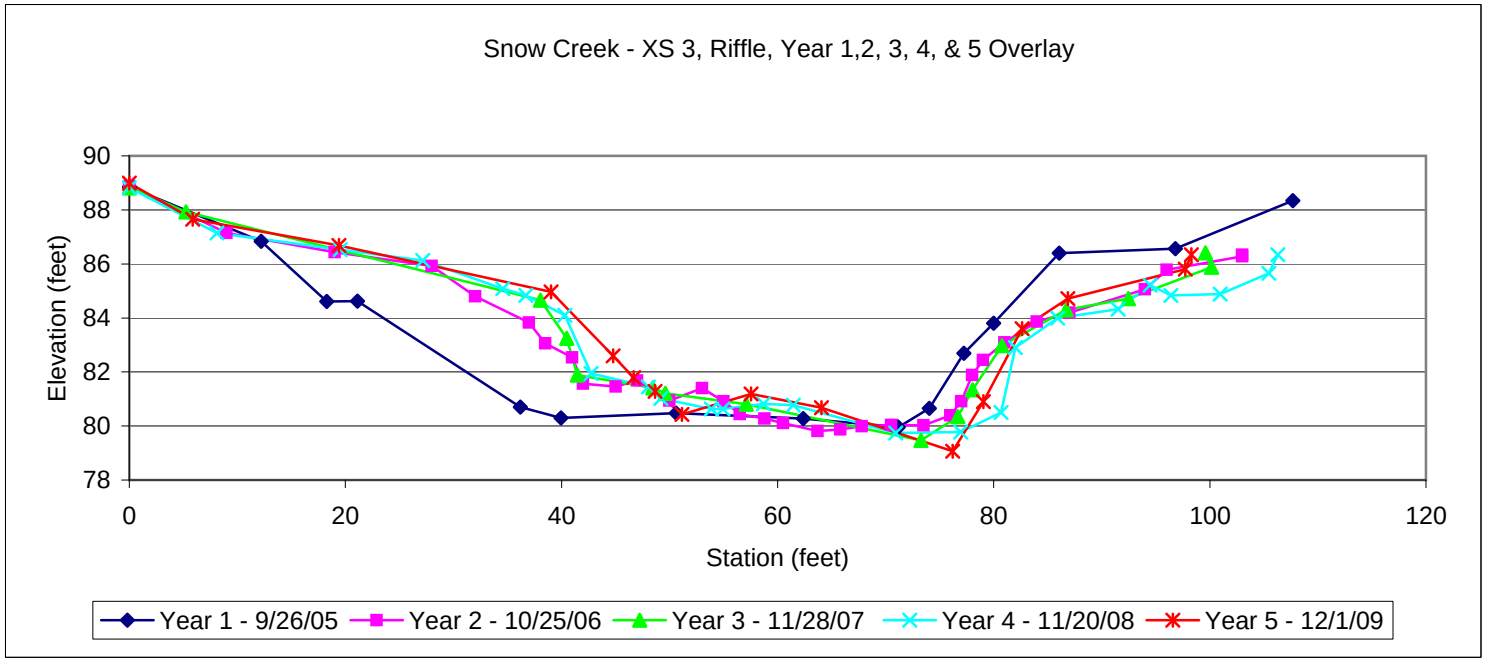
Facing Left Bank

Facing Right Bank



Facing Left Bank

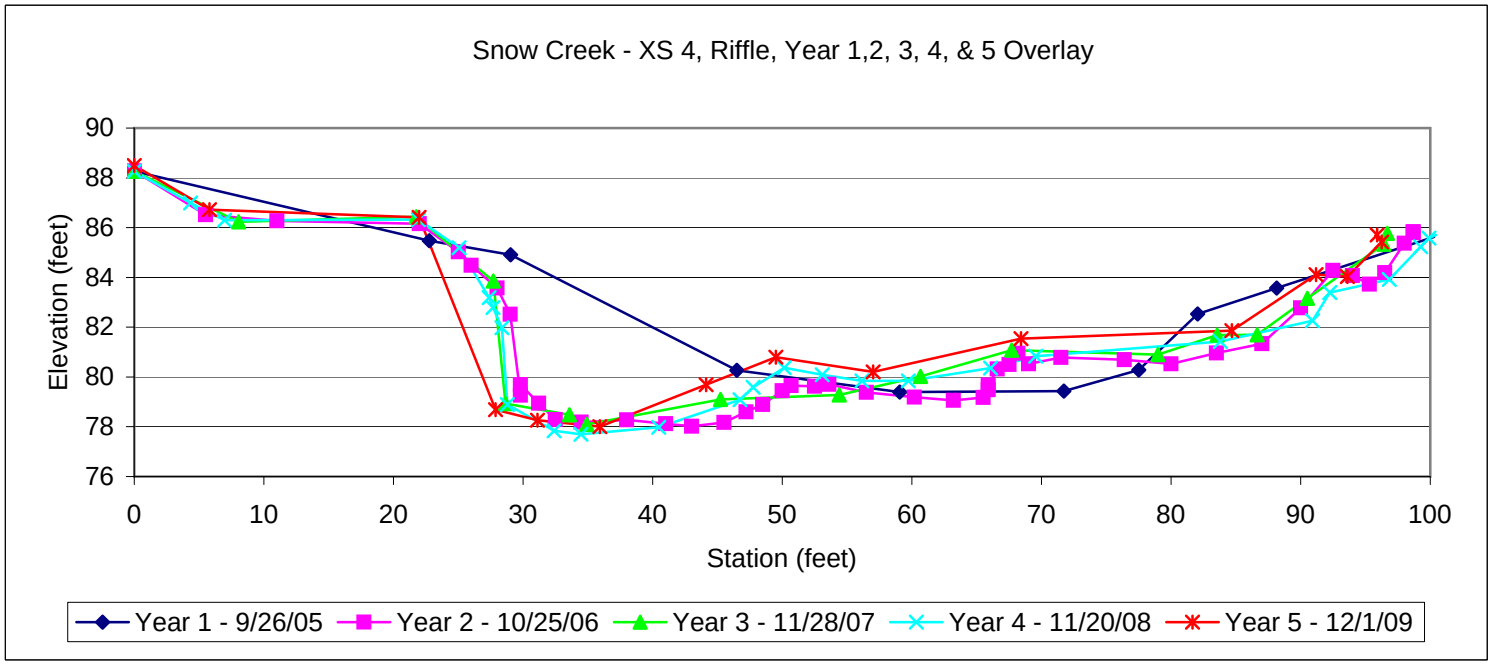
Facing Right Bank



Facing Left Bank

