

**Snow Creek Stream Restoration
2008 Final Monitoring Report
Monitoring Year Four**

Ecosystem Enhancement Program Project Number 00344



Submitted to: NCDENR-Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Project Designed by: EcoLogic Associates, P.C.
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Submitted: February 12, 2009



**Snow Creek Stream Restoration
2008 Final Monitoring Report
Monitoring Year Four**

Ecosystem Enhancement Program Project Number 00344



Prepared by:

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February 12, 2009

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1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

URS Corporation (URS) was retained by the North Carolina Ecosystem Enhancement Program (EEP) to conduct stream monitoring at the Snow Creek stream restoration project, located in the Upper Dan River Watershed of the Upper Roanoke River Basin in Stokes County. The stream monitoring effort conducted by URS in November 2008 represents Monitoring Year (MY) 4 for this project. Prior to the 2006 (MY3) monitoring effort, URS received a digital As-Built drawing for the project site from EEP. In addition, URS received the Snow Creek Stream Restoration Design Report prepared by EcoLogic Associates, P.C. (EcoLogic 2002), and a 2004 (MY1) Monitoring Report also produced by EcoLogic Associates, P.C. (EcoLogic 2006).

EEP initiated the restoration of 3,310 linear feet of Snow Creek and 700 feet of an unnamed tributary in 2002. The original condition of Snow Creek included very steep, tall banks, with a single row of mature trees at the top of the banks. Snow Creek was straightened by previous landowners to optimize the floodplain for agricultural fields and pastures.

The original goals of the Snow Creek Stream Restoration Project were to improve water quality and re-establish a stable channel dimension, pattern, and profile through the implementation of the following objectives: reducing the sediment load generated by eroding banks and restoring a riparian buffer; restoring a functional floodplain; enhancing aquatic and terrestrial habitat in the stream corridor; providing a stable ford across the main channel for tractor access; providing two pedestrian bridges across the main channel for access to the temple property and agricultural fields; and enhancing habitat in the main channel and tributary for small-anthered bittercress (*Cardamine micranthera*), a federally endangered plant that occurs in the Snow Creek channel.

The morphological restoration included significant increases in belt width accomplished through the construction of new meander bends and bankfull benches. Gently sloping transitions were incorporated between the channel bottom and top of bank. Rock vanes, root wads, and coir matting provide bank protection and cross vanes provide grade control while promoting pool development.

Riparian corridor restoration included the preservation of as many mature streamside trees as possible, construction of two ford crossings, planting of native herbs and woody plants in the easement area, and fencing the conservation easement to prevent disturbance by livestock.

The presence of beavers continues to have detrimental effects on the Snow Creek site. Beaver were first noted during the 2007 (MY3) monitoring effort. Several dams and areas of stem chew were observed. During the 2008 initial assessment (performed in October 2008) it appeared as if the beaver had abandoned the site. The dams were not actively maintained and no new stem chew was observed. However, during the 2008 (MY4) monitoring effort, recent beaver activity was noted. It appears that beaver have returned to the site. A new dam has been constructed and several new stem chews were scattered along the mainstem and Unnamed Tributary. The site is currently supporting four beaver dams (two on the mainstem, one on the Unnamed Tributary, and one on the small tributary at the top of the project). Backwater from the two dams on the mainstem extends approximately 800 linear feet and has affected the substrate and movement of materials in the stream.

Although vegetation survival at the site is excellent, and up until the 2007 (MY3) monitoring period all vegetative problem areas were improving, the presence of beavers continues to have detrimental effects on the streamside vegetation. Beavers are using livestakes, namely black willow (*Salix nigra*) to construct their dams along the mainstem and the Unnamed Tributary. As of November 2008 (MY4), streamside vegetation remains in good condition. However, if beaver are not controlled at the site, the

condition will worsen rapidly. Additionally, the site experienced two large storm events between 2006 (MY2) and 2007 (MY3) monitoring. The storm events deposited large amounts of sediment both in the project reach and on its floodplain. While the majority of the planted vegetation (livesakes) appears to have faired the sedimentation well, several areas were covered in more than two feet of sand. In these areas, smaller bare root seedlings were buried and many did not survive. Volunteer species have begun to colonize many of the affected areas, but are still small (less than 100 cm).

The Snow Creek Stream Restoration Project is in overall very good condition. There were very few problem areas that will require immediate attention. Several of the cross vanes continue to show signs that a boulder(s) have slipped; however, most continue to hold grade and are beginning to fill behind the vane arms. Beavers are present throughout the site and are influencing the nature of the stream and sediment transport. 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. However, the beaver dams are influencing the streambed grade, sediment transport, and bed material. Upstream of the beaver dams, riffles are submerged therefore causing the bed to become finer.

2.0 PROJECT BACKGROUND

2.1 PROJECT OBJECTIVES

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

1. Reduce the sediment load generated by eroding banks and by restoring a riparian buffer;
2. Restore a functioning floodplain;
3. Enhance aquatic and terrestrial habitat in the stream corridor;
4. Provide a stable ford across the main channel for tractor access;
5. Provide two pedestrian bridges across the main channel for access to the temple property and agricultural fields, and
6. 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.

2.2 PROJECT STRUCTURE, MITIGATION TYPE, AND APPROACH

The original condition of Snow Creek included a thin row of mature trees at the top of the banks and very steep, tall banks. Snow Creek was straightened by previous landowners to optimize the floodplain for use as agricultural fields and pastures. In addition, the previous landowners operated a stone quarry on the property, which was accessed by a road crossing over a culvert in Snow Creek. The combination of the straightening and the undersized culverts accelerated entrenchment of the channel until it reached bedrock. Six agricultural landowners have participated in the Snow Creek Stream Restoration project.

Prior to restoration, the main channel of Snow Creek began as a straight south flowing channel. After a sharp ninety degree bend, the channel turned and flowed to the east. Since much of the riparian buffer had been removed to facilitate channel straightening and to provide more land area, the banks of the channel were actively eroding, allowing for lateral movement of the stream. At the time restoration took place, bank heights were nearing eight feet.

The pre-restoration stream length was 3,310 linear feet of Snow Creek and approximately 700 feet of an unnamed tributary. Based on the Rosgen stream classification system, Snow Creek was an entrenched C4/1, while the unnamed tributary was an F4 stream type.

The morphological restoration included significant increases in belt width accomplished through the construction of new meander bends. Bankfull benches provide flood relief. Cross vanes provide grade control and pool development. Riparian corridor restoration included preservation of as many mature trees as possible, construction of two crossing fords, installation of native herbs and woody plants in the easement area, and fencing out the agricultural animals.

2.3 LOCATION AND SETTING

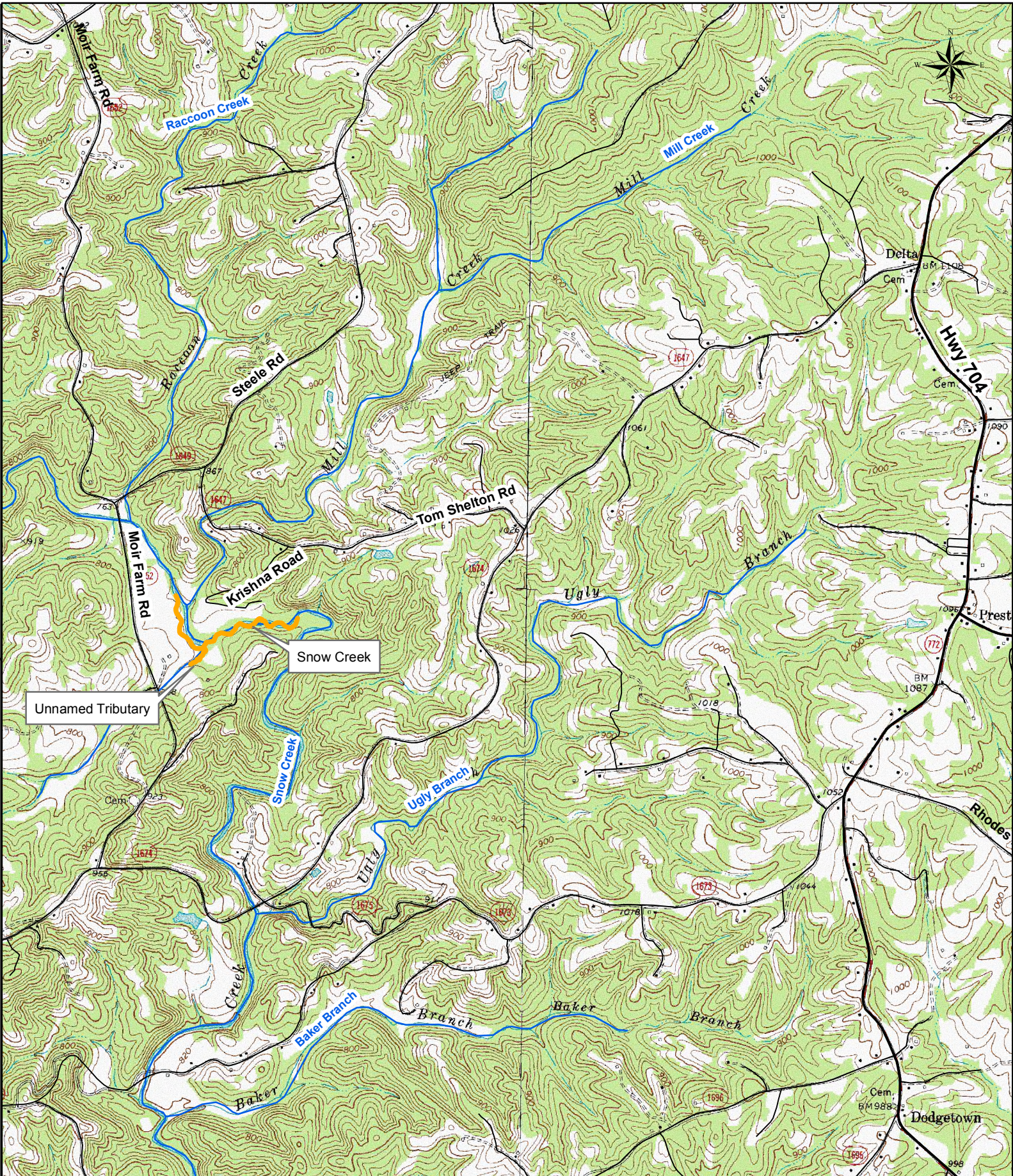
Snow Creek is located in the Upper Dan River Watershed of the Upper Roanoke River Basin in north-central Stokes County. The project reach is located in USGS 8-digit catalog number 03040102-Snow Creek, NC. The NCDWQ classification of the watershed is 0313 Roanoke River Basin, Snow Creek sections 22-20-(0.5) and 22-20-(5.5) (NCDWQ 2005).

The headwaters originate east of the town of Lawsonville, NC, which is just south of the Virginia-North Carolina border. The site's watershed is approximately 28 square miles and consists primarily of

woodland and agriculture. The majority of the upper watershed landscape is cultivated tobacco fields and includes some of the largest and oldest farms in Stokes County.

To reach the site from Raleigh, take I-40 west to exit 210 (NC-68 North) to High Point/Piedmont Triad International Airport. Turn left onto US-158. Continue on Belews Creek Road. Continue on NC-65. Turn right at US-311. Continue on NC-89, then turn right onto Shepherd Mill Road (SR 1674) and bear left onto Moir Farm Road (SR 1652).

Access to the upstream portion of the site is obtained from Moir Farm Road, northwest of its intersection with Sheppard Mill Road. The project reach begins behind the large white barn on Moir Farm Road. The project reach flows south, then east. The lower portion is accessed from the end of Prahbupada Road. The eastern portion of the project reach is accessed from Krishna Road (Figure 1).



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Prepared For:
 NC Ecosystem
 Enhancement Program



Project:
 Snow Creek
 Stream Restoration
 Stokes County, NC

Project Number:
 00344

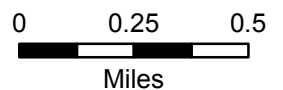
Monitoring Year:
 4(2008)

Date:
 February 2009

Legend

 Project Reach

Figure 1
 Project Vicinity



2.4 PROJECT HISTORY AND BACKGROUND

The tributary to Snow Creek was identified by inventory biologists as a potential restoration project in July 1998. This information was given to representatives of EEP during a field tour of potential restoration sites led by EcoLogic staff in Stokes County in June of 2001. The existing condition survey occurred in late May 2002 at which time a Federally Endangered plant species, small-anthered bittercress was found. Due to this discovery, a Biological Assessment was required with the U.S. Fish and Wildlife Service (USFWS), which started in June 2002. In September 2002, the final Biological Assessment for small-anthered bittercress was submitted to USFWS. In July 2004, construction began and was completed early January 2005. In January-March 2005, live stakes and bare root trees were installed. A heavy rainfall occurred two weeks after construction and caused some damage that required repair, which was accomplished in April 2005. The as-built survey was conducted in February 2005. The as-built morphological survey, installation of reference cross sections, and implementation of vegetation monitoring plots started in July 2005.

