

# **FINAL ANNUAL MONITORING REPORT TERRIBLE CREEK**

**BUFFER RESTORATION  
WAKE COUNTY, NORTH CAROLINA  
(EEP Project Number 134)  
NEUSE RIVER BASIN  
CATALOGING UNIT 03020201  
Monitoring Year 4 of 5 (2011)**



**Prepared for:**



**North Carolina Department of Environment and Natural Resources  
Ecosystem Enhancement Program  
1652 Mail Service Center  
Raleigh, North Carolina 27699-1652  
EEP Project Manager: Jessica Kemp**

**August 2011**

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**Prepared by:**



**Axiom Environmental, Inc.  
218 Snow Avenue  
Raleigh, North Carolina 27603  
(919) 215-1693 (phone)**

**August 2011**

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## 1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

This report describes annual monitoring at the **Terrible Creek Buffer Restoration Site** (Site), which was designed specifically to assist in fulfilling North Carolina Ecosystem Enhancement Program (EEP) restoration goals. The Site is located approximately 1 mile northeast of Willow Spring and 4 miles northeast of Fuquay-Varina, in Wake County. This portion of Wake County is located within Neuse River Basin Cataloging Unit 03020201120010 (Figure 1, Appendix A). This document details annual monitoring results for riparian buffer restoration on the 47.84-acre Site, which resulted in a total of 45.6 acres of riparian buffer restoration. This project was instituted prior to October 11, 2007 and therefore is eligible for riparian buffer restoration credit up to 200 feet from the top of bank of all perennial and intermittent waterways within the Site.

The primary goals of this buffer restoration project focused on reforestation of the floodplain with native species to

- 1) improve water quality;
- 2) enhance flood attenuation;
- 3) reduce sedimentation/siltation;
- 4) increase channel bank stability;
- 5) filter and reduce pollutants prior to entering Terrible Creek;
- 6) serve as a wildlife corridor by providing connectivity to forested areas adjacent to the Site;
- 7) provide increased habitat for aquatic and terrestrial wildlife;
- 8) increase organic matter, carbon export, and woody debris in the stream corridor;
- 9) restore shade to Site open waters; and
- 10) enhance characteristic macroinvertebrate species populations in the channel.

Sixteen vegetation plots (10 meters by 10 meters) were installed within the Site after planting was completed. An average density of 320 stems per acre of Character Tree Species must be surviving after five monitoring years in accordance with North Carolina Division of Water Quality Administrative Code 15A NCAC 02B.0242 (*Neuse River Basin, Mitigation Program for Protection and Maintenance of Existing Riparian Buffers*) (NCDWQ 2007). Based on the number of stems counted, average densities were measured at 435 planted stems per acre surviving in year 4 (2011). When considering tree species only and no shrub species average densities were measured at 390 planted tree stems per acre surviving in year 4 (2011). The dominant species identified at the Site were planted stems of cherrybark oak (*Quercus pagoda*), swamp chestnut oak (*Quercus michauxii*), river birch (*Betula nigra*), and common buttonbush (*Cephalanthus occidentalis*). Woody vegetation immediately adjacent to Terrible Creek and planted willow livestakes have declined drastically throughout the monitoring years; therefore, EEP is contracting to replant approximately 7 acres of riparian buffer and several outer bends of Terrible Creek during the 2011-2012 dormant season.

In summary, the Site achieved success criteria for vegetation in the Fourth Monitoring Year (2011). Approximately 430 linear feet of outerbend within the Site shows some sign of bank sloughing or reduced integrity. However, when compared to preconstruction conditions the issue areas have not worsened and in general, the stream channel as a whole is trending toward more stable conditions. Several small beaver dams located in the northern portion of the Site were removed in August 2009 (Appendix D); the larger dam located just off-site was not removed because it is not located on the State's easement. Beaver dams located within the Site were mapped on January 28, 2011 (Appendix D). These dams are scheduled to be removed in 2011.

Summary information and data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in table and figures within this report's appendices. Narrative background and supporting information formerly found in these reports can be found in the mitigation and restoration plan documents available on EEPs website. All raw data supporting the tables and figures in the appendices is available from EEP upon request.