Facing Right Bank

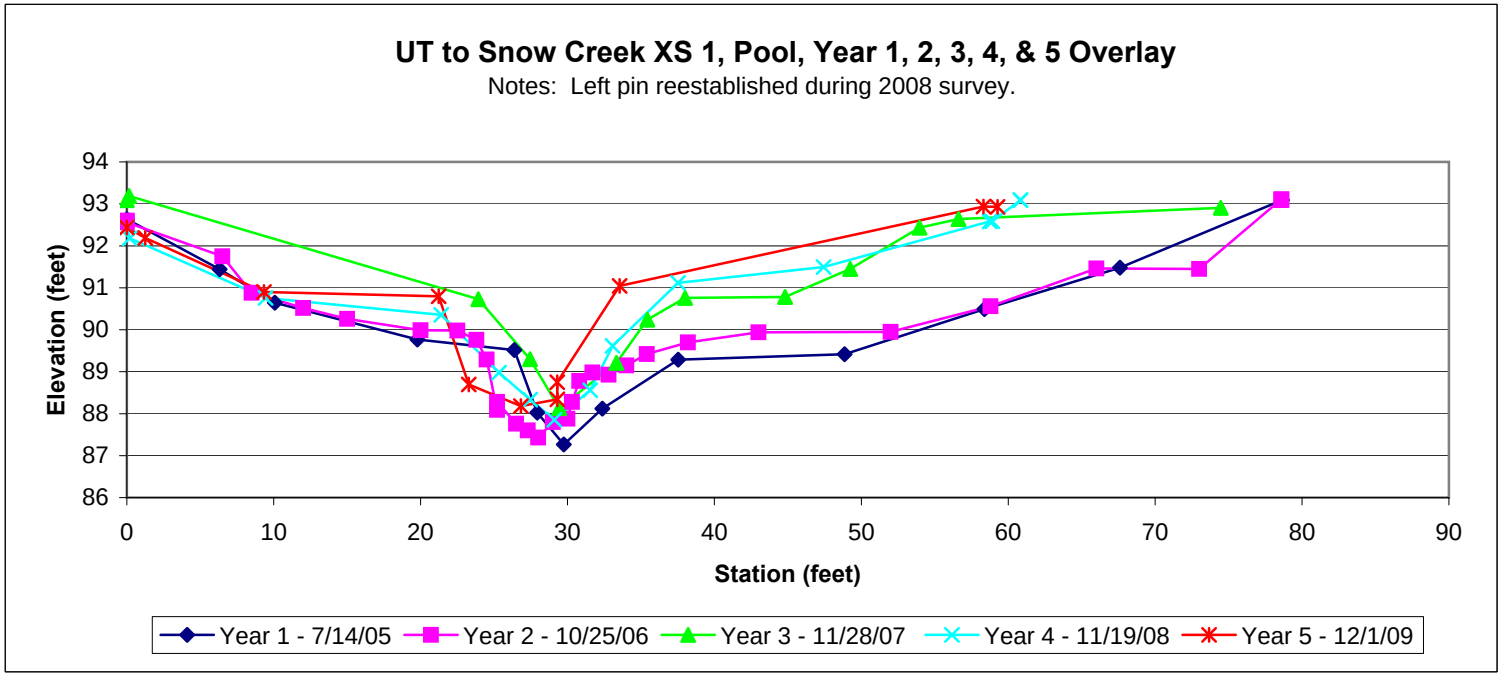
Note: Visual evaluations in 2006 did not indicate the cross section had shifted as may be indicated by overlay.