Table I: Project Mitigation Structure and Objectives Table

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	1,559*	0+00 to 12+00**	Portion of reach is new channel
Snow Creek – Reach 2		R	PII	2,526*	12+00 to 35+59**	Modify profile, dimension, pattern
UT to Snow Creek	1,355	R	PII	454*	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 URS' 2008 longitudinal survey.

**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 II: 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	Unknown	Unknown	April 2005
Final Walk Through	Unknown	Unknown	July 2005
As-Built Report	Unknown	Unknown	December 2005
Warranty Repairs	2005	Unknown	April 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	--	--

Table III: Project Contact Table

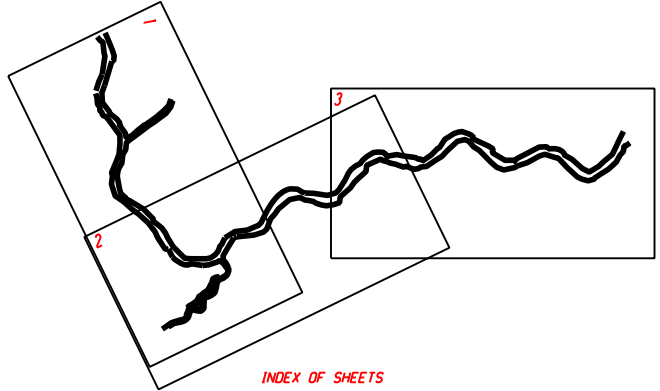
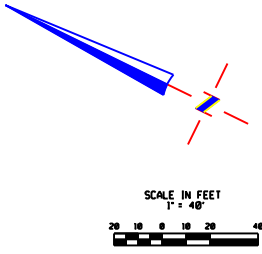
Snow Creek EEP Project Number 00344	
Designer Primary project design POC	EcoLogic Associates, P.C. 4321-A South Elm-Eugene Street Greensboro, NC 27406 Ken Bridle 336-355-8108
Construction Contractor Construction contractor POC	Shamrock Environmental PO Box 14987 Greensboro, NC 27415 Mike Granson 336-375-1989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

Table IV: Project Background 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	4 th
	Unnamed Tributary	2 nd
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

2.5 MONITORING PLAN VIEW

See Figure 2 for Monitoring Plan View.



- 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)

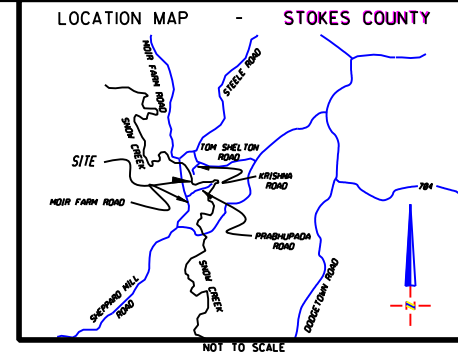
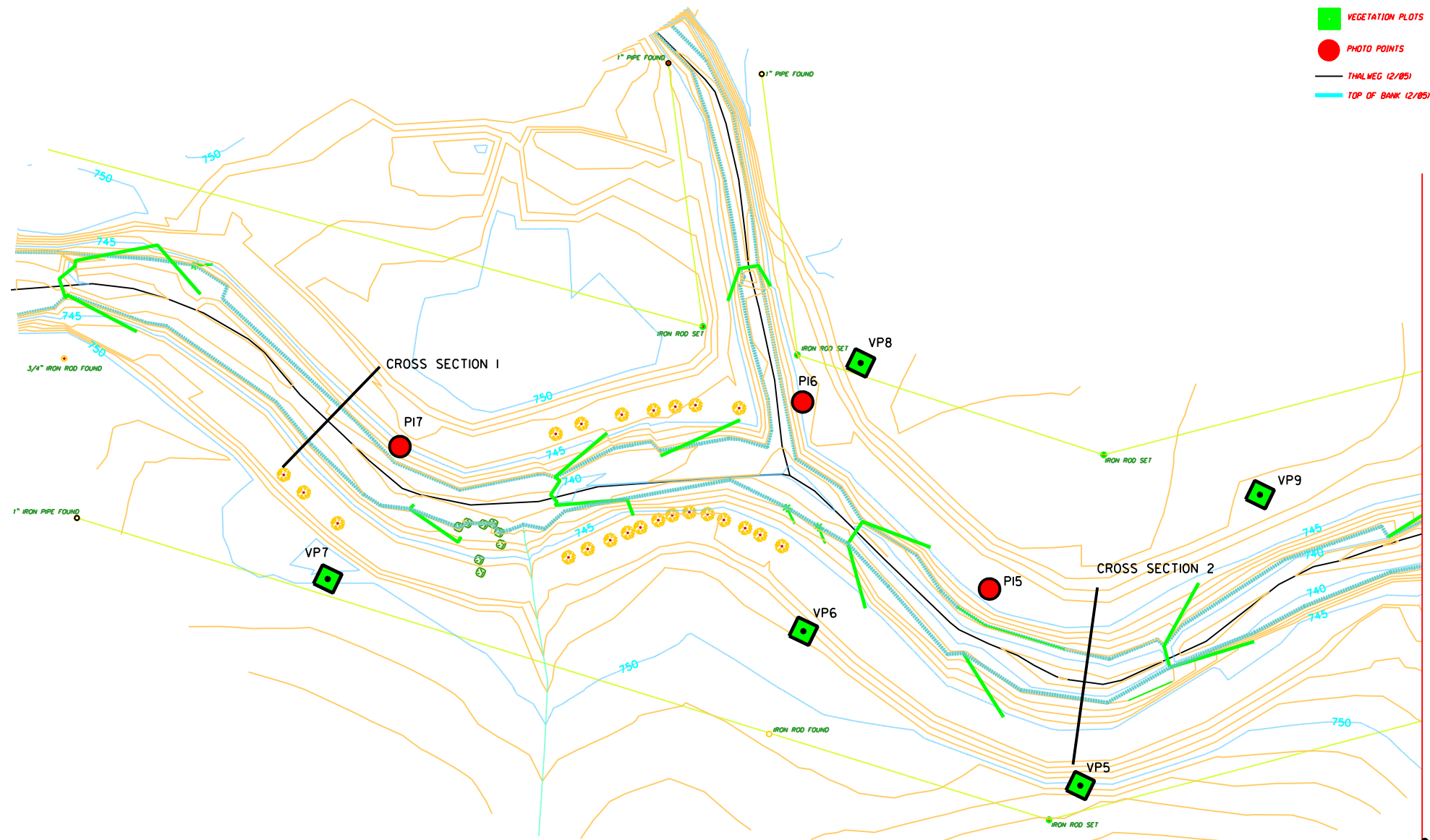


Photo Points		Veg Plots			
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2	986990.9	1664930	2	986435.1	1663280
3	987071.6	1664833	3	986561.4	1663373
4	987096.2	1664703	4	986695	1663101
5	987039.3	1664582	5	986881.3	1662913
6	987164.4	1664419	6	987084.5	1662935
7	987043.1	1664212	7	987281	1662828
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



I, KEITH P. GARRISON, CERTIFY THAT THIS PLAN 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 PLAN 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.

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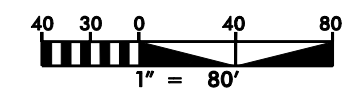
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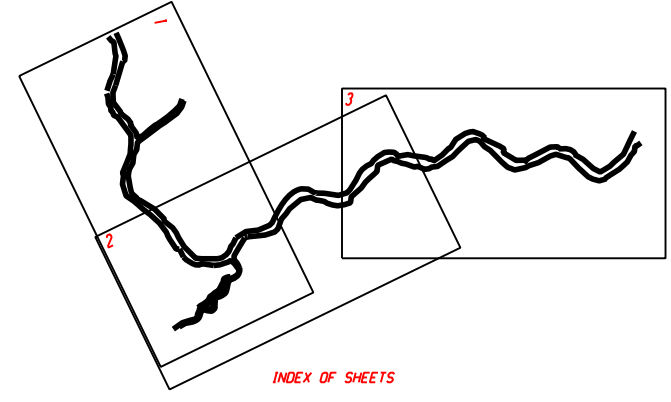
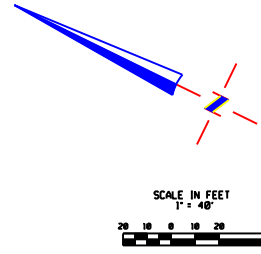
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PROJECT: SNOW CREEK STREAM RESTORATION
STREAM RESTORATION
2008 MONITORING REPORT
TITLE: MONITORING PLAN VIEW

CLIENT: NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

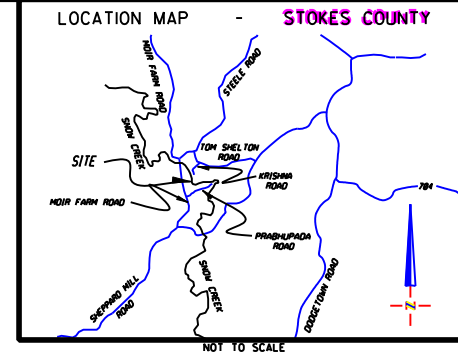
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TECHNICIAN: EHJ
CHECKED BY: KM
MONITORING YEAR 4
EEP PROJECT NO. 00344
SHEET NO. 1





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 - PHOTO POINTS
 - THALWEG (2/05)
 - TOP OF BANK (2/05)



REVISIONS

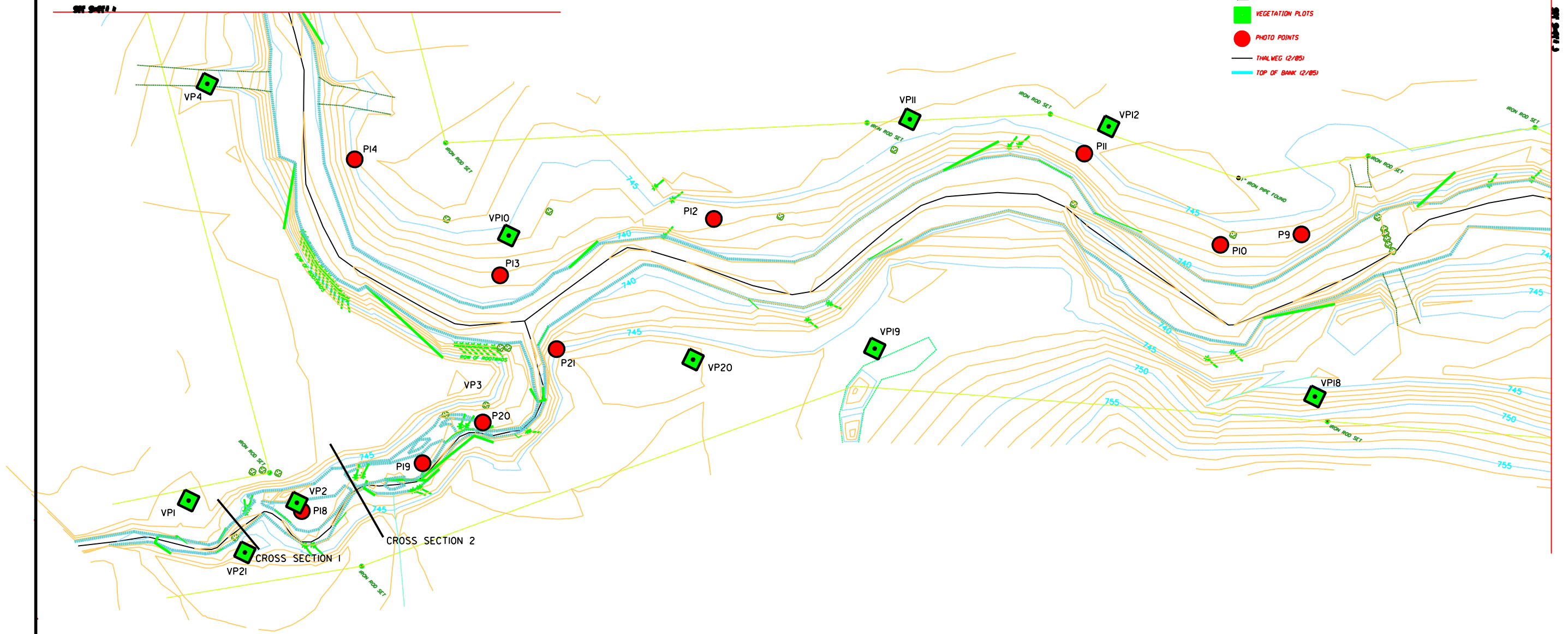
NO.	DATE

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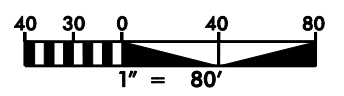
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 CHECKED BY: KM
 MONITORING YEAR 4
 EEP PROJECT NO. 00344
 SHEET NO. 2

