Hillsdale Park (South Buffalo Creek) Stream Restoration
Greensboro, North Carolina
Final Annual Monitoring Report
Monitoring Year 2008

NCDENR EEP
1619 Mail Service Center
Raleigh, NC 27699-1619

Monitoring Year: 2008
Measurement Year 5
As-Built Date: 2004
NCEEP Project Number 177

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Submitted by:

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HILLSDALE PARK (SOUTH BUFFALO CREEK) STREAM RESTORATION
2008 MONITIORING REPORT

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I. EXECUTIVE SUMMARY/PROJECT ABSTRACT

The Hillsdale Park Stream Restoration Site includes 5,302 linear feet of South Buffalo Creek and 529 linear feet of a tributary within the City of Greensboro, Guilford County, North Carolina. The site was constructed between February and March 2004. The following report provides the Year 5, 2008 Monitoring information.

Overall, the project is doing well with a few minor areas of erosion and several sections where coir fiber matting has pulled away from the bank. The unstable problem areas should be monitored and remediation options developed if they worsen.

Seven exotic and/or invasive species were observed within the riparian buffer during 2008 monitoring. The majority of the site has the presence of one or more invasive or exotic species with the ability to negatively impact the site. Most of the site is heavily covered in porcelain berry. Porcelain berry is very aggressive woody perennial vine, growing over and damaging the existing vegetation, including small shrubs and trees. Porcelain berry occurs on nearly all excavated floodplain benches and is aggressively invading the surrounding buffers. It is recommended that action be taken to control and eradicate the porcelain berry at this site. Mimosa is also present throughout much of the riparian buffer and is locally dense. Planted trees, live stakes, and desirable volunteers are locally dense and the target community is mostly intact where porcelain berry is absent or minimal. Due to the high coverage of invasive exotic species, EEP anticipates a thorough treatment of invasives with augmentation of plantings where needed.

The 2008 vegetation monitoring for Hillsdale Park did not utilize the Carolina Vegetation Survey (CVS) Ecosystem Enhancement Program's (EEP) protocol for recording vegetation. Rather, a qualitative visual assessment was performed per EEP guidance. This report summarizes the vegetation observations.

II. PROJECT BACKGROUND

A. Project Objectives

The objectives of the restoration of South Buffalo Creek in Hillsdale Park are:

- Restore unstable stream channels to natural stable forms by modifying dimension, pattern, and/or profile based on reference reach parameters,
- Improve floodplain functionality by matching bankfull stage with floodplain elevation,
- Establish native floodplain vegetation through a forested riparian buffer, and
- Improve the natural aesthetics of the stream corridor.

B. Project Restoration Components

South Buffalo Creek and its unnamed tributary (HR3) are located in Hillsdale Park, a community park in the City of Greensboro. The existing stream channels had low sinuosity and varying levels of incision due to historic channelization. The alternative of creating a stable meandering stream with bankfull stage corresponding to the existing floodplain elevation was evaluated. However, topographic and development restrictions did not allow for a reference channel pattern to be established. The existing incised channels were enhanced by excavating new floodplain benches at the design bankfull stage and installing structures to improve bed features and control channel grade.

The restoration project was divided into three reaches (i.e., HR1, HR2, tributary HR3), each having a different mitigation type and approach. The design for Reach 1 (HR1) was based on a Rosgen Priority 3 restoration approach along with establishment of a 25-foot vegetated buffer on both banks. A new floodplain was created at a lower elevation by excavating a stable bankfull bench of varying width. The resulting bank height ratio was 1.0. Reach 1 was further subdivided into two reaches, HR1a and HR1b. The break between the sub-reaches began at the Vanstory Street culvert. Reach HR1a from station 10+00 to 23+75 was converted from an incised E4/B4c to a B4c channel as part of the restoration work. The existing channel functioned like a Gc type stream due to the high banks.

Reach 2 (HR2) flows from West Meadow View Road to the I-40 culvert. The reach was stabilized by using rock cross vanes, J-hooks, and root wads for bank stability. Woody transplants and sod mats were also used to stabilize the streambanks along the channel. Reach HR2 from station 52+00 to 62+12 was converted from a B4c/E4/F4 to a B4c. A 25-foot vegetated buffer was added to the left bank of Reach 2.

Reach 3 (HR3) was an unnamed tributary to South Buffalo Creek, flowing into the creek at the end of Reach 2 just prior to the I-40 culvert. There were no changes in dimension, pattern, or profile for this reach. However, three rock cross vanes were used to stabilize the channel upstream of its confluence with Reach HR2.

Additional details regarding the restoration components of the project are provided in Table I.

Table 1a. Project Restoration Components
Hillsdale Park Stream Restoration/Project No. 177

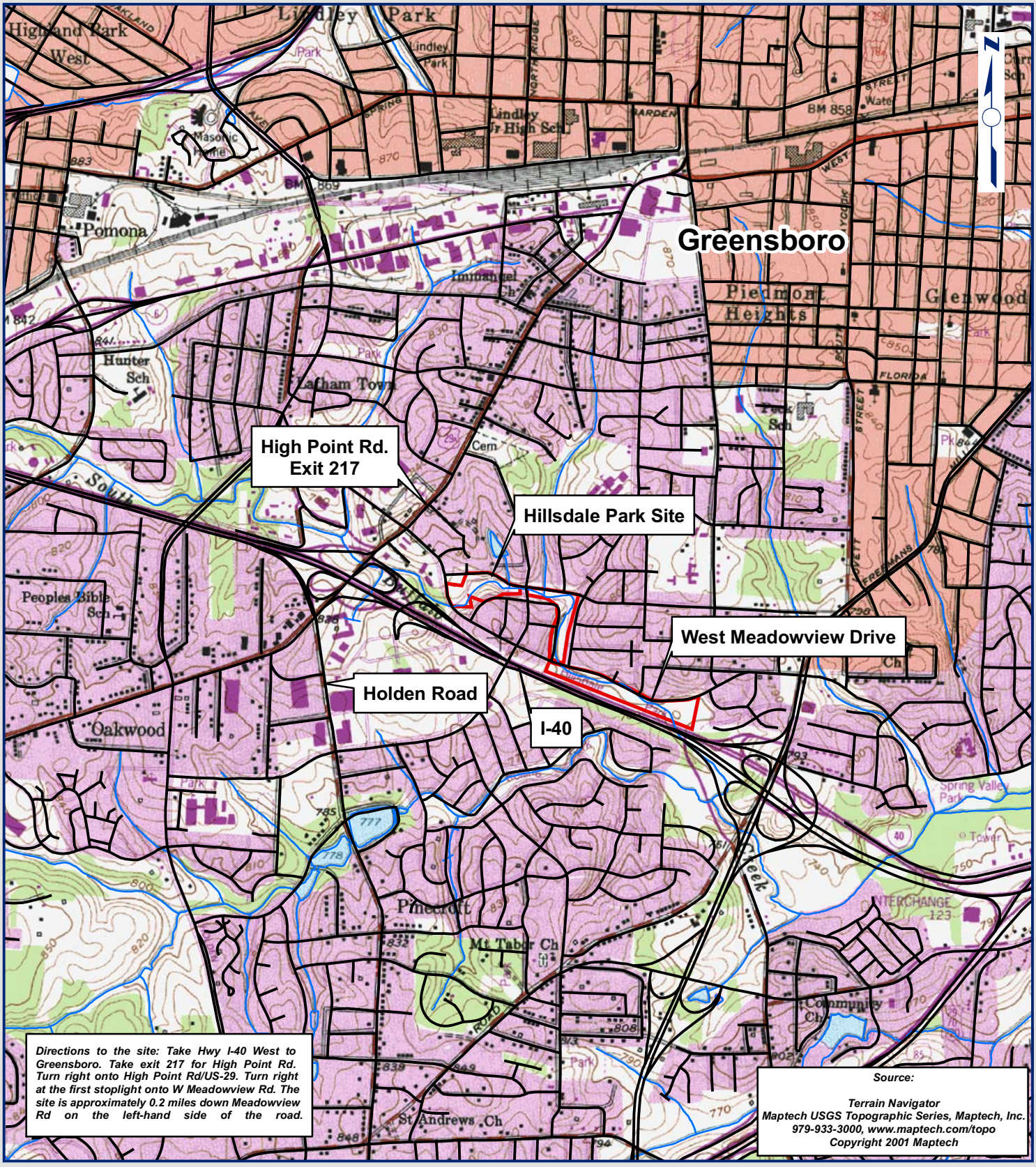
Project Component or Reach ID	Existing Feet/ Acres	Restoration Level	Approach	Footage or Acreage	Stationing	Buffer Acres	BMP Elements1	Comment
Reach HR1	3,037	Enhancement	P3	3,037	10+00 - 40+45	-		Bankfull benches and rock cross vanes
Reach HR2	2,265	Enhancement	P3	2,265	40+45 - 62+12	-		Root wads and stabilization
Tributary HR3	138	Stabilization	SS	138	10+00 - 11+66	-		Stabilization using rock cross vanes

