Candiff Creek Restoration Project
Stream Mitigation Plan
Surry County, North Carolina

Prepared for:

NCDENR - Ecosystem Enhancement Program
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NCEEP Project Number 92767

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Candiff Creek Restoration Project
Mitigation Plan
Surry County, North Carolina

Submitted by Surry Soil and Water Conservation District

Surry Soil and Water Conservation District

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EXECUTIVE SUMMARY

Michael Baker Engineering, Inc., (Baker) proposes to restore 4,109 linear feet (LF) of stream, enhance 1,757 LF (265 LF of Enhancement I and 1,492 LF of Enhancement II), and preserve 1,200 LF of stream along Candiff Creek and two unnamed tributaries. The Candiff Creek Restoration Project (Project) site is located in Surry County, approximately 1.75 miles west of Siloam Township within cataloging unit 03040101, and NC Division of Water Quality (NCDWQ) sub-basin 03-07-02 of the Yadkin Pee-Dee River Basin (see Figure 1). The Candiff Creek Restoration Project is located in a North Carolina Ecosystem Enhancement Program (NCEEP)-Targeted Local Watershed (HU 03040101110060). The purpose of the project is to restore stream functions to areas where the impaired stream channel flows through agriculture fields. A recorded conservation easement consisting of 27.54 acres will protect all stream reaches and riparian buffers in perpetuity. The available hydrology and soil data indicate that there is good potential for the restoration of a productive stream ecosystem.

Based on the Yadkin River Restoration Plan, the principal stressors identified in the Upper Yadkin River Basin include naturally erodible soils and erosion from agriculture. Cattle have had access to the reaches on the Candiff Creek site for many years, and their activities have caused bank erosion. Also, portions of the riparian zones adjacent to the stream have been cleared, further promoting bank erosion.

The proposed project area is described briefly in Table ES-1. The goals for the stream restoration project are as follows:

- Create geomorphically stable conditions along Candiff Creek through the project area,
- Prevent cattle from accessing the project reaches, reducing excessive bank erosion,
- Improve habitat quality in a riffle dominated stream by adding pool/riffle sequences and expanding the floodplain while improving overall ecosystem functionality,
- Improve water quality within the Candiff Creek Restoration Project area through reduction of bank erosion, and reductions in nutrient and sediment loads,
- Stabilize streambanks through installation of in-stream structures and establishing a riparian buffer consisting of native plant species,
- Improve aquatic and terrestrial habitat through increased substrate and in-stream cover, additional woody debris, and reduced water temperature by increasing stream shading, and restored terrestrial habitat,

To accomplish these goals, this project will pursue the following objectives:

- Restore existing incised, eroding, and channelized streams by creating a stable channel with access to its floodplain,
- Improve in-stream habitat by providing a more diverse bedform with riffles and pools, creating deeper pools and areas of water re-aeration, and reducing bank erosion,
- Control invasive species within the project reaches,
- Establish native stream bank and floodplain vegetation protected by a permanent conservation easement to increase stormwater runoff filtering capacity, improve bank stability, shade the stream to decrease water temperature, and provide improved wildlife habitat quality.

Table ES-1 Candiff Creek Site Project Overview

Candiff Creek Mitigation Project -NCEEP Project #92767

Reach	Design Approach	Existing Reach Length (LF)	Design Reach Length (LF)	SMU Credit Ratio	Potential SMUs	Stationing	Comment
Candiff Creek (M1, M2, and M3) & Unnamed Tributaries (UT1 and UT2)[1]							
M1	E II	690	690	2.5:1	276	10+00 to 17+35[2]	Enhancement II applications will involve control of invasive species vegetation, re-establishment of a buffer, and permanent fencing installed outside the easement.
M2	E I	265	265	1.5:1	177	17+35 to 20+00	Stream Enhancement I is proposed for the second reach of the mainstem. Work will include bank sloping, installation of in-stream structures, vegetation planting in the riparian zone, and permanent fencing.
M3	R-PI and PII	3,828	4,109	1:1	4,109	20+00 to 61+09	Restoration would follow Rosgen Priority Levels I and II approaches in order to provide an adequate floodplain and restore appropriate dimension, pattern, and profile.
UT1	E II	485	485	2.5:1	194	14+00 to 18+85	Enhancement II applications will involve control of invasive species vegetation, re-establishment of a buffer, and permanent fencing installed outside the easement.
UT1	P	400	400	5:1	80	10+00 to 14+00	Stream Preservation is proposed for the uppermost section of UT1, beginning at the top of the reach where UT1 flows over the property line and continuing for 400 LF.
UT2	E II	317	317	2.5:1	127	18+00 to 21+62[2]	Enhancement II applications will involve control of invasive species vegetation, re-establishment of a buffer, and permanent fencing installed outside the easement.
UT2	P	800	800	5:1	160	10+00 to 18+00	Preservation on UT2 will begin at the top of the reach where UT2 flows over the property line and continues for 800 LF.
Total		6,785	7,066		5,123		

Note:

1. *Fencing will be installed outside the permanent conservation easement to ensure livestock exclusion.*
2. *Denotes a difference between the stationing and reach length. This is due to a 45-foot right of way not included within the easement (see Sheet 5 within the construction plans).*

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)).

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1.0 PROJECT SITE IDENTIFICATION AND LOCATION

1.1 Directions to Project Site

Candiff Creek Stream Restoration Project (Project) is located in Surry County in western North Carolina, approximately 1.75 miles west of Siloam Township and just north of the Surry-Yadkin County line, as shown in Figure 1.

To reach the site from Asheville, take I-40 east to I-77 North (exit 152B), just east of Statesville. Take exit 82 east on NC 67 towards Boonville. Travel 12.5 miles, and turn left on Smithtown Road (SR 1541). After 1.2 miles, turn left on Siloam Road (SR 1003). Cross the Yadkin River and turn left on River-Siloam Road (SR 2230). Follow River-Siloam Road for approximately 1.3 miles and project site is on the left and can be accessed via a gravel farm road.

To reach the site from Raleigh, take I-40 West to Winston-Salem. Take Exit 193B and travel north on US52 from Winston Salem. Take Exit 129 (Pinnacle) and take a left turn off of the exit ramp onto Perch Road (SR 2065). Follow Perch Road for 2.4 miles and turn right onto Stony Ridge Road. Follow Stony Ridge Road (SR 2048) for 3.4 miles and turn left onto Quaker Church Road (SR 2080). Follow Quaker Church Road for 3.1 miles and turn left onto Hardy Road (SR 2081). Follow Hardy Road for 1.6 miles and turn right onto Siloam Road. Take the immediate left onto River-Siloam Road. Follow River-Siloam Road for approximately 2.5 miles and project site is on the left and can be accessed via gravel farm road.

1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designations

Candiff Creek Stream Restoration Project is in the US Geological Survey (USGS) Hydrologic Unit Code 03040101 and North Carolina Division of Water Quality (NCDWQ) sub-basin 03-07-02, as shown in Figure 1. The project watershed is shown in Figure 2.

1.3 Project Vicinity Map

As stated previously, the project is located in Surry County and the project vicinity map is included as Figure 1.

1.4 Project Components and Structure

Distinct project reaches are summarized in Table 1.1 below and are shown in the Project Components table in the Executive Summary (ES-1). Table 2.1 summarizes project component attributes.

Table 1.1 Restoration Approaches and Potential SMU Credits

Candiff Creek Mitigation Project -NCEEP Project #92767

Reach	Design Approach	Existing Reach Length (LF)	Design Reach Length (LF)	SMU Credit Ratio	Potential SMUs	Stationing	Comment
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Total		6,785	7,066		5,123		

Note:

1. *Fencing will be installed outside the permanent conservation easement to ensure livestock exclusion.*
2. *Denotes a difference between the stationing and existing or design length. This is due to a 45-foot right of way not included within the easement (see Sheet 5 within the construction plans).*

2.0 WATERSHED CHARACTERIZATION

2.1 Drainage Area, Project Area, and Easement Acreage

The Candiff Creek Stream Restoration Project is located in Surry County, approximately 1.75 miles west of Siloam Township. The area lies within cataloging unit 03040101 and NCDWQ sub-basin 03-07-02 of the Yadkin Pee-Dee River Basin. Project attributes are summarized in Table 2.1 and site photographs are provided in Appendix A.

The watershed areas for the project reaches were delineated using 5-foot contour intervals generated from a LiDAR (Light Distance and Ranging) DEM (Digital Elevation Model) obtained from the NC Department of Transportation (NCDOT). The total drainage area of the unnamed tributaries (UTs) and Candiff Creek at the project site is estimated to be approximately 2.74 square miles. Figure 2 shows the sub-watershed boundaries for the project area.

Table 2.1 Project Attribute Table

Candiff Creek Mitigation Project -NCEEP Project #92767

Project County	Surry				
Physiographic Region	Piedmont				
Ecoregion	Northern Inner Piedmont				
Project River Basin	Yadkin Pee-Dee				
USGS HUC for Project	03040101				
Identity Planning Area (LWP, RBRP)	LWP				
WRC Class (Warm Cool Cold)	Warm				
% Project Easement Fenced/Demarcated	100%				
Observed Beaver Activity	No activity observed				
Restoration Component Attribute Table					
Parameter	**M1**	**M2**	**M3**	**UT1**	**UT2**
Drainage Area (sq miles)	2.35	2.53	2.74	0.06	0.14
Stream Order	3	3	3	1	2
Existing Length (LF)	690	265	3,828	885	1,117
Restored Length (LF)	690	265	4,109	885	1,117
Perennial (P)/Intermittent (I)	P	P	P	I[1]	P
Watershed Type (Rural, Urban, etc.)	R	R	R	R	R
Watershed LULC Distribution					
Residential	0%	0%	0%	0%	0%
Ag-Row Crop	0%	0%	30%	0%	0%
Ag-Livestock	0%	20%	30%	0%	0%
Forested	45%	80%	40%	45%	100%
Other/Open Area	55%	0%	0%	55%	0%
Watershed Impervious Cover (%)	<1	<1	<1	<1	<1
NCDWQ AU/Index#	12-69	12-69	12-69	12-69	12-69
NCDWQ Classification	C	C	C	C	C
303(d) Listed	No	No	No	No	No
Stressor	NA	NA	NA	NA	NA
Total Acreage of Easement	3.36	0.61	18.17	2.33	3.07
Total Vegetated Easement Acreage	0.9	0.28	6.2	1.43	2.5
Total Planted Acreage for Restoration	3.36	0.61	10.08	0.9	0.57
Rosgen Classification (existing)	--	F4/1	F4/1, C4/1	--	--
Rosgen Classification (as-built)	--	B4c/1	C4/1	--	--

Table 2.1 Project Attribute Table Candiff Creek Mitigation Project -NCEEP Project #92767					
Valley Type	VIII	VIII	VIII	II	II
Parameter	**M1**	**M2**	**M3**	**UT1**	**UT2**
Valley Slope	--	.0072	.0076	--	--
Valley Slope Range	--			--	--
Trout Waters Designation	No	No	No	No	No
Protected Species (Inc, FSC)	*	*	*	*	*
Dominant Soil Series[2]					
Series	CsA	CsA	CsA	FsE	FsE
Depth	80”	80”	80”	30” to 80”	30” to 80”
Clay %	0-38%	0-38%	0-38%	8-60%	8-60%
K	0.28-0.37	0.28-0.37	0.28-0.37	0.15-0.37	0.15-0.37
T	3-5	3-5	3-5	3-5	3-5

* Brook Floater (*Alasmidonta varicose*) an FSC species is listed in 1:20,000 USGS Siloam Quadrangle, no records within NCNHP Heritage Database in project area

Notes:

1. *Scored 27.5 (wooded area) and 26.5 (open area) on the NCDWQ Stream Identification Sheets (Appendix B).*
2. *See Table 2.2 for soil unit names.*

2.2 Surface Water Classification / Water Quality

NCDWQ designates surface water classifications for water bodies such as streams, rivers, and lakes, which define the best uses to be protected within these waters (e.g., swimming, fishing, and drinking water supply). These classifications carry with them an associated set of water quality standards to protect those uses. All surface waters in North Carolina must at least meet the standards for Class C (fishable/swimmable) waters. The other primary classifications provide additional levels of protection for primary water contact recreation (Class B) and drinking water supplies (WS). Class C waters are protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture and other uses suitable for Class C. Classifications and their associated protection rules may also be designed to protect the free flowing nature of a stream or other special characteristics.

North Carolina Ecosystem Enhancement Program (NCEEP) has identified the 14-digit HU (03040101110060) that includes Candiff (aka Cundiff) Creek as a Targeted Local Watershed within their latest River Basin Restoration Priorities (RBRP) document for the Upper Yadkin River Basin (NCEEP, 2009). This designation essentially means that conditions within the Candiff and Hogan Creek drainage areas reflect a significant need for stream and/or wetlands restoration. These two streams are direct tributaries to the Yadkin River in southeastern Surry County, a priority area for aquatic habitat conservation, per the North Carolina Wildlife Resources Commission (NCWRC) and the North Carolina Natural Heritage Program (NCNHP). They comprise a 23-square mile watershed that is predominantly agricultural in nature (41 percent agricultural land cover; 26 permitted animal operations). With 25 percent non-forested riparian buffers and numerous animal farms, NCEEP has concluded that this watershed likely contains significant opportunities to work with landowners towards the implementation of stream, wetlands and buffer restoration/enhancement projects. In addition, the implementation of agricultural best management practice (BMP) projects within this watershed (e.g., livestock fencing, gully, and streambank stabilization) could help address local water quality and habitat stressors.

The project involves two unnamed tributaries (UTs) to Candiff Creek and Candiff Creek, which flows directly into the Yadkin River. From its source to the Yadkin River, Candiff Creek is classified as a Class C water, indicating that the stream and its tributaries are considered to support aquatic life and secondary recreational uses (North Carolina Department of Environment and Natural Resources [NCDENR], 2006). Restoration of the site would reduce the amount of sediment and nutrients being discharged into the system, improving the overall water quality in Candiff Creek, and the Yadkin River. Reducing soil erosion caused by agricultural practices in areas with easily erodible soils would address a major stressor of the Upper Yadkin River Basin (NCDENR, 2009).

2.3 Physiography, Geology, and Soils

The Candiff Creek site is located in the Northern Inner Piedmont Level IV Ecoregion. The underlying geology of the project consists of metamorphic rocks including gneiss, schist, and amphibolites (Geologic Map of North Carolina, NC Geological Survey, 1998). The topography of the project reaches is characterized as gently rolling. At the upstream terminus of the project on Candiff Creek, the elevation is approximately 830 feet above mean sea level (AMSL). Elevation at the southern terminus of the project is approximately 810 feet AMSL.

Soils in the project area of disturbance are shown in Figure 3 and described in Table 2.2. Classifications and characteristics were determined using the Natural Resources Conservation Service (NRCS) Soil Survey for Surry County (NRCS, 2007). Colvard and Suches soils are listed as Prime and Important Farmland by the NRCS Soil Data Mart website. Fairview sandy clay loam soils with 8-15 percent slopes are listed as Farmland of Statewide Importance (NRCS, 2009). As part of the Categorical Exclusions for the project (included as Appendix C), AD-1006 Prime and Important Farmland Ratings Sheets were completed for the Candiff Creek site. The forms were returned by NRCS on December 11, 2009.

Table 2.2 Project Soil Types and Descriptions

Candiff Creek Mitigation Project -NCEEP Project #92767

Symbol	Soil Unit Name	Slope	General Characteristics
CsA	Colvard and Suches	0-3%	Nearly level, well drained soil found on flood plains mainly used as croplands, pasture and woodlands.
FeC2	Fairview sandy clay loam	8-15%	Deep, well drained, Piedmont uplands soils, found on interfluves, ridges, and low hills.
FeD2	Fairview sandy clay loam	15-25%	Very deep, well drained, Piedmont uplands soils, found on ridges, and low hills.
FsE	Fairview-Stott Knob complex	25-45%	Very deep, well drained, Piedmont uplands soils, found on ridges, and low hills.

Source: NRCS, 2007

2.4 Historical Land Use and Development Trends

The land cover within the project area consists primarily of pasture and forest. The watershed is mostly rural and largely forested with land uses that include historic cattle pastures, forested areas, and agricultural fields. No significant urbanization is expected in the near future. The Surry County Land Use Plan 2015, Southeast Surry County Growth Management Map projects that the project area will remain rural with little residential growth (Surry County Department of Planning and Development, 2006). River-Siloam Road (SR 2230), a paved roadway, is located northeast of the project site. Unpaved farm roads cross Candiff Creek and UT2. Permanent ford crossings will be kept in these locations.

2.5 Watershed Planning

The Candiff Creek Stream Restoration Project Site is located in a NCEEP-Targeted Local Watershed (HU 03040101110060). Candiff Creek is a direct tributary to the Yadkin River in southeastern Surry County, which is a priority area for aquatic habitat conservation per the NCWRC Wildlife Action Plan (NCWRC, 2005). No 303(d) streams are listed in this HU. The major stressors identified in the Upper Yadkin River Basin Restoration Priorities include naturally erodible soils and erosion from agriculture.

NCEEP has identified the 14-digit HU (03040101110060) that includes Candiff (aka Cundiff) Creek as a Targeted Local Watershed within their latest River Basin Restoration Priorities (RBRP) document for the Upper Yadkin River Basin (NCEEP, 2009). This designation essentially means that conditions within the Candiff and

Hogan Creek drainage areas reflect a significant need for stream and/or wetlands restoration. These two streams are direct tributaries to the Yadkin River in southeastern Surry County, a priority area for aquatic habitat conservation, per NCWRC and NCNHP (2005 Wildlife Action Plan). They comprise a 23-square mile watershed that is predominantly agricultural in nature (41 percent agricultural land cover; 26 permitted animal operations). With 25 percent non-forested riparian buffers and numerous animal farms, NCEEP has concluded that this watershed likely contains significant opportunities to work with landowners towards the implementation of stream, wetlands and buffer restoration/enhancement projects. In addition, the implementation of agricultural BMP projects within this watershed (e.g., livestock fencing, gully and streambank stabilization) could help address local water quality and habitat stressors.

In addition to it being part of an NCEEP designated Targeted Local Watershed, the Candiff Creek Stream Restoration Project site is within a priority sub-watershed identified in NCEEP's Upper Yadkin/Ararat River Local Watershed Plan (LWP) effort (NCEEP, 2009). The Candiff Creek sub-watershed was listed as the third highest priority area for both restoration/agricultural best management practices and for preservation. Surry SWCD has been the key local stakeholder partnering with NCEEP in this effort.

2.6 Endangered / Threatened Species

Some populations of plants and animals are declining because of either natural forces or their inability to compete for resources with the encroachment of humans. NCNHP and US Fish and Wildlife Service (USFWS) lists of rare and protected animal and plant species contain four federally protected species known to exist in Surry County (USFWS, 2009 and NCNHP, 2009).

Legal protection for federally listed species, Threatened (T) or Endangered (E) status, is conferred by the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1534). This act makes illegal the killing, harming, harassing, or removing of any federally listed animal species from the wild; plants are similarly protected, but only on federal lands. Section 7 of this act requires federal agencies to ensure that actions they fund or authorize do not jeopardize any federally listed species.

Organisms that are listed as Endangered (E), Threatened (T), or Special Concern (SC) on the NCNHP list of Rare Plant and Animal Species are afforded state protection under the State Endangered Species Act and the North Carolina Plant Protection and Conservation Act of 1979.

Species that the NCNHP and USFWS list under federal protection for Surry County as of August 2, 2009, and November 15, 2007, respectively are shown in Table 2.3. A brief description of the characteristics and habitat requirements of the federally protected species is included in the following section, along with a conclusion regarding potential project impacts. For FSC and state protected species, efforts will be made to avoid any listed species during the project. Brook Floater (*Alasmidonta varicose*), a FSC species, is listed for the Siloam USGS Quadrangle Map, but there is no sampling available for the species within two miles of the project study area.

A search was conducted using the NCNHP's Virtual Workroom website on November 23, 2009. The search returned no records of any listed species within two miles of the project site.

Table 2.3 Federally Protected Species for Surry County

Candiff Creek Mitigation Project -NCEEP Project #92767

Scientific Name	Common Name	Federal Status	Biological Conclusion
Vertebrates			
Glyptemys muhlenbergii	Bog Turtle	T	No Effect
Haliaeetus leucocephalus	Bald Eagle	BGEPA	No Effect
Vascular Plants			
Helianthus schweinitzii	Schweinitz's sunflower	E	No Effect
Isotria medeoloides	Small whorled pogonia	T	No Effect

Notes: E – Endangered denotes a species in danger of extinction throughout all or a significant portion of its range
T-Threatened denotes a species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range
BGEPA – Protected by the Bald and Golden Eagle Protection Act

2.6.1 Site Evaluation and Methodology

A pedestrian survey of the project area was conducted on October 14, November 3, and November 4, 2009, for species listed in Table 2.3. No federally protected species were observed in or adjacent to the project area during the field survey.

2.6.2 Federally-Protected Species

Glyptemys muhlenbergii (Bog turtle)

Federal Status: Threatened Due to Similar Appearance
Animal Family: Emydidae Federally Listed: November 4, 1997

Bog turtles are small (3 to 4.5 inches) turtles with a weakly keeled carapace (upper shell) that ranges from light brown to ebony in color. The species is readily distinguished from other turtles by a large, conspicuous bright orange to yellow blotch on each side of its head. Bog turtles are semi-aquatic and are only infrequently active above their muddy habitats during specific times of year and temperature ranges. They can be found during the mating season from June to July and at other times from April to October when the humidity is high, such as after a rain event, and temperatures are in the seventies (degrees Fahrenheit). Bog turtle habitat consists of bogs, swamps, marshy meadows, and other wet environments, specifically those that have soft muddy bottoms. The southern populations of bog turtles (VA, TN, NC, SC, and GA) are listed as threatened due to similar appearance to northern bog turtles that are listed as threatened. The southern bog turtle population is not fully protected under the ESA, but may not be possessed, sold, traded, or collected. In the northern states (CT, DE, MA, MD, NJ, NY, and PA) bog turtles are fully protected under the ESA. A Biological Conclusion is not required since Threatened Due to Similarity of Appearance [T (S/A)] species are not afforded full protection under the ESA. There were small areas of potential bog turtle habitat noted during the site assessment, but no individuals were observed.

Haliaeetus leucocephalus (Bald eagle)
Federal Status: Protected by the Bald and Golden Eagle Protection Act
Animal Family: Accipitridae

Adult bald eagles can be identified by their large white head and short white tail. The body plumage is dark-brown to chocolate-brown in color. In flight, bald eagles can be identified by their flat wing soar. Eagle nests are found in close proximity to water (within 0.5 mile) with a clear flight path to the water, in the largest living tree in an area, and having an open view of the surrounding land. Human disturbance can cause an eagle to abandon otherwise suitable habitat. The breeding season for the bald eagle begins in December or January. Fish are the major food source for bald eagles. Other sources include coots, herons, and wounded ducks. Food may be live or carrion.

Biological Conclusion: No Effect

No suitable habitat exists for the bald eagle within the project area. A search of the NCNHP database of rare species and unique habitats, conducted on November 23, 2009, shows no occurrences of this species within two miles of the project area. Therefore, no impacts to this species are anticipated during the project construction.

***Helianthus schweinitzii* (Schweinitz's sunflower)**
Federal Status: Endangered
Plant Family: Asteraceae
Federally Listed: May 7, 1991

Schweinitz's sunflower, usually 3 to 6 feet tall, is a perennial herb with one to several fuzzy purple stems growing from a cluster of carrot-like tuberous roots. Leaves are 2 to 7 inches long, 0.4 to 0.8 inch wide, lance-shaped, and usually opposite, with upper leaves alternate. Leaves feel like felt on the underside and rough, like sandpaper, on the upper surface. The edges of the leaves tend to curl under. Flowers are yellow composites, and generally smaller than other sunflowers in North America. Flowering and fruiting occur mid-September to frost. This plant grows in clearings and along the edges of upland woods, thickets and pastures. It is also found along roadsides, powerline clearings, old pastures, and woodland openings. It prefers full sunlight or partial shade, but is intolerant of full shade.

Biological Conclusion: No Effect

Potential habitat for Schweinitz's sunflower occurs along field edges throughout the project area. The project study area was evaluated for potential Schweinitz's sunflower habitat and extensive field surveys were performed in October and November 2009. No populations were found within the area of potential impact. The NCNHP website was searched for potential protected species on November 23, 2009. No populations of this species have been reported within one mile of the project area. Therefore, the proposed project is not anticipated to result in an adverse impact to this species.

***Isotria medeoloides* (Small whorled pogonia)**
Federal Status: Threatened
Plant Family: Orchidaceae
Federally Listed: September 9, 1982

Small whorled pogonia is a small perennial member of the Orchidaceae. These plants arise from long slender roots with hollow stems terminating in a whorl of five or six light green leaves. The single flower is approximately one inch long, with yellowish-green to white petals and three longer green sepals. This orchid blooms in late spring from mid May to mid-June. Populations of this plant are reported to have extended periods of dormancy and to bloom sporadically. This small spring ephemeral orchid is not observable outside of the spring growing season. When not in flower, young plants of Indian cucumber-root (*Medeola virginiana*) also resemble small whorled pogonia. However, the hollow stout stem of *Isotria* will separate it from the genus *Medeola*, which has a solid, more slender stem (USFWS 2002c).

Small whorled pogonia may occur in young as well as maturing forests, but typically grows in open, dry deciduous woods and areas along streams with acidic soil. It also grows in rich, mesic woods in association with white pine and rhododendron.

Biological Conclusion: No Effect

Potential habitat for small whorled pogonia occurs along field edges throughout the project area. The project study area was evaluated for potential small whorled pogonia habitat and extensive field surveys were performed in October and November 2009. No populations were found within the area of potential impact. The NCNHP website was searched for potential protected species on November 23, 2009. No populations of this species have been reported within one mile of the project area. Therefore, the proposed project is not anticipated to result in an adverse impact to this species.

2.6.3 Federal Designated Critical Habitat

The ESA requires the federal government to designate "critical habitat" for any species it lists under the ESA. "Critical habitat" is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation. There are no federal designated critical habitat areas within the project boundaries.

2.6.4 USFWS Concurrence

The USFWS and NCWRC were notified of the project via letter on October 16, 2009. Michael Baker Engineering, Inc. (Baker) sent a follow-up letter to USFWS on November 25, informing USFWS that the proposed project would have no effect to protected species. Correspondence on this issue is included in Appendix D.

2.7 Cultural Resources

Baker sent a letter on October 19, 2009 requesting that the North Carolina State Historic Preservation Office (HPO) review and comment for the potential of cultural resources in the vicinity of the Candiff Creek Stream Restoration Project. On November 23, 2009, HPO sent a response which noted that there are no known archaeological sites within the proposed project area and that the proposed project will have no effect on the C.C. Cundiff House, a National Register-listed property. All correspondence on the cultural resources associated with this project are included in Appendix D.

2.8 Potential Constraints

Baker assessed the Candiff Creek Stream Restoration Project site in regards to potential fatal flaws and site constraints. The project is located in a predominantly rural watershed, with no plans for significant land use changes in the foreseeable future. Four existing ford crossings were considered during the design of the stream alignment. All existing stream crossings must be maintained for farm operations. No other foreseen constraints or fatal flaws associated with structure and/or infrastructure encroachments have been identified during project design development.

2.8.1 Property Ownership and Boundary

NCEEP has entered into a formal agreement for the acquisition of a conservation easement with the landowners of the Candiff Creek Project: (Everette and Mike Johnson). The agreement allows NCEEP to proceed with the project and to restrict future land-use and development within the project corridors in perpetuity. The conservation easement plat and documents are in the final stages of development. On May 12, 2010, personnel from the State Property Office walked the staked the approximate location of the proposed easement boundaries with one of the landowners (Mike Johnson) and both were in agreement with the staked boundary. Baker completed monumenting (installing rebar, cap, and witness stake) the easement on May 20, 2010 so that the conservation easement plat and documents can be finalized, signed, and recorded by the Surry County Register of Deeds. The southern terminus of the project area is a railroad right of way just north of the Yadkin River. The northern terminus of the project is at the intersection of Candiff Creek with River-Siloam Road (SR 2230). The proposed restoration activities will not trespass onto these rights of way.

2.8.2 Site Access

The site is located just south of River-Siloam Road (SR 2230) and may be accessed by existing farm roads off of River-Siloam Road (SR 2230) for construction and post-restoration monitoring. Temporary access during construction for haul roads will need to be coordinated with the landowners and secured. Discussions with the landowners indicate agricultural practices will be discontinued until construction activities are completed.

2.8.3 Utilities

There is an overhead power line on the upstream portion of the project site near the existing upstream ford crossing that powers the livestock drinking well (located outside the conservation easement) between UT1 and UT2.

2.8.4 FEMA / Hydrologic Trespass

The Candiff Creek site is currently located within a Federal Emergency Management Agency (FEMA)-identified flood zone (FIRM 3710592200 Zone AE) (NCFMP, 2009). Specific base flood elevations have been determined for Zone AE areas and it appears that most of M3 area is located within the Yadkin River's 100-year floodplain (i.e. Yadkin River backs water up Candiff Creek during the 100-year storm event). Baker has spoken with the Surry County Floodplain Administrator summarizing the project and will determine if a Letter of Map Revision (LOMR) is needed based on continued consultation. In any case, a no-rise certificate generated by Baker will be signed by Surry County prior to construction. A copy of the NCEEP Floodplain Requirements Checklist is included in Appendix E.

3.0 PROJECT SITE STREAMS (EXISTING CONDITIONS)

3.1 Existing Condition Survey

Detailed channel morphology and topography were surveyed with a total station and tied to North Carolina State Plane coordinates. Along with providing detailed topography, this survey included seven Candiff Creek mainstem cross-sections, including longitudinal profiles for all reaches. Baker also conducted pebble counts and collected substrate samples to characterize stream sediments. Figure 4 illustrates the locations of cross-section surveys and each project reach. Surveyed longitudinal profiles and cross-sections are included in Appendix F. A photo log that depicts the existing conditions at the Candiff Creek project site is provided in Appendix A.

These surveys were used to analyze, predict, and confirm the stability of the stream and generate the design parameters. The existing conditions of designated project reaches that are proposed for intensive channel work (i.e. M2 and M3) are described below with Table 3.1. Reach M3 is listed before M2 in the tables, as this reach is much larger and will require greater channel modifications. The table also provides regional curve data for comparison based on the drainage area of both reaches (Harman et al, 1999; Walker, 2008). A more detailed discussion of the assessment conducted to determine channel stability and channel discharge for project streams is included in Sections 3.4 through 3.6.

Baker assessed the stream and valley types present and considered their evolutionary stage and likely endpoint in order to develop a basis for the proposed restoration efforts. The site contains alluvial and colluvial valleys with a wide range of slopes present. Alluvial valleys are associated with alluvial deposits and a wide floodplain while colluvial valleys have colluvial deposits mixed with some alluvium and floodplains of limited width. There are B, Bc, C, and F type streams found within the project reaches. All streams have been altered in the past by straightening, moving of channels to enlarge pastures, gardens, and livestock impacts.

3.2 Channel Classification

For analysis purposes, Baker labeled the existing reaches M1, M2, M3, UT1, and UT2 (Figures 4, 5a, and 5b). UT1 begins at the northernmost project boundary and extends south to the confluence with Candiff Creek (M1), a distance of approximately 885 LF. M1 flows from the confluence of UT1 southward to the confluence with UT2, a distance of 690 LF. UT2 begins at the westernmost project boundary and flows through a young forest into Candiff Creek (M1), a distance of 1,117 LF. Candiff Creek M2 begins after the confluence of UT2 and M1 and flows southward for 265 LF. Candiff Creek M3 begins downstream of M2 and flows south 3,828 LF to the southern project boundary. Candiff Creek (M1, M2, and M3) and UT2 were determined to be perennial streams, while UT1 was determined to be a high intermittent (~27) using the NCDWQ *Determination of the Origin of Perennial Streams* stream assessment protocols and guidelines (see stream forms in Appendix B). The total current length of the existing stream, Candiff Creek (M1, M2, and M3) and its associated tributaries (UT1 and UT2) on the project site is 6,785 LF, which is based on the field survey conducted by Baker. The main channel (M1, M2, and M3) will be designated Candiff Creek for the purposes of this report and M3 (restoration) and M2 (Enhancement I) will be the only reaches shown in the tables for design analyses, since they are the only reaches where channel modifications are proposed.

Candiff Creek is a small, perennial stream with a total drainage area of approximately 2.74 square miles at the southernmost project boundary (Figure 2). Historically, the site has been used for agricultural cattle grazing and row crop agriculture. Cleared areas throughout the project boundaries are currently used for cattle grazing and hay production. The riparian vegetation at the lower end of Candiff Creek consists predominantly of herbaceous plants that are regularly maintained by mowing and cattle grazing. A small wooded riparian buffer exists in the upper end of Candiff Creek (M1 and M2). Additionally, cattle activities have limited the establishment of native woody vegetation along the trampled stream banks, which has resulted in bank degradation and an inadequate riparian buffer throughout the majority of the project reaches.

The lower two reaches of Candiff Creek (M2 and M3) have experienced the most historical channelization, which is why restoration activities are urgently needed. Based on the Rosgen Classification system (Rosgen, 1994) Reach M2 is classified as an F4/1 that is nearly straight and entrenched with a moderate width-to-depth ratio. M2 has some woody riparian vegetation, but additional buffer plantings will be required to stabilize the stream banks after the first invasive vegetation application. M3 is classified as a C4/1 and F4/1 channel that displays moderate meander geometry with a sinuosity of 1.29. The channel is currently increasing sinuosity and evolving from an F to a C channel. In places, the C channel is trying to form inside the F channel, since the creek has vertically incised, widened, and is no longer able to effectively transport sediment. M3 is not protected with adequate riparian vegetation and cattle have access to the stream throughout much of this reach, causing severe bank instability. South of the southernmost stream crossing, the left bank on the existing channel is essentially vertical, with bank heights of up to 15 feet.

The northernmost end of the project (M1, UT1, and UT2) is relatively stable and will require intense invasive species control, planting a native species riparian zone, and installing permanent fencing. M1 has no riparian vegetation on the right bank. Kudzu dominates the right bank to the northernmost stream crossing, while the left bank has some riparian vegetation mixed with invasive species (see photos in Appendix A). The upper portions of UT1 and UT2 flow through forested areas before running through a large community of invasive species (kudzu, privet, multiflora rose, and privet), which empties into Candiff Creek.

A modified Wolman pebble count (Rosgen, 1994) was conducted to characterize the bed material. The data show that the Candiff Creek has a D_{50} of 37 mm, indicating that the dominant bed material in the stream channel is gravel.

Table 3.1 Representative Geomorphic Data for Candiff Creek

Candiff Creek Mitigation Project -NCEEP Project #92767

Candiff Creek Project[1]	M3 Existing Stream Values[2] (Restoration)		M2 Existing Stream Values[3] (Enhancement I)	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**
Stream Length (ft)	3,828		265	
Drainage Area, DA (sq mi)	2.74		2.53	
Stream Type (Rosgen)	C4/1, F4/1[4,5]		F4/1[5]	
Bankfull Discharge, Qbkf (cfs)	115		105	
Bankfull Riffle XSEC Area, Abkf (sq ft)	29.2	32.6	28.2	
Bankfull Mean Velocity, Vbkf (ft/s)	3.5	3.9	3.7	
Bankfull Riffle Width, Wbkf (ft)	20.7	32.2	19.8	
Bankfull Riffle Mean Depth, Dbkf (ft)	0.9	1.4	1.42	
Width to Depth Ratio, W/D (ft/ft)	14.6	34.6	13.9	
Width Floodprone Area, Wfpa (ft)	35.45	94.1	23.8	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.7	2.9	1.2	
Riffle Max Depth @ bkf, Dmax (ft)	2.0	2.4	1.85	
Riffle Max Depth Ratio, Dmax/Dbkf	1.7	2.2	1.3	
Max Depth @ tob, Dmaxtob (ft)	2.0	5.4	4.8	
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	2.5	2.6	
Meander Length, Lm (ft)	40	225	---	
Meander Length Ratio, Lm/Wbkf *	1.9	7.0	---	
Radius of Curvature, Rc (ft)	15	145	---	
Rc Ratio, Rc/Wbkf *	0.7	4.5	---	
Belt Width, Wblt (ft)	24	82	---	
Meander Width Ratio, Wblt/Wbkf *	1.2	2.5	---	
Sinuosity, K	1.29		1.00	
Valley Slope, Sval (ft/ft)	0.0076		0.0072	
Channel Slope, Schan (ft/ft)	0.0055		0.0045	
Riffle Slope, Srif (ft/ft)	0.002	0.026	0.0056	0.0122

Table 3.1 Representative Geomorphic Data for Candiff Creek

Candiff Creek Mitigation Project -NCEEP Project #92767

Candiff Creek Project[1]	M3 Existing Stream Values[2] (Restoration)		M2 Existing Stream Values[3] (Enhancement I)	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**
Riffle Slope Ratio, Srif/Schan	0.36	4.73	1.2	2.7
Slope Pool, Spool (ft/ft)	---		---	
Pool Slope Ratio, Spool/Schan	---		---	
Pool Max Depth, Dmaxpool (ft)	3.1	3.7	---	
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.6	3.4	---	
Pool Width, Wpool (ft)	29.5	35.6	---	
Pool Width Ratio, Wpool/Wbkf	1.1	1.4	---	
Pool-Pool Spacing, Lps (ft)	48.0	161.0	---	
Pool-Pool Spacing Ratio, Lps/Wbkf	2.3	5.0	---	
d16 (mm)	8.32		8.32	
d35 (mm)	24.42		24.42	
d50 (mm)	36.68		36.68	
d84 (mm)	82.01		82.01	
d95 (mm)	119.29		119.29	
NC Piedmont Regional Curve (W_{bkf}) [6]	20.08		19.51	
NC Piedmont Regional Curve (D_{bkf}) [6]	2.12		2.08	
NC Piedmont Regional Curve (A_{bkf}) [6]	42.53		40.39	
NRCS NC Piedmont Regional Curve (W_{bkf}) [7]	18.45		17.82	
NRCS NC Piedmont Regional Curve (D_{bkf}) [7]	1.52		1.49	
NRCS NC Piedmont Regional Curve (A_{bkf}) [7]	31.59		29.26	

Notes:
1. Data in table reflect typical conditions where Restoration (M3) and Enhancement I (M2) approaches are proposed. Reaches M1 (690'), UT1 (835'), UT2 (1,117') are either Preservation or Enhancement II Reaches and were not geomorphically analyzed. The Enhancement II Reaches (M1and lower portions of UT1 and UT2) involve invasive species control, buffer revegetation, and livestock exclusion through fencing. M3 is located before M2 in the tables since it is longer and involves greater channel modification.
2. Denotes M3 was analyzed from 3 riffle and 2 pool cross-sections.
3. Denotes M2 was analyzed from 1 riffle cross-section.
4. M3 is in the process of evolving from an F channel to a C channel. The upper and lower ends of M3 are classified as a C channel early within its evolutionary stage while the middle is an F channel that is late in its evolutionary stage.
5. The "/1" indicates bedrock is present within the reach.
6. Harman et al, 1999
7. Unpublished NC Rural Piedmont Regional Curve that is being developed by NRCS (A. Walker personal communication, 2008).

