ANNUAL MONITORING REPORT
GOOSE CREEK

STREAM RESTORATION
DURHAM COUNTY, NORTH CAROLINA
(EEP Project Number 147)

Monitoring Year 1 of 5 (2009)

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

November 2009

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Prepared by:
Axiom Environmental, Inc.
20 Enterprise Street, Suite 7
Raleigh, North Carolina 27607

Design Firm:
Biohabitats
8218 Creedmoor Road
Raleigh, North Carolina 27613

Axiom Environmental, Inc.

Ecosystem Enhancement PROGRAM

November 2009

1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

The Goose Creek Stream Restoration Site (Site) is located in the City of Durham, North Carolina in a highly developed watershed (Figure 1, Appendix A). Goose Creek is part of the Neuse River Basin (Upper Neuse, Subbasin 03-04-01) and is located in USGS Cataloging Unit 03020201. The preproject stream was highly modified and artificially confined by concrete on the channel and banks upstream and by rock walls downstream. The goals of the project were to eradicate artificial hardening structures, restore a more natural channel geometry and riparian buffer. Project restoration efforts provided 1465 linear feet of stream restoration and 1.4 acres of riparian buffer restoration. This report summarizes data for year 1 (2009) monitoring.

The goals of the Goose Creek stream restoration project were:

- To improve aquatic habitat by removing the fabriform channel liner on the Eastway Elementary School reach and the stone retaining walls on the Longmeadow Park reach and reintroducing a more defined and natural riffle/pool channel geometry sequence.
- To improve water quality by reducing nutrient loading from adjacent developed properties through restoration of a riparian buffer.
- To improve terrestrial habitat by restoring a riparian buffer.
- To decrease sediment and nutrient content of stormwater flow originating in the Barnes Street Redevelopment project site, which flows through the Site and into Goose Creek, through the means of a re-configured stormwater channel which slows stormwater flow, allowing sediment to settle and nutrients to be absorbed by planted vegetation.

Goals were accomplished by constructing a natural, stable profile and dimension for the stream channel and reestablishing a continuous riparian buffer along the stream banks. Project implementation has greatly increased the prominence of riffles and pools in the reach and improved aquatic habitat.

Success criteria dictate that an average density of 320 stems per acre 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 455 planted stems per acre surviving in year 1 (2009). The dominant species identified at the Site were planted stems of green ash (*Fraxinus pennsylvanica*), tulip tree (*Liriodendron tulipifera*), and sycamore (*Platanus occidentalis*). In addition, each individual plot met success criteria when counting planted stems alone with the exception of Plot 2, which was one stem shy; however, when including appropriate naturally recruited stems this plot was also well-above success criteria.

Success criteria for stream restoration reaches dictate that little to no change from the as-built channel over the five-year monitoring period. Year 1 (2009) monitoring measurements indicate that there have been minimal changes in cross-sections and profile downstream of Liberty Street as compared to as-built data. Profile upstream of Liberty Street was designed to adjust itself to changes in watershed flows. One bankfull event was documented to occur on November 11, 2009 during the year 1 (2009) monitoring period as the result of Tropical Storm Ida. Noted problem areas within the Site include an area of bank erosion on the right bank just downstream of Cross-section 7 and Cross-section 5, which was originally intended to be a pool, was functioning like a riffle (Figure 2, Appendix A).

In summary, the Site achieved success criteria for vegetation and stream attributes in the First Monitoring Year (2009). 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 tables 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.

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2.0 METHODOLOGY

2.1 Vegetation Assessment

Following Site construction, four plots (10-meters square) were established and monumented with metal rebar at all plot corners. Plots were surveyed in September 2009 for the year 1 (2009) 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

Eight 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

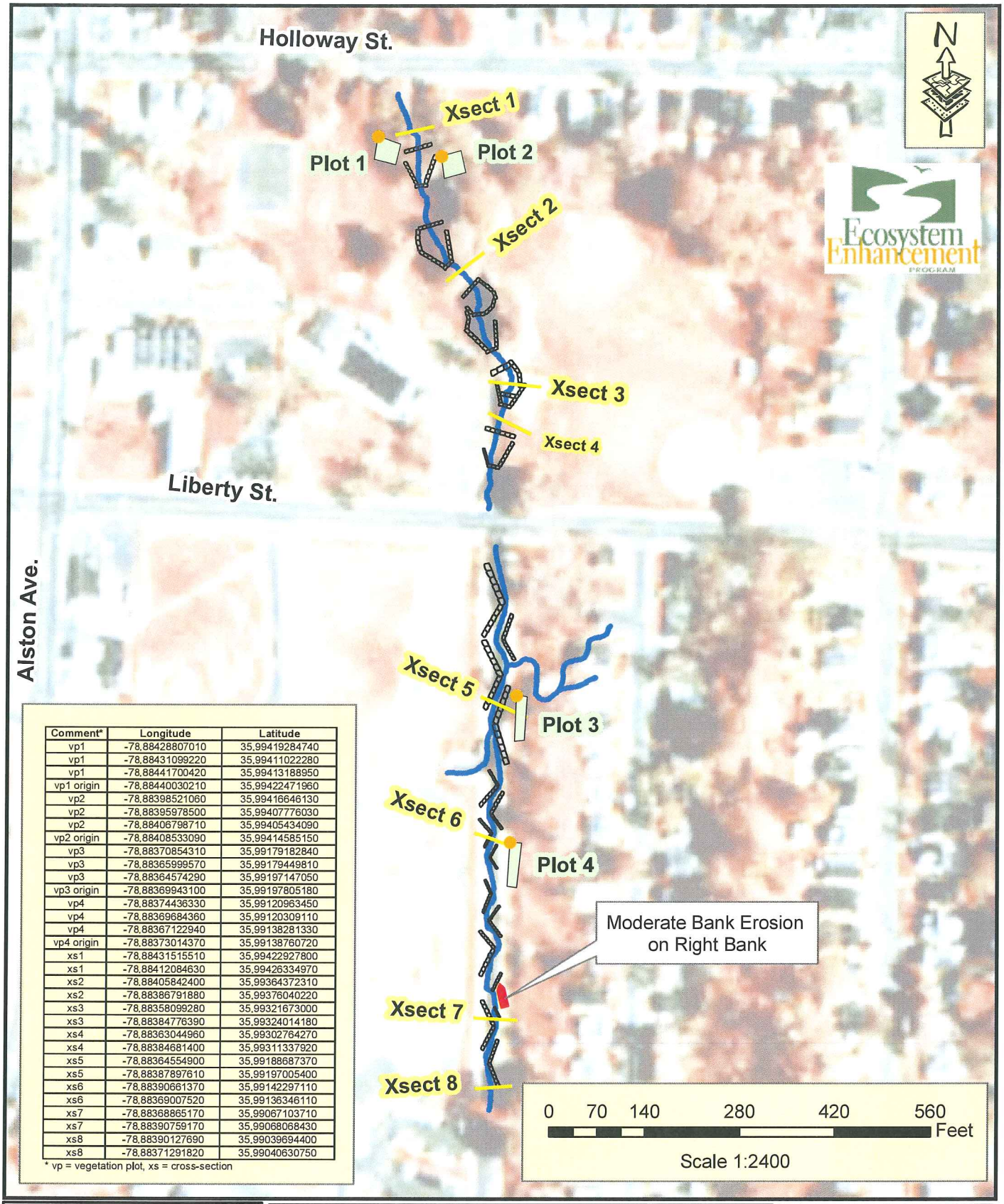
Figure 2. Monitoring Plan View

Axiom Environmental, Inc.
Axiom Environmental
20 Enterprise Street
Suite 7
Raleigh, NC 27607
(919) 215-1693

SITE LOCATION MAP
GOOSE CREEK SITE
EEP PROJECT NUMBER 147
Durham County, North Carolina