P3 = Priority 3
SS = Stream Bank Stabilization

Table 1b. Project Restoration Components Hillsdale Park Stream Restoration/Project No. 177							
Restoration Level	Stream (lf)	Riparian Wetland (Ac)		Non-Ripar (Ac)	Upland (Ac)	Buffer (Ac)	BMP
		Riverine	Non-Riverine				
Restoration	-	-	-	-	-		
Enhancement	5303	-	-	-	-		
Enhancement I							
Enhancement II							
Creation		-	-	-	-		
Preservation	-	-	-	-	-		
HQ Preservation	-	-	-	-	-		
		0	0				
Totals	**5303**	**0**		**0**	**0**	**-**	**-**
= Non-Applicable Categories							
- = Non-Applicable for this Project							

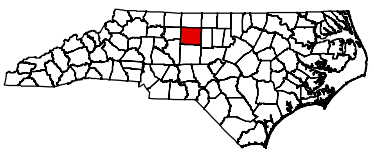
C. Location and Setting

The Hillsdale Park Stream Restoration Site includes 5,302 linear feet of South Buffalo Creek and 529 linear feet of a tributary referred to as Tributary HR3. These streams are tributaries to the Haw River (USGS 8-digit hydrologic unit 03030002, 14-digit hydrologic unit 03030002020050). The site is located in the City of Greensboro near the intersection of Interstate 40 and High Point Road (US Highway 29A) in Guilford County, North Carolina (See Figure 1).



Ecosystem Enhancement Program

Figure 1.
Hillsdale Park Stream Restoration Site
Vicinity Map
Guilford County, NC



0 1,000 2,000 4,000 Feet

D. Project History and Background

The construction of South Buffalo Creek was completed in September 2003, and the As-Built survey was completed the same month. Year 1 monitoring took place in April 2005, Year 2 monitoring occurred in October 2005, Year 3 monitoring occurred in October 2006, Year 4 monitoring occurred in November 2007, and Year 5 monitoring was completed in July 2008. Additional details regarding the timeline of the project are provided in Table II below.

The project was designed by Buck Engineering. Construction was performed by LJ, Incorporated. Monitoring activities for Year 4 were performed by WK Dickson and Co., Inc. Additional information regarding contractors is shown in Table III.

The project is located within Guilford County, within the ecoregion of the Southern Outer Piedmont in the Piedmont physiographic province of North Carolina. The site is located within a highly urbanized area. Additional information regarding this stream is included in Table IV.

E. Monitoring Plan View

A series of monitoring devices have been installed on-site. A total of twelve (12) individual cross-sections were located. Cross-sections were plotted from left to right facing downstream. Each cross-section is also a designated photographic point that is photographed annually. There are forty-five (45) permanent photo points located at various points along the length of the channel. Seven (7) vegetation-monitoring plots were randomly located within the riparian buffer of the Hillsdale Park Stream Restoration project. The locations of all monitoring devices are shown on Figures 2a through 2d (Monitoring Plan View).

Table II. Project Activity and Reporting History
Hillsdale Park Stream Mitigation/Project No. 177

Activity or Report	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	NA	February 2005
Final Design – 90%	NA	NA
Construction	NA	September 2003
Temporary S&E mix applied to entier project area	NA	NA
Permanent seed mix applied to entire project area	NA	NA
Containerized and B7B plantings for each reach/segments 1&2	NA	March 2004
Mitigation Plan / As-built (Year 0 Monitoring – baseline)	September 2003	February 2005
Year 1 Monitoring	April 2005	April 2005
Year 2 Monitoring	October 2005	October 2005
Year 3 Monitoring	October 2006	December 2006
Year 4 Monitoring	November 2007	November 2007
Year 5 Monitoring	July 2008	December 2008
Year 5 + Monitoring		
NA-Historical project documents necessary to provide this data were unavilable at the time of this report submission		

Table III. Project Contacts Table Hillsdale Park Stream Mitigation Site/Project No. 177	
Designer Primary project design POC	Buck Engineering 8000 Regency Parkway, Suite 200 Cary, NC 27511 Mr. Mike Rooney (919) 799-5490
Construction Contractor Construction Contractor POC	LJ, Incorporated Point of Contact-Mr. Arden Reiser PO Box 3188 Mooresville, North Carolina 28117 (704) 799-2670
Planting Contractor	NA*
Seeding Contractor	
	NA*
Monitoring Performers	WK Dickson and Co., Inc. 720 Corporate Center Drive Raleigh, NC 27607 (919) 782-0495
Stream Monitoring POC	Daniel Ingram
Vegetation Monitoring POC	Daniel Ingram
Wetland Monitoring POC	George Lankford
*Historical project documents necessary to provide this data were unavailable at the time of this report submission	

