FINAL
Stream Mitigation Plan
Thomas Creek Restoration Project

Wake County, North Carolina

NCEEP Project ID No. 96074

Cape Fear River Basin: 03030004-020010

USACE Action ID No. SAW-2013-02009

Prepared for:

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

March 2015

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
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EXECUTIVE SUMMARY

Michael Baker Engineering, Inc. (Baker) proposes to restore 4,687 linear feet (LF) of stream, and enhance 3,952 LF of stream Thomas Creek and several unnamed tributaries. The Thomas Creek Restoration Project site (project) is located in Wake County, North Carolina (NC) (Figure 2.1), approximately 1.5 miles southwest of the Community of New Hill. The project is located in the Cape Fear River Basin within NC Division of Water Resources (NCDWR) subbasin 03-06-07 and in the Targeted Local Watershed (TLW) of Harris Lake (HU 03030004-020010), as listed by the NC Ecosystem Enhancement Program (NCEEP). The purpose of the project is to restore and/or enhance stream and riparian buffer functions along impaired stream channels at the site. A recorded conservation easement consisting of 22.7 acres (Figure 3.1) will protect all stream reaches and riparian buffers in perpetuity. Examination of available hydrology and soil data indicate the project will potentially provide numerous water quality and ecological benefits within the Harris Lake subwatershed, as well as to the Cape Fear River Basin.

Based on the NCEEP 2009 Cape Fear River Basin Restoration Priorities (RBRP) plan, the Thomas Creek Restoration Project area is located in an existing targeted local watershed (TLW) within the Cape Fear River Basin (2009 Cape Fear RBRP), and is located within the Middle Cape Fear / Kenneth and Parker Creeks Local Watershed Planning (LWP) area (LWP Fact Sheet). The restoration strategy as stated in the RBRP for the Cape Fear 03030004 8-digit Catalog Unit (CU) is to promote Low Impact Development, stormwater management, restoration and buffer protection in urbanizing areas, and buffer preservation elsewhere.

The primary goals of the project are to improve ecologic functions through the restoration and enhancement of streams and buffers in a degraded, urbanizing area as described in the NCEEP 2009 Cape Fear RBRP, and are identified below:

- Create geomorphically stable conditions along the unnamed tributaries throughout the site,
- Protect and improve water quality by reducing streambank erosion, and nutrient and sediment inputs,
- Restore stream and floodplain interaction by connecting historic flow paths and promoting natural flood processes,
- Restore and protect riparian buffer functions and corridor habitat in perpetuity by establishing a permanent conservation easement, and
- Improve aquatic and terrestrial habitat through improved substrate and in-stream cover, addition of woody debris, and reduction of water temperature.

To accomplish these goals, the following objectives have been identified:

- Restore existing incised, eroding, and channelized streams by providing them access to their relic floodplains,
- Implement agricultural BMPs to reduce nonpoint source inputs to receiving waters,
- Prevent cattle from accessing the conservation easement boundary by installing permanent fencing and thus reduce excessive streambank erosion and undesired nutrient inputs,
- Enhance aquatic habitat value by providing more bedform diversity, creating natural scour pools and reducing sediment from accelerated streambank erosion,
- Plant native species riparian buffer vegetation along streambank and floodplain areas, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve streambank stability and riparian habitat connectivity, and shade the stream to decrease water temperature,
- Control invasive species vegetation within much of the project area and, if necessary, continue treatments during the monitoring period.

The proposed project aligns with overall NCEEP goals, which focus on sediment, nutrient and other non-point source (NPS) pollutant management. Specific NCEEP RBRP goals include restoring streams and riparian areas, maintaining and enhancing water quality, increasing storage of floodwaters, and improving fish and wildlife habitat. The proposed natural channel design (NCD) approach will result in a stable riparian stream system that will reduce excess sediment and nutrient inputs to the Harris Lake subwatershed, while improving water quality conditions that support terrestrial and aquatic species, including priority species identified in the Cape Fear River Basin RBRP (NCEEP, 2009).

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 NCEEP operations and procedures for the delivery of compensatory mitigation.

Table ES.1 Thomas Creek Restoration Project Overview (Streams)
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Reach	Design Approach	Existing Reach Length (LF)	Design Reach Length (LF)	SMU Credit Ratio	Potential SMUs	Stationing	Comment
Unnamed Tributaries to Thomas Creek (Reaches R1, R2, R3, R4, R5, R6, R7, T1, T2)							
R1	R	397	266	1:1	266	41+81 to 44+47*	Restoration will continue from Reach R2 with a Priority Level II approach to tie into existing bedrock at the downstream project extent. A single thread meandering channel will be constructed mostly in line with the existing channel; energy will be dissipated by incorporating a step pool sequence. Work will include vegetation planting in disturbed riparian buffer areas, and permanent cattle exclusion fencing around the easement.
R2	R	1,995	2,107	1:1	2,087	20+74 to 41+81*	Restoration will follow a Rosgen Priority Level II approach initially but will transition to Priority Level I near the stream crossing. Priorty II is favored in the upstream portion of the reach due to the existing locations of mature trees. However, in the downstream section work will consist of raising the streambed elevation and constructing a new channel off-line. Work will also include planting native vegetation in disturbed riparian buffer areas and permanently excluding cattle from the easement with fencing.
R3 (downstream section)	R	937	949	1:1	929	11+30 to 20+74*	Restoration will primarly consist of Priority I restoration though there are sections where shallow Priority II will be implemented. The streambed will be raised along the upstream portion of the reach, and a bankfull bench, where necessary, will be graded to provide connection to a geomorphic floodplain.
R3 (upstream section)	E II	130	130	5:1	26	10+00 to 11+30*	Enhancement Level II will be implemented along the reach. A 50-foot riparian buffer will be planted with native vegetation along each bank and a conservation easement will be established. Invasive species will be removed throughout the buffer area.
R4 (downstream section)	R	327	361	1:1	361	10+10 to 13+71*	Restoration will follow a Rosgen Priority Level II approach. Work will involve a combination of raising a section of the streambed along the upstream portion of the reach, and grading a bankfull bench to provide connection to a geomorphic floodplain.
R4 (upstream section)	E II	870	870	10:1	87	0+99 to 9+69*	Enhancement Level II will be implemented to plant a 50-foot riparian buffer on each bank and establish a conservation easement. Invasive species will **not** be removed per an agreement with the NCIRT.

R5 (downstream section)	R	883	1064	1:1	1044	29+45 to 40+09*	Restoration will follow a Rosgen Priority Level I approach, and will involve a combination of raising the elevation of a section of streambed and constructing a new channel off-line. Work will also include planting native vegetation in disturbed riparian buffer areas and permanently excluding cattle from the easement with fencing.
R5 (upstream section)	E II	137	137	5:1	27	28+08 to 29+45*	Enhancement Level II will be implemented to plant a 50-foot riparian buffer on each bank and protect with a conservation easement. Invasive species will also be removed.
R6 (downstream section)	E II	1618	1618	5:1	320	12+10 to 28+08*	Enhancement Level II will be implemented to plant a 50-foot riparian buffer on each bank and establish a conservation easement. Invasive species will also be removed.
R6 (upstream section)	E I	210	210	1.5:1	140	10+00 to 12+10*	Work will follow an Enhancement Level I approach and will consist of the implementation of a step pool sequence and vertical bank grading, to include floodplain benches. Work will also include native vegetation planting in disturbed riparian buffer areas. A conservation easement will be established.
R7 (downstream section)	E II	286	286	5:1	57	13+60 to 16+46*	Enhancement Level II will be implemented to plant a 50-foot riparian buffer on each bank and protect with a conservation easement. Invasive species will also be removed.
R7 (upstream section)	E II	360	360	2.5:1	144	10+00 to 13+60*	Enhancement Level II is proposed for the reach. Work will include minor streambank sloping and stabilization, use of in-stream structures to provide grade control, and vegetation planting in disturbed riparian buffer areas. A conservation easement will be established.
T1	E I	242	253	1.5:1	155	10+00 to 12+53*	Initially, Enhancement Level I will be implemented to stabilize the channel. This will be followed a Rosgen Priority Level II approach and tie in to Reach R2. Work will also include vegetation planting in disturbed riparian buffer areas.
T2	E II	171	158	2.5:1	63	10+00 to 11+58*	Enhancement Level II is proposed for the reach. Work will include minor streambank sloping and stabilization, limited use of in-stream structures, vegetation planting in disturbed riparian buffer areas, and permanent cattle exclusion fencing around the easement.
Total				-	**5,706**	*Note: Crossings have been removed from the potential SMUs provided in this table.	

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1.0 RESTORATION PROJECT GOALS AND OBJECTIVES

The Thomas Creek Project is located in the Middle Cape Fear / Kenneth and Parker Creeks Local Watershed Plan (LWP) area (NCEEP, 2006; LWP Fact Sheet). The project site watershed includes Hydrologic Unit Code (HUC) 03030004-020010 which was identified as a Targeted Local Watershed (TLW) in EEP's 2009 Cape Fear River Basin Restoration Priority (RBRP) Plan (NCEEP, 2009; 2009 Cape Fear RBRP) and is identified in the Middle Cape Fear / Kenneth and Parker Creeks LWP Project Atlas (Atlas Reference Designation).

EEP developed a local watershed plan for the 180 square mile drainage area that included land use analysis, water quality monitoring and stakeholder input to identify problems with water quality, habitat, and hydrology. The Middle Cape Fear / Kenneth and Parker Creeks LWP covered a large area so only a subset of the watershed received further assessment. Thomas Creek was in the portion of the LWP that did not undergo further evaluation and assessment. Additionally, the Harris Lake subwatersheds (including Thomas Creek) were excluded from the functional assessment process. Nutrient management was cited as a key concern for the management of Harris Lake, though it was determined to be outside of the relevant scope of issues important to the rest of the study area.

Animal operations, agricultural development, disturbance of natural riparian buffers (timber harvesting) and other various land-disturbing activities in the Thomas Creek subwatershed have negatively impacted both water quality and streambank stability along Thomas Creek and its various tributaries. To improve watershed health, the 2009 Cape Fear RBRP emphasized the need for increased implementation of agricultural best management practices (BMPs) in the Thomas Creek watershed. Nutrients, sedimentation, streambank erosion, livestock access to streams, channel modification, and the loss of wetlands and riparian buffers were stressors observed by Baker staff within the watershed.

The primary goals of the project, as described in the NCEEP 2009 Cape Fear RBRP, are to improve ecologic functions and to manage nonpoint source loading to the impaired reaches. These are identified below:

- Create geomorphically stable conditions along the UTs throughout the site,
- Protect and improve water quality by reducing nutrient and sediment inputs,
- Restore stream and floodplain interaction by connecting historic flow paths and promoting natural flood processes,
- Restore and protect riparian buffer functions and corridor habitat in perpetuity by establishing a permanent conservation easement, and
- Improve aquatic habitat through improved substrate and in-stream cover, addition of woody debris, and reduction of water temperature.

To accomplish these goals, the following objectives have been identified:

- Restore existing incised, eroding, and channelized streams by providing them access to their relic floodplains,
- Implement agricultural BMPs to reduce nonpoint source (NPS) loading to receiving waters,
- Prevent cattle from accessing the conservation easement boundary by installing permanent fencing and thus reduce excessive streambank erosion and undesired nutrient inputs,
- Enhance aquatic habitat value by providing more bedform diversity, creating natural scour pools and reducing sediment from accelerated streambank erosion,

- Plant native species riparian buffer vegetation along streambank and floodplain areas, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve streambank stability and riparian habitat connectivity, and shade the stream to decrease water temperature,
- Control invasive species vegetation within much of the project area and, if necessary, continue treatments during the monitoring period.

The proposed project aligns with overall NCEEP goals, which focus on restoring streams and riparian value by maintaining and enhancing water quality, increasing storage of floodwaters, and improving fish and wildlife habitat, as well as specific NCEEP RBRP goals including, but not limited to, nutrient and other nonpoint source pollutant management. The proposed natural channel design (NCD) approach will result in a stable riparian stream system that will reduce excess sediment and nutrient inputs to the Thomas Creek subwatershed, while improving water quality conditions that support terrestrial and aquatic species, including priority species identified in the Cape Fear River Basin RBRP (NCEEP, 2009).

The project will involve the restoration and enhancement of a rural Piedmont stream system (USACE, 2010, Schafale et al., 1990) which has been impaired due to past agricultural conversion and cattle grazing. Due to the productivity and accessibility of these smaller stream systems, many have experienced heavy human and cattle disturbance. Though the upper portion of the mainstem (Reach R3) has a narrow wooded buffer, some sections have become highly unstable and are experiencing active widening and downcutting. The lower mainstem (Reaches R1 and R2) flows through active pasture, and is downcutting and widening as it seeks to reestablish stable stream pattern.

Restoration practices will include raising the existing streambed elevation, reconnecting the stream to its relic floodplain, and restoring natural overbank flows to areas previously drained by ditching activities. The existing channels to be abandoned within the restoration areas will be partially filled to decrease surface and subsurface drainage and raise the local water table. Permanent cattle exclusion fencing will be installed around all proposed reaches and riparian buffers where cattle have access (R1, R2, lower R5, upper R4, T1, and T2). Vegetation buffers in excess of 50 feet will be established along both sides of the reaches and a conservation easement consisting of 22.7 acres (AC) will be recorded protect the site in perpetuity.

2.0 SITE SELECTION

2.1 Project Description

The Thomas Creek Restoration Project (project) is located in Wake County, North Carolina (NC) (Figure 2.1), approximately 1.5 miles southwest of the Community of New Hill, as shown on the Project Site Vicinity Map (Figure 2.1). To access the site from Raleigh, take Interstate 40 and head south on US-1 towards Sanford, for approximately 12 miles. Take the ramp for Exit 89 to New Hill/Jordan Lake. At the end of the ramp turn right on New Hill-Holleman Rd. and continue for 0.8 miles to the stop sign at Old US Highway 1. Turn left on Old US Highway 1 and continue 1.1 miles before turning left on Shearon Harris Rd. The destination will be on the right in 0.5 miles. Turn right onto the gravel road and continue to the end to park among the farm buildings. The restoration site is to the west.

The project site is located in the NC Division of Water Resources (DWR) subbasin 03-06-07 of the Cape Fear River Basin (Figure 2.2) and includes numerous unnamed tributaries (UTs) to Thomas Creek. Soils and topographic information (Figures 2.2, 2.3, 2.4, 2.5, and 2.6) indicate that the project reaches are underlain by Wehadkee and Bibb soils, which are frequently flooded and considered hydric. See Figure 2.3 for soil conditions outside of the floodplain area. Note that the GIS soils layer in Figure 2.3 does not line up well with the streams and conservation easement; however, the NRCS 1970 Wake County soil survey confirms that the floodplain soils for all of the project reaches are Wehadkee and Bibb soils.

Project Reaches R1, R2, R3, R4, and T1 are shown as dashed blue-line streams on the USGS topographic quadrangle map (Figure 2.2a). Project Reaches R5, R6, R7, and T2 are not shown as blue-line streams, dashed or solid. Reaches R1, R2, R3, and R4 are listed as perennial streams within the project limits on the 1970 Wake County Soil Survey. The remaining reaches are all shown in the Soil Survey maps and are listed as intermittent, unclassified streams. The presence of historic valleys for each of the project stream systems can be seen from LIDAR imagery for the site (Figure 2.8) and was confirmed during field investigations.

Field evaluations of intermittent/perennial stream status were made in late March 2012. These evaluations were based on NC Division of Water Resources (NCDWR) Methodology for Identification of Intermittent and Perennial Streams and Their Origins, (v 4.11) stream assessment protocols. Table 1 below presents the results of the field evaluations along with the assessed status of each project reach. Figure 2.2b shows the intermittent and perennial sections of the project reaches based on the field evaluations. Copies of the NCDWR classification forms are located in Appendix B.

Table 1. Summary Information for Field Investigations to Determine Intermittent/Perennial Status
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Project Reach Designation	Existing Project Reach Length (ft)	NCDWR Stream Classification Form Score	Watershed Drainage Area (acres) [1]	Stream Status Based on Field Analyses
R1	397	37.5	246	Perennial
R2	1,995	38	176	Perennial
R3	1,067	37 / 25	68	Perennial / Intermittent
R4	1,197	31	36	Perennial

R5	1,020	31	53	Perennial
R6	1,828	25	32	Intermittent
R7	646	35 / 20	14	Perennial / Intermittent
T1	242	23.75	49	Intermittent
T2	171	20.75	5	Intermittent

Note 1: Watershed drainage area was approximated based on USGS topographic (NC Streamstats) and LIDAR information at the downstream end of each reach.

The project site is located in the middle of the Durham-Sanford Triassic subbasin (Figure 2.1). This is part of the Chatham Group, which consists of sedimentary rock, including conglomerate, fanglomerate, sandstone, and mudstone. Observations by field staff in the watershed indicate that the project area has sandstone and mudstone; as such, fine grained sediment is prevalent, and material coarser than gravel is essentially absent. Bedrock is evident in isolated locations, which provides grade control for the streams in those locations.

The geomorphic setting is at the headwaters of the Thomas Creek subwatershed. Many of the project reaches are zero- or first-order. The zero-order streams include Reaches R6, R7, and T2, and the first-order streams include Reaches R3, R4, and T1. Reaches R2 and R5 are a second-order stream and Reach R1 is a third-order stream. The floodplains are generally narrow, though Reaches R5, R2, and R1 have wider available floodplains, which are typically inactive due to incision and channelization.

2.1.1 Historical Land Use and Development Trends

The project is situated in a rural area of southern Wake County (project watershed percent impervious cover less than 5 percent). The majority of the land use within the project watershed is comprised of a mix of forested and active agricultural (cropland and pasture) lands. Residential, urban, and transportation uses make up a small percentage of the remaining land use. Figure 2.2 shows the topography of the watershed for the project area. Soils data for the project are shown in Figure 2.3. The project area (proposed conservation easement area) encompasses 22.7 acres of land that includes agricultural fields, cattle pastures, clear cuts, riparian wetlands, and narrow forested buffer lands (Figure 2.4). Potential for land use change or future development in the area adjacent upstream to the conservation easement is moderate, given the proximity to the Research Triangle metropolitan area.

Over time, channels have incised and the project reaches have become disconnected from their historic floodplain, while the riparian buffer has been cleared or narrowed in numerous locations to increase pastureland and harvest timber. These processes and practices have contributed excessive sediment and nutrient loading to the project reaches and their receiving waters: Thomas Creek, Harris Lake, and the Cape Fear River.

2.1.2 Successional Trends and Watershed Overview

To convert the land for agricultural use, landowners historically cleared portions of the mature forest and manipulated site streams to increase land for grazing and agriculture. According to the landowner, whose family purchased the property in 1915, early settlers moved the stream (Reaches R2 and R1) to one side of the valley in the 1800s to accommodate farming of the floodplain. The hummocky floodplain along Reach R2 appears to show where the excavated material had been deposited.

A historical aerial photograph from 1938 (Figure 2.5) shows that the area had reverted to forestland and did not appear to be actively used for agriculture. However, a 1959 historical aerial photograph

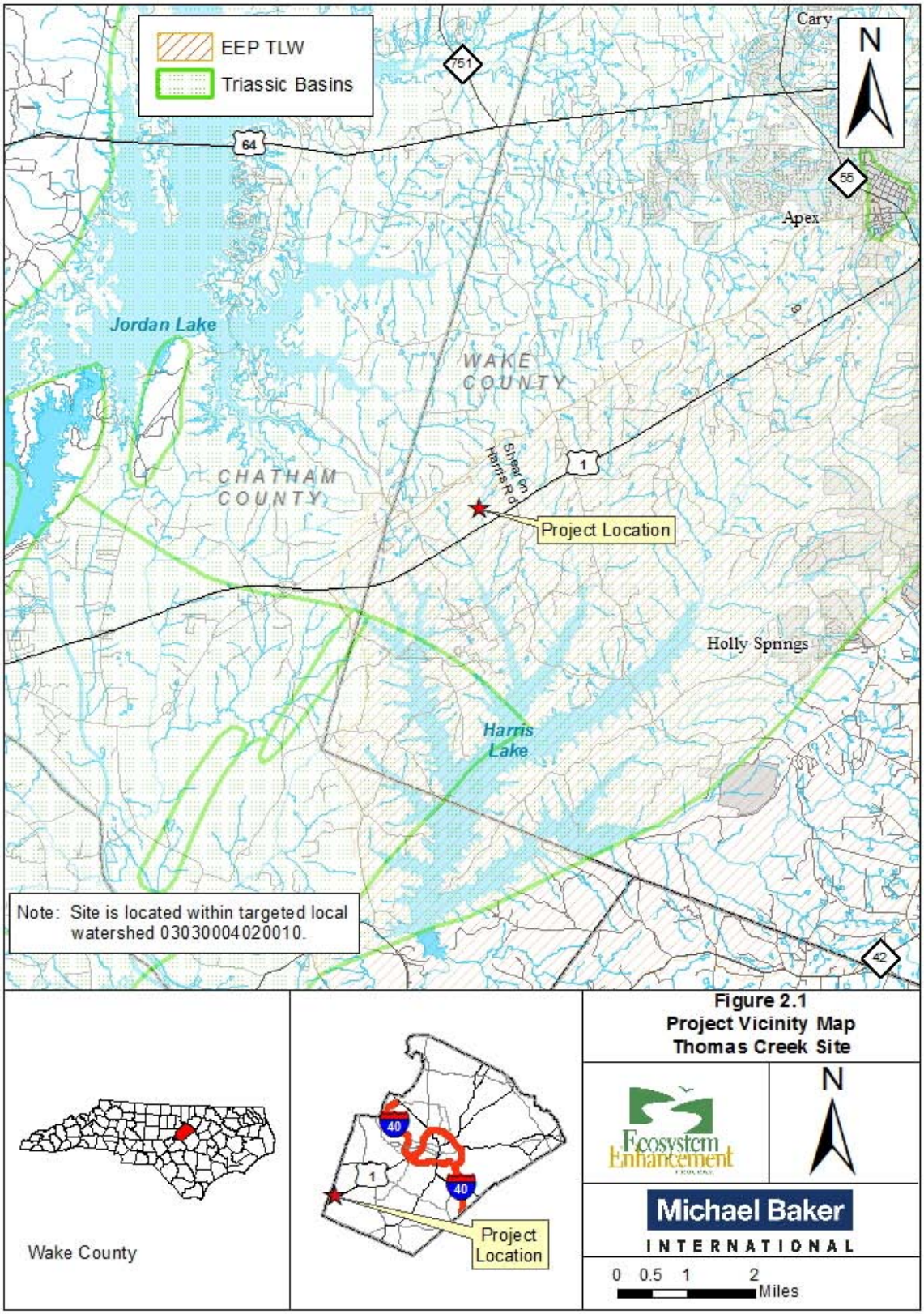
(Figure 2.6) shows the area around Reaches R1, R2, lower R5, T1, and T2 had been cleared again actively to be used for agriculture purposes (presumably pasture). This is the same area that is presently grazed (2014). A 1981 historical aerial photograph (Figure 2.7) shows the timber surrounding the remaining reaches (R3, R4, upper R5, R6, and R7) had been harvested in 1979. In 2011, much of the timber surrounding those same upper reaches (R3, R4, upper R5, R6, and R7) was harvested again, leaving a very narrow buffer (10 to 30 feet) along those stream channels. Figure 2.5 shows a 2012 aerial photograph with clearly narrow buffers.

Each project reach has been heavily impacted from historic land use practices, predominantly cattle farming and forestry uses. Within the project area, approximately 90 percent of the streambanks have inadequate (less than 50 feet wide) riparian buffers in both the right and the left floodplains. Hoof shear and/or shear stress have severely impacted the streambanks along Reaches R1, R2, and R5. The lack of adequate and quality buffer vegetation, past land use disturbances, and current cattle activities present a significant opportunity for water quality and ecosystem improvements through the implementation of this project.

Baker staff conducted field assessments that included an existing conditions survey and photographic documentation to evaluate and document the impacts of past land use management practices and current site conditions for each project stream reach. The existing conditions assessment is presented in Section 17.1.1. Sections 7 and 17 describe the restoration approaches proposed to achieve functional uplift and improve overall watershed health.

The project site is located in the Triassic Basin (see Figure 2.1), which has notoriously erodible soils. Additionally, the project watershed has fairly steep slopes and high runoff rates, and when coupled with sand bed streams it makes for challenging conditions to conduct stream stabilization work. Baker has taken steps to reduce risk of post-construction erosion, including higher width-to-depth ratios to reduce stream power and frequent riffle grade control structures to prevent head cuts from developing. Further discussion of the project approach is presented in Section 17.1.2.1 Proposed Design Approach and Section 17.3 Sediment Transport Analysis.