Dwn. by:	CLF
Date:	NOV 2009
Project:	08-001

FIGURE
1



Comment*	Longitude	Latitude
vp1	-78.88428807010	35.99419284740
vp1	-78.88431099220	35.99411022280
vp1	-78.88441700420	35.99413188950
vp1 origin	-78.88440030210	35.99422471960
vp2	-78.88398521060	35.99416646130
vp2	-78.88395978500	35.99407776030
vp2	-78.88406798710	35.99405434090
vp2 origin	-78.88408533090	35.99414585150
vp3	-78.88370854310	35.99179182840
vp3	-78.88365999570	35.99179449810
vp3	-78.88364574290	35.99197147050
vp3 origin	-78.88369943100	35.99197805180
vp4	-78.88374436330	35.99120963450
vp4	-78.88369684360	35.99120309110
vp4	-78.88367122940	35.99138281330
vp4 origin	-78.88373014370	35.99138760720
xs1	-78.88431515510	35.99422927800
xs1	-78.88412084630	35.99426334970
xs2	-78.88405842400	35.99364372310
xs2	-78.88386791880	35.99376040220
xs3	-78.88358099280	35.99321673000
xs3	-78.88384776390	35.99324014180
xs4	-78.88363044960	35.99302764270
xs4	-78.88384681400	35.99311337920
xs5	-78.88364554900	35.99188687370
xs5	-78.88387897610	35.99197005400
xs6	-78.88390661370	35.99142297110
xs6	-78.88369007520	35.99136346110
xs7	-78.88368865170	35.99067103710
xs7	-78.88390759170	35.99068068430
xs8	-78.88390127690	35.99039694400
xs8	-78.88371291820	35.99040630750

* vp = vegetation plot, xs = cross-section

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Axiom Environmental
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Suite 7
Raleigh, NC 27607
(919) 215-1693

MONITORING PLAN VIEW
GOOSE CREEK SITE
EEP PROJECT NUMBER 147
Durham County, North Carolina

Dwn. by.	CLF
Date:	NOV 2009
Project:	08-001

FIGURE 2

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
Goose Creek Restoration Site (EEP Project Number 147)

Reach	Pre-Project Length (ft)	Stationing	Restoration Level	Approach	Planted Easement Acreage	Buffer Restoration (acres)*	Restoration Length (ft)**
Eastway Upstream	514	3+48-8+61	Restoration	P2	0.86	--	514
Eastway Downstream	347	0+00-3+47	Restoration	P2	1.4	0.6	347
Longmeadow Park Section	659	0+55-6+59	Restoration	P2	1.69	0.8	604
TOTALS	**1500**				**3.95**	**1.4**	**1465**

Component Summations		
Restoration Level	**Stream (ft)**	**Restoration Buffer Acreage***
Restoration	1465	1.4

*0.6 acres in Eastway downstream section and 0.8 acres in the Longmeadow Park Section; buffer restoration is to be used to mitigate for buffer impacts per the Neuse River Buffer Rules

**Restored length of Longmeadow reach does not include 55 feet of stream between the end of the project and the Holloway Street culvert that was not restored.

Table 2. Project Activity and Reporting History
Goose Creek Restoration Site (EEP Project Number 147)

Activity or Report	Data Collection Completion	Actual Completion or Delivery
Restoration Plan	July 2005	October 2005
Final Design-Construction Plans	November 2006	April 2008
Construction	--	September 2008
Permanent Seeding Completed	--	September 2008
As-Builts	October 2008	December 2008
Planting	--	February 2009
Mitigation Plan	March 2009	March 2009
Year 1 (2009) Monitoring	October 2009	November 2009

Table 3. Project Contacts Table
Goose Creek Restoration Site (EEP Project Number 147)

Designer Biohabitats, Inc	8918 Creedmoor Road, Suite 200 Raleigh, NC 27613 Kevin Nunnery 919-518-0311
Construction Contractor Shamrock Environmental, Inc	6106 Corporate Park Dr. Browns Summit, NC 27214 Dan Albert 336-375-1989
Survey Contractor Level Cross Surveying, PLLC	668 Marsh Country Lane Randleman, NC 23717 Sheri Willard 336-495-1713
Planting Contractor Southern Garden, Inc	1932 Holt Rd Cary, NC 27519 Todd Laakso 919-362-1050
Seed Mix Suppliers Green-Resource	1218 Management Way, Garner, NC 27529 Rodney Montgomery 919-779-4727
Planting Stock Suppliers Container Stock-Cure Nursery	880 Buteo Ridge Road Pittsboro, NC 27312 Bill Cure 919-542-6186
Balled in Burlap Taylor's Nursery	3705 New Bern Ave Raleigh, NC 27610 Richard Taylor 919 231-6161
Year 1 (2009) Monitoring Performer Axiom Environmental, Inc.	20 Enterprise Street, Suite 7 Raleigh, NC 27607 Grant Lewis (919) 215-1693

Table 4. Project Attribute Table
Goose Creek Restoration Site (EEP Project Number 147)

Project County	Durham		
Physiographic Region	Piedmont		
Ecoregion	Triassic Basin		
Project River Basin	Neuse		
USGS HUC for Project (14 digit)	3020201050010		
NCDWQ Sub-basin for Project	03-04-01		
Within extent of EEP Watershed Plan?	Ellerbe Creek Local Watershed Plan		
WRC Hab Class (Warm, Cool, Cold)	Warm		
% of project easement demarcated	~50		
Beaver activity observed?	No		
	Eastway upstream	Eastway downstream	Longmeadow
Drainage area	~350	396	481
Stream order	2	2	2
Restored length (feet)	514	347	604
Perennial or Intermittent	perennial	perennial	perennial
Watershed type (Rural, Urban, etc.)	urban	urban	urban
Watershed LULC Distribution (%)			
Urban-Low Intensity Developed		44	43
Urban-High Intensity Developed		22	22
Residential Urban		18	19
Forest, Herbaceous, Open Water		16	16
Watershed impervious cover (%)		~55	~54
NCDWQ AU/Index number	27-5-1	27-5-1	27-5-1
NCDWQ classification	WS-IV, NSW	WS-IV, NSW	WS-IV, NSW
303d listed?	no	no	no
Upstream of a 303d listed segment?	yes	yes	yes
Reasons for 303d listing or stressor	urban stormwater	urban stormwater	urban stormwater
Total acreage of easement		2.3	1.7
Rosgen classification of pre-existing	N/A	N/A	N/A
Rosgen classification of As-built	Bc5	Bc5	Bc5
Valley type/slope	N/A	N/A	N/A
Valley side slope range (e.g. 2-3.%)	10-15%	10-15%	10-15%
Valley toe slope range (e.g. 2-3.%)	3-5%	3-5%	3-5%
Dominant soil series/characteristics			
Series	Whitestore-Urban	Whitestore-Urban	Whitestore-Urban
Depth	60"	60"	60"
Clay%	5-70	5-70	5-70

Used N/A for items that may not apply. Use "-" for items that are unavailable and "U" for items that are unknown

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
Goose Creek Restoration Site (EEP Project Number 147)

Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean
1	Yes	100%
2	No	
3	Yes	
4	Yes	

Goose Creek Restoration Site
Year 1 (2009) Annual Monitoring
Vegetation Plot Photos (taken November 2009)

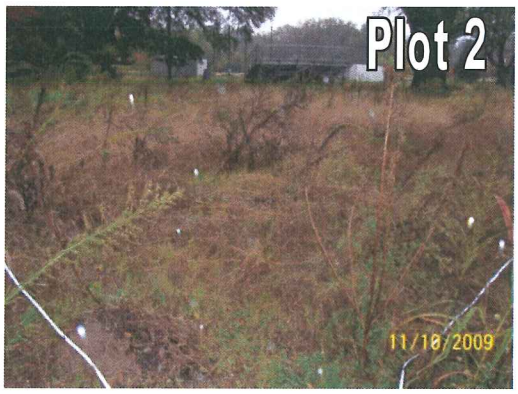


Table 6. Vegetation Metadata Table
Goose Creek Restoration Site (EEP Project Number 147)

Report Prepared By	Corri Faquin
Date Prepared	9/10/2009 15:01
database name	Axiom-2009-A-v2.2.7.mdb
database location	C:\Axiom\Business\CVS database
computer name	CORRILAPTOP
file size	52404224
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 PLANTED living stems of each species for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	147
project Name	Goose Creek
Description	
River Basin	Neuse
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	4

