

Garner Branch (Chavis Park)  
Stream Restoration  
As-Built Report  
September 2002

As-Built Report  
**Garner Branch Stream Restoration Project**  
Chavis Park, Raleigh North Carolina

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As-Built Report  
**Garner Branch Stream Restoration Project**  
Chavis Park, Raleigh North Carolina

## **1. INTRODUCTION**

The Wetlands Restoration Program identified the Garner Branch project in 1999 for a design project. Garner Branch was investigated from the Confluence with Walnut Creek to the origin of the stream at Lenoir Street. After submittal of preliminary findings to WRP final design/build plans were prepared for the reach of Garner Branch from Martin Luther King Boulevard to Lenoir Street approximately 1,830 linear feet. Two short segments of tributaries within the Chavis Park boundaries were also included in this project. The first location is approximately 250 linear feet of tributary just upstream of Station 55+00. The second tributary is located just above Station 63+00 and is approximately 120 feet in length. The total length of stream in the project is approximately 2,200 linear feet.

The project is located on Garner Branch within the limits of Chavis Park. Chavis Park is a very old & established park located in downtown Raleigh, North Carolina. The park is an urban park located approximately one mile south east of the state capitol building in downtown Raleigh. The upstream limit of the project is Lenoir Street and the lower limit is Martin Luther King Boulevard.

The goal of this stream restoration project was to improve the water quality, riparian quality and stability of the stream. Restoring the natural flow pattern of the stream and stabilizing the steep channel banks accomplished this. Long-term stabilization will be accomplished by planting the riparian area with native vegetation.

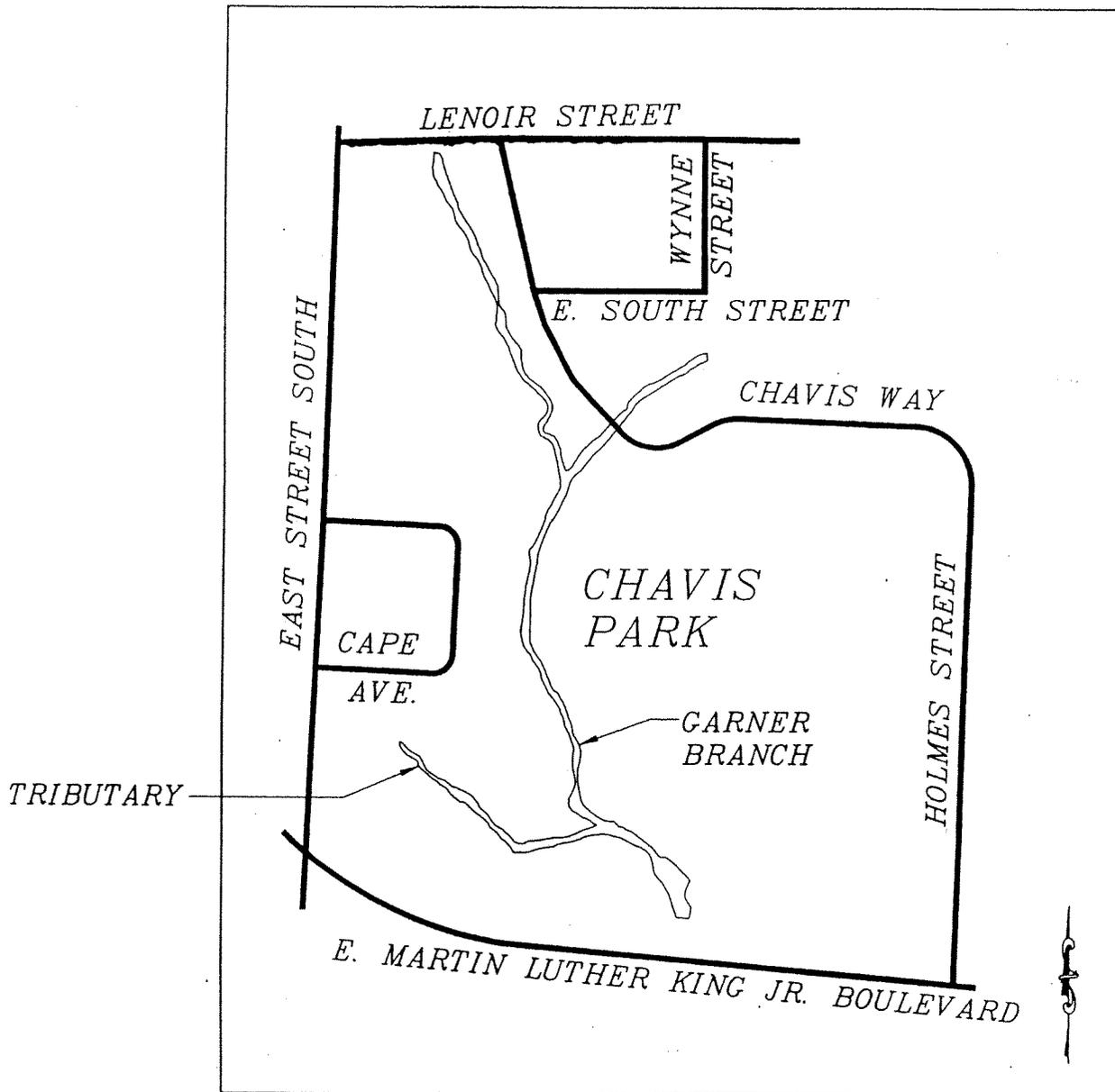
- Reduce bank erosion by adjustment of the existing channel pattern or by bio-engineered methods.
- Improve water quality by reducing erosion and by increasing the connectivity between the channel and floodplain.
- Stabilize the bankfull elevation along the reach.
- Enhance in stream habitat by placing 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.

## **2. SUMMARY**

### **2.1 Project Description:**

The stream work completed consisted of stream bank stabilization, in-stream structures, stream plan form adjustments and storm drainage retrofits. The existing non-native and nuisance vegetation along the steep stream banks was cleared along the entire 2,200 linear feet and replanted with native species sensitive to the park setting and visibility

Garner Branch Location Map  
within  
Chavis Park, Raleigh North Carolina



LOCATION MAP  
NOT TO SCALE

# Chavis Park Downtown Raleigh, North Carolina



Garner Branch  
Located in  
Chavis Park

concerns. In-stream structures were installed to establish additional bed form and provide better habitat. Some bio-technical practices were installed areas where the banks were steep and severely eroded.

The completed channel work was completed within the confines of the existing incised channel. At locations where possible, the banks were sloped back form stable slopes before re-vegetation. No utilities except for storm water discharge point sources into the creek were changed during construction. All existing bridges remained in place as well as the existing sanitary sewer lines within the park. A rock cross vane was installed down stream of the existing stone bridge to assist in re-establishing the channel grade through the existing undercut footings of the bridge structure. Construction work stopped twenty feet upstream and downstream of all existing culverts and the stone bridge

From station 52+60 to station 62+00 the work consisted primarily of stream bank stabilization and re-grading of the stream floodplain. The floodplain was reworked to allow for more frequent stormwater access. A “W” Vane structure was placed just upstream of the Martin Luther King culverts to help direct the flow into both barrels. A second rock vane was installed between the “W” Vane and the existing upstream bedrock feature to assist in redirecting the flow away from the reconstructed bank. At station 55+50 the existing in-stream island was reconstructed and rock cross vane structures were placed to assist with stability. At station 64+00 through 69+00 the stream was re-meandered through the floodplain. The floodplain was widened in areas where severe restrictions occurred.

## **2.2 Methodologies:**

The as-built data for the stream profile, topography development, and physical locations were developed using a 610 Geodimeter, Total Station. Combined Surveying Resources provided the as-built survey data. The area within the conservation easement boundary was completely surveyed to develop as-built contours, locate the top and toe of the stream bank as well as the terrace, locate storm drainage outlet pipes, locate in-stream structures and vegetated geogrids, locate the stream profile, reset any conservation easement pins that were disturbed during construction, and monuments for cross sections. Pipe inverts and storm drainage tops were also located by the surveyor and elevations are shown on the as-built plans.

The surveyor established elevations on the rock in-stream structures that were constructed during the project at a minimum of three locations on the cross vane structures. These elevations are shown on the as-built plans. In addition, all rock bedrock outcrops in the channel were located by the surveyor. The stream profile and stationing of the channel was established by the surveyor using the Total Station equipment. The stream profile has been included below the plan view on the as-built drawings. The profile also shows the location of all of the constructed in-stream structures and the existing bedrock within the channel.

The storm drainage structures that were built as part of this contract were surveyed by the contractor, White Oak Construction. The contractor obtained inverts in and out of the

yard inlets and junction boxes during construction. This as-built data has been transferred on to the as-built plans.

Wolman Pebble counts were made at each permanent cross section. The particle size classification used for the analysis is from the Reference Reach Field Book published by Wildland Hydrology. Two pebble counts were performed for cross section 4, one on the main channel and one on the tributary.

The stream channel cross sections were surveyed using a FG 020 Frieberger Automatic level to measure the elevations. The cross sections and pebble counts were field measured & counted by Becky L. Ward Consulting. The distance for each elevation point was located by stretching a cloth tape from one monument to the other and the distance was determined by observing the position of the survey rod along the extended tape. The elevations at each cross section point was established by differential level readings using the benchmark monument elevation provided by the surveyor (shown on the plan for each monument) to establish the instrument height.

The entire length center line of the main channel from Martin Luther King Boulevard to Lenoir Street ( Approximately 1,890lf.) and the tributary between the Culvert at MLK and the stone bridge in the park (Approximately 300 lf.) was profiled after the project was completed. The tributary just upstream of the stone bridge that extends under Chavis Way was not profiled because the original project did not address any changes to this channel. Only the banks in this area were cleaned up and new vegetation planted.

The five cross section locations were selected along the entire length of the main channel. In the discussion below all cross sections are referenced as viewed from left to right looking downstream.