2.2 Vicinity Map



2.3 Watershed Maps

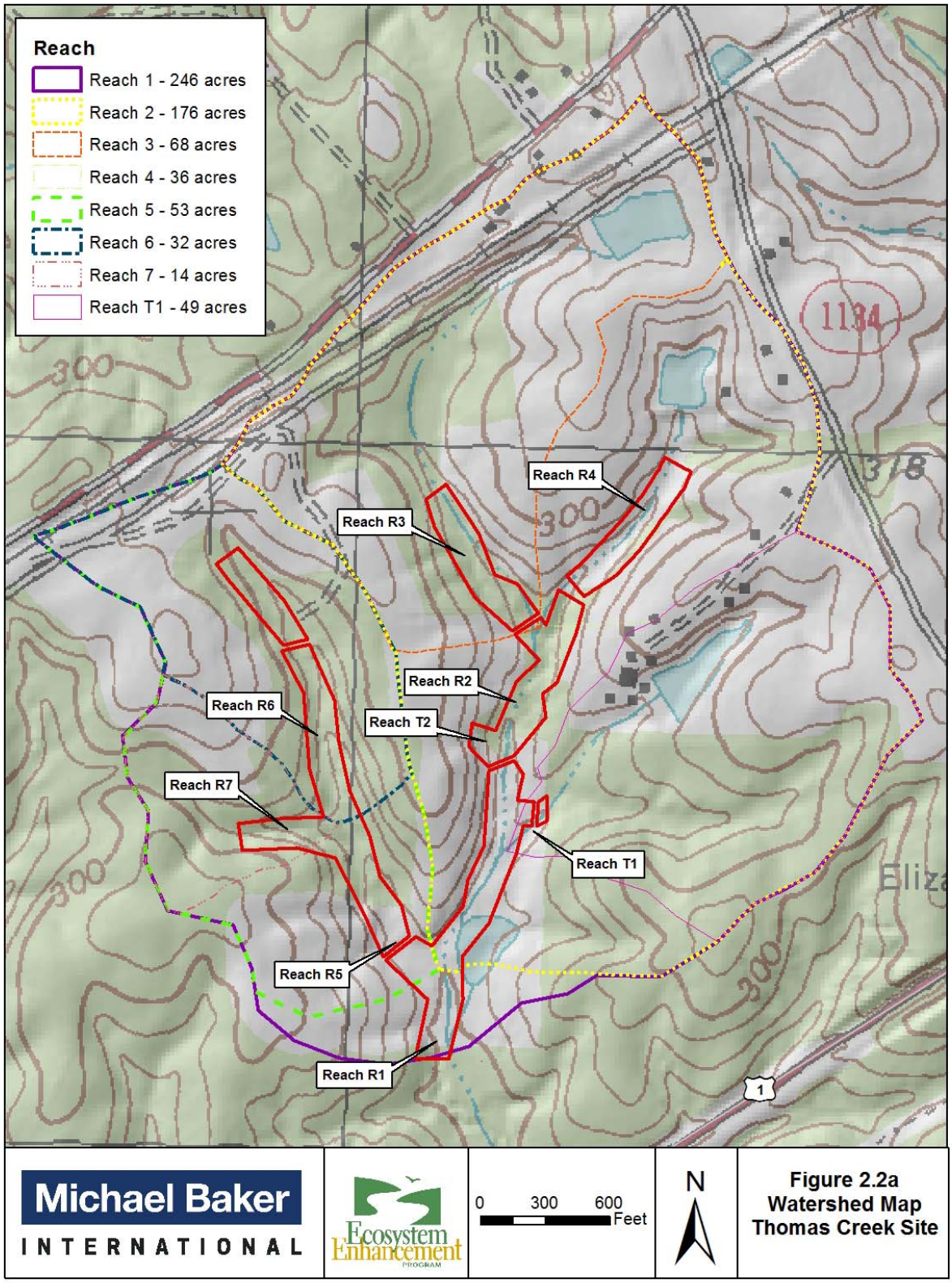


Figure 2.2a
Watershed Map
Thomas Creek Site

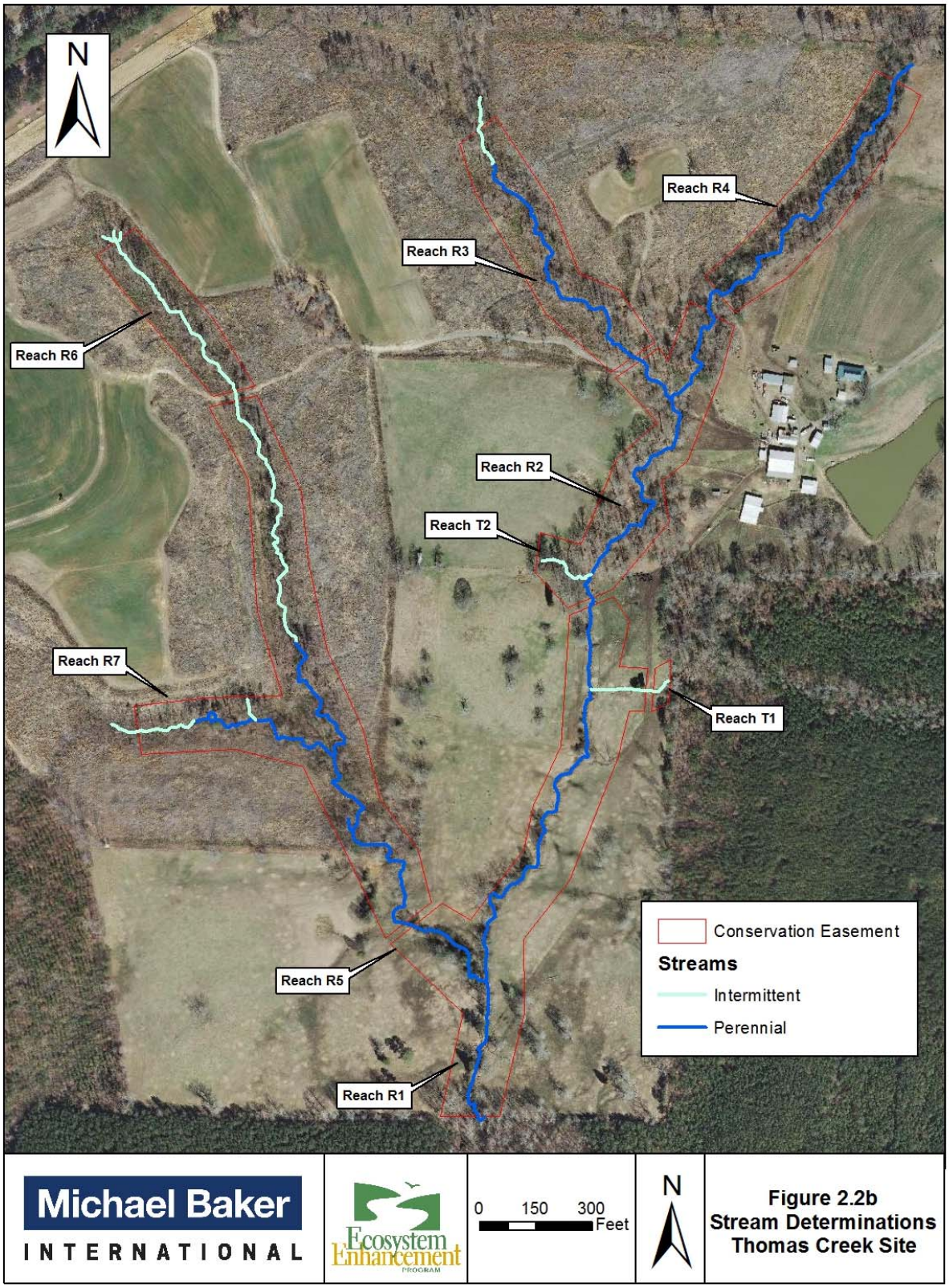


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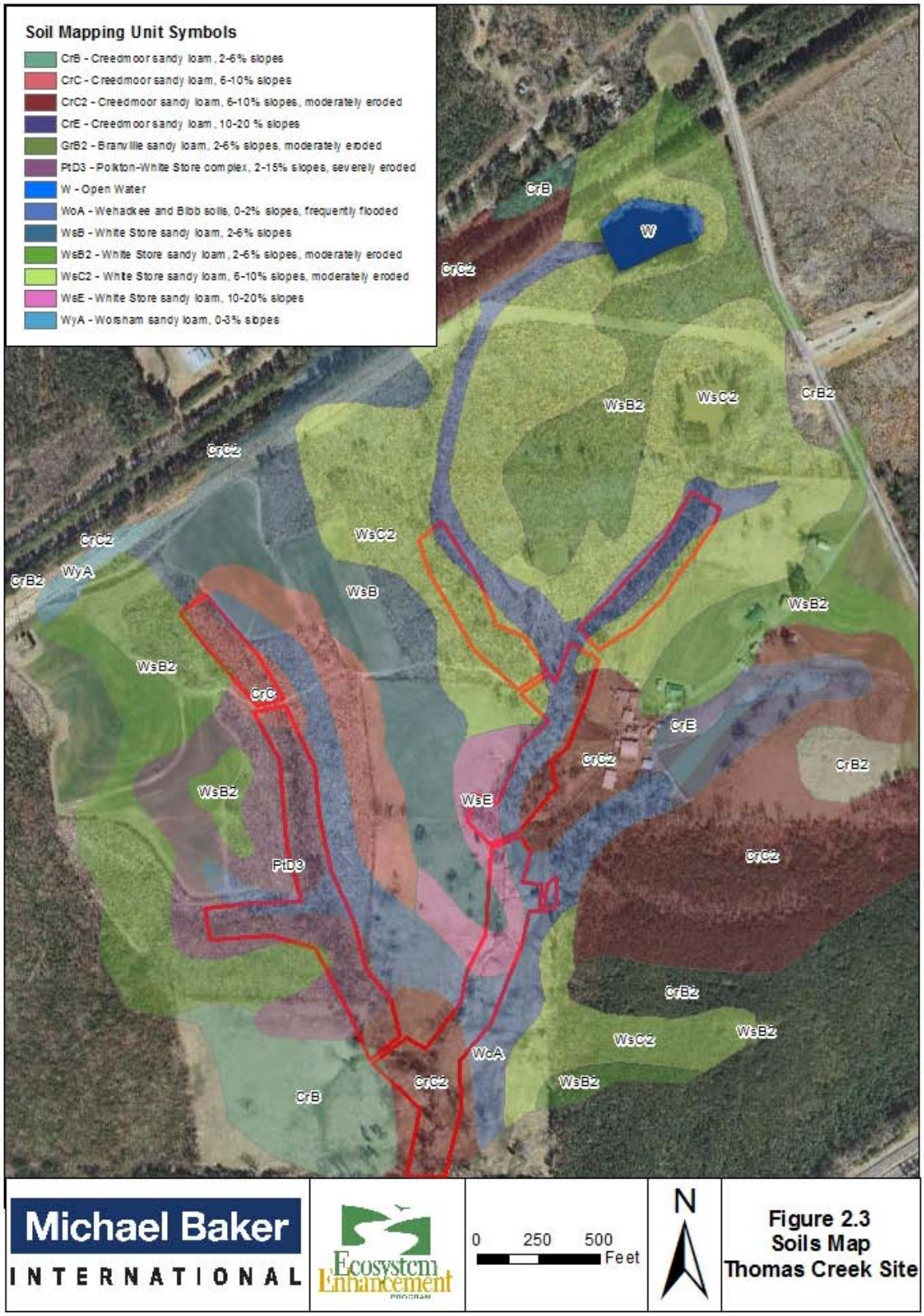
Figure 2.2b
Stream Determinations
Thomas Creek Site

2.4 Soils Map


Soil Mapping Unit Symbols
CrB - Creedmoor sandy loam, 2-6% slopes
CrC - Creedmoor sandy loam, 6-10% slopes
CrC2 - Creedmoor sandy loam, 6-10% slopes, moderately eroded
CrE - Creedmoor sandy loam, 10-20 % slopes
GrB2 - Granville sandy loam, 2-6% slopes, moderately eroded
PtD3 - Polkton-White Store complex, 2-15% slopes, severely eroded
W - Open Water
WoA - Wehadkee and Bibb soils, 0-2% slopes, frequently flooded
WsB - White Store sandy loam, 2-6% slopes
WsB2 - White Store sandy loam, 2-6% slopes, moderately eroded
WsC2 - White Store sandy loam, 6-10% slopes, moderately eroded
WsE - White Store sandy loam, 10-20% slopes
WyA - Worsham sandy loam, 0-3% slopes
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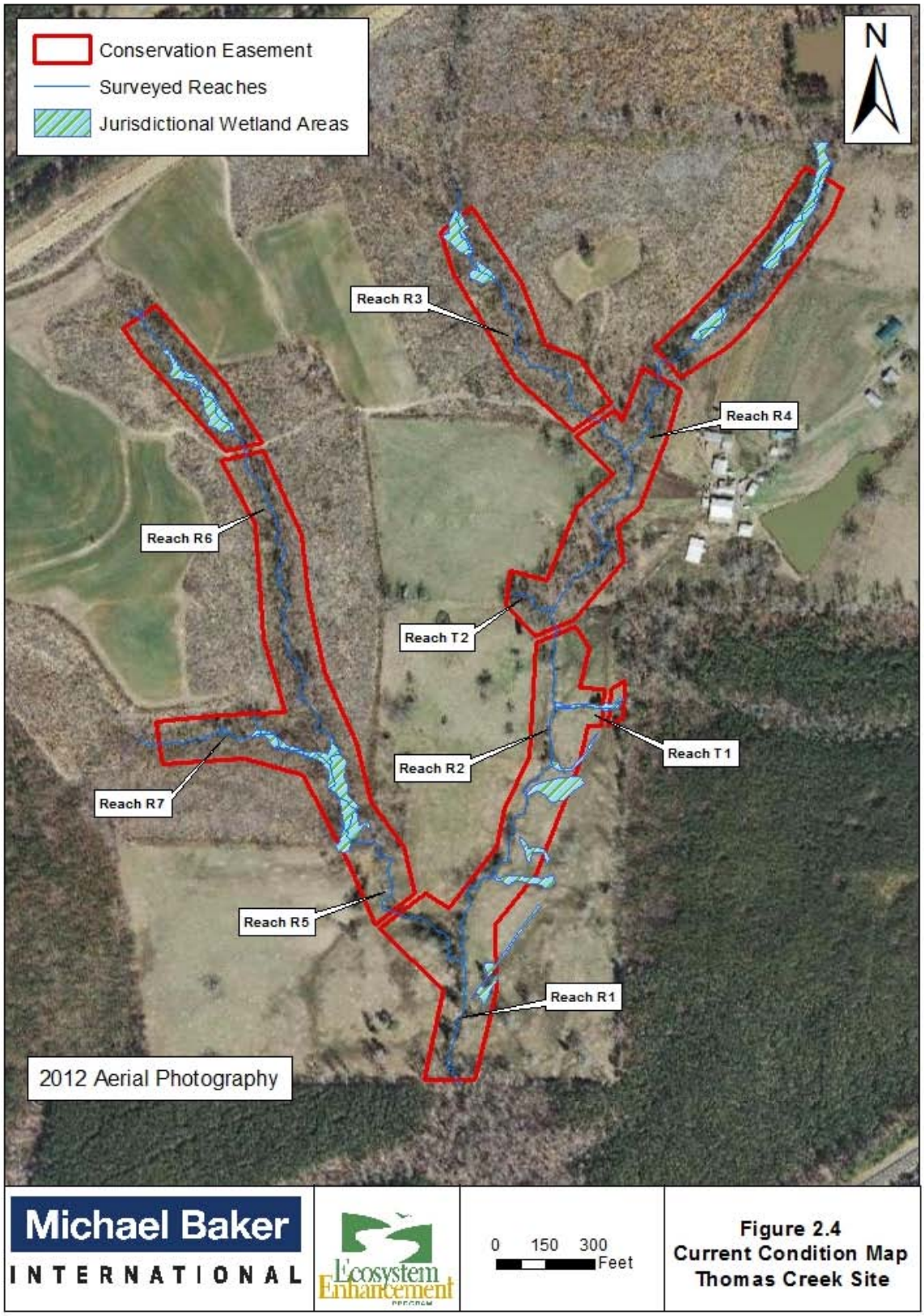
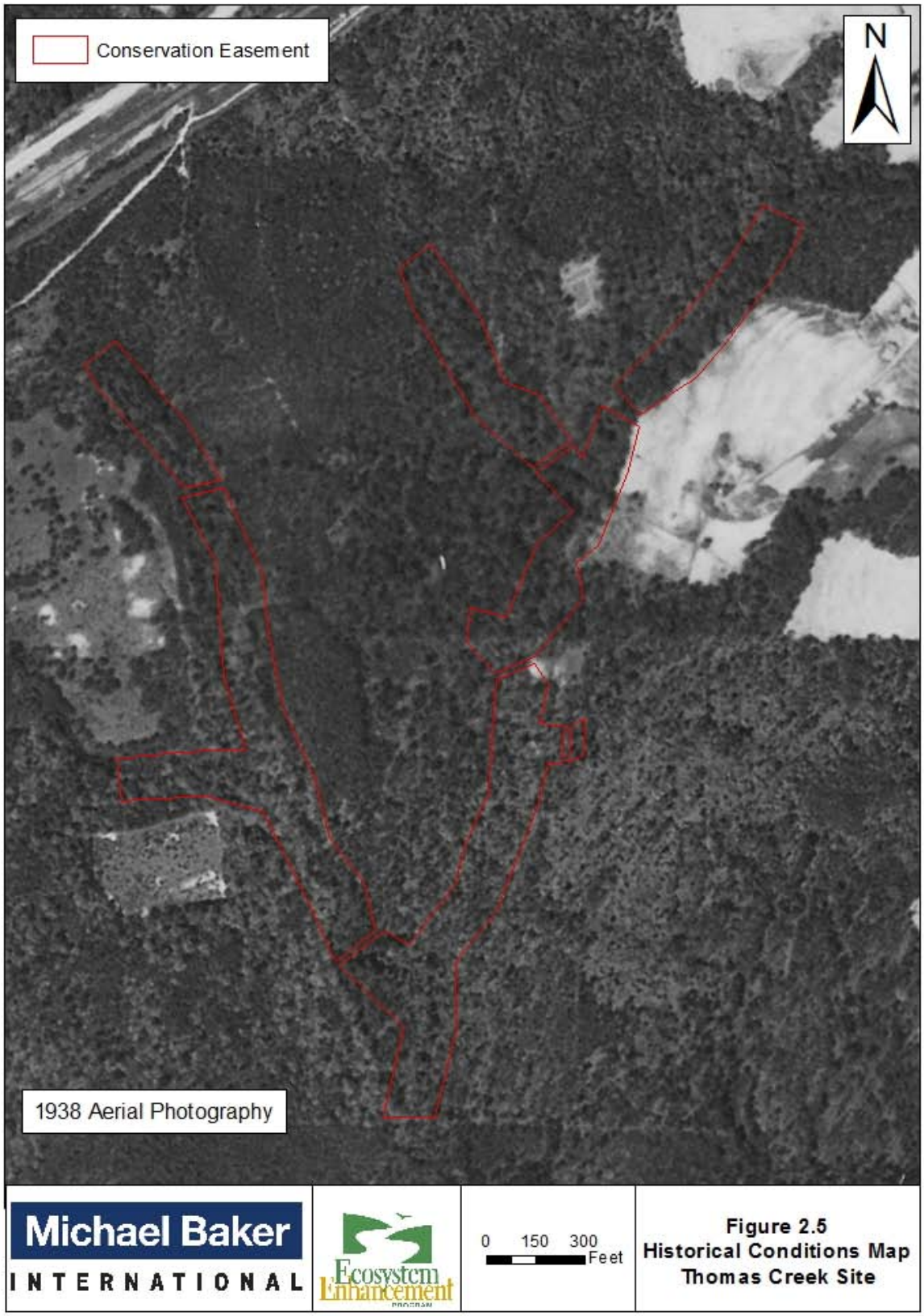
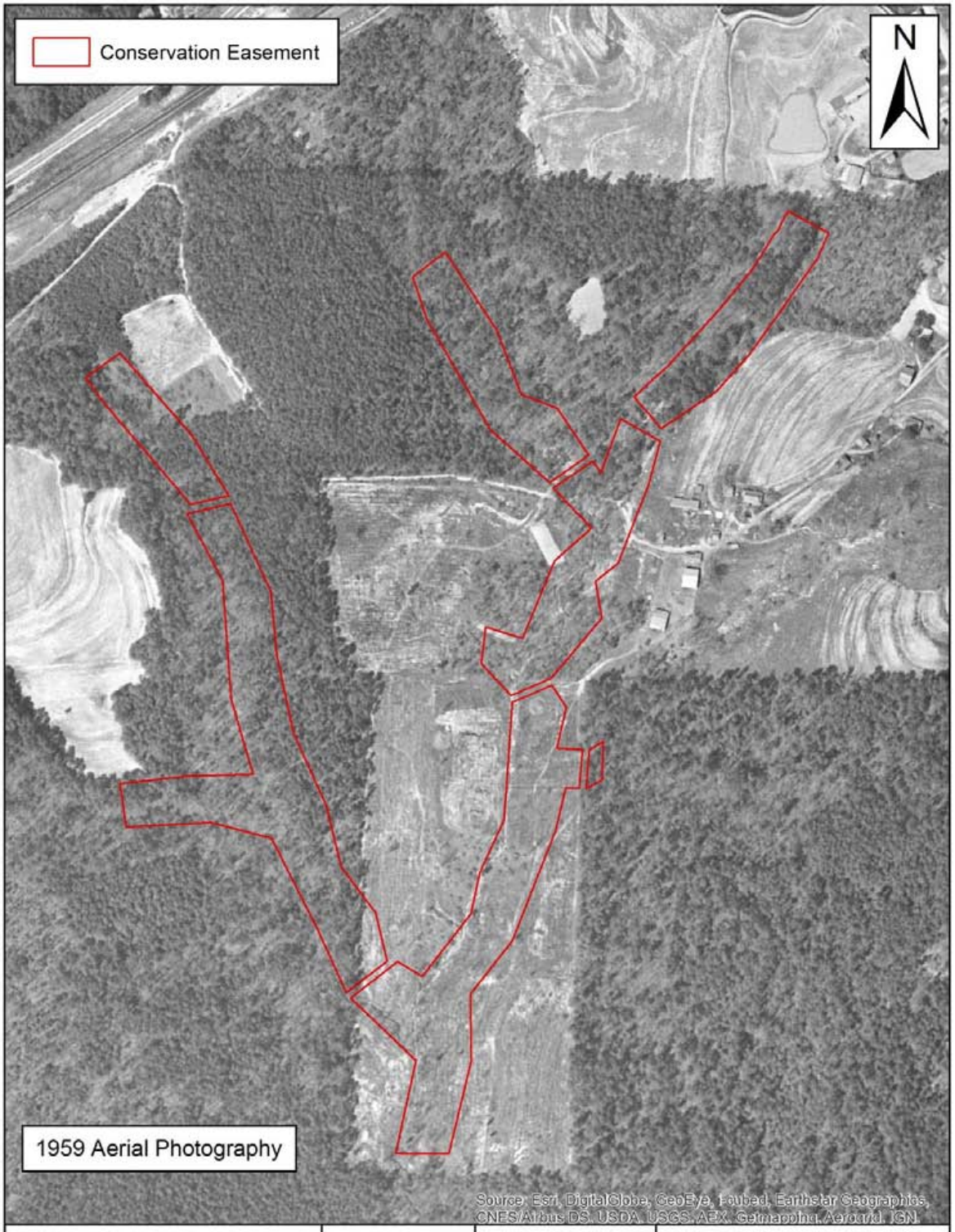
0 250 500 Feet
N
Figure 2.3
Soils Map
Thomas Creek Site

2.5 Current Conditions Map



2.6 Historical Conditions Maps





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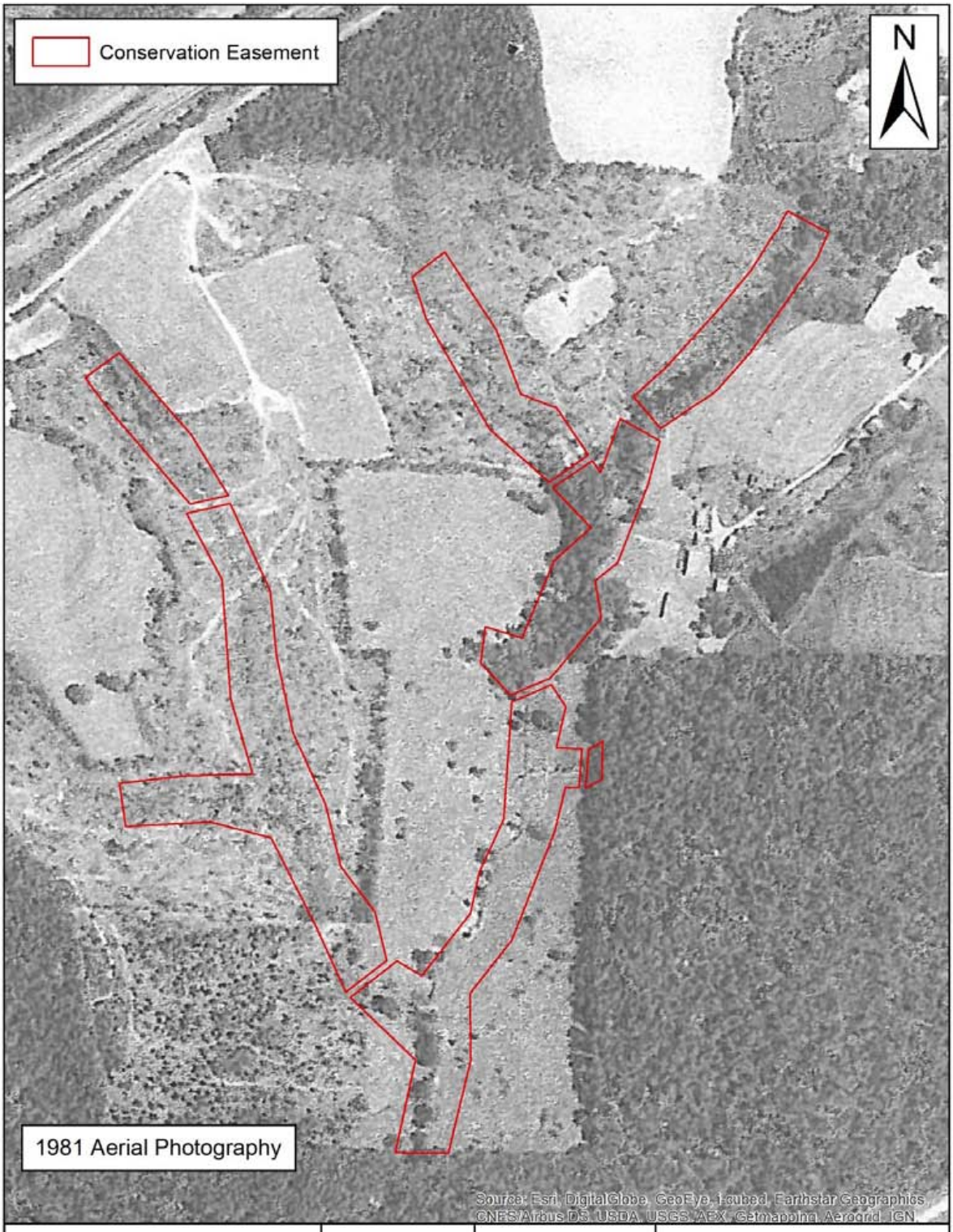
0 150 300 Feet

Figure 2.6
Historical Conditions Map
Thomas Creek Site



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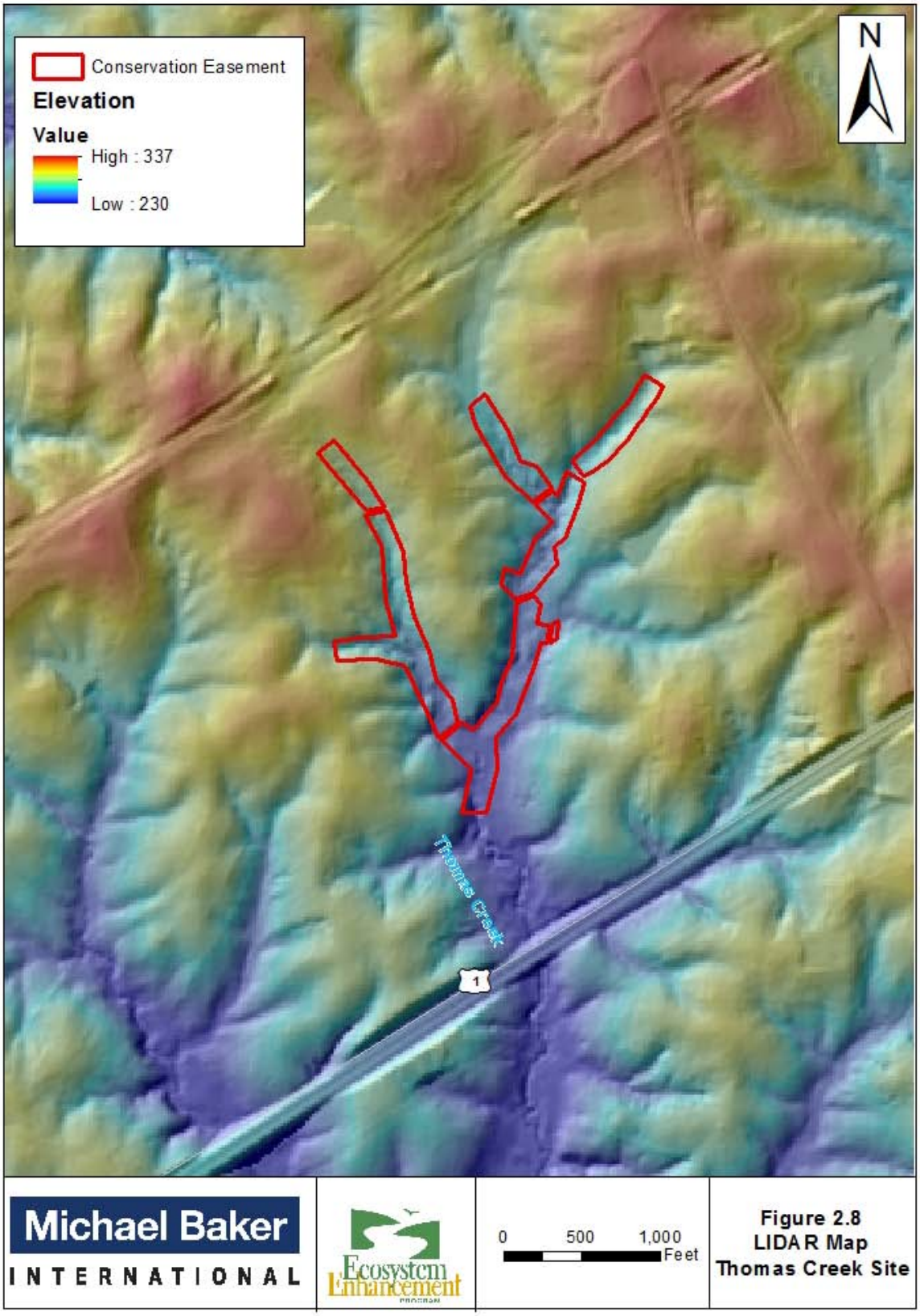
0 150 300 Feet

Figure 2.7
Historical Conditions Map
Thomas Creek Site

2.7 LiDAR Map


Conservation Easement
Elevation
Value
High : 337
Low : 230
N
Thomas Creek
1
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0
500
1,000
Feet
Figure 2.8
LIDAR Map
Thomas Creek Site

2.8 Site Photographs

2.8.1 Reach R1

View looking at downstream end of project. Reach R1 is incised but has reached bedrock (4/16/2013)

Close up of bedrock grade control at lower end of Reach R1 (4/16/2013)

View looking at incised and eroding channel along Reach R1 (4/16/2013)

View looking across Reach R1 at in incised channel with cattle crossing and minimal buffer (4/25/2013)

View looking downstream at channel incision with vertical eroding bank along Reach R1 (6/19/2014)

View looking upstream at cross section of Reach 1 with channel incision and eroding banks (4/22/13)

2.8.2 Reach R2

View looking upstream at confluence of Reach R3 (left) and Reach R4 (right) to form Reach R2 (4/25/13)

View looking downstream at impacted riparian buffer and cattle access trails near middle of Reach R2 (5/21/13)

Looking upstream at cross section R2a on lower Reach R2 (5/21/13)

Looking upstream at cross section R2b on upper Reach R2 (5/21/13)

View looking at incised channel, eroding outside bend, and minimal buffer along lower Reach R2 (5/22/13)

Collecting sediment sample and assessing sediment composition at depth on upper Reach R2 (5/22/13)

2.8.3 Reaches R3 and R4

Existing ford crossing on lower Reach R3 (5/8/2013)

Eroding right bank along the middle Reach R3 (4/16/2013)

View looking upstream on Reach R3 at left bank with bedrock and tree in center of channel (5/9/14)

View looking upstream at minimal buffer vegetation following 2011 clear cut along Reach R3 (4/16/2013)

Incised channel on lower Reach R4 targeted for restoration (5/22/13)

View looking upstream at reference section of upper Reach R4 (2/7/14)

2.8.4 Reaches R5 and R6

View looking upstream on Reach R5. Cattle trampling is evident (5/8/2013)

View looking upstream on Reach R5 at transition from forest to pasture (5/8/2013)

Enhancement Level II section of upper Reach R5 (4/25/13)

View looking at proposed Enhancement Level II section of lower R6 (5/8/13)

Incised channel targeted for enhancement on upper Reach R6 (5/22/2013)

View of riparian corridor on upper Reach R6 targeted for enhancement (5/22/2013)

2.8.5 Reaches R7, T1, and T2

View looking upstream along Reach R7. This area is targeted for supplemental buffer planting only. (5/8/13)

View looking upstream at incised channel on Reach R7 (5/22/13)

View looking upstream along Reach T1 (& across Reach R2 in foreground), which is targeted for enhancement. (5/9/14)

View looking downstream along Reach T1 at trampled banks and minimal buffer vegetation (4/17/14)

Spring at head of Reach T2 (4/25/13)

Cattle loafing at spring head on T2 (5/21/13)

3.0 SITE PROTECTION INSTRUMENT

3.1 Site Protection Instrument Summary Information

The land required for the construction, management, and stewardship of this mitigation project includes portions of the following parcels. A copy of the land protection instrument is included in Appendix A.