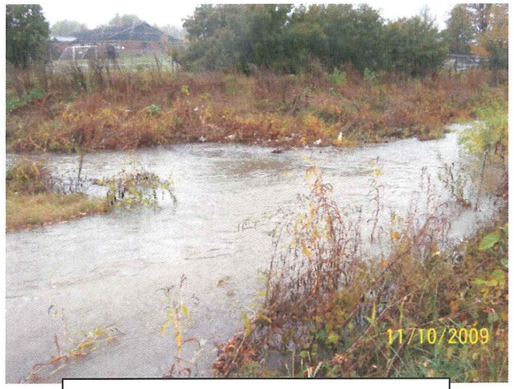
Table 7. Total and Planted Stems by Plot and Species
Goose Creek Restoration Site (EEP Project Number 147)

		Current Data (MY3 2009)								Annual Totals			
		plot 1		plot 2		plot 3		plot 4		Current Mean MY1 (2009)		Asbuilt	
Species	CommonName	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total stems	Planted stems	Total stems	Planted stems
Acer negundo	boxelder					1				1			
Acer rubrum	red maple	1	1							1	1	1	1
Acer saccharinum	sugar maple											2	2
Amelanchier arborea	common serviceberry	2	2			1	1			3	3	3	3
Betula nigra	river birch	1		1		1	1	2	1	5	2	11	11
Callicarpa americana	American beautyberry	2	2			1	1			3	3	3	3
Cephalanthus occidentalis	common buttonbush							1	1	1	1	10	10
Cercis canadensis	eastern redbud					1	1	1	1	2	2	3	3
Cornus	dogwood			1	1					1	1		
Fraxinus pennsylvanica	green ash	2		1		3	3	4	4	10	7		
Ilex decidua	possumhaw	2	1			1		1	1	4	2	7	7
Liriodendron tulipifera	tuliptree			4	4	1	1	5	5	10	10	10	10
Morus rubra	red mulberry					17		3		20			
Oxydendrum arboreum	sourwood	1	1	2		1	1			4	2		4
Platanus occidentalis	American sycamore			4	1			4	4	8	5	6	6
Prunus serotina	black cherry			1	1					1	1	1	1
Quercus phellos	willow oak					2	2	2	2	4	4	3	3
unknown	unknown											1	1
Viburnum dentatum	southern arrowwood	1	1							1	1		
Plot area (acres)		0.0247		0.0247		0.0247		0.0247					
Species Count		**8**	**6**	**7**	**4**	**11**	**8**	**9**	**8**	**17**	**15**	**13**	**14**
Stem Count		**12**	**8**	**14**	**7**	**30**	**11**	**23**	**19**	**79**	**45**	**61**	**65**
Stems per acre		**486**	**324**	**567**	**283**	**1215**	**445**	**931**	**769**	**800**	**455**	**617**	**658**

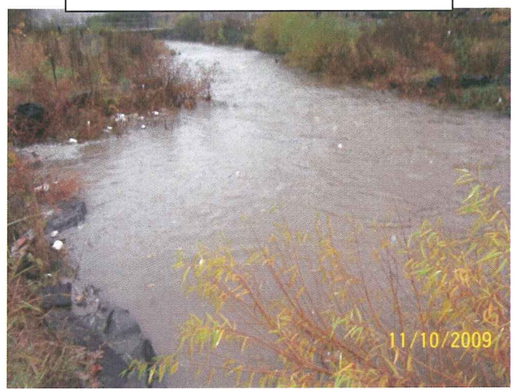
Table 8. Verification of Bankfull Events

Goose Creek Restoration Site (EEP Project Number 147)

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
November 11, 2009	November 11, 2009	Visual observation of overbank as the result of Tropical Storm Ida	1-2



Bankfull Event Photos 1-2 showing an overbank event.

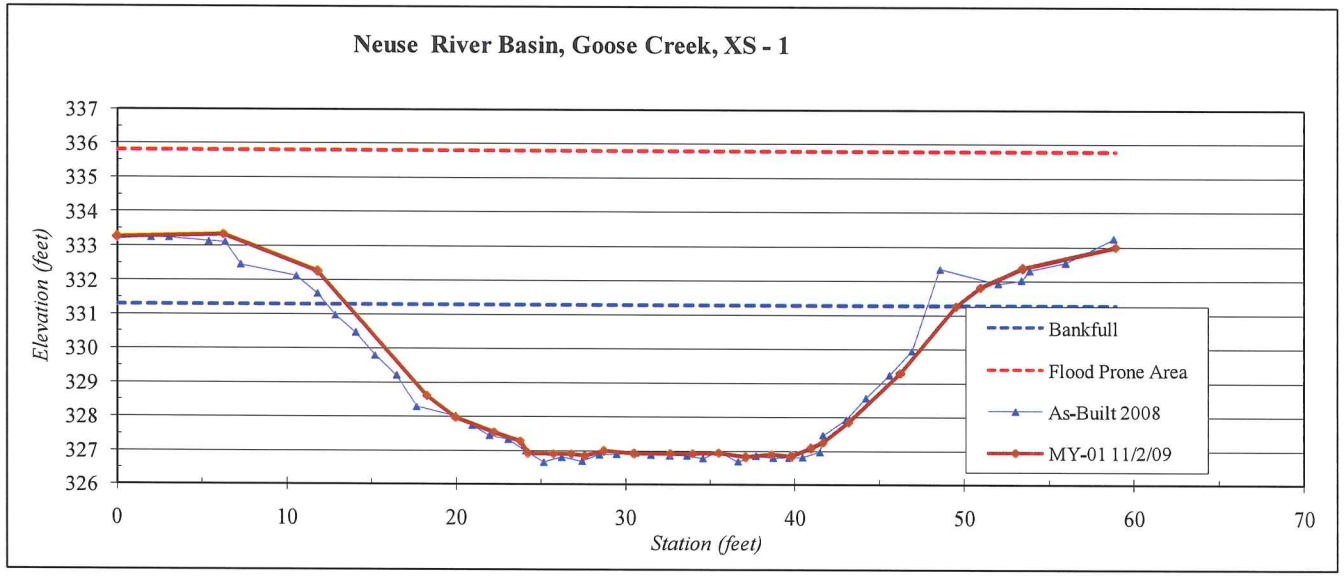


River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 1
Feature	Riffle
Date:	11/6/2008
Field Crew:	Dean, Perkinson

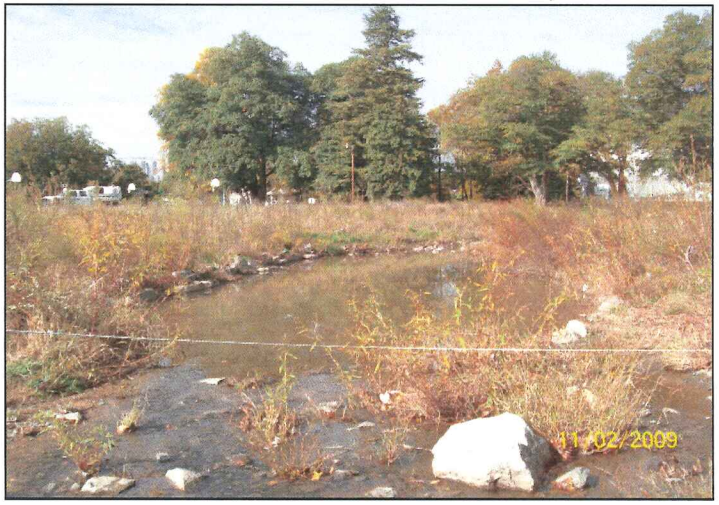
Station	Elevation
0.0	333.25
6.3	333.34
11.8	332.26
18.3	328.62
20.0	327.98
22.2	327.54
23.8	327.29
24.2	326.92
25.7	326.91
26.8	326.92
27.6	326.85
28.7	327.00
30.5	326.92
32.7	326.93
34.0	326.93
35.5	326.96
37.1	326.8
38.6	326.9
39.8	326.8
40.9	327.1
41.6	327.3
43.2	327.9
46.3	329.3
49.5	331.3
51.0	331.8
53.5	332.4
58.9	333.0

