Mitigation Plan

UT Clarke Creek Stream and Wetland Restoration

Mecklenburg County, North Carolina
Catalog Unit 03040105
EEP Job Number: 92500
SCO Number: 09-07763-01
Submission Date: February 2011

Prepared for: NCDENR-EEP
1652 Mail Service Center
Raleigh, NC 27699-1652

Prepared by: Jordan, Jones, and Goulding, Inc.
309 E. Morehead St., Suite 110
Charlotte, NC 28202
704-527-4106 (Main Line)
704-527-4108 (Fax)

TABLE OF CONTENTS

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The UT Clarke Creek[1] Project is located in the Rocky River (Yadkin) Local Watershed Planning (LWP) area and the Mallard Creek local watershed (HU 03040105010040). The project is located in the Yadkin-Pee Dee River Basin, DWQ Subbasin 30711. The project site watershed was identified as a Targeted Local Watershed (TLW) in EEP's 2003 Yadkin-Pee Dee River Basin Restoration Priority (RBRP) Plan. The project site was assessed in the Upper Rocky River Local Watershed Plan (LWP) that was prepared for EEP by MACTEC in 2004 http://www.nceep.net/services/lwps/Clarke_Creek/wmp_r04-15-05.pdf. The goals developed by the stakeholder group for the LWP were to engage and educate the public and government, implement land use planning, enhance recreation and open space preservation, improve water quality, restore physical habitat, identify potential funding sources, and follow up and implement for long term. The UT Clarke Creek project site is located in a subwatershed (MC01-01) targeted by the LWP for stream and wetland restoration. The LWP characterizes the site as having problems associated with channelization, bank instability, and a limited riparian buffer zone. The LWP identifies the project site as having the potential to restore over 2,200 linear feet (lf) of stream and recommends stream restoration. The LWP also notes the potential to restore the forested riparian corridor between the two forested areas upstream and downstream of the project site. The implementation of this proposed stream restoration project will help achieve the LWP goals of improving water quality and restoring physical habitat.

The UT Clarke Creek is located in Mecklenburg County, North Carolina near the Town of Huntersville. The property parcel is owned by Mecklenburg County and is referred to as Clark's Creek Nature Preserve. The project consists of approximately 4,594 linear feet of existing restorable/enhanceable/preserveable stream on the site. The stream mitigation effort will occur along the main reach of UT Clarke Creek and six unnamed tributaries to the main reach. Two small drainage ditches on the project site appear to have been created at some time in the past for draining wetlands for agricultural purposes. These ditches, which have naturalized and are now considered jurisdictional waters of the U.S., provide the opportunity for wetland restoration and enhancement. The ditches are identified as Wetland D and include a portion of Wetland E. A portion of an emergent wetland, Wetland A, also provides wetland restoration opportunity. Wetland C provides the opportunity for enhancement. Another emergent wetland, Wetland B, is proposed for preservation.

The LWP identified the major stressors in the watershed: stream bank erosion, lack of adequate forested buffer, stream channelization, agricultural impacts, land use changes, sedimentation, point source in-stream impacts, nutrients, and fecal coliform bacteria.

Restoration goals for this project include:

- Reduce sediment stressors caused by stream bank erosion and shear stress along the reach
- Improve stream bank stability and sediment transport efficiency

---

[1] The project site is identified as the "UT Clarke Creek" in the EEP database; however, the project is actually a tributary to Clark's Creek. Therefore, in order to maintain consistency with the database, the project will be referred to as UT Clarke Creek. The CU and HU shown in this document are correct for the project site.

- Provide for uplift in water quality functions and nutrient filtration
- Provide for greater overall stream and wetland habitat complexity and quality
- Improve and maintain riparian buffer habitat

The project objectives include:

- Implement a sustainable, reference-based, rehabilitation of the project reaches' dimension to support sediment transport equilibrium.
- Provide a sustainable and functional bankfull floodplain feature and reslope banks at a more stable slope.
- Strategically install stream structures and plantings designed to maintain lateral stability and habitat to the stream channel.
- Install, augment, and maintain appropriate vegetative riparian buffer and riverine wetland community types with sufficient density and vigor to support native vegetation. The buffer should have a minimum width of 50 feet (ft) on each side of project streams and consist of a mix of native species representative of a bottomland hardwood forest.
- Restore and/or enhance the natural hydrology, vegetation, and soil composition in adjacent wetlands.

Existing Amount of Streams and Wetlands

Within the easement limits of the UT Clarke Creek project area, the existing streams and wetlands available for restoration, creation, enhancement, and preservation consist of the following components:

- 4,594 linear feet of stream, and
- 0.455 acres of wetland.

Amount of Streams and Wetlands Designed

JJG evaluated Priority One Restoration, Priority Two Restoration, and Enhancement approaches along the UT Clarke Creek and UTs 1, 2, 3, 4, and 5. A Preservation approach was evaluated for UT 6. Restoration, Creation, Enhancement and Preservation were also evaluated for the Wetland Areas A-E. The following summarizes the analysis of each stream and wetland area.

Due to multiple constraints (active sanitary sewer main and easement, numerous bedrock outcrops, and steep topography) along the project reaches, full restoration (pattern, profile, and dimension adjustment) cannot be performed along a majority of the project reaches. Therefore, restoration efforts along the main channel of UT Clarke Creek and its unnamed tributaries will consist of in-place bank stabilization, floodplain establishment at the existing bankfull elevation to the extent possible, and the adjustment of the channel dimensions to provide adequate transport of the watershed's runoff and sediment load. These enhancement efforts include establishing a floodplain at an appropriate bankfull elevation by excavating a bankfull bench, laying back bank slopes, and replanting stream banks in the stream's existing alignment. Prioritized meander bends will also be stabilized by utilizing in-stream structures such as rock and log vanes and brush matting. Invasive vegetation will be removed from adjacent stream banks, and the riparian zones of the project reaches will be replanted using bare roots and live stakes of native species appropriate to the area.

The project will also include riparian wetland restoration, preservation, and enhancement. The former maintained ditches that now comprise Wetland D and a portion of Wetland A will be plugged, and the surrounding areas will be planted with native tree and shrub species in order to restore wetlands in the floodplain of UT Clarke Creek. Enhancement techniques such as planting hydrophytic trees and shrubs and removing invasive vegetation will be applied to the other wetland areas found on the project site. A summary of the proposed mitigation stream reaches and wetlands are provided in Table 1.

Table 1
Project Components for UT Clarke Creek

Project Components						
Project Component or Reach ID	**Existing Feet/Acres**	**Restoration Level***	**Approach**	**Footage or Acreage**	**Stationing**	**Comment**
UT Clarke Creek	1507	E1	P 2/3	1507	00+00-15+87	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 1	723	E1	P 2/3	758	00+00-07+78	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 2	308	E2	P 4	308	04+22-05+99, 07+16-08+47	Planting of native vegetation, removal of invasive vegetation
UT 3	100	E1	P 2/3	100	00+00-01+03	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 4	373	E1	P 2/3	363	01+92-05+65	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 5	119	E1	P2/3	119	03+56-04+75	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 6	1464	P		1464	00+00-14+64	Designated as Preservation
Wetland A	0.085	R		0.0*		Restoring aerial extent of riparian wetland adjacent to stream
Wetland B	0.134	P		0.134		Designate as Preservation

Wetland C	0.057	E		0.057		Includes improving hydrology and vegetation to enhance the riparian wetland adjacent to stream
Wetland D	0.070	R		1.020		Restoring aerial extent of riparian wetland adjacent to stream
Wetland E	0.109	E		0.201		Includes improving hydrology and vegetation to enhance the riparian wetland adjacent to stream and create additional wetland

*****One segment of WL A will be incorporated into the enhancement of UT 2. The remainder of WL A will be incorporated into the restoration of WL D.

This document is consistent with the requirements of the federal rule for compensatory mitigation project sites as described in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.8 paragraphs (c)(2) through (c)(14). Specifically, the document addresses the following requirements of the federal rule:

- (2) *Objectives.* A description of the resource type(s) and amount(s) that will be provided, the method of compensation (i.e., restoration, establishment, enhancement, and/or preservation), and the manner in which the resource functions of the compensatory mitigation project will address the needs of the watershed, ecoregion, physiographic province, or other geographic area of interest.
- (3) *Site selection.* A description of the factors considered during the site selection process. This should include consideration of watershed needs, onsite alternatives where applicable, and the practicability of accomplishing ecologically self-sustaining aquatic resource restoration, establishment, enhancement, and/or preservation at the compensatory mitigation project site (see § 332.3(d)).
- (4) *Site protection instrument.* A description of the legal arrangements and instrument, including site ownership, that will be used to ensure the long-term protection of the compensatory mitigation project site (see § 332.7(a)).
- (5) *Baseline information.* A description of the ecological characteristics of the proposed compensatory mitigation project site and, in the case of an application for a DA permit, the impact site. This may include descriptions of historic and existing plant communities, historic and existing hydrology, soil conditions, a map showing the locations of the impact and mitigation site(s) or the geographic coordinates for those site(s), and other site characteristics appropriate to the type of resource proposed as compensation. The baseline information should also include a delineation of waters of the United States on the proposed compensatory mitigation project site. A prospective permittee planning to secure credits from an approved mitigation bank or in-lieu fee program only needs to provide baseline information about the impact site, not the mitigation bank or in-lieu fee project site.
- (6) *Determination of credits.* A description of the number of credits to be provided, including a brief explanation of the rationale for this determination (see § 332.3(f)).
- (7) *Mitigation work plan.* Detailed written specifications and work descriptions for the compensatory mitigation project, including, but not limited to, the geographic boundaries of the project; construction methods, timing, and sequence; source(s) of

water, including connections to existing waters and uplands; methods for establishing the desired plant community; plans to control invasive plant species; the proposed grading plan, including elevations and slopes of the substrate; soil management; and erosion control measures. For stream compensatory mitigation projects, the mitigation work plan may also include other relevant information, such as plan form geometry, channel form (e.g. typical channel cross-sections), watershed size, design discharge, and riparian area plantings.

- (8) *Maintenance plan.* A description and schedule of maintenance requirements to ensure the continued viability of the resource once initial construction is completed.
- (9) *Performance standards.* Ecologically-based standards that will be used to determine whether the compensatory mitigation project is achieving its objectives (see § 332.5).
- (10) *Monitoring requirements.* A description of parameters to be monitored in order to determine if the compensatory mitigation project is on track to meet performance standards and if adaptive management is needed. A schedule for monitoring and reporting on monitoring results to the district engineer must be included (see § 332.6).
- (11) *Long-term management plan.* A description of how the compensatory mitigation project will be managed after performance standards have been achieved to ensure the long-term sustainability of the resource, including long-term financing mechanisms and the party responsible for long-term management (see § 332.7(d)).
- (12) *Adaptive management plan.* A management strategy to address unforeseen changes in site conditions or other components of the compensatory mitigation project, including the party or parties responsible for implementing adaptive management measures. The adaptive management plan will guide decisions for revising compensatory mitigation plans and implementing measures to address both foreseeable and unforeseen circumstances that adversely affect compensatory mitigation success (see § 332.7(c)).
- (13) *Financial assurances.* A description of financial assurances that will be provided and how they are sufficient to ensure a high level of confidence that the compensatory mitigation project will be successfully completed, in accordance with its performance standards (see § 332.3(n)).

SECTION 1

PROJECT SITE IDENTIFICATION AND LOCATION

SECTION 1

PROJECT SITE IDENTIFICATION AND LOCATION

1.1 Directions to Project Site

From Interstate 77, take Exit 16A (Sunset Road) east. Sunset Road becomes Old Statesville Road/NC 115 after it crosses US 21/Statesville Road. Continue north on Old Statesville Road/NC 115, cross W.T. Harris Blvd./NC 24, then continue for approximately 1.2 miles to Hucks Road. Turn right onto Hucks Road. Travel approximately 0.7 miles to a dirt road on the left near the Mecklenburg County Park and Recreation sign.

1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designations

The UT Clarke Creek and its unnamed tributaries are located in Mecklenburg County, North Carolina, approximately 3 miles southeast of the Town of Huntersville. The project is located in the Yadkin-Pee Dee River Basin, Catalog Unit 03040105010040 (Mallard Creek), DWQ Subbasin 30711. According to the USGS Topographic Quad of the project area, UT Clarke Creek, UT 2, and UT 6 are second order streams, and UT 1, UT 3, UT 4, and UT 5 are first order streams.

1.3 Project Site Vicinity Map

Refer to Figure 1, Vicinity Map for the project site location.

1.4 Project Components and Structure

The UT Clarke Creek project components/assets are summarized in Table 1 of Section 12.

SECTION 2

WATERSHED CHARACTERIZATION

SECTION 2

WATERSHED CHARACTERIZATION

2.1 Drainage Area, Project Area, and Easement Acreage

UT Clarke Creek drains approximately 1.08 square miles at the farthest downstream point of the NCEEP project easement. The drainage basin is situated in Mecklenburg County, NC. In general, UT Clarke Creek flows north to south through its watershed. Elevations range between 854 ft near the watershed's headwaters to approximately 740 ft at the farthest downstream point of the NCEEP project easement. The project will be conducted within a 57.2 acre conservation easement along UT Clarke Creek and its tributaries. Refer to Table 2.1, Drainage Areas for details of the drainage area for each project reach.

Table 2.1
Drainage Areas

UT Clarke Creek		
Reach	**Drainage Area (acres)**	**Drainage Area (square miles)**
UT Clarke Creek	688.9	1.08
UT 1	294.63	0.46
UT 2	25.1	0.04
UT 3	38.85	0.06
UT 4	15.1	0.02
UT 5	9.9	0.02
UT 6	67.7	0.11

Surface drainage to UT Clarke Creek within the project easement follows two main pathways:

- Drainage directly to UT Clarke Creek via several unnamed tributaries, and
- Sheet/overland flow drainage into adjacent linear emerging wetland areas, which eventually contribute to groundwater seepage and baseflow to UT Clarke Creek.

The main contributors to the wetland hydrology on the site include:

- Groundwater seepage and springs – Wetlands A, B, C, and D;
- Overland flow draining into adjacent riparian areas – Wetlands C, D and E;
- Flooding of UT Clarke Creek and its tributaries – Wetland E, and
- Rainfall – Wetlands C, D, and E.

According to the former property owner, Wetland D and UT 5/Wetland E were at one time ditches that had been created to drain the UT Clarke Creek floodplain for agricultural operations. In addition, Wetlands A and B and UT 2A and UT 2B are contained within a former ditch that had been maintained to carry drainage from a natural spring.

2.2 Surface Water Classification/Water Quality

Clarke Creek has been classified by the North Carolina Department of Environment and Natural Resources (NC DENR) Division of Water Quality (DWQ) as Class C Waters. Class C waters are considered swimmable/fishable waters. The C classification is described by DWQ as waters protected for uses such as secondary recreation, fishing, wildlife, fish consumption, aquatic life including propagation, survival and maintenance of biological integrity, and agriculture. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner. Although not currently classified, the UT Clarke Creek, UT 1, UT 2, UT 3, UT 4, UT 5, and UT 6 are assumed to be Class C waters.

2.3 Physiography, Geology and Soils

The UT Clarke Creek project site is located in the Piedmont Physiographic Region. The Piedmont is characterized by broad, gently rolling interstream areas and by steeper slopes along drainage ways. Elevations in the Piedmont range from 300 to 600 feet above mean sea level near its border with the Coastal Plain to 1,500 feet at the foot of the Blue Ridge. More specifically, the project site lies within the Southern Outer Piedmont belt and is comprised primarily of foliated to weakly foliated, locally migmatic metamorphosed granite rocks (NCGS, 1991). These rocks are estimated to be 300 to 500 million years old and have undergone several deformations over time resulting in folding, fracturing, crushing, and shearing. In addition to these processes, chemical and physical weathering of these rocks has generated deep soil profiles generally referred to as saprolite. Saprolite develops on igneous and metamorphic rocks. Saprolite comprises compact clayey to sandy soil with original bedrock textures and features preserved (Cady, 1950).

The project site resides in a Valley Type VIII. These valley types are characterized by wide, gentle valley slopes with well-developed floodplains adjacent to river terraces. Stream types “C” and “E”, which are slightly entrenched and meandering channels that develop a riffle/pool bedform, normally develop in the Type VIII Valley (Rosgen, 1996).

Mapped Soils within the Study Area

The *Soil Survey of Mecklenburg County, North Carolina* (USDA, 1980) was consulted to determine soil-mapping units within the study area. According to the soil data, three soil-mapping units occur within the proposed project area. Four additional soil map units are located within the proposed conservation easement but are not anticipated to be impacted by the project. See Figure 3, Site Soil Survey Map.

Below are brief descriptions of the soil map units that occur within the proposed project area.

- **Monacan loam (MO) –** Monacan soils are very deep, moderately well and somewhat poorly-drained, moderately permeable soils found along stream corridors. These soils are formed in recent alluvium sediments of the Piedmont and Coastal Plain. Slopes are generally less than 2 percent.

- **Mecklenburg fine to sandy loam, 8 to 15 percent slopes (MeD) -** The Mecklenburg series consists of very deep, well-drained, slowly permeable soils that formed in residuum weathered from intermediate and mafic crystalline rocks of the Piedmont uplands.

- **Enon sandy loam, 8 to 15 percent slopes (EnD) -** The Enon series consists of very deep, well-drained, slowly permeable soils on ridgetops and side slopes in the Piedmont. They have formed in residuum weathered from mafic or intermediate igneous and high-grade metamorphic rocks such as diorite, gabbro, diabase, or hornblende gneiss or schist.

Below are brief descriptions of the four additional soil map units located within the proposed conservation easement but not proposed to be impacted by the project:

- **Enon sandy loam, 2 to 8 percent slopes (EnB) -** The Enon series consists of very deep, well-drained, slowly permeable soils on ridgetops and side slopes in the Piedmont. They have formed in residuum weathered from mafic or intermediate igneous and high-grade metamorphic rocks such as diorite, gabbro, diabase, or hornblende gneiss or schist.

- **Cecil sandy clay loam, 2 to 8 percent slopes, eroded (CeB2) and Cecil sandy clay loam, 8 to 15 percent slopes, eroded (CeD2) -** The Cecil series consists of well drained, moderately permeable soils found on broad ridges and side slopes. These soils formed in residuum from acid igneous and metamorphic rock.

- **Pacolet sandy loam, 15 to 25 percent slopes (PaE) -** The Pacolet series consists of well drained, moderately permeable soils found on side slopes adjacent to drainageways. These soils formed in residuum from acid igneous and metamorphic rock.

Of the seven soil map units within the proposed conservation easement, six are considered to be prime farmland soils or farmland soils of statewide importance. Specifically, EnD, MeD and CeD2 are farmland soils of statewide importance, CeB2 and EnB are prime farmland soils, and MO is a prime farmland soil if drained and either protected from flooding or not frequently flooded during the growing season (USDA Soil Data Mart 2009). PaE is not a prime farmland soil or a farmland soil of statewide importance.

Hydric Soils

The soil map units occurring within the conservation easement were compared to the *Hydric Soils of North Carolina* (http://soils.usda.gov/use/hydric/lists/state.html) to determine if hydric soils are known to occur within the study area. The Monacan loam soil series is the only mapped soil within the proposed conservation easement that is included on the list of *Hydric Soils of North Carolina* for Mecklenburg County and is designated 2B3, 4 hydric criterion. In Mecklenburg County, the Monacan loam map unit contains approximately 5% hydric inclusions. According to the NRCS Soil Data Mart, hydric inclusions consist of the Wehadkee soil series (undrained), which is designated an A hydric criterion (100% hydric), and typically occurs on depressions and floodplains. The Wehadkee series consists of very deep, poorly drained and very poorly drained soils on floodplains along streams that drain from the mountains and piedmont. They are formed in loamy sediments.

Since Monacan soils have a hydric B status, field observations were performed to determine areas within the easement as having hydric conditions. Throughout the easement area, soil samples were collected to determine the hydromorphic condition. In general, field observations of reduced chroma and aquic moisture regime were used in determining if a particular area was hydric. Indicators of wetland hydrology included saturated soils within the upper 12 inches, areas of inundation, oxidized rhizospheres, and water-stained vegetation. Additional hydrologic indicators included oxidized rhizospheres, water-stained leaves, crayfish burrows and multi-trunked tree species.

Field soil samples were taken to a minimum depth of 12 inches. The soils were studied for examples of hydric properties (i.e., oxidized rhizospheres, mottling, low chroma, concretions, and water saturation). *Munsell Soil Color Charts* (GretagMacbeth, 2000) were used to determine hue, value, and chroma of both the matrix and the mottle colors of each horizon. Hue indicates the relationship to the primary colors in the spectrum of white light, value indicates the lightness of the color, and chroma represents the strength. A low chroma soil with bright mottles or gleyed soil indicates a hydric soil if the low chroma is a result of a reducing environment rather than natural color or parent materials. A low chroma soil generally has a matrix chroma of 2 or less in mottled soils or a matrix chroma of 1 or less in unmottled soils.

Soils present in Wetland D and in the adjacent pasture targeted for restoration, to a depth of 12+ inches, match the profile of, and are typical of, Wehadkee loam. Wehadkee soils are designated a hydric A soil, and thus suitable for restoration. Note that, given the former cattle pasture operation in this area, it is highly likely that the upper portions of the soil profile have been repeatedly impacted in the past. Soils in Wetland D from 0 – 12 inches had a matrix color of 2.5Y 5/2 with common and distinct redoximorphic features of 7.5YR 4/6, and clayey loam texture. Soils in the adjacent pasture from 0 – 12 inches had a matrix color of 2.5Y 5/3 with common and distinct redoximorphic features of 7.5YR 4/6, and loam texture.

2.4 Historical Land Use and Development Trends

Land use within the UT Clarke Creek watershed is dominated by residential use. Within the residential land use parcels, there are some areas of open space that appear to be used for farm/agricultural use. According to Mecklenburg GIS data for proposed future land use, the entire drainage area of the UT Clarke Creek project will be Single Family and Multi-Family Residential land use except for a 35.5 acre parcel characterized for Institutional land use and a 1.7 acre parcel proposed for Greenway land use. The site has 16.5% Impervious Area.

According to the former property owner, beef cows grazed the riparian areas and had unrestricted access to the streams within the project site until the fall of 1999. The former property owner was fairly certain that no straightening or channelization of UT Clarke Creek or UT 1 was ever done but said that several parallel ditches were maintained on the south side of the stream to keep the bottom land dry enough to mow (these ditches were delineated by JJG as Wetland D and Wetland E/UT 5). Another ditch was maintained on the south side near the eastern pasture/timber boundary to drain runoff and water from a natural spring to the stream (this ditch was delineated by JJG and contains UT 2A, UT 2B, Wetland A and Wetland B). Most of the property on both sides of the stream was gullied and covered with 2nd or 3rd growth timber until it was cleared around 1950.

Beaver and their associated dams have also impacted the project reaches in the past. According to the LWP, which was prepared in 2004, livestock were still grazing the area. The property is currently used as a Nature Preserve for the Mecklenburg County Park and Recreation Department and is referred to as Clark's Creek Nature Preserve.

A summary of proposed land uses as designated by Mecklenburg County is provided in Table 2.2.

Table 2.2
Land Use of Watershed

Land Use*	Acres (ac)	Percentage (%)
Residential	651.7	**94.6**
Institutional	35.5	**5.2**
Greenway	1.7	**0.2**
Total	**688.9**	**100.0**

Source: Mecklenburg County GIS (2007)

2.5 Watershed Planning

EEP developed the Upper Rocky River local watershed plan (LWP) for the 200 square mile (sq mi) drainage area that included land use analysis, water quality monitoring, and stakeholder input to identify problems with water quality, habitat and hydrology. The Upper Rocky River LWP area is characterized as both urban and rural landscapes and has a history of water quality problems due to impacts related to high imperviousness. EEP completed the Upper Rocky River LWP in November 2004 (http://www.nceep.net/services/lwps/Clarke_Creek/wmp_r04-15-05.pdf). The LWP identified the following major stressors in the watershed: stream bank erosion, lack of adequate forested buffer, stream channelization, agricultural impacts, land use changes, sedimentation, point source in-stream impacts, nutrients, and fecal coliform bacteria. The LWP project atlas identified the Project Site MC01-1 in the Mallard Creek Subwatershed as a stream restoration opportunity with the potential to improve water quality and habitat within the project site watershed. Restoration of UT Clarke Creek and its unnamed tributaries will increase bank stability, nutrient filtration and aquatic habitat, and reduce stream bank erosion. The LWP also notes the potential to restore the forested riparian corridor between the two forested areas upstream and downstream of the project site.

2.6 Endangered / Threatened Species

Table 2.3 provides a summary of federal-listed threatened and endangered species for Mecklenburg County, North Carolina as reported by the U.S. Fish and Wildlife Service's

(USFWS) Region 4 Asheville Ecological Services Field Office website. Brief descriptions of the federal-protected species follow Table 2.3.

Table 2.3
Summary of Federal-Listed Species for Mecklenburg County

Species	Vernacular Name	Federal Rank	Record Status (as of January 31, 2008)	Preferred Habitat	Habitat Present
Faunal					
Lasmigona decorata	Carolina heelspiltter	E*	Current	The Carolina heelspiltter inhabits streams or small rivers and is usually found in mud, muddy sand, or muddy gravel substrates along stable, well-shaded stream banks.	No
Haliaeetus leucocephalus	Bald eagle	BGPA	Current	Bald eagles nest in mature live pines or cypress trees in the transition zone between mature forests and large bodies of water. Nesting trees are usually less than two miles from open water. Winter roosts are usually in mature trees, similar to nesting trees, but may be somewhat farther from water.	No
Floral					
Rhus michauxii	Michaux's sumac	E	Current	Michaux's sumac grows in sandy or rocky open woods in association with basic soils. Apparently, this plant survives best in areas where some form of disturbance has provided an open area.	No
Helianthus schweinitzii	Schweinitz's sunflower	E	Current	Occurs in clearings and edges of upland woods on moist to dryish clays, clay-loams, or sandy clay-loams; Schweinitz's sunflower usually grows in open habitats such as roadsides, powerline right-of-ways, and fallow pastures where there is little or no competition.	No
Echinacea laevigata	Smooth coneflower	E	Current	Smooth coneflower is typically found in open woods, cedar barrens, roadsides, clearcuts, dry limestone bluffs, and power line rights-of-way. It occurs in plant communities that have been described as xeric hardpan forests, diabase glades or dolomite woodlands. Optimal sites are characterized by abundant sunlight and little competition in the herbaceous layer.	No

E = Endangered; BGPA = Bald and Golden Eagle Protection Act
* There are only 6 known populations of this species left. None of which is in this portion of Mecklenburg County, North Carolina

2.6.1 Species Description

Carolina heelsplitter – The following description is extracted from the USFWS Asheville Ecological Services Field Office website for information pertaining to the Carolina heelsplitter (USFWS, 2008 A):

> The Carolina heelsplitter "has an ovate, trapezoid-shaped shell. The outer surface of the shell varies from greenish brown to dark brown in color, and shells from younger specimens have faint greenish brown or black rays. The nacre (inside surface) is often pearly white to bluish white, grading to orange in the deepest part of the shell. However, in older specimens the entire nacre may be a mottled pale orange. The shell of the largest known specimen of the species measures 4.6 inches in length. Like other freshwater mussels, the Carolina heelsplitter feeds by siphoning and filtering food particles from the water column. Historically the Carolina heelsplitter occurred in several locations within the Catawba and Pee Dee River systems in North Carolina and the Catawba, Pee Dee, Saluda, and Savannah River systems in South Carolina. Today, only ten populations are known to survive. The species still occurs in two small streams in North Carolina – one in the Catawba River system and one in the Pee Dee River systems. In South Carolina there are [seven] remaining populations, one in the Pee Dee; four in the Catawba; and two in small tributary streams in the Savannah River system. Finally, one population sits on the North Carolina/South Carolina state line, in the Catawba River system."

The Carolina heelsplitter is usually located within six feet of shorelines. Its best populations are found in areas with significant woodland as a dominant land use. Substrates found in creek reaches associated with the species vary from clay to various combinations of coarse substrates. It appears that creeks with complex mixtures of fine to coarse substrates may be required by the species and/or its fish host(s) (NatureServe, 2009).

Bald eagle – Juvenile bald eagles have mottled brown and white plumage, gradually acquiring their dark brown body and distinctive white head and tail as they mature. Bald eagles generally attain adult plumage by 5 years of age. Most are capable of breeding at 4 or 5 years of age, but in healthy populations they may not start breeding until much older. Bald eagles may live 15 to 25 years in the wild. Adults weigh 8 to 14 pounds (occasionally reaching 16 pounds in Alaska) and have wingspans of 5 to 8 feet. Those in the northern range are larger than those in the south, and females are larger than males. Eagle nests are constructed with large sticks, and may be lined with moss, grass, plant stalks, lichens, seaweed, or sod. Nests are usually about 4-6 feet in diameter and 3 feet deep, although larger nests exist (USFWS, 2007). In the July 9, 2007 Federal Register (72:37346-37372), the bald eagle was declared recovered and removed (de-listed) from the Federal List of Threatened and Endangered wildlife. This delisting took effect August 8, 2007. After delisting, the Bald and Golden Eagle Protection Act (BGPA) (16 U.S.C. 668-668d) becomes the primary law protecting bald eagles. The BGPA prohibits take of bald and golden eagles and provides a statutory definition of "take" that includes "disturb".

Bald eagle breeding habitat most commonly includes areas close to (within 2 miles of) coastal areas, bays, rivers, lakes, or other bodies of water where there is an availability of primary food sources including fish, waterfowl, and seabirds. Nests are usually situated in tall trees or on cliffs near water. Nest trees include pines, spruce, firs, cottonwoods, oaks, populars, and beech. Preferential roosting sites include conifers or other sheltered sites in winter in some areas; eagles will typically select the larger, more accessible trees (NatureServe, 2009).

Michaux's sumac – Michaux's sumac is a rhizomatous, densely hairy shrub, with erect stems from 1 to 3 feet in height. The compound leaves contain evenly serrated, oblong to lanceolate, acuminate leaflets. Most plants are unisexual; however, more recent observations have revealed plants with both male and female flowers on one plant. The flowers are small, borne in a terminal, erect, dense cluster, and colored greenish yellow to white. Flowering usually occurs from June to July; while the fruit, a red drupe, is produced through the months of August to October. Michaux's sumac grows in sandy or rocky open woods in association with basic soils. Apparently, this plant survives best in areas where some form of disturbance has provided an open area. At least twelve of the plant's populations in North Carolina are on highway rights-of way, roadsides, or on the edges of artificially maintained clearings. Two other populations are in areas with periodic fires, and two populations exist on sites undergoing natural succession. One population is situated in a natural opening on the rim of a Carolina bay (USFWS, 2008 C).

Schweinitz's sunflower – The following description is extracted from the USFWS Asheville Ecological Services Field Office website for information pertaining to Schweinitz's sunflower (USFWS, 2008 B):

> "Schweinitz's sunflower is a perennial that regularly grows approximately 6½ feet tall (though it can be shorter if young or injured) and can occasionally reach heights of 16 feet. It has thickened roots that are specially designed to store starch. The stem is purple, and the upper third bears secondary branches at 45-degree angles. The leaves are arranged in pairs on the lower part of the stem but usually occur singly on the upper part. Leaves grow out from the stem at a right angle, and the tips of the leaves tend to droop. The leaves are thick and stiff, with a rough upper surface. They have broad spiny hairs that are directed toward the tip, and soft white hairs cover the underside. The plant produces small yellow flowers. Schweinitz's sunflower blooms from late August until frost. It's able to colonize through the dispersal of seeds that readily germinate without a dormant period. In good conditions, it can grow 3 to 6 feet in a year and can live for decades."

Schweinitz's sunflower rarely occurs in Xeric Hardpan Forests where it is in relatively natural vegetation. The species is more typically found along roadside rights-of-way, maintained power lines and other utility rights-of-way, edges of thickets and old pastures, clearings and edges of upland oak-pine-hickory woods and Piedmont longleaf pine forests, and other sunny or semi-sunny habitats where disturbances (*e.g.*, mowing, clearing, grazing, blow downs, storms, frequent fire) create open areas for sunlight. It is intolerant of full shade and excessive competition from other vegetation (NatureServe, 2009).

Smooth coneflower – Smooth coneflower is a perennial herb in the Aster family (Asteraceae) that grows up to 1.5 meters (m) tall from a vertical root stock. The large elliptical to broadly lanceolate basal leaves may reach 20 centimeters (cm) in length and 7.5 cm in width and taper into long petioles toward the base. They are smooth to slightly rough in texture. The stems are smooth, with few leaves. The mid-stem leaves are smaller than the basal leaves and have shorter petioles. Flower heads are usually solitary. The rays of the flowers (petal-like structures) are light pink to purplish in color, usually drooping, and 5 to 8 cm long. Flowering occurs from late May through mid-July and fruits develop from late June to September. The fruiting structures often persist through the fall. Many of the herbs associated with smooth coneflower are also sun-loving species that depend on periodic disturbances to reduce the shade and competition of woody plants (USFWS, 2008 C).

2.6.2 Biological Conclusion

Field surveys were conducted in January 2010, and no observations were made of any listed species. Habitat was not observed for any of the listed species; therefore, it is not likely that the project will affect any of the listed species. Specific biological conclusions are as follows:

Carolina heelsplitter: Field surveys were conducted in January 2010, and no observations were made of the Carolina heelsplitter. Creeks with complex mixtures of fine to coarse substrates may be required by the species. The best populations are on sites with significant woodland as the dominant land use. Due to bank erosion and heavy sedimentation of the streams on-site, the limited canopy cover throughout the site, and the disturbed and narrow riparian buffers, habitat for the Carolina heelsplitter is not present in the proposed project area.

The following paragraph is excerpted from the USFWS North Carolina Ecological Services website pertaining to the Carolina heelsplitter (http://www.fws.gov/nc-es/mussel/carolheel.html):

> The Carolina heelsplitter "historically was known from several locations within the Catawba and Pee Dee River systems in North Carolina. Historically, the species was collected from the Catawba River, Mecklenburg County, North Carolina; several streams and ponds in the Catawba River system around the Charlotte area of Mecklenburg County, North Carolina; one small stream in the Pee Dee River system in Cabarrus County, North Carolina; one pond in the Pee Dee River system in Union County, North Carolina; and an area in South Carolina referred to only as the Abbeville District, a terminology no longer employed. Recent collection records (Keferl and Shelly 1988, Keferl 1991, Alderman 1995 and 1998) indicate that the Carolina heelsplitter has been eliminated from all but one of the streams from which it was known to have been originally collected…. In North Carolina one small remnant population occurs in the Catawba River system in Waxhaw Creek, a tributary to the Catawba River, in Union County, North Carolina, and another small population occurs in a short stretch of Goose Creek, a tributary to the Rocky River in the Pee Dee River system, in Union County, North Carolina."

The Carolina heelsplitter is not known to currently exist in Mecklenburg County, which is situated in both the Catawba River basin and Yadkin-Pee Dee River basin. However, as mentioned above, one small population occurs in Goose Creek, a tributary to the Rocky River in the Pee Dee River basin, in Union County. Like Goose Creek, UT Clarke Creek and its tributaries (via Mallard Creek) all drain to the Rocky River.

Sediment generated from project construction activities will not impact the Carolina heelsplitter population in Goose Creek for the following reasons: a) project impacts will be temporary; b) the distance between the project site and the Carolina heelsplitter population in Goose Creek is more than 30 stream miles; and c) the Carolina heelsplitter population in Goose Creek is situated upstream of the Rocky River, therefore should any sediment generated from the project site be transported over 30 miles, the sediment would not move upstream from the Rocky River and into Goose Creek.

Urbanization has impacted the Mallard Creek watershed and Rocky River basin between the project site and Goose Creek, and the resulting storm water runoff and point-source discharges have impacted water quality. According to the Watershed Management Plans and Recommendations for the Upper Rocky River Basin, the Mallard Creek sub-watersheds, including the sub-watershed that encompasses the project site, have experienced an increase in urban land use of greater than 30% in the riparian corridor between 1936 and 2002 (Mactec, 2004). This increase in urban land use has resulted in increased impervious cover, increased runoff, and increased sedimentation. In addition, given the urbanized nature of the Mallard Creek watershed, perched culverts are likely to present along Mallard Creek, Clarks Creek, and UT Clarke Creek, impeding the upstream migration of the Carolina heelsplitter.

According to the 2008 Yadkin – Pee Dee River Basin Plan, four major National Pollution Discharge Elimination System (NPDES) permit holders discharge to the Rocky River and Mallard Creek between the project site and Goose Creek, including the Rocky River Waste Water Treatment Plant (WWTP) and the Mallard Creek WWTP (NCDWQ, 2008B). In addition, two minor NPDES discharge facilities are located between the project site and the Carolina heelsplitter population site (NCDWQ, 2008B).

Water quality is impaired between the project site and Goose Creek. Clarks Creek, located downstream of the project site, is on the 2008 North Carolina 303(d) list of impaired waters due to impaired ecological/biological integrity (NCDWQ, 2008A). Mallard Creek, located downstream of the project site, is on the 303(d) list due to copper, turbidity, and impaired ecological/biological integrity (NCDWQ, 2008A). Rocky River between Mallard Creek and Goose Creek is also on the 303(d) list due to numerous parameters, including copper, zinc, turbidity, and ecological/biological integrity (NCDWQ, 2008B).

Due to the lack of appropriate habitat on the project site, the chemical and biological impairment between the project site and the known Carolina heelsplitter population in Goose Creek, the likelihood of physical barriers, and the distance between the project site and the population site, the proposed project will not impact the Carolina heelsplitter. Therefore, the biological conclusion for the Carolina heelsplitter is No Effect.

Bald Eagle: Field surveys were conducted in January 2010, and no observations were made of bald eagles. Bald eagles prefer to nest in large trees in close proximity to large bodies of waters that offer a primary food source. Roosting sites are in similar trees but may be further from water. Due to the lack of nesting or roosting sites within the proposed project area and no large bodies of water nearby, habitat for the bald eagle is not present in the proposed project area. Therefore, the biological conclusion for the bald eagle is No Effect.

Michaux’s sumac: Field surveys were conducted in January 2010, and no observations were made of Michaux’s sumac. Michaux's sumac grows in sandy or rocky open woods in association with basic soils. Habitat within the proposed project area consists of pasture and narrow riparian corridors with few canopy trees; therefore, suitable habitat is not present. Furthermore, the Clarks Creek Nature Preserve, including the proposed project area, has been reviewed and inventoried by Mecklenburg County Park and Recreation biologists, and no protected species have been identified (Luckenbaugh personal communication, 2010). Therefore, the biological conclusion for Michaux’s sumac is No Effect.

Schweinitz’s sunflower: Field surveys were conducted in January 2010, and no observations were made of Schweinitz’s sunflower. Schweinitz’s sunflower is typically found along roadside and utility rights-of-way, edges of thickets and pastures, and other similar locations, especially where disturbance has created sunny and semi-sunny habitats and has reduced competition. Suitable habitat is not present within the proposed project area due to haying operations within the pasture, competition in the herbaceous layer, and excessive soil moisture. Furthermore, the Clarks Creek Nature Preserve, including the proposed project area, has been reviewed and inventoried by Mecklenburg County Park and Recreation biologists, and no protected species have been identified (Luckenbaugh personal communication, 2010). Therefore, the biological conclusion for Schweinitz’s sunflower is No Effect.

Smooth coneflower: Field surveys were conducted in January 2010, and no observations were made of Smooth coneflower. Similar to Schweinitz’s sunflower, smooth coneflower grows best where there is abundant sunlight, little competition in the herbaceous layer, and periodic disturbances that prevents encroachment of shade-producing woody shrubs and trees. Suitable habitat is not present within the proposed project area due to haying operations within the pasture and competition in the herbaceous layer. Furthermore, the Clarks Creek Nature Preserve, including the proposed project area, has been reviewed and inventoried by Mecklenburg County Park and Recreation biologists, and no protected species have been identified (Luckenbaugh personal communication, 2010). Therefore, the biological conclusion for smooth coneflower is No Effect.

2.6.3 Federal Designated Critical Habitat

2.6.3.1 Habitat Description

The project area is not designated as Federal Critical Habitat. The project area has been impacted from past and present land use (agricultural practices).

2.6.3.2 Biological Conclusion

Since the project area has not been designated as Federal Critical Habitat, the project will not have an effect on a critical habitat area.

2.6.4 USFWS Concurrence

Prior to the field survey, a letter was submitted to the North Carolina Asheville Ecological Services Field Office of USFWS to obtain information regarding the listed species within Mecklenburg County, North Carolina. The letter dated January 6, 2010 requests any information of known occurrence within the vicinity of the project area. At this time, no response has been issued from the USFWS.

2.7 Cultural Resources

2.7.1 Site Evaluation Methodology

A review of the National Register of Historic Places database (http://www.nr.nps.gov/) indicates that there are no records of any historic places within the proposed study area. No known archeological resources will be affected by the proposed project and no historic properties will be affected. Should cultural resources be identified during construction, the USACE and State Historic Preservation Officer would be contacted.

2.7.2 Field Evaluation

2.7.2.1 Potential for Historic Architectural Resources

Because of the low probability of intact Architectural resources occurring within the study area and because no standing structures over 50 years old were observed during surveys, it is not anticipated that any historical structures would be impacted by construction of this project.

2.7.2.2 Potential for Archaeological Resources

Because the majority of the site has historically been disturbed due to past management for cattle grazing and rearing, it is not anticipated that any artifacts would be impacted by construction of this project. No archeological artifacts have been observed or noted during preliminary surveys of the site for restoration purposes. However, the previous landowner has mentioned that he has found evidence of Native American artifacts in the area where UT Clarke Creek leaves the eastern property boundary. He did not believe that the location was likely to be a settlement site because of its close proximity to the stream.

2.7.3 SHPO/THPO Concurrence

A letter was submitted on January 6, 2010 to the State Historic Preservation Office (SHPO) regarding the potential presence of archaeological, historic, or cultural resources. JJG received a response letter from the SHPO dated January 19, 2010 that stated that the agency is not aware of any resources that would be affected by the project. The letter to SHPO and SHPO's response letter are provided in Appendix 4.

2.8 Potential Constraints

2.8.1 Property Ownership and Boundary

The parcel that the proposed UT Clarke Creek restoration/enhancement will occur on is owned by the Mecklenburg County Park and Recreation Department. EEP will acquire a minimum 50-foot conservation easement along both banks of the project streams and wetlands. The conservation easement area, which is approximately 57.2 acres, should be large enough that it will not be a constraint to the project. With the exception of areas necessary for access, the proposed disturbance should occur within these limits.

2.8.2 Site Access

Communication with the County indicates that construction access should not be a major project concern and can occur beyond the conservation easement limits. A construction access plan is included in the designed sheets.

2.8.3 Utilities and Easements

Charlotte-Mecklenburg Utilities owns a sanitary sewer easement within the project site. An active sanitary sewer main parallels UT Clarke Creek and UT 1, with a perpendicular crossing of UT 3. The average depth of the sewer main is 10.4 feet. The easement is 15 feet wide along UT 1 and the upstream reach of UT Clarke Creek, and 20 feet wide along UT Clarke Creek downstream of its confluence with UT 1. The sewer line and utility easement will reduce buffer width to less than 50 feet along nearly the entire left bank of UT Clarke Creek, the entire right bank of UT 1, and a section of both banks along UT 3. The estimated buffer widths measured from the existing top of bank along the entire left bank of UT Clarke Creek will range from 3.5 – 30 feet, along the entire right bank of UT 1 will range from 7.5 – 45 feet, and along both banks of UT 3 will be 0 feet because of the perpendicular easement crossing of the stream.

There are no other utilities or utility easements within the project site.

2.8.4 FEMA / Hydrologic Trespass

According to the current FEMA-mapped floodplain for streams in the project area, segments of UT Clarke Creek, UT 2, and UT 3 are within the 100-year floodplain.

After discussing the project with the Flood Mitigation Program of Charlotte-Mecklenburg Storm Water Services, it is anticipated that a local floodway encroachment permit will be required. It is also anticipated that flood elevations are likely to change because of project implementation; if so, a FEMA Letter of Map Revision (LOMR) will be required within six months of project completion.

The HEC-RAS model shows the proposed restoration to result in a no-rise in the FEMA floodplain elevation.

SECTION 3

PROJECT SITE STREAMS (EXISTING CONDITIONS)

SECTION 3

PROJECT SITE STREAMS (EXISTING CONDITIONS)

3.1 Existing Conditions Survey

Field studies identified the presence of five wetlands within the NCEEP easement areas identified for wetland restoration, enhancement, or preservation. The wetlands were classified as palustrine emergent or palustrine scrub-shrub systems. Routine wetland determination data points were collected within each wetland polygon. Upland data points were also collected within areas adjacent to the wetland features but are not within the wetland boundary. Wetlands were marked with pink flagging and located with a Trimble Pro XH GPS. Eight streams were identified as jurisdictional waters. Six streams (namely UT Clarke Creek, UT 1, UT 2A, UT 2B, UT 3, and UT 6) were classified as riverine, upper perennial. The remaining streams (namely UT 4 and UT 5) were classified as riverine, intermittent. Each of these streams is included in plans for stream restoration, enhancement, or preservation. The locations of the wetlands and streams are shown on Figure 4, Project Site Hydrological Features Map With Gauge Locations. Please refer to Table 3.1 for a summary of the stream features.

Stream Characteristics

General Conditions for All Streams

Areas of mass wasting, bank slumping, incision, and/or sediment deposition are evident throughout all project reaches. In some areas, excess sediment from the eroding banks has deposited within the stream and covered the native substrate. During the initial site assessment, numerous beaver dams were found on UT Clarke Creek, UT 1, and UT 5, and these were removed in December 2009. Backwater from the beaver dams has also resulted in increased aggradation. These sediment deposits have likely reduced in-stream habitat for fish and macroinvertebrates. In certain areas, the sediment has formed sandbars. These sandbars tend to re-direct the stream flow into the banks encouraging potential erosion. UTs 1 – 5 all appear to be incised with eroding banks. The majority of substrate in UT Clarke Creek, UT 1, UT 3, and UT 6 is dominated by gravel-sized particles with numerous bedrock outcrops; cobble substrate is also evident in UT 6. In areas along these streams that were impacted by beaver dams, the substrate is composed of a silt-mud material. The majority of stream banks of these reaches are lacking in vegetative cover. UT 2, UT 4, and UT 5 are dominated by fine sediments with some in-stream vegetation.

Bedrock outcroppings were observed within various locations along UT Clarke Creek, UT 1, and throughout the floodplain and riparian areas.

The main sources of instability for the project reaches are lack of vegetation and lack of frequent connection with the floodplain. Lateral stream instability is much more abundant than vertical instability within the project site due to the bedrock providing natural grade control. Overall, the instability of the project streams is contributing to stream bank loss, increased sedimentation, and less viable biological habitat.

The buffer along the stream channels consists of heavy thickets of blackberry and fescue that have recently been mowed, and few trees are found along the project streams. Several invasive species (e.g. Japanese honeysuckle, multiflora rose, blackberry) occur along the project streams.

UT Clarke Creek – UT Clarke Creek is classified as riverine, upper perennial and is unnamed on the Derita, NC USGS 7.5 minute Topographic Map (NC OneMap, 2009). UT Clarke Creek is approximately 10 to 15 feet in width at the ordinary high water mark and approximately 10 to 20 feet in width at the top of bank. The stream is slightly incised; however, bedrock outcroppings throughout the existing stream bed provide grade control and prevent the stream from further incision and entrenchment. Indicators of over-bank flows (wrack lines, flood debris, and sediment deposition) were observed during JJG's field surveys. This evidence could indicate that the stream is not deeply incised and is somewhat connected to its floodplain. However, the banks are actively eroding and unstable. The over-bank flow indicators could also have been caused by the beaver dams that have occurred on the stream in the past. Areas of severe mass wasting, bank slumping, and sediment deposition are evident throughout the UT Clarke Creek. The dominant substrate within the majority of the project is coarse sand and gravel, which is overlain in many areas by a thick layer of fine sediment (mud and silt); however, numerous rock outcrops are present throughout the reach within the project area. The riffles that were not impacted by beaver dams consisted of coarse gravel. Please refer to Appendix 1 for a photograph of this stream.

UT 1 - This unnamed tributary is classified as riverine, upper perennial and drains directly into UT Clarke Creek. UT 1 is approximately 6 to 10 feet in width at the ordinary high water mark and approximately 10 to 15 feet in width at the top of bank. Top of bank height ranges from 3 to 6 feet. The dominant substrate within the project area is coarse sand and gravel overlain by fine sediments of mud and silt. Some areas of rock outcrops are also present. The stream is impaired due to surrounding land use and heavy siltation from bank erosion. Please refer to Appendix 1 for a photograph of this stream.

UT 2 – This unnamed tributary contains two reaches, UT 2A and UT 2B, which are separated by Wetland A (WL A). WL A, described in greater detail below, is an emergent wetland that has formed from sediment deposition and has severed the connection between the two stream reaches. According to the former property owner, UT 2 was maintained in the past as a ditch to drain runoff from a natural spring. This natural spring was observed in Wetland B (WL B) and is described in greater detail below.

- *UT 2A* – This unnamed tributary is classified as a riverine, upper perennial stream. UT 2A ranges in width from 6 to 10 feet at the ordinary high water mark and 8 to 12 feet at the top of bank. Top of bank height ranges from 2 to 4 feet. The dominant substrate is medium sand and silt. UT 2A begins at WL A and drains directly into UT Clarke Creek. The bankfull bench and portions of the channel bottom are covered in dense vegetation, including rice cutgrass (*Leersia oryzoides*), soft rush (*Juncus effusus*), and arrow-leaved tearthumb (*Polyginum sagitatum*). The presence of larval salamanders indicates a perennial flow regime. Please refer to Appendix 1 for a photograph of this stream.

- *UT 2B* **–** This unnamed tributary is classified as a riverine, upper perennial stream. UT 2B ranges in width from 8 to 12 feet at the ordinary high water mark and 8 to 15 feet at the top of bank. Top of bank height ranges from 2 to 3 feet. The dominant substrate is medium sand and silt. UT 2B begins at Wetland B (WL B) and ends at WL A, where bed and bank features are no longer evident. The bankfull bench and the majority of the channel bottom are covered in dense vegetation, including rice cutgrass and arrow-leaved tearthumb. The presence of larval salamanders indicates a perennial flow regime. Please refer to Appendix 1 for a photograph of this stream.

UT 3 – This unnamed tributary is classified as riverine, upper perennial, and drains directly into UT Clarke Creek. UT 3 is approximately 3 to 6 feet in width at the ordinary high water mark and approximately 4 to 6 feet in width at the top of bank. Top of bank height ranges from 2 to 4 feet. The dominant substrate within the project area is coarse and medium sand and gravel, overlain in areas by sediment comprised of mud and silt. The stream is impaired due to surrounding land use and heavy siltation from bank erosion. Please refer to Appendix 1 for a photograph of this stream.

UT 4 – This unnamed tributary is classified as an intermittent stream. UT 4 ranges in width from 3 to 6 feet at the ordinary high water mark and 4 to 8 feet at the top of bank. Top of bank height ranges from 2 to 4 feet. The dominant substrate is medium and coarse sand with some gravel overlain by fine sediments comprised of silt. UT 4 begins at Wetland C (WL C) and drains directly into UT 2B. The downstream-most portion of the channel bottom is covered in dense vegetation, including rice cutgrass and arrow-leaved tearthumb. Please refer to Appendix 1 for a photograph of this stream.

