Clear Creek Final Monitoring Report Year 4 of 5 (2007)

Henderson County, North Carolina

USGS HUC: 06010105

Project ID No. 92

Prepared for:

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

February 2008

Executive Summary

The Clear Creek Stream Restoration project falls within USGS hydrologic unit **06010105.** The project lies within a rural setting that includes pasture, farmland, and low density residential areas. Prior to restoration work, the project stream had been destabilized though channelization and hoof-shear.

EcoLogic Associates designed the restoration plans and restoration was completed in 2002. Kimley-Horn and Associates (KHA) performed stream and riparian monitoring during 2007 for this year 4 monitoring report. During the late growing season, KHA assessed four (4) vegetation quads. Combined stem count density for all the quads equaled approximately 450 stems per acre for planted stems: exceeding year 4 success criteria. Vegetation on the left side is performing better than vegetation on the right side of the stream. A small area of Kudzu remains near the downstream section of the stream. This area has not expanded since 2006. Isolated areas of invasives such as Russian Olive are also present.

The stream assessment that included a visual assessment and geomorphic survey indicated that the project reach was performing mostly within established success criteria ranges. Several isolated sections showed bank erosion and a few structures were stressed or failing. Most of the project reach continues to be stable. The geomorphic measurements are within the ranges of the design parameters.

Table of Contents

Tables

Figures

Appendices

1.0 Project Background

1.1 Location and Setting

The Clear Creek stream restoration project is located between I-26 and Clear Creek Road in Henderson County, NC. The site, a fourth order tributary to Mud Creek in the French Broad River Basin, is located in a relatively low slope mountain valley.

Figure 1 shows the project vicinity and mitigation features.

1.2 Project Structure, Mitigation Type, Approach and Objectives

Prior to restoration, the majority of the reach's stream banks were nearly vertical and exposed, with minimal vegetative cover. As a result, the banks were actively eroding, subsequently slumping and promoting lateral channel migration and meander creation. The degraded channel was classified as an "F" type channel under the Rosgen Stream Classification System. Some sections of channel were incised and had limited access to their historic flood plain during large flood flows, but not during bankfull events that typically occur as a result of the 1.5 to 2 year storm event.

The project included 1,300 linear feet of stream restoration. Table I shows a summary of the project structure and objectives.

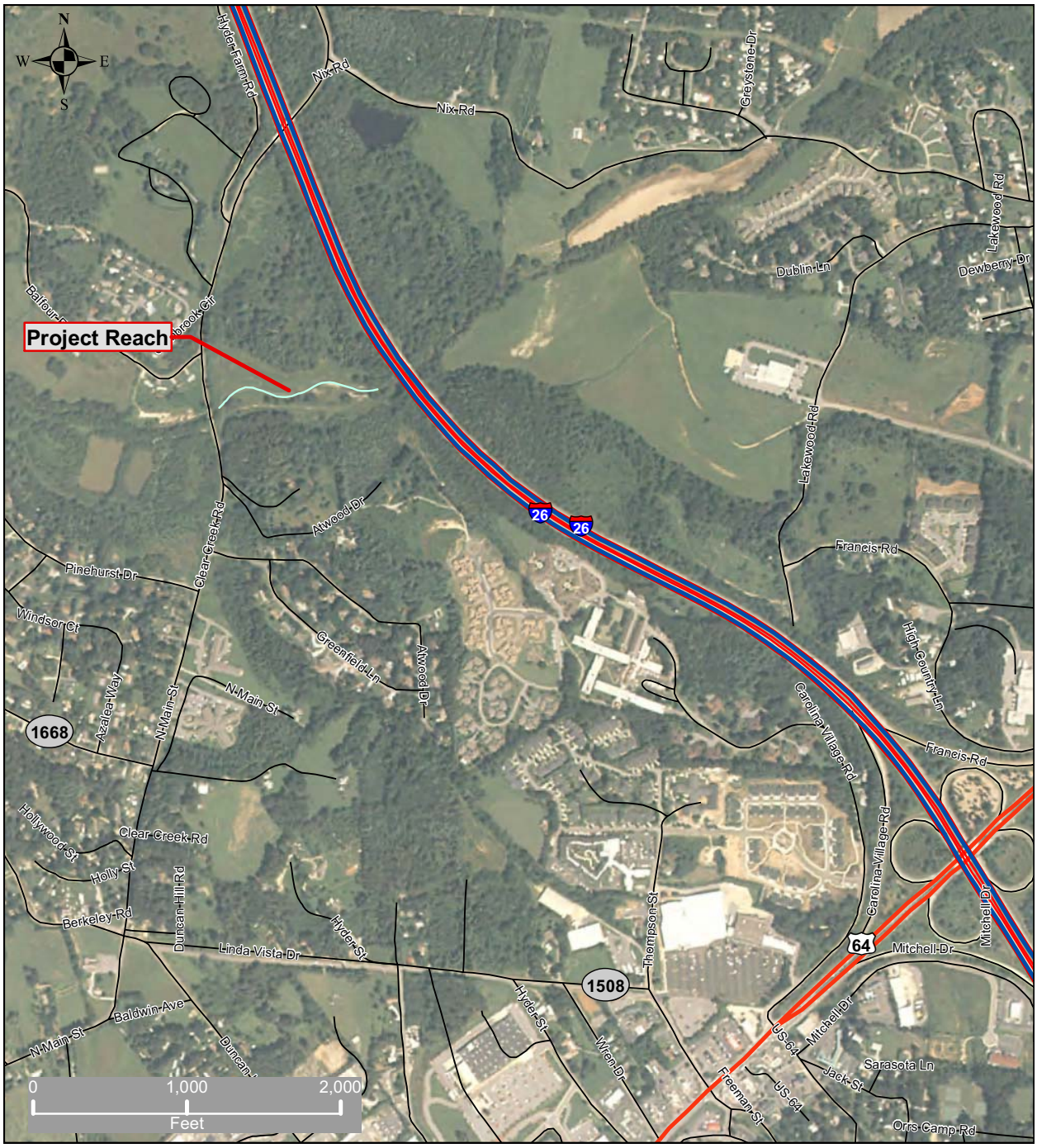
Table I: Project Mitigation Structure and Objectives Table

Table I. Project Restoration Components Clear Creek Stream Restoration Site (EEP Project #92)								
Project Segment or Reach ID	**Existing Feet / Acreage**	**Type**	**Approach**	**Footage or Acreage**	**Mitigation Ratio**	**Mitigation Units**	**Stationing**	**Comment**
Main	1,300	R	PI	1,300 lf	1:1	1,300	0+00.0 - 13+00.0	
Mitigation Unit Summaries								
Stream (lf)	**Riparian Wetland (Ac.)**		**Non-Riparian Wetland (Ac.)**		**Total Wetland (Ac.)**		**Buffer (Ac.)**	**Comment**
1,300	0.0		0.0		0.0			

R = Restoration
EI = Enhancement I
EII = Enhancement II
S = Stabilization

P1 = Priority I
P2 = Priority II
P3 = Priority III
SS = Stream Bank stabilization

Figure 1: Project Setting



Prepared For	Project	Clear Creek Stream Restoration Monitoring Year 4 (2007) Henderson, North Carolina	Prepared By
Ecosystem Enhancement Program			Kimley-Horn and Associates, Inc.
	Date	Project Number	
	2/18/08	92	

1.3 Project History and Background

Construction of the Clear Creek Stream Restoration began in early 2002 with construction ending in the fall of 2002. The As-built survey was completed in early 2003. 2007 served as Year 4 of monitoring. Table II provides additional details regarding the timeline of the project.

Table II: Project Activity and Reporting History

Table II. Project Activity and Reporting History Clear Creek Stream Restoration Site (EEP Project #92)				
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**	**Comments**
Restoration Plan		December-01	March-02	
Final Design – 90%				
Construction			Fall 2002	
Temporary S&E mix applied to entire project area				
Permanent seed mix applied				
Containerized and B&B plantings for reach/segments 1&2				
Mitigation Plan / As-built (Year 0 Monitoring – baseline)			October-02	
Year 1 Monitoring	December-04			
Year 2 Monitoring	December-05	November-05	December-05	Performed by Soil and Environmental Consultants, PA
Year 3 Monitoring	December-06	November-06	January-07	Performed by Kimley - Horn and Associates, Inc.
Year 4 Monitoring	December-07	Novermber-07	February-08	Performed by Kimley - Horn and Associates, Inc.
Year 5 Monitoring	December-08			

The project was designed by EcoLogic Associates. The construction contractor is unknown. KHA performed monitoring work for Year 4. Table III provides additional information regarding contractors.