SUMMARY DATA	
Bankfull Elevation:	331.3
Bankfull Cross-Sectional Area:	120.9
Bankfull Width:	36.1
Flood Prone Area Elevation:	335.8
Flood Prone Width:	170.0
Max Depth at Bankfull:	4.5
Mean Depth at Bankfull:	3.3
W / D Ratio:	10.8
Entrenchment Ratio:	4.7
Bank Height Ratio:	1.0

Stream Type	E



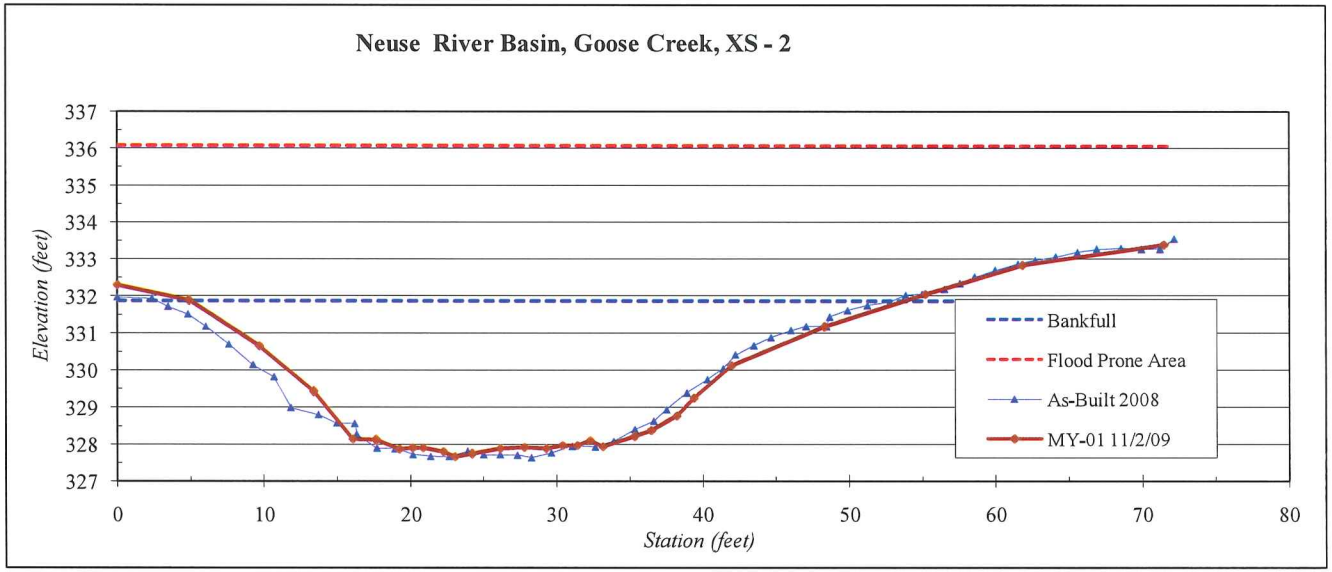
River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 2
Feature	Riffle
Date:	11/2/2009
Field Crew:	Dean, Perkinson



Station	Elevation
0.0	332.3
4.9	331.9
9.7	330.7
13.4	329.4
16.0	328.1
17.6	328.1
19.2	327.9
20.2	327.9
20.9	327.9
22.2	327.8
23.0	327.7
24.2	327.7
26.1	327.9
27.8	327.9
29.3	327.9
30.4	328.0
31.4	328.0
32.3	328.1
33.1	327.9
35.3	328.2
36.5	328.4
38.2	328.8
39.4	329.3
41.9	330.1
48.3	331.2
55.2	332.1
61.8	332.9
71.5	333.4

SUMMARY DATA	
Bankfull Elevation:	331.9
Bankfull Cross-Sectional Area:	122.1
Bankfull Width:	48.8
Flood Prone Area Elevation:	336.1
Flood Prone Width:	300.0
Max Depth at Bankfull:	4.2
Mean Depth at Bankfull:	2.5
W / D Ratio:	19.5
Entrenchment Ratio:	6.1
Bank Height Ratio:	1.0

Stream Type	E/C

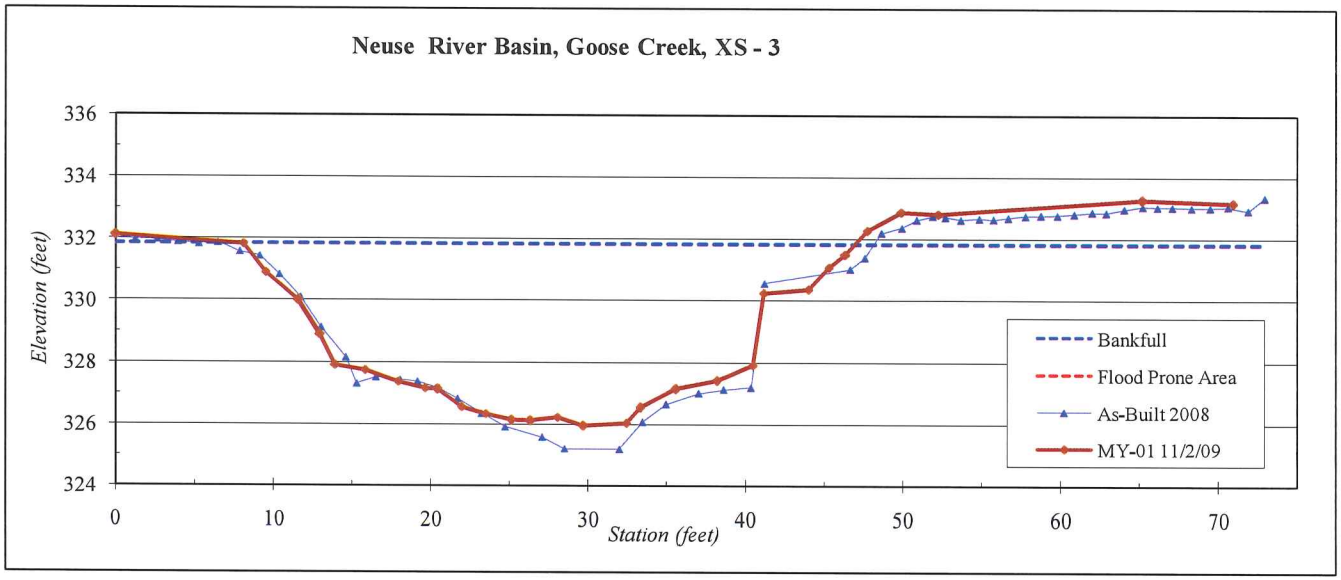


River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 3
Feature	Pool
Date:	11/2/2009
Field Crew:	Dean, Perkinson

Station	Elevation
0.0	332.1
8.1	331.8
9.5	330.9
11.6	330.0
13.0	328.9
13.9	327.9
15.8	327.7
17.9	327.4
19.6	327.2
20.4	327.1
22.0	326.6
23.5	326.3
25.1	326.1
26.3	326.1
28.0	326.2
29.7	326.0
32.4	326.1
33.3	326.6
35.6	327.2
38.2	327.4
40.5	327.9
41.2	330.3
44.0	330.4
45.3	331.1
46.3	331.5
47.7	332.3
49.9	332.9
52.3	332.8
65.2	333.3
70.9	333.2

SUMMARY DATA	
Bankfull Elevation:	331.8
Bankfull Cross-Sectional Area:	150.7
Bankfull Width:	38.9
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	5.9
Mean Depth at Bankfull:	3.9
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

