Northgate Park (Ellerbe Creek)
Stream Restoration Monitoring Report

EEP Project # 272 **Contract#: 6230**
USACE Action ID#: 200620453 **DWR Project#: N/A**
County: Durham
Monitoring Year 03

Submitted to:

Ecosystem Enhancement PROGRAM

NCDENR-EEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

Data Collection: 2014
Construction Completed: December 2008
Submitted: January 2015

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1.0 EXECUTIVE SUMMARY / PROJECT ABSTRACT

In 2008, the North Carolina Ecosystem Enhancement Program (EEP) restored and enhanced a reach of Ellerbe Creek, an Unnamed Tributary to Ellerbe Creek (UT 3), and stream buffer within Northgate Park in Durham County, NC. The project also included the creation of two stormwater wetlands with outfalls to the project streams. The 5.9-mi^2 project watershed is located in US Geological Survey Hydrologic Unit 03020201-05-0010 (NC Division of Water Quality Sub-basin 03-04-01) of the Neuse River Basin. This Hydrologic Unit is within EEP's *Ellerbe Creek Local Watershed Plan* (2003) area and is also listed as a Targeted Local Watershed (TLW) in EEP's *Neuse River Basin Priorities Plan* (2010).This project is within the Falls Lake watershed, a drinking supply reservoir for the City of Raleigh. The drainage area for the site is urban residential land. The State has a permanent conservation easement of 7.5 acres and the project is located entirely within Northgate Park, which is a City of Durham public park. The project stream begins at the pedestrian bridge near the baseball diamond and flows 2,284 linear feet to the culvert under Acadia Street. The project goals and objectives are listed below.

Project Goals

- Improving water quality.
- Enhancing flood attenuation.
- Restoring aquatic and riparian habitat.

Project Objectives

- Restoring the Project Reach to a stable urban stream channel that will retain its dimension, pattern, and profile over time, and that is capable of transporting watershed flows and sediment load efficiently.
- Using Priority II restoration to change Ellerbe Creek from a G5c type stream channel to a E type channel.
- Enhancing the capacity of the site to mitigate flood flows by improving the connection of the stream to its floodplain.
- Improving aquatic habitat by establishing a heterogeneous bed morphology with riffle-pool sequences supported by in-stream structures.
- Restoring the riparian buffer from park grasses and herbaceous vegetation to Piedmont Bottomland Forest to provide filtration of nutrients and organic matter inputs into the stream, to improve wildlife habitat, and to provide shade for the stream channel.
- Reducing sediment inputs from localized streambank erosion by re-establishing stream geometry and by stabilizing and revegetating the stream banks.
- Installing three stormwater wetland best management practices (BMPs) to reduce stormwater pollutants (namely nitrogen and phosphorus) and improve water quality prior to discharging into the stream.

Construction was completed at the site in December 2008. In March 2009, live stakes were planted along the stream and the stormwater wetlands were planted. The planting of the riparian buffer was delayed until November 2009 when the rest of the site was planted with tublings and containerized plants. After planting, six vegetation plots were installed following the CVS-EEP vegetation monitoring procedure, five in buffer restoration areas and one in the planted stream riparian zone. Repairs were conducted at the site beginning in late 2013 and ending in March 2014. Once construction was completed, newly repaired banks were planted with live stakes and disturbed construction areas were planted with native transplants.

The vegetation monitoring success criterion for the planted stream riparian zone is a density of 320 stems/acre after the third year of monitoring and an allowance for 10% mortality in the fourth and fifth years with a final density of 260 stems/acre. The vegetation monitoring success criterion for the buffer restoration zone is a density of 320 stems/acre after the fifth year of monitoring. Plot 1 is located in the stream riparian zone and Plots 2-6 are located in the buffer enhancement and restoration zones. The third-

year vegetation monitoring was based on the Level 2 CVS-EEP vegetation monitoring protocol. The site's average density for this monitoring period was 182 planted stems/acre. Five of the six plots had less than 320 planted stems/acre, with plot 6 being the only one to meet the success criteria. Despite this lack of planted woody vegetation, volunteer species are robust throughout the site and including volunteers, the site averaged 3,642 total stems/acre. The easement includes a few isolated areas of managed herbaceous zones (as shown in Figure 2) for public safety sight line considerations and pedestrian trail access. Invasive species are present throughout the site, but are only scattered in small patches throughout the easement. The 2014 monitoring found some areas with low densities of trees. The streamside vegetation, especially the willows (*Salix spp.*) on the lower half of the site, has also been impacted by beaver, and they have destroyed many of the previously large and healthy trees along the bankfull bench. There is no beaver dam or lodge on-site; the beaver are most likely accessing the site from downstream of the project reach.

The project as-built survey was conducted in January 2009 and KCI conducted the first-year monitoring survey in January 2010. The longitudinal profile in Appendix D includes the longitudinal profile data from both of these surveys. The as-built profile data are limited in that the survey measurements taken were not annotated in the field and water surface measurements were not taken. As a result, the survey is not detailed enough to generate baseline profile morphology data. The five detailed cross-sections were installed after the as-built survey, so there are no baseline dimensional data, but there are first-year dimensional data. Because of the repair work that occurred in 2013 and 2014, cross-sections 3, 4, and 5 were all reinstalled in October 2014. An effort was made to install these as close to the original cross-sections as possible, but there are slight differences between the first two years and the current year of monitoring. This year's cross-sectional survey showed all cross-sections functioning as intended. Cross-sections 1 and 2 continue to trend towards stability. The banks of cross-sections 3 and 5 received vegetated soil lifts and the bank of cross-section 4 was graded as part of the repair work mentioned above. The third year of monitoring found both Reach 1 and 2 to be stable and functioning as designed. Although the bed shows areas of significant aggradation along Reach 1 and degradation along Reach 2 compared to the as-built conditions, it shows little change compared to the MY01 and MY02 surveys. Areas of bank erosion and structural failure mentioned in previous reports were corrected during the repairs mentioned above. As a part of the stream success criterion, the stream must experience at least two bankfull events, each in separate monitoring years. The site has experienced multiple bankfull events since construction.

Summary information/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 the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report and in the Mitigation Plan documents available on the EEP's website. All raw data supporting the tables and figures in the appendices are available from EEP upon request.

2.0 METHODOLOGY

The survey data were collected with a total station instrument, using control coordinates supplied by URS and the as-built surveyor, Level Cross. The MY03 stream survey was completed on December 22, 2015

The stationing for the longitudinal profile is based on the thalweg stationing and has been adjusted to match grade control structures from previous longitudinal profiles.

The CVS-EEP protocol, Level 2 (http://cvs.bio.unc.edu/methods.htm) was used to collect vegetation data from the site. The MY03 vegetation survey was conducted on October 22, 2014.

3.0 REFERENCES

DWQ, 2000. Neuse Riparian Buffer Mitigation Rules. **15A NCAC 2B .0242** (http://ncrules.state.nc.us/ncac/title%2015a%20-%20environment%20and%20natural%20resources/chapter%2002%20-%20environmental%20management/subchapter%20b/15a%20ncac%2002b%20.0242.html)

EEP. 2003. Ellerbe Creek Local Watershed Plan. (http://www.nceep.net/services/lwps/Upper_Neuse/Ellerbe_Creek_Local_Watershed_Plan.pdf)

EEP. 2010. Neuse River Basin Restoration Priorities. (draft available: http://www.nceep.net/services/restplans/DRAFT_RBRP_Neuse_201007.pdf)

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

USACE. 2003. Stream Mitigation Guidelines. (http://www.saw.usace.army.mil/wetlands/Mitigation/Documents/Stream/).

Weakley, A. S. 2006. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas. (http://www.herbarium.unc.edu/FloraArchives/WeakleyFlora_2006-Jan.pdf).

Appendix A

Project Vicinity Map and Background Tables

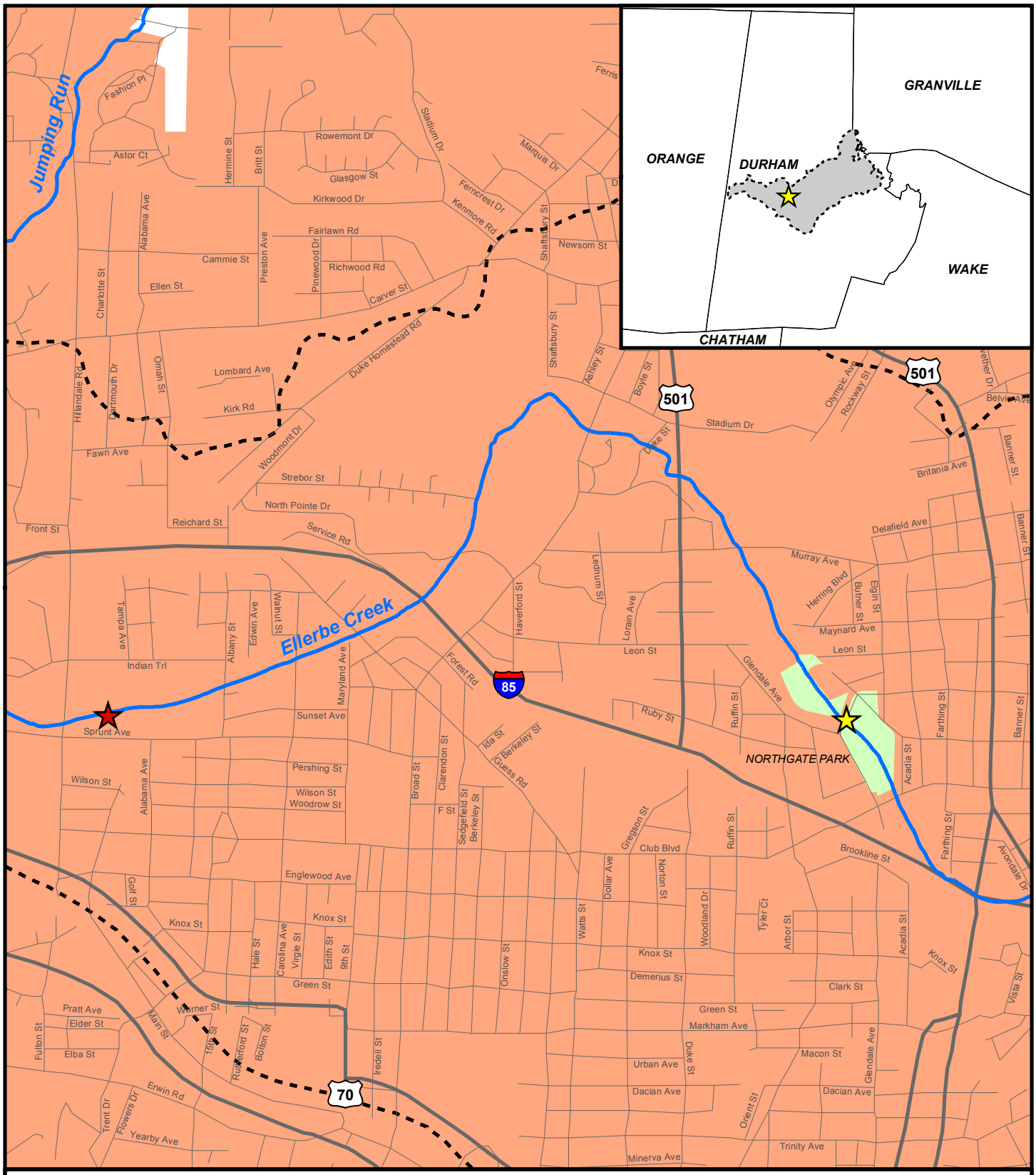


Figure 1. Vicinity Map

Table 1. Project Components and Mitigation Credits
Northgate Park (Ellerbe Creek), EEP Project #272

Mitigation Credits

	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Length	867	1,247							
Credits	867	831							
TOTAL CREDITS	1,698								

Project Components

Project Component -or- Reach ID	Stationing/ Location	Existing Footage/ Acreage	Approach (PI, PII etc.)	Restoration -or- Restoration Equivalent	Restoration Footage/Acreage	Mitigation Ratio
Reach 1	10+00 – 25+20	1,520	PII	Enhancement I	1,247*	1.5:1
Reach 2	25+20 – 32+70	646	PII	Restoration	750	1:1
UT 3	100+00 – 101+17	104	PII	Restoration	117	1:1
Buffer				Restoration	3.63	1:1
Buffer				Enhancement	0.23	3:1

Component Summation

Restoration Level	Stream (linear feet)	Riparian Wetlands (Acres)		Non-Riparian Wetlands (Acres)	Buffer (square feet)	Upland (Acres)
Restoration	867				158,172	
Enhancement I	1,247				10,000	
Enhancement II						
TOTAL SMU	**1,698**					
TOTAL RBMU					**161,505**	

