RESTORATION PLAN

RICH FORK MITIGATION SITE

Davidson County, North Carolina

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Resource Technologies, Inc.

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ENVIRONMENTAL TECHNOLOGIES AND CONSTRUCTION, INC.

EXECUTIVE SUMMARY

The Rich Fork Mitigation Site is located within the Abbotts Creek watershed (USGS Hydrologic Unit 03040103 and NCDWQ sub-basin 03-07-07) and drains approximately 26.1 square miles of the Yadkin River Basin. The watershed is part of the Piedmont physiographic region and it is dominated by forest, agriculture, and urban land uses. The North Carolina Wetlands Restoration Program has identified the study drainage as a component of Priority Hydrologic Unit #3.

The site is located downstream of SR 109 on the western floodplain of Rich Fork; west, southwest of High Point in Davidson County. It comprises approximately 26.1 acres, of which approximately 80% has been cleared, drained, and ditched for agricultural use. The remaining 20% is mature forest occupying the levee position adjacent to Rich Fork.

Historical site conditions were reviewed to understand the chronology of land use at the site and to assist in the development of an appropriate restoration strategy. Aerial photographs of the site were obtained from the Davidson County Soil and Water Conservation District for the years 1936, 1950, 1955, 1966, 1981, and 1988. During the entire period of photographic record, the site was under agricultural production, with plowed fields and drainage ditches evident. Additionally, the streams that transect the site was channelized and straightened prior to 1936.

A detailed soils evaluation was conducted to determine the distribution and extent of soil types on the site, using the Davidson County Soil Survey as a general guide. Although the county soil survey mapped the entire site as Chewacla soil, the field evaluation revealed that four soil designations and their variants occur on the site: 1) Chewacla loam (Fine-loamy, mixed, thermic Fluvaquentic Dystrochrepts); 2) Wehadkee loam (Fine-loamy, mixed, active, nonacid, thermic Fluvaquentic Endoaquepts); 3) Congaree loam (Fine-loamy, mixed, nonacid, thermic Typic Udifluvents), and 4) Udorthents. In general, Chewacla with Wehadkee inclusions account for approximately 45%, Congaree generally occurs in the levee position along Rich Fork and represents 20%, and Udorthents occupy a band adjacent to Rich Fork and the ditched stream channel on site and occupy 35% of the site.

The soil's current/historic status as hydric was evaluated to determine the extent to which wetland restoration can be achieved on the site. Resolution of this issue was achieved through agency directives and conducting detailed field evaluations. Based on these evaluations it was determined that approximately 40% of the site has hydric soils, defined as having redoximorphic features within the top 12 inches of the surface, and 30% of the site had a buried hydric soil profile. The remaining 30% is comprised of non-hydric soils.

Site hydrology was evaluated during field investigations, and using flood frequency and water budget analyses. Hydrology and hydraulics on the site reflect those typically found in Piedmont riparian zones. The primary hydrologic inputs to the site include seasonal groundwater and precipitation. The site is in the two-year floodplain of Rich Fork and becomes inundated under natural conditions by discharges exceeding 1000 ft^3/s. The results of the flood frequency analysis show that this discharge corresponds to a 1.007-year return period flood.

Groundwater monitoring data was collected plotted to determine the hydroperiod (duration of saturation within 12" of the ground surface) for the site and reference wetland. This evaluation indicated that the site's hydroperiod has been significantly altered when compared to that of the reference wetland. The reference wetland, exhibited on average, a groundwater elevation between 0 and 2 inches below the surface for 40 days (17% of the growing season) with relatively constant elevation. The site exhibited average groundwater elevations between 0 and 12 inches below the surface for intervals between 2 days (1% of growing season) and 12 days (4% of growing season) with rapid fluctuations. If the rapid fluctuations (drawdowns) were removed, the site would maintain a groundwater elevation averaging 5 inches below the surface for between 20 days (8% of growing season) and 30 days (12% of growing season).

Both surface water and groundwater are removed from the property via lateral drains and ditches. Two series of ditch networks drain the site. Both networks discharge into Rich Fork at the southern end of the site. They jointly have the capacity to discharge surface and subsurface water at a rate of 32 ft^3/s. These ditches depress groundwater elevations on-site by providing a discharge path, which subsequently lowers the adjacent water table. They also decrease the extent and duration of flooding. Under the current conditions, lateral drains and the ditching of the stream channel have effectively altered the hydrology of the site, decreasing the time of concentration and the amount of water available for soil saturation. The ditching system outlet also provides an artificial break in the natural stream levee and speeds drainage of the site during flood events.

Existing site hydrology was modeled by developing an annual water budget that calculates water inputs and outputs, and the change in storage on a monthly time step. The hydrographs for the average, dry and wet years show a similar pattern of seasonal water table levels. Water table recharge occurs during the late fall and winter months until a rapid water table draw down occurs as PET rates increase in the spring. During the summer, the water budget model shows the existing site is unsaturated within the upper 36 inches of soil. The proposed conditions water budget shows the annual hydrographs for the same three climatic years reflecting dry, average, and wet conditions. Without the estimated groundwater loss from the ditch network, the water table recharges earlier in the fall, maintains a shallower soil depth for a greater duration, and remains within 12 inches of the soil surface for a greater proportion of the growing season.

At present, the site exhibits the effects of hydrologic modifications that prevent the attainment of jurisdictional hydrology, by limiting the number of consecutive days in which saturation occurs within 12” of the grounds surface. However, approximately 70% of the site has indicators of reducing conditions in the upper 12” of the soil profile. Given the extent of human induced alterations to the vegetative communities and hydrology (through draining and ditching), the restoration plan focuses on re-establishing hydrology and vegetation in order to restore the functions and values of a bottomland hardwood community.

The restoration of the site will focus on re-establishing the historic bottomland hardwood communities and associated stream network to re-establish an integrated wetland-stream complex that will restore ecosystem processes, structure, and composition to mitigate for wetland functions and values that have been lost as a result of anthropogenic disturbances in this region of the Yadkin River Basin. Specific goals and objectives for the restoration of the site include: Restoration/enhancement of bottomland hardwood communities, Restoration of floodplain/wetland interfaces, Restoration of stream channels and drainage patterns, Restoration of water quality functions, Restoration of wildlife habitat, Re-establishment of wildlife travel corridors.

Specific actions proposed to achieve the restoration goals and objectives include: Filling of lateral ditches, Recreating microtopography across the site (to enhance surface water retention and storage, to provide the necessary slope for stream restoration and to provide amphibian breeding habitat where possible), Restoration of unnamed tributaries to Rich Fork to re-establish stream/wetland interface, Re-vegetation of the site with Piedmont Bottomland Hardwood and Piedmont Levee Forest species.

The restoration types and extents that will result from executing this project are:

Restoration Type and Extent				
COMMUNITY TYPE	**Restoration**	**Creation**	**Enhancement**	**Preservation**
Piedmont Bottomland Hardwood Forest	17.1 ac.	3.9 ac.	0	0
Low Elevation Seep	0	0	0.31 ac.	0.18 ac.
Piedmont Levee Forest	.62 ac.	0	0	4.1 ac.
Stream	3,386 lf	N/A	0	1,972 lf

RICH FORK MITIGATION PLAN

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1.0 INTRODUCTION

The following section presents background information pertaining to the Rich Fork Mitigation Site, including assessments of both historical and existing site conditions, developed from data gathered during field investigations, desktop review of relevant documents, and landowner interviews conducted between January 2000 and July 2002.

1.1 Site Description The site is located downstream of SR 109 on the western floodplain of Rich Fork; west, southwest of High Point, in Davidson County (Figure 1). The site occupies approximately 26.1 acres. It is composed of two parcels of land, the KCI tract (14.57 acres) and the Parker tract (11.52 acres). Both parcels have been protected in perpetuity though a deed restriction and conservation easement respectively (Appendix A).

Approximately 80% of the site has been cleared, ditched and drained for agricultural use. The remaining 20% is situated on a levee paralleling Rich Fork, occupied primarily by mature forest. The landscape position of the site is characteristic of Piedmont/Mountain Bottomland Forests that are present in undisturbed floodplain areas adjacent and landward of Piedmont/Mountain Levee Forests (Schafale and Weakley 1990). The hydrology of the site has been altered by a network of ditches that drain groundwater and surface water inputs from the agricultural fields and the adjacent uplands into Rich Fork. In addition, the dredge spoils from the channelization of Rich Fork have been utilized to enhance the natural levee and elevate the fields nearest Rich Fork to restrict flooding of the site.

