ANNUAL MONITORING REPORT
BOLD RUN

STREAM AND BUFFER RESTORATION
WAKE COUNTY, NORTH CAROLINA
(EEP Project Number 439)

Monitoring Year 4 of 5 (2010)

Submitted to:
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina

Ecosystem Enhancement PROGRAM

February 2011

ANNUAL MONITORING REPORT
BOLD RUN

STREAM AND BUFFER RESTORATION
WAKE COUNTY, NORTH CAROLINA
(EEP Project Number 439)

Monitoring Year 4 of 5 (2010)

Submitted to:
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina

Prepared by:
Axiom Environmental, Inc.
218 Snow Avenue
Raleigh, North Carolina 27603

Design Firm:
KCI Associates of North Carolina, PA
4601 Six Forks Road
Raleigh, NC 27609

Axiom Environmental, Inc.

Ecosystem Enhancement PROGRAM

February 2011

Table of Contents

List of Figures

List of Tables

Appendices

1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

The Bold Run Stream and Buffer Restoration Site (Site) is located five miles northwest of the Town of Wake Forest on Bold Hill Road, approximately 1.5 miles east of the intersection with Mangum Dairy Road in Wake County. The Site is located within United States Geological Survey Hydrologic Unit 03020201065010 (North Carolina Division of Water Quality Subbasin 03-04-08) of the Neuse River Basin. The Site was identified to assist the North Carolina Ecosystem Enhancement Program in meeting stream and buffer restoration goals. Primary activities at the Site included stream restoration and riparian buffer restoration by stabilizing stream banks, installing in-stream structures, adjusting stream plan form, and replanting riparian areas with native vegetation. Project restoration efforts provided 640 Stream Mitigation Units, 14.9 Buffer Mitigation Units, and 14.7 Nutrient Offset Credit. This project was instituted prior to October 11, 2007 and therefore is eligible for riparian buffer restoration credit up to 200 feet from the top of bank of all perennial and intermittent waterways within the Site. This report summarizes data for year 4 (2010) monitoring.

The primary components of the restoration project included the following.

- Construct a stable, riffle-pool stream channel capable of moving sediments supplied by the watershed so the channel neither aggrades nor degrades.
- Stabilize stream banks, install in-stream structures, adjust stream planform, and replant riparian areas with native vegetation.
- Improve water quality and reduce lateral erosion and bed degradation of stream channels by establishment of riparian vegetation.
- Enhance aquatic and terrestrial wildlife habitat through improvements to stream water quality including improved oxygen levels, reduced sediments and nutrients, and varied stream bed features.

Success criteria dictate that an average density of 320 stems per acre of planted hardwoods must be surviving after five monitoring years in accordance with North Carolina Division of Water Quality Administrative Code 15A NCAC 02B.0242 (Neuse River Basin, Mitigation Program for Protection and Maintenance of Existing Riparian Buffers) (NCDWQ 2007). Based on the number of stems counted, average densities were measured at 526 planted stems per acre surviving in year 4 (2010). The dominant species identified at the Site were planted stems of green ash (*Fraxinus pennsylvanica*), cherrybark oak (*Quercus pagoda*), and willow oak (*Quercus phellos*). In addition, each individual plot met success criteria based on planted stems alone with the exception of Plot 14, which had 283 planted stems per acre. However, when counting appropriate natural recruit species stems such as box elder (*Acer negundo*) and overcup oak (*Quercus lyrata*) this plot was well-above success criteria.

Success criteria for stream restoration reaches should show little to no change from the as-built channel over the five-year monitoring period. Year 4 (2010) monitoring measurements indicate that there have been minimal changes in both the longitudinal profile and cross-sections as compared to as-built data. In addition, two bankfull event were documented to occur in November 2009 and February 2010 for a total of six documented bankfull events with events occurring in multiple monitoring years.

In summary, the Site achieved success criteria for vegetation and stream attributes in the Fourth Monitoring Year (2010). Summary information and data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in table and figures within this report's appendices. Narrative background and supporting information formerly found in these reports can be found in the mitigation and restoration plan documents available on EEPs website. All raw data supporting the tables and figures in the appendices is available from EEP upon request.

2.0 METHODOLOGY

2.1 Vegetation Assessment

Following Site construction, fifteen plots (10-meters square) were established and monumented with metal fence posts at all plot corners and PVC at each plot origin. Five plots are located in the streamside riparian buffer planting zone and ten plots are located within the remaining buffer area. Plots were surveyed in June 2010 for the year 4 (2010) monitoring season. Sampling was conducted as outlined in the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee et al. 2006) (http://cvs.bio.unc.edu/methods.htm); results are included in Appendix C. The taxonomic standard for vegetation used for this document was *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas* (Weakley 2007). The locations of vegetation monitoring plots are depicted on Figure 2 in Appendix A.

2.2 Stream Assessment

Five permanent cross-sections were established after construction was completed. Measurements of each cross-section include points at all breaks in slope including top of bank, bankfull, and thalweg. Riffle cross-sections are classified using the Applied Fluvial Morphology (Rosgen 1996) stream classification system. Longitudinal profile measurements of the entire Site restoration reaches include thalweg and water surface; with each measurement taken at the head of facets (i.e. riffle, run, pool, and glide) in addition to the maximum pool depth. Visual assessment of in-stream structures was conducted to determine if failure has occurred. Failure of a structure may be indicated by collapse of the structure, undermining of the structure, abandonment of the channel around the structure, and/or stream flow beneath the structure.

3.0 REFERENCES

Lee, Michael T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0. (online). Available: http://cvs.bio.unc.edu/methods.htm

North Carolina Division of Water Quality (NCDWQ). 2007. Redbook, Surface Waters and Wetlands Standards. North Carolina Department of Environment and Natural Resources, Division of Water Quality. Raleigh, North Carolina.

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology (Publisher). Pagosa Springs, Colorado.

Weakley, Alan S. 2007. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas (online). Available: http://www.herbarium.unc.edu/WeakleysFlora.pdf [February 1, 2008]. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina, Chapel Hill, North Carolina.