Stream Type	-

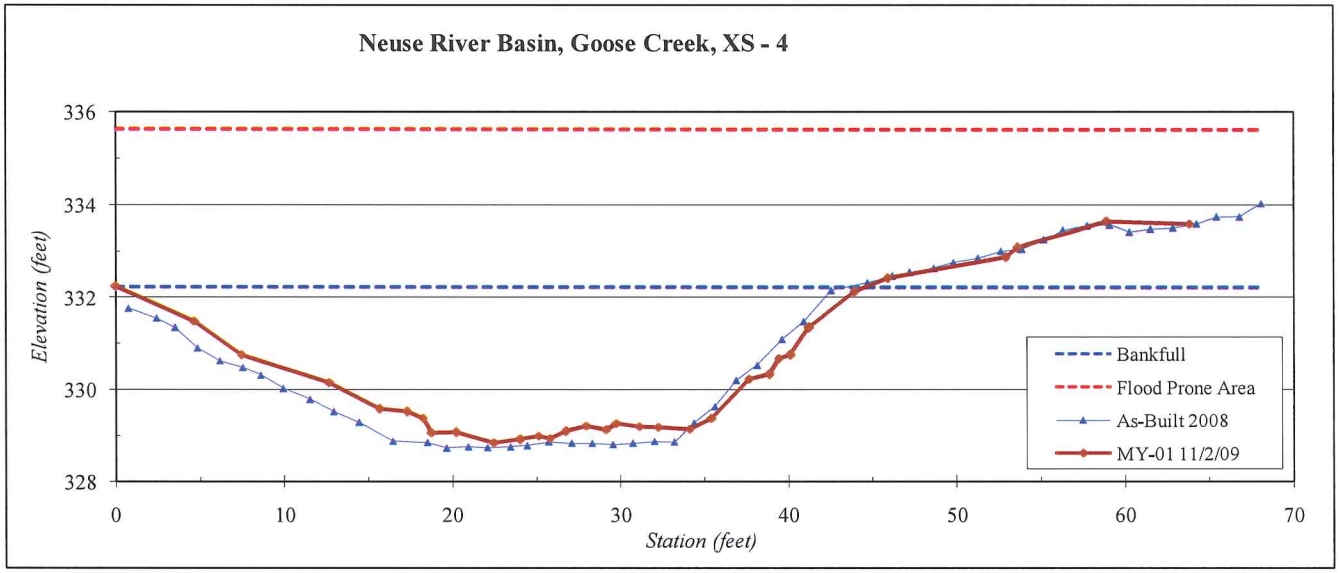


River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 4
Featuer	Riffle
Date:	11/2/2009
Field Crew:	Dean, Perkinson

Station	Elevation
0.0	332.2
4.7	331.5
7.5	330.8
12.7	330.2
15.7	329.6
17.3	329.5
18.2	329.4
18.8	329.1
20.2	329.1
22.5	328.8
24.0	328.9
25.1	329.0
25.8	328.9
26.7	329.1
28.0	329.2
29.2	329.1
29.8	329.3
31.1	329.2
32.3	329.2
34.1	329.1
35.4	329.4
37.6	330.2
38.9	330.3
39.4	330.7
40.1	330.8
41.2	331.4
43.9	332.1
45.9	332.4
52.9	332.9
53.6	333.1
58.9	333.6
63.8	333.6

SUMMARY DATA	
Bankfull Elevation:	332.2
Bankfull Cross-Sectional Area:	94.3
Bankfull Width:	44.5
Flood Prone Area Elevation:	335.6
Flood Prone Width:	240.0
Max Depth at Bankfull:	3.4
Mean Depth at Bankfull:	2.1
W / D Ratio:	21.0
Entrenchment Ratio:	5.4
Bank Height Ratio:	1.0

Stream Type	C

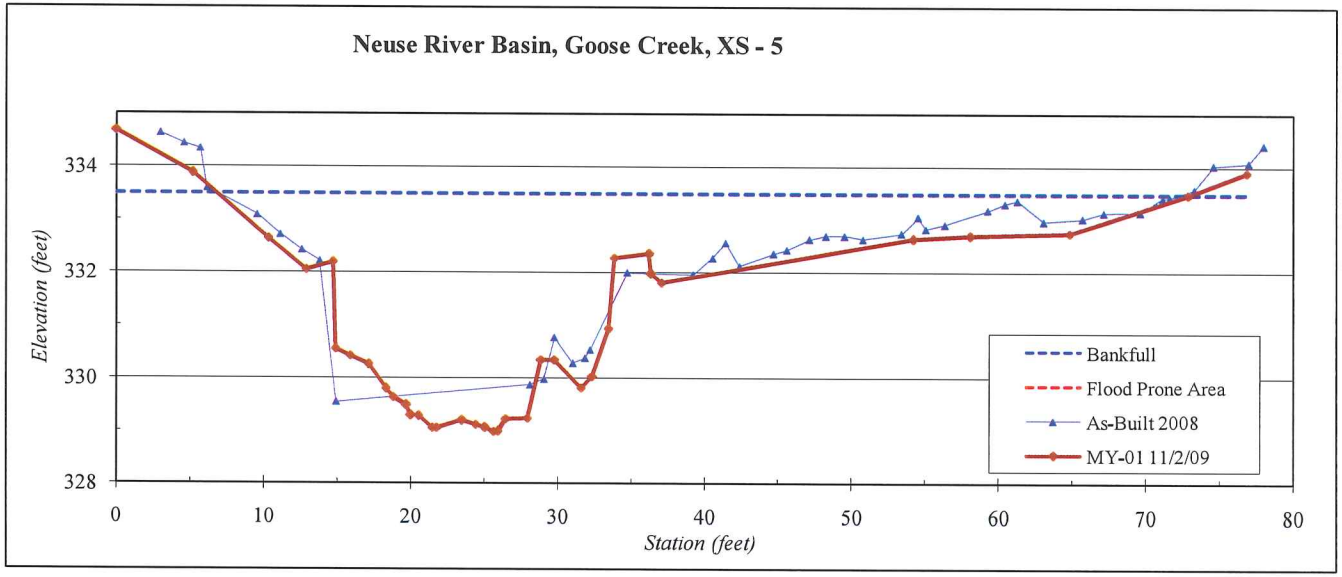


River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 5
Feature	Pool
Date:	11/2/2009
Field Crew:	Dean, Perkinson

Station	Elevation
0.0	334.7
5.2	333.9
10.3	332.6
12.9	332.0
14.7	332.2
14.9	330.6
15.9	330.4
17.2	330.3
18.3	329.8
18.8	329.6
19.7	329.5
20.0	329.3
20.6	329.3
21.5	329.1
21.8	329.1
23.5	329.2
24.4	329.1
25.1	329.1
25.6	329.0
26.0	329.0
26.5	329.2
28.0	329.2
28.9	330.3
29.8	330.3
31.6	329.8
32.4	330.0
33.5	330.9
33.9	332.3
36.2	332.4
36.4	332.0
37.1	331.8
54.2	332.6
58.1	332.7
64.8	332.8
72.9	333.5
76.8	333.9

SUMMARY DATA	
Bankfull Elevation:	333.5
Bankfull Cross-Sectional Area:	115.7
Bankfull Width:	66.1
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	4.5
Mean Depth at Bankfull:	1.8
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	-

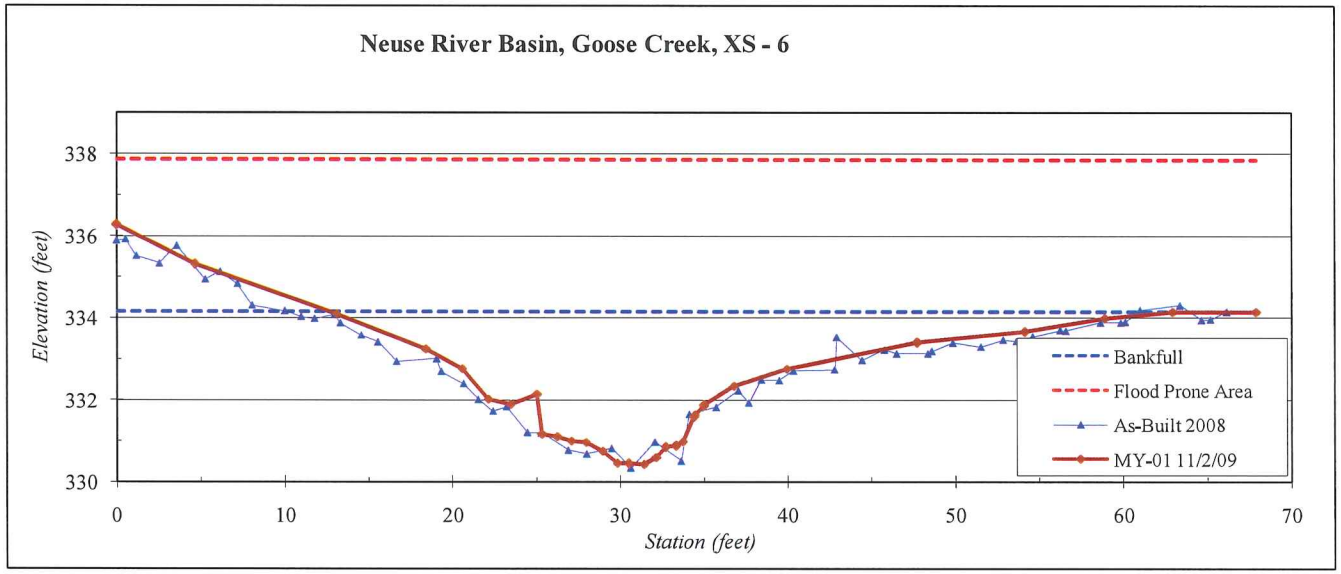


River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 6
Feature	Riffle
Date:	11/2/2009
Field Crew:	Dean, Perkinson