1. Cross Sections 1 and 2 were located in the upstream reach of the project above the stone bridge. Two locations were selected one section at a pool and one section in a riffle. In this section of the project the stream was completely reconstructed within the floodplain. In addition the floodplain was widened to provide a continuous corridor for storm water flows in areas of previous restrictions. The terrace banks were stabilized with vegetation. Cross vane structures were placed in the reconstructed channel to create bed form features for habitat and water quality as well as to stabilize the redirected flow.
2. Cross Section 3 was located just downstream of the stone bridge approximately one half way into the project. The two tributaries just upstream of the stone bridge combine to provide approximately twice as much flow through this channel segment as the seen in sections 1 & 2 above. The construction work completed in this area involved lowering the existing floodplain elevation, bank toe stabilization with stone and joint plantings on the south bank, re-vegetation of the terrace banks, and the installation of a junction box and pipe to bring the stormwater discharge down into the stream. Cross Vane structures were also installed as shown on the as-built plan

3. Cross Section 4 was placed to monitor the reconstructed floodplain between the main channel and the tributary entering from the south. The cross section begins on the left bank of the main channel crosses to the right bank and then turns to continue to the right bank of the tributary. This area was originally an island that had been cut around and had severely eroded and was contributing a significant amount of sediment over the years. The floodplain point was reconstructed to a slightly higher than bankfull elevation so that as floodwaters rise in the channel more flow is directed to the wider floodplain to the left of the channel. This was done to protect the point from erosion until vegetation is established. Structures were also an important part in the design of this area by directing flows to the reconstructed channel location. The placement of the cross vanes at the near the tip of the point and the continuation of the arms to connect around the point of the floodplain reinforces the point of convergence. In this area two sections of Vegetated Geogrids were constructed to stabilize the terrace banks.
4. The last cross section is located just upstream of the culverts under MLK. This area was selected because it will experience the entire flow of the watershed. The flood plain was lowered to allow for the point bar in this area to develop. A large natural pool created by a bedrock nick point in the stream exists just upstream of the cross section. Just below the section a single rock vane, installed to protect the bank, and a “W” vane, installed to divide the flow into the twin culverts, were installed in the channel. Other work in this area involved the construction of storm drainage pipe and structures to bring an existing storm water pipe discharge point down into the pool location and not over the banks. The previously eroded bank near the newly constructed pipe was repaired and re-vegetated. A rock toe with joint plantings was also placed during construction to stabilize this bank.

### **2.3 Watershed:**

The watershed basin has a western boundary located primarily along Rock Quarry Road and Cumberland Street. The northern boundary extends almost to New Bern Avenue and the eastern limit is approximately defined by Chavis Way. The southern watershed boundary is Martin Luther King Boulevard. The watershed contributing stormwater runoff to Garner Branch is very 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 shown on Exhibit “A” attached.

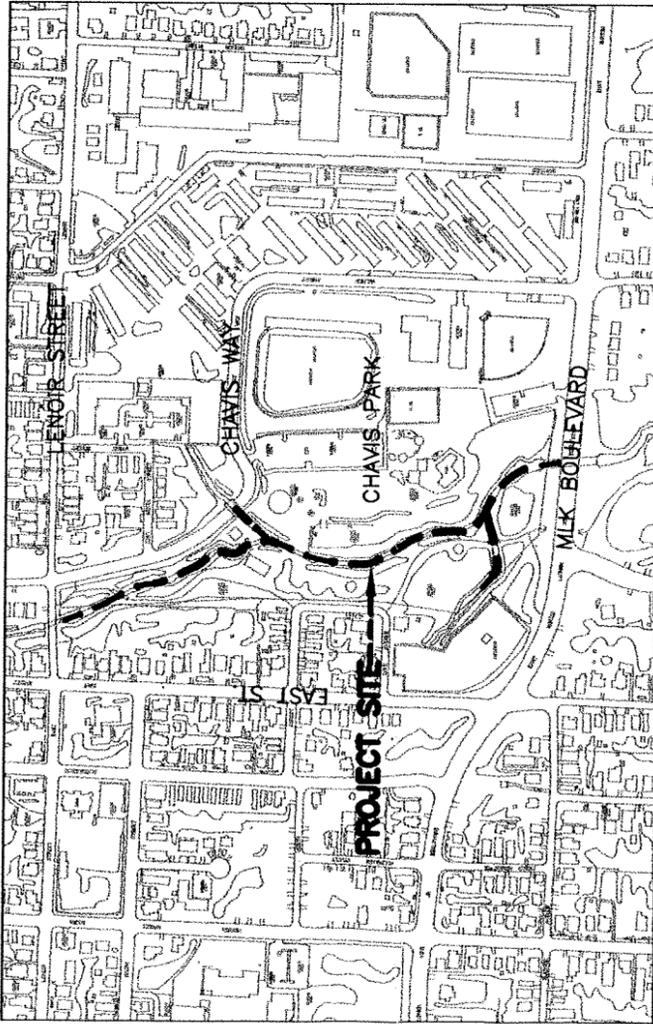
### **2.4 Consultant, Contractor & Project Manager:**

***Design Firm Natural Areas Ecosystem Management***

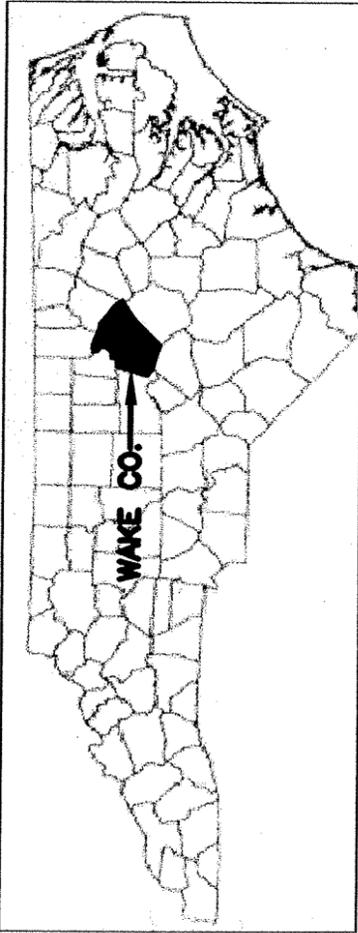
Contact: Mr. Randy Stowe  
10015 Wright Road  
Harvard, Illinois 60033  
Phone: (815) 648-2253  
Fax: (815) 648-2403



TOTAL WATERSHED AREA=347 AC., 0.54 SQ.MI.



8-DIGIT HYDROLOGIC UNIT NUMBER - 03020201



NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES DIVISION OF WATER QUALITY WETLAND RESTORATION PROGRAM 320 WEST JONES ST. RALEIGH, NC 27604		WATERSHED MAP EXHIBIT 'A' PREPARED FOR: NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES DIVISION OF WATER QUALITY WETLAND RESTORATION PROGRAM 320 WEST JONES ST. RALEIGH, NC 27604
DATE: SEPT. 17, 2008 SCALE: 1" = 800' SHEET: 1 OF: 1	PROJECT: WATERSHED MAP EXHIBIT 'A' DRAWN BY: [Name] CHECKED BY: [Name] APPROVED BY: [Name]	PROJECT: WATERSHED MAP EXHIBIT 'A' DRAWN BY: [Name] CHECKED BY: [Name] APPROVED BY: [Name]

**Contractor: *White Oak Construction Corporation (Prime)***

Contact: Mr. Bruce Hollis  
4020 Pea Ridge Road  
New Hill, North Carolina 27562  
Phone: (919) 545-0442  
Fax: (919) 545-2034

**Contractor: *Tower Engineering Professionals (Vegetation & Bioengineering)***

Contact: Mr. George T. Swearingen  
3703 Junction Boulevard  
Raleigh, North Carolina 27603-5263  
Phone: (919) 661-6351  
Fax: (919) 661-6350

**WRP Project Manager:**

North Carolina Wetland Restoration Program  
Contact: Mr. Larry Hobbs  
320 West Jones Street  
Raleigh, North Carolina 27603  
Phone: (919) 733-5208  
Fax: (919) 733-9919

**3. SUCCESS CRITERIA**

**3.1 Dimension:**

No significant change in channel geometry from constructed cross sections. The pool depths and widths should remain consistent with the constructed geometry. The channel was built as a “C” type channel and may develop over time into a “E” type channel. Five cross section locations have been included in the Appendix section of this report. Permanent cross sections are located at the following stations along the channel:

<b>Cross Section No.</b>	<b>Cross Section Station</b>
1	67+44
2	66+23
3	60+85
4	Main 56+10 Tributary 0+67
5	53+46

**3.2 Pattern**

No significant change in pattern of channel. The channel meander lengths, radius of curvature, and belt widths as shown on the as-built plans shall remain constant.

### **3.3 Profile**

The profile should show development of pools and riffles. The profile should continue to show the development of bed form features and not evidence of channel aggradation or degradation.

### **3.4 Materials**

The materials in the riffle areas should show changes as the riffles & pools develop. The materials should show coarsening in the riffles and a change in the fineness in pools.

### **3.5 Structures**

The structures should not show any breaching. The water should flow over the center top rock. The structures should not show any erosion along the arms or evidence of water bypassing the structure.

### **3.5 Stream Cross Section Photo Reference Points**

Photographs should show no change in physical location of channel. The vegetation development should be observed to show progressive growth over the five-year monitoring period.

Photo Reference Locations:

1. Cross Section #1: Third structure downstream of pipe crossing, 4<sup>th</sup> bolder downstream on the left arm as viewed looking upstream.
2. Cross Section #2: Structure just downstream of cross section, last bolder on right arm looking upstream.
3. Standing on top of the storm drainage concrete outlet pipe end, looking upstream at cross section #3.
4. Cross Section #4: At the rock structure that wraps around the island end, left cross vane, standing on left bolder on left arm of structure looking upstream at the main channel and the tributary.
5. Cross Section #5: Standing on the upstream left point of the "W" rock structure just downstream of the cross section looking upstream.

### **3.6 Vegetation Plots**

The vegetation will be planted in the fall of 2002. The vegetation plots will be established and provided with the first year monitoring report.

## **4. MONITORING**

### **Monitoring Schedule and Methods**

The project will be monitored once each year for a period of five (5) years with the first year monitoring to be completed in August of 2003 by the design consultant, *Natural Areas Ecosystem Management*.

## **5. MITIGATION**

The mitigation plan is attached to this report as Exhibit “B”.

## **6. MAINTENANCE & CONTINGENCY PLANS**

The State of North Carolina Wetland Restoration Program (NCWRP) will be responsible for the maintenance of this project, for a period of five (5), years after project completion. Repairs will be made as necessary by NCWRP.