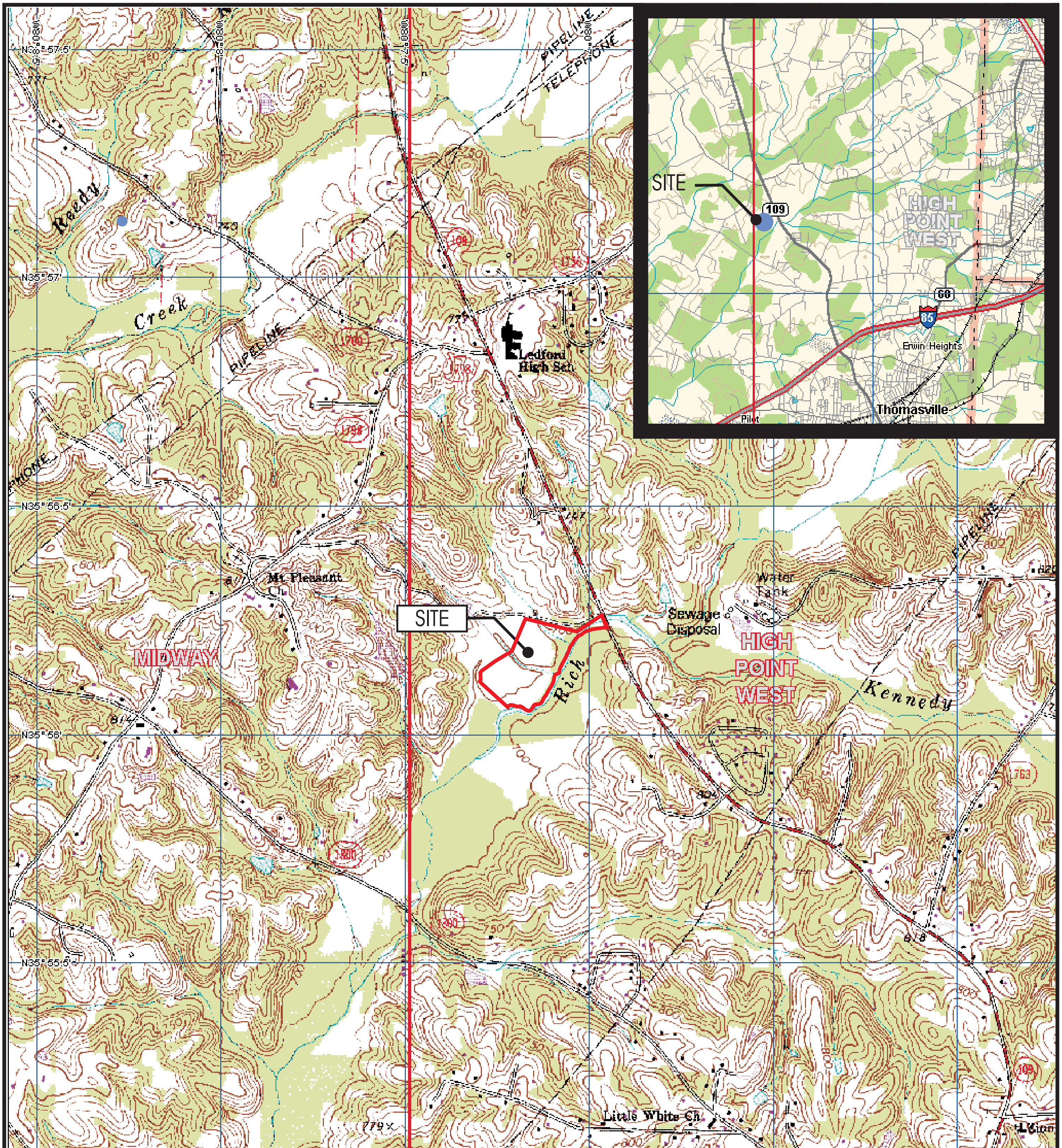
1.2 Watershed Characteristics The site is located in the Abbotts Creek watershed (USGS Hydrologic Unit 03040103 and North Carolina Division of Water Quality (NCDWQ) sub-basin 03-07-07) of the Yadkin River Basin (Figure 2). The North Carolina Wetlands Restoration Program (NCWRP) has identified the study drainage as part of Priority Hydrologic Unit #3.

The topographic relief of the contributing watershed is approximately 120 feet (37 meters) ranging from 700 feet (213 meters) above mean sea level (MSL) in the southeast portion of the drainage to 820 feet (250 meters) above MSL at its northern most point. At its furthest point downstream, the watershed drains approximately 16,724 acres (26.1 mi^2). The watershed is dominated by urban (2,677 ac.), forest (10,157 ac.) and agricultural (3,790 ac.) land uses.

The watershed is situated in the Charlotte and Milton Belts of the Piedmont physiographic region. The site is underlain by metamorphosed granite, with well-foliated megacrystic intrusions, locally containing hornblende. Appropriate geomorphic characterization in the upper watershed is a Valley Type II, according to the Rosgen Classification System.[1] The valley transitions into a Type VIII. A Type II valley is defined as having moderate relief, relatively stable, moderate side slope gradients, and valley floor slopes that are often less than 4%. Common stream types for this valley include the stable "B" stream type, and, occasionally, the gullied "G" stream type. The Type VIII valley is broad, with gentle down-valley elevation relief. It features multiple river terraces formed in alluvial soils. Common stream types for this valley include the stable "C" and "E" stream types, which are slightly entrenched, meandering channels. Type "D", "F", and "G" streams may occur in developed watersheds where channels are manipulated and flow regimes altered.

According to the NCDWQ, the water quality rating for Rich Fork is Class C. Class C waters are protected for aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture. NCDWQ has assigned Rich Fork a water quality use-support rating of "Impaired" in the Draft 2002 § 303(d) list. The City of High Point west of SR 311 accounts for the majority of the non-point source loading into Rich Fork. High turbidity and elevated concentrations of iron, copper, nitrites-nitrates (NO_2-

[1] Rosgen, D. 1996. Applied River Morphology. Printed Media Companies, Minneapolis, Minnesota.



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Rich Fork Mitigation Site

Figure 1: Vicinity Map

Site Location

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Rich Fork Mitigation Site

Figure 2: Site Boundary

RICH FORK

SITE BOUNDARY

North

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$NO_{3)}$ and fecal coliforms have been documented in Rich Fork, indicating problem levels of nonpoint source pollution (NCDWQ 1998). In addition, numerous point source discharges enter the creek from industry, as well as the High Point Westside WWTP (1 mile upstream of site), which discharges 6.2 MGD into Rich Fork. A TMDL limit has been set for Rich Fork at its present level.

1.3 Historical Site Conditions Historical site conditions were reviewed to understand the chronology of land use at the site and to assist in the development of an appropriate restoration strategy. Aerial photographs of the site were obtained from the Davidson County Soil and Water Conservation District for the years 1936, 1950, 1955, 1966, 1981, and 1988. During the entire period of photographic record, the site was under agricultural production, with plowed fields and drainage ditches evident. Additionally, the stream that transects the site was channelized and straightened prior to 1936. The 1936 aerial has been included in Appendix B. Rich Fork itself was channelized in the early 1900's from just below SR 109 to the southern extent of the site.

2.0 EXISTING CONDITIONS

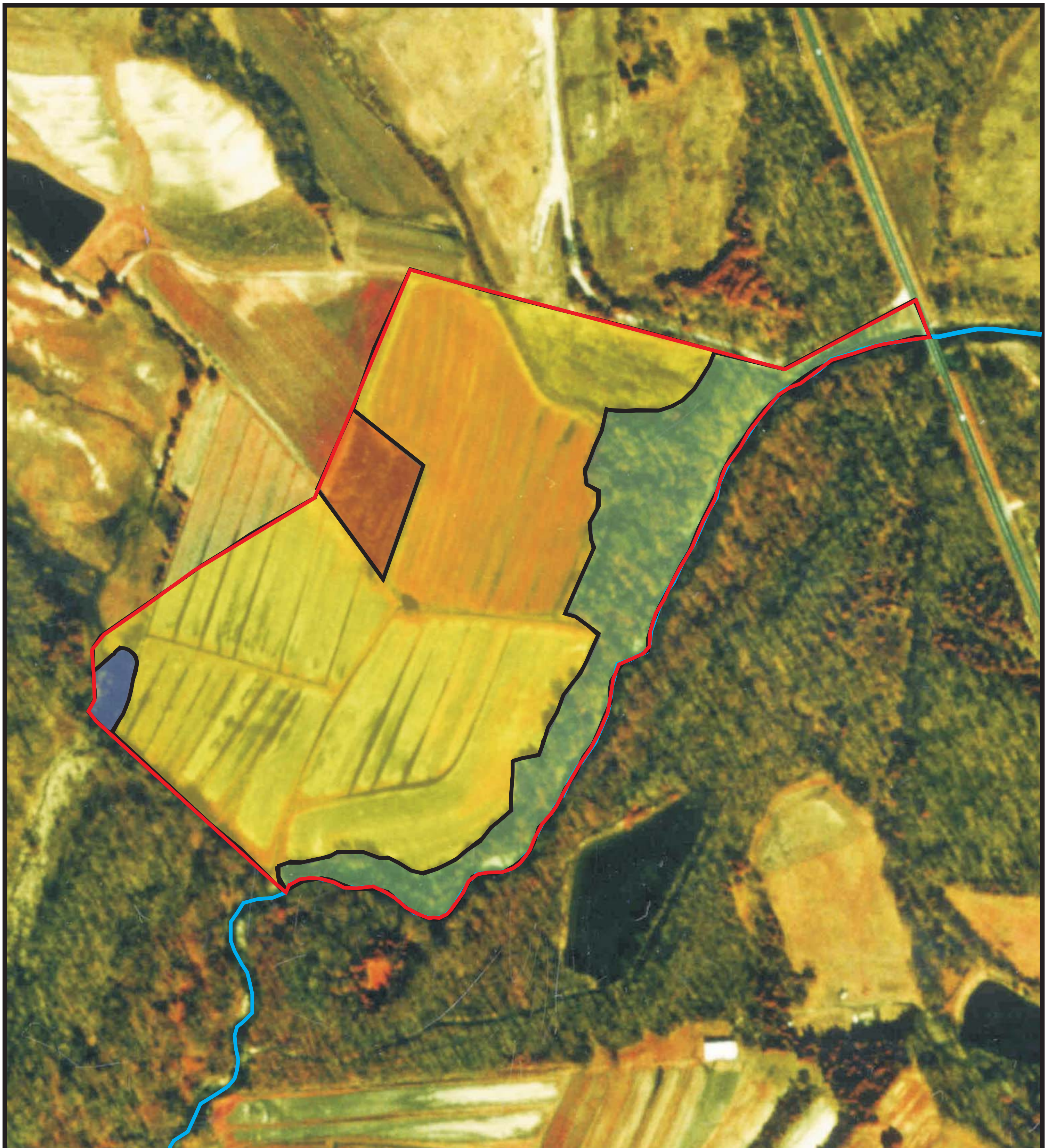
2.1 Ecological Communities Terrestrial and aquatic communities were sampled to document the extent, diversity and functional quality of the remnant ecological communities, to act as a base for the development of the restoration plan for the site.

2.1.1 Terrestrial A field survey was conducted in the summer of 2000 to identify the dominant terrestrial communities on the site. This review documented that the site was predominantly in active agricultural use (row crops and pasture) with only small remnants of Piedmont/Mountain Levee Forest, Piedmont/Mountain Bottomland Forest and Low Elevation Seep remaining on the site (Schafele and Weakley 1990). A schematic of the existing terrestrial communities at the time of the investigation is included (Figure 3).

A Piedmont Levee Forest occupies a band of varying width adjacent to Rich Fork. Woody species of the canopy include *Fraxinus pennsylvanica* (green ash), *Platanus occidentalis* (sycamore), *Betula nigra* (river birch), *Celtis occidentalis* (hackberry), *Asimina triloba* (pawpaw), *Juglans nigra* (black walnut), *Liquidambar styraciflua* (sweet gum), *Acer rubrum* (red maple), and *Quercus falcata* (southern red oak). The midstory includes *Acer negundo* (boxelder) and *Acer rubrum* (red maple). The understory includes vines and herbs such as *Smilax sp.* (greenbriar) and *Toxicodendron radicans* (poison ivy).