Table III: Project Contact Table

Table III. Project Contact Table Clear Creek Stream Restoration Site (EEP Project #92)		
Designer		
EcoLogic Associates	Greensboro, NC	
Primary Designer POC		
Construction Contractor		
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	
Stream Monitoring POC	Andrew Kiley	(919) 678-4150
Vegetation Monitoring POC	Andrew Kiley	(919) 678-4150

The project is located within Henderson County, portions of which are located within the Blue Ridge Belt of the Mountains of North Carolina. The site is located within a moderately rural area. Table IV provides additional information regarding the stream.

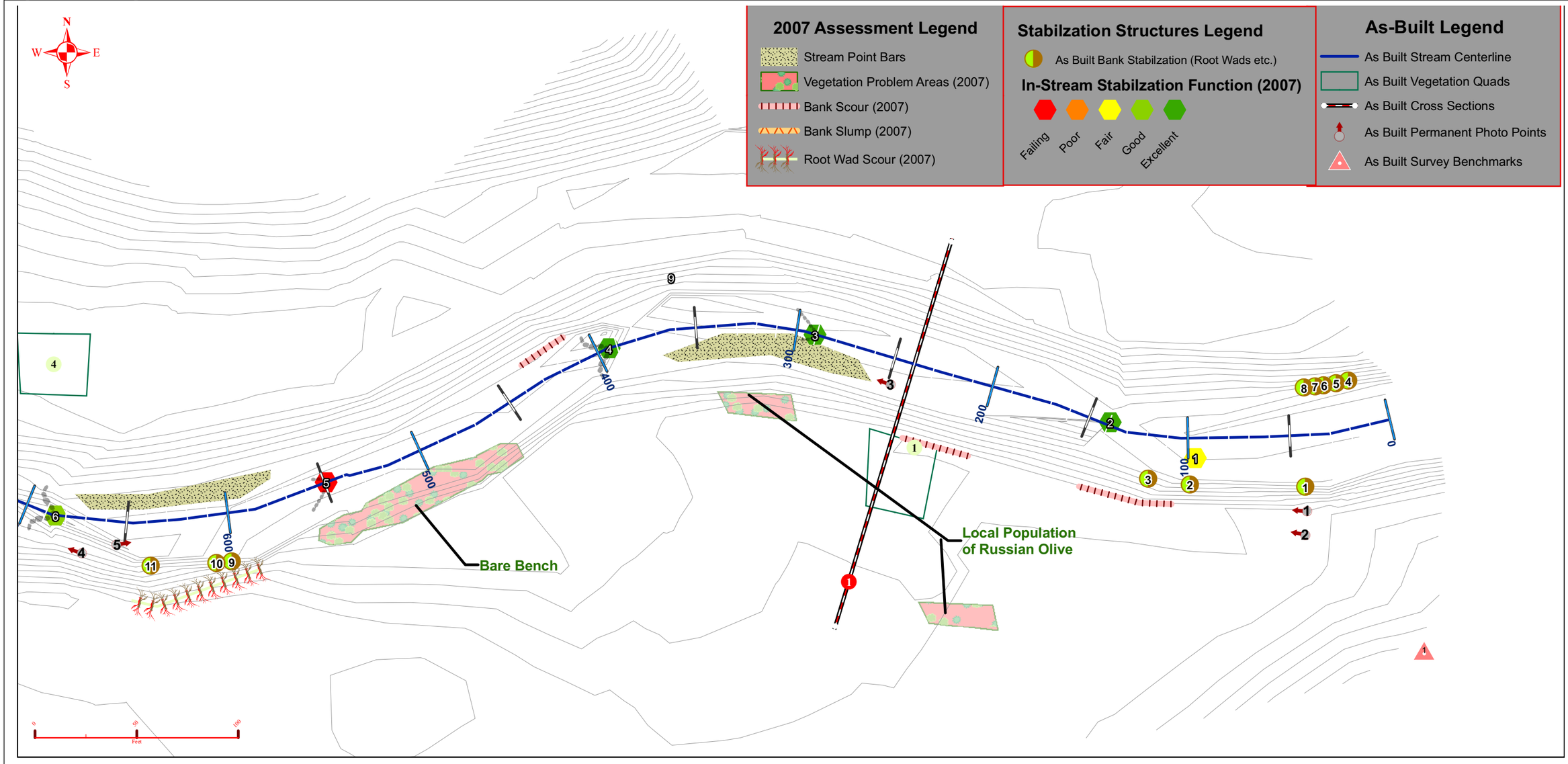
Table IV: Project Background Table

Table IV. Project Background Table Clear Creek Stream Restoration Site (EEP Project #92)	
Project County	Henderson
Drainage Area	44 mi^2
Drainage impervious cover estimate (%)	20%
Stream Order	4^{th}
Physiographic Region	Mountains
Ecoregion	Blue Ridge Belt
Rosgen Classification of As-built	C4
Cowardin Classification	N/A
Dominant soil types	Codorus
Reference site ID	N/A
USGS HUC for Project and Reference	06010105
NCDWQ Sub-basin for Project and Reference	04-03-02
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	N/A
% of project easement fenced	0%

1.4 Monitoring Plan View

The monitoring plan assesses the project stream's geomorphology using a set of three (3) cross sections located throughout the project reach. The longitudinal profile and pattern assessment covered the entire reach. Twenty-nine (29) permanent photo points had been used to provide for a visual comparison of key site features through time. During the 2007, KHA modified the number and location of the photo points to reduce redundancies and streamline comparison points. The monitoring plan uses four (4) randomly placed vegetation quads to assess riparian buffer restoration. KHA performed channel material sampling at each cross section. Figures 2 and 3 show the locations of the monitoring features.

Figure 2: Monitoring Plan View Sheet 1



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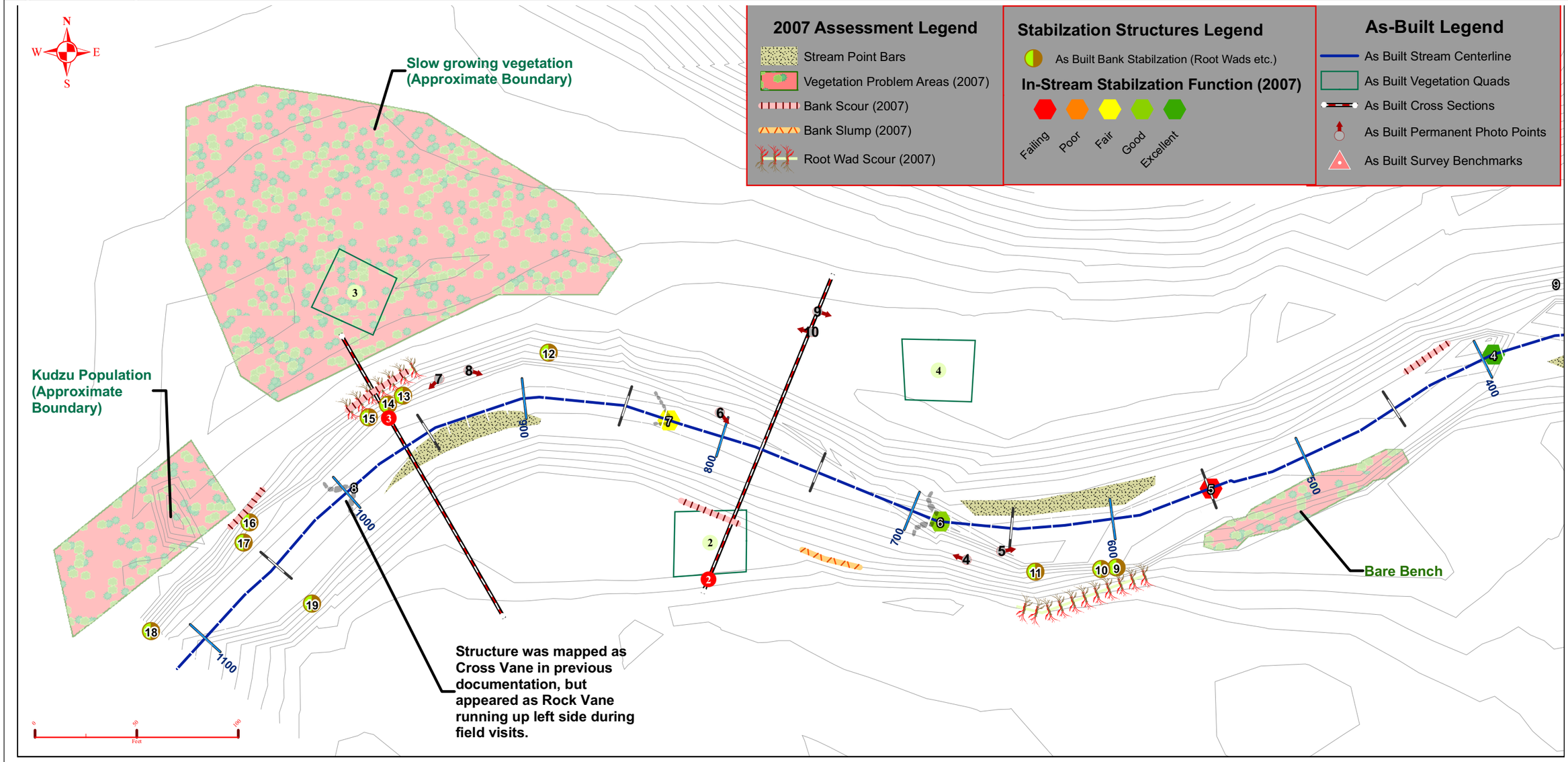
	2/22/08	92	

Figure 3: Monitoring Plan View Sheet 2



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2.0 Project Conditions and Monitoring Results

2.1 Vegetation Assessment

The Clear Creek site consists of two vegetative zones: riparian buffer and 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. Success criteria require 288 live stems per acre within the restoration area during year 4 of a 5-year monitoring period.

