MCDONALDS POND RESTORATION SITE
2008 Annual Monitoring Report (Year 3)

Richmond County, North Carolina
EEP Project No. D04020-2
Design Firm: International Paper

March 2009

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RICHMOND COUNTY, NORTH CAROLINA

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EXECUTIVE SUMMARY

Introduction

In response to a Request for Proposal (RFP, No. 16-D04016) issued in December of 2003, International Paper Company (IP) proposed the establishment of the McDonalds Pond Restoration Site (hereafter referred to as the "Site") located in Richmond County, approximately two (2) miles northeast of the town of Hamlet and three (3) miles east of the town of Rockingham. In order to provide stream channel restoration and riverine wetland restoration, IP has removed the McDonalds Pond Dam (Dam) located on Falling Creek.

The Site comprises approximately 128 acres, and includes the 17.7 acre McDonalds Pond (a.k.a Shepards Lake), portions of Falling Creek, numerous headwater tributaries and over 80 acres of forested riparian wetlands, seepage wetlands, and marsh wetlands.

The Dam was removed in a manner to minimize potential impacts to water resources both upstream and downstream of the dam. Gradual dewatering and phased dam removal were undertaken to avoid introducing sediments and pollutants into the receiving Falling Creek reaches downstream. Heavy equipment operated from or within the footprint of the former Dam during dam removal operations, thereby minimizing the impact to the adjacent intact forest and wetland soil. Dam removal began with the dewatering (lowering) of the pond in the fall of 2005, followed by the clearing of trees and small bushes from the former earthen dam in February 2006. Excavation activities continued for approximately two weeks until dam removal was complete in mid-March 2006.

Monitoring Plan

Monitoring activities began in March 2006 (Year 1), and will be performed for at least five-years or until success criteria are achieved. Post removal monitoring data will be compared to reference sites as well as biological baseline values collected in September 2004. Primary success criteria of the project include: 1) the successful classification of restored/enhanced reaches as functioning systems, 2) channel stability indicative of a stable stream system, 3) development of characteristic lotic aquatic communities, 4) establishment of wetland hydrology (as defined in the U.S. Army Corps of Engineers [USACE] Wetlands Delineation Manual) within the former pond footprint, and 5) vegetative success of 320 stems/acre after the third year of monitoring and 260 stems/acre after the fifth and final year of monitoring. The following monitoring report describes the results of monitoring activities completed during (2008) Year 3 monitoring.

Year 3 Monitoring Results (2008)

Stream Assessment

Restored and enhanced segments of Falling Creek have continued to establish braided, anastomosed, bifurcated, and single-threaded channels characteristic of the area. Restored and enhanced stream segments across the Site have further developed stream pattern, profile, and dimension similar to that of reference reaches. Cross-sections located within the former pond indicate that deposited pond sediment

continues to be transported downstream, as evidenced by increased bankfull areas. In addition, stream banks have further stabilized with native vegetation.

Aquatic community assemblages within the former pond have maintained characteristics of a natural lotic system. Fifty-eight percent (58%) of the macroinvertebrate samples taken in October 2008 (Year 3) from restored segments of Falling Creek (within the former pond) consisted of macroinvertebrate genera predominantly found in lotic systems. Genera predominantly found in lentic systems represented only eight percent (8%) of species collected within the former pond from the Year 3 sample.

North Carolina Division of Water Quality (NCDWQ) Habitat Assessment Forms (HAFs) were completed at multiple locations along the restored and enhanced segments of Falling Creek. The HAF scores indicate that the restored and enhanced stream segments continue to develop in-stream habitat characteristic of reference reaches.

Wetland Vegetation Assessment

Vegetation monitoring for Year 3 was performed based on the Carolina Vegetation Survey (CVS) Levels 1 and 2 at eight (8) 10 x 10 meter plots. Based on Year 3 monitoring, the average count of surviving planted species is 536 stems per acre. If volunteer species are included, the total survival increases to 3561 stems per acre. The Site exceeds the established success criteria of 320 stems/acre after the third year and is on track to exceed the success criteria of 260 stems/acre after the fifth and final year.

Wetland Hydrology Assessment

Even though extreme drought conditions occurred in the area, all four (4) on-Site groundwater gauges have registered water levels within the upper 12 inches of the soil surface for at least 28 consecutive days (Richmond County, NRCS) or 12.5 percent (12.5%) of the growing season. Therefore, wetland hydrology at the Site is meeting the required success criteria.

Summary

Following the third year of monitoring, restored streams within the former pond have continued to develop stable lotic conditions typical of reference systems. Pattern, profile, and dimension data obtained from channel surveys indicate that stream geomorphology continues to shift toward that of reference reaches. Stable single-threaded (E-channel) and braided (DA-channel) streams have continued to develop at the Site. Groundwater gauge data within the former pond indicates restored wetland hydrology (despite drought conditions) and closely resembles that of the upstream reference gauge. Vegetation surveys support the establishment of a Streamhead Pocosin/Atlantic White Cedar forest community with thriving planted and volunteer species. Stream, wetland vegetation, and wetland hydrology success criteria were met in Year 3 monitoring.

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1.0 PROJECT BACKGROUND

1.1 Location and Setting

The North Carolina Ecosystem Enhancement Program (EEP) is currently developing stream and wetland restoration strategies for the Yadkin-Pee Dee River Basin, Cataloging Unit 03040201. As a part of this effort, International Paper (IP) was selected to complete the McDonalds Pond Restoration Project located in Richmond County. The McDonalds Pond Restoration Site ('hereafter referred to as the "Site") is located approximately two (2) miles northeast of the town of Hamlet and three (3) miles east of the town of Rockingham between NC Route 1 and NC Route 177 (Figure 1, Appendix A).

1.2 Restoration Structure and Objectives

Falling Creek, the major drainage feature on-Site, was previously impounded by the McDonalds Pond Dam (Dam), constructed over 70 years ago. Approximately 3,700 linear feet of Falling Creek and tributaries were impacted by the construction of the pond dam including streams contained within the pond footprint, as well as stream sections located both up and downstream of the pond. In addition, approximately 17.7 acres of riverine wetland were inundated with the construction of the dam. Approximately 4.2 acres of the floodplain immediately upstream of the pond were impacted by the "backwater effect" (the backing-up of water), creating marsh wetlands with saturated conditions unsuitable for historic wetland communities. An eroded pond outfall channel located at the northern extent of the dam drained adjacent wetlands and redirected historic flows of the Falling Creek floodplain.

Stream restoration efforts were achieved through the removal of the Dam resulting in the restoration of 2,969 linear feet of stream. The former Dam was excavated to the approximate level of the pre-existing valley contours, allowing the stream unrestricted flow through the Site. Stream restoration efforts were designed to utilize passive stream channel restoration processes, allowing the channel to reestablish naturally following the removal of the dam. Stream enhancement (Level I) was achieved through the removal of the dam and the filling of the northern outfall channel, which returned the historic hydrologic characteristics (stream volume and velocity) to 770 feet of impacted stream channel downstream of the former dam. Riverine wetland restoration was accomplished within the former 17.7 acre pond footprint through the excavation of the Dam and the establishment of native Streamhead Pocosin and Atlantic White Cedar forest communities. Additionally, the Site includes the preservation of 5,800 linear feet of stream, 77.8 acres of wetland, and 25.6 acres of upland/wetland ecotone buffer.

1.3 Project Objectives

The primary project goals include 1) the restoration of a stable, meandering stream channel through the areas impacted by the Dam, 2) the restoration of historic lotic aquatic communities that represent the Site's natural range in variation, 3) the restoration of historic wetland conditions within the pond footprint, and 4) the restoration of natural wetland plant communities within their historic locations.

Additional potential benefits of the project include the restoration of wildlife functions associated with a riparian corridor and stable stream and the enhancement of water quality function in the on-Site, upstream, and downstream segments of Falling Creek and tributaries.

The specific goals of this project are to:

- Restore approximately 2,969 linear feet of historic stream course, flow volumes, and patterns through the marsh wetlands, McDonalds Pond footprint, and immediately downstream of the existing dam.

- Enhance an additional approximate 770 linear feet of Falling Creek downstream of the restored stream channel extending into the gas line easement.

- Protect the headwaters of Falling Creek that are located within the Site through preservation of approximately 5,800 linear feet of Falling Creek and associated tributaries.

- Restore approximately 17.7 acres of forested riverine wetlands within the McDonalds Pond footprint.

- Enhance 4.2 acres of forested riverine wetlands within the marsh wetlands located at the head of McDonalds Pond.

- Preserve 77.8 acres of forested riverine wetlands adjacent to Falling Creek and associated tributaries.

- Restore and enhance habitat for vegetation and wildlife species, characteristic of Streamhead Pocosin and Atlantic White Cedar Forest (Schafale and Weakley 1990).

- Enhance the function and value of the Falling Creek wetland community through the preservation of 25.6 acres of buffer along the Falling Creek stream/wetland complex.

Table 1. Summary of Stream and Wetland Mitigation Units

Restoration Activities	Linear feet	Acres	Mitigation Ratios	Percentage of Mitigation Units	Mitigation Units
Stream Restoration	1,784	N/A	1:1	75	1,784
Stream Restoration (undefined channel)	1,185	N/A	1:1		1,185
Stream Enhancement (Level I)	770	N/A	1:1.5		513
Stream Preservation	5,800	N/A	1:5	25	1,160
Total Stream Mitigation Units (SMUs) Provided					**4,642**
Total SMUs Under Contract					**4,364**
Wetlands Restoration	N/A	17.7	1:1	75	17.7
Wetland Enhancement	N/A	4.2	1:2	25	2.1
Wetlands Preservation	N/A	19	1:5		3.8
Total Wetland Mitigation Units (WMUs) Provided					**23.6**
Total WMUs Under Contract					**23.4**

1.4 Project History and Background

Table 2. Project Activity and Reporting History			
Activity Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan	*NA	July 2005	August 2005
Final Design (90%)	*NA	July 2005	August 2005
Construction	*NA	N/A	March 2006
Temporary S&E mix applied to entire project area	*NA	N/A	March 2006
Bare Root Seedling Installation	*NA	N/A	March 2006
Mitigation Plan	*NA	June 2006	July 2006
Final Report	*NA	Oct 2006	Oct 2006
Year 1 Vegetation Monitoring	Dec 2006	Oct 2006	Dec 2006
Year 1 Stream Monitoring	Dec 2006	Oct 2006	Dec 2006
Year 2 Vegetation Monitoring	Dec 2007	Oct 2007	February 2008
Year 2 Stream Monitoring	Dec 2007	Oct 2007	February 2008
Year 3 Vegetation Monitoring	Dec 2008	Oct 2008	Dec 2008
Year 3 Stream Monitoring	Dec 2008	Oct 2008	Dec 2008

*NA – Scheduled completion dates unknown due to unanticipated project delays.

Table 3. Project Contacts	
Designer International Paper	6400 Poplar Avenue Memphis, TN 38197 (901) 419-1854
Construction Contractor Environmental Repair, Inc.	28723 Marston Road Marston, NC 28363 (910) 280-6043
Planting Contractor Garcia Forest Service, Inc.	PO BOX 789 Rockingham, NC 28379 (910) 997-5011
Seeding Contactor Environmental Repair, Inc.	28723 Marston Road Marston, NC 28363 (910) 280-6043
Nursery Stock Suppliers International Paper	6726 Highway 169 Bellville, GA 30414 (912) 739-4613 Route 1, Box 1097: County Road #3 Shellman, GA 39886 (229) 679-5640

Table 3. Project Contacts (*Cont.*)	
Nursery Stock Suppliers International Paper North Carolina Division of Forest Resources	 5594 Highway 38 South Blenheim, SC 29516 (843) 528-3203 726 Claridge Nursery Road Goldsboro, NC 27530 (919) 731-7988
Monitoring Performers EcoScience: a Division of PBS&J	1101 Haynes Street, Suite 101 Raleigh, NC 27604 (919) 828-3433
Stream Monitoring POC	Jens Geratz
Vegetation Monitoring POC	Jens Geratz

Table 4. Project Background	
Project County	Richmond
Drainage Area	2.5 square miles
Impervious cover estimate (%)	<5 percent
Stream Order	3rd order
Physiographic Region	Southeastern Plains
Ecoregion (Griffith and Omernik)	Sandhills
Rosgen Classification of As-built	DA5/E5
Cowardin Classification	Stream (R2UB2)
Dominant soil types	Johnston (JmA)
	Ailey (AcB, AcC)
	Candor-Wakulla Complex (CaC, WcB)
Reference Site ID	Falling Creek
USGS HUC for Project and Reference	03040201
NCDWQ Sub-basin for Project and Reference	03-07-16
NCDWQ classification for Project and Reference	WSIII
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	Yes
Reasons for 303d listing or stressor	Aquatic weeds
Percent of project easement fenced	NA

2.0 PROJECT CONDITION AND MONITORING RESULTS

The monitoring results described herein document the Year 3 (2008) monitoring activities. Stream monitoring activities continued at two (2) stream reaches that were established in April 2006. Each monitoring reach is approximately 150 feet in length and is comprised of one (1) stream cross-section where stream profile and dimension are monitored. Another 575 feet of stream channel profile and eight (8) cross-sections were added to the Site monitoring activities in October 2006 (Figure 2, Appendix A). Wetland vegetation monitoring activities were conducted in October 2008 and consist of an inventory of planted and volunteer species within eight (8) plots located throughout the former pond (Figure 4, Appendix A). Wetland hydrology monitoring activities include groundwater gauge monitoring conducted throughout the growing season (March 27 - November 5) (NRCS 1999) at four (4) gauges located within the former pond (Figure 5, Appendix A).

2.1 Stream Assessment

2.1.1 Stream Channel Morphology

Stream channel cross-sectional surveys were performed at all ten (10) on-Site monitoring locations in October 2008 (Figure 2, Appendix 2). Bankfull channel geometry for surveyed cross-sections are presented in Tables 5, 6, 6a, and 6b. Cross-section parameters were not generated for XS2, XS7, or XS8 where stream braiding has developed multiple active channels. Stream pattern parameters including channel beltwidth, radius of curvature, meander wavelength, and meander width ratio were generated from Year 3 survey data, and will be re-evaluated during Year 5 monitoring. Cross-section plots are represented in Figures B1-B10 in Appendix B. Bankfull elevations depicted in cross-section plots were adjusted from Year 2 as needed.

In general, bankfull channel parameters were largely unchanged compared to conditions assessed during Year 2 monitoring. Scouring and transportation of bank and bed material was detected at some monitoring cross-sections where restored channels continue to migrate toward reference conditions. Soil subsidence has diminished as herbaceous and woody vegetation further stabilize the soil and begin to provide shading to the developing forest floor.

Stream longitudinal profile was surveyed for approximately 900 feet within the restored channel, including the section of stream between on-Site Reach 3 and on-Site Reach 2 (Figure 2, Appendix A). Longitudinal profile data for this portion of the stream is plotted along with Year 1 conditions in Figure B-11, Appendix B. A typical riffle/pool sequence is still developing within this portion of the stream. The Site's natural low gradient and the large amount of coarse woody debris present within the channel has produced numerous depositional features (traverse and diagonal bars) scattered among scour pools of varying sizes. As a result, longitudinal profile parameters were not generated for the stream due to the complexity and irregularity of the channel bed. These parameters may be calculated in future monitoring years as riffle/pool features continue to establish and stabilize.

The stream channel substrate is naturally comprised of more than 90 percent (90%) sand throughout the Site. As a result, substrate sampling was not conducted at the cross-sections and is not included with the summarized cross-sectional parameters in Tables 5-6b.

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Table 5. Baseline Morphology and Hydrologic Summary															
Parameter	Regional Curve Interval			Reference Stream Reach 1 (233 linear feet)			Reference Stream Reach 4 (175 linear feet)			As-Built On-Site Reach 2 (186 linear feet)			As-Built On-Site Reach 3 (293 linear feet)		
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BF Width (ft)	9.6	13.5	12.7	N/A	N/A	13.0	N/A	N/A	9.1	N/A	N/A	7.9	N/A	N/A	11.3
Floodprone Width (ft)	300.0	600.0	400.0	N/A	N/A	500.0	N/A	N/A	300.0	N/A	N/A	450.0	N/A	N/A	400.0
BF Cross Sectional Area (ft^2)	9.4	18.1	16.1	N/A	N/A	14.3	N/A	N/A	9.0	N/A	N/A	7.6	N/A	N/A	10.8
BF Mean Depth (ft)	1.0	1.3	1.3	N/A	N/A	1.1	N/A	N/A	1.0	N/A	N/A	1.0	N/A	N/A	1.0
BF Max Depth (ft)	N/A	N/A	N/A	N/A	N/A	1.9	N/A	N/A	2.0	N/A	N/A	1.3	N/A	N/A	1.5
Width/Depth Ratio	9.8	10.0	9.9	N/A	N/A	11.4	N/A	N/A	9.2	N/A	N/A	8.3	N/A	N/A	11.7
Entrenchment Ratio	28.4	49.7	32.2	N/A	N/A	38.6	N/A	N/A	33.0	N/A	N/A	57.0	N/A	N/A	35.5
Wetted Perimeter (ft)	N/A	N/A	N/A	N/A	N/A	14.9	N/A	N/A	10.9	N/A	N/A	9.4	N/A	N/A	12.4
Hydraulic Radius (ft)	N/A	N/A	N/A	N/A	N/A	1.0	N/A	N/A	0.8	N/A	N/A	0.8	N/A	N/A	0.9
Pattern															
Channel Beltwidth (ft)	N/A	N/A	N/A	18.2	35.5	22.1	12.6	18.5	14.0	19.3	22.6	21.0	8.9	20.9	11.0
Radius of Curvature (ft)	N/A	N/A	N/A	18.6	46.3	21.1	4.2	27.7	6.8	10.3	24.3	15.8	4.1	18.2	13.4
Meander Wavelength	N/A	N/A	N/A	61.2	88.1	78.9	17.5	44.6	21.6	39.1	59.9	47.9	19.1	49.2	28.0
Meader Width Ratio	N/A	N/A	N/A	1.4	2.8	1.7	1.5	2.2	1.6	1.6	1.9	1.7	1.5	2.2	1.9
Profile															
Riffle Length (ft)	N/A	N/A	N/A	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*
Riffle Slope (ft)	N/A	N/A	N/A	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*
Pool Length (ft)	N/A	N/A	N/A	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*
Pool Spacing (ft)	N/A	N/A	N/A	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*
Substrate															
d50 (mm)	N/A	N/A	N/A	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*
d84 (mm)	N/A	N/A	N/A	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*
Additional Reach Parameters															
Valley Length (ft)	N/A			N/A			N/A			N/A			N/A		
Channel Length (ft)	N/A			N/A			N/A			N/A			N/A		
Sinuosity	N/A			1.3			1.1			1.1			1.1		
Water Surface Slope (ft/ft)	N/A			0.003			0.005			0.004			0.004		
BF Slope (ft/ft)	N/A			0.003			0.005			0.004			0.004		
Rosgen Classification	N/A			E5			E5			E5			E5		
Habitat Index	N/A			NA*			NA*			NA*			NA*		
Macrobenthos	N/A			NA*			NA*			NA*			NA*		

*See document text for details.