## **2.0 METHODOLOGY**

Sixteen vegetation plots (10 meters by 10 meters) were installed within the Site after planting was completed as depicted on Figure 2 (Current Conditions Plan View) in Appendix A. These plots were surveyed in June 2010 for the 2010 (year 3) monitoring season using the *CVS-EEP Protocol for Recording Vegetation, Version 4.0 CVS-EEP Protocol for Recording Vegetation, Version 4.0, Levels 1 and 2 Plot Sampling Only* (Lee et al. 2006) (<http://cvs.bio.unc.edu/methods.htm>); results are included in Appendix C. The taxonomic standard for vegetation used for this document was *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas* (Weakley 2007).

## **3.0 REFERENCES**

Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation. Version 4.0. North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Raleigh, North Carolina.

North Carolina Division of Water Quality (NCDWQ). 2007. Redbook, Surface Waters and Wetlands Standards. North Carolina Department of Environment and Natural Resources, Division of Water Quality. Raleigh, North Carolina.

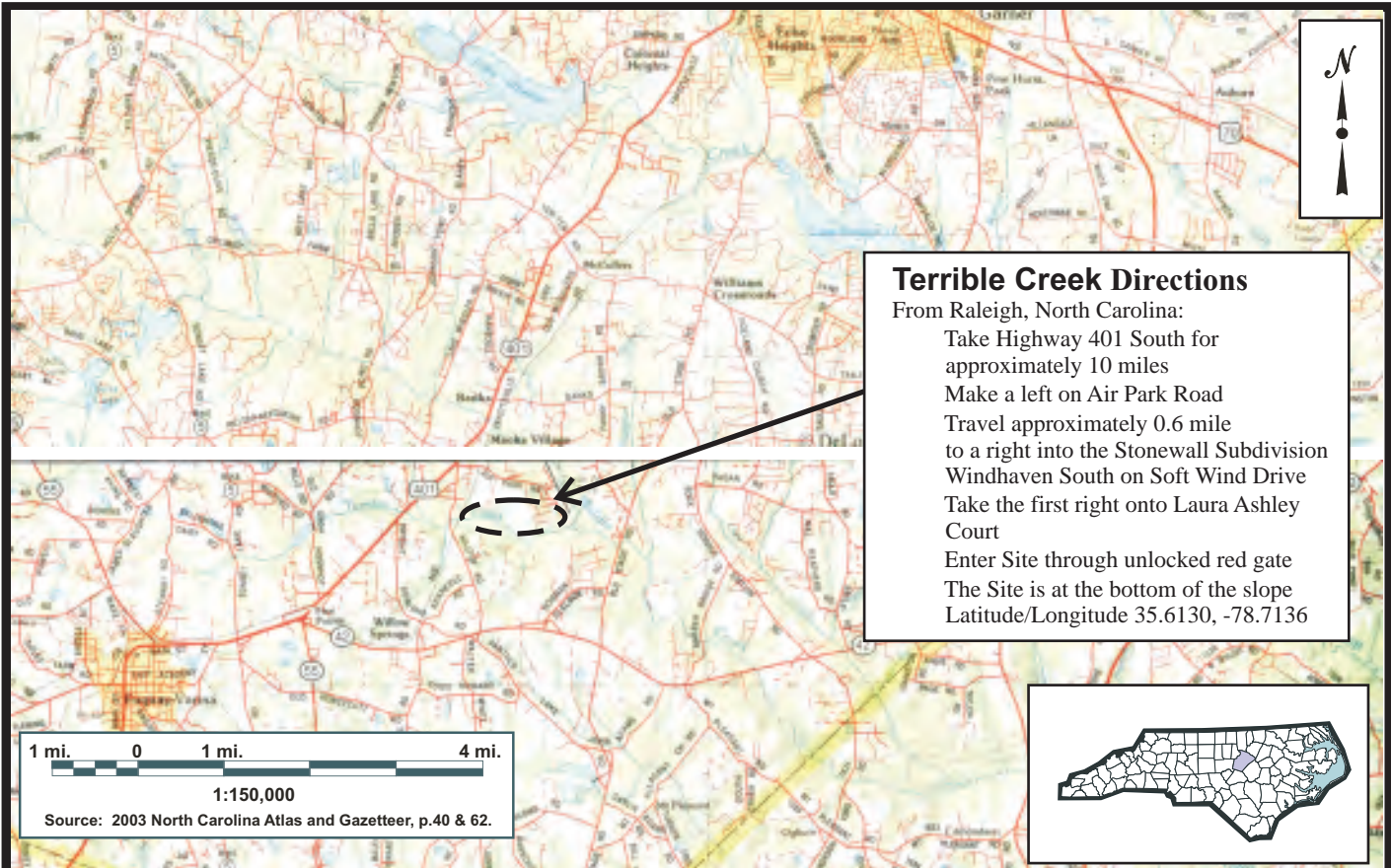
United States Geological Survey (USGS). 1974. Hydrologic Unit Map - 1974. State of North Carolina.

