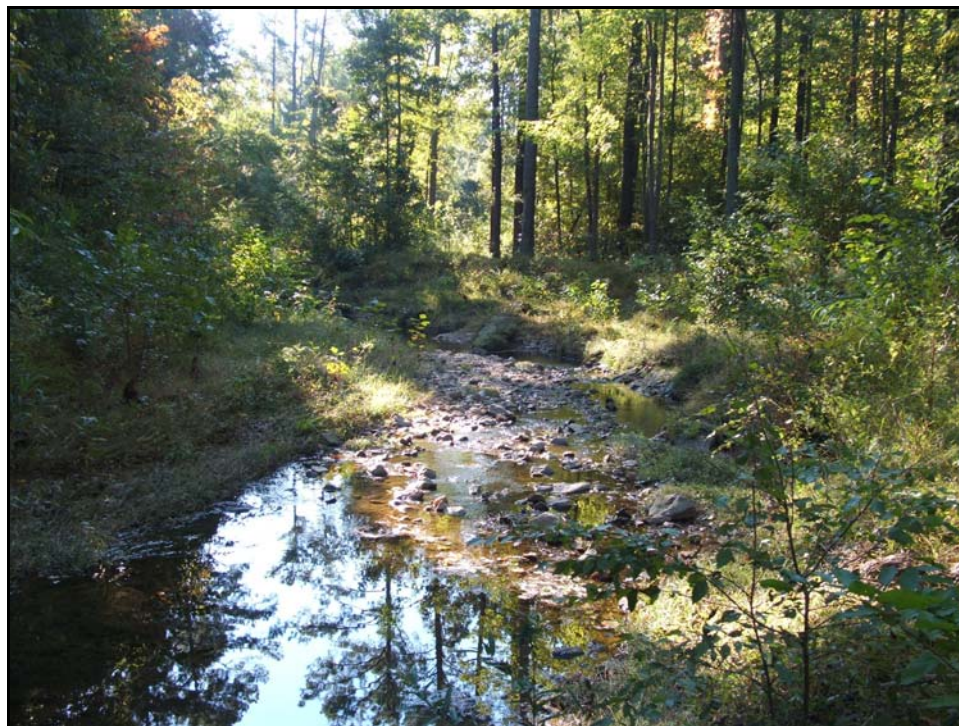


**Kentwood Park (Bushy Branch) Stream
Restoration Monitoring Report
EEP Project # 205
Monitoring Year – 01
2005**



Submitted to:



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

Monitoring Firm



**Landmark Center II, Suite 220
4601 Six Forks Road
Raleigh, NC 27609
Phone: (919) 783-9214
Fax: (919) 783-9266**

**Project Contact: Adam Spiller
Email: aspiller@kci.com**

Design Firm



TABLE OF CONTENTS

1.0	PROJECT BACKGROUND.....	1
1.1	Location and Setting	1
1.2	Structure and Objectives	1
1.3	Project History and Background.....	3
1.4	Monitoring Plan View.....	5
2.0	PROJECT CONDITIONS AND MONITORING RESULTS.....	6
2.1	Vegetation Assessment	6
2.1.1	Soil Data.....	6
2.1.2	Vegetative Problem Areas	6
2.1.3	Vegetative Problem Area Plan View	7
2.1.4	Stem Counts	7
2.1.5	Vegetation Plot Photos.....	8
2.2	Stream Assessment	8
2.2.1	Stream Problem Areas Plan View.....	8
2.2.2	Stream Problem Areas Table	8
2.2.3	Stream Issue Photos	9
2.2.4	Fixed Station Photos	9
2.2.5	Stream Assessment Tables.....	9
2.2.6	Quantitative Measures Summary Tables	10

LIST OF TABLES

Table 1.	Project Structure Table	1
Table 2.	Project Structure Table	1
Table 3.	Project Activity and Reporting History	3
Table 4.	Project Contact Table.....	3
Table 5.	Project Background Table.....	4
Table 6.	Preliminary Soil Data.....	6
Table 7.	Vegetative Problem Areas	6
Table 8.	Stem Count For Each Species Arranged by Plot	7
Table 9.	Stream Problem Areas	8
Table 10.	Categorical Stream Feature Visual Stability Assessment.....	9
Table 11.	Baseline Morphology and Hydraulic Summary	10
Table 12.	Morphology and Hydraulic Monitoring Summary.....	12

LIST OF FIGURES

Figure 1.	Vicinity Map.....	2
Figure 2.	Monitoring Plan View.....	5

APPENDIX A – VEGETATION RAW DATA

A1. Vegetation Survey Data Tables15
A2. Vegetative Problem Area Plan View16
A3. Vegetation Problem Area Photos.....17
A4. Vegetation Monitoring Plot Photos22

APPENDIX B – GEOMORPHOLOGIC RAW DATA

B1. Stream Problem Area Plan View26
B2. Representative Stream Problem Area Photos27
B3. Stream Photo Station Photos.....30
B4. Qualitative Visual Stability Assessment Table.....36
B5. Cross Section Plots and Raw Data Tables37
B6. Longitudinal Plots and Raw Data Tables.....41
B7. Pebble Count Plots and Raw Data Tables.....50
B8. USGS Gauge Discharge Plots.....54

EXECUTIVE SUMMARY

The Wetlands Restoration Program identified Bushy Branch in Kentwood Park as a restoration design project in 2000. The watershed of approximately 1.4 square miles is located within USGS 14-digit HUC 03020201090010 and NCDWQ Sub-basin 03-04-02 of the Neuse River Basin. The initial planning proposed to restore approximately 1,400 linear feet of channel, 1,070 feet on Bushy Branch and 350 feet on an unnamed tributary to Bushy Branch (UT to Bushy Branch). The restoration was designed to correct various problems with the existing stream corridor including unstable channel configuration, poor water quality, minimal bed features, exotic and invasive vegetation, and poor stream and riparian habitat. The restoration plan was completed in 2002 and called for correcting these problems by stabilizing stream banks, installing in-stream structures, adjusting stream planform, and clearing and replanting the riparian areas with native vegetation. Project construction occurred in 2002. This report is a description of the findings of the first year monitoring that took place in 2005.

The restoration plan called for removal of all existing problem vegetation along the stream banks and within the riparian buffer. The as-built survey found the original planting of native vegetation to be unsuccessful. To correct the initial failure a remedial vegetation plan was designed and planted in 2004. Remedial vegetation was planted at a density of 4,840 stems per acre in the streamside community and 680 stems per acre in the bottomland hardwood community. The first year vegetation monitoring plots were established during the as-built survey. Three plots were surveyed and the corners marked with metal conduit for future monitoring. The first year monitoring counted an average of 2,227 stems per acre in the streamside community based on plots 1 and 2, and 1,377 stems per acre in the bottomland hardwood community based on plot 3. The park's disc golf course has a detrimental effect on the vegetation of UT to Bushy Branch and on the west bank of the upper 250 feet of Bushy Branch. The damage to the vegetation primarily results in bare banks due to foot traffic from disc golf players retrieving discs from the stream area. Some damage is due to direct impact of the flying discs on the planted vegetation. *Microstegium* was a prominent exotic / invasive plant documented throughout the site. There are also a couple of spots where kudzu (*Pueraria lobata*) is present and should be controlled as soon as possible. The first year monitoring found the vegetation component of the project to be successful.

The stream assessment completed during the first year monitoring found the stream to be functioning and holding grade for the majority of the project. Channel dimensions have not changed drastically from the designed conditions with the exceptions of some areas of bank erosion. The first year monitoring profile shows some bed degradation from station 14+00 to 14+50 and 18+00 to 18+75 in comparison to the as-built profile. UT to Bushy Branch also shows some areas of bed degradation when the profile is compared to the as-built profile. Most of the in stream structures are functioning, though many are experiencing stress evidenced by localized erosion on cross vane arms. The most extensive stream problem appears to be the instability of the banks along various parts of Bushy Branch. These bank erosion issues are detailed in the following report and should be closely monitored to determine if repairs are warranted.

1.0 PROJECT BACKGROUND

1.1 Location and Setting

This project is located within the city limits of Raleigh, North Carolina. From Interstate I-440 take exit 2A to Western Boulevard. From Western Boulevard, turn right (south) onto Kent Street. At a traffic light at the end of Kent Street, turn right (west) onto Kaplan Drive. Kentwood Park parking will be on the left (south) side of Kaplan Drive. Refer to Figure 1.

1.2 Structure and Objectives

Previously incised channels through the Kentwood Recreational Park, Bushy Branch and a tributary were restored using channel dimension and profile modifications and the establishment of a vegetated riparian zone adjacent to the creek. Channel profile is maintained through the use of rock cross vanes. Channel pattern is maintained through the use of single vanes, root wads, and vegetation along the channel banks. Due to heavy site use and poor planting success, corrective actions in the form of a vegetation and stream maintenance plan have been implemented since initial project completion.

Table 1. Project Structure Table	
Project Number and Name: 205 – Kentwood Park (Bushy Branch)	
Segment/Reach ID	Linear Feet or Acreage
Bushy Branch	1,070 feet
UT to Bushy Branch	350 feet

Table 2. Project Objectives Table			
Project Number and Name: 205 – Kentwood Park (Buushy Branch)			
Segment/Reach ID	Objectives	Linear Feet or Acreage	Comment
Bushy Branch	Restoration	1,070 feet	Priorities 1, 2, and 3 Natural Channel Design with urban constraints
UT to Bushy Branch	Restoration	350 feet	Priority 3 Natural Channel Design, with urban constraints
Bushy Branch and UT – Riparian Area	Establish / improve habitat	2.9 acres	Complete replanting and streamside stabilization

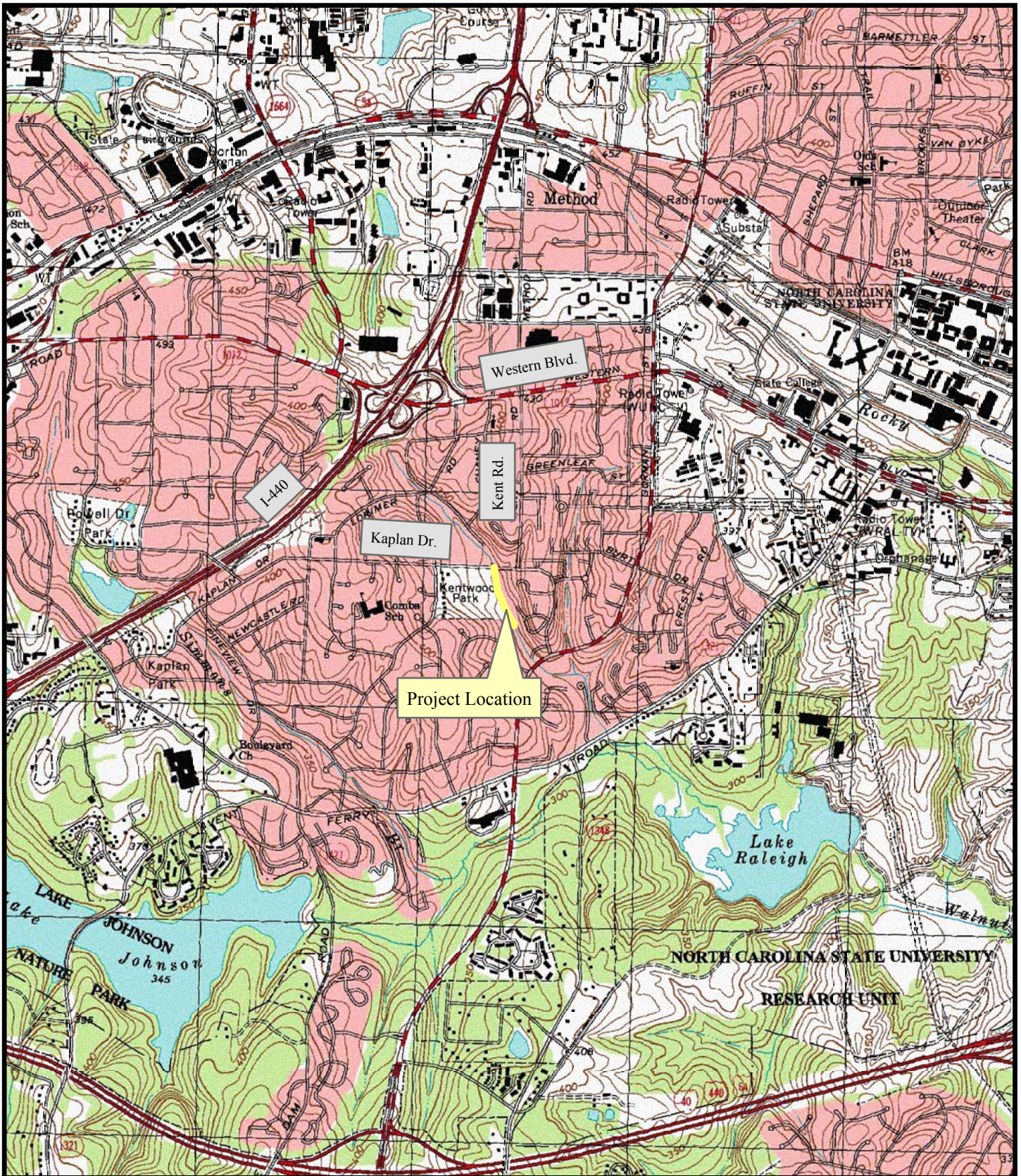


Figure 1. Site Vicinity Map
Kentwood Park, Wake County, EEP Project # 205 - MY01



Date: 12/29/05
 Source: USGS Topo Quad
 Raleigh West, 1987.