Table 3.1 Site Protection Instrument Summary
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project 96074

Parcel Number	Landowner	PIN	County	Site Protection Instrument	Deed Book and Page Numbers	Acreage Protected
CE-1	Irvin Woodrow Goodwin	0619268591	Wake	Conservation easement	15894 / 2170	1.51
CE-2	Irvin Woodrow Goodwin	0619268591	Wake	Conservation easement	15894 / 2170	6.52
CE-3	Irvin Woodrow Goodwin	0619268591	Wake	Conservation easement	15894 / 2170	6.01
CE-4	Irvin Woodrow Goodwin	0619268591	Wake	Conservation easement	15894 / 2170	0.10
CE-5	Irvin Woodrow Goodwin	0619268591	Wake	Conservation easement	15894 / 2170	1.12
CE-6	Irvin Woodrow Goodwin and Michael L. Goodwin	0619368876	Wake	Conservation easement	15894 / 2276	1.98
CE-7	Irvin Woodrow Goodwin	0619268591	Wake	Conservation easement	15894 / 2170	0.01
CE-8	Irvin Woodrow Goodwin	0619268591	Wake	Conservation easement	15894 / 2170	1.31
CE-9	Michael L. Goodwin	0619473680	Wake	Conservation easement	15894 / 2236	1.26
CE-10	Michael L. Goodwin	0619473680	Wake	Conservation easement	15894 / 2236	0.41
CE-11	Michael L. Goodwin	0619473680	Wake	Conservation easement	15894 / 2236	2.50

Baker has obtained a conservation easement from the current landowners for the entire project area. The easement and survey plat was reviewed and approved by NCEEP and State Property Office (SPO) and is now held by the State of North Carolina. The easement and survey plat (Deed Book BM2015 / Pages 121-122) was recorded at the Alamance County Courthouse on January 16th, 2015. The secured conservation easement allows Baker to proceed with the restoration project and restricts the land use in perpetuity.

3.1.1 Potential Constraints

No fatal flaws have been identified at the time of this mitigation plan. Five existing farm crossings along Reaches R3, R4, R5, R6, and T1 will be improved as part of this project. No existing or proposed easements for power and telephone utilities are located within the project boundary. Riparian buffer widths will be at least 50 feet from top of bank along all proposed streambanks (100 foot minimum total buffer width) for all of the stream reaches. In fact, many of the project buffers are more than 120 feet in total length. None of the proposed project reaches are located within a FEMA regulated floodplain (Figure 16.1); thus, FEMA

permitting or documentation is not required. Baker has notified the local floodplain administrator and learned that Wake County has requirements for a flood study and permit fees if culverts are installed (Appendix B). Consequently, Baker has decided that ford crossings will be used, which do not require flood studies or permit fees. Other regulatory factors discussed in Section 16, Appendix B were also not determined to pose potential site constraints. Construction access and staging areas have been identified and will be determined during final design.

3.2 Site Protection Instrument Figure

The conservation easement for the project area is shown in Figure 3.1 and copies of the recorded survey plat will be included in Section 15, Appendix A.

Figure 3.1 Site Protection Instrument Map

4.0 BASELINE INFORMATION

Table 4.1 Baseline Information
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Project Information					
Project Name	Thomas Creek Restoration Project				
County	Wake				
Project Area (acres)	22.7				
Project Coordinates (latitude and longitude)	35.6636 N, -79.9547 W				
Project Watershed Summary Information					
Physiographic Province	Piedmont				
River Basin	Cape Fear				
USGS Hydrologic Unit 8-digit and 14-digit	03030004 / 03030004020010				
NCDWR Sub-basin	03-06-07				
Project Drainage Area (acres)	246 (Reach R1 main stem at downstream extent)				
Project Drainage Area Percent Impervious	<1%				
CGIA / NCEEP Land Use Classification	2.01.01.01, 2.03.01, 2.99.01, 3.02 / Forest (66%) Agriculture (19%) Impervious Cover (1%)				
Reach Summary Information					
Parameters	**Reach R1**	**Reach R2**	**Reach R3**	**Reach R4**	**Reach R5**
Length of Reach (linear feet)	397	1,995	1,067	342	1,020
Valley Classification (Rosgen)	VII	VII	VII	VII	VII
Drainage Area (acres)	246	176	62	36	62
NCDWR Stream Identification Score	37.5	38	37 / 25	31	31
NCDWR Water Quality Classification	C				
Morphological Description (Rosgen stream type)	Bc	F (upstream)/ Gc (downstream)	Gc (upstream)/ Bc (downstream)	Bc	Bc
Evolutionary Trend	Bc→Gc→F	Bc→Gc→F	Bc→Gc→F	Bc→Gc→F	Bc→Gc→F
Underlying Mapped Soils	WoA	WoA	WoA	WoA	WoA
Drainage Class	Poorly drained	Poorly drained	Poorly drained	Poorly drained	Poorly drained
Soil Hydric Status	Hydric	Hydric	Hydric	Hydric	Hydric
Average Channel Slope (ft/ft)	0.0165	0.0083	0.014	0.0102	0.0172
FEMA Classification	N/A	N/A	N/A	N/A	N/A
Native Vegetation Community	Piedmont Small Stream				
Percent Composition of Exotic/Invasive Vegetation	<5%	25%	<5%	<5%	<5%
Parameters	**Reach R6**	**Reach R7**	**Reach T1**	**Reach T2**	
Length of Reach (linear feet)	1,828	646	242	171	
Valley Classification (Rosgen)	VII	VII	VII	VII	
Drainage Area (acres)	32	14	49	5	
NCDWR Stream Identification Score	25	35/20	23.75	20.75	
NCDWR Water Quality Classification	C				
Morphological Description (Rosgen stream type)	G5c (upstream)/ B5c (downstream)	G5 (upstream)/ B5c (downstream)	B5c	B5c	

Table 4.1 Baseline Information Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074					
Evolutionary Trend	Bc→Gc→F	Bc→Gc→F	Bc→Gc→F	Bc→Gc→F	
Underlying Mapped Soils	WoA	WoA	WoA	WoA	
Drainage Class	Poorly drained	Poorly drained	Poorly drained	Poorly drained	
Soil Hydric Status	Hydric	Hydric	Hydric	Hydric	
Average Channel Slope (ft/ft)	0.015/0.025	0.025	0.020	0.041	
FEMA Classification	N/A	N/A	N/A	N/A	
Native Vegetation Community	Piedmont Small Stream				
Percent Composition of Exotic/Invasive Vegetation	<5%	<5%	<5%	<5%	

Regulatory Considerations			
Regulation	**Applicable**	**Resolved**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	Yes	Categorical Exclusion (Appendix B)
Waters of the United States – Section 401	Yes	Yes	Categorical Exclusion (Appendix B)
Endangered Species Act	No	N/A	Categorical Exclusion (Appendix B)
Historic Preservation Act	No	N/A	Categorical Exclusion (Appendix B)
Coastal Area Management Act (CAMA)	No	N/A	Categorical Exclusion (Appendix B)
FEMA Floodplain Compliance	No	Yes	Categorical Exclusion (Appendix B)
Essential Fisheries Habitat	No	N/A	Categorical Exclusion (Appendix B)

5.0 DETERMINATION OF CREDITS

Table 5.1 Project Components and Mitigation Credits
Thomas Creek Restoration Project Stream Mitigation Plan, Wake County - NCEEP Project No. 96074

Mitigation Credits								
	Stream	**Riparian Wetland**		**Non-riparian Wetland**		**Buffer**	**Nitrogen Nutrient Offset**	**Phosphorus Nutrient Offset**
Type	R, E1, E2	R	E					
Totals	5,706 SMU	0.0	0.0					

Project Components						
Project Component or Reach ID	**Stationing/ Location**	**Existing Footage/ Acreage**	**Approach**	**Restoration or Restoration Equivalent**	**Restoration Footage**	**Mitigation Ratio**
Reach R1	41+81 – 44+47	397 LF	Restoration	266 SMU	R	1:1
Reach R2	20+74 – 41+81	1,995 LF	Restoration	2,087 SMU	R	1:1
Reach R3 (upstream section)	10+00 – 11+30	130 LF	Enhancement Level II	26 SMU	130 LF	5:1
Reach R3 (downstream section)	11+30 – 20+74	937 LF	Restoration	929 SMU	R	1:1
Reach R4 (upstream section)	0+99 – 9+59	870 LF	Enhancement Level II	87 SMU	870 LF	10:1
Reach R4 (downstream section)	10+10 – 13+71	327 LF	Restoration	361 SMU	R	1:1
Reach R5 (upstream section)	28+08 – 29+45	137 LF	Enhancement Level II	27 SMU	137 LF	5:1
Reach R5 (downstream section)	29+45 – 40+09	883 LF	Restoration	1,044 SMU	R	1:1
Reach R6 (upstream section)	10+00 – 12+10	210 LF	Enhancement Level I	140 SMU	210 LF	1.5:1
Reach R6 (downstream section)	12+10 – 28+08	1,618 LF	Enhancement Level II	320 SMU	1,598 LF	5:1
Reach R7 (upstream section)	10+00 – 13+50	360 LF	Enhancement Level II	144 SMU	360 LF	2.5:1
Reach R7 (downstream section)	13+50 – 16+46	286 LF	Enhancement Level II	57 SMU	286 LF	5:1
Reach T1	10+00 – 12+53	242 LF	Enhancement Level I	155 SMU	233 LF	1.5:1
Reach T2	10+00 – 11+58	171 LF	Enhancement Level II	63 SMU	158 LF	2.5:1

Component Summation						
Restoration Level	**Stream (LF)**	**Riparian Wetland (AC)**		**Non-riparian Wetland (AC)**	**Buffer (SF)**	**Upland (AC)**
		Riverine	Non-Riverine			
Restoration	4,687					
Enhancement I	443					
Enhancement II	3,539					

6.0 CREDIT RELEASE SCHEDULE

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 Department of the Army (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 NCIRT, 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 6.1 as follows:

Table 6.1 Credit Release Schedule
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Stream Credits			
Monitoring Year	**Credit Release Activity**	**Interim Release**	**Total Release**
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% (60%*)
3	Third year monitoring report demonstrates performance standards are being met	10%	60% (70%*)
4	Fourth year monitoring report demonstrates performance standards are being met	5%	65% (75%*)
5	Fifth year monitoring report demonstrates performance standards are being met.	10%	75% (85%*)
6	Sixth year monitoring report demonstrates performance standards are being met.	5%	80% (90%)
7	Seventh year monitoring report demonstrates performance standards are being met and project has received closeout approval.	10%	90% (100%)

Initial Allocation of Released Credits

The initial allocation of released credits, as specified in the mitigation plan can be released by the NCEEP 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 NCEEP 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.

Subsequent Credit Releases

All subsequent credit releases must be approved by the DE, in consultation with the NCIRT, based on a determination that required performance standards have been achieved. For stream projects a reserve of 10% of a site's total stream credits shall be released after two bankfull 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 bankfull events occur during the monitoring period, release of these reserve credits shall be at the discretion of the NCIRT. As projects approach milestones associated with credit release, the NCEEP 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.

7.0 MITIGATION WORK PLAN

7.1 Target Stream Type(s), Wetland Type(s), and Plant Communities

7.1.1 Target Stream Types

The primary goal when targeting a stream type was to select a site-specific design approach that would return rural piedmont stream functions to a stable state prior to past disturbances. Current assessment methods and data analyses were utilized for identifying lost or impaired functions at the site and to determine overall mitigation potential. Among these are reviewing existing hydrogeomorphic conditions, historical aerials and LiDAR (Light Detection and Ranging) mapping, evaluating stable reference reaches, and a comparison of results from similar past projects in rural piedmont stream systems.

After examining the assessment data collected at the site and exploring the potential for restoration, an approach was developed that would address restoration of stream functions within the project area. Topography and soils on the site indicate that the project area most likely functioned in the past as small tributary stream system, eventually flowing downstream into the larger Little White Oak Creek system, which is now the Harris Lake reservoir. Prior to selecting the proposed design approach, Baker considered assigning an appropriate stream type for the corresponding valley that also accommodates the existing and future hydrologic conditions, as well as sediment supply. This decision was based primarily on the desired performance of the stream of the channels given the valley slope and width.

7.1.2 Target Wetland Types

No wetland restoration or enhancement is included in this mitigation project.

7.1.3 Target Plant Communities

Native species riparian vegetation will be established in the riparian buffer throughout the site. Schafale and Weakley's (1990) guidance on vegetation communities as well as the USACE Wetland Research Program (WRP) Technical Note VN-RS-4.1 (1997) were referenced during the development of riparian planting lists for the site. In general, bare root vegetation will be planted at a target density of 680 stems per acre. Live stakes will be planted along the channels at a targeted density of 40 stakes per 1,000 square feet. Using triangular spacing along the streambanks, the live stakes will be spaced two to three feet apart in meander bends and six to eight feet apart in the straight sections between the toe of the streambank and bankfull elevation. Site variations may require slightly different spacing. Baker prefers to have a row of livestakes near the toe in case of drought conditions, when baseflow may only sustain livestakes at that elevation.

Invasive species vegetation, such as Chinese privet (*Ligustrum sinense*) and multiflora rose (*Rosa multiflora*) will be removed to allow native species plants to become established within the conservation easement. Larger native tree species will be preserved and harvested woody material will be utilized to provide streambank stabilization cover and/or nesting habitat. Hardwood species will be planted to provide the appropriate vegetation for the restored riparian buffer areas. Species will include tulip poplar (*Liriodendron tulipifera*), river birch (*Betula nigra*), arrowwood viburnum (*Viburnum dentatum*), persimmon (*Diospyros virginiana*), red maple (*Acer rubrum*), and swamp chestnut oak (*Quercus michauxii*).

7.2 Design Parameters

Selection of design criteria is based on a combination of approaches, including review of reference reach data, regime equations, evaluation of monitoring results from past projects, and best professional judgment. Evaluating data from reference reach surveys and monitoring results from multiple Piedmont stream projects provided pertinent background information to determine the appropriate design

parameters given the existing conditions and overall site potential. The design parameters for the site (shown in Section 17, Appendix C) also considered current guidelines from the USACE.

The restoration activities and structural elements are justified for the following reasons:

1. Many of the stream sections are incised (Bank Height Ratios greater than 1.5) with active bank erosion.
2. Cattle access has resulted in significant degradation through the lower reaches (Reaches R1, R2, T1, and lower R5) of the site;
3. Past agricultural and silvicultural activities, such as channelization and timber harvesting, have resulted in streambank erosion, excessive sedimentation, and the loss of woody vegetation within the riparian zone;
4. Enhancement or preservation measures alone would not achieve the highest possible level of functional lift for many portions of the degraded stream system.

For design purposes, the stream channels were divided into nine reaches labeled Reaches R1, R2, R3, R4, R5, R6, R7, T1, and T2, as shown in Table 7.1. Selection of a general restoration approach was the first step in selecting design criteria for the project reaches. The approach was based on the potential for restoration as determined during the site assessment and the specific design parameters were developed so that plan view layout, cross-section dimensions, and profile could be described for developing construction documents. The design philosophy is to use these design parameters as conservative values for the selected stream types and to allow natural variability in stream dimension, facet slope, and bed features to form over long periods of time under the processes of flooding, re-colonization of vegetation, and watershed influences.

Table 7.1 Project Design Stream Types
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Reach	Proposed Stream Type	Approach/Rationale
Reach R1	C	Restoration: Priority Level II Restoration will ensue below the confluence of Reaches R2 and R5 to tie into the existing bed elevation by the downstream extent of the project. The restored channel will be designed as a Rosgen C type channel. The existing channel will be stabilized and a floodplain benches will be incorporated along this reach. Riparian buffers in excess of 50 feet will be restored or protected along both sides of Reach R1.
Reach R2	C	Restoration: A combination of Priority Level I and II approaches will provide floodplain reconnection and long-term channel stability. In upper Reach R2, below the confluence of Reaches R3 and R4, the existing channel is in the process of forming stable, but narrow and localized, floodplain benches. The existing pattern will be used with minor alterations to provide improved bedform diversity and floodplain benching will be incorporated to both widen and provide continuity throughout the reach. Once Reach R2 enters the open field (just downstream from Reach T2) it becomes less sinuous and lacks riparian buffer along the streambanks. Here, Priority Level I restoration will be targeted by constructing a Rosgen 'C' stream type channel off line in order to reconnect the channel with its historic floodplain and restore adequate meander geometry. These restoration techniques will create a stable channel with appropriate bedform diversity, as well as improve channel function by improving aquatic habitat, increasing overbank flooding frequency, restoring riparian and terrestrial habitats, and excluding cattle from accessing the

Table 7.1 Project Design Stream Types
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Reach	Proposed Stream Type	Approach/Rationale
		stream. The design width/depth ratio for the channel will be 14, and over time, the channel may narrow to an E-type channel due to deposition of sediment and streambank vegetation growth. Riparian buffers in excess of 50 feet will be restored along both sides of Reach R2. A 20-foot wide ford stream crossing will be constructed near the transition from upper to lower Reach R2. Gates will be included to restrict livestock access to the crossing.
Reach R3	E/C	Enhancement: Level II Enhancement will be implemented in the upper 130 feet of Reach R3. The channel is mostly stable thoughout this upper section; however, the riparian buffer width is narrow. A 50-foot buffer will be planted on both sides of the existing channel, invasive species will be removed, and a conservation easement will protect the area in perpetuity. Restoration: The remaining downstream portion of Reach R3 will be restored using Rosgen Priority Level I and II Restoration. In the transition area from enhancement to restoration there is a significant headcut that has been restrained by trees roots. This headcut will be stabilized with a grade control log jam and restoration will continue below it. A restoration approach is warranted because the channel is incised and the streambanks are eroding, particularly on the outside of meander bends. The riparian buffer along Reach R3 will be planted with native riparian vegetation to a width of at least 50 feet from the top of the streambanks. An existing ford crossing at the lower end of Reach R3 will be enhanced. Cattle do not and will not have access to this crossing.
Reach R4	C	Enhancement: Reach R4 begins as a stable, 870-foot reference-quality section; thus, Enhancement Level II is proposed. This will include supplemental planting to restore the riparian buffer and establishing conservation easement. Invasive species will not be removed per agreement with the NCIRT during the post-contract site visit. This agreement is due to a low credit ratio of 10:1 for this upper section. Restoration: The downstream portion of Reach R4 will be designed as a Rosgen 'E/C' stream type using Priority Level II restoration. Grade control structures will be implemented to dissipate flow energies and eliminate the potential for upstream channel incision. Channel banks will be graded to stable slopes, bankfull benches will be incorporated to promote stability, and the riparian vegetation will be reestablished. This section of Reach R4 will be designed as a Rosgen C type channel. The design width/depth ratio for the channel will be 13. Riparian buffers in excess of 50 feet will be restored along both sides of Reach R4 in its entirety. A stable existing ford crossing at the upper end of Reach R4 will remain. Cattle do not and will not have access to this crossing.
Reach R5	C	Enhancement: Reach R5 begins as a stable channel; thus, Enhancement Level II will be incorporated in the upstream extent of the reach. Work will include supplemental native planting to restore the riparian buffer, invasive species control, and establishing a conservation easement to protect the reach.

Table 7.1 Project Design Stream Types
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Reach	Proposed Stream Type	Approach/Rationale
		Restoration: Priority Level I restoration will begin, approximately 145 feet from the origin of Reach R5 at an active headcut and will continue throughout the remainder of Reach R5 to address an incised channel and eroding streambanks. The new channel will be constructed mostly off - line. This approach will restore floodplain connections, will allow channel pattern to accommodate the preservation of desirable native species, and will restore natural channel functions. An existing ford crossing will be moved slightly upstream and improved. Gates will be included to restrict livestock access to the easement.
Reach R6	Bc	Enhancement: Due to a steep valley slope of 3.7%, Baker will stabilize approximately 210 feet of the upstream section of Reach R6 by implementing Level I Enhancement to form a floodplain bench near the existing channel elevation The stream channel on the lower 1,618 feet of Reach R6 is relatively stable despite typically high bank height ratios of greater than 2.5. Consequently, Baker proposes Enhancement Level II including supplemental planting, invasive species control, and conservation easement establishment to enhance and protect the reach. Riparian buffers in excess of 50 feet will be restored or enhanced along both sides of Reach R6. An existing stream crossing near the upstream end of Reach R6 will remain as part of the proposed project. Livestock will not have access to this area.
Reach R7	Bc	Enhancement: The upstream section of Reach R7 is unstable and a headcut is actively migrating upstream. Level II Enhancement will be implemented in this section, Seven grade control structures will be used to promote channel stability and bedform diversity. Minor grading of isolated sections of the streambanks, as well as gully stabilization of a tributary ditch will be included. A credit ratio of 2.5:1 is proposed for the upper 360 feet of this reach. The lower section of Reach R7 will employ Level II Enhancement but the practices will focus on supplemental planting, invasive species control, and conservation easement establishment. The lower section is proposed at a lower 5:1 credit ratio. Riparian buffers in excess of 50 feet will be restored or enhanced along both sides of Reach R7. No stream crossings will be included on Reach R7.
Reach T1	C	Enhancement: Reach T1 is a tributary that has been historically re-routed to form a channelized ditch running perpendicular to the mainstem of Thomas Creek. Putting the stream back in its historic path is not feasible, however, due to a lateral constraint between the property line to the east and a need to provide a cattle crossing on the reach. A Level I Enhancement approach will be employed to form a step pool channel along T1 that will conform to the existing valley and allow flow energies to be dissipate vertically. The channel will continue off-line once it attains the Reach R2 floodplain. A 1.5:1 credit ratio is proposed for Reach T1.

Table 7.1 Project Design Stream Types Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074		
Reach	**Proposed Stream Type**	**Approach/Rationale**
		Riparian buffers in excess of 50 feet will be restored along both sides of Reach T1. An existing ford crossing at the upstream end of Reach T1 will be improved and gates will be installed to eliminate livestock access to the stream and easement.
Reach T2	Bc	Enhancement: Reach T2 is a tributary that runs from a continuous spring to Reach R2. The channel is mostly impacted by heavy cattle use, though a headcut has migrated upstream and grade is currently held by tree roots. Baker will implement Level II Enhancement to provide grade control, to stabilize bank slopes, to exclude cattle from the reach, and to restore the riparian buffer. A 2.5:1 credit ratio is proposed for Reach T2 .

7.3 Data Analysis

Baker compiled and assessed watershed information such as drainage areas, historical land use, geologic setting, soil types, and terrestrial plant communities. The results of the existing condition analyses along with reference reach data from previous projects were used to develop a proposed stream restoration design for the project reaches. Numerous sections of the existing channels throughout the project have been straightened/channelized or moved in the past. This manipulation has impacted channels so that they are now overly wide and deep for their respective drainage areas. Additionally, detailed topographic surveys were conducted along the channel and floodplain to determine the elevation of the stream where it flows throughout property, and to validate the valley signatures shown on the LiDAR imagery (Figure 2.6).

The design approach follows a step-wise methodology in which dimensionless ratios from successful past project experience, and to a lesser extent reference reaches, are used to restore stable dimension, pattern, and profile, as well as proper bankfull sediment transport competency for the proposed reaches. The stream channel design included analysis of the hydrology, hydraulics, shear stress, sediment transport, and appropriate channel dimensions. Critical shear stress and boundary shear stress analyses were used verify that the design channels will not aggrade nor degrade.

The Thomas Creek project includes several headwater reaches that are steeper and have narrow valleys. Often this setting may be associated with Bc stream types. However, the entrenchment ratio on the restored channels will be greater than 2.2, which makes either an E or a C channel. Though the channels will no longer be incised or entrenched, narrower valley widths and boundary conditions that prevented pattern adjustments commonly associated with C or E meander geometry. This typically translates to shorter riffles with higher slopes, and thus higher stream power. Higher stream power is ameliorated to some extent by increasing the width-to-depth ratios than the nearby reference reach. Additionally, constructing higher width-to-depth ratios (e.g., 11-14) will put less stress on the newly constructed streambanks. The channel may narrow with time as vegetation becomes established and if sediment deposits along the channel.

The channel substrate throughout the project area is predominately sand with minimal gravel. Consequently, Baker collected bulk sediment samples in order to evaluate bed material characteristics, classify the stream type, and complete sediment transport and stability analyses.

Regional curve equations, developed for the North Carolina Piedmont, (Harman et al., 1999) estimate a bankfull cross-sectional area of approximately 11.2 square feet for the downstream terminus of Reach R1's 0.384 square mile watershed (see Appendix C, Table 17.5). Rosgen's stream classification system (Rosgen, 1996) depends on the proper identification of the bankfull elevation. The existing upper and middle sections of the main stem (Reach R3 & R2) were classified as channelized B5c-F5 stream types

based on their calculated entrenchment ratios (where the bankfull areas were based on an estimation of bankfull area from the published NC Piedmont regional curve), channel slope, and channel substrate (sand). Entrenchment ratios of greater than 1.4 put the channel in the Bc category though the channel is clearly incised with bank height ratios of 1.9 to 3.3.

Bedform diversity and riffle/pool feature formation throughout the impaired reaches is poor and habitat diversity is minimal. The pools in the impaired project reaches are typically not noticeably deeper than the riffles. The riparian buffer vegetation is scattered and marginal along most the reach areas. Each stream displays limited meander geometry due to their current channelized conditions and valley formation.

The existing and proposed conditions data indicate that the mitigation activities will result in the re-establishment of a functional stream and floodplain ecosystem. The restoration and enhancement efforts, including site protection from a conservation easement, will promote the greatest ecological benefit, a rapid recovery period, and a justifiable and reduced environmental impact over a natural recovery that would otherwise occur through erosional processes with associated impacts on water quality and flooding. Currently, sediment, excess nutrients, and cattle excrement are entering the system from adjacent farm fields and pastures where existing riparian buffer widths are marginal or non-existent. Reducing streambank sediment loading and removing cattle will provide ecological uplift by improving water quality and promoting the restoration of diverse aquatic and terrestrial habitats that are appropriate for the piedmont ecoregion and landscape setting.

Additionally, by raising the streambed and reconnecting the active floodplains, the maximum degree of potential uplift will be provided, restoring stream, buffer, and wetland functions whenever possible. Uplift will also be provided to the system by improving and extending wildlife corridors that connect with wooded areas near the downstream extent of the project. The water quality of Thomas Creek will be improved by reducing nutrient and sediment inputs, and providing cattle exclusion fencing along all tributaries. Approximately 22.7 acres of riparian buffer will be restored and/or protected in perpetuity by a conservation easement.

8.0 MAINTENANCE PLAN

The site will be monitored on a regular basis and a physical inspection of the site will be performed at least once a 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 will be most likely in the first two years following site construction and may include the following components as described in Table 8.1:

Table 8.1 Routine Maintenance Components
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Component/Feature	Maintenance through project close-out
Stream	Routine channel maintenance and repair activities may include modifying in-stream structures to prevent piping, securing loose coir matting, and supplemental installations of live stakes and other target vegetation along the project reaches. Areas of concentrated stormwater and floodplain flows that intercept the channel may also require maintenance to prevent streambank failures and head-cutting until vegetation becomes established.
Wetland	N/A
Vegetation	Vegetation will be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, and fertilizing. Exotic invasive plant species will be controlled by mechanical and/or chemical methods. Any invasive plant species control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.
Site Boundary	Site boundaries will be demarcated in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, 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.
Farm Road Crossing	The farm road crossings within the site may be maintained only as allowed by the recorded Conservation Easement, deed restrictions, rights of way, or corridor agreements.
Beaver Management	Routine maintenance and repair activities caused by beaver activity may include supplemental planting, pruning, and dam breeching/dewatering and/or removal. Beaver management will be performed in accordance with US Department of Agriculture (USDA) rules and regulations using accepted trapping and removal techniques only within the project boundary.

9.0 PERFORMANCE STANDARDS

Baker has obtained regulatory approval for numerous stream mitigation plans involving NCDOT and NCEEP full-delivery projects. The success criteria for the project site will follow the mitigation plans developed for these projects, as well as the *Stream Mitigation Guidelines* (SMG) issued in April 2003 and October 2005 (USACE and NCDWR) and NCEEP's recent supplemental guidance document *Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation* dated November 7, 2011. All monitoring activities will be conducted for a period of 7 years, unless the site demonstrates complete success by year 5 and no concerns have been identified. An early closure provision may be requested by the provider for some or all of the monitoring components. Early closure may only be obtained through written approval from the USACE in consultation with the NCIRT.

Based on the design approaches, different monitoring methods are proposed for the project reaches. For reaches that involve a combination of traditional Restoration (Rosgen Priority Levels I and/or II) and Enhancement Level I (stream bed/bank stabilization) approaches, geomorphic monitoring methods will follow those recommended by the 2003 SMG and the 2011 NCEEP supplemental guidance. For reaches involving Enhancement Level II approaches, monitoring efforts will focus primarily on visual inspections, photo documentation, and vegetation assessments. The monitoring parameters shall be consistent with the requirements described in the Federal Rule for compensatory mitigation sites in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.5 paragraphs (a) and (b). Specific success criteria components and evaluation methods are described below and report documentation will follow the NCEEP Baseline Monitoring Document template and guidance (v 2.0, dated 10/14/2010).

