Paschal Golf Course (Richland Creek)
Stream Restoration Monitoring Report
EEP Project # 276
EEP Contract # D080285
Monitoring Year 02

Submitted to:

Ecosystem Enhancement PROGRAM

NCEEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

Construction Completed: May 2010
Data Collection: August 2012
Submitted: January 2013

Monitoring Firm

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KCI Project No: 12071067B_RC12

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Table of Contents

1.0 EXECUTIVE SUMMARY / PROJECT ABSTRACT

The Paschal Golf Course (Richland Creek) Stream Restoration Site, completed in May 2010, restored a total of 2,919 linear feet of stream and 167,092 square feet of buffer restoration in the Neuse River Basin. The project is located in the USGS Hydrologic Unit 03020201-07-0060. This HU is within the EEP's Neuse River Basin Local Watershed Plan and is also listed as a Targeted Local Watershed (TLW) in EEP's *Neuse River Basin Restoration Priorities 2010*. The project goals and objectives are listed below.

Project Goals

- Restore a stable channel morphology and floodplain to the project stream that is capable of moving the flows and sediment provided by its watershed.
- Improve water quality by reducing bank erosion and bed degradation.
- Provide a riparian management zone that is compatible with the surrounding uses (golf course and electrical transmission corridor) and yet retains the ecological function of the riparian zone.
- Enhance aquatic and terrestrial habitat in the stream corridor.

Project Objectives

- Restore 2,919 linear feet of stable stream channel with the appropriate pattern, profile, and dimension that can support efficient sediment transport.
- Plant native trees and shrubs throughout the site.
- Grade a floodplain adjacent to the stream.

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 second-year vegetation monitoring was based on the Level 2 CVS-EEP vegetation monitoring protocol. The site's average density for this monitoring period was 439 planted stems/acre, including live stakes, and 387 planted stems/acre, excluding live stakes. Including volunteers, the site averaged 5,064 total stems/acre. Both of the vegetation monitoring plots in the streamside planting area (Plots 1 and 6), had planted stem densities below the five-year success criterion of 260 stems/acre. Of the plots in the buffer restoration area (Plots 2, 3, 4, 5, and 7), Plot 7 had a planted stem density below the five-year success criterion of 320 stems/acre. The 2012 monitoring found an overall low vigor and live stake survivability throughout the site. Due to the fact that the planted vegetation is still young, the low vigor areas have not been quantified. There were many loblolly pine and sweetgum volunteers throughout the easement; in certain areas these volunteers are extremely dense. Invasive species are not currently an issue of concern at the site.

Second-year monitoring found Richland Creek to be mostly stable, with only minor changes from the baseline conditions. The stream has had areas of localized bank erosion since construction (2% of all banks), with six areas along the stream, only one area (Station 26+25) displaying signs of mass wasting (1% of all banks). One area along the stream is experiencing bed degradation along with one area experiencing deposition. These areas will continue to be watched closely in Monitoring Year Three. The longitudinal and cross-sectional data also reflect the overall stability in the project streams. 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 (formerly the Restoration Plan) documents available on the EEPs 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.

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 stationing was adjusted by changing the stationing between grade control structures to match the stationing from previous surveys.

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

3.0 REFERENCES

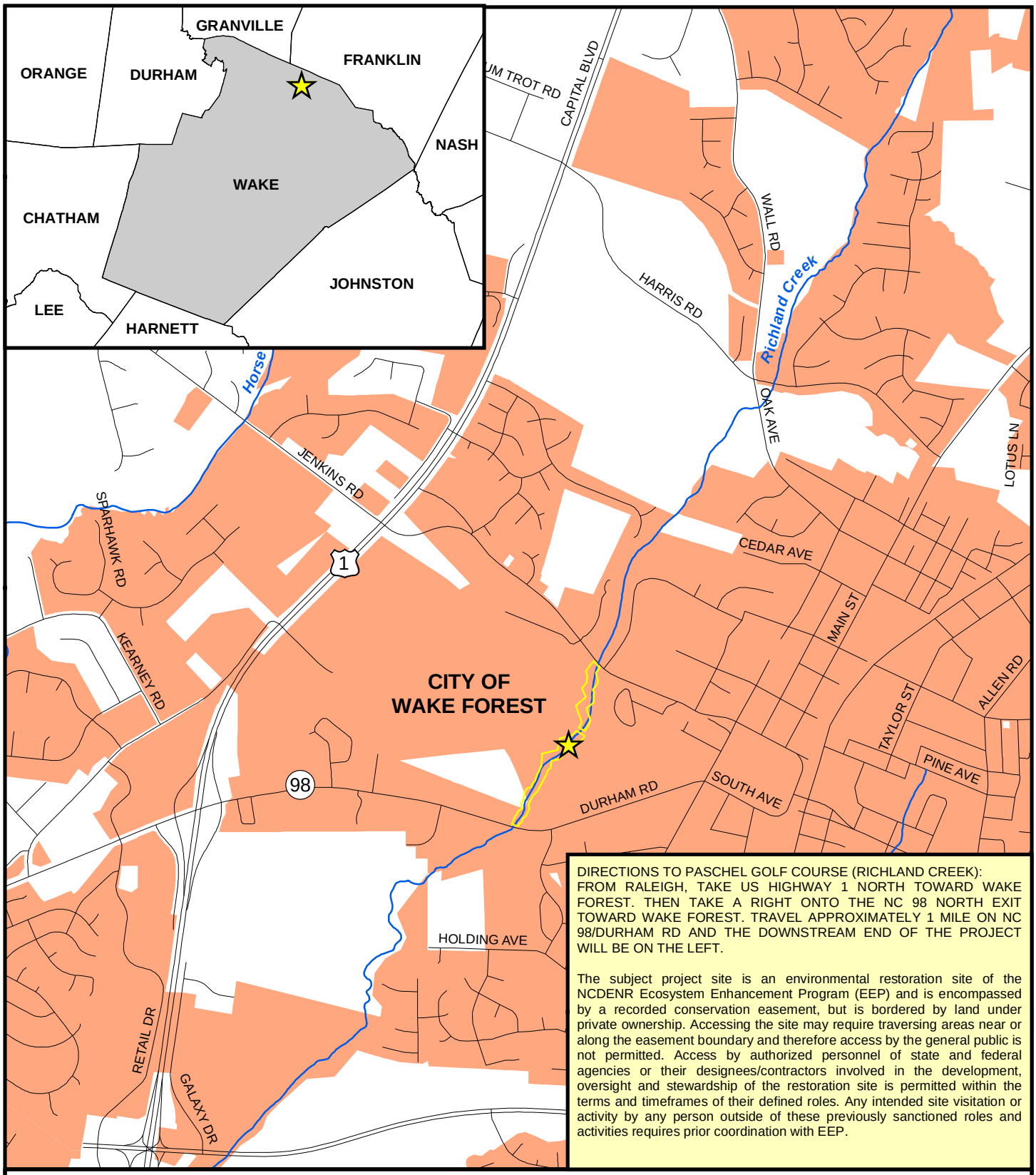
Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0 (http://cvs.bio.unc.edu/methods.htm)

NCEEP. 2010. DRAFT - Neuse River Basin Restoration Priorities. (http://www.nceep.net/services/restplans/DRAFT_RBRP_Neuse_201007.pdf)

USACE. 2003. Stream Mitigation Guidelines. USACE, NCDENR-DWQ, USEPA, NCWRC.

Appendix A

Project Vicinity Map and Background Tables



DIRECTIONS TO PASCHEL GOLF COURSE (RICHLAND CREEK):
FROM RALEIGH, TAKE US HIGHWAY 1 NORTH TOWARD WAKE FOREST. THEN TAKE A RIGHT ONTO THE NC 98 NORTH EXIT TOWARD WAKE FOREST. TRAVEL APPROXIMATELY 1 MILE ON NC 98/DURHAM RD AND THE DOWNSTREAM END OF THE PROJECT WILL BE ON THE LEFT.

The subject project site is an environmental restoration site of the NCDENR Ecosystem Enhancement Program (EEP) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight and stewardship of the restoration site is permitted within the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activities requires prior coordination with EEP.

Figure 1. Vicinity Map - Paschal Golf Course (Richland Creek), Project No. 276

KCI

Project Location
Roads
Major Streams and Rivers
Municipalities
Project Easement

N
W E
S

1:24,000

0.2 0.1 0 0.2
Miles

Ecosystem Enhancement PROGRAM

Figure 2. Site Map
Paschal Golf Course (Richland Creek)
Project No. 276

KCI ASSOCIATES OF NC

Ecosystem Enhancement PROGRAM

N

0 150 300

Feet

Project Easement

Thalweg

Buffer Restoration

Utility Right of Way

Play Over Area

Managed Golf Course Area

Existing Jurisdictional Wetland

1:1,800

1 inch = 150 feet

Map created 12/19/2011 by KCI.
Image Source: NC Statewide Orthoimagery, 2010.

Note: Image taken during project construction.

Table 1a. Project Components Paschal Golf Course (Richland Creek) / Project No. 276									
Project Component or Reach ID	**Existing Feet/Acres**	**Restoration Level**	**Approach**	**Linear Footage or Square Feet***	**Stationing**	**Mitigation Ratio**	**Mitigation Credits+**	**BMP Elements**	**Comment**
Richland Creek	N/A	R	P2	2,919	10+00 - 39+80	1:1	2,766		In-stream structures, including offset rock cross vanes, riffle grade controls, and rock sills, were used to stabilize restored channel. Planted a riparian buffer.
Buffer		R		167,092.2		1:1	167,092.2		Buffer was planted with native vegetation.

*Linear footage does not include the stream length that runs under a golf cart bridge through an easement exception. Square feet of buffer are limited to the areas of the buffer that meet the regulatory criteria for buffer restoration credit. See Figure 2 for the locations of the creditable buffer.

+The credits have been reduced to account for areas where the stream flows through vegetation management zones within the easement. These management areas are depicted on Figure 2. They include a utility right of way and a play over area for the golf course. Under the utility right of way the buffer will be allowed to grow to a height of 12'. Due to this restriction the 309 mitigation credits that would be generated by the stream in the right of way is reduced by 25% to 231 stream credits. The vegetation in the play over area will be trimmed to a few feet high. Due to this restriction, the 151 mitigation credits that would be generated by the stream in the play over area are reduced by 50% to 76 stream credits. There is 2,459 lf of stream that does not have any reductions and will generate 2,459 credits.

