FINAL MITIGATION PLAN

Crooked Creek #2 Restoration Project

Union County, North Carolina

EEP ID # 94687

DENR Contract D09126S

SCO Project Number: 09-0751301

Yadkin River Basin

HUC 03040105

Prepared for:

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

August 19, 2013

FINAL MITIGATION PLAN

Crooked Creek #2 Restoration Project
Union County, North Carolina
EEP ID # 94687DENR Contract D09126S
SCO Project Number: 09-0751301

Yadkin River Basin
HUC 03040105

Prepared for:

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

Prepared by:

Wildlands Engineering, Inc.
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Phone – 704-332-7754
Project Manager: Aaron Earley

August 19, 2013

EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (EEP) proposes to restore 1,762 linear feet (LF) and enhance 4,429 LF of perennial stream and restore, enhance, and create 11.5 acres (ac) of wetlands in Union County, NC (Table ES.1). The streams proposed for restoration include Crooked Creek, a fourth order stream, as well as unnamed first order tributaries to Crooked Creek (UT). The project is being completed to provide stream mitigation units (SMUs) and wetland mitigation units (WMUs) in the Yadkin River Basin. The project streams ultimately flow into the Rocky River which is part of the Yadkin River Basin.

Table ES.1 Project Components
Crooked Creek #2 Restoration Project

Project Reach/Wetland Area	Existing Length/ Area	Mitigation Level	Approach	Proposed Length/ Area
Crooked Creek Reach A	1,555 LF	Enhancement II	N/A	1,555 LF
Crooked Creek Reach B	2,404 LF	Enhancement II	N/A	2,404 LF
UT1	1,762 LF	Restoration	Priority 1	1,718 LF
UT2	470 LF	Enhancement II	N/A	470 LF
Zone A (Drained Hydric Soils)	0.7 AC	Enhancement	planting	0.7 AC
Zone A (Drained Hydric Soils)	N/A	Restoration	grading, planting	6.6 AC
Zone B	0.3 AC	Enhancement	grading, planting	0.3 AC
Zone B	N/A	Creation	grading, planting	3.9 AC

The Crooked Creek #2 Project is located within Hydrologic Unit Code (HUC) 03040105040010 which was identified as a targeted local watershed in EEP's 2009 Lower Yadkin Pee-Dee River Basin Restoration Priority Plan. Goals for the HUC listed in the RBRP include improved stormwater management, protection of threatened and endangered wildlife resources, mitigation of impacts resulting from rapid development, and restoring water quality in impaired streams. The project area is also located within a local watershed planning (LWP) area and the Goose and Crooked Creeks Watershed Management Plan (WMP) was finalized in July 2012. Major stressors to watershed function identified in the WMP included sediment pollution, increases in peak stream flows, nonpoint source runoff, degraded terrestrial habitat, and disconnected floodplains. Management opportunities to offset these stressors include stream and wetland restoration. The Crooked Creek #2 Project will help meet the management goals in the RBRP and WMP documents. The site was identified in the WMP as a wetland restoration priority.

The proposed project will provide numerous ecological benefits within the Yadkin River Basin as listed in Table ES.2. While many of these benefits are limited to the Crooked Creek #2 project area, others, such as pollutant removal, reduced sediment loading, and improved aquatic

and terrestrial habitat have more far-reaching effects. The UT1 restoration design will impact approximately 0.06 acres of linear wetland that is currently being maintained as an agricultural ditch. This impact can be considered insignificant given that the rest of the linear ditch wetland will be filled as part of the restoration plan in order to improve wetland hydrology.

Table ES.2 Project Goals and Objectives

Crooked Creek #2 Restoration Project

	Goal/Benefit	How project will seek to reach goal/benefit
Monitored Project Goals	Improve hydrologic connectivity	Wetland areas will be disked to increase surface roughness to better capture rainfall and to improve connection with the water table for groundwater recharge. Adjacent streams will be stabilized and connected to an appropriate floodplain elevation to promote hydrologic transfer between wetland and stream.
	Create appropriate in-stream habitat	A channel form that includes riffle-pool sequences, rock/gravel zones of macroinvertebrate habitat and deep pool habitat for fish will be implemented. Introduction of large woody debris, rock structures, brush toe, and native stream bank vegetation will substantially increase habitat value.
	Create appropriate terrestrial habitat	Adjacent buffer areas will be restored by planting native vegetation. These areas will be allowed to receive more regular inundating flows. Riparian wetland areas will be restored and planted to provide wetland habitat.
	Decrease water temperature and increase dissolved oxygen concentrations	Restored riffle-pool sequences where distinct points of re-aeration can occur will allow for oxygen levels to be maintained in the perennial reaches. Creation of pool zones will lower temperature, helping to maintain dissolved oxygen concentrations. Establishment of riparian buffers will create long-term shading of the channel flow to minimize heating.
Expected Project Benefits	Decrease nutrient and adverse chemical levels	Fecal coliform input will be decreased by filtering runoff from cattle and poultry operations through restored wetlands and native buffer zones. Offsite nutrient input will be absorbed onsite by filtering flood flows through restored floodplain areas. Flood flows can disperse through native vegetation and be captured in vernal pools and restored wetlands. Increased surface water residency time will increase contact treatment time and groundwater recharge potential.
	Decrease sediment input	Sediment from offsite sources will be captured by deposition on restored floodplain areas where native vegetation will slow overland flow velocities. Sediment input from unprotected stream banks will be reduced by installing bioengineering and in-stream structures while creating a stable channel form using geomorphic design principles.

This mitigation plan has been written in conformance with the requirements of the following:

- 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).

- NCDENR Ecosystem Enhancement Program In-Lieu Fee Instrument signed and dated July 28, 2010.

These documents govern EEP operations and procedures for the delivery of compensatory mitigation.

Crooked Creek #2 Restoration Project
Mitigation Plan

TABLES

FIGURES

APPENDICES

1.0 Restoration Project Goals and Objectives

The overall goal of this project is to maximize the ecological improvement of Crooked Creek by modifying the existing stream channels and wetlands on the site. The existing stream channels have been impaired by cattle and show signs of erosion and unstable banks. The existing wetlands have also been clear cut, impaired by cattle, and drained by ditches.

The Crooked Creek #2 Project Site's watershed is within Hydrologic Unit Code (HUC) 03040105040010 which was identified as a Targeted Local Watershed in EEP's 2009 Lower Yadkin Pee-Dee River Basin Restoration Priority (RBRP) plan (http://portal.ncdenr.org/c/document_library/get_file?uuid=081b34ec-8b4c-434f-9e25-57c713cb136c&groupId=60329). Goals for the HUC listed in the RBRP include improved stormwater management, protection of threatened and endangered wildlife resources, continued mitigation of impacts resulting from rapid development, and restoring water quality in impaired streams. Biological communities within the North Fork and South Fork of Crooked Creek have been listed as poor due to impaired water quality. Stressors such as construction, stormwater runoff, and agricultural use most likely have attributed to the streams impaired aquatic health. EEP targeted this HUC for water quality and habitat improvements due to the impacts from agricultural land uses and anticipated residential growth.

The Crooked Creek #2 Restoration Project is also located within an area covered by the Goose Creek and Crooked Creek Local Watershed Plan, or LWP (http://www.gooseandcrooked.org). For the LWP, EEP worked with community stakeholders, Centralina CCOG, and a technical consultant, Tetra Tech, to identify watershed functional stressors and develop potential management strategies to direct mitigation project implementation. The final watershed management plan (WMP) was completed by Tetra Tech and CCOG in July 2012 (http://www.gooseandcrooked.org/documents/GooseandCrookedLWP-WMP_Final_7-2012.pdf). The most serious stressors to watershed function identified in the WMP were sediment pollution and increases in peak stream flows. Sources of sediment listed in the WMP include construction sites, agricultural runoff, livestock access to streams, streambank and channel erosion, and ATVs. The problems caused by sediment deposition in channels includes impairments to aquatic habitat and aquatic life. Stream enhancement and restoration is identified as the best "management opportunity" to offset these impacts. Other stressors identified included nonpoint source runoff, degraded terrestrial habitat, and disconnected floodplains among others. Wetland enhancement and restoration is identified as the best management opportunity to offset impacts related to these stressors.

The enhancement and restoration work proposed for Crooked Creek and its UTs will correspond with the goals identified in the RBRP and LWP by increasing bank stability, reducing erosion, eliminating a direct nutrient source to the stream and downstream recreational areas, and enhancing aquatic and terrestrial habitat. The wetland portion of the proposed project was identified as a specific priority (ranked as the 19th highest priority in the Goose and Crooked Creek watersheds) in the Project Atlas that accompanies the 2012 WMP.

The goals of the Crooked Creek #2 Restoration Project address stressors identified in the LWP and include the following:

- Improve water quality
- Reduce stream bank erosion
- Improve aquatic and terrestrial habitat

The project goals will be addressed through the following project objectives:

- Excluding cattle access from stream channels
- Restoration of a tributary using natural channel design techniques
- Planting the riparian buffer with native species
- Restoring and enhancing wetlands in the floodplain of Crooked Creek.

2.0 Site Selection

2.1 Directions

The proposed Crooked Creek #2 Restoration Project is located off NC Highway 218 in the northern portion of Union County, NC (Figure 1). The site is approximately 7 miles east of the intersection of NC Highway 218 and Interstate 485 in Mecklenburg County, NC. The proposed project is located in an active cattle pasture surrounded by woods and small agricultural operations.

From US-74 East, take 27 East/Albemarle Road. Travel on Albemarle Road approximately 8 miles to Interstate 485. Take Interstate 485 South (Inner Loop) for approximately 3 miles to exit 44 for NC Highway 218 toward Mint Hill. Turn left off ramp on to NC218 and follow for approximately 7 miles. The project site is located approximately 0.85 miles after US 601/Concord Highway on the right hand side of the road.

2.2 Site Selection

The Crooked Creek #2 Restoration Project was originally identified for its restoration potential by EEP. The Crooked Creek #2 Restoration Project totals 54 acres, and is located within three (3) tracts of land. One tract of land is owned by Reuben and Lorna Price and the other two (2) tracts are owned by Logan and Mildred Tucker. A conservation easement has been recorded on the 54-acre project study area within the three tracts. The conservation easement is held by the State of North Carolina and allows for the restoration and enhancement work to occur and protects the project area in perpetuity. This site has historically been used for agricultural operations. No restoration efforts have occurred on the site at this time.

EEP proposes to restore 1,718 linear feet (LF) and enhance 4,429 LF of perennial and intermittent stream. In addition, EEP will restore, enhance, and create 11.5 acres of wetlands in Union County, NC. The project includes Crooked Creek, at least a fourth order stream, as well as two unnamed first order tributaries to Crooked Creek (UT1 and UT2). The project streams ultimately flow into the Rocky River which is part of the Yadkin River Basin.

2.3 Vicinity Map

The Crooked Creek #2 Restoration Project streams are located within Yadkin River Basin (USGS Hydrologic Unit 03040105 and 03040105040010) as shown in Figure 1. Crooked Creek (DWQ Index No. 13-17-20) and its UTs are located within Yadkin-Pee Dee River Subbasin (DWQ Subbasin 03-07-12). Crooked Creek is the main tributary of the project and is at least a fourth order stream. UT1 and UT2 are first order streams that flow into Crooked Creek.

The North Carolina Division of Water Quality (DWQ) assigns best usage classifications to State Waters that reflect water quality conditions and potential resource usage. Crooked Creek (DWQ Index No. 13-17-20) is the main tributary of the project and has been classified as Class C waters. Class C waters are protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture, and other uses.

2.4 Watershed Map

The proposed Crooked Creek #2 Restoration Project is located in the northern portion of Union County in the Yadkin River Basin (USGS Hydrologic Unit 03040105). At the downstream limits of the project, the drainage area of Crooked Creek is 24,619 acres (38.47 square miles). Drainage areas for the project reaches were determined by delineating watersheds on the USGS 7.5-minute topographic quadrangle (Figures 2a and 2b). The drainage areas and land uses are summarized in Table 1.

Table 1. Drainage Areas
Crooked Creek #2 Restoration Project

Project Reach	Existing Length (LF)	Drainage Area (acres)	Drainage Area (square miles)	Predominant Land Use
Crooked Creek Reach A and B	Reach A: 1,555 LF Reach B: 2,404 LF	24,619	38.47	Agriculture 38%, Forested 29%, Developed 28%, Wetlands 3%, and Herbaceous Upland 2%
UT1	1,762 LF	153	0.24	Agriculture 81%, Forested 17%, and Developed 2%
UT2	470 LF	51	0.08	Agriculture 59%, Forested 8%, and Herbaceous Upland 33%

Source: 2001 National Cartography and Geospatial Center, National Land Cover Dataset

The Crooked Creek #2 Restoration Project is located in the Carolina Slate Belt of the Piedmont Physiographic Province (USGS, 1998). The Piedmont Province is characterized by gently rolling, well rounded hills with long low ridges, with elevations ranging anywhere from 300 to 1500 feet above sea level. The Carolina Slate Belt consists of heated and deformed volcanic and sedimentary rocks. Approximately 550 to 650 million years ago, this region was the site of a series of oceanic volcanic islands. The belt is known for its numerous abandoned gold mines and prospects. Specifically, the proposed restoration site is located in the metamudstone and meta-argillite (CZmd) mapped unit of the Carolina Slate Belt composed of Ordovician and Cambrian-aged rock. These rock types are described as thin to thick bedded and interbedded with metasandstone, metaconglomerate, and metavolcanic rock (NCGS, 2009). A significant slate outcropping exists along the right bank of Crooked Creek Reach B. The outcroppings along Crooked Creek extend an average height of 6 feet from the channel bed for approximately

100 LF and exhibit horizontal veins. Slate bedrock is present in the channel bottom of UT3 and along its banks near the confluence with Crooked Creek.

2.5 Soil Survey

Soil mapping units are based on the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Soil Survey for Union County. Soil types within the study area include Chewacla silt loam (ChA), Badin channery silt loam (BaB and BaC), Badin channery silty clay loam (BdB2), and Cid channery silt loam (CmB). Chewacla soils are somewhat poorly-drained, found mainly within valleys and floodplains, exhibit moderate permeability and are frequently flooded. Chewacla soils are listed by the NRCS as having inclusions of hydric soils for Union County. Badin soils are typically found on hillslopes, interfluves, and ridges, are well-drained, and exhibit moderately high permeability. Cid soils are moderately well-drained, typically found on uplands and interfluves, and exhibit moderately low permeability. These soils are described below in Table 2. A soils map is provided in Figure 3.

Table 2. Project Soil Types and Descriptions
Crooked Creek #2 Restoration Project

Soil Name	Description
Chewacla silt loam	Chewacla soils are found in valleys and floodplains. They are nearly level and somewhat poorly drained. Shrink-swell potential is low. These soils are frequently flooded.
Badin channery silt loam	Badin soils are typically on gently rolling to steep uplands in the Piedmont. They are well drained, moderately permeable soils. Slopes range from 2 to 55 percent.
Badin channery silty clay loam	
Cid channery silt loam	Cid soil series consists of nearly level to gently sloping, moderately well drained, to somewhat poorly drained soils on uplands at toe slopes and head of drainageways. Slope ranges from 0 to 15 percent.

Source: Union County Soil Survey, USDA-NRCS, http://efotg.nrcs.usda.gov

An investigation of the existing soils on the wetland restoration/enhancement/creation site was performed by Wildlands on July 1, 2011. This investigation supplemented the soils analysis performed by Wildlands between June 8 and June 10, 2011. Soil cores were collected at locations across the site to provide data to refine NRCS soils mapping units, establish areas suitable for wetland restoration, and aid in developing a wetland restoration plan. Forty-eight soil cores were taken at approximately 100 to 200-foot grid spacing across the site at varying depths. The cores were taken to a depth at which either hydric soil features or groundwater was encountered. Soil texture; Munsell chart hue, chroma, and value; and hydric soil characteristics were recorded for each core. The depth to hydric indicators and groundwater table, if attainable, was then measured at each core. Data for these forty-eight soil borings as well as a map showing their locations is included in Figure 4 and Appendix B.

2.6 Current Condition Plan View

On May 19, 2011, Wildlands Engineering, Inc. (Wildlands) investigated on-site jurisdictional waters of the U.S. using the U.S. Army Corps of Engineers (USACE) Routine On-Site Determination Method. This method is defined in the 1987 Corps of Engineers Wetlands

Delineation Manual and subsequent Eastern Mountain and Piedmont Regional Supplement. Determination methods included stream classification utilizing the DWQ Stream Identification Form and the USACE Stream Quality Assessment Worksheet. Potential jurisdictional wetland areas as well as typical upland areas were classified using the USACE Wetland Determination Data Form.

The results of the on-site field investigation indicate that there are four jurisdictional stream channels located within the proposed project area including Crooked Creek and two unnamed tributaries (UT1 and UT2) to Crooked Creek. Five jurisdictional wetland areas were identified within the proposed project area (Wetlands AA – EE) and are located within the floodplain of Crooked Creek. Routine Determination Forms representative of on-site jurisdictional wetlands as well as non-jurisdictional upland areas have been enclosed in Appendix B (DP1-DP6). Site photographs are included in Appendix C, taken at locations as indicated in Figure 4.

2.7 Historical Condition Plan View

The Yadkin 03040105 watershed includes some of the fastest developing areas in the region at the Union County and Mecklenburg County line along US-74. Development is expected to continue to increase, which will pose a significant threat to water quality. Portions of Crooked Creek are currently listed as impaired under Section 303(d) of the Clean Water Act. Point and non-point sources attributable to urbanization and agriculture have resulted in the watershed's poor water quality rating. Population growth and the associated development and infrastructure projects create the necessity for mitigation projects in this region.

The project site includes two first-order streams and one fourth-order stream. Along UT1, the off-site watersheds are small and provide a limited footprint where development could impact the site. The watershed to UT2 is dominated by agricultural land uses including open pasture and a poultry operation located immediately to the northeast of the project site. The Crooked Creek watershed is located outside the town limits of Fairview. Land use within the Crooked Creek watershed is historically rural and dominated by forest and agriculture and is approximately 38% agricultural, 29% forested, 28% developed, 3% wetlands, and 2% herbaceous upland.

The Crooked Creek site is located in the mapped 100-year floodplain of Crooked Creek (Figure 5). While the conservation easement will primarily discourage future development, the 100-year floodplain adds further protection against development outside the conservation easement. Figure 6 and Appendix B provides aerial views of the project site from the 1940s to the present.

2.8 Site Photographs

See Appendix C for representative site photographs of the Crooked Creek #2 Restoration Project.

3.0 Site Protection Instrument

3.1 Site Protection Instruments Summary Information

The land required for construction, management, and stewardship of the mitigation project includes portions of the parcel(s) listed in Table 3. A copy of the land protection instrument is included in the Appendix A.

Table 3. Site Protection Instrument
Crooked Creek #2 Restoration Project

Landowner	PIN	County	Site Protection Instrument	Deed Book and Page Number	Acreage Protected
Reuben and Lorna Price	08153002J	Union	Conservation Easement		20.810
Logan and Mildred Tucker	08153002H	Union	Conservation Easement		18.990
	08153009C				15.138

All site protection instruments require 60-day advance notification to the Corps and the State prior to any action to void, amend, or modify the document. No such action shall take place unless approved by the State.

3.2 Site Protection Instrument Figure

See Figure 7 for the Site Protection Instrument for the Crooked Creek #2 Restoration Project.

4.0 Baseline Information

Table 4 summarizes the attributes of the overall project and of the project reaches.

Table 4. Baseline Information
Crooked Creek #2 Restoration Project

Project Information	
Project Name	Crooked Creek #2 Restoration Project
County	Union County
Project Area (acres)	54.94
Project Coordinates (latitude and longitude)	34° 58' 54.78"N, 080° 31' 25.79"W
Project Watershed Summary Information	
Physiographic Province	Carolina Slate Belt of the Piedmont
River Basin	Yadkin
USGS Hydrologic Unit 8-digit	03040105
USGS Hydrologic Unit 14-digit	03040105040010
DWQ Sub-basin	Yadkin-Pee Dee, 03-07-12
Project Drainage Area (acres)	24,619
Project Drainage Area Percentage of Impervious Area	28%
CGIA Land Use Classification	Agriculture 38%, Forested 29%, Developed 28%, Wetlands 3%, and Herbaceous Upland 2%

Reach Summary Information					
Parameters	**Crooked Creek Reach A**	**Crooked Creek Reach B**	**UT1**	**UT2**	
Length of reach (linear feet)	1,555 LF	2,404 LF	1,762 LF	275/195 LF	
Drainage area (acres)	24,619		153	51	
DWQ stream identification score	52	52	34.5	24.25/ 38	
DWQ Water Quality Classification	C	C	C	C	
Morphological Description (stream type)	Perennial	Perennial	Perennial	Intermittent/ Perennial	
Evolutionary trend	N/A	N/A	Stage III	Stage IV	
Underlying mapped soils	Chewacala silt loam 0-2% slopes (ChA)	Chewacala silt loam 0-2% slopes (ChA)	Chewacala silt loam 0-2% slopes (ChA)	Badin channery silt loam 8-15% slopes (BaC)	
Drainage class	Somewhat poorly drained	Somewhat poorly drained	Somewhat poorly drained	Well drained	
Soil Hydric status	Type B (inclusions)	Type B (inclusions)	Type B (inclusions)	N/A	
Slope	0.0022	0.0022	0.0047	0.0050	
FEMA classification	Zone AE	Zone AE	no regulated floodplain	no regulated floodplain	
Native vegetation community	Piedmont Bottomland forest	Piedmont Bottomland forest	Piedmont Bottomland forest	Piedmont Bottomland forest	
Percent composition of exotic invasive vegetation	5%	5%	60%	5%	
Wetland Summary Information					
Parameters	**Wetland AA**	**Wetland BB**	**Wetland CC**	**Wetland DD**	**Wetland EE**
Size of Wetland (acres)	1.1	0.1	0.4	0.03	0.05
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Cha/ BaC	ChA	ChA	ChA/ BaC	ChA/ BaC
Drainage class	Somewhat poorly drained/ well drained	Somewhat poorly drained	Somewhat poorly drained	Somewhat poorly drained/ well drained	Somewhat poorly drained/ well drained
Soil Hydric status	Type B/ N/A	Type B (inclusions)	Type B (inclusions)	Type B/ N/A	Type B/ N/A

Wetland Summary Information					
Parameters	**Wetland AA**	**Wetland BB**	**Wetland CC**	**Wetland DD**	**Wetland EE**
Source of Hydrology	Ground water	Ground water	Ground water/ flooding	Ground water/ flooding	Ground water/ flooding
Hydrologic Impairment	Partially ditched	Ditch	Ditch	Partially Ditched	N/A
Native vegetation community	Emergent	Emergent	Emergent	Emergent/ Bottomland Forest	Emergent/ Bottomland Forest
Percent composition of exotic invasive vegetation	5%	5%	5%	5%	5%

Regulatory Considerations			
Regulation	**Applicable**	**Resolved**	**Supporting Documentation**
Waters of the United States - Section 404	X		
Waters of the United States - Section 401	X		
Endangered Species Act	X	X	See Appendix B
Historic Preservation Act	X	X	See Appendix B
Coastal Zone Management Act (CZMA) / Coastal Area Management Act (CAMA)	N/A	N/A	N/A
FEMA Floodplain Compliance	X		
Essential Fisheries Habitat	N/A	N/A	N/A

4.1 Watershed Summary Information

Crooked Creek (DWQ Index No. 13-17-20) and its UTs are located within Yadkin-Pee Dee River Subbasin (DWQ Subbasin 03-07-12). Crooked Creek is the main tributary of the project and is at least a fourth order stream. UT1 and UT2 are first order streams that flow into Crooked Creek. The project area is located within a local watershed planning area, as described below. EEP, along with community stakeholders, Centralina COG, and Tetra Tech, have developed potential restoration needs and protection strategies to address EEP's objectives and meet the mitigation needs of the Goose and Crooked Creek watersheds (http://www.gooseandcrooked.org/index.php).

EEP develops local watershed plans (LWP) for specific priority areas where critical watershed issues need to be addressed. These LWPs describe projects and management strategies to restore, enhance, or protect local water resources. The Crooked Creek #2 Restoration Project is located within an area covered by the Goose Creek and Crooked Creek Local Watershed Plan Phase 1. Biological communities within the Crooked Creek watershed have been listed as poor due to impaired water quality. Stressors such as construction, stormwater runoff, and agricultural use have attributed to the streams' impaired aquatic health (Tetra Tech, 2012).

EEP also develops River Basin Restoration Priorities (RBRPs) to guide its restoration activities within each of the state's 54 cataloging units. RBRPs delineate specific watersheds that exhibit both the need and opportunity for wetland, stream and riparian buffer restoration. These watersheds are called Targeted Local Watersheds (TLWs) and receive priority for EEP planning and restoration project funds. The 2009 Lower Yadkin Pee-Dee RBRP identified HUC 03040105040010, which includes the Crooked Creek #2 Restoration Project (http://www.nceep.net/services/restplans/Yadkin_Pee_Dee_RBRP_2009_Final.pdf). EEP targeted the this watershed for water quality and habitat improvements due to the impacts from agricultural land uses and anticipated residential growth. The restoration and enhancement of Crooked Creek and its UTs on the project site will correspond with the goals identified in the RBRPs by increasing bank stability, reducing erosion, eliminating a direct nutrient source to the stream and downstream recreational areas, and enhancing aquatic and terrestrial habitat.

4.2 Reach Summary Information

Crooked Creek is the primary tributary draining the project area from west to east. The Crooked Creek system has a 38.47-square mile drainage area and was classified as perennial, relatively permanent water (RPW). RPWs are defined by the USACE Approved Jurisdictional Determination Form as channels that typically flow year-round or have continuous flow at least seasonally. This channel exhibits average bankfull widths of 35 to 60 feet, access to a large well-developed floodplain, well-defined riffle-pool sequences, and substrate consisting of large cobble. Portions of Crooked Creek within the project area exhibit moderate to extensive bank erosion from cattle activity and low water farm equipment crossings. In addition to these over-widened areas, several large intermittent overflow channels have developed immediately adjacent to the main channel. The majority of the project reach exhibits well-shaded in-stream habitat from a well-developed canopy layer. However, where vertical, bare, and overhanging banks exist, very little understory vegetation growth has occurred, resulting in additional bank instability. Biological sampling within this channel revealed an abundant presence of fish, a moderate presence of benthic macroinvertebrates and aquatic mollusks, and a weak presence of crayfish and amphibians. Macroinvertebrate sampling was performed as a visual observation as part of the DWQ and USACE stream assessment protocols; a formal collection and evaluation was not performed at the time of this investigation. Crooked Creek scored 73 out of a possible 100 points on the USACE Stream Assessment Form and scored 52 out of 63 possible points on the DWQ Stream Classification Form, indicating perennial status (SCP4, enclosed in Appendix B). Stream assessment forms representative of the intermittent overflow channels have also been included (SCP5).

UT1 to Crooked Creek drains the northern portion of the project area with a drainage area of approximately 153 acres. UT1 was classified as a perennial RPW and exhibits average bankfull widths of 8-10 feet, weak perennial flow conditions, low sinuosity, moderate alluvial deposits, poor profile diversity, and substrate consisting of silt to small cobbles. This channel exhibits effects from past ditching efforts. A spoil berm exists along the left top of bank throughout the upper reach along the property line. This disconnection from a stable floodplain has resulted in increased channel velocities and shear stresses, causing bank erosion and bed incision. The middle portion of UT1 is incised with no floodplain connectivity. Additionally, a large overflow ditch from Crooked Creek has been created adjacent to UT1. This overflow ditch allows for

large flow events from Crooked Creek to empty into UT1, causing incision and over-widening to the downstream portion of this channel. The stream bed exhibits few stabilizing structures and long runs with few poorly-defined, shallow pools provide low quality in-stream habitat throughout the entire reach. The riparian buffer along most of the upstream section of UT1 is dominated by invasive vine and shrub species with few mature trees and stabilizing vegetation. The downstream section of this reach exhibits impacts from cattle access including trampled banks and little to no understory growth under a well-developed canopy. Biological sampling of this channel indicated a low presence of benthic macroinvertebrates and amphibians. UT1 scored 49 out of a possible 100 points on the USACE Stream Assessment Form and scored 34.5 out of 63 possible points on the DWQ Stream Classification Form, indicating perennial status (SCP1).

UT2 to Crooked Creek drains a 51-acre watershed northeast of the project. The upstream portion of UT2 was classified as an intermittent RPW and exhibits average bankfull widths of 6 to 8 feet, moderate sinuosity, minimal groundwater flow, and substrate consisting of fine sand and gravel. The intermittent portion of this reach scored 38 out of a possible 100 points on the USACE Stream Assessment Form and scored 24.25 out of 63 possible points on the DWQ Stream Classification Form, indicating intermittent status (SCP2). UT2 transitions to a perennial RPW at the confluence with the open water wetland with a total drainage area of approximately 51 acres. This portion of UT2 exhibits bankfull widths of 6 to 10 feet, contributing groundwater flow, poor profile diversity, and substrate consisting of gravel to small cobbles. The entire length of UT2 shows impacts from cattle access and grazing including trampled banks and bed incision. Riparian habitat is similarly degraded from cattle activities and includes a well-developed canopy layer with little to no understory stabilizing vegetation. Biological sampling of the perennial portion of this reach indicated a low presence of benthic macroinvertebrates and amphibians. This portion of UT2 scored 49 out of a possible 100 points on the USACE Stream Assessment Form and scored 38 out of 63 possible points on the DWQ Stream Classification Form, indicating perennial status (SCP3).

A copy of all stream and wetland assessment forms are located in Appendix B along with a map showing stream and wetland data collection points in Figure 8. A copy of the Jurisdictional Determination is included in Appendix B.

4.2.1 Channel Classification

Crooked Creek Reach A is located in a wide valley and is not extremely incised, with an entrenchment ratio greater than 2.2. Cattle trampling is the primary reason for moderate vertical incision and widened banks along Reach A. The shallow depth and wide banks provides a width-to-depth ratio close to 37. The bed material appears to be dominated by gravel and cobble as well as a small-grain fraction.

Crooked Creek Reach B is less incised than Reach A, leading to lower bank height ratios and higher entrenchment ratios. This reach is deeper than and not as wide as Reach A, with a width-to-depth ratio close to 16. Like Reach A, bed material appears to be dominated by gravel and cobble as well as a small-grain fraction.

UT1 Reach 1 to Crooked Creek has a low width-to-depth ratio and a high entrenchment ratio with extensive floodplain access. The reach has been channelized and straightened, so

sinuosity cannot be used for classification. The channel contains sediment with a median diameter in the very fine gravel fraction.

UT1 Reach 2 to Crooked Creek exhibits a moderate width-to-depth ratio and a high entrenchment ratio with extensive floodplain access. The reach has been channelized and straightened, so sinuosity cannot be used for classification. The channel contains sediment with a median diameter in the gravel fraction.

UT2 to Crooked Creek is slightly entrenched and exhibits low width-to-depth ratios. The channel appears to have been altered and straightened, so sinuosity cannot be used for classification.

Tables 5a and 5b summarize the existing conditions parameters for Crooked Creek and UT1 based on geomorphic survey data. Detailed geomorphic surveys were not conducted on UT2 since a lower level of enhancement II is proposed.

Table 5a. Crooked Creek Existing Conditions
Crooked Creek #2 Restoration Project

	Notation	Units	Reach A		Reach B	
			min	max	min	max
stream type			C4		C4	
drainage area	DA	sq mi	38.50		38.63	
Q- NC Rural Regional Curve		cfs	1223		1223	
$Q_{2\text{-}yr}$ NFF regression		cfs	1751		1751	
Q- USGS extrapolation		cfs	1055	1578	1055	1578
Q Mannings		cfs	1459		1231	
bankfull design discharge	Q_{bkf}	cfs	1200	1400	1200	1400
Cross-Section Features						
bankfull cross-sectional area	A_{bkf}	SF	221.5		233.9	
average velocity during bankfull event	v_{bkf}	fps	5.6	6.3	5.3	6.0
width at bankfull	w_{bkf}	feet	90.9		61.2	
maximum depth at bankfull	d_{max}	feet	4.5		6.2	
mean depth at bankfull	d_{bkf}	feet	2.4		3.8	
bankfull width to depth ratio	w_{bkf}/d_{bkf}		37.3		16.0	
depth ratio	d_{max}/d_{bkf}		1.8		1.6	
low bank height			7.4		6.2	
bank height ratio	BHR		1.6		1.1	
floodprone area width	w_{fpa}	feet	>1000		>1000	
entrenchment ratio	ER		>5.5		>16.3	
Slope						
valley slope	S_{valley}	feet/ foot	0.0031		0.0027	
channel slope	$S_{channel}$	feet/ foot	0.0025		0.0022	
Riffle Features						
riffle slope	S_{riffle}	feet/ foot	0.007	0.037	0.007	0.037
riffle slope ratio	$S_{riffle}/S_{channel}$		3.0	15.1	3.0	16.9

	Notation	Units	Reach A		Reach B	
			min	max	min	max
Pool Features						
pool slope	S_{pool}	feet/ foot	0.000	0.002	0.000	0.002
pool slope ratio	$S_{poo}l/S_{channel}$		0.0	1.0	0.0	1.0
pool-to-pool spacing	L_{p-p}	feet	61	168	61	168
pool spacing ratio	L_{p-p}/w_{bkf}		1.4	3.8	1.4	3.8
maximum pool depth at bankfull	d_{pool}	feet	4.0	5.3	4.0	5.3
pool depth ratio	d_{pool}/d_{bkf}		0.8	1.0	0.8	1.0
pool width at bankfull	w_{pool}	feet	48.0	54.1	48.0	54.1
pool width ratio	w_{pool}/w_{bkf}		0.5	0.6	0.8	0.9
pool cross-sectional area at bankfull	A_{pool}	SF	200.9	240.1	200.9	240.1
pool area ratio	A_{pool}/A_{bkf}		0.9	1.1	0.9	1.1
Pattern Features						
sinuosity	K		1.3		1.2	
belt width	w_{blt}	feet	420		405	
meander width ratio	w_{blt}/w_{bkf}		4.6		6.6	
meander length	L_m	feet	934		1135	
meander length ratio	L_m/w_{bkf}		10.3		18.6	
radius of curvature	R_c	feet	57	344	57	344
radius of curvature ratio	R_c/ w_{bkf}		1.3	5.6	1.3	5.6
Sediment						
Particle Size Distribution from Reachwide Count						
d_{50}	Very Coarse Gravel					
	d_{16}	mm	9.1			
	d_{35}	mm	33.6			
	d_{50}	mm	46.3			
	d_{84}	mm	88.2			
	d_{95}	mm	155.2			
	d_{99}	mm	362.0			

Table 5b. UT1 Existing Conditions
Crooked Creek #2 Restoration Project

	Notation	Units	Reach 1		Reach 2	
			min	Max	min	max
stream type			N/A[1]		N/A[1]	
drainage area	DA	sq mi	0.24		N/A[2]	
Q- NC Rural Regional Curve		cfs	33		N/A[2]	
$Q_{2\text{-}yr}$ NFF regression		cfs	50		N/A[2]	
Q- USGS extrapolation		cfs	17	40	N/A[2]	N/A[2]
Q Mannings		cfs	24		N/A[2]	
bankfull design discharge	Q_{bkf}	cfs	30		N/A[2]	
Cross-Section Features						
bankfull cross-sectional area	A_{bkf}	SF	8.6		7.8	
average velocity during bankfull event	v_{bkf}	fps	3.5		4.1	
width at bankfull	w_{bkf}	feet	17.7		10.9	
maximum depth at bankfull	d_{max}	feet	1.3		1.02	
mean depth at bankfull	d_{bkf}	feet	0.5		0.71	
bankfull width to depth ratio	w_{bkf}/d_{bkf}		36.4		15.3	
depth ratio	d_{max}/d_{bkf}		2.7		1.4	
low bank height			1.8		3.0	
bank height ratio	BHR		1.4		2.9	
floodprone area width	w_{fpa}	feet	500		539	
entrenchment ratio	ER		28.2		49.3	
Slope						
valley slope	S_{valley}	feet/ foot	0.0066		0.0058	
channel slope	$S_{channel}$	feet/ foot	0.0071		0.0034	
Riffle Features						
riffle slope	S_{riffle}	feet/ foot	*		*	
riffle slope ratio	$S_{riffle}/S_{channel}$		*		*	
Pool Features						
pool slope	S_{pool}	feet/ foot	*		*	
pool slope ratio	$S_{pool}/S_{channel}$		*		*	
pool-to-pool spacing	$L_{p\text{-}p}$	feet	20	74	20	74
pool spacing ratio	$L_{p\text{-}p}/w_{bkf}$		1.8	6.8	1.8	6.8
maximum pool depth at bankfull	d_{pool}	feet	0.76	1.27	0.76	1.27
pool depth ratio	d_{pool}/d_{bkf}		1.6	2.6	1.1	1.8
pool width at bankfull	w_{pool}	feet	12.5		11.8	
pool width ratio	w_{pool}/w_{bkf}		0.7		1.1	
pool cross-sectional area at bankfull	A_{pool}	SF	10.4		10.4	
pool area ratio	A_{pool}/A_{bkf}		1.2		1.3	
Pattern Features						

	Notation	Units	Reach 1		Reach 2	
			min	Max	min	max
sinuosity	K		1.0		1.5	
belt width	w_{blt}	feet	n/a		115	543
meander width ratio	w_{blt}/w_{bkf}		n/a		10.5	49.7
meander length	L_m	feet	n/a		163	400
meander length ratio	L_m/w_{bkf}		n/a		14.9	36.6
radius of curvature	R_c	feet	61.2	170.6	61	171
radius of curvature ratio	R_c/ w_{bkf}		3.5	9.6	3.5	9.6
Sediment						
Particle Size Distribution from Riffle 100-Count[3]						
d_{50}	Very Fine Gravel					
	d_{16}	mm	Silt/Clay			
	d_{35}	mm	Silt/Clay			
	d_{50}	mm	3.1			
	d_{84}	mm	8.6			
	d_{95}	mm	11.0			
	d_{100}	mm	16.0			

Notes
1. The Rosgen classification system is for natural streams. These channels have been heavily manipulated by man and therefore the Rosgen classification system is not applicable.
2. Reach 2 is downstream of the confluence with the overflow channel. Since further field analysis is required to determine the hydraulic regime of the overflow channel, estimating the discharge of Reach 2 at this point is not feasible.
3. Only the sediment samples from Reach 1 were used since Reach 2 is significantly affected by the overflow channel.
*Channel was dry during survey; slope was calculated using the channel's thalweg.

4.2.2 Valley Classification

The project reaches are located in a surrounding fluvial landform. Alluvial terraces and broad floodplains are the predominant depositional features for this valley type. Slightly entrenched and meandering channels are typically found in this valley type. Active agricultural operations have altered the valleys for each project reach through tilling, ditching, and grading. Characteristics of each project stream valley are summarized in Table 6.

Table 6. Summary of Project Stream Valley Characteristics
Crooked Creek #2 Mitigation Project

Reach	Avg. Valley Floor Width (ft)	Valley Aspect	Typical Valley Side Slopes (ft/ft)
Crooked Creek Reach A	1,300	N to S	0.006
Crooked Creek Reach B	450	N to S	0.012
UT1	120	E to W	0.015
UT2	100	SE to NW	0.020

4.2.3 Discharge

Multiple methods were used to approximate the bankfull discharge and choose a design discharge for the UT1 restoration reach. Design discharges for the other reaches on the project site were not developed since enhancement II are proposed. Due to the agricultural and forest land cover within the watershed, discharge estimates were made using methods intended for rural watersheds. The regional curve relating bankfull discharge to drainage area for rural watersheds in the Piedmont region of North Carolina (Harman, et al., 1999) was used to estimate the bankfull discharge for UT1. In addition, the U.S. Geological Survey (USGS) flood frequency equations for rural watersheds in the North Carolina Piedmont (Weaver, Feaster, and Gotvald, 2009) were used to estimate the 2-year through 100-year peak discharges for UT1. The 1.2-year and 1.8-year peak discharges were then extrapolated from the USGS peak discharge values. The 1.2-year and 1.8-year peak discharges give a bracketed approximation of bankfull. Historic gauge data were collected from multiple nearby stream gauges operated by the USGS. Two of these gauges with long-term, continuous records of discharge and relatively small drainage areas were selected to assist with developing the design discharge (USGS 021246600 Clear Creek at SR3181 near Mint Hill, NC and USGS 0212467595 Goose Creek at SR1525 near Indian Trail, NC). These two gauges passed the homogeneity test (Dalrymple, 1960) indicating that they are located within a single homogenous region in terms of streamflow characteristics. The percent impervious of the watershed at the Clear Creek gauge is 13% while the percent impervious of the watershed at the Goose Creek gauge is 11%. While these percent impervious of each of the two gauges are higher than the percent impervious of UT1 (3%), the gauge data can still be used as a tool in developing design discharge. Methods described in Bulletin 17 B (Interagency Advisory Committee on Water Data, 1982) were used to determine the discharges associated with the 1.4-year and 1.8-year recurrence intervals for these gauges. The basin ratio method was then used to estimate a bankfull discharge for the restoration reach based on the bankfull discharge at the Clear Creek and Goose Creek gauges. This method was applied by simply multiplying the ratio of discharge to drainage area of a gauge to the drainage area of the design reaches. Each of the methods described above was used to estimate a bankfull discharge or discharge with recurrence interval approximating bankfull for the UT1 design reach. Manning's equation was also used to estimate a bankfull discharge with the existing cross-section dimensions. These estimates were plotted with the regional curve data to show the range of discharge estimation as shown in Figure 9.

A design discharge for the UT1 restoration reach was selected based on the analyses described above. The design discharge was chosen to be slightly smaller than the bankfull discharge estimated by the regional curve since frequent flooding and smaller channels are desirable adjacent to wetland mitigation areas. Table 7 summarizes the results of each of the discharge analyses described in this section.

Table 7. Summary of Project Stream Design Discharge Analysis
Crooked Creek #2 Restoration Project

Reach	Rural Piedmont Regional Curve Qbkf (cfs)	Extrapolated USGS Rural NFF (cfs)		Clear Creek Gauge Ratio Bankfull Q (cfs)		Goose Creek Gauge Ratio Bankfull Q (cfs)		Mannings Q (cfs)	Design Q (cfs)
		1.2-yr	1.8-yr	1.4-yr	1.8-yr	1.4-yr	1.8-yr		
UT1	33	17	40	45	48	68	72	24	30

4.2.4 Channel Morphology

Existing conditions channel morphology surveys were performed to document the current condition of the streams on the Crooked Creek site and to provide a basis for the design. Overall, channelization of the streams and surrounding agricultural land use has led to channel incision, severe bank erosion, and loss of aquatic habitat. It is likely that all of these streams originally had higher entrenchment values and frequently accessed their floodplains.

Overall, Reaches A and B of Crooked Creek are over-wide in some locations, but not extremely vertically incised with well-defined riffle-pool sequences, and substrate consisting of large cobble. Bank height ratios typically range from 1.1 to 1.6. Portions of Crooked Creek Reach A exhibit moderate to extensive bank erosion from cattle activity and low water farm equipment crossings. The landowner verbally confirmed this cattle activity stating that the cattle typically congregate on the south side of Crooked Creek in the shade of the mature trees. Most of the floodplain is populated with mature hardwoods which provide ample shade along the stream. However, where vertical, bare, and overhanging banks exist, very little understory vegetation growth has occurred, resulting in additional bank instability. Along Crooked Creek Reach B, the majority of the reach exhibits stable vegetated banks, minor incision, and a hardwood canopy. The stream appears to frequently access an adequate floodplain with the exception of approximately 340 LF where the right bank is up against a hillside. The section that is adjacent to the hillside is stable due to bedrock outcroppings and mature vegetation.

UT1 to Crooked Creek drains the northern portion of the project area and exhibits effects from past ditching efforts throughout the upper reach, along the property line. Additionally, a large overflow ditch from Crooked Creek was created adjacent to UT1. This overflow ditch allows for large flow events from Crooked Creek to empty into UT1, causing incision and over-widening to the downstream portion of this channel. A small berm also exists along the left top of bank from the upstream project limit to its confluence with the Crooked Creek overflow channel. The cross sectional area of UT1 changes drastically after the confluence with the overflow channel, from around 20 square feet (SF) to about 73 SF. The stream bed exhibits few stabilizing structures and long runs with few poorly-defined, shallow pools provide low quality in-stream habitat throughout the entire reach. The riparian buffer along most of the upstream section of UT1 (Reach 1) is dominated by invasive vine and shrub species with few mature trees and stabilizing vegetation. The downstream section (Reach 2) of this reach exhibits impacts from cattle access including trampled banks and little to no understory growth under a well-developed canopy.

The bed material of the channels is a distribution of gravel and cobble. D50 values range from 3.1 (very fine gravel) to 43.8 (very coarse gravel). UT1 upstream of the overflow ditch consists of primarily silt/clay and fine gravels. With the exception of UT1's upstream reach, all of the channels have both gravel and cobble substrate. While the coarser material was predominantly found in the riffles and runs and the finer material in the pools, particles of both size ranges were found throughout all streambed features.

4.2.5 Channel Evolution

A review of aerial photos for the project area dating back to 1948 indicates that the unnamed tributaries to Crooked Creek were channelized and much of the woody vegetation along the channels was removed prior to that time. The pattern and vegetation along Crooked Creek seem to have remained the same since then. However, the land cover in the contributing watershed to Crooked Creek has changed at a fast pace since the early 1970's and continues to be one of the fastest developing areas in the region at the Union County and Mecklenburg County line along US-74. Historic channelization, on-going agricultural practices, and development have attributed to the streams' impaired aquatic health in the Crooked Creek Watershed. Urbanization within the Crooked Creek watershed is expected to continue.

Along Crooked Creek Reach A, the channel banks have been continuously trampled and widened by cattle activity. The channel appears to be aggrading as evidenced by several mid-channel bars. Removal of cattle and restoration of a woody vegetated buffer will help to stabilize the channel thereby reducing in-stream sediment erosion and deposition. The enhancement II approach will address the problem spots along the channel while preserving the positive features such as the mature hardwood buffer.

UT1 has historically been straightened. Channelization usually includes straightening and deepening of streams and is one of the major causes of channel down-cutting, or incision (Simon, 1989; Simon and Rinaldi, 2006). This maintenance of a straight-line channel has steepened the channel such that sediment transport calculations indicate the existing condition slope is steeper than needed to move the sediment load. This indicates that the channel has the potential to degrade. The portion of the channel upstream of the overflow channel (Reach 1) appears to be actively degrading. This section is not extremely vertically incised, but lacks channel habitat diversity and bank-stabilizing vegetation. The portion of the channel downstream of the overflow channel (Reach 2) appears to be actively degrading and widening. This section is downcutting to meet the incised grade at Crooked Creek with continuous and unlimited cattle trampling. These disturbances have not allowed the channel to stabilize itself.

Channelization induced channel incision which led directly to over-steepened banks that subsequently began to fail resulting in channel widening and creation of the current U-shaped channels. Livestock have had access to most of the streams located in the downstream area for decades which has increased the degree of lateral erosion.

4.2.6 Channel Stability Assessment

The primary cause of Crooked Creek's destabilization is cattle access. Bank height ratios range from 1.1 to 1.6. The removal of cattle access and the addition of woody vegetation for bank protection will help to protect this reach from further degradation.

UT1 is incised, over-wide, and will continue to have stability problems without corrective action. Vertical banks appear to be eroding and the few mature trees at the top of bank are falling into the creek. Bank angles need to be reduced, a stable cross-section should be constructed, and floodplain access should be provided. Establishment of bank vegetation will help to stabilize the banks.

UT2 receives runoff from an intermittent channel to the northeast and from the existing wetland CC. The channel is somewhat incised and has a few sections of unstable banks. UT2 is relatively straight with gravel/cobble substrate. Stabilizing eroded banks and establishing bank vegetation will preserve several mature hardwoods.

4.2.7 Bankfull Verification

Bankfull stage indicators on the project streams were few and difficult to identify due to incision of the channels and trampling of the banks by livestock. However, during the existing conditions assessment, Wildlands staff identified the best available bankfull indicators and surveyed cross sections at those locations. Bankfull indicators included flat depositional features and prominent breaks in slope.

Bankfull data for the surveyed project reaches and nearby reference reaches were compared with the NC rural Piedmont regional curves and are shown overlaid with the rural curves for area and discharge in Figure 9. Analysis of the bankfull cross-sectional areas and discharges for the project reaches reveal that the data consistently plot within the 95% confidence intervals of the area and discharge regional curves in all cases where the points are within the range of drainage area (independent variable) covered by the regional curves. This information indicates that the bankfull indicators identified during the existing conditions assessment provide reasonable estimates of bankfull geometry for the existing conditions.

A HEC-RAS hydraulic model was developed from the survey data to verify the selected bankfull discharge for UT1. A range of flows from the 1-year discharge to the 2-year discharge was run with the model. The resulting stage for each flow was compared to the bankfull indicator height above water surface elevation estimated during geomorphic surveys. The hydraulic model indicated that a discharge of 10 to 40 cfs corresponds to the elevation of bankfull indicators observed in the field. Based on extrapolation from the USGS regression equations, the recurrence interval of this flow range is between 1 and 1.8 years.

4.2.8 Vegetation Community Types Descriptions

Vegetation habitats within the project area are primarily comprised of open pastures dominated by various graminoid and herbaceous species, in addition to areas of mature mixed hardwood trees with few pockets of invasive vine and shrub species. The open areas within the site have been heavily mowed and maintained as active cattle pastures. These areas completely lack canopy, sub-canopy, and understory shrub layers and are dominated by buttercup (*Ranunculus bulbosus*), soft stem rush (*Juncus effuses*), curly dock (*Rumex crispus*), smartweed (*Polygonum pensylvanicum*), purple deadnettle (*Lamium purureum*), perennial ryegrass (*Lolium perenne*), Nepalese browntop (*Microstegium vimineum*), and white clover (*Trifolium repense*).

The stream banks of Crooked Creek and its adjacent floodplain exhibit hardwood tree species typical of a mesic mixed hardwood forest or bottomland forest (Schafale and Weakley, 1990). These areas exhibit a well-developed, mature canopy layer; however, they lack a true sub-canopy, shrub, and herbaceous layers due to persistent cattle access and impacts from grazing. Typical canopy species include box elder (*Acer negundo*), American sycamore (*Platanus occidentalis*), red maple (*Acer rubrum*), southern red oak (*Quercus falcata*), green ash (*Fraxinus pennsylvanica*), red elm (*Ulmus rubra*), and ironwood (*Carpinus caroliana*).

A small portion of site exhibits an abundance of invasive vine and shrub species and includes the upstream corridor of UT1. Typical vegetation includes sub-canopy species of black willow (*Salix nigra*), box elder, red cedar (*Juniperus virginiana*), and red maple. Shrub layer vegetation includes multi-flora rose (*Rosa multiflora*), common blackberry (*Rubus argutus*), and invasive Chinese privet (*Ligustrum sinense*) with vine species including green catbriar (*Smilax rotundifolia*), poison ivy (*Toxicodendron radicans*), and invasive honeysuckle (*Lonicera japonica*).

4.3 Wetland Summary Information

4.3.1 Jurisdictional Wetlands

On May 19, 2011, Wildlands Engineering investigated and delineated on-site jurisdictional waters of the U.S. using the USACE Routine On-Site Determination Method. This method is defined by the 1987 Corps of Engineers Delineation Manual and subsequent Eastern Mountain and Piedmont Regional Supplement Guide. The results of the on-site jurisdictional determination indicate that there are five jurisdictional wetland areas located within and adjacent to the floodplain of Crooked Creek and UT1 (Wetlands AA – EE).

Wetland AA is located in the north portion of the project area and is approximately 1.1 acres in size. This jurisdictional system was classified as a partially ditched palustrine emergent (PEM) wetland and exhibited surface water from 1 to 4 inches, water-stained vegetation, oxidized rhizospheres, low chroma soils (7.5YR 5/1), many distinct mottles (5YR 4/6), and saturation in the upper 12 inches of the soil profile. Existing soil conditions are indicative of a Depleted Matrix (F3 hydric soil indicator). Wetland AA is located in an active cattle pasture and portions of this wetland have been ditched to allow for increased surface drainage.

Wetland BB is palustrine emergent (PEM) system located in the active pasture west of Wetland AA and is approximately 0.1 acre in size. This jurisdictional feature is the result of past ditching efforts to remove excess water from these agricultural areas. This system is a linear conveyance that exhibited pockets of surface water, water-stained vegetation, oxidized rhizospheres, low chroma soils (7.5YR 5/1), many distinct concentrations (5YR 4/4), and saturation in the upper 12 inches of the soil profile.

Wetland CC is a ditched/linear wetland complex that receives drainage from both Wetlands AA and BB and is approximately 0.4 acre in size. This wetland complex is the result of past ditching efforts along with existing floodplain depressions that have been heavily trampled from cattle activity and incision from flooding events. Portions of this feature exhibit deep, stagnant surface water from 2 to 3 feet, ultimately leading to a direct surface water connection with UT2. The remainder of Wetland CC exhibited sediment deposits, drainage

patterns, an algal mat, water-stained leaves, oxidized rhizospheres, low chroma soils (5YR 5/1), distinct iron concentrations (7.5YR 4/6), and saturation within the upper 12 inches of the soil profile.

Wetlands DD and EE are located in the eastern portion of the project area adjacent to Crooked Creek and are approximately 0.03 and 0.05 acre in size, respectively. These small linear wetlands are classified as palustrine emergent (PEM) and exhibited impacts from cattle trampling and grazing. Typical wetland indicators include pockets of surface water up to 3 inches, drainage patterns, sediment deposits, oxidized rhizospheres, low chroma soils (10YR 4/2 and 2.5Y 5/2), distinct concentrations (5YR 4/6), and saturation within the upper 12 inches of the soil profile. Wetland Determination Data Forms representative of these jurisdictional wetland areas have been enclosed in Appendix B (DP1, DP3, DP5, and DP6).

Based on a similar geomorphic reference area and nearby vegetation communities, it was determined that these jurisdictional systems historically functioned as Bottomland Hardwood Forests, prior to their conversion to agricultural pasture. An assessment of these wetlands was performed according to the recent North Carolina Wetland Assessment Method (NCWAM) in order to determine their level of hydrologic function, water quality, and habitat condition. Due to heavy agricultural activities over the past several decades along with aggressive vegetation management, these wetland systems scored out as low functioning systems when compared to reference conditions. Particularly low scoring parameters include the effects from ditching on decreased surface and subsurface hydrology. Additionally, vegetation management has reduced aquatic and terrestrial habitat along with eliminating the systems' connection to adjacent natural habitats. An NCWAM Wetland Rating Sheet representative of these jurisdictional wetland areas is enclosed in Appendix B (AA – EE).

4.3.2 Hydrological Characterization

In order to develop a wetland restoration and enhancement design for the Crooked Creek Mitigation Site, an analysis of the existing and proposed conditions for groundwater hydrology was necessary. DrainMod (version 6.1) was used to model existing and proposed groundwater hydrology at the site. DrainMod simulates water table depth over time and produces statistics describing long term water table characteristics and an annual water budget. DrainMod was selected for this application because it is a well-documented modeling tool for assessing wetland hydrology (NCSU, 2010) and is commonly used in wetland restoration projects. For more information on DrainMod and its application to high water table soils see Skaggs (1980).

4.3.2.1 Groundwater Modeling

For the Crooked Creek wetland site, two models were developed to represent the existing and proposed conditions at two different gauge locations – gauges GWG5 and GWG10 – on the site (Figure 8). Groundwater gauge 5 represents the wetland creation area and groundwater gauge 10 represents the wetland restoration area. Resulting model output was used to validate the proposed plan for wetland creation and restoration on site and to develop a water budget for the site. The modeling procedures are described below.

Data Collection

DrainMod models are built using site hydrology, soil, climate, and crop data. Prior to building the models, soil cores were taken to validate existing mapped soils across the site. Further explanation of the site soils can be found in section 4.3.3 of this report. Rainfall and temperature data were obtained from nearby weather station Monroe 2 SE (Station No. 315771) operated by the National Oceanic and Atmospheric Administration (NOAA) National Weather Service. The data set for this station was obtained from the North Carolina State Climate Office from January of 1935 through April of 2012. These data were used to test the models and performance against observed data and perform the long term simulations. Information to develop model inputs for vegetation on the site was obtained through interviews with the landowner and review of historical aerial photos.

Existing Conditions Base Model Setup and Calibration

Models were created to represent two monitoring gauge locations on the site at as shown on Figure 8. The models were developed using the conventional drainage water management option to best simulate the drainage of the site. Gauge 5 was installed in late May 2011 and gauge 10 was installed in February of 2012. Both gauges recorded groundwater depth once per day with Ecotone water level monitoring gauges through April 2012.

The first step in developing the model was to prepare input files from various data sources. A soil input file obtained from N.C. State University, which has similar characteristics to the soils on the site, was used as a base soil input file for each model. Temperature and precipitation data from a nearby weather station, described above, were used to produce weather input files for each model. The existing drainage characteristics for the site were input into the model along with information on site vegetation and climate. The site has been used for grazing cattle so no crop data were necessary.

Once the necessary input files were created, the project settings were adjusted for this application to represent the site conditions as well as possible. The groundwater monitoring data collected between May 2011 and April 2012 were used to calibrate the models. Calibration is an iterative process of making reasonable adjustments to model inputs, running the models, and comparing the output groundwater depth over time to the observed gauge data groundwater depth for the same time period until the model's prediction is acceptable. Plots of calibrated model output compared to observed data are included in Appendix D.

Proposed Conditions Model Setup

The proposed conditions models for gauges 5 and 10 were developed based on the calibrated existing conditions models to predict whether wetland criteria would be met over a long period of recorded climate data. Proposed plans for the site include minimal grading in the wetland creation area of three to twelve inches in most locations. One small high area in the creation zone will require approximately 15 inches of cut. Other construction activities will include removing a system of existing agricultural ditches that currently drain portions of the site, planting native wetland plants, and roughing the

surface soil through disking. These proposed plans were developed to increase the wetland hydrology in drained hydric soils on site and create wetland hydrology in the creation zone. Settings for the proposed conditions model were altered to reflect these changes to the site. Filling of the existing agricultural ditches on the site was simulated by increasing the drain spacing for each of the two gauges. The proposed conditions drain spacing accounts for the proposed alignment of UT1. Drain depths were altered from the existing ditch depth to the proposed depth of UT1. Changes in the vegetation on the site were simulated by altering the rooting depth of plants on the site from relatively shallow depths for pasture grasses to deeper values for hardwood tree species. Surface storage values were increased at all gauges to account for proposed disking to the site. Because proposed grading will not be lower than the existing ground surface at the gauge locations, the ground surface elevation were not altered in the proposed conditions models. Once the proposed conditions models were developed, each model was run for a 76-year period from January 1935 through December 2010 using the weather data from the Monroe 2 SE weather station to perform the long term simulation.

Modeling Results and Conclusions

DrainMod was used to compare calibrated existing conditions models with proposed conditions scenarios to estimate the effect of proposed practices on site hydrology. Two gauge locations were evaluated to establish how often annual wetland criteria would be met over the 76-year simulation period. The wetland criteria are that the water table must be continuously within 12 inches of the ground surface at each gauge for a minimum of a certain percentage of the growing season (March 23 through November 6). This minimum percentage is increased with each model run to a point where results start to decrease rapidly. Using a minimum percentage of 7.5% of the growing season as requested by the Interagency Review Team (IRT), the modeling results show that gauges GWG5 and GWG10 would meet the criteria 66 years and 71 years respectively out of the 76-year period following implementation of the restoration/creation activities described above.

4.3.2.2 Surface Water Modeling at Restoration Site

No other modeling of surface hydrology, other than the HEC-RAS hydraulic flood study, was performed for this project.

4.3.2.3 Hydrologic Budget for Restoration Site

DrainMod computes daily water balance information and outputs summaries that describe the loss pathways for rainfall over the model simulation period. Tables 8a and 8b summarize the average annual amount of rainfall, surface runoff, infiltration, subsurface drainage, and evapotranspiration estimated for the two modeled locations on site. Runoff is water that flows overland and reaches the drainage ditches before infiltration. Infiltration represents the amount of water that percolates into the soil. Runoff and infiltration are equal to precipitation. Drainage is the loss of infiltrated water that travels through the soil profile and is discharged to the drainage ditches or to underlying aquifers. Evapotranspiration (ET) is water that is lost by the direct evaporation of water from the soil or through the transpiration of plants. From the water

balance results provided in Tables 8a and 8b, it is clear that most rainfall on the site, for existing and proposed conditions, is lost via ET (i.e., ET is greater than runoff and drainage). For GWG5, the proposed modifications to the site result in little change in the amount of precipitation that becomes runoff or infiltrates the soil; however the amount of infiltrated precipitation that is lost through evapotranspiration increases while drainage decrease. However, for GWG10, the amount of precipitation that becomes runoff is decreased significantly while evapotranspiration is decreased and drainage is increased. So for GWG5, existing conditions runoff is relatively low but improved wetland hydrology is provided in the proposed condition by a decrease in subsurface drainage along with no increase in surface runoff. For GWG10, the proposed conditions hydrology is provided by a significant decrease in water lost through runoff on the site.

Table 8a. Water Balance for GWG5
Crooked Creek #2 Restoration Project

Hydrologic Parameter	Existing Conditions		Proposed Conditions	
	Average Annual Amount (cm of water)	Average Annual Amount (% of precipitation + runon)	Average Annual Amount (cm of water)	Average Annual Amount (% of precipitation + runon)
Precipitation	118.0	100.0%	118.0	100.0%
Runoff	5.91	5.01%	6.01	5.09%
Infiltration	112.09	94.99%	111.95	94.87%
Evapotranspiration	66.47	56.33%	80.17	67.94%
Drainage	45.56	38.61%	31.7	26.86%

Table 8b. Water Balance for GWG10
Crooked Creek #2 Restoration Project

Hydrologic Parameter	Existing Conditions		Proposed Conditions	
	Average Annual Amount (cm of water)	Average Annual Amount (% of precipitation + runon)	Average Annual Amount (cm of water)	Average Annual Amount (% of precipitation + runon)
Precipitation	118.0	100.0%	118.0	100.0%
Runoff	32.06	27.21	10.96	9.29%
Infiltration	85.74	72.78	107.0	90.68%
Evapotranspiration	80.9	68.67	85.91	72.81%
Drainage	4.84	4.11	21.08	17.86%

4.3.3 Soil Characterization

An investigation of the existing soils on the wetland restoration/enhancement site was performed by Wildlands between June 8 and June 10, 2011, and on August 1, 2011. This investigation supplemented the soils analysis performed by a licensed soil scientist (LSS) on October 26, 2011. Soil cores were collected at locations across the site to provide data to refine NRCS soils mapping units, establish areas suitable for wetland restoration, and aid in developing a wetland restoration plan. Wildlands took forty-eight soil cores at approximately 100 to 200-foot grid spacing across the site at varying depths. The cores were taken to a depth at which either hydric soil features or groundwater was encountered. Soil texture; Munsell chart hue, chroma, and value; and hydric soil characteristics were recorded for each core. The depth to hydric indicators and groundwater table, if attainable, was then measured at each core. Soils were also evaluated at six additional locations around the site during the wetland delineation described above. The soil core data from these six locations were added to the 48 grid-spaced cores and the 16 cores taken by the LSS for a total of 70 cores in the soil core data base for the site. The most recent 48 soil cores taken by Wildlands and the 16 cores taken by the LSS along with the mapped soil units are shown on Figure 4. The data for each core is included in Appendix B.

4.3.3.1 Taxonomic Classification

Two soils types are mapped within the boundaries of the jurisdictional wetland areas in the Natural Resources Conservation Service (NRCS) Soil Survey (NRCS, 2009). Much of the site is mapped as Chewacla silt loam (ChA) while the northern portions of Wetlands AA, CC, and DD are mapped as Badin channery silt loam (BaC). Analysis of the soil core samples collected from the project site along with consideration of site topography indicated that soil classifications at the 48 core locations largely agreed with the mapped soil units however they more closely matched the Wehadkee soil inclusions listed for Chewacla soils. The Chewacla silt loam is listed as a Type B soil for Union County, indicating a small portion of the series has inclusions of hydric indicators. Chewacla soils are somewhat poorly drained and frequently flooded. Analysis of the core data indicates that the soils on the site mapped as Chewacla exhibited a lower chroma matrix and other hydric indicators in areas of poor drainage and flat topography. The Badin series is not listed on the NC hydric soil list and is a well-drained soil type. Jurisdictional wetland areas located within this soil type can be attributed to their location within the floodplain at the toe of slope where shallow groundwater is present.

4.3.3.2 Profile Description

The Chewacla series is described in the NRCS official series description as a piedmont and coastal plain floodplain soil that is very deep, somewhat poorly drained found on zero to two percent slopes. The typical texture profile of Chewacla soils is a medium granular loam at zero to four inches, a silty clay loam from four to 14 inches, and loam/ clay loam layering from 14 to 80 inches. The Badin series is described as a moderately deep, well-drained soil. The Badin series is found on gently sloping to steep uplands in the piedmont. The texture profile of Badin soils is channery silt loam from zero to six inches, channery silty clay loam from six to nine inches, silty clay from nine to 18 inches,

channery silty clay loam from 18 to 25 inches, and weathered highly-fractured metasedimentary rock from 25 to 40 inches.

4.3.3.3 Hydraulic Conductivity

The Chewacla series has a moderately high to high Ksat value ranging from 0.57 to 1.98 in/hr. It is somewhat poorly drained and typically has a water table depth of six to 24 inches. The Badin series has a very low to high Ksat value ranging from 0.00 to 1.98 in/hr. It is well drained and generally has low available water capacity.

4.3.4 Vegetation Community Types Descriptions and Disturbance History

The existing vegetation communities within the on-site jurisdictional wetland area are representative of a stressed Palustrine Emergent system (Cowardin, 1979). Based on historical aerial photographs, farming activities and cattle pastures have been prevalent in this area since at least 1948 (Appendix B). Due to persistent cattle grazing and vegetation management over the past several decades, several major strata are completely absent from this area resulting in a dominant herbaceous layer with no mature trees present within Wetlands AA, BB, and CC. Wetlands DD and EE maintain a well-developed canopy layer, however active cattle grazing has completely removed native understory vegetation. Dominant herbaceous species within these areas includes buttercup (*Ranunculus bulbosus*), soft stem rush (*Juncus effuses*), curly dock (*Rumex crispus*), and various grass species.

4.4 Regulatory Considerations

4.4.1 Endangered and Threatened Species

The Endangered Species Act (ESA) of 1973, amended (16 U.S.C. 1531 et seq.), defines protection for species with the Federal Classification of Threatened (T) or Endangered (E). An "Endangered Species" is defined as "any species which is in danger of extinction throughout all or a significant portion of its range" and a "Threatened Species" is defined as "any species which is likely to become an Endangered Species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. 1532).

Wildlands utilized the U.S. Fish and Wildlife Service (USFWS) and North Carolina Natural Heritage Program (NHP) databases in order to identify federally listed Threatened and Endangered plant and animal species for Union County, NC (USFWS, 2008 and NHP, 2009). Three federally listed species, the Carolina heelsplitter (*Lasmigona decorate*), Michaux's sumac (*Rhus michauxii*), and Schweinitz's sunflower (*Helianthus schweinitzii*) are currently listed in Union County (Table 9). The approved Categorical Exclusion Checklist for the project is included in Appendix B.

Table 9. Listed Threatened and Endangered Species in Union County, NC
Crooked Creek #2 Restoration Project

Species	Federal Status	Habitat
Invertebrate		
Carolina Heelsplitter (*Lasmigona decorata*)	E	Stable, silt-free stream bottoms with well-vegetated banks
Vascular Plant		
Michaux's sumac (*Rhus michauxii*)	E	Sandy or rocky open woods with basic soils
Schweinitz's sunflower (*Helianthus schweinitzii*)	E	Disturbed roadsides, old pastures, woodland openings and rights-of-way
E = Endangered; T=Threatened		

4.4.1.1 Species Description

Carolina Heelsplitter

The Carolina Heelsplitter is a freshwater mussel with an ovate trapezoidal shell ranging from 3 to 4 inches in length. This species requires cool, clean, well-oxygenated water with stable, silt-free stream bottoms as apparent critical habitat. Typical threats to this species include common pollutants from municipal and industrial wastewater discharges as well as sedimentation and runoff from agricultural and forestry operations. This species is known to exist within two small tributaries in North Carolina around the Mecklenburg County/ Union County line.

Michaux's Sumac

Michaux's sumac is a densely hairy shrub with serrated compound leaves that grows from 3 to 10 feet in height. These plants are found in disturbed, sandy, or rocky open woods with basic soil types. Typical habitat may also include road rights-of-way and edges of artificially maintained clearings. This plant is threatened by habitat destruction from residential and industrial development as well as fire suppression.

Schweinitz's Sunflower

Schweinitz's sunflower is a perennial herb ranging from 3 to 6 feet tall with yellow disk and ray flowers. This species is typically found in open areas where disturbance has occurred such as roadsides, power line clearings, old pastures and woodland openings. This species is generally found growing in shallow, poor, clayey, and/or rocky soils.

4.4.1.2 Biological Conclusion

A pedestrian survey of the site was performed on May 19, 2011. On-site habitats include active agricultural pastures and open, wooded riparian areas. There is no suitable habitat for the Carolina Heelsplitter in the project area. The majority of Crooked Creek within the project area is moderately affected by cattle access which has resulted in stream bank instabilities, sedimentation, and water turbidity. There are somewhat suitable open and artificially maintained areas within the project area for the presence of Michaux's sumac and Schweinitz's sunflower, however due to active cattle grazing and mowing, along with acidic soil conditions, on-site habitats are unable to support either of these species.