Table 6. Morphology and Hydraulic Monitoring Summary																		
Parameter	Cross-Section XS1						Cross-Section XS2						Cross-Section XS3					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	11.8	11.8	9.5				NA*	NA*	NA*				8.4	8.8	8.3			
Floodprone Width (ft)	400.0	400.0	400.0				NA*	NA*	NA*				400.0	400.0	400.0			
BF Cross Sectional Area (ft^2)	4.9	4.9	5.3				NA*	NA*	NA*				4.2	6.3	4.7			
BF Mean Depth (ft)	0.4	0.4	0.6				NA*	NA*	NA*				0.5	0.7	0.6			
BF Max Depth (ft)	0.8	0.8	0.8				NA*	NA*	NA*				1.0	1.2	0.9			
Width/Depth Ratio	28.9	28.8	17.3				NA*	NA*	NA*				16.7	12.4	14.8			
Entrenchment Ratio	33.8	33.9	42.0				NA*	NA*	NA*				47.9	45.4	48.3			
Wetted Perimeter (ft)	12.1	11.1	9.8				NA*	NA*	NA*				9.3	8.7	8.6			
Hydraulic Radius (ft)	0.4	0.4	0.5				NA*	NA*	NA*				0.4	0.7	0.5			
Substrate																		
d50 (mm)	NA*	NA*					NA*	NA*	NA*				NA*	NA*	NA*			
d84 (mm)	NA*	NA*					NA*	NA*	NA*				NA*	NA*	NA*			

Parameter	MY-01 (2006)			MY-02 (2007)			MY-03 (2008)			MY-04 (2009)			MY-05 (2010)			MY+ (2011)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	8.9	22.6	15.6	NA*	NA*	NA*	6.9	32.3	15.5									
Radius of Curvature (ft)	4.1	24.3	13.4	NA*	NA*	NA*	5.6	29.2	21.0									
Meander Wavelength	19.1	59.9	38.0	NA*	NA*	NA*	18.4	70.4	49.0									
Meader Width Ratio	1.5	2.2	1.9	NA*	NA*	NA*	0.8	2.5	1.52									
Profile																		
Riffle Length (ft)	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*									
Riffle Slope (ft)	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*									
Pool Length (ft)	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*									
Pool Spacing (ft)	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*	NA*									
Additional Reach Parameters																		
Valley Length (ft)	N/A			N/A			N/A											
Channel Length (ft)	N/A			N/A			N/A											
Sinuosity	1.1			1.1			1.1											
Water Surface Slope (ft/ft)	0.004			0.004			0.004											
BF Slope (ft/ft)	0.004			0.004			0.004											
Rosgen Classification	DA5/E5			DA5/E5			DA5/E5											
Habitat Index	NA*			NA*			NA*											
Macrobenthos	NA*			NA*			NA*											

*See document text for details.

Table 6a. Morphology and Hydraulic Monitoring Summary (*Cont.*)																		
Parameter	Cross-Section XS4						Cross-Section XSR2						Cross-Section XS5					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	25.1	29.8	37.3				7.9	8.9	10.8				6.4	19.2	23.47			
Floodprone Width (ft)	500.0	500.0	500.0				450.0	450.0	450.0				400.0	400.0	400.0			
BF Cross Sectional Area (ft^2)	6.7	14.0	24.3				7.6	8.7	11.4				3.9	6.9	12.6			
BF Mean Depth (ft)	0.3	0.5	0.7				1.0	1.0	1.0				0.6	0.4	0.5			
BF Max Depth (ft)	0.9	1.9	1.6				1.3	1.6	1.6				1.9	2.2	1.3			
Width/Depth Ratio	96.7	64.8	57.3				8.2	9.1	10.5				10.6	53.3	43.5			
Entrenchment Ratio	19.9	16.8	13.4				57.0	50.6	41.4				62.9	20.9	21.3			
Wetted Perimeter (ft)	25.2	30.4	26.8				9.4	10.3	9.0				8.6	21.0	9.6			
Hydraulic Radius (ft)	0.3	0.5	0.9				0.8	0.9	1.3				0.5	0.3	1.3			
Substrate																		
d50 (mm)	NA*	NA*	NA*				NA*	NA*	NA*				NA*	NA*	NA*			
d84 (mm)	NA*	NA*	NA*				NA*	NA*	NA*				NA*	NA*	NA*			

Parameter	Cross-Section XSR3						Cross-Section XS6						Cross-Section XS7					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	11.3	16.1	15.5				13.9	21.7	23.7				NA*	NA*	NA*			
Floodprone Width (ft)	400.0	400.0	400.0				350.0	350.0	350.0				NA*	NA*	NA*			
BF Cross Sectional Area (ft^2)	10.8	11.4	12.7				8.1	13.1	12.7				NA*	NA*	NA*			
BF Mean Depth (ft)	1.0	0.7	0.8				0.6	0.6	0.5				NA*	NA*	NA*			
BF Max Depth (ft)	1.5	1.8	1.5				2.5	3.3	1.9				NA*	NA*	NA*			
Width/Depth Ratio	11.7	22.9	20.7				24.0	36.2	44.7				NA*	NA*	NA*			
Entrenchment Ratio	35.5	24.9	24.21				25.1	16.1	21.1				NA*	NA*	NA*			
Wetted Perimeter (ft)	12.4	16.7	8.9				15.0	24.8	16.3				NA*	NA*	NA*			
Hydraulic Radius (ft)	0.9	0.7	1.4				0.5	0.5	0.8				NA*	NA*	NA*			
Substrate																		
d50 (mm)	NA*	NA*	NA*				NA*	NA*	NA*				NA*	NA*	NA*			
d84 (mm)	NA*	NA*	NA*				NA*	NA*	NA*				NA*	NA*	NA*			

*See document text for details.

Table 6b. Morphology and Hydraulic Monitoring Summary (*Cont.*)																		
Parameter	Cross-Section XS8																	
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	NA*	NA*	NA*															
Floodprone Width (ft)	NA*	NA*	NA*															
BF Cross Sectional Area (ft^2)	NA*	NA*	NA*															
BF Mean Depth (ft)	NA*	NA*	NA*															
BF Max Depth (ft)	NA*	NA*	NA*															
Width/Depth Ratio	NA*	NA*	NA*															
Entrenchment Ratio	NA*	NA*	NA*															
Wetted Perimeter (ft)	NA*	NA*	NA*															
Hydraulic Radius (ft)	NA*	NA*	NA*															
Substrate																		
d50 (mm)	NA*	NA*	NA*															
d84 (mm)	NA*	NA*	NA*															

*See document text for details.

2.1.2 Stream Problem Areas

During Year 3 monitoring, a beaver dam was constructed just upstream of the former Dam. Throughout the year, scientists worked to breach the beaver dam and discourage beaver activities. Nuisance species removal techniques were utilized with the successful removal of one beaver from the Site. While beaver activities have resulted in minimal damage to the Site, a pro-active approach to manage and prevent future beaver disturbance is proposed.

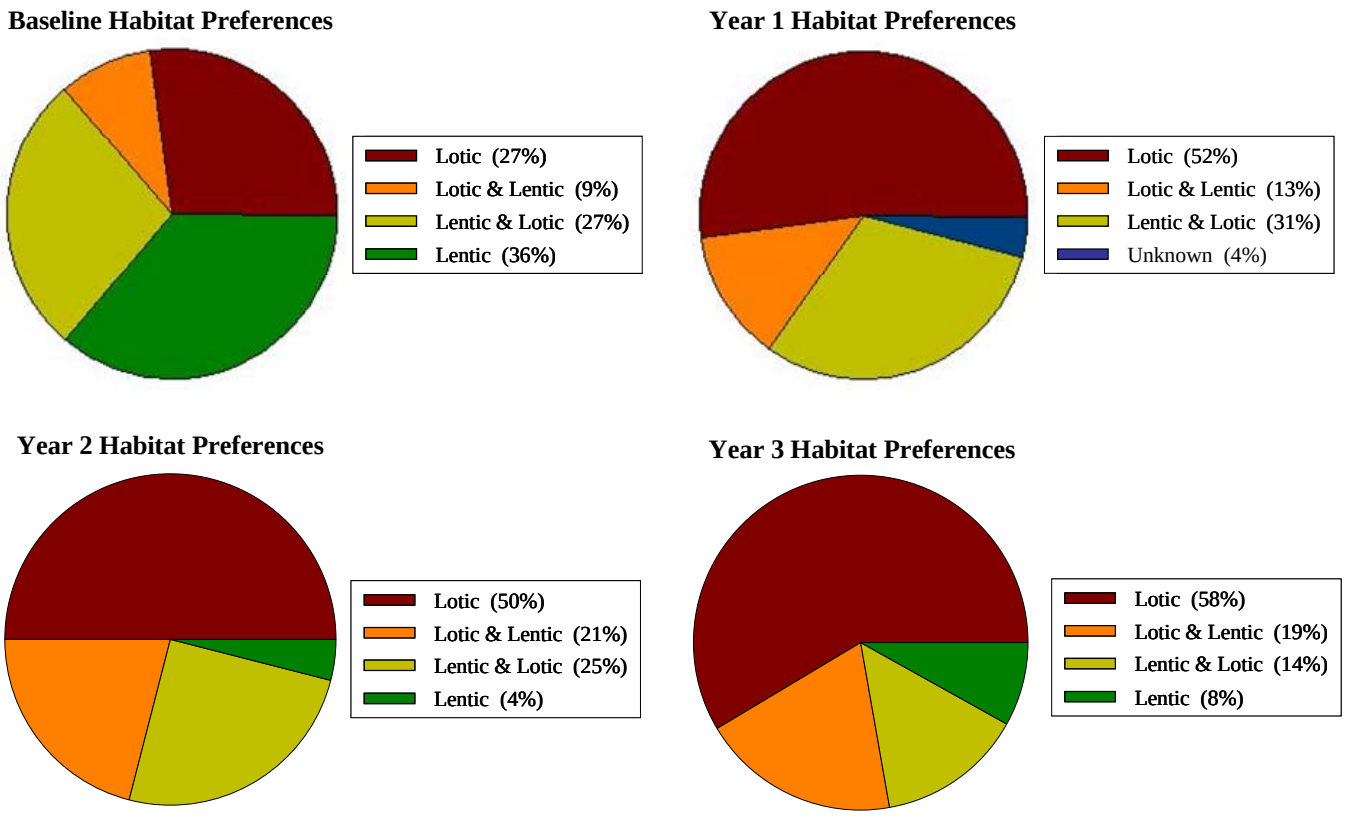
As discussed with the EEP project manager, IP and EcoScience propose to perform minor grading activities on the former Dam and to remove all components of the existing beaver dam. Minor grading will be targeted at lowering the elevation of the former Dam in areas where the residual footprint is above adjacent floodplain elevations. It is assumed that these slightly elevated areas of the former Dam support the establishment of beaver dams and upon removal, will reduce opportunities for beavers to re-construct dams during the last two years of the project. Once grading activities are complete, the area will be planted according to reference plant communities at agency required stocking levels. An immediate inventory of planted stems will be taken and re-evaluated during Year 4 vegetation monitoring activities. As discussed with EEP, if vegetation success of remedial planted stems is on target at the end of Year 5, then no additional vegetative monitoring will be required. As with the first planting at the Site, it is expected that planted stems will survive with little mortality and natural volunteers will further supplement the establishment of woody species.

2.1.3 Aquatic Communities

Benthic macroinvertebrates were sampled within Falling Creek during Year 3 monitoring in October 2008. Aquatic community data, located in Appendix C, are based on laboratory identifications of benthic macroinvertebrate taxa by Pennington and Associates, Inc., a NCDWQ-certified lab.

Aquatic community assemblages within the former pond continue to develop characteristics associated with a lotic system. Fifty-eight percent (58%) of the macroinvertebrate samples collected during Year 3 monitoring from restored segments of Falling Creek (within the former pond) consisted of macroinvertebrate genera predominantly found in lotic systems. Compared to baseline samples collected prior to dam removal, the macroinvertebrate genera favoring lotic systems have increased thirty-one percent (31%). Genera found in both lotic and lentic systems (with a preference for lotic) decreased slightly within Falling Creek, while genera favoring lentic and lotic (with a preference for lentic) also decreased. Genera predominantly found in lentic systems made up only eight percent (8%) of taxa collected from Falling Creek.

Graph 1. Comparisons between collected benthic macroinvertebrates and their habitat preferences (Source: Merritt and Cummins 1984).



In addition to benthic macroinvertebrate habitat preference comparisons, other comparative metrics including the total number of organisms collected, the total taxa represented in the collection, the richness (diversity) of EPT taxa, and the biotic index can be used to evaluate aquatic habitat restoration. Table 7 summarizes the mean values for all these metrics from benthic macroinvertebrates collected within Falling Creek prior to dam removal and all subsequent monitoring years.

Table 7. Benthic Macroinvertebrate Metric Summary

Monitoring Year	Total Organisms	Total Taxa	EPT Richness	Biotic Index*
Baseline (2005)	32	15	2	7.42
Year 1 (2006)	209	35	16	5.33
Year 2 (2007)	187	38	12	4.95
Year 3 (2008)	73	24	8	5.21

*The biotic index is derived from North Carolina Tolerance Values that are assigned to each collected species. These Tolerance Values range from 0 for organisms intolerant of organic wastes to 10 for organisms very tolerant of organic wastes.

As seen in Table 7, all comparative metrics quantitatively improved following dam removal; but have subsequently fallen in Year 3 monitoring. In the current monitoring year, the total number of organisms and overall species diversity decreased. Additionally, the increase in biotic index values (following a

decrease in 2006 and 2007 indicative of improved water quality) shows that some variability between years may be present. The decrease in total organisms, total taxa, and EPT richness from 2006 to 2008 could be due to an initial colonization spike of opportunistic species during the early successional stages of stream development, followed by the stabilization of stream macroinvertebrate communities typical of the area. As the restored stream migrates more towards that of reference reaches, it is expected that macroinvertebrate communities will further migrate more towards assemblages typical of the area. This shift may result in an increase or decrease in the metrics presented in Table 7, but will ultimately represent more historic/natural conditions.

Drought conditions within the Falling Creek watershed throughout the monitoring season has likely contributed to degraded benthic macroinvertebrate collections. Data obtained from the North Carolina Drought Management Advisory Council indicates that drought conditions have persisted within Richmond County continuously from May 2007 to September 2008 (just prior to Year 3 benthic sampling). During that time, Richmond County experienced rainfall deficits resulting in a classification of Exceptional Drought ([D4] highest ranking drought classification) for fourteen straight weeks. Figure 6 (Appendix A) displays drought conditions in North Carolina during Year 3 monitoring and shows the progression of drought intensity in the Falling Creek watershed.

2.1.4 Habitat Assessment

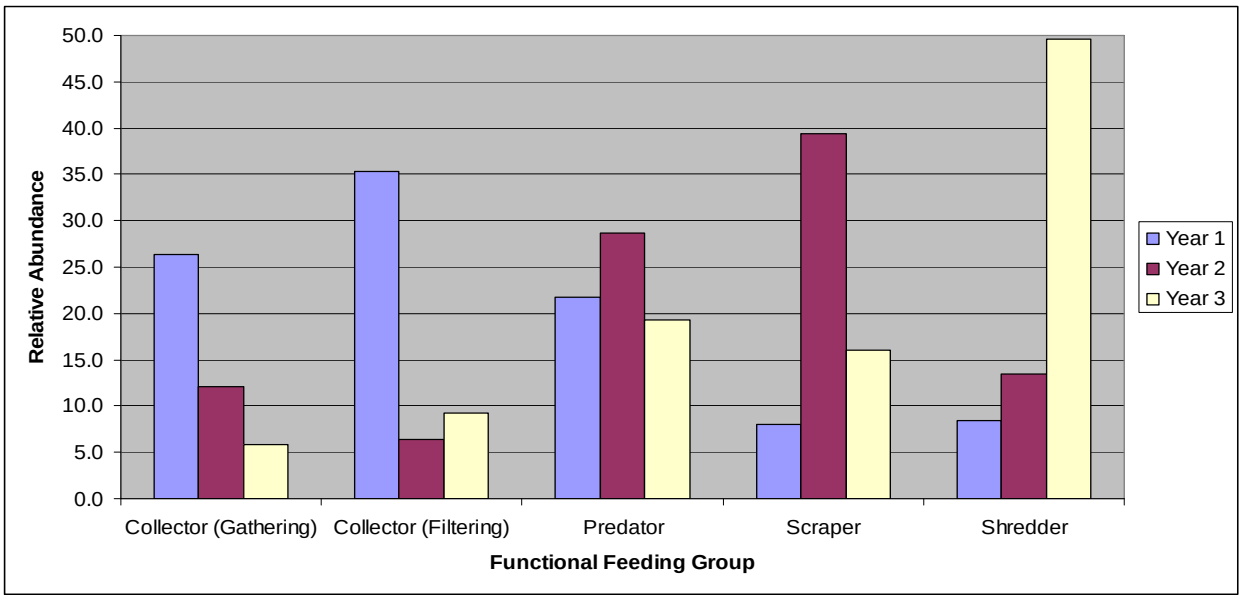
North Carolina Division of Water Quality (NCDWQ) Habitat Assessment Forms (HAFs) were completed at each cross-section location across the Site (Appendix D). Several HAF scores increased during Year 3 monitoring demonstrating an increased availability and quality of aquatic habitat at those locations. This improvement is largely due to the favorable prevalence of in stream habitat including sticks, snags, logs, leafpacks, and macrophytic vegetation. Limitations to habitat scores result from the lack of canopy trees within the former pond that would otherwise provide stream shading and allochthonous input for in-stream habitat. These scores will likely increase as the developing forest community begins to provide shading and plant material to the establishing stream systems. The HAF scores are summarized in Table 8.

Table 8. NCDWQ Habitat Assessment Form Scores

Cross-section	Score					
	MY1	MY2	MY3	MY4	MY5	MY+
XSR1 (Reference)	98	98	96			
XSR4 (Reference)	97	97	96			
XS1	78	95	91			
XS2	80	80	82			
XS3	84	98	93			
XS4	63	66	75			
XSR2	88	93	88			
XS5	69	80	83			
XSR3	85	90	88			
XS6	65	71	74			
XS7	74	76	82			
XS8	86	90	91			

In addition, stream habitat characterizations including habitat composition and percentage representation were completed using plan-view drawings derived from total station surveys of the stream monitoring reaches (Figure 3, Appendix A). Drawings were updated in the field through visual observation and habitat composition was transcribed onto each drawing by hand. Drawings were digitized using GIS technology to determine rough estimates of habitat type representation. Representative habitat included adjacent stream bank trees, root mats/balls, stumps, coarse woody debris, leaf packs, and undercut banks. During Year 2 monitoring, an increase in the number of predators, shredders, and shredder/collectors and a decrease in the number of collector/gatherers and filter/collectors was observed. Year 3 monitoring indicates a continued progression towards a stable aquatic community with a continued shift from early successional composition. The following graph displays functional feeding group composition following dam removal at the Site.

Graph 2. Functional Feeding Group Composition



2.2 Wetland Assessment

2.2.1 Vegetation Assessment

Eight (8) 10 x 10 meter plots were sampled in accordance with the Carolina Vegetation Survey Protocol. Planted stems (woody) were marked with flagging and the species, height, diameter, vigor and coordinate location within each plot was recorded. Volunteer species where noted and placed into height classes. Success criteria for vegetation requires that at least 320 stems per acre must survive after the completion of the third growing season. The required survival criterion will decrease by 10 percent per year after the third year of vegetation monitoring (i.e., for an expected 290 stems per acre for Year 4, and 260 stems per acre for Year 5). The Site is currently meeting the established success criteria for vegetation based on the survival of the planted species with an average density of 536 trees per acre. Some large volunteer species may have been included in the planted species inventory, for instances in which the yearly monitoring species totals exceed the initial totals. Including all volunteer species raises the vegetation survival within the Site to 3561 trees per acre. An inventory of planted stems is given in Table 9 and

plots are mapped in Figure 4 (Appendix A). A tally of volunteer woody species is listed in Table 9a. Year 3 photographs are provided in Appendix E.

