

**Paschal Golf Course (Richland Creek)
Stream Restoration Monitoring Report**

**EEP Project # 276
EEP Contract # D080285
Monitoring Year 03**



Submitted to:



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

**Construction Completed: May 2010
Data Collection: June 2013
Submitted: December 2013**

Monitoring Firm



**Landmark Center II, Suite 220
4601 Six Forks Road
Raleigh, NC 27609
Phone: (919) 278-2514
Fax: (919) 783-9266**

Project Contact: Adam Spiller
Email: adam.spiller@kci.com
KCI Project No: 12071067B_RC12

Design Firm

EcoLogic Associates, P.C.
3808 Clifton Road
Greensboro, NC 27407
Phone: (336) 632-4441
Fax: (336) 632-4445

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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 streamside area 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 success criterion for the planted riparian buffer area is a density of 320 stems/acre after the third and fifth year of monitoring. 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 399 planted stems/acre, including live stakes, and 358 planted stems/acre, excluding live stakes. Including volunteers, the site averaged 7,203 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 2013 monitoring found an overall moderate vigor and low live stake survivability throughout the site. About one third of the planted stems have a vigor rating of excellent, while about half have a vigor rating of fair to good. Due to the fact that the planted vegetation is still young, however, the low vigor areas have not been quantified. There were many loblolly pine and sweetgum volunteers throughout the easement; in certain areas these volunteers were extremely dense. In late summer of 2013, after the vegetation monitoring, the loblolly pine density was reduced to improve the condition of the site for the planted vegetation. Plot 5 contains one stem of autumn olive (*Elaeagnus umbellate*). The presence of this invasive species is limited and is not widespread throughout the site.

Third-year monitoring found Richland Creek to be mostly stable, with only minor changes from the baseline conditions. The stream has four areas of localized bank erosion since construction (2% of all banks), and five areas displaying signs of mass wasting (1% of all banks). There is currently one headcut located approximately at Station 5+75, with two areas along the stream experiencing bed deposition. Please see Appendix B Problem Area Photos. These areas will continue to be watched closely in Monitoring Year Four. 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. Neuse River Basin Restoration Priorities. (http://portal.ncdenr.org/c/document_library/get_file?uuid=665be84c-cf93-477b-918c-1993778ef11f&groupId=60329)

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

Appendix A

Project Vicinity Map and Background Tables

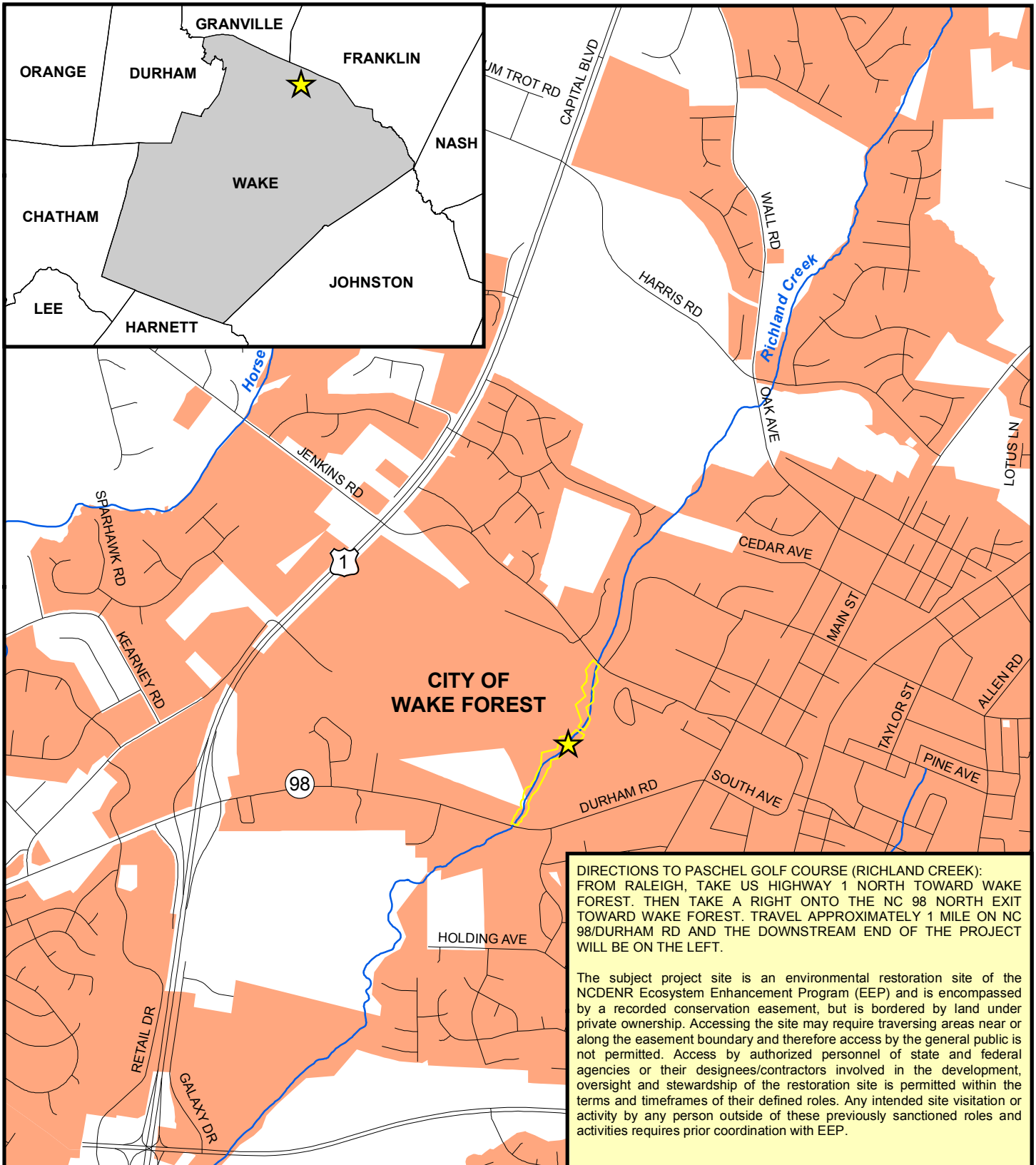







Figure 1. Vicinity Map - Paschal Golf Course (Richland Creek), Project No. 276



-  Project Location
-  Roads
-  Major Streams and Rivers
-  Municipalities
-  Project Easement

N
 W — O — E
 S

1:24,000






0.2 0.1 0 0.2
 Miles



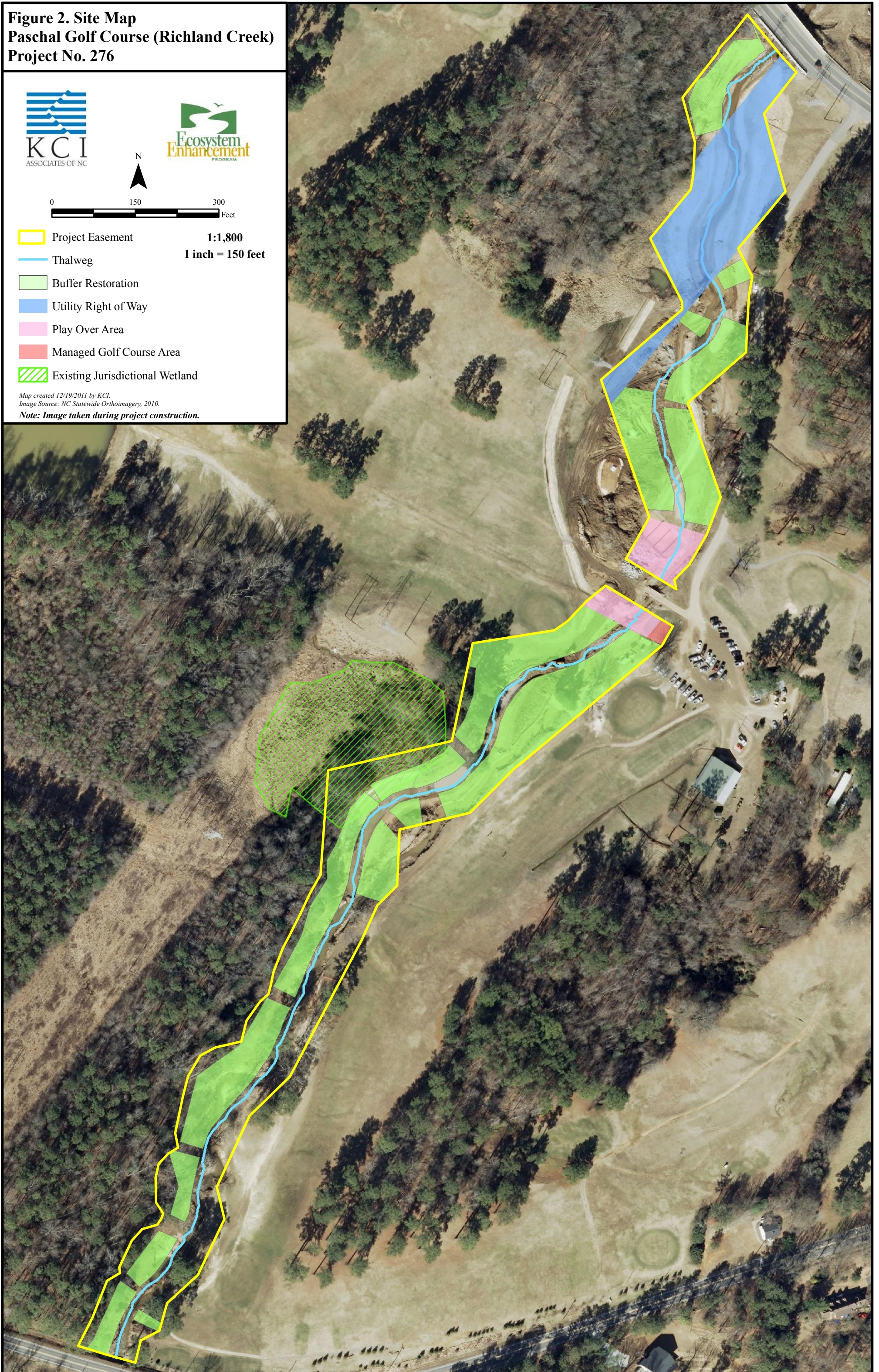
Figure 2. Site Map
Paschal Golf Course (Richland Creek)
Project No. 276



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	0	3.84	0
MU Totals	2,766	0	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: 3 yr 7 months Elapsed Time Since Planting Complete: 3 yr 7 months Number of Reporting Years: 3		
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
Year 3 Monitoring	Jun 2013	Dec 2013