*The stream length for Reach 1 does not include the following easement exceptions: stream with one-sided easement, Lavender Street Road right-of-way, pedestrian bridge crossing

Table 2. Project Activity and Reporting History Project Number and Name: 272 - Northgate Park (Ellerbe Creek)		
Elapsed Time Since Grading Complete: 6 yr 1 months **Elapsed Time Since Planting Complete: 5 yr 2 months** **Number of Reporting Years: 3**		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Concept Plan		Jan 06
Restoration Plan		Jun 06
Final Design - 90%		May 07
Construction		Dec 08
As-Built Survey		Jan 09
Live Stake Planting		Mar 09
Riparian Buffer Planting		Nov 09
Year 1 Monitoring	Nov 09 - Jan 10	May 10
Year 2 Monitoring	Sept 10 - Dec 10	Dec 10
Repair		Mar 14
Year 3 Monitoring	Jan 15	Jan 15

Table 3. Project Contacts Table Project Number and Name: 272 - Northgate Park (Ellerbe Creek)	
Design Firm	URS 1600 Perimeter Park Drive, Suite 400 Morrisville, North Carolina 27560 Contact: Ms. Kathleen McKeithan Phone: (919) 461-1597
Construction Contractor	Environmental Quality Resources, LLC 1405 Benson Court, Suite C Arbutus, MD 21227 Contact: Mr. John Talley Phone: (443) 304-3310 ext.110 Fax: (443) 304-3315
Planting Contractor	HARP 301 McCullough Drive, 4th Floor Charlotte, North Carolina 28262 Contact: Mr. Alan Peoples Phone: (704) 841-2841
Repair Design Firm	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 278-2514 Fax: (919) 783-9266
Repair Construction Contractor	Carolina Environmental Contracting, Inc. PO Box 1905 Mount Airy, NC 27030-6905 Contact: Ms. Joanne Cheatham Phone: (336) 320-3849
Monitoring Performers	
MY-00 - 03	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 278-2514 Fax: (919) 783-9266

Table 4. Project Attribute Table Project Number and Name: 272 - Northgate Park (Ellerbe Creek)			
Project County	Durham County		
Physiographic Region	Piedmont		
Ecoregion	Triassic Basin		
Project River Basin	Neuse		
USGS HUC for Project (14 digit)	03020201050010		
NCDWQ Sub-basin for Project	03-04-01		
Within extent of EEP Watershed Plan?	Yes - Ellerbe Creek LWP		
WRC Class (Warm, Cool, Cold)	Warm		
% of project easement demarcated	100%		
Beaver activity observed during design phase?	No		
Restoration Component Attribute Table			
	Reach 1	Reach 2	UT 3
Drainage Area	5.9 sq.mi.	5.9 sq.mi.	-
Stream Order	Third	Third	First
Restored length (feet)	1,466	690	117
Perennial or Intermittent	Perennial	Perennial	Perennial
Watershed Type (Rural, Urban, Developing, etc.)	Urban		
Watershed LULC Distribution			
Urban	38%		
Ag-Row Crop	0%		
Ag-Livestock	0%		
Forested	62%		
Water/Wetlands	<1%		
Watershed impervious cover (%)	-		
NCDWQ AU/Index Number	27-5-(0.7)		
NCDWQ Classification	WS-IV; NSW		
303d listed?	Yes		
Upstream of a 303d listed segment?	Yes		
Reasons for 303d Listing or Stressor	impaired biological integrity		
Total acreage of easement	7.5 Acres		
Total vegetated acreage within the easement	1.0 Acre		
Total planted acreage as part of the restoration	6.4 Acres		
Rosgen Classification of pre-existing	G5c	G5c	-
Rosgen Classification of As-built	C5	C5	-
Valley Type	U	U	U
Valley Slope	0.0006	0.0005	U
Valley side slope range (e.g. 2-3%)	U	U	U
Valley toe slope range (e.g. 2-3%)	U	U	U
Trout waters designation	No		
Species of concern, endangered etc.? (Y/N)	No		
Dominant soil series and characteristics			
Series	Chewacla and Wehadkee		
Depth Clay%	-	-	-
K	-	-	-
T	-	-	-

"N/A" is for items that do not apply.

"-" is for items that are unavailable.

"U" is for items that are unknown.

Appendix B

Visual Assessment Data

LEGEND

- EASEMENT BOUNDARY
- AS-BUILT STATIONED
- PHOTO POINT (PP)
- CROSS-SECTION (XS)
- BMP

PROJECT CONDITION

- VEG PLOT ACHIEVING DENSITY CRITERION
- VEG PLOT BELOW DENSITY CRITERION
- VEG PLOT TOTAL / PLANTED STEM DENSITY — 3642 / 182
- LOW PLANTED STEM DENSITY

2013 REPAIR ITEMS

- SOIL LIFT
- GRADED BANK
- RIFFLE GRADE CONTROL

REVISIONS

STM	DESCRIPTION	DATE

Ecosystem Enhancement PROGRAM

KCI ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

NORTHGATE PARK (ELLERBE CREEK) PROJECT #272 - MONITORING YEAR 03

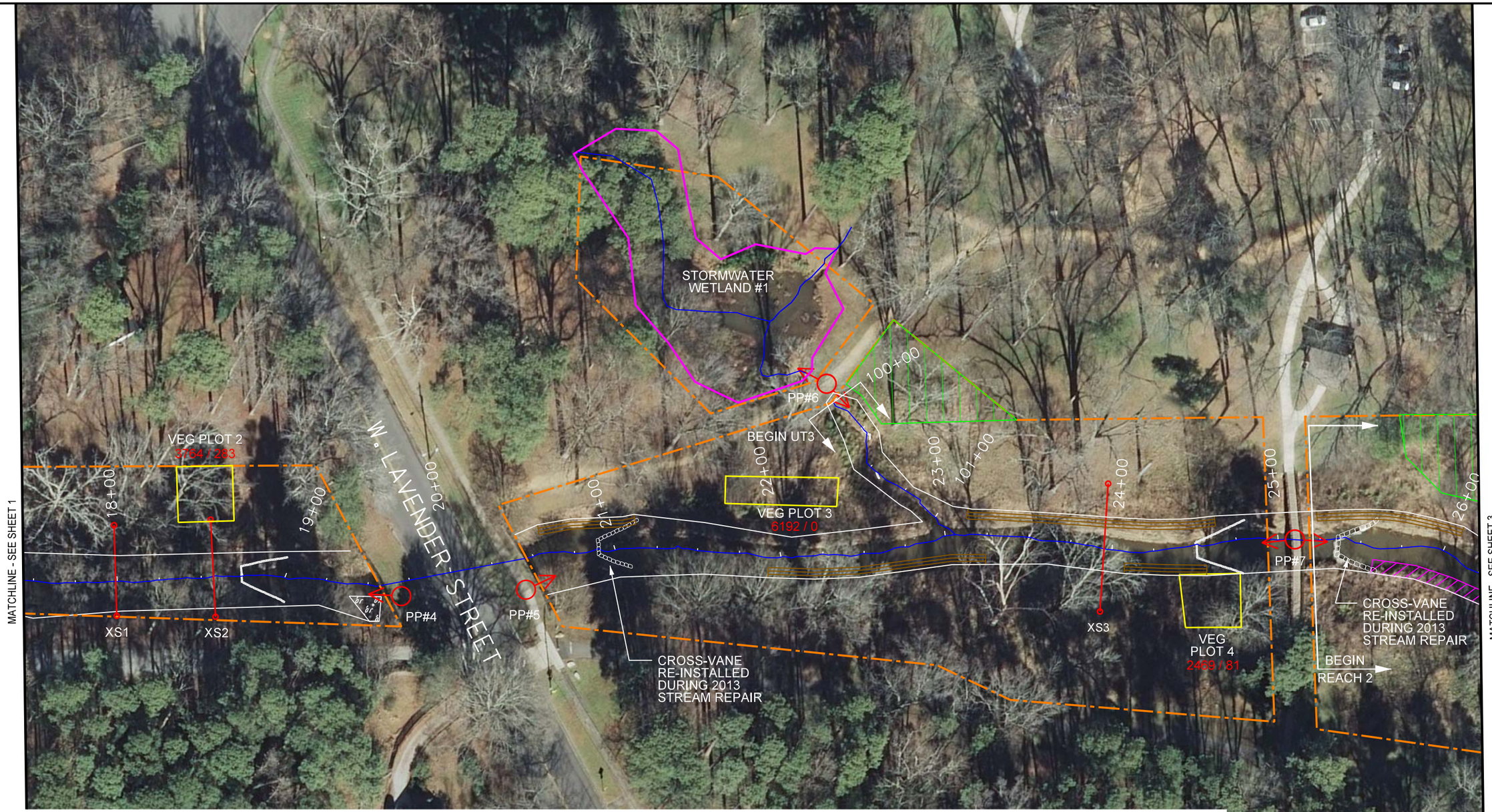
DURHAM, DURHAM COUNTY, NORTH CAROLINA

ELLERBE CREEK: STATION 10+00 TO STATION 17+40

DATE: JAN 2015
SCALE: GRAPHIC

CURRENT CONDITION PLAN VIEW

SHEET 1 OF 3



LEGEND

- EASEMENT BOUNDARY
- AS-BUILT STATIONED
- PHOTO POINT (PP)
- CROSS-SECTION (XS)
- BMP

PROJECT CONDITION

- VEG PLOT ACHIEVING DENSITY CRITERION
- VEG PLOT BELOW DENSITY CRITERION
- VEG PLOT TOTAL / PLANTED STEM DENSITY — 3642 / 182
- LOW PLANTED STEM DENSITY

2013 REPAIR ITEMS

- SOIL LIFT
- GRADED BANK
- RIFFLE GRADE CONTROL

NC GRID NAD 1983

–30 –15 0 30 60

GRAPHIC SCALE

REVISIONS

SYM.	DESCRIPTION	DATE

Ecosystem Enhancement PROGRAM

KCI
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NORTHGATE PARK (ELLERBE CREEK) PROJECT #272 - MONITORING YEAR 03