Table 1b. Component Summations Paschal Golf Course (Richland Creek) / Project No. 276							
Restoration Level	**Stream (lf)**	**Riparian Wetland (Ac)**		**Non-Ripar (Ac)**	**Upland (Ac)**	**Buffer (Ac)**	**BMP**
		Riverine	**Non-Riverine**				
Restoration	2,919					3.84	
Enhancement							
Enhancement I							
Enhancement II							
Creation							
Preservation							
HQ Preservation							
		0	0				
Totals (Feet/Acres)	**2,919**	**0**		**0**	**0**	**3.84**	**0**
MU Totals	**2,766**	**0**		**0**	**0**	**3.84**	**0**

Table 2. Project Activity & Reporting History Paschal Golf Course (Richland Creek) / Project No. 276		
Elapsed Time Since Grading Complete: 2 yr 7 months **Elapsed Time Since Planting Complete: 2 yr 7 months** **Number of Reporting Years: 2**		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan	2004	June 2007
Final Design - Construction Plans		Sept 2007
Construction		May 2010
Planting		May 2010
Baseline Monitoring/Report	Aug 2010	Dec 2010
Year 1 Monitoring	Aug 2011	Dec 2011
Year 2 Monitoring	Aug 2012	Nov 2012

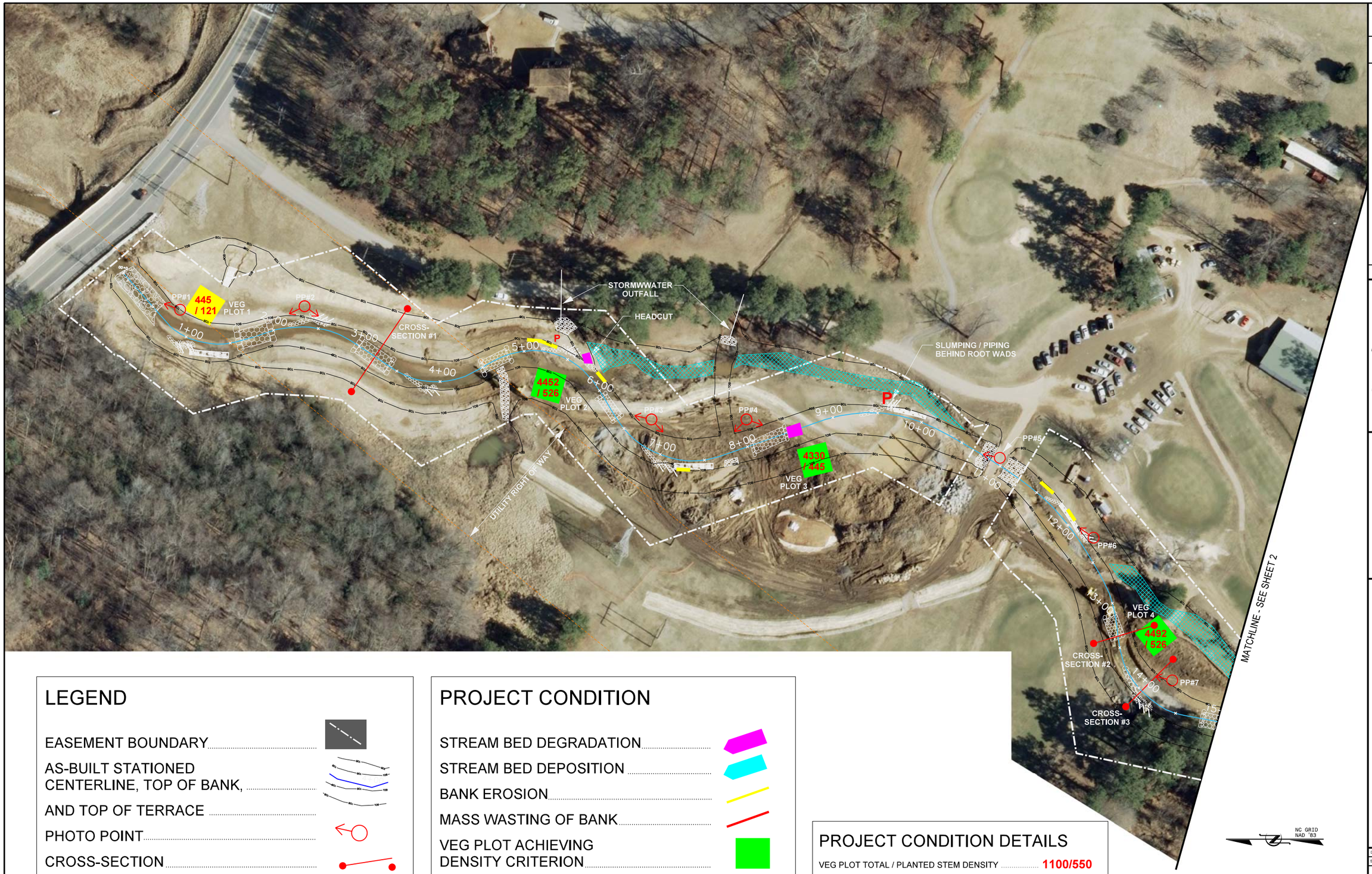
Table 3. Project Contacts Paschal Golf Course (Richland Creek) / Project No. 276	
Designer	EcoLogic Associates, P.C. 3808 Clifton Road Greensboro, NC 27407
Primary Project Design POC	Mark Taylor, PE (336) 632-4441
Construction Contractor	River Works 8000 Regency Parkway, Suite 200 Cary, NC 27518
Construction Contractor POC	William Pedersen (919) 459-9034
Planting Contractor	H + J Forest Service
Planting Contractor POC	Matt Hitch (910) 264-1612
Monitoring Performers	KCI Associates of North Carolina 4601 Six Forks Road, Suite 220 Raleigh, NC 27609
Monitoring POC	Adam Spiller (919) 278-2514

Table 4. Project Attributes Paschal Golf Course (Richland Creek) / Project No. 276	
Project County	Wake County
Physiographic Region	Piedmont
Ecoregion	Northern Outer Piedmont
River Basin	Neuse
USGS HUC	03020201
NCDWQ Sub-Basin	03-04-02
Within Extent of EEP Watershed Plan	Yes - Draft - Neuse River Basin Restoration Priorities 2010
WRC Class	Warm
% of Project Easement Demarcated	70%, with wooden bollards
Beaver Activity Observed During Design Phase	Yes
Restoration Component Attributes	
Drainage Area (sq.mi.)	7.8
Stream Order	Second
Restored Length (feet)	2,919
Perennial or Intermittent	Perennial
Watershed Type	Suburban
Watershed LULC Distribution	
Forest/Wetland	35%
Agricultural/Managed Herbaceous	35%
Developed	30%
Watershed Impervious Cover	10%
NCDWQ AU/Index Number	27-21
NCDWQ Classification	C; NSW
303d Listed	U
Upstream of 303d Listed Segment	U
Reasons for 303d Listing or Stressor	U
Total Acreage of Easement	8.5
Total Vegetated Acreage within Easement	1.3
Total Planted Acreage as Part of Restoration	7.2
Rosgen Classification of Pre-Existing	C4/F4
Rosgen Classification of As-Built	C4
Valley Type	-
Valley Slope	0.002
Valley Side Slope Range	-
Valley Toe Slope Range	-
Cowardin Classification	-
Trout Waters Designation	No
Species of Concern, Endangered, Etc.	None
Dominant Soil Series and Characteristics	
Series	Chewacla
Depth	Deep
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 CENTERLINE, TOP OF BANK,
- AND TOP OF TERRACE
- PHOTO POINT
- CROSS-SECTION
- OLD STREAM CHANNEL

PROJECT CONDITION

- STREAM BED DEGRADATION
- STREAM BED DEPOSITION
- BANK EROSION
- MASS WASTING OF BANK
- VEG PLOT ACHIEVING DENSITY CRITERION
- VEG PLOT BELOW DENSITY CRITERION

PROJECT CONDITION DETAILS

VEG PLOT TOTAL / PLANTED STEM DENSITY	1100/550
STRUCTURE PIPING	P
STRUCTURE NOT PROTECTING BANK	B

IMAGE SOURCE: NC 2010 STATEWIDE ORTHOIMAGERY
NOTE: IMAGE TAKEN DURING PROJECT CONSTRUCTION

NC GRID
NAD '83

–50 –25 0 50 100
GRAPHIC SCALE

REVISIONS

SYM	DESCRIPTION	DATE	APPROVED

Ecosystem Enhancement PROGRAM

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

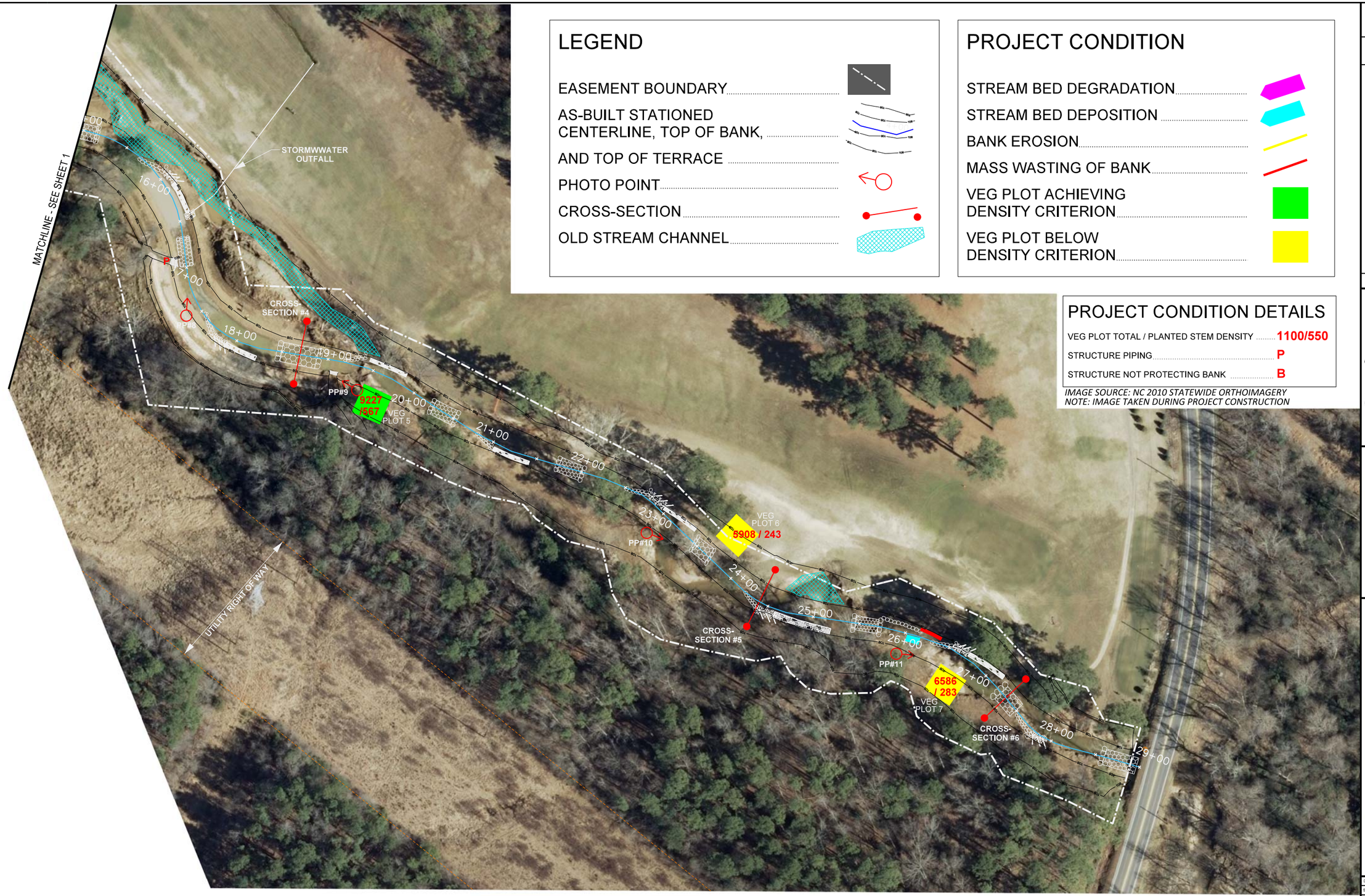
PASCHAL GOLF COURSE (RICHLAND CREEK)
PROJECT #276 - MONITORING YEAR 2

WAKE FOREST, WAKE COUNTY, NORTH CAROLINA

DATE: NOV 2012
SCALE: 1" = 100'
FIGURE 3

CURRENT CONDITION PLAN VIEW

SHEET 1 OF 2



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–50 –25 0 50 100
GRAPHIC SCALE

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PASCHAL GOLF COURSE (RICHLAND CREEK) PROJECT #276 - MONITORING YEAR 2

WAKE FOREST, WAKE COUNTY, NORTH CAROLINA

DATE: NOV 2012
SCALE: 1" = 100'

FIGURE 3

CURRENT CONDITION PLAN VIEW

SHEET 2 OF 2

Table 5. Visual Stream Morphology Stability Assessment

Project Number and Name: 276 - Paschal Golf Course (Richland Creek)

Assessed Length 2,919 **Reach - Richland Creek**

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
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)			1	10	100%
		2. Degradation - Evidence of downcutting			1	20	99%
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	17	17			100%
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	13	13			100%
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	13	13			100%
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	17	17			100%
		2. Thalweg centering at downstream of meander (Glide)	17	17			100%
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			6	105	98%
	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%
	3. Mass Wasting	Bank slumping, calving, or collapse			1	20	100%
				Totals	7	125	98%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	16	16			100%
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	15	15			100%
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	1	2			50%
	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)	14	16			88%
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	16	16			100%

Table 6. Vegetation Condition Assessment
Project Number and Name: 276 - Paschal Golf Course (Richland Creek)

Planted Acreage 7.2 **Easement Acreage 8.5**

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 acre	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 acre	Pattern and Color+	0	0.00	0.0%
			Total	0	0.00	0.0%
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 acre	Pattern and Color	0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%
4. Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale).	1,000 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%

*These areas were not depicted on the CCPV. Generally, the floodplain of Richland Creek has many small scattered bare areas that are below the mapping threshold, but are significant when combined.

