Chavis Park (Garner Branch) Stream Restoration Monitoring Report

EEP Project # 87

Monitoring Year – 03

2006

Submitted to:

Ecosystem Enhancement PROGRAM

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

January 2007

Monitoring Firm

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Design Firms

Becky L. Ward Consulting

Ecological Consultants

Natural Areas Ecosystem Management

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EXECUTIVE SUMMARY

The Wetlands Restoration Program identified the Garner Branch of Walnut Creek in Chavis Park as a restoration design project in 1999. The watershed of approximately 0.54-mi^2 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 2,000 linear feet of channel. The restoration was designed to correct various problems with the existing stream corridor including unstable channel configuration, poor water quality, no 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. Monitoring was completed for the first and second years in 2004 and 2005, respectively. This report is a description of the findings of the third year monitoring that took place in 2006.

The restoration plan called for removal of all existing vegetation along the stream banks and within the riparian buffer. The original planting of native vegetation was found to be unsuccessful during the first year monitoring. A remedial vegetation plan was designed in 2004 and implemented the same year. Vegetation was planted at a density of 680 and 890 stems per acre in the streamside and terrace slope communities, respectively. The wooden stakes marking the first year vegetation monitoring plot corners were not located during the second year. Four new plots were surveyed and the corners marked with metal conduit for the remaining monitoring years. The third year monitoring counted an average of 749 stems per acre. Vegetation is extensive for the length of the project with minimal bare banks and slopes. Widespread microstegium growth is the most visible sign of exotic/invasive plants throughout the site. Other invasive vegetation has been noted as described within this report. The third year monitoring found the vegetation component of the project to be successful.

The stream assessment completed during the third 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 local areas of bank erosion. The stream profile does not have well defined features, but some are discernible along the profile length. Many of the in-stream structures are functioning, though several are experiencing stress evidenced by localized erosion on cross vane arms. The most obvious stream problem occurs in the main channel immediately upstream of the confluence with the tributary. A hydraulic path has been cut around the left side of the cross vane and the cross vane boulders have moved to direct water towards the bank instead of down the center of the stream. This has resulted in severe bank erosion leaving a shear bank face of unconsolidated material that will continue to erode. This issue should be addressed to prevent further stream bank erosion. Other bank erosion issues of moderate concern are detailed in the report and should be monitored, but do not call for immediate action. Due to the nature of Chavis Park as an urban stream setting, it is expected that trash and urban debris will exist throughout the project site. Monitoring observed large amounts of trash in the riparian area and stream channel, including a shopping cart full of debris in one of the pools. The level of trash and debris should continue to be monitored to prevent debris from causing damaging blockages to flow or other problems.

1.0 PROJECT BACKGROUND

1.1 Project Objectives

- Reduce bank erosion by adjustment of the existing channel pattern or by bioengineered methods.
- Improve water quality by reducing erosion and by increasing the connectivity between the channel and floodplain.
- Stabilize the bankfull elevation along the reach.
- Enhance instream habitat by placing structures, overhanging vegetation and removal of aggressive species.
- Enhance riparian corridor with native vegetative species to improve the function and aesthetic value.
- Slope and vegetate the stream banks so that they are more resistant to flooding.
- Plant native trees, bushes and ground cover that will stabilize the stream banks, shade the stream, and provide wildlife cover and food.

1.2 Project Structure, Restoration Type, and Approach

Before restoration, the channel of Garner Branch of Walnut Creek through Chavis Recreational Park was deeply incised and entrenched with heavy bank erosion due to urban storm runoff. The creek was restored using channel dimension, pattern, and profile modifications and the establishment of a 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 and vegetation along the channel banks. Due to multiple urban constraints, pattern modifications were limited throughout the project.

1.3 Location and Setting

Chavis Park is located within the city limits of Raleigh, North Carolina. The watershed 0.54 mi.^{2} is urban and fully developed. The current zoning and planimetric maps from the City of Raleigh show three-quarters of the watershed development consists primarily of residential high density properties. Land usage in the upper northeastern quarter of the watershed supports dense developments of downtown city offices, businesses and industrial facilities. The watershed is completely built out with little potential for future development.

1.4 Project History and Background

Table 1. Project Restoration Components
Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)

Segment / Reach ID	Existing Linear Feet	Type	Approach	Linear Feet	Mitigation Ratio	Mitigation Units	Stationing	Comment
Garner Branch	N/A	R	P2/3	1,880	1.0	1,880	10+00 - 28+80	
UT to Garner Branch	N/A	R	P2/3	330	1.0	330	30+00 - 33+30	

Mitigation Unit Summations

Stream (lf)	Riparian Wetland (Ac)	Nonriparian Wetland (Ac)	Total Wetland (Ac)	Buffer (Ac)	Comment
2,210					

R = Restoration P2/3 = Combination of Priority II and III

DIRECTIONS TO CHAVIS PARK SITE: From Interstate I-440 take exit 15 to Poole Road, west toward the City of Raleigh. Poole Road diverges into Martin Luther King Jr. Boulevard; continue on MLK Boulevard until you reach The City of Raleigh's Chavis Park on the north side of MLK Boulevard. Make a right and proceed north on Holmes Street; the site is on the left side (west) before the inersection with E. Lenoir Street.

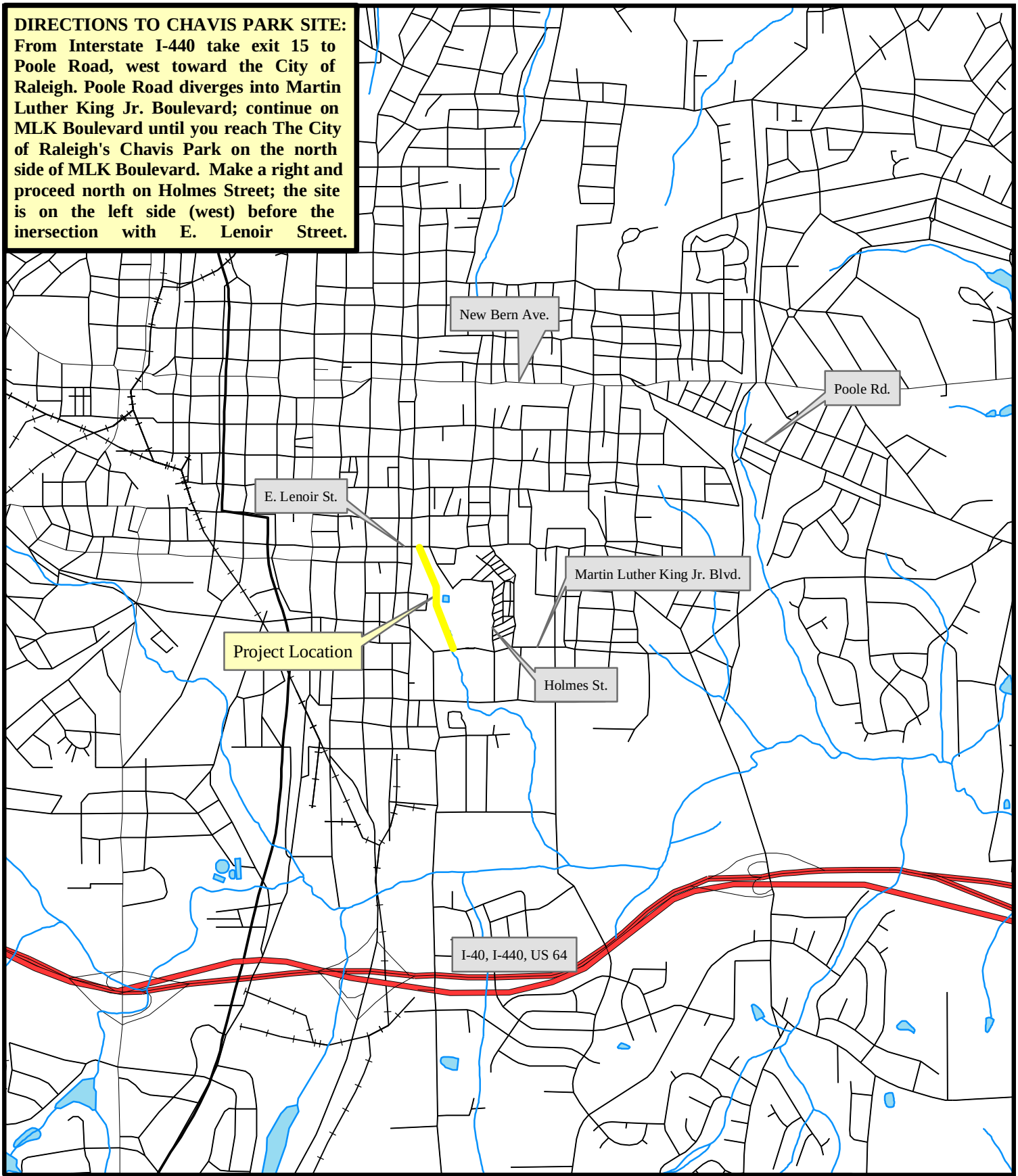


Figure 1. Site Vicinity Map
Chavis Park, Wake County, EEP Project # 87 - MY03

0.25 0.125 0 0.25 0.5
Miles

Date: 01/02/07

Ecosystem Enhancement Program

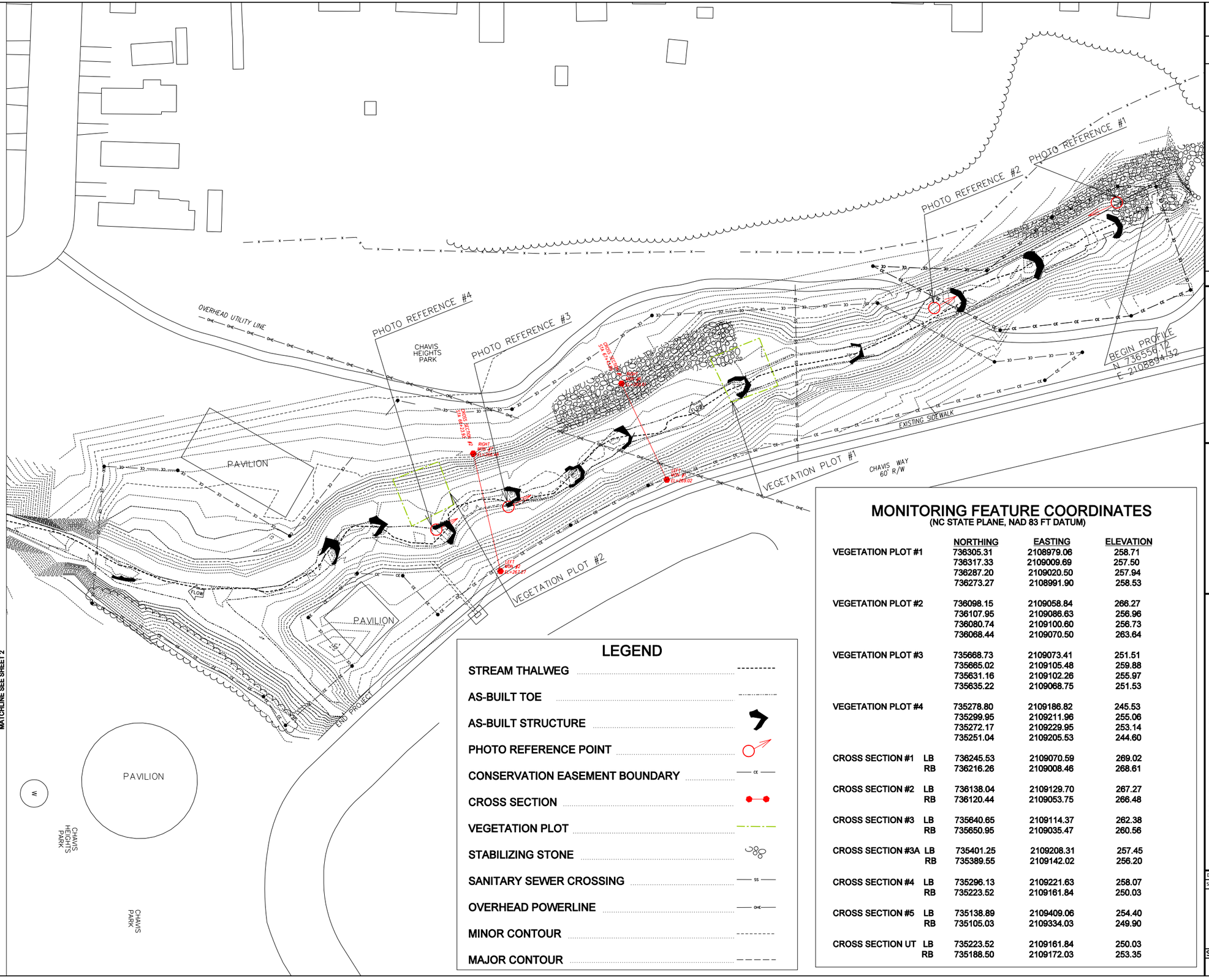
KCI Associates of NC

Table 2. Project Activity and Reporting History Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan	2002	Feb 02
Final Design - 90%		
Construction	2002	2002
As-built Report	Sep 02	2002
Year 1 Monitoring	Jun 04	Feb 05
Vegetative Maintenance Plan	2004	Mar 04
Vegetative Maintenance Planting	2004	Jun 05
Year 2 Monitoring	Aug 05	Jan 06
Year 3 Monitoring	Oct 06	Jan 07

Table 3. Project Contact Table Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)	
Design Firms	Becky L. Ward Consulting 1512 Eglantyne Ct. Raleigh, NC 27613
	Ecological Consultants 4216 Hope Valley Drive Raleigh, NC 27278
	Natural Areas Ecosystem Management 10015 Wright Road Harvard, Illinois 60033 Contact: Mr. Randy Stowe Phone: (815) 648-2253 Fax: (815) 648-2403
Construction Contractor	White Oak Construction Corporation 4020 Pea Ridge Road New Hill, North Carolina 27562 Contact: Mr. Bruce Hollis Phone: (919) 545-0442 Fax: (919) 545-2034
Planting and Vegetation Contractor	Tower Engineering Professionals 3703 Junction Boulevard Raleigh, North Carolina 27603-5263 Contact: Mr. George T. Swearingen Phone: (919) 661-6351 Fax: (919) 661-6350