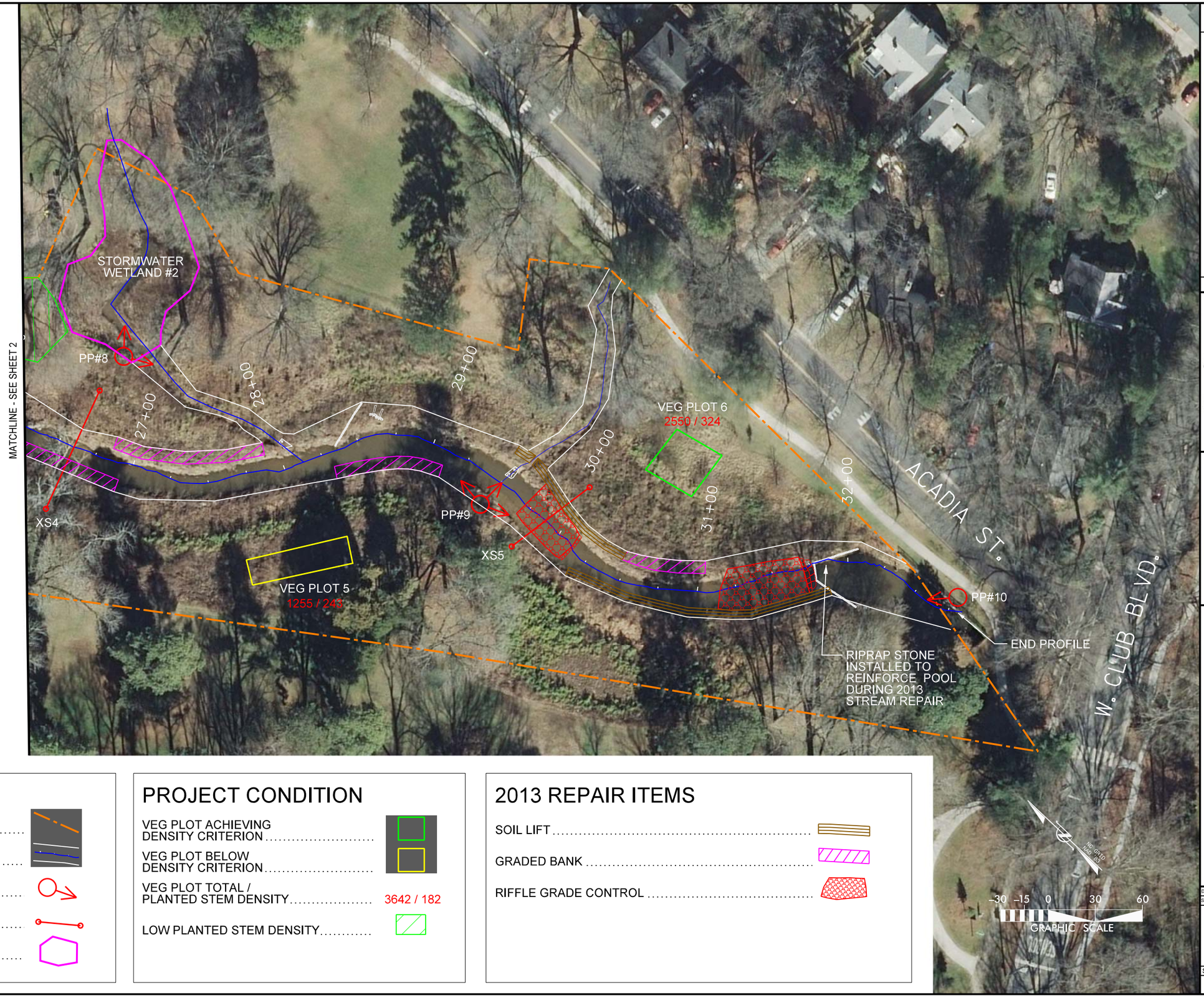
DURHAM, DURHAM COUNTY, NORTH CAROLINA

ELLERBE CREEK: STATION 17+40 TO STATION 26+25

DATE: JAN 2015
SCALE: GRAPHIC

CURRENT CONDITION PLAN VIEW

SHEET 2 OF 3



LEGEND

- EASEMENT BOUNDARY
- AS-BUILT STATIONED
- PHOTO POINT (PP)
- CROSS-SECTION (XS)
- BMP

PROJECT CONDITION

- VEG PLOT ACHIEVING DENSITY CRITERION
- VEG PLOT BELOW DENSITY CRITERION
- VEG PLOT TOTAL / PLANTED STEM DENSITY 3642 / 182
- LOW PLANTED STEM DENSITY

2013 REPAIR ITEMS

- SOIL LIFT
- GRADED BANK
- RIFFLE GRADE CONTROL

REVISIONS

SYM	DESCRIPTION	DATE

Ecosystem Enhancement PROGRAM

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ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

NORTHGATE PARK (ELLERBE CREEK)
PROJECT #272 - MONITORING YEAR 03

DURHAM, DURHAM COUNTY, NORTH CAROLINA

ELLERBE CREEK: STATION 26+25 TO STATION 32+70

DATE: JAN 2015
SCALE: GRAPHIC

CURRENT CONDITION PLAN VIEW

Table 5. Visual Stream Morphology Stability Assessment
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)
Reach 1 Assessed Length 1520

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition*	1. Texture/Substrate - Riffle maintains coarser substrate	8	8			100%			
	3. Meander Pool Condition[+]	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	6	13			46%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	6	13			46%			
	4.**Thalweg Position**[+]	1. Thalweg centering at upstream of meander bend (Run)	0	0			N/A			
		2. Thalweg centering at downstream of meander (Glide)	0	0			N/A			
2. Bank	**1. Scoured/ Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	6	6			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	6	6			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	6	6			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	6	6			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	6	6			100%			

[+]This is not a meandering reach, so all pools are associated with structures.

Table 5. Visual Stream Morphology Stability Assessment
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)
Reach 2 Assessed Length 750

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	5	5			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	4	6			67%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	4	6			67%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	5	5			100%			
		2. Thalweg centering at downstream of meander (Glide)	5	5			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	4	4			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	4	4			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	2	2			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	2	2			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	2	2			100%			

Table 6. Vegetation Condition Assessment

Project Number and Name: 272 - Northgate Park (Ellerbe Creek)

Planted Acreage 6.4 **Easement Acreage 7.5**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.1 acres	Pattern and Color	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres	Pattern and Color	2	0.14	2.2%
			Total	2	0.14	2.2%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	Pattern and Color	0	0.00	0.0%
			Cumulative Total	2	0.14	2.2%
4. Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale).	1000 SF	Pattern and Color	0	0.00	0.0%
5. Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale).	none	Pattern and Color	0	0.00	0.0%

Stream Station Photos

PP#1 – MY01 – 1/19/10


PP#1 – MY03 – 10/22/14

PP#2A – MY01 – 1/19/10


PP#2A – MY03 – 10/22/14

PP#2B – MY01 – 1/19/10


PP#2B – MY03 – 10/22/14

PP#3A – MY01 – 1/19/10


PP#3A – MY03 – 10/22/14

PP#3B – MY01 – 1/19/10


PP#3B – MY03 – 10/22/14

PP#4 – MY01 – 1/19/10


PP#4 – MY03 – 10/22/14

PP#5 – MY01 – 1/19/10


PP#5 – MY03 – 10/22/14

PP#6A – MY01 – 1/19/10


PP#6A – MY03 – 10/22/14

PP#6B – MY01 – 1/19/10


PP#6B – MY03 – 10/22/14

PP#7A – MY01 – 1/19/10


PP#7A – MY03 – 10/22/14

PP#7B – MY01 – 1/19/10


PP#7B – MY03 – 10/22/14


PP#8A – MY01 – 1/19/10


PP#8A – MY03 – 10/22/14

PP#8B – MY01 – 1/19/10


PP#8B – MY03 – 10/22/14

PP#9A – MY01 – 1/19/10


PP#9A – MY03 – 10/22/14

PP#9B – MY01 – 1/19/10


PP#9B – MY03 – 10/22/14

PP#9C – MY01 – 1/19/10

PP#9C – MY03 – 10/22/14

PP#10 – MY01 – 1/19/10

PP#10 – MY03 – 10/22/14

Vegetation Monitoring Plot Photos

Plot 1 Photo – Taken looking southeast from the plot origin. MY03 – 10/22/14

Plot 4 Photo – Taken looking south from the plot origin. MY03 – 10/22/14

Plot 2 Photo – Taken looking south from the plot origin. MY03 – 10/22/14

Plot 5 Photo – Taken looking east from the plot origin MY03 – 10/22/14

Plot 3 Photo – Taken looking east from the plot origin. MY03 – 10/22/14

Plot 6 Photo – Taken looking south from the plot origin. MY03 – 10/22/14

Appendix C

Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment Project Number and Name: 272 - Northgate Park (Ellerbe Creek)	
Vegetation Plot ID	**Vegetation Survival Threshold Met?**
1	No
2	No
3	No
4	No
5	No
6	Yes

Table 8. CVS Vegetation Plot Metadata Project Number and Name: 272 - Northgate Park (Ellerbe Creek)	
Report Prepared By	Tommy Seelinger
Date Prepared	1/27/2015 14:38
database name	KCI-2014-Elerbe.mdb
database location	M:\2014\16146867_NGP Monitoring
computer name	12-3ZV4FP1
file size	48521216
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.
Planted 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.
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	272
project Name	Ellerbe Creek
Description	Stream and Buffer Restoration and Enhancement
River Basin	Neuse
length(ft)	2200
stream-to-edge width (ft)	40
area (sq m)	16349.28
Required Plots (calculated)	6
Sampled Plots	6

Table 9. CVS Stem Count Total and Planted by Plot and Species
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)

			Current Plot Data (MY3 2014)																		Annual Means								
			E272-A-0001			E272-A-0002			E272-A-0003			E272-A-0004			E272-A-0005			E272-A-0006			MY3 (2014)			MY2 (2010)			MY1 (2009)		
Scientific Name	Common Name	Species Type	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoL	P-all	T	PnoLS	P-all	T
Acer	maple	Tree																									5	5	5
Acer negundo	boxelder	Tree																		1			1						
Acer rubrum	red maple	Tree			3															3			6			1			
Acer saccharum	sugar maple	Tree				3	3	3									3				3	3	6	4	4	5			
Alnus serrulata	hazel alder	Shrub			1						2	1	1	12							1	1	15			54	3	3	3
Aronia arbutifolia	Red Chokeberry	Shrub																						1	1	1	1	1	1
Baccharis halimifolia	eastern baccharis	Shrub									1												1						
Betula nigra	river birch	Tree			2			3			1												6			15			
Celtis laevigata	sugarberry	Tree			1			3						1									5	8	8	8	9	9	9
Cercis canadensis	eastern redbud	Tree																2	2	2	2	2	2						
Cornus	dogwood	Shrub or Tree																									3	3	3
Cornus amomum	silky dogwood	Shrub																		2			2	4	4	6	2	3	3
Diospyros virginiana	common persimmon	Tree				3	3	3			3				4	4	6				7	7	12	10	10	10	2	2	2
Fraxinus pennsylvanica	green ash	Tree			20			7			5						1						33	1	1	30	1	1	1
Ilex cornuta	Chinese holly	Exotic						1															1						
Juglans nigra	black walnut	Tree			1			3			2						1			1			8						
Juniperus virginiana	eastern redcedar	Tree	1	1	2			23			2			1	2	2	3				3	3	31	5	5	6	5	5	5
Liquidambar styraciflua	sweetgum	Tree			69						62			28			14			16			189			144			
Liriodendron tulipifera	tuliptree	Tree			20			1			6			6				2	2	3	2	2	36	4	4	9	5	5	5
Morus alba	white mulberry	Exotic						4			1			1									6						
Oxydendrum arboreum	sourwood	Tree																						1	1	1	1	1	1
Physocarpus	ninebark	Shrub																										1	1
Pinus taeda	loblolly pine	Tree			10			29			53			6			2			26			126			4			
Platanus occidentalis	American sycamore	Tree			4			1			10			3									18	1	1	30	1	1	1
Prunus virginiana	chokecherry	Shrub												1									1						
Quercus	oak	Tree																								4			
Quercus coccinea	scarlet oak	Tree				1	1	7						1						1	1	1	9	1	1	1	4	4	4
Quercus lyrata	overcup oak	Tree																1	1	1	1	1	1	1	1	1	1	1	1
Quercus michauxii	swamp chestnut oak	Tree	3	3	3													3	3	3	6	6	6	9	9	9	12	12	12
Quercus pagoda	cherrybark oak	Tree																						1	1	1			
Quercus phellos	willow oak	Tree									3												3	3	3	4	3	3	3
Quercus rubra	northern red oak	Tree			1			1															2						
Salix nigra	black willow	Tree										1	1	1						4	1	1	5			2		2	2
Sambucus canadensis	Common Elderberry	Shrub			1						1												2	1	1	11	1	1	1
Spiraea	spirea	Shrub																									11	11	11
Symphoricarpos orbiculi	coralberry	Shrub						1															1			1	1	1	1
Taxodium distichum	bald cypress	Tree						2															2						
Ulmus	elm	Tree																								1			
Ulmus americana	American elm	Tree			1						1						1						3						
Ulmus parvifolia	Chinese elm	Tree						1															1						
Unknown		Shrub or Tree																						2	2	2	14	14	14
		Stem count	4	4	139	7	7	93	0	0	153	2	2	61	6	6	31	8	8	63	27	27	540	57	57	361	85	89	89
		size (ares)	1			1			1			1			1			1			6			6			6		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.15			0.15			0.15		
		Species count	2	2	15	3	3	17	0	0	15	2	2	11	2	2	8	4	4	12	10	10	31	17	17	26	20	22	22
		Stems per ACRE	162	162	5625	283	283	3764	0	0	6192	80.9	80.9	2469	243	243	1255	324	324	2550	182	182	3642	384	384	2435	573	600	600

