Moccasin Creek Riparian Buffer Restoration
Johnston County, North Carolina

MITIGATION PLAN

February 2006

August 2006

January 2006

August 2006

Ecosystem Enhancement Program

RJG&A Environmental Consultants
800-407-0889 www.RJGAcarolina.com

GES

Greene Environmental Services, LLC
90 Ham Produce Rd.
Snow Hill, NC 28580

Table of Contents

Tables

Figures

1.0 Introduction

In 2002, the Division of Water Quality's, Ecosystem Enhancement Program (EEP) (formerly the Wetland Restoration Program) collaborated with private environmental firms to restore riparian buffers, streams, and wetlands within the Neuse River drainage basin in an effort to reduce non-point source pollution in its riparian and estuarine systems, particularly nitrate and phosphate. EEP awarded Greene Environmental Services, LLC (GES) of Snow Hill, North Carolina a contract to restore 37.1 acres of riparian buffer along 5,800 feet of an unnamed perennial first order tributary to Contentnea Creek on the Moye Farm in southeastern Greene County (Moye Farm/Contentnea Creek Riparian Buffer Restoration – Phase 1).

Approximately 17,000 bare root, hardwood tree saplings (18 species) were planted during spring 2003. Weeds were controlled throughout the 2003 growing season using chemical and manual methods. Monitoring along permanent transects during December 2003 indicated an overall density of 792 live saplings per acre (GES, 2003). The 2004 sampling indicated 763 stems per acre. EEP staff toured the site on 18 March 2004 to evaluate the project's status and determined that restoration goals were met or exceeded.

On 31 December 2003, the North Carolina Division of Purchase and Services (PS) issued a Request for Proposals (RFP) on behalf of the EEP to provide Riparian Buffer Mitigation in the Neuse River Basin (RFP16-D4009). Up to 150 Buffer Mitigation Units (BMUs) were requested in four Cataloging Units (CUs). Fifty BMUs were requested in the Contentnea Creek Basin (CU 03020203).

Pursuant to the RFP, projects in Hydrologic Units (HUs) within these four CUs identified as Targeted Local Watersheds (TLWs) in EEP's *Neuse River Basin Watershed Restoration Plan* were given priority during proposal evaluation. TLWs demonstrate the need and opportunity for water and riparian resource restoration, enhancement, and preservation. EEP's selection criteria include water quality problems, cumulative wetland and stream impacts, resource values, watershed approach, partnership opportunities, land cover, and local resource professional comments and recommendations (WRP, 2002).

EEP identified ten TLWs in the Contentnea Creek Basin. In July 2004 GES was awarded a contract for riparian buffer restoration in one of them (HU 03020203070050) and in an adjacent HU (03020203050040), also in Cataloging Unit 03020203 (Phase 2).

The Phase 2 project has restored 50 acres of riparian buffer along 14,312 feet of stream (20.87 acres are along 5,825 feet of stream that is contiguous with and upstream of the Phase 1 project, and 29.21 acres are along 8,487 feet of Little Contentnea Creek and its unnamed tributary). The Little Contentnea portion of the project lies on the C.L. Stokes farm in HU 03020203070050, an EEP Targeted Local Watershed (TLW) and EPA 303d listed stream reach. The restoration areas are in USGS Cataloging Unit 03020203, are geographically contiguous, receive nutrient inputs from the same local turkey and on-site hog operations, and are part of neighboring farming operations. Vegetation monitoring during the fall of 2004 indicated a stem density of 474 woody stems per acre.

On 21 October 2004 EEP and PS published another full delivery RFP (16-D05015) for 175 BMUs in the upper Neuse River Basin (CU 03020203). On 17 February 2005 GES submitted a

proposal for 20.2 BMUs. The proposal was accepted by EEP on 27 June 2005. The project, Moccasin Creek Riparian Buffer Restoration, was planted in early February 2006 and has restored 20.2 acres of riparian buffer along approximately 4,550 feet of unnamed tributaries to Moccasin Creek. Pursuant to the RFP, all project acreage qualifies as "restoration" because tree density is below the 100 stems per acre threshold in all tracts.