Table 3 cont. Project Contact Table	
Maintenance Planting and Plan Designer	EcoScience 1101 Haynes Street, Suite 101 Raleigh, North Carolina 27604 Phone: (919) 828-3433
Monitoring Performers	
MY-01	Biological & Agricultural Engineering Water Resources Research Institute North Carolina State University Campus Box 7625 Raleigh, NC 27695 Contact: Mr. Dan Clinton Phone: (919) 515-3723
MY-02, MY-03	KCI Associates of NC Landmark Center II, Suite 220 4602 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: 87 - Chavis Park (Garner Branch of Walnut Creek)**	
Project County	Wake County
Drainage Area	0.54 sq. mi. (Garner Branch)
	0.20 sq. mi. (UT)
Drainage Impervious Cover Estimate (%)	65% (Garner Branch)
	70% (UT)
Stream Order	First/Second Order (Garner Branch)
	First Order (UT)
Physiographic Region	Piedmont
Ecoregion	Northern Outer Piedmont
Rosgen Classification of As-built	C4
Dominant Soil Types	Wehadkee and Bibb Soils and Cecil Sandy Loam (Garner Branch)
	Cecil Sandy Loam (UT)
Reference Site ID	Brookhaven Park
USGS HUC for Project and Reference	03020201090010 (Garner Branch)
	03020201080020 (Brookhaven Park)
NCDWQ Sub-basin for Project and Reference	03-04-02 (Garner Branch)
	03-04-02 (Brookhaven Park)
NCDWQ Classification for Project and Reference	C - NSW (Garner Branch)
	Not listed (Brookhaven Park)
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%
% of Project Easement Demarcated with Plastic Lath Signs	90%



LEGEND

- STREAM THALWEG
- AS-BUILT TOE
- AS-BUILT STRUCTURE
- PHOTO REFERENCE POINT
- CONSERVATION EASEMENT BOUNDARY
- CROSS SECTION
- VEGETATION PLOT
- STABILIZING STONE
- SANITARY SEWER CROSSING
- OVERHEAD POWERLINE
- MINOR CONTOUR
- MAJOR CONTOUR

MONITORING FEATURE COORDINATES
(NC STATE PLANE, NAD 83 FT DATUM)

		NORTHING	EASTING	ELEVATION
VEGETATION PLOT #1		736305.31	2108979.06	258.71
		736317.33	2109009.69	257.50
		736287.20	2109020.50	257.94
		736273.27	2108991.90	258.53
VEGETATION PLOT #2		736098.15	2109058.84	266.27
		736107.95	2109086.63	256.96
		736080.74	2109100.60	256.73
		736068.44	2109070.50	263.64
VEGETATION PLOT #3		735668.73	2109073.41	251.51
		735665.02	2109105.48	259.88
		735631.16	2109102.26	255.97
		735635.22	2109068.75	251.53
VEGETATION PLOT #4		735278.80	2109186.82	245.53
		735299.95	2109211.96	255.06
		735272.17	2109229.95	253.14
		735251.04	2109205.53	244.60
CROSS SECTION #1	LB	736245.53	2109070.59	269.02
	RB	736216.26	2109008.46	268.61
CROSS SECTION #2	LB	736138.04	2109129.70	267.27
	RB	736120.44	2109053.75	266.48
CROSS SECTION #3	LB	735640.65	2109114.37	262.38
	RB	735650.95	2109035.47	260.56
CROSS SECTION #3A	LB	735401.25	2109208.31	257.45
	RB	735389.55	2109142.02	256.20
CROSS SECTION #4	LB	735296.13	2109221.63	258.07
	RB	735223.52	2109161.84	250.03
CROSS SECTION #5	LB	735138.89	2109409.06	254.40
	RB	735105.03	2109334.03	249.90
CROSS SECTION UT	LB	735223.52	2109161.84	250.03
	RB	735188.50	2109172.03	253.35

–60 –30 0 30 60
GRAPHIC SCALE

REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVED

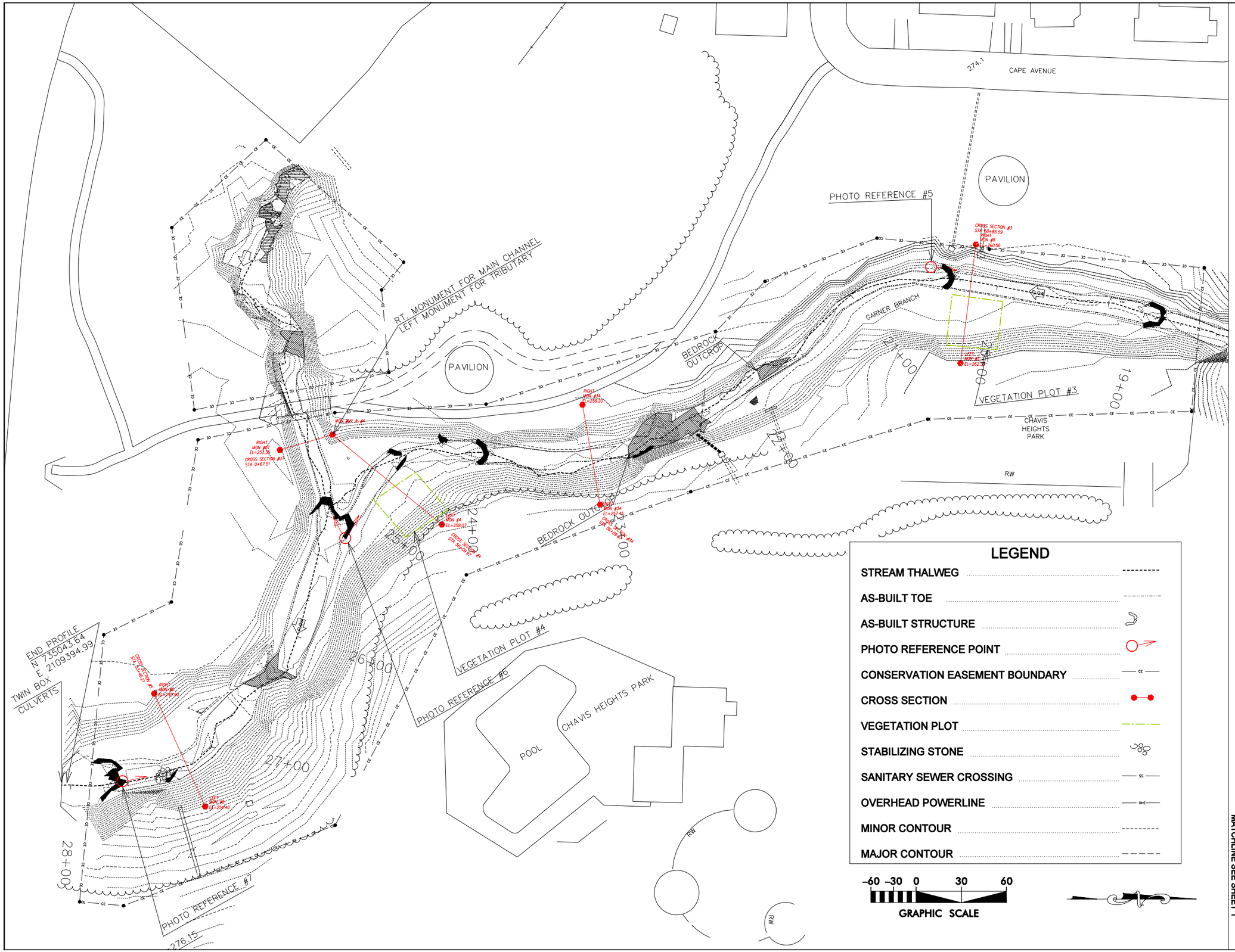
Ecosystem Enhancement Program

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

CHAVIS PARK (GARNER BRANCH)
MONITORING PLAN VIEW
WAKE COUNTY
EEP PROJECT NUMBER 87 - MY03
STATION 10+00 TO STATION 18+40

DATE: AUGUST 2006
SCALE: SEE SHEET

MONITORING PLAN VIEW SHEET 1



LEGEND

- STREAM THALWEG
- AS-BUILT TOE
- AS-BUILT STRUCTURE
- PHOTO REFERENCE POINT
- CONSERVATION EASEMENT BOUNDARY — CE —
- CROSS SECTION
- VEGETATION PLOT
- STABILIZING STONE
- SANITARY SEWER CROSSING — SS —
- OVERHEAD POWERLINE — OHE —
- MINOR CONTOUR
- MAJOR CONTOUR

–60 –30 0 30 60

GRAPHIC SCALE

MATCHLINE SEE SHEET 1

REVISIONS			
STAL	DESCRIPTION	DATE	APPROVED

Ecosystem Enhancement Program

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

CHAVIS PARK (GARNER BRANCH) MONITORING PLAN VIEW
WAKE COUNTY
EEP PROJECT NUMBER 87 - MY03
STATION 18+40 TO STATION 28+06

DATE: AUGUST 2006
SCALE: SEE SHEET

MONITORING PLAN VIEW SHEET 2

SHEET 2 OF 2

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 Area 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: 87 - Chavis Park (Garner Branch of Walnut Creek)

Date of Data Collection	Date of Occurance	Method	Photo Number
6/15/06	6/14/06	Site visit to evaluate stage indicators after storm event	

2.2.1.b BEHI and Sediment Export Table

Table 6. BEHI and Sediment Export Estimates
Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)

Time Point	Segment/ Reach	Linear Footage	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%	ton/yr
BEHI will be completed during MY05															

2.2.2 Stream Problem Areas

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: 87 - Chavis Park (Garner Branch of Walnut Creek)
Segment/Reach: Garner Branch (1,750 ft.)

Feature	Initial	MY - 01	MY - 02	MY - 03	MY - 04	MY - 05
A. Riffles	100%	N/A	83%	65%		
B. Pools	100%	N/A	83%	58%		
C. Thalweg	100%	N/A	88%	69%		
D. Meanders	100%	N/A	69%	78%		
E. Bed General	100%	N/A	97%	97%		
F. Bank Condition	100%	N/A	97%	93%		
G. Vanes / J Hooks etc.	100%	N/A	83%	83%		

Table 7b. Categorical Stream Feature Visual Stability Assessment
Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)
Segment/Reach: UT to Garner Branch (250 ft.)

Feature	Initial	MY - 01	MY - 02	MY - 03	MY - 04	MY - 05
A. Riffles	100%	N/A	95%	90%		
B. Pools	100%	N/A	100%	100%		
C. Thalweg	100%	N/A	100%	100%		
D. Meanders	100%	N/A	100%	100%		
E. Bed General	100%	N/A	100%	95%		
F. Bank Condition	100%	N/A	100%	97%		
G. Vanes / J Hooks etc.	100%	N/A	100%	100%		

2.2.4 Quantitative Measures Summary Tables

Table 8a. Baseline Morphology and Hydraulic Summary

Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)

Segment Reach: Garner Branch (1,750 ft.)

Parameter	USGS Gage Data			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Bankfull Width (ft)				12	24	16	10	15.6	12.8	21	25	23	16.4	44.8	35.8
Floodprone Width (ft)				52	57		19	33	27	40	63	52	35.5	74	49
Bankfull Cross Sectional Area (ft^2)						18.6	5.5	11.8	8.6			25	19.9	41	23.8
Bankfull Mean Depth (ft)				1.4	2	1.55	0.55	0.8	0.67	1.1	1.3	1.2	0.53	1.4	0.96
Bankfull Maximum Depth (ft)				3	3.8		1	1.2	1.1	1.7	2	1.8	1.54	3.06	2.01
Width/Depth Ratio						7.7	18.2	20.6	19.4	18	21	19	11.7	84.5	31.4
Entrenchment Ratio						4.5	1.9	3.3	2.6	1.9	2.5	2.2	1.51	3.1	1.93
Bank Height Ratio						1.2	0.9	1.1	1.0	0.9	1.1	1.0	1.0	1.0	1.0
Wetted Perimeter (ft)															
Hydraulic Radius (ft)															
Pattern															
Channel Beltwidth (ft)				19	50	37	28	41	34.5	35	50	43			
Radius of Curvature (ft)				8	31	20	12	35	23.5	23	40	32			
Meander Wavelength (ft)						96			47	70	108	80			
Meander Width Ratio						3	2.2	3.2	2.7	1.5	2.2	1.9			
Profile															
Riffle Length (ft)															
Riffle Slope (ft/ft)															
Pool Length (ft)															
Pool Spacing (ft)				44	95	69	40	50	45	50	78	64			
Substrate															
d50 (mm)						3			16			3	1.04	19	9
d84 (mm)						11.5			70			11.5			
Additional Reach Parameters															
Valley Length (ft)															
Channel Length (ft)															
Sinuosity					1.05			1.7			1.1				
Water Surface Slope (ft/ft)															
BF Slope (ft/ft)															
Rosgen Classification					E4			C4			C4			C4	

Table 8b. Baseline Morphology and Hydraulic Summary

Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)

Segment Reach: UT to Garner Branch (250 ft.)

Parameter	USGS Gage Data			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Bankfull Width (ft)															17.1
Floodprone Width (ft)															24
Bankfull Cross Sectional Area (ft^2)															27
Bankfull Mean Depth (ft)															1.57
Bankfull Maximum Depth (ft)															2.57
Width/Depth Ratio															
Entrenchment Ratio															1.4
Bank Height Ratio															
Wetted Perimeter (ft)															
Hydraulic Radius (ft)															
Pattern															
Channel Beltwidth (ft)															
Radius of Curvature (ft)															
Meander Wavelength (ft)															
Meander Width Ratio															
Profile															
Riffle Length (ft)															
Riffle Slope (ft/ft)															
Pool Length (ft)															
Pool Spacing (ft)															
Substrate															
d50 (mm)															17
d84 (mm)															
Additional Reach Parameters															
Valley Length (ft)															
Channel Length (ft)															
Sinuosity															
Water Surface Slope (ft/ft)															
BF Slope (ft/ft)															
Rosgen Classification															

Table 9. Morphology and Hydraulic Monitoring Summary
Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)
Segment / Reach: Garner Branch (1,750 ft.)

Parameter	Cross Section 1 Riffle						Cross Section 2 Pool						Cross Section 3 Riffle					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	15.2	13.0	14.5				14.7	13.0	14.2				15.1	16.0	15.0			
Floodprone Width (ft)		33	36					42	44					51	50			
Bankfull Cross Sectional Area (ft^2)	12.8	15.2	12.8				22.1	18.3	19.4				15.8	18.3	17.0			
Bankfull Mean Depth (ft)	0.8	1.2	0.9				1.5	1.4	1.4				1.0	1.1	1.1			
Bankfull Maximum Depth (ft)	1.7	1.9	1.7				2.1	1.9	2.0				1.7	1.9	1.8			
Width/Depth Ratio	18.1	11.1	16.4				9.8	9.2	10.4				15.1	14	13.2			
Entrenchment Ratio		2.5	2.4					3.2	3.1					3.2	3.4			
Bank Height Ratio	1.0	1.0	1.0				1.0	1.0	1.0				1.0	1.0	1.0			
Wetted Perimeter (ft)		14.1	15.1					14.1	15.2					16.8	15.9			
Hydraulic Radius (ft)		1.1	0.9					1.3	1.3					1.1	1.1			
Substrate																		
d50 (mm)	0.6	12.5	15.5				0.7	0.9	1.0				0.7	8.8	16			
d84 (mm)	9.5	28	36				10.5	39	27				10.5	20	39			

Table 9 cont. Morphology and Hydraulic Monitoring Summary
Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)
Segment / Reach: Garner Branch (1,750 ft.)