Table 9. Stem Counts for Planted Species Arranged by Plot

Species	Plots								Initial Totals	Year 1 Totals	Year 2 Totals	Year 3 Totals	Survival %
	1	2	3	4	5	6	7	8					
Trees													
Chamaecyparis thyoides	3	5	3	2	2	6	7	2	32	31	31	30	94
Liriodendron tulipifera	0	0	1	0	0	0	0	0	6	6	3	1	17
Magnolia virginiana	0	1	3	0	0	1	0	0	10	10	11	5	50
Nyssa biflora	4	7	4	6	0	2	5	2	29	29	28	30	100
Persea borbonia	0	0	0	0	0	0	0	0	1	1	1	0	0
Pinus serotina	6	3	3	7	7	5	1	4	32	32	30	36	100
Pinus taeda	1	0	0	0	1	0	0	2	12	12	12	4	33

Table 9a. Stem Counts for Volunteer Species Arranged by Plot

Species	Plots								Year 1 Totals	Year 2 Totals	Year 3 Totals
	1	2	3	4	5	6	7	8			
Trees											
Acer rubrum	5	0	4	9	0	0	1	6	12	16	25
Betula nigra	0	0	0	0	0	0	0	0	0	5	0
Chamaecyparis thyoides	10	0	0	2	0	1	0	0	0	4	13
Cyrilla racemifllora	0	0	3	0	0	1	0	0	1	0	4
Liquidambar stryaciflua	0	0	1	0	0	0	0	0	0	1	1
Liriodendron tulipifera	1	0	0	0	0	4	0	0	14	7	5
Magnolia virginiana	0	7	0	0	0	0	0	1	2	1	8
Nyssa biflora	0	0	0	0	0	0	0	0	0	1	0
Pinus serotina	30	40	168	9	58	87	4	136	105	168	532
Pinus taeda	6	0	0	0	0	0	0	0	0	29	6
Salix nigra	0	0	0	0	0	0	1	0	7	1	1
Shrubs											
Clethra alnifolia	0	0	0	0	0	0	0	0	1	1	0
Baccharis halimifolia	0	0	1	0	0	0	0	0	1	0	1
Kalmia angustifolia	0	0	0	0	0	0	0	0	1	0	0
Vaccinium corymbosum	0	0	0	0	0	0	0	0	0	2	0

2.2.2 Groundwater Hydrology

Success criteria for groundwater hydrology on the Site requires that wetland mitigation areas be inundated or saturated (within 12 inches of the surface) by surface or groundwater for at least 28 consecutive days (Richmond County, NRCS) or 12.5 percent of the growing season. All four (4) groundwater gauges located on-Site are currently meeting the wetland hydrologic success criteria. Groundwater gauge locations are depicted in Figure 5 (Appendix A). Groundwater gauge hydrographs are plotted on Figure F-1 (2008) (Appendix F).

2.2.3 Wetland Criteria Attainment

Table 10. Wetland Criteria Attainment

Gauge ID	Gauge Hydrology Threshold Met?	Vegetation Plot ID	Vegetation Survival Threshold Met?
Gauge1	Yes (26% of growing season)	1	Yes
		2	Yes
Gauge2	Yes (26% of growing season)	3	Yes
		4	Yes
Gauge3	Yes (33% of growing season)	5	Yes
		6	Yes
Gauge4	Yes (32% of growing season)	7	Yes
		8	Yes

REFERENCES

Harod, J.J. 1964. The Distribution of Invertebrates on Submerged Aquatic Plants in a Chalk Stream. Journal of Animal Ecology. Vol. 33, No. 2. (June 1964), pp. 335-348.

Merritt, R.W. and K.W. Cummins. 1984. An Introduction to the Aquatic Insects of North America. Kendall-Hunt Publ.

Natural Resources Conservation Service (NRCS). 1999. Soil Survey of Richmond County, North Carolina. United States Department of Agriculture.

North Carolina Drought Management Advisory Council (NCDMAC). 2007. Statewide Drought Conditions Archive (online). Retrieved November 2007 from: www.ncdrought.org.

Rosgen, D. 1994. Applied Fluvial Geomorphology. Wildland Hydrology: Pagosa Springs, CO.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, N.C. Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.

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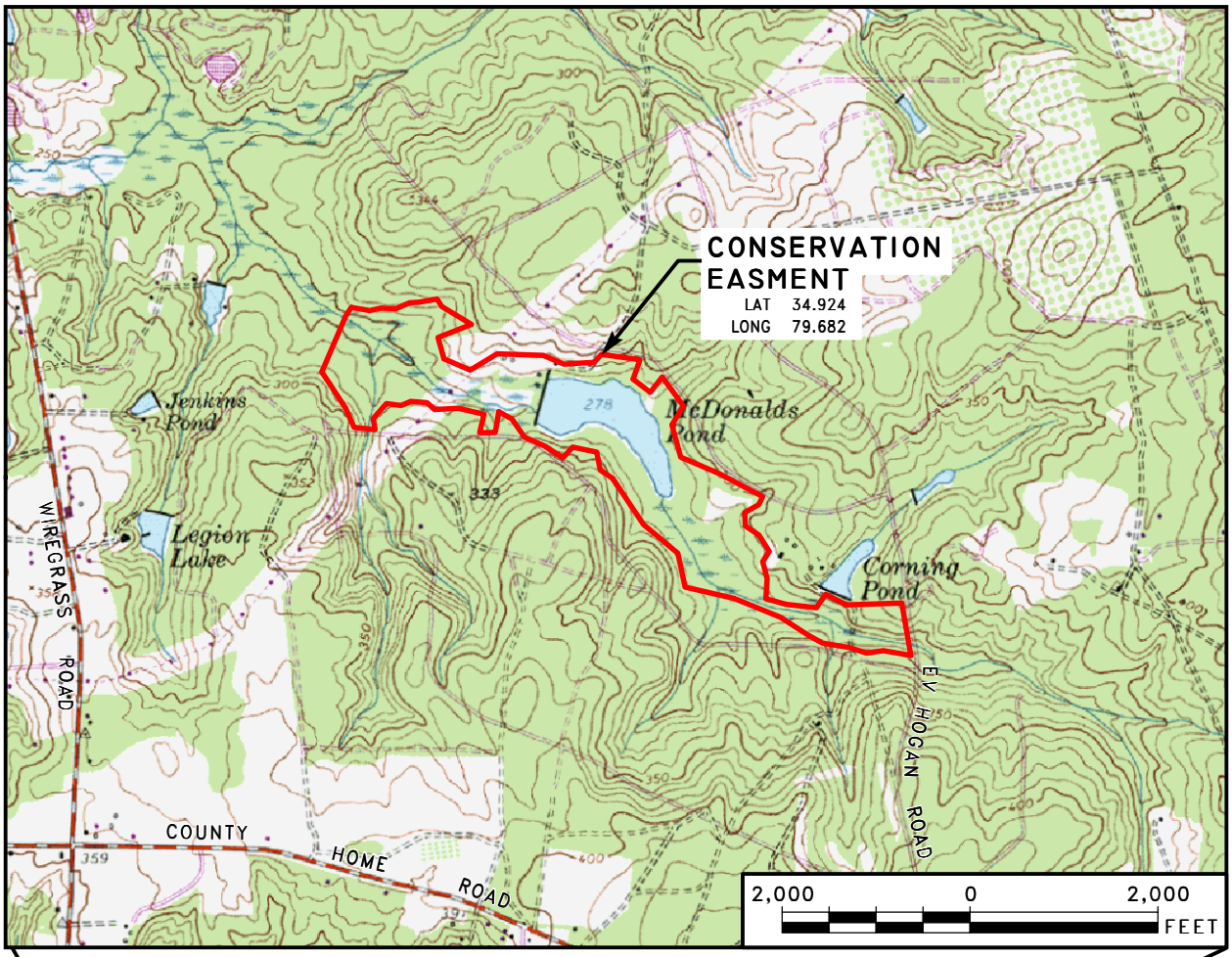
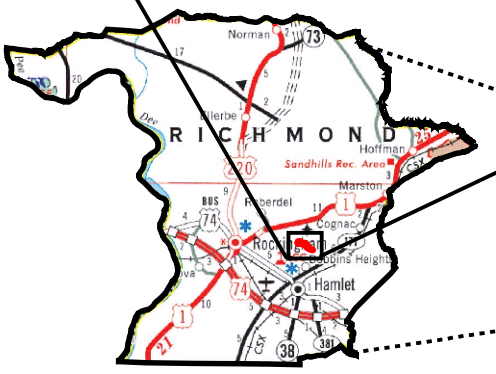
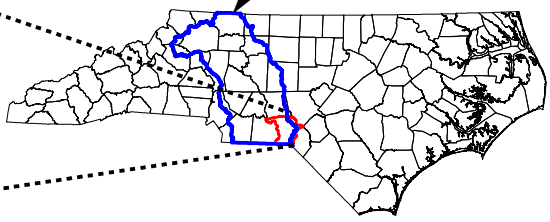
APPENDIX A: FIGURES







NAD 83

INTERNATIONAL PAPER

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Ecosystem Enhancement PROGRAM

SITE LOCATION

McDONALDS POND RESTORATION SITE

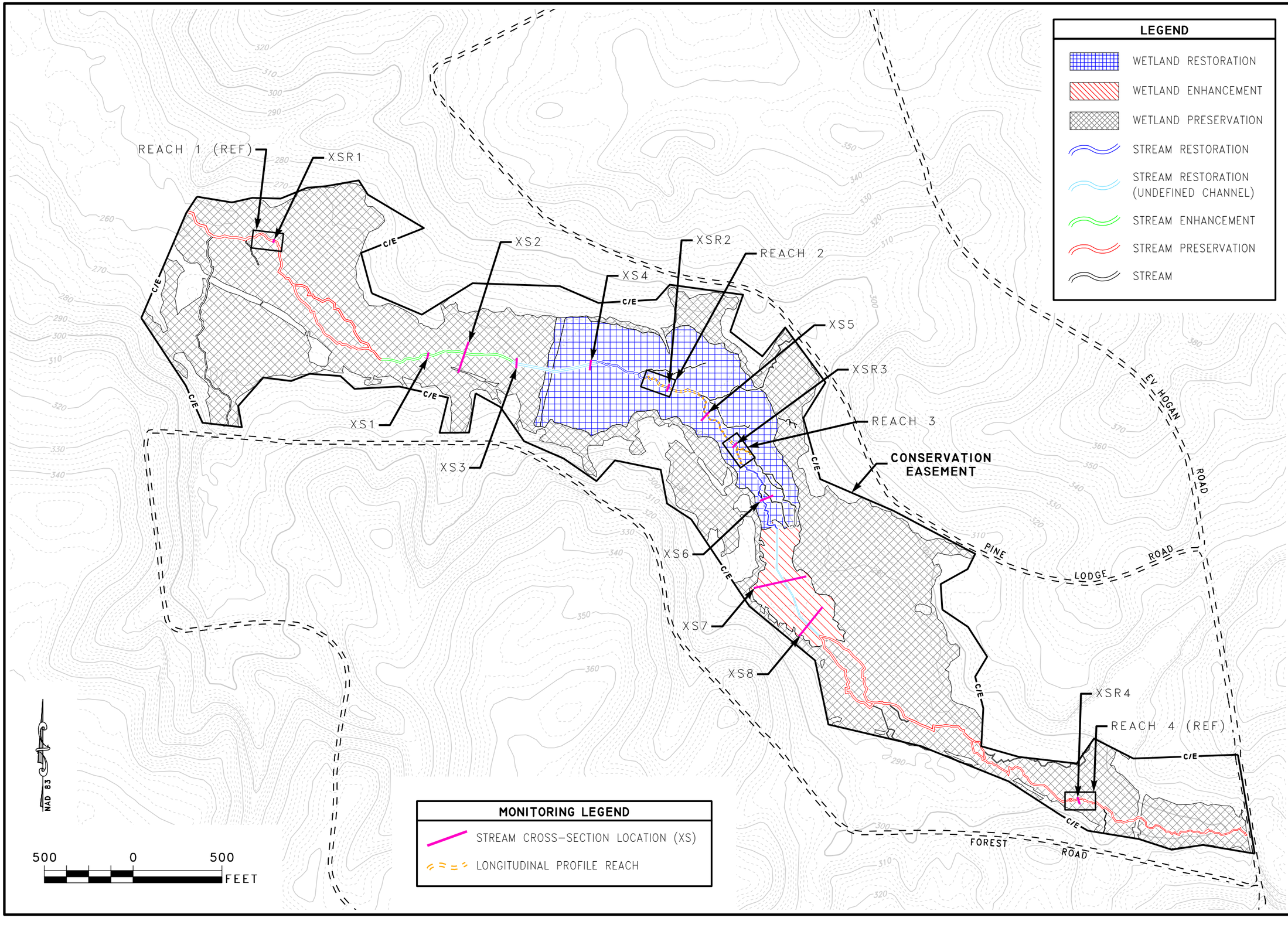
EEP Project No. D04020-2

RICHMOND COUNTY, NORTH CAROLINA

Dwn By:	DGJ
Ckd By:	JWG
Date:	DEC 2008
ESC Project:	07-330.00

FIGURE

1



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CLIENT:
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PROJECT:

McDONALDS POND RESTORATION SITE

EEP Project No. D04020-2

RICHMOND COUNTY, NORTH CAROLINA

TITLE:

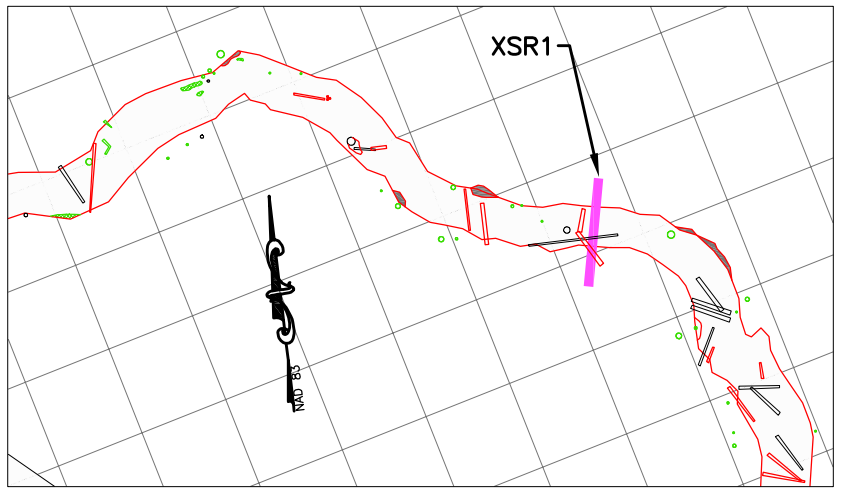
STREAM MONITORING PLAN VIEW

DWN BY:	DATE:
DGJ	DEC 2008
CKD BY:	SCALE:
JWG	1" = 500'

ESC PROJECT NO.: 07-330.00

FIGURE

2



REACH 1 (REF)

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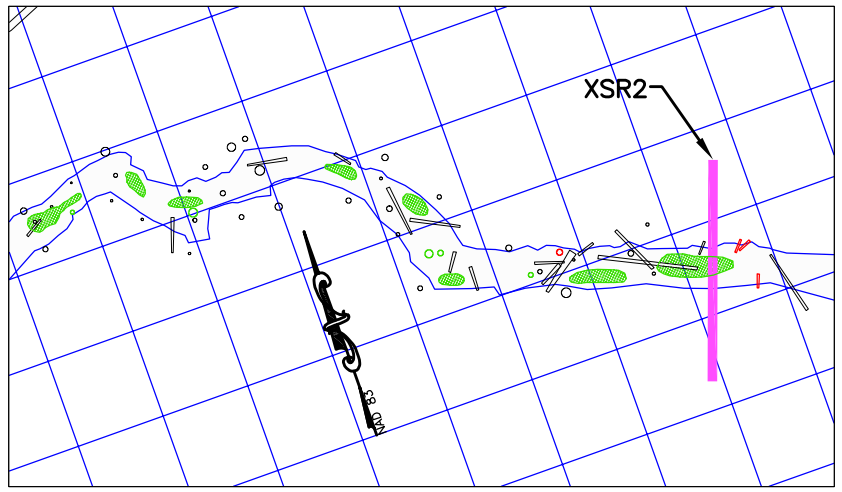

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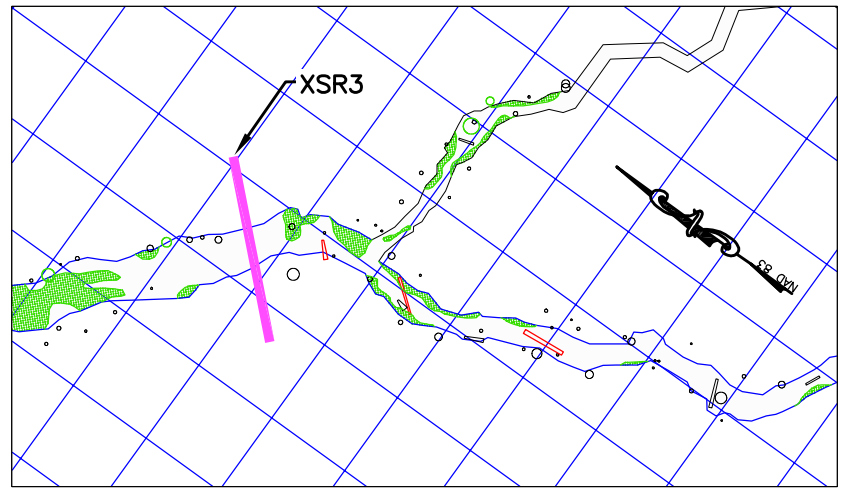

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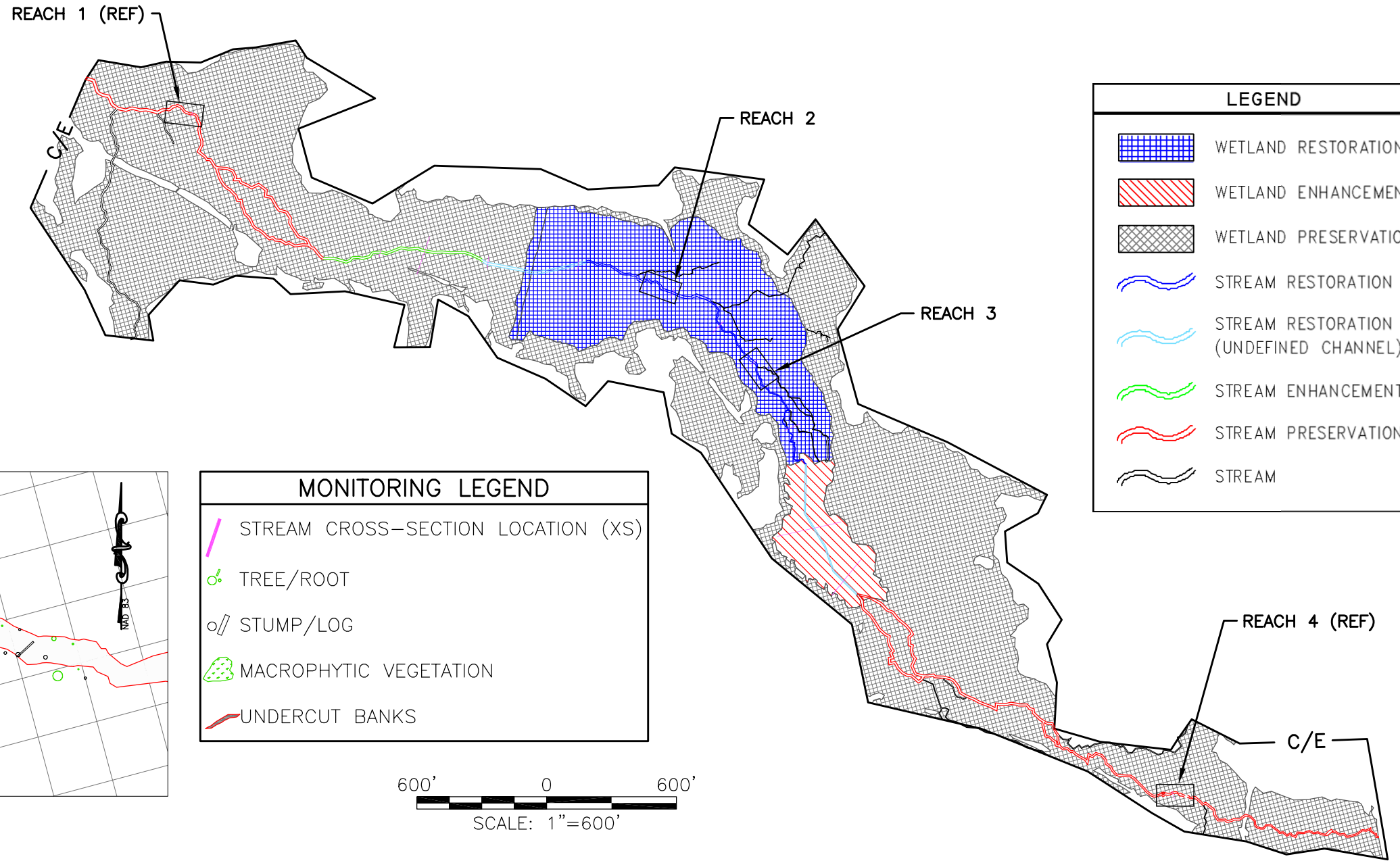