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	-

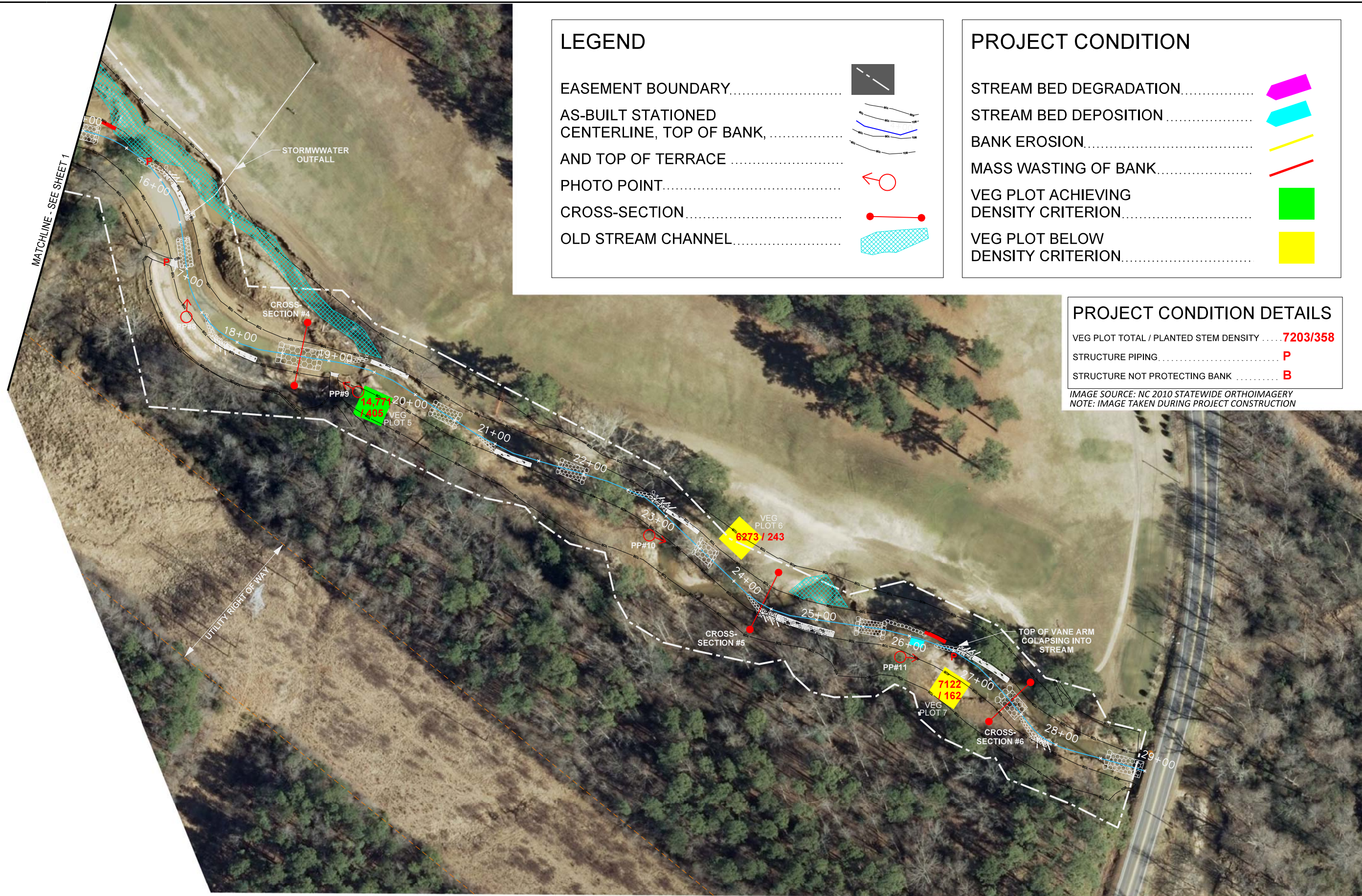
"N/A" is for items that do not apply.

"-" is for items that are unavailable.

"U" is for items that are unknown.

Appendix B

Visual Assessment Data



LEGEND

- EASEMENT BOUNDARY..... [Symbol: Dashed line]
- AS-BUILT STATIONED CENTERLINE, TOP OF BANK, AND TOP OF TERRACE..... [Symbol: Solid lines]
- PHOTO POINT..... [Symbol: Circle with arrow]
- CROSS-SECTION..... [Symbol: Red line with dots]
- OLD STREAM CHANNEL..... [Symbol: Blue hatched area]

PROJECT CONDITION

- STREAM BED DEGRADATION..... [Symbol: Pink arrow]
- STREAM BED DEPOSITION..... [Symbol: Cyan arrow]
- BANK EROSION..... [Symbol: Yellow arrow]
- MASS WASTING OF BANK..... [Symbol: Red arrow]
- VEG PLOT ACHIEVING DENSITY CRITERION..... [Symbol: Green square]
- VEG PLOT BELOW DENSITY CRITERION..... [Symbol: Yellow square]

PROJECT CONDITION DETAILS

VEG PLOT TOTAL / PLANTED STEM DENSITY **7203/358**
 STRUCTURE PIPING..... **P**
 STRUCTURE NOT PROTECTING BANK **B**
 IMAGE SOURCE: NC 2010 STATEWIDE ORTHOIMAGERY
 NOTE: IMAGE TAKEN DURING PROJECT CONSTRUCTION

NO.	DESCRIPTION	DATE	APPROVED



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

PASCHAL GOLF COURSE (RICHLAND CREEK)
 PROJECT #276 - MONITORING YEAR 3
 WAKE FOREST, WAKE COUNTY, NORTH CAROLINA

DATE: NOV 2013
 SCALE: 1" = 100'
 FIGURE 3
 CURRENT
 CONDITION
 PLAN VIEW
 SHEET 2 OF 2

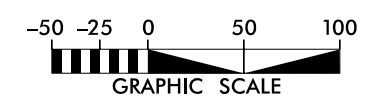


Table 5. Visual Stream Morphology Stability Assessment							
Project Number and Name: 276 - Paschal Golf Course (Richland Creek)							
Assessed Length 2,919				Reach - Richland Creek			
Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended
1. Bed	1. Vertical Stability (Riffle and Run units)	1. <u>Aggradation</u> - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			2	60	98%
		2. <u>Degradation</u> - Evidence of downcutting			0	0	100%
	2. Riffle Condition	1. <u>Texture/Substrate</u> - Riffle maintains coarser substrate	17	17			100%
	3. Meander Pool Condition	1. <u>Depth</u> Sufficient (Max Pool Depth : Mean Bankfull Depth \geq 1.6)	13	13			100%
		2. <u>Length</u> appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream 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			4	80	99%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does <u>NOT</u> include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			5	185	97%
Totals					9	265	95%
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 ams.	1	2			50%
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>not</u> 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 \geq 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 noticeable 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 11/15/2013 MY-03



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



Photo Point #2 – Looking downstream 11/15/2013 MY-03



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



Photo Point #2 – Looking upstream 11/15/2013 MY-03



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



Photo Point #3 – Looking downstream 11/15/2013 MY-03



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



Photo Point #3 – Looking upstream 11/15/2013 MY-03



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



Photo Point #4 – Looking downstream 11/15/2013 MY-03



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



Photo Point #4 – Looking upstream 11/15/2013 MY-03



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



Photo Point #5 – Looking upstream from bridge 11/15/2013 MY-03



Photo Point #6 – 8/6/2010 – Baseline



Photo Point #6 – 11/15/2013 MY-03



Photo Point #7 – 8/6/2010 – Baseline



Photo Point #7 – 11/15/2013 MY-03



Photo Point #8 – 8/6/2010– Baseline



Photo Point #8 – 11/15/2013 MY-03



Photo Point #9 –8/6/2010– Baseline



Photo Point #9 –11/15/2013 MY-03



Photo Point #10 – 8/6/2010 – Baseline



Photo Point #10 – 11/15/2013 MY-03



Photo Point #11 – 8/6/2010– Baseline



Photo Point #11 – 11/15/2013 MY-03

Problem Area Photos



Station 1+00 Right Bank – 11/15/2013



Station 4+00 Right Bank – 11/15/2013



Station 11+75 Left Bank – 11/15/2013



Station 15+65 Left Bank – 11/15/2013



Station 26+10 Left Bank – 11/15/2013

Vegetation Plot Photos



Veg Plot #1 – 6/10/2013



Veg Plot #2 – 6/10/2013



Veg Plot #3 – 6/10/2013



Veg Plot #4 – 6/10/2013



Veg Plot #5 – 6/10/2013



Veg Plot #6 – 6/10/2013



Veg Plot #7 – 6/10/2013

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	¹Stream Stems	²Volunteers	³Total	Success Criteria Met?
1	162	769	769	No
6	243	6,273	6,273	No
Project Avg	203	3,521	3,177	
Buffer Vegetation Totals (per acre)				
Plot ID	⁴Buffer Stems	Success Criteria Met?		
2	526	Yes		
3	486	Yes		
4	526	Yes		
5	405	Yes		
7	162	No		
Project Avg	421			

¹Stream Stems Native planted woody stems. Includes shrubs, does NOT include live stakes.

²Volunteers Native woody stems. NOT planted.

³Total Planted + volunteer native woody stems. Includes live stakes.