As a result of the pedestrian survey, it is determined that no Federally-listed individual species were found to exist on the site and that the proposed restoration activities will have "no effect" on these Endangered species.

4.4.2 Federal Designated Critical Habitat

4.4.2.1 Habitat Description

Habitat for the Carolina Heelsplitter includes cool, clean, well-oxygenated water with stable, silt-free stream bottoms of creeks and rivers. Individuals can be found in areas with permanently flowing, cool, clean water, geomorphically stable stream bed and banks, and stable substrates with low amounts of fine sediment. According to the USFWS database, designated critical habitat for the Carolina Heelsplitter exists within Union County. These areas include the main stem of Goose Creek from the NC Highway 218 Bridge, downstream to its confluence with the Rocky River and the main stem of Duck Creek, from the Mecklenburg County/Union County line, downstream to its confluence with Goose Creek. Additional Critical Habitat with Union County includes the main stem of Waxhaw Creek (Catawba River Basin) from the NC Highway 200 Bridge downstream to the North Carolina/South Carolina State line.

4.4.2.2 Biological Conclusion

Designated Critical Habitat for the Carolina Heelsplitter is not located within or downstream of the project watershed area of Crooked Creek. It is therefore determined that the proposed project will have "no effect" on the designated critical habitat.

4.4.3 Cultural Resources

The National Historic Preservation Act (NHPA) of 1966, as amended (16 U.S.C. 470), defines the policy of historic preservation to protect, restore, and reuse districts, sites, structures, and objects significant in American history, architecture, and culture. Section 106 of the NHPA mandates that federal agencies take into account the effect of an undertaking on any property that is included in, or is eligible for inclusion in, the National Register of Historic Places. A letter was sent to the North Carolina State Historic Preservation Office (SHPO) on May 26, 2011, requesting review and comment for the potential of cultural resources potentially affected by the Crooked Creek project. The SHPO responded on June 23, 2011, and stated they were aware of no historic resources which would be affected by the project. A Categorical Exclusion Checklist for the project is included in Appendix B.

4.4.4 FEMA and Hydrologic Trespass

Crooked Creek is mapped as a FEMA Zone AE floodplain on Firm panel 5540. Base flood elevations have been defined and the floodway has been delineated and is mapped on the FIRM panel. UT1 to Crooked Creek has not been studied and is not mapped on the FIRM panel.

The effective hydraulic model for the mapped floodplain will be obtained from the NC Floodplain Mapping Program. Wildlands will model existing and proposed hydraulic conditions on the site for the 100-year flood event along Crooked Creek. If appropriate, a Conditional Letter of Map Revision (CLOMR) will be prepared for submittal to the Union County local floodplain administrator and the NC Floodplain Mapping Program for approval

prior to construction. If hydraulic modeling indicates that the 100-year flood elevation will not increase, then a no-rise study will be submitted. Following construction completion, if a CLOMR was required or a no-rise indicates that flood elevations will drop by more than 0.1 foot, an as-built survey and Letter of Map Revision (LOMR) will be finalized and submitted to the Union County local floodplain administrator and the NC Floodplain Mapping Program. Steep hill slopes should prevent off-site flooding adjacent to the wetland restoration areas.

5.0 Determination of Credits

Mitigation credits presented in Table 10 are projections based upon site design. Upon completion of site construction the project components and credits data will be revised to be consistent with the as-built condition.

Table 10. Determination of Credits
Crooked Creek #2 Restoration Project

Crooked Creek #2 Restoration Project, Union County, DENR Contract D09126S									
Mitigation Credits									
	Stream		**Riparian Wetland**		**Non-riparian Wetland**		**Goose Creek Buffer**	**Nitrogen Nutrient Offset**	**Phosphorus Nutrient Offset**
Type	R	RE	R	RE	R	RE			
Totals	1,718.0	1771.6	6.6	1.9			1.3		

Project Components							
Project Component or Reach ID	**Stationing / Location**	**Existing Footage/ Acreage**	**Approach (P1, P2, etc.)**	**Restoration or Restoration Equivalent**	**Restoration Footage or Acreage**	**Mitigation Ratio**	**Mitigation Credit**
Crooked Creek Reach A	200+00-228+29	1,555 LF	n/a	Enhancement II	1,555 LF	2.5:1	622.0
Crooked Creek Reach B		2,404 LF	n/a	Enhancement II	2,404 LF	2.5:1	961.6
UT1	100+00-117+89	1,789 LF	P1	Restoration	1,718 LF	1:1	1,718.0
UT2	300+00-305+60	470 LF	n/a	Enhancement II	470 LF	2.5:1	188.0
Zone A (Drained Hydric Soils)	N/A	0.7 AC		Enhancement	0.7 AC	2:1	0.4
Zone A (Drained Hydric Soils)	N/A	N/A		Restoration	6.6 AC	1:1	6.6
Zone B	N/A	0.3 AC		Enhancement	0.3 AC	2:1	0.2
Zone B	N/A	N/A		Creation	3.9 AC	3:1	1.3
Goose Creek Buffer	N/A	0.6 AC		Enhancement	0.6 AC	3:1	0.2
Goose Creek Buffer	N/A	N/A		Restoration	1.1 AC	1:1	1.1

Table 10. Determination of Credits
Crooked Creek #2 Restoration Project

Component Summation							
Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Goose Creek Buffer (square feet)	Upland (acres)	
		Riverine	Non-Riv.				
Restoration	1,718	6.6			45,735		
Enhancement		1.0			25,201		
Enhancement I							
Enhancement II	4,429						
Creation		3.9					
Preservation							
High Quality Preservation							

6.0 Determination of Credits

All credit releases will be based on the total credit generated as reported by the as-built survey of the mitigation site. Under no circumstances shall any mitigation project be debited until the necessary DA authorization has been received for its construction or the District Engineer (DE) has otherwise provided written approval for the project in the case where no DA authorization is required for construction of the mitigation project. The DE, in consultation with the Interagency Review Team (IRT) will determine if performance standards have been satisfied sufficiently to meet the requirements of the release schedules below. In cases where some performance standards have not been met credits may still be released depending on the specifics of the case. Monitoring may be required to restart or be extended, depending on the extent to which the site fails to meet the specified performance standard. The release of project credits will be subject to the criteria described in Table 11.

Table 11. Release of Credits
Crooked Creek #2 Restoration Project

Forested Wetlands Credits			
Monitoring Year	Credit Release Activity	Interim Release	Total Released
0	Initial Allocation – see requirements below	30%	30%
1	First year monitoring report demonstrates performance standards are being met	10%	40%
2	Second year monitoring report demonstrates performance standards are being met	10%	50%
3	Third year monitoring report demonstrates performance standards are being met	10%	60%
4	Fourth year monitoring report demonstrates performance	10%	70%

Forested Wetlands Credits			
Monitoring Year	**Credit Release Activity**	**Interim Release**	**Total Released**
	standards are being met		
5	Fifth year monitoring report demonstrates performance standards are being met; Provided that all performance standards are met, the IRT may allow the EEP to discontinue hydrologic monitoring after the fifth year, but vegetation monitoring must continue for an additional two years after the fifth year for a total of seven years.	10%	80%
6	Sixth year monitoring report demonstrates performance standards are being met	10%	90%
7	Seventh year monitoring report demonstrates performance standards are being met, and project has received close-out approval	10%	100%
Stream Credits			
Monitoring Year	**Credit Release Activity**	**Interim Release**	**Total Released**
0	Initial Allocation – see requirements below	30%	30%
1	First year monitoring report demonstrates performance standards are being met	10%	40%
2	Second year monitoring report demonstrates performance standards are being met	10%	50% (65%*)
3	Third year monitoring report demonstrates performance standards are being met	10%	60% (75%*)
4	Fourth year monitoring report demonstrates performance standards are being met	10%	70% (85%*)
5	Fifth year monitoring report demonstrates performance standards are being met and project has received closeout approval	15%	100%

6.0.1 Initial Allocation of Released Credits

The initial allocation of released credits, as specified in the mitigation plan can be released by the EEP without prior written approval of the DE upon satisfactory completion of the following activities:

a. Approval of the final Mitigation Plan
b. Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property
c. Completion of project construction (the initial physical and biological improvements to the mitigation site) pursuant to the mitigation plan; Per the EEP Instrument, construction means that a mitigation site has been constructed in its entirety, to include planting, and an as-built report has been produced. As-built reports must be sealed by an engineer prior to project closeout, if appropriate but not prior to the initial allocation of released credits.

d. Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.

6.0.2 Subsequent Credit Releases

All subsequent credit releases must be approved by the DE, in consultation with the IRT, based on a determination that required performance standards have been achieved. For stream projects a reserve of 15% of a site's total stream credits shall be released after two bank-full events have occurred, in separate years, provided the channel is stable and all other performance standards are met. In the event that less than two bank-full events occur during the monitoring period, release of these reserve credits shall be at the discretion of the IRT. As projects approach milestones associated with credit release, the EEP will submit a request for credit release to the DE along with documentation substantiating achievement of criteria required for release to occur. This documentation will be included with the annual monitoring report.

6.1 Goose Creek Watershed Buffer

The Goose Creek Watershed Plan (GCWP, 2002), developed in September 2002 by the Goose Creek Watershed Advisory Committee, presents recommendations to protect creeks from urban Stormwater runoff and to remove Goose Creek from the 303(D) list. Among the recommendations is the protection of riparian buffers. The Site Specific Water Quality Management Plan for the Goose Creek Watershed (SSWQMP, 2009) defines the rules and conditions by which riparian buffers are protected and mitigated. Buffer restoration and enhancement requires native hardwood tree species planted at 320 trees per acre, along with a fertilization plan, conservation easement, and five-year annual survival monitoring. The proposed riparian planting plan and monitoring plan exceed these requirements. Buffer enhancement credit is awarded at 3:1 mitigation credit ratio while buffer restoration is awarded at a 1:1 mitigation credit ratio. Table 10 lists the total Goose Creek Buffer credits for this project.

7.0 Mitigation Work Plan

The restoration design developed for this project was completed with careful consideration of goals and objectives that were described in the LWP and RBRP (Section 1.0). The goals were established to meet EEP's mitigation needs while maximizing the ecological and water quality uplift provided by the project. The goals represent the "ends" that the finer objectives (or "means") were formulated to achieve and were directed by the specific stressors discussed in Section 1.0. The overarching goals of this mitigation plan are broad and similar to those of other mitigation plans. The objectives are more specific in order to replace specific ecological functions and to remain sustainable given watershed trajectory.

7.0.1 Overarching Goals of Mitigation Plans

The overall goal of this project is to maximize the ecological improvement of Crooked Creek by modifying the existing stream channels and wetlands on the site. The existing stream channels have been impaired by cattle and show signs of erosion and unstable banks. The existing wetlands have also been impaired by cattle and drained by ditches. The Crooked Creek #2 Restoration Project has been designed to meet the overarching goals described

above in section 1.0. The project will also address multiple watershed stressors that have been documented for both Crooked Creek and the Goose Creek watersheds. The project specific goals include:

- Improve wetland hydrologic connectivity
- Create appropriate in-stream habitat
- Decrease sediment input into stream
- Create appropriate terrestrial habitat
- Decrease water temperature and increase dissolved oxygen concentrations
- Decrease nutrient and adverse chemical levels

7.0.2 Mitigation Project Goals and Objectives

The design features of this project were developed to achieve multiple project objectives. The stream restoration elements have been designed to frequently flood the reconnected floodplain and adjacent riparian wetlands. This design will provide more frequent dissipation of energy from higher flows (bankfull and above) to improve channel stability; provide water quality treatment through detention, settling, and biological removal of pollutants; and restore a more natural hydrologic regime. Existing, restored, and created wetlands are key components of the design incorporated to better meet goals described above. The project objectives have been defined as follows:

- Construct stream channels that will remain relatively stable over time and adequately transport their sediment loads without significant erosion or aggradation.
- Construct stream channels that maintain riffles with coarse bed material and pools with finer bed material.
- Provide aquatic and benthic habitat diversity in the form of pools, riffles, woody debris, and in-stream structures.
- Add riffle features and structures and riparian vegetation to decrease water temperatures and increase dissolved oxygen to improve water quality.
- Construct stream reaches so that floodplains and wetlands are frequently flooded to provide energy dissipation, detain and treat flood flows, and create a more natural hydrologic regime.
- Construct fencing to keep livestock out of the streams.
- Raise local groundwater table through raising stream beds and plugging agricultural drainage features.
- Perform minor grading in wetland areas as necessary to promote wetland hydrology.
- Plant native tree species to establish appropriate wetland and floodplain communities and retain existing, native trees where possible.

7.1 Target Stream Types, Wetland Types and Plant Communities

7.1.1 Target Stream Type(s)

Two reference reaches were identified near the project area and used to support the design of the project reaches (Figures 10 and 11). Reference reaches can be used as a basis for design or, more appropriately, as one source of information on which to base a stream restoration design. Most, if not all, reference reaches identified in the North Carolina Piedmont are in heavily wooded areas and the mature vegetation contributes greatly to their stability. Design parameters for this project were also developed based on the design discharge along with dimensionless ratio values associated with successful restoration designs of streams in the North Carolina Piedmont. Reference reach data for similar streams were obtained from existing data sets and used to verify design parameters. The reference streams considered when developing design parameters for this project include Spencer Creek and UT to Lyle Creek. These reference streams were chosen because of similarities to the project streams including drainage area, valley slope and morphology, bed material, and location within the Piedmont.

7.1.2 Reference Streams Channel Morphology and Classification

The first reference site (Spencer Creek) is located in Montgomery County west of Troy with a drainage area of 0.5 mi^2. Data from the Spencer Creek reference site were used from the Big Cedar Creek Restoration Plan by Baker Engineering (2007) and from the NC Department of Transportation Reference Reach Database. Spencer Creek is located in a mature forested area with 20- to 50-year-old forest growth. Land uses within the watershed are 98% forested and 2% agricultural fields. This reference reach is vertically and horizontally stable, has moderate pattern with a sinuosity measurement of 1.1, has well-established pools at outside of channel bends, has several points of aeration in the form of riffles and woody debris jams and tree roots, and show excellent in-stream habitat. This reference stream classified as an E4/C4. Wildlands previously visited the reference site to verify the data presented in the both reports. Two riffles were surveyed during the site visit. The surveyed riffles had a width to depth ratio of 7.3 and an entrenchment ratio of 26.3 with an overall channel slope of 1.32%. The D_{50} of the two riffles were sampled to be 8.6 and 8.8 mm and classified as fine gravel and medium gravel.

The second reference reach investigated for the project, UT to Lyle Creek, is located just north of Interstate 40 in Catawba County. At the downstream limits of this unnamed tributary, the drainage area is 160 acres (0.25 mi^2). Land uses within this watershed are approximately 70% forested and 30% open pasture and active agriculture. UT to Lyle Creek receives drainage from adjacent wooded uplands and is fully connected to the floodplain with a bank height ratio of 1.0 and an entrenchment ratio over 2.5. The width-to-depth ratio is 31.7 and the overall channel slope is approximately 0.4%. UT to Lyle Creek has a sinuosity of 1.7. In-stream habitat structures within this reach included short, shallow pools and small sections of tree roots. This channel classifies as a Rosgen C5/6 stream type (1994). The channel substrate classifies as very coarse sand with a D_{50} of 0.2 mm. Wildlands previously performed a geomorphic survey on this reference reach.

The reference reach data were useful in evaluating the eventual design goal of the project with the realization that without the mature vegetation observed on the reference reaches, the

extreme dimensionless ratios are not appropriate for a newly-restored stream with little or no bank and floodplain vegetation. All of these reference reaches have width to depth ratios in the C to E range depending on the particular cross section considered. For general classification purposes, they are on the cusp between E and narrow C streams. There is often considerable variability of the widths and depths of a stable natural channel – even within a morphologically similar reach. This is very common of smaller Piedmont streams and is representative of the conditions planned for the Crooked Creek site. Although each of the reference sites has one or two parameters that are not similar to UT1, they are still valuable resources. The Spencer Creek reference reach is steeper than UT1, but has a similar D_{50}. While the UT to Lyle Creek reference reach has smaller substrate than UT1, the channel slope is very similar. Dixon Creek exhibits larger substrate but has a comparable slope and bankfull discharge as UT1. Summaries of geomorphic parameters for the reference reaches analyzed for this project are included in Table 12.

Table 12. Reference Reach Geomorphic Data
Crooked Creek #2 Restoration Project

	Notation	Units	Spencer Creek 1		UT to Lyle Creek	
			min	max	min	max
stream type			E4/C4		C5/6	
drainage area	DA	sq mi	0.50		0.25	
bankfull design discharge	Q_{bkf}	cfs	N/P		18.00	
Cross-Section Features						
bankfull cross-sectional area	A_{bkf}	SF	10.6		3.5	4.1
average velocity during bankfull event	v_{bkf}	fps	N/P		4.7	
width at bankfull	w_{bkf}	feet	8.7		7.0	8.6
maximum depth at bankfull	d_{max}	feet	1.9		1.0	1.1
mean depth at bankfull	d_{bkf}	feet	1.2		0.5	
bankfull width to depth ratio	w_{bkf}/d_{bkf}		7.3		14.9	18.3
depth ratio	d_{max}/d_{bkf}		1.6		2.1	2.3
bank height ratio	BHR		1.0		0.6	0.9
floodprone area width	w_{fpa}	feet	229		45	49
entrenchment ratio	ER		26.3		5.7	6.4
Slope						
valley slope	S_{valley}	feet/ foot	0.0139		0.0090	
channel slope	$S_{channel}$	feet/ foot	0.0132		0.0040	
Riffle Features						
riffle slope	S_{riffle}	feet/ foot	0.0100	0.0670	0.0055	0.0597
riffle slope ratio	$S_{riffle}/S_{channel}$		0.0	0.1	0.0	0.1
Pool Features						
pool slope	S_{pool}	feet/ foot	0.000		0.0000	0.0013
pool slope ratio	$S_{pool}/S_{channel}$		0.01		0.00	0.32

Table 12. Reference Reach Geomorphic Data
Crooked Creek #2 Restoration Project

	Notation	Units	Spencer Creek 1		UT to Lyle Creek	
			min	max	min	max
pool-to-pool spacing	L_{p-p}	feet	13	47	15	28
pool spacing ratio	L_{p-p}/w_{bkf}		1.5	5.3	1.9	3.6
maximum pool depth at bankfull	d_{pool}	feet	2.5		1.3	
pool depth ratio	d_{pool}/d_{bkf}		2.1		2.9	
pool width at bankfull	w_{pool}	feet	8.4		6.1	
pool width ratio	w_{pool}/w_{bkf}		1.0		0.8	
pool cross-sectional area at bankfull	A_{pool}	SF	12.80		4.00	
pool area ratio	A_{pool}/A_{bkf}		1.2		1.0	1.1
Pattern Features						
sinuosity	K		1.1		1.1	
belt width	w_{blt}	feet	24	52	21	
meander width ratio	w_{blt}/w_{bkf}		2.8	6.0	2.4	3.0
meander length	L_m	feet	54	196	39	44
meander length ratio	L_m/w_{bkf}		6.2	22.5	5.1	7.0
radius of curvature	R_c	feet	5	22	19	32
radius of curvature ratio	R_c/ w_{bkf}		0.6	2.5	2.7	3.7
Sediment						
	d_{16}	mm	0.062 – 0.1		N/P	
	d_{35}	mm	3.0		0.1	
	d_{50}	mm	8.6 – 8.8		0.2	
	d_{84}	mm	77.0 – 42.0		0.5	
	d_{95}	mm	180.0 – 90.0		4.0	
	d_{100}	mm	N/P		8.0	

N/P: Data was not provided

7.1.3 Target Wetland Type(s)

The wetland elements of this project include the following (Figure 12):

Zone A: This area encompasses drained hydric soils in the floodplain surrounding existing Wetlands AA and BB. The existing ditches that drain a portion of Wetland AA and include Wetland BB will be plugged in order to restore hydrology to this portion of the floodplain and the area will be planted with native hydrophytic tree and shrub species. The plugging of these wetland ditches will result in a total of 0.25 acre of temporary wetland impacts. It is anticipated that plugging the existing ditches as well as the proposed rerouting UT1 will raise the groundwater table to within 12 inches of the ground surface for a significant portion of the growing season and will achieve hydrology criteria for the agreed upon minimum length of the growing season. Wetland areas will be disked to increase surface roughness to better capture rainfall and to improve connection with the water table for groundwater recharge.

The specific percentage of the growing season meeting this hydrologic criterion will be more accurately determined based on the future assessment of groundwater gauge data. Zone A will include approximately 6.6 acres of wetland restoration and 0.7 acre of wetland enhancement. This area will be restored to a Piedmont Bottomland Forest (Shafale and Weakley, 1990).

Zone B: This area is comprised of a linear ditch feature (Wetland CC) and surrounding upland pasture. The existing ditch will be filled in order to eliminate stagnant open water areas and result in the enhancement of 0.3 acre of existing wetland habitat. A 3.9 acre area of non-hydric soils surrounding the ditch will be graded to a lower elevation to create a larger wetland feature. Most of this area will be cut 3 to 12 inches with one small high area cut 15 inches. Minimal grading will also be performed along the perimeter of the ditch in order to lay back the vertical banks. This entire 4.2 acre area will be disked to increase surface roughness to better capture rainfall and to improve connection with the water table for groundwater recharge. The entire area of Zone B will be planted with native shrub and tree species. This planted community will also be a Piedmont Bottomland Forest.

7.1.4 Target Wetland and Buffer Plant Communities

The target communities for the restored and enhanced wetlands and riparian buffer zones will be based on reference conditions. The main wetland reference site is a combination of species indicative of a Piedmont Bottomland Forest and a Piedmont/Low Mountain Alluvial Forest (Schafale and Weakley, 1990). The reference site is a preserved wetland within a conservation easement held by the EEP located in Cabarrus County along Dutch Buffalo Creek (Suther Property). Because most of the proposed wetland restoration and enhancement areas as well as the riparian buffer will have hydrology similar to the reference wetland site, that community will be the primary target. The species to be planted are described in Section 6.2.2.

7.2 Design Parameters

Based on assessments of the watershed and existing channels, the designs have been developed to correct incision and lack of pattern caused by channelization, bank instability caused by erosion and livestock access, lack of vegetation in riparian zones, lack of riparian and aquatic habitat, and depletion of hydrology for adjacent wetlands. All stream restoration and enhancement II reaches included in the design for this project will be constructed as C type streams according to the Rosgen classification system (Rosgen, 1996). Type C streams are slightly entrenched, meandering streams with well-developed floodplains and gentle gradients of 2% or less. They occur within a wide range of valley types and are appropriate for the project landscape. The proposed stream and wetland concept design is provided in Figure 12.

7.2.1 Stream Design Parameters

The morphologic design parameters for the restoration reach (Table 13) fall within the ranges specified for C streams (Rosgen, 1996). However, the specific values for the design parameters were selected based on designer experience and judgment and were verified with morphologic data form reference reach data sets. The width to depth ratio for UT1 will be approximately 17. The design riffle slopes of the restoration reach range from 0.0045 to

0.0080. UT1 will be reconnected with the existing floodplain (Priority 1). The restored channel will have an entrenchment ratio of greater than 2.2. The sinuosity for the restored channel will be near 1.27. Due to the favorable topography and the absence of constraints, Wildlands proposes a Rosgen Priority 1 restoration approach for UT1 completely off-line of the existing channel. Surveyed topography shows a natural valley exists near the middle of the site, suggesting that the existing channel was relocated in the past for agricultural reasons. The new channel will achieve the appropriate dimension, pattern, and profile for its watershed and valley type. A short section of Rosgen Priority 2 will be necessary at the end of UT1 in order to tie into Crooked Creek. The restored channel will improve in-stream habitat, reduce bank erosion, and improve water quality.

An overflow channel that is fed by Crooked Creek upstream of the project limits flows onto the project site and connects to UT1 before flowing back into Crooked Creek. Extensive flow records and/or hydraulic modeling would be required to accurately determine the channel-forming discharge of UT1 downstream of its confluence with the intermittent overflow channel. The overflow channel will be re-routed into Crooked Creek separate of UT1. The overflow connector cross section will be designed based on the dimensions of the surveyed cross sections collected on UT1 downstream of the confluence. On-site wetlands will be restored or enhanced by plugging existing channels to improve wetland hydrology.

Enhancement II is proposed for Reach A and B of Crooked Creek as shown in Figure 12. Cattle will be excluded and riparian vegetation will be planted to encourage bank stabilization.

Enhancement II also is proposed for UT2. Banks will be graded, stabilized, and vegetated to prevent further erosion. The project will also include the restoration, creation, and enhancement of riparian wetland areas adjacent to Crooked Creek, UT1, and UT2.

Geomorphic design parameters have not been developed for Crooked Creek Reach A and B or UT2 since enhancement II is proposed. Geomorphic design parameters have been developed only for UT1 since this channel is where restoration is proposed.

Table 13. Design Morphologic Parameters
Crooked Creek #2 Restoration Project

			UT1	
	Notation	**Units**	**min**	**max**
stream type			C4	
drainage area	DA	sq mi	0.42	
bankfull design discharge	Q_{bkf}	cfs	30	
Cross-Section Features				
bankfull cross-sectional area	A_{bkf}	SF	8.7	
average velocity during bankfull event	v_{bkf}	fps	3.4	
width at bankfull	w_{bkf}	feet	12	
maximum depth at bankfull	d_{max}	feet	1.00	

Table 13. Design Morphologic Parameters
Crooked Creek #2 Restoration Project

			UT1	
	Notation	**Units**	**min**	**max**
mean depth at bankfull	d_{bkf}	feet	0.7	
bankfull width to depth ratio	w_{bkf}/d_{bkf}		**16.6**	
depth ratio	d_{max}/d_{bkf}		**1.4**	
bank height ratio	BHR		**1.0**	
floodprone area width	w_{fpa}	feet	44+	
entrenchment ratio	ER		2.2+	
Sinuosity				
valley slope	S_{valley}	feet/ foot	0.0041	
channel slope	$S_{channel}$	feet/ foot	0.0032	
sinuosity	K		**1.27**	
Riffle Features				
riffle slope	S_{riffle}	feet/ foot	0.0045	0.0080
riffle slope ratio	$S_{riffle}/S_{channel}$		**1.4**	**2.5**
Pool Features				
pool slope	S_{pool}	feet/ foot	0.0000	0.0013
pool slope ratio	$S_{pool}/S_{channel}$		**0.0**	**0.4**
pool-to-pool spacing	L_{p-p}	feet	42	84
pool spacing ratio	L_{p-p}/w_{bkf}		**3.5**	**7.0**
maximum pool depth at bankfull	d_{pool}	feet	1.5	2.1
pool depth ratio	d_{pool}/d_{bkf}		**2.0**	**2.9**
pool width at bankfull	w_{pool}	feet	9.6	14.4
pool width ratio	w_{pool}/w_{bkf}		**0.80**	**1.20**
pool cross-sectional area at bankfull	A_{pool}	SF	8.7	10.9
pool area ratio	A_{pool}/A_{bkf}		**1.0**	**1.3**
Pattern Features				
belt width	w_{blt}	feet	30	72
meander width ratio	w_{blt}/w_{bkf}		**2.5**	**6.0**
meander length	L_m	feet	72	132
meander length ratio	L_m/w_{bkf}		**6.0**	**11.0**

Table 13. Design Morphologic Parameters
Crooked Creek #2 Restoration Project

			UT1	
	Notation	**Units**	**min**	**max**
radius of curvature	R_c	feet	22	48
radius of curvature ratio	R_c/w_{bkf}		**1.8**	**4.0**

7.2.2 Wetland and Buffer Plant Design Communities

As a final stage of construction, riparian stream buffers and wetland mitigation zones will be planted and restored to the dominant natural plant community that exists within the project watershed. This natural community within and adjacent to the project easement is classified as Piedmont Bottomland Forest and was determined based on existing canopy and herbaceous species (Schafale and Weakley, 1990). Proposed plant and seed materials will be placed on stream banks and bench areas as well as the floodplain, for a total of 19.2 acres of planting. These areas will be planted with bare root trees, live stakes, and a seed mixture of permanent herbaceous vegetation ground cover.

A permanent seed mixture of native herbaceous and grass species will be applied to all disturbed areas within the project easement. An herbaceous seed mixture was chosen that would provide quick stabilization of constructed stream banks, benches, and side slopes. These species will also provide early habitat value through rapid growth of ground cover on the tops of banks and floodplain areas. Permanent riparian herbaceous species will be selected from the species listed in Table 14a and 14b.

Table 14a. Permanent Riparian Herbaceous Seed Mixture
Crooked Creek #2 Stream Restoration Project

Scientific Name	Common Name
Agrostis stolonifera	Creeping bentgrass
Andropogon ternarius	Split beardgrass
Bouteloua curtipendula	Side oats grama
Bouteloua gracilis	Blue grama
Chasmanthium latifolium	River oats
Carex vulpinoidea	Fox sedge
Panicum clandestinum	Deer tongue
Schizachyrium scoparium	Little bluestem
Sporobolus asper	Rough dropseed
Vicia villosa	Hairy vetch
Chasmanthium latifolium	River oats
Carex vulpinoidea	Fox sedge

Individual tree and shrub species will be planted throughout the project easement including stream banks, benches, tops of banks, and floodplains zones. These species will be planted as bare root, live stakes, and containerized plants and will provide additional stabilization to the outsides of constructed meander bends and side slopes. Species planted as bare roots will spaced at an initial density of 680 plants per acre (8 feet on center). Live stakes will be

planted at 4,840 stakes per acre (3 feet on center) on channel banks. Targeted densities after monitoring year 3 are 320 woody stems per acre. Proposed tree and shrub species are representative of existing on-site vegetation communities and are typical of Piedmont Bottomland Forests, shown in Table 15.

Table 15. Riparian Woody Vegetation
Crooked Creek #2 Stream Restoration Project

Scientific Name	Common Name
Stream Bank Live Stakes	
Salix nigra	Black willow*
Cornus amomum	Silky dogwood
Salix sericea	Silky willow
Juncus effusus	Soft rush
Stream Benches/ Upper Banks (Buffer) Bare Roots	
Liriodendron tulipifera	Tulip Poplar
Quercus phellos	Willow Oak
Plantus occidentalis	Sycamore
Betula nigra	River Birch
Carpinus caroliniana	Ironwood
Fraxinus pennsylvanica	Green Ash
Quercus rubra	Northern Red Oak
Buffer Understory Bare Roots	
Asimina triloba	Pawpaw
Amelanchier alnifolia	Serviceberry
Cornus florida	Flowering Dogwood
Viburnum dentatum	Arrowwood Viburnum
Hamamelis virginiana	Witch-hazel
Cercis canadensis	Redbud
Wetland FACW Bare Roots	
Alnus serrulata	Tag Alder
Cornus ammomum	Silky Dogwood
Quercus phellos	Willow Oak
Plantus occidentalis	Sycamore
Betula nigra	River Birch
Nyssa sylvatica	Blackgum
Quercus michauxii	Swamp Chestnut Oak
Fraxinus pennsylvanica	Green Ash
Wetland FAC Bare Roots	
Alnus serrulata	Tag Alder
Carpinus caroliniana	Ironwood
Quercus phellos	Willow Oak
Plantus occidentalis	Sycamore
Betula nigra	River Birch
Nyssa sylvatica	Blackgum
Liriodendron tulipifera	Tulip Poplar

Table 15. Riparian Woody Vegetation
Crooked Creek #2 Stream Restoration Project

Scientific Name	Common Name
Stream Bank Live Stakes	
Fraxinus pennsylvanica	Green Ash

**will not exceed 5% of live stakes*

7.3 Stream Project and Design Justification

The existing conditions assessment of the project reaches of Crooked Creek, UT1, and UT2 indicate that channelization of the streams and livestock operations have resulted in incision and enlargement of the channels. Livestock access is causing lateral erosion and enlargement of the stream cross sections. The incision and lateral erosion have also resulted in degraded aquatic and benthic habitat, altered hydrology (related to loss of floodplain connection and lowered water table) and reduction of quality and amount of riparian wetlands. The enlargement of the channels has also contributed to water quality problems including lower dissolved oxygen levels (due to wide channels with shallow flow). The riparian buffer along UT1 has been removed completely or is severely degraded. Based on assessments of the watershed and existing channels, designs have been developed to correct incision and lack of pattern caused by channelization, bank instability caused by erosion and livestock access, lack of vegetation in riparian zones, lack of riparian and aquatic habitat, and depletion of hydrology for adjacent wetlands.

UT1 appears to be degrading. This reach is not extremely vertically incised, but lacks channel habitat diversity and bank-stabilizing vegetation. It seems that UT1 will eventually progress to degradation and widening given the condition of the downstream reach of UT1. Installing a channel to the proper dimension, pattern, and profile and planting a native riparian buffer will restore the habitat function, stabilize the banks, and ultimately have a positive benefit on water quality.

Crooked Creek Reach A appears to be aggrading and widening. It is highly unlikely that Crooked Reach A will progress to equilibrium without excluding the cattle from the stream. Livestock have trampled the banks and created cut-off channels and seem to be the main catalyst of bank erosion. The least invasive treatment option has been selected to ensure long term stability.

7.4 Data Analysis

7.4.1 Sediment Transport Analysis

Sediment transport analysis is based on data collected by Wildlands during geomorphic and windshield surveys. A sediment transport analysis is only necessary for UT1 since it is the only proposed restoration reach. Neither aggradation nor degradation is a significant concern for Crooked Creek Reach A and B and UT2. Enhancement II efforts on those reaches are not expected to change the sediment transport characteristics. Since the sediment distribution and cross sectional area of UT1 change significantly downstream of the confluence with the

overflow channel, only the upstream sediment samples and cross section were used in the analysis (XS6).

7.4.1.1 Assessment

A windshield survey of the contributing watershed to UT1 confirmed that it is relatively stable with no significant source of sediment. Most of the watershed is established agricultural field crops, with the remainder being woods and farming operations. A review of historical aerial photographs shows that the land use in the watershed has been agricultural since 1948, with the addition of chicken houses in the upper portion sometime prior to 1993. The upstream channel seems to be somewhat stable with no signs of bank erosion. Although it lacks a mature riparian buffer, the bank slopes are well vegetated and have relatively flat side slopes. There are no plans of future development within the watershed according to local planning documents.

The supply limited watershed coincides with the sediment regime observed in the on-site UT1 reach. The on-site reach contains no mid-channel bars or other sediment depositional areas that would indicate a capacity problem. UT1 becomes more incised downstream and seems to be actively degrading before the confluence with the overflow channel. There is no indication that the deterioration of this channel has been driven by recent watershed disturbances. Sediment samples collected from UT1 have a D_{50} of 3.1mm and are somewhat homogeneous within the very fine gravel to fine gravel range (Appendix B). UT1 exhibits no problem transporting the limited sediment supplied by its watershed or its bed material. Based on the low sediment load of the watershed and the very fine to fine gravel substrate in the existing channel a threshold channel design approach and competency analysis is valid for UT1; capacity is not a concern. This design approach is based on the concept that the morphology of the channels is not sensitive to sediment supply and channel migration and changes in slopes are not expected or desired.

7.4.1.2 Modeling and Design

Threshold channel design uses standard equations to calculate the critical dimensionless shear stress needed to move the bed material and the depth and slope combination needed to produce that stress. The equations are:

(1) $\tau_{ci} = 0.0834(d_{50}/ds_{50})^{-0.872}$
(2) $\tau_{ci} = ds/(\gamma s * Di)$
(3) $d = (\tau_{ci} * \gamma s * Di)/S$

where τ_{ci} is critical dimensionless shear stress, d_{50} is median diameter of pavement material, ds_{50} is median diameter of subpavement material, γs is specific weight of sediment, Di is the largest diameter of subpavement material, d is mean bankfull depth of channel, and S is the water surface slope at bankfull stage. The very fine to fine gravel particle sizes collected on UT1 do not fall within the appropriate range for the empirical equations to be applicable.

The bankfull shear stress for UT1 was calculated using the sediment competence equation,

$$\tau = \gamma RS$$

where τ is the bankfull shear stress, γ is the specific weight of water, R is the hydraulic radius, and S is the average water surface slope. The bankfull shear stress for the proposed channel will be approximately 0.13 lbs/ft^2. Using the modified Shield's relationship of critical shear stress to the largest movable particle indicates that the calculated bankfull shear stress will move a 20 to 40 mm particle. The largest subpavement particle size collected was 16 mm, which indicates that the design channel will have the shear stress necessary to move the sediment particles found in the channel. The channel may have a small amount of excess shear stress. In-stream structures and constructed riffles will be used to protect against degradation.

A HEC-RAS model was developed to verify the bankfull shear stresses for the proposed conditions. Proposed riffle and pool typical sections were used to produce a more accurate representation of the shear stresses within the channel. Table 16 summarizes the riffle and pool shear stresses calculated in HEC-RAS. As expected, riffle shear stresses are greater than pool shear stresses. In most cases, the calculated shear stress is at or greater than the shear stress required to move the largest particle according the modified Shield's relationship. The overall channel shear stress median value of 0.12 lbs/ft^2 reinforces the bankfull shear stress as predicted by the sediment competence equation (0.13 lbs/ft^2).

Table 16. Summary of Shear Stress in Design
Crooked Creek #2 Restoration Project

Shear Stress Statistic	Calculated Channel Shear Stress (lbs/ft^2)		
	Channel	Riffle	Pool
Minimum	0.03	0.05	0.03
25 Percentile	0.05	0.10	0.03
50 Percentile	0.12	0.14	0.035
75 Percentile	0.18	0.18	0.04
Maximum	0.93	0.93	0.04

The existing and proposed channels were analyzed using the hydraulic design module within HEC-RAS to further validate the design slope and typical section with respect to sediment transport. The existing channel cross section, slope, and sediment distribution collected during the geomorphic survey was computed with the stable channel design option (Copeland method). For the proposed channel, the typical riffle section and proposed slope were computed with the same sediment distribution used for the existing channel. The resulting stability curves compare base width of the channel to the average channel slope (Appendix B). Plotting the existing base width and slope data point and the proposed base width and slope data point indicate that the proposed design channel will be more stable than the existing channel.

Based on competency analysis results (Table 17), the proposed UT1 channel typical sections and slope will adequately transport the sediment found in the channel. Even though the calculated shear stresses are greater than the modified Shield's critical shear stress, the values are still within a normal range. The design specifies constructed riffles, grade control sills, J-hook vanes and other grade control structures to prevent bed scour and incision. Constructed riffle material will consist of 4 to 8 inch native substrate from Crooked Creek mixed with 3 to 6 inch quarry stone. The results of the sediment transport analysis discussed above indicate that this material size will be large enough to provide grade control and withstand excess shear stress. Using material larger than that which the critical shear stress can transport coincides with the threshold channel design approach. The threshold channel is designed for minimal or nonexistent boundary migration. To accomplish this, the allowable shear stress calculated from X should be greater than the design shear stress. Native material will be harvested from a side channel along Crooked Creek during the enhancement II operations. The side channel will be filled in but contains excellent native material. These features, along with vegetated 3:1 side slopes and reconnection with the floodplain, will help to prevent incision at bankfull and larger storm events while still allowing the proper transport of sediment.

Table 17. Summary of Shear Stress Calculations
Crooked Creek #2 Restoration Project

Method	Value
Sediment Competency Equation Bankfull Shear Stress (lbs/ft^2)	0.13
HEC-RAS Model Median Channel Shear Stress (lbs/ft^2)	0.12
Modified Shield's Diagram Critical shear stress (lbs/ft^2)	0.06

8.0 Maintenance Plan

EEP shall monitor the site on a regular basis and shall conduct a physical inspection of the site a minimum of once per year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance should be expected most often in the first two years following site construction and may include the components listed in Table 18.

Table 18. Maintenance Plan Components
Crooked Creek #2 Restoration Project

Component / Feature	Maintenance Through Project Close-Out
Stream	Stream – Routine channel maintenance and repair activities may

Table 18. Maintenance Plan Components
Crooked Creek #2 Restoration Project

Component / Feature	Maintenance Through Project Close-Out
	include securing of loose coir matting, and supplemental installations of live stakes and other target vegetation along the channel.
Wetland	Routine wetland maintenance and repair activities may include securing of loose coir matting and supplemental installation of live stakes and other target vegetation within the wetland. Areas where stormwater and floodplain flows intercept the wetland may also require maintenance to prevent scour.
Vegetation	Vegetation shall be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, mulching, and fertilizing. Exotic invasive plant species shall be controlled by mechanical and/or chemical methods. Any vegetation control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.
Site Boundary	Site boundaries shall be identified in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, tree-blazing, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.

9.0 Monitoring Requirements

Using the EEP Baseline Monitoring Plan Template (version 2.0. 10/14/2010), a baseline monitoring plan report and an as-built record drawing of the project documenting the stream and wetland restoration and enhancement, will be developed within 60 days of the planting completion and monitoring installation on the project site. If planting is delayed and does not occur within 60 days following grading activities, a record drawing will be submitted and the following schedule would be applied for the stream, vegetation, and wetland assessments.

- Stream and wetland assessments would be conducted within the required timeframe (60 days) following construction grading.
- Vegetation assessment would be conducted within 21 days following the completion of planting.
- A baseline monitoring report for the Crooked Creek #2 Restoration Project would be submitted within 30 days of the planting completion.

Monitoring reports will be prepared in the fall of each year of monitoring and submitted to EEP. These reports will be based on the EEP Monitoring Report Template (version 1.4, 11/7/11). The monitoring period will extend seven years for stream and wetland hydrology assessments and seven years for wetland vegetation assessments beyond completion of construction or until performance criteria have been met. The monitoring report shall provide a project data chronology that will facilitate an understanding of project status and trends, population of EEP

databases for analysis, research purposes, and assist in decision making regarding close-out. Project monitoring requirements are listed in more detail below and in Table 19.

Table 19. Monitoring Requirements
Crooked Creek #2 Restoration Project

Parameter	Monitoring Feature	Quantity/Length by Reach					Frequency	Notes
		Crooked Creek Reach A	Crooked Creek Reach B	UT1	UT2	Wetlands		
Dimension	Riffle Cross-sections	N/A	N/A	2	N/A	N/A	Annual	1
	Pool Cross-sections	N/A	N/A	2	N/A	N/A		
Profile	Profile	N/A	N/A	N/A	N/A	N/A	Annual	2
Pattern	Pattern	N/A	N/A	N/A	N/A	N/A	Annual	
Substrate	Reach wide, Riffle 100 pebble count	N/A	N/A	3	N/A	N/A	Annual	
Surface Water Hydrology	Crest Gauge	1		1	1	N/A	Annual	3
Groundwater Hydrology	Groundwater Gauges	N/A	N/A	N/A	N/A	TBD	Annual	4
Vegetation (CVS Level 2)	Vegetation Plots	5	7	6	2	12	Annual	5
Exotic and Nuisance Vegetation							Annual	6
Project Boundary							Semi-annual	7
Photo Documentation		8	12	9	2	3	Annual	8

1. Cross-sections will be permanently marked with rebar to establish location. Surveys will include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg.
2. Pattern and profile will be assessed visually during bi-annual site visits.
3. Device will be inspected quarterly or semi-annually, evidence of bankfull will be documented with a photo.
4. Groundwater gauges will be monitored on a monthly basis during the growing season.
5. Vegetation monitoring will follow CVS protocols.
6. Locations of exotic and nuisance vegetation will be mapped.
7. Locations of fence damage, vegetation damage, boundary encroachments, etc. will be mapped.
8. Permanent markers will be established so that the same locations and view directions on the site are monitored.

9.1 Streams

9.2.1 Dimension

In order to monitor the channel dimension, a total of four permanent cross-sections will be installed along UT1. Cross-sections will be located at representative riffle and pool sections on each monitored reach. Each cross-section will be permanently marked with pins to

establish its location. For channels with bankfull of greater than 3 feet, bank pins will also be installed on the outside bend of each surveyed pool cross-section in at least three locations (one in the upper third of the pool, one at the permanent cross-section, and one in the lower third of the pool). Bank pins will be monitored by measuring exposed rebar and maintaining pins flush to the bank to capture bank erosion. Cross-section and bank pin surveys will be conducted in monitoring years one, two, three, five, and seven and compared with data from previous years.

9.1.2 Pattern and Profile

Longitudinal profile surveys will not be conducted during the seven year monitoring period unless other indicators during the annual monitoring indicate a trend toward vertical and lateral instability. If a longitudinal profile is deemed necessary, monitoring will follow standards as described in the EEP Monitoring Requirements and Performance Standards for Stream and /or Wetland Mitigation (11/7/2011) and the 2003 USACE and NCDWQ Stream Mitigation Guidance for the necessary reaches.

9.1.3 Photo Documentation

Approximately 34 permanent photographs will be established within the project stream and wetland areas after construction. Photographs will be taken once a year to visually document stability for seven years following construction. Permanent markers will be established so that the same locations and view directions on the site are monitored each year. Photographs will be used to monitor restoration and enhancement of stream and wetland areas as well as vegetation plots. The photographer will make every effort to maintain the same area in each photo over time. Reference photos will also be taken for each of the vegetation plots and cross-sections. The representative digital photo(s) will be taken on the same day surveys are conducted.

9.1.4 Substrate

A reach-wide pebble count will be conducted for classification purposes on the restoration reach (UT1). Pebble counts will also be conducted at permanent riffle cross-sections. The pebble counts will be conducted annually for seven years following construction and compared with data from previous years

9.1.5 Bankfull Events

Bankfull events will be documented using a crest gauge, photographs, and visual assessments such as debris lines. Three crest gauges will be installed; one on Crooked Creek, one on UT1, and the other gage on UT2. The crest gauges will be installed onsite in a riffle cross-section of the channels at a central site location. The gauges will be checked at each site visit to determine if a bankfull event has occurred during the seven year monitoring period. Photographs will be used to document the occurrence of debris lines and sediment deposition.

9.1 Visual Assessments

Visual assessments will be performed along all stream and wetland areas on a bi-annual basis during the seven year monitoring period. Problem areas will be noted such as channel instability

(i.e. lateral and/or vertical instability, in-stream structure failure/instability and/or piping, headcuts), vegetated buffer health (i.e. low stem density, vegetation mortality, invasive species or encroachment), beaver activity, livestock access, etc. Areas of concern will be mapped and photographed accompanied by a written description in the annual report. Problem areas with be re-evaluated during each subsequent visual assessment. Should remedial actions be required, recommendations will be provided in the annual monitoring report.

9.2 Vegetation

A total of 32 vegetation monitoring plots will be installed and evaluated within the restoration and enhancement areas to measure the survival of the planted trees. The number of monitoring quadrants required is based on the EEP monitoring guidance documents (version 1.4, 11/7/11) and the EEP Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation (11/7/11). The size of individual quadrants will be 100 square meters for woody tree species and shrubs. Vegetation assessments will be conducted following the Carolina Vegetation Survey (CVS) Level 2 Protocol for Recording Vegetation (2006).

The initial baseline survey will be conducted within 21 days from completion of site planting and used for subsequent monitoring year comparisons. The first annual vegetation monitoring activities will commence at the end of the first growing season, during the month of September. The restoration and enhancement sites will then be evaluated each subsequent year between June 1st and September 31st. Species composition, density, and survival rates will be evaluated on an annual basis by plot and for the entire site. Individual plot data will be provided and will include diameter, height, density, vigor, damage (if any), and survival. Planted woody stems will be marked annually as needed and given a coordinate, based off of a known origin, so they can be found in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living planted stems and the current year's living planted stems.

9.3 Wetlands

Groundwater monitoring gauges will be established throughout the wetland restoration and enhancement areas. Generally, the gauges will be installed at appropriate locations so that the data collected will provide an indication of groundwater levels throughout the wetland project area.

9.4 Schedule

The monitoring program described above will be performed on an annual basis. The estimated reporting schedule is shown below in Table 20.

Table 20. Project Activity and Reporting Schedule
Crooked Creek #2 Restoration Project

Activity or Report	Completion or Delivery
Mitigation Plan	February 2013
Final Design-Construction Plans	November 2013
Permanent Seed Mix Applied	March 2014
Bare Root Plantings	March 2014
Baseline Monitoring Report and Record Drawing*	March 2014

Activity or Report	Completion or Delivery
Year 1 Monitoring	December 2014
Year 2 Monitoring	December 2015
Year 3 Monitoring	December 2016
Year 4 Monitoring	December 2017
Year 5 Monitoring	December 2018
Year 6 Monitoring	December 2019
Year 7 Monitoring	December 2020

*Schedule subject to change if planting does not occur immediately following construction grading.

10.0 Performance Standards

The stream restoration success criteria for the project site will follow approved performance criteria presented in the EEP Mitigation Plan Template (version 2.1, 09/01/2011), the EEP Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation (11/7/2011), and the Stream Mitigation Guidelines issued in April 2003 by the USACE and NCDWQ. Annual monitoring and bi-annual site visits will be conducted to assess the condition of the finished project for seven years, or until success criteria are met. The stream restoration reach (UT1) of the project will be assigned specific performance criteria components for stream morphology, hydrology, and vegetation. The enhancement level II reaches (Crooked Creek Reach A and UT2) will be documented through photographs and visual assessments to verify that no significant degradational changes are occurring in the stream channel or riparian corridor. The wetland restoration and enhancement sections will be assigned specific performance criteria for hydrology and vegetation. These success criteria are covered in detail as follows.

10.1 Streams

10.1.1 Dimension

Riffle cross-sections on the restoration reaches should be stable and should show little change in bankfull area, maximum depth ratio, and width-to-depth ratio. Per EEP guidance, bank height ratios shall not exceed 1.2 and entrenchment ratios shall be at least 2.2 for restored channels to be considered stable. All riffle cross-sections should fall within the parameters defined for channels of the appropriate Rosgen stream type. If any changes do occur, these changes will be evaluated to assess whether the stream channel is showing signs of instability. Indicators of instability include a vertically incising thalweg or eroding channel banks. Changes in the channel that indicate a movement toward stability or enhanced habitat include a decrease in the width-to-depth ratio in meandering channels or an increase in pool depth. Remedial action would not be taken if channel changes indicate a movement toward stability.

10.1.2 Pattern and Profile

Visual indicators for the stream restoration reaches should show that the bedform features are remaining stable. The riffles should be steeper and shallower than the pools, while the pools should be deep with flat water surface slopes. The relative percentage of riffles and pools should not change significantly from the design parameters. Adjustments in length and slope of run and glide features are expected and will not be considered a sign of instability.

10.1.3 Photo Documentation

Photographs should illustrate the site's vegetation and morphological stability on an annual basis. Cross-section photos should demonstrate no excessive erosion or degradation of the banks. Longitudinal photos should indicate the absence of persistent bars within the channel or vertical incision. Grade control structures should remain stable. Deposition of sediment on the bank side of vane arms is preferable. Maintenance of scour pools on the channel side of vane arms is expected. Reference photos will also be taken for each of the vegetation plots.

10.1.4 Substrate

Substrate materials in the restoration reaches should indicate a progression towards or the maintenance of coarser materials in the riffle features and smaller particles in the pool features.

10.1.5 Bankfull Events

Two bankfull flow events in separate years must be documented on the project within the seven-year monitoring period. Bankfull events will be documented using a crest gauge, photographs, and visual assessments such as debris lines.

10.2 Vegetation

The final vegetative success criteria will be the survival of 210 planted stems per acre in the riparian corridor along restored and enhanced reaches at the end of the required monitoring period (year seven). The interim measure of vegetative success for the site will be the survival of at least 320 planted stems per acre at the end of the third monitoring year and at least 260 stems per acre at the end of the fifth year of monitoring. Planted vegetation must average 10 feet in height in each plot at the end of the seventh year of monitoring. If this performance standard is met by year five and stem density is trending towards success (i.e., no less than 260 five year old stems/acre), monitoring of vegetation on the site may be terminated provided written approval is provided by the USACE in consultation with the NC Interagency Review Team. The extent of invasive species coverage will also be monitored and controlled as necessary throughout the required monitoring period (year five or seven).

10.3 Wetlands

The target performance criteria for wetland hydrology will be a free groundwater surface within 12 inches of the ground surface for 7.5 percent of the growing season, which is measured on consecutive days under typical precipitation conditions. This success criterion was determined through model simulations of post restoration conditions and comparison to an immediately adjacent existing wetland system. If a particular groundwater monitoring gauge does not meet the success criteria for a given monitoring year, rainfall patterns will be analyzed and the hydrograph will be compared to that of the reference well to assess whether atypical weather conditions occurred during the monitoring period.

11.0 Long-Term Management Plan

Upon approval for close-out by the Interagency Review Team (IRT) the site will be transferred to the NCDENR Division of Natural Resource Planning and Conservation and Stewardship

Program. This party shall be responsible for periodic inspection of the site to ensure that restrictions required in the conservation easement or the deed restriction document(s) are upheld. Endowment funds required to uphold easement and deed restrictions shall be negotiated prior to site transfer to the responsible party.

The NCDENR Division of Natural Resource Planning and Conservation's Stewardship Program currently houses EEP stewardship endowments within the non-reverting, interest-bearing Conservation Lands Stewardship Endowment Account. The use of funds from the Endowment Account is governed by North Carolina General Statue GS 113A-232(d)(3). Interest gained by the endowment fund may be used only for the purpose of stewardship, monitoring, stewardship administration, and land transaction costs, if applicable. The NCDENR Stewardship Program intends to manage the account as a non-wasting endowment. Only interest generated from the endowment funds will be used to steward the compensatory mitigation sites. Interest funds not used for those purposes will be re-invested in the Endowment Account to offset losses due to inflation.

12.0 Adaptive Management Plan

Upon completion of site construction EEP will implement the post-construction monitoring protocols previously defined in this document. Project maintenance will be performed as described previously in this document. If, during the course of annual monitoring it is determined the site's ability to achieve site performance standards are jeopardized, EEP will notify the USACE of the need to develop a Plan of Corrective Action. The Plan of Corrective Action may be prepared using in-house technical staff or may require engineering and consulting services. Once the Corrective Action Plan is prepared and finalized EEP will:

1. Notify the USACE as required by the Nationwide 27 permit general conditions.
2. Revise performance standards, maintenance requirements, and monitoring requirements as necessary and/or required by the USACE.
3. Obtain other permits as necessary.
4. Implement the Corrective Action Plan.
5. Provide the USACE a Record Drawing of Corrective Actions. This document shall depict the extent and nature of the work performed.

13.0 Financial Assurances

Pursuant to Section IV H and Appendix III of the Ecosystem Enhancement Program's In-Lieu Fee Instrument dated July 28, 2010, the North Carolina Department of Environment and Natural Resources has provided the US Army Corps of Engineers Wilmington District with a formal commitment to fund projects to satisfy mitigation requirements assumed by EEP. This commitment provides financial assurance for all mitigation projects implemented by the program.

14.0 References

North Carolina Geological Survey (NCGS), 2009. Mineral Resources. http://www.geology.enr.state.nc.us/Mineral%20resources/mineralresources.html

North Carolina Natural Heritage Program (NHP), 2009. Natural Heritage Element Occurrence Database, Chatham County, NC. http://149.168.1.196/nhp/county.html

Rosgen, D. L. 1994. A classification of natural rivers. *Catena* 22:169-199.

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

Rosgen, D.L. 1997. A Geomorphological Approach to Restoration of Incised Rivers. Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision. Center For Computational Hydroscience and Bioengineering, Oxford Campus, University of Mississippi, Pages 12-22.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina, 3rd approx. North Carolina Natural Heritage Program, Raleigh, North Carolina.

Simon, A. 1989. A model of channel response in disturbed alluvial channels. *Earth Surface Processes and Landforms* 14(1):11-26.

United States Department of Agriculture (USDA), 2009. Natural Resources Conservation Service, Soil Survey Geographic (SSURGO) database for Chatham County, North Carolina. http://SoilDataMart.nrcs.usda.gov

United States Fish and Wildlife Service (USFWS), 2008. Endangered Species, Threatened Species, Federal Species of Concern and Candidate Species, Chatham County, NC. http://www.fws.gov/nc-es/es/countyfr.html

United States Geological Survey (USGS), 1998. North Carolina Geology. http:// http://www.geology.enr.state.nc.us/usgs/carolina.htm

Dalrymple, Tate, 1960. Flood-Frequency Analysis. U.S. Geological Survey Water-Supply Paper 1543-A. U.S. Government Printing Office, Washington, D.C., 80 p.

Interagency Advisory Committee on Water Data, 1981. Guidelines for Determining Flood Flow Frequency. Bulletin 17B. Washington, D.C.

Shields, D. F., Copeland, R. R, Klingman, P. C., Doyle, M. W., and Simon, A. 2003. Design for Stream Restoration. Journal of Hydraulic Engineering 129(8): 575-582.

Simon, A., Rinaldi, M. 2006. Disturbance, stream incision, and channel evolution: The roles of excess transport capacity and boundary materials in controlling channel response. Geomorphology 79: 361-383.

North Carolina State University (NCSU), 2010. DrainMod Related Publications. Accessed May 10, 2010, at:http://www.bae.ncsu.edu/soil_water/drainmod/drainmod_papers.html#wetland

Harman, W.H., et al. 1999. Bankfull Hydraulic Geometry Relationships for North Carolina

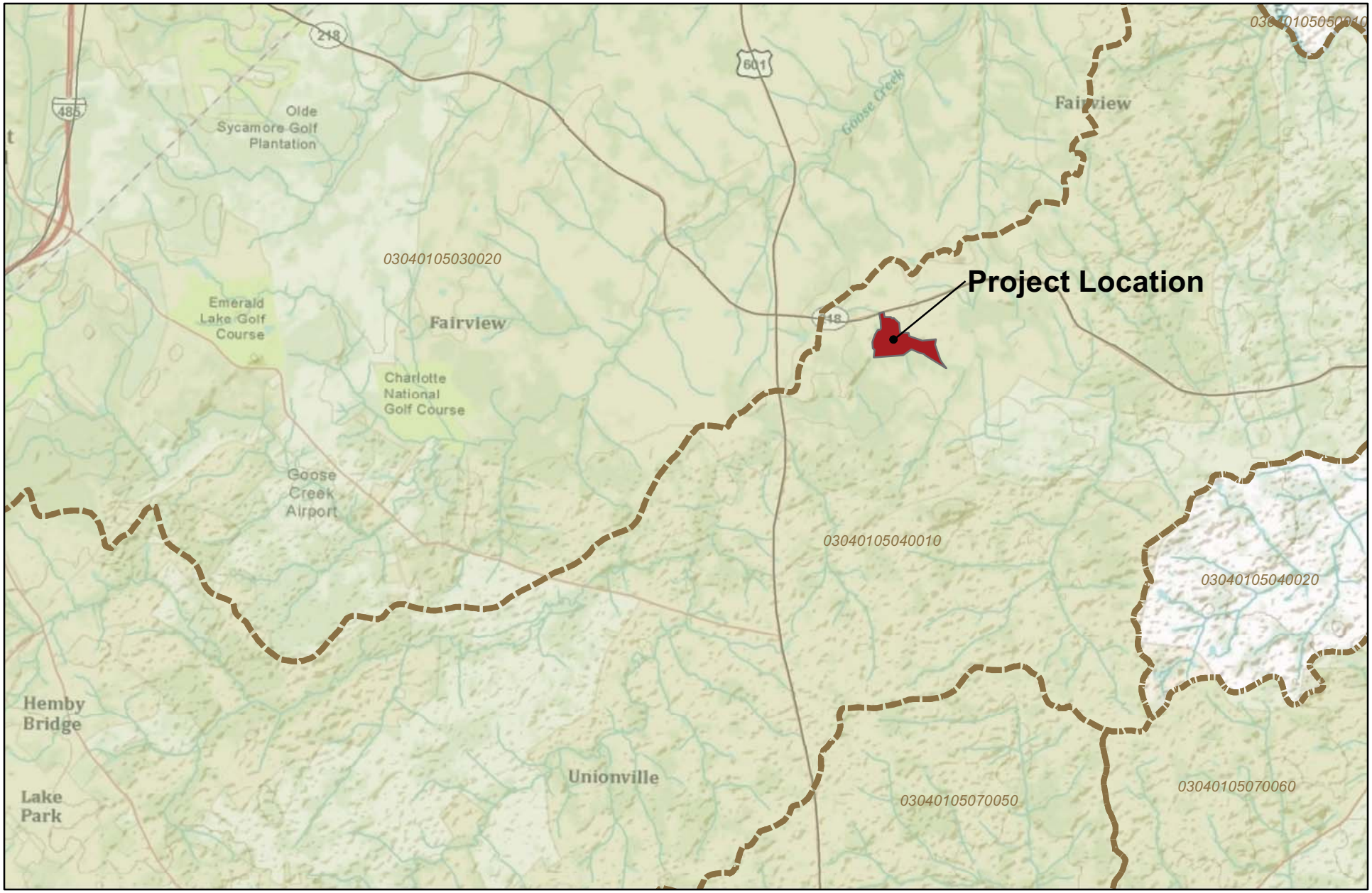
Streams. AWRA Wildland Hydrology Symposium Proceedings. Edited By: D.S. Olsen and J.P. Potyondy. AWRA Summer Symposium. Bozeman, MT.

Cowardin, L. M., V. Carter, F. C. Golet, E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U. S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/1998/classwet/classwet.htm (Version 04DEC98)

Weaver, J.C., Feaster, T.D., and Gotvald, A.J., 2009, Magnitude and frequency of rural floods in the Southeastern United States, through 2006—Volume 2, North Carolina: U.S. Geological Survey Scientific Investigations Report 2009–5158, 111 p.