Further description of the performance standards are provided below; however, a brief synopsis is listed here:

- Two bankfull discharge events within a five year period (two events cannot be in the same calendar year)
- Cross sections will be surveyed to demonstrate channel stability.
- Pattern (planimetric survey) and profile (longitudinal profile survey) are measured as part of the baseline survey (year 0) and should be checked by visual monitoring in subsequent years.
- One constructed riffle substrate sample will be compared to existing riffle substrate data collected during the design phase and any significant changes (i.e.; aggradation, degradation) will be noted after streambank vegetation becomes established and a minimum of two bankfull flows or greater have been documented.
- At year five, planted tree stem density must be no less than 260, 5-year old, planted trees per acre. The final vegetative success criteria will be the survival of 210, 7-year old, planted trees per acre at the end of the seven-year monitoring period, which must average 10 feet in height.

9.1 Stream Monitoring

Geomorphic monitoring of the proposed restoration reaches will be conducted once a year for five to seven years following the completion of construction to evaluate the effectiveness of the restoration practices. Monitored stream parameters include stream dimension (cross sections), pattern (planimetric survey), profile (longitudinal profile survey), and visual observation with photographic documentation. The success criteria for the proposed Enhancement Level II reaches/sections will follow the methods described under Photo Reference Stations and Vegetation Monitoring. The methods used and related success criteria are described below for each parameter. Figure 9.1 shows approximate locations of the proposed monitoring devices throughout the project site.

9.1.1 Bankfull Events and Flooding Functions

The occurrence of bankfull events within the monitoring period will be documented by the use of pressure transducers and photographs. Three pressure transducers gauges will be installed on the floodplain within five to ten feet (horizontal) of the restored channel. Installing the instrument on the floodplain reduces the risk of it being washed away by stormflow. The instruments will record water depth and flow duration. Photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits.

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

9.1.2 Cross Sections

Permanent cross sections will be installed at an approximate rate of one cross section per twenty bankfull widths or an average distance interval (not to exceed 500 LF) of restored stream, with approximately twelve (12) cross sections located at riffles, and five (5) located at pools. Each cross section will be marked on both streambanks with permanent monuments using rebar cemented in place to establish the exact transect used. A common benchmark will be used for cross sections and to facilitate easy comparison of year-to-year data. The cross-section surveys will occur in years one, two, three, five, and seven, and must include measurements of Bank Height Ratio (BHR) and Entrenchment Ratio (ER). The monitoring survey will include points measured at all breaks in slope, including top of streambanks, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross sections will be classified using the Rosgen Stream Classification System.

There should be little change in as-built cross sections. If changes do take place, they will be documented in the survey data and evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the streambanks, or decrease in width/depth ratio). Using the Rosgen Stream Classification System, all monitored cross sections should fall within the quantitative parameters (i.e. BHR no more than 1.2 and ER no less than 2.2 for ‘C’ stream types) defined for channels of the design stream type. Given the smaller channel sizes and meander geometry of the proposed steams, bank pins will not be installed unless monitoring results indicate active lateral erosion.

Reference photo transects will be taken at each permanent cross section. Lateral photos should not indicate excessive erosion or continuing degradation of the streambanks. Photographs will be taken of both streambanks at each cross section. The survey tape will be centered in the photographs of the streambanks. The water line will be located in the lower edge of the frame, and as much of the streambank as possible will be included in each photo. Photographers shall make an effort to consistently maintain the same area in each photo over time.

9.1.3 Pattern

The plan view measurements such as sinuosity, radius of curvature, meander width ratio will be taken on newly constructed meanders during baseline (year-0) only. Subsequent visual monitoring will be conducted twice a year, at least five months apart, to document any changes or excessive lateral movement in the plan view of the restored channel.

9.1.4 Longitudinal Profile

A longitudinal profile will be surveyed for the entire length of restored channel immediately after construction to document as-built baseline conditions for the first year of monitoring only. The survey will be tied to a permanent benchmark and measurements will include thalweg, water surface, bankfull, and top of low bank. Each of these measurements will be taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. The longitudinal profile should show that the bedform features

installed are consistent with intended design stream type. The longitudinal profiles will not be taken during subsequent monitoring years unless vertical channel instability has been documented or remedial actions/repairs are deemed necessary.

9.1.5 Bed Material Analyses

After construction, there should be minimal change in the bulk sample data over time given the current watershed conditions and sediment supply regime. Significant changes in particle sizes or size distribution in otherwise stable riffles and pools could warrant additional sediment transport analyses and calculations. A substrate sample will be collected where certain constructed riffles are installed as part of the project. One constructed riffle substrate sample will be compared to existing riffle substrate data collected during the design phase and any significant changes (i.e.; aggradation, degradation) will be noted after streambank vegetation becomes established and a minimum of two bankfull flows or greater have been documented.

9.1.6 Visual Assessment

Visual monitoring assessments of all stream sections will be conducted by qualified personnel twice per monitoring year with at least five months in between each site visit. Photographs will be used to visually document system performance and any areas of concern related to streambank stability, condition of in-stream structures, channel migration, headcuts, live stake mortality, impacts from invasive plant species or animal species, and condition of pools and riffles. The photo locations and descriptions will be shown on a plan view map per NCEEP's monitoring report guidance (v1.5, June 2012).

The photographs will be taken from a height of approximately five to six feet to ensure that the same locations (and view directions) at the site are documented in each monitoring period. A series of photos over time will be also be used to subjectively evaluate channel aggradation (bar formations) or degradation, streambank erosion, successful maturation of riparian vegetation, and effectiveness of sedimentation and erosion control measures.

9.2 Vegetation Monitoring

Successful restoration of the vegetation on a site is dependent upon hydrologic restoration, planting of preferred canopy species, and volunteer regeneration of the native plant community. In order to determine if the criteria are achieved, vegetation-monitoring quadrants will be installed and monitored across the restoration site in accordance with the CVS-NCEEP Protocol for Recording Vegetation, Version 4.1 (Lee at al., 2007). The vegetation monitoring plots shall be a minimum of 2% of the planted portion of the site with a minimum of five (5) plots established randomly within the planted riparian buffer areas per Monitoring Levels 1 and 2. No monitoring quadrants will be established within the undisturbed wooded areas of Reaches R4, R5, R6, and R7. The size of individual quadrants will be 100 square meters for woody tree species.

Vegetation monitoring will occur in the fall, prior to the loss of leaves. Individual quadrant data will be provided and will include species diameter, height, density, and coverage quantities. Relative values will be calculated, and importance values will be determined. Individual seedlings will be marked such that they can be found in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings.

At the end of the first full growing season (from baseline/year 0) or after 180 days between March 1st and November 30th, species composition, stem density, and survival will be evaluated. For each subsequent year, vegetation plots shall be monitored for seven years in years 1, 2, 3, 5 and 7 or until the final success criteria are achieved. The restored site will be evaluated between March and November. The interim measure of vegetative success for the site will require the survival of at least 320, 3-year old, planted trees per acre at the end of year three of the monitoring period. At year five, density must be no less than 260, 5-year old, planted trees per acre. The final vegetative success criteria will be the survival of 210, 7-year

old, planted trees per acre at the end of the seven-year monitoring period, which must average 10 feet in height. However, if the performance standard is met by year 5 and stem densities are greater than 260, 5-year old stems/acre, vegetation monitoring may be terminated with approval by the USACE and the NCIRT.

While measuring species density and height is the current accepted methodology for evaluating vegetation success on mitigation projects, species density and height alone may be inadequate for assessing plant community health. For this reason, the vegetation monitoring plan will incorporate the evaluation of additional plant community indices, native volunteer species, and the presence of invasive species vegetation to assess overall vegetative success.

Baker will provide required remedial action on a case-by-case basis, such as: replanting more wet/drought tolerant species vegetation, conducting beaver management/dam removal, and removing undesirable/ invasive species vegetation, and will continue to monitor vegetation performance until the corrective actions demonstrate that the site is trending towards or meeting the standard requirement. Existing mature woody vegetation will be visually monitored during annual site visits to document any mortality, due to construction activities or changes to the water table, that negatively impact existing forest cover or favorable buffer vegetation.

Additionally, herbaceous vegetation, primarily native species grasses, will be seeded/planted throughout the site. During and immediately following construction activities, all ground cover at the project site must be in compliance with the NC Erosion and Sedimentation Control Ordinance.

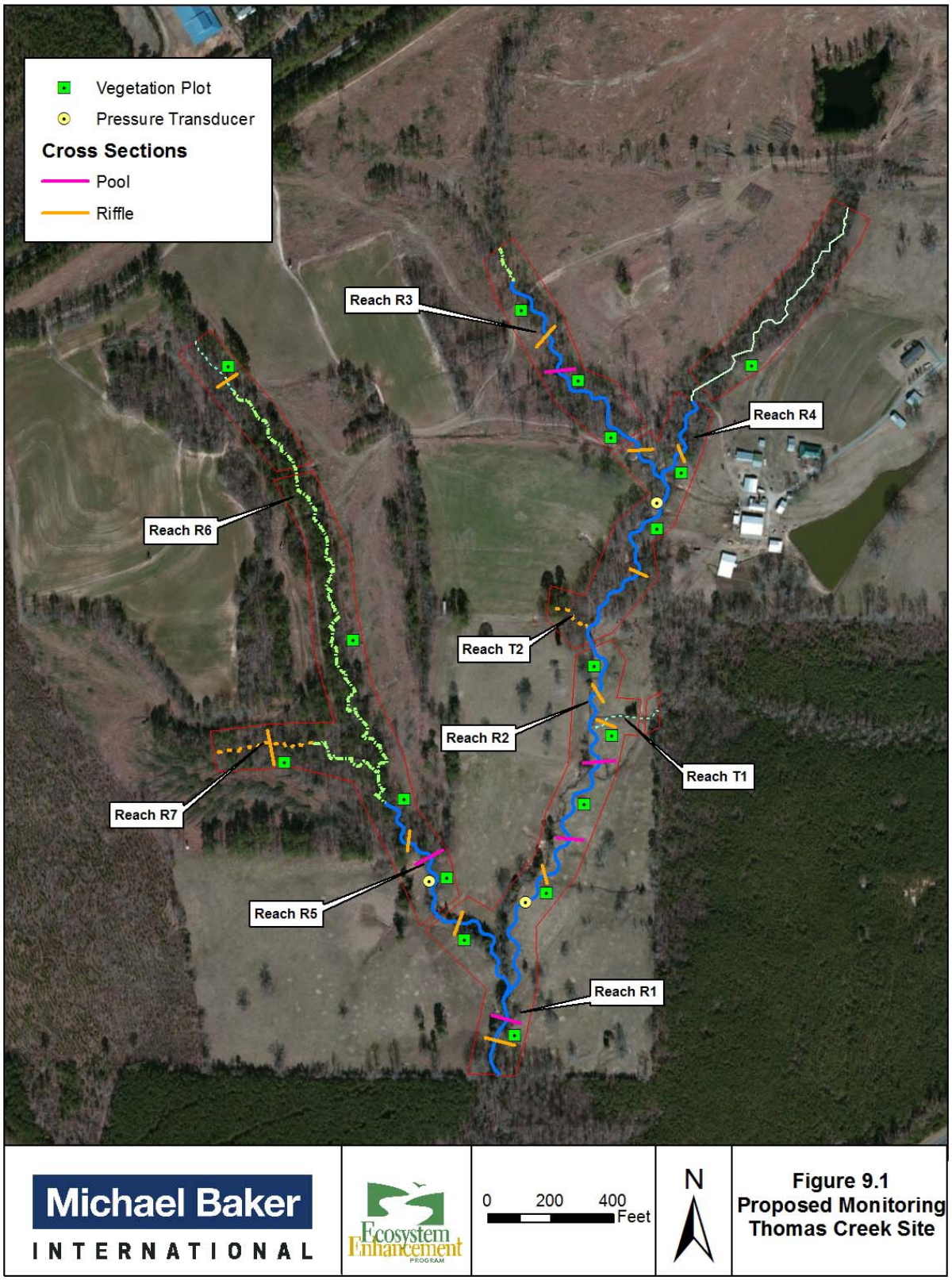
9.3 Wetland Monitoring

No wetlands are proposed at the site therefore no such monitoring will be included.

9.4 Stormwater Management Monitoring

No stormwater BMPs are proposed at the site therefore no such monitoring will be included.

Figure 9.1 Proposed Monitoring Device Locations



10.0 MONITORING REQUIREMENTS

Annual monitoring reports containing the information defined within Table 10.1 below will be submitted to NCEEP by December 31st of the each year during which the monitoring was conducted. The monitoring report shall provide a project data chronology for NCEEP to document the project status and trends, population of NCEEP databases for analysis, research purposes, and assist in decision making regarding project close-out. Project success criteria must be met by the final monitoring year prior to project closeout, or monitoring will continue until unmet criteria are successfully met.

Table 10.1 Monitoring Requirements
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Required	Parameter	Quantity	Frequency	Notes
X	Pattern	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	As-built Year and as needed	Pattern data, including bank erosion pins/arrays in pool cross-sections, will be collected only if there are indications through profile and dimensional data that significant geomorphological adjustments occurred.
X	Dimension	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines and November 2011 NCEEP Monitoring Requirements	Monitoring Years 1, 2, 3, 5 and 7	Cross sections to be monitored over seven (7) years and shall include assessment of bank height ratio (BHR) and entrenchment ratio (ER).
X	Profile	As per November 2011 NCEEP Monitoring Requirements	As-built Year and as needed	For restoration or enhancement I components, 3,000 linear feet or less, the entire length will be surveyed. For mitigation segments in excess of this footage, 30% of the length or 3,000 feet will be surveyed, whichever is greater.
X	Substrate	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines and November 2011 NCEEP Monitoring Requirements	Monitoring Years 1, 2, 3, 5 and 7	A substrate sample will be collected if constructed riffles are installed as part of the project. One constructed riffle substrate sample will be compared to existing riffle substrate data collected during the design phase.
X	Surface Water Hydrology	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	Annually	A Crest Gauge and/or Pressure Transducer will be installed on site; the device will be inspected on a quarterly/semi-annual basis to document the occurrence of bankfull events on the project.
X	Vegetation	NCEEP-CVS Guidance	Monitoring Years 1, 2, 3, 5 and 7	Vegetation will be monitored using the Carolina Vegetation Survey (CVS) protocols.
X	Exotic and Nuisance Vegetation		Semi-Annually	Locations of exotic and nuisance vegetation will be visually assessed and mapped a minimum of 5 months apart.
X	Visual Assessment	As per November 2011 NCEEP Monitoring Requirements	Semi-Annually and as needed	Representative photographs will be taken to capture the state of the restored channel and vegetated buffer conditions. Stream photos will be preferably taken in the same location when the vegetation is minimal to document any areas of concern or to identify trends.
X	Project Boundary		Semi-Annually	Locations of fence damage, vegetation damage, boundary encroachments, etc. will be mapped

11.0 LONG-TERM MANAGEMENT PLAN

Upon approval for close-out by the Interagency Review Team (IRT) the site will be transferred to a third party for long term management as described in EEP's In Lieu Fee Instrument. This party shall be responsible for periodic inspection of the site to ensure that restrictions required in the conservation easement or the deed restriction documents (s) are upheld. Endowment funds required to uphold easement and deed restrictions shall be negotiated prior to site transfer to the responsible party.

12.0 ADAPTIVE MANAGEMENT PLAN

Upon completion of site construction, NCEEP 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, NCEEP 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 NCEEP 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 USACE-Wilmington District with a formal commitment to fund projects to satisfy mitigation requirements assumed by NCEEP. This commitment provides financial assurance for all mitigation projects implemented by the program.

14.0 OTHER INFORMATION

14.1 Definitions

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

(2) *Objectives.* A description of the resource type(s) and amount(s) that will be provided, the method of compensation (i.e., restoration, establishment, enhancement, and/or preservation), and the manner in which the resource functions of the compensatory mitigation project will address the needs of the watershed, ecoregion, physiographic province, or other geographic area of interest.

(3) *Site selection.* A description of the factors considered during the site selection process. This should include consideration of watershed needs, onsite alternatives where applicable, and the practicability of accomplishing ecologically self-sustaining aquatic resource restoration, establishment, enhancement, and/or preservation at the compensatory mitigation site. (See § 332.3(d).)

(4) *Site protection instrument.* A description of the legal arrangements and instrument, including site ownership, that will be used to ensure the long-term protection of the compensatory mitigation site (see § 332.7(a)).

(5) *Baseline information.* A description of the ecological characteristics of the proposed compensatory mitigation site and, in the case of an application for a DA permit, the impact site. This may include descriptions of historic and existing plant communities, historic and existing hydrology, soil conditions, a map showing the locations of the impact and mitigation site(s) or the geographic coordinates for those site(s), and other site characteristics appropriate to the type of resource proposed as compensation. The baseline information should also include a delineation of waters of the United States on the proposed compensatory mitigation site. A prospective permittee planning to secure credits from an approved mitigation bank or in-lieu fee program only needs to provide baseline information about the impact site, not the mitigation bank or in-lieu fee site.

(6) *Determination of credits.* A description of the number of credits to be provided, including a brief explanation of the rationale for this determination. (See § 332.3(f).)

(7) *Mitigation work plan.* Detailed written specifications and work descriptions for the compensatory mitigation project, including, but not limited to, the geographic boundaries of the project; construction methods, timing, and sequence; source(s) of water, including connections to existing waters and uplands; methods for establishing the desired plant community; plans to control invasive plant species; the proposed grading plan, including elevations and slopes of the substrate; soil management; and erosion control measures. For stream compensatory mitigation projects, the mitigation work plan may also include other relevant information, such as plan form geometry, channel form (e.g. typical channel cross-sections), watershed size, design discharge, and riparian area plantings.

(8) *Maintenance plan.* A description and schedule of maintenance requirements to ensure the continued viability of the resource once initial construction is completed.

(9) *Performance standards.* Ecologically-based standards that will be used to determine whether the compensatory mitigation project is achieving its objectives. (See § 332.5.)

(10) *Monitoring requirements.* A description of parameters to be monitored in order to determine if the compensatory mitigation project is on track to meet performance standards and if adaptive management is

needed. A schedule for monitoring and reporting on monitoring results to the district engineer must be included. (See § 332.6.)

(11) *Long-term management plan.* A description of how the compensatory mitigation project will be managed after performance standards have been achieved to ensure the long-term sustainability of the resource, including long-term financing mechanisms and the party responsible for long-term management. (See § 332.7(d).)

(12) *Adaptive management plan.* A management strategy to address unforeseen changes in site conditions or other components of the compensatory mitigation project, including the party or parties responsible for implementing adaptive management measures. The adaptive management plan will guide decisions for revising compensatory mitigation plans and implementing measures to address both foreseeable and unforeseen circumstances that adversely affect compensatory mitigation success. (See § 332.7(c).)

(13) *Financial assurances.* A description of financial assurances that will be provided and how they are sufficient to ensure a high level of confidence that the compensatory mitigation project will be successfully completed, in accordance with its performance standards (see § 332.3(n)). 2) *Objectives.* A description of the resource type(s) and amount(s) that will be provided, the method of compensation (i.e., restoration, establishment, enhancement, and/or preservation), and the manner in which the resource functions of the compensatory mitigation project will address the needs of the watershed, ecoregion, physiographic province, or other geographic area of interest.

14.2 References

33 CFR 328.3, (b), (c)

40 CFR 230.3, (t)

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15.0 APPENDIX A - SITE PROTECTION INSTRUMENT

OWNER(S) CERTIFICATE

PIN: 0619268591
PIN: 0619368876

WE, IRVIN WOODROW GOODWIN AND SPOUSE, MARY FRANCES GOODWIN HEREBY CERTIFY THAT WE ARE THE OWNERS OF THE PROPERTIES SHOWN AND DESCRIBED HEREON, WHICH WERE CONVEYED TO US BY DEEDS RECORDED IN DEED BOOK 2653, PAGE 235 AND DEED BOOK 2653 PAGE 233 (PIN: 0619268591), AND LIFE ESTATE IN THE PROPERTY DESCRIBED IN DEED BOOK 8959, PAGE 108 (PIN: 0619368876), OF THE WAKE COUNTY REGISTRY; AND THAT WE HEREBY ADOPT THIS PLAN OF SUBDIVISION AND GRANT AND CONVEY THE EASEMENTS HEREIN WITH FREE CONSENT. FURTHER, I HEREBY CERTIFY THAT THE LAND AS SHOWN HEREON IS WITHIN THE SUBDIVISION REGULATION JURISDICTIONS OF WAKE COUNTY, NORTH CAROLINA.

Irvin Woodrow Goodwin 1-16 2015
IRVIN WOODROW GOODWIN DATE

Mary Frances Goodwin 1-16-2015
MARY FRANCES GOODWIN DATE

STATE OF NORTH CAROLINA
COUNTY OF WAKE

I, Robert H. Merritt, Jr. A NOTARY PUBLIC FOR THE COUNTY AND STATE AFORESAID, DO HEREBY CERTIFY THAT IRVIN WOODROW GOODWIN AND WIFE, MARY FRANCES GOODWIN PERSONALLY APPEARED BEFORE ME THIS DAY AND ACKNOWLEDGED THE DUE EXECUTION OF THE FOREGOING INSTRUMENT.

WITNESS MY HAND AND OFFICIAL STAMP OR SEAL THIS 16th DAY OF JANUARY 2015.

Robert H. Merritt Jr
NOTARY PUBLIC

MY COMMISSION EXPIRES: 5-1-2017

ROBERT H. MERRITT, JR. NOTARY PUBLIC WAKE COUNTY, NC

NOTES

1. THE PURPOSE OF THIS PLAT IS TO IDENTIFY THE LOCATION OF CONSERVATION EASEMENTS DEPICTED AS CE-1, CE-2, CE-3, CE-4, CE-5, CE-6, CE-7, CE-8, CE-9, CE-10 AND CE-11 AS SHOWN HEREIN.

2. BOUNDARY INFORMATION IS DERIVED FROM FIELD SURVEY, DEEDS, PLATS, GIS DATA, AND TAX RECORDS OF THE WAKE COUNTY REGISTRY AS SHOWN HEREON. SURVEYED BOUNDARY LINES ARE SHOWN AS SOLID LINES.

APPROXIMATELY 2900' OF PROPERTY BOUNDARY WAS FIELD LOCATED FOR VERIFICATION OF THE COMMON SOUTHERLY AND EASTERLY LINE OF PIN: 0619268591 (IRVING GOOWIN), AND THE NORTHERLY AND WESTERLY LINE OF PIN: 0619147086 (DUKE ENERGY PROGRESS INC.) IN THE PROXIMITY OF THE EASTERLY EXTENT OF CE-4 AND THE SOUTHERLY EXTENT OF CE-3. APPROXIMATELY 850' OF STREAM CENTERLINE WAS FIELD LOCATED FOR VERIFICATION OF THE COMMON EASTERLY LINE OF PIN: 0619268591 (IRVING GOODWIN), AND THE WESTERLY LINE OF PIN: 0619268591 (MICHAEL L. GOODWIN) IN THE PROXIMITY OF THE EASTERLY EXTENT OF CE-8 AND THE WESTERLY EXTENT OF CE-9.

3. NORTH CAROLINA GRID COORDINATES FOR GPS DERIVED CONTROL POINTS WERE ESTABLISHED BY MICHAEL BAKER ENGINEERING, INC. (COMBINED FACTOR=0.99988976)

4. ALL DISTANCES ARE GRID DISTANCE UNLESS OTHERWISE NOTED.

5. THE BEARING BASIS FOR THIS PLAT IS NAD 83 (2011) NC GRID.

6. ALL AREAS SHOWN WERE CALCULATED BY COORDINATE COMPUTATION.

7. ALL CONSERVATION EASEMENT POINTS ARE MONUMENTED WITH REBAR AND CAP WITH NC STATE SEAL, AND NUMBERED TO COORDINATE WITH SURVEY.

8. THE RIGHT(S) OF NON-EXCLUSIVE INGRESS, EGRESS, AND REGRESS OVER AND ALONG ANY AND ALL EXISTING PATHS/ROADS TRANSECTING SUBJECT PROPERTY, AS SHOWN ON SHEET 2 OF 2 OF THIS PLAT, ARE RESERVED BY THE GRANTOR(S) AND THE GRANTEE(S) OF THE CONSERVATION EASEMENTS FOR USES AND PURPOSES NOT INCONSISTENT WITH THE USES OF THE CONSERVATION EASEMENTS DESCRIBED HEREON.

THE LOCATION OF THE EXISTING FARM ROADS FOR NON-EXCLUSIVE ACCESS SHOWN ON SHEET 2 OF 2 OF THIS PLAT WERE DERIVED FROM GIS BASED AERIAL PHOTOGRAPHY AND VERIFIED BY FIELD SURVEY.

A FLOOD STUDY MAY BE REQUIRED BY THE WAKE COUNTY FLOODPLAIN MANAGER IN THE FUTURE IN ORDER TO INSTALL PIPES AND BRIDGES AT STREAM CROSSING. PROPOSED FENCE COINCIDES WITH EASEMENT AT STREAM CROSSING. THE CURRENT ZONING IS R-30.

9. MICHAEL L. GOODWIN EXECUTES THIS PLAT UNDER THE AUTHORITY AND PROVISIONS OF A SEPARATION AND PROPERTY SETTLEMENT AGREEMENT, A MEMORANDUM OF WHICH IS RECORDED AT BOOK 015886, PAGE 01958-01961, WAKE COUNTY REGISTRY.

OWNER(S) CERTIFICATE

PIN: 0619473680
PIN: 0619368876

MICHAEL L. GOODWIN CERTIFIES THAT HE IS THE OWNER OF THE PROPERTIES SHOWN AND DESCRIBED HEREON, WHICH WERE CONVEYED TO HIM BY DEED RECORDED IN DEED BOOK 8959, PAGE 105 OF THE WAKE COUNTY REGISTRY WHICH INCLUDED THE PROPERTY DESCRIBED UNDER PIN: 0619473680 AND PIN: 0619368876; AND THAT HE EXECUTES THIS DOCUMENT UNDER AUTHORITY OF NCGS 39-13.4 (SEE NOTE 9, BELOW) AND HEREBY ADOPTS THIS PLAN OF SUBDIVISION AND GRANTS AND CONVEYS THE EASEMENTS HEREIN WITH FREE CONSENT. FURTHER, I HEREBY CERTIFY THAT THE LAND AS SHOWN HEREON IS WITHIN THE SUBDIVISION REGULATION JURISDICTIONS OF WAKE COUNTY, NORTH CAROLINA.

1-16 2015
MICHAEL L. GOODWIN DATE

STATE OF NORTH CAROLINA
COUNTY OF WAKE

I, Robert H. Merritt, Jr. A NOTARY PUBLIC FOR THE COUNTY AND STATE AFORESAID, DO HEREBY CERTIFY THAT MICHAEL L. GOODWIN PERSONALLY APPEARED BEFORE ME THIS DAY AND ACKNOWLEDGED THE DUE EXECUTION OF THE FOREGOING INSTRUMENT.

WITNESS MY HAND AND OFFICIAL STAMP OR SEAL THIS 16th DAY OF JANUARY 2015.

Robert H. Merritt, Jr.
NOTARY PUBLIC

MY COMMISSION EXPIRES: 5-1-2017

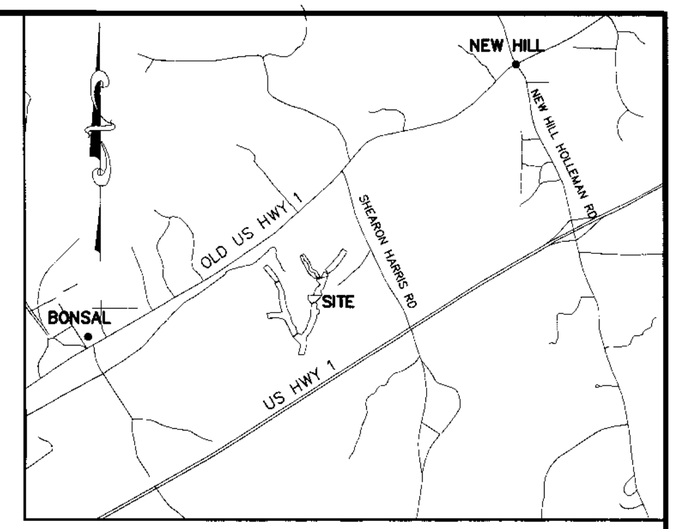
ROBERT H. MERRITT, JR. NOTARY PUBLIC WAKE COUNTY, NC

CONSERVATION EASEMENT AREA SUMMARY

CE-1 PIN: 0619268591	1.51 Acres	(IRVIN WOODROW GOODWIN)
CE-2 PIN: 0619268591	6.52 Acres	(IRVIN WOODROW GOODWIN)
CE-3 PIN: 0619268591	6.01 Acres	(IRVIN WOODROW GOODWIN)
CE-4 PIN: 0619268591	0.10 Acres	(IRVIN WOODROW GOODWIN)
CE-5 PIN: 0619268591	1.12 Acres	(IRVIN WOODROW GOODWIN)
CE-6 PIN: 0619368876	1.98 Acres	(MICHAEL GOODWIN & IRVIN)
CE-7 PIN: 0619268591	0.01 Acres	(IRVIN WOODROW GOODWIN)
CE-8 PIN: 0619268591	1.31 Acres	(IRVIN WOODROW GOODWIN)
CE-9 PIN: 0619473680	1.26 Acres	(MICHAEL L. GOODWIN)
CE-10 PIN: 0619473680	0.41 Acres	(MICHAEL L. GOODWIN)
CE-11 PIN: 0619473680	2.50 Acres	(MICHAEL L. GOODWIN)

PIN: 0619268591(IRVIN WOODROW GOODWIN): 16.58 Acres
PIN: 0619368876(MICHAEL GOODWIN & IRVIN): 1.98 Acres
PIN: 0619473680(MICHAEL L. GOODWIN): 4.17 Acres
TOTAL ACRES: 22.73 Acres

WAKE COUNTY, NC 183
LAURA M RIDDICK
REGISTER OF DEEDS
PRESENTED & RECORDED ON
01/16/2015 14:51:03
BOOK: BM2015 PAGE: 00121



VICINITY MAP

NTS

REFERENCES

WAKE COUNTY REGISTRY

PB 2001, PG 857
DB 2653, PG 235
DB 2653, PG 233
DB 8959, PG 105
DB 8959, PG 108
DB 15289, PG 2437
DB 14278, PG 344

WAKE COUNTY CERTIFICATION

I, Stacy Harper, PLANNING DIRECTOR AND REVIEW OFFICER OF WAKE COUNTY, CERTIFY THAT THIS PLAT DOES NOT CONSTITUTE A SUBDIVISION AND THAT IT MEETS ALL STATUTORY REQUIREMENTS FOR RECORDING. BECAUSE OF ITS "EXEMPT" STATUS, THE COUNTY HAS NOT REVIEWED THIS PLAT FOR COMPLIANCE WITH APPLICABLE LOT STANDARDS AND OTHER SUBDIVISION REGULATIONS (e.g., road standards). PROSPECTIVE PURCHASERS SHOULD BE AWARE THAT PLANS FOR BUILDING AND DEVELOPMENT MAY BE DENIED FOR LOTS THAT DO NOT MEET APPLICABLE COUNTY STANDARDS.
Approval Expires if Not Recorded Before 1-30-15.