Weakley, Alan S. 2007. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas (online). Available: <http://www.herbarium.unc.edu/WeakleysFlora.pdf> [February 1, 2008]. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina, Chapel Hill, North Carolina.

APPENDIX A  
FIGURES AND PLAN VIEWS

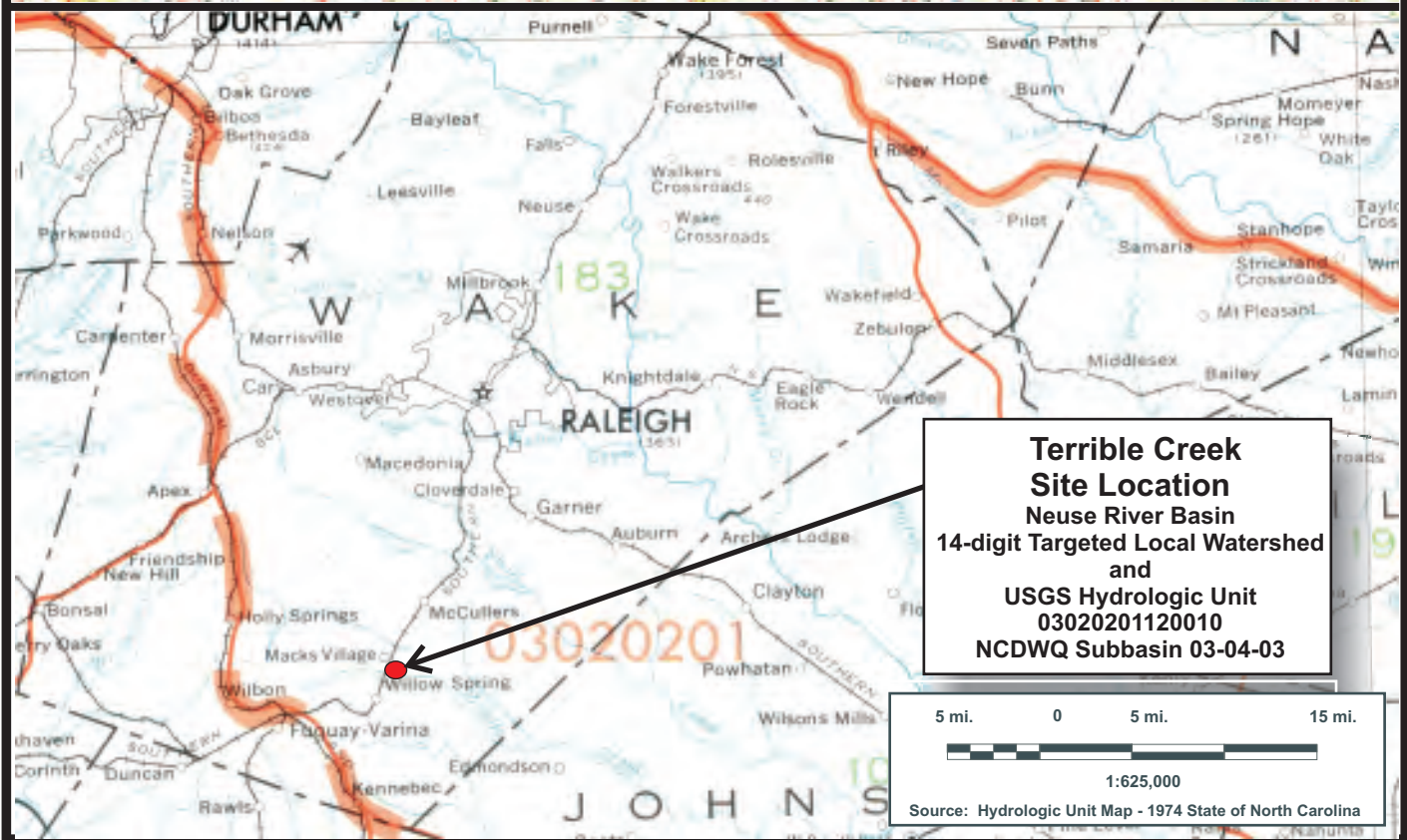
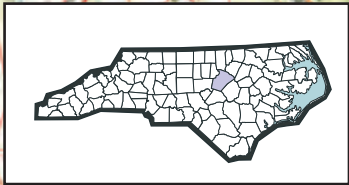
Figure 1. Site Location

