Freedom Park (Little Sugar Creek) Monitoring Report Year 4 of 5 (2008)

Mecklenburg County, North Carolina

USGS HUC: 03050103

Project ID No. 141

Prepared for:

NCDENR-Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, North Carolina 27699-1652

May 2009

Executive Summary

The Freedom Park Stream Restoration project falls within USGS hydrologic unit **03050103**. The project stream lies within an urban setting of the City of Charlotte that is comprised of predominantly residential and commercial uses. Prior to restoration work, the project stream (Little Sugar Creek) had been destabilized through historic channelization and dredging. Also, prior to restoration work, the channel consisted of a concrete lining.

HDR Engineering designed the restoration plans and restoration was completed in 2003. Baker Engineering prepared maintenance plans and Fluvial Solutions completed the maintenance construction in early 2008. Kimley-Horn and Associates (KHA) performed stream and riparian monitoring during 2008 for this Year 4 Monitoring Report. During the late growing season, KHA assessed six (6) vegetation quads. Vegetation within two (2) of the quads had been cleared for the preparation of a staging area for maintenance work. The Ecosystem Enhancement Program (EEP) has scheduled replanting of these quads during winter/spring of 2008-2009. Combined stem count density for the intact quads equaled approximately 670 stems per acre for planted stems; exceeding year 4 success criteria. All quads exceeded the year 4 success criteria. Overall, the floodplain vegetation is performing well with the exception of two cleared locations. Stream bank vegetation has had difficulty becoming established in some sections.

A stream assessment including a visual assessment and geomorphic survey indicated that the project reaches were performing mostly within established success criteria ranges. A few isolated sections showed bank erosion, but the length and occurrence of erosion was less than previous years. Most of the project reach continues to be stable. The geomorphic measurements are within the range of the design parameters.

Table of Contents

Figures

Project Tables

Appendices

1.0 Project Background

The background information for this report references previous monitoring reports submitted by the Biological and Agricultural Engineering Department at North Carolina State University and Soil and Environmental Consultants, PA.

1.1 Location and Setting

The Little Sugar Creek stream restoration site lies within in the Catawba River Basin (HU No. 03050103) in Mecklenburg County, North Carolina. East Boulevard and Princeton Avenue bound the upper and lower endpoints of the stream reach and the site lies entirely within Freedom Park and the City of Charlotte. Freedom Park is part of the Mecklenburg County Park and Recreation Department public park system. (See Figure 1)

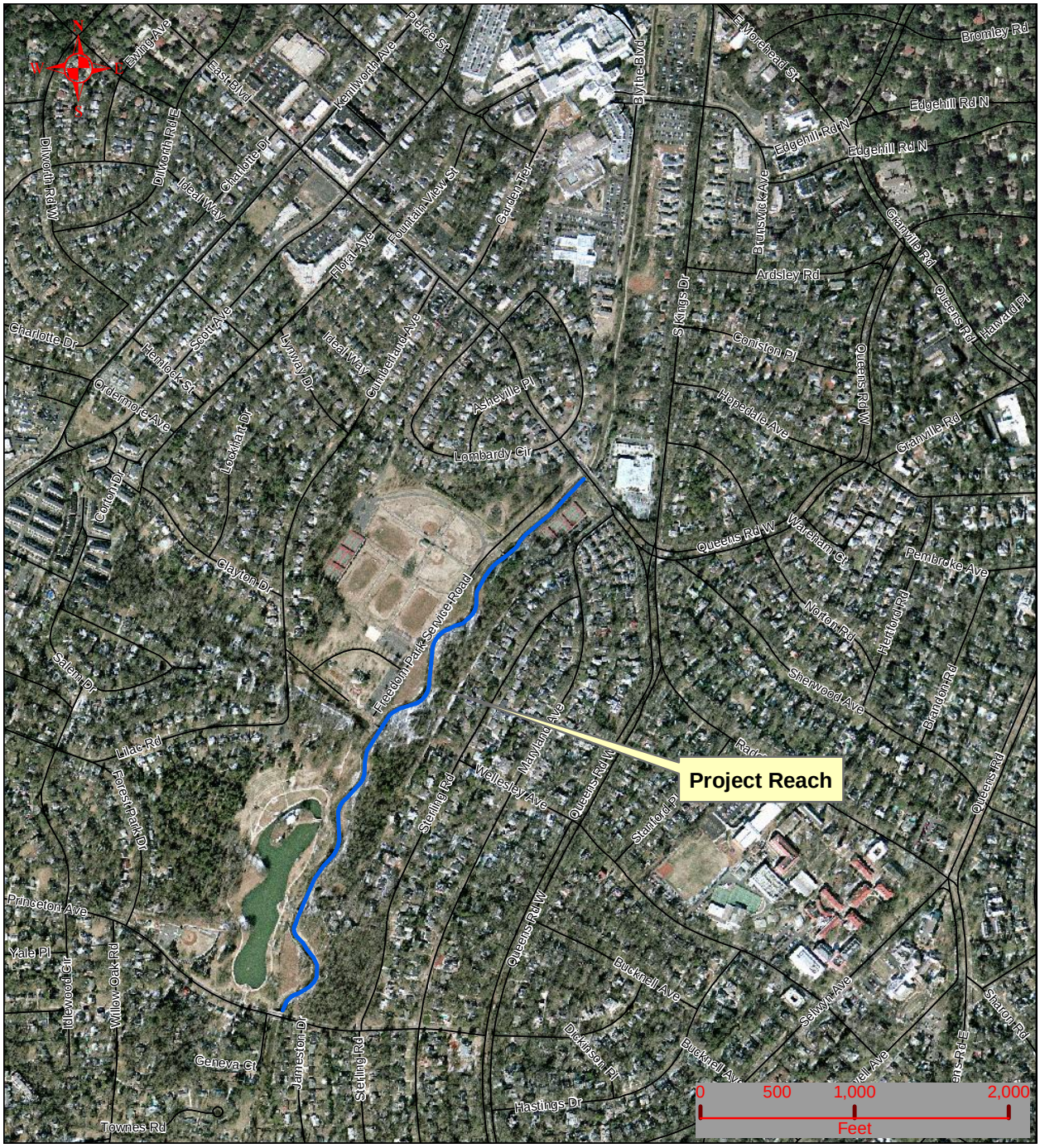
1.2 Project Structure, Mitigation Type, Approach and Objectives

Little Sugar Creek was dredged in 1917 to a minimum width of approximately 20 feet and a depth of 8 feet. Overall, the current alignment has existed since the early part of the 1900s. In the mid-1960s and early 1970s, the City initiated an erosion control system along the banks of Little Sugar Creek, as it flows through Freedom Park, using a combination of grouted riprap and concrete bank covering. In July 2002, the County removed the grouted riprap and concrete banking and temporarily stabilized the banks with erosion control matting. Additionally, the large flood control weir structure located approximately 450 feet upstream of Princeton Avenue was removed.

The restoration plan proposed to increase aquatic habitat diversity, improve on-site water quality, stabilize the stream banks, provide flood storage, and aesthetically enhance the stream setting.

Project Table I provides project mitigation structure and objectives:

Figure 1: Project Site Setting



Prepared For	Project	Freedom Park (Little Sugar Creek) Stream Restoration Monitoring Year 4 – 2008 Mecklenburg County, North Carolina	Prepared By
Ecosystem Enhancement Program			Kimley-Horn and Associates, Inc.
	Date	**Project Number**	
	05/27/2009	141	

1.3 Project History and Background

Construction of the Little Sugar Creek Stream Restoration project began in mid-2003 and ended in September 2003. The As-built survey was completed in June 2004. Maintenance work was completed in early 2008. Year 4 monitoring occurred during 2008. Project Table II provides additional details regarding the timeline of the project.

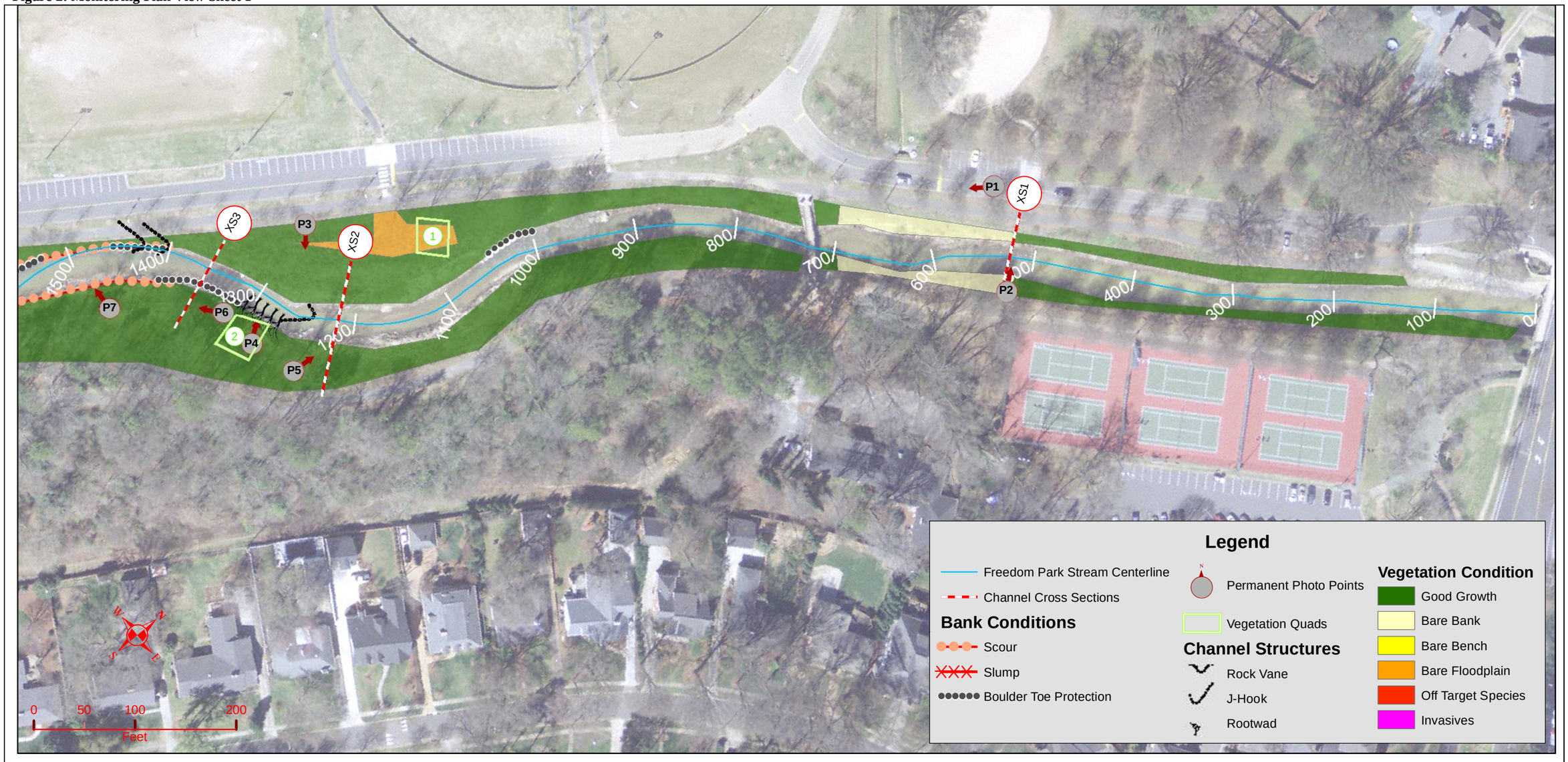
The project was designed by HDR Engineering, Inc of the Carolinas. Construction was performed by SEI Environmental. Maintenance designs were prepared by Baker Engineering and construction was performed by Fluvial Solutions. Monitoring activities for Year 1 were performed by S&EC. Kimley-Horn and Associates performed monitoring for Years 2, 3, and 4. Project Table III provides additional information regarding contractors.

The project is located within Mecklenburg County, portions of which are located within the Charlotte Belt of the Piedmont of North Carolina. The site is located within a highly urbanized area. Project Table IV provides additional information regarding this stream.

1.4 Monitoring Plan View

The monitoring plan assesses the project stream's geomorphology using a set of nine (9) cross sections located throughout the project reach. The longitudinal profile and pattern assessment covered the entire reach. Twenty-three (23) permanent photo points provide for a visual comparison of key site features through time. The monitoring plan uses six (6) randomly placed vegetation quads to assess riparian buffer restoration. Monitoring Plan View Sheets 1 to 3 show the locations of the monitoring features.

Figure 2: Monitoring Plan View Sheet 1



Prepared For	Project	Freedom Park (Little Sugar Creek) Stream Restoration Monitoring Year 4 – 2008 Mecklenburg County, North Carolina	Prepared By
Ecosystem Enhancement Program	Date	Project Number	Kimley-Horn and Associates, Inc.
	05/27/2009	141	

Figure 3: Monitoring Plan View Sheet 2

Prepared For	Project	Prepared By
Ecosystem Enhancement Program	Freedom Park (Little Sugar Creek) Stream Restoration Monitoring Year 4 – 2008 Mecklenburg County, North Carolina	Kimley-Horn and Associates, Inc.
	Date: 05/27/2009	**Project Number**: 141

Figure 4: Monitoring Plan View Sheet 3

Prepared For	Project	Freedom Park (Little Sugar Creek) Stream Restoration Monitoring Year 4 – 2008 Mecklenburg County, North Carolina	Prepared By
Ecosystem Enhancement Program			Kimley-Horn and Associates, Inc.
	Date	**Project Number**	
	05/27/2009	141	

2.0 Project Conditions and Monitoring Results

2.1 Vegetation Assessment

Planted zones related to the stream restoration consisted of the riparian buffer zone and the stream banks. The riparian buffer zone begins at the top of the bank and continues out perpendicular from the stream. The planted stream bank begins at the normal base flow elevation and extends to the top of bank or interface with the flood plain.

KHA assessed site vegetation in September and October, 2008. Several sections continue to exhibit bare banks. As noted in previous monitoring reports, the cause of the bare banks may be due to a lack of root development capable of withstanding stresses to during flood flows and/or compacted soils inhibiting vegetation growth. Two sections of floodplain appear to have been cleared for maintenance work. Appendix A provides a summary of vegetative problem areas. Figures 2-4 show the problem areas.

KHA conducted a vegetation assessment during the early fall of 2008. The stem count table in appendix A summarizes the results of the vegetation sample. Two (2) of the six (6) plots had been cleared for maintenance work. Each of the intact plots meet success criteria for planted stem counts. In several plots, species such as *Betula nigra*, *Acer negundo*, *Populus deltoids*, F*raxinus pennsylvanicum*, and *Liquidambar styraciflua* continue to dominate.

2.2 Stream Assessment

KHA assessed the stream channel during the spring and fall of 2008. A few isolated sections exhibited bank scour (3%). Causes of scour may include lack of vegetative establishments; frequent flooding flows; unstable soils; and failed short-term protection such as coir fiber matting.

Most structures seemed to remain in place and functional. A set of root wads near the bottom of the reach showed severe scour behind the root balls. Large boulders have been placed at the base of theses root wads. The boulders have held the root wads in place. Maintenance work removed some structures and used the structure materials to build new structures. The maintenance work added J-hooks, boulder toe protection in several sections, and a step down structure located on a bank side. Monitoring Plan View Sheets 1 through 3 show the location of the stream problem areas and table B1 in appendix B summarizes the stream problem areas.

Project Table V provides a listing of probable bankfull events based on site observations and limited gage data. Photographic evidence and eye witness accounts indicate at least one (1) bankfull event occurred in 2008.

Project Table VI provides a categorical view of the stream visual stability assessment. The visual assessment shows little change from 2007 with the exception of pools, vane like structures, and root wads. Survey measurements showed that some pools lacked adequate depth. All observed vane structures appeared stable. Impaired structures observed in 2007 had been removed or repaired. Rootwads designated as scoured and unstable in 2007 were upgraded to scoured but stable due to a history of stability through multiple bankfull events. Table B2 in appendix B provides a breakdown of the visual assessment.