UT 5 – This unnamed tributary is classified as an intermittent stream. The upper reach of UT 5 is approximately 4 to 6 feet wide at the ordinary high water mark and 4 to 8 feet at the top of bank. The banks of this reach are shallow, generally less than 12 inches in height. The dominant substrate in the upper reach is medium sand and silt. The lower reach of UT 5 as it approaches its confluence with UT Clarke Creek is 2 to 4 feet wide at the ordinary high water mark and 3 to 6 feet wide at the top of bank. Top of bank height of this reach is 1 to 2 feet. The lower reach is significantly downcut where the dominant substrate is comprised of clay and saprolite. According to the former property owner, this stream was a man-made ditch dug and maintained to drain the soils in the floodplain of UT Clarke Creek for haying operations. Please refer to Appendix 1 for a photograph of this stream.

UT 6 - This unnamed tributary is classified as riverine, upper perennial, and drains directly into UT Clarke Creek. UT 6 is approximately 6 to 12 feet in width at the ordinary high water mark and approximately 6 to 15 feet in width at the top of bank. Top of bank height ranges from 3 to 6 feet. The dominant substrate is coarse sand, gravel, and cobble with numerous boulders noted throughout. Riffle-pool structure was noted throughout with well-formed riffles of gravel and cobble. Areas of severe bank erosion were observed throughout the reach. The majority of the riparian corridor is wooded and offers nearly 100% canopy cover. Please refer to Appendix 1 for a photograph of this stream.

Table 3.1
Summary of Stream Features

Jurisdictional Area	USGS Stream Association	Classification	Flow regime / Community	Approximate Linear Distance (ft)	Notes
UT Clarke Creek	Tributary to Clarke Creek	Upper perennial	R3UB2	1507	Proposed project to include Enhancement Level I
UT 1	Tributary to Clarke Creek	Upper perennial	R3UB2	723	Proposed project to include Enhancement Level I
UT 2A	Tributary to Clarke Creek	Upper perennial	R3UB2/3	144	Proposed project to include Enhancement Level II
UT 2B	Tributary to Clarke Creek	Upper perennial	R3UB3/AB3	177	Proposed project to include Enhancement Level II
UT 3	Tributary to Clarke Creek	Upper perennial	R3UB2	100	Proposed project to include Enhancement Level I
UT 4	Tributary to Clarke Creek	Intermittent	R4SB4/5	363	Proposed project to include Enhancement Level I
UT 5	Tributary to Clarke Creek	Intermittent	R4SB5/7	109	Proposed project to include Restoration
UT 6	Tributary to Clarke Creek	Upper perennial	R3UB1/2	1,464	Proposed project to include Preservation
			Total Stream Length	**4,594**	

Local Watershed Plan

The UT Clarke Creek project stream was studied in the Upper Rocky River Local Watershed Plan (LWP; http://www.nceep.net/services/lwps/pull_down/by_county/Mecklenburg.html). The LWP was completed in November 2004. According to the study, the project watershed is located in the MC01 subwatershed, which is located in the western portion of the Mallard Creek Local Watershed. The study indicated that the MC01 subwatershed is characterized by residential and commercial developments and has experienced the largest decrease (37%) in forested riparian lands within the Mallard Creek Local Watershed. Within the MC01 watershed, four (4) sites were selected for visual assessment (Sites MC01-1, MC01-2, MC01-3, and MC01-4). Site MC01-1 is located at the confluence of UT Clarke Creek and UT 1 within the current EEP project site. MC01-1 received a “Fair” stream rating. Observed problems during the study included channelization, bank instability, and a limited riparian buffer. At the time of the study, MC01-1 was bordered by pastures characterized by unrestricted livestock access to the channel and riparian zone. At some time since the LWP was completed, the livestock was removed from the land surrounding the stream and no longer has access to the stream. The land is now used by the county as a nature preserve. The riparian zone is now comprised of heavy thickets of blackberry and fescue. There are very few, if any, trees along the project reaches.

The LWP revealed that all of the assessed reaches in MC-01 showed signs of hydrologic stress (i.e., severe downcutting, bank instability, and channelization); however, it was less than anticipated given the level of development in the watershed. The presence of stable coarse substrate (e.g., bedrock, boulders, and large cobble) could be providing grade control and preventing the stream from further hydrologic stress (incision and downcutting).

The LWP did not provide any water quality data for site MC01-1. Other surrounding subwatersheds in the Mallard Creek Local Watershed exhibited elevated levels of numerous constituents including aluminum, iron, and fecal coliform. The most likely source of fecal coliform is from agricultural use, which is no longer taking place along MC01-1.

The LWP revealed good habitat with well-developed riffles, diverse substrates, pools, root mats, and undercut banks within the MC01 watershed. The negative impacts to habitat in the MC01-1 site described in the study most likely occurred due to livestock access. Because the livestock has been removed from the project area, it is likely that habitat in proximity to the MC01-1 site has improved since the time of the study.

Table 3.2 summarizes the visual assessment findings from the LWP for Site MC01-1.

Table 3.2
MC01-1 Stream Visual Assessments

Category	Score
Channel condition	4
Hydrologic alteration	6
Riparian zone	5
Bank stability	6
Nutrient enrichment	7
In-stream habitat	8
Canopy coverage	5
Manure presence	4
Riffle embeddedness	7
Macroinvertebrates observed	10
Stream Rating*	**6.2 (Fair)**

*<=6.0=Poor, 6.1-7.4=Fair, 7.5-8.9=Good, >=9.0=Excellent

3.2 Channel Classification

UT Clarke Creek and the unnamed tributaries were classified using the Rosgen stream classification system, based on surveyed morphological measurements (Rosgen, 1996).

The existing surveyed reach of UT Clarke Creek was classified as two different reaches. Reach 1, which is identified as the project reach of UT Clarke Creek upstream of the confluence with UT 1, was classified as an E4. It did not have the sinuosity that would be associated with an E type stream, but this is probably due to previous land use disturbances. Reach 2 of UT Clarke Creek, which is located downstream of the confluence with UT 1, was classified as a B4c. The "little c" designation was added to the classification because the slope/gradient of the stream

(<0.02) resembles more of a C-type stream than a B-type stream. It did not have the sinuosity that would be associated with a B-type stream, but this is probably due to previous land use disturbances. UT 1 classified as a B4c due to its entrenchment ratio. It had the W/D ratio of an E type stream and lacked the sinuosity of either a B or an E. The little c designation was due to the low water surface slope (<0.02). It did not have the sinuosity that would be associated with a B type stream, but this is probably due to previous land use disturbances. UT 2 was classified as a B5 stream due to its entrenchment ratio and W/D ratio. It did not have the sinuosity that would be associated with a B type stream, but this is probably due to previous land use disturbances. UT 3 was classified as an E5 stream due to its entrenchment ratio and W/D ratio. It did not have the sinuosity that would be associated with an E type stream, but this is probably due to previous land use disturbances. UT 4 could classify as either an A or G5. UT 4's entrenchment and W/D ratios fall within the ranges for both A and G type streams. The sinuosity of the project reach places it in the A stream type range since the stream alignment was probably channelized due to previous land disturbance. However, due to decreasing sinuosity, it could also be a G type stream. UT 5 was classified as an E5 stream due to its entrenchment and W/D ratios. It did not have the sinuosity that would be associated with an E type stream, but this is probably due to previous land use disturbances. UT 6 was classified as a B4 due to its entrenchment ratio. It had the W/D ratio of an E type stream but lacked the sinuosity of either a B or an E. This is probably due to previous land use disturbances.

E and B type streams are typically considered relatively stable when dense riparian vegetation is present, but the stream banks of UT Clarke Creek and its tributaries are extremely eroded and unstable. The history of unrestricted livestock access in this area has severely impacted the riparian areas of the project streams and caused significant stream bank disturbance.

G type streams are considered unstable and are therefore prime candidates for stream restoration efforts.

3.3 Valley Classification

The project site resides in a Valley Type VIII. These valley types are characterized by wide, gentle valley slopes with well-developed floodplains adjacent to river terraces. Stream types C and E, which are slightly entrenched with meandering channels that develop a riffle/pool bedform, normally develop in the Type VIII Valley (Rosgen, 1996).

3.4 Discharge (bankfull, trends)

Using USGS rural regression equations for North Carolina's Blue Ridge Piedmont hydrologic area (2001), peak flows for the 2-, 5-, 10-, 25-, 50- and 100-year storms were calculated for UT Clarke Creek and UT 1 to determine the existing discharges. The UT Clarke Creek peak flows for the 2-, 5-, 10-, 25-, 50- and 100-year storms were modeled using Hydrologic Engineering Center's River Analysis System (HEC-RAS) to determine water surface elevations associated with the different peak flows. Table 3.3 presents the discharge trends calculated for the main channel and UT 1. A typical cross-section for the main channel and UT 1 were modeled in Bentley Flowmaster to determine bankfull discharge (the water surface at which flow reached the bankfull indicator; see Table 3.4). Refer to Section 3.8 for information on regional curve bankfull discharge and crest gauge results.

Table 3.3
Peak Discharges (Q) from Regression Equations

Reach	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)
UT Clarke Creek	142	255	351	500	632	782
UT1	78	143	200	288	368	459

Table 3.4
Bankfull Discharges (Qbkf) from Bentley Flowmaster

Reach	Qbkf -Calculated (cfs)
UT Clarke Creek	92
UT1	64

3.5 Channel Morphology (pattern, dimension, profile)

Existing stream morphological conditions for the two main stream components of the project, UT Clarke Creek and UT 1 are summarized in Table 3.5. The additional unnamed tributaries do not have morphology broken down in detail since only minor benching and vegetation is proposed. Pattern and profile were surveyed and summarized below but not included in the morphological table because all project streams will remain in their existing alignments due to project constraints, and the only component that will be altered is stream dimension. All geomorphic assessments (cross-section, longitudinal, and pebble counts) were performed following guidelines outlined in the *Stream Channel Reference Sites: An Illustrated Guide to Field Techniques* (Harrelson et al., 1994). A topographic survey of the project site was completed by Avioimage Mapping Services, Inc. The survey consisted of collecting detailed data for all stream, wetland, and floodplain areas, and the location of trees within the established conservation easement.

Currently, the main channel of UT Clarke Creek is classified as two different reaches. Reach 1, which is identified as the project reach of UT Clarke Creek upstream of the confluence with UT 1, was moderately incised (Bank Height Ratio of 1.43 – 1.48) with highly erosive banks. The channel has down-cut slightly and widened slightly over the course of time. The stream's vertical stability is maintained due to the numerous bedrock knick points throughout the reach; however, lateral stability varies depending upon tree rooting and existing rocks within the soil. Reach 2 of UT Clarke Creek, which is located downstream of the confluence with UT 1, is more incised (Bank Height Ratio of 1.75 – 2.09) and has widened more than the upstream reach of UT Clarke Creek. There are not many areas of stable banks or bank protection along the project reach of UT Clarke Creek because of the lack of large trees and mature riparian areas. Lateral stability is the main concern of the project reach. There is not much potential for vertical adjustment due to the presence of bedrock. The sinuosity of the project reach of UT Clarke Creek is low (1.07) and is probably due to previous land use disturbances which may have altered the stream pattern. The sinuosity may also be low because of the presence of bedrock throughout the floodplain which prevents the stream from developing a more sinuous pattern. The stream is "locked in" to its pattern by the bedrock.

UT 1 is moderately incised (Bank Height Ratio of 1.34 – 1.56) with highly erosive banks. The channel has down-cut and widened slightly over the course of time. The stream's vertical stability is maintained due to the numerous bedrock knick points throughout the reach; however, lateral stability varies depending upon tree rooting and existing rocks within the soil. There are not many areas of stable banks or bank protection along the project reach of UT 1 because of the lack of large trees and mature riparian areas. Lateral stability is the main concern of the project reach. There is not much potential for vertical adjustment due to the presence of bedrock. The sinuosity of the project reach of UT 1 is low (1.1) and is probably due to previous land use disturbances which may have altered stream pattern. The sinuosity may also be low because of the presence of bedrock throughout the floodplain which prevents the stream from developing a more sinuous pattern. The stream is "locked in" to its pattern by the bedrock.

The bankfull cross-sectional area (20.88 – 22.29 ft^2) of both reaches of UT Clarke Creek is currently very close to what is predicted in the North Carolina Regional Curves for Rural Piedmont streams (23.15 ft^2). The W/D ratio range (6.22 - 11.57) of the existing UT Clarke Creek project reach is also in the vicinity of what would be expected according to the North Carolina Regional Curve for Rural Piedmont streams (8.9 ft^2). The average water surface slope of Reach 1 of UT Clarke Creek is 0.012 ft/ft and for Reach 2 the slope is 0.0029 ft/ft. The low slope in Reach 2 is probably due to the beaver dams that were abundant in the past. The beaver dams are probably also a factor in the wider stream width of Reach 2. This results in the occurrence of a higher sediment deposition rate within this channel. Typically, upstream bank failure and overwidened channels leads to aggradation. These areas of aggradation are also indicating a shift in stream bed form; some of the areas where riffles are expected are flat, filled with sediment, and evolving into runs. UT Clarke Creek is characterized by a reach wide D50 of 12.28 millimeters (mm), indicating a channel substrate dominated by gravel sized particles. Given the highly erosive stream banks and the large amount of stream bank erosion, one would expect to find minimal habitat and few coarse substrates; however, UT Clarke Creek contains well developed riffles and diverse substrates, especially in Reach 1. There are also numerous bedrock riffles in Reach 1. The bed features vary from a riffle-pool sequence in Reach 1 of UT Clarke Creek to a continuous run with sporadic pools located within Reach 2. There are several bedrock outcrops in Reach 2, and there exists the possibility that bedrock is buried under the sediment in the over-widened runs.

The bankfull cross-sectional area (15.46 – 17.01 ft^2) of UT 1 is currently very close to what is predicted in the North Carolina Regional Curves for Rural Piedmont streams (13.07 ft^2). The W/D ratio range (5.34 - 7.46) of the existing UT 1 project reach is slightly lower that what is expected according to the North Carolina Regional Curve for Rural Piedmont streams (8.4). The lower W/D ratio could be due to the channel over-widening in areas, and adjusting to re-establish a dynamic equilibrium. Shrubby woody vegetation along the banks of UT 1 could also be preventing the project reach from over widening. The average water surface slope of UT 1 is 0.009 ft/ft. At approximately station 5+60 there is a ford crossing on the channel. The elevation of this crossing has created backwater on the project reach upstream of the crossing. This backwater has resulted in the deposition of fine substrates in this area as well as the stream being over widened. These areas of aggradation are also indicating a shift in stream bed form; some of the areas where riffles are expected are flat, filled with sediment, and evolving into runs. Downstream of the ford crossing, the riffles are well developed with coarse substrate. UT 1 is characterized by a reach-wide D50 of 2.31 mm, indicating a channel substrate dominated by gravel and sand-sized particles. Given the highly erosive stream banks and the large amount of stream bank erosion, one would expect to find minimal habitat and few coarse substrates; however, UT 1 contains areas of well-developed riffles and diverse substrates, especially downstream of the ford crossing. The bed features vary from a riffle-pool sequence in the lower reach of UT 1 to a continuous run with sporadic pools located upstream of the ford crossing.

Because the project streams are disconnected from their floodplains, high shear stresses and discharge volumes contained within the channels are greater. This leaves the streams vulnerable to bank erosion and failure, which is occurring throughout the project reach.

Table 3.5
Existing Morphology

		UT Clarke Creek 1		**UT Clarke Creek 2**		**UT 1**	
	Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
General	Drainage Area (sq mi)	1.00		1.08		0.46	
	Stream Type (Rosgen)	E4*		B4c*		B4c*	
	Valley Type	VIII		VIII		VIII	
Dimension	BKF Mean Velocity (Vbkf) (ft/s)	5.03		2.32		4.11	
	Bankfull Discharge (Qbkf)(cfs)	110.8**		49.7**		64.0**	
	Bankfull XSEC Area, Abkf (sq ft)	20.88	22.29	21.44	22.19	15.46	17.01
	Bankfull Width, Wbkf (ft)	11.38	12.62	15.73	15.77	9.08	11.26
	Bankfull Mean Depth, dbkf (ft)	1.83	1.77	1.36	1.41	1.7	1.51
	Width to Depth Ratio, W/D (ft/ft)	6.22	7.13	11.18	11.57	5.34	7.46
	Width Floodprone Area, Wfpa (ft)	36.14	49.08	22.47	28.67	19.5	20.02
	Entrenchment Ratio, Wfpa/Wbkf) (ft/ft)	2.86	4.31	1.42	1.82	1.73	2.2
	Max Depth @ bkf, Dmax (ft)	3.5	3.51	1.82	2.27	1.83	2.45
	Max Depth Ratio, Dmax/dbkf	1.91	1.98	1.29	1.67	1.21	1.44
	Max Depth @ tob, Dmaxtob (ft)	5.01	5.19	3.17	4.74	2.85	3.28
	Bank Height Ratio, Dtob/Dmax (ft/ft)	1.43	1.48	1.74	2.09	1.34	1.56
Substrate	d16 (mm)	2.46				0.1	
	d35 (mm)	7.96				1.07	
	d50 (mm)	12.28				2.31	
	d84 (mm)	43.87				9.65	
	d95 (mm)	75.19				13.99	

Cells noted with a (*) have been classified using a typical cross-section within each reach, Cells noted with a (**) were calculated using using Flowmaster.

3.6 Channel Evolution

Any change within and around a channel typically results in a period of instability and adjustments to re-establish a state of dynamic equilibrium with the sediment load and discharge of the stream (Leopold et al., 1992, Simon, 1989, and Rosgen, 2004a). The sequence of adjustments that a channel undergoes can be predicted using Simon's (1989) conceptual evolution model. Determining the stream type evolution can be predicted using Rosgen's (2006a) successional stages of channel evolution.

Simon's (1989) model predicts that following some type of disturbance, such as straightening or channelization, degradation occurs, resulting in an incised channel with vertical banks. When critical bank heights of a channel are exceeded, extensive bank failure and mass wasting occur, beginning the widening stage of the channel evolution process (Simon, 1989). As the widening and bank failure continue upstream, aggradation will occur downstream. The final stage of the channel evolution process results in the development of a new channel within the alluvium deposits downstream. The new channel is now at a lower elevation and typically has similar dimension and pattern to that of the pre-modified channel (Simon, 1989). Rosgen (2006a) describes nine different stream type channel evolution scenarios to assist the observer in determining the appropriate stage and evolution direction of a stream.

The process for a channel to naturally evolve through these stages to re-establish a state of dynamic equilibrium typically occurs over a long period of time depending upon channel inputs and channel substrate characteristics (10's to 1000's of years). This evolution can result in excessive stream bank erosion rates, which is a major cause of non-point source pollution (Rosgen, 2001). Using the stream evolution prediction models, the current trends in a disturbed stream can be identified, and the direction in which the stream is moving can be predicted. The current and future stage of evolution of a stream should be assessed before selecting appropriate restoration action to undertake. For this study, both concepts were applied to UT Clarke Creek and UT 1 to assess current conditions and provide guidance for future trends.

Both reaches of UT Clarke Creek and UT 1 have been historically altered due to beaver activity. The resulting stream morphology may not follow the typical channel evolution scenarios because of these impacts.

According to Rosgen's stream channel succession scenarios (Rosgen, 2006b) and the guidance on the referenced website (http://water.epa.gov/scitech/datait/tools/warsss/successn.cfm), the upper reach of UT Clarke Creek does not fall under any of the scenarios. The reach's current condition is classified as an E type stream with bedrock-controlled vertical stability and degrading/eroding stream banks. The reach is currently an E but is on its way to becoming an F. The stream will not be able to evolve from an F to a C because the presence of bedrock limits downcutting, which would be needed to create a C type stream. The reach could perhaps evolve into a C type stream through aggradation. The reach would most closely fall under Scenario 9, which follows a stream type evolution from C→G→F→C, if not for the bedrock control. Using Simon's conceptual channel evolution model, the upper reach of UT Clarke Creek is in the widening level within stage V. The lower reach of UT Clarke Creek, which is below the confluence with UT 1, would most closely fall under Scenario 6, which follows a stream type evolution from B→G→Fb→B. It currently appears to be in between the Fb→B phase. The upper reach of UT Clarke Creek appears to be in the early stage of the aggradation and widening process. However, within the lower reach of UT Clarke below UT1, the stream appears to be in the later part of stage V where it has been aggrading and widening for a longer period. UT 1 seems to be following the stream type evolution scenario from a B→G→Fb→B, which is Scenario 6 according to Rosgen's predicted channel evolution scenario. The stream channel is most likely in stage IV of Simon's channel evolution model, a state of degradation and widening. Bedrock nickpoints through the reach are protecting the stream from further vertical degradation. Channel changes due to instability (removal of riparian vegetation) for the reaches of UT Clarke Creek and UT 1 mainly involve lateral extension processes. It could take an extended length of time, but with proper riparian vegetation, the streams should eventually restore themselves to stable B4 stream types. Excavation of a bankfull floodplain bench should accelerate this process. Because the project streams are incised, storm flows are prevented from accessing the floodplain. All of the energy and stress from these flows are being dissipated on the stream banks, thereby causing erosion. By excavating a bankfull bench, the project stream will be reconnected to its floodplain, where the energy and shear stress will be dissipated. This will help to reduce stream bank erosion.

3.7 Channel Stability Assessment

The chief problems associated with the project reaches are severe bank erosion and lack of an appropriate riparian buffer.

Stream Bed and Bank Stability

Stream bed and bank composition provide indicators for changes in channel form, hydraulics, erosion rate and sediment supply (Doll et al., 2003). Streambank erosion rate (lateral erosion rate) and sediment supply (tons/yr) is a very important variable in the river stability assessment. One consequence of a disturbed stream is streambank erosion and associated land-loss and sediment supply to the system. Extensive streambank erosion rates tend to create a loss of in-stream habitats, leaving a homogenized environment due to extensive sedimentation (Waters, 1995 and Brooks et al., 2002).

Rosgen (2001) developed a channel stability assessment using the channel dimension relationships, river profile and bed features, vertical stability (degradation/aggradation), lateral stability, degree of confinement, degree of incision, channel enlargement, channel evolution, and near bank velocity stresses along the channel. Two prediction methodologies are used in Rosgen's channel stability assessment to determine the potential for bank erosion: Bank Erodibility Hazard Index (BEHI) and Near-Bank Stress (NBS). BEHI assesses the physical properties of the stream bank to determine the possible sources of bank instability, such as removal of vegetation, livestock access, high bank height ratios, bank angle, lack of vegetative or rock surface protection, and poor, non-cohesive bank/soil material type.

The second factor in the channel stability assessment is NBS, which assesses the bank with respect to the stress associated with the velocity in that portion of the channel. Using these methodologies, the expected annual sediment load produced from a stream system is estimated.

Table 4 in Section 12 summarizes the BEHI/NBS results and sediment export estimates for UT Clarke Creek and UT 1. Both the existing UT Clarke Creek and UT 1 are showing signs of channel instability. This instability is probably a result of the removal of riparian vegetation, urbanization, and beaver activity occurring locally and within the watershed. The loss of riparian vegetation has exposed raw soil resulting in excessive sedimentation within the channel and on the stream banks. UT Clarke Creek and UT 1 are contributing large amounts of sediment from within the stream channels and stream banks.

3.8 Bankfull Verification

Visual bankfull indicators were difficult to identify in the field, primarily because of the recent beaver activity. Also, the existing UT Clarke Creek and UT 1 are incised in a majority of the reaches, which makes it difficult to identify bankfull in the field. Within the existing main channel of UT Clarke Creek, Cross-section 4 is stable and has developed a bankfull bench within the incised channel. Since it appeared stable, the surveyed data from Cross-section 4 was used in Bentley Flowmaster to determine the existing bankfull discharge of UT Clarke Creek, which was assumed to be the flow associated with the water surface level on the bankfull bench feature of the cross-section. The same process was used for Cross-section 1 of UT 1. The discharges were calculated and compared to the North Carolina Regional Curves for Rural Piedmont streams (Harman, et al., 1999). The calculated bankfull discharge for UT Clarke Creek is very similar to the discharge from the regional curves associated with the drainage area predicted. The calculated bankfull discharge for UT 1 is slightly higher than the regional curves associated with the drainage area predicted. A possible reason for the calculated discharge being higher than the predicted discharge on UT 1 could be due to the steeper gradient of the stream (0.009 ft/ft).

Table 3.6 illustrates calculated and verified bankfull discharges for UT Clarke Creek and UT 1.

Table 3.6
Existing Bankfull Discharge (Qbkf)

Reach	Drainage Area (sq miles)	Qbkf -Calculated (cfs)	Qbkf-Regional Curve* (cfs)
UT Clarke	1.08	92.2	96.8
UT 1	0.46	64.0	52.8

* NC Regional Curve for Rural Piedmont Streams

Indicators of over-bank flows (wrack lines, flood debris, etc.) were visually observed several times during JJG's field surveys between January 2010 and June 2010. These over-bank flood deposits could also have been results from the beaver dams.

A crest-gauge will be installed after construction to record stage during high flow events. This gauge will be installed to assist in verifying that a bankfull discharge or greater is occurring within the project.

3.9 Vegetation Community Type Descriptions and Disturbance History

The project site is situated on a Mecklenburg County Parks and Recreation Department passive preserve known as the Davis Farm Nature Preserve, or Clarks Creek Nature Preserve, and is primarily comprised of recently pastured land with narrow riparian buffers surrounding the streams on-site. Several unnamed tributaries of Clarke Creek traverse the project site. The riparian vegetation associated with these tributaries range from herbaceous and scrub-shrub vegetation to early successional forest vegetation with few mature hardwoods observed. Relatively frequent disturbance within Charlotte-Mecklenburg Utilities (CMU) 15-foot and 20-foot wide sanitary sewer easements has resulted in a predominantly herbaceous cover within the sewer maintenance corridors adjacent to UT Clarke Creek and UT 1.

UT Clarke Creek is located within a riverine bottomland between two topographic ridgelines. From the upstream-most portion to its confluence with UT 2 (from Station 0+00 to approximately Station 1180+00), the south side of UT Clarke Creek consists of cleared floodplain pasture and rolling hills planted in fescue (*Festuca sp.*). A 50 – 70-foot wide buffer situated between the pasture and the top-of-bank, consisting of herbaceous and scrub-shrub species, is located between Station 0+00 and approximately Station 06+30. This portion of the buffer also includes Wetland E and UT 5 and appears to have been impacted by recent clearing. The buffer on the north side of UT Clarke Creek from its upstream-most portion to near the confluence with UT 2 is generally 20 – 30 feet wide between the top-of-bank and the aforementioned sewer right-of-way. Typical species found within the buffer on both sides of UT Clarke Creek include black willow (*Salix nigra*), elderberry (*Sambucus canadensis*), tag alder (*Alnus serrulata*), sweetgum saplings (*Liquidambar styraciflua*), buttonbush (*Cephalanthus occidentalis*), Eastern red cedar (*Juniperus virginiana*), blackberry (*Rubus sp.*), Japanese honeysuckle (*Lonicera japonica*), goldenrod (*Solidago sp.*), and common milkweed (*Asclepias syriaca*). No buffer exists along the south side of UT Clarke Creek from approximately Station 06+30 to Station 11+80 (between UT 2 and UT 5); pasture is located at the top of bank in this area.

The riparian buffer on both sides of UT Clarke Creek, between UT 2 and the downstream-most portion of the project site (approximately from Station 11+80 to Station 15+30), consists of early to mid-successional forest on a relatively narrow floodplain. This forest is categorized as a Mesic Mixed Hardwood Forest community (Schafale and Weakley, 1990). The north side of UT Clarke Creek in this reach is also impacted by the 20-foot wide CMU sanitary sewer easement. Typical species on both sides of the stream in this area include red maple (*Acer rubrum*), tulip poplar (*Liriodendron tulipifera), ash* (*Fraxinus sp.*), Eastern red cedar, American beech (*Fagus grandifolia*), and ironwood (*Carpinus caroliniana*).

UT 1 is situated in a narrow riverine bottomland with topographic ridges to the east and west. A CMU sanitary sewer line is located to the west and within the riparian buffer of UT 1, paralleling the entire length of the stream on the project site (between Station 0+00 and Station 07+70. The buffer between the sewer line easement and UT 1 is generally less than 25 feet wide and includes box elder (*Acer negundo*), black willow, tag alder, Eastern red cedar, Autumn olive, blackberry (*Rubus sp.*), and greenbriar (*Smilax sp.*). The buffer to the east of UT 1 has been cleared in the past and is largely overgrown in vines and herbaceous species with shrubs mostly adjacent to the top-of-bank. Typical vegetation to the east of UT 1 includes poison ivy (*Toxicodendron radicans*), greenbriar, Japanese honeysuckle, Autumn olive, black willow, and tag alder.

UT 2 is situated in a narrow valley. The area to the west of UT 2 is comprised of pasture planted in fescue, including the cleared floodplain pasture adjacent to the UT 2 confluence with UT Clarke Creek. A very narrow and discontinuous buffer of varied width (no more than 25 feet wide at its widest point) is located to the west of UT 2. The riparian buffer to the east of UT 2 is generally less than 15 feet wide and has been impacted by a dirt/grass road that parallels the entire length of the stream. Typical species located in the UT 2 buffer include Autumn olive (*Elaeagnus pungens*), sweetgum, flowering dogwood (*Cornus florida*), blackberry (*Rubus sp.*), saw greenbriar (*Smilax bona-nox*), and Japanese honeysuckle (*Lonicera japonica*).

UT 3 is situated in a narrow valley with early and mid-successional forest on both sides of the stream from Station 0+00 to approximately Station 0+85. This forest is categorized as a Mesic Mixed Hardwood Forest community (Schafale and Weakley, 1990). Typical species include tulip poplar, American beech, flowering dogwood, and red cedar. From Station 0+85 to the confluence with UT Clarke Creek at approximately Station 1+40, the buffer has been impacted by the perpendicular crossing of the 20-foot wide CMU sanitary sewer easement. Typical riparian vegetation in this downstream portion of UT 3 includes sweetgum saplings, Autumn olive, tag alder, blackberry, and Japanese honeysuckle.

UT 4 is situated in a narrow valley with moderately sloping terrain to the north and south. An early successional forest exists to the south side of the stream that can be categorized as a Mesic Mixed Hardwood Forest community (Schafale and Weakley, 1990). Typical species found in the riparian area to the south of UT 4 includes American beech, Eastern red cedar, white oak (*Quercus alba*), sweetgum, flowering dogwood, and winged elm (*Ulmus alata*). The area to the north of UT 4 is comprised of pasture. A narrow buffer dominated by herbaceous and vine cover with shrubs adjacent to the top of bank is situated between the pasture and the stream. Dominant species in the buffer to the north of UT 4 include sweetgum saplings, Chinese privet (*Ligustrum sinense*), Japanese honeysuckle, and blackberry.

SECTION 4

REFERENCE STREAMS

SECTION 4

REFERENCE STREAMS

Natural channel design methodology employs the characteristics of stable streams as a template for designing restored streams. Selection of a (Rosgen) stream type identifies the broad characteristics for the restored stream but does not provide sufficient design parameters to develop stream restoration plans. Additional geomorphic measurements must be collected from stable streams that fully detail the characteristics of a stable stream's cross section, pattern, and profile. A stream possessing stable characteristics is termed a "reference reach." The geomorphic characteristics of the reference reach are used as a template for designing stream restoration projects. The primary requirement of a reference reach is that the stream reach is stable; often, reference reach streams are not pristine. A suitable reference reach should possess similar hydrologic, geologic, and physiographic characteristics to the reach that is to be restored. The shape of a particular stream presents the balance between erosive forces applied to a stream by water flowing down a slope and the resistive forces supplied by the native stream substrate and stream banks. Streams formed in differing types of alluvium or rock respond differently to the same hydrology. Likewise, streams of the same lithology and geology exhibit differing forms if subjected to differing hydrologic regimes.

JJG assessed stream reaches within the watershed and segments of UT Clarke Creek and UT 1 upstream and downstream of the project reaches, and apparently stable reaches of each stream were found. This was very beneficial because the location of the reference reaches to the project reaches are in the same physiographic region, have the same valley types, land use, topography, and similar drainage areas of the project reaches to be restored. These reaches were selected as the best reference streams because they are subject to the same conditions as the sites proposed for restoration and enhancement. Since adjustment to the cross-section is the main component of the Enhancement Level 1 design, JJG's top priority was to find a reference reach that had developed an appropriate bankfull bench/floodplain. The following two reference reach sites were selected.

- UT Clarke Creek Reference Reach: located approximately 150 feet upstream from where the project reach begins. The reference reach is a B4c stream type.
- UT 1 Reference Reach: located approximately 450 feet upstream from where the project reach begins. The reference reach is a B4c stream type.

4.1 Watershed Characterization

The UT Clarke Creek Reference Reach and UT 1 Reference Reach are located in Mecklenburg County, North Carolina, approximately 3 miles southeast of the Town of Huntersville. The reference reaches are located in the Yadkin-Pee Dee River Basin, Catalog Unit 03040105010040 (Mallard Creek), DWQ Subbasin 30711. According to the USGS Topographic Quad of the reference reach areas, UT Clarke Creek Reference Reach is a second order stream and UT 1 Reference Reach is a first order stream. UT Clarke Creek Reference Reach drains approximately 0.41 square miles. UT 1 Reference Reach drains approximately 0.39 square miles. Land use within the watershed is dominated by residential land use. Within the residential land use parcels, there are some areas of open space that appear to be used for farm/agricultural use.

Both reference reaches are located in the Piedmont Physiographic Province. More specifically, the reference sites lie within the Southern Outer Piedmont belt and are comprised primarily of foliated to weakly foliated, locally migmatic metamorphosed granite rocks (NCGS, 1991). The reference reaches reside in a Valley Type VIII.

For more detailed watershed information see Section 2.

Refer to Figure 6a for a site location map and Figure 7 for a watershed map of the reference reaches.

4.2 Channel Classification

The UT Clarke Creek Reference Reach and UT 1 Reference Reach were classified using the Rosgen stream classification system, based on surveyed morphological measurements (Rosgen, 1996).

Both the UT Clarke Creek Reference Reach and UT 1 Reference Reach were classified as B4c types. The “little c” designation was added to the classification because the slope/gradient of the stream (<0.02) resembles more of a C-type stream than a B-type stream.

Typically, the channel bed morphology of B4 type streams is dominated by gravel material and characterized as a series of rapids with irregular spaced scour pools, has a moderate width/depth ratio and a sinuosity greater than 1.2. Channel materials are composed predominantly of gravel with lesser amounts of boulders, cobble, and sand. The B4 stream type is considered relatively stable and is not a high sediment supply stream (Rosgen, 1996). When dense riparian vegetation is present along the stream banks, B4 stream types are even more stable.

4.3 Discharge (bankfull, trends)

JJG surveyed both sites to verify the bankfull cross-sectional area and discharge and compared those measurements to regional curves developed by North Carolina State University Stream Restoration Institute (Harman, et al., 1999). A typical cross-section for the UT Clarke Reference Reach and UT 1 Reference Reach were modeled in Bentley Flowmaster to determine bankfull discharge (the water surface at which flow reached the bankfull indicator). Table 4.1 presents the bankfull discharge estimates for UT Clarke Creek Reference Reach and UT 1 Reference Reach.

Table 4.1
Reference Bankfull Discharge (Qbkf)

Reach	Drainage Area (sq miles)	Qbkf - Calculated (cfs)	Qbkf-Regional Curve* (cfs)
UT Clarke Ref Reach	0.41	28.0	48.6
UT 1 Ref Reach	0.39	38.9	47.0
* NC Regional Curve for Rural Piedmont Streams			

4.4 Channel Morphology (pattern, dimension, profile)

A reference reach survey was conducted on UT Clarke Creek Reference Reach and UT 1 Reference Reach following methods described in *Stream Channel Reference Sites: An Illustrated Guide to Field Technique* (Harrelson et al., 1994). Table 4.2 summarizes the results from the reference reach survey.

Table 4.2
Reference Reach Morphology

	Parameter	UT Clarke Creek Ref		UT 1 Ref	
		MIN	MAX	MIN	MAX
General	Drainage Area (sq mi)	0.41		0.39	
	Stream Type (Rosgen)	B4c*		B4c*	
	Valley Type	VIII		VIII	
Dimension	BKF Mean Velocity (Vbkf) (ft/s)	3.53		3.41	
	Bankfull Discharge (Qbkf)(cfs)	28.0**		38.9**	
	Bankfull XSEC Area, Abkf (sq ft)	8.42	17.17	8.69	13.75
	Bankfull Width, Wbkf (ft)	8.26	10.93	7.09	11.96
	Bankfull Mean Depth, dbkf (ft)	1.02	1.98	0.78	1.33
	Width to Depth Ratio, W/D (ft/ft)	6.96	8.1	5.81	15.33
	Width Floodprone Area, Wfpa (ft)	11.69	19.17	13.18	39.46
	Entrenchment Ratio, Wfpa/Wbkf) (ft/ft)	1.41	1.86	1.85	3.80
	Max Depth @ bkf, Dmax (ft)	1.57	2.05	1.11	1.82
	Max Depth Ratio, Dmax/dbkf	1.04	1.54	1.31	1.42
	Max Depth @ tob, Dmaxtob (ft)	2.92	4.56	1.78	3.55
	Bank Height Ratio, Dtob/Dmax (ft/ft)	1.86	2.22	1.53	1.60
Substrate	d16 (mm)	3.43		0.83	
	d35 (mm)	7.58		2.5	
	d50 (mm)	11.82		5.02	
	d84 (mm)	46.73		39.43	
	d95 (mm)	68.33		120.4	

Cells noted with a (*) have been classified using a typical cross-section within each reach, Cells noted with a (**) were calculated using Flowmaster.

4.5 Channel Stability Assessment

The reference reaches were walked to visually assess the channel stability. Both reference reaches appeared to be stable at the time of the survey and did not illustrate any signs of lateral or vertical instability. The stream bed features also appeared to be stable and did not show signs of migration. The sediment deposition appeared to be normal for each stream type; no heavy sediment deposition or degradation was occurring.

4.6 Bankfull Verification

Within the UT Clarke Creek Reference Reach, the cross-sections are stable and have access to their floodplain. A surveyed cross-section was used in Bentley Flowmaster to determine the existing bankfull discharge of UT Clarke Creek Reference Reach, which was assumed to be the flow associated with the water surface level on the floodplain feature of the cross-section. This process was also used for the UT 1 Reference Reach. The discharges were calculated and compared to the North Carolina Regional Curves for Rural Piedmont streams (Harman, et al., 1999).

See Section 4.3, Table 4.1 above for calculated and predicted bankfull discharges.

4.7 Vegetation

Reference vegetative communities must be established for stream and wetland restoration sites. Streambank, riparian, and floodplain restoration should be based on reference areas found within close proximity of the project site and should be based on initial riparian assessments of the proposed restoration area. Reference vegetative communities are areas in which to model restoration efforts of the restoration site in relation to soils, topography, hydrology, and vegetation. Reference sites should represent pre-disturbed conditions and be as pristine as possible (i.e., undisturbed areas which are free of exotic vegetation).

A reference vegetative survey was conducted upstream of the project site along UT Clarke Creek by JJG ecologists. The survey was used to guide plant community restoration and is presented in Section 7.4.2. In general, riparian areas along UT Clarke Creek upstream of the project site are intact and most closely resemble that of a Piedmont/Low Mountain Alluvial Forest Community (Schafale and Weakley, 1990). This community type displays the following characteristics:

- Soils: Various alluvial soils, most typically Chewacla (Fluvaquentic Dystrochrepts) or Congaree (Typic Udifluvent);
- Hydrology: Palustrine, seasonally or intermittently flooded; and
- Vegetation: Forest with open to dense understory or shrub layer and sparse to dense diverse herb layer. Canopy a mixture of bottomland and mesophytic trees (Schafale and Weakley, 1990).

Vegetation identified in the reference reaches included a dense upper-canopy and sub-canopy of mature hardwoods, an understory comprised of trees and shrubs, and a sparse to moderately dense herbaceous layer. Species identified in the reference reaches are identified in Table 4.3.

Table 4.3
Reference Reach Vegetation

Scientific Name	**Common Name**	**Stratum**	**Indicator Status**
Acer rubrum	Red maple	Canopy	FAC
Liriodendron tulipifera	Tulip poplar	Canopy	FAC
Juglans nigra	Black walnut	Canopy	FACU
Quercus falcata	Southern red oak	Canopy	FACU+
Quercus michauxii	Swamp chestnut oak	Canopy	FACW-
Carya glabra	Pignut hickory	Canopy	FACU
Fraxinus pennsylvanica	Green ash	Canopy	FACW
Diospyros virginiana	American persimmon	Canopy	FAC
Acer negundo	Box elder	Canopy	FACW
Carpinus caroliniana	Ironwood	Understory	FAC
Asimina triloba	Paw paw	Understory	FAC
Celtis laevigata	Sugarberry	Understory	FACW
Lindera benzoin	Spicebush	Understory	FACW
Elaeagnus pungens	Autumn olive	Understory	UPL
Cercis canadensis	Redbud	Understory	FACU
Ligustrum sinense	Chinese privet	Understory	FAC
Cornus florida	Flowering dogwood	Understory	FACU
Smilax rotundifolia	Common Greenbriar	Understory	FAC
Morus rubra	Red mulberry	Understory	FAC
Polystichum acrostichoides	Christmas fern	Herbaceous	FAC
Microstegium vimineum	Nepal grass	Herbaceous	FAC+
Asplenium platyneron	Spleenwort	Herbaceous	FACU
Boehmeria cylindrica	False nettle	Herbaceous	FACW+
Lonicera japonica	Japanese honeysuckle	Herbaceous	FAC-
Parthenocissus quinquefolia	Virginia creeper	Herbaceous	FAC

SECTION 5

PROJECT SITE WETLANDS (EXISTING CONDITIONS)

SECTION 5

PROJECT SITE WETLANDS (EXISTING CONDITIONS)

Two small drainage ditches on the project site appear to have been created at some time in the past for draining wetlands for agricultural purposes. These ditches, which have naturalized and are now considered jurisdictional waters of the U.S., may provide the opportunity for wetland restoration, creation, and enhancement. The ditches are identified as Wetland D and a portion of Wetland E. A portion of an emergent wetland, Wetland A, also provides wetland restoration opportunity. Wetland C provides the opportunity for enhancement. Another emergent wetland, Wetland B, is proposed for preservation.

Field studies identified the presence of five wetlands within the NCEEP easement areas identified for wetland restoration, enhancement, or preservation. The wetlands were classified as palustrine emergent or palustrine scrub-shrub systems. According to the former property owner, Wetland D and UT 5/Wetland E were, at one time, ditches that had been created to drain the UT Clarke Creek floodplain for agricultural operations. In addition, Wetlands A and B and UT 2A and UT 2B are contained within a former ditch that had been maintained to carry drainage from a natural spring.

5.1 Jurisdictional Wetlands

Jurisdictional features were identified by a JJG ecologist and located with Trimble Geo XH Global Positioning Unit (GPS) surveying equipment. The GPS is designed to collect remote positions on the ground without the need for survey traverse lines. The GPS unit has sub-meter accuracy with a 95% confidence rating on each point. The Trimble Geo XH handheld receiver uses Wide Area Augmentation Systems (WAAS) correction messages to improve the accuracy and integrity of the data. The data can be differentially corrected with desktop software provided with the unit. The Pathfinder software allows the data to be exported from the data collector and used in GIS or other design programs.

Field studies identified the presence of five wetlands within the NCEEP easement areas identified for wetland restoration, enhancement, or preservation. The wetlands were classified as palustrine emergent or palustrine scrub-shrub systems. Routine wetland determination data points were collected within each wetland polygon. Upland data points were also collected within areas adjacent to the wetland features but were not within the wetland boundary. Wetlands were marked with pink flagging and located with a Trimble Pro XH GPS unit. The locations of the wetlands are shown in Figure 5. Please refer to Table 5.1 for a summary of wetland features.

A Request for Jurisdictional Determination (JD) was submitted to the USACE, Wilmington District, Asheville Regulatory Field Office on March 17, 2010. An Approved JD has been issued by the USACE dated April 9, 2010. The JD is valid for a period of five years.

Table 5.1
Summary of Wetland Features

Jurisdictional Area	USGS Stream Association	Classification	Flow regime / Community	Approximate Acreage (ac)	Restoration/ Enhancement
WL A	Clarke Creek	PEM2C	Emergent	0.085	Associated areas proposed for restoration*
WL B	Clarke Creek	PEM2E	Emergent	0.134	Associated areas proposed for preservation
WL C	Clarke Creek	PEM2B	Emergent	0.057	Associated areas proposed for preservation
WL D	Clarke Creek	PEM1E	Emergent	0.070	Associated areas proposed for restoration
WL E	Clarke Creek	PEM1E/PSS1E	Scrub/Shrub	0.109	Associated areas proposed for enhancement
			Total Wetland Acreage Delineated	**0.455**	

*****One segment of WL A will be incorporated into the enhancement of UT 2. The remainder of WL A will be incorporated into the restoration of WL D.

5.1.1 Wetland Characteristics

Five wetland areas were delineated within the proposed project area as described below. Wetlands A and B are emergent wetlands that are largely situated within a former maintained ditch feature that also contains UT 2A and UT 2B. Wetland C is an emergent wetland situated immediately upstream of UT 4. Wetland D is a linear emergent wetland that has naturalized from a man-made ditch in the floodplain of UT Clarke Creek. Wetland E is an emergent and scrub/shrub wetland that abuts UT 5.

Wetland A (WL A): This wetland is classified as a palustrine, emergent system with a seasonally flooded hydrologic regime. Dominant vegetation associated with WL A includes the species listed below. The vegetation criterion was satisfied with 100 percent of the species being facultative, facultative wetland, or obligate wetland. Please refer to Appendix 1 for a representative photograph.

Indicators of wetland hydrology in WL A included soils saturated to the surface and areas of inundation of up to six inches deep. Additional hydrologic indicators included water stained leaves and crayfish burrows.

Wetland B (WL B): This wetland is classified as a palustrine, emergent system with a seasonally flooded/saturated hydrologic regime. Dominant vegetation associated with WL B includes the species listed below. The vegetation criterion was satisfied with 100 percent of the species being facultative, facultative wetland, or obligate wetland. Please refer to Appendix 1 for a representative photograph.

Indicators of wetland hydrology included soils saturated to the surface and areas of inundation of up to 4 inches deep. Additional hydrologic indicators included oxidized rhizospheres. In addition, an apparent spring was observed near the upper portion of WL B.

Wetland C (WL C): This wetland is classified as a palustrine, emergent system with a saturated hydrologic regime. Dominant vegetation associated with WL C includes the species listed below. The vegetation criterion was satisfied with 100 percent of the species being facultative, facultative wetland, or obligate wetland. Please refer to Appendix 1 for a representative photograph.

Indicators of wetland hydrology included soils saturated to the surface as well as areas of inundation of up to 2 inches deep. Additional hydrologic indicators included oxidized rhizospheres.

Wetland D (WL D): This wetland is classified as a palustrine, emergent system with a seasonally flooded/saturated hydrologic regime. Dominant vegetation associated with WL D includes the species listed below. This wetland area is a linear depression located in the middle of a pasture and appears to have been man-made. According to Mr. Davis, this wetland was created as a ditch to drain the floodplain of UT Clarke Creek in order to mow the area. Persistent and non-persistent emergent vegetation is located throughout this feature, as indicated in the table below. Please refer to Appendix 1 for a representative photograph.

Indicators of wetland hydrology included soils saturated to the surface as well as areas of inundation of up to 4 inches deep. Additional hydrologic indicators included oxidized rhizospheres and water stained leaves.

Wetland E (WL E): This wetland is classified as a palustrine, emergent and scrub-shrub system with a saturated hydrologic regime. Dominant vegetation associated with WL E includes the species listed below. The vegetation criterion was satisfied with 75 percent of the species being facultative, facultative wetland, or obligate wetland. Please refer to Appendix 1 for a representative photograph.

Indicators of wetland hydrology included saturated soils within the upper 8 inches and drainage patterns in the wetland. Additional hydrologic indicators included water stained leaves.

5.1.2 Upland Characteristics

Data Points - Data was also collected for the upland areas adjacent to the wetlands. The dominant vegetation found in the upland areas includes the following species.

Table 5.2
Upland Vegetation

Scientific Name	**Common Name**	**Indicator Status**
Adjacent to Wetlands A and B		
Eupatorium capillifolium	dog fennel	FACU
Lonicera japonica	Japanese honeysuckle	FAC-
Cornus florida	flowering dogwood	FACU
Liquidambar styaciflua	sweet-gum	FAC+
Rubus sp.	blackberry	UPL - FACW
Elaeagnus pungens	Autumn olive	UPL
Smilax bona nox	saw greenbriar	FAC
Adjacent to Wetland C		
Solidago sp.	goldenrod	UPL - OBL
Rubus sp.	blackberry	UPL - FACW
Festuca sp.	fescue	UPL - FAC
Liquidambar styraciflua	sweet-gum	FAC+
Andropogon virginicus	broom sedge	FAC-
Adjacent to Wetland D		
Festuca sp.	fescue	UPL - FAC
Andropogon virginicus	broom sedge	FAC-
Adjacent to Wetland E		
Microstegium vimineum	Nepal grass	FAC+
Festuca sp.	fescue	UPL - FAC
Andropogon virginicus	broom sedge	FAC-
Rubus sp.	blackberry	UPL - FACW
Asclepias sp.	milkweed	UPL - OBL

Upland habitats have insufficient indicators of wetland hydrology or hydric soils. Soil samples taken from a depth of 0 to 12 inches exhibited a matrix color of 2.5Y 5/3 to 2.5YR 4/8. For the upland areas, the data points were determined to be outside of the wetland area because all three wetland parameters were not met. The vegetation was generally dominated by facultative to facultative upland species. Soils are oxidized; therefore, adequate hydrology indicators were not observed.

Riparian areas located adjacent to the streams in the project area are characterized primarily as maintained pasture and overgrown fallow fields. Mixed hardwood forest is located to the east of UT 2 and north of UT 3. Dominant riparian vegetation observed along the stream corridors is listed below. A more comprehensive list of vegetation contained within the Clark Creek/Davis Farm Nature Preserve was provided by the Mecklenburg County Park and Recreation Department's Division of Nature Preserves and Natural Resources and is available upon request.

Table 5.3
Riparian Vegetation

Scientific Name	Common Name	Indicator Status
Liquidamabar styaciflua	sweet-gum	FAC+
Cornus florida	flowering dogwood	FACU
Juniperus virgianiana	Eastern red cedar	FACU-
Juglans nigra	black walnut	FACU
Fagus grandifolia	American beech	FACU
Ligustrum sinense	Chinese privet	FAC+
Elaeagnus pungens	Autumn olive	UPL
Cephalanthus occidentalis	buttonbush	OBL
Alnus serrulata	tag alder	FACW+
Lonicera japonica	Japanese honeysuckle	FAC-
Rosa multiflora	multiflora rose	UPL
Rubus sp.	blackberry	UPL - FACW
Solidago sp.	goldenrod	UPL - OBL
Panicum virgatum	switch grass	FAC+
Festuca sp.	fescue grass	UPL - FAC
Andropogon virginicus	broom sedge	FAC-

5.2 Hydrological Characterization

Wetland hydrology is the driving force for the creation of hydric soils and the development of hydrophytic vegetative communities. The observation of field indicators can help to assess hydrology. Research suggests that the most influential factor for plant community development is the duration of soil saturation or inundation rather than the frequency of the event

In addition, the presence of wetland hydrology is essential during the growing season. The growing season is defined as the period in which soil temperatures are above 5°C (41.5°F) or between the last frost of spring and the first frost of winter.

A classification system of wetland hydrology for non-tidal areas, developed by the Department of the Army Waterways Experiment Station, is presented in Table 5.4 (*Federal Manual*, 1987*)*.

