Snow Creek Stream Restoration
2006 Monitoring Report
Monitoring Year Two

Ecosystem Enhancement Program Project Number 00344

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

Prepared by:
URS Corporation – North Carolina
1600 Perimeter Park Drive, Suite 400
Morrisville, NC 27560

Project Designed by:
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4321-A S. Elm-Eugene St.
Greensboro, NC 27406

Submitted: January 19, 2007

Ecosystem Enhancement PROGRAM

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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 October 2006 represents Monitoring Year 2 for this project. Prior to the 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 Year 1 Monitoring Report also produced by EcoLogic Associates, P.C. (EcoLogic 2006).

The North Carolina Ecosystem Enhancement Program (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 goals and 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; reestablish stable channel dimension, pattern, and profile; restore a functional 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.

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.

Planted woody vegetation survival at the site is excellent. Live stakes are thick along the banks of Snow Creek and the Unnamed Tributary. Native herbaceous vegetation is filling in along the banks and floodplain. Most vegetative problem areas identified during 2005 monitoring have filled in naturally over the last year. Only two problem areas associated with bare banks and/or floodplains remain.

The presence of Japanese stilt grass (*Microstegium vimineum*) poses a concern at the site. During 2006 monitoring, it was observed along the entire right bank of the Unnamed Tributary. It was also noted that small populations of the invasive species were appearing on the left bank of the Unnamed Tributary and along portions of Snow Creek. 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.

The Snow Creek Stream Restoration Project is in overall very good condition. There were very few problem areas, and none that require immediate attention or repair. The majority of the problem areas are related to scour behind the cross vane arms. There are also a few areas where beaver activity may compromise structure integrity. Several areas of significant aggradation were observed, primarily in places where the channel appeared excessively wide and was not able to transport the sediment load adequately. In the upstream portion of Reach 1, the bed material was exceedingly soft, so that the survey

rod (as well as survey personnel) would sink almost three feet deep into the channel bed. It was unclear if this was due to recent aggradation or unconsolidated bed material from the new stream location.

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, riffle development is only fair to poor. Many of the designed riffles have transitioned into short runs, possibly due to problems with the meander wavelength to bankfull width ratio. The meander wavelength was observed to be short for the bankfull width, and cross vanes are located close to one another. The straight reaches are not long enough to form good riffles, and the close proximity of the structures is promoting pool development.

2.0 PROJECT BACKGROUND

2.1 PROJECT OBJECTIVES

The objectives of the Snow Creek Stream Restoration per EcoLogic's Stream Restoration Design Report (EcoLogic 2002) were to:

1. Improve water quality by reducing the sediment load generated by eroding banks and by restoring a riparian buffer;
2. Reestablish stable channel dimension, pattern, and profile;
3. Restore a functioning floodplain;
4. Enhance aquatic and terrestrial habitat in the stream corridor;
5. Provide a stable ford across the main channel for tractor access;
6. Provide two pedestrian bridges across the main channel for access to the temple property and agricultural fields, and
7. 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, RESTORATION 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 a F4 stream type.

The morphological restoration included significant increases in belt width accomplished through the construction of new meander bends. Bankfull benches and with gently sloping transitions between the channel bottom and top of bank, rock vanes, root wads and coir matting to provide bank protection. 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.

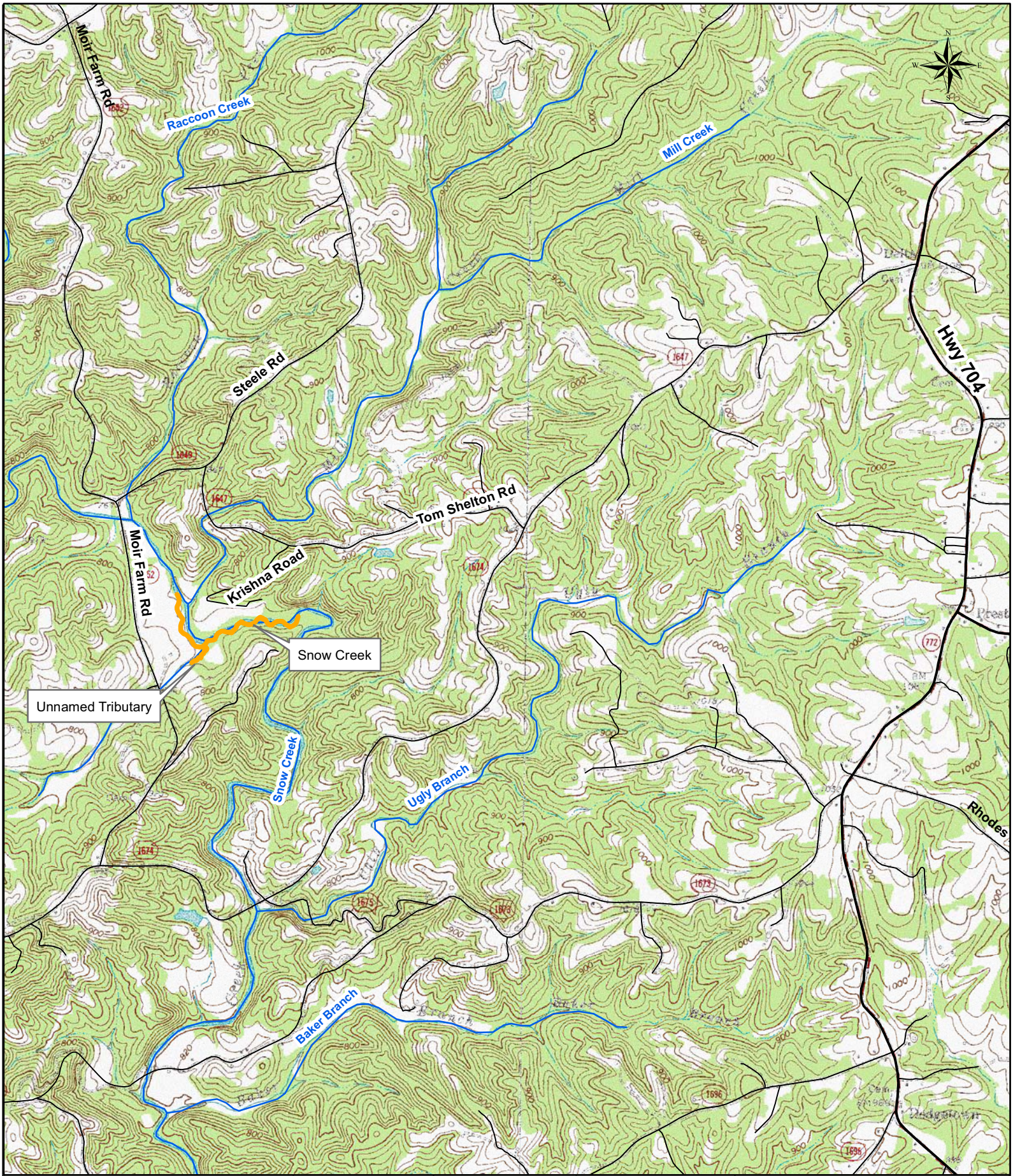
2.3 LOCATION AND SETTING

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).

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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1600 Perimeter Park Drive
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Morrisville, NC 27560
Phone: 919-461-1100
Fax: 919-461-1415

Prepared For:
NC Ecosystem Enhancement Program

Project:
Snow Creek
Stream Restoration
Stokes County, NC

Monitoring Year:
2 (2006)

Project Number:
00344

Date:
January 2007

Legend
Project Reach

Figure 1
Project Vicinity

0 0.25 0.5
Miles

2.4 PROJECT HISTORY AND BACKGROUND

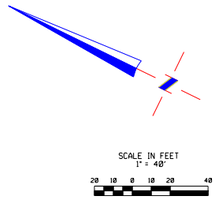
The tributary to Snow Creek was identified by inventory biologists as a restoration potential project in July 1998. This information was given to representatives of EEP during a field tour of potential restoration sites led by EcoLogic staff in Stokes County in June of 2001. The existing condition survey occurred in late May 2002 at which time a Federally Endangered plant species, small-anthered bittercress (*Cardamine micranthera*) 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.

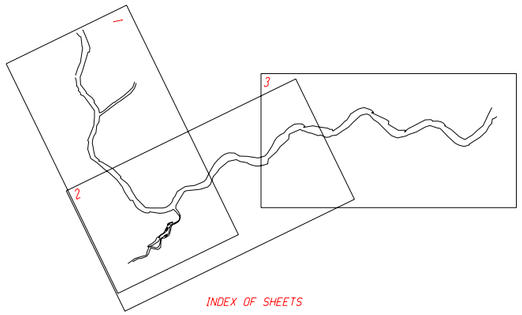
Table I. Project Restoration Components
Snow Creek
EEP Project Number 00344

Project Segment or Reach ID	Existing Feet	Mitigation Type	Approach	Linear Footage	Mitigation Ratio*	Mitigation Units*	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	2,200			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				Cattle exclusion and easement

* Mitigation Ratios and Units were not provided in previous reports.

R= Restoration P1= Priority I EI= Enhancement I PII= Priority II
EII= Enhancement II PIII= Priority III S= Stabilization SS= Stream Bank Stabilization





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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
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- ROCK OR STONE
- ROW OF STONES
- ROCK VANE
- CONTOUR LINE
- VEGETATION PLOTS
- PHOTO POINTS
- THALWEG (2/05)
- TOP OF BANK (2/05)

LOCATION MAP - STOKES COUNTY

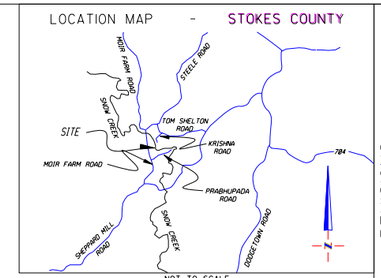

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Photo Points			Veg Plots		
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3	987071.6	1664833	3	986561.4	1663373
4	987096.2	1664703	4	986695	1663101
5	987039.3	1664582	5	986881.3	1662913
6	987164.4	1664419	6	987084.5	1662935
7	987043.1	1664212	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
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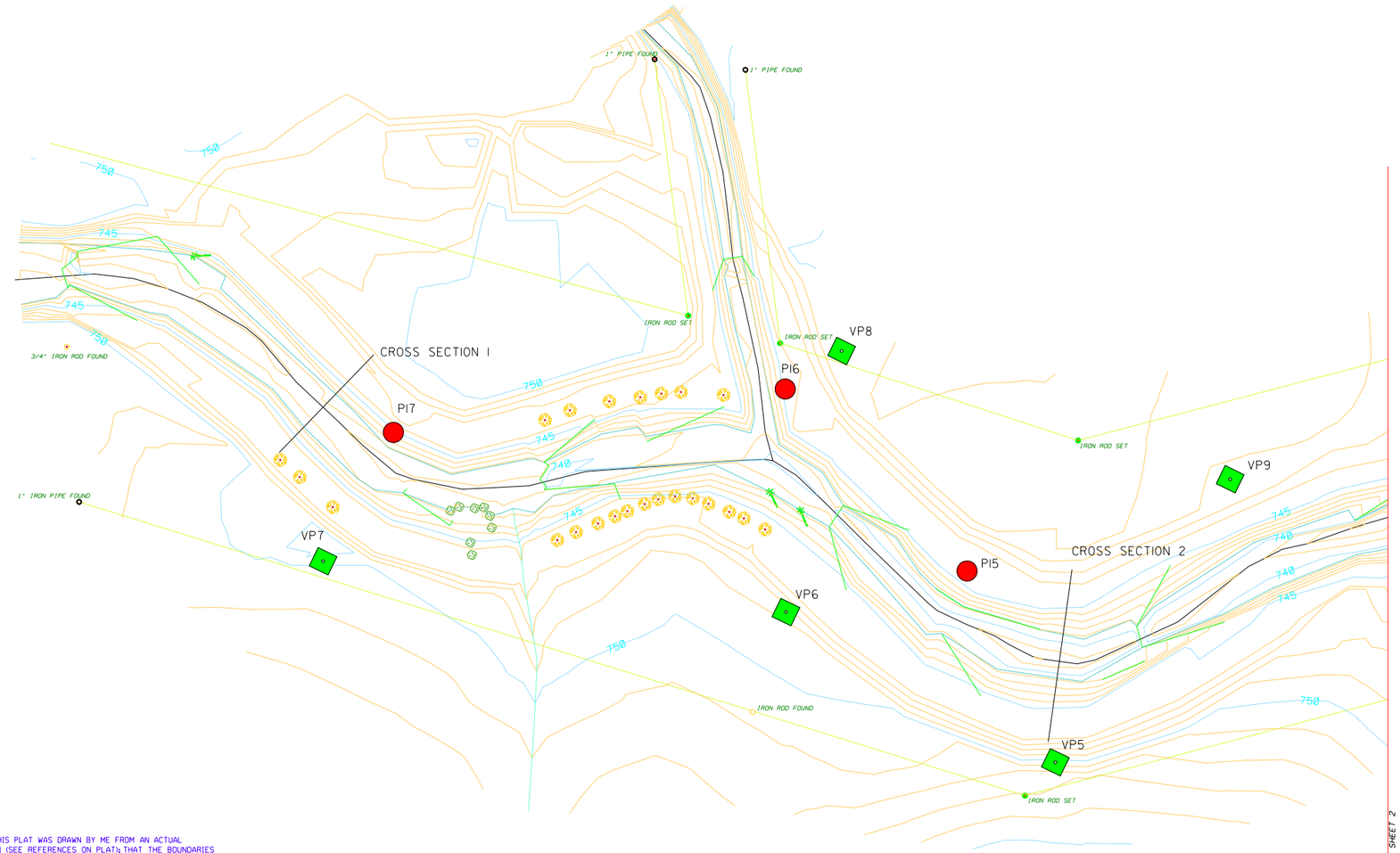

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KEITH P. GARRISON
NORTH CAROLINA PROFESSIONAL LAND SURVEYOR *L-4434

This document originally issued and sealed by KEITH P. GARRISON, PLS, NC Registration No. L-4434, ON MARCH 30, 2005

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40 30 0 40 80
1" = 80'

REVISIONS

NO.	DATE

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Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: SNOW CREEK STREAM RESTORATION 2006 MONITORING REPORT

TITLE: MONITORING PLAN VIEW

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

FIGURE 2

DATE: DEC 2006

TECHNICIAN: EHJ

CHECKED BY: KM

MONITORING YEAR 2

EEP PROJECT NO. 00344

SHEET NO. 1

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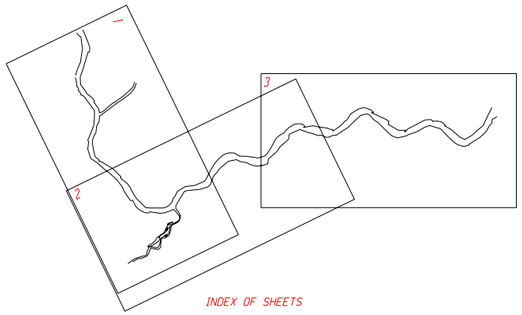