Appendix D

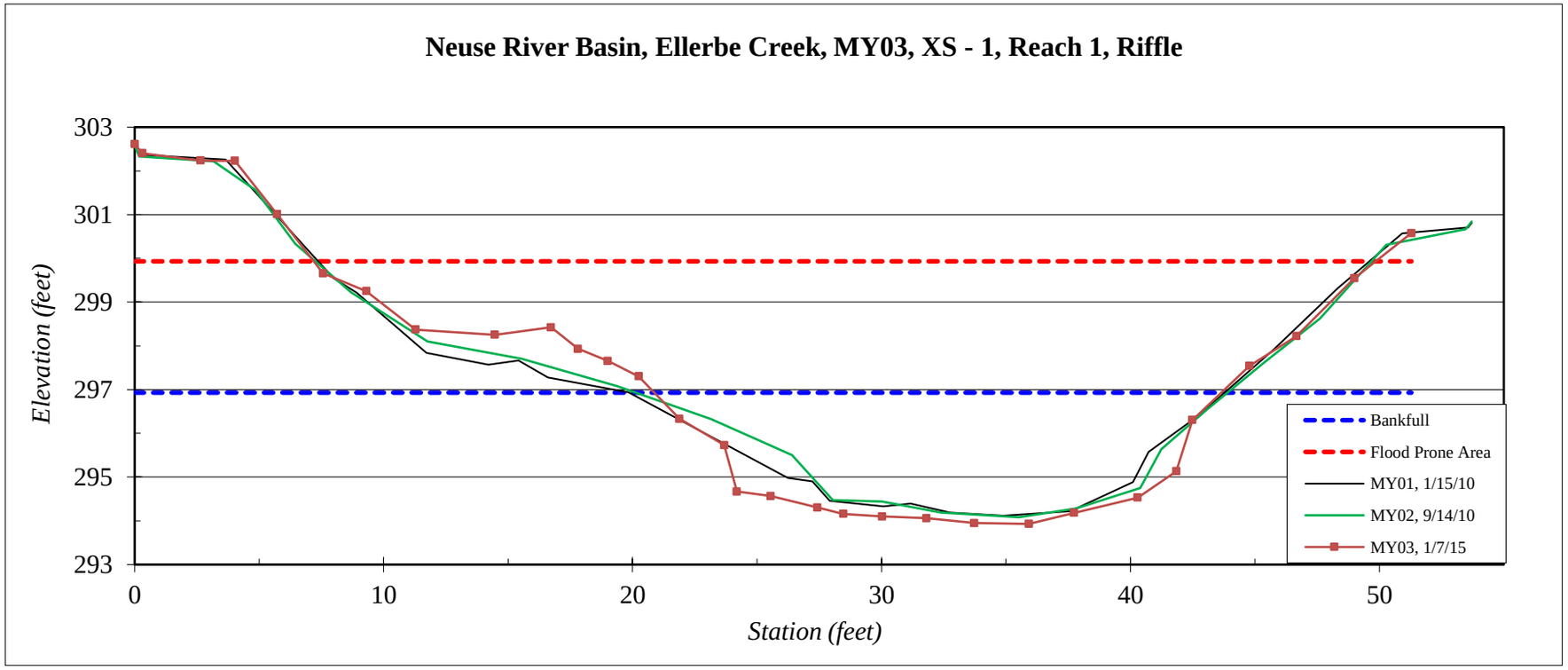
Stream Survey Data

Cross-Section Plots

River Basin:	Neuse
Watershed:	Ellerbe Creek, MY03
XS ID	XS - 1, Reach 1, Riffle
Drainage Area (sq mi):	5.9
Date:	1/7/2015
Field Crew:	T. Seelinger, A. Eason

Station	Elevation
0.0	302.61
0.3	302.40
2.6	302.24
4.0	302.23
5.7	301.01
7.6	299.66
9.3	299.25
11.3	298.37
14.5	298.25
16.7	298.42
17.8	297.93
19.0	297.65
20.2	297.30
21.9	296.33
23.7	295.73
24.2	294.67
25.5	294.57
27.4	294.30
28.5	294.16
30.0	294.10
31.8	294.06
33.7	293.95
35.9	293.93
37.7	294.18
40.3	294.53
41.8	295.13
42.5	296.30
44.8	297.54
46.7	298.22
49.0	299.54
51.3	300.58

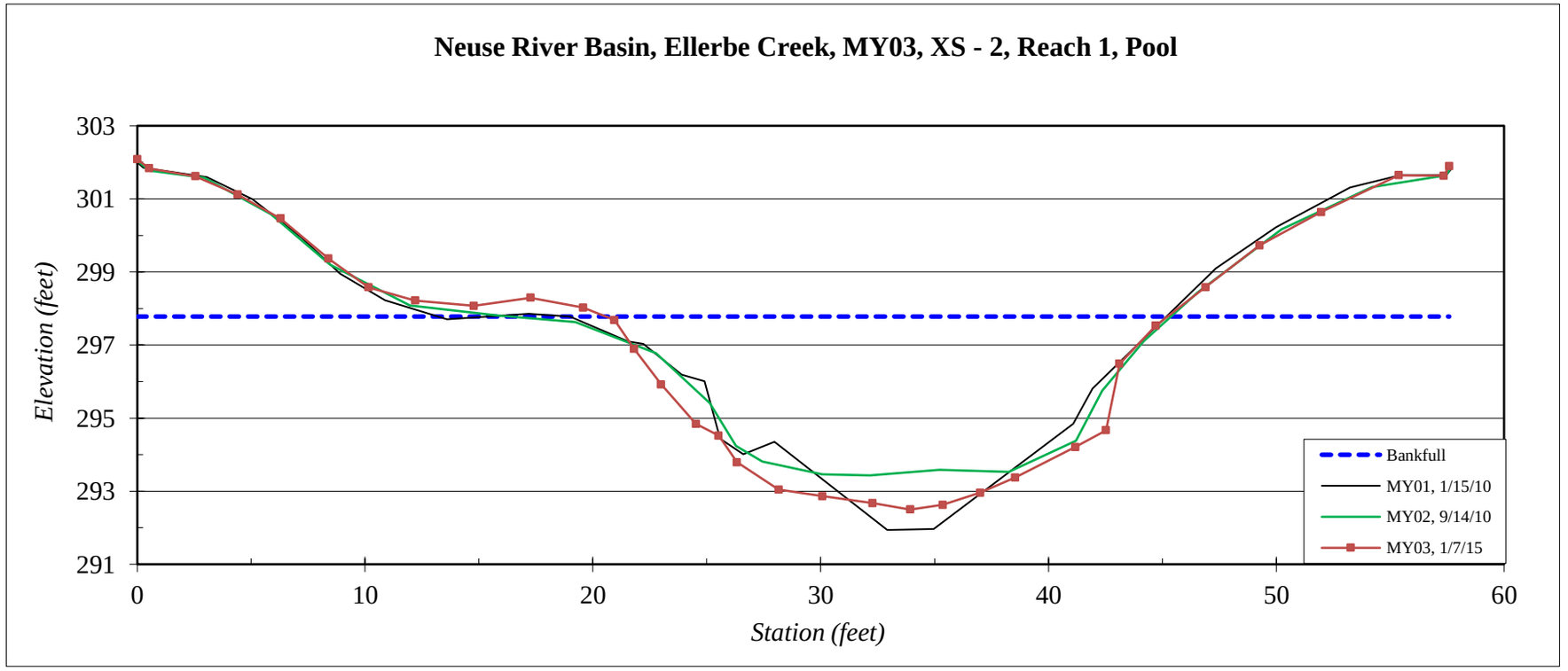
SUMMARY DATA	
Bankfull Elevation:	296.9
Bankfull Cross-Sectional Area:	51.4
Bankfull Width:	22.8
Flood Prone Area Elevation:	299.9
Flood Prone Width:	42.7
Max Depth at Bankfull:	3.0
Mean Depth at Bankfull:	2.3
W / D Ratio:	10.1
Entrenchment Ratio:	1.9
Bank Height Ratio:	1.0



River Basin:	Neuse
Watershed:	Ellerbe Creek, MY03
XS ID	XS - 2, Reach 1, Pool
Drainage Area (sq mi):	5.9
Date:	1/7/2015
Field Crew:	T. Seelinger, A. Eason

Station	Elevation
0.0	302.1
0.5	301.8
2.5	301.6
4.4	301.1
6.3	300.5
8.4	299.4
10.2	298.6
12.2	298.2
14.8	298.1
17.3	298.3
19.6	298.0
20.9	297.7
21.8	296.9
23.0	295.9
24.5	294.8
25.5	294.5
26.3	293.8
28.2	293.0
30.1	292.9
32.3	292.7
33.9	292.5
35.4	292.6
37.0	293.0
38.5	293.4
41.2	294.2
42.5	294.7
43.1	296.5
44.7	297.5
46.9	298.6
49.3	299.7
52.0	300.6
55.4	301.6
57.4	301.6
57.6	301.9

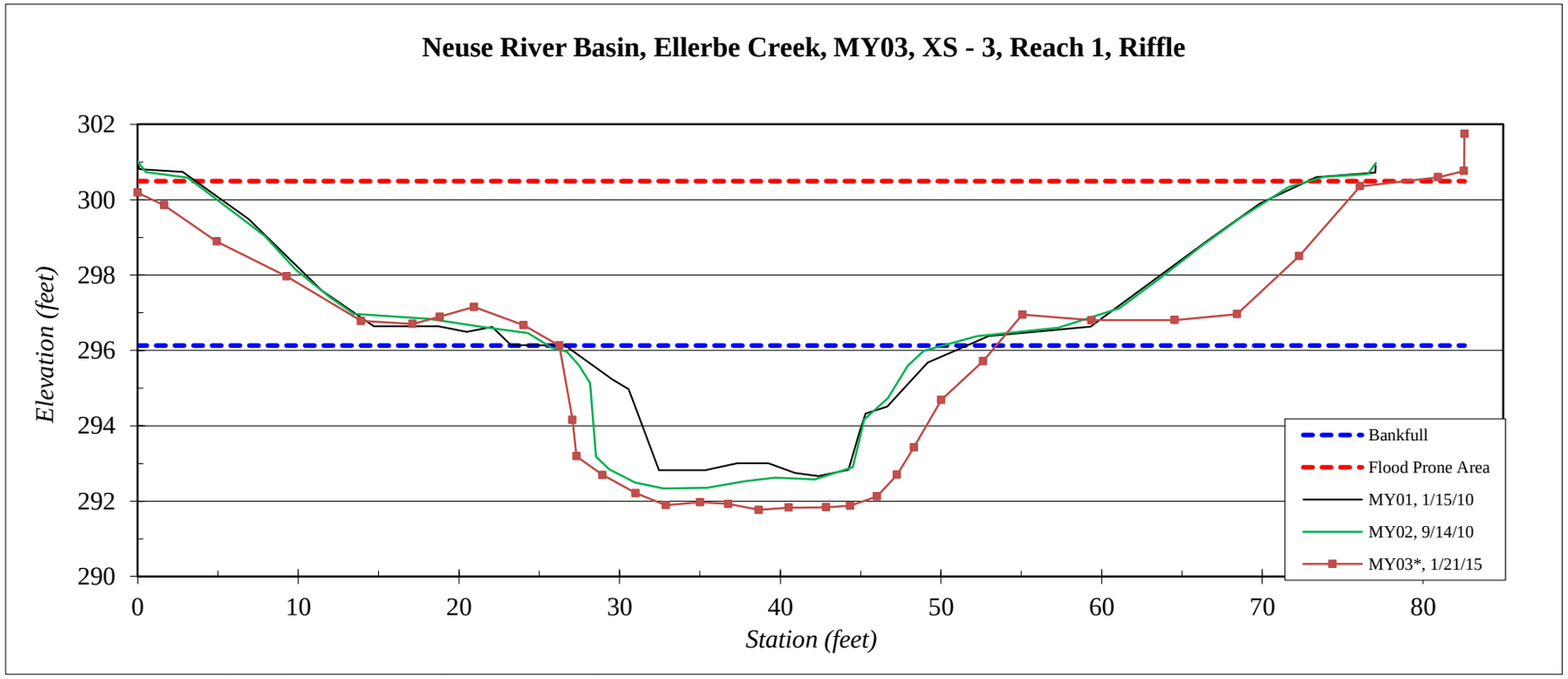
SUMMARY DATA	
Bankfull Elevation:	297.8
Bankfull Cross-Sectional Area:	89.1
Bankfull Width:	24.7
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	5.3
Mean Depth at Bankfull:	3.6
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-



River Basin:	Neuse
Watershed:	Ellerbe Creek, MY03
XS ID	XS - 3, Reach 1, Riffle
Drainage Area (sq mi):	5.9
Date:	1/21/2015
Field Crew:	T. Seelinger, A. French

Station	Elevation
0.0	300.19
1.7	299.85
4.9	298.89
9.3	297.96
13.9	296.78
17.1	296.70
18.8	296.90
20.9	297.15
24.0	296.67
26.3	296.13
27.1	294.15
27.3	293.19
28.9	292.70
31.0	292.21
32.9	291.89
35.0	291.97
36.8	291.92
38.7	291.77
40.5	291.83
42.9	291.84
44.4	291.88
46.0	292.12
47.3	292.70
48.3	293.42
50.0	294.69
52.6	295.72
55.1	296.95
59.4	296.80
64.5	296.81
68.4	296.96
72.3	298.50
76.1	300.36
80.9	300.60
82.6	300.77
82.6	301.75

SUMMARY DATA	
Bankfull Elevation:	296.1
Bankfull Cross-Sectional Area:	98.5
Bankfull Width:	28.7
Flood Prone Area Elevation:	300.5
Flood Prone Width:	74.6
Max Depth at Bankfull:	4.4
Mean Depth at Bankfull:	3.4
W / D Ratio:	8.4
Entrenchment Ratio:	2.6
Bank Height Ratio:	1.0