+These areas were not depicted on the CCPV. Generally, the floodplain of Richland Creek has many scattered areas of noticable low stem densities that are below the mapping threshold, but are significant when combined.

Stream Station Photos

Photo Point #1 – Looking upstream at fish ramp 8/6/2010– Baseline

Photo Point #1 – Looking upstream at fish ramp 11/5/2012– MY-02

Photo Point #2 – Looking downstream 8/6/2010– Baseline

Photo Point #2 – Looking downstream 11/5/2012– MY-02

Photo Point #2 – Looking upstream 8/6/2010– Baseline

Photo Point #2 – Looking upstream 11/5/2012– MY-02

Photo Point #3 – Looking downstream 8/6/2010– Baseline

Photo Point #3 – Looking downstream 11/5/2012– MY-02

Photo Point #3 – Looking upstream 8/6/2010– Baseline

Photo Point #3 – Looking upstream 11/5/2012– MY-02

Photo Point #4 – Looking downstream 8/6/2010– Baseline

Photo Point #4 – Looking downstream 11/5/2012– MY-02

Photo Point #4 – Looking upstream 8/6/2010– Baseline

Photo Point #4 – Looking upstream 11/5/2012– MY-02

Photo Point #5 – Looking upstream from bridge 8/6/2010– Baseline

Photo Point #5 – Looking upstream from bridge 11/5/2012– MY-02

Photo Point #6 – 8/6/2010 – Baseline

Photo Point #6 – 11/5/2012– MY-02

Photo Point #7 – 8/6/2010 – Baseline

Photo Point #7 – 11/5/2012– MY-02

Photo Point #8 – 8/6/2010– Baseline

Photo Point #8 – 11/5/2012– MY-02

Photo Point #9 –8/6/2010– Baseline

Photo Point #9 –11/5/2012– MY-02

Photo Point #10 – 8/6/2010 – Baseline

Photo Point #10 – 11/5/2012– MY-02

Photo Point #11 – 8/6/2010– Baseline

Photo Point #11 – 11/5/2012– MY-02

Vegetation Plot Photos

Veg Plot #1 – 7/17/2012

Veg Plot #2 – 7/17/2012

Veg Plot #3 – 7/17/2012

Veg Plot #4 – 7/17/2012

Veg Plot #5 – 7/17/2012

Veg Plot #6 – 7/17/2012

Veg Plot #7 – 7/17/2012

Appendix C

Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment
Paschal Golf Course (Richland Creek) / Project No. 276

Stream Vegetation Totals (per acre)				
Plot ID	**[1]Stream Stems**	**[2]Volunteers**	**[3]Total**	**Success Criteria Met?**
1	121	121	445	No
6	243	243	5,908	No
Project Avg	182	182	3,177	

Buffer Vegetation Totals (per acre)		
Plot ID	**[4]Buffer Stems**	**Success Criteria Met?**
2	526	Yes
3	445	Yes
4	526	Yes
5	567	Yes
7	283	No
Project Avg	469	

[1]Stream Stems Native planted woody stems. Includes shrubs, does NOT include live stakes.
[2]Volunteers Native woody stems. NOT planted.
[3]Total Planted + volunteer native woody stems. Includes live stakes.
[4]Buffer Stems Native planted hardwood trees. Does NOT include live stakes and shrubs.

Table 8. CVS Vegetation Plot Metadata Paschal Golf Course (Richland Creek) / Project No. 276	
Report Prepared By	April Helms
Date Prepared	11/7/2012 10:20
database name	KCI-2012-R.mdb
database location	M:\2007\12071067_2007 EEP OPEN END\Veg_database
computer name	12-CV76KF1
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.
PROJECT SUMMARY----------	
Project Code	304
project Name	Richland Creek
Description	
River Basin	Neuse
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	

Table 9. CVS Stem Count Total and Planted by Plot and Species
Paschal Golf Course (Richland Creek) / Project No. 276

			Current Plot Data (MY2 2012)																	
			E304-01-0001			E304-01-0002			E304-01-0003			E304-01-0004			E304-01-0005			E304-01-0006		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Alnus serrulata	hazel alder	Shrub				4	4	4	2	2	2									
Aronia arbutifolia	Red Chokeberry	Shrub										2	2	2	5	5	5	4	4	4
Betula nigra	river birch	Tree																		
Baccharis	baccharis	Shrub															1			
Betula nigra	river birch	Tree												28			5			
Celtis	hackberry	Tree										1	1	1	1	1	1			
Celtis occidentalis	common hackberry	Tree																		
Cephalanthus occidentalis	common buttonbush	Shrub				1	1	1	1	1	1				1	1	1			
Clethra alnifolia	coastal sweetpepperbush	Shrub	1	1	1	2	2	2												
Cornus amomum	silky dogwood	Shrub	2	2	2		1	1	1	1	1	1	1	1		3	3			
Diospyros virginiana	common persimmon	Tree										1	1	1						
Fraxinus pennsylvanica	green ash	Tree							2	2	2	2	2	2	2	2	2			1
Liquidambar styraciflua	sweetgum	Tree			5			1			1						5			7
Liriodendron tulipifera	tuliptree	Tree						1												
Nyssa sylvatica	blackgum	Tree				1	1	5			1				1	1	1			
Pinus taeda	loblolly pine	Tree			3			81			94			68			197			132
Platanus occidentalis	American sycamore	Tree				4	4	7	5	5	5	5	5	7			2	2	2	2
Quercus laurifolia	laurel oak	Tree													1	1	1			
Quercus michauxii	swamp chestnut oak	Tree																		
Quercus nigra	water oak	Tree																		
Quercus phellos	willow oak	Tree													3	3	4			
Salix sericea	silky willow	Shrub				1	3	7												
Sambucus canadensis	Common Elderberry	Shrub																		
Unknown		Shrub or Tree																		
Viburnum dentatum	southern arrowwood	Shrub										1	1	1						
		Stem count	3	3	11	13	16	110	11	11	107	13	13	111	14	17	228	6	6	146
		size (ares)	1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	2	2	4	6	7	10	5	5	8	7	7	9	7	8	13	2	2	5
		Stems per ACRE	121	121	445	526	647	4452	445	445	4330	526	526	4492	567	688	9227	243	243	5908

Table 9. CVS Stem Count Total and Planted by Plot and Species continued
Paschal Golf Course (Richland Creek) / Project No. 276

			Annual Means											
			E304-01-0007			MY2 (2012)			MY1 (2011)			MY0 (2010)		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Alnus serrulata	hazel alder	Shrub				6	6	6	6	6	6	8	8	8
Aronia arbutifolia	Red Chokeberry	Shrub	2	2	2	13	13	13	7	7	7			
Betula nigra	river birch	Tree									1			
Baccharis	baccharis	Shrub						1						
Betula nigra	river birch	Tree						33						
Celtis	hackberry	Tree				2	2	2	3	3	3	3	3	3
Celtis occidentalis	common hackberry	Tree										1	1	1
Cephalanthus occidentalis	common buttonbush	Shrub				3	3	3	3	3	3	5	5	5
Clethra alnifolia	coastal sweetpepperbush	Shrub				3	3	3	3	3	3	3	3	3
Cornus amomum	silky dogwood	Shrub	1	3	3	5	11	11	9	19	19	18	54	54
Diospyros virginiana	common persimmon	Tree				1	1	1	2	2	2	4	4	4
Fraxinus pennsylvanica	green ash	Tree	1	1	1	7	7	8	8	8	8	8	8	8
Liquidambar styraciflua	sweetgum	Tree			65			84			2			
Liriodendron tulipifera	tuliptree	Tree			1			2			2			
Nyssa sylvatica	blackgum	Tree				2	2	7	4	4	7	5	5	5
Pinus taeda	loblolly pine	Tree			81			656			10			
Platanus occidentalis	American sycamore	Tree	3	3	9	19	19	32	19	19	31	20	20	20
Quercus laurifolia	laurel oak	Tree				1	1	1						
Quercus michauxii	swamp chestnut oak	Tree							1	1	1	1	1	1
Quercus nigra	water oak	Tree										1	1	1
Quercus phellos	willow oak	Tree				3	3	4	4	4	4	6	6	6
Salix sericea	silky willow	Shrub		1	1	1	4	8	1	20	20	1	21	21
Sambucus canadensis	Common Elderberry	Shrub								1	1	1	12	12
Unknown		Shrub or Tree							8	10	10	28	40	40
Viburnum dentatum	southern arrowwood	Shrub				1	1	1	1	1	1	1	1	1
		Stem count	7	10	163	67	76	876	79	111	141	114	193	193
		size (ares)	1			7			7			7		
		size (ACRES)	0.02			0.17			0.17			0.17		
		Species count	4	5	8	14	14	19	15	16	20	17	17	17
		Stems per ACRE	283	405	6596	387	439	5064	457	642	815	659	1116	1116

Appendix D

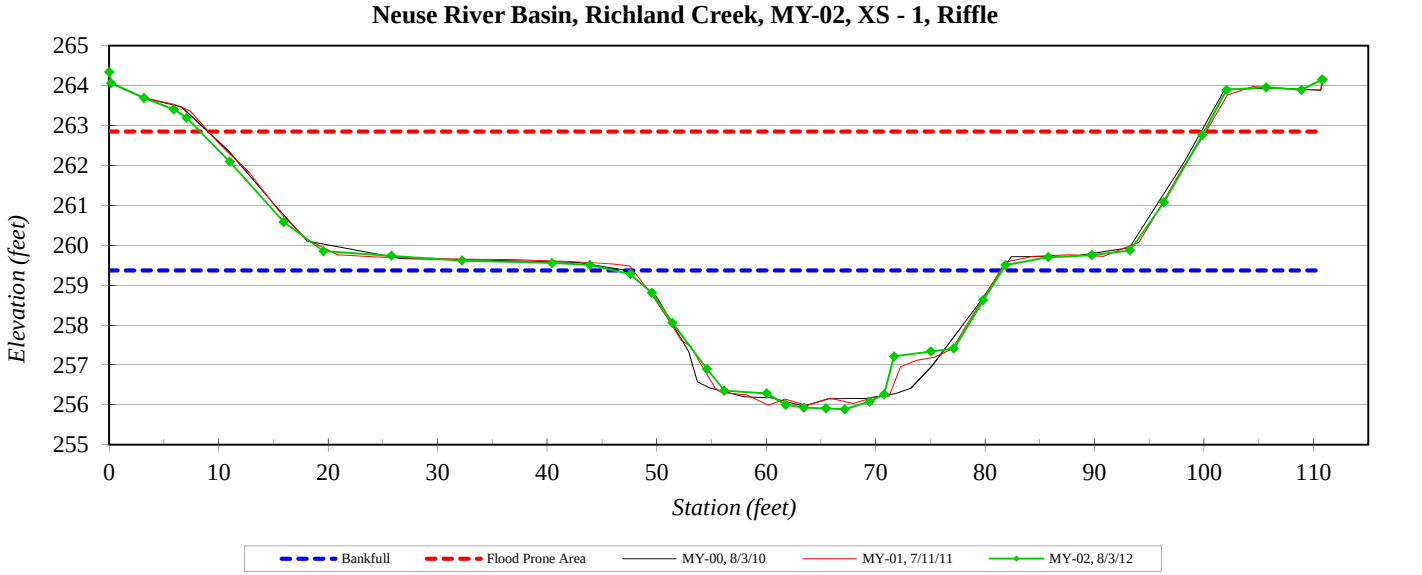
Stream Survey Data

Cross-Section Plots

River Basin:	Neuse
Watershed:	Richland Creek, MY-02
XS ID	XS - 1, Riffle
Drainage Area (sq mi):	7.8
Date:	8/3/2012
Field Crew:	A. French, F. Davis