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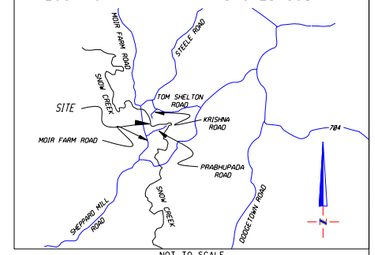

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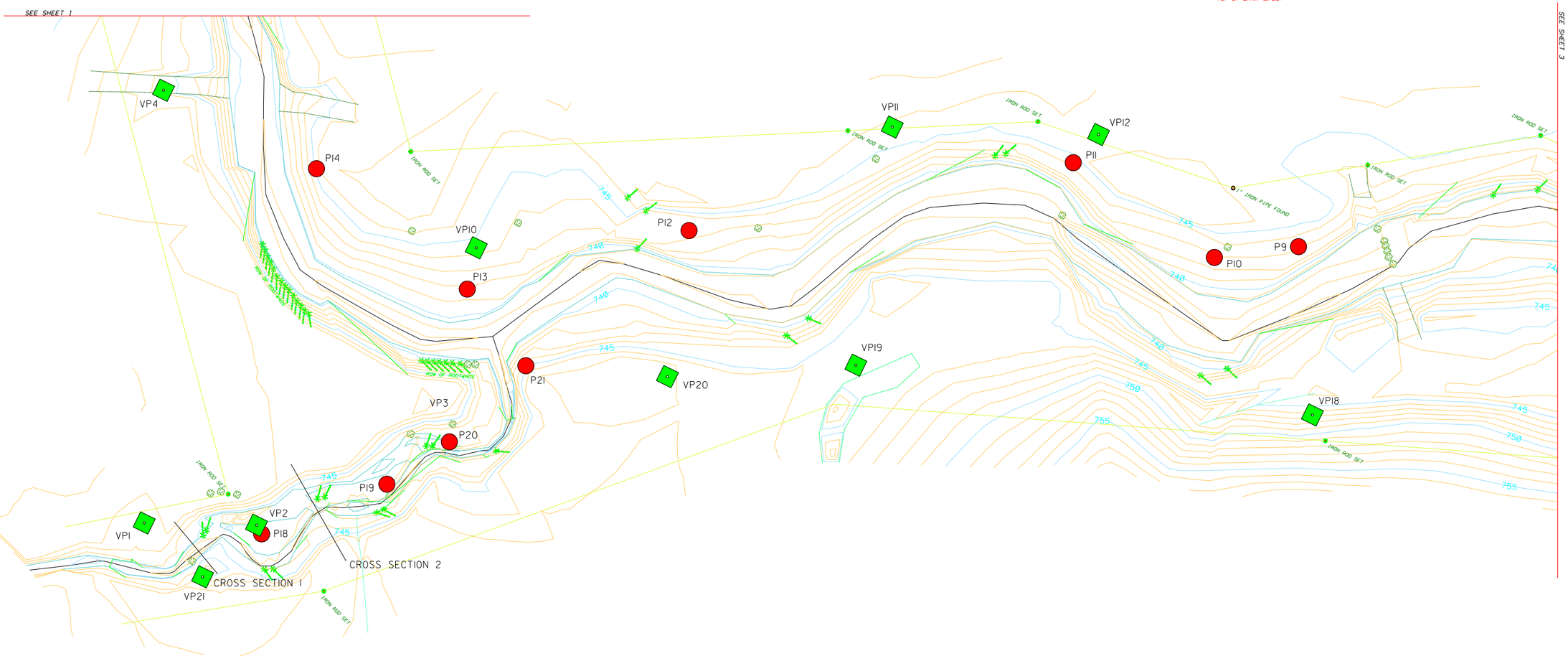

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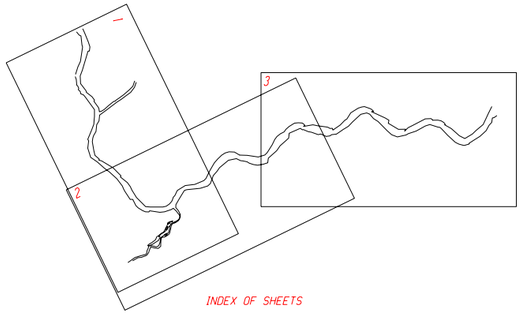

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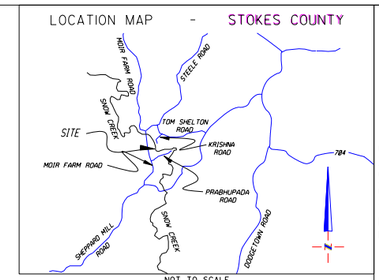

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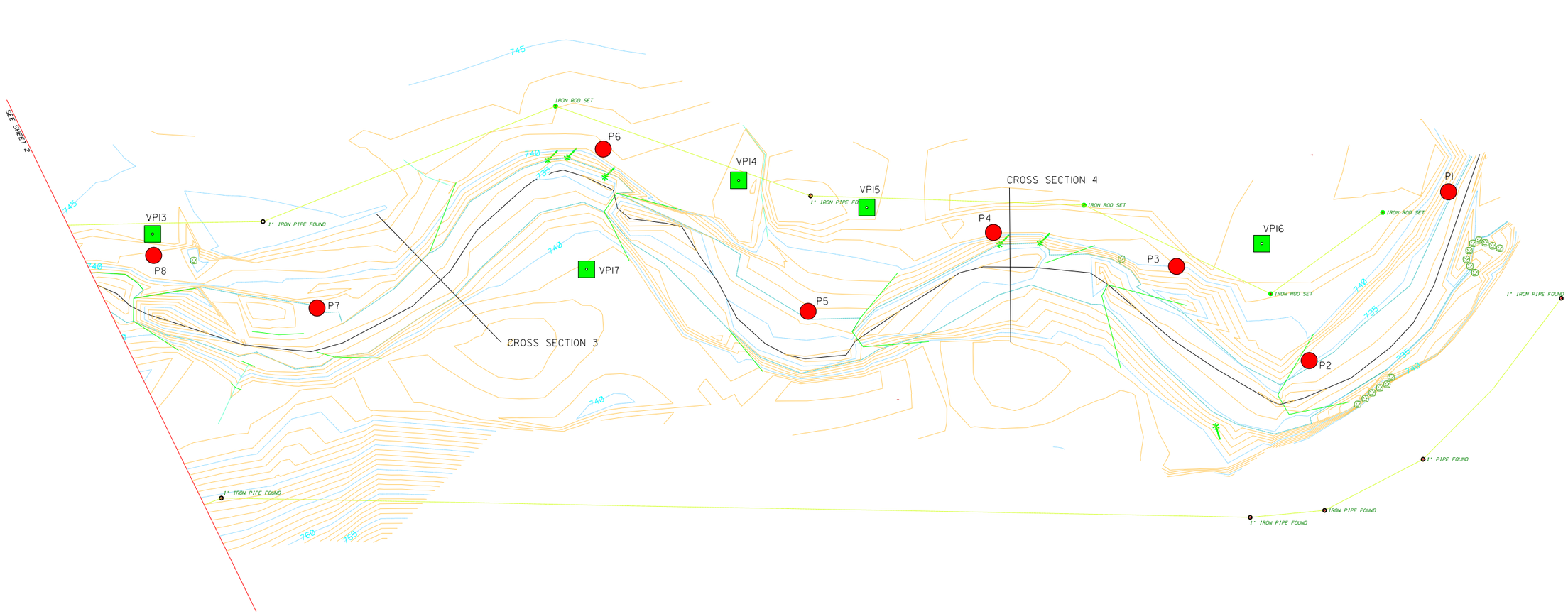

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MONITORING YEAR 2

EEP PROJECT NO. 00344

SHEET NO. 3

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	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	2005
Year 1 Monitoring	2005	Unknown	April 2006
Year 2 Monitoring	2006	October 2006	December 2006
Year 3 Monitoring	2007		
Year 4 Monitoring	2008		
Year 5 Monitoring	2009		
Year + Monitoring	Not Scheduled		

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 Bill Wright 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 Bill Wright 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 Monitoring POC – Ken Bridle	EcoLogic Associates P.C. 4321-A South Elm-Eugene Street Greensboro, NC 27406 336-335-1108
Monitoring Performers – 2006 Monitoring POC – Kathleen McKeithan	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560 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	4th order
Unnamed Tributary	2nd order
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	03010103 – Project
NCDWQ Sub-basin for Project	ROA01 22-20 – Project
NCDWQ classification for Project	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 Monitoring Plan View (Figure 2).

3.0 PROJECT CONDITION AND MONITORING RESULTS

3.1 VEGETATION ASSESSMENT

3.1.1 Vegetative Problem Areas

Vegetation survival at the site is excellent; therefore, few Vegetative Problem Areas have been identified. During the 2005 monitoring period, EcoLogic identified six problem areas on Snow Creek, and two on the Unnamed Tributary. Vegetative Problem Area data tables are located in Appendix A-I. Four of the six along Snow Creek have naturally improved as vegetation has filled in most of the bare areas. Two problem areas remain on Snow Creek (Table A6a). Two problem areas were identified on the Unnamed Tributary in 2005. 2006 monitoring indicated that both areas have stabilized.

The 2006 monitoring revealed one new problem area along the Unnamed Tributary (Table A6b). The presence of Japanese stilt grass (*Microstegium vimineum*) poses a concern at the site. During 2006 monitoring, it was observed along the entire right bank of the Unnamed Tributary. It was also noted that small populations of the invasive species were appearing on the left bank of the Unnamed Tributary and along portions of Snow Creek. 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. Vegetative Problem Area Photos are located in Appendix A-II.

3.1.2 Vegetative Problem Areas Plan View

The Vegetative Problem Areas Plan View is located in Appendix A-III.

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 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 4,759 linear feet of Snow Creek (1,200 of Reach 1 and 3,559 of Reach 2), and 454 linear feet of the unnamed tributary, for a total survey length of 5,213 linear feet. Measurements include thalweg, water surface, bankfull, and top of low bank.

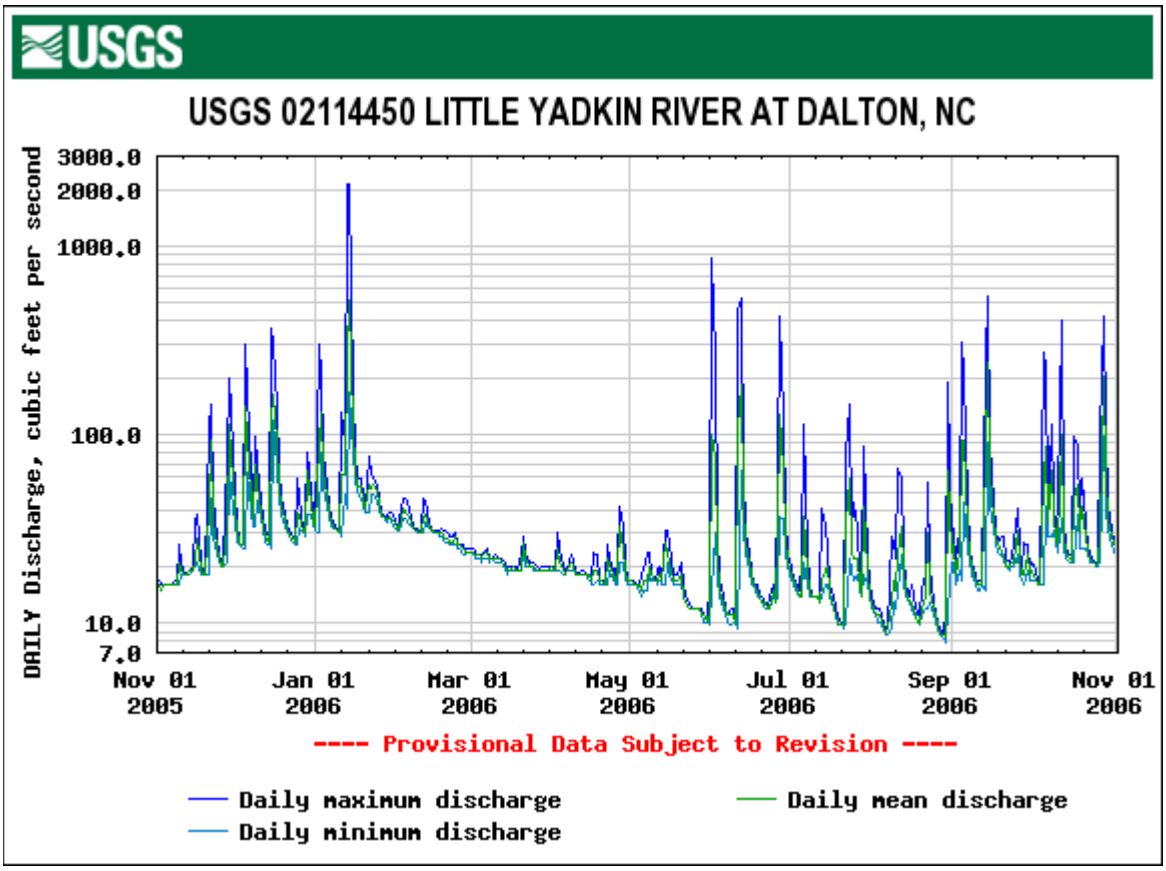
3.2.1.2 Hydrologic Criteria

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 2006). The USGS gage plot is shown below (Figure 4). 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 2006 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 mid January of 2006, indicating that the Little Yadkin River has had one bankfull event this year (as of November 2, 2006). Snow Creek is in proximity to the Little Yadkin River, and it is likely that the project site also experienced a bankfull event in mid January 2006.

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

Figure 4. USGS Stream Gage Discharge Data



3.2.1.3 Bank Stability Assessments

A detailed BEHI and NBS assessment was not required for the Big Warrior Creek Stream Restoration site during this monitoring year. According to the 2006 Monitoring Guidelines (EEP 2006), an assessment is required during year 5, post construction only.

3.2.2 Stream Problem Areas Plan View

Overall, the Snow Creek Stream Restoration Project is in very good condition. There were very few problem areas and none that require immediate attention or repair. During the 2005 monitoring period, EcoLogic identified 14 problem areas on Snow Creek, and seven on the Unnamed Tributary. Stream Problem Area data tables are located in Appendix B-II. On Snow Creek nine of the previous problem areas have been repaired or have naturally stabilized; however, five of them still exist. In addition, three new problem areas were identified during 2006 monitoring (Table B1a). On the Unnamed Tributary, six of the seven problem areas have been repaired or have stabilized, and one still exists. Two new problem areas were identified in 2006 (Table B1b).

