ANNUAL RIPARIAN BUFFER MONITORING REPORT
YEAR 2007 (YEAR 5)

CASEY DAIRY-WALNUT CREEK
RIPARIAN BUFFER RESTORATION SITE
WAYNE COUNTY, NORTH CAROLINA
Contract # AW03011-4

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November 2007

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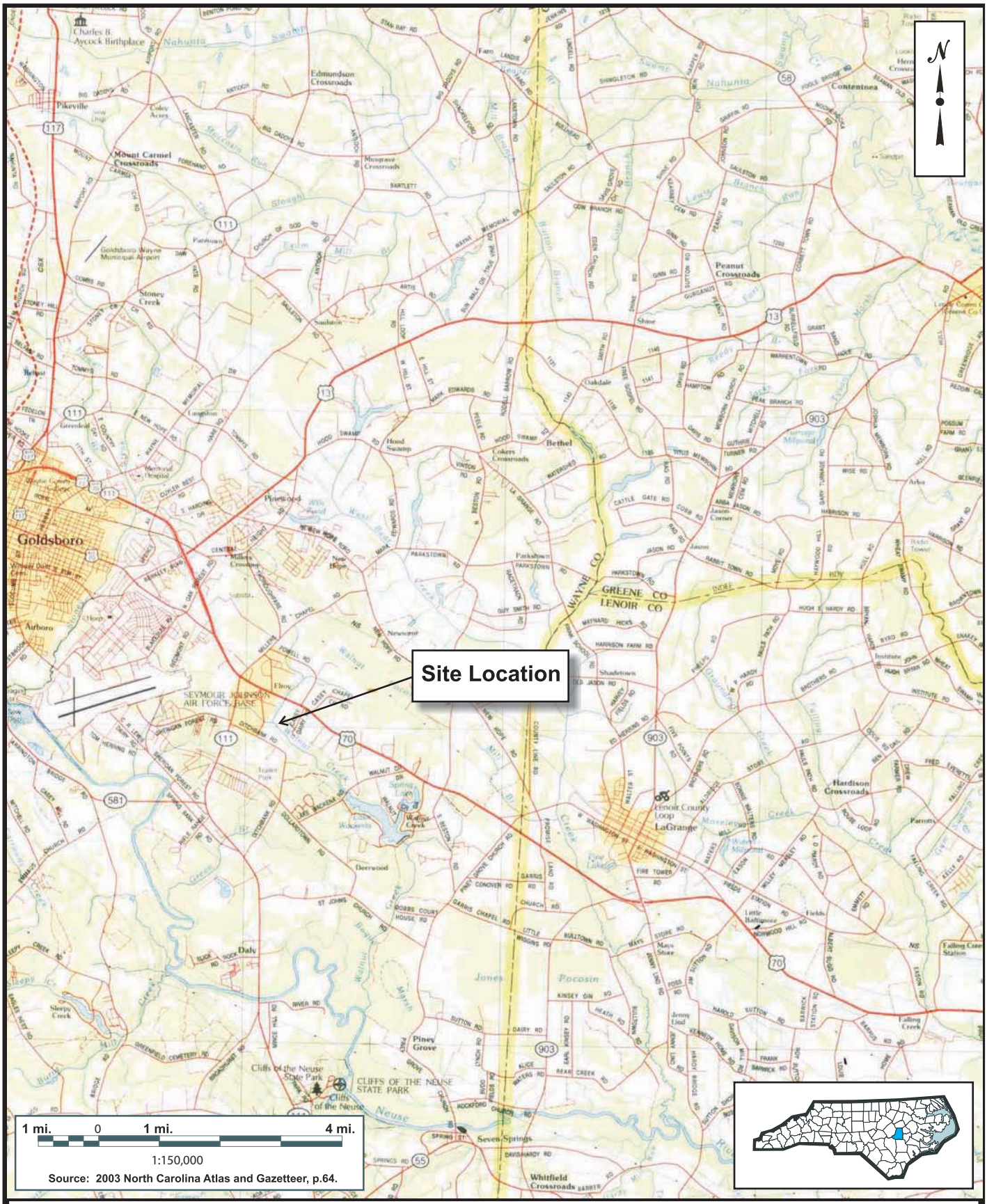
1.0 INTRODUCTION

Restoration Systems and the North Carolina Wetlands Restoration Program established the Casey Dairy-Walnut Creek Riparian Buffer Restoration Site (Site) to provide for wildlife and water quality benefits within the coastal region of the Neuse River basin. The Site comprises a 72-acre cattle farm, pasture, and dairy situated within the floodplain of Walnut Creek, approximately 4 miles upstream of its confluence with the Neuse River (Sheet 1). This riparian buffer restoration is expected to reduce nutrient loads six-fold from the Site to the Neuse River Basin relative to existing conditions. This restoration plan has been developed in accordance with the *Guidelines for Riparian Buffer Restoration* (NCDENR 2001). The plan was implemented in November and December of 2002 and included the following primary components.