## **7. REFERENCES**

- 7.1 Applied River Morphology, Rosgen Dave, 1996 Wildland Hydrology
- 7.2 The Reference Reach Field Book, 1998 Wildland Hydrology
- 7.3 As-built surveys by: Combined Surveying Resources, 3701 National Drive Suite 110, Raleigh North Carolina 27612, (919) 787-0900
- 7.4 As-built Cross Sections by Becky L. Ward Consulting 1512 Eglantyne Court, Raleigh North Carolina 27613 (919)870-0526
- 7.5 Constructed Storm Drainage Structure Invert As-built data by White Oak Construction 4020 Pea Ridge Road New Hill, North Carolina 27562, (919) 545-0442.
- 7.6 Topographic and Planimetric information outside the Conservation Easement limits from City of Raleigh GIS Information.
- 7.7 Record Map For Easement Location for Rocky Branch (Also known as Garner Branch) in Chavis Park Wake County NC. Included in the Appendix section of this report.
- 7.8 Easement Description for Rocky Branch (Also known as Garner Branch) Creek in Chavis Park, Raleigh, NC. Included in the Appendix section of this report.



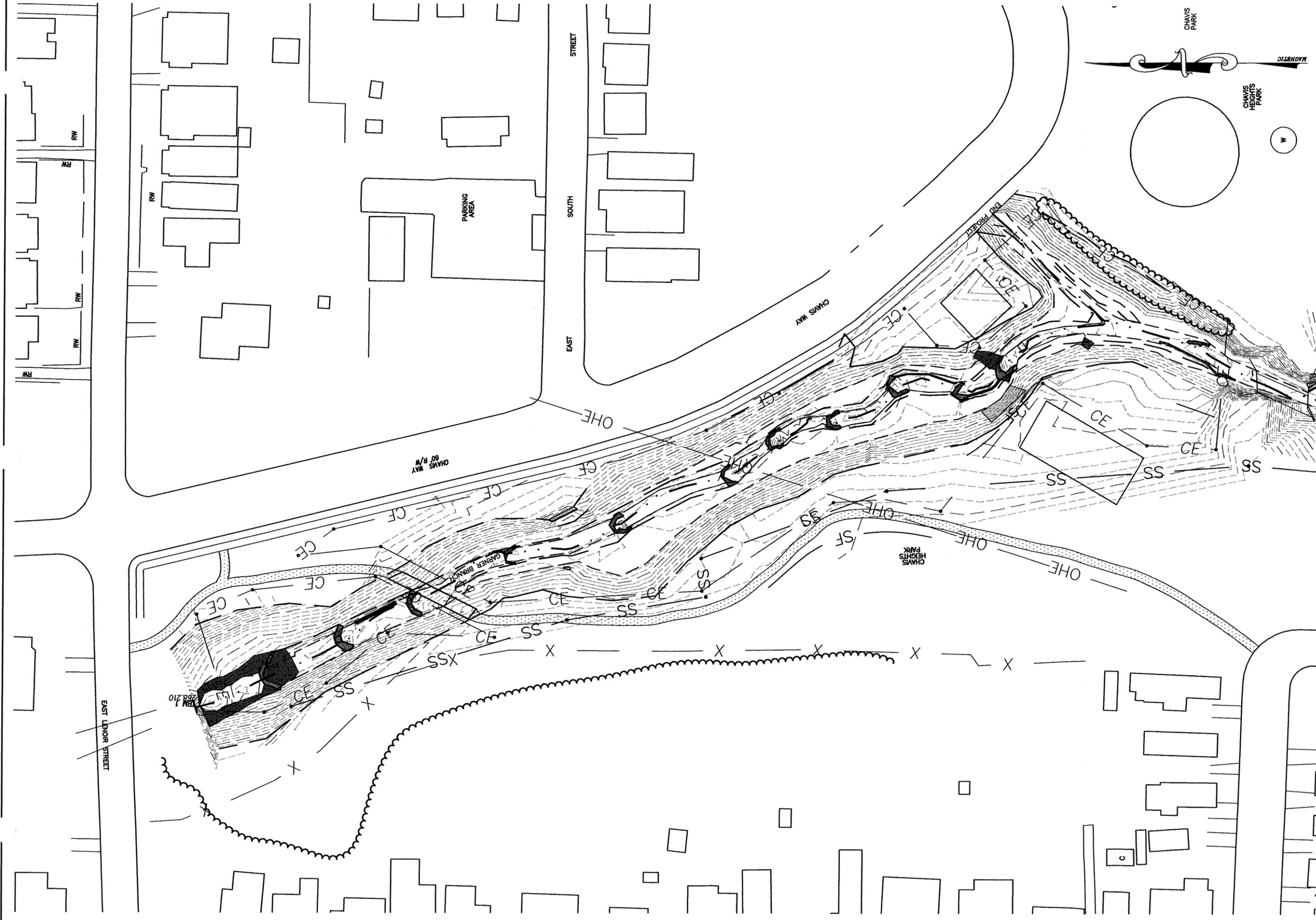
77M 400 2  
MAGNETIC

EAST MARTIN LUTHER KING JR. BOULEVARD

CAPE AVENUE  
77M1

1" = 60'

REGIONAL AREA ECOSYSTEM MANAGEMENT 10015 WEST ROAD RALEIGH, NC 27616 (919) 791-5500	PREPARED FOR: NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES DIVISION OF WATER QUALITY WETLAND RESTORATION PROGRAM 320 WEST JONES ST. RALEIGH, NC 27604	DATE: SEPT. 17, 2009 SCALE: 1" = 60' SHEETS: 1 OF 2
	PROJECT TITLE: MITIGATION PLAN EXHIBIT 'B'	



NORTHERN AREA COORDINATE MANAGEMENT  
 HARRAS, ALBERTA T8003  
 (416) 816-2525

PREPARED FOR:  
 NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES  
 DIVISION OF WATER QUALITY  
 WETLAND RESTORATION PROGRAM  
 320 WEST JONES ST. RALEIGH, NC 27604

DATE: SEPT. 17, 2002    SCALE: 1" = 60'    SHEET: 2 OF 2

1" = 60'

**Photo Reference Chavis Park , Garner Branch Permanent Cross Sections**  
September 3, 2002



**Cross Section #1 As Viewed Looking Upstream**



**Cross Section #2 As Viewed Looking Upstream**

**Photo Reference Chavis Park , Garner Branch Permanent Cross Sections**  
September 3, 2002



**Cross Section #3 As Viewed Looking Upstream**



**Cross Section #4 Main Channel As Viewed Looking Upstream**

**Photo Reference Chavis Park , Garner Branch Permanent Cross Sections**  
September 3, 2002



**Cross Section #4 Tributary As Viewed Looking Upstream**



**Cross Section #5 Main Channel As Viewed Looking Upstream**

# Appendix

**Project:** Chavis Park Garner Branch Stream Restoration Project  
**Location:** Permanent Cross Section #1, Station 67+44, RIFFLE

USGS Grid Coordinates  
 North East  
 Plan Sheet Ref. No.

<b>Date:</b> 09/08/2002	Left Permanent Benchmark Elevation:	269.02	Left Permanent Benchmark Location:	735977.7133	2109362.5254	1
	Right Permanent Benchmark Elevation:	268.61	Right Permanent Benchmark Location:	735948.4413	2109300.4008	6

Benchmark description: 4x4 Concrete post with nail, top of nail is benchmark elevation

Note: Cross Section taken from left to right looking downstream

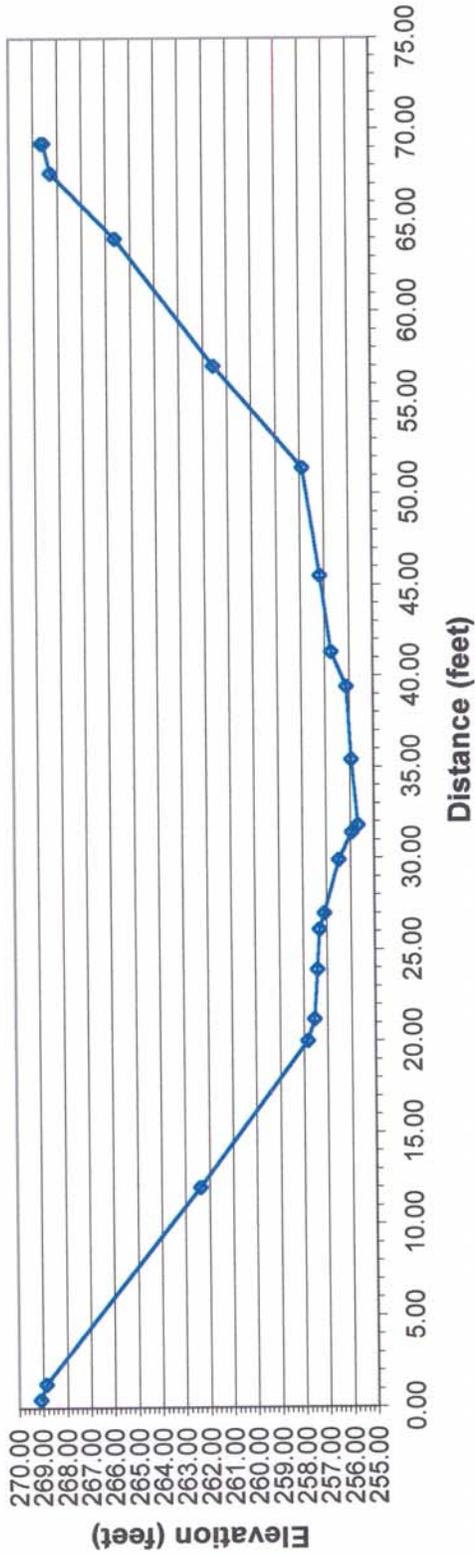
Photo Reference Location: Third structure downstream of pipe crossing, 4th bolder downstream on left arm, as viewed looking upstream.