Table IV. Project Background Table Hillsdale Park Stream Mitigation Site/Project No. 177	
Project County	Guilford
Drainage Area	
South Buffalo Creek	10.0 sq. mi.
Tributary	0.29 sq. mi.
Drainage impervious cover estimate (%)	>20%
Stream Order	
South Buffalo Creek	3rd order
Tributary	1st order
Physiographic Region	Piedmont
Ecoregion	Southern Outer Piedmont
Rosgen Classification of As-Built	B4c
Cowardian Classification	NA
Dominant Soil Types	Congaree loam, Enon-Urban land complex, Mecklenburg-Urban land complex
Reference Site ID	E5, Ut Lake Jeanette (Guilford), McClintock 1 & 2 (Mecklenburg); B4c, DuHart (Gaston), Silas (Forsyth), Morgan (Orange)
USGS HUC for Project	3030002
USGS HUC for Reference	Ut Lake Jeanette 03030002, McClintock 03050103, DuHart 03050102, Silas 03040101, Morgan 03030002
NCDWQ Sub-basin for Project	30602
NCDWQ Sub-basin for Reference	Ut Lake Jeanette 030602, McClintock 030834, DuHart 030836, Silas 030704, Morgan 030606
NCDWQ Classification for Project	C, NSW
NCDWQ Classification for Reference	Ut Lake Jeanette-WSIII, NSW; McClintock-C, DuHart-WS-V, Silas-C, Morgan-WS-II, HQW, NSW, CA
Any Portion of any project segment 303d listed?	Yes-all of South Buffalo Creek
Any portion of any project segment upstream of a 303d listed segment?	Yes, South Buffalo Creek to confluence with Buffalo Creek
Reasons for 303d listing or stressor	Impaired biological stressor, stressor not identified, Urban runoff-storm sewers
% of project easement fenced	None

Figure 2
Hillsdale Park Current Condition Plan View (a)
Year 5 Monitoriing
July 2008

0 100 200 400 Feet

1 inch equals 100 feet

N

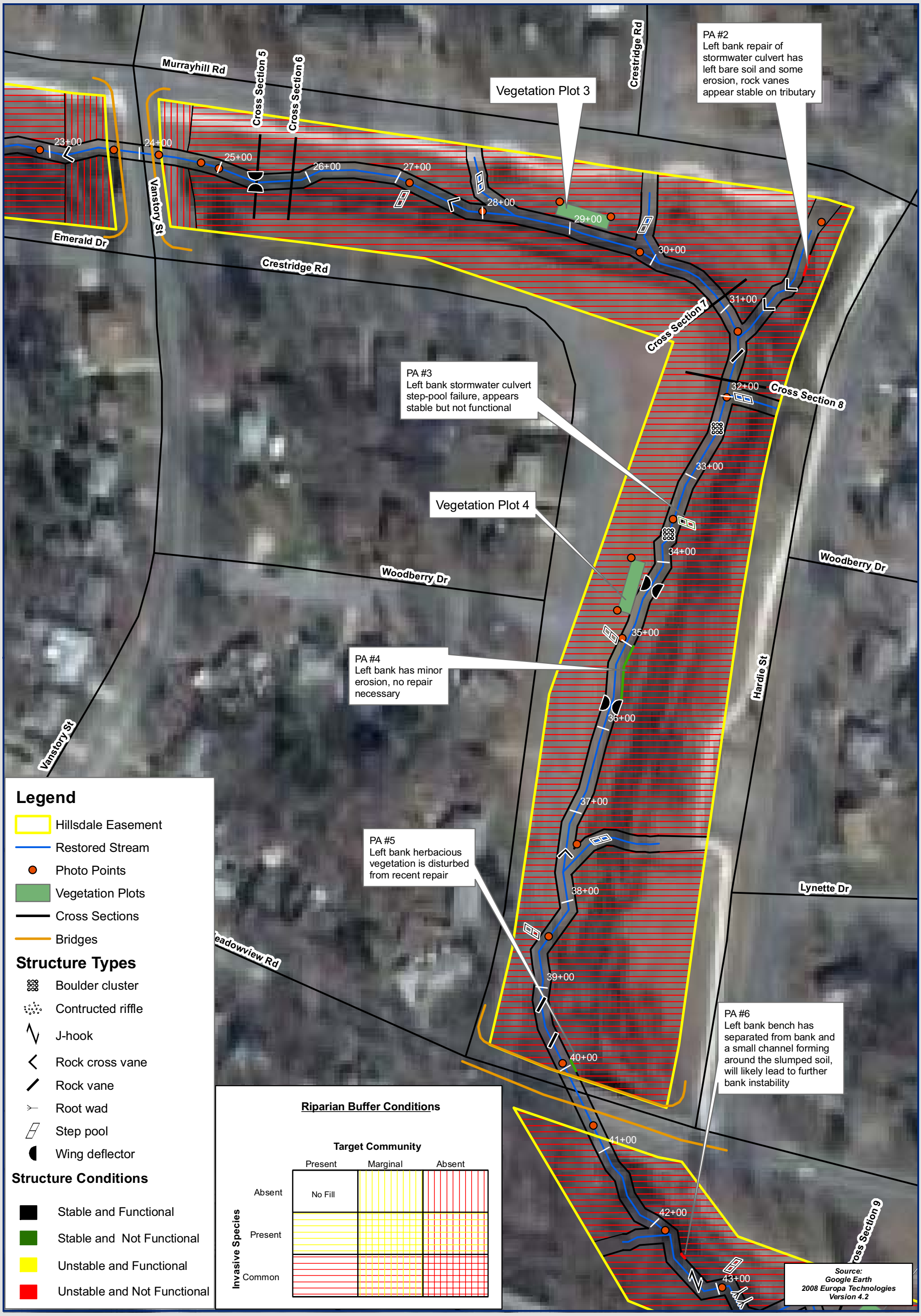


Figure 2
Hillsdale Park Current Condition Plan View (b)
Year 5 Monitoriing
July 2008