Goose Creek Watershed Plan (GCWP), 2002, Goose Creek Watershed Advisory Committee. http://www.ces.ncsu.edu/depts/agecon/WECO/publication/FINALGooseCreekPlanSept2002.pdf

Site Specific Water Quality Management Plan for the Goose Creek Watershed (SSWQM), 2009, North Carolina Department of Environment & Natural Resources, http://portal.ncdenr.org/c/document_library/get_file?folderId=285750&name=DLFE-8516.pdf



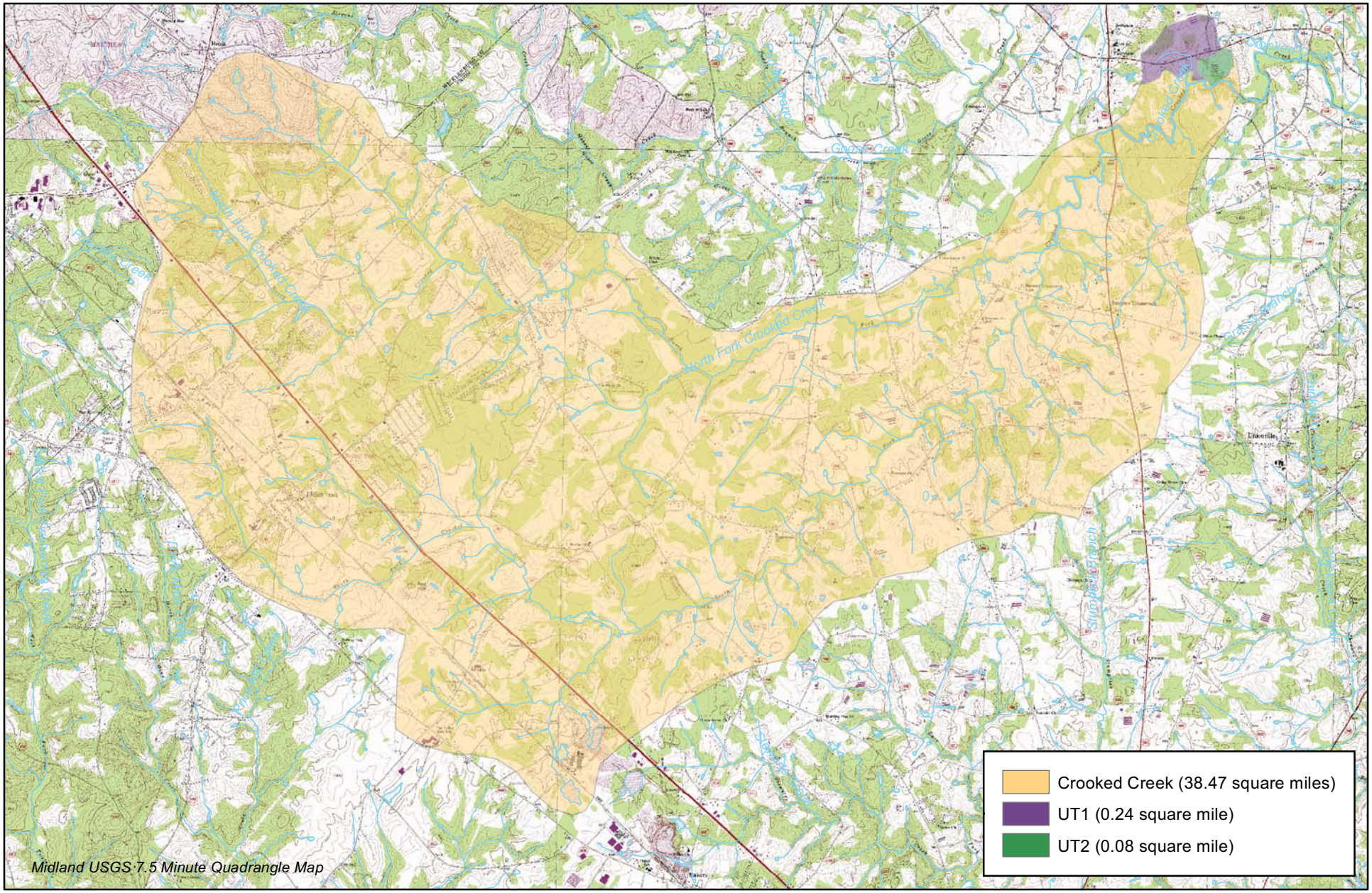
WILDLANDS ENGINEERING

Ecosystem Enhancement Program

0 0.5 1 2 Miles

N

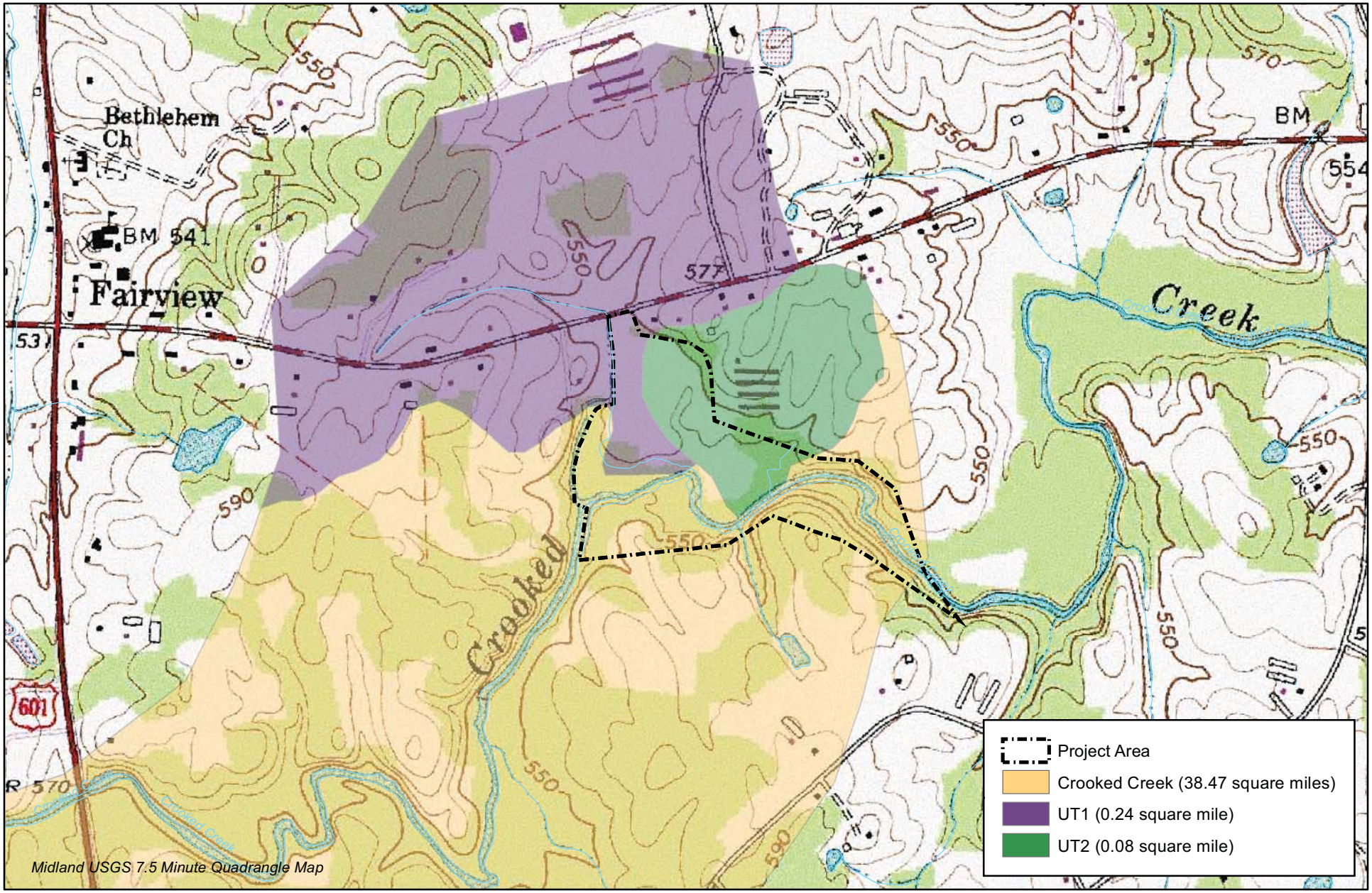
Figure 1. Vicinity Map
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105
Union County, NC



WILDLANDS ENGINEERING

Ecosystem Enhancement PROGRAM

Figure 2a. Watershed Map
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105
Union County, NC



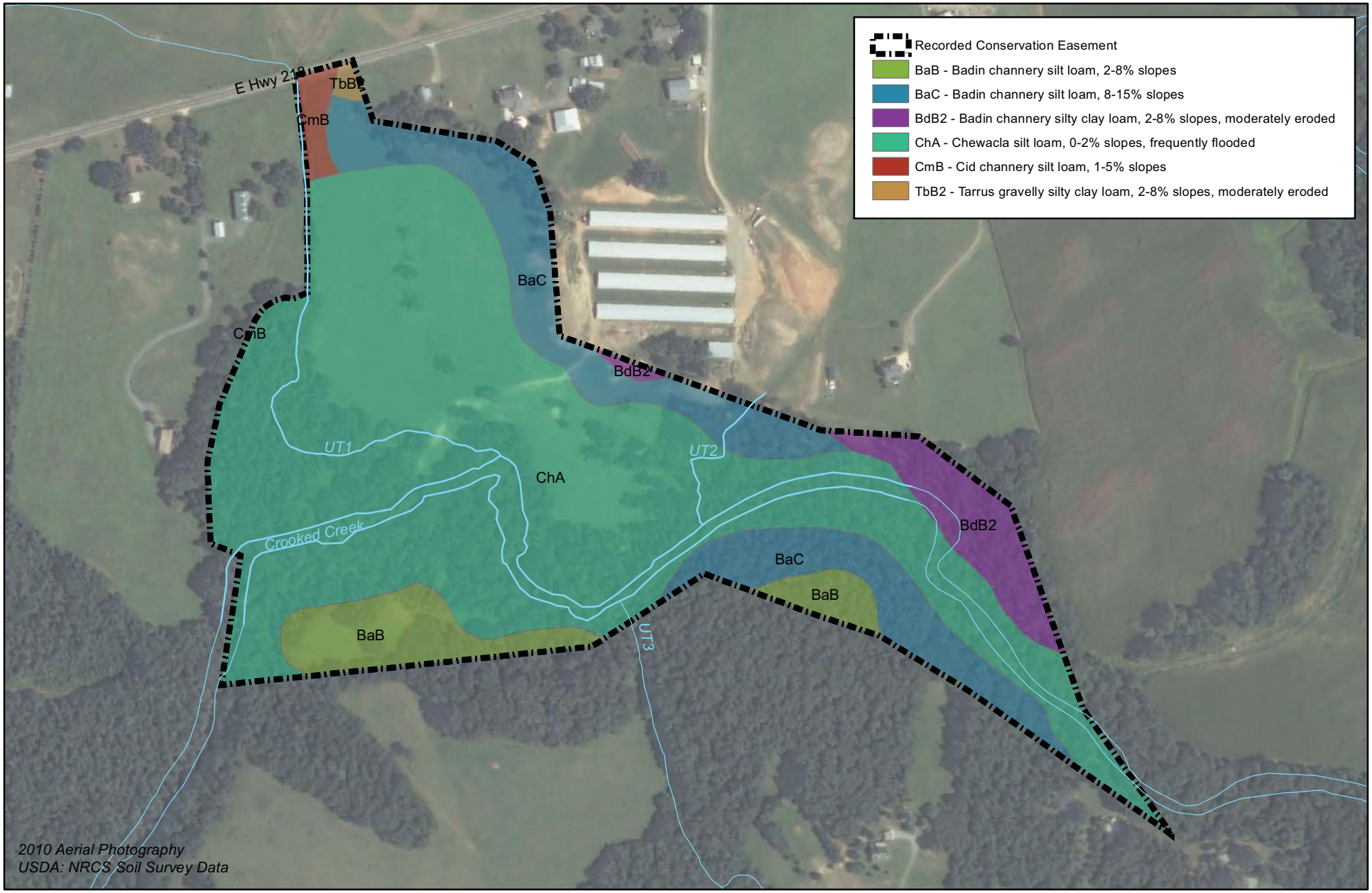
WILDLANDS ENGINEERING

Ecosystem Enhancement Program

0 500 1,000 2,000 Feet

N

Figure 2b. Watershed Map
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105
Union County, NC



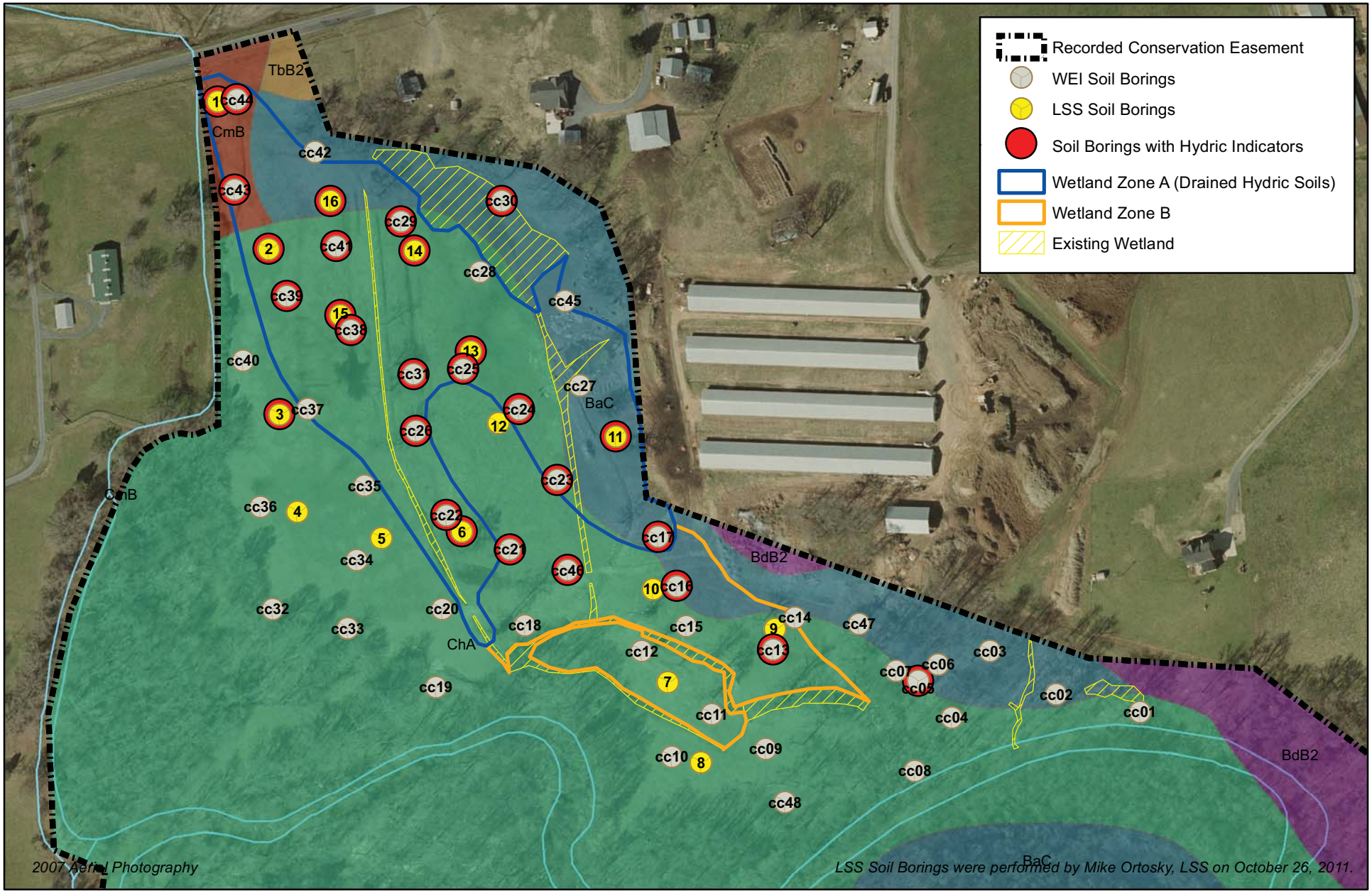
WILDLANDS ENGINEERING

Ecosystem Enhancement Program

0 200 400 800 Feet

N

Figure 3. Soils Map
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105
Union County, NC



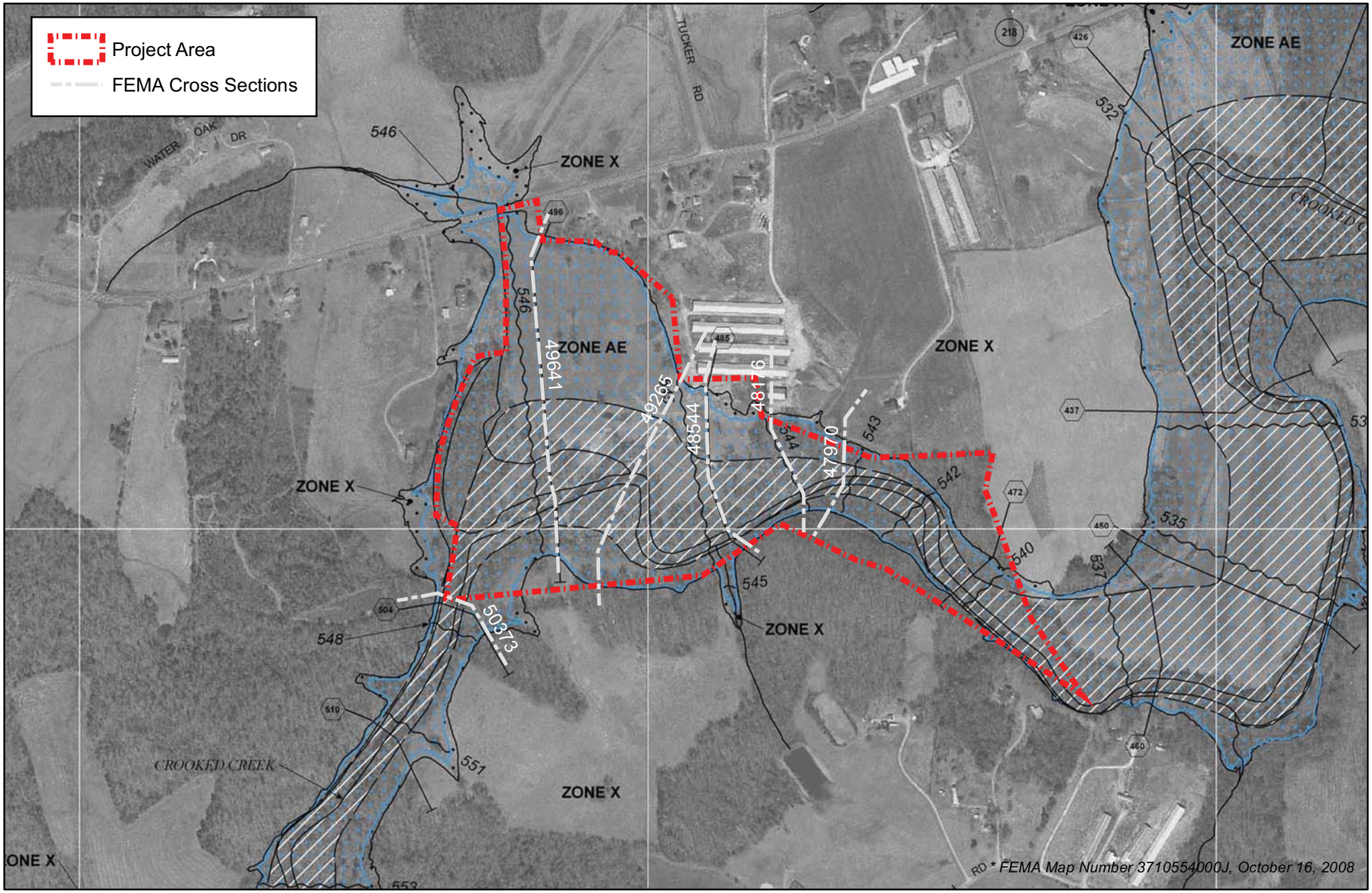
WILDLANDS ENGINEERING

Ecosystem Enhancement Program

0 100 200 400 Feet

N

Figure 4. Wetland Soil Boring Locations
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105
Union County, NC



WILDLANDS ENGINEERING

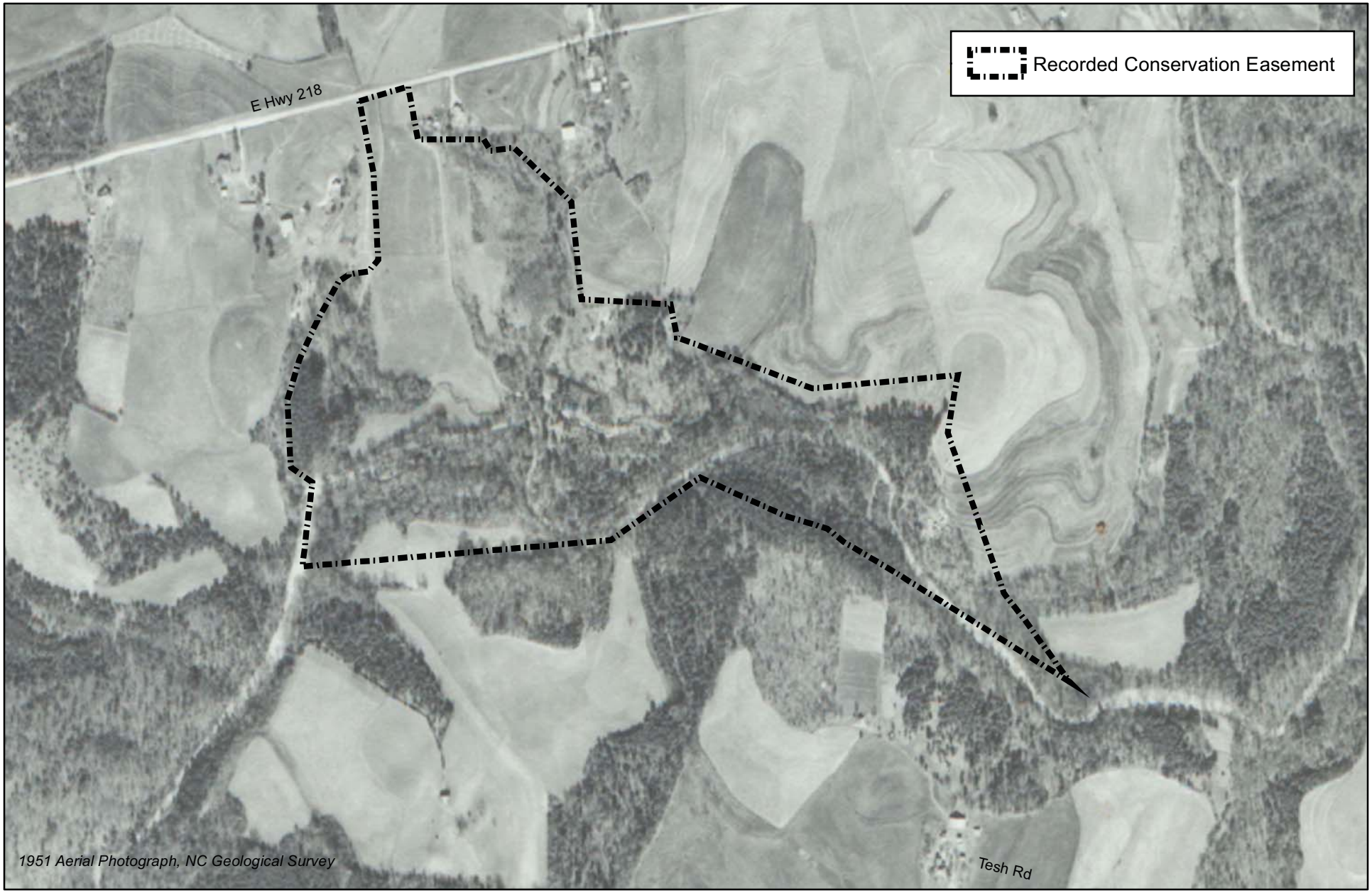
Ecosystem Enhancement Program

0 300 600 1,200 Feet

N

Figure 5. FEMA Floodplain Map
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105

Union County, NC



WILDLANDS ENGINEERING

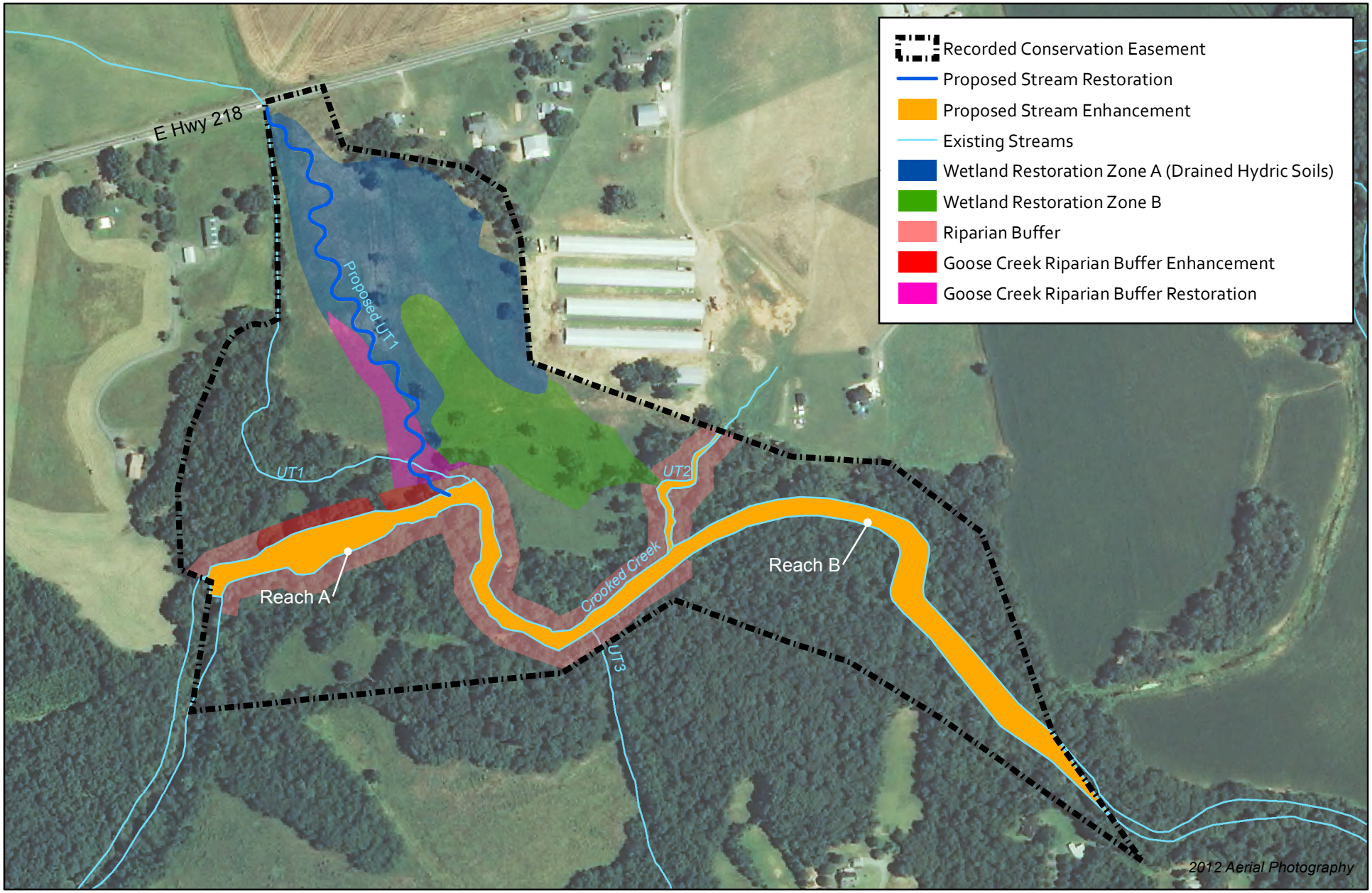
Ecosystem Enhancement Program

0 250 500 1,000 Feet

N

Figure 6. Historical Aerial Photograph
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105

Union County, NC



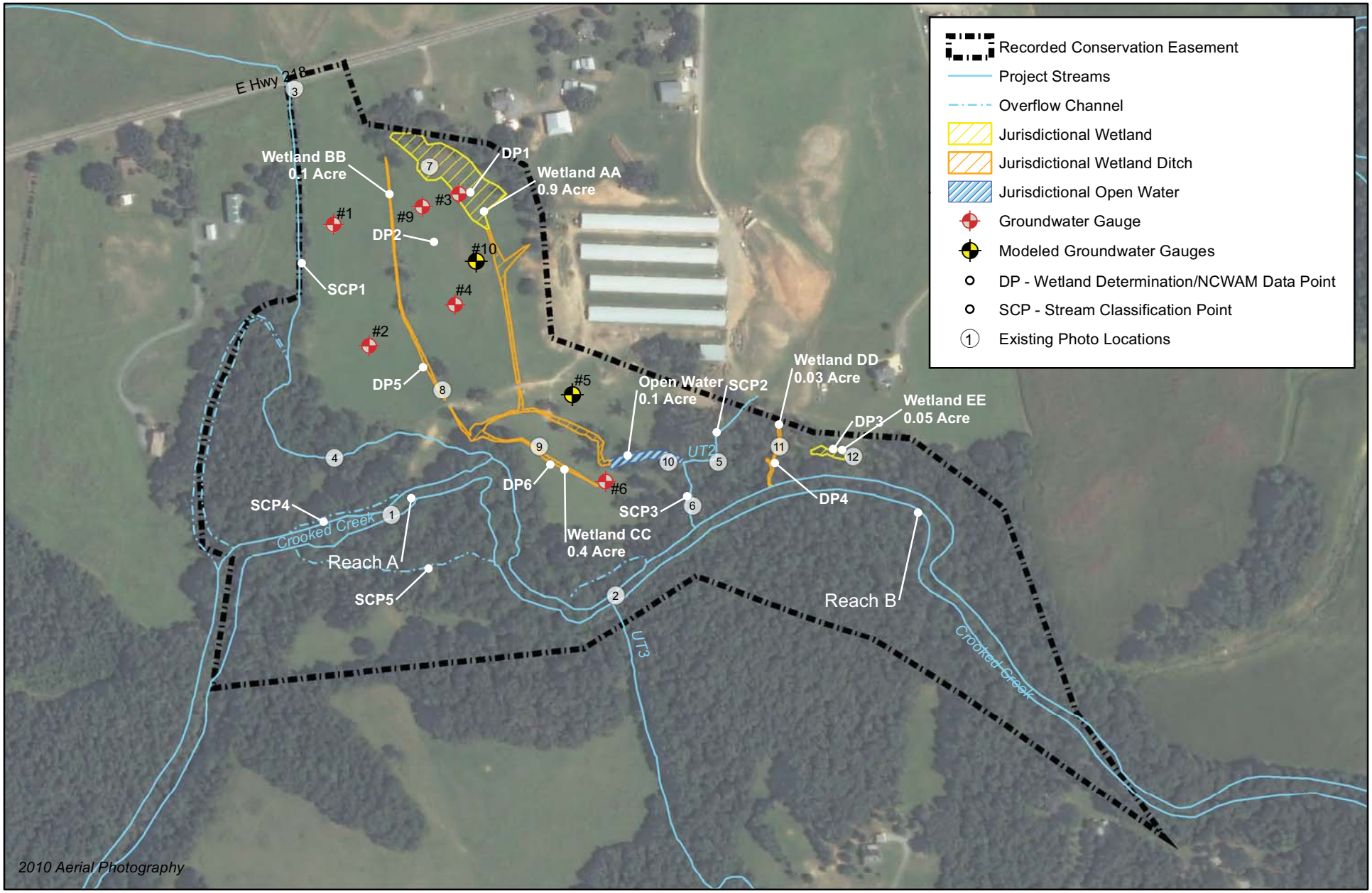
WILDLANDS ENGINEERING

Ecosystem Enhancement Program

0 200 400 800 Feet

N

Figure 7. Site Protection Instrument
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105
Union County, NC



WILDLANDS ENGINEERING

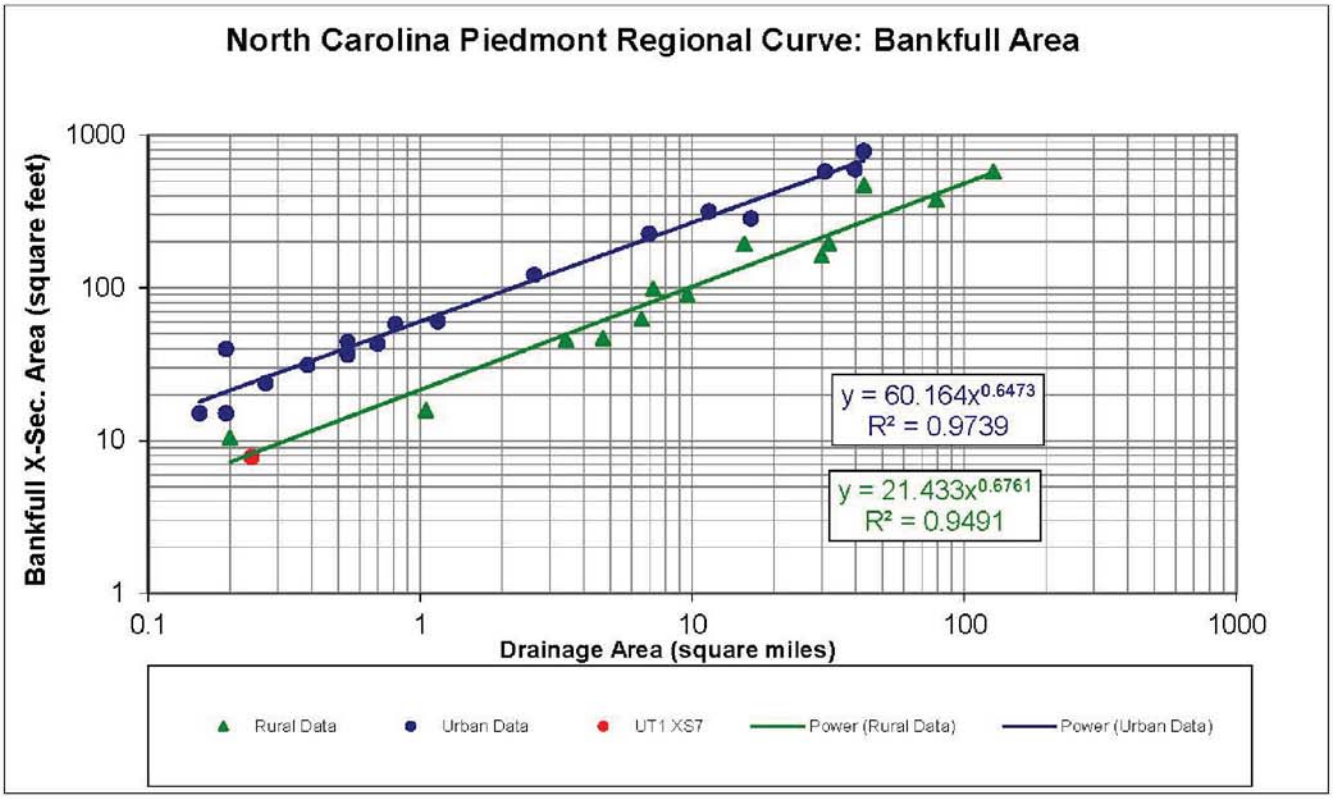
Ecosystem Enhancement Program

0 200 400 800 Feet

N

Figure 8. Hydrological Features and Data Sampling Locations
Crooked Creek #2 Restoration Project
MitigationPlan
Yadkin River Basin 03040105

Union County, NC



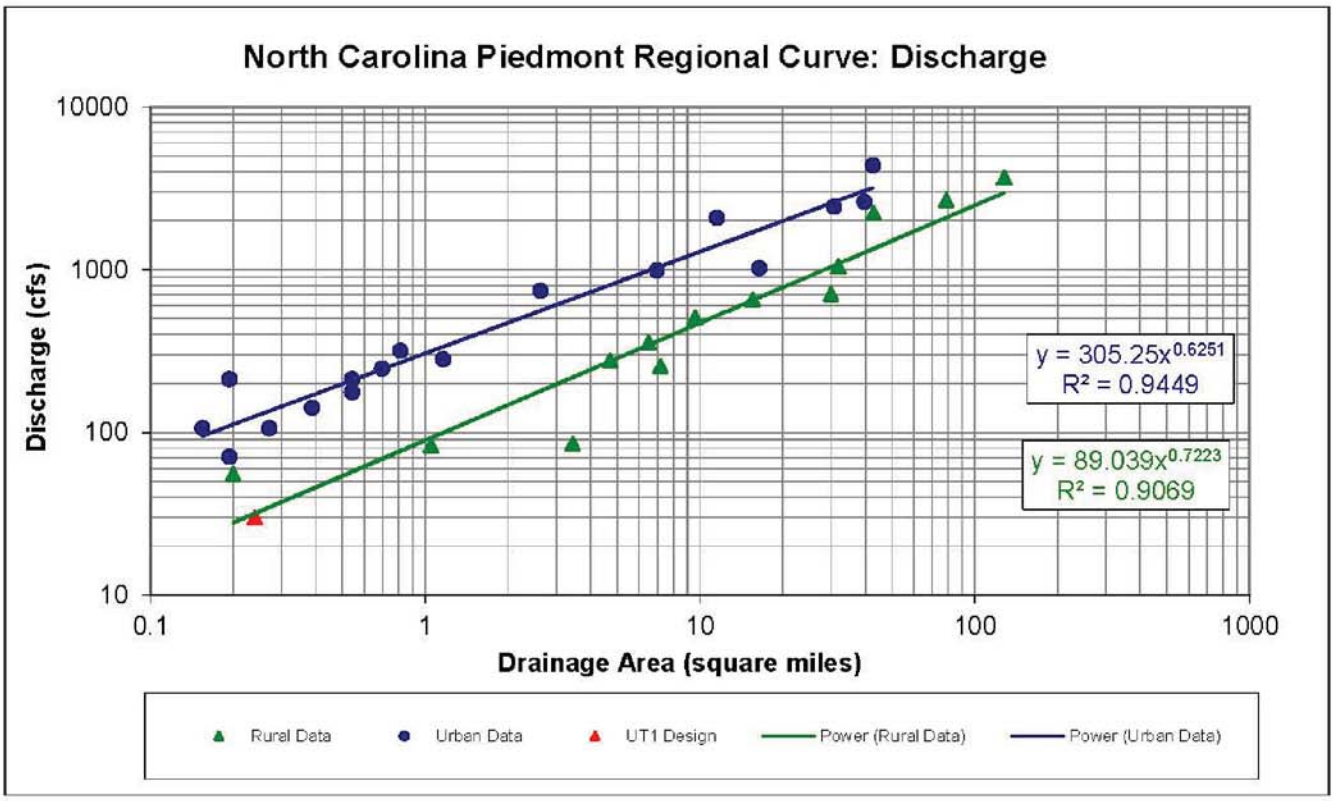
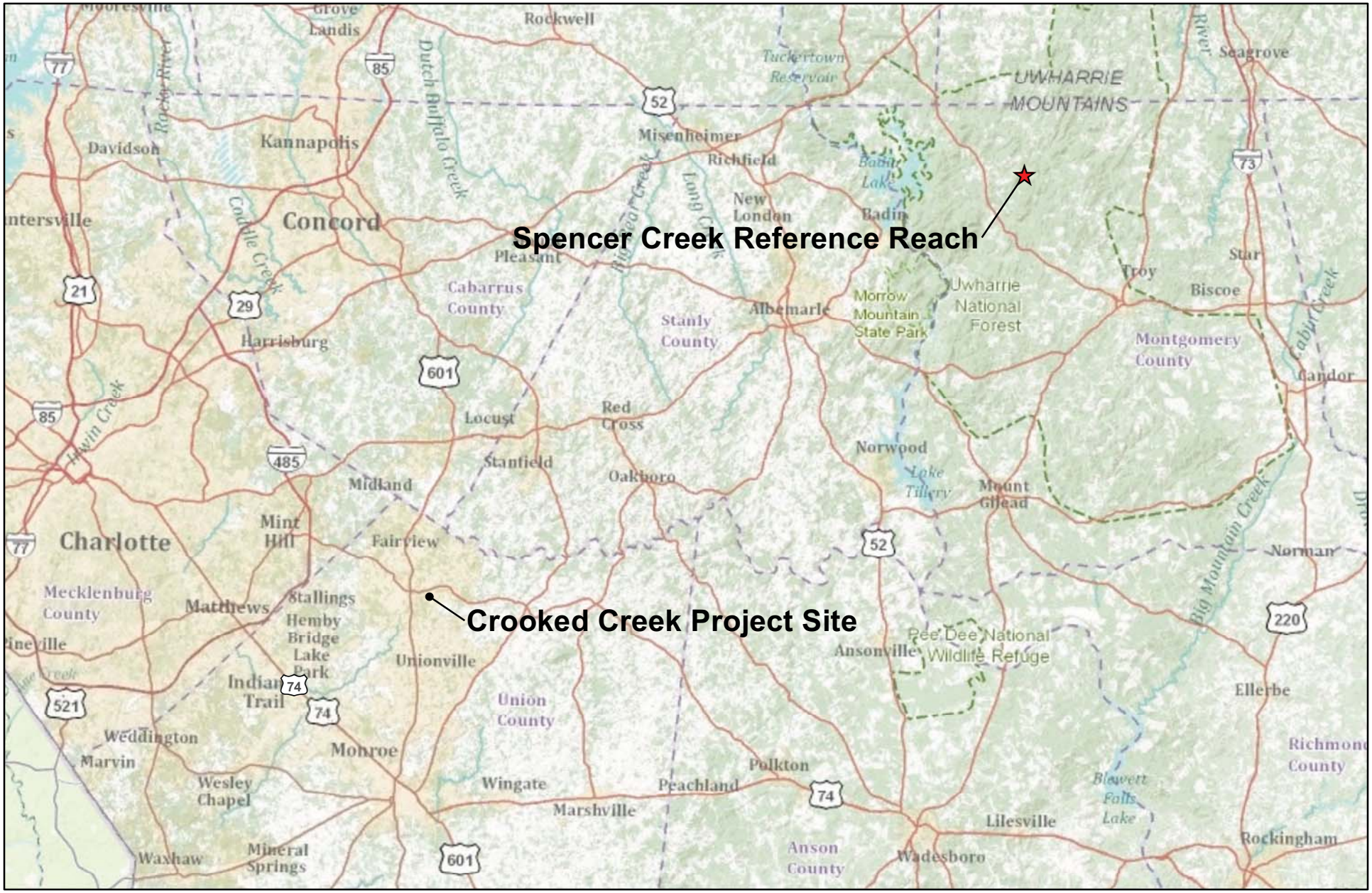


Figure 9. Piedmont Regional Curve Data
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105

Union County, NC



WILDLANDS ENGINEERING

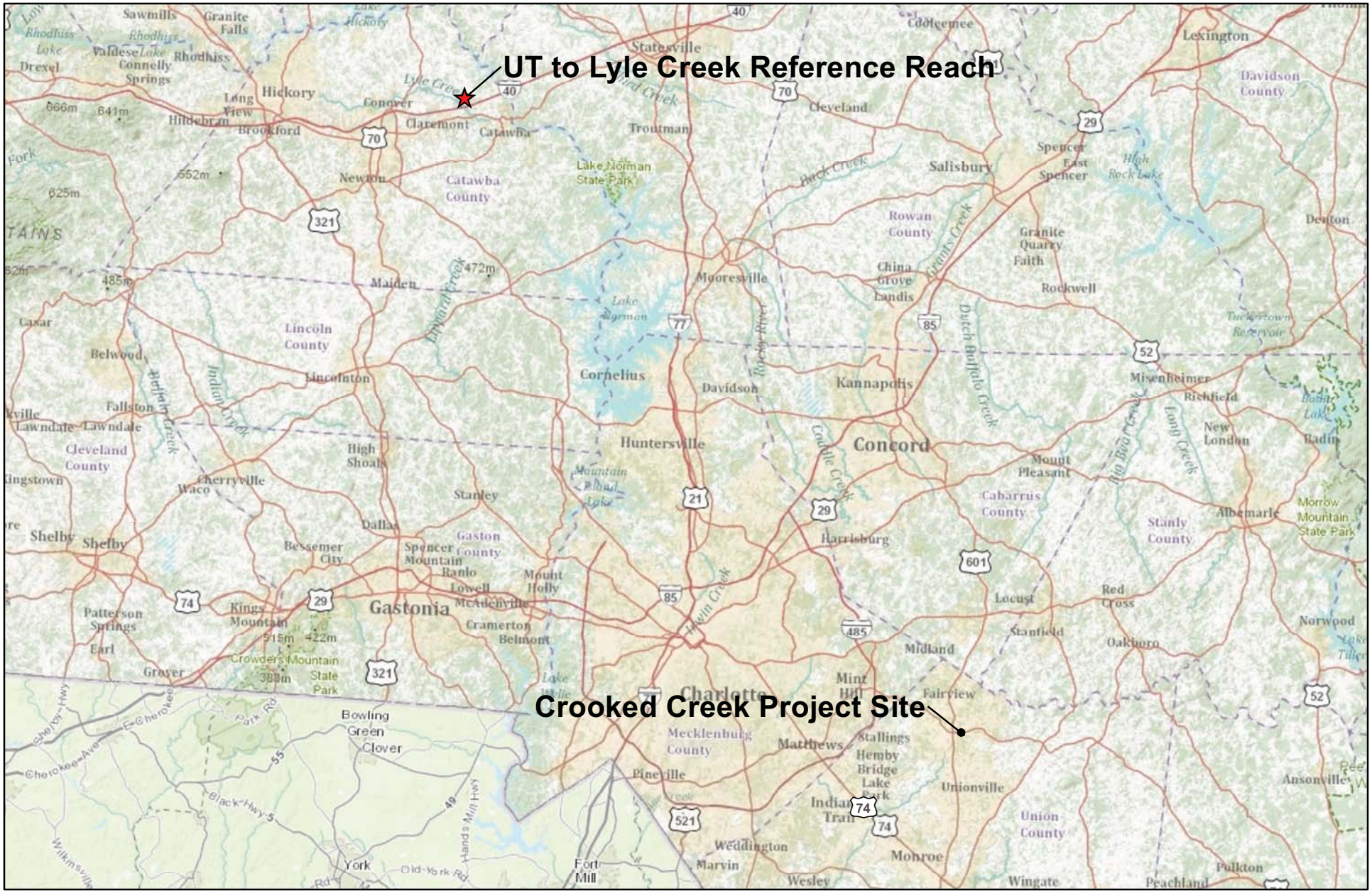
Ecosystem Enhancement Program

0 3.5 7 14 Miles

N

Figure 10 Reference Reach Vicinity Map (Spencer Creek)
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105

Union County, NC



WILDLANDS ENGINEERING

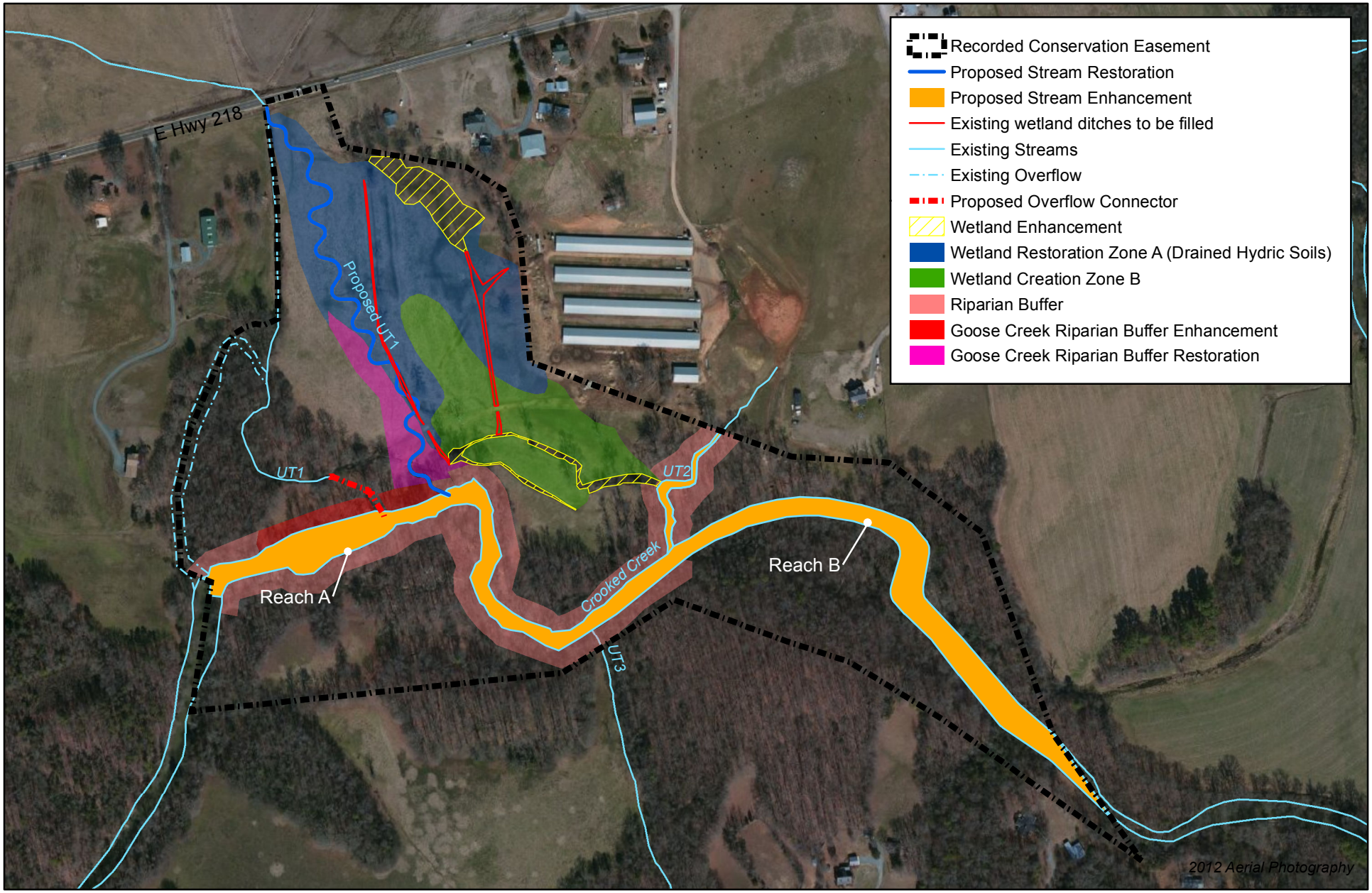
Ecosystem Enhancement Program

0 4.5 9 18 Miles

N

Figure 11 Reference Reach Vicinity Map (UT to Lyle Creek)
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105

Union County, NC



WILDLANDS ENGINEERING

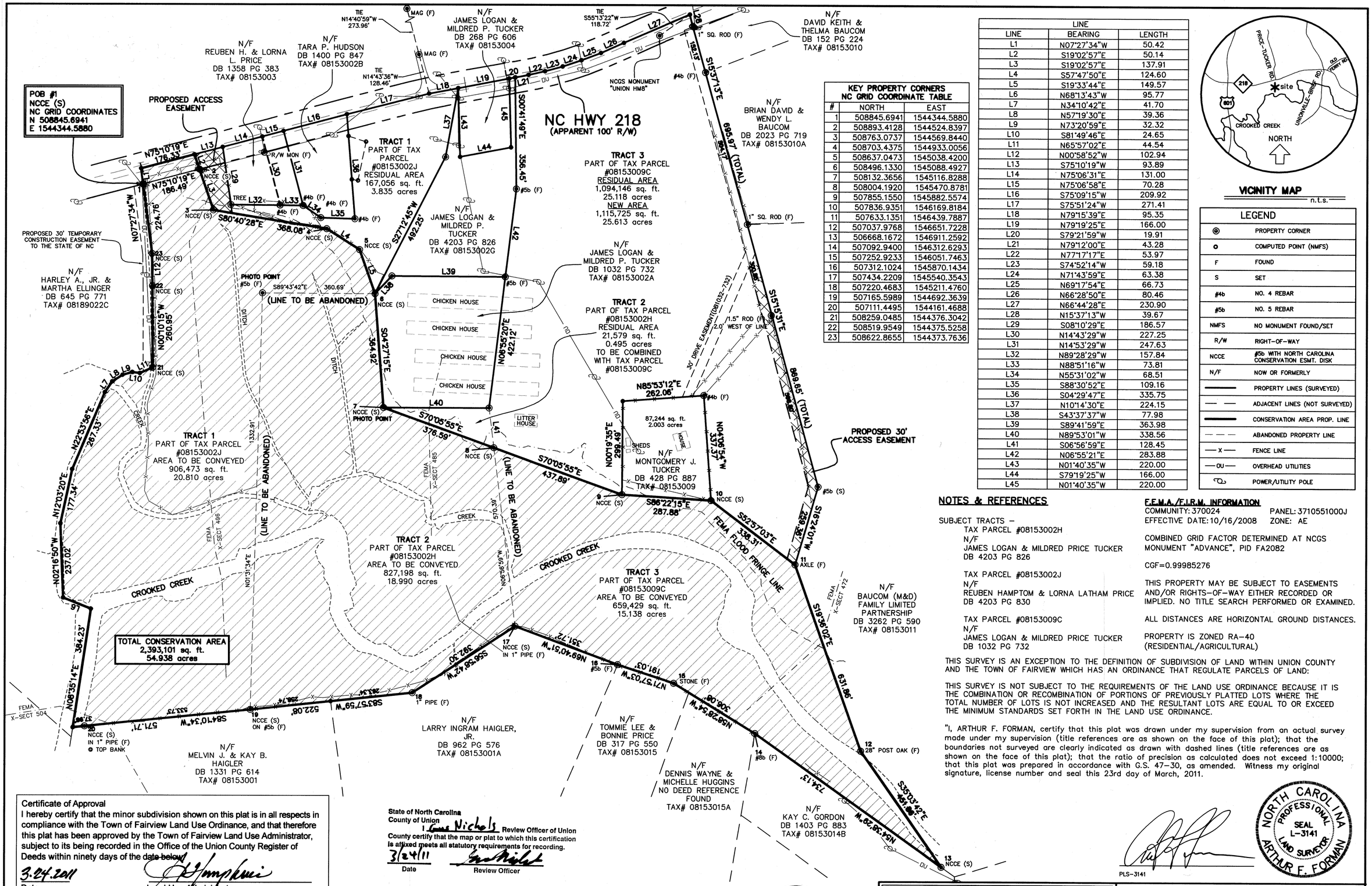
Ecosystem Enhancement Program

0 200 400 800 Feet

N

Figure 12. Proposed Concept Plan
Crooked Creek #2 Restoration Project
Mitigation Plan
Yadkin River Basin 03040105
Union County, NC

APPENDIX A. Site Protection Instrument(s)



KEY PROPERTY CORNERS NC GRID COORDINATE TABLE		
#	NORTH	EAST
1	508845.6941	1544344.5880
2	508893.4128	1544524.8397
3	508763.0737	1544569.8440
4	508703.4375	1544933.0056
5	508637.0473	1545038.4200
6	508496.1330	1545088.4927
7	508132.3656	1545116.8288
8	508004.1920	1545470.8781
9	507855.1550	1545882.5574
10	507836.9351	1546169.8184
11	507633.1351	1546439.7887
12	507037.9768	1546651.7228
13	506668.1672	1546911.2592
14	507092.9400	1546312.6293
15	507252.9233	1546051.7463
16	507312.1024	1545870.1434
17	507434.2209	1545540.3543
18	507220.4683	1545211.4760
19	507165.5989	1544692.3639
20	507111.4495	1544161.4688
21	508259.0485	1544376.3042
22	508519.9549	1544375.5258
23	508622.8655	1544373.7636

LINE		
LINE	BEARING	LENGTH
L1	N07°27'34"W	50.42
L2	S19°02'57"E	50.14
L3	S19°02'57"E	137.91
L4	S57°47'50"E	124.60
L5	S19°33'44"E	149.57
L6	N68°13'43"W	95.77
L7	N34°10'42"E	41.70
L8	N57°19'30"E	39.36
L9	N73°20'59"E	32.32
L10	S81°49'46"E	24.65
L11	N65°57'02"E	44.54
L12	N00°58'52"W	102.94
L13	S75°10'19"W	93.89
L14	N75°06'31"E	131.00
L15	N75°06'58"E	70.28
L16	S75°09'15"W	209.92
L17	S75°51'24"W	271.41
L18	N79°15'39"E	95.35
L19	N79°19'25"E	166.00
L20	S79°21'59"W	19.91
L21	N79°12'00"E	43.28
L22	N77°17'17"E	53.97
L23	S74°52'14"W	59.18
L24	N71°43'59"E	63.38
L25	N69°17'54"E	66.73
L26	N66°28'50"E	80.46
L27	N66°44'28"E	230.90
L28	N15°37'13"W	39.67
L29	S08°10'29"E	186.57
L30	N14°43'29"W	227.25
L31	N14°53'29"W	247.63
L32	N89°28'29"W	157.84
L33	N88°51'16"W	73.81
L34	N55°31'02"W	68.51
L35	S88°30'52"E	109.16
L36	S04°29'47"E	335.75
L37	N10°14'30"E	224.15
L38	S43°37'37"W	77.98
L39	S89°41'59"E	363.98
L40	N89°53'01"W	338.56
L41	S06°56'59"E	128.45
L42	N06°55'21"E	283.88
L43	N01°40'35"W	220.00
L44	S79°19'25"W	166.00
L45	N01°40'35"W	220.00

VICINITY MAP

n.t.s.

LEGEND	
◉	PROPERTY CORNER
o	COMPUTED POINT (NMFS)
F	FOUND
S	SET
#4b	NO. 4 REBAR
#5b	NO. 5 REBAR
NMFS	NO MONUMENT FOUND/SET
R/W	RIGHT-OF-WAY
NCCE	#5b WITH NORTH CAROLINA CONSERVATION ESMT. DISK
N/F	NOW OR FORMERLY
———	PROPERTY LINES (SURVEYED)
— — —	ADJACENT LINES (NOT SURVEYED)
═══	CONSERVATION AREA PROP. LINE
— — —	ABANDONED PROPERTY LINE
—x—	FENCE LINE
—OU—	OVERHEAD UTILITIES
	POWER/UTILITY POLE

NOTES & REFERENCES

SUBJECT TRACTS –
TAX PARCEL #08153002H
N/F
JAMES LOGAN & MILDRED PRICE TUCKER
DB 4203 PG 826

TAX PARCEL #08153002J
N/F
REUBEN HAMPTOM & LORNA LATHAM PRICE
DB 4203 PG 830

TAX PARCEL #08153009C
N/F
JAMES LOGAN & MILDRED PRICE TUCKER
DB 1032 PG 732

F.E.M.A./F.I.R.M. INFORMATION
COMMUNITY: 370024 PANEL: 3710551000J
EFFECTIVE DATE: 10/16/2008 ZONE: AE

COMBINED GRID FACTOR DETERMINED AT NCGS MONUMENT "ADVANCE", PID FA2082

CGF=0.99985276

THIS PROPERTY MAY BE SUBJECT TO EASEMENTS AND/OR RIGHTS-OF-WAY EITHER RECORDED OR IMPLIED. NO TITLE SEARCH PERFORMED OR EXAMINED.

ALL DISTANCES ARE HORIZONTAL GROUND DISTANCES.

PROPERTY IS ZONED RA-40 (RESIDENTIAL/AGRICULTURAL)

THIS SURVEY IS AN EXCEPTION TO THE DEFINITION OF SUBDIVISION OF LAND WITHIN UNION COUNTY AND THE TOWN OF FAIRVIEW WHICH HAS AN ORDINANCE THAT REGULATE PARCELS OF LAND:

THIS SURVEY IS NOT SUBJECT TO THE REQUIREMENTS OF THE LAND USE ORDINANCE BECAUSE IT IS THE COMBINATION OR RECOMBINATION OF PORTIONS OF PREVIOUSLY PLATTED LOTS WHERE THE TOTAL NUMBER OF LOTS IS NOT INCREASED AND THE RESULTANT LOTS ARE EQUAL TO OR EXCEED THE MINIMUM STANDARDS SET FORTH IN THE LAND USE ORDINANCE.

"I, ARTHUR F. FORMAN, certify that this plat was drawn under my supervision from an actual survey made under my supervision (title references are as shown on the face of this plat); that the boundaries not surveyed are clearly indicated as drawn with dashed lines (title references are as shown on the face of this plat); that the ratio of precision as calculated does not exceed 1:10000; that this plat was prepared in accordance with G.S. 47-30, as amended. Witness my original signature, license number and seal this 23rd day of March, 2011.

PLS-3141

NORTH CAROLINA PROFESSIONAL SEAL L-3141 LAND SURVEYOR ARTHUR F. FORMAN

Certificate of Approval
I hereby certify that the minor subdivision shown on this plat is in all respects in compliance with the Town of Fairview Land Use Ordinance, and that therefore this plat has been approved by the Town of Fairview Land Use Administrator, subject to its being recorded in the Office of the Union County Register of Deeds within ninety days of the date below.

3.24.2011
Date

Land Use Administrator

State of North Carolina
County of Union
I Gene Nichols Review Officer of Union County certify that the map or plat to which this certification is affixed meets all statutory requirements for recording.

3/24/11
Date

Review Officer

AREA TABLE (IN ACRES)			
TRACT	TOTAL AREA	AREA TO BE CONVEYED	RESIDUAL AREA
1	24.645	20.810	3.835
2	19.485	18.990	0.495
3	40.256	15.138	25.118
CONSERVATION AREA		54.938	

The NC Grid coordinates shown on this plat were derived by RTK Network differential GPS observations using one Trimble 5800 receiver. The vectors were adjusted by the NCGS RTK Network server using Trimble VRS software producing a weighted least squares adjustment of the NAD 83 positions.

DESIGNATION - MONROE CORS LI PHASE CENTER
CORS_ID - NCMR
NAD 83(CORS)- 34 58 54.77690(N) 080 31 25.79078(W)
ELLIP HEIGHT- 144.442 (meters) (06/??/03) ADJUSTED
GEOID HEIGHT- -30.28 (meters) GEOID03
EPOCH DATE - 2002.00

NC GRID – NAD 83(CORS)

0 100 200 400

1 inch = 200 ft.

Lucas-Forman Incorporated
Land Surveying
Planning & Engineering
N.C. License C-1215
4000 Stuart Andrew Boulevard
Charlotte, North Carolina 28217
P.O. Box 11386 28220-1386
(704) 527-6626 Fax 527-9640

FINAL PLAT
"CONSERVATION AREA SURVEY"
FOR
THE STATE OF NORTH CAROLINA, ECOSYSTEM ENHANCEMENT PROGRAM
CROOKED CREEK #2, EEP ID #94687, SPO #090-AM, 090-AL

GOOSE CREEK TOWNSHIP, UNION COUNTY, N.C.

BEING PORTIONS OF TAX PARCELS – 08153002H, 08153002J & 08153009C
OWNERS: LOGAN & MILDRED TUCKER, REUBEN & LORNA PRICE

SURVEYED BY	DESIGNED BY	DRAWN BY	DATE
RDH/TES	N/A	J.T. EASTERWOOD	03/23/2011
CHECKED BY	JOB NUMBER	FILE NUMBER	SHEET
A.F. FORMAN	10214	UNI	1 OF 1

PLAT CAB - L FILE - 414

APPENDIX B. Baseline Information Data

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action Id. SAW-2011-02201 County: Union U.S.G.S. Quad: Midland

NOTIFICATION OF JURISDICTIONAL DETERMINATION

Property Owner:		Agent:	Matt Jenkins
			Wildlands Engineering
Address:		Address:	1430 South Mint Street
			Suite 104
			Charlotte, NC 28203

Property description:

Size (acres)	~75	Nearest Town	Fairview
Nearest Waterway	Crooked Creek	River Basin	Rocky
USGS HUC	03040105	Coordinates	35.1374 N -80.5227 W

Location description: This property is mostly pasture with some forested areas and is located on the south side of Hwy 218 approximately 800' feet west of its intersection with Price Tucker Road, Fairview, Union County, NC.

Indicate Which of the Following Apply:

A. Preliminary Determination

_ Based on preliminary information, there may be wetlands on the above described property. We strongly suggest you have this property inspected to determine the extent of Department of the Army (DA) jurisdiction. To be considered final, a jurisdictional determination must be verified by the Corps. This preliminary determination is not an appealable action under the Regulatory Program Administrative Appeal Process (Reference 33 CFR Part 331). If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also, you may provide new information for further consideration by the Corps to reevaluate the JD.

B. Approved Determination

_ There are Navigable Waters of the United States within the above described property subject to the permit requirements of Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

X There are waters of the U.S. including wetlands on the above described project area subject to the permit requirements of Section 404 of the Clean Water Act (CWA)(33 USC § 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ We strongly suggest you have the wetlands on your property delineated. Due to the size of your property and/or our present workload, the Corps may not be able to accomplish this wetland delineation in a timely manner. For a more timely delineation, you may wish to obtain a consultant. To be considered final, any delineation must be verified by the Corps.

X The waters of the U.S. including wetlands on your project area have been delineated and the delineation has been verified by the Corps. We strongly suggest you have this delineation surveyed. Upon completion, this survey should be reviewed and verified by the Corps. Once verified, this survey will provide an accurate depiction of all areas subject to CWA jurisdiction on your property which, provided there is no change in the law or our published regulations, may be relied upon for a period not to exceed five years.

_ The waters of the U.S. including wetlands have been delineated and surveyed and are accurately depicted on the plat signed by the Corps Regulatory Official identified below on ___. Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ There are no waters of the U.S., to include wetlands, present on the above described project area which are subject to the permit requirements of Section 404 of the Clean Water Act (33 USC 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ The property is located in one of the 20 Coastal Counties subject to regulation under the Coastal Area Management Act (CAMA). You should contact the Division of Coastal Management in Morehead City, NC, at (252) 808-2808 to determine their requirements.

Placement of dredged or fill material within waters of the US and/or wetlands without a Department of the Army permit may constitute a violation of Section 301 of the Clean Water Act (33 USC § 1311). If you have any questions regarding this determination and/or the Corps regulatory program, please contact **Steve Kichefski** at**828-271-7980 x234.**

C. Basis For Determination: This site contains wetlands that meet the criteria of the 1987 Corps Delineation Manual and stream channels that exhibit indicators of ordinary high water marks. The stream channels on the property are UTs to Crooked Creek. Crooked Creek flows into the Atlantic Ocean via the Rocky, Yadkin and Pee-Dee Rivers.

D. Remarks

E. Attention USDA Program Participants

This delineation/determination has been conducted to identify the limits of Corps' Clean Water Act jurisdiction for the particular site identified in this request. The delineation/determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985. If you or your tenant are USDA Program participants, or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resources Conservation Service, prior to starting work.

F. Appeals Information (This information applies only to approved jurisdictional determinations as indicated in B. above)

This correspondence constitutes an approved jurisdictional determination for the above described site. If you object to this determination, you may request an administrative appeal under Corps regulations at 33 CFR Part 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet and request for appeal (RFA) form. If you request to appeal this determination you must submit a completed RFA form to the following address:

US Army Corps of Engineers
South Atlantic Division
Attn: Jason Steele, Review Officer
60 Forsyth Street SW, Room 10M15
Atlanta, Georgia 30303-8801

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR part 331.5, and that it has been received by the Division Office within 60 days of the date of the NAP. Should you decide to submit an RFA form, it must be received at the above address by January 26, 2011.

It is not necessary to submit an RFA form to the Division Office if you do not object to the determination in this correspondence.

Corps Regulatory Official: Steve Kichefski

Date: 28 November 2011 Expiration Date: 28 November 2011

The Wilmington District is committed to providing the highest level of support to the public. To help us ensure we continue to do so, please complete the attached customer Satisfaction Survey or visit http://per2.nwp.usace.army.mil/survey.html to complete the survey online.

Copy furnished:

NC DWQ Stream Identification Form Version 4.11

Date: 5/19/11	**Project/Site:** Crooked Creek	**Latitude:** 35.135837° N
Evaluator: MLS	**County:** Union	**Longitude:** 80.519916° W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 24.25	**Stream Determination (circle one)** Ephemeral (Intermittent) Perennial	**Other** SCP2 - UT2 *e.g. Quad Name:*

A. Geomorphology (Subtotal = 12.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	(2)	3
2. Sinuosity of channel along thalweg	0	1	(2)	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	(1)	2	3
4. Particle size of stream substrate	0	(1)	2	3
5. Active/relict floodplain	0	1	(2)	3
6. Depositional bars or benches	0	(1)	2	3
7. Recent alluvial deposits	0	(1)	2	3
8. Headcuts	0	(1)	2	3
9. Grade control	0	(0.5)	1	1.5
10. Natural valley	0	0.5	(1)	1.5
11. Second or greater order channel	No = (0)		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6)				
12. Presence of Baseflow	0	(1)	2	3
13. Iron oxidizing bacteria	(0)	1	2	3
14. Leaf litter	(1.5)	1	0.5	0
15. Sediment on plants or debris	0	(0.5)	1	1.5
16. Organic debris lines or piles	(0)	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = (3)	

C. Biology (Subtotal = 5.75)				
18. Fibrous roots in streambed	3	(2)	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	(0)	1	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	(0)	0.5	1	1.5
23. Crayfish	(0)	0.5	1	1.5
24. Amphibians	(0)	0.5	1	1.5
25. Algae	(0)	0.5	1	1.5
26. Wetland plants in streambed	FACW = (0.75) OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 5/19/11	**Project/Site:** Crooked Creek	**Latitude:** 35.135347° N
Evaluator: MLJ	**County:** Union	**Longitude:** 80.520184° W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 38	**Stream Determination (circle one)** Ephemeral Intermittent (Perennial)	**Other** SCP3 - UT2 *e.g. Quad Name:*

A. Geomorphology (Subtotal = 22)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	(2)	3
4. Particle size of stream substrate	0	1	2	(3)
5. Active/relict floodplain	0	1	2	(3)
6. Depositional bars or benches	0	(1)	2	3
7. Recent alluvial deposits	0	1	(2)	3
8. Headcuts	0	1	(2)	3
9. Grade control	0	0.5	(1)	1.5
10. Natural valley	0	0.5	(1)	1.5
11. Second or greater order channel	No = 0		Yes = (3)	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8.5)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	(0)	1	2	3
14. Leaf litter	(1.5)	1	0.5	0
15. Sediment on plants or debris	0	(0.5)	1	1.5
16. Organic debris lines or piles	0	(0.5)	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = (3)	

C. Biology (Subtotal = 7.5)				
18. Fibrous roots in streambed	(3)	2	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	0	(1)	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	(0)	0.5	1	1.5
23. Crayfish	(0)	0.5	1	1.5
24. Amphibians	0	(0.5)	1	1.5
25. Algae	(0)	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 5/19/11	**Project/Site:** Crooked Creek	**Latitude:** 35.135074° N
Evaluator: MLJ	**County:** Union	**Longitude:** 80.523784° W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 52	**Stream Determination (circle one)** Ephemeral Intermittent (Perennial)	**Other** SCP4 - Crooked Creek *e.g. Quad Name:*

A. Geomorphology (Subtotal = 29)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	1	2	(3)
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	(3)
4. Particle size of stream substrate	0	1	2	(3)
5. Active/relict floodplain	0	1	2	(3)
6. Depositional bars or benches	0	1	2	(3)
7. Recent alluvial deposits	0	1	2	(3)
8. Headcuts	0	1	(2)	3
9. Grade control	0	0.5	1	(1.5)
10. Natural valley	0	0.5	1	(1.5)
11. Second or greater order channel	No = 0		Yes = (3)	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 10.5)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	(0)	1	2	3
14. Leaf litter	(1.5)	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	(1.5)
16. Organic debris lines or piles	0	0.5	1	(1.5)
17. Soil-based evidence of high water table?	No = 0		Yes = (3)	

C. Biology (Subtotal = 12.5)				
18. Fibrous roots in streambed	(3)	2	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	(2)	3
21. Aquatic Mollusks	(0)	1	(2)	3
22. Fish	0	0.5	1	(1.5)
23. Crayfish	0	(0.5)	1	1.5
24. Amphibians	0	(0.5)	1	1.5
25. Algae	(0)	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 5/19/11	**Project/Site:** Crooked Creek	**Latitude:** 35.134735°N
Evaluator: MLS	**County:** Union	**Longitude:** 80.522744°W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 28	**Stream Determination (circle one)** Ephemeral (Intermittent) Perennial	**Other** SCPS - Crooked Creek *e.g. Quad Name:* Overflows

A. Geomorphology (Subtotal = 15)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	(1)	2	3
4. Particle size of stream substrate	0	(1)	2	3
5. Active/relict floodplain	0	1	(2)	3
6. Depositional bars or benches	0	(1)	2	3
7. Recent alluvial deposits	0	1	(2)	3
8. Headcuts	0	1	(2)	3
9. Grade control	0	0.5	(1)	1.5
10. Natural valley	0	0.5	(1)	1.5
11. Second or greater order channel	No = (0)		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7)				
12. Presence of Baseflow	0	(1)	2	3
13. Iron oxidizing bacteria	(0)	1	2	3
14. Leaf litter	1.5	(1)	0.5	0
15. Sediment on plants or debris	0	0.5	(1)	1.5
16. Organic debris lines or piles	0	0.5	(1)	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = (3)	

C. Biology (Subtotal = 6)				
18. Fibrous roots in streambed	(3)	2	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	(0)	1	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	(0)	0.5	1	1.5
23. Crayfish	(0)	0.5	1	1.5
24. Amphibians	(0)	0.5	1	1.5
25. Algae	(0)	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: data form is representative of a series of 3 overflow channels located within the floodplain and immediately adjacent to Crooked Creek.

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 5/19/11	**Project/Site:** Crooked Creek	**Latitude:** 35.134541° N
Evaluator: MLS	**County:** Union	**Longitude:** 80.520913° W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 22.5	**Stream Determination (circle one)** Ephemeral (Intermittent) Perennial	**Other** SCPG - UT3 *e.g. Quad Name:*

A. Geomorphology (Subtotal = 12.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	(2)	3
2. Sinuosity of channel along thalweg	0	(1)	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	(1)	2	3
4. Particle size of stream substrate	0	1	(2)	3
5. Active/relict floodplain	(0)	1	2	3
6. Depositional bars or benches	(0)	1	2	3
7. Recent alluvial deposits	0	1	(2)	3
8. Headcuts	0	1	(2)	3
9. Grade control	0	0.5	(1)	1.5
10. Natural valley	0	0.5	1	(1.5)
11. Second or greater order channel	No = (0)		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 4)				
12. Presence of Baseflow	0	(1)	2	3
13. Iron oxidizing bacteria	(0)	1	2	3
14. Leaf litter	1.5	(1)	0.5	0
15. Sediment on plants or debris	0	0.5	(1)	1.5
16. Organic debris lines or piles	0	0.5	(1)	1.5
17. Soil-based evidence of high water table?	No = (0)		Yes = 3	

C. Biology (Subtotal = 6)				
18. Fibrous roots in streambed	(3)	2	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	(0)	1	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	(0)	0.5	1	1.5
23. Crayfish	(0)	0.5	1	1.5
24. Amphibians	(0)	0.5	1	1.5
25. Algae	(0)	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

OFFICE USE ONLY: USACE AID#_____ DWQ #_____

SCP2 – UT2 to Crooked Creek (Intermittent)

STREAM QUALITY ASSESSMENT WORKSHEET

1. Applicant's Name: Wildlands Engineering, Inc.
2. Evaluator's Name: Matt Jenkins
3. Date of Evaluation: 5/19/2011
4. Time of Evaluation: 9:30 am
5. Name of Stream: UT2 to Crooked Creek
6. River Basin: Yadkin 03040105
7. Approximate Drainage Area: 12.5 acres
8. Stream Order: First
9. Length of Reach Evaluated: 200 lf
10. County: Union
11. Location of reach under evaluation (include nearby roads and landmarks): From downtown Charlotte, travel east on NC 24/27 to Interstate 485. Take I-485 southbound to NC 218/ Fairview Road (Exit 44); travel east on NC 218 for approximately 6.8 miles; site will be on the right.
12. Site Coordinates (if known): N 35.135837°, W 80.519916°
13. Proposed Channel Work (if any): restoration/enhancement
14. Recent Weather Conditions: rain within the past 48 hours
15. Site conditions at time of visit: sunny, 70°
16. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)
17. Is there a pond or lake located upstream of the evaluation point? YES (NO) If yes, estimate the water surface area:_____
18. Does channel appear on USGS quad map? YES (NO) 19. Does channel appear on USDA Soil Survey? YES (NO)
20. Estimated Watershed Land Use: ___% Residential ___% Commercial ___% Industrial 100 % Agricultural ___% Forested ___% Cleared / Logged ___% Other (_____)
21. Bankfull Width: 6-8 feet
22. Bank Height (from bed to top of bank): 2-3 feet
23. Channel slope down center of stream: X Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)
24. Channel Sinuosity: ____Straight X Occasional Bends ___Frequent Meander ___Very Sinuous ___Braided Channel

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

Total Score (from reverse): 38 **Comments:**_____

Evaluator's Signature_____ **Date** 5/19/2011

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers in order to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 05/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET
SCP2 – UT2 to Crooked Creek (Intermittent)

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	2
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	1
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	2
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	2
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	3
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	3
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	2
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture or livestock production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	0
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	1
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	1
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	2
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						38

* These characteristics are not assessed in coastal streams.