(1) Approximately 4,800 feet of cattle exclusion fencing was erected to reduce cattle excrement within surface water runoff and to eliminate stream bank collapse and erosion due to hoof damage.
(2) Pasture surfaces on the floodplain were ripped and disked in two directions to remove soil compaction and to facilitate vegetation establishment and nutrient uptake.
(3) Water control structures (rock cross-vanes) were installed within ditches to passively raise the water table within the rooting zone of planted riparian species.
(4) Cross-vanes have served to reduce flow velocity, promote passive filling of ditches through siltation, and to facilitate vegetation growth within surface water flow pathways throughout the riparian buffer.
(5) Approximately 59,640 trees and shrubs were planted to promote riparian community restoration, nutrient uptake/recycling, and associated water quality benefits.
(6) A perpetual conservation easement was established over the tract to ensure continued protection of the restored riparian buffer.

This report documents the results of the fifth year of monitoring according to the monitoring program as outlined in the restoration plan. Monitoring activities have been performed throughout 2007, including evaluations of surface water flow, erosion potential, and vegetation growth. Results are compared to success criteria. In summary, the Site met success criteria for riparian buffer vegetation establishment in 2007 with an average of 497 character stems per acre.



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SITE LOCATION
CASEY DAIRY - WALNUT CREEK
RIPARIAN BUFFER RESTORATION
WAYNE COUNTY, NORTH CAROLINA

SHEET 1

2.0 MONITORING PROGRAM

2.1 General Description

Primary construction activities were completed in December 2002, including bank stabilization, subsurface ripping, and water table manipulations. Vegetation planting was completed in January 2003; 59,640 seedlings were planted as outlined in Sheet 2. A significant flood event occurred during Hurricane Isabel in September 2003. Three subsequent floods were documented during the fall hurricane season of 2004 and 2006. Constructed fences have not been damaged or breached by cattle or hurricanes during the report period.

Successional (old-field) vegetation growth continued to include heavy recruitment of herbaceous species including smartweeds (*Polygonum* spp.), climbing hempweed (*Mikania scandens*), morning glory (*Ipomoea* spp.), blackberry (*Rubus* spp.), rice cutgrass (*Leersia oryzoides*), dog fennel (*Eupatorium capillifolium*), ragweed (*Ambrosia* spp.), horseweed (*Erigeron canadensis*), goldenrod (*Solidago* spp.), beggar-ticks (*Bidens* sp.), cattail (*Typha* sp.), and soft rush (*Juncus effusus*). The fifth-year growth of herbaceous vegetation occasionally includes dense thickets 5 feet or greater in height overtopping planted seedlings. In areas containing a predominance of smartweeds, climbing hempweed, and/or blackberry, many of the seedlings have been pulled to the ground and are producing secondary shoots.

Natural recruitment also includes intermittent pockets of shrub and tree seedlings dominated by red maple (*Acer rubrum*) and sweetgum (*Liquidambar styraciflua*) and additionally, hickory (*Carya* sp.), loblolly pine (*Pinus taeda*), green ash (*Fraxinus pennsylvanica*), black cherry (*Prunus serotina),* American sycamore (*Platanus occidentalis*), and willow (*Salix* spp.).

Several stems of privet (*Ligustrum sinense*) were recorded. However, this invasive species lacks aggressive tendencies within the organic soils of the Site and does not present any potential to dominate.

In some areas, old-field herbaceous vegetation continued to overtop and flatten the planted seedlings during the growing seasons of 2003, 2004, 2005, 2006, and 2007. Dense successional vegetation averaged 5 feet or greater in height. However, vegetation sampling in dense thickets indicate that planted seedlings continue to exhibit survival rates in excess of 75 percent. Therefore, control of vigorous herbaceous competition is not warranted. In addition, the herbaceous competition continues to reduce beaver consumption of planted trees on the floodplain. Severe stress and mortality of planted seedlings in relatively large numbers was only noted where soft rush (*Juncus effusus*) developed into dense stands. Herbaceous growth rates are expected to decline over the next several years as canopy closure progresses.