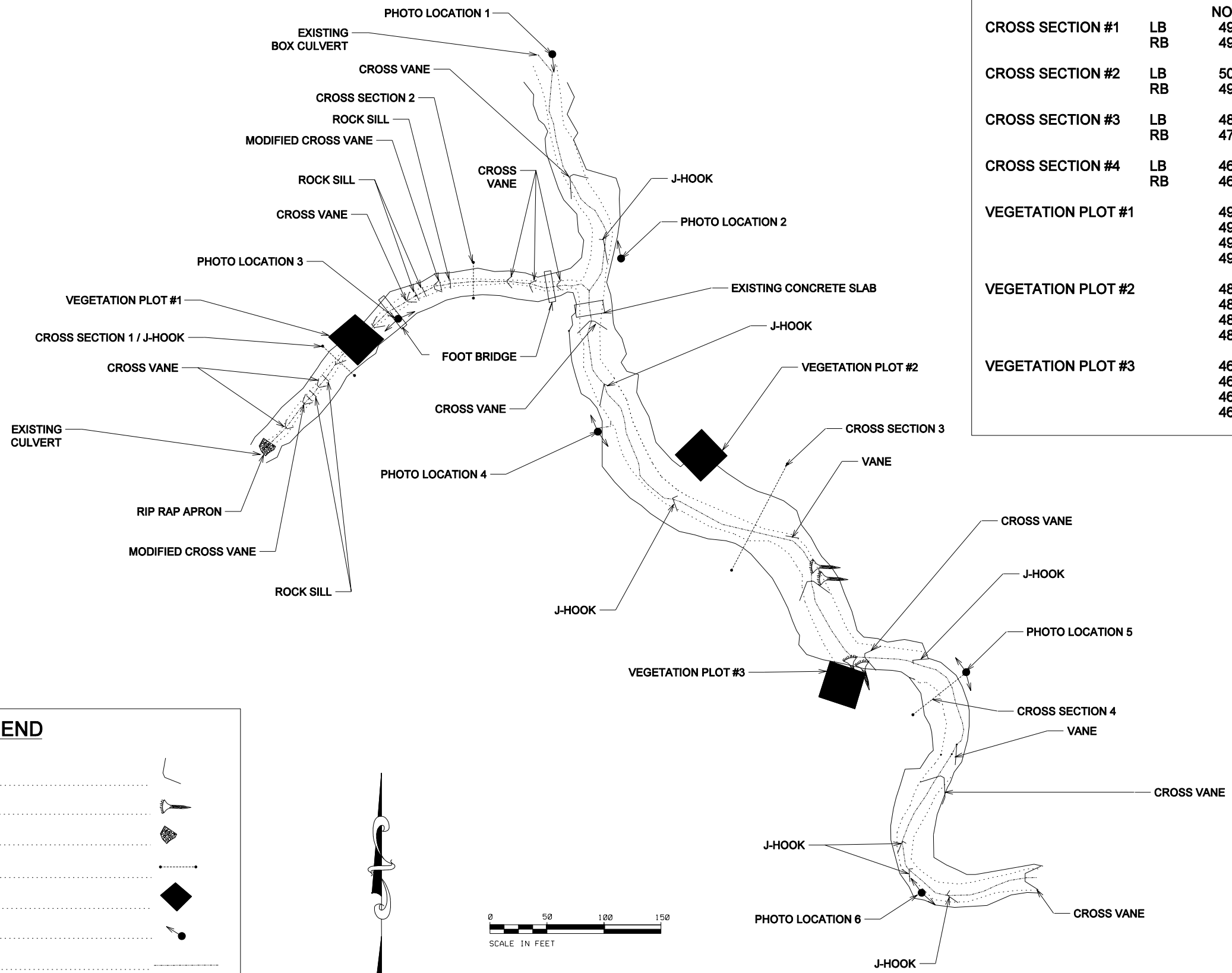


1.3 Project History and Background

Table 3. Project Activity and Reporting History		
Project Number and Name: 205 – Kentwood Park (Bushy Branch)		
Activity or Report	Calendar Year of Completion or Planned Completion	Actual Completion Date
Restoration Plan	2002	2002
Construction	2002	2002
Stream Maintenance and Planting	2004	2004
As-Built Report	2005	2005
Year 1 Monitoring	2005	2005

Table 4. Project Contact Table
Project Number and Name: 205 – Kentwood Park (Bushy Branch)
Design Firm
Arcadis G&M of North Carolina, Inc.
2301 Rexwoods Dr., Suite 102
Raleigh, North Carolina 27607
Contact: Mr. William Scott Hunt, III
Phone: (919) 782-5511
Fax: (919) 782-5905
Vegetation Design Firm (2004 Vegetation and Stream Maintenance Plan)
EcoScience Corporation
1101 Haynes St., Suite 101
Raleigh, North Carolina 27604
Contact: Mr. Jens Geratz
Phone: (919) 828-3433
Fax: (919) 828-3518
Construction Contractor
Shamrock Environmental Group
6106 Corporate Park Dr.
Brown Summit, North Carolina 27214
Contact: Mr. Bill Wright
Phone: (336) 375-1989
Fax: (336) 375-1801
Supplemental Vegetation and Structure Repair Contractor
Seal Brothers
P.O. Box 86
Dobson, North Carolina 27017
Contact: Mr. Brian Seal
Phone: (336) 710-3560
Monitoring Performers
MY-01
KCI Associates of NC
4602 Six Forks Rd., Suite 220
Raleigh, NC 27609
Contact: Mr. Adam Spiller
Phone: (919) 783-9214
Fax: (919) 783-9266

Table 5. Project Background Table	
Project Number and Name: 205 – Kentwood Park (Bushy Branch)	
Project County	Wake County
Drainage Area	1.27 sq. mi. (Bushy Branch)
	0.06 sq. mi. (UT to Bushy Branch)
Drainage Impervious Cover Estimate (%)	N/A (Bushy Branch)
	N/A (UT to Bushy Branch)
Stream Order	Second Order (Bushy Branch)
	First Order (UT to Bushy Branch)
Physiographic Region	Raleigh Belt
Ecoregion	Piedmont
Rosgen Classification of As-built	C-E 4/2
Dominant Soil Types	Wehadkee and Bibb Soils (Bushy Branch)
	Wehadkee and Bibb Soils (UT to Bushy Branch)
Reference Site ID	UT to Lake Wheeler
	UT to Mine Creek
USGS HUC for Project and Reference	03020201090010 (Bushy Branch)
	03020201110010 (UT to Lake Wheeler)
	03020201080020 (UT to Mine Creek)
NCDWQ Sub-basin for Project and Reference	03-04-02 (Bushy Branch)
	03-04-02 (UT to Lake Wheeler)
	03-04-02 (UT to Mine Creek)
NCDWQ Classification for Project and Reference	C - NSW (Bushy Branch)
	N/A (UT to Lake Wheeler)
	N/A (UT to Mine Creek)
Any portion of the project segment 303d listed?	No - not rated
Any portion of the project segment upstream of a 303d listed segment?	N/A
Reasons for 303d Listing or Stressor	N/A
% of Project Easement Fenced	0%



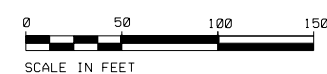
MONITORING FEATURE COORDINATES

(ASSUMED COORDINATE SYSTEM)

		NORTHING	EASTING
CROSS SECTION #1	LB	4926.58	4867.78
	RB	4900.81	4895.77
CROSS SECTION #2	LB	5000.00	5000.00
	RB	4968.67	5000.00
CROSS SECTION #3	LB	4823.34	5275.32
	RB	4730.05	5226.37
CROSS SECTION #4	LB	4638.91	5430.32
	RB	4603.30	5385.38
VEGETATION PLOT #1		4934.50	4873.00
		4954.20	4896.28
		4932.65	4921.47
		4909.86	4898.56
VEGETATION PLOT #2		4853.57	5200.12
		4830.40	5222.44
		4808.07	5199.27
		4831.25	5176.94
VEGETATION PLOT #3		4650.23	5312.82
		4639.72	5343.80
		4608.49	5334.53
		4618.94	5302.79

LEGEND

AS-BUILT STRUCTURE	
AS-BUILT ROOT WAD	
RIP RAP	
CROSS SECTION	
VEGETATION PLOT	
PHOTO LOCATION	
AS-BUILT THALWEG	
AS-BUILT TOP OF BANK	
AS-BUILT CHANNEL BOUNDARY	



SYMBOL	DESCRIPTION	DATE	APPROVED



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

**KENTWOOD PARK (BUSHY BRANCH)
MONITORING PLAN VIEW
WAKE COUNTY
EEP PROJECT NUMBER 205 - MY01**

DATE: 12-29-2005
SCALE: SEE SHEET

**MONITORING
PLAN VIEW**

2.0 PROJECT CONDITIONS AND MONITORING RESULTS

2.1 Vegetation Assessment

2.1.1 Soil Data

Table 6. Preliminary Soil Data					
Project Number and Name: 205 – Kentwood Park (Bushy Branch)					
Series	Max Depth (in.)	% Clay on Surface	K	T	% OM
Wehadkee and Bibb (Wo)	36	5-20			2.0-5.0

2.1.2 Vegetative Problem Areas

Table 7a. Vegetative Problem Areas			
Project Number and Name: 205 – Kentwood Park (Bushy Branch)			
Segment/Reach: Bushy Branch (1,070 ft.)			
Feature/Issue	Station # / Range	Probable Cause	Photo #
Bare Terrace	10+50 - 11+10	Foot traffic from disc golf course	VP1
	11+50 - 12+00	Foot traffic from disc golf course	
Invasive/Exotic Population	10+00 - 10+50	English Ivy: encroachment from outside project	VP2
	16+00 - 16+75 and 19+25 - 19+75	Kudzu: unknown	VP3
	Heavy Throughout	Microstegium: previously established	VP4
	Scattered Throughout	Japanese honeysuckle: previously established	VP5
	Scattered Throughout	Chinese privet: previously established	VP6
	Scattered Throughout	Russian olive: previously established	VP7

Table 7b. Vegetative Problem Areas			
Project Number and Name: 205 – Kentwood Park (Bushy Branch)			
Segment/Reach: UT to Bushy Branch (350 ft.)			
Feature/Issue	Station # / Range	Probable Cause	Photo #
Bare Bank	00+50	Poor subsoil	VP8
Bare Terrace	03+25 - 03+50	Foot traffic from disc golf course	see VP1
Path worn across stream area	00+50	Disc golf players crossing stream	VP9
	02+60	Disc golf players crossing stream	
	03+10	Disc golf players crossing stream	
	03+20	Disc golf players crossing stream	

2.1.3 Vegetative Problem Area Plan View

See vegetative problem area plan view in Appendix A2.

2.1.4 Stem Counts

Table 8. Stem counts for each species arranged by plot						
Project Number and Name: 205 – Kentwood Park (Bushy Branch)						
Species	Plot			Initial Totals	Year 2 Totals	Survival %
	1	2	3			
Shrubs						
<i>Ilex verticillata</i>	3	7		16	10	63%
<i>Euonymus americana</i>	3			6	3	50%
<i>Lindera benzoin</i>	4			4	4	100%
<i>Sambucus canadensis</i>		3		7	3	43%
<i>Cornus amomum</i>		22	2	34	24	71%
<i>Alnus serrulata</i>		10	1	14	11	79%
Trees						
<i>Quercus michauxii</i>	8		14	23	22	96%
<i>Quercus phellos</i>			5	4	5	125%
<i>Quercus alba</i>			2	2	2	100%
<i>Fraxinus pennsylvanica</i>	11			10	11	110%
<i>Nyssa sylvatica</i>	13			13	13	100%
<i>Oxydendrum arboreum</i>	4			8	4	50%
<i>Betula nigra</i>	6	10		18	16	89%
<i>Cornus florida</i>	1			1	1	100%
<i>Platanus occidentalis</i>		4		8	4	50%
<i>Liriodendron tulipifera</i>			4	6	4	67%
<i>Acer negundo</i>			4	4	4	100%
<i>Ulmus americana</i>			2	2	2	100%
<i>Hamamelis virginiana</i>	1			3	1	33%

Explanation of Probable Causes of Vegetation Mortality

- The majority of the *Ilex verticillata*, *Sambucus canadensis*, *Cornus amomum*, *Platanus occidentalis*, and *Alnus serrulata* mortality can be attributed to the low survival rate of these species in vegetation plot 2. Since much of plot 2 is located on a bankfull bench; subject to frequent storm discharges, this part of the plot is subjected to large flows, which may cause some of the plantings to become uprooted and flow downstream.
- The surviving *Euonymus americana* in plot 1 appeared to be heavily affected by browse and retained very few leaves. For this reason browsing pressure is believed to be the cause of the *Euonymus americana* mortality.
- The high mortality of *Oxydendrum arboreum* and *Hamamelis virginiana* in plot 1 may have been due to dry growing conditions. Since plot 1 is located on an intermittent stream reach, the reach is frequently dry during the growing season.
- In plot 3, there were two *Liriodendron tulipifera* trees that were standing dead with no obvious causes of the mortality. In this case it is assumed that these trees did not survive the planting process.
- There is over 100% survival for *Quercus phellos* in plot 3. This is due to a miscount during the as-built stem count.

2.1.5 Vegetation Plot Photos

See vegetation plot photos in Appendix A4.

2.2 Stream Assessment

2.2.1 Stream Problem Areas Plan View

See stream problem area plan view in Appendix B1.

2.2.2 Stream Problem Areas Table

Table 9a. Stream Problem Areas			
Project Number and Name: 205 – Kentwood Park (Bushy Branch)			
Segment/Reach: Bushy Branch (1,070 ft.)			
Feature Issue	Station numbers	Suspected Cause	Photo #
Aggradation/Bar Formation	16+60 - 16+70	unknown	SP1
Degradation	13+90 - 14+60	unknown	N/A
	17+90 - 18+60	unknown	
Bank Scour	10+50-11+17	unknown	SP2
	11+30-11+50	unknown	
	11+60-12+40	unknown	
	12+75-13+00	scour from misdirected cross vane	
	15+50-15+65	unknown	
	16+80-17+25	unknown	
	17+35-17+55	unknown	
Engineered Structures - back or arm scour	12+60	poorly backfilled vane arm	SP3
	13+10	poorly backfilled vane arm	
	16+00	unknown	
	18+00	unknown	
	18+30	unknown	
	19+40	poorly backfilled vane arm	

Table 9b. Stream Problem Areas			
Project Number and Name: 205 – Kentwood Park (Bushy Branch)			
Segment/Reach: UT to Bushy Branch (350 ft.)			
Feature Issue	Station numbers	Suspected Cause	Photo #
Aggradation/Bar Formation	01+80 - 02+10	herbaceous vegetation accumulating soil	SP4
Bank Scour	03+30 - 03+45	geogrid breakdown on unstable, steep bank	SP5
Engineered Structures - scour in front of cross vane	02+25	unstable fill on upstream side	SP6

2.2.3 Stream Issue Photos

Example issue photos can be found in Appendix B2

2.2.4 Fixed Station Photos

Stream photos from established photo stations in Appendix B3

2.2.5 Stream Assessment Tables

Table 10a. Categorical Stream Feature Visual Stability Assessment						
Project Number and Name: 205 – Kentwood Park (Bushy Branch)						
Segment/Reach: Bushy Branch (1,070 ft.)						
Feature	Initial	MY - 01	MY - 02	MY - 03	MY - 04	MY - 05
A. Riffles	100%	98%				
B. Pools	100%	92%				
C. Thalweg	100%	75%				
D. Meanders	100%	75%				
E. Bed General	100%	93%				
F. Channel General	100%	100%				
G. Banks	100%	78%				
H. Vanes / J Hooks etc.	100%	83%				
I. Wads and Boulders	100%	80%				