Station	Elevation
0.0	336.3
4.7	335.3
13.1	334.1
18.4	333.2
20.6	332.8
22.1	332.0
23.5	331.9
25.1	332.1
25.4	331.2
26.3	331.1
27.1	331.0
28.0	331.0
29.0	330.8
29.8	330.5
30.5	330.5
31.4	330.4
32.2	330.6
32.7	330.9
33.4	330.9
33.7	331.0
34.4	331.6
34.5	331.6
35.0	331.9
36.8	332.3
40.0	332.8
47.7	333.4
54.2	333.7
58.9	334.0
63.0	334.2
67.9	334.1

SUMMARY DATA	
Bankfull Elevation:	334.2
Bankfull Cross-Sectional Area:	69.2
Bankfull Width:	54.6
Flood Prone Area Elevation:	337.9
Flood Prone Width:	162.0
Max Depth at Bankfull:	3.7
Mean Depth at Bankfull:	1.3
W / D Ratio:	43.1
Entrenchment Ratio:	3.0
Bank Height Ratio:	1.0

Stream Type	C

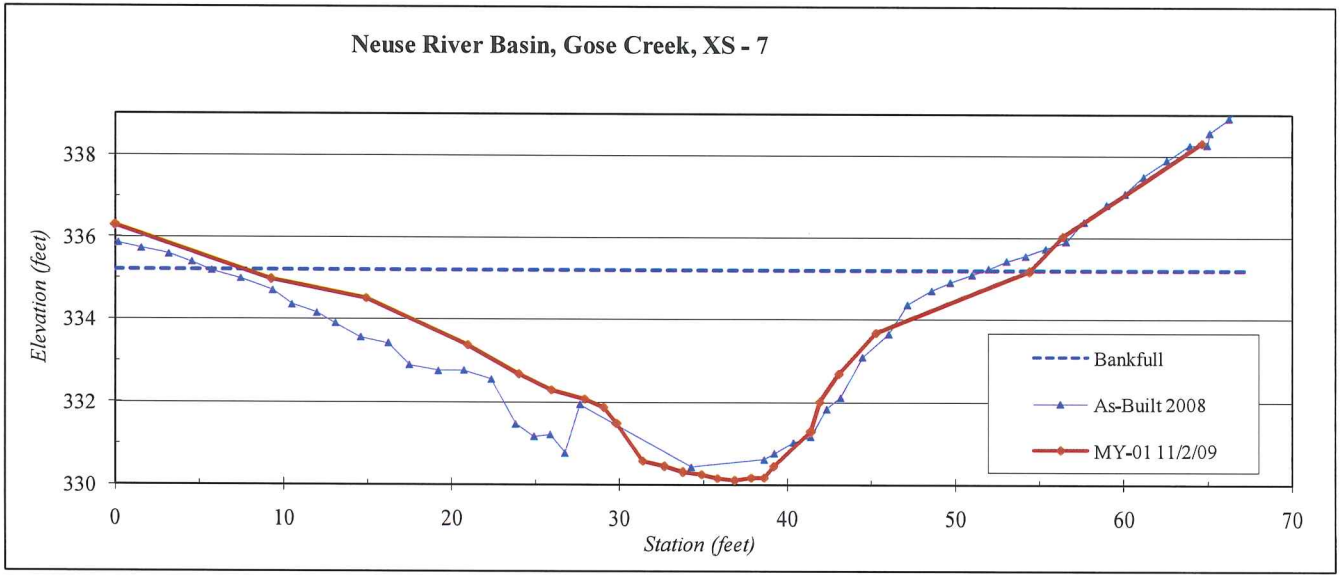


River Basin:	Neuse
Watershed:	Gose Creek
XS ID	XS - 7
Feature	Pool
Date:	11/2/2009
Field Crew:	Dean, Perkinson

Station	Elevation
0.0	283.9
9.3	283.8
13.6	283.9
14.8	283.8
17.2	281.7
18.8	281.5
26.2	281.4
32.8	281.5
35.3	281.6
36.8	283.0
38.2	284.1
40.5	284.0
45.2	284.0
47.5	284.5
49.9	284.6

SUMMARY DATA	
Bankfull Elevation:	335.2
Bankfull Cross-Sectional Area:	104.6
Bankfull Width:	46.7
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	5.1
Mean Depth at Bankfull:	2.2
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	-

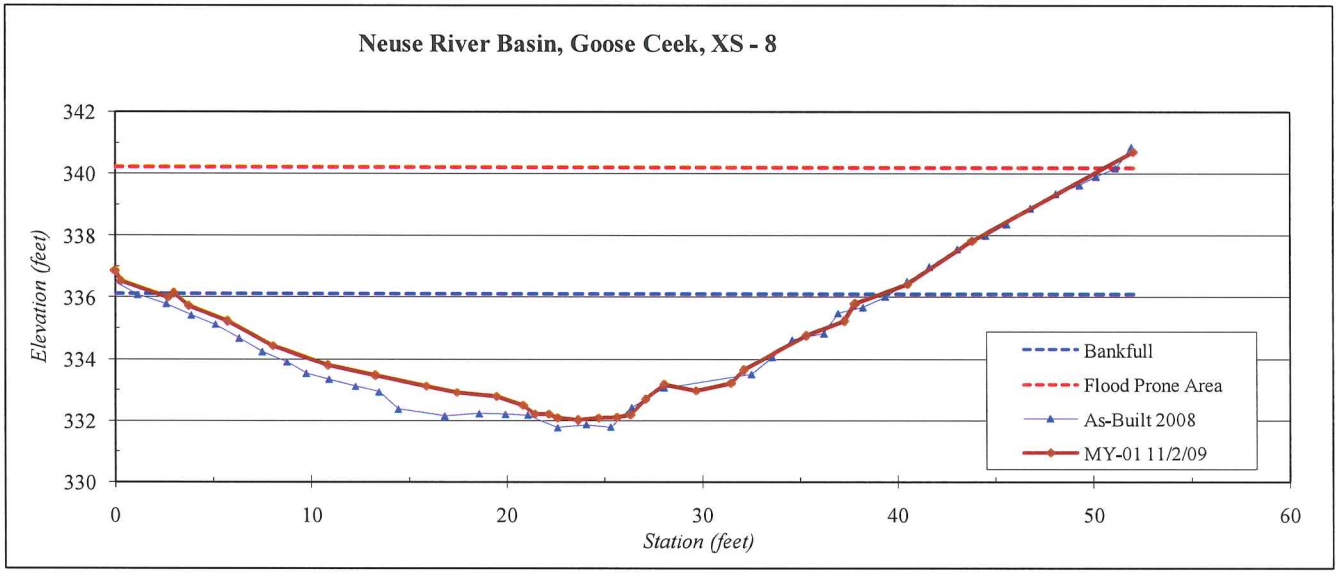


River Basin:	Neuse
Watershed:	Goose Ceek
XS ID	XS - 8
Feature	Riffle
Date:	11/2/2009
Field Crew:	Dean, Perkinson

Station	Elevation
0.0	336.8
0.3	336.5
2.7	336.0
3.0	336.1
3.7	335.7
5.7	335.2
8.1	334.4
10.9	333.8
13.3	333.5
15.9	333.1
17.4	332.9
19.5	332.8
20.9	332.5
21.4	332.2
22.1	332.2
22.6	332.1
23.6	332.0
24.7	332.1
25.6	332.1
26.3	332.2
27.1	332.7
28.0	333.2
29.7	333.0
31.5	333.2
32.1	333.7
35.3	334.8
37.3	335.2
37.8	335.8
40.5	336.4
43.8	337.8
52.0	340.7