Station	Elevation
0.0	264.34
0.2	264.06
3.2	263.69
0.0	263.40
1.2	263.19
5.1	262.09
10.0	260.58
13.7	259.85
19.9	259.73
26.3	259.61
34.6	259.56
38.0	259.51
41.7	259.28
43.7	258.81
45.5	258.05
48.7	256.90
50.3	256.36
54.2	256.29
55.9	256.00
57.6	255.93
59.6	255.91
61.3	255.89
63.6	256.08
64.9	256.27
65.8	257.21
69.2	257.34
71.2	257.41
73.9	258.62
76.0	259.50
79.9	259.70
83.9	259.75
87.3	259.87
90.4	261.08
94.0	262.76
96.2	263.89

SUMMARY DATA	
Bankfull Elevation:	259.4
Bankfull Cross-Sectional Area:	78.5
Bankfull Width:	35.4
Flood Prone Area Elevation:	262.8
Flood Prone Width:	89
Max Depth at Bankfull:	3.5
Mean Depth at Bankfull:	2.2
W / D Ratio:	16.0
Entrenchment Ratio:	>2.2
Bank Height Ratio:	1.0

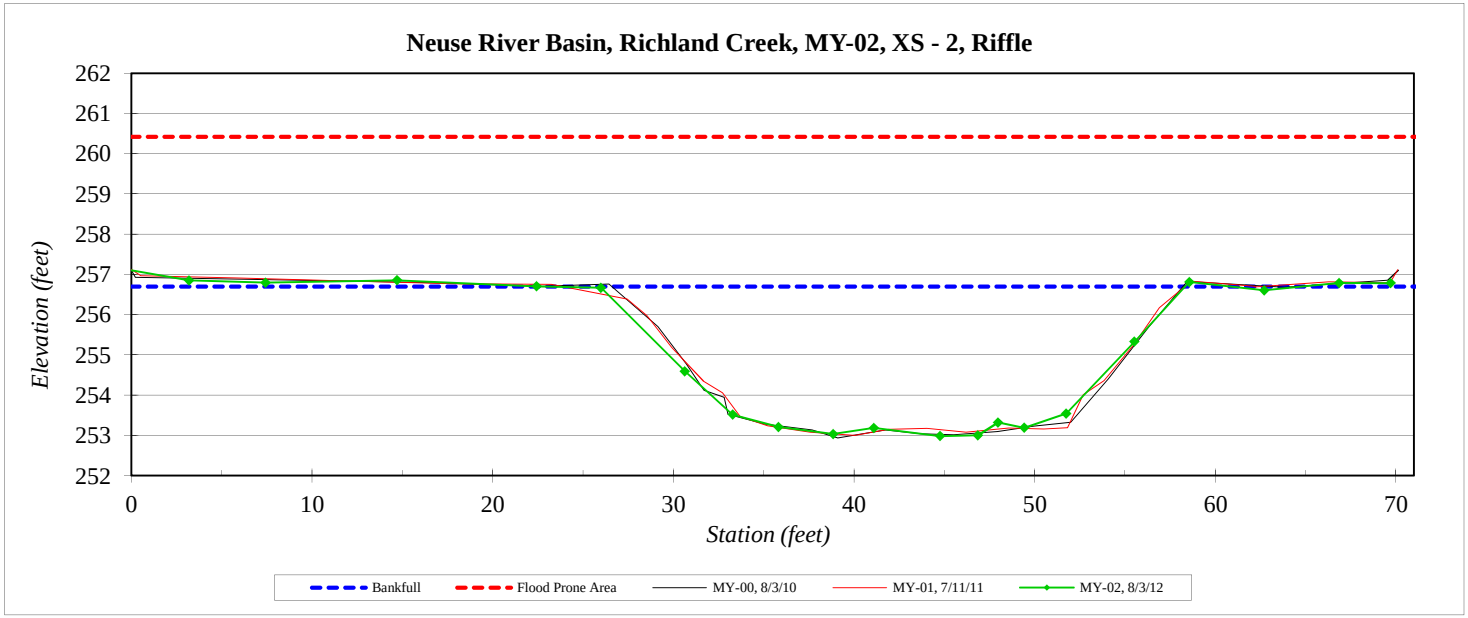


*Other shots not included due to space

River Basin:	Neuse
Watershed:	Richland Creek, MY-02
XS ID	XS - 2, Riffle
Drainage Area (sq mi):	7.8
Date:	8/3/2012
Field Crew:	A. French, F. Davis

Station	Elevation
0.0	257.11
3.3	256.85
7.5	256.79
14.8	256.85
22.5	256.70
26.1	256.67
30.7	254.59
33.3	253.51
35.9	253.21
38.9	253.04
41.2	253.18
44.8	252.98
46.9	253.00
49.5	253.19
51.8	253.54
55.6	255.33
58.6	256.81
62.8	256.60
66.9	256.79
69.8	256.79
70.1	257.13

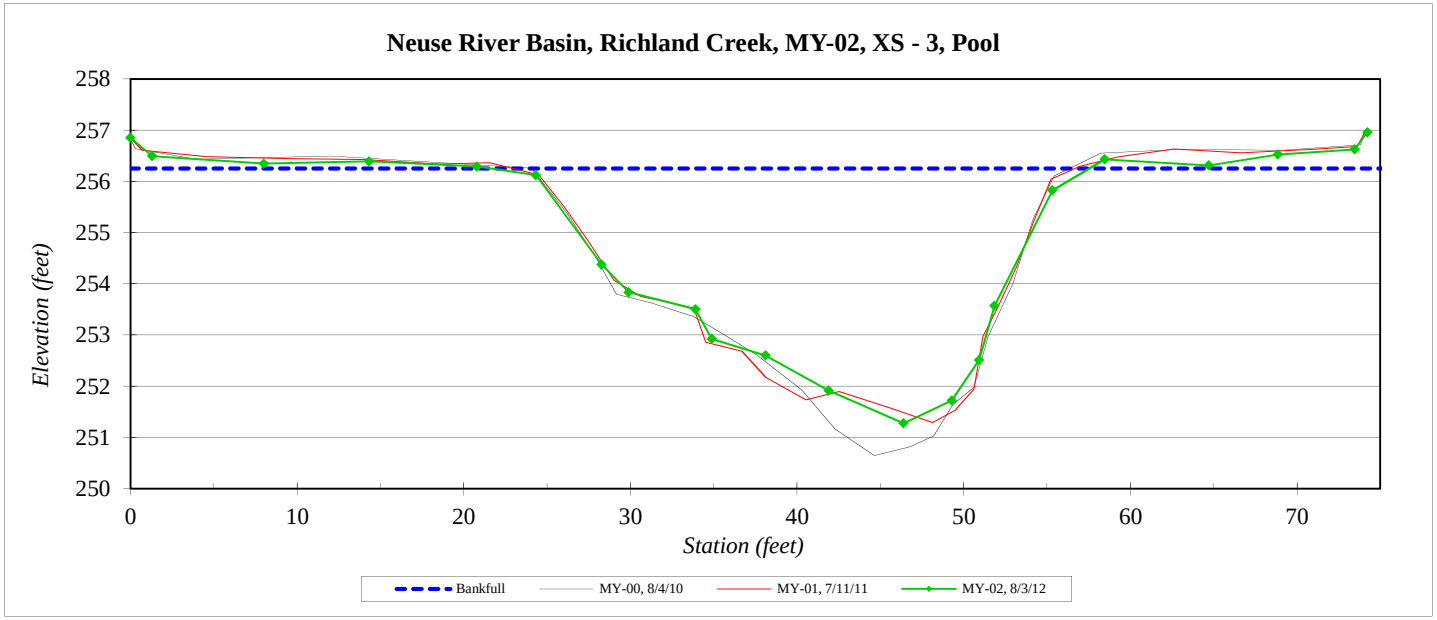
SUMMARY DATA	
Bankfull Elevation:	256.7
Bankfull Cross-Sectional Area:	87.6
Bankfull Width:	35.6
Flood Prone Area Elevation:	260.4
Flood Prone Width:	>70
Max Depth at Bankfull:	3.7
Mean Depth at Bankfull:	2.5
W / D Ratio:	14.5
Entrenchment Ratio:	>2.2
Bank Height Ratio:	1.0



River Basin:	Neuse
Watershed:	Richland Creek, MY-02
XS ID	XS - 3, Pool
Drainage Area (sq mi):	7.8
Date:	8/3/2012
Field Crew:	A. French, F. Davis

Station	Elevation
0.0	256.85
1.3	256.50
8.0	256.35
14.3	256.39
20.8	256.29
24.3	256.12
28.3	254.38
29.9	253.84
33.9	253.50
34.9	252.93
38.1	252.60
41.9	251.92
46.4	251.28
49.3	251.72
50.9	252.51
51.8	253.57
55.3	255.83
58.5	256.43
64.7	256.31
68.8	256.52
73.5	256.62
74.2	256.96

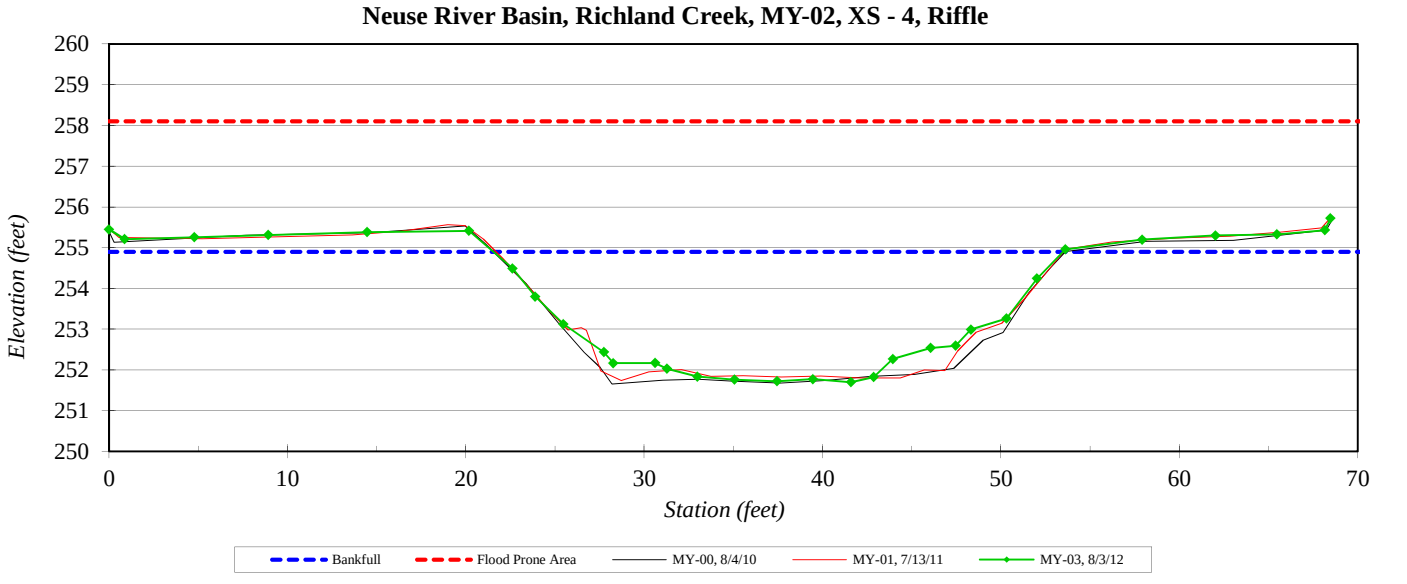
SUMMARY DATA	
Bankfull Elevation:	256.3
Bankfull Cross-Sectional Area:	97.8
Bankfull Width:	36.1
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	5.0
Mean Depth at Bankfull:	2.7
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-



River Basin:	Neuse
Watershed:	Richland Creek, MY-02
XS ID	XS - 4, Riffle
Drainage Area (sq mi):	7.8
Date:	8/3/2012
Field Crew:	A. French, F. Davis