A Piedmont Bottomland Forest occupies a small isolated pocket along the western central portion of the site. The area is heavily ditched but supports a young stand (5-10 years) of remnant vegetation that is currently regenerating from past disturbances. Woody species of the canopy include *Fraxinus pennsylvanica* (green ash), *Liquidambar styraciflua* (sweet gum), *Liriodendron tulipifera* (yellow poplar), and *Acer rubrum* (red maple). The understory includes vines and herbs such as *Smilax sp.* (greenbriar) and *Toxicodendron radicans* (poison ivy).

A Low Elevation Seep occupies the western most corner of the site at the edge of the floodplain. This seep has been partially impacted by grazing but maintains sufficient characteristics to meet the community description. Woody species include *Vibernum dentatum* (arrow wood), and *Cephalanthus occidentalis* (button bush). Herbaceous species identified include *Impatiens capensis* (jewel weed) and *Juncas spp.* (rush).



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Rich Fork Mitigation Site

Figure 3: Existing Communities

RICH FORK

AGRICULTURE

PIEDMONT / MOUNTAIN BOTTOMLAND FOREST

PIEDMONT / MOUNTAIN LEVEE FOREST

LOW ELEVATION SEEP

SITE BOUNDARY

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Agriculture occupies the majority of the site with row crops and pasture being the primary utilization. Within the agricultural area, heavy ditching has influenced the composition of the historic natural communities including a perennial and intermittent stream that transect the site. Remaining vegetation consists entirely of herbaceous species commonly found in fallow fields.

Table 1: Summary of Existing Communities	
Community[1]	**Area**
Piedmont/Mountain Levee Forest	7.21 ac
Piedmont/Mountain Bottomland Forest	1 ac
Low Elevation Seep	.05 ac
Agriculture	19.69 ac

[1] follows Schafale and Weakley (1990)

2.1.2 Aquatic Field surveys were conducted in the winter/spring of 2002 to identify the status of the aquatic communities on the site. These surveys were conducted on the perennial and intermittent streams that transect the site. Biological monitoring for benthic macroinvertebrates was conducted in accordance with the requirements set forth by the North Carolina Department of Water Quality (NCDWQ). Monitoring procedures were based on NCDENR's *Internal Technical Guide for Streamwork in North Carolina* (Version 3.0, April 2001) and the *Interim, Internal Technical Guide: Benthic Macroinvertebrate Monitoring Protocols for Compensatory Stream Restoration Projects* (NC Division of Water Quality, 401/Wetlands Unit, May 2001). Sampling was conducted by an NCDENR-certified biologist for collecting benthic macroinvertebrate samples as part of the 401 certification process.

Samples were collected at an upstream (reference), mid stream and downstream site utilizing the methods described by the *Standard Operating Procedures for Benthic Macroinvertebrates* (Biological Assessment Group, Division of Water Quality, NCDENR, April 2001). The collected specimens were submitted to Law Engineering and Environmental Services, Inc. (NCDWQ Biological Certification #038) for identification and classification.

The "Standard Qualitative Method" (Qual-4) technique was performed along two (2) representative riffle and pool sections at each sampling location to determine the Ephemeroptera + Plecoptera + Trichoptera (EPT) Index, a Biotic Index Rating, Taxa Richness and Abundance values. The results of this analysis, data values and Biotic and EPT Index values have been summarized below. Additional data, sampling locations, individual data sheets and photographs have been compiled to provide detailed information of the physical, chemical, and biological parameters evaluated at each sampling location. These are included in Appendix C.

The biological monitoring was performed on February 13, 2002. NCDENR suggests sampling between June and September for restoration projects located in the mountain and piedmont ecoregions. However, sampling was postponed while a prolonged period of less than normal rainfall caused low to no flow conditions. Weather conditions at the time of the fieldwork were sunny and clear, windy, with ambient air temperatures approximately 40-45°F. Stream flow conditions at the time of the investigation were considered to be seasonally normal, with no significant precipitation inputs within the preceding 72 hours. The results of the benthic macroinvertebrate survey are summarized in Table 2

Table 2: Aquatic Community Summary							
Sampling Location	**Habitat Assessment**	**EPT Index**	**Biotic Index**	**Taxa Richness**	**# of Organisms**	**D50**	**D84**
Upstream Site	29	1	6.61	9	24	0.2	1.0
Midstream Site	53	3	6.98	6	54	0.3	2.0
Downstream Site	65	3	6.44	16	124	0.9	2.0

Percentages within Each Functional Feeding Group						
Sampling Location	**Filtering Collectors**	**Collector/ Gatherer**	**Shredders**	**Predators**	**Scrapers**	**Piercer**
Upstream Site	14.29	14.29	14.29	57.13	0	0
Midstream Site	50.00	50.00	0	0	0	0
Downstream Site	0	72.73	9.09	18.18	0	0

From the benthic survey data, it is apparent that the current conditions of the stream play a significant role in determining the population and community structure observed. All three sampling locations ranked fair to poor according to the Biotic Index values. The sites were ranked closely with the downstream site exhibiting a slightly less tolerant benthic community and the midstream site having a slightly more tolerant benthic community. All sites had a relatively low habitat assessment score, as well as low values for taxa richness, organism abundance and EPT Index.

Of the three locations, the downstream site returned the highest values for the habitat assessment score, taxa richness and organism abundance. These results may be due in part to the increased amount of vegetative cover in the riparian area, the greater distance from agricultural disturbance, increased frequency of flooding from and closer proximity to Rich Fork, and a slight change in sediment size distribution

2.2 Soils A detailed soils evaluation was conducted to determine the distribution and extent of soil types on the site, using the Davidson County Soil Survey as a general guide. Although the county soil survey mapped the entire site as Chewacla soil, the field evaluation revealed that four soil designations and their variants occur on the site: 1) Chewacla loam (Fine-loamy, mixed, thermic Fluvaquentic Dystrochrepts); 2) Wehadkee loam (Fine-loamy, mixed, active, nonacid, thermic Fluvaquentic Endoaquepts); 3) Congaree loam (Fine-loamy, mixed, nonacid, thermic Typic Udifluvents), and 4) Udorthents (Figure 4).

Many of the soil profiles performed as part of this evaluation were identified as a variant of the mapping unit in which a soil property such as the matrix chroma, texture or horizon thickness was not within the range of characteristics established for the soil type. In general, Chewacla with Wehadkee inclusions in depressional areas are found towards the interior of the site and account for approximately 45% of the project area, while Congaree generally occurs in the levee position along Rich Fork, representing 20% of the site. The Udorthents occupy a band adjacent to Rich Fork and the ditched stream channel on site and occupy 35% of the site. All of these soil series are alluvial in nature and are commonly found on floodplains where flooding is frequent under natural conditions. During the field investigation, seasonal ponding of water in low areas was noted across the site.

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Figure 4: Soils

ChA - Chewalca variant
Ch - Chewacla loam
Co - Congaree loam
Wt - Wehadkee
Ud - Udorthants
WtA - Wehadkee variant
Site Boundary

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The following sections describe each soil series, in detail, and basic soil properties of each series are summarized in Table 3.

Chewacla loam (Ch**) and Chewacla variant** (ChA) was the dominant soil on the site as well as upstream and downstream along Rich Fork and occurs in close association with the Wehadkee soil series. The Chewacla soils consist of very deep, moderately permeable, somewhat poorly drained soils of floodplains along first bottoms, creeks and rivers. They formed in recent alluvium washed from soils formed in residuum from schist, gneiss, granite, phyllite, and other metamorphic and igneous rocks. They occur on nearly level floodplains along streams that drain from the mountains and piedmont.

Typically, the surface layer is brown loam about 9 inches thick. The subsoil is about 43 inches thick and is dark yellowish brown fine sandy loam in the upper part; brown, yellowish brown and light brownish gray sandy clay loam to yellowish brown sandy loam in the lower part. The underlying material to a depth of 62 inches or more is yellowish brown loamy sand and gravelly loamy sand. They have a seasonally high water table of 0.5 feet to 2.0 feet below the surface from about November to April. The Chewacla soil is frequently flooded from November to April.

Wehadkee loam (Wt) and **Wehadkee variant** (WtA) was typically located in depressions in association with Chewacla soils. These soils consist of very deep, poorly drained and very poorly drained soils on nearly level floodplains along streams that drain from the mountains and piedmont. They formed in recent alluvium washed from soils formed in residuum from schist, gneiss, granite, phyllite, and other metamorphic and igneous rocks. They are more poorly drained than the Chewacla soils and they are darker colored and more intensely mottled.

Typically, the surface layer is brown loam about 8 inches thick. The subsoil ranges from 20 to more than 60 inches and generally ranges in color from gray, light brownish gray and grayish brown to dark gray and dark grayish brown. Texture is sandy clay loam, silt loam, loam, clay loam or silty clay loam. Wehadkee soils have a seasonally high water table of 0 to 1.0 feet below the surface from November to May. They have a seasonally high water table of 0 feet to 1.0 feet below the surface from about November to May. The Wehadkee soil is commonly flooded for brief duration from November to June. The Wehadkee series is a poorly drained representative of the Chewacla soil series.

Congaree loam (Co) was found in long, elevated areas, the "levee" position, along Rich Fork. This soil type consists of well drained and moderately well drained soils on nearly level floodplains along streams. Typically, the surface layer is dark brown loam about 10 inches thick. The underlying material to a depth of 62 inches or more is yellowish brown and strong brown loam. Texture is silty clay loam, fine sandy loam, and loam. Congaree soils have a seasonally high water table of 2.5 to 4.0 feet below the surface and are occasionally flooded.

Udorthents (Ud) were found immediately adjacent to the levee position along Rich Fork and in a band extending into the field adjacent to the ditched perennial stream on site. The field investigation identified a buried horizon 7 to 36 inches below the surface at an elevation consistent with the surrounding fields. The overburden material is coarse and sandy and appears to be associated with dredge spoil disposal from the channelization of Rich Fork.