Facing Left Bank

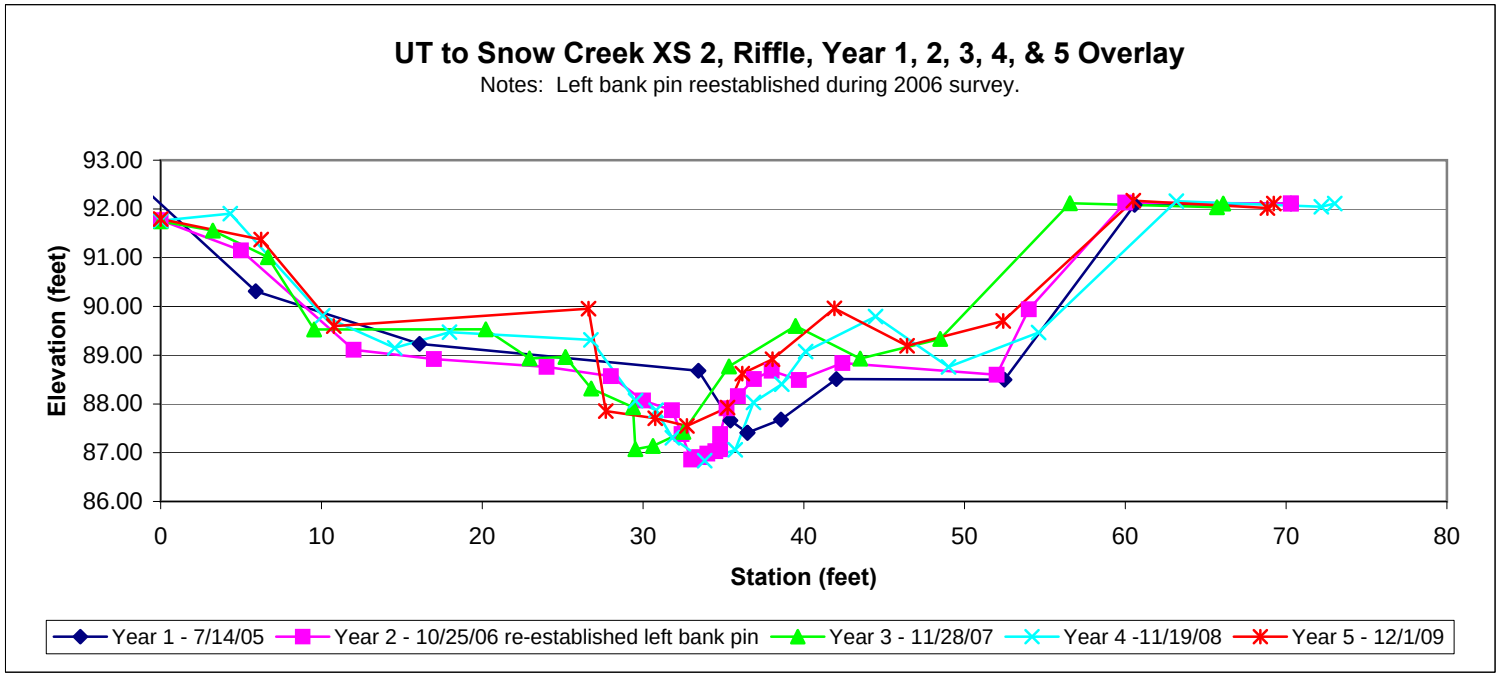
Facing Right Bank

Note: Year 1 data appears to be missing a bed shot. Visual evaluations of the site do not indicate massive cutting between 2005 and 2006.