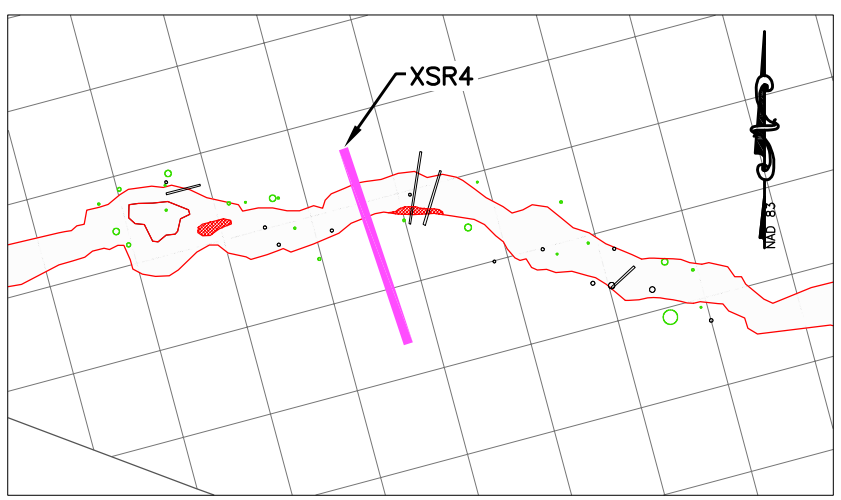

REACH 4 (REF)

1"=40'

MONITORING LEGEND
STREAM CROSS-SECTION LOCATION (XS)
TREE/ROOT
STUMP/LOG
MACROPHYTIC VEGETATION
UNDERCUT BANKS

600' 0 600'

SCALE: 1"=600'

LEGEND
WETLAND RESTORATION
WETLAND ENHANCEMENT
WETLAND PRESERVATION
STREAM RESTORATION
STREAM RESTORATION (UNDEFINED CHANNEL)
STREAM ENHANCEMENT
STREAM PRESERVATION
STREAM

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Project:

MCDONALDS POND RESTORATION SITE

RICHMOND COUNTY, NORTH CAROLINA

Title:

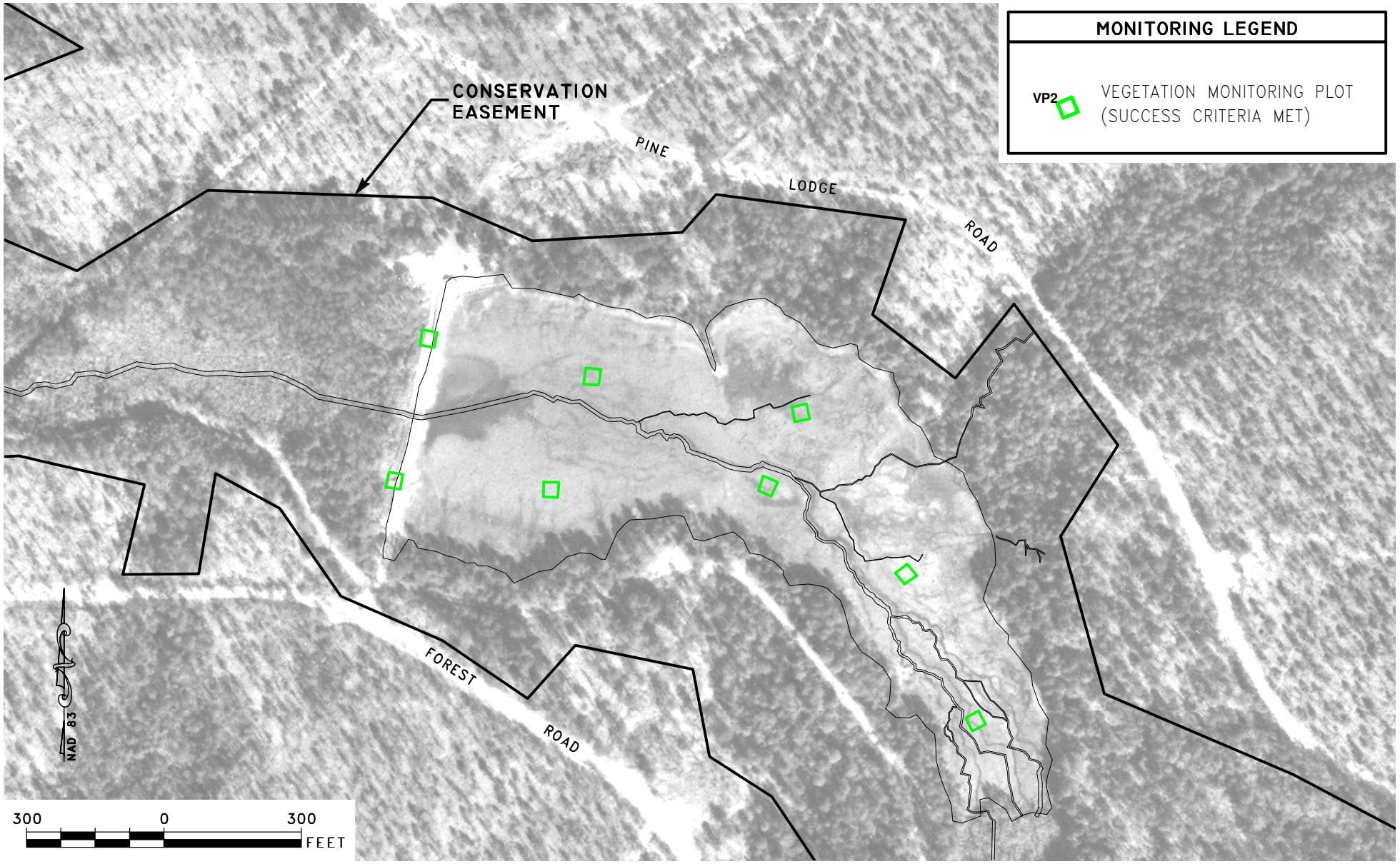
STREAM MONITORING REACH PLAN VIEWS

Dwn. By:	Ckd. By:
TAL	MCG
Date:	Scale:
DEC 2008	AS SHOWN

Project No.: 07-330

FIGURE

3



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VEGETATION MONITORING PLOTS

McDONALDS POND RESTORATION SITE

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RICHMOND COUNTY, NORTH CAROLINA

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DATE:	DEC 2008
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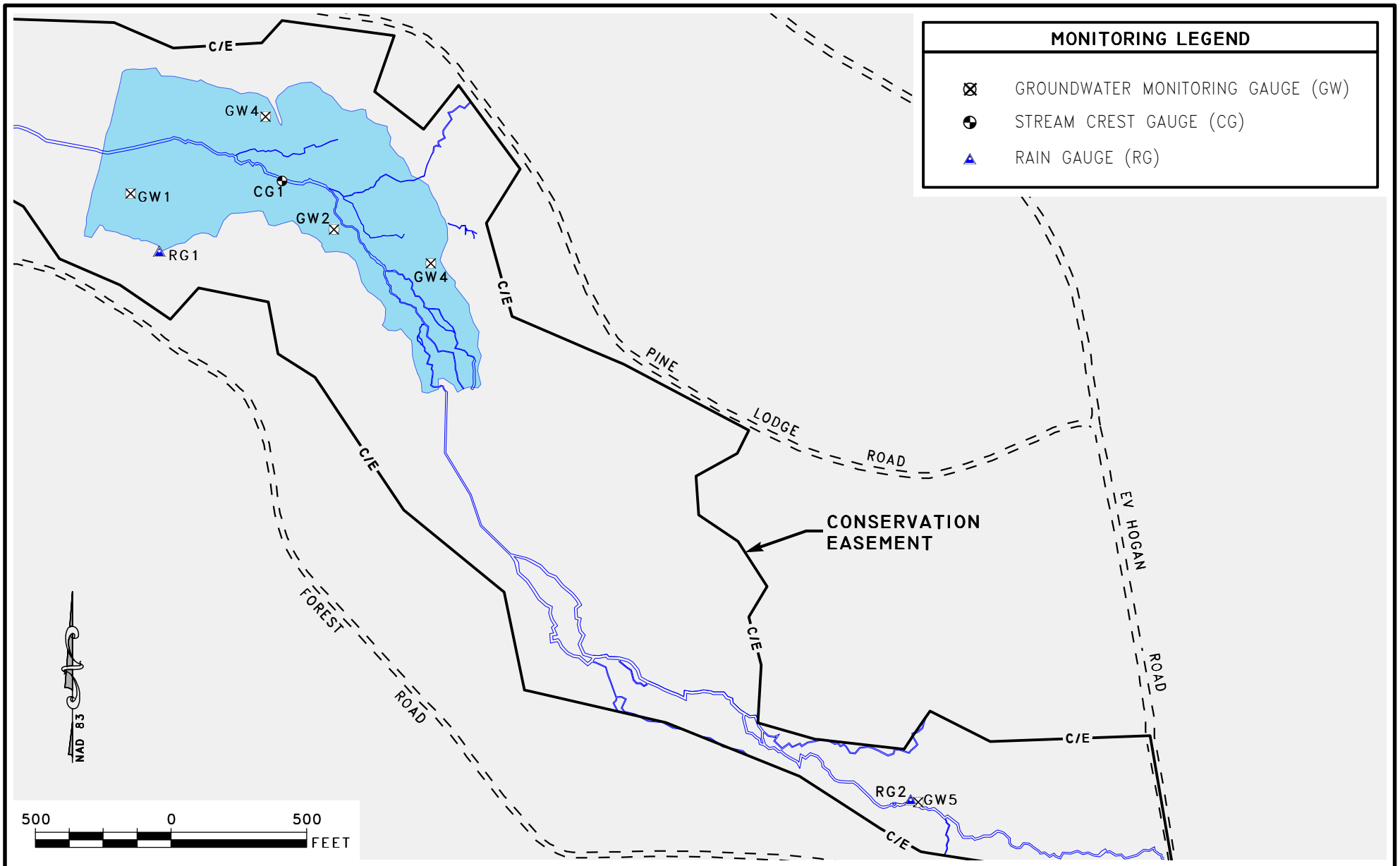
FIGURE 4



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MONITORING GAUGES

McDONALDS POND RESTORATION SITE

EEP Project No. D04020-2

RICHMOND COUNTY, NORTH CAROLINA

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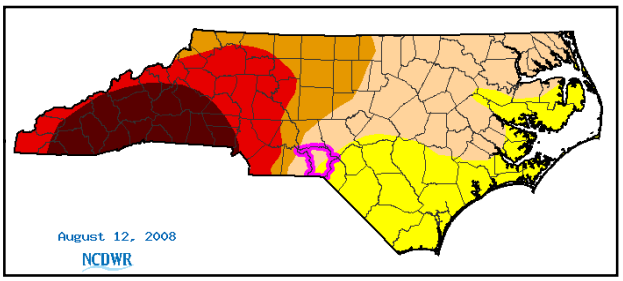
DATE:	DEC 2008
ESC PROJECT:	07-330.00

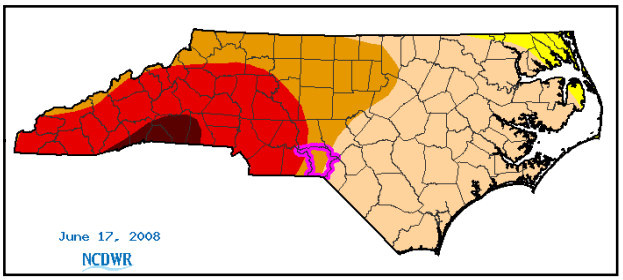
FIGURE

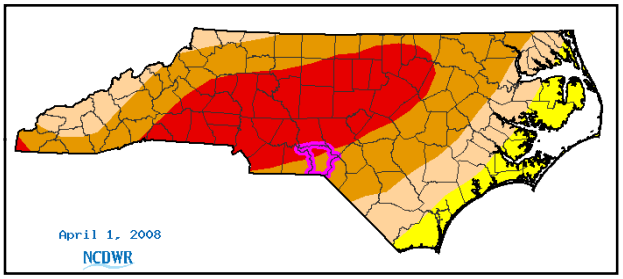
5

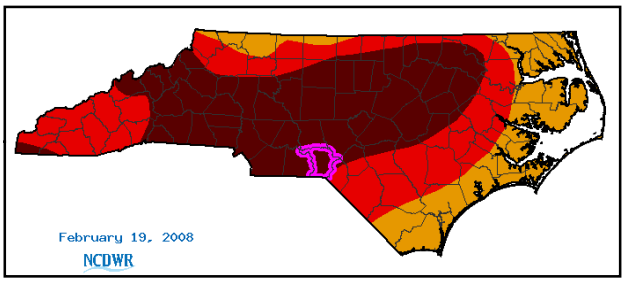
Richmond County Drought Data

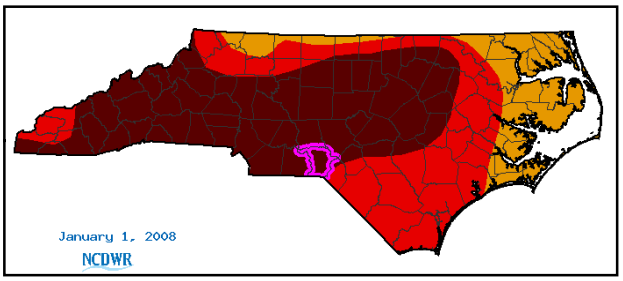
Date	DM Level	Drought Level Description	Drought Conditions by Percent Area					
			None	D0	D1	D2	D3	D4
11/4/2008		Normal	99.92	0.08	0	0	0	0
10/28/2008		Normal	100	0	0	0	0	0
10/21/2008		Normal	100	0	0	0	0	0
10/14/2008		Normal	100	0	0	0	0	0
10/7/2008		Normal	100	0	0	0	0	0
9/30/2008		Normal	100	0	0	0	0	0
9/23/2008		Normal	99.95	0.05	0	0	0	0
9/16/2008		Normal	95.77	4.23	0	0	0	0
9/9/2008		Normal	95.77	4.23	0	0	0	0
9/2/2008	D0	Abnormally Dry	40.98	51.83	7.19	0	0	0
8/26/2008	D0	Abnormally Dry	40.98	51.83	7.19	0	0	0
8/19/2008	D1	Moderate Drought	0	38.92	61.08	0	0	0
8/12/2008	D1	Moderate Drought	0	36.66	63.07	0.27	0	0
8/5/2008	D1	Moderate Drought	0	13.11	86.81	0.09	0	0
7/29/2008	D2	Severe Drought	0	0	69.63	30.37	0	0
7/22/2008	D2	Severe Drought	0	0	69.63	30.37	0	0
7/15/2008	D2	Severe Drought	0	0	69.63	30.37	0	0
7/8/2008	D2	Severe Drought	0	0	0	100	0	0
7/1/2008	D2	Severe Drought	0	0	0	88.1	11.9	0
6/24/2008	D2	Severe Drought	0	0	20.6	74.15	5.25	0
6/17/2008	D2	Severe Drought	0	0	20.6	74.15	5.25	0
6/10/2008	D1	Moderate Drought	0	0	79.54	20.46	0	0
6/3/2008	D1	Moderate Drought	0	0	90.87	9.13	0	0
5/27/2008	D1	Moderate Drought	0	0	90.87	9.13	0	0
5/20/2008	D1	Moderate Drought	0	4.21	95.8	0	0	0
5/13/2008	D1	Moderate Drought	0	4.21	95.8	0	0	0
5/6/2008	D1	Moderate Drought	0	4.21	95.8	0	0	0
4/29/2008	D1	Moderate Drought	0	4.21	95.8	0	0	0
4/22/2008	D2	Severe Drought	0	0	35.02	64.98	0	0
4/15/2008	D2	Severe Drought	0	0	35.02	64.98	0	0
4/8/2008	D2	Severe Drought	0	0	35.02	64.98	0	0
4/1/2008	D3	Extreme Drought	0	0	0	66.52	33.48	0
3/25/2008	D3	Extreme Drought	0	0	0	66.52	33.48	0
3/18/2008	D3	Extreme Drought	0	0	0	66.52	33.48	0
3/11/2008	D3	Extreme Drought	0	0	0	66.52	33.48	0
3/4/2008	D3	Extreme Drought	0	0	0	0	77.84	22.16
2/26/2008	D3	Extreme Drought	0	0	0	0	77.84	22.16
2/19/2008	D4	Exceptional Drought	0	0	0	0	1.65	98.35
2/12/2008	D4	Exceptional Drought	0	0	0	0	1.65	98.35
2/5/2008	D4	Exceptional Drought	0	0	0	0	1.65	98.35
1/29/2008	D4	Exceptional Drought	0	0	0	0	1.65	98.35
1/22/2008	D4	Exceptional Drought	0	0	0	0	1.65	98.35
1/15/2008	D4	Exceptional Drought	0	0	0	0	1.65	98.35
1/8/2008	D4	Exceptional Drought	0	0	0	0	1.65	98.35
1/1/2008	D4	Exceptional Drought	0	0	0	0	1.65	98.35
12/25/2007	D4	Exceptional Drought	0	0	0	0	0	100
12/18/2007	D4	Exceptional Drought	0	0	0	0	0	100
12/11/2007	D4	Exceptional Drought	0	0	0	0	0	100
12/4/2007	D4	Exceptional Drought	0	0	0	0	0	100
11/27/2007	D4	Exceptional Drought	0	0	0	0	1.14	98.86
11/20/2007	D4	Exceptional Drought	0	0	0	0	5.44	94.56
11/13/2007	D3	Extreme Drought	0	0	0	0	100	0
11/6/2007	D3	Extreme Drought	0	0	0	0	100	0

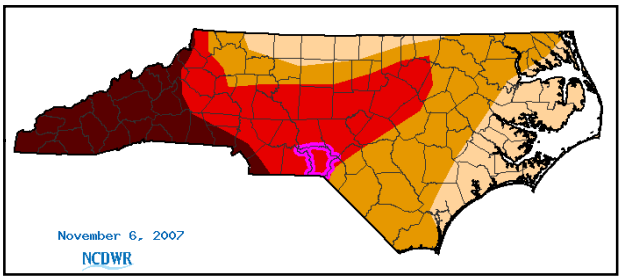












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North Carolina Drought Monitor Data

McDonalds Pond Restoration Site
2008 Annual Monitoring Report (2008)