0 100 200 400 Feet

1 inch equals 100 feet

N

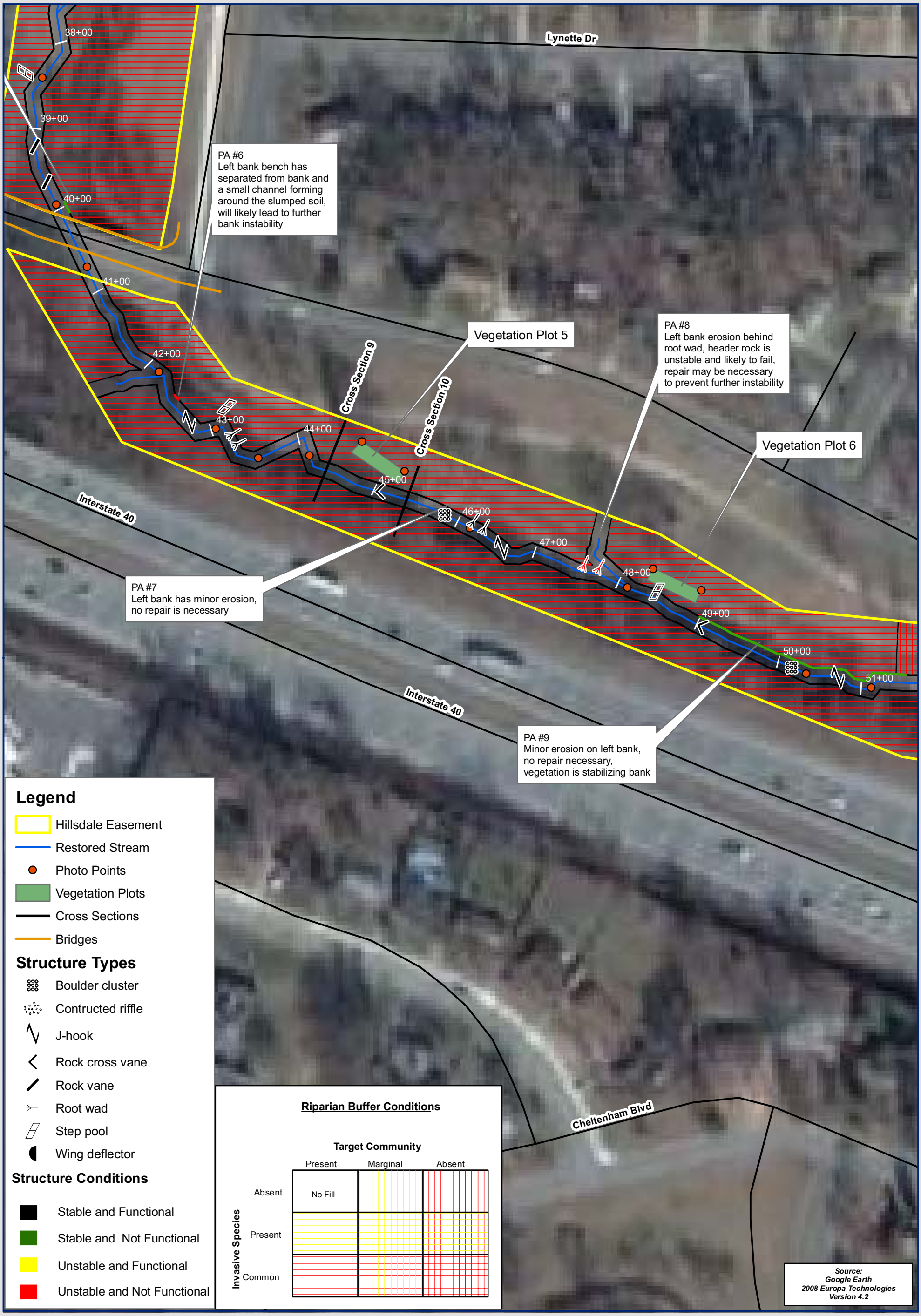


Figure 2
Hillsdale Park Current Condition Plan View (c)
Year 5 Monitoriing
July 2008

0 100 200 400 Feet

1 inch equals 100 feet

N

Figure 2
Hillsdale Park Current Condition Plan View (d)
Year 5 Monitoriing
July 2008

0 100 200 400 Feet

1 inch equals 100 feet

N

III. PROJECT CONDITION AND MONITORING RESULTS

Monitoring results are discussed below. An initial visual survey was conducted on April 7, 2008, and a more detailed monitoring survey (evaluation of vegetation plots) was conducted in July 2008.

A. VEGETATION ASSESSMENT

Planted zones related to the stream restoration consist of the riparian buffer zone and the stream banks. The riparian buffer zone initiates at the top of the bank and continues out perpendicular to the immediate channel following the general pattern of the meandering channel. The planted stream bank initiates at the normal base flow elevation and extends to the top of bank or interface with the floodplain.

The "CVS-EEP Protocol for Recording Vegetation" was not utilized during Year 5 vegetation monitoring, per EEP guidance. A qualitative visual assessment of vegetation was performed throughout the entire project area. Vegetation observations were recorded at cross sections, problem areas, and representative locations. Representative photographs of vegetation conditions were recorded throughout the project area (Appendix A-1).

1. Soil Data

Soils present in the riparian areas adjacent to South Buffalo Creek are characteristic of those found in alluvial landforms in the Southern Outer Piedmont. However, extensive grading and dredging has likely modified much of the naturally occurring soils on site.

Congaree soils (*Oxyaquic Udifluvents*) are the prevalent map unit along the channel. Formed in recent alluvial sediments, they are deep, well to moderately well drained soils with moderate permeability.

Other soil series found along the stream corridor are Enon-Urban land complex and Mecklenburg-Urban land complex soils. Enon soils (*Ultic Hapludalfs*) are very deep, well drained, slowly permeable soils found on ridgetops and side slopes in the Piedmont. Mecklenburg soils (*Ultic Hapludalfs*) are very deep, well drained soils with slow permeability.

2. Vegetative Problem Areas

Vegetation plots were not monitored in Year 5 in anticipation of invasives control and replanting, and no new vegetative problem area were identified. Based on qualitative observations, the majority of the site was found to have the presence of one or more invasive or exotic species with the ability to impact the site. Most of the site is heavily covered in porcelain berry. This woody perennial vine is very aggressive and has a tendency to grow over vegetation, including small shrubs and trees. In some areas porcelain berry is extremely dense and is damaging trees. It is recommended that action be taken to control and eradicate the porcelain berry at this site.

The vegetative plan view is provided in Appendix B, B-1 Current Conditions Plan View.

3. Stem Counts

Methodology
In anticipation of invasives control and replanting, no quantitative vegetation monitoring was performed at Hillsdale in 2008, per EEP guidance. Qualitative vegetation observations were made throughout the project area.

4. Vegetation Plot Photos

Appendix A contains a vegetation photo log.

B. STREAM ASSESSMENT

WK Dickson and Co., Inc personnel performed an initial site visit at Hillsdale Park on July 7th and 8th, 2008. During the field visit, qualitative observations were recorded regarding the condition of the stream restoration project. Cross section and longitudinal surveys were also performed at the time of this visit. Twelve cross sections and approximately 3,000 linear feet of stream profile were surveyed. Photographs were taken at all permanent photo points. A bed material analysis was not performed since this is a sand/small gravel stream. No significant coarsening is expected over time. A pebble count was performed for Year 5. The photographs show that vegetation is generally growing well and is a good combination of woody and herbaceous growth. However, invasive species are rapidly colonizing the project corridor. Banks are stable with no unusual bank erosion. Stream problem areas are described in Appendix B, Table B.1. A few areas of bank and structure instability were documented that may require repairs to prevent further instability. But, no repairs are recommended at this time. Problem areas should be monitored and if they worsen over time, then solutions should be discussed to assess the reason for the problem and potential repair options.