Facing Left Bank

Facing Right Bank



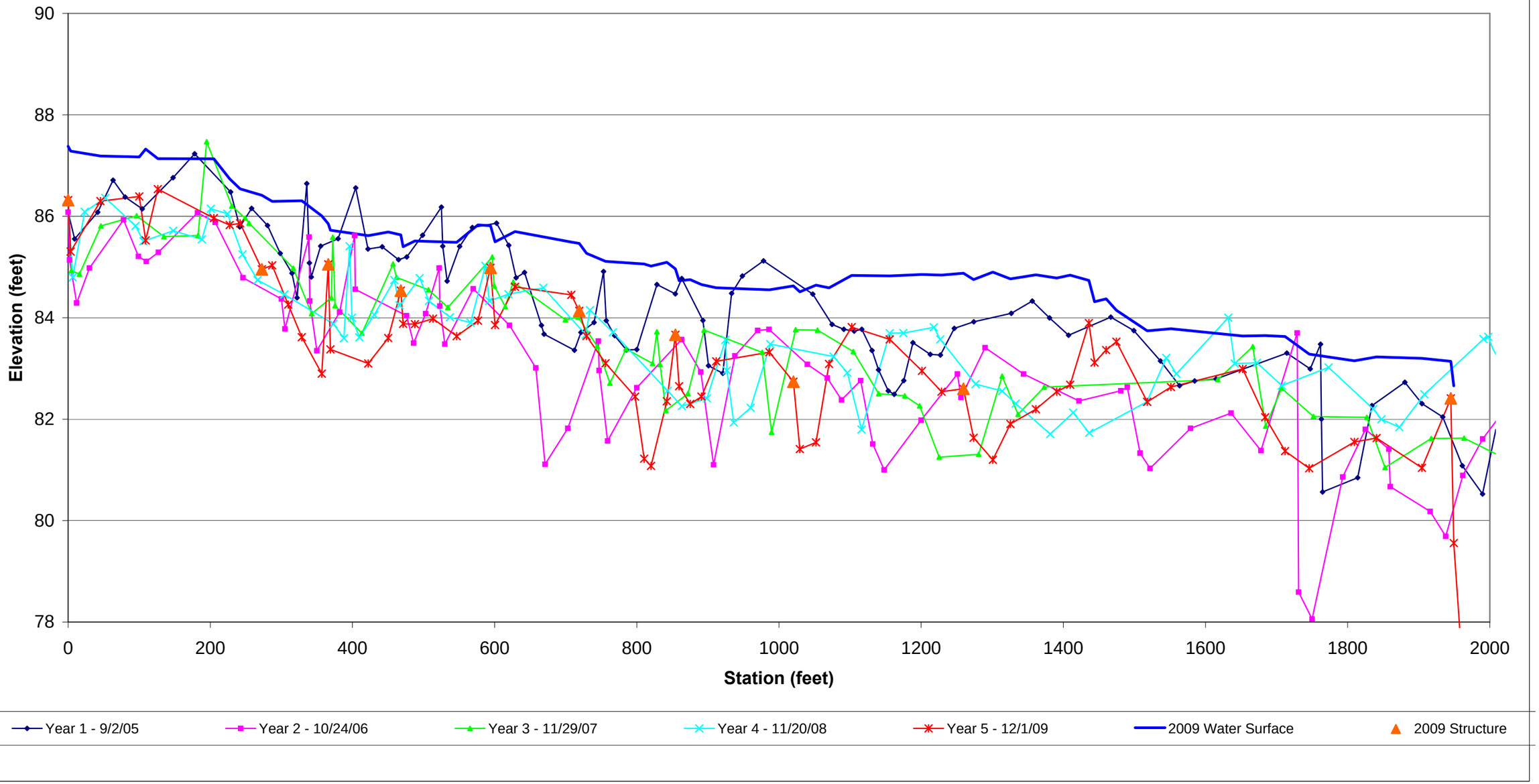
Facing Left Bank

Facing Right Bank

Appendix D-IV: Longitudinal Profile Plot

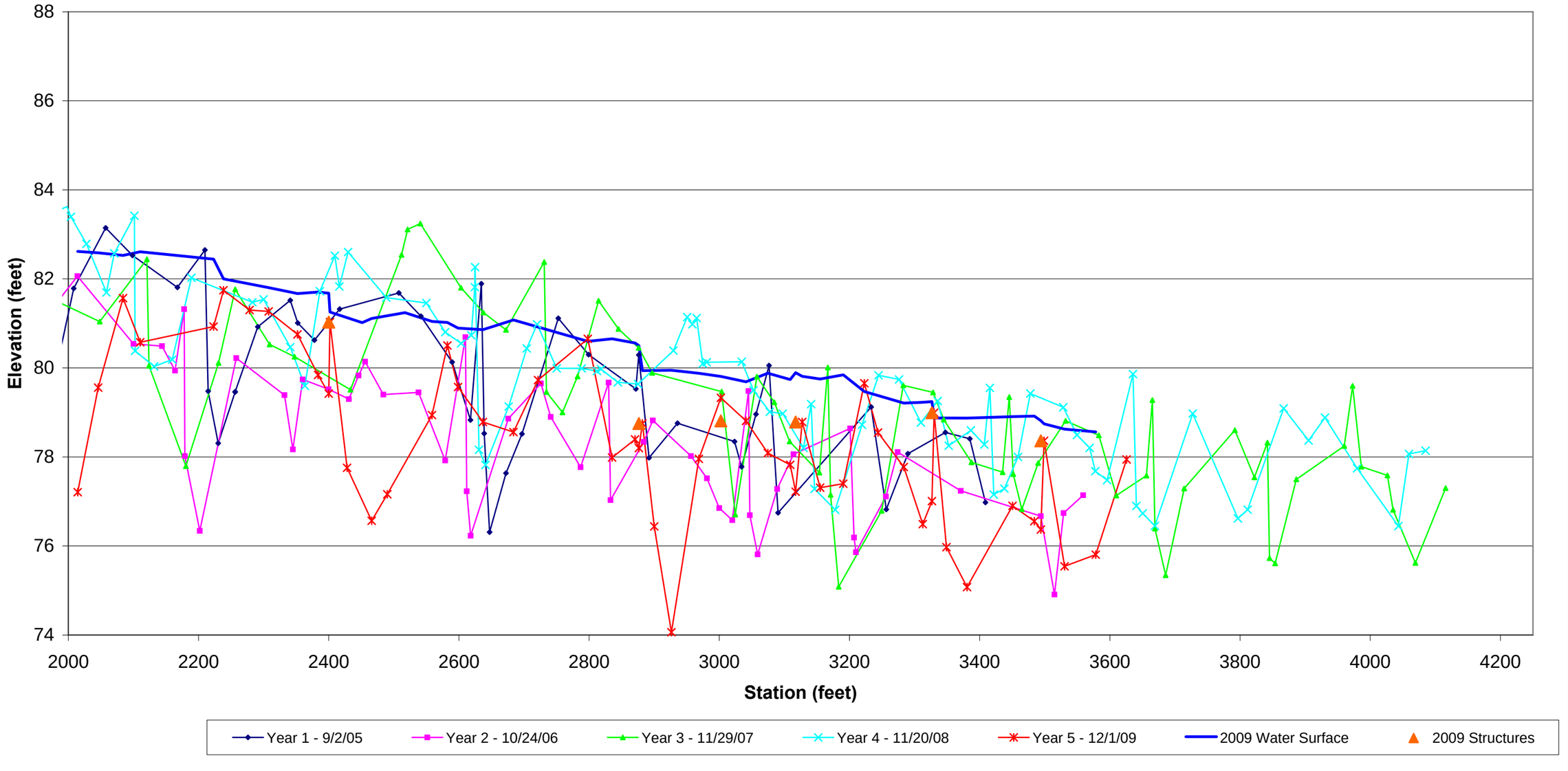
Snow Creek - Year 1, 2, 3, 4, & 5 Overlay (0-2000)

Notes: 2007 and 2008 data extend beyond project's downstream limits.