The majority of the problem areas are related to scour behind the cross vane arms. There are also a few areas where beaver activity may compromise structure integrity. Several areas of significant aggradation were observed, primarily in places where the channel appeared excessively wide and was not able to transport the sediment load adequately. In the upstream portion of Reach 1, the bed material was exceedingly soft, so that the survey rod (as well as survey personnel) would sink almost three feet deep into the channel bed. It was unclear if this was due to recent aggradation or unconsolidated bed material from the new stream location.

The Stream Problem Areas Plan View is located in Appendix B-I. Stream Problem Areas Photos are located in Appendix B-III.

3.2.3 Fixed Photo Station Photos

Fixed Photo Station Photos are Located in Appendix B-III.

3.2.4 Stability Assessment

Table VIa. Categorical Stream Feature Visual Stability Assessment – Snow Creek
Snow Creek
EEP Project Number 00344

Feature	Initial*	MY-01**	MY-02	MY-03	MY-04	MY-05
A. Riffle	100	N/A	88			
B. Pool	100	N/A	90			
C. Thalweg	100	N/A	100			
D. Meanders	100	N/A	100			
E. Bed General	100	N/A	98			
F. Bank Condition	100	N/A	100			
G. Vanes / J Hooks	100	N/A	91			
H. Wads and Boulders	100	N/A	100			

* It is assumed that all were 100 percent functional upon completion of construction.
**No stability data are presented in the previous report.

Table VIb. Categorical Stream Feature Visual Stability Assessment – Unnamed Tributary
Snow Creek
EEP Project Number 00344

Feature	Initial*	MY-01**	MY-02	MY-03	MY-04	MY-05
A. Riffle	100	N/A	80			
B. Pool	100	N/A	100			
C. Thalweg	100	N/A	100			
D. Meanders	100	N/A	100			
E. Bed General	100	N/A	95			
F. Bank Condition	100	N/A	100			
G. Vanes / J Hooks	100	N/A	100			
H. Wads and Boulders	100	N/A	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)

Exhibit Table VIIa. Baseline Morphology and Hydraulic Summary – Snow Creek 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**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
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
Bank Height Ratio	--	--	--	--	--	--	--	--	1.4	1.0	1.5	1.18	--	--	1.0	--	--	1.0
Entrenchment 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

Exhibit Table VIIa. Baseline Morphology and Hydraulic Summary – Snow Creek 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**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
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

Exhibit Table VIIb. Baseline Morphology and Hydraulic Summary – Unnamed Tributary 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**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
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

Exhibit Table VIIb. Baseline Morphology and Hydraulic Summary – Unnamed Tributary 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**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Meander Width Ratio	--	--	6.3	--	--	--	--	--	1.75	--	--	2.9	--	--	7	--	--	10.8
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

Exhibit Table VIIIa. Morphology and Hydraulic Monitoring Summary Snow Creek – Reach 1 Snow Creek EEP Project Number 00344												
Parameter	**Cross Section 1 Riffle**						**Cross Section 2 Pool**					
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY+**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY+**
BF Width (ft)	68	52.9					75.6	61.5				
Floodprone Width (ft)	132	>133					151	>132				
BF Cross Sectional Area (ft^2)	186	169.9					249	237.2				
BF Mean Depth	2.7	3.2					3.3	3.9				
BF Max Depth	5.1	5.1					7.5	8.1				
Width/Depth Ratio	25	16.5					22.9	15.9				
Entrenchment Ratio	1.9	>2.5					2	>2.1				
Bank Height Ratio	--	1.0					--	1.0				
Wetted Perimeter (ft)	69.7	55.8					77.6	64.1				
Hydraulic radius (ft)	2.7	3.0					3.2	3.7				
Substrate												
d50 (mm)	37.6	37					4.85	37				
d84 (mm)	102.7	94					24.2	94				

Exhibit Table VIIIb. Morphology and Hydraulic Monitoring Summary Snow Creek – Reach 2 Snow Creek EEP Project Number 00344												
Parameter	**Cross Section 3 Run***						**Cross Section 4 Run***					
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY+**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY+**
BF Width (ft)	63	46.9					67	63.3				
Floodprone Width (ft)	107	>97.7					100	>98.7				
BF Cross Sectional Area (ft^2)	205	125.9					238	238.8				
BF Mean Depth	3.2	2.7					3.5	3.8				
BF Max Depth	4.7	4.0					5.6	5.6				
Width/Depth Ratio	19.7	17.5					19.2	16.8				
Entrenchment Ratio	1.7	>2.1					1.48	>1.6				
Bank Height Ratio	--	1.0					--	1.0				
Wetted Perimeter (ft)	65.2	48.7					69	68.8				
Hydraulic radius (ft)	3.2	2.6					3.5	3.5				
Substrate												
d50 (mm)	10.4	8					12.1	21				
d84 (mm)	40.4	47					36.3	56				

* Cross Sections 3 and 4 were identified as riffles in the Monitoring Year One Report. They have transitioned to runs.

Exhibit Table VIIIc. Morphology and Hydraulic Monitoring Summary – Snow Creek Snow Creek EEP Project Number 00344																		
Parameter	**MY1**			**MY2**			**MY3**			**MY4**			**MY5**			**MY+**		
Pattern	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Channel Beltwidth (ft)	100	250	170	--	--	--												
Radius of Curvature (ft)	85	168	130	--	--	--												
Meander Wavelength (ft)	320	400	360	--	--	--												
Meander Width Ratio	4.7	5.8	6.4	--	--	--												
Profile																		
Riffle Length (ft)	27.7	77.1	45.4	15.0	110.0	63												
Riffle Slope (ft/ft)	0.0056	0.015	0.010	0.0004	0.009	0.004												
Pool Length (ft)	64.7	262	129	27.0	239.0	65.0												
Pool Spacing (ft)	23	271	149	35	287	138												
Additional Reach Parameters																		
Valley Length (ft)	--	--	2200	--	--	2200												
Channel Length (ft)	--	--	3404	--	--	3559												
Sinuosity	--	--	1.5	--	--	1.6												
Water Surface Slope (ft/ft)	--	--	0.002	--	--	0.003												
BF Slope (ft/ft)	--	--	0.003	--	--	0.002												
Rosgen Classification	--	--	C	--	--	C4												

Exhibit Table VIIId. Morphology and Hydraulic Monitoring Summary – Unnamed Tributary Snow Creek EEP Project Number 00344												
Parameter	**Cross Section 1 Pool**						**Cross Section 2 Riffle**					
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY+**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY+**
BF Width (ft)	10.9	14.4					7.8	12.3				
Floodprone Width (ft)	59	66.5					41	48.3				
BF Cross Sectional Area (ft^2)	11	15.4					4.7	8.1				
BF Mean Depth	1	1.1					0.6	0.7				
BF Max Depth	2	2.3					1	1.8				
Width/Depth Ratio	10.8	13.5					13.2	18.7				
Bank Height Ratio	--	1.0					--	1.0				
Entrenchment Ratio	5.4	4.6					5.2	3.9				
Wetted Perimeter (ft)	11.8	16.1					8.2	13.5				
Hydraulic radius (ft)	0.9	1.0					0.57	0.6				
Substrate												
d50 (mm)	0.56	0.43					1.64	16				
d84 (mm)	4.0	4.9					6.58	38				

Exhibit Table VIIIe. Morphology and Hydraulic Monitoring Summary – Unnamed Tributary Snow Creek EEP Project Number 00344																		
Parameter	**MY1**			**MY2**			**MY3**			**MY4**			**MY5**			**MY+**		
Pattern	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Channel Beltwidth (ft)	40	65	45	--	--	--												
Radius of Curvature (ft)	15	35	20	--	--	--												
Meander Wavelength (ft)	65	95	87	--	--	--												
Meander Width Ratio	5.9	8.7	10.8	--	--	--												
Profile																		
Riffle Length (ft)	6.1	12.3	8.8	11	33	19												
Riffle Slope (ft/ft)	0.015	0.043	0.031	0.008	0.028	0.014												
Pool Length (ft)	9.2	38.1	16.9	12	41	22												
Pool Spacing (ft)	11.83	67.8	42.4	14	74	32												
Additional Reach Parameters																		
Valley Length (ft)	--	--	382	--	--	382												
Channel Length (ft)	--	--	464	--	--	454												
Sinuosity	--	--	1.2	--	--	1.2												
Water Surface Slope (ft/ft)	--	--	0.013	--	--	0.014												
BF Slope (ft/ft)	--	--	0.011	--	--	0.013												
Rosgen Classification	--	--	C	--		C5												

4.0 METHODOLOGY SECTION

All monitoring methodologies follow the most current templates and guidelines provided by EEP. Photographs were taken at high resolution using an Olympus Stylus 4.0 megapixel digital camera. GPS location information was collected 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 Year One 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 Topcon PL-H3C Rotating Laser and the data were analyzed and displayed using the Reference Reach Spreadsheet, Version 4.2L (Mecklenburg 2006). Individual pebble counts were conducted at each cross section. 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 for Year 1 monitoring in 2005.

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 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 Year 2 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 marked with red flagging and recorded. 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 (*Cornus amomum*) and black willow (*Salix nigra*). Over 200 stems of these species were observed in several vegetation plots.

The sub-sample method consisted of counting all stems within a 1-meter by 10-meter sub-sample area, which is approximately 10 percent of the vegetation plot. The sub-sample area was situated within the main sampling plot so as to represent the overall condition of the main plot. A threshold height was determined for silky dogwoods and black willows within each vegetation plot following a count of all stems within the sub-sample plot. Once the threshold height was determined, stem counts within the main plot did not include silky dogwood or black willow not meeting the threshold criteria. It was assumed that the 10 percent sample captured an approximate number and size of these species. The sub-sample stem count was multiplied by 10. All species other than silky dogwood and black willow were counted according to normal protocol. The threshold value was recorded on the raw data forms.

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

5.0 REFERENCES

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Appendix A
(Click here)

APPENDIX A

VEGETATION RAW DATA

Table A1. Vegetation Metadata

Report Prepared By	Susan Shelingoski
Date Prepared	1/18/2007 11:00
database name	URS-2006-A.mdb
database location	P:\Jobs3\31825348_Monitoring
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	This worksheet, which is a summary of the project and the project data.
Plots	List of plots surveyed.
Vigor	Frequency distribution of vigor classes.
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.
Stem Count by Plot and Spp	Count of living stems of each species for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	344
project Name	Snow Creek
Description	Stream Restoration
length (ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	12

Table A2. Vegetation Vigor by Species

	Species	4	3	2	1	0	Missing
	EMPTY_MODULE: This module has no species in it, but was sampled.						
	DONTKNOW: unsure record		2				
	Ailanthus altissima						
	Alnus serrulata		3	3			
	Aronia arbutifolia	1	4	1			
	Betula nigra						
	Cornus amomum	51	125	17			
	Cornus florida	5	11				
	Diospyros virginiana						
	Nyssa sylvatica	1	5				
	Quercus velutina	1					
	Rhus glabra						
	Salix nigra	71	48	7			
	Sambucus canadensis	2	6	2			
	Alnus	1					
	Cercis canadensis			2			
	Quercus rubra	1					
	Liriodendron tulipifera						
	Platanus occidentalis	5					
	Crataegus	1	4	1			
	Prunus						
	Prunus serotina	1					
	Acer negundo						
TOT:	**23**	**141**	**208**	**33**			

Table A3. Vegetation Damage by Species

	Species	All Damage Categories	(no damage)	Beaver
	Acer negundo	3	3	
	Ailanthus altissima	1	1	
	Alnus	1	1	
	Alnus serrulata	9	4	5
	Aronia arbutifolia	8	8	
	Betula nigra	6	6	
	Cercis canadensis	2	2	
	Cornus amomum	349	349	
	Cornus florida	16	16	
	Crataegus	6	6	
	Diospyros virginiana	1	1	
	DONTKNOW: unsure record	2	2	
	EMPTY_MODULE: This module has no species in it, but was sampled.	1	1	
	Liriodendron tulipifera	4	4	
	Nyssa sylvatica	9	9	

	Species	All Damage Categories	(no damage)	Beaver
	Platanus occidentalis	15	15	
	Prunus	2	2	
	Prunus serotina	6	6	
	Quercus rubra	2	2	
	Quercus velutina	1	1	
	Rhus glabra	6	6	
	Salix nigra	199	199	
	Sambucus canadensis	10	10	
TOT:	**23**	**659**	**654**	**5**

Table A4. Vegetation Damage by Plot

	plot	All Damage Categories	(no damage)	Beaver
	344-01-0003	79	79	
	344-01-0005	16	16	
	344-01-0007	35	35	
	344-01-0008	42	42	
	344-01-0010	25	25	
	344-01-0011	122	122	
	344-01-0013	72	72	
	344-01-0015	24	23	1
	344-01-0016	47	45	2
	344-01-0017	31	29	2
	344-01-0018	92	92	
	344-01-0021	74	74	
TOT:	**12**	**659**	**654**	**5**

Table A5. Stem Count by Plot and Species

	Species	Total Stems	# plots	avg# stems	plot 344-01-0003	plot 344-01-0005	plot 344-01-0007	plot 344-01-0008	plot 344-01-0010	plot 344-01-0011	plot 344-01-0015	plot 344-01-0016	plot 344-01-0017	plot 344-01-0018	plot 344-01-0021
	Alnus	1	1	1											1
	Alnus serrulata	6	5	1.2		1					1		2	1	1
	Aronia arbutifolia	6	4	1.5		1	2	1						2	
	Cercis canadensis	2	2	1			1							1	
	Cornus amomum	193	10	19.3	66	1	17	3		2	14	2	15	35	38
	Cornus florida	16	1	16										16	
	Crataegus	6	3	2				4	1				1		
	DONTKNOW: unsure record	2	1	2				2							
	Nyssa sylvatica	6	1	6				6							
	Platanus occidentalis	5	2	2.5										2	3
	Prunus serotina	1	1	1										1	
	Quercus rubra	1	1	1				1							
	Quercus velutina	1	1	1	1										
	Salix nigra	126	10	12.6	4	10	12	22	21	1	2		9	24	21
	Sambucus canadensis	10	4	2.5			2				3			2	3
TOT:	**15**	**382**	**15**		**71**	**13**	**34**	**39**	**22**	**3**	**20**	**2**	**27**	**84**	**67**