Table 5.4
Hydrologic Zones - Non-Tidal Areas

Zone	Name	Duration*	Comments
I†	Permanently inundated	100%	Inundation > 6.6 feet mean water depth
II	Semi permanently to nearly permanently inundated or saturated	> 75% - < 100%	Inundation defined as ≤ 6.6 feet mean water depth
III	Regularly inundated or saturated	> 25% - 75%	
IV	Seasonally inundated or saturated	> 12.5% - 25%	
V	Irregularly inundated or saturated	≤ 5% - 12.5%	Many areas having these hydrologic characteristics are not wetlands
VI	Intermittently or never inundated or saturated	< 5%	Areas with these hydrologic characteristics are not wetlands

* Refers to duration of inundation and/or soil saturation during the growing season.
† This defines an aquatic habitat zone.

Analysis of the hydrology parameter for a Routine Determination involves reviewing a study area for indicators of extended periods of hydrology. Some indicators of wetland hydrology are identified in the 1987 *Federal Manual.* These indicators include recorded data, visual observation of inundation, visual observation of soil saturation, watermarks, drift lines, sediment deposits, drainage patterns within the wetlands, oxidized rhizospheres by live roots within the soil profile, and water-stained leaves. In addition, the presence of wetland hydrology may be inferred from certain morphological, physiological, and reproductive adaptations of plants to an anaerobic environment. Only the morphological adaptations can be field determined. Examples of morphological adaptations include buttressed tree trunks, pneumatophores, adventitious roots, shallow root systems, inflated vegetative structures, polymorphic leaves, floating leaves and stems, hypertrophied lenticels, and multi-trunks or stooling. The facultative-neutral option also can be used as a secondary indicator of wetland hydrology. Documented hydrologic data are described in Section 5.2.1.

5.2.1 Groundwater Monitoring

Four groundwater monitoring gauges were installed on July 21, 2010 throughout the project area surrounding UT Clarke Creek. The monitoring gauges are programmed to download water levels daily and were downloaded monthly from July to September to capture hydrologic data. In order to attain hydrologic success, groundwater levels must be within 12 inches of the ground surface for 29 consecutive days during the growing season. The growing season in Mecklenburg County averages 232 days beginning March 22 and ending November 11. For this report, hydrologic data was unavailable for the entire growing season due to installation and report submittal timing.

The site’s four groundwater monitoring wells are located within Wetlands D and E. The target hydrologic characteristics range from saturation to periodic inundation. Two of the site’s four groundwater monitoring gauges (Gauges 2 and 4) are located within upland areas. Gauge 2 is located in an upland area of Wetland D and in the proposed wetland restoration area. Gauge 4 is located in an upland area of Wetland E. Groundwater monitoring gauge 2 and Groundwater monitoring gauge 4, confirmed that groundwater elevations were within the upper 12 inches of the soil profile for the duration of 4 and 3 consecutive days during the growing season, respectively. Field surveys determined these areas are currently underlain by relic hydric soils that have been impacted by ditching of fields and vegetative clearing associated with past agricultural land uses. Groundwater gauges 1 and 3 are located within the wet areas of Wetland D and E. Groundwater monitoring gauge 1 (Wetland D) and Groundwater monitoring gauge 3 (Wetland E), confirmed that groundwater elevations were within the upper 12 inches of the soil profile for the duration of 7 and 17 consecutive days during the growing season, respectively.

In summary, the groundwater gauges suggest that existing wetland hydrology is at or near the surface for portions of Wetlands D and E during the durations of the summer growing season that was collected. JJG will continue to monitor existing wetland areas throughout the growing season in order to accurately determine wetland hydrology. These gauges appear to reflect the desired hydrology in the areas proposed for wetland restoration and enhancement. Refer to Figure 4 for mapped locations of groundwater gauges and Appendix 7 for Hydrologic Gauge Data Summary, Groundwater, and Rainfall Information.

5.2.2 Hydrologic Budget for Restoration Site

The main contributors and inputs to the wetland hydrology on the proposed wetland restoration of the Wetland D site include:

- Groundwater seepage and springs;
- Overland flow draining into adjacent riparian areas; and
- Rainfall.

Current water outputs from the site include evapotranspiration, storm water outflow, and deep infiltration. The significant hydrologic input of storm water runoff is currently being depleted from the existing wetland and upland area from the drainage ditch that the former property owner excavated to drain UT Clarke Creek’s floodplain. The ditch decreases depressional water storage and groundwater levels within the restoration project site. The proposed wetland restoration activities will prevent storm water outflow from leaving the site and will help keep the water stored within the proposed wetland boundary.

A site water budget was estimated for the restoration site using the Pierce Approach (Pierce, 1993). Hydrologic inputs and outputs were estimated for Wetland D (~1.02 acres) from site precipitation data and regional potential evapotranspiration (PET) data provided by the State Climate Office of North Carolina (SCONC, 2010). PET estimates were calculated using the Food and Agricultural Organization's Penman-Monteith equation from data obtained from the ASOS station Douglas International Airport (KCLT). In addition, fifty years (1960-2010) of historical climatological data obtained from the COOP station, and the Charlotte Douglas AP (311690) was used to calculate a water budget for an average year, a wet year, and a dry year (SCONC, 2010).

Based on site visits, JJG observed a shallow water table in portions of the restoration area which is likely to contribute hydrology to the restoration site. However, it is difficult to predict groundwater input because long term fluctuation in groundwater levels are not known and existing off-site data is not reliable because site specific conditions affect groundwater inflow. Due to these issues and for the purpose of this water budget, JJG conservatively assumes that no groundwater will enter the site, even though it is highly probable that it will. Any groundwater input into the proposed site will be additional hydrology not predicted by the water budget.

JJG used a typical rate of 0.003 inches per hour for the wetlands soil infiltration based on observations of a clayey loam subsoil, a compacted top soil, and a seasonally high groundwater table.

The site water budget demonstrates that sufficient hydrologic inputs are available for restoration of the surrounding riparian areas which are currently losing hydrology due to the drainage ditches.

5.3 Soil Characterization

The soil parameter is the least reliable for determining the current status of a community. Because of the time required for formation of hydric soils, which is estimated to take from 15 to 50 years by some accounts, review of the soil parameter more reliably reveals historical data. Hydric soils that have been drained and fail to support hydrophytic vegetation do not meet the criteria of the soil parameter. Hydric soils are formed during periods of saturation or inundation. These periods create an anaerobic environment within the upper horizons of the soil profile. According to the 1987 *Federal Manual*, the following criteria apply to hydric soils:

- All histosols except folists;
- Soils in aquic suborders, aquic subgroups, albolls suborder, salorthids great group, or pell great groups of vertisols that are:

    - Somewhat poorly drained and have a water table less than 0.5 feet from the surface for a significant period (usually a week or more) during the growing season; or
    - Poorly drained or very poorly drained and have either:

        - A water table at less than 1.0 foot from the surface for a significant period (usually a week or more) during the growing season if permeability is less than 6 inches in any layer within 20 inches; or
        - A water table at less than 1.5 feet from the surface for a significant period (usually a week or more) during the growing season if permeability is less than 6 inches in any layer within 20 inches; or

- Soils that are ponded for a long or very long duration during the growing season; or
- Soils that frequently flood for long or very long durations during the growing season.

Soils may be determined to be hydric by using regional indicators in addition to referencing the *Hydric Soils of the United States* (USDA, 1991). Several criteria are listed in the 1987 *Federal Manual,* each of which indicates the presence of hydric soils.

Non-Sandy Soils:

- **Organic soils (histosols)** - Organic soils are saturated for long periods of time and commonly are called muck. Soils are determined to be organic if more than 50 percent of the upper 12 inches of soil is composed of organic material or if organic material lies directly over bedrock.

- **Histic epipedons** - Histic epipedons are soils with an 8- to 16-inch layer of soil that is sufficiently saturated to prevent aerobic decomposition of the organic surface. Histic epipedons must be saturated for 30 consecutive days or more for soils containing a minimum of 20 percent organic matter when no clay is present or a minimum of 30 percent organic matter when the clay content is 60 percent or higher.

- **Sulfidic material** - Sulfidic material is determined to be present within the soils when waterlogged and permanently saturated soils emit an odor of rotten eggs. This odor is an indication of the presence of hydrogen sulfide created from a reducing environment.

- **Aquic or peraquic moisture regime** - An aquic moisture regime essentially is free of dissolved oxygen due to strong reducing conditions. The soil is saturated by groundwater, and dissolved oxygen is removed from the soil by soil fauna and root systems. The soil temperature must be above 5 degrees Celsius (°C) at some point while the soil is saturated. A peraquic soil regime requires the presence of groundwater always at or near the soil surface.

- **Reducing soil conditions** - During periods of prolonged inundation or saturation, soils will begin to undergo reducing conditions. These conditions result in iron being reduced from the ferric state to the ferrous state. In the field, this can be confirmed by a qualitative test using alpha, alpha dipyridil and a chemical reagent. If the iron in the soil has been reduced, a pink color would occur when the alpha, alpha dipyridil is added to the soil sample.

- **Soil colors** - When anaerobic conditions result in soil reduction, mineral soils often will produce gray or very dark colors. These colors are a direct result of the reduction of iron, manganese, and other elements in the soil. Soils that are saturated for a long duration usually exhibit bluish- to greenish-gray colors. This effect is referred to as gleying. The Munsell Color Charts can be used to determine gleyed soils. Mineral soils that are saturated (but not for prolonged periods) will develop a low chroma matrix that may or may not contain mottles. Under these conditions, the mottles often will be "bright" Munsell colors. As a general rule, mineral hydric soils will exhibit one of the following conditions: 1) matrix chroma of 2 or less in mottled soils; or 2) matrix color of 1 or less in unmottled soils.

- **Soil appearing on hydric soils list** - The National Technical Committee for Hydric Soils maintains an updated list of soil types that are known to be hydric or to have hydric inclusions. This list can be referenced to determine if a soil type is hydric. Many NRCS offices also maintain a list of known hydric soils that can be more beneficial on a regional basis.

Sandy Soils:

- **High organic matter content in surface horizon** - Sandy soils that are inundated or saturated for prolonged periods usually develop a layer of organic matter near the surface horizon. This can be attributed to anaerobic conditions that greatly reduce decomposition of the organic matter.

- **Streaking of subsurface horizons by organic matter** - As the water table fluctuates in sandy soils, organic material is carried through the soil profile. The movement of the organics through the soil profile often results in organic streaking in certain portions of the soil profile that are subject to water table fluctuation. Areas of organic streaking can be observed visually with the assistance of a sharpshooter shovel.

- **Organic pans** - As stated above, organic material moves within the soil profile as the water table fluctuates. The organics have a tendency to accumulate in the area that represents the average depth of the water table. The presence of elemental aluminum can result in the soils becoming hardened at the average depth of groundwater. This hardened layer often is referred to as a spodic horizon. Soil pits must be excavated to determine if spodic horizons are present.

Along with the 1987 *Federal Manual*, several other publications are available that provide guidance in the identification of hydric soils. These publications are available for use at both the regional and national levels. Examples include *Redoximorphic Features for Identifying Aquic Conditions* (Vepraskas, 1995) and *Field Indicators of Hydric Soils in the United States* (United States Department of Agriculture, 1995). These resources often provide detailed information on the identification of hydric soils. The USACE district in which the work would be performed should be contacted to ensure that the usage of hydric soil indicators other than those in the 1987 *Federal Manual* is acceptable.

Wetland Soil Characteristics

Wetland A (WL A): Soil samples were taken from a depth of 0 to 12 inches. Soils in the A horizon at a depth of 0 to 4 inches had a matrix color of 10YR 5/2 with common and distinct redox concentrations of 10YR 4/6. The soil texture in the A horizon was sandy loam. Soils in the B horizon at a depth of 4 to 12 inches had a matrix color of 5Y 5/1 with common and prominent redox concentrations of 10YR 5/6. The soil texture in the B horizon was loam. Hydric soil indicators included the presence of reducing conditions, redoximorphic features, and low chroma.

Wetland B (WL B): Soil samples were taken from a depth of 0 to 12 inches. Soils at a depth of 0 to 4 inches had a matrix color of 5Y 4/2 with no redoximorphic features present and a mucky mineral soil texture. Soils in the B horizon at a depth of 4 to 12 inches had a matrix color of 10YR 3/2 with common and distinct redox concentrations of 5YR 5/6. The soil texture in the B horizon was clay loam. Hydric soil indicators included the presence of mucky mineral soil texture, reducing conditions, redoximorphic features, and low chroma.

Wetland C (WL C): Soil samples were taken from a depth of 0 to 12 inches. Soils at a depth of 0 to 12 inches had a matrix color of 2.5Y 2/1 with common and prominent redox concentrations of 7.5YR 5/6. The soil texture throughout the wetland area is sandy clay loam. Hydric soil indicators included the presence of reducing conditions, redoximorphic features, and low chroma.

Wetland D (WL D): Soil samples were taken from a depth of 0 to 12 inches. Soils at a depth of 0 to 12 inches had a matrix color of 2.5Y 5/2 with common and prominent redox concentrations of 7.5YR 4/6. The soil texture throughout the wetland area is clay loam. Hydric soil indicators included the presence of reducing conditions, redoximorphic features, and low chroma.

Wetland E (WL E): Soils in the A horizon at a depth of 0 to 4 inches had a matrix color of 10YR 4/4 with no redoximorphic features present. The soil texture in the A horizon was loam. Soils in the B horizon at a depth of 4 to 12 inches had a matrix color of 10YR 5/2 with common and distinct redox concentrations of 10YR 4/4. Hydric soil indicators included the presence of reducing conditions, redoximorphic features, and low chroma.

Mapped Soils within the Study Area

The *Soil Survey of Mecklenburg County, North Carolina* (USDA, 1980) was consulted to determine soil-mapping units within the study area. The soil map units occurring within the conservation easement were compared to the *Hydric Soils of North Carolina* (http://soils.usda.gov/use/hydric/lists/state.html) to determine if hydric soils are known to occur within the study area. The Monacan loam soil series is the only mapped soil within the proposed conservation easement that is included on the list of *Hydric Soils of North Carolina* for Mecklenburg County and is designated 2B3, 4 hydric criterion. In Mecklenburg County, the Monacan loam map unit contains approximately 5% hydric inclusions. According to the NRCS Soil Data Mart, hydric inclusions consist of the Wehadkee soil series (undrained), which is designated an A hydric criterion (100% hydric) and typically occurs on depressions and floodplains. The Wehadkee series consists of very deep, poorly drained, and very poorly drained soils on floodplains along streams that drain from the mountains and piedmont. They are formed in loamy sediments. Both the Monacan loam and Wehadkee soils series are described below. The Monacan loam soil series is characterized as follows:

5.3.1 Taxonomic Classification

According to Natural Resource Conservation Service (NRCS) Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/) , the taxonomic classifications of Monacan Series soils is fine-loamy, mixed, active, thermic Fluvaquentic Eutrudepts.

5.3.2 Profile Descriptions

The following profile description for Monacan Series soils was taken from the NRCS Soil Series Query Facility on-line at https://soilseries.sc.egov.usda.gov/osdnamequery_look.aspx (profile descriptions from field observations are described above in Section 5.1):

- Ap--0 to 12 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine granular structure; very friable, nonsticky, nonplastic; common fine roots; few very fine dark colored oxide concretions; few fine flakes of mica; slightly acid; clear smooth boundary.
- Bw1--12 to 25 inches; dark yellowish brown (10YR 4/4) silt loam; few fine faint grayish brown (10YR 5/2), light yellowish brown (10YR 6/4), and dark brown (7.5YR 3/2) mottles; weak coarse subangular blocky structure; friable, nonsticky, slightly plastic; few fine roots; common fine dark colored oxide concretions and stains; few worm channels; few fine flakes of mica; slightly acid; clear smooth boundary.
- Bw2--25 to 34 inches; dark yellowish brown (10YR 4/4) silt loam; common fine faint grayish brown (10YR 5/2) and brown (7.5YR 4/4) mottles; weak coarse subangular blocky structure; friable, slightly sticky, slightly plastic; few fine roots; few fine dark colored oxide stains and concretions; few fine flakes of mica; medium acid; clear smooth boundary.
- Bw3--34 to 42 inches; grayish brown (10YR 5/2) silty clay loam; few fine faint dark yellowish brown (10YR 4/4) and gray (10YR 5/1) mottles; weak coarse subangular blocky structure; friable, slightly sticky, slightly plastic; few fine roots; few fine dark colored oxide concretions and stains; few fine flakes of mica; medium acid; abrupt wavy boundary.
- 2Bgb--42 to 63 inches; gray (5Y 5/1) clay; few fine distinct dark yellowish brown (10YR 3/4) and yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure; firm, sticky, slightly plastic; few fine roots; thin patchy gray (5Y 5/1) clay films on faces of ped and in root channels; many dark colored oxide concretions up to 1/4 inch in size; many fine flakes of mica; medium acid; gradual wavy boundary.

5.3.3 Hydraulic Conductivity
According to the NRCS Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/), the saturated hydraulic conductivity for drained and undrained Moncan loam (MO) is 4.00 – 14.00 *micro m/sec* from 0 – 65 inches, and 0.42 – 141.00 *micro m/sec* from 65 – 80 inches.

5.3.4 Organic Matter Content
According to the NRCS Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/), the organic matter content for Monacan loam (MO) is 2.0 – 3.0 percent from 0 – 14 inches, 0.5 – 1.0 percent from 14 – 65 inches, and 0.0 – 0.5 percent from 65 – 85 inches.

5.3.5 Bulk Density
According to the NRCS Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/), the moist bulk density for Moncan loam (MO) is 1.00 – 1.20 *g/cc* from 0 – 14 inches, 1.20 – 1.50 from 14 – 65 inches, and 1.00 – 1.30 from 65 – 80 inches.

The Wehadkee loam soil series is characterized as follows:

5.3.1 Taxonomic Classification
According to Natural Resource Conservation Service (NRCS) Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/) , the taxonomic classifications of Wehadkee Series soils is fine-loamy, mixed, active, nonacid, thermic Fluvaquentic Endoaquepts.

5.3.2 Profile Descriptions

The following profile description for Wehadkee Series soils was taken from the NRCS Soil Series Query Facility on-line at https://soilseries.sc.egov.usda.gov/osdnamequery_look.aspx:

- Ap--0 to 8 inches; grayish brown (10YR 5/2) fine sandy loam; weak medium granular structure; very friable; few flakes of mica; moderately acid; abrupt smooth boundary. (6 to 14 inches thick)
- Bg1--8 to 17 inches; dark gray (10YR 4/1) loam; common medium prominent strong brown (7.5YR 5/6) soft masses of iron accumulation; weak fine and medium subangular blocky structure; friable; few flakes of mica; moderately acid; clear smooth boundary. (8 to 20 inches thick)
- Bg2--17 to 40 inches; gray (10YR 6/1) sandy clay loam; common medium prominent strong brown (7.5YR 5/6) soft masses of iron accumulation; weak medium subangular blocky structure; friable; common flakes of mica; moderately acid; clear smooth boundary. (0 to 30 inches thick)
- Cg--40 to 50 inches; gray (10YR 6/1) sandy loam; common medium faint grayish brown (10YR 5/2) iron depletions and prominent strong brown (7.5YR 5/6) soft masses of iron accumulation; massive; friable; common flakes of mica; moderately acid.

5.3.3 Hydraulic Conductivity

According to the NRCS Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/), the saturated hydraulic conductivity for Wehadkee (WeA) is 14.00 – 42.00 *micro m/sec* from 0 – 8 inches, 4.00 – 14.00 *micro m/sec* from 8 – 43 inches, and 4.00 – 42.00 *micro m/sec* from 43 – 80 inches.

5.3.4 Organic Matter Content

According to the NRCS Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/), the organic matter content for Wehadkee (WeA) is 2.0 – 5.0 percent from 0 – 8 inches, 0 – 1.0 percent from 8 – 43 inches, and 0.0 – 0.5 percent from 43 – 80 inches.

5.3.5 Bulk Density

According to the NRCS Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/), the moist bulk density for Wehadkee (WeA) is 1.35 – 1.60 *g/cc* from 0 – 8 inches, 1.30 – 1.50 from 8 – 43 inches, and 1.35 – 1.60 from 43 – 80 inches.

Since Monacan soils have a hydric B status, field observations were performed to determine areas within the easement as having hydric conditions. Throughout the easement area, soil samples were collected to determine the hydromorphic condition. In general, field observations of reduced chroma and aquic moisture regime were used in determining if a particular area was hydric. Indicators of wetland hydrology included saturated soils within the upper 12 inches, areas of inundation, oxidized rhizospheres, and drainage features in the wetland. Additional hydrologic indicators included crayfish burrows and water-stained leaves.

Field soil samples were taken to a minimum depth of 12 inches. The soils were studied for examples of hydric properties (i.e., oxidized rhizospheres, mottling, low chroma, concretions, and water saturation). *Munsell Soil Color Charts* (GretagMacbeth, 2000) were used to determine hue, value, and chroma of both the matrix and the mottle colors of each horizon. Hue indicates the relationship to the primary colors in the spectrum of white light; value indicates the lightness of the color; and chroma represents the strength. A low chroma soil with bright redoximporphic features (i.e., mottles) or gleyed soil indicates a hydric soil, if the low chroma is a result of a reducing environment rather than natural color or parent materials. A low chroma soil generally has a matrix chroma of 2 or less in mottled soils or a matrix chroma of 1 or less in unmottled soils.

5.4 Plant Community Characterization

In both the Routine and Comprehensive Determinations, all dominant plants should be identified to species. The vegetation parameter is the strongest, most reliable parameter in undisturbed wetland communities. Following identification, the *National List of Plant Species that Occur in Wetlands - Southeast Region* (Reed, 1988) should be consulted to determine the wetland indicator status of each species. The indicator status of a plant may fall into one of the categories listed in Table 5.5.

Table 5.5
Plant Indicator Status Categories (adopted from the *Federal Manual*)*

Indicator Category	**Indicator Symbol**	**Definition**
Obligate Wetland Plants	OBL	Plants that occur almost always (estimated probability > 99%) in wetlands under natural conditions, but also may rarely occur (estimated probability < 1%) in non-wetlands. Examples: *Spartina alterniflora, Taxodium distichum.*
Facultative Wetland Plants	FACW	Plants that usually occur (estimated probability > 67% to 99%) in wetlands, but also occur (estimated probability 1% to 33%) in non-wetlands. Examples: *Fraxinus pennsylvanica, Cornus amomum.*
Facultative Plants	FAC	Plants with a similar probability (estimated probability 33% to 67%) of occurring in both wetlands and non-wetlands. Examples: *Acer rubrum, Smilax rotundifolia.*
Facultative Upland Plants	FACU	Plants that occur sometimes (estimated probability 1% to > 33%) in wetlands but occur more often (estimated probability > 67% to > 99%) in non-wetlands. Examples: *Quercus rubra, Andropogon virginica.*
Obligate Upland Plants	UPL	Plants that rarely occur (estimated probability > 1%) in wetlands, but almost always occur (estimated probability > 99%) in non-wetlands under natural conditions. Examples: *Pinus echinata, Bromus mollis.*

* Categories were originally developed and defined by the USFWS National Wetlands Inventory and subsequently modified by the National Plant List Panel. The three facultative categories are subdivided by (+) and (-) modifiers.

Analysis of the vegetation parameter in a Comprehensive Determination involves detailed sampling of various strata to establish plant dominance. In a Routine Determination, dominance may be based on visual observations of each strata. For the vegetation parameter to be satisfied, a plant community should have greater than 50 percent of the dominant species with a rating of facultative, facultative wetland, or obligate wetland. An alternative to the 50 percent dominance criteria is the facultative-neutral option. This option may be used when a district questions the indicator status of a dominant species. When dominant species with an indicator of facultative occur with facultative upland or facultative wetland dominant plant species, the facultative species may be considered neutral; therefore, the jurisdictional status of the parameter would be based on the greater number of facultative wetland species versus facultative upland species. Should the facultative wetland dominant species equal the facultative upland species, then associate species are considered. Should the number still be equal, then the jurisdictional status is determined by the soil and hydrology parameters. The final step within the vegetation parameter is to identify the type of vegetation community and wetland system following the *Classification of Wetlands and Deepwater Habitats* (Cowardin *et al.*, 1979). Refer to Section 5.1.1 for a list of plants found in delineated wetlands.

Dominant Wetland Vegetation

Tables 5.6 through 5.10 describe the dominant vegetation present in each of the project area wetlands.

Table 5.6
Wetland A Vegetation

Scientific Name	Common Name	Indicator Status
Carex sp.	sedge species	FAC - OBL
Juncus effusus	soft rush	FACW+
Leersia oryzoides	rice cutgrass	OBL
Betula nigra	river birch	FACW

Table 5.7
Wetland B Vegetation

Scientific Name	Common Name	Indicator Status
Carex sp.	sedge species	FAC - OBL
Juncus effusus	soft rush	FACW+
Leersia oryzoides	rice cutgrass	OBL
Polygonum sagittatum	arrow-leaved tearthumb	OBL
Panicum scoparium	broom panic grass	FACW

Table 5.8
Wetland C Vegetation

Scientific Name	Common Name	Indicator Status
Polygonum sagittatum	arrow-leaved tearthumb	OBL
Juncus effusus	soft rush	FACW+
Leersia oryzoides	rice cutgrass	OBL
Panicum virgatum	switch grass	FAC+
Liquidambar styraciflua	sweetgum	FAC+

Table 5.9
Wetland D Vegetation

Scientific Name	**Common Name**	**Indicator Status**
Juncus effusus	soft rush	FACW+
Leersia oryzoides	rice cutgrass	OBL
Rubus sp.	blackberry	UPL - FACW

Table 5.10
Wetland E Vegetation

Scientific Name	**Common Name**	**Indicator Status**
Liquidambar styraciflua	sweet-gum	FAC+
Carex sp.	sedge species	FAC - OBL
Juncus effusus	soft rush	FACW+
Rubus sp.	blackberry	UPL - FACW

SECTION 6

REFERENCE WETLANDS

SECTION 6

REFERENCE WETLANDS

Reference wetlands are minimally impaired sites that are representative of the expected ecological conditions, functions, and values of other wetlands of the same type and region (USEPA, 2000). A recently constructed EEP stream and wetland restoration project, the Suther (Dutch Buffalo Creek) site (EEP Project #370), was selected as the reference wetland site. The Suther site is in the same HUC (03040105) as the project site and has hydrology, vegetation, and soil characteristics similar to those of the project site wetlands. Although off-site reference wetlands are typically limited for comparison and on-site comparison for species composition and comparable function are typically recommended (Clewell and Lea, 1990), the lack of suitable reference wetlands on the project site dictated that an off-site reference be used.

Three wetland areas were restored or enhanced for the Suther project. Wetland B-1 (enhancement) was selected as the most suitable reference wetland, due to its similarity to the UT Clarke Creek site and to the proposed restoration and enhancement areas. Wetland B-1 was classified as a palustrine forested system with a saturated to seasonally flooded hydrologic regime. The dominant community type within Wetland B-1 is a Piedmont/Mountain Bottomland Forest (Schafale and Weakley, 1990); however, it transitions into a Piedmont/Mountain Alluvial Forest (Schafale and Weakley, 1990) along its southeastern edge. The proposed wetland communities will be similar to the dominant community type found within the reference site. The location of the reference wetland is shown on Figure 6b.

6.1 Hydrological Characterization

Dutch Buffalo Creek generally flows west to east through the project area and drains approximately 23 square miles at the farthest downstream point of the NCEEP project easement. In general, the project easement encompasses a relatively wide floodplain. Elevations within the project easement floodplain appear to be gently sloping to flat and ranging between 650 feet near the upper end to approximately 645 feet at the lower end. Surface drainage to Dutch Buffalo Creek within the project easement follows two main pathways.

- Drainage directly to Dutch Buffalo Creek via several unnamed tributaries.
- Sheet/overland flow drainage into adjacent riparian wetlands, which eventually contribute to groundwater seepage and baseflows to Dutch Buffalo Creek.

Seeps at the outer edge of the floodplain, overland flow draining into adjacent riparian buffer areas, frequent flooding of Dutch Buffalo Creek and its tributaries, and rainfall appear to be the main contributors to wetland hydrology for the site. This unique combination of hydrology results in scattered zones of inundation typically following the natural micro-topography of the floodplain. As a result of this zonation, the existing wetlands provide a diverse habitat and high species richness.

6.1.1 Gauge Data Summary

Refer to Figure 9 for a map of gauge locations within the reference wetland area. Groundwater monitoring gauges 1 and 2 are located within the Piedmont/Mountain Bottomland Forest community type. These gauges were used for reference, as they are located within the proposed wetland restoration type. Data points were collected within this wetland area, and upland data points were also collected within areas adjacent to the wetland feature.

Groundwater monitoring gauges 1 and 2 confirmed that continuous daily groundwater elevations were within the upper 12 inches of the soil profile for duration of greater than 29 consecutive days during the growing season (May, 2007 gauge monitoring data). Daily groundwater elevations were within the upper 12 inches of the soil profile between March 23 and May 31 (70 days) and between March 23 and May 16 (55 days) for gauges 1 and 2, respectively. Average groundwater levels during this period were approximately 5 and 6 inches below the surface for gauges 1 and 2, respectively. Numerous site visits have been conducted since May 2007, and anecdotal evidence from those visits indicates that Wetland B-1 generally remains saturated to some degree.

Reference wetland groundwater levels and visual evaluations suggest that normal wetland hydrological conditions should, at a minimum, be at or near the surface with scattered pockets of inundation during the winter and early and late growing seasons. Refer to Appendix 7 for Hydrologic Gauge Data Summary, Groundwater and Rainfall Information.

6.2 Soil Characterization

6.2.1 Taxonomic Classification (including series)

The dominant soil type within the Reference Wetland B-1 is the Chewacla sandy loam, frequently flooded (Ch) series (USDA, 1988). The Chewacla series is listed as a Class B hydric soil (USDA-SCS, 1991). The Chewacla series consists of very deep, moderately permeable, somewhat poorly drained soils on floodplains. They formed in recent alluvium washed largely from soils formed in residuum from schist, gneiss, granite, phyllite, and other metamorphic and igneous rocks. Refer to Figure 8b for a map of soil mapping units within reference wetland area.

Chewacla sandy loam, frequently flooded (Ch) - The Chewacla series consists of very deep, moderately permeable, somewhat poorly drained soils on floodplains. These soils formed in recent alluvium washed largely from soils formed in residuum from schist, gneiss, granite, phyllite, and other metamorphic and igneous rocks. Typically, the surface layer is dark brown loam approximately 6 inches in depth. The upper subsoil layer is a reddish-brown sandy clay loam with grayish mottles from a depth of 6 inches to approximately 20 inches. The middle of the subsoil layer is a sandy clay loam with grayish-brown to yellowish-brown colors. The middle of the subsoil layer also has many grayish mottles at a depth of approximately 20 inches to 40 inches or more. The lower subsoil layer is yellowish-brown to brown with light grayish mottles from approximately 40 inches to the maximum depth of approximately 60 inches. Field soil samples were taken to a minimum depth of 12 inches. The soils were studied for examples of hydric properties (i.e., oxidized rhizospheres, mottling, low chroma, concretions, and water saturation). *Munsell Soil Color Charts* (GretagMacbeth, 2000) were used to determine hue, value, and chroma of both the matrix and the mottle colors of each horizon. The profile for the Chewacla soil series found within the project corridor typically displays the following profile.

- A horizon = 0 to 6 inches depth; brown loam. Hue is 10YR, value is 3 or 4, and chroma is 2.
- B1 Horizon = 6 to 15 inches depth; reddish-brown sandy clay loam. Hue is 7.5YR, value is 4, and chroma is 2.
- B2 Horizon = 15 to 35 inches depth; grayish-brown to yellowish-brown sandy clay loam. Hue is 10YR, value is 5, and chroma is 2.
- B3 Horizon = 36 to 60 inches depth; light grayish brown sandy clay loam. Its hue is 10YR, value is 5 or 6, and chroma is 2.

The Chewacla sandy loam soils within the project corridor are frequently flooded with a typical water table depth at approximately 15 inches below the ground surface. Chewacla sandy loam soils are medium in percent organic matter and natural fertility. These soils are moderately suited for farming due to frequent flooding or saturation. Chewacla soils are well suited for farming, if drainage ditches are present. Permeability is moderate, and the available water capacity is high. Therefore, the infiltration rate is moderate when wet.

The susceptibility of sheet or rill erosion by water (K-Factor) within Chewacla sandy loam is moderate. These numbers present the percentages of silt, sand, and organic matter relative to soil structure and permeability. The T factor is the estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity. Table 6.1 provides a brief summary of the physical properties for the Chewacla sandy loam soil within the project corridor.

Table 6.1
Summary of Physical Properties for the Chewacla Soil Series

Soil Series	Max Depth (in)	Percent Clay	Percent Sand	Percent Silt	% Organic Matter	K Factor (% silt, sand, organic matter)	T Factor (tons/ac/ yr)	Bulk Density (g/cm^3)
Chewacla	60	22.5	39.8	37.7	2.5	0.32	5	0.36

6.3.1 Taxonomic Classification

According to Natural Resource Conservation Service (NRCS) Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/) , the taxonomic classifications of Chewacla Series soils is fine-loamy, mixed, active, thermic Fluvaquentic Dystrudepts.

6.3.2 Profile Description

- Ap--0 to 4 inches; brown (7.5YR 4/4) loam; weak medium granular structure; friable; common very fine, fine, and medium roots; few fine flakes of mica; very strongly acid; clear smooth boundary. (1 to 10 inches thick)
- Bw1--4 to 14 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak medium subangular blocky structure; friable; common fine and medium roots; common fine flakes of mica; few medium faint brown (10YR 5/3) iron depletions; very strongly acid; gradual wavy boundary.
- Bw2--14 to 26 inches; dark yellowish brown (10YR 4/4) clay loam; weak medium subangular blocky structure; friable; common fine and medium roots; many fine flakes of mica; common medium faint grayish brown (10YR 5/2) iron depletions and common medium distinct strong brown (7.5YR 4/6) masses of oxidized iron; very strongly acid; gradual wavy boundary.
- Bw3--26 to 38 inches; brown (7.5YR 4/4) loam; weak medium subangular blocky structure; friable; common fine roots; many fine flakes of mica; common medium distinct gray (10YR 5/1) iron depletions; very strongly acid; gradual wavy boundary.
- Bw4--38 to 47 inches; strong brown (7.5YR 5/8) clay loam; weak medium subangular blocky structure; friable; few fine roots; many fine flakes of mica; common medium distinct gray (10YR 5/1) iron depletions; very strongly acid; gradual wavy boundary.
- Bw5--47 to 60 inches; gray (10YR 5/1), strong brown (7.5YR 5/8), and red (2.5YR 5/8) clay loam; weak medium subangular blocky structure; friable; few fine roots; many fine flakes of mica; areas with gray color are iron depletions and areas with red color are masses of oxidized iron; very strongly acid; gradual wavy boundary. (Combined thickness of the Bw horizons is 6 to 60 inches)
- C--60 to 80 inches; brown (7.5YR 4/4) and gray (7.5YR 5/1) loam; massive; friable; many fine flakes of mica; areas with gray color are iron depletions very strongly acid.

6.3.3 Hydraulic Conductivity

According to the NRCS Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/), the saturated hydraulic conductivity for Chewacla (Ch) is 4.00 – 14.00 *micro m/sec* from 0 – 60 inches, and 4.00 – 42.00 *micro m/sec* from 60 – 80 inches.

6.3.4 Organic Matter Content

According to the NRCS Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/), the organic matter content for Chewacla (Ch) is 1.0 – 4.0 percent from 0 – 4 inches, 0.5 – 2.0 percent from 4 – 60 inches, and 1.0 – 3.0 percent from 60 – 80 inches.

6.3.5 Bulk Density

According to the NRCS Soil Datamart website (available at: http://soildatamart.nrcs.usda.gov/), the moist bulk density for Chewacla (Ch) is 1.30 – 1.60 *g/cc* from 0 – 4 inches, 1.30 – 1.50 from 4 – 26 inches, 1.30 – 1.60 *g/cc* from 26 – 38 inches, and 1.30 – 1.50 from 38 – 80 inches.

6.3 Plant Community Characterization

6.3.1 Community Description(s) – All Strata

Reference Wetland B-1 is classified as a palustrine forested system with a saturated to seasonally flooded hydrologic regime. The dominant community type within the reference area is a Piedmont/Mountain Bottomland Forest community (Schafale and Weakley, 1990). Dominant vegetation associated with these areas includes the species listed below. The vegetation criterion was satisfied with 90 percent of the species being facultative, facultative wetland, or obligates wetland. Refer to Figure 10b for a map of vegetative communities within the reference wetland area.

Dominant vegetation associated with Wetland B-1 includes the species listed below. The vegetation criterion was satisfied with 100 percent of the species being facultative, facultative wetland, or obligates wetland.

Table 6.2
Dominant Vegetation within Reference Wetland B

Scientific Name	**Common Name**	**Strata**	**Indicator Status**
Ulmus americana	American elm	Upper Canopy	FACW
Quercus michauxii	swamp chestnut oak	Upper Canopy	FACW-
Quercus phellos	willow oak	Upper Canopy	FACW-
Quercus bicolor	swamp white oak	Upper Canopy	FACW+
Liquidambar styraciflua	sweet-gum	Upper Canopy	FAC+
Lindera benzoin	spice bush	Sub-Canopy	FACW
Cornus amomum	silky dogwood	Sub-Canopy	FACW+
Betula nigra	river birch	Upper Canopy	FACW
Platanus occidentalis	American sycamore	Upper Canopy	FACW-
Arundinaria gigantea	giant cane	Herbaceous	FACW
Carex spp.	sedge species	Herbaceous	FAC - OBL
Juncus effusus	soft rush	Herbaceous	FACW+
Boehmeria cylindrica	false nettle	Herbaceous	FACW+

6.3.2 Basal Area

The dominant size class within the reference wetlands is 12 to 18 inch diameter at breast height (DBH). This size converts to a dominant basal area of 0.11 to 0.32 ft^2 (.01 to .03 m^2). Several specimen trees of American sycamore are greater than 18 inches DBH.

SECTION 7

PROJECT SITE RESTORATION PLAN

SECTION 7

PROJECT SITE RESTORATION PLAN

7.1 Overarching Goals and Applications of Restoration Plan

7.1.1

The overarching goals and applications of the proposed restoration plan for UT Clarke Creek is the timely, cost effective delivery of sustainable ecological uplift for the purpose of meeting compensatory mitigation requirements.

7.1.2

The goals developed by the stakeholder group for the LWP were to engage and educate the public and government, implement land use planning, enhance recreation and open space preservation, improve water quality, restore physical habitat, identify potential funding sources, and follow up and implement for long term. The LWP characterizes the project site as having problems associated with channelization, bank instability, and a limited riparian buffer zone. The LWP identifies the project site as having the potential to restore over 2,200 lf of stream and recommends stream restoration. The LWP also notes the potential to restore the forested riparian corridor between the two forested areas upstream and downstream of the project site. The implementation of this proposed stream restoration project and the project specific goals discussed in Section 7.1.5 below will help achieve the LWP goals of improving water quality and restoring physical habitat.

7.1.3

The proposed approach discussed below will allow the timely, cost effective delivery of sustainable ecological uplift and meet compensatory mitigation requirements by meeting project goals, designing away from the multiple constraints that exist onsite, minimizing disturbance, and proposing a restoration plan that uses the benefits of existing stability (i.e. bedrock grade control). The primary stream restoration effort will consist of Enhancement Level I along the main reach of UT Clarke Creek and its unnamed tributaries. The multiple constraints, including the utility easement, numerous bedrock outcrops, and steep topography, limits the restoration level to Enhancement Level 1 instead of Restoration. UT 6 provides the opportunity for Preservation. The restoration plan will also include wetland restoration and enhancement, the re-establishment of native riparian areas, and preservation of native vegetation and wetlands.

7.1.4

The factors of influence on the design effort included the existing vertical stability (bedrock outcrops) throughout a majority of the project streams and the existing design constraints. The constraints prevented JJG from realigning the stream, but the proposed level of intervention complements and enhances the existing conditions that currently provide stability and minimizes disturbance to the site. The proposed restoration plan was designed to meet the goals and objectives of the project. These factors justify the proposed level of intervention.

7.1.5

Restoration goals for this project include:

- Reduce sediment stressors caused by stream bank erosion and shear stress along the reach;
- Improve stream bank stability and sediment transport efficiency;
- Provide for uplift in water quality functions and nutrient filtration;
- Provide for greater overall stream and wetland habitat complexity and quality; and
- Improve and maintain riparian buffer habitat.

The project objectives include:

- Implement a sustainable, reference-based, rehabilitation of the project reaches' dimension to support sediment transport equilibrium.;
- Provide a sustainable and functional bankfull floodplain feature and reslope banks at a more stable slope;
- Strategically install stream structures and plantings designed to maintain lateral stability and habitat to the stream channel;
- Install, augment, and maintain appropriate vegetative riparian buffer and riverine wetland community types with sufficient density and vigor to support native vegetation. The buffer should have a minimum width of 50 ft on each side of project streams and consist of a mix of native species representative of a bottomland hardwood forest; and
- Restore and/or enhance the natural hydrology, vegetation, and soil composition in adjacent wetlands.

7.1.6

An existing conditions morphological survey, pebble counts, and channel stability assessments (i.e. BEHI) were performed to serve as pre-restoration baseline data so that post-construction monitoring data can be compared for the purpose of demonstrating attainment of the proposed goals and objectives of the project.

7.1.7

The grading plans and construction drawings of the proposed restoration plan display jurisdictional areas that will be impacted by project implementation.

7.1.8

The project will not result in a rise in the 100-year flood elevation.

7.1.9

This proposed enhancement approach along UT Clarke Creek and its unnamed tributaries will achieve the project goals of reducing stream bank erosion and increasing stream bank stability through creating a lower bank height ratio, establishment of vegetation roots along the channel banks, and improving channel dimension. It will achieve the other project goals of improving in-stream habitat and water quality by establishing a riparian buffer, stabilizing the channel banks with vegetation, and channel modifications.

The implementation of the proposed restoration plan on the project wetland areas will achieve the project goals of increasing nutrient filtration and improving aquatic habitat and water quality.

7.2 Restoration Project Goals and Objectives

The UT Clarke Creek Project is located in the Rocky River (Yadkin) LWP, in the Mallard Creek local watershed (HU 03040105010040). The project is located in the Yadkin-Pee Dee River Basin, DWQ Subbasin 30711. The project site watershed was identified as a Targeted Local Watershed (TLW) in EEP's 2003 Yadkin-Pee Dee River Basin Restoration Priority (RBRP) Plan. The project site was assessed in the Upper Rocky River LWP that was prepared for EEP by MACTEC in 2004 (http://www.nceep.net/services/lwps/Clarke_Creek/wmp_r04-15-05.pdf). The goals developed by the stakeholder group for the LWP were to engage and educate the public and government, implement land use planning, enhance recreation and open space preservation, improve water quality, restore physical habitat, identify potential funding sources, and follow up and implement for long term. The UT Clarke Creek project site is located in a subwatershed (MC01-01) targeted by the LWP for stream and wetland restoration. The LWP characterizes the site as having problems associated with channelization, bank instability, and a limited riparian buffer zone. The LWP identifies the project site as having the potential to restore over 2,200 lf of stream and recommends stream restoration. The LWP also notes the potential to restore the forested riparian corridor between the two forested areas upstream and downstream of the project site. The implementation of this proposed stream restoration project will help achieve the LWP goals of improving water quality and restoring physical habitat.

The LWP identified the major stressors in the watershed: stream bank erosion, lack of adequate forested buffer, stream channelization, agricultural impacts, land use changes, sedimentation, point source in-stream impacts, nutrients, and fecal coliform bacteria.

Site visits and research of available data identified the following causes of instability and project stressors: mechanical channel degradation and widening by livestock, buffer removal and deforestation, disconnection of wetland hydrologic features, and promotion of invasive, non-native vegetation biomass and see sources.

Ecological services and functions reduced from the stressors described above include the following: sediment transport equilibrium, maintenance of instream habitat, support of wetland habitat and hydrology, provision of riparian buffer and habitat, and floodplain storage of fine sediments.

Restoration goals for this project include:

- Reduce sediment stressors caused by stream bank erosion and shear stress along the reach
- Improve stream bank stability and sediment transport efficiency
- Provide for uplift in water quality functions and nutrient filtration
- Provide for greater overall stream and wetland habitat complexity and quality
- Improve and maintain riparian buffer habitat

The project objectives include:

- Implement a sustainable, reference-based, rehabilitation of the project reaches' dimension to support sediment transport equilibrium.
- Provide a sustainable and functional bankfull floodplain feature and reslope banks at a more stable slope.
- Strategically install stream structures and plantings designed to maintain lateral stability and habitat to the stream channel.
- Install, augment, and maintain appropriate vegetative riparian buffer and riverine wetland community types with sufficient density and vigor to support native vegetation. The buffer should have a minimum width of 50 ft on each side of project streams and consist of a mix of native species representative of a bottomland hardwood forest.
- Restore and/or enhance the natural hydrology, vegetation, and soil composition in adjacent wetlands.

7.2.1 Designed Channel Classification

Reach 1 UT Clarke Creek (station 0+00 – 08+00)

Along UT Clarke Creek, a majority of the streambed appears stable within the existing grade control consisting of bedrock and cobble. The current stream alignment cannot be moved onto its adjacent floodplain due to project constraints. These include numerous bedrock outcroppings throughout the project reach and the active sanitary sewer main with utility easement that parallels the entire project reach. The presence of the sewer main and its easement limits realignment potential to the north side of the stream. The known and likely presence of bedrock in the streambed, along both stream banks, and sporadically throughout the floodplain makes realignment difficult, if not physically impossible. Another factor in limiting full restoration potential as an option is wetland location and wetland enhancement/creation in Wetland E, which is located on the south side of the stream. If the stream were realigned on the south floodplain, it would likely adversely impact the existing wetland.

Due to the multiple constraints discussed above, JJG recommends restoration efforts that consist of in-place bank stabilization, floodplain establishment at the existing bankfull elevation to the extent possible, and the adjustment of the channel dimensions. This enhancement effort will involve leaving the stream in its current alignment and stabilizing the stream banks by establishing a floodplain at an appropriate bankfull elevation by excavating a bankfull bench, laying back bank slopes at a 2:1 slope (maximum), and replanting stream banks. Prioritized meander bends will also be stabilized by utilizing in-stream structures such as rock, log vanes and brush matting. Stream dimension has been designed so the new stream will maintain stability while conveying its watershed's runoff and transporting its sediment load. This proposed approach will likely qualify as Enhancement Level 1. The proposed restoration work will be a combination of Priority 2 and Priority 3 restoration (Rosgen, 1997). It appears that the presence of bedrock has had the effect of limiting rapid lateral and horizontal adjustment, and the current pattern is not likely to change. Proposed enhancement efforts will stabilize any potential lateral erosion as well as reduce the stress from the stream banks.

The existing sewer line and utility easement will limit the buffer to less than 50 feet along almost all of the left side of the channel. Approximately 415 linear feet will have a 0 – 15 foot buffer, approximately 310 linear feet will have a 15 – 30 foot buffer, and approximately 75 linear feet will have a 30 – 50 foot buffer.

The designed channel's target bankfull dimensions are based on a combination of the dimensionless ratios from the UT Clarke Creek reference reach, the NC Regional Curve for Rural Piedmont streams, and existing conditions. Trash, fallen trees, and debris will be removed from the stream to improve habitat, water quality, and aesthetics. All of the proposed work will occur within the conservation easement.

Refer to Design Sheets in Section 14 for a more detailed plan of the stream and wetland restoration site and Table 7.1 for the design values and dimensionless ratios. Components of this restoration plan may be modified based on construction and access constraints.

Reach 2 UT Clarke Creek (station 08+00 – 15+87)

Along Reach 2 of UT Clarke Creek, the stream shows more signs of degradation primarily due to previous beaver activity. In sections of this project reach, the stream has over widened, the slope has become less steep, and the stream bed has aggraded with fine sediments. The current stream alignment cannot be moved onto its adjacent floodplain due project constraints. These include numerous bedrock outcroppings throughout the project reach and the active sanitary sewer main with utility easement that parallels the entire project reach. The presence of the sewer main and its easement limits realignment potential to the north side of the stream. Another factor in limiting full restoration potential as an option is wetland location and proposed wetland restoration in Wetland D, which is located on the south side of the stream. If the stream were realigned on the south floodplain, it would decrease the area of the proposed wetland.

Due to the multiple constraints discussed above, JJG recommends restoration efforts that consist of in-place bank stabilization, floodplain establishment at the existing bankfull elevation to the extent possible, and the adjustment of the channel dimensions. This enhancement effort will involve leaving the stream in its current alignment and stabilizing the stream banks by establishing a floodplain at an appropriate bankfull elevation (which will be achieved by excavating a bankfull bench), laying back bank slopes at a 2:1 slope (maximum), and replanting stream banks. Prioritized meander bends will also be stabilized by utilizing in-stream structures such as rock, log vanes, and brush matting. Stream dimension has been designed so the new stream will maintain stability while conveying its watershed's runoff and transporting its sediment load. Along the over widened reach (station 8+50 – 10+50), a boulder double wing deflector has been proposed to narrow the channel to its appropriate dimension to transport the aggraded sediment. This proposed approach will likely qualify as Enhancement Level 1. The proposed restoration work will be a combination of Priority 2 and Priority 3 restoration (Rosgen, 1997). It appears that the presence of bedrock has had the effect of limiting rapid lateral and horizontal adjustment, and the current pattern is not likely to change. Proposed enhancement efforts will stabilize any potential lateral erosion as well as reduce the stress from the stream banks.

The existing sewer line and utility easement will limit the buffer to less than 50 feet along the entire left side of the channel. Approximately 500 linear feet will have a 0 – 15 foot buffer, approximately 145 linear feet will have a 15 – 30 foot buffer, and approximately 60 linear feet will have a 30 – 50 foot buffer.

The designed channel’s target bankfull dimensions are based on a combination of the dimensionless ratios from the UT Clarke Creek reference reach, the NC Regional Curve for Rural Piedmont streams, and existing conditions. Trash, fallen trees, and debris will be removed from the stream to improve habitat, water quality, and aesthetics. All of the proposed work will occur within the conservation easement.

Refer to Design Sheets in Section 14 for a more detailed plan of the stream and wetland restoration site and Table 7.1 for the design values and dimensionless ratios. Components of this restoration plan may be modified based on construction and access constraints.

UT 1 (station 0+00 – 07+78)

Conditions along UT 1 are similar to those along UT Clarke Creek. Not only do the sewer main, utility easement, and likelihood of the presence of bedrock outcrops exist along the entire length of UT 1, but a steep hill slope located adjacent to the east stream bank makes realignment and pattern/sinuosity adjustment very difficult, therefore limiting full Restoration potential. Due to the multiple limitations that exist throughout the project reach of UT 1, JJG recommends restoration efforts that consist of in-place bank stabilization, floodplain establishment at the existing bankfull elevation to the extent possible, and the adjustment of the channel dimensions. This enhancement effort will involve leaving the stream in its current alignment and stabilizing the stream banks by establishing a floodplain at an appropriate bankfull elevation by excavating a bankfull bench, laying back bank slopes at a 2:1 slope (maximum), and replanting stream banks. Prioritized meander bends will also be stabilized utilizing in-stream structures such as rock and log vanes and brush matting.

One extremely unstable existing meander bend (station 01+65 – 02+99) will be relocated to mimic the natural sinuosity pattern and establish riffle/pool sequences that occur in typical Piedmont streams. The ratio of radius of curvature to bankfull width is designed to be 2.5 to 3.0, which provides a moderate to very low potential for bank erosion to occur (Rosgen, 2006b). The meandering will also allow the stream to dissipate energy and decrease shear stress. The presence of bedrock and the adjacent steep hill slope have had the effect of limiting rapid lateral and horizontal adjustment, and the current pattern is not likely to change. Proposed enhancement efforts will stabilize any potential lateral erosion as well as reduce the stress from the stream banks.