The Kudzu population reported during the MY2 2005 and MY3 2006 monitoring reports remains on site. The population falls within an isolated area near Clear Creek Road and does not appear be spreading. A small riparian area upstream of the Kudzu population along the right bank does not appear to be thriving. Vegetation growth in this area is more scattered and less vigorous than the rest of the site. A small floodplain bench on the left side of the channel between stations 455 and 560 is covered with grasses and lacks significant numbers of woody vegetation. Russian Olive (*Elaegnus pungens*) grows in isolated populations (3-4 specimens) throughout the site. The larger populations are show on Figure 2.

Appendix A provides representative photos of problem areas and sampling areas. Figures 2 and 3 show the problem areas.

KHA conducted a vegetation assessment during the early fall of 2007. Appendix A summarizes the results of the vegetation sample. Three (3) of the four (4) plots met success criteria for planted stem counts. Plot 3 contains less planted stems than required, but total stems including volunteers exceed success criteria. The plot summary also shows that in the plots on the left side of the stream, *Betula nigra* is rapidly colonizing.

2.2 Stream Assessment

KHA assessed the stream channel during the spring and fall of 2007. Several isolated sections exhibited bank scour. Excessive shear stresses and possibly historic flood flows may have a role in the scour. Back eddy currents immediately below a structure may be causing bank slumping along a section of the left bank (Station 710-750). Some structures seemed to exhibit signs of stress including partial to complete structure collapse; excessive arm scour; and missing header rock. Several root wads along the middle and lower section of the reach have experienced scour behind the root balls and may be unstable. Figures 1 and 2 show the location of the stream problem areas and table B1 in appendix B summarizes the stream problem areas.

EEP installed a crest gage near permanent cross section XS-2. During the November field visit, the gage did not indicate that bankfull events had occurred since the last reading. Table V provides a listing of bankfull events based on the estimated bankfull discharge from a proximate USGS gauge.

Table V: Verification of Bankfull Events

Table V. Verification of Bankfull Events Clear Creek Stream Restoration Site (EEP Project #92)			
Date of Data	**Date of Occurrence**	**Method**	**Photo #**
7/2/2003	7/2/2003	Proximal USGS Gauge (ID#03446000)	
9/8/2004	9/8/2004	Proximal USGS Gauge (ID#03446000)	

Table VI provides a categorical view of the stream visual stability assessment. The visual assessment shows an apparent decrease in stability related to bank condition. Riffles, thalweg, meanders, and in-stream structures function similarly to the previous year. Bank stabilization structures did not show a decrease in stability, but they also did not improve. Meander instability relates to floodplain relief and point bar slope. All four (4) of the point bars appear to be overly steep and may not provide adequate floodplain relief. Each meander shows active, likely slow, lateral migration evidenced by outer bank erosion with coincident point bar formation and expansion. The thalweg appears to be actively shifting and mobile. In some locations the alignment of the thalweg appeared to be out of place. Also, in some locations multiple thalweg lines were present within a section of channel. The riffles appeared to be short and this may be related to the shifting thalweg. Table B2 in Appendix B provides a breakdown of the visual assessment.

Table VI: Categorical Stream Features Visual Stability Assessment

Table VI. Categorical Stream Feature Visual Stability Assessment Clear Creek Stream Restoration Site (EEP Project #92)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	--	--	90%	80%	80%	--
B. Pools	--	--	100%	100%	100%	--
C. Thalweg	--	--	100%	50%	50%	--
D. Meanders	--	--	100%	75%	75%	--
E. Bed General	--	--	100%	100%	100%	--
F. Bank Condition	--	--	98%	93%	90%	--
G. Vanes / J Hooks etc.	--	--	85%	75%	75%	--
H. Wads and Boulders	--	--	63%	65%	65%	--

Table VII and Table VIII summarize the site geomorphic assessment. The longitudinal profile utilizes bankfull measurements based on observations in the field. Bankfull indicators for cross sections align with the previous years data to allow direct comparison. The field investigators had difficulty identifying and/or isolating 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 last year. Appendix B provides photographs and graphing for geomorphic data.

Table VII: Baseline Morphology and Hydraulic Summary

Table VII. Baseline Morphology and Hydraulic Summary
Clear Creek Stream Restoration Site (EEP Project #92)

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	*	*	*	60.5	77.3	*	*	*	53	32	69	*	*	*	73	*	*	*
Floodprone Width	ft	*	*	*	*	*	*	*	*	129	85	220	*	*	*	275	*	*	*
BF Cross Sectional Area	ft^2	*	*	*	281	286	*	*	*	246	66	199	*	*	*	339	*	*	*
BF Mean Depth	ft	*	*	*	3.6	5	*	*	*	4.64	2.1	2.9	*	*	*	4.66	*	*	*
BF Max Depth	ft	*	*	*	*	*	*	*	*	7.7	2.5	5.2		*	*	7	*	*	*
Width/Depth Ratio		*	*	*	*	*	*	*	*	11.4	15.6	23.9	*	*	*	15.6	*	*	*
Entrenchment Ratio		*	*	*	*	*	*	*	*	2.4	2.6	4.7	*	*	*	3.8	*	*	*
Bank Height Ratio		*	*	*	*	*	*	*	*	1.6	1	1.1	1	*	*	1	*	*	*
Wetted Perimeter	ft	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Hydraulic radius	ft	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Pattern																			
Channel Beltwidth	ft	*	*	*	*	*	*	67	100	*	50	75	*	*	*	131	*	*	*
Radius of Curvature	ft	*	*	*	*	*	*	*	*	69	20.4	69	*	90	150	*	*	*	*
Meander Wavelength	ft	*	*	*	*	*	*	*	*	230	339	350	*	*	*	763	*	*	*
Meander Width ratio		*	*	*	*	*	*	*	*	1.6	1.6	2	*	*	*	1.8	*	*	*
Profile																			
Riffle length	ft	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Riffle slope	ft/ft	*	*	*	*	*	*	*	*	0.008	0.021	0.034	*	*	*	0.003	*	*	*
Pool length	ft	*	*	*	*	*	*	*	*	87	17	285	*	*	*	80	*	*	*
Pool spacing	ft	*	*	*	*	*	*	235	393	*	66	631	*	300	420	*	*	*	*
Substrate																			
d50	mm	*	*	*	*	*	*	*	*	3	12	58	*	*	*	3	*	*	*
d84	mm	*	*	*	*	*	*	*	*	20	31	425	*	*	*	20	*	*	*
Additional Reach Parameters																			
Valley Length	ft	*			*			*			*			*			*		
Channel Length	ft	*			*			*			*			*			*		
Sinuosity		*			*			1.09				1.2		1.17			*		
Water Surface Slope	ft/ft	*			*			0.002				0.004		0.002			*		
BF slope	ft/ft	*			*			*				*		*			*		
Rosgen Classification		*			*			C4				C4/1		C4			*		
*Habitat Index		*			*			*				*		*			*		
*Macrobenthos		*			*			*				*		*			*		

Table VIII: Morphology and Hydraulic Monitoring Summary

Table VIII. Morphology and Hydraulic Monitoring Summary
Clear Creek Stream Restoration Site (EEP Project #92)

