

# **FINAL ANNUAL MONITORING REPORT TERRIBLE CREEK**

**BUFFER RESTORATION  
WAKE COUNTY, NORTH CAROLINA  
(EEP Project Number 134)  
NEUSE RIVER BASIN  
CATALOGING UNIT 03020201  
Monitoring Year 3 of 5 (2010)**



**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**

**January 2011**

# **FINAL ANNUAL MONITORING REPORT TERRIBLE CREEK**

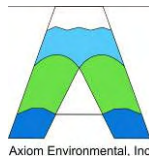
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**Prepared by:**



**Axiom Environmental, Inc.  
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(919) 215-1693 (phone)**

**January 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 367 planted stems per acre surviving in year 3 (2010). When considering tree species only and no shrub species average densities were measured at 326 planted tree stems per acre surviving in year 3 (2010). The dominant species identified at the Site were planted stems of cherrybark oak (*Quercus pagoda*), swamp chestnut oak (*Quercus michauxii*), green ash (*Fraxinus pennsylvanica*), pawpaw (*Asimina triloba*), and common buttonbush (*Cephalanthus occidentalis*). 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 Third Monitoring Year (2010). 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. Beaver dams located near the eastern portion of the Site were mapped in August 2009 (Appendix D). The smaller beaver dams located in the northern portion of the Site were removed; the larger dam located just off-site was not removed because it is not located on the State's easement.

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 EEP's 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.

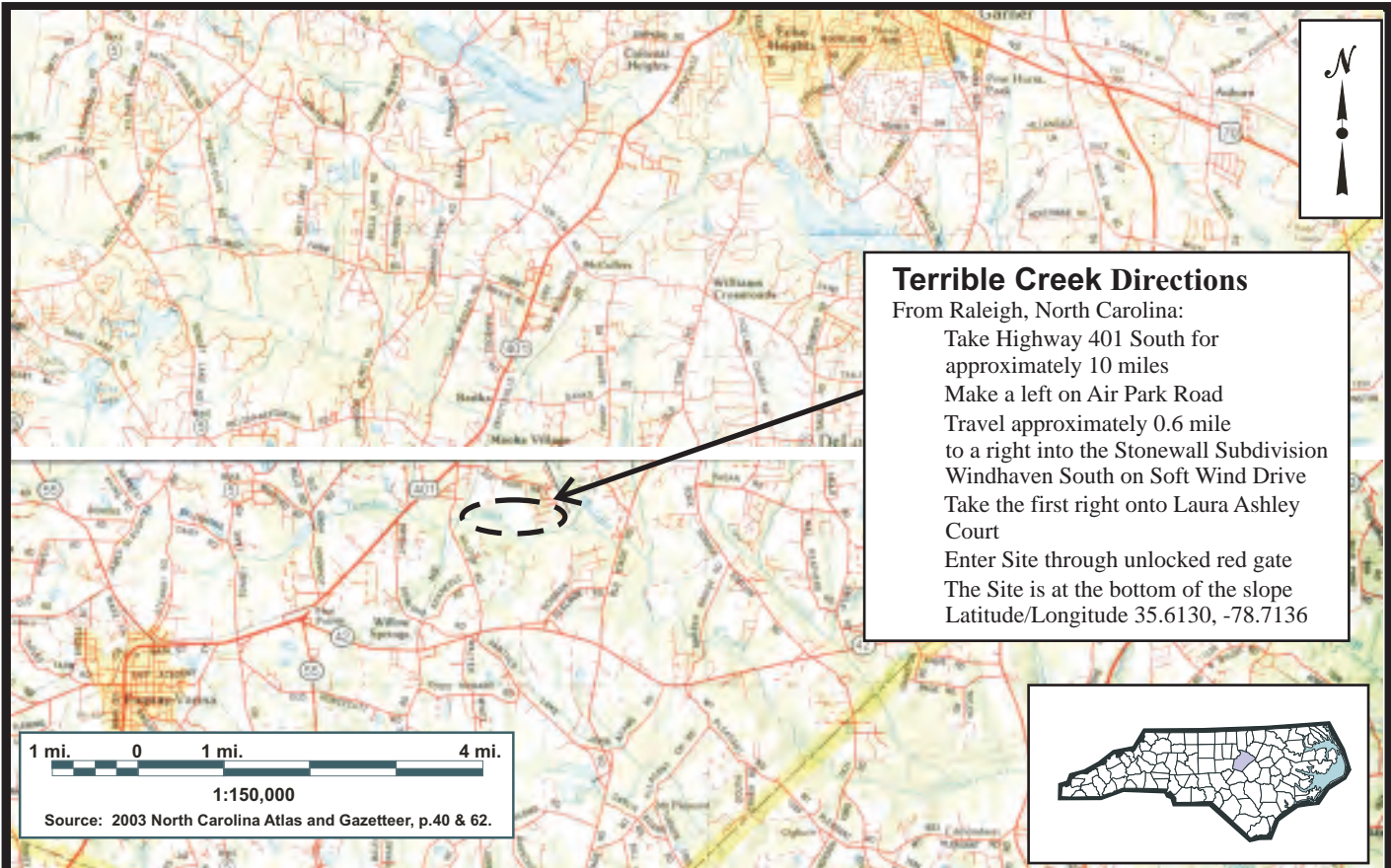
United States Geological Survey (USGS). 1974. *Hydrologic Unit Map - 1974*. State of North Carolina.