Table 10b. Categorical Stream Feature Visual Stability Assessment						
Project Number and Name: 205 – Kentwood Park (Bushy Branch)						
Segment/Reach: UT Bushy Branch (350 ft.)						
Feature	Initial	MY - 01	MY - 02	MY - 03	MY - 04	MY - 05
A. Riffles	100%	92%				
B. Pools	100%	90%				
C. Thalweg	100%	100%				
D. Bed General	100%	80%				
E. Channel General	100%	100%				
F. Banks	100%	95%				
G. Vanes / J Hooks etc.	100%	90%				

2.2.6 Quantitative Measures Summary Tables

Table 11a. Baseline Morphology and Hydraulic Summary																		
Project Number and Name: 205 – Kentwood Park (Bushy Branch)																		
Segment Reach: Bushy Branch (1,070 ft.)																		
Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built*		
	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Bankfull Width (ft)			36				25	36	31	11	12.5	11.5			24			18
Floodprone Width (ft)			100				67	135	107	70	137	97	52	>100				43
Bankfull Cross Sectional Area (ft ²)			135.8				51.5	69.8	63	11.2	12.8	12.2			40			22.2
Bankfull Mean Depth (ft)			3.8				1.8	2.1	2	0.9	1.2	1.1			1.7			1.2
Bankfull Maximum Depth (ft)			5.5				2.8	3.1	2.9	1.4	1.8	1.6	2.2	2.7	2.4			1.8
Width/Depth Ratio							12	20	16	9	14	11			14			14.6
Entrenchment Ratio			2.2				1.9	4.8	3.6	6.4	12.5		2.2	>6				2.4
Wetted Perimeter (ft)																		19.8
Hydraulic Radius (ft)																		1.1
Pattern																		
Channel Beltwidth (ft)							40	95	77	50	110	69	103	230	144			
Radius of Curvature (ft)							32	204	138	7	66	25	15	137	53			
Meander Wavelength (ft)							180	380	269	45	120	74	94	250	156			
Meander Width Ratio							5.8	12.2	8.7	3.9	10.4	6.5	3.9	10.4	6.5			
Profile																		
Riffle Length (ft)																		
Riffle Slope (ft/ft)							0.001	0.028	0.016	0.0125	0.0419	0.028	0.0168	0.056	0.0368			
Pool Length (ft)							16	60.1	34.3	11	112	30	24	233	62			
Pool Spacing (ft)							46.9	140.8	111	22	148	57	46	310	120			
Substrate																		
d50 (mm)									12			4			12			6
d84 (mm)									45			17			45			44
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)																		
Sinuosity								1.16			1.57			1.3				
Water Surface Slope (ft/ft)																		
BF Slope (ft/ft)								0.009			0.006			0.008				
Rosgen Classification			E					C-E4/1			C-E4/1			C-E4/2				C-E4/2

*As-built data is from a single cross section survey.

Table 11b. Baseline Morphology and Hydraulic Summary
Project Number and Name: 205 – Kentwood Park (Bushy Branch)
Segment Reach: UT to Bushy Branch (350 ft.)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built*		
	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Bankfull Width (ft)			36				6	6.3	6.2	10.1	10.5	10.4			8			6.5
Floodprone Width (ft)			100				8	8.5	8.25	12.3	23	16.3	12	18				16
Bankfull Cross Sectional Area (ft ²)			135.8				7.3	8	7.7	8.9	10.9	10.1			5			2.9
Bankfull Mean Depth (ft)			3.8				1.2	1.3	1.25	0.8	1.1	1			0.6			0.4
Bankfull Maximum Depth (ft)			5.5				1.6	1.8	1.7	1.5	1.7	1.6	0.9	1	1			0.8
Width/Depth Ratio									5	9	12	10.3			12			14.5
Entrenchment Ratio			2.2				1.3	1.4	1.35	1.2	2.2	1.6	1.5	2.2				2.5
Wetted Perimeter (ft)																		6.9
Hydraulic Radius (ft)																		0.4
Pattern																		
Channel Beltwidth (ft)							58	105	82	19	49	34	14	38	26			
Radius of Curvature (ft)							42	94	75	12	23.4	15.8	10	18	14			
Meander Wavelength (ft)									490			127			98			
Meander Width Ratio									79			12.2			12.2			
Profile																		
Riffle Length (ft)																		
Riffle Slope (ft/ft)										0.01	0.055	0.032	0.012	0.06	0.034			
Pool Length (ft)										3	14	6.7	2.4	10.4	6.4			
Pool Spacing (ft)										27	43	32	21	33	25			
Substrate																		
d50 (mm)									12			11			12			6.3
d84 (mm)									29			176			29			59
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)																		
Sinuosity								1.14			1.2			1.14				
Water Surface Slope (ft/ft)																		
BF Slope (ft/ft)								0.033			0.022			0.024				
Rosgen Classification			E					G4			B4/1			B4/2				B4/2

*As-built data is from a single cross section survey.

Table 12a. Morphology and Hydraulic Monitoring Summary												
Project Number and Name: 205 – Kentwood Park (Bushy Branch)												
Segment Reach: Bushy Branch (1,070 ft.)												
Parameter	Cross Section 3 Riffle						Cross Section 4 Pool					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	20.3						23.3					
Floodprone Width (ft)	36						44					
Bankfull Cross Sectional Area (ft ²)	34.6						50.8					
Bankfull Mean Depth (ft)	1.7						2.2					
Bankfull Maximum Depth (ft)	2.3						3.2					
Width/Depth Ratio	11.9						10.6					
Entrenchment Ratio	1.8						1.9					
Wetted Perimeter (ft)	21.8						25.4					
Hydraulic Radius (ft)	1.6						2					
Substrate												
d50 (mm)	15.3						17.9					
d84 (mm)	38						59					

Table 12b. Morphology and Hydraulic Monitoring Summary												
Project Number and Name: 205 – Kentwood Park (Bushy Branch)												
Segment Reach: UT to Bushy Branch (350 ft.)												
Parameter	Cross Section 1 Pool						Cross Section 2 Riffle					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	8.9						7.9					
Floodprone Width (ft)	20						13.5					
Bankfull Cross Sectional Area (ft ²)	10.8						4.1					
Bankfull Mean Depth (ft)	1.2						0.5					
Bankfull Maximum Depth (ft)	1.8						0.9					
Width/Depth Ratio	7.4						15.2					
Entrenchment Ratio	2.2						1.7					
Wetted Perimeter (ft)	10.1						8.2					
Hydraulic Radius (ft)	1.1						0.5					
Substrate												
d50 (mm)	30.3						29.8					
d84 (mm)	82						56					

Table 12c. Morphology and Hydraulic Monitoring Summary continued

Project Number and Name: 205 - Kentwood Park (Bushy Branch)

Segment Reach: Bushy Branch (1,070 ft.)

Parameter	MY - 01 (2005)			MY - 02 (2006)			MY - 03 (2007)			MY - 04 (2008)			MY - 05 (2009)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern															
Channel Beltwidth (ft)	26	83	34												
Radius of Curvature (ft)	60	100	90												
Meander Wavelength (ft)	138	219	194												
Meander Width Ratio	1.6	5.3	2.2												
Profile															
Riffle Length (ft)	9	35	16												
Riffle Slope (ft/ft)	0.008	0.049	0.025												
Pool Length (ft)	13	96	32												
Pool Spacing (ft)	5	103	35												
Additional Reach Parameters															
Valley Length (ft)		845													
Channel Length (ft)		1,070													
Sinuosity		1.27													
Water Surface Slope (ft/ft)		0.008													
Number of Bankfull Events		0													
Rosgen Classification		C4													

Table 12d. Morphology and Hydraulic Monitoring Summary continued

Project Number and Name: 205 - Kentwood Park (Bushy Branch)

Segment Reach: UT to Bushy Branch (350 ft.)

Parameter	MY - 01 (2005)			MY - 02 (2006)			MY - 03 (2007)			MY - 04 (2008)			MY - 05 (2009)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern															
Channel Beltwidth (ft)			N/A												
Radius of Curvature (ft)			N/A												
Meander Wavelength (ft)			N/A												
Meander Width Ratio			N/A												
Profile															
Riffle Length (ft)	10	38	15												
Riffle Slope (ft/ft)															
Pool Length (ft)	6	46	10												
Pool Spacing (ft)	13	62	45												
Additional Reach Parameters															
Valley Length (ft)		318													
Channel Length (ft)		350													
Sinuosity		1.10													
Water Surface Slope (ft/ft)															
Number of Bankfull Events		0													
Rosgen Classification		B4													

Appendix A

Vegetation Raw Data

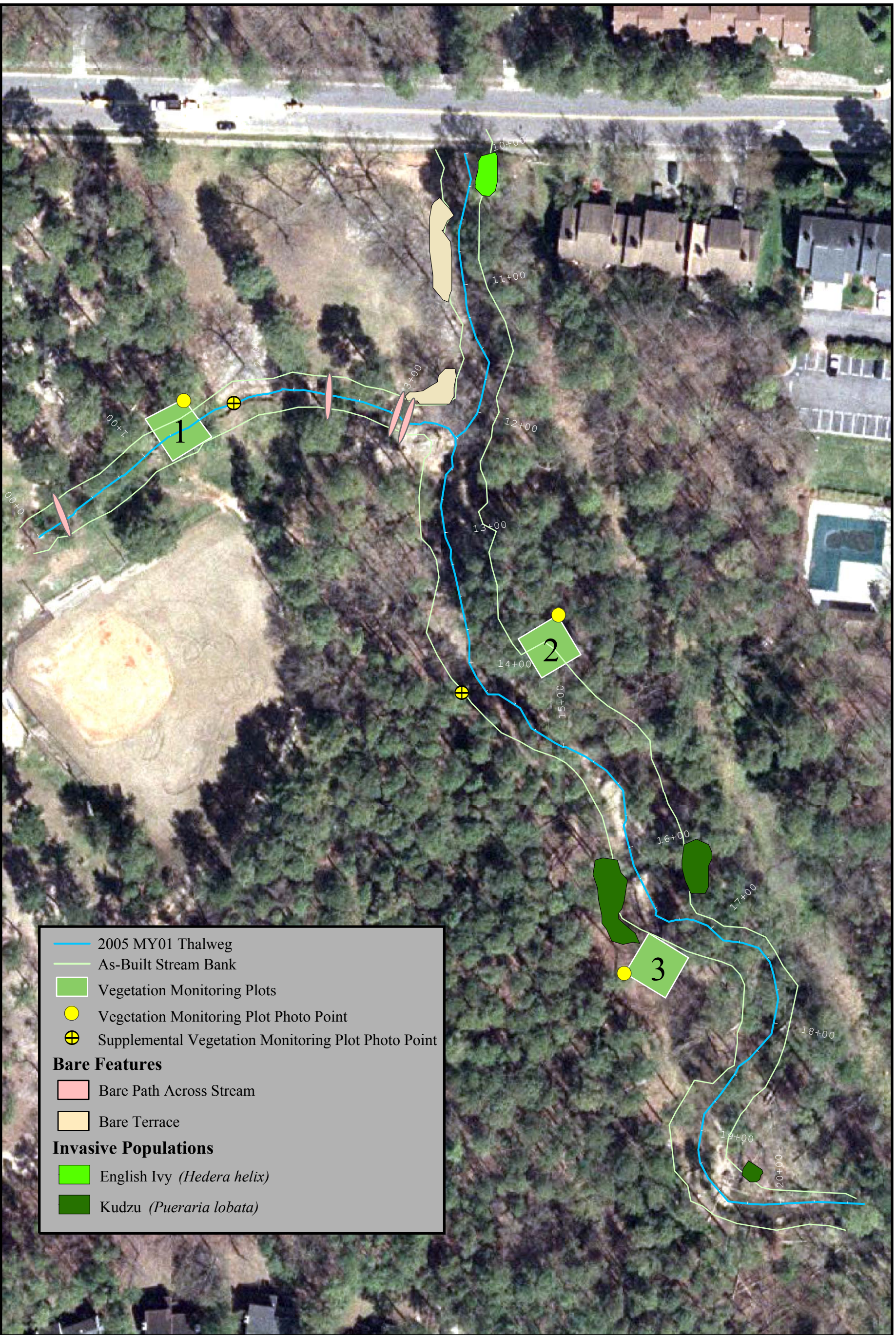
App A1 - Vegetation Data Sheet

Kentwood Park (Bushy Branch) Stream Restoration

Date : 7/20/05

Crew : A. Spiller

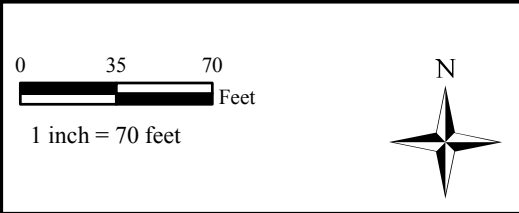
Plot #	Winterberry <i>Ilex verticillata</i>	Swamp Chestnut Oak <i>Quercus michauxii</i>	Green Ash <i>Fraxinus pennsylvanica</i>	Black Gum <i>Nyssa sylvatica</i>	Witch Hazel <i>Hamelis virginiana</i>	Sourwood <i>Oxydendrum arboreum</i>	Hearts-a-busting <i>Euonymus americana</i>	Spice Bush <i>Lindera benzoin</i>	River Birch <i>Betula nigra</i>	Flowering Dogwood <i>Cornus florida</i>	Elderberry <i>Sambucus canadensis</i>	Silky Dogwood <i>Cornus amomum</i>	Sycamore <i>Platanus occidentalis</i>	Tag Alder <i>Alnus serrulata</i>	Willow Oak <i>Quercus phellos</i>	Tulip Poplar <i>Liriodendron tulipifera</i>	White Oak <i>Quercus alba</i>	Box Elder <i>Acer negundo</i>	American Elm <i>Ulmus americana</i>	Total (Year 1)	Density (Trees/Acre)
1	3	8	11	13	1	4	3	4	6	1										54	2,186
2	7								10		3	22	4	10						56	2,267
3		14										2		1	5	4	2	4	2	34	1,377
Average Density																				1,943	



	2005 MY01 Thalweg
	As-Built Stream Bank
	Vegetation Monitoring Plots
	Vegetation Monitoring Plot Photo Point
	Supplemental Vegetation Monitoring Plot Photo Point
Bare Features	
	Bare Path Across Stream
	Bare Terrace
Invasive Populations	
	English Ivy (<i>Hedera helix</i>)
	Kudzu (<i>Pueraria lobata</i>)



Appendix A2: Vegetative Problem Area Plan View
 Kentwood Park, Wake County, EEP Project Number 205 - MY01



Date: 12-29-05
 Note: Area of invasive populations and bare terraces estimated from visual field inspections. Stream banks adjusted to accommodate discrepancies between as-built and monitoring year 01 surveys.
 Source: USGS High Resolution Orthoimage, Raleigh-Durham, NC, 2003.