Parameter		Cross Section 1						Cross Section 2						Cross Section 3					
		Riffle						Pool						Riffle					
Dimension	**Units**	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5
BF Width	ft	*	*	60.67	54.4	59.7	*	*	*	66.3	65.3	61.2	*	*	*	56.8	55.0	54.7	*
Floodprone Width	ft	*	*	202.15	200.6	184.0	*	*	*	169.72	132.5	165.4	*	*	*	168.11	135.3	155.3	*
BF Cross Sectional Area	ft	*	*	287.43	264.4	284.0	*	*	*	298.3	296.1	296.0	*	*	*	281.43	239.6	275.0	*
BF Mean Depth	ft	*	*	4.74	4.9	4.8	*	*	*	4.5	4.5	4.9	*	*	*	4.95	4.4	5.0	*
BF Max Depth	ft	*	*	5.91	6.4	6.2	*	*	*	7.99	8.2	8.0	*	*	*	7.7	7.4	7.7	*
Width/Depth Ratio		*	*	12.81	11.2	12.5	*	*	*	14.74	14.4	12.6	*	*	*	11.46	12.6	10.9	*
Entrenchment Ratio		*	*	3.33	3.7	3.1	*	*	*	2.56	2.0	2.7	*	*	*	2.96	2.5	2.8	*
Bank Height Ratio		*	*	1.4	1.3	1.3	*	*	*	*	*	*	*	*	*	1.3	1.2	1.2	*
Wetted Perimeter	ft	*	*	65.66	59.1	63.5	*	*	*	71.09	69.8	66.3	*	*	*	61.38	59.1	60.4	*
Hydraulic radius	ft	*	*	4.38	4.5	4.5	*	*	*	4.2	4.2	4.5	*	*	*	4.59	4.1	4.6	*
Substrate																			
d50	mm	*	*	*	0.28	1.4	*	*	*	*	0.5	2.2	*	*	*	*	0.33	0.5	*
d84	mm	*	*	*	13.45	6.5	*	*	*	*	7.91	5.8	*	*	*	*	20.45	1.6	*
Parameter		**AB (2003)**			**MY-01 (2004)**			**MY-02 (2005)**			**MY-03 (2006)**			**MY-04 (2007)**			**MY-05 (2008)**		
Pattern		**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Channel Beltwidth	ft	*	*	*	*	*	*	131	153	143	122	198	148	122	153.75	198	*	*	*
Radius of Curvature	ft	*	*	*	*	*	*	89	105	97	124	194	183	124	170.75	194	*	*	*
Meander Wavelength	ft	*	*	*	*	*	*	497	576	536	511	541	526	512	523	534	*	*	*
Meander Width ratio		*	*	*	*	*	*	2.2	2.6	2.4	2.0	3.3	2.5	2	2.55	3.3	*	*	*
Profile																			
Riffle length	ft	*	*	*	*	*	*	15	89	38	15	23	21	21.723	89.193	44.5505	*	*	*
Riffle slope	ft/ft	*	*	*	*	*	*	0.0007	0.0019	0.0014	0.0040	0.0040	0.0040	0.0060543	0.0228878	0.0137256	*	*	*
Pool length	ft	*	*	*	*	*	*	28	135	65	131	290	182	91.521	277.793	169.6825	*	*	*
Pool spacing	ft	*	*	*	*	*	*	260	291	311	227	360	279	249.874	306.801	277.882			
Additional Parameters																			
Valley Length	ft	*	*	*	*	*	*	*	*	1115	*	*	1115	*	*	1115	*	*	*
Channel Length	ft	*	*	*	*	*	*	*	*	1228	*	*	1228	*	*	1228	*	*	*
Sinuosity		*	*	*	*	*	*	*	*	1.11	*	*	1.11	*	*	1.11	*	*	*
Water Surface Slope	ft/ft	*	*	*	*	*	*	*	*	0.0015	0.0002	0.0014	0.0009	*	*	0.0012	*	*	*
BF slope	ft/ft	*	*	*	*	*	*	*	*	*	*	*	0.0009	*	*	0.0008	*	*	*
Rosgen Classification		*	*	*	*	*	*	*	*	C4	*	*	C4	*	*	C4	*	*	*
Habitat Index*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Macrobenthos*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

3.0 Methodology

Monitoring methods for 2007 were similar to those used during the 2006 effort.

APPENDIX A
VEGETATION MONITORING DATA

Table V. Preliminary Soil Data Clear Creek Stream Restoration Site (EEP Project #19)					
Series	**Max Depth (in.)**	**% Clay on Surface**	**K**	**T**	**OM %**
Codorus (Co)	60	15-25	0.37	2	1.0-5.0

Table 6. Vegetative Problem Areas Clear Creek Stream Restoration Site (EEP Project #92)			
Feature/Issue	**Station # / Range**	**Probable Cause**	**Photo #**
2007			
Bare Bank	--	--	--
Bare Bench	455 - 560 (Left Bank)	Limited Woody Vegetation	VP 1
Bare Flood Plain	850 - 1,000 (Right Bank)	Limited or Stunted Growth - cause unknown	VP 2
Invasive/Exotic Populations	165 - 210 (Left Side)	Small Russian Olive Population	VP 3
	300 - 340 (Left Side)	Small Russian Olive Population	--
	1,020 - 1,120	Kudzu Population	VP 4
2006			
Bare Flood Plain	850 - 1,000 (Right Bank)	Limited or Stunted Growth - cause unknown	
Invasive/Exotic Populations	300 - 340	Small Russian Olive Population	
	1,020 - 1,120	Kudzu Population	

Table VII: Stem counts for each species arranged by plot.

Clear Creek Stream Restoration Site (EEP Project #19)

Species		Plots																				Species Y2 Totals	Species Y3 Totals	Species Y4 Totals
		1					2					3					4							
		Y2	Y3		Y4		Y2	Y3		Y4		Y2	Y3		Y4		Y2	Y3		Y4				
			P	V	P	V		P	V	P	V		P	V	P	V		P	V	P	V			
		100 m^2					100 m^2					100 m^2					100 m^2							
Trees																								
Acer	*negundo*	2				1					3						1	1		1	2	**2**	**1**	**7**
Acer	*rubrum*													1		1						**2**	**1**	**1**
Acer	*sacchirinum*											2	2	1	2	1						**8**	**3**	**3**
Betula	*nigra*	8	8	52	8	129	7	7	35	7	39	2	2	1	2		2	2		2	1	**8**	**107**	**188**
Cephalanthus	*occidentalis*					1																**0**	**0**	**1**
Elaegnus	*pungens*			1																		**1**	**1**	**0**
Fraxinus	*pennsylvanicum*																1	1	1			**3**	**2**	**0**
Plantus	*occidentalis*	1	1		1	1								1			5	4		4	1	**1**	**6**	**7**
Quercus	*phellos*	1	1		1							1	1	1	1							**1**	**3**	**2**
Quercus	*spp.*								1		3			1							1	**5**	**2**	**4**
Salix	*nigra*	2	2	6	2	5	3	3	3	1							4	4		4		**2**	**18**	**12**
Shrubs																								
Alnus	*serrulata*			2		3																**5**	**2**	**3**
Cerclis	*candensis*															1						**4**	**0**	**1**
Cornus	*amomum*	4	2	1	2	2	5	5	1	5	1			1		1	2			2	1	**4**	**10**	**14**
Illicuim	*spp.*						2															**2**	**0**	**0**
Sambucus	*candensis*										3						1					**4**	**0**	**3**
Plot Y2 Total		**18**					**17**					**5**					**16**							
Plot Y3 Totals		**76**	14	62			**55**	15	40			**12**	5	7			**13**	12	1					
Plot Y4 Totals		**156**			14	142	**62**			13	49	**9**			5	4	**19**			13	6			
Year 5 Count Success Criteria			7		7			7		7			7		7			7		7				

Y2: Year 2 Total; P: Planted; V: Volunteer

VQ1: Vegetation Quad 1 (2005)

VQ1: Vegetation Quad 1 (2006)

VQ1: Vegetation Quad 1 (2007)

VQ2: Vegetation Quad 2 (2005)

VQ2: Vegetation Quad 2 (2006)

VQ2: Vegetation Quad 2 (2007)

VQ3: Vegetation Quad 3 (2005)

VQ3: Vegetation Quad 3 (2006)

VQ3: Vegetation Quad 3 (2007)

VQ4: Vegetation Quad 4 (2005)

VQ4: Vegetation Quad 4 (2006)

VQ4: Vegetation Quad 4 (2007)