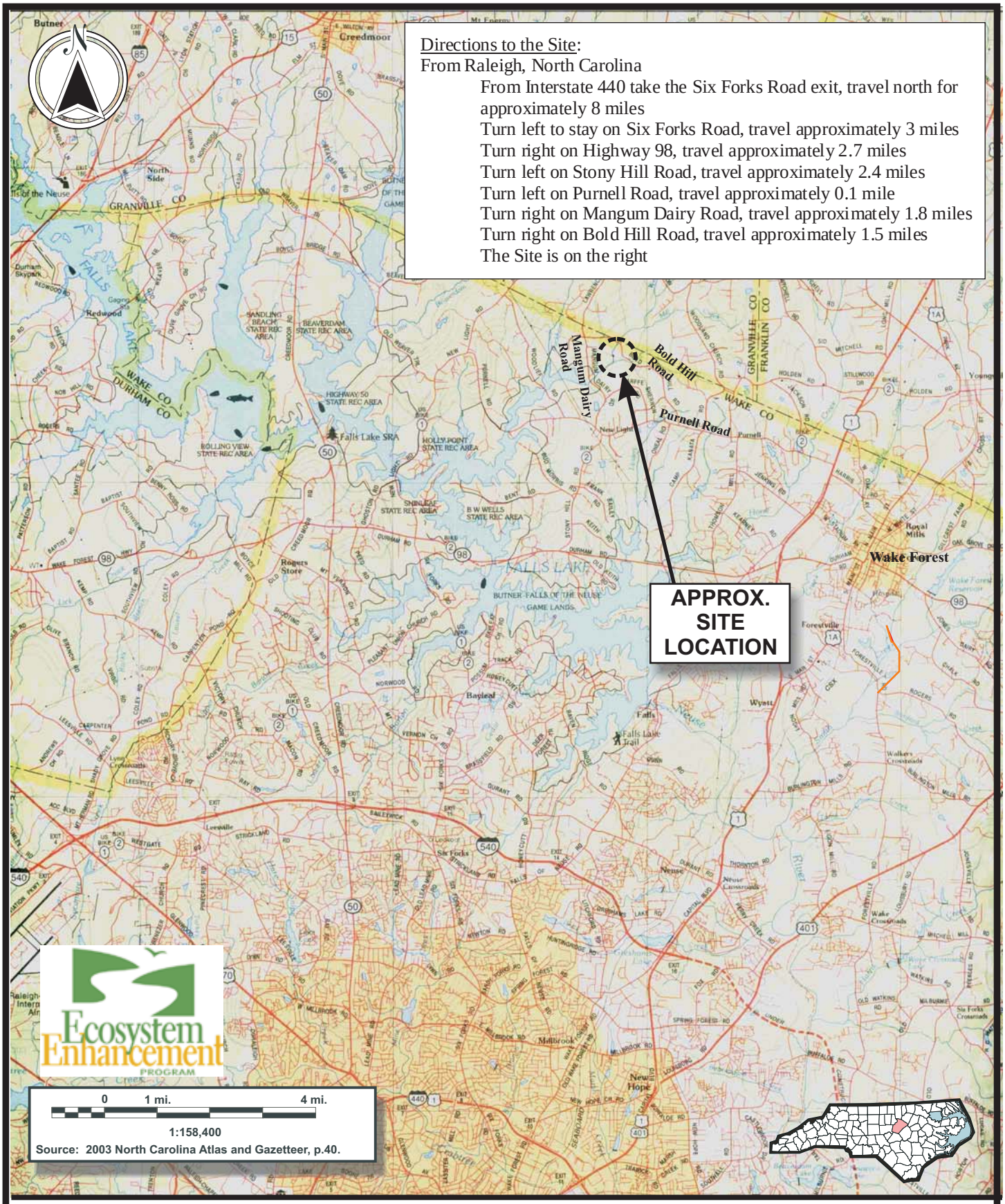
APPENDIX A

FIGURES AND PLAN VIEWS

Figure 1. Site Location

Figure 2. Monitoring Plan View

Figure 3. Current Conditions Plan View



Axiom Environmental
2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

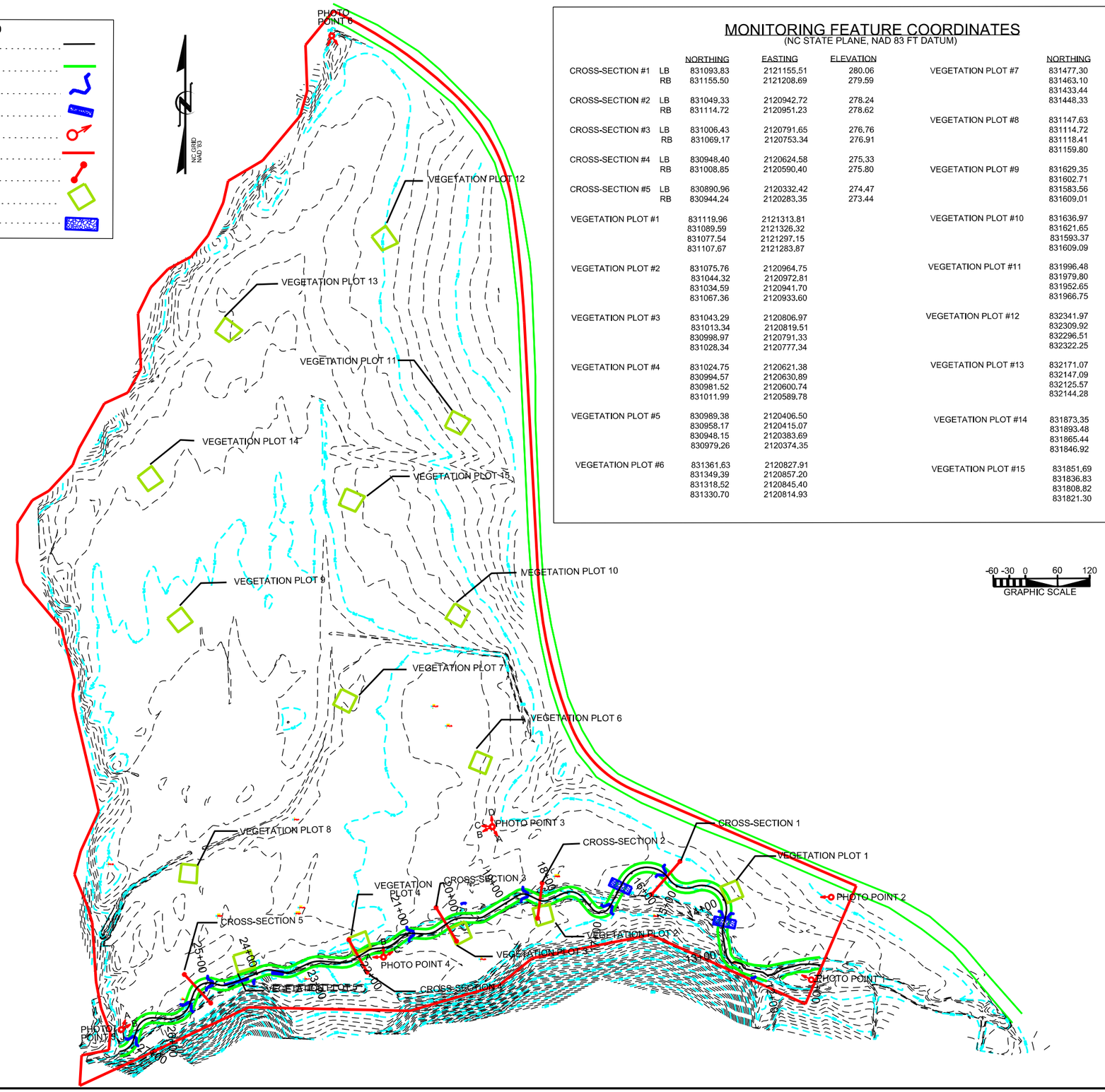
SITE LOCATION
BOLD RUN RESTORATION SITE
Project Number 439
Wake County, North Carolina

Dwn. by:	CLF
Ckd by:	WGL
Date:	Oct 2008
Project:	08-001

FIGURE 1

LEGEND

- STREAM THALWEG
- AS-BUILT TOP OF BANK
- AS-BUILT STRUCTURE
- RIFFLE ENHANCEMENT
- PHOTO REFERENCE POINT
- PROPERTY BOUNDARY
- CROSS-SECTION
- VEGETATION PLOT
- FORD CROSSING



MONITORING FEATURE COORDINATES

(NC STATE PLANE, NAD 83 FT DATUM)

		NORTHING	EASTING	ELEVATION
CROSS-SECTION #1	LB	831093.83	2121155.51	280.06
	RB	831155.50	2121208.69	279.59
CROSS-SECTION #2	LB	831049.33	2120942.72	278.24
	RB	831114.72	2120951.23	278.62
CROSS-SECTION #3	LB	831006.43	2120791.65	276.76
	RB	831069.17	2120753.34	276.91
CROSS-SECTION #4	LB	830948.40	2120624.58	275.33
	RB	831008.85	2120590.40	275.80
CROSS-SECTION #5	LB	830890.96	2120332.42	274.47
	RB	830944.24	2120283.35	273.44

	NORTHING	EASTING
VEGETATION PLOT #1	831119.96	2121313.81
	831089.59	2121326.32
	831077.54	2121297.15
	831107.67	2121283.87
VEGETATION PLOT #2	831075.76	2120964.75
	831044.32	2120972.81
	831034.59	2120941.70
	831067.36	2120933.60
VEGETATION PLOT #3	831043.29	2120806.97
	831013.34	2120819.51
	830998.97	2120791.33
	831028.34	2120777.34
VEGETATION PLOT #4	831024.75	2120621.38
	830994.57	2120630.89
	830981.52	2120600.74
	831011.99	2120589.78
VEGETATION PLOT #5	830989.38	2120406.50
	830958.17	2120415.07
	830948.15	2120383.69
	830979.26	2120374.35
VEGETATION PLOT #6	831361.63	2120827.91
	831349.39	2120857.20
	831318.52	2120845.40
	831330.70	2120814.93
VEGETATION PLOT #7	831477.30	2120576.84
	831463.10	2120605.34
	831433.44	2120590.84
	831448.33	2120561.39
VEGETATION PLOT #8	831147.63	2120307.85
	831114.72	2120306.17
	831118.41	2120273.86
	831159.80	2120277.98
VEGETATION PLOT #9	831629.35	2120277.54
	831602.71	2120298.24
	831583.56	2120271.75
	831609.01	2120251.28
VEGETATION PLOT #10	831636.97	2120788.53
	831621.65	2120815.67
	831593.37	2120799.71
	831609.09	2120769.69
VEGETATION PLOT #11	831996.48	2120784.37
	831979.80	2120817.15
	831952.65	2120799.07
	831966.75	2120769.69
VEGETATION PLOT #12	832341.97	2120658.90
	832309.92	2120681.60
	832296.51	2120652.76
	832322.25	2120632.55
VEGETATION PLOT #13	832171.07	2120359.42
	832147.09	2120366.83
	832125.57	2120366.83
	832144.28	2120340.27
VEGETATION PLOT #14	831873.35	2120195.95
	831893.48	2120221.92
	831865.44	2120242.78
	831846.92	2120215.30
VEGETATION PLOT #15	831851.69	2120584.90
	831836.83	2120620.00
	831808.82	2120602.25
	831821.30	2120572.14

NOTES/REVISIONS

Project:

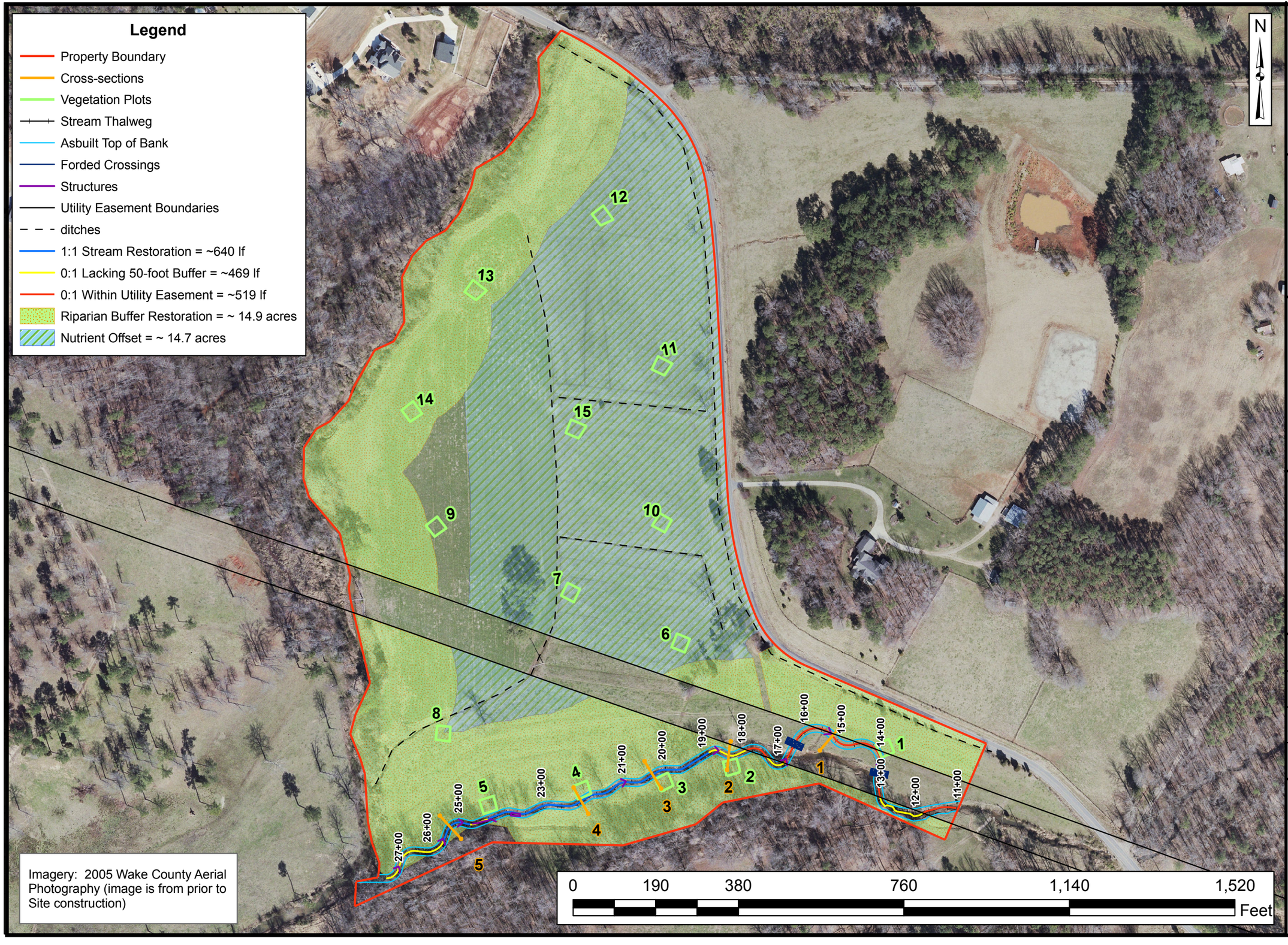
Bold Run Restoration Site

Project No. 439
Year 4 (2010) Monitoring Report
Wake County
North Carolina

Title:

Monitoring Plan View

Scale: As Shown	FIGURE NO. 2
Date: Mar 2010	
Project No.: 08-001	



Axiom Environmental, Inc.

