Kentwood Park (Bushy Branch) Stream Restoration Monitoring Report

EEP Project # 205

Monitoring Year – 02

2006

Submitted to:

Ecosystem Enhancement PROGRAM

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

January 2007

Monitoring Firm

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Design Firm

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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 second year monitoring that took place in 2006.

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 implemented 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 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 second year monitoring counted an average of 2,085 stems per acre in the streamside community based on plots 1 and 2, and 1,255 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 few areas where kudzu (*Pueraria lobata*) is present and should be controlled as soon as possible. The second year monitoring found the vegetation component of the project to be successful.

The stream assessment completed during the second year monitoring found Bushy Branch to be functioning. Channel dimensions have not changed drastically from the designed conditions with the exceptions of some areas of bank erosion and lateral adjustment of the channel. The second year monitoring profile shows some bed degradation from station 14+00 to 14+50, 15+10 to 15+50, and 18+00 to 18+50 in comparison to the as-built profile. Slight bed aggradation is apparent from station 17+00 to 17+50. UT to Bushy Branch also shows some areas of bed degradation when the profile is compared to the as-built profile. The most notable change on the UT to Bushy Branch is an area of bed degradation near station 02+20 that occurred after the profile had been surveyed. Many of the in-stream structures are functioning across the project site, though several 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 Project Objectives

- Installation of in-stream structures to define additional bed features.
- Relocate a section of the stream in order to restore stream pattern.
- Grade severely eroding banks and excavate new bankfull benches.
- Install root wads to promote bank stability.
- Revegetate the adjacent banks to promote the establishment of native plant communities.

1.2 Project Structure, Restoration Type and Approach

A previously incised channel, Bushy Branch, and an unnamed tributary were restored using channel dimension, pattern, and profile modifications and the establishment of a vegetated riparian zone adjacent to the stream. 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.

1.3 Location and Setting

Kentwood Recreational Park, Bushy Branch and an unnamed tributary are located within the city limits of Raleigh, North Carolina. The landuse of the 1.33 square mile watershed is a park setting surrounded by urban residential development with little potential for future development.

1.4 Project History and Background

Table 1. Project Mitigation Structure and Objectives
Project Number and Name: 205 - Kentwood Park (Bushy Branch)

Segment / Reach ID	Existing Linear Feet	Type	Approach	Linear Feet	Mitigation Ratio	Mitigation Units	Stationing	Comment
Bushy Branch	N/A	R	P1/2/3	1,070	1.0	1,070	10+00 - 20+70	
UT to Bushy Branch	N/A	R	P3	350	1.0	350	00+00 - 03+50	

Mitigation Unit Summations

Stream (lf)	Riparian Wetland (Ac)	Nonriparian Wetland (Ac)	Total Wetland (Ac)	Buffer (Ac)	Comment
1,420					

R = Restoration P1/2/3 = Combination of Priority I, II, III
P3 = Priority III

DIRECTIONS TO KENTWOOD PARK SITE:
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.

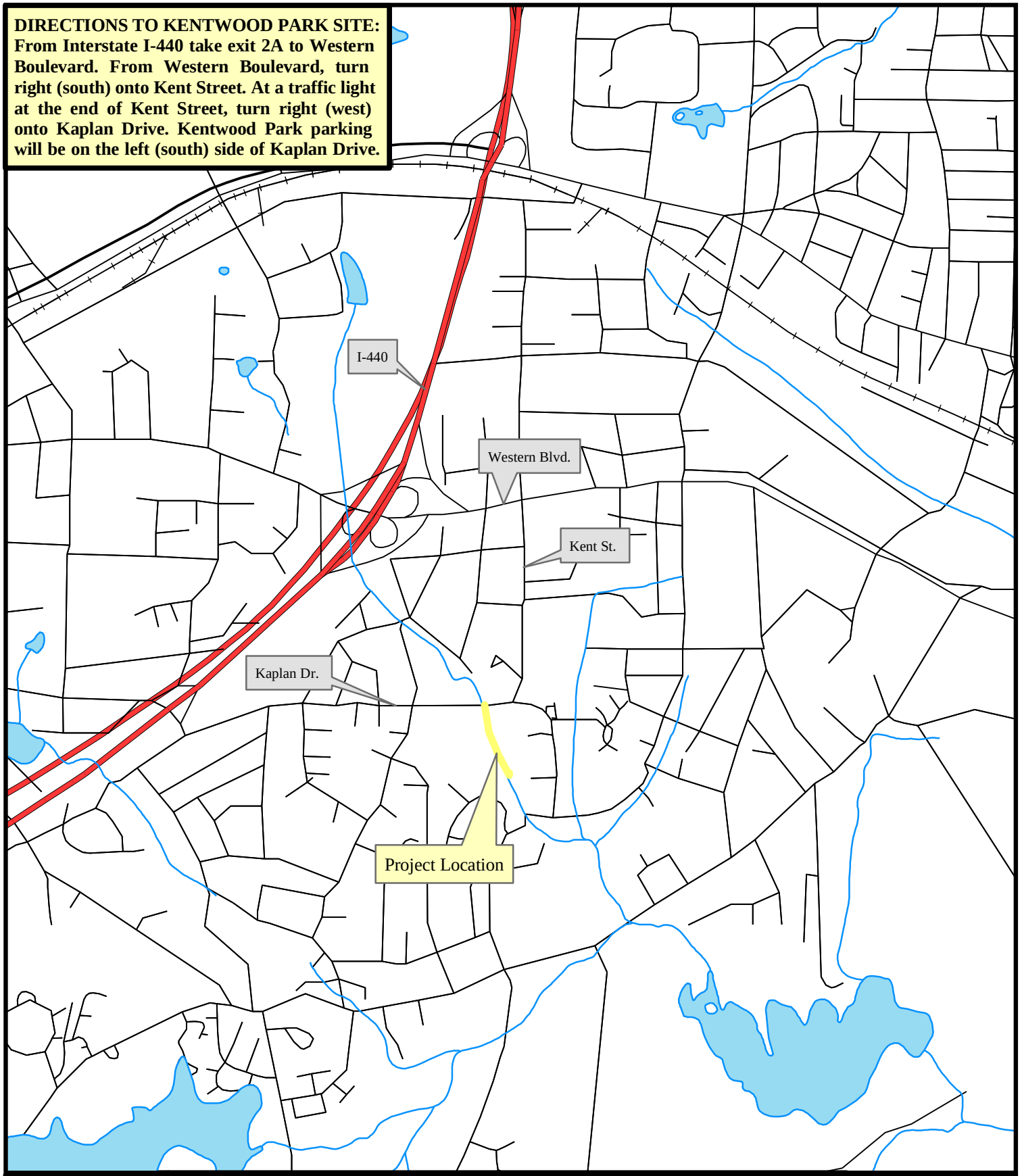


Figure 1. Site Vicinity Map
Kentwood Park, Wake County, EEP Project # 205 - MY02

0.25 0.125 0 0.25 0.5
Miles

Date: 1/02/07

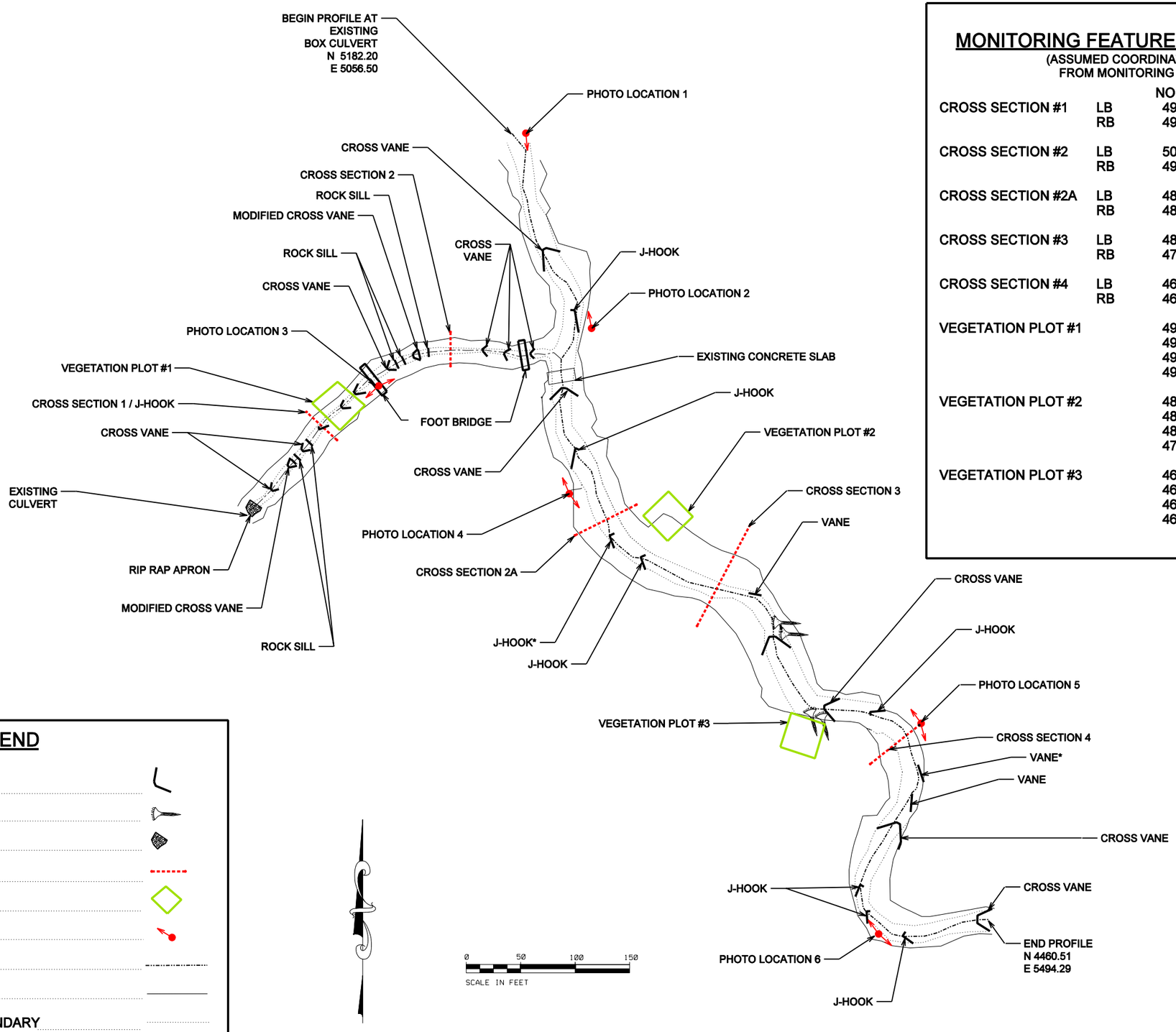
Ecosystem Enhancement PROGRAM

KCI ASSOCIATES OF NC

Table 2. Project Activity and Reporting History Project Number and Name: 205 - Kentwood Park (Bushy Branch)		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan	Apr 00	Mar 02
Final Design - 90%		
Construction		2002
Stream Maintenance Plan		Feb 04
Stream Repair and Maintenance Seeding		2004
As-Built Report		Feb 05
Year 1 Monitoring	Jul 05	Jan 06
Year 2 Monitoring	Jun 06	Jan 07

Table 3. Project Contact Table Project Number and Name: 205 - Kentwood Park (Bushy Branch)	
Design Firms	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
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
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
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, 02	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 783-9214 Fax: (919) 783-9266

Table 4. 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	45%
Stream Order	Second Order (Bushy Branch)
	First Order (UT to Bushy Branch)
Physiographic Region	Piedmont
Ecoregion	Raleigh Belt
Rosgen Classification of As-built	C-E4/2
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 FROM MONITORING SURVEY)

		NORTHING	EASTING
CROSS SECTION #1	LB	4926.60	4867.91
	RB	4900.65	4895.52
CROSS SECTION #2	LB	5000.00	5000.00
	RB	4968.67	5000.00
CROSS SECTION #2A	LB	4841.45	5170.71
	RB	4813.25	5114.21
CROSS SECTION #3	LB	4820.56	5259.23
	RB	4723.49	5219.47
CROSS SECTION #4	LB	4651.82	5430.88
	RB	4611.46	5389.46
VEGETATION PLOT #1		4931.15	4873.69
		4954.36	4896.34
		4909.86	4898.86
		4932.60	4921.73
VEGETATION PLOT #2		4819.84	5161.42
		4823.76	5206.52
		4844.74	5182.31
		4798.86	5185.63
VEGETATION PLOT #3		4619.82	5305.75
		4651.83	5312.74
		4644.35	5344.63
		4612.48	5338.48

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

* INDICATES AS-BUILT STRUCTURE THAT WAS NOT ORIGINALLY INCLUDED IN THE AS-BUILT DRAWING

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

Ecosystem Enhancement Program

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 - MY02

DATE: JUNE 2006
SCALE: SEE SHEET

MONITORING PLAN VIEW

SHEET 1 OF 1

2.0 PROJECT CONDITIONS AND MONITORING RESULTS

2.1 Vegetation Assessment

See vegetation assessment in Appendix A.