A conservation easement on the property was transferred to the state of North Carolina on 17 October 2005. It protects the land from development and other specified uses in perpetuity. GES will monitor the restoration area and perform necessary maintenance (including remedial planting, where warranted) for five years to ensure project success. When monitoring has indicated planted stem density of greater than 320 stems per acre after five years, the state of North Carolina will assume maintenance and management responsibilities, in accordance with the terms of the easement.

The Moccasin Creek project's primary goal is to improve water quality in the Moccasin Creek Watershed of the upper Neuse River Basin by reducing agricultural nutrient inputs. Establishing, maintaining, and protecting the buffer will enhance microbial denitrification in shallow surface water and ground water that is currently entering local streams, sequester nutrients (chiefly nitrogen and phosphorous) in woody biomass as the buffer matures, and trap nutrient laden sediments before they enter local streams.

A number of secondary benefits will be realized as the buffer matures. As leaf litter and other organic material in the upper soil profile increases, flood attenuation and storage will become important values. A growing canopy that shades the stream will decrease water temperature and algal blooms, which will increase dissolved oxygen levels. As stream banks stabilize and water quality improves, native terrestrial and aquatic organisms will colonize the restoration area and increase local species richness.

2.0 Summary

2.1 Project Description

The Moccasin Creek project has restored 20.2 acres of riparian buffer along approximately 4,550 feet of unnamed first order tributaries to Moccasin Creek. The project area is in southeastern Johnston County, approximately 2.75 miles south of Princeton along Moccasin Creek's western bank. The unnamed tributary that the buffer surrounds confluences Moccasin Creek immediately to the southeast of the restoration site, approximately 7.5 stream miles north of its confluence with the Neuse River (Figure 1). The entire project lies on the Danny Kornegay Farm in USGS Hydrologic Unit 03020201160010 (Figure 2). Hay fields and cattle pastures adjacent to the buffers receive liquid hog waste from the farm and typically have 65 cow/calf pairs rotating between fields (Figure 3).

2.2 Methods

2.2.1 Site preparation

Because the entire restoration area was used as hay fields and cow pasture for many years, and nearly all of it lies in Moccasin Creek's floodplain with groundwater contact and surface overflow most of the year, little preparation was required. Prior to planting, fences were moved, and debris and undesirable vegetation was removed. Remaining woody debris that would have interfered with planting and maintenance was pushed into windrows adjacent to planting areas. All native woody vegetation was left intact.

Only one very short stream reach (~100 feet) in Tract A has bank slopes that approach 3:1. Mature mixed mesic hardwood forest exists on southwestern bank of this intermittent reach and a row of mature native trees occupies the bank along the northeastern bank. Because buffer restoration was only necessary on one side of this reach and the existing mature vegetation was holding the bank stable, no bank stabilization was necessary. The balance of the buffer restoration project is directly on Moccasin Creek's very flat and stable floodplain. No earth work was therefore necessary anywhere inside the easement boundary.

2.2.2 Implementation

Approximately 9,700 bare root hardwood saplings of 6 species and 2,000 bald cypress saplings were planted in the restoration area during February 2006 (Table 1). The saplings were purchased from Super Tree Seedlings (Blenheim, SC). Rainbow Reforestation, Inc. (New Bern, North Carolina) was contracted to plant the saplings in irregular rows following surface contours and channel alignment during February 2006. Between and within rows, saplings were planted approximately nine feet apart. Density was approximately 580 saplings per acre after planting. This planting density was selected to allow up to 45 percent mortality while meeting the 320 stem per acre targeted density. In addition to the bare root saplings, black willow stakes were planted at the top and on the sides of stream banks in erosion-prone reaches.