Prepared for:

Ecosystem Enhancement Program

Project:

BOLD RUN RESTORATION SITE

Wake County, NC

Title:

CURRENT CONDITIONS PLAN VIEW

Drawn by: CLF

Date: FEB 2011

Scale: 1:2500

Project No.: 10-009

FIGURE

3

APPENDIX B

GENERAL PROJECT TABLES

Table 1. Site Restoration Structures and Objectives

Table 2. Project Activity and Reporting History

Table 3. Project Contacts Table

Table 4. Project Attributes Table

Table 1. Site Restoration Structures and Objectives
Bold Run Restoration Site (EEP Project Number 439)

Restoration Segment/ Reach ID	Existing Linear Footage/Acres	Restoration Type/Approach*	Designed Linear Footage/Acreage	Mitigation Ratio	Mitigation Units	Stationing	Comment
1:1 Stream Restoration	--	Restoration/ P4 & P2	640	1:1	640	--	--
0:1 Stream Restoration Lacking 50-foot Buffers **	--		469	0:1**	0	--	--
0:1 Stream Restoration within Utility Easement **	--		519	0:1**	0	--	--
Riparian Buffer Restoration	0	Restoration	14.9	1:1	14.9	--	--
Nutrient Offset Buffer	0	Restoration	14.7	1:1	14.7	--	--

Mitigation Unit Summations

Stream	Riparian Wetland	Nonriparian Wetland	Total Wetland	Riparian Buffer	Nutrient Offset
640	0	0	0	14.9	14.7

*P2=Priority 2, P4=Priority 4
**Awaiting guidance for asset reduction.

Table 2. Project Activity and Reporting History
Bold Run Restoration Site (EEP Project Number 439)

Activity or Report	Data Collection Completion	Actual Completion or Delivery
Restoration Plan	November 2005	February 2006
Final Design – Construction Plans	NA	July 2006
Construction	NA	February 2007
Termporary Seed Mix Applied to Entire Project Area	NA	February 2007
Permanent Seed Mix Applied to Entire Project Area	NA	February 2007
Tree Planting	NA	February 2007
Mitigation Plan/As-builts (Year 0 Monitoring-Baseline)	March 2007	March 2007
Year 1 Monitoring (2007)	October 2007	January 2008
Year 2 Monitoring (2008)	September 2008	October 2008
Year 3 Monitoring (2009)	June 2009	July 2009
Year 4 Monitoring (2010)	July 2010	September 2010

Table 3. Project Contacts Table
Bold Run Restoration Site (EEP Project Number 439)

Designer, Monitoring Year 0 Performer, Monitoring Year 1 (2007) Performer	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Road Raleigh, North Carolina 27609 April Davis and Adam Spiller (919) 783-9214
Construction and Seeding Contractor	Vaughn Contracting, Inc. PO Box 796 Wadesboro, North Carolina 28170 Don Vaughn (704) 694-6450
Planting Contractor and Nursery Stock Supplier	Bruton Nurseries and Landscapes PO Box 1197 Freemont, North Carolina 27830 Kelly Bruton (919) 524-5304
Seed Mix Source	Evergreen Seed Company (919)567-1333
Year 2 (2008) Monitoring Performer	Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis (919) 215-1693

Table 4. Project Attribute Table
Bold Run Restoration Site (EEP Project Number 439)

Project County	Wake County, North Carolina
Drainage Area	1.6 square miles
Drainage impervious cover estimate (%)	< 1 percent
Stream Order	Second
Physiographic Region	Piedmont
Ecoregion	Northern Outer Piedmont
Rosgen Classification of As-built	C4-type
Dominant Soil Types	Chewacla, Chewacla variant, Chewacla-Riverview
Reference Site ID	Richland Creek
USGS HUC	Site-03020201065010 Reference-03020201070060
NCDWQ Subbasin	Site-03-04-08 Reference-03-04-02
NCDWQ Classification for Project	WS-IV, NSW, CA (Stream Index # 27-13-(0.1))
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	Not Applicable
% of project easement fenced	100 percent

APPENDIX C

VEGETATION ASSESSMENT DATA

Table 5. Vegetation Plot Mitigation Success Summary

Vegetation Monitoring Plot Photos

CVS Summary Data Tables

Table 6. Vegetation Metadata Table

Table 7. Total and Planted Stems by Plot and Species

Table 5. Vegetation Plot Mitigation Success Summary Table
Bold Run Restoration Site (EEP Project Number 439)

Vegetation Plot ID	Vegetation Survival Threshold Met? Based on Riparian Buffer Success Criteria	Tract Mean
1	Yes	93%
2	Yes	
3	Yes	
4	Yes	
5	Yes	
6	Yes	
7	Yes	
8	Yes	
9	Yes	
10	Yes	
11	Yes	
12	Yes	
13	Yes	
14	No*	
15	Yes	

* This plot was one stem shy of meeting success criteria when counting planted stems alone; however, when including naturally recruited stems of box elder (*Acer negundo*) this plot was well-above success criteria.

Bold Run Restoration Site
Year 4 (2010) Annual Monitoring
Vegetation Plot Photos (taken June 2010)

Bold Run Restoration Site
Year 4 (2010) Annual Monitoring
Vegetation Plot Photos (taken June 2010), continued

Table 6. Vegetation Metadata Table
Bold Run Restoration Site (EEP Project Number 439)

Report Prepared By	Corri Faquin
Date Prepared	9/21/2010 9:46
database name	Axiom-EEP-2010-A.mdb
database location	C:\Axiom\Business\CVS Database\2010
computer name	CORRI
file size	36941824
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	BR
project Name	Bold Run
Description	Bold Run Stream and Buffer Mitigation Site
River Basin	Neuse
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	15

Table 7. Total and Planted Stems by Plot and Species
Bold Run Restoration Site (EEP Project Number 439)

Current Plot Data (MY4 2010)

Scientific Name	Common Name	Species Type	E439-01-0001			E439-01-0002			E439-01-0003			E439-01-0004			E439-01-0005		
			P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T
Acer negundo	**boxelder**	Tree			1												1
Acer rubrum	**red maple**	Tree															
Baccharis halimifolia	eastern baccharis	Shrub Tree			2												
Betula nigra	**river birch**	Tree					1	1					2	2		2	3
Celtis laevigata	**sugarberry**	Shrub Tree															
Cornus amomum	silky dogwood	Shrub	1	1	1												
Diospyros virginiana	**common persimmon**	Tree									1						
Fraxinus pennsylvanica	**green ash**	Tree		4	5		5	7		3	3		9	10		7	9
Juglans nigra	**black walnut**	Tree															
Juniperus virginiana	eastern redcedar	Tree			1												
Liquidambar styraciflua	**sweetgum**	Tree			2			2			3			5			
Liriodendron tulipifera	**tuliptree**	Tree		1	1			1			1		1	2			
Pinus	pine	Tree															
Pinus taeda	loblolly pine	Tree			4						4			1			1
Platanus occidentalis	**American sycamore**	Tree		3	4		2	11		6	25		1	2		4	4
Prunus serotina	**black cherry**	Shrub Tree															
Quercus	**oak**	Shrub Tree															
Quercus lyrata	**overcup oak**	Tree															
Quercus michauxii	**swamp chestnut oak**	Tree		2	2											2	2
Quercus pagoda	**cherrybark oak**	Tree															
Quercus phellos	**willow oak**	Tree															
Rhus copallinum	flameleaf sumac	Shrub Tree												2			
Salix	**willow**	Shrub Tree															
Salix nigra	**black willow**	Tree	1	1	1				5	5	5	5	5	5			
Salix sericea	silky willow	Shrub Tree	7	7	7	1	1	1									
Sambucus canadensis	Common Elderberry	Shrub Tree											1	1			
Ulmus	**elm**	Tree			5			6			7			26			30
Ulmus alata	**winged elm**	Tree															
Ulmus americana	**American elm**	Tree															
Ulmus rubra	**slippery elm**	Tree															
Unknown		unknown															
Totals		**Stem count**	9	19	36	1	9	29	5	14	49	5	19	56	0	15	50
		size (ares)	1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02		
		Species count	3	7	13	1	4	7	1	3	8	1	6	10	0	4	7
		Stems per ACRE	364	769	1457	40	364	1174	202	567	1983	202	769	2266	0	607	2023
Riparian Buffer Success Criteria Totals		**Stem count**	8	18	28	1	9	29	5	14	45	5	18	52	0	15	49
		size (ares)	1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02		
		Species count	1	4	7	0	2	5	1	2	6	1	4	6	0	3	5
		Stems per ACRE	324	728	1133	40	364	1174	202	567	1821	202	728	2104	0	607	1983

Scientific Name	Common Name	Species Type	E439-01-0006			E439-01-0007			E439-01-0008			E439-01-0009			E439-01-0010		
			P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T
Acer negundo	**boxelder**	Tree			3			2						19			3
Acer rubrum	**red maple**	Tree						1									1
Baccharis halimifolia	eastern baccharis	Shrub Tree															
Betula nigra	**river birch**	Tree															
Celtis laevigata	**sugarberry**	Shrub Tree											2	2			
Cornus amomum	silky dogwood	Shrub				2	2	2									
Diospyros virginiana	**common persimmon**	Tree															
Fraxinus pennsylvanica	**green ash**	Tree					8	54		1	1						
Juglans nigra	**black walnut**	Tree											3	3			
Juniperus virginiana	eastern redcedar	Tree															
Liquidambar styraciflua	**sweetgum**	Tree															
Liriodendron tulipifera	**tuliptree**	Tree		2	2					1	1					3	3
Pinus	pine	Tree															
Pinus taeda	loblolly pine	Tree			1												
Platanus occidentalis	**American sycamore**	Tree															
Prunus serotina	**black cherry**	Shrub Tree															2
Quercus	**oak**	Shrub Tree															
Quercus lyrata	**overcup oak**	Tree											6	6			
Quercus michauxii	**swamp chestnut oak**	Tree		6	6											1	1
Quercus pagoda	**cherrybark oak**	Tree		2	2					6	6					3	3
Quercus phellos	**willow oak**	Tree		3	3								3	3		5	5
Rhus copallinum	flameleaf sumac	Shrub Tree															
Salix	**willow**	Shrub Tree															
Salix nigra	**black willow**	Tree															
Salix sericea	silky willow	Shrub Tree															
Sambucus canadensis	Common Elderberry	Shrub Tree															
Ulmus	**elm**	Tree			8		2	2									
Ulmus alata	**winged elm**	Tree			1												
Ulmus americana	**American elm**	Tree															
Ulmus rubra	**slippery elm**	Tree															
Unknown		unknown															
Totals		**Stem count**	0	13	26	2	12	61	0	8	8	0	14	33	0	12	18
		size (ares)	1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02		
		Species count	0	4	8	1	3	5	0	3	3	0	4	5	0	4	7
		Stems per ACRE	0	526	1052	81	486	2469	0	324	324	0	567	1335	0	486	728
Riparian Buffer Success Criteria Totals		**Stem count**	0	13	25	0	10	59	0	8	8	0	14	33	0	12	18
		size (ares)	1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02		
		Species count	0	4	7	0	2	4	0	3	3	0	4	5	0	4	7
		Stems per ACRE	0	526	1012	0	405	2388	0	324	324	0	567	1335	0	486	728