Station Feet	Back-Sight		Height of Instrument		Fore-Sight		Height		Notes Comments Remarks
	BS Feet	5.02	HI Feet	274.04	FS Feet	Elevation Feet	Feet	Feet	
0.45									Benchmark Lt. Hub
0.45					4.92	269.12			Ground
1.30					5.17	268.87			Top of Terrace
12.00					11.67	262.37			
20.00					16.20	257.84			
21.20					16.49	257.55			
23.90					16.61	257.43			
26.10					16.73	257.31			
27.00					16.92	257.12			
29.90					17.54	256.50			
31.40					18.10	255.94			TOB
31.80					18.35	255.69			TW
35.40					18.09	255.95			
39.40					17.92	256.12			
41.30					17.29	256.75			TOB
45.50					16.85	257.19			
51.40					16.14	257.90			TOE Slope
57.00					12.46	261.58			
64.00					8.40	265.64			TOB
67.60					5.74	268.30			
69.25					5.44	268.60			Rt. Benchmark Hub
69.25					5.36	268.68			Ground
					17.98	256.06			Water Surface
					5.02	274.04			Check Left Hub

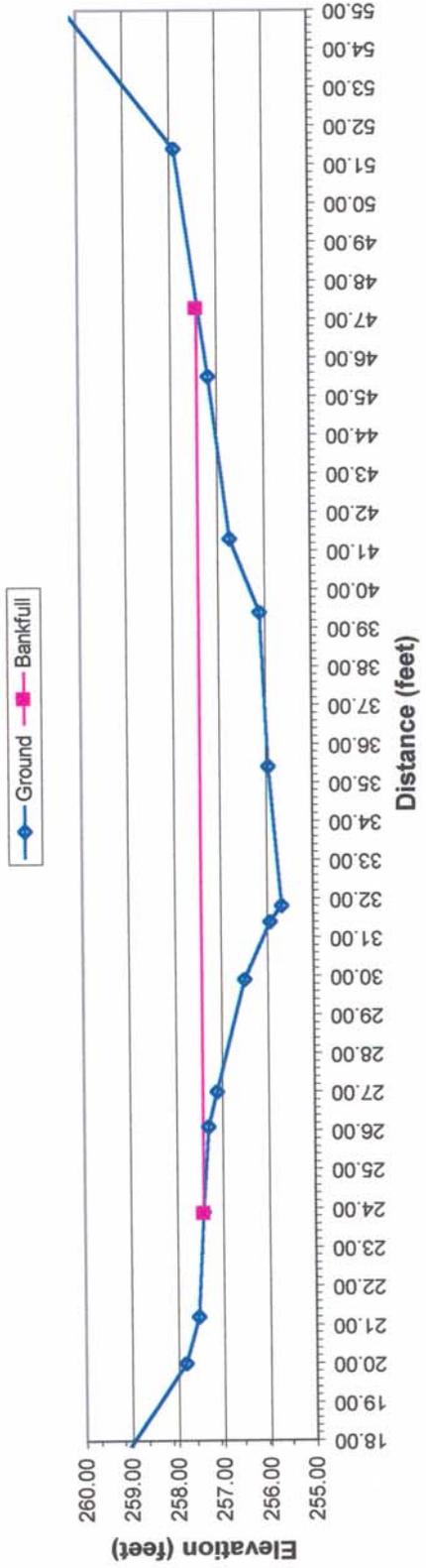
**Stream Morphology**

Wbkf =	23.4 ft
dbkf =	0.94 ft
Abkf =	22.04
dmbkf =	1.74 ft
Wfpa =	35.5 ft
ER =	1.54
D50 =	1.4 mm
Qbkf =	115 cfs
DA =	90 Ac
Slope =	0.005
Sinuosity =	1.15

Permanent Cross Section #1, Station 67+44



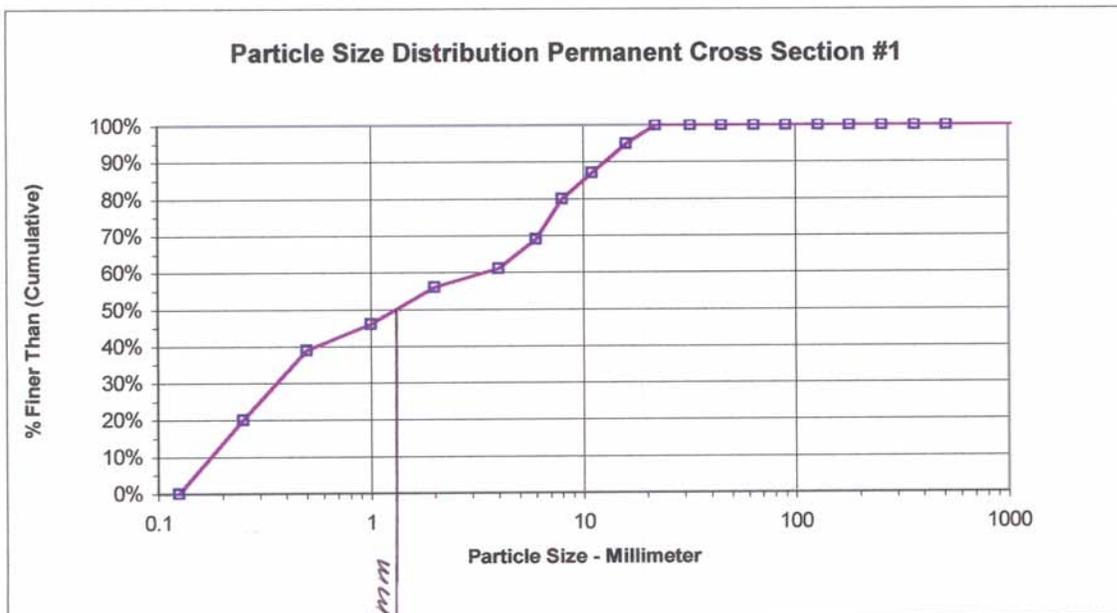
Permanent Cross Section #1, Station 67+44, Riffle



**PEBBLE COUNT**

**Project:** Chavis Park Garner Branch **Date:** 09/03/02  
**Location:** Permanent Cross Section #1

Particle Counts							
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %
	Silt/Clay	< 0.062	S/C	0		0	0%
.04 - .08	Very Fine	.062 - .125	S			0	0%
	Fine	.125 - .25	A	20		20	20%
	Medium	.25 - .50	N	19		19	19%
	Coarse	.50 - 1.0	D	7		7	7%
	Very Coarse	1.0 - 2.0	S	10		10	10%
.08 - .16	Very Fine	2.0 - 4.0		5		5	5%
.16 - .22	Fine	4.0 - 5.7	G	8		8	8%
.22 - .31	Fine	5.7 - 8.0	R	11		11	11%
.31 - .44	Medium	8.0 - 11.3	A	7		7	7%
.44 - .63	Medium	11.3 - 16.0	V	8		8	8%
.63 - .89	Coarse	16.0 - 22.6	E	5		5	5%
.89 - 1.26	Coarse	22.6 - 32.0	L			0	0%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S			0	0%
1.77 - 2.5	Very Coarse	45.0 - 64.0				0	0%
2.5 - 3.5	Small	64 - 90	C	0	0	0	0%
3.5 - 5.0	Small	90 - 128	O	0	0	0	0%
5.0 - 7.1	Large	128 - 180	B	0	0	0	0%
7.1 - 10.1	Large	180 - 256	L	0	0	0	0%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%
14.3 - 20	Small	362 - 512	L	0	0	0	0%
20 - 40	Medium	512 - 1024	D	0	0	0	0%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0	0	0	0%
	Bedrock		BDRK	0	0	0	0%
<b>Totals</b>				<b>100</b>	<b>0</b>	<b>100</b>	<b>100%</b>



**Project:** Chavis Park Garner Branch Stream Restoration Project

**Location:** Permanent Cross Section #2, Station 66+23, POOL

**Date:** 09/08/2002

USGS Grid Coordinates

North

East

Plan Sheet

Ref. No.

Left Permanent Benchmark Elevation:	267.27	Left Permanent Benchmark Location:	735870.2214	2109421.6342	2
Right Permanent Benchmark Elevation:	266.48	Right Permanent Benchmark Location:	735852.6232	2109345.6826	7

Benchmark description: 4x4 Concrete post with nail, top of nail is benchmark elevation

Note: Cross Section taken from left to right looking downstream

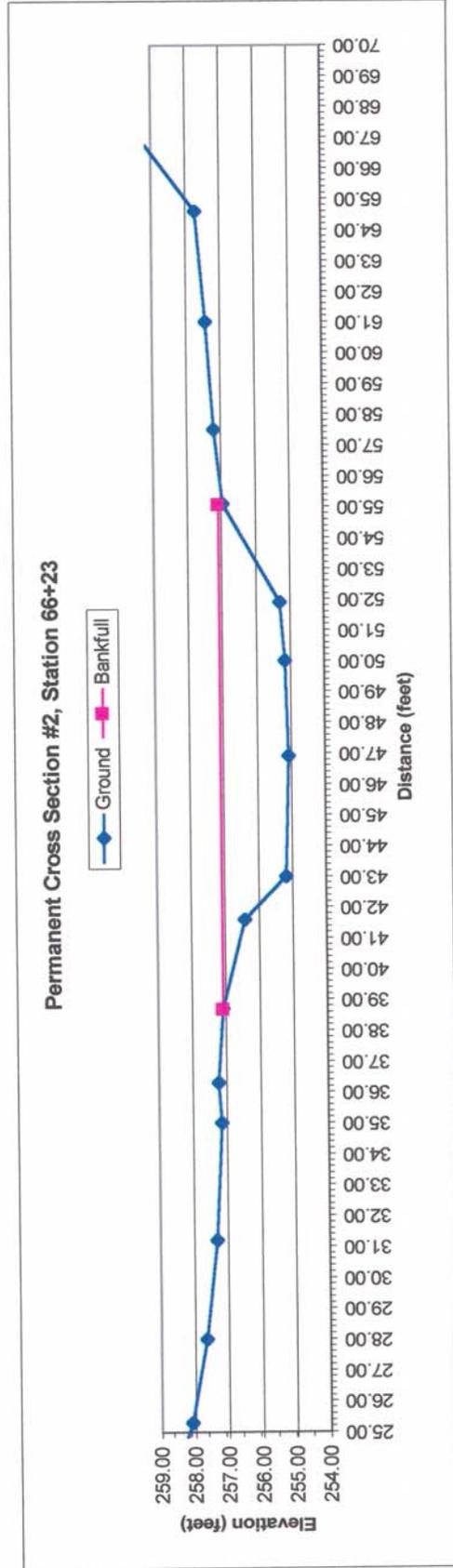
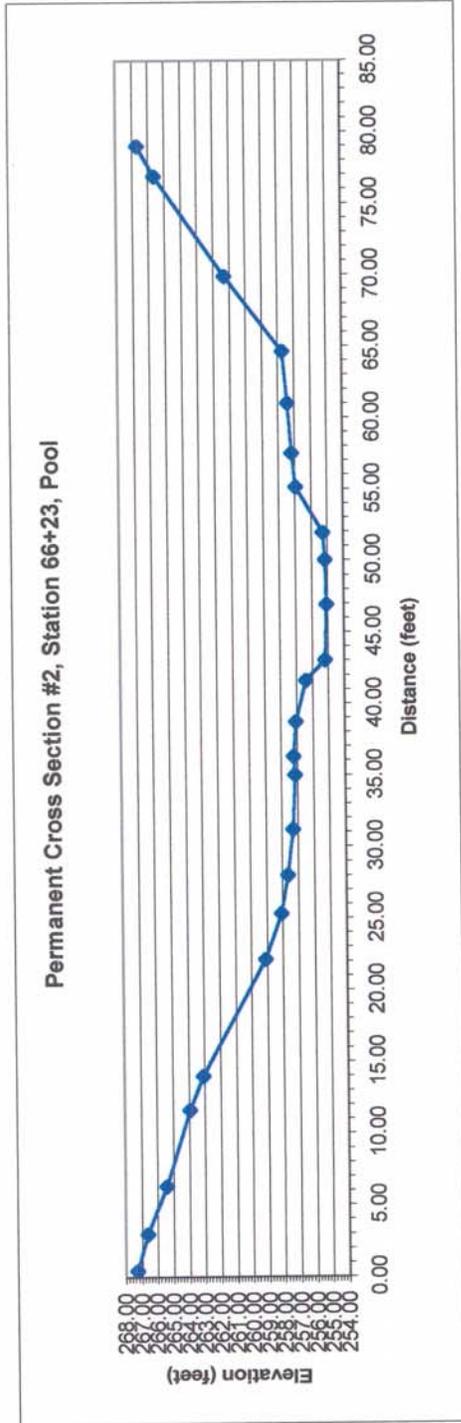
Photo Reference Location: Structure just downstream of cross section, last bolder on right arm looking upstream.

