Gillespie Golf Course (Mile Run 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 144

March 2009

Submitted by:

WK Dickson and Co., Inc.
720 Corporate Center Drive
Raleigh, NC 27607
(919) 782-0495

GILLESPIE GOLF COURSE (MILE RUN CREEK) STREAM RESTORATION
2008 MONITIORING REPORT

TABLE OF CONTENTS

LIST OF FIGURES

TABLES

APPENDICES

I. EXECUTIVE SUMMARY/PROJECT ABSTRACT

The Gillespie Golf Course Stream Restoration Site includes 2,634 linear feet of Mile Run Creek and 3,436 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, but has a few areas of minor erosion. Previously, there had been a beaver dam constructed on Mile Run Creek, but it has since been eliminated and is no longer creating a problem along the restoration reach.

Vegetation monitoring of the site was not performed in 2008 per EEP guidance. A qualitative visual assessment of the vegetation was performed, and common problems included invasive exotic species and mowing by golf course personnel. Due to the presence of invasive species and some mowing, EEP anticipates invasive species treatment with augmentation of plantings in those areas that require it. Vegetation monitoring will resume in 2009.

II. PROJECT BACKGROUND

A. Project Objectives

The objectives of the restoration of Mile Run Creek that flows through Gillespie Golf Course were to:

- 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

Mile Run Creek and its unnamed tributary are located on Gillespie Golf Course, a public golf course in the City of Greensboro. The stream channel has low sinuosity and varying levels of incision due to historic channelization. The alternative of creating a stable meandering channel with bankfull stage located at the existing floodplain elevation was evaluated. However, in these streams, topographic and development restrictions did not allow for a new channel pattern to be established. The existing incised channels were enhanced by excavating new floodplain benches at the bankfull stage and installing structures to improve bed features and control channel grade.

The restoration project was divided into one main stem (GR1) and four small unnamed tributaries (GR2, GR3, GR4, and GR5) that flow into Mile Run Creek. The design was based on a Rosgen Priority 3 restoration approach. Bankfull benches were constructed along both banks. In-stream structures, including root wads, double wing deflectors, and rock vanes were used to stabilize eroding stream banks and improve channel profile and bed form. Cross vanes were installed upstream and downstream of the golf cart bridges to prevent near bank scour at the bridges. A cross vane was constructed upstream of the box culverts to decrease the width of the low flow channel. Reach GR1 from station 0+00 to 24+34 was converted from an incised E5/C5 to a C5. Managed and unmanaged forested buffers consisting of herbaceous perennials, shrubs, and bare roots were planted along the banks to provide stabilization.

Reach GR2 was designed using a Rosgen Priority 3 restoration approach. Reach GR2 is an unnamed tributary that drains off the city maintenance yard and flows into Reach GR1 at station 17+00. Seven rock vanes were used to stabilize the stream banks and improve bed form diversity. A forested buffer 25 feet wide was painted to provide additional bank stabilization.

Restoration of GR3 was based on a Rosgen Priority 3 restoration approach. Reach GR3 is an unnamed tributary that is 450 feet long. A forested buffer, varying in width from 50 to 55 feet, was planted for additional stabilization.

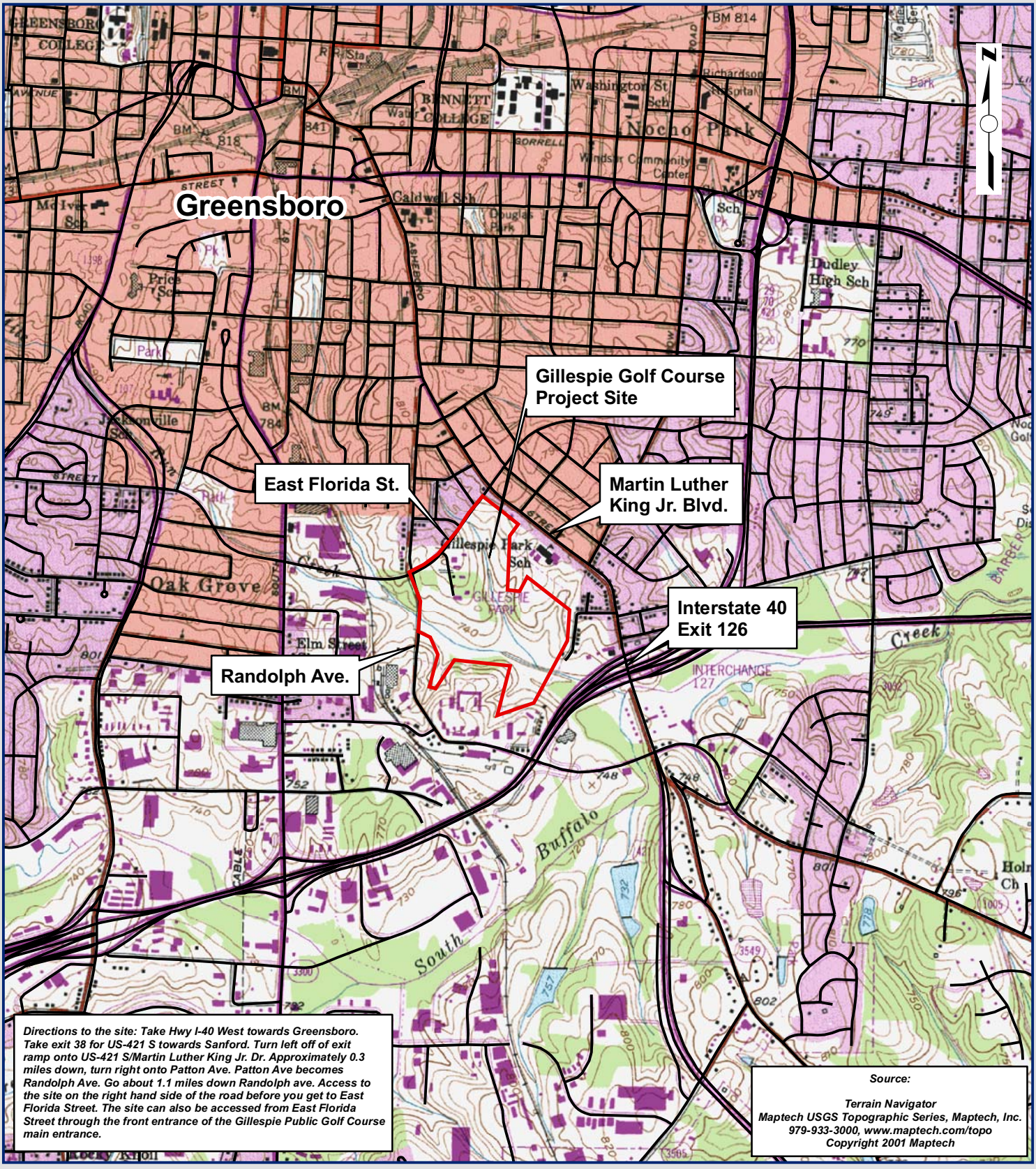
Reach GR4 was designed based on a bank stabilization restoration approach. Reach GR4 is an unnamed tributary that runs 1,300 feet before it intersects with Reach GR5 and then runs 300 feet into Mile Run Creek. Forested and herbaceous buffers, varying in width from 20 to 50 feet were planted along the reach to provide stability.