3.3 Valley Classification

There are two valley types in the Candiff Creek project area. The valley type found on the mainstem of Candiff Creek Stream Restoration Project site is a Rosgen Type VIII valley (Rosgen, 1996). Type VIII valleys generally have multiple river terraces that are positioned laterally on broad, low-sloping valleys. Alluvial terraces and floodplains are the predominant depositional features, and these can act as substantial sources of sediment if buffer vegetation is removed or the channel is straightened. The most common stream types encountered in Type VIII valleys are E and C, which have slightly entrenched, meandering channels and developed riffle/pool bedforms. In some instances, D, F, Bc, or G type streams may occur in Type VIII valleys, depending on local conditions.

Candiff Creek tributaries, UT1 and UT2, are both located within a Rosgen Type II valley (Rosgen, 1996). Type II valleys are generally colluvial valleys that are moderately steep with gentle sloping side slopes. Type II valleys usually contain soils developed from parent material, alluvium, and/or colluvium. Over time, the stream tends to migrate to the lowest part of the valley. The project site valley gradient ranges from approximately 0.041 ft/ft to 0.032 ft/ft for UT1 and UT2, respectively. Streams found in these valley types in these areas are commonly Rosgen B type streams.

3.4 Discharge

Baker used physical, analytical, and empirical methods to verify the bankfull discharge of the project reaches of Candiff Creek. Subsequent methods were used to interpret and sometimes adjust field observations.

In summary, the following steps were taken to estimate bankfull discharge:

1. Identified and performed detailed survey of representative cross-sections with physical bankfull indicators,
2. Conducted internal comparison of the surveyed cross-sections to ensure consistency,
3. Compared values to regional empirical data (regional curves),
4. Applied bankfull areas, widths, and slopes to WARRSS (2006) Bankfull Velocity/Discharge Estimates spreadsheet to estimate the discharge,
5. Considered all results and determined the flows that most closely corresponded to bankfull.

3.4.1 Physical Field Measurement

Physical bankfull discharge measurements were not measured in the field, but physical bankfull dimension indicators were surveyed in order to help estimate the discharge. Physical bankfull dimension indicators surveyed during the existing conditions analysis were typically depositional bars, defined breaks in slope at a consistent elevation relative to the water surface, or transitions in bank vegetation. Upon completion of the field survey, data were plotted to check for consistency and correlation with region-specific empirical equations and regional reference data. These data were analyzed to determine the most likely bankfull stages on all project reaches. Once bankfull stage was determined using these methods, the bankfull dimensions were analyzed using WARRSS (2006) Bankfull Velocity/Discharge Estimates spreadsheet to assess whether a bankfull discharge would produce the same relative particular flow rate as regional curve data.

3.4.2 Regional Curve Equations

Publicly available and in-house bankfull regional curves are available for a range of stream types and physiographic provinces. The North Carolina Piedmont Regional Curve (Harman et al., 1999) and an unpublished NC Piedmont Regional Curve being developed by the Natural Resources Conservation Service (A. Walker private communication, 2008) were used for comparison to other more site-specific means of estimating bankfull discharge. The tributaries on the Candiff Creek Stream Restoration Project site are small streams; small streams are poorly represented on the regional curves. It has been found that the NC Piedmont Regional Curve Equations may overestimate discharge and channel dimension for smaller streams, such as those present at this site. The unpublished NC Piedmont Regional Curve corresponds closer to the discharge and channel dimension that were compared with the WARSSS (2006) worksheets. Baker has conducted numerous projects in small drainages in western North Carolina, and has produced “mini-curves” specific to these projects. The growing number of data points on these small streams curves provides supporting evidence for the selection of bankfull indicators that produce smaller dimensions and flow rates than the published regional data.

According to the unpublished NRCS North Carolina Rural Piedmont Regional Curve, the bankfull discharge appropriate for Candiff Creek’s Reach M3 is approximately 127.63 cubic feet per second (cfs). Using the Friction Factor to Relative Roughness Ratio method, the discharge is estimated to be 107.9 cfs. This method relates hydraulic radius, D84, and shear velocity to flow velocity. Using the Manning

Equation with the Manning's n from the friction factor and relative roughness the bankfull discharge is estimated to be 114.73 cfs. Using the Manning Equation with the Manning's n from the stream type is estimated to be 91.79 cfs. A discharge of 183.98 cfs was also calculated from the NC Rural Piedmont Regional Curve. Based on these data, Baker estimated M3 bankfull flow to be 115.0 cfs. See Table 3.2 for comparisons.

For M2, the bankfull discharge from the unpublished NRCS North Carolina Rural Piedmont Regional Curve is estimated to be approximately 120.32 cfs. The Friction Factor to Relative Roughness Ratio method estimated the discharge to be 80.86 cfs. Using the Manning Equation with the Manning's n from the friction factor and relative roughness the bankfull discharge is estimated to be 90.59 cfs. The Manning Equation with the Manning's n from the stream type method estimated the discharge to be 72.47 cfs. A discharge of 174.21 cfs was also calculated from the NC Rural Piedmont Regional Curve. Based on these data, Baker estimated M3 bankfull flow to be 105.0 cfs. See Table 3.2 for comparisons.

Table 3.2 Discharge Analysis for Candiff Creek

Candiff Creek Mitigation Project -NCEEP Project #92767

Estimating Method	Bankfull Velocity (Ft/Sec)	Bankfull Discharge (cfs)
M3[1]		
NRCS NC Rural Piedmont Regional Curve[2]	3.92	127.63
Friction Factor to Relative Roughness Ratio method[3]	3.31	107.9
Manning's "n" from friction factor and relative roughness[3]	3.52	114.73
Manning's "n" from stream type[3]	2.82	91.79
NC Rural Piedmont Regional Curve[4]	5.62	183.98
Baker Estimated Discharge	3.5	115.0
M2[1]		
NRCS NC Rural Piedmont Regional Curve[2]	4.25	120.32
Friction Factor to Relative Roughness Ratio method[3]	2.87	80.86
Manning's "n" from friction factor and relative roughness[3]	3.21	90.59
Manning's "n" from stream type[3]	2.57	72.47
NC Rural Piedmont Regional Curve[4]	6.17	174.21
Baker Estimated Discharge	3.7	105.0

Notes:

1. *M3 is located before M2 in the table since it is longer and involves greater channel modification.*
2. *Unpublished NC Rural Piedmont Regional Curve that is being developed by NRCS (A. Walker personal communication, 2008).*
3. *WARSSS, 2006 spreadsheet*
4. *Harman et al, 1999*

3.5 Channel Morphology (Pattern, Dimension, and Profile)

Baker performed general topographic and planimetric surveying of the project site and produced topographic mapping, based on survey data, in order to create plan set base mapping. Cross-section surveys were also performed to assess the current condition and overall stability of the stream channels. Cross-section locations are shown in Figure 4. The following discussion summarizes the survey results for the existing reaches. The watershed size was calculated at the terminus of the each reach and shown in Figure 2 and the existing parameters for dimension, pattern, and profile are summarized in Table 3.1.

3.6 Channel Evolution

Channel stability is defined as the ability of a stream to transport incoming flows and sediment loads supplied by the watershed without undergoing significant changes over a geologically short time-scale. A generalized relationship of stream stability was proposed by Lane (1955); it states that the product of sediment load and sediment size is in balance with the product of stream slope and discharge, or stream power. A change in any one of these variables induces physical adjustment of one or more of the other variables to compensate and maintain the proportionality.

Longitudinally, the water and sediment flows delivered to each subsequent section are the result of the watershed and upstream or backwater (downstream) conditions. Water and sediment pass through the channel, which is defined by its shape, material, and vegetative condition. Flow and sediment are either stored or passed through at each section along the reach. The resulting physical changes balance gravity, friction, and the sediment and water being delivered into the system (Leopold et al., 1964).

Observed stream response to induced instability, as described by Simon's (1989) Channel Evolution Model, involve extensive modifications to channel form resulting in profile, cross-sectional, and plan form changes which often take decades or longer to achieve resolution. The Simon (1989) Channel Evolution Model characterizes typical evolution in six steps:

1. Pre-modified,
2. Channelized,
3. Degradation,
4. Degradation and widening,
5. Aggradation and widening,
6. Quasi-equilibrium.

The channel evolution process is initiated once a stable, well-vegetated stream that interacts frequently with its floodplain is disturbed. Channelization, dredging, changes in land use, removal of streamside vegetation, upstream or downstream channel modifications, and/or change in other hydrologic variables result in adjustments in channel morphology to compensate for the new condition(s). Disturbance commonly results in an increase in stream power that can cause degradation, often referred to as channel incision (Lane, 1955). Incision eventually leads to over-steepening of the banks and, when critical bank heights are exceeded, the banks begin to fail and mass wasting of soil and rock leads to channel widening. Incision and widening continue to propagate upstream in the form of a head-cut. Eventually the mass wasting slows, and the stream begins to aggrade. A new, low-flow channel begins to form in the deposited sediment. By the end of the evolutionary process, a stable stream with dimension, pattern, and profile similar to those of undisturbed channels forms in the deposited alluvium. The new channel is at a lower elevation than its original form, with a new floodplain constructed of alluvial material (FISRWG, 1998).

Channels within the project area are mostly perennial, have experienced prior channelization or other kinds of watershed disturbance, and are currently impacted by grazing and row crop agriculture. Channel stability was assessed with the following methods: qualitative and quantitative site observations, site-specific geomorphic facets using detailed topographic data collected for the project, and sediment analyses. Conclusions reached from these methods were used to define site stability and determine appropriate restoration approaches for both reaches (M2 and M3).

Candiff Creek is a perennial stream in a watershed where historical and current land rural management practices include timber harvesting, pasture conversion, channelization, and livestock grazing. Based on site assessments, the mainstem channel was divided into three reaches (M1, M2, and M3).

M1 is moderately stable with adequate riparian vegetation on the left bank and invasive kudzu dominating the right bank. M1 has stable channel geometry and has access to its floodplain on at least one side of the channel.

M2 is an entrenched F4/1 that has been channelized near the fall of the valley. The channel seems moderately stable since the banks are slightly sloped and riparian buffer has held the banks in place. However, the channel is incised with no chance, in the near future, of reaching the floodplain unless the channel is modified to access a new floodplain. M2 is currently in the early stages of Simon Evolutionary Model Stage 4 (Simon, 1989) and in a Rosgen Channel Evolution Scenario 4 (Rosgen 2001b) since it lacks access to its floodplain; further degradation or widening is inevitable without some stream modification.

M3 has both unstable F4 and C4 channel classifications with the F4 channel being found mostly in areas where cattle have had access to the stream causing the channel to have a high width to depth ratio and lack bedform diversity. M3 is currently in a Simon Stage 5 (aggradation and widening) and a Rosgen Channel Evolution Scenario 9 (Rosgen 2001b) with the earliest stages of evolution occurring upstream and evolving downstream. Scenario 9 ranges from stable to degrading to recovery with the stream types E, G, F, C, and E respectively. In the past, M3 was moved to the edge of the valley and straightened. M3 is also in the recovery stage of its evolution, but to fully recover, the stream would erode much more of its banks to increase sinuosity and decrease its width to depth ratio, converting it to a C stream type. Based on field observations, aggradation downstream from slumping banks and erosion from upstream sources is causing the channel to shift from an F to a C channel; the logical conclusion of this progression would be the formation of a stable E stream. Baker plans to convert the unstable F and C reaches of M3 into a stable C channel with appropriate dimension, pattern, and profile in order to improve habitat, and increase water quality by preventing large amounts of sediment from eroding from its banks. It is anticipated that this proposed C channel will narrow and eventually become an E channel.

Tables 3.1 through 3.4 summarize existing channel morphology in the project area. Data were taken from surveyed cross-sections distributed across the project area. Table 3.5 summarizes research findings by Rosgen (2001) concerning bank height ratios as an indicator of channel stability.

The project area consists of channels that are primarily either in an aggradational or degradational phase of the channel evolutionary sequence. As a result, these streams are prime candidates for restoration and enhancement. Stream restoration techniques act to minimize the erosion and geomorphic disturbance required to achieve a new stable state naturally. Restoration activities proposed along Candiff Creek will recreate channel types that are appropriate to the valley types and slopes present. In addition to the installation of grade control structures, restoration efforts will involve the alteration of channel dimension, profile, and on M3, pattern. This resets the evolutionary cycle; the structures and measures installed, in conjunction with the protective buffer, should ensure the continued stability of the streams within the project area, barring major disturbance in the unprotected areas of the greater watershed.

Table 3.3 Boundary Shear Stresses and Stream Power for Existing Conditions of M3 and M2
Candiff Creek Mitigation Project NCEEP Project #92767

Parameter	Candiff Creek Values	
	M3 Existing Conditions[1]	M2 Existing Conditions[1]
Bankfull Discharge, Q (cfs)	115	105
Bankfull Area (square feet)	32.6	28.2
Mean Bankfull Velocity (cfs)	3.5	3.7
Bankfull Width, W (feet)	32.2	19.8

Table 3.3 Boundary Shear Stresses and Stream Power for Existing Conditions of M3 and M2 Candiff Creek Mitigation Project NCEEP Project #92767		
Parameter	**Candiff Creek Values**	
	M3 Existing Conditions[1]	**M2 Existing Conditions[1]**
Bankfull Mean Depth, D (feet)	1.4	1.4
Width to Depth Ratio, w/d (feet/ foot)	23.0	13.9
Wetted Perimeter (feet)	35.0	22.6
Hydraulic Radius, R (feet)	0.9	1.2
Channel Slope (feet/ foot)	.0055	.0045
Boundary Shear Stress, τ (lbs/ft^2)	0.32	0.35
Subpavement D_{100} (mm)	115	90
Largest Moveable Particle (mm) per Modified Shield's Curve	84	92
Critical Depth (feet)	1.2	1.4
Critical Slope (feet/ foot)	.0048	.0045
Stream Power (W/m^2)	22.1	21.7
Note: *1. M3 is located before M2 in the table since it is longer and involves greater channel modification.*		

Table 3.4 Channel Morphology Features and Stability Indicators for Candiff Creek Candiff Creek Mitigation Project -NCEEP Project #92767		
Parameter	**Candiff Creek**	
	M3 – Restoration[1]	**M2 – Enhancement I[1]**
Stream Type		
Riparian Vegetation	Upper portion of M3 is thinly forested on both sides of the stream with adjacent pasture land. Middle portion of M3 has grazed pasture on the left side of the stream and mature forest on the right side. Lower portion of M3 has grazed pasture on the right side of the stream and thin elevated forest on the left side.	Thinly forested on both sides of stream with adjacent pasture land.
Channel Dimension		
Bankfull Area (SF)	29.2 - 32.6	28.2
Width/Depth Ratio	14.6 – 34.6	13.9
Channel Pattern		
Meander Width Ratio	1.2 – 2.5	N/A[2]
Sinuosity	1.29	1
Vertical Stability		
Bank Height Ratio	1.0 – 2.5	2.6

Table 3.4 Channel Morphology Features and Stability Indicators for Candiff Creek Candiff Creek Mitigation Project -NCEEP Project #92767		
Parameter	**Candiff Creek**	
	M3 – Restoration[1]	**M2 – Enhancement I[1]**
(BHR)		
Entrenchment Ratio (ER)	1.7 – 2.9	1.2
Evolution Scenario (I-II-III…)	G-F-C	G-F-Bc
Existing Evolution Stage[3]	Aggradation and Widening	Degradation and Widening

Notes:
1. *M3 is located before M2 in the table since it is longer and involves greater channel modification.*
2. *N/A: Meander Width Ratio not measured due to past channelization.*
3. *Simon Channel Evolution Model (Simon, 1989).*

Table 3.5 Rosgen Channel Stability Assessment Candiff Creek Mitigation Project -NCEEP Project #92767	
Stability Rating	**Bank Height Ratio (BHR)**
Stable (low risk of degradation)	1.0 - 1.05
Moderately unstable	1.06 - 1.3
Unstable (high risk of degradation)	1.3 - 1.5
Highly unstable	>1.5

Notes: Rosgen, 2001b.

3.7 Channel Stability Assessment

Channel stability is defined as the ability of a stream to transport incoming flows and sediment loads supplied by the watershed without undergoing significant changes over a geologically short time-scale. A generalized relationship of stream stability was proposed by Lane (1955); it states that the product of sediment load and sediment size is in balance with the product of stream slope and discharge, or stream power. A change in any one of these variables induces physical adjustment of one or more of the other variables to compensate and maintain the proportionality.

Channels within the project area are mostly perennial, have experienced prior channelization or other kinds of watershed disturbance, and are currently impacted by grazing and row crop agriculture. Channel stability was assessed with the following methods: qualitative and quantitative site observations, site-specific geomorphic facets using detailed topographic data collected for the project and sediment analyses. Conclusions reached from these methods were used to define site stability and determine appropriate restoration approaches for both reaches (M2 and M3).

For further analysis, please refer to the tables and discussion in Section 3.6.

3.8 Bankfull Verification

Bankfull stage was verified using existing relatively stable cross-sections and field bankfull indicators. The indicators used included high scour marks, top of the bank at stable cross-sections, and the back of point bars. Bankfull stage was also identified through the use of regional curve information. By comparison of consistent field indicators and regional curves, an accurate estimation of bankfull was identified. Bankfull parameters are summarized in Table 3.1.

Baker used physical, analytical, and empirical methods to verify the bankfull stage of the project reaches of Candiff Creek. Physical field measurements were given a slightly higher weight due to their site-specific nature. Subsequent methods were used to interpret and sometimes adjust field observations.

In summary, the following steps were taken to estimate bankfull stage:

1. Identified and performed detailed survey of representative cross-sections with physical bankfull indicators,
2. Conducted internal comparison of the surveyed cross-sections to ensure consistency,
3. Compared values to regional empirical data (regional curves),
4. Applied bankfull areas, widths, and slopes to WARRSS (2006) Bankfull Velocity/Discharge Estimates spreadsheet to estimate the discharge and to evaluate bankfull parameters,
5. Considered all results and determined dimensions that most closely corresponded to bankfull.

3.8.1 Physical Field Measurement

Physical bankfull indicators surveyed during the existing conditions analysis were typically depositional bars, defined breaks in slope at a consistent elevation relative to the water surface, or transitions in bank vegetation. Upon completion of the field survey, data were plotted to check for consistency and correlation with region-specific empirical equations and regional reference data. These data were analyzed to determine the most likely bankfull stages on all project reaches. Once bankfull stage was determined using these methods, a secondary check was performed using WARRSS (2006) Bankfull Velocity/Discharge Estimates spreadsheet to assess whether a bankfull stage would produce the same relative particular flow rate as regional curve data.

3.8.2 Regional Curve Equations

Publicly available and in-house bankfull regional curves are available for a range of stream types and physiographic provinces. The North Carolina Piedmont Regional Curve (Harman et al., 1999) and an unpublished NC Piedmont Regional Curve being developed by the Natural Resources Conservation Service (A. Walker private communication, 2008) were used for comparison to other more site-specific means of estimating bankfull dimensions. The tributaries on the Candiff Creek Stream Restoration Project site are small streams; small streams are poorly represented on the regional curves. It has been found that the NC Piedmont Regional Curve Equations may overestimate channel dimension (which also effects the discharge estimate) for smaller streams such as those present at this site. The unpublished NC Piedmont Regional Curve corresponds closer to the channel dimension that was compared with the WARSSS (2006) worksheets. Baker has conducted numerous projects in small drainages in western North Carolina, and has produced “mini-curves” specific to these projects. The growing number of data points on these small streams curves provides supporting evidence for the selection of bankfull indicators that produce smaller dimensions (and flow rates) than the published regional data.

According to the unpublished NRCS North Carolina Rural Piedmont Regional Curve, the bankfull width, depth, and area appropriate for Candiff Creek’s Reach M3 is approximately 18.45 feet, 1.52 feet, 31.59 square feet, respectively. The bankfull width, depth, and area from the NC Rural Piedmont Regional Curve is approximately 20.08 feet, 2.12 feet, 42.53 square feet, respectively. Bankfull parameters are summarized in Table 3.1.

For M2, the bankfull discharge from the unpublished NRCS North Carolina Rural Piedmont Regional Curve, the bankfull width, depth, and area appropriate for Candiff Creek’s Reach M3 is approximately 17.82 feet, 1.49 feet, 29.36 square feet, respectively. The bankfull width, depth, and area from the NC Rural Piedmont Regional Curve is approximately 19.51 feet, 2.08 feet, 40.39 square feet, respectively. Bankfull parameters are summarized in Table 3.1.

3.9 Vegetation Community Type Description and Disturbance History

The habitat within and adjacent to the proposed project area consists of pasture and disturbed hardwood forest. The riparian areas ranged from relatively disturbed to very disturbed. Photographs of the project area are included in Appendix A, and a general description of each community follows, based on Schafale and Weakley, 1990.

3.9.1 Pasture Areas

These areas cover approximately 75 percent of the project area and are mostly on the left bank of M1, M2, and M3. In some areas, there are sparse trees directly on the stream banks. Currently, this land is used for grazing cattle and hay production. The vegetation within these pasture areas is primarily comprised of Fescues (*Festuca* spp.), white clover (*Trifolium repens*), and bromegrass (*Bromus inermis*). The sparse trees along stream banks include American tulip tree (*Liriodendron tulipifera*), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), River Birch (*Betula nigra*), and Eastern Sycamore *(Platanus occidentalis)*.

3.9.2 Disturbed Hardwood Forest

These forested areas comprise approximately 25 percent of the project area. The canopy is dominated by various bottomland trees such as American tulip tree (*Liriodendron tulipifera*), sweetgum (*Liquidambar styraciflua*), Cherrybark oak (*Quercus pagoda*), Swamp chestnut oak (*Quercus michauxii*), American elm (*Ulmus americana*), sugarberry (*Celtis laevigata*), green ash (*Fraxinus pennsylvanica*), loblolly pine (*Pinus taeda*), shagbark hickory (*Carya ovata*), and bitternut hickory (*Carya cordiformis*). Understory trees include American hornbeam (*Carpinus caroliniana*), Southern sugar maple (*Acer floridanum*), and red maple (*Acer rubrum*). In the lower portion of the study area, the canopy is dominated by mixtures of flood-tolerant species, such as sweetgum, American elm, water tolerant oak species, red maple, black willow (*Salix nigra*), swamp cottonwood (*Populus heterophylla*), and green ash. Other species observed included Eastern Sycamore (*Platanus occidentalis*), Yellow Buckeye (*Aesculus octandra*), River Birch (*Betula nigra*), Eastern Redcedar (*Juniperus virginiana*) and American hornbeam (*Carpinus caroliniana*). The understory is absent, or of species such as Winged elm (*Ulmus alata*), possumhaw (*Ilex deciduas*), Carolina holly (*Ilex ambigua*), and American hornbeam. Woody vines, primarily poison ivy, crossvine (*Bignonia (Anisostichus) capreolata*), and greenbriar (*Smilax spp*.), are frequently prominent. Herbs generally are sparse. Typical species include lizard's tail (*Saururus cernuus*), sedges (*Carex spp.*), jewelweed (*Impatiens capensis*), false nettle (*Boehmeria cylindrical*), three-way sedge (*Dulichium arundinaceum*), rain lily (*Zephyranthes atamasco*), and bluntleaf bedstraw (*Galium obtusum*).

3.9.3 Invasive Species

The primary invasive species present on the project site are kudzu (*Pueraria lobata*), Chinese privet (*Ligustrum sinense),* Japanese honeysuckle (*Lonicera japonica*), and multiflora rose (*Rosa multiflora*). The kudzu has completely overtaken the native vegetation in the upper section of M1 and lower sections of UT1 and UT2. The Chinese privet, Japanese honeysuckle, and multiflora rose were found interspersed primarily throughout the minimal riparian buffer areas along the stream banks.

The contractor will spray, cut and paint, or grub the areas infested with the invasive species within the easement. A couple treatments will be done in order control the invasive species with the easement (minimum kudzu control: once prior to construction-2010, once a year later-2011, and one application during the monitoring period as needed). Once the stream restoration construction is complete, a permanent fence outside the easement will be erected and the landowner intends to graze cattle and goats to control the invasive species outside the easement.

4.0 REFERENCE STREAMS

4.1 Watershed Characterization

A suitable reference quality stream that could be used to guide design of the mainstem of Candiff Creek was not available within the immediate watershed. As is the case in much of North Carolina, streams that exhibit reference quality geomorphology have long since been altered for various reasons. See Section 4.8 for design criteria discussion.

4.2 Channel Characterization

A suitable reference quality stream that could be used to guide design of the mainstem of Candiff Creek was not available within the immediate watershed. As is the case in much of North Carolina, streams that exhibit reference quality geomorphology have long since been altered for various reasons. See Section 4.8 for design criteria discussion.

4.3 Discharge

A suitable reference quality stream that could be used to guide design of the mainstem of Candiff Creek was not available within the immediate watershed. As is the case in much of North Carolina, streams that exhibit reference quality geomorphology have long since been altered for various reasons. See Section 4.8 for design criteria discussion.

4.4 Channel Morphology

A suitable reference quality stream that could be used to guide design of the mainstem of Candiff Creek was not available within the immediate watershed. As is the case in much of North Carolina, streams that exhibit reference quality geomorphology have long since been altered for various reasons. See Section 4.8 for design criteria discussion.

4.5 Channel Stability Assessment

A suitable reference quality stream that could be used to guide design of the mainstem of Candiff Creek was not available within the immediate watershed. As is the case in much of North Carolina, streams that exhibit reference quality geomorphology have long since been altered for various reasons. See Section 4.8 for design criteria discussion.

4.6 Bankfull Verification

A suitable reference quality stream that could be used to guide design of the mainstem of Candiff Creek was not available within the immediate watershed. As is the case in much of North Carolina, streams that exhibit reference quality geomorphology have long since been altered for various reasons. See Section 4.8 for design criteria discussion.

4.7 Vegetative Community Types and Disturbance History

In general, habitats in this portion of the Piedmont that are in the vicinity of floodplains are classified as palustrine, intermittently to frequently flooded. A general description of palustrine communities follow, based on Schafale and Weakley, 1990. Vegetative communities along lower portions of palustrine reaches may be flooded for relatively long periods. Sediment deposition is generally less than on the levees and of finer texture. The periodic input of nutrients makes these sites fertile, but growth is limited by flooding.

In the upper portion of project floodplain reaches, the canopy is dominated by various bottomland trees such as American tulip tree (*Liriodendron tulipifera*), sweetgum (*Liquidambar styraciflua*), Cherrybark oak (*Quercus pagoda*), Swamp chestnut oak (*Quercus michauxii*), American elm (*Ulmus americana*), sugarberry (*Celtis laevigata*), green ash (*Fraxinus pennsylvanica*), loblolly pine (*Pinus taeda*), shagbark hickory (*Carya ovata*), and bitternut hickory (*Carya cordiformis*). Understory trees include American hornbeam (*Carpinus caroliniana*), Southern sugar maple (*Acer floridanum*), and red maple (*Acer rubrum*). In the lower portion of these reaches, the canopy is dominated by mixtures of flood-tolerant species, such as sweetgum, American elm, water tolerant oak species, red maple, black willow (*Salix nigra*), swamp cottonwood (*Populus heterophylla*), and green ash.

Understory absent, or of species such as Winged elm (*Ulmus alata*), possumhaw (*Ilex decidua*), Carolina holly (*Ilex ambigua*), and American hornbeam. Woody vines, primarily poison ivy, crossvine (*Bignonia (Anisostichus) capreolata*), and greenbriar (*Smilax spp*.), are frequently prominent. Herbs generally are sparse. Typical species include lizard’s tail (*Saururus cernuus*), sedges (*Carex spp.*), jewelweed (*Impatiens capensis*), false nettle (*Boehmeria cylindrical*), three-way sedge (*Dulichium arundinaceum*), rain lily (*Zephyranthes atamasco*), and bluntleaf bedstraw (*Galium obtusum*).

4.8 Design Criteria Selection

A suitable reference quality stream that could be used to guide design of the mainstem of Candiff Creek was not available within the immediate watershed. As is the case in much of North Carolina, streams that exhibit reference quality geomorphology have long since been altered for various reasons. This is particularly true of C type channels because they were typically channelized so that the water would move off the landscape faster or to increase acreage for agriculture. For this reason Baker utilized relatively stable cross-sections within each reach as a reference guide for dimension and matched their geomorphic ratios against reference reach and past project design ratios.

In the design of the project reaches, Baker will not rely on a single reference reach. Instead, accumulated data from several stream restoration and enhancement projects from the North Carolina Piedmont were used. Generalized data on stream classification, velocity, channel morphology, and vegetation relevant to this project are summarized in the table below.

Baker has conducted numerous reference reach surveys in rural Piedmont North Carolina for C and B stream types, including many in Surry County. In addition to reference reach surveys, Baker has used past successful stream restoration projects to compile design ratios. The past successful projects were included in the design ratios to eliminate some of the error introduced from the reference reach only surveys. The errors from these surveys arise due to the fact that some, if not most, reference reaches have substantial vegetative influence. For example, on many reference reaches, streambanks are protected by mature riparian vegetation. If a restoration design used a similar pattern, severe bank stability issues could occur on the newly graded stream channel that is not armored by established vegetation. For this reason reference reach streambanks may be steeper and the width to depth ratio may be lower than a newly excavated channel could maintain. By compiling reference ratios and past successful projects appropriate design ratios have been developed. These design ratios and cross-sectional surveys from stable reaches of the stream allow for stable design parameters for dimension, pattern, and profile. These ratios can be found in the morphological design table (Table 4.1).

The specific design parameters are described in detail in Section 7. On-site data, restoration project design data, and reference reach data were used in this design and these data are described below and summarized in Table 4.2a and 4.2b. Surveyed cross-sections and longitudinal profiles from the site are included in Appendix F.

Table 4.1 Reference Reach and Past Project Data used in the Design of Candiff Creek Reaches M3 and M2

Candiff Creek Mitigation Project -NCEEP Project #92767

Parameter	MIN	MAX	MIN	MAX
Stream Type (Rosgen)	C4		B4c	
Bankfull Mean Velocity, Vbkf (ft/s)	3.5	5.0	4.0	6.0
Width to Depth Ratio, W/D (ft/ft)	10.0	14.0	12.0	18.0
Riffle Max Depth Ratio, Dmax/Dbkf	1.1	1.3	1.2	1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	1.1	1.0	1.1
Meander Length Ratio, Lm/Wbkf	7.0	12.0	N/A	N/A
Rc Ratio, Rc/Wbkf	2.0	3.0	N/A	N/A
Meander Width Ratio, Wblt/Wbkf	3.5	8.0	N/A	N/A
Sinuosity, K	1.2	1.6	1.1	1.2
Riffle Slope Ratio, Srif/Schan	1.5	2.0	1.1	1.8
Pool Slope Ratio, Spool/Schan	0	0.2	0	.4
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.0	3.5	2.0	3.5
Pool Width Ratio, Wpool/Wbkf	1.3	1.7	1.1	1.5
Pool-Pool Spacing, Lps/Wbkf	4.0	7.0	1.5	5.0

Table 4.2a Reference Reach/Past Project Geomorphic Parameters: Candiff Creek Reach M3

Candiff Creek Mitigation Project -NCEEP Project #92767

	Candiff Creek[1]						
	M3 - Existing Stream Values[2] (Restoration)		M3 - Proposed 20+00 to 61+09 (Restoration)		Composite Reference Data from Past Projects		Rationale
Parameter	Min	Max	Min	Max	Min	Max	
Stream Length (ft)	3,828		4,109				
Drainage Area, DA (sq mi)	2.74		2.74				
Stream Type (Rosgen)	C4/1, F4/1[3,4]		C4/1[3,4]				Note 1
Bankfull Discharge, Qbkf (cfs)	115		115				Note 2
Bankfull Riffle XSEC Area, Abkf (sq ft)	29.2	32.6	32.0				
Bankfull Mean Velocity, Vbkf (ft/s)	3.5	3.9	3.6		3.5	5	V=QA
Bankfull Riffle Width, Wbkf (ft)	20.7	32.2	20.4				
Bankfull Riffle Mean	0.9	1.4	1.6				D=A/W

Table 4.2a Reference Reach/Past Project Geomorphic Parameters: Candiff Creek Reach M3 Candiff Creek Mitigation Project -NCEEP Project #92767							
	Candiff Creek[1]						
	M3 - Existing Stream Values[2] (Restoration)		**M3 - Proposed 20+00 to 61+09 (Restoration)**		**Composite Reference Data from Past Projects**		**Rationale**
Parameter	Min	Max	Min	Max	Min	Max	
Depth, Dbkf (ft)							
Width to Depth Ratio, W/D (ft/ft)	14.6	34.6	13.0		11	14	Note 3
Width Floodprone Area, Wfpa (ft)	35.45	94.1	60	120			
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.7	2.9	2.9	5.9			Note 4
Riffle Max Depth @ bkf, Dmax (ft)	2.0	2.4	1.9	2.2			
Riffle Max Depth Ratio, Dmax/Dbkf	1.7	2.2	1.2	1.4	1.2	1.4	Note 5
Max Depth @ tob, Dmaxtob (ft)	2.0	5.4	1.9	2.5			
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	2.5	1.0	1.1	1	1.1	Note 6
Meander Length, Lm (ft)	40	225	143	245			Note 5
Meander Length Ratio, Lm/Wbkf	1.9	7.0	7	12	7	12	Note 5
Radius of Curvature, Rc (ft)	15	145	41	61			Note 5
Rc Ratio, Rc/Wbkf	0.7	4.5	2	3	2	3	Note 5
Belt Width, Wblt (ft)	24	82	71	133			Note 5
Meander Width Ratio, Wblt/Wbkf	1.2	1.5	3.5	6.5	3.5	7	Note 5
Sinuosity, K	1.29		1.33		1.2	1.4	
Valley Slope, Sval (ft/ft)	.0076		0.0076		.005	.015	
Channel Slope, Schan (ft/ft)	.0052		0.0052				
Riffle Slope, Srif (ft/ft)	.002	.026	0.0078	0.0104			
Riffle Slope Ratio, Srif/Schan	0.36	4.73	1.5	2.0	1.5	2.0	Note 5
Slope Pool, Spool (ft/ft)	---		0.0010	0.0001			
Pool Slope Ratio, Spool/Schan	---		0.01	0.20	0	0.2	Note 5
Pool Max Depth, Dmaxpool (ft)	3.1	3.7	3.2	5.6			
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.6	3.4	2.0	3.5	2.0	3.5	Note 5
Pool Width, Wpool (ft)	29.5	35.6	26.5	34.7			
Pool Width Ratio, Wpool/Wbkf	1.1	1.4	1.3	1.7	1.3	1.7	Note 7
Pool-Pool Spacing, Lps	48.0	161.0	81.6	142.8			

Table 4.2a Reference Reach/Past Project Geomorphic Parameters: Candiff Creek Reach M3

Candiff Creek Mitigation Project -NCEEP Project #92767

	Candiff Creek[1]						
	M3 - Existing Stream Values[2] (Restoration)		M3 - Proposed 20+00 to 61+09 (Restoration)		Composite Reference Data from Past Projects		Rationale
Parameter	Min	Max	Min	Max	Min	Max	
(ft)							
Pool-Pool Spacing Ratio, Lps/Wbkf	2.3	5.0	4.0	7.0	4.0	7.0	Note 5
d16 (mm)	8.32		8.32				
d35 (mm)	24.42		24.42				
d50 (mm)	36.68		36.68				
d84 (mm)	82.01		82.01				
d95 (mm)	119.29		119.29				

Notes:
1. Data in table reflect typical conditions where Restoration (M3) and Enhancement I (M2) approaches are proposed. Reaches M1 (690'), UT1 (835'), UT2 (1,117') are either Preservation or Enhancement II Reaches and were not geomorphically analyzed. The Enhancement II Reaches (M1and lower portions of UT1 and UT2) involve invasive species control, buffer revegetation, and livestock exclusion through fencing.
2. Denotes M3 was analyzed from 3 riffle and 2 pool cross-sections.
3. M3 is in the process of evolving from an F channel to a C channel. The upper and lower ends of M3 are classified as a C channel early within its evolutionary stage while the middle is an F channel that is late in its evolutionary stage.
4. The "/1" indicates bedrock is present within the reach.

Rationale Notes:
1. A C stream type is appropriate for gently sloped channels (generally less than 0.015 ft/ft), with a wide alluvial valleys.
2. Bankfull discharge was estimated using Manning's equation.
3. A final W/D ratio was selected based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, in-house composite ratios, as well as sediment transport analyses.
4. Required for stream classification.
5. Values were chosen based on reference reach database analysis and past project evaluation of similar C type channels in the Piedmont.
6. A bank height ratio near 1.0 ensures that all flows greater than bankfull will spread onto a floodplain. This minimizes shear stress in the channel and maximizes floodplain functionality resulting in lower risk of channel instability.
7. Values were chosen based on reference reach database analysis and past project evaluation. It is more conservative to design a pool wider than the riffle. Over time, the pool width may narrow, which is a positive evolutionary step towards greater stability.