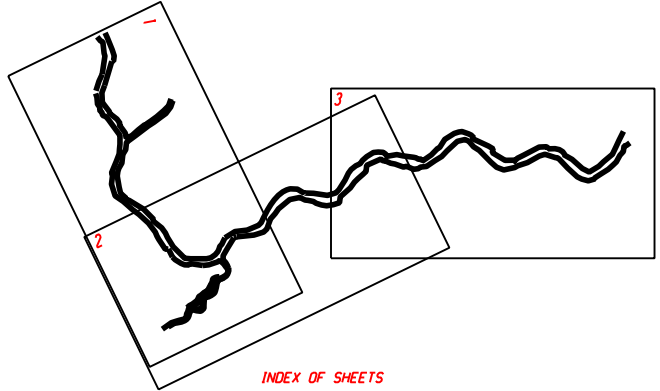
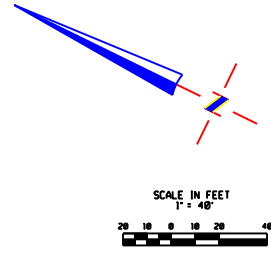


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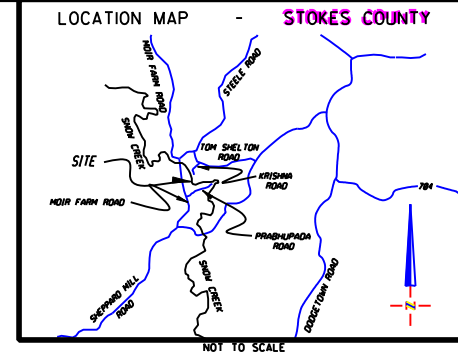
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 2. NO NCGS CONTROL MONUMENT FOUND WITHIN 2000 FEET.
 3. PROPERTY SUBJECT TO ANY AND ALL EASEMENTS, RIGHTS OF WAYS AND RECORDED OR UNRECORDED ENCUMBRANCES THAT MAY AFFECT SAID SUBJECT TRACT.
 4. NORTH BASED ON PLANS PREPARED BY ECOLOGIC ENTITLED "SNOW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

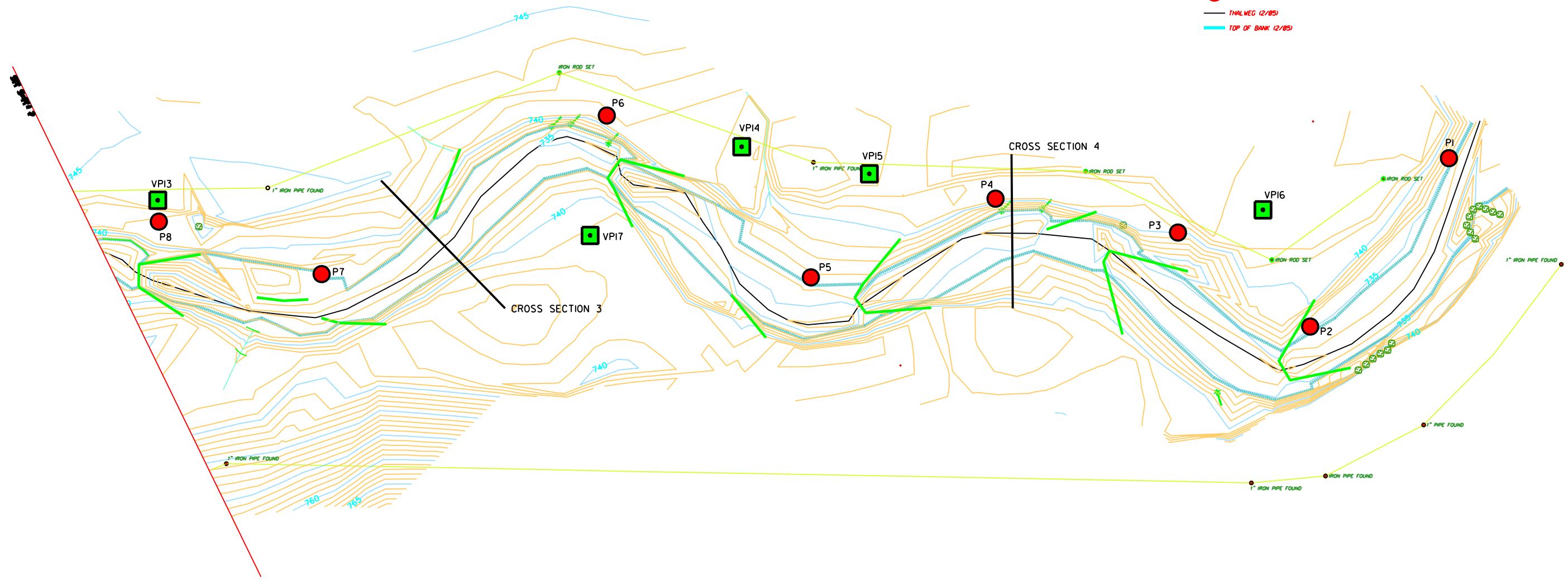
- LEGEND**
- IRON MARKER FOUND
 - IRON MARKER SET
 - △ STONE FOUND
 - PK NAIL FOUND
 - COMPUTED POINT
 - PK NAIL SET
 - CONCRETE NAIL SET
 - MAG NAIL SET
 - CONC. MONUMENT FOUND
 - ROOT WAD
 - CROSS VANE
 - VANE
 - ROCK OR STONE
 - ROW OF STONES
 - ROCK VANE
 - CONTOUR LINE
 - VEGETATION PLOTS
 - PHOTO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



REVISIONS

NO.	DATE

Prepared by
URS
 URS Corporation - North Carolina
 1600 Perimeter Park Drive
 Morrisville, North Carolina 27560
 TEL: 919-461-1100 FAX: 919-461-1415



PROJECT: SNOW CREEK STREAM RESTORATION
 2008 MONITORING REPORT
 TITLE: MONITORING PLAN VIEW



I, KEITH P. GARRISON, CERTIFY THAT THIS PLAN 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 PLAN 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, P.L.S.
 16
 101 INGLETON DR, MORRISVILLE, NC 27560
 NORTH CAROLINA PROFESSIONAL LAND SURVEYOR #L-4434

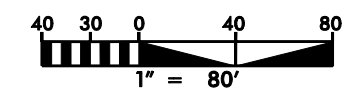


FIGURE 2

DATE: NOV 2008
TECHNICIAN: EHJ
CHECKED BY: KM
MONITORING YEAR 4
EEP PROJECT NO. 00344
SHEET NO. 3

3.0 PROJECT CONDITION AND MONITORING RESULTS

3.1 VEGETATION ASSESSMENT

3.1.1 VEGETATION PROBLEM AREAS

Although vegetation survival at the site is excellent, and up until the 2007 (MY3) monitoring period all vegetative problem areas were improving, the presence of beavers continues to affect the streamside vegetation. Beavers are using livestakes (namely black willow) to construct their dams along the mainstem and the Unnamed Tributary. Vegetation along Snow Creek has recovered from the storm events experienced by the site in 2007 (MY3), and volunteer species are populating previously bare areas.

The presence of exotic and invasive species continues to be a concern at the site. Japanese stilt grass (*Microstegium vimineum*) and mimosa (*Albizia julibrissin*) have begun populating the project buffer. While the current infestation is not severe, Japanese stilt grass is known to be an aggressive plant and prolific seed producer and will likely 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. Therefore, eradication of the Japanese stilt grass is recommended.

Six vegetative problem areas were identified in 2007 (MY3). One has been removed, and one added, leaving six problem areas present in 2008 (MY4). Vegetative Problem Area data tables are located in Appendix A-I. Vegetative Problem Area Photos are located in Appendix A-II.

3.1.2 VEGETATION CURRENT CONDITION PLAN VIEW

See Appendix A-III for the Vegetation Current Condition Plan View.

3.2 STREAM ASSESSMENT

3.2.1 PROCEDURAL ITEMS

3.2.1.1 Morphometric Criteria

Dimension and profile were sampled at a rate as per the USACE Stream Mitigation Guidelines (USACE 2003) and the 2005 (MY1) Monitoring Report (EcoLogic 2006) as follows:

Dimension: Four cross sections are located on Snow Creek for a total of three riffles and one pool. Two cross sections, a riffle and a pool, are located on the Unnamed Tributary. The cross sections are to include points at all breaks in slope.

Profile: The longitudinal survey includes 4,085 linear feet of Snow Creek and 454 linear feet of the unnamed tributary, for a total survey length of 4,539 linear feet. Measurements include thalweg, water surface, bankfull, and top of low bank.

3.2.1.2 Hydrologic Criteria

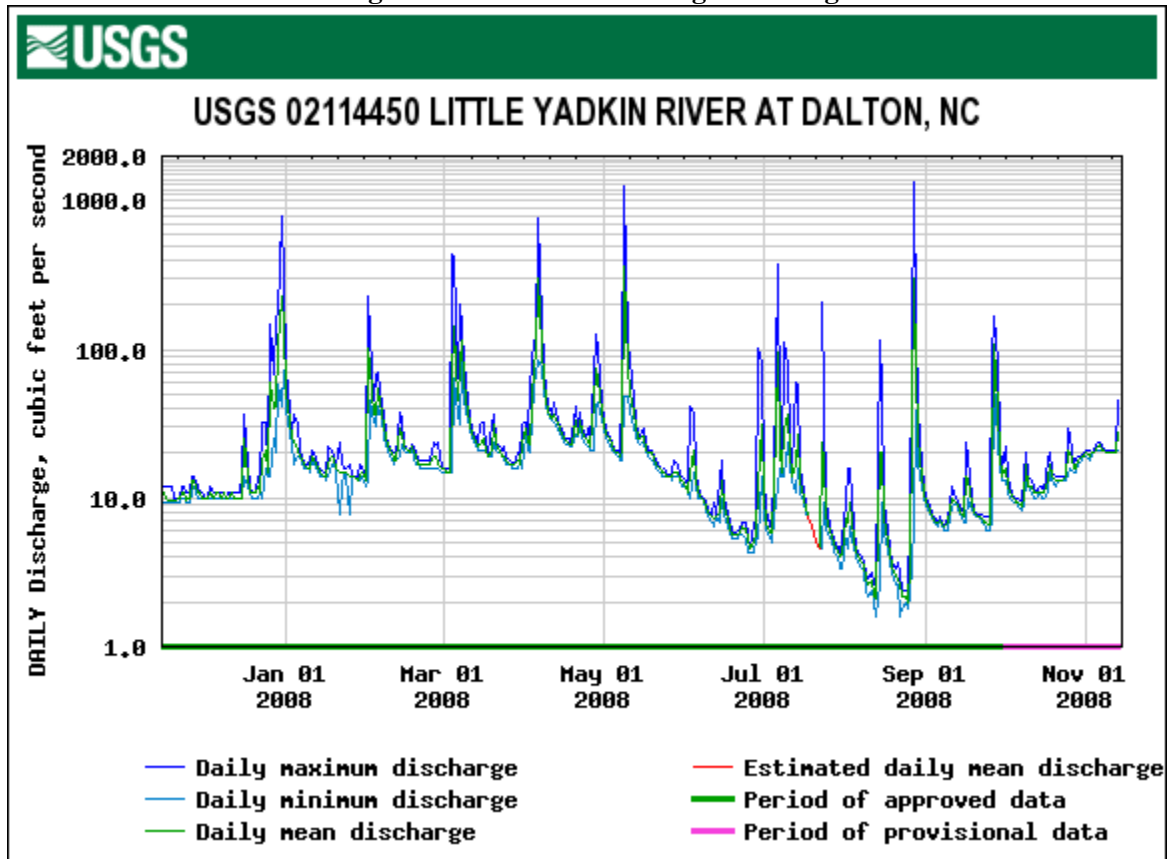
No crest gages are installed at this site to document bankfull events. Therefore, potential occurrence was extrapolated based on USGS stream gage discharge data for the Little Yadkin River at Dalton, NC (USGS 2008). The USGS gage plot is shown below (Figure 3). The gage is located about 25 miles from the project site and has a drainage area of 43 square miles. An estimate of the number of bankfull events in 2008 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 May and September of 2008, indicating that the Little Yadkin River has had two bankfull events this year (as of November 14, 2008). Snow Creek is in proximity to the Little Yadkin River, and it is likely that the project site also experienced two bankfull events during 2008.