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.

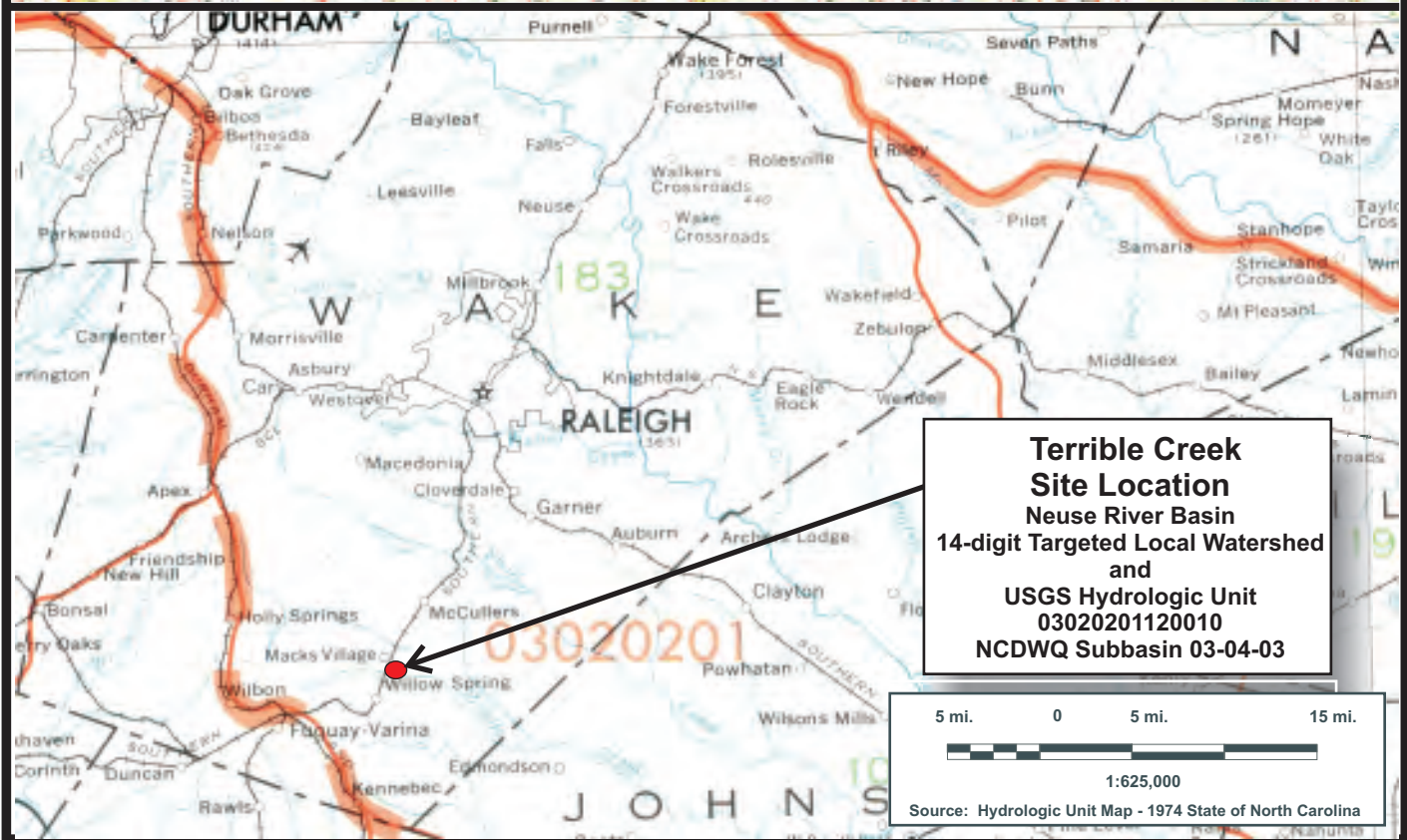
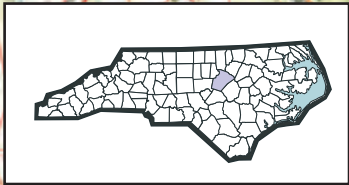
APPENDIX A  
FIGURES AND PLAN VIEWS