Table 3: Summary of Soil Series Mapping					
Map Symbol	**Soil Series**	**Soil Subgroup**	**Hydric Status [1]**	**Depth & Duration of High Water Table [2]**	**Estimated Extent**
Ch & Cha	Chewacla loam	Fluvaquentic Dystrochrepts	Hydric	0.5' to 1.5' (Nov. - April)	45%
Wt & Wta	Wehadkee loam	Fluvaquentic Endoaquepts	Hydric	0' to 1.0' (Nov. - April)	10%
Co	Congaree loam	Typic Udifluvents	Non-Hydric	2.5'-4.0 (Nov. - April)	20%
Ud	Udorthents	N/A	N/A	N/A	25%

[1] Hydric soil list for North Carolina
[2] Based on soil taxonomy for undrained condition

The soil's current/historic status as hydric was evaluated to determine the extent to which wetland restoration can be achieved on the site. This determination was complicated by site conditions that have severely altered the upper 12 inches of the site over the past 100 years of agricultural use, the application of dredge spoils to the site and disparity over the status of Chewacla soils. Resolution of this issue was achieved through agency directives and conducting detailed field evaluations.

Guidance on establishing the hydric status of the soils mapped for the site was provided by the ACOE (David Franklin letter of 12/12/2000 to NCDOT regarding restoration of Chewacla soils on the Shepherds Tree Mitigation Site). The guidance specified that "depleted (reduced) soils must occur in the upper 12 inches" of the soil profile for Chewacla soils to be considered hydric for the purposes of determining wetland restoration areas. Further direction was provided by ACOE in regards to buried soils, which indicated the need to document buried hydric soils through detailed soil profiles. Detailed field evaluations were conducted to identify both redoximorphic features in the upper 12 inches of soil and fill areas.

The redoximorphic feature evaluation was conducted by establishing nine transects over the site, running perpendicular to the existing drainage ditch network. Soil borings were performed along the transect lines at approximately 300-foot (90-meter) intervals (Figure 5 and Appendix D). This process was complicated by the disturbed nature of the agricultural fields which have homogenized the horizons in the upper 12-18 inches of soil by plowing. Repetitive plowing and mixing of crop residues into the soil, along with the artificial drainage, has affected and altered the hydric features (soil color and mottling) normally found in the upper soil horizons in an undisturbed, natural site. This evaluation identified 24 borings that exhibited redoximorphic features (i.e. mottling and concretions), within 12-14" (the plow layer zone) of the surface (Figure 6).

The fill (overburden) evaluation was conducted by developing seven detailed soil profile descriptions to a depth of 50 inches (Figure 5, Appendix D). Additional borings not documented by soil profile descriptions were advanced to determine the extent and location of the fill layer across the site. A control boring (boring #2) was located in the remnant Bottomland Hardwood Community near the western property line due to its relatively undisturbed condition. The other six borings are discussed as they relate to this control point. The soil profile description for Boring #2 does not show evidence of an overburden. The soil surface does appear to have been compacted possibly by heavy equipment traffic, since no observable structure was described in the surface layer (A1 horizon). The Bg1 horizon (subsurface layer)

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Figure 5: Soil Boring Locations

Red line	SITE BOUNDARY
Yellow dot, A2	SOIL BORING LOCATIONS
Circled cross	DETAILED SOIL DESCRIPTIONS
Green triangle, 1	COE WETLAND FORMS

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Rich Fork Mitigation Site — Figure 6: Depleted Soils

SOME INDICATORS OF REDUCING CONDITIONS IN THE UPPER 12"

DEPLETED SOILS WITHIN 12" OF THE SURFACE

North

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described for Boring #2 is shown with an asterisk to indicate a horizon that is similar in color and texture as other horizons found in the six non-control soil borings. This layer may have horizon designations different from Bg1. This horizon also appears at different depths within each of the soil profiles, which provides evidence of an overburden from sources unrelated to soil morphology or soil forming processes. The overburden generally has not developed structure and therefore, it is referred to as being massive.

Seven detailed soil profile descriptions were written to assist in characterizing the soils on the site. The soil profile descriptions identified individual horizons in the topsoil and upper subsoil that exhibit stratification, defined as a succession of horizontal layers of differing colors and textures with little or no structure. These stratified layers range in thickness from 1 to 13 inches, and generally overlay or have buried a "healthy" soil profile or one that resulted from natural soil forming processes.

Based on this analysis, the extent and depth of the overburden was mapped. The overburden ranges in depth from 7 to 36 inches of either sandy or loamy textured materials from either overbank flooding or excavated spoil materials spread onto the site. Typically, the soils with the thicker overburden are found closer to Rich Fork and the soils with less overburden transition away from Rich Fork toward the control point. Horizons within the soil profile descriptions that are marked with an asterisk occur as a buried horizon, which have multiple stratified horizons with little to no structure and differing colors and textures. Buried horizons are designated in the soil profile with a lower case "b" subletter, which follows a capital letter like A, B or C. These horizons typically have a hue of 2.5Y, a value of 5 or 6 and a chroma of 2. Additionally, a second horizon with similar color and texture may also appear in the same soil profile as shown in the soil descriptions number 1 and 3A. These are indicative of several previously buried soil horizons.

Based on these evaluations it was determined that approximately 40% of the site has hydric soils, defined as having redoximorphic features within the top 12 inches of the surface, and 30% of the site had a buried hydric soil profile. The remaining 30% is comprised of non-hydric soils (Figure 7).

2.3 Hydrology/Hydraulics Site hydrology was evaluated during field investigations, and using flood frequency and water budget analyses. Hydrology and hydraulics on the site reflect those typically found in Piedmont riparian zones. The primary hydrologic inputs to the site include seasonal groundwater and precipitation. The site is in the two-year floodplain of Rich Fork. Interviews with the landowners indicate that the site regularly floods and that the fields are often too wet to plow. In the years when planting is accomplished, crops are often still lost to flooding.

Both surface water and groundwater are removed from the property via lateral drains and ditches. Two series of ditch networks drain the site (Figure 8). Both networks discharge into Rich Fork at the southern end of the site. They jointly have the capacity to discharge surface and subsurface water at a rate of 32 ft^3/s. These ditches depress groundwater elevations on-site by providing a discharge path, which subsequently lowers the adjacent water table. They also decrease the extent and duration of flooding. Under the current conditions, lateral drains and the ditching of the stream channel have effectively altered the hydrology of the site, decreasing the time of concentration and the amount of water available for soil saturation. The ditching system outlet also provides an artificial break in the natural stream levee and speeds drainage of the site during flood events.

2.3.1 Surface Water Three surface water inputs contribute to the site. Rich Fork provides the primary surface water input. The site is on the Rich Fork floodplain and is inundated under natural conditions by discharges exceeding 1000 ft^3/s, (discharge required to exceed existing levee height). Additional surface water inputs enter the site from two drainages to the west (Figure 9). These areas contribute approximately 216 acres of drainage. The northern drainage supports a perennial stream and the southern drainage supports an apparent intermittent stream.

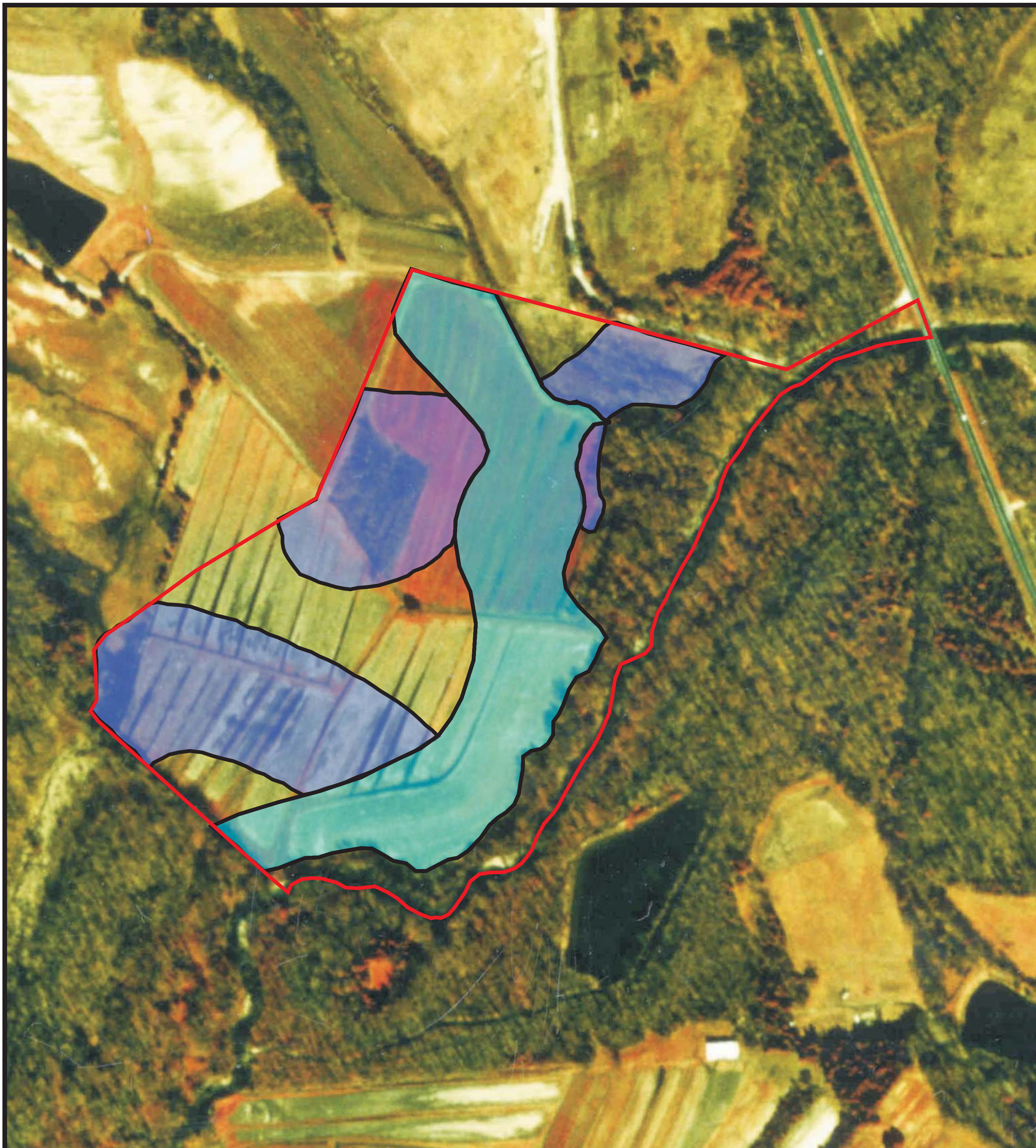

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Figure 7: Limits of Hydric Soils

BURIED HYDRIC SOILS

HYDRIC SOILS

SITE BOUNDARY

North

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Figure 8: Site Hydrology

RICH FORK

STREAMS

DRAINAGE DITCH (DIRECTION OF FLOW)