Table A6a. Vegetative Problem Areas – Snow Creek Snow Creek EEP Project Number 00344			
Feature/Issue	**Station #/Range**	**Probable Cause**	**Photo #**
Bare floodplain	5+60	Poor vegetation establishment	VPA1
Bare slope	7+60	Dry slope	VPA2

Table A6b. Vegetative Problem Areas – Unnamed Tributary Snow Creek EEP Project Number 00344			
Feature/Issue	**Station #/Range**	**Probable Cause**	**Photo #**
Invasive population	0+00 to 4+50	*Microstegium vimineum*	UTVPA1

SNOW CREEK


VPA1 on left bank, facing south

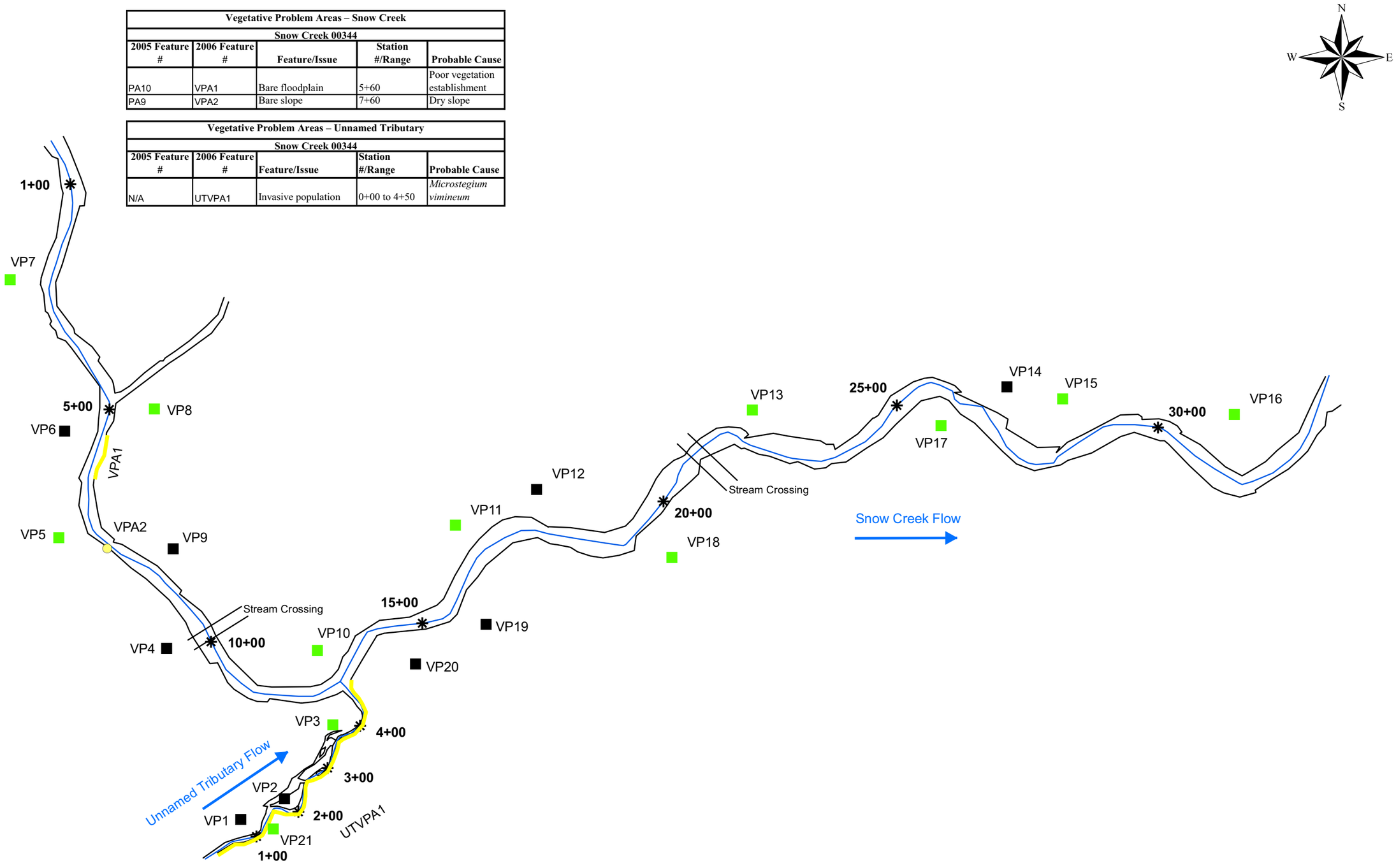

VPA2 on right bank, facing south

UNNAMED TRIBUTARY


UTVPA1 on right bank, facing north

Vegetative Problem Areas – Snow Creek				
Snow Creek 00344				
2005 Feature #	2006 Feature #	Feature/Issue	Station #/Range	Probable Cause
PA10	VPA1	Bare floodplain	5+60	Poor vegetation establishment
PA9	VPA2	Bare slope	7+60	Dry slope

Vegetative Problem Areas – Unnamed Tributary				
Snow Creek 00344				
2005 Feature #	2006 Feature #	Feature/Issue	Station #/Range	Probable Cause
N/A	UTVPA1	Invasive population	0+00 to 4+50	*Microstegium vimineum*



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Prepared For:
NC Ecosystem
Enhancement Program

Ecosystem Enhancement PROGRAM

Project:
Snow Creek
Stream Restoration
Stokes County, NC

Monitoring Year:
2 (2006)

Project Number:
00344

Date:
January 2007

Legend
- Problem Area Concern
- Problem Area Concern
- Inventoried
- Not Inventoried
- Stations
- As-Built Centerline
- As-Built Streambank

Figure 3
Vegetative
Problem Areas
Plan View


VP3


VP5


VP7


VP8


VP10


VP11


VP13


VP15


VP16


VP17


VP18


VP21

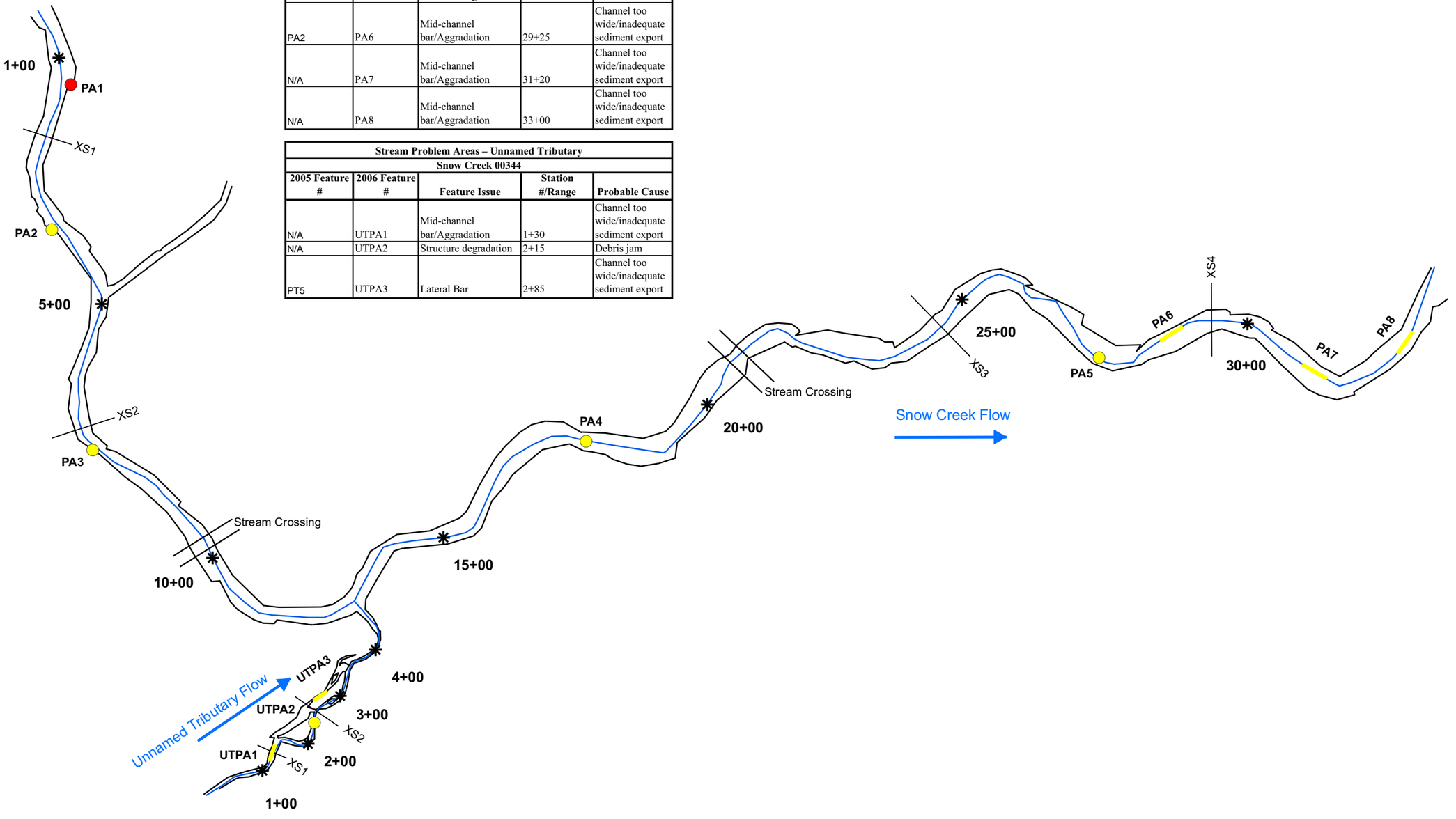
Appendix B
(Click here)

APPENDIX B

GEOMORPHIC RAW DATA

Stream Problem Areas – Snow Creek Snow Creek 00344				
2005 Feature #	2006 Feature #	Feature Issue	Station #/Range	Probable Cause
PA11	PA1	Structure degradation	1+05	Unknown
N/A	PA2	Structure failure	3+80	Unknown
PA9	PA3	Structure degradation	7+60	Unknown
PA13	PA4	Structure degradation	17+50	Beaver activity
PA14	PA5	Structure degradation	27+70	Unknown
PA2	PA6	Mid-channel bar/Aggradation	29+25	Channel too wide/inadequate sediment export
N/A	PA7	Mid-channel bar/Aggradation	31+20	Channel too wide/inadequate sediment export
N/A	PA8	Mid-channel bar/Aggradation	33+00	Channel too wide/inadequate sediment export

Stream Problem Areas – Unnamed Tributary Snow Creek 00344				
2005 Feature #	2006 Feature #	Feature Issue	Station #/Range	Probable Cause
N/A	UTPA1	Mid-channel bar/Aggradation	1+30	Channel too wide/inadequate sediment export
N/A	UTPA2	Structure degradation	2+15	Debris jam
PT5	UTPA3	Lateral Bar	2+85	Channel too wide/inadequate sediment export



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Prepared For:

NC Ecosystem
Enhancement Program

Ecosystem Enhancement PROGRAM

Project:

Snow Creek
Stream Restoration
Stokes County, NC

Monitoring Year:

2 (2006)

Project Number:

00344

Date:

January 2007

Legend

- Stations
- Problem Area Concern (structure)
- Problem Area High Concern (structure)
- Problem Area Concern (bed/bank)
- Cross Section
- As-Built Centerline
- As-Built Streambank

Figure 5
Stream
Problem Areas
Plan View

Table B1a. Stream Problem Areas – Snow Creek Snow Creek 00344			
Feature Issue	**Station**	**Suspected Cause**	**Photo #**
Structure degradation	1+05	Unknown	PA1
Structure failure	3+80	Unknown	PA2
Structure degradation	7+60	Unknown	PA3
Structure degradation	17+50	Beaver activity	PA4
Structure degradation	27+70	Unknown	PA5
Mid-channel bar/Aggradation	29+25	Channel too wide/inadequate sediment export	PA6
Mid-channel bar/Aggradation	31+20	Channel too wide/inadequate sediment export	PA7
Mid-channel bar/Aggradation	33+00	Channel too wide/inadequate sediment export	PA8

Table B1b. Stream Problem Areas – Unnamed Tributary Snow Creek 00344			
Feature Issue	**Station**	**Suspected Cause**	**Photo #**
Mid-channel bar/Aggradation	1+30	Channel too wide/inadequate sediment export	UTPA1
Structure degradation	2+15	Debris jam	UTPA2
Lateral Bar	2+85	Channel too wide/inadequate sediment export	UTPA3

SNOW CREEK


PA1


PA2


PA3


PA4


PA5


PA6


PA7


PA8

UNNAMED TRIBUTARY


UTPA1


UTPA2


UTPA3

SNOW CREEK


PS1


PS2


PS3


PS4


PS5


PS6


PS7


PS8


PS9


PS10


PS11


PS12


PS13


PS14


PS15


PS16


PS17

UNNAMED TRIBUTARY


PS18


PS19


PS20


PS21

Exhibit Table B1a. Visual Morphological Stability Assessment – Snow Creek Snow Creek 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*	1. Present?	10	16	0	100	
	2. Armor stable (no displacement)?	10	16	0	100	
	3. Facet grade appears stable?	10	16	0	100	
	4. Minimal evidence of embedding/fining?	8	16	2	80	
	5. Length appropriate?	6	16	4	60	
						88
B. Pools**	1. Present (not subject to severe aggrad. or migration)?	26	19	0	100	
	2. Sufficiently deep (max pool D:mean Bkf >1.6)	23	19	3	88	
	3. Length appropriate?	21	19	5	81	
						90
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	19	19	0	100	
	2. Downstream of meander (glide/inflection) centering?	19	19	0	100	
						100
D. Meanders	1. Outer bend in state of limited/controlled erosion?	19	19	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	19	19	0	100	
	3. Apparent Rc within spec?	19	19	0	100	
	4. Sufficient floodplain access and relief?	19	19	0	100	
						100
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	3404	3/171	95	
	2. Channel bed degradation–areas of increasing downcutting/headcutting?	NA	3404	0	100	
						98
F. Bank	1. Actively eroding, wasting, or skumping banks	NA	NA	0	100	
						100
G. Vanes***	1. Free of back or arm scour?	21	23	3	88	
	2. Height appropriate?	23	NA	1	96	
	3. Angle and geometry appear appropriate?	20	NA	4	83	
	4. Free of piping or other structural failures?	23	NA	1	96	
						91
H. Wads/ Boulders	1. Free of scour?	1	NA	0	100	
	2. Footing stable?	1	NA	0	100	
						100

* 16 riffles were reported in the 2005 monitoring report. Only 10 were observed during 2006 monitoring
** 19 pools were reported in the 2005 monitoring report. Twenty-six were observed during 2006 monitoring.
*** 23 vanes were reported in the 2005 monitoring report. Twenty-four were observed during 2006 monitoring.