App A3 – Representative Vegetation Problem Area Photos



VP1 – Bare terrace occurs near the confluence of Bushy Branch and the UT. Photo taken near station 12+00. 10/27/05 - MY 01



VP2 – English ivy (*Hedera helix*) on stream bank. Photo taken near station 10+25. 10/27/05 - MY 01



VP3 – Kudzu (*Pueraria lobata*) on tree along stream bank. Photo taken near station 16+25. 10/27/05 - MY 01



VP4 – Microstegium (*Microstegium vimineum*) covering stream bank. Photo taken near station 10+75. 10/27/05 - MY 01



VP5 – Japanese honeysuckle (*Lonicera japonica*) covering stream bank. Photo taken near station 19+60. 10/27/05 - MY 01



VP6 – Chinese privet (*Ligustrum sinense*) on stream bank. Photo taken near station 15+40. 10/27/05 - MY 01



VP7 – Russian olive (*Elaeagnus angustifolia*) on stream bank. Photo taken near station 17+75. 10/27/05 - MY 01



VP8 – Breakdown of geogrid stabilization, with bare subsoil exposed on stream bank. Photo taken near station 00+30. 10/27/05 - MY 01



VP9 – Path worn into stream bank from people access and crossing the stream. Photo taken near station 02+60.
10/27/05 - MY 01

App A4 - Vegetation Monitoring Plot Photos



Plot 1 Photo – Taken looking south from the north corner. 7/20/05 - MY 01.



Plot 1 Supplemental Photo – Taken looking upstream towards the center of the plot from established photo station #3. 10/27/05 - MY 01.



Plot 2 Photo – Taken looking south from the north corner. 7/20/05 - MY 01.



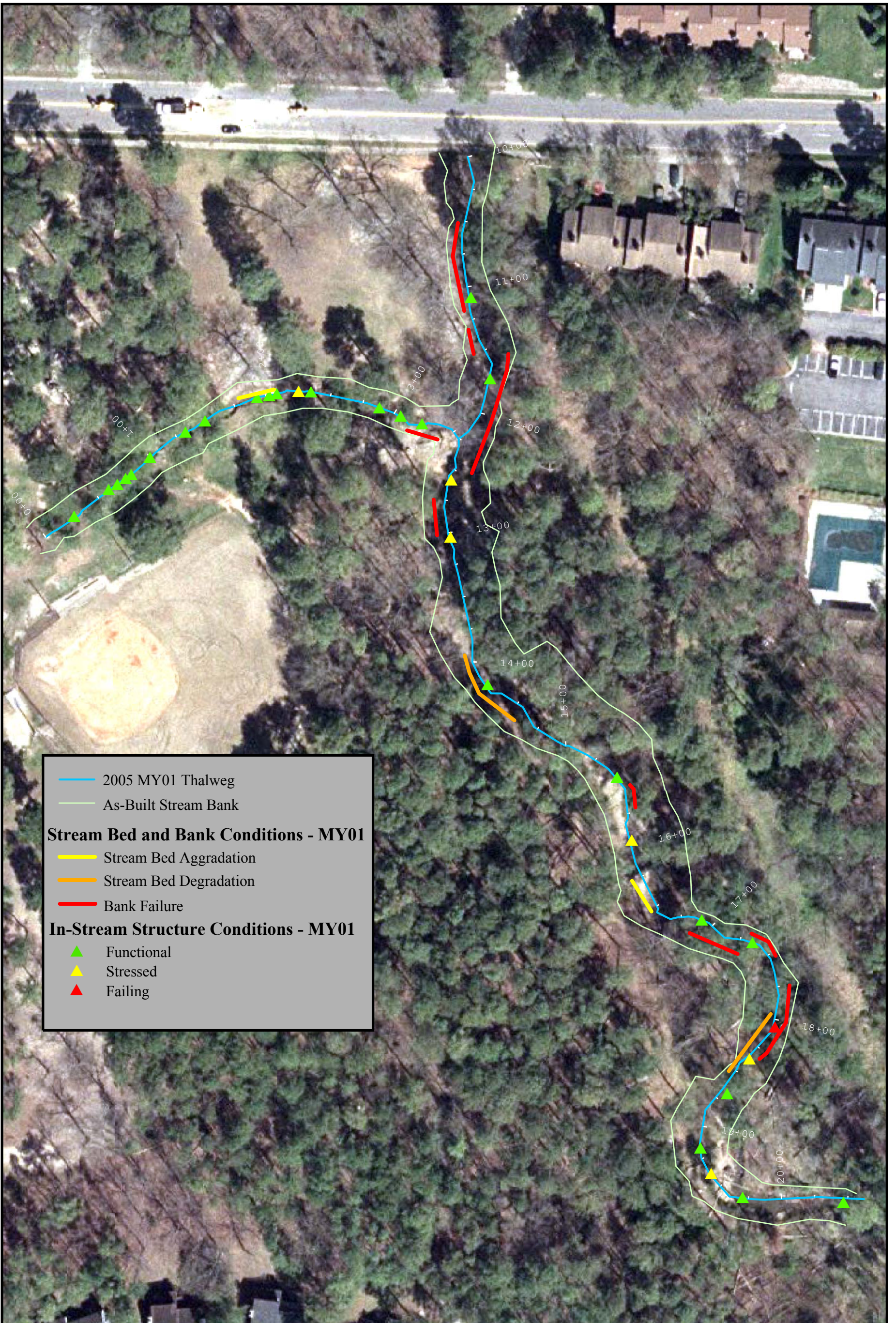
Plot 2 Supplemental Photo – Taken looking at center of plot from the top of the right bank across the stream from the veg plot. 10/27/05 - MY 01.



Plot 3 Photo – Taken looking east from the west corner. 7/20/05 - MY 01.

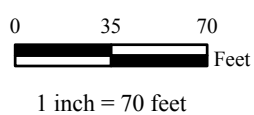
Appendix B

Geomorphologic Raw Data



	2005 MY01 Thalweg
	As-Built Stream Bank
Stream Bed and Bank Conditions - MY01	
	Stream Bed Aggradation
	Stream Bed Degradation
	Bank Failure
In-Stream Structure Conditions - MY01	
	Functional
	Stressed
	Failing

Appendix B1: Stream Problem Area Plan View
 Kentwood Park, Wake County, EEP Project Number 205 - MY01



Date: 12-29-05
 Note: Length of bank and aggradation problems approximated.
 Stream banks adjusted to accommodate discrepancies between
 as-built and monitoring year 01 surveys.
 Source: USGS High Resolution Orthoimage, Raleigh-Durham, NC, 2003.



App B2 – Representative Stream Problem Area Photos



SP1 – Mid-channel bar forming. Photo taken near station 16+70. 10/27/05 - MY 01



SP2 – Bank erosion. Photo taken near station 18+00. 10/27/05 - MY 01



SP3 – Back arm scour on right arm of cross vane. Photo taken near station 12+60. 10/27/05 - MY 01



SP4 – Bed aggradation and weedy growth in channel. Photo taken near station 02+00. 10/27/05 - MY 01



SP5 – Unstable, steep bank on UT to Bushy Creek, near confluence with Busy Creek. Photo taken near station 03+30. 10/27/05 - MY 01



SP6 – Hole degrading on upstream side of cross vane. Photo taken near station 02+25. 10/27/05 - MY 01

App B3 –Stream Photo-Station Photos



Photo Point 1 – Taken looking downstream from bridge on Kaplan Drive. 10/27/05 - MY 01



Photo Point 1, supplemental – Taken looking downstream from streambed in front of bridge on Kaplan Drive. 10/27/05 - MY 01



Photo Point 2 – Taken looking upstream. 10/27/05 - MY 01



Photo Point 3 – Taken looking upstream. 10/27/05 - MY 01



Photo Point 3 – Taken looking downstream. 10/27/05 - MY 01



Photo Point 4 – Taken looking upstream. 10/27/05 - MY 01



Photo Point 4 – Taken looking downstream. 10/27/05 - MY 01



Photo Point 5 – Taken looking upstream. 10/27/05 - MY 01



Photo Point 5 – Taken looking downstream. 10/27/05 - MY 01



Photo Point 6 – Taken looking upstream. 10/27/05 - MY 01

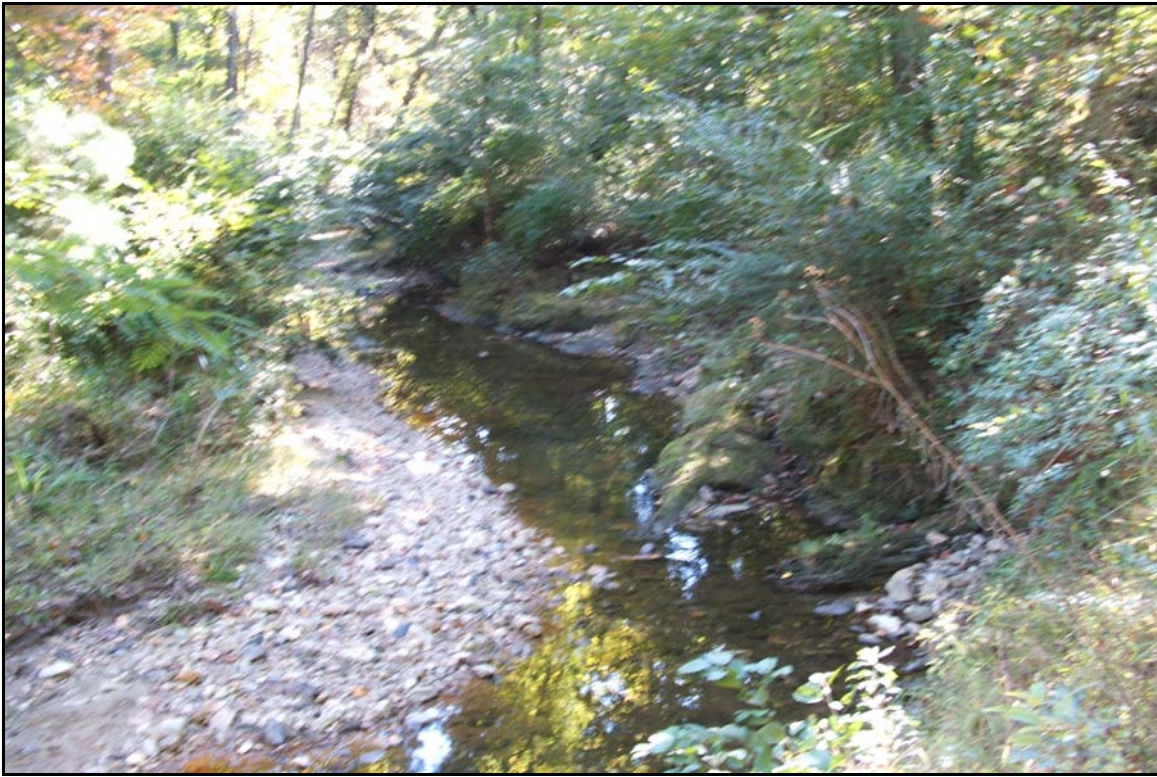


Photo Point 6 – Taken looking downstream. 10/27/05 - MY 01

App B4 –Qualitative Visual Stability Assessment

Table B1. Qualitative Visual Stability Assessment						
Project Number and Name: 205 – Kentwood Park (Bushy Branch)						
Segment/Reach: Bushy Branch (1,050 ft.)						
Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total Number per As-built *	Total Number / feet in unstable state	% Perform. in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	12	12	N/A	100	
	2. Armor stable (e.g. no displacement)?	12	12	N/A	100	
	3. Facet grade appears stable?	10	12	N/A	83	
	4. Stable interval grade?	12	12	N/A	100	
	5. Feature spacing appropriate?	12	12	N/A	100	
	6. Minimal evidence of embedding/fining?	12	12	N/A	100	
	7. Depth appears appropriate for current discharge?	12	12	N/A	100	
	8. Length appropriate?	12	12	N/A	100	98
B. Pools	1. Present? (e.g. no severe aggradation)	11	11	N/A	100	
	2. Sufficiently deep (Dmax pool:Mean Bkf > 1.6?)	11	11	N/A	100	
	3. Thalweg located outer bend?	9	11	N/A	82	
	4. Feature spacing appropriate?	10	11	N/A	91	
	5. Non-aggrading?	10	11	N/A	91	
	6. Length appropriate?	10	11	N/A	91	92
C. Thalweg	1. Upstream of meander bend centering?	6	8	N/A	75	
	2. Downstream of meander centering?	6	8	N/A	75	75
D. Meanders	1. Outer bend in state of limited/controlled erosion?	4	8	N/A	50	
	2. Of those eroding, # w/ concomitant point bar formation?	3	4	N/A	75	
	3. Apparent Rc within spec?	8	8	N/A	100	
	4. Sufficient floodplain access and relief?	6	8	N/A	75	75
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	1/10	99	
	2. Channel bed degradation - areas of increasing down cutting or head cutting?	N/A	N/A	2/140	87	93
F. Channel Capac / Dimen.	1. Channel width:depth appears out of design/type spec?	N/A	N/A	0/0	100	100
G. Banks	1. Apparent scour points from channel processes	N/A	N/A	6/270	13	
	2. Apparent cut points from overland flow	N/A	N/A	1/2	0	
	3. Apparent cut or scour from flood water re-entry to channel (e.g. inadequate floodplain access?)	N/A	N/A	0/0	0	
	4. Tension cracks	N/A	N/A	0/0	0	
	5. Unstable cantilever blocks (e.g. height/undercut/soil type versus vegetation penetration and extent)	N/A	N/A	0/0	0	
	6. Collapse/slumping	N/A	N/A	2/195	9	
	7. Ratio of bank height: bankfull height elevated	N/A	N/A	0/0	0	78
H. Vanes	1. Free of back or arm scour?	10	15	N/A	67	
	2. Height appropriate?	13	15	N/A	87	
	3. Angle and geometry appear appropriate?	13	15	N/A	87	
	4. Free of piping or other structural failures?	14	15	N/A	93	83
I. Wads / Boulders	1. Free of scour?	3	5	N/A	60	
	2. Footing stable?	5	5	N/A	100	80

* Total number of features per as-built estimated from as-built profile and planview sheets.