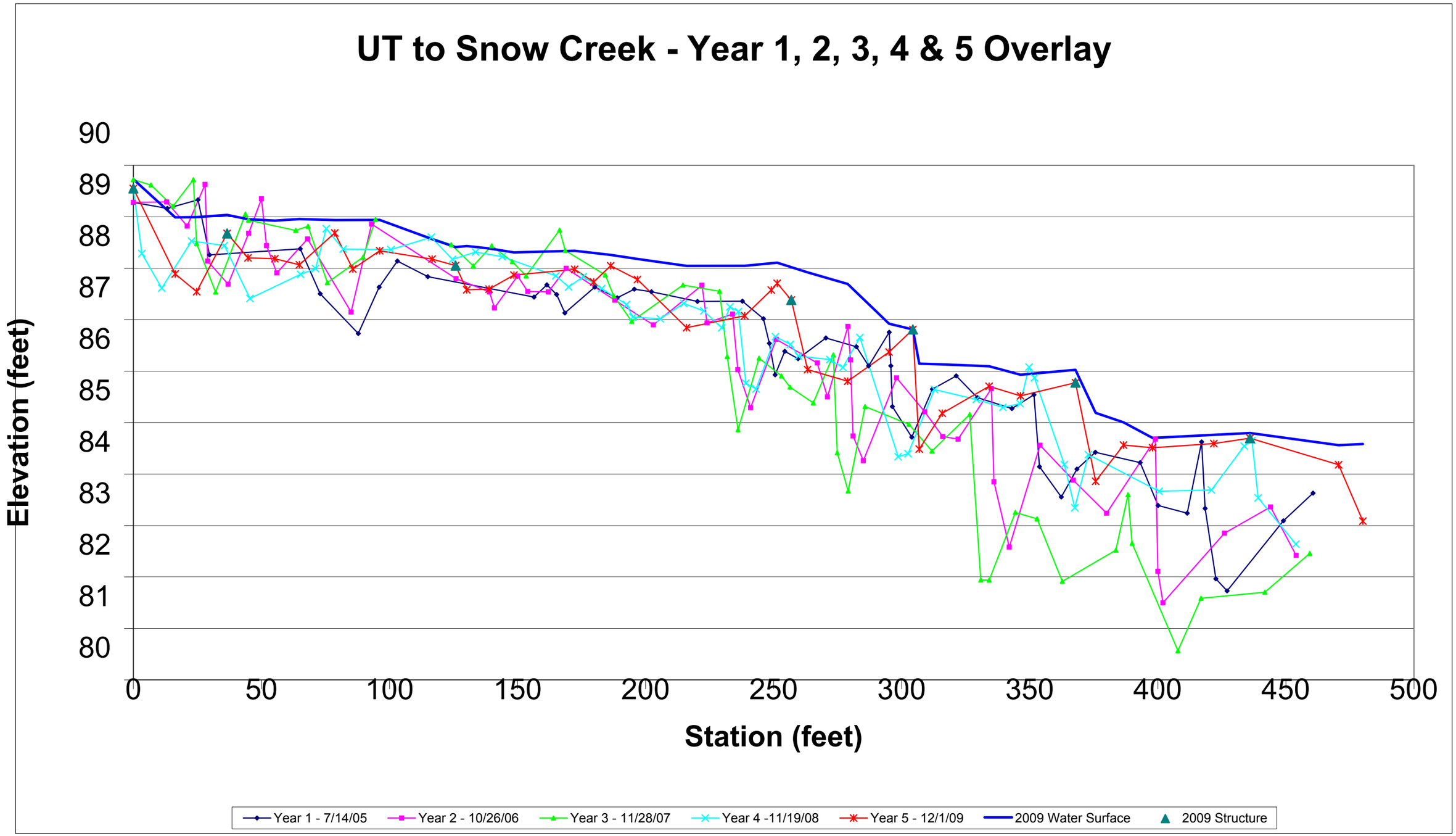


Snow Creek - Year 1, 2, 3, 4, & 5 Overlay (2000-4100)

Notes: 2007 and 2008 data extend beyond project's downstream limits.