Most of the tree species planted are suitable for the range of soil moisture conditions found at the site, but some species (e.g. bald cypress and water tupelo) are best suited for the more hydric soils nearest the stream and in other low-lying areas. Other planted species species (e.g. black gum and yellow poplar) are more successful on the more well-drained soils. Two planting zones were developed based on site-specific hydrologic conditions. The hydric zone includes the areas closest to streams with saturated and low chroma soils at or near the surface. The mesic zone includes areas of drier and higher chroma soils that are further from stream banks and low-lying inundation areas (Figure 3). Because most of the tree species planted are suitable for a range of soil moisture conditions found at the site, 77 percent of the individuals were planted in both zones.

The hydric zone occupies approximately 77 percent of the restoration area (the entire downhill (eastern-most) portion of Tract A (63 percent); north and south of the stream in Tract B (61 percent); all of Tract C, except it's southwestern-most corner (92 percent); and most of Tract D (84 percent), except it's southwestern-most corner, and an upland rise in it's eastern half).

The hydric zone was significantly expanded where soil moisture warranted (Figure 3). Similarly, where a drier soil moisture regime prevailed, species suitable for more well drained conditions were planted in the mesic zone, which extended to the interior buffer boundary in the upper portions of Tract A.

Robert J. Goldstein and Associates, Inc. (Raleigh, North Carolina) is the project's technical consultant. RJG&A was responsible for technical design, planning, and construction oversight. Greene Environmental Services performed all construction and maintenance and managed all real estate transactions and negotiations.

Table 1. Trees Planted in the Moccasin Creek Riparian Buffer Restoration (February 2006)

Species	Common Name	Number Planted	% of Total	Indicator Status*	Soil Drainage Suitability
Fraxinus pennsylvanica	green ash	3,500	30	FACW	mesic, hydric
Nyssa aquatica	water tupelo	500	4	OBL	hydric
Nyssa biflora	swamp black gum	200	2	OBL	hydric
Nyssa sylvatica	black gum	500	4	FAC	mesic
Liriodendron tulipifera var. *tulipifera*	yellow poplar	3,500	30	FAC	mesic
Platanus occidentalis var. *occidentalis*	sycamore	1,500	13	FACW-	mesic, hydric
Taxodium distichum	bald cypress	2,000	17	OBL	hydric
	TOTAL	**11,700**	**100**		

plant names follow Weakley, January 2006

*= *US Fish and Wildlife Service Region 2 List of Plant Species that Occur in Wetlands* (1998)
FAC = Facultative. Equally likely to occur in wetlands or non wetlands (estimated probability 34%-66%)
FACW = Facultative Wetland. Usually occur in wetlands (estimated probability 67%-99%)
OBL = Obligate Wetland. Occur almost always in wetlands under natural conditions (estimated probability >99%)
- = a frequency toward the lower end of the category (less frequently found in wetlands)

3.0 Success Criteria

The project will demonstrate successful buffer restoration by establishing no fewer than 320 live trees per acre of at least three species in the project area after five consecutive years of monitoring. The average number of trees per acre will be calculated using monitoring data for the entire project. This shall be the sole criterion used to evaluate the project's success. After five years' monitoring, and meeting this targeted density, the project will be deemed successful and complete.

While total density is the only criterion that will be used to evaluate ultimate project success from a contractual perspective, other parameters will be considered during the monitoring period to gauge interim progress and identify management needs. In addition to total density, cross-sectional area and height measurements will be recorded during monitoring. These data will allow relative average values for these parameters to be calculated for each species. Average and relative values will be calculated for the entire project and individual 1,000 foot reaches.

4.0 Monitoring

Robert J. Goldstein and Associates, Inc. ((RJGA) (Raleigh, North Carolina)) will conduct monitoring during the latter part of the growing season for five consecutive years, starting in September 2006. Their report will be submitted to EEP on or before 31 December of each year during the project's five year monitoring period (2006 through and including 2010).