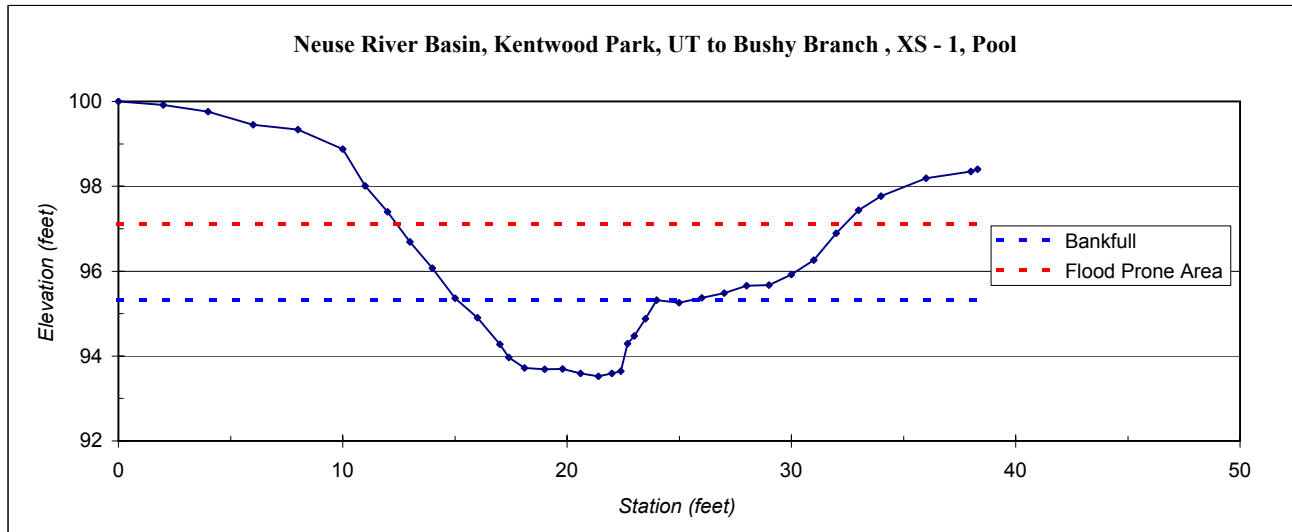
Appendix B-5 Cross Section Plots and Data Tables

River Basin:	Neuse
Watershed:	Kentwood Park, UT to Bushy Branch
XS ID	XS - 1, Pool
Drainage Area (sq mi):	
Date:	7/21/2005
Field Crew:	A. Spiller, K. Knight



Station	Rod Ht.	Elevation
0	5.74	100.00
2	5.82	99.92
4	5.98	99.76
6	6.29	99.45
8	6.4	99.34
10	6.86	98.88
11	7.73	98.01
12	8.34	97.40
13	9.05	96.69
14	9.67	96.07
15	10.38	95.36
16	10.84	94.90
17	11.46	94.28
17.4	11.77	93.97
18.1	12.02	93.72
19	12.05	93.69
19.8	12.04	93.70
20.6	12.15	93.59
21.4	12.22	93.52
22	12.15	93.59
22.4	12.1	93.64
22.7	11.45	94.29
23	11.27	94.47
23.5	10.86	94.88
24	10.42	95.32
25	10.48	95.26
26	10.37	95.37
27	10.26	95.48
28	10.08	95.66
29	10.07	95.67
30	9.82	95.92
31	9.48	96.26
32	8.85	96.89
33	8.3	97.44
34	7.97	97.77
36	7.55	98.19
38	7.39	98.35
38.3	7.34	98.40

SUMMARY DATA	
Bankfull Elevation:	95.3
Bankfull Cross-Sectional Area:	10.8
Bankfull Width:	8.9
Flood Prone Area Elevation:	97.1
Flood Prone Width:	20.0
Max Depth at Bankfull:	1.8
Mean Depth at Bankfull:	1.2
W / D Ratio:	7.3
Entrenchment Ratio:	2.2
Bank Height Ratio:	0.8

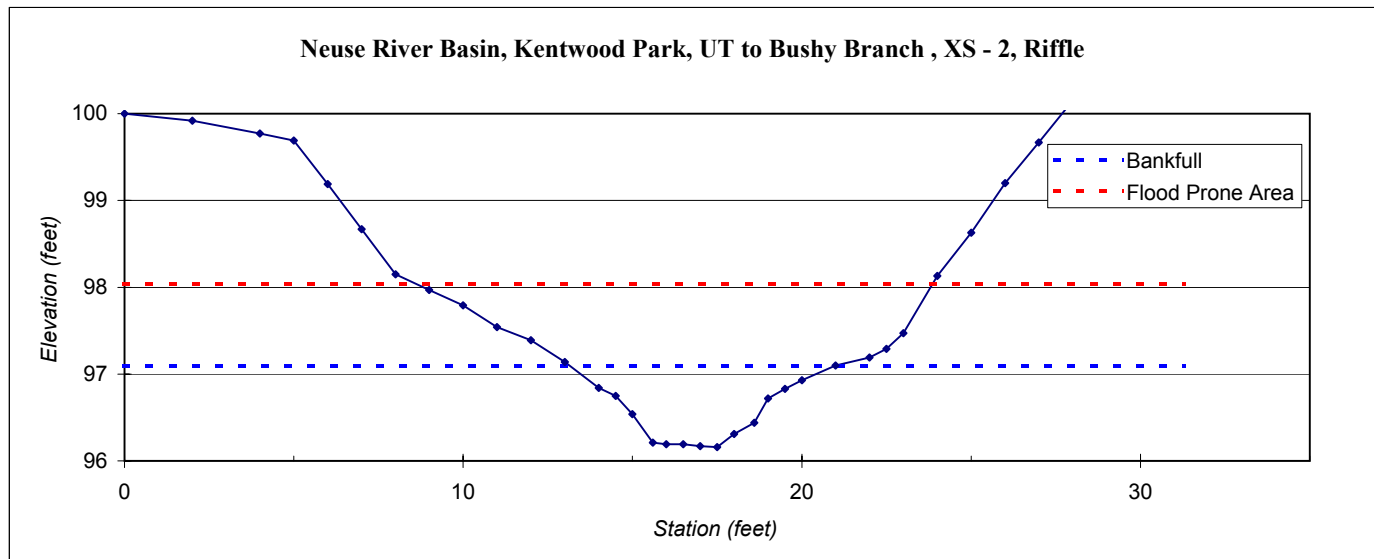


River Basin:	Neuse
Watershed:	Kentwood Park, UT to Bushy Branch
XS ID	XS - 2, Riffle
Drainage Area (sq mi):	
Date:	7/21/2005
Field Crew:	A. Spiller, K. Knight



Station	Rod Ht.	Elevation
0	5.64	100.00
2	5.72	99.92
4	5.87	99.77
5	5.95	99.69
6	6.45	99.19
7	6.97	98.67
8	7.49	98.15
9	7.67	97.97
10	7.85	97.79
11	8.1	97.54
12	8.25	97.39
13	8.5	97.14
14	8.8	96.84
14.5	8.89	96.75
15	9.1	96.54
15.6	9.43	96.21
16	9.45	96.19
16.5	9.45	96.19
17	9.47	96.17
17.5	9.48	96.16
18	9.33	96.31
18.6	9.2	96.44
19	8.92	96.72
19.5	8.81	96.83
20	8.71	96.93
21	8.54	97.10
22	8.45	97.19
22.5	8.35	97.29
23	8.17	97.47
24	7.51	98.13
25	7.01	98.63
26	6.44	99.20
27	5.97	99.67
28	5.49	100.15
30	5.23	100.41
31	5.2	100.44
31.3	5.13	100.51

SUMMARY DATA	
Bankfull Elevation:	97.1
Bankfull Cross-Sectional Area:	4.1
Bankfull Width:	7.9
Flood Prone Area Elevation:	98.0
Flood Prone Width:	13.5
Max Depth at Bankfull:	0.9
Mean Depth at Bankfull:	0.5
W / D Ratio:	15.2
Entrenchment Ratio:	1.7
Bank Height Ratio:	0.6

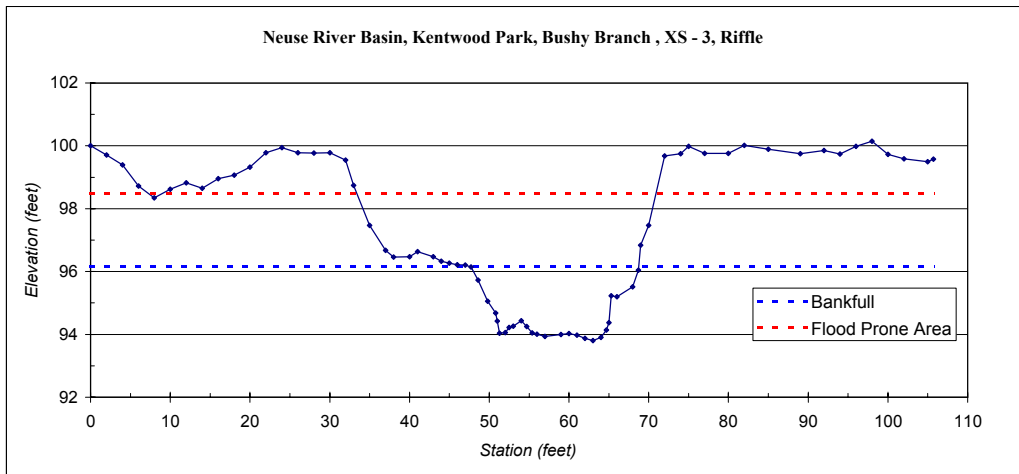


River Basin:	Neuse
Watershed:	Kentwood Park, Bushy Branch
XS ID	XS - 3, Riffle
Drainage Area (sq mi):	
Date:	7/21/2005
Field Crew:	A. Spiller, K. Knight



Station	Rod Ht.	Elevation
0	4.54	100.00
2	4.83	99.71
4	5.15	99.39
6	5.82	98.72
8	6.2	98.34
10	5.92	98.62
12	5.72	98.82
14	5.89	98.65
16	5.58	98.96
18	5.47	99.07
20	5.22	99.32
22	4.76	99.78
24	4.6	99.94
26	4.76	99.78
28	4.77	99.77
30	4.76	99.78
32	4.99	99.55
33	5.8	98.74
35	7.07	97.47
37	7.87	96.67
38	8.08	96.46
40	8.07	96.47
41	7.91	96.63
43	8.07	96.47
44	8.21	96.33
45	8.27	96.27
46	8.32	96.22
47	8.33	96.21
47.7	8.4	96.14
48.6	8.81	95.73
49.8	9.49	95.05
50.8	9.86	94.68
51	10.12	94.42
51.3	10.5	94.04
52	10.48	94.06
52.5	10.32	94.22
53	10.28	94.26
54	10.11	94.43
54.7	10.29	94.25
55.4	10.49	94.05
56	10.53	94.01
57	10.61	93.93
59	10.54	94.00
60	10.51	94.03
61	10.56	93.98
62	10.67	93.87
63	10.74	93.80
64	10.64	93.90
64.7	10.4	94.14
65	10.17	94.37
65.3	9.31	95.23
66	9.34	95.20
68	9.03	95.51
68.7	8.5	96.04
69	7.7	96.84
70	7.07	97.47
72	4.86	99.68
74	4.79	99.75
75	4.56	99.98
77	4.78	99.76
80	4.78	99.76
82	4.53	100.01
85	4.65	99.89
89	4.79	99.75
92	4.69	99.85
94	4.8	99.74
96	4.56	99.98
98	4.39	100.15
100	4.81	99.73
102	4.95	99.59
105	5.05	99.49
105.7	4.96	99.58

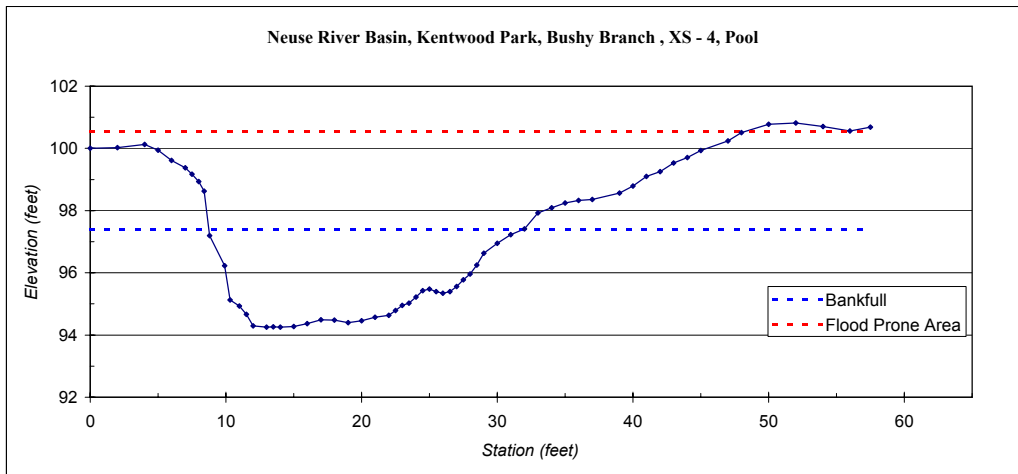
SUMMARY DATA	
Bankfull Elevation:	96.1
Bankfull Cross-Sectional Area:	34.6
Bankfull Width:	20.3
Flood Prone Area Elevation:	98.5
Flood Prone Width:	36.0
Max Depth at Bankfull:	2.3
Mean Depth at Bankfull:	1.7
W / D Ratio:	11.9
Entrenchment Ratio:	1.8
Bank Height Ratio:	67.2