Reach GR5 of Mile Run Creek was based on a bank stabilization approach. Reach GR5 is an unnamed tributary that runs 800 feet before it intersects with Reach GR4 and then runs 300 feet into Mile Run Creek. Forested and herbaceous buffers, varying in width from 20 to 50 feet, were planted along the reach to provide stability.

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

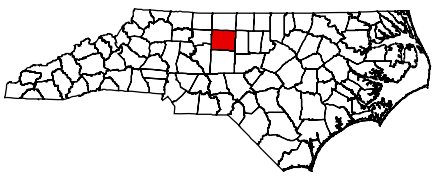
C. Location and Setting

The Gillespie Golf Course Stream Restoration Site includes 2,634 linear feet of Mile Run Creek and 3,436 linear feet of an unnamed tributary. The site is located in the City of Greensboro near the intersection of Interstate 85 and North Carolina Highway 22 (NC-22) in Guilford County, North Carolina (See Figure 1).



Ecosystem Enhancement PROGRAM

Figure 1.
Gillespie Golf Course
Stream Restoration Site
Vicinity Map
Guilford County, NC



0 1,000 2,000 4,000 Feet

Table Ia. Project Restoration Components Gillespie Golf Course Stream Restoration/Project No. 144								
Project Component or Reach ID	**Existing Feet/ Acres**	**Restoration Level**	**Approach**	**Footage or Acreage**	**Stationing**	**Buffer Acres**	**BMP Elements1**	**Comment**
Mile Run Creek Reach I GR1a-e	2234	EI	P3	2234	00+00 - 22+34	-		Dimension and profile - instream structures
Mile Run Creek Reach I GR1f	400	EII	SS	400	22+35 - 26+34	-		Stream bank stabilization and plantings
UT Reach GR2	250	EI	P3	250	00+00 - 2+50	-		Dimension and profile - instream structures
UT Reach GR3a	461	EII	SS	461	Not stationed	-		Stream bank stabilization and plantings
UT Reach GR3b	225	EI	P3	225	Not stationed	-		Dimension and profile - instream structures
UT Reach GR4	1425	EII	SS	1425	Not stationed	-		Stream bank stabilization and plantings
UT Reach GR5	800	EII	SS	800	Not stationed	-		Stream bank stabilization and plantings

EI = Enhancement I P3 = Priority 3
EII = Enhancement II SS = Stream Bank Stabilization

Table Ib. Component Summations Gillespie Golf Course Stream Restoration/Project No. 144							
Restoration Level	Stream (lf)	Riparian Wetland (Ac)		Non-Ripar (Ac)	Upland (Ac)	Buffer (Ac)	BMP
		Riverine	Non-Riverine				
Restoration	-	-	-	-	-		
Enhancement		-	-	-	-		
Enhancement I	2709						
Enhancement II	3086						
Creation		-	-	-	-		
Preservation	-	-	-	-	-		
HQ Preservation	-	-	-	-	-		
		0	0				
Totals	**5795**	**0**		**0**	**0**	**-**	**-**

= Non-Applicable Categories
- = Non-Applicable for this project

D. Project History and Background

The construction of Mile Run Creek was completed in May 2003, and the As-Built survey was completed during the same month. Year 1 monitoring took place in April 2005, and Year 2 monitoring occurred in October 2005. Additional details regarding the timeline of the project are provided in Table II.

The project was designed by Buck Engineering. Construction was performed by LJ, Incorporated. Monitoring activities for Year 5 were performed by WK Dickson and Co., Inc. Additional information regarding contractors is shown in Table III.