Table 8. CVS Vegetation Plot Metadata Paschal Golf Course (Richland Creek) / Project No. 276	
Report Prepared By	Tommy Seelinger
Date Prepared	6/13/2013 15:54
database name	cvs-eeep-entrytool-Richland Creek.mdb
database location	M:\2007\12071067_2007 EEP OPEN END\Veg_database\2013 Sites_cvs-ee
computer name	12-7GSWCX1
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 (MY3 2013)																	
Scientific Name	Common Name	Species Type	E304-01-0001			E304-01-0002			E304-01-0003			E304-01-0004			E304-01-0005			E304-01-0006		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
<i>Alnus serrulata</i>	hazel alder	Shrub				4	4	4	2	2	2									
<i>Aronia arbutifolia</i>	Red Chokeberry	Shrub							1	1	1	2	2	2	2	2	2	3	3	3
<i>Baccharis</i>	baccharis	Shrub																		
<i>Betula nigra</i>	river birch	Tree						7			1			51						
<i>Celtis</i>	hackberry	Tree										1	1	1	1	1	1			
<i>Celtis occidentalis</i>	common hackberry	Tree																		
<i>Cephalanthus occidentalis</i>	common buttonbush	Shrub				1	1	1	1	1	1				1	1	1			
<i>Clethra alnifolia</i>	coastal sweetpepperbush	Shrub	1	1	1	2	2	2												
<i>Cornus amomum</i>	silky dogwood	Shrub	3	3	3		1	1	1	1	1	1	1	1		1	1			
<i>Diospyros virginiana</i>	common persimmon	Tree				1	1	1				1	1	1						
<i>Elaeagnus umbellata</i>	autumn olive	Exotic																		1
<i>Fraxinus pennsylvanica</i>	green ash	Tree							2	2	2	2	2	2	2	2	2			2
<i>Ligustrum sinense</i>	Chinese privet	Exotic			4															1
<i>Liquidambar styraciflua</i>	sweetgum	Tree			9			3			1			2						24
<i>Liriodendron tulipifera</i>	tuliptree	Tree																		1
<i>Nyssa sylvatica</i>	blackgum	Tree																		
<i>Pinus taeda</i>	loblolly pine	Tree			2			96			102			220			324			116
<i>Platanus occidentalis</i>	American sycamore	Tree				4	4	6	5	5	5	5	5	7			1	2	2	4
<i>Quercus laurifolia</i>	laurel oak	Tree													1	1	1			
<i>Quercus michauxii</i>	swamp chestnut oak	Tree																1	1	1
<i>Quercus nigra</i>	water oak	Tree																		
<i>Quercus phellos</i>	willow oak	Tree													3	3	3			
<i>Salix nigra</i>	black willow	Tree						3												
<i>Salix sericea</i>	silky willow	Shrub				1	3	3												
<i>Sambucus canadensis</i>	Common Elderberry	Shrub																		
<i>Ulmus alata</i>	winged elm	Tree															2			
Unknown		Shrub or Tree																		
<i>Viburnum dentatum</i>	southern arrowwood	Shrub										1	1	1						
Stem count			4	4	19	13	16	127	12	12	116	13	13	288	10	11	365	6	6	155
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	5	6	7	11	6	6	9	7	7	10	6	7	14	3	3	6
Stems per ACRE			162	162	769	526	647	5,140	486	486	4,694	526	526	11,655	405	445	14,771	243	243	6,273

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

Scientific Name	Common Name	Species Type	Annual Means														
			E304-01-0007			MY3 (2013)			MY2 (2012)			MY1 (2011)			MY0 (2010)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
<i>Alnus serrulata</i>	hazel alder	Shrub				6	6	6	6	6	6	6	6	6	8	8	8
<i>Aronia arbutifolia</i>	Red Chokeberry	Shrub	1	1	1	9	9	9	13	13	13	7	7	7			
<i>Baccharis</i>	baccharis	Shrub									1						
<i>Betula nigra</i>	river birch	Tree			4			63			33			1			
<i>Celtis</i>	hackberry	Tree				2	2	2	2	2	2	3	3	3	3	3	3
<i>Celtis occidentalis</i>	common hackberry	Tree													1	1	1
<i>Cephalanthus occidentalis</i>	common buttonbush	Shrub				3	3	3	3	3	3	3	3	3	5	5	5
<i>Clethra alnifolia</i>	coastal sweetpepperbush	Shrub				3	3	3	3	3	3	3	3	3	3	3	3
<i>Cornus amomum</i>	silky dogwood	Shrub		2	2	5	9	9	5	11	11	9	19	19	18	54	54
<i>Diospyros virginiana</i>	common persimmon	Tree				2	2	2	1	1	1	2	2	2	4	4	4
<i>Elaeagnus umbellata</i>	autumn olive	Exotic						1									
<i>Fraxinus pennsylvanica</i>	green ash	Tree				6	6	8	7	7	8	8	8	8	8	8	8
<i>Ligustrum sinense</i>	Chinese privet	Exotic						5									
<i>Liquidambar styraciflua</i>	sweetgum	Tree			67			135			84			2			
<i>Liriodendron tulipifera</i>	tuliptree	Tree						1			2			2			
<i>Nyssa sylvatica</i>	blackgum	Tree							2	2	7	4	4	7	5	5	5
<i>Pinus taeda</i>	loblolly pine	Tree			92			952			657			10			
<i>Platanus occidentalis</i>	American sycamore	Tree	3	3	9	19	19	32	19	19	32	19	19	31	20	20	20
<i>Quercus laurifolia</i>	laurel oak	Tree				1	1	1	1	1	1						
<i>Quercus michauxii</i>	swamp chestnut oak	Tree				1	1	1				1	1	1	1	1	1
<i>Quercus nigra</i>	water oak	Tree													1	1	1
<i>Quercus phellos</i>	willow oak	Tree				3	3	3	3	3	4	4	4	4	6	6	6
<i>Salix nigra</i>	black willow	Tree						3									
<i>Salix sericea</i>	silky willow	Shrub		1	1	1	4	4	1	4	8	1	20	20	1	21	21
<i>Sambucus canadensis</i>	Common Elderberry	Shrub											1	1	1	12	12
<i>Ulmus alata</i>	winged elm	Tree						2									
<i>Unknown</i>		Shrub or Tree										8	10	10	28	40	40
<i>Viburnum dentatum</i>	southern arrowwood	Shrub				1	1	1	1	1	1	1	1	1	1	1	1
Stem count			4	7	176	62	69	1246	67	76	877	79	111	141	114	193	193
size (ares)			1			7			7			7			7		
size (ACRES)			0.02			0.17			0.17			0.17			0.17		
Species count			2	4	7	14	14	22	14	14	19	15	16	20	17	17	17
Stems per ACRE			162	283	7,122	358	399	7,203	387	439	5,070	457	642	815	659	1,116	1,116

Appendix D

Stream Survey Data

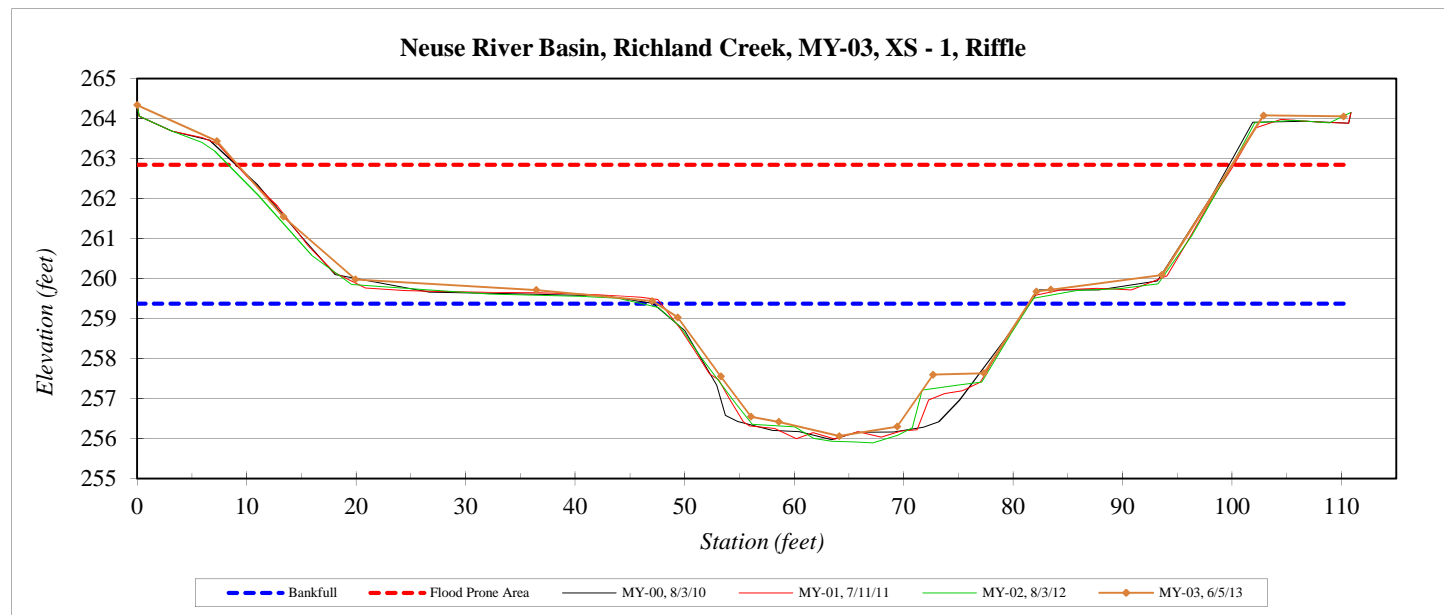
Cross-Section Plots

River Basin:	Neuse
Watershed:	Richland Creek, MY-03
XS ID	XS - 1, Riffle
Drainage Area (sq mi):	7.8
Date:	6/5/2013
Field Crew:	A. French, T. Seelinger, A. Bubel



Station	Elevation
0.0	264.34
7.3	263.44
13.3	261.55
19.9	259.98
36.4	259.71
47.0	259.44
49.4	259.03
53.3	257.55
56.1	256.55
58.6	256.42
64.1	256.06
69.4	256.30
72.7	257.60
77.3	257.63
82.1	259.68
83.4	259.72
93.6	260.09
102.9	264.08
110.2	264.06
110.9	264.15

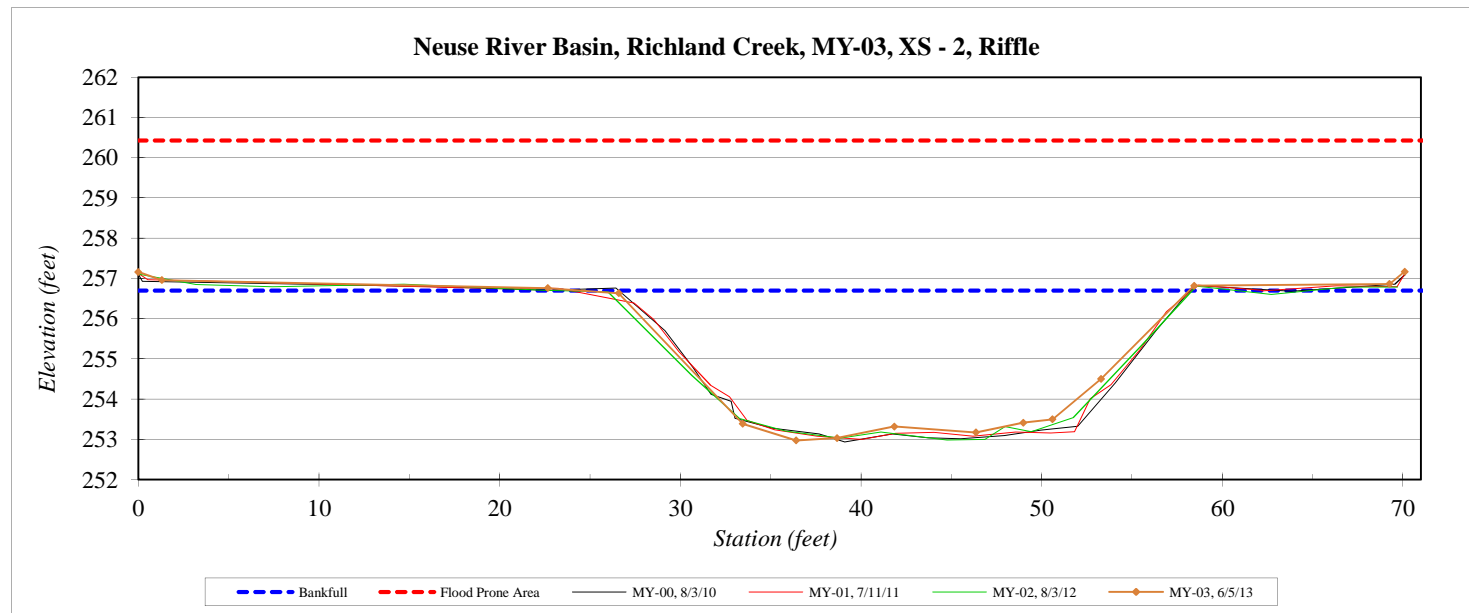
SUMMARY DATA	
Bankfull Elevation:	259.4
Bankfull Cross-Sectional Area:	72.1
Bankfull Width:	34.0
Flood Prone Area Elevation:	262.8
Flood Prone Width:	92
Max Depth at Bankfull:	3.5
Mean Depth at Bankfull:	2.1
W / D Ratio:	16.0
Entrenchment Ratio:	2.7
Bank Height Ratio:	0.9