Scientific Name	Common Name	Species Type	E439-01-0011			E439-01-0012			E439-01-0013			E439-01-0014			E439-01-0015		
			P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T
Acer negundo	**boxelder**	Tree						1			5		1	17			1
Acer rubrum	**red maple**	Tree						1									2
Baccharis halimifolia	eastern baccharis	Shrub Tree															
Betula nigra	**river birch**	Tree															
Celtis laevigata	**sugarberry**	Shrub Tree								3	3		1	1			
Cornus amomum	silky dogwood	Shrub															
Diospyros virginiana	**common persimmon**	Tree															
Fraxinus pennsylvanica	**green ash**	Tree			19		9	18			4						3
Juglans nigra	**black walnut**	Tree															
Juniperus virginiana	eastern redcedar	Tree															
Liquidambar styraciflua	**sweetgum**	Tree						1									
Liriodendron tulipifera	**tuliptree**	Tree															
Pinus	pine	Tree															
Pinus taeda	loblolly pine	Tree			1												
Platanus occidentalis	**American sycamore**	Tree															
Prunus serotina	**black cherry**	Shrub Tree															
Quercus	**oak**	Shrub Tree															
Quercus lyrata	**overcup oak**	Tree								5	5		3	3			
Quercus michauxii	**swamp chestnut oak**	Tree		2	2		1	1									
Quercus pagoda	**cherrybark oak**	Tree		7	7		2	2		1	1					5	5
Quercus phellos	**willow oak**	Tree		3	3		8	8					2	2		6	6
Rhus copallinum	flameleaf sumac	Shrub Tree															
Salix	**willow**	Shrub Tree															
Salix nigra	**black willow**	Tree															
Salix sericea	silky willow	Shrub Tree															
Sambucus canadensis	Common Elderberry	Shrub Tree															
Ulmus	**elm**	Tree						4									
Ulmus alata	**winged elm**	Tree															
Ulmus americana	**American elm**	Tree					1	1									
Ulmus rubra	**slippery elm**	Tree															
Unknown		unknown															
Totals		**Stem count**	0	12	32	0	21	37	0	9	18	0	7	23	0	11	17
		size (ares)	1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02		
		Species count	0	3	5	0	5	9	0	3	5	0	4	4	0	2	5
		Stems per ACRE	0	486	1295	0	850	1497	0	364	728	0	283	931	0	445	688
Riparian Buffer Success Criteria Totals		**Stem count**	0	12	31	0	21	37	0	9	18	0	7	23	0	11	17
		size (ares)	1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02		
		Species count	0	3	4	0	5	9	0	3	5	0	4	4	0	2	5
		Stems per ACRE	0	486	1255	0	850	1497	0	364	728	0	283	931	0	445	688

P-LS = planted livestakes; P-All = all planted stems; T = all planted and naturally recruited stems

Table 7. Total and Planted Stems by Plot and Species 9 (cont'd)
Bold Run Restoration Site (EEP Project Number 439)

			Annual Means														
			MY4 (2010)			MY3 (2009)			MY2 (2008)			MY1 (2007)			MY0 (2007)		
Scientific Name	Common Name	Species Type	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T
Acer negundo	**boxelder**	Tree		1	53		1	1			3						
Acer rubrum	**red maple**	Tree			5												
Baccharis halimifolia	eastern baccharis	Shrub Tree			2						1						
Betula nigra	**river birch**	Tree		5	6		3	3		3	7		3	3		7	7
Celtis laevigata	**sugarberry**	Shrub Tree		6	6		6	6		6	6		7	7			
Cornus amomum	silky dogwood	Shrub	3	3	3	3	3	3	5	5	5	3	5	5	4	6	6
Diospyros virginiana	**common persimmon**	Tree			1												
Fraxinus pennsylvanica	**green ash**	Tree		46	133		45	45		45	56		33	33		34	34
Juglans nigra	**black walnut**	Tree		3	3		3	3		3	3		2	2			
Juniperus virginiana	eastern redcedar	Tree			1												
Liquidambar styraciflua	**sweetgum**	Tree			13						3						
Liriodendron tulipifera	**tuliptree**	Tree		8	11		8	8		8	10		5	5			
Pinus	pine	Tree									9						
Pinus taeda	loblolly pine	Tree			12												
Platanus occidentalis	**American sycamore**	Tree		16	46		16	16		16	30		18	18		19	19
Prunus serotina	**black cherry**	Shrub Tree			2						1						
Quercus	**oak**	Shrub Tree											2	2		7	7
Quercus lyrata	**overcup oak**	Tree		14	14		17	17		18	18		21	21			
Quercus michauxii	**swamp chestnut oak**	Tree		14	14		13	13		13	13		12	12		1	1
Quercus pagoda	**cherrybark oak**	Tree		26	26		25	25		25	25		22	22			
Quercus phellos	**willow oak**	Tree		30	30		28	28		28	28		33	33		1	1
Rhus copallinum	flameleaf sumac	Shrub Tree			2												
Salix	**willow**	Shrub Tree													8	8	8
Salix nigra	**black willow**	Tree	11	11	11	12	12	12	9	9	9	7	7	7			
Salix sericea	silky willow	Shrub Tree	8	8	8	7	7	7	8	8	8	7	7	7			
Sambucus canadensis	Common Elderberry	Shrub Tree		1	1		1	1		1	1	1	1	1	3	3	3
Ulmus	**elm**	Tree		2	88					1	4						
Ulmus alata	**winged elm**	Tree			1												
Ulmus americana	**American elm**	Tree		1	1		1	1		1	1						
Ulmus rubra	**slippery elm**	Tree					1	1		1	1						
Unknown		unknown											4	4	7	112	112
Totals		**Stem count**	22	195	493	22	190	190	22	191	242	18	182	182	22	198	198
		size (ares)	15			15			15			15			15		
		size (ACRES)	0.37			0.37			0.37			0.37			0.37		
		Species count	3	17	26	3	17	17	3	17	22	4	16	16	4	10	10
		tems per ACRE	59	526	1330	59	513	513	59	515	653	49	491	491	59	534	534
Riparian Buffer Success Criteria Totals		**Stem count**	19	191	472	19	186	186	17	185	226	14	172	172	0	69	69
		size (ares)	15			15			15			15			15		
		size (ACRES)	0.37			0.37			0.37			0.37			0.37		
		Species count	1	13	18	1	13	13	1	13	16	1	11	11	1	6	6
		tems per ACRE	769	7729	19101	769	7527	7527	688	7487	9146	567	6961	6961	0	2792	2792

P-LS = planted livestakes; P-All = all planted stems; T = all planted and naturally recruited stems

APPENDIX D

STREAM ASSESSMENT DATA

Fixed-Station Photos

Table 8. Qualitative Visual Stability Assessment

Table 9. Verification of Bankfull Events

Cross-section Plots and Tables

Longitudinal Profile Plots

Pebble Count Plots

Bold Run Restoration Site

Fixed-Station Photographs

taken June 2010

Bold Run Restoration Site

Fixed-Station Photographs

taken June 2010 (continued)

Bold Run Restoration Site

Fixed-Station Photographs

taken June 2010 (continued)

Table 8. Qualitative Visual Stability Assessment

Bold Run Restoration Site (EEP Project Number 439)

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?	21	21	N/A	100%	
	2. Armor stable (e.g. no displacement)?	21	21	N/A	100%	
	3. Facet grade appears stable?	21	21	N/A	100%	
	4. Minimal evidence of embedding/fining?	21	21	N/A	100%	
	5. Length appropriate?	21	21	N/A	100%	**100%**
B. Pools	1. Present? (e.g. no severe aggradation)	15	15	N/A	100%	
	2. Sufficiently deep (Dmax pool:Mean Bkf > 2.2?)	15	15	N/A	100%	
	3. Length appropriate?	15	15	N/A	100%	**100%**
C. Thalweg	1. Upstream of meander bend centering?	14	14	N/A	100%	
	2. Downstream of meander centering?	14	14	N/A	100%	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	14	14	N/A	100%	
	2. Of those eroding, # w/ concomitant point bar formation?	0	0	N/A	N/A	
	3. Apparent Rc within spec?	14	14	N/A	100%	
	4. Sufficient floodplain access and relief?	14	14	N/A	100%	**100%**
E. Bed General	1.General channel bed aggradation areas (bar formation)	N/A	N/A	0	100%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting?	N/A	N/A	0	100%	**100%**
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A	N/A	2/35	98%	**98%**
G. Vanes	1. Free of back or arm scour?	8	8	N/A	100%	
	2. Height appropriate?	8	8	N/A	100%	
	3. Angle and geometry appear appropriate?	8	8	N/A	100%	
	4. Free of piping or other structural failures?	8	8	N/A	100%	**100%**
H. Wads / Boulders	1. Free of scour?	6	6	N/A	100%	
	2. Footing stable?	6	6	N/A	100%	**100%**

Table 9. Verification of Bankfull Events

Bold Run Restoration Site (EEP Project Number 439)

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
November 19, 2007	Between 8/31/2007 and 11/19/2007	Crest Gauge	--
October 8, 2008	August 28, 2008	Total of 3.48 inches* of rain reported to fall over 2 days (August 27 – 28, 2008) as well as crest gauge readings at the Site	--
February 9, 2009	Between 10/8/2008 and 2/9/2009	Crest Gauge	---
June 19, 2009	Between June 15-17, 2009	1.43 inches of rain fall between June 4-5, 2009, followed by 0.5 inches of rain fall between June 9-10, 2009, followed by an additional 2.24 inches of rain fall between June 14-17, 2009* as well as crest gauge readings at the Site	Event Photos 1-2 (see below)
March 16, 2010	November 11, 2009	3.44 inches of rain fall between November 10-12, 2009*	--
February 17, 2010	February 5, 2010	Visual observations of overbank event including wrack lines and sediment deposition resulting from a 1.36 inch* rainfall event on February 5, 2010 that occurred after numerous rainfall events, within the 3 weeks prior, that totaled 3.52 inches.	Event Photo 3 (see below)

* Reported at KNCWAKEF1 Weather Station on Welcome Drive in Wake Forest.