Figure 2. Monitoring Plan View



**Terrible Creek Directions**  
 From Raleigh, North Carolina:  
 Take Highway 401 South for approximately 10 miles  
 Make a left on Air Park Road  
 Travel approximately 0.6 mile to a right into the Stonewall Subdivision  
 Windhaven South on Soft Wind Drive  
 Take the first right onto Laura Ashley Court  
 Enter Site through unlocked red gate  
 The Site is at the bottom of the slope  
 Latitude/Longitude 35.6130, -78.7136

1 mi. 0 1 mi. 4 mi.  
 1:150,000  
 Source: 2003 North Carolina Atlas and Gazetteer, p.40 & 62.



**Terrible Creek Site Location**  
 Neuse River Basin  
 14-digit Targeted Local Watershed and  
 USGS Hydrologic Unit  
 0302021120010  
 NCDWQ Subbasin 03-04-03

5 mi. 0 5 mi. 15 mi.  
 1:625,000  
 Source: Hydrologic Unit Map - 1974 State of North Carolina

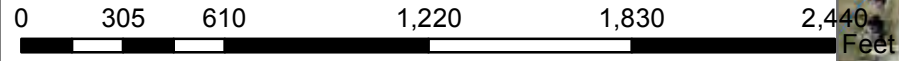


**SITE LOCATION**  
**TERRIBLE CREEK**  
**ANNUAL MONITORING REPORT**  
**Wake County, North Carolina**

Dwn. by: CLF  
 Date: Aug 2010  
 Project: 09-010

FIGURE  
 1

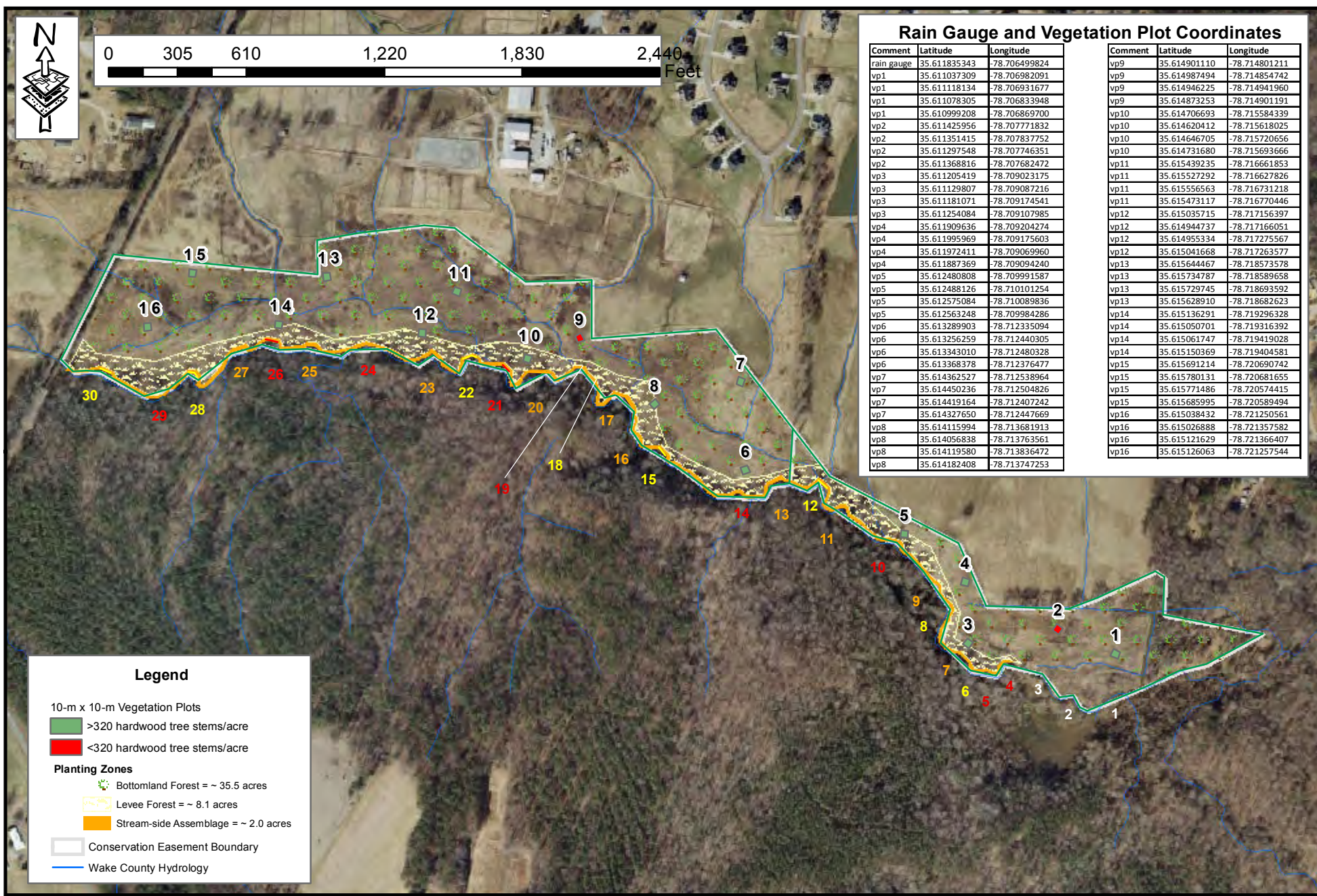




### Rain Gauge and Vegetation Plot Coordinates

Comment	Latitude	Longitude
rain gauge	35.611835343	-78.706499824
vp1	35.611037309	-78.706982091
vp1	35.611118134	-78.706931677
vp1	35.611078305	-78.706833948
vp1	35.610999208	-78.706869700
vp2	35.611425956	-78.707771832
vp2	35.611351415	-78.707837752
vp2	35.611297548	-78.707746351
vp2	35.611368816	-78.707682472
vp3	35.611205419	-78.709023175
vp3	35.611129807	-78.709087216
vp3	35.611181071	-78.709174541
vp3	35.611254084	-78.709107985
vp4	35.611909636	-78.709204274
vp4	35.611995969	-78.709175603