Table II. Project Activity and Reporting History
Gillespie Golf Course Stream Restoration/Project No. 144

Activity or Report	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	NA*	February 2005
Final Design – 90%	NA*	NA
Construction	NA*	May 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)	May 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	October 2007	December 2007
Year 5 Monitoring	October 2008	December 2008
Year 5 + Monitoring		

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

Table III. Project Contacts Table Gillespie Golf Course Stream Restoration/Project No. 144	
Designer	Buck Engineer
	8000 Regency Parkway, Suite 200
	Cary, NC 27511
Primary project design POC	Mr. Mike Rooney (919) 463-5490
Construction Contractor	LJ, Incorporated
	P.O. Box 3188
	Mooresville, NC 28117
Construction Contractor POC	Mr. Arden Reiser (704) 799-2670
Planting Contractor	NA*
Planting Contractor POC	NA*
Seeding Contractor	NA*
Seeding Contractor POC	NA*
Seed mix sources	NA*
Nursery Stock Suppliers	NA*
Monitoring Performers	WK Dickson and Co., Inc.
	720 Corporate Center Drive
	Raleigh, NC 27607
Stream Monitoring POC	Mr. Daniel Ingram (919) 782-0495

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

The project is located within Guilford County, within the Southern Outer Piedmont of 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.

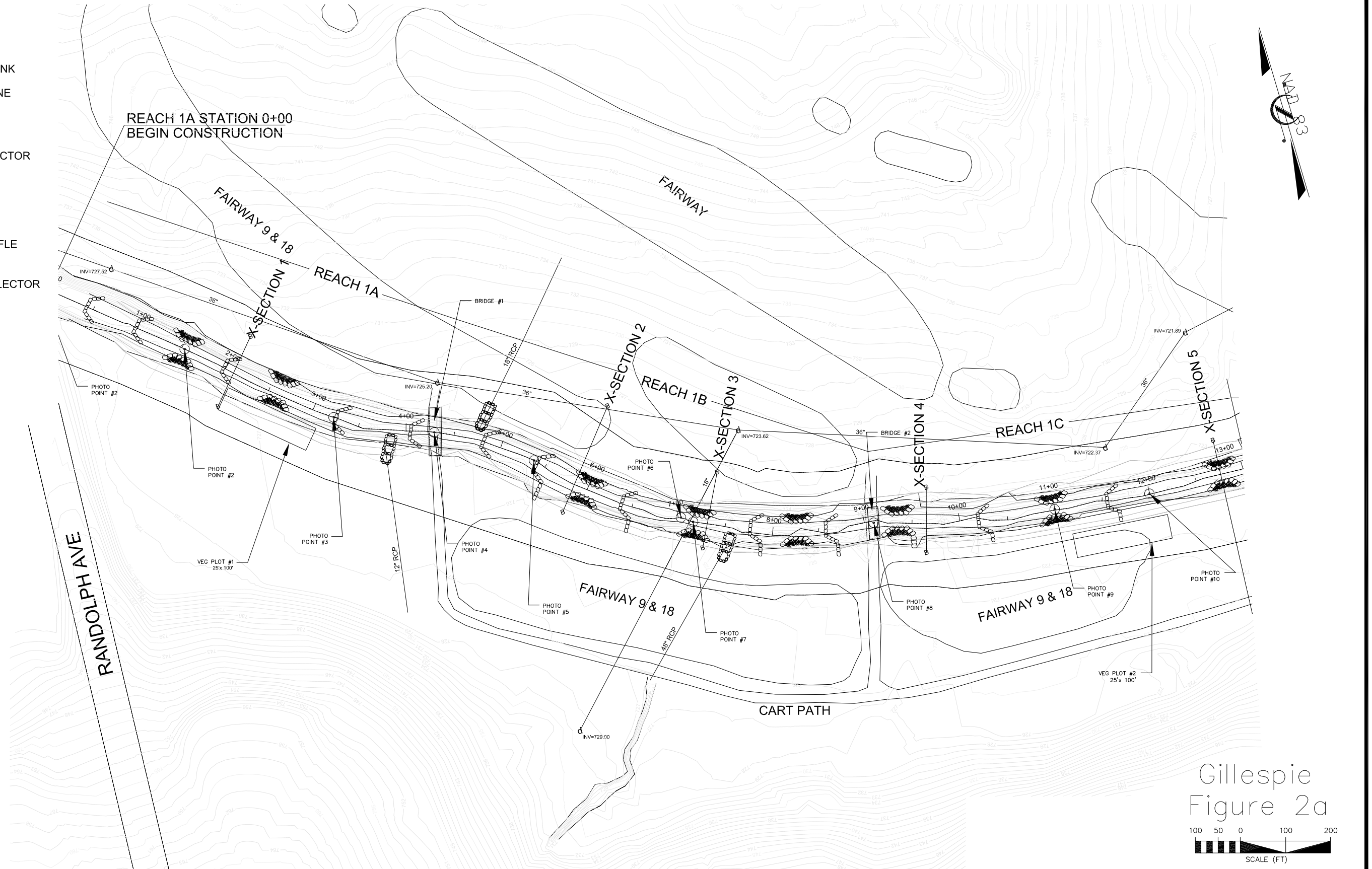
E. Monitoring Plan View

A series of monitoring points have been installed on site. A total of six (6) 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 will be photographed annually. There are thirty-four (34) permanent photo points located at various points along the length of the channel. Four (4) vegetation monitoring plots were randomly located within the riparian buffer of the Gillespie Golf Course Stream Restoration project. The locations of all monitoring installations are shown on the Monitoring Plan View (Figures 2a and 2b).