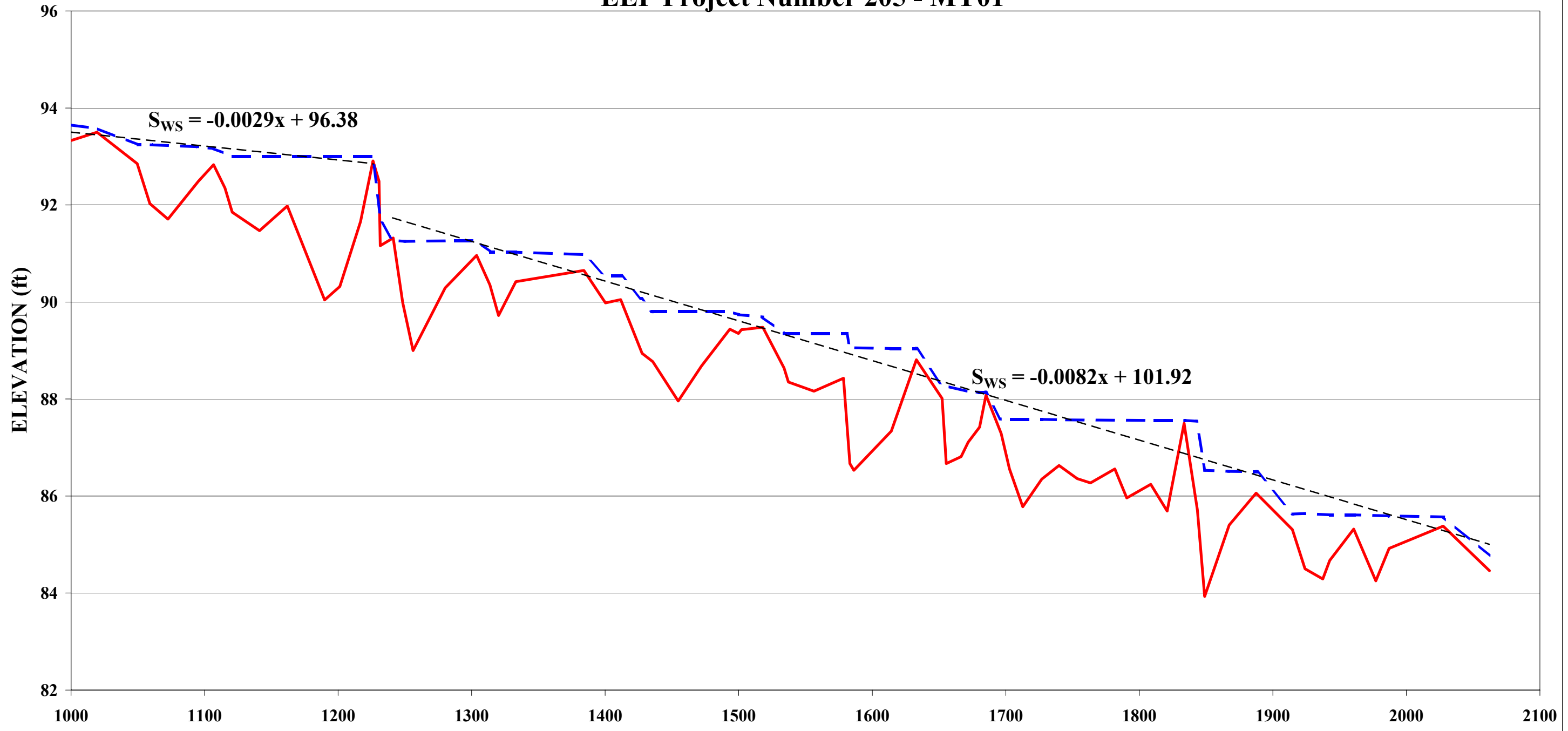
River Basin:	Neuse
Watershed:	Kentwood Park, Bushy Branch
XS ID	XS - 4, Pool
Drainage Area (sq mi):	
Date:	7/21/2005
Field Crew:	A. Spiller, K. Knight

Station	Rod Ht.	Elevation
0	4.7	100.00
2	4.68	100.02
4	4.57	100.13
5	4.76	99.94
6	5.09	99.61
7	5.32	99.38
7.5	5.53	99.17
8	5.77	98.93
8.4	6.07	98.63
8.8	7.5	97.20
9.9	8.47	96.23
10.3	9.57	95.13
11	9.77	94.93
11.5	10.04	94.66
12	10.41	94.29
13	10.45	94.25
13.5	10.44	94.26
14	10.45	94.25
15	10.43	94.27
16	10.33	94.37
17	10.21	94.49
18	10.22	94.48
19	10.3	94.40
20	10.24	94.46
21	10.13	94.57
22	10.07	94.63
22.5	9.91	94.79
23	9.75	94.95
23.5	9.68	95.02
24	9.48	95.22
24.5	9.27	95.43
25	9.22	95.48
25.5	9.31	95.39
26	9.36	95.34
26.5	9.3	95.40
27	9.14	95.56
27.5	8.92	95.78
28	8.74	95.96
28.5	8.45	96.25
29	8.07	96.63
30	7.75	96.95
31	7.47	97.23
32	7.29	97.41
33	6.77	97.93
34	6.61	98.09
35	6.45	98.25
36	6.37	98.33
37	6.34	98.36
39	6.14	98.56
40	5.91	98.79
41	5.6	99.10
42	5.45	99.25
43	5.17	99.53
44	4.99	99.71
45	4.77	99.93
47	4.46	100.24
48	4.19	100.51
50	3.92	100.78
52	3.88	100.82
54	4	100.70
56	4.14	100.56
57.5	4.02	100.68

SUMMARY DATA	
Bankfull Elevation:	97.4
Bankfull Cross-Sectional Area:	50.8
Bankfull Width:	23.3
Flood Prone Area Elevation:	100.6
Flood Prone Width:	44.0
Max Depth at Bankfull:	3.2
Mean Depth at Bankfull:	2.2
W / D Ratio:	10.7
Entrenchment Ratio:	1.9
Bank Height Ratio:	49.8

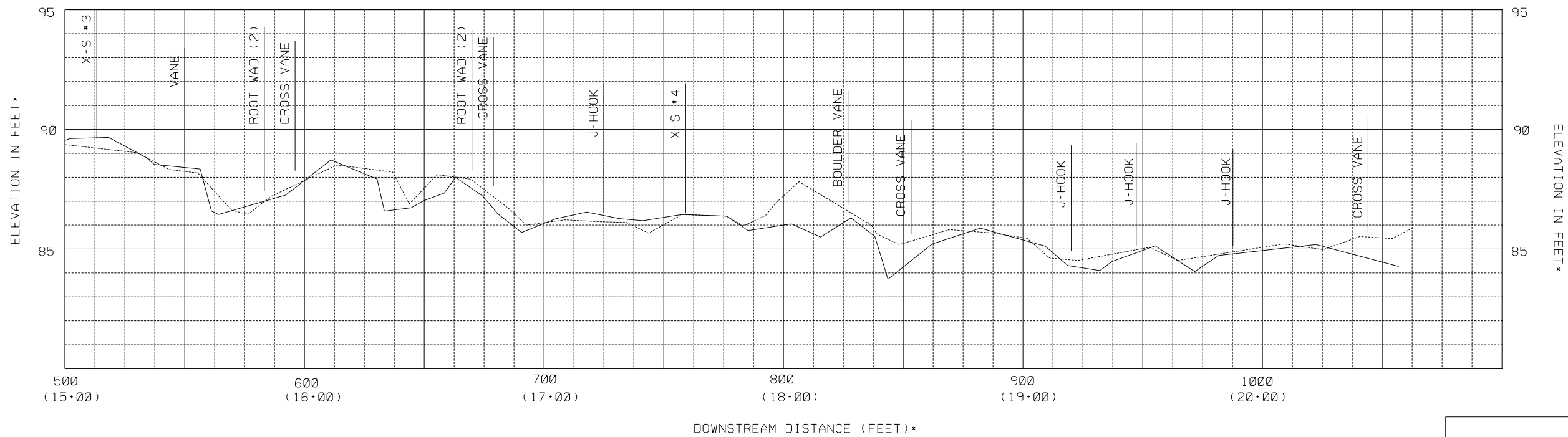
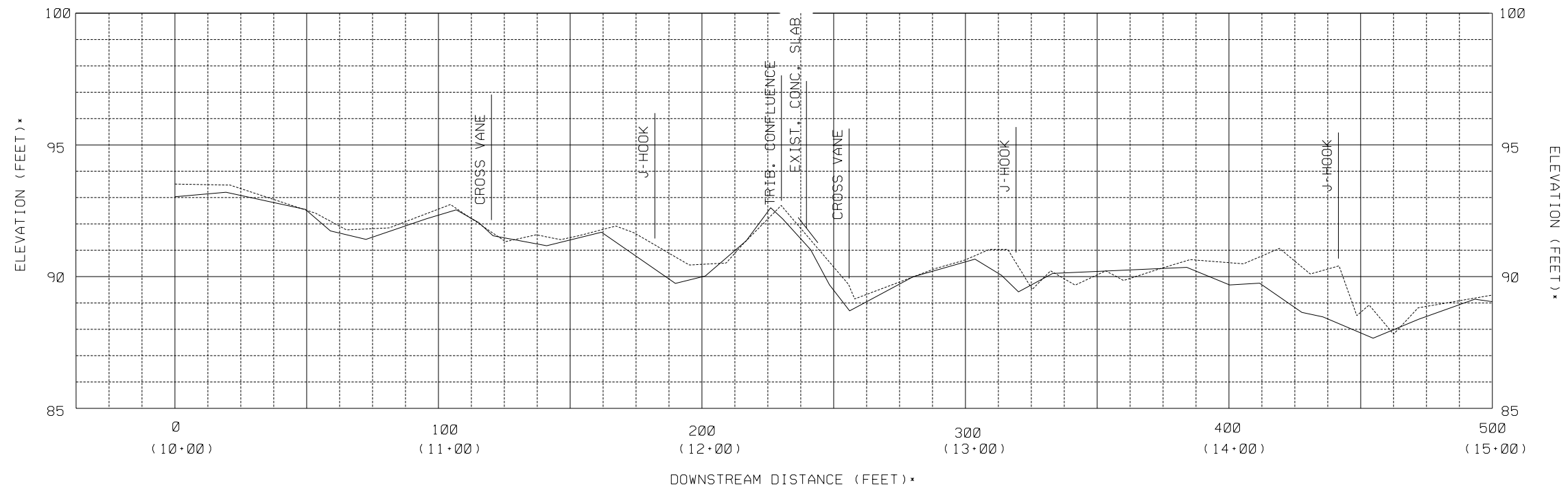


Appendix B6a - Longitudinal Profile for Bushy Branch
Kentwood Park, Wake County
EEP Project Number 205 - MY01



- 1st Year Monitoring
- - - WS
- - - Linear (WS Slope)

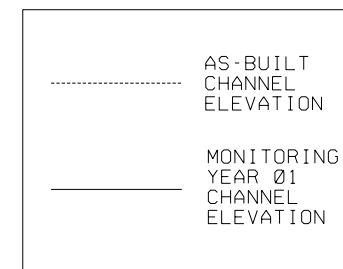
MAIN CHANNEL PROFILE



MAIN CHANNEL PROFILE

•NOTE:

MONITORING YEAR 01 PROFILE BASED ON CURRENT THALWEG LOCATION WHICH HAS MIGRATED IN SOME PLACES, DUE TO NATURAL STREAM PROCESSES, SINCE AS BUILT SURVEY IN 2004.



SYL.	DESCRIPTION	DATE	APPROVED



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

**KENTWOOD PARK (BUSHY BRANCH)
MONITORING PLAN VIEW
WAKE COUNTY
EEP PROJECT NUMBER 205 - MY01**

DATE: 12-29-2005
SCALE: SEE SHEET
BUSHY BRANCH PROFILE
SHEET 1 OF 1

**Table B2: Profile Points for Bushy Branch
Kentwood Park, Wake County
EEP Project number 205 - MY01**

TW Station	TW Elevation*	TW Station	TW Elevation*
1000.00	93.33	1614.23	87.34
1019.37	93.50	1633.09	88.81
1049.51	92.85	1652.37	88.01
1059.02	92.03	1655.41	86.67
1072.52	91.71	1666.58	86.81
1095.38	92.49	1671.91	87.11
1106.75	92.83	1680.37	87.42
1115.29	92.35	1685.17	88.08
1120.73	91.85	1696.59	87.29
1141.09	91.47	1702.78	86.56
1161.90	91.98	1712.73	85.78
1189.92	90.04	1726.99	86.35
1201.27	90.32	1739.83	86.63
1216.83	91.66	1753.45	86.36
1226.08	92.91	1763.40	86.27
1230.63	92.49	1781.62	86.56
1231.56	91.16	1790.58	85.96
1241.27	91.32	1808.63	86.24
1248.37	89.99	1820.85	85.69
1256.06	89.00	1833.53	87.50
1280.12	90.29	1843.49	85.71
1303.66	90.96	1848.96	83.93
1313.70	90.35	1867.36	85.40
1320.13	89.72	1887.50	86.06
1333.13	90.42	1914.60	85.31
1384.01	90.65	1924.04	84.50
1400.27	89.98	1937.45	84.29
1411.63	90.05	1942.54	84.67
1427.69	88.94	1960.55	85.32
1435.67	88.77	1977.06	84.25
1454.71	87.96	1987.08	84.92
1472.07	88.68	2027.62	85.38
1493.33	89.44	2062.27	84.46
1499.80	89.35		
1501.95	89.43		
1518.10	89.48		
1533.91	88.64		
1537.14	88.35		
1556.35	88.16		
1578.49	88.43		
1583.21	86.67		
1586.19	86.53		

*Elevations are based on an assumed elevation, XS #2 left bank pin is at an elevation of 100ft.