Table B1b. Visual Morphological Stability Assessment – Unnamed Tributary Snow Creek 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*	1. Present?	2	6	0	100	
	2. Armor stable (no displacement)?	2	6	0	100	
	3. Facet grade appears stable?	2	6	0	100	
	4. Minimal evidence of embedding/fining?	2	6	0	100	
	5. Length appropriate?	0	6	2	100	
						80
B. Pools**	1. Present (not subject to severe aggrad. or migration)?	12	9	0	100	
	2. Sufficiently deep (max pool D:mean Bkf >1.6)	12	9	0	100	
	3. Length appropriate?	12	9	0	100	
						100
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	All	NA	None	100	
	2. Downstream of meander (glide/inflection) centering?	All	NA	None	100	
						100
D. Meanders	1. Outer bend in state of limited/controlled erosion?	9	9	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	9	9	0	100	
	3. Apparent Rc within spec?	9	9	0	100	
	4. Sufficient floodplain access and relief?	9	9	0	100	
						100
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	454	2/45	90	
	2. Channel bed degradation–areas of increasing downcutting/headcutting?	NA	454	0	100	
						95
F. Bank	1. Actively eroding, wasting, or slumping banks	NA	NA	0	100	
						100
G. Vanes	1. Free of back or arm scour?	7	7	0	100	
	2. Height appropriate?	7	7	0	100	
	3. Angle and geometry appear appropriate?	7	7	0	100	
	4. Free of piping or other structural failures?	7	7	0	100	
						100
H. Wads/ Boulders***	1. Free of scour?	2	7	0	100	
	2. Footing stable?	2	7	0	100	
						100

* 6 riffles were reported in the 2005 monitoring report. Only 2 were observed during 2006 monitoring
** 9 pools were reported in the 2005 monitoring report. Twelve were observed during 2006 monitoring.
*** 7 wads/boulders were reported in the 2005 monitoring report. Two were observed during 2006 monitoring.

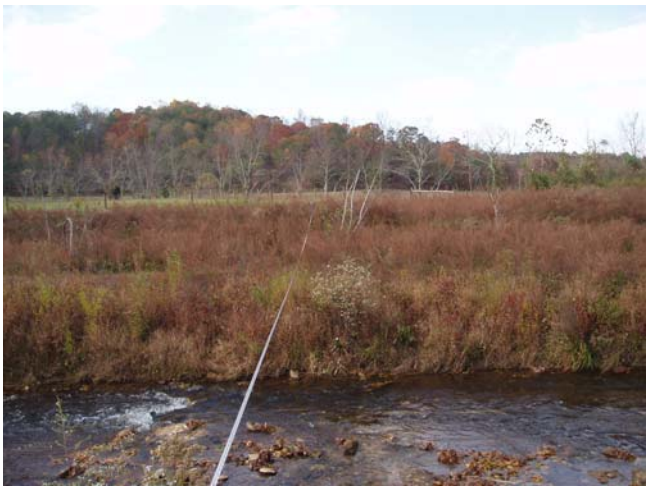
Elevation data were not provided to URS. However, elevation data were used by EcoLogic in plotting Year 1 cross section data. URS was unable to locate benchmarks in the field to establish elevations for the 2006 cross sections. Cross section data were hand manipulated to negate elevation data used in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

Cross section pins were located for all plots with the exception of cross section 2 on the UT to Snow Creek, where the left bank pin was not found. URS re-established the left bank pin in the field. Data from this cross section are not comparable to the previous year's data. The re-establishment of pins effectively relocates the cross sections.

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.

SNOW CREEK

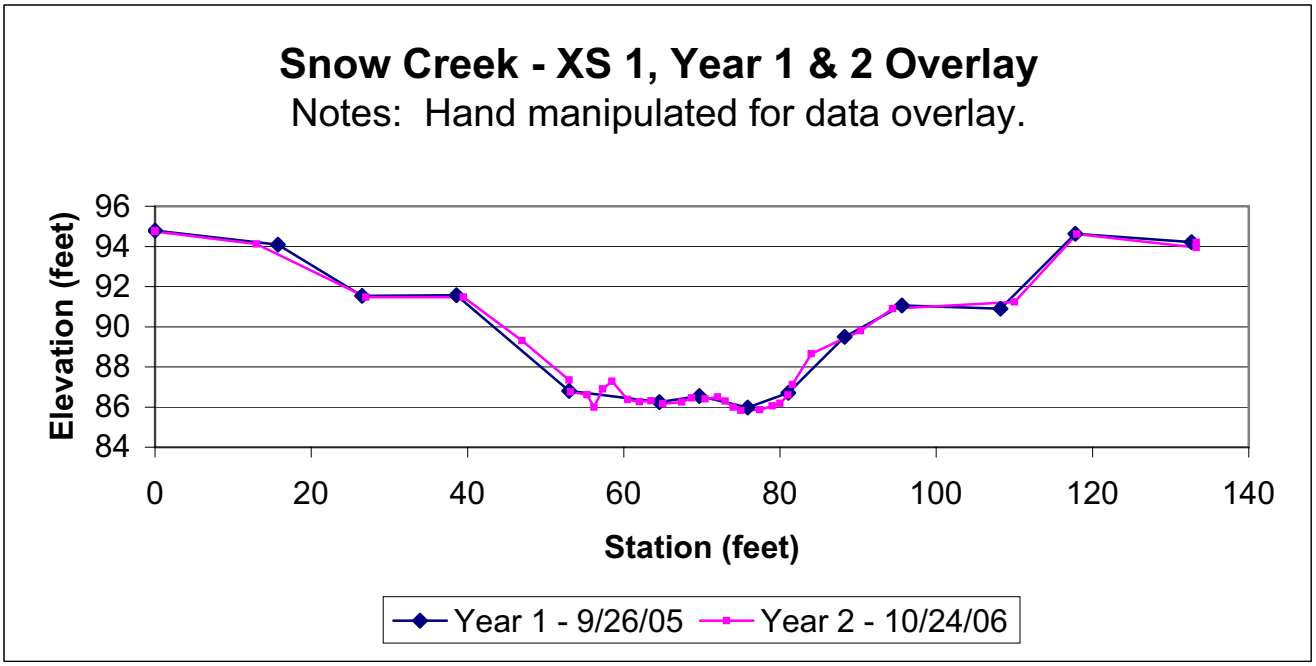
REACH 1

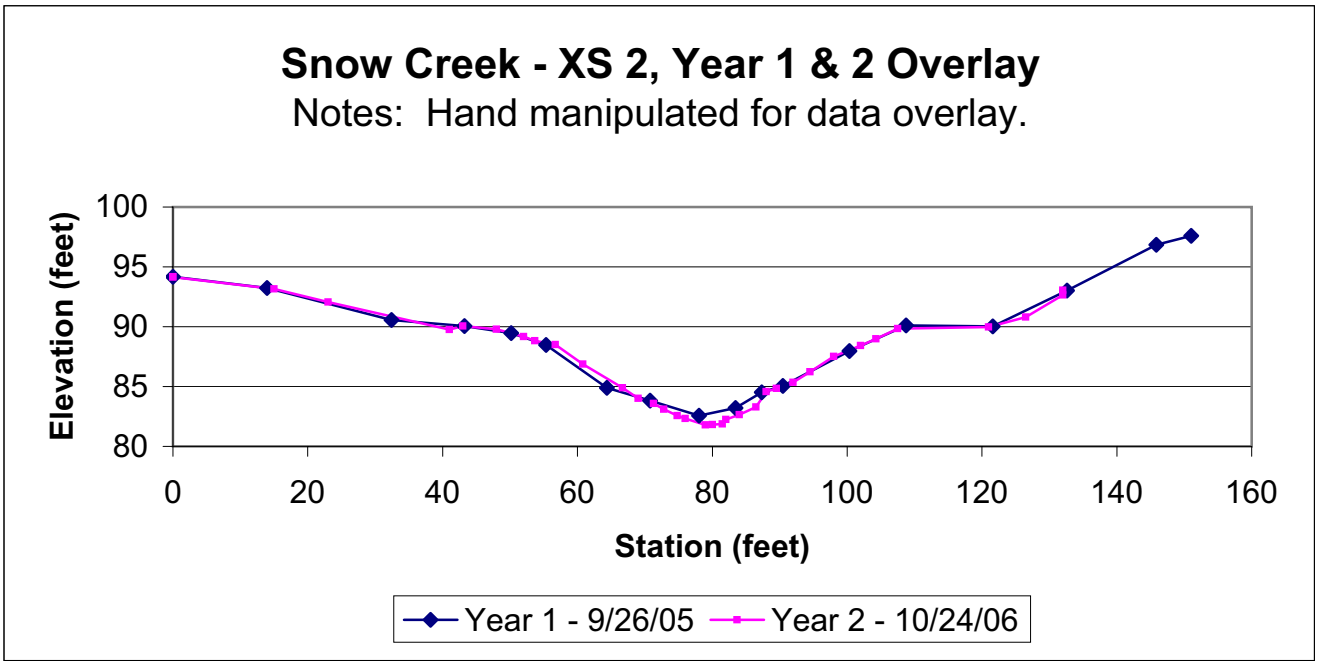

XS1 facing right bank


XS1 facing left bank


XS2 facing right bank


XS2 facing left bank


Snow Creek - XS 1, Year 1 & 2 Overlay
Notes: Hand manipulated for data overlay.
Elevation (feet)
96
94
92
90
88
86
84
0
20
40
60
80
100
120
140
Station (feet)
Year 1 - 9/26/05
Year 2 - 10/24/06


Snow Creek - XS 2, Year 1 & 2 Overlay
Notes: Hand manipulated for data overlay.
Elevation (feet)
100
95
90
85
80
0
20
40
60
80
100
120
140
160
Station (feet)
Year 1 - 9/26/05
Year 2 - 10/24/06

SNOW CREEK

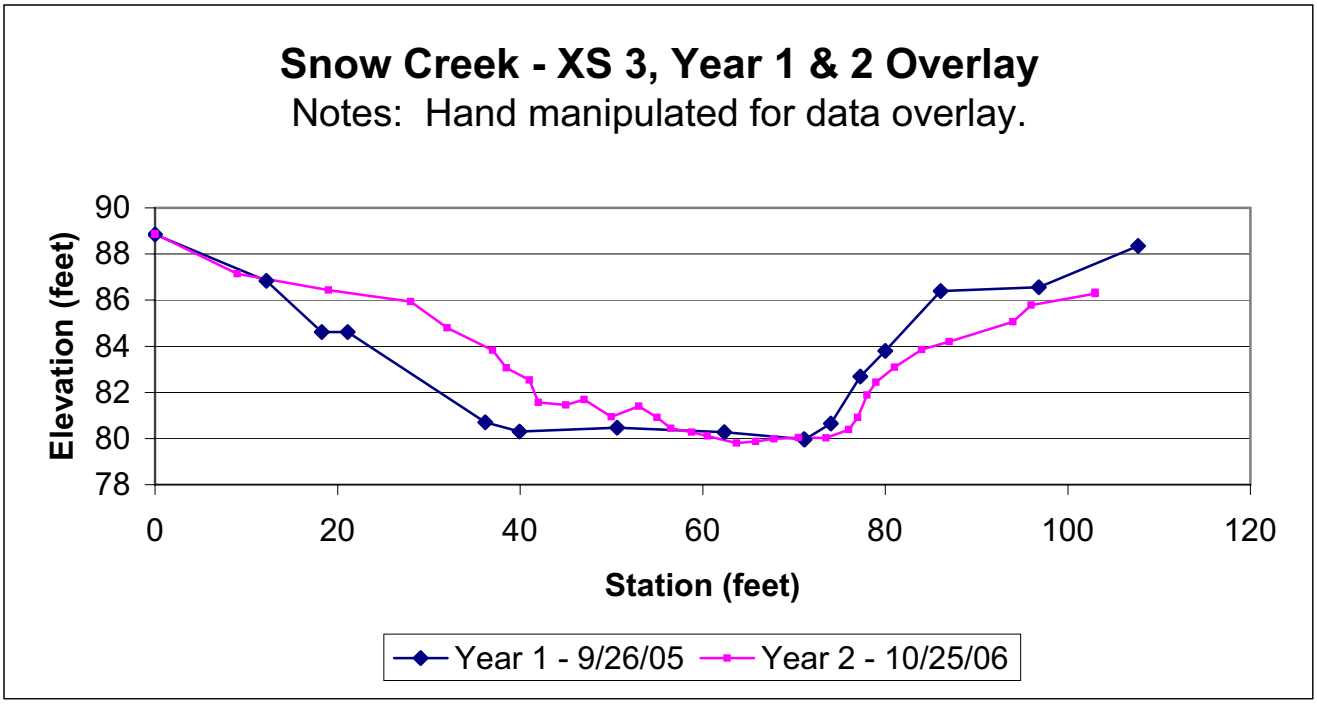
REACH 2

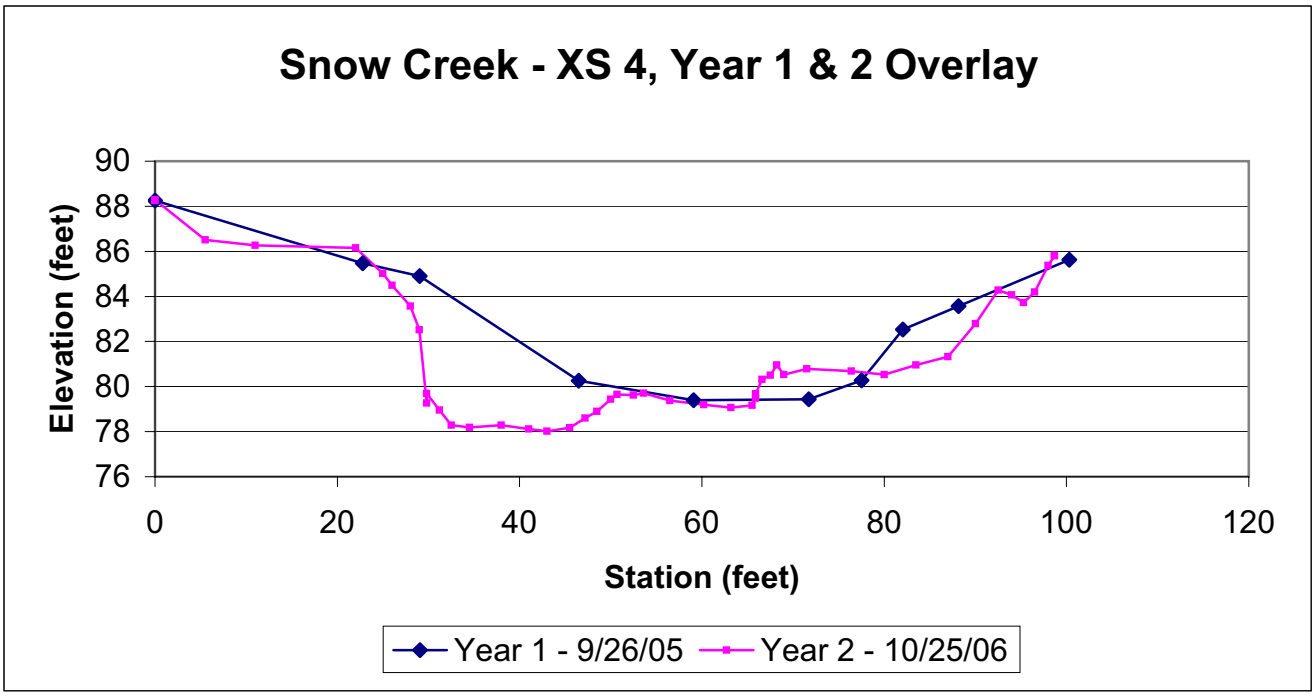

XS3 facing right bank


XS3 facing left bank


XS4 facing right bank


XS4 facing left bank


Snow Creek - XS 3, Year 1 & 2 Overlay
Notes: Hand manipulated for data overlay.
Elevation (feet)
90
88
86
84
82
80
78
0
20
40
60
80
100
120
Station (feet)
Year 1 - 9/26/05
Year 2 - 10/25/06