The existing sewer line and utility easement will limit the buffer to less than 50 feet along the entire right side of the channel. Approximately 140 linear feet will have a 0 – 15 foot buffer, approximately 350 linear feet will have a 15 – 30 foot buffer, and approximately 230 linear feet will have a 30 – 50 foot buffer.

The designed channel's target bankfull dimensions are based on a combination of the dimensionless ratios from the reference reach, the NC Regional Curve for Rural Piedmont streams, and existing conditions. Trash, fallen trees, and debris will be removed from the stream to improve habitat, water quality, and aesthetics. All of the proposed work will occur within the conservation easement.

Refer to Design Sheets in Section 14 for a more detailed plan of the stream and wetland restoration site and Table 7.1 for the design values and dimensionless ratios. Components of this restoration plan may be modified based on construction and access constraints.

UT 2 (station 04+22 – 05+99, 07+16-08+47)

UT 2 contains two reaches which are separated by Wetland A. UT 2B drains from Wetland B to Wetland A. UT 2A drains from Wetland A to UT Clarke Creek. The former property owner created and maintained the ditch to drain the spring that originates at the upstream end of UT 2 at Wetland B. This channel maintenance resulted in creating a stream that did not have the appropriate dimension for its watershed and a stream that is wider than is needed. Due to overwidening of the stream aggradation and sediment deposition were accelerated, which resulted in the development of Wetland A. Aggradation and sediment deposition appear to be the typical condition throughout UT 2, especially UT 2B. Although the stream is overwidened, the banks have become stable and dense vegetation has established on the deposited sediments. The stream is also connected to its floodplain and shows no sign of incision. UT 2A has more of a defined, low-flow channel with a bankfull bench which aids in transporting the deposited sediments. The defined channel feature is probably due to a steeper slope through this reach. There is established herbaceous vegetation along both banks of the project reach but very few woody species. Since both reaches appear physically stable, JJG recommends minimal disturbance and channel improvements that include planting bare roots and live stakes of native species appropriate to the area. These plantings will aid in stream bank stabilization and establish a 50-foot riparian buffer on each side of the stream.

Refer to Design Sheets in Section 14 for a more detailed plan of the stream and wetland restoration site. Components of this restoration plan may be modified based on construction and access constraints.

UT 3 (station 0+00 – 01+03)

Due to its short length in the project area and its alignment through the sewer utility easement, JJG recommends restoring UT 3 using efforts that consist of in-place bank stabilization, floodplain establishment at the existing bankfull elevation to the extent possible, and adjustment of the channel dimensions. This enhancement effort will involve leaving the stream in its current alignment and stabilizing the stream banks by establishing a floodplain at an appropriate bankfull elevation by excavating a bankfull bench, laying back bank slopes at a 2:1 slope (maximum), and replanting stream banks. The steep valley and stream conditions support a B-type channel consisting of step pool features. Invasive vegetation will be removed and adjacent stream banks and riparian zones of UT 3 will be replanted using bare roots and live stakes of native species appropriate to the area. These plantings will aid in stream bank stabilization and establish a 50-foot riparian buffer on each side of the stream.

The existing sewer line and associated utility easement cross the stream at a perpendicular angle. The estimated buffer widths measured from the existing top of bank along UT 3 will be 0 feet at the crossing and 0 – 15 feet from the south side of the easement to the confluence of UT 3 and UT Clarke Creek. A total of approximately 55 linear feet of stream will have a buffer width of 0 – 15 feet, and approximately 45 linear feet of stream will have a buffer width of 50 feet on the north side of the easement.

Refer to Design Sheets in Section 14 for a more detailed plan of the stream and wetland restoration site. Components of this restoration plan may be modified based on construction and access constraints.

UT 4 (station 01+92 – 05+65)

UT 4 is surrounded by steep hill slopes. The channel thalweg slope from its headwaters at Wetland C to its confluence with UT 2 is also very steep. Due to the surrounding steep slopes and the stream’s existing location on the side of a hill, pattern realignment/adjustment and full restoration is not feasible. JJG recommends restoring UT 4 using efforts that consist of in-place bank stabilization, floodplain establishment at the existing bankfull elevation to the extent possible, and adjustment of the channel dimensions. This enhancement effort will involve leaving the stream in its current alignment, establishing a floodplain on the left stream bank at an appropriate bankfull elevation by excavating a bankfull bench, laying back bank slopes at a 2:1 slope (maximum), and replanting stream banks. The right bank will not be graded because it is composed of mature trees and has a steep topography. The steep valley and stream conditions support a B-type channel consisting of step pool features. Invasive vegetation will be removed and adjacent stream banks and riparian zones of UT 4 will be replanted using bare roots and live stakes of native species appropriate to the area. These plantings will aid in stream bank stabilization and establish a 50-foot riparian buffer on each side of the stream. A log sill will be installed at the headwaters of UT 4 to protect the grade/elevation of the existing Wetland C.

Refer to Design Sheets in Section 14 for a more detailed plan of the stream and wetland restoration site. Components of this restoration plan may be modified based on construction and access constraints.

UT 5 (station 03+56 – 04+75)

The current alignment of UT 5 extends from its headwaters at the downstream end of Wetland E and continues down the valley until discharging into UT Clarke Creek. Approximately 40 feet downstream of the existing upper limits of UT 5, a plug will be installed for the purpose of creating a new wetland area which will extend and increase the size of the existing Wetland E. Due to the remaining short length of UT 5 in the project area (approximately 70 feet), JJG recommends restoring UT 5 in order to provide a functional outfall from the larger Wetland E. The remaining 70 feet of UT 5 to its confluence with UT Clarke Creek will be restored using efforts that consist of in-place bank stabilization, floodplain establishment at the existing bankfull elevation to the extent possible, and adjustment of the channel dimensions. A log/boulder sill or a series of sills will be installed at the existing upper limits of UT 5 to protect the wetland fill/plug upstream and to function as an outlet/weir for flow out of Wetland E into UT 5.

Refer to Design Sheets in Section 14 for a more detailed plan of the stream and wetland restoration site. Components of this restoration plan may be modified based on construction and access constraints.

UT 6 (station 0+00 – 14+64)

The project reach of UT 6 within the conservation easement will be placed in preservation.

Approximately 1,464 linear feet of UT 6 flows through the proposed conservation easement. An active sanitary sewer main with a 15-foot utility easement parallels the entire project reach. The majority of the riparian corridor is wooded and offers nearly 100% canopy cover consisting of mature hardwoods. Given the physical characteristics of UT 6, JJG recommends restoration efforts consisting of preservation. This effort will result in minimal, if any, land disturbance and will prevent future disturbance to the stream reach.

The existing sewer line and utility easement will limit the buffer to less than 50 feet along the entire right side of the channel. Approximately 167 linear feet will have a 0 – 15 foot buffer, approximately 793 linear feet will have a 15 – 30 foot buffer, and approximately 504 linear feet will have a 30 – 50 foot buffer.

Table 7.1
Design Values for Proposed Conditions

		UT Clarke Creek 1		UT Clarke Creek 2		UT 1	
	Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
General	Drainage Area (sq mi)	1.00		1.08		0.46	
	Stream Type (Rosgen)	E4*		E4*		E4*	
	Valley Type	VIII		VIII		VIII	
Dimension	BKF Mean Velocity (Vbkf) (ft/s)	4.36-4.87		2.49-2.82		3.60-3.95	
	Bankfull Discharge (Qbkf)(cfs)	56.10-86.90**		77.26-96.43**		42.16-53.43**	
	Bankfull XSEC Area, Abkf (sq ft)	12.89	17.86	31.48	34.19	11.84	13.54
	Bankfull Width, Wbkf (ft)	10.57	12.20	19.34	21.75	10.6	10.77
	Bankfull Mean Depth, dbkf (ft)	1.22	1.46	1.45	1.77	1.10	1.28
	Width to Depth Ratio, W/D (ft/ft)	8.36	8.66	10.93	15.00	8.28	9.79
	Width Floodprone Area, Wfpa (ft)	54.63	63.43	51.63	59.48	49.4	93.72
	Entrenchment Ratio, Wfpa/Wbkf) (ft/ft)	5.17	5.20	2.67	2.73	4.59	8.84
	Max Depth @ bkf, Dmax (ft)	1.89	2.21	1.83	2.96	1.60	2.14
	Max Depth Ratio, Dmax/dbkf	1.51	1.55	1.26	1.67	1.45	1.67
	Max Depth @ tob, Dmaxtob (ft)	1.89	2.21	1.83	2.96	1.60	2.14
	Bank Height Ratio, Dtob/Dmax (ft/ft)	1.00	1.00	1.00	1.00	1.00	1.00
Substrate	d16 (mm)	2.46				0.83	
	d35 (mm)	7.96				2.5	
	d50 (mm)	12.28				5.02	
	d84 (mm)	43.87				39.43	
	d95 (mm)	75.19				120.4	

Cells noted with a (*) have been classified using a typical cross-section within each reach, Cells noted with a (**) were calculated using using Flowmaster.

Hydrological Modifications (for wetland restoration, creation, or enhancement)

The project will also include riparian wetland restoration, preservation, and enhancement. Both Wetlands A and D are former maintained ditches. The ditch containing Wetland A was constructed to convey flow from a natural spring to UT Clarke Creek. The ditch containing Wetland D was created to drain soils to improve soil moisture conditions for growing hay within the adjacent floodplain. These channelized ditches effectively drain surface water and shallow groundwater from the surrounding area. The former maintained ditches that now comprise Wetland D and a portion of Wetland A will be plugged and compacted, and the surrounding areas will be planted with native tree and shrub species in order to restore wetlands in the floodplain of UT Clarke Creek. The floodplain surrounding Wetland D is currently comprised of a pasture of fescue (*Festuca sp.*) and does not satisfy the hydrophytic vegetation criterion. The groundwater table was within 8 inches of the ground surface at the time of the January 27, 2010 site visit; however, it is important to note that this site visit was conducted outside of the growing season and approximately 48 hours following a heavy rain event. Based on existing vegetative and surface hydrologic indicators, the existing groundwater elevation during the growing season is expected to be deeper than 8 inches in this location. Plugging and compacting these two ditches will reduce drainage of the floodplain and is anticipated to satisfy wetland hydrology criterion by raising the groundwater table to within 12 inches of the ground surface for a minimum 12.5 percent of the growing season. The ditch in Wetland D will be plugged with earth material (95% Standard Proctor) to restore the ditch to current grade and restore groundwater to its "pre-ditched" level. A portion of the ditch in Wetland A will be partially filled. The proposed restoration approach will include installing a series of log sills throughout Wetland A and at the downstream terminus of Wetland A to create areas of inundation, which will raise the groundwater in this area and result in a shallower groundwater table. The log sill will also facilitate some controlled drainage from the proposed wetland area and provide a step-down change in elevation to UT 2A. A small berm (6 to 12 inches high) will also be constructed along the floodplain of UT 2A and UT Clarke Creek in the proposed wetland restoration area to aid in inundation, prevent surface water from leaving the area, and raising the groundwater table. Hydrologic functions that are expected to be enhanced include moderation of groundwater discharge to sustain base flows, nutrient cycling through chemical transformations such as denitrification, and restoration of wetland plant and animal communities, habitat structure, and detrital biomass.

Construction materials will consist of clay plug material, native fill material (from grading the stream bank), logs from felled trees onsite, and coir fabric.

Similar to an unaltered wetland area, inundation and saturation levels will vary with seasonal and climatological variability. In droughts, groundwater will be at a lower elevation; therefore, groundwater in these areas will be at a lower elevation and may not inundate or saturate the proposed restoration areas.

As detailed above, UT 5 will be plugged approximately 40 feet downstream of its existing upper limit in order to create a new wetland area which will extend and increase the size of the existing Wetland E. Invasive species will be removed from the area and native vegetation will be planted according to the planting plan. The non-linear area of Wetland E proposed for enhancement and creation currently contains blackberry, soft rush, and carex sedge tussocks, evidence of drainage patterns in the wetland, and evidence of past impoundment due to beaver activity. Saturated soils were noted at a depth of 8 inches below the ground surface; however, no inundation or free water in the shovel pit was observed. The remaining length of UT 5 (approximately 70 feet), will be restored in order to provide a functional outfall from the larger Wetland E. These restoration efforts will consist of in-place bank stabilization, floodplain establishment at the existing bankfull elevation, and adjustment of the channel dimensions. A log/boulder sill or a series of sills will be installed at the existing upper limits of UT 5 to protect the wetland fill/plug upstream and to function as an outlet/weir for flow out of Wetland E into UT 5.

Enhancement techniques such as planting hydrophytic trees and shrubs and removing invasive vegetation will be applied to Wetland C (0.057 ac).

Enhancement of Wetland B (0.134 ac) is not feasible. Wetland B is an emergent wetland confined within a narrow gully feature created and maintained as a ditch by the former property owner to drain a spring located at the headwaters of Wetland B. Given that Wetland B is confined within a narrow gully feature, additional plantings are not advisable. In addition, no invasive species were noted within Wetland B, and no other opportunities for wetland enhancement are present.

7.2.2 Target Wetland Communities/Buffer Communities

The proposed wetland communities will be similar to the existing reference site at EEP's Suther (Dutch Buffalo Creek) stream and wetland restoration site. This palustrine forested area is classified as a Piedmont/Mountain Bottomland Forest community (Schafale and Weakley, 1990). Typical overstory/canopy vegetation associated with these wetlands includes American elm, box elder, tulip polar, river birch (*Betula nigra*), swamp chestnut oak, red maple, green ash, and sugarberry. Typical understory vegetation includes silky dogwood (*Cornus amomum*), flowering dogwood, silky willow (*Salix sericea*), and ironwood. Wetland hydrology is achieved by overbank flooding and a seasonally high groundwater table resulting in periodic inundation and seasonal saturation. Alluvial, hydric soils are present consisting of the Monacan soil series, with inclusion of Wehadkee soil series.

7.3 Stream Project and Design Justification

7.3.1 Sediment Transport Analysis

A sediment transport competency analysis was conducted on the UT Clarke Creek and UT 1 of Clarke Creek to ensure that the design stream will move their sediment load without significant potential for aggradation or degradation. Stream competency was analyzed to determine what sediment particle sizes are typically available for mobility at bankfull flows. Characterizing the streambed sediment stratification also provided the means to calculate and verify the channels' existing and proposed critical dimensionless shear stress, target design slope, and the required minimum mean depth needed for channel stability.

7.3.1.1 Methodology

Entrainment data was collected within the UT Clarke Creek and UT 1. Pavement and subpavement samples were collected at a riffle cross-section, and a wetted pebble count was conducted at each cross-section to calculate entrainment and velocity. Calculated fields consist of critical dimensionless shear stress (cdss), mean depth of bankfull (d_{BKF}), and water surface/bankfull slope. Using Shields and Rosgen Colorado curve, maximum grain diameter and shear stresses were determined to verify entrainment calculations (Rosgen, 2006). The Shields and Rosgen Colorado curve can be used to predict two stream parameters. Shear stress can be predicted using the largest particle size (Di) from a bar or subpavement sample, or the Di can be predicted using a calculated shear stress. Field collection and calculations followed methods described by Rosgen (2004 a, b) and North Carolina Stream Restoration Institute (Doll et. al., 2003). Lab procedures for processing pavement and subpavement samples followed methods described by Bunte et. al. (2001).

7.3.1.2 Calculations and Discussion

Tables 7.2 and 7.3 summarize the results of the sediment transport analysis for UT Clarke Creek.

Table 7.2
Entrainment Calculations

Parameter	UTC	UT1
	Design-E4	**Design-E4**
Existing Bankfull Slope (ft/ft)	0.0083	0.0090
Median particle size-wetted pebble count, D50 (mm)	11.30	11.3
Median particle size subpavement, D50^ (mm)	10.20	11.65
D50/D50^	1.11	0.97
Largest Particle Size from Subpavement, Di (mm)	75.00	70.00
Critical Dimensionless Shear Stress, cdss	0.0074	0.0078
Minimum Mean Bankfull Depth, dBKF (ft)	0.36	0.38
Minimum Bankfull/Water Surface Slope (ft/ft)	0.0083	0.0077

Table 7.3
Sediment Transport Validation

Parameter		UTC		UT1	
		Existing-B4c	**Design-E4**	**Existing-B4c**	**Design-E4**
Bankfull Shear Stress (lbs/sqft):	γRS	0.74	0.74	0.88	0.59
Grain Diameter (mm)*	*Using Bankfull Shear Stress*	0.68	0.68	0.73	0.73
Grain Diameter (mm)**		4.15	4.15	4.27	4.27
Predicted Shear Stress (lbs/sqft)*	*Using Di*	1.00	1.00	0.95	0.95
Predicted Shear Stress (lbs/sqft)**		0.40	0.40	0.32	0.32

* Results using Shields Curve, ** Results using Rosgen CO curve
Source for Curve Data from Watershed Assessment of River Stability and Sediment Supply (Rosgen, 2006b)

Results

UT Clarke Creek

Competency

- Using Shields and Rosgen CO Curves, the largest particle available for transport is respectively, 1.00 and 0.41 mm for the existing channel and the designed channel.
- The critical dimensionless shear stress required to mobilize and transport the Di is 0.0074.
- To entrain the Di, the minimum bankfull depth and slope required for the design are 0.36 ft, and 0.0083 ft/ft, respectively.
- The calculated existing and design bankfull shear stress is 0.74 lbs/ft^2. Shields predicted a shear stress value of 1.00 lbs/ft^2, which is greater than the calculated shear stress and the Rosgen CO curve predicted a shear stress value of 0.40 lbs/ft^2. The calculated design

shear stress is within the range of the two curves, and therefore, the potential for aggradation or degradation to occur is minimal.

UT 1

Competency

- Using Shields and Rosgen CO Curves, the largest particle available for transport is 0.75 and 4.27 mm, respectively, for the existing channel and the designed channel.
- The critical dimensionless shear stress required to mobilize and transport the Di is 0.0078.
- To entrain the Di, the minimum bankfull depth and slope required for the design are 0.38 ft, and 0.0077 ft/ft, respectively. These parameters are met within JJG's design.
- The calculated existing bankfull shear stress is 0.88 lbs/ft^2. The calculated design bankfull shear stress is 0.59 lbs/ft^2. Shields curve predicted shear stress values of 0.95 lbs/ft^2. The Rosgen CO curve predicted a shear stress value of 0.32 lbs/ft^2. The cacluated design shear stress is within the range of the two curves, and therefore, the potential for aggradation or degradation to occur is minimal.

Summary

The channel design for UT Clarke Creek and UT 1 demonstrate that the proposed Enhancement and Restoration efforts will aid in decreasing the amount of in-stream bank erosion, thereby decreasing in-stream sediment. It can be assumed that there is no significant potential for aggradation or degradation to occur within the main channel or unnamed tributary for the proposed channel designs.

7.3.2 HEC-RAS Analysis

A hydraulic model was developed for the project reach of the main channel of UT Clarke Creek using HEC-RAS software to determine water surface elevations along the project reach and to identify the extent of flooding for both the existing stream and proposed stream geometry. Peak flow rates discussed in Section 3.2 were used in the model. The model was also used to verify that the proposed enhancement will not increase the water surface elevation of the FEMA 100-year floodplain. The model indicates that there will not be a rise in the water surface elevation for the 100-year floodplain due to the proposed conditions. These results can be seen in the following table. Refer to Table 7.4 for the 100-year water surface elevations for the existing and proposed conditions.

Table 7.4
100-year Water Surface Elevations (WSE) for Existing and Proposed Conditions

Cross-Section Station (ft)	Existing Conditions 100-yr WSE (ft)	Proposed Conditions 100-yr WSE (ft)	Difference in WSE from Existing to Proposed (ft)
1139.019	748.77	747.77	-1.00
920.9172	746.09	744.74	-1.35
562.1335	744.48	744.06	-0.42
311.7481	744.04	743.94	-0.10
126.4304	743.40	743.40	0.00

7.3.2.1 No-Rise, LOMR, CLOMR

After discussing the project with the Flood Mitigation Program of Charlotte-Mecklenburg Storm Water Services, it has been determined that a local floodway encroachment permit will be required. It is also anticipated that flood elevations are likely to change because of project implementation; if so, a FEMA Letter of Map Revision (LOMR) will be required within six months of project completion

7.3.2.2 Hydrologic Trespass

According to the FEMA FIRM map of the project area (effective date March 2, 2009), segments of UT Clarke Creek, UT 2, and UT 3 are within the 100-year floodplain.

The proposed restoration project was designed to avoid hydrologic trespass. Hydrologic trespass occurs when there is a rise in the 100-year storm floodplain (water surface elevation) when compared to the published FEMA FIRM map. The HEC-RAS model of the proposed restoration/enhancement reaches indicates that the 100-year floodplain elevations on adjacent properties will not increase.

7.4 Site Construction

7.4.1 Site Grading, Structure Installation, and Other Project Related Construction

Site Grading and Scaled Schematic of Grading

JJG recommends restoration efforts that consist of in-place bank stabilization, floodplain establishment at the existing bankfull elevation to the extent possible, and adjustment of the channel dimensions. This enhancement effort will include establishing a floodplain at an appropriate bankfull elevation by excavating a bankfull bench and laying back bank slopes at a 2:1 slope.

The site will be graded according to the construction plans and cross-sections. For UT Clarke Creek and UT 1, a continuous floodplain will be excavated. On inside meander bends, the floodplain will be graded at a 12:1 slope to tie into the upstream and downstream outside meander bend graded floodplains so that water can flow down the valley during larger storm events. Where the existing cross-sections' stream banks are steeper than a 2:1 slope, the banks will be graded to a 2:1 slope to tie into the floodplain. The outside edge of the floodplain will be graded at a 2:1 slope to tie into the existing terrace grade.

All of the proposed work will occur within the conservation easement.

For restoration components requiring new channel alignment, the channel will be constructed offline and stabilized prior to the introduction of water into the restoration reach. For restoration components requiring modification of the existing alignment, the channel will be dewatered as necessary to construct and stabilize the reach prior to reintroduction of water into the restoration reach. Through the duration of construction, the site will be stabilized with erosion and sedimentation control measures consistent with the requirements of the NC Sedimentation and Pollution Control Act of 1973, as regulated by the NCDENR Division of Land Resources Land Quality Section.

Structure Installation

Along UT Clarke Creek and its unnamed tributaries, a majority of the streambeds appears stable within the existing grade control consisting of bedrock and cobble. Due to numerous bedrock outcroppings and coarse substrate, vertical instability is not a major concern. The streams appear to be vertically stable, and most of the instability and degradation is occurring along the stream banks through lateral adjustment and erosion. Due to the vertical stability provided by natural grade control, boulder grade control structures are not necessary. Potential lateral erosion will be stabilized by excavating a continuous floodplain throughout the project reaches, planting vegetation, and installing brush mats; therefore, a relatively small number of structures are proposed for this design. A boulder double wing deflector will be installed on an overwidened section of UT Clarke Creek to maintain a narrower baseflow width which will maintain adequate sediment transport since there are significant aggraded sediments in this area. The double wing deflector will also help provide a stable footing for the stream banks, thus minimizing the risk of bank slumping while vegetation can become established.

Stabilization structures such as log vanes will be installed in prioritized areas to provide habitat and to protect the stream banks while vegetation is established. Most of the structures will be constructed with logs and large woody debris, where possible, since a supply of these natural materials is available on the project site. At the confluences of UT 1 and UT 3 to UT Clarke Creek, a series of log or rock step-pools will be placed to transition the tributaries from their elevation to the elevation of the main channel. Log sills will be used in the proposed wetland areas to create areas of inundation, resulting in a shallower groundwater table.

Erosion and Sediment Control

Stormwater Best Management Practices (BMPs) will be implemented within the UT Clarke Creek project area following guidelines outlined in the North Carolina Department of Environment and Natural Resources (NCDENR) *Erosion and Sediment Control Planning and Design Manual* (2006) and the NCDENR *Stormwater Best Management Practices* (1999).

Through the use of non-structural controls, runoff will be treated, thereby limiting the potential for pollutant runoff. The existing streams and wetlands will be protected from erosion and sedimentation problems during construction. No significant storm water concerns are prevalent within the project limits.

Construction Access Plan

The parcel adjacent to EEP's conservation easement and project area is owned by the Mecklenburg County Park and Recreation Department. Communication with the County indicates that construction access can occur beyond the conservation easement limits. The access point from Huck's Road will be protected with a construction entrance according to the Details Sheets of the Construction Plans. There is currently a path through the pasture from Huck's Road to the project site, and this path will be used for construction access. Grading a haul road is not necessary for this project since one already exists. If site conditions become muddy, rock will be used along the path. A temporary bridgemat stream crossing will be needed to cross a drainage feature where there is currently a wooden bridge, if the Contractor determines the existing bridge cannot handle their equipment loads. Temporary stream crossings across UT Clarke Creek will also be needed to access UT 1 and UT 3. The locations of these potential temporary crossings can be found on the Construction Plans.

Proposed Wetland Impacts

None of the existing delineated wetlands on the project site will be temporarily impacted as a result of required construction access to build the proposed restoration plan.

7.4.2 Natural Plant Community Restoration

7.4.2.1 Soil Preparation and Amendments

Typically, the soils of the Piedmont/Mountain Bottomland Forest community are prime farm and planting soils due to their fertility and periodic flooding (Schafale and Weakely, 1990). The existing soils within the proposed wetland restoration and enhancement areas consist of Monacan soils which are naturally fertile and well-suited for planting (USDA, 1988). Most of the areas within the project easement will be heavily planted with the species shown below in Table 7.5. To JJG's knowledge, the areas to be planted have not been regularly plowed and replanted, so it is unlikely to have been over utilized for agriculture purposes. Hay is periodically harvested by the previous landowner, but he will not continue to do this after the restoration plan is implemented. Top soil taken from cut areas along the streams will be reserved for the topsoil dressing in nutrient poor areas located along the project reaches. The soil along the stream banks is naturally fertile due to its alluvial nature, so this topsoil should be well suited for planting. Disking the soil prior to planting will add organic matter and also diminish any compaction and increase the rooting volume (Clewel and Lea, 1990). In addition, disking will ensure adequate drainage and beneficial microtopography for planting and drainage. Prior to planting, soil analysis will be performed by the Contractor to determine what, if any, soil amendments need to be added to establish correct soil conditions for the trees/shrubs to be planted.

With the exception of the drainage ditches, minimal grading (fill or cut) is proposed for the wetland restoration and enhancement areas. Top soil taken from cut areas along the stream will be reserved for the top soil dressing utilized for ditch filling.

7.4.2.2 Narrative & Plant Community Restoration

The wetland restoration/enhancement areas and the areas of disturbance associated with the ditch filling will be planted with species similar to those found in the reference areas to achieve a Piedmont/Mountain Bottomland Forest community as described in Schafale and Weakely (1990). The reference area, its surrounding forest, and Schafale and Weakley's species descriptions were used to develop a species list as shown in Table 7.5. Similarly, the stream banks and immediately adjacent riparian areas (a minimum of 50 feet on each side of the streams except where the sanitary sewer easement exists) associated with disturbance due to bank stabilization will be planted with species similar to those currently found on the project site and at the reference areas to develop a Piedmont/Low Mountain Alluvial Forest community (Schafale and Weakely 1990). The sewer line and utility easement will reduce buffer width to less than 50 feet along most of the left bank of UT Clarke Creek and the entire right bank of UT 1. Refer to Section **7.2.1 Designed Channel Classification** above for a more detailed breakdown of the buffer widths in these areas.

Wetland Plantings

Wetland tree plantings will include green ash, sugar berry, box elder, willow oak, American elm, and river birch. Shrub plantings will include flowering and silky dogwood, pawpaw, spicebush, ironwood, red mulberry, and rose mallow.

Stream Bank and Adjacent Riparian Plantings

Stream banks and their adjacent riparian areas will be planted with live stakes, shrubs, and trees. Live stakes will include elderberry, silky willow, and silky dogwood. Shrub (understory) plantings will include flowering and silky dogwood, buttonbush, redbud, pawpaw, spicebush, ironwood, red mulberry, and rose mallow. Tree (overstory) plantings will include black walnut, hackberry, green ash, sugar berry, box elder, willow oak, southern red oak, and common shagbark hickory.

Topsoil removed during construction shall be conserved, stockpiled and reapplied to the site prior to planting. Installation of plantings into low quality, low fertility subsoil shall be avoided.

The species list found in Table 7.6 was developed based on on-site and reference areas inventories, input from the Mecklenburg County Parks and Recreation Department and Schafale and Weakley's species descriptions. Species selected for live staking were based on on-site inventories, prior experience, and input from the Mecklenburg County Parks and Recreation Department. Refer to Table 7.6 for a list of live staking material.

Table 7.5
Piedmont/Mountain Bottomland Forest Community Wetland Planting List - Woody Species

Common Name	Scientific Name	Wetl Ind. Stat.	Size	Spacing	Quantity
Trees					
Green ash	*Fraxinus pennsylvanica*	FACW	24” or > b.r.	10-feet O.C. random	99
Sugar berry	*Celtis laevigata*	FACW	24” or > b.r.	10-feet O.C. random	75
Box elder	*Acer negundo*	FACW	24” or > b.r.	10-feet O.C. random	99
Willow oak	*Quercus phellos*	FAC	24” or > b.r.	10-feet O.C. random	75
American elm	*Ulmus americana*	FACW	24” or > b.r.	10-feet O.C. random	75
River birch	*Betula nigra*	FACW	24” or > b.r.	10-feet O.C. random	75
Total Trees					**497**
Shrubs					
Flowering dogwood	*Cornus florida*	FACU	24” or > b.r.	6-feet O.C. random	173
Spicebush	*Lindera benzoin*	FACW	24” or > b.r.	6-feet O.C. random	207
Pawpaw	*Asimina triloba*	FAC	24” or > b.r.	6-feet O.C. random	207
Silky dogwood	*Cornus amomum*	FACW	24” or > b.r.	6-feet O.C. random	173
Ironwood	*Carpinus caroliniana*	FAC	24” or > b.r.	6-feet O.C. random	207
Red Mulberry	*Morus rubra*	FAC	24” or > b.r.	6-feet O.C. random	207
Rose mallow	*Hibiscus moscheutos*	OBL	24” or > b.r.	6-feet O.C. random	207
Total shrubs					**1,382**

Table 7.6
Piedmont/Mountain Bottomland Forest community
Stream Banks and Adjacent Riparian Planting List - Woody Species

Zone(s)	Common Name	Scientific Name	Wetl Ind. Stat.	Size	Spacing	Quantity
Trees/Overstory						
3	Black walnut	*Juglans nigra*	FACU	24” or > b.r.	10-feet O.C. random	74
3	Hackberry	*Celtis occidentalis*	FACU	24” or > b.r.	10-feet O.C. random	208
3	Green ash	*Fraxinus pennsylvanica*	FACW	24” or > b.r.	10-feet O.C. random	295
3	Sugar berry	*Celtis laevigata*	FACW	24” or > b.r.	10-feet O.C. random	208
3	Box elder	*Acer negundo*	FACW	24” or > b.r.	10-feet O.C. random	221
3	Willow oak	*Quercus phellos*	FAC	24” or > b.r.	10-feet O.C. random	148
3	Southern red oak	*Quercus falcata*	FACU-	24” or > b.r.	10-feet O.C. random	249
3	Common shagbark Hickory	*Carya ovata*	FACU	24” or > b.r.	10-feet O.C. random	74
	Total Trees					**1,477**
Shrubs/Understory						
3	Flowering dogwood	*Cornus florida*	FACU	24” or > b.r.	8-feet O.C. random	122
2	Buttonbush	*Cephalanthus occidentalis*	OBL	24” or > b.r.	8-feet O.C. random	183
3	Redbud	*Cercis canadensis*	FACU	24” or > b.r.	8-feet O.C. random	122
2	Silky dogwood	*Cornus amomum*	FACW	24” or > b.r.	8-feet O.C. random	122
2	Spicebush	*Lindera benzoin*	OBL	24” or > b.r.	8-feet O.C. random	122
3/2	Ironwood	*Carpinus caroliniana*	FAC	24” or > b.r.	8-feet O.C. random	122
3/2	Red Mulberry	*Morus rubra*	FAC	24” or > b.r.	8-feet O.C. random	122
3/2	Pawpaw	*Asimina triloba*	FAC	24” or > b.r.	8-feet O.C. random	183
2	Rose mallow	*Hibiscus moscheutos*	OBL	24” or > b.r.	8-feet O.C. random	122
	Total shrubs					**1,217**
Live Stakes						
1	Elderberry	*Sambucus Canadensis*	FACW-	24” or >	3-feet O.C.	964
1	Silky willow	*Salix sericea*	OBL	24” or >	3-feet O.C.	964
1	Silky dogwood	*Cornus amomum*	FACW	24” or >	3-feet O.C.	993
	Total stakes					**2,920**

7.4.2.3 On-site Invasive Species Management

Several invasive species including blackberry (*Rubus sp.*), multiflora rose (*Rosa multiflora*), Chinese privet (*Ligustrum sinense*), saw greenbriar (*Smilax bona-nox*), and Japanese honeysuckle (*Lonicera japonica*) occur throughout the project area. The invasive species will be mowed and sprayed with an herbicide during construction. Fescue also occurs within the project boundary. It can also be managed by mowing and spraying with an herbicide. It is anticipated that the invasive species will likely persist within the project area after restoration of the stream channel and riparian areas despite efforts to control its growth. Therefore, it is in the opinion of JJG that a long-term solution to vegetation restoration would likely prove to be beneficial. This long-term solution would consist of allowing the natural succession of a riparian forest to eventually eliminate the amount of available habitat (i.e., sunlight) of the invasives. This long-term approach to vegetation restoration would likely result in an overall greater success of the project and would surely prove to be beneficial to water quality and the overall bank stability following restoration. If invasive species appear to be deterring growth of planted species during monitoring, the use of an herbicide approved for use in aquatic areas will be explored.

SECTION 8

PERFORMANCE CRITERIA

SECTION 8

PERFORMANCE CRITERIA

The following success criteria are provided from the NCEEP *Mitigation Plan Document Guidance* and the ACOE (2003).

8.1 Stream Morphological Parameters and Channel Stability

Restored or enhanced streams should demonstrate morphologic stability to be considered successful. Stability does not equate to an absence of change, but rather to sustainable rates of change or stable patterns of variation. Restored streams often demonstrate some level of initial adjustment in the several months that follow construction, and some change/variation subsequent to that is also to be expected. However, the observed change should not be unidirectional such that it represents a robust trend. If some trend is evident, it should be very modest or indicate migration to another stable form. Annual variation is to be expected, but over time, this should demonstrate maintenance around some acceptable baseline with maintenance of, or even a reduction in, the amplitude of variation. Lastly, all of this must be evaluated in the context of hydrologic events to which the system is exposed.

8.1.1 Dimension

Cross-section measurements should indicate little change from the as-built cross-sections; however, some change is natural and expected. Any changes that occur will be evaluated to determine whether the adjustments are indicative of movement toward an unstable condition, or whether it is natural and of something to be expected. The following thresholds will be considered indicators of instability if: 1) W/D ratio increases by more than 10 to 15 percent, 2) BHR increases by more than 25 to 30 percent, or 3) change in stream classification (for example, a change from a C/E to a F/G).

8.1.2 Pattern and Profile

The channels' profile should not demonstrate any trends in thalweg aggradation or degradation over any significant continuous portion of its length. Annual measurements should indicate stable bed features with little change from the as-built ranges. Riffle/pool facets and pattern features should illustrate minimal adjustments over the five year monitoring period. Although a pool cross-section may experience periodic infilling due to watershed activity and the timing of events relative to monitoring, the majority of the pool cross-sections need to be maintained over time, and the rates of lateral migration need to be minimal. The following thresholds will be considered indicators of instability if: 1) Facet slopes increase by 50 percent, 2) riffle/pool bed feature spacing shifts are greater than one bankfull width, and 3) the longitudinal profile water surface slope increases by more than 20 percent.

8.1.3 Substrate

Substrate measurements should indicate the progression towards, or the maintenance of, the known distributions from the design phase. The D50 and D84 should coarsen over the five year monitoring period. Generally, riffles will contain coarser material, and the fines will deposit in the pools. Fluctuations in the substrate composition may occur over the five year monitoring period. Any change should be evaluated as to whether it is a localized change or something larger out of the project area. The following threshold will be considered a concern if: 1) the D50 increases by 30 percent and 2) the substrate composition has an increase of silt and/or sand by more than 50 percent.

8.1.4 Sediment Transport

There should be no trend toward aggradation or degradation over the course of the five year monitoring period. Point bar deposition is normal and expected to occur as long as it does not encroach the channel. Lateral and mid-channel bars should not be present, and if found and are large enough to impact normal flow, they would be considered a concern.

8.1.5 Stream Hydrology

Stream hydrology attainment will be monitored in accordance to the ACOE (2003) standards. At the end of the five year monitoring period, two or more bankfull events must occur in separate years within the restoration reach.

8.2 Stormwater Management Devices

During construction, all disturbed areas, access roads, and stock piles within the project site will have appropriate prevention methods installed to avoid erosion and sedimentation impacts on the existing streams and wetlands of UT Clarke Creek. Erosion and sedimentation control measures will consist of installing silt fencing around disturbed areas prior to disturbance and maintaining throughout the construction phases. All newly constructed stream banks will be matted and staked at the end of each work day.

8.3 Wetlands

Wetland hydrology attainment will be monitored in accordance to the ACOE (2003) standards. The target wetland hydrological success criterion is saturation or inundation for at least 12.5 percent of the growing season in the lower landscape (floodplain) positions. To achieve the hydrologic success criterion, groundwater levels must be within 12 inches of the ground surface for 29 consecutive days, which is 12.5 percent of the March 22 to November 11 (232 days) growing season.

8.4 Vegetation

Planted vegetation will be monitored for five years in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-NCEEP Level 2 Protocol (Lee et al., 2006). To achieve vegetative success criteria, the average number of planted stems per acre must exceed or meet 320 stems/acre after the third year of monitoring, 288 stems/acre after four years, and 260 stems/acre after the fifth year of project monitoring.

8.5 Schedule/Reporting

Monitoring, scheduling, and reporting will be finalized by NCEEP. Typically, there is an initial as-built monitoring survey and a monitoring plan established immediately following construction. The establishment of monitoring features and the collection and summarization of monitoring data shall be conducted in accordance with the most current EEP document entitled "Content, Format, and Data Requirements for EEP Monitoring Reports." Subsequently, the site will be monitored and reported annually for five years or until success criteria are met, whichever occurs last.

SECTION 9

PRELIMINARY MONITORING

SECTION 9

PRELIMINARY MONITORING

9.0 MONITORING PLAN

The methods to be employed for the project are a combination of those established by the NCEEP *Mitigation Plan Document Guidance* and the U.S. Army Corps of Engineers (USACE) *Stream Mitigation Guidelines for Stream Mitigation* (2003) (Monitoring Level 1 for restoration and enhancement areas and Monitoring Level 3 for all preservation areas). Vegetation assessments will be performed following the Carolina Vegetation Survey-NCEEP Level 2 Protocol (Lee et al., 2006). The *Flora of the Carolinas, Virginia, Georgia, and surrounding areas* by Alan S. Weakley will be used as the taxonomic standard for vegetation nomenclature for this project.

Monitoring shall be conducted for a minimum of five years or until success criteria are met, as required in the guidelines. The initial baseline assessment will be conducted within 30 days after construction has been completed.

9.1 Hydrology Attainment and Bankfull Verification

Stream flow will be monitored to determine the occurrence of bankfull events on the UT Clarke Creek and UT 1 reaches. A crest gauge will be installed along the main channel of UT Clarke Creek and UT 1. Both gauges should be monitored on a monthly basis to capture stream flow data and carry out necessary maintenance. Depending on the type of crest gauge installed, each field visit will involve recording the high water mark and/or electronically downloading the automatic gauge with compatible handheld software, resetting of the devices or download of any data, and carry out necessary maintenance or replacement of gauges. Should gauge malfunction occur, observations of wrack lines and deposition may serve to augment gauge observations.

Monitored groundwater gauges will be used to determine the success of the wetland areas before and after restoration. Four groundwater monitoring gauges were installed in the wetland areas to document water table hydrology in the required wetland restoration and enhancement locations. The monitoring gauges are programmed to download groundwater levels daily and will be downloaded monthly from March to November in order to capture hydrological data during the growing season and carry out necessary maintenance. These gauges will be monitored both pre- and post-construction.

9.2 Stream Channel Stability and Geomorphology

In order to ensure the Site meets regulatory stream and wetland enhancement success criteria, each feature on-site will be monitored annually for five years. Stream monitoring will be conducted on the UT Clarke Creek and UT 1 to evaluate the stability and function of the restoration reach. Geomorphic and stream assessments should be performed following guidelines outlined in the *Stream Channel Reference Sites: An Illustrated Guide to Field Techniques* (Harrelson et al., 1994), methodologies utilized in the Rosgen stream assessment and classification (Rosgen, 1994 and 1996), and in the *Stream Restoration: A Natural Channel Design Handbook* (Doll et al, 2003).

9.2.1 Dimension

Permanent cross-sections will be installed to represent the restored reach stream type and capture the variability in the dimensional features along UT Clarke Creek and UT 1. Cross-sections will be established approximately 20 bankfull width lengths apart along the entire length of the project. Permanent monuments will be established at each cross-section pins that are recoverable either through field identification or with the use of a GPS unit. Each assessment following the initial as-built survey should include re-surveying the same permanent cross-sections. Cross-section surveys will detail the stream, bank and floodplain topography of the channel including but not limited to top of bank, bankfull, all breaks in slope, water's edge, and the channel thalweg. Subsequently, each cross-section's Bankfull Area, W/D, ER, and Bank Height Ratios (BHR) will be calculated to meet the requirements as described in the EEP monitoring and mitigation protocols. Reference photographs looking upstream and downstream at each cross-section will be taken with the as-built survey. Subsequently, assessments following the initial as-built survey should capture the same reference photograph.

9.2.2 Profile

The longitudinal profile will be conducted along UT Clarke Creek and UT 1 covering the entire length of the restoration project. Each assessment following the initial as-built survey should include re-surveying the same longitudinal profile. Calculated values for riffle and pool facet slopes, riffle length, pool-to-pool spacing, and pool depth will be performed annually to evaluate changes in the bedform.

9.2.3 Pattern

Evaluation of UT Clarke Creek and UT 1 stream patterns will be assessed in MY0, and ranges will be defined. Stream pattern will only need to be measured in MY5, unless pattern appears to be significantly changing. Calculated sinuosity, meander width ratio, radius of curvature/bankfull width ratio, and meander length/bankfull width ratio will be used to evaluate channel migration/changes over the five year monitoring period.

9.2.4 Visual Assessment

Visual assessments will be conducted along the entire reaches of UT Clarke Creek, UT 1, UT 2, UT 3, UT 4, and UT 5. Assessments will follow the latest monitoring format document on the EEP website.

9.2.5 Bank Stability Assessments

Stream bed and bank composition will provide indicators for changes in channel form, hydraulics, erosion rate, and sediment supply (Doll et al., 2003). Two prediction methodologies will be used to determine the stream's (UT Clarke Creek and UT 1) potential for bank erosion:

Bank Erodibility Hazard Index (BEHI) and Near-Bank Stress (NBS). The BEHI analysis will be used to assess the physical properties of the stream bank and to determine the possible sources of bank instability. The NBS will be used to assess the bank with respect to the stress associated with the velocity in that portion of the channel. Using these methodologies, the expected annual sediment load produced from a stream system will be estimated and compared to pre-construction conditions. BEHI and NBS assessments will only be conducted in MY5.

9.3 Vegetation Monitoring

Planted vegetation will be monitored in accordance with the guidelines and procedures developed by the *Carolina Vegetation Survey-NCEEP Level 2 Protocol* (Lee et al., 2008) to monitor and assess the planted woody vegetation in the wetland areas and along the stream banks of the project reaches. Plots will be randomly established within planted portions of the wetland and stream restoration and enhancement areas to capture the heterogeneity of the designed vegetative communities. The plot corners will be marked so they can be recoverable either through field identification or with the use of a GPS unit. Reference photographs at the origin looking diagonally across the plot to the opposite corner will be taken with the as-built and each subsequent monitoring year. Subsequently, assessments following the initial as-built survey should capture the same reference photograph.

9.4 Photograph Reference Points

Permanent photographic reference points established along the wetland and channels will be used to support the qualitative visual assessments for the annual monitoring and subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Photographs will indicate the absence of developing bars within the channel, excessive bank erosion, changes in channel depth over time, and maturation of riparian vegetation. Reference photographs looking upstream and downstream at each photo point will be taken with the as-built. Subsequently, assessments following the initial as-built survey should capture the same reference photograph.

9.5 Wetland Monitoring

As described by the USACE Wilmington District, success criteria must be SMART (specific, measurable, attainable, reasonable, and trackable). Wetland restoration success criteria are normally addressed in terms of the three parameters (vegetation, soils, and hydrology) (USACE, 2007).

9.5.1 Hydrology

Wetland restoration success is largely dictated by the hydrology of the site. Factors considered in establishing wetlands hydrologic success criteria include knowledge of existing and/or relic hydric soil types and target wetland systems, as well as relevant scientific literature. Hydrology will be monitored through the use of Ecotone Water Level Loggers during each growing season for the first five years of monitoring or until the success criteria have been met, whichever occurs later. The USACE 1987 *Manual* defines an area as wetland if the soil is ponded, flooded, or saturated within 12 inches of the surface for at least 8% (19 consecutive days) of the growing season. The target wetland hydrological success criterion is saturation or inundation for at least 12.5 percent of the growing season in the lower landscape (floodplain) positions. To achieve this hydrologic success criterion, groundwater levels must be within 12-inches of the ground surface for 29 consecutive days, which is 12.5 percent of the March 22 to November 11 (232 days) growing season. A rain gauge will be downloaded monthly in order to compare the groundwater levels to precipitation levels. Tables and charts will be prepared to illustrate the groundwater levels and precipitation totals for the entire growing season. Hydrologic success criteria will be reviewed for each well and presented in the report. Once all wells have reached the success criterion, then the site has reached success.

Groundwater monitoring wells have already been installed in each restoration community type. Groundwater gauges were provided and maintained by the NCEEP. Groundwater monitoring well installation followed the USACE standard methods found in Technical Notes ERDC TNWRAP- 00-02 (July 2000).

Precipitation data collected by the State Climate Office of North Carolina for Charlotte, NC will be used to determine “normal/average” precipitation for months within the growing season. In the event that there are years of “normal/average” precipitation during the monitoring period and the data for those years does not show that the site has been inundated or saturated for the appropriate hydroperiod during the normal precipitation year, the review agencies may require remedial action. The “Monitoring Team” will provide any required remedial action and continue to monitor hydrology on the site until it demonstrates that the site has been inundated or saturated for the appropriate hydroperiod.

SECTION 10

SITE PROTECTION AND ADAPTIVE MANAGEMENT STRATEGY

SECTION 10

SITE PROTECTION AND ADAPTIVE MANAGEMENT STRATEGY

10.0 SITE PROTECTION AND ADAPTIVE MANAGEMENT STRATEGY

Mecklenburg County owns the underlying fee on the project property. Upon completion of site construction, the NC Ecosystem Enhancement Program shall monitor the project in keeping with the monitoring plan. Post-construction monitoring activities will be conducted to evaluate site performance, to identify maintenance and/or repair concerns, and to maintain the integrity of the project boundaries. If during the post-construction monitoring period it is determined that project compliance is jeopardized, the NC Ecosystem Enhancement Program shall take the necessary action to resolve the project concerns and bring the project back into compliance. At the conclusion of the post-construction monitoring period, the project shall be presented to the regulatory authority for project acceptance and close-out. Upon close-out, the project shall be transferred to the NCDENR Division of Natural Resource Planning and Conservation Stewardship Program for long-term management and stewardship.

SECTION 11
REFERENCES

Bunte, K., Abt, S.R. 2001. Sampling surface and subsurface particle-size distributions in wadable gravel- and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring. Gen. Tech. Rep. RMRS-GTR-74. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, 428 p.

Cady, J.G. 1950. Rock weathering and soil formation in the North Carolina Piedmont region. Soil Sci. Soc. Am. Proc. 15: 337- 342.

Clewell, A. F. and R. Lea. 1990. Creation and restoration of forested wetland vegetation of the southeastern United States. pp. 195-228. In: Kusler, J.A. and M.E. Kentula, editors. *Wetland Creation and Restoration: The Status of the Science*. Island Press, Washington, DC.

Cowardin, L. M., V. Carter, and F. C. Golet. 1979. *Classification of Wetland and Deepwater Habitats of the United States*. U.S. Fish and Wildlife Service. U. S. Department of Interior, Washington. DC.

Doll, B.A., Grabow, G.L., Hall, K.A., Halley, J., Harman, W.A., Jennings, G.D., and Wise, D.E., 2003. Stream Restoration: A Natural Channel Design Handbook.

Federal Emergency Management Agency (FEMA). Flood Insurance Rate Map. Map Number 3710456800J, Panel 4568, Effective March 2, 2009.

GretagMacbeth. 2000. Munsell Soil Color Charts. New Windsor, NY.

Harman, W.A., Jennings, G.D., Patterson, J.M., Clinton, D.R., Slate, L.O., Jessup, A.G., Everhart, J.R., and Smith, R.E., 1999. Bankfull hydraulic relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. Edited By: D.S. Olsen and J.P. Potondy. American Water Resources Associations. June 30-July 2, 1999. Bozeman, MT.

Harrelson, Cheryl C; Rawlins, C.L.; Potyondy, John P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique.* Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Jordan Jones & Goulding. UT Clarke Creek Stream and Wetland Restoration Conceptual Plan. 2010.

Leopold, L.B., Wolman, M.G., and Miller, J.P. 1992. Fluvial Processes in Geomorphology. Mineola, New York: Dover Publications Inc.

Luckenbaugh, Catherine McRae. Personal Communication on February 25, 2010. Mecklenburg County Parks and Recreation Department.

Mactec Engineering and Consulting, Inc. November 30, 2004. *Watershed Management Plan and Recommendations, Lower Yadkin/Upper Rocky River Basin, Local Watershed Planning (Phase II), Cabarrus, Iredell, Rowan and Mecklenburg Counties, North Carolina*. Prepared for North Carolina Ecosystem Enhancement Program.

Mactec Engineering and Consulting, Inc. December 10, 2003. *Preliminary Findings and Recommendations, Lower Yadkin River Basin Local Watershed Planning (Phase II), Rocky River Basin, North Carolina.* Prepared for North Carolina Wetlands Restoration Program.

Mecklenburg County Gis (2007). http://charmeck.org/maps/Pages/GISData.aspx

Mecklenburg County Parks and Recreation Department, Natural Resources Division. 2010. Species Inventory for Davis Farm Nature Preserve, Site ID 23.0.

National Register of Historic Places Database. 2007. Park Net (http://www.nr.nps.gov/).

NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed 01/19/10).

NC Onemap Viewer. 2009. http://www.nconemap.com/

North Carolina Atlas of NC Freshwater Mussells and Endangered Fish (NCAMEF), 2006. An online encyclopedia of aquatic species [web application]. Version 4.0 http://www.ncwildlife.org

North Carolina Department of Environment and Natural Resources (NCDENR), 1999. Stormwater Best Management Practices.

NCDENR, 2006. Erosion and Sediment Control Planning and Design Manual.

North Carolina Division of Water Quality (NCDWQ). 2008A. 2008 North Carolina Integrated Report Categories 4 and 5 (Impaired Waters List).

NCDWQ. 2008B. *Yadkin – Pee Dee River Basin Plan.* 553 pages.

North Carolina Geological Survey (NCGS). 1991. *Generalized Geologic Map of North Carolina. Available:* http://gis.enr.state.nc.us/sid/bin/index.plx?client=zGeologic_Maps&site=9AM. Accessed March 2007.