2.1.1 Vegetative Problem Areas

See Table A3. Vegetative Problem Areas in Appendix A.

2.1.2 Vegetative Problem Areas Plan View

See Vegetative Problem Area Plan View in Appendix A.

2.2. Stream Assessment

2.2.1 Bankfull Event and Stability Assessment

2.2.1.a Verification of Bankfull Events Table

Table 5. Verification of Bankfull Events
Project Number and Name: 205 - Kentwood Park (Bushy Branch)

Date of Data Collection	Date of Occurrence	Method	Photo Number
06/15/06	06/14/06	Site visit to evaluate evidence indicators of stage after storm event	

2.2.1.b BEHI and Sediment Export Table

Table 6. BEHI and Sediment Export Estimates
Project Number and Name: 205 – Kentwood Park (Bushy Branch)

To Be Conducted During Monitoring Year 05

2.2.2 Stream Problem Areas Plan View

See Stream Problem Areas Table, Plan View, and Photos in Appendix B.

2.2.3 Stability Assessment Table

Table 7a. 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%	75%			
B. Pools	100%	92%	94%			
C. Thalweg	100%	75%	75%			
D. Meanders	100%	75%	72%			
E. Bed General	100%	93%	94%			
G. Banks	100%	78%	77%			
H. Vanes / J Hooks etc.	100%	83%	82%			
I. Wads and Boulders	100%	80%	50%			

Table 7b. 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%	85%			
B. Pools	100%	90%	90%			
C. Thalweg	100%	100%	100%			
D. Bed General	100%	80%	80%			
F. Banks	100%	95%	95%			
G. Vanes / J Hooks etc.	100%	90%	90%			

2.2.4 Quantitative Measures Summary Tables

Table 8a. 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*		
Dimension	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
Bank Height Ratio							2.2	2.9	2.6	1.1	1.4	1.2						1.3
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 8b. 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*		
Dimension	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
Bank Height Ratio							1.8	2.1	1.9									1.0
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 9a. Morphology and Hydraulic Monitoring Summary
Project Number and Name: 205 – Kentwood Park (Bushy Branch)
Segment Reach: Bushy Branch (1,070 ft.)

Parameter	Cross Section 2A Riffle						Cross Section 3 Riffle						Cross Section 4 Pool					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)		26.5					20.3	21.4					23.3	23.2				
Floodprone Width (ft)		43					36	38					> 44	> 46				
Bankfull Cross Sectional Area (ft^2)		38.5					34.6	38.2					50.8	39.7				
Bankfull Mean Depth (ft)		1.5					1.7	1.8					2.2	1.7				
Bankfull Maximum Depth (ft)		2.0					2.3	2.6					3.2	3.0				
Width/Depth Ratio		18.2					11.9	12.0					10.6	13.6				
Entrenchment Ratio		1.6					1.8	1.8					1.9	>2.0				
Bank Height Ratio		1.0					1.0	1.0					1.0	1.0				
Wetted Perimeter (ft)		27.8					21.8	23.4					25.4	25.0				
Hydraulic Radius (ft)		1.4					1.6	1.6					2	1.6				
Substrate																		
d50 (mm)		10					15	10					18	2				
d84 (mm)		41					38	35					59	32				

Table 9b. 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	8.5					7.9	8.0				
Floodprone Width (ft)	20	19					14	15				
Bankfull Cross Sectional Area (ft^2)	10.8	9.7					4.1	3.3				
Bankfull Mean Depth (ft)	1.2	1.1					0.5	0.4				
Bankfull Maximum Depth (ft)	1.8	1.7					0.9	0.9				
Width/Depth Ratio	7.4	7.4					15.2	19.4				
Entrenchment Ratio	2.2	2.2					1.7	1.9				
Bank Height Ratio	1.0	1.0					1.0	1.0				
Wetted Perimeter (ft)	10.1	12.1					8.2	8.2				
Hydraulic Radius (ft)	1.1	0.8					0.5	0.4				
Substrate												
d50 (mm)	30	39					30	38				
d84 (mm)	82	69					56	72				

Table 9c. 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)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	26	83	34	36	93	38									
Radius of Curvature (ft)	60	100	90	32	96	60									
Meander Wavelength (ft)	138	219	194	170	210	195									
Meander Width Ratio	1.6	5.3	2.2	1.2	4.5	2.5									
Profile															
Riffle Length (ft)	9	35	16	9	40	23									
Riffle Slope (ft/ft)	0.008	0.049	0.025	0.003	0.036	0.019									
Pool Length (ft)	13	96	32	8	130	33									
Pool Spacing (ft)	5	103	35	43	136	74									
Additional Reach Parameters															
Valley Length (ft)	845			845											
Channel Length (ft)	1,070			1,070											
Sinuosity	1.27			1.27											
Water Surface Slope (ft/ft)	0.008			0.008											
Number of Bankfull Events	0			1*											
Rosgen Classification	C4			C4											

Table 9d. 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)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)			N/A			N/A									
Radius of Curvature (ft)			N/A			N/A									
Meander Wavelength (ft)			N/A			N/A									
Meander Width Ratio			N/A			N/A									
Profile															
Riffle Length (ft)	10	38	15	5	38	11									
Riffle Slope (ft/ft)	N/A	N/A	N/A	N/A	N/A	N/A									
Pool Length (ft)	6	46	10	6	36	10									
Pool Spacing (ft)	13	62	45	5	66	28									
Additional Reach Parameters															
Valley Length (ft)	318			318											
Channel Length (ft)	350			350											
Sinuosity	1.10			1.10											
Water Surface Slope (ft/ft)	N/A			N/A											
Number of Bankfull Events	0			1*											
Rosgen Classification	B4			B4											

*Documented bankfull event refers to the largest measured event during current monitoring year.

Appendix A
Vegetation Raw Data

App A1 - Vegetation Data Tables

Table A1. Stem counts for each species arranged by plot
Project Number and Name: 205 – Kentwood Park (Bushy Branch)

Species	Plot 1	Plot 2	Plot 3	Initial Totals	Year 1 Totals	Year 2 Totals	Survival %
Shrubs							
Ilex verticillata	1	6		16	10	7	44%
Euonymus americana	4			6	3	4	67%
Lindera benzoin	4			4	4	4	100%
Sambucus canadensis		1		7	3	1	14%
Cornus amomum		18	2	34	24	20	59%
Alnus serrulata		6	1	14	11	7	50%
Trees							
Quercus michauxii	8		12	23	22	20	87%
Quercus phellos			5	4	5	5	125%
Quercus alba			2	2	2	2	100%
Fraxinus pennsylvanica	10			10	11	10	100%
Nyssa sylvatica	14			13	13	14	108%
Oxydendrum arboreum	3			8	4	3	38%
Betula nigra	8	13		18	16	21	117%
Cornus florida	1			1	1	1	100%
Platanus occidentalis		3		8	4	3	38%
Liriodendron tulipifera			4	6	4	4	67%
Acer negundo			3	4	4	3	75%
Ulmus americana			2	2	2	2	100%
Hamamelis virginiana	3			3	1	3	100%

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.
- One *Euonymus americana* found in plot 1 had resprouted from the original planting, but had not been counted in monitoring year 01. The surviving *Euonymus americana* in plot 1 retained very few leaves. Browsing pressure is believed to be the cause of the *Euonymus americana* mortality.
- The high mortality of *Oxydendrum arboreum* 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.
- The *Hamamelis virginiana* increased in number because plants that were considered dead in monitoring year 1 had resprouted or put out new growth.
- In plot 3, the two *Liriodendron tulipifera* trees that were standing dead during monitoring year 1, were not found during the current monitoring. It is assumed that the dead trees were either removed manually or knocked over during a storm.

- There is over 100% survival for *Quercus phellos* in plot 3. This is due to a miscount during the as-built stem count.
- There is also over 100% survival for *Nyssa sylvatica* and *Betula nigra* in plots 1 and 2. This is due to either a miscount during the as-built and first year monitoring stem count or resprouts from the original plantings that had died back.
- The *Acer negundo* decreased in number in plot 3 because one of the trees had been cut down. This appears to be from beaver activity; however no significant beaver damage was documented throughout the rest of the site.

Table A2. Stem Density By Plot
Project Number and Name: 205 -Kentwood Park (Bushy Branch)
Date : 5/4/06
Crew : A. Spiller

Plot #	Winterberry *Ilex verticillata*	Swamp Chestnut Oak *Quercus michauxii*	Green Ash *Fraxinus pennsylvanica*	Black Gum *Nyssa sylvatica*	Witch Hazel *Hamamelis virginiana*	Sourwood *Oxydendrum arboreum*	Hearts-a-busting *Euonymus americana*	Spice Bush *Lindera benzoin*	River Birch *Betula nigra*	Flowering Dogwood *Cornus florida*	Elderberry *Sambucus canadensis*	Silky Dogwood *Cornus amomum*	Sycamore *Platanus occidentalis*	Tag Alder *Alnus serrulata*	Willow Oak *Quercus phellos*	Tulip Poplar *Liriodendron tulipifera*	White Oak *Quercus alba*	Box Elder *Acer negundo*	American Elm *Ulmus americana*	Total (Year 2)	Density (Trees/Acre)
1	1	8	10	14	3	3	4	4	8	1										56	2,267
2	6								13		1	18	3	6						47	1,902
3		12										2		1	5	4	2	3	2	31	1,255
															Streamside Community (Plots 1 and 2)					2,085	
															Bottomland Hardwood Community (Plot 3)					1,255	

Table A3a. 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	
	11+50 - 12+00	Foot traffic from disc golf course	
Invasive/Exotic Population	10+00 - 10+50	English Ivy: encroachment from outside project	VP1
	16+00 - 16+75 and 19+25 - 19+75	Kudzu: unknown	VP2
	Scattered Throughout	Mimosa: outside seed source	VP2
	Heavy Throughout	Microstegium: previously established	VP3
	Scattered Throughout	Japanese honeysuckle: previously established	
	Scattered Throughout	Chinese privet: previously established	
	Scattered Throughout	Thorny olive: previously established	VP4

Table A3b. 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 Coir Matting	00+25 – 00+70	Poor subsoil, foot traffic on matting	VP5
	01+75 – 02+10	Poor subsoil, foot traffic on matting	
Bare Terrace	03+25 - 03+50	Foot traffic from disc golf course	
Path worn across stream area	00+25	Disc golf players crossing stream	VP6
	02+50	Disc golf players crossing stream	
	03+05	Disc golf players crossing stream	
	03+20	Disc golf players crossing stream	

Appendix A2: Vegetative Problem Area Plan View
Kentwood Park, Wake County, EEP Project Number 205 - MY02

0 35 70 Feet

1 inch = 70 feet

Date: 10-17-06

Note: Area of invasive populations and bare terraces estimated from visual field inspections. Stream banks adjusted to accomodate discrepancies between as-built and monitoring survey.