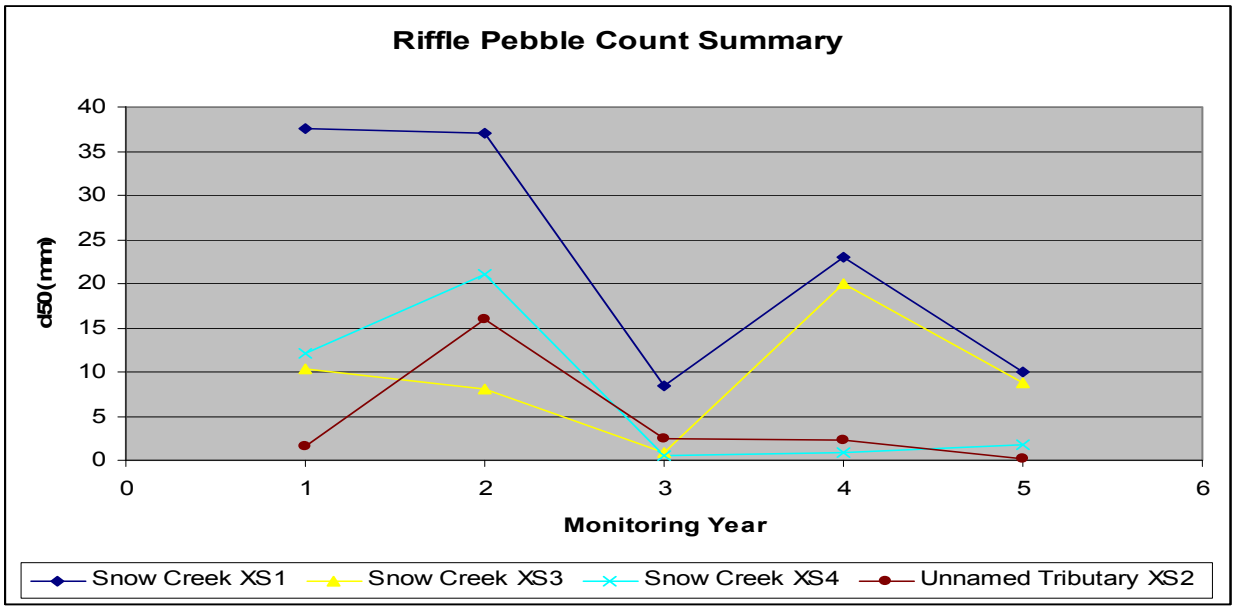


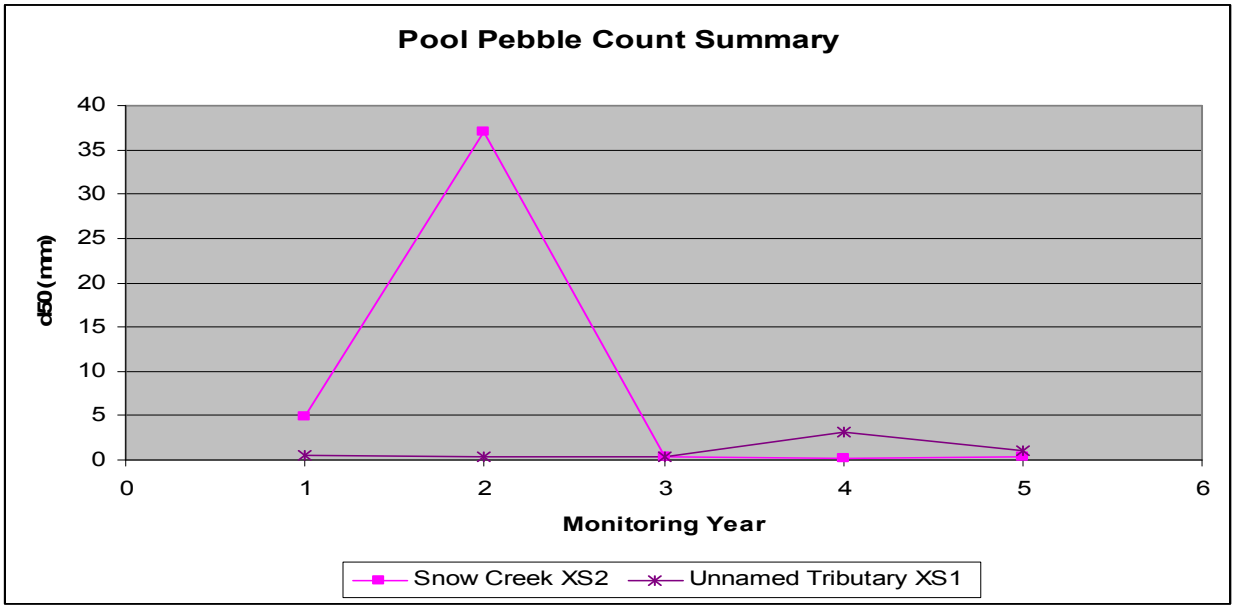
UT to Snow Creek - Year 1, 2, 3, 4 & 5 Overlay



Appendix D-V: Pebble Count Frequency Distribution Plots

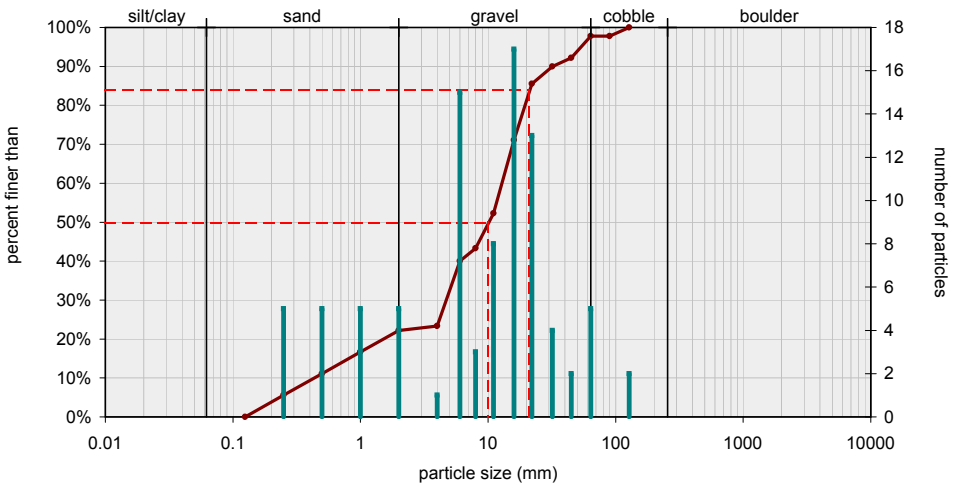
Figure 6: Pebble Count Summaries





In a riffle cross section, a stable system is indicated by a d50 maintaining or increasingly. Maintaining a d50 indicates the riffles are not filling with sediment and pools are not moving into the reach. In a pool cross section, the bed material in a stable system typically remains small.