River Basin:	Neuse
Watershed:	Richland Creek, MY-03
XS ID	XS - 2, Riffle
Drainage Area (sq mi):	7.8
Date:	6/5/2013
Field Crew:	A. French, T. Seelinger, A. Bubel

Station	Elevation
0.00	257.16
0.00	256.96
21.36	256.76
25.30	256.63
32.16	253.39
35.11	252.97
37.37	253.03
40.55	253.32
45.06	253.17
47.69	253.42
49.31	253.50
51.99	254.50
57.14	256.82
67.96	256.86
68.80	257.17

SUMMARY DATA	
Bankfull Elevation:	256.7
Bankfull Cross-Sectional Area:	84.0
Bankfull Width:	33.6
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:	13.5
Entrenchment Ratio:	>2.1
Bank Height Ratio:	1.0

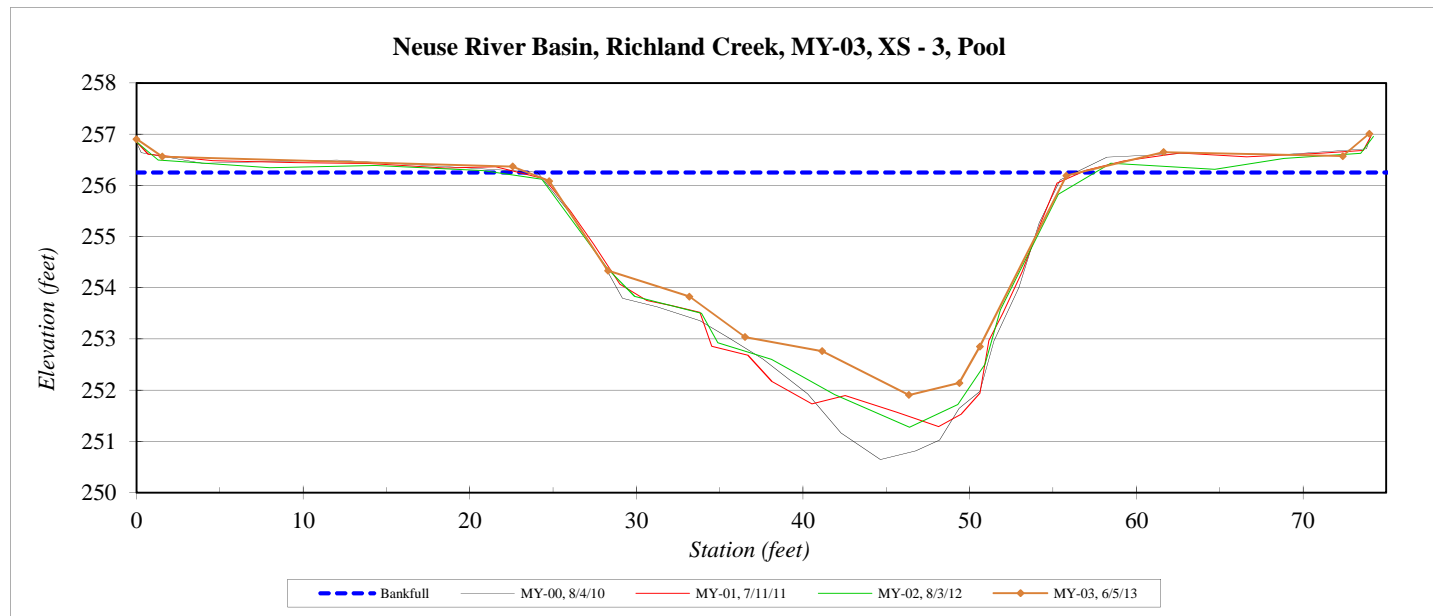


River Basin:	Neuse
Watershed:	Richland Creek, MY-03
XS ID	XS - 3, Pool
Drainage Area (sq mi):	7.8
Date:	6/5/2013
Field Crew:	A. French, T. Seelinger, A. Bubel



Station	Elevation
0.0	256.90
1.5	256.56
22.6	256.37
24.8	256.09
28.3	254.34
33.2	253.83
36.5	253.04
41.2	252.76
46.4	251.91
49.4	252.14
50.6	252.85
55.8	256.19
61.6	256.65
72.4	256.57
74.0	257.01

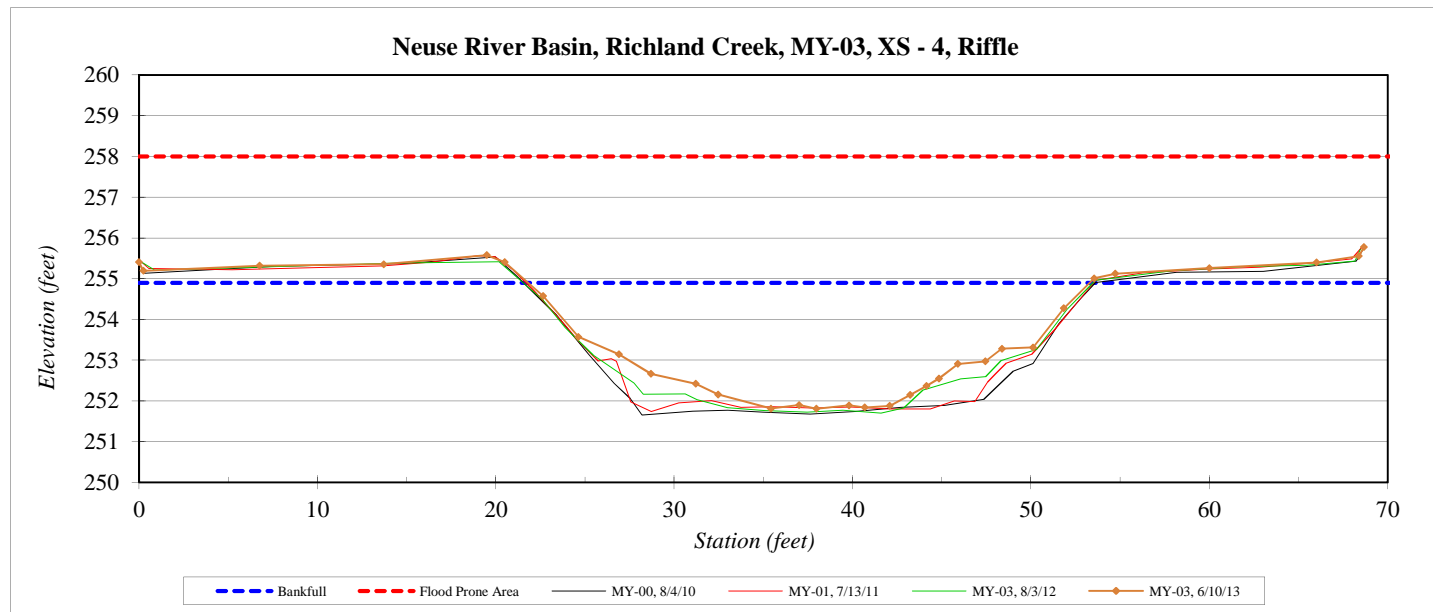
SUMMARY DATA	
Bankfull Elevation:	256.3
Bankfull Cross-Sectional Area:	86.3
Bankfull Width:	33.2
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	4.3
Mean Depth at Bankfull:	2.6
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-



River Basin:	Neuse
Watershed:	Richland Creek, MY-03
XS ID	XS - 4, Riffle
Drainage Area (sq mi):	7.8
Date:	6/10/2013
Field Crew:	A. French, T. Seelinger, A. Bubel

Station	Elevation
0.00	255.41
0.24	255.19
6.76	255.32
13.71	255.36
19.49	255.58
20.50	255.41
22.66	254.57
24.63	253.57
26.91	253.14
28.70	252.66
31.21	252.42
32.46	252.16
35.43	251.81
37.01	251.90
37.97	251.81
39.81	251.89
40.69	251.84
42.09	251.88
43.23	252.14
44.14	252.36
44.85	252.55
45.91	252.91
47.44	252.97
48.37	253.28
50.13	253.31
51.85	254.27
53.55	255.01
54.73	255.12
60.01	255.26
66.01	255.40
68.39	255.55
68.67	255.77

SUMMARY DATA	
Bankfull Elevation:	254.9
Bankfull Cross-Sectional Area:	66.6
Bankfull Width:	31.5
Flood Prone Area Elevation:	258.0
Flood Prone Width:	>68
Max Depth at Bankfull:	3.1
Mean Depth at Bankfull:	2.1
W / D Ratio:	14.9
Entrenchment Ratio:	>2.2
Bank Height Ratio:	1.0