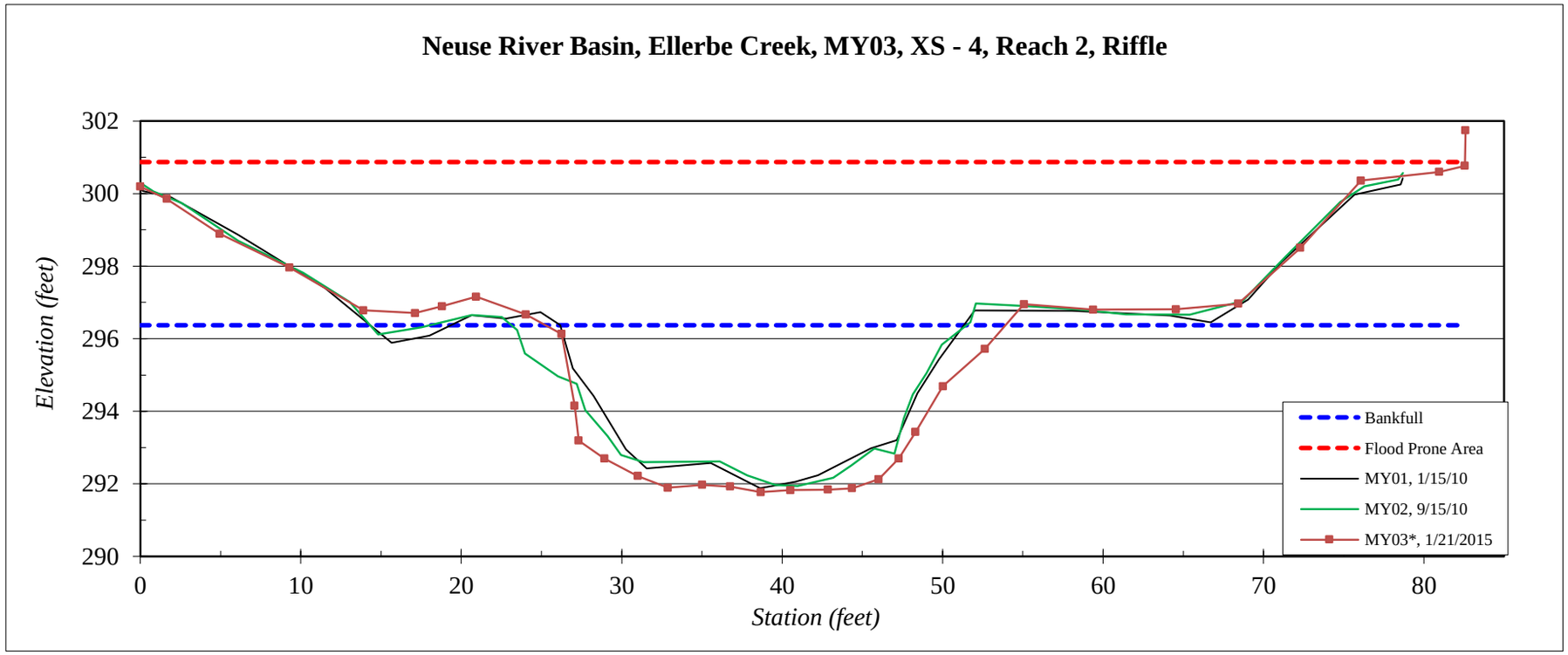


*=pins reset for MY03 due to construction activity on site

River Basin:	Neuse
Watershed:	Ellerbe Creek, MY03
XS ID	XS - 4, Reach 2, Riffle
Drainage Area (sq mi):	5.9
Date:	1/21/2015
Field Crew:	T. Seelinger, A. French

Station	Elevation
0.0	300.19
1.7	299.85
4.9	298.89
9.3	297.96
13.9	296.78
17.1	296.70
18.8	296.90
20.9	297.15
24.0	296.67
26.3	296.13
27.1	294.15
27.3	293.19
28.9	292.70
31.0	292.21
32.9	291.89
35.0	291.97
36.8	291.92
38.7	291.77
40.5	291.83
42.9	291.84
44.4	291.88
46.0	292.12
47.3	292.70
48.3	293.42
50.0	294.69
52.6	295.72
55.1	296.95
59.4	296.80
64.5	296.81
68.4	296.96
72.3	298.50
76.1	300.36
80.9	300.60
82.6	300.77
82.6	301.75

SUMMARY DATA	
Bankfull Elevation:	296.4
Bankfull Cross-Sectional Area:	98.5
Bankfull Width:	28.7
Flood Prone Area Elevation:	300.9
Flood Prone Width:	>75
Max Depth at Bankfull:	4.6
Mean Depth at Bankfull:	3.4
W / D Ratio:	8.4
Entrenchment Ratio:	>3.0
Bank Height Ratio:	1.0

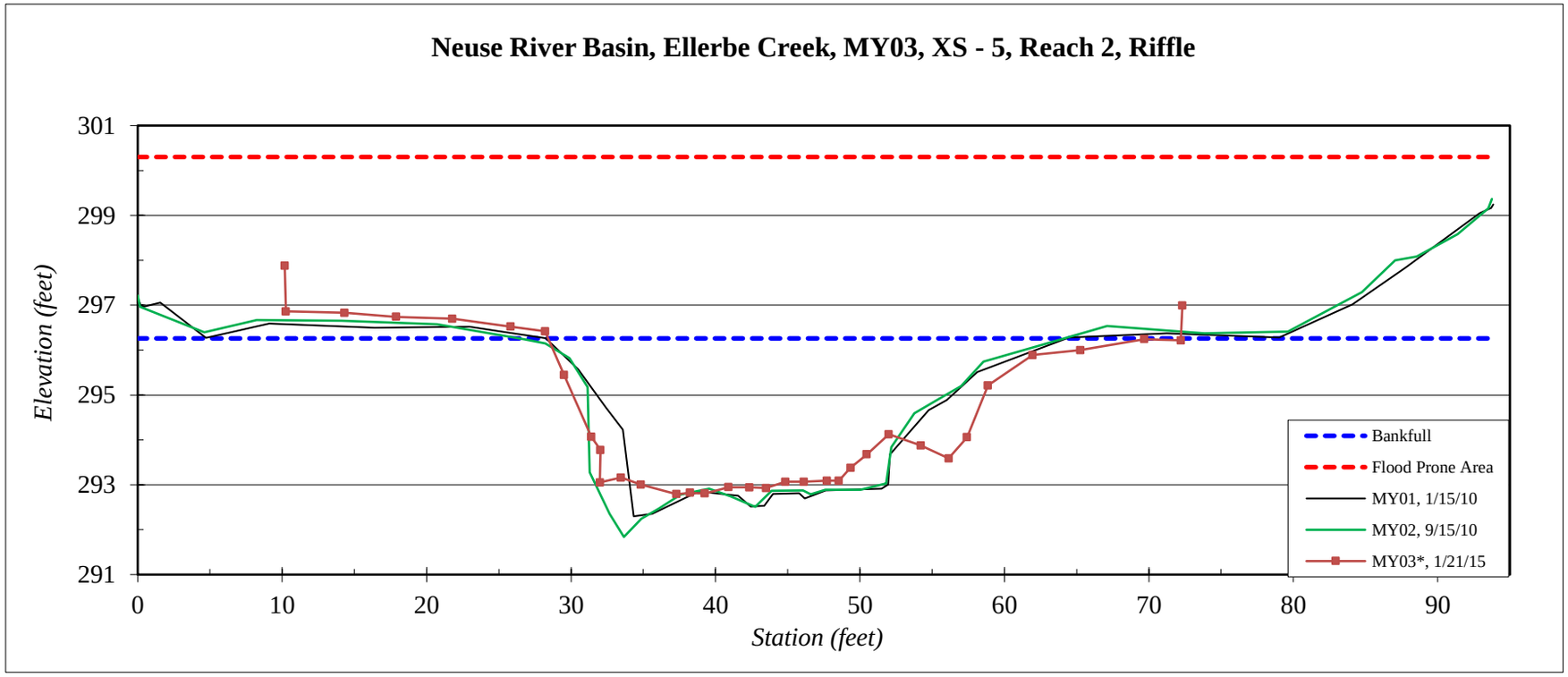


*=pins reset for MY03 due to construction activity on site

River Basin:	Neuse
Watershed:	Ellerbe Creek, MY03
XS ID	XS - 5, Reach 2, Riffle
Drainage Area (sq mi):	5.9
Date:	1/21/2015
Field Crew:	T. Seelinger, A. French

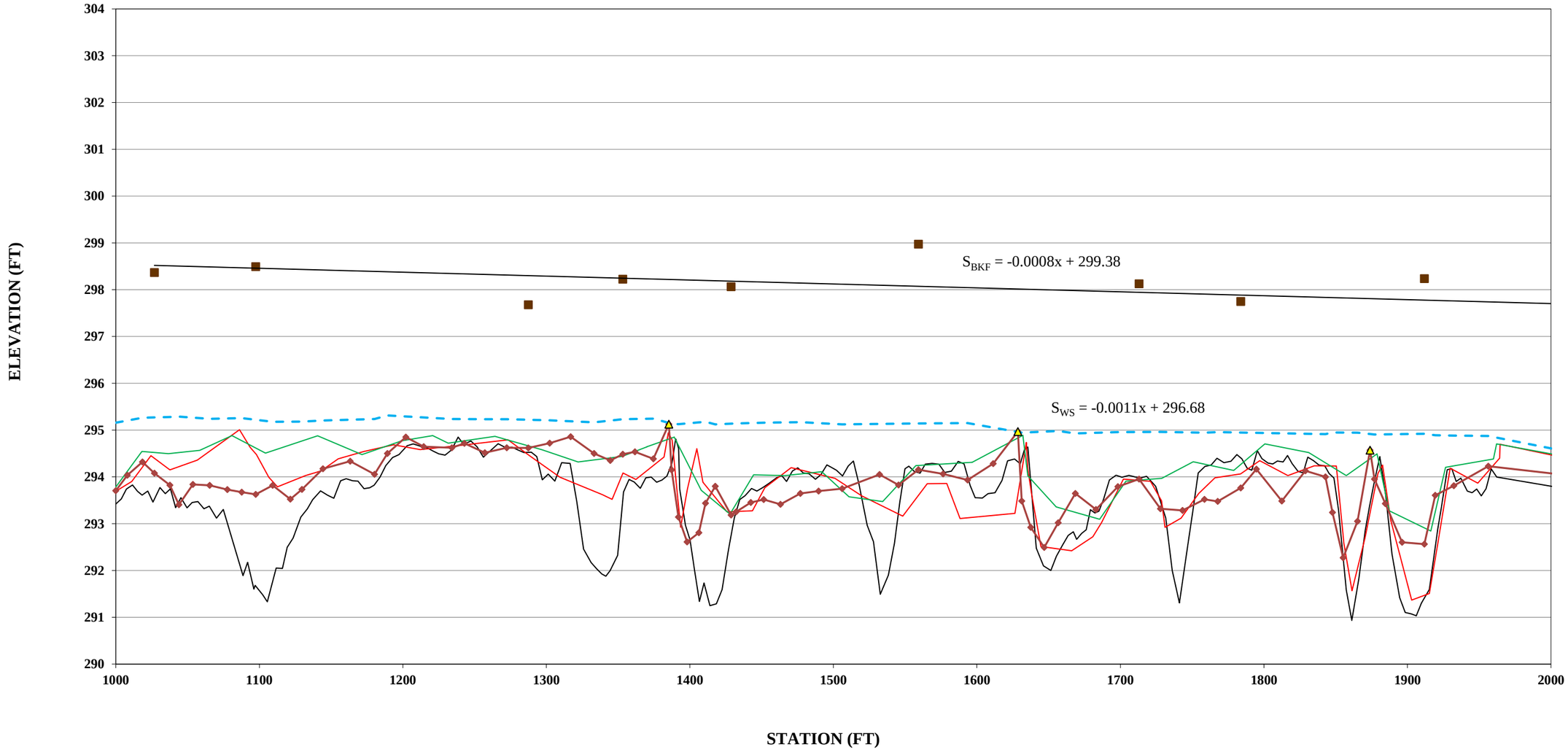
Station	Elevation
0.0	297.88
0.1	296.86
4.1	296.83
7.7	296.74
11.6	296.70
15.6	296.52
18.0	296.42
19.3	295.44
21.2	294.07
21.9	293.77
21.8	293.05
23.3	293.16
24.6	293.00
27.1	292.79
28.1	292.82
29.1	292.81
30.7	292.95
32.2	292.94
33.3	292.93
34.7	293.07
35.9	293.07
37.5	293.09
38.4	293.09
39.2	293.38
40.3	293.68
41.8	294.12
44.0	293.88
46.0	293.59
47.2	294.06
48.7	295.21
51.8	295.89
55.1	296.00
59.5	296.24
62.0	296.22
62.1	296.99