1-16-15 Stacy Harper
DATE PLANNING DIRECTOR/REVIEW OFFICER

SURVEYOR'S CERTIFICATION

I, MARSHALL WIGHT, DO HEREBY CERTIFY THAT THIS SURVEY IS OF ANOTHER CATEGORY AND IS AN EXCEPTION TO THE DEFINITION OF SUBDIVISION.

Marshall Wight
MARSHALL WIGHT, PLS L-5034

I, MARSHALL WIGHT, CERTIFY THAT THIS PLAT WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION USING REFERENCES SHOWN HEREON; THAT THE BOUNDARIES NOT SURVEYED ARE SHOWN AS BROKEN LINES PLOTTED FROM INFORMATION SHOWN HEREON; THAT THE RATIO OF PRECISION AS CALCULATED IS 1:10,000+; THAT THIS PLAT WAS PREPARED IN ACCORDANCE WITH G.S. 47-30 AS AMENDED. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 15th DAY OF January, 2015.

Marshall Wight
MARSHALL WIGHT, PLS L-5034

I, MARSHALL WIGHT CERTIFY THAT THIS PLAT WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL GPS (OR GNSS) SURVEY MADE UNDER MY SUPERVISION AND THE FLOLLOWING INFORMATION WAS USED TO PERFORM THE SURVEY.

CLASS OF SURVEY: CLASS C
POSITIONAL ACCURACY: .15' (NETWORK RTK)
TYPE OF GPS (GNSS) FIELD PROCEDURE: VRS
DATE(S) OF SURVEY: 03/17/14
DATUM/EPOCH: NAD 83 (2011)
PUBLISHED FIXED CONTROL: N/A-VRS
GEOID MODEL: GEOID 12A
COMBINED GRID FACTOR: 0.99988976
UNITS: US FEET
HORIZONTAL POSITIONS ARE REFERENCED TO NAD83\NSRS (2011)
VERTICAL POSITIONS ARE REFERENCED TO NAVD88 USING (GEIOD12A)

NORTH CAROLINA PROFESSIONAL SEAL L-5034 LAND SURVEYOR MARSHALL G. WIGHT

EEP PROJECT NAME: 'THOMAS CREEK' Drawing No. ThomasCreek_96074_CE_Baker_Final.dwg

Michael Baker INTERNATIONAL
8000 Regency Parkway, Suite 600
Cary, NORTH CAROLINA 27518
Phone: 919.463.5488
Fax: 919.463.5490
License #: F-1084

THOMAS CREEK CONSERVATION EASEMENT SURVEY

FOR

STATE OF NORTH CAROLINA – ECOSYSTEM ENHANCEMENT PROGRAM

ON THE PROPERTY OF

IRVIN WOODROW GOODWIN & MARY FRANCES GOODWIN AND MICHAEL L. GOODWIN

BUCKHORN TOWNSHIP WAKE COUNTY NORTH CAROLINA

SPO FILE No. 92-DV, 92-DY, 92-DZ
EEP Project No.: 96074
BE Project No.: 135794
Date: September 27, 2014
Scale: 1"=200'
S-100-15

WAKE COUNTY, NC 184
LAURA M RIDDICK
REGISTER OF DEEDS
PRESENTED & RECORDED ON
01/16/2015 14:51:03
BOOK:BM2015 PAGE:00122

EASEMENT CORNERS

Point	Northing	Easting
1	697362.95	2012468.87
2	697440.47	2012576.84
3	697196.22	2012789.07
4	697017.65	2012898.72
5	696991.75	2012786.11
6	696963.69	2012775.69
7	696993.29	2012904.33
8	696735.68	2013022.59
9	696542.84	2013041.95
10	696314.14	2013091.02
11	696102.03	2013186.65
12	695918.15	2013232.19
13	695782.87	2013334.15
14	695639.47	2013368.68
15	695545.18	2013247.21
16	695733.13	2013161.15
17	696002.71	2013026.02
18	696050.15	2012845.86
19	696036.22	2012594.44
20	696163.80	2012576.23
21	696186.52	2012773.83
22	696192.18	2012970.95
23	696416.67	2012905.43
24	696768.64	2012879.96
25	695529.76	2013259.96
26	695637.37	2013398.60
27	695593.64	2013472.44
28	695779.16	2013616.29
29	695901.31	2013642.88
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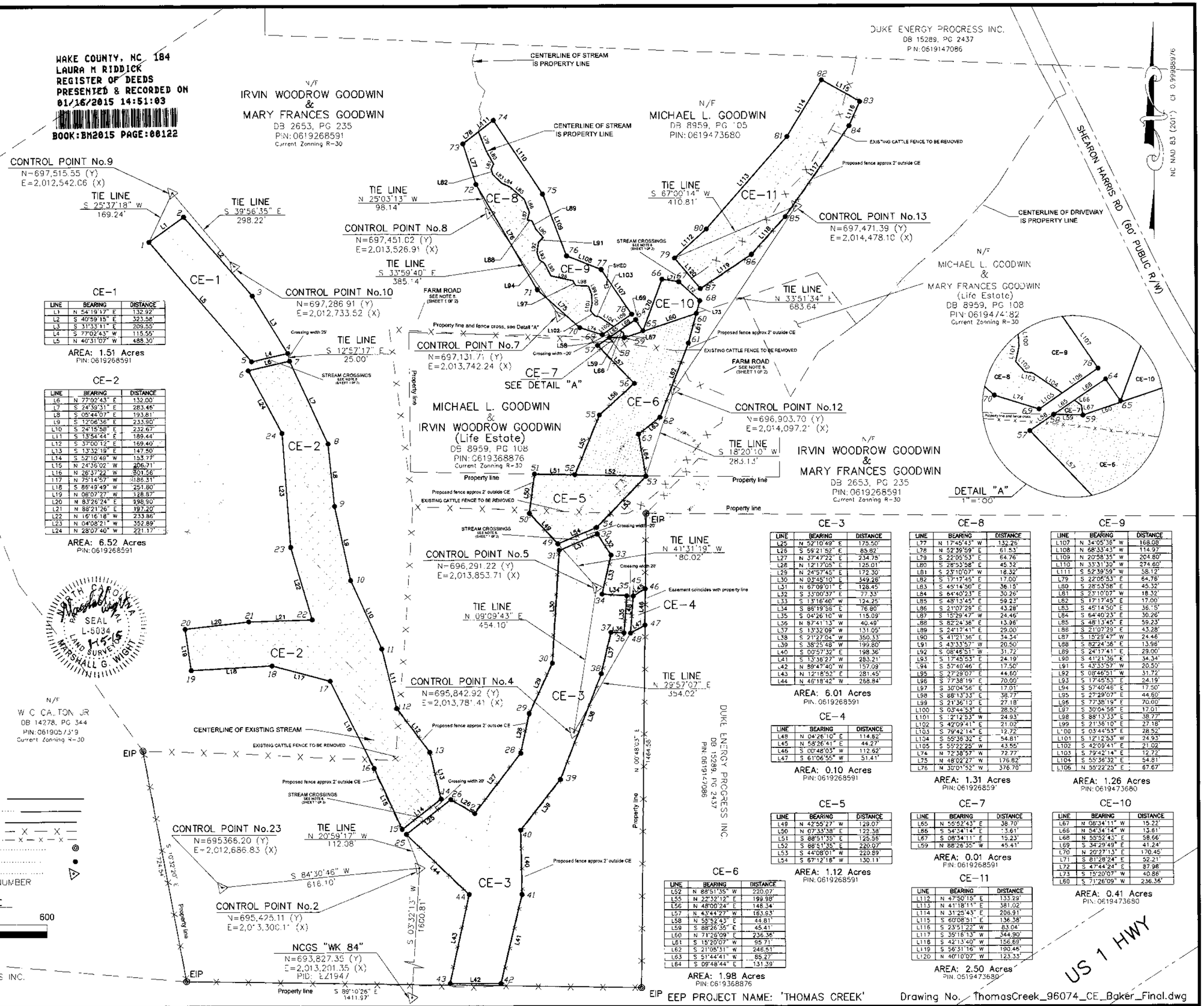

CE-1

LINE	BEARING	DISTANCE
L1	N 54°19'17" E	132.92'
L2	S 40°59'15" E	323.58'
L3	S 31°33'11" E	209.55'
L4	S 77°02'43" W	115.55'
L5	N 40°31'07" W	488.30'

AREA: 1.51 Acres
PIN: 0619268591

CE-2

LINE	BEARING	DISTANCE
L6	N 77°02'43" E	132.00'
L7	S 24°39'31" E	283.46'
L8	S 05°44'07" E	193.81'
L9	S 12°06'56" E	233.90'
L10	S 24°15'58" E	232.67'
L11	S 13°54'44" E	189.44'
L12	S 37°00'12" E	169.40'
L13	S 13°32'19" E	147.50'
L14	S 52°10'49" W	153.77'
L15	N 24°36'02" W	206.71'
L16	N 26°37'22" W	301.56'
L17	N 75°14'57" W	186.31'
L18	S 86°49'49" W	251.80'
L19	N 06°07'27" W	128.87'
L20	N 83°26'24" E	198.90'
L21	N 88°21'26" E	197.20'
L22	N 16°16'18" W	233.86'
L23	N 04°08'21" W	352.89'
L24	N 28°07'40" W	221.17'

AREA: 6.52 Acres
PIN: 0619268591

CE-3

LINE	BEARING	DISTANCE
L25	N 52°10'49" E	175.50'
L26	S 59°21'52" E	85.82'
L27	N 37°47'22" E	234.75'
L28	N 12°17'05" E	125.01'
L29	N 24°57'45" E	172.30'
L30	N 03°45'10" E	349.26'
L31	N 67°09'01" E	128.45'
L32	S 33°00'37" E	77.33'
L33	S 13°16'40" W	124.25'
L34	S 86°19'56" E	76.80'
L35	S 04°26'10" W	115.09'
L36	N 87°41'13" W	40.49'
L37	S 13°32'09" W	131.05'
L38	S 21°27'04" W	350.33'
L39	S 38°25'48" W	199.80'
L40	S 00°57'32" E	198.36'
L41	S 13°36'27" W	283.21'
L42	N 89°47'40" W	157.09'
L43	N 12°18'52" E	281.45'
L44	N 46°18'42" W	268.84'

AREA: 6.01 Acres
PIN: 0619268591

CE-4

LINE	BEARING	DISTANCE
L48	N 04°26'10" E	114.82'
L45	N 58°26'41" E	44.27'
L46	S 00°48'03" W	112.62'
L47	S 61°06'55" W	51.41'

AREA: 0.10 Acres
PIN: 0619268591

CE-5

LINE	BEARING	DISTANCE
L49	N 42°55'27" W	129.07'
L50	N 07°33'38" E	122.38'
L51	S 88°51'35" E	125.56'
L52	S 88°51'35" E	220.07'
L53	S 44°08'01" W	220.89'
L54	S 67°12'18" W	130.11'

AREA: 1.12 Acres
PIN: 0619268591

CE-6

LINE	BEARING	DISTANCE
L52	N 88°51'35" W	220.07'
L55	N 22°32'12" E	199.98'
L56	N 48°00'24" E	146.34'
L57	N 43°44'27" W	163.93'
L58	N 55°52'43" E	44.81'
L59	S 88°26'35" E	45.41'
L60	N 71°26'09" E	236.36'
L61	S 15°20'07" W	95.71'
L62	S 21°05'31" W	246.51'
L63	S 51°44'41" W	85.27'
L64	S 09°48'44" E	131.39'

AREA: 1.98 Acres
PIN: 0619368876

CE-8

LINE	BEARING	DISTANCE
L77	N 17°45'43" W	132.26'
L78	N 52°39'59" E	61.53'
L79	S 22°05'53" E	64.76'
L80	S 28°53'58" E	45.32'
L81	S 23°10'07" W	18.32'
L82	S 17°17'45" E	17.00'
L83	S 45°14'50" E	36.15'
L84	S 64°40'23" E	30.26'
L85	S 48°13'45" E	59.23'
L86	S 21°07'29" E	43.28'
L87	S 15°29'47" W	24.46'
L88	S 82°24'36" E	13.96'
L89	S 24°17'41" E	29.00'
L90	S 41°21'36" E	34.34'
L91	S 43°33'57" W	20.50'
L92	S 08°46'51" W	31.72'
L93	S 17°45'53" E	24.19'
L94	S 57°40'46" E	17.50'
L95	S 27°29'07" E	44.60'
L96	S 77°38'19" E	70.00'
L97	S 30°04'56" E	17.01'
L98	S 88°13'33" E	38.77'
L99	S 21°36'10" E	27.18'
L100	S 03°44'53" E	28.52'
L101	S 12°12'53" W	24.93'
L102	S 42°09'41" E	21.02'
L103	S 79°42'14" E	12.72'
L104	S 55°36'32" E	54.81'
L105	S 55°22'25" W	43.55'
L74	N 72°38'57" W	72.77'
L75	N 48°02'27" W	176.82'
L76	N 30°01'52" W	376.70'

AREA: 1.31 Acres
PIN: 0619268859

CE-7

LINE	BEARING	DISTANCE
L65	N 55°52'43" E	38.70'
L66	S 54°34'14" E	13.61'
L67	S 08°34'11" E	15.23'
L59	N 88°26'35" W	45.41'

AREA: 0.01 Acres
PIN: 0619268591

CE-11

LINE	BEARING	DISTANCE
L112	N 47°50'15" E	133.29'
L113	N 41°18'11" E	381.02'
L114	N 31°25'43" E	206.91'
L115	S 60°08'51" E	136.38'
L116	S 23°51'22" W	83.04'
L117	S 35°16'13" W	344.90'
L118	S 42°13'40" W	156.69'
L119	S 56°31'16" W	190.46'
L120	N 40°10'07" W	123.33'

AREA: 2.50 Acres
PIN: 0619473680

CE-9

LINE	BEARING	DISTANCE
L107	N 34°05'36" W	168.08'
L108	N 68°33'43" W	114.97'
L109	N 20°58'35" W	204.80'
L110	N 33°31'30" W	274.60'
L111	S 52°39'59" W	58.12'
L79	S 22°05'53" E	64.76'
L80	S 28°53'58" E	45.32'
L81	S 23°10'07" W	18.32'
L82	S 17°17'45" E	17.00'
L83	S 45°14'50" E	36.15'
L84	S 64°40'23" E	30.26'
L85	S 48°13'45" E	59.23'
L86	S 21°07'29" E	43.28'
L87	S 15°29'47" W	24.46'
L88	S 82°24'36" E	13.96'
L89	S 24°17'41" E	29.00'
L90	S 41°21'36" E	34.34'
L91	S 43°33'57" W	20.50'
L92	S 08°46'51" W	31.72'
L93	S 17°45'53" E	24.19'
L94	S 57°40'46" E	17.50'
L95	S 27°29'07" E	44.60'
L96	S 77°38'19" E	70.00'
L97	S 30°04'56" E	17.01'
L98	S 88°13'33" E	38.77'
L99	S 21°36'10" E	27.18'
L100	S 03°44'53" E	28.52'
L101	S 12°12'53" W	24.93'
L102	S 42°09'41" E	21.02'
L103	S 79°42'14" E	12.72'
L104	S 55°36'32" E	54.81'
L106	N 55°22'25" E	67.67'

AREA: 1.26 Acres
PIN: 0619473680

CE-10

LINE	BEARING	DISTANCE
L67	N 08°34'11" W	15.22'
L66	N 54°34'14" W	13.61'
L68	N 55°52'43" E	58.66'
L69	S 34°29'49" E	41.24'
L70	N 20°27'13" E	170.45'
L71	S 81°28'24" E	92.21'
L72	S 47°44'24" E	87.98'
L73	S 15°20'07" W	40.88'
L60	S 71°26'09" W	236.36'

AREA: 0.41 Acres
PIN: 0619473680

LEGEND

PROPERTY LINE SURVEYED
PROPERTY LINE(R/W) NOT SURVEYED
CONSERVATION EASEMENT
EXISTING FENCE — X — X —
PROPOSED FENCE — x — x — x —
EXISTING IRON PIPE/ROD(E.P)
EASEMENT MONUMENT SET
CONTROL POINT SET
PIN ..... PARCEL IDENTIFICATION NUMBER

GRAPHIC SCALE
0 200 400 600
1"=200'
(US ft.)

DUKE ENERGY PROGRESS INC.
DB 15289, PG 2437
PIN: 0619147086

Michael Baker INTERNATIONAL
8000 Regency Parkway, Suite 600
Cary, NORTH CAROLINA 27518
Phone: 919.463.5488
Fax: 919.463.5490
License #: F-1084

THOMAS CREEK CONSERVATION EASEMENT SURVEY
FOR
STATE OF NORTH CAROLINA — ECOSYSTEM ENHANCEMENT PROGRAM
ON THE PROPERTY OF
IRVIN WOODROW GOODWIN & MARY FRANCES GOODWIN AND MICHAEL L. GOODWIN
BUCKHORN TOWNSHIP WAKE COUNTY NORTH CAROLINA

SPO FILE No. 92-DV, 92-DY, 92-DZ
EEP Project No.: 96074
BE Project No.: 135794
Date: September 27, 2014
Scale: 1"=200'
S-100-15

WAKE COUNTY, NC 185
LAURA M RIDDICK
REGISTER OF DEEDS
PRESENTED & RECORDED ON
01/16/2015 14:51:03
STATE OF NC REAL ESTATE
EXCISE TAX: $320.00
BOOK:015894 PAGE:02170 - 02186

Prepared by and return to:
Robert H. Merritt, Jr.
Bailey & Dixon, LLP
P. O. Box 1351
Raleigh, NC 27602

STATE OF NORTH CAROLINA

WAKE COUNTY

DEED OF CONSERVATION EASEMENT AND RIGHT OF ACCESS PROVIDED PURSUANT TO FULL DELIVERY MITIGATION CONTRACT NO.: 5549 CE-1, CE-2, CE-3, CE-4, CE-5, CE-7, and CE-8

Revenue $ 320.00

SPO File Number: 92-DV
EEP Project Number: 96074

THIS DEED OF CONSERVATION EASEMENT AND RIGHT OF ACCESS, made this 16th day of JANUARY, 2015, by IRVIN WOODROW GOODWIN and wife, MARY FRANCES GOODWIN (**"Grantor"**), whose mailing address is 4300 Shearon Harris Road, New Hill, NC 27562, to the State of North Carolina, (**"Grantee"**), whose mailing address is State of North Carolina, Department of Administration, State Property Office, 1321 Mail Service Center, Raleigh, NC 27699-1321. The designations of Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine, or neuter as required by context.

WITNESSETH:

WHEREAS, pursuant to the provisions of N.C. Gen. Stat. § 143-214.8 et seq., the State of North Carolina has established the Ecosystem Enhancement Program (formerly known as the Wetlands Restoration Program) within the Department of Environment and Natural Resources for the purposes of acquiring, maintaining, restoring, enhancing, creating and preserving wetland and riparian resources that contribute to the protection and improvement of water quality, flood prevention, fisheries, aquatic habitat, wildlife habitat, and recreational opportunities; and

WHEREAS, this Conservation Easement from Grantor to Grantee has been negotiated, arranged and provided for as a condition of a full delivery contract between Michael Baker Engineering, Inc. and the North Carolina Department of Environment and Natural Resources, to provide stream, wetland and/or buffer mitigation pursuant to the North Carolina Department of Environment and Natural Resources Purchase and Services Contract Number 5549.

WHEREAS, The State of North Carolina is qualified to be the Grantee of a Conservation Easement pursuant to N.C. Gen. Stat. § 121-35; and

WHEREAS, the Department of Environment and Natural Resources and the United States Army Corps of Engineers, Wilmington District entered into a Memorandum of Understanding, (MOU) duly executed by all parties on November 4, 1998. This MOU recognized that the Wetlands Restoration Program was to provide effective compensatory mitigation for authorized impacts to wetlands, streams and other aquatic resources by restoring, enhancing and preserving the wetland and riparian areas of the State; and

WHEREAS, the Department of Environment and Natural Resources, the North Carolina Department of Transportation and the United States Army Corps of Engineers, Wilmington District entered into a Memorandum of Agreement, (MOA) duly executed by all parties in Greensboro, NC on July 22, 2003, which recognizes that the Ecosystem Enhancement Program is to provide for compensatory mitigation by effective protection of the land, water and natural resources of the State by restoring, enhancing and preserving ecosystem functions; and

WHEREAS, the Department of Environment and Natural Resources, the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the North Carolina Wildlife Resources Commission, the North Carolina Division of Water Quality, the North Carolina Division of Coastal Management, and the National Marine Fisheries Service entered into an agreement to continue the In-Lieu Fee operations of the North Carolina Department of Natural Resources' Ecosystem Enhancement Program with an effective date of 28 July, 2010, which supersedes and replaces the previously effective MOA and MOU referenced above; and

WHEREAS, the acceptance of this instrument for and on behalf of the State of North Carolina was granted to the Department of Administration by resolution as approved by the Governor and Council of State adopted at a meeting held in the City of Raleigh, North Carolina, on the 8th day of February 2000; and

WHEREAS, the Ecosystem Enhancement Program in the Department of Environment and Natural Resources, which has been delegated the authority authorized by the Governor and Council of State to the Department of Administration, has approved acceptance of this instrument; and

WHEREAS, Grantor owns in fee simple certain real property situated, lying, and being in Buckhorn Township, Wake County, North Carolina (the "**Property**"), and being more particularly described as that certain parcel of land containing approximately 149.99 acres and being conveyed

to the Grantor by deeds recorded in **Deed Book 2653 at Page 235** and **Deed Book 2653 at Page 233** of the Wake County Registry, North Carolina; and

WHEREAS, Grantor is willing to grant a Conservation Easement and Right of Access over the herein described areas of the Property, thereby restricting and limiting the use of the areas of the Property subject to the Conservation Easement to the terms and conditions and purposes hereinafter set forth, and Grantee is willing to accept said Easement and Access Rights. The Conservation Easement shall be for the protection and benefit of the waters of Thomas Creek.

NOW, THEREFORE, in consideration of the mutual covenants, terms, conditions, and restrictions hereinafter set forth, Grantor unconditionally and irrevocably hereby grants and conveys unto Grantee, its successors and assigns, forever and in perpetuity, a Conservation Easement along with a general Right of Access, as follows:

The Easement Area consists of the following:

Tracts Number CE-1, CE-2, CE-3, CE-4, CE-5, CE-7 and CE-8 containing a total of 16.58 acres as shown on a Plat entitled "Thomas Creek Conservation Easement Survey for the State of North Carolina-Ecosystem Enhancement Program on the Property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin" dated September 27, 2014, certified by Marshall Wight, PLS Number L-5034 and recorded in Plat Book 2015, Page 121-122, Wake County Registry.

TOGETHER with an easement for access, ingress, egress and regress as described on the above-referenced recorded plat and this Conservation Easement Deed.

The Conservation Easements described above are hereinafter referred to as the "Easement Area" or the "Conservation Easement Area" and are further set forth in a metes and bounds description attached hereto as Exhibit A and incorporated herein by reference.

The purposes of this Conservation Easement are to maintain, restore, enhance, construct, create and preserve wetland and/or riparian resources in the Conservation Easement Area that contribute to the protection and improvement of water quality, flood prevention, fisheries, aquatic habitat, wildlife habitat, and recreational opportunities; to maintain permanently the Conservation Easement Area in its natural condition, consistent with these purposes; and to prevent any use of the Easement Area that will significantly impair or interfere with these purposes. To achieve these purposes, the following conditions and restrictions are set forth:

I. DURATION OF EASEMENT

Pursuant to law, including the above referenced statutes, this Conservation Easement and Right of Access shall be perpetual and it shall run with, and be a continuing restriction upon the use of, the Property, and it shall be enforceable by the Grantee against the Grantor and against Grantor's heirs, successors and assigns, personal representatives, agents, lessees, and licensees.

II. GRANTOR RESERVED USES AND RESTRICTED ACTIVITIES

The Conservation Easement Area shall be restricted from any development or usage that would impair or interfere with the purposes of this Conservation Easement. Unless expressly reserved as a compatible use herein, any activity in, or use of, the Conservation Easement Area by the Grantor is prohibited as inconsistent with the purposes of this Conservation Easement. Any rights not expressly reserved hereunder by the Grantor have been acquired by the Grantee. Any rights not expressly reserved hereunder by the Grantor, including the rights to all mitigation credits, including, but not limited to, stream, wetland, and riparian buffer mitigation units, derived from each site within the area of the Conservation Easement, are conveyed to and belong to the Grantee. Without limiting the generality of the foregoing, the following specific uses are prohibited, restricted, or reserved as indicated:

A. Recreational Uses. Grantor expressly reserves the right to undeveloped recreational uses, including hiking, bird watching, hunting and fishing, and access to the Conservation Easement Area for the purposes thereof.

B. Motorized Vehicle Use. Motorized vehicle use in the Conservation Easement Area is prohibited except within a Crossing Area(s) or Road or Trail as shown on the recorded survey plat **or as specifically allowed within a fence maintenance zone as described in section D or a Road or Trail described in section H.**

The Grantor reserves the right, for himself, his successors and assigns, to operate motorized vehicles within Crossing Area(s) described on the survey recorded in Plat Book _____, Page _____, of the _____County Registry as "reserved stream crossing". Said crossing shall not exceed ____ feet in width, and must be maintained and repaired by Grantor, his successors or assigns to prevent degradation of the Conservation Easement Area.

C. Educational Uses. The Grantor reserves the right to engage in and permit others to engage in educational uses in the Conservation Easement Area not inconsistent with this Conservation Easement, and the right of access to the Conservation Easement Area for such purposes including organized educational activities such as site visits and observations. Educational uses of the property shall not alter vegetation, hydrology or topography of the site.

D. Damage to Vegetation. Except within Crossing Area(s) as shown on the recorded survey plat and as related to the removal of non-native plants, diseased or damaged trees, or vegetation that destabilizes or renders unsafe the Conservation Easement Area to persons or natural habitat, all cutting, removal, mowing, harming, or destruction of any trees and vegetation in the Conservation Easement Area is prohibited with the following exception:

Notwithstanding the foregoing, if there is a fence within the Conservation Easement Area, the Grantor reserves the right to mow and maintain vegetation within 10 feet of the Conservation Easement boundary ***as shown on the Survey Plat*** and extending along the entire length of the fence. The Grantor, his successors or assigns shall be solely responsible for maintenance of the fence for as long as there is livestock on the Grantor's property adjacent to the Conservation Easement Area.

E. Industrial, Residential and Commercial Uses. All industrial, residential and commercial uses are prohibited in the Conservation Easement Area.

F. Agricultural Use. All agricultural uses are prohibited within the Conservation Easement Area including any use for cropland, waste lagoons, or pastureland.

G. New Construction. There shall be no building, facility, mobile home, antenna, utility pole, tower, or other structure constructed or placed in the Conservation Easement Area.

H. Roads and Trails. There shall be no construction or maintenance of roads, trails, walkways, or paving in the Conservation Easement Area with the following exception:

Only roads and trails located within the Conservation Easement Area prior to completion of the construction of the restoration project and within crossings shown on the recorded survey plat may be maintained by Grantor, successors or assigns to allow for access to the interior of the Property, and must be repaired and maintained to prevent runoff and degradation to the Conservation Easement Area. Such roads and trails shall be covered with pervious materials such as loose gravel or permanent vegetation in order to minimize runoff and prevent sedimentation.

I. Signs. No signs shall be permitted in the Conservation Easement Area except interpretive signs describing restoration activities and the conservation values of the Conservation Easement Area, signs identifying the owner of the Property and the holder of the Conservation Easement, signs giving directions, or signs prescribing rules and regulations for the use of the Conservation Easement Area.

J. Dumping or Storing. Dumping or storage of soil, trash, ashes, garbage, waste, abandoned vehicles, appliances, machinery, or any other material in the Conservation Easement Area is prohibited.

K. Grading, Mineral Use, Excavation, Dredging. There shall be no grading, filling, excavation, dredging, mining, drilling, hydraulic fracturing; removal of topsoil, sand, gravel, rock, peat, minerals, or other materials.