Table V: 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

Figure 3: USGS Stream Gage Discharge Data



3.2.2 STREAM CURRENT CONDITION PLAN VIEW

Overall, the Snow Creek Stream Restoration Project is in very good condition. Up until the 2007 monitoring event, the problem areas listed in the initial monitoring reports, 2004 (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. The channel seems to be narrowing and has used the sand deposition from the 2007 storm(s) to aid in the process. However, increased beaver activity is negatively affecting the functioning of the site. Backwater extends approximately 800 linear feet along the mainstem and has altered the substrate and movement of materials.

A total of 14 stream problem areas were noted in 2007 (MY3). Eleven were removed during 2008 (MY4) monitoring and four additional areas added, leaving seven stream problem areas in 2008 (MY4).

Stream Problem Area data tables are located in Appendix B-II. The Stream Current Condition Plan View is located in Appendix B-I. Stream Current Condition Photos are located in Appendix B-III.

3.2.3 FIXED PHOTO STATION PHOTOS

Stream Photo Station Photos are located in Appendix B-IV.

3.2.4 STABILITY ASSESSMENT

Table VI: Categorical Stream Feature Visual Stability Assessment (% Functioning)

Snow Creek EEP Project Number 00344						
Feature	Initial*	MY-01**	MY-02	MY-03	MY-04	MY-05
A. Riffle	100	N/A	88	49	69	
B. Pool	100	N/A	90	100	93	
C. Thalweg	100	N/A	100	100	100	
D. Meanders	100	N/A	100	100	100	
E. Bed General	100	N/A	98	80.5	93	
F. Bank Condition	100	N/A	100	100	100	
G. Vanes / J Hooks	100	N/A	91	98	94	
H. Wads and Boulders	100	N/A	100	100	100	
Unnamed Tributary EEP Project Number 00344						
Feature	Initial*	MY-01**	MY-02	MY-03	MY-04	MY-05
A. Riffle	100	N/A	80	80	80	
B. Pool	100	N/A	100	93	93	
C. Thalweg	100	N/A	100	100	100	
D. Meanders	100	N/A	100	97	97	
E. Bed General	100	N/A	95	86	89	
F. Bank Condition	100	N/A	100	100	100	
G. Vanes / J Hooks	100	N/A	100	100	100	
H. Wads and Boulders	100	N/A	100	29	100	

* It is assumed that all were 100 percent functional upon completion of construction.

** No stability data are presented in the previous report.

3.2.5 QUANTITATIVE MEASURES TABLES (MORPHOLOGY AND HYDROLOGY)

Table VII: Baseline Morphology and Hydraulic Summary

Snow Creek EEP Project Number 00344																		
Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
BF Width (ft)	--	--	66	26	90	50	66	85	68	13.5	15.2	14.4	52	68	55	55	70	65
Floodprone Width (ft)	--	--	126	--	--	--	120	800+	535	25	125	94	80	800+	535	100	250	132
BF Cross Sectional Area (ft ²)	--	--	358	100	350	175	250	325	294	15.9	19	17.6	--	--	204	186	238	205
BF Mean Depth (ft)	--	--	5.4	2.5	6	4	4.2	5.5	4.3	1.1	1.4	1.2	--	--	3.7	2.7	3.7	3.5
BF Max Depth (ft)	--	--	6.4	--	--	--	5.7	8.1	6.2	1.5	1.9	1.7	--	--	5.4	5.1	7.5	5.5
Width/Depth Ratio	--	--	12.4	--	--	--	12	20	15.9	9.6	13.2	11.8	--	--	14.9	19	25	22
Entrenchment Ratio	--	--	--	--	--	--	--	--	1.4	1.0	1.5	1.18	--	--	1.0	--	--	1.0
Bank Height Ratio	--	--	1.9	--	--	--	6.6	8	7.8	6.6	7	6.6	--	--	9.7	1.4	1.9	1.6
Wetted Perimeter (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydraulic radius (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pattern																		
Channel Beltwidth (ft)	--	--	230	--	--	--	75	150	120	--	--	42	--	--	175	100	250	170
Radius of Curvature (ft)	--	--	155	--	--	--	75	125	100	--	--	25	--	--	127	85	168	130
Meander Wavelength (ft)	--	--	420	--	--	--	320	450	360	--	--	97	--	--	385	320	400	360
Meander Width Ratio	--	--	6.3	--	--	--	--	--	1.75	--	--	2.9	--	--	3.2	--	--	6.4

Table VII: Baseline Morphology and Hydraulic Summary (cont.)

Snow Creek EEP Project Number 00344																		
Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Profile																		
Riffle Length (ft)	--	--	95	--	--	--	5	65	42	20	109	53	25	100	50	27	77	45
Riffle Slope (ft/ft)	--	--	0.004	--	--	--	--	--	0.020	--	--	0.017	--	--	0.005	0.002	0.056	0.005
Pool Length (ft)	--	--	200	--	--	--	25	145	93	10	28	18.7	--	--	72	64	262	129
Pool Spacing (ft)	--	--	444	--	--	--	210	630	397	50	88	69	55	231	155	23	271	149
Substrate																		
d50 (mm)	--	--	13.3	--	--	--	--	--	9.4	--	--	18.4	--	--	9.4	--	--	--
d84 (mm)	--	--	69	--	--	--	--	--	54	--	--	73	--	--	54	--	--	--
Additional Reach Parameters																		
Valley Length (ft)	--	--	575	--	--	--	--	--	2200	--	--	895	--	--	2200	--	--	2200
Channel Length (ft)	--	--	745	--	--	--	--	--	3000	--	--	1074	--	--	3400	--	--	3404
Sinuosity	--	--	1.3	--	--	--	--	--	1.4	--	--	1.2	--	--	1.5	--	--	1.54
Water Surface Slope (ft/ft)	--	--	0.003	--	--	--	--	--	0	--	--	0.012	--	--	0.002	--	--	0.012
BF Slope (ft/ft)	--	--	0.003	--	--	--	--	--	0	--	--	0.012	--	--	0.002	--	--	
Rosgen Classification	--	--	B4	--	--	--	--	--	C4/1	--	--	C4	--	--	C4/1	--	--	C4/1

Table VII: Baseline Morphology and Hydraulic Summary (cont.)

Unnamed Tributary EEP Project Number 00344																		
Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
BF Width (ft)	--	--	66	6.5	25	13	66	85	68	13.5	15.2	14.4	9	15	12	7.8	13	8.5
Floodprone Width (ft)	--	--	126	--	--	--	120	800+	535	25	125	94	25	45	30	25	75	35
BF Cross Sectional Area (ft ²)	--	--	358	8.5	35	17	250	325	294	15.9	19	17.6	--	--	9.6	7.8	11	8
BF Mean Depth (ft)	--	--	5.4	0.8	2.2	1.4	4.2	5.5	4.3	1.1	1.4	1.2	--	--	0.8	0.5	1	0.6
BF Max Depth (ft)	--	--	6.4	--	--	--	5.7	8.1	6.2	1.5	1.9	1.7	--	--	1.2	0.8	1.2	1
Width/Depth Ratio	--	--	12.4	--	--	--	12	20	15.9	9.6	13.2	11.8	--	--	15	10.2	19.3	13.24
Entrenchment Ratio	--	--	1.9	--	--	--	6.6	8	7.8	6.6	7	6.6	--	--	2.5	4.5	8	5.2
Bank Height Ratio	--	--	--	--	--	--	1.8	4.1	2.2	1.0	1.5	1.18	--	--	1.0	--	--	1.0
Wetted Perimeter (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8
Hydraulic radius (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pattern																		
Channel Beltwidth (ft)	--	--	230	--	--	--	75	150	120	--	--	42	35	55	40	40	65	45
Radius of Curvature (ft)	--	--	155	--	--	--	75	125	100	--	--	25	25	35	28	15	35	20
Meander Wavelength (ft)	--	--	420	--	--	--	320	450	360	--	--	97	76	94	84	65	95	87
Meander Width Ratio	--	--	6.3	--	--	--	--	--	1.75	--	--	2.9	--	--	7	--	--	10.8

Table VII: Baseline Morphology and Hydraulic Summary (cont.)

Unnamed Tributary EEP Project Number 00344																		
Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Profile																		
Riffle Length (ft)	--	--	95	--	--	--	5	65	42	20	109	53	12	25	18	8	22	16
Riffle Slope (ft/ft)	--	--	0	--	--	--	--	--	0.020	--	--	0.017	--	--	0	0.015	0.040	0.030
Pool Length (ft)	--	--	200	--	--	--	25	145	93	10	28	18.7	--	--	16	9.2	38.1	17
Pool Spacing (ft)	--	--	444	--	--	--	210	630	397	50	88	69	35	65	52	12	68	42
Substrate																		
d50 (mm)	--	--	13.3	--	--	--	--	--	9.4	--	--	18.4	--	--	11	--	--	1.6
d84 (mm)	--	--	69	--	--	--	--	--	54	--	--	73	--	--	68	--	--	6.6
Additional Reach Parameters																		
Valley Length (ft)	--	--	575	--	--	--	--	--	382	--	--	895	--	--	382	--	--	382
Channel Length (ft)	--	--	745	--	--	--	--	--	700	--	--	1074	--	--	450	--	--	454
Sinuosity	--	--	1.3	--	--	--	--	--	1.8	--	--	1.2	--	--	1.2	--	--	1.2
Water Surface Slope (ft/ft)	--	--	0.003	--	--	--	--	--	0.002	--	--	0.012	--	--	0	--	--	0.010
BF Slope (ft/ft)	--	--	0.003	--	--	--	--	--	0.002	--	--	0.012	--	--	0	--	--	0.010
Rosgen Classification	--	--	B4	--	--	--	--	--	C5	--	--	C4	--	--	C4	--	--	C4

Table VIII: Morphology and Hydraulic Monitoring Summary

Snow Creek EEP Project Number 00344																				
Parameter	Cross Section 1 Riffle					Cross Section 2 Pool					Cross Section 3 Riffle					Cross Section 4 Riffle				
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	68	52.9	55.9	55.7		75.6	61.5	75.0	52.0		63	46.9	48.1	47.5		67	63.3	64.7	65.1	
Floodprone Width (ft)	132	>133	>133	>140		151	>132	>150	>150		107	>97.7	>100	>105		100	>98.7	>100	>100	
BF Cross Sectional Area (ft ²)	186	169.9	161.1	181.4		249	237.2	220.4	200.6		205	125.9	145.9	142.8		238	238.8	238.3	214.9	
BF Mean Depth	2.7	3.2	2.9	3.3		3.3	3.9	2.9	3.9		3.2	2.7	3.0	3.0		3.5	3.8	3.7	3.3	
BF Max Depth	5.1	5.1	5.2	5.2		7.5	8.1	6.9	6.9		4.7	4.0	4.8	4.4		5.6	5.6	5.7	5.7	
Width/Depth Ratio	25	16.5	19.4	17.1		22.9	15.9	25.5	13.5		19.7	17.5	15.8	15.8		19.2	16.8	17.6	19.7	
Entrenchment Ratio	1.9	>2.5	>2.4	>2.5		2	>2.1	>2.0	>2.9		1.7	>2.1	>2.1	>2.2		1.48	>1.6	>1.5	>1.5	
Bank Height Ratio	--	1.0	1.0	1.0		--	1.0	1.0	1.0		--	1.0	1.0	1.0		--	1.0	1.0	1.0	
Wetted Perimeter (ft)	69.7	55.8	58.6	58.6		77.6	64.1	77.7	54.5		65.2	48.7	50.2	50.1		69	68.8	69.5	69.5	
Hydraulic radius (ft)	2.7	3.0	2.7	3.1		3.2	3.7	2.8	3.7		3.2	2.6	2.9	2.8		3.5	3.5	3.4	3.1	
Substrate																				
d50 (mm)	37.6	37	8.5	23		4.85	37	0.4	0.12		10.4	8	0.8	20		12.1	21	0.6	0.93	
d84 (mm)	102.7	94	29	57		24.2	94	3.8	0.54		40.4	47	4.3	53		36.3	56	21	6.9	

Table VIII: Morphology and Hydraulic Monitoring Summary (cont.)