OFFICE USE ONLY: USACE AID#_____ DWQ #_____

SCP3 – UT2 to Crooked Creek (Perennial)

STREAM QUALITY ASSESSMENT WORKSHEET

1. Applicant's Name: Wildlands Engineering, Inc.
2. Evaluator's Name: Matt Jenkins
3. Date of Evaluation: 5/19/2011
4. Time of Evaluation: 10:00 am
5. Name of Stream: UT2 to Crooked Creek
6. River Basin: Yadkin 03040105
7. Approximate Drainage Area: 32 acres
8. Stream Order: Second
9. Length of Reach Evaluated: 200 lf
10. County: Union
11. Location of reach under evaluation (include nearby roads and landmarks): From downtown Charlotte, travel east on NC 24/27 to Interstate 485. Take I-485 southbound to NC 218/ Fairview Road (Exit 44); travel east on NC 218 for approximately 6.8 miles; site will be on the right.
12. Site Coordinates (if known): N 35.135347°, W 80.520184°
13. Proposed Channel Work (if any): restoration/enhancement
14. Recent Weather Conditions: rain within the past 48 hours
15. Site conditions at time of visit: sunny, 70°
16. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)
17. Is there a pond or lake located upstream of the evaluation point? YES (NO) If yes, estimate the water surface area:_____
18. Does channel appear on USGS quad map? YES (NO) 19. Does channel appear on USDA Soil Survey? YES (NO)
20. Estimated Watershed Land Use: ___% Residential ___% Commercial ___% Industrial 100 % Agricultural ___% Forested ___% Cleared / Logged ___% Other (_____)
21. Bankfull Width: 6-10 feet
22. Bank Height (from bed to top of bank): 4-5 feet
23. Channel slope down center of stream: X Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)
24. Channel Sinuosity: X Straight ___Occasional Bends ___Frequent Meander ___Very Sinuous ___Braided Channel

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

Total Score (from reverse): 49 **Comments:**_____

Evaluator's Signature_____ **Date** 5/19/2011

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers in order to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 05/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET
SCP3 – UT2 to Crooked Creek (Perennial)

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	4
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	2
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	1
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	4
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	4
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	2
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	1
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	3
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	4
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	1
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	2
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture or livestock production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	0
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	3
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	3
BIOLOGY	20	**Presence of stream invertebrates** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	1
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	2
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						49

* These characteristics are not assessed in coastal streams.

OFFICE USE ONLY: USACE AID#_____ DWQ #_____

SCP4 – Crooked Creek (Perennial)

STREAM QUALITY ASSESSMENT WORKSHEET

1. Applicant's Name: Wildlands Engineering, Inc.
2. Evaluator's Name: Matt Jenkins
3. Date of Evaluation: 5/19/2011
4. Time of Evaluation: 10:15 am
5. Name of Stream: Crooked Creek
6. River Basin: Yadkin 03040105
7. Approximate Drainage Area: 38 sq. miles
8. Stream Order: Third
9. Length of Reach Evaluated: 300 lf
10. County: Union
11. Location of reach under evaluation (include nearby roads and landmarks): From downtown Charlotte, travel east on NC 24/27 to Interstate 485. Take I-485 southbound to NC 218/ Fairview Road (Exit 44); travel east on NC 218 for approximately 6.8 miles; site will be on the right.
12. Site Coordinates (if known): N 35.135074°, W 80.523784°
13. Proposed Channel Work (if any): restoration/enhancement
14. Recent Weather Conditions: rain within the past 48 hours
15. Site conditions at time of visit: sunny, 70°
16. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)
17. Is there a pond or lake located upstream of the evaluation point? (YES) NO If yes, estimate the water surface area: numerous
18. Does channel appear on USGS quad map? (YES) NO 19. Does channel appear on USDA Soil Survey? (YES) NO
20. Estimated Watershed Land Use: 40 % Residential 20 % Commercial ___% Industrial 15 % Agricultural 25 % Forested ___% Cleared / Logged ___% Other (_____)
21. Bankfull Width: 50-60 feet
22. Bank Height (from bed to top of bank): 5-6 feet
23. Channel slope down center of stream: X Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)
24. Channel Sinuosity: ____Straight ___Occasional Bends X Frequent Meander ___Very Sinuous ___Braided Channel

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

Total Score (from reverse): 73 **Comments:**_____

Evaluator's Signature_____ **Date** 5/19/2011

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers in order to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 05/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET
SCP4 – Crooked Creek (Perennial)

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	4
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	3
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	4
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	4
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	3
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	4
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	4
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	4
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	3
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	2
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture or livestock production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	1
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	4
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	4
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	5
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	4
BIOLOGY	20	**Presence of stream invertebrates** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	3
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	4
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	4
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						73

* These characteristics are not assessed in coastal streams.

OFFICE USE ONLY: USACE AID#_____ DWQ #_____

SCP5 – Crooked Creek Overflow Channels (Intermittent)

STREAM QUALITY ASSESSMENT WORKSHEET

1. Applicant's Name: Wildlands Engineering, Inc.
2. Evaluator's Name: Matt Jenkins
3. Date of Evaluation: 5/19/2011
4. Time of Evaluation: 11:00 am
5. Name of Stream: Crooked Creek overflow channels
6. River Basin: Yadkin 03040105
7. Approximate Drainage Area: N/A
8. Stream Order: First
9. Length of Reach Evaluated: ~200 lf
10. County: Union
11. Location of reach under evaluation (include nearby roads and landmarks): From downtown Charlotte, travel east on NC 24/27 to Interstate 485. Take I-485 southbound to NC 218/ Fairview Road (Exit 44); travel east on NC 218 for approximately 6.8 miles; site will be on the right.
12. Site Coordinates (if known): N 35.134735°, W 80.522744°
13. Proposed Channel Work (if any): restoration/enhancement
14. Recent Weather Conditions: rain within the past 48 hours
15. Site conditions at time of visit: sunny, 70°
16. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)
17. Is there a pond or lake located upstream of the evaluation point? YES (NO) If yes, estimate the water surface area:_____
18. Does channel appear on USGS quad map? YES (NO) 19. Does channel appear on USDA Soil Survey? YES (NO)
20. Estimated Watershed Land Use: ___% Residential ___% Commercial ___% Industrial ___% Agricultural 100 % Forested ___% Cleared / Logged ___% Other (_____)
21. Bankfull Width: 8-10 feet
22. Bank Height (from bed to top of bank): 3-6 feet
23. Channel slope down center of stream: _X_ Flat (0 to 2%) ___Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)
24. Channel Sinuosity: _X_ Straight ___Occasional Bends ___Frequent Meander ___Very Sinuous ___Braided Channel

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

Total Score (from reverse): 41 **Comments:** Data form is representative of a series of 3 intermittent overflow channels located within the floodplain and immediately adjacent to Crooked Creek.

Evaluator's Signature _____ **Date** 5/19/2011

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers in order to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 05/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET
SCP5 – Crooked Creek Overflow Channels (Intermittent)

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	1
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	4
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	3
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	1
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	3
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	0
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	2
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	2
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	3
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture or livestock production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	2
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	2
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	1
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	2
BIOLOGY	20	**Presence of stream invertebrates** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	3
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						41

* These characteristics are not assessed in coastal streams.

OFFICE USE ONLY: USACE AID#_____ DWQ #_____

SCP6 – UT3 to Crooked Creek (Intermittent)

STREAM QUALITY ASSESSMENT WORKSHEET

1. Applicant's Name: Wildlands Engineering, Inc.
2. Evaluator's Name: Matt Jenkins
3. Date of Evaluation: 5/19/2011
4. Time of Evaluation: 11:30 am
5. Name of Stream: UT3 to Crooked Creek
6. River Basin: Yadkin 03040105
7. Approximate Drainage Area: 38 acres
8. Stream Order: First
9. Length of Reach Evaluated: 100 lf
10. County: Union
11. Location of reach under evaluation (include nearby roads and landmarks): From downtown Charlotte, travel east on NC 24/27 to Interstate 485. Take I-485 southbound to NC 218/ Fairview Road (Exit 44); travel east on NC 218 for approximately 6.8 miles; site will be on the right.
12. Site Coordinates (if known): N 35.134541°, W 80.520913°
13. Proposed Channel Work (if any): restoration/enhancement
14. Recent Weather Conditions: rain within the past 48 hours
15. Site conditions at time of visit: sunny, 70°
16. Identify any special waterway classifications known: ___Section 10 ___Tidal Waters ___Essential Fisheries Habitat ___Trout Waters ___Outstanding Resource Waters ___ Nutrient Sensitive Waters ___Water Supply Watershed ____(I-IV)
17. Is there a pond or lake located upstream of the evaluation point? YES (NO) If yes, estimate the water surface area:_____
18. Does channel appear on USGS quad map? (YES) NO 19. Does channel appear on USDA Soil Survey? (YES) NO
20. Estimated Watershed Land Use: ___% Residential ___% Commercial ___% Industrial 60 % Agricultural 40 % Forested ___% Cleared / Logged ___% Other (_____)
21. Bankfull Width: 5-6 feet
22. Bank Height (from bed to top of bank): 3-4 feet
23. Channel slope down center of stream: ___Flat (0 to 2%) X Gentle (2 to 4%) ___Moderate (4 to 10%) ___Steep (>10%)
24. Channel Sinuosity: X Straight ___Occasional Bends ___Frequent Meander ___Very Sinuous ___Braided Channel

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

Total Score (from reverse): 45 **Comments:**_____

Evaluator's Signature_____ **Date** 5/19/2011

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers in order to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ratio or requirement. Form subject to change – version 05/03. To Comment, please call 919-876-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET
SCP6 – UT3 to Crooked Creek (Intermittent)

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation = 0; strong flow = max points)	0 – 5	0 – 4	0 – 5	1
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	4
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	4
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	1
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	0
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	0
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	1
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	3
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	3
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture or livestock production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools = 0; well-developed = max points)	0 – 3	0 – 5	0 – 6	2
	17	**Habitat complexity** (little or no habitat = 0; frequent, varied habitats = max points)	0 – 6	0 – 6	0 – 6	1
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	5
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	2
BIOLOGY	20	**Presence of stream invertebrates** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	22	**Presence of fish** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	1
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						45

* These characteristics are not assessed in coastal streams.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Crooked Creek Restoration Project City/County: Union Sampling Date: 5/19/11

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP1

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Goose Creek Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): None Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 35.137823 Long: W 80.522536 Datum: _____

Soil Map Unit Name: Chewacla silt loam (ChA) NWI classification: PEM1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** Yes ✔ No _____
Hydric Soil Present?	Yes ✔	No _____	
Wetland Hydrology Present?	Yes ✔	No _____	

Remarks:

Sampling point is representative of a jurisdictional wetland area located in the floodplain of Crooked Creek. Site is an active cattle pasture.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ✔ Surface Water (A1)
- ___ High Water Table (A2)
- ✔ Saturation (A3)
- ___ Water Marks (B1)
- ✔ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ✔ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ✔ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ✔ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ✔ Microtopographic Relief (D4)
- ✔ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ✔	No _____	Depth (inches): 3-4"
Water Table Present?	Yes ✔	No _____	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes ✔	No _____	Depth (inches): _____

Wetland Hydrology Present? Yes ✔ No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP1

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	0 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Ranunculus bulbosus	75	Yes	FAC
2. Juncus effusus	20	Yes	FACW
3. Rumex crispus	5	No	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✔ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✔ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

Site is an active cattle pasture.

SOIL

Sampling Point: DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	7.5YR 5/1	90	5YR 4/6	10	C	PL	clay loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✔ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ✔ **No** _____

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Crooked Creek Restoration Project City/County: Union Sampling Date: 5/19/11

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP2

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Goose Creek Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): None Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 35.137399 Long: W 80.522739 Datum: _____

Soil Map Unit Name: Chewacla silt loam (ChA)) NWI classification: _____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No ✔	**Is the Sampled Area within a Wetland?** **Yes** _____ **No** ✔
Hydric Soil Present?	Yes _____	No ✔	
Wetland Hydrology Present?	Yes _____	No ✔	

Remarks:

Sampling point is representative of a non-jurisdictional upland area located in the floodplain of Crooked Creek. Site is an active cattle pasture.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____	No ✔	Depth (inches): _____
Water Table Present?	Yes _____	No ✔	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes _____	No ✔	Depth (inches): _____

Wetland Hydrology Present? **Yes** _____ **No** ✔

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP2

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	20	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	0	= Total Cover	
Herb Stratum (Plot size: 5')			
1. Ranunculus bulbosus	50	Yes	FAC
2. Lolium perenne	45	Yes	FACU
3. Rumex crispus	5	No	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	100	= Total Cover	
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
	0	= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species	55	x 3 =	165
FACU species	45	x 4 =	180
UPL species		x 5 =	
Column Totals:	100 (A)		345 (B)

Prevalence Index = B/A = 3.45

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes _____ No ✔

Remarks: (Include photo numbers here or on a separate sheet.)

Herbaceous layer is heavily impacted from cattle grazing.

SOIL

Sampling Point: DP2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 3/3	100					silt loam	
6-12	2.5Y 5/3	90	7.5YR 5/6	10	C	PL	silt loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** _____ **No** ✔

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Crooked Creek Restoration Project City/County: Union Sampling Date: 5/19/11

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP3

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Goose Creek Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): None Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 35.135747 Long: W 80.518962 Datum: _____

Soil Map Unit Name: Badin channery silt loam (BaC) NWI classification: PEM1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** Yes ✔ No _____
Hydric Soil Present?	Yes ✔	No _____	
Wetland Hydrology Present?	Yes ✔	No _____	

Remarks:

Sampling point is representative of a jurisdictional wetlands (DD and EE) located in the floodplain of Crooked Creek. Understory vegetation is heavily impacted from cattle grazing. Canopy trees present.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ✔ Surface Water (A1)
- ___ High Water Table (A2)
- ✔ Saturation (A3)
- ___ Water Marks (B1)
- ✔ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ✔ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ✔ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ✔ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ✔ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ✔ Microtopographic Relief (D4)
- ✔ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ✔	No _____	Depth (inches): 2-3"
Water Table Present?	Yes ✔	No _____	Depth (inches): <12"
Saturation Present? (includes capillary fringe)	Yes ✔	No _____	Depth (inches): <12"

Wetland Hydrology Present? Yes ✔ No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP3

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Quercus phellos	5	Yes	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	5 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	0 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Ranunculus bulbosus	50	Yes	FAC
2. Polygonum pensylvanicum	20	Yes	FACW
3. Peltandra virginica	10	No	OBL
4. Juncus effusus	5	No	FACW
5. Impatiens capensis	5	No	FACW
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	90 = Total Cover		
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✔ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✔ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

Canopy species are present; understory growth is heavily impacted from cattle grazing.

SOIL

Sampling Point: DP3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 4/2	100					clay loam	
2-12	2.5Y 5/2	80	5YR 4/6	20	C	PL	silt loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✔ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ✔ **No** _____

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Crooked Creek Restoration Project City/County: Union Sampling Date: 5/19/11

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP4

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Goose Creek Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): None Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 35.135747 Long: W 80.518962 Datum: _____

Soil Map Unit Name: Badin channery silt loam (BaC) NWI classification: _____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** Yes _____ No ✔
Hydric Soil Present?	Yes _____	No ✔	
Wetland Hydrology Present?	Yes _____	No ✔	

Remarks:

Sampling point is representative of a non-jurisdictional upland area located in the floodplain of Crooked Creek. Understory vegetation is heavily impacted from cattle grazing. Canopy trees present.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No ✔ Depth (inches): _____

Water Table Present? Yes _____ No ✔ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No ✔ Depth (inches): _____

Wetland Hydrology Present? Yes _____ No ✔

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP4

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Quercus phellos	20	Yes	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	20 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	0 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Ranunculus bulbosus	30	Yes	FAC
2. Trifolium repens	10	Yes	FACU
3. Urtica dioica	5	No	FAC
4. Microstegium vimineum	5	No	FAC
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	50 = Total Cover		
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✔ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✔ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

Canopy species are present; understory growth is heavily impacted from cattle grazing.

SOIL

Sampling Point: DP4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 4/3	100					clay loam	
6-12	10YR 5/4	95	7.5YR 5/6	5	C	PL	clay loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ **No** ✔

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Crooked Creek Restoration Project City/County: Union Sampling Date: 5/19/11

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP5

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Goose Creek Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): None Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 35.136376 Long: W 80.522818 Datum: _____

Soil Map Unit Name: Chewacla silt loam (ChA) NWI classification: PEM1 (ditch)

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes _____ No ✔

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** **Yes ✔** **No _____**
Hydric Soil Present?	Yes ✔	No _____	
Wetland Hydrology Present?	Yes ✔	No _____	

Remarks:

Sampling point is representative of a jurisdictional wetland area located in the floodplain of Crooked Creek. This wetland is a ditched linear conveyance, constructed to drain the adjacent upland areas.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ✔ Surface Water (A1)
- ___ High Water Table (A2)
- ✔ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ✔ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ✔ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ✔ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ✔ Microtopographic Relief (D4)
- ✔ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ✔	No _____	Depth (inches): 3-4"
Water Table Present?	Yes ✔	No _____	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes ✔	No _____	Depth (inches): _____

Wetland Hydrology Present? **Yes ✔** **No _____**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP5

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	0 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Ranunculus bulbosus	75	Yes	FAC
2. Juncus effusus	20	Yes	FACW
3. Rumex crispus	5	No	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✔ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✔ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

Site is a ditched, active cattle pasture.

SOIL

Sampling Point: DP5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	7.5YR 5/1	80	5YR 4/4	20	C	PL	clay loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✔ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ✔ **No** _____

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Crooked Creek Restoration Project City/County: Union Sampling Date: 5/19/11

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP6

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Goose Creek Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): None Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 35.135596 Long: W 80.521563 Datum: _____

Soil Map Unit Name: Chewacla silt loam (ChA) NWI classification: PEM1 (ditches)

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation ✔, Soil _____, or Hydrology ✔ significantly disturbed? Are "Normal Circumstances" present? Yes _____ No ✔

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** Yes ✔ No _____
Hydric Soil Present?	Yes ✔	No _____	
Wetland Hydrology Present?	Yes ✔	No _____	

Remarks:

Sampling point is representative of a jurisdictional wetland area located in the floodplain of Crooked Creek. This wetland is a ditched linear conveyance, constructed to drain the adjacent upland areas; portions of this complex exhibit linear open water characteristics.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ✔ Surface Water (A1)
- _____ High Water Table (A2)
- ✔ Saturation (A3)
- ✔ Water Marks (B1)
- ✔ Sediment Deposits (B2)
- _____ Drift Deposits (B3)
- ✔ Algal Mat or Crust (B4)
- _____ Iron Deposits (B5)
- ✔ Inundation Visible on Aerial Imagery (B7)
- ✔ Water-Stained Leaves (B9)
- _____ Aquatic Fauna (B13)
- _____ True Aquatic Plants (B14)
- _____ Hydrogen Sulfide Odor (C1)
- ✔ Oxidized Rhizospheres on Living Roots (C3)
- _____ Presence of Reduced Iron (C4)
- _____ Recent Iron Reduction in Tilled Soils (C6)
- _____ Thin Muck Surface (C7)
- _____ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- _____ Surface Soil Cracks (B6)
- _____ Sparsely Vegetated Concave Surface (B8)
- ✔ Drainage Patterns (B10)
- _____ Moss Trim Lines (B16)
- _____ Dry-Season Water Table (C2)
- _____ Crayfish Burrows (C8)
- ✔ Saturation Visible on Aerial Imagery (C9)
- _____ Stunted or Stressed Plants (D1)
- _____ Geomorphic Position (D2)
- _____ Shallow Aquitard (D3)
- ✔ Microtopographic Relief (D4)
- ✔ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ✔ No _____ Depth (inches): 12-36"

Water Table Present? Yes ✔ No _____ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ✔ No _____ Depth (inches): _____

Wetland Hydrology Present? Yes ✔ No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP6

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	0 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Ranunculus bulbosus	80	Yes	FAC
2. Juncus effusus	20	Yes	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✔ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✔ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

Site is a ditched, active cattle pasture.

SOIL

Sampling Point: DP6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	5YR 5/1	90	7.5YR 4/6	10	C	PL	clay silt loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✔ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ✔ **No** _____

Remarks:

APPROVED JURISDICTIONAL DETERMINATION FORM
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD): June, 2011

B. DISTRICT OFFICE, FILE NAME, AND NUMBER:Asheville Regional Office

C. PROJECT LOCATION AND BACKGROUND INFORMATION: Crooked Creek Mitigation Site - Crooked Creek and Wetlands DD and EE

State:NC County/parish/borough: Union City: Fairview
Center coordinates of site (lat/long in degree decimal format): Lat. 35.137823° **N**, Long. 80.522536° **W**.
Universal Transverse Mercator:
Name of nearest waterbody: Crooked Creek

Name of nearest Traditional Navigable Water (TNW) into which the aquatic resource flows: Rocky River
Name of watershed or Hydrologic Unit Code (HUC): Yadkin River 03040105

☒ Check if map/diagram of review area and/or potential jurisdictional areas is/are available upon request.
☐ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc…) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):

☒ Office (Desk) Determination. Date: June 7, 2011
☒ Field Determination. Date(s): May 19, 2011

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There **Are no** *"navigable waters of the U.S."* within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area. [*Required*]

☐ Waters subject to the ebb and flow of the tide.
☐ Waters are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce.
Explain: .

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There **Are** "*waters of the U.S.*" within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area. [*Required*]

1. Waters of the U.S.

a. Indicate presence of waters of U.S. in review area (check all that apply): [1]

☐ TNWs, including territorial seas
☐ Wetlands adjacent to TNWs
☒ Relatively permanent waters[2] (RPWs) that flow directly or indirectly into TNWs
☐ Non-RPWs that flow directly or indirectly into TNWs
☒ Wetlands directly abutting RPWs that flow directly or indirectly into TNWs
☒ Wetlands adjacent to but not directly abutting RPWs that flow directly or indirectly into TNWs
☐ Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs
☐ Impoundments of jurisdictional waters
☐ Isolated (interstate or intrastate) waters, including isolated wetlands

b. Identify (estimate) size of waters of the U.S. in the review area:
Non-wetland waters: 3,300 linear feet: 25-30 width (ft) and/or 2.0 acres.
Wetlands: ~0.20 acres.

c. Limits (boundaries) of jurisdiction based on: **1987 Delineation Manual**
Elevation of established OHWM (if known): .

2. Non-regulated waters/wetlands (check if applicable):[3]

☐ Potentially jurisdictional waters and/or wetlands were assessed within the review area and determined to be not jurisdictional.
Explain: .

[1] Boxes checked below shall be supported by completing the appropriate sections in Section III below.
[2] For purposes of this form, an RPW is defined as a tributary that is not a TNW and that typically flows year-round or has continuous flow at least "seasonally" (e.g., typically 3 months).
[3] Supporting documentation is presented in Section III.F.

SECTION III: CWA ANALYSIS

A. TNWs AND WETLANDS ADJACENT TO TNWs

The agencies will assert jurisdiction over TNWs and wetlands adjacent to TNWs. If the aquatic resource is a TNW, complete Section III.A.1 and Section III.D.1. only; if the aquatic resource is a wetland adjacent to a TNW, complete Sections III.A.1 and 2 and Section III.D.1.; otherwise, see Section III.B below.

1. TNW
Identify TNW: .

Summarize rationale supporting determination: .

2. Wetland adjacent to TNW
Summarize rationale supporting conclusion that wetland is "adjacent": .

B. CHARACTERISTICS OF TRIBUTARY (THAT IS NOT A TNW) AND ITS ADJACENT WETLANDS (IF ANY):

This section summarizes information regarding characteristics of the tributary and its adjacent wetlands, if any, and it helps determine whether or not the standards for jurisdiction established under *Rapanos* have been met.

The agencies will assert jurisdiction over non-navigable tributaries of TNWs where the tributaries are "relatively permanent waters" (RPWs), i.e. tributaries that typically flow year-round or have continuous flow at least seasonally (e.g., typically 3 months). A wetland that directly abuts an RPW is also jurisdictional. If the aquatic resource is not a TNW, but has year-round (perennial) flow, skip to Section III.D.2. If the aquatic resource is a wetland directly abutting a tributary with perennial flow, skip to Section III.D.4.

A wetland that is adjacent to but that does not directly abut an RPW requires a significant nexus evaluation. Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

If the waterbody[4] is not an RPW, or a wetland directly abutting an RPW, a JD will require additional data to determine if the waterbody has a significant nexus with a TNW. If the tributary has adjacent wetlands, the significant nexus evaluation must consider the tributary in combination with all of its adjacent wetlands. This significant nexus evaluation that combines, for analytical purposes, the tributary and all of its adjacent wetlands is used whether the review area identified in the JD request is the tributary, or its adjacent wetlands, or both. If the JD covers a tributary with adjacent wetlands, complete Section III.B.1 for the tributary, Section III.B.2 for any onsite wetlands, and Section III.B.3 for all wetlands adjacent to that tributary, both onsite and offsite. The determination whether a significant nexus exists is determined in Section III.C below.

1. Characteristics of non-TNWs that flow directly or indirectly into TNW

(i) General Area Conditions:
Watershed size: **Pick List**
Drainage area: **Pick List**
Average annual rainfall: inches
Average annual snowfall: inches

(ii) Physical Characteristics:
(a) Relationship with TNW:
☐ Tributary flows directly into TNW.
☐ Tributary flows through **Pick List** tributaries before entering TNW.

Project waters are **Pick List** river miles from TNW.
Project waters are **Pick List** river miles from RPW.
Project waters are **Pick List** aerial (straight) miles from TNW.
Project waters are **Pick List** aerial (straight) miles from RPW.
Project waters cross or serve as state boundaries. Explain: .

Identify flow route to TNW[5]: .
Tributary stream order, if known: .

[4] Note that the Instructional Guidebook contains additional information regarding swales, ditches, washes, and erosional features generally and in the arid West.
[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.

(b) General Tributary Characteristics (check all that apply):

Tributary is: ☐ Natural
☐ Artificial (man-made). Explain: .
☐ Manipulated (man-altered). Explain: .

Tributary properties with respect to top of bank (estimate):
Average width: feet
Average depth: feet
Average side slopes: **Pick List.**

Primary tributary substrate composition (check all that apply):

☐ Silts	☐ Sands	☐ Concrete
☐ Cobbles	☐ Gravel	☐ Muck
☐ Bedrock	☐ Vegetation. Type/% cover:	
☐ Other. Explain: .		

Tributary condition/stability [e.g., highly eroding, sloughing banks]. Explain: .
Presence of run/riffle/pool complexes. Explain: .
Tributary geometry: **Pick List**
Tributary gradient (approximate average slope): %

(c) Flow:
Tributary provides for: **Pick List**
Estimate average number of flow events in review area/year: **Pick List**
Describe flow regime: .
Other information on duration and volume: .

Surface flow is: **Pick List.** Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .
☐ Dye (or other) test performed: .

Tributary has (check all that apply):
☐ Bed and banks
☐ OHWM[6] (check all indicators that apply):

☐ clear, natural line impressed on the bank	☐ the presence of litter and debris
☐ changes in the character of soil	☐ destruction of terrestrial vegetation
☐ shelving	☐ the presence of wrack line
☐ vegetation matted down, bent, or absent	☐ sediment sorting
☐ leaf litter disturbed or washed away	☐ scour
☐ sediment deposition	☐ multiple observed or predicted flow events
☐ water staining	☐ abrupt change in plant community
☐ other (list):	

☐ Discontinuous OHWM.[7] Explain: .

If factors other than the OHWM were used to determine lateral extent of CWA jurisdiction (check all that apply):

☐ High Tide Line indicated by:	☐ Mean High Water Mark indicated by:
☐ oil or scum line along shore objects	☐ survey to available datum;
☐ fine shell or debris deposits (foreshore)	☐ physical markings;
☐ physical markings/characteristics	☐ vegetation lines/changes in vegetation types.
☐ tidal gauges	
☐ other (list):	

(iii) Chemical Characteristics:
Characterize tributary (e.g., water color is clear, discolored, oily film; water quality; general watershed characteristics, etc.).
Explain: .
Identify specific pollutants, if known: .

[6]A natural or man-made discontinuity in the OHWM does not necessarily sever jurisdiction (e.g., where the stream temporarily flows underground, or where the OHWM has been removed by development or agricultural practices). Where there is a break in the OHWM that is unrelated to the waterbody's flow regime (e.g., flow over a rock outcrop or through a culvert), the agencies will look for indicators of flow above and below the break.
[7]Ibid.

(iv) Biological Characteristics. Channel supports (check all that apply):

- ☐ Riparian corridor. Characteristics (type, average width): .
- ☐ Wetland fringe. Characteristics: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

2. Characteristics of wetlands adjacent to non-TNW that flow directly or indirectly into TNW

(i) Physical Characteristics:

(a) General Wetland Characteristics:

Properties:

Wetland size:~0.20acres

Wetland type. Explain:palustrine emergent (partially ditched).

Wetland quality. Explain:low to moderate - heavily impacted from cattle grazing.

Project wetlands cross or serve as state boundaries. Explain: N/A.

(b) General Flow Relationship with Non-TNW:

Flow is: **Intermittent flow**. Explain: .

Surface flow is**: Confined**

Characteristics: linear feature, partially ditched.

Subsurface flow: **Unknown**. Explain findings: .

- ☐ Dye (or other) test performed: .

(c) Wetland Adjacency Determination with Non-TNW:

- ☒ Directly abutting
- ☒ Not directly abutting
  - ☒ Discrete wetland hydrologic connection. Explain: Wetland DD has a direct surface water connection to Crooked Creek. Wetland EE is adjacent to Crooked Creek and exhibits discrete flows during larger storm events.
  - ☐ Ecological connection. Explain: .
  - ☐ Separated by berm/barrier. Explain: .

(d) Proximity (Relationship) to TNW

Project wetlands are **5-10** river miles from TNW.

Project waters are **2-5** aerial (straight) miles from TNW.

Flow is from: **Wetland to navigable waters.**

Estimate approximate location of wetland as within the **50 - 100-year** floodplain.

(ii) Chemical Characteristics:

Characterize wetland system (e.g., water color is clear, brown, oil film on surface; water quality; general watershed characteristics; etc.). Explain: water quality is low to moderate from active cattle grazing; exhibited low chroma soils (2.5Y 5/2), many distinct mottles (5YR 4/6), hydrophytic vegetation, surface water, oxidized root channels, and saturation in the upper 12 inches of the soil profile.

Identify specific pollutants, if known: .

(iii) Biological Characteristics. Wetland supports (check all that apply):

- ☐ Riparian buffer. Characteristics (type, average width): .
- ☐ Vegetation type/percent cover. Explain: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

3. Characteristics of all wetlands adjacent to the tributary (if any)

All wetland(s) being considered in the cumulative analysis: **2**

Approximately (~0.20) acres in total are being considered in the cumulative analysis.

For each wetland, specify the following:

Directly abuts? (Y/N)	Size (in acres)	Directly abuts? (Y/N)	Size (in acres)
Wetland DD (Y)	0.10		
Wetland EE (N)	0.10		

Summarize overall biological, chemical and physical functions being performed: very little physical function being performed since portions have been ditched.

C. SIGNIFICANT NEXUS DETERMINATION

A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of a TNW. For each of the following situations, a significant nexus exists if the tributary, in combination with all of its adjacent wetlands, has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of a TNW. Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to a TNW, and the functions performed by the tributary and all its adjacent wetlands. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and its adjacent wetland or between a tributary and the TNW). Similarly, the fact an adjacent wetland lies within or outside of a floodplain is not solely determinative of significant nexus.

Draw connections between the features documented and the effects on the TNW, as identified in the *Rapanos* Guidance and discussed in the Instructional Guidebook. Factors to consider include, for example:

- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to carry pollutants or flood waters to TNWs, or to reduce the amount of pollutants or flood waters reaching a TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), provide habitat and lifecycle support functions for fish and other species, such as feeding, nesting, spawning, or rearing young for species that are present in the TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to transfer nutrients and organic carbon that support downstream foodwebs?
- Does the tributary, in combination with its adjacent wetlands (if any), have other relationships to the physical, chemical, or biological integrity of the TNW?

Note: the above list of considerations is not inclusive and other functions observed or known to occur should be documented below:

1. **Significant nexus findings for non-RPW that has no adjacent wetlands and flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary itself, then go to Section III.D: .

2. **Significant nexus findings for non-RPW and its adjacent wetlands, where the non-RPW flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

3. **Significant nexus findings for wetlands adjacent to an RPW but that do not directly abut the RPW.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

D. DETERMINATIONS OF JURISDICTIONAL FINDINGS. THE SUBJECT WATERS/WETLANDS ARE (CHECK ALL THAT APPLY):

1. **TNWs and Adjacent Wetlands.** Check all that apply and provide size estimates in review area:
   - ☐ TNWs: linear feet width (ft), Or, acres.
   - ☐ Wetlands adjacent to TNWs: acres.

2. **RPWs that flow directly or indirectly into TNWs.**
   - ☒ Tributaries of TNWs where tributaries typically flow year-round are jurisdictional. Provide data and rationale indicating that tributary is perennial: Crooked Creek is large perennial channel with a watershed of approximately 38 square miles. This channel exhibited, strong base flow conditions, strong riffle-pool sequences, good access to a well-developed floodplain, and substrate consisting of large cobbles. Biological sampling within this reach resulted in a strong presence of fish, a moderate presence of benthic macroinvertebrates, and a weak presence of amphibians and crayfish. Scores on the USACE Stream Quality Assessment Form totalled 49 out of a possible 100 points and totalled 52 out of 63 possible points on the NCDWQ Stream Classification Form, indicating perennial status (SCP4).

☐ Tributaries of TNW where tributaries have continuous flow "seasonally" (e.g., typically three months each year) are jurisdictional. Data supporting this conclusion is provided at Section III.B. Provide rationale indicating that tributary flows seasonally: .

Provide estimates for jurisdictional waters in the review area (check all that apply):
☒ Tributary waters: **3,300** linear feet **25-30** width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

3. Non-RPWs[8] that flow directly or indirectly into TNWs.
☐ Waterbody that is not a TNW or an RPW, but flows directly or indirectly into a TNW, and it has a significant nexus with a TNW is jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional waters within the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

4. Wetlands directly abutting an RPW that flow directly or indirectly into TNWs.
☒ Wetlands directly abut RPW and thus are jurisdictional as adjacent wetlands.
☒ Wetlands directly abutting an RPW where tributaries typically flow year-round. Provide data and rationale indicating that tributary is perennial in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: **Wetland DD is a partially ditched jurisdictional floodplain wetland with a direct, confined surface water connection to Crooked Creek.**

☐ Wetlands directly abutting an RPW where tributaries typically flow "seasonally." Provide data indicating that tributary is seasonal in Section III.B and rationale in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

Provide acreage estimates for jurisdictional wetlands in the review area: **0.10**acres.

5. Wetlands adjacent to but not directly abutting an RPW that flow directly or indirectly into TNWs.
☒ Wetlands that do not directly abut an RPW, but when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisidictional. Data supporting this conclusion is provided at Section III.C.

Provide acreage estimates for jurisdictional wetlands in the review area: **0.10**acres.

6. Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs.
☐ Wetlands adjacent to such waters, and have when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional wetlands in the review area: acres.

7. Impoundments of jurisdictional waters.[9]
As a general rule, the impoundment of a jurisdictional tributary remains jurisdictional.
☐ Demonstrate that impoundment was created from "waters of the U.S.," or
☐ Demonstrate that water meets the criteria for one of the categories presented above (1-6), or
☐ Demonstrate that water is isolated with a nexus to commerce (see E below).

E. ISOLATED [INTERSTATE OR INTRA-STATE] WATERS, INCLUDING ISOLATED WETLANDS, THE USE, DEGRADATION OR DESTRUCTION OF WHICH COULD AFFECT INTERSTATE COMMERCE, INCLUDING ANY SUCH WATERS (CHECK ALL THAT APPLY):[10]

[8] See Footnote # 3.
[9] To complete the analysis refer to the key in Section III.D.6 of the Instructional Guidebook.
[10] Prior to asserting or declining CWA jurisdiction based solely on this category, Corps Districts will elevate the action to Corps and EPA HQ for review consistent with the process described in the Corps/EPA *Memorandum Regarding CWA Act Jurisdiction Following Rapanos.*

☐ which are or could be used by interstate or foreign travelers for recreational or other purposes.
☐ from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.
☐ which are or could be used for industrial purposes by industries in interstate commerce.
☐ Interstate isolated waters. Explain: .
☐ Other factors. Explain: .

Identify water body and summarize rationale supporting determination: .

Provide estimates for jurisdictional waters in the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .
☐ Wetlands: acres.

F. NON-JURISDICTIONAL WATERS, INCLUDING WETLANDS (CHECK ALL THAT APPLY):
☐ If potential wetlands were assessed within the review area, these areas did not meet the criteria in the 1987 Corps of Engineers Wetland Delineation Manual and/or appropriate Regional Supplements.
☐ Review area included isolated waters with no substantial nexus to interstate (or foreign) commerce.
☐ Prior to the Jan 2001 Supreme Court decision in "*SWANCC*," the review area would have been regulated based solely on the "Migratory Bird Rule" (MBR).
☐ Waters do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction. Explain: .
☐ Other: (explain, if not covered above): .

Provide acreage estimates for non-jurisdictional waters in the review area, where the sole potential basis of jurisdiction is the MBR factors (i.e., presence of migratory birds, presence of endangered species, use of water for irrigated agriculture), using best professional judgment (check all that apply):
☐ Non-wetland waters (i.e., rivers, streams): linear feet width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

Provide acreage estimates for non-jurisdictional waters in the review area that do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction (check all that apply):
☐ Non-wetland waters (i.e., rivers, streams): linear feet, width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

SECTION IV: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):
☒ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: .
☒ Data sheets prepared/submitted by or on behalf of the applicant/consultant.
☐ Office concurs with data sheets/delineation report.
☐ Office does not concur with data sheets/delineation report.
☐ Data sheets prepared by the Corps: .
☐ Corps navigable waters' study: .
☒ U.S. Geological Survey Hydrologic Atlas: .
☐ USGS NHD data.
☒ USGS 8 and 12 digit HUC maps.
☒ U.S. Geological Survey map(s). Cite scale & quad name:Midland, NC.
☒ USDA Natural Resources Conservation Service Soil Survey. Citation:Union County Soils.
☐ National wetlands inventory map(s). Cite name: .
☐ State/Local wetland inventory map(s): .
☐ FEMA/FIRM maps: .
☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date): .
or ☒ Other (Name & Date):see attached report.
☐ Previous determination(s). File no. and date of response letter: .
☐ Applicable/supporting case law: .
☐ Applicable/supporting scientific literature: .

☐ Other information (please specify): .

B. ADDITIONAL COMMENTS TO SUPPORT JD: .

APPROVED JURISDICTIONAL DETERMINATION FORM
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD): June, 2011

B. DISTRICT OFFICE, FILE NAME, AND NUMBER:Asheville Regional Office

C. PROJECT LOCATION AND BACKGROUND INFORMATION: Crooked Creek Mitigation Site - UT1
State:NC County/parish/borough: Union City: Fairview
Center coordinates of site (lat/long in degree decimal format): Lat. 35.137823° **N**, Long. 80.522536° **W**.
Universal Transverse Mercator:
Name of nearest waterbody: Crooked Creek
Name of nearest Traditional Navigable Water (TNW) into which the aquatic resource flows: Rocky River
Name of watershed or Hydrologic Unit Code (HUC): Yadkin River 03040105
☒ Check if map/diagram of review area and/or potential jurisdictional areas is/are available upon request.
☐ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc…) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):
☒ Office (Desk) Determination. Date: June 7, 2011
☒ Field Determination. Date(s): May 19, 2011

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There **Are no** *"navigable waters of the U.S."* within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area. [*Required*]
☐ Waters subject to the ebb and flow of the tide.
☐ Waters are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce.
Explain: .

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There **Are** "*waters of the U.S.*" within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area. [*Required*]

1. **Waters of the U.S.**
   a. **Indicate presence of waters of U.S. in review area (check all that apply):** [1]
      ☐ TNWs, including territorial seas
      ☐ Wetlands adjacent to TNWs
      ☒ Relatively permanent waters[2] (RPWs) that flow directly or indirectly into TNWs
      ☐ Non-RPWs that flow directly or indirectly into TNWs
      ☐ Wetlands directly abutting RPWs that flow directly or indirectly into TNWs
      ☐ Wetlands adjacent to but not directly abutting RPWs that flow directly or indirectly into TNWs
      ☐ Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs
      ☐ Impoundments of jurisdictional waters
      ☐ Isolated (interstate or intrastate) waters, including isolated wetlands

   b. **Identify (estimate) size of waters of the U.S. in the review area:**
      Non-wetland waters: 1,750 linear feet: 3-6 width (ft) and/or 0.16 acres.
      Wetlands: acres.

   c. **Limits (boundaries) of jurisdiction** based on: **1987 Delineation Manual**
      Elevation of established OHWM (if known): .

2. **Non-regulated waters/wetlands (check if applicable):**[3]
   ☐ Potentially jurisdictional waters and/or wetlands were assessed within the review area and determined to be not jurisdictional.
   Explain: .

[1] Boxes checked below shall be supported by completing the appropriate sections in Section III below.
[2] For purposes of this form, an RPW is defined as a tributary that is not a TNW and that typically flows year-round or has continuous flow at least "seasonally" (e.g., typically 3 months).
[3] Supporting documentation is presented in Section III.F.

SECTION III: CWA ANALYSIS

A. TNWs AND WETLANDS ADJACENT TO TNWs

The agencies will assert jurisdiction over TNWs and wetlands adjacent to TNWs. If the aquatic resource is a TNW, complete Section III.A.1 and Section III.D.1. only; if the aquatic resource is a wetland adjacent to a TNW, complete Sections III.A.1 and 2 and Section III.D.1.; otherwise, see Section III.B below.

1. TNW
Identify TNW: .

Summarize rationale supporting determination: .

2. Wetland adjacent to TNW
Summarize rationale supporting conclusion that wetland is "adjacent": .

B. CHARACTERISTICS OF TRIBUTARY (THAT IS NOT A TNW) AND ITS ADJACENT WETLANDS (IF ANY):

This section summarizes information regarding characteristics of the tributary and its adjacent wetlands, if any, and it helps determine whether or not the standards for jurisdiction established under *Rapanos* have been met.

The agencies will assert jurisdiction over non-navigable tributaries of TNWs where the tributaries are "relatively permanent waters" (RPWs), i.e. tributaries that typically flow year-round or have continuous flow at least seasonally (e.g., typically 3 months). A wetland that directly abuts an RPW is also jurisdictional. If the aquatic resource is not a TNW, but has year-round (perennial) flow, skip to Section III.D.2. If the aquatic resource is a wetland directly abutting a tributary with perennial flow, skip to Section III.D.4.

A wetland that is adjacent to but that does not directly abut an RPW requires a significant nexus evaluation. Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

If the waterbody[4] is not an RPW, or a wetland directly abutting an RPW, a JD will require additional data to determine if the waterbody has a significant nexus with a TNW. If the tributary has adjacent wetlands, the significant nexus evaluation must consider the tributary in combination with all of its adjacent wetlands. This significant nexus evaluation that combines, for analytical purposes, the tributary and all of its adjacent wetlands is used whether the review area identified in the JD request is the tributary, or its adjacent wetlands, or both. If the JD covers a tributary with adjacent wetlands, complete Section III.B.1 for the tributary, Section III.B.2 for any onsite wetlands, and Section III.B.3 for all wetlands adjacent to that tributary, both onsite and offsite. The determination whether a significant nexus exists is determined in Section III.C below.

1. Characteristics of non-TNWs that flow directly or indirectly into TNW

(i) General Area Conditions:
Watershed size: **Pick List**
Drainage area: **Pick List**
Average annual rainfall: inches
Average annual snowfall: inches

(ii) Physical Characteristics:
(a) Relationship with TNW:
☐ Tributary flows directly into TNW.
☐ Tributary flows through **Pick List** tributaries before entering TNW.

Project waters are **Pick List** river miles from TNW.
Project waters are **Pick List** river miles from RPW.
Project waters are **Pick List** aerial (straight) miles from TNW.
Project waters are **Pick List** aerial (straight) miles from RPW.
Project waters cross or serve as state boundaries. Explain: .

Identify flow route to TNW[5]: .
Tributary stream order, if known: .

[4] Note that the Instructional Guidebook contains additional information regarding swales, ditches, washes, and erosional features generally and in the arid West.
[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.

(b) General Tributary Characteristics (check all that apply):

Tributary is: ☐ Natural
☐ Artificial (man-made). Explain: .
☐ Manipulated (man-altered). Explain: .

Tributary properties with respect to top of bank (estimate):
Average width: feet
Average depth: feet
Average side slopes: **Pick List.**

Primary tributary substrate composition (check all that apply):

☐ Silts	☐ Sands	☐ Concrete
☐ Cobbles	☐ Gravel	☐ Muck
☐ Bedrock	☐ Vegetation. Type/% cover:	
☐ Other. Explain: .		

Tributary condition/stability [e.g., highly eroding, sloughing banks]. Explain: .
Presence of run/riffle/pool complexes. Explain: .
Tributary geometry: **Pick List**
Tributary gradient (approximate average slope): %

(c) Flow:
Tributary provides for: **Pick List**
Estimate average number of flow events in review area/year: **Pick List**
Describe flow regime: .
Other information on duration and volume: .

Surface flow is: **Pick List.** Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .
☐ Dye (or other) test performed: .

Tributary has (check all that apply):
☐ Bed and banks
☐ OHWM[6] (check all indicators that apply):

☐ clear, natural line impressed on the bank	☐ the presence of litter and debris
☐ changes in the character of soil	☐ destruction of terrestrial vegetation
☐ shelving	☐ the presence of wrack line
☐ vegetation matted down, bent, or absent	☐ sediment sorting
☐ leaf litter disturbed or washed away	☐ scour
☐ sediment deposition	☐ multiple observed or predicted flow events
☐ water staining	☐ abrupt change in plant community
☐ other (list):	

☐ Discontinuous OHWM.[7] Explain: .

If factors other than the OHWM were used to determine lateral extent of CWA jurisdiction (check all that apply):

☐ High Tide Line indicated by:	☐ Mean High Water Mark indicated by:
☐ oil or scum line along shore objects	☐ survey to available datum;
☐ fine shell or debris deposits (foreshore)	☐ physical markings;
☐ physical markings/characteristics	☐ vegetation lines/changes in vegetation types.
☐ tidal gauges	
☐ other (list):	

(iii) Chemical Characteristics:
Characterize tributary (e.g., water color is clear, discolored, oily film; water quality; general watershed characteristics, etc.).
Explain: .
Identify specific pollutants, if known: .

[6]A natural or man-made discontinuity in the OHWM does not necessarily sever jurisdiction (e.g., where the stream temporarily flows underground, or where the OHWM has been removed by development or agricultural practices). Where there is a break in the OHWM that is unrelated to the waterbody's flow regime (e.g., flow over a rock outcrop or through a culvert), the agencies will look for indicators of flow above and below the break.
[7]Ibid.

(iv) Biological Characteristics. Channel supports (check all that apply):

- ☐ Riparian corridor. Characteristics (type, average width): .
- ☐ Wetland fringe. Characteristics: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

2. Characteristics of wetlands adjacent to non-TNW that flow directly or indirectly into TNW

(i) Physical Characteristics:

(a) General Wetland Characteristics:

Properties:

Wetland size: acres

Wetland type. Explain: .

Wetland quality. Explain: .

Project wetlands cross or serve as state boundaries. Explain: .

(b) General Flow Relationship with Non-TNW:

Flow is: **Pick List**. Explain: .

Surface flow is**: Pick List**

Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .

- ☐ Dye (or other) test performed: .

(c) Wetland Adjacency Determination with Non-TNW:

- ☐ Directly abutting
- ☐ Not directly abutting
  - ☐ Discrete wetland hydrologic connection. Explain: .
  - ☐ Ecological connection. Explain: .
  - ☐ Separated by berm/barrier. Explain: .

(d) Proximity (Relationship) to TNW

Project wetlands are **Pick List** river miles from TNW.

Project waters are **Pick List** aerial (straight) miles from TNW.

Flow is from: **Pick List.**

Estimate approximate location of wetland as within the **Pick List** floodplain.

(ii) Chemical Characteristics:

Characterize wetland system (e.g., water color is clear, brown, oil film on surface; water quality; general watershed characteristics; etc.). Explain: .

Identify specific pollutants, if known: .

(iii) Biological Characteristics. Wetland supports (check all that apply):

- ☐ Riparian buffer. Characteristics (type, average width): .
- ☐ Vegetation type/percent cover. Explain: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

3. Characteristics of all wetlands adjacent to the tributary (if any)

All wetland(s) being considered in the cumulative analysis: **Pick List**

Approximately ( ) acres in total are being considered in the cumulative analysis.

For each wetland, specify the following:

Directly abuts? (Y/N)	Size (in acres)	Directly abuts? (Y/N)	Size (in acres)

Summarize overall biological, chemical and physical functions being performed: .

C. SIGNIFICANT NEXUS DETERMINATION

A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of a TNW. For each of the following situations, a significant nexus exists if the tributary, in combination with all of its adjacent wetlands, has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of a TNW. Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to a TNW, and the functions performed by the tributary and all its adjacent wetlands. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and its adjacent wetland or between a tributary and the TNW). Similarly, the fact an adjacent wetland lies within or outside of a floodplain is not solely determinative of significant nexus.

Draw connections between the features documented and the effects on the TNW, as identified in the *Rapanos* Guidance and discussed in the Instructional Guidebook. Factors to consider include, for example:

- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to carry pollutants or flood waters to TNWs, or to reduce the amount of pollutants or flood waters reaching a TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), provide habitat and lifecycle support functions for fish and other species, such as feeding, nesting, spawning, or rearing young for species that are present in the TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to transfer nutrients and organic carbon that support downstream foodwebs?
- Does the tributary, in combination with its adjacent wetlands (if any), have other relationships to the physical, chemical, or biological integrity of the TNW?

Note: the above list of considerations is not inclusive and other functions observed or known to occur should be documented below:

1. **Significant nexus findings for non-RPW that has no adjacent wetlands and flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary itself, then go to Section III.D: .

2. **Significant nexus findings for non-RPW and its adjacent wetlands, where the non-RPW flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

3. **Significant nexus findings for wetlands adjacent to an RPW but that do not directly abut the RPW.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

D. DETERMINATIONS OF JURISDICTIONAL FINDINGS. THE SUBJECT WATERS/WETLANDS ARE (CHECK ALL THAT APPLY):

1. **TNWs and Adjacent Wetlands.** Check all that apply and provide size estimates in review area:
   - ☐ TNWs: linear feet width (ft), Or, acres.
   - ☐ Wetlands adjacent to TNWs: acres.

2. **RPWs that flow directly or indirectly into TNWs.**
   - ☒ Tributaries of TNWs where tributaries typically flow year-round are jurisdictional. Provide data and rationale indicating that tributary is perennial: UT1 was determined to be a perennial channel and exhibited moderate base flow conditions, strong riffle-pool sequences, moderate access to a well-developed floodplain, and substrate consisting of fine sand to cobble. Biological sampling within this reach resulted in a weak presence of benthic macroinvertebrates and amphibians. Scores on the USACE Stream Quality Assessment Form totalled 49 out of a possible 100 points and totalled 34.5 out of 63 possible points on the NCDWQ Stream Classification Form, indicating perennial status (SCP1).

☐ Tributaries of TNW where tributaries have continuous flow "seasonally" (e.g., typically three months each year) are jurisdictional. Data supporting this conclusion is provided at Section III.B. Provide rationale indicating that tributary flows seasonally: .

Provide estimates for jurisdictional waters in the review area (check all that apply):
☒ Tributary waters: **1,750** linear feet **3-6** width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

3. Non-RPWs[8] that flow directly or indirectly into TNWs.
☐ Waterbody that is not a TNW or an RPW, but flows directly or indirectly into a TNW, and it has a significant nexus with a TNW is jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional waters within the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

4. Wetlands directly abutting an RPW that flow directly or indirectly into TNWs.
☐ Wetlands directly abut RPW and thus are jurisdictional as adjacent wetlands.
☐ Wetlands directly abutting an RPW where tributaries typically flow year-round. Provide data and rationale indicating that tributary is perennial in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

☐ Wetlands directly abutting an RPW where tributaries typically flow "seasonally." Provide data indicating that tributary is seasonal in Section III.B and rationale in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

5. Wetlands adjacent to but not directly abutting an RPW that flow directly or indirectly into TNWs.
☐ Wetlands that do not directly abut an RPW, but when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisidictional. Data supporting this conclusion is provided at Section III.C.

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

6. Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs.
☐ Wetlands adjacent to such waters, and have when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional wetlands in the review area: acres.

7. Impoundments of jurisdictional waters.[9]
As a general rule, the impoundment of a jurisdictional tributary remains jurisdictional.
☐ Demonstrate that impoundment was created from "waters of the U.S.," or
☐ Demonstrate that water meets the criteria for one of the categories presented above (1-6), or
☐ Demonstrate that water is isolated with a nexus to commerce (see E below).

E. ISOLATED [INTERSTATE OR INTRA-STATE] WATERS, INCLUDING ISOLATED WETLANDS, THE USE, DEGRADATION OR DESTRUCTION OF WHICH COULD AFFECT INTERSTATE COMMERCE, INCLUDING ANY SUCH WATERS (CHECK ALL THAT APPLY):[10]
☐ which are or could be used by interstate or foreign travelers for recreational or other purposes.

[8] See Footnote # 3.
[9] To complete the analysis refer to the key in Section III.D.6 of the Instructional Guidebook.
[10] Prior to asserting or declining CWA jurisdiction based solely on this category, Corps Districts will elevate the action to Corps and EPA HQ for review consistent with the process described in the Corps/EPA *Memorandum Regarding CWA Act Jurisdiction Following Rapanos.*

☐ from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.
☐ which are or could be used for industrial purposes by industries in interstate commerce.
☐ Interstate isolated waters. Explain: .
☐ Other factors. Explain: .

Identify water body and summarize rationale supporting determination: .

Provide estimates for jurisdictional waters in the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .
☐ Wetlands: acres.

F. NON-JURISDICTIONAL WATERS, INCLUDING WETLANDS (CHECK ALL THAT APPLY):
☐ If potential wetlands were assessed within the review area, these areas did not meet the criteria in the 1987 Corps of Engineers Wetland Delineation Manual and/or appropriate Regional Supplements.
☐ Review area included isolated waters with no substantial nexus to interstate (or foreign) commerce.
☐ Prior to the Jan 2001 Supreme Court decision in "*SWANCC*," the review area would have been regulated based solely on the "Migratory Bird Rule" (MBR).
☐ Waters do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction. Explain: .
☐ Other: (explain, if not covered above): .

Provide acreage estimates for non-jurisdictional waters in the review area, where the sole potential basis of jurisdiction is the MBR factors (i.e., presence of migratory birds, presence of endangered species, use of water for irrigated agriculture), using best professional judgment (check all that apply):
☐ Non-wetland waters (i.e., rivers, streams): linear feet width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

Provide acreage estimates for non-jurisdictional waters in the review area that do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction (check all that apply):
☐ Non-wetland waters (i.e., rivers, streams): linear feet, width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

SECTION IV: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):
☒ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: .
☒ Data sheets prepared/submitted by or on behalf of the applicant/consultant.
☐ Office concurs with data sheets/delineation report.
☐ Office does not concur with data sheets/delineation report.
☐ Data sheets prepared by the Corps: .
☐ Corps navigable waters' study: .
☒ U.S. Geological Survey Hydrologic Atlas: .
☐ USGS NHD data.
☒ USGS 8 and 12 digit HUC maps.
☒ U.S. Geological Survey map(s). Cite scale & quad name:Midland, NC.
☒ USDA Natural Resources Conservation Service Soil Survey. Citation:Union County Soils.
☐ National wetlands inventory map(s). Cite name: .
☐ State/Local wetland inventory map(s): .
☐ FEMA/FIRM maps: .
☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date): .
or ☒ Other (Name & Date):see attached report.
☐ Previous determination(s). File no. and date of response letter: .
☐ Applicable/supporting case law: .
☐ Applicable/supporting scientific literature: .
☐ Other information (please specify): .

B. ADDITIONAL COMMENTS TO SUPPORT JD: .

APPROVED JURISDICTIONAL DETERMINATION FORM
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD): June, 2011

B. DISTRICT OFFICE, FILE NAME, AND NUMBER:Asheville Regional Office

C. PROJECT LOCATION AND BACKGROUND INFORMATION: Crooked Creek Mitigation Site - UT2 and Wetlands AA BB and CC

State:NC County/parish/borough: Union City: Fairview
Center coordinates of site (lat/long in degree decimal format): Lat. 35.137823° **N**, Long. 80.522536° **W**.
Universal Transverse Mercator:
Name of nearest waterbody: Crooked Creek

Name of nearest Traditional Navigable Water (TNW) into which the aquatic resource flows: Rocky River
Name of watershed or Hydrologic Unit Code (HUC): Yadkin River 03040105

☒ Check if map/diagram of review area and/or potential jurisdictional areas is/are available upon request.
☐ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc…) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):

☒ Office (Desk) Determination. Date: June 7, 2011
☒ Field Determination. Date(s): May 19, 2011

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There **Are no** *"navigable waters of the U.S."* within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area. [*Required*]

☐ Waters subject to the ebb and flow of the tide.
☐ Waters are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce.
Explain: .

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There **Are** "*waters of the U.S.*" within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area. [*Required*]

1. Waters of the U.S.

a. Indicate presence of waters of U.S. in review area (check all that apply): [1]

☐ TNWs, including territorial seas
☐ Wetlands adjacent to TNWs
☒ Relatively permanent waters[2] (RPWs) that flow directly or indirectly into TNWs
☐ Non-RPWs that flow directly or indirectly into TNWs
☒ Wetlands directly abutting RPWs that flow directly or indirectly into TNWs
☐ Wetlands adjacent to but not directly abutting RPWs that flow directly or indirectly into TNWs
☐ Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs
☐ Impoundments of jurisdictional waters
☐ Isolated (interstate or intrastate) waters, including isolated wetlands

b. Identify (estimate) size of waters of the U.S. in the review area:
Non-wetland waters: 500 linear feet: 2-4 width (ft) and/or 0.03 acres.
Wetlands: ~1.5 acres.

c. Limits (boundaries) of jurisdiction based on: **1987 Delineation Manual**
Elevation of established OHWM (if known): .

2. Non-regulated waters/wetlands (check if applicable):[3]

☐ Potentially jurisdictional waters and/or wetlands were assessed within the review area and determined to be not jurisdictional.
Explain: .

[1] Boxes checked below shall be supported by completing the appropriate sections in Section III below.
[2] For purposes of this form, an RPW is defined as a tributary that is not a TNW and that typically flows year-round or has continuous flow at least "seasonally" (e.g., typically 3 months).
[3] Supporting documentation is presented in Section III.F.

SECTION III: CWA ANALYSIS

A. TNWs AND WETLANDS ADJACENT TO TNWs

The agencies will assert jurisdiction over TNWs and wetlands adjacent to TNWs. If the aquatic resource is a TNW, complete Section III.A.1 and Section III.D.1. only; if the aquatic resource is a wetland adjacent to a TNW, complete Sections III.A.1 and 2 and Section III.D.1.; otherwise, see Section III.B below.

1. TNW
Identify TNW: .

Summarize rationale supporting determination: .

2. Wetland adjacent to TNW
Summarize rationale supporting conclusion that wetland is "adjacent": .

B. CHARACTERISTICS OF TRIBUTARY (THAT IS NOT A TNW) AND ITS ADJACENT WETLANDS (IF ANY):

This section summarizes information regarding characteristics of the tributary and its adjacent wetlands, if any, and it helps determine whether or not the standards for jurisdiction established under *Rapanos* have been met.

The agencies will assert jurisdiction over non-navigable tributaries of TNWs where the tributaries are "relatively permanent waters" (RPWs), i.e. tributaries that typically flow year-round or have continuous flow at least seasonally (e.g., typically 3 months). A wetland that directly abuts an RPW is also jurisdictional. If the aquatic resource is not a TNW, but has year-round (perennial) flow, skip to Section III.D.2. If the aquatic resource is a wetland directly abutting a tributary with perennial flow, skip to Section III.D.4.

A wetland that is adjacent to but that does not directly abut an RPW requires a significant nexus evaluation. Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

If the waterbody[4] is not an RPW, or a wetland directly abutting an RPW, a JD will require additional data to determine if the waterbody has a significant nexus with a TNW. If the tributary has adjacent wetlands, the significant nexus evaluation must consider the tributary in combination with all of its adjacent wetlands. This significant nexus evaluation that combines, for analytical purposes, the tributary and all of its adjacent wetlands is used whether the review area identified in the JD request is the tributary, or its adjacent wetlands, or both. If the JD covers a tributary with adjacent wetlands, complete Section III.B.1 for the tributary, Section III.B.2 for any onsite wetlands, and Section III.B.3 for all wetlands adjacent to that tributary, both onsite and offsite. The determination whether a significant nexus exists is determined in Section III.C below.

1. Characteristics of non-TNWs that flow directly or indirectly into TNW

(i) General Area Conditions:
Watershed size: 38 **square miles**
Drainage area: 12.5 **acres**
Average annual rainfall: 40 inches
Average annual snowfall: 6 inches

(ii) Physical Characteristics:
(a) Relationship with TNW:
☐ Tributary flows directly into TNW.
☒ Tributary flows through **2** tributaries before entering TNW.

Project waters are **5-10** river miles from TNW.
Project waters are **1 (or less)** river miles from RPW.
Project waters are **2-5** aerial (straight) miles from TNW.
Project waters are **1 (or less)** aerial (straight) miles from RPW.
Project waters cross or serve as state boundaries. Explain: .

Identify flow route to TNW[5]: UT2 flows to Crooked Creek to Rocky River.
Tributary stream order, if known: First.

[4] Note that the Instructional Guidebook contains additional information regarding swales, ditches, washes, and erosional features generally and in the arid West.
[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.

(b) General Tributary Characteristics (check all that apply):

Tributary is: ☒ Natural
☐ Artificial (man-made). Explain: .
☒ Manipulated (man-altered). Explain: an upstream culvert has been installed.

Tributary properties with respect to top of bank (estimate):
Average width: 2-3 feet
Average depth: 1-2 feet
Average side slopes: **2:1.**

Primary tributary substrate composition (check all that apply):

☒ Silts	☒ Sands	☐ Concrete
☐ Cobbles	☒ Gravel	☐ Muck
☐ Bedrock	☐ Vegetation. Type/% cover:	
☐ Other. Explain: .		

Tributary condition/stability [e.g., highly eroding, sloughing banks]. Explain: relatively stable, no eroding bed or banks.
Presence of run/riffle/pool complexes. Explain: weak.
Tributary geometry: **Meandering**
Tributary gradient (approximate average slope): ~1 %

(c) Flow:

Tributary provides for: **Seasonal flow**
Estimate average number of flow events in review area/year: **11-20**
Describe flow regime: .
Other information on duration and volume: .

Surface flow is: **Confined.** Characteristics: moderately defined bed and bank.

Subsurface flow: **Unknown**. Explain findings: .
☐ Dye (or other) test performed: .

Tributary has (check all that apply):
☒ Bed and banks
☒ OHWM[6] (check all indicators that apply):

☒ clear, natural line impressed on the bank	☒ the presence of litter and debris
☒ changes in the character of soil	☐ destruction of terrestrial vegetation
☐ shelving	☐ the presence of wrack line
☐ vegetation matted down, bent, or absent	☒ sediment sorting
☐ leaf litter disturbed or washed away	☐ scour
☒ sediment deposition	☒ multiple observed or predicted flow events
☐ water staining	☐ abrupt change in plant community
☐ other (list):	

☐ Discontinuous OHWM.[7] Explain: .

If factors other than the OHWM were used to determine lateral extent of CWA jurisdiction (check all that apply):

☐ High Tide Line indicated by:	☐ Mean High Water Mark indicated by:
☐ oil or scum line along shore objects	☐ survey to available datum;
☐ fine shell or debris deposits (foreshore)	☐ physical markings;
☐ physical markings/characteristics	☐ vegetation lines/changes in vegetation types.
☐ tidal gauges	
☐ other (list):	

(iii) Chemical Characteristics:

Characterize tributary (e.g., water color is clear, discolored, oily film; water quality; general watershed characteristics, etc.).
Explain: The upstream portion of UT2 was determined to have seasonal/intermittent flow and exhibited weak base flow/groundwater, a moderately defined bed and bank, moderate access to the adjacent floodplain, weak riffle-pool sequences and substrate consisting of sand to gravel.
Identify specific pollutants, if known: cattle access.

[6]A natural or man-made discontinuity in the OHWM does not necessarily sever jurisdiction (e.g., where the stream temporarily flows underground, or where the OHWM has been removed by development or agricultural practices). Where there is a break in the OHWM that is unrelated to the waterbody's flow regime (e.g., flow over a rock outcrop or through a culvert), the agencies will look for indicators of flow above and below the break.
[7]Ibid.

(iv) Biological Characteristics. Channel supports (check all that apply):

☒ Riparian corridor. Characteristics (type, average width): 50-100' canopy cover, no understory growth.
☐ Wetland fringe. Characteristics: .
☐ Habitat for:
- ☐ Federally Listed species. Explain findings: .
- ☐ Fish/spawn areas. Explain findings: .
- ☐ Other environmentally-sensitive species. Explain findings: .
- ☐ Aquatic/wildlife diversity. Explain findings: .

2. Characteristics of wetlands adjacent to non-TNW that flow directly or indirectly into TNW

(i) Physical Characteristics:

(a) General Wetland Characteristics:
Properties:
Wetland size:~1.5acres
Wetland type. Explain:palustrine emergent (ditched portions).
Wetland quality. Explain:low to moderate - heavily impacted from cattle grazing.
Project wetlands cross or serve as state boundaries. Explain: N/A.

(b) General Flow Relationship with Non-TNW:
Flow is: **Intermittent flow**. Explain: .

Surface flow is**: Discrete and confined**
Characteristics: open pasture portions exhibit broad discrete flow conditions leading to linear ditched and confined flow areas.

Subsurface flow: **Yes**. Explain findings: groundwater present.
☐ Dye (or other) test performed: .

(c) Wetland Adjacency Determination with Non-TNW:
☒ Directly abutting
☐ Not directly abutting
- ☐ Discrete wetland hydrologic connection. Explain: .
- ☐ Ecological connection. Explain: .
- ☐ Separated by berm/barrier. Explain: .

(d) Proximity (Relationship) to TNW
Project wetlands are **5-10** river miles from TNW.
Project waters are **2-5** aerial (straight) miles from TNW.
Flow is from: **Wetland to navigable waters.**
Estimate approximate location of wetland as within the **50 - 100-year** floodplain.

(ii) Chemical Characteristics:

Characterize wetland system (e.g., water color is clear, brown, oil film on surface; water quality; general watershed characteristics; etc.). Explain: water quality is low to moderate from active cattle grazing; exhibited low chroma soils (7.5YR 5/1 and 5YR 5/1), many distinct mottles (5YR 4/6 and 7.5YR 4/6), hydrophytic FACW and OBL vegetation, surface water ranging in depth from 1-2" to 12-36", oxidized root channels, and saturation in the upper 12 inches of the soil profile.
Identify specific pollutants, if known: cattle waste.

(iii) Biological Characteristics. Wetland supports (check all that apply):

☐ Riparian buffer. Characteristics (type, average width): .
☒ Vegetation type/percent cover. Explain:100% FAC or wetter; herbaceous vegetation only.
☐ Habitat for:
- ☐ Federally Listed species. Explain findings: .
- ☐ Fish/spawn areas. Explain findings: .
- ☐ Other environmentally-sensitive species. Explain findings: .
- ☐ Aquatic/wildlife diversity. Explain findings: .

3. Characteristics of all wetlands adjacent to the tributary (if any)

All wetland(s) being considered in the cumulative analysis: **3**
Approximately (~1.5) acres in total are being considered in the cumulative analysis.

For each wetland, specify the following:

Directly abuts? (Y/N)	Size (in acres)	Directly abuts? (Y/N)	Size (in acres)
Wetland AA (Y)	~1.0		
Wetland BB (Y)	~0.20		
Wetland CC (Y)	~0.30		

Summarize overall biological, chemical and physical functions being performed: wetlands perform some water storage during flood events as well as some filtration.

C. SIGNIFICANT NEXUS DETERMINATION

A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of a TNW. For each of the following situations, a significant nexus exists if the tributary, in combination with all of its adjacent wetlands, has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of a TNW. Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to a TNW, and the functions performed by the tributary and all its adjacent wetlands. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and its adjacent wetland or between a tributary and the TNW). Similarly, the fact an adjacent wetland lies within or outside of a floodplain is not solely determinative of significant nexus.

Draw connections between the features documented and the effects on the TNW, as identified in the *Rapanos* Guidance and discussed in the Instructional Guidebook. Factors to consider include, for example:

- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to carry pollutants or flood waters to TNWs, or to reduce the amount of pollutants or flood waters reaching a TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), provide habitat and lifecycle support functions for fish and other species, such as feeding, nesting, spawning, or rearing young for species that are present in the TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to transfer nutrients and organic carbon that support downstream foodwebs?
- Does the tributary, in combination with its adjacent wetlands (if any), have other relationships to the physical, chemical, or biological integrity of the TNW?