Table 4.2b Reference Reach/Past Project Geomorphic Parameters: Candiff Creek Reach M2

Candiff Creek Mitigation Project -NCEEP Project #92767

	Candiff Creek[1]						
	M2 Existing Stream Values[2] Enhancement I		M2 - Proposed 17+35 to 20+00 Enhancement I		Composite Reference Data from Past Projects		Rationale
Parameter	Min	Max	Min	Max	Min	Max	

Table 4.2b Reference Reach/Past Project Geomorphic Parameters: Candiff Creek Reach M2

Candiff Creek Mitigation Project -NCEEP Project #92767

	Candiff Creek[1]						
	M2 Existing Stream Values[2] Enhancement I		M2 - Proposed 17+35 to 20+00 Enhancement I		Composite Reference Data from Past Projects		Rationale
Parameter	Min	Max	Min	Max	Min	Max	
Stream Length (ft)	265		265				
Drainage Area, DA (sq mi)	2.53		2.53				
Stream Type (Rosgen)	F4/1[3]		B4c/1[3]				Note 1
Bankfull Discharge, Qbkf (cfs)	105		105				Note 2
Bankfull Riffle XSEC Area, Abkf (sq ft)	28.2		29.0				
Bankfull Mean Velocity, Vbkf (ft/s)	3.7		3.6		3.5	5	V=QA
Bankfull Riffle Width, Wbkf (ft)	19.8		19.8				
Bankfull Riffle Mean Depth, Dbkf (ft)	1.42		1.42				D=A/W
Width to Depth Ratio, W/D (ft/ft)	13.9		13.9		11	14	Note 3
Width Floodprone Area, Wfpa (ft)	23.8		27.7	30.0			
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.2		1.4	1.5			Note 4
Riffle Max Depth @ bkf, Dmax (ft)	1.85		1.7	2.0			
Riffle Max Depth Ratio, Dmax/Dbkf	1.3		1.2	1.4	1.2	1.4	Note 5
Max Depth @ tob, Dmaxtob (ft)	4.8		1.7	2.2			
Bank Height Ratio, Dtob/Dmax (ft/ft)	2.6		1.0	1.1	1	1.1	Note 6
Meander Length, Lm (ft)	---		----				Note 7
Meander Length Ratio, Lm/Wbkf	---		----		----	----	Note 7
Radius of Curvature, Rc (ft)	---		----				Note 7
Rc Ratio, Rc/Wbkf	---		----		----	----	Note 7
Belt Width, Wblt (ft)	---		----				Note 7
Meander Width Ratio, Wblt/Wbkf	---		----		----	----	Note 7
Sinuosity, K	1.00		1.0		1.2	1.4	
Valley Slope, Sval (ft/ft)	0.0072		0.0072		.005	.015	
Channel Slope, Schan (ft/ft)	0.0045		0.0045				
Riffle Slope, Srif (ft/ft)	0.0056	0.0122	0.0050	0.0081			
Riffle Slope Ratio, Srif/Schan	1.2	2.7	1.1	1.8	1.5	2.0	Note 5
Slope Pool, Spool (ft/ft)	---		0.0000	0.0011			

Table 4.2b Reference Reach/Past Project Geomorphic Parameters: Candiff Creek Reach M2

Candiff Creek Mitigation Project -NCEEP Project #92767

<table>
<tr><th rowspan="2"></th><th colspan="7">Candiff Creek[1]</th></tr>
<tr><th colspan="2">M2 Existing Stream Values[2]
Enhancement I</th><th colspan="2">M2 - Proposed
17+35 to 20+00
Enhancement I</th><th colspan="2">Composite Reference Data from Past Projects</th><th rowspan="2">Rationale</th></tr>
<tr><th>Parameter</th><th>Min</th><th>Max</th><th>Min</th><th>Max</th><th>Min</th><th>Max</th></tr>
<tr><td>Pool Slope Ratio, Spool/Schan</td><td colspan="2">---</td><td>0.01</td><td>0.25</td><td>0</td><td>0.2</td><td>Note 5</td></tr>
<tr><td>Pool Max Depth, Dmaxpool (ft)</td><td colspan="2">---</td><td>2.8</td><td>4.3</td><td colspan="2"></td><td></td></tr>
<tr><td>Pool Max Depth Ratio, Dmaxpool/Dbkf</td><td colspan="2">---</td><td>2.0</td><td>3.0</td><td>2.0</td><td>3.5</td><td>Note 5</td></tr>
<tr><td>Pool Width, Wpool (ft)</td><td colspan="2">---</td><td>21.8</td><td>29.7</td><td colspan="2"></td><td></td></tr>
<tr><td>Pool Width Ratio, Wpool/Wbkf</td><td colspan="2">---</td><td>1.1</td><td>1.5</td><td>1.3</td><td>1.7</td><td>Note 8</td></tr>
<tr><td>Pool-Pool Spacing, Lps (ft)</td><td colspan="2">---</td><td>29.7</td><td>99.0</td><td colspan="2"></td><td></td></tr>
<tr><td>Pool-Pool Spacing Ratio, Lps/Wbkf</td><td colspan="2">---</td><td>1.5</td><td>5.0</td><td>4.0</td><td>7.0</td><td>Note 5</td></tr>
<tr><td>d16 (mm)</td><td colspan="2">8.32</td><td colspan="2">8.32</td><td colspan="2" rowspan="5"></td><td></td></tr>
<tr><td>d35 (mm)</td><td colspan="2">24.42</td><td colspan="2">24.42</td><td></td></tr>
<tr><td>d50 (mm)</td><td colspan="2">36.68</td><td colspan="2">36.68</td><td></td></tr>
<tr><td>d84 (mm)</td><td colspan="2">82.01</td><td colspan="2">82.01</td><td></td></tr>
<tr><td>d95 (mm)</td><td colspan="2">119.29</td><td colspan="2">119.29</td><td></td></tr>
</table>

Note:

1. Data in table reflect typical conditions where Restoration (M3) and Enhancement I (M2) approaches are proposed. Reaches M1 (690'), UT1 (835'), UT2 (1,117') are either Preservation or Enhancement II Reaches and were not geomorphically analyzed. The Enhancement II Reaches (M1 and portions of UT1 and UT2) involve invasive species control, buffer revegetation, and livestock exclusion through fencing.

2. Denotes M2 was analyzed from 1 riffle cross-section.

3. The "/1" indicates bedrock is present within the reach.

Rationale Notes:

1. A B/c stream type is appropriate for gently sloped channels (generally less than 0.015 ft/ft) that are moderately confined due to incision.
2. Bankfull discharge was estimated using Manning's equation.
3. A final W/D ratio was selected based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, in-house composite ratios, as well as sediment transport analyses.
4. Required for stream classification.
5. Values were chosen based on reference reach database analysis and past project evaluation of similar B/c type channels in the Piedmont.
6. A bank height ratio near 1.0 ensures that all flows greater than bankfull will spread onto a floodplain. This minimizes shear stress in the channel and maximizes floodplain functionality resulting in lower risk of channel instability.
7. Parameters were not derived since the channel is relatively straight (low sinuosity).
8. Values were chosen based on reference reach database analysis and past project evaluation. It is more conservative to design a pool wider than the riffle. Over time, the pool width may narrow, which is a positive evolutionary step towards greater stability.

5.0 PROJECT SITE WETLANDS (EXISTING CONDITIONS)

5.1 Jurisdictional Wetlands

No Jurisdictional Wetlands were found within the project, therefore there will be no wetland impacts.

5.2 Hydrological Characterization

No Jurisdictional Wetlands were found within the project, therefore there will be no wetland impacts.

5.3 Soil Characterization

No Jurisdictional Wetlands were found within the project, therefore there will be no wetland impacts.

5.4 Vegetative Community Types and Disturbance History

No Jurisdictional Wetlands were found within the project, therefore there will be no wetland impacts.

6.0 REFERENCE WETLANDS

6.1 Hydrological Characterization

No reference wetlands will be needed since there will be no wetland impacts on the Candiff Creek Stream Restoration Project site.

6.2 Soil Characterization

No reference wetlands will be needed since there will be no wetland impacts on the Candiff Creek Stream Restoration Project site.

6.3 Vegetative Community Types and Disturbance History

No reference wetland vegetation will be needed since there will be no wetland impacts on the Candiff Creek Stream Restoration Project site.

7.0 PROJECT SITE MITIGATION PLAN

This section relates the goals and objectives of the Candiff Creek Stream Restoration Project to the goals identified in NCEEP's River Basin Restoration Priorities (RBRP) document for the Upper Yadkin River Basin (2009). It also covers the design criteria selected for stream restoration and enhancement on the Candiff Creek project site.

Restoration and enhancement practices along Candiff Creek are justified for the following reasons:

1. Candiff Creek has been channelized and is incised along much of the project reach. Pattern, profile, and dimension adjustments to the channel will reduce erosion, improve floodplain connectivity, and improve floodplain hydrology;
2. Most of the eroded areas suffer from the loss of woody vegetation within the riparian zone. Replanting these areas will increase the stability of the stream channel and floodplain.
3. There are widespread cattle impacts that have resulted in erosion, sedimentation, and silt-clogged stream channels. The permanent easement will be fenced immediately after construction to provide livestock exclusion.

The design proposed for the project will include Rosgen Priority Level I and II Stream Restoration (4,109 LF), Levels I and II Enhancement (1,492 LF), and Preservation (1,200 LF) approaches. A Priority I approach will be applied to the upper half of M3 and will involve constructing a new channel at the elevation of the existing top of bank, so that the channel becomes reconnected with its old floodplain. A Priority II approach will be applied to the lower half of M3 and will involve constructing a new channel at a lower elevation than the existing top of bank, so that this becomes the new elevation for the floodplain. The new M3 channel will be more sinuous and have a greater interaction with its floodplain. Level I and Level II Enhancement efforts will also be used where adjustments to channel pattern are not needed and where riparian enhancement can be limited to control of exotic invasive vegetation and replanting native vegetation within a fenced permanent easement. Preservation efforts will be fenced such that livestock cannot access the stream within the easement.

The restoration and enhancement design for the mainstem of the Candiff Creek site will allow stream flows greater than bankfull to spread onto the restored floodplain, dissipating flow energies and reducing the stress on streambanks. Where abandoned, the old stream channels will be backfilled using fill material generated by the grading of new channel and floodplain benches. Any excess fill material generated during construction will be disposed of on-site in designated disposal areas. In-stream structures will be used to control streambed grade, reduce stresses on streambanks, and promote diversity of bedform and habitat. In-stream structures may consist of constructed riffles, boulder drop structures, and rock or log vanes (various types). Reach-wide grade control will be provided by the aforementioned in-stream structures, constructed riffles and by bedrock, where present. Where possible, both wood and rock will be incorporated into the structures to promote a diversity of habitat features. Streambanks will be stabilized with a combination of bioengineering measures, erosion control matting, bare-root plantings, and live staking.

7.1 Overarching Goals and Application of Mitigation Plans

After examining the assessment data collected at the site and exploring the potential for restoration, an approach to the site was developed that would address restoration and enhancement of the site reaches. The approach also needed to address invasive species issues at the upstream end of the site. An appropriate stream type was selected, based on the valley type and slope characteristics of the site, as discussed in Section 3. It was determined that enhancement and preservation would be most appropriate at the northern portion of the site (see Figure 5a and 5b). Baker developed a restoration approach for the downstream portion of the mainstem of Candiff Creek to restore historic flow patterns within the lowest part of the valley and allow this portion of the creek to access the floodplain. Special consideration was given to minimizing disturbance to existing wooded areas.

7.2 Restoration Project Goals and Objectives

Candiff Creek was identified as being in need of restoration because the project reaches have been impacted by agricultural practices. Cattle currently have access to portions of the stream, generally in areas with well-developed floodplains. The northern portion of the project area retains a partially forested buffer, but is heavily overgrown with invasive species, predominantly kudzu, Chinese privet, and multiflora rose that will be controlled by a couple treatments within the easement and livestock grazing outside the easement.

The most recent Basinwide Plan for the Yadkin-Pee Dee River Basin was completed in 2008. In the review of cataloging unit 03040101, 2006 biological community ratings indicated that out of the 70 sites monitored, 91 percent were supporting their designated uses, while 9 percent were impaired for one or more uses. Approximately 240 miles of streams in the Yadkin River Headwaters are impaired or impacted by habitat degradation. In most cases habitation is caused by the cumulative effect of several stressors acting in concert. These stressors often originate in the upland portions of the watershed and may include the addition of impervious surfaces, sedimentation and erosion from construction, general agriculture, and other land disturbing activities. Naturally erodible soils in the Yadkin River Headwaters make streams highly vulnerable to these stressors. The report notes that turbidity violations are common in this portion of the Yadkin River, and that soil erosion is the most common cause of turbidity impacts (NCDENR, 2008).

NCEEP has identified the 14-digit HU (03040101110060) that includes Candiff (aka Cundiff) Creek as a Targeted Local Watershed within their latest River Basin Restoration Priorities (RBRP) document for the Upper Yadkin River Basin (NCEEP, 2009). This designation essentially means that conditions within the Candiff and Hogan Creek drainage areas reflect a significant need for stream and/or wetlands restoration. These two streams are direct tributaries to the Yadkin River in southeastern Surry County, a priority area for aquatic habitat conservation, per NCWRC and NCNHP (2005 Wildlife Action Plan). They comprise a 23-square mile watershed that is predominantly agricultural in nature (41 percent agricultural land cover; 26 permitted animal operations). With 25 percent non-forested riparian buffers and numerous animal farms, NCEEP has concluded that this watershed likely contains significant opportunities to work with landowners towards the implementation of stream, wetlands and buffer restoration/enhancement projects. In addition, NCEEP has contributed to the implementation of agricultural BMP projects outside the project easement (see Appendix G), but further implementation within this watershed (e.g., livestock fencing, gully and streambank stabilization) could help address local water quality and habitat stressors.

In addition to it being part of an NCEEP designated Targeted Local Watershed, the Candiff Creek Stream Restoration Project site is within a priority sub-watershed identified in NCEEP's Upper Yadkin/Ararat River Local Watershed Plan (LWP) effort (NCEEP, 2009). The Candiff Creek sub-watershed was listed as the third highest priority area for both restoration/agricultural best management practices and for preservation. Surry SWCD has been the key local stakeholder partnering with NCEEP in this effort.

The goals for the stream restoration project are as follows:

- Create geomorphically stable conditions within Candiff Creek in the project area,
- Prevent cattle from accessing the project reaches to reduce excessive bank erosion,
- Improve habitat quality in a riffle dominated stream by adding pool/riffle sequences and expanding the floodplain while improving overall ecosystem functionality,
- Improve water quality within the Candiff Creek Stream Restoration Project area through reduction of bank erosion, and reductions in nutrient and sediment loads,
- Stabilization of streambanks through installation of in-stream structures and establishing a riparian buffer consisting of native species,

- Improve aquatic and terrestrial habitat through improved substrate and in-stream cover, addition of woody debris, reduction of water temperature by increasing shading, and restoration of terrestrial habitat

To accomplish these goals, this project will pursue the following objectives:

- Restore existing incised, eroding, and channelized streams by creating a stable channel with access to a floodplain,
- Improve in-stream habitat by providing a more diverse bedform with riffles and pools, creating deeper pools and areas of water re-aeration, and reducing bank erosion,
- Control invasive species from the project reaches,
- Establish native stream bank and floodplain vegetation protected by a permanent conservation easement to increase stormwater runoff filtering capacity, improve bank stability, shade the stream to decrease water temperature, and provide improved wildlife habitat quality.

7.2.1 Design Channel Classification

A number of analyses and data were incorporated in the development of site-specific natural channel design approaches. Among these are hydraulic and sediment analyses, existing site conditions data collection, incorporation of reference reach databases, regime equations, and evaluation of results from past projects.

Design criteria are dependent on the general restoration approach determined to be a best fit for the Candiff Creek reaches (Table 7.1). The approach for restoration was based on an assessment of each reach and its assigned needs. After selection of the general restoration approach, specific design criteria were developed so that the plan view layout, cross-section dimensions, and profile could be described for each reach. These criteria are presented in the preliminary construction documents included in this submittal.

Assigning an appropriate stream type for the corresponding valley to accommodate the existing and future hydrologic and sediment contributions was considered conceptually prior to developing design approaches. Design criteria for the proposed stream concept were selected based on the range of the reference data ratios and the desired performance of the proposed channel.

Following initial application of the design criteria, refinements were made to accommodate the existing valley morphology, to work around project constraints, to minimize unnecessary disturbance of the riparian area, and to allow for natural channel adjustment following construction. The construction documents have been tailored to produce a cost- and resource-efficient design that is constructible, using a level of detail that corresponds to the tools of construction. The design also reflects a philosophy that the stream will adapt to the inherent uniformity of the restoration project and be allowed to adjust over long periods of time under the processes of flooding, re-colonization of vegetation, and local topographic influences.

Table 7.1 Project Design Stream Types

Candiff Creek Mitigation Project -NCEEP Project #92767

Stream	Reach	Proposed Stream Type	Rationale[1]
Candiff Creek	M3 Restoration	C4/1	Rosgen Priority Level I and II Restoration will be used to recreate a channel with more sinuosity, increased bed diversity, and a connection to a floodplain. The reconstruction of the stream will facilitate the removal of the existing headcuts propagating up the channel, improve floodplain connectivity, move the

Table 7.1 Project Design Stream Types Candiff Creek Mitigation Project -NCEEP Project #92767			
Stream	**Reach**	**Proposed Stream Type**	**Rationale[1]**
			channel away from the hillslope, and eliminate the presence of vertical, eroding banks. Meandering riffle-pool sequences and a series of small grade drops will be used to aid in dissipating stream flow energy, decrease pool-to-pool spacing and improve the quality of pool habitat present. Planting of buffers and installing bioengineering practices with native vegetation will also improve habitat and stabilize the banks.
	M2 Enhancement I	B4c/1	An Enhancement Level I approach will be used to restore channel dimension and profile. Profile will be stabilized using grade control structures at key points where headcutting is or may occur due to changes in slope. Channel dimension will adjusted to provide a stable cross-section where it does not presently exist. Non-native, invasive vegetation will be controlled and native vegetation planted.
	M1 Enhancement II	N/A[2]	This reach will be restored using an Enhancement Level II approach. Non-native, invasive vegetation will be controlled and replanted with native herbaceous, shrub, and tree species within the newly fenced easement.
UT1[3]	Enhancement II	N/A[2]	The lower portion of this reach will be restored using an Enhancement Level II approach. Non-native, invasive vegetation will be controlled and replanted with native herbaceous, shrub, and tree species within the newly fenced easement.
UT2[4]	Enhancement II	N/A[2]	The lower portion of this reach will be restored using an Enhancement Level II approach. Non-native, invasive vegetation will be controlled and replanted with native herbaceous, shrub, and tree species within the newly fenced easement.

Notes:

1. *The conservation easement will be permanently fenced along all reaches. The landowner has indicated that he will use cattle and goats to graze areas outside of the fenced easement to further reduce invasive species on site.*
2. *N/A means that channel type was not determined due to the low level of enhancement needed.*
3. *UT1 also has 400' of Preservation upstream that will be permanently fenced.*
4. *UT2 also has 800' of Preservation upstream that will be permanently fenced.*

7.2.2 Stream Restoration Reach (M3)

Restoration efforts will include establishing appropriate pattern, profile, and dimension of Candiff Creek (M3) for 4,109 LF (Figure 5a and 5b). Grade control structures will be used to maintain channel slope and sediment transport functions while increasing habitat through bedform diversity. Dimension changes will be made to improve the overall connectivity between the stream and the floodplain as it meanders through its valley.

Rosgen Priority Level I and II Restoration approaches will be applied to M3, as aforementioned at the beginning of Section 7. A new off-line channel will be constructed to restore floodplain connectivity, provide stability, improve transport of sediment and water quality, and provide habitat and bedform diversity. Where abandoned, old stream channels will be backfilled using fill material generated by the grading of a new channel and floodplain benches or otherwise graded to make them continuous with local topography. Any excess fill material generated during construction will be stabilized on-site in locations that are at least 50 feet away from any surface water.

7.2.3 Stream Enhancement I Reach (M2)

Enhancement Level I activities are proposed on the mainstem of Candiff Creek (M2) from the end of M1 downstream for 265 LF (Figure 5a and 5b). The Enhancement I design approach on this tributary will entail bank grading and stabilization to correct channel dimension and repair livestock impacts, and the addition of grade control measures to maintain a more stable channel profile, provide bedform diversity, and for energy dissipation. Invasive species vegetation will also be controlled and native plant communities enhanced through riparian plantings. Based on the extent of the invasive vegetation and past experience, it is likely that multiple treatments will be required. The landowner has indicated that he will use cattle and goats to graze areas outside of the fenced easement to further reduce invasive species on site. Bank grading and stabilization measures are proposed in areas where channel incision has reduced connectivity of the channel to the floodplain and where cattle grazing or trampling has eroded the banks. Profile adjustments will entail installation of grade control structures to improve bedform diversity, dissipate energy, and maintain channel slope.

7.2.4 Stream Enhancement II Reaches (M1, UT1, and UT2)

Enhancement Level II practices will be applied to the top reach of Candiff Creek (M1), starting from the culvert underneath River-Siloam Road and continuing for 690 LF to the start of M2 (Figure 5a and 5b). UT1 Enhancement Level II begins after the Preservation section and continues for 485 LF to the confluence with Candiff Creek (M1). UT2 Enhancement Level II begins after the preservation section and continues for 317 LF to the confluence with Candiff Creek (M1). Enhancement II applications will involve fencing the permanent conservation easement, control of invasive species vegetation, and re-establishment of a buffer consisting of woody and herbaceous vegetation native to the ecoregion. It is likely that multiple treatments will be required to control invasive species. The landowner has indicated that he will use cattle and goats to graze areas outside of the fenced easement to further reduce invasive species on site.

7.2.5 Preservation Reaches (UT1 and UT2)

Preservation activities are proposed for sections of UT1 and UT2 (Figure 5a and 5b). Preservation on UT1 will begin at the top of the reach where UT1 flows over the property line and continues for 400 LF. Preservation on UT2 will begin at the top of the reach where UT2 flows over the property line and continues for 800 LF. The preservation approach will entail the implementation of a permanent conservation easement and fencing on an area that is a minimum of 50 feet off the top of the banks of both sides of the stream, except where the left bank of UT1, which will vary from a minimum of approximately 23 feet to in excess of 50 feet due to its proximity to the River-Siloam Road right of way. Approximately 690 feet of the left bank of UT1 will have a conservation easement less than 50 feet.

7.3 Stream Project and Design Justification

The primary objective of the restoration design is to construct a stable stream that has access to its floodplain at bankfull flows while enhancing riparian and aquatic habitat. The philosophy applied by Baker to the Candiff Creek site consisted of creating a more stable Bc and C type channels. The proposed design parameters for each of the reaches are detailed in Table 7.2a and 7.2b.

The design rationale and design parameters for all of the design reaches are presented below.

7.3.1 Dimension

Throughout the entire proposed design, the channel dimensions were adjusted to reduce velocities and near-bank shear stress. The selected design parameters eliminate incision and restore stream access to the floodplain, increasing the entrenchment ratio. Due to the size of the channels, it was necessary to use a width to depth ratio at the lower end of the range for C-type channels. It is expected that these channels may narrow to E-type morphology over time. A low bank height ratio (BHR) of 1.0 was chosen to develop a channel with access to its floodplain for relief during events having flows in excess of bankfull. Typical cross-sections are shown on the plan sheets provided with this submittal.

7.3.2 Pattern

The existing pattern of these project streams is representative of stream channelization, relocation, and livestock impacts. In general, the proposed restoration of M3 is designed to dissipate energy through meandering and in-stream structures. A meandering morphology is most appropriate for streams that have slopes less than 2 percent, as is the case of M3. Where applicable and feasible, the new channel alignment will bring the channel away from the valley wall to allow for overbank flow on both sides of the stream. The sinuosity of M3 will increase from 1.29 to 1.33 with the development of the meandering channel. The design radius of curvature for meanders ranged from 41 feet to 61 feet and design meander length ranged from 143 feet to 245 feet. These ranges were used to provide a diversity of form in order to support a wider range of potential aquatic inhabitants.

7.3.3 Profile/Bedform

The existing profile of M3 has little diversity of bedform and is comprised of long riffles with relatively short pools, common on channelized streams. The proposed meandering channel will have a regular riffle – pool sequence. The first few hundred linear feet of this new channel will have a minimal slope in order to have the channel rise (relative to the dropping valley) to an elevation where it can use the existing ground elevation as the channels floodplain, in order to achieve a Rosgen Priority I approach. The designed channel will meander through the valley connected to its original floodplain for approximately 2,000 feet before slightly increasing in slope to tie into the existing channel at the end of the project. Increasing the slope for approximately 1,500 feet will vertically lower the channel from the original floodplain causing a new floodplain to be excavated at a lower elevation than its original floodplain (i.e. a Rosgen Priority II approach).

Design riffle slopes vary from 0.0078 for low slope riffles to 0.0104 for steeper slopes. Pools have a minimal slope of 0 to 0.0001. These slopes should provide for a diversity of bedform and maintain quality habitat as sediment is moved through the reach. The profile on M2 will be adjusted in those areas that are experiencing headcuts or that appear to have the potential to headcut due the existing slope difference. In these locations, boulder cross-vane type and constructed riffle structures will be used to stabilize the profile change and improve pool habitat and diversity. M2's riffle slope will vary from 0.005 to 0.008. At any location, there will generally be one or two structures. However, it should be remembered that these structures are intended to address localized profile instability and they do not run the length of the channel.

Table 7.2a Geomorphic Characteristics of the Proposed Candiff Creek Reach M3

Candiff Creek Mitigation Project -NCEEP Project #92767

	Candiff Creek[1]				
	M3 - Proposed 20+00 to 61+09 Restoration		Composite Reference Data from Past Projects		Rationale
Parameter	Min	Max	Min	Max	
Stream Length (ft)	4,109				
Drainage Area, DA (sq mi)	2.74				
Stream Type (Rosgen)	C4/1[2,3]				Note 1
Bankfull Discharge, Qbkf (cfs)	115				Note 2
Bankfull Riffle XSEC Area, Abkf (sq ft)	32.0				
Bankfull Mean Velocity, Vbkf (ft/s)	3.6		3.5	5	V=QA

Table 7.2a Geomorphic Characteristics of the Proposed Candiff Creek Reach M3 Candiff Creek Mitigation Project -NCEEP Project #92767					
	Candiff Creek[1]				
	M3 - Proposed 20+00 to 61+09 Restoration		**Composite Reference Data from Past Projects**		**Rationale**
Parameter	Min	Max	Min	Max	
Bankfull Riffle Width, Wbkf (ft)	20.4				
Bankfull Riffle Mean Depth, Dbkf (ft)	1.6				D=A/W
Width to Depth Ratio, W/D (ft/ft)	13.0		11	14	Note 3
Width Floodprone Area, Wfpa (ft)	60	120			
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	2.9	5.9			Note 4
Riffle Max Depth @ bkf, Dmax (ft)	1.9	2.2			
Riffle Max Depth Ratio, Dmax/Dbkf	1.2	1.4	1.2	1.4	Note 5
Max Depth @ tob, Dmaxtob (ft)	1.9	2.5			
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	1.1	1	1.1	Note 6
Meander Length, Lm (ft)	143	245			Note 5
Meander Length Ratio, Lm/Wbkf	7	12	7	12	Note 5
Radius of Curvature, Rc (ft)	41	61			Note 5
Rc Ratio, Rc/Wbkf	2	3	2	3	Note 5
Belt Width, Wblt (ft)	71	133			Note 5
Meander Width Ratio, Wblt/Wbkf	3.5	6.5	3.5	7	Note 5
Sinuosity, K	1.33		1.2	1.4	
Valley Slope, Sval (ft/ft)	0.0076		.005	.015	
Channel Slope, Schan (ft/ft)	0.0052				
Riffle Slope, Srif (ft/ft)	0.0078	0.0104			
Riffle Slope Ratio, Srif/Schan	1.5	2.0	1.5	2.0	Note 5
Slope Pool, Spool (ft/ft)	0.0010	0.0001			
Pool Slope Ratio, Spool/Schan	0.01	0.20	0	0.2	Note 5
Pool Max Depth, Dmaxpool (ft)	3.2	5.6			
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.0	3.5	2.0	3.5	Note 5
Pool Width, Wpool (ft)	26.5	34.7			
Pool Width Ratio, Wpool/Wbkf	1.3	1.7	1.3	1.7	Note 7
Pool-Pool Spacing, Lps (ft)	81.6	142.8			
Pool-Pool Spacing Ratio, Lps/Wbkf	4.0	7.0	4.0	7.0	Note 5
d16 (mm)	8.32				
d35 (mm)	24.42				
d50 (mm)	36.68				
d84 (mm)	82.01				
d95 (mm)	119.29				

<u>*Notes:*</u>
1. Data in table reflect design parameters where Restoration (M3) and Enhancement I (M2) approaches are proposed. Reaches M1 (690'), UT1 (835'), UT2 (1,117') are either Preservation or Enhancement II Reaches and were not geomorphically analyzed. The Enhancement II Reaches (M1 and portions of UT1 and UT2) involve invasive species control, buffer revegetation, and livestock exclusion through fencing.
2. M3 is in the process of evolving from an F channel to a C channel. The upper and lower ends of M3 are classified as a C channel early within its evolutionary stage while the middle is an F channel that is late in its evolutionary stage.
3. The "/1" indicates bedrock is present within the reach.

<u>*Rationale Notes:*</u>

Table 7.2a Geomorphic Characteristics of the Proposed Candiff Creek Reach M3 Candiff Creek Mitigation Project -NCEEP Project #92767					
	Candiff Creek[1]				
	M3 - Proposed 20+00 to 61+09 Restoration		**Composite Reference Data from Past Projects**		**Rationale**
Parameter	Min	Max	Min	Max	

1. A C stream type is appropriate for gently sloped channels (generally less than 0.015), with a wide alluvial valleys.
2. Bankfull discharge was estimated using Manning's equation.
3. A final W/D ratio was selected based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, in-house composite ratios, as well as sediment transport analyses.
4. Required for stream classification.
5. Values were chosen based on reference reach database analysis and past project evaluation of similar C type channels in the Piedmont.
6. A bank height ratio near 1.0 ensures that all flows greater than bankfull will spread onto a floodplain. This minimizes shear stress in the channel and maximizes floodplain functionality resulting in lower risk of channel instability.
7. Values were chosen based on reference reach database analysis and past project evaluation. It is more conservative to design a pool wider than the riffle. Over time, the pool width may narrow, which is a positive evolutionary step.

Table 7.2b Geomorphic Characteristics of the Proposed Candiff Creek Reach M2

Candiff Creek Mitigation Project -NCEEP Project #92767

	Candiff Creek[1]				
	M2 - Proposed 17+35 to 20+00 Enhancement I		**Composite Reference Data from Past Projects**		**Rationale**
Parameter	Min	Max	Min	Max	
Stream Length (ft)	265				
Drainage Area, DA (sq mi)	2.53				
Stream Type (Rosgen)	B4c/1[2]				Note 1
Bankfull Discharge, Qbkf (cfs)	105				Note 2
Bankfull Riffle XSEC Area, Abkf (sq ft)	29.0				
Bankfull Mean Velocity, Vbkf (ft/s)	3.6		3.5	5	V=QA
Bankfull Riffle Width, Wbkf (ft)	19.8				
Bankfull Riffle Mean Depth, Dbkf (ft)	1.42				D=A/W
Width to Depth Ratio, W/D (ft/ft)	13.9		11	14	Note 3
Width Floodprone Area, Wfpa (ft)	27.7	30.0			
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.4	1.5			Note 4
Riffle Max Depth @ bkf, Dmax (ft)	1.7	2.0			
Riffle Max Depth Ratio, Dmax/Dbkf	1.2	1.4	1.2	1.4	Note 5
Max Depth @ tob, Dmaxtob (ft)	1.7	2.2			
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	1.1	1	1.1	Note 6
Meander Length, Lm (ft)	----				Note 7
Meander Length Ratio, Lm/Wbkf	----		----	----	Note 7
Radius of Curvature, Rc (ft)	----				Note 7
Rc Ratio, Rc/Wbkf	----		----	----	Note 7
Belt Width, Wblt (ft)	----				Note 7
Meander Width Ratio, Wblt/Wbkf	----		----	----	Note 7

Table 7.2b Geomorphic Characteristics of the Proposed Candiff Creek Reach M2

Candiff Creek Mitigation Project -NCEEP Project #92767

	Candiff Creek[1]				
	M2 - Proposed 17+35 to 20+00 Enhancement I		Composite Reference Data from Past Projects		Rationale
Parameter	Min	Max	Min	Max	
Sinuosity, K	1.0		1.2	1.4	
Valley Slope, Sval (ft/ft)	0.0072		.005	.015	
Channel Slope, Schan (ft/ft)	0.0045				
Riffle Slope, Srif (ft/ft)	0.0050	0.0081			
Riffle Slope Ratio, Srif/Schan	1.1	1.8	1.5	2.0	Note 5
Slope Pool, Spool (ft/ft)	0.0000	0.0011			
Pool Slope Ratio, Spool/Schan	0.01	0.25	0	0.2	Note 5
Pool Max Depth, Dmaxpool (ft)	2.8	4.3			
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.0	3.0	2.0	3.5	Note 5
Pool Width, Wpool (ft)	21.8	29.7			
Pool Width Ratio, Wpool/Wbkf	1.1	1.5	1.3	1.7	Note 8
Pool-Pool Spacing, Lps (ft)	29.7	99.0			
Pool-Pool Spacing Ratio, Lps/Wbkf	1.5	5.0	4.0	7.0	Note 5
d16 (mm)	8.32				
d35 (mm)	24.42				
d50 (mm)	36.68				
d84 (mm)	82.01				
d95 (mm)	119.29				

Note:

1. *Data in table reflect design parameters where Restoration (M3) and Enhancement I (M2) approaches are proposed. Reaches M1 (690'), UT1 (835'), UT2 (1,117') are either Preservation or Enhancement II Reaches and were not geomorphically analyzed. The Enhancement II Reaches (M1 and portions of UT1 and UT2) involve invasive species control, buffer revegetation, and livestock exclusion through fencing.*
2. *The "/1" indicates bedrock is present within the reach.*

Rationale Notes:

1. *A B/c stream type is appropriate for gently sloped channels (generally less than 0.015) that are moderately confined due to incision.*
2. *Bankfull discharge was estimated using Manning's equation.*
3. *A final W/D ratio was selected based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, in-house composite ratios, as well as sediment transport analyses.*
4. *Required for stream classification.*
5. *Values were chosen based on reference reach database analysis and past project evaluation of similar B/c type channels in the Piedmont.*
6. *A bank height ratio near 1.0 ensures that all flows greater than bankfull will spread onto a floodplain. This minimizes shear stress in the channel and maximizes floodplain functionality resulting in lower risk of channel instability.*
7. *Parameters were not derived since the channel is relatively straight (low sinuosity).*
8. *Values were chosen based on reference reach database analysis and past project evaluation. It is more conservative to design a pool wider than the riffle. Over time, the pool width may narrow, which is a positive evolutionary step.*

7.3.4 Sediment Transport

The purpose of sediment transport analysis is to ensure that the stream restoration design creates a stable channel that does not aggrade or degrade over time. The overriding assumption is that the project reach should be transporting all the sediment delivered from upstream sources, thereby being a “transport” reach and classified as a Rosgen C or E type channel.

Shear stress and stream power relationships were only generated for reaches that would be restored or enhanced (M3 and M2 respectively) within the project. M2 and M3 reaches have median particle sizes of coarse gravel. In isolated locations, coarse material and bedrock in riffles appears to control grade. The streams also receive significant quantities of fine materials from both bank erosion and contributions from the upstream catchment. While restoration of the channel will reduce localized bank erosion, the channel will still need to transport the fine materials from upstream sources. In sand bed streams, sediment transport capacity is a critical analysis, whereas in gravel bed streams, sediment transport competency is a critical analysis. Since the design reaches must transport both sand and gravel sized particles, both capacity and competency were analyzed.

Sediment transport capacity, measured as unit stream power (Watts/meter^2), was compared for the existing stream channels and the design conditions. Table 7.3 shows bankfull boundary shear stress and stream power values for existing and design conditions. Stream power values for the existing and design conditions all compare well to values for similar streams and valley types described by Bledsoe et al. (2002). Bankfull boundary shear stress and stream power values for M2 are basically the same for the existing and design values since the channel is currently transporting sediment through the reach and will continue once construction is complete. Currently, M3 has lower bankfull boundary shear stress and stream power values than the proposed design. This is because the existing reach is aggradational, since it is in the process of transiting from an F channel to a C channel; meaning that the channel has overly widened and is now aggrading within its banks to form a new channel that can appropriately move the required sediment load. The design for M3 will be able to transport the sediment load.

Sediment transport competency is estimated in terms of the relationship between critical and actual depth at a given slope and occurs when the critical depth produces enough shear stress to move the largest (d_{100}) sub pavement particle. As shown in Table 7.3, M2 and M3 have design depths greater than or equal to the critical depth which may indicate the tendency to degrade. The concern for degradation will be addressed by grade control structures which will be installed. As a second check of sediment transport competency, boundary shear stress was plotted on Shield’s Curve to estimate the largest moveable particle. In both streams, as shown in Table 7.3, the Shield’s Curve predicts the mobility of particles approximately equal to the d_{100} observed in the subpavement. Both of these sediment transport competency analyses confirm the ability of the design channel to transport the coarse sediment load.

Table 7.3 Boundary Shear Stresses and Stream Power for Existing and Proposed Conditions of M3 and M2

Candiff Creek Mitigation Project NCEEP Project #92767

Parameter	Candiff Creek Values[1]			
	M3 Existing Conditions	**M3 Proposed Conditions**	**M2 Existing Conditions**	**M2 Proposed Conditions**
Bankfull Discharge, Q (cfs)	115	115	105	105
Bankfull Area (square feet)	32.6	32.0	28.2	29.0
Mean Bankfull Velocity (cfs)	3.5	3.6	3.7	3.6
Bankfull Width, W (feet)	32.2	20.4	19.8	19.8

Table 7.3 Boundary Shear Stresses and Stream Power for Existing and Proposed Conditions of M3 and M2 Candiff Creek Mitigation Project NCEEP Project #92767				
Parameter	**Candiff Creek Values[1]**			
	M3 Existing Conditions	**M3 Proposed Conditions**	**M2 Existing Conditions**	**M2 Proposed Conditions**
Bankfull Mean Depth, D (feet)	1.4	1.6	1.4	1.4
Width to Depth Ratio, w/d (feet/ foot)	23.0	13.0	13.9	13.9
Wetted Perimeter (feet)	35.0	23.6	22.6	22.6
Hydraulic Radius, R (feet)	0.9	1.4	1.2	1.3
Channel Slope (feet/ foot)	0.0055	0.0052	0.0045	0.0045
Boundary Shear Stress, τ (lbs/ft^2)	.32	0.44	0.35	0.36
Subpavement D_{100} (mm)	115	115	90	90
Largest Moveable Particle (mm) per Modified Shield's Curve	84	115	92	94
Critical Depth (feet)	1.2	1.3	1.4	1.4
Critical Slope (feet/ foot)	0.0048	0.0042	0.0045	0.0045
Stream Power (W/m^2)	22.1	26.6	21.7	21.7
Note: 1. *M3 is located before M2 in the table since it is longer and involves greater channel modification.*				

7.4 Site Construction

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

A construction sequence is provided below and can be found within the accompanying restoration plan set for the Candiff Creek stream restoration project.