SUMMARY DATA	
Bankfull Elevation:	336.1
Bankfull Cross-Sectional Area:	87.6
Bankfull Width:	36.8
Flood Prone Area Elevation:	340.2
Flood Prone Width:	170.0
Max Depth at Bankfull:	4.1
Mean Depth at Bankfull:	2.4
W / D Ratio:	15.5
Entrenchment Ratio:	4.6
Bank Height Ratio:	1.0

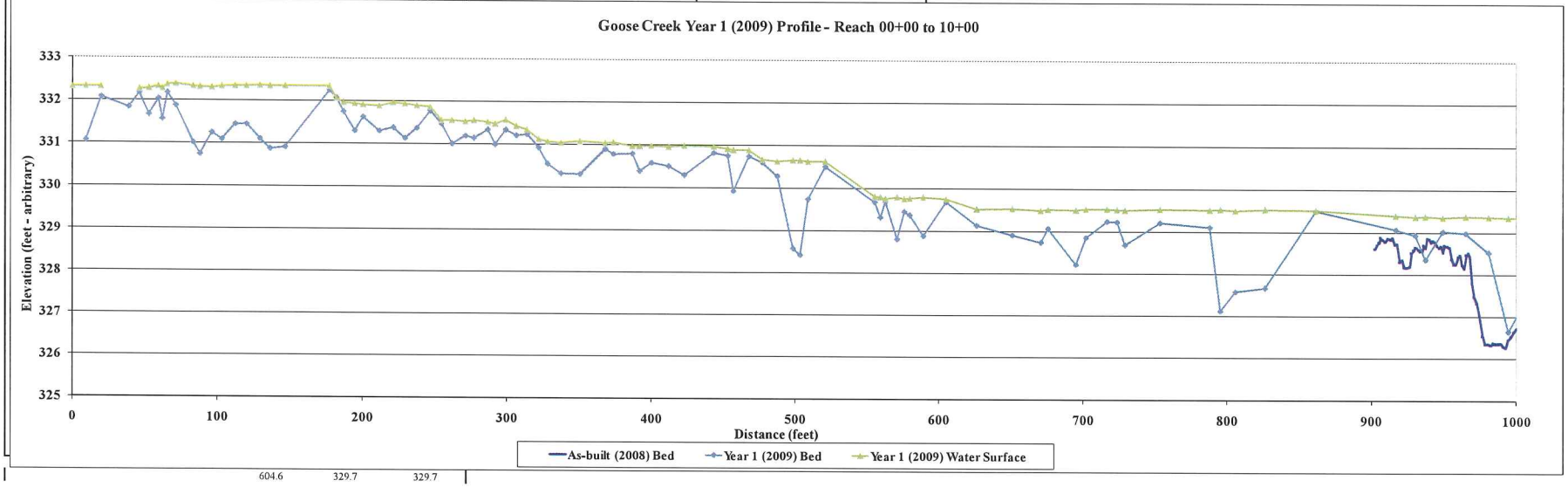
Stream Type	E/C



Project Name	Goose Creek - Year 1 (2009) Profile
Reach	00+00 to 10+00
Feature	Profile
Date	11/2/09
Crew	Dean, Perkinson

2008 As-built Survey			2009 Year 1 Monitoring \Survey			2010 Year 2 Monitoring \Survey			2011 Year 3 Monitoring \Survey		
Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation
902.6	328.6		0.0		332.3						
903.9	328.7		9.1	331.1	332.3						
905.2	328.8		19.6	332.1	332.3						
906.4	328.9		38.4	331.8							
907.9	328.8		46.1	332.2	332.2						
909.4	328.8		52.6	331.7	332.3						
911.2	328.9		59.1	332.0	332.3						
913.4	328.8		61.7	331.6	332.3						
914.7	328.9		65.3	332.2	332.4						
916.2	328.7		71.2	331.9	332.4						
917.6	328.7		83.0	331.0	332.3						
919.6	328.3		87.9	330.7	332.3						
921.2	328.3		96.0	331.2	332.3						
922.7	328.2		102.8	331.1	332.3						
924.4	328.2		112.2	331.4	332.3						
926.7	328.2		120.0	331.4	332.3						
927.8	328.5		129.1	331.1	332.3						
929.2	328.6		136.3	330.9	332.3						
930.3	328.6		146.6	330.9	332.3						
931.5	328.6		177.2	332.2	332.3						
932.7	328.6		181.8	332.1	332.1						
933.8	328.6		186.9	331.7	331.9						
935.1	328.6		194.6	331.3	331.9						
936.1	328.7		200.5	331.6	331.9						
937.5	328.6		211.7	331.3	331.9						
938.8	328.9		221.4	331.4	332.0						
940.3	328.8		229.3	331.1	331.9						
941.4	328.8		237.5	331.4	331.9						
			604.6	329.7	329.7						

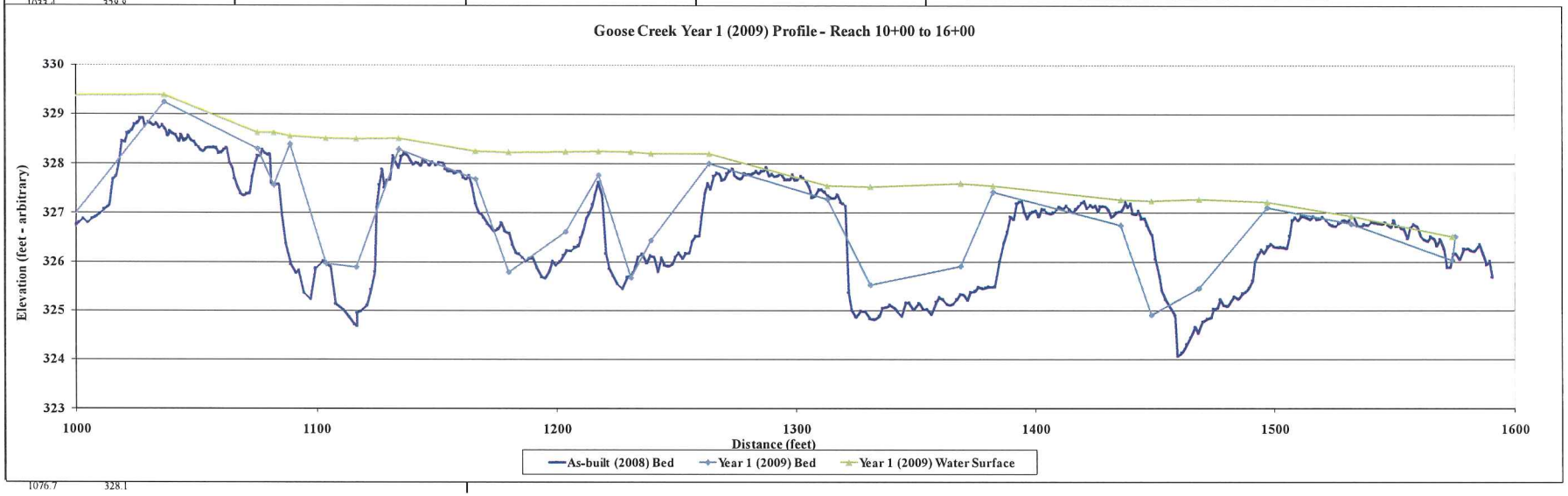
	2009	2010	2011	2012
Avg. Water Surface Slope	0.0037			
Riffle Length	35			
Avg. Riffle Slope	0.2290			
Pool Length	40			
Pool Slope	0.0008			