VP1 – Bare bench lacking woody vegetation

VP2 – Limited coverage of woody vegetation

VP3 – Isolated population of Russian Olive

VP4 – Population of kudzu near bottom of project

APPENDIX B
STREAM MONITORING DATA

Table B1. Stream Problem Areas Clear Creek Stream Restoration Site (EEP Project #92)					
Feature Issue	**Reach**	**Station numbers**	**Description**	**Suspected Cause**	**Photo number**
2007					
Aggradation/Bar Formation					
Bank scour		100 - 150	Bank Scour	Excessive shear stress	
		200 - 240	Bank Scour	Excessive shear stress	
		410 - 430	Bank Scour	Excessive shear stress	SP 1
		710 - 750	Bank Slump/ Bank Scour	Back eddy from upstream in-stream stabilization	SP 2
		780 - 810	Bank Scour	Excessive shear stress	
		940 - 980	Bank Scour	Excessive shear stress	SP 3
		1,020 - 1,050	Bank Scour	Excessive shear stress	
Engineered structures – back or arm scour Etc.		100 - 150	Partial Strucutre Collapse	Excessive shear stress	SP 4
		545	Structure Collapse	Excessive shear stress	
		690	Excessive Arm Scour	Back eddy due to improper geomerty	SP 5
		810	Missing header rock	Excessive shear stress	
		600 - 650	Rootwad Scour	Excessive shear stress	
		940 - 980	Rootwad Scour	Excessive shear stress	SP 6
2006					
Aggradation/Bar Formation					
Bank scour		100 - 150	Bank Scour	Excessive shear stress	
		200 - 240	Bank Scour	Excessive shear stress	
		710 - 750	Bank Slump/ Bank Scour	Back eddy from upstream in-stream stabilization	
		780 - 810	Bank Scour	Excessive shear stress	
		1,020 - 1,050	Bank Scour	Excessive shear stress	
Engineered structures – back or arm scour Etc.		100 - 150	Partial Strucutre Collapse	Excessive shear stress	
		545	Structure Collapse	Excessive shear stress	
		690	Excessive Arm Scour	Back eddy due to improper geomerty	
		810	Missing header rock	Excessive shear stress	
		600 - 650	Rootwad Scour	Excessive shear stress	
		940 - 980	Rootwad Scour	Excessive shear stress	
2005					
Bank Scour		121 - 166		Scour at arm of crossvane	
		212 - 229		Scour at arm of crossvane	
		975 - 1,007		Root wads on outside bend, excessive scour	
Stressed or Failing Structures					
		1,068 - 1,092		Root wads on outside bend (near crossvane), excessive scour	
		975 - 1,007		Root wads on outside bend, excessive scour	
		1,068 - 1,092		Root wads on outside bend (near crossvane), excessive scour	

Table B2. Visual Morphological Stability Assessment

Clear Creek Stream Restoration Site (EEP Project #19)

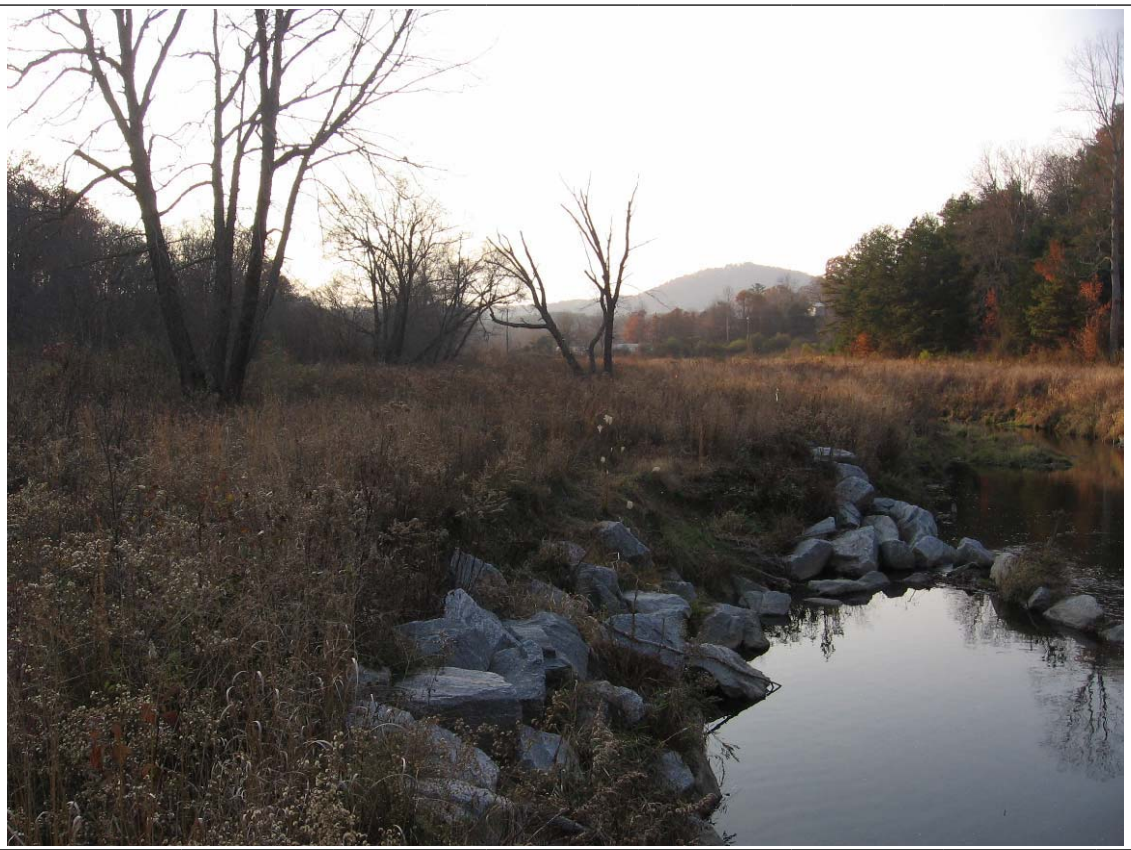
Reach

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?	3	3	NA	100%	80%
	2	Armor stable (e.g. no displacement)?	3	3	NA	100%	
	3	Facet grade appears stable?	3	3	NA	100%	
	4	Minimal evidence of embedding/fining?	3	3	NA	100%	
	5	Length appropriate?	0	3	NA	0%	
B. Pools	1	Present? (e.g not subject to severe aggrad. or migrat.?)	3	3	NA	100%	100%
	2	Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	3	3	NA	100%	
	3	Length appropriate?	3	3	NA	100%	
C. Thalweg	1	Upstream of meander bend (run/inflection) centering?	2	3	NA	67%	50%
	2	Downstream of meander (glide/inflection) centering?	1	3	NA	33%	
D. Meanders	1	Outer bend in state of limited/controlled erosion?	4	4	NA	100%	75%
	2	Of those eroding, # w/concomitant point bar formation?	4	4	NA	100%	
	3	Apparent Rc within spec?	4	4	NA	100%	
	4	Sufficient floodplain access and relief?	0	4	NA	0%	
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	--	--	5 / 250	90%	90%
G. Vanes	1	Free of back or arm scour?	5	7	NA	71%	75%
	2	Height appropriate?	7	7	NA	100%	
	3	Angle and geometry appear appropriate?	5	7	NA	71%	
	4	Free of piping or other structural failures?	4	7	NA	57%	
H. Wads/ Boulders	1	Free of scour?	13	20	NA	65%	65%
	2	Footing stable?	13	20	NA	65%	