Riffle Surface Pebble Count, Snow Creek

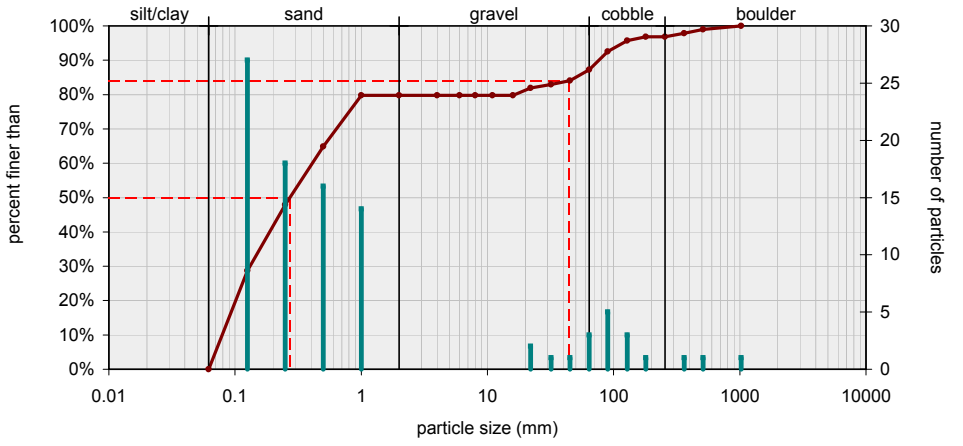


Size (mm)	
D16	0.92
D35	5.3
D50	10
D65	14
D84	21
D95	54

Size Distribution	
mean	4.4
dispersion	6.5
skewness	-0.31

Type			
silt/clay	0%	bedrock	10%
sand	20%		
gravel	68%		
cobble	2%		
boulder	0%		

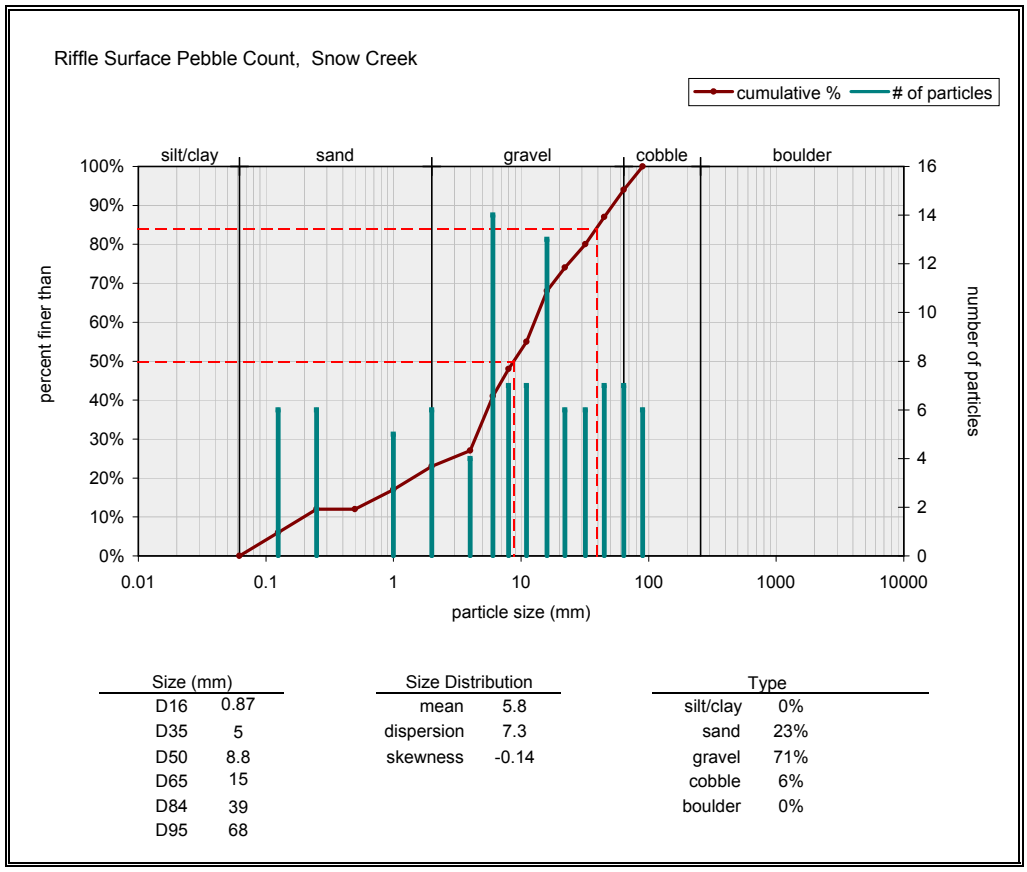
Bed Surface Pebble Count, Snow Creek



Size (mm)		
D16	0.092	3.4
D35	0.16	12
D50	0.27	17
D65	0.5	20
D84	44	29
D95	120	39

Size Distribution	
mean	2.0
dispersion	82.9
skewness	0.53

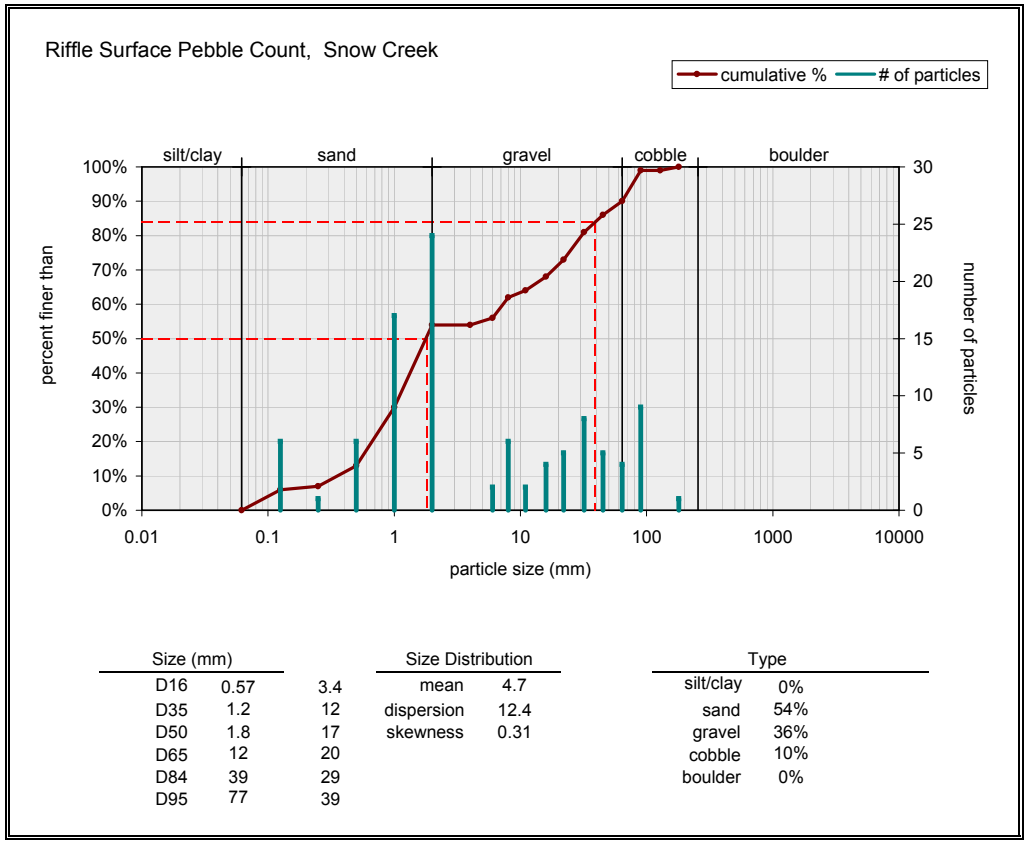
Type			
silt/clay	0%	bedrock	6%
sand	75%		
gravel	7%		
cobble	9%		
boulder	3%		