SUMMARY DATA	
Bankfull Elevation:	296.3
Bankfull Cross-Sectional Area:	87.4
Bankfull Width:	33.5
Flood Prone Area Elevation:	300.3
Flood Prone Width:	>90
Max Depth at Bankfull:	3.5
Mean Depth at Bankfull:	2.6
W / D Ratio:	12.8
Entrenchment Ratio:	>2.5
Bank Height Ratio:	1.0

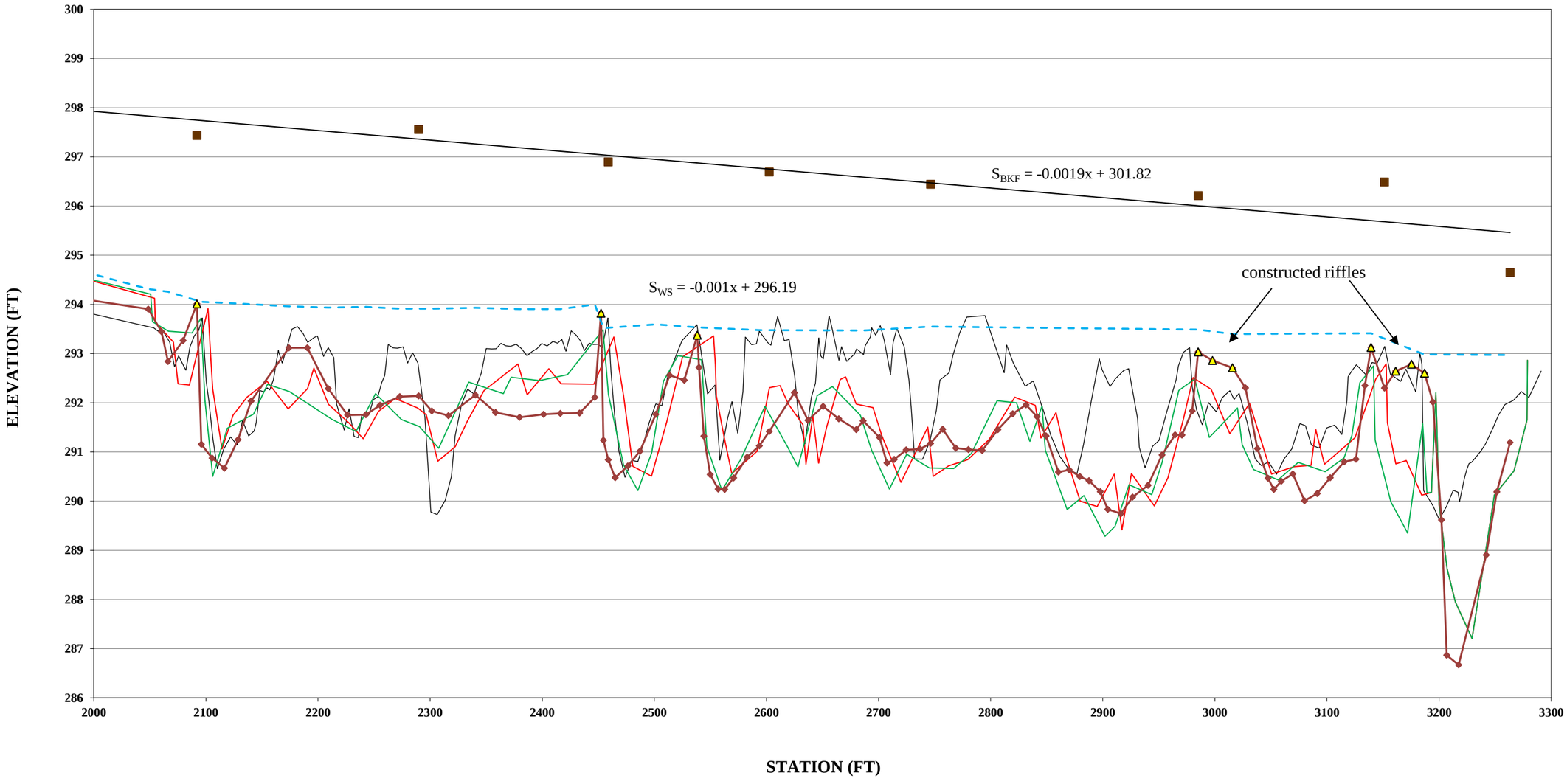


*=pins reset for MY03 due to construction activity on site

Longitudinal Profile
Ellerbe Creek
EEP Project Number 272- MY03
Stations 10+00 - 20+00



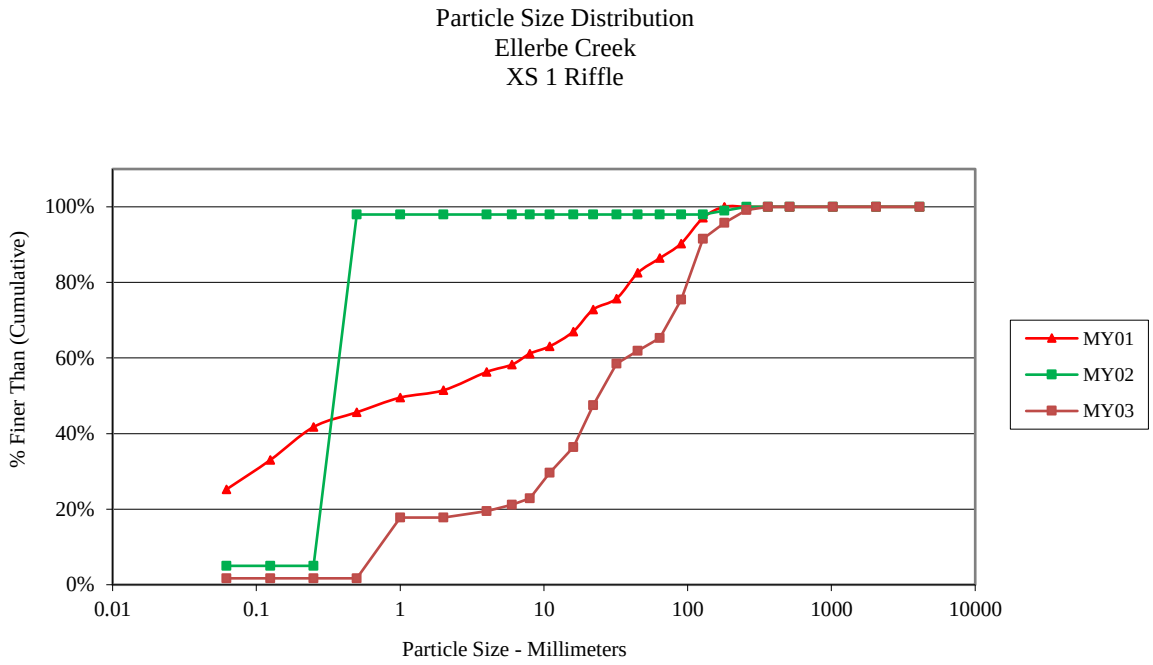
Longitudinal Profile
Ellerbe Creek
EEP Project Number 272- MY03
Stations 20+00 - 33+00



Pebble Count Plots

Cross-Section 1 Riffle - MY03			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	2
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	
Coarse	.50 - 1	D	19
Very Coarse	1 - 2	S	
Very Fine	2 - 4		2
Fine	4 - 5.7	G	2
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	8
Medium	11.3 - 16	V	8
Coarse	16 - 22.6	E	13
Coarse	22.6 - 32	L	13
Very Coarse	32 - 45	S	4
Very Coarse	45 - 64		4
Small	64 - 90	C	12
Small	90 - 128	O	19
Large	128 - 180	B	5
Large	180 - 256	L	4
Small	256 - 362	B	1
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	118

Note:



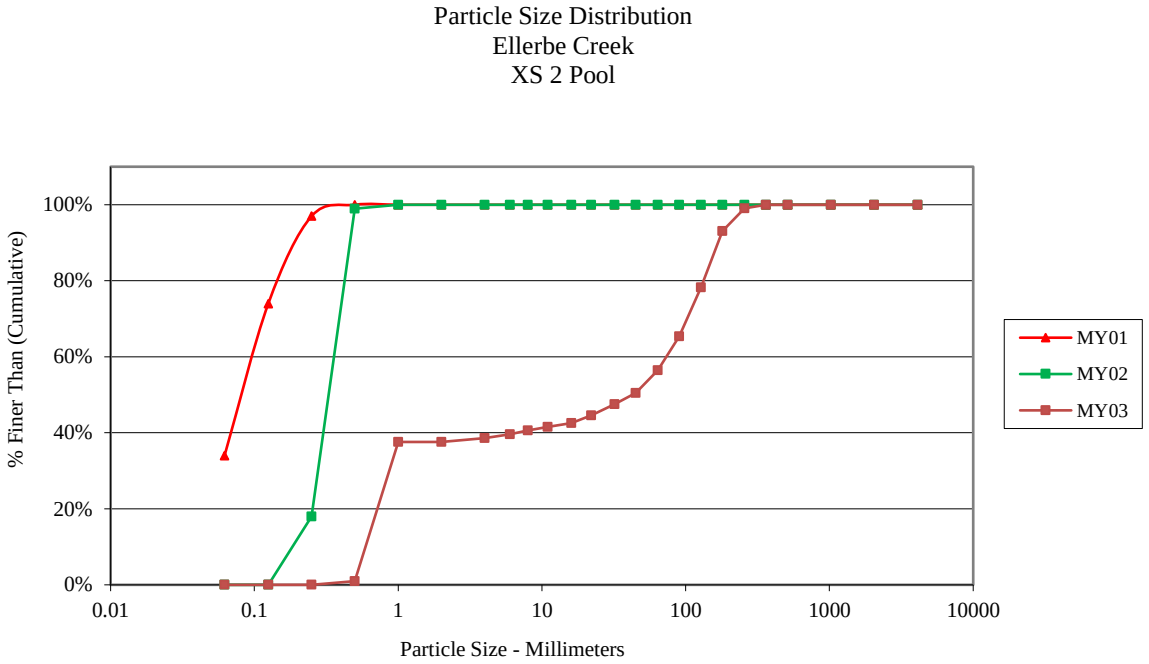
Size (mm)	
D16	0.93
D35	15
D50	24
D65	62
D84	110
D95	170

Size Distribution	
mean	0.3
dispersion	1.3
skewness	0.00

Type	
silt/clay	2%
sand	16%
gravel	47%
cobble	34%
boulder	1%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 2 Pool - MY03			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	1
Coarse	.50 - 1	D	37
Very Coarse	1 - 2	S	
Very Fine	2 - 4		1
Fine	4 - 5.7	G	1
Fine	5.7 - 8	R	1
Medium	8 - 11.3	A	1
Medium	11.3 - 16	V	1
Coarse	16 - 22.6	E	2
Coarse	22.6 - 32	L	3
Very Coarse	32 - 45	S	3
Very Coarse	45 - 64		6
Small	64 - 90	C	9
Small	90 - 128	O	13
Large	128 - 180	B	15
Large	180 - 256	L	6
Small	256 - 362	B	1
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	101

Note:



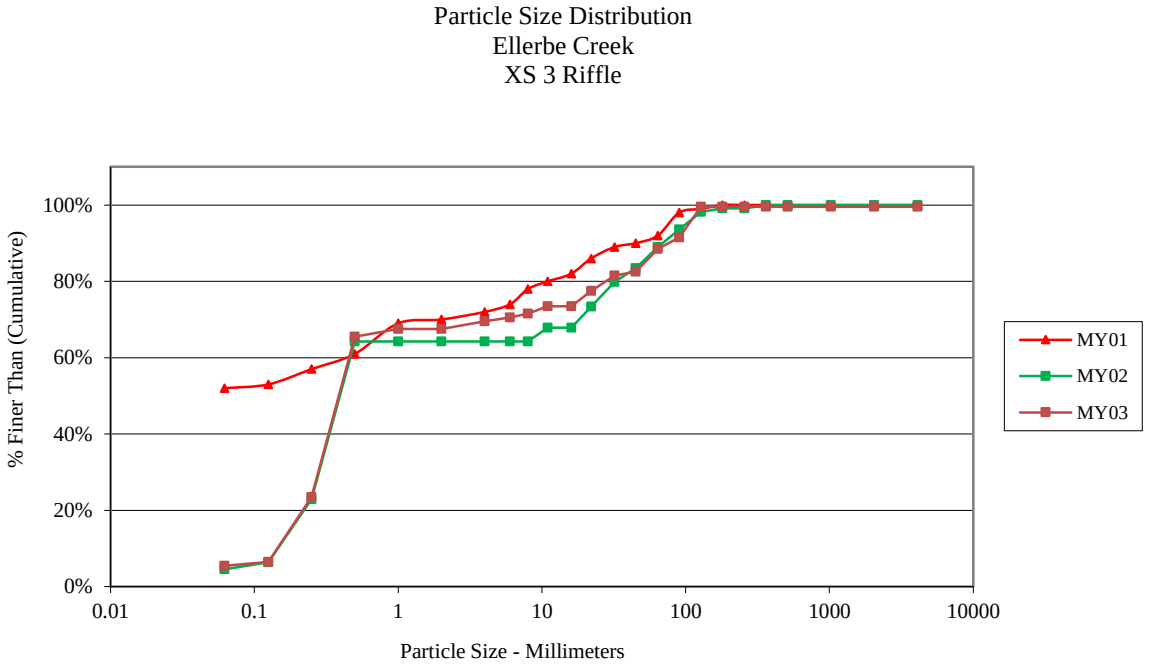
Size (mm)	
D16	0.66
D35	0.95
D50	43
D65	89
D84	150
D95	200