SITE BOUNDARY

SEEP

North

NOT TO SCALE

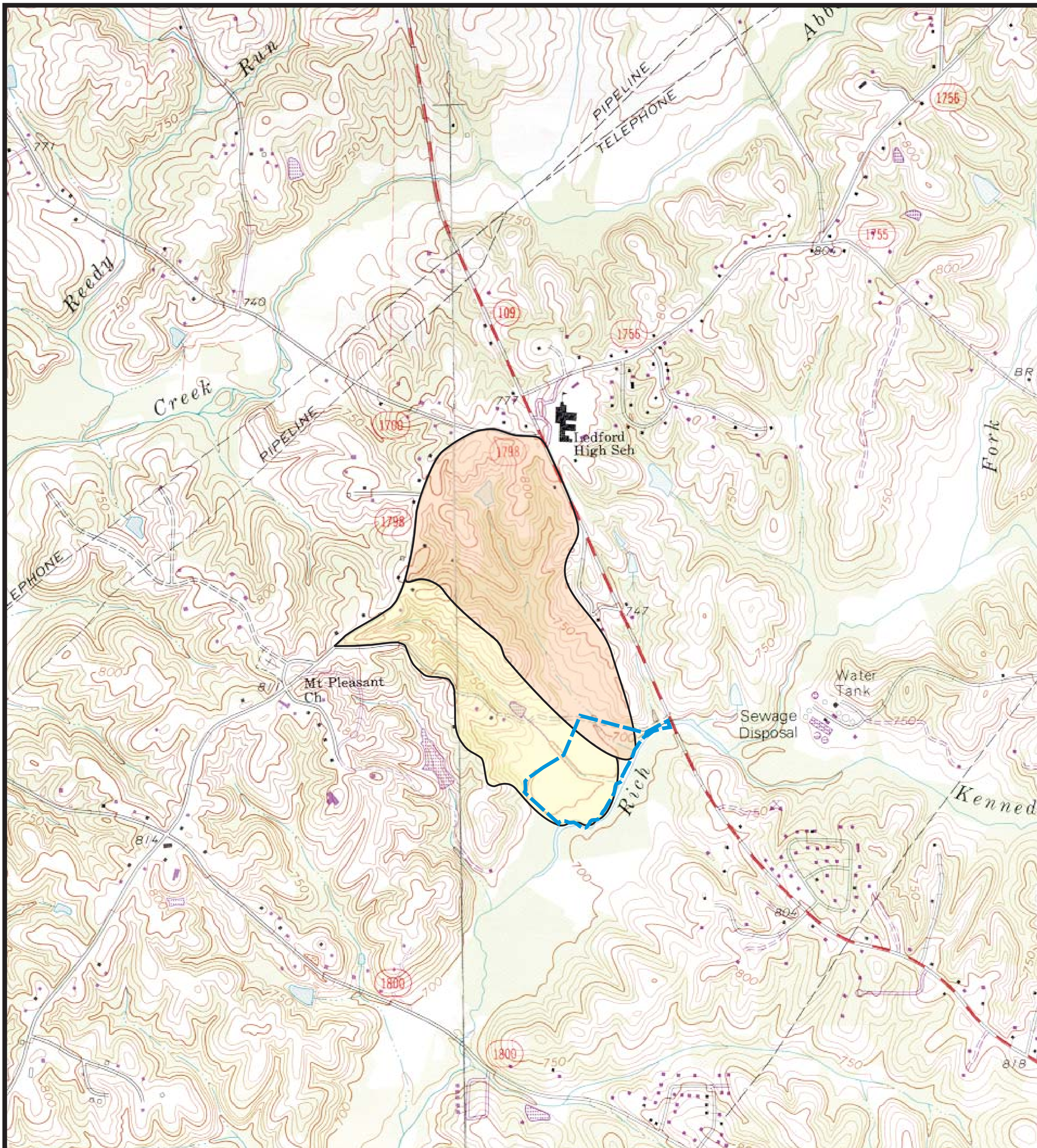

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Figure 9: Hydrologic Inputs

- SITE BOUNDARY
- SECONDARY INPUT DRAINAGE
- SECONDARY INPUT DRAINAGE

North
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As no gauges are available on Rich Fork, a regional average standardized Probability Weighted Moments (PWM) approach was used to estimate the frequency and intensity of flooding on the Rich Fork Mitigation Site. This analysis identified that the return interval for a 1000 ft^3/s discharge was 1.007 years and corresponds well with rural Piedmont regional curves for bankfull discharge (Appendix E). The previous landowners have indicated that flooding is occurring with increasing frequency and currently occurs 2 to 3 times per year.

2.3.2 Groundwater High groundwater has historically been reported for the site and occurs seasonally at or near the surface in the surrounding natural areas. The site groundwater was evaluated by monitoring the water level with five on-site Solinst Levelogger gages, a barometric control gage, and a reference wetland on an adjacent property (Figure 10). The Leveloggers were installed across the site on January 26, 2001 and programmed to measure water levels twice a day, at 12-hour intervals. The data was downloaded periodically and evaluated to determine the depth and duration of the groundwater levels on the site. Data has been collected and evaluated through January 30, 2002.

Data from each monitoring gauges was plotted to determine the hydroperiod (duration of saturation within 12" of the ground surface) for the site and reference wetland (Appendix F). This evaluation indicated that the site's hydroperiod has been significantly altered when compared to that of the reference wetland (Appendix G). The reference wetland, exhibited on average, a groundwater elevation between 0 and 2 inches below the surface for 40 days (17% of the growing season) with relatively constant elevation. The site exhibited average groundwater elevations between 0 and 12 inches below the surface for intervals between 2 days (1% of growing season) and 12 days (4% of growing season) with rapid fluctuations. If the rapid fluctuations (drawdowns) were removed, the site would maintain a groundwater elevation averaging 5 inches below the surface for between 20 days (8% of growing season) and 30 days (12% of growing season). The growing season calculated to be 237 days beginning March 14th ending November 10th, based on information from the Davidson County NRCS.

2.3.3 Water Budget Existing site hydrology was modeled by developing an annual water budget that calculates water inputs and outputs, and the change in storage on a monthly time step (Appendix H). Under existing conditions, water inputs to the site are precipitation (P) and surface runoff (Si). Historic precipitation data from the National Climatic Data Center (NCDC) Summary of the Day Data Set was obtained from Earth Info, Inc. The data was obtained for the City of High Point, Davidson County, NC, located approximately 8 miles from the Rich Fork site. Total precipitation for the years of the period of record, from 1948-1997, was reviewed. Three years were selected that represent precipitation conditions for an average year (1991), dry year (1986) and wet year (1989).

Daily surface runoff from the watershed of the unnamed tributary was calculated using the Runoff Curve Number Method from TR-55 and daily precipitation data for the representative years listed above. However, since the proposed restoration design routes the surface water flow through the site, surface water input (Si) equals surface water output (So). It is expected that overbank flooding from the unnamed tributary will contribute to wetland hydrology on site, however this water input was not considered in order to provide a conservative estimate of water availability. In a similar manner, water inputs due to overbank flooding by Rich Fork were not considered, although anecdotal evidence suggests flooding may occur 2-3 times year and the flood frequency analysis of Rich Fork predicts overbank flooding on an approximately annual basis.

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Figure 10: GW Monitoring Gauges

G-1 Groundwater Monitoring Gauge I.D. Number

C Barometric Control for Groundwater Monitoring Gauges

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Groundwater input to the site is likely; due to the landscape position of the site and observation of three groundwater seep discharge zones in the central and southern portions of the site and along the western boundary of the site. However, groundwater input was not calculated for the water budget since it is difficult to quantify and its exclusion provides for a conservative estimate of water availability.

Water outputs from the site include potential evapotranspiration (PET), surface water output (So), groundwater output (Go), and groundwater infiltration. PET was calculated by the Thornthwaite method using mean monthly temperatures determined from 1961-1990 data from Lexington, NC, and daytime hours. As mentioned above, surface water output (So) was assumed to equal the surface water input from runoff. Groundwater output (Go) represents the loss of groundwater via the ditch network on the site, and was estimated from observations of depth of water flow, and the cross section and slope of the collector ditch at the base of the site. Groundwater infiltration represents groundwater losses from the site due to downward seepage through the soil profile. Soil permeability was assumed to be $2x10^{-6}$ ft/min, which is typical of low permeability soils associated with wetlands.

Net surface water and groundwater inputs and outputs were calculated in inches, and normalized across the site on a monthly time step. Net water inputs and outputs were then added or subtracted from a running wetland water volume, expressed as a depth in inches, and normalized across the total area of the site. A maximum wetland water volume of 4.32 inches was calculated, based on 36 inches of soil with a specific yield of 0.12. All of the calculated water volume came from water in the soil, there was no surface water storage factored into the calculation.

The hydrographs for the average dry- and wet-year show a similar pattern of seasonal water table levels. Water table recharge occurs during the late fall and winter months, until a rapid water table drawdown occurs as PET rates increase in the spring. During the summer, the water budget model shows the existing site is unsaturated within the upper 36 inches of soil (Appendix H).

2.4 Assessment of Site Conditions The Rich Fork mitigation site has an extensive history of disturbance, undergoing dramatic land cover alterations prior to 1936 for the purposes of agricultural production. The site consisted of Piedmont Levee and Bottomland Hardwood Forest communities before these modifications. Three small remnant natural communities of Piedmont/Mountain Levee Forest, Piedmont/Mountain Bottomland Forest and Low Elevation Seep remain. Two tributary streams transect the site. These streams have been severely altered by ditching. Habitat within these systems has suffered from a lack of in-stream structures, bed features and decreased stream length.

The soils have been disturbed, manipulated and filled on the site. The horizons in the upper 12 to 18 inches of soil have been homogenized and mixed with decades of plowing and grading the land. A network of ditches has effectively drained the site for agricultural use. Repetitive plowing and mixing of crop residues into the soil, along with artificial drainage, has affected and altered the hydric features (soil color and mottling) normally found in the upper soil horizons of an undisturbed site. The extensive land alteration described has complicated the identification and determination of historic hydric soil conditions. Despite drainage and regular plowing, field investigations indicate relict hydric features, i.e. mottling and concretions, within 12-14" (the plow layer zone) of the surface over a significant portion of the site.