Hydrologic Assessment

One crest gage was installed in the fall of 2007 at this site to document bankfull flow events (located at X: 1756282.738; Y: 833937.777). The following USGS stream gauge data had been used in past reports to verify bankfull events. It is currently the only means available to infer the occurrence of bankfull discharge(s) at the site, as no high water marks were observed in the field. Potential occurrences were extrapolated based on USGS stream gauge discharge data for South Buffalo Creek at US 220 (approximately 2 miles southeast of project site) with a drainage area of 15.4 square miles. Bankfull events were determined by comparing the stream discharge (cfs) against the drainage area on the urban piedmont regional curve. According to the urban piedmont curve, a bankfull event occurs on a stream with a 15.4 square mile drainage area when the discharge is between 1,538 and 1,718 cfs. Based on USGS data, one bankfull event occurred in 2008. The dates and maximum discharges of these bankfull events are listed in Table V.

Although this technique has been used to establish the occurrence of bankfull events for the history of this project, it should be used as a proxy estimator. The idealized approach would be to transfer the discharge to the project reach from the gauge site, and then run a step-backwater or other flow model to predict slope and water surface elevation. The event captured by the USGS gauge was the result of Tropical Storm Fay, which produced 6-10 inches of rain in central Guilford County, and at least 6 inches throughout the Buffalo Creek drainage basin, with reports of widespread flooding in Greensboro.

Figure 3. USGS Stream Gauge Discharge Data for South Buffalo Creek at US 220.

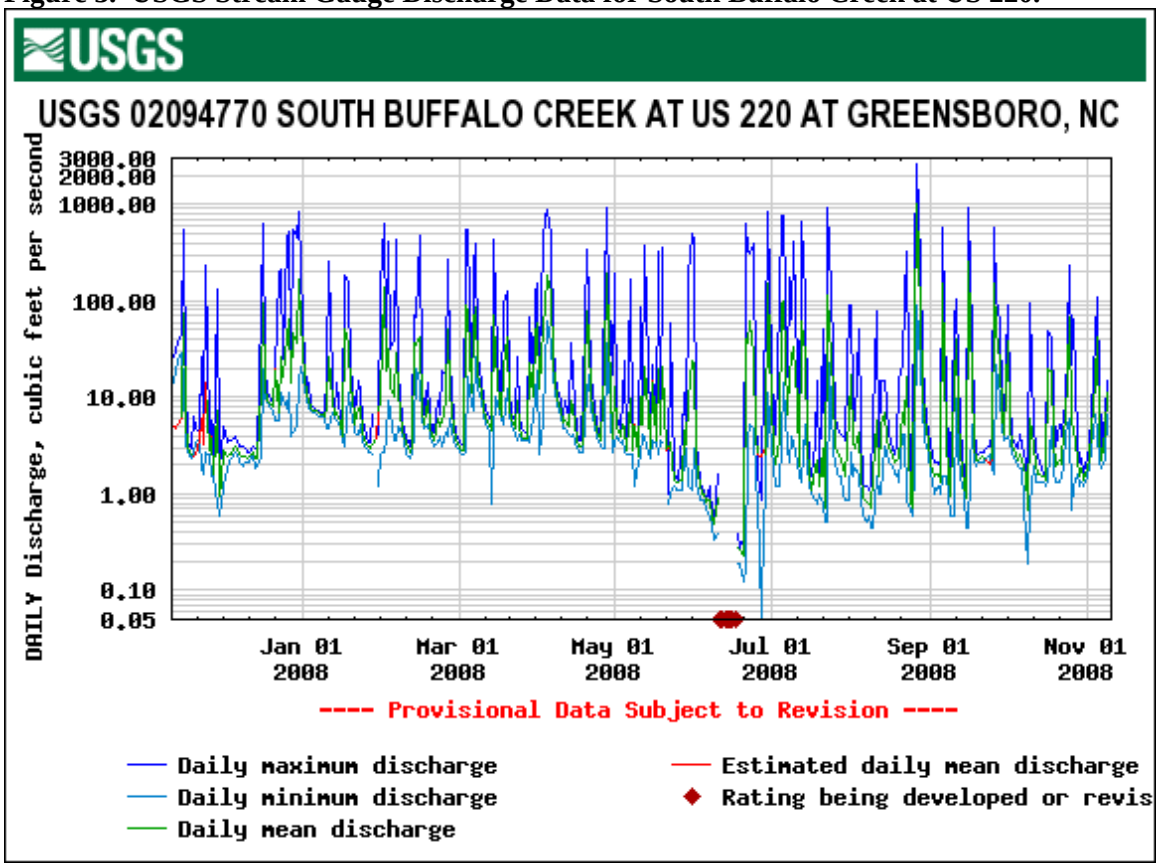


Table V. Verfication of Bankfull Events Hillsdale Park Stream Mitigation Site/Project No. 177				
Date of Data Collection	**Date of Occurrence**	**Maximum Discharge (cfs)**	**Method**	**Photo # (if available)**
2004	December 10, 2004	1700	Proximal USGS gauge resource	NA
2005	None	NA	NA	NA
2006	June 23, 2006	1670	Proximal USGS gauge resource	NA
2006	June 24, 2006	1260	Proximal USGS gauge resource	NA
2006	July 22, 2006	1310	Proximal USGS gauge resource	NA
2006	July 23, 2006	1890	Proximal USGS gauge resource	NA
2007	February 13, 2007	1560	Proximal USGS gauge resource	NA
2007	February 14, 2007	2170	Proximal USGS gauge resource	NA
2007	February 25, 2007	1550	Proximal USGS gauge resource	NA
2007	March 2, 2007	2340	Proximal USGS gauge resource	NA
2007	April 15, 2007	2320	Proximal USGS gauge resource	NA
2007	April 16, 2007	2350	Proximal USGS gauge resource	NA
2007	June 27, 2007	1990	Proximal USGS gauge resource	NA
2007	June 28, 2007	2130	Proximal USGS gauge resource	NA
2008	August 27, 2008	2580	Proximal USGS gauge resource	NA

1. Problem Areas Plan View

An assessment of the stability of the channel was performed on July 8-9, 2008 by WK Dickson and Co., Inc. Several areas of concern were observed and documented including localized bank scour and failure of engineered structures. These problem areas are shown in Appendix B, Section B-1.

2. Problem Areas Summary Table

The Problem Areas Table Summary is located in Appendix B as Table B.1.

3. Representative Stream Problem Areas Photos Section

Representative photos of each category of stream problem area were taken and are shown in Appendix B, Section B-3.

4. Fixed Photo Station Photos

Photos from established photo stations were collected on July 8, 2008 during the stream survey. These photos are included in Appendix B, Section B-4.

5. Stability Assessment

A visual qualitative assessment was performed to inspect channel facets, meanders, bed, banks, and installed structures. This visual assessment was confirmed and enhanced with a quantitative assessment of the physical stream survey. The goal of this assessment is to provide a percentage of the features listed in Table VI that are stable.