Richmond County, North Carolina

Dwn By:	Ckd By:
MCG	DGJ

Date: JAN 2009

Scale: N/A

ESC Project No. 07-330

FIGURE 6

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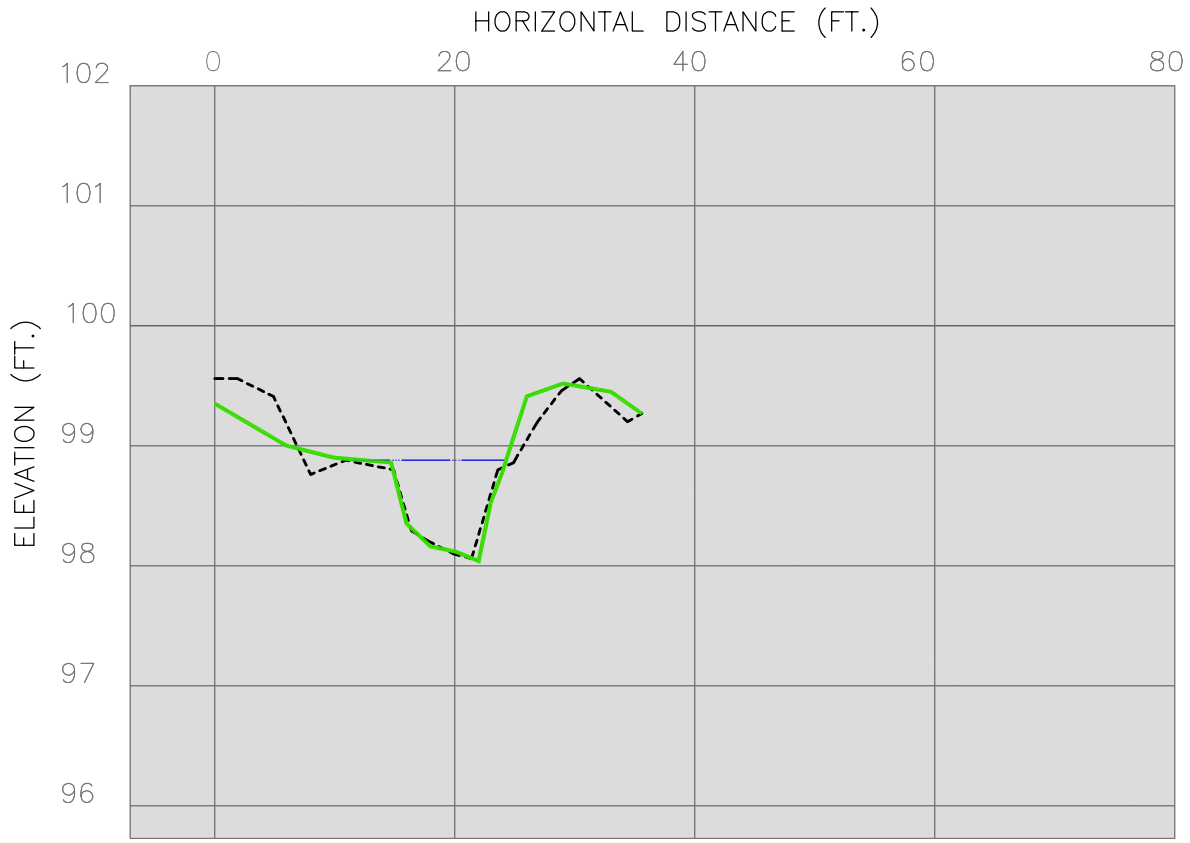
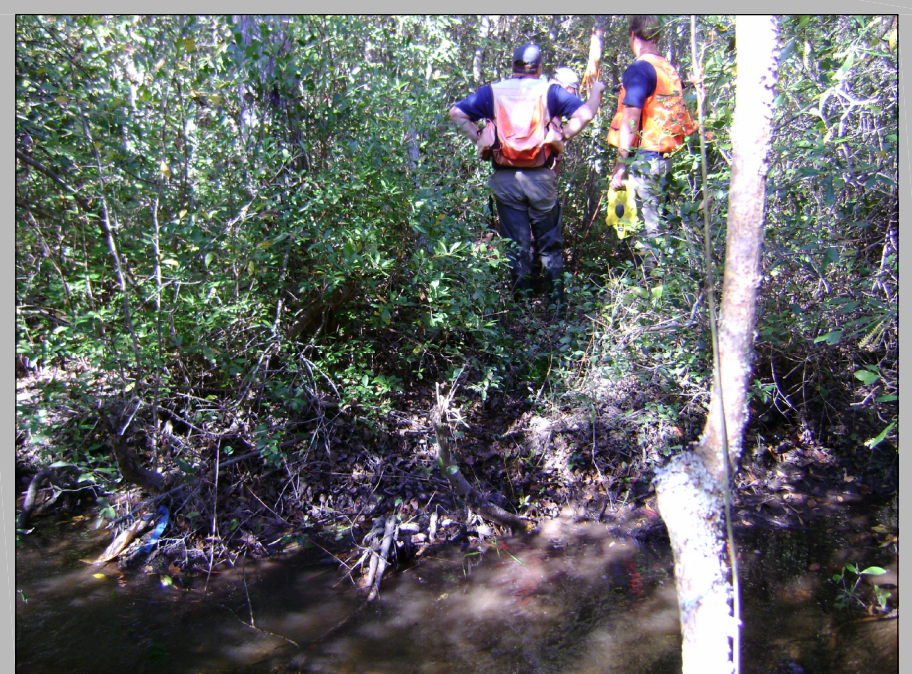
APPENDIX B: STREAM GEOMORPHOLOGY DATA

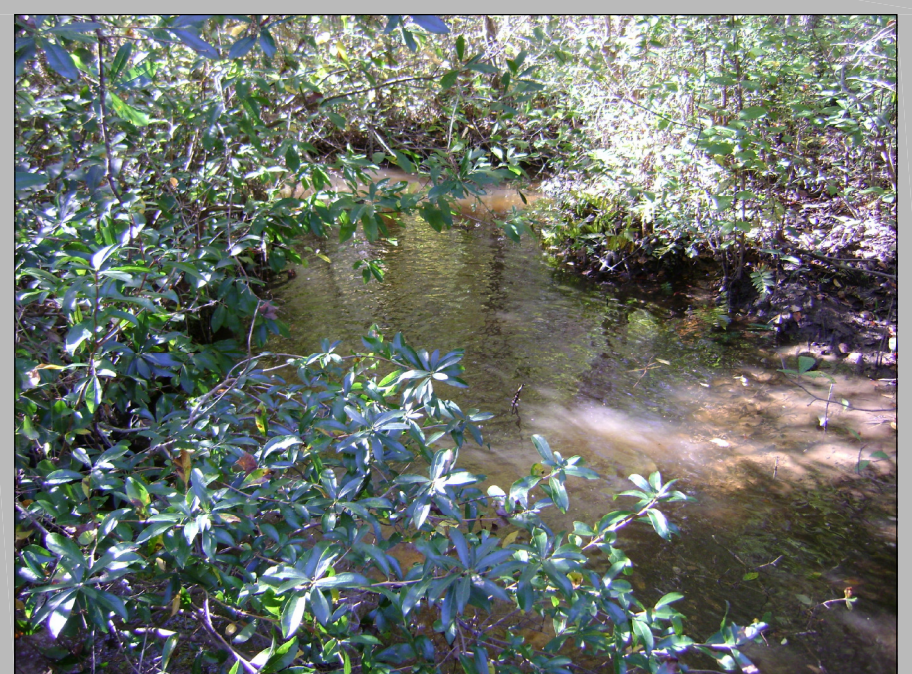


CROSS SECTION XS1–POOL

GRADE ELEVATION (2007)
GRADE ELEVATION (2008)
BANKFULL ELEVATION



XS1 LEFT BANK LOOKING RIGHT BANK



XS1 LOOKING DOWNSTREAM

SURVEY DATA

STATION	ELEVATION	FEATURE
0.0	100.00	LPIN
0.0	99.35	BLPIN
6	99	
10	98.9	
14.7	98.86	EOW
16	98.35	
18	98.16	
20	98.12	
22	98.04	
23	98.52	
24	98.79	
26	99.41	
29	99.52	
33	99.45	
35.6	99.27	BRPIN
35.6	99.6	RPIN

SUMMARY DATA

BANKFULL CROSS SECTIONAL AREA	5.33 SQ. FT.
BANKFULL WIDTH	9.52 FT.
BANKFULL MEAN DEPTH	0.55 FT.
BANKFULL MAX DEPTH	0.82 FT.
WIDTH–DEPTH RATIO	17.30
ENTRENCHMENT RATIO	42.01
CLASSIFICATION	N/A

NOTES:

1. All cross–sections facing the downstream direction
2. Cross–section stationing represents approximate field locations.
3. Elevations based on relative benchmark; left pin elevation=100.0 ft.

Survey Date	OCT. 2008
Survey Weather	Sunny
Field Team	Jones, Schmid
Location	XS1

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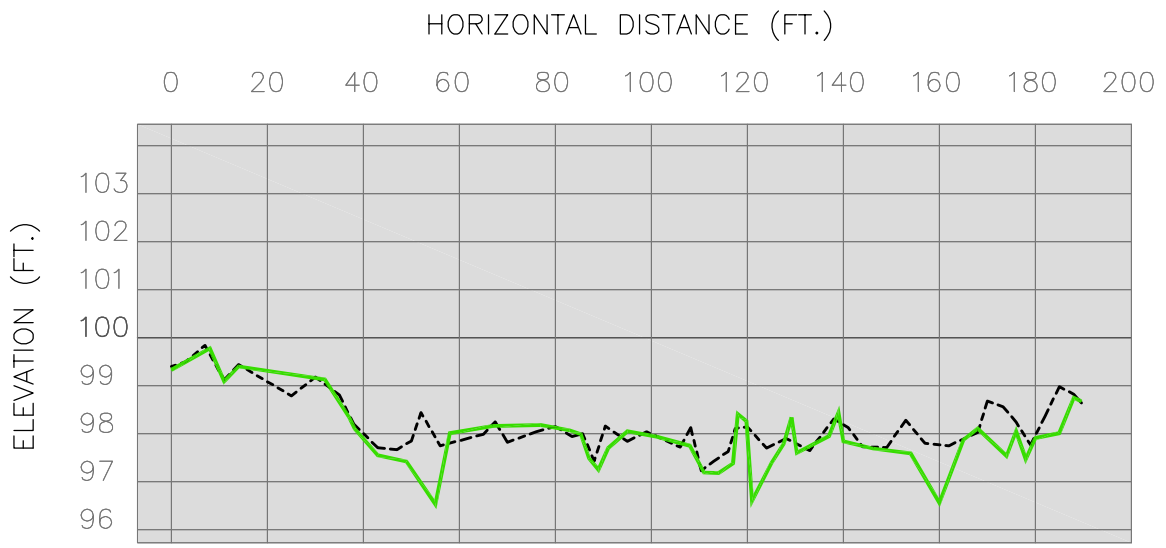
EEP Project No. D04020–2

RICHMOND COUNTY, NORTH CAROLINA

Title:
CROSS SECTION XS1–POOL

Dsn. By: TAL	Dwn. By: TAL
Ckd. By: MCG	Date: DEC 2008
Scale: NO SCALE	
ESC Project No.: 07–330.00	

SHEET
B1



CROSS SECTION XS2–BRAIDED CHANNELS

GRADE ELEVATION (2007)
GRADE ELEVATION (2008)

XS2 LEFT BANK LOOKING RIGHT BANK

XS2 LOOKING DOWNSTREAM AT 113 ft.

SURVEY DATA		
STATION	ELEVATION	FEATURE
0.00	100.00	LPIN
0.00	99.33	BLPIN
8.00	99.78	
11.00	99.09	
14.00	99.40	
32.00	99.13	
37.00	98.35	
38.20	98.10	EOW
43.00	97.55	
49.00	97.42	
55.00	96.53	
58.00	98.01	
67.00	98.16	
77.00	98.18	
83.00	98.07	
85.30	97.99	EOW
87.00	97.49	
89.00	97.25	
91.00	97.70	
95.00	98.05	
101.00	97.94	
108.00	97.75	
111.00	97.19	
114.00	97.18	
117.00	97.38	
118.00	98.41	
119.80	98.26	
121.00	96.60	
125.00	97.39	
127.60	97.79	
129.20	98.34	
130.30	97.60	
137.00	97.95	
139.00	98.44	
140.00	97.84	
146.20	97.69	
154.00	97.59	
160.00	96.56	
165.00	97.87	
168.00	98.11	
174.00	97.54	
176.00	98.05	
178.00	97.47	
180.00	97.91	
185.00	98.01	
188.00	98.75	
189.60	98.68	BRPIN
189.60	99.18	RPIN

SUMMARY DATA	
BANKFULL CROSS SECTIONAL AREA	N/A*
BANKFULL WIDTH	N/A*
BANKFULL MEAN DEPTH	N/A*
BANKFULL MAX DEPTH	N/A*
WIDTH–DEPTH RATIO	N/A*
ENTRENCHMENT RATIO	N/A*
CLASSIFICATION	DA5

* See document text for details

NOTES:

1. All cross–sections facing the downstream direction
2. Cross–section stationing represents approximate field locations.
3. Elevations based on relative benchmark; left pin elevation=100.0 ft.

Survey Date	OCT. 2008
Survey Weather	Sunny
Field Team	Jones, Schmid
Location	XS2

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RICHMOND COUNTY, NORTH CAROLINA

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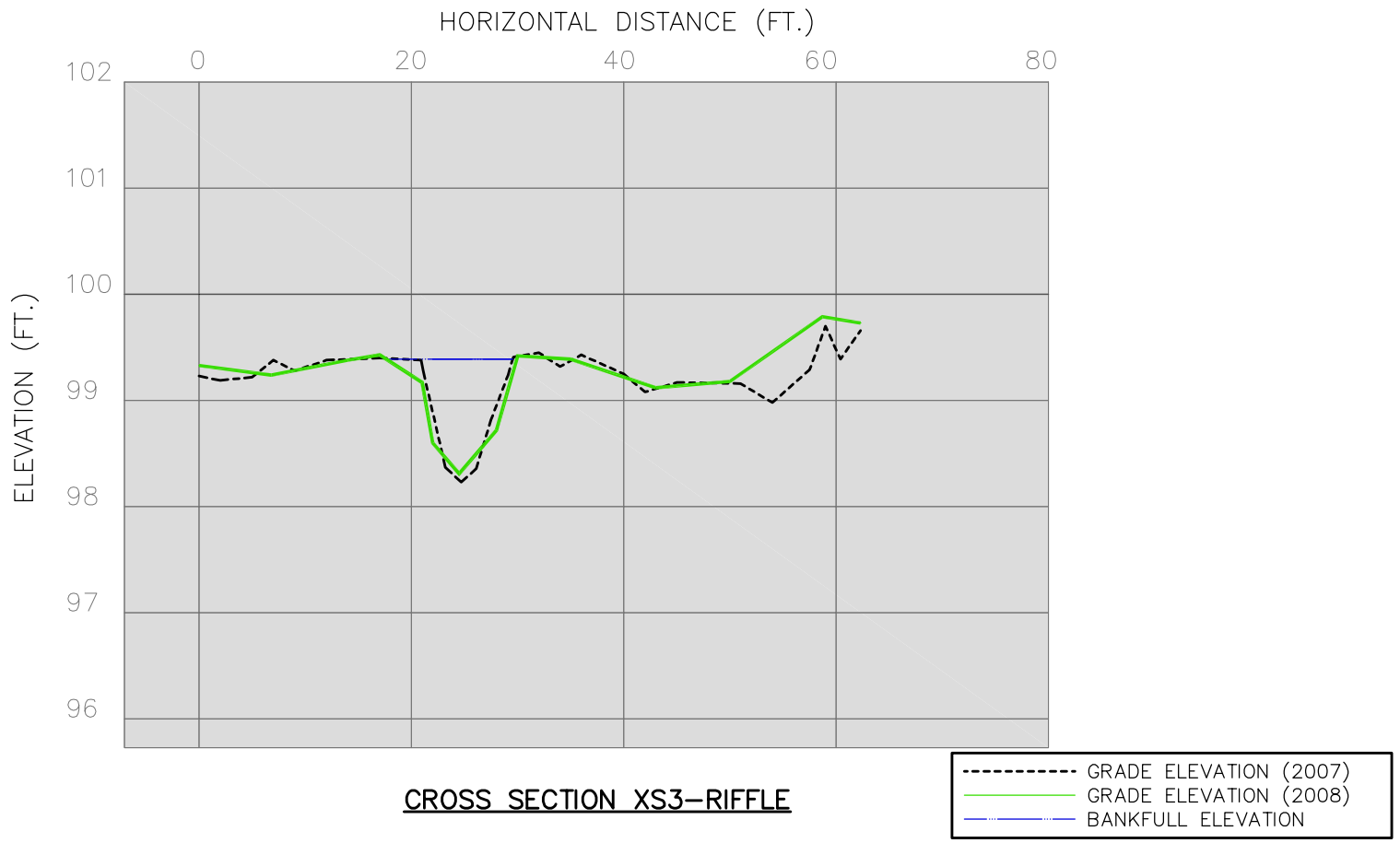
CROSS SECTION XS2–BRAIDED CHANNELS

Dsn. By: TAL	Dwn. By: TAL
Ckd. By: MCG	Date: DEC 2008
Scale: NO SCALE	
ESC Project No.: 07–330.00	

SHEET
B2



CROSS SECTION XS3–RIFFLE

XS3 LEFT BANK LOOKING RIGHT BANK

XS3 LOOKING DOWNSTREAM

SURVEY DATA

STATION	ELEVATION	FEATURE
2.00	100.00	LPIN
2.00	99.33	BLPIN
8.80	99.24	
16.00	99.38	
19.00	99.43	
23.00	99.17	EOW
24.00	98.60	
26.50	98.31	
30.00	98.72	
32.00	99.42	
37.00	99.39	
45.00	99.12	
52.00	99.18	
60.70	99.79	
64.30	99.73	BRPIN
64.30	100.19	RPIN

SUMMARY DATA

BANKFULL CROSS SECTIONAL AREA	4.65 SQ. FT.
BANKFULL WIDTH	8.28 FT.
BANKFULL MEAN DEPTH	0.56 FT.
BANKFULL MAX DEPTH	0.86 FT.
WIDTH–DEPTH RATIO	14.79
ENTRENCHMENT RATIO	48.31
CLASSIFICATION	C5

NOTES:

1. All cross–sections facing the downstream direction
2. Cross–section stationing represents approximate field locations.
3. Elevations based on relative benchmark; left pin elevation=100.0 ft.