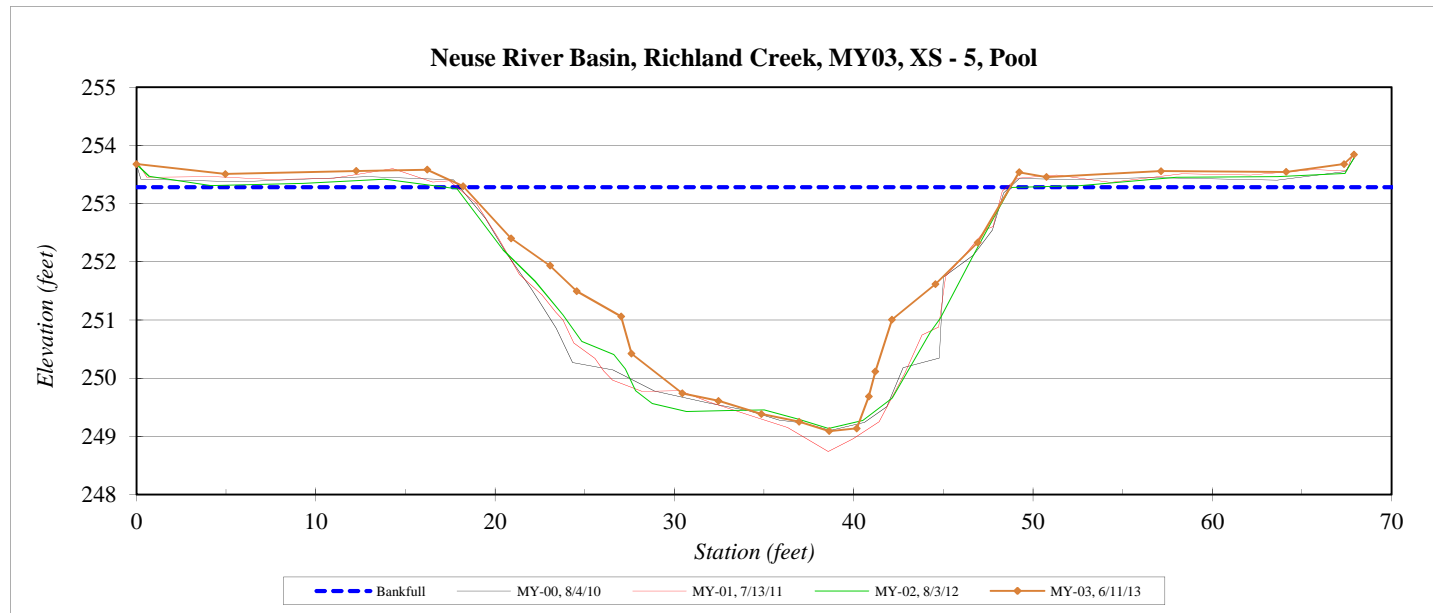


River Basin:	Neuse
Watershed:	Richland Creek, MY-03
XS ID	XS - 5, Pool
Drainage Area (sq mi):	7.8
Date:	6/11/2013
Field Crew:	T. Seelinger, A. Bubel



Station	Elevation
0.00	253.68
4.95	253.51
12.25	253.56
16.22	253.58
18.22	253.30
20.89	252.40
23.07	251.93
24.55	251.50
27.03	251.06
27.61	250.42
30.45	249.74
32.47	249.61
34.85	249.38
36.95	249.25
38.64	249.09
40.17	249.14
40.84	249.68
41.21	250.11
42.14	251.01
44.57	251.62
46.92	252.33
49.23	253.54
50.76	253.46
57.14	253.56
64.12	253.54
67.35	253.68
67.90	253.84

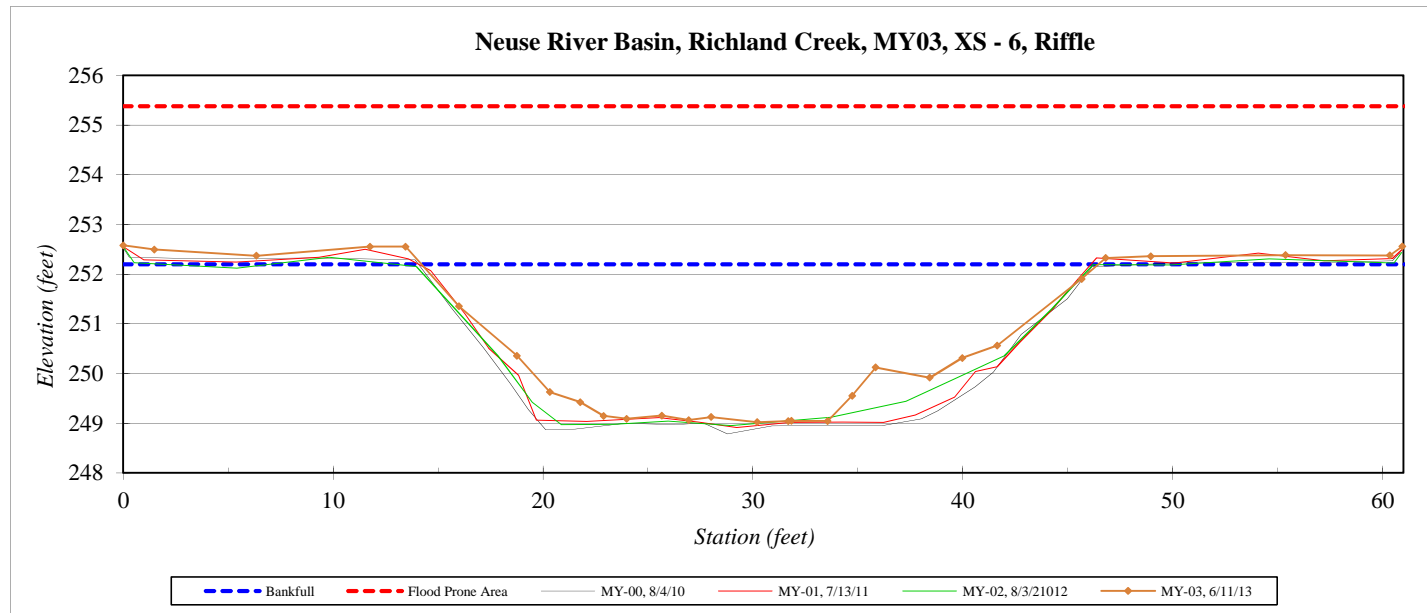
SUMMARY DATA	
Bankfull Elevation:	253.3
Bankfull Cross-Sectional Area:	74.4
Bankfull Width:	30.5
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	4.2
Mean Depth at Bankfull:	2.4
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-



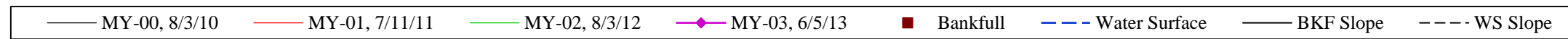
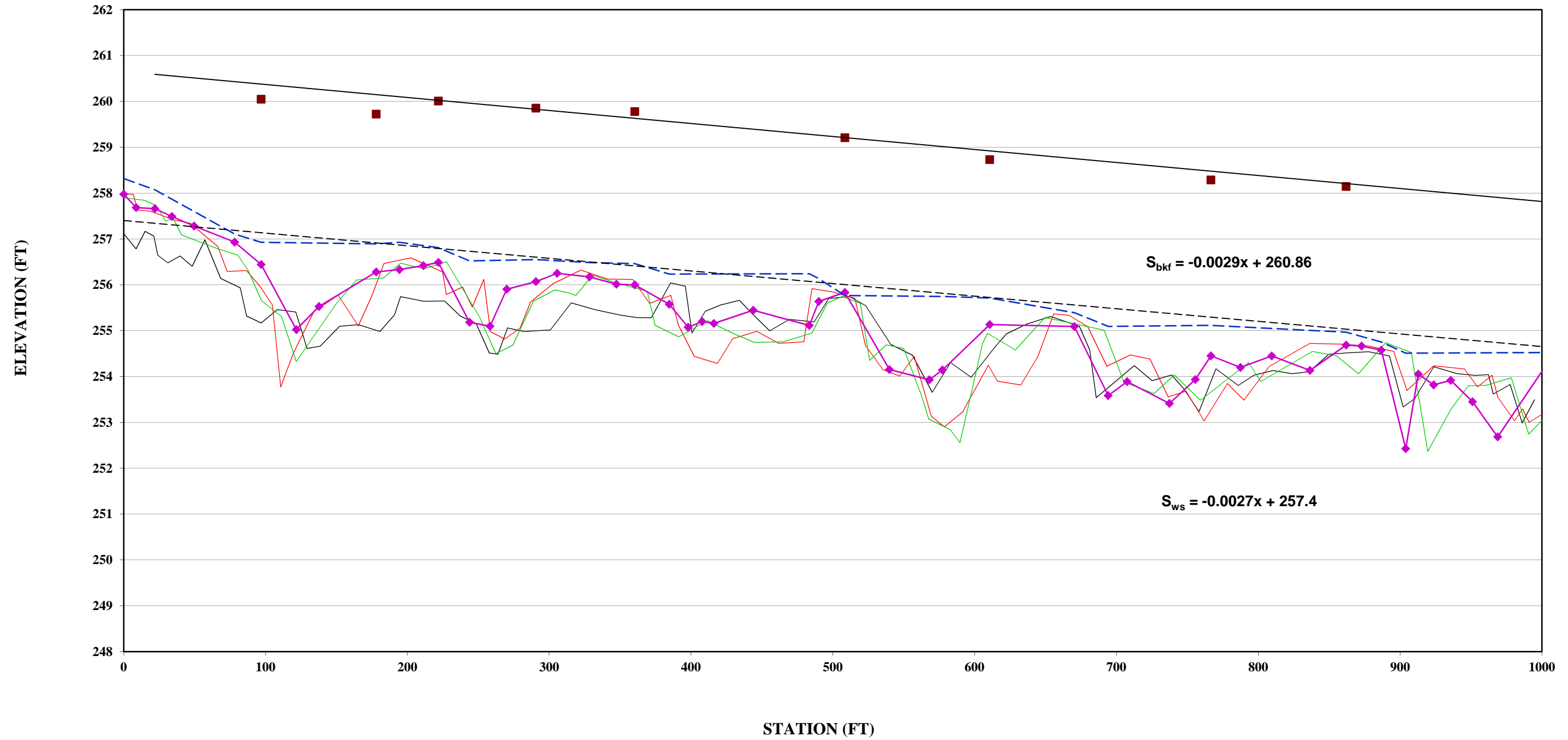
River Basin:	Neuse
Watershed:	Richland Creek, MY-03
XS ID	XS - 6, Riffle
Drainage Area (sq mi):	7.8
Date:	6/11/2013
Field Crew:	T. Seelinger, A. Bubel