vp4	35.611972411	-78.709069960
vp4	35.611887369	-78.709094240
vp5	35.612480808	-78.709991587
vp5	35.612488126	-78.710101254
vp5	35.612575084	-78.710089836
vp5	35.612563248	-78.709984286
vp6	35.613289903	-78.712335094
vp6	35.613256259	-78.712440305
vp6	35.613343010	-78.712480328
vp6	35.613368378	-78.712376477
vp7	35.614362527	-78.712538964
vp7	35.614450236	-78.712504826
vp7	35.614419164	-78.712407242
vp7	35.614327650	-78.712447669
vp8	35.614115994	-78.713681913
vp8	35.614056838	-78.713763561
vp8	35.614119580	-78.713836472
vp8	35.614182408	-78.713747253

Comment	Latitude	Longitude
vp9	35.614901110	-78.714801211
vp9	35.614987494	-78.714854742
vp9	35.614946225	-78.714941960
vp9	35.614873253	-78.714901191
vp10	35.614706693	-78.715584339
vp10	35.614620412	-78.715618025
vp10	35.614646705	-78.715720656
vp10	35.614731680	-78.715693666
vp11	35.615439235	-78.716661853
vp11	35.615527292	-78.716627826
vp11	35.615556563	-78.716731218
vp11	35.615473117	-78.716770446
vp12	35.615035715	-78.717156397
vp12	35.614944737	-78.717166051
vp12	35.614955334	-78.717275567
vp12	35.615041668	-78.717263577
vp13	35.615644467	-78.718573578
vp13	35.615734787	-78.718589658
vp13	35.615729745	-78.718693592
vp13	35.615628910	-78.718682623
vp14	35.615136291	-78.719296328
vp14	35.615050701	-78.719316392
vp14	35.615061747	-78.719419028
vp14	35.615150369	-78.719404581
vp15	35.615691214	-78.720690742
vp15	35.615780131	-78.720681655
vp15	35.615771486	-78.720574415
vp15	35.615685995	-78.720589494
vp16	35.615038432	-78.721250561
vp16	35.615026888	-78.721357582
vp16	35.615121629	-78.721366407
vp16	35.615126063	-78.721257544