The project's monitoring program will follow the new *CVS-EEP Protocol for Recording Vegetation* (levels one and two) (Version 4.0, 2006), not EEP's Exhibits 3 and 4, which were referenced in the Request for Proposals (EEP, 2004), as well as the proposal provided to EEP on 17 February 2005. Based on the Excel table provided with the protocol and data sheets, 17 quadrats (plots), each measuring 100 square meters, were placed in the restoration area. The project was divided into four Tracts, each along approximately 1,000 stream feet. Four quadrats were placed in each tract A, B, and D (12 total). Five quadrats were placed in Tract C.

Pursuant to the *Protocol*, each quadrat was placed to accurately represent a given stand's physical, biological, and hydrologic characteristics. Every effort was made to select sites that were not overly influenced by the heterogeneity of adjacent areas. All sample quadrats measure 100 square meters and are either ten by ten meter squares (15 of 17) or five by 20 meter rectangles (two of 17 (B4 and D4)). Quadrat dimension and orientation were determined at each randomly located point based on species composition, diversity, range of hydroperiod and other locally important factors (e.g., presence of erosion control devices or disturbance) (Figure 3).

The corner of each quadrat was marked in the field using 18 inch long, one-half inch diameter galvanized steel conduit. The conduit was driven into the ground at an approximately 45 degree angle, with approximately four to six inches left exposed above ground, outside the quadrat. This angle of installation will facilitate marking the quadrat boundaries in during the 2006-2010 annual monitoring (i.e. survey tapes can be wrapped around each corner). To facilitate relocation, quadrat corners were also marked with ten foot tall PVC pipe and/or five foot tall fiberglass electric fence posts. Because the entire restoration area is within the privately owned and operated Danny Kornegay Farm (i.e. not viewed or visited by the public) this marking will assist monitoring crews, especially during years three, four, and five, when vegetation density will be extremely high. Upon completion of five years' monitoring, these additional quadrat corner markers will be permanently removed.

Pursuant to the *Protocl*, in each 100 square meter quadrat, each planted woody stem's height (measured from the ground to the tip of longest stem's terminal bud (not leaf)), diameter (at decimeter height (ddh) for individuals that are less than 137 centimeters tall; at ddh and at breast height (DBH (137 centimeters)) for individuals between 137 and 250 centimeters in height; and at DBH for individuals greater than 250 centimeters tall), and x and y coordinates are to be recorded on the Level 1 data form. The 0,0 coordinate (starting point corner) will be located on each quadrat's northeastern-most corner. Also pursuant to the *Protocol*, the source, vigor, and damage of all planted individuals is recorded. For *live stakes* ddh is not recorded. Individuals that naturally colonized plots (i.e. those not planted; e.g., *Pinus tadea*, *Liquidambar styraciflua*, and *Acer rubra*) will be recorded using the *Protocol's Level 2* methodology and data sheets.

Annual monitoring reports will present average and relative density, height, and cross-sectional area by species for the entire project area. Summary data for each sampling unit will also be presented.

5.0 Mitigation

Vegetation within the Moccasin Creek riparian buffer restoration site has been modified by farming and drainage for decades. Remnant tree stands with individuals at least five inches in diameter at breast height exist along narrow strips immediately adjacent to the stream channels in portions of Tracts C and D.

The project's *Request for Proposals* defines areas eligible for riparian buffer restoration as those containing less than 100 trees greater than five inches (12.7 centimeters) diameter at breast height (137 centimeters, 4.5 feet) per acre. Tree density for each tract was calculated on a per acre basis pursuant to the RFP's Buffer Restoration definition.

Tracts A and B have no mature trees inside the restoration area. Remnant woodland occurs along the southwestern bank in the southern portion of Tract C. The 12 trees in Tract C equate to eight trees per acre according the RFP definition and two trees per acre if the entire tract is included. Remnant woodland (mostly hardwood) exists along the Tract D central reach. The 108 trees in Tract D equate to 77 trees per acre according to the RFP definition and 22 trees per acre if the entire tract is included.