Table VI. Categorical Stream Feature Visual Stability Assessment Hillsdale Park Stream Mitigation Site/Project No. 177						
Reach HR1/ (3,037 feet)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	100%	100%	100%	91%	91%	100%
B. Pools	100%	95%	100%	97%	87%	100%
C. Thalweg	100%	100%	50%	88%	88%	100%
D. Meanders	100%	100%	96.70%	77%	78%	100%
E. Bed General	100%	100%	96.70%	100%	100%	100%
F. Bank Condition	NA	NA	NA	98%	98%	96%
G. Vanes/J-Hooks etc.	100%	100%	100%	100%	100%	100%
H. Wads and Boulders	100%	100%	100%	100%	100%	100%
Reach HR2 (2,265 feet)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	100%	100%	100%	98%	98%	100%
B. Pools	100%	95%	95%	83%	83%	100%
C. Thalweg	100%	100%	NA	90%	90%	100%
D. Meanders	100%	100%	NA	100%	100%	100%
E. Bed General	100%	100%	100%	100%	100%	100%
F. Bank Condition	NA	NA	NA	96%	96%	94%
G. Vanes/J-Hooks etc.	100%	100%	100%	93%	93%	100%
H. Wads and Boulders	100%	100%	94%	100%	100%	94%

Note: Year 1 estimates are based upon review of text within the Buck Engineering Year 1 Monitoring Report.

6. Quantitative Morphology

The following tables (Table VII and Table VIII) summarize the quantitative data collected from the cross-sectional and longitudinal stream survey. These data were analyzed and summarized, and then compared with as-built data and data from previous years. The SRI urban Piedmont curve was used to determine an average bankfull cross-sectional area, and bankfull was placed at the elevation that would yield this area (for 2008 cross-sections). When the elevations chosen for bankfull were plotted on the longitudinal profile, the points formed a reasonably uniform slope that was consistent with the low flow water surface slope. The baseline that has been chosen for 2008 is consistent with the regional curve and will provide accurate illustrations of departure if bankfull is located in the same manner for future years of monitoring. The results of the data analysis show that the 2008 data are consistent with data from previous years overall. Minor disparities between the 2008 data and the data from previous years can be explained by the fact that bankfull elevation fluctuates from year to year, but for ease of analysis the bankfull elevation has been kept at the same elevation as previous year's datum elevation. The Quantitative Morphology Tables illustrate the degree of departure, if any, of the current channel from the baseline data. Tables VII and VIII were compiled from the cross-section and profile raw data and plots located in Appendix B of this report.

Table VII. Baseline Morphology and Hydraulic Summary
Hillsdale Park Stream Mitigation Site/Project No. 144

Reach HR1 (3,037 feet)

Parameter	USGS Gage Data			Regional Curve Interval			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**	**Min**	**Max**	**Med**
BF Width (ft)				46	59	52	36	44	*	25.6	46	33.5	36	44	*	28	40.2	37.95
BF Cross Sectional Area (ft2)				255	283	269	103	113	*	43.5	122	80	103	113	*	70.7	154.4	117.55
BF Mean Depth (ft)				4.5	6	5.2	2.6	2.9	*	1.7	2.6	2.4	2.6	2.9	*	2.5	3.9	3.2
BF Max Depth (ft)							3.7	4	*	*	*	*	3.7	4	*	3.4	5.9	5
Width/Depth Ratio							12.2	17.3	*	14	17	15.1	12.2	17.3	*	8.8	14.7	10.9
Entrenchment Ratio							1.5	2.4	*	*	*	*	2.3	2.3	*	1.8	3.3	2.5
Wetted Perimeter (ft)							*	*	*	*	*	*	*	*	*	33	47.2	43.35
Hydraulic Radius (ft)							*	*	*	*	*	*	*	*	*	2.14	3.27	2.71
Pattern																		
Channel Beltwidth (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Radius of Curvature (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Meander Wavelength (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Meander Width Ratio							*	*	*	*	*	*	*	*	*	*	*	*
Profile																		
Riffle Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Riffle Slope (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Pool Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Pool -to-Pool Spacing (ft)							*	*	*	*	*	*	76	152	*	*	*	*
Substrate																		
d50 (mm)							*	*	*	3	64	19.1	*	*	*	*	*	*
d84 (mm)							*	*	*	77	180	bedrock	*	*	*	*	*	*
Additional Reach Parameters																		
Valley Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Channel Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Sinuosity							*	*	1.1	*	*	1.1	*	*	1.1	*	*	*
Water Surface Slope (ft/ft)							*	*	0.0016	*	*	*	*	*	0.0016	*	*	*
BF Slope (ft/ft)							*	*	*	*	*	*	*	*	*	*	*	*
Rosgen Classification							*	*	E4/B4c	*	*	B4c	*	*	E4/B4c	*	*	*
*Habitat Index							*	*	*	*	*	*	*	*	*	*	*	*
*Macrobenthos							*	*	*	*	*	*	*	*	*	*	*	*

*Historical documents necessary to provide this information were unavailable at the time of the report submission

Table VII (Continued). Baseline Morphology and Hydraulic Summary
Hillsdale Park Stream Restoration/Project No. 177

Reach HR2 (2,265 feet)																		
Parameter	**USGS Gage Data**			**Regional Curve Interval**			**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**	**Min**	**Max**	**Med**
BF Width (ft)				46	59	52	66	66	*	25.6	46	33.5	*	*	66	19.7	52.4	41.1
BF Cross Sectional Area (ft2)				255	283	269	166	166	*	43.5	122	80	*	*	166	72.6	242.3	112.9
BF Mean Depth (ft)				4.5	6	5.2	*	*	2.5	1.7	2.6	2.4	*	*	2.5	2.3	5	3.4
BF Max Depth (ft)							*	*	3.6	*	*	*	*	*	3.6	2.9	7.4	4.75
Width/Depth Ratio							*	*	26.4	14	17	15.1	*	*	26.4	5.3	22.6	10.3
Entrenchment Ratio							*	*	1.1	*	*	*	*	*	2.3	1.5	4.3	2.15
Wetted Perimeter (ft)							*	*	*	*	*	*	*	*	*	27.1	58.6	48.4
Hydraulic Radius (ft)							*	*	*	*	*	*	*	*	*	2.13	4.13	2.65
Pattern																		
Channel Beltwidth (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Radius of Curvature (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Meander Wavelength (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Meander Width Ratio							*	*	*	*	*	*	*	*	*	*	*	*
Profile																		
Riffle Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Riffle Slope (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Pool Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Pool -to-Pool Spacing (ft)							*	*	*	*	*	*	76	152	*	*	*	*
Substrate																		
d50 (mm)							*	*	*	3	64	19.1	*	*	*	*	*	*
d84 (mm)							*	*	*	77	bedrock	157.5	*	*	*	*	*	*
Additional Reach Parameters																		
Valley Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Channel Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Sinuosity							*	*	1.1	*	*	1.1	*	*	1.1	*	*	*
Water Surface Slope (ft/ft)							*	*	0.0035	*	*	*	*	*	0.0035	*	*	*
BF Slope (ft/ft)							*	*	*	*	*	*	*	*	*	*	*	*
Rosgen Classification							*	*	E4/B4c	*	*	B4c	*	*	E4/B4c	*	*	*
*Habitat Index							*	*	*	*	*	*	*	*	*	*	*	*
*Macrobenthos							*	*	*	*	*	*	*	*	*	*	*	*
*Macorbenthos																		

*Historical documents necessary to provide this information were unavailable at the time of the report submission
**Typically a flood prone width and entrenchment ratio are not calculated for a pool cross section.