Old PS4 (2005) – Similar View to New PS 1 and PS 2

Old PS4 (2006) – Similar View to New PS 1 and PS 2

PS 1



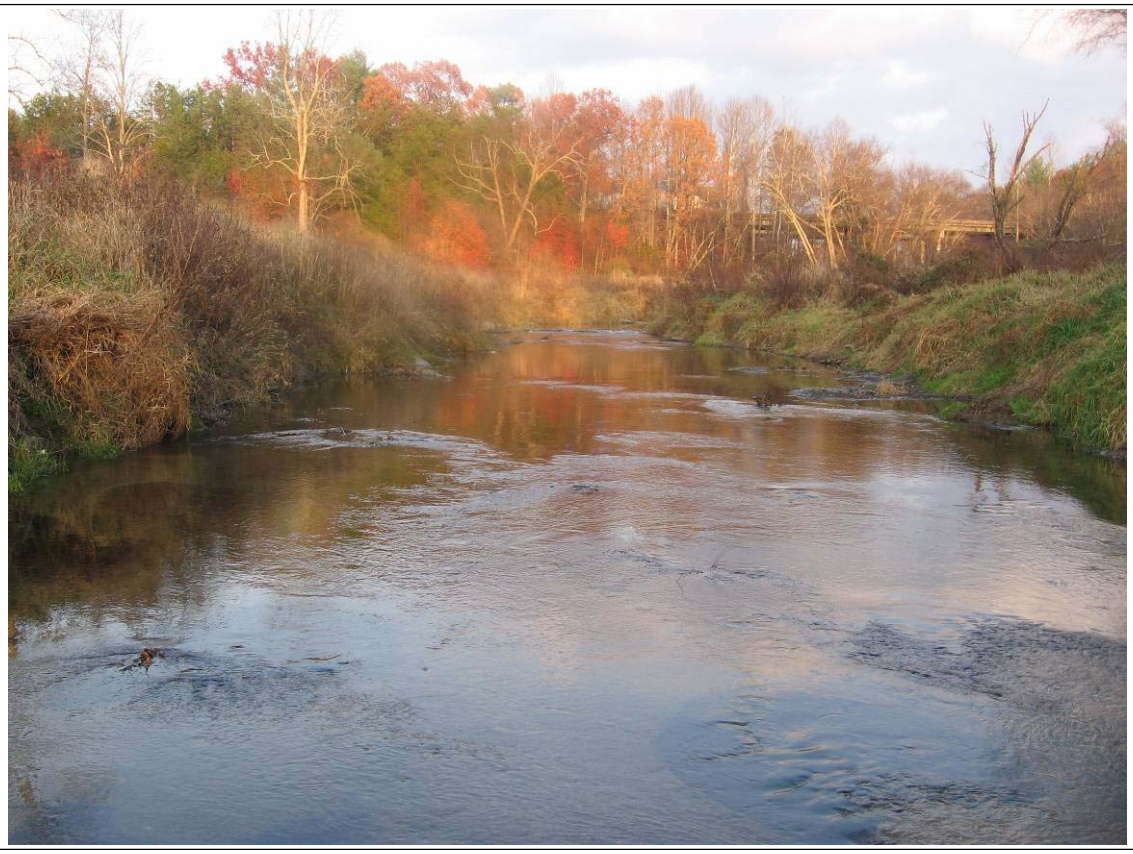
PS2

PS 3

Old PS 16 (2005) – Similar View to New PS 4

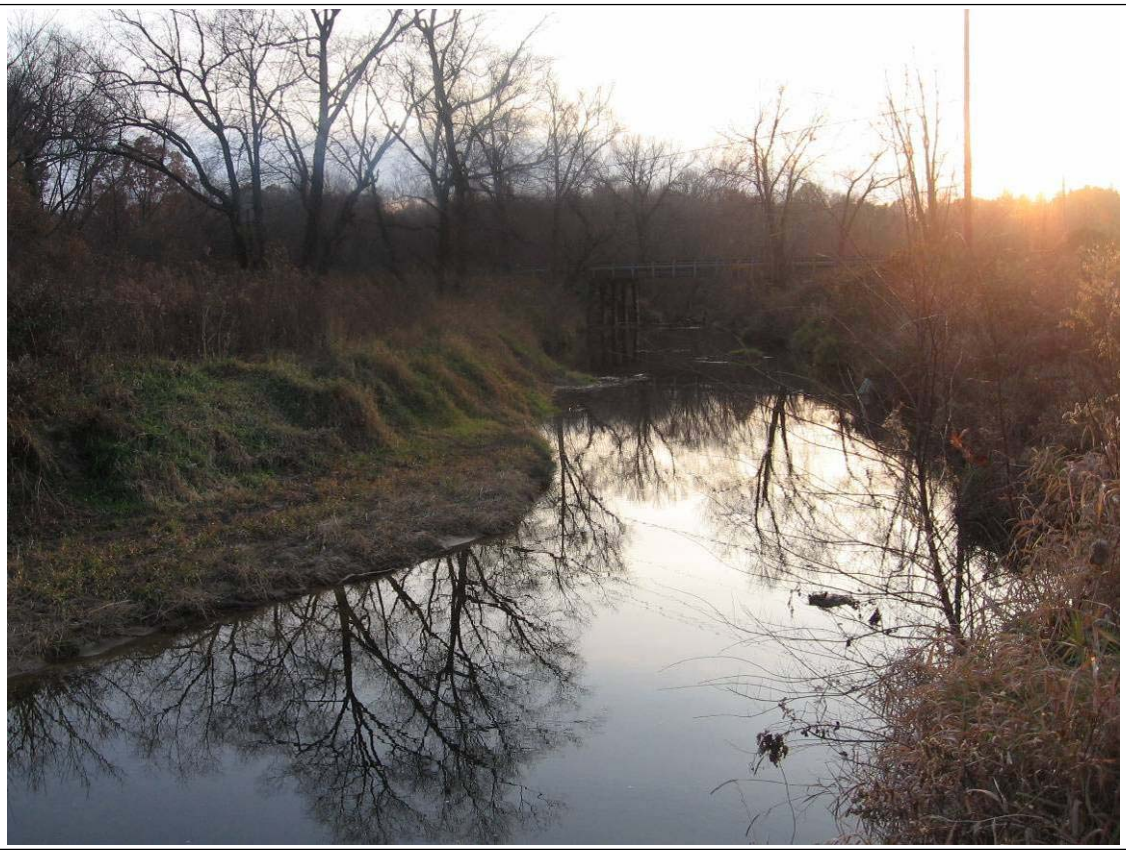
Old PS 16 (2006) – Similar View to New PS 4

PS 4



PS 5

PS 6



PS 7

PS 8

Old PS 25 (2005) – Similar view to New PS 9

Old PS 25 (2006) – Similar view to New PS 9

PS 9

PS 10

SP 1 – Looking upstream, bank scour on right bank downstream of structure arm

SP 2 – Looking upstream, bank scour on left bank downstream of structure arm

SP 3 – Looking upstream, root wad scour on right bank

SP 4 – Looking downstream, collapse of rock used for bank protection

SP 5 – Looking downstream, scour of left bank

SP 6 – Looking upstream, scour of right bank and scour of root wads of right bank

Clear Creek Stream Thalweg Profile 2007

Bankfull Slope
y = -0.0008x + 2071.5

Water Surface Slope
y = -0.0012x + 2066.7

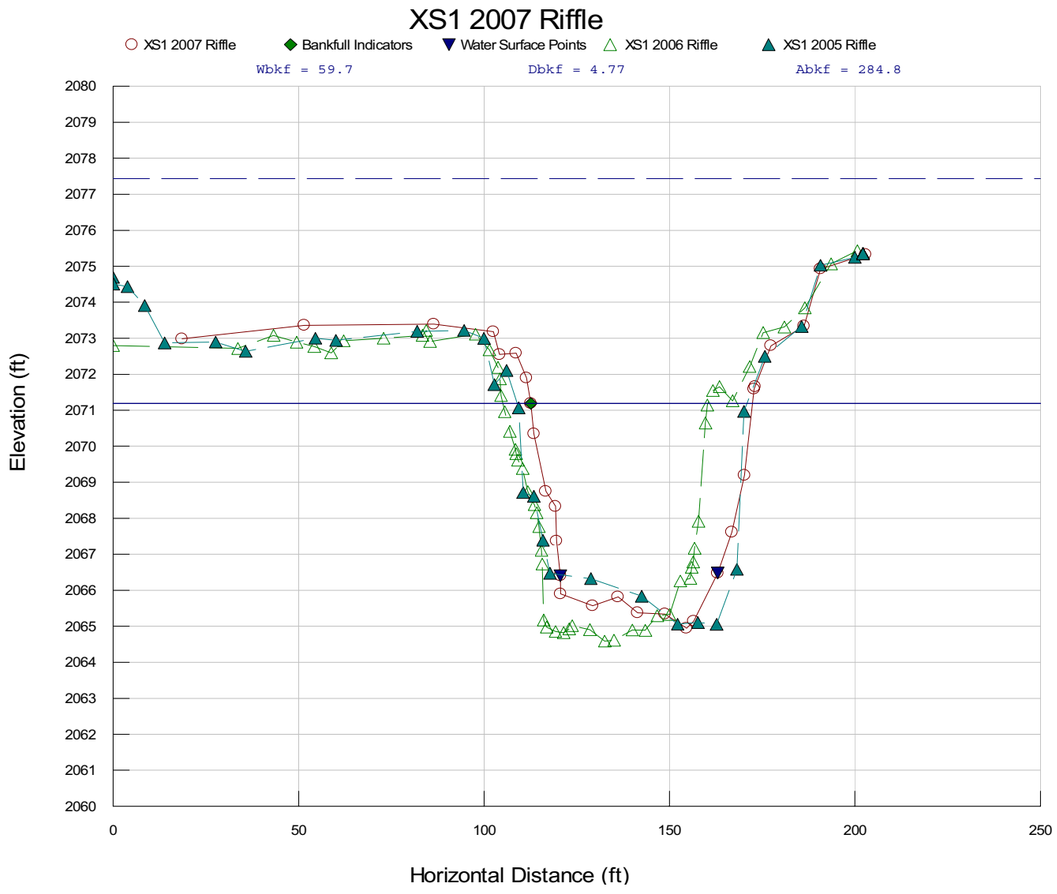
2076
2075
2074
2073
2072
2071
2070
2069
2068
2067
2066
2065
2064
2063
2062
2061
2060

0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300

XS-1
XS-2
XS-3

- Bed Elevation
- Water Surface Elevation
- Bankfull Elevation
- Left TOB Elevation
- Right TOB Elevation
- In-Stream Structures
- Cross Sections
- Bed Elevation 2006
- Bed Elevation 2005
- Bankfull Slope
- Water Surface Slope