Survey Date	OCT. 2008
Survey Weather	Sunny
Field Team	Jones, Schmid
Location	XS3

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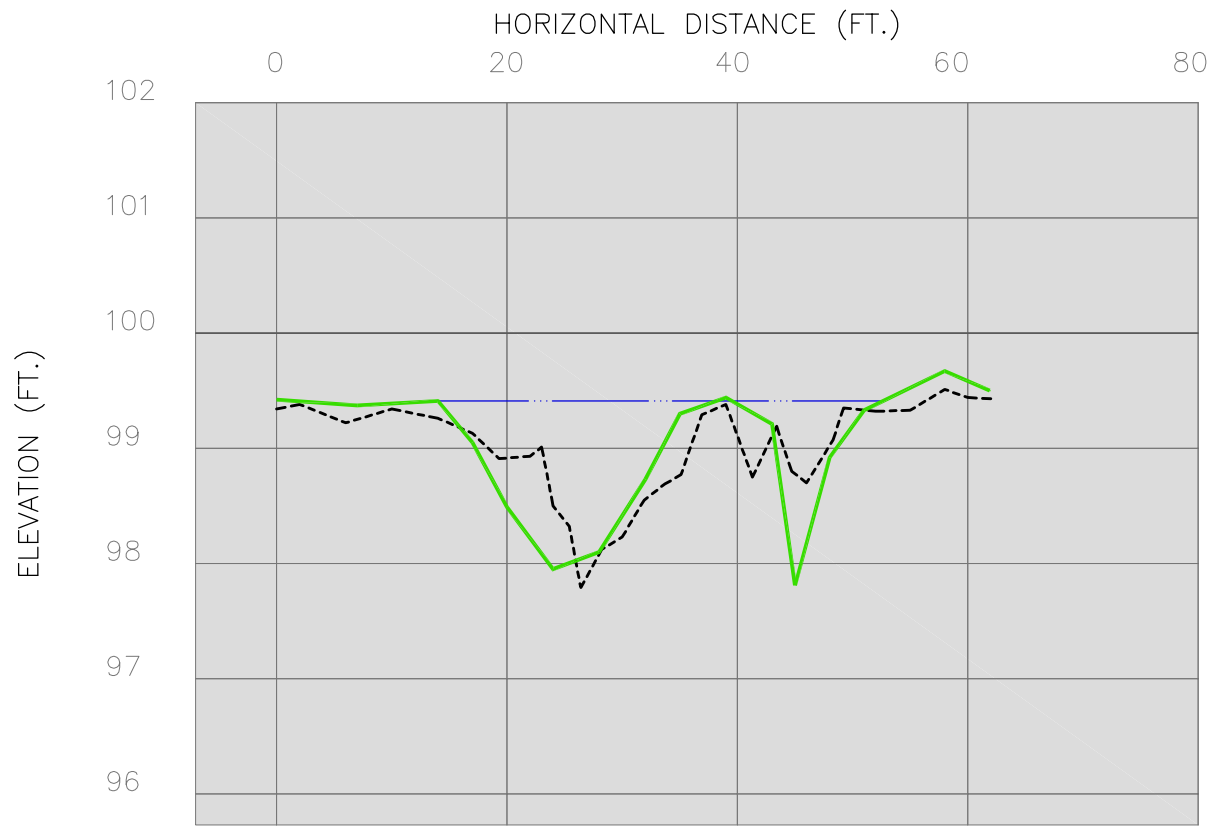
Scale: NO SCALE	
ESC Project No.: 07–330.00	

SHEET
B3



CROSS SECTION XS4–RIFFLE

XS4 LEFT BANK LOOKING RIGHT BANK

XS4 LOOKING DOWNSTREAM

SURVEY DATA

STATION	ELEVATION	FEATURE
0.00	100.00	LPIN
1.00	99.42	BLPIN
8.00	99.37	
15.00	99.41	
18.00	99.05	
21.00	98.49	
25.00	97.95	
29.00	98.10	
33.00	98.73	
36.00	99.30	
40.00	99.44	
44.00	99.21	
46.00	97.81	
49.00	98.92	
52.00	99.33	
59.00	99.67	
62.90	99.50	BRPIN
62.90	100.22	RPIN

SUMMARY DATA

BANKFULL CROSS SECTIONAL AREA	24.30 FT.
BANKFULL WIDTH	37.26 FT.
BANKFULL MEAN DEPTH	0.65 FT.
BANKFULL MAX DEPTH	1.60 FT.
WIDTH–DEPTH RATIO	57.32
ENTRENCHMENT RATIO	13.41
CLASSIFICATION	DA5/C5

NOTES:

1. All cross–sections facing the downstream direction
2. Cross–section stationing represents approximate field locations.
3. Elevations based on relative benchmark; left pin elevation=100.0 ft.

Survey Date	OCT. 2008
Survey Weather	Sunny
Field Team	Jones, Schmid
Location	XS4

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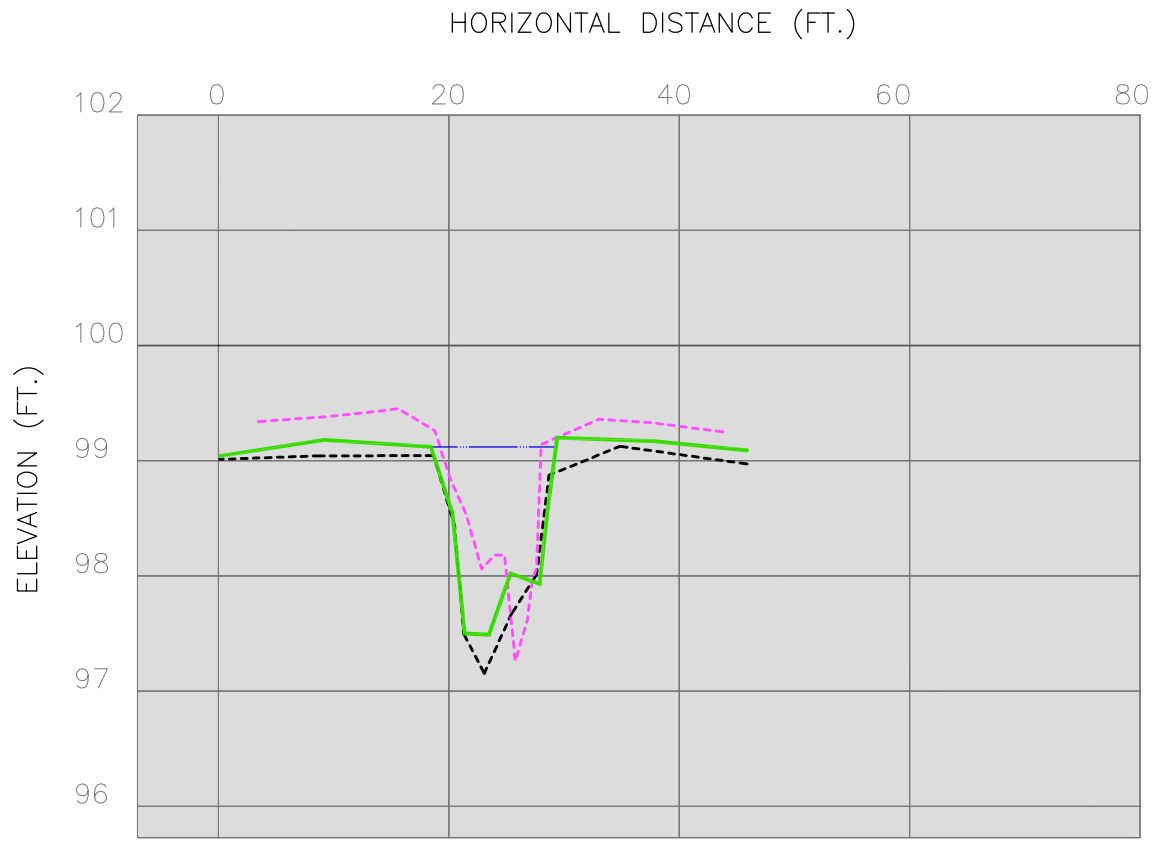
Title:
CROSS SECTION XS4–RIFFLE

Dsn. By: TAL	Dwn. By: TAL
Ckd. By: MCG	Date: DEC 2008
Scale: NO SCALE	
ESC Project No.: 07–330.00	

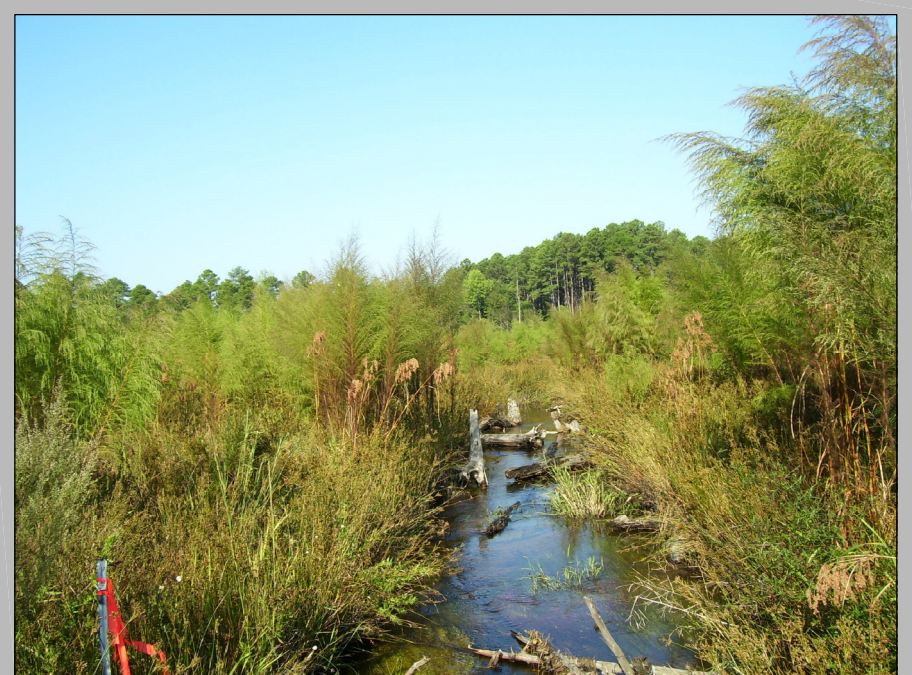
SHEET
B4



CROSS SECTION XSR2–RIFFLE

GRADE ELEVATION (2007)
GRADE ELEVATION (2008)
GRADE ELEVATION (AS–BUILT)
BANKFULL ELEVATION

XSR2 LEFT BANK LOOKING RIGHT BANK



XSR2 LOOKING DOWNSTREAM

SURVEY DATA

STATION	ELEVATION	FEATURE
0.00	100.00	LPIN
0.05	100.96	
9.17	100.14	
18.43	100.08	
20.32	99.51	
21.38	98.46	
23.49	98.45	
25.36	98.98	
27.89	98.89	
28.56	99.52	
29.41	100.16	
37.80	100.13	
46.06	100.66	
46.01	100.00	RPIN

SUMMARY DATA

BANKFULL CROSS SECTIONAL AREA	11.38 SQ. FT.
BANKFULL WIDTH	10.87 FT.
BANKFULL MEAN DEPTH	1.04 FT.
BANKFULL MAX DEPTH	1.63 FT.
WIDTH–DEPTH RATIO	10.45
ENTRENCHMENT RATIO	41.40
CLASSIFICATION	E5

NOTES:

1. All cross–sections facing the downstream direction
2. Cross–section stationing represents approximate field locations.
3. Elevations based on relative benchmark; left pin elevation=100.0 ft.

Survey Date	OCT. 2008
Survey Weather	Sunny
Field Team	Jones, Schmid
Location	XSR2

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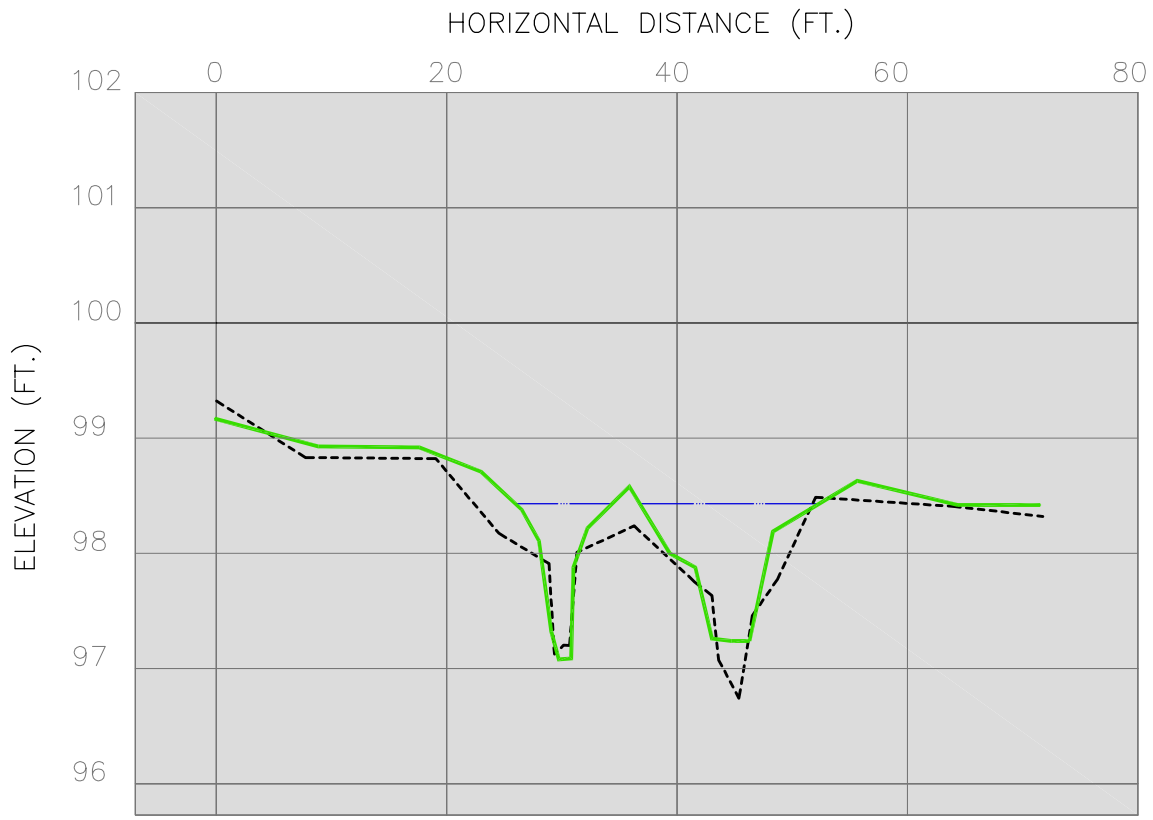
Title:
CROSS SECTION XSR2–RIFFLE

Dsn. By:	Dwn. By:
TAL	TAL
Ckd. By:	Date:
MCG	DEC 2008

Scale: NO SCALE

ESC Project No.: 07–330.00

SHEET
B5



CROSS SECTION XS5–POOL

SURVEY DATA

STATION	ELEVATION	FEATURE
0.00	100.00	LPIN
0.14	100.83	
9.02	99.76	
17.78	99.75	
23.14	99.54	
26.67	99.21	
28.17	98.94	
29.24	98.15	
29.88	97.91	
30.96	97.92	
31.15	98.71	
32.38	99.05	
36.01	99.41	
39.52	98.83	
41.73	98.71	
43.18	98.09	
44.88	98.07	
46.41	98.77	
46.44	98.07	
48.47	99.02	
55.80	99.46	
64.53	99.25	
71.69	99.25	
71.85	100.02	RPIN

SUMMARY DATA

BANKFULL CROSS SECTIONAL AREA	12.59 SQ. FT.
BANKFULL WIDTH	23.47 FT.
BANKFULL MEAN DEPTH	0.54 FT.
BANKFULL MAX DEPTH	1.33 FT.
WIDTH–DEPTH RATIO	43.46
ENTRENCHMENT RATIO	21.30
CLASSIFICATION	N/A

XS5 LEFT BANK LOOKING RIGHT BANK

XS5 LOOKING DOWNSTREAM

NOTES:

1. All cross–sections facing the downstream direction
2. Cross–section stationing represents approximate field locations.
3. Elevations based on relative benchmark; left pin elevation=100.0 ft.

Survey Date	OCT. 2008
Survey Weather	Sunny
Field Team	Jones, Schmid
Location	XS5

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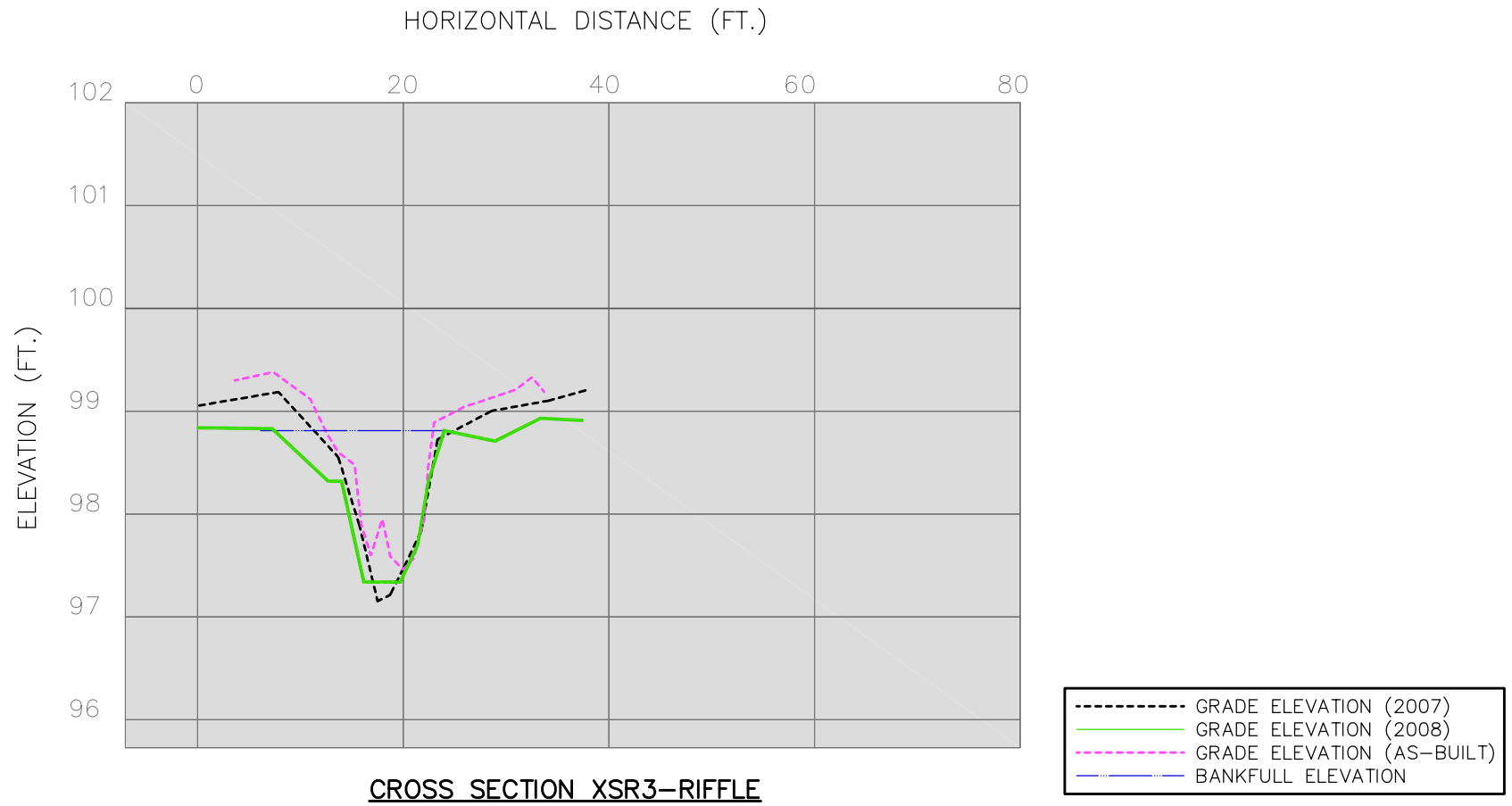
Title:

CROSS SECTION XS5–POOL

Dsn. By: TAL	Dwn. By: TAL
Ckd. By: MCG	Date: DEC 2008
Scale: NO SCALE	
ESC Project No.: 07–330.00	

SHEET

B6



CROSS SECTION XSR3-RIFFLE

XSR3 LEFT BANK LOOKING RIGHT BANK

XSR3 LOOKING DOWNSTREAM

SURVEY DATA

STATION	ELEVATION	FEATURE
0.00	100.00	LPIN
0.04	99.91	
7.29	98.74	
12.75	98.23	
14.04	98.23	
16.21	97.25	
17.83	97.25	
19.76	97.25	
21.45	97.61	
22.48	98.22	
24.03	98.72	
28.99	98.62	
33.37	98.84	
37.55	98.82	
37.61	99.48	RPIN

SUMMARY DATA

BANKFULL CROSS SECTIONAL AREA	12.65 SQ. FT.
BANKFULL WIDTH	16.52 FT.
BANKFULL MEAN DEPTH	0.76 FT.
BANKFULL MAX DEPTH	1.49 FT.
WIDTH-DEPTH RATIO	20.69
ENTRENCHMENT RATIO	24.21
CLASSIFICATION	C5

NOTES:

1. All cross-sections facing the downstream direction
2. Cross-section stationing represents approximate field locations.
3. Elevations based on relative benchmark; left pin elevation=100.0 ft.