L. Water Quality and Drainage Patterns. There shall be no diking, draining, dredging, channeling, filling, leveling, pumping, impounding or diverting, causing, allowing or permitting the diversion of surface or underground water in the Conservation Easement Area. No altering or tampering with water control structures or devices, or disruption or alteration of the restored, enhanced, or created drainage patterns is allowed. All removal of wetlands, polluting or

discharging into waters, springs, seeps, or wetlands, or use of pesticide or biocides in the Conservation Easement Area is prohibited. In the event of an emergency interruption or shortage of all other water sources, water from within the Conservation Easement Area may temporarily be withdrawn for good cause shown as needed for the survival of livestock on the Property.

M. Subdivision and Conveyance. Grantor voluntarily agrees that no further subdivision, partitioning, or dividing of the Conservation Easement Area portion of the Property owned by the Grantor in fee simple ("fee") that is subject to this Conservation Easement is allowed. Any future transfer of the Property shall be subject to this Conservation Easement and Right of Access and to the Grantee's right of unlimited and repeated ingress and egress over and across the Property to the Conservation Easement Area for the purposes set forth herein.

N. Development Rights. All development rights are permanently removed from the Conservation Easement Area and are non-transferrable.

O. Disturbance of Natural Features. Any change, disturbance, alteration or impairment of the natural features of the Conservation Easement Area or any intentional introduction of non-native plants, trees and/or animal species by Grantor is prohibited.

The Grantor may request permission to vary from the above restrictions for good cause shown, provided that any such request is not inconsistent with the purposes of this Conservation Easement, and the Grantor obtains advance written approval from the N.C. Ecosystem Enhancement Program, whose mailing address is 1652 Mail Services Center, Raleigh, NC 27699-1652.

III. GRANTEE RESERVED USES

A. Right of Access, Construction, and Inspection. The Grantee, its employees and agents, successors and assigns, receive a perpetual Right of Access to the Conservation Easement Area over the Property at reasonable times to undertake any activities to restore, construct, manage, maintain, enhance, protect, and monitor the stream, wetland and any other riparian resources in the Conservation Easement Area, in accordance with restoration activities or a long-term management plan. Unless otherwise specifically set forth in this Conservation Easement, the rights granted herein do not include or establish for the public any access rights.

B. Restoration Activities. These activities include planting of trees, shrubs and herbaceous vegetation, installation of monitoring wells, utilization of heavy equipment to grade, fill, and prepare the soil, modification of the hydrology of the site, and installation of natural and manmade materials as needed to direct in-stream, above ground, and subterraneous water flow.

C. Signs. The Grantee, its employees and agents, successors or assigns, shall be permitted to place signs and witness posts on the Property to include any or all of the following: describe the project, prohibited activities within the Conservation Easement, or identify the project boundaries and the holder of the Conservation Easement.

D. Fences. The Grantee, its employees and agents, successors or assigns, shall be permitted to place fencing on the Property within the Conservation Easement Area to restrict livestock

access. Although the Grantee is not responsible for fence maintenance, the Grantee reserves the right to maintain, repair or replace the fence at the sole discretion of the Grantee and at the expense of the Grantor, who agrees to indemnify the Grantee for any costs incurred as a result of maintenance, repair or replacement of the fence if such costs are required to protect the Conservation Easement Area from repeated incidents of grazing or other prohibited activities.

E. **Crossing Area(s).** The Grantee is not responsible for maintenance of crossing area(s), however, the Grantee, its employees and agents, successors or assigns, reserve the right to repair crossing area(s), at its sole discretion and to recover the cost of such repairs from the Grantor if such repairs are needed as a result of activities of the Grantor, his successors or assigns.

IV. ENFORCEMENT AND REMEDIES

A. **Enforcement.** To accomplish the purposes of this Conservation Easement, Grantee is allowed to prevent any activity within the Conservation Easement Area that is inconsistent with the purposes of this Conservation Easement and to require the restoration of such areas or features in the Conservation Easement Area that may have been damaged by such unauthorized activity or use. Upon any breach of the terms of this Conservation Easement by Grantor, the Grantee shall, except as provided below, notify the Grantor in writing of such breach and the Grantor shall have ninety (90) days after receipt of such notice to correct the damage caused by such breach. If the breach and damage remains uncured after ninety (90) days, the Grantee may enforce this Conservation Easement by bringing appropriate legal proceedings including an action to recover damages, as well as injunctive and other relief. The Grantee shall also have the power and authority, consistent with its statutory authority: (a) to prevent any impairment of the Conservation Easement Area by acts which may be unlawful or in violation of this Conservation Easement; (b) to otherwise preserve or protect its interest in the Property; or (c) to seek damages from any appropriate person or entity. Notwithstanding the foregoing, the Grantee reserves the immediate right, without notice, to obtain a temporary restraining order, injunctive or other appropriate relief, if the breach is or would irreversibly or otherwise materially impair the benefits to be derived from this Conservation Easement, and the Grantor and Grantee acknowledge that the damage would be irreparable and remedies at law inadequate. The rights and remedies of the Grantee provided hereunder shall be in addition to, and not in lieu of, all other rights and remedies available to Grantee in connection with this Conservation Easement.

B. **Inspection.** The Grantee, its employees and agents, successors and assigns, have the right, with reasonable notice, to enter the Conservation Easement Area over the Property at reasonable times for the purpose of inspection to determine whether the Grantor is complying with the terms, conditions and restrictions of this Conservation Easement.

C. **Acts Beyond Grantor's Control.** Nothing contained in this Conservation Easement shall be construed to entitle Grantee to bring any action against Grantor for any injury or change in the Conservation Easement Area caused by third parties, resulting from causes beyond the Grantor's control, including, without limitation, fire, flood, storm, and earth movement, or from any prudent action taken in good faith by the Grantor under emergency conditions to prevent, abate, or mitigate significant injury to life or damage to the Property resulting from such causes.

D. Costs of Enforcement. Beyond regular and typical monitoring expenses, any costs incurred by Grantee in enforcing the terms of this Conservation Easement against Grantor, including, without limitation, any costs of restoration necessitated by Grantor's acts or omissions in violation of the terms of this Conservation Easement, shall be borne by Grantor.

E. No Waiver. Enforcement of this Easement shall be at the discretion of the Grantee and any forbearance, delay or omission by Grantee to exercise its rights hereunder in the event of any breach of any term set forth herein shall not be construed to be a waiver by Grantee.

V. MISCELLANEOUS

A. This instrument sets forth the entire agreement of the parties with respect to the Conservation Easement and supersedes all prior discussions, negotiations, understandings or agreements relating to the Conservation Easement. If any provision is found to be invalid, the remainder of the provisions of the Conservation Easement, and the application of such provision to persons or circumstances other than those as to which it is found to be invalid, shall not be affected thereby.

B. Grantor is responsible for any real estate taxes, assessments, fees, or charges levied upon the Property. Grantee shall not be responsible for any costs or liability of any kind related to the ownership, operation, insurance, upkeep, or maintenance of the Property, except as expressly provided herein. Upkeep of any constructed bridges, fences, or other amenities on the Property are the sole responsibility of the Grantor. Nothing herein shall relieve the Grantor of the obligation to comply with federal, state or local laws, regulations and permits that may apply to the exercise of the Reserved Rights.

C. Any notices shall be sent by registered or certified mail, return receipt requested to the parties at their addresses shown herein or to other addresses as either party establishes in writing upon notification to the other.

D. Grantor shall notify Grantee in writing of the name and address and any party to whom the Property or any part thereof is to be transferred at or prior to the time said transfer is made. Grantor further agrees that any subsequent lease, deed, or other legal instrument by which any interest in the Property is conveyed is subject to the Conservation Easement herein created.

E. The Grantor and Grantee agree that the terms of this Conservation Easement shall survive any merger of the fee and easement interests in the Property or any portion thereof.

F. This Conservation Easement and Right of Access may be amended, but only in writing signed by all parties hereto, or their successors or assigns, if such amendment does not affect the qualification of this Conservation Easement or the status of the Grantee under any applicable laws, and is consistent with the purposes of the Conservation Easement. The owner of the Property shall notify the State Property Office and the U.S. Army Corps of Engineers in writing sixty (60) days prior to the initiation of any transfer of all or any part of the Property or of any request to void or modify this Conservation Easement. Such notifications and modification requests shall be

addressed to:

Ecosystem Enhancement Program Manager
State Property Office
1321 Mail Service Center
Raleigh, NC 27699-1321

and

General Counsel
US Army Corps of Engineers
69 Darlington Avenue
Wilmington, NC 28403

G. The parties recognize and agree that the benefits of this Conservation Easement are in gross and assignable provided, however, that the Grantee hereby covenants and agrees, that in the event it transfers or assigns this Conservation Easement, the organization receiving the interest will be a qualified holder under N.C. Gen. Stat. § 121-34 et seq. and § 170(h) of the Internal Revenue Code, and the Grantee further covenants and agrees that the terms of the transfer or assignment will be such that the transferee or assignee will be required to continue in perpetuity the conservation purposes described in this document.

VI. QUIET ENJOYMENT

Grantor reserves all remaining rights accruing from ownership of the Property, including the right to engage in or permit or invite others to engage in only those uses of the Conservation Easement Area that are expressly reserved herein, not prohibited or restricted herein, and are not inconsistent with the purposes of this Conservation Easement. Without limiting the generality of the foregoing, the Grantor expressly reserves to the Grantor, and the Grantor's invitees and licensees, the right of access to the Conservation Easement Area, and the right of quiet enjoyment of the Conservation Easement Area,

TO HAVE AND TO HOLD, the said rights and easements perpetually unto the State of North Carolina for the aforesaid purposes,

AND Grantor covenants that Grantor is seized of said premises in fee and has the right to convey the permanent Conservation Easement herein granted; that the same is free from encumbrances and that Grantor will warrant and defend title to the same against the claims of all persons whomsoever.

IN TESTIMONY WHEREOF, the Grantors have hereunto set their hand and seals, the day and year first above written.

Irvin Woodrow Goodwin (SEAL)
Irvin Woodrow Goodwin

Mary Frances Goodwin (SEAL)
Mary Frances Goodwin

NORTH CAROLINA
COUNTY OF WAKE

I, Robert H. Merritt, Jr., a Notary Public in and for the County and State aforesaid, do hereby certify that Irvin Woodrow Goodwin and wife, Mary Frances Goodwin, Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument.

IN WITNESS WHEREOF, I have hereunto set my hand and Notary Seal this the 16th day of JANUARY, 2015.

Notary Public

ROBERT H. MERRITT, JR. NOTARY PUBLIC WAKE COUNTY, NC

My commission expires:

5-1-2017

00375363 / 1

Exhibit A
Legal Description
Permanent Conservation Easements
Thomas Creek
Wake County, NC

1. Permanent Conservation Easement (Ref: PIN: 0619268591) (CE-1)

A permanent conservation easement over a portion of land in Buckhorn Township, Wake County, North Carolina, as shown on a map entitled *"Thomas Creek Conservation Easement Survey for State of North Carolina - Ecosystem Enhancement Program on the property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin"* dated September 27, 2014, and recorded in Plat Book 2015, Page 121-122, of the Wake County Registry, and being a portion of the parcel owned by *Irvin Woodrow Goodwin and wife Mary Frances Goodwin* (PIN:0619268591), more particularly described as follows:

Commencing at an iron bar and cap with NC Grid coordinates of X=2,012,542.06; Y=697,515.55, and identified as Control Point # 9 on the above referenced plat and running S 25° 37'18" W, 169.24' to a point, which is the **POINT AND PLACE OF BEGINNING**; thence continuing the following courses and distances:

N 54°19'17" E a distance of 132.92' to a point;
thence S 40°59'15" E a distance of 323.58' to a point;
thence S 31°33'11" E a distance of 209.55' to a point;
thence S 77°02'43" W a distance of 115.55' to a point;
thence N 40°31'07" W a distance of 488.30' to a point;
the **point and place of beginning**, said permanent conservation easement containing 1.51 acres, more or less

2. Permanent Conservation Easement (Ref: PIN: 0619268591) (CE-2)

A permanent conservation easement over a portion of land in Buckhorn Township, Wake County, North Carolina, as shown on a map entitled *"Thomas Creek Conservation Easement Survey for State of North Carolina - Ecosystem Enhancement Program on the property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin"* dated September 27, 2014, and recorded in Plat Book 2015, Page 121-122, of the Wake County Registry, and being a portion of the parcel owned by *Irvin Woodrow Goodwin and wife Mary Frances Goodwin* (PIN:0619268591), more particularly described as follows:

Commencing at an iron bar and cap with NC Grid coordinates of X=2,012,898.72; Y=697,017.65, and identified as Conservation Easement Point # 4 on the above referenced plat and running S 12°57'17" E , 25.00' to a point, which is the **POINT AND PLACE OF BEGINNING,** Conservation Easement Point # 7; thence continuing the following courses and distances:

S 24°39'31" E a distance of 283.46' to a point;
thence S 05°44'07" E a distance of 193.81' to a point;
thence S 12°06'36" E a distance of 233.90' to a point;
thence S 24°15'58" E a distance of 232.67' to a point;
thence S 13°54'44" E a distance of 189.44' to a point;
thence S 37°00'12" E a distance of 169.40' to a point;
thence S 13°32'19" E a distance of 147.50' to a point;
thence S 52°10'49" W a distance of 153.77' to a point;
thence N 24°36'02" W a distance of 206.71' to a point;
thence N 26°37'22" W a distance of 301.56' to a point;
thence N 75°14'57" W a distance of 186.31' to a point;
thence S 86°49'49" W a distance of 251.80' to a point;
thence N 08°07'27" W a distance of 128.87' to a point;
thence N 83°26'24" E a distance of 198.90' to a point;
thence N 88°21'26" E a distance of 197.20' to a point;
thence N 16°16'18" W a distance of 233.86' to a point;
thence N 04°08'21" W a distance of 352.89' to a point;
thence N 28°07'40" W a distance of 221.17' to a point;
thence N 77°02'43" E a distance of 132.00' to a point;
the **point and place of beginning**, said permanent conservation easement containing 6.52 acres, more or less

3. Permanent Conservation Easement (Ref: PIN: 0619268591) (CE-3)

A permanent conservation easement over a portion of land in Buckhorn Township, Wake County, North Carolina, as shown on a map entitled *"Thomas Creek Conservation Easement Survey for State of North Carolina - Ecosystem Enhancement Program on the property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin"* dated September 27, 2014, and recorded in Plat Book 2015, Page 121-122, of the Wake County Registry, and being a portion of the parcel owned by *Irvin Woodrow Goodwin and wife Mary Frances Goodwin* (PIN:0619268591), more particularly described as follows:

Commencing at an iron bar and cap with NC Grid coordinates of X=2,013,300.11; Y=695,425.11, and identified as Control Point # 2 on the above referenced plat and running N 20°59'17" W, 112.08', to a point, which is the **POINT AND PLACE OF BEGINNING,** Conservation Easement Point # 25; thence continuing the following courses and distances:

N 52°10'49" E a distance of 175.50' to a point;
thence S 59°21'52" E a distance of 85.82' to a point;
thence N 37°47'22" E a distance of 234.75' to a point;
thence N 12°17'05" E a distance of 125.01' to a point;
thence N 24°57'45" E a distance of 172.30' to a point;
thence N 03°45'10" E a distance of 349.26' to a point;
thence N 67°09'01" E a distance of 128.45' to a point;
thence S 33°00'37" E a distance of 77.33' to a point;
thence S 13°16'40" W a distance of 124.25' to a point;
thence S 86°19'56" E a distance of 76.80' to a point;
thence S 04°26'10" W a distance of 115.09' to a point;
thence N 87°41'13" W a distance of 40.49' to a point;
thence S 13°32'09" W a distance of 131.05' to a point;
thence S 21°27'04" W a distance of 350.33' to a point;
thence S 38°25'48" W a distance of 199.80' to a point;
thence S 00°57'32" E a distance of 198.36' to a point;
thence S 13°36'27" W a distance of 283.21' to a point;
thence N 89°47'40" W a distance of 157.09' to a point;
thence N 12°18'52" E a distance of 281.45' to a point;
thence N 46°18'42" W a distance of 268.84' to a point;
the **point and place of beginning**, said permanent conservation easement containing 6.01 acres, more or less.

4. Permanent Conservation Easement (Ref: PIN: 0619268591) (CE-4)

A permanent conservation easement over a portion of land in Buckhorn Township, Wake County, North Carolina, as shown on a map entitled *"Thomas Creek Conservation Easement Survey for State of North Carolina - Ecosystem Enhancement Program on the property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin"* dated September 27, 2014, and recorded in Plat Book 2015, Page 121 - 122, of the Wake County Registry, and being a portion of the parcel owned by *Irvin Woodrow Goodwin and wife Mary Frances Goodwin* (PIN:0619268591), more particularly described as follows:

Commencing at an iron bar and cap with NC Grid coordinates of X=2,013,781.41; Y=695,842.92, and identified as Control Point # 4 on the above referenced plat and running N 29°57'07" E , 354.02', to a point, which is the **POINT AND PLACE OF BEGINNING**; thence continuing the following courses and distances:

N 04°26'10" E a distance of 114.62' to a point;
thence N 58°26'41" E a distance of 44.27' to a point;
thence S 00°48'03" W a distance of 112.62' to a point;
thence S 61°06'55" W a distance of 51.41' to a point;

the **point and place of beginning**, said permanent conservation easement containing 0.10 acres, more or less.

5. Permanent Conservation Easement (Ref: PIN: 0619268591) (CE-5)

A permanent conservation easement over a portion of land in Buckhorn Township, Wake County, North Carolina, as shown on a map entitled *"Thomas Creek Conservation Easement Survey for State of North Carolina - Ecosystem Enhancement Program on the property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin"* dated September 27, 2014, and recorded in Plat Book 2015, Page 121-122, of the Wake County Registry, and being a portion of the parcel owned by *Irvin Woodrow Goodwin and wife Mary Frances Goodwin* (PIN:0619268591), more particularly described as follows:

Commencing at an iron bar and cap with NC Grid coordinates of X=2,013,853.71; Y=696,291.22, and identified as Control Point # 5 on the above referenced plat and running N 41°31'19" W, 180.02', to a point, which is the **POINT AND PLACE OF BEGINNING**; thence continuing the following courses and distances:

N 42°55'27" W a distance of 129.07' to a point;
thence N 07°33'38" E a distance of 122.38' to a point;
thence S 88°51'35" E a distance of 125.56' to a point;
thence S 88°51'35" E a distance of 220.07' to a point;
thence S 44°08'01" W a distance of 220.89' to a point;
thence S 67°12'18" W a distance of 130.11' to a point;
the **point and place of beginning**, said permanent conservation easement containing 1.12 acres, more or less

6. Permanent Conservation Easement (Ref: PIN: 0619268591) (CE-7)

A permanent conservation easement over a portion of land in Buckhorn Township, Wake County, North Carolina, as shown on a map entitled *"Thomas Creek Conservation Easement Survey for State of North Carolina - Ecosystem Enhancement Program on the property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin"* dated September 27, 2014, and recorded in Plat Book 2015, Page 121-122, of the Wake County Registry, and being a portion of the parcel owned by *Irvin Woodrow Goodwin and wife Mary Frances Goodwin* (PIN:0619268591), more particularly described as follows:

Commencing at an iron bar and cap with NC Grid coordinates of X=2,013,897.27; Y=697,065.50, and identified as Conservation Easement Corner # 58 on the above referenced plat, which is the **POINT AND PLACE OF BEGINNING**; thence continuing the following courses and distances:

N 55°52'43" E a distance of 38.70' to the center of the stream
thence S 54°34'14" E a distance of 13.61' to the center of the stream
thence S 08°34'11" E a distance of 15.23' to a point;
thence N 88°26'35" W a distance of 45.41' to a point;
the **point and place of beginning**, said permanent conservation easement containing 0.01 acres, more or less.

7. Permanent Conservation Easement (Ref: PIN: 0619268591) (CE-8)

A permanent conservation easement over a portion of land in Buckhorn Township, Wake County, North Carolina, as shown on a map entitled *"Thomas Creek Conservation Easement Survey for State of North Carolina - Ecosystem Enhancement Program on the property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin"* dated September 27, 2014, and recorded in Plat Book 2015, Page 121-122, of the Wake County Registry, and being a portion of the parcel owned by *Irvin Woodrow Goodwin and wife Mary Frances Goodwin* (PIN:0619268591), more particularly described as follows:

Commencing at an iron bar and cap with NC Grid coordinates of X=2,013,526.91, Y=697,451.02, and identified as Control Point #8 on the above referenced plat, and running N 25° 03'13" W, 98.14' to a point, which is the POINT AND PLACE OF BEGINNING, Conservation Easement Point # 72; thence continuing the following courses and distances:

N 17°45'43" W a distance of 132.26' to a point;
thence N 52°39'59" E a distance of 61.53' to the center of the stream;
thence S 22°05'53" E a distance of 64.76' to the center of the stream;
thence S 28°53'58" E a distance of 45.32' to the center of the stream;
thence S 23°10'07" W a distance of 18.32' to the center of the stream;
thence S 17°17'45" E a distance of 17.00' to the center of the stream;
thence S 45°14'50" E a distance of 36.15' to the center of the stream;
thence S 64°40'23" E a distance of 30.26' to the center of the stream;
thence S 48°13'45" E a distance of 59.23' to the center of the stream;
thence S 21°07'29" E a distance of 43.28' to the center of the stream;
thence S 15°29'47" W a distance of 24.46' to the center of the stream;
thence S 82°24'36" E a distance of 13.96' to the center of the stream;
thence S 24°17'41" E a distance of 29.00' to the center of the stream;
thence S 41°21'36" E a distance of 34.34' to the center of the stream;
thence S 43°33'57" W a distance of 20.50' to the center of the stream;
thence S 08°46'51" W a distance of 31.72' to the center of the stream;
thence S 17°45'53" E a distance of 24.19' to the center of the stream;
thence S 57°40'46" E a distance of 17.50' to the center of the stream;
thence S 27°29'07" E a distance of 44.60' to the center of the stream;
thence S 77°38'19" E a distance of 70.00' to the center of the stream;
thence S 30°04'56" E a distance of 17.01' to the center of the stream;
thence S 88°13'33" E a distance of 38.77' to the center of the stream

thence S 21°36'10" E a distance of 27.18' to the center of the stream;
thence S 03°44'53" E a distance of 28.52' to the center of the stream;
thence S 12°12'53" W a distance of 24.93' to the center of the stream;
thence S 42°09'41" E a distance of 21.02' to the center of the stream;
thence S 79°42'14" E a distance of 12.72' to the center of the stream;
thence S 55°36'32" E a distance of 54.81' to the center of the stream;
thence S 55°22'25" W a distance of 43.55' to a point;
thence N 72°38'57" W a distance of 72.77' to a point;
thence N 48°02'27" W a distance of 176.82' to a point;
thence N 30°01'52" W a distance of 376.70' to a point;
the **point and place of beginning**, said permanent conservation easement containing 1.31 acres, more or less.

7. Access to the Permanent Conservation Easements

Access to and through the permanent conservation easements described above and conveyed herein, shall be (1) as provided in this deed,(2) as provided on the Plat referenced above (see Note 8, Sheet 1 of 2), from the 60' Public Right-of-Way of Shearon Harris Road, (NCSR 1134), to provide ingress, egress, and regress for purposes of accessing the permanent conservation easements set forth above, and as shown on the aforesaid map recorded in Plat Book 2015, Page 121-122, of the Wake County Registry.

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BOOK:015894 PAGE:02170 - 02186

WAKE
COUNTY
NORTH CAROLINA

Please retain yellow trailer page

It is part of the recorded document and must be submitted with the original for re-recording.

Laura M. Riddick
Register of Deeds
Wake County Justice Center
300 South Salisbury Street, Suite 1700
Raleigh, NC 27601

☐ New Time Stamp ☐ $25 Non-Standard Fee

☐ Additional Document Fee ☐ Additional Reference Fee

This Customer Group

____# of Time Stamps Needed

This Document

17 ___# of Pages 7

WAKE COUNTY, NC 196
LAURA M RIDDICK
REGISTER OF DEEDS
PRESENTED & RECORDED ON
01/16/2015 15:01:00
STATE OF NC REAL ESTATE
EXCISE TAX: $184.00
BOOK:015894 PAGE:02276 - 02288

Prepared by and return to:
Robert H. Merritt, Jr.
Bailey & Dixon, LLP
P. O. Box 1351
Raleigh, NC 27602

STATE OF NORTH CAROLINA

WAKE COUNTY

DEED OF CONSERVATION EASEMENT AND RIGHT OF ACCESS PROVIDED PURSUANT TO FULL DELIVERY MITIGATION CONTRACT NO.: 5549

CE-6

Revenue $ 184.00

SPO File Number: 92-DY
EEP Project Number: 96074

THIS DEED OF CONSERVATION EASEMENT AND RIGHT OF ACCESS, made this 16th day of January, 2015, by MICHAEL L. GOODWIN pursuant to authority described in Section V, Paragraph H, below, and with respect to their life estate in the Property, Irvin Woodrow Goodwin and wife, Mary Frances Goodwin, (collectively "**Grantor**"), whose mailing address is 4232 Shearon Harris Road, New Hill, NC 27562, to the State of North Carolina, ("**Grantee**"), whose mailing address is State of North Carolina, Department of Administration, State Property Office, 1321 Mail Service Center, Raleigh, NC 27699-1321. The designations of Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine, or neuter as required by context.

WITNESSETH:

WHEREAS, pursuant to the provisions of N.C. Gen. Stat. § 143-214.8 et seq., the State of North Carolina has established the Ecosystem Enhancement Program (formerly known as the Wetlands Restoration Program) within the Department of Environment and Natural Resources for the purposes of acquiring, maintaining, restoring, enhancing, creating and preserving wetland and

riparian resources that contribute to the protection and improvement of water quality, flood prevention, fisheries, aquatic habitat, wildlife habitat, and recreational opportunities; and

WHEREAS, this Conservation Easement from Grantor to Grantee has been negotiated, arranged and provided for as a condition of a full delivery contract between Michael Baker Engineering, Inc. and the North Carolina Department of Environment and Natural Resources, to provide stream, wetland and/or buffer mitigation pursuant to the North Carolina Department of Environment and Natural Resources Purchase and Services Contract Number 5549.

WHEREAS, The State of North Carolina is qualified to be the Grantee of a Conservation Easement pursuant to N.C. Gen. Stat. § 121-35; and

WHEREAS, the Department of Environment and Natural Resources and the United States Army Corps of Engineers, Wilmington District entered into a Memorandum of Understanding, (MOU) duly executed by all parties on November 4, 1998. This MOU recognized that the Wetlands Restoration Program was to provide effective compensatory mitigation for authorized impacts to wetlands, streams and other aquatic resources by restoring, enhancing and preserving the wetland and riparian areas of the State; and

WHEREAS, the Department of Environment and Natural Resources, the North Carolina Department of Transportation and the United States Army Corps of Engineers, Wilmington District entered into a Memorandum of Agreement, (MOA) duly executed by all parties in Greensboro, NC on July 22, 2003, which recognizes that the Ecosystem Enhancement Program is to provide for compensatory mitigation by effective protection of the land, water and natural resources of the State by restoring, enhancing and preserving ecosystem functions; and

WHEREAS, the Department of Environment and Natural Resources, the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the North Carolina Wildlife Resources Commission, the North Carolina Division of Water Quality, the North Carolina Division of Coastal Management, and the National Marine Fisheries Service entered into an agreement to continue the In-Lieu Fee operations of the North Carolina Department of Natural Resources' Ecosystem Enhancement Program with an effective date of 28 July, 2010, which supersedes and replaces the previously effective MOA and MOU referenced above; and

WHEREAS, the acceptance of this instrument for and on behalf of the State of North Carolina was granted to the Department of Administration by resolution as approved by the Governor and Council of State adopted at a meeting held in the City of Raleigh, North Carolina, on the 8th day of February 2000; and

WHEREAS, the Ecosystem Enhancement Program in the Department of Environment and Natural Resources, which has been delegated the authority authorized by the Governor and Council of State to the Department of Administration, has approved acceptance of this instrument; and

WHEREAS, Grantor owns in fee simple certain real property situated, lying, and being in Buckhorn Township, Wake County, North Carolina (the "**Property**"), subject to a life estate in

Irvin Woodrow Goodwin and Mary Frances Goodwin, and being more particularly described as that certain parcel of land containing approximately 8.48 acres and being conveyed to the Grantor by deeds recorded in **Deed Book 8959 at Page 105** and **Deed Book 8959 at Page 108** of the Wake County Registry, North Carolina; and

WHEREAS, Grantor is willing to grant a Conservation Easement and Right of Access over the herein described areas of the Property, thereby restricting and limiting the use of the areas of the Property subject to the Conservation Easement to the terms and conditions and purposes hereinafter set forth, and Grantee is willing to accept said Easement and Access Rights. The Conservation Easement shall be for the protection and benefit of the waters of Thomas Creek.

NOW, THEREFORE, in consideration of the mutual covenants, terms, conditions, and restrictions hereinafter set forth, Grantor unconditionally and irrevocably hereby grants and conveys unto Grantee, its successors and assigns, forever and in perpetuity, a Conservation Easement along with a general Right of Access, as follows:

The Easement Area consists of the following:

Tract Number CE-6 containing a total of 1.98 acres as shown on a Plat entitled "Thomas Creek Conservation Easement Survey for the State of North Carolina-Ecosystem Enhancement Program on the Property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin" dated September 27, 2014, certified by Marshall Wight, PLS Number L-5034 and recorded in Plat Book 2015, Page 121-122, Wake County Registry.

TOGETHER with an easement for access, ingress, egress and regress as described on the above-referenced recorded plat and this Conservation Easement Deed.

The Conservation Easement(s) described above are hereinafter referred to as the "Easement Area" or the "Conservation Easement Area" and are further set forth in a metes and bounds description attached hereto as Exhibit A and incorporated herein by reference.