Project Table VI and Table VII summarize the site geomorphic assessment. KHA continued using the bankfull elevations established during the 2006 monitoring period. These elevations

were determined using a combination of upstream gage data, urban piedmont regional curves, and site indicators. The field investigators had difficulty identifying cross section benchmarks in the field; therefore some of the cross sections had a slightly different alignment than previous year's cross sections. The difference in alignment negates a very fine comparison between years for a cross section but does allow for the identification of significant changes in cross section. The cross sections did not show a significant change in the shape or area compared to earlier years. Upon review of the repair plans dated July 2007, it was noted that three cross-sections were affected by the repair work: XS3, XS6, and XS9. Appendix B provides photographs and graphing for geomorphic data.

3.0 Methodology

Monitoring methods for 2008 were similar to those used in 2007.

PROJECT TABLES

Table I. Project Restoration Components Little Sugar Creek Stream Restoration Site (EEP Project #141)								
Project Segment or Reach ID	**Existing Feet / Acres**	**Type**	**Approach**	**Footage or Acreage**	**Mitigation Ratio**	**Mitigation Units**	**Stationing**	**Comment**
Main	4,200	R	P2 / P3	4,450 lf	1:1	4,450	0+00.0 - 44+50.0	

Table II. Project Activity and Reporting History Little Sugar Creek Stream Restoration Site (EEP Project #141)				
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**	**Comments**
Restoration Plan			Oct-02	
Final Design – 90%				
Construction	2003		Sept-03	
Temporary S&E mix applied to entire project area	2003		Sept-03	
Permanent seed mix applied	2003		Sept-03	
Containerized and B&B plantings for reach/segments 1&2	2004		June-04	
Mitigation Plan / As-built (Year 0 Monitoring –	2004		Spring 04	Performed by NCSU
Year 1 monitoring	2005	Oct-05	Nov-05	Performed by SEC, PA
Year 2 Monitoring	2006	Oct-06	Jan-07	Performed by KHA, Inc.
Year 3 Monitoring	2007	Nov-07	Feb-08	Performed by KHA, Inc.
Year 4 Monitoring	2008	Oct-08		Performed by KHA, Inc.
Year 5 Monitoring	2009			

Table III. Project Contact Table Little Sugar Creek Stream Restoration Site (EEP Project #141)		
Designer	128 South Tryon St., Suite 1400	
HDR Engineering, Inc. of the Carolinas	Charlotte, NC 28202	
Primary Designer POC		
Construction Contractor	5100 North I-85, Suite 7	
SEI Environmental	Charlotte, NC 28206	
Primary Contractor POC		
Planting Contractor		
Planting contractor POC		
Seeding Contractor		
Planting contractor POC		
Seed Mix Sources		
Nursery Stock Suppliers		
Monitoring Performers	PO Box 33068	
Kimley-Horn and Associates	Raleigh, NC 27636	
Stream Monitoring POC	Daren Pait	(919) 678-4155
Vegetation Monitoring POC	Daren Pait	(919) 678-4155

Table IV. Project Background Table Little Sugar Creek Stream Restoration Site (EEP Project #141)	
Project County	Mecklenburg
Drainage Area	13.6 square miles
Drainage impervious cover estimate (%)	75%
Stream Order	3
Physiographic Region	Piedmont
Ecoregion	Charlotte Belt
Rosgen Classification of As-built	C4
Cowardin Classification	N/A
Dominant soil types	Cecil, Monacan
Reference site ID	N/A
USGS HUC for Project and Reference	03050103
NCDWQ Sub-basin for Project and Reference	03-08-34
NCDWQ classification for Project and Reference	C
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	No
% of project easement fenced	0%

Table V. Verification of Bankfull Events Little Sugar Creek Stream Restoration Site (EEP Project #141)			
Date of Data	**Date of Occurrence**	**Method**	**Photo #**
10/1/2006	Before 10/1/2006	Photographed On-Site	BE1
11/3/2008	Before 11/03/2008	Photographed On-Site	PS4

Table VI. Categorical Stream Feature Visual Stability Assessment Little Sugar Creek Stream Restoration Site (EEP Project #141)						
Reach 1						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	--	100%	100%	100%	100%	--
B. Pools	--	95%	98%	98%	89%	--
C. Thalweg	--	100%	100%	100%	100%	--
D. Meanders	--	85%	72%	72%	70%	--
E. Bed General	--	94%	100%	100%	100%	--
F. Bank Condition	--	92%	82%	95%	97%	
G. Vanes / J Hooks etc.	--	100%	80%	80%	100%	--
H. Wads and Boulders	--	100%	35%	35%	68%	--

Table VII. Baseline Morphology and Hydraulic Summary

Little Sugar Creek Stream Restoration Site (EEP Project #141)

Reach

Parameter		USGS Gage Data			Regional Curve			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Units	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																			
BF Width	ft	*	*	*	36	56	*	*	*	64	37	49	*	51	57	*	45.3	68.4	52.3
Floodprone Width	ft	*	*	*	*	*	*	*	*	300	72	150	*	*	*	300	60.2	85.9	75.7
BF Cross Sectional Area	ft^2	*	*	*	122	319	*	*	*	302	119	314	*	335	343	*	197.3	239.2	219.7
BF Mean Depth	ft	*	*	*	3.5	5.7	*	*	*	5.1	2.8	6.4	*	6	6.5	*	3.5	4.6	4.3
BF Max Depth	ft	*	*	*	*	*	*	*	*	9	5.2	11.1	*	8	8	*	4.8	6.9	5.5
Width/Depth Ratio		*	*	*	*	*	*	*	*	12.5	7.6	13.2	*	7.8	9.5	*	9.8	19.5	12.3
Entrenchment Ratio		*	*	*	*	*	*	*	*	5	1.9	2.2	*	*	*	5	1.3	1.6	1.3
Bank Height Ratio																	1.5	2.2	1.9
Wetted Perimeter	ft	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	48.5	70.8	59.3
Hydraulic radius	ft	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3.4	4.3	3.7
Pattern																			
Channel Beltwidth	ft	*	*	*	*	*	*	0	125	*	92	100	*	200	467	*	105	236	153
Radius of Curvature	ft	*	*	*	*	*	*	*	*	*	64	210	*	160	220	*	72	232	147.5
Meander Wavelength	ft	*	*	*	*	*	*	433	532	*	362	552	*	*	*	395	403	840	531
Meander Width ratio		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1.9	4.3	3
Profile																			
Riffle length	ft	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	15	207	66
Riffle slope	ft/ft	*	*	*	*	*	*	*	*	*	0.007	0.07	*	0.01	0.014	*	0.0027	0.0175	0.0115
Pool length	ft	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	76	252	132
Pool spacing	ft	*	*	*	*	*	*	*	*	*	98	104	*	*	*	141	171	587	294
Substrate[1]																			
d50	mm	*	*	*	*	*	*	*	*	4.8	1.1	1.9	*	*	*	4.8	0.2	1.1	*
d84	mm	*	*	*	*	*	*	*	*	6.4	2.6	3	*	*	*	6.4	0.2	4.7	*
Additional Reach Parameters																			
Valley Length	ft		*			*			*			*			*			*	
Channel Length	ft		*			*			*			*			*			*	
Sinuosity			*			*			1.04		1.1	1.4			1.11			*	
Water Surface Slope	ft/ft		*			*			0.003		0.003	0.008		0.0026	0.0029			0.0025	
BF slope	ft/ft		*			*			*			*			*			*	
Rosgen Classification			*			*			C3-C5			*			*			*	
*Habitat Index			*			*			*			*			*			*	
*Macrobenthos			*			*			*			*			*			*	

[1]Substrate collected at each cross section

Table VIII. Morphology and Hydraulic Monitoring Summary
Little Sugar Creek Stream Restoration Site (EEP Project #141)

Parameter		Cross Section 1 Riffle						Cross Section 2 Pool						Cross Section 3 Riffle					
Dimension	**Units**	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5
BF Width	ft	46.3	47.6	47.6	48.9	48.58	*	66.5	71.4	64.8	74.6	72.93	*	45.3	46.1	46.3	46.9	41.36	*
Floodprone Width	ft	67	71.3	69.5	101.6	82.64	*	106	109.6	110.3	106	113.95	*	60.2	61.3	58.3	62.9	100.32	*
BF Cross Sectional Area	ft	197.3	205.7	214.7	223	229.52	*	235.9	253.5	236	235.6	262.77	*	208.2	213	213	215	174.95	*
BF Mean Depth	ft	4.3	4.3	4.5	4.6	4.72	*	3.6	3.5	3.6	3.2	3.6	*	4.6	4.6	4.6	4.6	4.23	*
BF Max Depth	ft	5.5	5.6	5.8	5.9	6.27	*	6.5	7.1	7	6.8	7.29	*	6.7	6.3	6.5	6.6	6.85	*
Width/Depth Ratio		10.9	11	10.6	10.7	10.3	*	18.7	20.1	17.8	23.3	20.3	*	9.8	10	10	10.2	9.8	*
Entrenchment Ratio		1.5	1.5	1.5	1.5	1.7	*	1.6	1.5	1.7	1.4	1.6	*	1.3	1.3	1.3	1.3	2.4	*
Bank Height Ratio		1.9	1.9	1.8	1.8	1.7		1.9	1.8	1.8	1.8	1.5		1.5	1.6	1.3	1.5	1.4	
Wetted Perimeter	ft	50.1	50.5	50.9	52.4	51.83	*	68.8	74.3	68.5	77.6	76.56	*	48.5	49.2	49.5	49.8	44.93	*
Hydraulic radius	ft	*	4.1	4.2	4.3	4.43	*	3.4	3.4	3.5	3	3.43	*	4.3	4.3	4.3	4.3	3.89	*
Substrate																			
d50	mm	1.1	*	15.8	26.1	16	*	0.31	*	1.54	0.6	0.5	*	0.19	*	1.71	2.9	9.7	*
d84	mm	2.8	*	93.8	107.5	63	*	2.3	*	36.61	1.7	54.5	*	4.7	*	47.47	7.6	128	*

Parameter		Cross Section 4 Pool						Cross Section 5 Riffle						Cross Section 6 Pool					
Dimension	**Units**	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5
BF Width	ft	68.7	63.7	56.44	61.2	50.46	*	52.3	53.9	56	53	58.69	*	79.5	85.2	79.5	85.1	76.88	*
Floodprone Width	ft	100.7	104.8	88.4	99.8	72.6	*	81.3	81.06	92.6	86.9	97.33	*	140.4	145	131.2	144	145.15	*
BF Cross Sectional Area	ft	223.6	219.9	204.8	188.4	188.4	*	222.2	236.6	223.9	228.3	220.95	*	273.7	284.6	284.3	286.3	256.91	*
BF Mean Depth	ft	3.3	3.5	3.6	3.1	3.73	*	4.3	4.4	4	4.3	3.76	*	3.4	3.3	3.6	3.4	3.34	*
BF Max Depth	ft	6.6	6.8	6.5	6.6	5.69	*	6.9	7.2	7.4	7.8	7.73	*	7.8	8.2	7.7	8.3	7.84	*
Width/Depth Ratio		21.1	18.5	15.6	19.7	13.5	*	12.3	12.3	14	12.3	15.6	*	23.1	25.5	22.2	25	23	*
Entrenchment Ratio		1.5	1.7	1.6	1.6	1.4	*	1.6	1.5	1.7	1.6	1.7	*	1.8	1.7	1.7	1.7	1.9	*
Bank Height Ratio		2.0	2.0	1.8	2	1.9		1.7	1.6	1.4	1.6	1.7		2.1	2.0	1.9	1.9	1.9	
Wetted Perimeter	ft	72.8	67.9	59.9	66.4	54.49	*	59.3	58.1	60.1	57	62.38	*	83.2	88.1	82.3	88.6	81.01	*
Hydraulic radius	ft	3.1	3.2	3.4	2.8	3.46	*	3.8	4.1	3.7	4	3.54	*	3.3	3.2	3.5	3.2	3.17	*
Substrate																			
d50	mm	0.24	*	4.52	1.2	11.3	*	0.52	*	11.15	59.3	11.3	*	0.06	*	0.79	0.8	0.1	*
d84	mm	1.4	*	29.99	26.9	128	*	2	*	151.9	291.3	230	*	0.2	*	1.56	1.8	171	*

Parameter		Cross Section 7 Riffle						Cross Section 8 Riffle						Cross Section 9 Pool					
Dimension	**Units**	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5
BF Width	ft	68.4	66.5	70	69.3	60.15	*	59.5	59.7	60.75	61	57.14	*	59.8	59.9	66.5	62.4	65.01	*
Floodprone Width	ft	85.9	84	91.1	85	91.93	*	75.7	76.6	82.1	78.6	74.81	*	96.4	96.5	95.3	105	105.3	*
BF Cross Sectional Area	ft	239.2	214.1	213.8	233.7	264.71	*	219.7	219.9	221.3	219.7	181.27	*	235.3	250.5	247.6	244.4	277.27	*
BF Mean Depth	ft	3.5	3.2	3.1	3.4	4.4	*	3.7	3.7	3.6	3.6	3.17	*	3.9	4.2	3.7	3.9	4.26	*
BF Max Depth	ft	5.02	5.02	4.3	4.4	5.4	*	4.8	5	4.9	4.8	4.23	*	9.6	9.5	9	9.5	8.36	*
Width/Depth Ratio		19.5	20.6	22.9	20.4	13.7	*	16.1	16.2	16.7	16.9	18	*	15.2	14.3	17.8	16	15.3	*
Entrenchment Ratio		1.3	1.3	1.3	1.2	1.5	*	1.3	1.3	1.4	1.3	1.3	*	1.6	1.6	1.4	1.7	1.6	*
Bank Height Ratio		2.1	2.1	2.3	2.4	1.8		2.2	2.2	1.5	2	2.6		1.7	1.7	1.7	1.7	1.6	
Wetted Perimeter	ft	70.8	68.2	71.5	70.7	63.39	*	61.3	61.4	62.3	63.1	59.19	*	66.6	67.3	70.2	69	71.28	*
Hydraulic radius	ft	3.4	3.1	3	3.3	4.18	*	3.6	3.6	3.6	3.5	3.06	*	3.5	3.7	3.5	3.5	3.89	*
Substrate																			
d50	mm	0.53	*	17.65	66.2	30.7	*	0.18	*	42.64	36.2	19.3	*	0.85	*	1.24	1.9	7.2	*
d84	mm	1.5	*	55.41	135.1	73.8	*	1.3	*	205.33	175.8	59.4	*	1.5	*	15.81	16.9	41.7	*

Parameter		AB (2004)			MY-01 (2005)			MY-02 (2006)			MY-03 (2007)			MY-04 (2008)			MY-05 (2009)		
Pattern		**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Channel Beltwidth	ft	105	236	153	103	304	184	118	225	150	118	225	150	118	225	150	*	*	*
Radius of Curvature	ft	72	232	148	126	195	159	90	392	154	90	392	154	90	392	154	*	*	*
Meander Wavelength	ft	403	840	531	523	837	634	411	852	501	411	852	501	411	852	501	*	*	*
Meander Width ratio		1.9	4.3	2.8	1.9	5.5	3.3	2.1	4.1	2.7	2.1	4.1	2.7	2.1	4.1	2.7	*	*	*
Profile											*	*	*	*	*	*	*	*	*
Riffle length	ft	15	207	66	*	*	*	26	192	54	9.9	114.9	49.6	39	83.9	64.8	*	*	*
Riffle slope	ft/ft	0.0027	0.0175	0.0115	0.0021	0.0026	0.0023	0.0010	0.0240	0.0080	0.0000	0.0265	0.0083	0.0011	0.0238	0.0117	*	*	*
Pool length	ft	76	252	132	83	413	168	34	296	126	64.9	403	168.3	34.3	377.2	163.6	*	*	*
Pool spacing	ft	171	587	294	133	651	372	131	600	250	146	434	266	213	658	466	*	*	*
Additional Parameters											*	*	*						
Valley Length	ft	*	*	*	*	*	39.26	*	*	39.26	*	*	39.26	*	*	39.26	*	*	*
Channel Length	ft	*	*	*	*	*	4437	*	*	4437	*	*	4437	*	*	4437	*	*	*
Sinuosity		*	*	*	*	*	1.13	*	*	1.13	*	*	1.13	*	*	1.13	*	*	*
Water Surface Slope	ft/ft	*	*	*	*	*	0.00234	0.0006	0.0095	0.0021	0.0003	0.0065	0.0029	0.0015	0.0101	0.0028	*	*	*
BF slope	ft/ft	*	*	*	*	*	0.00234	*	*	0.0015	0.0022	0.0039	0.0031	0.0016	0.005	0.002	*	*	*
Rosgen Classification		*	*	*	*	*	B5	*	*	B5	*	*	B5	*	*	B5	*	*	*
Habitat Index*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Macrobenthos*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