Station Feet	Back-Sight		Height of Instrument Feet	Fore-Sight		Height		Notes Comments Remarks
	BS Feet	FS Feet		HI Feet	Elevation Feet			
0.45	0.44		267.71					Benchmark Hub left
0.45		0.42		267.29				ground
3.00		1.08		266.63				
6.30		2.30		265.41				
11.60		3.75		263.96				
14.00		4.61		263.10				
22.10		8.62		259.09				
25.30		9.60		258.11				TOE
28.00		10.05		257.66				
31.20		10.38		257.33				
35.00		10.54		257.17				
36.30		10.47		257.24				
38.70		10.61		257.10				
41.60		11.28		256.43				TOB
43.00		12.52		255.19				TOE
46.90		12.62		255.09				TW
50.00		12.54		255.17				
51.90		12.41		255.30				TOE
55.10		10.73		256.98				TOB
57.50		10.50		257.21				
61.00		10.28		257.43				
64.60		9.98		257.73				TOE
69.90		6.36		261.35				

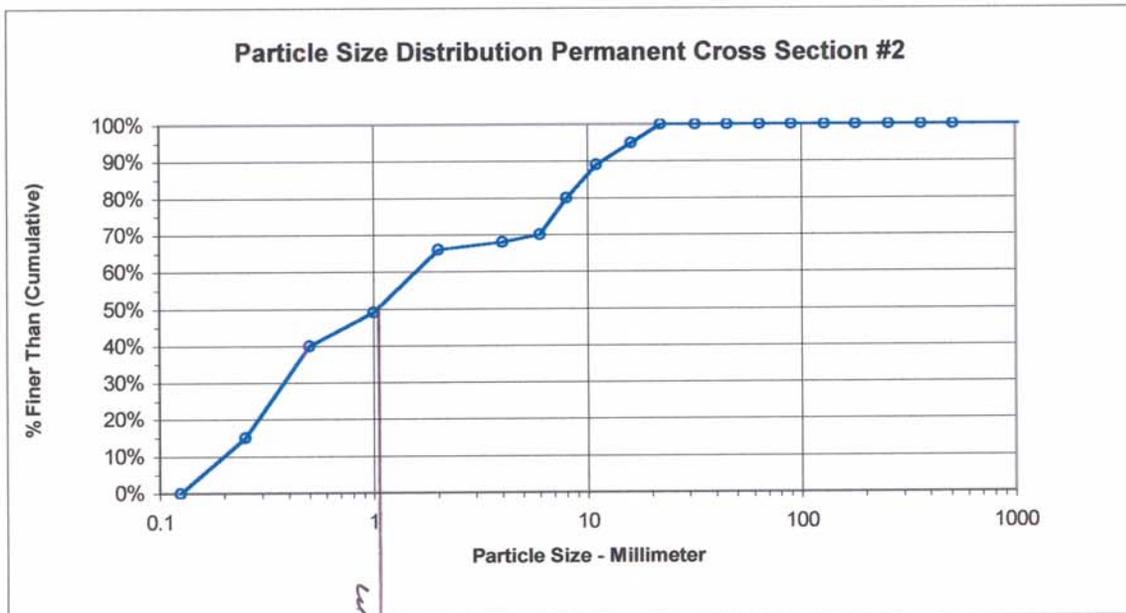
**Stream Morphology**

Wbkf =	16.4 ft
dbkf =	1.6 ft
Abkf =	26.1sq.ft
dmbkf =	2.01 ft
Wfpa =	46 ft
ER =	2.8
D50 =	1.04
Qbkf =	115 cfs
DA =	90 Ac
Slope =	0.004
Sinuosity =	1.15

76.90		2.04	265.67	
79.00		1.00	266.71	ground
78.40		1.24	266.47	Benchmark Hub Right
		12.26	255.45	Water surface Elevation
	0.44			Benchmark left check



PEBBLE COUNT								
Project: Chavis Park Garner Branch						Date: 09/03/02		
Location: Permanent Cross Section #2								
Particle Counts								
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	Cumulative
	Silt/Clay	< 0.062	S/C	0		0	0%	0%
.04 - .08	Very Fine	.062 - .125	S	0	0	0	0%	0%
	Fine	.125 - .25	A	0	15	15	15%	15%
	Medium	.25 - .50	N	0	25	25	25%	40%
	Coarse	.50 - 1.0	D	0	9	9	9%	49%
	Very Coarse	1.0 - 2.0	S	0	17	17	17%	66%
.08 - .16	Very Fine	2.0 - 4.0		0	2	2	2%	68%
.16 - .22	Fine	4.0 - 5.7	G	0	2	2	2%	70%
.22 - .31	Fine	5.7 - 8.0	R	0	10	10	10%	80%
.31 - .44	Medium	8.0 - 11.3	A	0	9	9	9%	89%
.44 - .63	Medium	11.3 - 16.0	V	0	6	6	6%	95%
.63 - .89	Coarse	16.0 - 22.6	E	0	5	5	5%	100%
.89 - 1.26	Coarse	22.6 - 32.0	L	0	0	0	0%	100%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S	0	0	0	0%	100%
1.77 - 2.5	Very Coarse	45.0 - 64.0		0	0	0	0%	100%
2.5 - 3.5	Small	64 - 90	C	0	0	0	0%	100%
3.5 - 5.0	Small	90 - 128	O	0	0	0	0%	100%
5.0 - 7.1	Large	128 - 180	B	0	0	0	0%	100%
7.1 - 10.1	Large	180 - 256	L	0	0	0	0%	100%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	100%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	Large - Very Large	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
<b>Totals</b>				<b>0</b>	<b>100</b>	<b>100</b>	<b>100%</b>	<b>100%</b>



**Project:** Chavis Park Garner Branch Stream Restoration Project  
**Location:** Permanent Cross Section #3, Station 60+85, RIFFLE

USGS Grid Coordinates  
 North East  
 735372.8281 2109406.3043  
 735383.1359 2109327.4076

Plan Sheet  
 Ref. No.  
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**Date:** 09/08/2002

Left Permanent Benchmark Elevation:	262.38	Left Permanent Benchmark Location:	735372.8281	2109406.3043	3
Right Permanent Benchmark Elevation:	260.56	Right Permanent Benchmark Location:	735383.1359	2109327.4076	8

Benchmark description: 4x4 Concrete post with brass cap, top of cap is benchmark elevation

Note: Cross Section taken from left to right looking downstream

Photo Reference Location: Standing on top of stormdrainage concrete outlet pipe end looking upstream at cross section.

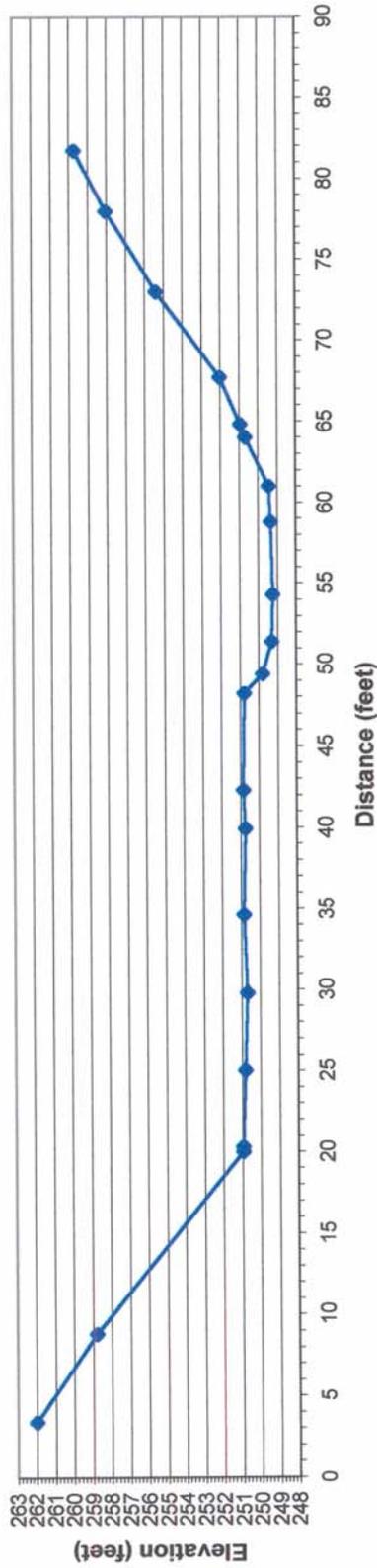
Station Feet	Back-Sight		Height of Instrument		Fore-Sight		Height		Notes Comments Remarks
	BS Feet	4.36	HI Feet	266.74	FS Feet		Elevation Feet		
2.0					4.72		262.02		Left Benchmark Hub & ground
3.4					7.94		258.80		
8.8							250.95	bankfull	
20.0					15.80		250.94	TOE	
20.3					15.91		250.83		
25.0					16.04		250.70		
29.8					15.87		250.87		
34.6					15.98		250.76		
39.9					15.90		250.84		
42.3					15.94		250.80	TOB	
48.2					16.92		249.82	TOE	
49.4					17.42		249.32		
51.4					17.48		249.26	TW	
54.3					17.39		249.35		
58.8					17.28		249.46	TOE	
61.0					16.04		250.70	TOB	
64.0							250.95	bankfull	
64.8					14.69		252.05	TOE	
67.7					11.32		255.42		
73.0					8.67		258.07		
78.0					6.99		259.75	Ground	
81.7					6.20		260.54	TOP	