Note: the above list of considerations is not inclusive and other functions observed or known to occur should be documented below:

1. **Significant nexus findings for non-RPW that has no adjacent wetlands and flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary itself, then go to Section III.D: .

2. **Significant nexus findings for non-RPW and its adjacent wetlands, where the non-RPW flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

3. **Significant nexus findings for wetlands adjacent to an RPW but that do not directly abut the RPW.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

D. DETERMINATIONS OF JURISDICTIONAL FINDINGS. THE SUBJECT WATERS/WETLANDS ARE (CHECK ALL THAT APPLY):

1. **TNWs and Adjacent Wetlands.** Check all that apply and provide size estimates in review area:
   - ☐ TNWs: linear feet width (ft), Or, acres.
   - ☐ Wetlands adjacent to TNWs: acres.

2. **RPWs that flow directly or indirectly into TNWs.**
   - ☒ Tributaries of TNWs where tributaries typically flow year-round are jurisdictional. Provide data and rationale indicating that tributary is perennial: The lower portion of UT2 was determined to be a perennial channel with a watershed of approximately 32 acres. This portion of the channel exhibited, strong base flow conditions, moderate riffle-pool sequences, and substrate consisting of large cobbles. Biological sampling within this reach resulted in a weak presence of benthic macroinvertebrates and amphibians. Scores on the USACE Stream Quality Assessment Form totalled 49 out of a possible 100 points and totalled 38 out of 63 possible points on the NCDWQ Stream Classification Form, indicating perennial status (SCP3).

☒ Tributaries of TNW where tributaries have continuous flow "seasonally" (e.g., typically three months each year) are jurisdictional. Data supporting this conclusion is provided at Section III.B. Provide rationale indicating that tributary flows seasonally: The upper portion of UT2 was determined to be perennial due to a smaller watershed drainage area (12.5 acres), weak base flow conditions, weak riffle-pool sequences and debris piles, and substrate consisting of sand to small gravel. Scores on the USACE Stream Quality Assessment Form totalled 38 out of a possible 100 points and totalled 24.25 out of 63 possible points on the NCDWQ Stream Classification Form, indicating intermittent status (SCP2).

Provide estimates for jurisdictional waters in the review area (check all that apply):
☒ Tributary waters: **500** linear feet**2-4**width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

3. Non-RPWs[8] that flow directly or indirectly into TNWs.
☐ Waterbody that is not a TNW or an RPW, but flows directly or indirectly into a TNW, and it has a significant nexus with a TNW is jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional waters within the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: **.**

4. Wetlands directly abutting an RPW that flow directly or indirectly into TNWs.
☒ Wetlands directly abut RPW and thus are jurisdictional as adjacent wetlands.
☒ Wetlands directly abutting an RPW where tributaries typically flow year-round. Provide data and rationale indicating that tributary is perennial in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: **Wetlands AA and BB are directly connected to Wetland CC via a series of wet linear ditches. Wetland CC exhibited a direct surface water connection to the perennial portion of UT2.**

☐ Wetlands directly abutting an RPW where tributaries typically flow "seasonally." Provide data indicating that tributary is seasonal in Section III.B and rationale in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

Provide acreage estimates for jurisdictional wetlands in the review area: **~1.5**acres.

5. Wetlands adjacent to but not directly abutting an RPW that flow directly or indirectly into TNWs.
☐ Wetlands that do not directly abut an RPW, but when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisidictional. Data supporting this conclusion is provided at Section III.C.

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

6. Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs.
☐ Wetlands adjacent to such waters, and have when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional wetlands in the review area: acres.

7. Impoundments of jurisdictional waters.[9]
As a general rule, the impoundment of a jurisdictional tributary remains jurisdictional.
☐ Demonstrate that impoundment was created from "waters of the U.S.," or
☐ Demonstrate that water meets the criteria for one of the categories presented above (1-6), or
☐ Demonstrate that water is isolated with a nexus to commerce (see E below).

E. ISOLATED [INTERSTATE OR INTRA-STATE] WATERS, INCLUDING ISOLATED WETLANDS, THE USE, DEGRADATION OR DESTRUCTION OF WHICH COULD AFFECT INTERSTATE COMMERCE, INCLUDING ANY SUCH WATERS (CHECK ALL THAT APPLY):[10]

[8]See Footnote # 3.
[9] To complete the analysis refer to the key in Section III.D.6 of the Instructional Guidebook.

☐ which are or could be used by interstate or foreign travelers for recreational or other purposes.
☐ from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.
☐ which are or could be used for industrial purposes by industries in interstate commerce.
☐ Interstate isolated waters. Explain: .
☐ Other factors. Explain: .

Identify water body and summarize rationale supporting determination: .

Provide estimates for jurisdictional waters in the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .
☐ Wetlands: acres.

F. NON-JURISDICTIONAL WATERS, INCLUDING WETLANDS (CHECK ALL THAT APPLY):
☐ If potential wetlands were assessed within the review area, these areas did not meet the criteria in the 1987 Corps of Engineers Wetland Delineation Manual and/or appropriate Regional Supplements.
☐ Review area included isolated waters with no substantial nexus to interstate (or foreign) commerce.
☐ Prior to the Jan 2001 Supreme Court decision in "*SWANCC*," the review area would have been regulated based solely on the "Migratory Bird Rule" (MBR).
☐ Waters do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction. Explain: .
☐ Other: (explain, if not covered above): .

Provide acreage estimates for non-jurisdictional waters in the review area, where the sole potential basis of jurisdiction is the MBR factors (i.e., presence of migratory birds, presence of endangered species, use of water for irrigated agriculture), using best professional judgment (check all that apply):
☐ Non-wetland waters (i.e., rivers, streams): linear feet width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

Provide acreage estimates for non-jurisdictional waters in the review area that do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction (check all that apply):
☐ Non-wetland waters (i.e., rivers, streams): linear feet, width (ft).
☐ Lakes/ponds: acres.
☐ Other non-wetland waters: acres. List type of aquatic resource: .
☐ Wetlands: acres.

SECTION IV: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):
☒ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: .
☒ Data sheets prepared/submitted by or on behalf of the applicant/consultant.
☐ Office concurs with data sheets/delineation report.
☐ Office does not concur with data sheets/delineation report.
☐ Data sheets prepared by the Corps: .
☐ Corps navigable waters' study: .
☒ U.S. Geological Survey Hydrologic Atlas: .
☐ USGS NHD data.
☒ USGS 8 and 12 digit HUC maps.
☒ U.S. Geological Survey map(s). Cite scale & quad name:Midland, NC.
☒ USDA Natural Resources Conservation Service Soil Survey. Citation:Union County Soils.
☐ National wetlands inventory map(s). Cite name: .
☐ State/Local wetland inventory map(s): .
☐ FEMA/FIRM maps: .
☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date): .

---

[10] Prior to asserting or declining CWA jurisdiction based solely on this category, Corps Districts will elevate the action to Corps and EPA HQ for review consistent with the process described in the Corps/EPA *Memorandum Regarding CWA Act Jurisdiction Following Rapanos.*

or ☒ Other (Name & Date):see attached report.

☐ Previous determination(s). File no. and date of response letter: .

☐ Applicable/supporting case law: .

☐ Applicable/supporting scientific literature: .

☐ Other information (please specify): .

B. ADDITIONAL COMMENTS TO SUPPORT JD: .

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Crooked Creek - Wetland AA | **Date** 05/19/11

Wetland Type Bottomland Hardwood Forest | **Assessor Name/Organization** Matt Jenkins, PWS

Level III Ecoregion Piedmont | **Nearest Named Water Body** Crooked Creek

River Basin Yadkin-PeeDee | **USGS 8-Digit Catalogue Unit** 03040105

( ) Yes (•) No **Precipitation within 48 hrs?** | **Latitude/Longitude (deci-degrees)** 35.137823°N, 80.522536°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? (•) Yes ( ) No

Describe effects of stressors that are present.
Wetland located within an actively managed agricultural pasture. Vegetation is regularly mowed and grazed, soils are occasionally driven on and somewhat compacted.

Regulatory Considerations
Select all that apply to the assessment area.

- [ ] Anadromous fish
- [ ] Federally protected species or State endangered or threatened species
- [ ] NCDWQ riparian buffer rule in effect
- [ ] Abuts a Primary Nursery Area (PNA)
- [ ] Publicly owned property
- [ ] N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
- [ ] Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
- [ ] Designated NCNHP reference community
- [x] Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)

- [ ] Blackwater
- [•] Brownwater
- [ ] Tidal (if tidal, check one of the following boxes) ( ) Lunar ( ) Wind ( ) Both

Is the assessment area on a coastal island? ( ) Yes (•) No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ( ) Yes (•) No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**
Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
(•) A	( ) A	Not severely altered
( ) B	(•) B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**
Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
( ) A	( ) A	Water storage capacity and duration are not altered.
(•) B	(•) B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
( ) C	( ) C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric**
Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
( ) A	( ) A	Majority of wetland with depressions able to pond water > 1 foot deep
( ) B	( ) B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
(•) C	(•) C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
( ) D	( ) D	Depressions able to pond water < 3 inches deep

( ) A	Evidence that maximum depth of inundation is greater than 2 feet
( ) B	Evidence that maximum depth of inundation is between 1 and 2 feet
(•) C	Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

- ☐ A Sandy soil
- ☉ B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
- ☐ C Loamy or clayey soils not exhibiting redoxymorphic features
- ☐ D Loamy or clayey gleyed soil
- ☐ E Histosol or histic epipedon

- ☉ A Soil ribbon < 1 inch
- ☐ B Soil ribbon ≥ 1 inch

- ☉ A No peat or muck presence
- ☐ B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☉ A	☉ A	Little or no evidence of pollutants or discharges entering the assessment area
☐ B	☐ B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☐ C	☐ C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS	5M	2M	
☐ A	☐ A	☐ A	≥ 10% impervious surfaces
☑ B	☑ B	☑ B	< 10% impervious surfaces
☑ C	☑ C	☑ C	Confined animal operations (or other local, concentrated source of pollutants)
☑ D	☑ D	☑ D	≥ 20% coverage of pasture
☐ E	☐ E	☐ E	≥ 20% coverage of agricultural land (regularly plowed land)
☑ F	☑ F	☑ F	≥ 20% coverage of maintained grass/herb
☐ G	☐ G	☐ G	≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H	☐ H	☐ H	Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area condition metric

7a. Is assessment area within 50 feet of a tributary or other open water?

☐ Yes ☉ No If Yes, continue to 7b. If No, skip to Metric 8.

Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.

- ☐ A ≥ 50 feet
- ☐ B From 30 to < 50 feet
- ☐ C From 15 to < 30 feet
- ☐ D From 5 to < 15 feet
- ☐ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.

☐ ≤ 15-feet wide ☐ > 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?

☐ Yes ☐ No

7e. Is tributary or other open water sheltered or exposed?

- ☐ Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
- ☐ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex metric

Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT	WC	
☐ A	☐ A	≥ 100 feet
☉ B	☉ B	From 80 to < 100 feet
☐ C	☐ C	From 50 to < 80 feet
☐ D	☐ D	From 40 to < 50 feet
☐ E	☐ E	From 30 to < 40 feet
☐ F	☐ F	From 15 to < 30 feet
☐ G	☐ G	From 5 to < 15 feet
☐ H	☐ H	< 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

- [x] A Evidence of short-duration inundation (< 7 consecutive days)
- [ ] B Evidence of saturation, without evidence of inundation
- [ ] C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

- [x] A Sediment deposition is not excessive, but at approximately natural levels.
- [ ] B Sediment deposition is excessive, but not overwhelming the wetland.
- [ ] C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
☐ A	☐ A	☐ A	≥ 500 acres
☐ B	☐ B	☐ B	From 100 to < 500 acres
☐ C	☐ C	☐ C	From 50 to < 100 acres
☐ D	☐ D	☐ D	From 25 to < 50 acres
☐ E	☐ E	☐ E	From 10 to < 25 acres
☐ F	☐ F	☐ F	From 5 to < 10 acres
☒ G	☒ G	☐ G	From 1 to < 5 acres
☐ H	☐ H	☐ H	From 0.5 to < 1 acre
☐ I	☐ I	☐ I	From 0.1 to < 0.5 acre
☐ J	☐ J	☐ J	From 0.01 to < 0.1 acre
☐ K	☐ K	☒ K	< 0.01 acre or assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

- [ ] A Pocosin is the full extent (≥ 90%) of its natural landscape size.
- [ ] B Pocosin is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
☐ A	☐ A	≥ 500 acres
☐ B	☐ B	From 100 to < 500 acres
☐ C	☐ C	From 50 to < 100 acres
☐ D	☐ D	From 10 to < 50 acres
☐ E	☐ E	< 10 acres
☒ F	☒ F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

☐ Yes ☐ No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

- [ ] A No artificial edge within 150 feet in all directions
- [ ] B No artificial edge within 150 feet in four (4) to seven (7) directions
- [x] C An artificial edge occurs within 150 feet in more than four (4) directions or assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

- [ ] A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
- [ ] B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
- [x] C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

- [ ] A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
- [ ] B Vegetation diversity is low or has > 10% to 50% cover of exotics.
- [ ] C Vegetation is dominated by exotic species (>50% cover of exotics).

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☒ Yes ☐ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐ A ≥ 25% coverage of vegetation
☐ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
☐ A	☐ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
☐ B	☐ B	Canopy present, but opened more than natural gaps
☒ C	☒ C	Canopy sparse or absent
☐ A	☐ A	Dense mid-story/sapling layer
☐ B	☐ B	Moderate density mid-story/sapling layer
☒ C	☒ C	Mid-story/sapling layer sparse or absent
☐ A	☐ A	Dense shrub layer
☐ B	☐ B	Moderate density shrub layer
☒ C	☒ C	Shrub layer sparse or absent
☒ A	☒ A	Dense herb layer
☐ B	☐ B	Moderate density herb layer
☐ C	☐ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

☐ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
☒ B Not A

19. Diameter Class Distribution – wetland type condition metric

☐ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
☒ C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

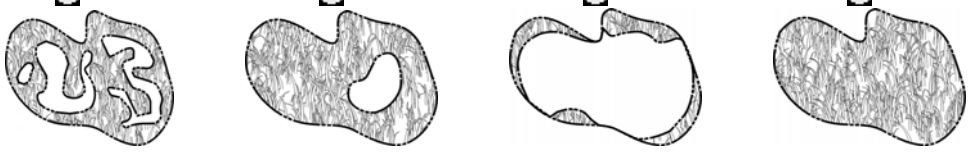
Include both natural debris and man-placed natural debris.

☐ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒ B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐ A ☐ B ☐ C ☐ D



22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

☐ A Overbank and overland flow are not severely altered in the assessment area.
☐ B Overbank flow is severely altered in the assessment area.
☒ C Overland flow is severely altered in the assessment area.
☐ D Both overbank and overland flow are severely altered in the assessment area.

Notes

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Crooked Creek - Wetland BB | **Date** 05/19/11

Wetland Type Bottomland Hardwood Forest | **Assessor Name/Organization** Matt Jenkins, PWS

Level III Ecoregion Piedmont | **Nearest Named Water Body** Crooked Creek

River Basin Yadkin-PeeDee | **USGS 8-Digit Catalogue Unit** 03040105

☐ Yes ☉ No **Precipitation within 48 hrs?** | **Latitude/Longitude (deci-degrees)** 35.136376°N, 80.522818°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ☉ Yes ☐ No

Describe effects of stressors that are present.
Wetland located within an actively managed agricultural pasture. Vegetation is regularly mowed and grazed, soils are occasionally driven on and somewhat compacted. Wetland is a linear ditched conveyance.

Regulatory Considerations
Select all that apply to the assessment area.

- ☐ Anadromous fish
- ☐ Federally protected species or State endangered or threatened species
- ☐ NCDWQ riparian buffer rule in effect
- ☐ Abuts a Primary Nursery Area (PNA)
- ☐ Publicly owned property
- ☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
- ☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
- ☐ Designated NCNHP reference community
- ☑ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)

- ☐ Blackwater
- ☉ Brownwater
- ☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

Is the assessment area on a coastal island? ☐ Yes ☉ No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ☐ Yes ☉ No

1. Ground Surface Condition/Vegetation Condition – assessment area condition metric
Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
☐ A	☐ A	Not severely altered
☉ B	☉ B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric
Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
☐ A	☐ A	Water storage capacity and duration are not altered.
☐ B	☐ B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
☉ C	☉ C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. Water Storage/Surface Relief – assessment area/wetland type condition metric
Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
☐ A	☐ A	Majority of wetland with depressions able to pond water > 1 foot deep
☐ B	☐ B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
☉ C	☉ C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
☐ D	☐ D	Depressions able to pond water < 3 inches deep

- ☐ A Evidence that maximum depth of inundation is greater than 2 feet
- ☐ B Evidence that maximum depth of inundation is between 1 and 2 feet
- ☉ C Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

- ☐ A Sandy soil
- ☑ B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
- ☐ C Loamy or clayey soils not exhibiting redoxymorphic features
- ☐ D Loamy or clayey gleyed soil
- ☐ E Histosol or histic epipedon

- ☑ A Soil ribbon < 1 inch
- ☐ B Soil ribbon ≥ 1 inch

- ☑ A No peat or muck presence
- ☐ B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☑ A	☑ A	Little or no evidence of pollutants or discharges entering the assessment area
☐ B	☐ B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☐ C	☐ C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS	5M	2M	
☐ A	☐ A	☐ A	≥ 10% impervious surfaces
☑ B	☑ B	☑ B	< 10% impervious surfaces
☑ C	☑ C	☑ C	Confined animal operations (or other local, concentrated source of pollutants)
☑ D	☑ D	☑ D	≥ 20% coverage of pasture
☐ E	☐ E	☐ E	≥ 20% coverage of agricultural land (regularly plowed land)
☑ F	☑ F	☑ F	≥ 20% coverage of maintained grass/herb
☐ G	☐ G	☐ G	≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H	☐ H	☐ H	Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area condition metric

7a. Is assessment area within 50 feet of a tributary or other open water?

☐ Yes ☑ No If Yes, continue to 7b. If No, skip to Metric 8.

Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.

- ☐ A ≥ 50 feet
- ☐ B From 30 to < 50 feet
- ☐ C From 15 to < 30 feet
- ☐ D From 5 to < 15 feet
- ☐ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.

☐ ≤ 15-feet wide ☐ > 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?

☐ Yes ☐ No

7e. Is tributary or other open water sheltered or exposed?

- ☐ Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
- ☐ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex metric

Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT	WC	
☐ A	☐ A	≥ 100 feet
☐ B	☐ B	From 80 to < 100 feet
☐ C	☐ C	From 50 to < 80 feet
☐ D	☐ D	From 40 to < 50 feet
☐ E	☐ E	From 30 to < 40 feet
☐ F	☐ F	From 15 to < 30 feet
☑ G	☑ G	From 5 to < 15 feet
☐ H	☐ H	< 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

- [x] A Evidence of short-duration inundation (< 7 consecutive days)
- [ ] B Evidence of saturation, without evidence of inundation
- [ ] C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

- [x] A Sediment deposition is not excessive, but at approximately natural levels.
- [ ] B Sediment deposition is excessive, but not overwhelming the wetland.
- [ ] C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
[ ] A	[ ] A	[ ] A	≥ 500 acres
[ ] B	[ ] B	[ ] B	From 100 to < 500 acres
[ ] C	[ ] C	[ ] C	From 50 to < 100 acres
[ ] D	[ ] D	[ ] D	From 25 to < 50 acres
[ ] E	[ ] E	[ ] E	From 10 to < 25 acres
[ ] F	[ ] F	[ ] F	From 5 to < 10 acres
[ ] G	[ ] G	[ ] G	From 1 to < 5 acres
[ ] H	[ ] H	[ ] H	From 0.5 to < 1 acre
[ ] I	[ ] I	[ ] I	From 0.1 to < 0.5 acre
[x] J	[x] J	[ ] J	From 0.01 to < 0.1 acre
[ ] K	[ ] K	[x] K	< 0.01 acre or assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

- [ ] A Pocosin is the full extent (≥ 90%) of its natural landscape size.
- [ ] B Pocosin is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
[ ] A	[ ] A	≥ 500 acres
[ ] B	[ ] B	From 100 to < 500 acres
[ ] C	[ ] C	From 50 to < 100 acres
[ ] D	[ ] D	From 10 to < 50 acres
[ ] E	[ ] E	< 10 acres
[x] F	[x] F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

[ ] Yes [ ] No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

- [ ] A No artificial edge within 150 feet in all directions
- [ ] B No artificial edge within 150 feet in four (4) to seven (7) directions
- [x] C An artificial edge occurs within 150 feet in more than four (4) directions or assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

- [ ] A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
- [ ] B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
- [x] C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

- [ ] A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
- [ ] B Vegetation diversity is low or has > 10% to 50% cover of exotics.
- [ ] C Vegetation is dominated by exotic species (>50% cover of exotics).

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☒ Yes ☐ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐ A ≥ 25% coverage of vegetation
☐ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
☐ A	☐ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
☐ B	☐ B	Canopy present, but opened more than natural gaps
☒ C	☒ C	Canopy sparse or absent
☐ A	☐ A	Dense mid-story/sapling layer
☐ B	☐ B	Moderate density mid-story/sapling layer
☒ C	☒ C	Mid-story/sapling layer sparse or absent
☐ A	☐ A	Dense shrub layer
☐ B	☐ B	Moderate density shrub layer
☒ C	☒ C	Shrub layer sparse or absent
☒ A	☒ A	Dense herb layer
☐ B	☐ B	Moderate density herb layer
☐ C	☐ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

☐ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
☒ B Not A

19. Diameter Class Distribution – wetland type condition metric

☐ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
☒ C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

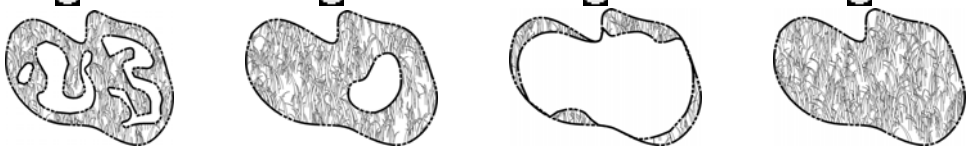
Include both natural debris and man-placed natural debris.

☐ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒ B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐ A ☐ B ☐ C ☐ D



22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

☐ A Overbank and overland flow are not severely altered in the assessment area.
☐ B Overbank flow is severely altered in the assessment area.
☒ C Overland flow is severely altered in the assessment area.
☐ D Both overbank and overland flow are severely altered in the assessment area.

Notes

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Crooked Creek - Wetland CC | **Date** 05/19/11

Wetland Type Bottomland Hardwood Forest | **Assessor Name/Organization** Matt Jenkins, PWS

Level III Ecoregion Piedmont | **Nearest Named Water Body** Crooked Creek

River Basin Yadkin-PeeDee | **USGS 8-Digit Catalogue Unit** 03040105

( ) Yes (•) No **Precipitation within 48 hrs?** | **Latitude/Longitude (deci-degrees)** 35.135596°N, 80.521563°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? (•) Yes ( ) No

Describe effects of stressors that are present.
Wetland located within an actively managed agricultural pasture. Vegetation is regularly mowed and grazed, soils are occasionally driven on and somewhat compacted. Wetland is a linear ditched conveyance.

Regulatory Considerations
Select all that apply to the assessment area.

- [ ] Anadromous fish
- [ ] Federally protected species or State endangered or threatened species
- [ ] NCDWQ riparian buffer rule in effect
- [ ] Abuts a Primary Nursery Area (PNA)
- [ ] Publicly owned property
- [ ] N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
- [ ] Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
- [ ] Designated NCNHP reference community
- [x] Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)

- [ ] Blackwater
- [•] Brownwater
- [ ] Tidal (if tidal, check one of the following boxes) ( ) Lunar ( ) Wind ( ) Both

Is the assessment area on a coastal island? ( ) Yes (•) No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ( ) Yes (•) No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**
Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
( ) A	( ) A	Not severely altered
(•) B	(•) B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**
Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
( ) A	( ) A	Water storage capacity and duration are not altered.
( ) B	( ) B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
(•) C	(•) C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric**
Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
( ) A	( ) A	Majority of wetland with depressions able to pond water > 1 foot deep
(•) B	(•) B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
( ) C	( ) C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
( ) D	( ) D	Depressions able to pond water < 3 inches deep

( ) A Evidence that maximum depth of inundation is greater than 2 feet
(•) B Evidence that maximum depth of inundation is between 1 and 2 feet
( ) C Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

- ☐ A Sandy soil
- ☑ B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
- ☐ C Loamy or clayey soils not exhibiting redoxymorphic features
- ☐ D Loamy or clayey gleyed soil
- ☐ E Histosol or histic epipedon

- ☑ A Soil ribbon < 1 inch
- ☐ B Soil ribbon ≥ 1 inch

- ☑ A No peat or muck presence
- ☐ B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☐ A	☐ A	Little or no evidence of pollutants or discharges entering the assessment area
☐ B	☑ B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☑ C	☐ C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS	5M	2M	
☐ A	☐ A	☐ A	≥ 10% impervious surfaces
☑ B	☑ B	☑ B	< 10% impervious surfaces
☑ C	☑ C	☑ C	Confined animal operations (or other local, concentrated source of pollutants)
☑ D	☑ D	☑ D	≥ 20% coverage of pasture
☐ E	☐ E	☐ E	≥ 20% coverage of agricultural land (regularly plowed land)
☑ F	☑ F	☑ F	≥ 20% coverage of maintained grass/herb
☐ G	☐ G	☐ G	≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H	☐ H	☐ H	Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area condition metric

7a. Is assessment area within 50 feet of a tributary or other open water?

☑ Yes ☐ No If Yes, continue to 7b. If No, skip to Metric 8.

Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.

- ☑ A ≥ 50 feet
- ☐ B From 30 to < 50 feet
- ☐ C From 15 to < 30 feet
- ☐ D From 5 to < 15 feet
- ☐ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.

☑ ≤ 15-feet wide ☐ > 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?

☑ Yes ☐ No

7e. Is tributary or other open water sheltered or exposed?

- ☑ Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
- ☐ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex metric

Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT	WC	
☐ A	☐ A	≥ 100 feet
☐ B	☐ B	From 80 to < 100 feet
☐ C	☐ C	From 50 to < 80 feet
☐ D	☐ D	From 40 to < 50 feet
☐ E	☐ E	From 30 to < 40 feet
☐ F	☐ F	From 15 to < 30 feet
☑ G	☑ G	From 5 to < 15 feet
☐ H	☐ H	< 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

- ☐ A Evidence of short-duration inundation (< 7 consecutive days)
- ☐ B Evidence of saturation, without evidence of inundation
- ☉ C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

- ☉ A Sediment deposition is not excessive, but at approximately natural levels.
- ☐ B Sediment deposition is excessive, but not overwhelming the wetland.
- ☐ C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
☐ A	☐ A	☐ A	≥ 500 acres
☐ B	☐ B	☐ B	From 100 to < 500 acres
☐ C	☐ C	☐ C	From 50 to < 100 acres
☐ D	☐ D	☐ D	From 25 to < 50 acres
☐ E	☐ E	☐ E	From 10 to < 25 acres
☐ F	☐ F	☐ F	From 5 to < 10 acres
☐ G	☐ G	☐ G	From 1 to < 5 acres
☐ H	☐ H	☐ H	From 0.5 to < 1 acre
☉ I	☉ I	☐ I	From 0.1 to < 0.5 acre
☐ J	☐ J	☐ J	From 0.01 to < 0.1 acre
☐ K	☐ K	☉ K	< 0.01 acre or assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

- ☐ A Pocosin is the full extent (≥ 90%) of its natural landscape size.
- ☐ B Pocosin is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
☐ A	☐ A	≥ 500 acres
☐ B	☐ B	From 100 to < 500 acres
☐ C	☐ C	From 50 to < 100 acres
☐ D	☐ D	From 10 to < 50 acres
☐ E	☐ E	< 10 acres
☉ F	☉ F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

☐ Yes ☐ No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

- ☐ A No artificial edge within 150 feet in all directions
- ☐ B No artificial edge within 150 feet in four (4) to seven (7) directions
- ☉ C An artificial edge occurs within 150 feet in more than four (4) directions or assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

- ☐ A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
- ☐ B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
- ☉ C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

- ☐ A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
- ☐ B Vegetation diversity is low or has > 10% to 50% cover of exotics.
- ☐ C Vegetation is dominated by exotic species (>50% cover of exotics).

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☒ Yes ☐ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐ A ≥ 25% coverage of vegetation
☐ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
☐ A	☐ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
☐ B	☐ B	Canopy present, but opened more than natural gaps
☒ C	☒ C	Canopy sparse or absent
☐ A	☐ A	Dense mid-story/sapling layer
☐ B	☐ B	Moderate density mid-story/sapling layer
☒ C	☒ C	Mid-story/sapling layer sparse or absent
☐ A	☐ A	Dense shrub layer
☐ B	☐ B	Moderate density shrub layer
☒ C	☒ C	Shrub layer sparse or absent
☒ A	☒ A	Dense herb layer
☐ B	☐ B	Moderate density herb layer
☐ C	☐ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

☐ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
☒ B Not A

19. Diameter Class Distribution – wetland type condition metric

☐ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
☒ C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

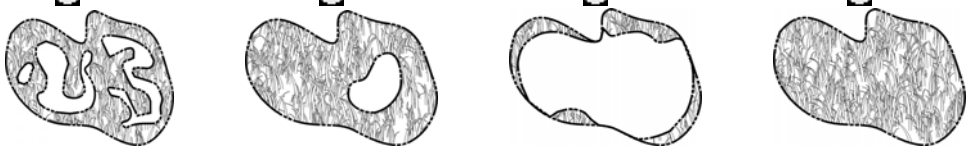
Include both natural debris and man-placed natural debris.

☐ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒ B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐ A ☐ B ☐ C ☐ D



22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

☐ A Overbank and overland flow are not severely altered in the assessment area.
☐ B Overbank flow is severely altered in the assessment area.
☒ C Overland flow is severely altered in the assessment area.
☐ D Both overbank and overland flow are severely altered in the assessment area.

Notes

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Crooked Creek - Wetlands DD & EE | **Date** 05/19/11

Wetland Type Bottomland Hardwood Forest | **Assessor Name/Organization** Matt Jenkins, PWS

Level III Ecoregion Piedmont | **Nearest Named Water Body** Crooked Creek

River Basin Yadkin-PeeDee | **USGS 8-Digit Catalogue Unit** 03040105

( ) Yes (•) No **Precipitation within 48 hrs?** | **Latitude/Longitude (deci-degrees)** 35.135747°N, 80.518962°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? (•) Yes ( ) No

Describe effects of stressors that are present.
Wetland located within an actively managed agricultural pasture. Vegetation is regularly mowed and grazed, soils are occasionally driven on and somewhat compacted. Few mature trees are present.

Regulatory Considerations
Select all that apply to the assessment area.

- [ ] Anadromous fish
- [ ] Federally protected species or State endangered or threatened species
- [ ] NCDWQ riparian buffer rule in effect
- [ ] Abuts a Primary Nursery Area (PNA)
- [ ] Publicly owned property
- [ ] N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
- [ ] Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
- [ ] Designated NCNHP reference community
- [x] Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)

- [ ] Blackwater
- [•] Brownwater
- [ ] Tidal (if tidal, check one of the following boxes) ( ) Lunar ( ) Wind ( ) Both

Is the assessment area on a coastal island? ( ) Yes (•) No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ( ) Yes (•) No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**
Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
(•) A	( ) A	Not severely altered
( ) B	(•) B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**
Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
( ) A	( ) A	Water storage capacity and duration are not altered.
(•) B	(•) B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
( ) C	( ) C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric**
Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
( ) A	( ) A	Majority of wetland with depressions able to pond water > 1 foot deep
( ) B	( ) B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
( ) C	( ) C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
(•) D	(•) D	Depressions able to pond water < 3 inches deep

( ) A Evidence that maximum depth of inundation is greater than 2 feet
( ) B Evidence that maximum depth of inundation is between 1 and 2 feet
(•) C Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

- ☐ A Sandy soil
- ☑ B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
- ☐ C Loamy or clayey soils not exhibiting redoxymorphic features
- ☐ D Loamy or clayey gleyed soil
- ☐ E Histosol or histic epipedon

- ☑ A Soil ribbon < 1 inch
- ☐ B Soil ribbon ≥ 1 inch

- ☑ A No peat or muck presence
- ☐ B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☑ A	☑ A	Little or no evidence of pollutants or discharges entering the assessment area
☐ B	☐ B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☐ C	☐ C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS	5M	2M	
☐ A	☐ A	☐ A	≥ 10% impervious surfaces
☑ B	☑ B	☑ B	< 10% impervious surfaces
☑ C	☑ C	☑ C	Confined animal operations (or other local, concentrated source of pollutants)
☑ D	☑ D	☑ D	≥ 20% coverage of pasture
☐ E	☐ E	☐ E	≥ 20% coverage of agricultural land (regularly plowed land)
☑ F	☑ F	☑ F	≥ 20% coverage of maintained grass/herb
☐ G	☐ G	☐ G	≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H	☐ H	☐ H	Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area condition metric

7a. Is assessment area within 50 feet of a tributary or other open water?

☑ Yes ☐ No If Yes, continue to 7b. If No, skip to Metric 8.

Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.

- ☐ A ≥ 50 feet
- ☐ B From 30 to < 50 feet
- ☐ C From 15 to < 30 feet
- ☑ D From 5 to < 15 feet
- ☐ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.

☐ ≤ 15-feet wide ☑ > 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?

☐ Yes ☑ No

7e. Is tributary or other open water sheltered or exposed?

- ☑ Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
- ☐ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex metric

Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT	WC	
☐ A	☐ A	≥ 100 feet
☐ B	☐ B	From 80 to < 100 feet
☐ C	☐ C	From 50 to < 80 feet
☐ D	☐ D	From 40 to < 50 feet
☐ E	☐ E	From 30 to < 40 feet
☐ F	☐ F	From 15 to < 30 feet
☑ G	☑ G	From 5 to < 15 feet
☐ H	☐ H	< 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

- [x] A Evidence of short-duration inundation (< 7 consecutive days)
- [ ] B Evidence of saturation, without evidence of inundation
- [ ] C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

- [x] A Sediment deposition is not excessive, but at approximately natural levels.
- [ ] B Sediment deposition is excessive, but not overwhelming the wetland.
- [ ] C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
[ ] A	[ ] A	[ ] A	≥ 500 acres
[ ] B	[ ] B	[ ] B	From 100 to < 500 acres
[ ] C	[ ] C	[ ] C	From 50 to < 100 acres
[ ] D	[ ] D	[ ] D	From 25 to < 50 acres
[ ] E	[ ] E	[ ] E	From 10 to < 25 acres
[ ] F	[ ] F	[ ] F	From 5 to < 10 acres
[ ] G	[ ] G	[ ] G	From 1 to < 5 acres
[ ] H	[ ] H	[ ] H	From 0.5 to < 1 acre
[ ] I	[ ] I	[ ] I	From 0.1 to < 0.5 acre
[x] J	[x] J	[ ] J	From 0.01 to < 0.1 acre
[ ] K	[ ] K	[x] K	< 0.01 acre or assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

- [ ] A Pocosin is the full extent (≥ 90%) of its natural landscape size.
- [ ] B Pocosin is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
[ ] A	[ ] A	≥ 500 acres
[ ] B	[ ] B	From 100 to < 500 acres
[ ] C	[x] C	From 50 to < 100 acres
[ ] D	[ ] D	From 10 to < 50 acres
[ ] E	[ ] E	< 10 acres
[x] F	[ ] F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

[ ] Yes [ ] No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

- [ ] A No artificial edge within 150 feet in all directions
- [x] B No artificial edge within 150 feet in four (4) to seven (7) directions
- [ ] C An artificial edge occurs within 150 feet in more than four (4) directions or assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

- [ ] A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
- [x] B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
- [ ] C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

- [ ] A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
- [ ] B Vegetation diversity is low or has > 10% to 50% cover of exotics.
- [ ] C Vegetation is dominated by exotic species (>50% cover of exotics).

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☉ Yes ☐ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐ A ≥ 25% coverage of vegetation
☐ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
☐ A	☐ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
☉ B	☉ B	Canopy present, but opened more than natural gaps
☐ C	☐ C	Canopy sparse or absent
☐ A	☐ A	Dense mid-story/sapling layer
☐ B	☐ B	Moderate density mid-story/sapling layer
☉ C	☉ C	Mid-story/sapling layer sparse or absent
☐ A	☐ A	Dense shrub layer
☐ B	☐ B	Moderate density shrub layer
☉ C	☉ C	Shrub layer sparse or absent
☉ A	☉ A	Dense herb layer
☐ B	☐ B	Moderate density herb layer
☐ C	☐ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

☐ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
☉ B Not A

19. Diameter Class Distribution – wetland type condition metric

☐ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☉ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
☐ C Majority of canopy trees are < 6 inches DBH or no trees.

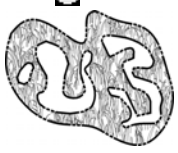
20. Large Woody Debris – wetland type condition metric

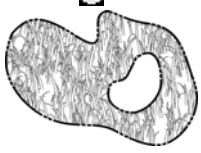
Include both natural debris and man-placed natural debris.

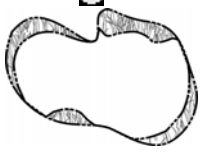
☐ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☉ B Not A

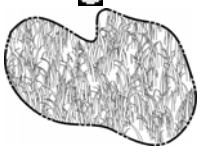
21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐ A 

☐ B 

☐ C 

☐ D 

22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

☉ A Overbank and overland flow are not severely altered in the assessment area.
☐ B Overbank flow is severely altered in the assessment area.
☐ C Overland flow is severely altered in the assessment area.
☐ D Both overbank and overland flow are severely altered in the assessment area.

Notes

Crooked Creek Soil Borings

Sample Number	Depth (in)	Munsell Color	Texture	Mottle %	Munsell Color	Notes
CC01	0-12	10YR 6/3	silt loam	10%	7.5YR 5/6	adjacent to Wetland EE
	12-24	2.5Y 6/6	silt	0%	N/A	
CC02	0-8	2.5Y 5/3	silt loam	5%	7.5YR 4/6	adjacent to Wetland DD
	8-16	2.5Y 6/3	silt loam	5%	10YR 4/4	
	16-24	2.5Y 6/4	silt loam	20%	2.5Y 6/8	
CC03	0-10	10YR 6/3	silt loam	5%	10YR 5/6	
	10-24	2.5Y 6/4	silt loam	5%	2.5Y 6/8	
CC04	0-3	10YR 6/4	silt loam	10%	7.5YR 5/8	floodplain depression ~12" below surrounding area
	3-24	7.5YR 6/8	silt loam	0%	N/A	
CC05	0-24	10YR 5/2	silt loam	20%	5YR 4/4	benched area adjacent to intermittent channel
CC06	0-16	10YR 5/4	silt loam	0%	N/A	
	16-24	2.5Y 6/4	silt loam	0%	N/A	
CC07	0-24	10YR 6/6	silt (powdery dry)	0%	N/A	highly compacted
CC08	0-14	10YR 5/6	silt loam	0%	N/A	levee area of Crooked Creek
	14-20	10YR 6/4	silt loam	5%	10YR 5/4	
	20-24	10YR 6/6	silt loam	0%	N/A	
CC09	0-8	10YR 5/4	silt loam	10%	7.5YR 4/6	
	8-18	2.5Y 5/3	silt loam	20%	7.5YR 5/6	
	18-24	10YR 5/4	clay sand	0%	N/A	
CC10	0-3	10YR 6/4	silt loam	5%	10YR 4/4	
	3-24	2.5Y 7/6	silt loam	0%	N/A	
CC11	0-24	10YR 6/4	silt (powdery dry)	0%	N/A	located on upland area amidst Wetland CC
CC12	0-3	10YR 5/4	silt loam	10%	10YR 4/4	
	3-24	2.5Y 6/3	silt loam	20%	10YR 5/6	
CC13	0-4	10YR 5/2	silt loam	20%	7.5YR 4/6	
	4-24	2.5Y 6/4	silt loam	30%	2.5Y 6/6	
CC14	0-10	10YR 5/3	silt loam	5%	10YR 4/4	
	10-24	2.5Y 6/2	silt loam	20%	2.5Y 6/6	
CC15	0-3	10YR 5/4	silt loam	10%	10YR 3/6	
	3-24	2.5Y 6/6	silt loam	10%	10YR 5/6	
CC16	0-3	10YR 4/2	silt loam	0%	N/A	next to gwg #5
	3-12	10YR 5/2	silt loam	10%	7.5YR 5/6	
	12-24	2.5Y 7/2	silty clay loam	20%	10YR 5/8	
CC17	0-2	10YR 5/3	silt loam	0%	N/A	
	2-14	10YR 6/2	silt loam	20%	10YR 5/8	
	14-24	10YR 5/2	clay loam	20%	10YR 5/8	
CC18	0-4	10YR 5/3	silt loam	5%	7.5YR 5/6	
	4-12	2.5Y 6/3	silt loam	10%	7.5YR 5/8	
	12-24	2.5Y 6/6	clay loam	30%	10YR 5/2	
CC19	0-24	10YR 5/4	silt loam	0%	N/A	right bank side of UT to Crooked Creek
CC20	0-3	10YR 5/3	silt loam	0%	N/A	
	3-8	2.5Y 5/3	silt loam	10%	7.5YR 3/4	
	8-24	2.5Y 6/2	clay silt loam	20%	10YR 3/4	
CC21	0-2	10YR 5/3	silt loam	0%	N/A	
	2-24	2.5Y 5/2	clay loam	20%	5YR 3/4	
CC22	0-2	10YR 5/3	silt loam	0%	N/A	
	2-12	10YR 5/2	silt loam	10%	7.5YR 4/4	
	12-24	10YR 5/6	clay loam	40%	2.5Y 6/2	
CC23	0-4	10YR 5/2	silt loam	0%	N/A	
	4-10	10YR 5/2	silt loam	5%	10YR 5/6	
	10-24	2.5Y 6/1	clay loam	20%	10YR 5/6	
CC24	0-4	10YR 4/2	silt loam	0%	N/A	adjacent to Wetland AA
	4-12	10YR 5/2	clay silt loam	10%	7.5YR 5/6	
	12-24	2.5Y 7/1	clay loam	30%	10YR 6/6	

Crooked Creek Soil Borings

Sample Number	Depth (in)	Munsell Color	Texture	Mottle %	Munsell Color	Notes
CC25	0-2	10YR 4/2	silt loam	0%	N/A	adjacent to Wetland AA
	2-8	10YR 6/2	silt loam	10%	7.5YR 5/6	
	8-24	10YR 7/1	clay loam	20%	10YR 5/8	
CC26	0-2	10YR 5/3	silt loam	0%	N/A	
	2-12	2.5Y 5/2	silt loam	10%	10YR 5/6	
	12-24	2.5Y 7/3	clay silt loam	30%	2.5Y 6/6	
CC27	0-14	5YR 5/6	gravelly silt loam	0%	N/A	adjacent to ditched portion of Wetland AA
	14-24	5YR 5/1	clay	10%	5YR 4/6	
CC28	0-5	7.5YR 3/2	silt loam	5%	7.5YR 4/6	
	5-8	10YR 5/2	silt loam	10%	7.5YR 5/6	
	8-24	10YR 6/2	loamy sand	30%	10YR 6/8	
CC29	0-8	2.5Y 5/3	silt loam	10%	7.5YR 4/6	
	8-24	2.5Y 7/2	clay loam	20%	10YR 6/8	
CC30	0-5	7.5YR 5/2	silt loam	5%	5YR 4/6	taken within Wetland AA
	5-20	7.5YR 5/2	clay loam	10%	5YR 4/6	
	20-24	7.5YR 5/2	clay loam	20%	10YR 5/8	
CC31	0-2	10YR 4/2	silt loam	0%	N/A	
	2-5	2.5Y 4/2	silt loam	5%	10YR 4/6	
	5-24	2.5Y 6/2	clay loam	20%	10YR 4/4	
CC32	0-2	10YR 4/2	silt loam	0%	N/A	
	2-12	10YR 5/3	silt loam	5%	10YR 3/6	
	12-24	10YR 5/6	clay loam	40%	2.5Y 6/3	
CC33	0-6	10YR 4/3	silt loam	0%	N/A	
	6-24	10YR 5/4	clay silt loam	30%	10YR 4/4	
CC34	0-2	10YR 4/2	silt loam	0%	N/A	
	2-8	10YR 5/3	silt loam	5%	10YR 2/2	
	8-20	10YR 5/4	clay loam	40%	10YR 2/2	
	20-24	10YR 6/4	clay loam	30%	10YR 5/6	
CC35	0-5	10YR 5/4	silt loam	5%	10YR 3/3	
	5-15	2.5Y 5/3	silt loam	20%	7.5YR 2.5/2	
	15-24	2.5Y 5/4	clay loam	20%	7.5YR 2.5/2	
CC36	0-18	10YR 5/4	silt loam	0%	N/A	
	18-24	10YR 5/6	clay loam	10%	10YR 6/2	
CC37	0-10	10YR 5/3	silt loam	10%	5YR 4/4	
	10-24	2.5Y 5/4	clay loam	10%	7.5YR 3/2	
CC38	0-10	10YR 6/2	silt loam	10%	7.5YR 4/6	
	10-24	2.5Y 7/2	sandy clay loam	20%	10YR 6/6	
CC39	0-3	10YR 4/2	silt loam	0%	N/A	
	3-14	10YR 5/4	silt loam	10%	7.5YR 4/6	
	14-24	2.5Y 6/4	sandy clay loam	0%	N/A	
CC40	0-16	10YR 5/4	silt loam	0%	N/A	
	16-24	7.5YR 5/6	sandy silt loam	0%	N/A	
CC41	0-2	10YR 3/3	silt loam	0%	N/A	
	2-12	10YR 6/2	silt loam	20%	7.5YR 4/4	
	12-24	10YR 6/6	sandy clay loam	0%	N/A	
CC42	0-6	10YR 5/3	silt loam	5%	7.5YR 5/8	
	6-16	10YR 5/3	silt loam	10%	7.5YR 5/6	
	16-24	2.5Y 6/4	clay loam	20%	10YR 5/6	
CC43	0-2	10YR 4/2	silt loam	0%	N/A	
	2-10	10YR 4/2	silt loam	10%	7.5YR 3/4	
	10-24	10YR 6/2	clay loam	20%	7.5YR 3/4	
CC44	0-4	10YR 3/3	silt loam	0%	N/A	
	4-18	10YR 5/2	gravelly clay loam	20%	7.5YR 5/8	
	18-24	2.5Y 6/4	clay loam	30%	10YR 6/6	
CC45	0-24		gravelly silt			fill dirt - varying matrix, mixed gravel and stone
CC46	0-2	10YR 4/2	silt loam	0%	N/A	low lying area near existing culvert
	2-7	10YR 5/2	gravelly silt loam	30%	7.5YR 4/6	
	7+					restrictive stone layer at ~8"
CC47	0-16	10YR 5/3	gravelly silt loam	5%	7.5YR 4/4	heavily compacted and very dry silt
	16+					restrictive stone layer at ~16"
CC48	0-8	10YR 5/4	silt loam	5%	7.5YR 5/6	
	8-24	2.5Y 7/4	clay loam	20%	2.5Y 6/6	

Crooked Creek #2
630 Highway 218
Monroe, NC 28110

Inquiry Number: 3080442.4
June 01, 2011

The EDR Aerial Photo Decade Package

EDR® Environmental Data Resources Inc

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

EDR Aerial Photo Decade Package

Environmental Data Resources, Inc. (EDR) Aerial Photo Decade Package is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's professional researchers provide digitally reproduced historical aerial photographs, and when available, provide one photo per decade.

When delivered electronically by EDR, the aerial photo images included with this report are for ONE TIME USE ONLY. Further reproduction of these aerial photo images is prohibited without permission from EDR. For more information contact your EDR Account Executive.

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

Date EDR Searched Historical Sources:

Aerial Photography June 01, 2011

Target Property:

630 Highway 218

Monroe, NC 28110

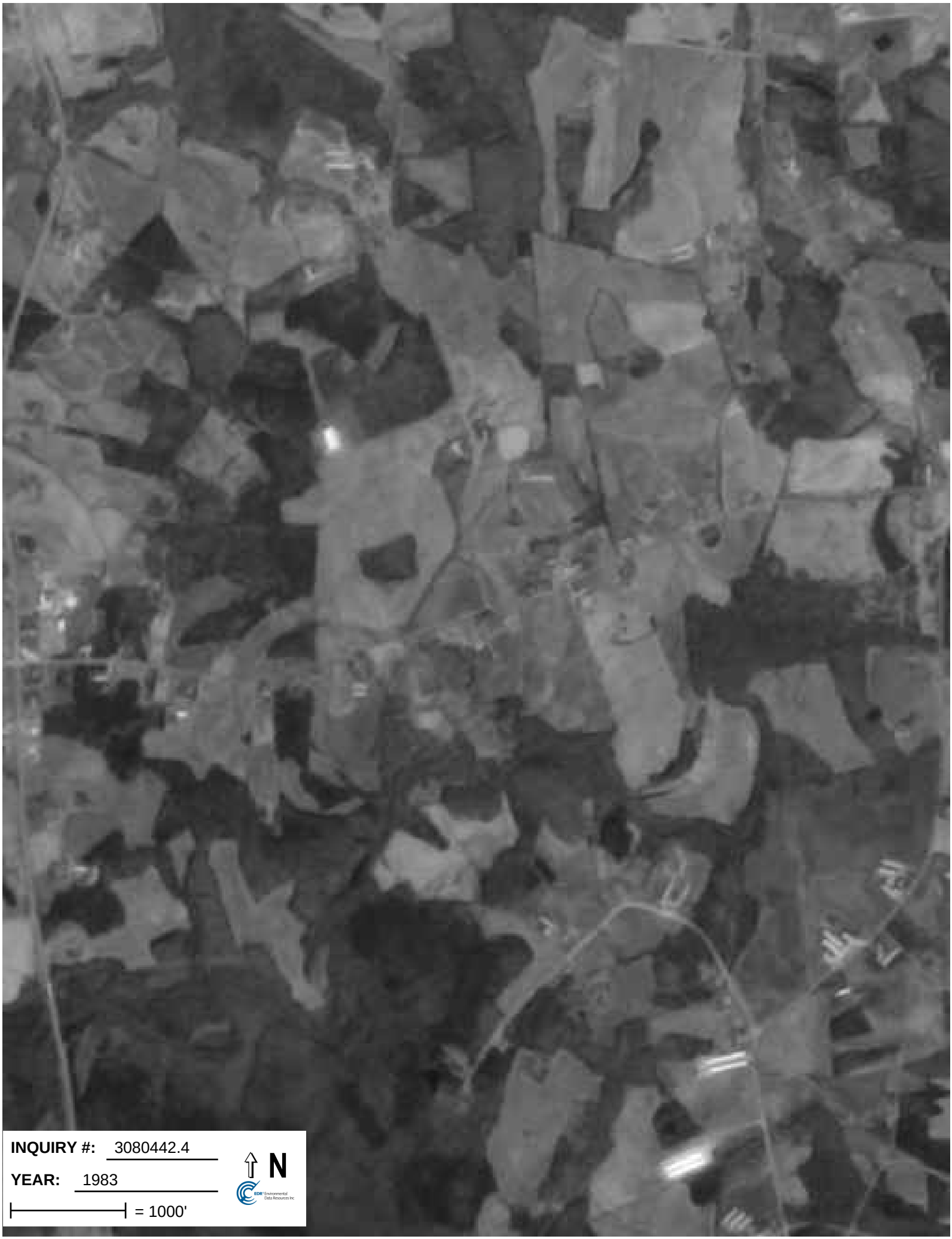
Year	*Scale*	*Details*	*Source*
1948	Aerial Photograph. Scale: 1"=1000'	Panel #: 35080-B5, Midland, NC;/Flight Date: May 15, 1948	EDR
1961	Aerial Photograph. Scale: 1"=1000'	Panel #: 35080-B5, Midland, NC;/Flight Date: July 29, 1961	EDR
1969	Aerial Photograph. Scale: 1"=500'	Panel #: 35080-B5, Midland, NC;/Flight Date: March 14, 1969	EDR
1976	Aerial Photograph. Scale: 1"=1000'	Panel #: 35080-B5, Midland, NC;/Flight Date: March 24, 1976	EDR
1983	Aerial Photograph. Scale: 1"=1000'	Panel #: 35080-B5, Midland, NC;/Flight Date: March 02, 1983	EDR
1993	Aerial Photograph. Scale: 1"=750'	Panel #: 35080-B5, Midland, NC;/Flight Date: February 23, 1993	EDR
1998	Aerial Photograph. Scale: 1"=750'	Panel #: 35080-B5, Midland, NC;/Flight Date: March 13, 1998	EDR
2006	Aerial Photograph. Scale: 1"=604'	Panel #: 35080-B5, Midland, NC;/Flight Date: January 01, 2006	EDR


INQUIRY #: 3080442.4
YEAR: 1948
= 1000'
N


INQUIRY #: 3080442.4
YEAR: 1961
= 1000'
N
EDR Environmental Data Resources Inc


INQUIRY #: 3080442.4
YEAR: 1969
= 500'
N


INQUIRY #: 3080442.4
YEAR: 1976
= 1000'
N


INQUIRY #: 3080442.4
YEAR: 1983
= 1000'
N
EDR Environmental Data Resources Inc

INQUIRY #: 3080442.4

YEAR: 1993

= 750'

N


INQUIRY #: 3080442.4
YEAR: 1998
= 750'
N


INQUIRY #: 3080442.4
YEAR: 2006
= 604'
N

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:	Crooked Creek #2 Restoration Project
County Name:	Union County
EEP Number:	D09126S, SCO 09-0751301
Project Sponsor:	Wildlands Engineering, Inc.
Project Contact Name:	Andrea Spangler Eckardt
Project Contact Address:	1430 S. Mint Street, Suite 104, Charlotte, NC 28203
Project Contact E-mail:	aeckardt@wildlandsinc.com
EEP Project Manager:	Robin Hoffman

Project Description

The Crooked Creek #2 Restoration Project is a stream and wetland mitigation project located in Union County, NC. The project is located on Crooked Creek and its tributaries immediately south of NC Highway 218. The project will provide stream and wetland mitigation units to NCEEP in the Yadkin River Basin (03040105). The mitigation project involves a combination of stream restoration, enhancement, and preservation and wetland restoration and enhancement.

For Official Use Only

Reviewed By:

Robin Hoffman 8/8/11

Date

Robin Hoffman

EEP Project Manager

Conditional Approved By:

Date

For Division Administrator FHWA

☐ **Check this box if there are outstanding issues**

Final Approval By:

8-8-11

Date

For Division Administrator FHWA

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:	Crooked Creek #2 Stream Restoration
Name of stream or feature:	Crooked Creek (entire portion is FEMA mapped) and several unnamed tributaries (UTs) to Crooked Creek (not FEMA-mapped)
County:	Union
Name of river basin:	Yadkin
Is project urban or rural?	rural
Name of Jurisdictional municipality/county:	Town of Fairview
DFIRM panel number for entire site:	Community: Town of Fairview Community No. 370024 FIRM Panel: 5540 Map Number: 3710554000J Effective Date: October 16, 2008
Consultant name:	Wildlands Engineering, Inc. Aaron S. Earley, PE, CFM
Phone number:	704-332-7754
Address:	1430 S. Mint Street, Suite 104 Charlotte, NC 28203

Design Information

Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500'.
Please see attached Figure 4 Hydrologic Features and Figure 10 Proposed Stream Restoration Design from the Mitigation Plan report.

Summarize stream reaches or wetland areas according to their restoration priority.
The construction on Crooked Creek will be comprised of enhancement II. Stream banks will be graded and stabilized, an in-stream structure will be installed, and riparian vegetation will be planted. The channel pattern and profile will not be changed. Native vegetation will be planted within the conservation easement boundary to establish a riparian buffer. The unnamed tributaries (UTs) to Crooked Creek will be restored to meandering channels, enhanced in place by laying back banks, adding in-stream habitat structures, and planting riparian buffers, or preserved. Wetland restoration, enhancement, and creation will take place in the floodplain of Crooked Creek, which will consist of planting and minor soil roughening.

Reach	**Length**	**Priority**
SFHA mapped channel		
Crooked Creek	**2,300 LF**	**Priority 1 Restoration**
non-SFHA mapped channels		
UT1	1,700 LF	Priority 1 Restoration
UT2	400 LF	Enhancement II
UT3	60 LF	Preservation

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

YES- Crooked Creek only. The Unnamed tributaries (UTs) do not have associated SFHA.

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☑ Detailed Study

☐ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation:

Check if applies:

☑ AE Zone

- ◉ Floodway
- ○ Non-Encroachment

☐ A Zone

- ○ Local Setbacks Required
- ○ No Local Setbacks Required

If local setbacks are required, list how many feet: n/a

Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks?

○ Yes ◉ No

Land Acquisition (Check)

☐ State owned (fee simple)

☑ Conservation easment (Design Bid Build)

☐ Conservation Easement (Full Delivery Project)

Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)

Is community/county participating in the NFIP program?

◉ Yes ○ No

Name of Local Floodplain Administrator: Mr. Ed Humphries
Land Use Administrator – Town of Fairview
Phone Number: 704 564-3412

Floodplain Requirements

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

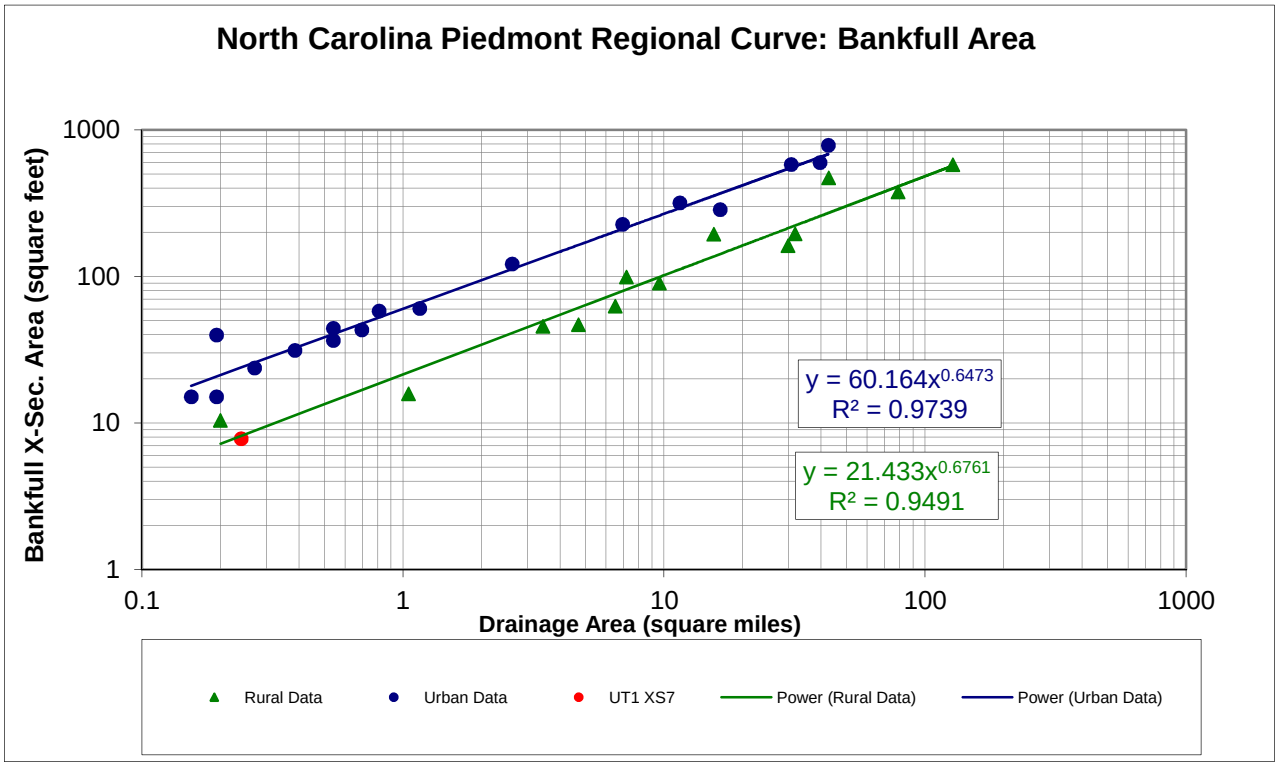
- ☐ No Action
- ☑ No Rise
- ☐ Letter of Map Revision
- ☐ Conditional Letter of Map Revision
- ☐ Other Requirements

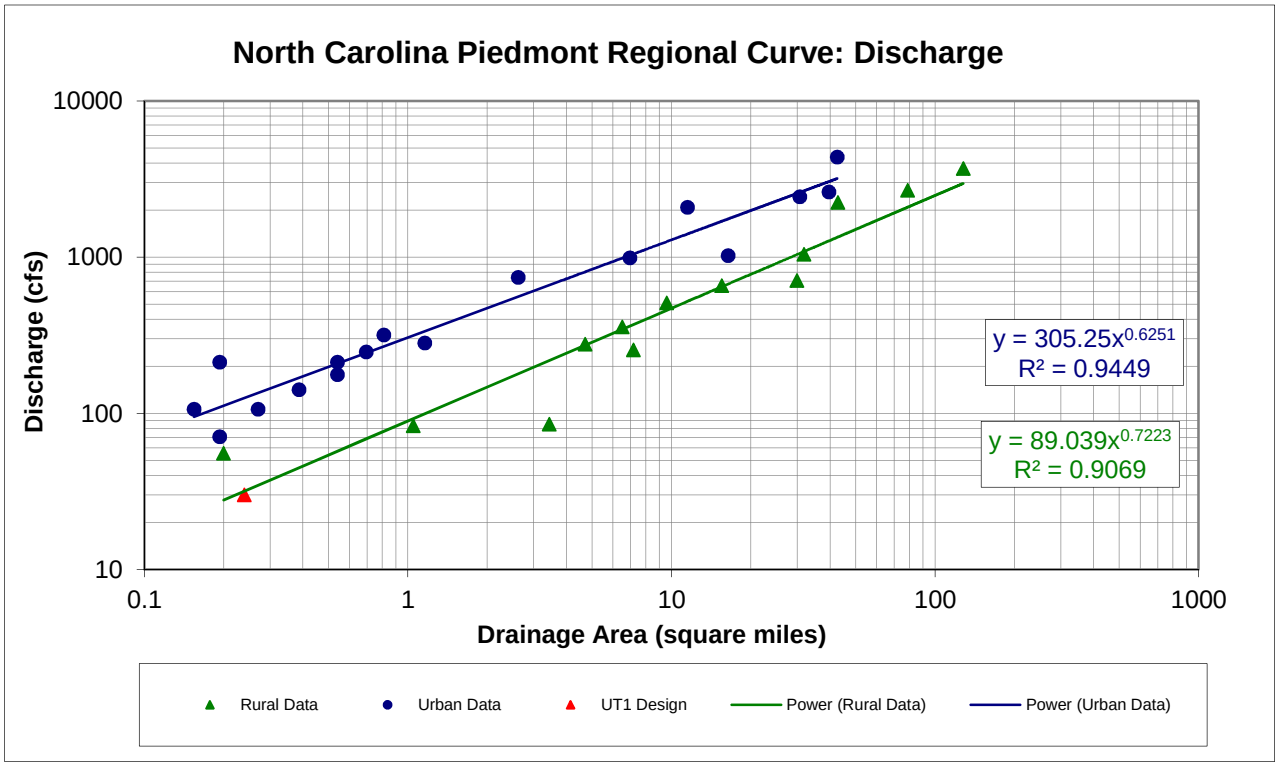
List other requirements:

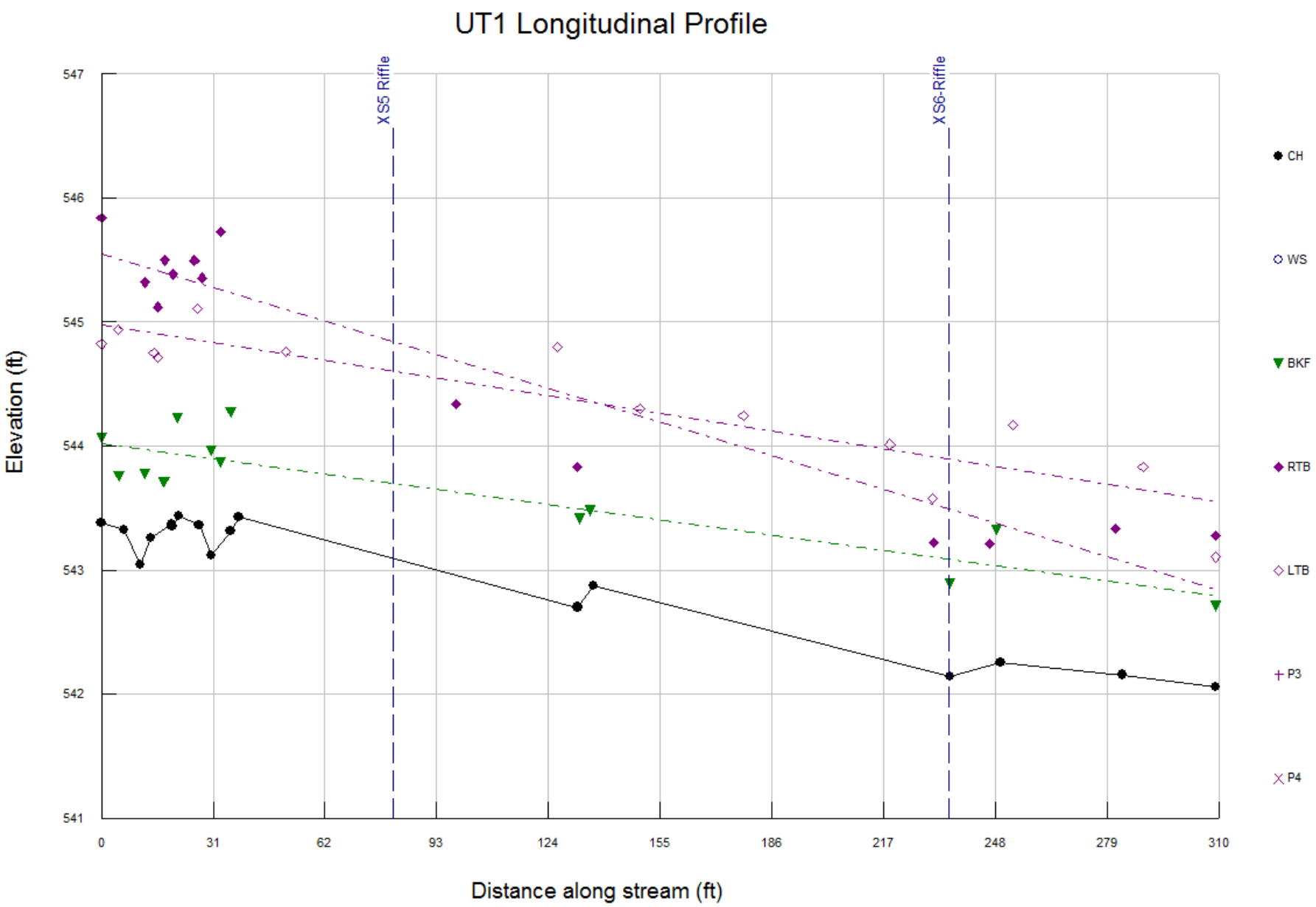
Comments:

Name: Aaron S. Earley, PE, CFM Signature: AEE

Title: Senior Water Resources Engineer Date: 9-23-11


North Carolina Piedmont Regional Curve: Bankfull Area
Bankfull X-Sec. Area (square feet)
1000
100
10
1
0.1
1
10
100
1000
Drainage Area (square miles)
y = 60.164x^0.6473
R² = 0.9739
y = 21.433x^0.6761
R² = 0.9491
Rural Data
Urban Data
UT1 XS7
Power (Rural Data)
Power (Urban Data)


North Carolina Piedmont Regional Curve: Discharge
Discharge (cfs)
10000
1000
100
10
0.1
1
10
100
1000
Drainage Area (square miles)
y = 305.25x^0.6251
R² = 0.9449
y = 89.039x^0.7223
R² = 0.9069
Rural Data
Urban Data
UT1 Design
Power (Rural Data)
Power (Urban Data)


UT1 Longitudinal Profile
XS5 Riffle
XS6-Riffle
Elevation (ft)
547
546
545
544
543
542
541
0
31
62
93
124
155
186
217
248
279
310
Distance along stream (ft)
CH
WS
BKF
RTB
LTB
P3
P4

UT1_LP_edited
RIVERMORPH PROFILE SUMMARY

River Name: UT1
Reach Name: Reach 1 - Upstream
Profile Name: UT1 Reach 1 (Upstrem) Profile
Survey Date: 06/10/11