Bankfull Event Photos 1-2 showing evidence of overbank through wrack lines on banks and vegetation matted from overland flow within the floodplain.

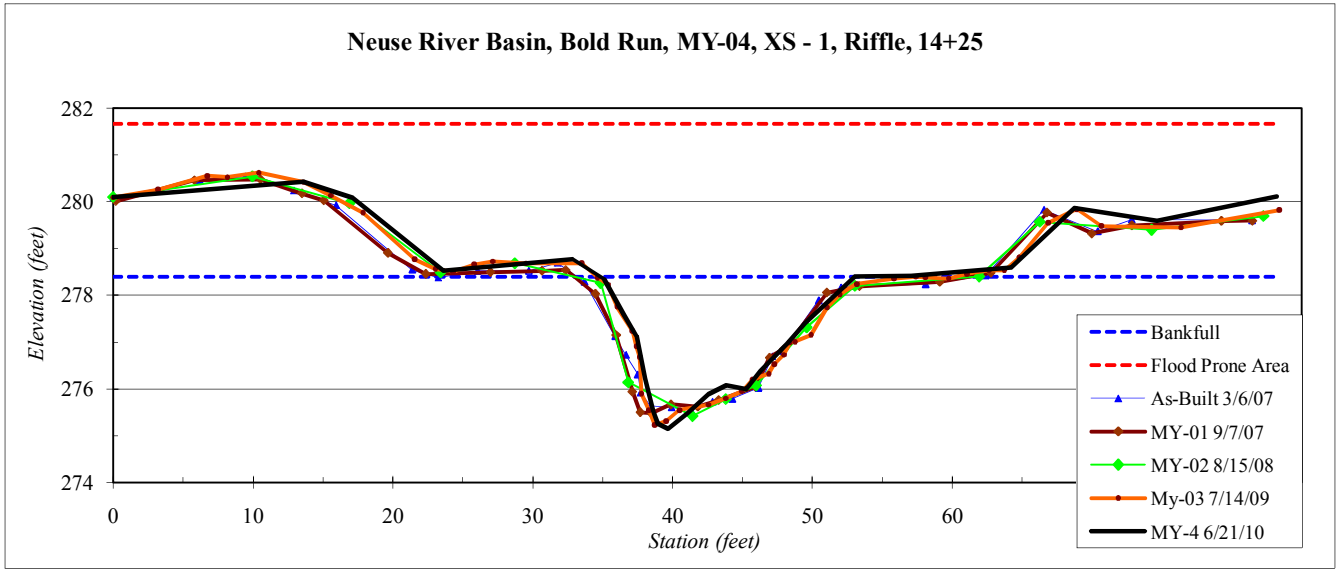
Bankfull Event Photo 3 showing evidence of overbank through wrack/debris lines on banks.

River Basin:	Neuse
Watershed:	Bold Run, MY-04
XS ID	XS - 1, Riffle, 14+25
Drainage Area (sq mi):	1.6
Date:	6/21/2010
Field Crew:	Dean, Perkinson

Station	Elevation
0.00	280.09
13.58	280.42
17.10	280.08
23.59	278.52
32.86	278.77
35.11	278.35
36.52	277.59
37.45	277.13
38.01	276.23
38.61	275.52
38.94	275.26
39.67	275.15
41.03	275.48
42.57	275.89
43.84	276.08
45.28	276.00
46.26	276.38
48.19	276.97
49.47	277.40
53.06	278.40
57.07	278.41
64.19	278.60
68.74	279.87
74.63	279.58
83.23	280.11

SUMMARY DATA	
Bankfull Elevation:	278.4
Bankfull Cross-Sectional Area:	31.1
Bankfull Width:	18.2
Flood Prone Area Elevation:	281.7
Flood Prone Width:	>80
Max Depth at Bankfull:	3.3
Mean Depth at Bankfull:	1.7
W / D Ratio:	10.7
Entrenchment Ratio:	>4
Bank Height Ratio:	1.0

Stream Type	E4

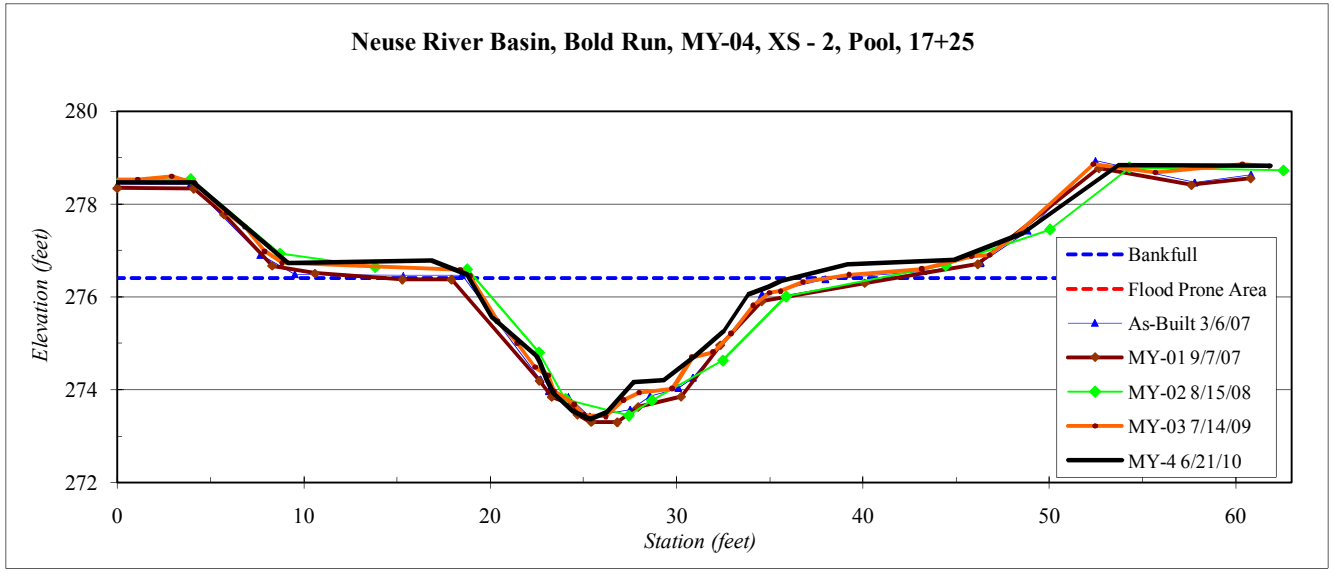


River Basin:	Neuse
Watershed:	Bold Run, MY-04
XS ID	XS - 2, Pool, 17+25
Drainage Area (sq mi):	1.6
Date:	6/21/2010
Field Crew:	Dean, Perkinson

Station	Elevation
-4.18	274.20
-4.08	278.47
4.08	278.47
9.14	276.73
16.86	276.78
18.77	276.48
20.12	275.55
22.49	274.73
22.65	274.60
23.04	274.22
23.42	273.92
23.76	273.79
24.40	273.55
25.37	273.37
26.24	273.51
27.69	274.16
29.31	274.20
30.95	274.72
32.53	275.27
33.84	276.05
34.95	276.22
35.58	276.34
39.18	276.70
44.91	276.80
48.62	277.38
53.73	278.84
61.88	278.82

SUMMARY DATA	
Bankfull Elevation:	276.4
Bankfull Cross-Sectional Area:	27.7
Bankfull Width:	17.4
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.0
Mean Depth at Bankfull:	1.6
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	E4

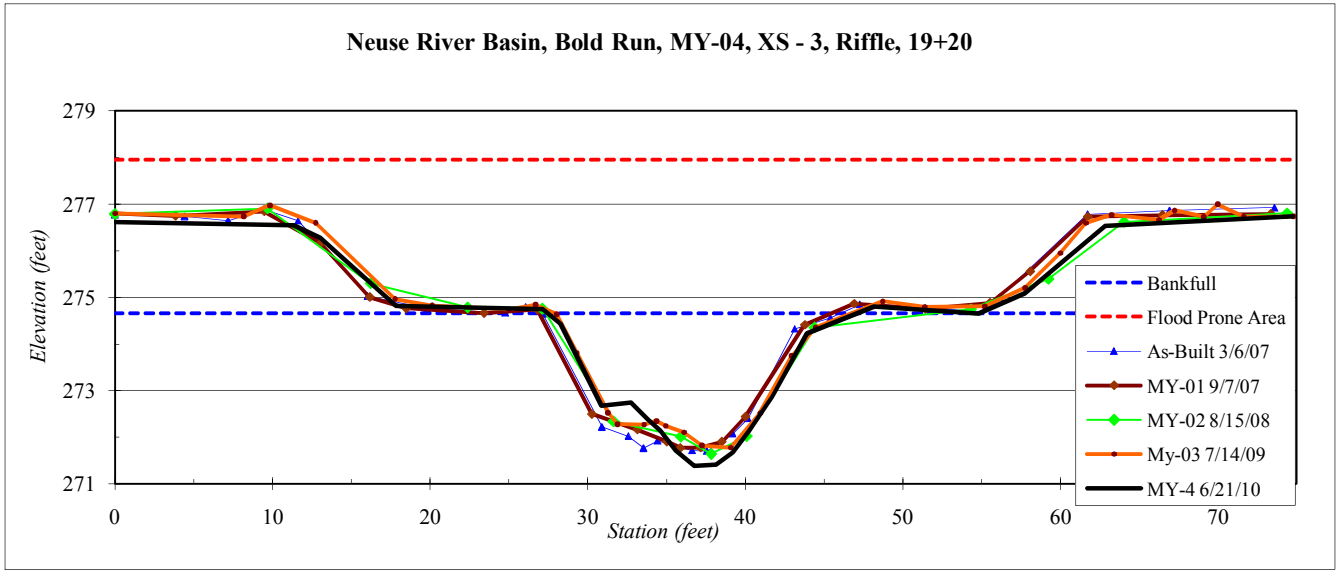


River Basin:	Neuse
Watershed:	Bold Run, MY-04
XS ID	XS - 3, Riffle, 19+20
Drainage Area (sq mi):	1.6
Date:	6/21/2010
Field Crew:	Dean, Perkinson

Station	Elevation
0.00	276.62
11.32	276.56
13.05	276.28
17.85	274.82
27.12	274.76
28.28	274.43
30.89	272.67
32.76	272.75
33.81	272.39
34.63	272.15
35.60	271.72
36.78	271.38
38.14	271.41
39.22	271.68
40.24	272.12
41.73	272.88
43.90	274.23
48.20	274.81
54.80	274.66
57.76	275.09
62.84	276.53
74.73	276.74