### Legend

10-m x 10-m Vegetation Plots

■ >320 hardwood tree stems/acre

■ <320 hardwood tree stems/acre

#### Planting Zones

■ Bottomland Forest = ~ 35.5 acres

■ Levee Forest = ~ 8.1 acres

■ Stream-side Assemblage = ~ 2.0 acres

Conservation Easement Boundary

— Wake County Hydrology

## CURRENT CONDITIONS PLAN VIEW TERRIBLE CREEK BUFFER RESTORATION SITE Wake County, North Carolina



Axiom Environmental, Inc.  
218 Snow Avenue  
Raleigh, NC 27603  
(919) 215-1693

Dwn. by:  
CLF  
Date:  
July 2011  
Project:  
10-009

FIGURE  
**2**



APPENDIX B  
GENERAL PROJECT TABLES

Table 1. Site Restoration Structures and Objectives

Table 2. Project Activity and Reporting History

Table 3. Project Contacts Table

Table 4. Project Attributes Table

<b>Table 1. Project Restoration Components</b>								
<b>Project Segment or Reach ID</b>	<b>Existing Acreage</b>	<b>Mitigation Type</b>	<b>Approach</b>	<b>Acreage</b>	<b>Mitigation Ratio</b>	<b>Mitigation Units</b>	<b>Stationing</b>	<b>Comment</b>
Riparian Buffer	45.6	Restoration	--	45.6	1	45.6	--	--
<b>Mitigation Unit Summations</b>								
Stream	Riparian Wetland	Nonriparian Wetland	Total Wetland	Buffer		Comment		
0	0	0	0	45.6		--		

<b>Table 2. Project Activity and Reporting History</b>		
<b>Activity or Report</b>	<b>Data Collection Completion</b>	<b>Actual Completion or Delivery</b>
Restoration Plan	---	July 2007
Construction	---	February 2008
Planting/Permanent Seed Mix Applied	---	February 2008
Mitigation Plan/As-built Report (Year 0 Monitoring – baseline)	---	June 2008
Year 1 Monitoring (2008)	September 2008	July 2009
Year 2 Monitoring (2009)	July 2009	August 2009
Conservation Easement Boundary Marked	---	March 2010
Year 3 Monitoring (2010)	July 2010	July 2010
Year 4 Monitoring (2011)	June 2011	July 2011

<b>Table 3. Project Contacts Table</b>	
<b>Designer and Year 1-4 (2008-2011) Monitoring Performers</b>	Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis (919) 215-1693
<b>Construction, Planting, and Seeding Contractor</b>	Backwater Environmental PO Box 1654 Pittsboro, North Carolina 27312 Wes Newell (919) 523-4375

<b>Table 4. Project Background Table</b>	
Project County	Wake County, North Carolina
Drainage Area	13-square miles
Drainage impervious cover estimate (%)	< 10 percent
Stream Order	Terrible Creek-fourth order, UTs-first order
Physiographic Region	Piedmont
Ecoregion	Outer Piedmont
Rosgen Classification of As-built	Not Applicable
Cowardin Classification	Palustrine
Dominant Soil Types	Appling, Augusta, Chewacla, Wehadkee
Reference Site ID	Terrible Creek
USGS HUC for Project and Reference	03020201
NCDWQ Subbasin for Project and Reference	03-04-03
NCDWQ Classification for Project and Reference	C NSW
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	Not Applicable
% of project easement fenced	None

APPENDIX C  
VEGETATION ASSESSMENT DATA  
Table 5. Vegetation Plot Mitigation Success Summary  
Vegetation Monitoring Plot Photos  
CVS Summary Data Tables  
Table 6. Vegetation Metadata Table  
Table 7. Total and Planted Stems by Plot and Species



**Table 5. Vegetation Plot Mitigation Success Summary**

<b>Vegetation Plot ID</b>	<b>Vegetation Survival Threshold Met?</b>	<b>Tract Mean</b>
1	Yes	87.5%
2	No	
3	Yes*	
4	Yes	
5	Yes	
6	Yes	
7	Yes	
8	Yes	
9	No	
10	Yes	
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	

\*This plot exceeds 320 stems/acre when taking into account planted stems as well as a naturally recruited stem of sourwood (*Diospyros virginiana*).