Station	Elevation
0.0	255.45
0.9	255.21
4.8	255.25
8.9	255.31
14.5	255.38
20.2	255.41
22.6	254.49
23.9	253.80
25.5	253.12
27.7	252.44
28.3	252.16
30.6	252.17
31.3	252.03
33.0	251.83
35.1	251.76
37.4	251.72
39.5	251.77
41.6	251.70
42.9	251.82
43.9	252.26
46.1	252.54
47.5	252.59
48.3	252.99
50.3	253.26
52.0	254.24
53.6	254.96
57.9	255.20
62.0	255.30
65.5	255.33
68.2	255.43
68.5	255.72

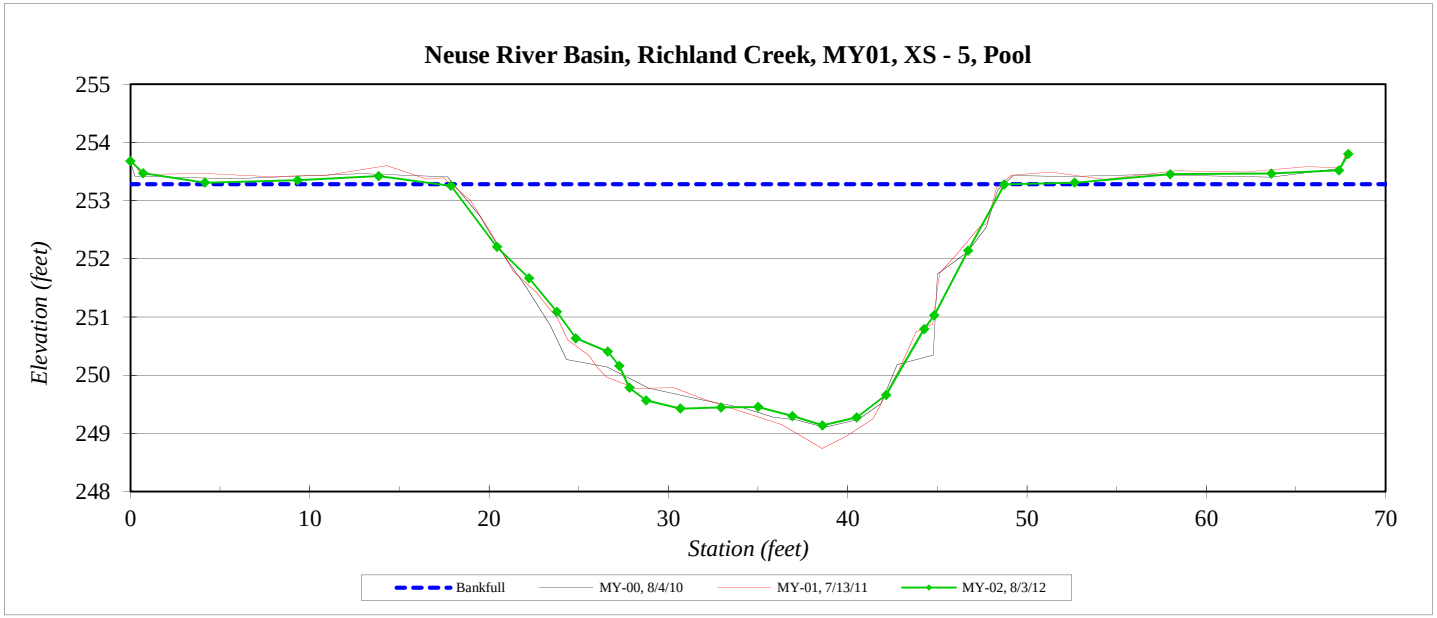
SUMMARY DATA	
Bankfull Elevation:	254.9
Bankfull Cross-Sectional Area:	73.1
Bankfull Width:	31.9
Flood Prone Area Elevation:	258.1
Flood Prone Width:	>68
Max Depth at Bankfull:	3.2
Mean Depth at Bankfull:	2.3
W / D Ratio:	13.9
Entrenchment Ratio:	>2.2
Bank Height Ratio:	1.0



River Basin:	Neuse
Watershed:	Richland Creek, MY-02
XS ID	XS - 5, Pool
Drainage Area (sq mi):	7.8
Date:	8/3/2012
Field Crew:	A. French, F. Davis

Station	Elevation
0.0	253.68
0.7	253.47
4.2	253.31
9.3	253.35
13.8	253.42
17.9	253.25
20.4	252.20
22.2	251.66
23.8	251.09
24.9	250.63
26.6	250.41
27.3	250.16
27.8	249.78
28.8	249.56
30.7	249.43
32.9	249.45
34.9	250.28
36.9	249.30
38.6	249.14
40.5	249.27
42.1	249.66
44.3	250.79
44.8	251.03
46.7	252.14
48.7	253.28
52.7	253.31
58.0	253.45
63.6	253.46
67.4	253.52
67.9	253.80

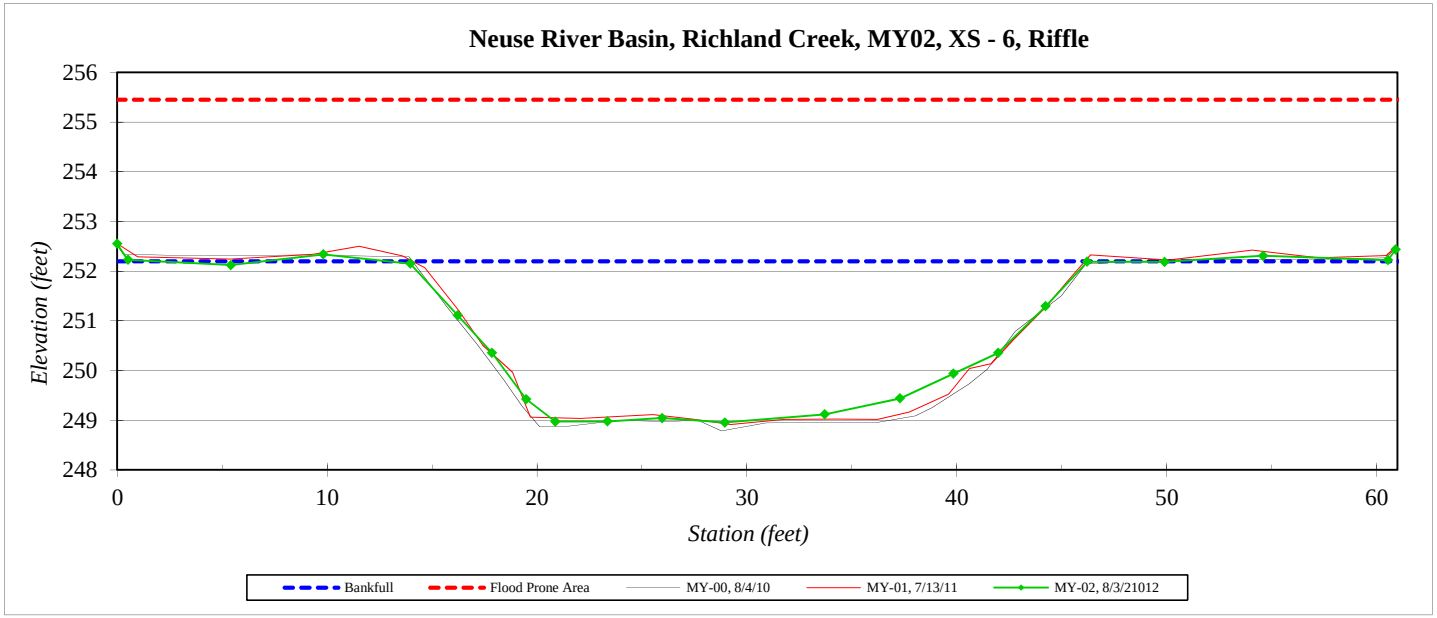
SUMMARY DATA	
Bankfull Elevation:	253.3
Bankfull Cross-Sectional Area:	85.0
Bankfull Width:	31.9
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	4.1
Mean Depth at Bankfull:	2.7
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-



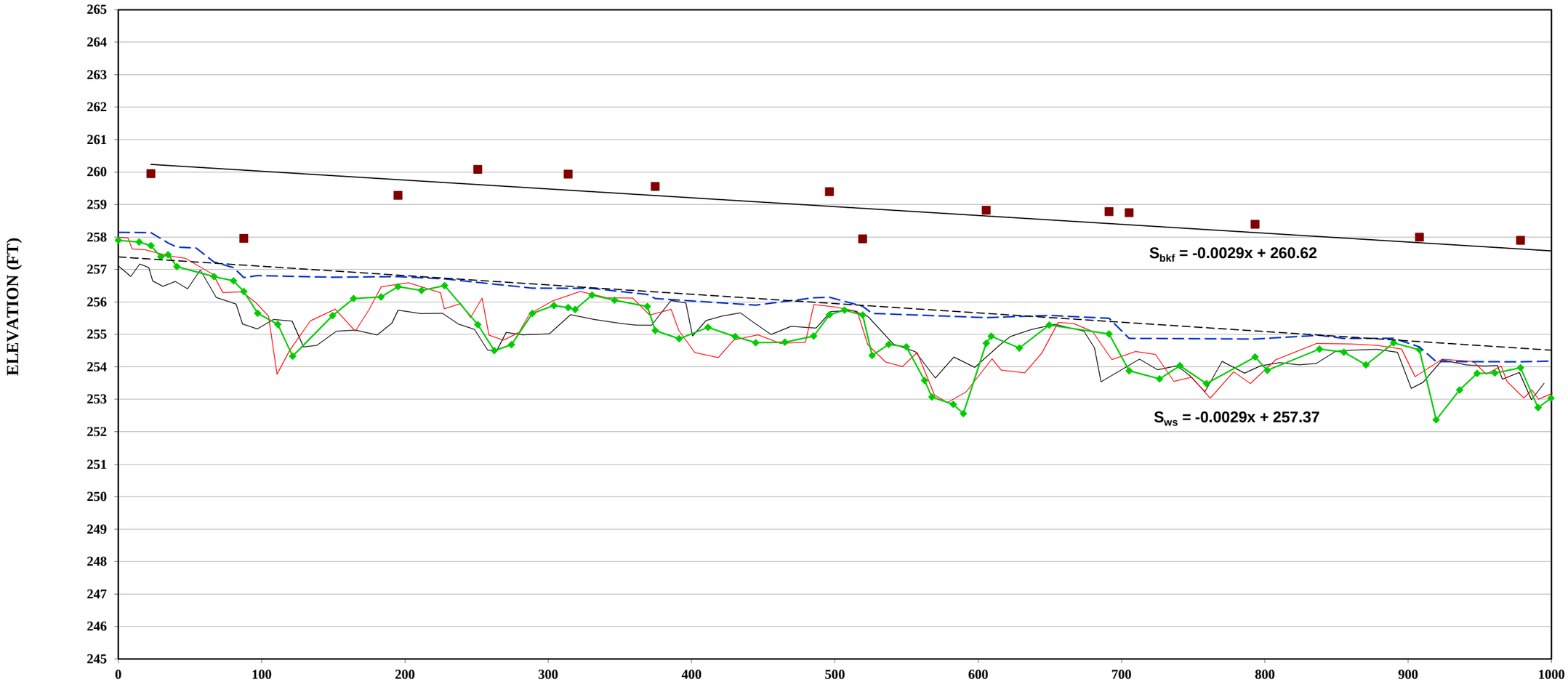
River Basin:	Neuse
Watershed:	Richland Creek, MY-02
XS ID	XS - 6, Riffle
Drainage Area (sq mi):	7.8
Date:	8/3/2012
Field Crew:	A. French, F. Davis

Station	Elevation
0.0	252.55
0.5	252.23
5.4	252.12
9.8	252.34
14.0	252.15
16.2	251.11
17.9	250.36
19.5	249.42
20.9	248.97
23.4	248.97
26.0	249.04
29.0	248.95
33.7	249.12
37.3	249.44
39.8	249.93
42.0	250.35
44.2	251.29
46.2	252.19
49.9	252.19
54.6	252.31
60.5	252.22
60.9	252.44