1. Equipment and materials shall be mobilized to the site.

2. Utility locations shown on these plans are approximate. The contractor shall have all utilities within the project limits located and marked prior to beginning construction. The contractor will be responsible for the repair of any utilities damaged during construction, including any new stock watering waterlines crossing the project area.

3. A gravel, Class A Stone "construction entrance" at least 50 feet in length, shall be incorporated into every access point that connects to a public road.

4. Temporary and permanent stream crossings and temporary rock dams shall be installed as shown in the plan set. Temporary rock dams shall be removed when grading work upstream has been completed.

5. Construction shall proceed upstream to downstream. Grading of bankfull benches within a work area shall be done before new channels are graded.

6. Temporary rock dams shall be installed upstream of each work area and flow in the work reach shall be diverted by pumping and piping around the work area. The length of each diversion shall be approximately 300 to 600 linear feet. Pumping will be done when work is required in a channel where the stream is flowing. Much of the mainstem work will be done offline. Existing channel material should be stockpiled and incorporated in constructed off-line reaches.

7. The limited clearing and grubbing required within the grading limits shall be performed so as to limit sediment migration off-site. Logs and root wads from trees larger than 10 inches in diameter shall be stockpiled for use as in-stream structures. Salvageable native vegetation (black willow, tag alder, silky dogwood, etc.) shall be harvested for transplanting or for cutting and live-staking materials.

8. The new channel sections shall be stabilized with in-stream structures, erosion control matting, seed, and transplants before turning water into these sections. Compacted soil channel plugs shall be installed in areas where the new channel diverges from the original channel, and the original, abandoned channel sections will be backfilled.

9. Dewatering effluent from off-line sections shall be diverted through a sediment filter before being discharged into the downstream reach.

10. Earthwork shall be staged such that no more channel will be disturbed than can be stabilized by the end of the work day or before flow is diverted into a new channel segment.

11. Disturbed areas within the first 25 feet of buffer adjacent to the channel will be seeded, mulched, or otherwise stabilized with temporary ground cover until a more permanent ground cover is established across the buffer area disturbed during construction. If temporary ground cover is not applied at the end of the workday, straw wattles will be staked down at the top of the bank where erosion control matting ends to prevent sediment loading from upland portions of the buffer that have not stabilized.

12. Excess soil materials shall be stockpiled in designated staging and stockpile areas, with silt fence installed on the stream side(s) of the base of the stockpiles and maintained when sediment has accumulated above one third of the height of the silt fence and/or the silt fence has failed. Excess soil shall be hauled outside the conservation easement before demobilization.

13. The flow diversions and temporary stream crossings shall be removed when no longer needed and the banks in these areas stabilized with seeding and matting.

14. Bank and floodplain vegetation, including brush materials and live stakes, are preferably installed during the dormant season (November to May).

15. Staging and stockpile areas, and silt fences shall be removed and the ground shall be repaired to its original conditions once planting is complete or once they are no longer needed. Construction entrances may also be removed or left in place if the land owner wishes to retain them.

16. The Contractor shall ensure that the project is free of trash and leftover materials prior to demobilization of equipment from the site.

7.4.2 In-stream Structures and Other Construction Elements

A variety of in-stream structures are proposed for the Candiff Creek site. Structures such as constructed riffles, rock cross vanes, log and rock vanes, log and rock j-hook vanes, and log and rock step pools will be used to stabilize the newly-restored stream reaches. This project will primarily utilize those structures which provide grade control and enhance pool habitat as C and B type streams make up the project site. Wood structures will alternate with boulder structures on this site to utilize and mimic the material observed in the existing system. Some wood will be generated through the construction of this project;

however, we understand that some logs and rootwads used in this project may have to be brought to the site or extracted outside the easement. Table 7.4 summarizes the use of in-stream structures at the site.

Table 7.4 Proposed In-Stream Structure Types and Locations
Candiff Creek Mitigation Project -NCEEP Project #92767

Structure Type	Location
Constructed Riffle	Through straight, steeper sections to provide grade control.
Cover Log	Located along outside bends or against one bank in straight reaches to increase pool diversity and provide cover for fish.
Log/Rock Vane	In meander bends to turn water to protect outside banks and promote scour to maintain pools.
Log/Rock Step Sequence	In steep channels to control grade and maintain step-pool system.
Rock Cross Vane	Downstream of floodplain constrictions to direct high velocity flow emerging from the constriction to the center of the channel to prevent bank erosion and provide grade control.
Step Pool Structure	Swales that are tying into the channel tend to be slightly incised. A series of steps are used to control grade and to reduce headcutting.
Vegetated Geolift	To create new banks in areas where fill has been added. Outside of meander bends under particularly high stress or in areas where slight lateral migration is unacceptable.
Rootwad	Outside bank of meander bends to reduce bank shear stress and improve aquatic habitat.

Constructed Riffle

A constructed riffle consists of the placement of coarse bed material in the stream at specific riffle locations along the profile. A buried log or rocks at the upstream and downstream end of riffles may be used to control the slope through the riffle in steeper sections. The purpose of this structure is to provide grade control and establish riffle habitat. Constructed riffles will be placed throughout both reaches. Constructed riffles and cross vanes will be intermixed to provide diversity of structure and in-stream habitat.

Cover Log

Cover logs are used typically driven into streambanks or secured using rebar and, as noted above, can be used in straight stream reaches as well as the outer bends of streams. The primary purpose of these structures is to improve bed form diversity by creating small pools in addition to those created by boulder steps and vanes. In addition to improving pool habitat, cover logs are also placed to create cover for fish.

Log/Rock Vane

A log/rock vane is used to protect the stream bank. The length of a single vane structure can span one-half to two-thirds the bankfull channel width. Vanes are located either upstream or downstream along a meander bend and function to initiate or complete the redirecting of flow energies resulting in reduced near bank shear stress and alignment maintenance. Vanes are located just downstream of the point where the stream flow intercepts the bank at acute angles. These vanes may also be used outside of meanders on moderate to steep channel gradients for grade control (usually as J-hooks), a primary concern in this restoration project. Logs and or boulders may be used to construct vanes.

Log/Rock Sequence

In a log/rock sequence, logs/rocks are usually placed in a series and at opposing angles and slopes. These structures are used in riffles to create small meanders within the riffle, diversifying habitat.

Rock Cross Vane

Cross vanes are used to provide grade control, keep the thalweg in the center of the channel, and protect the stream bank. A cross vane consists of two rock vanes joined by a center structure installed perpendicular to the direction of flow. This centering structure sets the invert elevation of the stream bed.

Boulder Step Pool Structure

Boulder step structures consist of boulders placed in the channel in a U-shape constructed similarly to a cross-vane. These structures provide grade control in swales and side tributaries, direct high velocity flows to the center of the channel, and promote diverse habitat through the creation of plunge pools immediately downstream of the structure.

Vegetated Geolift

A geolift consists of a layer of biodegradable matting back filled with soil (creating a lift) that is stacked upon a stone toe base. A row of native, riparian, woody vegetation is laid on top of this first soil lift and a second lift is constructed on top of the woody material. This alternating of lift and woody material continues up to the desired elevation. The mesh that makes up the matting acts much like a traditional gabion, but is designed to break down over time and is more economical. Unlike gabions that are filled over with topsoil to create a bank, the geolift actually holds the soil in place between layers of matting that are set perpendicular to the bank slope making it more effective in supporting the slope while vegetation is established. Geolifts also work to retain moisture for live stakes or other vegetation and provide a substrate for the establishment of a root system.

Rootwad

Rootwads are large intact root masses placed at the toe of the stream bank in high stress areas to absorb energy, increase flow roughness and provide a physical barrier to the erosion of vulnerable stream banks. In the process, they can help induce scour-pool formation and serve as habitat for organisms favoring wood or cover. In addition to stream bank protection, they provide structural support to the stream bank and habitat for fish and other aquatic animals. They also increase substrate surface area for aquatic insects and other benthic organisms. Root wads include the root mass or root ball of a tree plus a portion of the trunk which is driven or buried into the bank.

7.4.3 Natural Plant Community Restoration

Native riparian vegetation will be established in the restored stream buffer. Areas of invasive vegetation such as kudzu, Chinese privet, multiflora rose, and Japanese honeysuckle will be controlled so as not to threaten the newly-established native plants within the conservation easement.

7.4.3.1 Soil Preparation and Amendments

Soil amendments will be prepared according to the dominant soil types present within the floodplains along Candiff Creek. Application of soil amendments will occur as temporary site stabilization measures are implemented, during construction and during installation of permanent bank and riparian vegetation. The use of soil amendments will be minimized to the extent possible to prevent the accelerated growth of weed species as the native riparian seed mix becomes established.

7.4.3.2 Stream Buffer Vegetation

Bare-root and containerized trees, live stakes, shrubs, and permanent seeding will be planted within designated areas of the conservation easement. A minimum 50-foot buffer measured from the top of banks (sometimes substantially more) will be established along the restored or enhanced stream reaches. In the preservation reach, the combined buffer width outside the left and right banks will be approximately 100 feet, but often more than 100 feet. Bare-root and containerized vegetation (trees and shrubs) will be planted at a target density of 680 or greater stems per acre, or approximately 8-foot by 8-foot grid. The proposed species to be planted are listed in Table 7.5. Planting of bare-root or containerized trees, live stakes and shrubs will be conducted during the first dormant season following construction. If construction activities are completed in summer/fall of a given year, all vegetation will be installed prior to the start of the growing season of the following calendar year.

Species selection for re-vegetation of the site will generally follow those suggested by Schafale and Weakley (1990). Tree species selected for stream restoration areas will generally be weakly tolerant to tolerant of flooding. Weakly tolerant species are able to survive and grow in areas where the soil is saturated or flooded for relatively short periods of time. Moderately tolerant species are able to survive in soils that are saturated or flooded for several months during the growing season. Flood tolerant species are able to survive on sites in which the soil is saturated or flooded for extended periods during the growing season (WRP, 1997).

Once trees are transported to the site, they will be planted within two days. Soils across the site will be sufficiently disked and loosened prior to planting. Trees will be planted by manual labor using a dibble bar, mattock, planting bar, or other approved method. Planting holes for the trees will be sufficiently deep to allow the roots to spread out and down without "J-rooting." Soil will be loosely compacted around trees once they have been planted to prevent roots from drying out.

Live stakes will be installed two to three feet apart in meander bends and six to eight feet apart in the riffle sections using triangular spacing along the stream banks between the toe of the stream bank and bankfull elevation. Site variations may require slightly different spacing.

Permanent seed mixtures will be applied to all disturbed areas of the project site. Table 7.6 lists the species, mixtures, and application rates that will be used. Mixtures will also include temporary seeding (rye grain during cold season or browntop millet during warm season). The permanent seed mixture specified for floodplain areas will be applied to all disturbed areas outside the banks of the restored stream channel and is intended to provide rapid growth of herbaceous ground cover and biological habitat value. The species provided are deep-rooted and have been shown to proliferate along restored stream channels, providing long-term stability.

Temporary seeding will be applied to all disturbed areas of the site that are susceptible to erosion. These areas include constructed stream banks, access roads, side slopes, and spoil piles. If temporary seeding is applied from November through April, rye grain will be used and applied at a rate of 130 pounds per acre. If applied from May through October, temporary seeding will consist of browntop millet, applied at a rate of 45 pounds per acre.

Table 7.5 Proposed Bare-Root and Live Stake Species (may also include species to be seeded or installed as container plantings)

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Common Name	Scientific Name	% Planted by Species	Wetness Tolerance
Riparian Buffer Plantings			
Trees (75%) Planted 9' X 9' Spacing – 538 Trees/ Acre			
River Birch	*Betula nigra*	15%	FACU
Black Walnut	*Juglans nigra*	10%	FACU
Sycamore	*Platanus occidentalis*	20%	FACW
Tulip Poplar	*Liriodendron tulipifera*	15%	FAC

Southern Red Oak	*Quercus falcata*	15%	FACU
Willow Oak	*Quercus phellos*	15%	FACU-
Persimmon	*Diospyros virginiana*	10%	FAC
Shrubs (25%) Planted 16' X 16' Spacing - 164 Shrubs/ Acre			
Tag Alder	*Alnus serrulata*	20%	FACW+
Spicebush	*Lindera benzoin*	25%	FACW
Redbud	*Cercis canadensis*	20%	FACU
Elderberry	*Sambucus canadensis*	15%	FACW-
Silky Dogwood	*Cornus amomum*	20%	FAC
Riparian Livestake Plantings			
Elderberry	*Sambucus canadensis*	20%	FACW-
Silky Dogwood	*Cornus amonum*	25%	FACW+
Silky Willow	*Salix sericea*	25%	OBL
Black Willow	*Salix nigra*	10%	OBL
Ninebark	*Physocarpus opulifolius*	20%	FAC-
Note: Species selection may change due to refinement or availability at the time of planting.			

Table 7.6 Proposed Permanent Seed Mixture

Candiff Creek Mitigation Project -NCEEP Project #92767

Common Name	Scientific Name	% Planted by Species	Density (lbs/ac)	Wetness Tolerance
Redtop	*Agrostis alba*	10%	1.5	FACW
Virginia Wildrye	*Elymus virginicus*	15%	2.25	FAC
Switchgrass	*Panicum virgatum*	15%	2.25	FAC+
Eastern Gamma Grass	*Tripsacum dactyloides*	5%	0.75	FAC+
Pennsylvania Smartweed	*Polygonum pennsylvanicum*	5%	0.75	FACW
Little Blue Stem	*Schizachyrium scoparium*	5%	0.75	FACU
Soft Rush	*Juncus effusus*	5%	0.75	FACW+
Beggars Tick	*Bidens frondosa (or aristosa)*	5%	0.75	FACW
Lance-Leaved Tick Seed	*Coreopsis lanceolata*	10%	1.5	FAC
Tioga Deer Tongue	*Dichanthelium clandestinum*	15%	2.25	FACW
Big Blue Stem	*Andropogon gerardii*	5%	0.75	FAC
Indian Grass	*Sorgastrum nutans*	5%	0.75	FACU
	Total	**100%**	**15**	
Note: Species selection may change due to refinement or availability at the time of planting.				

7.4.3.3 On-site Invasive Species Management

The site has some infestation of kudzu (*Pueraria lobata*), Chinese privet (*Ligustrum sinense*), multiflora rose (*Rosa multiflora*), and Japanese honeysuckle (*Lonicera japonica*). These areas will be treated and monitored so that the invasive species do not threaten the newly-planted riparian vegetation. The contractor will spray, cut and paint, or grub the areas infested with the invasive species within the easement. A couple treatments will be carried out in order control the invasive species within the easement (minimum kudzu control: once prior to construction-2010, once a year later-2011, and one application during the monitoring period as needed). Once the stream restoration construction is complete, a permanent fence outside the easement will be erected and the landowner intends use cattle and goats to graze areas outside of the fenced easement to further reduce invasive species on site. Ultimately, the invasive species control will provide a window to allow the native herbaceous and woody vegetation to thrive and take over where the invasive species currently exist at the site.

Fields within the easement boundaries are predominantly planted in fescue. Fescue will be treated by physical and chemical means in order to reduce competition for native grasses.

The most appropriate means of treating invasive grasses growing in the creek and on the margins of the channel will be assessed and implemented prior to vegetation control. In many cases, building a new offline channel will reduce or eliminate this issue and the long-term development of a forested creek will provide shade to limit invasive species habitat.

8.0 PERFORMANCE CRITERIA

Based on the restoration approaches to be used, different success criteria are proposed for the restored stream reaches. For reaches M3 and M2, which involves the Restoration and Enhancement I of the historic flow patterns as a single-thread channel, success criteria will follow those recommended by the Stream Mitigation Guidelines (USACE and NCDWQ 2003). For the Enhancement II and Preservation reaches UT1, UT2, and M1, success criteria will focus primarily on visual assessments and vegetation success (at least for the Enhancement reaches). The approaches to be used relative to the restoration type are described below.

8.1 Streams

Channel stability and vegetation survival will be monitored for success on the project site. Post-restoration monitoring will be conducted for a minimum of five years or until the success criteria are met following the completion of construction to document project success. The methods used and related success criteria are described below for each reach and parameter.

8.1.1 Stream Success - M3 (Restoration) and M2 (Enhancement I)

Stream monitoring of the restoration portion of reach M3 and the enhancement portion of M2 will be conducted for a minimum of five years to evaluate the effectiveness of the restoration practices. Monitored stream parameters include stream dimension (cross-sections), profile (longitudinal profile), and photographic documentation. The methods used and related success criteria are described below for each parameter.

8.1.1.1 Bankfull Events

Two bankfull events must be documented within the 5-year monitoring period. The bankfull events must occur in separate years; otherwise, the monitoring will continue until two floodplain events have been documented in separate years.

8.1.1.2 Cross-sections

There should be little change in as-built cross-sections. If changes do take place they should be evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross-sections shall be classified using the Rosgen Stream Classification System, and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

8.1.1.3 Longitudinal Profile

The longitudinal profiles should show that the bedform features are remaining stable (i.e., they are not aggrading or degrading). The pools should remain deep with flat water surface slopes, and the riffles should remain steeper and shallower than the pools. Bedforms observed should be consistent with those observed for channels of the design stream type.

8.1.1.4 Bed Material Analysis

Pebble counts shall be conducted immediately after construction and annually thereafter at the time the cross-section and longitudinal surveys are performed during the five-year monitoring period. These samples will reveal any changes in sediment gradation that occur over time as the stream adjusts to upstream sediment loads. Significant changes in sediment gradation shall be evaluated with respect to stream stability and watershed changes.

8.1.2 Stream Success – UT1, UT2, and M1 (Enhancement I)

Visual monitoring of reach UT1, UT2, and M1 will be conducted for a minimum of five years or until the success criteria are met to evaluate the effectiveness of the restoration practices. Since this reach involves Level II Enhancement techniques to stabilize the existing channel single channel, monitoring efforts will focus on visual documentation of channel stability. The methods used and any related success criteria are described below for each parameter.

8.1.2.1 Photo Reference Sites

Photographs will be used to visually document success.

8.1.3 Stream Success – UT1 and UT2 (Preservation)

Visual monitoring of reaches UT1 and UT2 will be conducted for a minimum of five years. Since these reaches are considered Preservation, monitoring efforts will focus on visual documentation of stability. No significant planting or channel construction is proposed for the Preservation sections of UT1 and UT2 since the surrounding areas are wooded. The methods used and any related success criteria are described below for each parameter.

8.1.3.1 Photo Reference Sites

Photographs will be used to document success visually. The photographs will document the channel and existing riparian buffer being preserved.

8.2 Stormwater Management Devices

This restoration project does not include stormwater management devices.

8.3 Wetlands

There are no wetlands associated with this project.

8.4 Vegetation

The interim measure of vegetative success for the site will be the survival of at least 320, 3-year old, planted woody stems per acre at the end of year three of the monitoring period. The final vegetative success criteria will be the survival of 260, 5-year old, planted woody stems per acre at the end of year five of the monitoring period. Photos will be taken and density counts will be completed in order to show the riparian vegetation progression.

8.5 Schedule/Reporting

8.5.2 Schedule

A mitigation plan and as-built report documenting both stream restoration activities will be developed after the completion of site planting and the installation of wells on the restored site. The report will include all information required by NCEEP mitigation plan guidelines in accordance with NCEEP Mitigation Plan Document, Version 2.0 (2008).

A monitoring program will be implemented to document system development and progress toward achieving the success criteria referenced in the previous sections. The monitoring program will be undertaken for five years, or until the final success criteria are achieved, whichever is longer. Monitoring reports will be prepared in the fall of each monitoring year and submitted to NCEEP in accordance with NCEEP Monitoring Report, Version 1.2 (2006). The monitoring reports will include:

- A detailed narrative summarizing the project background that will include, project objectives restoration approach, project history and background
- Stream assessment that includes morphometric and hydrologic success criteria, monitoring results and/or problems areas, stream photographs, and data tables
- Vegetation assessment that includes vegetative success criteria, monitoring results and/or problem areas, vegetative photographs, and data tables
- Overall conclusions and recommendations
- Wildlife observations
- References
- As-built topographic maps showing locations of monitoring gauges, vegetation sampling plots, permanent photo points, and location of transects.

9.0 MONITORING PLAN

Based on the restoration approaches to be used, different monitoring techniques are proposed for the restored stream reaches. For reaches M3 and M2, which involves the Restoration and Enhancement I of the historic flow patterns as a single-thread channel, monitoring will follow those recommended by the Stream Mitigation Guidelines (USACE and NCDWQ 2003). For the Enhancement II and Preservation reaches UT1, UT2, and M1, monitoring will focus primarily on visual assessments and vegetation success (at least for the Enhancement reaches). The approaches to be used relative to the restoration type are described below.

9.1 Streams

Channel stability and vegetation survival will be monitored on the project site. Post-restoration monitoring will be conducted for a minimum of five years or until the success criteria are met following the completion of construction to document project success. The methods used and related success criteria are described below for each reach and parameter.

9.1.1 Stream Monitoring - M3 (Restoration) and M2 (Enhancement I)

Stream monitoring of the restoration portion of reach M3 and the enhancement portion of M2 will be conducted for a minimum of five years to evaluate the effectiveness of the restoration practices. Monitored stream parameters include stream dimension (cross-sections), profile (longitudinal profile), and photographic documentation. The methods used and related success criteria are described below for each parameter.

9.1.1.1 Bankfull Events

The occurrence of bankfull events within the monitoring period will be documented by the use of one crest gauge and site photographs. The crest gauge will be installed within 10 feet of the restored channel on the restored portion M3. The crest gauge will record the highest watermark between site visits and the gauge will be checked during each site visit to determine if a bankfull event has occurred. Site photographs may be used to document the occurrence of debris lines and sediment deposition on the floodplain during site visits.

9.1.1.2 Cross-sections

Two permanent cross-sections will be installed per 1,000 LF of stream restoration work, with one located at a riffle cross-section and one located at a pool cross-section. Each cross-section will be marked on both banks with permanent pins to establish the exact transect used. A common benchmark will be used for cross-sections and consistently used to facilitate easy comparison of year-to-year data. The annual cross-section survey will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross-sections will be classified using the Rosgen Stream Classification System.

9.1.1.3 Longitudinal Profile

A longitudinal profile will be completed immediately after construction and annually thereafter for the duration of the five-year monitoring period. The as-built survey will be used as the baseline for subsequent surveys. The profile will be conducted for 3,000 LF of the restored Candiff Creek channel. Measurements will include thalweg, water surface, inner berm, bankfull, and top of low bank. Each of these measurements will be taken at the head of each feature (e.g., riffle, run, pool, glide) and the maximum pool depth. The survey will be tied to a permanent benchmark.

9.1.1.4 Bed Material Analysis

Reach wide pebble counts shall be conducted annually for the M3 reach. Pebble counts shall be conducted immediately after construction and annually thereafter at the time the cross-section and longitudinal surveys are performed during the five-year monitoring period. These samples will reveal any changes in sediment gradation that occur over time as the stream adjusts to upstream sediment loads. Significant changes in sediment gradation shall be evaluated with respect to stream stability and watershed changes.

9.1.1.5 Photo Reference Sites

Photographs will be used to document success visually. Reference stations will be photographed for a minimum of five years following construction. Reference photos will be taken once a year. Photographs will be taken from a height of approximately five to six feet. Permanent markers will be established to ensure that the same locations (and view directions) on the site are documented in each monitoring period.

The stream will be photographed longitudinally beginning at the downstream end of the restoration site and moving upstream to the start of the project. Photographs will be taken looking upstream at delineated locations. Reference photo locations will be marked and described for future reference. Points will be close enough together to provide an overall view of the reach. The angle of the shot will depend on what angle provides the best view and will be noted and continued in future shots. When modifications to photo position must be made due to obstructions or other reasons, the position will be noted along with any landmarks and the same position will used in the future.

9.1.2 Stream Monitoring – UT1, UT2, M1 (Enhancement II)

Visual monitoring of reach UT1, UT2, and M1 will be conducted for a minimum of five years or until the success criteria are met to evaluate the effectiveness of the restoration practices. Since this reach involves Level II Enhancement techniques to stabilize the existing channel single channel, monitoring efforts will focus on visual documentation of stability. The methods used and any related success criteria are described below for each parameter.

9.1.2.1 Photo Reference Sites

Photographs will be used to document success visually. Reference stations will be photographed for at a minimum of five years or until the success criteria are met following construction. Reference photos will be taken once a year. Photographs will be taken from a height of approximately five to six feet. Permanent markers will be established to ensure that the same locations (and view directions) on the site are documented in each monitoring period.

The stream will be photographed longitudinally. Photographs will be taken looking upstream at delineated locations. Reference photo locations will be marked and described for future reference. Points will be close enough together to provide an overall view of the reach. The angle of the shot will depend on what angle provides the best view and will be noted and continued in future shots. When modifications to photo position must be made due to obstructions or other reasons, the position will be noted along with any landmarks and the same position will used in the future.

9.1.3 Stream Monitoring – UT1 and UT2 (Preservation)

Visual monitoring of reaches UT1 and UT2 will be conducted for a minimum of five years or until the success criteria are met. Since these reaches are considered Preservation, monitoring efforts will focus on visual documentation of stability. No significant planting is proposed for the Preservation sections of UT1 and UT2 since the surrounding areas are wooded. The methods used and any related success criteria are described below for each parameter.

9.1.3.1 Photo Reference Sites

Photographs will be used to document success visually. Reference stations will be photographed for at a minimum of five years or until the success criteria are met following construction. Reference photos will be taken once a year. Photographs will be taken from a height of approximately five to six feet. Permanent markers will be established to ensure that the same locations (and view directions) on the site are documented in each monitoring period.

The stream will be photographed longitudinally. Photographs will be taken looking upstream at delineated locations. Reference photo locations will be marked and described for future reference. Points will be close enough together to provide an overall view of the reach. The angle of the shot will depend on what angle provides the best view and will be noted and continued in future shots. When modifications to photo position must be made due to obstructions or other reasons, the position will be noted along with any landmarks and the same position will used in the future.

9.2 Stormwater Management Devices

This restoration project does not include stormwater management devices.

9.3 Wetlands

There are no wetlands associated with this project.

9.4 Vegetation

Successful restoration of the vegetation on a mitigation site is dependent upon hydrologic restoration, active planting of preferred canopy species, and volunteer regeneration of the native plant community. In order to determine if the criteria are achieved, vegetation-monitoring quadrants will be installed and monitored across the site in accordance with the Carolina Vegetation Survey (CVS)-NCEEP Protocol for Recording Vegetation, Version 4.2 (2008). The number and locations of the permanent monitoring quadrants will be established within the restored areas (riparian and non-riparian) per CVS-NCEEP Protocol Levels 1 and 2. Vegetation monitoring quadrants will not be installed within the established wooded areas of the site. The size of individual quadrants will be 100 square meters for woody tree species and 1 square meter for herbaceous vegetation. Vegetation monitoring will occur in the fall, prior to the loss of leaves. Individual quadrant data will be provided and will include diameter, height, density, and coverage quantities. Relative values will be calculated, and importance values will be determined. Individual seedlings will be marked such that they can be found in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings.

At the end of the first growing season, species composition, density, and survival will be evaluated. For each subsequent year, until the final success criteria are achieved, the site will be evaluated between July and November. Specific and measureable success criteria for plant density on the site shall be based on the recommendations found the WRP Technical Note and past project experience.

The interim measure of vegetative success for the site will be the survival of at least 320, 3-year old, planted woody stems per acre at the end of year three of the monitoring period. The final vegetative success criteria will be the survival of 260, 5-year old, planted woody stems per acre at the end of year five of the monitoring period. While measuring species density is the current accepted methodology for evaluating vegetation success on restoration projects, species density alone may be inadequate for assessing plant community health due to natural variability within the riparian and non-riparian planting zones. For this reason, the vegetation monitoring plan will incorporate the evaluation of additional plant community indices to assess overall vegetative success as described in Section 7.4.3. During site monitoring, areas within the conservation easement will be evaluated to determine if invasive species are impacting the growth of native vegetation. If this is found to be the case, appropriate action will be taken.

Herbaceous vegetation, primarily native grasses, shall be seeded/planted throughout the site. During and immediately following construction activities, all ground cover at the site shall be in compliance with permitting requirements such that all disturbed areas provide initial ground cover that will eventually provide stabilization, under typical conditions. Bare-root tree species will be planted within all areas of the site conservation easement. Bare-root vegetation is typically planted at a target density of 680 or greater stems per acre, or approximately 8- by 8-foot grid. Experience has shown this density to be favorable for overall survival of at least 320 planted stems at the end of five years, which is a common success criterion for mitigation sites. Planting of bare-root trees is conducted during the dormant season, which lasts from late November to early March for most of North Carolina.

10.0 SITE PROTECTION AND ADAPTIVE MANAGEMENT STRATEGY

The Candiff Creek Stream Restoration Project will be protected by a permanent conservation easement that will be held by the state. The site should be monitored for a minimum of five years following construction. 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 project compliance is jeopardized, Baker shall take the necessary action to resolve the project concerns and bring the project back into compliance. If maintenance or site repairs become necessary, Baker will evaluate the level of response required, secure a contractor to make the repairs and monitor the work performed by the construction contractor.

Maintenance requirements vary from site to site and are generally driven by the following conditions:

- Projects without established, woody floodplain vegetation are more susceptible to erosion from floods than those with a mature, hardwood forest.
- Projects with sandy, non-cohesive soils are more prone to short-term bank erosion than cohesive soils or soils with high gravel and cobble content.
- Alluvial valley channels with wide floodplains are less vulnerable than confined channels.
- Wet weather during construction can make accurate channel and floodplain excavations difficult.
- Extreme and/or frequent flooding can cause floodplain and channel erosion.
- Extreme hot, cold, wet, or dry weather during and after construction can limit vegetation growth, particularly temporary and permanent seed.
- The presence and aggressiveness of invasive species can affect the extent to which a native buffer can be established.

Maintenance issues and recommended remediation measures will be detailed and documented in monitoring reports. The conditions listed above and any other factors that may have necessitated maintenance should be discussed.

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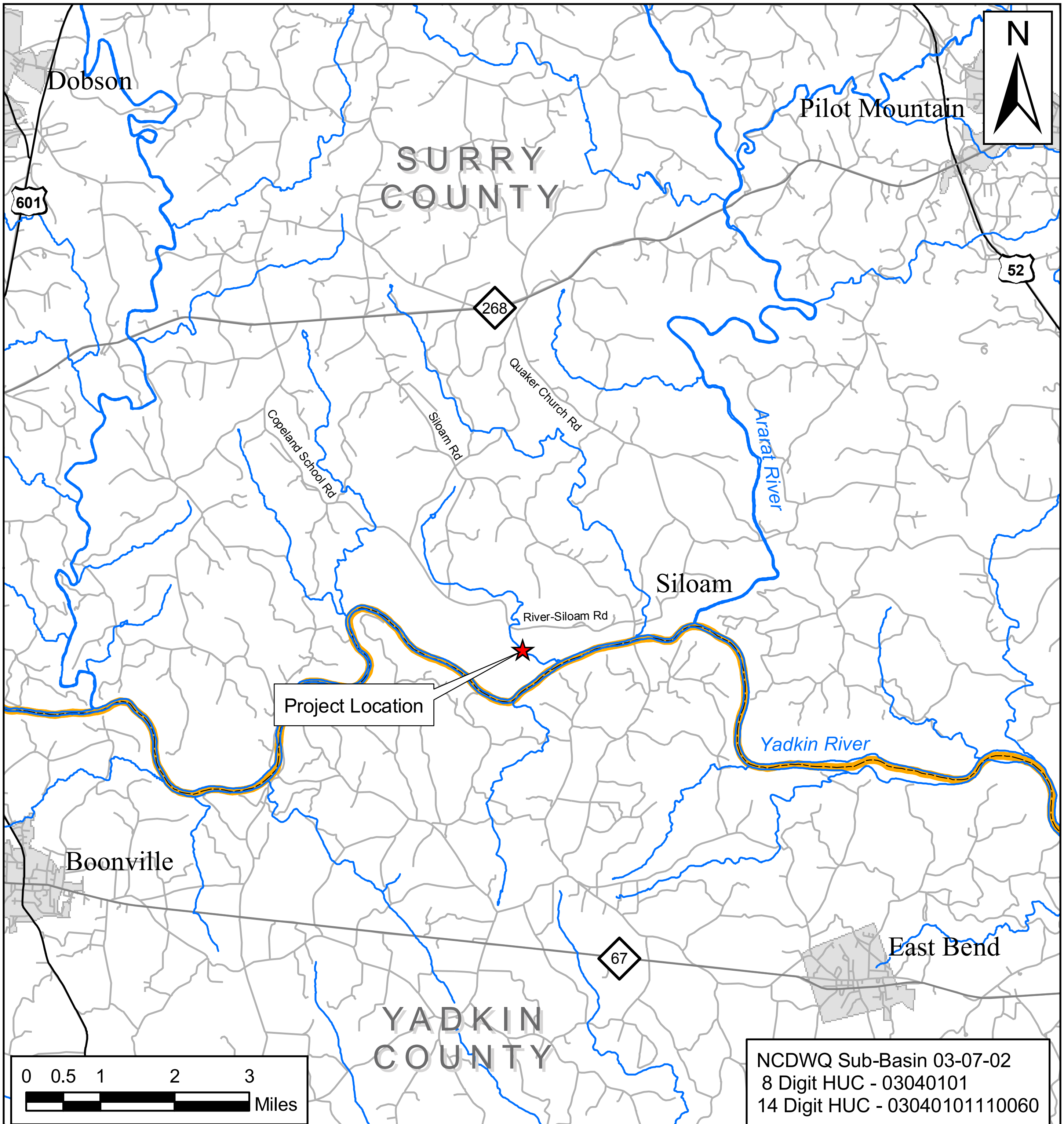

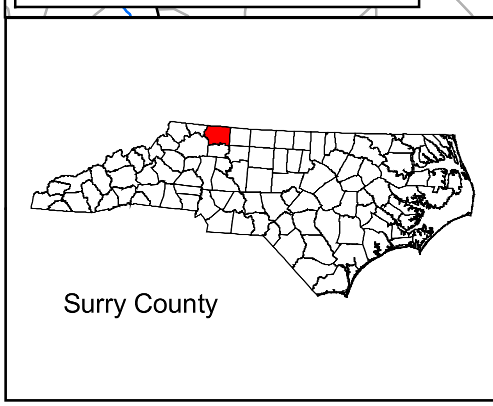

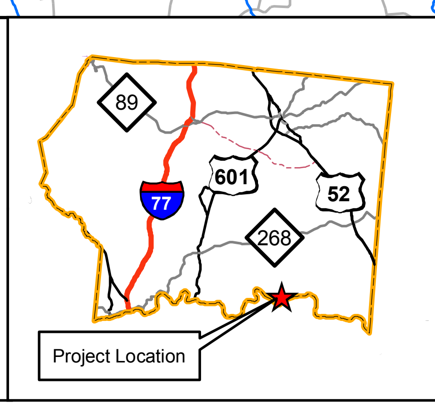

Figure 1. Vicinity Map
Candiff Creek - Surry County, NC

Surry Soil and Water Conservation District

Ecosystem Enhancement PROGRAM

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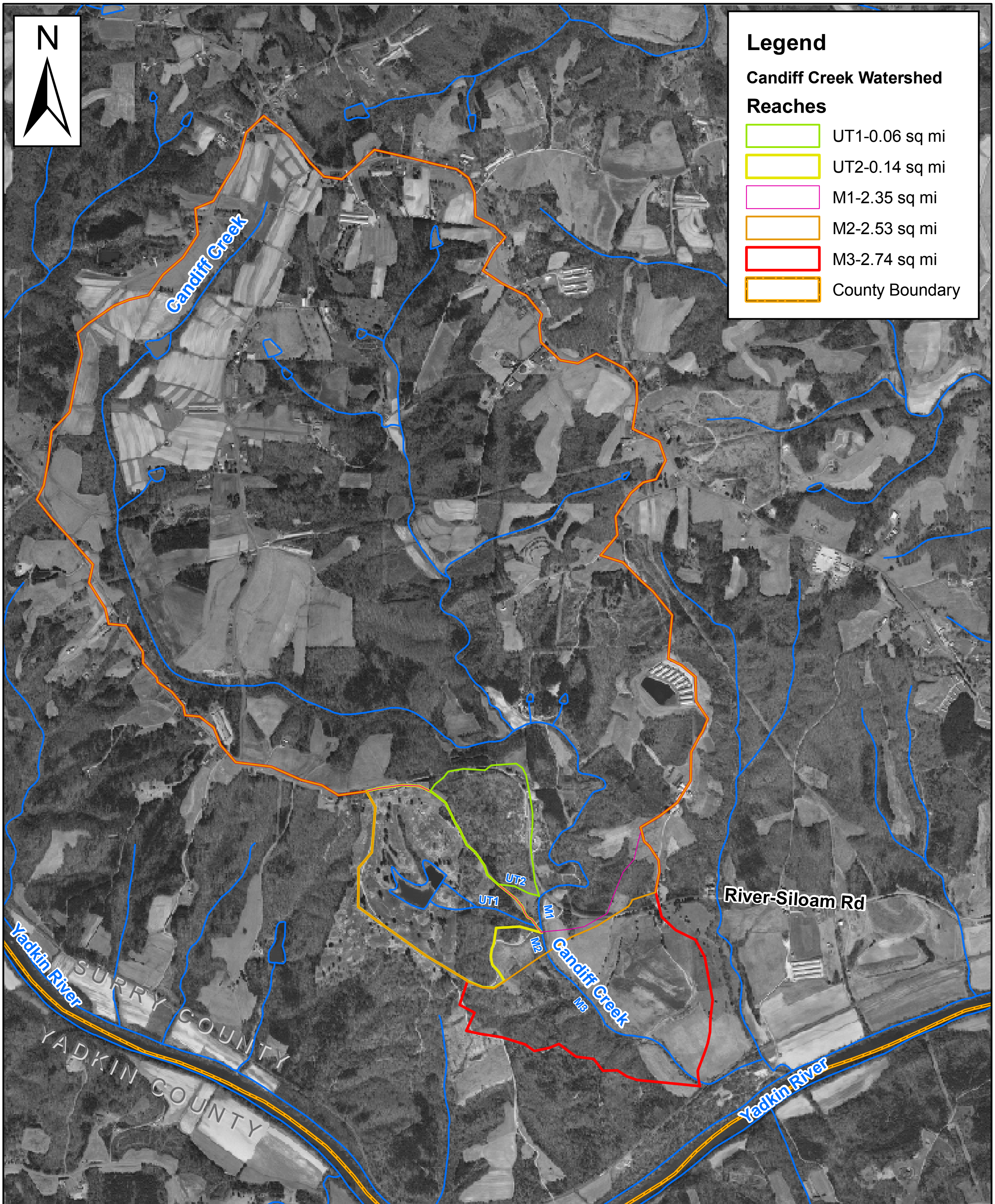