**Terrible Creek Buffer Restoration  
Year 4 (2011) Vegetation Plot Photographs  
Taken June 2011**





**Terrible Creek Buffer Restoration  
Year 4 (2011) Vegetation Plot Photographs (continued)  
Taken June 2011**



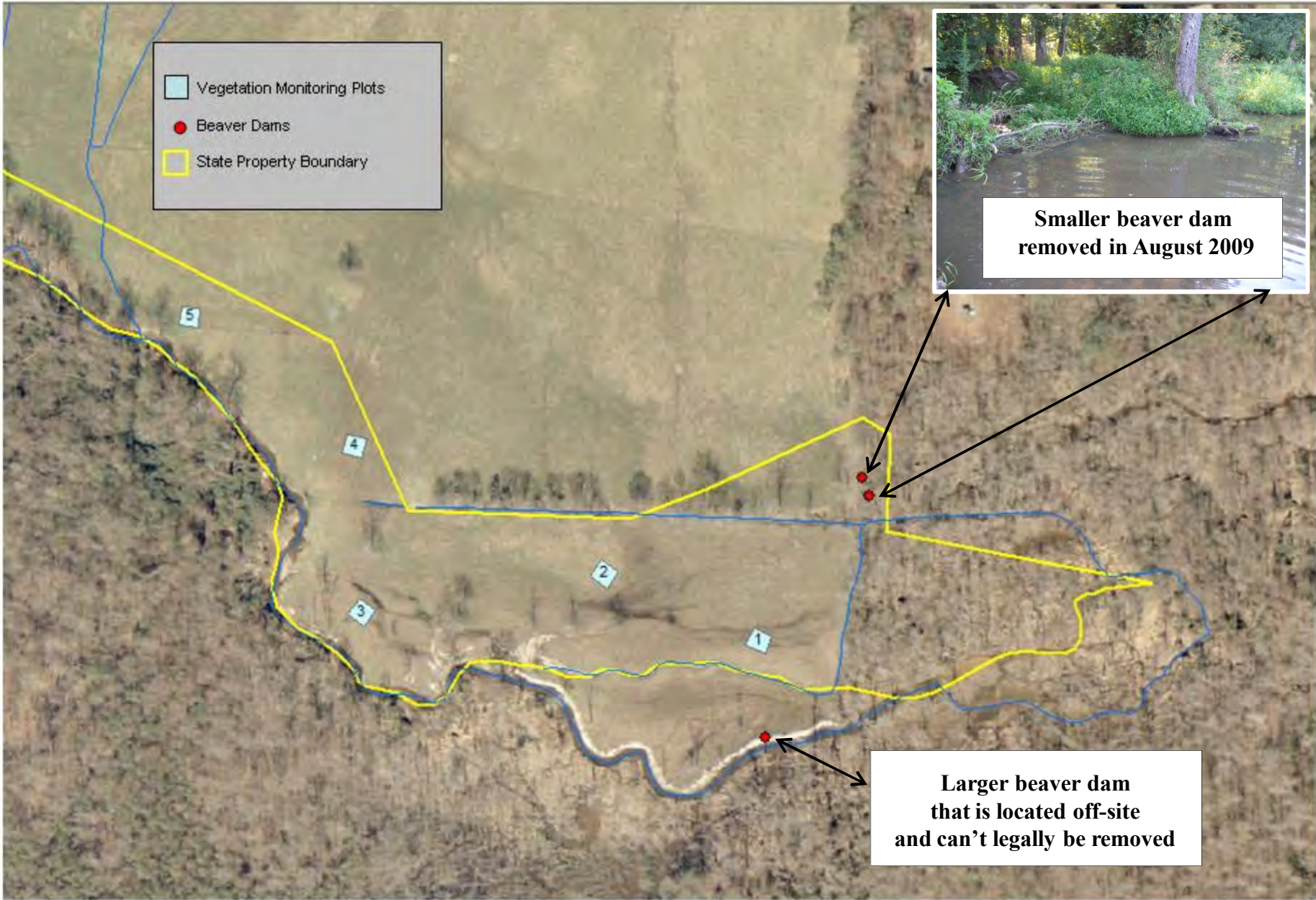
**Table 6. Vegetation Metadata Table**

<b>Report Prepared By</b>	Corri Faquin
<b>Date Prepared</b>	6/14/2011 12:35
<b>database name</b>	Axiom-EEP-2011-B.mdb
<b>database location</b>	C:\Axiom\Business\CVS
<b>computer name</b>	CORRI-PC
<b>file size</b>	29462528
<b>DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----</b>	
<b>Metadata</b>	Description of database file, the report worksheets, and a summary of project(s) and project data.
<b>Proj, planted</b>	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
<b>Proj, total stems</b>	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
<b>Plots</b>	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
<b>Vigor</b>	Frequency distribution of vigor classes for stems for all plots.
<b>Vigor by Spp</b>	Frequency distribution of vigor classes listed by species.
<b>Damage</b>	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
<b>Damage by Spp</b>	Damage values tallied by type for each species.
<b>Damage by Plot</b>	Damage values tallied by type for each plot.
<b>Planted Stems by Plot and Spp</b>	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
<b>PROJECT SUMMARY-----</b>	
<b>Project Code</b>	134
<b>project Name</b>	Terrible Creek Buffer (Fish Property) (G)
<b>Description</b>	Buffer Restoration Site
<b>River Basin</b>	Neuse
<b>length(ft)</b>	
<b>stream-to-edge width (ft)</b>	
<b>area (sq m)</b>	
<b>Required Plots (calculated)</b>	
<b>Sampled Plots</b>	16

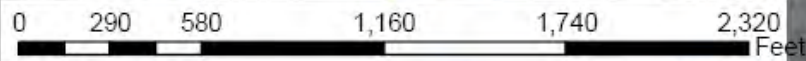




APPENDIX D  
BEAVER MANAGEMENT INFORMATION  
Map of Located and/or Removed Beaver Dams







### Rain Gauge and Vegetation Plot Coordinates

Comment	Latitude	Longitude
rain gauge	35.611835343	-78.706498824
vp1	35.611037309	-78.706982091
vp1	35.611118134	-78.706931677
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vp1	35.610999208	-78.706869700
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vp2	35.611351415	-78.707893752
vp2	35.611297548	-78.707746351
vp2	35.611368816	-78.707682472