Parameter	Cross Section 3A Riffle						Cross Section 4 Pool					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)			12.0				19.2	20.5	20.0			
Floodprone Width (ft)			30					77	75			
Bankfull Cross Sectional Area (ft^2)			20.5				25.0	37.2	36.9			
Bankfull Mean Depth (ft)			1.7				1.3	1.8	1.8			
Bankfull Maximum Depth (ft)			2.3				2.3	3.3	3.6			
Width/Depth Ratio			7.0				14.8	11.3	10.8			
Entrenchment Ratio			2.5					3.8	3.7			
Bank Height Ratio			1.0				1.0	1.0	1.0			
Wetted Perimeter (ft)			13.6					22.2	22.7			
Hydraulic Radius (ft)			1.5					1.7	1.6			
Substrate												
d50 (mm)			15.3				0.9	2.1	0.7			
d84 (mm)			38				5.8	10	6.0			

Table 9 cont. Morphology and Hydraulic Monitoring Summary
Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)
Segment / Reach: Garner Branch (1,750 ft.) and UT to Garner Branch (250 ft.)

Parameter	Cross Section 5 Pool						Cross Section UT Riffle					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	25.5	21.2	20.3				14.6	12.0	9.6			
Floodprone Width (ft)		46	46					20	17			
Bankfull Cross Sectional Area (ft^2)	22.4	23.3	23.3				12	13.9	10.3			
Bankfull Mean Depth (ft)	0.9	1.1	1.1				0.8	1.2	1.1			
Bankfull Maximum Depth (ft)	1.6	1.8	1.9				1.3	1.7	1.4			
Width/Depth Ratio	28.3	19.3	17.7				18.3	10.4	8.9			
Entrenchment Ratio		2.2	2.3					1.7	1.8			
Bank Height Ratio	1.0	1.0	1.0				1.0	1.0	1.0			
Wetted Perimeter (ft)		22	21.2					13.4	10.7			
Hydraulic Radius (ft)		1.1	1.1					1.0	1.0			
Substrate												
d50 (mm)	1.0	0.9	1.6				1.3	17	13			
d84 (mm)	6.8	18	22				19.2	33	31			

Table 9 cont. Morphology and Hydraulic Monitoring Summary continued
Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)
Segment Reach: Garner Branch (1,750 ft.)

Parameter	MY - 01 (2004)			MY - 02 (2005)			MY - 03 (2006)			MY - 04 (2007)			MY - 05 (2008)		
Pattern*	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	24	56	33	13	44	29	20	45	26						
Radius of Curvature (ft)	28	87	66	15	80	50	20	75	50						
Meander Wavelength (ft)	83	104	100	72	113	84	77	118	96						
Meander Width Ratio	1.58	3.71	2.18	1.6	4.1	2.6	1.4	3.2	1.8						
Profile															
Riffle Length (ft)	22	71	31	4	52	20	8	86	22						
Riffle Slope (ft/ft)	0.62%	4.53%	1.49%	1.06%	12.50%**	2.60%	0.10%	3.54%	1.66%						
Pool Length (ft)	9	51	18	6	57	22	11	90	22						
Pool Spacing (ft)	19	402	61	9	404	44	34	673	61						
Additional Reach Parameters															
Valley Length (ft)				1,550			1,550								
Channel Length (ft)				1,773			1,780								
Sinuosity				1.15			1.15								
Water Surface Slope (ft/ft)															
Bankfull Slope (ft/ft)															
Rosgen Classification				C4			C4								

*Pattern measurements for MY – 02 & 03 calculated from approximately station 11+00 to 16+50, where the stream was re-meandered.
**Max riffle slope from bedrock riffle, omitted from riffle calculations for MY03

Appendix A
Vegetation Raw Data

App A1 - Vegetation Data Tables

Table A1. Stem counts for each species arranged by plot

Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)

Species	Plots				Initial Totals	Year 2 Totals	Year 3 Totals	Survival %
	1	2	3	4				
Shrubs								
Viburnum nudum	1	2	2	4	N/A	10	9	90%
Cornus amomum	6	4	5	3	N/A	17	18	106%
Ilex verticillata	2	3			N/A	4	4	100%
Ilex glabra		1			N/A	1	1	100%
Myrica cerifera	2				N/A	2	2	100%
Callicarpa americana	1	4		1	N/A	5	6	120%
Alnus serrulata	1	1	4		N/A	6	6	100%
Trees								
Platanus occidentalis	4	3	6	1	N/A	14	14	100%
Hamamelis virginiana	1	5			N/A	6	6	100%
Fraxinus pennsylvanica		2	2		N/A	6	4	67%
Liriodendron tulipifera		1		2	N/A	3	3	100%
Betula nigra					N/A	1	0	0%

Monitoring year 01 revealed poor survival of planted species within the vegetation plots. The first year monitoring report recommended that the project area be replanted with larger containerized trees. Maintenance planting throughout the entire site was completed in 2004. The vegetation plot corners established during monitoring year 01 could not be found and new plots were established and permanently marked for monitoring year 02. The species indicated in Table A1 above are predominantly from the maintenance planting. A few species from the original planting are also included in the stem count.

Two plots were observed to have more trees in the current monitoring year than in monitoring year 2. This can be attributed to some trees either resprouting after having died back or being overlooked in the previous monitoring year.

Explanation of Probable Causes of Vegetation Mortality

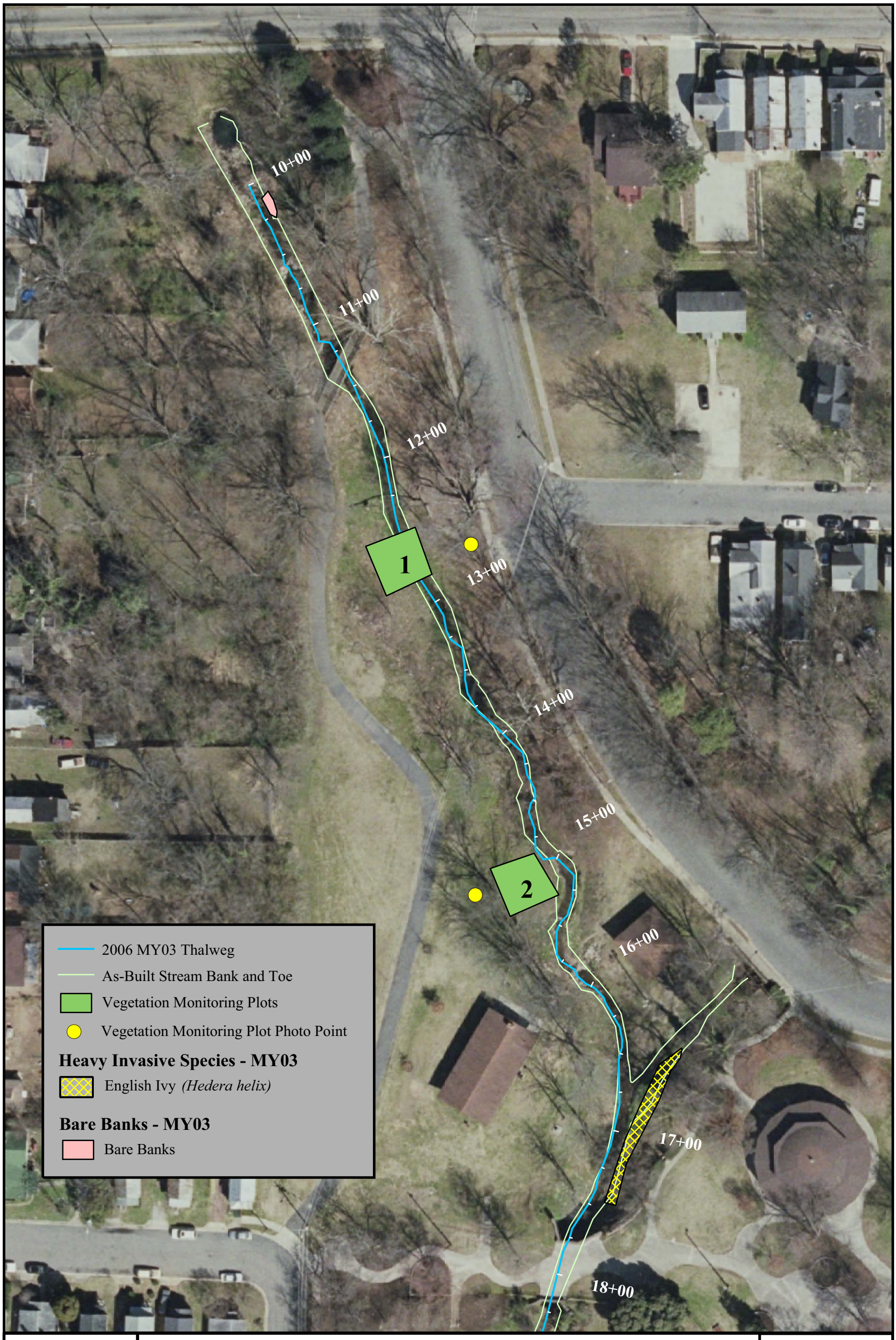
The planted vegetation has experienced a small amount of mortality over the past year. There are no apparent causes for the mortality of four planted stems. Overall the site appears to have fertile soil and few negative impacts on vegetation from the surrounding park. The only challenge to the growth of the planted vegetation is the large amount of competition from herbaceous vegetation. This could potentially lead to some mortality of the planted vegetation.

Table A2. Stem Density By Plot
Project Number and Name: 87 - Chavis Park (Garner Branch) Stream Restoration
Date : 5/8/06
Crew : A. Spiller

Plot #	Winterberry *Ilex verticillata*	Silky Dogwood *Cornus amomum*	Green Ash *Fraxinus pennsylvanica*	Tag Alder *Alnus serrulata*	Witch Hazel *Hamamelis virginiana*	Possum Haw *Viburnum nudum*	River Birch *Betula nigra*	Sycamore *Platanus occidentalis*	Tulip Poplar *Liriodendron tulipifera*	Beauty Berry *Callicarpa americana*	Wax Myrtle *Myrica cerifera*	Inkberry *Ilex glabra*	Total (Year 3)	**Density (Trees/Acre)**
1	2	6		1	1	1		4		1	2		18	729
2	3	4	2	1	5	2		3	1	4		1	26	1,053
3		5	2	4		2		6					19	769
4		3				4		1	2	1			11	445
											Average Density			749

Table A3. Vegetative Problem Areas
Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)

Feature/Issue	Station # / Range	Probable Cause	Photo #
Invasive/Exotic Population	Scattered Throughout	Japanese Honeysuckle: previously established	VP1
	Scattered Throughout Especially Heavy 24+25 – 26+00	Japanese Hops: unknown cause	VP2
	Sparse Throughout	Chinese Privet: previously established	VP3
	Scattered Throughout Especially Heavy 16+50 – 17+50	English Ivy: previously established	VP4
	Heavy Throughout	Microstegium: established seed source	VP5
Bare Banks	10+15 – 10+25	Small pile of dirt freshly dumped on bank	VP6
	26+25 – 26+35	Steep hillslope, poor soil	



Appendix A2a: Vegetative Problem Area Plan View
Chavis Park, Wake County, EEP Project Number 87 - MY03

30 15 0 30 60 Feet

1 inch = 60 feet

N

Date: 10-17-06

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

Ecosystem Enhancement Program

KCI Associates of NC

Appendix A2b: Vegetative Problem Area Plan View
Chavis Park, Wake County, EEP Project Number 87 - MY03

30 15 0 30 60 Feet

1 inch = 60 feet

N

Date: 10-17-06

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

Ecosystem Enhancement Program

KCI Associates of NC

App A3 – Representative Vegetation Problem Area Photos

VP1 – Microstegium on stream bank continues sporadically throughout site. Photo taken near station 10+25. 10/3/06 - MY 03

VP2 – Japanese honeysuckle (*Lonicera japonica*) on stream bank and sewer pipe. Photo taken near station 21+10. 10/3/06 - MY 03

VP3 – Japanese hops (*Humulus japonicus*) on stream bank. Photo taken near station 24+50. 10/3/06 - MY 03

VP4 – Chinese privet (*Ligustrum sinense*) on stream bank. Photo taken near station 27+00. 10/3/06 - MY 03

VP5 – English ivy (*Hedera helix*) on stream bank. Photo taken near station 17+00. 10/3/06 - MY 03

VP6 – Bare bank on streamside, above bedrock. Photo taken near station 26+25. 10/3/06 - MY 03

App A4 - Vegetation Monitoring Plot Photos

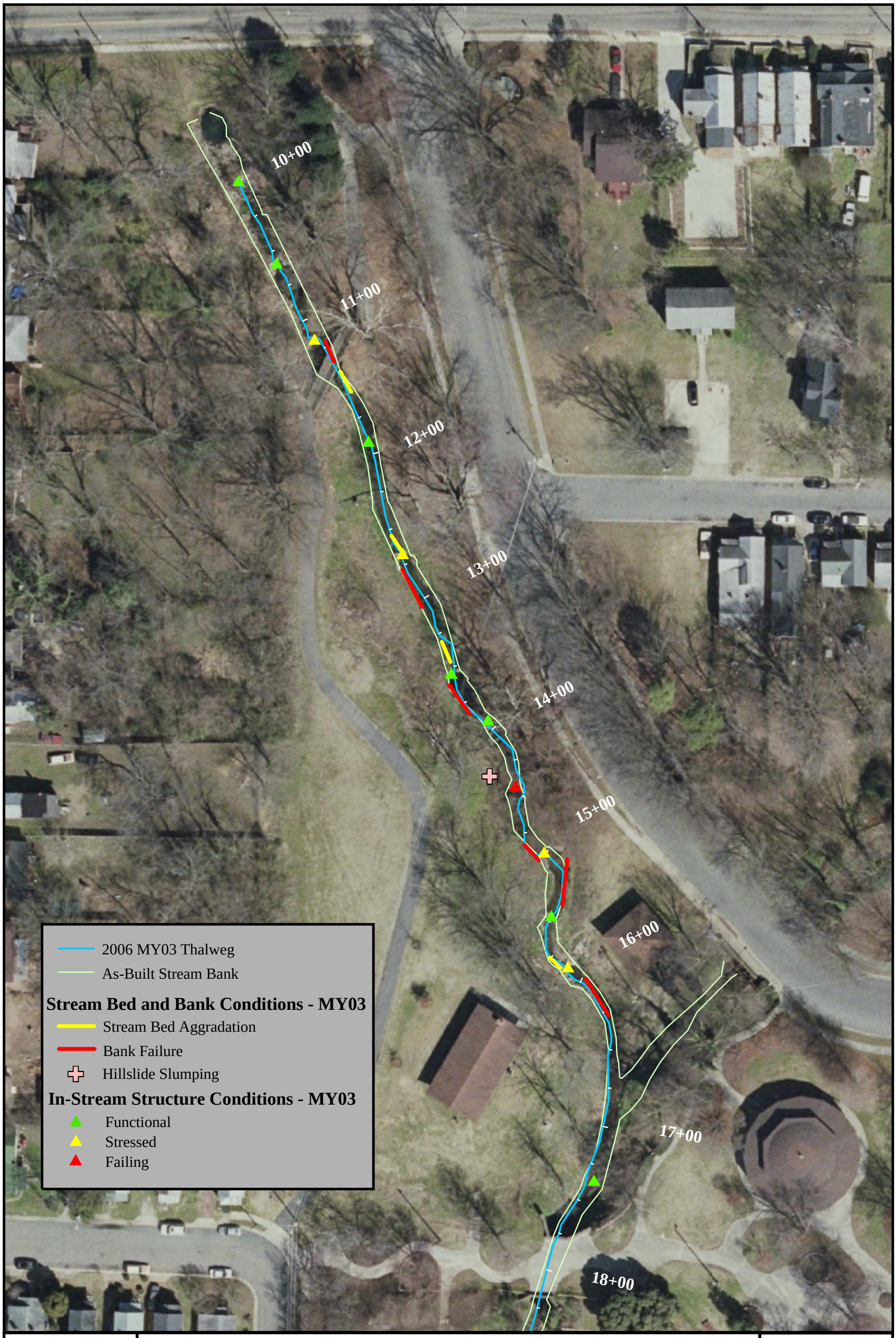
Plot 1 Photo – Taken looking at center of plot on right bank from top of left bank. 5/8/06 - MY 03.