Planting Regime

Planting Zone	1 (0-20 feet)	2 (20-50 feet)	3 (50-200 feet)	TOTAL STEMS PLANTED
Planting Association	Stream Bank	Stream-Side	Floodplain	
Planting Area (acres)	11.2	15.3	45.5	72
UNDERSTORY / SHRUBS				
Species Name	# Planted	# Planted	# Planted	# Planted
Buttonbush (Cephalanthus occidentalis)	1600	800		2400
Elderberry (Sambucus canadensis)	1120	370		1490
Swamp Red Bay (Persea palustris)	440	660		1100
Red Chokeberry (Aronia arbutifolia)	460	120		580
Possumhaw Viburnum (Viburnum nudum)	390	350		740
TREES				
River Birch (Betula nigra)	970	1190	2940	5100
American Sycamore (Platanus occidentalis)	340	330	590	1260
Green Ash (Fraxinus pennsylvanica)	240	270	590	1100
Bald Cypress (Taxodium distichum)	1290	1770	5440	8500
Swamp Chestnut Oak (Quercus michauxii)	460	640	1900	3000
Water Tupelo (Nyssa aquatica)	620	1180	3300	5100
Swamp Tupelo (Nyssa biflora)	560	760	2270	3590
Overcup Oak (Quercus lyrata)	670	980	2740	4390
Laurel Oak (Quercus laurifolia)	760	970	3080	4810
Willow Oak (Quercus phellos)	510	630	2070	3210
Cherrybark Oak (Quercus pagoda)	450	620	2030	3100
Tulip Poplar (Liriodendron tulipifera)	440	670	1990	3100
Water Oak (Quercus nigra)	330	520	1550	2400
Water Hickory (Carya aquatica)	240	330	1390	1960
TOTAL	12,290	13,640	33,715	59,640
Average Planting Density	1100	890	740	830
Average Plant Spacing	6 feet x 6 feet	7 feet x 7 feet	7.5 feet x 7.5 feet	7 feet x 7 feet

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Project:

Casey Dairy - Walnut Creek Riparian Buffer Restoration Wayne County North Carolina

Title:

As-Built Planting

SHEET 2

Wildlife species observations were noted throughout the monitoring activities. Diagnostic bird species that use the restored floodplain wetlands include common yellowthroat (*Geothlypis trichas*), sora (*Porzana carolina*), great blue heron (*Ardea herodias*), belted kingfisher (*Ceryle alcyon*), Canada goose (*Branta canadensis*), red-winged blackbird (*Agelaius phoeniceus*), green heron (*Butorides virescens*), wood duck (*Aix sponsa*), and mallard (*Anas platyrhynchos*).

2.2 Vegetation Monitoring Procedure

Quantitative vegetation sampling was performed in October and November of 2007. Permanent, 0.15-acre transect plots were established at the locations depicted on Sheet 3. Each transect measures 600 feet in length and 10.9 feet in width. Ten plots were established, providing a 2 percent quantitative sample.