APPENDIX A
VEGETATION MONITORING DATA

Table I. Vegetative Metadata

Little Sugar Creek Stream Restoration Site (EEP Project #141)

Report Prepared By	Josh Allen
Date Prepared	May 2009
database name	KHA-2007-A-FreedomPark141-VMD-v210.mdb
database location	K:\RAL_Environmental\PN\011795 Freedom Park Monitoring FPARK\MY 2008

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	141
project Name	Freedom Park
Description	Riparian Buffer Restoration
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	18

Table II. Vegetation Vigor by Species

Little Sugar Creek Stream Restoration Site (EEP Project

	Species	4	3	2	1	0	Missing
	Alnus serrulata	1	2				
	Betula nigra	34	7	2			5
	Celtis laevigata						
	Cornus amomum	7	10	4			
	Elaeagnus angustifolia						
	Fraxinus pennsylvanica	23	14	4			7
	Lagerstroemia indica						
	Liquidambar styraciflua						
	Pinus taeda						
	Quercus falcata	7	2				
	Quercus michauxii	5	6				4
	Quercus phellos	5	3	1			
	Robinia pseudoacacia						
	Salix nigra	20	9				1
	Sambucus canadensis	2	12	2		1	1
	Morus rubra	8	4				
	Juniperus virginiana						
	Cercis canadensis						
	Liriodendron tulipifera		1			2	
	Platanus occidentalis	11		1			
	Populus deltoides	11	5	1			4
	Acer negundo	1		1			1
	Acer rubrum	7	2				3
	Unknown	3	12	2		1	
TOT:	**24**	**145**	**89**	**18**		**4**	**26**

Table III. Vegetation Damage by Species

Little Sugar Creek Stream Restoration Site (EEP Project #141)

	Species	All Damage Categories	(no damage)	Human Trampled	Insects	Removal	Unknown	Vine Strangulation	(other damage)
	Acer negundo	11	10			1			
	Acer rubrum	14	11			3			
	Alnus serrulata	5	4						1
	Betula nigra	63	52			4		7	
	Celtis laevigata	1	1						
	Cercis canadensis	1	1						
	Cornus amomum	25	21						4
	Elaeagnus angustifolia	1	1						
	Fraxinus pennsylvanica	55	45			7		3	
	Juniperus virginiana	1	1						
	Lagerstroemia indica	1	1						
	Liquidambar styraciflua	10	10						
	Liriodendron tulipifera	4	3				1		
	Morus rubra	19	19						
	Pinus taeda	1	1						
	Platanus occidentalis	16	16						
	Populus deltoides	27	23					4	
	Quercus falcata	10	9					1	
	Quercus michauxii	16	12			4			
	Quercus phellos	9	7	1				1	
	Robinia pseudoacacia	1	1						
	Salix nigra	31	30			1			
	Sambucus canadensis	24	22				2		
	Unknown	24	21		1		1	1	
TOT:	**24**	**370**	**322**	**1**	**1**	**20**	**4**	**17**	**5**

Table IV. Vegetation Damage by Plot

Little Sugar Creek Stream Restoration Site (EEP Project #141)

	plot	All Damage Categories	(no damage)	Human Trampled	Insects	Removal	Unknown	Vine Strangulation	(other damage)
	141-01-0001	18	18						
	141-01-0001-year:1	16	13	1				2	
	141-01-0001-year:2	12	2			10			
	141-01-0002	31	20					8	3
	141-01-0002-year:1	31	29						2
	141-01-0002-year:2	28	28						
	141-01-0003	26	26						
	141-01-0003-year:1	25	22				3		
	141-01-0003-year:2	23	23						
	141-01-0004	19	19						
	141-01-0004-year:1	17	16				1		
	141-01-0004-year:2	16	16						
	141-01-0005	20	17		1			2	
	141-01-0005-year:1	21	16					5	
	141-01-0005-year:2	18	18						
	141-01-0006	18	18						
	141-01-0006-year:1	19	19						
	141-01-0006-year:2	12	2			10			
TOT:	**18**	**370**	**322**	**1**	**1**	**20**	**4**	**17**	**5**

Table V. Stem Count by Plot and Species

Little Sugar Creek Stream Restoration Site (EEP Project #141)

	Species	Total Stems	# plots	avg# stems	plot 141-01-0001	plot 141-01-0001-year:1	plot 141-01-0001-year:2	plot 141-01-0002	plot 141-01-0002-year:1	plot 141-01-0002-year:2	plot 141-01-0003	plot 141-01-0003-year:1	plot 141-01-0003-year:2	plot 141-01-0004	plot 141-01-0004-year:1	plot 141-01-0004-year:2	plot 141-01-0005	plot 141-01-0005-year:1	plot 141-01-0005-year:2	plot 141-01-0006	plot 141-01-0006-year:1	plot 141-01-0006-year:2
	Acer negundo	2	2	1																1	1	
	Acer rubrum	9	3	3																4	4	1
	Alnus serrulata	3	3	1				1	1	1												
	Betula nigra	43	11	3.91	4	4		4	3	4	6	6	6				2	2	2			
	Cornus amomum	21	3	7				7	7	7												
	Fraxinus pennsylvanica	41	10	4.1	3	3								7	7	7	2	2	2	4	4	
	Liriodendron tulipifera	1	1	1										1								
	Morus rubra	12	6	2							1	1	1				3	3	3			
	Platanus occidentalis	12	12	1	1	1	1				1	1	1				1	1	1	1	1	1
	Populus deltoides	17	6	2.83				6	4	4							1	1	1			
	Quercus falcata	9	6	1.5										2	2	2	1	1	1			
	Quercus michauxii	11	7	1.57	2	2					1	1	1							2	2	
	Quercus phellos	9	9	1	1	1	1							1	1	1	1	1	1			
	Salix nigra	29	8	3.62	1	1		7	7	7	2	2	2									
	Sambucus canadensis	16	3	5.33							6	4	6									
	Unknown	17	8	2.12							1		1	1	1	1	4	4	4			
TOT:	**16**	**252**	**16**		**12**	**12**	**2**	**25**	**22**	**23**	**18**	**15**	**18**	**12**	**11**	**11**	**15**	**15**	**15**	**12**	**12**	**2**

Table VI. Vegetative Problem Areas
Little Sugar Creek Stream Restoration Site (EEP Project #141)

Feature/Issue	Station # / Range	Probable Cause	Photo #
		2008	
Bare Bank	520 - 700 (Right Bank)	Excessive bank stresses during yearly flooding events	VP1
	520 - 700 (Left Bank)	Excessive bank stresses during yearly flooding events	
	1,690 - 1,750 (Left Bank)	Excessive bank stresses during yearly flooding events	VP2
	2,030 - 2,110 (Left Bank)	Excessive bank stresses during yearly flooding events	
	2,220 - 2,330 (Right Bank)	Excessive bank stresses during yearly flooding events	
	2,220 - 2,330 (Left Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
Bare Bench	--	--	
Bare Flood Plain	1,070 - 1,250 (Right Floodplain)	Cleared for staging area for channel maintenance	VP3
	4,000 - 4,250 (Right Floodplain)	Cleared for staging area for channel maintenance	
Invasive/Exotic Populations	--	--	
		2007	
Bare Bank	100 - 350 (Right Bank)	Excessive bank stresses during yearly flooding events	
	400 - 700 (Right Bank)	Excessive bank stresses during yearly flooding events	
	750 - 775 (Right Bank)	Excessive bank stresses during yearly flooding events	
	800 - 850 (Right Bank)	Excessive bank stresses during yearly flooding events	
	930 - 950 (Right Bank)	Excessive bank stresses during yearly flooding events	
	1,690 - 1,750 (Left Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
	2,070 - 2,130 (Right Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
	2,250 - 2,600 (Left Bank)	Excessive bank stresses during yearly flooding events	
	2,280 - 2,335 (Right Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
	2,600 - 2,700 (Left Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
	3,010 - 3,070 (Left Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
	3,120 - 3,190 (Right Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
Bare Bench	--	--	
Bare Flood Plain	1,250 - 1,580 (Left Floodplain)	Cleared area exhibiting sucessional growth including invasives from local sources	
	2,065 - 2,200 (Left Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
Invasive/Exotic Populations	1,250 - 1,580 (Left Floodplain)	Cleared area exhibiting sucessional growth including invasives from local sources	
		2006	
Bare Bank	410 - 1,140 (Both Banks)	Excessive bank stresses during yearly flooding events	
	1,690 - 1,750 (Left Bank)		
	2,065 - 2,350 (Both Banks)		
Bare Bench	--	--	
Bare Flood Plain	1,250 - 1,580 (Left Floodplain)	Cleared area exhibiting sucessional growth including invasives from local sources	
Invasive/Exotic Populations	35 - 1,030 (Both Banks)	Local source colonization after bank scour	
	1,240 - 1,860 (Left Bank)		
	1,250 - 1,580 (Left Floodplain)	Cleared area exhibiting sucessional growth including invasives from local sources	
	1,950 - 2,190 (Left Bank)		
	2,210 - 2,380 (Right Bank)		
	2,680 - 3,065 (Left Bank)		
	2,690 - 3,555 (Right Bank)		
	3,555 - 3,790 (Left Bank)		
		2005	
Bare Bank	2,100 - 2,175	Overbank flow / Compacted soils	
	2,560 - 2,735	Overbank flow / Compacted soils	
		2004	
General	2,500 - 2,800	Left bank has poor herbaceous success	
	3,100 - 3,200	Left bank has poor herbaceous success	
	3,400 - 3,500	Right bank has poor herbaceous success	
	3,700 - 4,479	Both banks have poor herbaceous success	
	Throughout	Poor hardwood tree and live stake establishment	

VQ1: Vegetation Quad 1
Taken: 2005

VQ1: Vegetation Quad 1
Taken: 10/19/2006

VQ1: Vegetation Quad 1
Taken: 10/16/2007

VQ1: Vegetation Quad 1
Taken: 11/03/2008

VQ2: Vegetation Quad 2
Taken: 2005

VQ2: Vegetation Quad 2
Taken: 10/19/2006

VQ2: Vegetation Quad 2
Taken: 10/16/2007

VQ2: Vegetation Quad 2
Taken: 11/03/2008

VQ3: Vegetation Quad 3
Taken: 2005

VQ3: Vegetation Quad 3
Taken: 10/19/2006

VQ3: Vegetation Quad 3
Taken: 10/16/2007

VQ3: Vegetation Quad 3
Taken: 11/03/2008

VQ4: Vegetation Quad 4
Taken: 2005

VQ4: Vegetation Quad 4
Taken: 10/19/2006

VQ4: Vegetation Quad 4
Taken: 10/16/2007

VQ4: Vegetation Quad 4
Taken: 11/03/2008

VQ5: Vegetation Quad 5
Taken: 10/19/2006

VQ5: Vegetation Quad 5
Taken: 10/16/2007

VQ5: Vegetation Quad 5
Taken: 11/03/2008

VQ6: Vegetation Quad 6
Taken: 10/19/2006

VQ6: Vegetation Quad 6
Taken: 10/16/2007

VQ6: Vegetation Quad 6
Taken: 11/03/2008

VP1: Bare bank
Taken on 9/24/2008

VP2: Bare Bank
Taken on 9/24/2008

VP3: Bare floodplain – mechanically cleared for channel maintenance staging area
Taken on 9/24/2008

APPENDIX B
STREAM MONITORING DATA

Table B1. Stream Problem Areas
Little Sugar Creek Stream Restoration Site (EEP Project #141)

Feature Issue	Reach	Station numbers	Description	Suspected Cause	Photo number
2008					
Aggradation/Bar Formation					
Bank scour		1,410 - 1,600	Bank Scour (Both Banks)	Excessive shear stresses	
		1,710 - 1,900	Bank Scour and Slump (Right Bank)	Excessive shear stresses	SP1
		2,770 - 2,890	Bank Scour (Both Banks)	Excessive shear stresses	
		3,100 - 3,300	Bank Scour (Right Bank)	Excessive shear stresses	
		4,110 - 4,170	Bank Scour (Right Bank)	Excessive shear stresses	SP2
Engineered structures – back or arm scour Etc.		2,020 - 2,060	Stressed rip-rap clusters (both sides of channel)	Excessive shear stresses	
		3,950 - 4,140	Scour behind root wads	Excessive shear stresses	
2007					
Aggradation/Bar Formation					
Bank scour		315 - 320	Bank Scour (Left Bank)	Stormwater Drain	
		1,300 - 1,360	Bank Scour (Left Bank)	Excessive shear stresses	
		2,015 - 2,060	Bank Scour (Right Bank)	Excessive shear stresses	
		2,040 - 2,140	Bank Scour (Left Bank)	Excessive shear stresses	
		2,630 - 2,700	Bank Scour (Left Bank)	Excessive shear stresses	
		2,625 - 2,740	Scour behind toe protect (Right Bank)	Excessive shear stresses	
		4,030 - 4,070	Scour (Left Bank) - Possibly displaced root wads	Excessive shear stresses	
Engineered structures – back or arm scour Etc.		1,260	Missing header rock	Excessive shear stresses	
		2,020 - 2,060	Scour behind coir log. Stressed rip-rap clusters (both sides of channel)	Excessive shear stresses	
		2,660	Arm boulder collapse	Excessive shear stresses	
		3,950 - 4,140	Scour behind root wads	Excessive shear stresses	
2006					
Aggradation/Bar Formation					
Bank scour		945 - 1,140	Bank Scour (Both Banks)	Excessive shear stresses	
		315 - 320	Bank Scour (Left Bank)	Stormwater Drain	
		1,260 - 1,330	Bank Scour (Left Bank)	Excessive shear stresses	
		1,310 - 1,390	Bank Scour (Right Bank)	Excessive shear stresses	
		1,395 - 1,500	Bank Scour (Left Bank)	Excessive shear stresses	
		1,570 - 1,620	Bank Scour (Right Bank)	Excessive shear stresses	
		1,940 - 2,015	Bank Scour (Right Bank)	Excessive shear stresses	
		2,040 - 2,140	Bank Scour (Left Bank)	Excessive shear stresses	
		2,190 - 2,700	Bank Scour (Left Bank)	Excessive shear stresses	
		2,625 - 2,740	Scour behind toe protect (Right Bank)	Excessive shear stresses	
		3,270 - 3,340	Bank Scour (Left Bank)	Excessive shear stresses	
		3450	Scour behind toe protection (Right Bank)	Excessive shear stresses	
		4,030 - 4,070	Scour (Left Bank) - Possibly displaced root wads	Excessive shear stresses	
Engineered structures – back or arm scour Etc.		1,260	Missing header rock	Excessive shear stresses	
		1,960	Missing structure	Excessive shear stresses	
		2,660	Arm boulder collapse	Excessive shear stresses	
		3,950 - 4,140	Scour behind root wads	Excessive shear stresses	
2005					
Bank Scour		1,047 - 1,117		Excessive bank shear stress	
		1,339 - 1,394		Resultant from floodplain drainage	
		2,066 - 2,182		Excessive bank shear stress	

Table B2. Visual Morphological Stability Assessment

Little Sugar Creek Stream Restoration Site (EEP Project #141)

Reach

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?	15	15	NA	100%	100%
	2	Armor stable (e.g. no displacement)?	15	15	NA	100%	
	3	Facet grade appears stable?	15	15	NA	100%	
	4	Minimal evidence of embedding/fining?	15	15	NA	100%	
	5	Length appropriate?	15	15	NA	100%	
B. Pools	1	Present? (e.g not subject to severe aggrad. or migrat.?)	15	15	NA	100%	89%
	2	Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	13	15	NA	87%	
	3	Length appropriate?	12	15	NA	80%	
C. Thalweg	1	Upstream of meander bend (run/inflection) centering?	12	12	NA	100%	100%
	2	Downstream of meander (glide/inflection) centering?	12	12	NA	100%	
D. Meanders	1	Outer bend in state of limited/controlled erosion?	9	11	NA	82%	70%
	2	Of those eroding, # w/concomitant point bar formation?	0	2	NA	0%	
	3	Apparent Rc within spec?	11	11	NA	100%	
	4	Sufficient floodplain access and relief?	11	11	NA	100%	
E. Bed General	1	General channel bed aggradation areas (bar formation)	--	--	0 / 0	100%	100%
	2	Channel bed degradation – areas of increasing down-cutting or head cutting?	--	--	0 / 0	100%	
F. Bank	2	Actively eroding, wasting, or slumping bank	--	--	2 / 250	97%	97%
G. Vanes	1	Free of back or arm scour?	19	19	NA	100%	100%
	2	Height appropriate?	19	19	NA	100%	
	3	Angle and geometry appear appropriate?	19	19	NA	100%	
	4	Free of piping or other structural failures?	19	19	NA	100%	
H. Wads/ Boulders	1	Free of scour?	11	31	NA	35%	68%
	2	Footing stable?	31	31	NA	100%	