Snow Creek - XS 4, Year 1 & 2 Overlay
Elevation (feet)
90
88
86
84
82
80
78
76
0
20
40
60
80
100
120
Station (feet)
Year 1 - 9/26/05
Year 2 - 10/25/06

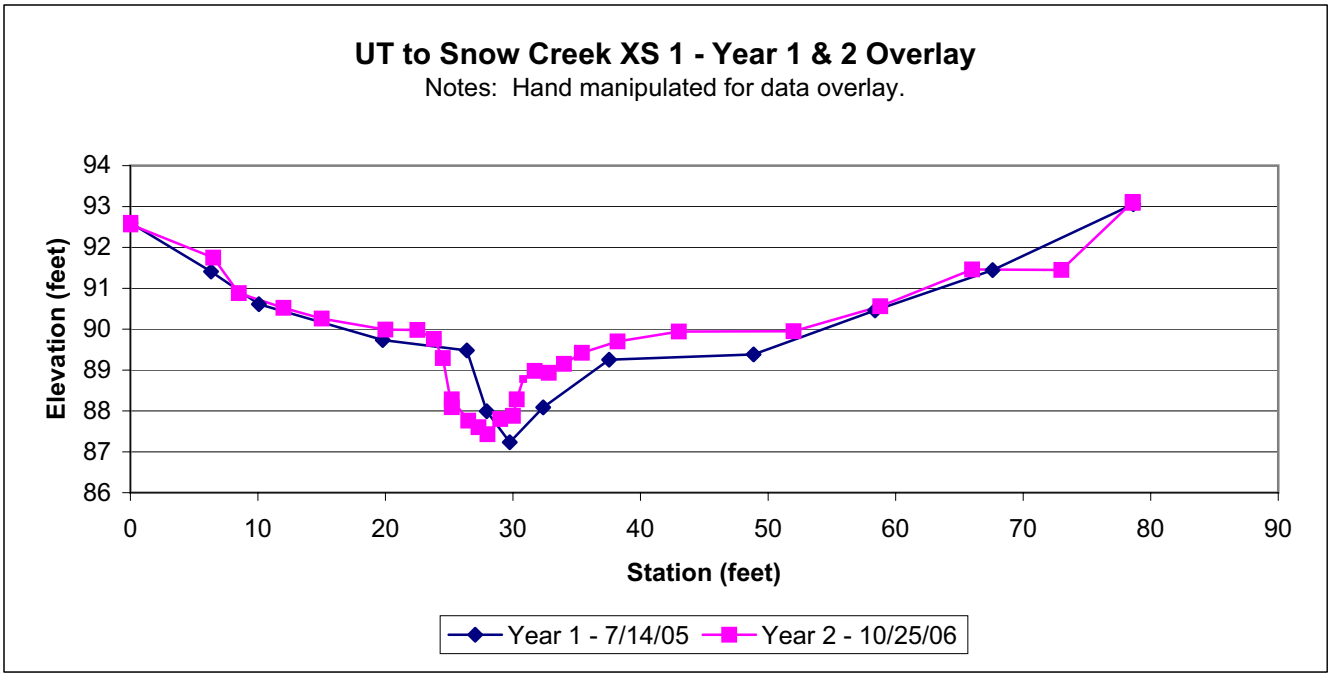
UNNAMED TRIBUTARY

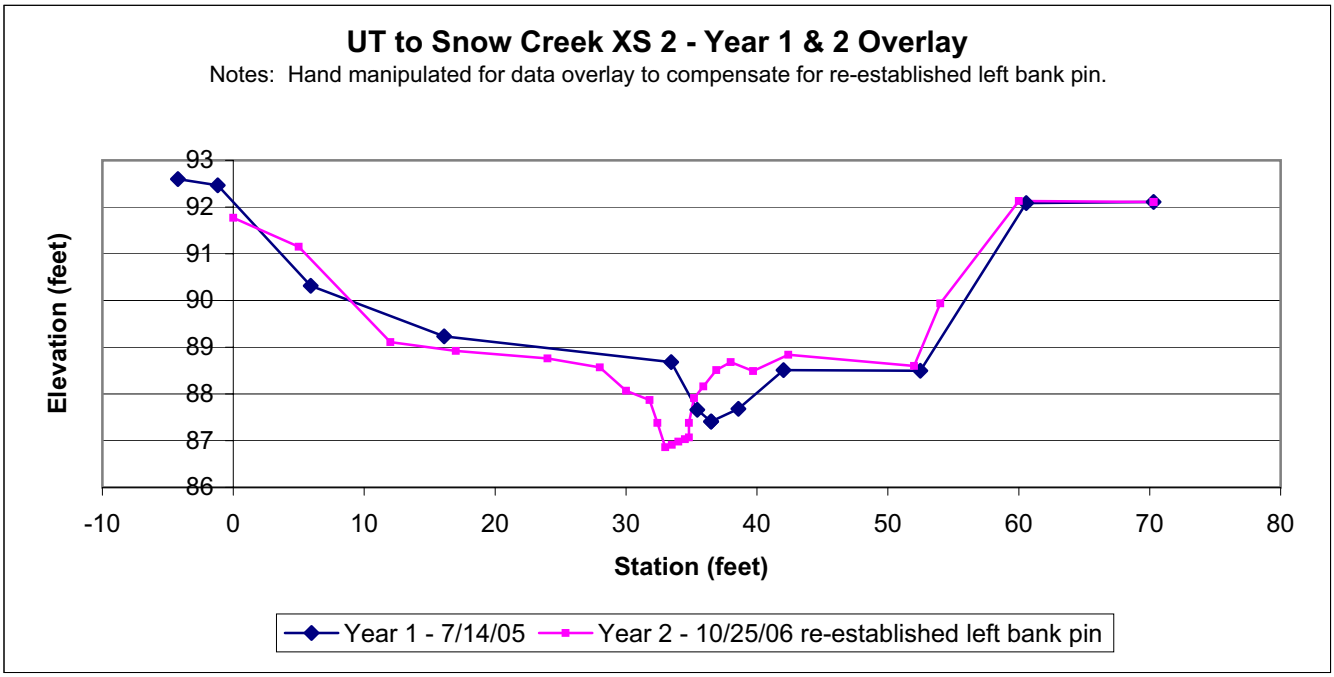

UTXS1 facing right bank


UTXS1 facing left bank


UTXS2 facing right bank


UTXS2 facing left bank

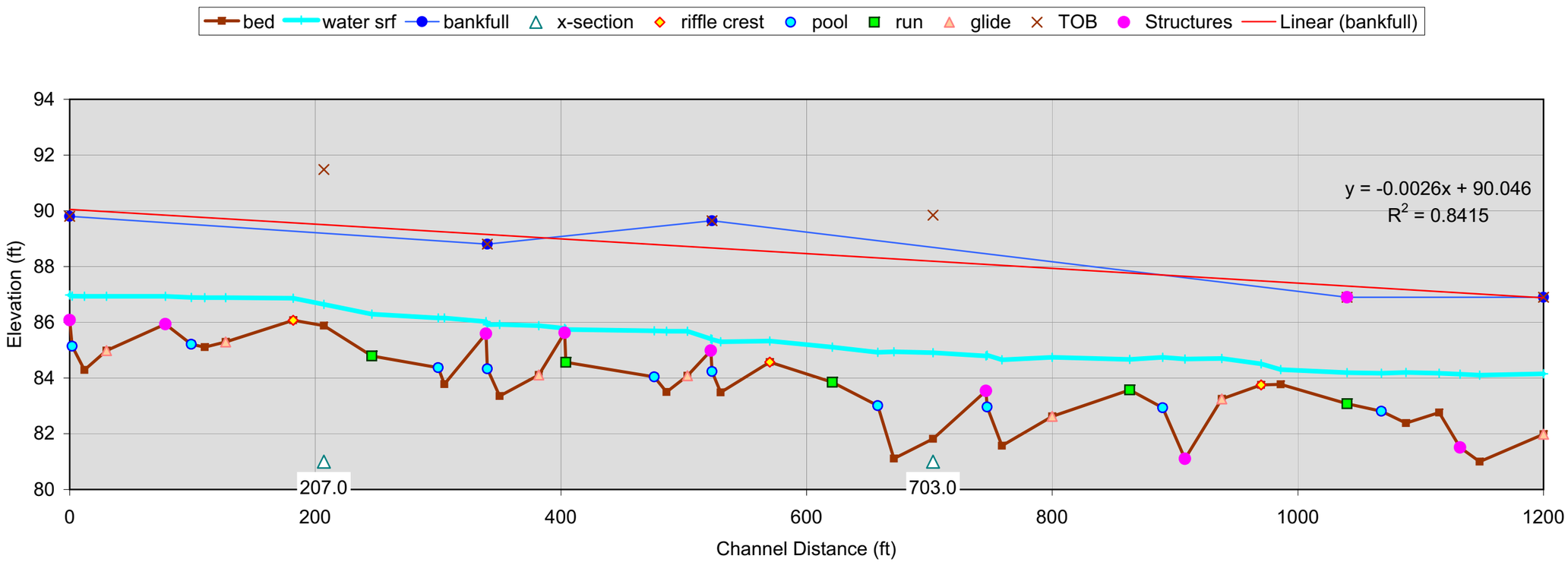

UT to Snow Creek XS 1 - Year 1 & 2 Overlay
Notes: Hand manipulated for data overlay.
Elevation (feet)
94
93
92
91
90
89
88
87
86
0
10
20
30
40
50
60
70
80
90
Station (feet)
Year 1 - 7/14/05
Year 2 - 10/25/06


UT to Snow Creek XS 2 - Year 1 & 2 Overlay
Notes: Hand manipulated for data overlay to compensate for re-established left bank pin.
Elevation (feet)
93
92
91
90
89
88
87
86
-10
0
10
20
30
40
50
60
70
80
Station (feet)
Year 1 - 7/14/05
Year 2 - 10/25/06 re-established left bank pin