Base on the RFP definition, tree density for all tracts combined measured 19 trees per acre. This calculation assumes a 50 foot wide buffer on each side (100 feet total width) that produces a total project area of 6.3 acres. Much wider buffers were appropriate for restoration in all tracts. If density calculations were based on the actual restoration area, the total density for existing, mature, native, woody vegetation would be six trees per acre.

The tree density inside the mitigation area is well below the EEP definition of restoration. The project will therefore be eligible for 1:1 riparian buffer mitigation credit (20.2 credits), upon the completion of five years' monitoring.

6.0 Maintenance and Contingency Plans

Glyphosate herbicide with a concentration of 0.25% will be used to control competing grasses and herbaceous vegetation, as deemed necessary. Backpack sprayers will be used to apply herbicide concentrating in a 3-foot radius around and in between saplings. Existing native vegetation that is stabilizing the stream bank will be avoided. Where competing weed species threaten plantings past mid-summer, when herbicide application becomes less successful, weeds will be controlled using manual and mechanical methods (machetes, small mowers and string trimmers). Naturally colonizing tree species (e.g., *Pinus tadea*, *Liquidambar styraciflua*, and *Acer rubra*) will be removed if they appear to be out-competing planted species that are dominant in a more mature sere. Pursuant to EEP vegetation monitoring protocol, and all past monitoring conducted by RJG&A, native *volunteers* that persist will be noted separately during stem density measurements and in associated monitoring reports.

In areas with significant mortality, as evidenced by monitoring data and qualitative observation, remedial planting will be done. Planting density will be determined on a case-by-case basis, depending on local conditions and needs. Silt fences and other erosion control measures will be inspected at least twice per year and replaced or maintained as needed.

7.0 References

Green Environmental Services, LLC. 2003. First Annual Monitoring Report – 2003 Growing Season. Moye Farm Riparian Buffer Restoration Project – Phase 1.

Green Environmental Services, LLC. 2004. Second Annual Monitoring Report – 2004 Growing Season. Moye Farm Riparian Buffer Restoration Project – Phase 1.

Green Environmental Services, LLC. 2004. First Annual Monitoring Report – 2004 Growing Season. Moye Farm Riparian Buffer Restoration Project – Phase 2.

North Carolina Ecosystem Enhancement Program. 2004. Request for Proposal, Full Delivery Project to Provide Riparian Buffer Mitigation in the Neuse River Basin. RFP 16-D05015.