The site hydrology and hydraulics reflect those characteristically found in Piedmont riparian zones. The primary surface water input is Rich Fork. The site is located in the Rich Fork floodplain and it is frequently inundated by flows from Rich Fork (2 to 3 times a year, according to the previous property owners). A flood frequency analysis was performed to verify this information. The results of the analysis support the claim that surface water inputs from the flooding of Rich Fork are reliable in terms of their effect on wetland hydrology. The inflow from two streams that enter the site from the west provide additional surface water to the project site. Under the current conditions, lateral drains and the ditching of the stream channel have effectively altered the hydrology of the site, deceasing the amount of water available for soil saturation and duration of flooding. The ditching system outlet also provides an artificial break in the natural stream levee and speeds drainage of the site during over bank flooding events.

The site shows significant fluctuations in groundwater levels when compared to the reference wetland. This fluctuation can be attributed to the ditch networks, which allow groundwater discharge from the site and dampen the effects of flooding and precipitation. Current saturation on the site varies from 1 to 4% of the growing season as compared to the reference wetland, which is 17% of the growing season. Removal of the drainage networks on site should achieve saturation between 8 to 12% of the growing season.

A water budget was developed for existing conditions, in order to calculate water inputs and outputs, and the change in storage on a monthly time step. Under existing conditions, water input to the site comes from precipitation and surface runoff. Water outputs from the site include potential evapotranspiration, surface water output, groundwater outflow via the ditch network, and groundwater infiltration. All of the calculated water volume for the site came from water in the soil; there was no surface water storage factored into the calculation. The results of the existing water budget show the expected pattern of rapidly declining water table levels in the spring and water table recharge during the fall and winter. The model indicates that the upper 36" of soil will remain dry through the summer and early fall.

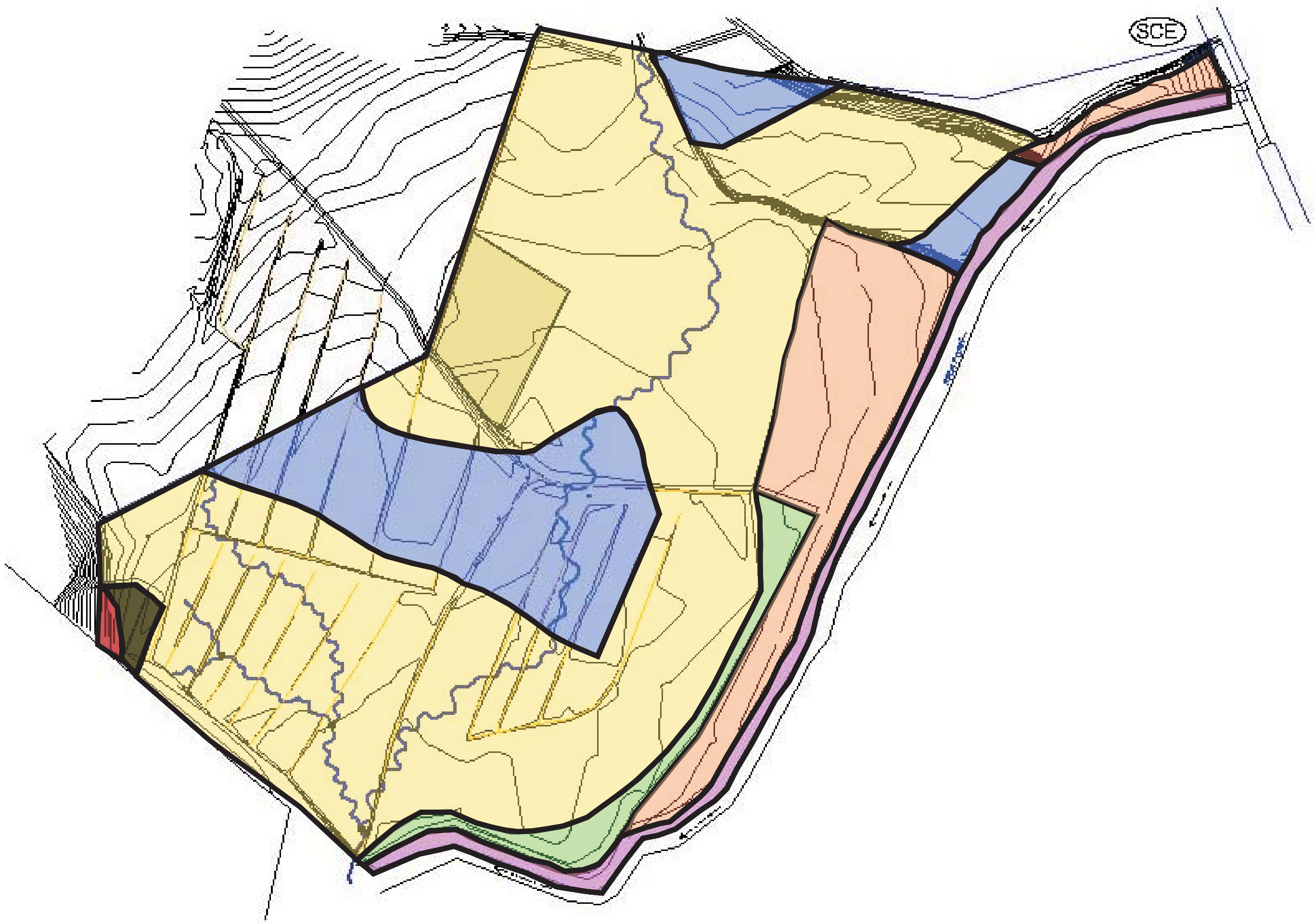
In summary, the clearing, draining and conversion of the site to agriculture has altered its natural wetland ecological function and diminished its capacity for natural biological productivity, biogeochemical cycling, nutrient cycling, and water quality enhancement. In its present state, the site is only fulfilling a small proportion of its potential and historical wetland functional role on the landscape.

3.0 STREAM AND WETLAND RESTORATION ACTIVITIES

The Rich Fork Mitigation Site will focus on re-establishing the historic bottomland hardwood communities and associated stream network. At present, the site exhibits the effects of hydrologic modifications that prevent the attainment of jurisdictional hydrology, by limiting the number of consecutive days in which saturation occurs within 12" of the grounds surface. However, approximately 70% of the site has indicators of reducing conditions in the upper 12" of the soil profile. Given the extent of human induced alterations to the vegetative communities and hydrology (through draining and ditching), the restoration plan focuses on re-establishing hydrology and vegetation in order to restore the functions and values of a bottomland hardwood community. The restoration types and extents that will are available are found in Table 4 and Figure 11.

Table 4: Restoration Type and Extent

COMMUNITY TYPE	Restoration	Creation	Enhancement	Preservation
Piedmont Bottomland Hardwood Forest	17.1 ac.	3.9 ac.	0	0
Low Elevation Seep	0	0	0.31 ac.	0.18 ac.
Piedmont Levee Forest	.62 ac.	0	0	4.1 ac.
Stream	3,386 lf	N/A	0	1,972 lf



Rich Fork Mitigation Site

Figure 11: Restoration Type, Extents, and Distribution

WETLAND COMMUNITIES
- LOW ELEVATION SEEP PRESERVATION
- BOTTOMLAND HARDWOOD RESTORATION
- BOTTOMLAND HARDWOOD CREATION
- BOTTOMLAND HARDWOOD ENHANCEMENT
- STREAM PRESERVATION
- STREAM RESTORATION

UPLAND COMMUNITIES
- LEVEE FOREST RESTORATION
- LEVEE FOREST PRESERVATION

North
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3.1 Goals and Objectives The goal of the project is to re-establish an integrated wetland-stream complex that will restore ecosystem processes, structure, and composition to mitigate for wetland functions and values that have been lost as a result of anthropogenic disturbances in this region of the Yadkin River Basin.

A detailed evaluation of the watershed (Basinwide Assessment Report- Yadkin River Basin, DEHNR, June 1997; Yadkin River Basin Technical Report - Wetland Mitigation Site Search, KCI, May 1997) identified significant losses of functions and values associated with the dredging and berming of the major streams in the Yadkin River Basin. Specifically, the restriction of overbank flooding has allowed for the conversion of the basin's floodplains into agricultural fields, thus promoting the clearing of riparian zones, the channelization of tributary streams and the drainage of adjacent wetlands. These activities have subsequently resulted in the degradation of water quality, wildlife habitat, and flood cycling capacities, as well as habitat fragmentation, the loss of wildlife travel corridors and an overall decrease in regional biodiversity. The goals and objectives of the restoration will focus on the reconstruction of the function and values lost in the watershed.

Specific goals and objectives for the restoration of the site include:

- Restoration/enhancement of bottomland hardwood communities
- Restoration of floodplain/wetland interfaces
- Restoration of stream channels and drainage patterns
- Restoration of water quality functions
- Restoration of wildlife habitat
- Re-establishment of wildlife travel corridors

3.2 **Wetland Restoration** The proposed wetland restoration/creation/enhancement area within the site consists of 21.49 acres of agricultural fields that are currently non-wetlands. Based on existing relict hydric soils and examination of forest areas adjacent to these fields, it is presumed that all 21.49 acres were jurisdictional wetlands prior to conversion. The proposed actions will be directed at restoring the character and function of the Piedmont Bottomland Hardwood wetland type that occupied these fields, historically.

The wetland mitigation activities associated with the site will result in substantial enhancement of the existing water quality and habitat functions onsite. Elimination of channelized flow from agricultural ditches to Rich Fork will drastically reduce nutrient, pesticide and sediment runoff from the site and improve water quality downstream. The proposed ditch plugging and filling will result in increased short-term surface and subsurface water storage and subsequent increase in the duration and elevation of the seasonally high water table. The increased retention time of surface and subsurface water will result in reduced peak flows and augmented base flow to Rich Fork. Increased retention time will also facilitate a variety of biogeochemical transformations such as denitrification and dissolved organic carbon export. Reduced nitrogen export and increased carbon export will benefit downstream aquatic habitat areas in Rich Fork Creek and the Yadkin River.

Converting the agricultural fields back to a natural vegetative species composition will improve the feeding, shelter and breeding habitat for many indigenous and migrant faunal species. The riverine nature of the restored wetlands will also augment wildlife corridors between existing habitat islands.