Table IV. Project Background Table Gillespie Golf Course Stream Restoration/Project No. 144	
Project County	Guilford
Drainage Area	
Mile Run Creek	2.2 sq. mi.
Tributary GR2	0.002 sq. mi.
Tributary GR3	0.04 sq. mi.
Tributary GR4	0.13 sq. mi.
Tributary GR5	0.04 sq. mi.
Drainage impervious cover estimate (%)	>20%
Stream Order	
Mile Run Creek	2nd order
Tributary GR2	1st order
Tributary GR3	1st order
Tributary GR4	1st order/2nd order
Tributary GR5	1st order
Physiographic Region	Piedmont
Ecoregion	Southern Outer Piedmont
Rosgen Classification of As-built	C5
Cowardin Classification	NA
Dominant soil types	
Mile Run Creek	Chewacla sandy loam, Enon fine sandy loam
Tributary GR2	Chewacla sandy loam, Enon fine sandy loam
Tributary GR3	Chewacla sandy loam, Enon fine sandy loam
Tributary GR4	Chewacla sandy loam, Enon fine sandy loam
Tributary GR5	Chewacla sandy loam, Enon fine sandy loam
Reference site ID	E5, Ut Lake Jeanette (Guilford), McClintock 1 & 2 (Mecklenburg); B4c, DuHart (Gaston), Silas (Forsyth), Morgan (Orange)
USGS HUC for Project and Reference	03030002 (Cape Fear)
NCDWQ Sub-basin for Project and Reference	Ut Lake Jeanette 030602, McClintock 030834, DuHart 030836, Silas 030704, Morgan 030606
NCDWQ classification for Project and Reference	
Mile Run Creek	C, NSW
Tributary GR2	C, NSW
Tributary GR3	C, NSW
Tributary GR4	C, NSW
Tributary GR5	C, NSW
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	Yes, Mile Run Creek is upstream of South Buffalo Creek
Reasons for 303d listing or stressor	Impaired biological stressor, stressor not identified, Urban runoff-storm sewers
% of project easement fenced	None

LEGEND

- STREAM TOP OF BANK
- STREAM CENTERLINE
- VEG PLOT
- SINGLE-ARM DEFLECTOR
- OUTLET BASIN
- DROP CROSS-VANE
- CONSTRUCTED RIFFLE
- DOUBLE-WING DEFLECTOR
- J-HOOK
- BOULDER CLUSTER
- BEDROCK
- PHOTO POINT



Gillespie
Figure 2a

100 50 0 100 200
SCALE (FT)

PROJECT MANAGER	DPI
DRAWN BY	TRS
APPROVED BY	DPI
PROJECT NUMBER	8018401RA
DRAWING SCALE	1" = 100'
SURVEY DATE	07/2008
MAP DATE	11/2008

WK DICKSON
community infrastructure consultants

720 CORPORATE CENTER DRIVE
RALEIGH, NC 27607
(919) 782-0495

Office Locations:
North Carolina
South Carolina
Georgia
Florida

Ecosystem Enhancement Program

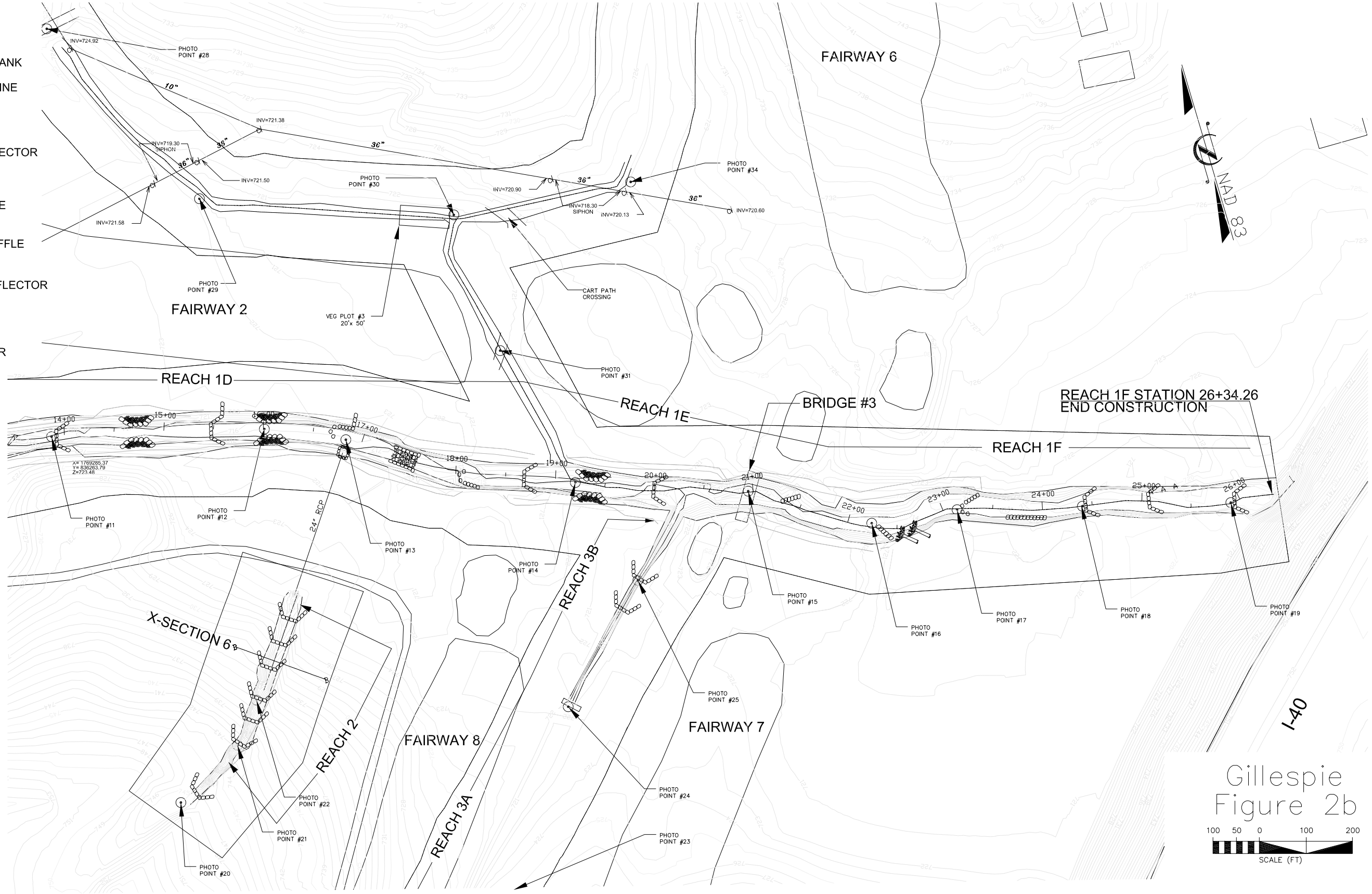
PREPARED FOR:

NORTH CAROLINA
ECOSYSTEM ENHANCEMENT PROGRAM

TITLE: YEAR 5 MONITORING – MONITORING PLAN VIEW
GILLESPIE GOLF COURSE
GREENSBORO
NORTH CAROLINA

LEGEND

- STREAM TOP OF BANK
- STREAM CENTERLINE
- VEG PLOT
- SINGLE-ARM DEFLECTOR
- OUTLET BASIN
- DROP CROSS-VANE
- CONSTRUCTED RIFFLE
- DOUBLE-WING DEFLECTOR
- J-HOOK
- BOULDER CLUSTER
- BEDROCK
- PHOTO POINT



Gillespie
Figure 2b

100 50 0 100 200
SCALE (FT)

PROJECT MANAGER	DPI
DRAWN BY	TRS
APPROVED BY	DPI
PROJECT NUMBER	8018401RA
DRAWING SCALE	1" = 100'
SURVEY DATE	07/2008
MAP DATE	11/2008

WK DICKSON
community infrastructure consultants

720 CORPORATE CENTER DRIVE
RALEIGH, NC 27607
(919) 782-0495

Office Locations:
North Carolina
South Carolina
Georgia
Florida

Ecosystem Enhancement Program

PREPARED FOR:

NORTH CAROLINA
ECOSYSTEM ENHANCEMENT PROGRAM

TITLE: YEAR 5 MONITORING – MONITORING PLAN VIEW
GILLESPIE GOLF COURSE
GREENSBORO
NORTH CAROLINA

III. PROJECT CONDITION AND MONITORING RESULTS

A. Vegetation Assessment

1. Soil Data

Soils present in the riparian areas adjacent to Mile Run 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.

Chewacla soils (*Fluvaquentic Dystrudepts*) are the prevalent map unit along the channel. Formed in recent alluvial sediments, they are very deep, moderately well and somewhat poorly drained soils with moderate permeability.

Other soil series found along the stream corridor are Enon soils. Enon soils (*Ultic Hapludalfs*) are very deep, well drained, slowly permeable soils found on ridgetops and side slopes in the Piedmont.

2. Vegetative Problem Areas

No quantitative vegetation monitoring was conductedin 2008 per EEP guidance. In past years mowing by golf course personnel has been a problem. There was no evidence of recent mowing during 2008 monitoring. Invasive species such as porcelain berry, mimosa, and coral berry are common throughout the restoration corridor. Common volunteer species include ragweed, Johnson grass, red mulberry, and switchgrass. The planted trees and shrubs appear to have suffered high mortality and likely do not meet the minimum survival criteria of 260 trees per acre. The CCPV details the presence of invasive exotic species versus the target natural community.

3. Stem Counts

No stem counts were performed in 2008 per EEP guidance.

4. Vegetation Plot Photos

Appendix A contains typical vegetation photographs from 2008 monitoring.

B. Stream Assessment

WK Dickson and Co., Inc personnel conducted stream monitoring activities during a site visit at Gillespie Golf Course on July 9, 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 during this visit. Six cross sections and approximately 3,000 linear feet of stream profiles were surveyed. Photographs were taken at all permanent photo points. 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, although aggressive mowing has killed some of the trees and shrubs, thereby narrowing the buffer and reducing the vegetative height and diversity. Overall, the project is doing well, but has a few areas of minor erosion or areas of minimal vegetation. At this time, no repairs are recommended. Stream problem areas are described in Appendix B, Table B.1.

Hydrologic Assessment

Potential occurrences were extrapolated based on USGS stream gauge discharge data for South Buffalo Creek at US 220 (approximately 2 miles downstream of the project site), which has a drainage area of 15.4 square miles (Figure 3). Bankfull events were determined by comparing the stream discharge cubic feet per second (cfs) against the drainage area on the urban Piedmont regional curve. According to the urban Piedmont regional curve, a bank full event occurs on a stream with a 15.4 mi^2 drainage area when the discharge is between 1,538 and 1,704 cfs. Based on USGS data and the Piedmont urban regional curves, one bankfull event occurred in 2008. Table V lists bankfull events as they occurred in 2008.