Plot 2 Photo – Taken looking at center of plot from top of right bank. 5/8/06 - MY 03.

Plot 3 Photo – Taken looking at center of plot from top of left bank. 5/8/06 - MY 03.

Plot 4 Photo – Taken looking at center of plot from top of left bank. 5/8/06 - MY 03.

Appendix B
Geomorphologic Raw Data



Appendix B1a: Stream Problem Area Plan View
Chavis Park, Wake County, EEP Project Number 87 - MY03

30 15 0 30 60 Feet

1 inch = 60 feet

N

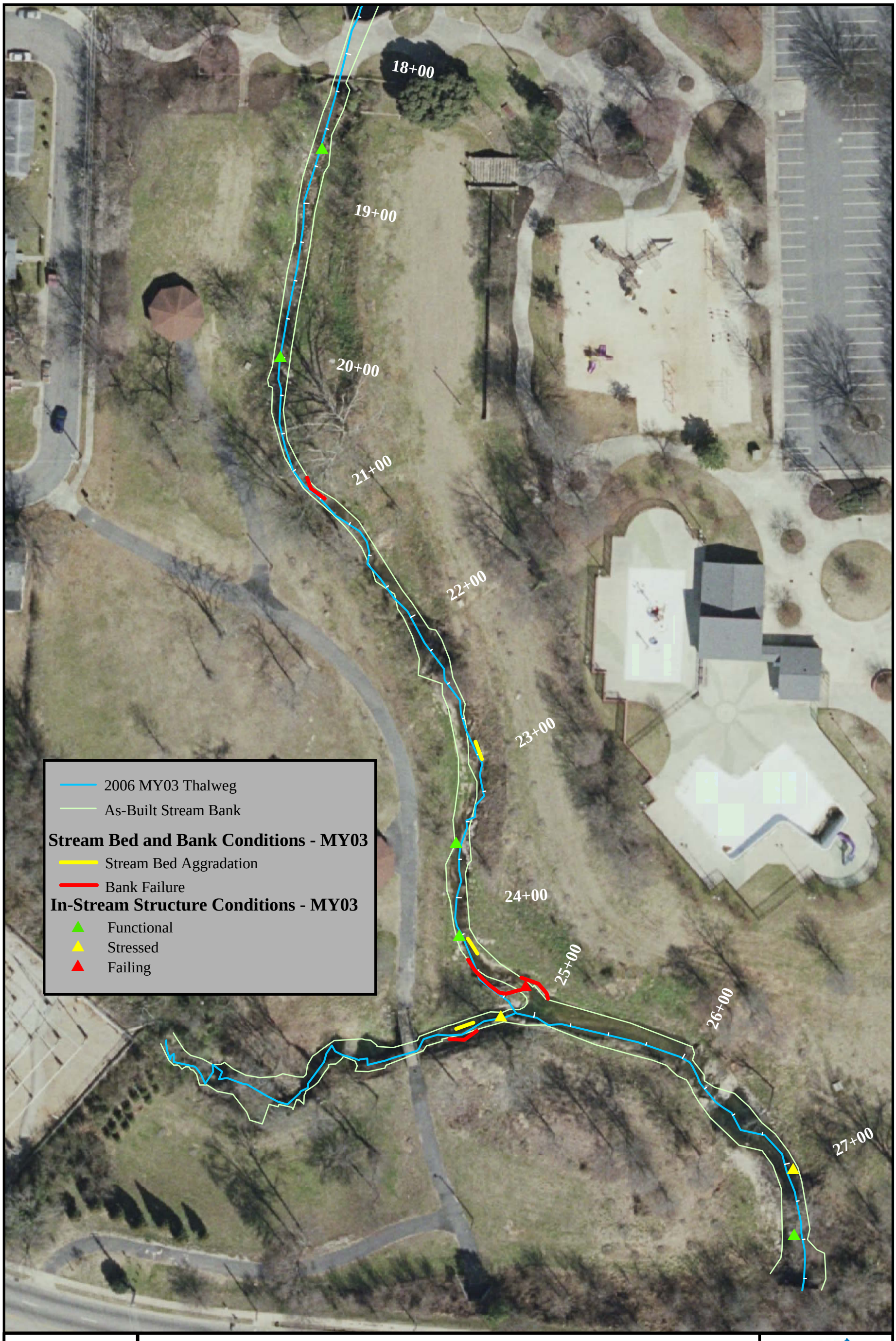
Date: 10-17-06

Note: Length of bank and aggradation problems approximated.

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

Ecosystem Enhancement Program

KCI Associates of NC



Appendix B1b: Stream Problem Area Plan View
Chavis Park, Wake County, EEP Project Number 87 - MY03

30 15 0 30 60 Feet

1 inch = 60 feet

N

Date: 10-17-06

Note: Length of bank and aggradation problems approximated.

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

Ecosystem Enhancement Program

KCI Associates of NC

App B2 – Stream Problem Areas Table

Table B1. Stream Problem Areas
Project Number and Name: 87 - Chavis Park (Garner Branch of Walnut Creek)

Feature Issue	Station numbers	Suspected Cause	Photo #
Aggradation/Bar Formation	11+50	aggradation - - sediment influx from upstream eroding bank	SP1
	12+60	aggradation - unknown	
	13+40	aggradation - unknown	
	15+80	aggradation - unknown	
	23+00	aggradation - unknown	
	24+30	aggradation - unknown	
Bank Scour	11+25	unknown	SP2
	12+80	unknown	
	13+75	unknown	
	14+90	unknown	
	15+25	unknown	
	16+10	unknown	
	20+90	unknown	
	24+70	unknown	
	24+90	unknown	
Engineered Structures - back or arm scour	12+70	unknown	SP3
	14+50	unknown	
	15+00	stream moving around structure	
	15+90	unknown	
	24+85	poor structure placement, structure has fallen apart	
	27+05	unknown	
Engineered Structures - piping	10+60	poor fabric placement, structure still functional	
	11+15	unknown	
Excessive Trash	throughout	typical of urban setting	SP4

App B3 – Representative Stream Problem Area Photos

SP1 – Mid-channel bar forming. Photo taken near station 13+30. 10/3/06 - MY 03

SP2 – Bank erosion/slumping. Photo taken near station 24+50. 10/3/06 - MY 03

SP3 – Back arm scour on cross vane. Photo taken near station 14+50. 10/3/06 - MY 03

SP4 – Excessive trash. Photo taken near station 25+30. 10/3/06 - MY 03

App B4 –Stream Photo Station Photos

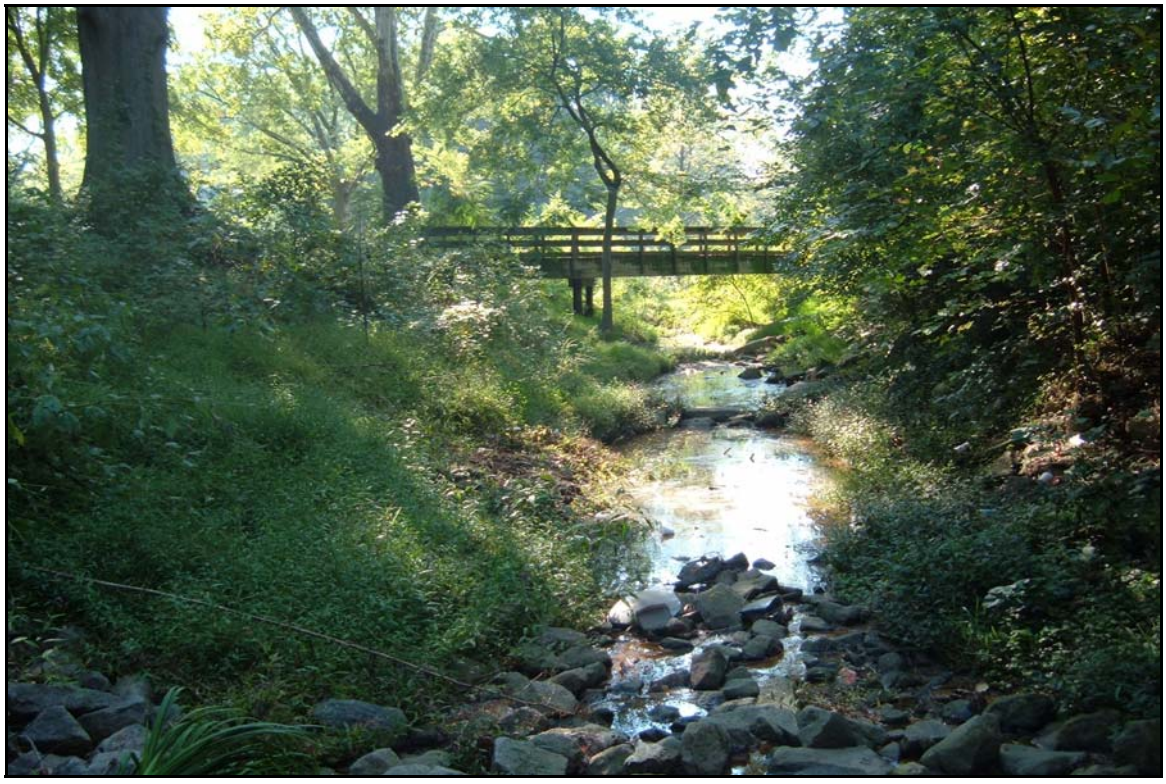


Photo Point 1 – 10/3/06 - MY 03

Photo Point 2 – 10/3/06 - MY 03

Photo Point 3 – 10/3/06 - MY 03

Photo Point 4 – 10/3/06 - MY 03

Photo Point 5 – 10/3/06 - MY 03

Photo Point 6 (Garner Branch) – 10/3/06 - MY 03

Photo Point 6 (UT) – 10/3/06 - MY 03

Photo Point 7 – 10/3/06 - MY 03

App B5 –Qualitative Visual Stability Assessment

Table B2. Qualitative Visual Stability Assessment
Project Number 87 - Chavis Park (Garner Branch of Walnut Creek)
Segment/Reach: Garner Branch (1,750 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	18	N/A	67	
	2. Armor stable (e.g. no displacement)?	11	18	N/A	61	
	3. Facet grade appears stable?	12	18	N/A	67	
	4. Minimal evidence of embedding/fining?	12	18	N/A	67	
	5. Length appropriate?	11	18	N/A	61	**65%**
B. Pools	1. Present? (e.g. no severe aggradation or migration)	17	28	N/A	61	
	2. Sufficiently deep (Dmax pool:Mean Bkf > 1.6?)	17	28	N/A	61	
	3. Length appropriate?	15	28	N/A	54	**58%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	12	16	N/A	75	
	2. Downstream of meander (glide/inflection) centering?	10	16	N/A	63	**69%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	11	16	N/A	69	
	2. Of those eroding, # w/ concomitant point bar formation?	3	5	N/A	60	
	3. Apparent Rc within spec?	13	16	N/A	81	
	4. Sufficient floodplain access and relief?	16	16	N/A	100	**78%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	7/105	94	
	2. Channel bed degradation - areas of increasing down cutting or head cutting?	N/A	N/A	0/0	100	**97%**
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A	N/A	9/240	93	**93%**
G. Vanes	1. Free of back or arm scour?	13	19	N/A	68	
	2. Height appropriate?	16	19	N/A	84	
	3. Angle and geometry appear appropriate?	18	19	N/A	95	
	4. Free of piping or other structural failures?	16	19	N/A	84	**83%**

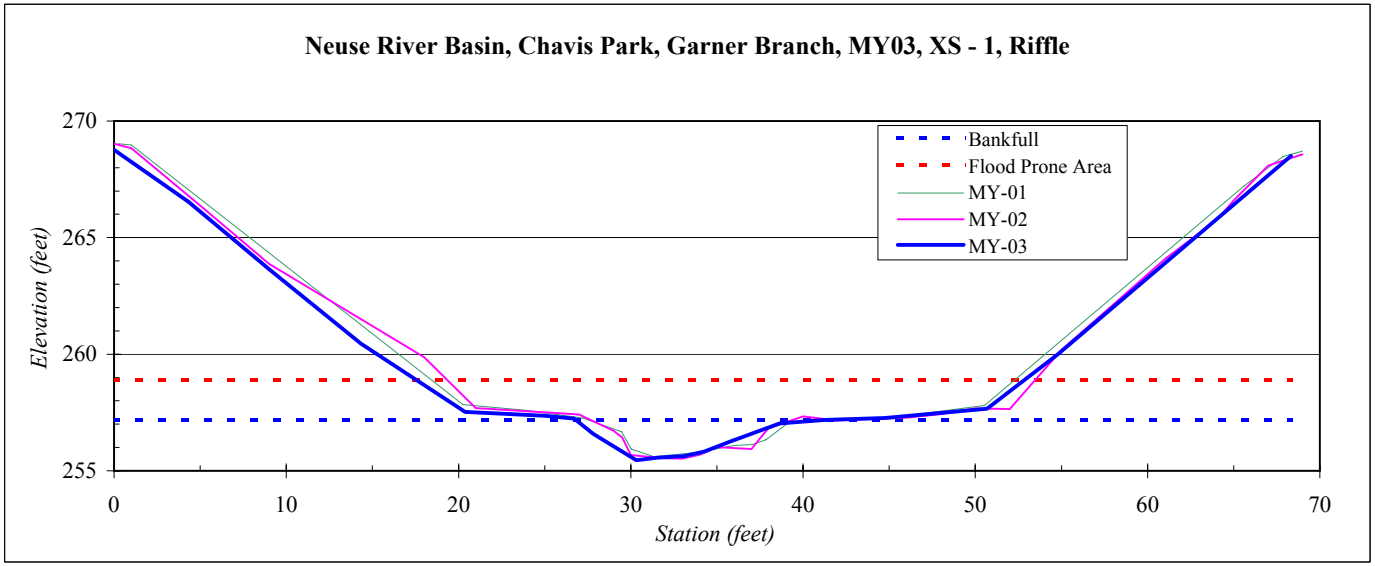
* Total number of features per as-built estimated from as-built profile and planview sheets.