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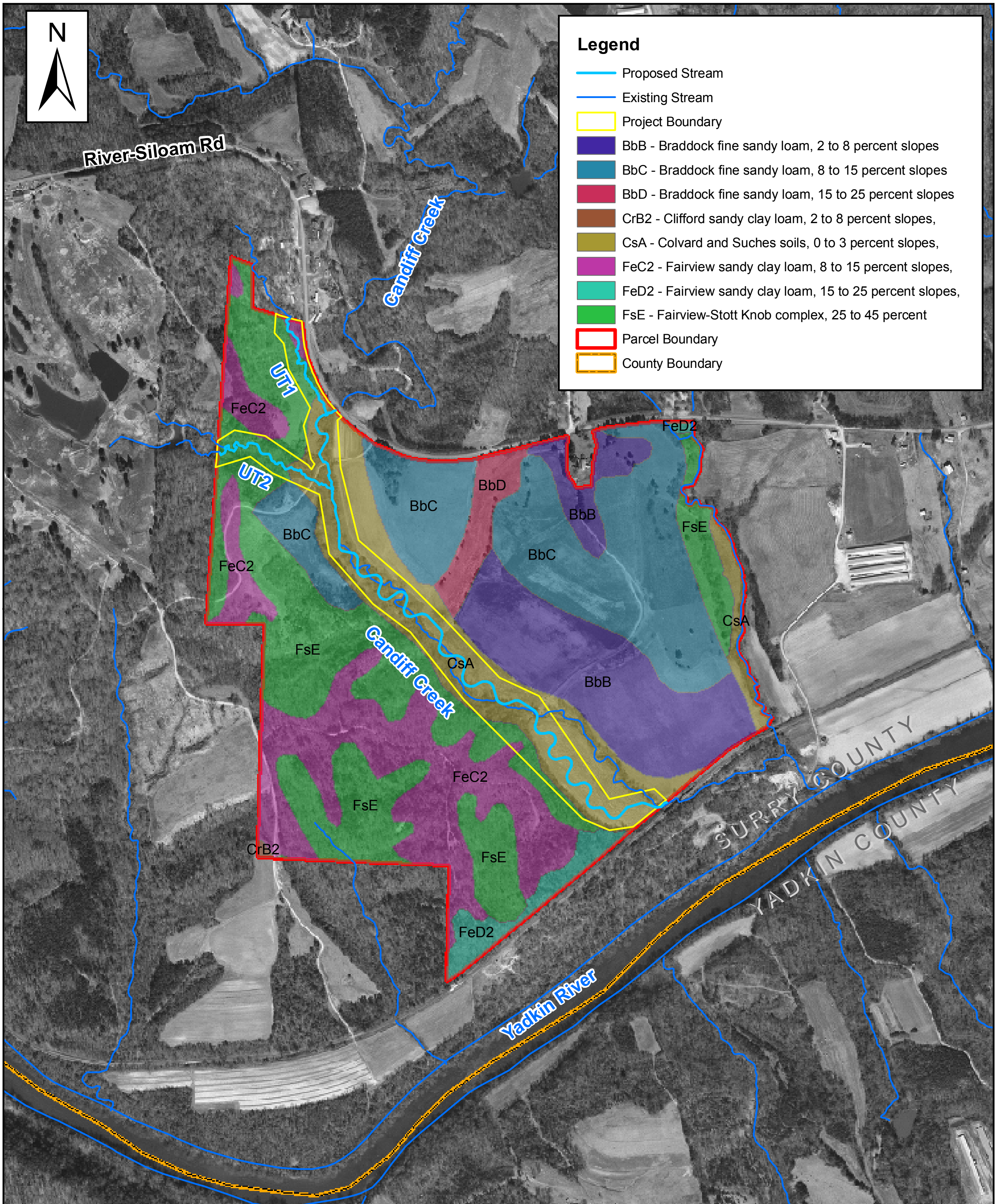
Ecosystem Enhancement Program

Figure 2. Watershed Map
Candiff Creek - Surry County, NC

0 1,000 2,000 4,000 Feet



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Ecosystem Enhancement Program

Figure 3. Soils Map
Candiff Creek - Surry County, NC

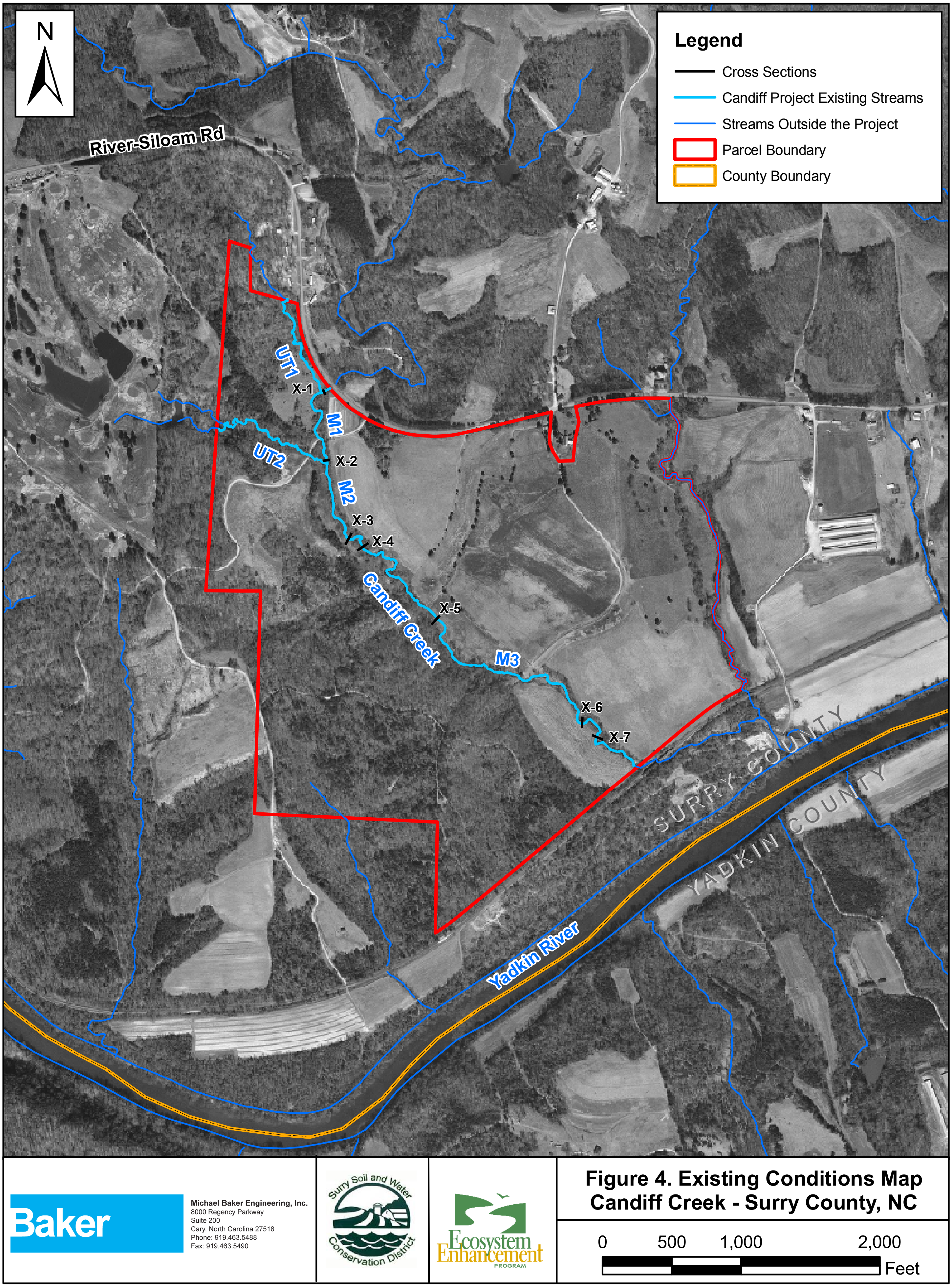

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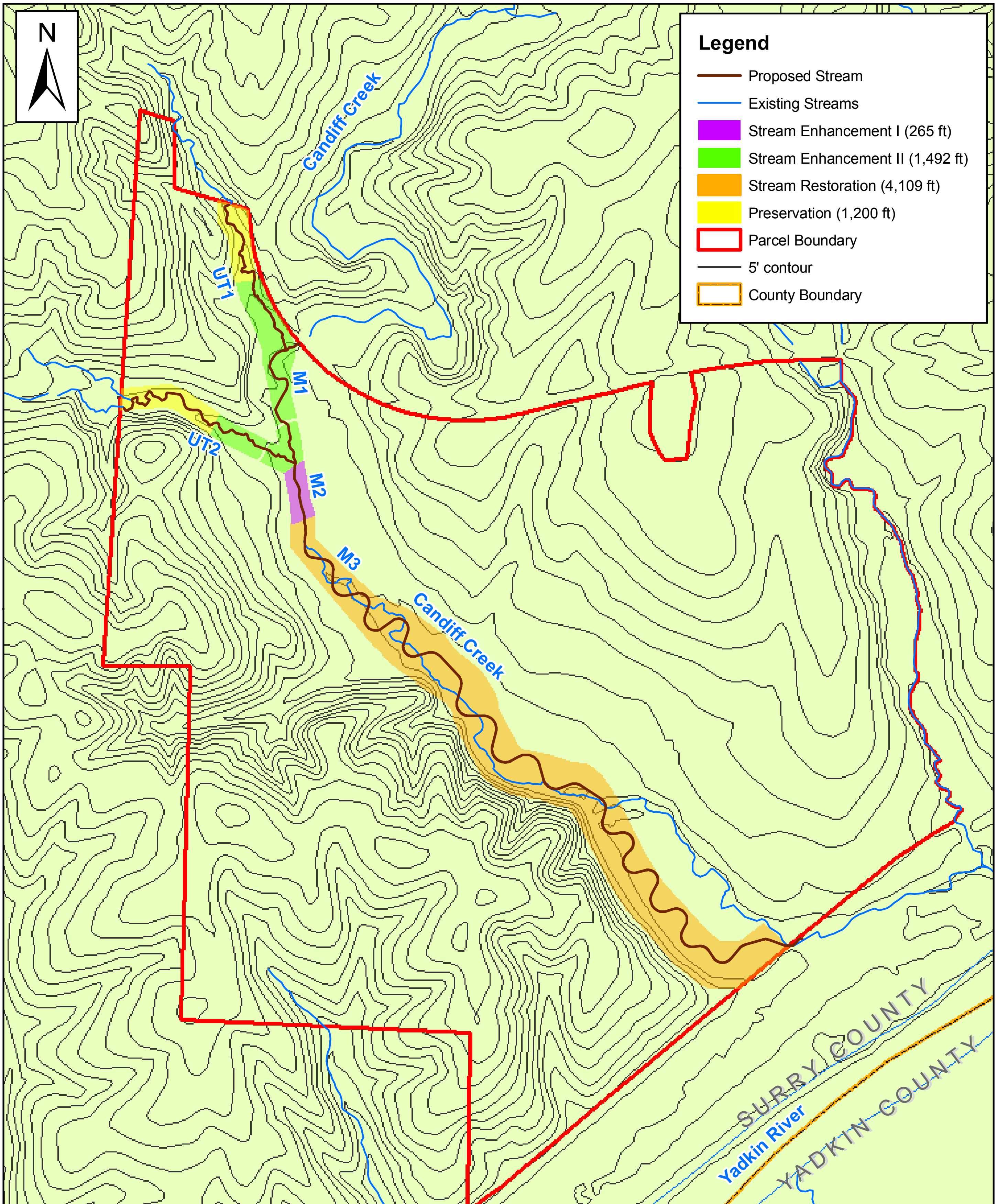
Figure 4. Existing Conditions Map
Candiff Creek - Surry County, NC



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Ecosystem Enhancement Program

Figure 5a. Restoration Approaches Map
Candiff Creek - Surry County, NC

0 300 600 1,200
Feet

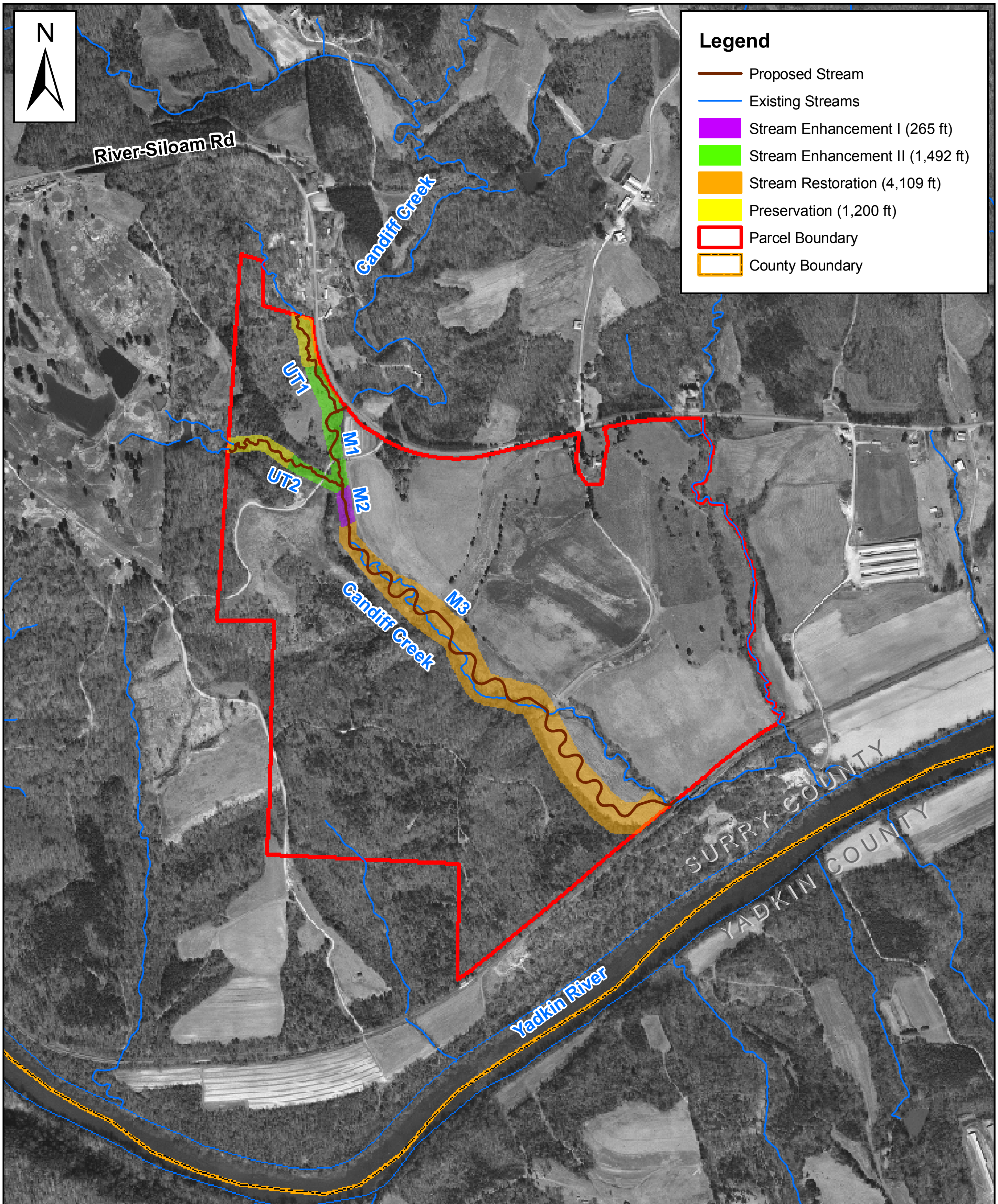

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Figure 5b. Restoration Approaches Map
Candiff Creek - Surry County, NC

0 500 1,000 2,000 Feet


Overly wide channel through pasture


Kudzu on mainstem near crossing


Bank slumping


Box culvert under River Siloam Rd


Overly wide channel with falling trees


Near vertical banks on mainstem

Severe bank failure on mainstem

Vertical bank on mainstem

Vertical bank on mainstem

Vertical bank on mainstem

Stable riffle on mainstem

Channel regaining sinuosity

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

Date: 12/3/09	**Project:** Candiff	**Latitude:** 36° 16' 40.83"N
Evaluator: DH, MW	**Site:** Main-downstream	**Longitude:** 80° 35'08.65"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 44.5	**County:** Surry	**Other** *e.g. Quad Name:* Siloam

A. Geomorphology (Subtotal = 23.5)	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 = 11.5)				
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 = 9.5)				
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	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.)

Sketch:

dragonfly larvae, 1 unknown, mayfly (species unknown)

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

Date: 12-3-09	Project: Cancliff	Latitude: 36°16'57.34"N
Evaluator: DH, MW	Site: Main - upstream	Longitude: 80°35'32.44"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 45.5	County: Surry	Other *e.g. Quad Name:* Siloam

A. Geomorphology (Subtotal = 23.5)	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 = 11.5)				
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 = 10.5)				
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	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.)

Sketch:

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

Date: 12/3/09	Project: Candiff	Latitude: 36° 17' 05.59" N
Evaluator: DH MW	Site: UT1 - below woodline	Longitude: 80° 35' 33.92" W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 26.5	County: Surry	Other *e.g. Quad Name:* Siloam

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 = 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 = 8)				
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.)

crawfish (2)

Sketch:

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

Date:	12/3/09	Project:	Candiff	Latitude:	36° 17'08.7"N
Evaluator:	DH, MW	Site:	UT1 - above woodline	Longitude:	80° 35'35.84"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30*	27.5	County:	Surry	Other *e.g. Quad Name:*	Siloam

A. Geomorphology (Subtotal = 14)	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 = 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 = 8)				
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.)

right-handed snail, caddisfly (1), many small crayfish

Sketch:

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

Date:	12-3-09	Project:	Candiff	Latitude:	36°17'01.58"N
Evaluator:	DH, MW	Site:	UT2	Longitude:	80°35'39.40"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30*	38.25	County:	Surry	Other *e.g. Quad Name:*	Siloam

A. Geomorphology (Subtotal = 21.75)	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 = 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.)

stonefly, caddisflies, dragonfly larve

Sketch:

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:	Candiff Creek Stream Restoration Project
County Name:	Surry County
EEP Number:	92767
Project Sponsor:	Michael Baker Engineering
Project Contact Name:	Josh White, P.G. (919-459-9044)
Project Contact Address:	8000 Regency Parkway Suite 200 Cary, NC 27518
Project Contact E-mail:	jawhite@mbakercorp.com
EEP Project Manager:	Julie Cahill

Project Description

The Candiff Creek stream restoration site is located in Surry County, approximately 1.8 miles west of Siloam Township within cataloging unit 03040101, NC Division of Water Quality sub-basin 03-07-02 of the Yadkin Pee-Dee River Basin. The proposed project easement covers approximately 225 acres of land. The project goals are to restore 3,168 linear feet (LF) of stream and enhance 3,328 LF (846 LF of Enhancement I and 2,482 LF of Enhancement II) of stream along Candiff Creek with the following breakdown: 3,168 LF of restoration, 846 LF of enhancement I, and 2,482 LF of enhancement II. Assuming credit ratios of 1:1, 1.5:1, and 2.5:1 for restoration, enhancement I, and enhancement II, respectively, the total credits will equal 4,725. However, it is possible that some of the enhancement II areas can be changed to enhancement I after the geomorphic assessment is completed.

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

United States Department of Agriculture

NRCS
Natural Resources Conservation Service
589 Raccoon Road, Suite 246
Waynesville, NC 28786
Phone 828 456-6341 ext. 5 FAX 828 452-7031

December 11, 2009

Ken Gilland
Baker Engineering, NY, Inc.
8000 Regency Parkway, Suite 200
Cary, NC 27518

Re: USDA Farmland Conversion Impact Rating Form (AD-1006)
NCEEP Project, Candiff Creek Stream Restoration - Surry County, NC

Mr. Gilland,

Attached you will find an AD-1006 with Parts II, IV, and V completed as required of NRCS. Based on the information that you provided, it appears that 15.1 acres of prime farmland and 0.4 acres of statewide important farmland will be impacted by the proposed project.

If I can be of further assistance, please feel free to contact me.

M. Kent Clary

M. Kent Clary
Area Resource Soil Scientist
USDA-NRCS

cc w/attach.: Richard Everhart, District Conservationist, USDA-NRCS, Dobson, NC

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

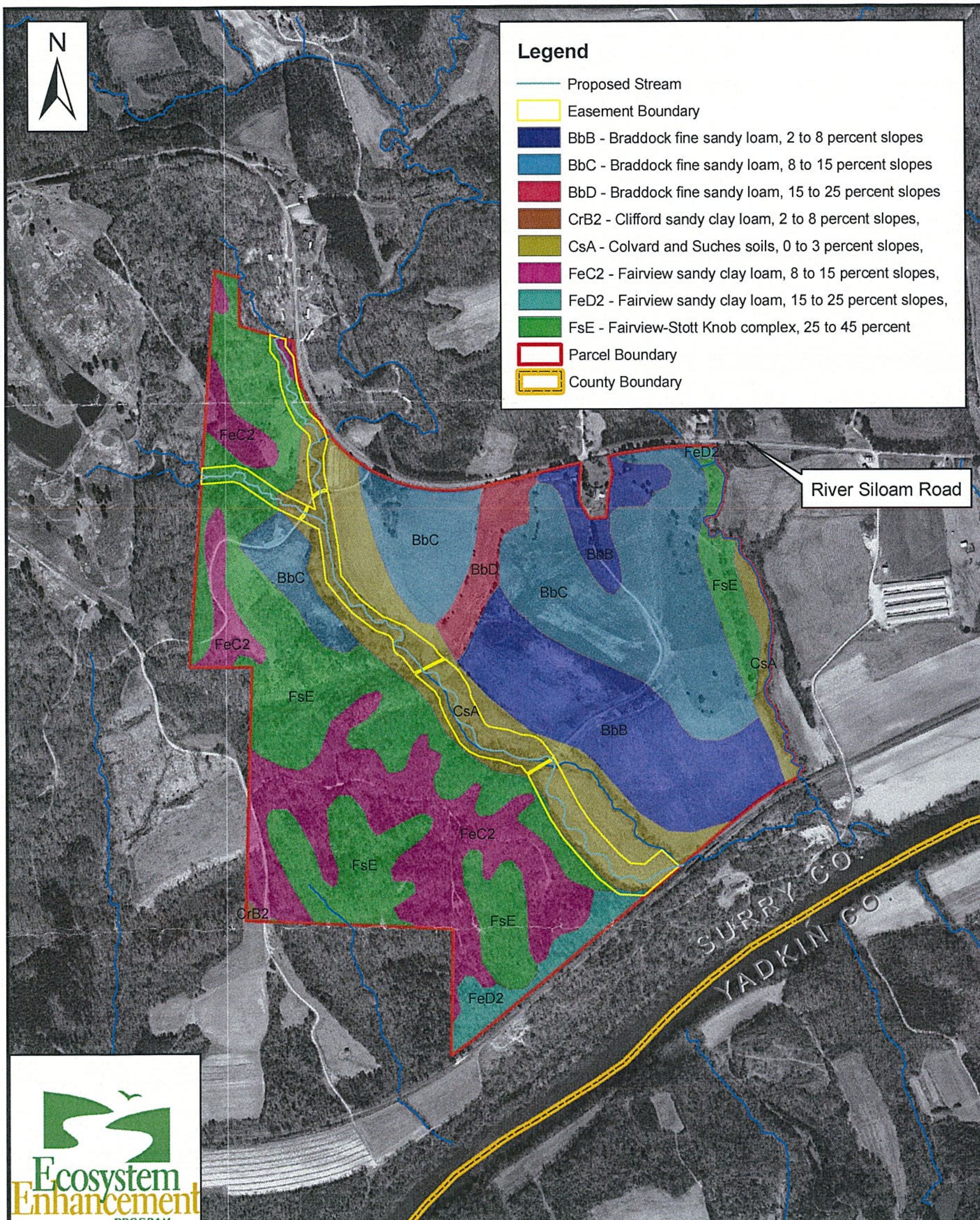
PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 11/25/09
Name Of Project Candiff Creek Stream Restoration Project	Federal Agency Involved FHWA
Proposed Land Use Stream Restoration	County And State Surry, NC
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 12/3/2009

Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply – do not complete additional parts of this form).*		Yes ☑	No ☐	Acres Irrigated —	Average Farm Size 91 AC.
Major Crop(s) HAY, SOYBEANS, CORN	Farmable Land In Govt. Jurisdiction Acres: 318,204 % 92			Amount Of Farmland As Defined in FPPA Acres: 103,621 % 30	
Name Of Land Evaluation System Used SURRY CALES	Name Of Local Site Assessment System			Date Land Evaluation Returned By NRCS 12/11/2009	

	Maximum Points	Site A	Site B	Site C	Site D
PART III *(To be completed by Federal Agency)*		Alternative Site Rating			
A. Total Acres To Be Converted Directly		~~15.5~~ 18.0			
B. Total Acres To Be Converted Indirectly		0.0			
C. Total Acres In Site		~~15.5~~ 18.0	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland		15.1			
B. Total Acres Statewide And Local Important Farmland		0.4			
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted		0			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value		25.4			
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*		70	0	0	0
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points				
1. Area In Nonurban Use					
2. Perimeter In Nonurban Use					
3. Percent Of Site Being Farmed					
4. Protection Provided By State And Local Government					
5. Distance From Urban Builtup Area					
6. Distance To Urban Support Services					
7. Size Of Present Farm Unit Compared To Average					
8. Creation Of Nonfarmable Farmland					
9. Availability Of Farm Support Services					
10. On-Farm Investments					
11. Effects Of Conversion On Farm Support Services					
12. Compatibility With Existing Agricultural Use					
TOTAL SITE ASSESSMENT POINTS	160	0	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100	0	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*	160	0	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	0	0	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? Yes ☐ No ☐

Reason For Selection:



Baker
Michael Baker Engineering, Inc.
8000 Regency Parkway
Suite 200
Cary, North Carolina 27518
Phone: 919.463.5488
Fax: 919.463.5490

0 500 1,000 1,500 Feet

Exhibit 3
Soils Map
Candiff Creek

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 11/25/09
Name Of Project Candiff Creek Stream Restoration Project	Federal Agency Involved FHWA
Proposed Land Use Stream Restoration	County And State Surry, NC
PART II *(To be completed by NRCS)*	Date Request Received By NRCS

Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply -- do not complete additional parts of this form).*	Yes ☑	No ☐	Acres Irrigated	Average Farm Size 91 acres
Major Crop(s) Hay, Soybeans, Corn	Farmable Land In Govt. Jurisdiction Acres: 318,204 % 92		Amount Of Farmland As Defined in FPPA Acres: 103,621 % 30	
Name Of Land Evaluation System Used Surry CALES	Name Of Local Site Assessment System		Date Land Evaluation Returned By NRCS 12/11/09	

PART III *(To be completed by Federal Agency)*		Alternative Site Rating			
		Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly		18.0			
B. Total Acres To Be Converted Indirectly		0.0			
C. Total Acres In Site		18.0	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland		15.1			
B. Total Acres Statewide And Local Important Farmland		0.4			
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted		0.0			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value		25.4			
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*		70	0	0	0
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points				
1. Area In Nonurban Use		13			
2. Perimeter In Nonurban Use		8			
3. Percent Of Site Being Farmed		8			
4. Protection Provided By State And Local Government		20			
5. Distance From Urban Builtup Area		10			
6. Distance To Urban Support Services		10			
7. Size Of Present Farm Unit Compared To Average		4			
8. Creation Of Nonfarmable Farmland		2			
9. Availability Of Farm Support Services		3			
10. On-Farm Investments		7			
11. Effects Of Conversion On Farm Support Services		0			
12. Compatibility With Existing Agricultural Use		0			
TOTAL SITE ASSESSMENT POINTS	160	85	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100	70	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*	160	85	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	155	0	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? Yes ☐ No ☐

Reason For Selection:

(See Instructions on reverse side)

This form was electronically produced by National Production Services Staff

Clear Form

Form AD-1006 (10-83)

Candiff Creek Site
SR 2230
Siloam, NC 27047

Inquiry Number: 2644426.1s
November 23, 2009

The EDR Radius Map™ Report with GeoCheck®

EDR® Environmental Data Resources Inc

440 Wheelers Farms Road
Milford, CT 06461
Toll Free: 800.352.0050
www.edrnet.com

TABLE OF CONTENTS

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-05) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

TARGET PROPERTY INFORMATION

ADDRESS

SR 2230
SILOAM, NC 27047

COORDINATES

Latitude (North):	36.280100 - 36˚ 16' 48.4''
Longitude (West):	80.589700 - 80˚ 35' 22.9''
Universal Tranverse Mercator:	Zone 17
UTM X (Meters):	536849.1
UTM Y (Meters):	4014893.2
Elevation:	836 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property Map:	36080-C5 SILOAM, NC
Most Recent Revision:	2000

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the search radius around the target property for the following databases:

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL - National Priority List
Proposed NPL - Proposed National Priority List Sites
NPL LIENS - Federal Superfund Liens

Federal Delisted NPL site list

Delisted NPL - National Priority List Deletions

EXECUTIVE SUMMARY

Federal CERCLIS list

CERCLIS - Comprehensive Environmental Response, Compensation, and Liability Information System

Federal CERCLIS NFRAP site List

CERC-NFRAP - CERCLIS No Further Remedial Action Planned

Federal RCRA CORRACTS facilities list

CORRACTS - Corrective Action Report

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF - RCRA - Transporters, Storage and Disposal

Federal RCRA generators list

RCRA-LQG - RCRA - Large Quantity Generators
RCRA-SQG - RCRA - Small Quantity Generators
RCRA-CESQG - RCRA - Conditionally Exempt Small Quantity Generator

Federal institutional controls / engineering controls registries

US ENG CONTROLS - Engineering Controls Sites List
US INST CONTROL - Sites with Institutional Controls

Federal ERNS list

ERNS - Emergency Response Notification System

State- and tribal - equivalent NPL

NC HSDS - Hazardous Substance Disposal Site

State- and tribal - equivalent CERCLIS

SHWS - Inactive Hazardous Sites Inventory

State and tribal landfill and/or solid waste disposal site lists

SWF/LF - List of Solid Waste Facilities
OLI - Old Landfill Inventory

State and tribal leaking storage tank lists

LUST - Regional UST Database
LUST TRUST - State Trust Fund Database
INDIAN LUST - Leaking Underground Storage Tanks on Indian Land

State and tribal registered storage tank lists

UST - Petroleum Underground Storage Tank Database
AST - AST Database

EXECUTIVE SUMMARY

INDIAN UST .... Underground Storage Tanks on Indian Land

State and tribal institutional control / engineering control registries

INST CONTROL .... No Further Action Sites With Land Use Restrictions Monitoring

State and tribal voluntary cleanup sites

VCP .... Responsible Party Voluntary Action Sites
INDIAN VCP .... Voluntary Cleanup Priority Listing

State and tribal Brownfields sites

BROWNFIELDS .... Brownfields Projects Inventory

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS .... A Listing of Brownfields Sites

Local Lists of Landfill / Solid Waste Disposal Sites

ODI .... Open Dump Inventory
DEBRIS REGION 9 .... Torres Martinez Reservation Illegal Dump Site Locations
HIST LF .... Solid Waste Facility Listing
INDIAN ODI .... Report on the Status of Open Dumps on Indian Lands

Local Lists of Hazardous waste / Contaminated Sites

US CDL .... Clandestine Drug Labs
US HIST CDL .... National Clandestine Laboratory Register

Local Land Records

LIENS 2 .... CERCLA Lien Information
LUCIS .... Land Use Control Information System

Records of Emergency Release Reports

HMIRS .... Hazardous Materials Information Reporting System

Other Ascertainable Records

RCRA-NonGen .... RCRA - Non Generators
DOT OPS .... Incident and Accident Data
DOD .... Department of Defense Sites
FUDS .... Formerly Used Defense Sites
CONSENT .... Superfund (CERCLA) Consent Decrees
ROD .... Records Of Decision
UMTRA .... Uranium Mill Tailings Sites
MINES .... Mines Master Index File
TRIS .... Toxic Chemical Release Inventory System
TSCA .... Toxic Substances Control Act

EXECUTIVE SUMMARY

FTTS	FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
HIST FTTS	FIFRA/TSCA Tracking System Administrative Case Listing
SSTS	Section 7 Tracking Systems
ICIS	Integrated Compliance Information System
PADS	PCB Activity Database System
MLTS	Material Licensing Tracking System
RADINFO	Radiation Information Database
FINDS	Facility Index System/Facility Registry System
RAATS	RCRA Administrative Action Tracking System
IMD	Incident Management Database
UIC	Underground Injection Wells Listing
DRYCLEANERS	Drycleaning Sites
NPDES	NPDES Facility Location Listing
INDIAN RESERV	Indian Reservations
SCRD DRYCLEANERS	State Coalition for Remediation of Drycleaners Listing
PCB TRANSFORMER	PCB Transformer Registration Database
COAL ASH	Coal Ash Disposal Sites

EDR PROPRIETARY RECORDS

EDR Proprietary Records

Manufactured Gas Plants - - - - - EDR Proprietary Manufactured Gas Plants

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were not identified.

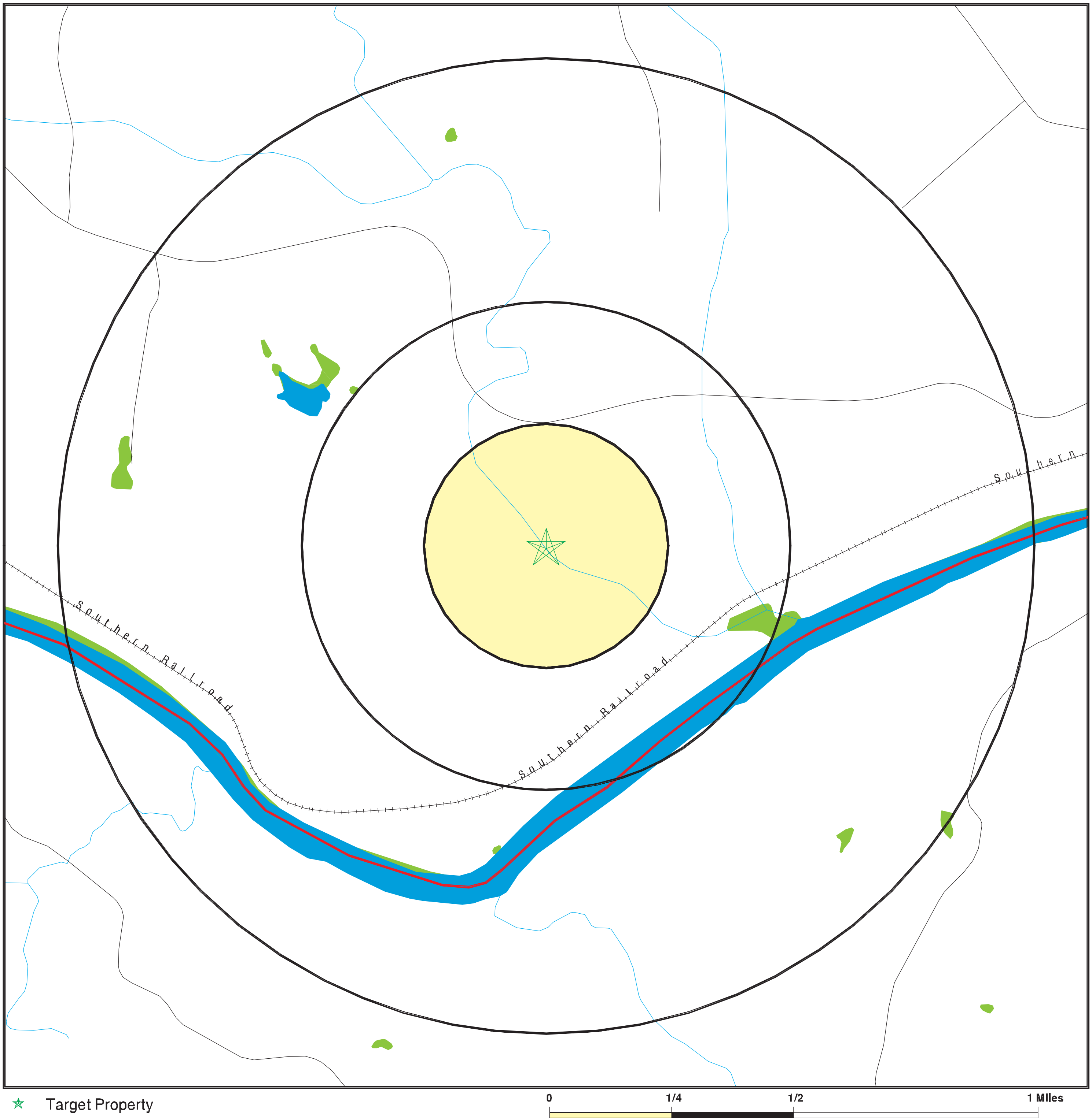
Unmappable (orphan) sites are not considered in the foregoing analysis.

EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped:

Site Name	Database(s)
HOWARD STREET WELL	IMD, SHWS
GRIMES SEPTIC TANK PUMPING	SWF/LF
BOONEVILLE CLEANING CENTER	IMD, LUST
BOONEVILLE SERVICE CENTER	IMD, LUST
D & D METAL PRODUCTS	IMD, LUST
EAST BEND SPUR	IMD, LUST, UST
WOOTEN'S GROCERY	IMD, LUST
WISEMAN OIL COMPANY	IMD, LUST, UST
MIDWAY GROCERY - EAST BEND	LUST
TRADING POST (FORMER)	IMD, LUST
JOHNSON MODERN ELECTRIC	IMD, LUST
BOONEVILLE BP	UST
HITCHCOCK GROCERY	UST
BOONE CASTLE	UST
WENDELL MUNCUS	UST
SHADY GROVE FARM SERVICE	UST
GARY'S FAST FOODS	UST
BOONEVILLE SERVICE CENTER	UST
BOONVILLE CLEANING CENTER	UST
CENTER FOR DEVELOPMENTAL RESO	UST
EAST BEND BUILDING SUPPLY	UST
MIDWAY GROCERY	UST
POINDEXTER'S GARAGE	UST
WEBB'S GROCERY	UST
WISEMAN SERVICE STATION	UST
LARRY J. MATTHEWS	UST
ENON BAPTIST CHURCH	UST
C.G. ANGELL EXXON	UST
CRAFT & GARDEN SHOP	UST
UNION HILL GROCERY	UST
STEVEN'S GROCERY	UST
UNION 76 STATION	UST
WILLIAM 76	UST
268 WAREHOUSE	UST
FORMER KELLYS CORNER	UST
NC HWY 67	RCRA-NonGen, FINDS
RIK'S MOTOR CO	RCRA-NonGen
7925 HWY 601 N	RCRA-CESQG, FINDS
CUNDIFF CREEK FARMS LLC	FINDS
BEAULAH COMM. DUMP	OLI

OVERVIEW MAP - 2644426.1s



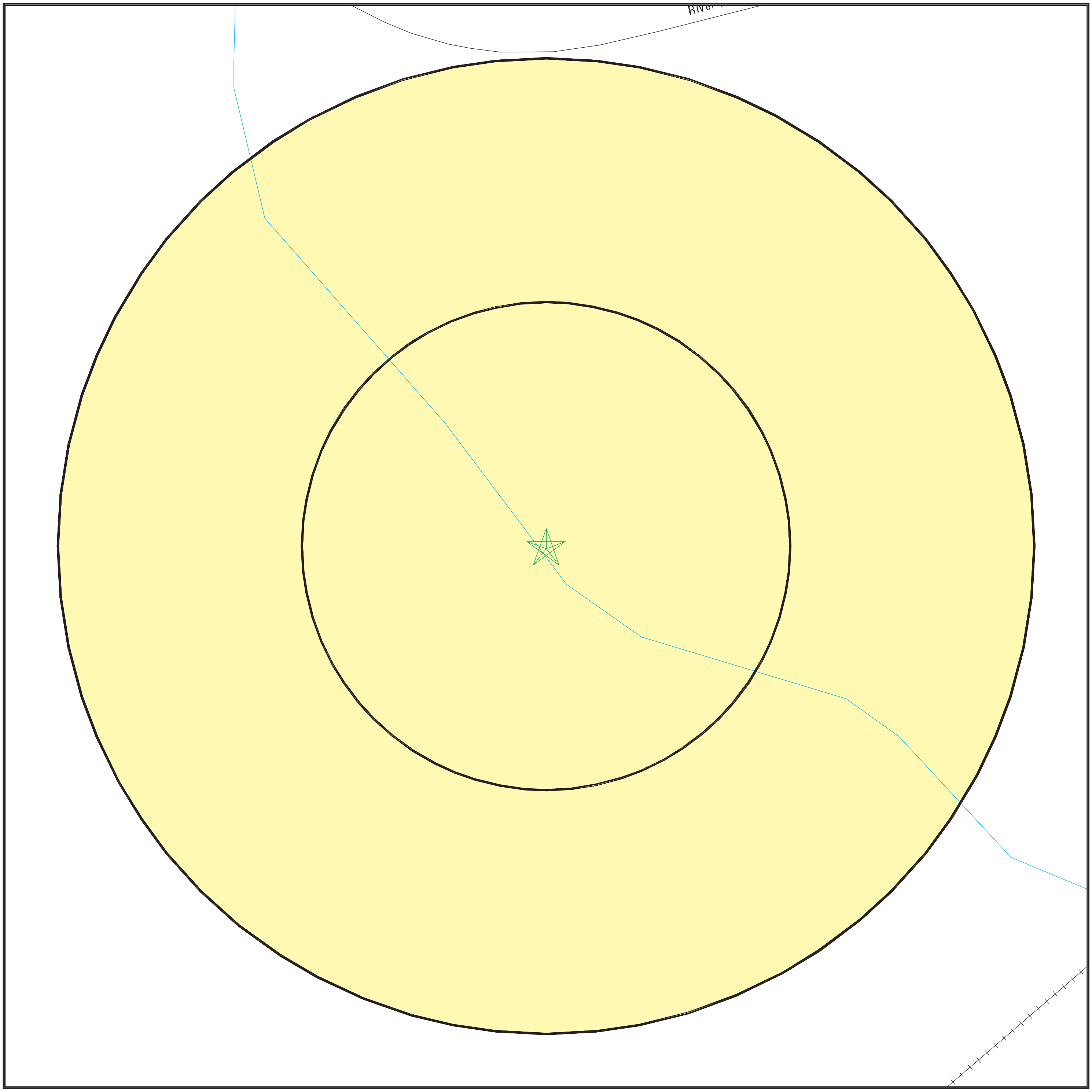
Target Property
Sites at elevations higher than or equal to the target property
Sites at elevations lower than the target property
Manufactured Gas Plants
National Priority List Sites
Dept. Defense Sites

Indian Reservations BIA
County Boundary
Oil & Gas pipelines
National Wetland Inventory
State Wetlands

Hazardous Substance Disposal Sites

SITE NAME: Candiff Creek Site ADDRESS: SR 2230 Siloam NC 27047 LAT/LONG: 36.2801 / 80.5897	CLIENT: Michael Baker Engineering, Inc. CONTACT: Ken Gilland INQUIRY #: 2644426.1s DATE: November 23, 2009 11:38 am

DETAIL MAP - 2644426.1s



0 1/16 1/8 1/4 Miles

- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- Sensitive Receptors
- National Priority List Sites
- Dept. Defense Sites
- Indian Reservations BIA
- Oil & Gas pipelines
- Hazardous Substance Disposal Sites

SITE NAME:	Candiff Creek Site	CLIENT:	Michael Baker Engineering, Inc.
ADDRESS:	SR 2230 Siloam NC 27047	CONTACT:	Ken Gilland
		INQUIRY #:	2644426.1s
LAT/LONG:	36.2801 / 80.5897	DATE:	November 23, 2009 11:38 am

Baker

Shannon Deaton
North Carolina Wildlife Resource Commission
Division of Inland Fisheries
1721 Mail Service Center
Raleigh, NC 27699

10/16/2009

Subject: EEP stream mitigation project in Surry County.

Dear Ms. Deaton,

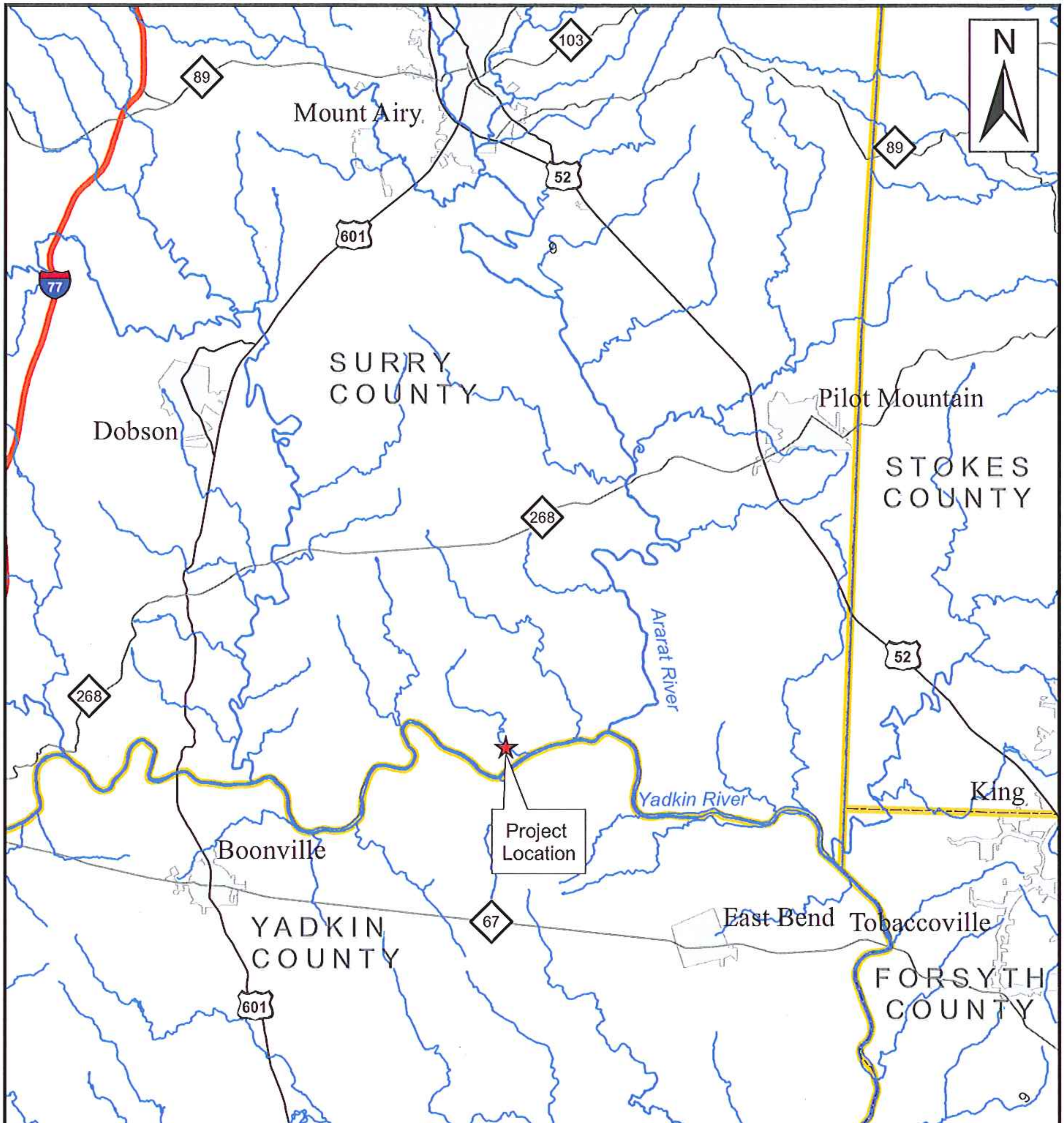
The purpose of this letter is to request review and comment on any possible issues that might emerge with respect to fish and wildlife issues associated with a potential wetland and stream restoration project on the attached site (USGS site maps with approximate project limits and areas of potential ground disturbance are enclosed).

The Candiff Creek has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts. Several sections of channel have been identified as significantly degraded. The goal of this project is to restore approximately 3,168 LF and enhance 3,328 LF (846 LF of Enhancement I and 2,482 LF of enhancement II) of stream for the purpose of obtaining stream mitigation credit in the Yadkin River basin. The total length of the project is 6,496 LF.

We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

Ken Gilland
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 200
Cary, NC 27518
Phone: (919) 459-9035
Email: kgilland@mbakercorp.com

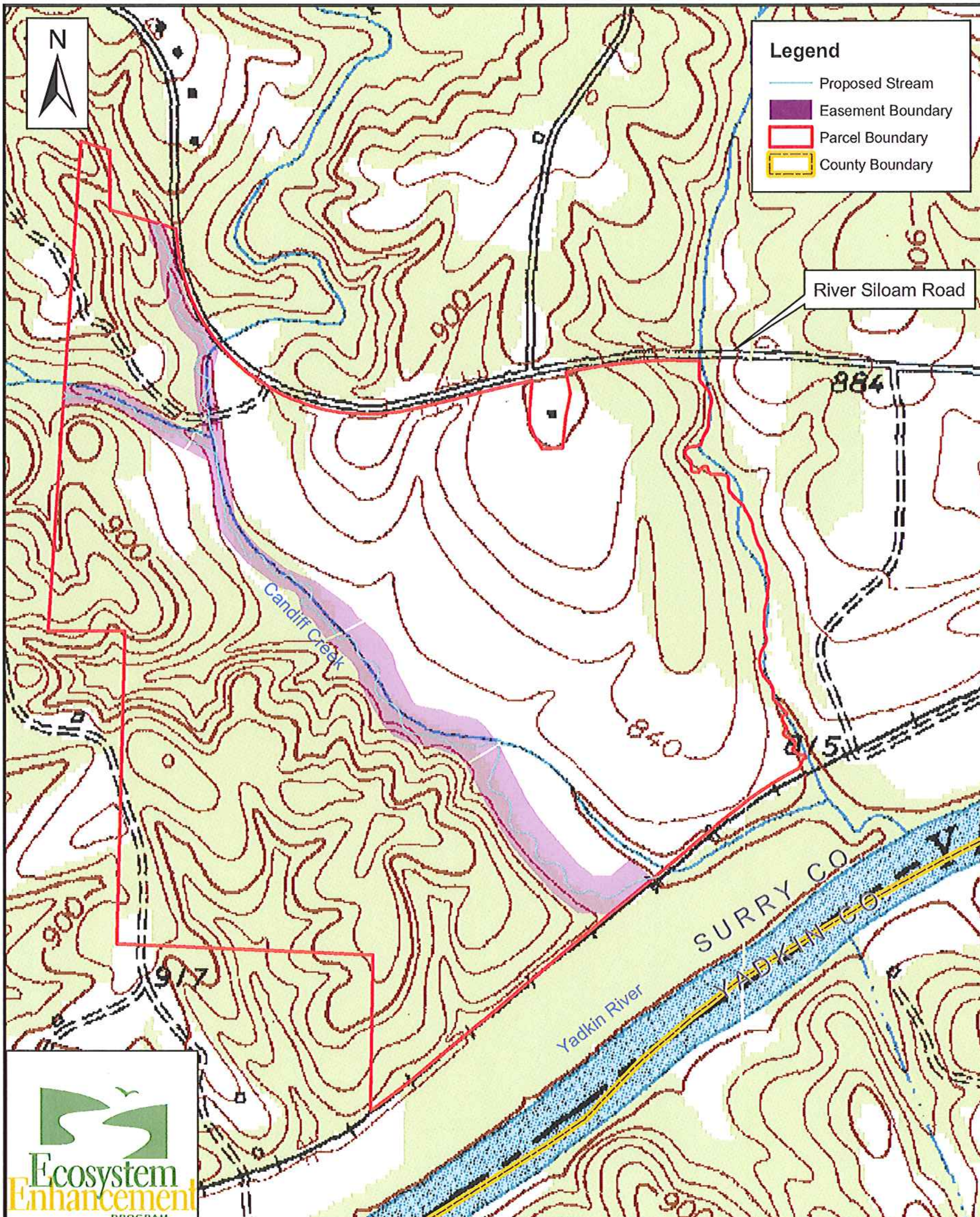


Ecosystem Enhancement PROGRAM

Figure 1
Candiff Creek Vicinity Map

Baker
Michael Baker Engineering, Inc.
8000 Regency Parkway
Suite 200
Cary, North Carolina 27518
Phone: 919.463.5488
Fax: 919.463.5490

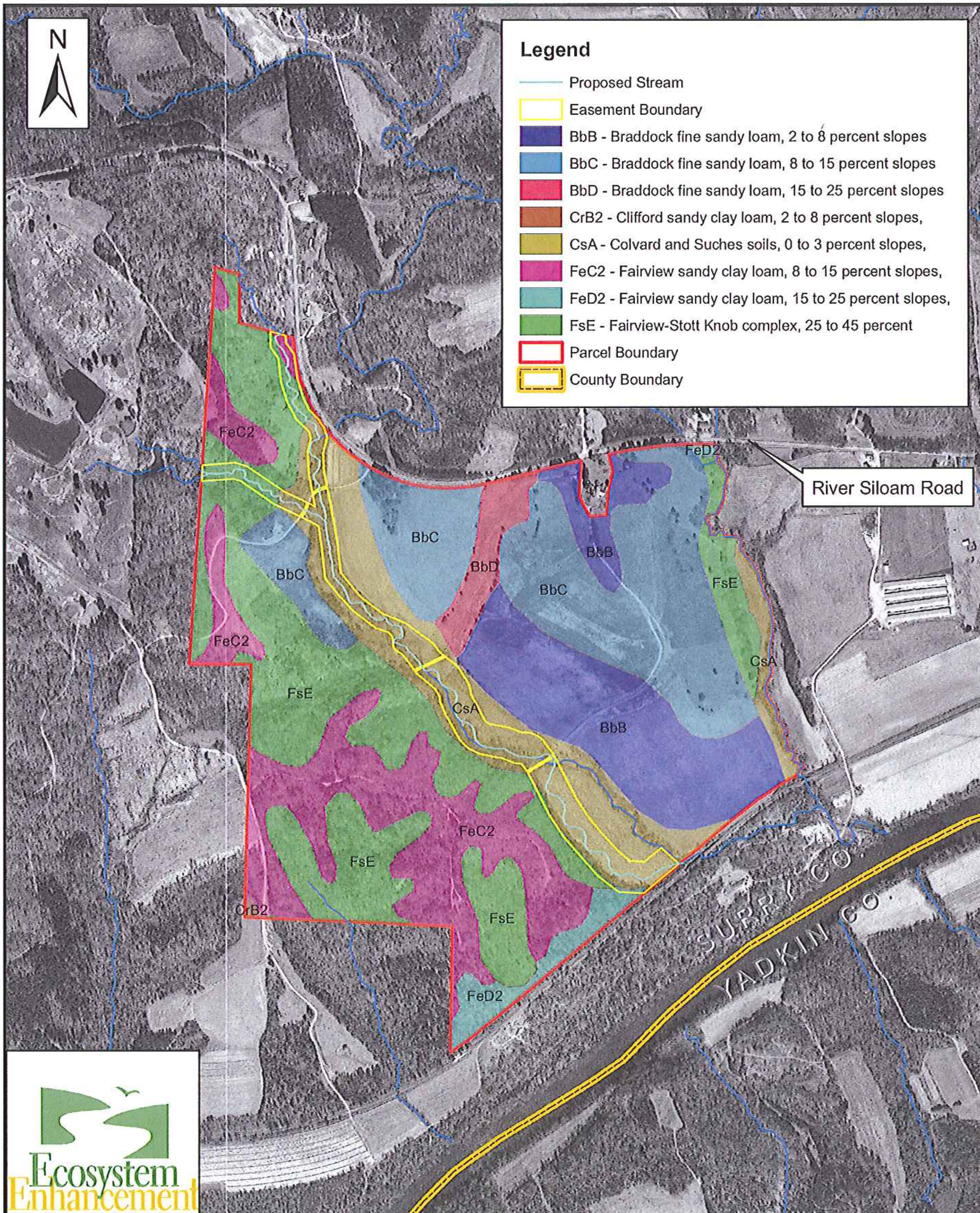
0 1 2 4 Miles



Baker
Michael Baker Engineering, Inc.
8000 Regency Parkway
Suite 200
Cary, North Carolina 27518
Phone: 919.463.5488
Fax: 919.463.5490

0 400 800 1,200 Feet

Exhibit 2
Limits of Disturbance
Candiff Creek



Ecosystem Enhancement Program

Michael Baker Engineering, Inc.
8000 Regency Parkway
Suite 200
Cary, North Carolina 27518
Phone: 919 463 5488
Fax: 919 463 5490

Exhibit 3
Soils Map
Candiff Creek

North Carolina Wildlife Resources Commission

Gordon Myers, Executive Director

October 26, 2009

Mr. Ken Gilland
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 200
Cary, North Carolina 27518

RE: Bog Candiff Creek Restoration/Mitigation Project, Surry County

Dear Mr. Gilland:

This correspondence is in response to your letter of October 16, 2009 requesting site determinations. Biologists with the North Carolina Wildlife Resources Commission (NCWRC) are familiar with habitat values in the area. The NCWRC is authorized to comment and make recommendations which relate to the impacts of this project on fish and wildlife pursuant to pursuant to the Clean Water Act of 1977, North Carolina Environmental Policy Act, US National Environmental Policy Act, Endangered Species Act (16 U. S. C. 1531-1543; 87 Stat 884), and Fish and Wildlife Coordination Act (48 Stat. 401, as amended.

The proposed project is to restore about 3,168 linear feet of stream and enhance 3,328 linear feet of stream. Total impacts are indicated to be 6,496 linear feet. Waters in the area support warm water fisheries as well as the Brook floater, *Alasmidonta varicosa* (NCE/FSC) that has been documented south of Siloam in the Yadkin River.

Based on our review of your correspondence and the maps provided, we have found no reason to object to the restoration and enhancement project(s) providing Clean Water Act permits and certifications are obtained prior to beginning any in channel work.

Thank you for the opportunity to comment on this project during its early planning stages. If you have any questions regarding these comments, please contact me at 336-769-9453.

Sincerely,

Ron Linville
Regional Coordinator
Habitat Conservation Program

Mailing Address: Division of Inland Fisheries • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 707-0220 • **Fax:** (919) 707-0028

Baker

Marella Buncick,
US Fish and Wildlife Service
Asheville Field Office
160 Zillicoa Street
Asheville, NC 28801

October 16, 2009

Subject: EEP stream mitigation project in Surry County.

Dear Ms. Buncick,

The Candiff Creek has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts. Several sections of channel have been identified as significantly degraded. The goal of this project is to restore approximately 3,168 LF and enhance 3,328 LF (846 LF of Enhancement I and 2,482 LF of enhancement II) of stream for the purpose of obtaining stream mitigation credit in the Yadkin River basin. The total length of the project is 6,496 LF.

We have already obtained an updated species list for Surry County from your web site (http://nc-es.fws.gov/es/countyfr.html). The threatened or endangered species for this county are: Bog turtle (*Clemmys muhlenbergii*), Schweinitz's sunflower (*Helianthus schweinitzii*), and Small whorled pogonia (*Isotria medeoloides*). We are requesting that you please provide any known information for each species in the county. The USFWS will be contacted if suitable habitat for any listed species is found or if we determine that the project may affect one or more federally listed species or designated critical habitat.

Please provide comments on any possible issues that might emerge with respect to endangered species, migratory birds or other trust resources from the construction of a wetland and/or stream restoration project on the subject property. A USGS map showing the approximate property lines and areas of potential ground disturbance is enclosed.

If we have not heard from you in 30 days we will assume that our species list is correct, that you do not have any comments regarding associated laws, and that you do not have any information relevant to this project at the current time.

We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

Ken Gilland

Ken Gilland
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 200
Cary, NC 27518
Phone: (919) 459-9035
Email: kgilland@mbakercorp.com

Baker

Marella Buncick,
US Fish and Wildlife Service
Asheville Field Office
160 Zillicoa Street
Asheville, NC 28801

November 25, 2009

Subject: EEP stream mitigation project in Surry County.

Dear Ms. Buncick,

The Candiff Creek has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts. Several sections of channel have been identified as significantly degraded. The goal of this project is to restore approximately 3,168 LF and enhance 3,328 LF (846 LF of Enhancement I and 2,482 LF of enhancement II) of stream for the purpose of obtaining stream mitigation credit in the Yadkin River basin. The total length of the project is 6,496 LF.

We have already obtained an updated species list for Surry County from your web site and sent a letter to you on October 16, 2009. This letter contains our determination of potential effects to protected species based on that list, website searches of the Natural Heritage Program's (NHP's) Virtual Workroom, and field surveys of the site conducted on October 14, and November 4-5, 2009. Based on the NHP review, conducted on November 24 2009, no federally protected species have been observed within two miles of the project area.

Table 1. Federally Protected Species for Surry County

Scientific Name	Common Name	Federal Status	Biological Conclusion
Vertebrates			
Glyptemys muhlenbergii	Bog Turtle	T	No Effect
Haliaeetus leucocephalus	Bald Eagle	BGEPA	No Effect
Vascular Plants			
Helianthus schweinitzii	Schweinitz's sunflower	E	No Effect
Isotria medeoloides	Small whorled pogonia	E	No Effect

Notes: E – Endangered denotes a species in danger of extinction throughout all or a significant portion of its range
T-Threatened denotes a species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range
BGEPA – Protected by the Bald and Golden Eagle Protection Act

Glyptemys muhlenbergii (Bog turtle)

Federal Status: Threatened Due to Similar Appearance
Animal Family: Emydidae
Federally Listed: November 4, 1997

Bog turtles are small (3 to 4.5 inches) turtles with a weakly keeled carapace (upper shell) that ranges from light brown to ebony in color. The species is readily distinguished from other turtles by a large, conspicuous bright orange to yellow blotch on each side of its head. Bog turtles are semi-aquatic and are only infrequently active above their muddy habitats during specific times of year and temperature ranges. They can be found during the mating season from June to July and at other times from April to October when the humidity is high, such as after a rain event, and temperatures are in the seventies. Bog turtle habitat consists of bogs, swamps, marshy meadows, and other wet environments, specifically those that have soft muddy bottoms. The southern populations of bog turtles (VA, TN, NC, SC, and GA) are listed as threatened due to similar appearance to northern bog turtles that are listed as threatened. The southern bog turtle population is not fully protected under the ESA, but may not be possessed, sold, traded, or collected. In the northern states (CT, DE, MA, MD, NJ, NY, and PA) bog turtles are fully protected under the ESA. A Biological Conclusion is not required since Threatened Due to Similarity of Appearance [T (S/A)] species are not afforded full protection under the ESA. There were small areas of potential bog turtle habitat noted during the site assessment, but no individuals were observed.

Haliaeetus leucocephalus (Bald eagle)
Federal Status: Protected by the Bald and Golden Eagle Protection Act
Animal Family: Accipitridae

Adult bald eagles can be identified by their large white head and short white tail. The body plumage is dark-brown to chocolate-brown in color. In flight, bald eagles can be identified by their flat wing soar. Eagle nests are found in close proximity to water (within 0.5 mile) with a clear flight path to the water, in the largest living tree in an area, and having an open view of the surrounding land. Human disturbance can cause an eagle to abandon otherwise suitable habitat. The breeding season for the bald eagle begins in December or January. Fish are the major food source for bald eagles. Other sources include coots, herons, and wounded ducks. Food may be live or carrion.

Biological Conclusion: No Effect

No suitable habitat exists for the bald eagle within the project area. A search of the NHP database of rare species and unique habitats, conducted on November 23, 2009, shows no occurrences of this species within two miles of the project area. Therefore, no impacts to this species are anticipated during the project construction.

Vascular Plants

Helianthus schweinitzii (Schweinitz's sunflower)
Federal Status: Endangered
Plant Family: Asteraceae
Federally Listed: May 7, 1991

Schweinitz's sunflower, usually 3 to 6 feet tall, is a perennial herb with one to several fuzzy purple stems growing from a cluster of carrot-like tuberous roots. Leaves are 2 to 7 inches long, 0.4 to 0.8 inch wide, lance-shaped, and usually opposite, with upper leaves alternate. Leaves feel like felt on the underside and rough, like sandpaper, on the upper surface. The edges of the leaves tend to curl under. Flowers are yellow composites, and generally smaller than other sunflowers in North America. Flowering and fruiting occur mid-September to frost. This plant grows in clearings and along the edges of upland woods, thickets and pastures. It is also found along roadsides, powerline clearings, old pastures, and woodland openings. It prefers full sunlight or partial shade, but is intolerant of full shade.

Biological Conclusion: No Effect

Potential habitat for Schweinitz's sunflower occurs along field edges throughout the project area. The project study area was evaluated for potential Schweinitz's sunflower habitat and extensive field surveys were performed in October and November 2009. No populations were found within the area of potential impact. The NCNHP website was searched for potential protected species on November

23, 2009. No populations of this species have been reported within one mile of the project area. Therefore, the proposed project is not anticipated to result in an adverse impact to this species.

Isotria medeoloides (Small whorled pogonia)
Federal Status: Threatened
Plant Family: Orchidaceae
Federally Listed: September 9, 1982

Small whorled pogonia is a small perennial member of the Orchidaceae. These plants arise from long slender roots with hollow stems terminating in a whorl of five or six light green leaves. The single flower is approximately one inch long, with yellowish-green to white petals and three longer green sepals. This orchid blooms in late spring from mid May to mid-June. Populations of this plant are reported to have extended periods of dormancy and to bloom sporadically. This small spring ephemeral orchid is not observable outside of the spring growing season. When not in flower, young plants of Indian cucumber-root (Medeola virginiana) also resemble small whorled pogonia. However, the hollow stout stem of Isotria will separate it from the genus Medeola, which has a solid, more slender stem (USFWS 2002c).

Small whorled pogonia may occur in young as well as maturing forests, but typically grows in open, dry deciduous woods and areas along streams with acidic soil. It also grows in rich, mesic woods in association with white pine and rhododendron.

Biological Conclusion: No Effect

Potential habitat for small whorled pogonia occurs along field edges throughout the project area. The project study area was evaluated for potential small whorled pogonia habitat and extensive field surveys were performed in October and November 2009. No populations were found within the area of potential impact. The NCNHP website was searched for potential protected species on November 23, 2009. No populations of this species have been reported within one mile of the project area. Therefore, the proposed project is not anticipated to result in an adverse impact to this species.

We are requesting a letter or email concurrence with this assessment. We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

Ken Gilland
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 200
Cary, NC 27518
Phone: (919) 459-9035
Email: kgilland@mbakercorp.com

Gilland, Ken

From: Marella_Buncick@fws.gov
Sent: Wednesday, January 06, 2010 8:25 AM
To: Gilland, Ken
Cc: Donnie.Brew@fhwa.dot.gov
Subject: Re: Candiff Creek Stream Restoration Site

Ken,

We typically do not provide concurrence with no effect calls. If there was a request for concurrence it should come from FHWA. That said, it would appear that your calls are appropriate for this project. Any comment Donnie?

thanks, marella

marella buncick
USFWS
160 Zillicoa St.
Asheville, NC 28801
828-258-3939 ext 237

People don't resist change, they resist being changed.

"Gilland, Ken" <Kgilland@mbakercorp.com>

01/05/2010 02:37 PM

To "'marella_buncick@fws.gov'" <marella_buncick@fws.gov>
cc
Subject Candiff Creek Stream Restoration Site

Hi Marella:

I hope you had a great New Year's and that 2010 is treating you well.

I just wanted to check to see if you'd been able to review our effects determinations for the Candiff Creek Stream Restoration Project in Surry County (see enclosed). We're trying to finalize the CE and ERTR we wanted to make sure the document had reached you. If you have any questions, or if there's something we need to revise, just let me know.

We appreciate your review

Ken

Ken Gilland
Project Manager
Michael Baker Engineering
8000 Regency Parkway, Suite 200
Cary NC 27518

Phone: (919) 459-9035
Cell: (919) 741-0587
[attachment "candiff_USFWS2.pdf" deleted by Marella Buncick/R4/FWS/DOI]

Baker

Renee Gledhill-Earley
State Historic Preservation Office
4617 Mail Service Center
Raleigh, NC 27699-4617

November 2, 2009

Subject: EEP stream mitigation project in Surry County.

Dear Ms. Gledhill-Earley,

The Ecosystem Enhancement Program (EEP) requests review and comment on any possible issues that might emerge with respect to archaeological or cultural resources associated with a potential wetland and stream restoration project on the attached site (USGS site maps with approximate property lines and areas of potential ground disturbance are enclosed).

Candiff Creek, in the USGS Bottom Quadrangle, has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts. Several sections of channel have been identified as significantly degraded. The goal of this project is to restore approximately 3,168 LF and enhance 3,328 LF (846 LF of Enhancement I and 2,482 LF of enhancement II) of stream for the purpose of obtaining stream mitigation credit in the Yadkin River basin. The total length of the project is 6,496 LF.

A National Register listed property, the C.C. Cundiff House (added 1983 - Building - #83001918) is in the immediate vicinity of the project site; however, it is not anticipated that activities relating to this project would greatly change the visual environment of the historic property. No architectural structures or archeological artifacts have been observed or noted during preliminary surveys of the area of disturbance for the project. In addition, the majority of the project site has historically been disturbed by tilling and other agricultural purposes.

We ask that you review this project based on the attached information. We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

Ken Gilland

Ken Gilland
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 200
Cary, NC 27518
Phone: (919) 459-9035
Email: kgilland@mbakercorp.com

North Carolina Department of Cultural Resources
State Historic Preservation Office
Peter B. Sandbeck, Administrator

Beverly Eaves Perdue, Governor
Linda A. Carlisle, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

November 23, 2009

Ken Gilland
Michael Baker Engineering, Inc.
8000 Regency Parkway
Suite 200
Cary, NC 27518

Re: Candiff Creek Stream Restoration, Surry County, ER 09-2728

Dear Mr. Gilland:

Thank you for your letter of November 2, 2009, concerning the above project.

There are no known archaeological sites within the proposed project area. Based on our knowledge of the area, it is unlikely that any archaeological resources that may be eligible for inclusion in the National Register of Historic Places will be affected by the project. We, therefore, recommend that no archaeological investigation be conducted in connection with this project.

The project as proposed will have no effect on the C. C. Cundiff House, SR 207, a National Register-listed property.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

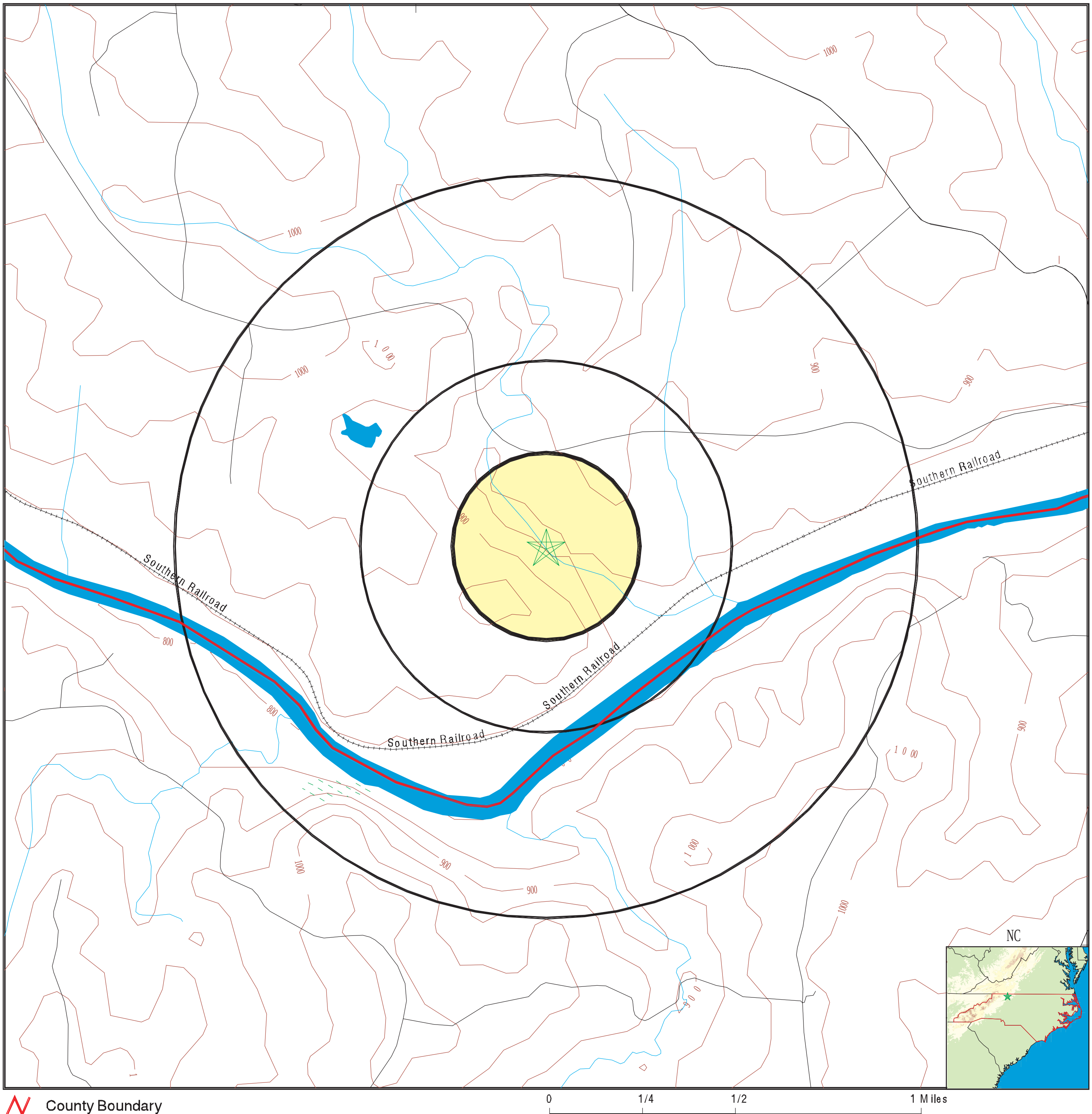
Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579. In all future communication concerning this project, please cite the above-referenced tracking number.

Sincerely,

Renee Gledhill-Earley

Peter Sandbeck

PHYSICAL SETTING SOURCE MAP - 2644426.1s



- County Boundary
- Major Roads
- Contour Lines
- Earthquake epicenter, Richter 5 or greater
- Water Wells
- Public Water Supply Wells
- Cluster of Multiple Icons

- Groundwater Flow Direction
- Indeterminate Groundwater Flow at Location
- Groundwater Flow Varies at Location

- Wildlife Areas
- Natural Areas
- Rare & Endangered Species

SITE NAME:	Candiff Creek Site	CLIENT:	Michael Baker Engineering, Inc.
ADDRESS:	SR 2230	CONTACT:	Ken Gilland
	Siloam NC 27047	INQUIRY #:	2644426.1s
LAT/LONG:	36.2801 / 80.5897	DATE:	November 23, 2009 11:38 am

Baker

May 27, 2010

Julie Cahill
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Subject: EEP Floodplain Requirements Checklist Stream and Wetland Restoration Project in Surry County, North Carolina Yadkin River Basin, Candiff Creek Stream Restoration Site, EEP # 92767, Baker # 118335

Dear Ms. Cahill:

Please find enclosed one copy of the EEP Floodplain Requirements Checklist for the Candiff Creek Stream Restoration site in Surry County, North Carolina (see Figure 1). The Candiff Creek site is located in Surry County, approximately 1.75 miles west of Siloam Township within cataloging unit 03040101, NC Division of Water Quality sub-basin 03-07-02 of the Yadkin Pee-Dee River Basin. The proposed project easement covers approximately 225 acres of land. The project goals are to restore 3,168 linear feet (LF) of stream and enhance 3,328 LF (846 LF of Enhancement I and 2,482 LF of Enhancement II) of stream along Candiff Creek. The restoration plan for the project is summarized in Figures 2a and 2b.