Assessment length is 4,450 linear feet

Permanent Photo PS01
Taken: 2004

Permanent Photo PS01
Taken: 2005

Permanent Photo PS01
Taken: 11/14/2006

Permanent Photo PS01
Taken: 11/20/2007

Permanent Photo PS01
Taken On: 11/03/2008

Permanent Photo PS02
Taken: 2004

Permanent Photo PS02
Taken: 2005

Permanent Photo PS02
Taken On: 11/14/2006

Permanent Photo PS02
Taken: 11/20/2007

Permanent Photo PS02
Taken: 11/03/2008

Permanent Photo PS03
Taken: 2004

Permanent Photo PS03
Taken: 2005

Permanent Photo PS03
Taken On: 11/14/2006

Permanent Photo PS03
Taken: 11/20/2007

Permanent Photo PS03
Taken: 11/03/2008

Permanent Photo PS04
Taken: 2004

Permanent Photo PS04
Taken: 2005

Permanent Photo PS04
Taken On: 11/14/2006

Permanent Photo PS04
Taken: 11/20/2007

Permanent Photo PS04
Taken: 10/13/2008

Permanent Photo PS05
Taken: 2004

Permanent Photo PS05
Taken: 2005

Permanent Photo PS05
Taken On: 11/14/2006

Permanent Photo PS05
Taken: 11/20/2007

Permanent Photo PS05
Taken: 10/13/2008

Permanent Photo PS06
Taken: 2004

Permanent Photo PS06
Taken: 2005

Permanent Photo PS06
Taken On: 11/14/2006

Permanent Photo PS06
Taken: 11/20/2007

Permanent Photo PS06
Taken: 10/13/2008

Permanent Photo PS07
Taken: 2004

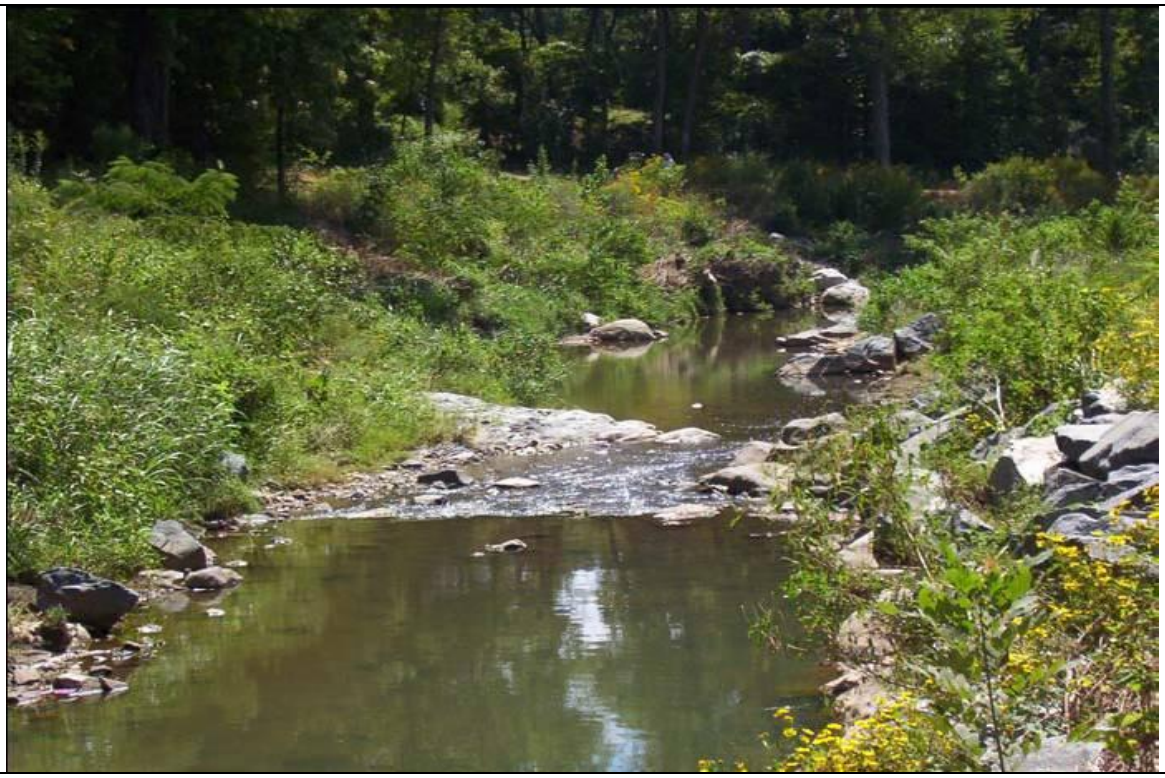
Permanent Photo PS07
Taken: 2005

Permanent Photo PS07
Taken On: 11/14/2006

Permanent Photo PS07
Taken: 11/20/2007

Permanent Photo PS07
Taken: 10/13/2008

Permanent Photo PS08
Taken: 2004



Permanent Photo PS08
Taken: 2005

Permanent Photo PS08
Taken On: 11/14/2006

Permanent Photo PS08
Taken: 11/20/2007

Permanent Photo PS08
Taken: 11/03/2008

Permanent Photo PS09
Taken: 2004

Permanent Photo PS09
Taken: 2005

Permanent Photo PS09
Taken On: 11/14/2006

Permanent Photo PS09
Taken: 11/20/2007

Permanent Photo PS09
Taken: 10/13/2008

Permanent Photo PS10
Taken: 2004

Permanent Photo PS10
Taken: 2005

Permanent Photo PS10
Taken On: 11/14/2006

Permanent Photo PS10
Taken: 11/20/2007

Permanent Photo PS10
Taken: 10/13/2008

Permanent Photo PS11
Taken: 2004

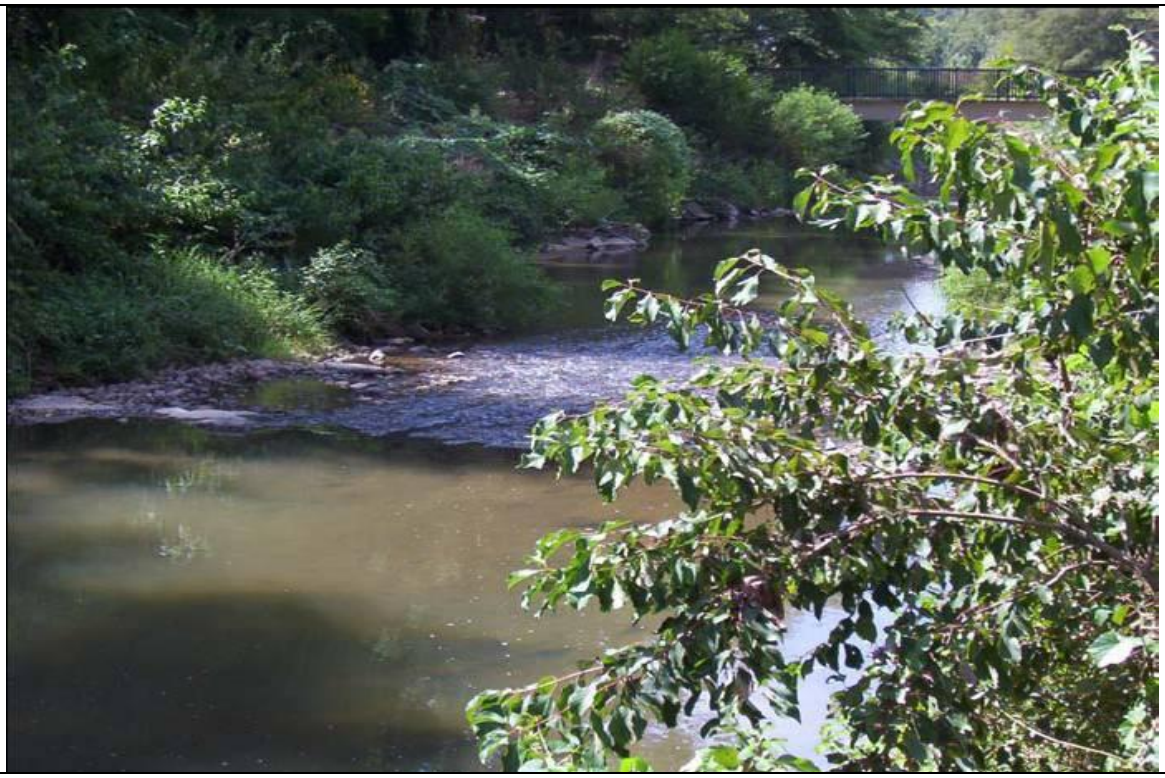
Permanent Photo PS11
Taken: 2005

Permanent Photo PS11
Taken On: 11/14/2006

Permanent Photo PS11
Taken: 11/20/2007

Permanent Photo PS11
Taken: 10/13/2008

Permanent Photo PS12
Taken: 2004



Permanent Photo PS12
Taken: 2005

Permanent Photo PS12
Taken On: 11/14/2006

Permanent Photo PS12
Taken: 11/20/2007

Permanent Photo PS12
Taken: 10/13/2008

Permanent Photo PS13
Taken: 2004

Permanent Photo PS13
Taken: 2005

=

Permanent Photo PS13
Taken On: 11/14/2006

Permanent Photo PS13
Taken: 11/20/2007

Permanent Photo PS13
Taken: 11/03/2008

Permanent Photo PS14
Taken: 2004

Permanent Photo PS14
Taken: 2005

Permanent Photo PS14
Taken On: 11/14/2006

Permanent Photo PS14
Taken: 11/20/2007

Permanent Photo PS14
Taken: 10/13/2008

Permanent Photo PS15
Taken: 2004

Permanent Photo PS15
Taken: 2005

Permanent Photo PS15
Taken On: 11/14/2006

Permanent Photo PS15
Taken: 11/20/2007

Permanent Photo PS15
Taken: 10/13/2008

Permanent Photo PS16
Taken: 2004

Permanent Photo PS16
Taken: 2005

Permanent Photo PS16