Table VIII. Morphology and Hydraulic Monitoring Summary
Hillsdale Park Stream Mitigation Site/Project No. 177

Reach HR1 CS 1-6 (3,037 feet)

Parameter	Cross-Section 1 12+01 Pool						Cross-Section 2 14+61 Riffle						Cross-Section 3 16+31 Pool						Cross-Section 4 20+31 Riffle						Cross-Section 5 25+43 Riffle						Cross-Section 6 25+82 Pool					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	33.5	32.8	38.3	36.4	40.2	37.6	38	37.5	38.5	38	38.9	38.2	33.8	36.9	37.3		36.3	33.2	37.9	40.1	41.7	38.9	38.8	38.8	40.2	41.1	44.5	38.7	38.8	39.1	39.4	38.4	47.8	36.1	34.4	32
Floodprone Width (ft)	95	95	>85	**	**	72	68	68	74.4	84	70	70	110	110	**	**	**	76.2	75	75	89	99	94.8	75	73	73	*	82	88	73	110	110	**	**	**	91.5
BF Cross Sectional Area (ft2)	127	126	178	166	177	164	105	103	109	115	113	115	114	139	166		147	133	97.8	104	110	109	113	108	121	128	133	120	118	120	154	160	224	168	164	158
BF Mean Depth (ft)	3.8	3.8	4.6	4.6	4.4	4.4	2.8	2.7	2.8	3	2.91	3	3.4	3.8	4.4		4.0	4.0	2.6	2.6	2.6	2.8	2.91	2.8	3	3.1	3	3.1	3.04	3.1	3.9	4.2	4.7	4.7	4.77	4.9
BF Max Depth (ft)	5.8	5.7	7.1	6.9	6.6	6.9	3.8	4.1	3.9	4.6	4.29	4.3	5.5	6.4	7.2		6.7	6.3	3.4	3.7	3.7	3.8	3.82	3.9	4.5	4.7	5.5	5	4.89	4.8	5.5	6	7.8	6.2	6.37	6.4
Width/Depth Ratio	8.8	8.6	8.3	8.0	9.1	8.6	13.8	13.7	13.7	12.6	13.4	12.7	10.0	9.8	8.4		9.0	8.3	15.4	15.8	15.8	13.9	13.3	13.9	13.4	13.2	14.9	12.5	12.8	12.8	10.1	9.2	10.2	7.7	7.2	6.5
Entrenchment Ratio	2.8	2.9	>2.2	**	2.3	1.9	1.8	1.8	1.9	2.2	1.8	1.8	3.3	3.0	**	**	**	2.3	1.9	2.1	2.1	2.5	2.4	1.9	1.8	1.8	*	2.1	2.3	1.9	2.8	2.9	**	**	**	2.9
Wetted Perimeter (ft)	41.1	*	47.6	41.1	44.8	41.1	43.6	*	44.1	39.8	40.9	40.4	40.6	*	46.2		40.5	37.4	*	47	47	41	40.5	40.8	46.2	*	50.5	41.2	42.8	42.7	47.2	*	57.2	40.1	40	37
Hydraulic Radius (ft)	3.1	*	3.7	4.0	4.0	4.0	2.4	*	2.46	2.9	2.8	2.8	2.8	*	3.6		3.6	3.5	*	2.35	2.35	2.7	2.8	2.6	2.62	*	2.63	2.9	2.8	2.8	3.27	*	3.92	4.2	4.1	4.3
Substrate																																				
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	MY-01 (2005)						MY-02 (2005)						MY-03 (2006)						MY-04 (2007)						MY-05 (2008)						MY+ (2009)					
Pattern	Min	Max	Med				Min	Max	Med				Min	Max	Med				Min	Max	Med				Min	Max	Med				Min	Max	Med			
Channel Beltwidth (ft)	*	*	*				*	*	*				22	69	39				16	79	49				24	76	54									
Radius of Curvature (ft)	*	*	*				*	*	*				6	22	12				6	33	17				7	31	15									
Meander Wavelength (ft)	*	*	*				*	*	*				33	74	49				25	79	48				32	75	47									
Meander Width Ratio	*	*	*				*	*	*				0.59	1.85	1.05				*	*	*				0.75	1.94	1.48									
Profile																																				
Riffle Length (ft)	*	*	*				6	434	26				11	421	132				13	433	37				36	124	65									
Riffle Slope (ft)	*	*	*				0	0.02	0				0	0.02	0				0	0.02	0				0.002	0.024	0.010									
Pool Length (ft)	*	*	*				10	140	28				12	155	37				14	160	40				45.1	114	77.4									
Pool -to-Pool Spacing (ft)	*	*	*				25	613	144				23	712	168				26	700	155				68.5	207	142									
Additional Reach Parameters																																				
Valley Length (ft)	NA						2720						2720						2720						2720											
Channel Length (ft)	NA						3045						3045						3045						3045											
Sinuosity	NA						1.1195						1.1195						NA						1.1195											
Water Surface Slope (ft/ft)	NA						0.00199						0.00104, 0.0013						NA						NA											
BF Slope (ft/ft)	NA						0.00181						0.0012, 0.00059						NA						0.0037											
Rosgen Classification	NA						B4c						B4c						B4c						B4c											
*Habitat Index	NA						NA						NA						NA						NA											
*Macrobenthos	NA						NA						NA						NA						NA											

*Historical documents necessary to provide this information were unavailable at the time of the report submission
**Typically a flood prone width and entrenchment ratio are not calculated for a pool cross section.