Station	Elevation
0.0	252.58
1.3	252.49
6.1	252.37
11.6	252.55
13.3	252.55
15.8	251.35
18.6	250.36
20.1	249.63
21.6	249.42
22.7	249.15
23.8	249.09
25.5	249.15
26.7	249.06
27.8	249.12
30.0	249.02
31.6	249.05
31.5	249.04
33.4	249.04
34.5	249.55
35.7	250.12
38.2	249.92
39.8	250.31
41.4	250.56
45.5	251.90
46.6	252.32
48.8	252.36
55.2	252.38
60.1	252.37
60.7	252.56

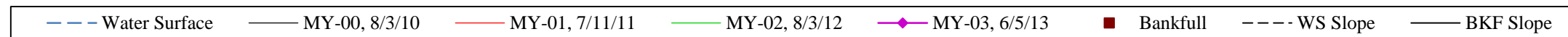
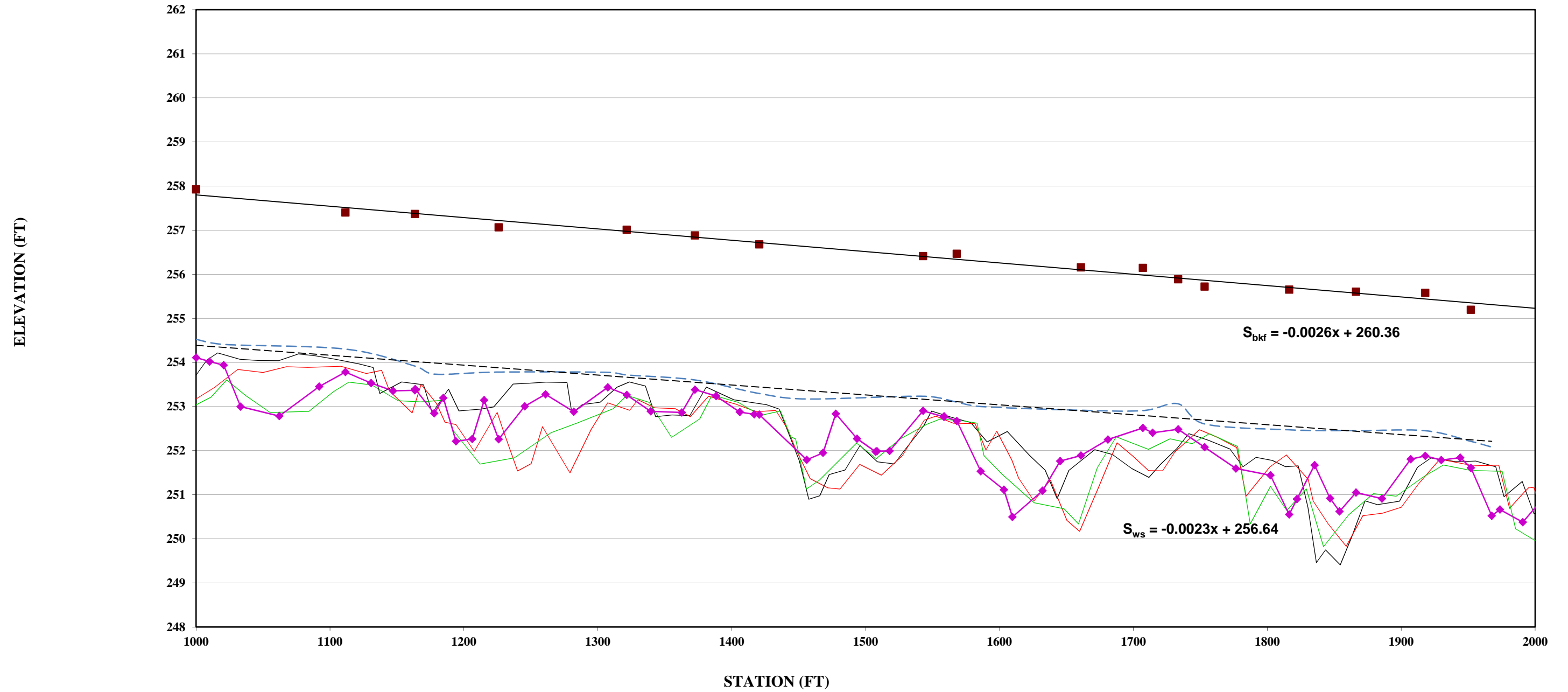
SUMMARY DATA	
Bankfull Elevation:	252.2
Bankfull Cross-Sectional Area:	70.2
Bankfull Width:	32.3
Flood Prone Area Elevation:	255.4
Flood Prone Width:	>60
Max Depth at Bankfull:	3.2
Mean Depth at Bankfull:	2.2
W / D Ratio:	14.8
Entrenchment Ratio:	>1.9
Bank Height Ratio:	1.0



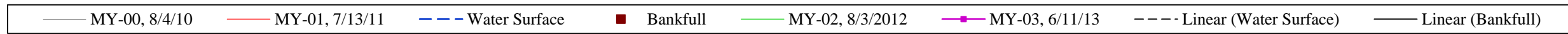
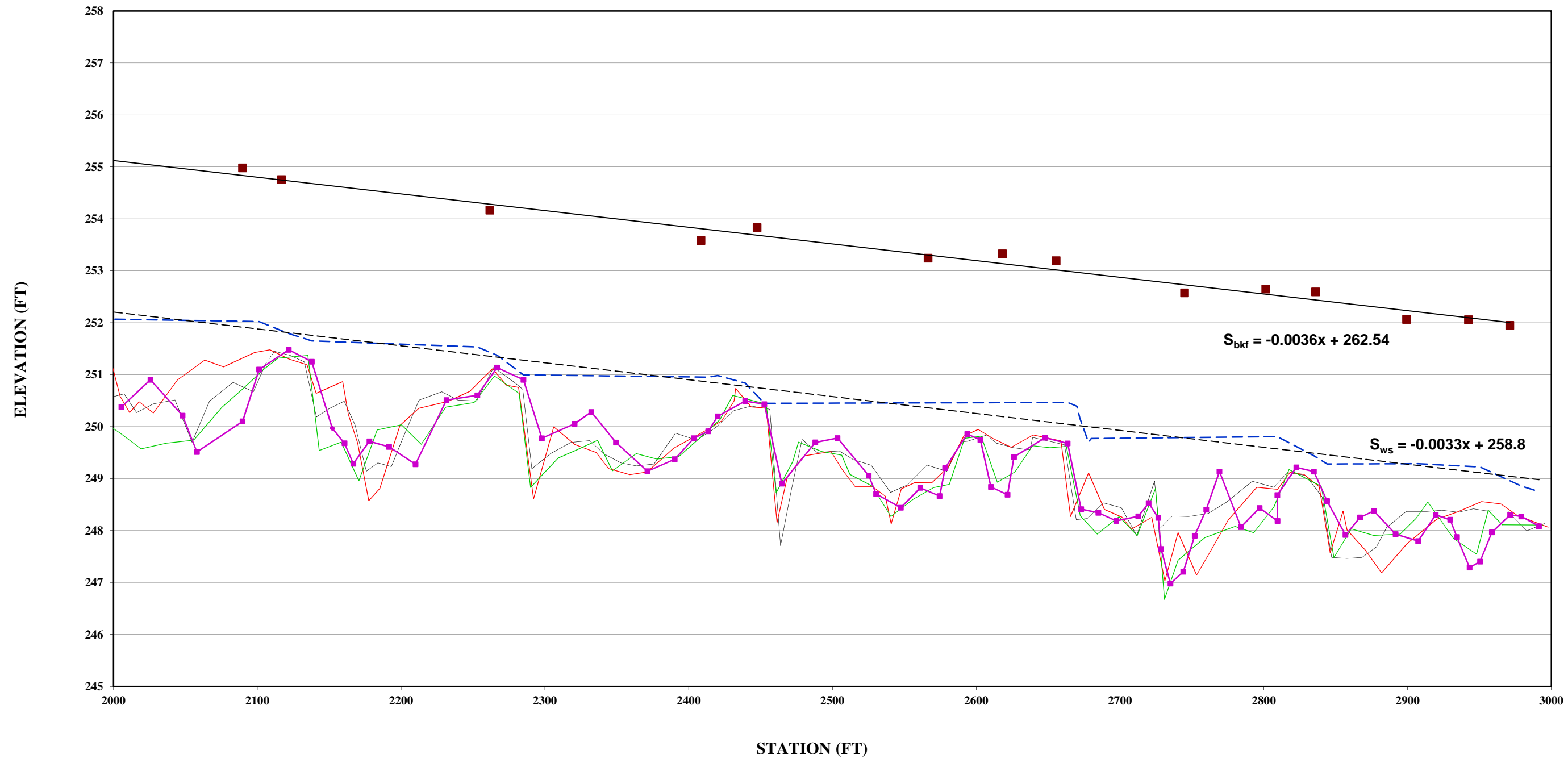
**Longitudinal Profile
Richland Creek
EEP Project Number 304- MY-03
Stations 0+00 - 10+00**



**Longitudinal Profile
Richland Creek
EEP Project Number 304- MY-03
Stations 10+00 - 20+00**

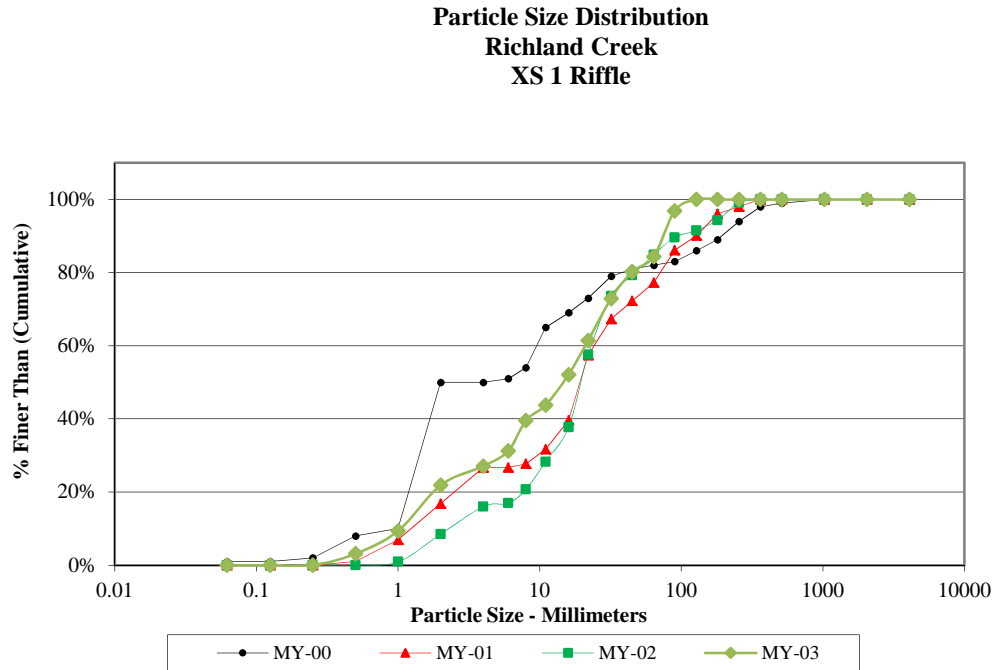


**Longitudinal Profile
Richland Creek
EEP Project Number 304- MY-03
Stations 20+00 - 30+00**



Pebble Count Plots

Cross-Section 1 Riffle - MY-03			
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	3
Very Coarse	1 - 2	S	6
Very Fine	2 - 4		12
Fine	4 - 5.7	G	5
Fine	5.7 - 8	R	4
Medium	8 - 11.3	A	8
Medium	11.3 - 16	V	4
Coarse	16 - 22.6	E	8
Coarse	22.6 - 32	L	9
Very Coarse	32 - 45	S	11
Very Coarse	45 - 64		7
Small	64 - 90	C	4
Small	90 - 128	O	12
Large	128 - 180	B	3
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	96
Note:			