Page, L.M. and Burr, 1991. A field guide to freshwater fishes of North America. Houghton Mifflin Company, Boston, 432 p.

Pierce, G.J. 1993. Planning Hydrology for Constructed Wetlands. Wetland Training Institute Inc. Pub. WTI 93-2. Poolesville, MD.

Radford, Albert. 1968. *Manual of Vascular Flora of the Carolinas.* The University of North Carolina Press, Chapel Hill. 596 p.

Reed, Porter B. 1988. *National List of Plant Species That Occur in Wetlands: Southeast (Region 2)*. National Wetlands Inventory, Biological Report 88(26.2). U.S. Fish and Wildlife Service. U.S. Department of Interior, Washington. DC.

Rosgen, D L. 1996. Applied River Morphology. Wildland Hydrology Books, Pagosa Springs, CO.

Rosgen, D.L. 1997. A geomorphological approach to restoration of incised rivers. *In Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision,* ed. S.S.Y. Wang, E.J. Langendoen and F.B. Shields, Jr. Oxford, Miss.: University of Mississippi.

Rosgen, D.L. 2001. A practical method of computing streambank erosion rate. In *Proceedings of the Seventh Federal Interagency Sedimentation Conference,* Vol. 2, Reno, Nevada, March 25-29.

Rosgen, D.L. 2004a. River Restoration and Natural Channel Design. Course Handbook. Gunnison, CO. Wildland Hydrology, Inc.

Rosgen, D.L. 2004b. River Assessment and Monitoring Field Guide. Course Handbook. Meadows of Dan, VA: Wildland Hydrology, Inc.

Rosgen, D.L. 2006a. Natural Channel Design Using a Geomorphic Approach. Wildland Hydrology Inc.

Rosgen, D.L. 2006b. Watershed Assessment of River Stability and Sediment Supply (WARSSS). Wildland Hydrology: Fort Collins, CO.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina, Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, NCDENR, Raleigh, NC.

Simon, Andrew. 1989. A model of channel responses in disturbed alluvial channels. Earth Surface Processes and Landforms: 14, 11-26.

State Climate Office of North Carolina (SCONC). 2010. Data retrieval from 311690 – Charlotte Douglas AP. NC CRONOS Database, Raleigh, North Carolina.

U. S. Army Corps of Engineers. 2000. Federal Register. Vol. 65, No. 47. Washington, DC.

U. S. Army Corps of Engineers. 2002. Federal Register. Vol. 65, No. 10. Washington, DC.

U. S. Army Corps of Engineers. 1987. *Wetland Delineation Manual* (Technical Report Y-87-1), Washington, DC.

U. S. Army Corps of Engineers. 2003. *Stream Mitigation Guidelines.* USACOE, USEPA, NCWRC, NCDENR-DWQ.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2009. Soil Data Mart. http://soildatamart.nrcs.usda.gov/

U.S. Department of Agriculture, Natural Resources Conservation Service. 2006. Plants Database. U.S. Department of Agriculture, Washington, DC.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2006. *Field Indicators of Hydric Soils in the United States, Version 6.0*. U.S. Department of Agriculture, Washington, DC.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1980. *Soil Survey of Mecklenburg County, North Carolina.* U.S. Department of Agriculture, Washington, DC.

U.S. Department of Agriculture, Soil Conservation Service. 1991. *Hydric Soils of the United States*. Soil Conservation Service. In cooperation with the National Technical Committee for Hydric Soils, Washington, DC.

U. S. Fish and Wildlife Service. 2008 A. Information on Threatened and Endangered Species for Carolina heelsplitter.
http://www.fws.gov/asheville/htmls/listedspecies/Carolina_heelsplitter.html

U. S. Fish and Wildlife Service. 2008 B. Information on Threatened and Endangered Species for Schweinitz's sunflower.
http://www.fws.gov/asheville/htmls/listedspecies/Schweinitzs_sunflower.html

U.S. Fish and Wildlife Service. 2008 C. Threatened and Endangered Species in North Carolina by County. http://www.fws.gov/nc-es/es/countyfr.html

U.S. Fish and Wildlife Service, North Carolina Ecological Services. Carolina Heelsplitter in North Carolina. Website accessed on July 20, 2010 at http://www.fws.gov/nc-es/mussel/carolheel.html

U.S. Fish and Wildlife Service. 2007. *National Bald Eagle Management Guidelines.*

U.S. Geological Survey, 2001. *Estimating the Magnitude and Frequency of Floods in Rural Basins of North Carolina, Revised.* Raleigh, NC.

U.S. Geological Survey. 1974. Hydrologic Unit Map, State of North Carolina.

U.S. Geological Survey. 1973. Derita, North Carolina Quadrangle 7.5 Minute Series.

Vepraskas, Micheal J. 1995. *Redoximorphic Features for Identifying Aquic Conditions*. Technical Bulletin 301. North Carolina Agricultural Research Service. North Carolina State University, Raleigh, NC.

SECTION 12
TABLES

Table 1. Project Components for UT Clarke Creek

Project Components						
Project Component or Reach ID	**Existing Feet/Acres**	**Restoration Level***	**Approach**	**Footage or Acreage**	**Stationing**	**Comment**
UT Clarke Creek	1507	E1	P 2/3	1507	00+00-15+87	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 1	723	E1	P 2/3	758	00+00-07+78	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 2	308	E2	P 4	308	04+22-05+99, 07+16-08+47	Planting of native vegetation, removal of invasive vegetation
UT 3	100	E1	P 2/3	100	00+00-01+03	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 4	373	E1	P 2/3	363	01+92-05+65	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 5	119	E1	P2/3	70	03+56-04+75	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 6	1464	P		1464	00+00-14+64	Designated as Preservation
Wetland A	0.085	R		0.0*		Restoring aerial extent of riparian wetland adjacent to stream
Wetland B	0.134	P		0.134		Designate as Preservation
Wetland C	0.057	E		0.057		Includes improving hydrology and vegetation to enhance the riparian wetland adjacent to stream
Wetland D	0.070	R		1.020		Restoring aerial extent of riparian wetland adjacent to stream
Wetland E	0.109	E C		0.109 0.137		Includes improving hydrology and vegetation to enhance the riparian wetland adjacent to stream and create new wetland area

<table>
<tr><th colspan="8">Component Summations</th></tr>
<tr><th>Restoration Level</th><th>Stream (lf)</th><th colspan="2">Riparian Wetland (Ac)</th><th>Non-Ripar (Ac)</th><th>Upland (Ac)</th><th>Buffer (Ac)</th><th>BMP</th></tr>
<tr><td></td><td></td><td>Riverine</td><td>Non-Riverine</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Restoration</td><td></td><td>1.020</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Enhancement</td><td></td><td>0.166</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Enhancement I</td><td>2,798</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Enhancement II</td><td>308</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Creation</td><td></td><td>0.137</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Preservation</td><td>1,464</td><td>0.134</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>HQ Preservation</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>**Totals**</td><td>**4,570**</td><td>**1.457**</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Table 2. Project Attribute Table

Project County	Mecklenburg County, North Carolina
Physiographic Region	Piedmont
Ecoregion	Southern Outer Piedmont
Project River Basin	Yadkin PeeDee
USGS HUC for Project (14 digit)	03040105010040
NCDWQ Sub-basin for Project and Reference	03-07-11
LWP	Upper Rocky River
WRC Class (Warm, Cool, Cold)	Warm
% of project easement fenced or demarcated?	100%
Beaver activity observed during design phase?	Yes

Restoration Component Attribute Table

	UT Clarke 1	UT Clarke 2	UT1
Drainage Area (sq.mi.)	1.0	1.08	0.46
Stream Order	2	2	1
Restored Length (ft)	790	717	758
Perennial or Intermittent	Perennial	Perennial	Perennial
Watershed type (Rural, Urban, Developing)	Rural		
Watershed LULC Distribution			
Agriculture	-		
Commercial	-		
Public/Institutional	5.40%		
Residential	94.60%		
Transportation	-		
Watershed Impervious Cover (%)	17		
NCDWQ AU/Index number	13-17-5-2		
NCDWQ classification	C		
303d listed?	No		
Upstream of a 303d listed sedment?	Yes		
Reasons for 303d listing or stressor	5, Ecological/biological integrity		
Total acreage of easement	57.2		
Total vegetated acreage within the easement	57.2		
Total planted acreage as part of the restoration	57.2		
Rosgen classification of the pre-existing	E4	B4c	B4c
Rosgen classification of the As-Built	N/A	N/A	N/A
Valley Type	VIII		
Valley slope	-		
Valley side slope range	-		
Valley toe slope range	-		
Cowardin classification	N/A		
Trout waters designation	N		
Species of concern, endangered, etc? (Y/N)	N		
Dominant soil series and characteristics	Mo, MeD, EnD		
Series	Monacan	Mecklenburg	Enon
Depth	-		
Clay %	-		
K	-		
T	-		

"N/A": items do not apply / "-": items are unavailable / "U": items are unknown

Table 3. Morphological Tables

Morphological Table UT Clarke Creek 1

Parameter	Existing Conditions	Designed Conditions	Reference Reach
Stream Type (Rosgen)	E4*	E4*	B4c*
Drainage Area (sq mi)	1.0	1.0	0.41
Bankfull Width, Wbkf (ft)	11.4-12.6	12.9-17.9	8.3-10.9
Bankfull Mean Depth, dbkf (ft)	1.8	1.2-1.5	1.0-2.0
Width to Depth Ratio, W/D (ft/ft)	6.2-7.1	8.4-8.7	7.0-8.0
Bankfull XSEC Area, Abkf (sq ft)	20.9-22.3	12.9-17.9	8.4-17.2
BKF Mean Velocity (Vbkf) (ft/s)	5.0	4.4-4.9	3.5
Bankfull Discharge (Qbkf)(cfs)	110.8	56.1-86.9	28.0
Max Depth @ bkf, Dmax (ft)	3.5	1.9-2.2	1.6-2.1
Width Floodprone Area, Wfpa (ft)	36.1-49.1	54.6-63.4	11.7-19.2
Entrenchment Ratio, Wfpa/Wbkf) (ft/ft)	2.9-4.3	5.2	1.4-1.9
Meander Length (ft)	42.4-81.4	42.4-81.4	*

Cells noted with a (*) have been classified using a typical cross-section within each reach, Cells noted with a (**) were calculated using using Flowmaster.

Morphological Table UT Clarke Creek 2

Parameter	Existing Conditions	Designed Conditions	Reference Reach
Stream Type (Rosgen)	B4c*	E4*	B4c*
Drainage Area (sq mi)	1.08	1.08	0.41
Bankfull Width, Wbkf (ft)	15.7-15.8	19.3-21.8	8.3-10.9
Bankfull Mean Depth, dbkf (ft)	1.4	1.5-1.8	1.0-2.0
Width to Depth Ratio, W/D (ft/ft)	11.2-11.6	10.9-15.0	7.0-8.0
Bankfull XSEC Area, Abkf (sq ft)	21.4-22.2	31.5-34.2	8.4-17.2
BKF Mean Velocity (Vbkf) (ft/s)	2.3	2.5-2.8	3.5
Bankfull Discharge (Qbkf)(cfs)	49.7	77.3-96.4	28.0
Max Depth @ bkf, Dmax (ft)	1.8-2.3	1.8-3.0	1.6-2.1
Width Floodprone Area, Wfpa (ft)	22.5-28.7	51.6-59.5	11.7-19.2
Entrenchment Ratio, Wfpa/Wbkf) (ft/ft)	1.4-1.8	2.7	1.4-1.9
Meander Length (ft)	66.8-171.1	66.8-171.1	*

Cells noted with a (*) have been classified using a typical cross-section within each reach, Cells noted with a (**) were calculated using using Flowmaster.

Morphological Table UT 1

Parameter	Existing Conditions	Designed Conditions	Reference Reach
Stream Type (Rosgen)	B4c*	E4*	B4c*
Drainage Area (sq mi)	0.46	0.46	0.39
Bankfull Width, Wbkf (ft)	9.1-11.3	10.6-10.8	7.1-12.0
Bankfull Mean Depth, dbkf (ft)	1.5-1.7	1.1-1.3	0.8-1.3
Width to Depth Ratio, W/D (ft/ft)	5.3-7.5	8.3-9.8	5.8-15.3
Bankfull XSEC Area, Abkf (sq ft)	15.5-17.0	11.8-13.5	8.7-13.8
BKF Mean Velocity (Vbkf) (ft/s)	4.1	3.6-4.0	3.4
Bankfull Discharge (Qbkf)(cfs)	64.0	42.2-53.4	38.9
Max Depth @ bkf, Dmax (ft)	1.8-2.5	1.6-2.1	1.1-1.8
Width Floodprone Area, Wfpa (ft)	19.5-20.0	49.4-93.7	13.2-39.5
Entrenchment Ratio, Wfpa/Wbkf) (ft/ft)	1.7-2.2	4.6-8.8	1.9-3.8
Meander Length (ft)	33.7-108.8	33.7-108.8	*

Cells noted with a (*) have been classified using a typical cross-section within each reach, Cells noted with a (**) were calculated using using Flowmaster.

Table 4. BEHI, NBS, and Sediment Export Estimates for Project Site Streams

Sediment Export Estimates for Project Site Streams

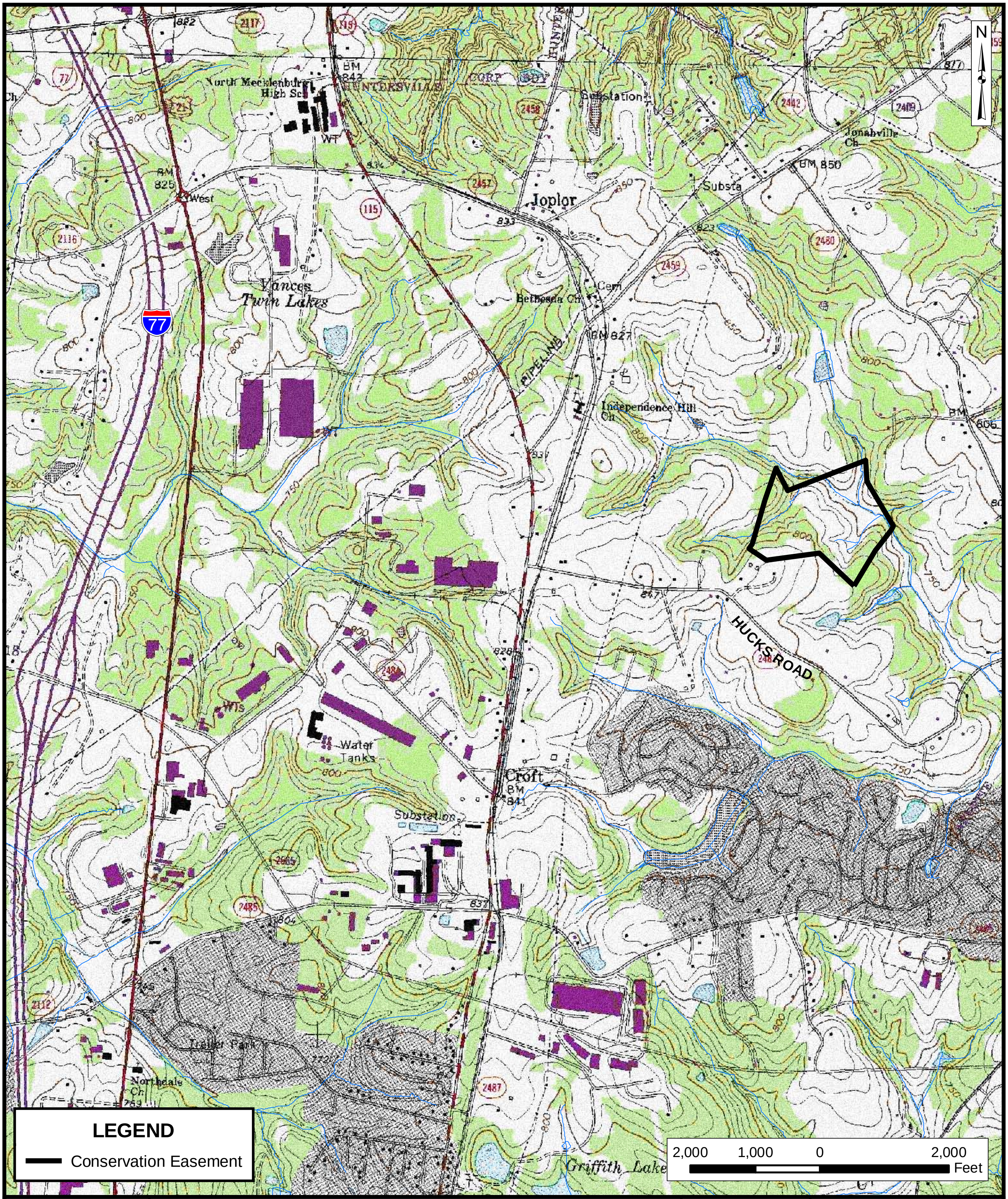
Reach	Bank	Linear Footage	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export*
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%	Tons/yr
UT Clarke Creek-Reach 1	Left	595	0	0	40	7	0	0	555	93	0	0	0	0	38
UT Clarke Creek-Reach 1	Right	495	0	0	0	0	210	32	155	31	130	26	0	0	25
UT Clarke Creek-Reach 2	Left	245	0	0	0	0	0	0	245	100	0	0	0	0	15
UT Clarke Creek-Reach 2	Right	255	0	0	30	12	0	0	125	49	100	39	0	0	13
UT 1-Reach 1	Left	280	0	0	150	54	0	0	130	46	0	0	0	0	10
UT 1-Reach 1	Right	280	0	0	0	0	150	54	130	46	0	0	0	0	21
UT 1-Reach 2	Left	330	0	0	0	0	0	0	330	100	0	0	0	0	1
UT 1-Reach 2	Right	290	0	0	0	0	0	0	290	100	0	0	0	0	2
Project Total		**2,770**	**0**	**0**	**220**	**8**	**360**	**13**	**1,960**	**71**	**230**	**8**	**0**	**0**	**125**

*Sediment export estimates were calculated as follows (ft^3/yr): (Section Length*Bank Height*Erosion Rate (ft/yr)) and converted to tons/year as follows: (ft^3/yr)*(1yd^3/27 ft^3)*(1.8 tons/yd^3).

Near Bank Stress Estimates for Project Site Streams

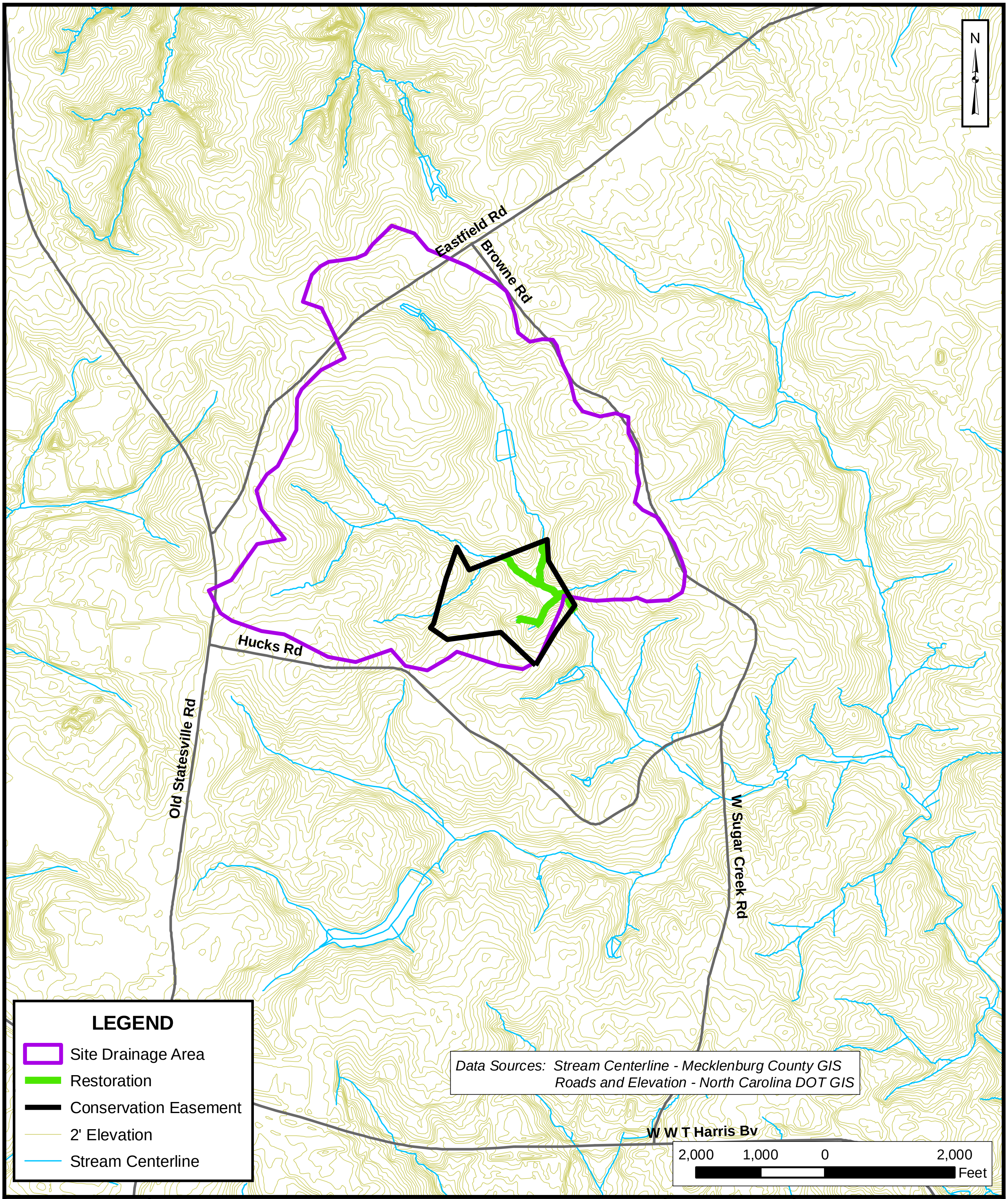
Reach	Bank	Linear Footage	Extreme		Very High		High		Moderate		Low		Very Low	
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%
UT Clarke Creek-Reach 1	Left	595	40	7	0	0	160	27	0	0	265	45	130	22
UT Clarke Creek-Reach 1	Right	495	0	0	30	6	0	0	160	32	205	41	100	20
UT Clarke Creek-Reach 2	Left	245	0	0	0	0	125	51	0	0	120	49	0	0
UT Clarke Creek-Reach 2	Right	255	0	0	30	12	0	0	0	0	225	88	0	0
UT 1-Reach 1	Left	280	0	0	0	0	0	0	0	0	280	100	0	0
UT 1-Reach 1	Right	280	0	0	0	0	150	54	0	0	30	11	100	36
UT 1-Reach 2	Left	330	0	0	0	0	0	0	0	0	250	76	80	24
UT 1-Reach 2	Right	290	0	0	0	0	0	0	0	0	170	59	120	41
Project Total		**2,770**	**40**	**1**	**60**	**2**	**435**	**16**	**160**	**6**	**1545**	**56**	**530**	**19**

SECTION 13
FIGURES



UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Project Site Vicinity Map
Derita, North Carolina 7.5 Minute USGS Topographic Map
Mecklenburg County, NC

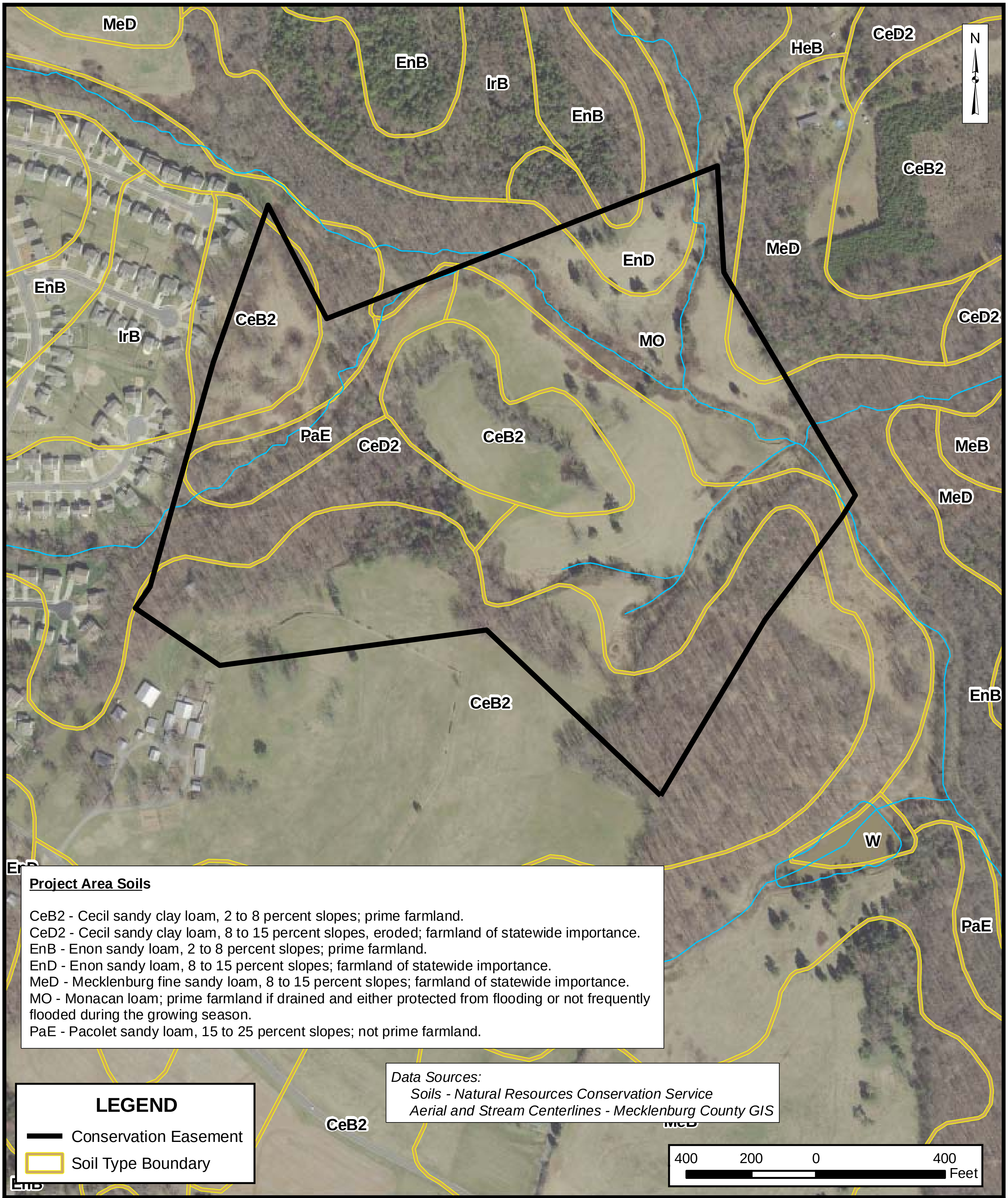
Figure 1
February 2011
EEP Job No: 92500



Data Sources: Stream Centerline - Mecklenburg County GIS
Roads and Elevation - North Carolina DOT GIS

UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Project Site Watershed Map
Mecklenburg County, NC

Figure 2
February 2011
EEP Job No: 92500



Project Area Soils

CeB2 - Cecil sandy clay loam, 2 to 8 percent slopes; prime farmland.
CeD2 - Cecil sandy clay loam, 8 to 15 percent slopes, eroded; farmland of statewide importance.
EnB - Enon sandy loam, 2 to 8 percent slopes; prime farmland.
EnD - Enon sandy loam, 8 to 15 percent slopes; farmland of statewide importance.
MeD - Mecklenburg fine sandy loam, 8 to 15 percent slopes; farmland of statewide importance.
MO - Monacan loam; prime farmland if drained and either protected from flooding or not frequently flooded during the growing season.
PaE - Pacolet sandy loam, 15 to 25 percent slopes; not prime farmland.

Data Sources:
Soils - Natural Resources Conservation Service
Aerial and Stream Centerlines - Mecklenburg County GIS

LEGEND

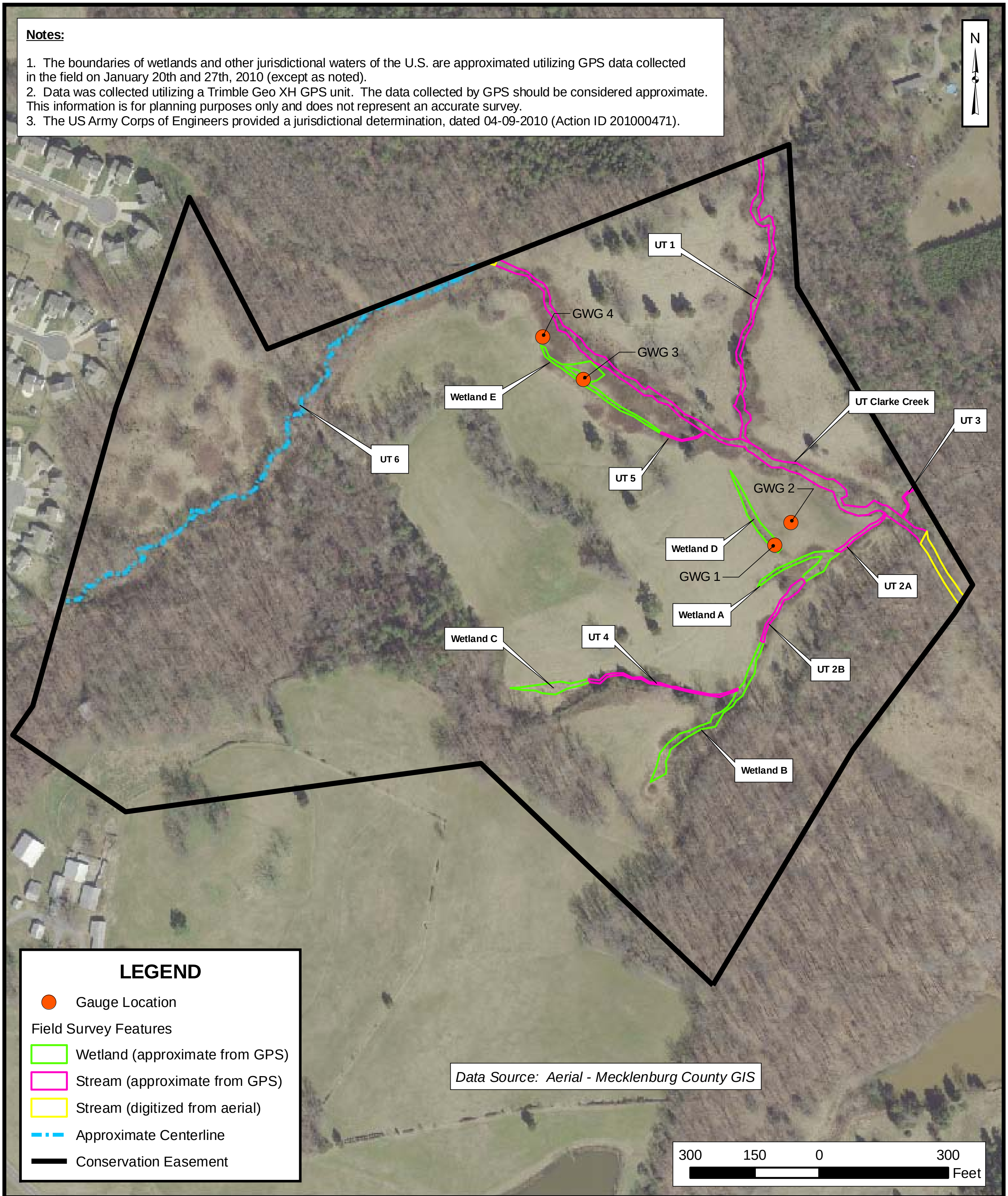
━ Conservation Easement
▭ Soil Type Boundary

UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Project Site NRCS Soil Survey Map
Mecklenburg County, NC

Figure 3
February 2011
EEP Job No: 92500

Notes:

1. The boundaries of wetlands and other jurisdictional waters of the U.S. are approximated utilizing GPS data collected in the field on January 20th and 27th, 2010 (except as noted).
2. Data was collected utilizing a Trimble Geo XH GPS unit. The data collected by GPS should be considered approximate. This information is for planning purposes only and does not represent an accurate survey.
3. The US Army Corps of Engineers provided a jurisdictional determination, dated 04-09-2010 (Action ID 201000471).



LEGEND

● Gauge Location

Field Survey Features

🟩 Wetland (approximate from GPS)

🟪 Stream (approximate from GPS)

🟨 Stream (digitized from aerial)

- · - Approximate Centerline

━ Conservation Easement

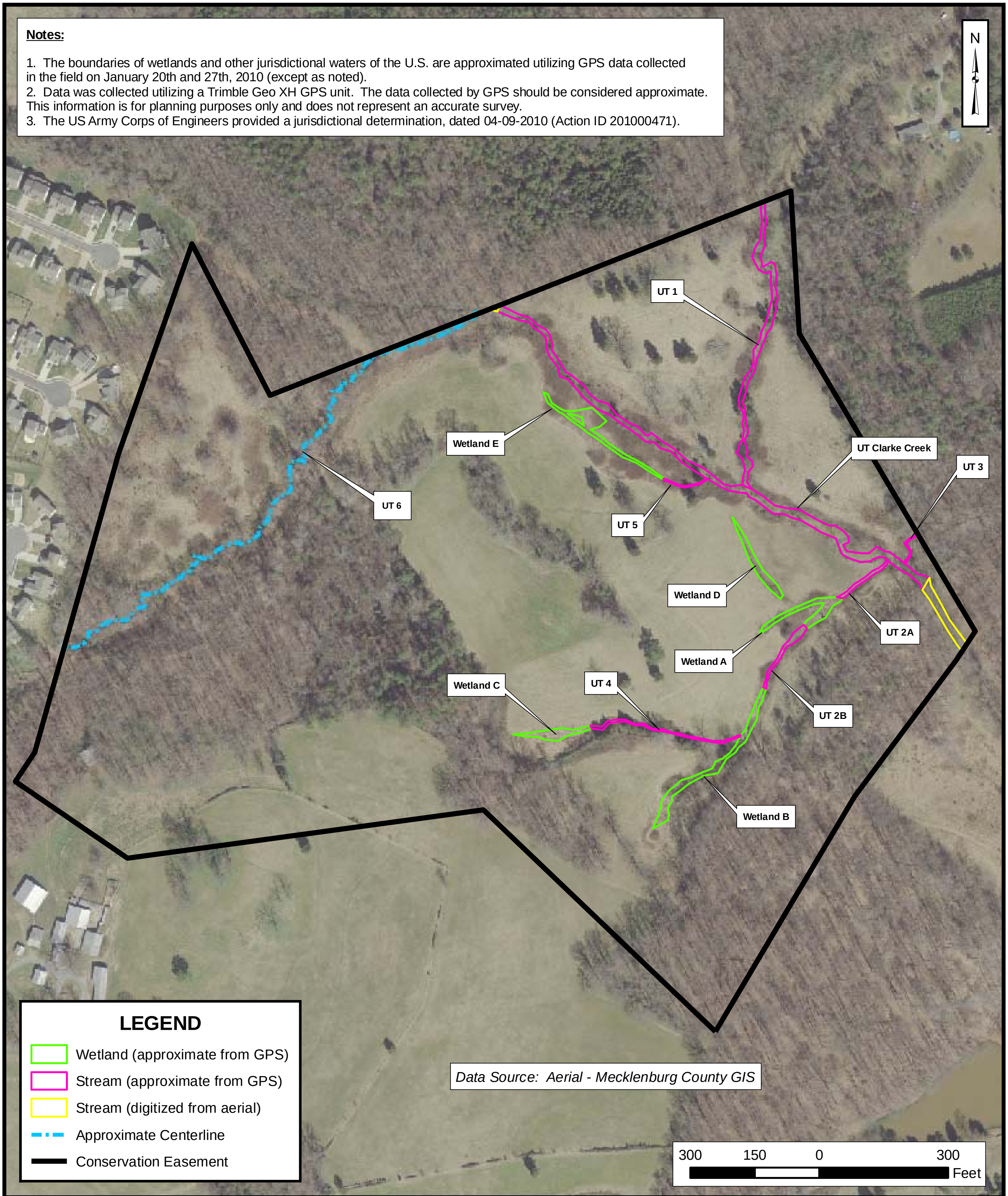
Data Source: Aerial - Mecklenburg County GIS

Ecosystem Enhancement PROGRAM

UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Project Site Hydrological Features and Gauge Locations
Mecklenburg County, NC

JJG

Figure 4
February 2011
EEP Job No: 92500



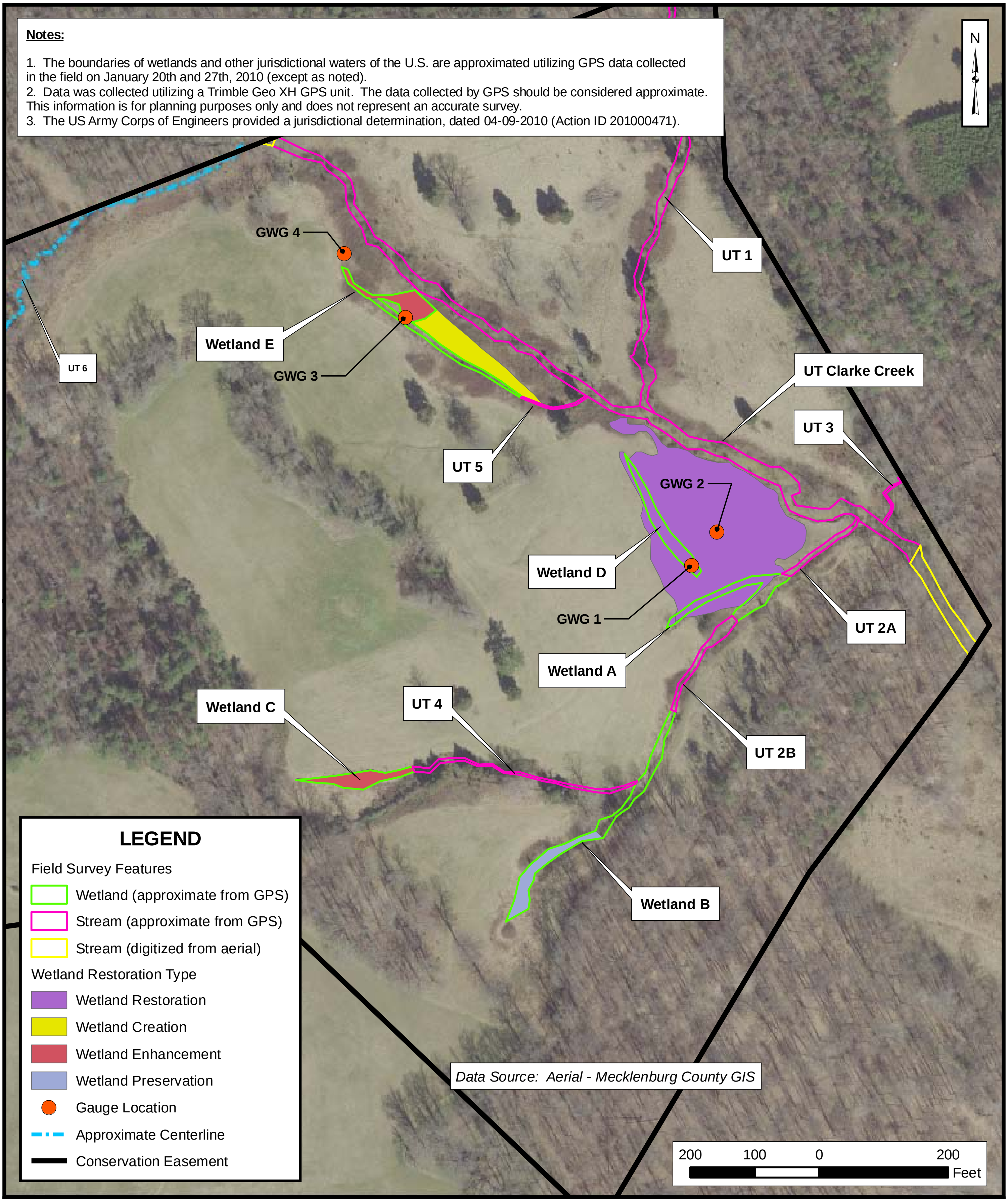
Notes:

1. The boundaries of wetlands and other jurisdictional waters of the U.S. are approximated utilizing GPS data collected in the field on January 20th and 27th, 2010 (except as noted).
2. Data was collected utilizing a Trimble Geo XH GPS unit. The data collected by GPS should be considered approximate. This information is for planning purposes only and does not represent an accurate survey.
3. The US Army Corps of Engineers provided a jurisdictional determination, dated 04-09-2010 (Action ID 201000471).

Data Source: Aerial - Mecklenburg County GIS

UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Project Site Wetland Delineation Map
Mecklenburg County, NC

Figure 5a
February 2011
EEP Job No: 92500



Notes:

1. The boundaries of wetlands and other jurisdictional waters of the U.S. are approximated utilizing GPS data collected in the field on January 20th and 27th, 2010 (except as noted).
2. Data was collected utilizing a Trimble Geo XH GPS unit. The data collected by GPS should be considered approximate. This information is for planning purposes only and does not represent an accurate survey.
3. The US Army Corps of Engineers provided a jurisdictional determination, dated 04-09-2010 (Action ID 201000471).

LEGEND

Field Survey Features

- Wetland (approximate from GPS)
- Stream (approximate from GPS)
- Stream (digitized from aerial)

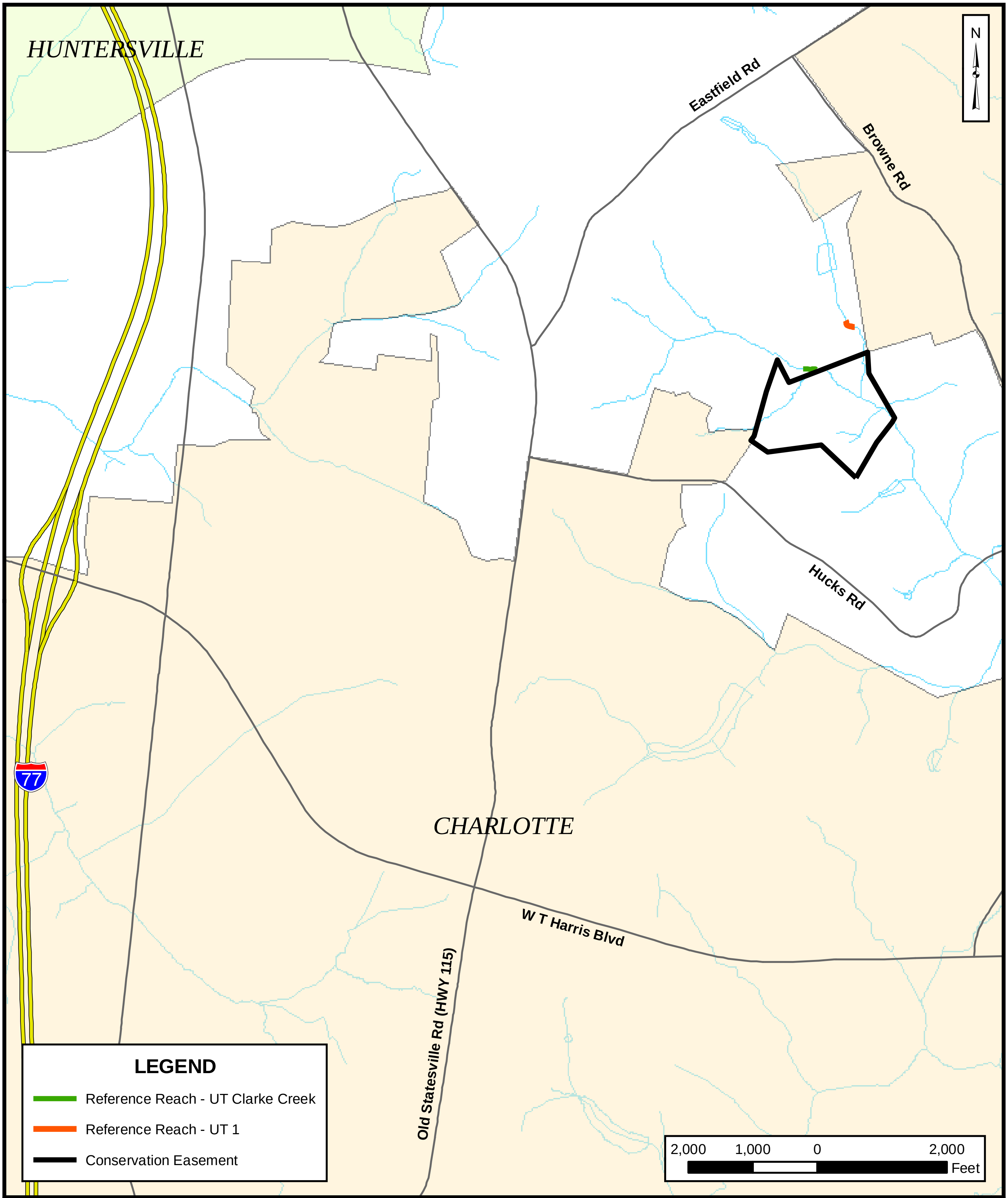
Wetland Restoration Type

- Wetland Restoration
- Wetland Creation
- Wetland Enhancement
- Wetland Preservation
- ● Gauge Location
- Approximate Centerline
- Conservation Easement

Data Source: Aerial - Mecklenburg County GIS

UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Project Site Existing and Proposed Wetlands
Mecklenburg County, NC

Figure 5b
February 2011
EEP Job No: 92500



LEGEND

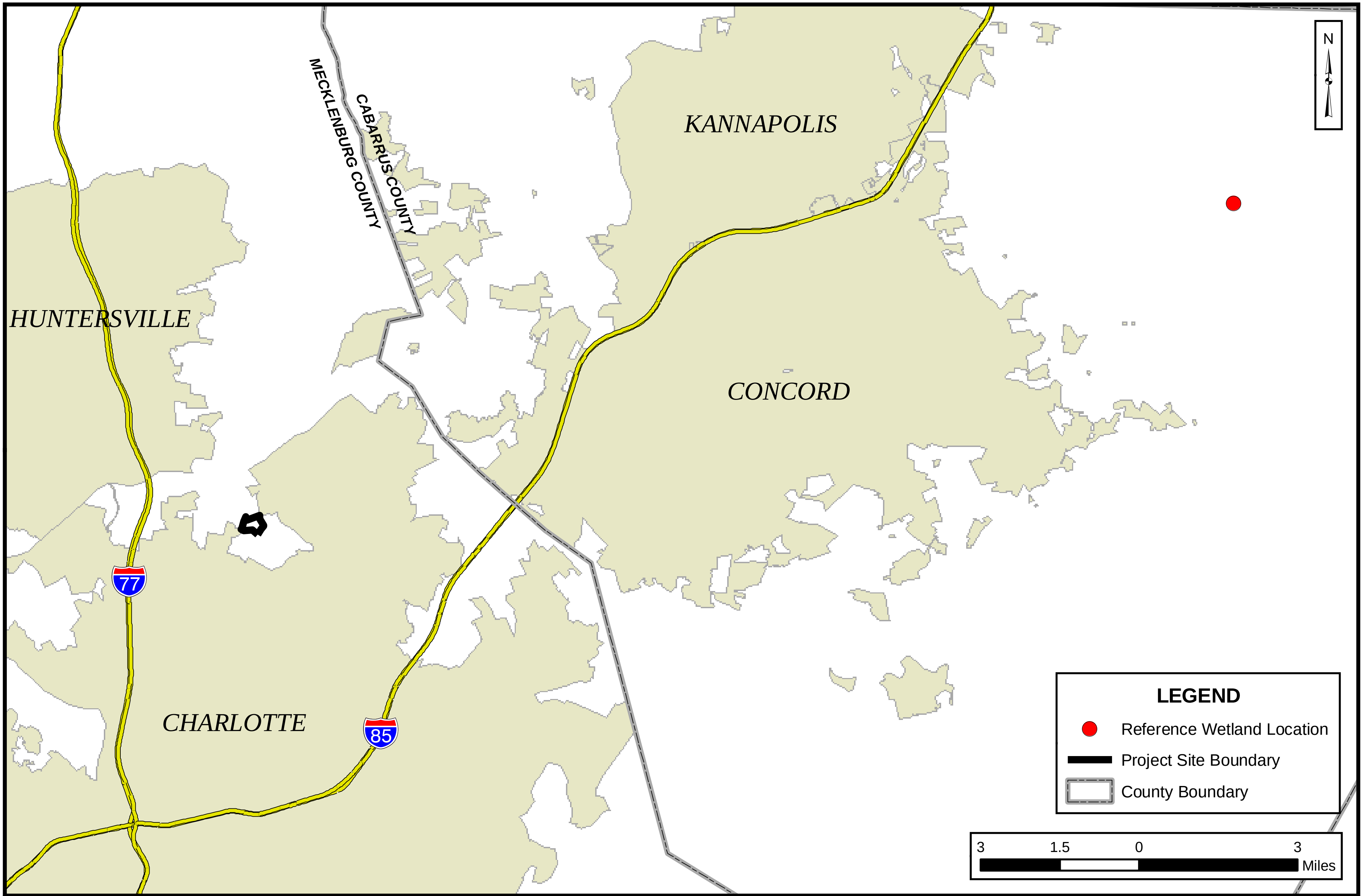
🟩 Reference Reach - UT Clarke Creek

🟥 Reference Reach - UT 1

■ Conservation Easement

UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Reference Reach Vicinity Map
Mecklenburg County, North Carolina

Figure 6a
February 2010
EEP Job No: 92500

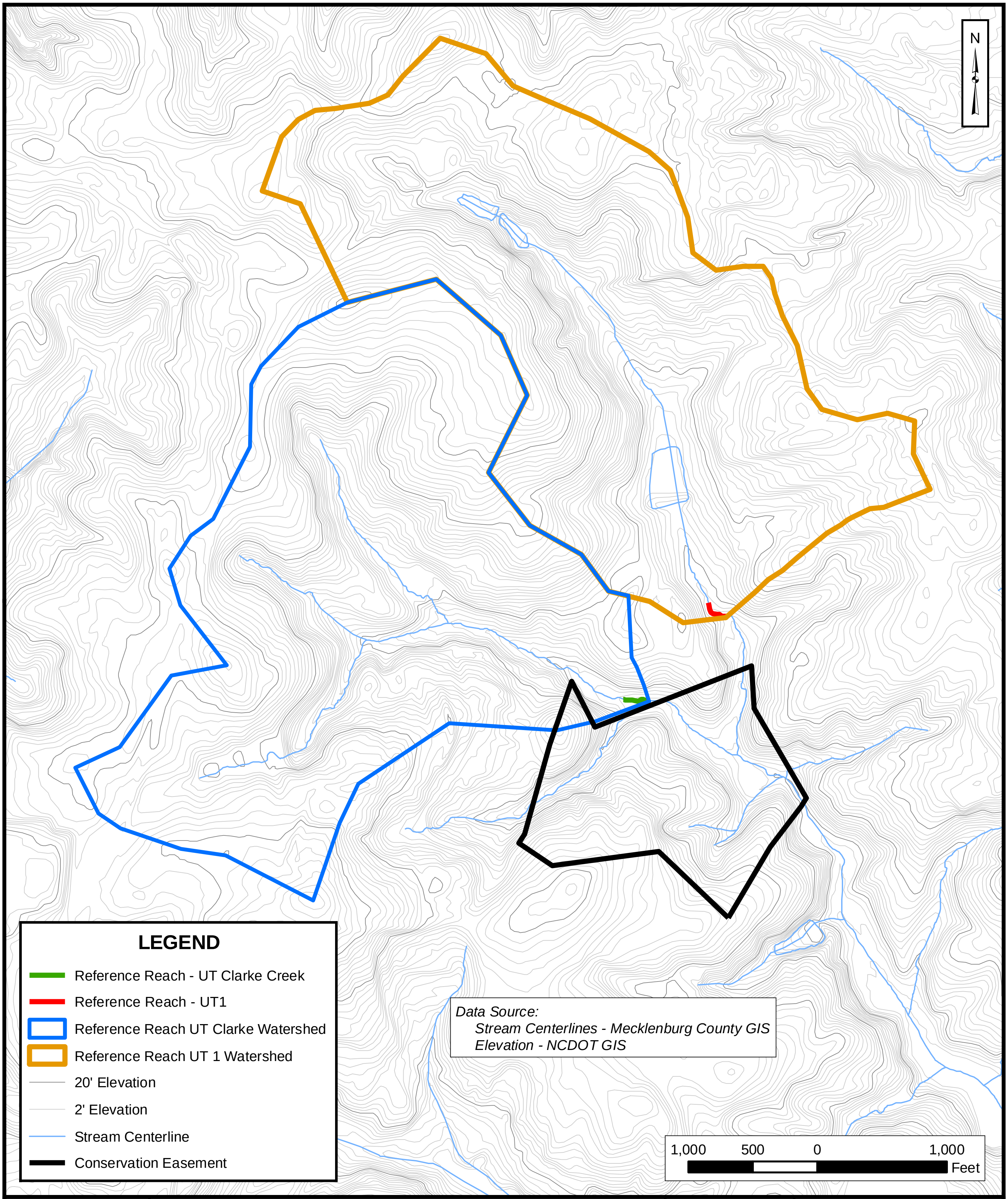


Ecosystem Enhancement PROGRAM

UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Reference Wetland Vicinity Map
Mecklenburg County, North Carolina