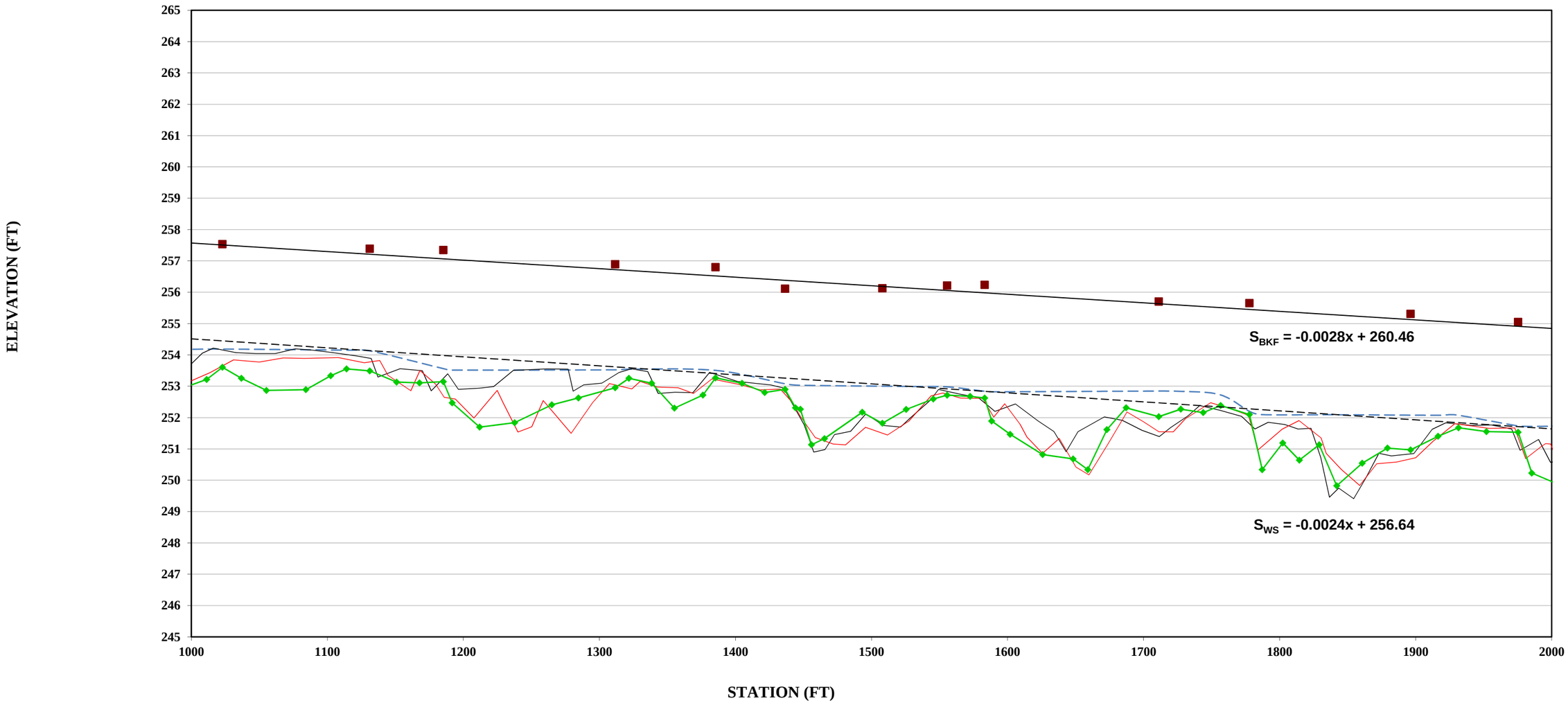
SUMMARY DATA	
Bankfull Elevation:	252.2
Bankfull Cross-Sectional Area:	77.9
Bankfull Width:	33.3
Flood Prone Area Elevation:	255.4
Flood Prone Width:	>60
Max Depth at Bankfull:	3.2
Mean Depth at Bankfull:	2.3
W / D Ratio:	14.2
Entrenchment Ratio:	>2.2
Bank Height Ratio:	1.0



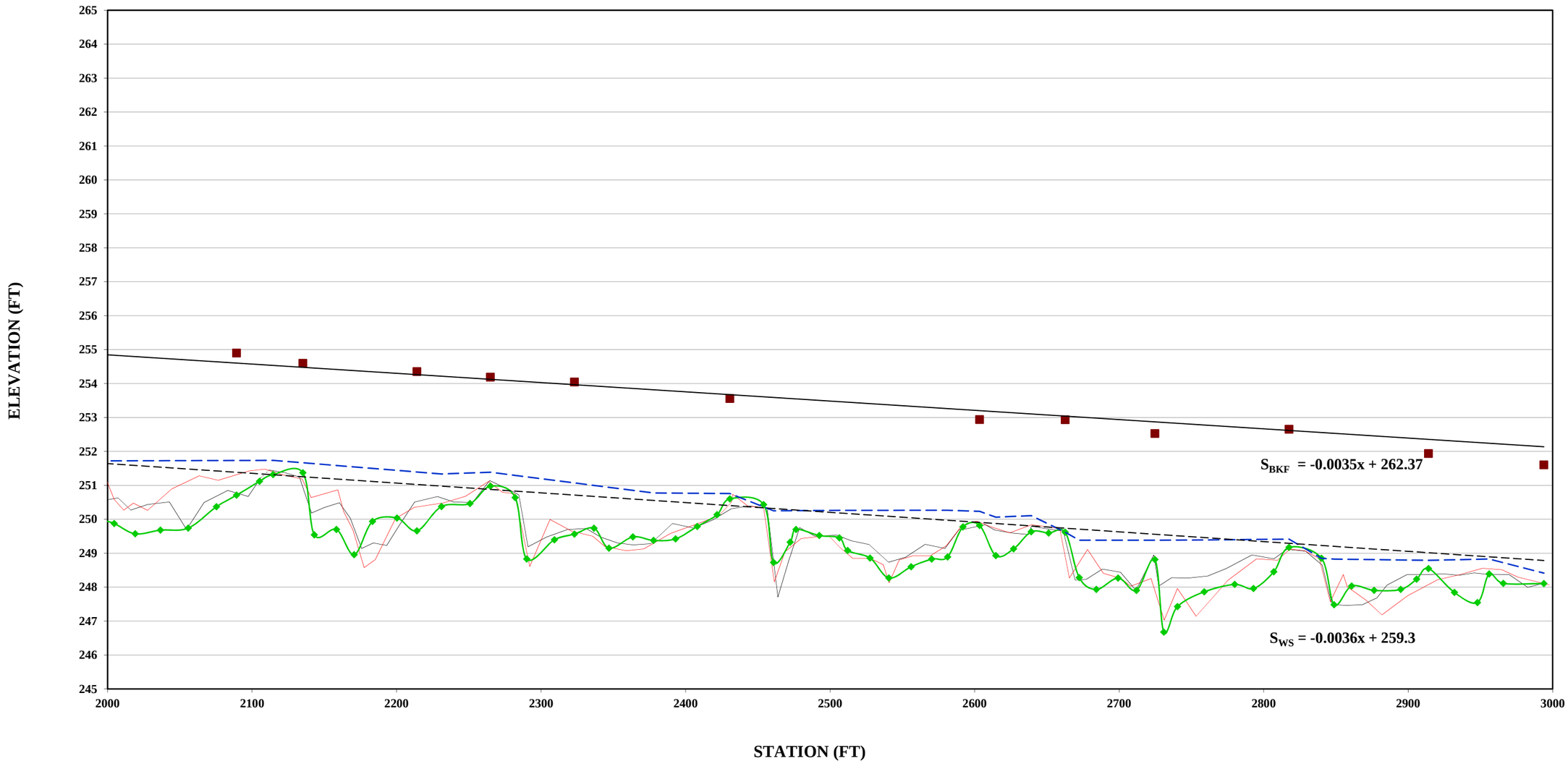
Longitudinal Profile
Richland Creek
EEP Project Number 304- MY-02
Stations 0+00 - 10+00



Longitudinal Profile
Richland Creek
EEP Project Number 304- MY-02
Stations 10+00 - 20+00



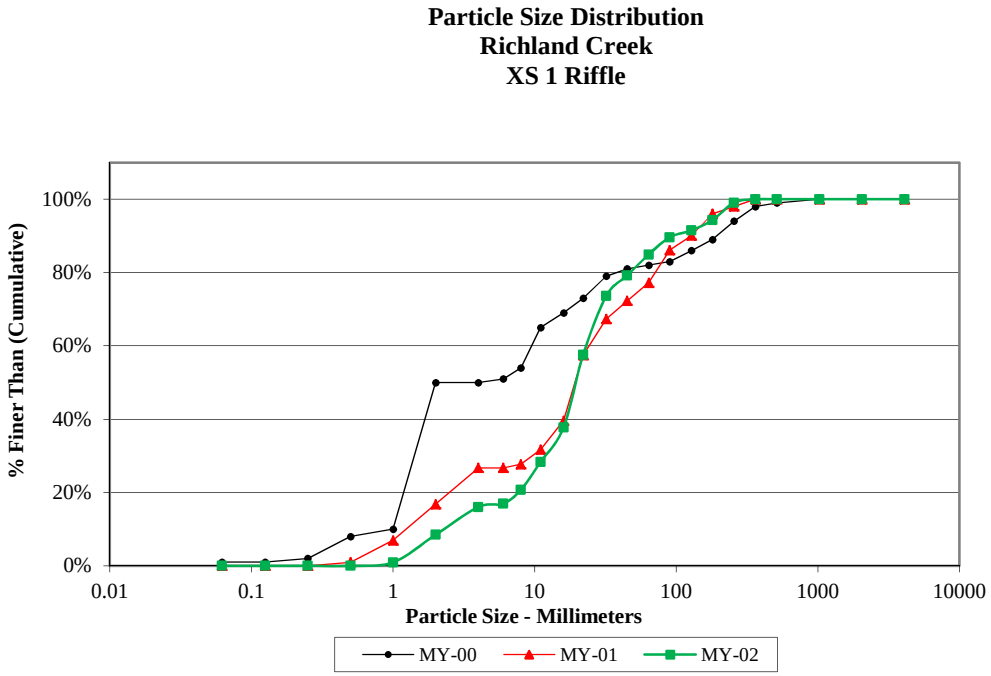
Longitudinal Profile
Richland Creek
EEP Project Number 304- MY-02
Stations 20+00 - 30+00



Pebble Count Plots

Cross-Section 1 Riffle - MY-02			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	
Coarse	.50 - 1	D	1
Very Coarse	1 - 2	S	8
Very Fine	2 - 4		8
Fine	4 - 5.7	G	1
Fine	5.7 - 8	R	4
Medium	8 - 11.3	A	7
Medium	11.3 - 16	V	9
Coarse	16 - 22.6	E	19
Coarse	22.6 - 32	L	15
Very Coarse	32 - 45	S	6
Very Coarse	45 - 64		6
Small	64 - 90	C	5
Small	90 - 128	O	2
Large	128 - 180	B	3
Large	180 - 256	L	5
Small	256 - 362	B	1
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	100

Note:



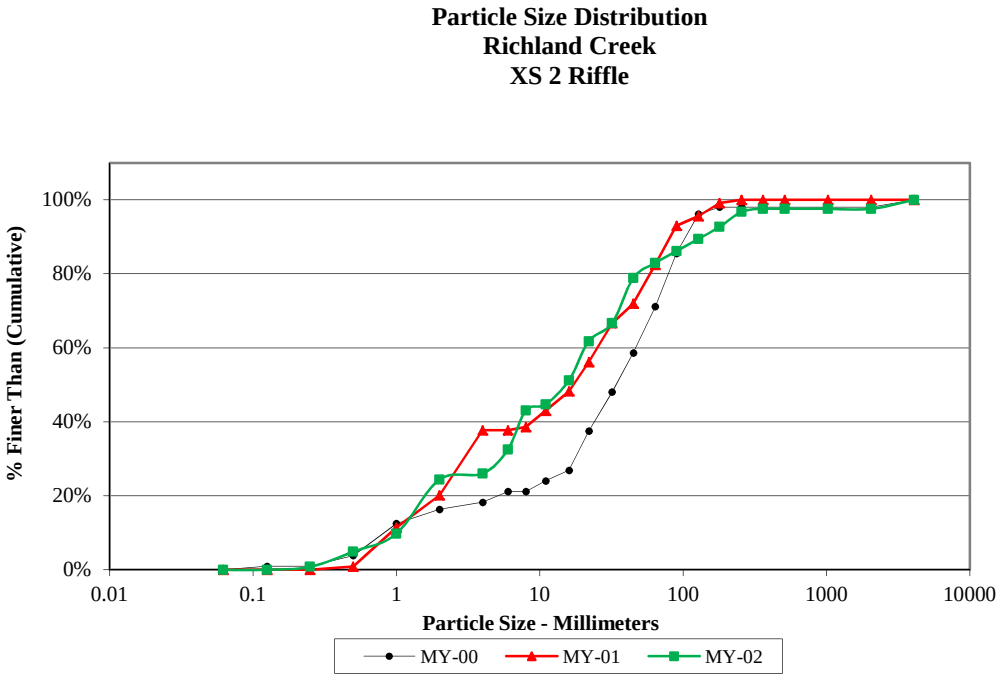
Size (mm)	
D16	3.7
D35	14
D50	20
D65	27
D84	64
D95	190