Taken On: 11/14/2006

Permanent Photo PS16
Taken: 11/20/2007

Permanent Photo PS16
Taken: 10/13/2008

Permanent Photo PS17
Taken: 2004

Permanent Photo PS17
Taken: 2005

Permanent Photo PS17
Taken On: 11/14/2006

Permanent Photo PS17
Taken: 11/20/2007

Permanent Photo PS17
Taken: 10/13/2008

Permanent Photo PS18
Taken: 2004

Permanent Photo PS18
Taken: 2005

Permanent Photo PS18
Taken On: 11/14/2006

Permanent Photo PS18
Taken: 11/20/2007

Permanent Photo PS18
Taken: 11/03/2008

Permanent Photo PS19
Taken: 2004

Permanent Photo PS19
Taken: 2005

Permanent Photo PS19
Taken On: 11/14/2006

Permanent Photo PS19
Taken: 11/20/2007

Permanent Photo PS19
Taken: 10/13/2008

Permanent Photo PS20
Taken: 2004

Permanent Photo PS20
Taken: 2005

Permanent Photo PS20
Taken On: 11/14/2006

Permanent Photo PS20
Taken: 11/20/2007

Permanent Photo PS20
Taken: 10/13/2008

Permanent Photo PS21
Taken: 2004

Permanent Photo PS21
Taken: 2005

Permanent Photo PS21
Taken On: 11/14/2006

Permanent Photo PS21
Taken: 11/20/2007

Permanent Photo PS21
Taken: 10/13/2008

Permanent Photo PS22
Taken: 2004

Permanent Photo PS22
Taken: 2005

Permanent Photo PS22
Taken On: 11/14/2006

Permanent Photo PS22
Taken: 11/20/2007

Permanent Photo PS22
Taken: 10/13/2008

Permanent Photo PS23
Taken: 2004

Permanent Photo PS23
Taken: 2005

Permanent Photo PS23
Taken On: 11/14/2006

Permanent Photo PS23
Taken: 11/20/2007

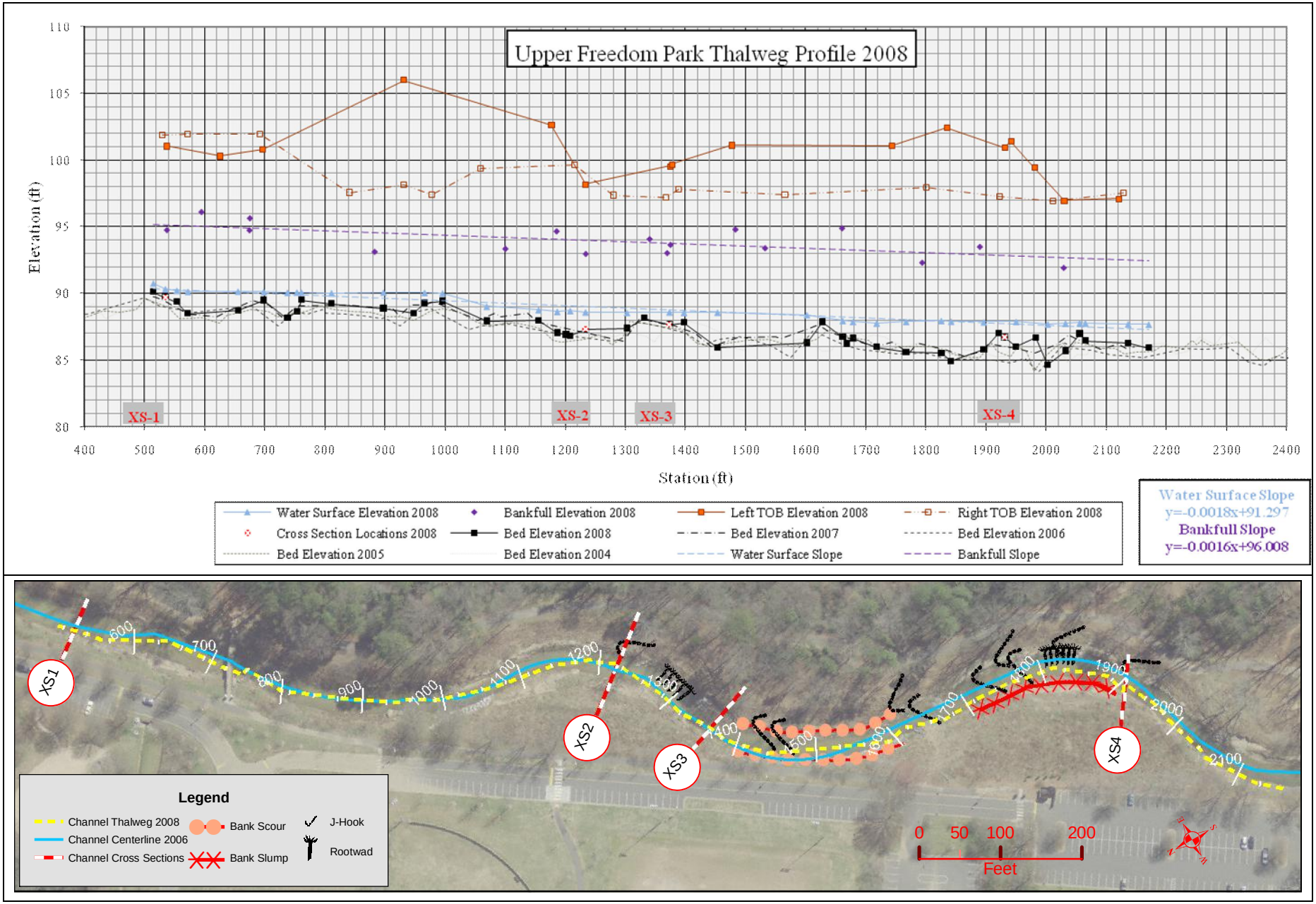
Permanent Photo PS23
Taken: 10/13/2008

Problem Photos

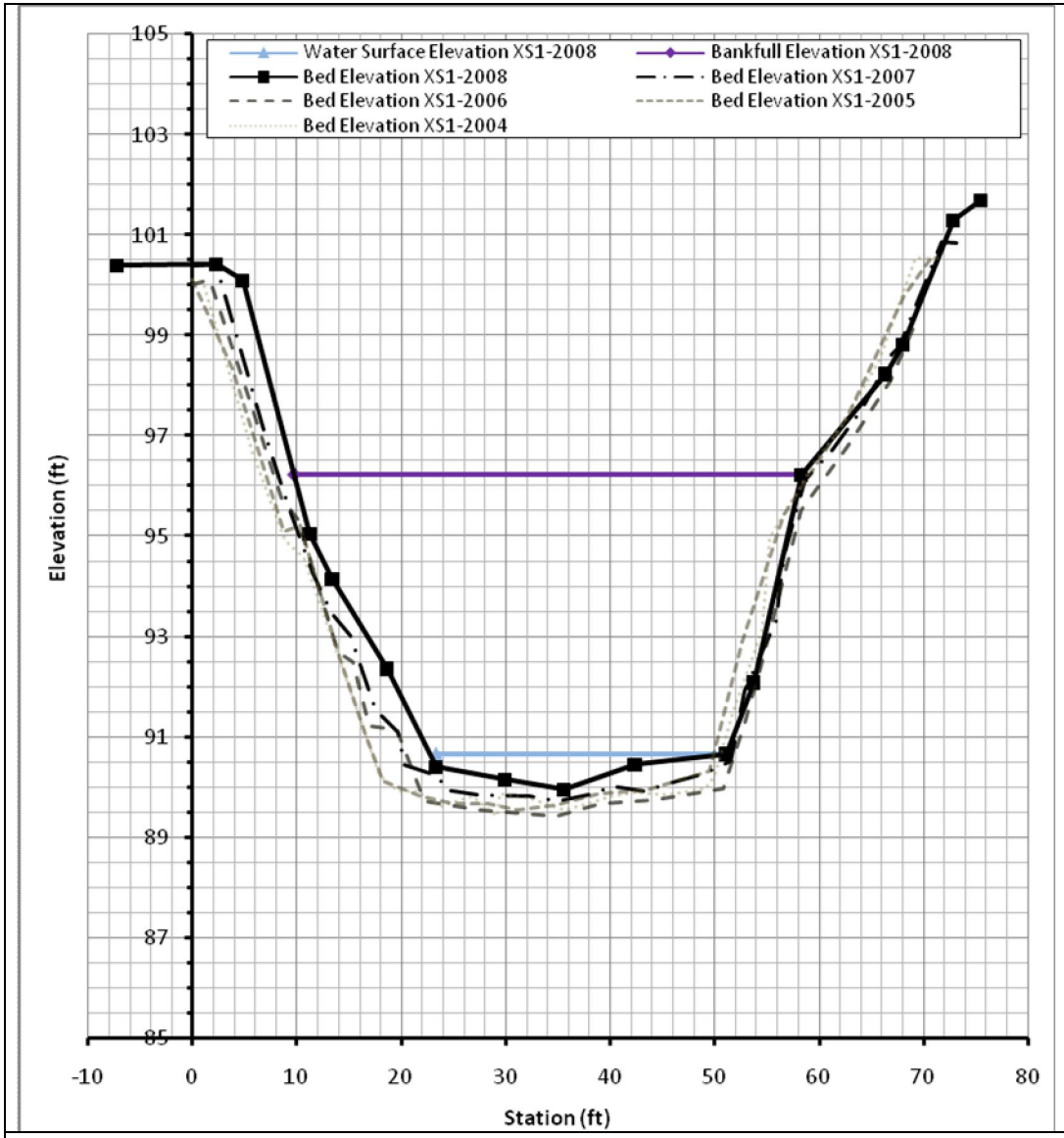
Problem Photos

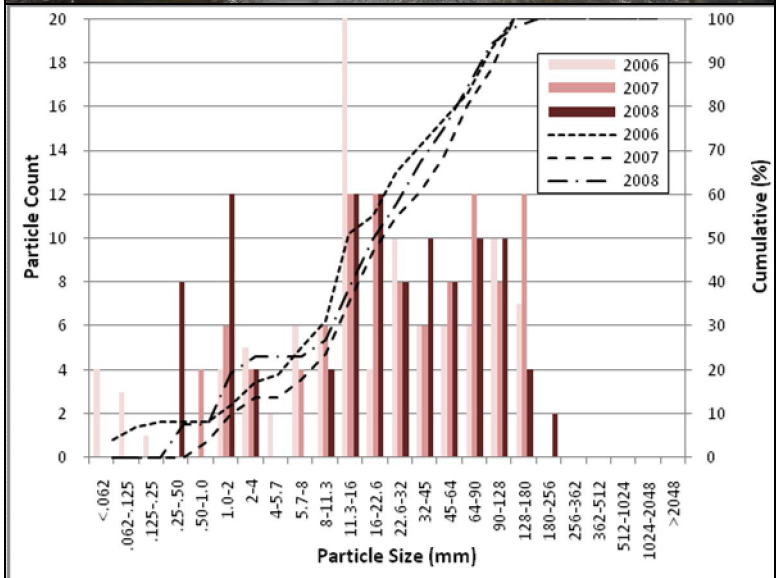
SP1: Bank erosion extending from point bar
Taken 9/24/2008

SP1: Bank erosion in area of limited woody vegetation
Taken 9/24/2008


Upper Freedom Park Thalweg Profile 2008
Elevation (ft)
Station (ft)
XS-1
XS-2
XS-3
XS-4
Water Surface Elevation 2008
Bankfull Elevation 2008
Left TOB Elevation 2008
Right TOB Elevation 2008
Cross Section Locations 2008
Bed Elevation 2008
Bed Elevation 2007
Bed Elevation 2006
Bed Elevation 2005
Bed Elevation 2004
Water Surface Slope
Bankfull Slope
Water Surface Slope
y=-0.0018x+91.297
Bankfull Slope
y=-0.0016x+96.008
XS1
XS2
XS3
XS4
Legend
Channel Thalweg 2008
Channel Centerline 2006
Channel Cross Sections
Bank Scour
Bank Slump
J-Hook
Rootwad
0
50
100
200
Feet

XS1 - RIFFLE

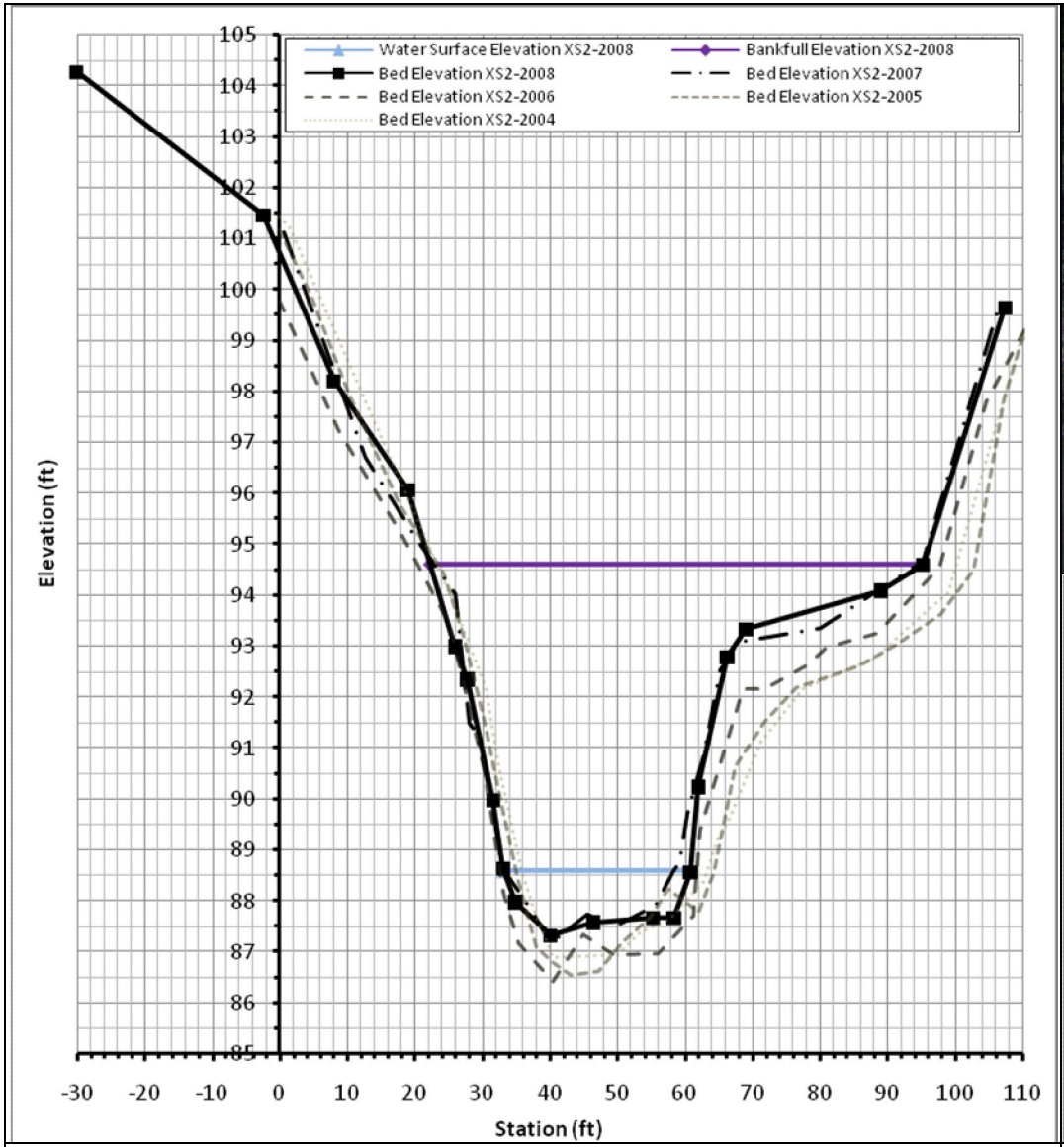


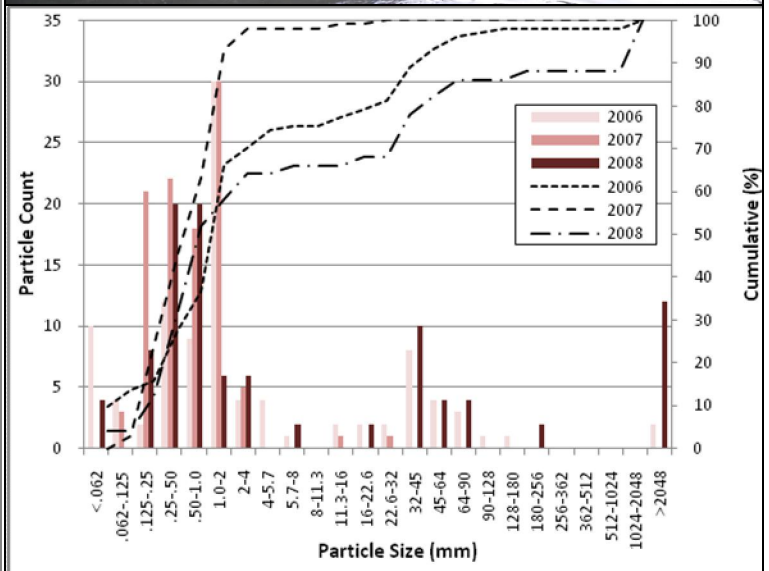


ID	Facet Type	Year	Phase	Wbkf	Abkf	Dbkf
XS1	Riffle		DS	54.0	339.0	6.3
XS1	Riffle	2004	AB	66.5	235.9	3.6
XS1	Riffle	2005	MY1	71.4	253.5	3.5
XS1	Riffle	2006	MY2	64.8	236.0	3.6
XS1	Riffle	2007	MY3	74.6	235.6	3.2
XS1	Riffle	2008	MY4	72.93	262.8	3.6

ID	Year	Phase	d50 (mm)	d84 (mm)
XS1	2006	MY2	11.14	66.60
XS1	2007	MY3	18.48	75.96
XS1	2008	MY4	16.00	62.78

XS2 -POOL

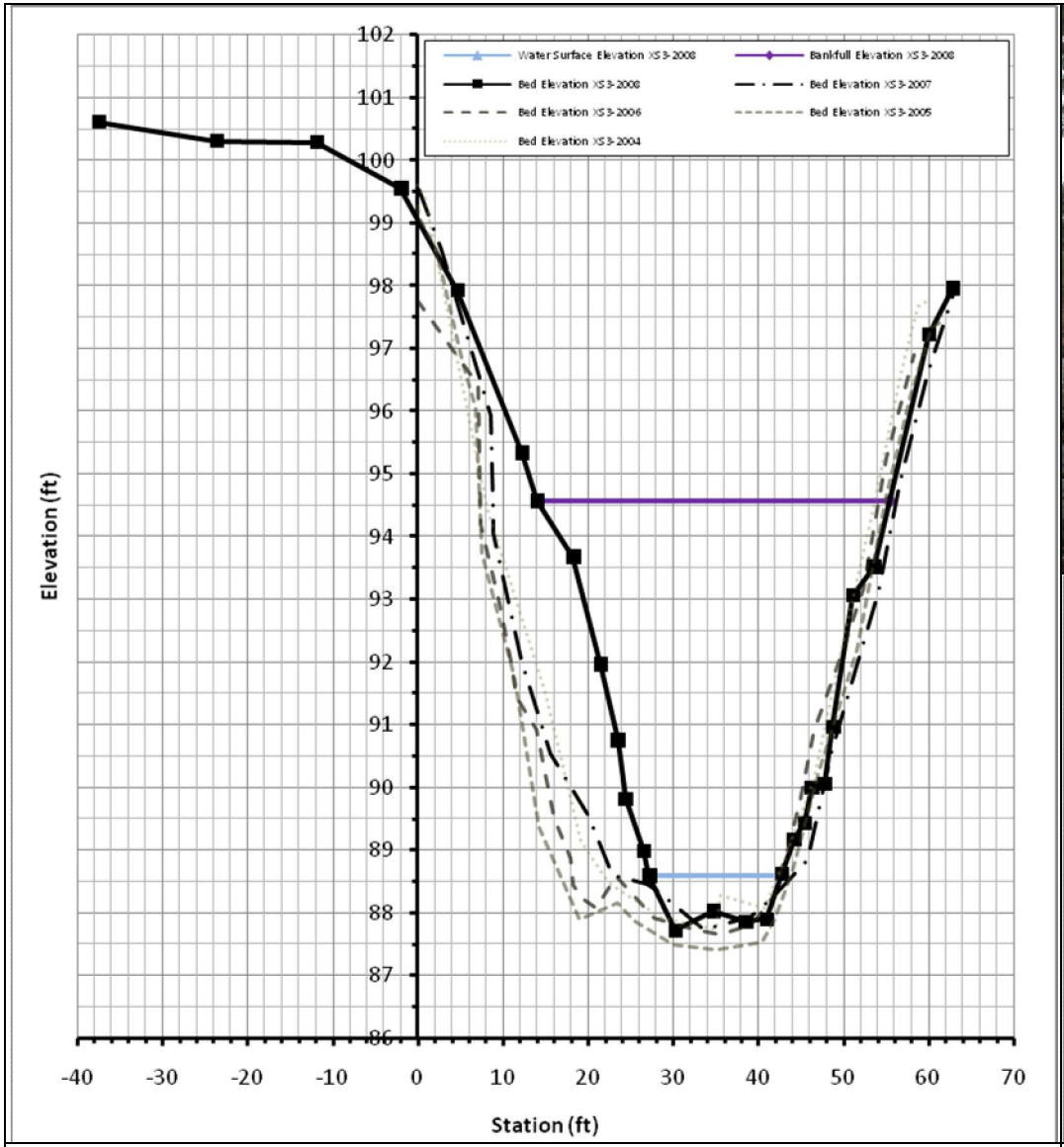


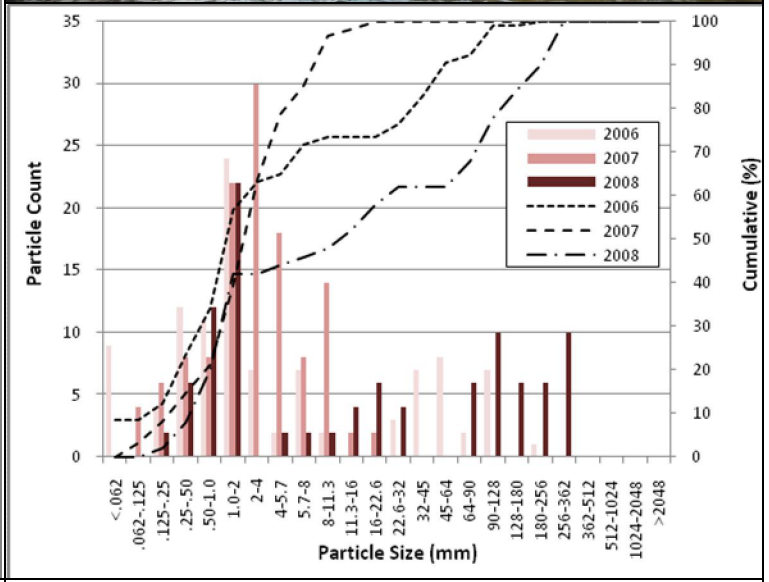


ID	Facet Type	Year	Phase	Wbkf	Abkf	Dbkf
XS2	Pool		DS	54.0	339.0	6.3
XS2	Pool	2004	AB	66.5	235.9	3.6
XS2	Pool	2005	MY1	71.4	253.5	3.5
XS2	Pool	2006	MY2	64.8	236.0	3.6
XS2	Pool	2007	MY3	74.6	235.6	3.2
XS2	Pool	2008	MY4	72.9	262.8	3.6