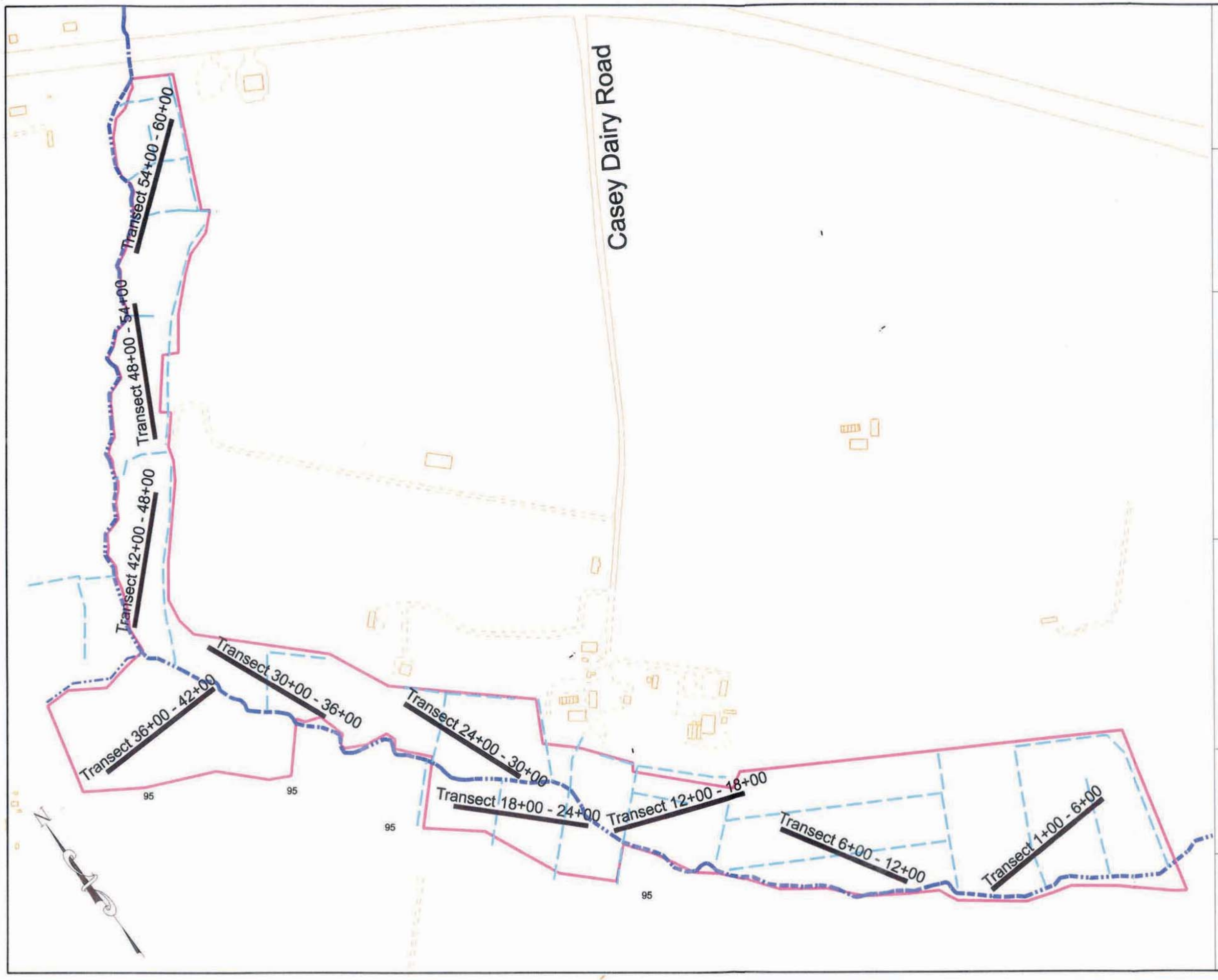
In each plot, tree/shrub species and number of stems were recorded. Species data collected from each plot were combined to calculate an average density of the riparian buffer restoration area based on success criteria.

2.3 Success Criteria

A minimum mean density of 320 character trees/shrubs stems must be surviving for 3 years after initial planting. Subsequently, 290 character stems must be surviving in year 4 and 260 character stems in year 5. With the exception of cypress (*Taxodium distichum*) and tupelo (*Nyssa* spp.), no character species can comprise more than 20 percent of the 260 stem/acre total required for year 5; the excess stems will be discarded from the statistical analyses. Because the Site likely supported extensive cypress-tupelo swamp under historic conditions, cypress and tupelo species may comprise up to 100 percent of the stem per acre requirement. Character species are defined as planted species or native species identified in reference (relatively undisturbed) riparian buffers in the region (Sheet 2 and Table 1). For this monitoring program, character species exclude pine (*Pinus* spp.), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), willow (*Salix* spp.), and exotic elements.

2.4 Sampling Results and Comparison to Success Criteria

Quantitative sampling of vegetation was performed in October and November of 2007. Results of the fall sampling are provided in Table 2. In summary, an average of 497 character stems per acre are surviving after the fifth year of monitoring. These densities are well-above the 260 character stems per acre requirement for success. Planted character species include bald cypress (*Taxodium distichum*, 115 stems per acre), swamp/water tupelo (*Nyssa biflora/aquatica*, 69 stems per acre), river birch (*Betula nigra*, 48 stems per acre), overcup oak (*Quercus lyrata*, 17 stems per acre), cherrybark oak (*Quercus pagoda*, 33 stems per acre), willow oak (*Quercus phellos*, 41 stems per acre), and water oak (*Quercus nigra*, 26 stems per acre). Only two plots (1200-1800 and 1800-2400) were slightly below the required 260 stems/acre. These plots are located in the wettest portion of the site where soft rush and cattail are abundant.