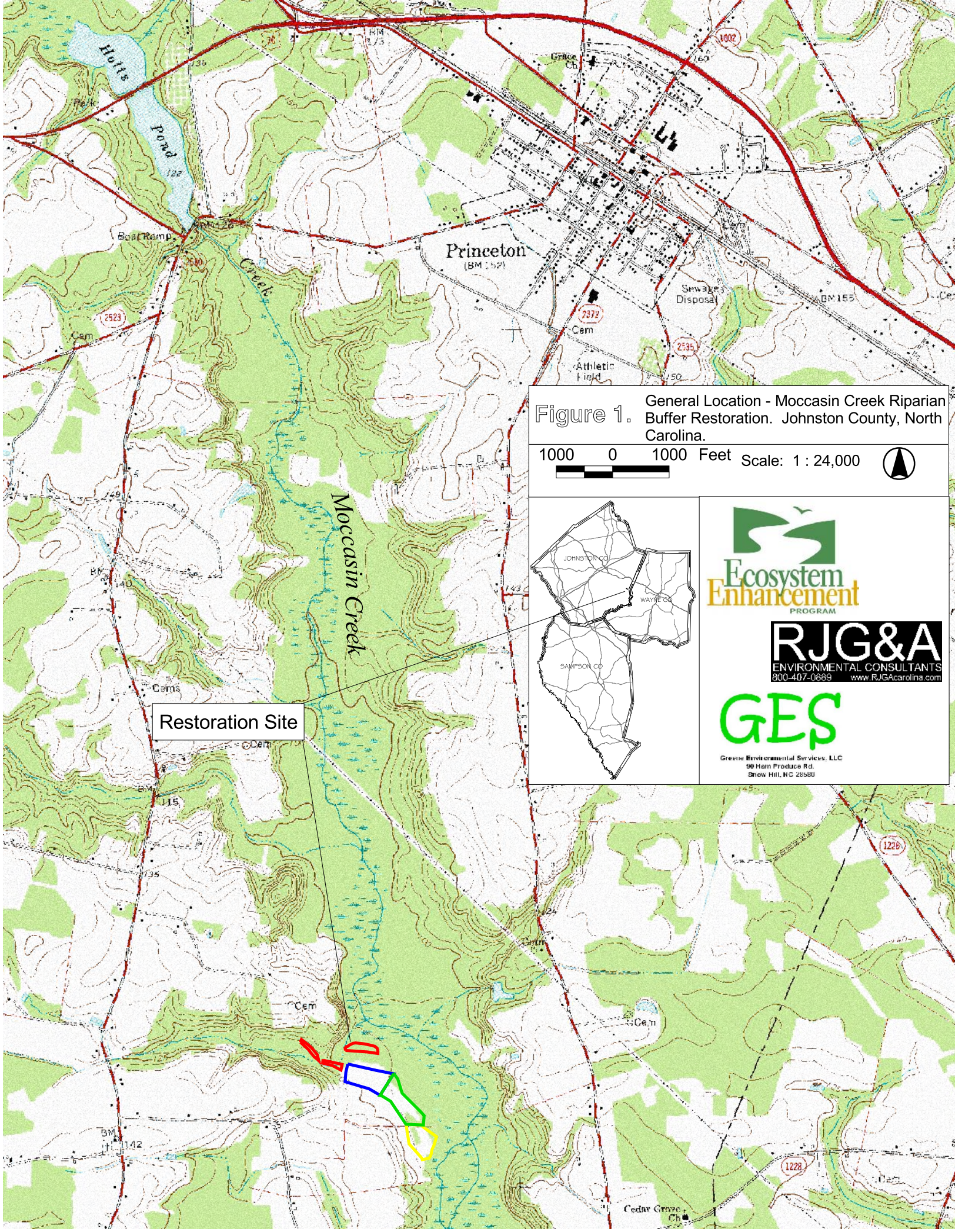

Figure 1. General Location - Moccasin Creek Riparian Buffer Restoration. Johnston County, North Carolina.