Snow Creek EEP Project Number 00344															
Parameter	MY1			MY2			MY3			MY4			MY5		
Pattern	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Channel Beltwidth (ft)	100	250	170	--	--	--	50	250	133	66	204	128			
Radius of Curvature (ft)	85	168	130	--	--	--	120	185	135	40	114	84			
Meander Wavelength (ft)	320	400	360	--	--	--	325	510	389	282	444	363			
Meander Width Ratio	1.5	3.7	2.5	--	--	--	0.9	4.5	2.4	5.2	8.6	6.9			
Profile															
Riffle Length (ft)	27.7	77.1	45.4	15.0	110.0	63	24	118	71	35	113	64.1			
Riffle Slope (ft/ft)	0.0056	0.015	0.010	0.0004	0.009	0.004	0.004	0.014	0.009	0.0015	0.02	0.009			
Pool Length (ft)	64.7	262	129	27.0	239.0	65.0	27	96	70	14.7	256.3	60.5			
Pool Spacing (ft)	23	271	149	35	287	138	53	300	168	26	1003.9	181.9			
Additional Reach Parameters															
Valley Length (ft)	--	--	2200	--	--	2200	--	--	2129	--	--	2214			
Channel Length (ft)	--	--	3404	--	--	3559	--	--	4182	--	--	4085			
Sinuosity	--	--	1.5	--	--	1.6	--	--	2.0	--	--	1.8			
Water Surface Slope (ft/ft)	--	--	0.002	--	--	0.003	--	--	0.003	--	--	0.002			
BF Slope (ft/ft)	--	--	0.003	--	--	0.002	--	--	0.001	--	--	0.002			
Rosgen Classification	--	--	C	--	--	C4	--	--	C4	--	--	C4			

Table VIII: Morphology and Hydraulic Monitoring Summary (cont.)

Unnamed Tributary EEP Project Number 00344										
Parameter	Cross Section 1 Pool					Cross Section 2 Riffle				
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
Dimension										
BF Width (ft)	10.9	14.4	13.8	13.9		7.8	12.3	14.1	10.5	
Floodprone Width (ft)	59	66.5	45.8	61.0		41	48.3	45.9	54.5	
BF Cross Sectional Area (ft ²)	11	15.4	17.1	18.0		4.7	8.1	10.7	12.9	
BF Mean Depth	1	1.1	1.2	1.3		0.6	0.7	0.8	1.2	
BF Max Depth	2	2.3	2.6	2.5		1	1.8	1.9	2.2	
Width/Depth Ratio	10.8	13.5	11.1	10.7		13.2	18.7	18.6	8.6	
Entrenchment Ratio	--	1.0	1.0	4.4		--	1.0	1.0	5.2	
Bank Height Ratio	5.4	4.6	3.3	1.0		5.2	3.9	3.3	1.0	
Wetted Perimeter (ft)	11.8	16.1	14.8	14.8		8.2	13.5	15.3	11.4	
Hydraulic radius (ft)	0.9	1.0	1.2	1.2		0.57	0.6	0.7	1.1	
Substrate										
d50 (mm)	0.56	0.43	0.29	3.2		1.64	16	2.4	2.2	
d84 (mm)	4.0	4.9	2.8	17		6.58	38	11	13	

Table VIII: Morphology and Hydraulic Monitoring Summary (cont.)

Unnamed Tributary EEP Project Number 00344															
Parameter	MY1			MY2			MY3			MY4			MY5		
Pattern	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Channel Beltwidth (ft)	40	65	45	--	--	--	18	40	26	30	60	45			
Radius of Curvature (ft)	15	35	20	--	--	--	15	40	30	20	36	29			
Meander Wavelength (ft)	65	95	87	--	--	--	65	100	78	78	108	89			
Meander Width Ratio	5.9	8.7	10.8	--	--	--	2	2.8	1.9	2.2	4.6	4.2			
Profile															
Riffle Length (ft)	6.1	12.3	8.8	11	33	19	9	30	18	5.8	21	12.2			
Riffle Slope (ft/ft)	0.015	0.043	0.031	0.008	0.028	0.014	0.000	0.030	0.014	0.0052	0.033	0.022			
Pool Length (ft)	9.2	38.1	16.9	12	41	22	11	45	24	0	72	23.5			
Pool Spacing (ft)	11.83	67.8	42.4	14	74	32	18	79	35	16.4	83	40			
Additional Reach Parameters															
Valley Length (ft)	--	--	382	--	--	382	--	--	382	--	--	317			
Channel Length (ft)	--	--	464	--	--	454	--	--	482	--	--	454			
Sinuosity	--	--	1.2	--	--	1.2	--	--	1.3	--	--	1.4			
Water Surface Slope (ft/ft)	--	--	0.013	--	--	0.014	--	--	0.017	--	--	0.022			
BF Slope (ft/ft)	--	--	0.011	--	--	0.013	--	--	0.0167	--	--	0.0089			
Rosgen Classification	--	--	C	--	--	C5	--	--	C4	--	--	E4			

4.0 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. Permanent photo station photographs were taken from locations marked in the 2005 (MY1) Monitoring Report, prepared by EcoLogic Associates.

4.1 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.

4.2 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 (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 livestock 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 (*Cornus amomum*) and black willow. 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). The sand deposition experienced 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, that 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) remains, the same basic methodologies used for vegetation sampling in 2007 (MY3) were used in 2008 (MY4). It is likely that many of the stems are still buried under (at least) several inches of sand, thus making ddh measurements inaccurate. During 2008 (MY4) monitoring URS recorded approximate height and dbh for planted stems listed on data sheets during 2007 (MY3) and reflagged planted stems.

Vegetation survey data tables are located in Appendix A-I. Vegetation Plot Photos are located in Appendix A-IV.

5.0 REFERENCES

EcoLogic Associates, P.C. 2002. Snow Creek Stream Restoration Design Report. Prepared for NC Ecosystem Enhancement Program. September 2002.

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Lee, Michael T., Peek, Robert K., Roberts, Steven D., Wentworth, Thomas R. 2006. CVS-EEP Protocol for Recording Vegetation. Version 4.0. (<http://cvs.bio.unc.edu/methods.htm>)

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USGS. 2008. Little Yadkin River at Dalton, NC streamflow gage. USGS Real-Time Water Data. Gage 02114450. <http://waterdata.usgs.gov>.

Weakley, A.S. 2007. Flora of the Carolinas, Virginia, Georgia, and surrounding Areas. Working Draft as of 11 January 2007. UNC Herbarium. North Carolina Botanical Garden. UNC at Chapel Hill.

Appendices

Appendix A: Vegetation Raw Data

Appendix A-I: Vegetation Survey Data Tables

Table A1: Vegetation Metadata

Report Prepared By	Susan Shelingoski
Date Prepared	11/25/2008 16:21
database name	BigWarrior_Beaver_Silas_Snow Database.mdb
database location	P:\Jobs3\31825348_Monitoring\Veg\2008 DATABASES
computer name	RDUXPL160
file size	54956032
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	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 A2: Vegetation Vigor by Species

	Species	4	3	2	1	0	Missing	Unknown
	Alnus serrulata		2				6	
	Aronia arbutifolia		1	1		1	5	
	Betula nigra		1					
	Cornus amomum	1	237	3	1	41	63	
	Cornus florida		5				11	
	Nyssa sylvatica			2			3	
	Quercus velutina		1					
	Salix nigra	27	98	5		29	35	
	Sambucus canadensis		7				4	
	Alnus		1					
	Cercis canadensis						2	
	Quercus rubra			1		1		
	Platanus occidentalis	6	3					
	Crataegus						6	
	Prunus serotina	1						
	Unknown						2	
TOT:	16	35	356	12	1	72	137	

Table A3: Vegetation Damage by Species

	Species	All Damage Categories	(no damage)	Beaver	Storm	Unknown
	Alnus	1	1			
	Alnus serrulata	8	8			
	Aronia arbutifolia	8	8			
	Betula nigra	1	1			
	Cercis canadensis	2	2			
	Cornus amomum	346	314	6	24	2
	Cornus florida	16	16			
	Crataegus	6	6			
	Nyssa sylvatica	5	5			
	Platanus occidentalis	9	9			
	Prunus serotina	1	1			
	Quercus rubra	2	1			1
	Quercus velutina	1	1			
	Salix nigra	198	166	29	1	2
	Sambucus canadensis	11	11			
	Unknown	2	2			
TOT:	16	617	552	35	25	5

Table A4: Vegetation Damage by Plot

	plot	All Damage Categories	(no damage)	Beaver	Storm	Unknown
	344-01-0003-year:4	72	72			
	344-01-0005-year:4	13	13			
	344-01-0007-year:4	34	34			
	344-01-0008-year:4	39	39			
	344-01-0010-year:4	24	15	8		1
	344-01-0011-year:4	120	99	21		
	344-01-0013-year:4	67	50		17	
	344-01-0015-year:4	20	15		5	
	344-01-0016-year:4	45	41		3	1
	344-01-0017-year:4	27	25			2
	344-01-0018-year:4	85	78	6		1
	344-01-0021-year:4	71	71			
TOT:	12	617	552	35	25	5

Table A5: Stem Count by Plot and Species

	Species	Total Planted Stems	# plots	avg# stems	plot 344-01-0003-year:4	plot 344-01-0005-year:4	plot 344-01-0007-year:4	plot 344-01-0008-year:4	plot 344-01-0010-year:4	plot 344-01-0011-year:4	plot 344-01-0013-year:4	plot 344-01-0015-year:4	plot 344-01-0016-year:4	plot 344-01-0017-year:4	plot 344-01-0018-year:4	plot 344-01-0021-year:4
	Alnus	1	1	1												1
	Alnus serrulata	2	2	1		1										1
	Aronia arbutifolia	2	1	2				2								
	Betula nigra	1	1	1												1
	Cornus amomum	242	11	22	54	1	17	3		61	38	3	16	12	19	18
	Cornus florida	5	1	5											5	
	Nyssa sylvatica	2	1	2				2								
	Platanus occidentalis	9	3	3					1						2	6
	Prunus serotina	1	1	1											1	
	Quercus rubra	1	1	1				1								
	Quercus velutina	1	1	1	1											
	Salix nigra	130	12	10.83	5	10	12	21	12	20	7	2	13	9	2	17
	Sambucus canadensis	7	4	1.75			2		1			1				3
TOT:	13	404	13		60	12	31	29	14	81	45	6	29	21	29	47

Table A6: Vegetative Problem Areas

Snow Creek EEP Project Number 00344				
Feature #	Feature/Issue	Station # / Range	Probable Cause	Photo #
VPA1	Poor survival	12+50 to 12+80	Beaver activity	VPA1
VPA2	Invasive/exotic plant	19+90 to 20+40	Microstegium	VPA2
VPA3	Poor survival	21+40 to 25+50	Beaver activity	VPA3
VPA4	Invasive/exotic plant	25+80 to 26+30	Mimosa	VPA4
VPA5	Bare bank	6+20 to 7+50	Poor vegetation survival	VPA5
VPA6	Poor survival	15+90 to 16+40	Beaver activity	VPA6
Unnamed Tributary EEP Project Number 00344				
UTVPA1	Poor survival	3+50 to 4+00	Beaver activity	UTVPA1

Appendix A-II: Vegetative Problem Area Photos



VPA1 on left bank (11/19/08)



VPA2 on right bank (11/20/08)



VPA3 facing left bank (9/10/08)



VPA4 facing left bank (9/10/08)



VPA5 on right bank (11/19/08)

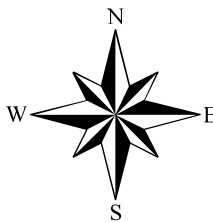


VPA6 on left bank (11/20/08)



UTVPA1 on right bank (11/19/08)