SUMMARY DATA	
Bankfull Elevation:	274.7
Bankfull Cross-Sectional Area:	34.0
Bankfull Width:	19.7
Flood Prone Area Elevation:	278.0
Flood Prone Width:	>74
Max Depth at Bankfull:	3.3
Mean Depth at Bankfull:	1.7
W / D Ratio:	11.4
Entrenchment Ratio:	>3
Bank Height Ratio:	1.0

Stream Type	E4

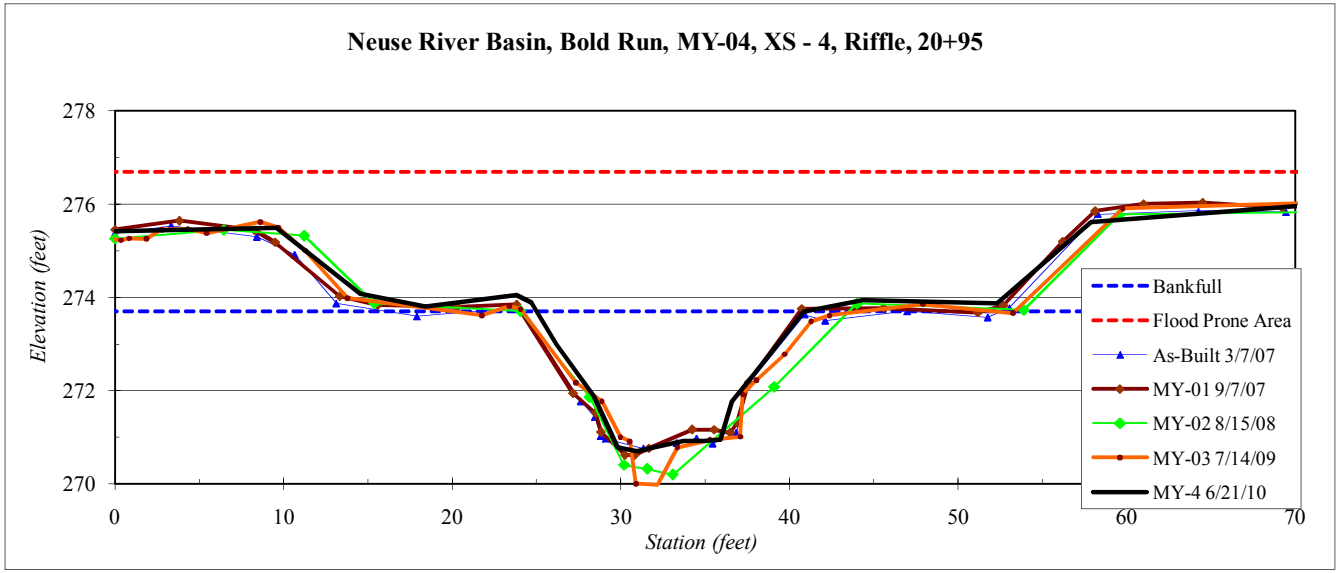


River Basin:	Neuse
Watershed:	Bold Run, MY-04
XS ID	XS - 4, Riffle, 20+95
Drainage Area (sq mi):	1.6
Date:	6/21/2010
Field Crew:	Dean, Perkinson

Station	Elevation
-1.3	275.4
9.6	275.5
14.6	274.1
18.4	273.8
23.8	274.1
24.7	273.9
26.2	273.0
28.4	271.9
29.8	270.8
30.9	270.7
33.7	270.9
35.0	270.9
35.9	270.9
36.6	271.8
38.4	272.6
40.9	273.7
44.4	273.9
52.3	273.9
57.9	275.6
73.0	276.0

SUMMARY DATA	
Bankfull Elevation:	273.7
Bankfull Cross-Sectional Area:	29.7
Bankfull Width:	15.8
Flood Prone Area Elevation:	276.7
Flood Prone Width:	>70
Max Depth at Bankfull:	3.0
Mean Depth at Bankfull:	1.9
W / D Ratio:	8.4
Entrenchment Ratio:	>4
Bank Height Ratio:	1.0

Stream Type	E4

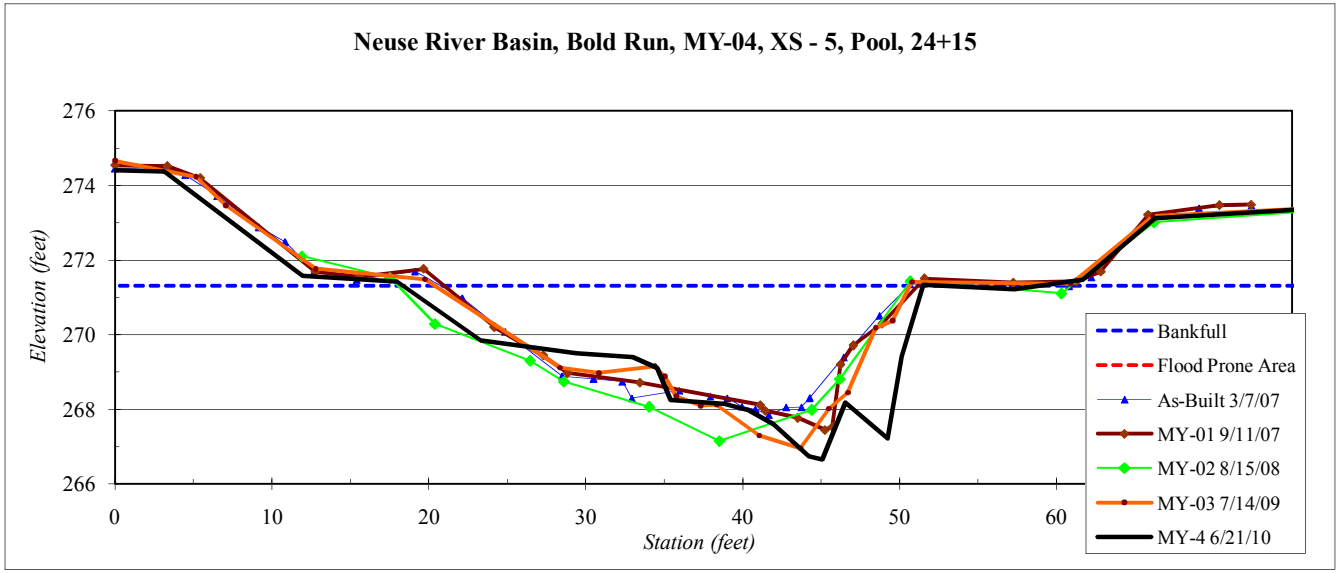


River Basin:	Neuse
Watershed:	Bold Run, MY-04
XS ID	XS - 5, Pool, 24+15
Drainage Area (sq mi):	1.6
Date:	6/21/2010
Field Crew:	Dean, Perkinson

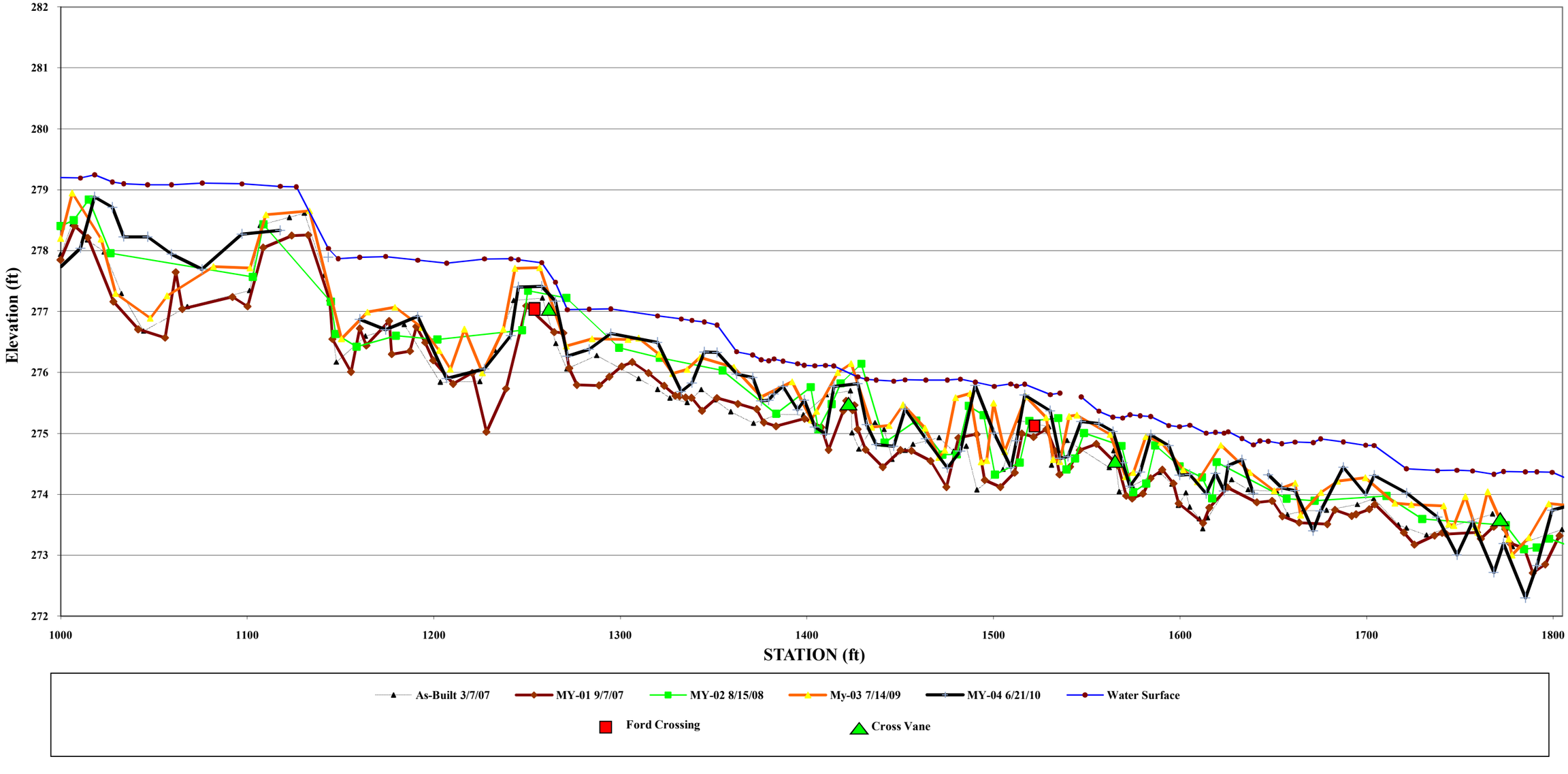
Station	Elevation
-1.7	274.4
3.1	274.4
12.0	271.6
18.0	271.4
23.3	269.8
29.4	269.5
33.0	269.4
34.5	269.1
35.4	268.2
38.8	268.2
40.4	268.0
42.0	267.6
44.2	266.7
45.1	266.7
46.5	268.2
49.2	267.2
50.1	269.4
51.5	271.3
57.3	271.2
61.7	271.5
66.3	273.1
77.7	273.4