Source: USGS High Resolution Orthoimage, Raleigh-Durham, NC, 2005.

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App A3 – Representative Vegetation Problem Area Photos

VP1 – English ivy (*Hedera helix*) on stream bank. Photo taken near station 10+25. 10/5/06 - MY 02

VP2 – Kudzu (*Pueraria lobata*) on mimosa (*Albizzia julibrissin*) along stream bank. Photo taken near station 16+75. 10/5/06 - MY 02

VP3 – Microstegium (*Microstegium vimineum*) covering stream bank. Photo taken near station 11+15. 10/5/06 - MY 02

VP4 – Thorny olive (*Elaeagnus pungens*) on stream bank. Photo taken near station 17+75. 10/5/06 - MY 02

VP5 – Breakdown of coir matting, with bare subsoil exposed on stream bank. Photo taken near station 03+40. 10/5/06 - MY 02

VP6 – Path worn into stream bank from pedestrian access to the stream. Photo taken near station 02+70. 10/5/06 - MY 02

App A4 - Vegetation Monitoring Plot Photos

Plot 1 Photo – Taken looking south from the north corner. 5/4/06 - MY 02.

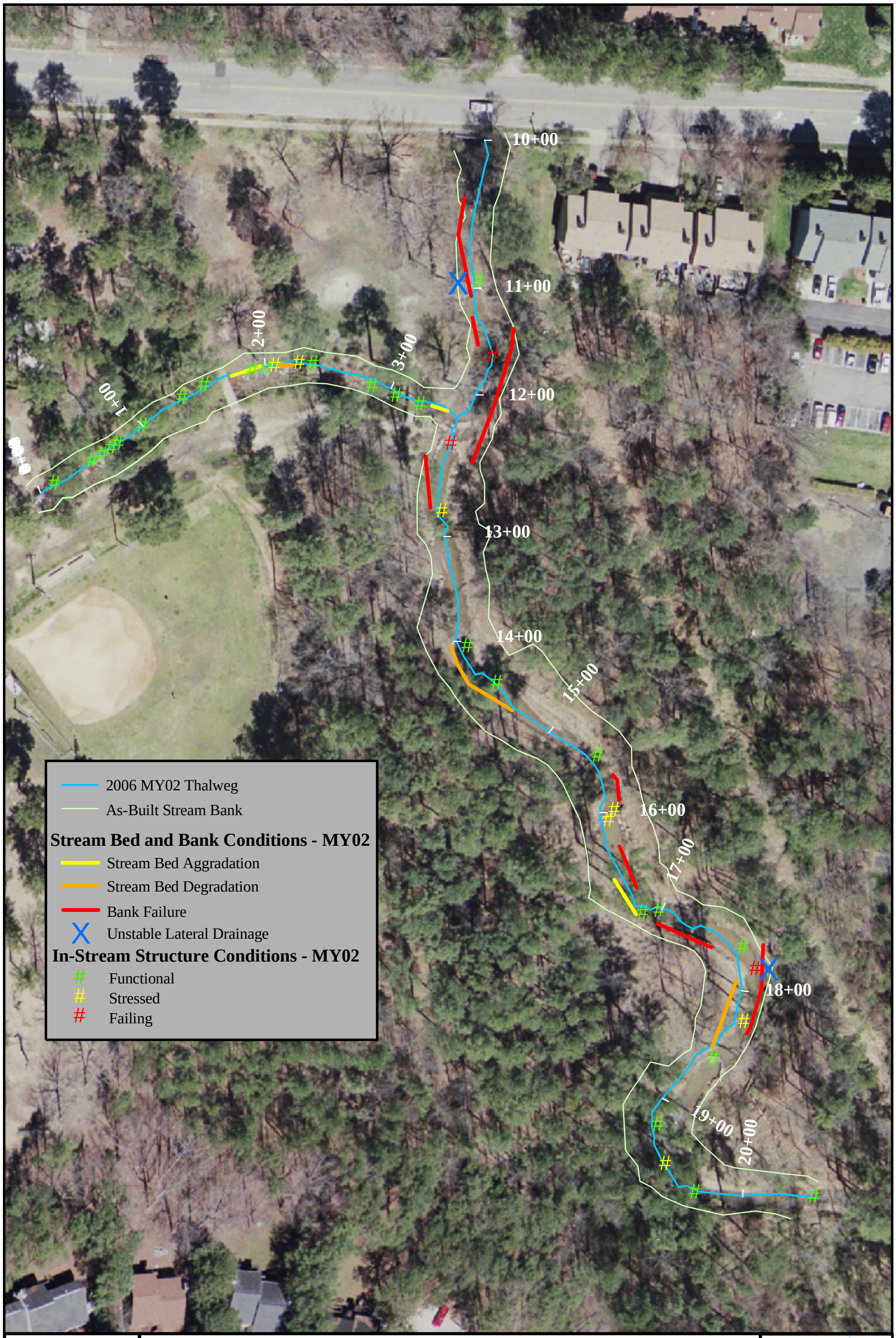
Plot 1 Supplemental Photo – Taken looking upstream towards the center of the plot from established photo station #3. 5/4/06 - MY 02.

Plot 2 Photo – Taken looking south from the north corner. 5/4/06 - MY 02.

Plot 2 Supplemental Photo – Taken looking at center of plot from the top of the right bank across the stream from the vegetation plot. 5/4/06 - MY 02.

Plot 3 Photo – Taken looking east from the west corner. 5/4/06 - MY 02.

Appendix B
Geomorphologic Raw Data



Appendix B1: Stream Problem Area Plan View
Kentwood Park, Wake County, EEP Project Number 205 - MY02

0 35 70 Feet

1 inch = 70 feet

Date: 10-17-06

Note: Length of bank and aggradation problems approximated. Stream banks adjusted to accomodate discrepancies between as-built and monitoring survey.

Source: USGS High Resolution Orthoimage, Raleigh-Durham, NC, 2005.

Ecosystem Enhancement PROGRAM

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App B2 – Stream Problem Areas Tables

Table B1a. 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+30 - 16+60	unknown	
Bed Degradation	14+00 - 14+60	unknown	
	18+00 - 18+60	unknown	
Bank Scour	10+50-11+20	unknown	SP1
	11+30-11+50	unknown	
	11+60-12+50	unknown	
	12+75-13+00	scour from misdirected cross vane	
	15+50-15+65	unknown	
	16+00-16+30	unknown	
	16+80-17+25	unknown	
	17+50-18+30	unknown	
Engineered Structures - back or arm scour	11+75	unknown	SP2
	12+60	improper placement	
	13+10	poorly backfilled vane arm	
	18+00	unknown	
	18+30	unknown	
	19+40	poorly backfilled vane arm	
Engineered Structures – piping	16+00	poor fabric installation	SP3
Root Wads - scour	16+00	unknown	SP4

Table B1b. 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+00	herbaceous vegetation accumulating soil	SP5
	03+30 - 03+40	herbaceous vegetation accumulating soil	
Bed Degradation	02+25	unstable soils downstream of sill damaged by large storm event	SP6

App B3 – Representative Stream Problem Area Photos

SP1 – Bank erosion. Photo taken near station 15+65 on left bank. 10/5/06 - MY 02

SP2 – Back arm scour on arm of j-hook. Photo taken near station 11+75. 10/5/06 - MY 02

SP3 – Piping through boulders in cross vane. Photo taken near station 16+00. 10/5/06 - MY 02

SP4 – Scour behind root wads. Photo taken near station 16+00. 10/5/06 - MY 02

SP5 – Bed aggradation and weedy growth in channel near confluence of UT to Bushy Branch and Bushy Branch. Photo taken near station 03+40. 10/5/06 - MY 02

SP6 – Bed degrading on downstream side of rock sill. Photo taken near station 02+25. 10/5/06 - MY 02

App B4 –Stream Photo Station Photos

Photo Point 1 – Taken looking downstream from bridge on Kaplan Drive. 10/5/06 - MY 02

Photo Point 1, supplemental – Taken looking downstream from streambed in front of bridge on Kaplan Drive. 10/5/06 - MY 02

Photo Point 2 – Taken looking upstream. 10/5/06 - MY 02

Photo Point 3 – Taken looking upstream. 10/5/06 - MY 02

Photo Point 3 – Taken looking downstream. 10/5/06 - MY 02

Photo Point 4 – Taken looking upstream. 10/5/06 - MY 02

Photo Point 4 – Taken looking downstream. 10/5/06 - MY 02

Photo Point 5 – Taken looking upstream. 10/5/06 - MY 02

Photo Point 5 – Taken looking downstream. 10/5/06 - MY 02

Photo Point 6 – Taken looking upstream. 10/5/06 - MY 02

Photo Point 6 – Taken looking downstream. 10/5/06 - MY 02

App B5 –Qualitative Visual Stability Assessment Table

Table B2. Qualitative Visual Stability Assessment
Project Number and Name: 205 – Kentwood Park (Bushy Branch)
Segment/Reach: Bushy Branch (1,070 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?	9	12	N/A	75	
	2. Armor stable (e.g. no displacement)?	9	12	N/A	75	
	3. Facet grade appears stable?	9	12	N/A	75	
	4. Minimal evidence of embedding/fining?	9	12	N/A	75	
	5. Length appropriate?	9	12	N/A	75	**75**
B. Pools	1. Present? (e.g. no severe aggradation)	12	12	N/A	100	
	2. Sufficiently deep (Dmax pool:Mean Bkf > 1.6?)	12	12	N/A	100	
	6. Length appropriate?	10	12	N/A	83	**94**
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?	5	8	N/A	63	**72**
E. Bed General	1.General channel bed aggradation areas (bar formation)	N/A	N/A	1/30	97	
	2. Channel bed degradation - areas of increasing down cutting or head cutting?	N/A	N/A	2/100	90	**94**
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A	N/A	8/490	77	**77**
G. Vanes	1. Free of back or arm scour?	10	17	N/A	59	
	2. Height appropriate?	15	17	N/A	88	
	3. Angle and geometry appear appropriate?	15	17	N/A	88	
	4. Free of piping or other structural failures?	16	17	N/A	94	**82**
H. Wads / Boulders	1. Free of scour?	1	2	N/A	50	
	2. Footing stable?	1	2	N/A	50	**50**

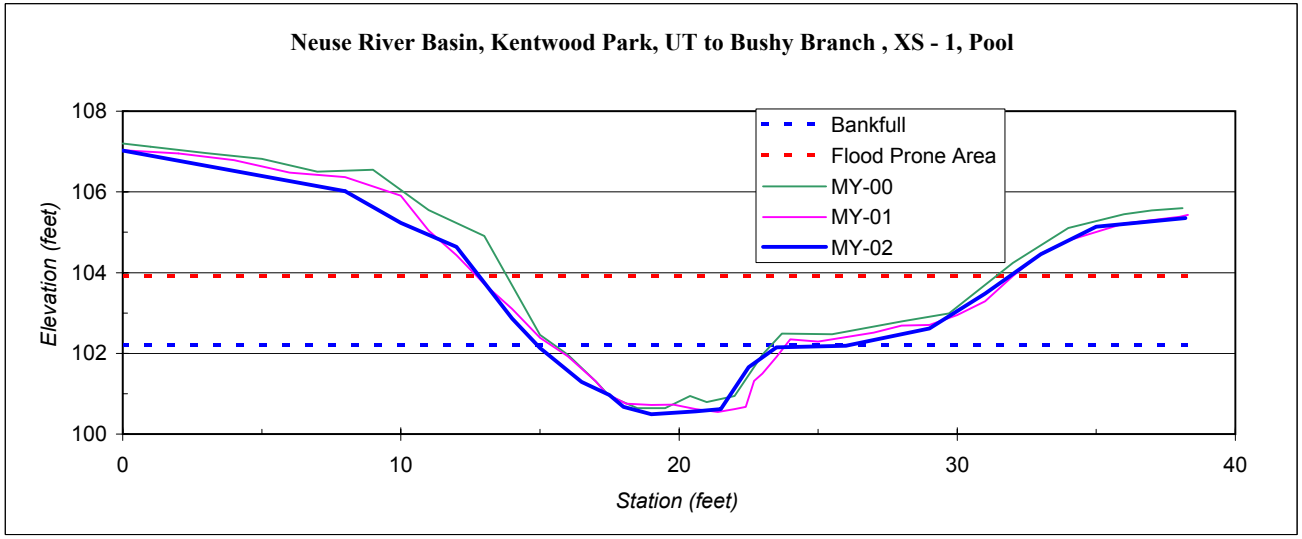
* Total number of features per as-built estimated from as-built profile and planview sheets.