App. B6 - Cross Section Plots

River Basin:	Neuse
Watershed:	Chavis Park, Garner Branch, MY03
XS ID	XS - 1, Riffle
Drainage Area (sq mi):	0.54
Date:	7/26/2006
Field Crew:	A. Spiller, K. Knight, L. Leiendecker

Station	Elevation
0.0	268.77
4.3	266.55
9.1	263.61
14.3	260.45
20.4	257.52
25.0	257.35
26.7	257.24
27.8	256.58
30.3	255.46
31.5	255.56
33.1	255.63
34.2	255.83
35.8	256.27
38.6	257.04
41.3	257.18
44.8	257.26
50.7	257.67
54.8	259.99
68.3	268.51

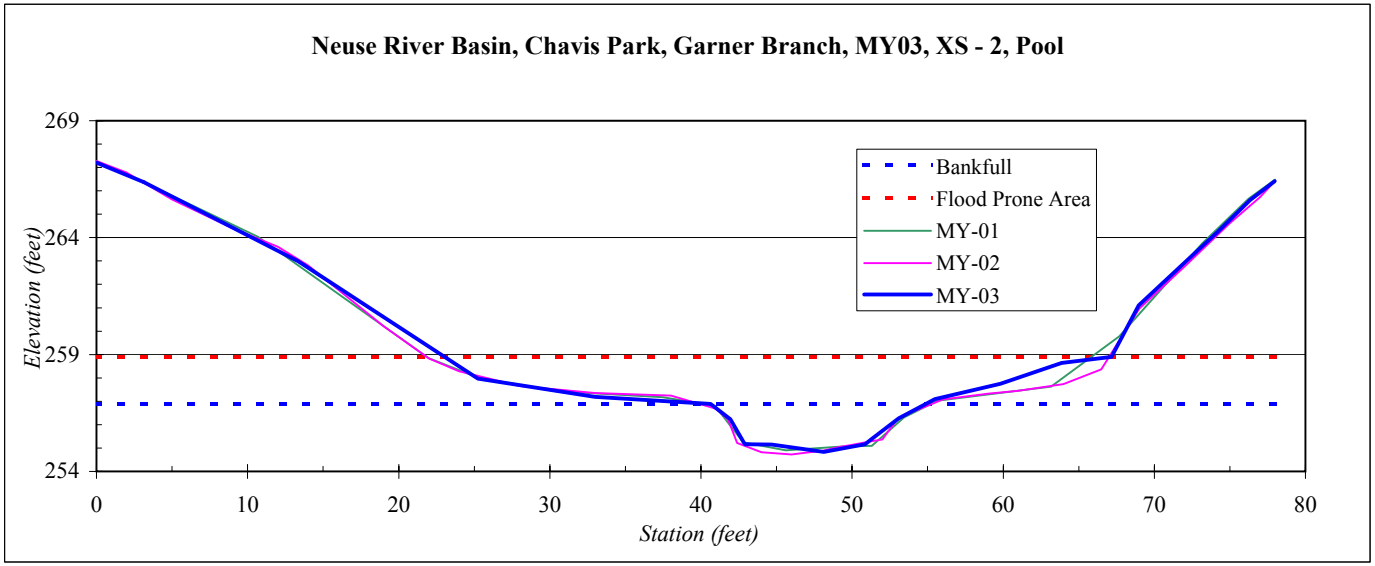
SUMMARY DATA	
Bankfull Elevation:	257.2
Bankfull Cross-Sectional Area:	12.8
Bankfull Width:	14.5
Flood Prone Area Elevation:	258.9
Flood Prone Width:	35.5
Max Depth at Bankfull:	1.7
Mean Depth at Bankfull:	0.9
W / D Ratio:	16.4
Entrenchment Ratio:	2.4
Bank Height Ratio:	0.9



River Basin:	Neuse
Watershed:	Chavis Park, Garner Branch, MY03
XS ID	XS - 2, Pool
Drainage Area (sq mi):	0.54
Date:	7/26/2006
Field Crew:	A. Spiller, K. Knight, L. Leiendecker

Station	Elevation
0.0	267.20
3.1	266.38
13.3	263.00
25.2	257.98
33.0	257.19
40.6	256.88
42.0	256.24
42.9	255.16
44.7	255.15
48.1	254.84
50.9	255.17
51.3	255.38
53.1	256.27
55.5	257.10
59.8	257.75
63.9	258.64
67.2	258.90
69.0	261.10
74.2	264.24
76.3	265.61
78.0	266.41

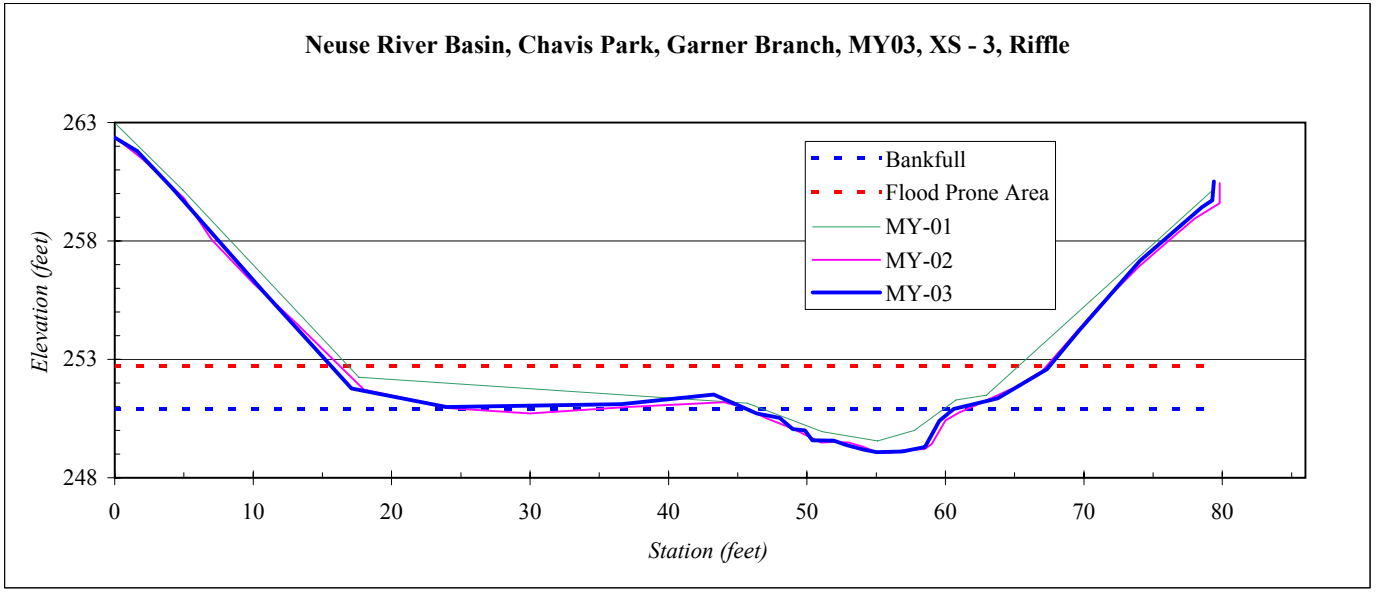
SUMMARY DATA	
Bankfull Elevation:	256.9
Bankfull Cross-Sectional Area:	19.4
Bankfull Width:	14.2
Flood Prone Area Elevation:	258.9
Flood Prone Width:	44.2
Max Depth at Bankfull:	2.0
Mean Depth at Bankfull:	1.4
W / D Ratio:	10.4
Entrenchment Ratio:	3.1
Bank Height Ratio:	0.6



River Basin:	Neuse
Watershed:	Chavis Park, Garner Branch, MY03
XS ID	XS - 3, Riffle
Drainage Area (sq mi):	0.54
Date:	7/26/2006
Field Crew:	A. Spiller, K. Knight, L. Leiendecker

Station	Elevation
0.0	262.36
1.6	261.79
4.1	260.25
10.8	255.80
17.1	251.77
24.0	250.99
36.6	251.11
43.3	251.52
46.4	250.71
48.0	250.53
49.0	250.05
49.8	250.00
50.4	249.57
51.9	249.57
52.9	249.38
54.1	249.19
55.0	249.08
56.9	249.11
58.5	249.30
59.6	250.40
60.6	250.91
63.8	251.35
67.3	252.58
69.6	254.17
74.0	257.16
78.5	259.41
79.3	259.72
79.4	260.51

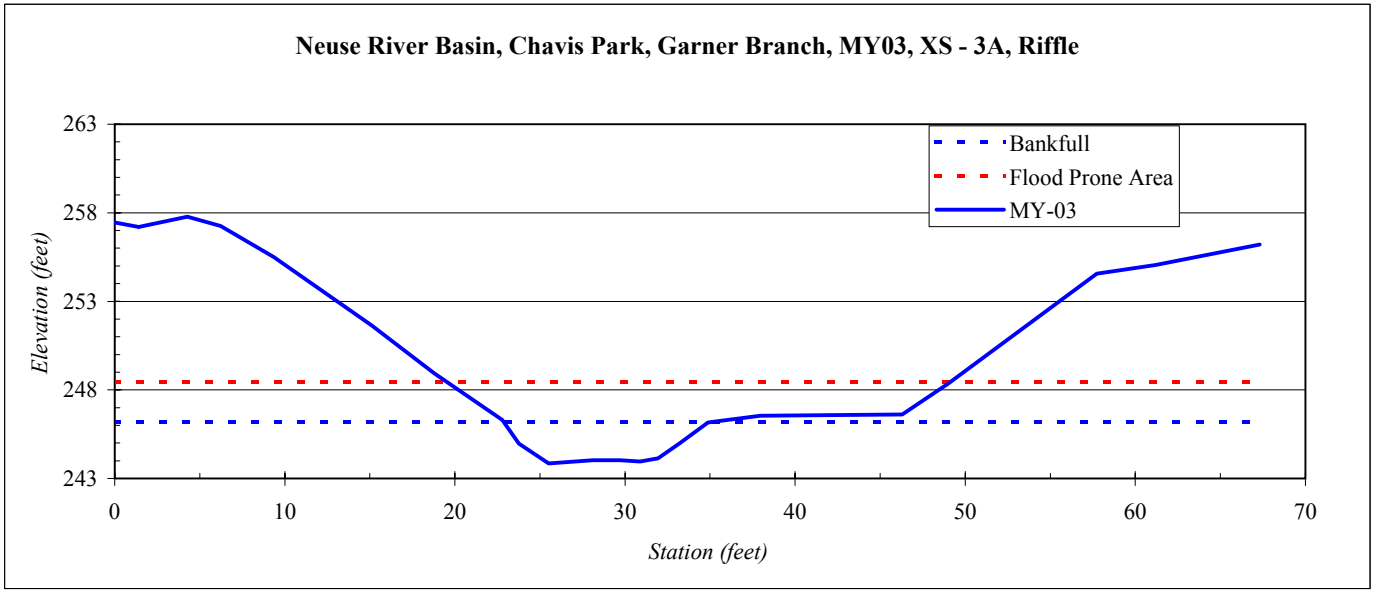
SUMMARY DATA	
Bankfull Elevation:	250.9
Bankfull Cross-Sectional Area:	17.0
Bankfull Width:	15.0
Flood Prone Area Elevation:	252.7
Flood Prone Width:	50.4
Max Depth at Bankfull:	1.8
Mean Depth at Bankfull:	1.1
W / D Ratio:	13.2
Entrenchment Ratio:	3.4
Bank Height Ratio:	1.1



River Basin:	Neuse
Watershed:	Chavis Park, Garner Branch, MY03
XS ID	XS - 3A, Riffle
Drainage Area (sq mi):	0.54
Date:	7/26/2006
Field Crew:	A. Spiller, K. Knight, L. Leiendecker

Station	Elevation
0.0	257.45
1.4	257.20
4.3	257.77
6.2	257.25
9.3	255.51
15.1	251.66
18.8	248.95
22.8	246.30
23.8	244.98
25.5	243.85
28.1	244.03
29.7	244.03
30.9	243.96
31.9	244.13
33.2	245.00
34.9	246.16
37.9	246.55
46.3	246.61
49.0	248.35
57.7	254.56
61.2	255.05
67.3	256.20

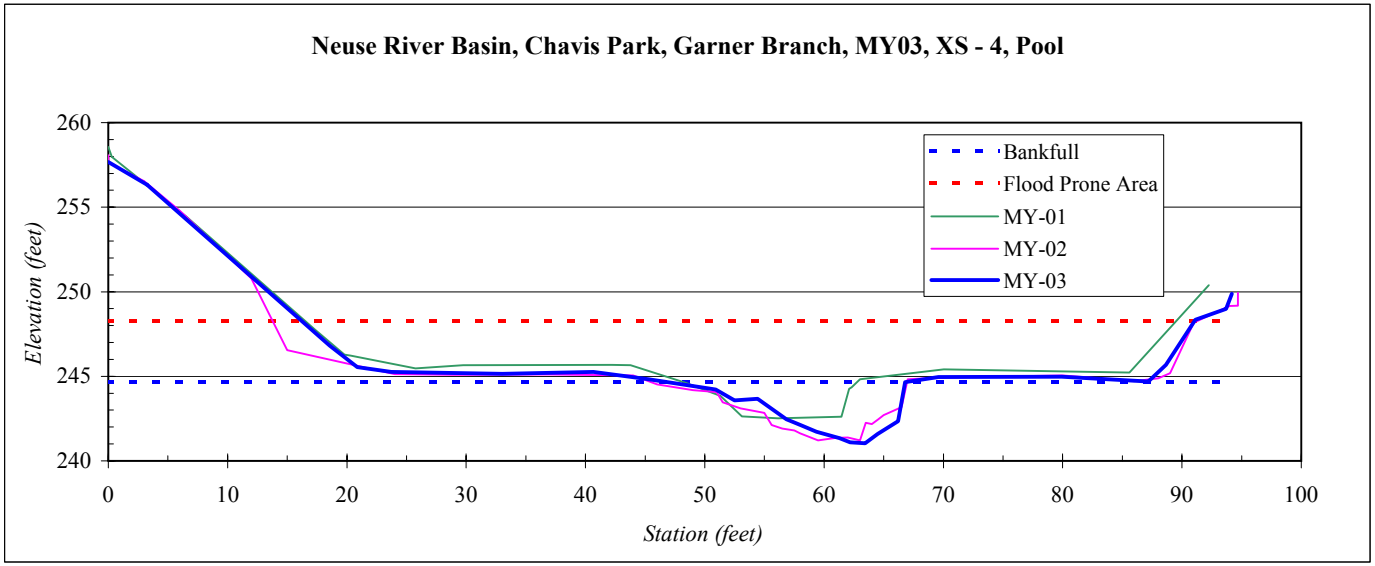
SUMMARY DATA	
Bankfull Elevation:	246.2
Bankfull Cross-Sectional Area:	20.5
Bankfull Width:	12.0
Flood Prone Area Elevation:	248.5
Flood Prone Width:	29.7
Max Depth at Bankfull:	2.3
Mean Depth at Bankfull:	1.7
W / D Ratio:	7.0
Entrenchment Ratio:	2.5
Bank Height Ratio:	0.9