Appendix A-III: Vegetation Current Condition Plan View



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 Enhancement Program



Project:
 Snow Creek
 Stream Restoration
 Stokes County, NC

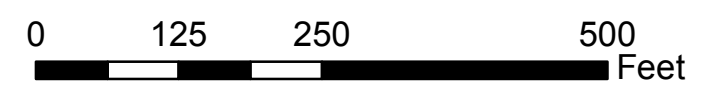
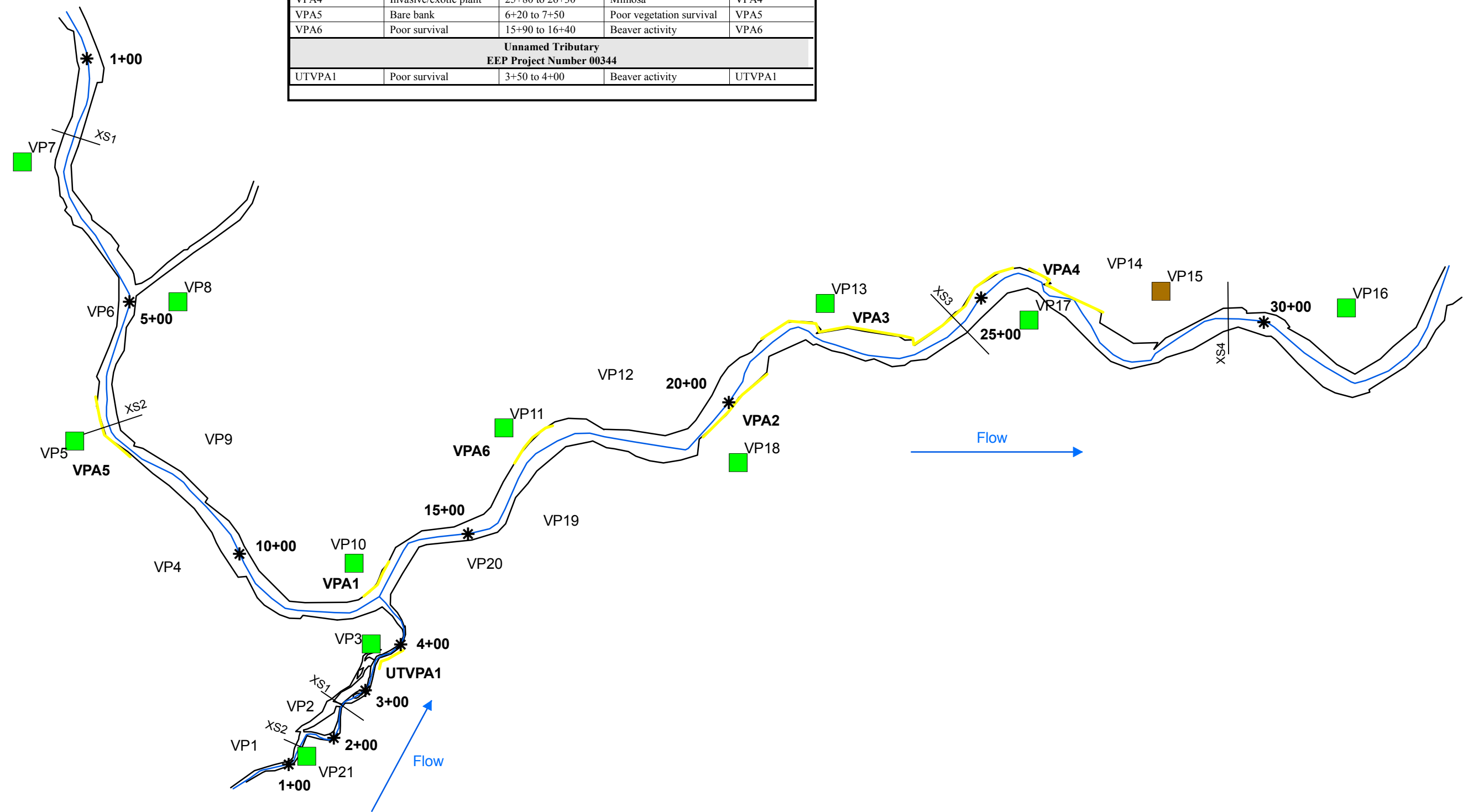
Monitoring Year:
 4 (2008)

Project Number:
 00344

Date:
 February 2009

- Legend**
- Problem Area Concern
 - * Stations
 - Cross Section
 - As-Built Centerline
 - As-Built Streambank
 - Vegetation Plot Meeting Success Criteria
 - Vegetation Plot Not Meeting Success Criteria

Snow Creek EEP Project Number 00344				
Feature #	Feature/Issue	Station # / Range	Probable Cause	Photo #
VPA1	Poor survival	12+50 to 12+80	Beaver activity	VPA1
VPA2	Invasive/exotic plant	19+90 to 20+40	Microstegium	VPA2
VPA3	Poor survival	21+40 to 25+50	Beaver activity	VPA3
VPA4	Invasive/exotic plant	25+80 to 26+30	Mimosa	VPA4
VPA5	Bare bank	6+20 to 7+50	Poor vegetation survival	VPA5
VPA6	Poor survival	15+90 to 16+40	Beaver activity	VPA6
Unnamed Tributary EEP Project Number 00344				
UTVPA1	Poor survival	3+50 to 4+00	Beaver activity	UTVPA1



Vegetation
 Current Condition
 Plan View

Appendix A-IV: Vegetation Monitoring Plot Photos



VP3



VP5



VP7



VP8



VP10



VP11



VP13



VP15



VP16



VP17



VP18

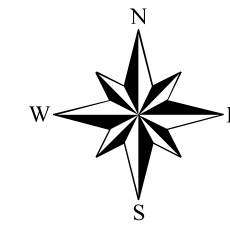


VP21

Appendix B: Geomorphic Raw Data

Appendix B-I: Stream Current Condition Plan View

Snow Creek EEP Project Number 00028				
Feature #	Feature/Issue	Station # / Range	Probable Cause	Photo #
PA4	Beaver dam	13+00	Beaver activity	PA4
PA6	Structure degradation	17+50	Slipped rock on left arm	PA6
PA8	Mid channel bar / aggradation	22+00 to 23+10	Storm event	PA8
PA14	Structure failure	28+80	Improper design and/or construction	PA14
PA15	Beaver dam	Tributary off site	Beaver activity	PA15
PA16	Beaver dam	16+00	Beaver activity	PA15
Snow Creek EEP Project Number 00028				
UTPA2	Beaver dam	4+50	Beaver activity	UTPA2



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 Enhancement Program



Project:
 Snow Creek
 Stream Restoration
 Stokes County, NC

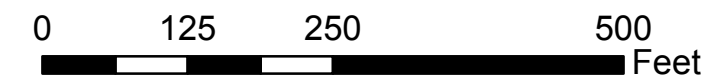
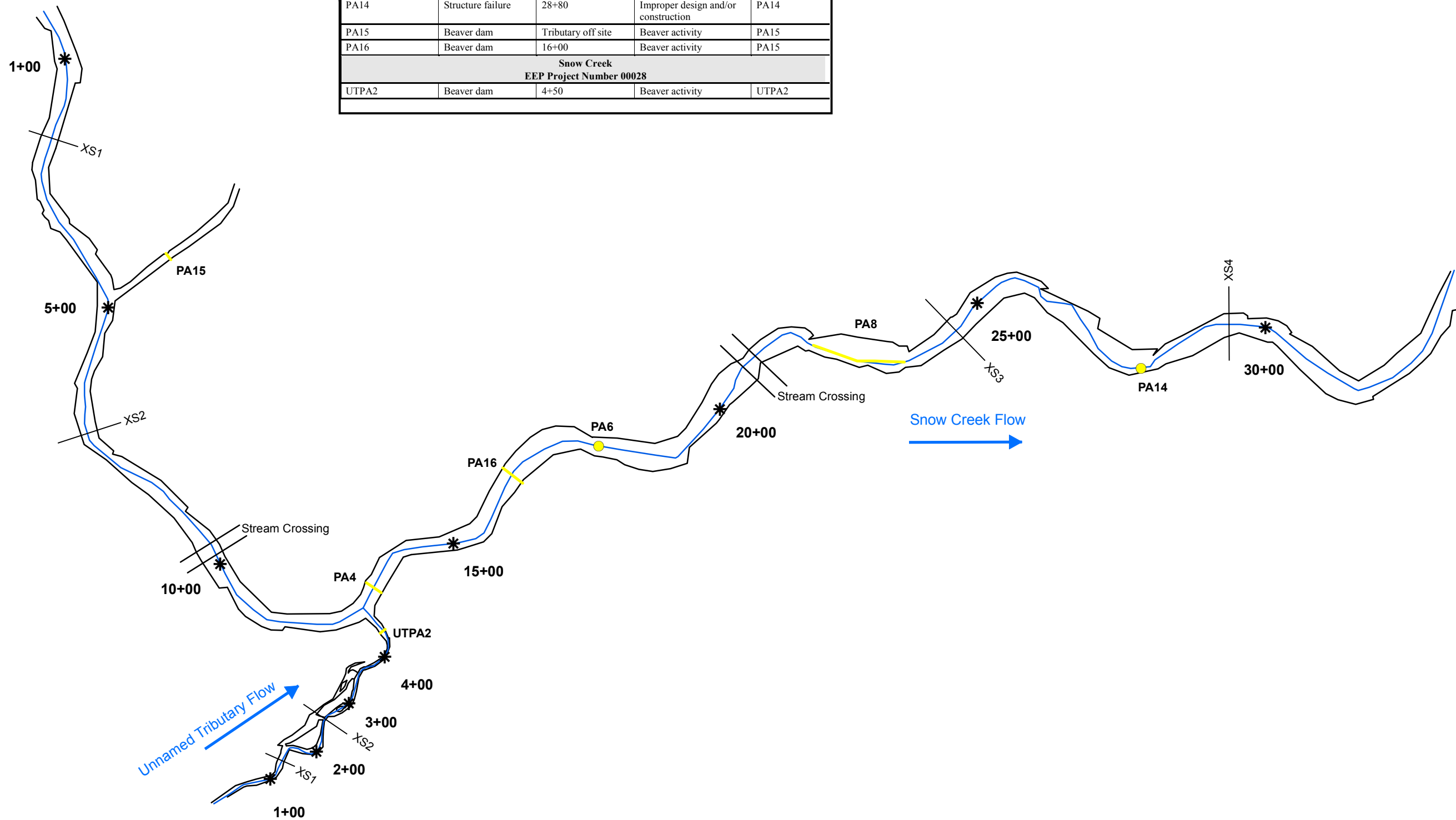
Monitoring Year:
 4 (2008)

Project Number:
 00344

Date:
 February 2009

Legend

- Problem Area Concern
- Problem Area Concern
- *** Stations
- Cross Section
- As-Built Centerline
- As-Built Streambank



Stream
 Current Condition
 Plan View

Appendix B-II: Stream Problem Areas Data Table

Table B1: Stream Problem Areas

Snow Creek				
EEP Project Number 00028				
Feature #	Feature/Issue	Station # / Range	Probable Cause	Photo #
PA4	Beaver dam	13+00	Beaver activity	PA4
PA6	Structure degradation	17+50	Slipped rock on left arm	PA6
PA8	Mid channel bar / aggradation	22+00 to 23+10	Storm event	PA8
PA14	Structure failure	28+80	Improper design and/or construction	PA14
PA15	Beaver dam	Tributary off site	Beaver activity	PA15
PA16	Beaver dam	16+00	Beaver activity	PA15
Unnamed Tributary				
EEP Project Number 00028				
UTPA2	Beaver dam	4+50	Beaver activity	UTPA2

Appendix B-III: Representative Stream Problem Area Photos



PA4 facing left bank (9/10/08)



PA6 facing upstream (9/10/08)



PA8 facing downstream (9/10/08)



PA14 facing left bank (9/10/08)



PA15 facing upstream (11/19/08)



PA16 facing right bank (11/20/08)



UTVPA2 facing upstream (11/19/08)

Appendix B-IV: 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 B-V: Visual Morphological Stability Assessment Table

Table B2: Visual Morphological Stability Assessment

Snow Creek 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?	8	16	N/A	50	
	Armor stable (no displacement)?	13	16	N/A	81	
	Facet grade appears stable?	13	16	N/A	81	
	Minimal evidence of embedding/fining?	8	16	N/A	50	
	Length appropriate?	13	16	N/A	81	
						69
B. Pools	Present (not subject to severe aggrad. or migration)?	17	19	N/A	89	
	Sufficiently deep (max pool D:mean Bkf >1.6)	19	19	N/A	100	
	Length appropriate?	17	19	N/A	89	
						93
C. Thalweg	Upstream of meander bend (run/inflection) centering?	4085	4085	N/A	100	
	Downstream of meander (glide/inflection) centering?	4085	4085	N/A	100	
						100
D. Meanders	Outer bend in state of limited/controlled erosion?	19	19	N/A	100	
	Of those eroding, # w/concomitant point bar formation?	19	19	N/A	100	
	Apparent Rc within spec?	19	19	N/A	100	
	Sufficient floodplain access and relief?	19	19	N/A	100	
						100
E. Bed General	General channel bed aggradation areas (bar formation)	3485	4085	3/600	85	
	Channel bed degradation—areas of increasing downcutting/headcutting?	4085	4085	0	100	
						93
F. Bank	Actively eroding, wasting, or slumping bank	4085	4085	0	100	
						100
G. Vanes	Free of back or arm scour?	23	25	N/A	92	
	Height appropriate?	24	25	N/A	96	
	Angle and geometry appear appropriate?	24	25	N/A	96	
	Free of piping or other structural failures?	23	25	N/A	92	
						94
H. Wads/ Boulders	Free of scour?	1	1	N/A	100	
	Footing stable?	1	1	N/A	100	
						100