JJG

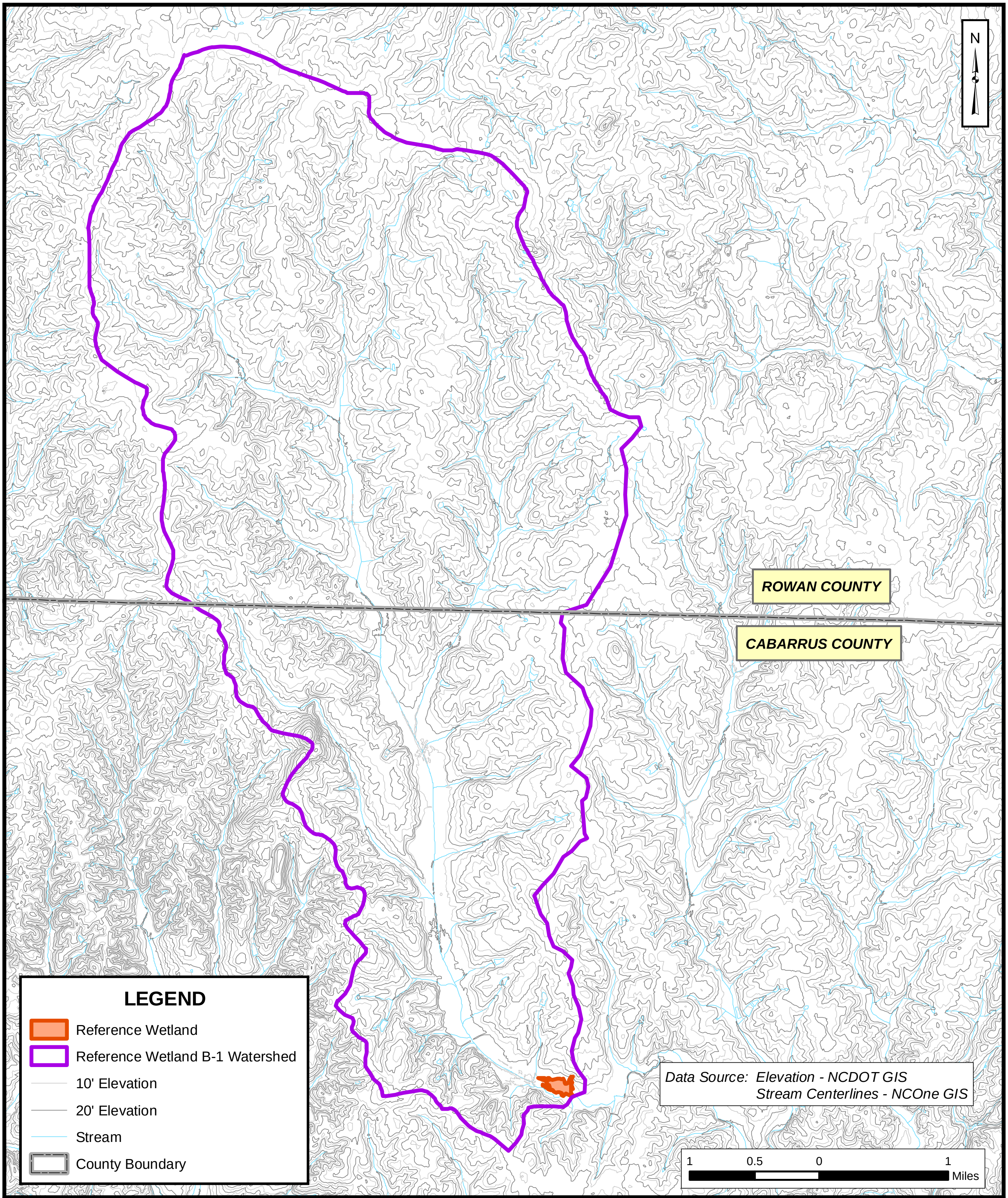
Figure 6b
February 2011
EEP Job No: 92500



Data Source:
Stream Centerlines - Mecklenburg County GIS
Elevation - NCDOT GIS

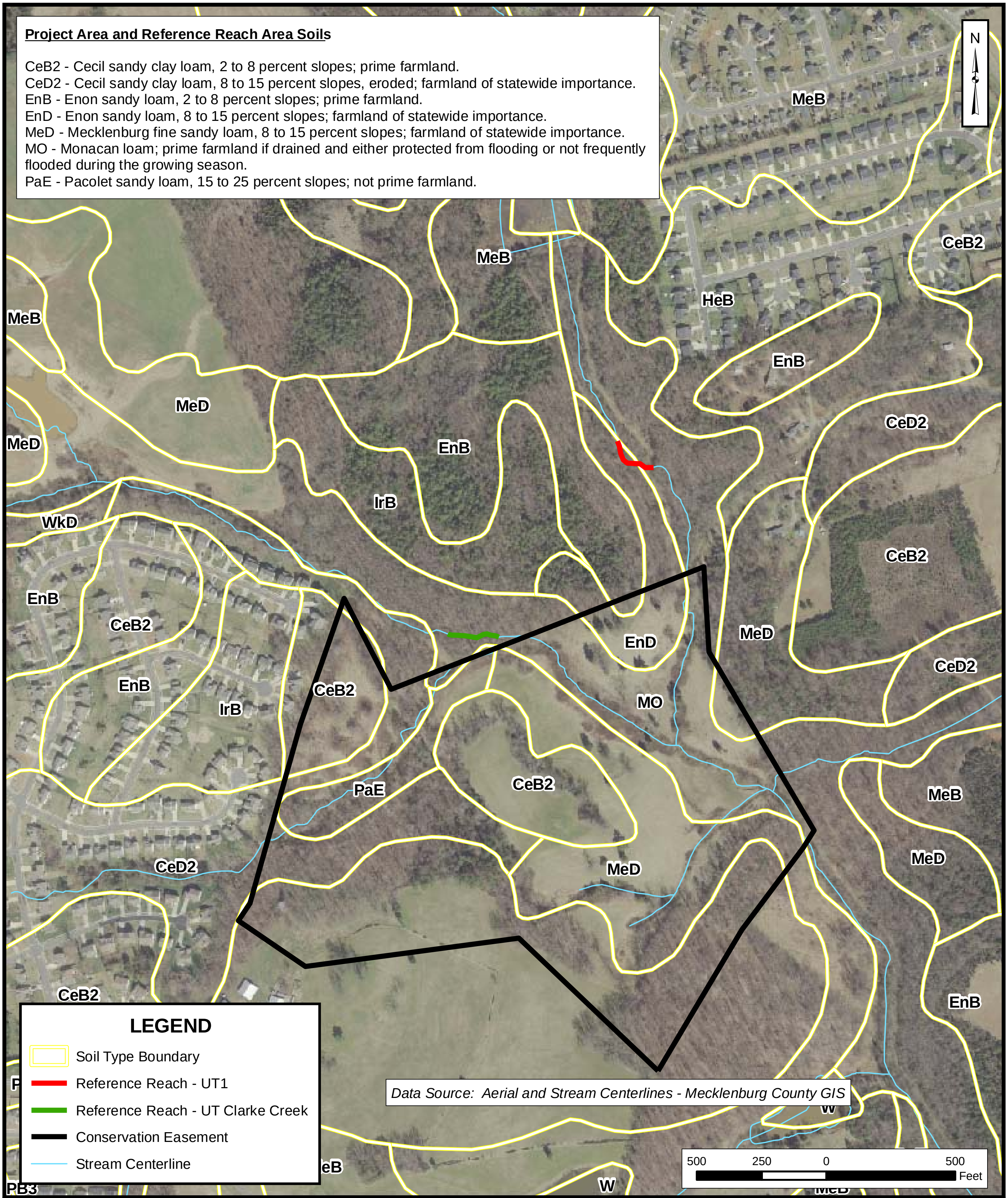
UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Reference Reach Site Watershed Map
Mecklenburg County, North Carolina

Figure 7a
February 2011
EEP Job No: 92500



UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Reference Wetland Site Watershed Map
Cabarrus County, NC

Figure 7b
February 2011
EEP Job No: 92500



Project Area and Reference Reach Area Soils

CeB2 - Cecil sandy clay loam, 2 to 8 percent slopes; prime farmland.
CeD2 - Cecil sandy clay loam, 8 to 15 percent slopes, eroded; farmland of statewide importance.
EnB - Enon sandy loam, 2 to 8 percent slopes; prime farmland.
EnD - Enon sandy loam, 8 to 15 percent slopes; farmland of statewide importance.
MeD - Mecklenburg fine sandy loam, 8 to 15 percent slopes; farmland of statewide importance.
MO - Monacan loam; prime farmland if drained and either protected from flooding or not frequently flooded during the growing season.
PaE - Pacolet sandy loam, 15 to 25 percent slopes; not prime farmland.

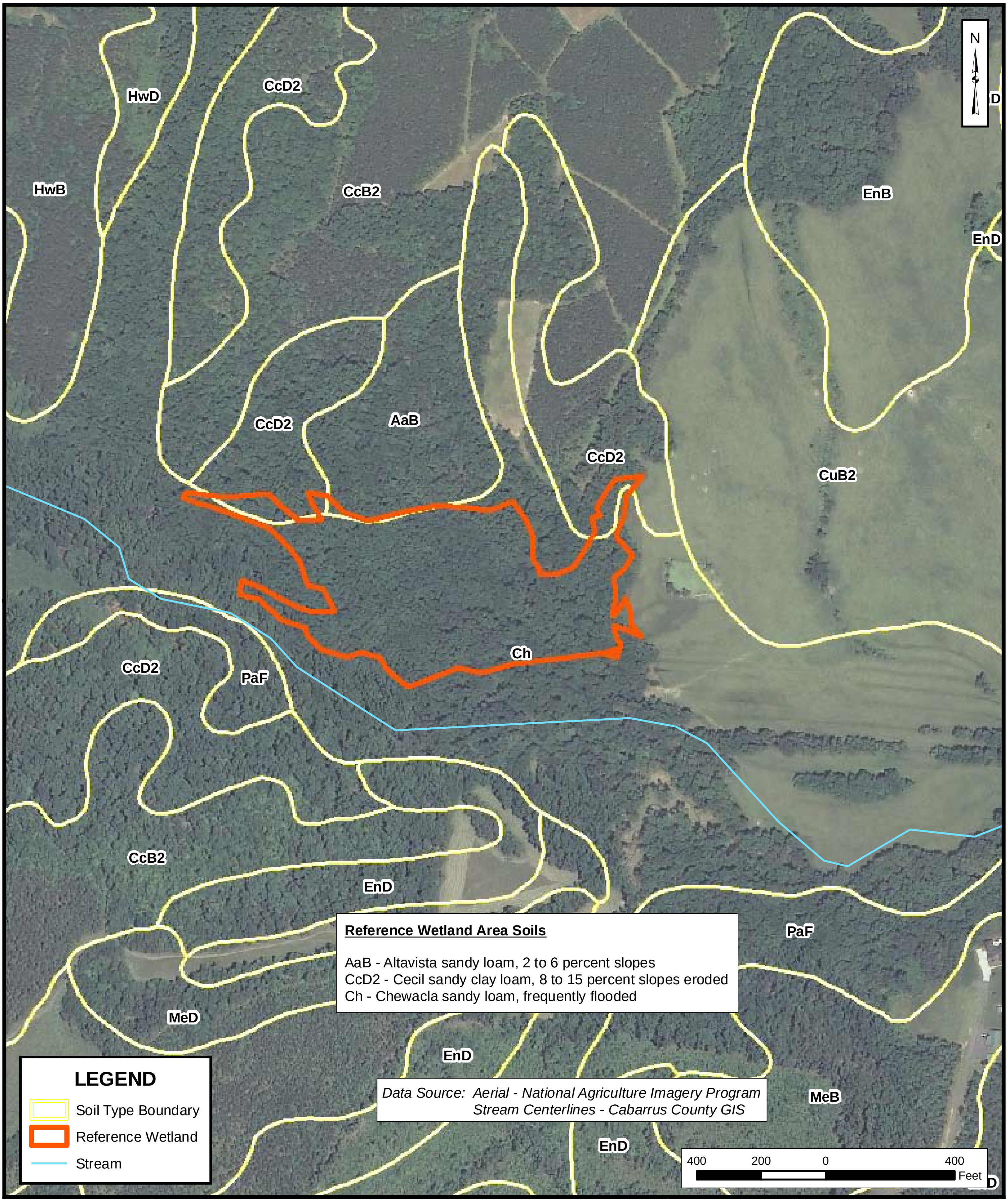
LEGEND

☐ Soil Type Boundary
🟥 Reference Reach - UT1
🟩 Reference Reach - UT Clarke Creek
⬛ Conservation Easement
— Stream Centerline

Data Source: Aerial and Stream Centerlines - Mecklenburg County GIS

UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Reference Reach Site NRCS Soil Survey Map
Mecklenburg County, NC

Figure 8a
February 2011
EEP Job No: 92500



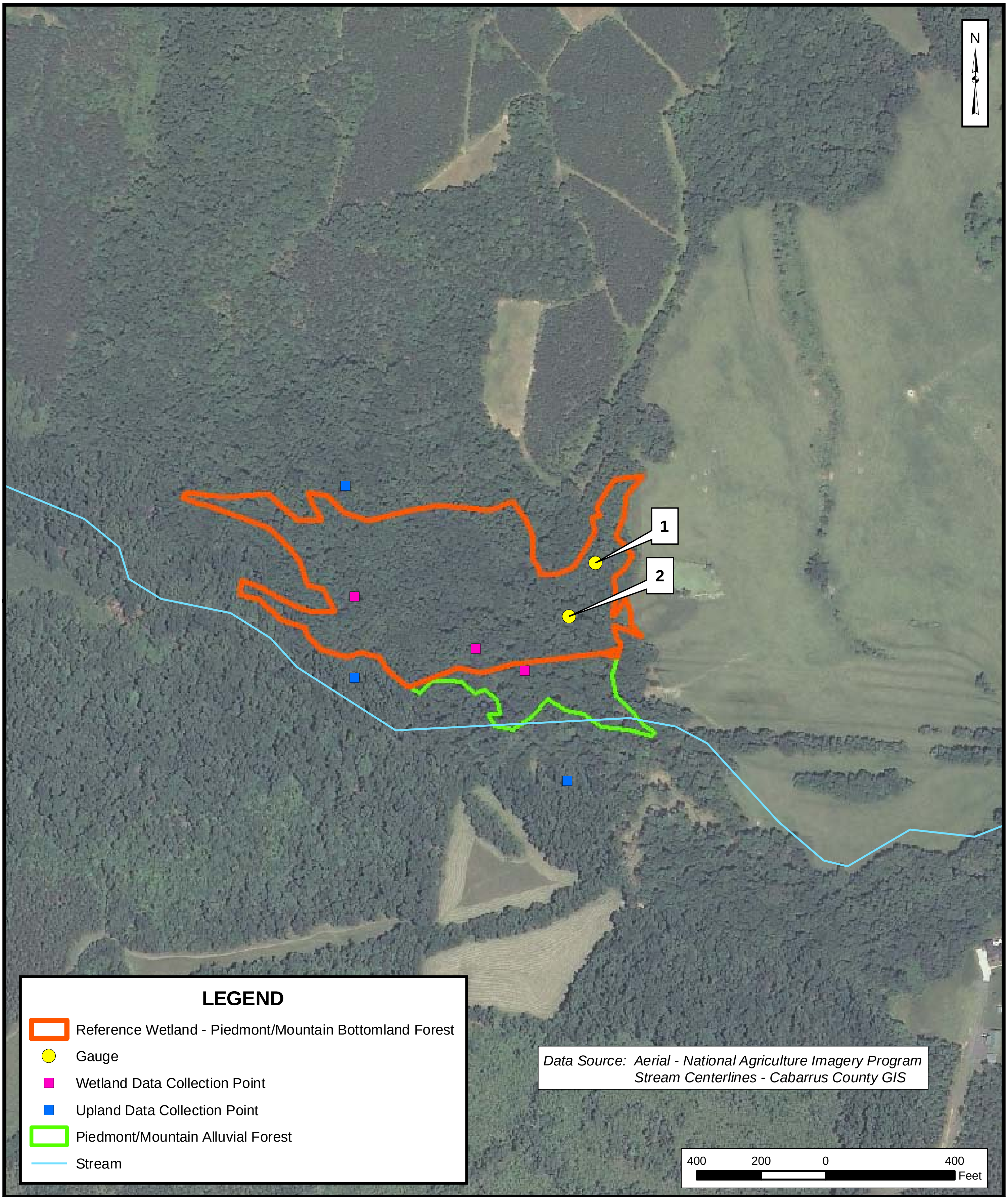
Reference Wetland Area Soils

AaB - Altavista sandy loam, 2 to 6 percent slopes
CcD2 - Cecil sandy clay loam, 8 to 15 percent slopes eroded
Ch - Chewacla sandy loam, frequently flooded

Data Source: Aerial - National Agriculture Imagery Program
Stream Centerlines - Cabarrus County GIS

UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Reference Wetland NRCS Soil Survey Map
Cabarrus County, NC

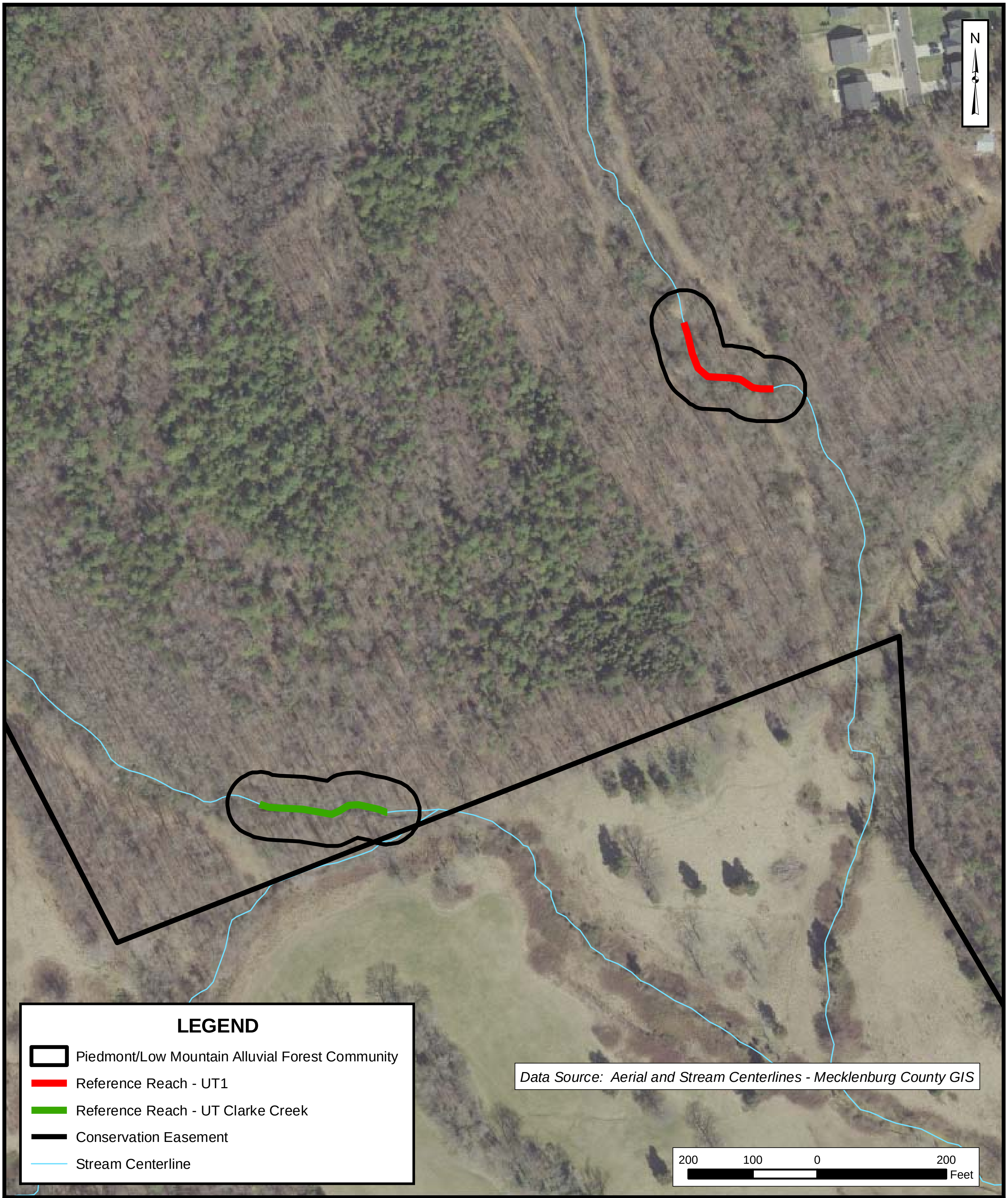
Figure 8b
February 2011
EEP Job No: 92500



Data Source: Aerial - National Agriculture Imagery Program
Stream Centerlines - Cabarrus County GIS

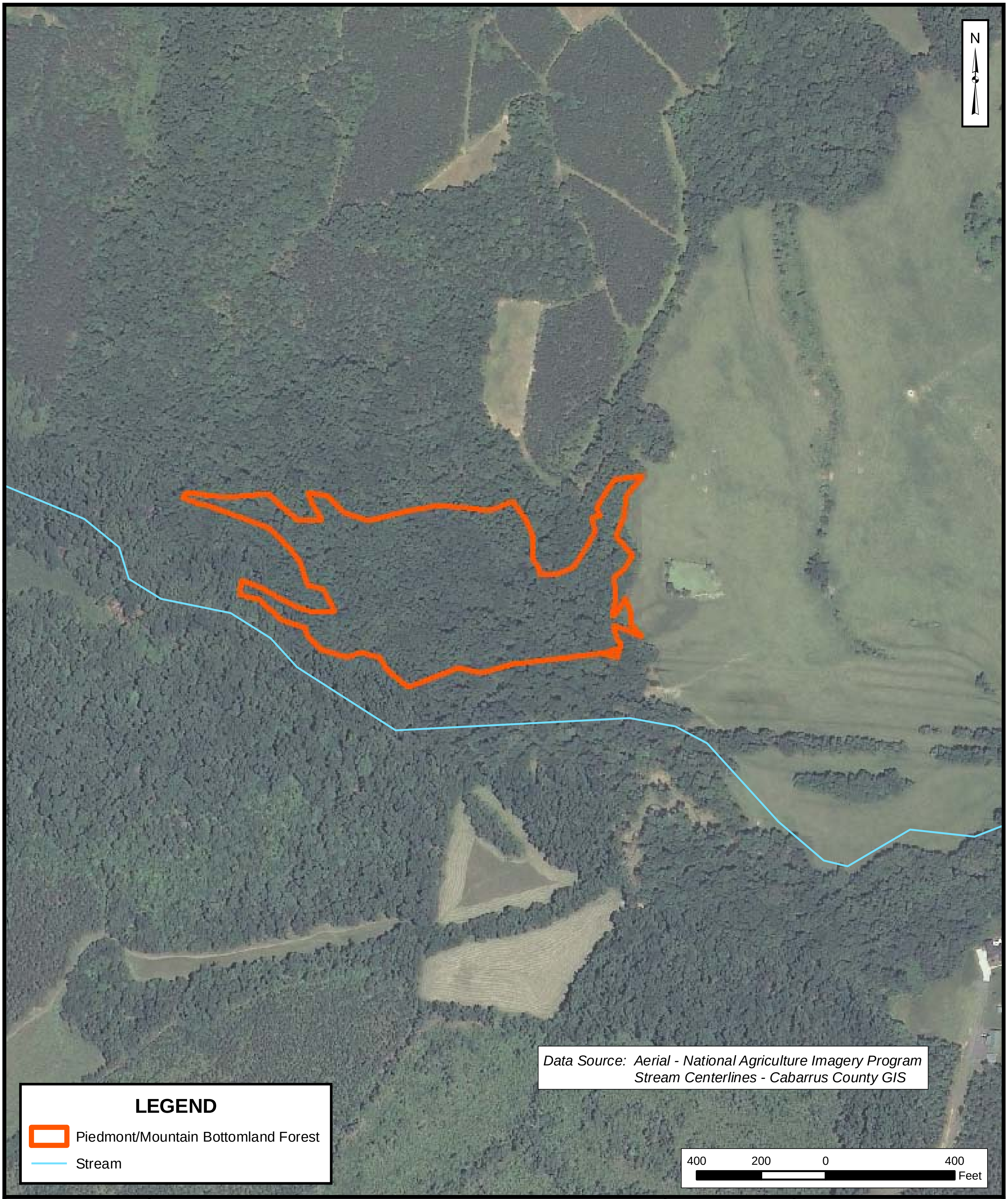
UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Reference Wetland Determination Sample Location with
Gauge Locations
Cabarrus County, NC

Figure 9
February 2011
EEP Job No: 92500



UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Reference Reach Site Vegetative Communities Map
Mecklenburg County, NC

Figure 10a
February 2011
EEP Job No: 92500



Data Source: *Aerial - National Agriculture Imagery Program*
Stream Centerlines - Cabarrus County GIS

UT Clarke Creek Stream and Wetland Mitigation
Mitigation Plan
Reference Wetland Site Vegetative Communities Map
Cabarrus County, NC

Figure 10b
February 2011
EEP Job No: 92500

SECTION 14
DESIGNED SHEETS

Sheets CG-101 – CG-108 Plan and Profile
Sheets CG-501 – CG-502 Typicals
Sheets CS-101 – CS-108 Planting Plan

SECTION 15
APPENDICES

Appendix 1 Project Site Photographs
Appendix 2 Project Site USACE Routine Wetland Determination Data Forms
Appendix 3 Project Site NCDWQ Stream Classification Forms
Appendix 4 Reference Site Photographs
Appendix 5 Reference Site USACE Routine Wetland Determination Data Forms
Appendix 6 Reference Site NCDWQ Stream Classification Forms
Appendix 7 Hydrologic Gauge Data Summary, Groundwater and Rainfall Info
Appendix 8 HEC-RAS Analysis Info
Appendix 9 Categorical Exclusion Form
Appendix 10 EEP Floodplain Requirements Checklist

APPENDIX 1

PROJECT SITE PHOTOGRAPHS

1-1

UT Clarke Creek facing downstream at the central reach (taken January 2010)

1-2

UT Clarke Creek facing upstream toward the upstream reach (taken January 2010)

UT Clarke Creek Stream and
Wetland Restoration Project
Mecklenburg County, North Carolina

Date: September 2010
JJG Project No.: 03060006

Appendix 1. Site Photographs

Sheet PH-1

2-1

UT Clarke Creek facing downstream toward the downstream reach (taken January 2010)

2-2

UT 1 facing downstream from the upstream reach (taken January 2010)

JJG	**UT Clarke Creek Stream and Wetland Restoration Project Mecklenburg County, North Carolina**	Date: September 2010 Project No.: 03060006
	Appendix 1. Site Photographs	**Sheet PH-2**

3-1

UT 1 facing upstream at the central reach (taken January 2010)

3-2

UT 2B facing downstream from the upstream reach (taken January 2010)

UT Clarke Creek Stream and
Wetland Restoration Project
Mecklenburg County, North Carolina

Date:	September 2010
Project No.:	03060006

Appendix 1. Site Photographs

Sheet PH-3

4-1

UT 2A facing downstream toward the downstream reach (taken January 2010)

4-2

UT 3 facing downstream toward the downstream reach (taken January 2010)

UT Clarke Creek Stream and
Wetland Restoration Project
Mecklenburg County, North Carolina

Date:	September 2010
Project No.:	03060006

Appendix 1. Site Photographs

Sheet PH-4

5-1

UT 4 facing downstream at the central reach
(taken January 2010)

5-2

UT 5 facing downstream toward the downstream reach
(taken January 2010)

UT Clarke Creek Stream and
Wetland Restoration Project
Mecklenburg County, North Carolina

Date: September 2010
Project No.: 03060006

Appendix 1. Site Photographs

Sheet PH-5

6-1

UT 6 facing upstream toward the upstream reach (taken May 2009)

	UT Clarke Creek Stream and Wetland Restoration Project **Mecklenburg County, North Carolina**	Date: September 2010 Project No.: 03060006
	Appendix 1. Site Photographs	**Sheet PH-6**

7-1

UT 5 facing upstream toward the upstream reach (taken January 2010)

7-2

Wetland A (taken January 2010)

	UT Clarke Creek Stream and **Wetland Restoration Project** **Mecklenburg County, North Carolina**	Date: September 2010 Project No.: 03060006
	Appendix 1. Site Photographs	**Sheet PH-7**

8-1

Wetland B (taken January 2010)

8-2

Wetland C (taken January 2010)

	UT Clarke Creek Stream and Wetland Restoration Project Mecklenburg County, North Carolina	Date: September 2010 Project No.: 03060006
	Appendix 1. Site Photographs	**Sheet PH-8**

9-1

Wetland D (taken March 2009)

9-2

Wetland E, scrub-shrub component (taken January 2010)

JJG	**UT Clarke Creek Stream and Wetland Restoration Project Mecklenburg County, North Carolina**	Date: September 2010 Project No.: 03060006
	Appendix 1. Site Photographs	**Sheet PH-9**

APPENDIX 2

PROJECT SITE USACE ROUTINE WETLAND DETERMINATION DATA FORMS

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **U.T. Clarke Creek**
Applicant/Owner: NCEEP
Investigator(s): **Adam Karagosian, PWS**
Date: **01/27/10**
County: **Mecklenburg**
State: **NC**
Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)
Community ID: Wet A
Transect ID:
Plot ID: DP4A

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Juncus effusus*	H	FACW+	9			
2	*Leersia oryzoides*	H	OBL	10			
3	*Carex sp*	H	FAC-OBL	11			
4	*Betula nigra*	T	FACW	12			
5				13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)

4/4 = 100%

HYDROLOGY

___ Recorded Data (Describe in remarks):
___ Stream, Lake or Tide Gauge
___ Aerial Photographs
___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: **1-6** (in.)

Depth to Free Water in Pit: **0** (in.)

Depth to Saturated Soil: **0** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
X Inundated
X Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
___ Sediment Deposits (on leaves)
___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
X Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

SOILS

DP4A Page 2

Map Unit Name
(Series and Phase): **Monacan loam (MO)**
Drainage Class SWP
Reference: USDA Johnston County Soil Survey (1994)
Taxonomy (Subgroup):
Indicate Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0 - 4	A	10YR 5/2	10YR 4/6	common/distinct	sandy loam
4 - 12+	B	5Y 5/1	10YR 5/6	common/prom.	loam

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- ___ Reducing Conditions
- X Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- X Listed on Local Hydric Soils List (Inclusions)
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

(Circle)
Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

All three criteria are present, therefore DP 4A is representative of a jurisdictional wetland area.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **U.T. Clarke Creek**
Applicant/Owner: **NCEEP**
Investigator(s): **Adam Karagosian, PWS**
Date: **01/27/10**
County: **Mecklenburg**
State: **NC**
Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)
Community ID: Upl A
Transect ID:
Plot ID: DP4B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1 *Liquidambar styraciflua*	S/S	FAC+	9		
2 *Rubus sp.*	H		10		
3 *Lonicera japonica*	S/S	FAC-	11		
4 *Lonicera japonica*	WV	FAC-	12		
5 *Cornus florida*	S/S	FACU	13		
6			14		
7			15		
8			16		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)
1/4 = 25%

HYDROLOGY

Recorded Data (Describe in remarks):
___ Stream, Lake or Tide Gauge
___ Aerial Photographs
___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: **NA** (in.)
Depth to Free Water in Pit: **>12** (in.)
Depth to Saturated Soil: **>12** (in.)

Wetland Hydrology Indicators:
Primary Indicators:
___ Inundated
___ Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
___ Sediment Deposits (on leaves)
___ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
___ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
Other (Explain in Remarks)

Remarks:

SOILS

DP4B Page 2

Map Unit Name
(Series and Phase): **Monacan loam (MO)** Drainage Class SWP
Reference: USDA Johnston County Soil Survey (1994)
Taxonomy (Subgroup): Indicate Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-6	A	10YR 4/4	None	NA	loam
6-12+	B	5YR 4/6	5Y 5/3	common/distinct	loam

- ___ Histosol
- ___ Histic Epipedon
- ___ Sulfidic Odor
- ___ Aquic Moisture Regime
- ___ Reducing Conditions
- ___ Gleyed or Low-Chroma Colors
- ___ Concretions
- ___ High Organic Content in Surface Layer in Sandy Soils
- ___ Organic Streaking in Sandy Soils
- ___ Listed on Local Hydric Soils List (Inclusions)
- ___ Listed on National Hydric Soils List
- ___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No] (Circle)
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

(Circle)
Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

DP 4B is representative of a non-jurisdictional upland area.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **U.T. Clarke Creek**

Applicant/Owner: **NCEEP**

Investigator(s): **Adam Karagosian, PWS**

Date: **01/27/10**

County: **Mecklenburg**

State: **NC**

Do Normal Circumstances exist on the site? [✓ Yes] No

Community ID: Wet B

Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]

Transect ID:

Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)

Plot ID: **DP2A**

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Juncus effusus*	H	FACW+	9			
2	*Leersia oryzoides*	H	OBL	10			
3	*Polygonum sagittatum*	H	OBL	11			
4	*Carex sp.*	H	FAC-OBL	12			
5	*Panicum scoparium*	H	FACW+	13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)

5/5 = 100%

HYDROLOGY

___ Recorded Data (Describe in remarks):
- ___ Stream, Lake or Tide Gauge
- ___ Aerial Photographs
- ___ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **1-4** (in.)

Depth to Free Water in Pit: **0** (in.)

Depth to Saturated Soil: **0** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- **X** Inundated
- **X** Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits (on leaves)
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- **X** Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS **DP2A Page 2**

Map Unit Name
(Series and Phase): **Cecil sandy clay loam, 2-8% slopes, eroded** Drainage Class **WD**
Reference: USDA Johnston County Soil Survey (1994)
Taxonomy (Subgroup): Indicate Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0 - 4	A	5Y 4/2	None	NA	mucky mineral
4 - 12+	B	10 YR 3/2	5YR 5/6	common/distinct	clay loam

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☒ Gleyed or Low-Chroma Colors

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soils
☐ Organic Streaking in Sandy Soils
☐ Listed on Local Hydric Soils List (Inclusions)
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks:

Mucky mineral soil at surface.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? (Circle) [✓ Yes] No

Remarks:

All three criteria are present, therefore DP 2A is representative of a jurisdictional wetland area.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	**U.T. Clarke Creek**	Date:	**01/27/10**
Applicant/Owner:	NCEEP	County:	**Mecklenburg**
Investigator(s):	**Adam Karagosian, PWS**	State:	**NC**
Do Normal Circumstances exist on the site?	[✓ Yes] No	Community ID:	UPL B
Is the site significantly disturbed (Atypical Situation)?	Yes [✓ No]	Transect ID:	
Is the area a potential Problem Area? (If needed, explain on reverse.)	Yes [✓ No]	Plot ID:	DP2B

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1 *Eupatorium capillifolium*	H	FACU	9		
2 *Rubus sp.*	H		10		
3 *Lonicera japonica*	H	FAC-	11		
4 *Andropogon virginicus*	H	FAC-	12		
5 *Elaeagnus angustifolia*	S/S	FAC	13		
6 *Smilax bona nox*	WV	FAC	14		
7			15		
8			16		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-) **2/5 = 40%**

HYDROLOGY

___ Recorded Data (Describe in remarks):
 ___ Stream, Lake or Tide Gauge
 ___ Aerial Photographs
 ___ Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: **NA** (in.)

Depth to Free Water in Pit: **>12** (in.)

Depth to Saturated Soil: **>12** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits (on leaves)
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

DP2B Page 2

Map Unit Name
(Series and Phase): **Cecil sandy clay loam, 2-8% slopes, eroded** Drainage Class WD
Reference: USDA Johnston County Soil Survey (1994)
Taxonomy (Subgroup): Indicate Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0 -5	A	7.5YR 4/6	None	NA	loam
5 - 8	B1	7.5YR 4/6	5YR 4/6	common/faint	loam
8 - 12+	B2	2.5YR 4/8	None	NA	loam

____ Histosol
____ Histic Epipedon
____ Sulfidic Odor
____ Aquic Moisture Regime
____ Reducing Conditions
____ Gleyed or Low-Chroma Colors

____ Concretions
____ High Organic Content in Surface Layer in Sandy Soils
____ Organic Streaking in Sandy Soils
____ Listed on Local Hydric Soils List (Inclusions)
____ Listed on National Hydric Soils List
____ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No] (Circle)
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

Is this Sampling Point Within a Wetland? (Circle) Yes [✓ No]

Remarks:

DP 2B is representative of a non-jurisdictional upland area.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **U.T. Clarke Creek**
Applicant/Owner: **NCEEP**
Investigator(s): **Adam Karagosian, PWS**
Date: **01/27/10**
County: **Mecklenburg**
State: **NC**
Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)
Community ID: Wet C
Transect ID:
Plot ID: DP1A

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Juncus effusus*	H	FACW+	9			
2	*Leersia oryzoides*	H	OBL	10			
3	*Polygonum sagittatum*	H	OBL	11			
4	*Liquidambar styraciflua*	T	FAC+	12			
5	*Panicum virgatum*	H	FAC+	13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-) **5/5 = 100%**

HYDROLOGY

___ Recorded Data (Describe in remarks):
- ___ Stream, Lake or Tide Gauge
- ___ Aerial Photographs
- ___ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **1-2** (in.)

Depth to Free Water in Pit: **0** (in.)

Depth to Saturated Soil: **0** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- X Inundated
- X Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits (on leaves)
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- X Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

DP1A Page 2

Map Unit Name
(Series and Phase): Mecklenburg fine sandy loam, 8-15% slopes Drainage Class WD
Reference: USDA Johnston County Soil Survey (1994)
Taxonomy (Subgroup): Indicate Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
4-0	O1				Organic material
0-12	B	2.5Y 5/1	7.5YR 5/6	common/prom.	sandy clay loam

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors

___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List (Inclusions)
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? (Circle) [✓ Yes] No

Remarks:

All three criteria are present, therefore DP 1A is representative of a jurisdictional wetland area.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **U.T. Clarke Creek**
Applicant/Owner: NCEEP
Investigator(s): **Adam Karagosian, PWS**
Date: **01/27/10**
County: **Mecklenburg**
State: **NC**
Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)
Community ID: UPL C
Transect ID:
Plot ID: DP1B

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Andropogon virginicus*	H	FAC-	9			
2	*Solidago sp.*	H		10			
3	*Rubus sp.*	H		11			
4	*Festuca sp.*	H		12			
5	*Liquidambar styraciflua*	S/S	FAC+	13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-) **1/2 - 50%**

Rubus sp. and Festuca sp. are likely non-hydrophytic species.

HYDROLOGY

Recorded Data (Describe in remarks):
- Stream, Lake or Tide Gauge
- Aerial Photographs
- Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **NA** (in.)

Depth to Free Water in Pit: **>12** (in.)

Depth to Saturated Soil: **>12** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- Inundated
- Saturated in Upper 12 Inches
- Water Marks
- Drift Lines
- Sediment Deposits (on leaves)
- Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- Oxidized Root Channels in Upper 12 Inches
- Water-Stained Leaves
- Local Soil Survey Data
- FAC-Neutral Test
- Other (Explain in Remarks)

Remarks:

SOILS

DP1B Page 2

Map Unit Name
(Series and Phase): **Mecklenburg fine sandy loam, 8-15% slopes** Drainage Class **WD**
Reference: USDA Johnston County Soil Survey (1994)
Taxonomy (Subgroup): Indicate Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0 - 6	A	7.5 YR 3/2	None	NA	loam
6 - 12+	B	10YR 5/2	7.5 YR 4/6	common/distinct	clay loam

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors

___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
___ Listed on Local Hydric Soils List (Inclusions)
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No] (Circle)
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? (Circle) Yes [✓ No]

Remarks:

DP 1B is representative of a non-jurisdictional upland area.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **U.T. Clarke Creek**
Applicant/Owner: **NCEEP**
Investigator(s): **Adam Karagosian, PWS**
Date: **01/27/10**
County: **Mecklenburg**
State: **NC**
Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)
Community ID: Wet D
Transect ID:
Plot ID: **DP3A**

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Juncus effusus*	H	FACW+	9			
2	*Leersia oryzoides*	H	OBL	10			
3	*Rubus sp.*	H		11			
4				12			
5				13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-) **2/3 = 67%**

HYDROLOGY

Recorded Data (Describe in remarks):
Stream, Lake or Tide Gauge
Aerial Photographs
Other
X No Recorded Data Available

Field Observations:

Depth of Surface Water: **1-4** (in.)

Depth to Free Water in Pit: **0** (in.)

Depth to Saturated Soil: **0** (in.)

Wetland Hydrology Indicators:
Primary Indicators:
X Inundated
X Saturated in Upper 12 Inches
Water Marks
Drift Lines
Sediment Deposits (on leaves)
Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
X Oxidized Root Channels in Upper 12 Inches
X Water-Stained Leaves
Local Soil Survey Data
FAC-Neutral Test
Other (Explain in Remarks)

Remarks:

SOILS

DP3A Page 2

Map Unit Name
(Series and Phase): Monacan loam
Drainage Class SWP
Reference: USDA Johnston County Soil Survey (1994)
Taxonomy (Subgroup):
Indicate Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0 - 12	B	2.5Y 5/2	7.5YR 4/6	common/prom.	clay loam

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
X Gleyed or Low-Chroma Colors

___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
X Listed on Local Hydric Soils List (Inclusions)
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

Soil matches typical profile of Wehadkee loam, a hydric inclusion of the Monacan loam map unit.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

Is this Sampling Point Within a Wetland? (Circle) [✓ Yes] No

Remarks:

All three criteria are present, therefore DP 3A is representative of a jurisdictional wetland area.

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **U.T. Clarke Creek**
Applicant/Owner: **NCEEP**
Investigator(s): **Adam Karagosian, PWS**
Date: **01/27/10**
County: **Mecklenburg**
State: **NC**
Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)
Community ID: UPL D
Transect ID: ____
Plot ID: **DP3B**

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Andropogon virginicus*	H	FAC-	9			
2	*Festuca sp.*	H		10			
3				11			
4				12			
5				13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-) **0%**

HYDROLOGY

___ Recorded Data (Describe in remarks):
- ___ Stream, Lake or Tide Gauge
- ___ Aerial Photographs
- ___ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **NA** (in.)

Depth to Free Water in Pit: **8** (in.)

Depth to Saturated Soil: **6** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- **X** Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits (on leaves)
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- **X** Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

DP3B Page 2

Map Unit Name
(Series and Phase): **Monacan loam** Drainage Class **SWP**
Reference: USDA Johnston County Soil Survey (1994)
Taxonomy (Subgroup): Indicate Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
3 - 0	O1				
0 - 4	A	2.5Y 5/3	7.5YR 4/6	common/distinct	loam
4 - 12+	B	2.5Y 5/3	7.5YR 4/6	common/distinct	loam

___ Histosol
___ Histic Epipedon
___ Sulfidic Odor
___ Aquic Moisture Regime
___ Reducing Conditions
___ Gleyed or Low-Chroma Colors

___ Concretions
___ High Organic Content in Surface Layer in Sandy Soils
___ Organic Streaking in Sandy Soils
X Listed on Local Hydric Soils List (Inclusions)
___ Listed on National Hydric Soils List
___ Other (Explain in Remarks)

Remarks:

Soil matches typical profile for Wehadkee loam, hydric inclusion of the Monacan loam map unit.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No] (Circle)
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

(Circle)
Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

DP 3B is representative of a non-jurisdictional upland area. Based on soil profile and presence of hydrologic indicators, as well as information provided by former property owner, this area appears to have been a wetland that was drained and converted to pasture some time in the past.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **U.T. Clarke Creek**
Applicant/Owner: **NCEEP**
Investigator(s): **Adam Karagosian, PWS**
Date: **01/27/10**
County: **Mecklenburg**
State: **NC**

Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)

Community ID: Wet E
Transect ID:
Plot ID: DP5A

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1 *Juncus effusus*	H	FACW+	9		
2 *Liquidambar styraciflua*	S/S	FAC+	10		
3 *Carex sp.*	H	FAC-OBL	11		
4 *Rubus sp.*	H		12		
5			13		
6			14		
7			15		
8			16		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)

3/3 = 100%

HYDROLOGY

Recorded Data (Describe in remarks):
- Stream, Lake or Tide Gauge
- Aerial Photographs
- Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **NA** (in.)

Depth to Free Water in Pit: **NA** (in.)

Depth to Saturated Soil: **8** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- Inundated
- X Saturated in Upper 12 Inches
- Water Marks
- Drift Lines
- Sediment Deposits (on leaves)
- X Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- Oxidized Root Channels in Upper 12 Inches
- X Water-Stained Leaves
- Local Soil Survey Data
- FAC-Neutral Test
- Other (Explain in Remarks)

Remarks:

SOILS

DP5A Page 2

Map Unit Name
(Series and Phase): **Monacan loam (MO)**
Drainage Class **SWP**
Reference: USDA Johnston County Soil Survey (1994)
Taxonomy (Subgroup):
Indicate Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0 - 4	A	10YR 4/4	None	NA	loam
4 - 12+	B	10YR 5/2	10YR 4/4	common/distinct	loam

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☒ Gleyed or Low-Chroma Colors

☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soils
☐ Organic Streaking in Sandy Soils
☒ Listed on Local Hydric Soils List (Inclusions)
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks:

Profile indicative of Wehadkee loam, a hydric inclusion of the Monacan loam map unit.

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [✓ Yes] No (Circle)
Wetland Hydrology Present? [✓ Yes] No
Hydric Soils Present? [✓ Yes] No

(Circle)
Is this Sampling Point Within a Wetland? [✓ Yes] No

Remarks:

All three criteria are present, therefore DP 5A is representative of a jurisdictional wetland area.

Approved by HQUSACE 2/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: **U.T. Clarke Creek**
Applicant/Owner: **NCEEP**
Investigator(s): **Adam Karagosian, PWS**
Date: **01/27/10**
County: **Mecklenburg**
State: **NC**
Do Normal Circumstances exist on the site? [✓ Yes] No
Is the site significantly disturbed (Atypical Situation)? Yes [✓ No]
Is the area a potential Problem Area? Yes [✓ No]
(If needed, explain on reverse.)
Community ID: UPL E
Transect ID:
Plot ID: **DP5B**

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1	*Microstegium vimineum*	H	FAC+	9			
2	*Festuca sp.*	H		10			
3	*Asclepias sp.*	H		11			
4	*Rubus sp.*	H		12			
5	*Andropogon virginicus*	H	FAC-	13			
6				14			
7				15			
8				16			

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-) **1/2 = 50%**

Rubus and pasture grass likely not hydrophytic

HYDROLOGY

___ Recorded Data (Describe in remarks):
- ___ Stream, Lake or Tide Gauge
- ___ Aerial Photographs
- ___ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: **NA** (in.)

Depth to Free Water in Pit: **NA** (in.)

Depth to Saturated Soil: **NA** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits (on leaves)
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

DP5B Page 2

Map Unit Name
(Series and Phase): **Monacan loam (MO)**
Drainage Class SWP
Reference: USDA Johnston County Soil Survey (1994)
Taxonomy (Subgroup):
Indicate Mapped Type? Yes [✓ No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0 - 3	A	10YR 4/3	None	NA	loam
3 - 10	B	10YR 4/4	None	NA	loam
10 - 12+	B2	5YR 4/6	None	NA	loam

____ Histosol
____ Histic Epipedon
____ Sulfidic Odor
____ Aquic Moisture Regime
____ Reducing Conditions
____ Gleyed or Low-Chroma Colors

____ Concretions
____ High Organic Content in Surface Layer in Sandy Soils
____ Organic Streaking in Sandy Soils
____ Listed on Local Hydric Soils List (Inclusions)
____ Listed on National Hydric Soils List
____ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes [✓ No] (Circle)
Wetland Hydrology Present? Yes [✓ No]
Hydric Soils Present? Yes [✓ No]

(Circle)
Is this Sampling Point Within a Wetland? Yes [✓ No]

Remarks:

DP 5B is representative of a non-jurisdictional upland area.

Approved by HQUSACE 2/92

APPENDIX 3

PROJECT SITE NCDWQ STREAM CLASSIFICATION FORMS

USACE AID#__________ DWQ #__________ Site # SA1 (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCEEP
2. Evaluator's name: A. Karagosian
3. Date of evaluation: 1/20/10
4. Time of evaluation: 3:45 PM
5. Name of stream: U.T. Clarke Creek
6. River basin: Rocky River / Yadkin
7. Approximate drainage area: ± 300 Ac.
8. Stream order: 2nd
9. Length of reach evaluated: ± 200 lf
10. County: Mecklenburg
11. Site coordinates (if known): prefer in decimal degrees.
12. Subdivision name (if any):__________

Latitude (ex. 34.872312): 35.357463

Longitude (ex. –77.556611): -80.807082

Method location determined (circle): [✓ GPS] Topo Sheet [✓ Ortho (Aerial) Photo/GIS] Other GIS Other__________

13. Location of reach under evaluation (note nearby roads ~~and landmarks and~~ attach map identifying stream(s) location): Northern ~~corner~~ portion of Clarke Creek Nature Preserve off Hucks Rd

14. Proposed channel work (if any): Restoration / enhancement

15. Recent weather conditions: mild and dry; no rain in past 72 hours

16. Site conditions at time of visit: Sunny; 65°F

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ___(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? [✓ YES] ~~NO~~ If yes, estimate the water surface area: 2.0 Acres

19. Does channel appear on USGS quad map? [✓ YES] NO

20. Does channel appear on USDA Soil Survey? [✓ YES] NO

21. Estimated watershed land use: 35 % Residential ___% Commercial ___% Industrial 45 % Agricultural

20 % Forested ___% Cleared / Logged ___% Other (__________)

22. Bankfull width: 10' – 15'

23. Bank height (from bed to top of bank): 4' – 5'

24. Channel slope down center of stream: ✓ Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ___Straight ___Occasional bends ✓ Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 48 **Comments:** Major bank failure and mass wasting throughout reach. Significant sediment accumulation on channel bottom, overlying coarse sand and gravel. Channel is entrenched but floodplain occassionally accessed during very heavy events. Beaver dams removed in past 2 months

Evaluator's Signature Ala Karagosian **Date** 1/20/10

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

SA-1

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	[✓ Piedmont]	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	4
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	3
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	2
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	3
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	1
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	2
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	1
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	0
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	1
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	2
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	3
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	2
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	4
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				48

* These characteristics are not assessed in coastal streams.