**Stream Morphology**

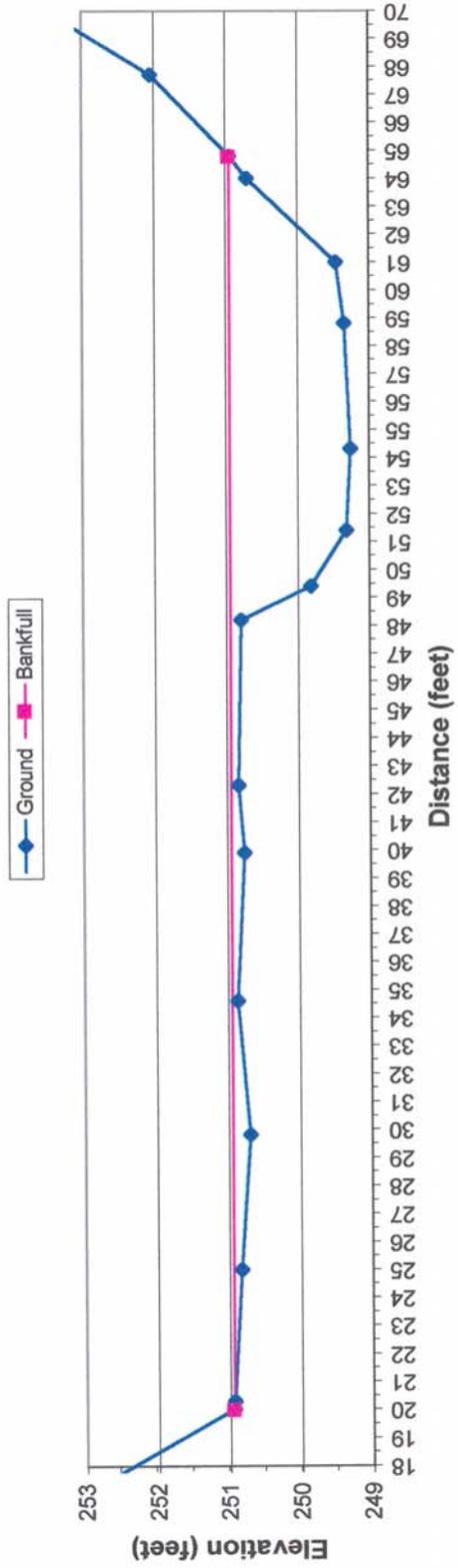
Wbkf =	44.8
dbkf =	0.9
Abkf =	40.35
dmbkf =	1.54 ft
Wfpa =	49 ft
ER =	3.1
D50 =	19 mm
Qbkf =	184 cfs
DA =	192 AC
Slope =	0.012
Sinuosity =	1.18

	4.36	17.29	249.45	Water Surface Hub left check
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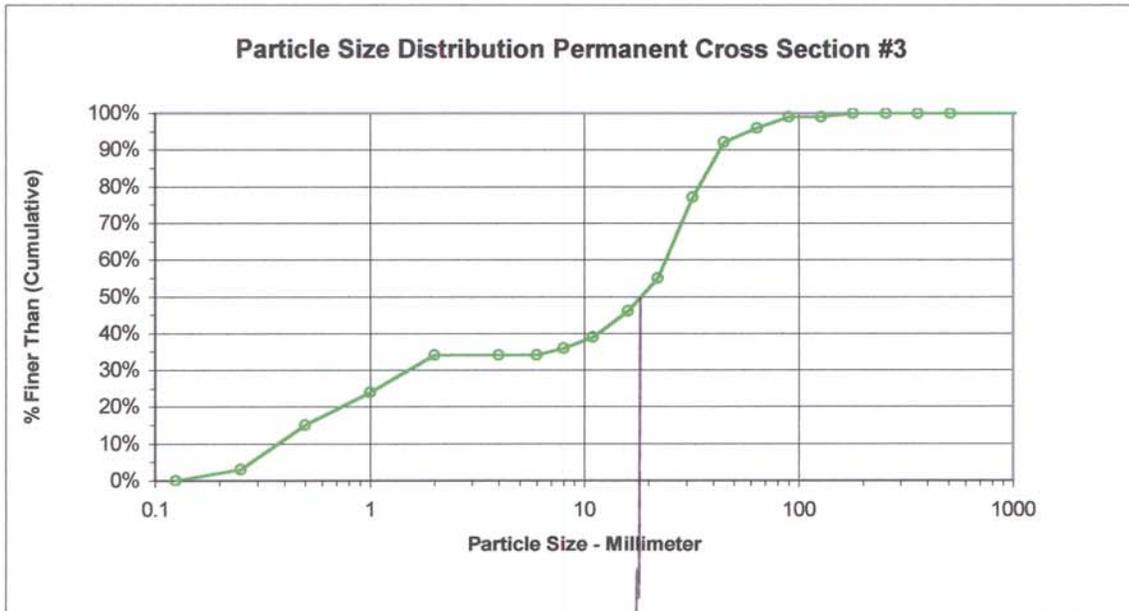
Permanent Cross Section #3, Station 60+85



Permanent Cross Section #3, Riffle



PEBBLE COUNT								
Project: Chavis Park Garner Branch						Date: 09/03/02		
Location: Permanent Cross Section # 3								
Particle Counts								
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	Cumulativ
	Silt/Clay	< 0.062	S/C	0		0	0%	0%
.04 - .08	Very Fine	.062 - .125	S	0	0	0	0%	0%
	Fine	.125 - .25	A	3	0	3	3%	3%
	Medium	.25 - .50	N	12	0	12	12%	15%
	Coarse	.50 - 1.0	D	9	0	9	9%	24%
	Very Coarse	1.0 - 2.0	S	10	0	10	10%	34%
.08 - .16	Very Fine	2.0 - 4.0		0	0	0	0%	34%
.16 - .22	Fine	4.0 - 5.7	G	0	0	0	0%	34%
.22 - .31	Fine	5.7 - 8.0	R	2	0	2	2%	36%
.31 - .44	Medium	8.0 - 11.3	A	3	0	3	3%	39%
.44 - .63	Medium	11.3 - 16.0	V	7	0	7	7%	46%
.63 - .89	Coarse	16.0 - 22.6	E	9	0	9	9%	55%
.89 - 1.26	Coarse	22.6 - 32.0	L	22	0	22	22%	77%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S	15	0	15	15%	92%
1.77 - 2.5	Very Coarse	45.0 - 64.0		4	0	4	4%	96%
2.5 - 3.5	Small	64 - 90	C	3	0	3	3%	99%
3.5 - 5.0	Small	90 - 128	O	0	0	0	0%	99%
5.0 - 7.1	Large	128 - 180	B	1	0	1	1%	100%
7.1 - 10.1	Large	180 - 256	L	0	0	0	0%	100%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	100%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	rg- Very Lr	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
<b>Totals</b>				<b>100</b>	<b>0</b>	<b>100</b>	<b>100%</b>	<b>100%</b>



**Project:** Chavis Park Gamer Branch Stream Restoration Project  
**Location:** Permanent Cross Section #4, Main Channel Station 56+10, Tributary Station 0+67  
**Date:** 09/08/2002

USGS Grid Coordinates  
 North East  
 735028.3120 2109513.5641  
 734955.6188 2109453.8724  
 734920.6817 2109463.9704

Plan Sheet Ref. No.  
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Left Permanent Benchmark Elevation(main channel):	258.07	Left Permanent Benchmark Location:	735028.3120	2109513.5641	4
Mid point( Main channel Rt./Tributary Lt.) BM Elev.:	250.03	Midpoint Benchmark Location:	734955.6188	2109453.8724	9
Right Permanent Benchmark Elevation (Tributary):	253.35	Right Permanent Benchmark Location:	734920.6817	2109463.9704	10

Benchmark description: 4x4 Concrete post with brass cap, top of cap is benchmark elevation

Note: Cross Section taken from left to right looking downstream

Photo Reference Location: Rock structure that wraps around the island, left cross vane, standing on left bolder on left arm of structure looking upstream at the main channel and the tributary.