App. B6 - Cross Section Plots

River Basin:	Neuse
Watershed:	Kentwood Park, UT to Bushy Branch
XS ID	XS - 1, Pool
Drainage Area (sq mi):	0.06
Date:	5/10/2006
Field Crew:	A. Spiller, K. Knight

Station	Elevation
0	107.03
8	106.02
10	105.23
12	104.64
14	102.86
15	102.13
16.5	101.29
17.5	100.97
18	100.68
19	100.49
20.6	100.56
21.5	100.62
22.5	101.65
23.5	102.15
26	102.19
29	102.62
31	103.48
33	104.46
35	105.14
38.2	105.35

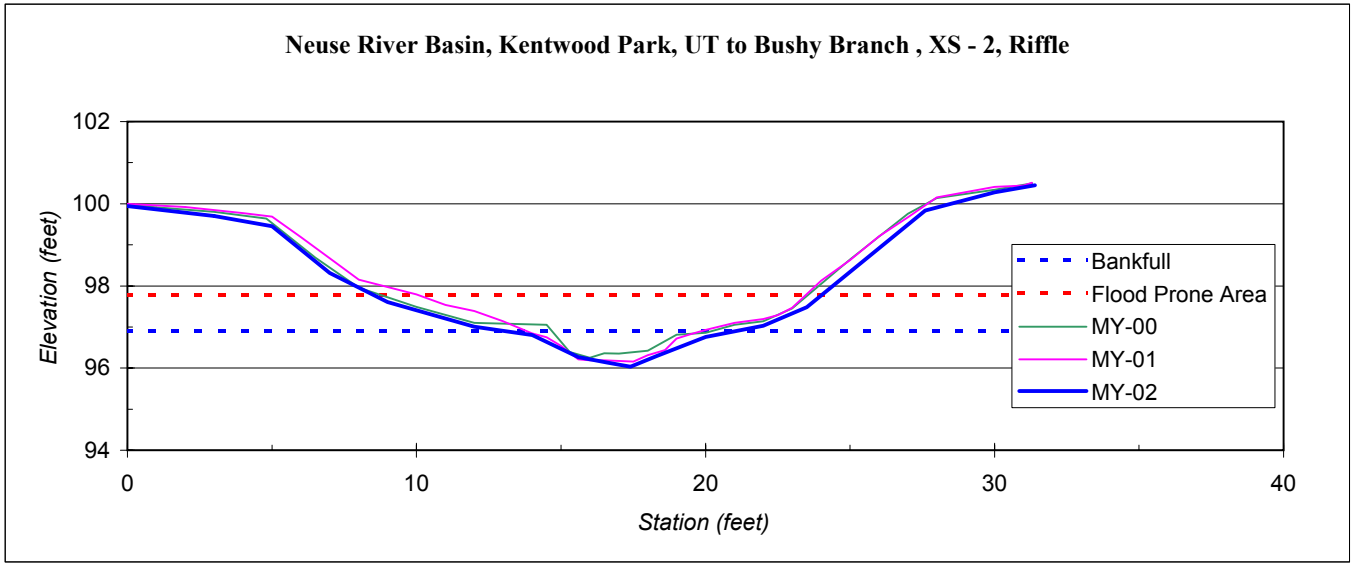
SUMMARY DATA	
Bankfull Elevation:	102.2
Bankfull Cross-Sectional Area:	9.7
Bankfull Width:	8.5
Flood Prone Area Elevation:	103.9
Flood Prone Width:	19.1
Max Depth at Bankfull:	1.7
Mean Depth at Bankfull:	1.1
W / D Ratio:	7.4
Entrenchment Ratio:	2.2
Bank Height Ratio:	1.0



River Basin:	Neuse
Watershed:	Kentwood Park, UT to Bushy Branch
XS ID	XS - 2, Riffle
Drainage Area (sq mi):	0.06
Date:	5/10/2006
Field Crew:	A. Spiller, K. Knight

Station	Elevation
0	99.94
3	99.70
5	99.45
7	98.31
9	97.60
12	97.01
14	96.81
15.6	96.27
16.6	96.14
17.4	96.03
18.3	96.29
20	96.76
22	97.03
23.5	97.48
27.6	99.83
30	100.28
31.4	100.45

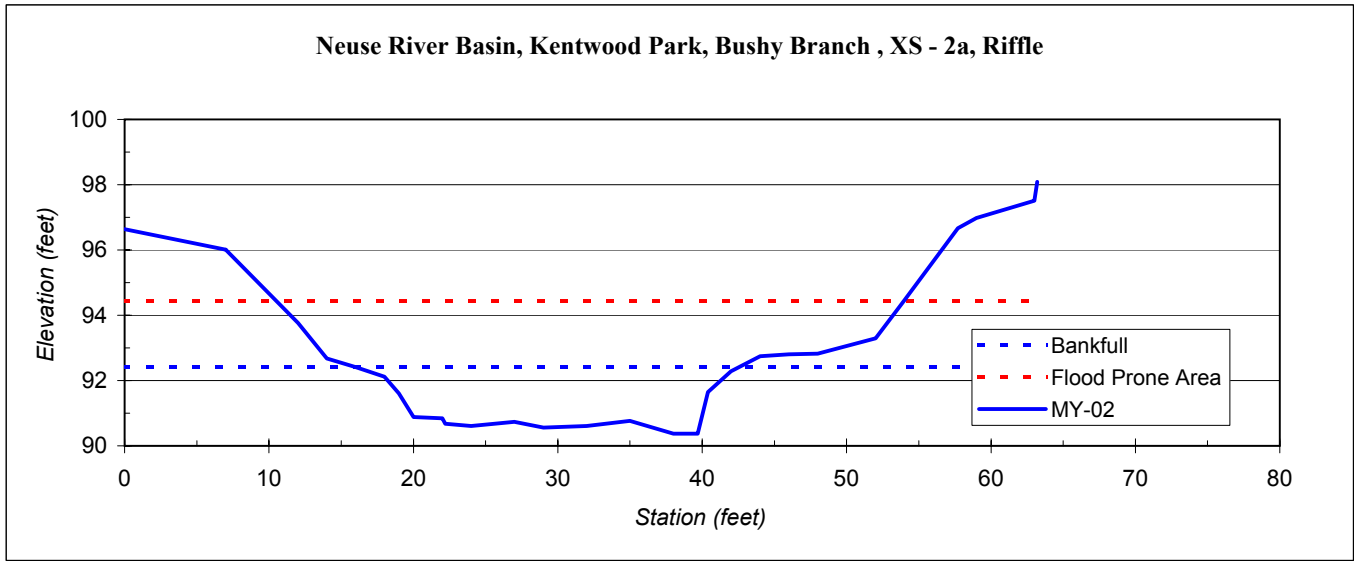
SUMMARY DATA	
Bankfull Elevation:	96.9
Bankfull Cross-Sectional Area:	3.3
Bankfull Width:	8.0
Flood Prone Area Elevation:	97.8
Flood Prone Width:	15.0
Max Depth at Bankfull:	0.9
Mean Depth at Bankfull:	0.4
W / D Ratio:	19.4
Entrenchment Ratio:	1.9
Bank Height Ratio:	1.0



River Basin:	Neuse
Watershed:	Kentwood Park, Bushy Branch
XS ID	XS - 2a, Riffle
Drainage Area (sq mi):	1.27
Date:	5/10/2006
Field Crew:	A. Spiller, K. Knight

Station	Elevation
0	96.64
7	96.01
12	93.76
14	92.68
16	92.41
18	92.12
19	91.60
20	90.88
22	90.84
22.2	90.68
24	90.61
27	90.73
29	90.56
32	90.61
35	90.76
38	90.37
39.7	90.37
40.4	91.64
42	92.28
44	92.74
46	92.80
48	92.82
52	93.29
54	94.46
57.7	96.67
59	96.98
63	97.51
63.2	98.09

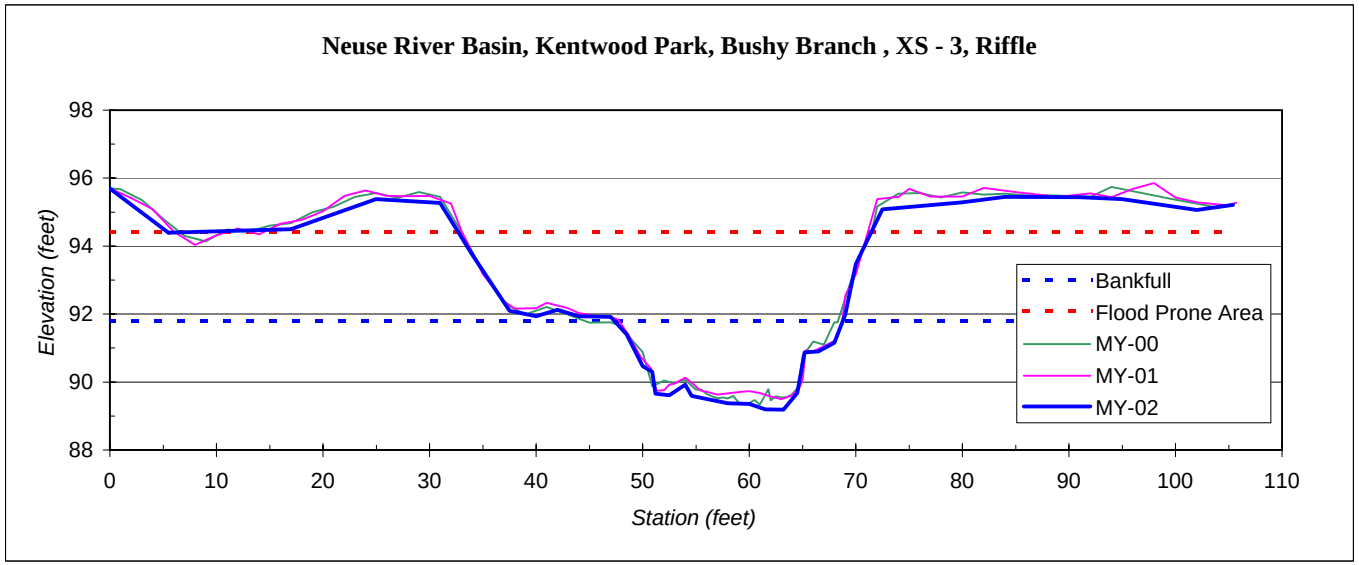
SUMMARY DATA	
Bankfull Elevation:	92.4
Bankfull Cross-Sectional Area:	38.5
Bankfull Width:	26.5
Flood Prone Area Elevation:	94.4
Flood Prone Width:	43.4
Max Depth at Bankfull:	2.0
Mean Depth at Bankfull:	1.5
W / D Ratio:	18.2
Entrenchment Ratio:	1.6
Bank Height Ratio:	1.0