River Basin:	Neuse
Watershed:	Chavis Park, Garner Branch, MY03
XS ID	XS - 4, Pool
Drainage Area (sq mi):	0.54
Date:	7/28/2006
Field Crew:	A. Spiller, A. French, L. Leiendecker

Station	Elevation
0.0	257.67
3.3	256.33
6.0	254.63
18.6	246.82
20.9	245.55
23.7	245.26
33.0	245.16
40.7	245.26
45.3	244.82
50.9	244.21
52.5	243.57
54.4	243.67
56.9	242.45
58.0	242.11
59.4	241.72
61.3	241.34
62.2	241.09
63.4	241.04
64.5	241.59
66.2	242.35
66.8	244.66
69.6	244.96
79.9	244.97
87.2	244.69
88.6	245.67
91.1	248.34
93.7	248.99
94.2	249.89

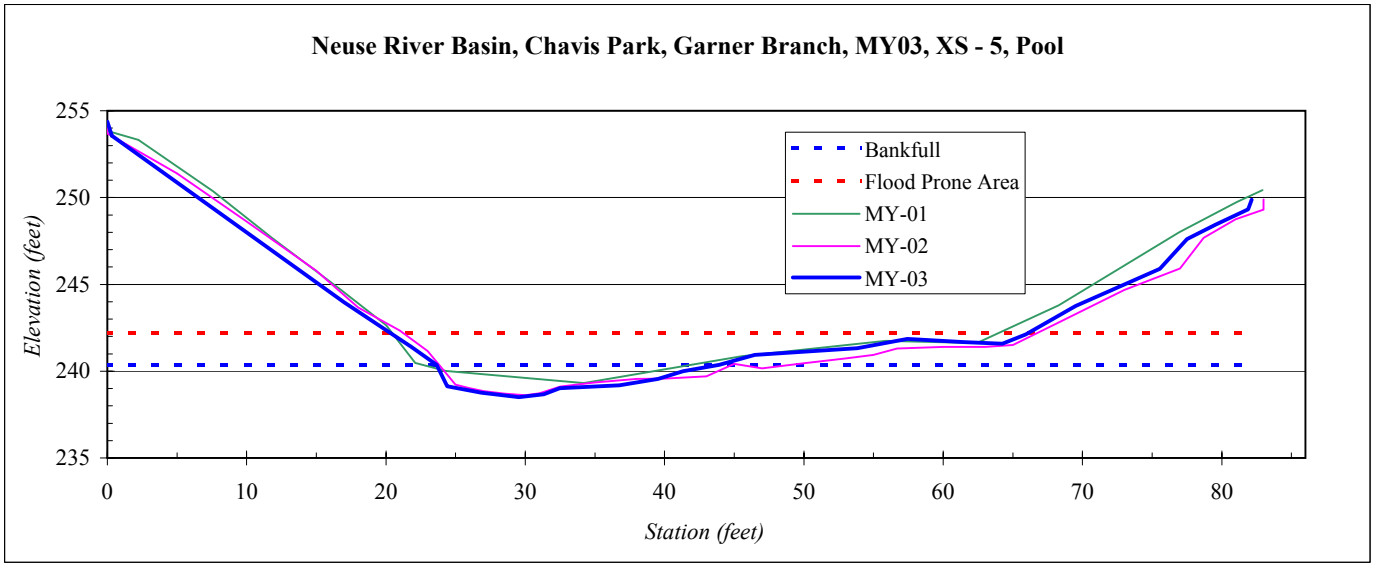
SUMMARY DATA	
Bankfull Elevation:	244.7
Bankfull Cross-Sectional Area:	36.9
Bankfull Width:	20.0
Flood Prone Area Elevation:	248.3
Flood Prone Width:	74.9
Max Depth at Bankfull:	3.6
Mean Depth at Bankfull:	1.8
W / D Ratio:	10.8
Entrenchment Ratio:	3.7
Bank Height Ratio:	0.8



River Basin:	Neuse
Watershed:	Chavis Park, Garner Branch, MY03
XS ID	XS - 5, Pool
Drainage Area (sq mi):	0.54
Date:	7/28/2006
Field Crew:	A. Spiller, A. French, L. Leiendecker

Station	Elevation
0.0	254.37
0.3	253.56
17.0	243.97
21.8	241.39
23.6	240.36
24.4	239.13
26.8	238.76
29.5	238.49
31.3	238.67
32.5	239.02
36.8	239.18
39.5	239.55
41.3	239.99
43.9	240.36
46.5	240.93
53.8	241.33
57.4	241.86
61.5	241.68
64.3	241.58
65.9	242.12
69.5	243.76
75.6	245.90
77.5	247.60
79.5	248.44
81.9	249.33
82.2	249.88

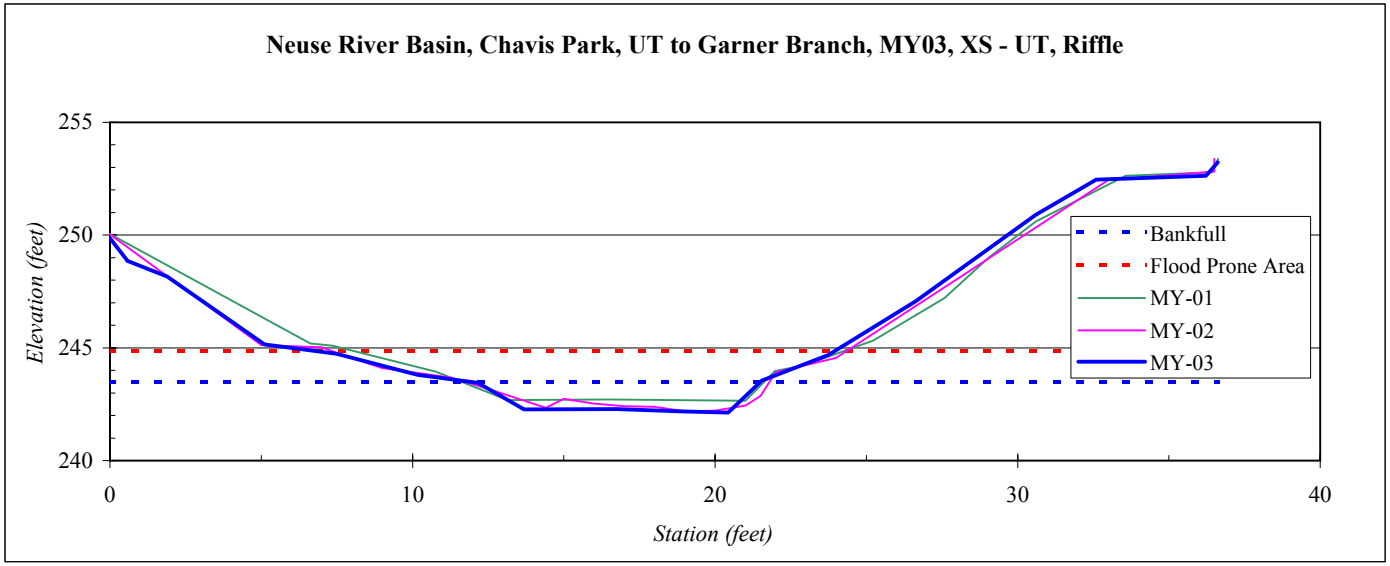
SUMMARY DATA	
Bankfull Elevation:	240.4
Bankfull Cross-Sectional Area:	23.3
Bankfull Width:	20.3
Flood Prone Area Elevation:	242.2
Flood Prone Width:	45.9
Max Depth at Bankfull:	1.9
Mean Depth at Bankfull:	1.1
W / D Ratio:	17.7
Entrenchment Ratio:	2.3
Bank Height Ratio:	0.8



River Basin:	Neuse
Watershed:	Chavis Park, UT to Garner Branch, MY03
XS ID	XS - UT, Riffle
Drainage Area (sq mi):	0.2
Date:	7/28/2006
Field Crew:	A. Spiller, A. French, L. Leiendecker

Station	Elevation
0.0	249.86
0.6	248.85
1.9	248.16
5.1	245.14
7.5	244.74
10.2	243.81
12.2	243.45
13.7	242.27
16.8	242.28
18.8	242.19
20.4	242.13
21.5	243.55
23.7	244.68
26.6	247.06
30.6	250.90
32.6	252.46
36.2	252.63
36.6	253.22

SUMMARY DATA	
Bankfull Elevation:	243.5
Bankfull Cross-Sectional Area:	10.3
Bankfull Width:	9.6
Flood Prone Area Elevation:	244.9
Flood Prone Width:	17.3
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	1.1
W / D Ratio:	8.9
Entrenchment Ratio:	1.8
Bank Height Ratio:	0.9



App. B7 - Longitudinal Profile
Chavis Park (Garner Branch), Wake County
EEP Project Number 87 - MY03

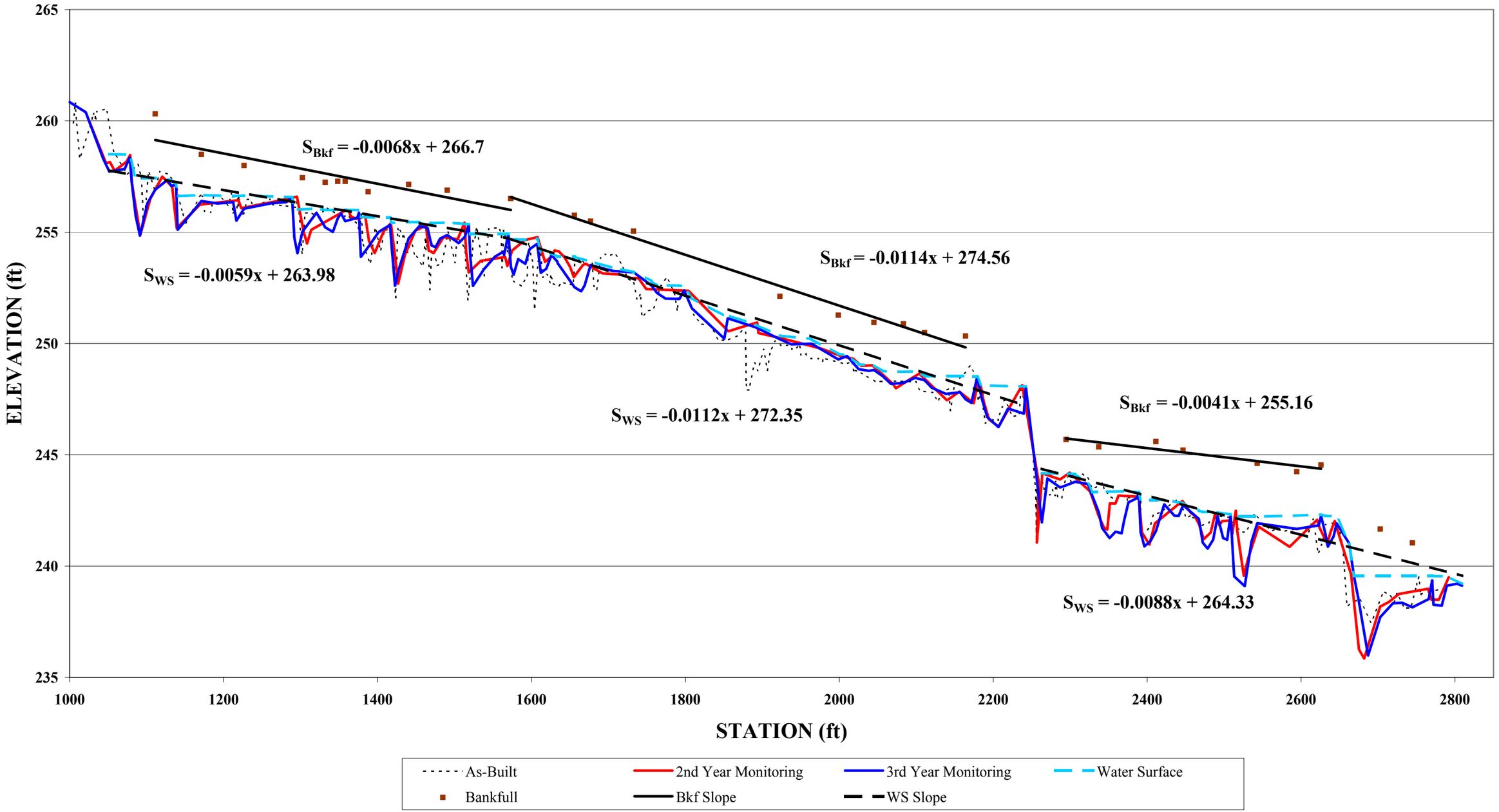


Table B3 - Profile Points
Chavis Park (Garner Branch), Wake County
EEP Project number 87 - MY03

TW Station	TW Elevation
1000.00	260.85
1020.94	260.39
1043.71	258.28
1051.66	257.72
1071.37	257.84
1077.94	258.36
1080.88	257.15
1085.75	255.72
1091.28	254.85
1100.97	256.30
1111.19	256.91
1126.94	257.35
1131.95	257.08
1138.25	257.13
1140.32	255.11
1171.18	256.40
1192.19	256.29
1212.40	256.35
1216.59	255.52
1226.63	256.06
1262.64	256.31
1281.48	256.35
1289.05	256.59
1291.89	254.76
1295.83	254.05
1302.48	255.02
1320.69	255.87
1331.98	255.22
1342.08	255.02
1348.43	255.62
1352.49	255.84
1358.16	255.49
1373.78	255.65
1375.80	255.87
1378.30	253.89
1387.84	254.33
1401.61	255.01
1416.17	255.32
1418.76	254.19
1422.73	252.60
1427.53	253.33
1440.42	254.72