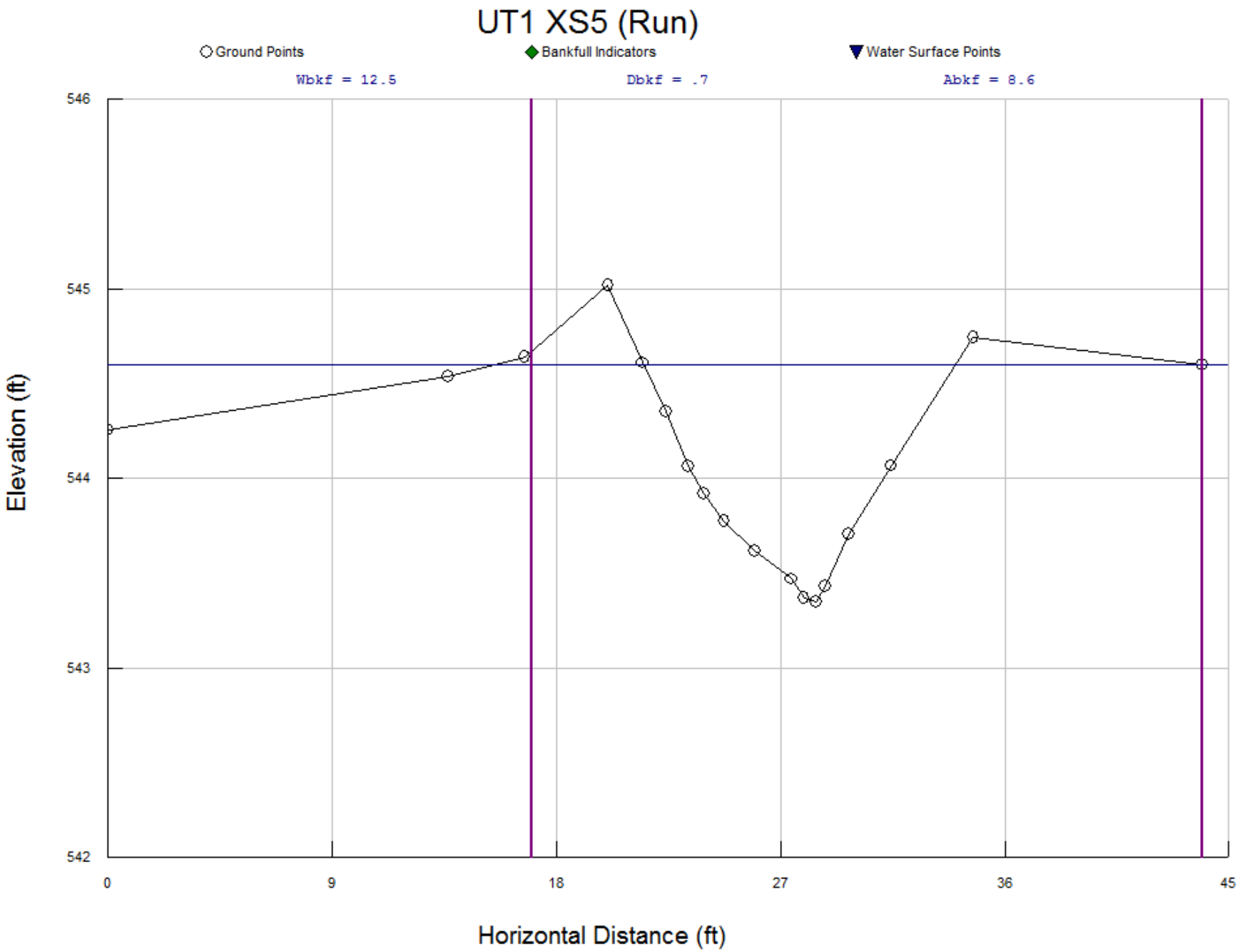
Survey Data

STA	CH	WS	BKF	RTB	LTB
0	543.382			545.842	544.822
0.118			544.069		
4.739					544.937
4.873			543.753		
6.176	543.328				
10.892	543.047				
12.128			543.773		
12.2				545.319	
13.789	543.263				
14.526					544.75
15.572				545.121	544.71
17.405			543.707		
17.598				545.498	
19.508	543.374				
19.697	543.355				
19.921				545.385	
21.152			544.23		
21.401	543.44				
25.848				545.497	
26.619					545.11
27.174	543.362				
27.868				545.356	
30.558	543.117		543.96		
33.219			543.866		
33.238				545.724	
35.896	543.314		544.274		
38.172	543.43				
51.092					544.763
98.365				544.336	
126.569					544.795
132.098				543.833	
132.143	542.701				
132.656			543.413		
135.555			543.48		
136.548	542.873				
149.352					544.301
178.142					544.244
218.795					544.015
230.545					543.577
231.007				543.224	
235.455	542.143		542.895		
246.323				543.216	
248.318			543.326		
249.511	542.257				
252.793					544.169
281.463				543.336	
283.253	542.157				

288.97 543.83
309.21 542.057 542.71 543.28 543.105

Cross Section Locations

Cross Section Name	Type	Profile Station
XS6-Riffle	Riffle	235
XS5 Riffle	Riffle	81


UT1 XS5 (Run)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 12.5
Dbkf = .7
Abkf = 8.6
546
545
544
543
542
Elevation (ft)
0
9
18
27
36
45
Horizontal Distance (ft)

UT1_XS5

RIVERMORPH CROSS SECTION SUMMARY

River Name: UT1
Reach Name: Reach 1 - Upstream
Cross Section Name: XS5 Riffle
Survey Date: 06/10/11

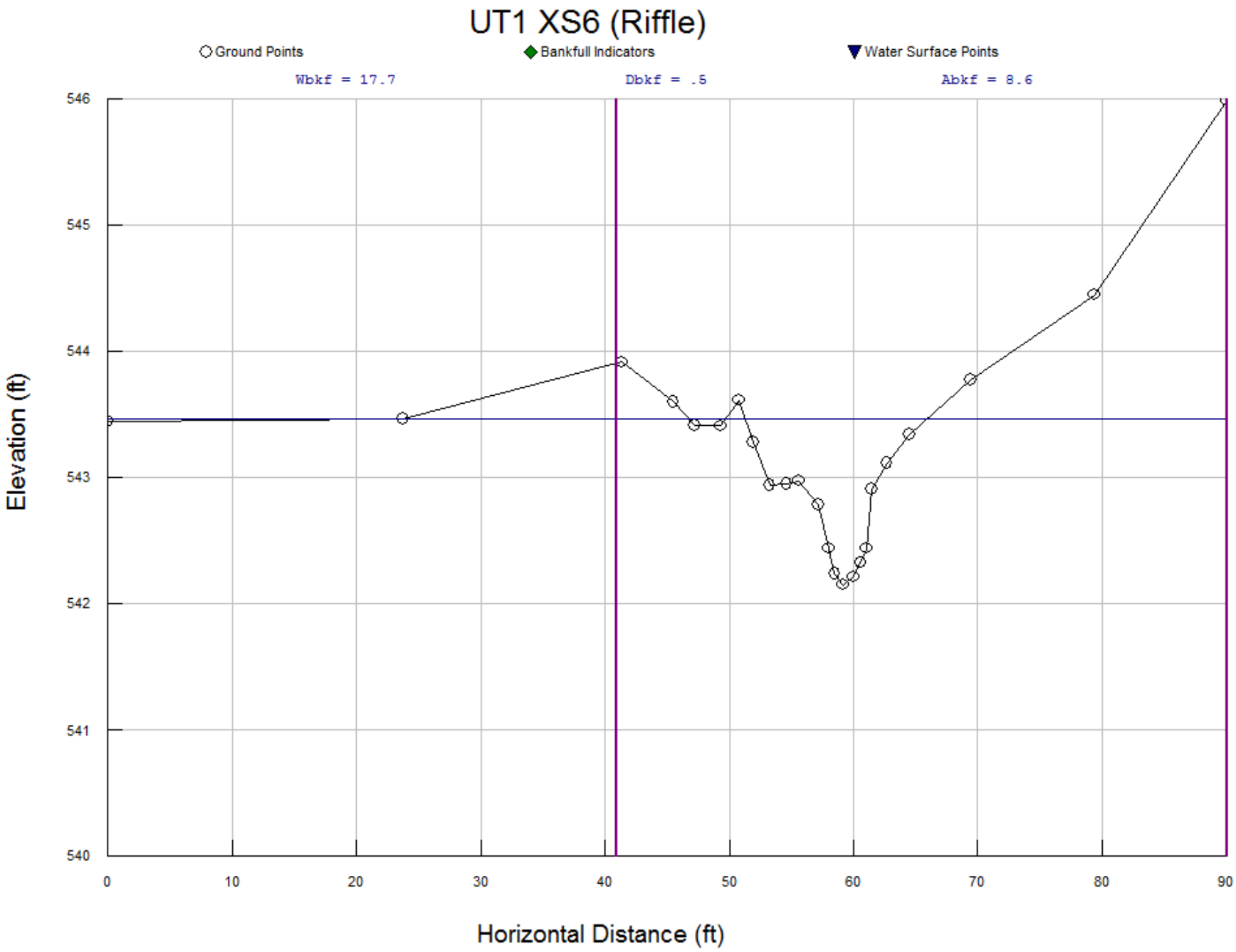
Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	544.255329	riffle
13.65	0	544.539645	
16.73	0	544.639611	
20.08	0	545.018367	ltb
21.46	0	544.609439	
22.41	0	544.353123	
23.29	0	544.063915	
23.91	0	543.917811	
24.73	0	543.774573	
25.97	0	543.616836	
27.43	0	543.469216	lch
27.94	0	543.367974	
28.44	0	543.347737	
28.81	0	543.433517	rch
29.74	0	543.70752	
31.44	0	544.067796	
34.73	0	544.744852	
43.93	0	544.600892	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	545.85	545.85	545.85
Bankfull Elevation (ft)	544.6	544.6	544.6
Floodprone Width (ft)	43.93	-----	-----
Bankfull Width (ft)	12.53	5.96	6.58
Entrenchment Ratio	3.51	-----	-----
Mean Depth (ft)	0.69	0.7	0.69
Maximum Depth (ft)	1.25	1.13	1.25
Width/Depth Ratio	18.16	8.56	9.6
Bankfull Area (sq ft)	8.65	4.14	4.5
Wetted Perimeter (ft)	12.81	7.22	7.86
Hydraulic Radius (ft)	0.67	0.57	0.57
Begin BKF Station	21.49	21.49	27.45
End BKF Station	34.03	27.45	34.03


UT1 XS6 (Riffle)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 17.7
Dbkf = .5
Abkf = 8.6
546
545
544
543
542
541
540
Elevation (ft)
0
10
20
30
40
50
60
70
80
90
Horizontal Distance (ft)

UT1_XS6

RIVERMORPH CROSS SECTION SUMMARY

River Name: UT1
Reach Name: Reach 1 - Upstream
Cross Section Name: XS6-Riffle
Survey Date: 06/10/11

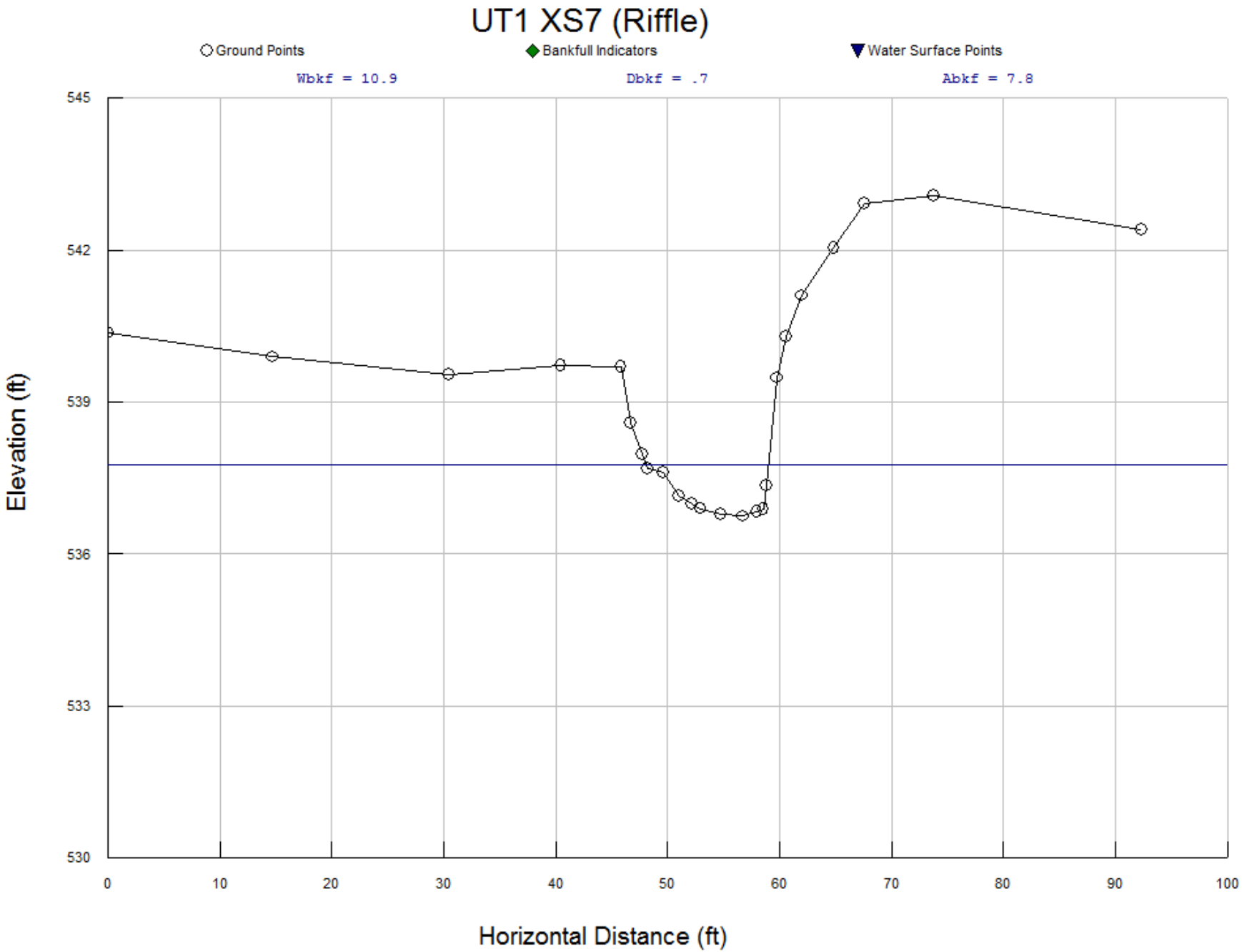
Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	543.442065	riffle
23.79	0	543.465369	
41.35	0	543.914534	
45.51	0	543.597804	
47.2	0	543.416686	
49.35	0	543.409246	
50.78	0	543.613121	
51.93	0	543.27925	
53.26	0	542.943646	
54.6	0	542.950615	
55.57	0	542.975108	
57.19	0	542.785746	
58.02	0	542.439996	
58.47	0	542.243524	lch
59.15	0	542.150918	
60.02	0	542.214383	
60.56	0	542.326391	
61.01	0	542.439538	rch
61.5	0	542.908894	
62.66	0	543.115243	
64.48	0	543.345281	
69.43	0	543.776339	
79.41	0	544.449339	
90.03	0	545.987537	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	544.79	544.79	544.79
Bankfull Elevation (ft)	543.47	543.47	543.47
Floodprone Width (ft)	500	-----	-----
Bankfull Width (ft)	17.71	10.81	8.4
Entrenchment Ratio	28.23	-----	-----
Mean Depth (ft)	0.49	0.33	0.66
Maximum Depth (ft)	1.32	0.82	1.32
Width/Depth Ratio	36.38	28.18	12.72
Bankfull Area (sq ft)	8.62	3.08	5.55
Wetted Perimeter (ft)	18.17	10.24	9.56
Hydraulic Radius (ft)	0.47	0.3	0.58
Begin BKF Station	46.7	46.7	57.51
End BKF Station	65.91	57.51	65.91


UT1 XS7 (Riffle)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 10.9
Dbkf = .7
Abkf = 7.8
Elevation (ft)
545
542
539
536
533
530
0
10
20
30
40
50
60
70
80
90
100
Horizontal Distance (ft)

UT1_XS7

RIVERMORPH CROSS SECTION SUMMARY

River Name: UT1
Reach Name: Reach 2 - Middle
Cross Section Name: XS7-Riffle
Survey Date: 06/10/11

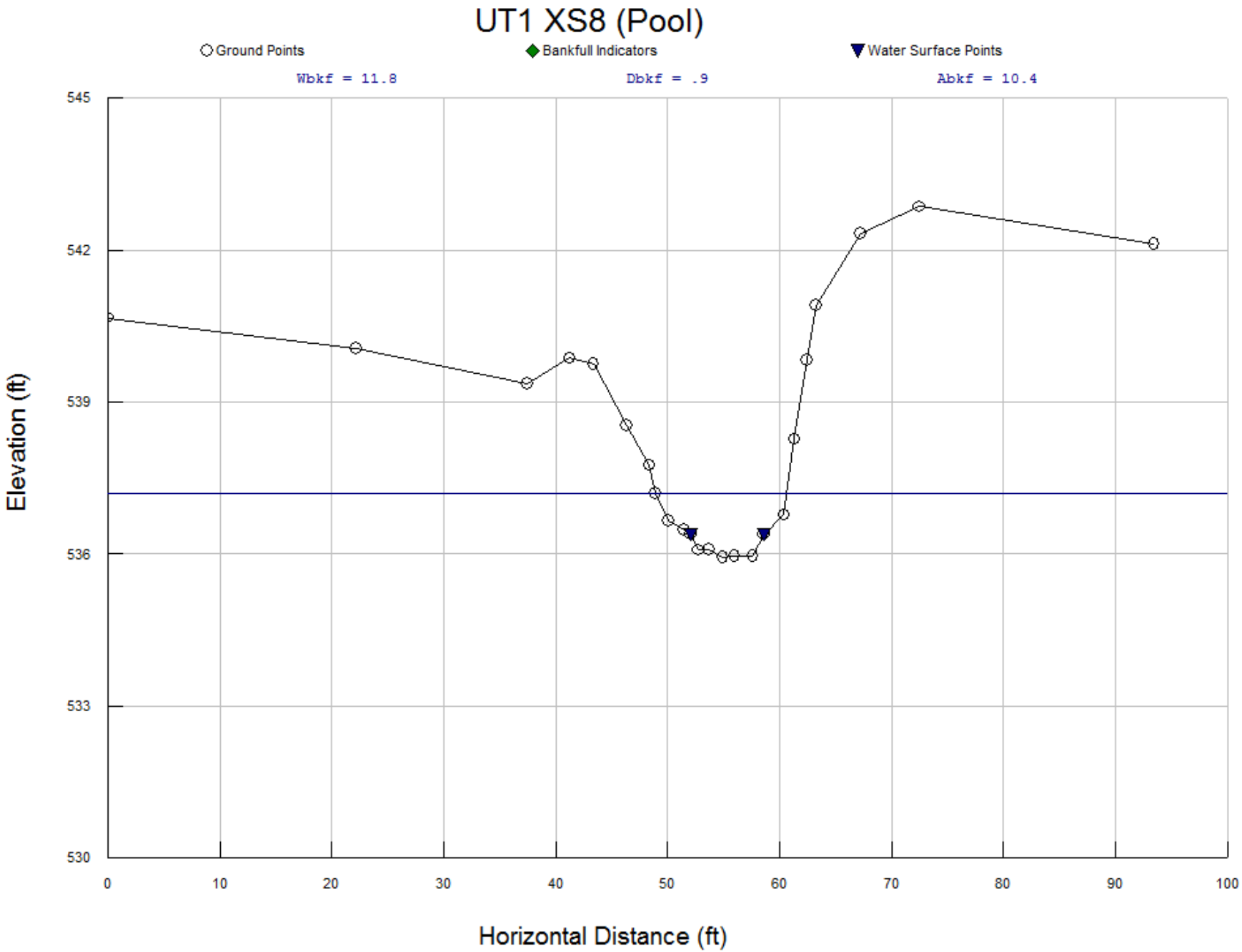
Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	540.372639	riffle
14.67	0	539.891129	
30.43	0	539.533114	
40.41	0	539.722917	
45.81	0	539.700174	
46.67	0	538.591557	
47.72	0	537.965109	
48.23	0	537.68867	
49.62	0	537.612485	
51.03	0	537.148213	
52.12	0	536.98438	
52.92	0	536.901172	lch
54.71	0	536.778157	
56.74	0	536.746218	
57.93	0	536.829524	
58.55	0	536.887549	rch
58.84	0	537.354776	
59.71	0	539.472557	
60.55	0	540.290701	
61.99	0	541.098806	
64.8	0	542.043749	
67.56	0	542.914044	
73.75	0	543.06966	
92.31	0	542.410758	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	538.79	538.79	538.79
Bankfull Elevation (ft)	537.77	537.77	537.77
Floodprone Width (ft)	12.92	-----	-----
Bankfull Width (ft)	10.93	5.52	5.41
Entrenchment Ratio	1.18	-----	-----
Mean Depth (ft)	0.72	0.5	0.94
Maximum Depth (ft)	1.02	0.92	1.02
Width/Depth Ratio	15.28	11.05	5.78
Bankfull Area (sq ft)	7.82	2.76	5.06
Wetted Perimeter (ft)	11.59	6.55	6.87
Hydraulic Radius (ft)	0.67	0.42	0.74
Begin BKF Station	48.08	48.08	53.6
End BKF Station	59.01	53.6	59.01


UT1 XS8 (Pool)
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 11.8
Dbkf = .9
Abkf = 10.4
Elevation (ft)
545
542
539
536
533
530
0
10
20
30
40
50
60
70
80
90
100
Horizontal Distance (ft)

UT1_XS8

RIVERMORPH CROSS SECTION SUMMARY

River Name: UT1
Reach Name: Reach 2 - Middle
Cross Section Name: XS8-Pool
Survey Date: 06/10/11

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	540.659698	pool
22.16	0	540.056412	
37.46	0	539.362581	
41.23	0	539.868318	
43.36	0	539.749112	
46.31	0	538.545346	
48.37	0	537.749365	
48.86	0	537.19529	
50.08	0	536.653855	
51.5	0	536.472583	
52.04	0	536.381018	lew
52.73	0	536.078327	
53.72	0	536.089656	
54.9	0	535.92651	
55.97	0	535.951271	
57.58	0	535.952485	
58.59	0	536.381294	rew
60.38	0	536.772417	
61.32	0	538.269445	
62.43	0	539.830152	
63.23	0	540.912783	
67.24	0	542.319962	
72.47	0	542.854949	
93.44	0	542.125318	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	538.47	538.47	538.47
Bankfull Elevation (ft)	537.2	537.2	537.2
Floodprone Width (ft)	14.97	-----	-----
Bankfull Width (ft)	11.79	5.82	5.97
Entrenchment Ratio	1.27	-----	-----
Mean Depth (ft)	0.88	0.78	0.98
Maximum Depth (ft)	1.27	1.24	1.27
Width/Depth Ratio	13.35	7.44	6.09
Bankfull Area (sq ft)	10.41	4.56	5.85
Wetted Perimeter (ft)	12.37	7.28	7.58
Hydraulic Radius (ft)	0.84	0.63	0.77
Begin BKF Station	48.86	48.86	54.68
End BKF Station	60.65	54.68	60.65

PEBBLE COUNT ANALYSIS WORKSHEET

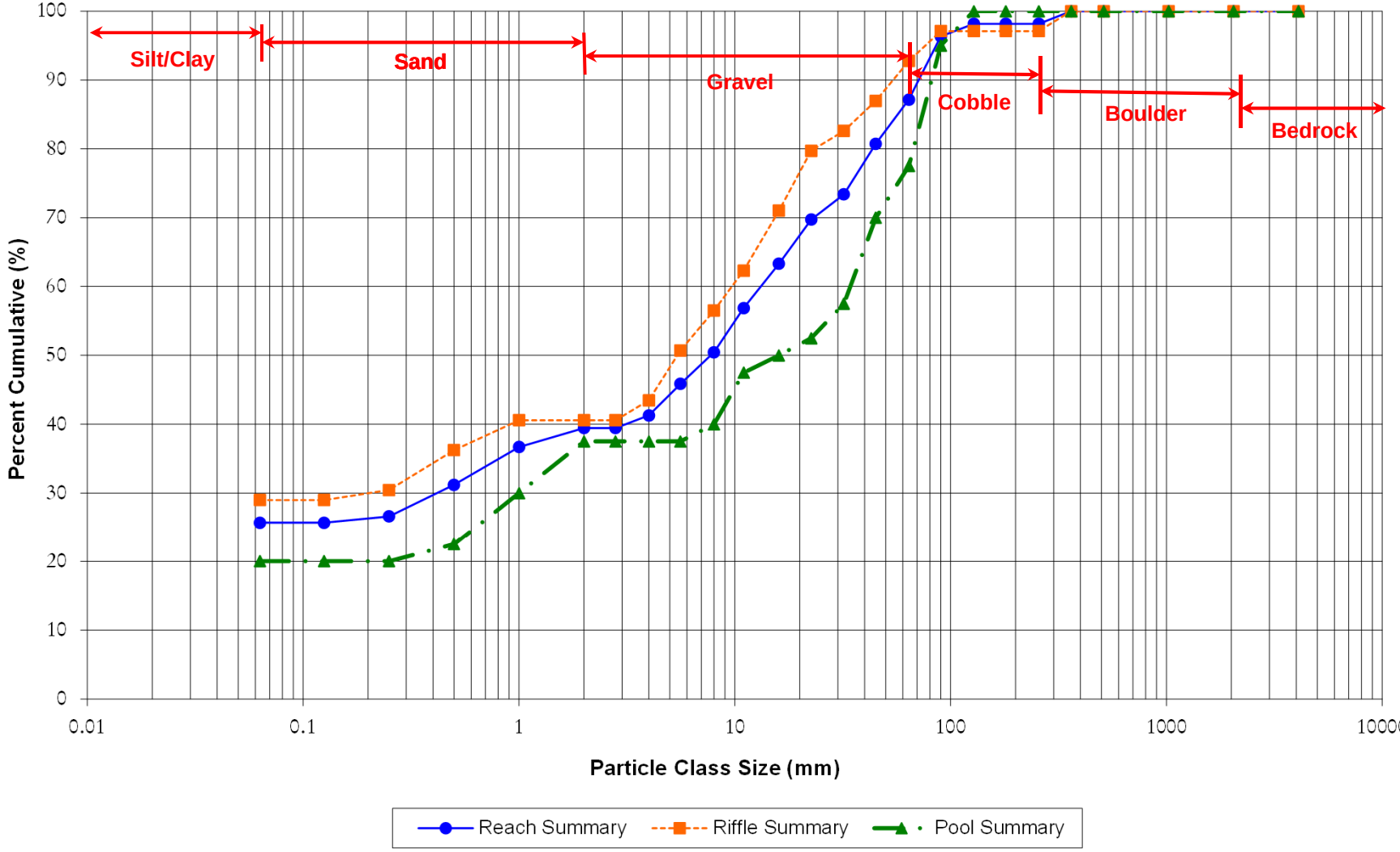
Project Name:	Crooked Creek	**Data Collected By:**	MLJ, KYG
Location:	Union County, NC	**Data Collected On:**	6/2/2011
Job #:	005-02127	**Reach:**	UT Reachwide
Date:	6/9/2011	**Cross Section #:**	n/a

Particle Class		Diameter (mm)		Particle Count			Riffle Summary		Pool Summary		Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	20	8	28	29.0	29	20	20	26	26
SAND	Very fine	0.062	0.125					29		20		26
	Fine	0.125	0.250	1		1	1.4	30		20	1	27
	Medium	0.250	0.500	4	1	5	5.8	36	3	23	5	31
	Coarse	0.5	1.0	3	3	6	4.3	41	8	30	6	37
	Very Coarse	1.0	2.0		3	3		41	8	38	3	39
GRAVEL	Very Fine	2.0	2.8					41		38		39
	Very Fine	2.8	4.0	2		2	2.9	43		38	2	41
	Fine	4.0	5.7	5		5	7.2	51		38	5	46
	Fine	5.7	8.0	4	1	5	5.8	57	3	40	5	50
	Medium	8.0	11.3	4	3	7	5.8	62	8	48	6	57
	Medium	11.3	16.0	6	1	7	8.7	71	3	50	6	63
	Coarse	16.0	22.6	6	1	7	8.7	80	3	53	6	70
	Coarse	22.6	32	2	2	4	2.9	83	5	58	4	73
	Very Coarse	32	45	3	5	8	4.3	87	13	70	7	81
	Very Coarse	45	64	4	3	7	5.8	93	8	78	6	87
COBBLE	Small	64	90	3	7	10	4.3	97	18	95	9	96
	Small	90	128		2	2		97	5	100	2	98
	Large	128	180					97		100		98
	Large	180	256					97		100		98
BOULDER	Small	256	362	2		2	2.9	100		100	2	100
	Small	362	512					100		100		100
	Medium	512	1024					100		100		100
	Large/Very Large	1024	2048					100		100		100
BEDROCK	Bedrock	2048	>2048					100		100		100
			Total	**69**	**40**	**109**	**100**	**100**	**100**	**100**	**100**	**100**

Largest Particle (mm): _____

Riffle Channel materials (mm)		Pool Channel materials		Cumulative Channel materials	
D_{16} =	Silt/Clay	D_{16} =	Silt/Clay	D_{16} =	Silt/Clay
D_{35} =	0.43	D_{35} =	1.59	D_{35} =	0.81
D_{50} =	5.41	D_{50} =	16.00	D_{50} =	7.72
D_{84} =	35.69	D_{84} =	72.64	D_{84} =	53.83
D_{95} =	76.33	D_{95} =	90.00	D_{95} =	85.66
D_{100} =	362	D_{99} =	128	D_{99} =	362

Crooked Creek UT
Reach-Wide Pebble Count Particle Distribution



PEBBLE COUNT ANALYSIS WORKSHEET

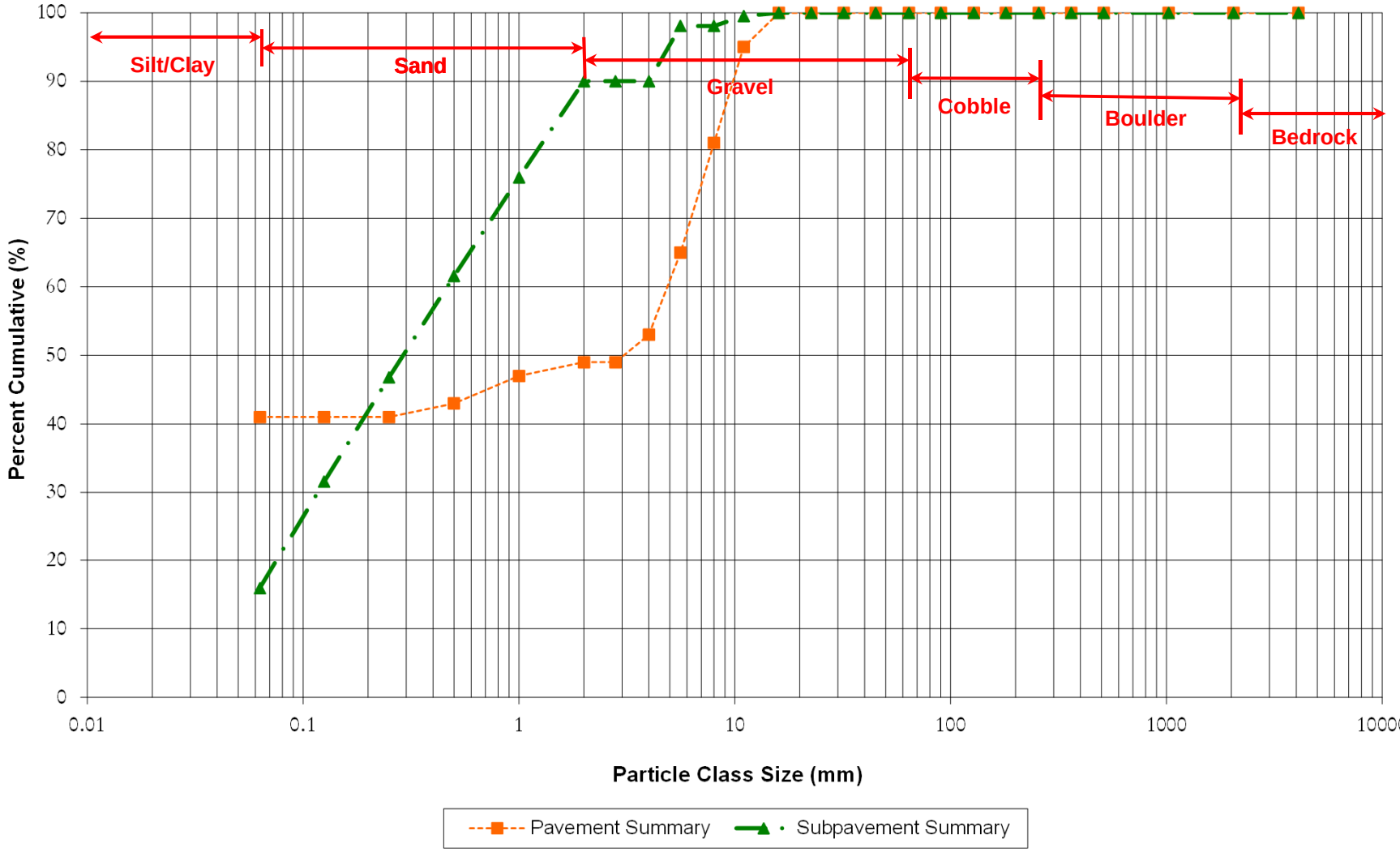
Project Name:	Crooked Creek	**Data Collected By:**	MLJ, KYG
Location:	Union County, NC	**Data Collected On:**	6/2/2011
Job #:	005-02127	**Reach:**	UT1
Date:	6/9/2011	**Cross Section #:**	XS6

Particle Class		Diameter (mm)		Particle Count			Pavement Summary		Subpavement Summary		Reach Summary	
		min	max	Pavement	Subpavement	Total	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	41	622	663	41.0	41	16	16	17	17
SAND	Very fine	0.062	0.125		611	611		41	16	32	15	32
	Fine	0.125	0.250		595	595		41	15	47	15	47
	Medium	0.250	0.500	2	578	580	2.0	43	15	62	14	61
	Coarse	0.5	1.0	4	561	565	4.0	47	14	76	14	75
	Very Coarse	1.0	2.0	2	549	551	2.0	49	14	90	14	89
GRAVEL	Very Fine	2.0	2.8					49		90		89
	Very Fine	2.8	4.0	4		4	4.0	53		90	0	89
	Fine	4.0	5.7	12	316	328	12.0	65	8	98	8	97
	Fine	5.7	8.0	16		16	16.0	81		98	0	98
	Medium	8.0	11.3	14	56	70	14.0	95	1	100	2	99
	Medium	11.3	16.0	5	19	24	5.0	100	0	100	1	100
	Coarse	16.0	22.6					100		100		100
	Coarse	22.6	32					100		100		100
	Very Coarse	32	45					100		100		100
	Very Coarse	45	64					100		100		100
COBBLE	Small	64	90					100		100		100
	Small	90	128					100		100		100
	Large	128	180					100		100		100
	Large	180	256					100		100		100
BOULDER	Small	256	362					100		100		100
	Small	362	512					100		100		100
	Medium	512	1024					100		100		100
	Large/Very Large	1024	2048					100		100		100
BEDROCK	Bedrock	2048	>2048					100		100		100
			Total	100	3905.9	4005.9	100	100	100	100	100	100

Largest Particle (mm): _____

Pavement Channel materials (mm)		Subpavement Channel materials	
D_{16} =	Silt/Clay	D_{16} =	0.06
D_{35} =	Silt/Clay	D_{35} =	0.15
D_{50} =	3.06	D_{50} =	0.29
D_{84} =	8.56	D_{84} =	1.49
D_{95} =	11.00	D_{95} =	4.92
D_{100} =	16	D_{99} =	16

UT1 - XS6 Riffle
Pavement & Subpavement Particle Distribution



PEBBLE COUNT ANALYSIS WORKSHEET

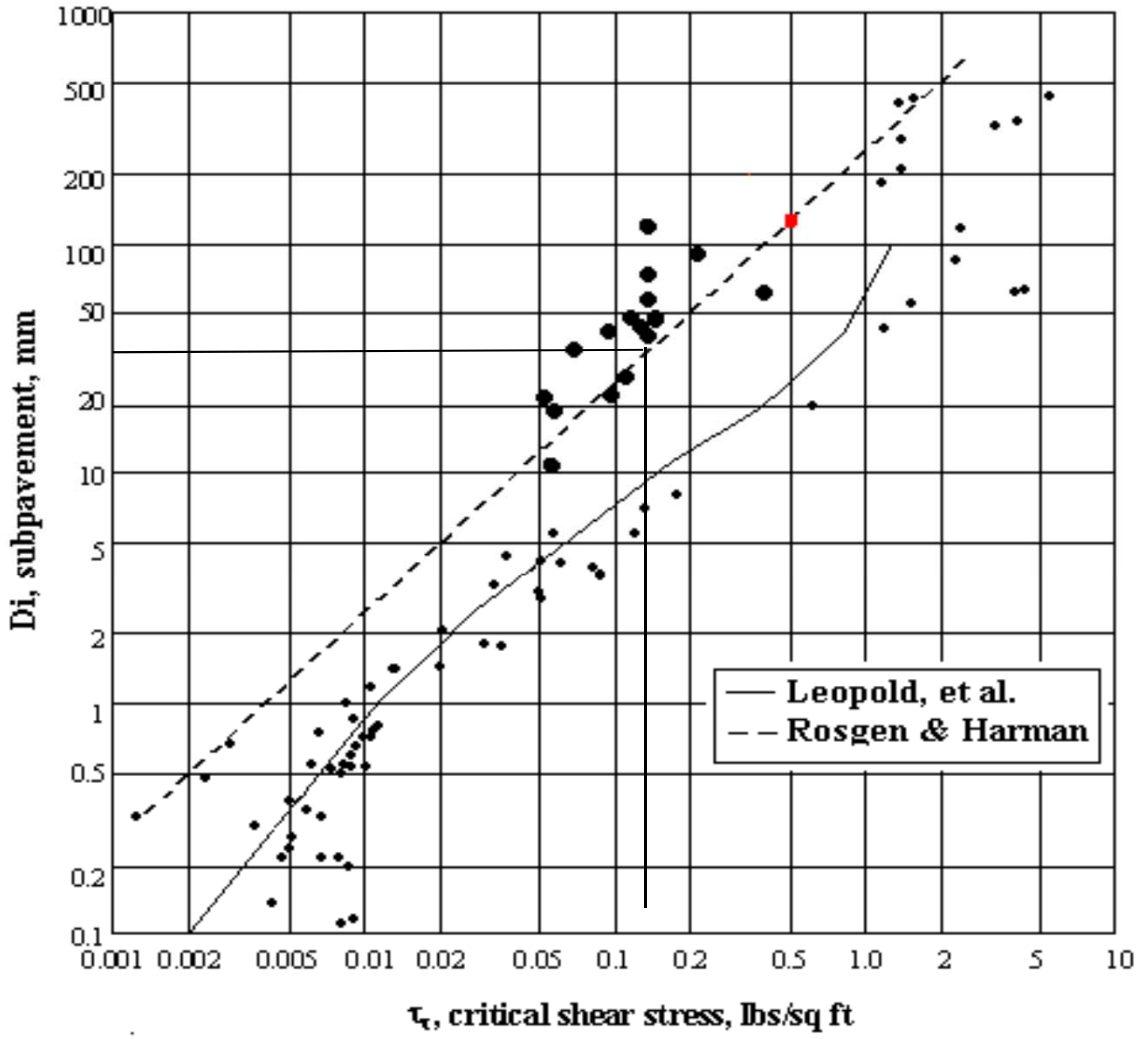
Project Name:	Crooked Creek	**Data Collected By:**	MLJ, KYG
Location:	Union County, NC	**Data Collected On:**	6/2/2011
Job #:	005-02127	**Reach:**	UT1
Date:	6/9/2011	**Cross Section #:**	XS7

Particle Class		Diameter (mm)		Particle Count			Pavement Summary		Subpavement Summary		Reach Summary	
		min	max	Pavement	Subpavement	Total	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	24	4123	4147	24.0	24	11	11	11	11
SAND	Very fine	0.062	0.125		4111	4111		24	11	23	11	23
	Fine	0.125	0.250		4055	4055		24	11	34	11	34
	Medium	0.250	0.500	10	3893	3903	10.0	34	11	45	11	44
	Coarse	0.5	1.0		3674	3674		34	10	55	10	55
	Very Coarse	1.0	2.0		3522	3522		34	10	64	10	64
GRAVEL	Very Fine	2.0	2.8					34		64		64
	Very Fine	2.8	4.0	2		2	2.0	36		64	0	64
	Fine	4.0	5.7	2	3326	3328	2.0	38	9	73	9	73
	Fine	5.7	8.0	6		6	6.0	44		73	0	73
	Medium	8.0	11.3	2	3132	3134	2.0	46	9	82	9	82
	Medium	11.3	16.0		3047	3047		46	8	90	8	90
	Coarse	16.0	22.6	2		2	2.0	48		90	0	90
	Coarse	22.6	32	2	2393	2395	2.0	50	7	97	7	97
	Very Coarse	32	45	4		4	4.0	54		97	0	97
	Very Coarse	45	64	20	1073	1093	20.0	74	3	100	3	100
COBBLE	Small	64	90	8		8	8.0	82		100	0	100
	Small	90	128	12		12	12.0	94		100	0	100
	Large	128	180	6		6	6.0	100		100	0	100
	Large	180	256					100		100		100
BOULDER	Small	256	362					100		100		100
	Small	362	512					100		100		100
	Medium	512	1024					100		100		100
	Large/Very Large	1024	2048					100		100		100
BEDROCK	Bedrock	2048	>2048					100		100		100
			Total	**100**	**36348.6**	**36448.6**	**100**	**100**	**100**	**100**	**100**	**100**

Largest Particle (mm): _____

Pavement Channel materials (mm)		Subpavement Channel materials	
D_{16} =	Silt/Clay	D_{16} =	0.08
D_{35} =	3.35	D_{35} =	0.27
D_{50} =	32.00	D_{50} =	0.73
D_{84} =	95.44	D_{84} =	11.98
D_{95} =	135.48	D_{95} =	28.72
D_{100} =	180	D_{99} =	64

UT1 - XS7 Riffle
Pavement & Subpavement Particle Distribution



(Data from: Leopold, Wolman, and Miller 1964; Rosgen, personal commun.; and Harman, personal commun.)

COMPETENCY CALCULATION WORKSHEET			
Project Name:		**Data Collected By:**	**Wildlands Engineering**
Location:		**Data Collected On:**	
Job #:		**Reach:**	
Designer:		**Cross Section #:**	
Date:			

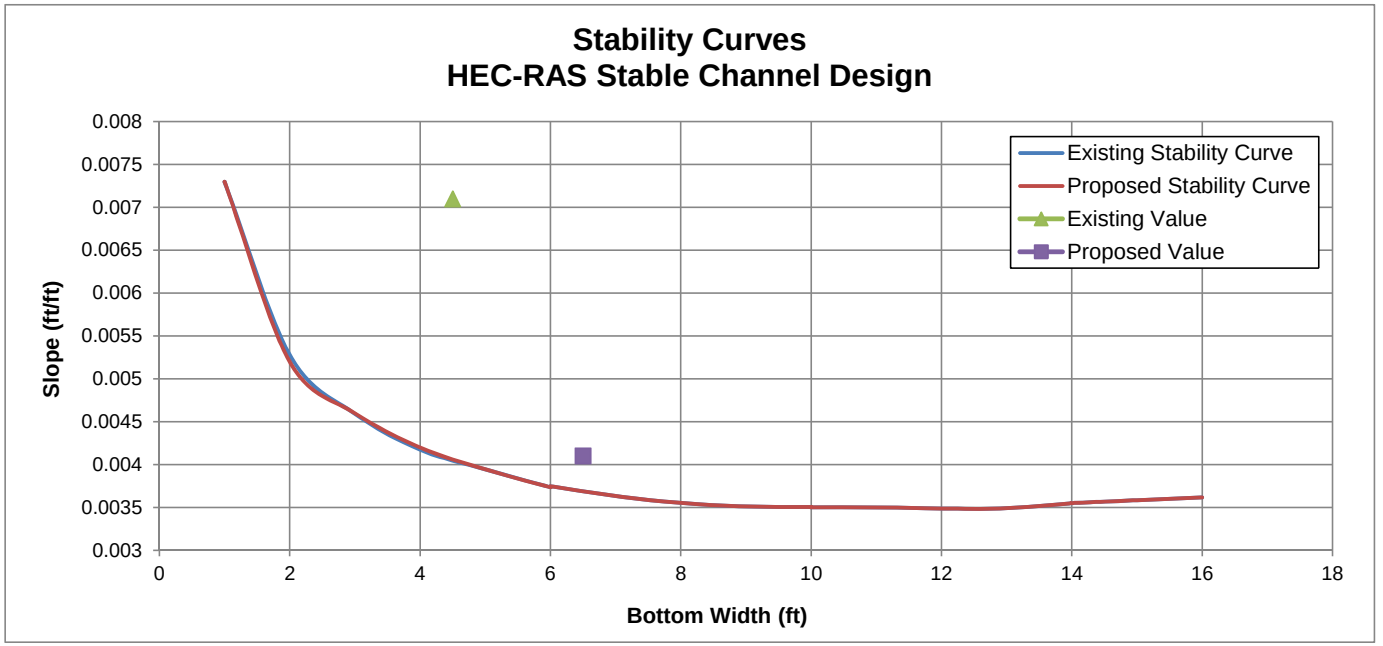
Shear Stress Analysis	Units	Notes	UT1 Proposed	
Bankfull Xsec Area, A_{bkf}	sq. ft.		8.7	
Bankfull Width, W_{bkf}	ft.		12	
Bankfull Mean Depth, D_{bkf}	ft.		0.7	
S_{chan}	ft./ft.		0.0032	
D_{50}	mm	Median Diameter of the Riffle Bed (From 100 Pebble Count In Riffle Or Pavement Sample)	3.06	
$D\hat{}_{50}$	mm	Median Diameter of the Bar Sample (Or Subpavement Sample)	0.29	
D_i	mm	D_{100}, Largest Particle From Bar Sample (Or Subpavment Sample)	16	
D_i	ft.	D_{100}, Largest Particle From Bar Sample (Or Subpavment Sample)	0.05	
$D_{50}/D\hat{}_{50}$	dimensionless		10.55	
D_i/D_{50}	dimensionless		5.23	
Wetted Perimeter, WP	ft.	$WP=W_{bkf}+2(D_{bkf})$	13.4	
Hydraulic Radius, R	ft.	$R=A_{bkf}/WP$	0.6	
Boundary/Bankfull Shear Stress, τ^*	lbs/sq. ft.	$\tau^*=62.4(R)(S_{chan})$	0.13	
τ^*_{ci} (Equation #1)	lbs/sq. ft.	$\tau^*_{ci}=0.0834[(D_{50}/D\hat{}_{50})^{-0.872}]$ Use When $3.0<D_{50}/D\hat{}_{50}<7.0$	NA	
τ^*_{ci} (Equation #2)	lbs/sq. ft.	$\tau^*_{ci}=0.0384[(D_i/D_{50})^{-0.887}]$ Use When $1.3<d_i/d_{50}<3.0$	NA	
D_{crit}	ft.	Required Bankfull Mean Depth $D_{crit}=[(1.65)(\tau^*_{ci)(}D_i)]/S_{chan}$	NA	
S_{crit}	ft./ft.		NA	
Largest movable particle (shields/CO curves)	mm		20-30	

Spreadsheet developed from Dave Rosgen - River Assessment and Monitoring 2002

existing	
1	0.0073
2	0.00528
3	0.00459
4	0.00418
5	0.00395
6	0.00374
6	0.00375
7	0.00363
8	0.00355
9	0.00351
10	0.00351
10	0.0035
11	0.0035
12	0.00349
13	0.00349
14	0.00355
14	0.00355
15	0.00359
16	0.00362

proposed	
1	0.0073
2	0.0052
3	0.0046
4	0.0042
5	0.00395
6	0.00374
6	0.00375
7	0.00363
8	0.00355
9	0.00351
10	0.00351
10	0.0035
11	0.0035
12	0.00349
13	0.00349
14	0.00355
14	0.00355
15	0.00359
16	0.00362

	bse width	slope
existing	4.5	0.0071
proposed	6.5	0.0041



****

D R A I N M O D 6.1

LAST UPDATE: January 2011
LANGUAGE FORTRAN 77/90

DRAINMOD IS A FIELD-SCALE HYDROLOGIC MODEL DEVELOPED FOR
THE DESIGN OF SUBSURFACE DRAINAGE SYSTEMS. THE MODEL WAS
DEVELOPED BY RESEARCHERS AT THE DEPT. OF BIOLOGICAL AND
AGRICULTURAL ENGINEERING, NORTH CAROLINA STATE UNIVERSITY
UNDER THE DIRECTION OF R. W. SKAGGS.

****

DATA READ FROM INPUT FILE: F:\Projects\005-02127 Crooked Creek\Design\Drain
Cream selector (0=no, 1=yes) = 0

TITLE OF RUN
****

Analysis of wetland hydrology for Crooked Cr

CLIMATE INPUTS
******* ******

DESCRIPTION	(VARIABLE)	VALUE	UNIT
FILE FOR RAINDATA	F:\Projects\005-02127 Crooked Creek\Design\Drain		
FILE FOR TEMPERATURE/PET DATA	F:\Projects\005-02127 Crooked Creek\Design\Drain		
RAINFALL STATION NUMBER	(RAINID)	315771	
TEMPERATURE/PET STATION NUMBER	(TEMPID)	315771	
STARTING YEAR OF SIMULATION	(START YEAR)	1935	YEAR
STARTING MONTH OF SIMULATION	(START MONTH)	1	MONTH
ENDING YEAR OF SIMULATION	(END YEAR)	2012	YEAR
ENDING MONTH OF SIMULATION	(END MONTH)	4	MONTH
TEMPERATURE STATION LATITUDE	(TEMP LAT)	34.58	DEG.MIN
HEAT INDEX	(HID)	75.00	

ET MULTIPLICATION FACTOR FOR EACH MONTH

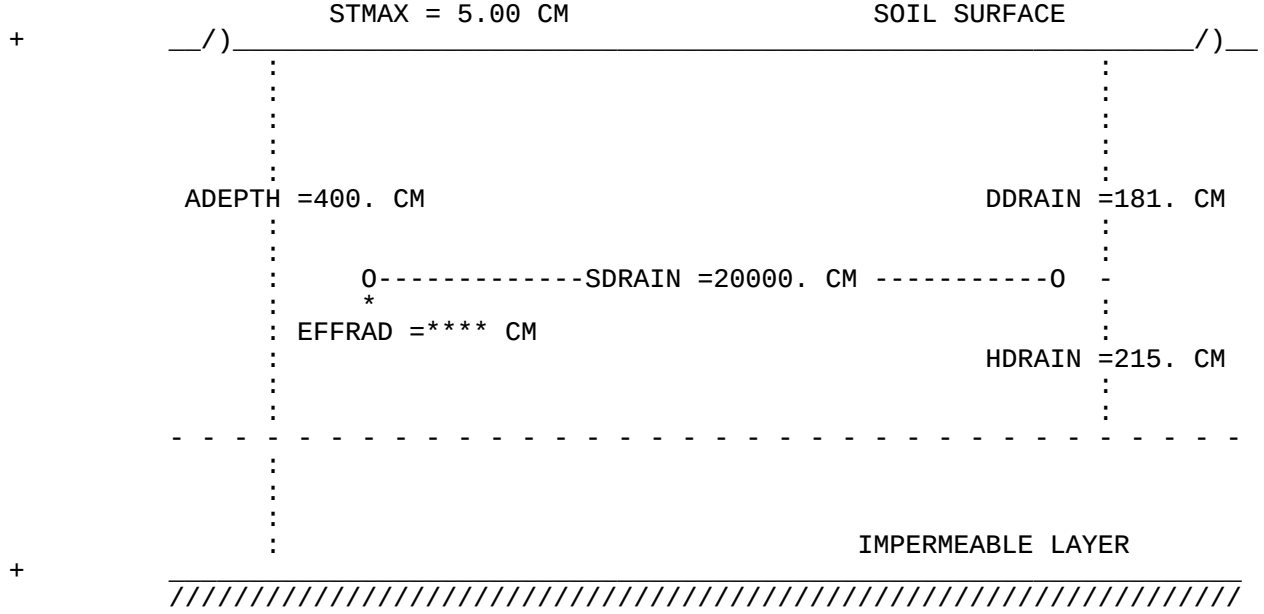
2.52	3.30	2.49	1.69	1.31	.99	.90	.87	.94	1.20	1.45	2.01

DRAINAGE SYSTEM DESIGN
****

*** CONVENTIONAL DRAINAGE ***

JOB TITLE:

Analysis of wetland hydrology for Crooked Cr



DEPTH (CM)			SATURATED HYDRAULIC CONDUCTIVITY (CM/HR)
.0	-	30.0	4.000
30.0	-	100.0	1.500
100.0	-	396.4	2.500

DEPTH TO DRAIN = 181.2 CM
EFFECTIVE DEPTH FROM DRAIN TO IMPERMEABLE LAYER = 215.2 CM
DISTANCE BETWEEN DRAINS = 20000.0 CM
MAXIMUM DEPTH OF SURFACE PONDING = 5.00 CM
EFFECTIVE DEPTH TO IMPERMEABLE LAYER = 396.4 CM
DRAINAGE COEFFICIENT(AS LIMITED BY SUBSURFACE OUTLET) = 2.50 CM/DAY
MAXIMUM PUMPING CAPACITY (SUBIRRIGATION MODE) = 2.50 CM/DAY
ACTUAL DEPTH FROM SURFACE TO IMPERMEABLE LAYER = 400.0 CM
SURFACE STORAGE THAT MUST BE FILLED BEFORE WATER
CAN MOVE TO DRAIN = 3.00 CM
FACTOR -G- IN KIRKHAM EQ. 2-17 = 5.12

*** SEEPAGE LOSS INPUTS ***

No seepage due to field slope

No seepage due to vertical deep seepage

No seepage due to lateral deep seepage

*** end of seepage inputs ***

WIDTH OF DITCH BOTTOM = 60.0 CM
SIDE SLOPE OF DITCH (HORIZ:VERT) = .50 : 1.00

INITIAL WATER TABLE DEPTH = 90.0 CM

DEPTH OF WEIR FROM THE SURFACE

DATE	1/ 1	2/ 1	3/ 1	4/ 1	5/ 1	6/ 1
WEIR DEPTH	181.2	181.2	181.2	181.2	181.2	181.2

DATE	7/ 1	8/ 1	9/ 1	10/ 1	11/ 1	12/ 1
WEIR DEPTH	181.2	181.2	181.2	181.2	181.2	181.2

SOIL INPUTS

TABLE 1

DRAINAGE TABLE

VOID VOLUME (CM)	WATER TABLE DEPTH (CM)
.0	.0
1.0	22.5
2.0	35.7
3.0	50.0
4.0	65.0
5.0	77.5
6.0	89.4
7.0	101.0
8.0	110.5
9.0	120.0
10.0	128.6
11.0	137.1
12.0	145.7
13.0	153.3
14.0	160.0
15.0	166.7
16.0	173.3
17.0	180.0
18.0	186.7
19.0	193.3
20.0	200.0
21.0	206.7
22.0	213.3
23.0	220.0
24.0	226.7
25.0	233.3
26.0	240.0
27.0	246.7
28.0	253.3
29.0	260.0
30.0	266.7
35.0	300.0
40.0	366.7
45.0	433.3
50.0	500.0
60.0	600.0
70.0	700.0
80.0	800.0
90.0	900.0

1 TABLE 2

SOIL WATER CHARACTERISTIC VS VOID VOLUME VS UPFLUX

HEAD (CM)	WATER CONTENT (CM/CM)	VOID VOLUME (CM)	UPFLUX (CM/HR)
.0	.3700	.00	.2000
10.0	.3000	.25	.1000
20.0	.2820	.80	.0800
30.0	.2720	1.60	.0250
40.0	.2660	2.30	.0112
50.0	.2580	3.00	.0058
60.0	.2540	3.60	.0031
70.0	.2480	4.40	.0018
80.0	.2440	5.20	.0010
90.0	.2410	6.05	.0007
100.0	.2380	6.90	.0004
110.0	.2360	7.95	.0002
120.0	.2340	9.00	.0000
130.0	.2320	10.17	.0000
140.0	.2300	11.33	.0000
150.0	.2280	12.50	.0000
160.0	.2272	14.00	.0000
170.0	.2264	15.50	.0000
180.0	.2256	17.00	.0000
190.0	.2248	18.50	.0000
200.0	.2240	20.00	.0000
210.0	.2236	21.50	.0000
220.0	.2232	23.00	.0000
230.0	.2228	24.50	.0000
240.0	.2224	26.00	.0000
250.0	.2219	27.50	.0000
260.0	.2215	29.00	.0000
270.0	.2211	30.50	.0000
280.0	.2207	32.00	.0000
290.0	.2203	33.50	.0000
300.0	.2199	35.00	.0000
350.0	.2178	38.75	.0000
400.0	.2158	42.50	.0000
450.0	.2137	46.25	.0000
500.0	.2117	50.00	.0000
600.0	.2076	60.00	15.0000
700.0	.2034	70.00	30.0000
800.0	.1993	80.00	45.0000
900.0	.1952	90.00	60.0000

GREEN AMPT INFILTRATION PARAMETERS

W.T.D. (CM)	A (CM)	B (CM)
.000	.000	.000
50.000	1.200	1.000
100.000	3.300	1.000
150.000	6.000	1.000
200.000	9.200	1.000
500.000	25.000	1.000
1000.000	25.000	1.000

TRAFFICABILITY

REQUIREMENTS	FIRST PERIOD	SECOND PERIOD
-MINIMUM AIR VOLUME IN SOIL (CM):	3.00	3.00
-MAXIMUM ALLOWABLE DAILY RAINFALL(CM):	1.20	1.20
-MINIMUM TIME AFTER RAIN BEFORE TILLING CAN CONTINUE:	2.00	2.00

WORKING TIMES

-DATE TO BEGIN COUNTING WORK DAYS:	4/ 1	12/31
-DATE TO STOP COUNTING WORK DAYS:	5/ 1	12/31
-FIRST WORK HOUR OF THE DAY:	8	8
-LAST WORK HOUR OF THE DAY:	20	20

CROP

SOIL MOISTURE AT WILTING POINT = .17

HIGH WATER STRESS: BEGIN STRESS PERIOD ON 4/10
END STRESS PERIOD ON 8/18
CROP IS IN STRESS WHEN WATER TABLE IS ABOVE 30.0 CM

DROUGHT STRESS: BEGIN STRESS PERIOD ON 4/10
END STRESS PERIOD ON 8/18

MO	DAY	ROOTING DEPTH(CM)
1	1	10.0
4	16	10.0
5	4	10.0
5	17	10.0
6	1	10.0
6	20	10.0
7	18	10.0
8	20	10.0
9	24	10.0
9	25	10.0
12	31	10.0

WASTEWATER IRRIGATION

NO WASTEWATER IRRIGATION SCHEDULED:

***** Wetlands Parameter Estimation *****

Start Day = 82 End Day = 310
Threshold Water Table Depth (cm) = 30.0
Threshold Consecutive Days = 17

Fixed Monthly Pet Values

1 1.00 2 1.00 3 1.00 4 1.00 5 1.00 6 1.00 7 1.00 8 1.00 9 1.00
10 1.00 11 1.00 12 1.00

```
   Mrank indicator =  0



 ****************************** END OF INPUTS ******************************

  ----------RUN STATISTICS ----------          time: 12/14/2012  @ 11:19
 input file:   F:\Projects\005-02127 Crooked Creek\Design\Drain
 parameters:    free drainage              and yields not calculated
               drain spacing =   20000. cm   drain depth =  181.2 cm
-------------------------------------------------------------------------


  *** WARNING - RAINFALL FILE ***
  MONTH           2, YEAR        1954 NOT FOUND
  RAINFALL IS ZERO, OR MISSING FOR THIS MONTH

  *** WARNING - RAINFALL FILE ***
  MONTH           9, YEAR        1954 NOT FOUND
  RAINFALL IS ZERO, OR MISSING FOR THIS MONTH

  *** WARNING - RAINFALL FILE ***
  MONTH          10, YEAR        1974 NOT FOUND
  RAINFALL IS ZERO, OR MISSING FOR THIS MONTH

  *** WARNING - RAINFALL FILE ***
  MONTH          10, YEAR        2000 NOT FOUND
  RAINFALL IS ZERO, OR MISSING FOR THIS MONTH
 TERMINATE SIMULATION DUE TO END OF LOOP



**> Computational Statistics       <**
**> Start Computations    = 679.307
**> End Computations      = 679.343
**> Total simulation time =     2.1 seconds.
```

****

D R A I N M O D 6.1

LAST UPDATE: January 2011
LANGUAGE FORTRAN 77/90

DRAINMOD IS A FIELD-SCALE HYDROLOGIC MODEL DEVELOPED FOR
THE DESIGN OF SUBSURFACE DRAINAGE SYSTEMS. THE MODEL WAS
DEVELOPED BY RESEARCHERS AT THE DEPT. OF BIOLOGICAL AND
AGRICULTURAL ENGINEERING, NORTH CAROLINA STATE UNIVERSITY
UNDER THE DIRECTION OF R. W. SKAGGS.