River Basin:	Neuse
Watershed:	Kentwood Park, Bushy Branch
XS ID	XS - 3, Riffle
Drainage Area (sq mi):	1.27
Date:	5/12/2006
Field Crew:	A. Spiller, L. Leiendecker

Station	Elevation
0	95.70
5.5	94.39
17	94.50
25	95.38
31	95.27
34	93.76
37.5	92.09
40	91.94
42	92.12
44	91.93
47	91.92
48.5	91.40
50	90.47
50.9	90.30
51.2	89.65
52.5	89.61
54	89.92
54.6	89.59
58	89.37
60	89.36
61.5	89.19
63.2	89.19
64.5	89.68
65.2	90.87
66.5	90.90
68	91.15
69	91.98
70	93.47
72.5	95.09
80	95.29
84	95.44
91	95.44
95	95.38
102	95.06
105.4	95.21

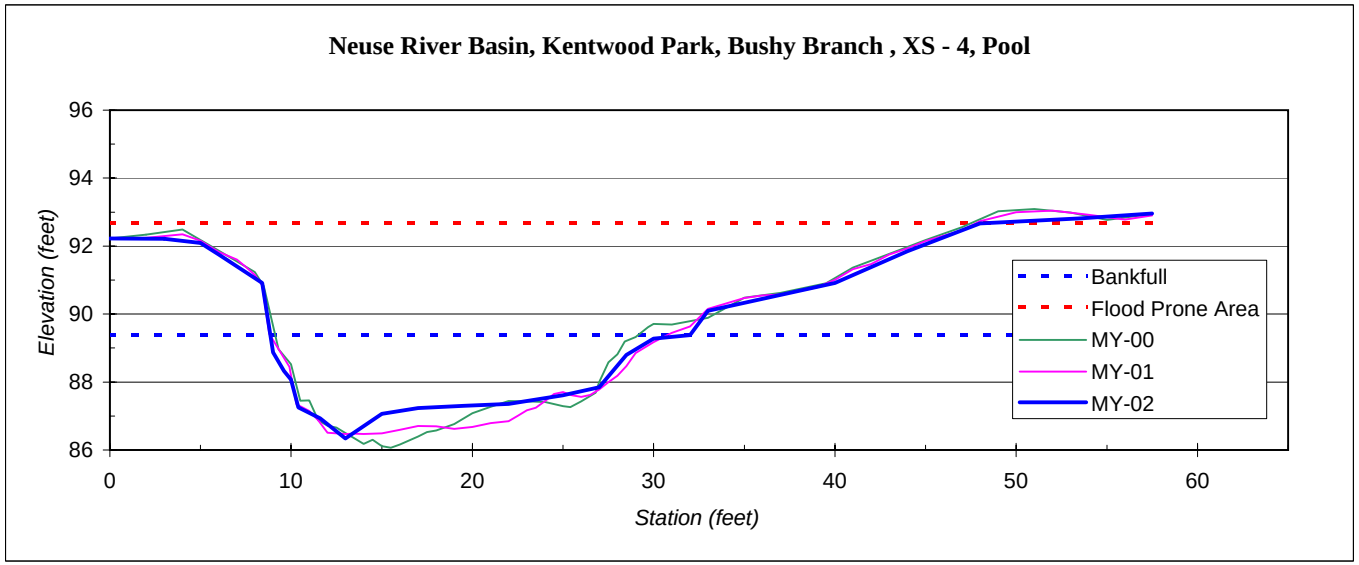
SUMMARY DATA	
Bankfull Elevation:	91.8
Bankfull Cross-Sectional Area:	38.2
Bankfull Width:	21.4
Flood Prone Area Elevation:	94.4
Flood Prone Width:	38.0
Max Depth at Bankfull:	2.6
Mean Depth at Bankfull:	1.8
W / D Ratio:	12.0
Entrenchment Ratio:	1.8
Bank Height Ratio:	1.0



River Basin:	Neuse
Watershed:	Kentwood Park, Bushy Branch
XS ID	XS - 4, Pool
Drainage Area (sq mi):	1.27
Date:	5/12/2006
Field Crew:	A. Spiller, L. Leiendecker

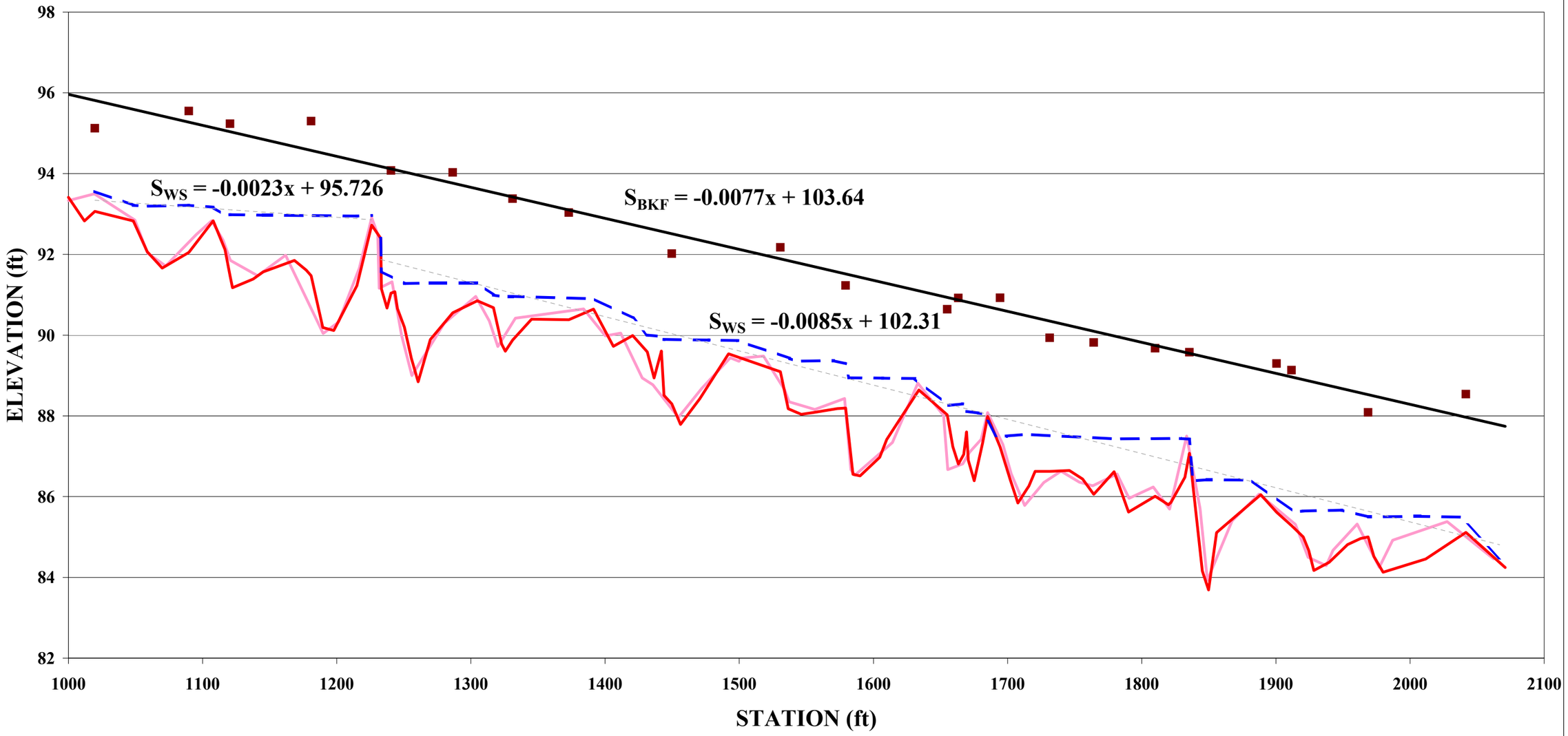
Station	Elevation
0	92.22
3	92.21
5	92.09
6	91.76
8.4	90.91
9	88.88
9.6	88.33
10	88.07
10.4	87.25
11.6	86.93
13	86.34
15	87.07
17	87.23
19.5	87.30
22	87.36
25	87.61
27	87.85
28.5	88.80
30	89.28
32	89.38
33	90.10
40	90.91
44	91.84
48	92.67
53.6	92.81
57.5	92.96

SUMMARY DATA	
Bankfull Elevation:	89.4
Bankfull Cross-Sectional Area:	39.7
Bankfull Width:	23.2
Flood Prone Area Elevation:	92.7
Flood Prone Width:	> 46
Max Depth at Bankfull:	3.3
Mean Depth at Bankfull:	1.7
W / D Ratio:	13.6
Entrenchment Ratio:	> 2.0
Bank Height Ratio:	1.0