TW Station	TW Elevation
1454.50	255.27
1465.02	255.19
1470.17	254.40
1475.34	254.32
1481.35	254.71
1490.68	254.88
1505.40	254.51
1513.68	254.80
1518.46	255.36
1520.53	253.87
1523.92	252.59
1538.24	253.33
1552.38	253.90
1564.01	254.14
1564.45	253.98
1570.15	254.94
1573.36	253.44
1576.85	253.09
1582.88	253.79
1592.07	253.58
1597.53	254.24
1607.42	254.48
1612.17	253.18
1619.32	253.36
1625.82	253.98
1633.70	253.67
1634.21	253.60
1637.98	253.42
1655.93	252.53
1664.52	252.35
1668.94	252.60
1676.92	253.52
1706.20	253.26
1732.60	253.20
1755.96	252.61
1763.06	252.27
1774.25	252.02
1792.35	252.00
1798.46	252.38
1808.46	251.58
1850.52	250.22
1855.00	251.13

TW Station	TW Elevation
1891.59	250.72
1922.79	250.19
1937.61	249.97
1963.80	250.00
1998.68	249.28
2009.96	249.44
2025.20	248.84
2038.32	248.78
2045.01	248.81
2056.42	248.53
2067.03	248.19
2083.32	248.23
2098.49	248.46
2110.78	248.35
2120.06	248.01
2138.47	247.73
2156.91	247.81
2164.00	247.50
2171.74	247.34
2179.34	248.53
2184.65	247.60
2192.28	246.70
2206.80	246.24
2219.27	247.08
2239.74	246.85
2242.38	248.07
2263.26	241.96
2270.39	243.93
2286.82	243.53
2294.68	243.63
2306.27	243.79
2323.08	243.69
2329.07	243.11
2337.19	242.42
2341.42	241.71
2351.14	241.26
2359.02	241.55
2366.79	241.47
2369.93	242.03
2375.62	242.86
2386.21	243.05
2389.19	243.27

TW Station	TW Elevation
2391.52	241.52
2396.30	240.89
2404.07	241.11
2411.36	241.57
2422.25	242.77
2435.54	242.26
2440.94	242.26
2446.71	242.74
2467.13	242.11
2472.20	241.05
2478.68	240.79
2485.82	241.19
2491.51	242.24
2498.71	241.26
2504.07	241.18
2508.50	242.32
2513.11	239.54
2526.90	239.10
2535.50	241.09
2542.98	241.93
2594.46	241.67
2622.91	241.83
2625.84	242.25
2631.51	241.48
2634.80	240.88
2642.11	241.33
2646.13	241.92
2662.55	241.01
2668.69	239.56
2674.58	238.51
2687.00	235.98
2702.96	237.71
2719.38	238.33
2731.27	238.36
2744.82	238.15
2765.90	238.52
2770.38	239.37
2772.04	238.27
2782.76	238.23
2789.25	239.12
2802.84	239.21
2809.11	239.12

Table B4 - Water Surface Points
Chavis Park (Garner Branch), Wake County
EEP Project number 87 - MY03

WS Station	WS Elevation
1051.66	258.50
1077.94	258.49
1085.75	257.41
1111.19	257.44
1131.95	257.34
1138.25	257.13
1140.32	256.62
1171.18	256.67
1212.40	256.63
1226.63	256.64
1289.05	256.59
1291.89	256.02
1302.48	256.03
1320.69	256.06
1331.98	256.00
1348.43	255.99
1358.16	256.00
1375.80	255.99
1378.30	255.70
1387.84	255.67
1416.17	255.65
1418.76	255.42
1440.42	255.45
1454.50	255.45
1470.17	255.40
1490.68	255.43
1518.46	255.36
1520.53	254.94
1570.15	254.94
1573.36	254.69
1592.07	254.66
1607.42	254.70
1612.17	254.10
1625.82	254.05
1634.21	253.90
1655.93	253.90
1676.92	253.68
1706.20	253.40
1732.60	253.21
1755.96	252.81
1763.06	252.61
1792.35	252.60

WS Station	WS Elevation
1798.46	252.57
1808.46	252.04
1850.52	251.25
1855.00	251.27
1891.59	250.85
1922.79	250.35
1963.80	250.21
1998.68	249.52
2009.96	249.48
2025.20	249.06
2045.01	249.03
2056.42	248.76
2083.32	248.73
2098.49	248.74
2110.78	248.54
2164.00	248.53
2179.34	248.53
2184.65	248.11
2242.38	248.07
2263.26	244.17
2294.68	244.16
2306.27	244.14
2323.08	243.73
2329.07	243.33
2337.19	243.34
2369.93	243.36
2389.19	243.32
2391.52	242.96
2411.36	242.97
2422.25	242.98
2446.71	242.83
2467.13	242.49
2472.20	242.43
2485.82	242.45
2491.51	242.41
2508.50	242.32
2513.11	242.23
2542.98	242.23
2594.46	242.27
2625.84	242.32
2631.51	242.26
2646.13	242.25

WS Station	WS Elevation
2662.55	241.01
2668.69	239.56
2702.96	239.55
2744.82	239.55
2770.38	239.55
2789.25	239.54
2809.11	239.20

Table B5 - Bankfull Points
Chavis Park (Garner Branch), Wake County
EEP Project number 87 - MY03

Bkf Station	Bkf Elevation
1111.19	260.32
1171.18	258.49
1226.63	257.99
1302.48	257.45
1331.98	257.24
1348.43	257.28
1358.16	257.28
1387.84	256.82
1440.42	257.15
1490.68	256.88
1573.36	256.52
1655.93	255.75
1676.92	255.49
1732.60	255.05
1922.79	252.12
1998.68	251.27
2045.01	250.94
2083.32	250.88
2110.78	250.49
2164.00	250.34
2294.68	245.69
2337.19	245.35
2411.36	245.59
2446.71	245.21
2542.98	244.62
2594.46	244.24
2625.84	244.54
2702.96	241.67
2744.82	241.04

Table B6 - Riffle and Pool Measurements
Chavis Park (Garner Branch), Wake County
EEP Project number 87 - MY03

Riffle Measurements			
Station	Length	WS Elev	WS Slope
1171 1212	41	256.67 256.63	0.0011
1626 1634	8	254.05 253.90	0.0188
1677 1763	86	253.68 252.61	0.0125
1855 1923	68	251.27 250.35	0.0136
1964 1999	35	250.21 249.52	0.0196
2010 2025	15	249.48 249.06	0.0278
2045 2056	11	249.03 248.76	0.0237
2098 2111	12	248.74 248.54	0.0167
2306 2329	23	244.14 243.33	0.0354
2422 2436	13	242.98 242.90	0.0061
2447 2467	20	242.83 242.49	0.0164
2543 2626	83	242.23 242.15	0.0009

Pool Measurements		
Station	Length	P-P Spacing
1052 1071	20	34
1086 1101	15	55
1140 1171	31	152
1292 1302	11	86
1378 1402	24	40
1419 1440	22	96
1515 1564	49	60
1575 1598	23	37
1612 1626	14	44
1656 1669	13	673
2329 2375	46	62
2391 2411	20	81
2472 2486	14	39
2511 2536	25	121
2632 2642	11	43
2675 2765	90	97
2772 2783	11	

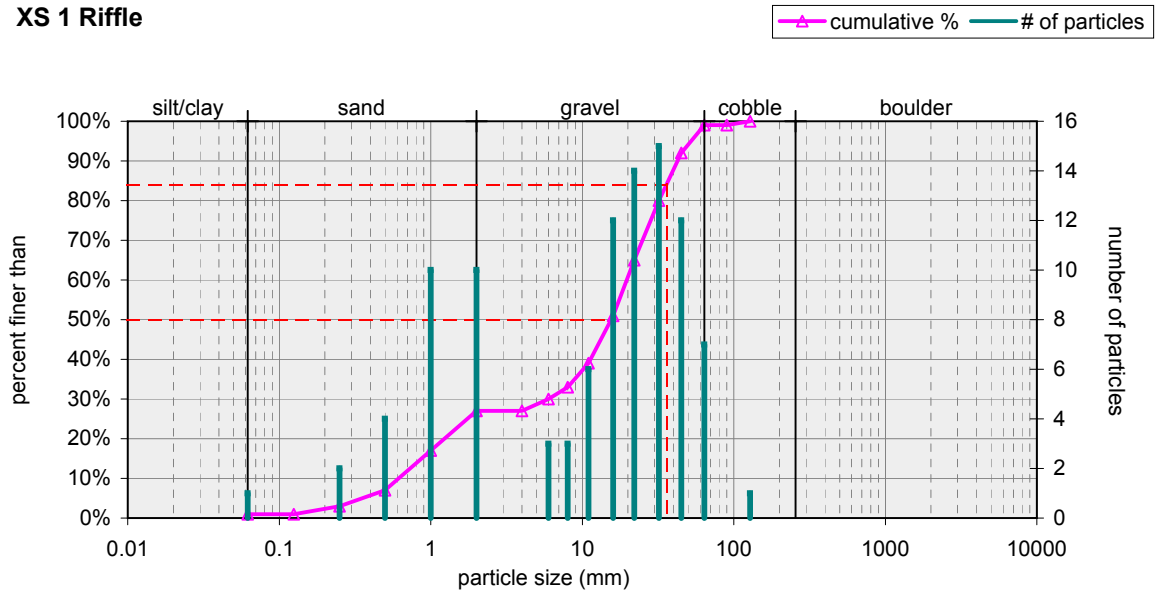
App B8 - Pebble Count Plots

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**1**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**2**
medium sand	0.25 - 0.5	**4**
coarse sand	0.5 - 1	**10**
very coarse sand	1 - 2	**10**
very fine gravel	2 - 4	
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**3**
medium gravel	8 - 11	**6**
medium gravel	11 - 16	**12**
coarse gravel	16 - 22	**14**
coarse gravel	22 - 32	**15**
very coarse gravel	32 - 45	**12**
very coarse gravel	45 - 64	**7**
small cobble	64 - 90	
medium cobble	90 - 128	**1**
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:

Chavis Park, MY03
XS 1 Riffle



Size (mm)	
D16	0.93
D35	8.9
D50	16
D65	22
D84	36
D95	52

Size Distribution	
mean	5.8
dispersion	9.7
skewness	-0.35

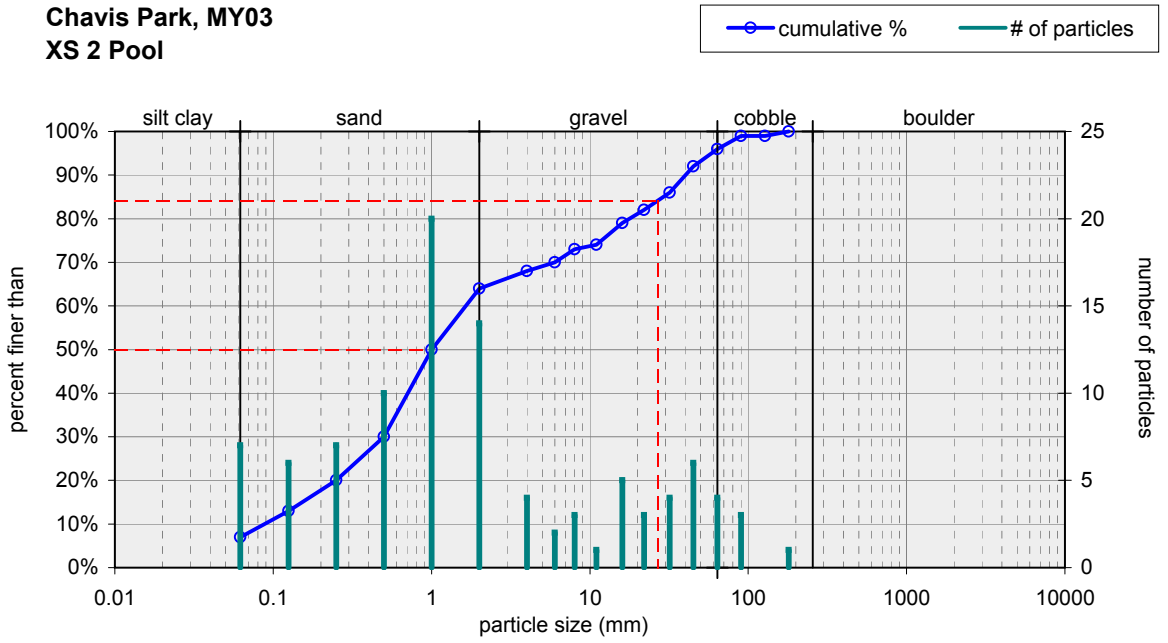
Type	
silt/clay	1%
sand	26%
gravel	72%
cobble	1%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**7**
very fine sand	0.062 - 0.125	**6**
fine sand	0.125 - 0.25	**7**
medium sand	0.25 - 0.5	**10**
coarse sand	0.5 - 1	**20**
very coarse sand	1 - 2	**14**
very fine gravel	2 - 4	**4**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**3**
medium gravel	8 - 11	**1**
medium gravel	11 - 16	**5**
coarse gravel	16 - 22	**3**
coarse gravel	22 - 32	**4**
very coarse gravel	32 - 45	**6**
very coarse gravel	45 - 64	**4**
small cobble	64 - 90	**3**
medium cobble	90 - 128	
large cobble	128 - 180	**1**
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:

Chavis Park, MY03
XS 2 Pool



Size (mm)	
D16	0.17
D35	0.59
D50	1
D65	2.4
D84	27
D95	59

Size Distribution	
mean	2.1
dispersion	16.4
skewness	0.22

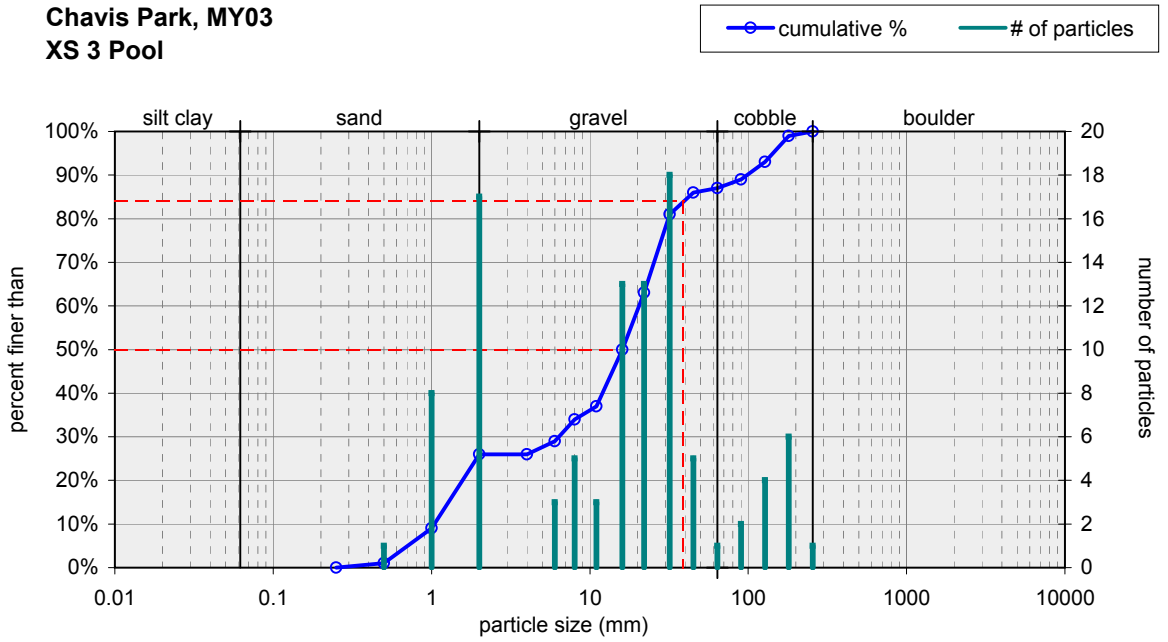
Type	
silt/clay	7%
sand	57%
gravel	32%
cobble	4%
boulder	0%