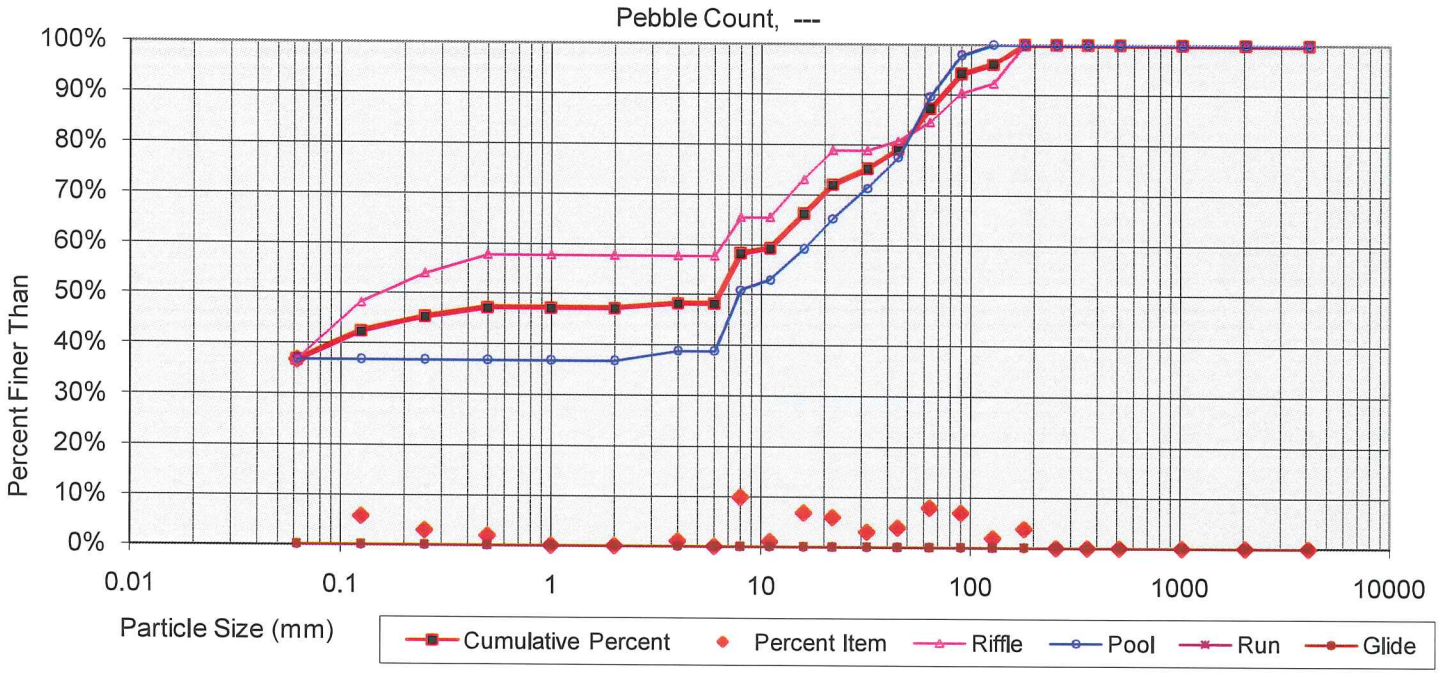
Project Name	Goose Creek - Year 1 (2009) Profile
Reach	10+00 to 16+00
Feature	Profile
Date	11/2/09
Crew	Dean, Perkinson

2008 As-built Survey			2009 Year 1 Monitoring \Survey			2010 Year 2 Monitoring \Survey			2011 Year 3 Monitoring \Survey		
Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation
998.4	326.6		994.5	326.7	329.4						
1000.2	326.7		1036.6	329.2	329.4						
1001.1	326.8		1075.4	328.3	328.6						
1002.9	326.9		1082.2	327.6	328.6						
1004.9	326.8		1088.8	328.4	328.5						
1006.7	326.9		1103.8	326.0	328.5						
1008.2	326.9		1116.3	325.9	328.5						
1009.8	327.0		1134.0	328.3	328.5						
1011.6	327.1		1166.1	327.7	328.2						
1013.9	327.2		1179.8	325.8	328.2						
1015.3	327.7		1203.7	326.6	328.2						
1016.7	327.7		1217.4	327.8	328.2						
1018.1	328.1		1231.0	325.7	328.2						
1019.1	328.4		1239.4	326.4	328.2						
1020.4	328.4		1263.6	328.0	328.2						
1021.3	328.6		1313.0	327.3	327.5						
1022.3	328.6		1331.0	325.5	327.5						
1023.2	328.7		1368.8	325.9	327.6						
1024.3	328.8		1382.4	327.4	327.6						
1025.6	328.8		1435.6	326.7	327.3						
1026.7	328.9		1448.5	324.9	327.2						
1027.9	328.9		1468.4	325.4	327.3						
1028.7	328.7		1496.8	327.1	327.2						
1030.0	328.8		1531.7	326.8	326.9						
1031.0	328.8		1574.0	326.0	326.5						
1032.2	328.8		1575.2	326.5							
1033.4	328.8										
1076.7	328.1										

	2009	2010	2011	2012
Avg. Water Surface Slope	0.0037			
Riffle Length	35			
Avg. Riffle Slope	0.2290			
Pool Length	40			
Pool Slope	0.0008			

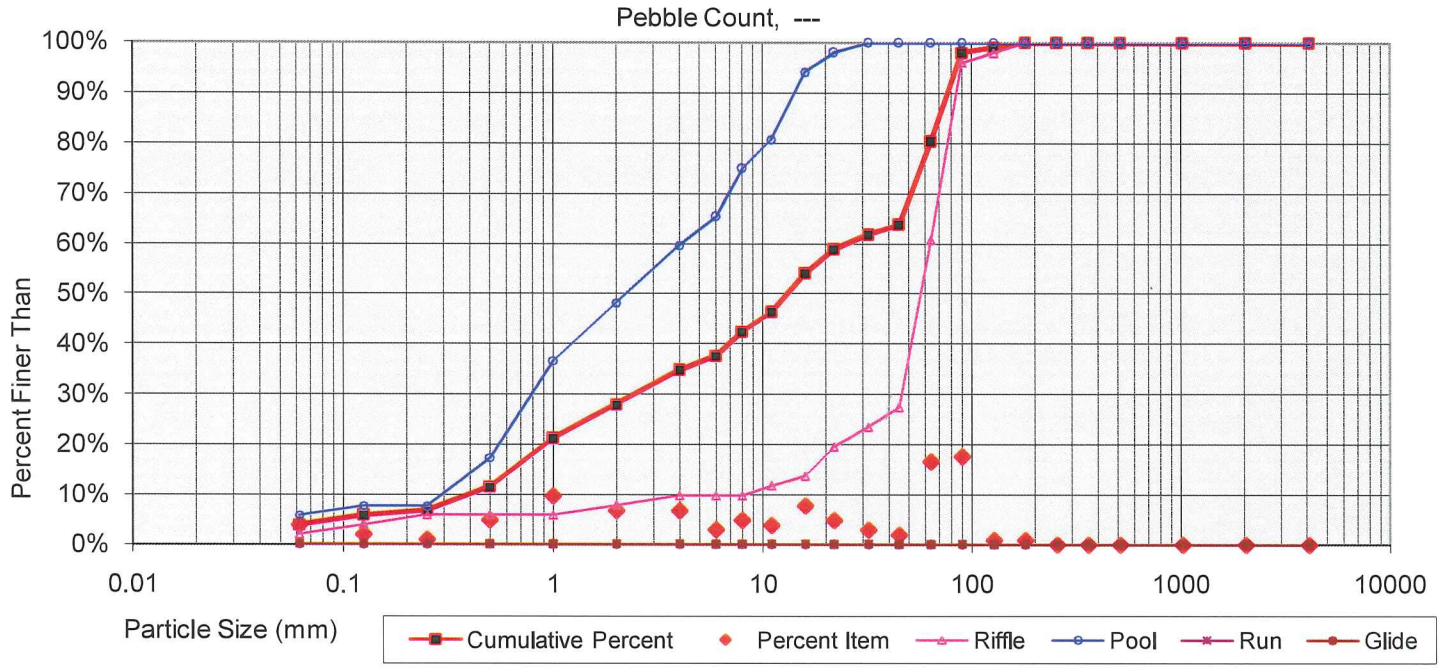


Note: Goose Creek Upstream Reach



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	#N/A	6.3	56	104	37%	11%	40%	13%	0%	0%

Note: Goose Creek Downstream Reach



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.687	4.17	13.2	69	85	4%	24%	52%	20%	0%	0%