Survey Date	OCT. 2008
Survey Weather	Sunny
Field Team	Jones, Schmid
Location	XSR3

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RICHMOND COUNTY, NORTH CAROLINA

Title:

CROSS SECTION XSR3-RIFFLE

Dsn. By:	Dwn. By:
TAL	TAL
Ckd. By:	Date:
MCG	DEC 2008

Scale: NO SCALE

ESC Project No.: 07-330.00

SHEET

B7

CROSS SECTION XS6–POOL

GRADE ELEVATION (2007)
GRADE ELEVATION (2008)
BANKFULL ELEVATION

XS6 LEFT BANK LOOKING RIGHT BANK

XS6 LOOKING DOWNSTREAM

SURVEY DATA

STATION	ELEVATION	FEATURE
0.00	100.00	LPIN
0.60	99.27	BLPIN
6.00	99.11	
10.00	99.41	
15.00	99.10	
18.00	98.56	
19.70	97.50	
22.00	98.41	
25.00	99.40	
31.00	99.47	
36.10	99.31	
42.00	99.35	
48.00	99.41	
53.00	99.52	
58.00	99.59	
61.80	99.20	
63.20	98.22	
65.00	99.08	
69.00	99.59	
73.00	99.29	
77.00	99.40	
82.00	99.56	
84.60	99.43	BRPIN
84.60	100.12	RPIN

SUMMARY DATA

BANKFULL CROSS SECTIONAL AREA	12.71 SQ. FT.
BANKFULL WIDTH	23.68 FT.
BANKFULL MEAN DEPTH	0.53 FT.
BANKFULL MAX DEPTH	1.91 FT.
WIDTH–DEPTH RATIO	44.67
ENTRENCHMENT RATIO	21.11
CLASSIFICATION	DA5/C5

NOTES:

1. All cross–sections facing the downstream direction
2. Cross–section stationing represents approximate field locations.
3. Elevations based on relative benchmark; left pin elevation=100.0 ft.

Survey Date	OCT. 2008
Survey Weather	Sunny
Field Team	Jones, Schmid
Location	XS6

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EEP Project No. D04020–2

RICHMOND COUNTY, NORTH CAROLINA

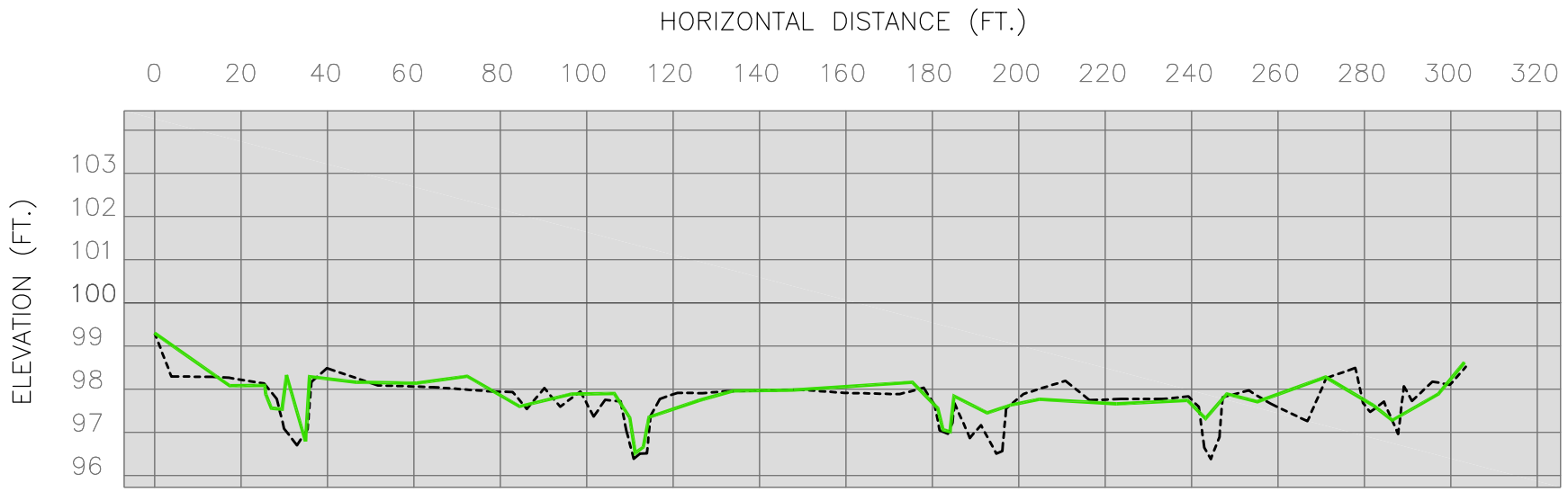
Title:
CROSS SECTION XS6–POOL

Dsn. By: TAL	Dwn. By: TAL
Ckd. By: MCG	Date: DEC 2008

Scale: NO SCALE

ESC Project No.: 07–330.00

SHEET
B8



CROSS SECTION XS7–BRAIDED CHANNELS

---------- GRADE ELEVATION (2007)
———— GRADE ELEVATION (2008)

XS7 LEFT BANK LOOKING RIGHT BANK

XS7 LOOKING DOWNSTREAM

SURVEY DATA

STATION	ELEVATION	FEATURE	STATION	ELEVATION	FEATURE
0.00	100.00	LPIN	286.49	99.14	
0.00	101.86		297.18	99.75	
17.40	99.94		303.15	100.48	
25.50	99.95		303.48	101.48	RPIN
25.77	99.74				
27.04	99.42				
29.52	99.40				
30.54	100.19				
34.94	98.65				
35.89	100.15				
46.80	100.02				
60.64	100.00				
72.36	100.16				
84.48	99.46				
106.40	99.76				
108.68	99.40				
110.00	99.20				
111.27	98.38				
113.13	98.52				
114.43	99.21				
126.01	99.60				
147.89	99.84				
175.37	100.02				
181.27	99.42				
182.48	98.92				
184.14	98.88				
185.02	99.70				
192.70	99.31				
198.08	99.49				
204.80	99.63				
222.66	99.52				
239.05	99.60				
243.25	99.18				
248.18	99.75				
255.26	99.57				
271.03	100.14				
282.08	99.49				

SUMMARY DATA

BANKFULL CROSS SECTIONAL AREA	N/A*
BANKFULL WIDTH	N/A*
BANKFULL MEAN DEPTH	N/A*
BANKFULL MAX DEPTH	N/A*
WIDTH–DEPTH RATIO	N/A*
ENTRENCHMENT RATIO	N/A*
CLASSIFICATION	DA5

* See document text for details

NOTES:

1. All cross–sections facing the downstream direction
2. Cross–section stationing represents approximate field locations.
3. Elevations based on relative benchmark; left pin elevation=100.0 ft.

Survey Date	OCT. 2008
Survey Weather	Sunny
Field Team	Jones, Schmid
Location	XS7

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Client:
Ecosystem Enhancement PROGRAM

Project:
McDONALDS POND RESTORATION SITE

EEP Project No. D04020–2

RICHMOND COUNTY, NORTH CAROLINA

Title:
CROSS SECTION XS7–BRAIDED CHANNELS

Dsn. By:	Dwn. By:
TAL	TAL
Ckd. By:	Date:
MCG	DEC 2008

Scale: NO SCALE

ESC Project No.: 07–330.00

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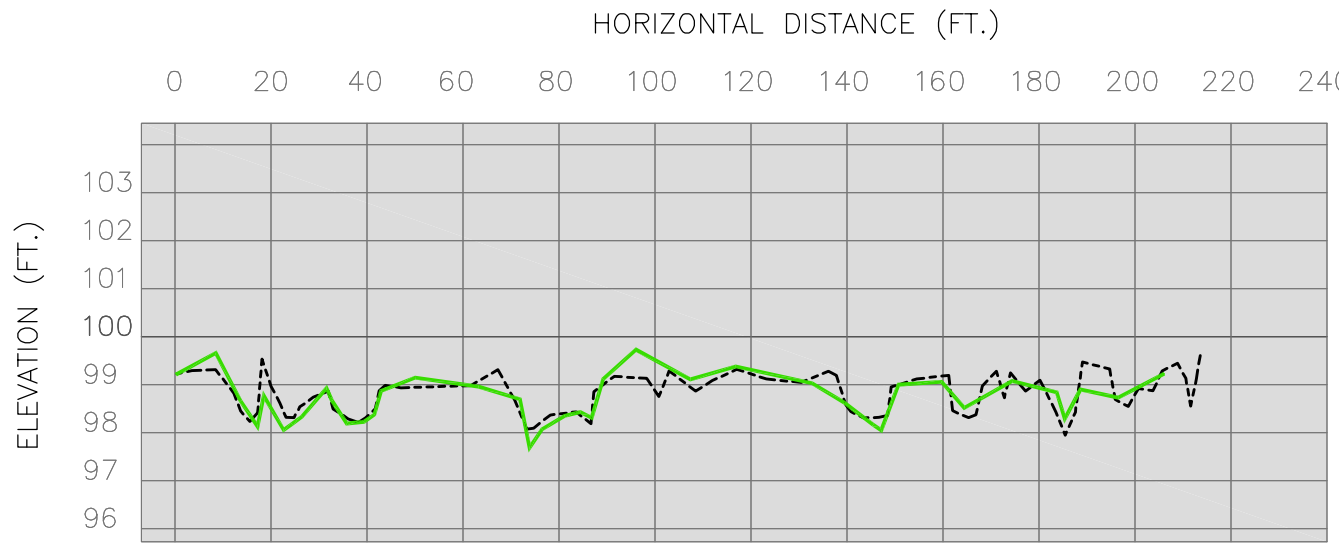

CROSS SECTION XS8–BRAIDED CHANNELS

---------- GRADE ELEVATION (2007)
———— GRADE ELEVATION (2008)

XS8 LEFT BANK LOOKING RIGHT BANK

XS8 LOOKING DOWNSTREAM

SURVEY DATA

STATION	ELEVATION	FEATURE	STATION	ELEVATION	FEATURE
0.00	100.00	LPIN	213.59	101.88	RPIN
0.20	99.84				
8.51	100.29				
13.64	99.29				
17.15	98.76				
18.47	99.40				
22.61	98.69				
24.32	98.81				
31.51	99.56				
32.66	99.30				
35.74	98.82				
39.33	98.86				
41.50	99.01				
42.86	99.50				
49.97	99.78				
63.16	99.59				
71.79	99.33				
73.82	98.32				
76.40	98.70				
81.08	98.98				
84.35	99.06				
86.71	98.94				
89.12	99.75				
95.94	100.36				
107.25	99.74				
116.72	100.01				
132.60	99.66				
139.31	99.26				
145.30	98.80				
146.99	98.68				
150.60	99.63				
159.53	99.69				
164.29	99.15				
174.22	99.71				
183.53	99.47				
185.20	98.92				
188.45	99.53				
196.31	99.36				
205.90	99.86				

SUMMARY DATA

BANKFULL CROSS SECTIONAL AREA	N/A*
BANKFULL WIDTH	N/A*
BANKFULL MEAN DEPTH	N/A*
BANKFULL MAX DEPTH	N/A*
WIDTH–DEPTH RATIO	N/A*
ENTRENCHMENT RATIO	N/A*
CLASSIFICATION	DA5

* See document text for details

NOTES:

1. All cross–sections facing the downstream direction
2. Cross–section stationing represents approximate field locations.
3. Elevations based on relative benchmark; left pin elevation=100.0 ft.

Survey Date	OCT. 2008
Survey Weather	Sunny
Field Team	Jones, Schmid
Location	XS8

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RICHMOND COUNTY, NORTH CAROLINA

Title:

CROSS SECTION XS8–BRAIDED CHANNELS

Dsn. By: TAL	Dwn. By: TAL
Ckd. By: MCG	Date: DEC 2008
Scale: NO SCALE	
ESC Project No.: 07–330.00	

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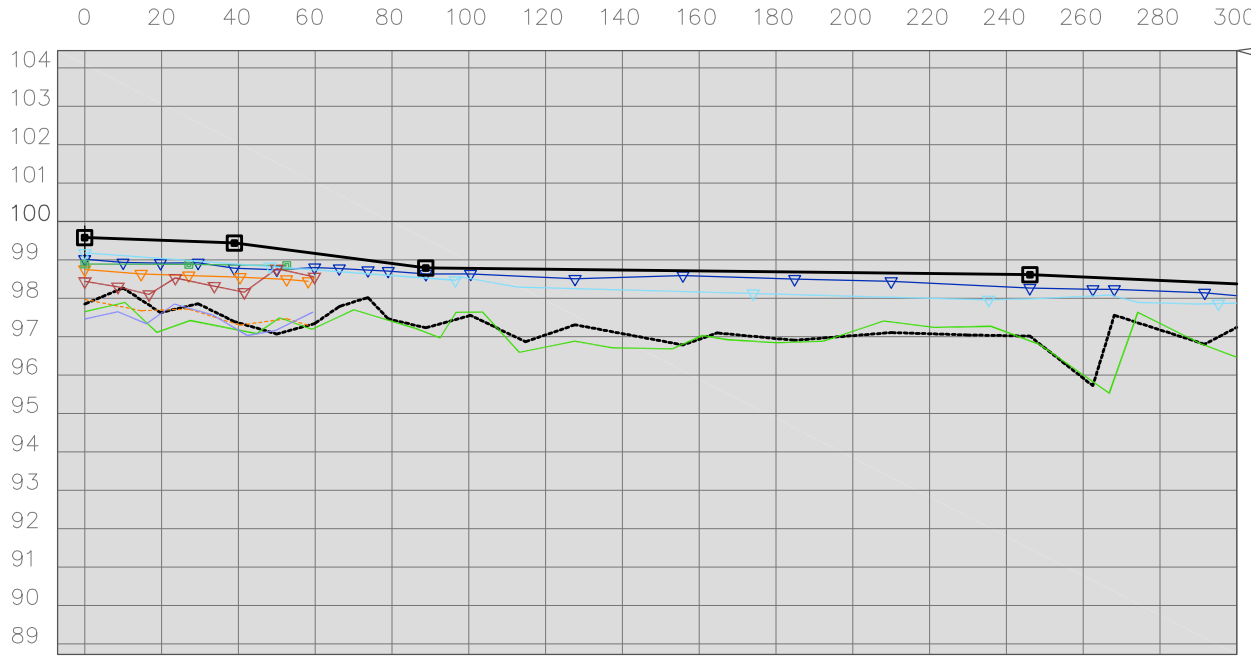
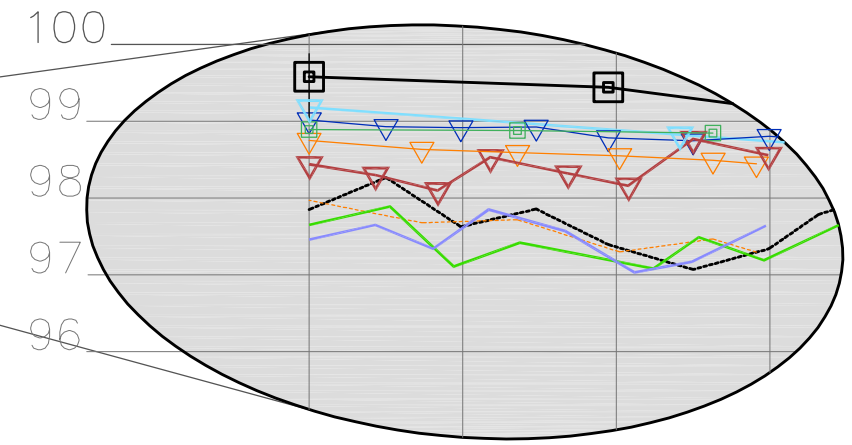
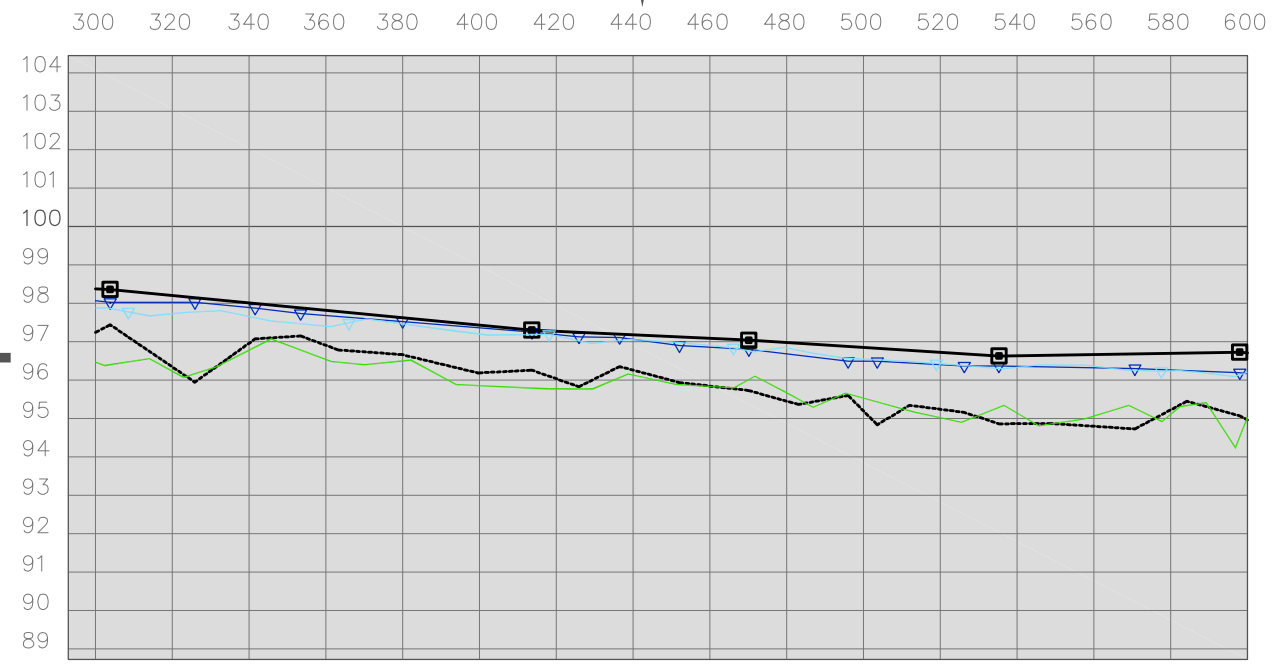