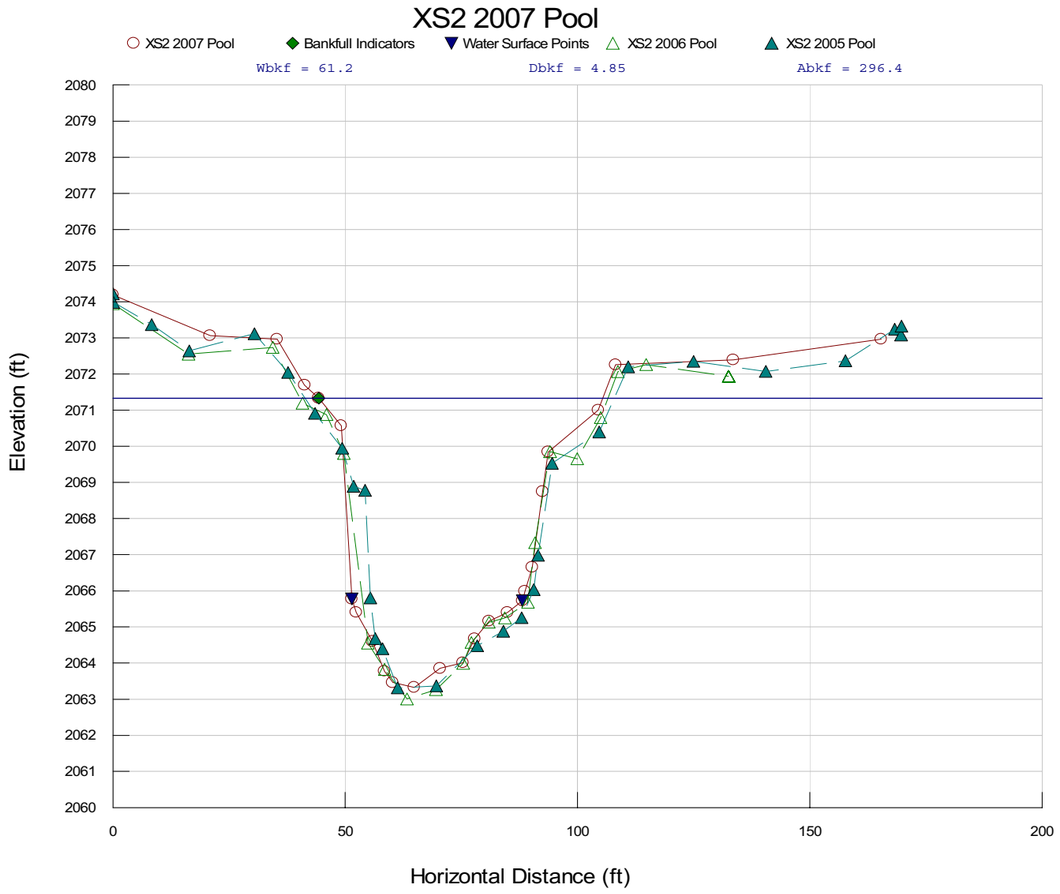
Cross XS1 - Riffle - Station 2+27



Looking Downstream

Looking Upstream

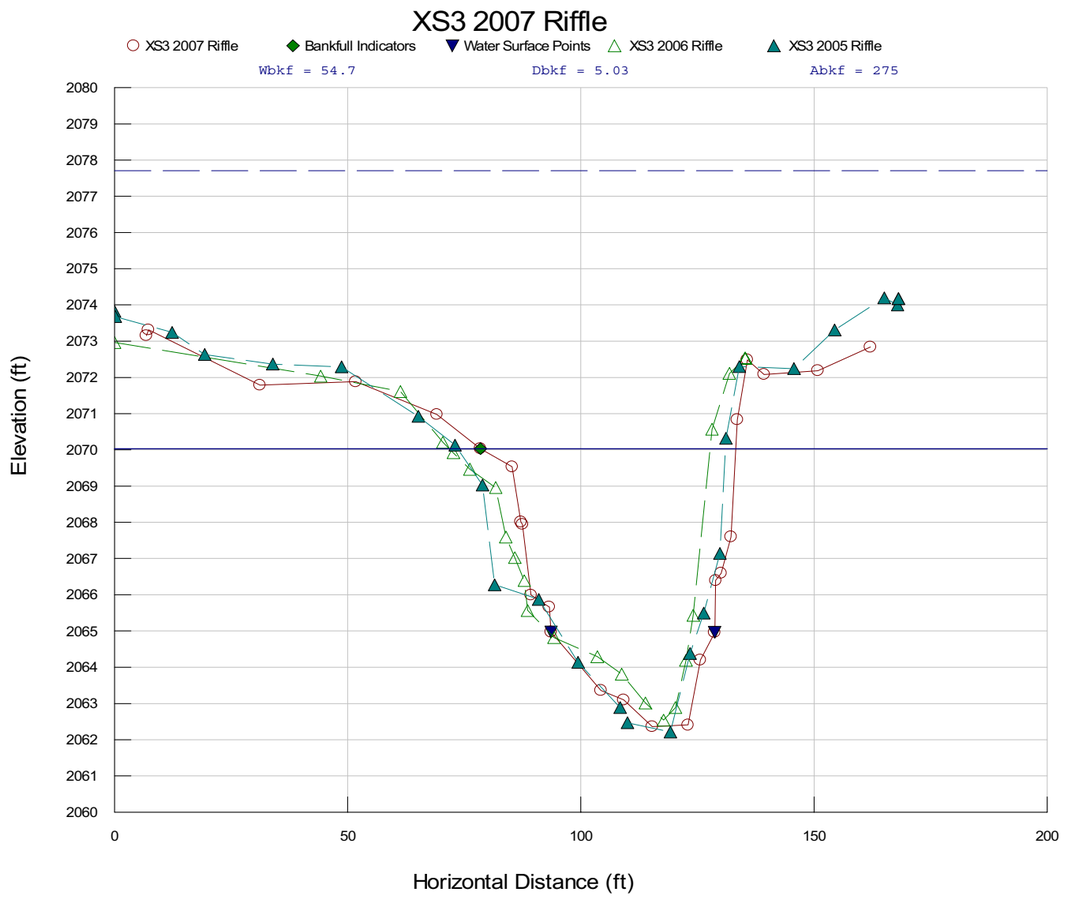
Cross Section XS2 - Pool - Station 7+92



Looking Downstream

Looking Upstream

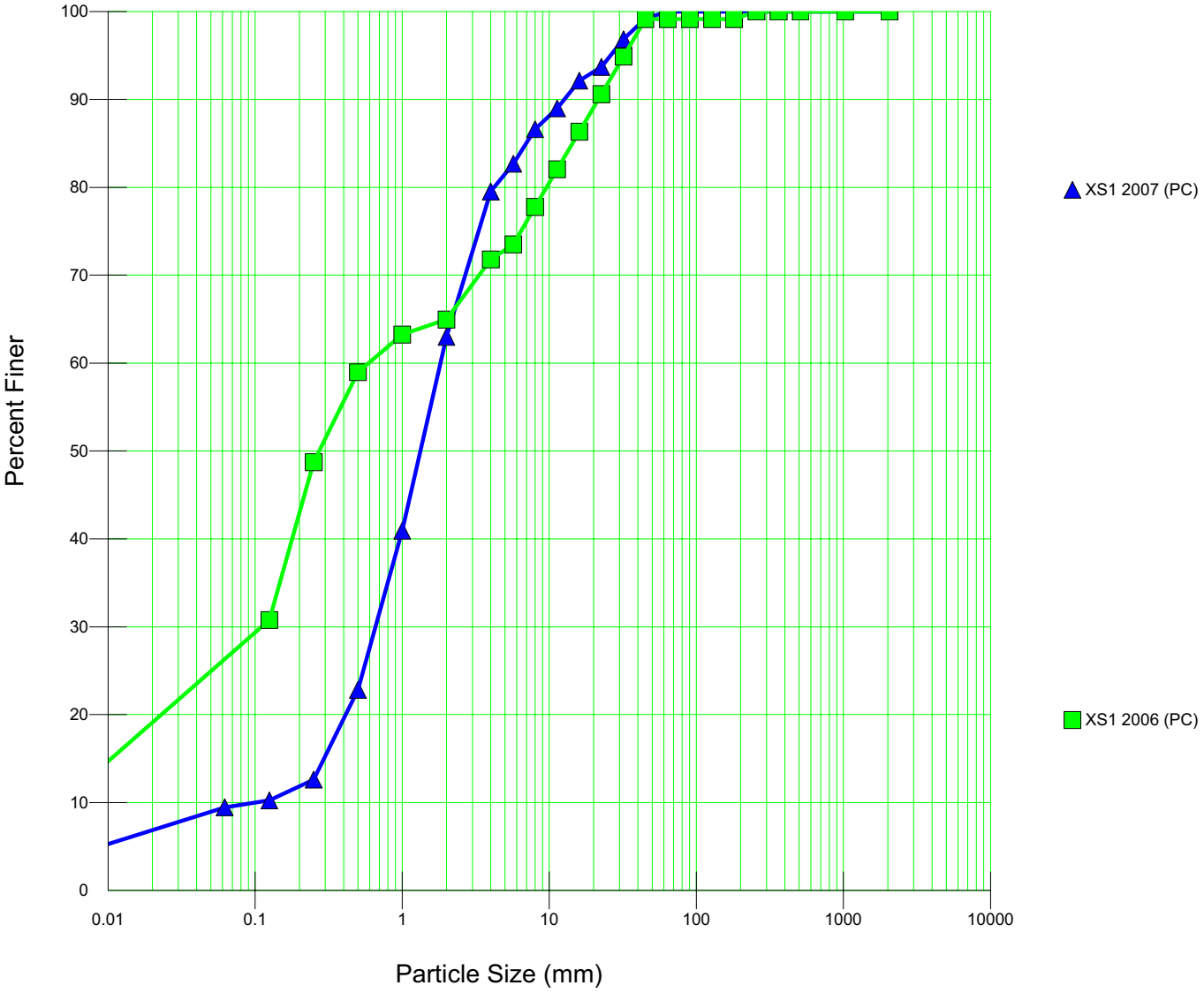
Cross Section XS3 - Riffle - Station 10+12