Size Distribution	
mean	15.4
dispersion	4.3
skewness	-0.10

Type	
silt/clay	0%
sand	9%
gravel	75%
cobble	15%
boulder	1%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 2 Riffle - MY-02			
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	4
Very Coarse	1 - 2	S	16
Very Fine	2 - 4		1
Fine	4 - 5.7	G	7
Fine	5.7 - 8	R	10
Medium	8 - 11.3	A	1
Medium	11.3 - 16	V	7
Coarse	16 - 22.6	E	11
Coarse	22.6 - 32	L	5
Very Coarse	32 - 45	S	14
Very Coarse	45 - 64		4
Small	64 - 90	C	3
Small	90 - 128	O	3
Large	128 - 180	B	3
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	1
		Total	100

Note:



Size (mm)	
D16	1.4
D35	6.4
D50	15
D65	28
D84	59
D95	200

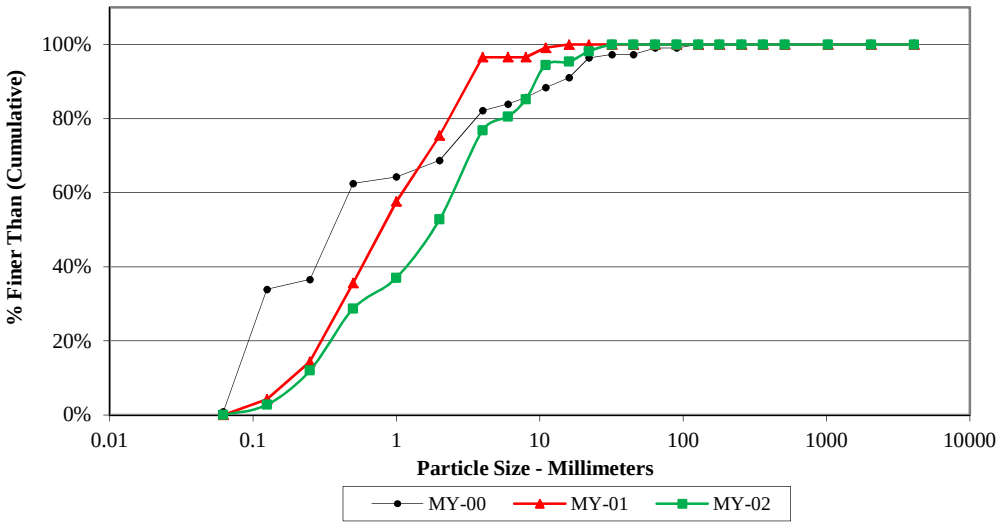
Size Distribution	
mean	9.1
dispersion	7.3
skewness	-0.17

Type	
silt/clay	0%
sand	25%
gravel	60%
cobble	13%
boulder	2%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 3 Pool - MY-02			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	3
Fine	.125 - .25	A	9
Medium	.25 - .50	N	17
Coarse	.50 - 1	D	8
Very Coarse	1 - 2	S	17
Very Fine	2 - 4		24
Fine	4 - 5.7	G	4
Fine	5.7 - 8	R	4
Medium	8 - 11.3	A	8
Medium	11.3 - 16	V	1
Coarse	16 - 22.6	E	3
Coarse	22.6 - 32	L	2
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	100

Note:

Particle Size Distribution
Richland Creek
XS 3 Pool



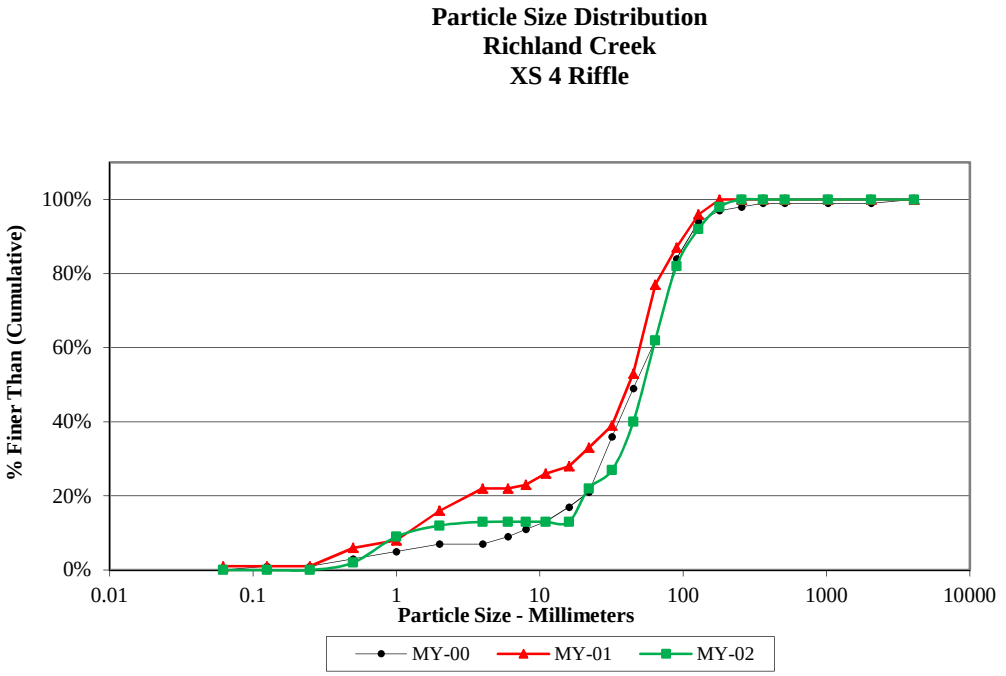
Size (mm)	
D16	0.29
D35	0.84
D50	1.7
D65	2.7
D84	6.9
D95	16

Size Distribution	
mean	1.4
dispersion	5.0
skewness	-0.07

Type	
silt/clay	0%
sand	54%
gravel	46%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 4 Riffle - MY-02			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	2
Coarse	.50 - 1	D	7
Very Coarse	1 - 2	S	3
Very Fine	2 - 4		1
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	
Medium	8 - 11.3	A	
Medium	11.3 - 16	V	
Coarse	16 - 22.6	E	9
Coarse	22.6 - 32	L	5
Very Coarse	32 - 45	S	13
Very Coarse	45 - 64		22
Small	64 - 90	C	20
Small	90 - 128	O	10
Large	128 - 180	B	6
Large	180 - 256	L	2
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	100

Note:



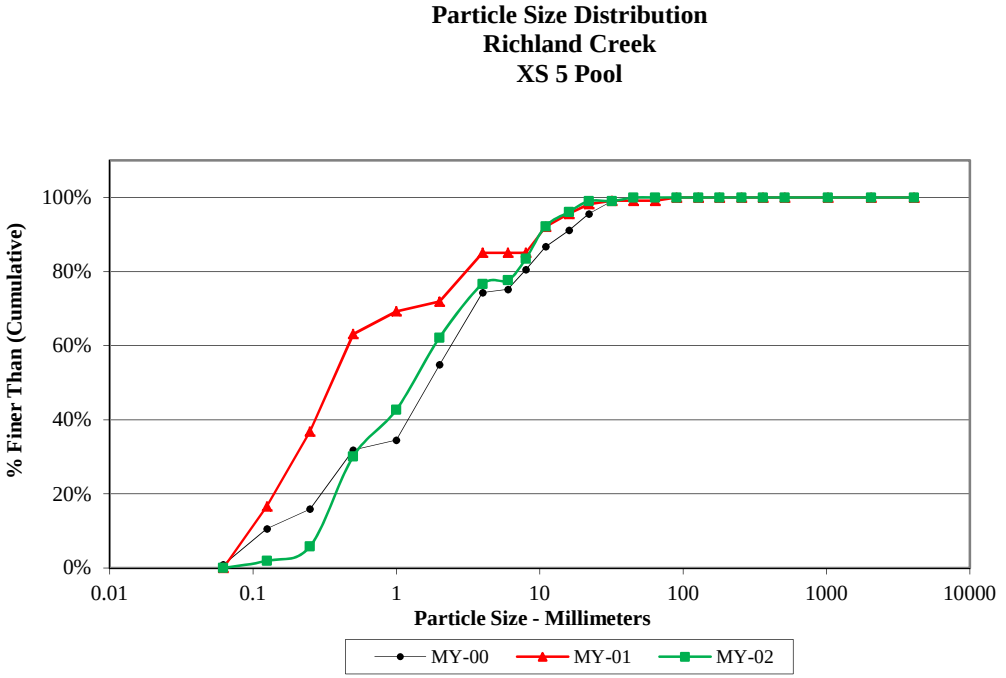
Size (mm)	
D16	18
D35	39
D50	53
D65	67
D84	97
D95	150

Size Distribution	
mean	41.8
dispersion	2.4
skewness	-0.12

Type	
silt/clay	0%
sand	12%
gravel	50%
cobble	38%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 5 Pool - MY-02			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	2
Fine	.125 - .25	A	4
Medium	.25 - .50	N	25
Coarse	.50 - 1	D	13
Very Coarse	1 - 2	S	18
Very Fine	2 - 4		14
Fine	4 - 5.7	G	1
Fine	5.7 - 8	R	6
Medium	8 - 11.3	A	9
Medium	11.3 - 16	V	4
Coarse	16 - 22.6	E	3
Coarse	22.6 - 32	L	
Very Coarse	32 - 45	S	1
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	100

Note:



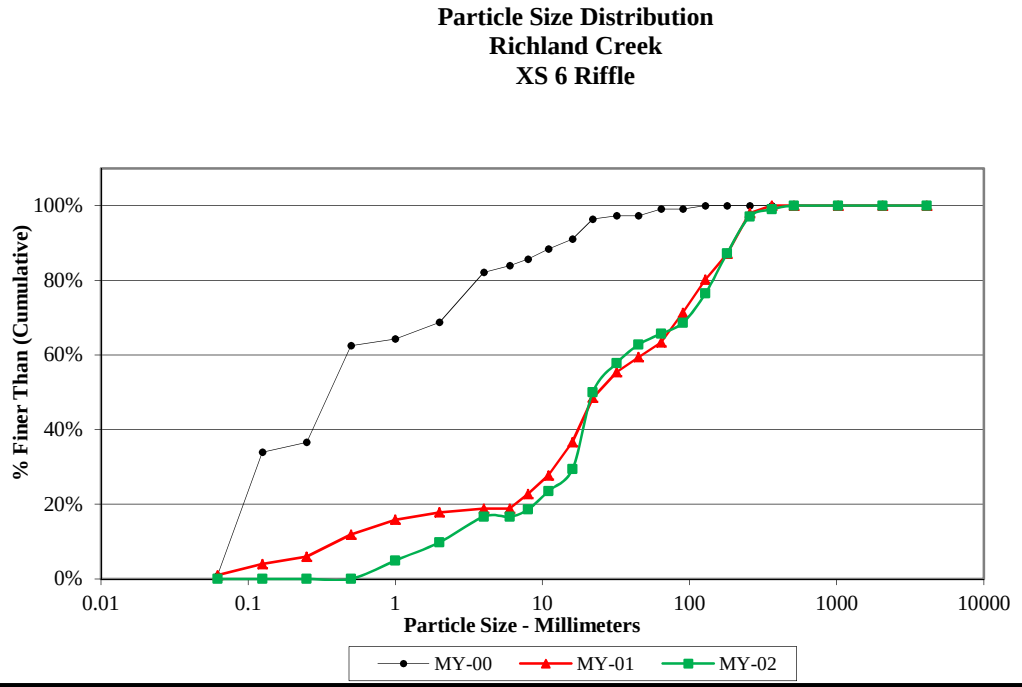
Size (mm)	
D16	0.33
D35	0.62
D50	1.3
D65	2.3
D84	8.3
D95	15