SUMMARY DATA	
Bankfull Elevation:	271.3
Bankfull Cross-Sectional Area:	79.6
Bankfull Width:	33.1
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	4.7
Mean Depth at Bankfull:	2.4
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

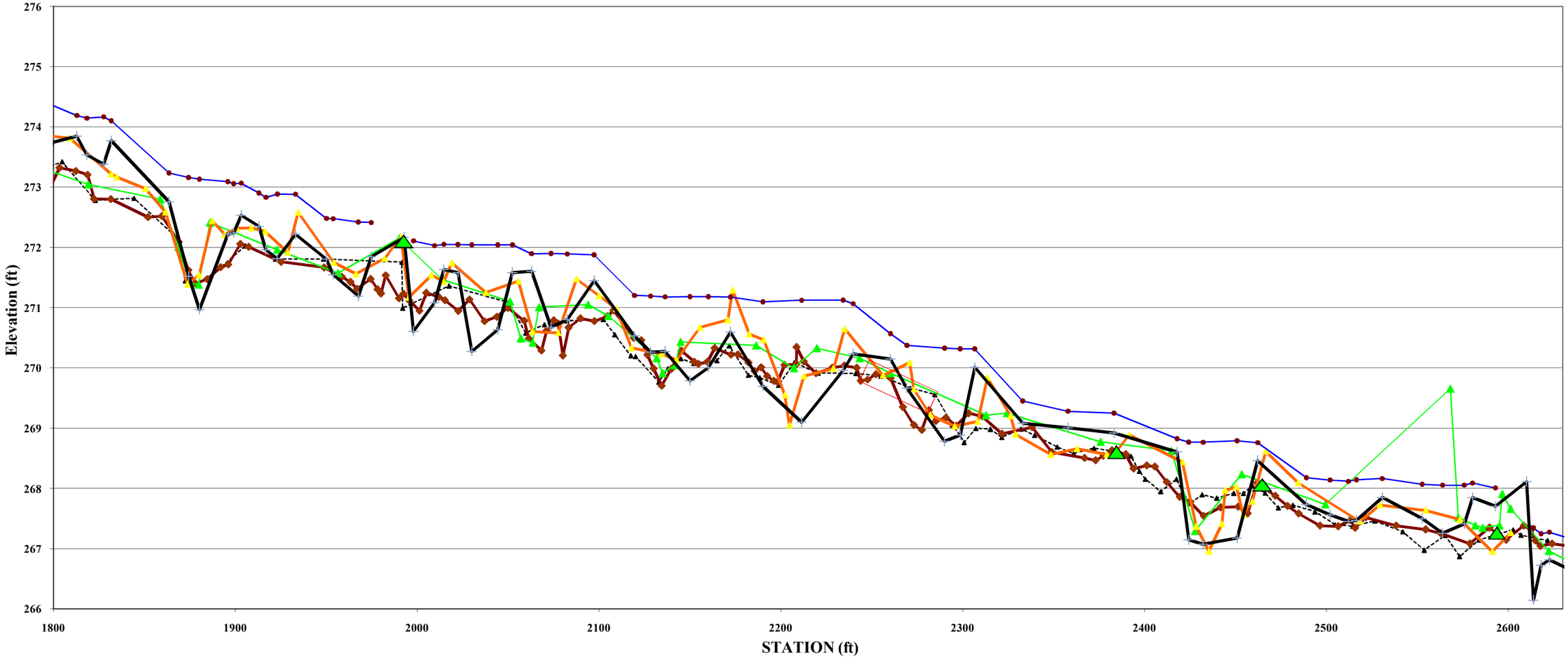
Stream Type	E4



Longitudinal Profile
Bold Run Creek
EEP Project Number 439 MY-04
Stations 10+00 - 18+00



Longitudinal Profile
Bold Run Creek
EEP Project Number 439 MY-04
Stations 18+00 - 26+30

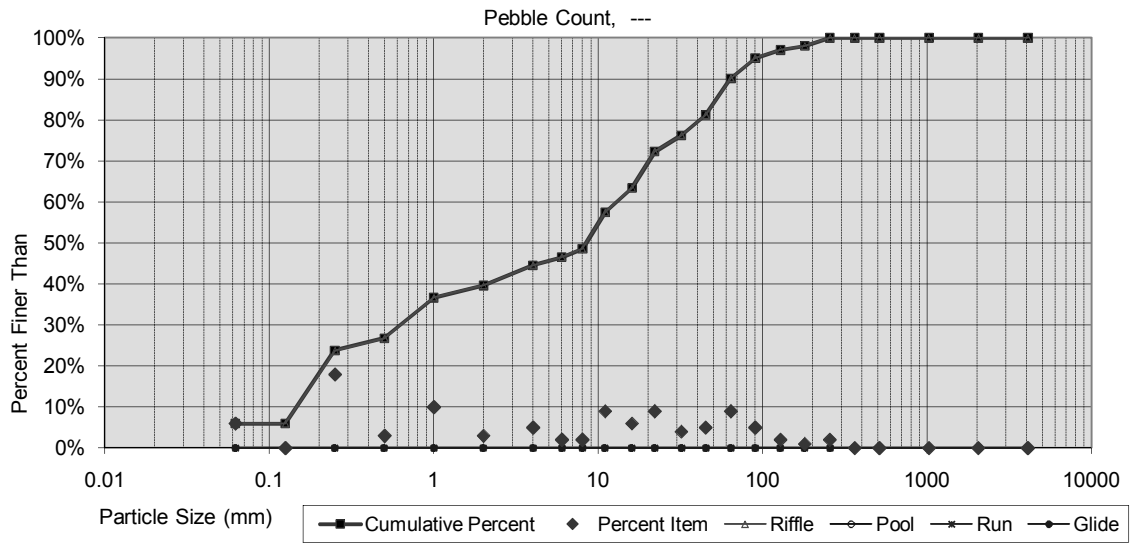


Weighted Pebble Count

Percent Riffle:	**100**	Percent Run:		Pebble Count,	
Percent Pool		Percent Glide:			

Material	Size Range (mm)		Total #		
silt/clay	0	0.062	5.9	#	#
very fine sand	0.062	0.13	0.0	#	#
fine sand	0.13	0.25	17.8	#	#
medium sand	0.25	0.5	3.0	#	#
coarse sand	0.5	1	9.9	#	#
very coarse sand	1	2	3.0	#	#
very fine gravel	2	4	5.0	#	#
fine gravel	4	6	2.0	#	#
fine gravel	6	8	2.0	#	#
medium gravel	8	11	8.9	#	#
medium gravel	11	16	5.9	#	#
coarse gravel	16	22	8.9	#	#
coarse gravel	22	32	4.0	#	#
very coarse gravel	32	45	5.0	#	#
very coarse gravel	45	64	8.9	#	#
small cobble	64	90	5.0	#	#
medium cobble	90	128	2.0	#	#
large cobble	128	180	1.0	#	#
very large cobble	180	256	2.0	#	#
small boulder	256	362	0.0	#	#
small boulder	362	512	0.0	#	#
medium boulder	512	1024	0.0	#	#
large boulder	1024	2048	0.0	#	#
very large boulder	2048	4096	0.0	#	#
bedrock			0.0	#	
		Weighted Count:	100		
		True Total Particle Count:	101		

Note: **Bold Run 2010 - XS 1**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.185	0.89	8.4	50	90	6%	34%	50%	10%	0%	0%

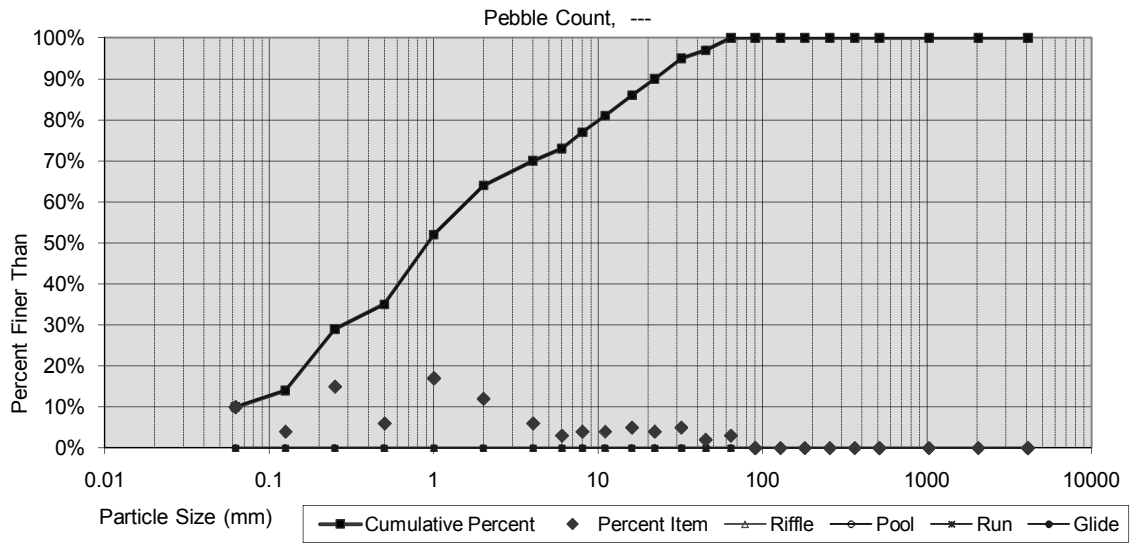
Weighted Pebble Count

Percent Riffle:		Percent Run:	
Percent Pool:	**100**	Percent Glide:	

Pebble Count,

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	10.0	# #
very fine sand	0.062	0.13	4.0	# #
fine sand	0.13	0.25	15.0	# #
medium sand	0.25	0.5	6.0	# #
coarse sand	0.5	1	17.0	# #
very coarse sand	1	2	12.0	# #
very fine gravel	2	4	6.0	# #
fine gravel	4	6	3.0	# #
fine gravel	6	8	4.0	# #
medium gravel	8	11	4.0	# #
medium gravel	11	16	5.0	# #
coarse gravel	16	22	4.0	# #
coarse gravel	22	32	5.0	# #
very coarse gravel	32	45	2.0	# #
very coarse gravel	45	64	3.0	# #
small cobble	64	90	0.0	# #
medium cobble	90	128	0.0	# #
large cobble	128	180	0.0	# #
very large cobble	180	256	0.0	# #
small boulder	256	362	0.0	# #
small boulder	362	512	0.0	# #
medium boulder	512	1024	0.0	# #
large boulder	1024	2048	0.0	# #
very large boulder	2048	4096	0.0	# #
bedrock			0.0	#
		Weighted Count:	100	
		True Total Particle Count:	100	