The purposes of this Conservation Easement are to maintain, restore, enhance, construct, create and preserve wetland and/or riparian resources in the Conservation Easement Area that contribute to the protection and improvement of water quality, flood prevention, fisheries, aquatic habitat, wildlife habitat, and recreational opportunities; to maintain permanently the Conservation Easement Area in its natural condition, consistent with these purposes; and to prevent any use of the Easement Area that will significantly impair or interfere with these purposes. To achieve these purposes, the following conditions and restrictions are set forth:

I. DURATION OF EASEMENT

Pursuant to law, including the above referenced statutes, this Conservation Easement and Right of Access shall be perpetual and it shall run with, and be a continuing restriction upon the use of, the Property, and it shall be enforceable by the Grantee against the Grantor and against Grantor's heirs, successors and assigns, personal representatives, agents, lessees, and licensees.

II. GRANTOR RESERVED USES AND RESTRICTED ACTIVITIES

The Conservation Easement Area shall be restricted from any development or usage that would impair or interfere with the purposes of this Conservation Easement. Unless expressly reserved as a compatible use herein, any activity in, or use of, the Conservation Easement Area by the Grantor is prohibited as inconsistent with the purposes of this Conservation Easement. Any rights not expressly reserved hereunder by the Grantor have been acquired by the Grantee. Any rights not expressly reserved hereunder by the Grantor, including the rights to all mitigation credits, including, but not limited to, stream, wetland, and riparian buffer mitigation units, derived from each site within the area of the Conservation Easement, are conveyed to and belong to the Grantee. Without limiting the generality of the foregoing, the following specific uses are prohibited, restricted, or reserved as indicated:

A. Recreational Uses. Grantor expressly reserves the right to undeveloped recreational uses, including hiking, bird watching, hunting and fishing, and access to the Conservation Easement Area for the purposes thereof.

B. Motorized Vehicle Use. Motorized vehicle use in the Conservation Easement Area is prohibited except within a Crossing Area(s) or Road or Trail as shown on the recorded survey plat **or as specifically allowed within a fence maintenance zone as described in section D or a Road or Trail described in section H.**

The Grantor reserves the right, for himself, his successors and assigns, to operate motorized vehicles within Crossing Area(s) described on the survey recorded in Plat Book _____, Page _____, of the _____County Registry as "reserved stream crossing". Said crossing shall not exceed ____ feet in width, and must be maintained and repaired by Grantor, his successors or assigns to prevent degradation of the Conservation Easement Area.

C. Educational Uses. The Grantor reserves the right to engage in and permit others to engage in educational uses in the Conservation Easement Area not inconsistent with this Conservation Easement, and the right of access to the Conservation Easement Area for such purposes including organized educational activities such as site visits and observations. Educational uses of the property shall not alter vegetation, hydrology or topography of the site.

D. Damage to Vegetation. Except within Crossing Area(s) as shown on the recorded survey plat and as related to the removal of non-native plants, diseased or damaged trees, or vegetation that destabilizes or renders unsafe the Conservation Easement Area to persons or natural habitat, all cutting, removal, mowing, harming, or destruction of any trees and vegetation in the Conservation Easement Area is prohibited with the following exception:

Notwithstanding the foregoing, if there is a fence within the Conservation Easement Area, the Grantor reserves the right to mow and maintain vegetation within 10 feet of the Conservation Easement boundary ***as shown on the Survey Plat*** and extending along the entire length of the fence. The Grantor, his successors or assigns shall be solely responsible for maintenance of the fence for as long as there is livestock on the Grantor's property adjacent to the Conservation Easement Area.

E. **Industrial, Residential and Commercial Uses.** All industrial, residential and commercial uses are prohibited in the Conservation Easement Area.

F. **Agricultural Use.** All agricultural uses are prohibited within the Conservation Easement Area including any use for cropland, waste lagoons, or pastureland.

G. **New Construction.** There shall be no building, facility, mobile home, antenna, utility pole, tower, or other structure constructed or placed in the Conservation Easement Area.

H. **Roads and Trails.** There shall be no construction or maintenance of roads, trails, walkways, or paving in the Conservation Easement Area with the following exception:

Only roads and trails located within the Conservation Easement Area prior to completion of the construction of the restoration project and within crossings shown on the recorded survey plat may be maintained by Grantor, successors or assigns to allow for access to the interior of the Property, and must be repaired and maintained to prevent runoff and degradation to the Conservation Easement Area. Such roads and trails shall be covered with pervious materials such as loose gravel or permanent vegetation in order to minimize runoff and prevent sedimentation.

I. **Signs.** No signs shall be permitted in the Conservation Easement Area except interpretive signs describing restoration activities and the conservation values of the Conservation Easement Area, signs identifying the owner of the Property and the holder of the Conservation Easement, signs giving directions, or signs prescribing rules and regulations for the use of the Conservation Easement Area.

J. **Dumping or Storing.** Dumping or storage of soil, trash, ashes, garbage, waste, abandoned vehicles, appliances, machinery, or any other material in the Conservation Easement Area is prohibited.

K. **Grading, Mineral Use, Excavation, Dredging.** There shall be no grading, filling, excavation, dredging, mining, drilling, hydraulic fracturing; removal of topsoil, sand, gravel, rock, peat, minerals, or other materials.

L. **Water Quality and Drainage Patterns.** There shall be no diking, draining, dredging, channeling, filling, leveling, pumping, impounding or diverting, causing, allowing or permitting the diversion of surface or underground water in the Conservation Easement Area. No altering or tampering with water control structures or devices, or disruption or alteration of the restored, enhanced, or created drainage patterns is allowed. All removal of wetlands, polluting or

discharging into waters, springs, seeps, or wetlands, or use of pesticide or biocides in the Conservation Easement Area is prohibited. In the event of an emergency interruption or shortage of all other water sources, water from within the Conservation Easement Area may temporarily be withdrawn for good cause shown as needed for the survival of livestock on the Property.

M. Subdivision and Conveyance. Grantor voluntarily agrees that no further subdivision, partitioning, or dividing of the Conservation Easement Area portion of the Property owned by the Grantor in fee simple ("fee") that is subject to this Conservation Easement is allowed. Any future transfer of the Property shall be subject to this Conservation Easement and Right of Access and to the Grantee's right of unlimited and repeated ingress and egress over and across the Property to the Conservation Easement Area for the purposes set forth herein.

N. Development Rights. All development rights are permanently removed from the Conservation Easement Area and are non-transferrable.

O. Disturbance of Natural Features. Any change, disturbance, alteration or impairment of the natural features of the Conservation Easement Area or any intentional introduction of non-native plants, trees and/or animal species by Grantor is prohibited.

The Grantor may request permission to vary from the above restrictions for good cause shown, provided that any such request is not inconsistent with the purposes of this Conservation Easement, and the Grantor obtains advance written approval from the N.C. Ecosystem Enhancement Program, whose mailing address is 1652 Mail Services Center, Raleigh, NC 27699-1652.

III. GRANTEE RESERVED USES

A. Right of Access, Construction, and Inspection. The Grantee, its employees and agents, successors and assigns, receive a perpetual Right of Access to the Conservation Easement Area over the Property at reasonable times to undertake any activities to restore, construct, manage, maintain, enhance, protect, and monitor the stream, wetland and any other riparian resources in the Conservation Easement Area, in accordance with restoration activities or a long-term management plan. Unless otherwise specifically set forth in this Conservation Easement, the rights granted herein do not include or establish for the public any access rights.

B. Restoration Activities. These activities include planting of trees, shrubs and herbaceous vegetation, installation of monitoring wells, utilization of heavy equipment to grade, fill, and prepare the soil, modification of the hydrology of the site, and installation of natural and manmade materials as needed to direct in-stream, above ground, and subterraneous water flow.

C. Signs. The Grantee, its employees and agents, successors or assigns, shall be permitted to place signs and witness posts on the Property to include any or all of the following: describe the project, prohibited activities within the Conservation Easement, or identify the project boundaries and the holder of the Conservation Easement.

D. Fences. The Grantee, its employees and agents, successors or assigns, shall be permitted to place fencing on the Property within the Conservation Easement Area to restrict livestock access. Although the Grantee is not responsible for fence maintenance, the Grantee reserves the

right to maintain, repair or replace the fence at the sole discretion of the Grantee and at the expense of the Grantor, who agrees to indemnify the Grantee for any costs incurred as a result of maintenance, repair or replacement of the fence if such costs are required to protect the Conservation Easement Area from repeated incidents of grazing or other prohibited activities.

E. Crossing Area(s). The Grantee is not responsible for maintenance of crossing area(s), however, the Grantee, its employees and agents, successors or assigns, reserve the right to repair crossing area(s), at its sole discretion and to recover the cost of such repairs from the Grantor if such repairs are needed as a result of activities of the Grantor, his successors or assigns.

IV. ENFORCEMENT AND REMEDIES

A. Enforcement. To accomplish the purposes of this Conservation Easement, Grantee is allowed to prevent any activity within the Conservation Easement Area that is inconsistent with the purposes of this Conservation Easement and to require the restoration of such areas or features in the Conservation Easement Area that may have been damaged by such unauthorized activity or use. Upon any breach of the terms of this Conservation Easement by Grantor, the Grantee shall, except as provided below, notify the Grantor in writing of such breach and the Grantor shall have ninety (90) days after receipt of such notice to correct the damage caused by such breach. If the breach and damage remains uncured after ninety (90) days, the Grantee may enforce this Conservation Easement by bringing appropriate legal proceedings including an action to recover damages, as well as injunctive and other relief. The Grantee shall also have the power and authority, consistent with its statutory authority: (a) to prevent any impairment of the Conservation Easement Area by acts which may be unlawful or in violation of this Conservation Easement; (b) to otherwise preserve or protect its interest in the Property; or (c) to seek damages from any appropriate person or entity. Notwithstanding the foregoing, the Grantee reserves the immediate right, without notice, to obtain a temporary restraining order, injunctive or other appropriate relief, if the breach is or would irreversibly or otherwise materially impair the benefits to be derived from this Conservation Easement, and the Grantor and Grantee acknowledge that the damage would be irreparable and remedies at law inadequate. The rights and remedies of the Grantee provided hereunder shall be in addition to, and not in lieu of, all other rights and remedies available to Grantee in connection with this Conservation Easement.

B. Inspection. The Grantee, its employees and agents, successors and assigns, have the right, with reasonable notice, to enter the Conservation Easement Area over the Property at reasonable times for the purpose of inspection to determine whether the Grantor is complying with the terms, conditions and restrictions of this Conservation Easement.

C. Acts Beyond Grantor's Control. Nothing contained in this Conservation Easement shall be construed to entitle Grantee to bring any action against Grantor for any injury or change in the Conservation Easement Area caused by third parties, resulting from causes beyond the Grantor's control, including, without limitation, fire, flood, storm, and earth movement, or from any prudent action taken in good faith by the Grantor under emergency conditions to prevent, abate, or mitigate significant injury to life or damage to the Property resulting from such causes.

D. Costs of Enforcement. Beyond regular and typical monitoring expenses, any costs incurred by Grantee in enforcing the terms of this Conservation Easement against Grantor, including, without limitation, any costs of restoration necessitated by Grantor's acts or omissions in violation of the terms of this Conservation Easement, shall be borne by Grantor.

E. No Waiver. Enforcement of this Easement shall be at the discretion of the Grantee and any forbearance, delay or omission by Grantee to exercise its rights hereunder in the event of any breach of any term set forth herein shall not be construed to be a waiver by Grantee.

V. MISCELLANEOUS

A. This instrument sets forth the entire agreement of the parties with respect to the Conservation Easement and supersedes all prior discussions, negotiations, understandings or agreements relating to the Conservation Easement. If any provision is found to be invalid, the remainder of the provisions of the Conservation Easement, and the application of such provision to persons or circumstances other than those as to which it is found to be invalid, shall not be affected thereby.

B. Grantor is responsible for any real estate taxes, assessments, fees, or charges levied upon the Property. Grantee shall not be responsible for any costs or liability of any kind related to the ownership, operation, insurance, upkeep, or maintenance of the Property, except as expressly provided herein. Upkeep of any constructed bridges, fences, or other amenities on the Property are the sole responsibility of the Grantor. Nothing herein shall relieve the Grantor of the obligation to comply with federal, state or local laws, regulations and permits that may apply to the exercise of the Reserved Rights.

C. Any notices shall be sent by registered or certified mail, return receipt requested to the parties at their addresses shown herein or to other addresses as either party establishes in writing upon notification to the other.

D. Grantor shall notify Grantee in writing of the name and address and any party to whom the Property or any part thereof is to be transferred at or prior to the time said transfer is made. Grantor further agrees that any subsequent lease, deed, or other legal instrument by which any interest in the Property is conveyed is subject to the Conservation Easement herein created.

E. The Grantor and Grantee agree that the terms of this Conservation Easement shall survive any merger of the fee and easement interests in the Property or any portion thereof.

F. This Conservation Easement and Right of Access may be amended, but only in writing signed by all parties hereto, or their successors or assigns, if such amendment does not affect the qualification of this Conservation Easement or the status of the Grantee under any applicable laws, and is consistent with the purposes of the Conservation Easement. The owner of the Property shall notify the State Property Office and the U.S. Army Corps of Engineers in writing sixty (60) days prior to the initiation of any transfer of all or any part of the Property or of any request to void or modify this Conservation Easement. Such notifications and modification requests shall be

addressed to:

Ecosystem Enhancement Program Manager
State Property Office
1321 Mail Service Center
Raleigh, NC 27699-1321

and

General Counsel
US Army Corps of Engineers
69 Darlington Avenue
Wilmington, NC 28403

G. The parties recognize and agree that the benefits of this Conservation Easement are in gross and assignable provided, however, that the Grantee hereby covenants and agrees, that in the event it transfers or assigns this Conservation Easement, the organization receiving the interest will be a qualified holder under N.C. Gen. Stat. § 121-34 et seq. and § 170(h) of the Internal Revenue Code, and the Grantee further covenants and agrees that the terms of the transfer or assignment will be such that the transferee or assignee will be required to continue in perpetuity the conservation purposes described in this document.

H. Michael L. Goodwin executes this document pursuant to that certain Memorandum of Marital Separation and Property Settlement Agreement recorded at Book 15886, Page 1958, Wake County Registry in accordance with N.C.G.S. §39-13.4, authorizing his free and valid conveyance of real property without the consent or joinder of Bethany R. Goodwin.

VI. QUIET ENJOYMENT

Grantor reserves all remaining rights accruing from ownership of the Property, including the right to engage in or permit or invite others to engage in only those uses of the Conservation Easement Area that are expressly reserved herein, not prohibited or restricted herein, and are not inconsistent with the purposes of this Conservation Easement. Without limiting the generality of the foregoing, the Grantor expressly reserves to the Grantor, and the Grantor's invitees and licensees, the right of access to the Conservation Easement Area, and the right of quiet enjoyment of the Conservation Easement Area,

TO HAVE AND TO HOLD, the said rights and easements perpetually unto the State of North Carolina for the aforesaid purposes,

AND Grantor covenants that Grantor is seized of said premises in fee and has the right to convey the permanent Conservation Easement herein granted; that the same is free from encumbrances and that Grantor will warrant and defend title to the same against the claims of all persons whomsoever.

IN TESTIMONY WHEREOF, the Grantors have hereunto set their hand and seals, the

day and year first above written.

(SEAL)
Michael L. Goodwin

(SEAL)
Irvin Woodrow Goodwin

(SEAL)
Mary Frances Goodwin

NORTH CAROLINA
COUNTY OF WAKE

I, Robert H. Merritt Jr, a Notary Public in and for the County and State aforesaid, do hereby certify that Michael L. Goodwin, Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument.

IN WITNESS WHEREOF, I have hereunto set my hand and Notary Seal this the 16th day of JANUARY, 2013.

Notary Public
My commission expires: 5-1-2017

ROBERT H. MERRITT, JR.
NOTARY PUBLIC
WAKE COUNTY, NC

NORTH CAROLINA
COUNTY OF WAKE

I, Robert H. Merritt, Jr., a Notary Public in and for the County and State aforesaid, do hereby certify that Irvin Woodrow Goodwin and wife, Mary Frances Goodwin, Grantor, who have a life estate in the above-referenced Property, personally appeared before me this day and acknowledged the execution of the foregoing instrument.

IN WITNESS WHEREOF, I have hereunto set my hand and Notary Seal this the 16th day of January, 2015.

Robert H. Merritt
Notary Public

My commission expires: 5-1-2015

ROBERT H. MERRITT, JR.
NOTARY PUBLIC
WAKE COUNTY, NC

00375370 / 1

Exhibit A
Legal Description
Permanent Conservation Easements
Thomas Creek
Wake County, NC

1. Permanent Conservation Easement (Ref: PIN: 0619368876) (CE-6)

A permanent conservation easement over a portion of land in Buckhorn Township, Wake County, North Carolina, as shown on a map entitled *"Thomas Creek Conservation Easement Survey for State of North Carolina - Ecosystem Enhancement Program on the property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin"* dated September 27, 2014, and recorded in Plat Book 2015, Page 121-122, of the Wake County Registry, and being a portion of the parcel owned by *Michael L. Goodwin,* subject to life estate of *Irvin Woodrow Goodwin and wife Mary Frances Goodwin,* (PIN: 0619368876), more particularly described as follows:

Commencing at an iron bar and cap with NC Grid coordinates of X=2,014,008.14; Y=696,634.95, and identified as Conservation Easement Point # 53 on the above referenced plat, which is the **POINT AND PLACE OF BEGINNING**; thence continuing the following courses and distances:

N 88°51'35" W a distance of 220.07' to a point;
thence N 22°32'12" E a distance of 199.98' to a point;
thence N 48°00'24" E a distance of 146.34 'to a point;
thence N 43°44'27" W a distance of 163.93' to a point;
thence N 55°52'43" E a distance of 44.81' to a point;
thence S 88°26'35" E a distance of 45.41' to a point;
thence N 71°26'09" E a distance of 236.36' to a point;
thence S 15°20'07" W a distance of 95.71' to a point;
thence S 21°05'31" W a distance of 246.51' to a point;
thence S 51°44'41" W a distance of 85.27' to a point;
thence S 09°48'44" E a distance of 131.39' to a point;
the **point and place of beginning**, said permanent conservation easement containing 1.98 acres, more or less.

2. Access to the Permanent Conservation Easements

Access to and through the permanent conservation easements described above and conveyed herein, shall be (1) as provided in this deed,(2) as provided on the Plat referenced above (see Note 8, Sheet 1 of 2), from the 60' Public Right-of-Way of Shearon Harris Road, (NCSR 1134), to provide ingress, egress, and regress for purposes of accessing the permanent conservation easements set forth above, and as shown on the aforesaid map recorded in Plat Book 2015, Page 121-122, of the Wake County Registry.

BOOK:015894 PAGE:02276 - 02288

WAKE
COUNTY
NORTH CAROLINA

Please retain yellow trailer page

It is part of the recorded document and must be submitted with the original for re-recording.

Laura M. Riddick
Register of Deeds

Wake County Justice Center
300 South Salisbury Street, Suite 1700
Raleigh, NC 27601

☐ New Time Stamp

☐ Additional Document Fee

☐ $25 Non-Standard Fee

☐ Additional Reference Fee

This Customer Group

____# of Time Stamps Needed

This Document

13 # of Pages J

WAKE COUNTY, NC 193
LAURA M RIDDICK
REGISTER OF DEEDS
PRESENTED & RECORDED ON
01/16/2015 14:57:56
STATE OF NC REAL ESTATE
EXCISE TAX: $320.00
BOOK:015894 PAGE:02236 - 02249

Prepared by and return to:
Robert H. Merritt, Jr.
Bailey & Dixon, LLP
P. O. Box 1351
Raleigh, NC 27602

STATE OF NORTH CAROLINA

WAKE COUNTY

DEED OF CONSERVATION EASEMENT AND RIGHT OF ACCESS PROVIDED PURSUANT TO FULL DELIVERY MITIGATION CONTRACT NO.: 5549 CE-9, CE-10, and CE-11

Revenue $ 320.00

SPO File Number: 92-DZ
EEP Project Number: 96074

THIS DEED OF CONSERVATION EASEMENT AND RIGHT OF ACCESS, made this 16th day of January, 2015, by MICHAEL L. GOODWIN pursuant to authority described in Section V, Paragraph H, below, ("**Grantor**"), whose mailing address is 4232 Shearon Harris Road, New Hill, NC 27562, to the State of North Carolina, ("**Grantee**"), whose mailing address is State of North Carolina, Department of Administration, State Property Office, 1321 Mail Service Center, Raleigh, NC 27699-1321. The designations of Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine, or neuter as required by context.

WITNESSETH:

WHEREAS, pursuant to the provisions of N.C. Gen. Stat. § 143-214.8 et seq., the State of North Carolina has established the Ecosystem Enhancement Program (formerly known as the Wetlands Restoration Program) within the Department of Environment and Natural Resources for the purposes of acquiring, maintaining, restoring, enhancing, creating and preserving wetland and riparian resources that contribute to the protection and improvement of water quality, flood prevention, fisheries, aquatic habitat, wildlife habitat, and recreational opportunities; and

WHEREAS, this Conservation Easement from Grantor to Grantee has been negotiated, arranged and provided for as a condition of a full delivery contract between Michael Baker Engineering, Inc. and the North Carolina Department of Environment and Natural Resources, to provide stream, wetland and/or buffer mitigation pursuant to the North Carolina Department of Environment and Natural Resources Purchase and Services Contract Number 5549.

WHEREAS, The State of North Carolina is qualified to be the Grantee of a Conservation Easement pursuant to N.C. Gen. Stat. § 121-35; and

WHEREAS, the Department of Environment and Natural Resources and the United States Army Corps of Engineers, Wilmington District entered into a Memorandum of Understanding, (MOU) duly executed by all parties on November 4, 1998. This MOU recognized that the Wetlands Restoration Program was to provide effective compensatory mitigation for authorized impacts to wetlands, streams and other aquatic resources by restoring, enhancing and preserving the wetland and riparian areas of the State; and

WHEREAS, the Department of Environment and Natural Resources, the North Carolina Department of Transportation and the United States Army Corps of Engineers, Wilmington District entered into a Memorandum of Agreement, (MOA) duly executed by all parties in Greensboro, NC on July 22, 2003, which recognizes that the Ecosystem Enhancement Program is to provide for compensatory mitigation by effective protection of the land, water and natural resources of the State by restoring, enhancing and preserving ecosystem functions; and

WHEREAS, the Department of Environment and Natural Resources, the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the North Carolina Wildlife Resources Commission, the North Carolina Division of Water Quality, the North Carolina Division of Coastal Management, and the National Marine Fisheries Service entered into an agreement to continue the In-Lieu Fee operations of the North Carolina Department of Natural Resources' Ecosystem Enhancement Program with an effective date of 28 July, 2010, which supersedes and replaces the previously effective MOA and MOU referenced above; and

WHEREAS, the acceptance of this instrument for and on behalf of the State of North Carolina was granted to the Department of Administration by resolution as approved by the Governor and Council of State adopted at a meeting held in the City of Raleigh, North Carolina, on the 8th day of February 2000; and

WHEREAS, the Ecosystem Enhancement Program in the Department of Environment and Natural Resources, which has been delegated the authority authorized by the Governor and Council of State to the Department of Administration, has approved acceptance of this instrument; and

WHEREAS, Grantor owns in fee simple certain real property situated, lying, and being in Buckhorn Township, Wake County, North Carolina (the "**Property**"), and being more particularly described as that certain parcel of land containing approximately 29.93 acres and being conveyed

to the Grantor by deeds recorded in **Deed Book 8959 at Page 105** of the Wake County Registry, North Carolina; and

WHEREAS, Grantor is willing to grant a Conservation Easement and Right of Access over the herein described areas of the Property, thereby restricting and limiting the use of the areas of the Property subject to the Conservation Easement to the terms and conditions and purposes hereinafter set forth, and Grantee is willing to accept said Easement and Access Rights. The Conservation Easement shall be for the protection and benefit of the waters of Thomas Creek.

NOW, THEREFORE, in consideration of the mutual covenants, terms, conditions, and restrictions hereinafter set forth, Grantor unconditionally and irrevocably hereby grants and conveys unto Grantee, its successors and assigns, forever and in perpetuity, a Conservation Easement along with a general Right of Access, as follows:

The Easement Area consists of the following:

Tract Number CE-9, CE-10 and CE-11 containing a total of 4.17 acres as shown on a Plat entitled "Thomas Creek Conservation Easement Survey for the State of North Carolina-Ecosystem Enhancement Program on the Property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin" dated September 27, 2014, certified by Marshall Wight, PLS Number L-5034 and recorded in Plat Book 2015, Page 121-122, Wake County Registry.

TOGETHER with an easement for access, ingress, egress and regress as described on the above-referenced recorded plat and this Conservation Easement Deed.

The Conservation Easements described above are hereinafter referred to as the "Easement Area" or the "Conservation Easement Area" and are further set forth in a metes and bounds description attached hereto as Exhibit A and incorporated herein by reference.

The purposes of this Conservation Easement are to maintain, restore, enhance, construct, create and preserve wetland and/or riparian resources in the Conservation Easement Area that contribute to the protection and improvement of water quality, flood prevention, fisheries, aquatic habitat, wildlife habitat, and recreational opportunities; to maintain permanently the Conservation Easement Area in its natural condition, consistent with these purposes; and to prevent any use of the Easement Area that will significantly impair or interfere with these purposes. To achieve these purposes, the following conditions and restrictions are set forth:

I. DURATION OF EASEMENT

Pursuant to law, including the above referenced statutes, this Conservation Easement and Right of Access shall be perpetual and it shall run with, and be a continuing restriction upon the

use of, the Property, and it shall be enforceable by the Grantee against the Grantor and against Grantor's heirs, successors and assigns, personal representatives, agents, lessees, and licensees.

II. GRANTOR RESERVED USES AND RESTRICTED ACTIVITIES

The Conservation Easement Area shall be restricted from any development or usage that would impair or interfere with the purposes of this Conservation Easement. Unless expressly reserved as a compatible use herein, any activity in, or use of, the Conservation Easement Area by the Grantor is prohibited as inconsistent with the purposes of this Conservation Easement. Any rights not expressly reserved hereunder by the Grantor have been acquired by the Grantee. Any rights not expressly reserved hereunder by the Grantor, including the rights to all mitigation credits, including, but not limited to, stream, wetland, and riparian buffer mitigation units, derived from each site within the area of the Conservation Easement, are conveyed to and belong to the Grantee. Without limiting the generality of the foregoing, the following specific uses are prohibited, restricted, or reserved as indicated:

A. Recreational Uses. Grantor expressly reserves the right to undeveloped recreational uses, including hiking, bird watching, hunting and fishing, and access to the Conservation Easement Area for the purposes thereof.

B. Motorized Vehicle Use. Motorized vehicle use in the Conservation Easement Area is prohibited except within a Crossing Area(s) or Road or Trail as shown on the recorded survey plat **or as specifically allowed within a fence maintenance zone as described in section D or a Road or Trail described in section H**.

The Grantor reserves the right, for himself, his successors and assigns, to operate motorized vehicles within Crossing Area(s) described on the survey recorded in Plat Book _____, Page _____, of the _____County Registry as "reserved stream crossing". Said crossing shall not exceed ____ feet in width, and must be maintained and repaired by Grantor, his successors or assigns to prevent degradation of the Conservation Easement Area.

C. Educational Uses. The Grantor reserves the right to engage in and permit others to engage in educational uses in the Conservation Easement Area not inconsistent with this Conservation Easement, and the right of access to the Conservation Easement Area for such purposes including organized educational activities such as site visits and observations. Educational uses of the property shall not alter vegetation, hydrology or topography of the site.

D. Damage to Vegetation. Except within Crossing Area(s) as shown on the recorded survey plat and as related to the removal of non-native plants, diseased or damaged trees, or vegetation that destabilizes or renders unsafe the Conservation Easement Area to persons or natural habitat, all cutting, removal, mowing, harming, or destruction of any trees and vegetation in the Conservation Easement Area is prohibited with the following exception:

Notwithstanding the foregoing, if there is a fence within the Conservation Easement Area, the Grantor reserves the right to mow and maintain vegetation within 10 feet of the Conservation Easement boundary ***as shown on the Survey Plat*** and extending along the entire length of the

fence. The Grantor, his successors or assigns shall be solely responsible for maintenance of the fence for as long as there is livestock on the Grantor's property adjacent to the Conservation Easement Area.

E. Industrial, Residential and Commercial Uses. All industrial, residential and commercial uses are prohibited in the Conservation Easement Area.

F. Agricultural Use. All agricultural uses are prohibited within the Conservation Easement Area including any use for cropland, waste lagoons, or pastureland.

G. New Construction. There shall be no building, facility, mobile home, antenna, utility pole, tower, or other structure constructed or placed in the Conservation Easement Area.

H. Roads and Trails. There shall be no construction or maintenance of roads, trails, walkways, or paving in the Conservation Easement Area with the following exception:

Only roads and trails located within the Conservation Easement Area prior to completion of the construction of the restoration project and within crossings shown on the recorded survey plat may be maintained by Grantor, successors or assigns to allow for access to the interior of the Property, and must be repaired and maintained to prevent runoff and degradation to the Conservation Easement Area. Such roads and trails shall be covered with pervious materials such as loose gravel or permanent vegetation in order to minimize runoff and prevent sedimentation.

I. Signs. No signs shall be permitted in the Conservation Easement Area except interpretive signs describing restoration activities and the conservation values of the Conservation Easement Area, signs identifying the owner of the Property and the holder of the Conservation Easement, signs giving directions, or signs prescribing rules and regulations for the use of the Conservation Easement Area.