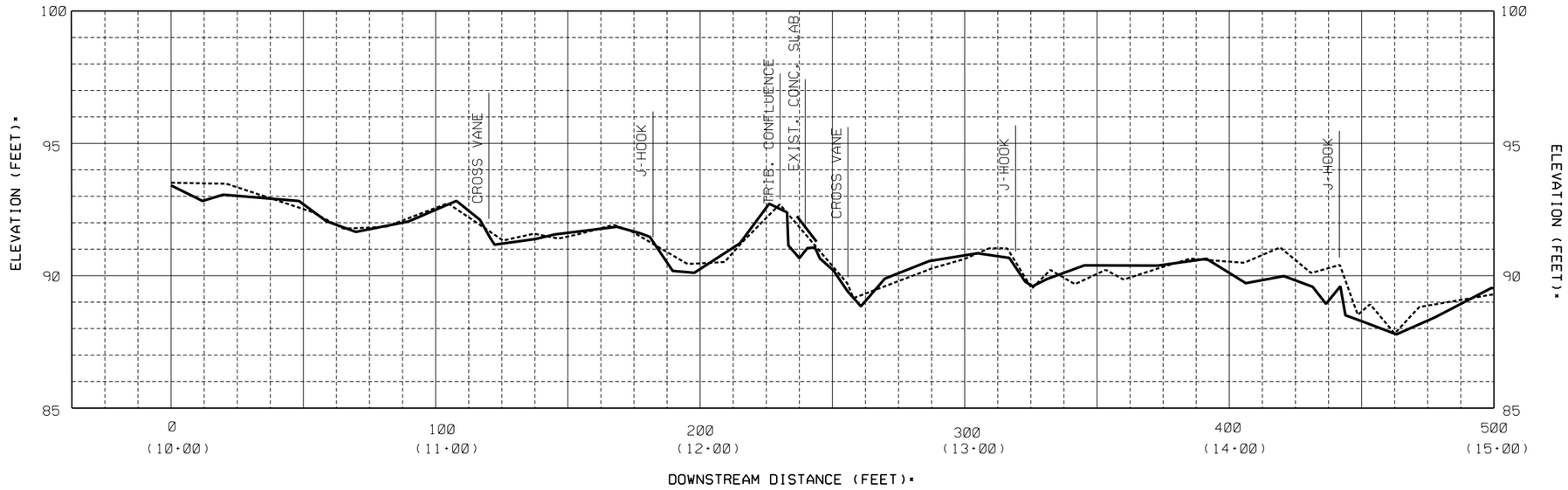


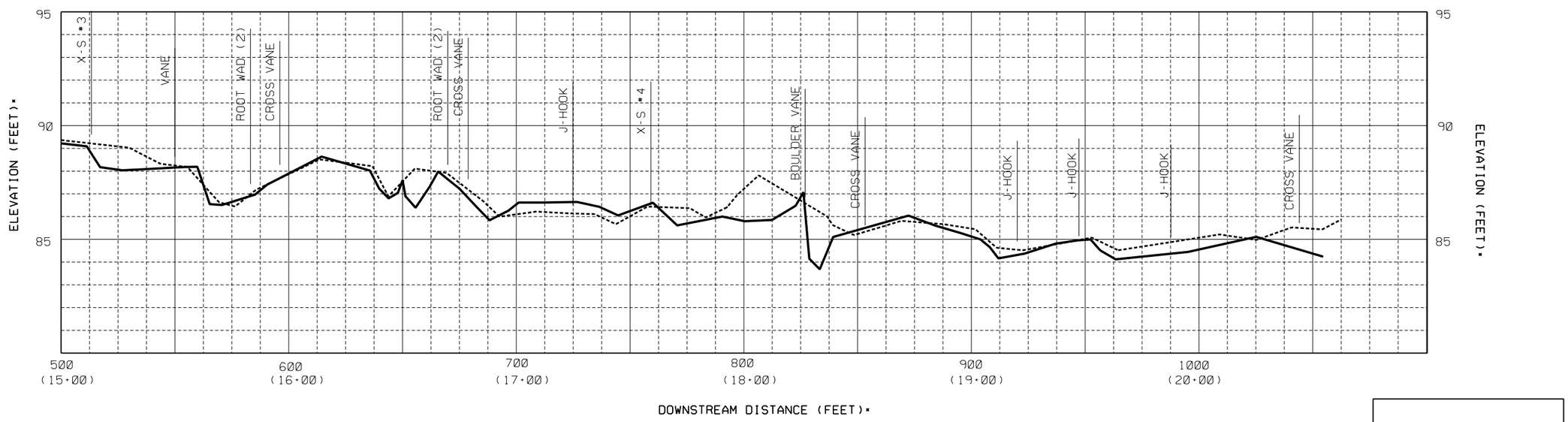
App B7 – Longitudinal Plots

Longitudinal Profile for Bushy Branch
Kentwood Park, Wake County
EEP Project Number 205 - MY02



MAIN CHANNEL PROFILE





MAIN CHANNEL PROFILE

*NOTE:

MONITORING YEAR 02 PROFILE BASED ON CURRENT THALWEG LOCATION WHICH HAS MIGRATED IN SOME PLACES, DUE TO NATURAL STREAM PROCESSES, SINCE AS BUILT SURVEY IN 2004.

REVISIONS

STM.	DESCRIPTION	DATE	APPROVED

Ecosystem Enhancement Program

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 - MY02

DATE: JUNE 2008
SCALE: SEE SHEET

BUSHY BRANCH PROFILE

SHEET 1 OF 1

Table B3: Thawleg Points for Bushy Branch
Kentwood Park (Bushy Branch), Wake County
EEP Project number 205 - MY02

Station	Elevation*
1000.0	93.4
1011.9	92.8
1019.7	93.1
1048.4	92.8
1058.7	92.1
1069.8	91.7
1089.7	92.0
1107.9	92.8
1116.8	92.1
1120.4	91.5
1122.3	91.2
1137.7	91.4
1145.1	91.6
1168.5	91.9
1177.3	91.6
1180.9	91.5
1189.6	90.2
1197.8	90.1
1215.0	91.2
1226.1	92.7
1232.8	92.4
1233.3	91.1
1237.5	90.7
1240.5	91.0
1243.3	91.1
1245.2	90.7
1250.4	90.2
1255.6	89.4
1260.7	88.8
1269.8	89.9
1286.5	90.6
1304.8	90.9
1316.8	90.7
1322.9	89.8
1325.6	89.6
1331.1	89.9
1345.2	90.4
1373.0	90.4
1391.4	90.6
1406.2	89.7
1420.6	90.0
1431.5	89.6

Station	Elevation*
1436.6	88.9
1442.0	89.6
1443.9	88.5
1449.7	88.3
1456.2	87.8
1470.7	88.4
1492.1	89.5
1530.7	89.1
1536.6	88.2
1546.2	88.0
1554.2	88.1
1573.2	88.2
1579.3	88.2
1584.7	86.6
1590.1	86.5
1604.7	87.0
1610.0	87.4
1633.9	88.6
1655.1	88.0
1659.2	87.2
1663.3	86.8
1667.4	87.0
1669.5	87.6
1670.7	86.9
1675.2	86.4
1681.4	87.3
1685.1	88.0
1694.5	87.2
1702.1	86.4
1707.7	85.8
1714.3	86.2
1715.9	86.3
1720.5	86.6
1731.5	86.6
1746.1	86.6
1755.9	86.4
1764.2	86.1
1779.4	86.6
1782.5	86.3
1790.1	85.6
1810.0	86.0
1819.8	85.8

Station	Elevation*
1821.8	85.9
1832.2	86.5
1835.6	87.1
1845.2	84.2
1849.8	83.7
1855.7	85.1
1888.8	86.0
1900.5	85.6
1911.7	85.3
1920.4	85.0
1924.5	84.7
1928.3	84.2
1939.7	84.4
1953.4	84.8
1963.1	85.0
1968.8	85.0
1973.0	84.5
1979.8	84.1
2011.6	84.5
2041.6	85.1
2071.0	84.2

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

Table B4: Water Surface Points for Bushy Branch
Kentwood Park (Bushy Branch), Wake County
EEP Project number 205 - MY02

TW Station	WS Elevation*
1019.73	93.56
1048.37	93.22
1058.70	93.19
1089.74	93.22
1107.86	93.17
1116.76	92.97
1120.42	92.98
1145.08	92.97
1180.94	92.96
1215.00	92.95
1226.06	92.97
1280.00	91.26
1232.82	92.40
1233.32	91.58
1250.41	91.28
1269.78	91.29
1304.80	91.29
1316.84	90.99
1322.86	90.96
1331.06	90.96
1391.38	90.90
1420.62	90.43
1431.50	90.00
1441.98	89.96
1443.89	89.89
1477.65	89.88
1499.06	89.86
1537.69	89.42

TW Station	WS Elevation*
1543.56	89.35
1570.25	89.37
1579.12	89.29
1581.74	88.94
1606.97	88.94
1630.88	88.93
1652.09	88.35
1656.19	88.26
1666.46	88.30
1667.74	88.12
1678.38	88.07
1682.12	88.05
1691.51	87.51
1699.05	87.50
1712.89	87.54
1779.50	87.43
1828.84	87.44
1835.56	87.42
1838.18	86.39
1848.75	86.42
1881.75	86.41
1913.36	85.62
1920.37	85.64
1949.28	85.67
1968.85	85.50
2007.48	85.51
2037.42	85.49
2066.85	84.48

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

Table B3: Bankfull Points for Bushy Branch
Kentwood Park (Bushy Branch), Wake County
EEP Project number 205 - MY02

TW Station	Bkf Elevation*
1019.73	95.12
1089.74	95.55
1120.42	95.24
1180.94	95.30
1240.47	94.08
1286.52	94.03
1331.06	93.38
1372.97	93.03
1449.71	92.02
1530.69	92.17
1579.28	91.23
1655.09	90.64
1663.30	90.92
1694.51	90.93
1731.46	89.93
1764.21	89.82
1809.98	89.67
1835.56	89.58
1900.49	89.30
1911.69	89.13
1968.76	88.08
2041.58	88.54

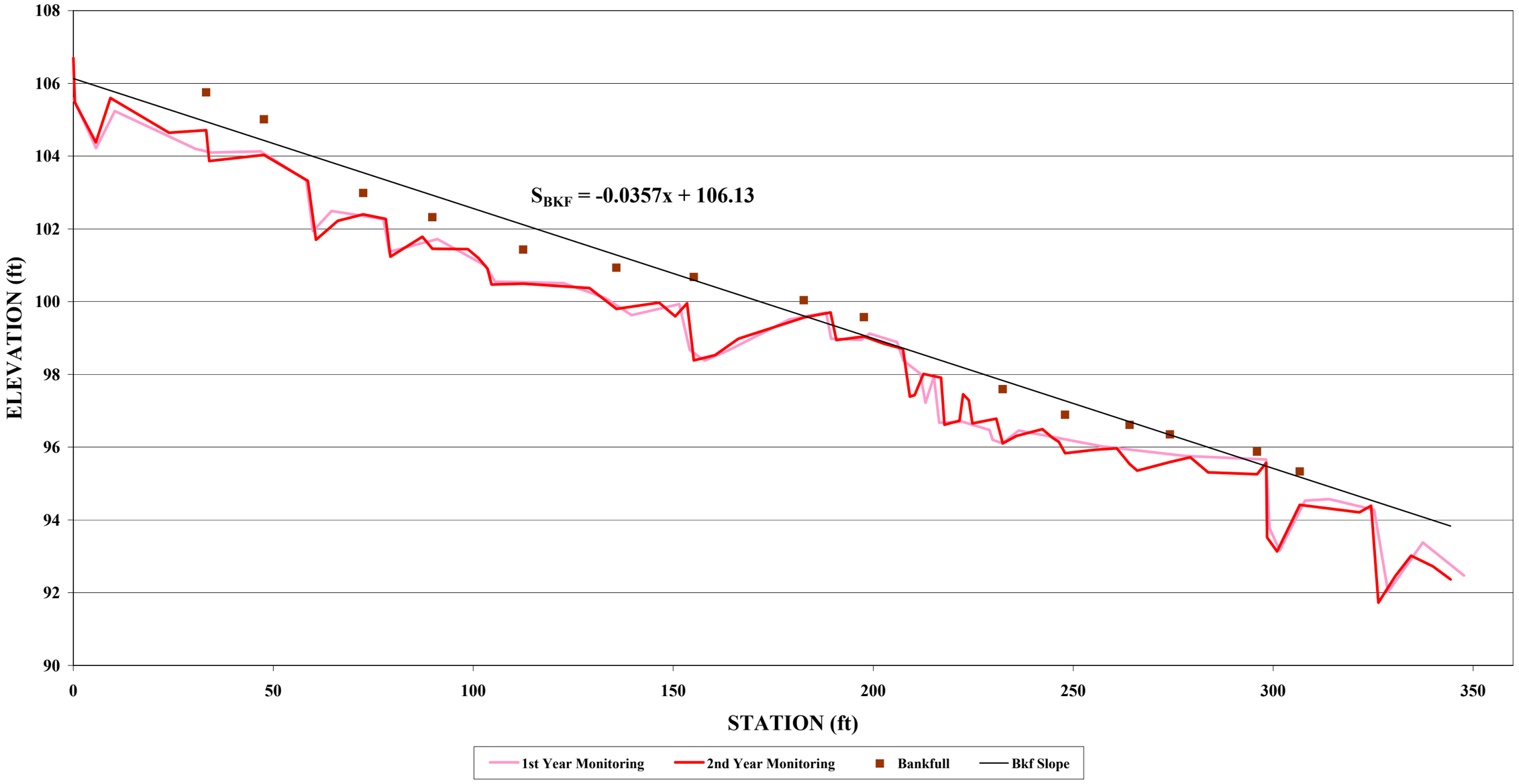
*Elevations are based on an assumed elevation, XS #2 left bank pin is at an elevation of 100ft.