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.

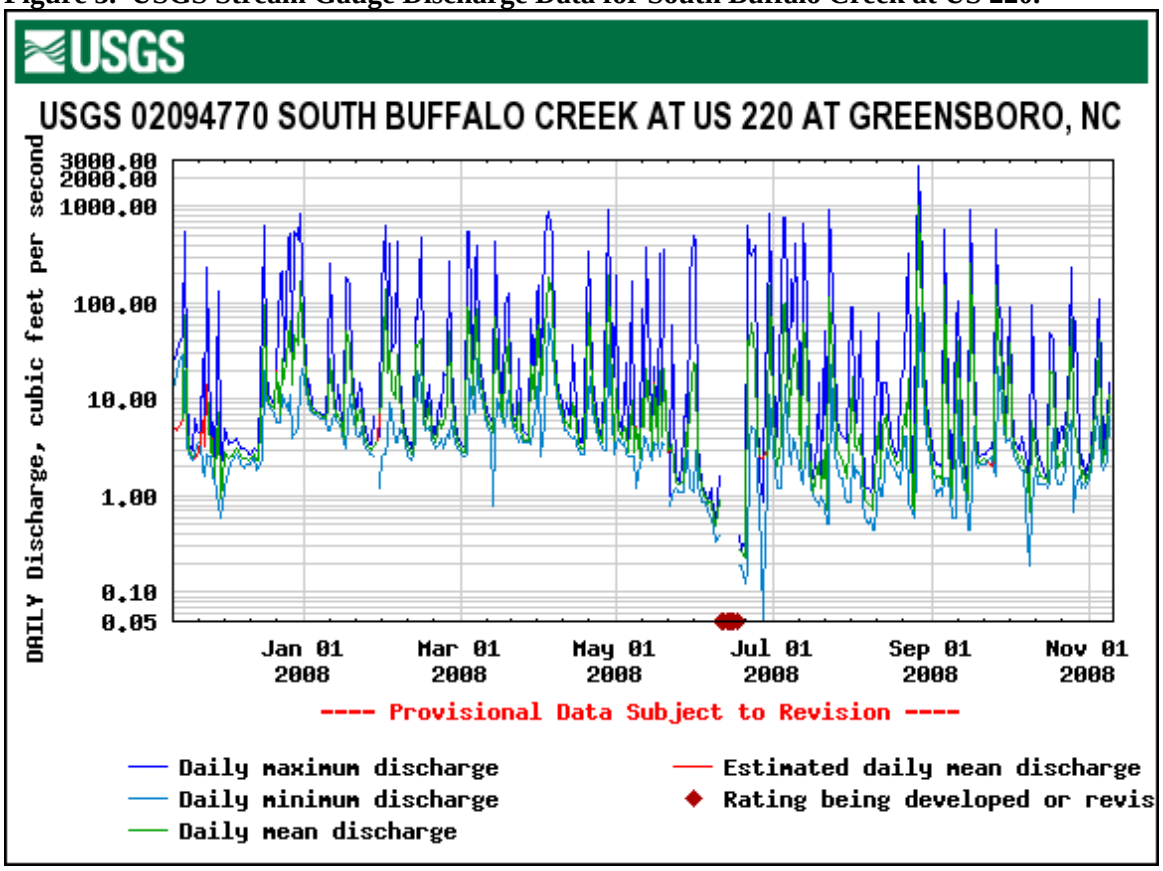


Table V. Verification of Bankfull Events Gillespie Golf Course Stream Mitigation Site/Project No. 144				
Date of Data Collection	**Date of Occurrence**	**Maximum Discharge (cfs)**	**Method**	**Photo # (if available)**
2004	December 10, 2004	1700	Proximal USGS gauge resource	NA
2005	None	NA	NA	NA
2006	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 channel stability was preformed on July 9, 2008 by WK Dickson and Co., Inc. Several areas of concern were observed and documented, including localized bank scour and aggradation. These problem areas are shown in Figure 2.

2. Problem Areas Table Summary

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

3. Representative Stream Problem Areas Photos

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 10, 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
Gillespie Golf Course Stream Restoration/Project No. 144
Reach GR1/ (2,634 feet)

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles	100%	98%	96%	82%	82%	92%
B. Pools	100%	95%	NA	90%	90%	97%
C. Thalweg	100%	100%	NA	NA	NA	NA
D. Meanders	100%	100%	NA	NA	NA	NA
E. Bed General	100%	100%	NA	98%	98%	98%
F. Bank Condition	NA	NA	NA	98%	96%	96%
G. Vanes / J. Hooks, etc.	100%	100%	96%	96%	96%	96%
H. Wads and Boulders	100%	100%	100%	86%	86%	86%