Table VIII (Continued). Morphology and Hydraulic Monitoring Summary
Hillsdale Park Stream Mitigation Site/Project No. 177

Reach HR1 CS 7-8 (3,037 feet)

Parameter	Cross-Section 7 30+89 Riffle						Cross-Section 8 31+81 Pool																											
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	28	28.1	33.4	29.4	28	26.3	38.9	35.7	42	33.8	38.5	40.3																								
Floodprone Width (ft)	62	62	70.5	64	60	62	130	130	**	**	90	93																								
BF Cross Sectional Area (ft2)	70.7	71.3	82	74.3	72.9	69.3	142	128	172	198	187	177																								
BF Mean Depth (ft)	2.5	2.5	2.5	2.5	2.6	2.6	3.7	3.6	4.1	5.9	4.87	4.4																								
BF Max Depth (ft)	3.8	3.8	4	3.9	3.8	4.1	5.9	5.6	6.6	9.6	7.12	7.2																								
Width/Depth Ratio	11.1	11.1	13.6	11.6	10.8	10	10.7	10	10.3	5.8	7.9	9.2																								
Entrenchment Ratio	2.2	2.2	2.1	2.2	2.1	2.4	3.3	3.6	**	**	2.3	2.3																								
Wetted Perimeter (ft)	33	*	38.3	32.2	29.9	32.3	46.3	*	50.2	41.7	45.3	48																								
Hydraulic Radius (ft)	2.14	*	2.14	2.3	2.4	2.1	3.07	*	3.42	4.8	4.1	3.7																								
Substrate																																				
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*																								
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*																								

Parameter	MY-01 (2005)						MY-02 (2005)						MY-03 (2006)						MY-04 (2007)						MY-05 (2008)						MY+ (2009)					
Pattern	Min	Max	Med				Min	Max	Med				Min	Max	Med				Min	Max	Med				Min	Max	Med				Min	Max	Med			
Channel Beltwidth (ft)																																				
Radius of Curvature (ft)																																				
Meander Wavelength (ft)																																				
Meander Width Ratio																																				
Profile																																				
Riffle Length (ft)																																				
Riffle Slope (ft)																																				
Pool Length (ft)																																				
Pool -to-Pool Spacing (ft)																																				
Additional Reach Parameters																																				
Valley Length (ft)																																				
Channel Length (ft)																																				
Sinuosity																																				
Water Surface Slope (ft/ft)																																				
BF Slope (ft/ft)																																				
Rosgen Classification																																				
*Habitat Index																																				
*Macrobenthos																																				

*Historical documents necessary to provide this information were unavailable at the time of the report submission

Table VIII (Continued). Morphology and Hydraulic Monitoring Summary
Hillsdale Park Stream Mitigation Site/Project No. 177

Reach HR2 CS 9-12 (2,265 feet)

Parameter	Cross-Section 9 44+41 Riffle						Cross-Section 10 45+39 Pool						Cross-Section 11 54+96 Riffle						Cross-Section 12 55+43 Pool																	
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	52.4	53.6	49.1	53.7	55.5		48.6	47.8	53.3	47	59.8	45.6	33.6	36.9	34	31.1	33.8	32.4	19.7	20.3	21.1	20.5	20.9	18.9												
Floodprone Width (ft)	80	80	67.6	76	80	80	210	210	**	**	**	**	55	55	>53	52	50	55	53	53	**	**	54.4	53.2												
BF Cross Sectional Area (ft2)	122	122	93.8	132	137	123	242	241	256	278	273	255	104	107	103	92.2	104	100	72.6	87.1	89.1	84.3	87.4	84.3												
BF Mean Depth (ft)	2.3	2.3	1.9	2.5	2.47	2.6	5	5	4.8	5.9	4.56	5.6	3.1	2.9	3	3	3.08	3.1	3.7	4.3	4.2	4.1	4.18	4.5												
BF Max Depth (ft)	2.9	2.9	2.2	3.1	3.08	3	7.4	7	7.4	7.7	7.81	7.5	4.4	4.4	4.2	7.6	4.01	4.3	5.1	5.6	5.4	5.6	5.52	5.6												
Width/Depth Ratio	22.6	23.6	25.7	21.9	22.4	18.7	9.8	9.5	11.1	7.9	13.1	8.1	10.8	12.7	11.2	10.5	11	10.5	5.3	4.7	5	5	5	4.2												
Entrenchment Ratio	1.5	1.5	1.4	1.4	1.4	1.7	4.3	4.4	**	**	**	**	1.6	1.5	*	1.7	1.5	1.7	2.7	2.6	**	**	2.6	2.8												
Wetted Perimeter (ft)	57	*	52.9	55.7	57.4	50.1	58.6	*	62.9	53	65	50.5	39.8	*	40.1	42.9	37.1	37.1	27.1	*	29.6	26.1	26.1	25.2												
Hydraulic Radius (ft)	2.13	*	1.77	2.4	2.4	2.5	4.13	*	4.07	5.2	4.2	5.1	2.62	*	2.58	2.2	2.8	2.7	2.68	*	3.02	3.2	3.3	3.3												
Substrate																																				
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*												

Parameter	MY-01 (2005)						MY-02 (2005)						MY-03 (2006)						MY-04 (2007)						MY-05 (2008)						MY+ (2009)					
Pattern	Min	Max	Med				Min	Max	Med				Min	Max	Med				Min	Max	Med				Min	Max	Med				Min	Max	Med			
Channel Beltwidth (ft)	*	*	*				*	*	*				24	66	46				32	64	45				30	70	45									
Radius of Curvature (ft)	*	*	*				*	*	*				9	21	12				12	26	15				18	40	25									
Meander Wavelength (ft)	*	*	*				*	*	*				34	81	60				31	88	62				57	108	65									
Meander Width Ratio	*	*	*				*	*	*				0.63	1.73	1.21				0.85	1.64	1.25				1.59	1.54	1.39									
Profile																																				
Riffle Length (ft)	*	*	*				11	194	50				15	234	75				13	215	65				52.3	102	79.6									
Riffle Slope (ft)	*	*	*				0	0.01	0				0	0.02	0.01				0	0.02	0.01				0	0.01	0.01									
Pool Length (ft)	*	*	*				8	104	67				10	125	80				12	130	75				59	180	111									
Pool -to-Pool Spacing (ft)	*	*	*				108	443	180				105	438	205				107	448	210				111	317	177									

Additional Reach Parameters				
Valley Length (ft)	NA	2115	2115	2115	2115	
Channel Length (ft)	NA	2167	2167	2167	2167	
Sinuosity	NA	1.025	1.025	NA	1.025	
Water Surface Slope (ft/ft)	NA	0.00392	0.0037	NA	NA	
BF Slope (ft/ft)	NA	0.00364	0.0022	NA	0.00275	
Rosgen Classification	NA	B4c	B4c	B4c	B4c	
*Habitat Index	NA	NA	NA	NA	NA	
*Macrobenthos	NA	NA	NA	NA	NA	

*Historical documents necessary to provide this information was unavailable at the time of the report submission.
**Typically a flood prone width and entrenchment ratio are not calculated for a pool cross section.

C. WETLAND ASSESSMENT

There is no wetland restoration associated with this site. Table X is not applicable to this project.

IV. METHODOLOGY SECTION

The methodology used for vegetative monitoring did not follow the "CVS-EEP Protocol for Recording Vegetation" per EEP guidance. Qualitative observations of vegetation were made due to anticipated treatment of invasive species and replanting.

RECOMMENDATIONS

It is recommended that an invasive species control plan be developed and implemented and the target tree and shrub species be replanted. CVS protocol vegetation monitoring should resume in 2009. Stream problem areas are mostly minor, but several areas of bank erosion may require repairs.

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Appendices