ID	Year	Phase	d50 (mm)	d84 (mm)
XS2	2006	MY2	0.73	25.94
XS2	2007	MY3	0.31	0.85
XS2	2008	MY4	0.48	54.50

XS3 - RIFFLE

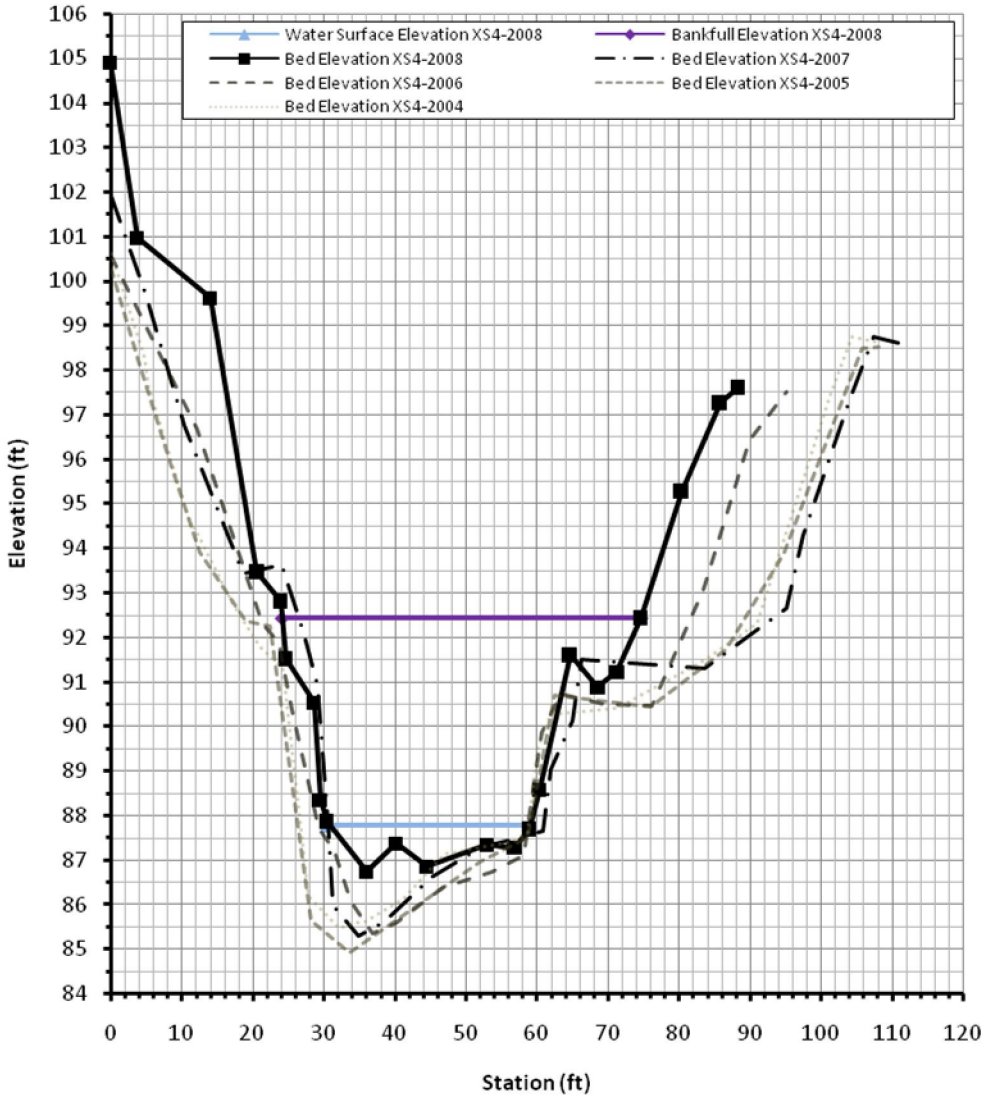


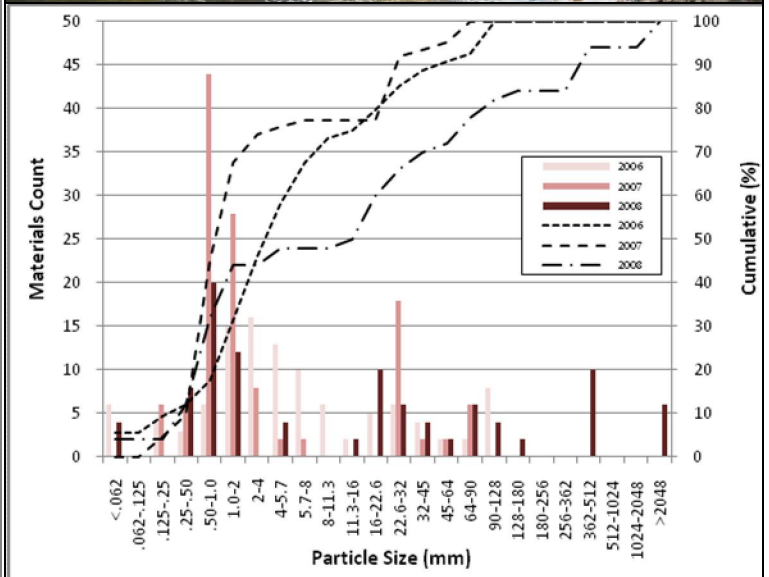


ID	Facet Type	Year	Phase	Wbkf	Abkf	Dbkf
XS3	Riffle		DS	5.4	339	6.3
XS3	Riffle	2004	AB	45.3	208	4.6
XS3	Riffle	2005	MY1	46.1	213	4.6
XS3	Riffle	2006	MY2	46.3	213	4.6
XS3	Riffle	2007	MY3	46.9	215	4.6
XS3	Riffle	2008	MY4	41.4	175	4.2

ID	Year	Phase	d50 (mm)	d84 (mm)
XS3	2006	MY2	0.85	33.69
XS3	2007	MY3	1.43	5.38
XS3	2008	MY4	9.65	128.00

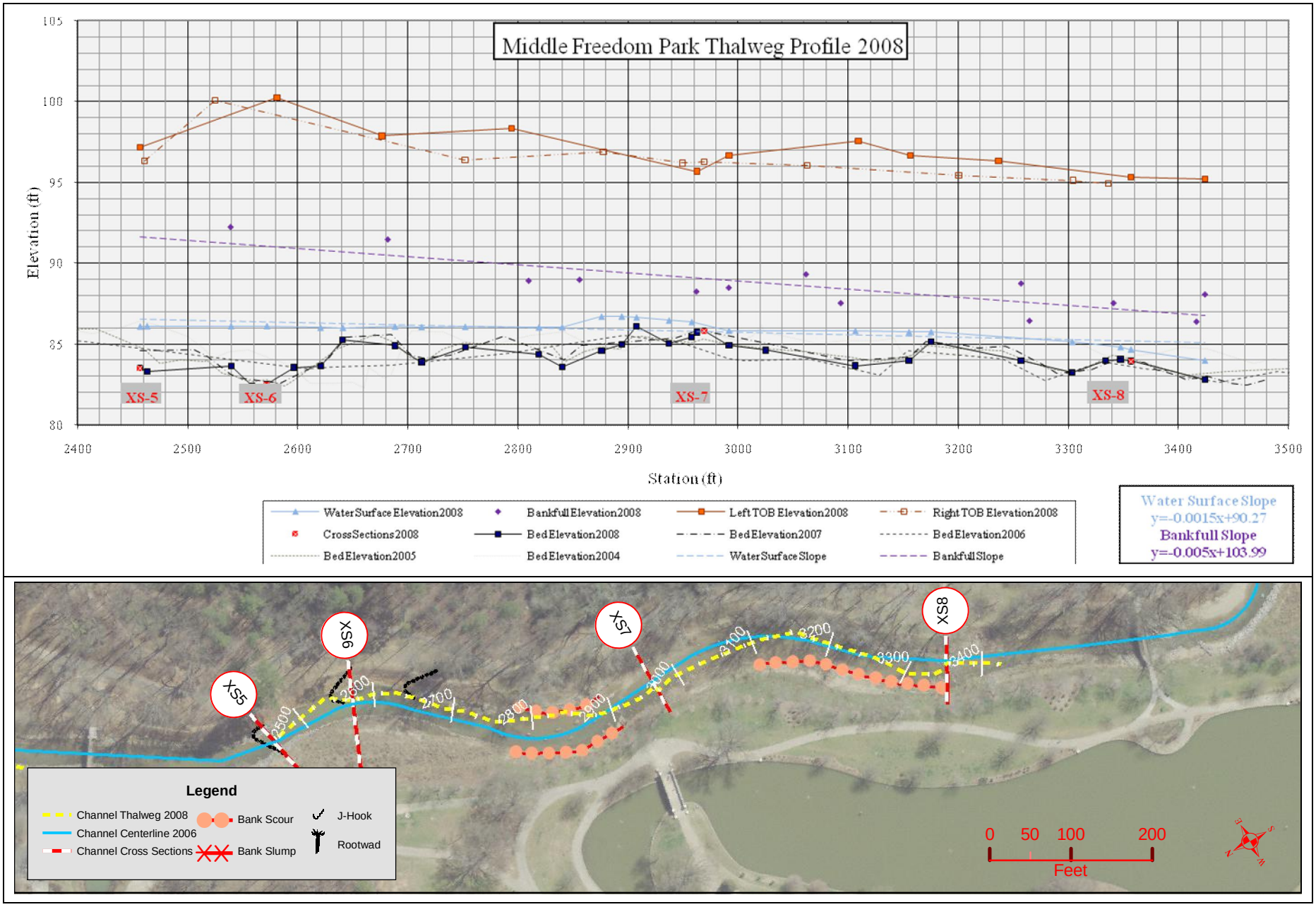
XS4 - RIFFLE



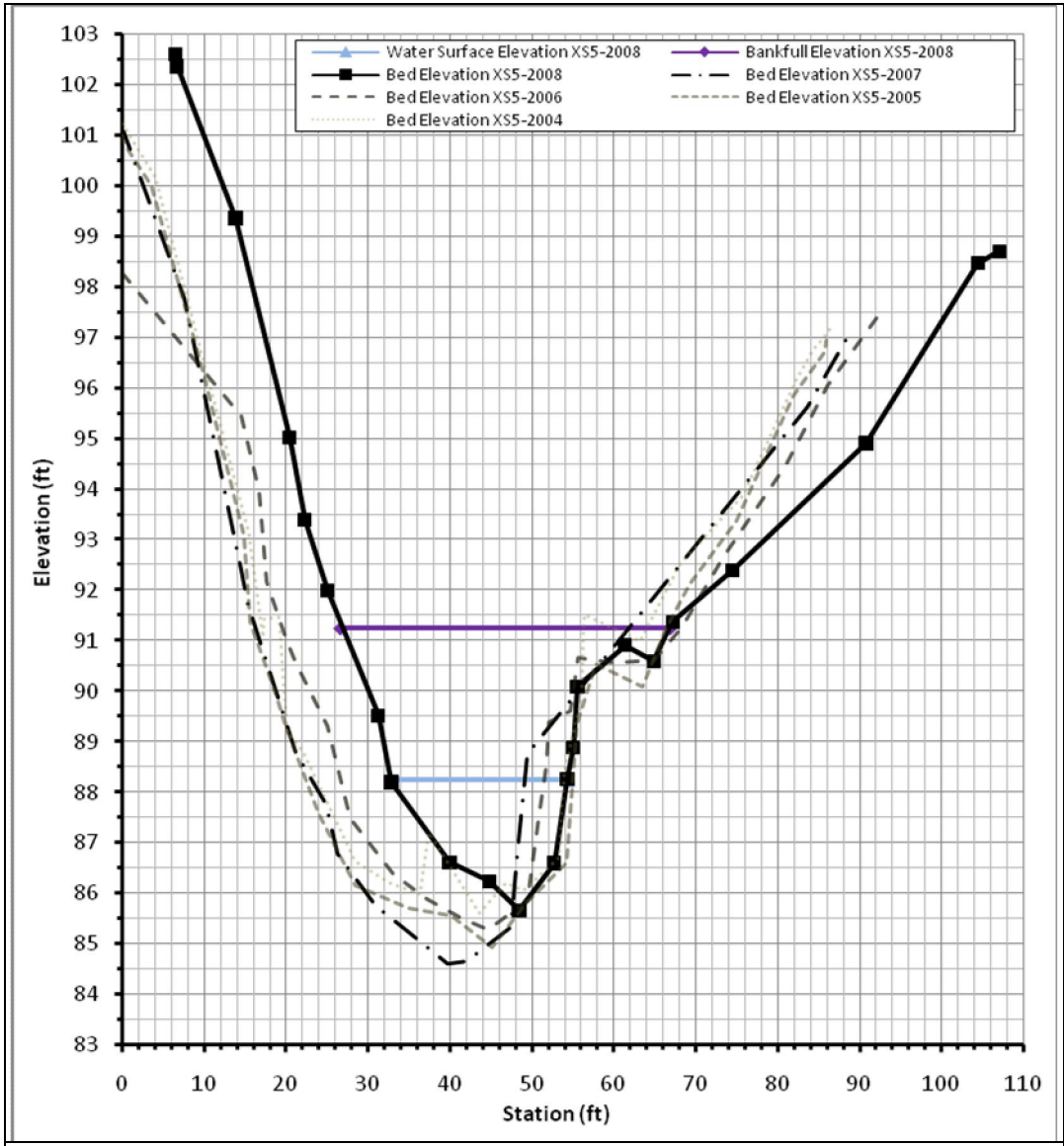


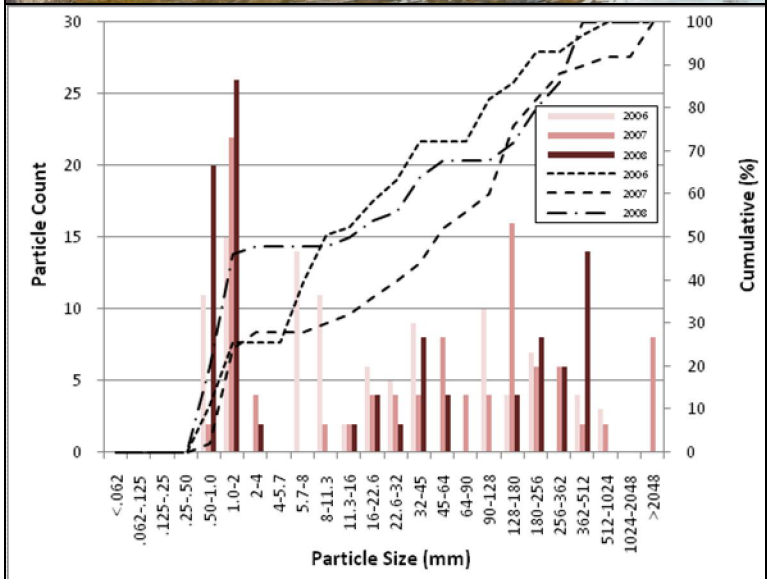
ID	Facet Type	Year	Phase	Wbkf	Abkf	Dbkf
XS4	Riffle		DS	54.0	339.0	6.3
XS4	Riffle	2004	AB	68.7	223.6	3.3
XS4	Riffle	2005	MY1	63.7	219.9	3.5
XS4	Riffle	2006	MY2	56.4	204.8	3.6
XS4	Riffle	2007	MY3	61.2	188.4	3.1
XS4	Riffle	2008	MY4	50.5	188.4	3.7