Station Feet	Back-Sight BS Feet	Height of Instrument HI Feet	Fore-Sight		Height Elevation Feet	Notes Comments Remarks
			FS Feet	Feet		
2.2	0	258.07				
2.2			0.40		257.67	ground
6.0			2.51		255.56	
23.3			12.58		245.49	TOE
27.0			13.00		245.07	
35.6			13.20		244.87	bankfull
41.3			13.57		244.50	
47.7			13.65		244.42	TOB
48.6			14.20		243.87	
54.0			14.87		243.20	
55.5			15.17		242.90	
58.0			15.71		242.36	
60.7			16.23		241.84	TW
61.1			16.25		241.82	Edge of Coir log
61.8			15.22		242.85	top of coir log
62.0			15.26		242.81	toe of slope
65.2			13.76		244.31	TOB
68.3			13.41		244.66	
74.0			13.19		244.88	bankfull
83.0			13.17		244.90	
89.9			13.35		244.72	Toe of VGG

**Main Channel Stream Morphology**

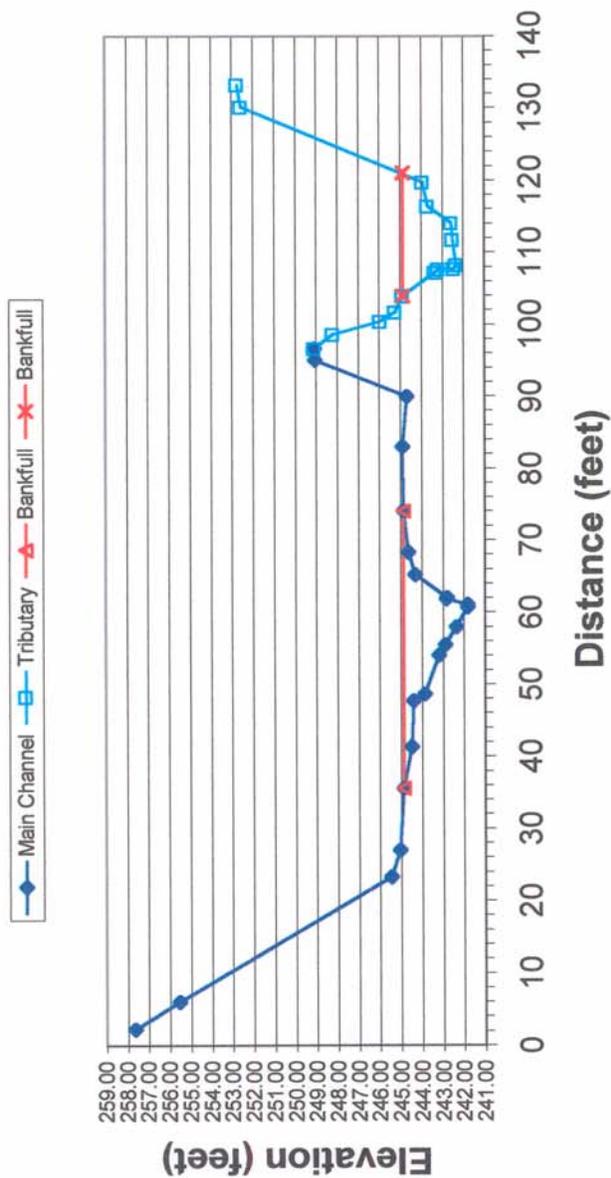
Wbkf =	38.4 ft.
dbkf =	1.05 ft.
Abkf =	40.5 sq.ft.
dmbkf =	3.06 ft
Wfpa =	74 ft
ER =	1.93
D50 =	9 mm
Qbkf =	190 cfs
DA =	204 AC
Slope =	0.007
Sinuosity =	1.18

95.0			8.99	249.08	Top of VGG
96.6			8.97	249.10	ground
96.6			8.05	250.02	Right Monument Main/ Lt monumnet trib.
			15.50	242.57	Water Surface
	0				Check left benchmark hub
Tributary portion of cross section					
96.6	8.05	258.08			Tributary left monument
96.6			8.97	249.11	ground
98.6			9.86	248.22	
100.4			12.12	245.96	
101.7			12.84	245.24	TOE
103.9			13.19	244.89	TOP
107.2			14.73	243.35	top of Coir Log
107.6			14.88	243.2	Top of Coir log
107.7			15.64	242.44	TOE
108.2			15.76	242.32	TW
111.7			15.57	242.51	
114.1			15.5	242.58	TOE
116.4			14.37	243.71	TOB
119.7			14.15	243.93	Toe of VGG
130.1			5.52	252.56	
133.2			5.34	252.74	ground
133.2			4.72	253.36	Right Benchmark Hub
			15.5	242.58	Water Surface
	8.05				Left Benchmark hub

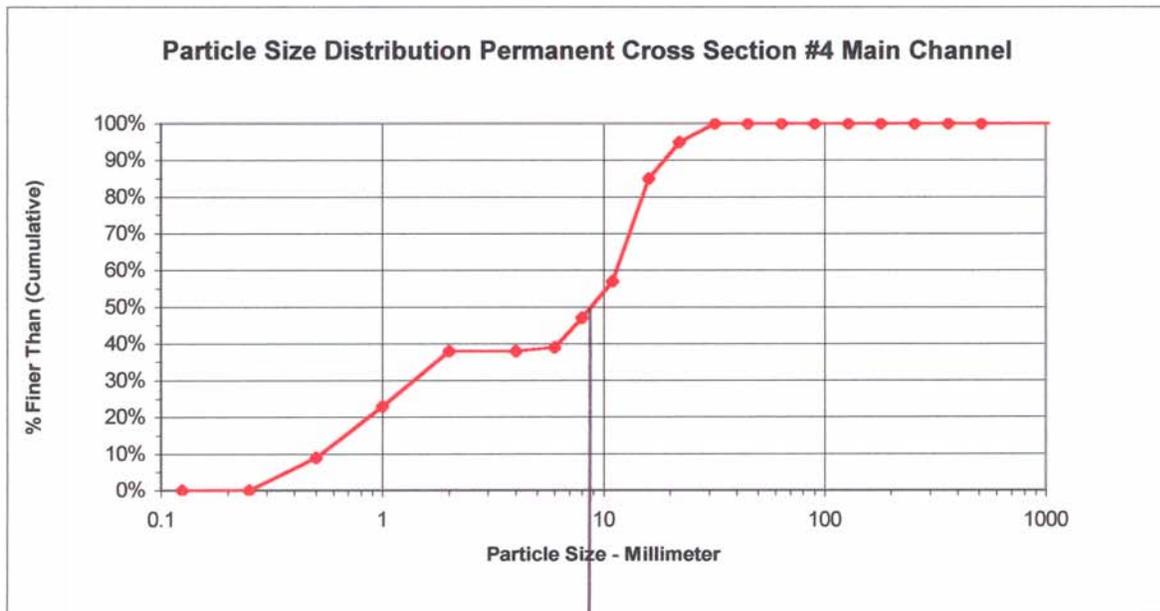
**Tributary Stream Morphology**

Wbkf =	17.1ft
dbkf =	1.64 ft
Abkf =	28.04 sq ft
dmbkf =	2.57ft
Wfpa =	24 ft
ER =	1.4
D50 =	17 mm
Qbkf =	127
DA =	126 Ac
Slope =	0.0035
Sinuosity =	1.16

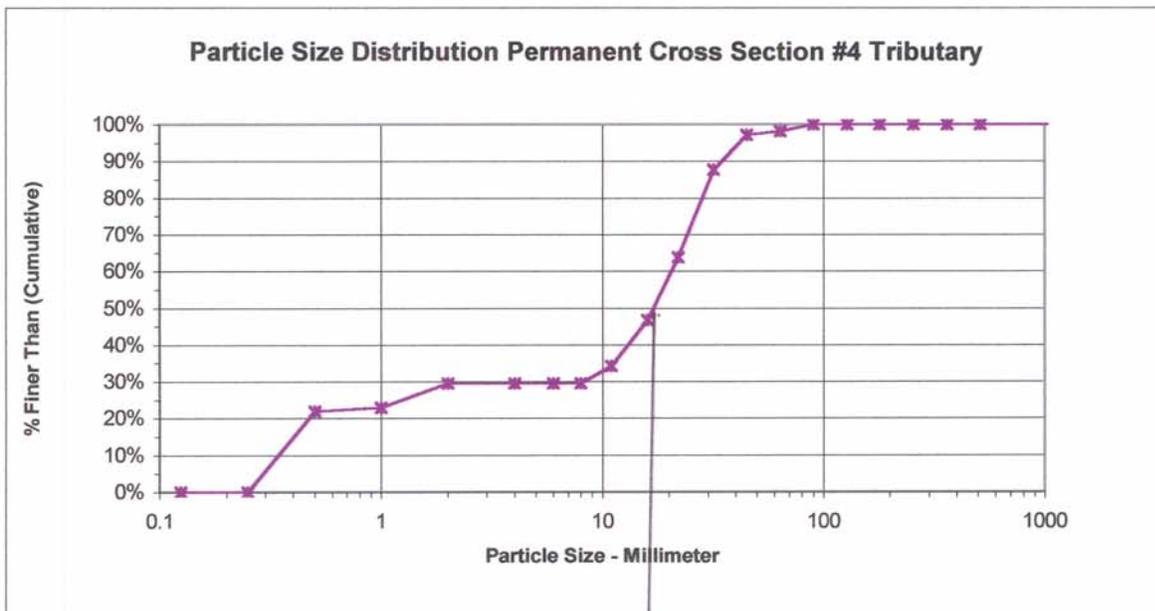
### Cross Section #4 Main Channel & Tributary Main channel Station 56+10, Tributary Station 0+67



PEBBLE COUNT								
Project: Chavis Park Garner Branch						Date: 09/08/02		
Location: Permanent Cross Section #4 Main Channel								
Particle Counts								
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	Cumulative
	Silt/Clay	< 0.062	S/C	0		0	0%	0%
.04 - .08	Very Fine	.062 - .125	S	0	0	0	0%	0%
	Fine	.125 - .25	A	0	0	0	0%	0%
	Medium	.25 - .50	N	0	9	9	9%	9%
	Coarse	.50 - 1.0	D	0	14	14	14%	23%
	Very Coarse	1.0 - 2.0	S	0	15	15	15%	38%
.08 - .16	Very Fine	2.0 - 4.0		0	0	0	0%	38%
.16 - .22	Fine	4.0 - 5.7	G	0	1	1	1%	39%
.22 - .31	Fine	5.7 - 8.0	R	0	8	8	8%	47%
.31 - .44	Medium	8.0 - 11.3	A	0	10	10	10%	57%
.44 - .63	Medium	11.3 - 16.0	V	0	28	28	28%	85%
.63 - .89	Coarse	16.0 - 22.6	E	0	10	10	10%	95%
.89 - 1.26	Coarse	22.6 - 32.0	L	0	5	5	5%	100%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S	0	0	0	0%	100%
1.77 - 2.5	Very Coarse	45.0 - 64.0		0	0	0	0%	100%
2.5 - 3.5	Small	64 - 90	C	0	0	0	0%	100%
3.5 - 5.0	Small	90 - 128	O	0	0	0	0%	100%
5.0 - 7.1	Large	128 - 180	B	0	0	0	0%	100%
7.1 - 10.1	Large	180 - 256	L	0	0	0	0%	100%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	100%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	Large - Very Large	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
<b>Totals</b>				<b>0</b>	<b>100</b>	<b>100</b>	<b>100%</b>	<b>100%</b>