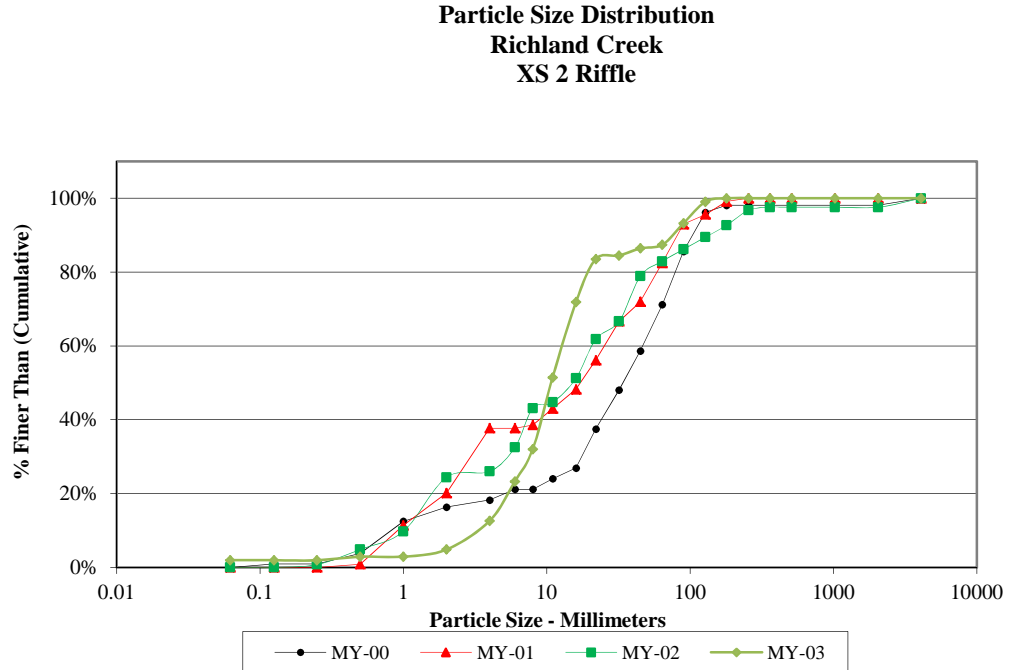


Size (mm)	
D16	2.9
D35	9.2
D50	20
D65	36
D84	87
D95	120

Size Distribution	
mean	15.9
dispersion	5.6
skewness	-0.08

Type	
silt/clay	0%
sand	9%
gravel	71%
cobble	20%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 2 Riffle - MY-03			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	2
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	1
Coarse	.50 - 1	D	
Very Coarse	1 - 2	S	2
Very Fine	2 - 4		8
Fine	4 - 5.7	G	11
Fine	5.7 - 8	R	9
Medium	8 - 11.3	A	20
Medium	11.3 - 16	V	21
Coarse	16 - 22.6	E	12
Coarse	22.6 - 32	L	1
Very Coarse	32 - 45	S	2
Very Coarse	45 - 64		1
Small	64 - 90	C	6
Small	90 - 128	O	6
Large	128 - 180	B	1
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	103
Note:			



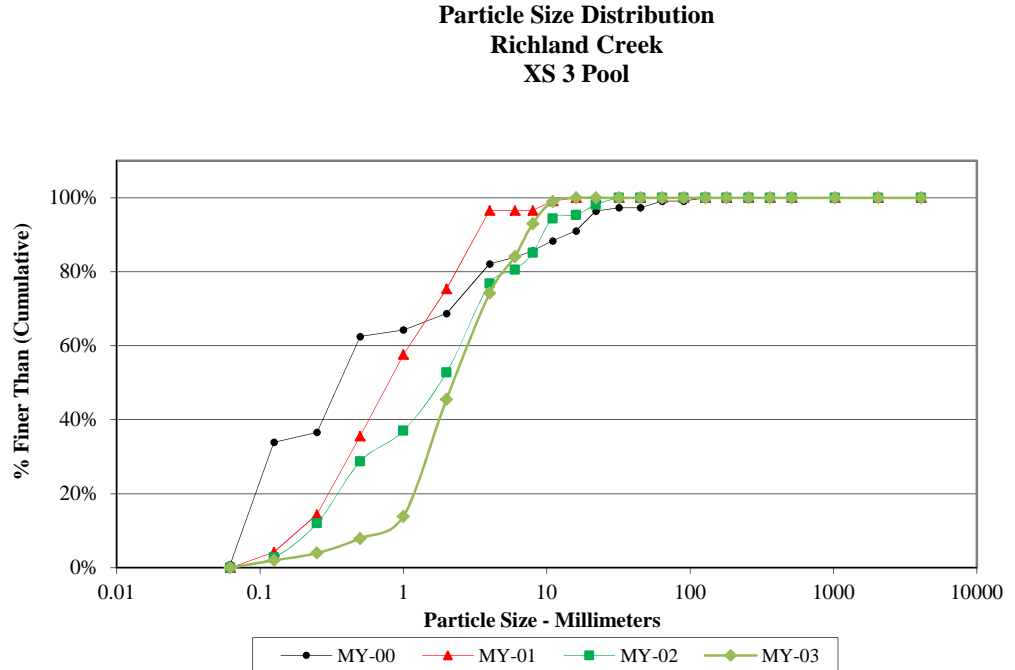
Size (mm)	
D16	2.8
D35	6.4
D50	7.9
D65	10
D84	21
D95	71

Size Distribution	
mean	9.1
dispersion	7.3
skewness	-0.17

Type	
silt/clay	2%
sand	3%
gravel	83%
cobble	13%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 3 Pool - MY-03			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	2
Fine	.125 - .25	A	2
Medium	.25 - .50	N	4
Coarse	.50 - 1	D	6
Very Coarse	1 - 2	S	32
Very Fine	2 - 4		29
Fine	4 - 5.7	G	10
Fine	5.7 - 8	R	9
Medium	8 - 11.3	A	6
Medium	11.3 - 16	V	1
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:

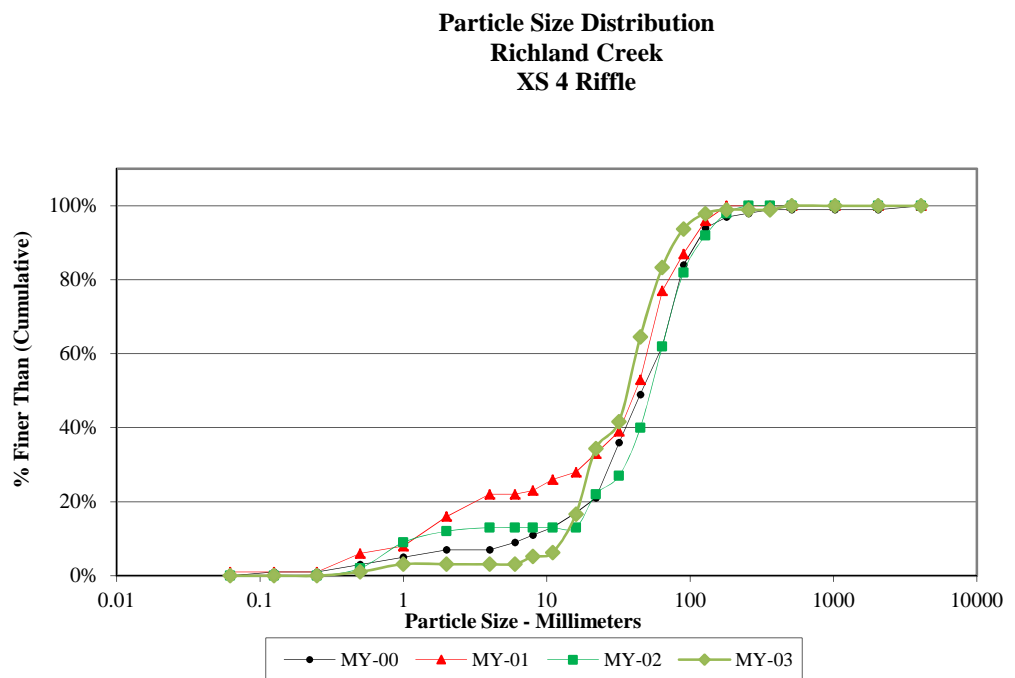


Size (mm)	
D16	1
D35	1.6
D50	2.2
D65	3.2
D84	6
D95	8.9

Size Distribution	
mean	1.4
dispersion	5.0
skewness	-0.07

Type	
silt/clay	0%
sand	74%
gravel	54%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 4 Riffle - MY-03			
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	2
Very Coarse	1 - 2	S	
Very Fine	2 - 4		
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	1
Medium	11.3 - 16	V	10
Coarse	16 - 22.6	E	17
Coarse	22.6 - 32	L	7
Very Coarse	32 - 45	S	22
Very Coarse	45 - 64		18
Small	64 - 90	C	10
Small	90 - 128	O	4
Large	128 - 180	B	1
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	1
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	96
Note:			