ID	Year	Phase	d50 (mm)	d84 (mm)
XS4	2006	MY2	2.62	21.19
XS4	2007	MY3	0.61	18.99
XS4	2008	MY4	11.30	128.00


Middle Freedom Park Thalweg Profile 2008
Elevation (ft)
Station (ft)
105
100
95
90
85
80
2400
2500
2600
2700
2800
2900
3000
3100
3200
3300
3400
3500
XS-5
XS-6
XS-7
XS-8
Water Surface Elevation2008
Bankfull Elevation2008
Left TOB Elevation2008
Right TOB Elevation2008
Cross Sections2008
Bed Elevation2008
Bed Elevation2007
Bed Elevation2006
Bed Elevation2005
Bed Elevation2004
Water Surface Slope
Bankfull Slope
Water Surface Slope
y=-0.0015x+90.27
Bankfull Slope
y=-0.005x+103.99
XS5
XS6
XS7
XS8
2500
2600
2700
2800
2900
3000
3100
3200
3300
3400
Legend
Channel Thalweg 2008
Channel Centerline 2006
Channel Cross Sections
Bank Scour
Bank Slump
J-Hook
Rootwad
0
50
100
200
Feet

XS5 -RIFFLE

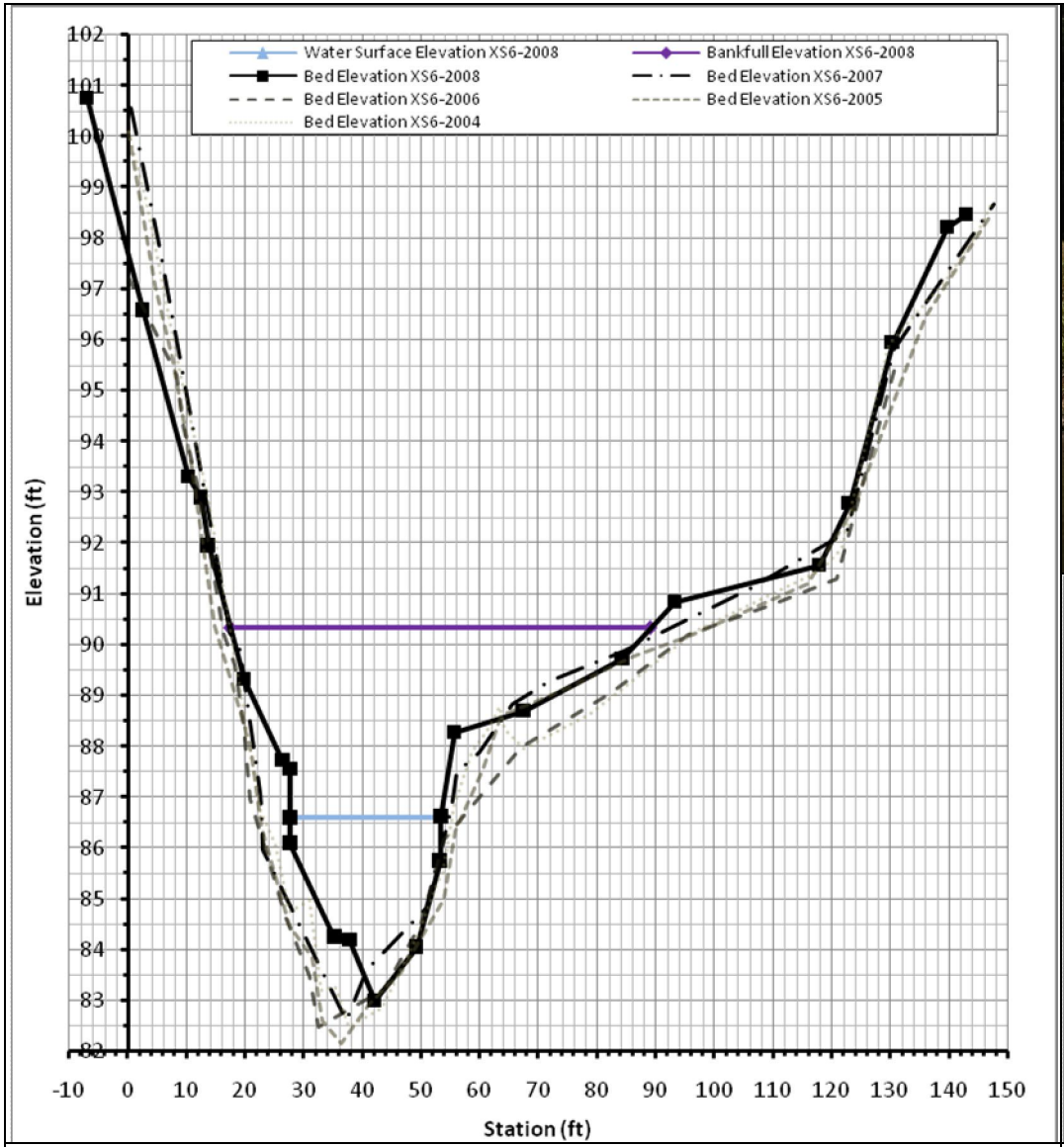


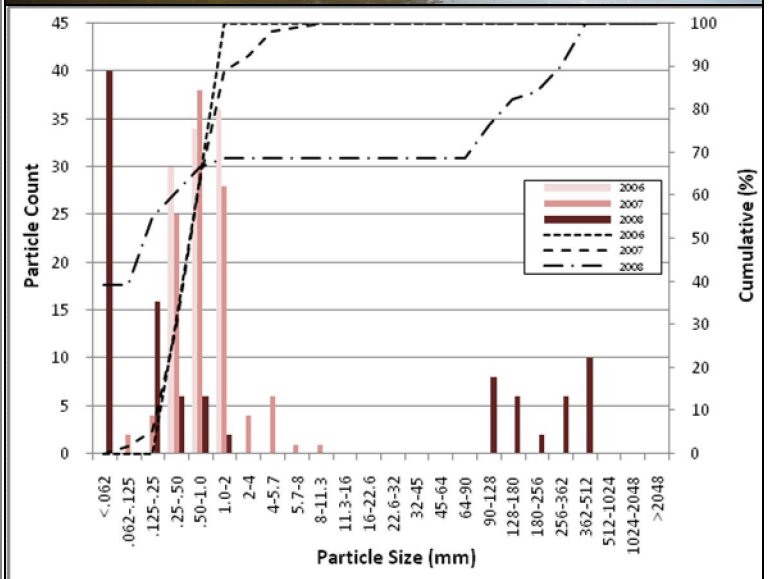


ID	Facet Type	Year	Phase	Wbkf	Abkf	Dbkf
XS5	Riffle		DS	54.0	333.9	6.3
XS5	Riffle	2004	AB	52.3	222.2	4.3
XS5	Riffle	2005	MY1	53.9	236.6	4.4
XS5	Riffle	2006	MY2	56.0	223.9	4.0
XS5	Riffle	2007	MY3	53.0	228.3	4.3
XS5	Riffle	2008	MY4	58.7	221.0	3.8

ID	Year	Phase	d50 (mm)	d84 (mm)
XS5	2006	MY2	7.90	107.48
XS5	2007	MY3	41.75	205.33
XS5	2008	MY4	11.30	230.67

XS6 - POOL

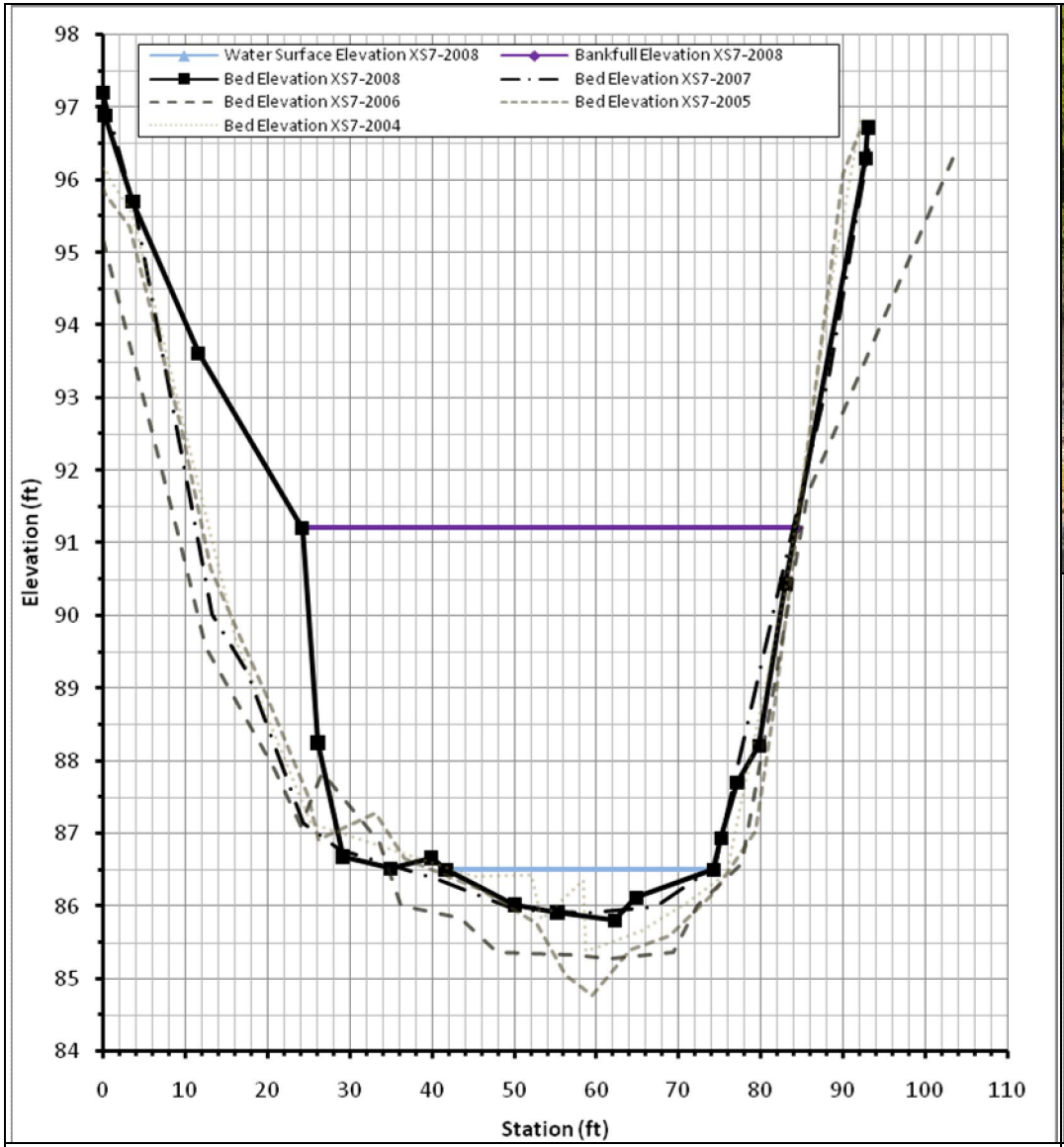


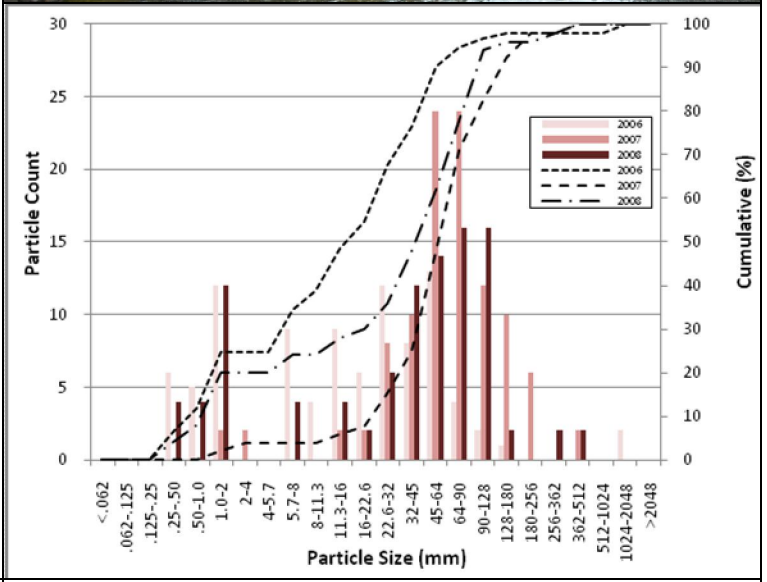


ID	Facet Type	Year	Phase	Wbkf	Abkf	Dbkf
XS6	Pool		DS	54.0	339.0	6.3
XS6	Pool	2004	AB	79.2	273.7	3.4
XS6	Pool	2005	MY1	85.2	284.6	3.3
XS6	Pool	2006	MY2	79.5	284.3	3.6
XS6	Pool	2007	MY3	85.1	286.3	3.4
XS6	Pool	2008	MY4	76.9	256.9	3.3

ID	Year	Phase	d50 (mm)	d84 (mm)
XS6	2006	MY2	0.40	0.78
XS6	2007	MY3	0.40	0.90
XS6	2008	MY4	0.11	171.68