**Unnamed Tributary
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	N/A	67	
	Armor stable (no displacement)?	6	6	N/A	100	
	Facet grade appears stable?	6	6	N/A	100	
	Minimal evidence of embedding/fining?	4	6	N/A	67	
	Length appropriate?	4	6	N/A	67	
						80
B. Pools	Present (not subject to severe aggrad. or migration)?	9	9	N/A	100	
	Sufficiently deep (max pool D:mean Bkf >1.6)	9	9	N/A	100	
	Length appropriate?	7	9	N/A	78	
						93
C. Thalweg	Upstream of meander bend (run/inflection) centering?	454	454	N/A	100	
	Downstream of meander (glide/inflection) centering?	454	454	N/A	100	
						100
D. Meanders	Outer bend in state of limited/controlled erosion?	8	8	N/A	100	
	Of those eroding, # w/concomitant point bar formation?	8	8	N/A	100	
	Apparent Rc within spec?	7	8	N/A	88	
	Sufficient floodplain access and relief?	8	8	N/A	100	
						97
E. Bed General	General channel bed aggradation areas (bar formation)	354	454	5/100	78	
	Channel bed degradation—areas of increasing downcutting/headcutting?	454	454	0	100	
						89
F. Bank	Actively eroding, wasting, or slumping bank	454	454	0	100	
						100
G. Vanes	Free of back or arm scour?	7	7	N/A	100	
	Height appropriate?	7	7	N/A	100	
	Angle and geometry appear appropriate?	7	7	N/A	100	
	Free of piping or other structural failures?	7	7	N/A	100	
						100
H. Wads/ Boulders	Free of scour?	7	7	N/A	100	
	Footing stable?	7	7	N/A	100	
						100

Appendix B-VI: Cross Section Photos and Plots

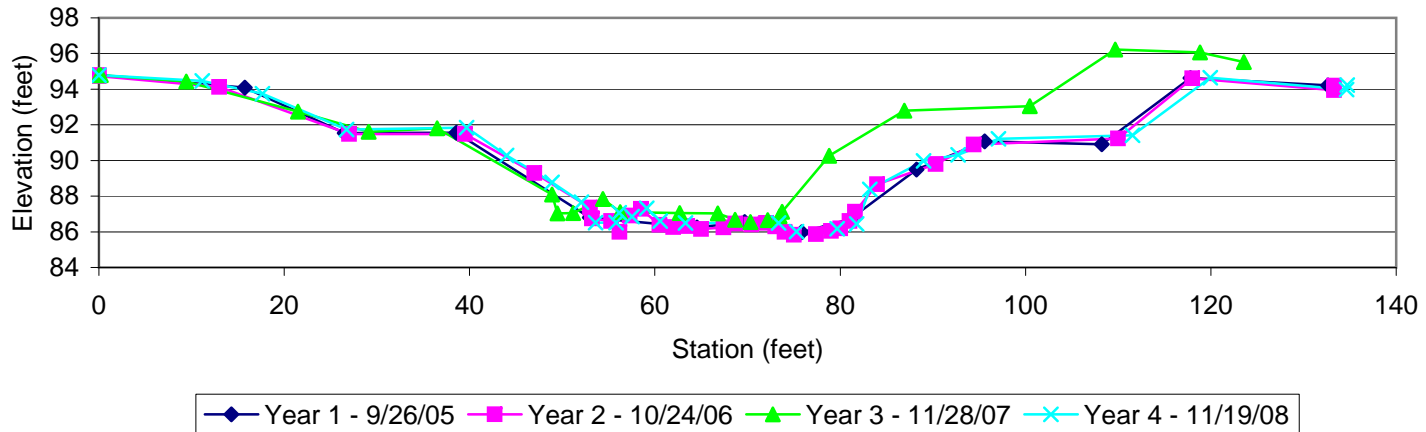
Elevation data were not provided to URS. However, elevation data were used by EcoLogic in plotting Year 1 cross section data. URS was unable to locate benchmarks in the field to establish elevations for 2006 and 2007 cross sections. Cross section data were hand manipulated to match elevation data used 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, and 2008 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, and 4. 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.

The longitudinal profiles for 2007 and 2008 extend beyond the project's downstream limit in order to ensure that the full extent of the project was captured. All data are shown.

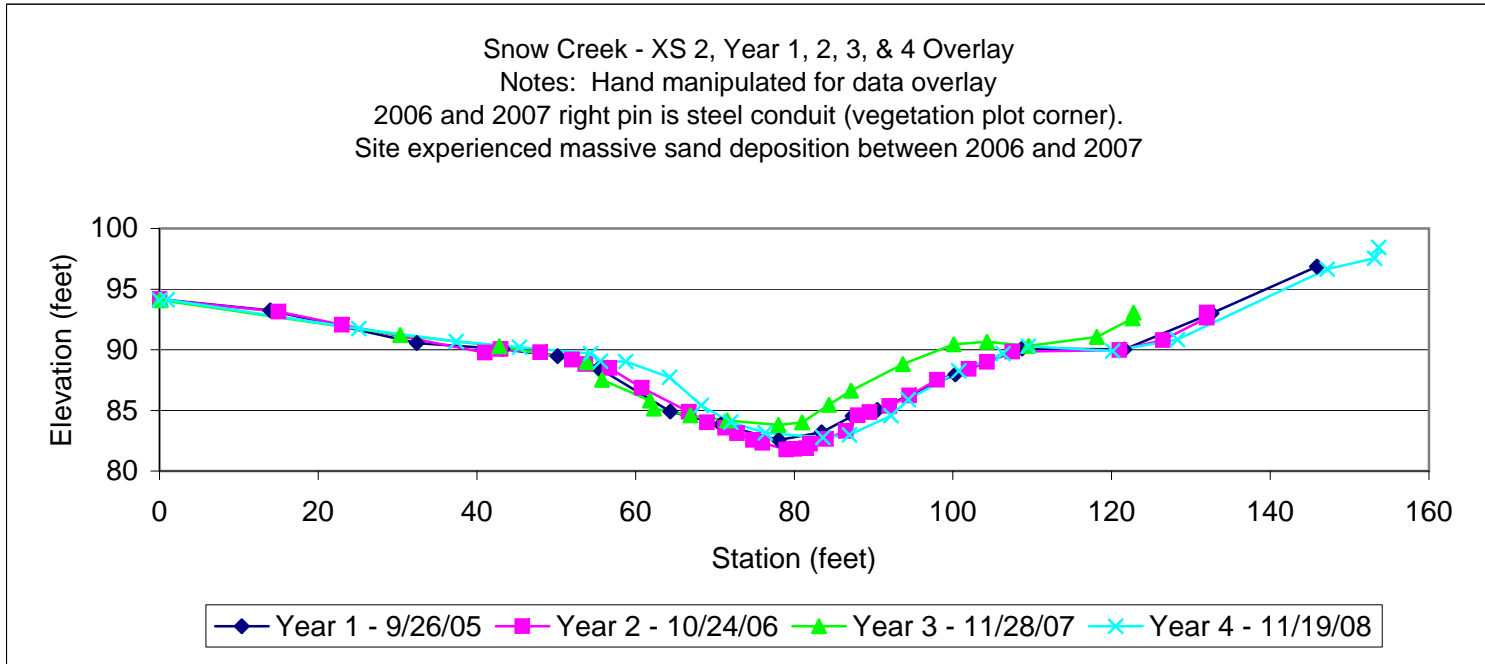
Snow Creek - XS 1, Year 1, 2, 3, & 4 Overlay
 Notes: Hand manipulated for data overlay.
 2007 Right pin shot deleted due to error in recording.
 Site experienced massive sand deposition between 2006 and 2007.