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 1/20/10	**Project:** U.T. Clarke Cr.	**Latitude:** 35.357463
Evaluator: A. Karagosian	**Site:** SA-1	**Longitude:** -80.807082
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 40	**County:** Mecklenburg	**Other** *e.g.* Quad Name: Derita, NC

A. Geomorphology (Subtotal = 24)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	[✓ 3]
2. Sinuosity	0	1	[✓ 2]	3
3. In-channel structure: riffle-pool sequence	0	1	[✓ 2]	3
4. Soil texture or stream substrate sorting	0	1	[✓ 2]	3
5. Active/relic floodplain	0	1	[✓ 2]	3
6. Depositional bars or benches	0	1	[✓ 2]	3
7. Braided channel	[✓ 0]	1	2	3
8. Recent alluvial deposits	0	1	2	[✓ 3]
9[a] Natural levees	0	1	← [✓ 2]	3
10. Headcuts	0	[✓ 1]	2	3
11. Grade controls	0	0.5	[✓ 1] →	1.5
12. Natural valley or drainageway	0	0.5	[✓ 1]	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = [✓ 3]	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7.5)				
14. Groundwater flow/discharge	0	[✓ 1]	2	3
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	[✓ 2]	3
16. Leaflitter	1.5	1	← [✓ 0.5]	0
17. Sediment on plants or debris	0	0.5	1	[✓ 1.5]
18. Organic debris lines or piles (Wrack lines)	0	0.5	[✓ 1]	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = [✓ 1.5]	

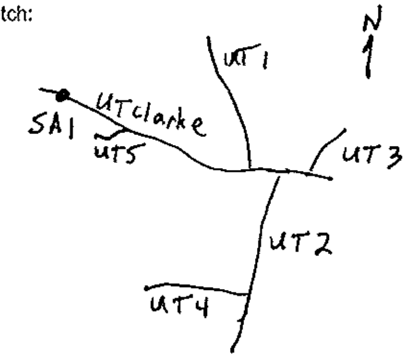
C. Biology (Subtotal = 8.5)				
20[b]. Fibrous roots in channel	3	[✓ 2]	1	0
21[b]. Rooted plants in channel	[✓ 3]	2	1	0
22. Crayfish	0	0.5	[✓ 1]	1.5
23. Bivalves	[✓ 0]	1	2	3
24. Fish	[✓ 0]	0.5	1	1.5
25. Amphibians	0	0.5	[✓ 1]	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	[✓ 1]	1.5
27. Filamentous algae; periphyton	[✓ 0]	1	2	3
28. Iron oxidizing bacteria/fungus.	0	[✓ 0.5]	1	1.5
29[b]. Wetland plants in streambed N/A	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

8. heavy sediment from mass wasting of banks
25. Salamanders in leaf pack
26. few damsel flies; isopods

Sketch:



USACE AID#__________ DWQ #__________ Site #SA2 (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NC EEP

2. Evaluator's name: A. Karagosian

3. Date of evaluation: 1/27/10

4. Time of evaluation: 5:15 PM

5. Name of stream: U.T. 3

6. River basin: Rocky River / Yadkin

7. Approximate drainage area: ± 35 Ac.

8. Stream order: 1st

9. Length of reach evaluated: ± 75 lf

10. County: Mecklenburg

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any):__________

Latitude (ex. 34.872312): ~~35.35505~~3 35.356176

Longitude (ex. –77.556611): ~~-80.805424~~ -80.804223

Method location determined (circle): [✓ GPS] Topo Sheet [✓ Ortho (Aerial) Photo/GIS] Other GIS Other__________

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): Northeast corner of Clarke Creek Nature Preserve off Hucks Rd.

14. Proposed channel work (if any): Restoration / enhancement

15. Recent weather conditions: Cool; no rain in past 48 hours

16. Site conditions at time of visit: partly cloudy; ± 48°F

17. Identify any special waterway classifications known: ____Section 10 ____Tidal Waters ____Essential Fisheries Habitat ____Trout Waters ____Outstanding Resource Waters ____ Nutrient Sensitive Waters ____Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES [✓ NO] If yes, estimate the water surface area:__________

19. Does channel appear on USGS quad map? YES [✓ NO]

20. Does channel appear on USDA Soil Survey? YES [✓ NO]

21. Estimated watershed land use: 5 % Residential ____% Commercial ____% Industrial 25 % Agricultural 70 % Forested ____% Cleared / Logged ____% Other (__________)

22. Bankfull width: 4' - 6'

23. Bank height (from bed to top of bank): 2' - 4'

24. Channel slope down center of stream: ____Flat (0 to 2%) ✓ Gentle (2 to 4%) ____Moderate (4 to 10%) ____Steep (>10%)

25. Channel sinuosity: ____Straight ✓ Occasional bends ____Frequent meander ____Very sinuous ____Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 46

Comments: Reach begins at property line and large headcut with significant scour. Reach is crossed by narrow trail - small PVC pipe and riprap in channel at the trail crossing

Evaluator's Signature A. Karagosian **Date** 1/27/10

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

SA 2

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	[✓ Piedmont]	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	2
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	2
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	1
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	3
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	2
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	1
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	2
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	3
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	3
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	3
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	3
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	2
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	2
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				46

* These characteristics are not assessed in coastal streams.

20. cranefly larvae, crayfish; isopods

21. Salamanders

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 1/27/10	Project: U.T. Clarke Creek	Latitude: 35.356~~[illegible]~~176
Evaluator:	Site: SA 2	Longitude: -80.804223
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 27	County: Mecklenburg	Other *e.g. Quad Name:* Derita, NC

A. Geomorphology (Subtotal = 15)

A. Geomorphology (Subtotal = 15)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	[✓ 3]
2. Sinuosity	0	1	[✓ 2]	3
3. In-channel structure: riffle-pool sequence	0	1	[✓ 2]	3
4. Soil texture or stream substrate sorting	0	1	[✓ 2]	3
5. Active/relic floodplain	0	[✓ 1]	2	3
6. Depositional bars or benches	0	[✓ 1]	2	3
7. Braided channel	[✓ 0]	1	2	3
8. Recent alluvial deposits	0	1	[✓ 2] →	3
9[a] Natural levees	[✓ 0]	1	2	3
10. Headcuts	[✓ 0]	1	2	3
11. Grade controls	0	0.5	[✓ 1]	1.5
12. Natural valley or drainageway	0	0.5	[✓ 1]	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = [✓ 0]		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 4.5)

14. Groundwater flow/discharge	0	[✓ 1]	2	3
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	[✓ 2]	3
16. Leaflitter	1.5	1	[✓ 0.5]	0
17. Sediment on plants or debris	0	[✓ 0.5]	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	[✓ 0.5]	1	1.5
19. Hydric soils (redoximorphic features) present?	No = [✓ 0]		Yes = 1.5	

C. Biology (Subtotal = 7.5)

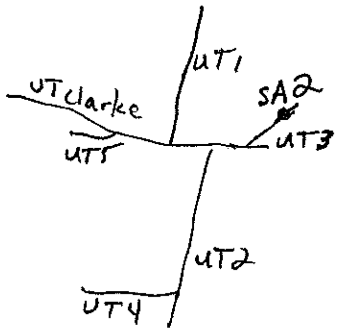
20[b]. Fibrous roots in channel	3	[✓ 2]	1	0
21[b]. Rooted plants in channel	[✓ 3]	2	1	0
22. Crayfish	0	0.5	[✓ 1]	1.5
23. Bivalves	[✓ 0]	1	2	3
24. Fish	[✓ 0]	0.5	1	1.5
25. Amphibians	0	0.5	[✓ 1]	1.5
26. Macrobenthos (note diversity and abundance)	0	[✓ 0.5]	1	1.5
27. Filamentous algae; periphyton	[✓ 0]	1	2	3
28. Iron oxidizing bacteria/fungus.	[✓ 0]	0.5	1	1.5
29[b]. Wetland plants in streambed N/A	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

25. Salamanders
26. cranefly larvae; isopods

Sketch:



USACE AID#____________ DWQ #____________ Site #SA3 (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NC EEP
2. Evaluator's name: A. Karagosian
3. Date of evaluation: 1/27/10
4. Time of evaluation: 4:40 PM
5. Name of stream: U.T. 1
6. River basin: Rocky River/Yadkin
7. Approximate drainage area: ± 260 Ac.
8. Stream order: 2nd
9. Length of reach evaluated: ± 200 lf
10. County: Meklenburg
11. Site coordinates (if known): prefer in decimal degrees.
12. Subdivision name (if any): ____________

Latitude (ex. 34.872312): 35.358224 Longitude (ex. –77.556611): -80.805402

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other____________

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): Near northern corner of Clarke Creek Nature Preserve off Hucks Road

14. Proposed channel work (if any): Restoration/Enhancement

15. Recent weather conditions: Cool; no rain in past 48 hours

16. Site conditions at time of visit: partly cloudy; ± 48°F

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ___(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? [✓ YES] NO If yes, estimate the water surface area: 1.0 Acre

19. Does channel appear on USGS quad map? [✓ YES] NO

20. Does channel appear on USDA Soil Survey? [✓ YES] NO

21. Estimated watershed land use: 25 % Residential ___% Commercial ___% Industrial 20 % Agricultural
55 % Forested ___% Cleared / Logged ___% Other (____________)

22. Bankfull width: 10'-15'

23. Bank height (from bed to top of bank): 4'-5'

24. Channel slope down center of stream: ✓ Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ___Straight ✓ Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 40 **Comments:** Severe bank erosion and sediment deposition in the reach. Very little biota in-stream, consisting of few salamanders, 1 cranefly larva and 1 dragonfly larva found. Channel possibly straightened in the past. Sewer line adjacent.

Evaluator's Signature Ale Karagosi **Date** 1/27/10

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

SA 3

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	[✓ Piedmont]	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	4
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	2
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	2
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	1
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	3
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	3
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	1
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	1
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	3
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	2
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	2
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	2
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				40

* These characteristics are not assessed in coastal streams.

2. Possibly straightened in past
4. Sewer line adjacent

11. coarse sand, gravel w/ some ^{2}boulders and outcrops downstream
20. dragonfly and cranefly larvae (1 of each) found
21. few salamanders

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 1/27/10
Project: U.T. Clarke Creek
Latitude: 35.358224
Evaluator: A. Karagosian
Site: SA 3
Longitude: -80.805402
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 37.5
County: Mecklenburg
Other *e.g. Quad Name:* Derita, NC

A. Geomorphology (Subtotal = 21)	Absent	Weak	Moderate	Strong
1ª. Continuous bed and bank	0	1	2	[✓ 3]
2. Sinuosity	0	1	[✓ 2]	3
3. In-channel structure: riffle-pool sequence	0	[✓ 1] →	2	3
4. Soil texture or stream substrate sorting	0	1	[✓ 2]	3
5. Active/relic floodplain	0	1	[✓ 2]	3
6. Depositional bars or benches	0	1	[✓ 2]	3
7. Braided channel	[✓ 0]	1	2	3
8. Recent alluvial deposits	0	1	[✓ 2]	3
9ª Natural levees	0	[✓ 1]	2	3
10. Headcuts	0	[✓ 1]	2	3
11. Grade controls	0	[✓ 0.5]	1	1.5
12. Natural valley or drainageway	0	0.5	1	[✓ 1.5]
13. Second or greater order channel on <u>existing</u> USGS or NRCS map or other documented evidence.	No = 0		[✓ Yes = 3]	

ª Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8.5)	Absent	Weak	Moderate	Strong
14. Groundwater flow/discharge	0	[✓ 1]	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	[✓ 3]
16. Leaflitter	1.5	[✓ 1]	0.5	0
17. Sediment on plants or debris	0	0.5	[✓ 1]	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	[✓ 1]	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		[✓ Yes = 1.5]	

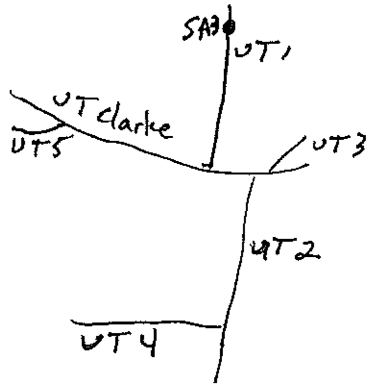
C. Biology (Subtotal = 8)	Absent	Weak	Moderate	Strong
20ᵇ. Fibrous roots in channel	[✓ 3]	2	1	0
21ᵇ. Rooted plants in channel	[✓ 3]	2	1	0
22. Crayfish	0	[✓ 0.5]	1	1.5
23. Bivalves	[✓ 0]	1	2	3
24. Fish	[✓ 0]	0.5	1	1.5
25. Amphibians	0	0.5	[✓ 1]	1.5
26. Macrobenthos (note diversity and abundance)	0	[✓ 0.5]	1	1.5
27. Filamentous algae; periphyton	[✓ 0]	1	2	3
28. Iron oxidizing bacteria/fungus.	[✓ 0]	0.5	1	1.5
29ᵇ. Wetland plants in streambed N/A	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

ᵇ Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

22. Chimneys only
25. salamanders
26. 1 cranefly larvae; 1 dragonfly larva

Sketch:



USACE AID#________ DWQ #________ Site #SA4 (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NC EEP
2. Evaluator's name: A. Karagosian
3. Date of evaluation: 1/27/10
4. Time of evaluation: 3:50 PM
5. Name of stream: U.T. 2A
6. River basin: Rocky River / Yadkin
7. Approximate drainage area: ± 30 Ac.
8. Stream order: ~~1st~~ 2nd
9. Length of reach evaluated: ± 150 lf
10. County: Mecklenburg
11. Site coordinates (if known): prefer in decimal degrees.
12. Subdivision name (if any):________

Latitude (ex. 34.872312): 35.355867 Longitude (ex. –77.556611): -80.804683

Method location determined (circle): [✓ GPS] Topo Sheet [✓ Ortho (Aerial) Photo/GIS] Other GIS Other______

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): Northeastern portion of Clarke Cr. Nature Preserve off Hucks Rd.

14. Proposed channel work (if any): Restoration / Enhancement

15. Recent weather conditions: No rain in past 48 hours

16. Site conditions at time of visit: Cool and dry; partly cloudy; ± 48° F

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___Nutrient Sensitive Waters ___Water Supply Watershed ___(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES [✓ NO] If yes, estimate the water surface area: —

19. Does channel appear on USGS quad map? YES [✓ NO]

20. Does channel appear on USDA Soil Survey? YES [✓ NO]

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial 50% Agricultural 50% Forested ___% Cleared / Logged ___% Other (______)

22. Bankfull width: 6'-10'

23. Bank height (from bed to top of bank): 2'-4'

24. Channel slope down center of stream: ✓ Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ___Straight ✓ Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 44 **Comments:** Overwidened stream with broad bankfull bench and narrow low-flow channel. Heavy sediment input. Portions of channel bottom and benches contain hydrophytic vegetation.

Evaluator's Signature Karagos **Date** 1/27/10

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

SA 4

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	[✓ Piedmont]	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	2
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	3
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	1
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	3
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	3
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	2
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	2
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	2
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	1
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	2
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						44

* These characteristics are not assessed in coastal streams.

11. fine sediment overlying coarse and medium sand

16. riffle-pool @ downstream end of reach

20. isopods only

21. few salamanders in leaf pack at upstream end of reach

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 1/27/10
Project: U.T. Clarke Cr.
Latitude: 35.355867
Evaluator: A. Karagosian
Site: SA 4
Longitude: -80.804683
Total Points: 28.25
Stream is at least intermittent if ≥ 19 or perennial if ≥ 30
County: Mecklenburg
Other *e.g. Quad Name:* Derita, NC

A. Geomorphology (Subtotal = 14.5)	Absent	Weak	Moderate	Strong
1^{a}. Continuous bed and bank	0	1	[✓ 2]	3
2. Sinuosity	0	[✓ 1]	2	3
3. In-channel structure: riffle-pool sequence	0	[✓ 1]	2	3
4. Soil texture or stream substrate sorting	0	[✓ 1]	2	3
5. Active/relic floodplain	0	[✓ 1]	2	3
6. Depositional bars or benches	0	1	[✓ 2] →	3
7. Braided channel	[✓ 0]	1	2	3
8. Recent alluvial deposits	0	1	[✓ 2]	3
9^{a} Natural levees	[✓ 0]	1	2	3
10. Headcuts	[✓ 0]	1	2	3
11. Grade controls	0	[✓ 0.5]	1	1.5
12. Natural valley or drainageway	0	0.5	[✓ 1]	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = [✓ 3]	

^{a} Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7.5)				
14. Groundwater flow/discharge	0	1	[✓ 2]	3
15. Water in channel and > 48 hrs since rain, or Water in channel -- dry or growing season	0	1	← [✓ 2]	3
16. Leaflitter	1.5	[✓ 1]	0.5	0
17. Sediment on plants or debris	0	0.5	[✓ 1]	1.5
18. Organic debris lines or piles (Wrack lines)	[✓ 0]	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = [✓ 1.5]	

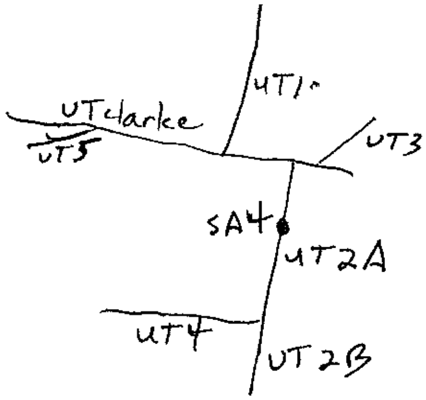
C. Biology (Subtotal = 6.25)				
20^{b}. Fibrous roots in channel	3	[✓ 2]	1	0
21^{b}. Rooted plants in channel	3	[✓ 2]	1	0
22. Crayfish	0	[✓ 0.5]	1	1.5
23. Bivalves	[✓ 0]	1	2	3
24. Fish	[✓ 0]	0.5	1	1.5
25. Amphibians	0	[✓ 0.5]	1	1.5
26. Macrobenthos (note diversity and abundance)	0	[✓ 0.5]	1	1.5
27. Filamentous algae; periphyton	[✓ 0]	1	2	3
28. Iron oxidizing bacteria/fungus.	[✓ 0]	0.5	1	1.5
29^{b}. Wetland plants in streambed	FAC = 0.5; FACW = [✓ 0.75]; OBL = 1.5 SAV = 2.0; Other = 0			

^{b} Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

22. Chimneys only
25. two salamanders in leafpack at upstream
26. isopods only
29. Carex sp.; Juncus effusus;
Leersia oryzoides

Sketch:



USACE AID#________ DWQ #________ Site # SA5 (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NC EEP

2. Evaluator's name: A. Karagosian

3. Date of evaluation: 1/27/10

4. Time of evaluation: 2:30 PM

5. Name of stream: UT2B

6. River basin: Rocky River / Yadkin

7. Approximate drainage area: ± 20 Ac.

8. Stream order: 1st and 2nd in reach

9. Length of reach evaluated: ± 150 lf

10. County: Mecklenburg

11. Site coordinates (if known): prefer in decimal degrees.

12. Subdivision name (if any):________

Latitude (ex. 34.872312): 35.355053

Longitude (ex. –77.556611): -80.805424

Method location determined (circle): [✓ GPS] Topo Sheet [✓ Ortho (Aerial) Photo/GIS] Other GIS Other________

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): Northeastern portion of Clarke Cr. Nature Preserve off Hucks Rd

14. Proposed channel work (if any): Restoration / Enhancement

15. Recent weather conditions: No rain within past 48 hours

16. Site conditions at time of visit: Cool; partly cloudy; ± 48° f

17. Identify any special waterway classifications known: ____Section 10 ____Tidal Waters ____Essential Fisheries Habitat ____Trout Waters ____Outstanding Resource Waters ____ Nutrient Sensitive Waters ____Water Supply Watershed ____(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES [✓ NO] If yes, estimate the water surface area: —

19. Does channel appear on USGS quad map? YES [✓ NO]

20. Does channel appear on USDA Soil Survey? YES [✓ NO]

21. Estimated watershed land use: ____% Residential ____% Commercial ____% Industrial 50% Agricultural 50% Forested ____% Cleared / Logged ____% Other (________)

22. Bankfull width: 8' – 12'

23. Bank height (from bed to top of bank): 2' – 3'

24. Channel slope down center of stream: ✓ Flat (0 to 2%) ____Gentle (2 to 4%) ____Moderate (4 to 10%) ____Steep (>10%)

25. Channel sinuosity: ____Straight ✓ Occasional bends ____Frequent meander ____Very sinuous ____Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 46 **Comments:** Overwidened channel with broad bankfull bench. Wetlands situated on bench. Hydrophytic vegetation in channel bottom. Significant sediment overlying medium sand. Channelized in past according to past property owner

Evaluator's Signature Ada Karagos **Date** 1/27/10

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

SA5

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	[✓ Piedmont]	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	2
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	2
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	1
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	3
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	4
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	3
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	2
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	1
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	3
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	3
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	2
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				46

* These characteristics are not assessed in coastal streams.

20. crayfish; isopods; midges
21. numerous salamanders in leaf pack and beneath hydrophytic veg.
23. racoon tracks

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 1/27/10	Project: U.T. Clarke Cr.	Latitude: 35.355053
Evaluator: A. Karagosian	Site: SA 5	Longitude: -80.805424
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 28	County: Mecklenburg	Other *e.g. Quad Name:* Derita

A. Geomorphology (Subtotal = 13)

	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	[✓ 1]	2	3
2. Sinuosity	0	1	[✓ 2]	3
3. In-channel structure: riffle-pool sequence	[✓ 0]	1	2	3
4. Soil texture or stream substrate sorting	[✓ 0]	1	2	3
5. Active/relic floodplain	0	[✓ 1]	2	3
6. Depositional bars or benches	0	1	[✓ 2]	3
7. Braided channel	[✓ 0]	1	2	3
8. Recent alluvial deposits	0	1	[✓ 2]	3
9[a] Natural levees	[✓ 0]	1	2	3
10. Headcuts	0	[✓ 1]	2	3
11. Grade controls	[✓ 0]	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	[✓ 1]	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = [✓ 3]	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6)

14. Groundwater flow/discharge	0	1	[✓ 2] →	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	[✓ 1]	2	3
16. Leaflitter	1.5	1	[✓ 0.5]	0
17. Sediment on plants or debris	0	[✓ 0.5]	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	[✓ 0.5]	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = [✓ 1.5]	

C. Biology (Subtotal = 9)

20[b]. Fibrous roots in channel	3	[✓ 2]	1	0
21[b]. Rooted plants in channel	[✓ 3]	2	1	0
22. Crayfish	0	0.5	[✓ 1]	1.5
23. Bivalves	[✓ 0]	1	2	3
24. Fish	[✓ 0]	0.5	1	1.5
25. Amphibians	0	0.5	[✓ 1]	1.5
26. Macrobenthos (note diversity and abundance)	0	[✓ 0.5]	1	1.5
27. Filamentous algae; periphyton	[✓ 0]	1	2	3
28. Iron oxidizing bacteria/fungus.	[✓ 0]	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = [✓ 1.5] SAV = 2.0; Other = 0			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

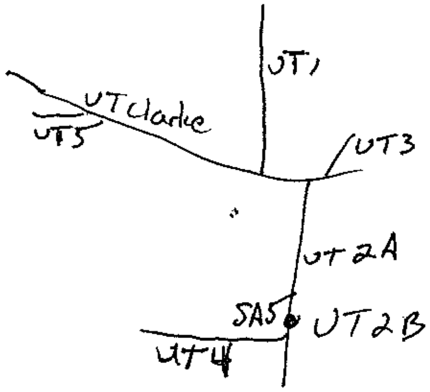
14. originates from wetland

25. salamanders

26. isopods; midges

29. Leersia oryzoides in channel bottom

Sketch:



USACE AID#________ DWQ #________ Site #SA6 (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NC EEP
2. Evaluator's name: A. Karagosian
3. Date of evaluation: 1/27/10
4. Time of evaluation: 2:50PM
5. Name of stream: UT 4
6. River basin: Rocky River/Yadkin
7. Approximate drainage area: ± 15 Ac.
8. Stream order: 1st
9. Length of reach evaluated: ± 150'
10. County: Mecklenburg
11. Site coordinates (if known): prefer in decimal degrees.
12. Subdivision name (if any):________

Latitude (ex. 34.872312): 35.355013 Longitude (ex. –77.556611): -80.806546

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other________

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): Central portion of Clarke Creek Nature Preserve off Hucks Rd

14. Proposed channel work (if any): Restoration/Enhancement

15. Recent weather conditions: No rain in past 48 hours

16. Site conditions at time of visit: Cool; partly cloudy; ± 50°

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ___(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES [✓ NO] If yes, estimate the water surface area:________

19. Does channel appear on USGS quad map? YES [✓ NO]

20. Does channel appear on USDA Soil Survey? YES [✓ NO]

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial 50% Agricultural 50% Forested ___% Cleared / Logged ___% Other (________)

22. Bankfull width: 4'-8'

23. Bank height (from bed to top of bank): 2'-4'

24. Channel slope down center of stream: ✓ Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ___Straight ✓ Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 44 Comments: Channel originates from emergent wetland. Downstream-most reach of channel bottom is vegetated by dense rice cutgrass.

Evaluator's Signature________ Date________

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

SA 6

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	2
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	3
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	3
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	2
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	2
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	2
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	2
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	3
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	2
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	2
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	3
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	3
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	2
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	1
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				44

* These characteristics are not assessed in coastal streams.

11. coare sand with some gravel, overlain by fine sediment

20. few crayfish; isopods

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 1/27/10	Project: U.T. Clarke Cr.	Latitude: 35.355013
Evaluator: A. Karagosian	Site: SA 6	Longitude: -80.806546
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 23.5	County: Mecklenburg	Other e.g. Quad Name: Derita, NC

A. Geomorphology (Subtotal = 12.5)	Absent	Weak	Moderate	Strong
1ª. Continuous bed and bank	0	1	[✓ 2]	3
2. Sinuosity	0	1	[✓ 2]	3
3. In-channel structure: riffle-pool sequence	0	[✓ 1]	2	3
4. Soil texture or stream substrate sorting	0	[✓ 1]	2	3
5. Active/relic floodplain	0	[✓ 1]	2	3
6. Depositional bars or benches	0	1	[✓ 2]	3
7. Braided channel	[✓ 0]	1	2	3
8. Recent alluvial deposits	0	1	[✓ 2]	3
9ª Natural levees	[✓ 0]	1	2	3
10. Headcuts	[✓ 0]	1	2	3
11. Grade controls	0	[✓ 0.5]	1	1.5
12. Natural valley or drainageway	0	0.5	[✓ 1]	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	[✓ No = 0]		Yes = 3	

ª Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6.5)				
14. Groundwater flow/discharge	0	1	[✓ 2]	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	[✓ 1]	2	3
16. Leaflitter	1.5	[✓ 1]	0.5	0
17. Sediment on plants or debris	0	[✓ 0.5]	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	[✓ 0.5]	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = [✓ 1.5]	

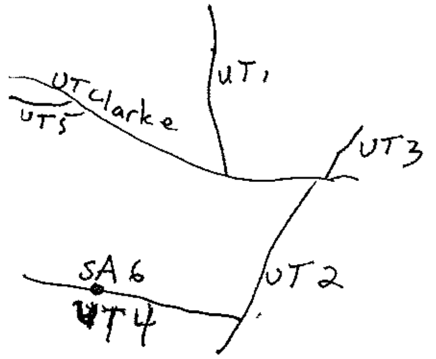
C. Biology (Subtotal = 4.5)				
20ᵇ. Fibrous roots in channel	3	2	[✓ 1]	0
21ᵇ. Rooted plants in channel	3	[✓ 2]	1	0
22. Crayfish	0	[✓ 0.5]	1	1.5
23. Bivalves	[✓ 0]	1	2	3
24. Fish	[✓ 0]	0.5	1	1.5
25. Amphibians	[✓ 0]	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	[✓ 0.5]	1	1.5
27. Filamentous algae; periphyton	[✓ 0]	1	2	3
28. Iron oxidizing bacteria/fungus.	[✓ 0]	0.5	1	1.5
29ᵇ. Wetland plants in streambed	FAC = [✓ 0.5]; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0			

ᵇ Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

26. few isopods
29. microstegium; sweetgum saplings

Sketch:



USACE AID#__________ DWQ #__________ Site # SA7 (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCEEP
2. Evaluator's name: A. Karagosian
3. Date of evaluation: 1/20/10
4. Time of evaluation: 5:00 PM
5. Name of stream: UT 5
6. River basin: Rocky River/Yadkin
7. Approximate drainage area: ± 10 Ac.
8. Stream order: 1st
9. Length of reach evaluated: ± 200'
10. County: Mecklenburg
11. Site coordinates (if known): prefer in decimal degrees.
12. Subdivision name (if any):__________

Latitude (ex. 34.872312): 35.356682 Longitude (ex. –77.556611): -80.806413

Method location determined (circle): [✓ GPS] Topo Sheet [✓ Ortho (Aerial) Photo/GIS] Other GIS Other__________

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): North-central portion of Clarke Cr. Nature Preserve off Hucks Rd.

14. Proposed channel work (if any): Restoration/Enhancement

15. Recent weather conditions: mild and dry; no rain in past 72 hours

16. Site conditions at time of visit: Sunny; 65° F

17. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ___(I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES [✓ NO] If yes, estimate the water surface area:__________

19. Does channel appear on USGS quad map? YES [✓ NO]

20. Does channel appear on USDA Soil Survey? YES [✓ NO]

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial 95% Agricultural ___% Forested ___% Cleared / Logged 5% Other (fallow)

22. Bankfull width: 6'–8'

23. Bank height (from bed to top of bank): 1'–2'

24. Channel slope down center of stream: ✓ Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)

25. Channel sinuosity: ___Straight ✓ Occasional bends ___Frequent meander ___Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions, enter 0 in the scoring box and provide an explanation in the comment section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluate each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 44 **Comments:** Small drainage originating from small wetland area. Upper reach containing some hydrophytic vegetation. Lower reach unvegetated and downcut to saprolite.

Evaluator's Signature Ale Karagosian **Date** 1/20/10

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 06/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

SA 7

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	[✓ Piedmont]	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	2
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	3
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	1
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	3
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	2
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	2
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	1
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	3
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	2
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	1
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	3
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	2
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	3
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	2
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				44

* These characteristics are not assessed in coastal streams.

8. wetland at upstream-most portion of reach

20. multiple types (midge, isopods?, damselfly larvae, dragonfly larvae)

21. tadpoles

23. racoon + deer tracks; adjacent beaver activity

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 1/20/10	**Project:** U.T. Clarke Cr.	**Latitude:** 35.356682
Evaluator: A. Karagosian	**Site:** SA 7	**Longitude:** -80.806413
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 25.75	**County:** Mecklenburg	**Other** *e.g. Quad Name:* Derita, NC

A. Geomorphology (Subtotal = 12.5)	Absent	Weak	Moderate	Strong
1ª. Continuous bed and bank	0	1	[✓ 2]	3
2. Sinuosity	0	[✓ 1]	2	3
3. In-channel structure: riffle-pool sequence	0	[✓ 1]	2	3
4. Soil texture or stream substrate sorting	0	[✓ 1]	2	3
5. Active/relic floodplain	0	1	[✓ 2]	3
6. Depositional bars or benches	0	1	[✓ 2]	3
7. Braided channel	[✓ 0]	1	2	3
8. Recent alluvial deposits	0	1	[✓ 2]	3
9ª Natural levees	[✓ 0]	1	2	3
10. Headcuts	[✓ 0]	1	2	3
11. Grade controls	0	[✓ 0.5]	1	1.5
12. Natural valley or drainageway	0	0.5	[✓ 1]	1.5
13. Second or greater order channel on <u>existing</u> USGS or NRCS map or other documented evidence.	[✓ No = 0]		Yes = 3	

ª Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 5.5)				
14. Groundwater flow/discharge	0	1	[✓ 2]	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	[✓ 1]	2	3
16. Leaflitter	1.5	1	[✓ 0.5]	0
17. Sediment on plants or debris	0	[✓ 0.5]	1	1.5
18. Organic debris lines or piles (Wrack lines)	[✓ 0]	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = [✓ 1.5]	

C. Biology (Subtotal = 7.75)				
20ᵇ. Fibrous roots in channel	3	[✓ 2]	1	0
21ᵇ. Rooted plants in channel	3	[✓ 2]	1	0
22. Crayfish	[✓ 0]	0.5	1	1.5
23. Bivalves	[✓ 0]	1	2	3
24. Fish	[✓ 0]	0.5	1	1.5
25. Amphibians	0	[✓ 0.5]	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	[✓ 1.5]
27. Filamentous algae; periphyton	[✓ 0]	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	[✓ 1]	1.5
29ᵇ. Wetland plants in streambed	FAC = 0.5; FACW = [✓ 0.75]; OBL = 1.5 SAV = 2.0; Other = 0			

ᵇ Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

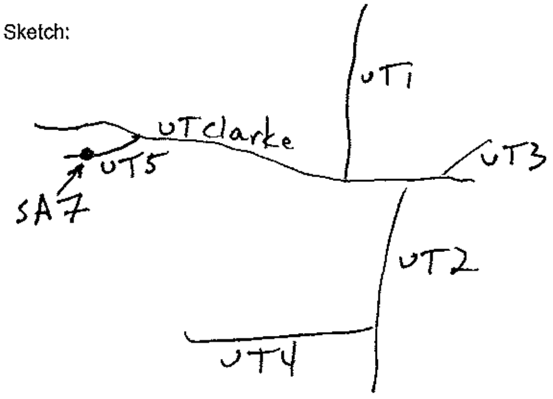
Notes: (use back side of this form for additional notes.)

Upstream portion more stable; downstream portion downcut to saprolite

25. tadpoles

26. Abundant benthos: damsel flies larvae
dragon fly larva
midges
isopods

Sketch:



APPENDIX 4

REFERENCE SITE PHOTOGRAPHS

1-1

Reference Piedmont/Mountain Bottomland Forest community at Suther (Dutch Buffalo Creek) Site Cabarrus County, NC

1-2

Reference Piedmont/Mountain Bottomland Forest community at Suther (Dutch Buffalo Creek) Site Cabarrus County, NC

	UT Clarke Creek Stream and Wetland Restoration Project Mecklenburg County, North Carolina	Date: January 2011 JJG Project No.: 03060006
	Appendix 4. Reference Site Photographs	**Sheet PH-1**

2-1

UT Clarke Creek Reference Reach: Riffle

2-2

UT Clarke Creek Reference Reach: Pool

	UT Clarke Creek Stream and Wetland Restoration Project Mecklenburg County, North Carolina	Date: January 2011 Project No.: 03060006
	Appendix 4. Reference Site Photographs	**Sheet PH-2**

3-1

UT 1 Reference Reach: Riffle

3-2

UT 1 Reference Reach: Pool

UT Clarke Creek Stream and
Wetland Restoration Project
Mecklenburg County, North Carolina

Date:	January 2011
Project No.:	03060006

Appendix 4. Reference Site Photographs

Sheet PH-3

APPENDIX 5

REFERENCE SITE USACE ROUTINE WETLAND DETERMINATION DATA FORMS

Data Form
Routine Wetland Determination

Job Number: **3060002**
City: **Concord**
Wetland Data Point: **B-1**

Project/Site: **Dutch Buffalo Creek Stream and Wetland Restoration**
Applicant/Owner: **NCEEP**
Investigator: **BF**

Date: **December 11, 2006**
County: **Cabarrus**
State: **NC**

[X] Do normal circumstances exist on the site?
[ ] Have vegetation, soils, or hydrology been disturbed?
[ ] Is the area a potential problem area?

Community ID: **PFO1B/E**
Station ID:
Plot ID:

Vegetation

Dominant	Species	Common Name	% Cover	Indicator
Herbaceous				
X	*Carex spp*	sedge species		FAC - OBL
X	*Boehmeria cylindrica*	False-Nettle,Small-Spike		FACW+
X	*Juncus effusus*	Rush,Soft		FACW+
X	*Arundinaria gigantea*	Cane,Giant		FACW
Shrub				
X	*Cornus amomum*	Dogwood,Silky		FACW+
X	*Lindera benzoin*	Spicebush,Northern		FACW
Tree				
X	*Platanus occidentalis*	Sycamore,American		FACW-
X	*Betula nigra*	Birch,River		FACW
X	*Liquidambar styraciflua*	Gum,Sweet		FAC+
X	*Quercus bicolor*	Oak,Swamp White		FACW+
X	*Quercus phellos*	Oak,Willow		FACW-
X	*Quercus michauxii*	Oak,Swamp Chestnut		FACW-
X	*Ulmus americana*	Elm,American		FACW

% Species that are OBL, FACW, or FAC (except FAC-): **92**

Cowardin Classification:

Remarks

Hydrology

[ ] Recorded Data (describe in remarks)
  [ ] Stream, Lake, or Tide Gage
  [ ] Aerial Photograph
  [ ] Other (describe in remarks)

Field Observations:
  Depth of Surface Water(in.): **NA**
  Depth to Free Water in Pit(in.): **NA**
  Depth to Saturated Soils(in.): **6-8**

Primary Wetland Hydrology Indicators
[X] Inundated
[X] Saturated in upper 12 inches
[X] Water marks
[X] Drift lines
[X] Sediment deposits
[X] Drainage patterns in wetlands

Secondary Hydrology Indicators
[X] Oxidized root channels
[X] Water-stained leaves
[ ] Local soil survey data
[ ] FAC-Neutral test
[ ] Other (explain in remarks)

Remarks

Soils

Depth (in.)	Hor.	Matrix Color	Mottle / 2nd Mottle Color	Abundance	Contrast	Texture, Structure, etc.
0-12	A/B	10YR 3/2				Sandy Clay Loam
0-12	A/B	10YR 5/2	10YR 4/4			Sandy Clay Loam

Hydric Soils Indicators
[ ] Histosol
[ ] Histic Epipedon
[ ] Sulfidic Odor
[ ] Probable Aquatic Moist Regime
[X] Reducing Conditions
[X] Gleyed or Low-Chroma Colors

[ ] Concretions
[ ] High Organic % in Surface Layer
[ ] Organic Streaking
[ ] Listed on Local Hydric Soils List
[ ] Listed on National Hydric Soils List
[ ] Other (explain in remarks)

Unit Name:
Drainage Class:

Taxonomy:
[ ] Field Observations match map

Remarks

Wetland Determination

[X] Hydrophytic Vegetation Present
[X] Hydric Soils Present
[X] Wetland Hydrology Present

[X] This Data Point is a Wetland

Remarks

APPENDIX 6

REFERENCE SITE NCDWQ STREAM CLASSIFICATION FORMS

NC Division of Water Quality –Methodology for Identification of Intermittent and Perennial Streams and Their Origins v. 4.11

NC DWQ Stream Identification Form Version 4.11

Date: 9/17/10	**Project/Site:** U.T. Clarke Creek Reference Reach	**Latitude:** 35° 21' 29"N
Evaluator: A. Karagosian	**County:** Mecklenburg	**Longitude:** -80° 48' 27"W
Total Points: 41.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** Derita, NC *e.g. Quad Name*:

A. Geomorphology (Subtotal = 21)	Absent	Weak	Moderate	Strong
1ª Continuity of channel bed and bank	0	1	2	[✓ 3]
2. Sinuosity of channel along thalweg	0	1	[✓ 2]	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	[✓ 3]
4. Particle size of stream substrate	0	1	[✓ 2] →	3
5. Active/relict floodplain	0	1	[✓ 2]	3
6. Depositional bars or benches	0	1	[✓ 2]	3
7. Recent alluvial deposits	0	1	[✓ 2]	3
8. Headcuts	[✓ 0]	1	2	3
9. Grade control	0	[✓ 0.5]	1	1.5
10. Natural valley	0	0.5	1	[✓ 1.5]
11. Second or greater order channel	No = 0		Yes = [✓ 3]	

ª artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 9)				
12. Presence of Baseflow	0	1	2	[✓ 3]
13. Iron oxidizing bacteria	[✓ 0]	1	2	3
14. Leaf litter	1.5	[✓ 1]	0.5	0
15. Sediment on plants or debris	0	0.5	[✓ 1]	1.5
16. Organic debris lines or piles	0	0.5	[✓ 1]	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = [✓ 3]	

C. Biology (Subtotal = 11.5)				
18. Fibrous roots in streambed	[✓ 3]	2	1	0
19. Rooted upland plants in streambed	[✓ 3]	2	1	0
20. Macrobenthos (note diversity and abundance)	0	[✓ 1]	2	3
21. Aquatic Mollusks	~~0~~	[✓ 1]	2	3
22. Fish	0	0.5	[✓ 1]	1.5
23. Crayfish	0	0.5	[✓ 1]	1.5
24. Amphibians	0	0.5	[✓ 1]	1.5
25. Algae	0	[✓ 0.5]	1	1.5
26. Wetland plants in streambed	N/A	FACW = 0.75; OBL = 1.5 Other = 0		

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: macrobenthos - few waterstriders; isopods; one damselfly nymph
mollusks: one fingernail clam ; fish: two gambusia

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 9/17/10	**Project/Site:** UT Clarke/UT1 Ref. Site	**Latitude:** 35° 21' 34"N
Evaluator: A. Karagosian	**County:** Mecklenburg	**Longitude:** -80° 48' 22"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 35	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* Derita, NC

A. Geomorphology (Subtotal = 21)	Absent	Weak	Moderate	Strong
1ᵃ. Continuity of channel bed and bank	0	1	2	[✓ 3]
2. Sinuosity of channel along thalweg	0	1	[✓ 2]	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	[✓ 2]	3
4. Particle size of stream substrate	0	1	~~2~~	[✓ 3]
5. Active/relict floodplain	0	1	[✓ 2] →	3
6. Depositional bars or benches	0	[✓ 1] →	2	3
7. Recent alluvial deposits	0	1	[✓ 2]	3
8. Headcuts	[✓ 0]	1	2	3
9. Grade control	0	0.5	1	[✓ 1.5]
10. Natural valley	0	0.5	1	[✓ 1.5]
11. Second or greater order channel	No = 0		Yes = [✓ 3]	

ᵃ artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7)				
12. Presence of Baseflow	0	[✓ 1]	2	3
13. Iron oxidizing bacteria	[✓ 0]	1	2	3
14. Leaf litter	1.5	[✓ 1]	0.5	0
15. Sediment on plants or debris	0	0.5	[✓ 1]	1.5
16. Organic debris lines or piles	0	0.5	[✓ 1]	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = [✓ 3]	

C. Biology (Subtotal = 7)				
18. Fibrous roots in streambed	3	[✓ 2]	1	0
19. Rooted upland plants in streambed	[✓ 3]	2	1	0
20. Macrobenthos (note diversity and abundance)	[✓ 0]	1	2	3
21. Aquatic Mollusks	[✓ 0]	1	2	3
22. Fish	[✓ 0]	0.5	1	1.5
23. Crayfish	0	0.5	[✓ 1]	1.5
24. Amphibians	0	0.5	[✓ 1]	1.5
25. Algae	[✓ 0]	0.5	1	1.5
26. Wetland plants in streambed	N/A	FACW = 0.75; OBL = 1.5 Other = 0		

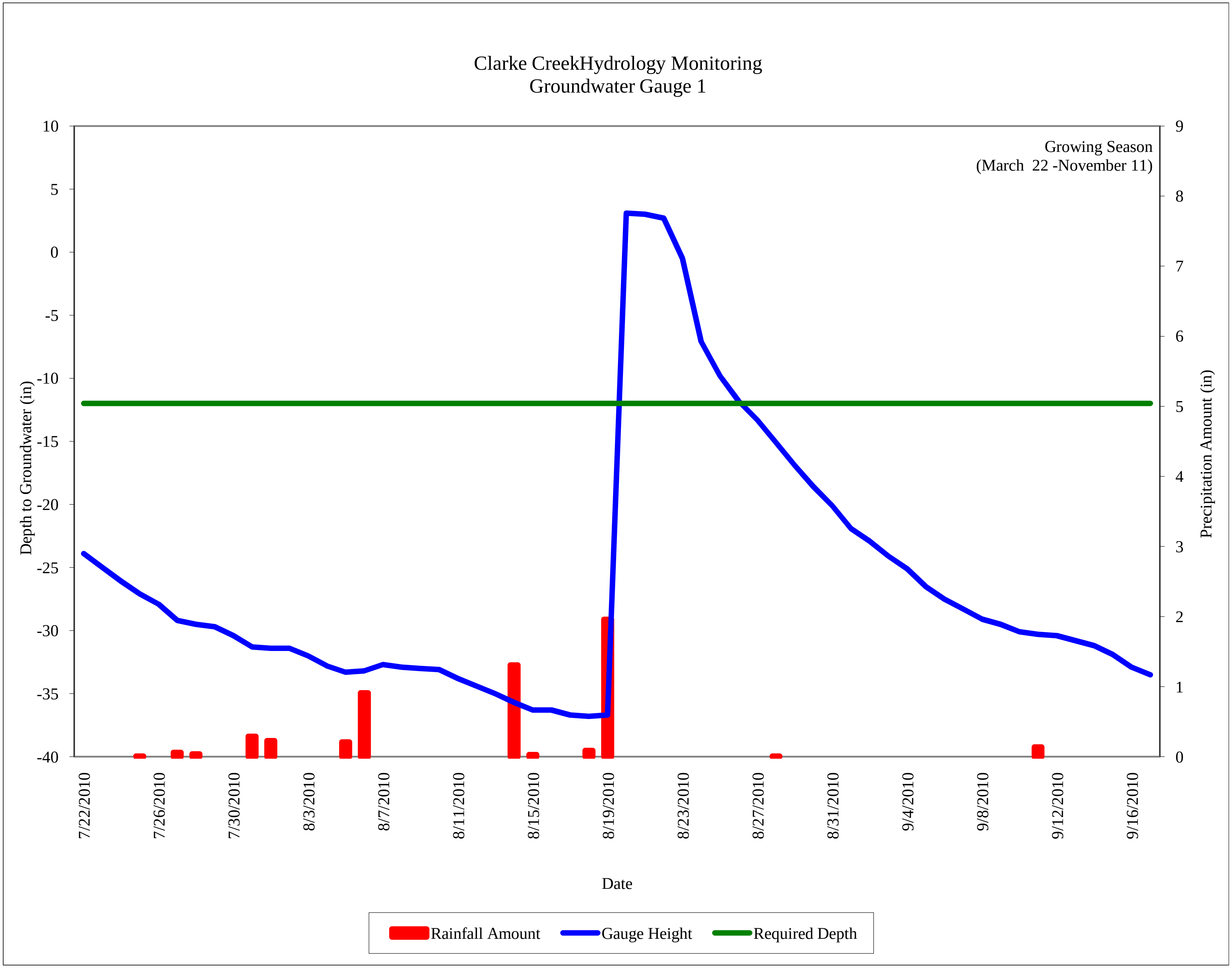
*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: Several Salamanders; 3 crayfish beneath cobbles

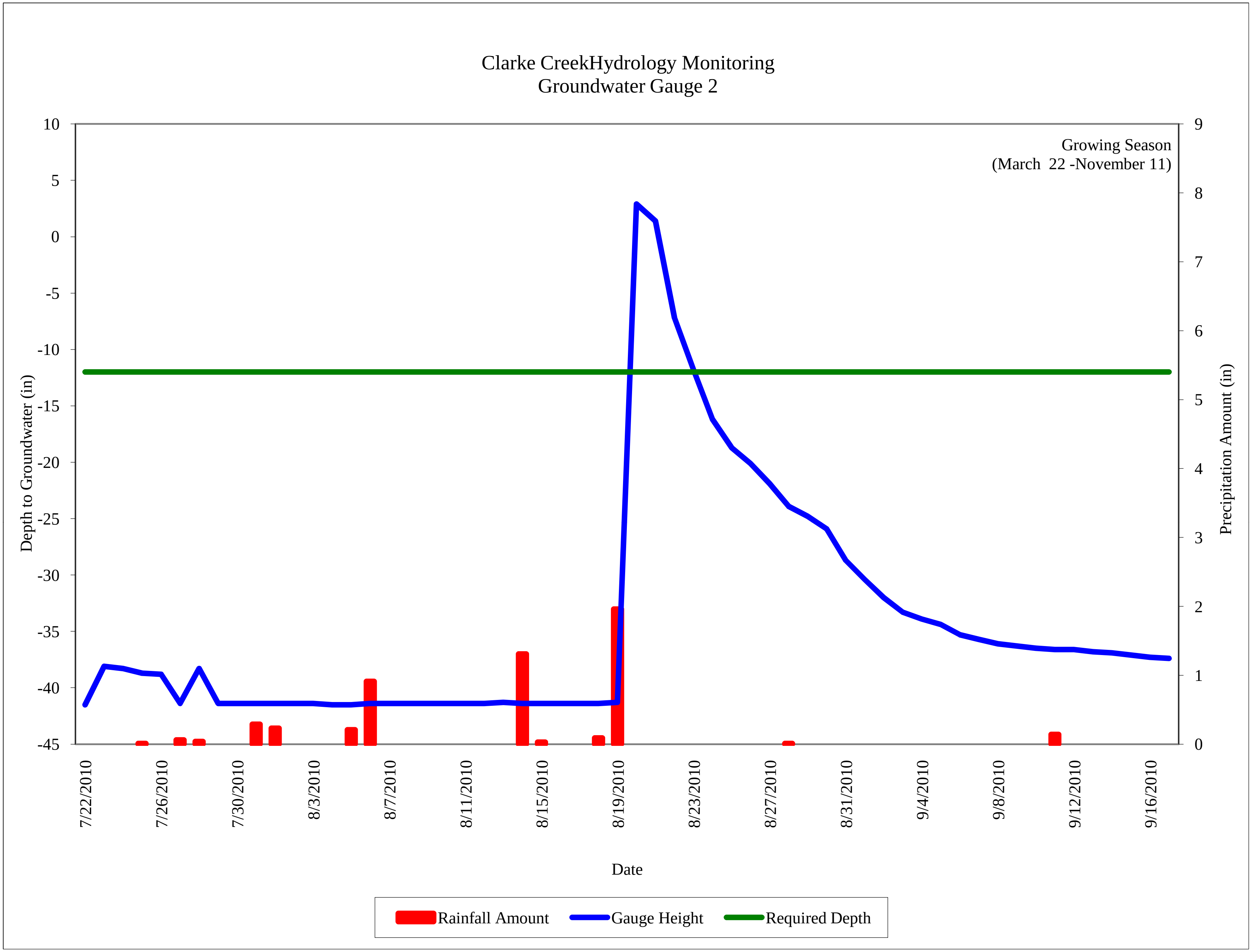
Sketch:

APPENDIX 7

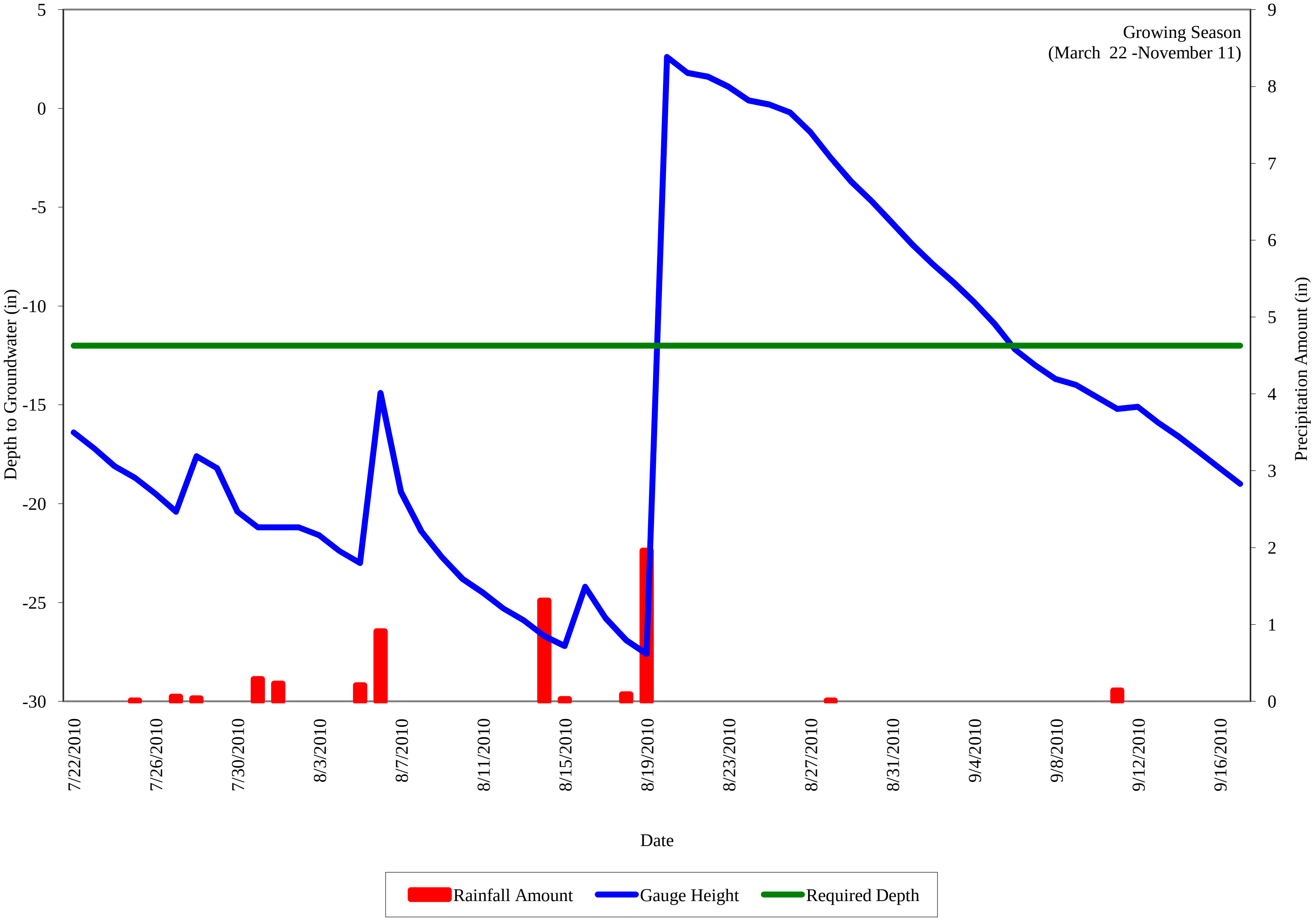
HYDROLOGIC GAUGE DATA SUMMARY, GROUNDWATER AND RAINFALL INFO



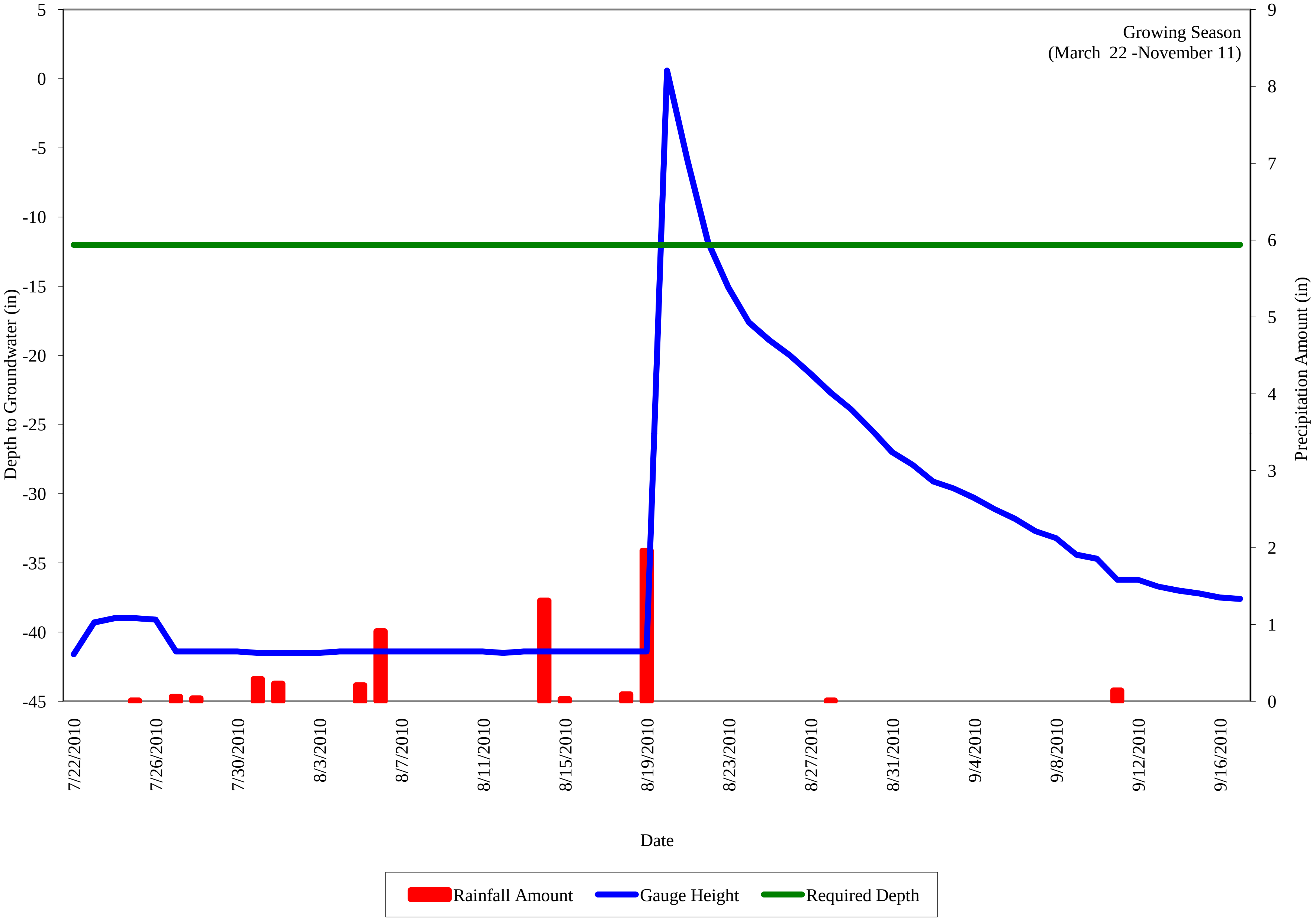
Clarke CreekHydrology Monitoring
Groundwater Gauge 1
Growing Season
(March 22 -November 11)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
Precipitation Amount (in)
9
8
7
6
5
4
3
2
1
0
7/22/2010
7/26/2010
7/30/2010
8/3/2010
8/7/2010
8/11/2010
8/15/2010
8/19/2010
8/23/2010
8/27/2010
8/31/2010
9/4/2010
9/8/2010
9/12/2010
9/16/2010
Date
Rainfall Amount
Gauge Height
Required Depth


Clarke CreekHydrology Monitoring
Groundwater Gauge 2
Growing Season
(March 22 -November 11)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
Precipitation Amount (in)
9
8
7
6
5
4
3
2
1
0
7/22/2010
7/26/2010
7/30/2010
8/3/2010
8/7/2010
8/11/2010
8/15/2010
8/19/2010
8/23/2010
8/27/2010
8/31/2010
9/4/2010
9/8/2010
9/12/2010
9/16/2010
Date
Rainfall Amount
Gauge Height
Required Depth

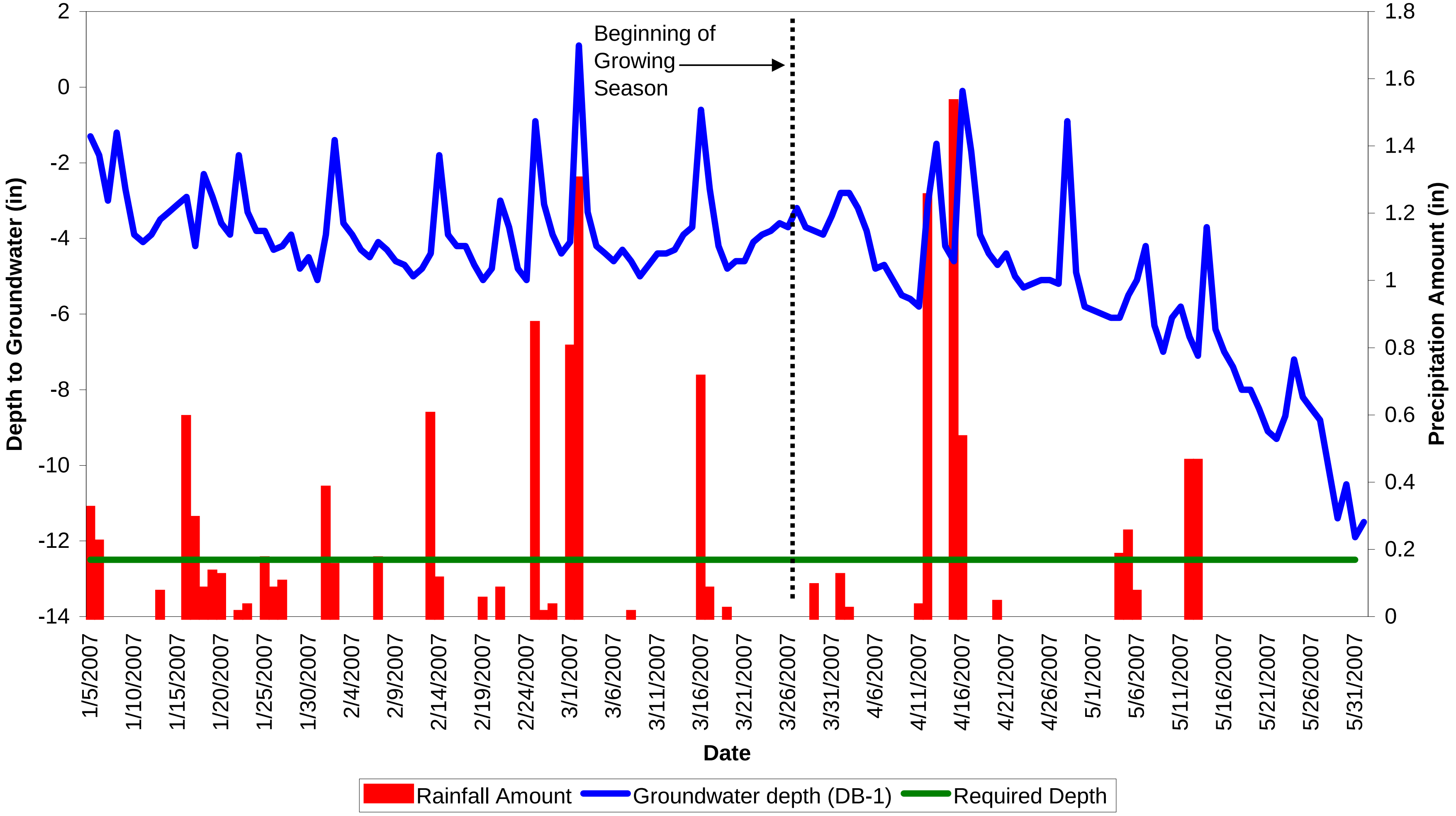
Clarke CreekHydrology Monitoring
Groundwater Gauge 3

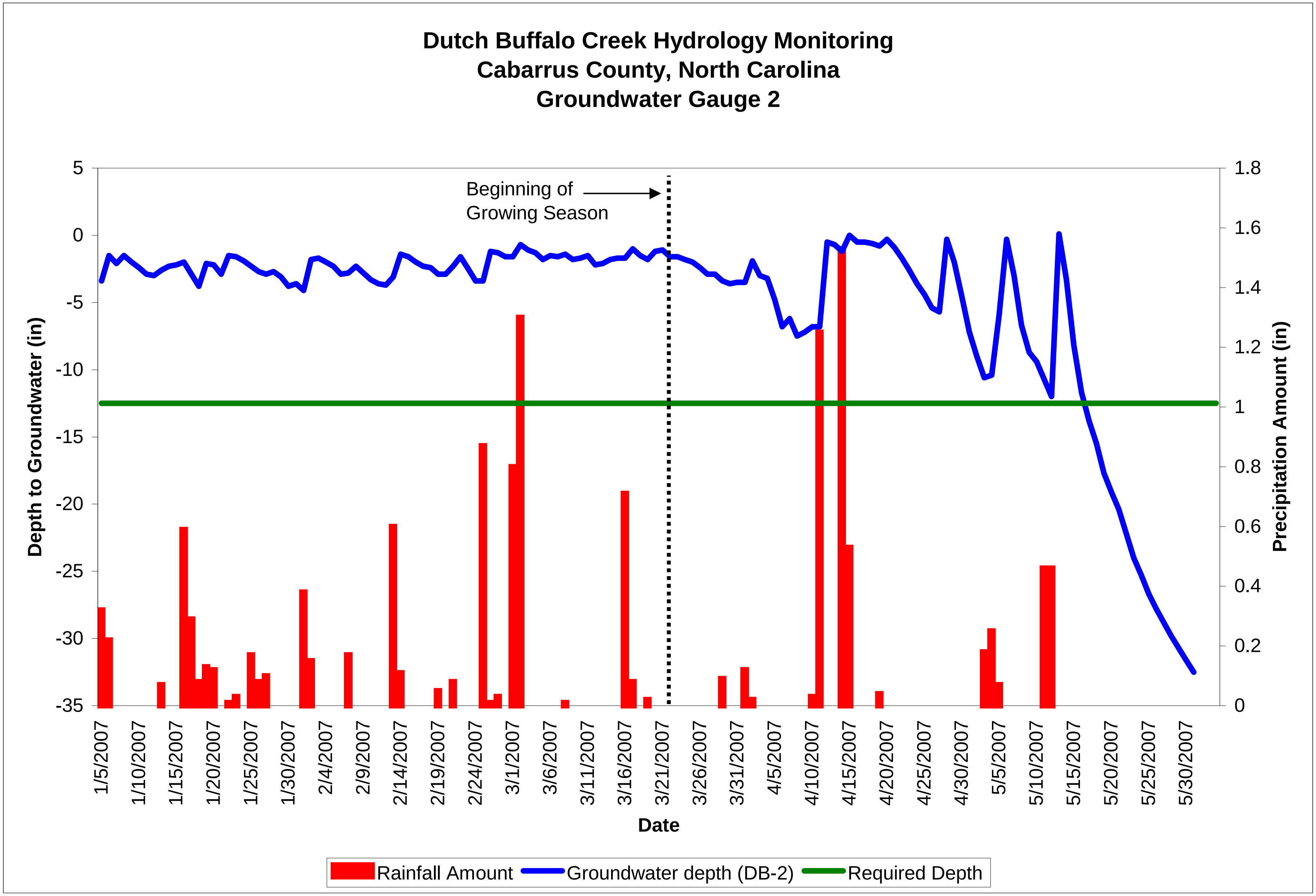


Clarke CreekHydrology Monitoring
Groundwater Gauge 4



Dutch Buffalo Creek Hydrology Monitoring
Cabarrus County, North Carolina
Groundwater Gauge 1




Dutch Buffalo Creek Hydrology Monitoring
Cabarrus County, North Carolina
Groundwater Gauge 2
Beginning of Growing Season
Depth to Groundwater (in)
5
0
-5
-10
-15
-20
-25
-30
-35
Precipitation Amount (in)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1/5/2007
1/10/2007
1/15/2007
1/20/2007
1/25/2007
1/30/2007
2/4/2007
2/9/2007
2/14/2007
2/19/2007
2/24/2007
3/1/2007
3/6/2007
3/11/2007
3/16/2007
3/21/2007
3/26/2007
3/31/2007
4/5/2007
4/10/2007
4/15/2007
4/20/2007
4/25/2007
4/30/2007
5/5/2007
5/10/2007
5/15/2007
5/20/2007
5/25/2007
5/30/2007
Date
Rainfall Amount
Groundwater depth (DB-2)
Required Depth

CONCORD, NORTH CAROLINA

Monthly Total Precipitation (inches)

(311975)

File last updated on Jan 4,
*** Note *** Provisional Data *** After Year/Month 201009
a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR (S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1891	0.00 z	0.00 z	5.90	4.35	4.75 s	3.36 a	5.20 t	9.00 p	0.55 z	1.20 y	0.00 z	2.30 y	13.61
1892	11.50	4.21	0.00 z	0.00 z	5.00 x	10.20 a	7.05	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	32.96
1893	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1894	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1895	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1896	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1897	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1898	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1899	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1900	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1901	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1902	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1903	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1904	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1905	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1906	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1907	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1908	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1909	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1910	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1911	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1912	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1913	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1914	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1915	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1916	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1917	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1918	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1919	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00

1920	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1921	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1922	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1923	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1924	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1925	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1926	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1927	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1928	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1929	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1930	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1931	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1932	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00
1933	0.00 z	0.00 z	4.27	1.77	2.80	1.99	1.79	7.42	2.33	1.90	0.94	2.11	27.32
1934	1.53	4.05	3.89	3.57	4.79	3.81	4.33	3.10	9.58	3.77	3.87	2.14	48.43
1935	2.85	2.64	7.83	4.61	3.58	1.11	6.28	2.49	5.63	3.26	4.33	2.67	47.28
1936	10.70	4.70	5.60	7.68	0.01	5.19	7.59	2.88	3.30	9.01	1.63	5.63	63.92
1937	7.76	2.93	1.88	6.19	2.15	2.70	3.88	7.66	1.71	3.50	2.16	2.40	44.92
1938	2.30	0.88	3.33	3.94	2.82	5.88	6.59	0.73	4.30	1.96	3.74	3.75	40.22
1939	3.20	7.09	5.42	2.17	1.88	2.00	4.57	6.81	1.10	1.82	1.04	2.81	39.91
1940	3.47	3.32	2.68	2.49	7.65	1.38	3.08	6.79	1.36	1.13	5.48	2.07	40.90
1941	1.68	1.57	3.59	3.70	1.66 a	3.97	9.66	2.71	2.57	1.15	0.50	4.66	37.42
1942	1.99	3.29	6.20	1.12	6.00	2.47	3.49	3.19	6.36	1.87	1.87	4.37	42.22
1943	5.15	1.33	5.17	3.21	6.47	7.64	4.66	6.48	2.48	0.48	1.01	3.12	47.20
1944	3.83	6.15	8.05	4.50	0.74	1.43	6.78	3.32	9.16	3.38	3.09	2.49	52.92
1945	2.04	5.05	2.34	5.08	1.79	2.49	5.50	2.64	11.83	1.89	1.85	7.20	49.70
1946	3.12	3.58	2.33	4.99	3.27	0.65	4.08	5.70	3.84	5.63	1.94	1.48	40.61
1947	7.20	1.31	3.38	1.78	2.12	3.82	6.53	5.53	5.74	6.96	6.90	1.94	53.21
1948	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	0.00 z	9.97	2.62	3.25	9.26	4.27	29.37
1949	3.40	3.54	3.15	5.28	4.96	1.40	4.98	6.41	1.48	4.56	2.52	1.48	43.16
1950	3.36	1.24	4.57	1.42	3.90	2.37	4.67	1.68	4.16	2.13	2.07	2.59	34.16
1951	1.24	1.29	3.59	5.39	0.55	4.96	3.28	1.91	3.79	0.45	3.07	5.20	34.72
1952	3.11	4.42	9.09	2.17	3.22	2.93	4.37	7.87	2.03	0.93	1.40	4.21	45.75
1953	3.90	6.46	4.84	2.87	2.75	5.73	1.69	3.93	5.38	0.06	0.75	5.47	43.83
1954	6.77	1.16	5.83	4.01	1.98	4.99	7.17	3.67	0.53	5.64	3.01	3.78	48.54
1955	2.58	3.80	3.13	4.41	5.09	2.36	6.13	3.19	2.55	7.57	2.28	0.43	43.52
1956	1.35	5.32	3.94	2.77	4.17	2.63	11.06	2.75	8.19	3.21	1.30	3.60	50.29
1957	2.20	5.12	3.62	2.52	3.66	6.07	3.44	3.45	4.21	2.75	7.52	2.28	46.84
1958	3.97	3.50	2.65	9.02	2.51	1.67	4.86	5.27	1.17	2.77	1.44	2.90	41.73
1959	3.04	3.45 a	4.47	4.91	3.10	3.84	6.79	9.80	5.51	6.96	1.54	2.52	55.93
1960	4.59	6.79	5.24	3.92	3.68	6.45	2.91	6.55	3.25	3.00 a	1.25	1.84	49.47
1961	2.91	5.10	4.18	4.64	5.23	5.41	3.79	3.46	0.08	0.72	1.91	5.97	43.40
1962	7.47	2.87 a	3.88	6.13	2.42	4.29	1.27	1.94 a	6.37	2.66	6.42	3.07	48.79
1963	2.71	3.30	5.44	2.41	2.68	3.57	5.04	3.35	3.40	0.05	4.14	2.71	38.80
1964	5.68	4.69	4.13	4.93	0.97	5.11	6.36	6.76	1.98	8.82	1.74	3.49	54.66
1965	1.93	3.01	6.22	3.22	1.95	6.92	8.19	3.05	2.41	2.13	2.53	0.59	42.15

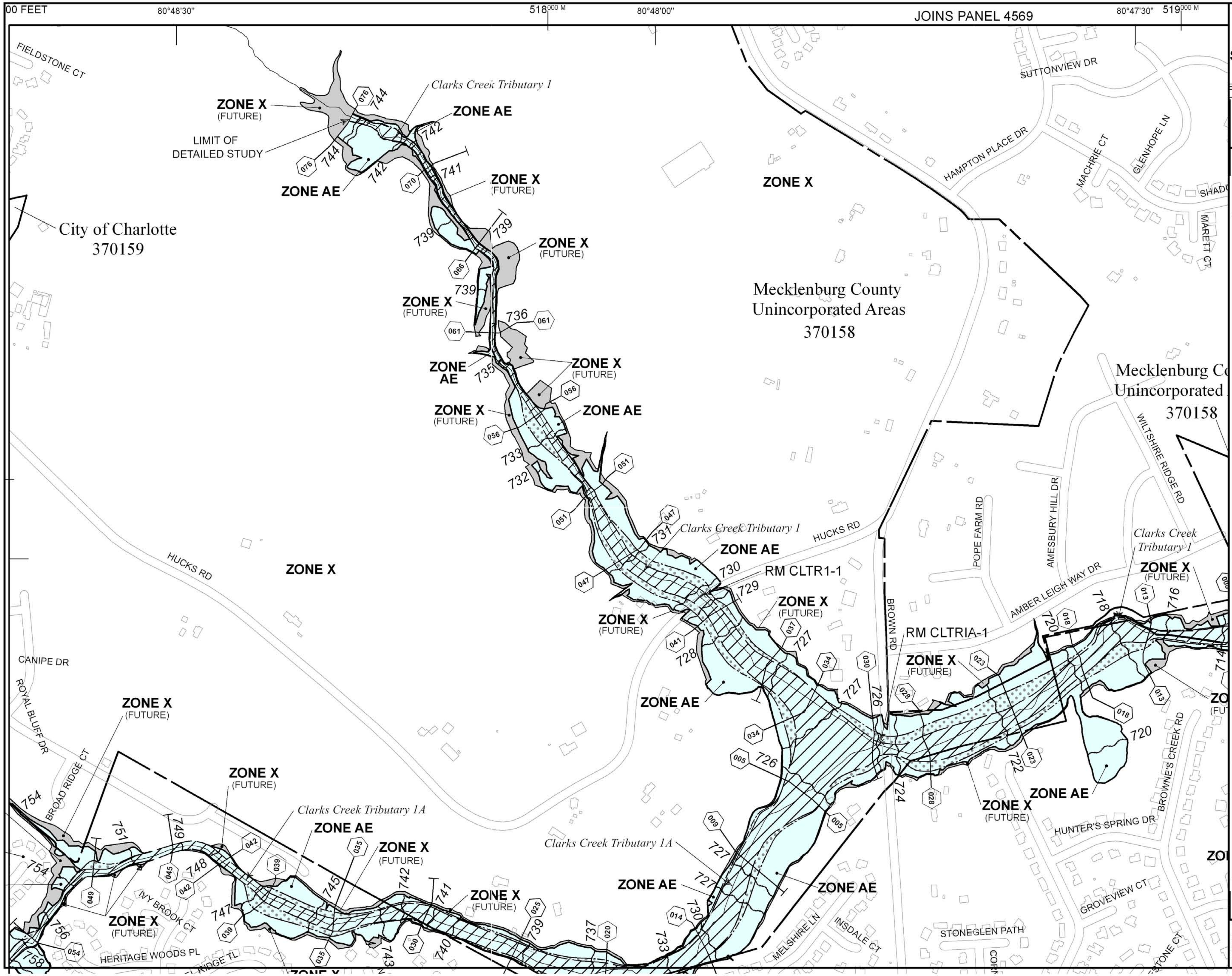
1966	4.70	4.56	3.12	1.56	2.44	1.31	2.08	5.94	4.32	3.16	1.05	2.42	36.66
1967	1.98	3.87	2.34	1.53	4.36	3.27	3.26	4.81	1.77	0.66	2.42	5.70	35.97
1968	5.42	0.68	4.55	2.57	2.93	4.19	7.28	1.77	0.49	4.37	3.91	2.17	40.33
1969	2.16	4.82	4.06	3.14	1.19	3.86	5.19	8.41	5.19	0.90	1.21	4.61	44.74
1970	1.56	3.56	3.25	2.63	2.87	3.94	8.60	5.29	1.21	5.49	1.38	2.90	42.68
1971	2.52	3.72	4.43	2.39	6.12	6.64	8.01	4.29	2.66	7.88	2.60	2.46	53.72
1972	4.74	3.33	2.83	2.49	6.23	5.47	5.10	1.29	4.92	1.72	5.40	5.20	48.72
1973	4.17	4.34	4.61	4.94	3.66	5.96	3.40	2.13	2.45	3.13	0.83	6.68	46.30
1974	5.49	4.91	3.40	4.49	5.89	3.87	3.81	4.44	5.51	0.74	2.25	5.43	50.23
1975	6.01	3.09	6.99	2.93	10.29	6.70	9.20	2.34	8.75	3.19	2.34	2.95	64.78
1976	2.91	1.61	3.29	0.92	4.00	4.73	2.53	1.45	3.33	10.91	2.91	6.04	44.63
1977	2.56	1.29	7.18	1.07	2.46	3.71	1.21	1.89	7.45	4.96	3.43	2.62	39.83
1978	8.00	0.38	5.11	3.25	4.41	3.74	3.23	6.30	2.22	1.20	3.94	3.34	45.12
1979	5.39	5.80	5.09	5.58	3.64	5.44	4.59	5.12	8.53	3.13	4.68	1.31	58.30
1980	4.33	0.99	7.63	2.05	5.15	1.51	3.90	1.18	3.97	3.66	3.49	1.09	38.95
1981	0.44	3.74	2.06	1.21	4.24	5.66	5.65	1.61	5.88	3.18	0.65	4.35	38.67
1982	5.72	4.99	1.51	3.94	8.00	9.61	2.18	2.90	1.17	4.80	2.62	4.27	51.71
1983	2.46	5.56	6.41	3.50	1.97	2.42	0.51	2.21	1.25	2.74	4.08	7.85	40.96
1984	4.17	7.00	6.34	4.44	5.48	2.08	15.02	1.93	0.01	1.85	1.75	2.66	52.73
1985	3.75	5.28	0.82	2.14	4.81	5.09	3.91	6.23	0.00	4.12	7.81	1.43	45.39
1986	1.34	1.23	2.55	1.12	1.73	0.32	4.39	4.91	1.25	3.14	3.76	3.33	29.07
1987	4.85	3.51	4.73	3.23	0.64	3.23	2.05	4.75	8.42	0.64	4.83	3.77	44.65
1988	3.62	1.66	3.31	2.38	2.20	2.58	3.47	9.18	4.79	2.76	4.70	1.06	41.71
1989	1.91	4.58	5.49	3.44	5.38	4.51	2.39	3.11	7.02	5.83	3.23	2.93	49.82
1990	4.32	5.85	4.13	2.81	8.47	1.20	4.56	2.25	0.63	15.44	3.19	3.15	56.00
1991	6.01	1.21	7.50	5.27	1.79	3.50	6.35	3.76	2.97	0.63	1.97	3.46	44.42
1992	2.86	3.67	4.25	5.40	4.63	7.12	1.35	2.85	4.68	6.90	7.37	2.40	53.48
1993	6.47	3.22	8.99	3.68	2.50	4.74	4.08	4.12	3.38	2.14	2.96	4.40	50.68
1994	4.90	2.76	6.19	3.93	1.77	9.72	6.61	4.95	2.42	3.65	2.90	1.49	51.29
1995	4.38	5.93	2.75	0.81	3.94	7.07	3.76	10.48	3.78	5.95	6.10	1.25	56.20
1996	4.81	2.40	3.44	3.94	2.40	3.77	5.69	4.40	5.26	3.18	2.88	2.76	44.93
1997	3.50	3.57	4.33	7.23	1.43	3.31	11.82	1.02	6.25	4.91	4.19	4.08	55.64
1998	7.08	4.04	3.26	5.40	2.23	2.57	2.58	1.32	5.31	1.24	2.35	3.96	41.34
1999	4.92	2.11	1.38	5.15	1.06	3.51	2.68	1.86	6.03	5.80	1.74	1.77	38.01
2000	4.10	2.50	4.29	5.46	3.33	0.93	3.81	3.26	9.54	0.00	2.87	0.93	41.02
2001	1.79	2.21	5.52	1.08	3.18	7.04	4.50	5.85	3.23	0.38	0.62	2.12	37.52
2002	4.75	1.31	4.26	1.15	1.90	0.74	3.76	2.39	4.90	8.20	4.24	4.98	42.58
2003	1.58	3.69	8.25	9.89	9.94	7.83	8.07	3.98	1.65	1.97	1.17	2.63	60.65
2004	1.29	3.99	0.81	1.75	3.18	6.16	7.34	4.39	11.23	1.81	3.78	0.71 b	46.44
2005	1.54	2.87	4.60	2.88	1.66	4.78	6.46	3.77	0.18	4.70	3.12	4.99	41.55
2006	2.21	1.12	1.91	3.44	1.16	7.03	3.03	6.84	3.79	4.21	6.40	2.46	43.60
2007	3.29	3.05	3.44	3.91	2.19	2.63	3.88	0.39	0.38	4.65	0.81	3.69	32.31
2008	1.41	2.86	3.90	4.63	3.60	3.49	6.43	11.35	5.24	1.76	1.55	4.70	50.92
2009	2.67	2.09	6.28	3.07	4.24	3.88	12.91	2.13	1.70	2.26	6.08	5.85	53.16
2010	6.31	3.68	3.72	1.44	3.87	4.02	5.54	5.34	2.47	0.82 e	0.84 e	0.00 z	38.05

Period of Record Statistics

MEAN	3.88	3.45	4.41	3.60	3.49	4.12	5.10	4.26	3.95	3.46	3.04	3.29	45.89
S.D.	2.13	1.64	1.83	1.82	2.07	2.18	2.69	2.45	2.74	2.73	1.93	1.61	7.12
SKEW	1.15	0.16	0.50	0.88	1.13	0.58	1.18	0.84	0.79	1.58	1.06	0.55	0.35
MAX	11.50	7.09	9.09	9.89	10.29	10.20	15.02	11.35	11.83	15.44	9.26	7.85	64.78
MIN	0.44	0.38	0.81	0.81	0.01	0.32	0.51	0.39	0.00	0.00	0.50	0.43	29.07
NO YRS	77	77	78	78	77	79	78	78	78	78	78	77	75

APPENDIX 8

HEC-RAS ANALYSIS



GRID NORTH

SCALE 1" = 500' (1 : 6,000)

250 500 750 1,000 FEET

METERS

PANEL 4568J

FIRM

FLOOD INSURANCE RATE MAP

NORTH CAROLINA

PANEL 4568

(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	CID No.	PANEL	SUFFIX
CHARLOTTE, CITY OF	370159	4568	J
MECKLENBURG COUNTY	370158	4568	J

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

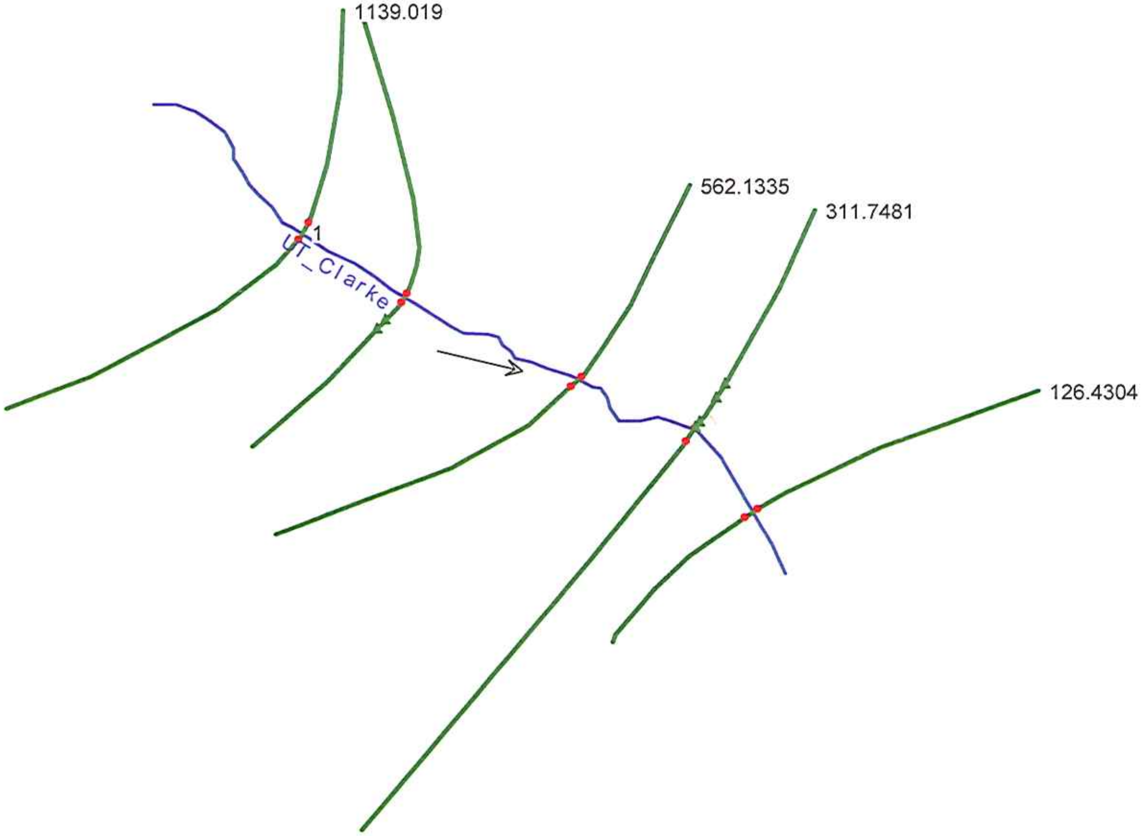
EFFECTIVE DATE
MARCH 2, 2009

MAP NUMBER
3710456800J

Charlotte-Mecklenburg STORM WATER Services

State of North Carolina
Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov


1139.019
1
UT_Clarke
562.1335
311.7481
126.4304

HEC-RAS Plan: Existing River: UT_Clarke Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width	Shear Chan
			(cfs)	(ft)	(ft)	(ft/s)	(ft)	(lb/sq ft)
1	1139.019	2-YR	88.00	743.15	746.77	3.96	11.84	0.82
1	1139.019	5-YR	159.00	743.15	747.75	4.28	49.92	0.93
1	1139.019	10-YR	222.00	743.15	748.14	4.38	122.82	0.96
1	1139.019	25-YR	320.00	743.15	748.44	4.73	154.32	1.08
1	1139.019	50-YR	407.00	743.15	748.55	5.43	161.41	1.40
1	1139.019	100-YR	507.00	743.15	748.77	5.57	170.50	1.43
1	920.9172	2-YR	88.00	740.52	742.97	6.79	7.26	2.55
1	920.9172	5-YR	159.00	740.52	744.17	6.61	13.58	2.34
1	920.9172	10-YR	222.00	740.52	744.79	6.61	16.57	2.23
1	920.9172	25-YR	320.00	740.52	745.56	6.29	77.44	1.92
1	920.9172	50-YR	407.00	740.52	745.95	5.84	178.94	1.60
1	920.9172	100-YR	507.00	740.52	746.09	6.37	188.22	1.87
1	562.1335	2-YR	142.00	738.11	741.26	3.17	19.72	0.40
1	562.1335	5-YR	255.00	738.11	742.29	3.75	24.88	0.52
1	562.1335	10-YR	351.00	738.11	742.94	4.15	30.92	0.61
1	562.1335	25-YR	500.00	738.11	743.59	4.56	208.12	0.72
1	562.1335	50-YR	632.00	738.11	744.05	4.36	227.35	0.63
1	562.1335	100-YR	782.00	738.11	744.48	4.17	247.63	0.56
1	311.7481	2-YR	142.00	736.94	740.44	3.00	25.36	0.38
1	311.7481	5-YR	255.00	736.94	741.58	3.26	29.17	0.39
1	311.7481	10-YR	351.00	736.94	742.35	3.33	116.25	0.38
1	311.7481	25-YR	500.00	736.94	743.07	3.42	161.53	0.38
1	311.7481	50-YR	632.00	736.94	743.56	3.46	192.93	0.37
1	311.7481	100-YR	782.00	736.94	744.04	3.48	208.35	0.36
1	126.4304	2-YR	142.00	736.78	739.84	3.15	18.49	0.39
1	126.4304	5-YR	255.00	736.78	741.03	3.66	24.40	0.48
1	126.4304	10-YR	351.00	736.78	741.82	3.88	46.34	0.53
1	126.4304	25-YR	500.00	736.78	742.50	4.36	79.23	0.63
1	126.4304	50-YR	632.00	736.78	742.95	4.69	89.46	0.70
1	126.4304	100-YR	782.00	736.78	743.40	5.01	98.02	0.77

HEC-RAS Plan: Proposed River: UT_Clarke Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width	Shear Chan
			(cfs)	(ft)	(ft)	(ft/s)	(ft)	(lb/sq ft)
1	1139.019	2-YR	88.00	743.15	746.17	3.01	26.51	0.53
1	1139.019	5-YR	159.00	743.15	746.73	3.45	34.40	0.66
1	1139.019	10-YR	222.00	743.15	747.02	3.93	39.17	0.81
1	1139.019	25-YR	320.00	743.15	747.34	4.65	56.40	1.06
1	1139.019	50-YR	407.00	743.15	747.46	5.53	66.11	1.48
1	1139.019	100-YR	507.00	743.15	747.77	5.77	100.99	1.53
1	920.9172	2-YR	88.00	740.52	742.52	5.85	17.65	2.06
1	920.9172	5-YR	159.00	740.52	743.07	6.50	28.80	2.37
1	920.9172	10-YR	222.00	740.52	743.44	6.95	40.01	2.48
1	920.9172	25-YR	320.00	740.52	743.94	7.37	54.64	2.56
1	920.9172	50-YR	407.00	740.52	744.50	6.94	67.15	2.10
1	920.9172	100-YR	507.00	740.52	744.74	7.68	72.60	2.50
1	562.1335	2-YR	142.00	738.11	740.57	2.94	36.76	0.35
1	562.1335	5-YR	255.00	738.11	741.62	3.13	49.95	0.35
1	562.1335	10-YR	351.00	738.11	742.38	3.23	56.05	0.34
1	562.1335	25-YR	500.00	738.11	743.09	3.73	77.90	0.43
1	562.1335	50-YR	632.00	738.11	743.56	4.29	211.52	0.55
1	562.1335	100-YR	782.00	738.11	744.06	4.22	233.37	0.51
1	311.7481	2-YR	142.00	736.94	740.25	1.81	69.56	0.12
1	311.7481	5-YR	255.00	736.94	741.44	1.90	93.41	0.12
1	311.7481	10-YR	351.00	736.94	742.24	2.03	142.79	0.13
1	311.7481	25-YR	500.00	736.94	742.96	2.26	186.19	0.15
1	311.7481	50-YR	632.00	736.94	743.46	2.42	207.03	0.17
1	311.7481	100-YR	782.00	736.94	743.94	2.55	216.80	0.18
1	126.4304	2-YR	142.00	736.78	739.84	3.15	18.49	0.39
1	126.4304	5-YR	255.00	736.78	741.03	3.66	24.40	0.48
1	126.4304	10-YR	351.00	736.78	741.82	3.88	46.34	0.53
1	126.4304	25-YR	500.00	736.78	742.50	4.36	79.23	0.63
1	126.4304	50-YR	632.00	736.78	742.95	4.69	89.46	0.70
1	126.4304	100-YR	782.00	736.78	743.40	5.01	98.02	0.77

APPENDIX 9

CATEGORICAL EXCLUSION FORM

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information

Project Name:	UT Clarke Creek Stream and Wetland Restoration
County Name:	Mecklenburg
EEP Number:	92500
Project Sponsor:	
Project Contact Name:	Robin Dolin
Project Contact Address:	1652 Mail Service Center, Raleigh, NC 27699-1652
Project Contact E-mail:	robin.dolin@ncdenr.gov
EEP Project Manager:	Robin Dolin

Project Description

For Official Use Only

Reviewed By:

Date

EEP Project Manager

Conditional Approved By:

Date

For Division Administrator
FHWA

☐ **Check this box if there are outstanding issues**

Final Approval By:

7-23-10

Date

For Division Administrator
FHWA

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects

Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information

Project Name:	UT Clarke Creek Stream and Wetland Restoration
County Name:	Mecklenburg
EEP Number:	92500
Project Sponsor:	
Project Contact Name:	Robin Dolin
Project Contact Address:	1652 Mail Service Center, Raleigh, NC 27699-1652
Project Contact E-mail:	robin.dolin@ncdenr.gov
EEP Project Manager:	Robin Dolin

Project Description

UT Clarke Creek is located in Mecklenburg Co., N.C. near the Town of Huntersville. The property parcel is owned by Mecklenburg Co. and is referred to as Clark's Creek Nature Preserve. Project streams consist of approximately 3,699 l.f. of existing restorable/enhanceable stream on the site. Stream mitigation effort will occur along the main reach of UT Clarke Creek and 5 unnamed tributaries to the main reach. Two small drainage ditches on the project site appear to have been created at some time in the past for draining wetlands for agricultural purposes. These ditches, which have naturalized and are now considered jurisdictional waters of the U.S., may provide the opportunity for wetland restoration and enhancement. The ditches are identified as Wetland D and include a portion of Wetland E. Three other emergent wetlands (Wetlands A, B, and C) are proposed for preservation.

For Official Use Only

Reviewed By:

Date **EEP Project Manager**

Conditional Approved By:

Date **For Division Administrator FHWA**

☐ **Check this box if there are outstanding issues**

Final Approval By:

Date **For Division Administrator FHWA**

Part 2: All Projects Regulation/Question	Response
Coastal Zone Management Act (CZMA)	
1. Is the project located in a CAMA county?	☐ Yes ☑ No
2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)?	☐ Yes ☐ No ☑ N/A
3. Has a CAMA permit been secured?	☐ Yes ☐ No ☑ N/A
4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program?	☐ Yes ☐ No ☑ N/A
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	
1. Is this a “full-delivery” project?	☐ Yes ☑ No
2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial?	☐ Yes ☐ No ☑ N/A
3. As a result of a limited Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☑ N/A
4. As a result of a Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☑ N/A
5. As a result of a Phase II Site Assessment, are there known or potential hazardous waste sites within the project area?	☐ Yes ☐ No ☑ N/A
6. Is there an approved hazardous mitigation plan?	☐ Yes ☐ No ☑ N/A
National Historic Preservation Act (Section 106)	
1. Are there properties listed on, or eligible for listing on, the National Register of Historic Places in the project area?	☐ Yes ☑ No
2. Does the project affect such properties and does the SHPO/THPO concur?	☐ Yes ☐ No ☑ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☑ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a “full-delivery” project?	☐ Yes ☑ No
2. Does the project require the acquisition of real estate?	☑ Yes ☐ No ☐ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☑ Yes ☐ No ☐ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☐ Yes ☐ No ☑ N/A

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☐ Yes ☑ No
2. Is the site of religious importance to American Indians?	☐ Yes ☐ No ☑ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☑ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☑ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☑ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☑ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☑ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species?	☐ Yes ☑ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☐ Yes ☐ No ☑ N/A
4. Is the project "likely to adversely affect" the species and/or "likely to adversely modify" Designated Critical Habitat?	☐ Yes ☐ No ☑ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☐ Yes ☐ No ☑ N/A
6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination?	☐ Yes ☐ No ☑ N/A

Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as “territory” by the EBCI?	☐ Yes ☑ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project?	☐ Yes ☐ No ☑ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☑ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☑ Yes ☐ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☑ Yes ☐ No ☐ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☑ Yes ☐ No ☐ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☑ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☑ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☑ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☑ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☑ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☑ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☑ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☑ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☑ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☑ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☑ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☑ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☑ N/A

APPENDIX 10

EEP FLOODPLAIN REQUIREMENTS CHECKLIST

Ecosystem Enhancement PROGRAM

CRIME CONTROL & PUBLIC SAFETY NORTH CAROLINA

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. Edward Curtis), NC Floodplain Mapping Unit (attn. John Gerber) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	UT Clarke Creek Stream and Wetland Restoration
Name if stream or feature:	Stream
County:	Mecklenburg
Name of river basin:	Yadkin-Pee Dee River Basin
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Mecklenburg
DFIRM panel number for entire site:	4568
Consultant name:	Jordan, Jones & Goulding
Phone number:	704-527-4106
Address:	309 East Morehead Street, Suite 110 Charlotte, NC 28202

Design Information

Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500'.

The UT Clarke Creek is located in Mecklenburg County, North Carolina near the Town of Huntersville. The property parcel is owned by Mecklenburg County and is referred to as Clark's Creek Nature Preserve. The project streams consist of approximately 4,570 linear feet of existing restorable/enhanceable/preserveable stream on the site. The stream mitigation effort will occur along the main reach of UT Clarke Creek and six unnamed tributaries to the main reach.

Project Components

Project Component or Reach ID	**Existing Feet/Acres**	**Restoration Level***	**Approach**	**Footage or Acreage**	**Stationing**	**Comment**
UT Clarke Creek	1507	E1	P 2/3	1507	00+00-15+87	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 1	723	E1	P 2/3	758	00+00-07+78	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 2	308	E2	P 4	308	04+22-05+99, 07+16-08+47	Planting of native vegetation, removal of invasive vegetation
UT 3	100	E1	P 2/3	100	00+00-01+03	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 4	373	E1	P 2/3	363	01+92-05+65	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 5	119	E1	P2/3	70	03+56-04+75	Creating bankfull bench, regrading bank slopes, installing structures, planting native vegetation
UT 6	1464	P		1464	00+00-14+64	Designated as Preservation
Wetland A	0.085	R		0.0*		Restoring aerial extent of riparian wetland adjacent to stream
Wetland B	0.134	P		0.134		Designate as Preservation
Wetland C	0.057	E		0.057		Includes improving hydrology and vegetation to enhance the riparian wetland adjacent to stream
Wetland D	0.070	R		1.020		Restoring aerial extent of riparian wetland adjacent to stream
Wetland E	0.109	E C		0.109 0.137		Includes improving hydrology and vegetation to enhance the riparian wetland adjacent to stream and create new wetland area

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

☑ Yes ☐ No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☑ Detailed Study

☐ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation:

Check if applies:

☑ AE Zone

  ☑ Floodway

  ☐ Non-Encroachment

  ☐ None

☐ A Zone

  ☐ Local Setbacks Required

  ☐ No Local Setbacks Required

If local setbacks are required, list how many feet:

Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks?

☐ Yes ☑ No

Land Acquisition (Check)

☐ State owned (fee simple)

☑ Conservation easment (Design Bid Build)

☐ Conservation Easement (Full Delivery Project)

Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)

Is community/county participating in the NFIP program?

☑ Yes ☐ No

Note: if community is not participating, then all requirements should be addressed to NFIP (attn: Edward Curtis, (919) 715-8000 x369)

Name of Local Floodplain Administrator: Bill Tingle
Phone Number: 704-336-3734

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☐ No Action

☐ No Rise

☑ Letter of Map Revision

☐ Conditional Letter of Map Revision

☐ Other Requirements

List other requirements:

Comments:

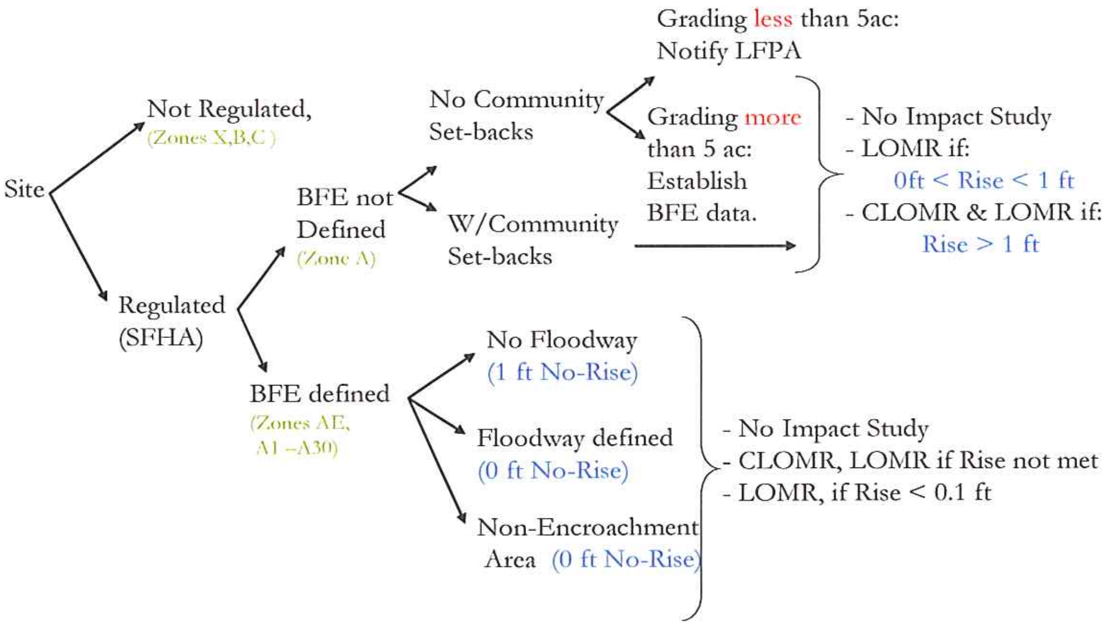
Name: Matt Clabaugh, PE

Signature:

Title: Project Engineer

Date: 9/21/10

Criteria for Flooding Requirements



Summary of Scenarios					
Zone (map)	SFHA	BFE	Floodway Or Non-Encroachment	Comm. Set-back	Floodplain Criteria
X,B,C	No	No	No	No	a. Notify Floodplain Administration b. FP Dev. Permit maybe required
A	Yes	No	No	No	a. If grading < 5 ac, notify LFPA.
A	Yes	No	No	Yes	a. If No-Rise = 0 ft, LOMR not required b. If Rise > 0 ft, LOMR is Required c. If Rise ≥ 1 ft, CLOMR is required
AE, A1-A30	Yes	Yes	No	n/a	a. No-Rise Study b. CLOMR if ≥ 1ft c. LOMR
AE A1-A30	Yes	Yes	Yes	n/a	a. No-Rise Study b. CLOMR if ≥ 0 ft c. LOMR