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Monitoring Plan

SHEET 3

Table 1: Inventory of Reference Wetland Tree Species
Walnut Creek-Neuse River Corridor, Wayne-Lenoir Counties

Scientific Name	Common Name	Scientific Name	Common Name
Acer rubrum[1]	Red Maple[1]	*Platanus occidentalis*	American Sycamore
Acer negundo	Box Elder	*Populus heterophylla*	Swamp Cottonwood
Betula nigra	River Birch	*Prunus serotina*	Black Cherry
Carpinus caroliniana	Ironwood	*Quercus alba*	White Oak
Carya aquatica	Water Hickory	*Quercus laurifolia*	Laurel Oak
Carya tomentosa	Mockernut Hickory	*Quercus lyrata*	Overcup Oak
Celtis laevigata	Hackberry	*Quercus michauxii*	Swamp Chestnut Oak
Chamaecyparis thyoides	Atlantic White Cedar	*Quercus nigra*	Water Oak
Cornus spp.	Dogwood	*Quercus pagoda*	Cherrybark Oak
Fagus grandifolia	American Beech	*Quercus phellos*	Willow Oak
Fraxinus caroliniana	Carolina Ash	*Quercus rubra*	Northern Red Oak
Fraxinus pennsylvanica	Green Ash	*Salix caroliniana*[1]	Carolina Willow[1]
Fraxinus profunda	Pumpkin Ash	*Salix nigra*[1]	Black Willow[1]
Gordonia lasianthus	Loblolly Bay	*Symplocus tinctoria*	Horse Sugar
Ilex opaca	American Holly	*Taxodium distichum*	Bald Cypress
Juglans nigra	Black Walnut	*Ulmus alata*	Winged Elm
Juniperus virginiana	Eastern Red Cedar	*Ulmus americana*	American Elm
Liquidambar styraciflua[1]	Sweet Gum[1]	*Ulmus rubra*	Slippery Elm
Liriodendron tulipifera	Tulip Poplar		
Magnolia virginiana	Sweet Bay		
Morus rubra	Red Mulberry		
Nyssa aquatica	Water Tupelo		
Nyssa biflora	Swamp Tupelo		
Nyssa sylvatica	Black Gum		
Oxydendrum arboreum	Sourwood		
Persea palustris	Red Bay		
Pinus serotina	Pond Pine		
Pinus taeda[1]	Loblolly Pine[1]		

1: Loblolly pine, red maple, sweet gum, and willow species have been excluded as character elements.

TABLE 2: Casey Dairy 2006 Vegetation Monitoring Data and Results

Plot Length (ft)	600	No. Plots	10
Plot Width (ft)	10.89	Sample Area (acre)	1.5
Plot Area (sq. ft)	6534	Plot Area (acre)	0.15

	NUMBER OF STEMS/PLOT										Total Stems	Total Stems/ Acre	Total Stems/ Acre to Success Criteria
Plot Number	**5400-6000**	**4800-5400**	**4200-4800**	**3600-4200**	**3000-3600**	**2400-3000**	**1800-2400**	**1200-1800**	**0600-1200**	**000-0600**			
Character Tree Species (Count Towards Success Criteria)													
Betula nigra	1	33	6	2		10	1	4	10	5	72	48	48
Carya sp.					1						1	1	1
Carya illinoinensis			5	1			1	1	3	1	12	8	8
Cephalanthus occidentalis							4	1			5	3	3
Cornus amomum			2					1	1	2	6	4	4
Diospyros virginiana										3	3	2	2
Fraxinus pennsylvanica		1	2		7	14		12	1	6	43	29	29
Ilex opaca										1	1	1	1
Liriodendron tulipifera		6	8			11				3	28	19	19
Myrica cerifera									25	1	26	17	17
Nyssa aquatica	7	10	11		3	8	9	2			50	33	33
Nyssa aquatica/biflora	2		4		17		8	1	18	4	54	36	36
Platanus occidentalis			1		4	4			17	5	31	21	21
Prunus serotina		2	3	4					3	3	15	10	10
Pyrus calleriana								1			1	1	1
Quercus lyrata			2	9	2				13		26	17	17
Quercus michauxii	3	4	10	2			3			2	24	16	16
Quercus nigra	3		6	9		5			10	6	39	26	26
Quercus pagoda	1	8		14	2	8			6	10	49	33	33
Quercus phellos	4	2	8	4	4	2		1	21	15	61	41	41
Quercus sp.							1				1	1	1
Sambucus canadensis		6	14				2	1			23	15	15
Taxodium distichum	24	48	4	14	18	27	6	16	12	4	173	115	115
Ulmus rubra				1	1						2	1	1
Total Stems/Plot	**45**	**120**	**86**	**60**	**59**	**89**	**35**	**41**	**140**	**71**	**746**	**497**	**497**
Total Stems/Acre	**300**	**800**	**573**	**400**	**393**	**593**	**233**	**273**	**933**	**473**			
Total Stems/Acre Counting Toward Success Criteria	**300**	**633**	**520**	**347**	**393**	**520**	**233**	**247**	**673**	**413**			
Don't Count Toward Success Criteria													
Acer rubrum	937	128	133	118	60	23	6	20	290	11	1726	1151	
Baccharis halimifolia	1	9	8		4	14			22	37	95	63	
Ligustrum sinense		1	1	5	2	2	5	2	2		20	13	
Liquidambar styraciflua	171	60	38	13	5	91	2	1	24		405	270	
Pinus taeda									7	3	10	7	
Rhus copallinum										3	3	2	
Juniperus virginiana									2	2	4	3	
Total Stems/Plot	**1109**	**198**	**180**	**136**	**71**	**130**	**13**	**23**	**347**	**56**	**2263**	**1509**	
Total Stems/Acre	**7393**	**1320**	**1200**	**907**	**473**	**867**	**87**	**153**	**2313**	**373**			