Size Distribution	
mean	0.3
dispersion	1.4
skewness	-0.03

Type	
silt/clay	0%
sand	38%
gravel	19%
cobble	43%
boulder	1%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 3 Riffle - MY03			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	6
Very Fine	.062 - .125	S	1
Fine	.125 - .25	A	17
Medium	.25 - .50	N	42
Coarse	.50 - 1	D	2
Very Coarse	1 - 2	S	
Very Fine	2 - 4		2
Fine	4 - 5.7	G	1
Fine	5.7 - 8	R	1
Medium	8 - 11.3	A	2
Medium	11.3 - 16	V	
Coarse	16 - 22.6	E	4
Coarse	22.6 - 32	L	4
Very Coarse	32 - 45	S	1
Very Coarse	45 - 64		6
Small	64 - 90	C	3
Small	90 - 128	O	8
Large	128 - 180	B	
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	100

Note:



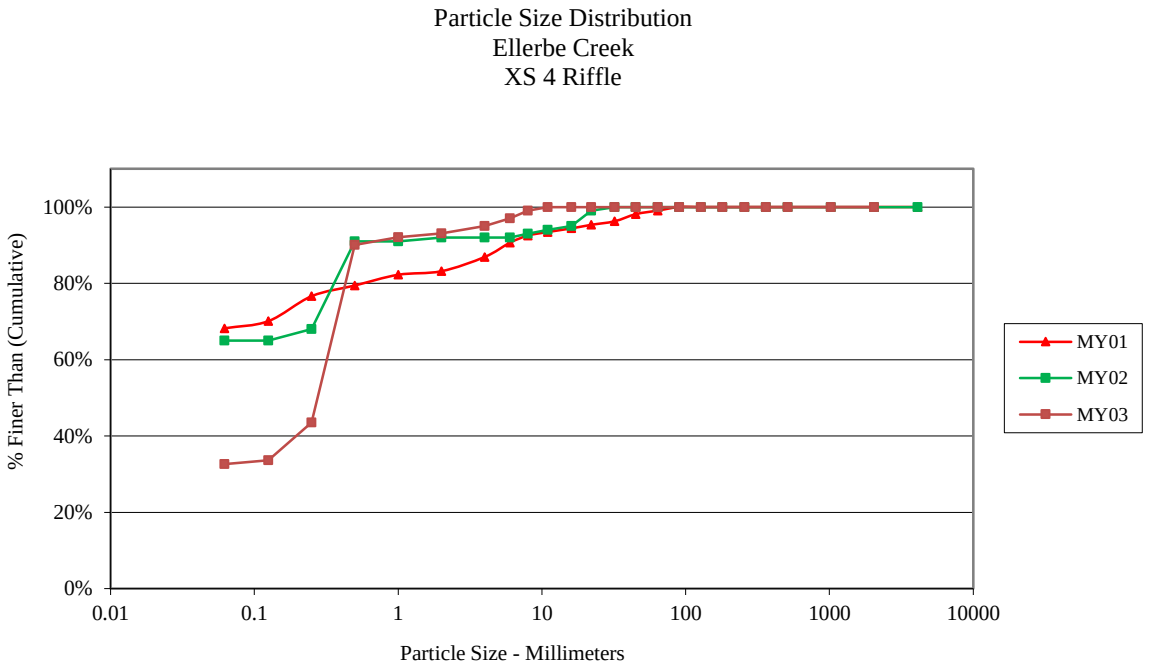
Size (mm)	
D16	0.18
D35	0.30
D50	0.38
D65	0.49
D84	48
D95	100

Size Distribution	
mean	2.9
dispersion	57.4
skewness	0.57

Type	
silt/clay	6%
sand	62%
gravel	21%
cobble	11%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 4 Riffle - MY03			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	33
Very Fine	.062 - .125	S	1
Fine	.125 - .25	A	10
Medium	.25 - .50	N	47
Coarse	.50 - 1	D	2
Very Coarse	1 - 2	S	1
Very Fine	2 - 4		2
Fine	4 - 5.7	G	2
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	1
Medium	11.3 - 16	V	
Coarse	16 - 22.6	E	
Coarse	22.6 - 32	L	
Very Coarse	32 - 45	S	
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	
Large	128 - 180	B	
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	101

Note:



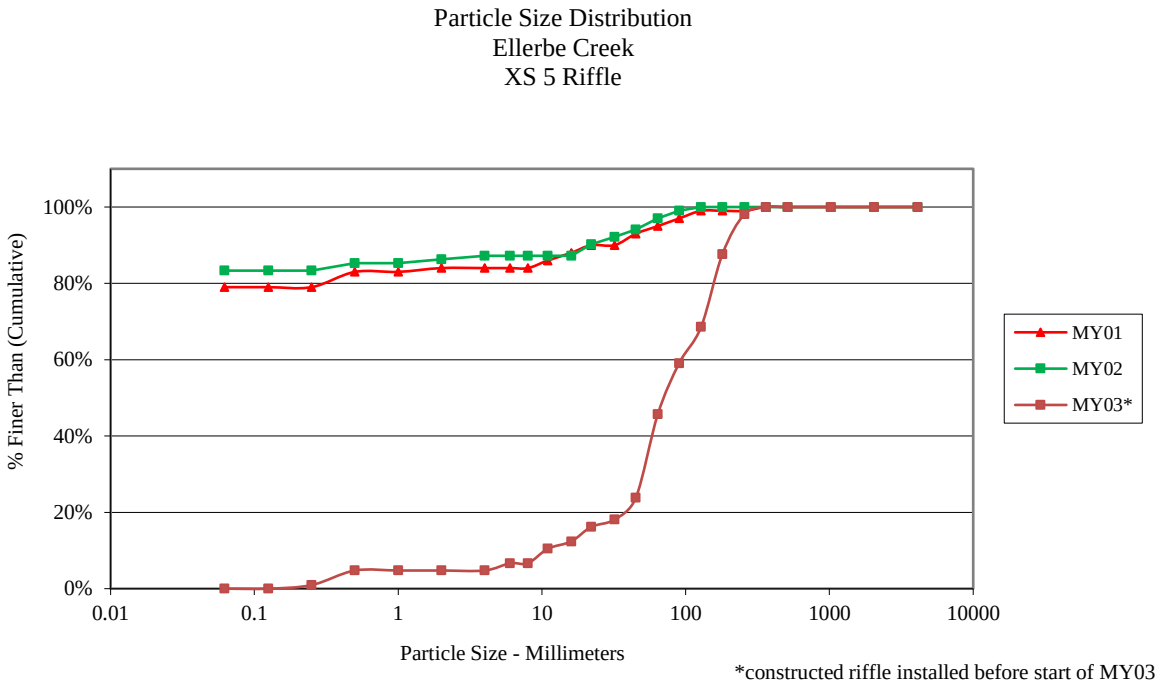
Size (mm)	
D16	0.062
D35	0.14
D50	0.28
D65	0.34
D84	0.46
D95	3.9

Size Distribution	
mean	0.2
dispersion	3.7
skewness	0.45

Type	
silt/clay	33%
sand	60%
gravel	7%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 5 Riffle - MY03			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	1
Medium	.25 - .50	N	4
Coarse	.50 - 1	D	
Very Coarse	1 - 2	S	
Very Fine	2 - 4		
Fine	4 - 5.7	G	2
Fine	5.7 - 8	R	
Medium	8 - 11.3	A	4
Medium	11.3 - 16	V	2
Coarse	16 - 22.6	E	4
Coarse	22.6 - 32	L	2
Very Coarse	32 - 45	S	6
Very Coarse	45 - 64		23
Small	64 - 90	C	14
Small	90 - 128	O	10
Large	128 - 180	B	20
Large	180 - 256	L	11
Small	256 - 362	B	2
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	105

Note:



*constructed riffle installed before start of MY03

Size (mm)	
D16	22
D35	54
D50	71
D65	110
D84	170
D95	230

Size Distribution	
mean	0.1
dispersion	3.1
skewness	0.42

Type	
silt/clay	0%
sand	5%
gravel	41%
cobble	52%
boulder	2%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Table 10. Baseline - Stream Data Summary Table
Project Number and Name: 272 – Northgate Park (Ellerbe Creek)
Segment Reach: Reach 1 (1,520 ft.)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Bankfull Width (ft)							30.8			13.5			30.0					
Floodprone Width (ft)							60			300								
Bankfull Cross-Sectional Area (ft^2)							118.6			30.8			54.6					
Bankfull Mean Depth (ft)							3.9			2.3			1.8					
Bankfull Maximum Depth (ft)							4.6			3.8			2.5					
Width/Depth Ratio							8.0			5.9			16.7					
Entrenchment Ratio							1.9			22.2								
Bank Height Ratio							1.7			0.9			1.0					
Pattern																		
Channel Beltwidth (ft)							50	100		50	125		40	60				
Radius of Curvature (ft)							150	180		16	30		165	180				
Meander Wavelength (ft)							700	1000		115	200		700	1000				
Meander Width Ratio							1.6	3.2		3.7	9.3		1.3	2.0				
Profile																		
Riffle Length (ft)																		
Riffle Slope (ft/ft)							0.014			0.005			0.002					
Pool Length (ft)																		
Pool Spacing (ft)							45	521		45	93		83	172				
Substrate																		
d50 (mm)																		
d84 (mm)																		
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)							1,466						1,466					
Sinuosity							1.02			1.33			1.01					
Water Surface Slope (ft/ft)							0.0009			0.0019			0.0006					
BF Slope (ft/ft)																		
Rosgen Classification							G5c			E5			C5					

Note: The Pre-Existing Condition and Project Reference Stream Data are the same for both reaches and are from the Restoration Plan document. The Design data are also from the Restoration Plan, except for the Dimension Parameter, which is from the Construction Plans. As-Built data were not taken due to project delays.

Table 10. Baseline - Stream Data Summary Table
Project Number and Name: 272 – Northgate Park (Ellerbe Creek)
Segment Reach: Reach 2 (750 ft.)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Bankfull Width (ft)							30.8			13.5			40.0					
Floodprone Width (ft)							60			300								
Bankfull Cross-Sectional Area (ft^2)							118.6			30.8			75.6					
Bankfull Mean Depth (ft)							3.9			2.3			1.9					
Bankfull Maximum Depth (ft)							4.6			3.8			2.8					
Width/Depth Ratio							8.0			5.9			21.1					
Entrenchment Ratio							1.9			22.2								
Bank Height Ratio							1.7			0.9			1.0					
Pattern																		
Channel Beltwidth (ft)							50	100		50	125		80	100				
Radius of Curvature (ft)							150	180		16	30		63	100				
Meander Wavelength (ft)							700	1000		115	200		260	300				
Meander Width Ratio							1.6	3.2		3.7	9.3		3.2	4.0				
Profile																		
Riffle Length (ft)																		
Riffle Slope (ft/ft)							0.014			0.005			0.001					
Pool Length (ft)																		
Pool Spacing (ft)							45	521		45	93		83	172				
Substrate																		
d50 (mm)																		
d84 (mm)																		
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)							1,466						690					
Sinuosity							1.02			1.33			1.02					
Water Surface Slope (ft/ft)							0.0009			0.0019			0.0005					
BF Slope (ft/ft)																		
Rosgen Classification							G5c			E5			C5					

Note: The Pre-Existing Condition and Project Reference Stream Data are the same for both reaches and are from the Restoration Plan document. The Design data are also from the Restoration Plan, except for the Dimension Parameter, which is from the Construction Plans. As-Built data were not taken due to project delays.