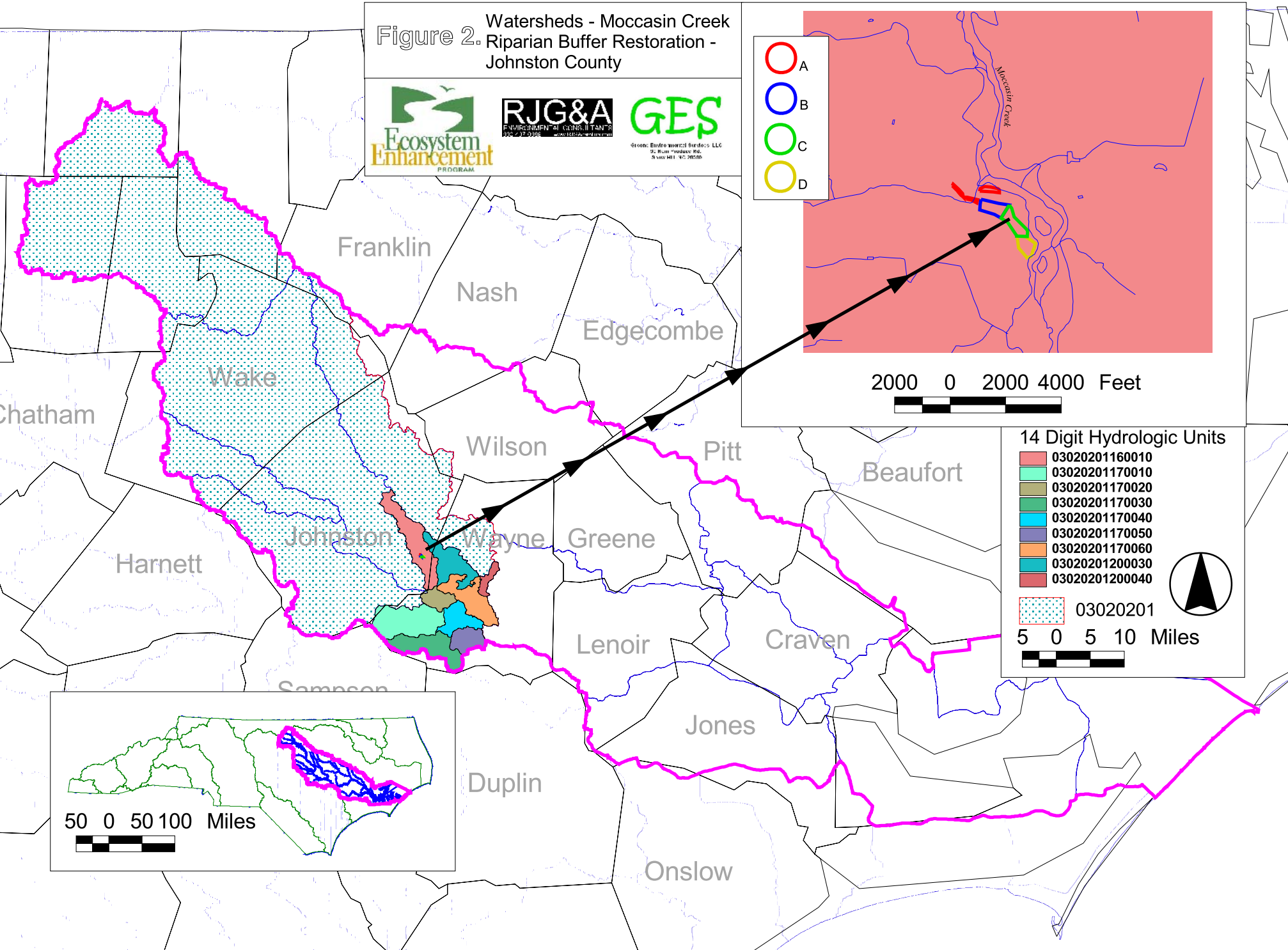
Figure 2. Watersheds - Moccasin Creek Riparian Buffer Restoration - Johnston County
Ecosystem Enhancement Program
RJG&A
GES
A
B
C
D
Moccasin Creek
2000 0 2000 4000 Feet
14 Digit Hydrologic Units
03020201160010
03020201170010
03020201170020
03020201170030
03020201170040
03020201170050
03020201170060
03020201200030
03020201200040
03020201
5 0 5 10 Miles
50 0 50 100 Miles
Franklin
Nash
Edgecombe
Wake
Chatham
Wilson
Pitt
Beaufort
Johnston
Wayne
Greene
Harnett
Lenoir
Craven
Jones
Duplin
Onslow

Figure 3. As Built Drawing - Plan View - Moccasin Creek Riparian Buffer Restoration - Johnston County

Tracts/Planting Zones

A — Hydric / Mesic

B — Hydric / Mesic

C — Hydric / Mesic

D — Hydric / Mesic

Monitoring Quadrats

200 0 200 Feet

Ecosystem Enhancement Program

GES
Greene Environmental Services, LLC
96 Main Firehouse Rd.
Snow Hill, NC 28580

RJG&A
ENVIRONMENTAL CONSULTANTS
800-407-0888 www.RJGAcarolina.com

A3
A4
A2
B4
B3
A1
B1
B2
C2
C1
C5
C3
C4
D2
D4
D1
D3