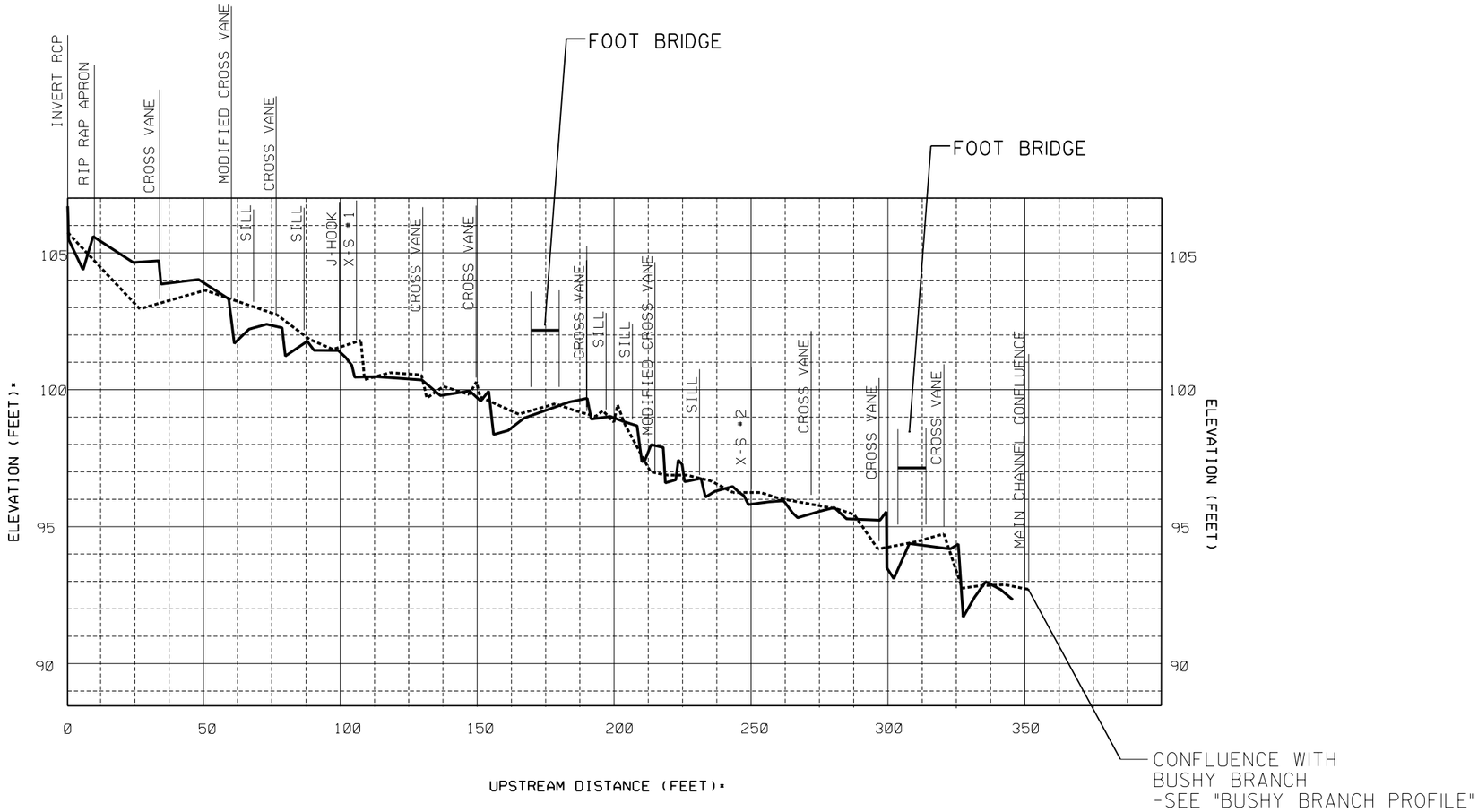
Table B4: Riffle and Pool Measurements for Bushy Branch
Kentwood Park (Bushy Branch), Wake County
EEP Project number 205 - MY02

Riffle Measurements			
Station	Length	WS Elev	WS Slope
1020	29	93.6	0.0112
1048		93.2	
1108	9	93.2	0.0180
1117		93.0	
1305	12	91.3	0.0245
1317		91.0	
1391	40	91.0	0.0110
1431		90.5	
1499	32	90.5	0.0354
1531		89.4	
1634	21	89.8	0.0033
1655		89.7	
1685	9	89.7	0.0362
1695		89.4	
1889	23	89.1	0.0336
1912		88.3	
2042	29	88.2	0.0190
2071		87.6	

Pool Measurements		
Station	Length	P-P Spacing
1058	31	62
1089		
1120	95	130
1215		
1250	19	72
1270		
1323	8	121
1331		
1444	34	100
1478		
1544	37	48
1580		
1592	25	74
1617		
1666	22	43
1688		
1709	130	136
1839		
1845	21	75
1866		
1920	33	53
1953		
1973	47	
2020		

Longitudinal Profile for UT to Bushy Branch
Kentwood Park, Wake County
EEP Project Number 205 - MY02





TRIBUTARY PROFILE

AS-BUILT CHANNEL ELEVATION

MONITORING YEAR 02 CHANNEL ELEVATION

REVISIONS

STM	DESCRIPTION	DATE	APPROVED

Ecosystem Enhancement Program

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 - MY02

DATE: JUNE 2006
SCALE: SEE SHEET

UT TO BUSHY BRANCH PROFILE

SHEET 1 OF 1

Table B5: Thawleg Points for UT to Bushy Branch
Kentwood Park (Bushy Branch), Wake County
EEP Project number 205 - MY02

Station	Elevation*
0.00	105.58
0.39	104.22
5.61	105.24
9.27	104.20
23.94	104.10
33.23	104.13
33.99	103.34
47.67	101.94
58.65	102.49
60.68	102.27
66.14	101.37
72.51	101.72
78.11	100.99
79.28	100.55
87.26	100.51
89.80	100.11
98.65	99.63
101.34	99.93
103.55	98.67
104.56	98.38
112.48	98.66
129.05	99.51
135.77	99.70
146.46	98.98
150.49	98.95
153.45	98.95
155.16	98.95
160.46	98.95
166.27	98.95
182.63	98.95
189.33	98.66
190.77	99.51
197.67	99.70
202.59	98.98
207.45	98.95
209.17	99.12

Station	Elevation*
210.34	97.43
212.58	98.01
216.97	97.91
217.79	96.62
221.60	96.73
222.48	97.45
223.91	97.29
224.82	96.66
230.78	96.78
232.40	96.10
235.83	96.31
242.28	96.49
244.85	96.26
246.42	96.15
247.99	95.83
255.69	95.93
260.88	95.97
264.10	95.53
266.05	95.35
274.23	95.59
279.29	95.72
283.75	95.31
296.00	95.26
298.28	95.57
298.49	93.52
300.98	93.13
306.67	94.41
321.55	94.21
324.49	94.39
326.32	91.73
330.54	92.46
334.50	93.02
339.95	92.73
344.38	92.36

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

Table B6: Bankfull Points for UT to Bushy Branch
Kentwood Park (Bushy Branch), Wake County
EEP Project number 205 - MY02

TW Station	Bkf Elevation*
33.23	105.75
47.67	105.01
72.51	102.99
89.80	102.32
112.48	101.43
135.77	100.93
155.16	100.67
182.63	100.04
197.67	99.57
232.40	97.59
247.99	96.89
264.10	96.61
274.23	96.35
296.00	95.88
306.67	95.33

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

Table B7: Riffle and Pool Measurements for UT to Bushy Branch
Kentwood Park (Bushy Branch), Wake County
EEP Project number 205 - MY02

Riffle Measurements*	
Station	Length
9 33	24
48 59	11
73 78	5
87 104	17
129 136	7
198 208	10
314 324	10
335 344	9

Pool Measurements*		
Station	Length	P-P Spacing
0 9	9	59
59 66	7	19
78 87	9	75
153 183	30	64
217 223	6	44
261 280	19	37
298 307	9	27
325 335	10	

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

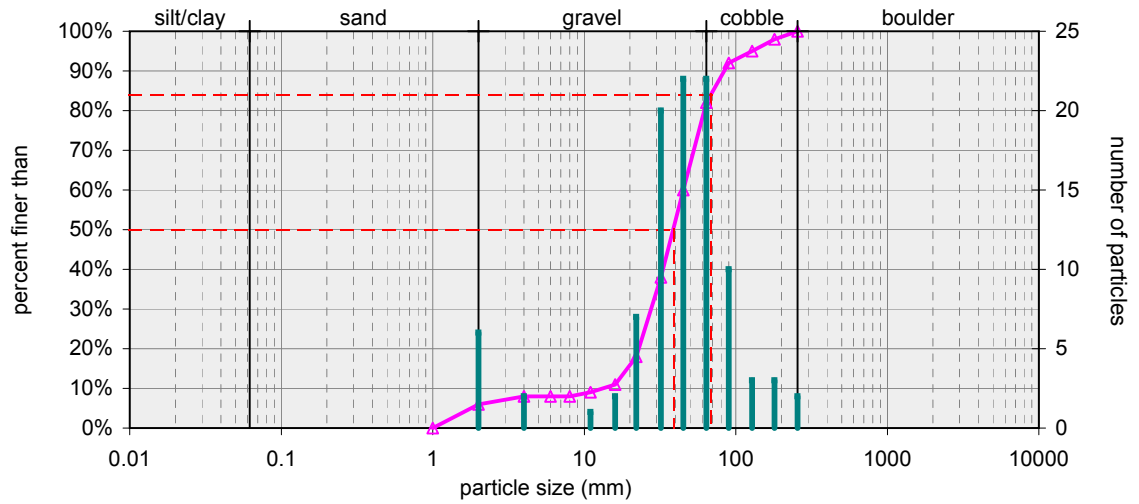
App B8 - Pebble Count Plots

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	
very coarse sand	1 - 2	**6**
very fine gravel	2 - 4	**2**
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	**1**
medium gravel	11 - 16	**2**
coarse gravel	16 - 22	**7**
coarse gravel	22 - 32	**20**
very coarse gravel	32 - 45	**22**
very coarse gravel	45 - 64	**22**
small cobble	64 - 90	**10**
medium cobble	90 - 128	**3**
large cobble	128 - 180	**3**
very large cobble	180 - 256	**2**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:

Kentwood Park, MY02
XS 1 Riffle



Size (mm)	
D16	20
D35	30
D50	39
D65	49
D84	69
D95	130

Size Distribution	
mean	37.1
dispersion	1.9
skewness	-0.03

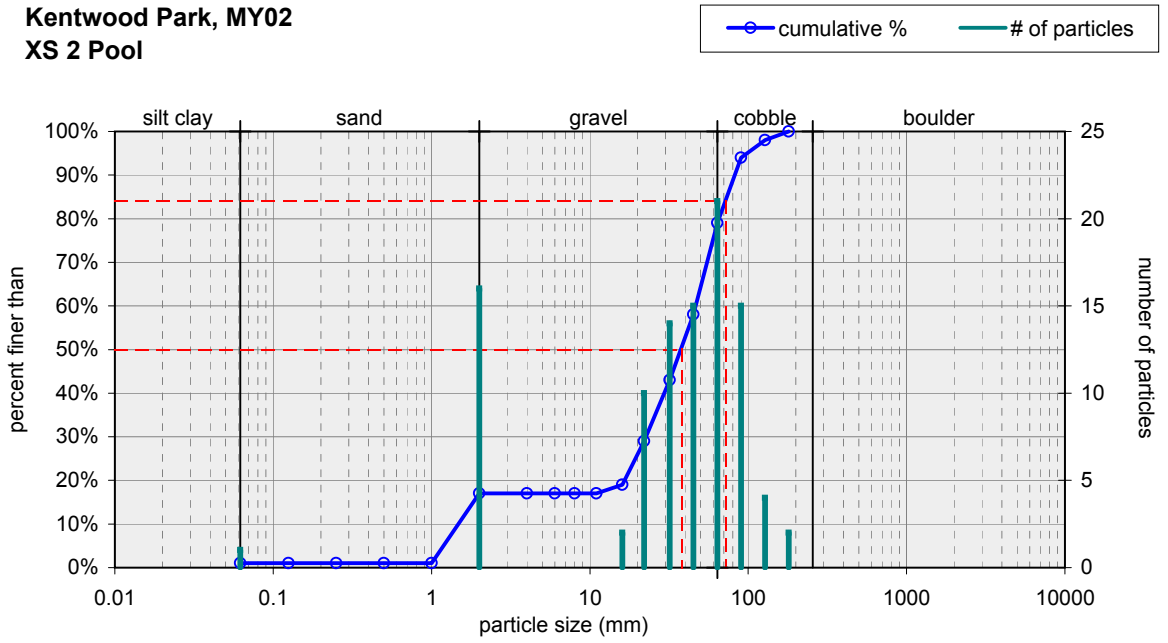
Type	
silt/clay	0%
sand	6%
gravel	76%
cobble	18%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**1**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	
very coarse sand	1 - 2	**16**
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	
medium gravel	11 - 16	**2**
coarse gravel	16 - 22	**10**
coarse gravel	22 - 32	**14**
very coarse gravel	32 - 45	**15**
very coarse gravel	45 - 64	**21**
small cobble	64 - 90	**15**
medium cobble	90 - 128	**4**
large cobble	128 - 180	**2**
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	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:

Kentwood Park, MY02
XS 2 Pool



Size (mm)	
D16	1.9
D35	26
D50	38
D65	51
D84	72
D95	98

Size Distribution	
mean	11.7
dispersion	10.9
skewness	-0.41

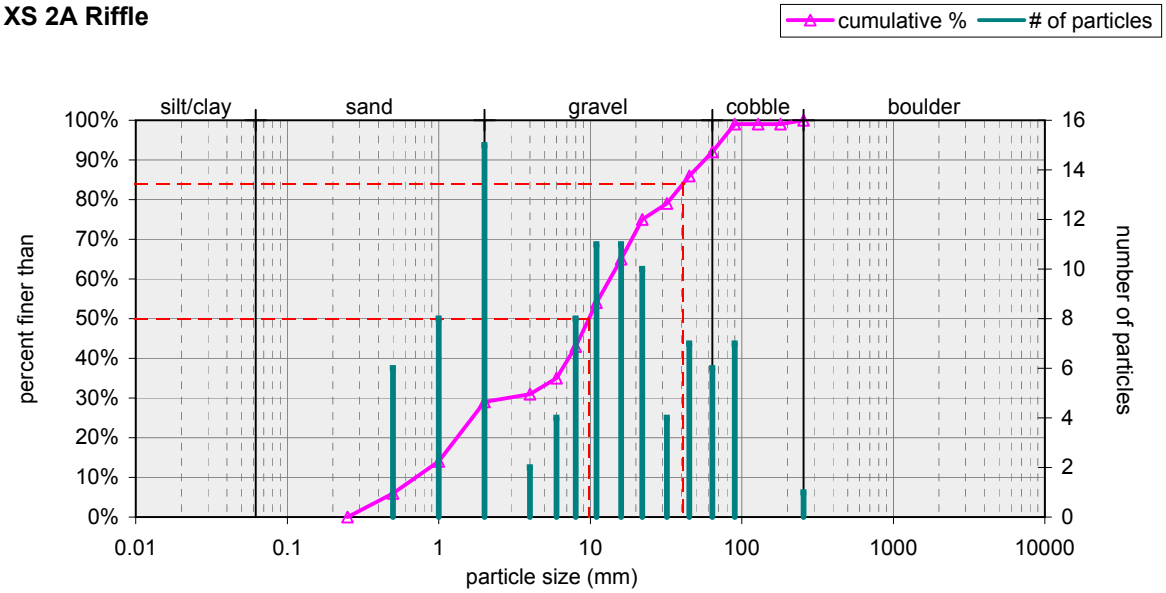
Type	
silt/clay	1%
sand	16%
gravel	62%
cobble	21%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	**6**
coarse sand	0.5 - 1	**8**
very coarse sand	1 - 2	**15**
very fine gravel	2 - 4	**2**
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**8**
medium gravel	8 - 11	**11**
medium gravel	11 - 16	**11**
coarse gravel	16 - 22	**10**
coarse gravel	22 - 32	**4**
very coarse gravel	32 - 45	**7**
very coarse gravel	45 - 64	**6**
small cobble	64 - 90	**7**
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	**1**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:

Kentwood Park, MY02
XS 2A Riffle



Size (mm)	
D16	1.1
D35	6
D50	9.8
D65	16
D84	41
D95	74

Size Distribution	
mean	6.7
dispersion	6.5
skewness	-0.13

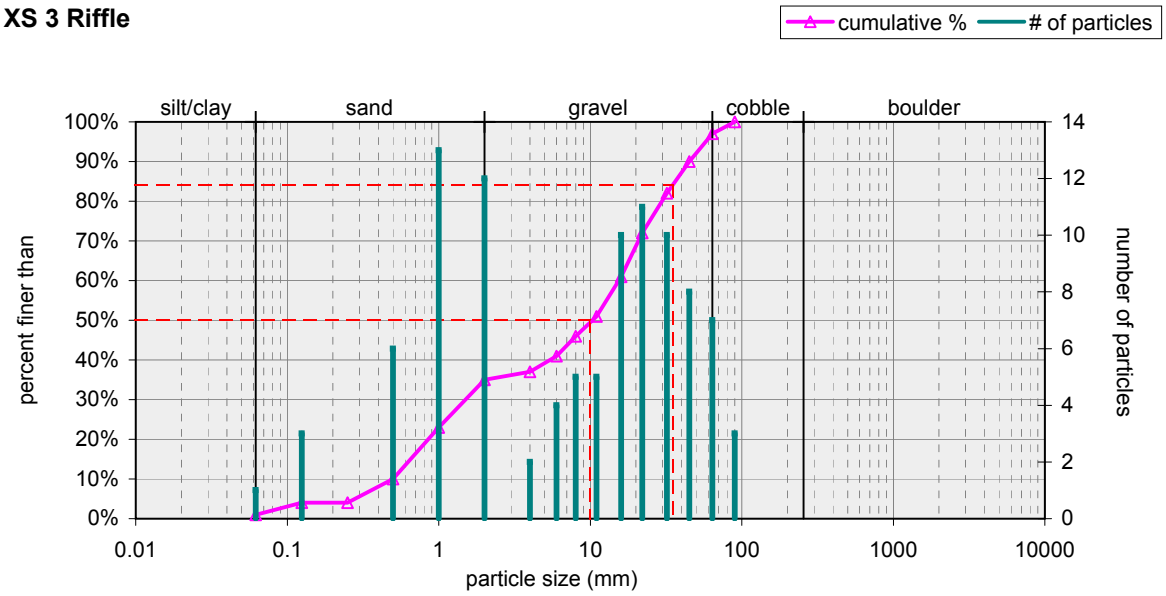
Type	
silt/clay	0%
sand	29%
gravel	63%
cobble	8%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**1**
very fine sand	0.062 - 0.125	**3**
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	**6**
coarse sand	0.5 - 1	**13**
very coarse sand	1 - 2	**12**
very fine gravel	2 - 4	**2**
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**5**
medium gravel	8 - 11	**5**
medium gravel	11 - 16	**10**
coarse gravel	16 - 22	**11**
coarse gravel	22 - 32	**10**
very coarse gravel	32 - 45	**8**
very coarse gravel	45 - 64	**7**
small cobble	64 - 90	**3**
medium cobble	90 - 128	
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	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:

Kentwood Park, MY02
XS 3 Riffle



Size (mm)	
D16	0.69
D35	2
D50	10
D65	18
D84	35
D95	58

Size Distribution	
mean	4.9
dispersion	9.0
skewness	-0.24

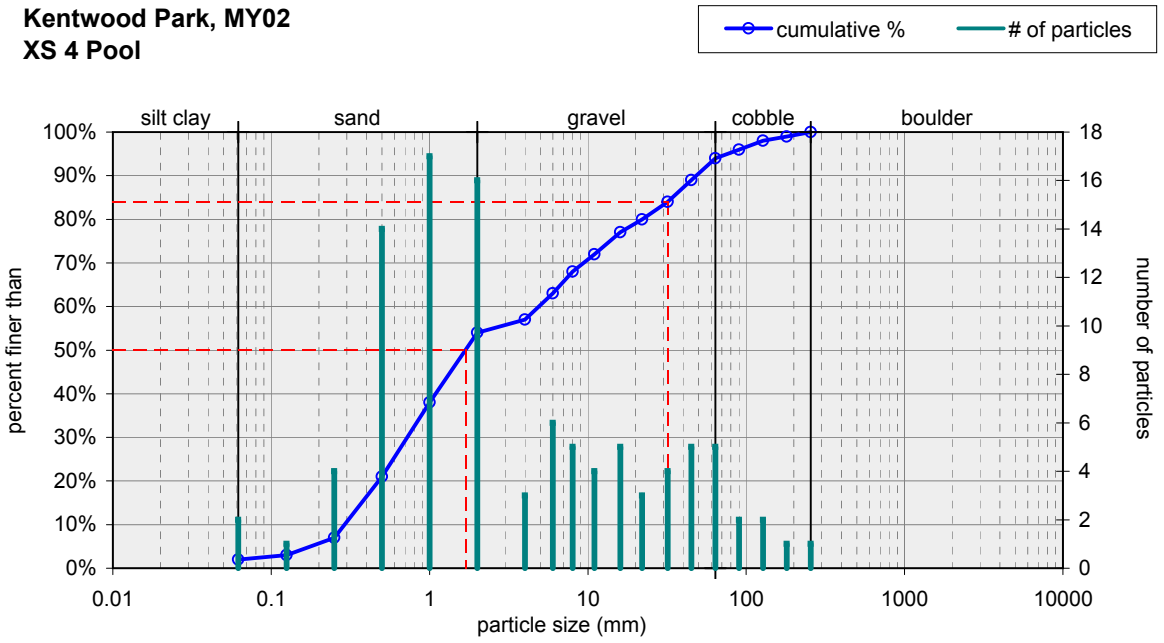
Type	
silt/clay	1%
sand	34%
gravel	62%
cobble	3%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**2**
very fine sand	0.062 - 0.125	**1**
fine sand	0.125 - 0.25	**4**
medium sand	0.25 - 0.5	**14**
coarse sand	0.5 - 1	**17**
very coarse sand	1 - 2	**16**
very fine gravel	2 - 4	**3**
fine gravel	4 - 6	**6**
fine gravel	6 - 8	**5**
medium gravel	8 - 11	**4**
medium gravel	11 - 16	**5**
coarse gravel	16 - 22	**3**
coarse gravel	22 - 32	**4**
very coarse gravel	32 - 45	**5**
very coarse gravel	45 - 64	**5**
small cobble	64 - 90	**2**
medium cobble	90 - 128	**2**
large cobble	128 - 180	**1**
very large cobble	180 - 256	**1**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:

Kentwood Park, MY02
XS 4 Pool



Size (mm)	
D16	0.39
D35	0.88
D50	1.7
D65	6.7
D84	32
D95	76

Size Distribution	
mean	3.5
dispersion	11.6
skewness	0.23

Type	
silt/clay	2%
sand	52%
gravel	40%
cobble	6%
boulder	0%