Table 10. Baseline - Stream Data Summary Table
Project Number and Name: 272 – Northgate Park (Ellerbe Creek)
Segment Reach: UT 3 (117 ft.)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Bankfull Width (ft)										13.5			3.2					
Floodprone Width (ft)										300								
Bankfull Cross-Sectional Area (ft^2)										30.8			1.5					
Bankfull Mean Depth (ft)										2.3			0.5					
Bankfull Maximum Depth (ft)										3.8			0.7					
Width/Depth Ratio										5.9			6.4					
Entrenchment Ratio										22.2								
Bank Height Ratio										0.9			1.0					
Pattern																		
Channel Beltwidth (ft)										50	125							
Radius of Curvature (ft)										16	30							
Meander Wavelength (ft)										115	200							
Meander Width Ratio										3.7	9.3							
Profile																		
Riffle Length (ft)																		
Riffle Slope (ft/ft)										0.005								
Pool Length (ft)																		
Pool Spacing (ft)										45	93							
Substrate																		
d50 (mm)																		
d84 (mm)																		
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)														117				
Sinuosity											1.33							
Water Surface Slope (ft/ft)											0.0019							
BF Slope (ft/ft)																		
Rosgen Classification											E5			E5				

Note: The Project Reference Stream Data are from the Restoration Plan document. The Design data are from the Construction Plans. There were no Pattern or Profile data for UT3 in the Restoration Plan.

Table 11a. Monitoring - Cross-Section Morphology Data Tables

Project Number and Name: 272 – Northgate Park (Ellerbe Creek)

Segment Reach: Reach 1 (1,520 ft.) and Reach 2 (750 ft.)

Parameter	Cross-Section 1 Riffle - Reach 1						Cross-Section 2 Pool - Reach 1						Cross-Section 3 Riffle - Reach 1					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3*	MY4	MY5
Record Elevation (datum) used		296.9	296.9	296.9				297.8	297.8	297.8				296.1	296.1	296.1		
Bankfull Width (ft)		24.0	23.8	22.8				28.5	29.2	24.7				25.0	23.8	28.7		
Floodprone Width (ft)		42.0	42.0	42.7				-	-	-				62.0	62.0	74.6		
Bankfull Cross-Sectional Area (ft^2)		45.0	43.1	51.4				82.4	77.3	89.1				53.4	63.4	98.5		
Bankfull Mean Depth (ft)		1.9	1.8	2.3				2.9	2.6	3.6				2.1	2.7	3.4		
Bankfull Maximum Depth (ft)		2.8	2.8	3.0				5.8	4.3	5.3				3.4	3.8	4.4		
Width/Depth Ratio		12.8	13.1	10.1				-	-	-				11.7	8.9	8.4		
Entrenchment Ratio		1.8	1.8	1.9				-	-	-				2.5	2.6	2.6		
Bank Height Ratio		1.0	1.0	1.0				-	-	-				1.0	1.0	1.0		
Cross-Sectional Area Between End Pins (ft^2)		-	188.5	178.6				-	250.3	262.5				-	327.4	326.1		
d50 (mm)		1.2	0.35	24				0.08	0.33	43				0.06	0.39	0.38		

Parameter	Cross-Section 4 Riffle - Reach 2						Cross-Section 5 Riffle - Reach 2					
Dimension	MY0	MY1	MY2	MY3*	MY4	MY5	MY0	MY1	MY2	MY3*	MY4	MY5
Record Elevation (datum) used		296.4	296.4	296.4				296.3	296.3	296.3		
Bankfull Width (ft)		25.2	28.4	28.7				36.1	26.9	33.5		
Floodprone Width (ft)		>75	>75	>75				>90	>90	>90		
Bankfull Cross-Sectional Area (ft^2)		80.2	84.9	98.5				82.0	81.2	87.4		
Bankfull Mean Depth (ft)		3.2	3.0	3.4				2.3	3.0	2.6		
Bankfull Maximum Depth (ft)		4.5	4.4	4.6				4.0	4.4	3.5		
Width/Depth Ratio		7.9	9.5	8.4				15.9	8.9	12.8		
Entrenchment Ratio		>3.0	>3.0	>3.0				>2.5	>2.5	>2.5		
Bank Height Ratio		1.0	1.0	1.0				1.0	1.0	1.0		
Cross-Sectional Area Between End Pins (ft^2)		-	326.9	330.7				-	151.8	124.7		
d50 (mm)		0.06	0.06	0.28				0.06	0.06	71		

*=Cross-sections 3, 4, and 5 reset in October 2014, before MY3 survey

Table 11b. Monitoring - Stream Reach Morphology Data Table
Project Number and Name: 272 – Northgate Park (Ellerbe Creek)
Segment Reach: Reach 1 (1,520 ft.)

Parameter	MY - 01 (2009)						MY - 02 (2010)						MY - 03 (2011)						MY - 04 (2012)						MY - 05 (2013)					
Dimension	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)	24.0	24.5		25.0		2	23.8	23.8		23.8		2	22.8	25.8		28.7		2												
Floodprone Width (ft)	42.0	52.0		62.0		2	42.0	52.0		62.0		2	42.7	58.7		74.6		2												
Bankfull Mean Depth (ft)	1.9	2.0		2.1		2	1.8	2.3		2.7		2	2.3	2.8		3.4		2												
Bankfull Max Depth (ft)	2.8	3.1		3.4		2	2.8	3.3		3.8		2	3.0	3.7		4.4		2												
Bankfull Cross-Sectional Area (ft^2)	45.0	49.2		53.4		2	43.1	53.3		63.4		2	51.4	75.0		98.5		2												
Width/Depth Ratio	11.7	12.3		12.8		2	8.9	11.0		13.1		2	8.4	9.2		10.1		2												
Entrenchment Ratio	1.8	2.2		2.5		2	1.8	2.2		2.6		2	1.9	2.2		2.6		2												
Bank Height Ratio	1.0	1.0		1.0		2	1.0	1.0		1.0		2	1.0	1.0		1.0		2												
Pattern																														
Channel Beltwidth (ft)	*	*	*	*	*	*																								
Radius of Curvature (ft)	*	*	*	*	*	*																								
Rad. of Curv. : Bankfull Width (ft/ft)	*	*	*	*	*	*																								
Meander Wavelength (ft)	*	*	*	*	*	*																								
Meander Width Ratio	*	*	*	*	*	*																								
Profile																														
Riffle Length (ft)	24.5		34.6	84.6			33.0	34.0		34.0		2	45.0	89.0	75.1	146.8	52.3	3												
Riffle Slope (ft/ft)	0.0000		0.0006	0.0010			0.0011	0.0010		0.0008		2	0.001	0.002	0.002	0.004	0.002	3												
Pool Length (ft)	10.1		36.7	52.8			29.0	36.4	36.0	43.5	25.6	5	17.5	34.5	33.7	53.9	12.4	8												
Pool Max Depth (ft)							1.6	2.4	2.4	3.2	0.65	6	1.7	2.7	2.6	3.4	0.6	8												
Pool Spacing (ft)	28.9		89.3	211.4			92.7	257.0	212.0	479.3	136.0	5	29.3	199.8	217.7	358.7	108.8	8												
Additional Reach Parameters																														
Valley Length (ft)	1,518						1,518						1,518																	
Channel Thalweg Length (ft)	1,580						1,580						1,580																	
Sinuosity	1.04						1.04						1.04																	
Water Surface Slope (ft/ft)	0.0014						0.0014						0.0011																	
Bankfull Slope (ft/ft)							0.0060						0.0008																	
Rosgen Classification	C5						C5						C5																	
Ri% / Ru% / P% / G% / S%							10 / 35 / 20 / 35 / 0						17 / 54 / 17 / 11 / 1																	
SC% / Sa% / G% / C% / B% / Be%	25 / 26 / 35 / 14 / 0 / 0						5 / 60 / 25 / 10 / 0 / 0						3 / 39 / 29 / 29 / 1 / 0																	
d16 / d35 / d50 / d84 / d95	0.062 / 0.15 / 1.2 / 51 / 110						0.019 / 0.3 / 0.39 / 44 / 94						0.6 / 5.4 / 23 / 51 / 103 / 158																	
% of Reach with Eroding Banks							15%						0%																	

*Reach 1 was enhanced, and is not a meandering channel

Table 11b. Monitoring - Stream Reach Morphology Data Table
Project Number and Name: 272 – Northgate Park (Ellerbe Creek)
Segment Reach: Reach 2 (750 ft.)

Parameter	MY - 01 (2009)						MY - 02 (2010)						MY - 03 (2011)						MY - 04 (2012)						MY - 05 (2013)					
Dimension	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)	25.2	30.7		36.1		2	23.8	25.4		28.4		2	28.7	31.1		33.5		2												
Floodprone Width (ft)	36.1	55.55		75		2	42.0	68.5		90.0		2	>75			>90		2												
Bankfull Mean Depth (ft)	2.3	2.7		3.2		2	1.8	2.8		3.0		2	2.6	3.0		3.4		2												
Bankfull Max Depth (ft)	4.0	4.3		4.5		2	2.8	4.1		4.4		2	3.5	4.0		4.6		2												
Bankfull Cross-Sectional Area (ft^2)	80.2	81.1		82.0		2	43.1	72.3		84.9		2	87.4	93.0		98.5		2												
Width/Depth Ratio	7.9	11.9		15.9		2	8.9	9.2		13.1		2	8.4	10.6		12.8		2												
Entrenchment Ratio	2.5	2.8		3.0		2	1.8	2.6		3.0		2	>2.5			>3.0		2												
Bank Height Ratio	1.0	1.0		1.0		2	1.0	1.0		1.0		2	1.0	1.0		1.0		2												
Pattern																														
Channel Beltwidth (ft)	59.0		74.0	94.0																										
Radius of Curvature (ft)	51.0		68.0	107.0																										
Rad. of Curv. : Bankfull Width (ft/ft)																														
Meander Wavelength (ft)	237.0		276.0	303.0																										
Meander Width Ratio	2.1		2.7	3.4																										
Profile																														
Riffle Length (ft)	9.2		16.1	29.2			12.1		15.8	25.0		3	30.6	39.1		47.6		2												
Riffle Slope (ft/ft)	0.001		0.001	0.003			0.001	0.001	0.002	0.003		3	0.003	0.006		0.009		2												
Pool Length (ft)	18.4		66.9	91.3			64.0	80.0	73.0	104.0		3	57.1	71.9	71.9	98.5	23.1	3												
Pool Max Depth (ft)							2.5	2.9	2.7	3.6		3	2.7	4.1	3.4	6.3	1.9	3												
Pool Spacing (ft)	67.7		156.6	183.7			154.8	170.0		185.7		2	167.2	254.1		341.0		2												
Additional Reach Parameters																														
Valley Length (ft)	658						658						658																	
Channel Thalweg Length (ft)	710						710						710																	
Sinuosity	1.08						1.08						1.08																	
Water Surface Slope (ft/ft)	0.00017						0.0009						0.001																	
Bankfull Slope (ft/ft)							0.0005						0.0019																	
Rosgen Classification	C5						C5						C5																	
Ri% / Ru% / P% / G% / S%							10 / 30 / 20 / 40 / 0						11 / 17 / 32 / 39 / 1																	
SC% / Sa% / G% / C% / B% / Be%	68 / 15 / 16 / 1 / 0 / 0						65 / 27 / 8 / 0 / 0 / 0						16 / 33 / 24 / 26 / 1 / 0																	
d16 / d35 / d50 / d84 / d95	0.062 / 0.062 / .0062 / 2.3 / 20						0.062 / 0.062 / 0.062 / 0.4 / 16						11 / 27 / 36 / 55 / 85 / 117																	
% of Reach with Eroding Banks							41%						0%																	

Appendix E

Hydrologic Data

Table 12. Verification of Bankfull Events Project Number and Name: 272 - Northgate Park (Ellerbe Creek)			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo Number**
6/14/2009	6/11/2009	Site visit to evaluate indicators of stage after storm event	N/A
11/11/2009	11/11/2009	Site visit to evaluate indicators of stage after storm event	N/A
12/25/2009	12/25/2009	Eye-witness account	N/A
1/25/2010	1/25/2010	Site visit to evaluate indicators of stage after storm event	N/A
5/17/2010	5/17/2010	Site visit to evaluate indicators of stage after storm event	N/A
9/30/2010	9/30/2010	Site visit to evaluate indicators of stage after storm event	N/A
6/30/2013	6/30/2013	Site visit to evaluate indicators of stage after storm event	1-2
9/24/2014	9/24/2014	Site visit to evaluate indicators of stage during storm event	3-4

Photo 1. Bankfull event 6/30/2013

Photo 2. Bankfull event 6/30/2013

Photo 3. Bankfull event 9/24/2014

Photo 4. Bankfull event 9/24/2014