Size Distribution	
mean	1.7
dispersion	5.2
skewness	0.09

Type	
silt/clay	0%
sand	62%
gravel	38%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 6 Riffle - MY-02			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	
Coarse	.50 - 1	D	5
Very Coarse	1 - 2	S	5
Very Fine	2 - 4		7
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	5
Medium	11.3 - 16	V	6
Coarse	16 - 22.6	E	20
Coarse	22.6 - 32	L	8
Very Coarse	32 - 45	S	5
Very Coarse	45 - 64		3
Small	64 - 90	C	3
Small	90 - 128	O	8
Large	128 - 180	B	10
Large	180 - 256	L	10
Small	256 - 362	B	2
Small	362 - 512	L	1
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	100

Note:



Size (mm)	
D16	3.6
D35	17
D50	22
D65	57
D84	160
D95	240

Size Distribution	
mean	24.0
dispersion	6.7
skewness	0.03

Type	
silt/clay	0%
sand	10%
gravel	56%
cobble	31%
boulder	3%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Table 10. Baseline Stream Data Summary: Richland Creek - 2,919 lf
Paschal Golf Course (Richland Creek) / Project No. 276

Parameter	Regional Curve			Pre-Existing Condition						Reference Reach Data (Upper Richland Creek)						Design			As-built					
Dimension and Substrate - Riffle	LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Med	Max	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)				22			35.0			28.0			32.0				33.0		31.9	32.7	32.2	34.4	1.2	4
Floodprone Width (ft)				28			60				>100						100		>60	>72	>69	>90	12.8	4
Bankfull Mean Depth (ft)				1.4			2.8			2.3			2.4				2.6		2.4	2.6	2.6	2.8	0.2	4
Bankfull Max Depth (ft)				3.4			3.8				3.75						3.4		3.3	3.5	3.5	3.8	0.2	4
Bankfull Cross-Sectional Area (ft^2)				48			72			67			75				85.0		80.2	84.2	83.7	89.3	4.1	4
Width/Depth Ratio				12.0			13.8			12.2			13.3				12.1		11.4	12.7	12.5	14.5	1.3	4
Entrenchment Ratio				1.7			1.9			3.1			3.6				3.0		>1.9	>2.0	>2.0	>2.0	0.0	4
Bank Height Ratio					1.2						1.1						1.0		1.0	1.0	1.0	1.0	0.0	4
d50 (mm)					12.0												12.0		4.1	12.7	14.0	20.0	8.0	4
Profile																								
Riffle Length (ft)																			14	48	30	177	42	20
Riffle Slope (ft/ft)				0.0200			0.0370			0.0050			0.0090				0.0056		0.0011	0.0089	0.0075	0.0212	0.0067	20
Pool Length (ft)				23			96			5			25				41		8	74	82	150	42	19
Pool Max Depth					4.0						4.6						5.5		4.3	5.0		5.6	0.92	2
Pool Spacing (ft)				38			258			25			90			150		230	63	153	155	216	49	19
Pool Volume (ft^3)																								
Pattern																								
Channel Beltwidth (ft)				22			71			100			300			60		300	37	78	83	116	25	9
Radius of Curvature (ft)				32			98			37			70			80		100	80	90	90	100	10	14
Rc:Bankfull width (ft/ft)					1.34					1.1			2.1				2.4		2.5	2.8	2.8	3.1		
Meander Wavelength (ft)				110			300			110			200			220		330	259	321	312	395	45	11
Meander Width Ratio					1.59					9.3			10.7				9.0		1.1	2.4	2.5	3.5		
Substrate, bed and transport parameters																								
Ri%/Ru%/P%/G%/S%																								
SC% / Sa% / G% / C% / B% / Be%																			0% / 16% / 55% / 27% / 2% / 0%					
d16 / d35 / d50 / d84 / d95 / di^p / di^{sp} (mm)				1.5 / 7.3 / 12 / 35 / 49 / - / -															1.9 / 20 / 34 / 54 / 87 / 120 / - / -					
Reach Shear Stress (competency) lb/ft^2				0.35												0.40			0.40					
Max part size (mm) mobilized at bankfull				20-80												20-90			31					
Stream Power (transport capacity) W/m^2																								
Additional Reach Parameters																								
Drainage Area (SM)				7.8						4.8						7.8			7.8					
Impervious cover estimate				10%												10%			10%					
Rosgen Classification				F4/1						C4						C4/1			C4/1					
Bankfull Velocity (fps)				3.1 - 7.0						3.6 - 5.0						5.0								
Bankfull Discharge (cfs)				305 - 400						260 - 280						425								
Valley length (ft)				2,710															2,710					
Channel thalweg length (ft)																			2,919					
Sinuosity				1.22						1.1						1.20			1.10					
Water Surface Slope (Channel) (ft/ft)				0.0028						0.0040						0.0028			0.0028					
BF slope (ft/ft)																0.0028			0.0027					
Bankfull Floodplain Area (acres)																								
Proportion over wide (%)																								
Entrenchment Class (ER Range)																								
Incision Class (BHR Range)																								
BEHI VL% / L% / M% / H% / VH% / E%																								
Channel Stability or Habitat Metric																								
Biological or Other																								

Table 11a. Monitoring - Cross-Section Morphology Data
Paschal Golf Course (Richland Creek) / Project No. 276

Dimension and Substrate	Cross-Section 1 (Riffle)							Cross-Section 2 (Riffle)							Cross-Section 3 (Pool)							Cross-Section 4 (Riffle)							Cross-Section 5 (Pool)						
Based on fixed baseline elevation	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	34.4	33.6	35.4					31.9	35.2	35.6					31.4	33.9	36.1					32.1	31.9	31.9					31.5	32.5	31.9				
Floodprone Width (ft)	>90	>90	>90					>70	>70	>70					-	-	-					>68	>68	>68					-	-	-				
Bankfull Mean Depth (ft)	2.4	2.4	2.2					2.8	2.5	2.5					3.3	2.9	2.7					2.5	2.4	2.3					2.9	2.8	2.7				
Bankfull Max Depth (ft)	3.4	3.4	3.5					3.8	3.8	3.7					5.6	5.0	5.0					3.3	3.2	3.2					4.3	4.7	4.1				
Bankfull Cross-Sectional Area (ft^2)	81.7	79.9	78.5					89.3	88.5	87.6					104.0	99.2	97.8					80.2	76.5	73.1					90.8	90.6	85.0				
Bankfull Width/Depth Ratio	14.5	14.1	16.0					11.4	14.0	14.5					-	-	-					12.8	13.3	13.9					-	-	-				
Bankfull Entrenchment Ratio	>2.0	>2.0	>2.2					>2.0	>1.8	>2.0					-	-	-					>2.0	>2.1	>2.2					-	-	-				
Bankfull Bank Height Ratio	1.0	1.0	1.0					1.0	1.0	1.0					-	-	-					1.0	1.0	1.0					-	-	-				
Cross-Sectional Area Between End Pins (ft^2)	477.5	478.0	477.4					111.4	108.6	114.4					135.7	134.2	135.6					100.1	100.6	96.2					106.4	110.6	107.4				
d50 (mm)	2.0	19.0	20.0					34.0	17.0	15.0					0.4	0.79	1.7					46.0	42.0	53.0					1.7	0.35	1.3				

	Cross-Section 6 (Riffle)						
Based on fixed baseline elevation	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	32.2	32.6	33.3				
Floodprone Width (ft)	>60	>60	>60				
Bankfull Mean Depth (ft)	2.7	2.5	2.3				
Bankfull Max Depth (ft)	3.5	3.4	3.2				
Bankfull Cross-Sectional Area (ft^2)	85.6	82.2	77.9				
Bankfull Width/Depth Ratio	12.1	12.9	14.2				
Bankfull Entrenchment Ratio	>1.9	>1.8	>1.9				
Bankfull Bank Height Ratio	1.0	1.0	1.0				
Cross-Sectional Area Between End Pins (ft^2)	94.3	94.1	92.1				
d50 (mm)	44.0	24.0	22.0				

Table 11b. Monitoring - Stream Reach Morphology Data Table
Paschal Golf Course (Richland Creek) / Project No. 276
Richland Creek (2,919 ft.)

Parameter	MY01 (2011)						MY02 (2012)						MY03 (2013)						MY04 (2014)						MY05 (2015)					
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)	31.9	34.2	33.1	35.2	3.031	4	31.9	34.1	34.4	35.6	1.771	4																		
Floodprone Width (ft)	68	72	69	90	12.754	4	60	72	69	89	12.285	4																		
Bankfull Mean Depth (ft)	2.3	2.4	2.4	2.5	0.082	4	2.2	2.3	2.3	2.5	0.126	4																		
Bankfull Max Depth (ft)	3.2	3.5	3.4	3.8	0.252	4	3.2	3.4	3.4	3.7	0.245	4																		
Bankfull Cross-Sectional Area (ft^2)	76.5	81.8	81.1	88.6	5.102	4	73.1	79.3	78.2	87.6	6.053	4																		
Width/Depth Ratio	12.9	14.3	13.7	16.8	1.756	4	13.9	14.7	14.4	16.0	0.933	4																		
Entrenchment Ratio	1.8	1.9	1.9	2.1	0.150	4	1.8	2.1	2.1	2.6	0.340	4																		
Bank Height Ratio	1.0	1.0	1.0	1.0	0.000	4	1.0	1.0	1.0	1.0	0.000	4																		
Pattern																														
Channel Beltwidth (ft)	37	78	83	116	25	9																								
Radius of Curvature (ft)	80	91.1	90	100	9	9																								
Rad. of Curv. : Bankfull Width (ft/ft)	2.5	2.7	2.7	2.6																										
Meander Wavelength (ft)	259	321	312	395	45	11																								
Meander Width Ratio	1.2	2.3	2.5	3.0																										
Profile																														
Riffle Length (ft)	18	41	30	103	23	17	17	33	26	65	16	18																		
Riffle Slope (ft/ft)	0.001	0.010	0.008	0.019	0.006	17	0.002	0.013	0.010	0.025	0.008	18																		
Pool Length (ft)	31	72	74	122	24	17	12	68	78	120	31	17																		
Pool Max Depth (ft)	1.5	1.5		1.5		1	1.5	1.5		1.5		1																		
Pool Spacing (ft)	86	172	169	262	45	16	51	161	159	256	54	16																		
Additional Reach Parameters																														
Valley Length (ft)	2,710						2,710																							
Channel Thalweg Length (ft)	2,919						2,919																							
Sinuosity	1.1						1.1																							
Water Surface Slope (ft/ft)	0.0032						0.0034																							
Bankfull Slope (ft/ft)	0.0029						0.0025																							
Rosgen Classification	C4						C4																							
SC% / Sa% / G% / C% / B% / Be%	0.33%/36%/47%/16%/0.67%						0%/29%/54%/16%/1%																							
d16 / d35 / d50 / d65/ d84 / d95	1.1/10/17/65/110						4.6/13/19/31/66/135																							
% of Reach with Eroding Banks	1%						2%																							

Appendix E

Hydrology Data

Table 12. Verification of Bankfull Events Paschal Golf Course (Richland Creek) / Project No. 276			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo #**
5/17/2010	5/17/2010	Photographed on site	1, See Below
9/28/2011	9/16/2011	Crest gauge	None
11/5/2012	unknown	Crest gauge and indicators of storm event	None

Photo #1 - Bankfull Event, 5/17/2010