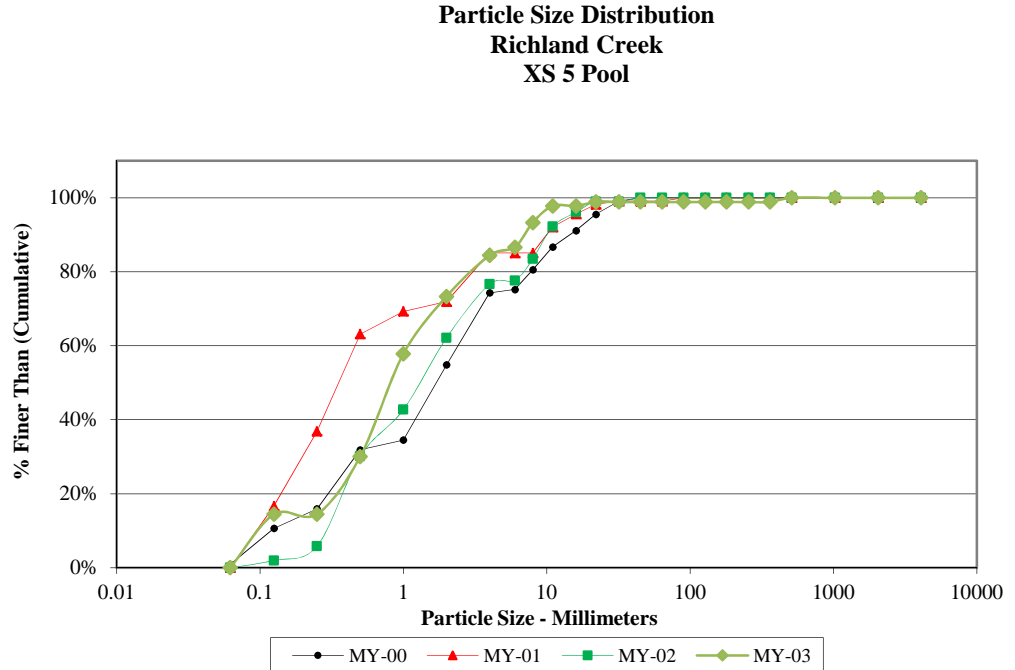


Size (mm)	
D16	21
D35	32
D50	51
D65	65
D84	93
D95	140

Size Distribution	
mean	41.8
dispersion	2.4
skewness	-0.12

Type	
silt/clay	0%
sand	3%
gravel	80%
cobble	16%
boulder	1%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 5 Pool - MY-03			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	13
Medium	.25 - .50	N	
Coarse	.50 - 1	D	14
Very Coarse	1 - 2	S	25
Very Fine	2 - 4		14
Fine	4 - 5.7	G	10
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	6
Medium	11.3 - 16	V	4
Coarse	16 - 22.6	E	
Coarse	22.6 - 32	L	1
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	1
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	90
Note:			

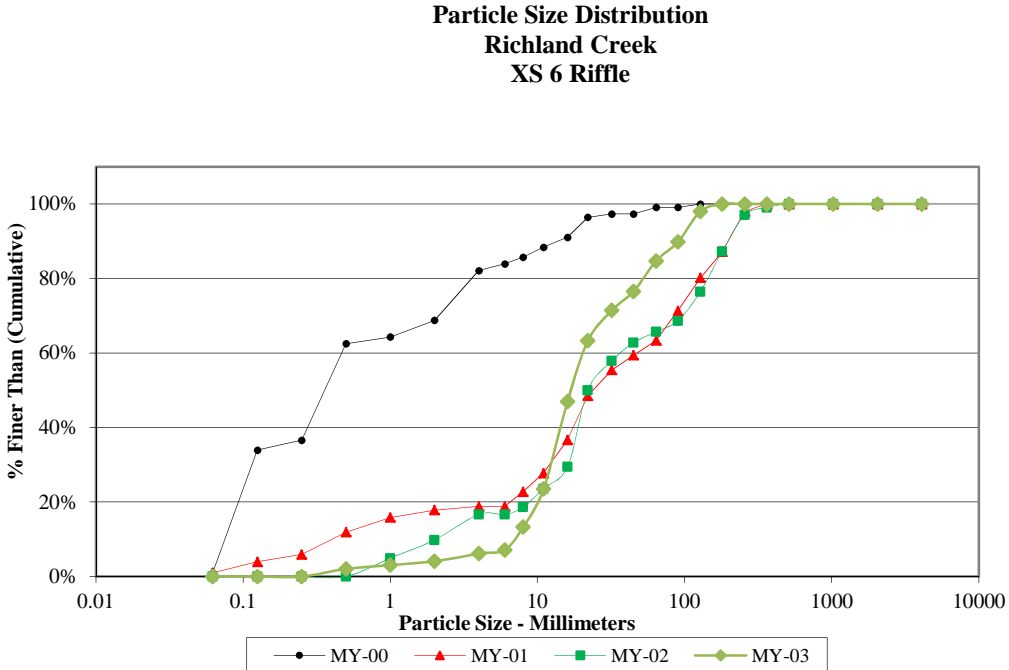


Size (mm)	
D16	0.31
D35	0.66
D50	1.1
D65	2.4
D84	7.2
D95	17

Size Distribution	
mean	1.7
dispersion	5.2
skewness	0.09

Type	
silt/clay	0%
sand	58%
gravel	41%
cobble	0%
boulder	1%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 6 Riffle - MY-03			
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	2
Very Coarse	1 - 2	S	1
Very Fine	2 - 4		1
Fine	4 - 5.7	G	2
Fine	5.7 - 8	R	1
Medium	8 - 11.3	A	6
Medium	11.3 - 16	V	10
Coarse	16 - 22.6	E	23
Coarse	22.6 - 32	L	16
Very Coarse	32 - 45	S	8
Very Coarse	45 - 64		5
Small	64 - 90	C	8
Small	90 - 128	O	5
Large	128 - 180	B	8
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	98



Size (mm)	
D16	12
D35	19
D50	23
D65	34
D84	87
D95	160

Size Distribution	
mean	24.0
dispersion	6.7
skewness	0.03

Type	
silt/clay	0%
sand	3%
gravel	73%
cobble	23%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Note:

**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					
	LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Med	Max	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																								
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)						
	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+
Based on fixed baseline elevation																																			
Bankfull Width (ft)	34.4	33.6	35.4	34.0				31.9	35.2	35.6	33.6				31.4	33.9	36.1	33.2				32.1	31.9	31.9	31.5				31.5	32.5	31.9	30.5			
Floodprone Width (ft)	>90	>90	>90	>90				>70	>70	>70	>70				-	-	-	-				>68	>68	>68	>68				-	-	-	-			
Bankfull Mean Depth (ft)	2.4	2.4	2.2	2.1				2.8	2.5	2.5	2.5				3.3	2.9	2.7	2.6				2.5	2.4	2.3	2.1				2.9	2.8	2.7	2.4			
Bankfull Max Depth (ft)	3.4	3.4	3.5	3.3				3.8	3.8	3.7	3.7				5.6	5.0	5.0	4.3				3.3	3.2	3.2	3.1				4.3	4.7	4.1	4.2			
Bankfull Cross-Sectional Area (ft ²)	81.7	79.9	78.5	72.1				89.3	88.5	87.6	84.0				104.0	99.2	97.8	86.3				80.2	76.5	73.1	66.6				90.8	90.6	85.0	74.4			
Bankfull Width/Depth Ratio	14.5	14.1	16.0	16.0				11.4	14.0	14.5	13.5				-	-	-	-				12.8	13.3	13.9	14.9				-	-	-	-			
Bankfull Entrenchment Ratio	>2.0	>2.0	>2.2	>2.2				>2.0	>1.8	>2.0	>2.0				-	-	-	-				>2.0	>2.1	>2.2	>2.2				-	-	-	-			
Bankfull Bank Height Ratio	1.0	1.0	1.0	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	460.5				111.4	108.6	114.4	110.9				135.7	134.2	135.6	123.3				100.1	100.6	96.2	105.9				106.4	110.6	107.4	99.8			
d50 (mm)	2.0	19.0	20.0	20.0				34.0	17.0	15.0	7.9				0.4	0.8	1.7	2.2				46.0	42.0	53.0	51.0				1.7	0.4	1.3	1.1			
	Cross-Section 6 (Riffle)																																		
Based on fixed baseline elevation																																			
Bankfull Width (ft)	32.2	32.6	33.3	32.3																															
Floodprone Width (ft)	>60	>60	>60	>60																															
Bankfull Mean Depth (ft)	2.7	2.5	2.3	2.2																															
Bankfull Max Depth (ft)	3.5	3.4	3.2	3.2																															
Bankfull Cross-Sectional Area (ft ²)	85.6	82.2	77.9	70.2																															
Bankfull Width/Depth Ratio	12.1	12.9	14.2	14.8																															
Bankfull Entrenchment Ratio	>1.9	>1.8	>1.9	>1.9																															
Bankfull Bank Height Ratio	1.0	1.0	1.0	1.0																															
Cross-Sectional Area Between End Pins (ft ²)	94.3	94.1	92.1	87.1																															
d50 (mm)	44.0	24.0	22.0	23.0																															

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)					
	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
Dimension																														
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	30.5	32.5	32.8	34.0	1.341	4												
Floodprone Width (ft)	68	72	69	90	12.754	4	60	72	69	89	12.285	4	-	-	-	-	-	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	2.1	2.3	2.3	2.6	0.214	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	3.1	3.6	3.5	4.3	0.520	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	66.6	75.6	73.3	86.3	7.860	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	13.5	14.8	14.9	16.0	1.023	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	-	-	-	-	-	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	1.0	1.0	1.0	1.0	1.0	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	14	29	25	78	11	16												
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	0.001	0.023	0.008	0.010	0.006	16												
Pool Length (ft)	31	72	74	122	24	17	12	68	78	120	31	17	9	129	74	78	32	14												
Pool Max Depth (ft)	1.5	1.5		1.5		1	1.5	1.5		1.5		1	3.3	3.3		3.3		1												
Pool Spacing (ft)	86	172	169	262	45	16	51	161	159	256	54	16	130	278	165	185	47	13												
Additional Reach Parameters																														
Valley Length (ft)				2,710						2,710						2,710														
Channel Thalweg Length (ft)				2,919						2,919						2,919														
Sinuosity				1.1						1.1						1.1														
Water Surface Slope (ft/ft)				0.0032						0.0034						0.0034														
Bankfull Slope (ft/ft)				0.0029						0.0025						0.0025														
Rosgen Classification				C4						C4						C5														
SC% / Sa% / G% / C% / B% / Be%				0.33%/36%/47%/16%/0.67%						0%/29%/54%/16%/1%						0%/25%/67%/12%/0%/0%														
d16 / d35 / d50 / d65 / d84 / d95				1.1/10/17/65/110						4.6/13/19/31/66/135						6.7/12/18/25/50/86														
% of Reach with Eroding Banks				1%						2%						5%														

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
6/10/2013	6/7/2013	Photographed on site	2, see below
11/15/2013	unknown	Photographed on site	3, see below



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



Photo #2 – Bankfull Evidence (wrack lines), 6/10/2013



Photo #3 – Bankfull Evidence (wrack lines), 11/15/2013