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 baseline data (i.e. as-built data and data from previous years) available for this project. 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 water surface slope. 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
Gillespie Golf Course Stream Restoration/Project No. 144
Reach GR1 (2,634 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)				27	35.9	31.6	27.2	44.4	29.2	9.1	12.6	10.6	*	*	27	24	28.5	26.3
Floodprone Width (ft)																		
BF Coss Sectional Area (ft^2)				96	106	101	61.5	112.8	88	14.2	21.8	20.5	*	*	74	49.9	85.5	52.3
BF Mean Depth (ft)				2.7	3.6	3.1	1.9	3.9	2.9	1.6	2	1.6	*	*	2.7	1.9	3.4	2.2
BF Max Depth (ft)							3.8	5.4	4.7	*	*	*	*	*	3.4	2.9	5.7	3.4
Width/Depth Ratio							7.2	19.3	9.9	5	8	6	*	*	10	7.3	13.9	11.15
Entrenchement Ratio							>2.5	>3.9	>3.1	*	*	*	3	3.6	*	2.1	9.4	3.75
Bank Height Ratio																		
Wetted Perimeter (ft)							34.6	49	35	*	*	*	*	*	*	28.4	34.3	30.7
Hydraulic radius (ft)							1.72	3.05	2.42	*	*	*	*	*	*	1.66	2.7	1.83
Pattern																		
Channel Beltwidth (ft)							*	*	*	32	45	*	*	*	*	*	*	*
Radius of Curvature (ft)							*	*	*	18	30	*	*	*	*	*	*	*
Meander Wavelength (ft)							*	*	*	35	69	*	*	*	*	*	*	*
Meader Width ratio							*	*	*	2.7	5.7	*	*	*	*	*	*	*
Profile																		
Riffle length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Riffle slope (ft/ft)							*	*	*	0.007	0.011	*	*	*	*	*	*	*
Pool length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Pool spacing (ft)							*	*	*	*	*	*	54	108	*	*	*	*
Substrate																		
d50 (mm)							*	*	1	0.28	0.5	0.4	*	*	*	*	*	*
d84 (mm)							*	*	20	2.5	10	3.5	*	*	*	*	*	*
Additional Reach Parameters																		
Valley Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Channel Length (ft)							*	*	2877	*	*	*	*	*	1867	*	*	*
Sinuosity							*	*	1.09	1.3	2.4	*	*	*	1.1	*	*	*
Water Surface Slope (ft/ft)							*	*	0.003	*	*	*	*	*	0.003	*	*	*
BF slope (ft/ft)							*	*	*	*	*	*	*	*	0.003	*	*	*
Rosgen Classification							*	*	E5/C5	E5	E5	E5	*	*	E5	*	*	*
*Habitate Index							*	*	*	*	*	*	*	*	*	*	*	*
*Macorbenthos							*	*	*	*	*	*	*	*	*	*	*	*

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

Table VII (cont.). Baseline Morphology and Hydraulic Summary
Gillespie Golf Course Stream Restoration/Project No. 144
Reach GR2 (250 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)							*	*	*	*	*	*	*	*	*	7.2	7.2	7.2
Floodprone Width (ft)																		
BF Coss Sectional Area (ft^2)							*	*	*	*	*	*	*	*	*	4.6	4.6	4.6
BF Mean Depth (ft)							*	*	*	*	*	*	*	*	*	0.6	0.6	0.6
BF Max Depth (ft)							*	*	*	*	*	*	*	*	*	0.8	0.8	0.8
Width/Depth Ratio							*	*	*	*	*	*	*	*	*	11.2	11.2	11.2
Entrenchement Ratio							*	*	*	*	*	*	*	*	*	3.1	3.1	3.1
Bank Height Ratio																		
Wetted Perimeter (ft)							*	*	*	*	*	*	*	*	*	8.4	8.4	8.4
Hydraulic radius (ft)							*	*	*	*	*	*	*	*	*	0.55	0.55	0.55
Pattern																		
Channel Beltwidth (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Radius of Curvature (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Meander Wavelength (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Meader Width ratio							*	*	*	*	*	*	*	*	*	*	*	*
Profile																		
Riffle length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Riffle slope (ft/ft)							*	*	*	*	*	*	*	*	*	*	*	*
Pool length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Pool spacing (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Substrate																		
d50 (mm)							*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)							*	*	*	*	*	*	*	*	*	*	*	*
Additional Reach Parameters																		
Valley Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Channel Length (ft)							*	*	*	*	*	*	*	*	*	*	*	*
Sinuosity							*	*	*	*	*	*	*	*	*	*	*	*
Water Surface Slope (ft/ft)							*	*	*	*	*	*	*	*	*	*	*	*
BF slope (ft/ft)							*	*	*	*	*	*	*	*	*	*	*	*
Rosgen Classification							*	*	*	*	*	*	*	*	*	E5b	E5b	E5b
*Habitate Index							*	*	*	*	*	*	*	*	*	*	*	*
*Macorbenthos							*	*	*	*	*	*	*	*	*	*	*	*

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

Table VIII. Morphology and Hydraulic Monitoring Summary
Gillespie Golf Course Stream Mitigation Site/Project No. 144
Reach GR1 CS 1-5 (2,634 feet)
Tributary CS 6 (250 feet)