SNOW CREEK

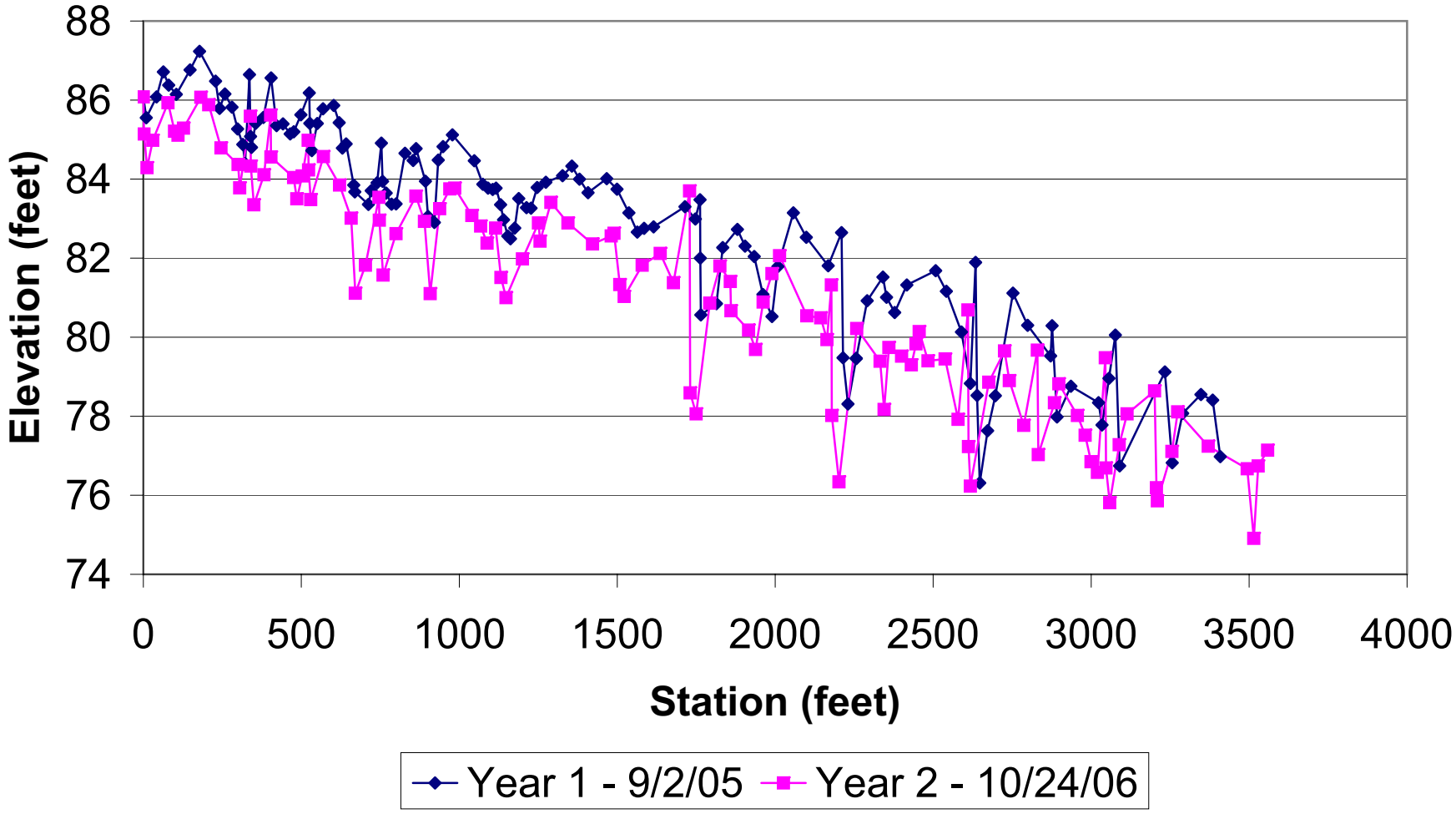
REACH 1

Snow Creek - Reach 1 - 10/24/06



Snow Creek - Year 1 & 2 Overlay

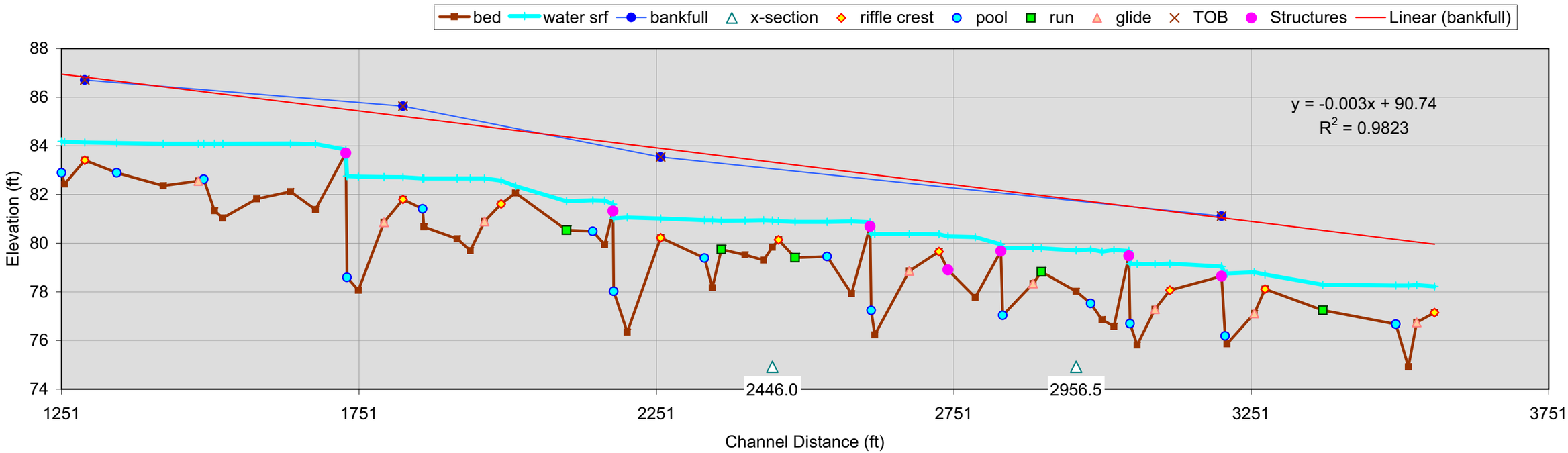
Notes: Hand manipulated for data overlay.



SNOW CREEK

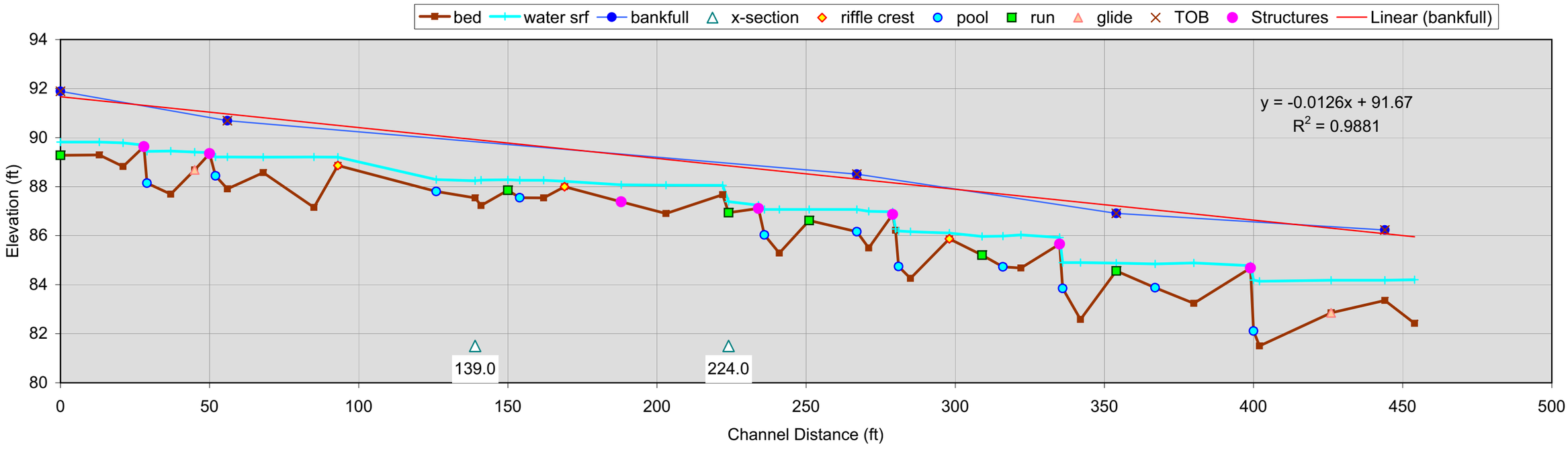
REACH 2

Snow Creek - Reach 2 - 10/25/06



UNNAMED TRIBUTARY

Unnamed Tributary to Snow Creek (10/26/06)



SNOW CREEK

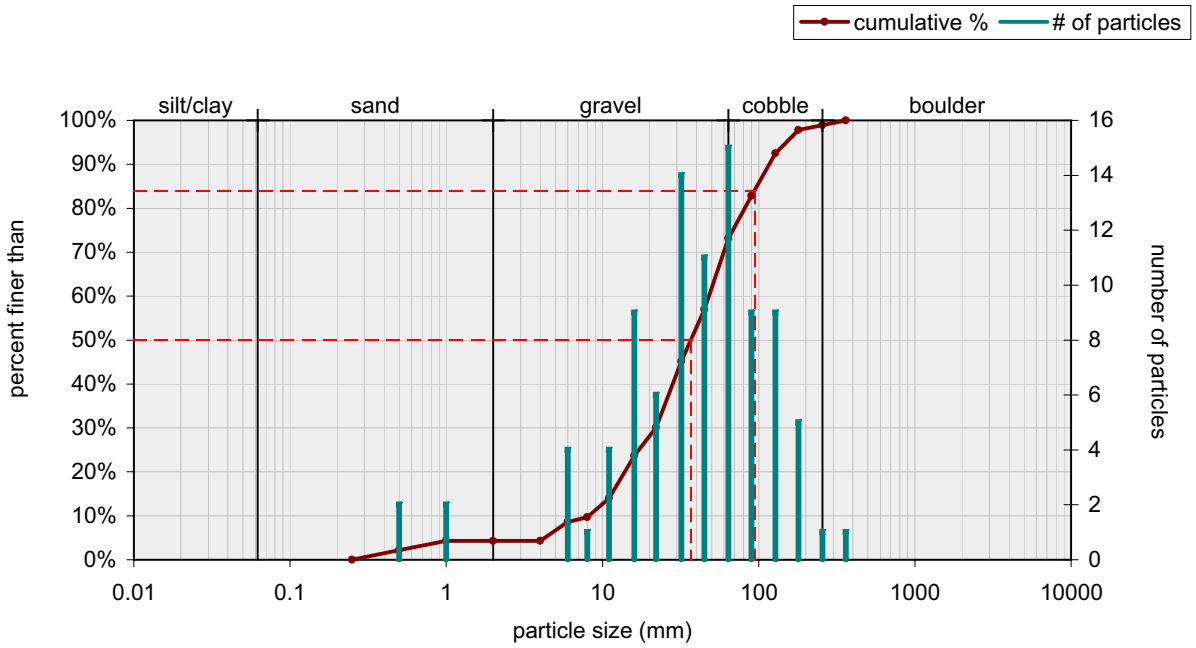
REACH 1

Snow Creek
Reach 1
Cross Section 1
10/24/06

Bed Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	**2**
coarse sand	0.5 - 1	**2**
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**1**
medium gravel	8 - 11	**4**
medium gravel	11 - 16	**9**
coarse gravel	16 - 22	**6**
coarse gravel	22 - 32	**14**
very coarse gravel	32 - 45	**11**
very coarse gravel	45 - 64	**15**
small cobble	64 - 90	**9**
medium cobble	90 - 128	**9**
large cobble	128 - 180	**5**
very large cobble	180 - 256	**1**
small boulder	256 - 362	**1**
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		93
bedrock ----------		**7**
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		100

Note:



Size (mm)	
D16	12
D35	25
D50	37
D65	54
D84	94
D95	150

Size Distribution	
mean	33.6
dispersion	2.8
skewness	-0.04

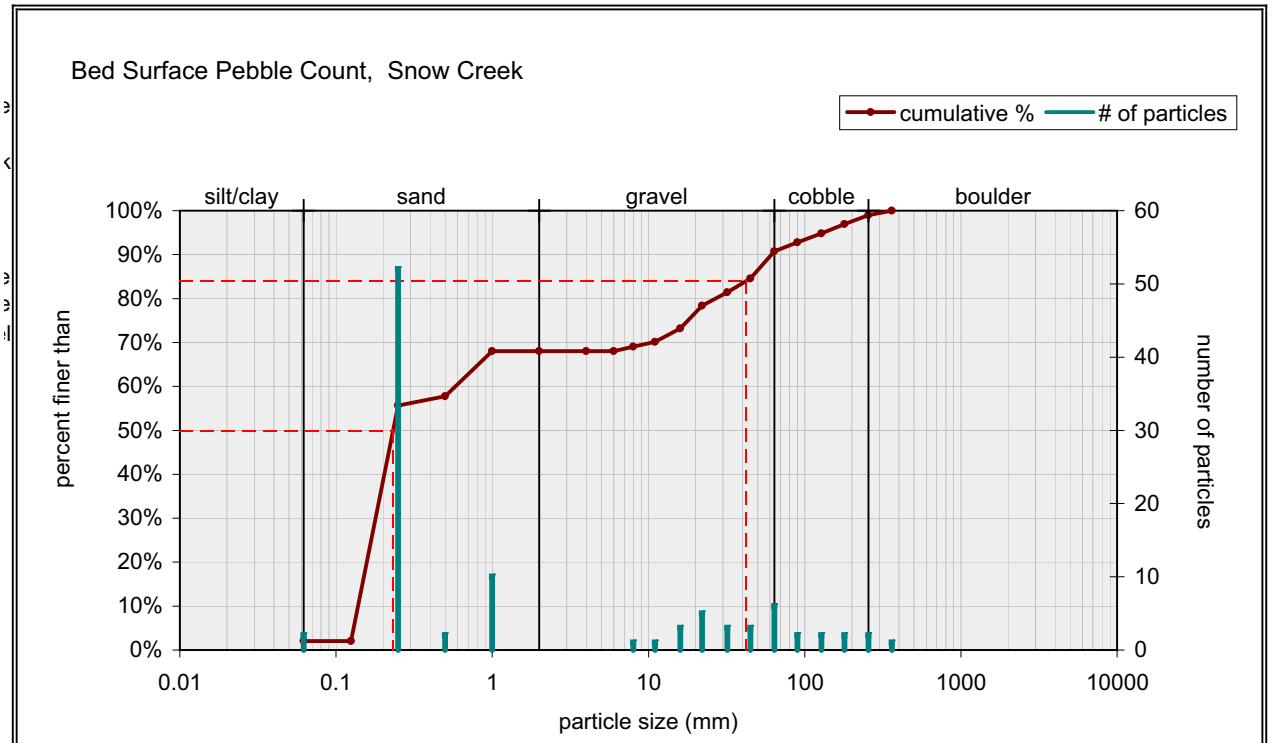
Type			
silt/clay	0%	bedrock	7%
sand	4%		
gravel	64%		
cobble	24%		
boulder	1%		

Snow Creek
Reach 1
Cross Section 2
10/24/06

Bed Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**2**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**52**
medium sand	0.25 - 0.5	**2**
coarse sand	0.5 - 1	**10**
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	**1**
medium gravel	8 - 11	**1**
medium gravel	11 - 16	**3**
coarse gravel	16 - 22	**5**
coarse gravel	22 - 32	**3**
very coarse gravel	32 - 45	**3**
very coarse gravel	45 - 64	**6**
small cobble	64 - 90	**2**
medium cobble	90 - 128	**2**
large cobble	128 - 180	**2**
very large cobble	180 - 256	**2**
small boulder	256 - 362	**1**
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		97
bedrock ----------		**3**
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		100

Note:



Size (mm)	
D16	0.15
D35	0.19
D50	0.23
D65	0.82
D84	42
D95	130

Size Distribution	
mean	2.5
dispersion	92.1
skewness	0.66

Type			
silt/clay	2%	bedrock	3%
sand	64%		
gravel	22%		
cobble	8%		
boulder	1%		

SNOW CREEK

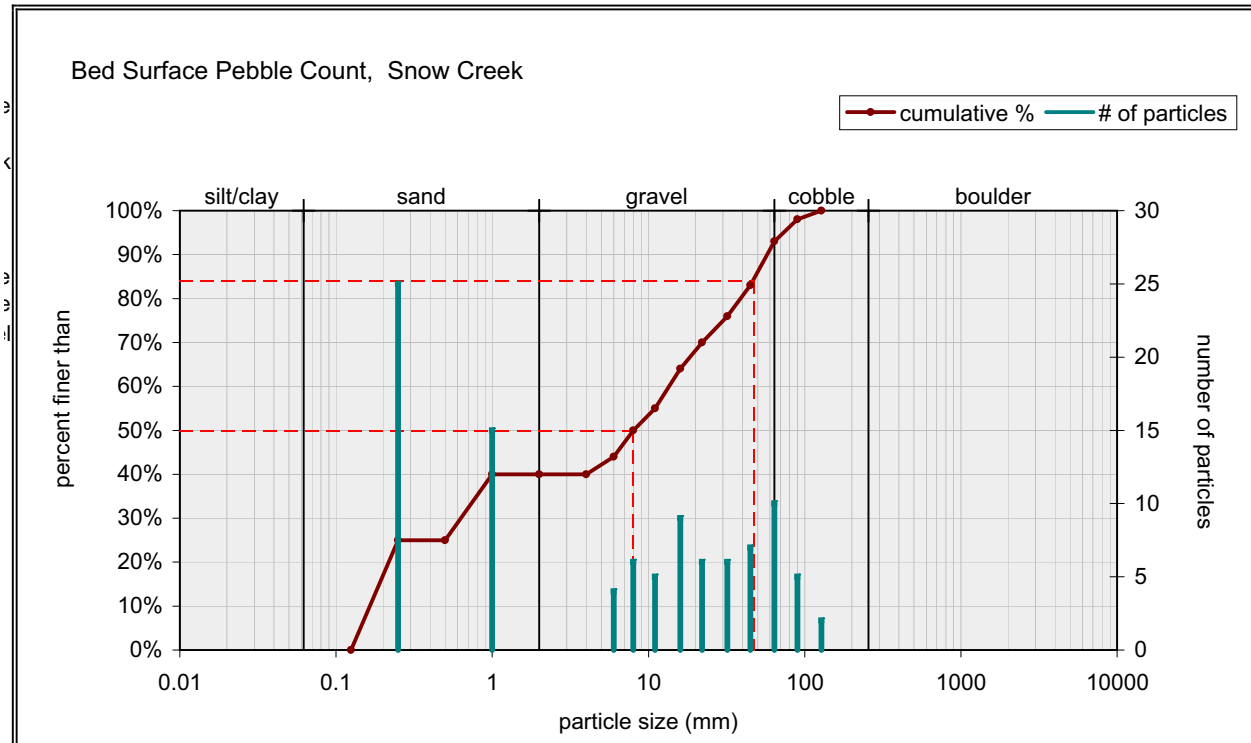
REACH 2

Snow Creek
Reach 2
Cross Section 3
10/25/06

Bed Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**25**
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	**15**
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**6**
medium gravel	8 - 11	**5**
medium gravel	11 - 16	**9**
coarse gravel	16 - 22	**6**
coarse gravel	22 - 32	**6**
very coarse gravel	32 - 45	**7**
very coarse gravel	45 - 64	**10**
small cobble	64 - 90	**5**
medium cobble	90 - 128	**2**
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:



Size (mm)	
D16	0.19
D35	0.79
D50	8
D65	17
D84	47
D95	73

Size Distribution	
mean	3.0
dispersion	24.0
skewness	-0.28

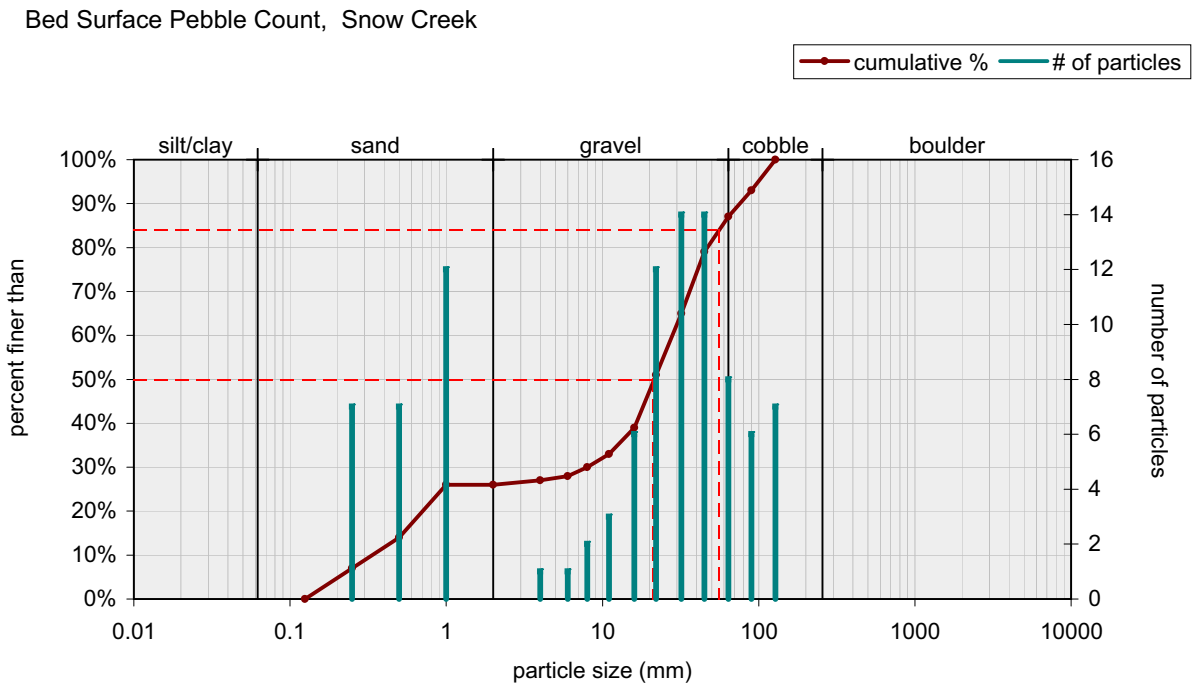
Type	
silt/clay	0%
sand	40%
gravel	53%
cobble	7%
boulder	0%

Snow Creek
Reach 2
Cross Section 4
10/25/06

Bed Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**7**
medium sand	0.25 - 0.5	**7**
coarse sand	0.5 - 1	**12**
very coarse sand	1 - 2	
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	**1**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**3**
medium gravel	11 - 16	**6**
coarse gravel	16 - 22	**12**
coarse gravel	22 - 32	**14**
very coarse gravel	32 - 45	**14**
very coarse gravel	45 - 64	**8**
small cobble	64 - 90	**6**
medium cobble	90 - 128	**7**
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:



Size (mm)	
D16	0.56
D35	12
D50	21
D65	32
D84	56
D95	100

Size Distribution	
mean	5.6
dispersion	20.1
skewness	-0.41

Type	
silt/clay	0%
sand	26%
gravel	61%
cobble	13%
boulder	0%

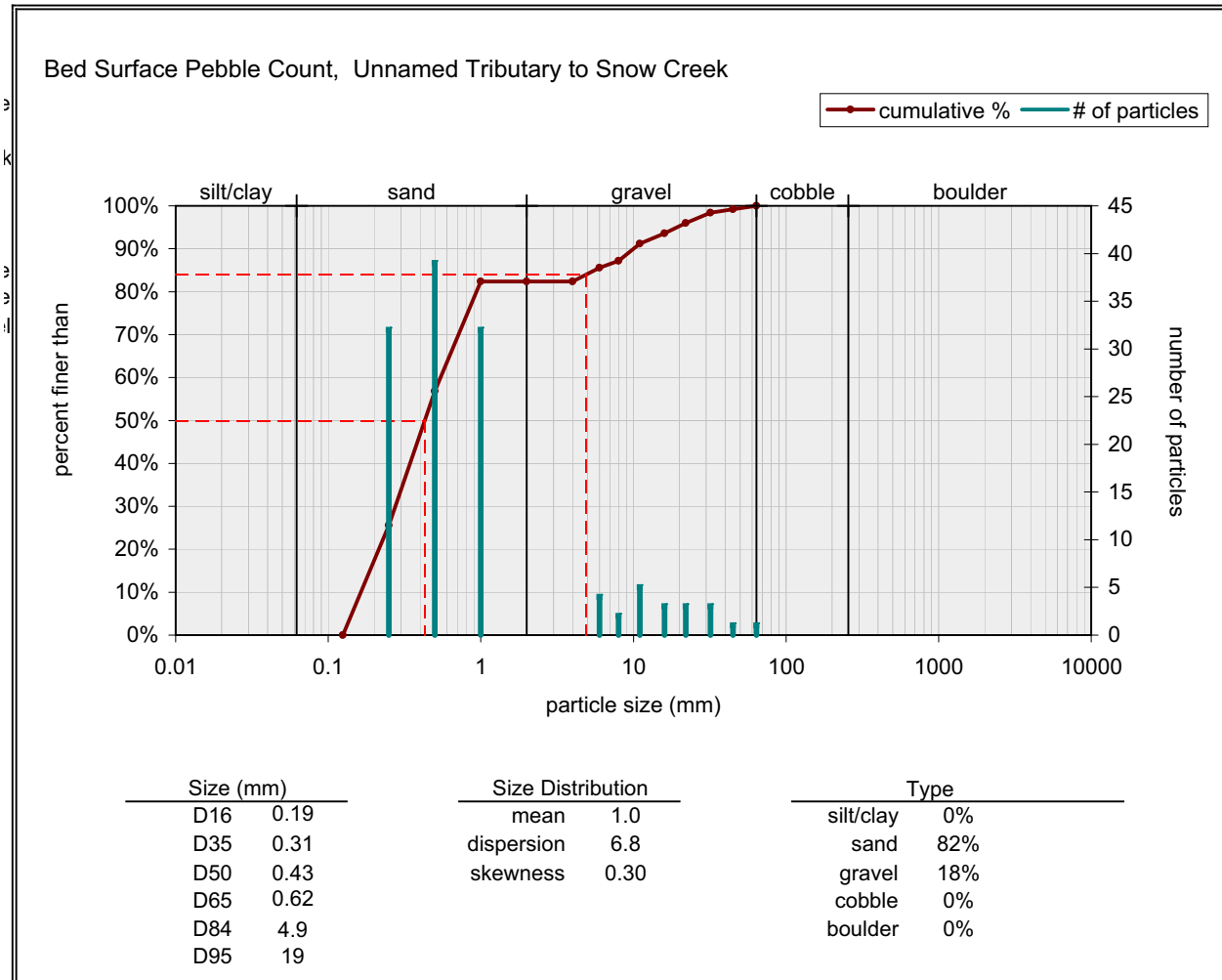
UNNAMED TRIBUTARY

Unnamed Tributary
Cross Section 1
10/25/06

Bed Surface

Material	Size Range (mm	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**32**
medium sand	0.25 - 0.5	**39**
coarse sand	0.5 - 1	**32**
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**2**
medium gravel	8 - 11	**5**
medium gravel	11 - 16	**3**
coarse gravel	16 - 22	**3**
coarse gravel	22 - 32	**3**
very coarse gravel	32 - 45	**1**
very coarse gravel	45 - 64	**1**
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		125
bedrock ----------		
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		125

Note:



Size (mm)	
D16	0.19
D35	0.31
D50	0.43
D65	0.62
D84	4.9
D95	19

Size Distribution	
mean	1.0
dispersion	6.8
skewness	0.30

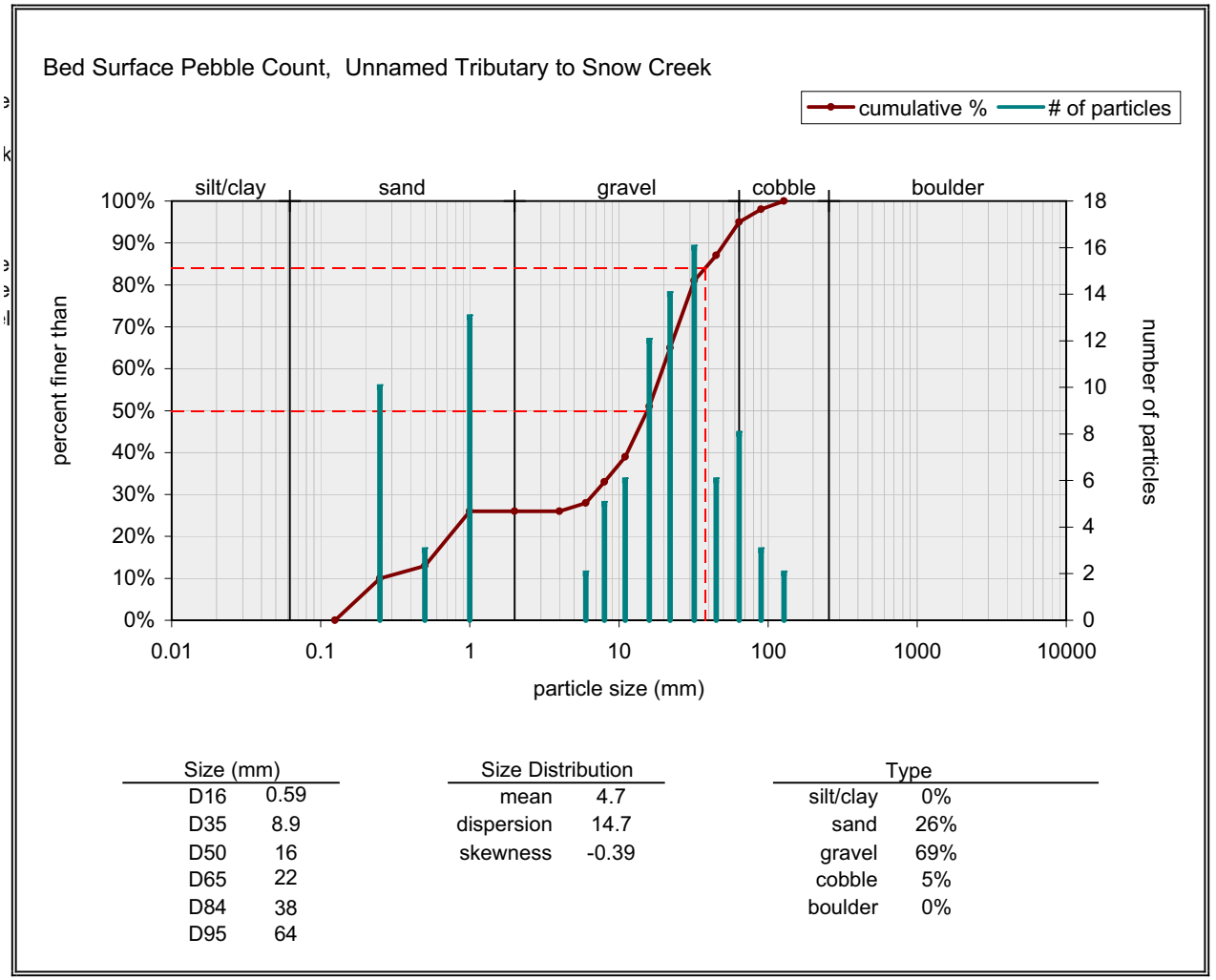
Type	
silt/clay	0%
sand	82%
gravel	18%
cobble	0%
boulder	0%

Unnamed Tributary
Cross Section 2
10/25/06

Bed Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**10**
medium sand	0.25 - 0.5	**3**
coarse sand	0.5 - 1	**13**
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**5**
medium gravel	8 - 11	**6**
medium gravel	11 - 16	**12**
coarse gravel	16 - 22	**14**
coarse gravel	22 - 32	**16**
very coarse gravel	32 - 45	**6**
very coarse gravel	45 - 64	**8**
small cobble	64 - 90	**3**
medium cobble	90 - 128	**2**
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock ----------		
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		100

Note:



Size (mm)	
D16	0.59
D35	8.9
D50	16
D65	22
D84	38
D95	64

Size Distribution	
mean	4.7
dispersion	14.7
skewness	-0.39

Type	
silt/clay	0%
sand	26%
gravel	69%
cobble	5%
boulder	0%