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



**Terrible Creek Site Location**  
 Neuse River Basin  
 14-digit Targeted Local Watershed and  
 USGS Hydrologic Unit  
 03020201120010  
 NCDWQ Subbasin 03-04-03

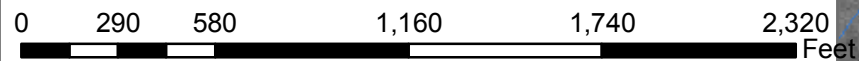


**SITE LOCATION**  
**TERRIBLE CREEK**  
**ANNUAL MONITORING REPORT**  
**Wake County, North Carolina**

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

FIGURE  
**1**





### Rain Gauge and Vegetation Plot Coordinates

Comment	Latitude	Longitude	Comment	Latitude	Longitude
rain gauge	35.611835343	-78.706499824	vp9	35.614901110	-78.714801211
vp1	35.611037309	-78.706982091	vp9	35.614987494	-78.714854742
vp1	35.611118134	-78.706931677	vp9	35.614946225	-78.714941960
vp1	35.611078305	-78.706833948	vp9	35.614873253	-78.714901191
vp1	35.610993208	-78.706869700	vp10	35.614706693	-78.715584339
vp2	35.611425956	-78.707771832	vp10	35.614620412	-78.715618025
vp2	35.611351415	-78.707837752	vp10	35.614646705	-78.715720656
vp2	35.611297548	-78.707746351	vp10	35.614731680	-78.715693666
vp2	35.611368816	-78.707682472	vp11	35.615439235	-78.716661853
vp3	35.611205419	-78.709023175	vp11	35.615527292	-78.716627826
vp3	35.611129807	-78.709087216	vp11	35.615556563	-78.716731218
vp3	35.611181071	-78.709174541	vp11	35.615473117	-78.716770446
vp3	35.611254084	-78.709107985	vp12	35.615035715	-78.717156397
vp4	35.611909636	-78.709204274	vp12	35.614944737	-78.717166051
vp4	35.611995969	-78.709175603	vp12	35.614955334	-78.717275567
vp4	35.611972411	-78.709069960	vp12	35.615041668	-78.717263577
vp4	35.611887369	-78.709094240	vp13	35.615644467	-78.718573578
vp5	35.612480808	-78.709991587	vp13	35.615734787	-78.718589658
vp5	35.612488126	-78.710101254	vp13	35.615729745	-78.718693592
vp5	35.612575084	-78.710089836	vp13	35.615628910	-78.718682623
vp5	35.612563248	-78.709984286	vp14	35.615136291	-78.719296328
vp6	35.613289903	-78.712335094	vp14	35.615050701	-78.719316392
vp6	35.613256259	-78.712440305	vp14	35.615061747	-78.719419028
vp6	35.613343010	-78.712480328	vp14	35.615150369	-78.719404581
vp6	35.613368378	-78.712376477	vp15	35.615691214	-78.720690742
vp7	35.614362527	-78.712538964	vp15	35.615780131	-78.720681655
vp7	35.614450236	-78.712504826	vp15	35.615771486	-78.720574415
vp7	35.614419164	-78.712407242	vp15	35.615685995	-78.720589494
vp7	35.614327650	-78.712447669	vp16	35.615038432	-78.721250561
vp8	35.614115994	-78.713681913	vp16	35.615026888	-78.721357582
vp8	35.614056838	-78.713763561	vp16	35.615121629	-78.721366407
vp8	35.614119580	-78.713836472	vp16	35.615126063	-78.721257544
vp8	35.614182408	-78.713747253			