Facing Left Bank



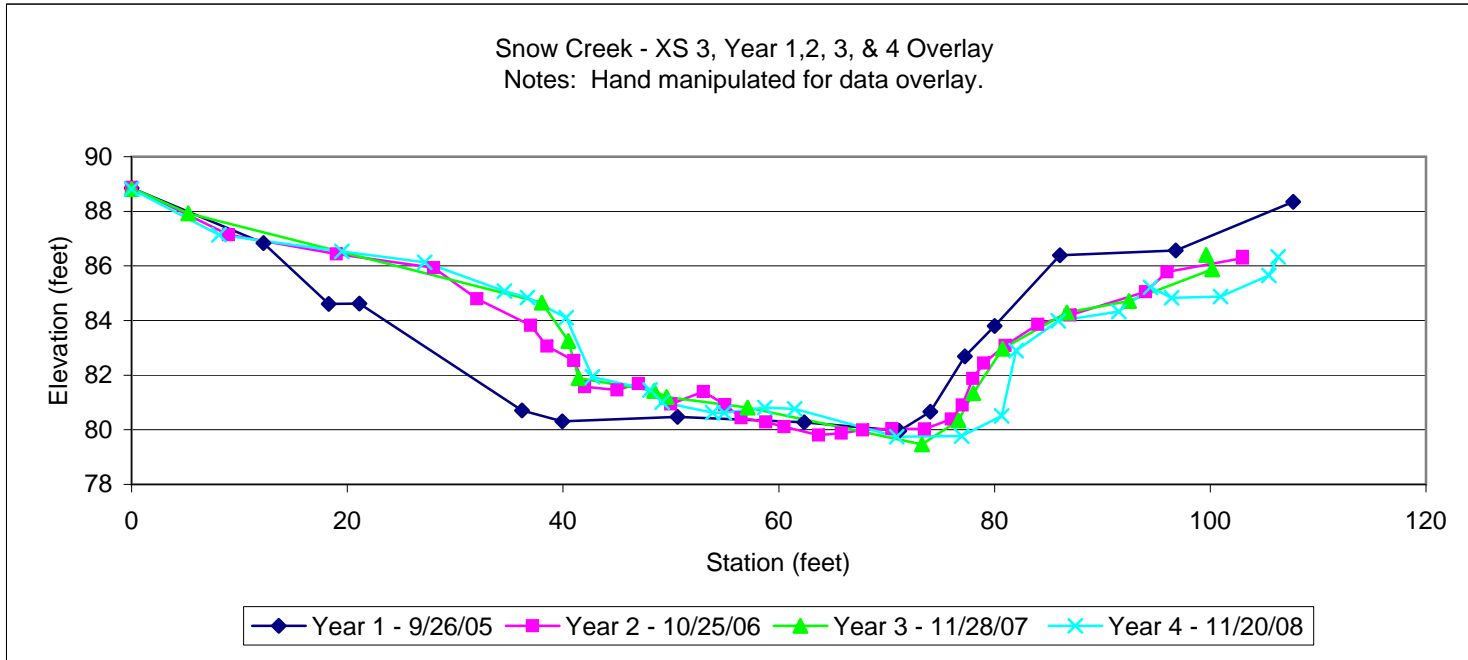
Facing Right Bank



Facing Left Bank



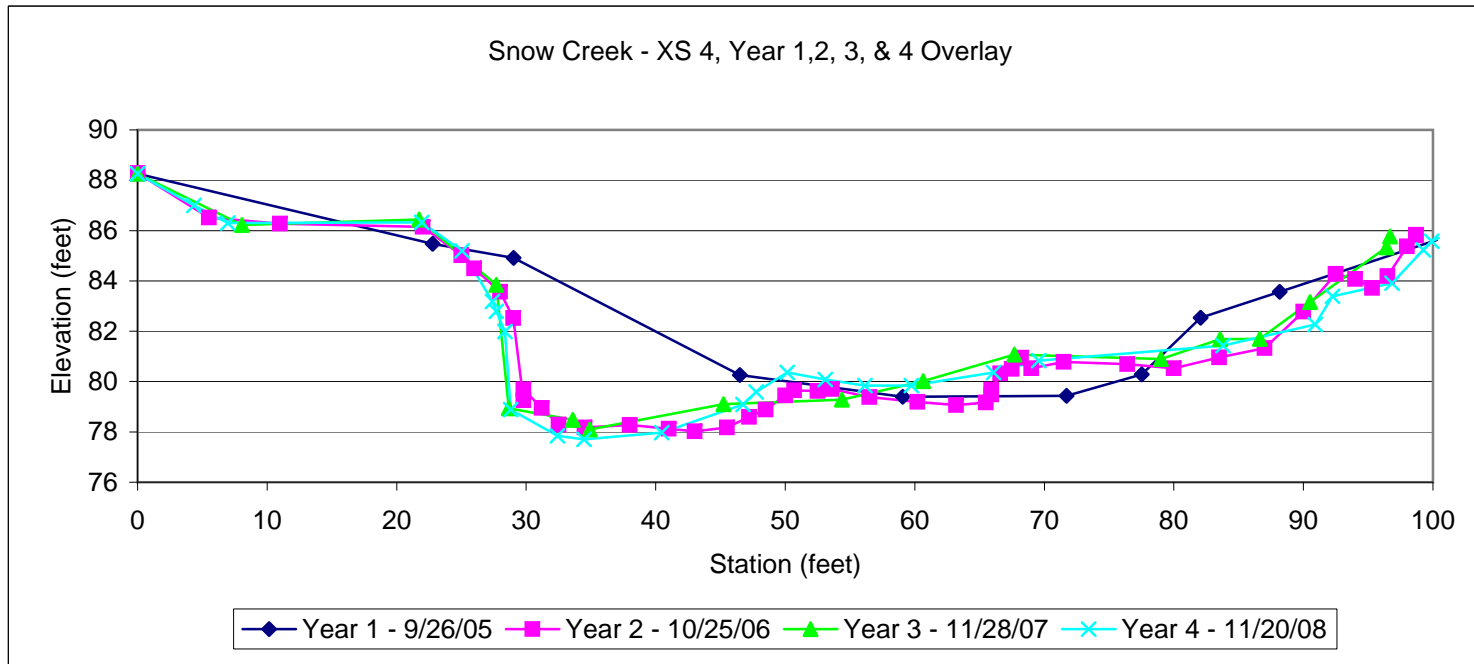
Facing Right Bank



Facing Left Bank



Facing Right Bank



Facing Left Bank

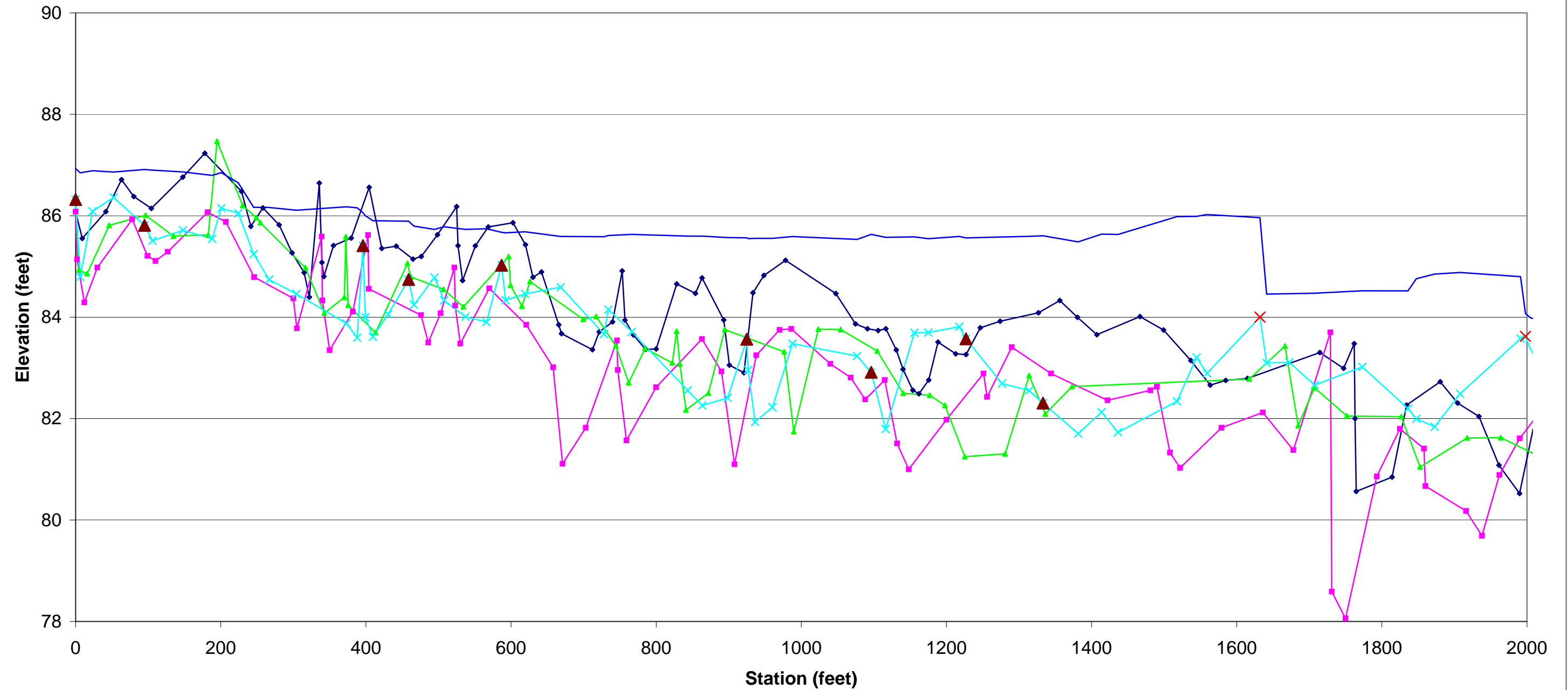


Facing Right Bank

Appendix B-VII: Longitudinal Profile Plot

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

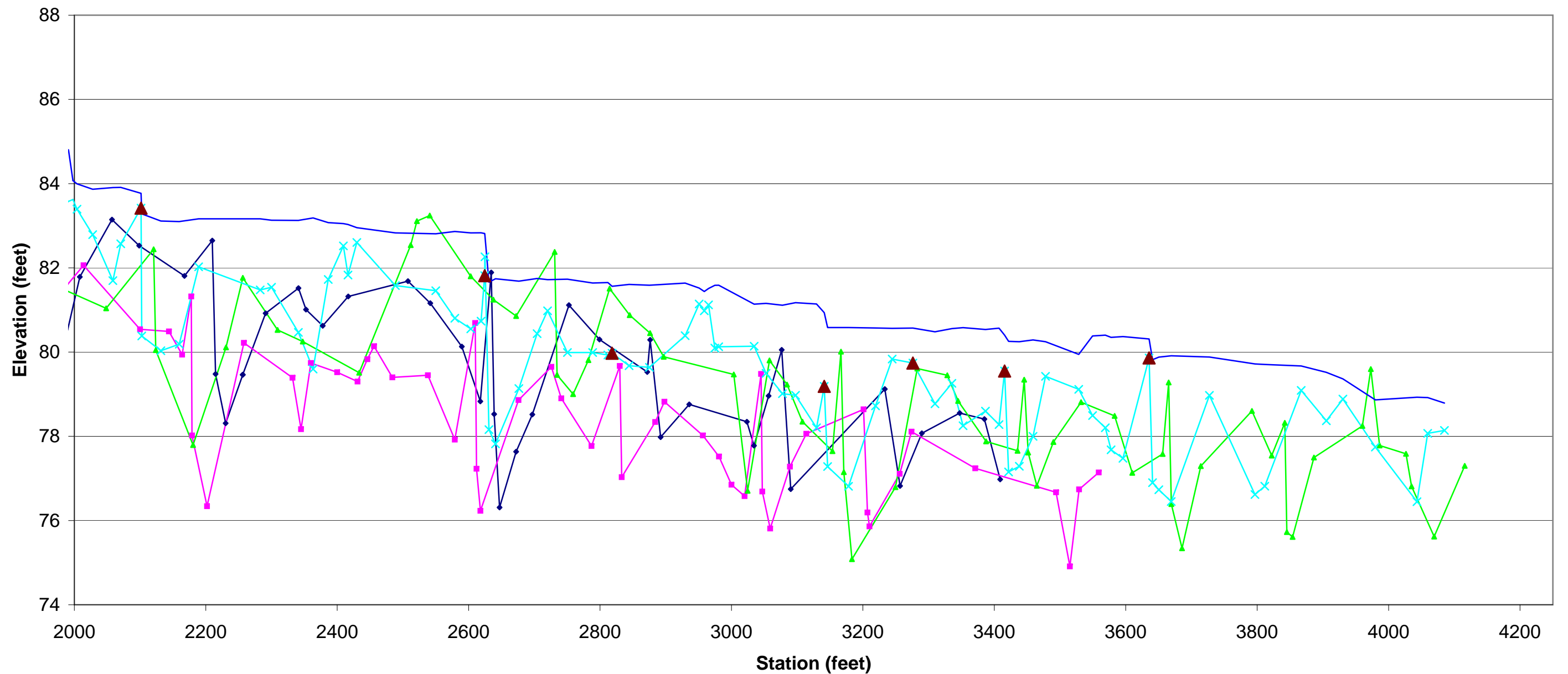
Notes: Hand manipulated for data overlay. 2007 and 2008 data extend beyond project's downstream limits.



—●— Year 1 - 9/2/05
 —■— Year 2 - 10/24/06
 —▲— Year 3 - 11/29/07
 —×— Year 4 - 11/20/08
— 2008 Water Surface
▲ 2008 Structure

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

Notes: Hand manipulated for data overlay. 2007 and 2008 data extend beyond project's downstream limits.



—◆— Year 1 - 9/2/05

—■— Year 2 - 10/24/06

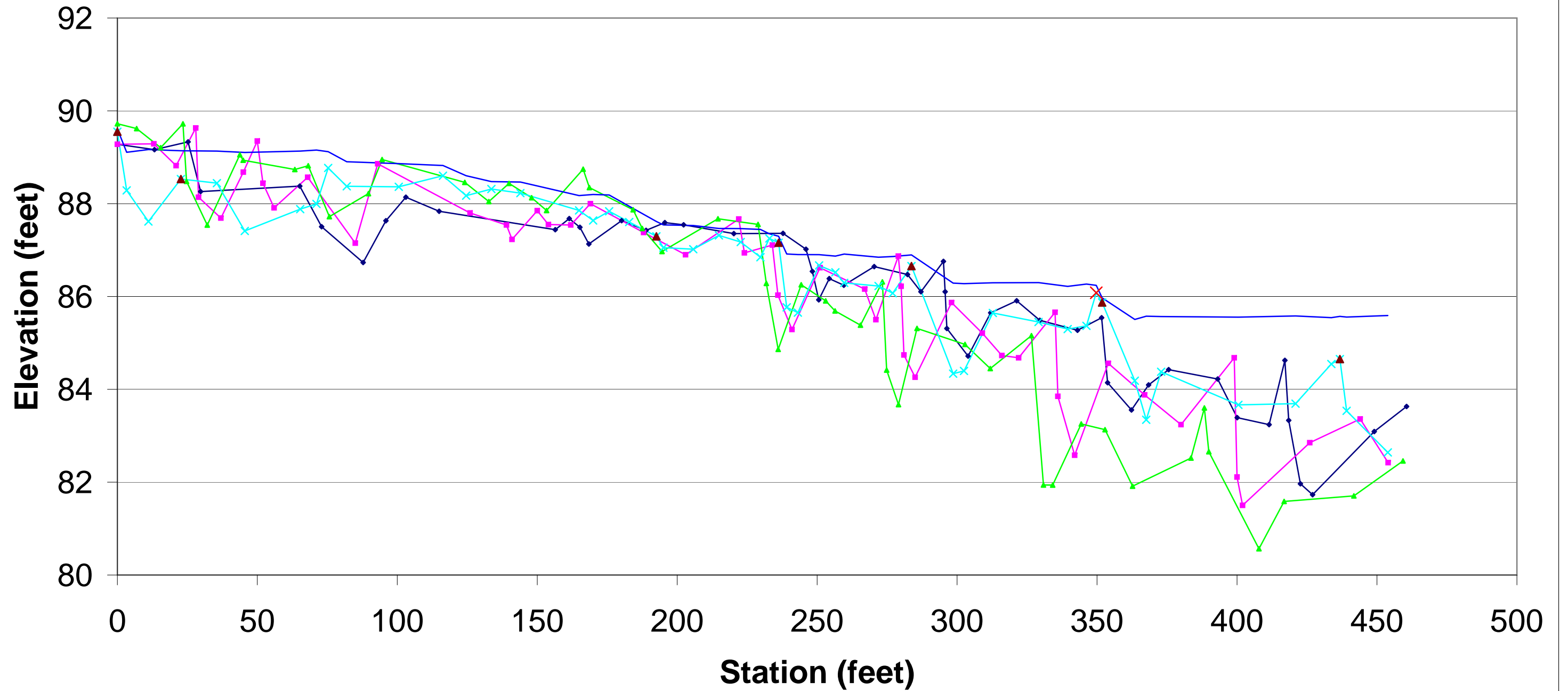
—▲— Year 3 - 11/29/07

—×— Year 4 - 11/20/08

— 2008 Water Surface

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

Notes: Hand manipulated for data overlay.



Legend: Year 1 - 7/14/05 (dark blue line with diamond), Year 2 - 10/26/06 (magenta line with square), Year 3 - 11/28/07 (green line with triangle), Year 4 - 11/19/08 (cyan line with 'x'), 2008 Water Surface (light blue line), 2008 Structure (red triangle), 2008 Beaver Dam (red 'x')

Appendix B-VIII: Pebble Count Frequency Distribution Plots