****

DATA READ FROM INPUT FILE: F:\Projects\005-02127 Crooked Creek\Design\Drain
Cream selector (0=no, 1=yes) = 0

TITLE OF RUN
****

Analysis of wetland hydrology for Crooked Cr

CLIMATE INPUTS
******* ******

DESCRIPTION	(VARIABLE)	VALUE	UNIT
FILE FOR RAINDATA	F:\Projects\005-02127 Crooked Creek\Design\Drain		
FILE FOR TEMPERATURE/PET DATA	F:\Projects\005-02127 Crooked Creek\Design\Drain		
RAINFALL STATION NUMBER	(RAINID)	315771	
TEMPERATURE/PET STATION NUMBER	(TEMPID)	315771	
STARTING YEAR OF SIMULATION	(START YEAR)	1935	YEAR
STARTING MONTH OF SIMULATION	(START MONTH)	1	MONTH
ENDING YEAR OF SIMULATION	(END YEAR)	2012	YEAR
ENDING MONTH OF SIMULATION	(END MONTH)	4	MONTH
TEMPERATURE STATION LATITUDE	(TEMP LAT)	34.58	DEG.MIN
HEAT INDEX	(HID)	75.00	

ET MULTIPLICATION FACTOR FOR EACH MONTH

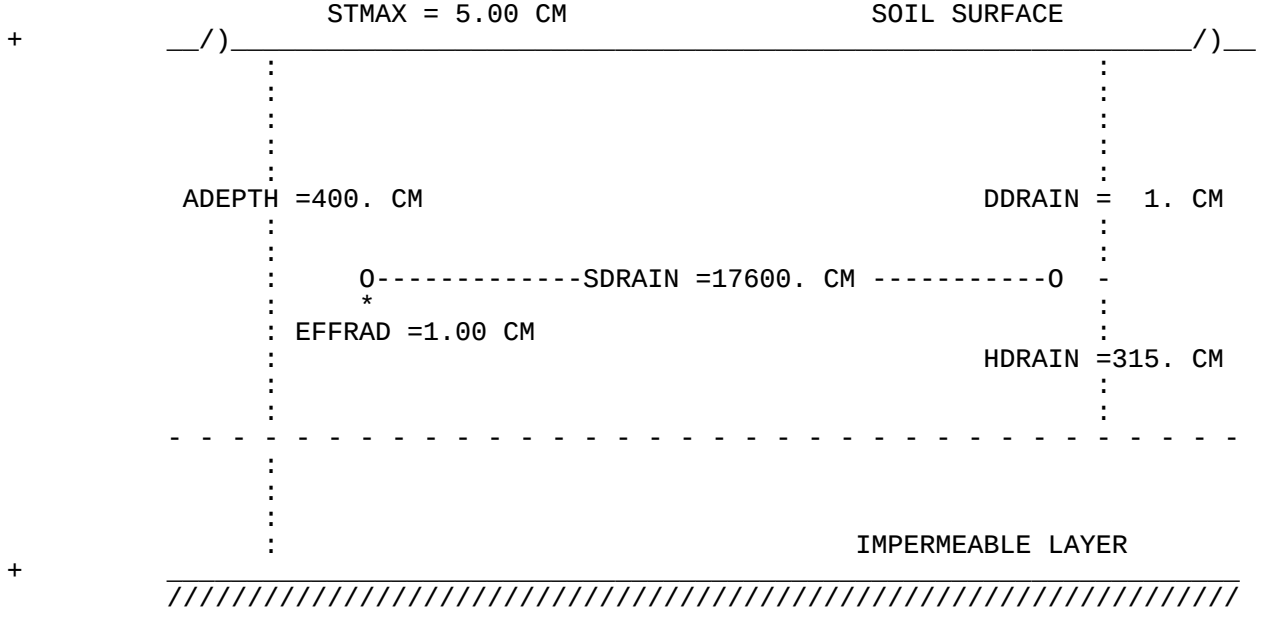
2.52	3.30	2.49	1.69	1.31	.99	.90	.87	.94	1.20	1.45	2.01

DRAINAGE SYSTEM DESIGN
****

*** CONVENTIONAL DRAINAGE ***

JOB TITLE:

Analysis of wetland hydrology for Crooked Cr



DEPTH (CM)	SATURATED HYDRAULIC CONDUCTIVITY (CM/HR)
.0 - 30.0	4.000
30.0 - 100.0	1.500
100.0 - 316.2	2.500

DEPTH TO DRAIN = 1.1 CM
EFFECTIVE DEPTH FROM DRAIN TO IMPERMEABLE LAYER = 315.1 CM
DISTANCE BETWEEN DRAINS = 17600.0 CM
MAXIMUM DEPTH OF SURFACE PONDING = 5.00 CM
EFFECTIVE DEPTH TO IMPERMEABLE LAYER = 316.2 CM
DRAINAGE COEFFICIENT(AS LIMITED BY SUBSURFACE OUTLET) = 2.50 CM/DAY
MAXIMUM PUMPING CAPACITY (SUBIRRIGATION MODE) = 2.50 CM/DAY
ACTUAL DEPTH FROM SURFACE TO IMPERMEABLE LAYER = 400.0 CM
SURFACE STORAGE THAT MUST BE FILLED BEFORE WATER
CAN MOVE TO DRAIN = 3.00 CM
FACTOR -G- IN KIRKHAM EQ. 2-17 = .36

*** SEEPAGE LOSS INPUTS ***

No seepage due to field slope

No seepage due to vertical deep seepage

No seepage due to lateral deep seepage

*** end of seepage inputs ***

WIDTH OF DITCH BOTTOM = 60.0 CM
SIDE SLOPE OF DITCH (HORIZ:VERT) = .50 : 1.00

INITIAL WATER TABLE DEPTH = 9.6 CM

DEPTH OF WEIR FROM THE SURFACE

DATE	1/ 1	2/ 1	3/ 1	4/ 1	5/ 1	6/ 1
WEIR DEPTH	1.1	1.1	1.1	1.1	1.1	1.1

DATE	7/ 1	8/ 1	9/ 1	10/ 1	11/ 1	12/ 1
WEIR DEPTH	1.1	1.1	1.1	1.1	1.1	1.1

SOIL INPUTS

TABLE 1

DRAINAGE TABLE

VOID VOLUME (CM)	WATER TABLE DEPTH (CM)
.0	.0
1.0	22.5
2.0	35.7
3.0	50.0
4.0	65.0
5.0	77.5
6.0	89.4
7.0	101.0
8.0	110.5
9.0	120.0
10.0	128.6
11.0	137.1
12.0	145.7
13.0	153.3
14.0	160.0
15.0	166.7
16.0	173.3
17.0	180.0
18.0	186.7
19.0	193.3
20.0	200.0
21.0	206.7
22.0	213.3
23.0	220.0
24.0	226.7
25.0	233.3
26.0	240.0
27.0	246.7
28.0	253.3
29.0	260.0
30.0	266.7
35.0	300.0
40.0	366.7
45.0	433.3
50.0	500.0
60.0	600.0
70.0	700.0
80.0	800.0
90.0	900.0

1 TABLE 2

SOIL WATER CHARACTERISTIC VS VOID VOLUME VS UPFLUX

HEAD (CM)	WATER CONTENT (CM/CM)	VOID VOLUME (CM)	UPFLUX (CM/HR)
.0	.3700	.00	.2000
10.0	.3000	.25	.1000
20.0	.2820	.80	.0800
30.0	.2720	1.60	.0250
40.0	.2660	2.30	.0112
50.0	.2580	3.00	.0058
60.0	.2540	3.60	.0031
70.0	.2480	4.40	.0018
80.0	.2440	5.20	.0010
90.0	.2410	6.05	.0007
100.0	.2380	6.90	.0004
110.0	.2360	7.95	.0002
120.0	.2340	9.00	.0000
130.0	.2320	10.17	.0000
140.0	.2300	11.33	.0000
150.0	.2280	12.50	.0000
160.0	.2272	14.00	.0000
170.0	.2264	15.50	.0000
180.0	.2256	17.00	.0000
190.0	.2248	18.50	.0000
200.0	.2240	20.00	.0000
210.0	.2236	21.50	.0000
220.0	.2232	23.00	.0000
230.0	.2228	24.50	.0000
240.0	.2224	26.00	.0000
250.0	.2219	27.50	.0000
260.0	.2215	29.00	.0000
270.0	.2211	30.50	.0000
280.0	.2207	32.00	.0000
290.0	.2203	33.50	.0000
300.0	.2199	35.00	.0000
350.0	.2178	38.75	.0000
400.0	.2158	42.50	.0000
450.0	.2137	46.25	.0000
500.0	.2117	50.00	.0000
600.0	.2076	60.00	15.0000
700.0	.2034	70.00	30.0000
800.0	.1993	80.00	45.0000
900.0	.1952	90.00	60.0000

GREEN AMPT INFILTRATION PARAMETERS

W.T.D. (CM)	A (CM)	B (CM)
.000	.000	.000
50.000	1.200	1.000
100.000	3.300	1.000
150.000	6.000	1.000
200.000	9.200	1.000
500.000	25.000	1.000
1000.000	25.000	1.000

TRAFFICABILITY
****

REQUIREMENTS	FIRST PERIOD	SECOND PERIOD
-MINIMUM AIR VOLUME IN SOIL (CM):	3.00	3.00
-MAXIMUM ALLOWABLE DAILY RAINFALL(CM):	1.20	1.20
-MINIMUM TIME AFTER RAIN BEFORE TILLING CAN CONTINUE:	2.00	2.00

WORKING TIMES

-DATE TO BEGIN COUNTING WORK DAYS:	4/ 1	12/31
-DATE TO STOP COUNTING WORK DAYS:	5/ 1	12/31
-FIRST WORK HOUR OF THE DAY:	8	8
-LAST WORK HOUR OF THE DAY:	20	20

CROP

SOIL MOISTURE AT WILTING POINT = .17

HIGH WATER STRESS: BEGIN STRESS PERIOD ON 4/10
END STRESS PERIOD ON 8/18
CROP IS IN STRESS WHEN WATER TABLE IS ABOVE 30.0 CM

DROUGHT STRESS: BEGIN STRESS PERIOD ON 4/10
END STRESS PERIOD ON 8/18

MO	DAY	ROOTING DEPTH(CM)
1	1	10.0
4	16	10.0
5	4	10.0
5	17	10.0
6	1	10.0
6	20	10.0
7	18	10.0
8	20	10.0
9	24	10.0
9	25	10.0
12	31	10.0

WASTEWATER IRRIGATION

NO WASTEWATER IRRIGATION SCHEDULED:

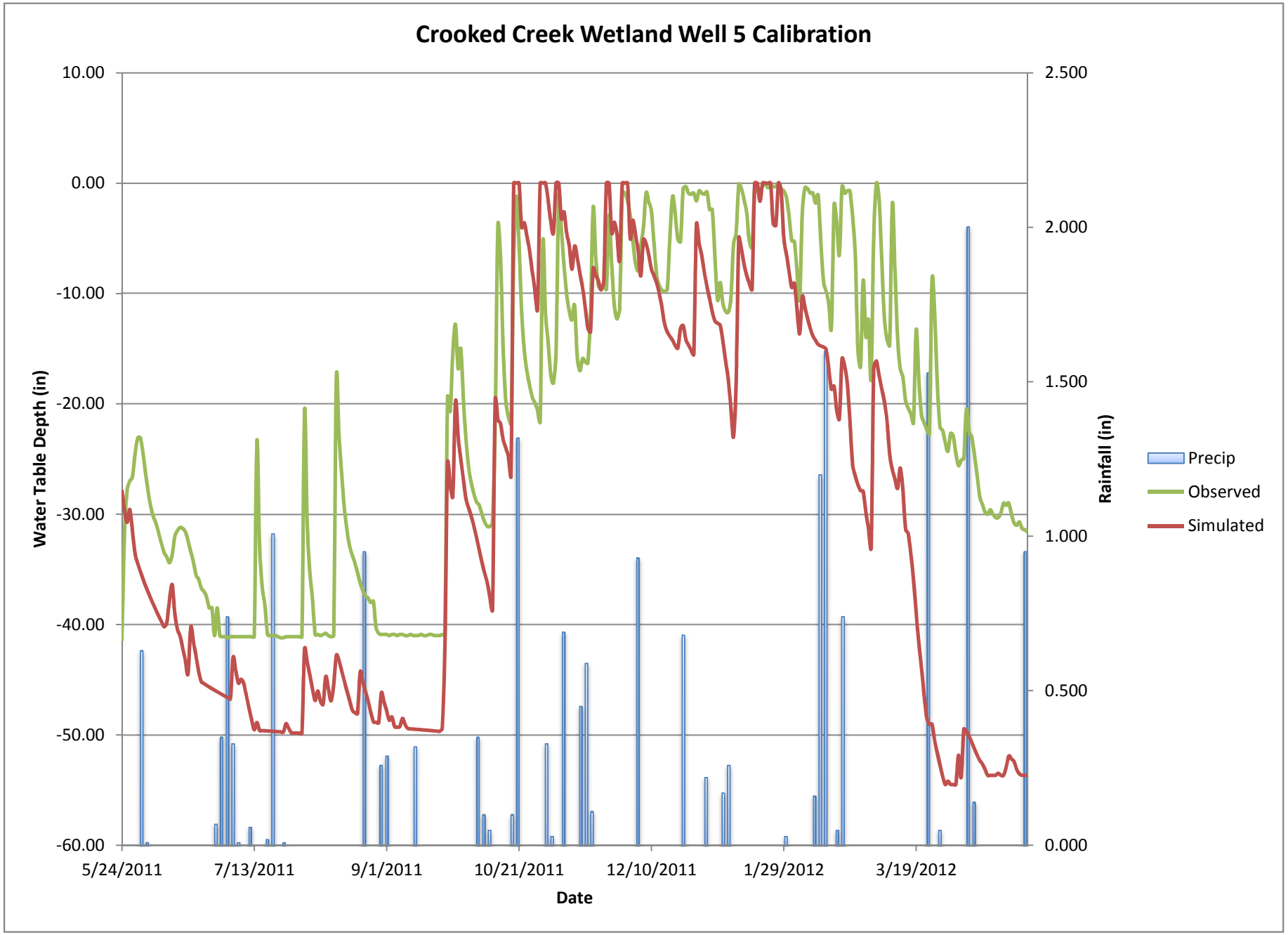
***** Wetlands Parameter Estimation *****

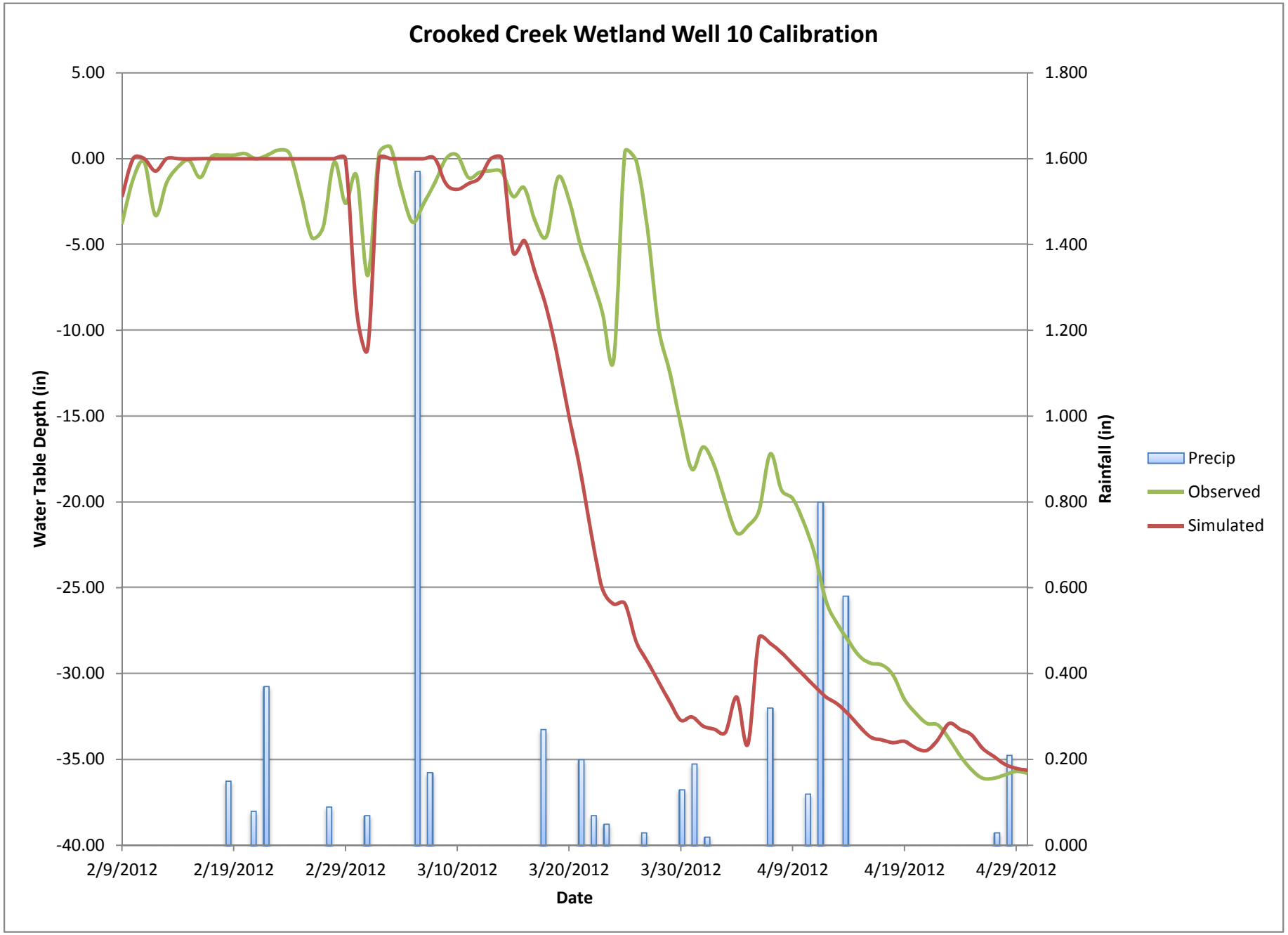
Start Day = 82 End Day = 310
Threshold Water Table Depth (cm) = 30.0
Threshold Consecutive Days = 17

Fixed Monthly Pet Values

1 1.00 2 1.00 3 1.00 4 1.00 5 1.00 6 1.00 7 1.00 8 1.00 9 1.00
10 1.00 11 1.00 12 1.00

```
   Mrank indicator =  0



 ****************************** END OF INPUTS ******************************

  ----------RUN STATISTICS ----------          time:  3/11/2013  @ 10:53
 input file:   F:\Projects\005-02127 Crooked Creek\Design\Drain
 parameters:    free drainage              and yields not calculated
               drain spacing =   17600. cm   drain depth =    1.1 cm
-------------------------------------------------------------------------


  *** WARNING - RAINFALL FILE ***
  MONTH           2, YEAR        1954 NOT FOUND
  RAINFALL IS ZERO, OR MISSING FOR THIS MONTH

  *** WARNING - RAINFALL FILE ***
  MONTH           9, YEAR        1954 NOT FOUND
  RAINFALL IS ZERO, OR MISSING FOR THIS MONTH

  *** WARNING - RAINFALL FILE ***
  MONTH          10, YEAR        1974 NOT FOUND
  RAINFALL IS ZERO, OR MISSING FOR THIS MONTH

  *** WARNING - RAINFALL FILE ***
  MONTH          10, YEAR        2000 NOT FOUND
  RAINFALL IS ZERO, OR MISSING FOR THIS MONTH
 TERMINATE SIMULATION DUE TO END OF LOOP



**> Computational Statistics       <**
**> Start Computations    = 653.562
**> End Computations      = 653.597
**> Total simulation time =     2.1 seconds.
```


Crooked Creek Wetland Well 5 Calibration
10.00
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Water Table Depth (in)
2.500
2.000
1.500
1.000
0.500
0.000
Rainfall (in)
5/24/2011
7/13/2011
9/1/2011
10/21/2011
12/10/2011
1/29/2012
3/19/2012
Date
Precip
Observed
Simulated


Crooked Creek Wetland Well 10 Calibration
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
Water Table Depth (in)
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Rainfall (in)
2/9/2012
2/19/2012
2/29/2012
3/10/2012
3/20/2012
3/30/2012
4/9/2012
4/19/2012
4/29/2012
Date
Precip
Observed
Simulated

APPENDIX C. Representative Photographs

Photo 1-View of UT1 upstream reach, facing downstream from NC 218.

Photo 2-View of UT1 downstream reach, facing downstream.

Photo 3- View of Intermittent UT2, facing downstream.

Photo 4-View of Perennial UT2, facing downstream to Crooked Creek confluence.

Photo 5-View of Wetland AA, facing east.

Photo 6-View of ditched Wetland BB, facing north.

Photo 7-View of ditched Wetland CC, facing southeast.

Photo 8-View of open water section of Wetland CC, facing north.

Photo 9-View of Wetland DD, facing south toward Crooked Creek.

Photo 10-View of Wetland EE, facing west through Crooked Creek floodplain.

Photo 11-View of Crooked Creek XS1 Riffle, facing downstream.

Photo 12-View of Crooked Creek XS1 Riffle, facing left bank.

Photo 13-View of Crooked Creek XS1 Riffle, facing right bank.

Photo 14-View of Crooked Creek XS2 Pool, facing downstream.

Photo 15-View of Crooked Creek XS2 Pool, facing left bank.

Photo 16-View of Crooked Creek XS2 Pool, facing right bank.

Photo 17-View of Crooked Creek XS3 Pool, facing downstream.

Photo 18-View of Crooked Creek XS3 Pool, facing left bank.

Photo 19-View of Crooked Creek XS3 Pool, facing right bank.

Photo 20-View of Crooked Creek XS4 Riffle, facing downstream.

Photo 21-View of Crooked Creek XS4 Riffle, facing left bank.

Photo 22-View of Crooked Creek XS4 Riffle, facing right bank.

Photo 23-View of UT1 XS5 Run, facing downstream.

Photo 24-View of UT1 XS5 Run, facing left bank.

Photo 25-View of UT1 XS5, facing right bank.

Photo 26-View of UT1 XS6 Riffle, facing downstream.

Photo 27-View of UT1 XS5 Riffle, facing left bank.

Photo 28-View of UT1 XS5 Riffle, facing right bank.

APPENDIX D. Project Plan Sheets

Crooked Creek #2 Restoration Project

Union County, North Carolina
for
North Carolina Ecosystem Enhancement Program

Vicinity Map
Not to Scale

Ecosystem Enhancement PROGRAM

BEFORE YOU DIG!
CALL 1-800-632-4949
N.C. ONE-CALL CENTER
IT'S THE LAW!

Project Summary

Crooked Creek Reach A Enhancement		1,555 LF
Crooked Creek Reach B Enhancement		2,404 LF
UT1 to Crooked Creek Restoration		1,718 LF
UT2 to Crooked Creek Enhancement		470 LF
Wetland Zone A	(FACW)	7.3 AC
Wetland Zone B	(FAC)	4.2 AC

60% PLANS
ISSUED AUGUST 19, 2013

Sheet Index

Project Directory

Surveying:
Dewberry
6135 Lakeview Road
Charlotte, NC 28269
John B. Primm, PLS
704-509-9918

Engineering:
Wildlands Engineering, Inc
License No. F-0831
1430 South Mint Street
Suite 104
Charlotte, NC 28203
Aaron S. Earley, PE
704-332-7754

Owner:
NC Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652
Julie Cahill
828-230-5172
SCO#09-0751301

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina
Cover Sheet

Revisions:

Date: March 28, 2013
Job Number: 003-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 0.1

60% Plans - Not for Construction

Date:	February 15, 2013
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	JK

Revisions:

0.2

Sheet

Crooked Creek #2 Restoration Project
Union County, North Carolina

Project Overview

PRELIMINARY DO NOT USE FOR CONSTRUCTION

WILDLANDS ENGINEERING
1430 S. Mint Street, Ste 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

60% Plans - Not for Construction

Existing Property Line

Existing Thalweg

Existing Ditch

100 Existing Major Contour

Existing Minor Contour

Existing Tree Line

Existing Tree

Existing Paved Road

OHE Existing Overhead Electric with Easement

Existing Power Pole

E E Existing Easement

X X Existing Fence

Existing Sanitary Sewer

Existing Culvert Pipe

Existing Wetland

10+00 Proposed Channel Centerline

Proposed Bankfull

100 Proposed Major Contour

Proposed Minor Contour

CE CE Proposed Conservation Easement

[x] [x] Proposed Silt Fence

SAF SAF Proposed Safety Fence

LOD LOD Proposed Limits of Disturbance

Proposed Log Vane
See Detail 3, Sheet 5.1

Proposed Construction Entrance
See Detail 3, Sheet 5.5

Proposed Brush Toe
See Detail x, Sheet x.x

Proposed Log Sill
See Detail 3, Sheet 5.3

Proposed Brush Sill
See Detail 4, Sheet 5.3

Proposed Angled Log Step Pool
See Detail 1, Sheet 5.2

Proposed Log J-Hook
See Detail 4, Sheet 5.2

Proposed Rock J-Hook
See Detail 2, Sheet 5.2

Proposed Boulder Sill
See Detail 3, Sheet 5.2

Proposed Temporary Stream Crossing
See Detail 4, Sheet 5.4

Proposed Constructed Riffle
See Details 1-4, Sheet 5.1

Proposed Channel Plug
See Detail 4, Sheet 5.7

Proposed Livestaking
See Detail 3, Sheet 5.5

Proposed Riparian Buffer - Understory

Proposed Riparian Buffer

Proposed Wetland FAC

Proposed Wetland FACW

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. P-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

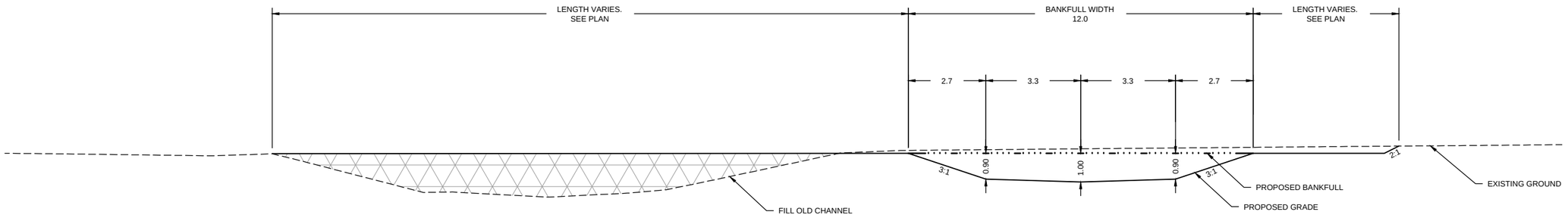
General Notes and Symbols

Revisions:

Date: February 15, 2013
Job Number: 003-02127
Project Engineer: ASH
Drawn By: JCK
Checked By: JK

Sheet 0.3

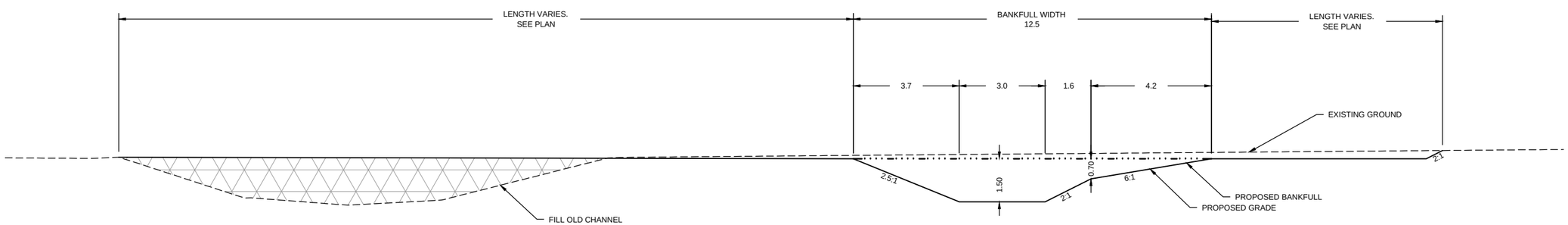
60% Plans - Not for Construction



UT1- Typical Section: Riffle

Sta: 100+00 to 117+18

Not To Scale



UT1 - Typical Section: Pool

Sta: 100+00 to 117+18

Not To Scale

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. P-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

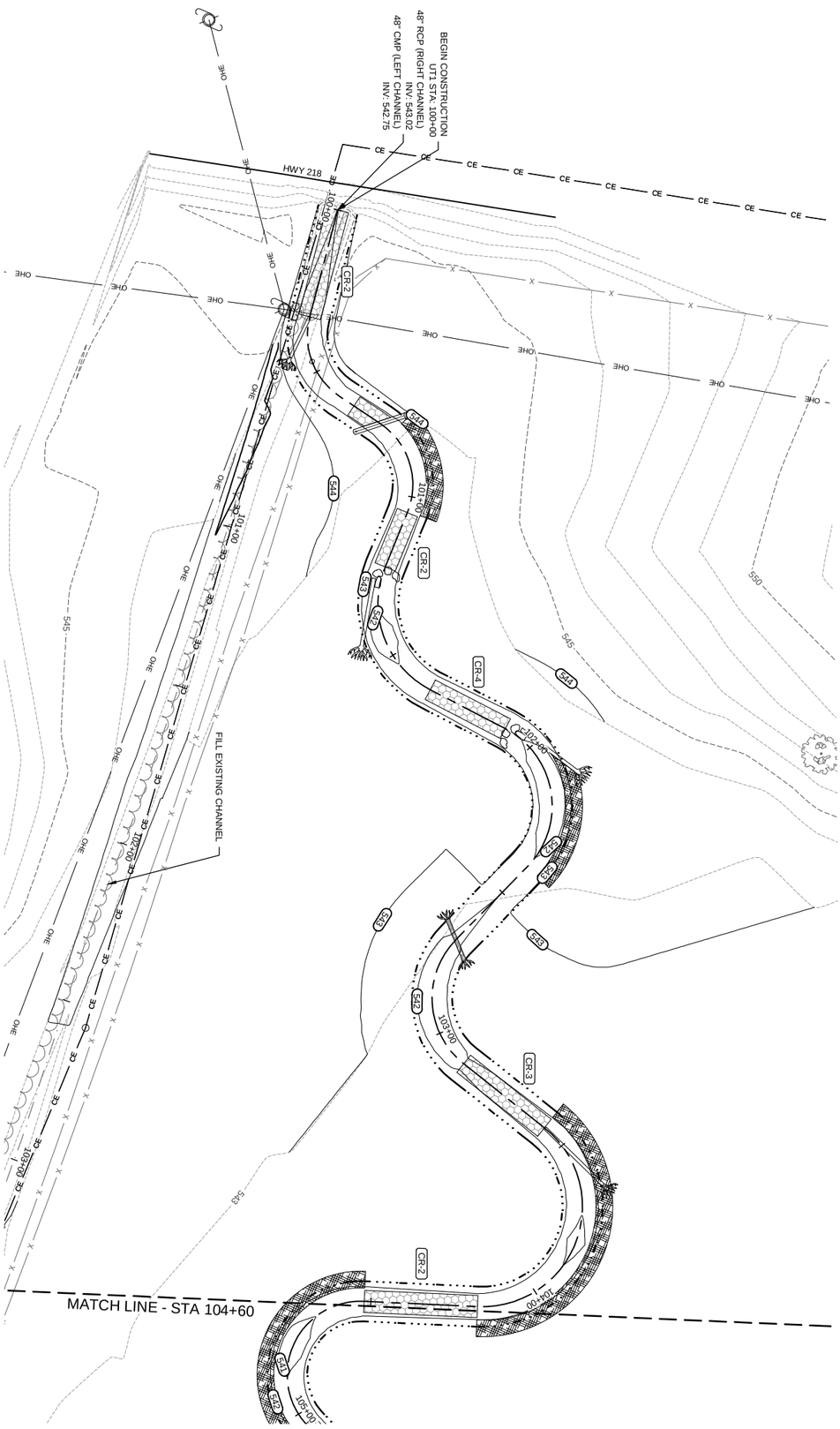
Typical Sections

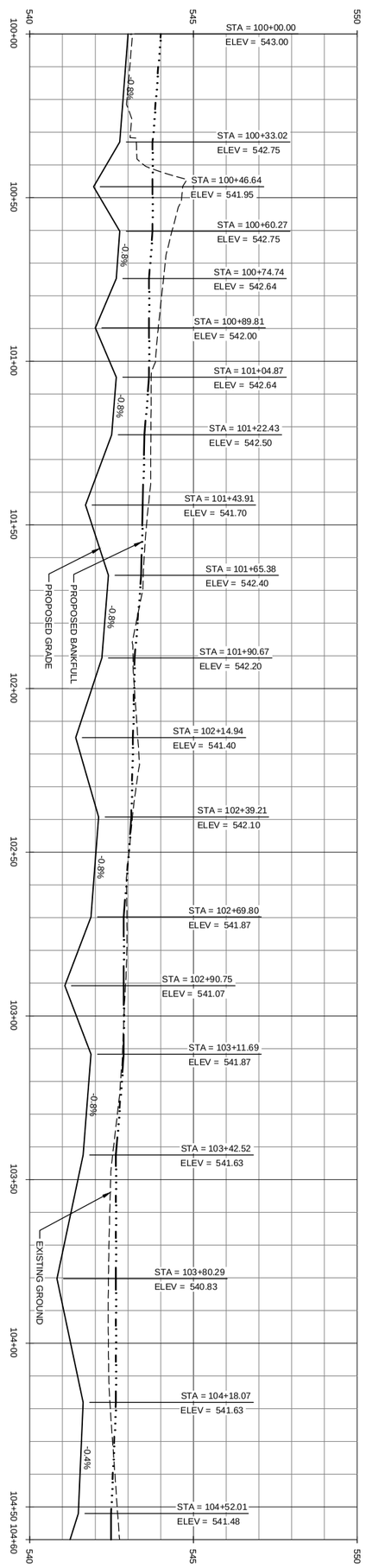
Revisions:

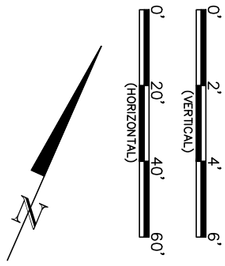
Date: February 15, 2013
Job Number: 003-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 1.1

60% Plans - Not for Construction







Date:	February 15, 2013
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	JK

Revisions:

2.1

Sheet

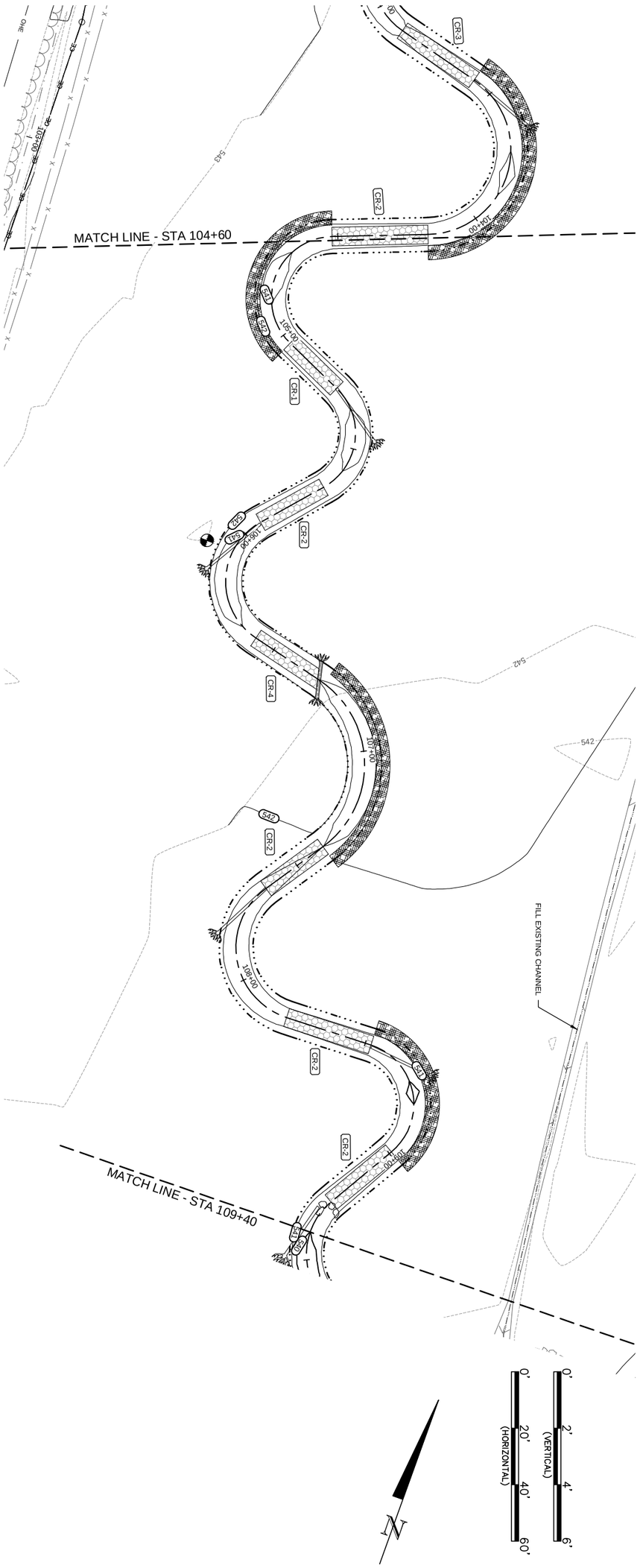
Crooked Creek #2 Restoration Project
Union County, North Carolina

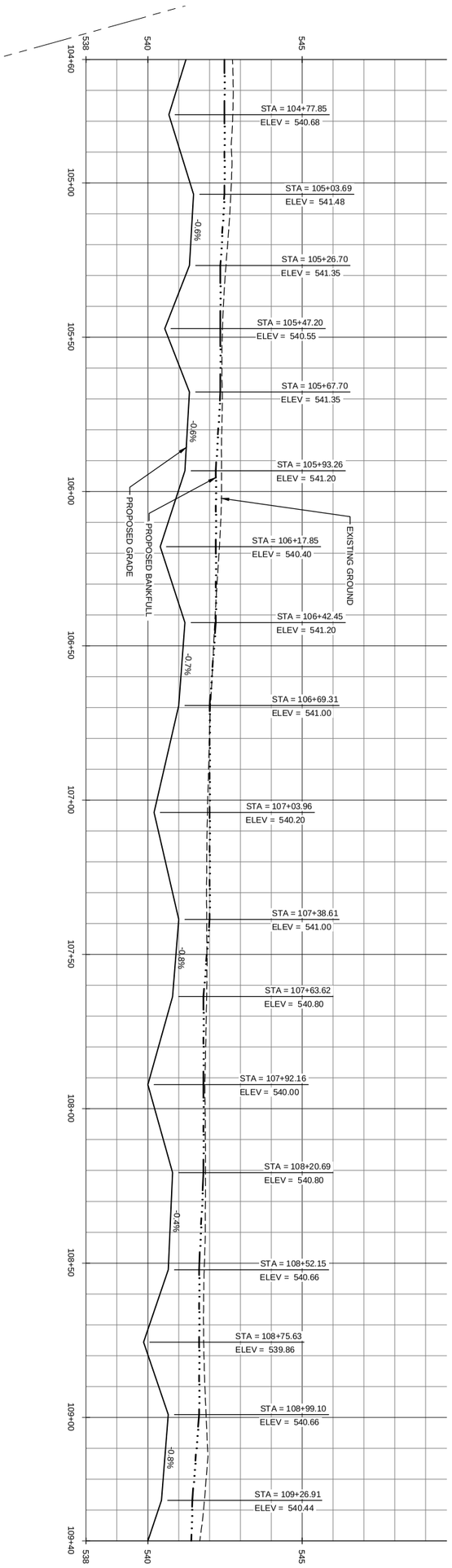
UT 1 Restoration
Stream Plan and Profile

NOT FOR CONSTRUCTION

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

60% Plans - Not for Construction





Date:	February 15, 2013
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	JK

Revisions:

2.2

Sheet

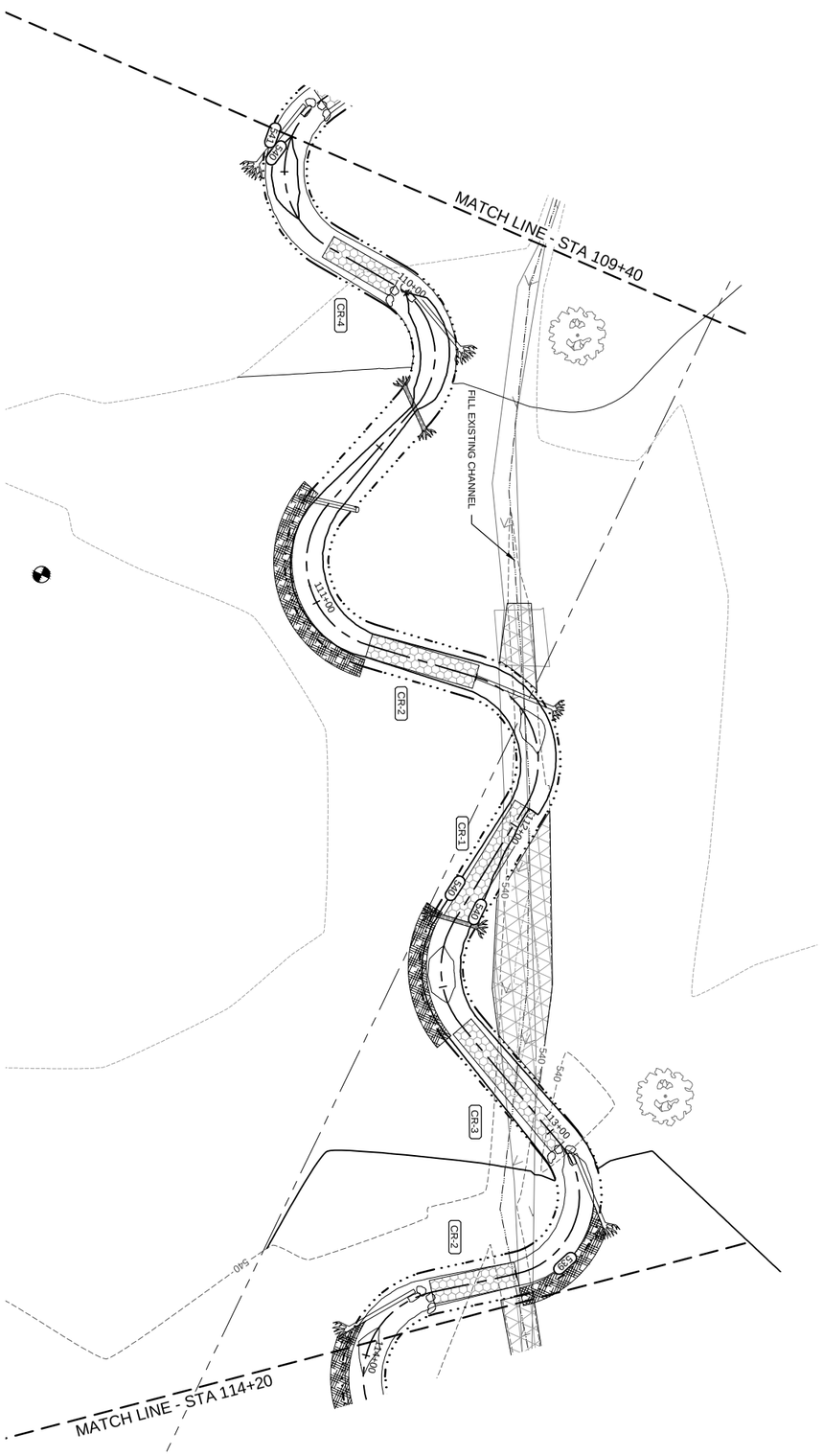
Crooked Creek #2 Restoration Project
Union County, North Carolina

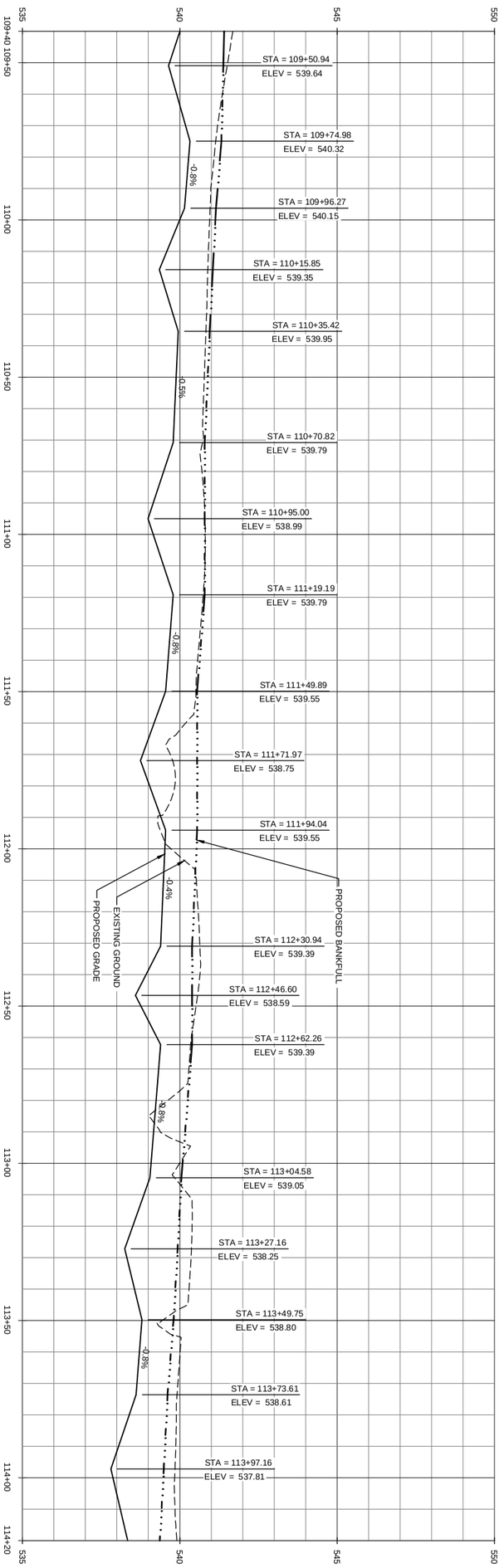
UT 1 Restoration
Stream Plan and Profile

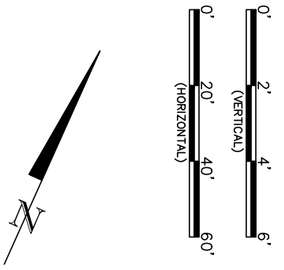
NOT FOR CONSTRUCTION

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

60% Plans - Not for Construction







Date:	February 15, 2013
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	JK

Revisions:

2.3

Sheet

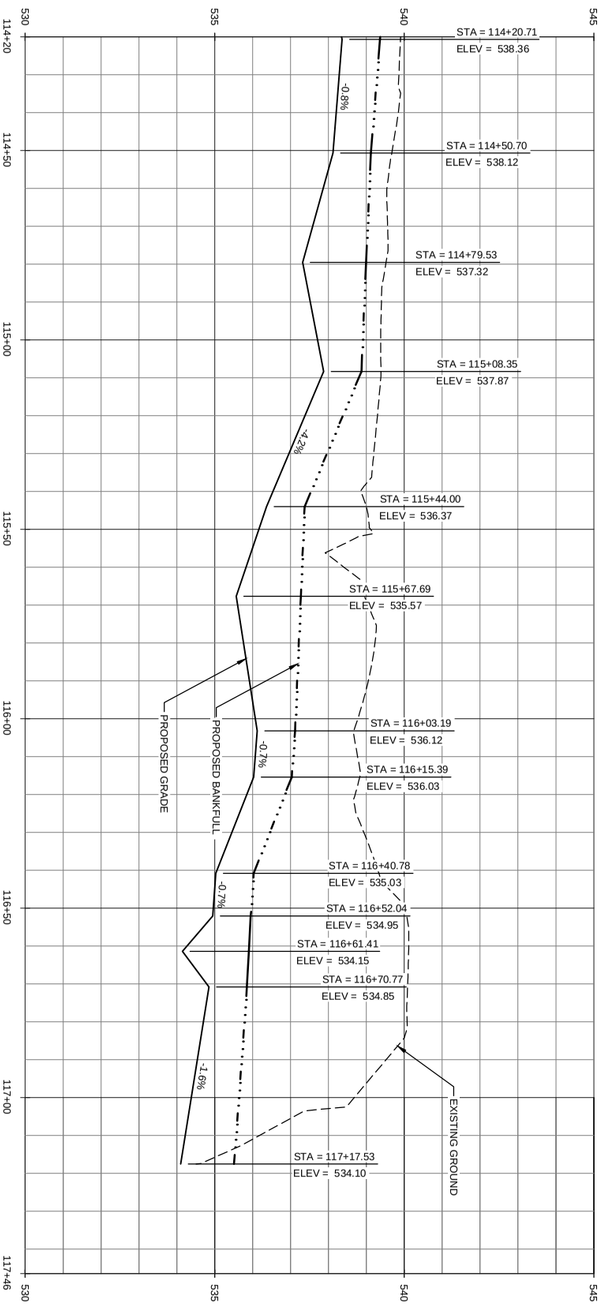
Crooked Creek #2 Restoration Project
Union County, North Carolina

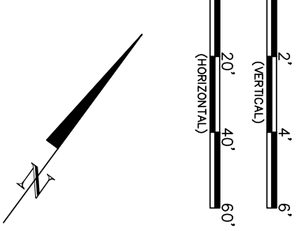
UT 1 Restoration
Stream Plan and Profile

NOT FOR CONSTRUCTION

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

60% Plans - Not for Construction





Date:	February 15, 2013
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	JK

Revisions:

2.4

Sheet

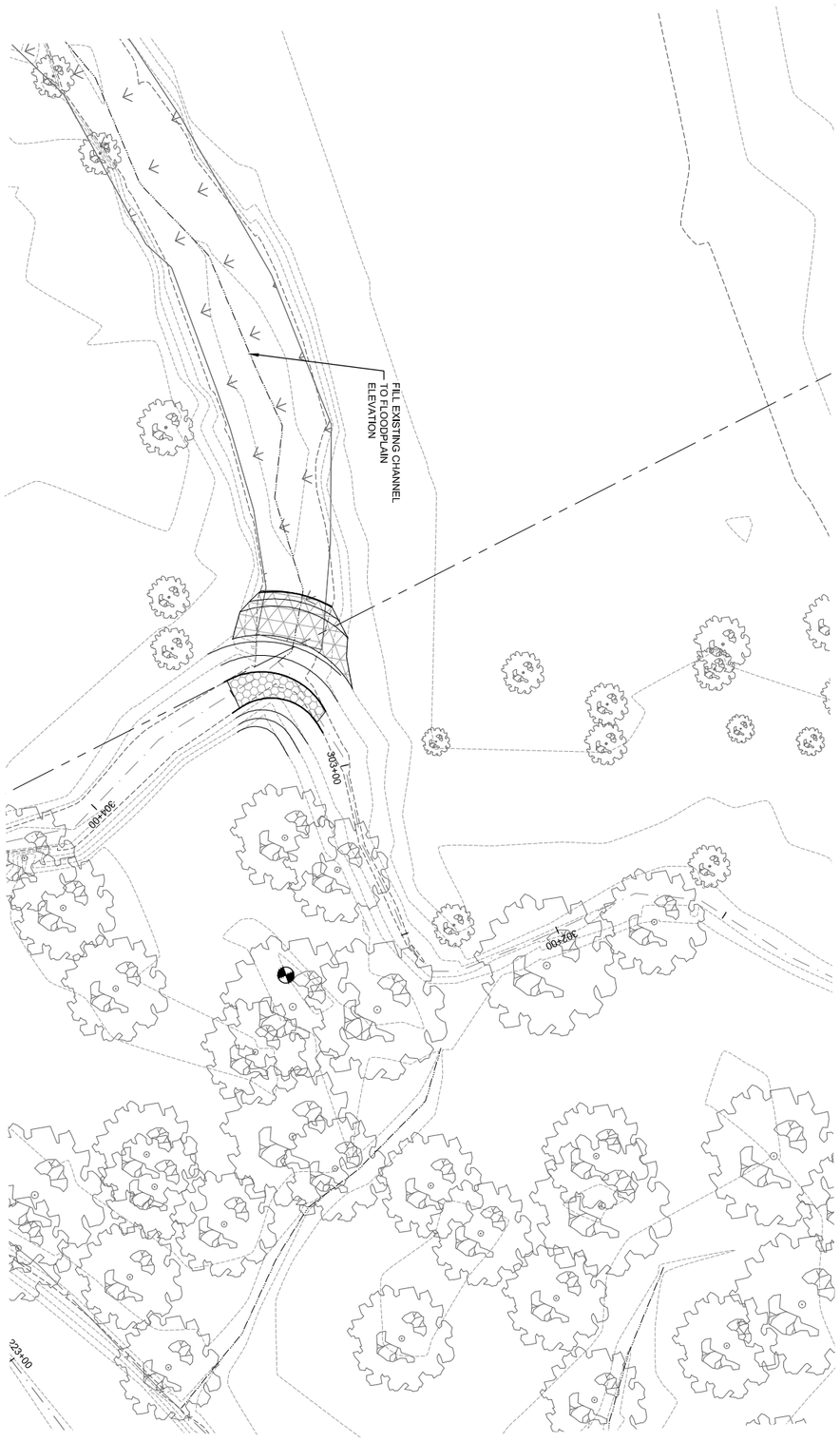
Crooked Creek #2 Restoration Project
Union County, North Carolina

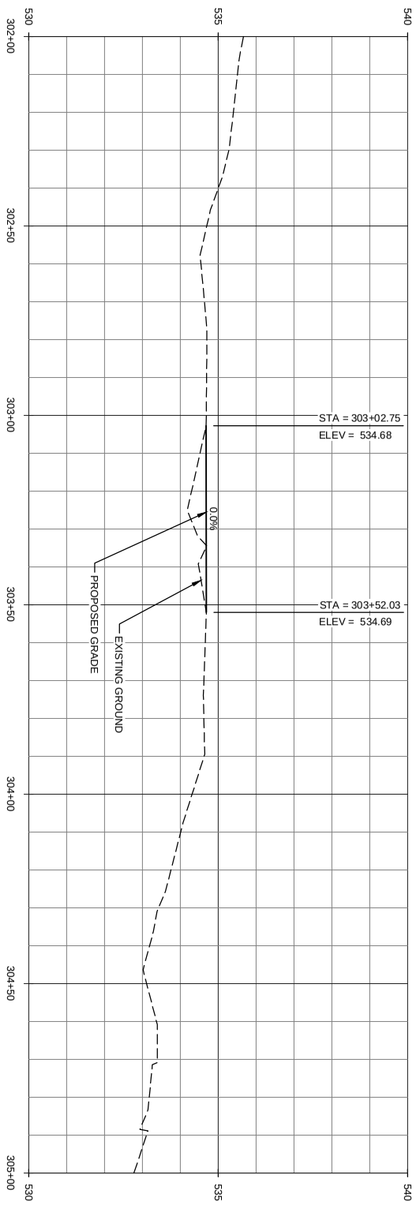
UT 1 Restoration
Stream Plan and Profile

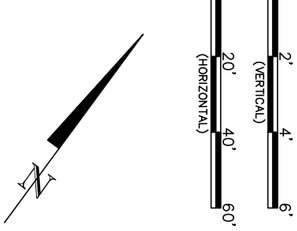
NOT FOR CONSTRUCTION

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

60% Plans - Not for Construction







Date:	February 15, 2013
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	JK

Revisions:

2.5

Sheet

Crooked Creek #2 Restoration Project
Union County, North Carolina

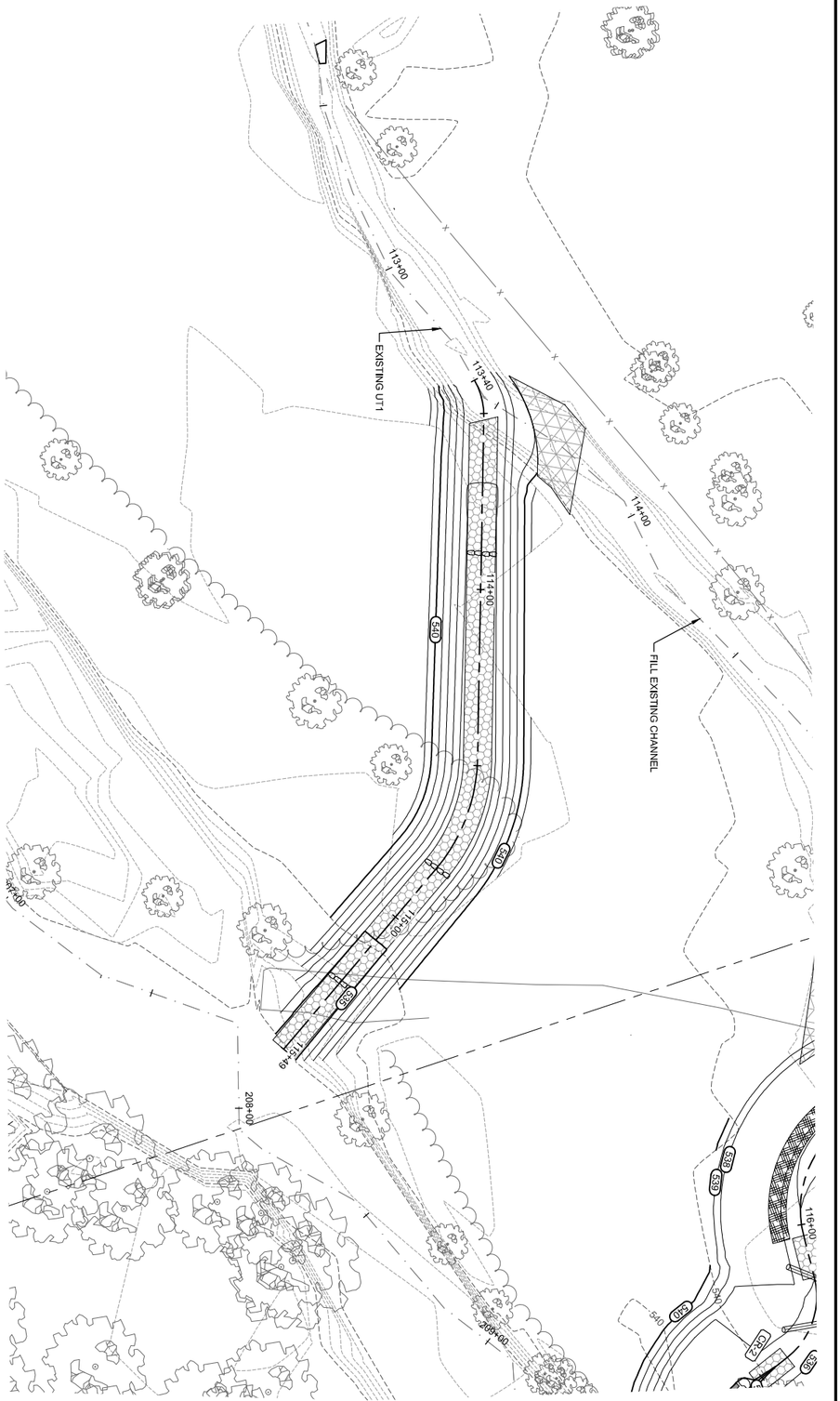
UT2

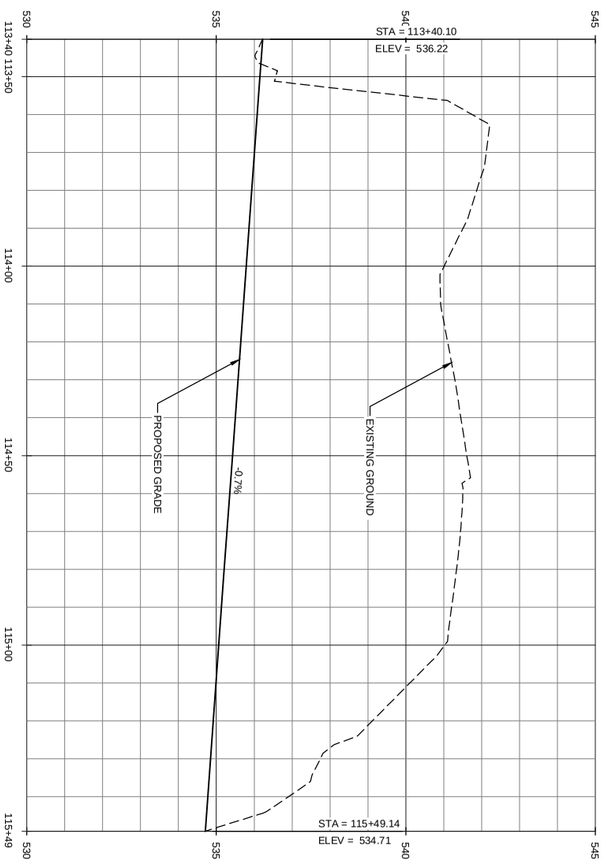
Stream Plan and Profile

NOT FOR CONSTRUCTION

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

60% Plans - Not for Construction





Date:	February 15, 2013
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	JK

Revisions:

2.6

Sheet

Crooked Creek #2 Restoration Project
Union County, North Carolina

Overflow Channel
Stream Plan and Profile

NOT FOR CONSTRUCTION

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

60% Plans - Not for Construction

Temporary Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
Aug 15 - May 1	*Secale cereale*	Herb	Rye Grain	140.00
May 1 - Aug 15	*Setaria italica*	Herb	German Millet	50.00

Permanent Wetland Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Chasmanthium latifolium	Herb	River Oats	0.80
All Year	Bouteloua curtipendula	Herb	Side oats grama	3.60
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	4.00
All Year	Schizachyrium scoparium	Herb	Little bluestem	3.60
All Year	Carex vulpinoidea	Herb	Fox sedge	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80

Permanent Riparian Buffer Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Andropogon ternarius	Herb	Split beardgrass	0.40
All Year	Bouteloua curtipendula	Herb	Side oats grama	2.80
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	3.60
All Year	Schizachyrium scoparium	Herb	Little bluestem	2.80
All Year	Sporobolus clandestinus	Herb	Rough dropseed	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80
All Year	Chasmanthium latifolium	Herb	River Oats	1.60
All Year	Carex vulpinoidea	Herb	Fox sedge	0.80

Livestake

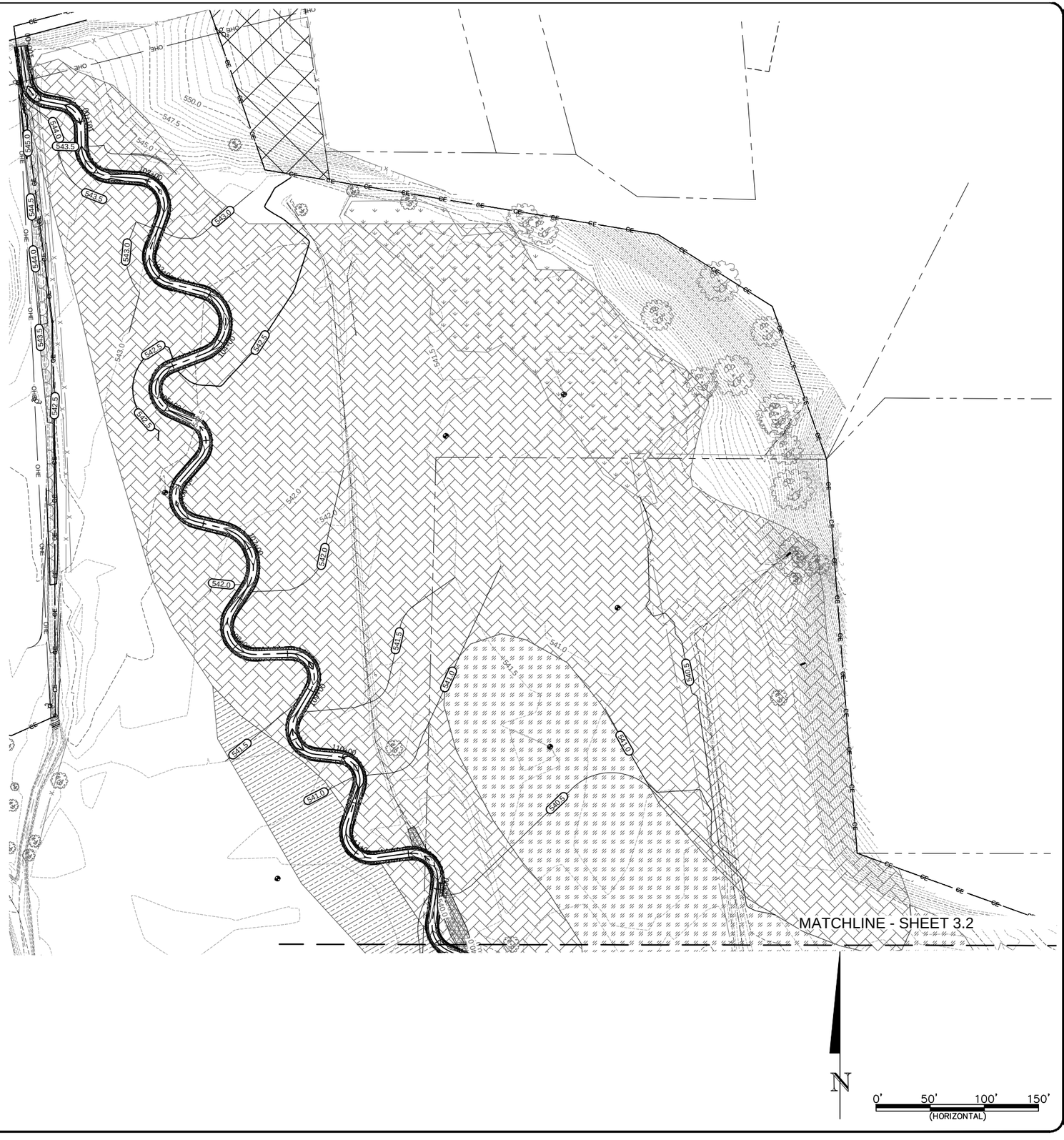
Species	Common Name	Max Spacing	Unit Type*	Min. Size	Stratum	Indiv. Spacing	# of Stems
Salix nigra	Black Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	202
Cornus amomum	Silky Dogwood	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	505
Salix sericea	Silky Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	303
Juncus effusus	Soft Rush	3 ft	L	1.0"-2.0" plug	Herb	3 ft	1665
						Subtotal	**2,676**

Wetland FACW

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Alnus serrulata	Tag Alder	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Cornus ammomum	Silky Dogwood	8 ft.	R	0.25"-1.0"	Shrub	6-8 ft.	540
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	1080
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	810
Nyssa sylvatica	Blackgum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	270
Quercus michauxii	Swamp Chestnut Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	1080
						Subtotal	**5,399**

Riparian Buffer (along UT1 Right Bank)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Liriodendron tulipifera	Tulip Poplar	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Carpinus caroliniana	Ironwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	143
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus rubra	Northern Red Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
						Subtotal	**1,428**



WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. P-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

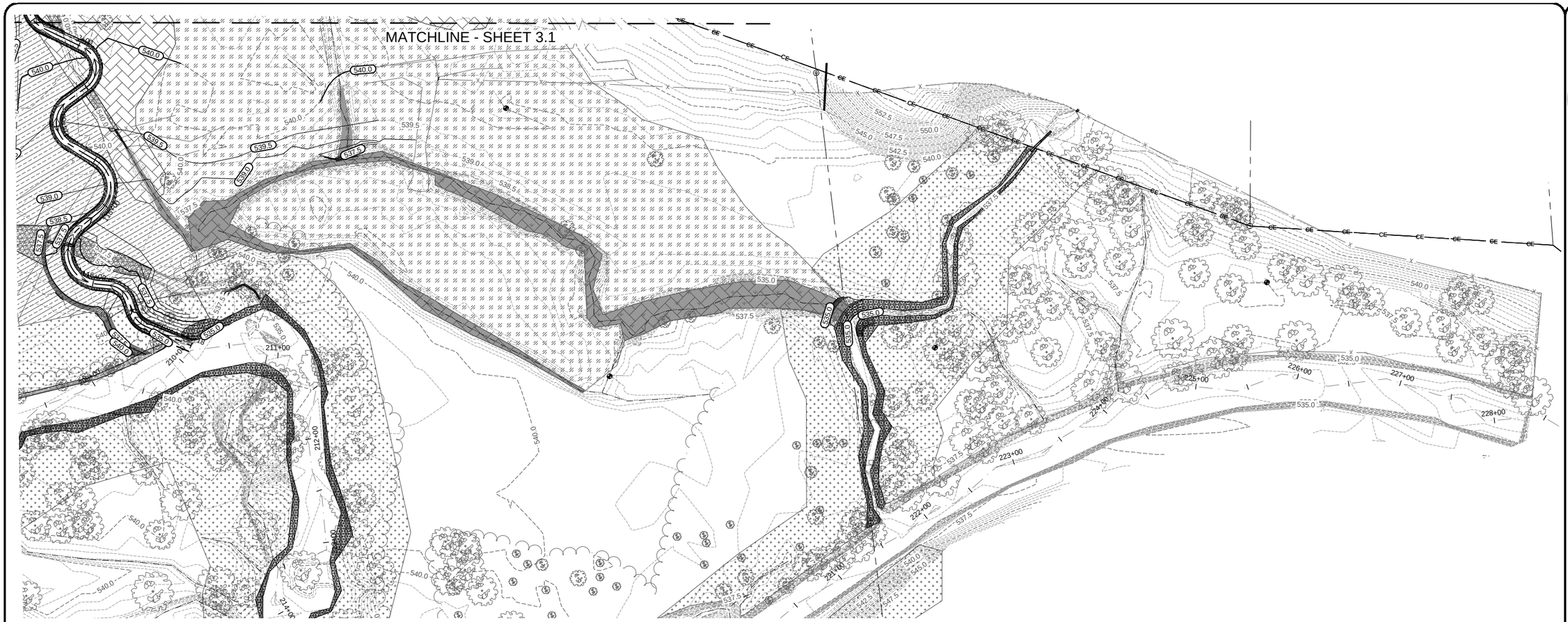
Wetlands
Planting & Grading

Revisions:

Date: February 15, 2013
Job Number: 003-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 3.1

60% Plans - Not for Construction



Livestake

Species	Common Name	Max Spacing	Unit Type*	Min. Size	Stratum	Indiv. Spacing	# of Stems
Salix nigra	Black Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	202
Cornus amomum	Silky Dogwood	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	505
Salix sericea	Silky Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	303
Juncus effusus	Soft Rush	3 ft	L	1.0"-2.0" plug	Herb	3 ft	1665
						Subtotal	**2,676**

Riparian Buffer (along Crooked Creek, UT2, and UT3)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Asimina triloba	Pawpaw	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	379
Lindera benzoin	Spicebush	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cornus florida	Flowering Dogwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Viburnum dentatum	Arrowwood Viburnum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Vaccinium corymbosum	Highbush Blueberry	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cercis canadensis	Redbud	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
						Subtotal	**3,788**

Riparian Buffer (along UT1 Right Bank)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Liriodendron tulipifera	Tulip Poplar	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Carpinus caroliniana	Ironwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	143
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus rubra	Northern Red Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
						Subtotal	**1,428**

Temporary Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
Aug 15 - May 1	*Secale cereale*	Herb	Rye Grain	140.00
May 1 - Aug 15	*Setaria italica*	Herb	German Millet	50.00

Permanent Riparian Buffer Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Andropogon ternarius	Herb	Split beardgrass	0.40
All Year	Bouteloua curtipendula	Herb	Side oats grama	2.80
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	3.60
All Year	Schizachyrium scoparium	Herb	Little bluestem	2.80
All Year	Sporobolus clandestinus	Herb	Rough dropseed	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80
All Year	Chasmanthium latifolium	Herb	River Oats	1.60
All Year	Carex vulpinoidea	Herb	Fox sedge	0.80

Permanent Wetland Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Chasmanthium latifolium	Herb	River Oats	0.80
All Year	Bouteloua curtipendula	Herb	Side oats grama	3.60
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	4.00
All Year	Schizachyrium scoparium	Herb	Little bluestem	3.60
All Year	Carex vulpinoidea	Herb	Fox sedge	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80

Wetland FAC

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Alnus serrulata	Tag Alder	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	81
Carpinus caroliniana	Ironwood	8 ft.	R	0.25"-1.0"	Shrub	6-8 ft.	244
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	163
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	325
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	81
Nyssa sylvatica	Blackgum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	163
Liriodendron tulipifera	Tulip Poplar	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	325
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	244
						Subtotal	**1,625**

Wetland FACW

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Alnus serrulata	Tag Alder	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Cornus ammomum	Silky Dogwood	8 ft.	R	0.25"-1.0"	Shrub	6-8 ft.	540
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	1080
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	810
Nyssa sylvatica	Blackgum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	270
Quercus michauxii	Swamp Chestnut Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	1080
						Subtotal	**5,399**

N

0' 50' 100' 150'
(HORIZONTAL)

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

Wetlands
Planting & Grading

Revisions:

Date: February 15, 2013
Job Number: 005-02127
Project Engineer: ASH
Drawn By: JCK
Checked By: JK

Sheet 3.2

60% Plans - Not for Construction

Temporary Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
Aug 15 - May 1	*Secale cereale*	Herb	Rye Grain	140.00
May 1 - Aug 15	*Setaria italica*	Herb	German Millet	50.00

Permanent Wetland Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Chasmanthium latifolium	Herb	River Oats	0.80
All Year	Bouteloua curtipendula	Herb	Side oats grama	3.60
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	4.00
All Year	Schizachyrium scoparium	Herb	Little bluestem	3.60
All Year	Carex vulpinoidea	Herb	Fox sedge	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80

Permanent Riparian Buffer Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Andropogon ternarius	Herb	Split beardgrass	0.40
All Year	Bouteloua curtipendula	Herb	Side oats grama	2.80
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	3.60
All Year	Schizachyrium scoparium	Herb	Little bluestem	2.80
All Year	Sporobolus clandestinus	Herb	Rough dropseed	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80
All Year	Chasmanthium latifolium	Herb	River Oats	1.60
All Year	Carex vulpinoidea	Herb	Fox sedge	0.80

Riparian Buffer (along Crooked Creek, UT2, and UT3)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Asimina triloba	Pawpaw	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	379
Lindera benzoin	Spicebush	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cornus florida	Flowering Dogwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Viburnum dentatum	Arrowwood Viburnum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Vaccinium corymbosum	Highbush Blueberry	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cercis canadensis	Redbud	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
						Subtotal	**3,788**

Livestake

Species	Common Name	Max Spacing	Unit Type*	Min. Size	Stratum	Indiv. Spacing	# of Stems
Salix nigra	Black Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	202
Cornus amomum	Silky Dogwood	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	505
Salix sericea	Silky Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	303
Juncus effusus	Soft Rush	3 ft	L	1.0"-2.0" plug	Herb	3 ft	1665
						Subtotal	**2,676**

Riparian Buffer (along UT1 Right Bank)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Liriodendron tulipifera	Tulip Poplar	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Carpinus caroliniana	Ironwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	143
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus rubra	Northern Red Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
						Subtotal	**1,428**

Wetland FACW

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Alnus serrulata	Tag Alder	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Cornus ammomum	Silky Dogwood	8 ft.	R	0.25"-1.0"	Shrub	6-8 ft.	540
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	1080
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	810
Nyssa sylvatica	Blackgum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	270
Quercus michauxii	Swamp Chestnut Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	1080
						Subtotal	**5,399**

N

0' 20' 40' 60'
(HORIZONTAL)

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

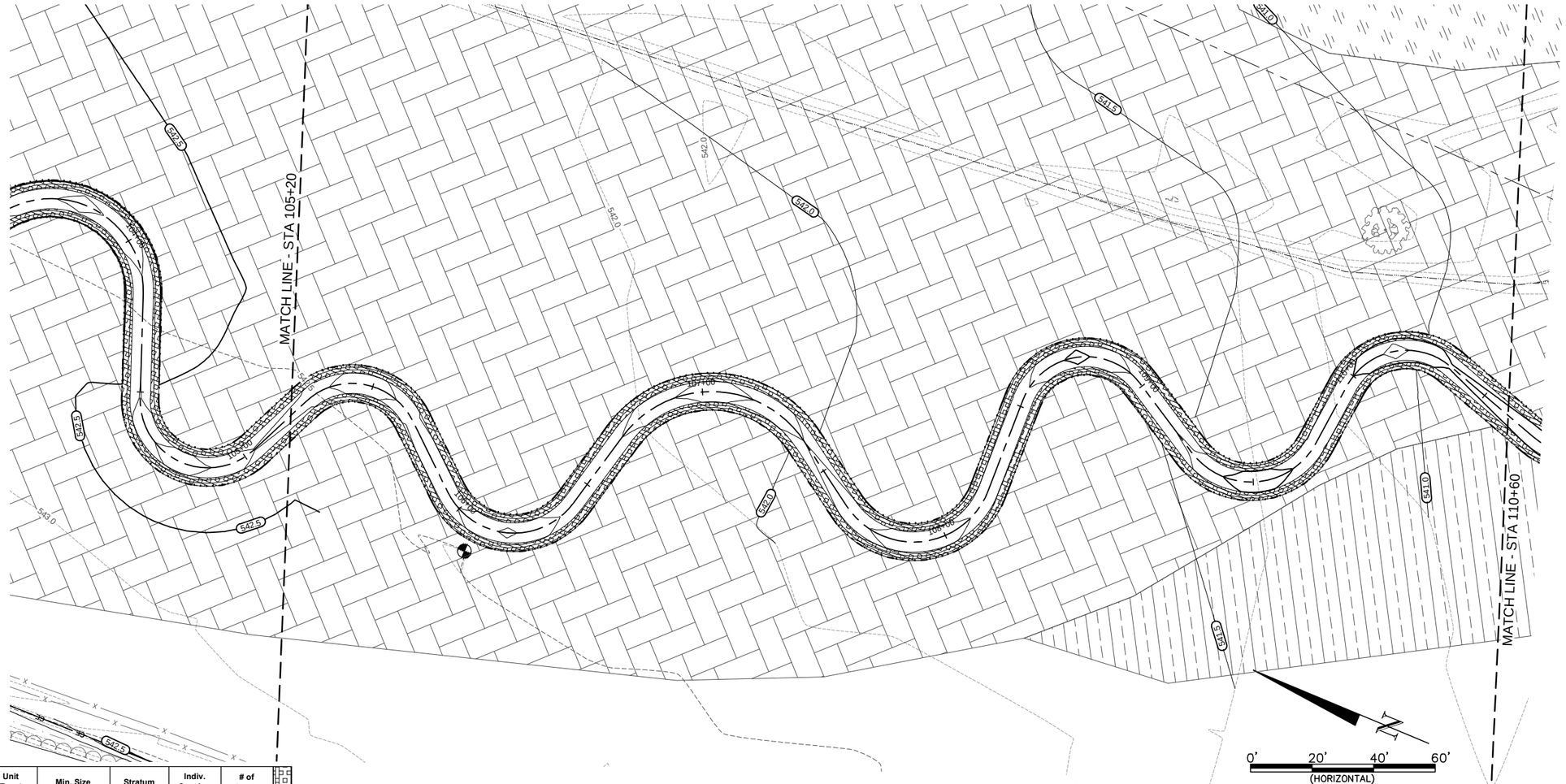
Crooked Creek #2 Restoration Project
Union County, North Carolina
UT1
Planting