**Table B3: Water Surface Points for Bushy Branch
Kentwood Park, Wake County
EEP Project number 205 - MY01**

TW Station	TW Elevation*	TW Station	TW Elevation*
1000.00	93.65	1614.00	89.04
1020.00	93.57	1633.00	89.04
1050.00	93.24	1652.00	88.29
1060.00	93.24	1672.00	88.15
1095.00	93.20	1680.00	88.14
1107.00	93.16	1685.00	88.14
1121.00	93.00	1696.00	87.59
1226.00	93.00	1703.00	87.58
1232.00	91.65	1727.00	87.58
1241.00	91.27	1740.00	87.57
1250.00	91.25	1809.00	87.56
1280.00	91.26	1834.00	87.56
1304.00	91.26	1843.00	87.54
1314.00	91.03	1849.00	86.53
1333.00	91.03	1867.00	86.51
1384.00	90.98	1888.00	86.50
1400.00	90.54	1915.00	85.63
1412.00	90.54	1924.00	85.64
1427.00	90.07	1943.00	85.61
1435.00	89.80	1961.00	85.61
1472.00	89.80	1987.00	85.59
1493.00	89.80	2028.00	85.57
1500.00	89.74	2062.00	84.77
1518.00	89.69		
1534.00	89.35		
1581.00	89.35		
1583.00	89.06		

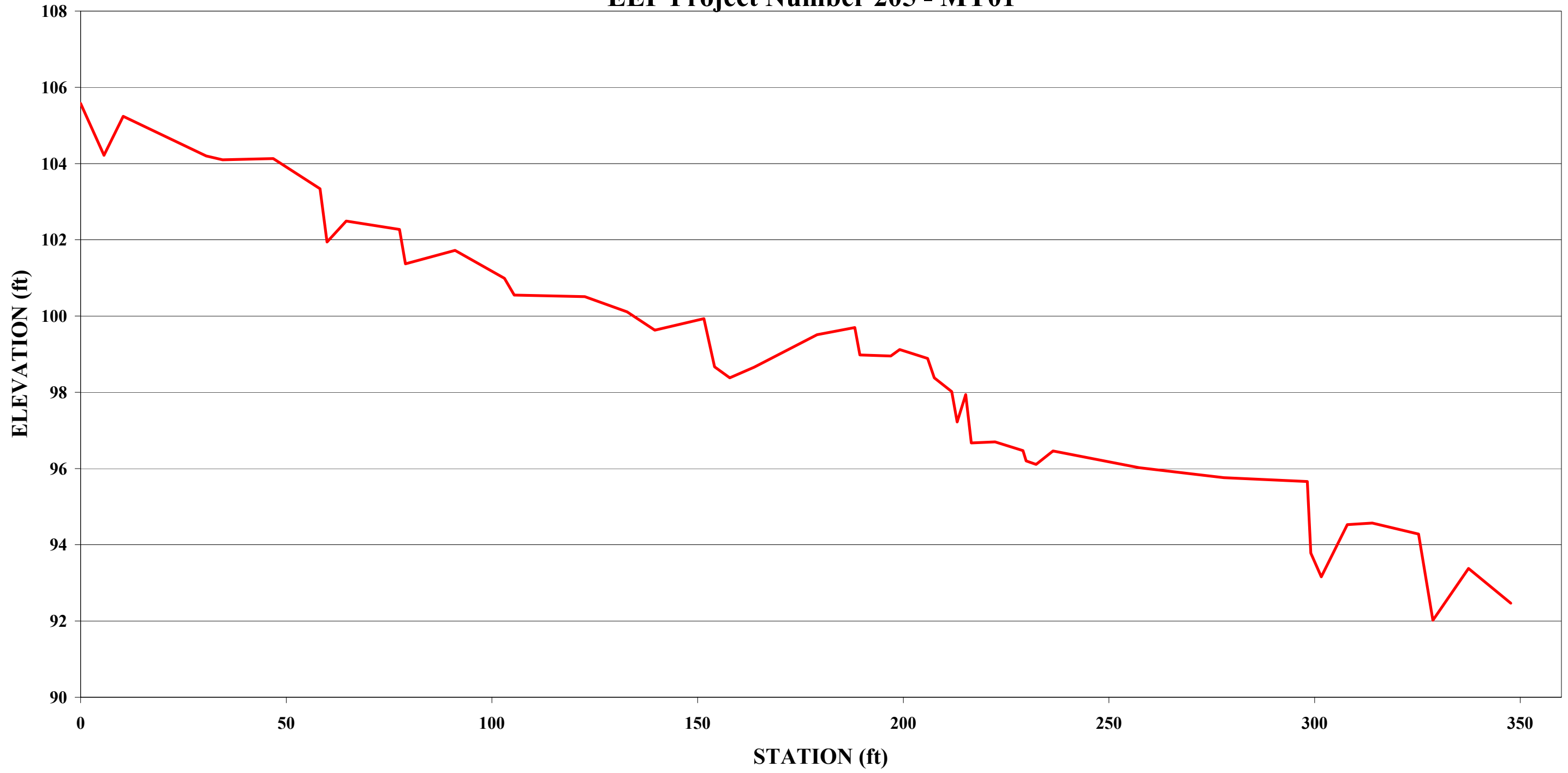
*Elevations are based on an assumed elevation, XS #2 left bank pin is at an elevation of 100ft.

**Table B4: Riffle and Pool Measurements for Bushy Branch
 Kentwood Park (Bushy Branch), Wake County
 EEP Project number 205 - MY01**

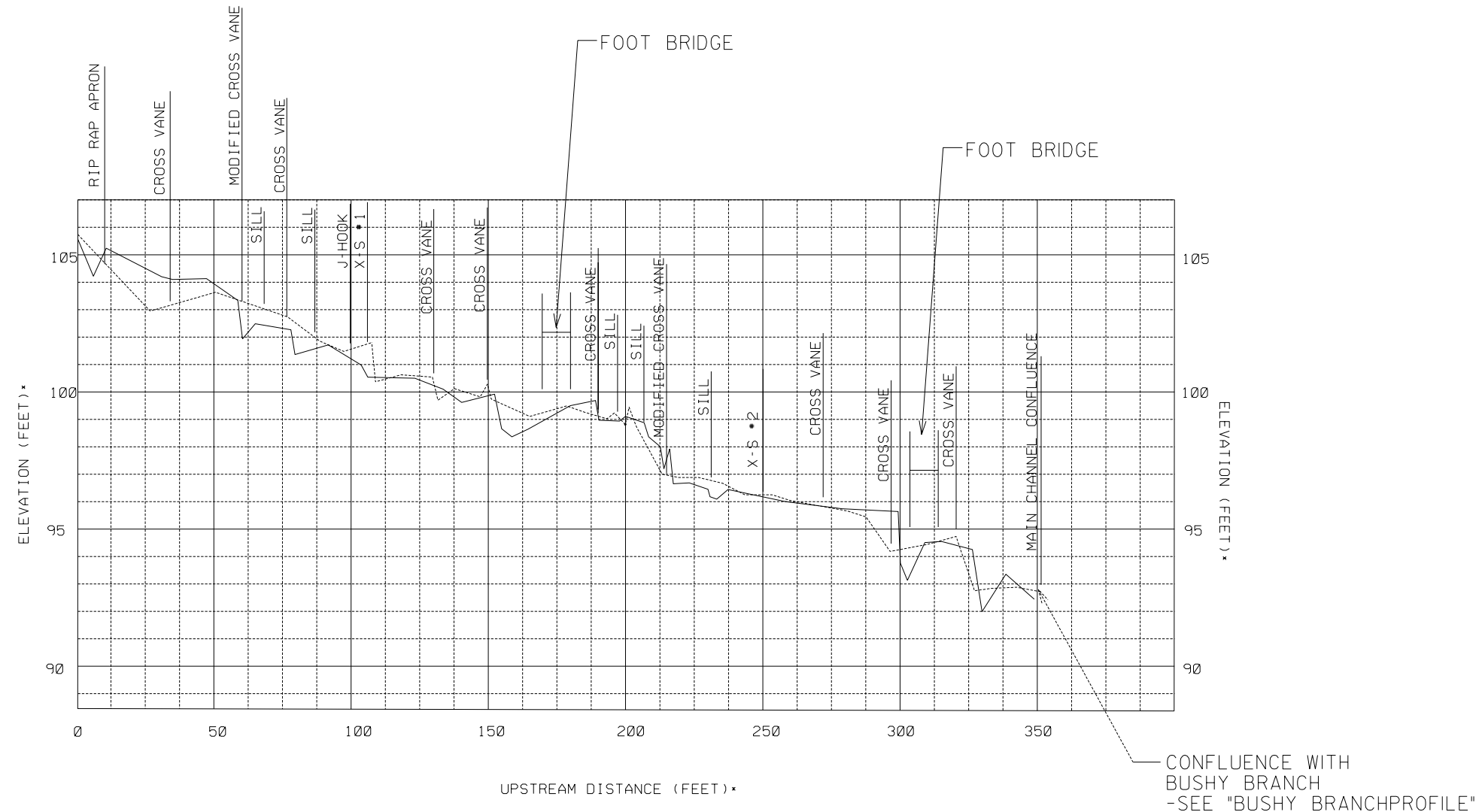
Riffle Measurements			
Station	Length	WS Elev	WS Slope
1019	30	93.6	0.0109
1050		93.2	
1107	9	93.2	0.0187
1115		93.0	
1232	10	91.7	0.0391
1241		91.3	
1304	10	91.3	0.0229
1314		91.0	
1384	16	91.0	0.0271
1400		90.5	
1412	16	90.5	0.0293
1428		90.1	
1493	9	89.8	0.0081
1502		89.7	
1518	16	89.7	0.0215
1534		89.4	
1633	19	89.1	0.0399
1652		88.3	
1685	11	88.2	0.0490
1697		87.6	
1888	27	86.5	0.0321
1915		85.6	
2028	35	85.6	0.0231
2062		84.8	

Pool Measurements		
Station	Length	P-P Spacing
1059	36	25
1095		
1121	96	32
1217		
1248	32	40
1280		
1320	13	103
1333		
1436	36	65
1472		
1537	41	5
1578		
1583	31	38
1614		
1652	20	31
1672		
1703	24	13
1727		
1740	81	103
1821		
1924	19	
1943		

**Appendix B6b - Longitudinal Profile for UT to Bushy Branch
Kentwood Park, Wake County
EEP Project Number 205 - MY01**

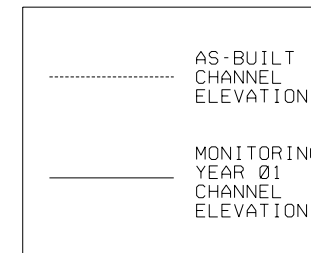


— 1st Year Monitoring



TRIBUTARY PROFILE

•NOTE:
 MONITORING YEAR 01 PROFILE BASED ON CURRENT THALWEG LOCATION WHICH HAS MIGRATED IN SOME PLACES, DUE TO NATURAL STREAM PROCESSES, SINCE AS BUILT SURVEY IN 2004.



 KCI ASSOCIATES OF NC ENGINEERS • PLANNERS • SCIENTISTS 4601 SIX FORKS ROAD RALEIGH, NORTH CAROLINA 27609										
KENTWOOD PARK (BUSHY BRANCH) MONITORING PLAN VIEW WAKE COUNTY EEP PROJECT NUMBER 205 - MY01		REVISIONS <table border="1"> <tr> <th>SYMBOL</th> <th>DESCRIPTION</th> <th>DATE</th> <th>APPROVED</th> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>	SYMBOL	DESCRIPTION	DATE	APPROVED				
SYMBOL	DESCRIPTION	DATE	APPROVED							
DATE: 12-29-2005 SCALE: SEE SHEET		UT TO BUSHY BRANCH PROFILE								
SHEET 1 OF 1										

**Table B5: Profile Points for UT to Bushy Branch
 Kentwood Park, Wake County
 EEP Project number 205 - MY01**

TW Station	TW Elevation*
0.00	105.58
5.69	104.22
10.38	105.24
30.53	104.20
34.50	104.10
46.82	104.13
58.20	103.34
59.90	101.94
64.57	102.49
77.52	102.27
78.97	101.37
91.05	101.72
103.04	100.99
105.44	100.55
122.57	100.51
132.86	100.11
139.59	99.63
151.52	99.93
154.13	98.67
157.83	98.38
163.74	98.66
179.04	99.51
188.22	99.70
189.46	98.98
196.96	98.95
199.14	99.12

TW Station	TW Elevation*
205.93	98.89
207.55	98.38
211.76	98.02
213.08	97.22
215.19	97.94
216.52	96.67
222.32	96.70
229.10	96.47
229.85	96.20
232.28	96.11
236.40	96.46
257.36	96.02
277.93	95.76
298.24	95.66
299.08	93.78
301.62	93.16
307.96	94.53
314.02	94.57
325.25	94.28
328.73	92.02
337.41	93.38
347.70	92.47

*Elevations are based on an assumed elevation, XS #2 left bank pin is at an elevation of 100ft.

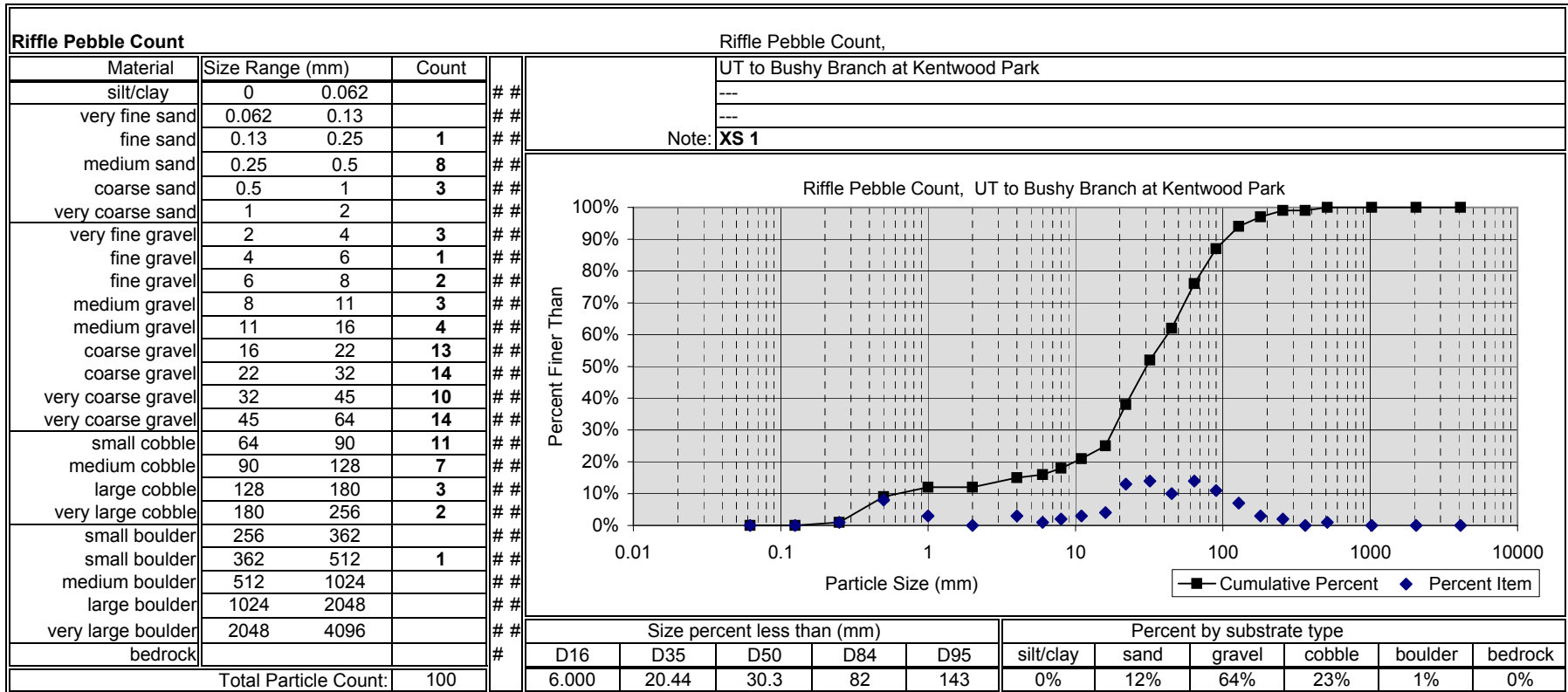
**Table B6: Riffle and Pool Measurements for UT to Bushy Branch
 Kentwood Park (Bushy Branch), Wake County
 EEP Project number 205 - MY01**