Project activities will be confined to installing riparian buffers, stabilizing stream channels, invasive species removal and constructing in-stream structures. As this is the case, no construction work outside the stream channel is envisioned for reaches UT1 (upstream and downstream), UT2 (upstream and downstream), M1 or M2. A new channel will be created for reach M3, which is mostly located in backwater from the Yadkin River. Baker has discussed the project with the Local Floodplain Administrator and at a minimum a no-rise certification will be obtained. Based on the Floodplain Administrator's decision, a LOMR may be required.

Sincerely,

Ken Gilland
Michael Baker Engineering
8000 Regency Parkway, Suite 200
Cary, NC 27518
Phone (919) 459-9035
Email kgilland@mbakercorp.com
Enclosures

Cc: Mr. Edward Curtis, NC Floodplain Mapping Program
John Gerber, NC Floodplain Mapping Unit
Kim Bates, Local Floodplain Administrator, Surry County

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:	Candiff Creek Stream Restoration Project
Name if stream or feature:	Candiff Creek
County:	Surry County
Name of river basin:	Yadkin/Pee Dee
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Surry County
DFIRM panel number for entire site:	3703645922J
Consultant name:	Kevin Tweedy, PE Michael Baker Engineering, Inc.
Phone number:	(919) 459-9004
Address:	8000 Regency Parkway, Suite 200 Cary, NC 27518

Design Information

Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500".

The Candiff Creek Stream Restoration Project is located in Surry County, approximately 1.75 miles west of Siloam Township. The area lies within cataloging unit 03040101 and NCDWQ sub-basin 03-07-02 of the Yadkin Pee-Dee River Basin (Figure 1). The project involves two unnamed tributaries (UTs) to

Candiff Creek and Candiff Creek, which flows directly into the Yadkin River. For analysis purposes, Baker labeled the existing reaches M1, M2, M3, UT1 and UT2 (Figure 2). Proposed preservation, enhancement, and restoration activities for the project reaches are summarized below

Reach	Length	Priority
Candiff Creek (M1)	690 LF	Enhancement II
Candiff Creek (M2)	265 LF	Enhancement I
Candiff Creek (M3)	3,828 LF (existing) 4,109 LF (design)	Restoration Priority I & II
UT1 (upstream)	400 LF	Preservation
UT1 (downstream)	485 LF	Enhancement II
UT2 (upstream)	800 LF	Preservation
UT2 (downstream)	317 LF	Enhancement II

Project activities will be confined to installing riparian buffers, stabilizing stream channels, invasive species removal and constructing in-stream structures. As this is the case, no construction work outside the stream channel is envisioned for reaches UT1 (upstream and downstream), UT2 (upstream and downstream), M1 or M2. A new channel will be created for reach M3, which is mostly located in backwater from the Yadkin River. Baker has discussed the project with the Local Floodplain Administrator and at a minimum a no-rise certification will be obtained. Based on the Floodplain Administrator's decision, a LOMR may be required.

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: Based on Federal Emergency Management Agency (FEMA) mapping, the entire mainstem length of the project area is classified as Zone AE, which is designated as a special flood hazard area inundated by the 100-year flood. Base flood elevations have been determined for Zone AE areas and range from 811 feet at the southern terminus of the project to 829 feet at River-Siloam Road. The lower portion of Reach M3 is in a backwater zone for the Yadkin River.

Check if applies:

☑ AE Zone

- [ ] Floodway
- [ ] Non-Encroachment
- [x] 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

No floodway is defined

Land Acquisition (Check)

- [ ] State owned (fee simple)
- [x] 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?

- [x] 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: Kim Bates – Surry County Phone Number (336) 401-8350

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

- [ ] No Action
- [x] No Rise
- [ ] Letter of Map Revision
- [ ] Conditional Letter of Map Revision
- [ ] Other Requirements

List other requirements:

Comments:

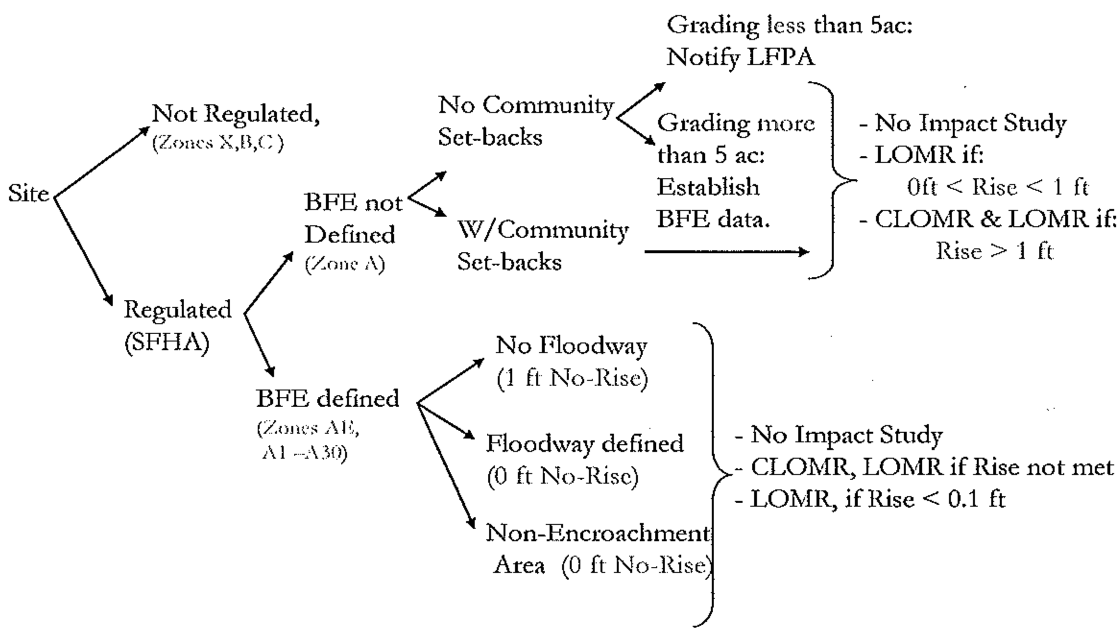
Name: Kevin Tweedy

Signature:

Title: Project Engineer

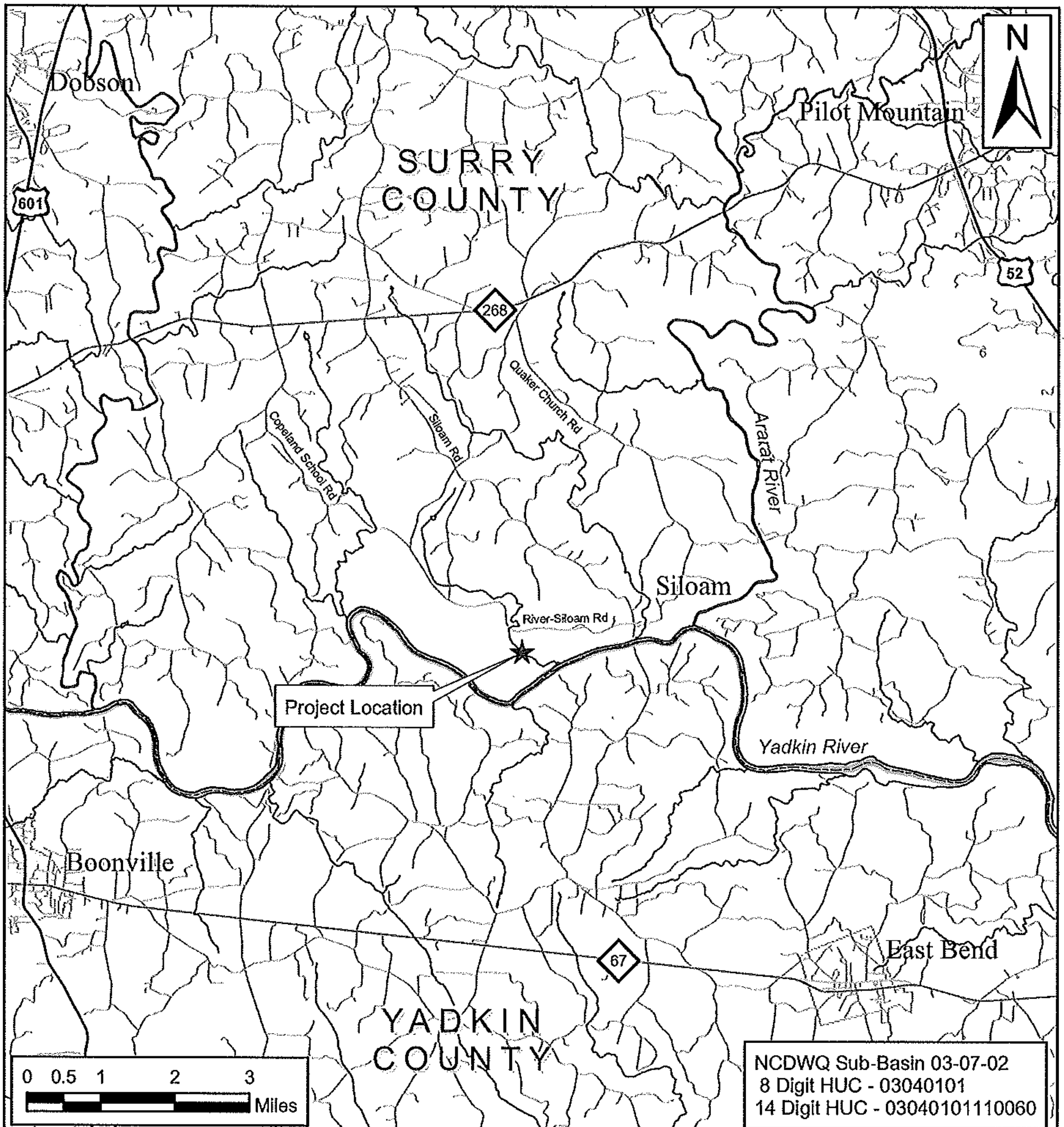
Date: 5-26-10

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 $\geq$ 1 ft, CLOMR is required
AE, A1-A30	Yes	Yes	No	n/a	a. No-Rise Study b. CLOMR if $\geq$ 1ft c. LOMR

AEFW A1-A30	Yes	Yes	Yes	n/a	a. No-Rise Study b. CLOMR if $\geq$ 0 ft c. LOMR



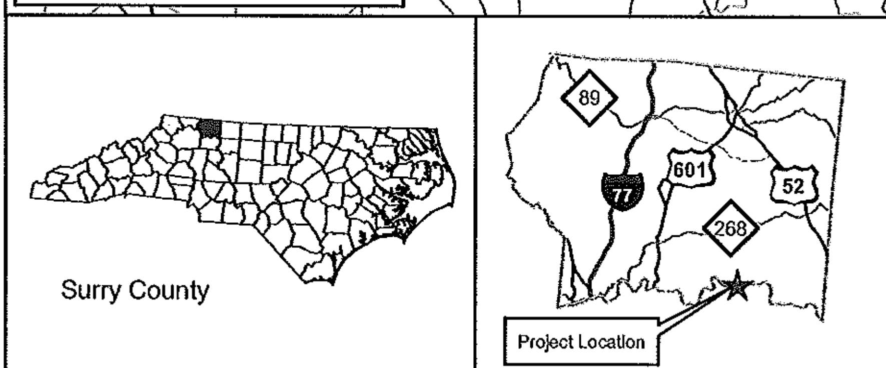


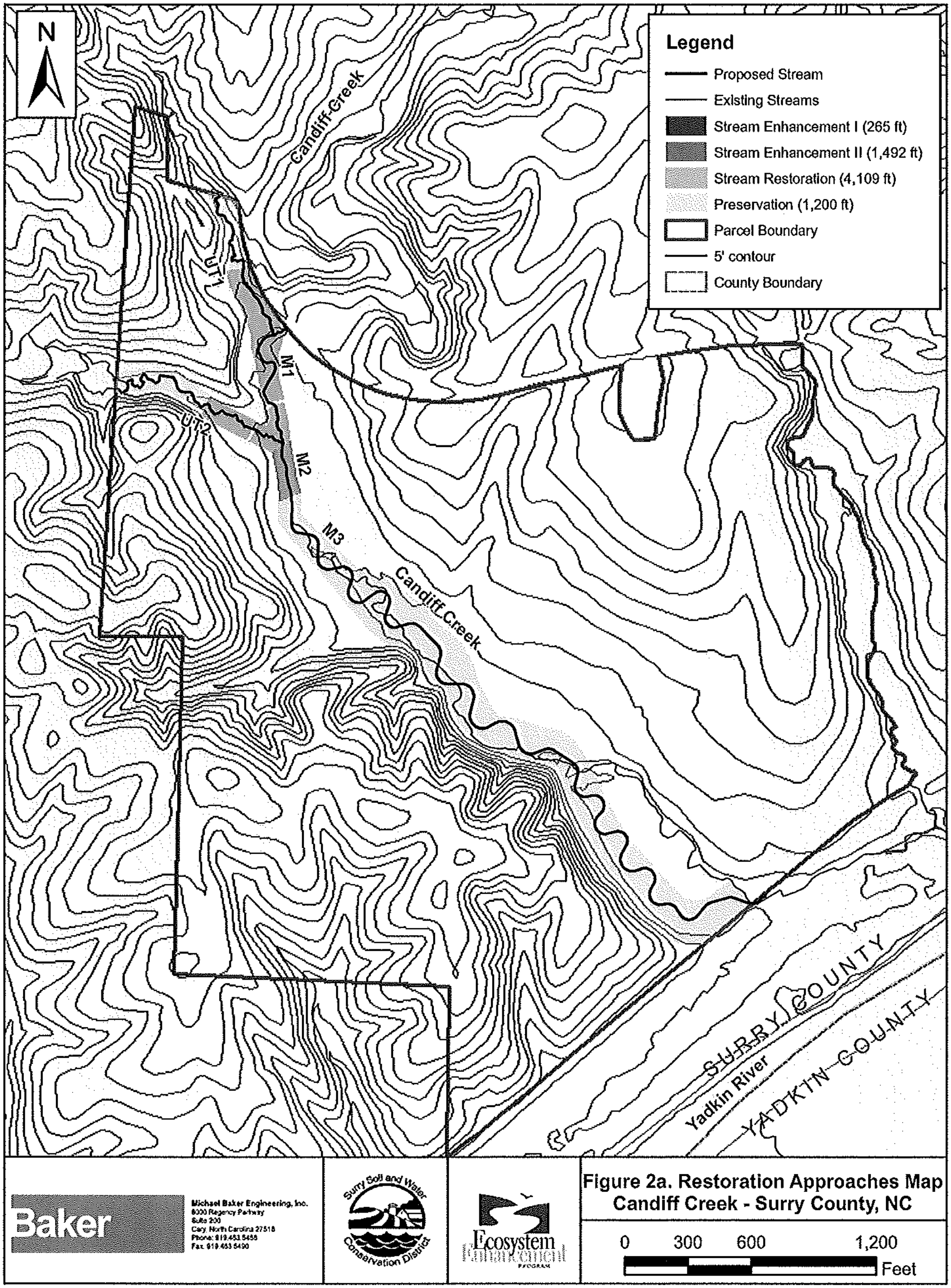
Figure 1. Vicinity Map
Candiff Creek - Surry County, NC

Surry Soil and Water Conservation District

Ecosystem Enhancement Program

Baker

Michael Baker Engineering, Inc.
8000 Regency Parkway
Suite 200
Cary, North Carolina 27518
Phone: 919.463.5488
Fax: 919.463.5490



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Surry Soil and Water Conservation District

Ecosystem Enhancement Program

Figure 2a. Restoration Approaches Map
Candiff Creek - Surry County, NC

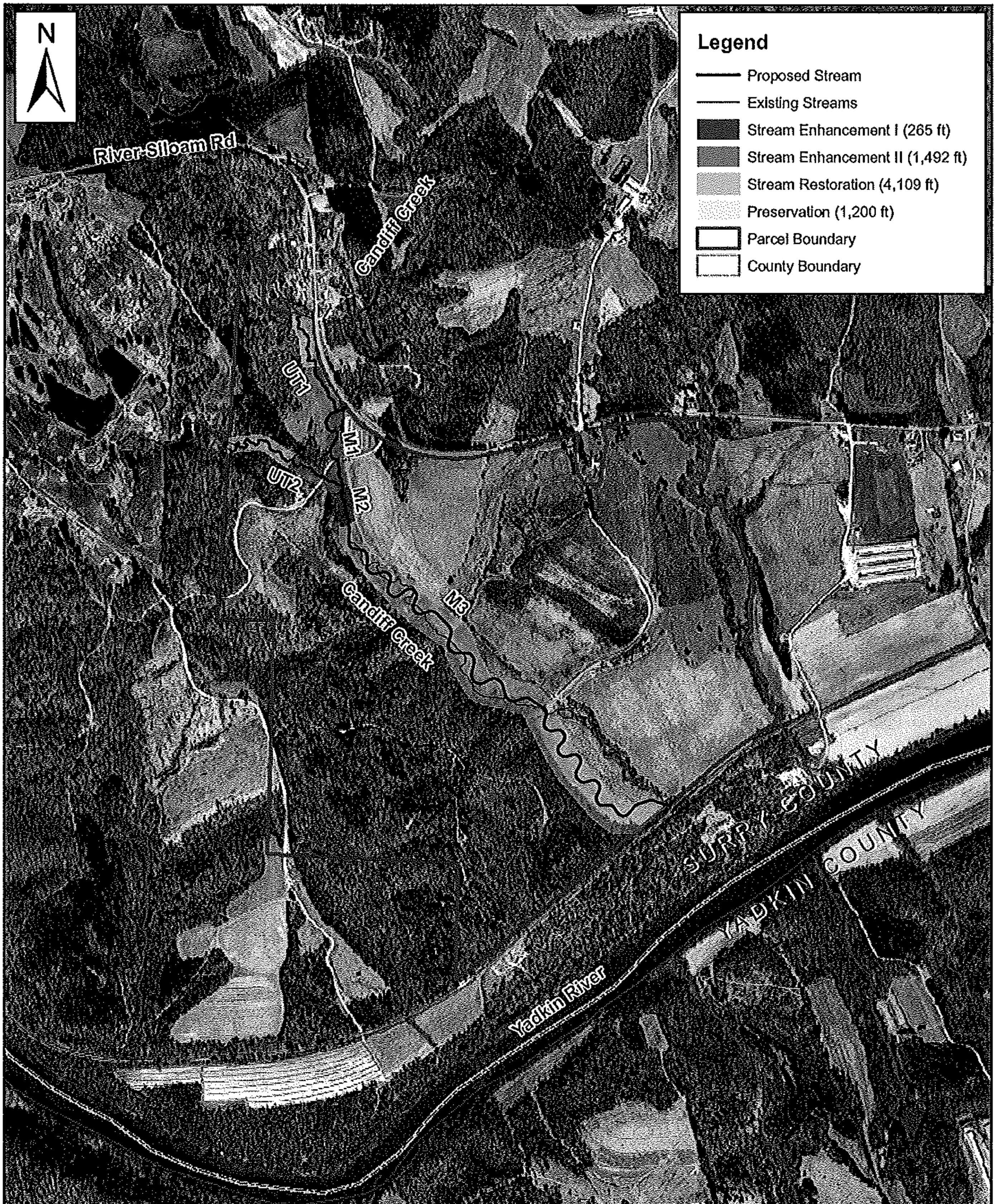

Figure 2b. Restoration Approaches Map
Candiff Creek - Surry County, NC

0 500 1,000 2,000 Feet

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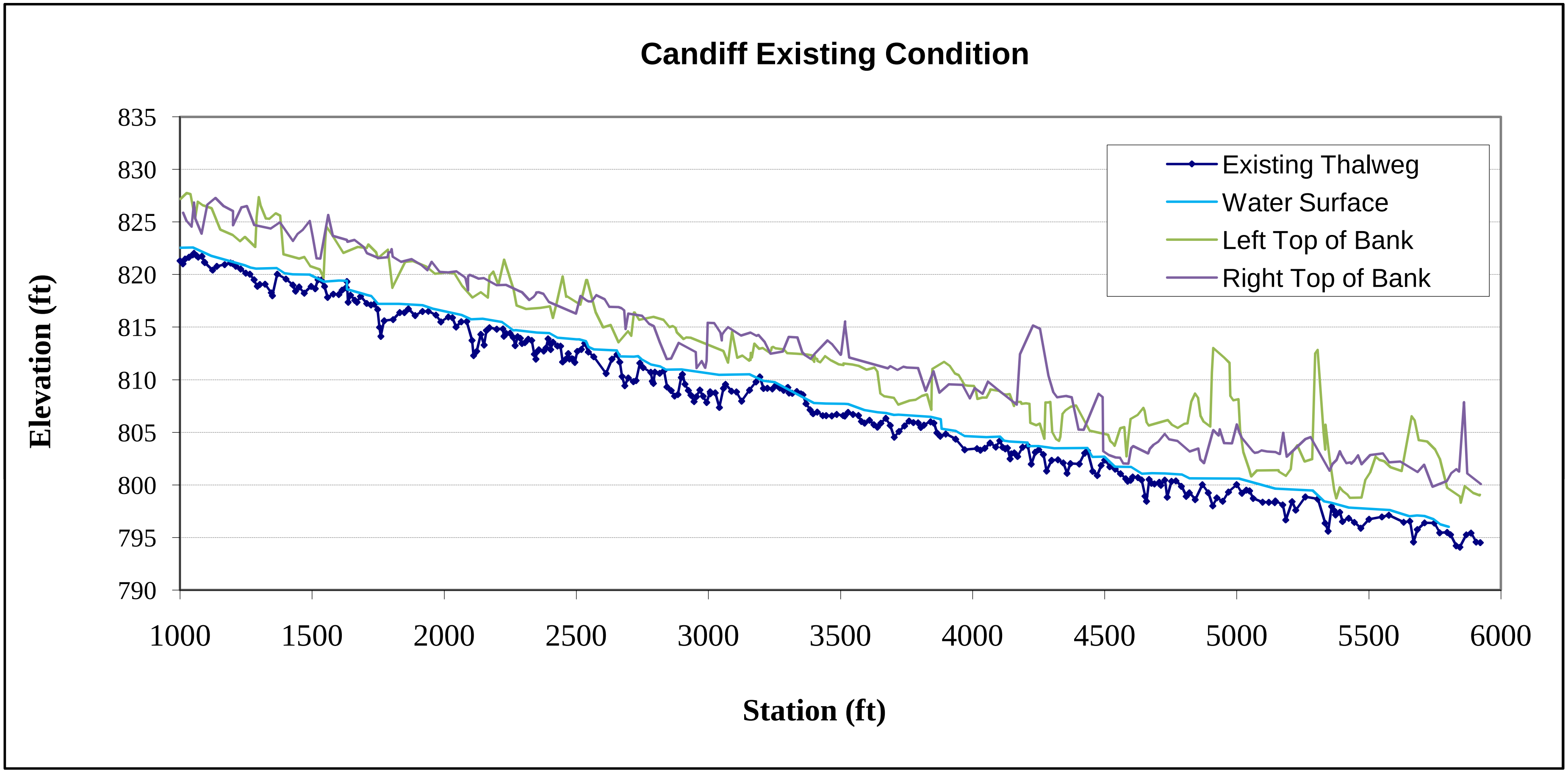
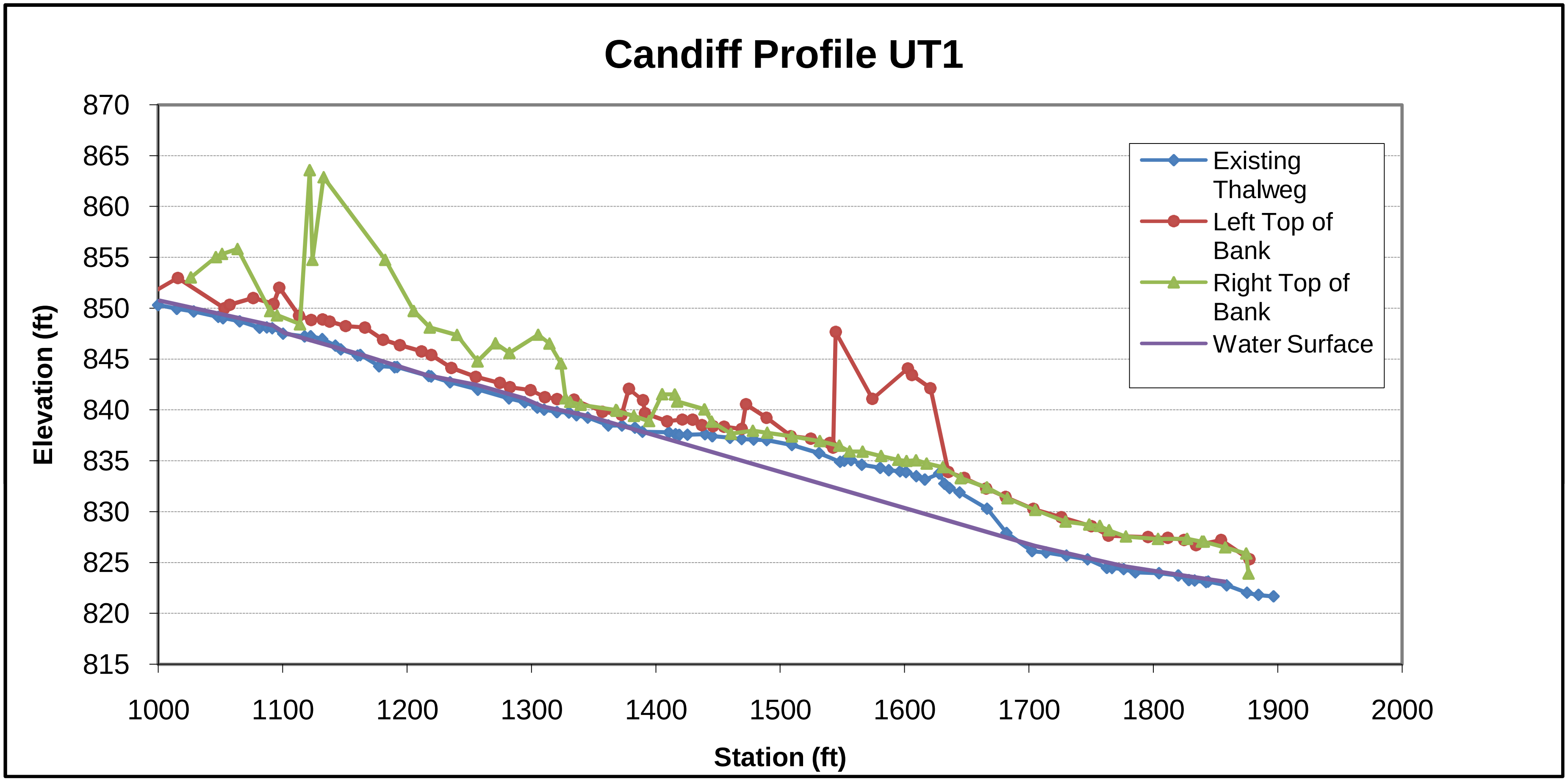
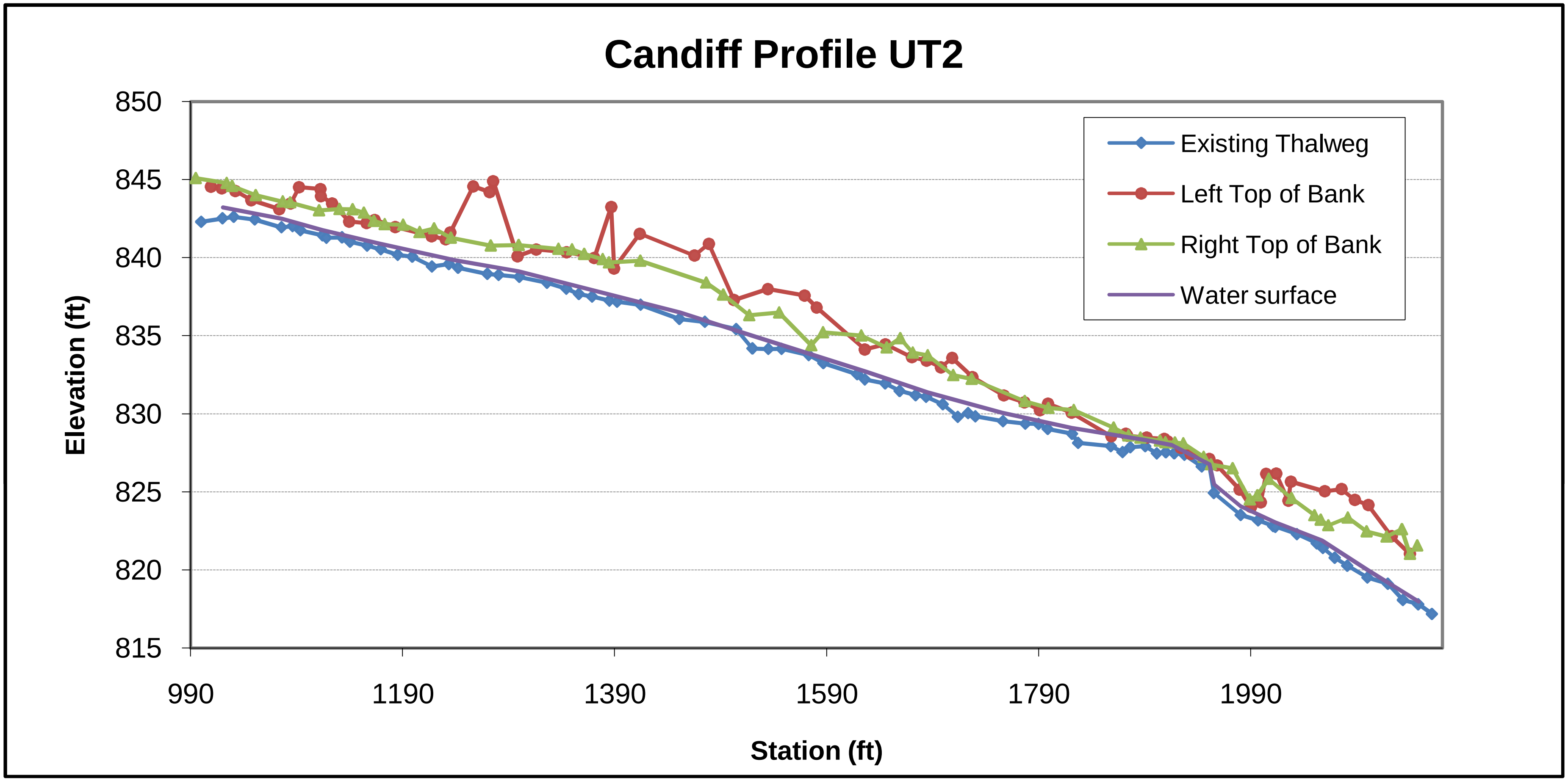

Candiff Existing Condition
Existing Thalweg
Water Surface
Left Top of Bank
Right Top of Bank
Elevation (ft)
835
830
825
820
815
810
805
800
795
790
Station (ft)
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000



Candiff Profile UT1
Elevation (ft)
870
865
860
855
850
845
840
835
830
825
820
815
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Station (ft)
Existing Thalweg
Left Top of Bank
Right Top of Bank
Water Surface



Candiff Profile UT2
850
845
840
835
830
825
820
815
Elevation (ft)
990
1190
1390
1590
1790
1990
Station (ft)
Existing Thalweg
Left Top of Bank
Right Top of Bank
Water surface

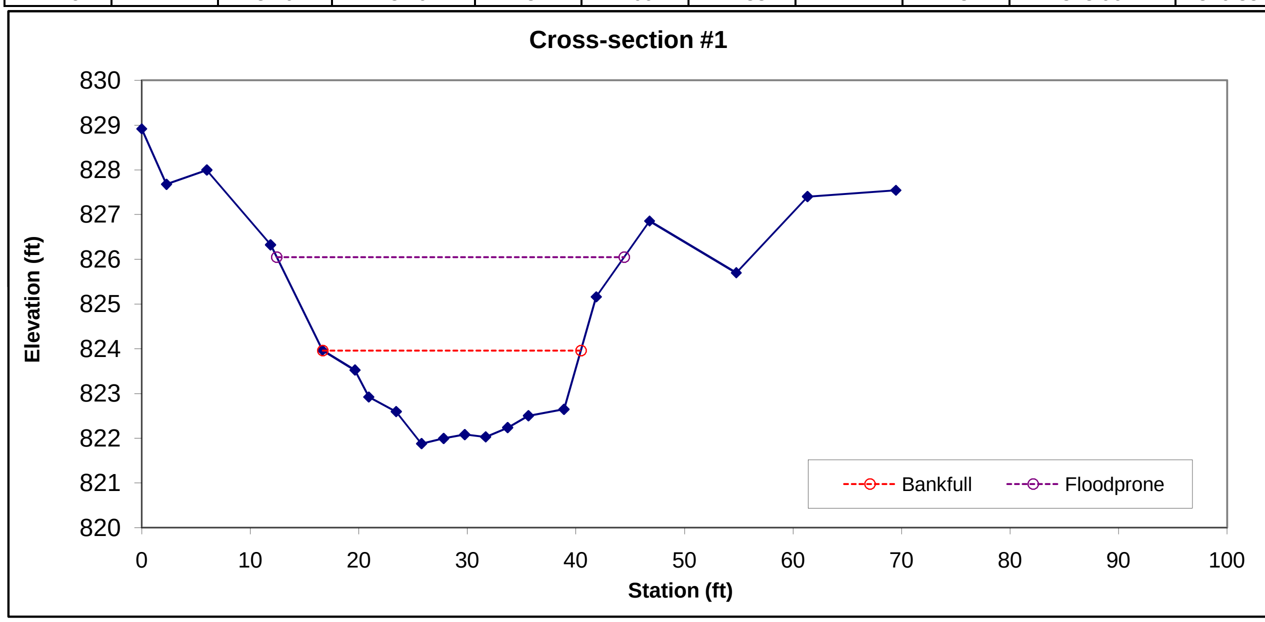
Cross-section #1

(Existing Condition Data - collected December 2009)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	F	32.6	23.79	1.37	2.09	17.38	2.4	1.3	823.96	826.85



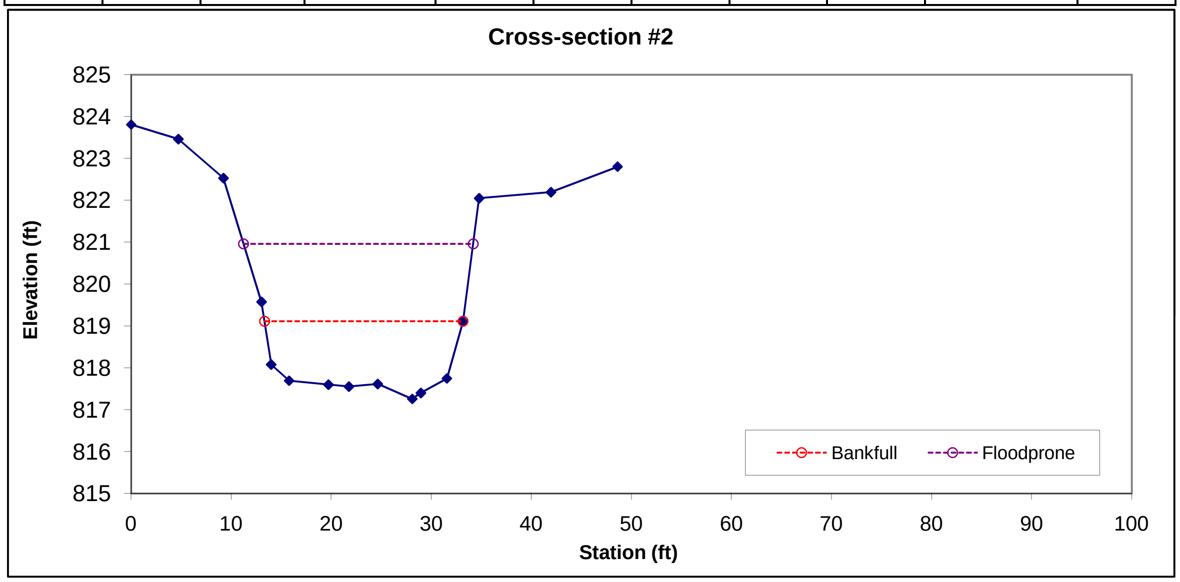
Cross-section #2

(Existing Condition Data - collected December 2009)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	F	28.2	19.83	1.42	1.85	13.94	2.6	1.2	819.11	822.05



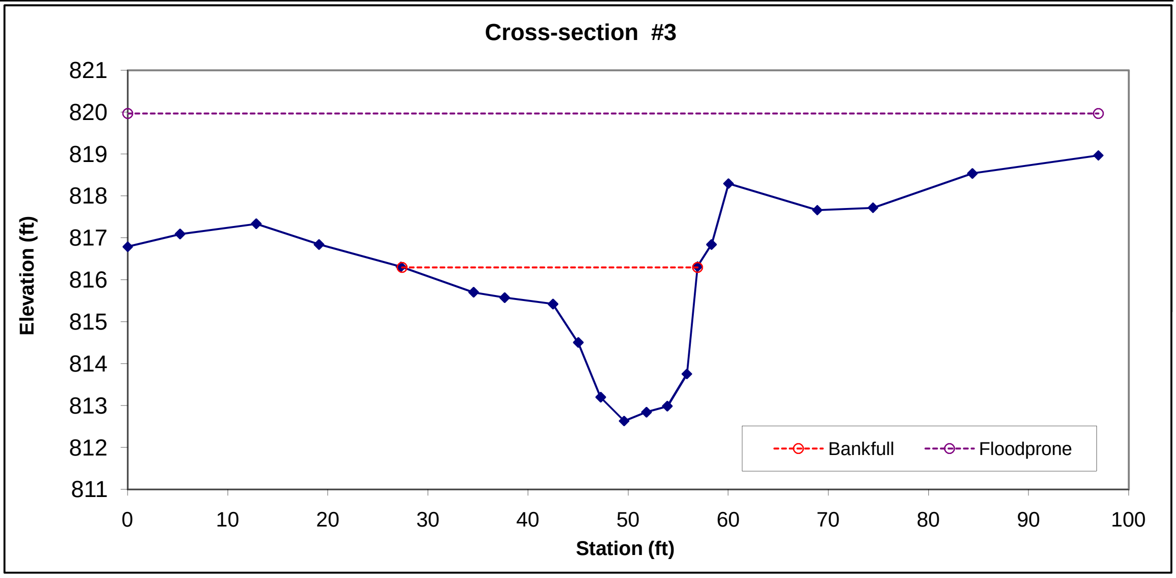
Cross-section #3

(Existing Condition Data - collected December 2009)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		47	29.49	1.59	3.67	18.52	1.1	3.3	816.3	816.84