Revisions:

Date: February 15, 2013
Job Number: 005-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 3.3

60% Plans - Not for Construction



Livestake

Species	Common Name	Max Spacing	Unit Type*	Min. Size	Stratum	Indiv. Spacing	# of Stems
Salix nigra	Black Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	202
Cornus amomum	Silky Dogwood	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	505
Salix sericea	Silky Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	303
Juncus effusus	Soft Rush	3 ft	L	1.0"-2.0" plug	Herb	3 ft	1665
						Subtotal	**2,676**

Riparian Buffer (along Crooked Creek, UT2, and UT3)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Asimina triloba	Pawpaw	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	379
Lindera benzoin	Spicebush	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cornus florida	Flowering Dogwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Viburnum dentatum	Arrowwood Viburnum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Vaccinium corymbosum	Highbush Blueberry	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cercis canadensis	Redbud	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
						Subtotal	**3,788**

Riparian Buffer (along UT1 Right Bank)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Liriodendron tulipifera	Tulip Poplar	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Carpinus caroliniana	Ironwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	143
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus rubra	Northern Red Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
						Subtotal	**1,428**

Wetland FACW

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Alnus serrulata	Tag Alder	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Cornus ammomum	Silky Dogwood	8 ft.	R	0.25"-1.0"	Shrub	6-8 ft.	540
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	1080
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	810
Nyssa sylvatica	Blackgum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	270
Quercus michauxii	Swamp Chestnut Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	1080
						Subtotal	**5,399**

Temporary Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
Aug 15 - May 1	*Secale cereale*	Herb	Rye Grain	140.00
May 1 - Aug 15	*Setaria italica*	Herb	German Millet	50.00

Permanent Riparian Buffer Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Andropogon ternarius	Herb	Split beardgrass	0.40
All Year	Bouteloua curtipendula	Herb	Side oats grama	2.80
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	3.60
All Year	Schizachyrium scoparium	Herb	Little bluestem	2.80
All Year	Sporobolus clandestinus	Herb	Rough dropseed	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80
All Year	Chasmanthium latifolium	Herb	River Oats	1.60
All Year	Carex vulpinoidea	Herb	Fox sedge	0.80

Permanent Wetland Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Chasmanthium latifolium	Herb	River Oats	0.80
All Year	Bouteloua curtipendula	Herb	Side oats grama	3.60
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	4.00
All Year	Schizachyrium scoparium	Herb	Little bluestem	3.60
All Year	Carex vulpinoidea	Herb	Fox sedge	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina
UT1
Planting

Revisions:

Date: February 15, 2013
Job Number: 005-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 3.4

60% Plans - Not for Construction

Temporary Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
Aug 15 - May 1	*Secale cereale*	Herb	Rye Grain	140.00
May 1 - Aug 15	*Setaria italica*	Herb	German Millet	50.00

Permanent Wetland Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Chasmanthium latifolium	Herb	River Oats	0.80
All Year	Bouteloua curtipendula	Herb	Side oats grama	3.60
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	4.00
All Year	Schizachyrium scoparium	Herb	Little bluestem	3.60
All Year	Carex vulpinoidea	Herb	Fox sedge	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80

Permanent Riparian Buffer Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Andropogon ternarius	Herb	Split beardgrass	0.40
All Year	Bouteloua curtipendula	Herb	Side oats grama	2.80
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	3.60
All Year	Schizachyrium scoparium	Herb	Little bluestem	2.80
All Year	Sporobolus clandestinus	Herb	Rough dropseed	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80
All Year	Chasmanthium latifolium	Herb	River Oats	1.60
All Year	Carex vulpinoidea	Herb	Fox sedge	0.80

Livestake

Species	Common Name	Max Spacing	Unit Type*	Min. Size	Stratum	Indiv. Spacing	# of Stems
Salix nigra	Black Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	202
Cornus amomum	Silky Dogwood	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	505
Salix sericea	Silky Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	303
Juncus effusus	Soft Rush	3 ft	L	1.0"-2.0" plug	Herb	3 ft	1665
						Subtotal	**2,676**

Riparian Buffer (along Crooked Creek, UT2, and UT3)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Asimina triloba	Pawpaw	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	379
Lindera benzoin	Spicebush	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cornus florida	Flowering Dogwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Viburnum dentatum	Arrowwood Viburnum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Vaccinium corymbosum	Highbush Blueberry	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cercis canadensis	Redbud	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
						Subtotal	**3,788**

Riparian Buffer (along UT1 Right Bank)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Liriodendron tulipifera	Tulip Poplar	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Carpinus caroliniana	Ironwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	143
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus rubra	Northern Red Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
						Subtotal	**1,428**

Wetland FAC

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Alnus serrulata	Tag Alder	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	81
Carpinus caroliniana	Ironwood	8 ft.	R	0.25"-1.0"	Shrub	6-8 ft.	244
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	163
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	325
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	81
Nyssa sylvatica	Blackgum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	163
Liriodendron tulipifera	Tulip Poplar	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	325
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	244
						Subtotal	**1,625**

Wetland FACW

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Alnus serrulata	Tag Alder	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Cornus ammomum	Silky Dogwood	8 ft.	R	0.25"-1.0"	Shrub	6-8 ft.	540
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	1080
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	810
Nyssa sylvatica	Blackgum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	270
Quercus michauxii	Swamp Chestnut Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	540
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	1080
						Subtotal	**5,399**

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

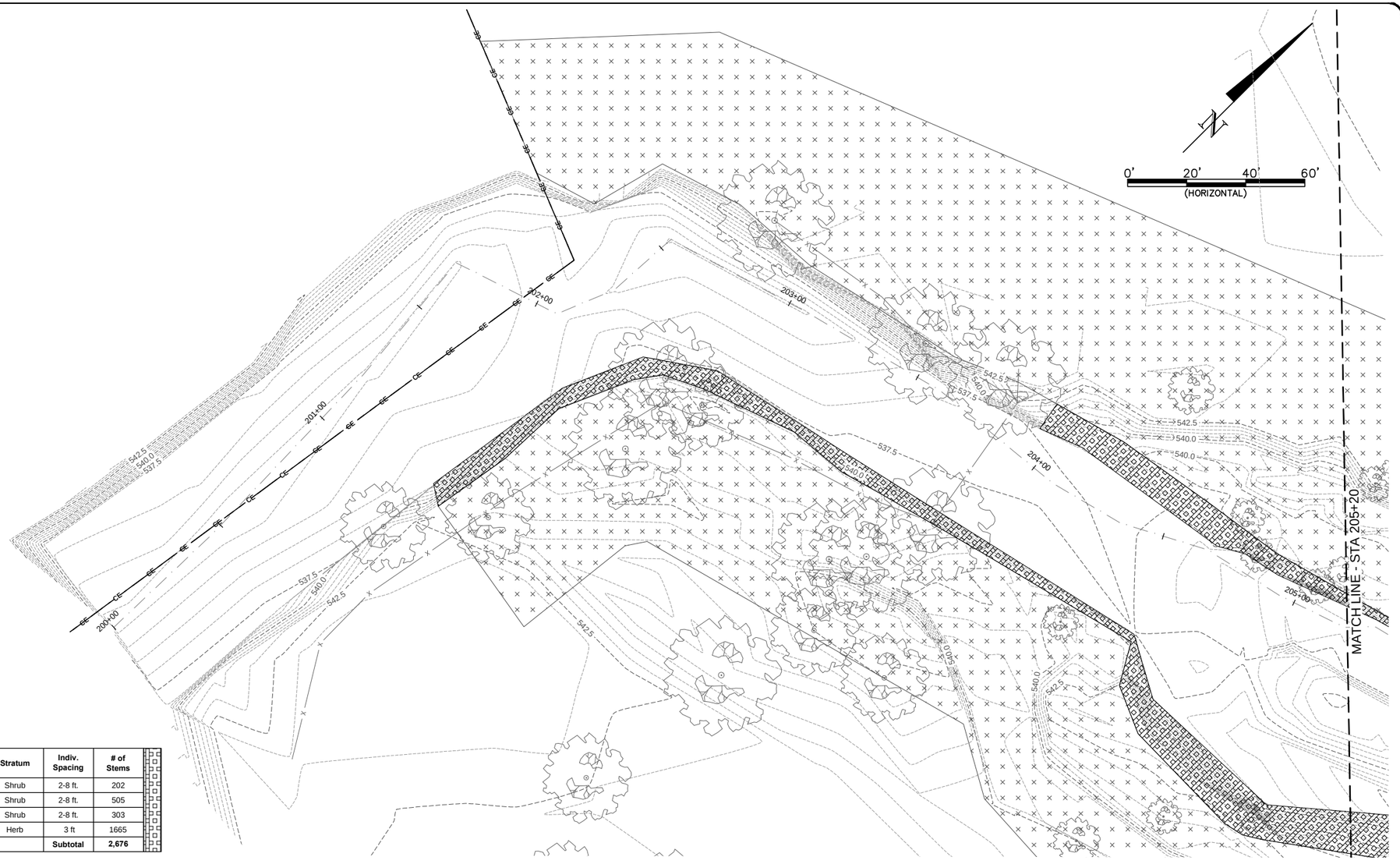
UT1
Planting

Revisions:

Date: February 15, 2013
Job Number: 093-0127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 3.5

60% Plans - Not for Construction



Livestake

Species	Common Name	Max Spacing	Unit Type*	Min. Size	Stratum	Indiv. Spacing	# of Stems
Salix nigra	Black Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	202
Cornus amomum	Silky Dogwood	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	505
Salix sericea	Silky Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	303
Juncus effusus	Soft Rush	3 ft	L	1.0"-2.0" plug	Herb	3 ft	1665
						Subtotal	**2,676**

Riparian Buffer (along Crooked Creek, UT2, and UT3)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Asimina triloba	Pawpaw	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	379
Lindera benzoin	Spicebush	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cornus florida	Flowering Dogwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Viburnum dentatum	Arrowwood Viburnum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Vaccinium corymbosum	Highbush Blueberry	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cercis canadensis	Redbud	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
						Subtotal	**3,788**

Permanent Riparian Buffer Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Andropogon ternarius	Herb	Split beardgrass	0.40
All Year	Bouteloua curtipendula	Herb	Side oats grama	2.80
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	3.60
All Year	Schizachyrium scoparium	Herb	Little bluestem	2.80
All Year	Sporobolus clandestinus	Herb	Rough dropseed	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80
All Year	Chasmanthium latifolium	Herb	River Oats	1.60
All Year	Carex vulpinoidea	Herb	Fox sedge	0.80

Permanent Wetland Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Chasmanthium latifolium	Herb	River Oats	0.80
All Year	Bouteloua curtipendula	Herb	Side oats grama	3.60
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	4.00
All Year	Schizachyrium scoparium	Herb	Little bluestem	3.60
All Year	Carex vulpinoidea	Herb	Fox sedge	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80

Temporary Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
Aug 15 - May 1	*Secale cereale*	Herb	Rye Grain	140.00
May 1 - Aug 15	*Setaria italica*	Herb	German Millet	50.00

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

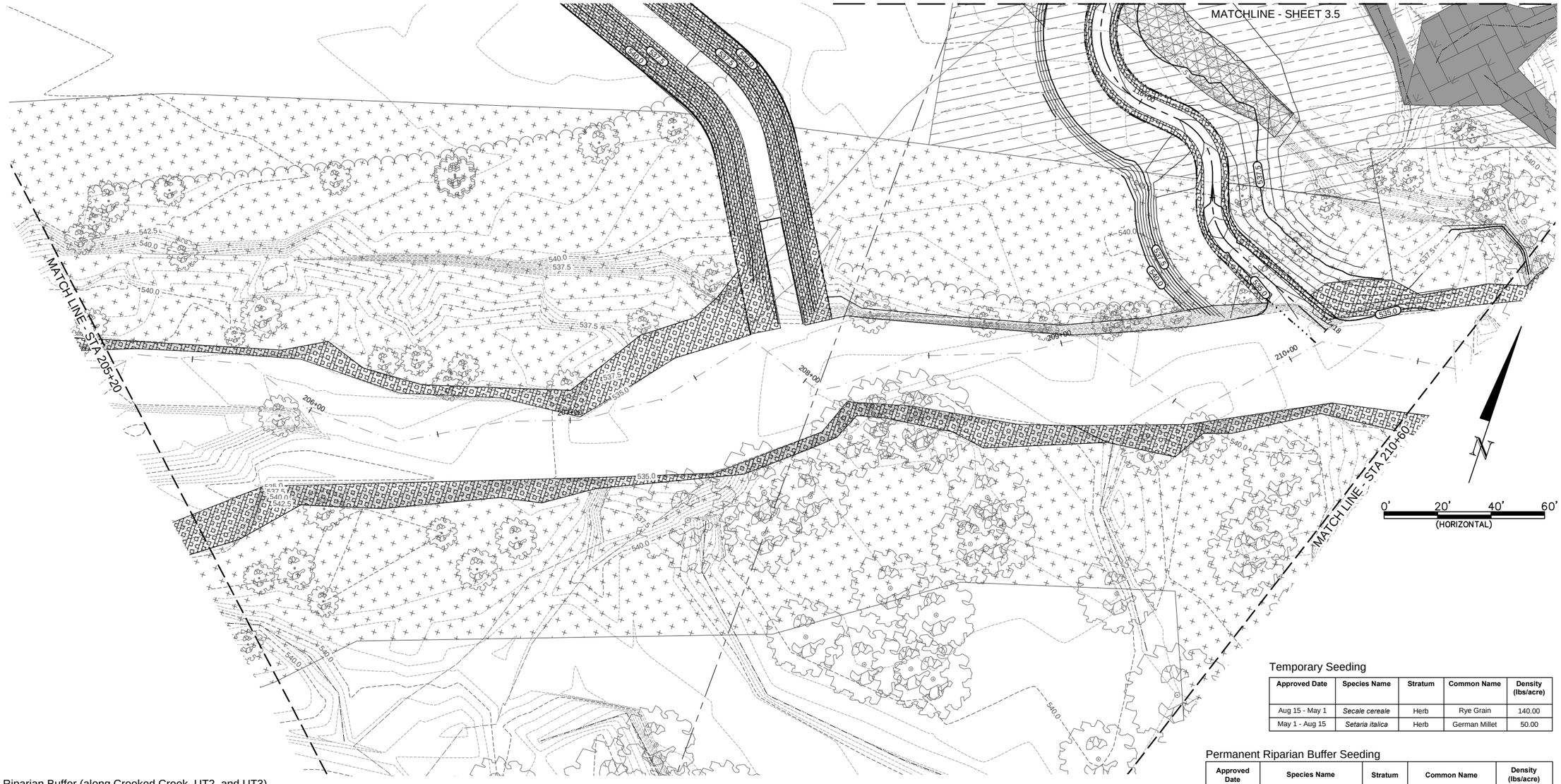
Crooked Creek
Planting

Revisions:

Date: February 15, 2013
Job Number: 093-0217
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 3.6

60% Plans - Not for Construction



Riparian Buffer (along Crooked Creek, UT2, and UT3)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Asimina triloba	Pawpaw	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	379
Lindera benzoin	Spicebush	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cornus florida	Flowering Dogwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Viburnum dentatum	Arrowwood Viburnum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Vaccinium corymbosum	Highbush Blueberry	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cercis canadensis	Redbud	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
						Subtotal	3,788

Riparian Buffer (along UT1 Right Bank)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Liriodendron tulipifera	Tulip Poplar	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Carpinus caroliniana	Ironwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	143
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	286
Quercus rubra	Northern Red Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	71
						Subtotal	1,428

Livestake

Species	Common Name	Max Spacing	Unit Type*	Min. Size	Stratum	Indiv. Spacing	# of Stems
Salix nigra	Black Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	202
Cornus amomum	Silky Dogwood	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	505
Salix sericea	Silky Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	303
Juncus effusus	Soft Rush	3 ft	L	1.0"-2.0" plug	Herb	3 ft	1665
						Subtotal	2,676

Wetland FAC

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Alnus serrulata	Tag Alder	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	81
Carpinus caroliniana	Ironwood	8 ft.	R	0.25"-1.0"	Shrub	6-8 ft.	244
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	163
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	325
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	81
Nyssa sylvatica	Blackgum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	163
Liriodendron tulipifera	Tulip Poplar	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	325
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	244
						Subtotal	1,625

Temporary Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
Aug 15 - May 1	*Secale cereale*	Herb	Rye Grain	140.00
May 1 - Aug 15	*Setaria italica*	Herb	German Millet	50.00

Permanent Riparian Buffer Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Andropogon ternarius	Herb	Split beardgrass	0.40
All Year	Bouteloua curtipendula	Herb	Side oats grama	2.80
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	3.60
All Year	Schizachyrium scoparium	Herb	Little bluestem	2.80
All Year	Sporobolus clandestinus	Herb	Rough dropseed	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80
All Year	Chasmanthium latifolium	Herb	River Oats	1.60
All Year	Carex vulpinoidea	Herb	Fox sedge	0.80

Permanent Wetland Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Chasmanthium latifolium	Herb	River Oats	0.80
All Year	Bouteloua curtipendula	Herb	Side oats grama	3.60
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	4.00
All Year	Schizachyrium scoparium	Herb	Little bluestem	3.60
All Year	Carex vulpinoidea	Herb	Fox sedge	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

Crooked Creek
Planting

Revisions:

Date: February 15, 2013
Job Number: 093-0127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 3.7

60% Plans - Not for Construction

Temporary Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
Aug 15 - May 1	*Secale cereale*	Herb	Rye Grain	140.00
May 1 - Aug 15	*Setaria italica*	Herb	German Millet	50.00

Permanent Riparian Buffer Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Andropogon ternarius	Herb	Split beardgrass	0.40
All Year	Bouteloua curtipendula	Herb	Side oats grama	2.80
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	3.60
All Year	Schizachyrium scoparium	Herb	Little bluestem	2.80
All Year	Sporobolus clandestinus	Herb	Rough dropseed	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80
All Year	Chasmanthium latifolium	Herb	River Oats	1.60
All Year	Carex vulpinoidea	Herb	Fox sedge	0.80

Permanent Wetland Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Chasmanthium latifolium	Herb	River Oats	0.80
All Year	Bouteloua curtipendula	Herb	Side oats grama	3.60
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	4.00
All Year	Schizachyrium scoparium	Herb	Little bluestem	3.60
All Year	Carex vulpinoidea	Herb	Fox sedge	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80

Riparian Buffer (along Crooked Creek, UT2, and UT3)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Asimina triloba	Pawpaw	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	379
Lindera benzoin	Spicebush	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cornus florida	Flowering Dogwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Viburnum dentatum	Arrowwood Viburnum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Vaccinium corymbosum	Highbush Blueberry	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cercis canadensis	Redbud	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
						Subtotal	**3,788**

Wetland FAC

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Alnus serrulata	Tag Alder	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	81
Carpinus caroliniana	Ironwood	8 ft.	R	0.25"-1.0"	Shrub	6-8 ft.	244
Quercus phellos	Willow Oak	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	163
Plantus occidentalis	Sycamore	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	325
Betula nigra	River Birch	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	81
Nyssa sylvatica	Blackgum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	163
Liriodendron tulipifera	Tulip Poplar	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	325
Fraxinus pennsylvanica	Green Ash	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	244
						Subtotal	**1,625**

Livestake

Species	Common Name	Max Spacing	Unit Type*	Min. Size	Stratum	Indiv. Spacing	# of Stems
Salix nigra	Black Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	202
Cornus amomum	Silky Dogwood	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	505
Salix sericea	Silky Willow	8 ft.	L	0.5"-1.0" cal.	Shrub	2-8 ft.	303
Juncus effusus	Soft Rush	3 ft	L	1.0"-2.0" plug	Herb	3 ft	1665
						Subtotal	**2,676**

0' 20' 40' 60'
(HORIZONTAL)

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

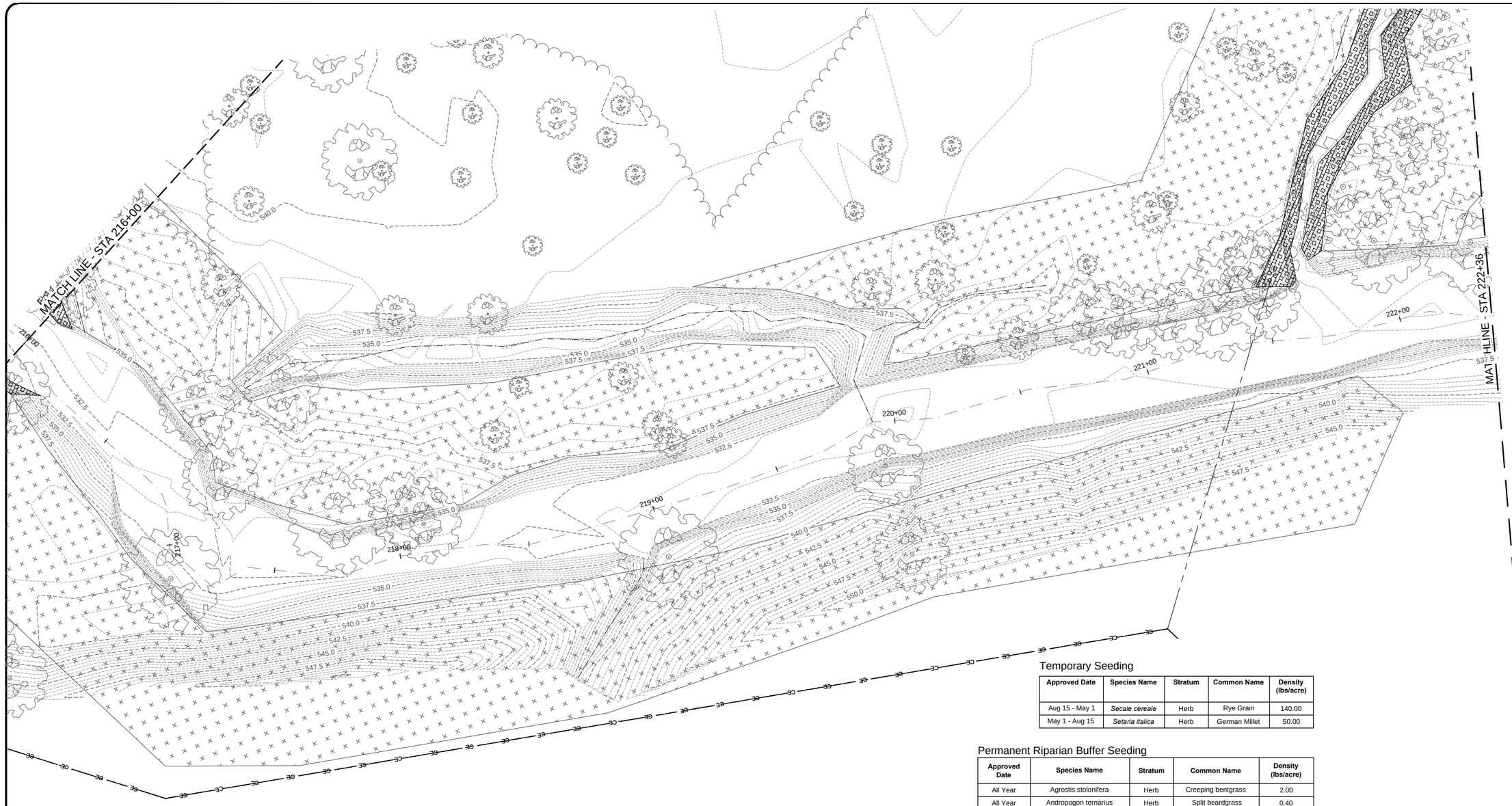
Crooked Creek
Planting

Revisions:

Date: February 15, 2013
Job Number: 003-02127
Project Engineer: ASH
Drawn By: JCK
Checked By: JK

Sheet 3.8

60% Plans - Not for Construction



Temporary Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
Aug 15 - May 1	*Secale cereale*	Herb	Rye Grain	140.00
May 1 - Aug 15	*Setaria italica*	Herb	German Millet	50.00

Permanent Riparian Buffer Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Andropogon ternarius	Herb	Split beardgrass	0.40
All Year	Bouteloua curtipendula	Herb	Side oats grama	2.80
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	3.60
All Year	Schizachyrium scoparium	Herb	Little bluestem	2.80
All Year	Sporobolus clandestinus	Herb	Rough dropseed	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80
All Year	Chasmanthium latifolium	Herb	River Oats	1.60
All Year	Carex vulpinoidea	Herb	Fox sedge	0.80

Permanent Wetland Seeding

Approved Date	Species Name	Stratum	Common Name	Density (lbs/acre)
All Year	Agrostis stolonifera	Herb	Creeping bentgrass	2.00
All Year	Chasmanthium latifolium	Herb	River Oats	0.80
All Year	Bouteloua curtipendula	Herb	Side oats grama	3.60
All Year	Bouteloua gracilis	Herb	Blue grama	3.60
All Year	Panicum clandestinum	Herb	Deer tongue	4.00
All Year	Schizachyrium scoparium	Herb	Little bluestem	3.60
All Year	Carex vulpinoidea	Herb	Fox sedge	1.60
All Year	Vicia villosa	Herb	Hairy vetch	0.80

Riparian Buffer (along Crooked Creek, UT2, and UT3)

Species	Common Name	Max Spacing	Unit Type*	Min. Caliper Size	Stratum	Indiv. Spacing	# of Stems
Asimina triloba	Pawpaw	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	379
Lindera benzoin	Spicebush	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cornus florida	Flowering Dogwood	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Viburnum dentatum	Arrowwood Viburnum	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
Vaccinium corymbosum	Highbush Blueberry	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	568
Cercis canadensis	Redbud	8 ft.	R	0.25"-1.0"	Canopy	6-8 ft.	758
						Subtotal	**3,788**

0’ 20’ 40’ 60’
(HORIZONTAL)

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

Crooked Creek
Planting

Revisions:

Date: February 15, 2013
Job Number: 005-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 3.9

60% Plans - Not for Construction

Date:	February 15, 2013
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	JK

3.10

Sheet

Revisions:

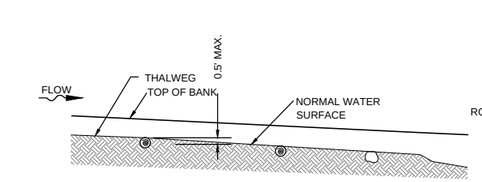
Crooked Creek #2 Restoration Project
Union County, North Carolina

Crooked Creek
Planting

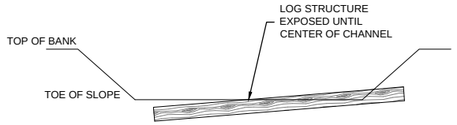
NOT FOR CONSTRUCTION

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

60% Plans - Not for Construction



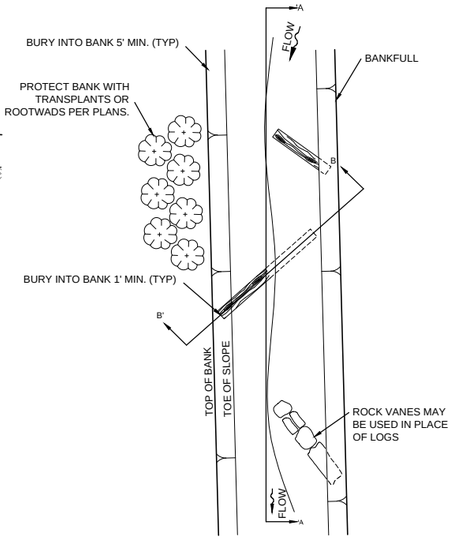
Profile View
A-A'



Log Profile B-B'

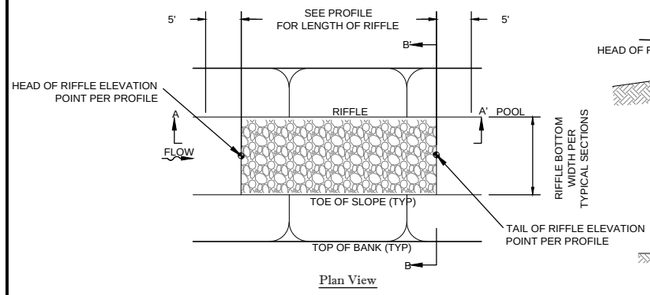
NOTES:

- STRUCTURES SHOULD VARY IN SIZE AND TYPE WITHIN EACH RIFFLE.
- LOGS MAY BE SUBSTITUTED BY ROCK AT ENGINEER'S DISCRETION.
- RIFFLE DIMENSIONS FROM TYPICAL SECTIONS.
- SEE PROFILE FOR LENGTH AND SLOPE.

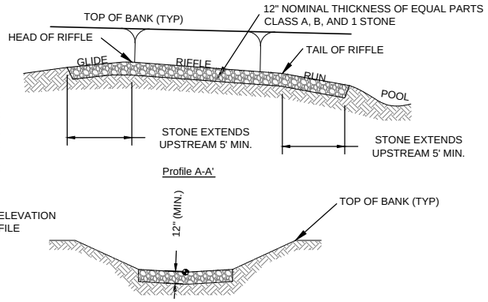


Plan View

1 / 5.1 Jazz Riffle Structure — Not to Scale — CR-1



Plan View

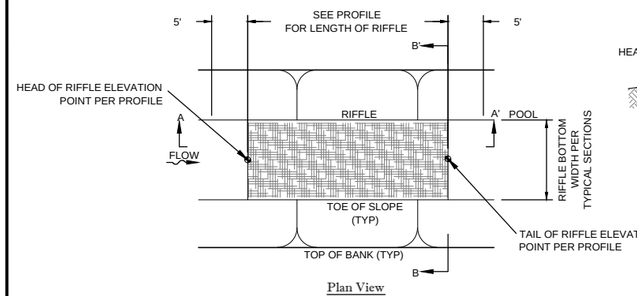


Section B-B'

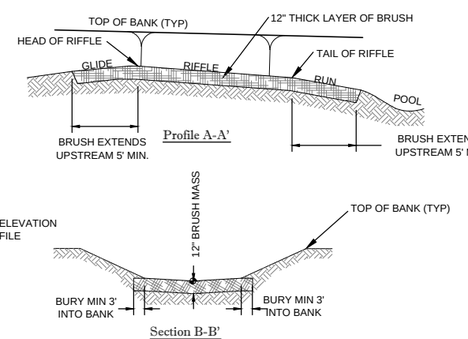
NOTES:

- RIFFLE DIMENSIONS FROM TYPICAL SECTIONS.
- SEE PROFILE FOR LENGTH AND SLOPE.

2 / 5.1 Constructed Riffle — Not to Scale — CR-2



Plan View

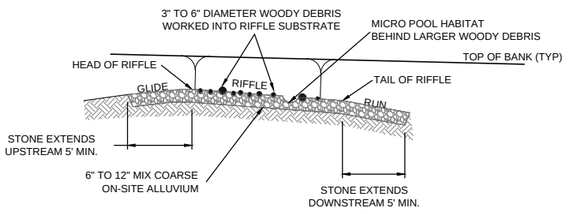


Section B-B'

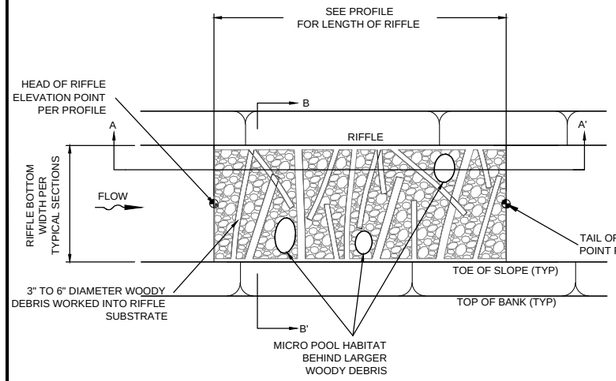
NOTES:

- BRUSH REFERS TO WOODY MATERIAL ONLY UP TO 6" IN DIAMETER.
- RIFFLE DIMENSIONS FROM TYPICAL SECTIONS.
- SEE PROFILE FOR LENGTH AND SLOPE.

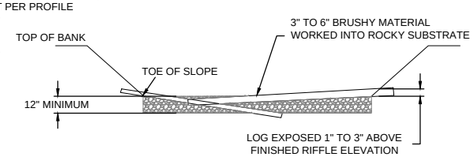
3 / 5.1 Brush Riffle — Not to Scale — CR-3



Section A-A'



Plan View



Section B-B'

NOTES:

- RIFFLE DIMENSIONS FROM TYPICAL SECTIONS.
- SEE PROFILE FOR LENGTH AND SLOPE.

4 / 5.1 Woody Riffle — Not to Scale — CR-4

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

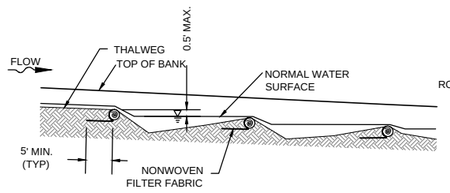
Details

Revisions:

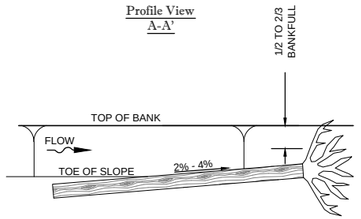
Date: February 15, 2013
Job Number: 005-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 5.1

60% Plans - Not for Construction



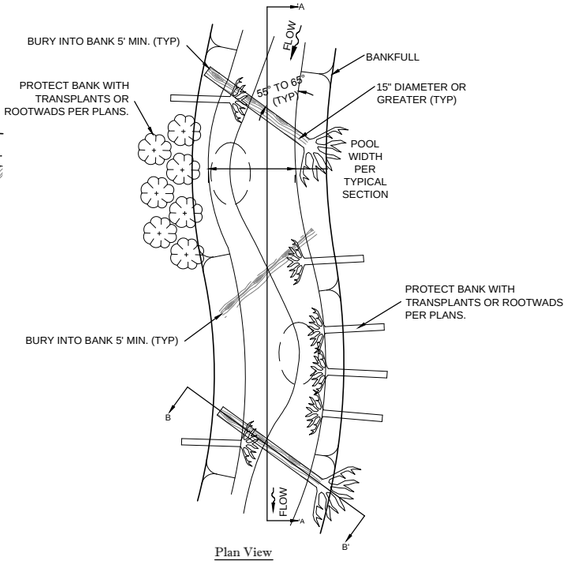
Profile View
A-A'



Log Profile B-B'

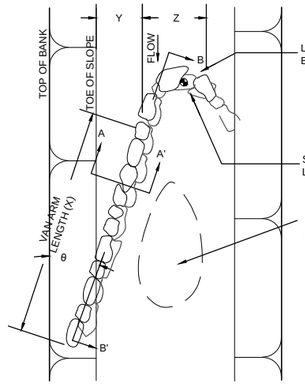
NOTE:

1. LOGS WITHOUT ROOT MASS MAY BE USED ONLY IF APPROVED BY ENGINEER.
2. BOULDER MATERIAL CAN BE SUBSTITUTED IN PLACE OF ANGLED LOGS IF APPROVED BY ENGINEER.

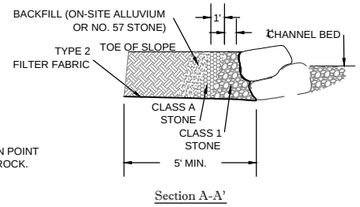


Plan View

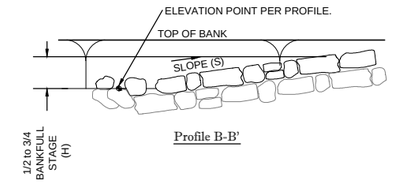
1 5.2 Angled Log Step Pool
Not to Scale



Plan



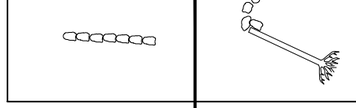
Section A-A'



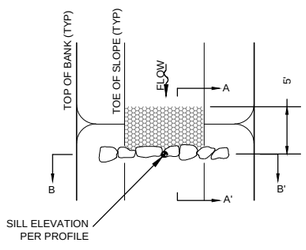
Profile B-B'

DIMENSIONS (TYP.)	
X (FT)	14.3
Y (FT)	2.2
H (FT)	0.8
θ (DEGREES)	20°
S (%)	5.2
Z (FT)	2.2

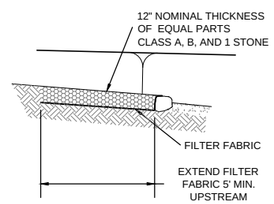
2 5.2 Rock J-Hook
Not to Scale



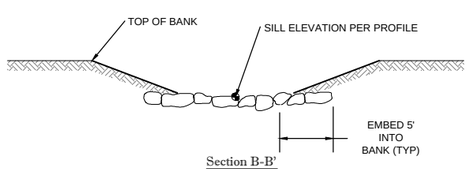
DIMENSIONS (TYP.)	
X (FT)	14.3
Y (FT)	2.2
H (FT)	0.8
θ (DEGREES)	20°
S (%)	5.2
Z (FT)	2.2



Plan View

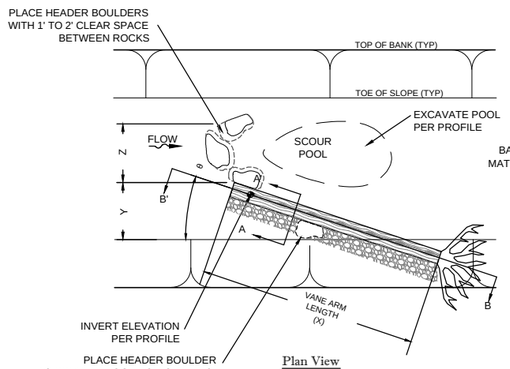


Profile A-A'

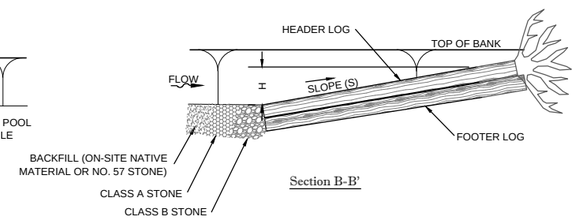


Section B-B'

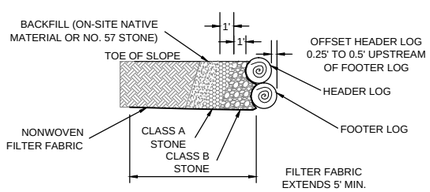
3 5.2 Boulder Sill
Not to Scale



Plan View



Section B-B'



Section A-A'

4 5.2 Log J-Hook
Not to Scale

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. P-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

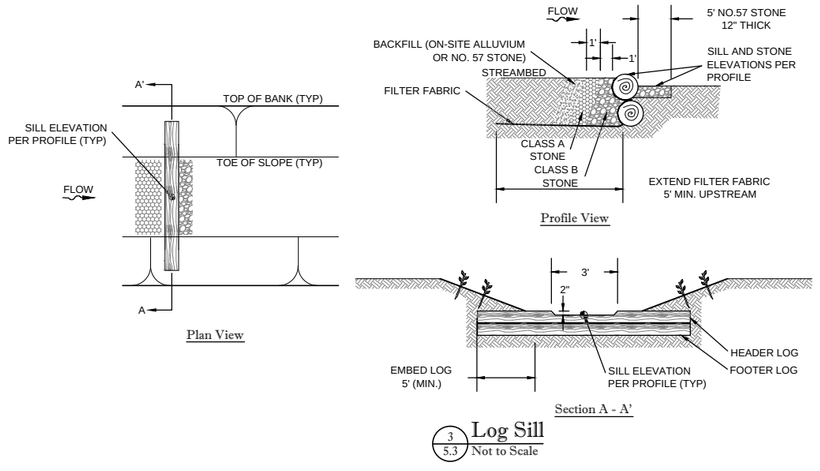
Details

Revisions:

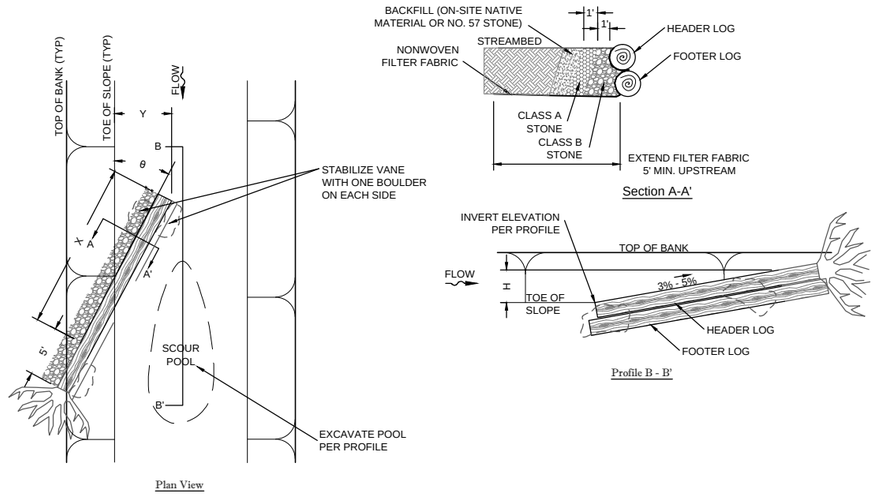
Date:	February 15, 2013
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	JK

Sheet 5.2

60% Plans - Not for Construction



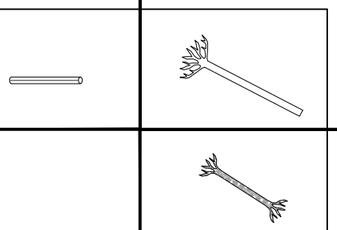
3 / 5.3 Log Sill
Not to Scale

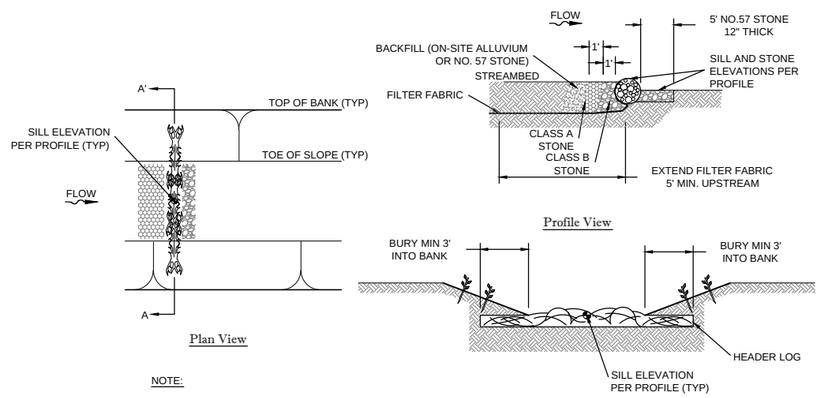


NOTE: DIMENSIONAL VALUES
LISTED ON SHEET 5.8.

DIMENSIONS (TYP.)	
X (FT)	14.3
Y (FT)	2.2
H (FT)	0.8
θ (DEGREES)	20°
S (%)	5.2

2 / 5.3 Log Vane
Not to Scale





NOTE:

1. MINIMUM 6" DIAMETER BRUSH MASS.
2. BIND WITH JUTE.
3. CONSTRUCT OF OAK TWIGS ½" TO 3" DIAMETER.

4 / 5.3 Brush Sill
Not to Scale

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

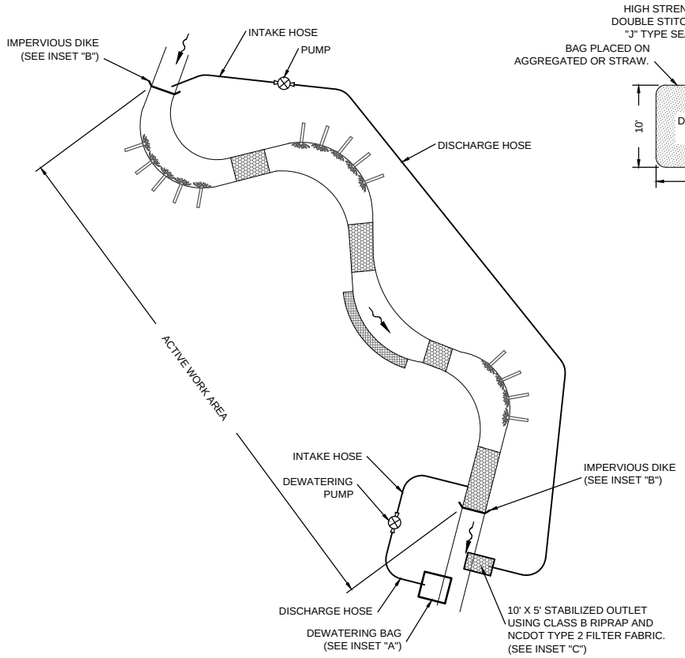
Details

Revisions:

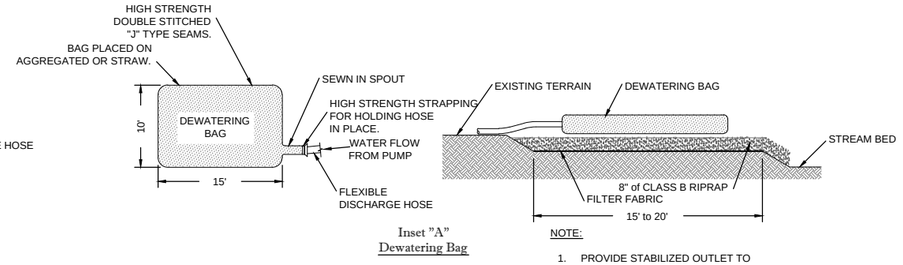
Date: February 15, 2013
Job Number: 005-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 5.3

60% Plans - Not for Construction



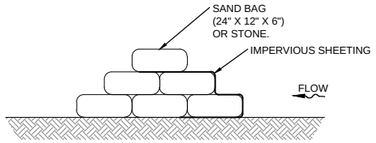
Plan View



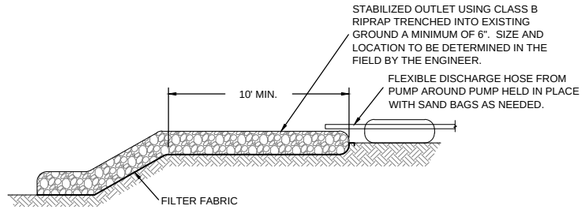
Inset "A"
Dewatering Bag

NOTE:

1. PROVIDE STABILIZED OUTLET TO STREAMBED.

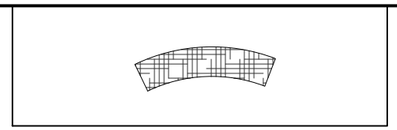


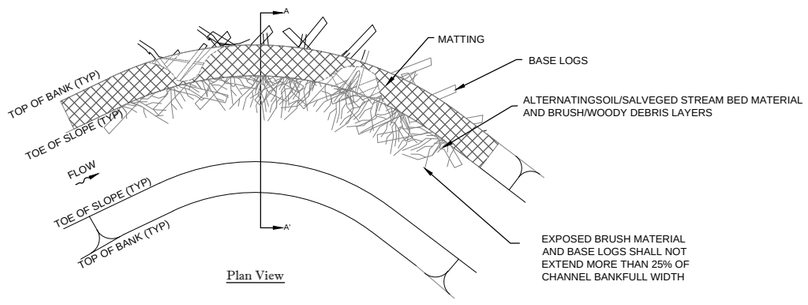
Inset "B"
Impervious Dike



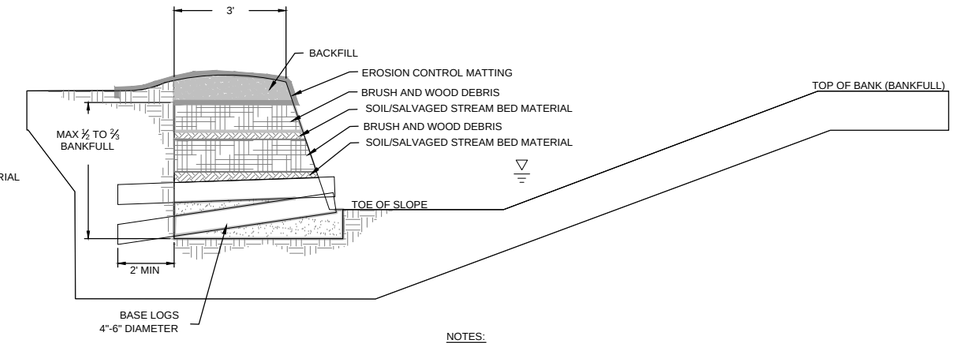
Inset "C"
Stabilized Outlet

1 / 5.4 Pump Around System
Not to Scale





Plan View



Section A-A'

NOTES:

1. OVEREXCAVATE 3' OUTSIDE OF TOP OF BANK (BANKFULL).
2. INSTALL BASE LOGS IN A CRISS CROSS PATTERN, DRIVING THEM INTO THE EXISTING BANK A MINIMUM OF 2'. BASE LOGS SHALL BE 6"-12" DIAMETER.
3. INSTALL A LAYER OF SOIL/SALVAGED STREAM BED MATERIAL ON TOP OF THE BASE LOGS.
4. LIGHTLY SPREAD SOIL/SALVAGED STREAM BED MATERIAL TO FILL VOIDS BETWEEN BASE LOGS. AVOID HEAVY COMPACTION TO PREVENT DAMAGE TO THE BASE LOGS.
5. INSTALL A LAYER OF BRUSH/WOODY DEBRIS, WHICH SHALL CONSIST OF SMALL BRANCHES AND ROOTS COLLECTED ON-SITE. LIGHTLY COMPACT BRUSH/WOODY DEBRIS LAYER.
6. BRUSH SHOULD BE ALIGNED SO STEMS ARE ROUGHLY PARALLEL AND IS INSTALLED POINTING SLIGHTLY UPSTREAM.
7. INSTALL ALTERNATING SOIL/SALVAGED STREAM BED MATERIAL AND BRUSH/WOODY DEBRIS LAYERS TO ⅓ TO ¾ BANKFULL HEIGHT.
8. INSTALL EARTH BACKFILL OVER FINAL BRUSH/WOODY LAYER ACCORDING TO TYPICAL SECTION DIMENSIONS.
9. INSTALL EROSION CONTROL MATTING AND BANK STABILIZATION PER PLANS.

2 / 5.4 Brush Toe
Not to Scale

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. P-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

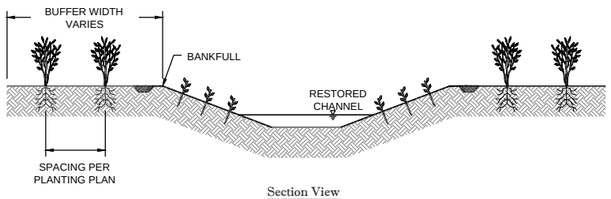
Details

Revisions:

Date:	February 15, 2013
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	JK

Sheet 5.4

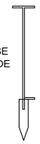
60% Plans - Not for Construction



Section View

DIBBLE BAR

PLANTING BAR SHALL HAVE A BLADE WITH A TRIANGULAR CROSS-SECTION, AND SHALL BE 12 INCHES LONG, 4 INCHES WIDE AND 1 INCH THICK AT CENTER.

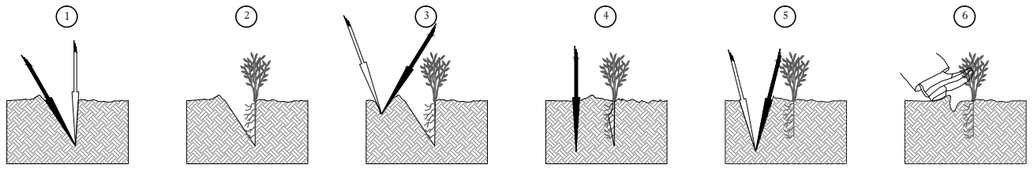


ROOTING PRUNING

ALL ROOTS SHALL BE PRUNED TO AN APPORIATE LENGTH TO PREVENT J-ROOTING.

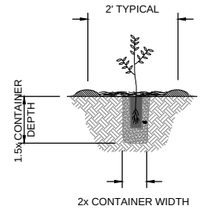
NOTES:

1. ALL SOILS WITHIN THE BUFFER PLANTING AREA SHALL BE DISKED, AS REQUIRED, PRIOR TO PLANTING.
2. ALL PLANTS SHALL BE PROPERLY HANDLED PRIOR TO INSTALLATION TO INSURE SURVIVAL.

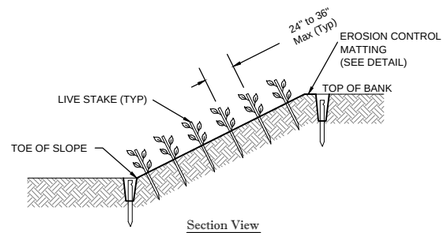


1. INSERT THE DIBBLE, OR SHOVEL, STRAIGHT DOWN INTO THE SOIL TO THE FULL DEPTH OF THE BLADE AND PULL BACK ON THE HANDLE TO OPEN THE PLANTING HOLE. (DO NOT ROCK THE SHOVEL BACK AND FORTH AS THIS CAUSES SOIL IN THE PLANTING HOLE TO BE COMPACTED, INHIBITING ROOT GROWTH.
2. REMOVE THE DIBBLE, OR SHOVEL, AND PUSH THE SEEDLING ROOTS DEEP INTO THE PLANTING HOLE. PULL THE SEEDLING BACK UP TO THE CORRECT PLANTING DEPTH (THE ROOT COLLAR SHOULD BE 1 TO 3 INCHES BELOW THE SOIL SURFACE). GENTLY SHAKE THE SEEDLING TO ALLOW THE ROOTS TO STRAIGHTEN OUT. DO NOT TWIST OR SPIN THE SEEDLING OR LEAVE THE ROOTS J-ROOTED.
3. INSERT THE DIBBLE, OR SHOVEL, SEVERAL INCHES IN FRONT OF THE SEEDLING AND PUSH THE BLADE HALFWAY INTO THE SOIL. TWIST AND PUSH THE HANDLE FORWARD TO CLOSE THE TOP OF THE SLIT TO HOLD THE SEEDLING IN PLACE.
4. PUSH THE DIBBLE, OR SHOVEL, DOWN TO THE FULL DEPTH OF THE BLADE.
5. PULL BACK ON THE HANDLE TO CLOSE THE BOTTOM OF THE PLANTING HOLD. THEN PUSH FORWARD TO CLOSE THE TOP, ELIMINATING AIR POCKETS AROUND THE ROOT.
6. REMOVE THE DIBBLE, OR SHOVEL, AND CLOSE AND FIRM UP THE OPENING WITH YOUR HEEL. BE CAREFUL TO AVOID DAMAGING THE SEEDLING.

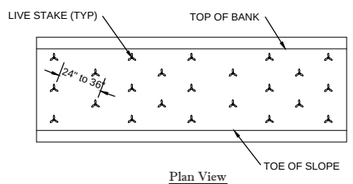
1/5.5 Bare Root Planting
Not to Scale



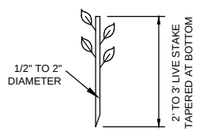
2/5.5 Containerized Planting
Not to Scale



Section View



Plan View



Live Stake Detail

NOTE:

1. LIVE STAKES TO BE PLANTED IN AREAS AS SHOWN ON PLANS AND DIRECTED BY THE ENGINEER.

3/5.5 Live Staking
Not to Scale

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

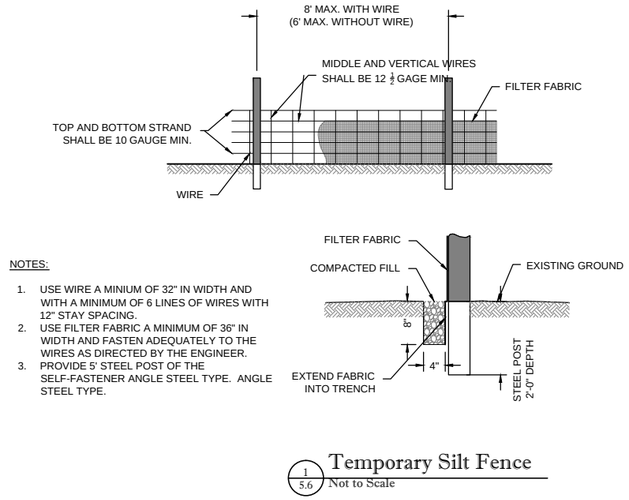
Details

Revisions:

Date: February 15, 2013
Job Number: 005-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

5.5
Sheet

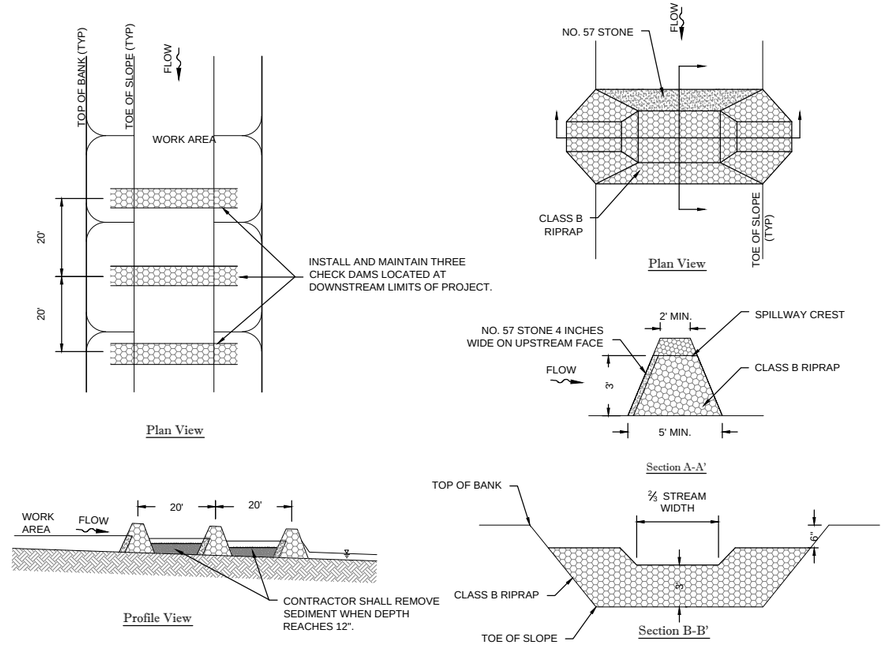
60% Plans - Not for Construction



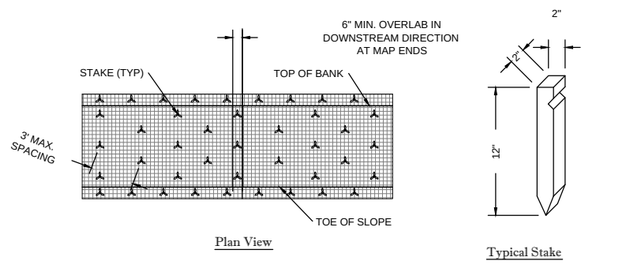
NOTES:

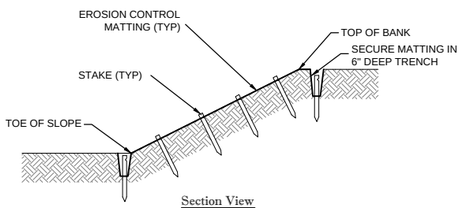
1. USE WIRE A MINIUM OF 32" IN WIDTH AND WITH A MINIMUM OF 6 LINES OF WIRES WITH 12" STAY SPACING.
2. USE FILTER FABRIC A MINIMUM OF 36" IN WIDTH AND FASTEN ADEQUATELY TO THE WIRES AS DIRECTED BY THE ENGINEER.
3. PROVIDE 5' STEEL POST OF THE SELF-FASTENER ANGLE STEEL TYPE. ANGLE STEEL TYPE.

1 / 5.6 Temporary Silt Fence
Not to Scale

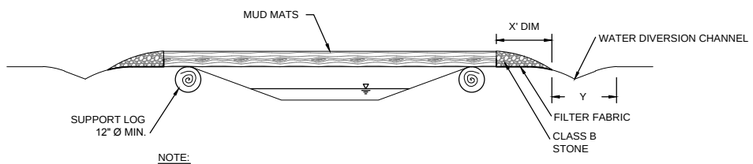


2 / 5.6 Temporary Rock Sediment Dam
Not to Scale





3 / 5.6 Erosion Control Matting
Not to Scale



NOTE:

1. CONSTRUCT STREAM CROSSING WHEN FLOW IS AT NORMAL BASEFLOW.
2. MINIMIZE CLEARING AND EXCAVATION OF STREAMBANKS. DO NOT EXCAVATE CHANNEL BOTTOM.
3. INSTALL STREAM CROSSING PERPENDICULAR TO THE FLOW.
4. MAINTAIN CROSSING SO THAT RUNOFF IN THE CONSTRUCTION ROAD DOES NOT ENTER EXISTING CHANNEL.
5. STABILIZE AN ACCESS RAMP OF CLASS B STONE TO THE EDGE OF THE MUD MAT.
6. CONTRACTOR SHALL DETERMINE AN APPROPRIATE RAMP ANGLE ACCORDING TO EQUIPMENT UTILIZED.

4 / 5.6 Temporary Stream Crossing - Mud Mat
Not to Scale

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. P-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

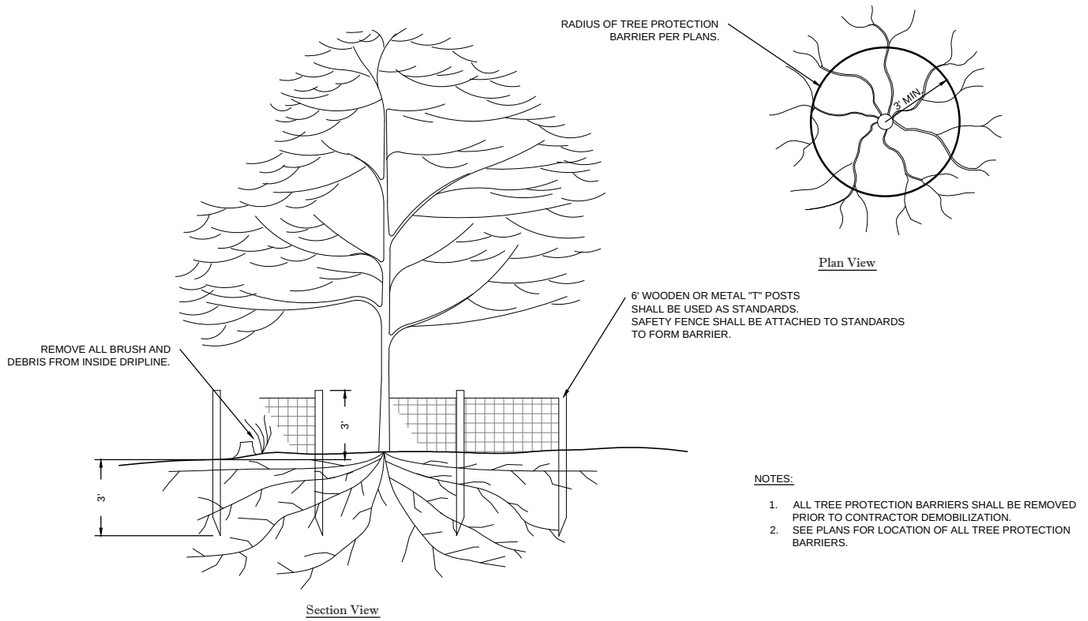
Details

Revisions:

Date: February 15, 2013
Job Number: 005-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 5.6

60% Plans - Not for Construction

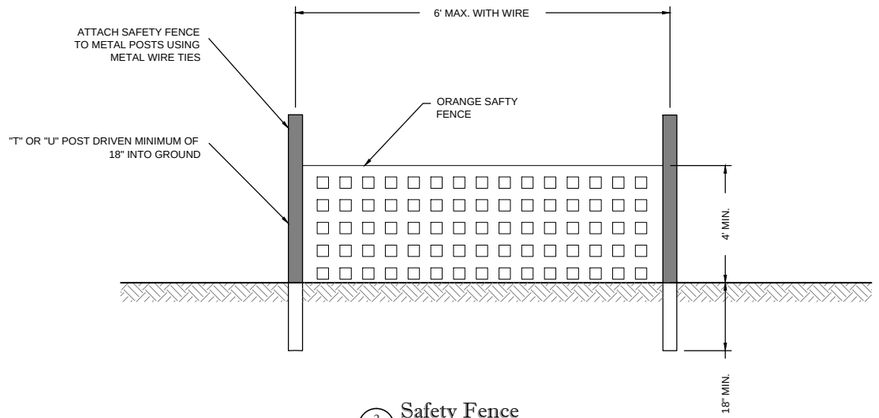


NOTES:

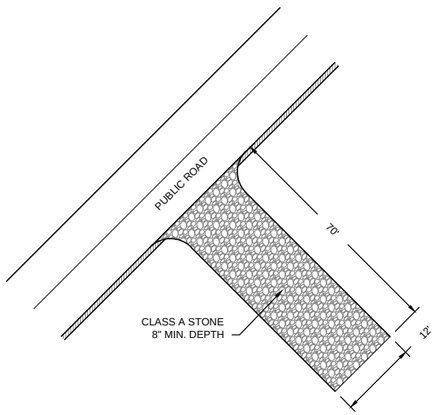
1. ALL TREE PROTECTION BARRIERS SHALL BE REMOVED PRIOR TO CONTRACTOR DEMOBILIZATION.
2. SEE PLANS FOR LOCATION OF ALL TREE PROTECTION BARRIERS.

1/5.7 Tree Protection
Not to Scale

MATERIAL SPECIFICATIONS		
PHYSICAL PROPERTY	TESTS	REQUIREMENTS
MATERIAL	N/A	POLYETHYLENE
RECOMENDED COLOR	N/A	"INTERNATIONAL ORANGE"
TENSILE YIELD	ASTM D638	AVE. 2000 LBS. PER 4' WIDE
ULTIMATE TENSILE STRENGTH	ASTM D638	AVE. 2900 LBS. PER 4' WIDE
ELONGATION AT BREAK (%)	ASTM D638	GREATER THAN 1000%
CHEMICAL RESISTANCE	N/A	INERT TO MOST CHEMICALS AND ACIDS



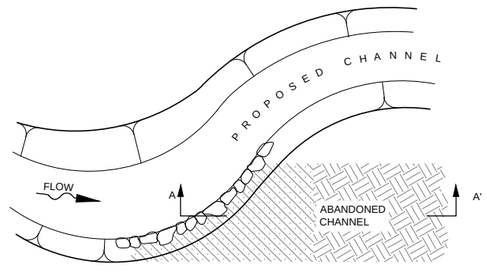
2/5.7 Safety Fence
Not to Scale



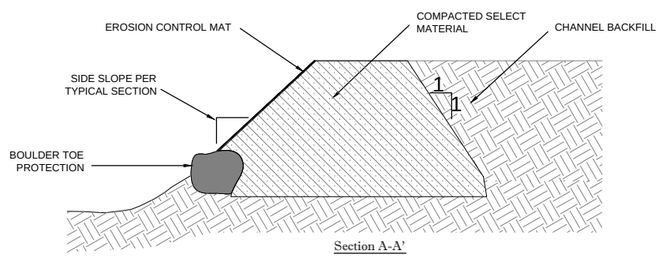
NOTES:

1. PROVIDE TURNING RADIUS SUFFICIENT TO ACCOMMODATE LARGE TRUCKS.
5. LOCATE CONSTRUCTION ENTRANCE AT ALL POINTS OF INGRESS AND EGRESS UNTIL SITE IS STABILIZED. PROVIDE FREQUENT CHECKS OF THE DEVICE AND TIMELY MAINTENANCE.
6. MUST BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR DIRECT FLOW OF MUD ONTO STREETS. PERIODIC TOP DRESSING WITH STONE WILL BE NECESSARY.
7. ANY MATERIAL TRACKED ONTO THE ROADWAY MUST BE CLEANED IMMEDIATELY.
8. USE CLASS A STONE OR OTHER COARSE AGGREGATE APPROVED BY THE ENGINEER.
9. PLACE FILTER FABRIC BENEATH STONE.

3/5.7 Construction Entrance
Not to Scale



Plan View



Section A-A'

4/5.7 Channel Plug
Not to Scale

WILDLANDS ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. P-0831

NOT FOR CONSTRUCTION

Crooked Creek #2 Restoration Project
Union County, North Carolina

Details

Revisions:

Date: February 15, 2013
Job Number: 005-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: JK

Sheet 5.7

60% Plans - Not for Construction