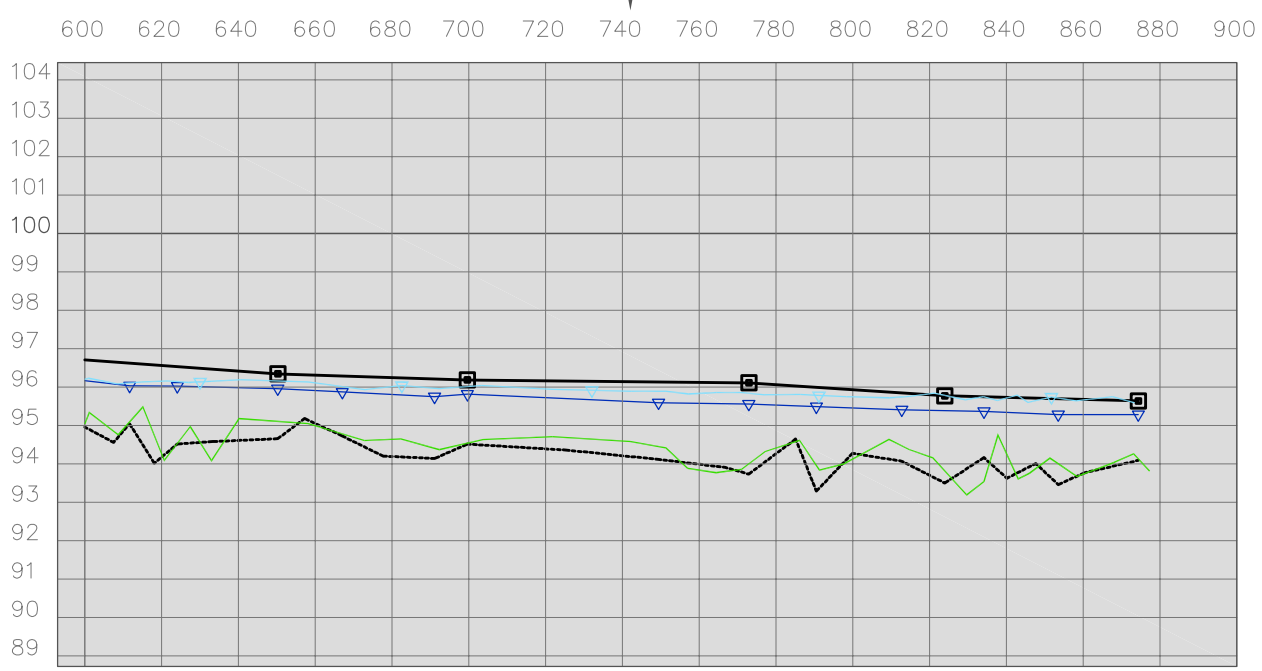
LONGITUDINAL PROFILE SECTION 1



RIGHT BRAID INSET



LONGITUDINAL PROFILE SECTION 2



LONGITUDINAL PROFILE SECTION 3

- GRADE ELEVATION THALWEG (2007)
- WATER SURFACE ELEVATION (2007)
- RIGHT BRAID THALWEG (2007)
- RIGHT BRAID WATER SURFACE ELEVATION (2007)
- RIGHT BRAID TOP OF BANK (2007)
- BANKFULL (2007)
- GRADE ELEVATION THALWEG (2008)
- WATER SURFACE ELEVATION (2008)
- RIGHT BRAID THALWEG (2008)
- RIGHT BRAID WATER SURFACE ELEVATION (2008)

BANKFULL SLOPE: 0.0044

WATER SURFACE SLOPE: 0.0041

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RICHMOND COUNTY, NORTH CAROLINA

Title:
LONGITUDINAL PROFILE

Dsn. By:	Dwn. By:
TAL	TAL
Ckd. By:	Date:
MCG	DEC 2008

Scale: NO SCALE

ESC Project No.: 07-330.00

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McDonalds Pond Restoration Site: Longitudinal Profile Data (Oct 2008)							
Station	TWG Elevation	WS Elevation	BKF Elevation	Station	TWG Elevation	WS Elevation	BKF Elevation
0.0	94.3	95.9	95.9	513.2	91.9		
10.5	94.6			525.6	91.6	93.1	
18.8	93.8			536.6	92.0	93.0	93.2
27.4	94.1			545.7	91.5	93.1	
44.8	93.8		95.9	557.8	91.7	93.1	
50.7	94.2			569.1	92.0	93.0	
59.2	93.9			577.8	91.6	92.9	93.1
70.1	94.4		95.6	582.5	92.0		
86.1	93.9			589.3	92.1	92.9	
92.6	93.7			596.9	90.9	92.8	
96.7	94.3	95.2	95.2	601.2	92.0	92.9	93.1
103.6	94.3			608.8	91.5		
113.2	93.3	95.0		615.2	92.2		
127.6	93.6			620.7	90.8		
137.6	93.4			627.5	91.7		93.1
153.1	93.4			633.0	90.8	92.8	93.0
160.8	93.7			640.2	91.9	92.9	
167.6	93.6		95.2	658.2	91.7	92.8	
180.3	93.5			672.9	91.3	92.6	92.6
192.4	93.6			682.3	91.3	92.7	
208.0	94.1			692.4	91.1	92.7	
221.4	93.9		94.8	703.7	91.3	92.7	92.9
236.0	94.0	94.7		721.8	91.4	92.6	
248.6	93.5	94.7		742.0	91.3	92.6	
266.8	92.2	94.8		751.3	91.1	92.6	92.5
274.2	94.3	94.6		757.0	90.6	92.5	
290.8	93.5	94.5		764.5	90.5	92.6	
302.4	93.1	94.6	94.3	771.1	90.6		92.9
314.1	93.3	94.4		777.2	91.0		
323.0	92.8	94.5		786.2	91.3	92.5	92.5
331.6	93.0			791.4	90.5	92.5	
345.7	93.8	94.2		797.7	90.7		
361.5	93.2	94.1		809.5	91.3	92.4	
370.2	93.1	94.3		814.8	91.1	92.5	92.5
382.2	93.2			820.8	90.9	92.5	
394.0	92.6	94.0		829.7	89.9	92.4	92.7
402.7	92.5	93.9		834.2	90.2	92.4	
418.2	92.5	93.9		837.8	91.4	92.3	
429.6	92.5	93.6	94.1	843.1	90.3	92.5	92.2
438.7	92.9	93.8		846.1	90.5		
451.4	92.6	93.7		851.3	90.8	92.4	
466.3	92.5	93.5		858.5	90.4		
471.8	92.8	93.4	93.4	868.0	90.7	92.4	
479.6	92.4	93.5		873.1	91.0		
486.9	92.0	93.4		877.4	90.5	92.3	
495.3	92.4	93.3	93.3				

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APPENDIX C: AQUATIC COMMUNITY DATA

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SPECIES	T.V.	F.F.G.	Reach 1 (Reference)	Reach 2	Reach 3	Reach 4 (Reference)
ARTHROPODA						
Isopoda						
Asellidae		**SH**				
Caecidotea sp.	**9.1**	**CG**				1
Insecta						
Ephemeroptera						
Baetidae		**CG**				
Pseudocloeon sp.	**4**	**CG**	1		2	
Eurylophella sp.	**4.3**	**SC**	2	4		
Heptageniidae		**SC**				
Maccaffertium (Stenonema) sp.		**SC**	12	4		
Leptophlebiidae		**CG**				1
Paraleptophlebia sp.	**0.9**	**CG**	9	3	1	
Odonata						
Aeshnidae		**P**				
Basiaeschna janata	**7.4**			1		
Boyeria vinosa	**5.9**	**P**	5	14	5	
Calopterygidae		**P**				
Calopteryx sp.	**7.8**	**P**	2	3	4	3
Coenagrionidae		**P**				
Argia sp.	**8.2**	**P**		3	1	
Cordulegastridae		**P**				
Cordulegaster sp.	**5.7**	**P**				1
Gomphidae		**P**				
Gomphus sp.	**5.8**	**P**	5	1	1	1
Dromogomphus armatus	**5.9**	**P**		4		
Hagenius brevistylus	**4**	**P**	3			1
Progomphus obscurus	**8.2**	**P**	5			1
Libellulidae		**P**				
Landona julia				2	1	
Macromia sp.	**6.2**	**P**			1	
Neurocordulia sp.	**5**			6	8	1
Plecoptera						
Leuctridae		**SH**				
Leuctra sp.	**2.5**	**SH**	9		4	31
Perlidae		**P**				
Acroneuria lycorias	**2.1**	**P**	8			
Eccoptura xanthenes	**3.7**	**P**	1			2
Perlesta placida sp. gp.	**4.7**	**P**			2	
Perlinella ephyre		**P**	5			
Perlodidae		**P**	1			

SPECIES	T.V.	F.F.G.	Reach 1 (Reference)	Reach 2	Reach 3	Reach 4 (Reference)
Hemiptera						
Belostomatidae						
Belostoma sp.	**9.8**	**P**				
Corixidae	**9**	**PI**		1		
Nepidae		**-**				
Ranatra sp.	**7.8**	**P**			1	
Megaloptera						
Corydalidae		**P**				
Chauliodes rastricornis	**8.4**	**P**				
Nigronia serricornis	**5**	**P**	2			3
Trichoptera						
Brachycentridae		**SH**				
Anisocentropus pyraloides	**0.9**	**SH**		1		1
Calamoceratidae		**SH**				
Heteroplectron americanum	**3.2**	**-**	1			
Hydropsychidae		**FC**				
Diplectrona modesta	**2.2**	**FC**	2			17
Hydropsyche sp.		**FC**	4	5	4	
Leptoceridae		**CG**				
Triaenodes sp.	**4.5**	**SH**		2		
Odontoceridae		**SC**				
Psilotreta sp.	**0**	**SC**	1			
Philopotamidae		**FC**				
Chimarra aterrima	**2.8**	**FC**	1	9	4	
Psychomyiidae		**CG**				
Lype diversa	**4.1**	**SC**		1		
Sericostomatidae						
Agarodes sp.	**0.7**	**0.69**	1	2		
Coleoptera						
Curculionidae						
Elmidae		**CG**				
Promoresia elegans	**2.2**	**SC**		1	1	
Stenelmis sp.	**5.1**	**SC**	2			
Hydrophilidae		**P**				
Sperchopsis tesselatus	**6.1**	**CG**	4			
Tropisternus sp.	**9.7**	**P**				

SPECIES	T.V.	F.F.G.	Reach 1 (Reference)	Reach 2	Reach 3	Reach 4 (Reference)
Diptera						
Ceratopogonidae		**P**	1			
Chironomidae						
Clinotanypus sp.		**P**	1		1	1
Conchapelopia sp.	**8.4**	**P**	2	12	4	
Cricotopus bicinctus	**8.5**	**CG**		1		
Cricotopus trifascia	**2.8**	**CG**		5		
Cricotopus sp.		**CG**		2		
Microtendipes pedellus gp.	**5.5**	**CG**	2			
Nanocladius sp.	**7.1**	**CG**		1		
Parachaetocladius sp.	**0**	**CG**	1		2	
Parametriocnemus sp.	**3.7**	**CG**	2			
Polypedilum flavum (convictu	**4.9**	**SH**	1			
Procladius sp.	**9.1**	**P**		1		
Rheosmittia sp.	**7**		2		1	
Rheotanytartsus exiguus gp.	**5.9**		1	4	1	
Tanytarsus sp.	**6.8**	**FC**		1		
Tvetenia paucunca	**3.7**	**CG**		2		1
Xylotopus par	**6**	**SH**	3			
Simuliidae		**FC**				
Simulium sp.	**6**	**FC**	1			2
Tipulidae		**SH**				
Hexatoma sp.	**4.3**	**P**	1			

TOTAL NO. OF ORGANISMS	**104**	**96**	**49**	**68**
TOTAL NO. OF TAXA	**35**	**28**	**20**	**16**
EPT	**15**	**9**	**6**	**5**
NCBI	**4.19**	**5.38**	**5.04**	**3.26**

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APPENDIX D: NCDWQ HABITAT ASSESSMENT FORM - COASTAL PLAIN

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3/06 Revision 7

Habitat Assessment Field Data Sheet
Coastal Plain Streams

TOTAL SCORE_____

Biological Assessment Unit, DWQ

Directions for use: The observer is to survey a **minimum of 100 meters with 200 meters preferred** of stream, preferably in an **upstream** direction starting above the bridge pool and the road right-of-way. The segment which is assessed should represent average stream conditions. To perform a proper habitat evaluation the observer needs to get into the stream. To complete the form, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. A final habitat score is determined by adding the results from the different metrics.

Stream_____Location/road: _____(Road Name_____)County_____

Date_____**CC#**_____Basin_____Subbasin_____

Observer(s)_____ Type of Study: ☐ Fish ☐Benthos ☐ Basinwide ☐Special Study (Describe) _____

Latitude _____Longitude _____Ecoregion: ☐ CA ☐ SWP ☐ Sandhills ☐ CB

Water Quality: Temperature_____^{0}C DO _____mg/l Conductivity (corr.) _____µS/cm pH _____

Physical Characterization: Visible land use refers to immediate area that you can see from sampling location. Check off what you observe driving thru the watershed in watershed land use.

Visible Land Use: _____%Forest _____%Residential _____%Active Pasture _____% Active Crops
_____%Fallow Fields _____% Commercial _____%Industrial _____%Other - Describe:_____

Watershed land use ☐ Forest ☐ Agriculture ☐Urban ☐ Animal operations upstream

Width: (meters) Stream_____ Channel (at top of bank)_____ **Stream Depth**: (m) Avg_____Max ____
☐ Width variable ☐Braided channel ☐Large river >25m wide
Bank Height (from deepest part of channel to top of bank): (m)_____

Flow conditions : ☐High ☐Normal ☐Low
Channel Flow Status
Useful especially under abnormal or low flow conditions.

A. Water reaches base of both banks, minimal channel substrate exposed	☐
B. Water fills >75% of available channel, or <25% of channel substrate is exposed	☐
C. Water fills 25-75% of available channel, many logs/snags exposed	☐
D. Root mats out of water	☐
E. Very little water in channel, mostly present as standing pools	☐

Turbidity: ☐Clear ☐ Slightly Turbid ☐Turbid ☐Tannic ☐Milky ☐Colored (from dyes) ☐Green tinge
Good potential for Wetlands Restoration Project?? ☐ YES ☐ NO
Details_____

☐Channelized ditch
☐Deeply incised-steep, straight banks ☐Both banks undercut at bend ☐Channel filled in with sediment
☐Recent overbank deposits ☐Bar development ☐Sewage smell
☐Excessive periphyton growth ☐Heavy filamentous algae growth

Manmade Stabilization: ☐N ☐Y: ☐Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐Berm/levee
Weather Conditions:_____**Photos:** ☐N ☐Y ☐Digital ☐35mm

Remarks:_____
TYPICAL STREAM CROSS SECTION DIAGRAM ON BACK

I. Channel Modification

	Score
A. Natural channel-minimal dredging.....	15
B. Some channelization near bridge, or historic (>20 year old), and/or bends beginning to reappear..	10
C. Extensive channelization, straight as far as can see, channelized ditch.....	5
D. Banks shored with hard structure, >80% of reach disrupted, instream habitat gone.....	0

Remarks_____ Subtotal____

II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. If >50% of the reach is snags, and 1 type is present, circle the score of 16. Definition: leafpacks consist of older leaves that are packed together and have begun to decay (not piles of leaves in pool areas). Mark as **R**are, **C**ommon, or **A**bundant.

____Sticks ____Snags/logs ____Undercut banks or root mats ____Macrophytes ____Leafpacks

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>50% Score	30-50% Score	10-30% Score	<10% Score
4 or 5 types present.....	20	15	10	5
3 types present.....	18	13	8	4
2 types present.....	17	12	7	3
1 type present.....	16	11	6	2
No substrate for benthos colonization and no fish cover.....0				

☐ No woody vegetation in riparian zone Remarks_____ Subtotal_____

III. Bottom Substrate (silt, clay, sand, detritus, gravel) look at entire reach for substrate scoring.

	Score
A. Substrate types mixed	
1. gravel dominant.....	15
2. sand dominant.....	13
3. detritus dominant.....	7
4. silt/clay/muck dominant.....	4
B. Substrate homogeneous	
1. nearly all gravel.....	12
2. nearly all sand	7
3. nearly all detritus.....	4
4. nearly all silt/clay/muck.....	1

Remarks_____Subtotal_____

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow.

	Score
A. Pools present	
1. Pools Frequent (>30% of 100m length surveyed)	
a. variety of pool sizes.....	10
b. pools about the same size (indicates pools filling in).....	8
2. Pools Infrequent (<30% of the 100m length surveyed)	
a. variety of pool sizes.....	6
b. pools about the same size.....	4
B. Pools absent	
1. Deep water/run habitat present.....	4
2. Deep water/run habitat absent.....	0
	Subtotal_____

Remarks_____ Page Total_____

V. Bank Stability and Vegetation

	Score	Score
A. Banks stable or no banks, just flood plain		
1. little or no evidence of erosion or bank failure, little potential for erosion	10	10
B. Erosion areas present		
1. diverse trees, shrubs, grass; plants healthy with good root systems.....	9	9
2. few trees or small trees and shrubs; vegetation appears generally healthy.....	7	7
3. sparse vegetation; plant types and conditions suggest poorer soil binding.....	4	4
4. mostly grasses, few if any trees and shrubs, high erosion and failure potential at high flow	2	2
5. little or no bank vegetation, mass erosion and bank failure evident.....0	0	

Total_____

Remarks_____

VI. Light Penetration (Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead).

	Score
A. Stream with **good** canopy with some breaks for light penetration	10
B. Stream with **full canopy** - breaks for light penetration absent.....	8
C. Stream with **partial** canopy - sunlight and shading are essentially equal.....	7
D. Stream with **minimal** canopy - full sun in all but a few areas.....	2
E. **No canopy** and no shading.....	0

Subtotal____

Remarks_____

VII. Riparian Vegetative Zone Width

Definition: A break in the riparian zone is any area which allows sediment to enter the stream. Breaks refer to the near-stream portion of the riparian zone (banks); places where pollutants can directly enter the stream.

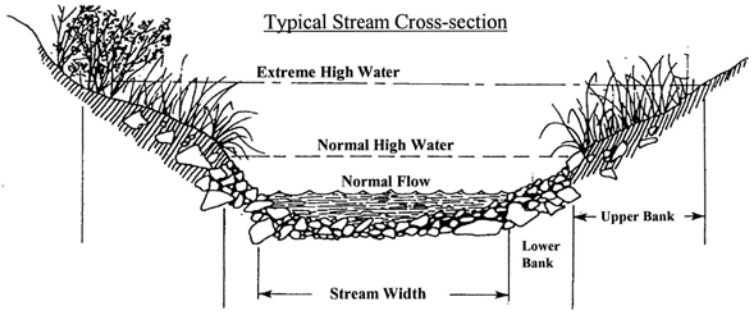
	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. zone width > 18 meters.....	5	5
2. zone width 12-18 meters.....	4	4
3. zone width 6-12 meters.....	3	3
4. zone width < 6 meters.....	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. zone width > 18 meters.....	4	4
b. zone width 12-18 meters.....	3	3
c. zone width 6-12 meters.....	2	2
d. zone width < 6 meters.....	1	1
2. breaks common		
a. zone width > 18 meters.....	3	3
b. zone width 12-18 meters.....	2	2
c. zone width 6-12 meters.....	1	1
d. zone width < 6 meters.....	0	0

Total_____

Remarks_____

Page Total_____

TOTAL SCORE _____


Typical Stream Cross-section
Extreme High Water
Normal High Water
Normal Flow
Upper Bank
Lower Bank
Stream Width
This side is 45° bank angle.

APPENDIX E: VEGETATION MONITORING PLOT PHOTOS

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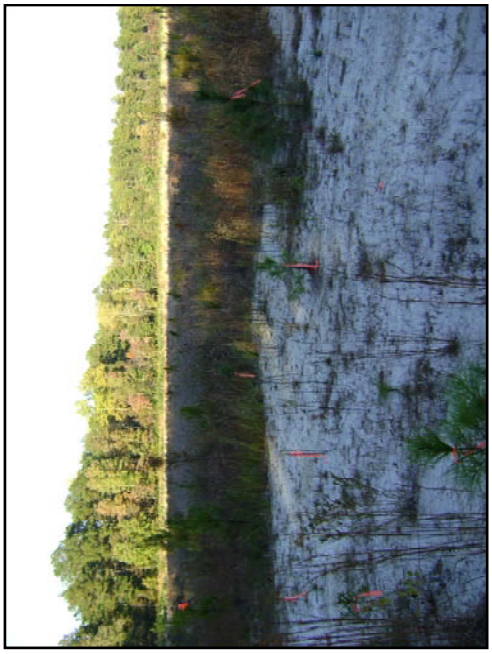

Vegetation Plot 1

Vegetation Plot 2

Vegetation Plot 3

Vegetation Plot 4

Vegetation Plot 5

Vegetation Plot 6

Vegetation Plot 7

Vegetation Plot 8

APPENDIX F: GROUNDWATER GAUGE HYDROGRAPH

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McDonalds Pond Restoration Site

Groundwater Gauge Hydrographs

Monitoring Year 3 (2008)

Figure F-1