Size (mm)	
D16	0.87
D35	5
D50	8.8
D65	15
D84	39
D95	68

Size Distribution	
mean	5.8
dispersion	7.3
skewness	-0.14

Type	
silt/clay	0%
sand	23%
gravel	71%
cobble	6%
boulder	0%

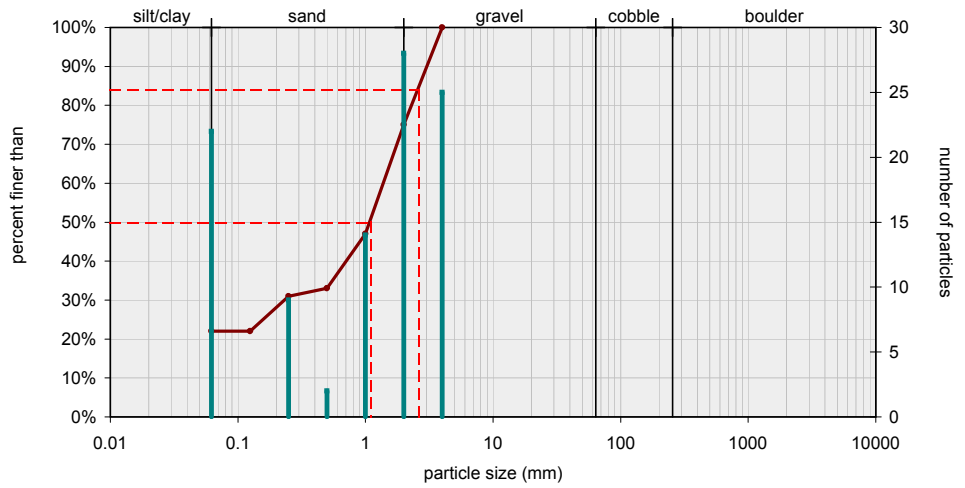


Size (mm)		
D16	0.57	3.4
D35	1.2	12
D50	1.8	17
D65	12	20
D84	39	29
D95	77	39

Size Distribution	
mean	4.7
dispersion	12.4
skewness	0.31

Type	
silt/clay	0%
sand	54%
gravel	36%
cobble	10%
boulder	0%

Bed Surface Pebble Count, Unnamed Tributary to Snow Creek

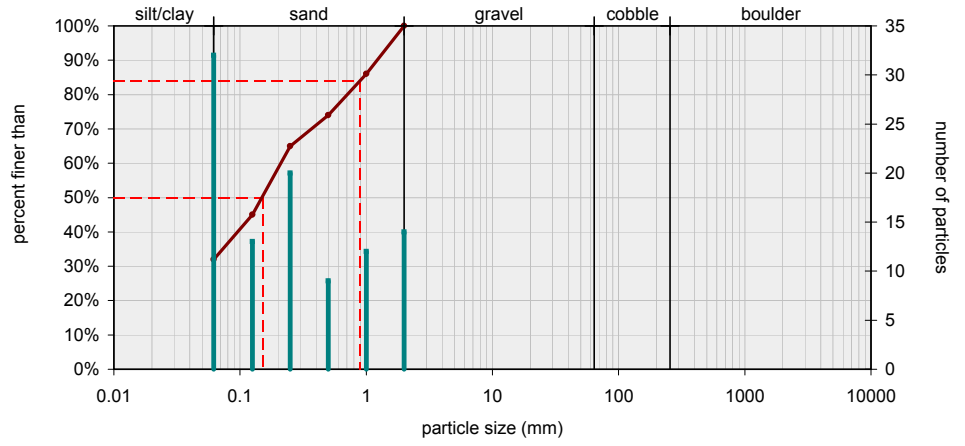


Size (mm)	
D16	0.062
D35	0.55
D50	1.1
D65	1.6
D84	2.6
D95	3.5

Size Distribution	
mean	0.4
dispersion	10.1
skewness	-0.34

Type	
silt/clay	22%
sand	53%
gravel	25%
cobble	0%
boulder	0%

Riffle Surface Pebble Count, Unnamed Tributary to Snow Creek



Size (mm)		
D16	0.062	3.4
D35	0.073	12
D50	0.15	17
D65	0.25	20
D84	0.89	29
D95	1.6	39

Size Distribution	
mean	0.2
dispersion	4.2
skewness	0.18

Type	
silt/clay	32%
sand	68%
gravel	0%
cobble	0%
boulder	0%