### Legend

- 10-m x 10-m Vegetation Plots
- 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



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20 Enterprise Street, Suite 7  
Raleigh, NC 27607  
(919) 215-1693

Dwn. by:  
CLF  
Date:  
Aug 2009  
Project:  
09-010

**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

<b>Table 3. Project Contacts Table</b>	
<b>Designer and Year 1-3 (2008-2010) Monitoring Performers</b>	Axiom Environmental, Inc. 20 Enterprise Street, Suite 7 Raleigh, NC 27607 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**

Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean
1	Yes	93.8%
2	Yes*	
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	

\*These plots exceed 320 stems/acre when taking into account planted stems as well as natural recruits such as *Ulmus* sp., *Carya illinoensis*, *Carya ovata*, *Diospyros virginiana*, and *Quercus pagoda*.

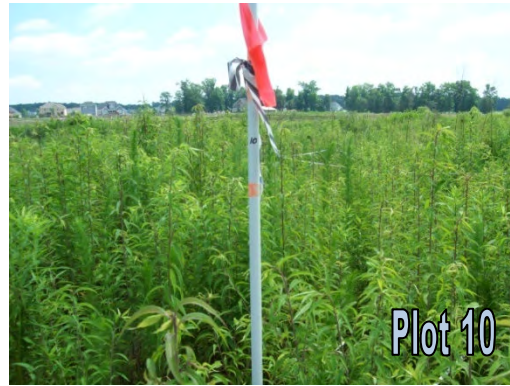


**Terrible Creek Buffer Restoration  
Year 3 (2010) Vegetation Plot Photographs  
Taken June 2010**





**Terrible Creek Buffer Restoration  
Year 3 (2010) Vegetation Plot Photographs (continued)  
Taken June 2010**



**Table 6. Vegetation Metadata Table**

<b>Report Prepared By</b>	Corri Faquin
<b>Date Prepared</b>	7/29/2010 14:13
<b>database name</b>	Axiom-EEP-2010-A.mdb
<b>database location</b>	C:\Axiom\Business\CVS Database\2010
<b>computer name</b>	CORRILAPTOP
<b>file size</b>	35717120
<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