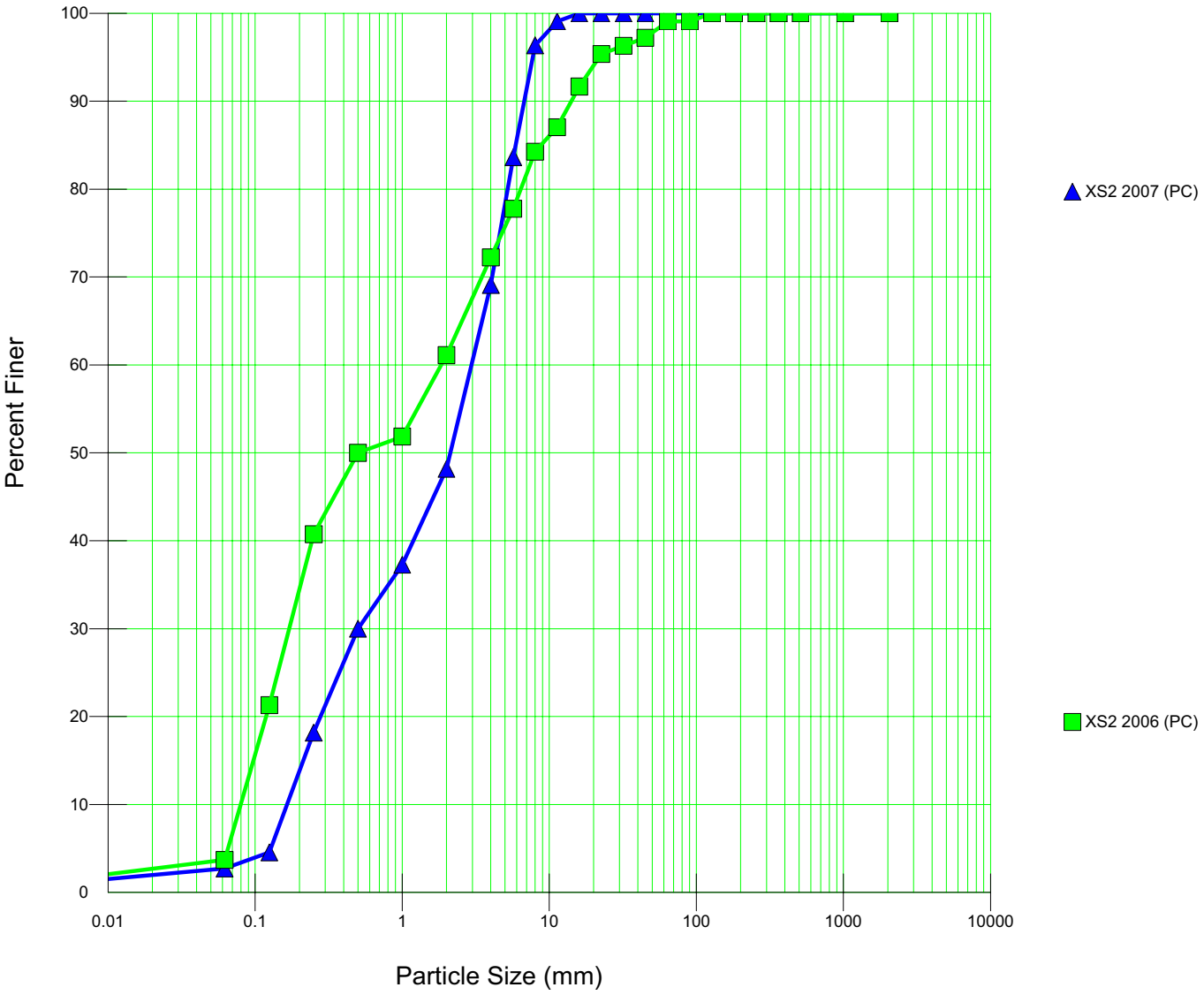
Looking Downstream

Looking Upstream

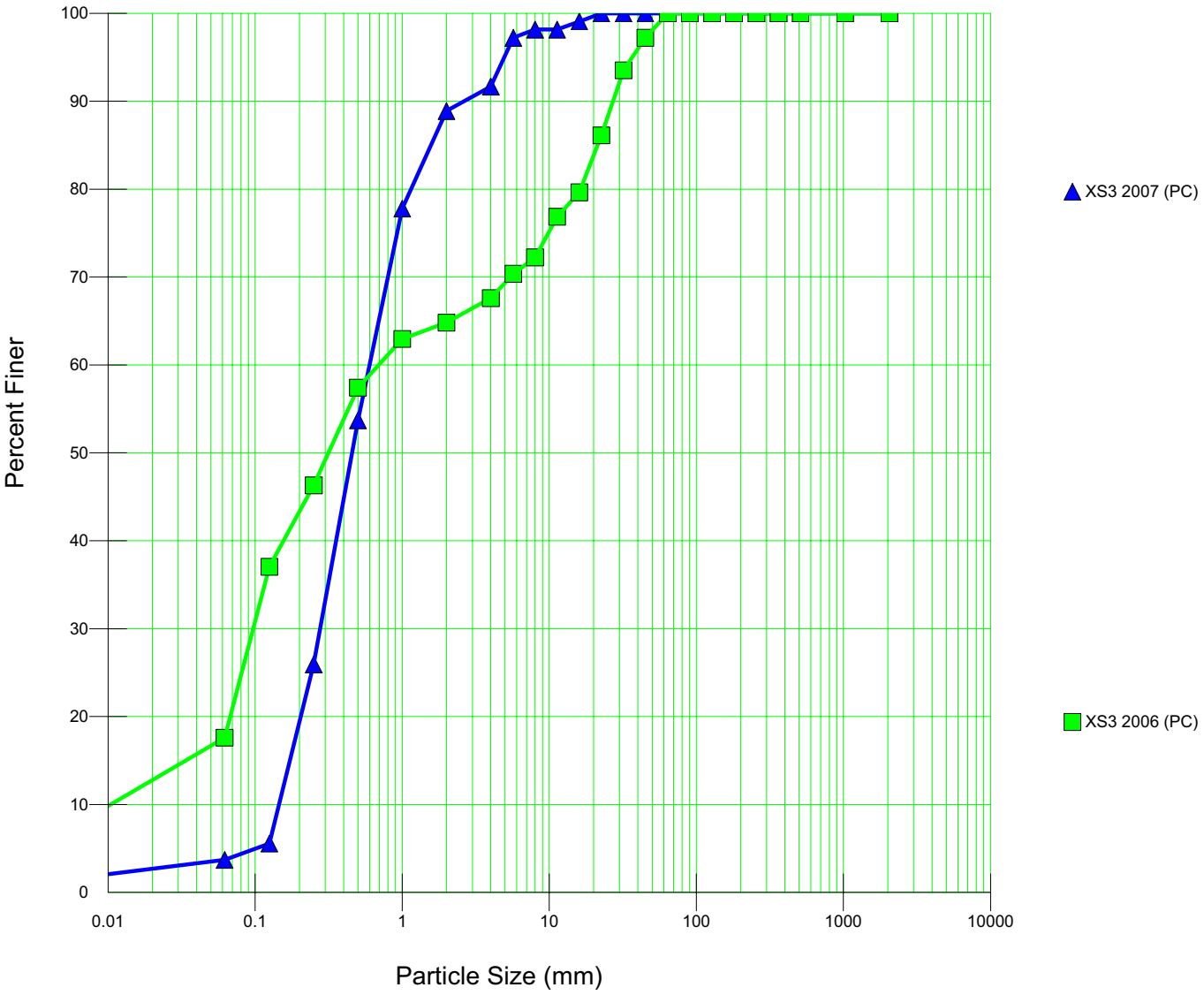
XS 1 2007


Percent Finer
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
XS1 2007 (PC)
XS1 2006 (PC)

XS2 2007


Percent Finer
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
XS2 2007 (PC)
XS2 2006 (PC)

XS3 2007


Percent Finer
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
XS3 2007 (PC)
XS3 2006 (PC)