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vp3	35.611129807	-78.709067216
vp3	35.611181071	-78.709174541
vp3	35.611254084	-78.709107985
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vp4	35.611995959	-78.709175603
vp4	35.611972411	-78.709069960
vp4	35.611887359	-78.709094240
vp5	35.612480808	-78.709991587
vp5	35.612488178	-78.710101254
vp5	35.612575084	-78.710089836
vp5	35.612563248	-78.709984286
vp6	35.613289903	-78.712335094
vp6	35.613256259	-78.712440305
vp6	35.613343010	-78.712480328
vp6	35.613368378	-78.712376477
vp7	35.614362527	-78.712538964
vp7	35.614450236	-78.712504826
vp7	35.614419164	-78.712407242
vp7	35.614327650	-78.712447669
vp8	35.614115994	-78.712681913
vp8	35.614056838	-78.712763561
vp8	35.614119580	-78.712836472
vp8	35.614182408	-78.712747253

Comment	Latitude	Longitude
vp9	35.614901110	-78.714801211
vp9	35.614987494	-78.714854742
vp9	35.614946225	-78.714941960
vp9	35.614873253	-78.714901191
vp10	35.614705693	-78.715584339
vp10	35.614620412	-78.715618025
vp10	35.614646705	-78.715720556
vp10	35.614731680	-78.715693666
vp11	35.615439235	-78.716661853
vp11	35.615527292	-78.716627826
vp11	35.615555563	-78.716731218
vp11	35.615473117	-78.716770446
vp12	35.615035715	-78.717156397
vp12	35.614944737	-78.717166051
vp12	35.614955334	-78.717275567
vp12	35.615041668	-78.717263577
vp13	35.615644467	-78.718573578
vp13	35.615734787	-78.718589658
vp13	35.615729745	-78.718693592
vp13	35.615628910	-78.718680623
vp14	35.615136291	-78.719296328
vp14	35.615050701	-78.719316392
vp14	35.615061747	-78.719419028
vp14	35.615150369	-78.719404581
vp15	35.615691214	-78.720690742
vp15	35.615780131	-78.720681655
vp15	35.615771486	-78.720574415
vp15	35.615685995	-78.720589494
vp16	35.615038432	-78.721150561
vp16	35.615026588	-78.721135752
vp16	35.615121629	-78.7211366407
vp16	35.615126063	-78.721257544

**Dam observed 1/28/11**

**Legend**

- 10-m x 10-m Vegetation Plots
- Planting Zones**
  - Bottomland Forest ~ 35.6 acres
  - Levee Forest ~ 8.1 acres
  - Stream-side Assemblage ~ 2.0 acres
- Conservation Easement Boundary
- Wake County Hydrology

## CURRENT CONDITIONS PLAN VIEW TERRIBLE CREEK BUFFER RESTORATION SITE Wake County, North Carolina



Drawn by	CLF	FIGURE <b>2</b>
Date:	Aug 2009	
Project:	09-010	