*Success criteria requires that each species make up less than 20 percent of the 260 stem/acre total (Exception: bald cypress, water tupelo, and/or swamp tupelo may make up 100 percent of the 260 stem/acre total). Using this criteria, no species can provide more than 52 stems/acre or 7.8 stems/plot towards success criteria.

3.0 CONCLUSIONS AND SUMMARY OF RESULTS FOR YEARS 1 THROUGH 5

In summary, the restoration site achieved success criteria for the fifth monitoring year with an average of 497 character stems per acre surviving. These densities are well-above the 260 character stems per acre requirement for success. In addition, the site is highly successful, having achieved success criteria over the entire 5-year monitoring period. Table 3 summarizes the vegetation data gathered each of the 5 monitoring years.

The cattle exclusion fencing and rock cross-vanes are functioning as intended. No erosion or sediment problems were noted within the Site.

Beaver have not had a significant impact by chewing/uprooting planted seedlings. The heavy herbaceous cover may serve to protect the seedlings from beaver. Several beaver dams have been constructed in downstream reaches of the project. However, long-term inundation has not yet induced extensive mortality of planted seedlings or herbaceous cover. Beaver are present and active within bottomland hardwood and swamp forest ecosystems throughout the Neuse River watershed. Measures to control this species are not necessary. The beaver dams have created excellent habitat for waterfowl and have not resulted in significant mortality of planted seedlings.

In some areas, old-field herbaceous vegetation has overtopped and flattened the planted seedlings during the growing seasons of each monitoring year. Dense successional vegetation averaged 5 feet or greater in height. However, vegetation sampling in dense thickets indicate that planted seedlings continue to exhibit survival rates in excess of 75 percent. Herbaceous growth rates are expected to decline over the next several years as the planted seedlings mature and provide increased shading. Therefore, control of vigorous herbaceous competition is not warranted.

Table 3. Summary of Vegetation Plot Results for Years 1 through 5
Casey Dairy – Walnut Creek Riparian Buffer Restoration Site

Total Stems/Acre Counting Toward Success Criteria				
Year 1 (2003)	Year 2 (2004)	Year 3 (2005)	Year 4 (2006)	Year 5 (2007)
575	**672**	**632**	**552**	**497**

4.0 REFERENCES

North Carolina Department of Environment and Natural Resources (NCDENR). 2001. Guidelines for Riparian Buffer Restoration. North Carolina Department of Environment and Natural Resources, Raleigh, North Carolina.

APPENDIX A
Vegetation Plot Photographs

Casey Dairy Riparian Buffer Restoration Site
Year 5 (2007) Annual Monitoring Report
Vegetation Photographs Taken November 2007

Plot 0000-0600

Plot 0600-1200

Plot 1200-1800

Plot 1800-2400

Plot 2400-3000

Plot 3000-3600

Plot 3600-4200

Plot 4200-4800

Plot 4800-5400

Plot 5400-6000