Parameter	Cross Section 1 2+09 Pool						Cross Section 2 5+86 Riffle						Cross Section 3 7+31 Riffle						Cross Section 4 9+65 Pool						Cross Section 5 12+76 Riffle						Cross Section 6 Trib 2 Riffle					
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)	24.9	25.4	25.9	34.3	33.6	26.3	26.7	26.3	24.2	25.9	24.7	24.0	24	26.8	36.9	26.1	25.8	26.5	28.5	30.1	29.8	26.1	24.3	25.6	26.3	27.1	25	25.2	22.6	26.5	7.2	7.4	7.3	6.9	8.4	6.5
Floodprone Width (ft)	235	235	235	**	**	**	56	66	>60	>90	65	60	52	63	>90	>80	80	75	262	262	262	**	**	**	115	115	>185	>185	>185	>184	22	22	18.2	22	22	16.9
BF Cross Sectional Area (ft^2)	85.5	91	87.3	87.5	95.8	88.9	52.3	61.4	46.3	45.7	46.8	45.4	51.9	79.6	87.1	58.7	61.4	56.6	82.6	79.7	99	84.2	73.2	80.7	49.9	51.6	55	58.8	66	59.5	4.6	2.8	3.3	3.4	4.8	2.4
BF Mean Depth (ft)	3.4	3.6	3.4	2.6	2.8	3.4	2	2.3	1.9	1.8	1.9	1.9	2.2	3	2.4	2.2	2.4	2.1	2.9	2.7	3.3	3.2	3.0	3.2	1.9	1.9	2.2	2.3	2.9	2.2	0.6	0.4	0.5	0.5	0.5	0.4
BF Max Depth (ft)	5.7	5.3	5.2	5.2	5.7	5.4	3.1	3.8	3.4	3.4	3.7	3.7	3.4	4.6	4.3	4.2	4.3	3.7	4.4	4	5.4	4.8	4.3	4.8	2.9	3.1	5.1	5.4	5.7	5.5	1	0.8	0.9	1	0.9	0.8
Width/Depth Ratio	7.3	7.1	7.6	13.4	11.8	7.8	13.6	11.3	12.7	14.6	13	12.7	11.1	9.0	15.6	11.6	10.9	12.5	9.8	11.3	9	8.1	8.1	8.1	13.9	14.2	11.4	10.8	7.7	11.8	12	18.5	14.6	14.3	17.7	17.4
Entrenchment Ratio	9.4	9.2	9.1	**	**	**	2.1	2.5	>2.5	>2.5	2.6	2.5	2.2	2.4	>2.4	3.1	3.1	2.8	9.2	8.7	8.8	**	**	**	4.4	4.2	>7.4	7.3	8.2	6.9	3.1	3	2.5	3.2	2.6	2.6
Wetted Perimenter (ft)	31.7	36	32.6	38	37	31.6	30.7	30.9	28.1	27.1	27.9	25.8	28.4	32.8	41.6	28.1	28.2	28.1	34.3	35.5	36.5	28.7	27.0	28.3	30.1	30.9	29.4	28.8	26.4	31.9	8.4	8.2	8.19	7.4	8.7	6.7
Hydraulic radius (ft)	2.7	2.53	2.67	2.3	2.6	2.8	1.7	1.99	1.91	1.7	1.7	1.8	1.83	2.43	2.09	2.1	2.2	2	2.41	2.25	2.72	2.9	2.7	2.9	1.66	1.67	1.87	2.0	2.5	1.9	0.55	0.34	0.41	0.5	0.5	0.4
Substrate																																				
d50 (mn)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mn)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	MY-01 (2005)			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)	*	*	*	*	*	*	8	34	25	4	40	30	8	21	14
Radius of Curvature (ft)	*	*	*	*	*	*	2	17	8	5	41	13	3	32	16
Meander Wavelength (ft)	*	*	*	*	*	*	8	45	30	5	49	35	53	139	81
Meander Width ratio	*	*	*	*	*	*	0.33	1.41	1.04	0.8	1.23	1.17	0.08	0.19	0.13
Profile															
Riffle length (ft)	*	*	*	5.0	79.0	24.0	15.0	65.0	37.0	2.0	106.0	36.0	7.4	90.7	39.0
Riffle slope (ft/ft)	*	*	*	0.000	0.066	0.003	0.000	0.041	0.023	0.000	0.038	0.010	0.002	0.022	0.010
Pool length (ft)	*	*	*	19.4	98.5	33.8	36.2	146.1	74.1	16.9	140.9	51.5	16.0	158.0	63.4
Pool spacing (ft)	*	*	*	19.4	292.7	100.2	38.7	203.5	107.4	24.0	222.6	107.6	28.8	223.9	82.9
Additional Reach Parameters															
Valley Length (ft0	2648			2648			2648			2648			2648		
Channel Length (ft)	2642			2642			2642			2642			2642		
Sinuosity	0.99			0.99			0.99			0.99			0.99		
Water Surface Slope (ft/ft)	0.00267			0.00296			0.00275			0.0027			0.0029		
BF Slope (ft/ft)	NA			0.002835			0.0029			0.003			0.0028		
Rosgen Classification	E/C			E/C			E/C			E/C			E/C		
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

C. Wetland Assessment

There is no wetland restoration associated with this site.

IV. METHODOLOGY SECTION

No deviations from the established procedures were performed in collecting data for this report.

RECOMMENDATIONS

It is recommended that an invasive species control plan be developed and implemented, the target tree and shrub species replanted, and vegetation monitoring continue in 2009. No stream channel repairs are recommended.

References:

USACOE (2003) *Stream Mitigation Guidelines*. USACOE, USEPA, NCWRC, NCDENR-DWQ

USACOE (1987) *Corps of Engineers Wetlands Delineation Manual*. Tech report Y-87-1. AD/A176.

Radford, A.E., H.E. Ahles and F.R. Bell. 1968. *Manual of the Vascular Flora of the Carolinas.* The University of North Carolina Press, Chapel Hill, North Carolina.

Rosgen, D.L. (1996) *Applied River Morphology*. Wildland Hydrology Books, Pagosa Springs, Co.

Click on the Desired Link Below

Appendices