Pool

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	**1**
coarse sand	0.5 - 1	**8**
very coarse sand	1 - 2	**17**
very fine gravel	2 - 4	
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**5**
medium gravel	8 - 11	**3**
medium gravel	11 - 16	**13**
coarse gravel	16 - 22	**13**
coarse gravel	22 - 32	**18**
very coarse gravel	32 - 45	**5**
very coarse gravel	45 - 64	**1**
small cobble	64 - 90	**2**
medium cobble	90 - 128	**4**
large cobble	128 - 180	**6**
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:

Chavis Park, MY03
XS 3 Pool



Size (mm)	
D16	1.3
D35	8.9
D50	16
D65	23
D84	39
D95	140

Size Distribution	
mean	7.1
dispersion	7.4
skewness	-0.29

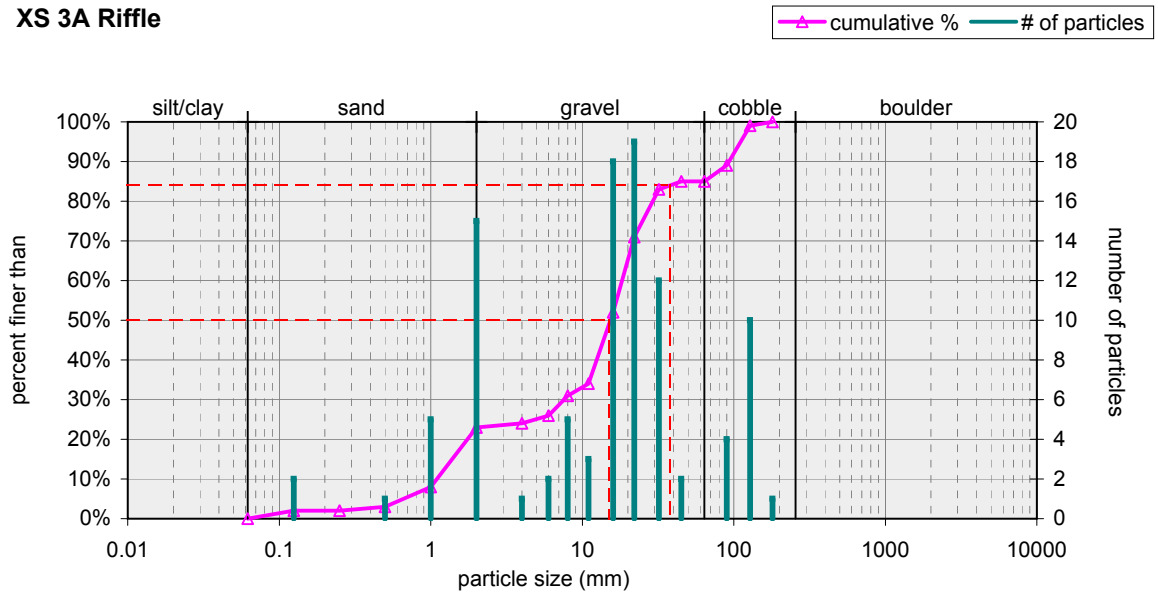
Type	
silt/clay	0%
sand	26%
gravel	61%
cobble	13%
boulder	0%

Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	**2**
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	**1**
coarse sand	0.5 - 1	**5**
very coarse sand	1 - 2	**15**
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**5**
medium gravel	8 - 11	**3**
medium gravel	11 - 16	**18**
coarse gravel	16 - 22	**19**
coarse gravel	22 - 32	**12**
very coarse gravel	32 - 45	**2**
very coarse gravel	45 - 64	
small cobble	64 - 90	**4**
medium cobble	90 - 128	**10**
large cobble	128 - 180	**1**
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:

Chavis Park, MY03
XS 3A Riffle



Size (mm)	
D16	1.4
D35	11
D50	15
D65	20
D84	38
D95	110

Size Distribution	
mean	7.3
dispersion	6.6
skewness	-0.26

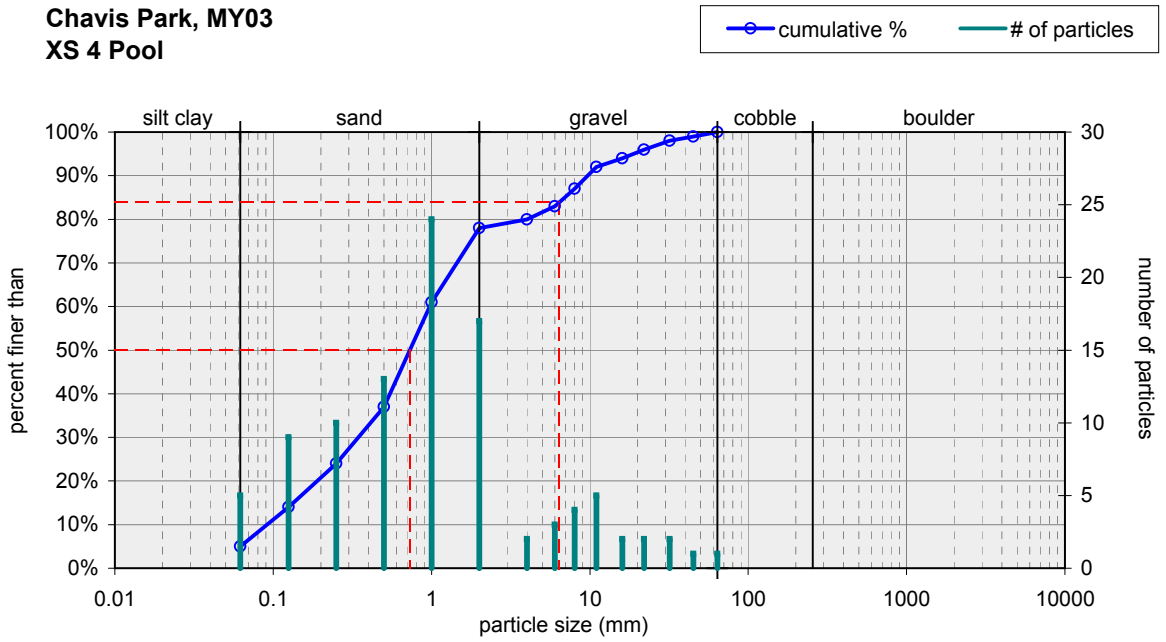
Type	
silt/clay	0%
sand	23%
gravel	62%
cobble	15%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**5**
very fine sand	0.062 - 0.125	**9**
fine sand	0.125 - 0.25	**10**
medium sand	0.25 - 0.5	**13**
coarse sand	0.5 - 1	**24**
very coarse sand	1 - 2	**17**
very fine gravel	2 - 4	**2**
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**4**
medium gravel	8 - 11	**5**
medium gravel	11 - 16	**2**
coarse gravel	16 - 22	**2**
coarse gravel	22 - 32	**2**
very coarse gravel	32 - 45	**1**
very coarse gravel	45 - 64	**1**
small cobble	64 - 90	
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:

Chavis Park, MY03
XS 4 Pool



Size (mm)	
D16	0.14
D35	0.45
D50	0.73
D65	1.2
D84	6.4
D95	19

Size Distribution	
mean	0.9
dispersion	7.0
skewness	0.09

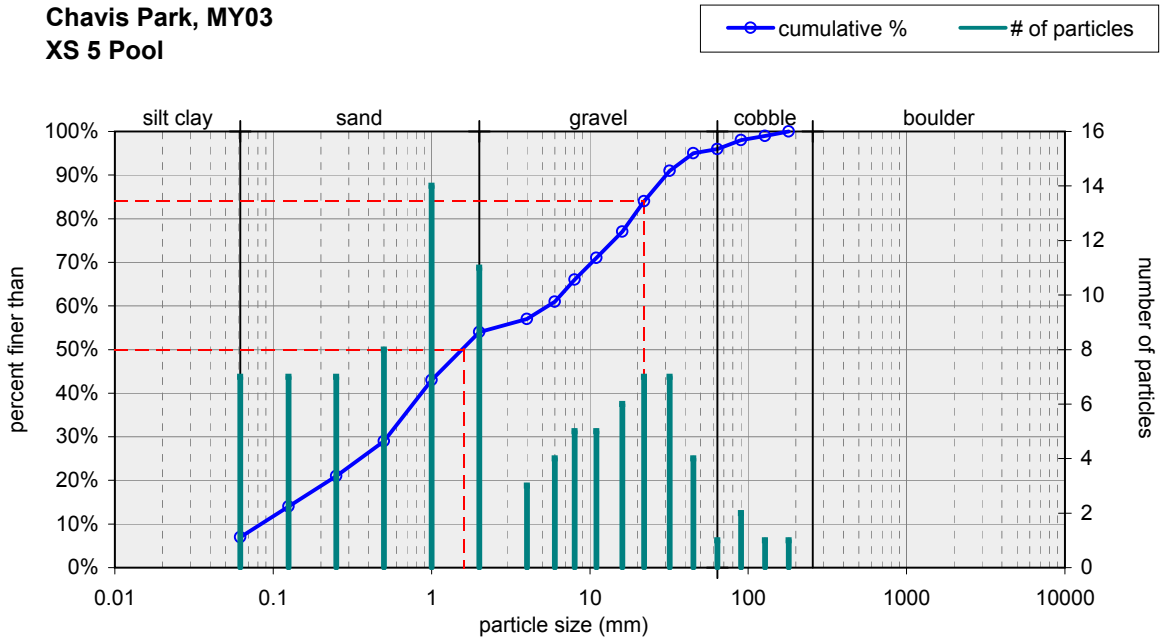
Type	
silt/clay	5%
sand	73%
gravel	22%
cobble	0%
boulder	0%

Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**7**
very fine sand	0.062 - 0.125	**7**
fine sand	0.125 - 0.25	**7**
medium sand	0.25 - 0.5	**8**
coarse sand	0.5 - 1	**14**
very coarse sand	1 - 2	**11**
very fine gravel	2 - 4	**3**
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**5**
medium gravel	8 - 11	**5**
medium gravel	11 - 16	**6**
coarse gravel	16 - 22	**7**
coarse gravel	22 - 32	**7**
very coarse gravel	32 - 45	**4**
very coarse gravel	45 - 64	**1**
small cobble	64 - 90	**2**
medium cobble	90 - 128	**1**
large cobble	128 - 180	**1**
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:

Chavis Park, MY03
XS 5 Pool



Size (mm)	
D16	0.15
D35	0.67
D50	1.6
D65	7.6
D84	22
D95	45

Size Distribution	
mean	1.8
dispersion	12.2
skewness	0.04

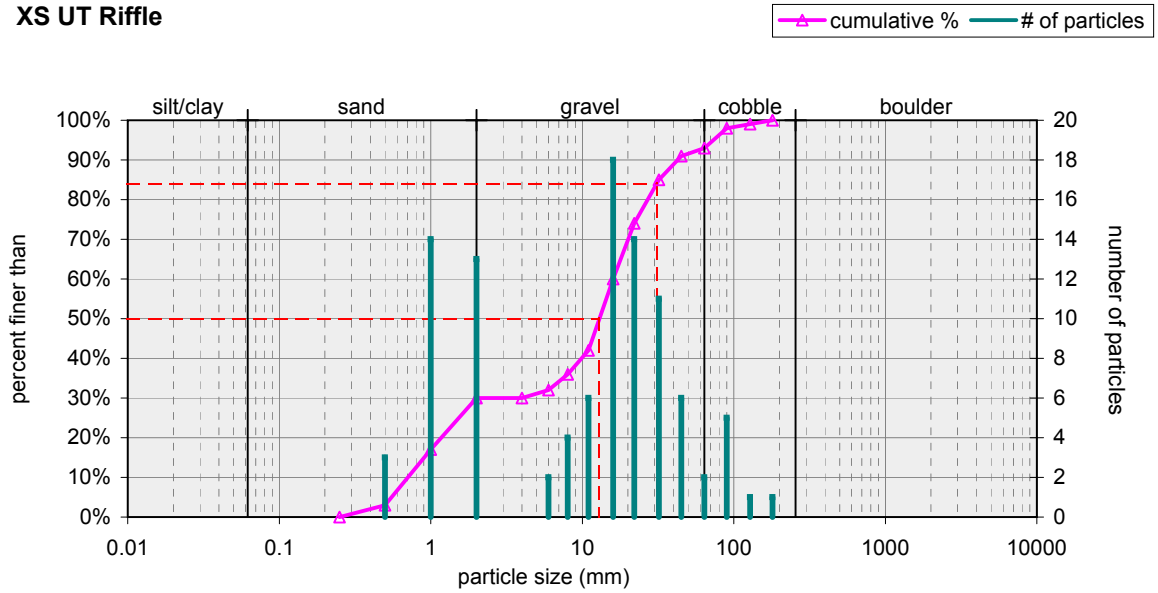
Type	
silt/clay	7%
sand	47%
gravel	42%
cobble	4%
boulder	0%

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	**3**
coarse sand	0.5 - 1	**14**
very coarse sand	1 - 2	**13**
very fine gravel	2 - 4	
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**4**
medium gravel	8 - 11	**6**
medium gravel	11 - 16	**18**
coarse gravel	16 - 22	**14**
coarse gravel	22 - 32	**11**
very coarse gravel	32 - 45	**6**
very coarse gravel	45 - 64	**2**
small cobble	64 - 90	**5**
medium cobble	90 - 128	**1**
large cobble	128 - 180	**1**
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:

Chavis Park, MY03
XS UT Riffle



Size (mm)	
D16	0.95
D35	7.4
D50	13
D65	18
D84	31
D95	73

Size Distribution	
mean	5.4
dispersion	8.0
skewness	-0.31

Type	
silt/clay	0%
sand	30%
gravel	63%
cobble	7%
boulder	0%