Note: **Bold Run 2010 - XS 2**



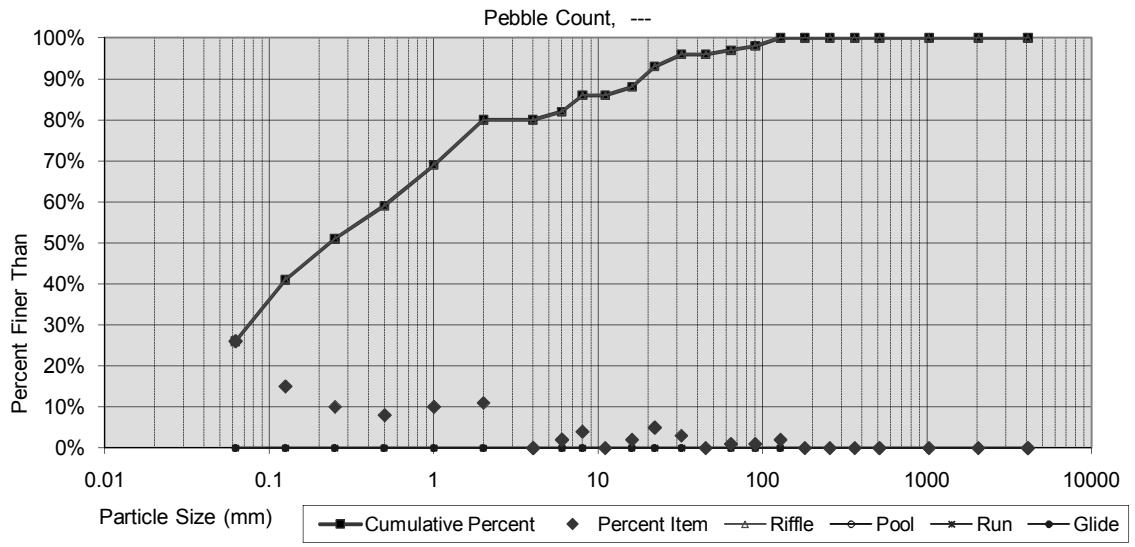
Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.137	0.50	0.9	14	32	10%	54%	36%	0%	0%	0%

Weighted Pebble Count

Percent Riffle:	**100**	Percent Run:		Pebble Count,	
Percent Pool		Percent Glide:			

Material	Size Range (mm)		Total #		
silt/clay	0	0.062	26.0	#	#
very fine sand	0.062	0.13	15.0	#	#
fine sand	0.13	0.25	10.0	#	#
medium sand	0.25	0.5	8.0	#	#
coarse sand	0.5	1	10.0	#	#
very coarse sand	1	2	11.0	#	#
very fine gravel	2	4	0.0	#	#
fine gravel	4	6	2.0	#	#
fine gravel	6	8	4.0	#	#
medium gravel	8	11	0.0	#	#
medium gravel	11	16	2.0	#	#
coarse gravel	16	22	5.0	#	#
coarse gravel	22	32	3.0	#	#
very coarse gravel	32	45	0.0	#	#
very coarse gravel	45	64	1.0	#	#
small cobble	64	90	1.0	#	#
medium cobble	90	128	2.0	#	#
large cobble	128	180	0.0	#	#
very large cobble	180	256	0.0	#	#
small boulder	256	362	0.0	#	#
small boulder	362	512	0.0	#	#
medium boulder	512	1024	0.0	#	#
large boulder	1024	2048	0.0	#	#
very large boulder	2048	4096	0.0	#	#
bedrock			0.0	#	
		Weighted Count:	100		
		True Total Particle Count:	100		

Note: **Bold Run 2010 - XS 3**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.09	0.2	7	28	26%	54%	17%	3%	0%	0%

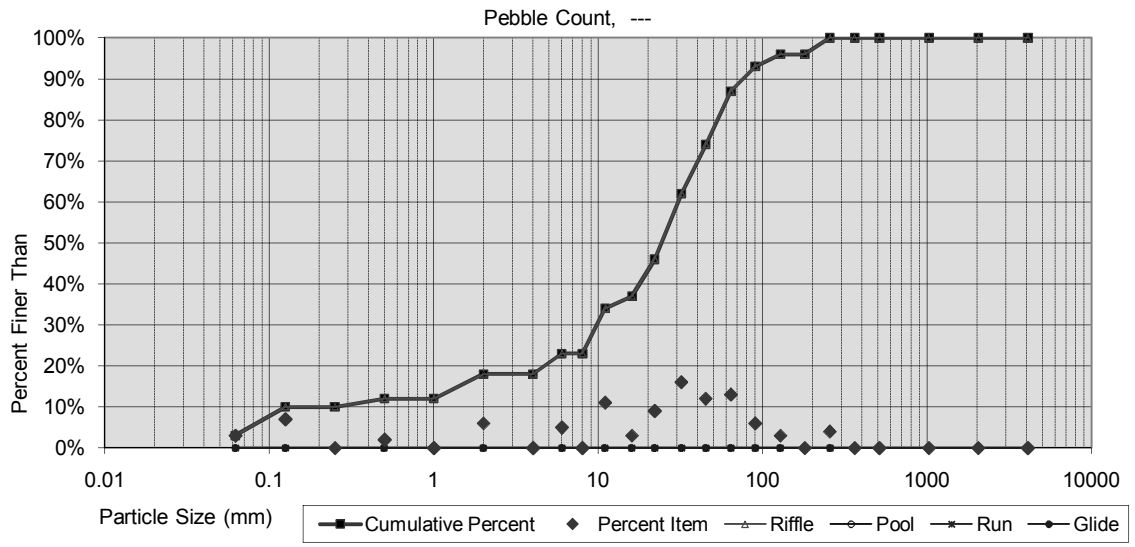
Weighted Pebble Count

Percent Riffle:	**100**	Percent Run:	
Percent Pool		Percent Glide:	

Pebble Count,

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	3.0	# #
very fine sand	0.062	0.13	7.0	# #
fine sand	0.13	0.25	0.0	# #
medium sand	0.25	0.5	2.0	# #
coarse sand	0.5	1	0.0	# #
very coarse sand	1	2	6.0	# #
very fine gravel	2	4	0.0	# #
fine gravel	4	6	5.0	# #
fine gravel	6	8	0.0	# #
medium gravel	8	11	11.0	# #
medium gravel	11	16	3.0	# #
coarse gravel	16	22	9.0	# #
coarse gravel	22	32	16.0	# #
very coarse gravel	32	45	12.0	# #
very coarse gravel	45	64	13.0	# #
small cobble	64	90	6.0	# #
medium cobble	90	128	3.0	# #
large cobble	128	180	0.0	# #
very large cobble	180	256	4.0	# #
small boulder	256	362	0.0	# #
small boulder	362	512	0.0	# #
medium boulder	512	1024	0.0	# #
large boulder	1024	2048	0.0	# #
very large boulder	2048	4096	0.0	# #
bedrock			0.0	#
		Weighted Count:	100	
		True Total Particle Count:	100	

Note: **Bold Run 2010 - XS 4**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
1.587	12.46	24.2	59	114	3%	15%	69%	13%	0%	0%

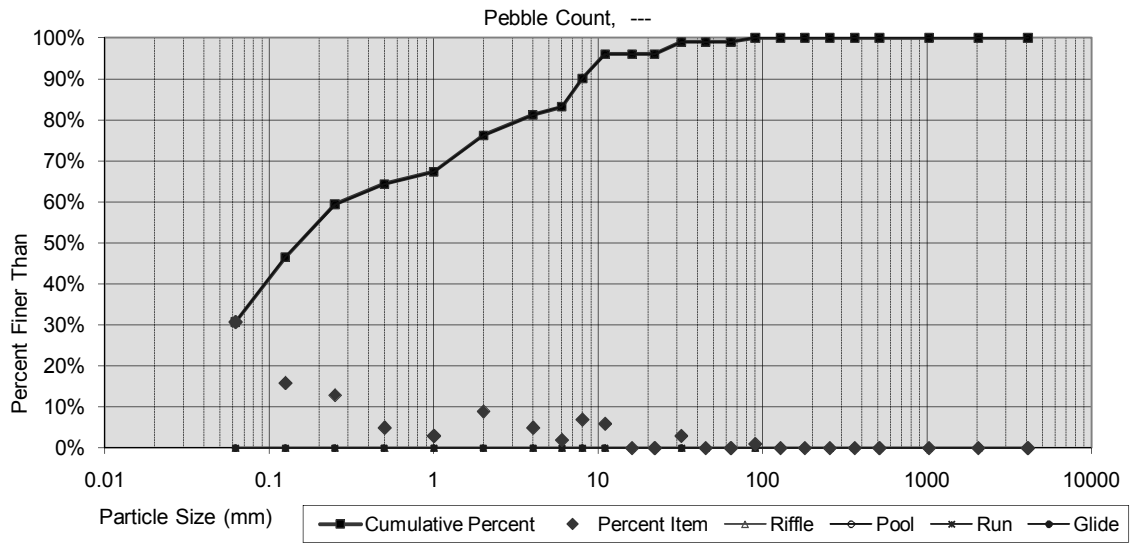
Weighted Pebble Count

Percent Riffle:		Percent Run:	
Percent Pool:	**100**	Percent Glide:	

Pebble Count,

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	30.7	# #
very fine sand	0.062	0.13	15.8	# #
fine sand	0.13	0.25	12.9	# #
medium sand	0.25	0.5	5.0	# #
coarse sand	0.5	1	3.0	# #
very coarse sand	1	2	8.9	# #
very fine gravel	2	4	5.0	# #
fine gravel	4	6	2.0	# #
fine gravel	6	8	6.9	# #
medium gravel	8	11	5.9	# #
medium gravel	11	16	0.0	# #
coarse gravel	16	22	0.0	# #
coarse gravel	22	32	3.0	# #
very coarse gravel	32	45	0.0	# #
very coarse gravel	45	64	0.0	# #
small cobble	64	90	1.0	# #
medium cobble	90	128	0.0	# #
large cobble	128	180	0.0	# #
very large cobble	180	256	0.0	# #
small boulder	256	362	0.0	# #
small boulder	362	512	0.0	# #
medium boulder	512	1024	0.0	# #
large boulder	1024	2048	0.0	# #
very large boulder	2048	4096	0.0	# #
bedrock			0.0	#
		Weighted Count:	100	
		True Total Particle Count:	101	

Note: **Bold Run 2010 - XS 5**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.08	0.2	6	10	31%	46%	23%	1%	0%	0%