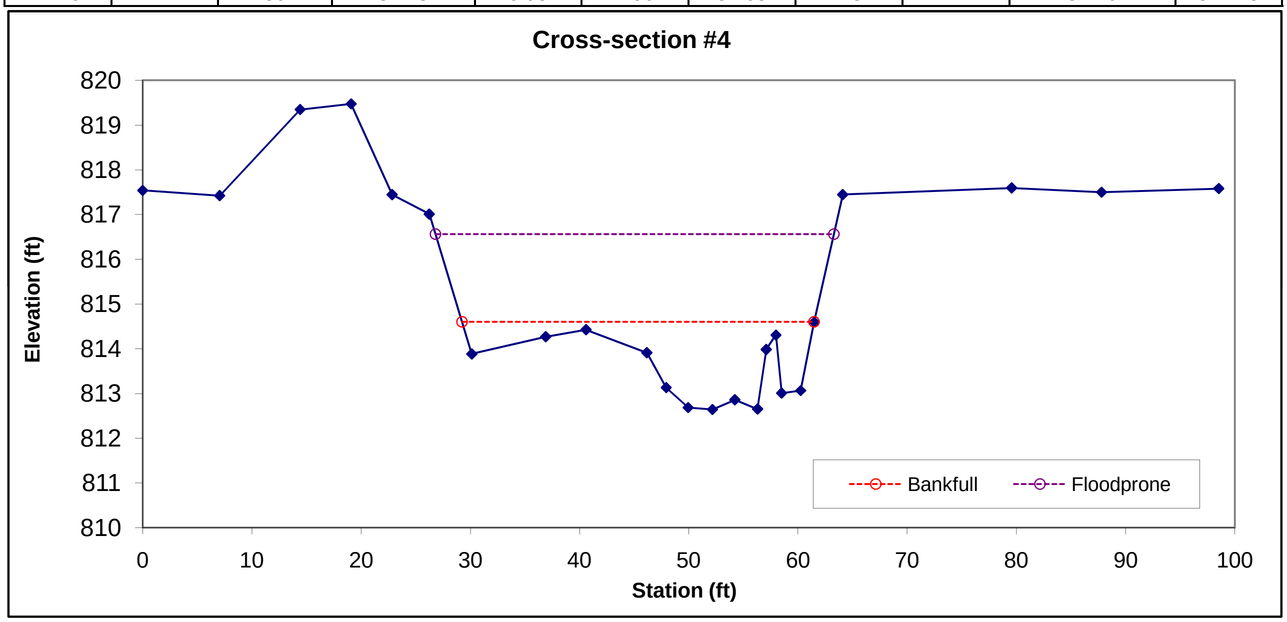
Cross-section #4

(Existing Condition Data - collected December 2009)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	F	30	32.23	0.93	1.96	34.63	2.5	1.1	814.6	817.45



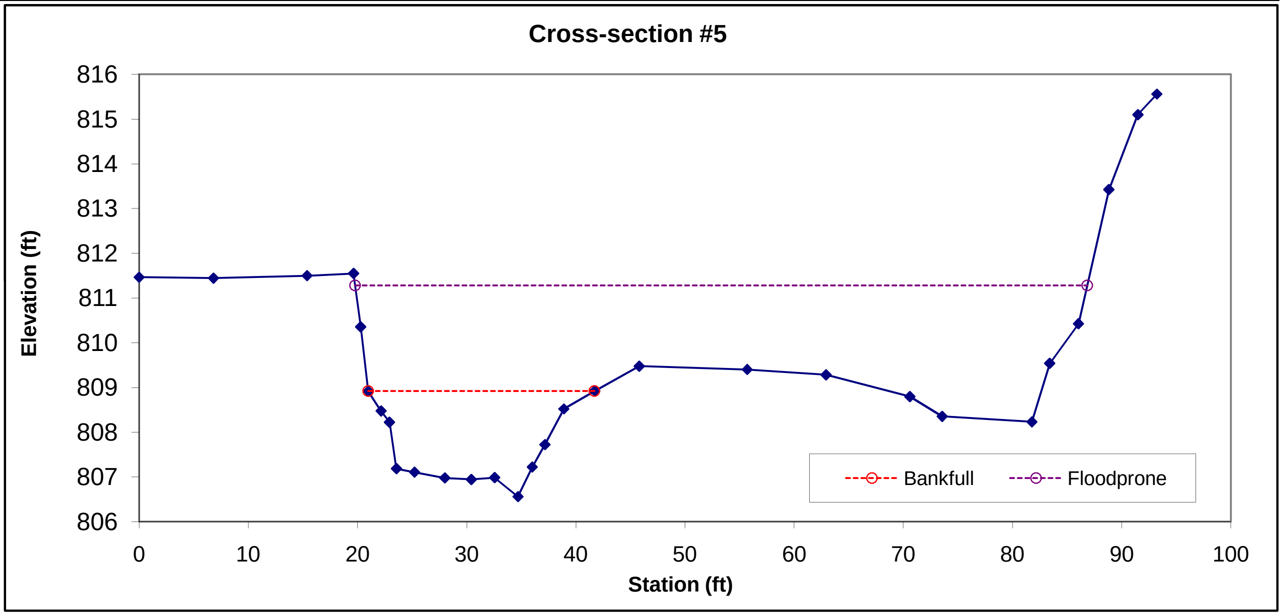
Cross-section #5

(Existing Condition Data - collected December 2009)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	29.4	20.72	1.42	2.36	14.59	2.1	3.2	808.92	811.55



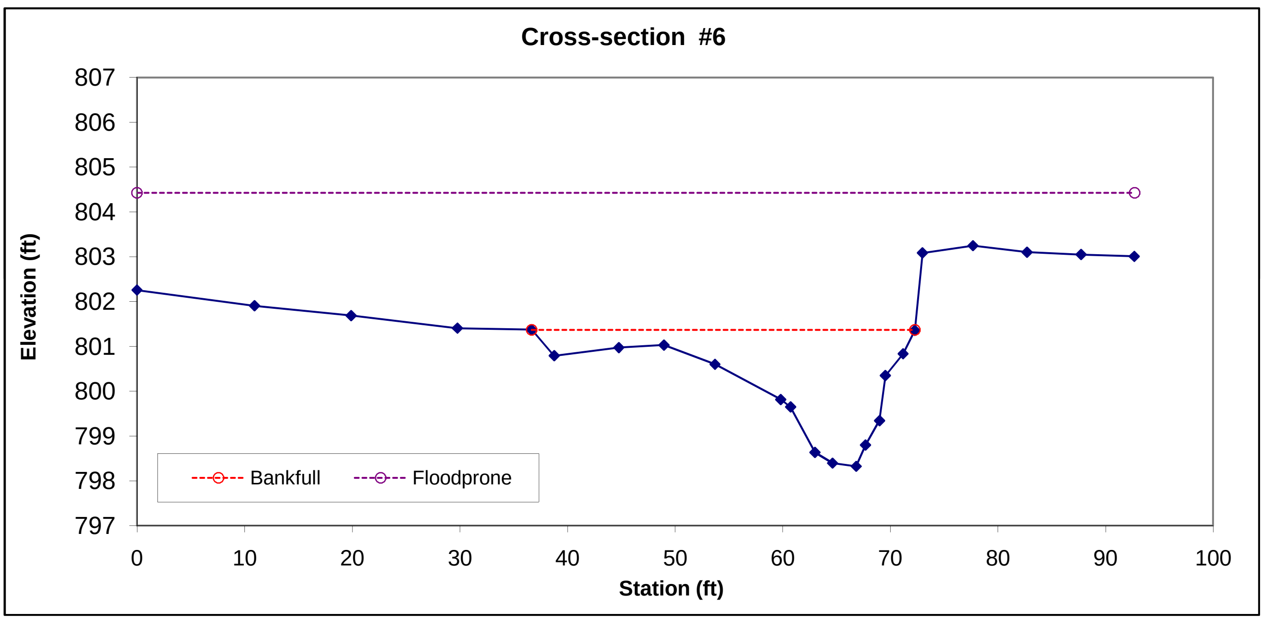
Cross-section #6

(Existing Condition Data - collected December 2009)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		40.6	35.62	1.14	3.05	31.23	1	2.6	801.37	801.37

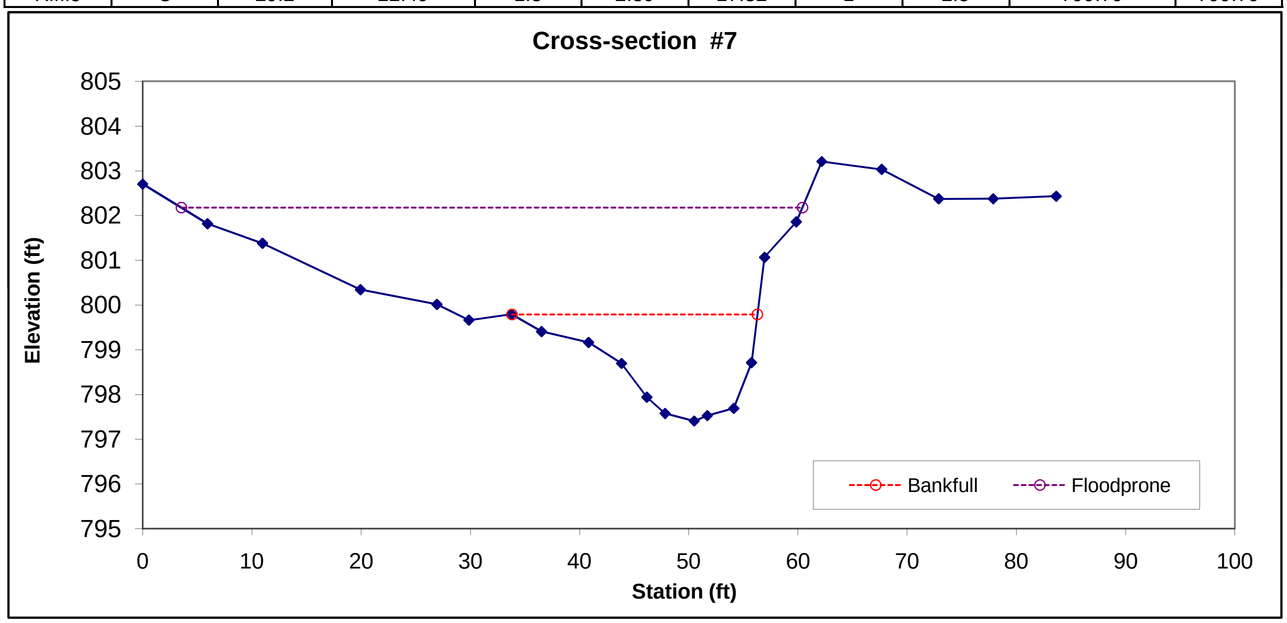


Cross-section #7
(Existing Condition Data - collected December 2009)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	29.2	22.49	1.3	2.39	17.32	1	2.5	799.79	799.79

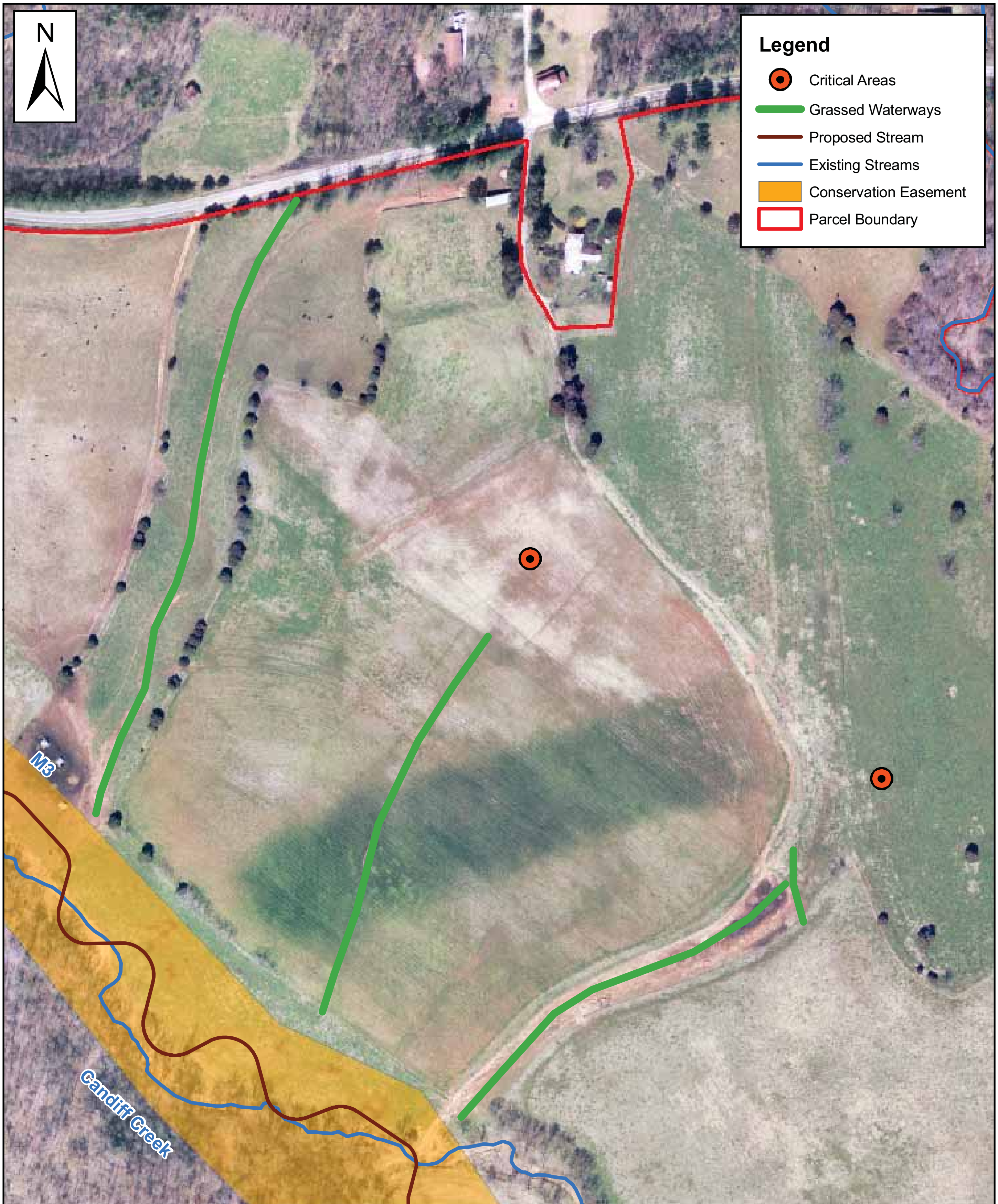


Johnson Farm Improvements outside the Conservation Easement

The Surry Soil and Water Conservation District has obtained funds from the North Carolina Agricultural Cost Share program (NCACSP), US Department of Agriculture's (USDA's) Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP), and NC Ecosystem Enhancement Program (NCEEP) to allow the Johnson property to continue to function as a cattle farm while complimenting NCEEP's stream restoration goals. NCACSP and EQIP were the grantors for the funding and NCEEP provided the matching funds to aid the improvements to the Johnson property outside the perpetual conservation easement. The NCEEP funding was consistent with their goal of providing best management practices (BMPs) to help address local water quality and habitat stressors in a Targeted Local Watershed (Upper Yadkin/Ararat River).

Currently, cattle have been removed from the site to allow contractors to have unimpeded access to the restoration reaches. The grant from the EQIP program will allow the owner to install approximately 11,500 feet of fencing to exclude cattle from the restored reaches of Candiff Creek once construction activities have been completed.

The EQIP grant has also allowed the owner to repair and plant 0.51 acres of the site as grassed swales to reduce sediment and nutrient impacts associated with degraded ephemeral channels (see Figure 1). These regraded, matted, mulched, and vegetated swales will assist in the removal of nutrients and sediment from outside of the conservation easement, especially in the vicinity of two areas designated as critical areas that were regraded such that runoff drainage can flow across the landscape and provide greater infiltration and nutrient treatment rather than being confined to a ditch. These critical areas cover approximately 2.32 acres on the Johnson property. In addition, the owner has installed a stock trail (funded by EQIP) approximately 1,600 feet long that leads to a 6,200-squre foot animal feeding plot (funded by NCACSP) that is also designated as a heavy use area (see Figure 2). Finally, the EQIP grant has allowed the owner to install 2 water wells that will be connected via approximately 5,300 feet of waterline to 12 livestock watering facilities (see Figure 3). The wells have submergible pumps; one well will operate at a rate of 50 gallons per minute while the other will operate at a rate of 35 gallons per minute.



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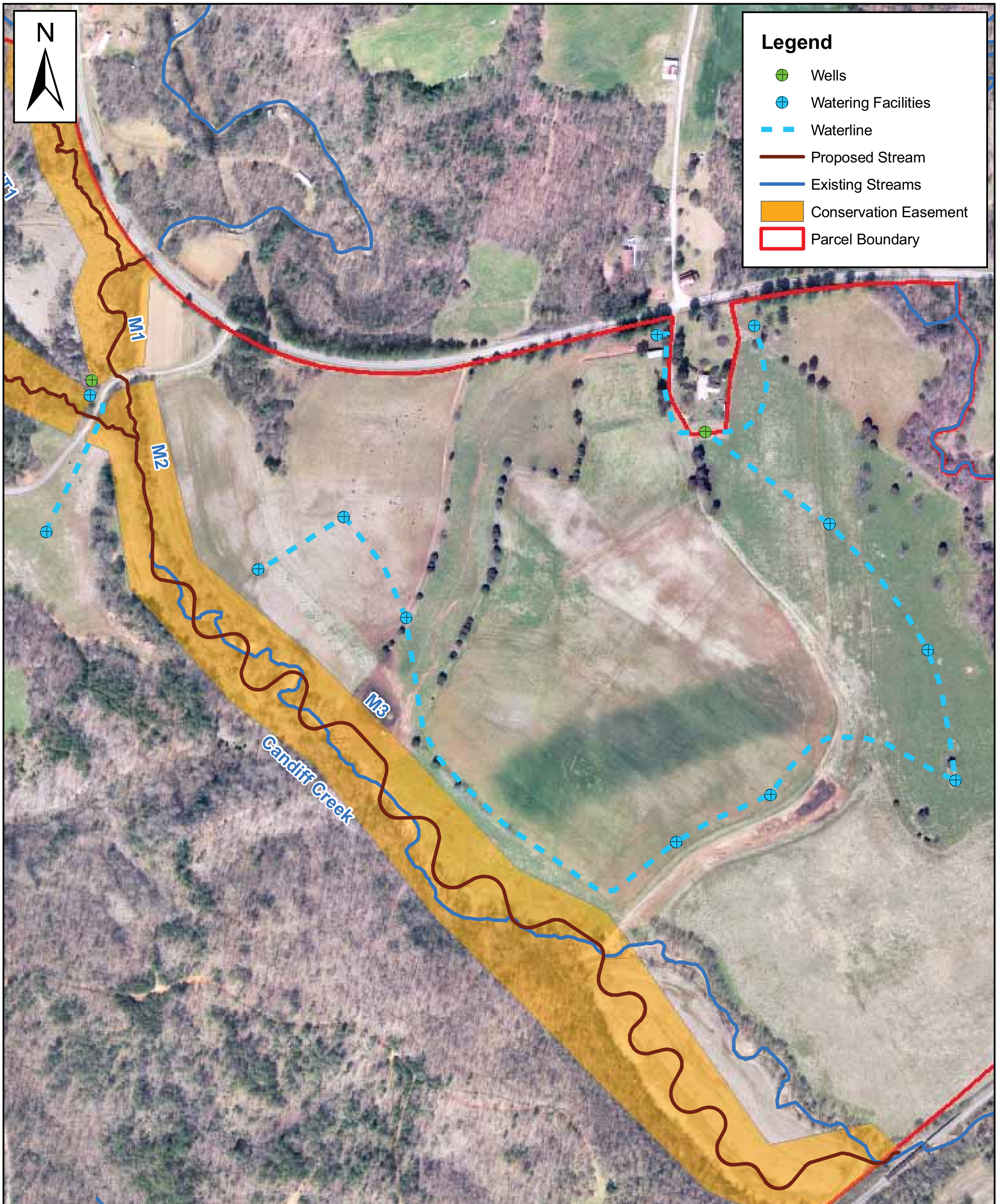
Surry Soil and Water Conservation District

Ecosystem Enhancement Program

Figure 1
Grassed Waterways and Critical Areas
Candiff Creek - Surry County, NC



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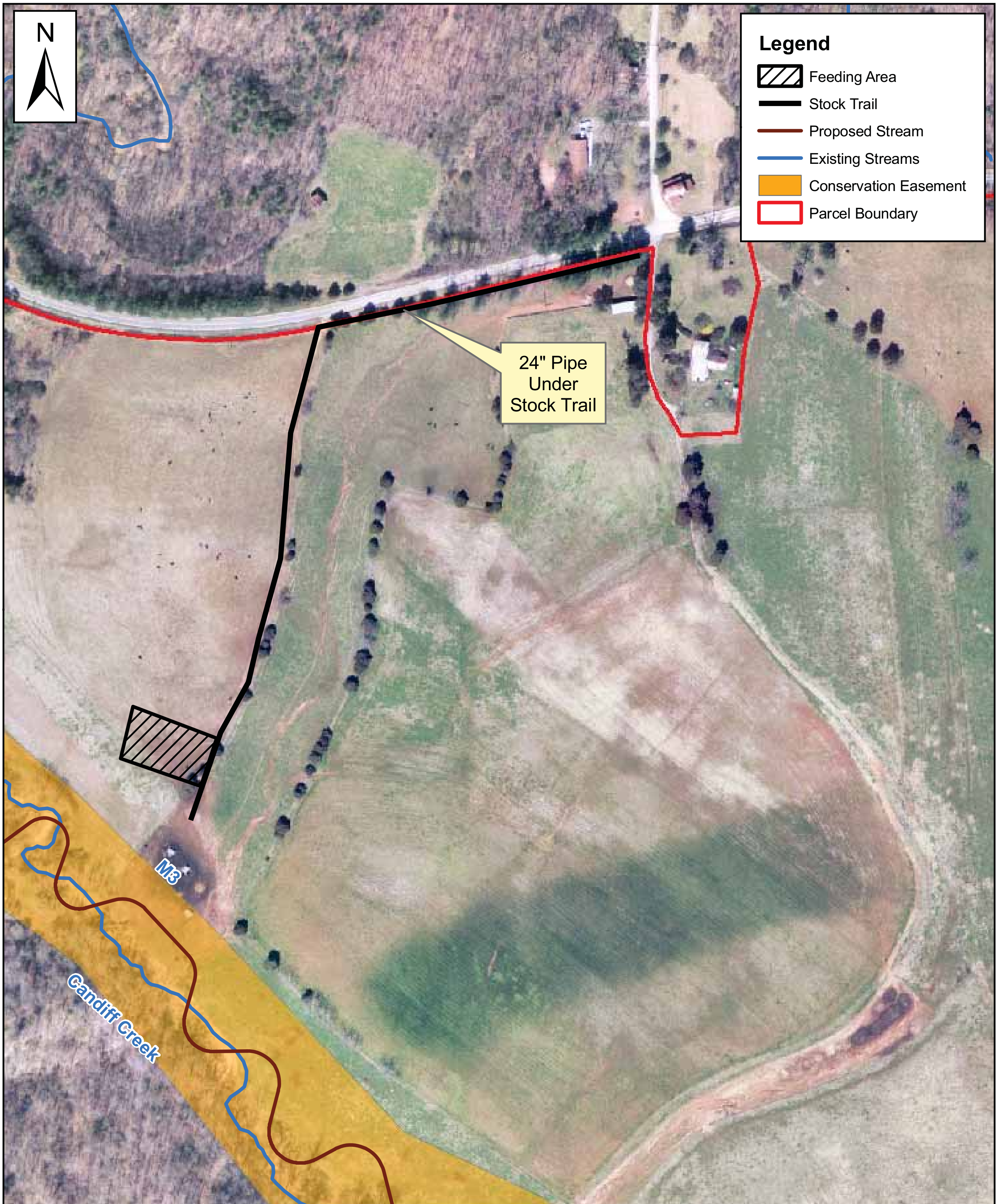
Surry Soil and Water Conservation District

Ecosystem Enhancement Program

Figure 3
Wells and Watering Facilities
Candiff Creek - Surry County, NC

0 200 400 800
Feet



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Surry Soil and Water Conservation District

Ecosystem Enhancement Program

Figure 2
Heavy Use Feeding Area
Candiff Creek - Surry County, NC

0 125 250 500 Feet

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

North Carolina 36.330 N 80.652 W 1197 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 2, Version 3
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2004
Extracted: Wed May 19 2010

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.35	0.56	0.70	0.96	1.20	1.43	1.55	1.93	2.38	2.87	3.42	3.85	4.41	5.04	6.78	8.39	10.61	12.62
2	0.42	0.67	0.84	1.16	1.46	1.74	1.88	2.34	2.88	3.48	4.13	4.65	5.29	6.03	8.04	9.90	12.44	14.74
5	0.49	0.79	1.00	1.42	1.82	2.20	2.38	2.95	3.63	4.43	5.21	5.81	6.49	7.29	9.56	11.50	14.21	16.69
10	0.55	0.88	1.11	1.61	2.10	2.54	2.76	3.42	4.22	5.19	6.06	6.72	7.43	8.28	10.74	12.69	15.53	18.15
25	0.61	0.98	1.24	1.84	2.45	3.02	3.28	4.08	5.05	6.25	7.24	7.99	8.72	9.61	12.32	14.23	17.21	19.99
50	0.66	1.05	1.33	2.01	2.72	3.38	3.68	4.60	5.71	7.13	8.20	9.02	9.76	10.66	13.54	15.38	18.45	21.36
100	0.70	1.12	1.41	2.16	2.98	3.75	4.09	5.14	6.40	8.06	9.20	10.08	10.82	11.73	14.77	16.50	19.64	22.66
200	0.74	1.18	1.49	2.31	3.24	4.13	4.51	5.69	7.12	9.04	10.24	11.19	11.92	12.82	16.01	17.59	20.79	23.91
500	0.79	1.25	1.57	2.50	3.59	4.64	5.08	6.46	8.14	10.43	11.70	12.74	13.43	14.30	17.68	19.00	22.25	25.47
1000	0.82	1.29	1.63	2.63	3.84	5.03	5.53	7.07	8.96	11.57	12.88	13.99	14.64	15.46	18.97	20.06	23.33	26.62

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

*** Upper bound of the 90% confidence interval**
Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.38	0.61	0.76	1.04	1.30	1.55	1.69	2.10	2.58	3.10	3.69	4.13	4.71	5.37	7.18	8.84	11.12	13.20
2	0.46	0.73	0.91	1.26	1.58	1.90	2.06	2.55	3.14	3.77	4.46	4.98	5.65	6.42	8.52	10.42	13.04	15.43
5	0.54	0.86	1.09	1.55	1.99	2.40	2.60	3.22	3.95	4.79	5.62	6.22	6.93	7.76	10.13	12.10	14.90	17.47
10	0.60	0.95	1.21	1.75	2.28	2.77	3.01	3.73	4.59	5.59	6.53	7.20	7.93	8.81	11.38	13.35	16.29	19.00
25	0.67	1.07	1.35	2.00	2.67	3.29	3.58	4.44	5.47	6.74	7.81	8.56	9.30	10.22	13.04	14.96	18.05	20.94
50	0.72	1.15	1.45	2.19	2.96	3.70	4.03	5.01	6.18	7.69	8.84	9.66	10.40	11.34	14.34	16.18	19.37	22.38
100	0.77	1.22	1.54	2.37	3.26	4.12	4.50	5.61	6.94	8.69	9.92	10.82	11.54	12.48	15.66	17.39	20.63	23.76
200	0.82	1.29	1.63	2.54	3.56	4.55	4.98	6.23	7.74	9.76	11.07	12.02	12.73	13.66	17.01	18.57	21.86	25.09
500	0.88	1.38	1.74	2.77	3.98	5.15	5.66	7.12	8.89	11.28	12.69	13.72	14.40	15.29	18.84	20.09	23.45	26.78
1000	0.92	1.45	1.81	2.94	4.29	5.63	6.20	7.85	9.82	12.53	14.01	15.11	15.73	16.58	20.25	21.25	24.63	28.04

* The upper bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are greater than.
** These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.

Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

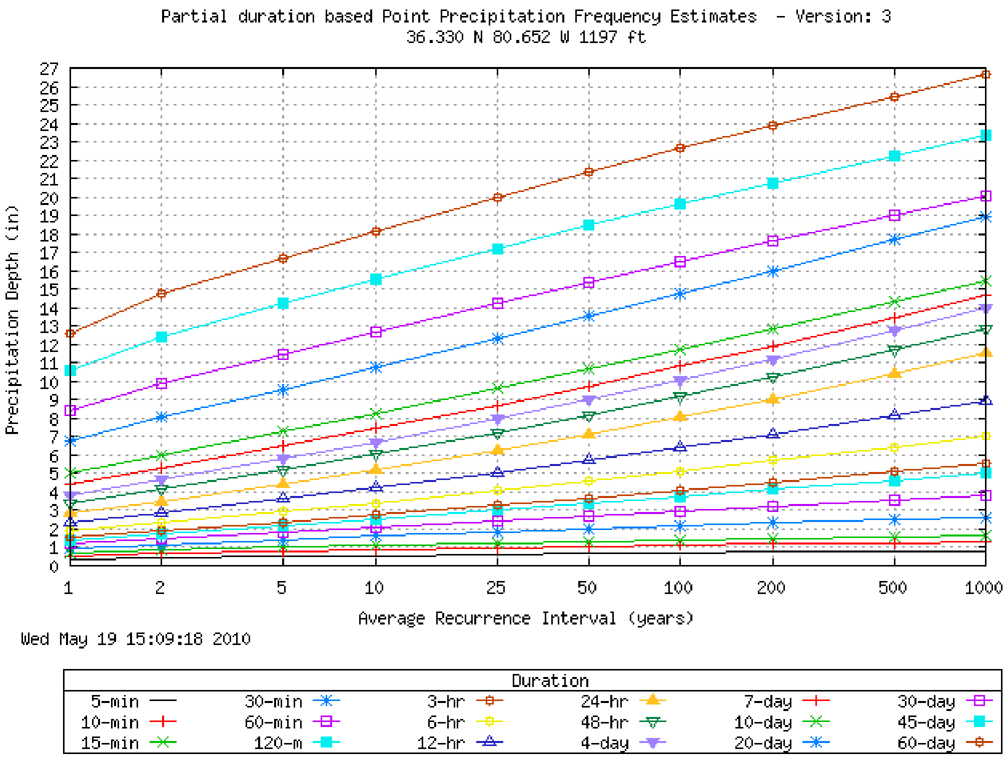
*** Lower bound of the 90% confidence interval**
Precipitation Frequency Estimates (inches)

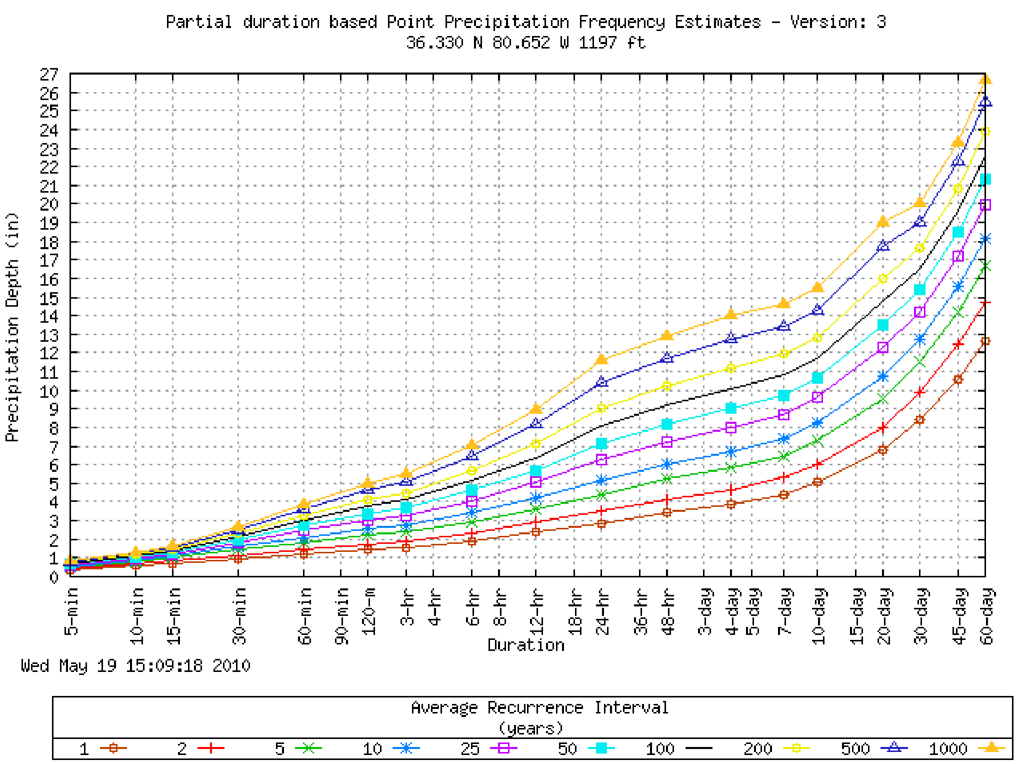
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.33	0.52	0.65	0.89	1.11	1.32	1.43	1.78	2.19	2.66	3.17	3.59	4.13	4.74	6.39	7.96	10.11	12.05
2	0.39	0.62	0.78	1.07	1.35	1.60	1.74	2.16	2.66	3.23	3.83	4.33	4.96	5.66	7.58	9.39	11.86	14.08
5	0.46	0.73	0.93	1.31	1.68	2.02	2.19	2.72	3.35	4.10	4.83	5.41	6.08	6.85	9.01	10.90	13.56	15.94
10	0.51	0.81	1.02	1.48	1.93	2.33	2.53	3.14	3.88	4.79	5.60	6.25	6.95	7.77	10.11	12.03	14.80	17.33
25	0.56	0.90	1.14	1.68	2.24	2.74	2.97	3.71	4.59	5.74	6.66	7.40	8.12	8.98	11.56	13.46	16.38	19.06
50	0.60	0.95	1.21	1.82	2.47	3.04	3.31	4.15	5.15	6.51	7.51	8.31	9.05	9.93	12.67	14.52	17.54	20.34
100	0.63	1.00	1.27	1.95	2.68	3.35	3.65	4.58	5.71	7.32	8.38	9.25	9.99	10.88	13.79	15.54	18.64	21.54
200	0.66	1.05	1.32	2.06	2.88	3.63	3.96	5.00	6.27	8.16	9.28	10.21	10.95	11.84	14.88	16.54	19.68	22.67
500	0.69	1.09	1.38	2.19	3.14	4.01	4.39	5.57	7.02	9.33	10.52	11.52	12.24	13.13	16.33	17.80	20.99	24.09
1000	0.71	1.12	1.41	2.28	3.32	4.28	4.70	6.00	7.60	10.27	11.49	12.56	13.25	14.11	17.43	18.73	21.95	25.12

* The lower bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are less than.

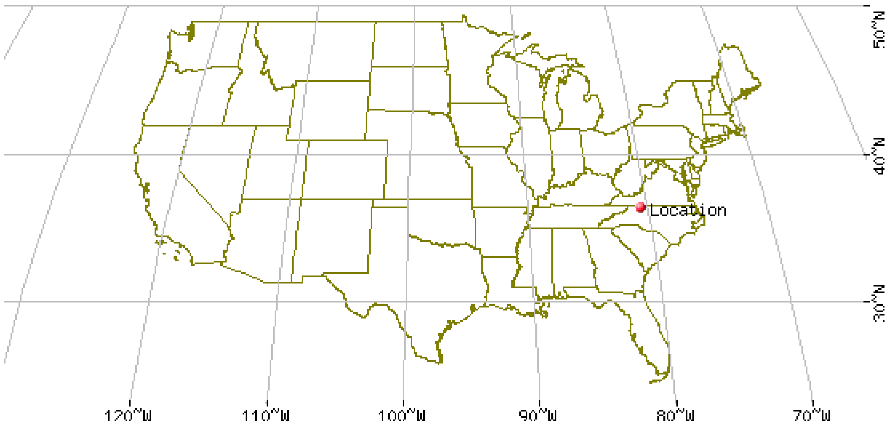
** These precipitation frequency estimates are based on a partial duration maxima series. ARI is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

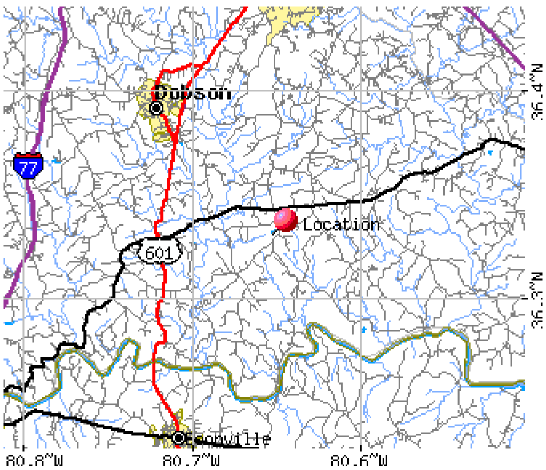
Text version of tables





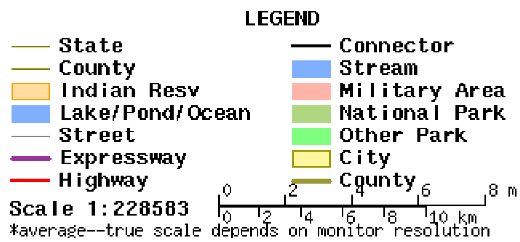
Maps -





These maps were produced using a direct map request from the [U.S. Census Bureau Mapping and Cartographic Resources Tiger Map Server](#).

Please read [disclaimer](#) for more information.



Other Maps/Photographs -

[View USGS digital orthophoto quadrangle (DOQ)](#) covering this location from TerraServer; **USGS Aerial Photograph** may also be available from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the [USGS](#) for more information.

Watershed/Stream Flow Information -

[Find the Watershed](#) for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study, please refer to [NOAA Atlas 14 Document](#).

Using the **[National Climatic Data Center's (NCDC)](#)** station search engine, locate other climate stations within:

+/-30 minutes ...OR... +/-1 degree of this location (36.330/-80.652). Digital ASCII data can be obtained directly from **[NCDC](#)**.

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