Riffle Measurements*	
Station	Length
10 31	20
47 58	11
65 78	13
91 103	12
123 133	10
199 217	17
236 257	21
314 352	38

Pool Measurements*		
Station	Length	P-P Spacing
0 10	10	48
58 65	6	13
78 91	14	42
133 179	46	50
229 236	7	62
298 308	10	17
325 337	12	

* Stations for riffles and pools extracted from profile due to dry stream conditions during survey

App. B7 - Pebble Count Plots and Raw Date Tables



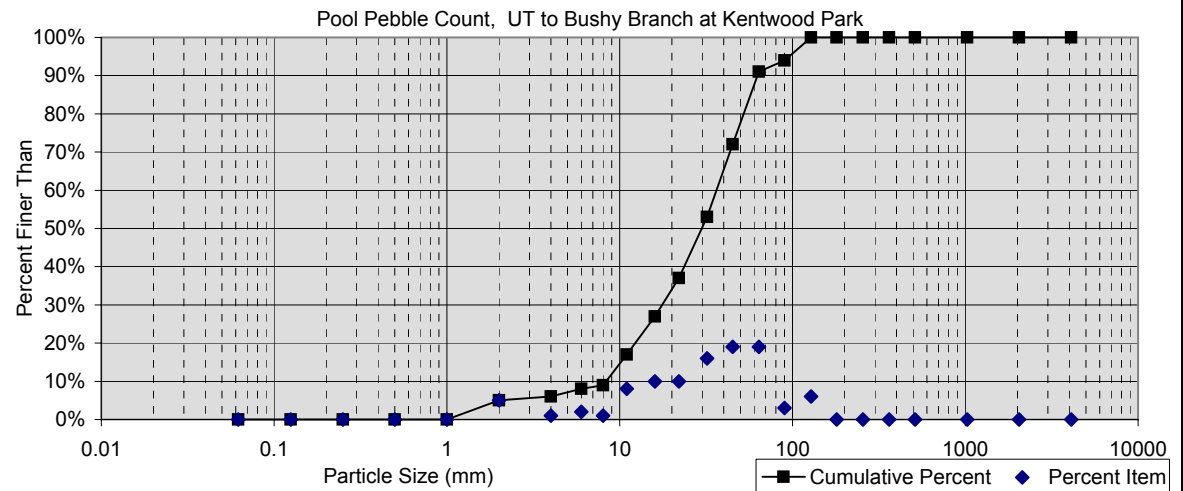
Pool Pebble Count

Pool Pebble Count,

Material	Size Range (mm)	Count	#	#
silt/clay	0 0.062		#	#
very fine sand	0.062 0.13		#	#
fine sand	0.13 0.25		#	#
medium sand	0.25 0.5		#	#
coarse sand	0.5 1		#	#
very coarse sand	1 2	5	#	#
very fine gravel	2 4	1	#	#
fine gravel	4 6	2	#	#
fine gravel	6 8	1	#	#
medium gravel	8 11	8	#	#
medium gravel	11 16	10	#	#
coarse gravel	16 22	10	#	#
coarse gravel	22 32	16	#	#
very coarse gravel	32 45	19	#	#
very coarse gravel	45 64	19	#	#
small cobble	64 90	3	#	#
medium cobble	90 128	6	#	#
large cobble	128 180		#	#
very large cobble	180 256		#	#
small boulder	256 362		#	#
small boulder	362 512		#	#
medium boulder	512 1024		#	#
large boulder	1024 2048		#	#
very large boulder	2048 4096		#	#
bedrock			#	#
Total Particle Count:		100		

UT to Bushy Branch at Kentwood Park

Note: **XS 2**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
10.571	20.64	29.8	56	95	0%	5%	86%	9%	0%	0%

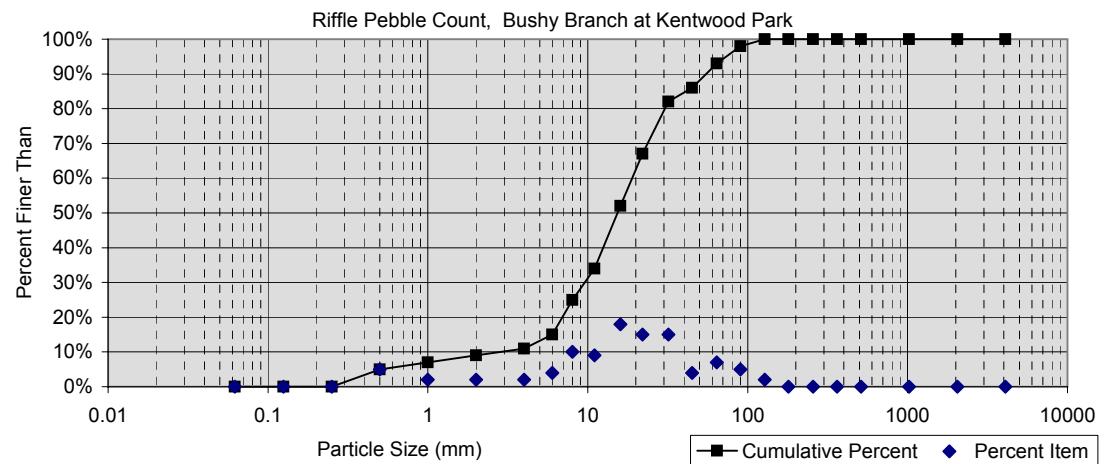
Riffle Pebble Count

Material	Size Range (mm)	Count	#	#
silt/clay	0 0.062			
very fine sand	0.062 0.13			
fine sand	0.13 0.25			
medium sand	0.25 0.5	5		
coarse sand	0.5 1	2		
very coarse sand	1 2	2		
very fine gravel	2 4	2		
fine gravel	4 6	4		
fine gravel	6 8	10		
medium gravel	8 11	9		
medium gravel	11 16	18		
coarse gravel	16 22	15		
coarse gravel	22 32	15		
very coarse gravel	32 45	4		
very coarse gravel	45 64	7		
small cobble	64 90	5		
medium cobble	90 128	2		
large cobble	128 180			
very large cobble	180 256			
small boulder	256 362			
small boulder	362 512			
medium boulder	512 1024			
large boulder	1024 2048			
very large boulder	2048 4096			
bedrock				
Total Particle Count:		100		

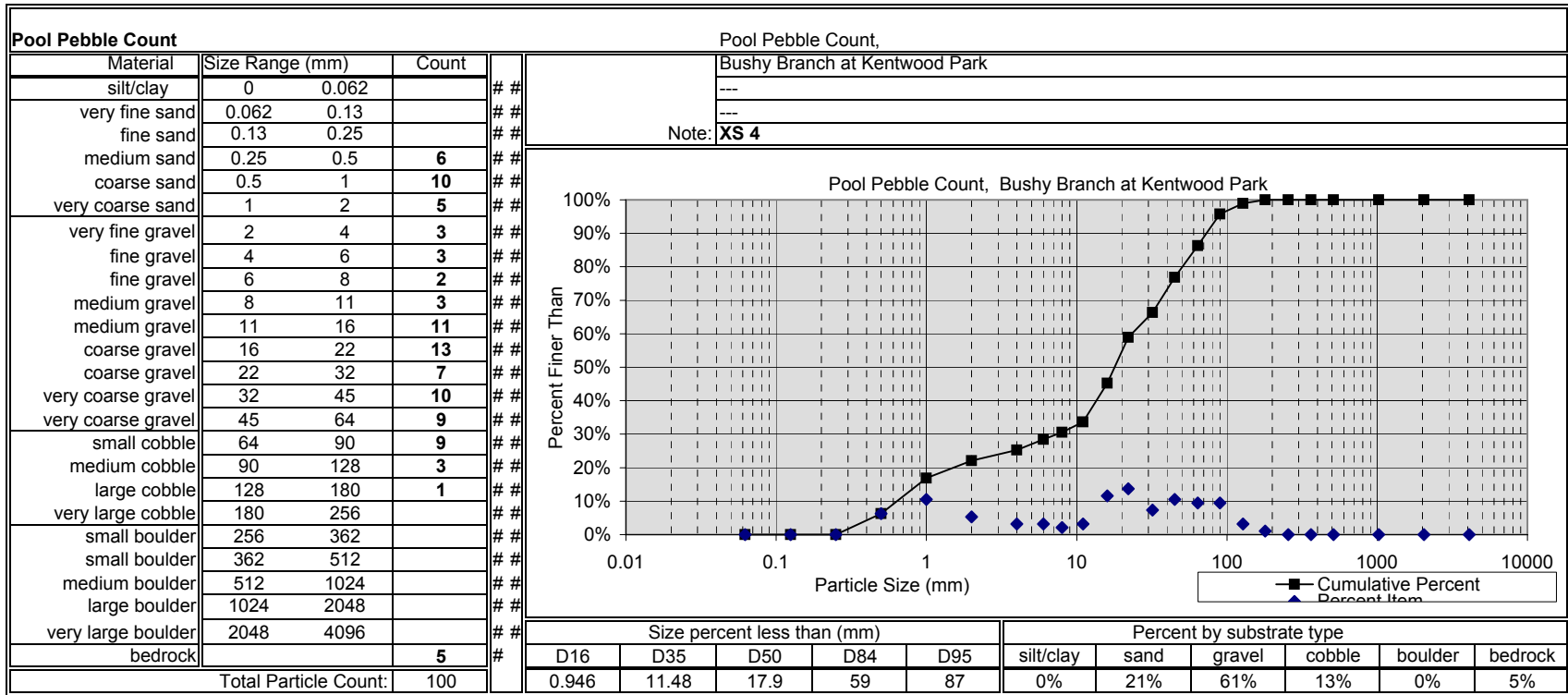
Riffle Pebble Count,

Bushy Branch at Kentwood Park

Note: XS 3



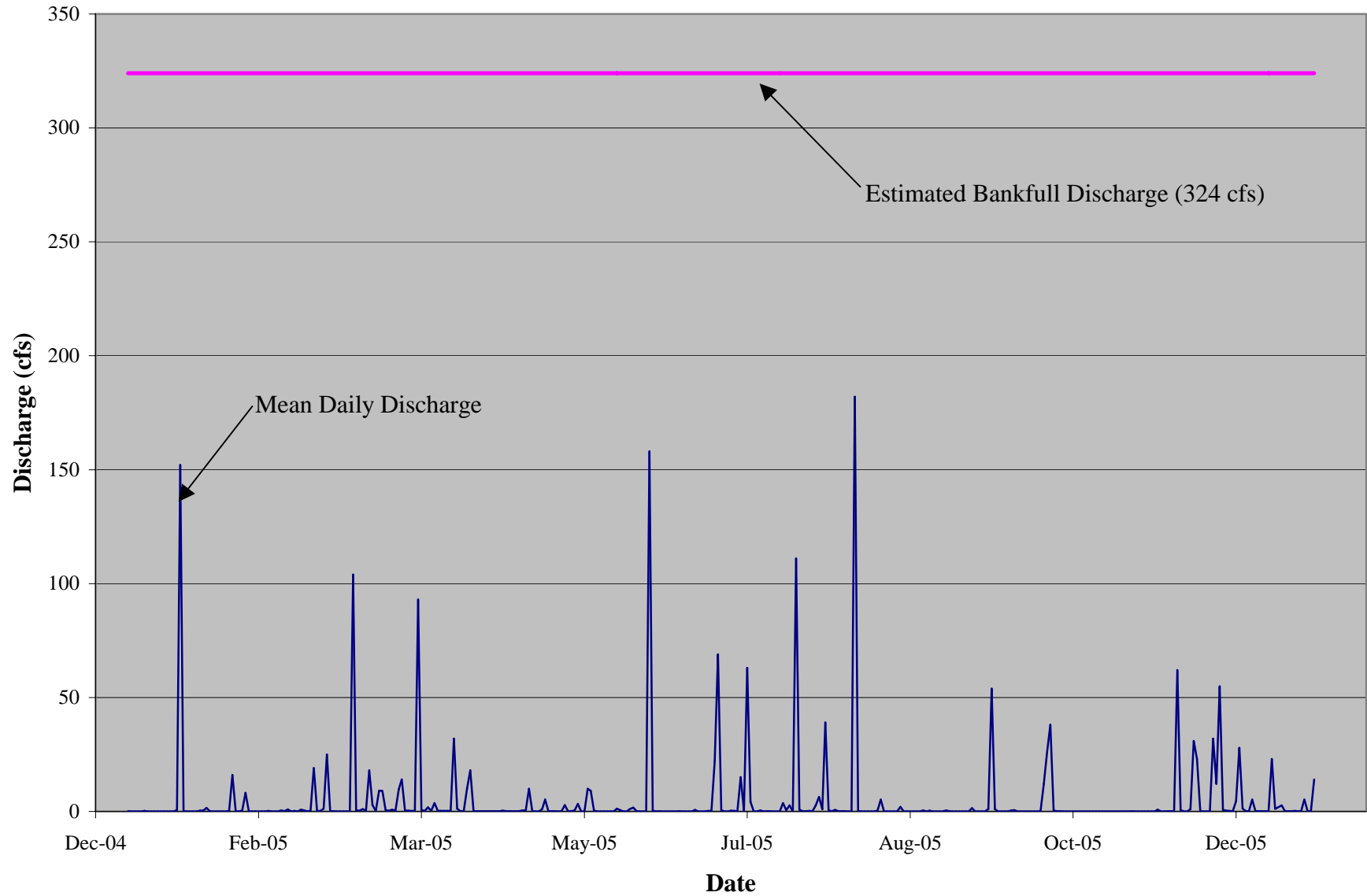
Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
6.175	11.23	15.3	38	73	0%	9%	84%	7%	0%	0%



App B8 – USGS Gauge Discharge Plots

The Kentwood Park Stream Restoration Site does not have a gauge installed to record bankfull events. In order to approximate the number of bankfull events USGS gauge data has been used as a secondary surrogate. Two gauges, both within three miles of the Kentwood Park Site, were used for this purpose. Since the bankfull discharge of the gauged streams is unknown, a flood frequency analysis was performed using an annual maximum series (AMS) for a period of 7 to 8 years to determine an approximate bankfull discharge. For this report it was assumed that the bankfull discharge is associated with a return period of 1.5 years. Due to the urban nature of the restoration site and its location outside the immediate drainages of the gauged streams this data is not a substitute for an on-site recording device. The three streams and the gauges' approximate distance from Kentwood Park are as follows; Pigeon House Creek, 2.4 miles; and Rocky Branch, 1mile.

Pigeon House Creek - USGS Gauge 0208732534



Rocky Branch - USGS Gauge 0208735012