PEBBLE COUNT								
Project: Chavis Park Garner Branch						Date: 09/08/02		
Location: Permanent Cross Section # 4 Tributary								
Particle Counts								
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	Cumulativ
	Silt/Clay	< 0.062	S/C	0		0	0%	0%
.04 - .08	Very Fine	.062 - .125	S	0	0	0	0%	0%
	Fine	.125 - .25	A	0	0	0	0%	0%
	Medium	.25 - .50	N	23	0	23	22%	22%
	Coarse	.50 - 1.0	D	1	0	1	1%	23%
	Very Coarse	1.0 - 2.0	S	7	0	7	7%	30%
.08 - .16	Very Fine	2.0 - 4.0		0	0	0	0%	30%
.16 - .22	Fine	4.0 - 5.7	G	0	0	0	0%	30%
.22 - .31	Fine	5.7 - 8.0	R	0	0	0	0%	30%
.31 - .44	Medium	8.0 - 11.3	A	5	0	5	5%	34%
.44 - .63	Medium	11.3 - 16.0	V	13	0	13	12%	47%
.63 - .89	Coarse	16.0 - 22.6	E	18	0	18	17%	64%
.89 - 1.26	Coarse	22.6 - 32.0	L	25	0	25	24%	88%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S	10	0	10	10%	97%
1.77 - 2.5	Very Coarse	45.0 - 64.0		1	0	1	1%	98%
2.5 - 3.5	Small	64 - 90	C	2	0	2	2%	100%
3.5 - 5.0	Small	90 - 128	O	0	0	0	0%	100%
5.0 - 7.1	Large	128 - 180	B	0	0	0	0%	100%
7.1 - 10.1	Large	180 - 256	L	0	0	0	0%	100%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	100%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	rg- Very Lr	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
<b>Totals</b>				<b>105</b>	<b>0</b>	<b>105</b>	<b>100%</b>	<b>100%</b>



**Project:** Chavis Park Garner Branch Stream Restoration Project

**Location:** Permanent Cross Section #5, Station 53+46

**Date:** 09/08/2002

USGS Grid Coordinates

North

East

Plan Sheet

Ref. No.

Left Permanent Benchmark Elevation:	254.40	Left Permanent Benchmark Location:	734871.0661	2109700.9947	5
Right Permanent Benchmark Elevation:	249.90	Right Permanent Benchmark Location:	734837.2108	2109625.9677	11

Benchmark description: 4x4 Concrete post with brass cap, top of cap is benchmark elevation

Note: Cross Section taken from left to right looking downstream

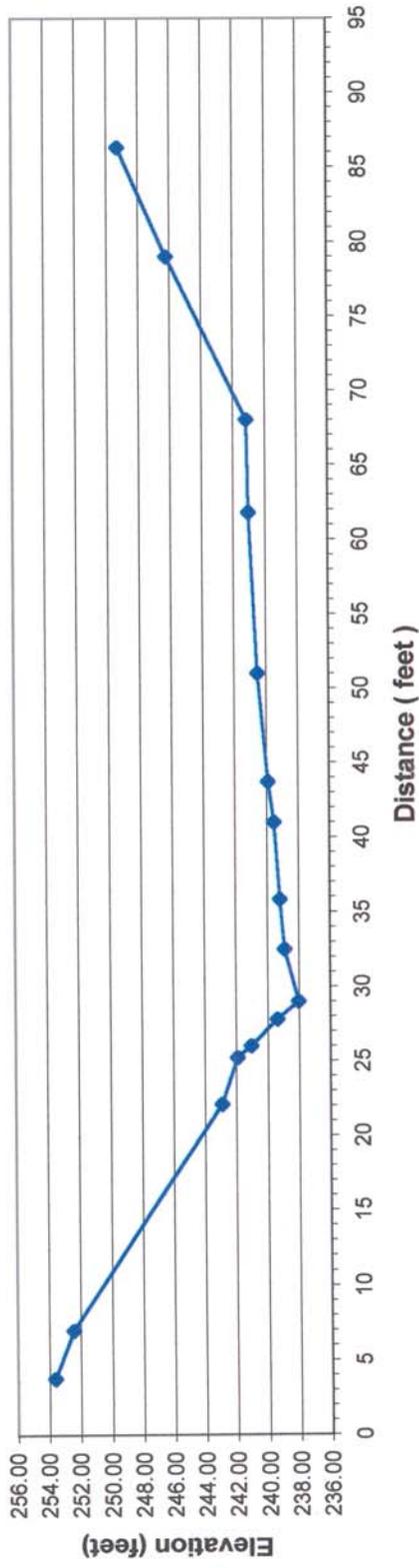
Photo Reference Location: Standing on the upstream left point of the "W" rock structure just downstream of the cross section looking upstream.

Station Feet	Back-Sight		Height of Instrument		Fore-Sight		Height		Notes Comments Remarks
	BS Feet		HI Feet		FS Feet		Elevation Feet		
3.8	0.26		254.66						Benchmark Left hub
3.8					1.01		253.65		ground
7					2.2		252.46		
22.1					11.74		242.92		Toe of Slope/ High water line
25.2					12.72		241.94		Top of Slope Rip-rap
26							241.06		bankfull
27.8					15.28		239.38		Toe
29					16.63		238.03		TW
32.5					15.77		238.89		
35.8					15.47		239.19		
41					15.1		239.56		
43.7					14.75		239.91		
51					14.1		240.56		
61.8					13.6		241.06		bankfull
68					13.48		241.18		Toe of Slope
79					8.44		246.22		
86.3					5.36		249.30		ground
86.3					4.76		249.90		Right Benchmark hub
					0.26				Check left hub

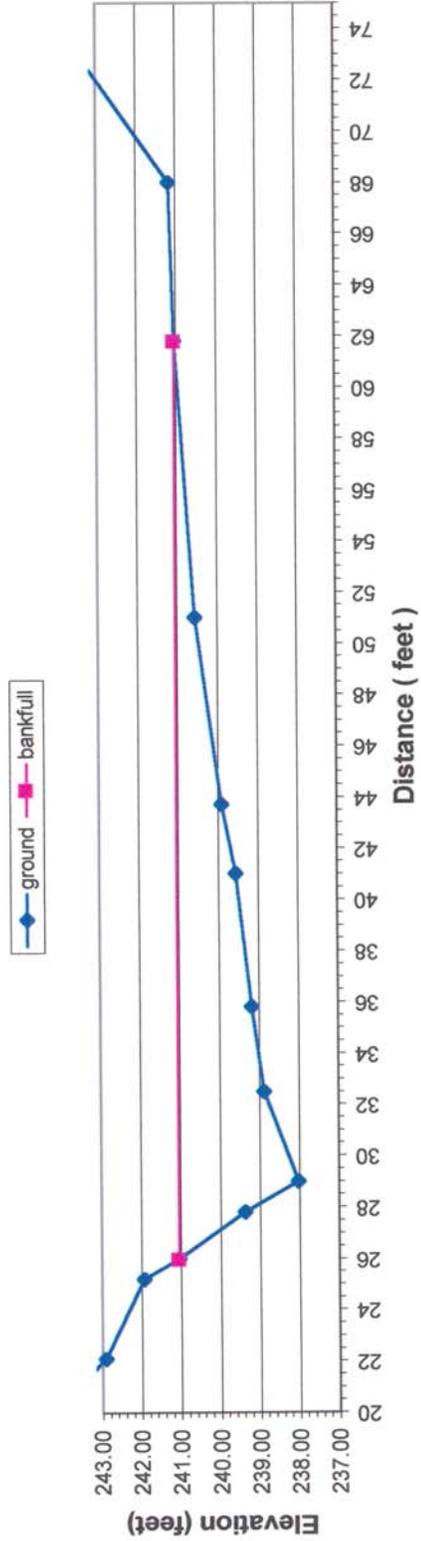
**Stream Morphology**

Wbkf =	35.8 ft
dbkf =	1.41 ft
Abkf =	50.42 sq ft
dmbkf =	3.03 ft
Wfpa =	54 ft
ER =	1.51
D50 =	14 mm
Qbkf =	245 cfs
DA =	346 Ac
Slope =	0.005
Sinuosity =	1.18

Permanent Cross Section #5  
Station 53+46



Permanent Cross Section #5  
Station 53+46



PEBBLE COUNT								
Project: Chavis Park Garner Branch						Date: 09/08/02		
Location: Permanent Cross Section # 5								
Particle Counts								
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	0		0	0%	0%
.04 - .08	Very Fine	.062 - .125	S	0	0	0	0%	0%
	Fine	.125 - .25	A	0	0	0	0%	0%
	Medium	.25 - .50	N	5	0	5	5%	5%
	Coarse	.50 - 1.0	D	14	0	14	14%	19%
	Very Coarse	1.0 - 2.0	S	5	0	5	5%	24%
.08 - .16	Very Fine	2.0 - 4.0		0	0	0	0%	24%
.16 - .22	Fine	4.0 - 5.7	G	1	0	1	1%	25%
.22 - .31	Fine	5.7 - 8.0	R	6	0	6	6%	31%
.31 - .44	Medium	8.0 - 11.3	A	4	0	4	4%	35%
.44 - .63	Medium	11.3 - 16.0	V	21	0	21	21%	56%
.63 - .89	Coarse	16.0 - 22.6	E	18	0	18	18%	74%
.89 - 1.26	Coarse	22.6 - 32.0	L	15	0	15	15%	89%
1.26 - 1.77	Very Coarse	32.0 - 45.0	S	6	0	6	6%	95%
1.77 - 2.5	Very Coarse	45.0 - 64.0		1	0	1	1%	96%
2.5 - 3.5	Small	64 - 90	C	2	0	2	2%	98%
3.5 - 5.0	Small	90 - 128	O	2	0	2	2%	100%
5.0 - 7.1	Large	128 - 180	B	0	0	0	0%	100%
7.1 - 10.1	Large	180 - 256	L	0	0	0	0%	100%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	100%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
<b>Totals</b>				<b>100</b>	<b>0</b>	<b>100</b>	<b>100%</b>	<b>100%</b>