Specific actions proposed to achieve the goals and objectives of the project include:

- Filling of lateral ditches
- Recreating microtopography across the site to: enhance surface water retention and storage, to provide the necessary slope for stream restoration and to provide amphibian breeding habitat where possible
- Restoration of unnamed tributary to Rich Fork to re-establish stream/wetland interface
- Re-vegetation of the site with Piedmont Bottomland Hardwood and Piedmont Levee Forest species

3.2.1 Hydrologic Alterations Currently, The site exhibited average groundwater elevations between 0 and 12 inches below the surface for intervals between 2 days (1% of growing season) and 12 days (4% of growing season) with rapid fluctuations. If the rapid fluctuations (drawdowns) were removed, the site would maintain a groundwater elevation averaging 5 inches below the surface for between 20 days (8% of growing season) and 30 days (12% of growing season).
In order to enhance the site functionality and increase habitat diversity, modifications that will influence the hydroperiod of the site are being proposed. These actions are described in more detail below:

Ditch Removal: Approximately 12 lateral ditches found on the site enhance removal of precipitation and flood flows. When constructed, the excavated material from the ditches was placed between the rows and crowned, directing runoff into the ditches. This ditch network will be filled as part of restoration activities.

Stream Channel Restoration: Stream restoration will include the re-establishment of a stable pattern, profile, and cross-section for two unnamed tributaries to Rich Fork. This will assist in restoring stream/floodplain connectivity and provide increased water quality and wildlife habitat diversity functions. This is described in greater detail in Section 3.3.

Fill Removal and Micro-topography Enhancement: Dredge spoils will be removed from the site to expose buried hydric soils and establish micro-topographic variations to enhance the retention of flood flows and precipitation and to provide appropriate gradients for stream restoration. Movement of material will be restricted to the top 6-12 inches as necessary to achieve project goals. This activity will not adversely affect soil fertility since the soil has been plowed and homogenized in the upper 12-15 inches for many decades.

Levee Break: The levee that restricts more regular flooding from Rich Fork will be breached to allow additional hydrologic inputs and natural functionality of the system.

3.2.2 Vegetative Community Establishment Vegetation will be restored to the site that is consistent with the Piedmont Bottomland Hardwood and Piedmont Levee Forest vegetation (Figure 11). The following actions will be taken to re-vegetate the site:

Site Preparation: The soils on the site have undergone significant disturbance for greater than 60 years. Agriculture operations have compacted the soil, thus decreasing infiltration. At the completion of the earth-moving activities the site will be ripped as necessary to create conditions conducive for the re-establishment of Piedmont Bottomland Hardwood systems on the site.

Planting: The community-planting plan described below provides a guide for the vegetative re-establishment of the targeted communities. If available, the following species will be planted:

Piedmont/Mountain Levee Forest

Species:	**Scientific Name**	**Common Name**
	Fraxinus pennsylvanica	green ash
	Acer negundo	boxelder
	Liriodendron tulipifera	yellow poplar
	Platanus occidentalis	sycamore
	Betula nigra	river birch

Planting Density: 680 Stems per acre
Comments: All trees will be 12"-18" bare root material.

Piedmont/Mountain Bottomland Forest

Species:	**Scientific Name**	**Common Name**
	Liriodendron tulipifera	yellow poplar
	Quercus falcata var. pagodaefolia	cherry bark oak
	Fraxinus pennsylvanica	green ash
	Quercus phellos	willow oak
	Quercus nigra	water oak
	Carya ovata	shagbark hickory

Planting Density: 680 Stems per acre
Comments: All trees will be 12”-18” bare root material.

3.3 **Stream Restoration** Two unnamed tributaries to Rich Fork enter the site at the northern boundary. A Rogsen Level II stream assessment was performed on these channels as a prelude to design (Appendix C). The analysis of the channels found them to be severely altered and ditched through or around the site. Restoration of these channels will encompass the development of 3,386 linear feet of Priority I restoration. The streams will be re-established on the floodplain with the appropriate pattern, profile and dimension. The intent of stream restoration efforts will be to recreate near-historical stream features, using fluvial geomorphological principles and bioengineering measures that are integrated with, and conducive to, supporting the proposed wetlands restoration efforts.

Specific actions proposed to achieve the goals and objectives of the project include:

- Establish stream geometry and instream flow characteristics that best support proposed wetland and corresponding wildlife habitat diversity restoration efforts
- Establish appropriate cross-sectional area to enhance overbank flooding frequency
- Establish channel profile that limits depression of ground water table in the near bank region
- Stabilize channel with vegetation and install habitat enhancement features as appropriate
- Re-vegetate riparian zone of streams with additional woody vegetation to that installed for wetlands restoration

3.3.1 **Dimension, Pattern and Profile** The stream design proposes the restoration of appropriate geomorphologic dimension, pattern and profile for 3,386 linear feet of "E5" Type stream channel with corresponding cross-sectional modifications, instream habitat development, bank stabilization, and riparian corridor establishment.

A Rosgen Level II stream assessment was performed on a selected reference reach to act as a guide in the development of the design criteria for the project. For this project, the selected reference site is a stable "E5" Type stream reach located in the Pee Dee National Wildlife Refuge. Selection of this site is appropriate due to its geomorphic similarity (i.e. same physiographic region, functioning as a part of an integrated wetland/stream complex, drainage size) (Appendix G). Design criteria (dimensionless ratios) were developed for the main stem, tributary and below the confluence of the tributary and main stem from the reference site based on drainage area and flows. These criteria are provided in Table 5.

3.3.2 **Bank Stabilization** Bank stabilization of the restored streams will rely exclusively on appropriate geomorphic design incorporating natural stabilization/habitat structures and bioengineering techniques.

Herbaceous: The entire stream channel will be planted with a herbaceous seed mix. Upon establishment and prior to turning flow into the channel, the vegetation in the bed of the channel will be killed and removed.

Bioengineering: Areas subject to high energy flows will be enhanced with the application of bioengineering techniques. This will be restricted to live stakes and fascines. No coir fiber material is proposed.

Structures: Rock cross vanes, root wads and step pools will be installed to provide grade control, stabilize banks in areas of poor soil and increase habitat diversity in the stream.

Table 5: Stream Restoration Design Criteria						
	Variables	**Existing Channel**	**Reference Reach**	**Main Stem**	**Tributary[2]**	**Below Confluence**
	Stream Type	G5b	E5	E5	E5	E5
	Reach Length (ft)	100	N/A	~2000	~1500	~40
	Drainage Area (mi^2)	0.21	0.37	0.061[1]	0.027[1]	0.13[1]
	Bankfull Width (W_{bkf}) (ft)	3.9	6.8-7.4	3.5-3.6	2.5-2.6	4.6-4.7
	Bankfull Mean Depth (d_{bkf}) (ft)	0.5	1.31	0.65	0.5	0.85
	Bankfull Cross-Sectional Area (A_{bkf}) (ft^2)	1.8	9-9.6	2.3	1.2	4.0
	Width/Depth Ratio (W_{bkf}/d_{bkf})	7.8	5.2-5.6	5.2-5.6	5.2-5.6	5.2-5.6
	Bankfull Max Depth (d_{mbkf}) (ft)	0.7	1.63-1.79	0.8-0.9	0.6-0.7	1.05-1.16
	Width of Floodprone Area (W_{fpa}) (ft)	8.0	>100	>30	>25	>50
	Entrenchment Ratio (ER)	2.05	>10	>9	>10	>10
	Channel Materials (D50) (mm)	0.25	0.25	0.25	0.25	0.25
	Sinuosity (K)	1	1.36	1.4	1.4	1.4
Dimension	Pool Depth (dp) (ft)	1.1	1.9-2.8	0.9-1.4	0.7-1.1	1.2-1.8
	Riffle Depth (dr) (ft)	0.7	1.11-1.57	0.5-0.8	0.4-0.6	0.7-1.0
	Ratio - Max. Pool Depth:Mean Bkf. Depth	2.2	1.65	2.1	2.2	2.1
	Bankfull mean velocity (u) (ft/sec)	3.0	3.2-3.5	2.6	2.5	2.9
	Bankfull discharge (Q) (CFS)	5.4	30.7-31.6	6.0	3.0	11.5
Pattern	Meander Length (L_m) (ft)	N/A	77-100.7	40-49	28-35	52-64
	Radius of Curvature (R_c) (ft)	N/A	13.1-22.3	6.7-10.85	4.8-7.9	8.9-63.9
	Belt Width (W_{blt}) (ft)	N/A	51-92	26-45	19-32	35-59
	Meander Width Ratio (MWR)	N/A	7.5-12.5	7.5-12.5	7.5-12.5	7.5-12.5
	Ratio- Rad. of Curv.:Bkf Width (R_c/W_{bkf})	N/A	1.93-3.03	1.93-3.03	1.93-3.03	1.93-3.03
	Ratio- Meander Lgth:Bkf Width (L_m/W_{bkf})	N/A	11.3-13.6	11.3-13.6	11.3-13.6	11.3-13.6
Profile	Valley Slope (%)	1.8%	0.57%	0.20%	0.20%	0.20%
	Water Surface Slope (%)	1.3	0.42	0.20	0.20	0.20
	Riffle Slope (%)	1.67	0.6-2.0	0.29-0.95	0.29-0.95	0.29-0.95
	Pool Slope (%)	0.06-0.3	0.08-0.18	0.04-0.09	0.04-0.09	0.04-0.09
	Pool to Pool Spacing (ft)	16	26-65	12.3-34.4	8.8-24.5	16.1-45.1
	Pool Length (ft)	10-28	13-22	6.15-	4.4-8.4	8.1-15.2
	Ratio - Riffle Slope:Water Surface Slope	1.28	1.43-4.76	1.43-4.76	1.43-4.76	1.43-4.76
	Ratio - Pool Slope:Water Surface Slope	0.05-0.23	0.19-0.43	0.19-0.43	0.19-0.43	0.19-0.43
	Ratio - Pool to Pool Spacing:Bkf width	4.1	3.5-9.6	3.5-9.6	3.5-9.6	3.5-9.6
	Ratio - Pool length:Bkf width	2.6-7.2	1.76-3.24	1.76-3.24	1.76-3.24	1.76-3.24

[1] Bankfull discharges for the proposed channels do not correlate with the actual channel drainage areas due to the presence of farm ponds upstream. Therefore, the drainage areas provided are "effective" drainage areas that correlate with the estimated bankfull discharge of the existing channels using the Bankfull Hydraulic Geometry Relationships for the NC Rural Piedmont.

[2] The Headwater stream shown in the plans has the same planform, cross-sectional area, bankfull width and mean depth as the Tributary channel. To approximate the natural form of a headwater stream, the channel dimensions have been designed such that the cross-sectional area is near 0 ft^2 at the beginning of the channel and increases in proportion to the distance along the channel length until reaching the dimensions specified by the design criteria.