Table 7. Total and Planted Stems by Plot and Species

Species*	CommonName	Type	Current Data (MY3 2010)																																Current Data MY3 (2010)	MY2 (2009)	MY1 (2008)	Asbuilt				
			plot 1		plot 2		plot 3		plot 4		plot 5		plot 6		plot 7		plot 8		plot 9		plot 10		plot 11		plot 12		plot 13		plot 14		plot 15		plot 16									
			Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted					Total stems	Planted stems		
Acer rubrum	red maple	tree	3		5		12		28		94				2								1								3		148		17		1					
Asimina triloba	pawpaw	tree								1	1	1	1	1	1	4	4	4	4	2	2		3	3									16	16	27	17	30	20	46	46		
Baccharis halimifolia	eastern baccharis	shrub			1										4		1					1				2		7		9		25		18								
Betula nigra	river birch	tree											1	1							1	1										2	2	3	2	2	2	2	2			
Carya illinoensis	pecan	tree			1																											1		2		1						
Carya ovata	shagbark hickory	tree				1	1																									1	1	1	1	7	5	7	7			
Celtis laevigata	sugarberry	tree			1	1		1	1													7	7									9	9	11	9	14	13	18	18			
Cephalanthus occidentalis	common buttonbush	shrub	2					4	4						8	8	4	4														18	16	14	10	10	8	4				
Diospyros virginiana	common persimmon	tree				1											1					1	1								3	1	1	1	1	1	1	1				
Fraxinus	ash	tree																																	1		3	3				
Fraxinus pennsylvanica	green ash	tree	3	3			3	2	2		4	4	1	1												1	1	1	1	5	5	6	6	26	23	28	23	23	21	47	47	
Ilex verticillata	common winterberry	shrub																						2								2										
Juglans nigra	black walnut	tree								2	1																2	2				4	3	3	3	1	1	5	5			
Liquidambar styraciflua	sweetgum	tree			6												1		2		1							4		2		16		5		3						
Liriodendron tulipifera	tuliptree	tree																											1			1										
Platanus occidentalis	American sycamore	tree								4	4	3	3														1	1				10	10	9	9	8	8					
Prunus serotina	black cherry	tree																														1		1								
Pyrus calleryana	Callery pear	tree																																	2		1					
Quercus	oak	tree																																		5	2	40	5	134	134	
Quercus michauxii	swamp chestnut oak	tree				1	1	2	2			1	1	3	3	1	1	1	1			4	4	6	4			5	4	5	4	29	25	31	29	30	30					
Quercus pagoda	cherrybark oak	tree	7	7	4	3	1	1	1	1		1	1	1	1	2	1			4	4	1	1	3	2	10	10	4	4	1	1	2	2	42	39	43	41	44	42			
Rhus copallinum	flameleaf sumac	shrub													1																	1										
Sambucus canadensis	common elderberry	shrub					2				1												1				1					5										
Ulmus	elm	tree										1		10		2							1		1							17		5								
Unknown	unknown	tree																																			1	1	6	6		
Plot area (acres)			0.0247		0.0247		0.0247		0.0247		0.0247		0.0247		0.0247		0.0247		0.0247		0.0247		0.0247		0.0247		0.0247		0.0247		0.0247											
Totals	Species Count		4	2	6	2	7	4	6	4	6	4	7	6	4	3	8	4	6	3	6	4	5	4	7	3	4	2	6	4	5	3	8	3	21	11	20	12	18	14	9	8
	Stem Count		15	10	18	4	21	5	38	8	106	10	9	8	15	5	24	14	12	9	12	9	14	13	16	9	14	11	11	8	22	10	30	12	377	145	227	147	220	160	269	265
	Stems per acre		607	405	729	162	850	202	1538	324	4291	405	364	324	607	202	972	567	486	364	486	364	567	526	648	364	567	445	445	324	891	405	1215	486	954	367	574	372	557	405	681	671
Riparian Buffer Success Criteria	Species Count		3	2	5	2	6	4	5	3	5	4	7	6	4	3	5	3	4	2	6	4	5	4	5	3	3	2	4	4	5	3	7	3	16	10	17	11	15	13	7	7
	Stem Count		13	10	17	4	19	5	34	4	105	10	9	8	15	5	11	6	7	5	12	9	14	13	14	9	12	11	8	8	22	10	21	12	326	129	193	137	208	159	259	259
	Stems per acre		526	405	688	162	769	202	1377	162	4251	405	364	324	607	202	445	243	283	202	486	364	567	526	567	364	567	486	445	324	324	891	405	850	486	825	326	488	347	526	402	655

\*Bolded hardwood tree species are counted toward riparian buffer success criteria.

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