XS7 - RIFFLE

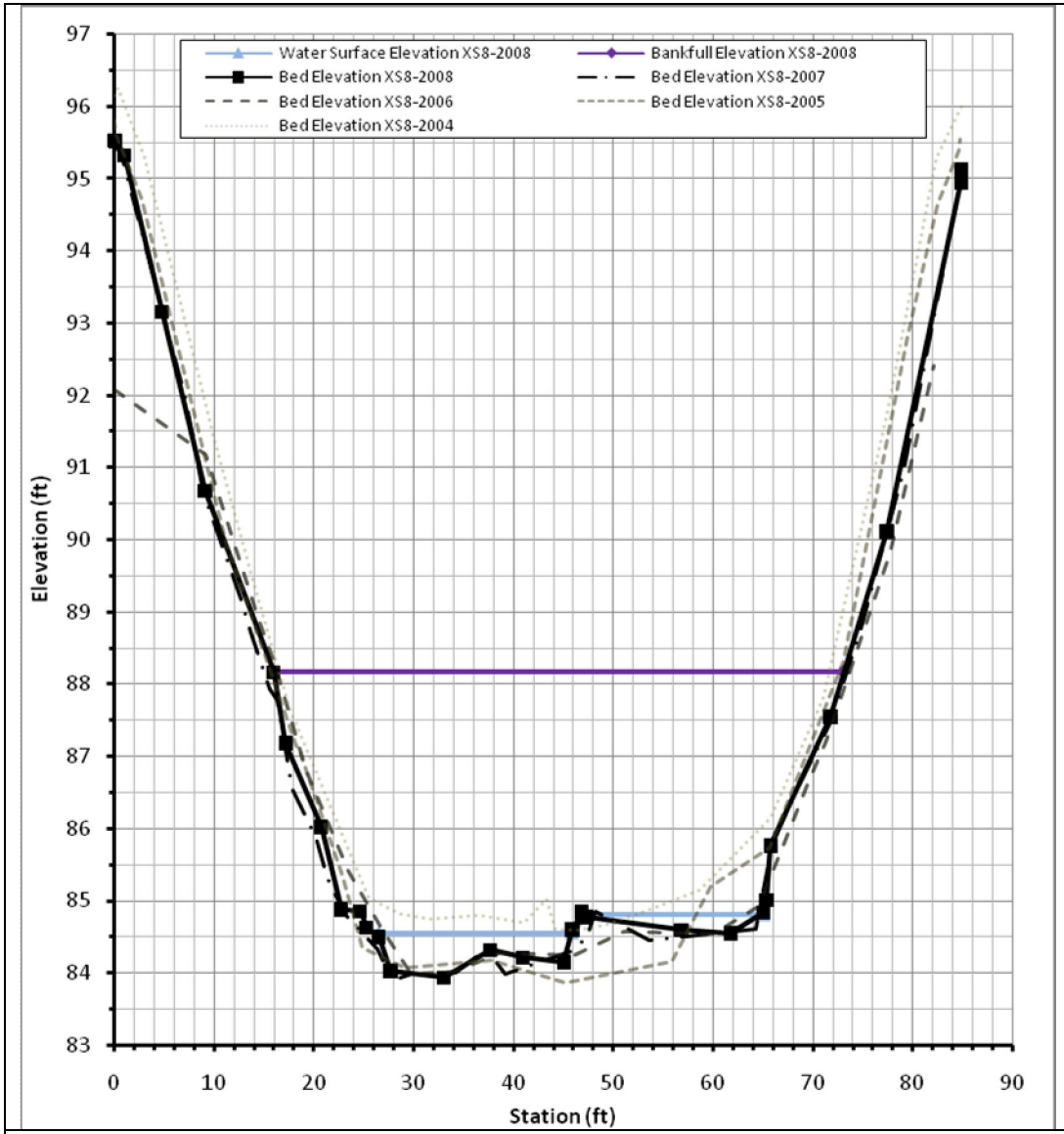


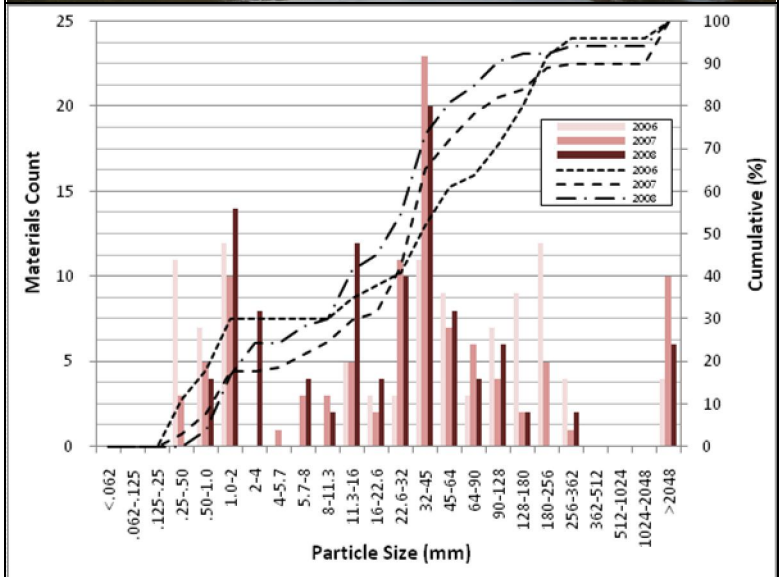


ID	Facet Type	Year	Phase	Wbkf	Abkf	Dbkf
XS7	Riffle		DS	54.0	339.0	6.3
XS7	Riffle	2004	AB	68.4	239.2	3.5
XS7	Riffle	2005	MY1	66.5	214.1	3.2
XS7	Riffle	2006	MY2	70.0	213.8	3.1
XS7	Riffle	2007	MY3	69.3	233.7	3.4
XS7	Riffle	2008	MY4	60.2	264.7	4.4

ID	Year	Phase	d50 (mm)	d84 (mm)
XS7	2006	MY2	12.48	39.12
XS7	2007	MY3	46.58	95.17
XS7	2008	MY4	30.66	73.75

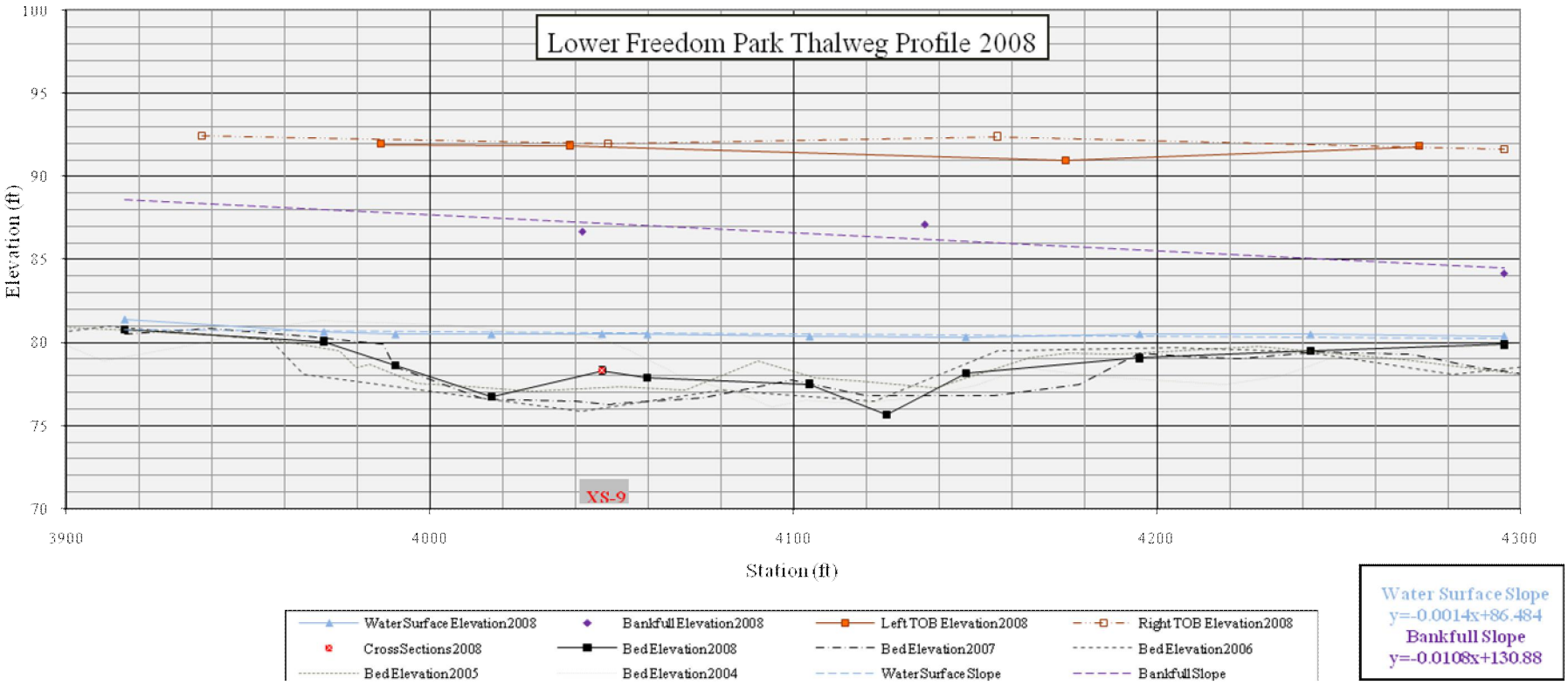
XS8 - RIFFLE

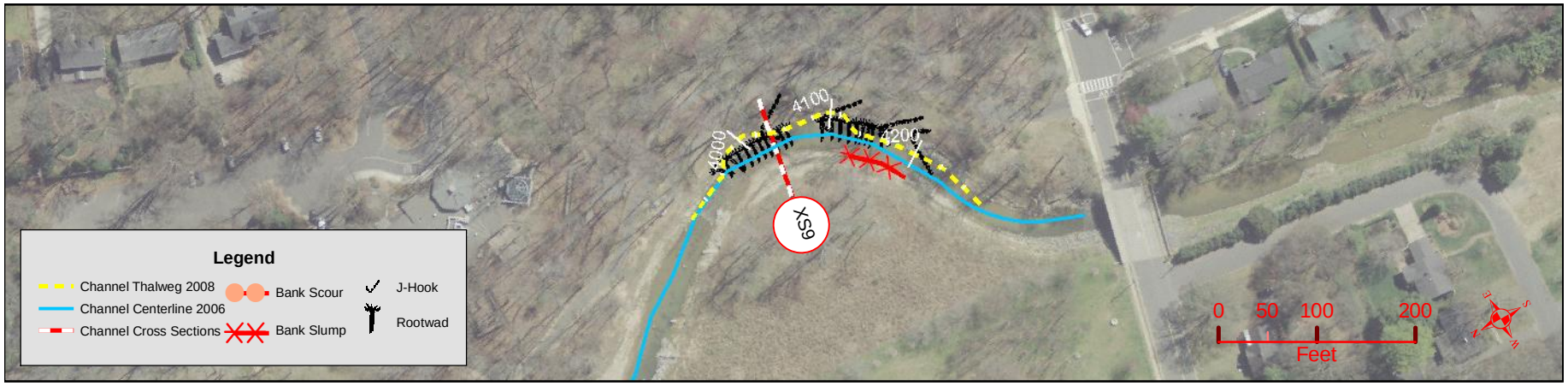




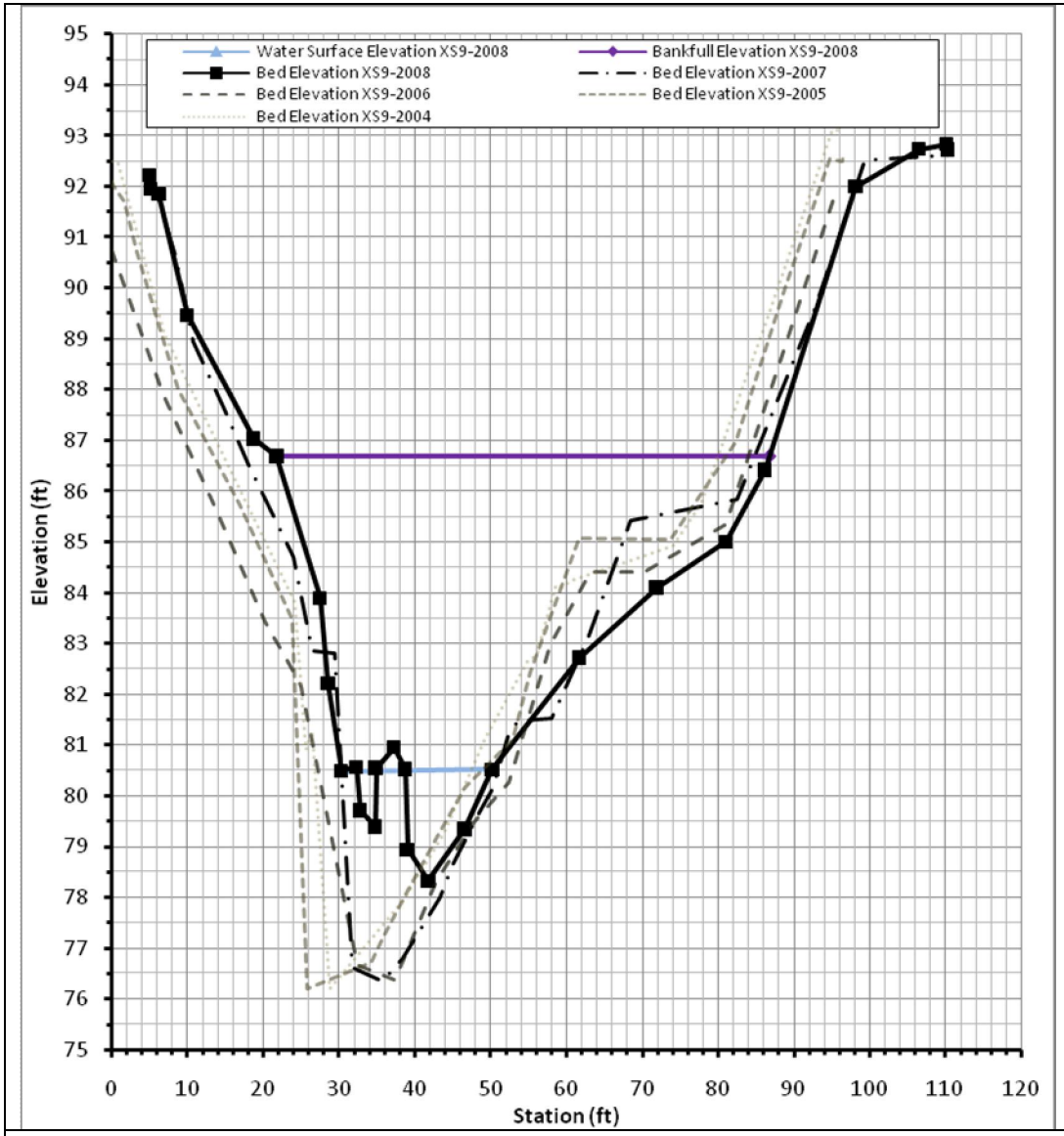
ID	Facet Type	Year	Phase	Wbkf	Abkf	Dbkf
XS8	Riffle		DS	54.0	339.0	6.3
XS8	Riffle	2004	AB	59.5	219.7	3.7
XS8	Riffle	2005	MY1	59.7	219.9	3.7
XS8	Riffle	2006	MY2	60.8	221.3	3.6
XS8	Riffle	2007	MY3	61.0	219.7	3.6
XS8	Riffle	2008	MY4	57.1	181.3	3.2

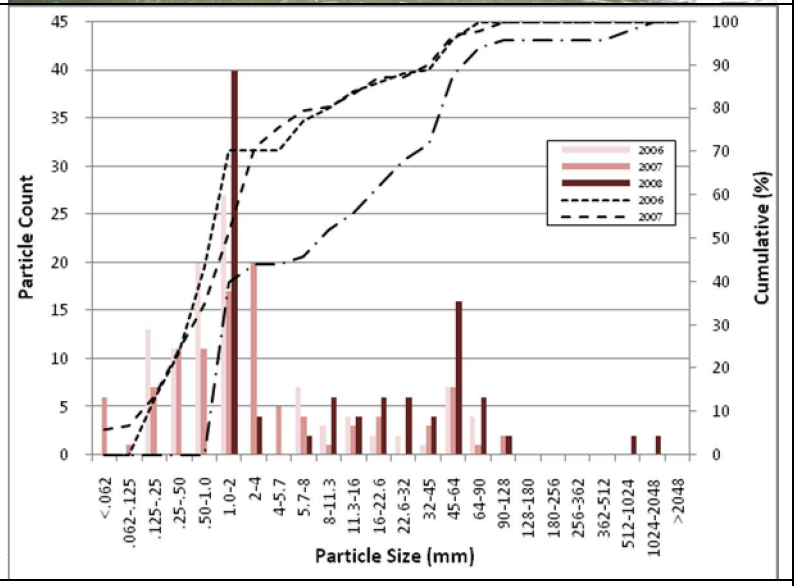
ID	Year	Phase	d50 (mm)	d84 (mm)
XS8	2006	MY2	30.29	145.33
XS8	2007	MY3	25.67	124.96
XS8	2008	MY4	19.30	59.44


Lower Freedom Park Thalweg Profile 2008
Elevation (ft)
100
95
90
85
80
75
70
3900
4000
4100
4200
4300
Station (ft)
XS-9
Water Surface Elevation 2008
Bankfull Elevation 2008
Left TOB Elevation 2008
Right TOB Elevation 2008
Cross Sections 2008
Bed Elevation 2008
Bed Elevation 2007
Bed Elevation 2006
Bed Elevation 2005
Bed Elevation 2004
Water Surface Slope
Bankfull Slope
Water Surface Slope
y=-0.0014x+86.484
Bankfull Slope
y=-0.0108x+130.88


Legend
Channel Thalweg 2008
Channel Centerline 2006
Channel Cross Sections
Bank Scour
Bank Slump
J-Hook
Rootwad
4000
4100
4200
XS9
0
50
100
200
Feet

XS9 - POOL





ID	Facet Type	Year	Phase	Wbkf	Abkf	Dbkf
XS9	Pool		DS	54.0	339.0	6.3
XS9	Pool	2004	AB	59.8	235.3	3.9
XS9	Pool	2005	MY1	59.9	250.5	4.2
XS9	Pool	2006	MY2	66.5	247.6	3.7
XS9	Pool	2007	MY3	62.4	244.4	3.9
XS9	Pool	2008	MY4	65.0	277.3	4.3

ID	Year	Phase	d50 (mm)	d84 (mm)
XS9	2006	MY2	0.62	11.17
XS9	2007	MY3	0.54	11.91
XS9	2008	MY4	7.23	41.75