3.3.3 **Sediment Transport** A sediment transport analysis was performed on the proposed stream channels (i.e., the main channel and tributary channels). The purpose of the analysis was to verify that the proposed channel design criteria would produce bankfull flows capable of entraining the largest particle size, thus providing an additional test of the stability of the proposed design. Pebble counts were conducted on three cross sections (upstream, middle and downstream) during the baseline documentation of the channel (Appendix C). The upstream and middle sections were used to determine competence of the channel, due to the influence on the downstream point from Rich Fork. The D_{50} for these counts averaged 0.25 mm.

Given the proposed channels will be sand bed streams, particle entrainment was calculated using the Shields[2] formula for the determination of the critical dimensionless shear stress (τ_{CR}) which can be expressed as the following:

$$\tau_{CR} = Fs\ (\rho_s - \rho)\ g\ D$$

where:
Fs (entrainment function) = 0.056
ρ_s (sediment density) = 162.6 lbs/ft^3
ρ (fluid density) = 62.4 lbs/ft^3
g (gravitation acceleration) = 32.37 ft/s^2
D = D_{50} particle size (ft)

Critical Dimensionless Shear Stress Calculations for Main and Tributary Channels
Given both channels will have the same bed material and a D_{50} of 0.25 mm:

$$D = 8.20 \times 10^{-4} \text{ ft}$$

for both the main and tributary channels. Therefore, the resulting critical dimensionless shear stress (τ_{CR}) is:

$$\tau_{CR} = 0.056 * (162.6 - 62.4) * 32.37 * 8.20 \times 10^{-4} = 0.15$$

By referring to the Shields curve of the *threshold of motion,* it can be estimated that an approximately 9.5 mm grain diameter could be entrained under these conditions. Therefore, the proposed stream designs are sufficient to entrain and transport the sediment that is expected from the respective watershed sources and the *in situ* streambed and banks.

[2] Shields, A. 1936. Application of similarity principles and turbulence research to bed-load movement. Translated from: Anwendung der aehnlichkeitsmechanik und der Turbulenzforschung auf die Geschiebebewegung by W.P. Ott and J.C. van Uchelen. California Institute of Technology, Hydrodynamics Laboratory, Report No. 167. Pasadena, CA. 43 pp.

3.3.4 Riparian Vegetation Establishment Reestablishment of riparian vegetation will consist of planting and seeding a twenty (20) foot wide riparian buffer adjacent to each side of the restored channel. The plantings will include both bare root and live stake materials. The riparian zones of the restored streams will be a sub-component of the overall bottomland hardwood community type being restored. The following actions will be taken to establish a buffer on the site;

Site Preparation: At the completion of the earth-moving activities the site will be prepared for seed as necessary (raking, smoothing, liming, etc.) to create conditions conducive for the re-establishment of herbaceous vegetation.

Planting:. If available, the following species will be planted:

Riparian Buffer

Species:	**Scientific Name**	**Common Name**
	Betula nigra	River birch
	Celtis laevigata	Sugarberry
	Salix nigra	Black willow
	Salix sericea	Silky willow
	Cephalanthus occidentalis	Buttonbush
	Cornus amomum	Silky dogwood
	Sambucus canadensis	Elderberry
	Itea virginica	Virginia willow

Planting Density: 680 Stems per acre
Comments: All trees will be 12"-18" bare root material.
Shrubs will be live stakes where appropriate; otherwise 12-18" bare root material.

3.4 **Design Plans and Restoration Schedule** Design plans were developed based on the activities described in sections 3.2 and 3.3. The plans provide the necessary structure to restore the site and include; details, existing conditions, grading plans, sediment and erosion control, stream geometry, stream geometry data, stream profile, and planting plan. These plans have been attached under separate cover.

Activity	**Status/Anticipated Completion date**
Site Acquisition	Completed 2001
Mitigation Planning	Completed Winter 2001
Site Design	Completed Spring 2002
Site Construction	Summer 2002
Site Planting	Winter/Spring 2002-2003

4.0 WETLAND AND STREAM MANAGEMENT ACTIVITIES

4.1 Post Implementation Documentation An "as built" report will be submitted to the COE within 90 days of the completion of planting and gauge installation and will include: elevations, photographs, gage locations, and a description of initial species composition by community and sampling plot locations. Included within the report will be a list of species planted, planting densities and a total number of stems in the mitigation area. This information will form the base for further monitoring and evaluation.

4.2 Monitoring and Success Criteria The monitoring program will be implemented to document system development and progress towards achieving mitigation goals and objectives. The site will be determined to be successful once wetland hydrology is established, vegetation success criteria are met, and stream stability and biological integrity is demonstrated. Monitoring data will be collected yearly for a period of 5 years or until success criteria are achieved. Annual reports will be submitted to the COE, documenting the monitored components of the restoration plan i.e. hydrology, vegetation, geomorphic stability, and macro-invertebrate indexes, and will include all collected data, analysis and photographs.

4.2.1 Hydrology Groundwater elevations will be monitored to demonstrate the attainment of jurisdictional hydrology. The reference wetland monitored during the design phase will also be monitored with the same procedures for comparative analysis.

Monitoring Procedure: Verification of wetland hydrology will be determined by automatic recording well data, collected within the project area and approved reference wetland. Automatic recording wells will be established within restoration areas at a density of 1 automatic well per 4 acres (6 wells total). One automatic recording well will be established at the reference wetland. Daily data will be collected from automatic wells over the 5-year monitoring period following implementation. In addition, 3 automated temperature loggers will also be installed 30 cm below ground to collect daily readings. This data will be utilized to aid in determination of the local growing season based on soil temperature and NRCS data.

Success Criteria: Wetland hydrology will be considered established if well data from site indicates that the water table is within 12 inches of the soil surface for 8% of the growing season (NRCS published or locally calculated) or if overbank flooding causes extended inundation such that an area is ponded or flooded for 7 or greater days (during normal weather conditions). A "normal" year, based on NRCS climatological data for Davidson County, using the "middle 40" percent average as documented in the USACOE Technical Report "Accessing and Using Meteorological Data to Evaluate Wetland Hydrology, April 2000".

4.2.2 Vegetation The success criteria for the planted species in the restoration areas will be based on survival and growth. Beginning at the end of the first growing season, the project team will monitor site vegetation for five years following planting.

Monitoring Procedure: Permanent monitoring plots will be established in wetland restoration areas at a density of 1 plot per 4 acres (6 plots) and systematically located to ensure even coverage. Data will be collected at each plot for: total number of stems, species, percent survival, height, estimated percent cover of all species, and evidence of insects, disease and browsing.

Success Criteria: Survival of planted species must be 260 stems/acre at the end of 5 years of monitoring. Non-target species must not constitute more than 20 percent of the woody vegetation based on permanent monitoring plots.

4.2.3 Streams The project team will monitor geomorphological and biological parameters of the restored stream in accordance with ACOE and NCDENR protocols.

Monitoring Procedure: Monitoring will follow the most recent NCDENR guidance: *Internal Technical Guide for Streamwork in North Carolina* (Version 3.0, April 2001) and the *Interim, Internal Technical Guide: Benthic Macroinvertebrate Monitoring Protocols for Compensatory Stream Restoration Projects* (NC Division of Water Quality, 401/Wetlands Unit, May 2001).

- ***Physical*** monitoring will be conducted by collecting geomorphic data on two reaches in each channel (main stem and tributary). Each reach will be twenty bankfull widths in length. Within each reach the following geomorphic elements will be collected; cross sections (one riffle and one pool), modified Wolman pebble counts, profile, and channel geometry. Permanent markers will be established for each monitoring point (profile and cross-section) with rebar and caps.

- ***Biological*** monitoring will be conducted in each physical monitoring reach in accordance with DWQ protocol. In addition to the samples collected within the restored reach, a sample upstream of the restoration will be collected as a reference.

Success Criteria:

- ***Physical*** success will be met when inherent stability is achieved as demonstrated by less than 10% variation in monitored elements for 2 consecutive years.

- ***Biological*** success will be met when the restored reaches meet or exceed the indexes calculated for the upstream reference.

4.3 Management Plan/Remedial Activities Restoration of streams/wetlands involves interpretation of collected information to devise a strategy that will ultimately lead to a functional ecosystem. In such, minor variations in expected responses can be anticipated due to unknown site conditions, inputs from outside the restoration site, regional climatic variations, acts of God, etc. Correspondingly, nurturing of the site through regular management activities is considered necessary to assure that the goals and objectives of the project are met. These activities will be conducted throughout the year and may include: invasive control, localized stabilization, debris or trash removal (flood flow deposited), etc. If the monitoring of the site thereafter identifies a failure to attain specific success criteria, a remedial action plan will be developed which investigates the cause of the failure and proposes actions to rectify the problem.

5.0 OTHER ECOLOGICAL AND NON-ECOLOGICAL CONSIDERATIONS

5.1 Historical/Archaeological The North Carolina Department of Cultural Resources, State Historic Preservation Office (SHPO) conducted a review of the proposed mitigation project to determine the presence of historic preservation sites or sites of archeological importance on the study site. No sites of historical importance listed on the National Register of Historic Places (NRHP) were noted on the subject property. Additionally, no sites of archaeological significance were identified on the subject site.

5.2 Rare, Threatened, and Endangered Species (RTE) Available records were reviewed at the North Carolina Department of Parks and Recreation, Natural Heritage Program (NCNHP) to determine the presence of any rare, threatened, or endangered (RTE) species or critical habitats on or near the study site. Additionally, during the field investigation, the existing site conditions were evaluated in order to determine if habitat suitable for supporting Anson County RTE species existed on the site. No occurrences of RTE species or critical habitats were identified on or near the mitigation site.

5.3 Utilities/Easements Deed records, aerial photographs, USGS and NWI maps, and county planning maps were reviewed to assess the presence and potential impact of any utilities and easements on wetland and stream restoration. The review of these documents did not identify any utilities or easements associated with the project site.

5.4 Dispensation Of Property The project team has communicated with several conservation groups and natural resource agencies (public or private) for the purpose of final dispensation of this property. In light of the fact that the dispensation will not occur for a period of five years and that several new organizations that deal exclusively with this type of mitigation project have formed or are in the process of forming, the project team suggests that some flexibility be maintained with respect to the dispensation of the site. This will ensure that the best possible scenario is realized when the site is ultimately turned over to an appropriate organization.

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Appendix A

Appendix B

Appendix C

Appendix D

Appendix E

Appendix F

Appendix G

Appendix H