J. Dumping or Storing. Dumping or storage of soil, trash, ashes, garbage, waste, abandoned vehicles, appliances, machinery, or any other material in the Conservation Easement Area is prohibited.

K. Grading, Mineral Use, Excavation, Dredging. There shall be no grading, filling, excavation, dredging, mining, drilling, hydraulic fracturing; removal of topsoil, sand, gravel, rock, peat, minerals, or other materials.

L. Water Quality and Drainage Patterns. There shall be no diking, draining, dredging, channeling, filling, leveling, pumping, impounding or diverting, causing, allowing or permitting the diversion of surface or underground water in the Conservation Easement Area. No altering or tampering with water control structures or devices, or disruption or alteration of the restored, enhanced, or created drainage patterns is allowed. All removal of wetlands, polluting or discharging into waters, springs, seeps, or wetlands, or use of pesticide or biocides in the Conservation Easement Area is prohibited. In the event of an emergency interruption or shortage of all other water sources, water from within the Conservation Easement Area may temporarily be withdrawn for good cause shown as needed for the survival of livestock on the Property.

M. Subdivision and Conveyance. Grantor voluntarily agrees that no further subdivision, partitioning, or dividing of the Conservation Easement Area portion of the Property owned by the Grantor in fee simple ("fee") that is subject to this Conservation Easement is allowed. Any future transfer of the Property shall be subject to this Conservation Easement and Right of Access and to the Grantee's right of unlimited and repeated ingress and egress over and across the Property to the Conservation Easement Area for the purposes set forth herein.

N. Development Rights. All development rights are permanently removed from the Conservation Easement Area and are non-transferrable.

O. Disturbance of Natural Features. Any change, disturbance, alteration or impairment of the natural features of the Conservation Easement Area or any intentional introduction of non-native plants, trees and/or animal species by Grantor is prohibited.

The Grantor may request permission to vary from the above restrictions for good cause shown, provided that any such request is not inconsistent with the purposes of this Conservation Easement, and the Grantor obtains advance written approval from the N.C. Ecosystem Enhancement Program, whose mailing address is 1652 Mail Services Center, Raleigh, NC 27699-1652.

III. GRANTEE RESERVED USES

A. Right of Access, Construction, and Inspection. The Grantee, its employees and agents, successors and assigns, receive a perpetual Right of Access to the Conservation Easement Area over the Property at reasonable times to undertake any activities to restore, construct, manage, maintain, enhance, protect, and monitor the stream, wetland and any other riparian resources in the Conservation Easement Area, in accordance with restoration activities or a long-term management plan. Unless otherwise specifically set forth in this Conservation Easement, the rights granted herein do not include or establish for the public any access rights.

B. Restoration Activities. These activities include planting of trees, shrubs and herbaceous vegetation, installation of monitoring wells, utilization of heavy equipment to grade, fill, and prepare the soil, modification of the hydrology of the site, and installation of natural and manmade materials as needed to direct in-stream, above ground, and subterraneous water flow.

C. Signs. The Grantee, its employees and agents, successors or assigns, shall be permitted to place signs and witness posts on the Property to include any or all of the following: describe the project, prohibited activities within the Conservation Easement, or identify the project boundaries and the holder of the Conservation Easement.

D. Fences. The Grantee, its employees and agents, successors or assigns, shall be permitted to place fencing on the Property within the Conservation Easement Area to restrict livestock access. Although the Grantee is not responsible for fence maintenance, the Grantee reserves the right to maintain, repair or replace the fence at the sole discretion of the Grantee and at the expense of the Grantor, who agrees to indemnify the Grantee for any costs incurred as a result of

maintenance, repair or replacement of the fence if such costs are required to protect the Conservation Easement Area from repeated incidents of grazing or other prohibited activities.

E. Crossing Area(s). The Grantee is not responsible for maintenance of crossing area(s), however, the Grantee, its employees and agents, successors or assigns, reserve the right to repair crossing area(s), at its sole discretion and to recover the cost of such repairs from the Grantor if such repairs are needed as a result of activities of the Grantor, his successors or assigns.

IV. ENFORCEMENT AND REMEDIES

A. Enforcement. To accomplish the purposes of this Conservation Easement, Grantee is allowed to prevent any activity within the Conservation Easement Area that is inconsistent with the purposes of this Conservation Easement and to require the restoration of such areas or features in the Conservation Easement Area that may have been damaged by such unauthorized activity or use. Upon any breach of the terms of this Conservation Easement by Grantor, the Grantee shall, except as provided below, notify the Grantor in writing of such breach and the Grantor shall have ninety (90) days after receipt of such notice to correct the damage caused by such breach. If the breach and damage remains uncured after ninety (90) days, the Grantee may enforce this Conservation Easement by bringing appropriate legal proceedings including an action to recover damages, as well as injunctive and other relief. The Grantee shall also have the power and authority, consistent with its statutory authority: (a) to prevent any impairment of the Conservation Easement Area by acts which may be unlawful or in violation of this Conservation Easement; (b) to otherwise preserve or protect its interest in the Property; or (c) to seek damages from any appropriate person or entity. Notwithstanding the foregoing, the Grantee reserves the immediate right, without notice, to obtain a temporary restraining order, injunctive or other appropriate relief, if the breach is or would irreversibly or otherwise materially impair the benefits to be derived from this Conservation Easement, and the Grantor and Grantee acknowledge that the damage would be irreparable and remedies at law inadequate. The rights and remedies of the Grantee provided hereunder shall be in addition to, and not in lieu of, all other rights and remedies available to Grantee in connection with this Conservation Easement.

B. Inspection. The Grantee, its employees and agents, successors and assigns, have the right, with reasonable notice, to enter the Conservation Easement Area over the Property at reasonable times for the purpose of inspection to determine whether the Grantor is complying with the terms, conditions and restrictions of this Conservation Easement.

C. Acts Beyond Grantor's Control. Nothing contained in this Conservation Easement shall be construed to entitle Grantee to bring any action against Grantor for any injury or change in the Conservation Easement Area caused by third parties, resulting from causes beyond the Grantor's control, including, without limitation, fire, flood, storm, and earth movement, or from any prudent action taken in good faith by the Grantor under emergency conditions to prevent, abate, or mitigate significant injury to life or damage to the Property resulting from such causes.

D. Costs of Enforcement. Beyond regular and typical monitoring expenses, any costs incurred by Grantee in enforcing the terms of this Conservation Easement against Grantor,

including, without limitation, any costs of restoration necessitated by Grantor's acts or omissions in violation of the terms of this Conservation Easement, shall be borne by Grantor.

E. No Waiver. Enforcement of this Easement shall be at the discretion of the Grantee and any forbearance, delay or omission by Grantee to exercise its rights hereunder in the event of any breach of any term set forth herein shall not be construed to be a waiver by Grantee.

V. MISCELLANEOUS

A. This instrument sets forth the entire agreement of the parties with respect to the Conservation Easement and supersedes all prior discussions, negotiations, understandings or agreements relating to the Conservation Easement. If any provision is found to be invalid, the remainder of the provisions of the Conservation Easement, and the application of such provision to persons or circumstances other than those as to which it is found to be invalid, shall not be affected thereby.

B. Grantor is responsible for any real estate taxes, assessments, fees, or charges levied upon the Property. Grantee shall not be responsible for any costs or liability of any kind related to the ownership, operation, insurance, upkeep, or maintenance of the Property, except as expressly provided herein. Upkeep of any constructed bridges, fences, or other amenities on the Property are the sole responsibility of the Grantor. Nothing herein shall relieve the Grantor of the obligation to comply with federal, state or local laws, regulations and permits that may apply to the exercise of the Reserved Rights.

C. Any notices shall be sent by registered or certified mail, return receipt requested to the parties at their addresses shown herein or to other addresses as either party establishes in writing upon notification to the other.

D. Grantor shall notify Grantee in writing of the name and address and any party to whom the Property or any part thereof is to be transferred at or prior to the time said transfer is made. Grantor further agrees that any subsequent lease, deed, or other legal instrument by which any interest in the Property is conveyed is subject to the Conservation Easement herein created.

E. The Grantor and Grantee agree that the terms of this Conservation Easement shall survive any merger of the fee and easement interests in the Property or any portion thereof.

F. This Conservation Easement and Right of Access may be amended, but only in writing signed by all parties hereto, or their successors or assigns, if such amendment does not affect the qualification of this Conservation Easement or the status of the Grantee under any applicable laws, and is consistent with the purposes of the Conservation Easement. The owner of the Property shall notify the State Property Office and the U.S. Army Corps of Engineers in writing sixty (60) days prior to the initiation of any transfer of all or any part of the Property or of any request to void or modify this Conservation Easement. Such notifications and modification requests shall be

addressed to:

Ecosystem Enhancement Program Manager
State Property Office
1321 Mail Service Center
Raleigh, NC 27699-1321

and

General Counsel
US Army Corps of Engineers
69 Darlington Avenue
Wilmington, NC 28403

G. The parties recognize and agree that the benefits of this Conservation Easement are in gross and assignable provided, however, that the Grantee hereby covenants and agrees, that in the event it transfers or assigns this Conservation Easement, the organization receiving the interest will be a qualified holder under N.C. Gen. Stat. § 121-34 et seq. and § 170(h) of the Internal Revenue Code, and the Grantee further covenants and agrees that the terms of the transfer or assignment will be such that the transferee or assignee will be required to continue in perpetuity the conservation purposes described in this document.

H. Michael L. Goodwin executes this document pursuant to that certain Memorandum of Marital Separation and Property Settlement Agreement recorded at Book 15886, Page 1958, Wake County Registry in accordance with N.C.G.S. §39-13.4, authorizing his free and valid conveyance of real property without the consent or joinder of Bethany R. Goodwin.

VI. QUIET ENJOYMENT

Grantor reserves all remaining rights accruing from ownership of the Property, including the right to engage in or permit or invite others to engage in only those uses of the Conservation Easement Area that are expressly reserved herein, not prohibited or restricted herein, and are not inconsistent with the purposes of this Conservation Easement. Without limiting the generality of the foregoing, the Grantor expressly reserves to the Grantor, and the Grantor's invitees and licensees, the right of access to the Conservation Easement Area, and the right of quiet enjoyment of the Conservation Easement Area,

TO HAVE AND TO HOLD, the said rights and easements perpetually unto the State of North Carolina for the aforesaid purposes,

AND Grantor covenants that Grantor is seized of said premises in fee and has the right to convey the permanent Conservation Easement herein granted; that the same is free from encumbrances and that Grantor will warrant and defend title to the same against the claims of all persons whomsoever.

IN TESTIMONY WHEREOF, the Grantors have hereunto set their hand and seals, the day and year first above written.

_____ (SEAL)
Michael L. Goodwin

NORTH CAROLINA
COUNTY OF WAKE

I, Robert H. Merritt, Jr., a Notary Public in and for the County and State aforesaid, do hereby certify that Michael L. Goodwin, Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument.

IN WITNESS WHEREOF, I have hereunto set my hand and Notary Seal this the 16th day of January, 2015.

_____
Notary Public
My commission expires: 5-1-2017

ROBERT H. MERRITT, JR. NOTARY PUBLIC WAKE COUNTY, NC

00375372 / 1

Exhibit A
Legal Description
Permanent Conservation Easements
Thomas Creek
Wake County, NC

1. Permanent Conservation Easement (Ref: PIN: 0619473680) (CE-9)

A permanent conservation easement over a portion of land in Buckhorn Township, Wake County, North Carolina, as shown on a map entitled *"Thomas Creek Conservation Easement Survey for State of North Carolina - Ecosystem Enhancement Program on the property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin"* dated September 27, 2014, and recorded in Plat Book 2015, Page 121-122, of the Wake County Registry, and being a portion of the parcel owned by *Michael L. Goodwin* (PIN: 0619473680), more particularly described as follows:

Commencing at an iron bar and cap with NC Grid coordinates of X=2,013,966.34; Y=697,137.08, and identified as Conservation Easement Point # 78 on the above referenced plat, which is the **POINT AND PLACE OF BEGINNING**; thence continuing the following courses and distances:

N 34°05'36" W a Distance of 168.08' to a point;
thence N 68°33'43" W a Distance of 114.97' to a point;
thence N 20°58'35" W a Distance of 204.80' to a point;
thence N 33°31'30" W a Distance of 274.60' to a point;
thence S 52°39'59" W a Distance of 58.12' to the center of the stream;
thence S 22°05'53" E a Distance of 64.76' to the center of the stream;
thence S 28°53'58" E a Distance of 45.32' to the center of the stream;
thence S 23°10'07" W a Distance of 18.32' to the center of the stream;
thence S 17°17'45" E a Distance of 17.00' to the center of the stream;
thence S 45°14'50" E a Distance of 36.15' to the center of the stream;
thence S 64°40'23" E a Distance of 30.26' to the center of the stream;
thence S 48°13'45" E a Distance of 59.23' to the center of the stream;
thence S 21°07'29" E a Distance of 43.28' to the center of the stream;
thence S 15°29'47" W a Distance of 24.46' to the center of the stream;
thence S 82°24'36" E a Distance of 13.96' to the center of the stream;
thence S 24°17'41" E a Distance of 29.00' to the center of the stream;
thence S 41°21'36" E a Distance of 34.34' to the center of the stream;
thence S 43°33'57" W a Distance of 20.50' to the center of the stream;
thence S 08°46'51" W a Distance of 31.72' to the center of the stream;
thence S 17°45'53" E a Distance of 24.19' to the center of the stream;
thence S 57°40'46" E a Distance of 17.50' to the center of the stream;
thence S 27°29'07" E a Distance of 44.60' to the center of the stream;

thence S 77°38'19" E a Distance of 70.00' to the center of the stream;
thence S 30°04'56" E a Distance of 17.01' to the center of the stream;
thence S 88°13'33" E a Distance of 38.77' to the center of the stream;
thence S 21°36'10" E a Distance of 27.18' to the center of the stream;
thence S 03°44'53" E a Distance of 28.52' to the center of the stream;
thence S 12°12'53" W a Distance of 24.93' to the center of the stream;
thence S 42°09'41" E a Distance of 21.02' to the center of the stream;
thence S 79°42'14" E a Distance of 12.72' to the center of the stream;
thence S 55°36'32" E a Distance of 54.81' to the center of the stream;
thence N 55°22'25" E a Distance of 67.67' to a point;
the **POINT AND PLACE OF BEGINNING**, said permanent conservation easement containing 1.26 Acres, more or less.

2. Permanent Conservation Easement (Ref: PIN: 0619473680) (CE-10)

A permanent conservation easement over a portion of land in Buckhorn Township, Wake County, North Carolina, as shown on a map entitled *"Thomas Creek Conservation Easement Survey for State of North Carolina - Ecosystem Enhancement Program on the property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin"* dated September 27, 2014, and recorded in Plat Book 2015, Page 121-122, of the Wake County Registry, and being a portion of the parcel owned by *Michael L. Goodwin* (PIN: 0619473680), more particularly described as follows:

Commencing at an iron bar and cap with NC Grid coordinates of X=2,013,942.67; Y=697,064.26, and identified as Conservation Easement Corner # 59 on the above referenced plat, which is the **POINT AND PLACE OF BEGINNING**; thence continuing the following courses and distances:

N 08°34'11" W a Distance of 15.22' to the center of the stream;
thence N 54°34'14" W a Distance of 13.61' to the center of the stream;
thence N 55°52'43" E a Distance of 58.66' to a point;
thence S 34°29'49" E a Distance of 41.24' to a point;
thence N 20°27'13" E a Distance of 170.45' to a point;
thence S 81°28'24" E a Distance of 52.21' to a point;
thence S 47°44'24" E a Distance of 87.98' to a point;
thence S 15°20'07" W a Distance of 40.86' to a point;
thence S 71°26'09" W a Distance of 236.36' to a point;
the **POINT AND PLACE OF BEGINNING**, said permanent conservation easement containing 0.41 Acres, more or less.

3. Permanent Conservation Easement (Ref: PIN: 0619473680) (CE-11)

A permanent conservation easement over a portion of land in Buckhorn Township, Wake County, North Carolina, as shown on a map entitled *"Thomas Creek Conservation Easement Survey for State of North Carolina - Ecosystem Enhancement Program on the property of Irvin Woodrow Goodwin & Mary Frances Goodwin and Michael L. Goodwin"* dated September 27, 2014, and recorded in Plat Book 2015, Page 121-122, of the Wake County Registry, and being a portion of the parcel owned by *Michael L. Goodwin* (PIN: 0619473680), more particularly described as follows:

Commencing at an iron bar and cap with NC Grid coordinates of X=2,014,478.10; Y=697,471.39, and identified as Control Point #13 on the above referenced plat and running S 67°00'14" W, 410.81', to a point CE 79, which is the **POINT AND PLACE OF BEGINNING**; thence continuing the following courses and distances:

N 47°50'15" E a Distance of 133.29' to a point;
thence N 41°18'11" E a Distance of 381.02' to a point;
thence N 31°25'43" E a Distance of 206.91' to a point;
thence S 60°08'51" E a Distance of 136.38' to a point;
thence S 23°51'22" W a Distance of 83.04' to a point;
thence S 35°16'13" W a Distance of 344.90' to a point;
thence S 42°13'40" W a Distance of 156.69' to a point;
thence S 56°31'16" W a Distance of 190.46' to a point;
thence N 40°10'07" W a Distance of 123.33' to a point;
the POINT AND PLACE OF BEGINNING, said permanent conservation easement containing 2.50 Acres, more or less

4. Access to the Permanent Conservation Easements

Access to and through the permanent conservation easements described above and conveyed herein, shall be (1) as provided in this deed,(2) as provided on the Plat referenced above (see Note 8, Sheet 1 of 2), from the 60' Public Right-of-Way of Shearon Harris Road, (NCSR 1134), to provide ingress, egress, and regress for purposes of accessing the permanent conservation easements set forth above, and as shown on the aforesaid map recorded in Plat Book 2015, Page 121-122, of the Wake County Registry.

BOOK:015894 PAGE:02236 - 02249

WAKE
COUNTY
NORTH CAROLINA

Please retain yellow trailer page

It is part of the recorded document and must be submitted with the original for re-recording.

Laura M. Riddick
Register of Deeds

Wake County Justice Center
300 South Salisbury Street, Suite 1700
Raleigh, NC 27601

☐ New Time Stamp ☐ $25 Non-Standard Fee

☐ Additional Document Fee ☐ Additional Reference Fee

This Customer Group

____# of Time Stamps Needed

This Document

14 # of Pages 5

16.0 APPENDIX B - BASELINE INFORMATION DATA

Michael Baker Engineering, Inc.
8000 Regency Parkway
Suite 600
Cary, North Carolina 27518
Phone: 919.463.5488
Fax: 919.463.5490

Meeting Minutes

THOMAS CREEK RESTORATION PROJECT

EEP Contract No. 5549

Date Prepared:	October 18, 2013
Meeting Date, Time, Location:	October 9, 2013, 9:00 am On-site (Wake County, NC)
Attendees:	USACE – Todd Tugwell, Tyler Crumbley, James Lastinger NCDWR – Eric Kulz, Jennifer Burdette, Ginny Baker NCEEP –Guy Pearce, Jeff Schaffer, Heather Smith Baker – Scott Hunt, Chris Roessler
Subject:	Site visit w/ NCIRT
Recorded By:	Chris Roessler

An on-site meeting was held on October 9th, 2013 to discuss the Thomas Creek Restoration (Full Delivery) Project in Wake County, NC. The purposes of this meeting were to:

1. Familiarize the NCIRT with the stream restoration project and discuss basic concepts for the proposed mitigation plan;
2. Reach agreement on mitigation approaches and credit ratios for each project reach and section;
3. Identify and discuss potential concerns/issues based on field observations.

After introductions, Chris Roessler provided background approaches for the project. Essentially, Baker proposes a watershed-based approach to include nearly all of the intermittent and perennial reaches on the property, as well as enhancement and restoration to provide functional uplift. The site visit began in the middle of Reach R2 and proceeded in a generally clockwise direction around the project area. All of the project stream reaches (Reaches R1, R2, R3, R4, R5, R6, R7, T1, and T2) were observed and discussed. Observations and conclusions for each reach are noted below.

Note: maps from the proposal and following this visit are included with this memo.

Reach R2 (middle & lower)
Group walked to middle of Reach R2 below wooded area and agreed with Priority 1 approach. After discussing Reach T1, the group continued down Reach R2 and agreed with continuing a Priority 1 approach.

Reach T1
Initial discussion on T1 focused on whether this reach is jurisdictional or not. The soils are hydric but the channel morphology is not well defined. The USACE described draft mitigation target of 30 consecutive days of flow for a jurisdictional channel, as typically monitored by a pressure transducer. That requirement will not apply for this project.

Recommendations were to keep channel at existing grade (instead of proposed Priority 1). The mitigation plan should discuss the goals and functional uplift to be provided if restoration is implemented. It was agreed that the Draft 30-day flow standard would not apply to this feature, but it still would be required to meet/exceed jurisdictional standards for flow when restored. The concern from the IRT was a removal from the groundwater if a PI approach was conducted. Scott Hunt had mentioned perhaps utilizing trail cameras to document flow events in lieu of transducer

implementation. The IRT is interested in this approach and the potential utility of this methodology. Baker will try to implement this methodology if the budget allows.

The group moved slightly down valley and decided that a relic channel for T1 could be restored instead of the existing channel. The existing channel is perpendicular to the valley/Reach R2 and it will be filled. The plan will be for T1 to follow the relic channel below a farm crossing as Priority 2 and gradually come up to Priority 1 as it enters the design floodplain for Reach R2.

The NCIRT noted wetland pockets in the relic channel. These should be delineated and quantified for the PCN; however, the impacts to them will be offset and considered temporary because wetland pockets should develop around a restored T1 channel, particularly in the floodplain of Reach R2.

Reach R1
Baker pointed out where Reach R1 (below confluence of Reach R2 and R5) is expected to transition from Priority 1 to Priority 2 in order to match grade at the downstream end of the project area. Bedrock at the downstream end will provide a stable point for the restored channel to tie to existing grade.

Reach R5
The proposed Priority 1 approach was accepted by NCIRT. Discussion about a stream crossing at this location ensued and the NCIRT expressed a preference for culverted crossings and mentioned that crossings can be included in the easement if language is included to allow for approved uses.

The group stopped at a headcut on upper Reach R5 to observe the transition point from restoration (downstream) to what was previously proposed as preservation (upstream). The NCIRT explained that the existing vegetation condition did not warrant preservation status and really what should be proposed is Enhancement Level II at a 5:1 credit ratio. This approach should be used on upper Reach R5, lower Reach R6, and lower Reach R7; supplemental planting should be done to bring the buffer width to 50 feet on both sides of the channel. No channel work will be done along these reaches.

Reach R7
As discussed above, lower R7 will be enhanced using Enhancement Level II at 5:1 credit. Where shown on proposal maps as Enhancement Level II, approximately 100 feet upstream from confluence with R6, Baker will implement Enhancement Level II at 2.5:1 credit ratio. To attain this ratio, Baker will install grade control structures approximately every 150 feet and stabilize the eroding side gullies by installing additional grade control and bank stabilization measures. The grade control structures should maintain and increase development of the benches forming along the channel, as well as re-wet some of the soils along the channel. As with all project reaches included for mitigation credit, 50-foot buffers will be established. This Enhancement Level II section will extend upstream of the headcut where the group stopped to complete an NCDWQ stream form. The mitigation plan should justify the 2.5:1 credit ratio. The previously proposed preservation section located upstream from the headcut will be omitted from the project.

Reach R6
The group reconvened at the lower section of Reach R6 that was proposed for Enhancement Level II at 2.5:1 credit ratio. The NCIRT concluded that though the reach is incised and has several headcuts, the streambanks are not actively eroding and the hydrology is not likely to induce problematic erosion. Thus it was concluded that the approach should be changed to Enhancement Level II at a 5:1 ratio. No channel work will be done along this reach. Invasive species vegetation removal and supplemental planting will be completed to bring the riparian buffer width to 50 feet beyond both streambanks.

Continuing upstream on Reach R6, the NCIRT recommended Enhancement Level II at a 5:1 ratio through what had been previously proposed as preservation, the upstream extent of which is approximately 300 feet above the existing stream crossing. Thus, all of Reach R6 up to this point will be implemented at Enhancement Level II at a 5:1 ratio. The uppermost approximately 265 feet of this section has low bank

height ratios and unverified wetlands along it. However, just upstream from this stable section, the channel is degraded and eroding in numerous locations. The NCIRT accepted Baker's proposal to implement Priority 1 restoration on the uppermost 200 feet of Reach R6 with the design target being similar to the stable and wet reach just below it, albeit with a high quality, planted buffer.

Reach R3
After a vigorous bushwhack across cutover terrain, the group reassembled on upper Reach R3. Similar to much of Reach R6, the NCIRT recommended Enhancement Level II at 5:1 ratio on upper Reach R3, instead of preservation as Baker proposed. Moving downstream, the 100 feet upstream from the closed stream crossing will be targeted for Enhancement Level I or possibly restoration. The channel begins to degrade and show eroding banks in this section. Baker will evaluate the survey data to determine if beginning restoration is appropriate upstream from the closed crossing.

Below the closed stream crossing the group noted a wider floodplain, as well as a degraded and eroding stream channel. The NCIRT stated that they were OK with Enhancement Level I at 1.5:1, as proposed, or restoration, with a preference toward Priority 1 to provide functional uplift through floodplain wetting. Baker expressed interest in implementing stream restoration in this section beginning with Priority 2 and transitioning to Priority 1 when the earthwork for the reach balances. The NCIRT agreed with this approach but cautioned that the existing condition survey would need to be analyzed in detail to determine if Enhancement Level I or restoration is most appropriate.

Reach R4
The group debated the appropriate credit ratio for Reach R4 after agreeing that an Enhancement Level II approach is warranted. Supplemental planting will be needed, particularly on the right bank, where the buffer is presently 10-20 feet wide. The livestock exclusion fence will need to be moved to allow for a 50-foot buffer on the lower left to middle left bank. Todd Tugwell expressed a preference for Enhancement Level II at a 10:1 ratio and stated his general disfavor crediting of invasive species vegetation removal, considering that at the end of the project and beyond existing seed sources allow many of the invasive plant species to become re-established. Baker accepted the 10:1 credit ratio but will not do invasive species removal in this reach. 50-foot buffers will be established, with livestock exclusion fencing on the left side adjacent to existing pasture.

The entire group did not walk along lower R4 but a restoration approach was tacitly accepted. Most of this section will need to be Priority 2 as the incised channel is brought up to grade. Baker should describe the functional uplift that will be attained through restoration in the mitigation plan.

Reach R2 (upper)
The group walked around to the origin of upper Reach R2 at the confluence of R3 and R4. Continuation of Priority 1 restoration is proposed in this section and the NCIRT accepted this approach.

Reach T2
This short reach begins at a spring at the base of a hill. Existing tree roots are providing grade control though the channel is steep and downcutting pressure is evident. The NCIRT recommended that Enhancement Level I at a 1:1 credit ratio. Baker will install a grade control structure where T2 ties into R2 at the R2 stream bank, and elsewhere, as appropriate.

<u>Contacts</u>

- Heather Smith will serve as the EEP Project Manager and main point of contact. Chris Roessler will be the Baker Project Manager and coordinate/submit project deliverables directly with Heather Smith for distribution to all NCIRT team members.

<u>Action Items and Next Steps</u>

- Project Schedule – Baker stated they are ready to proceed immediately with the Task 1 deliverable (Categorical Exclusion) and do not anticipate project delays.
- After the jurisdictional determination has been conducted, any wetland areas that will be impacted by the proposed work (filled or drained) will need to be identified and functional replacement for those losses should be proposed and discussed in the draft mitigation plan.
- USACE requires Jurisdictional (JD) stream/wetland calls for the project. Baker will coordinate with James Lastinger for on-site JD verification prior to mitigation plan submittal.
- Signage will be needed on all conservation easement areas. This will help to exclude future logging operations from the easement areas.

This represents Baker Engineering's interpretation of the meeting discussions. If you should find any information contained in these meeting notes to be in error and/or incomplete based on individual comments or conversations, please notify me with corrections/additions as soon as possible.

Sincerely,

Chris Roessler, Project Manager
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 600
Cary, NC 27518
Phone: 919.481.5737
Email: croessler@mbakercorp.com

16.1 USACE Routine Wetland Determination Forms – per regional supplement to 1987 Manual

From: Lastinger, James C SAW
To: Scott King
Subject: RE: Thomas Creek JD (UNCLASSIFIED)
Date: Tuesday, September 16, 2014 3:01:11 PM

Classification: UNCLASSIFIED
Caveats: NONE

Scott,

The maps submitted are accurate. I have not issued a JD letter yet because I have not received surveys to sign. If you want me to issue a JD now I can, and then sign the surveys later once they come in. It is up to you. I apologize for any confusion.

James Lastinger
Regulatory Specialist
Raleigh Regulatory Field Office
US Army Corps of Engineers, Wilmington District
ADDRESS: 3331 Heritage Trade Drive, Suite 105 Wake Forest, NC 27587
Tel: (919) 554-4884, x32
Fax: (919) 562-0421
Regulatory Homepage: http://www.saw.usace.army.mil/WETLANDS
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 Customer Satisfaction Survey located at http://regulatory.usacesurvey.com/.

-----Original Message-----
From: Scott King [mailto:Scott.King@mbakerintl.com]
Sent: Wednesday, September 10, 2014 2:27 PM
To: Lastinger, James C SAW
Subject: [EXTERNAL] RE: Thomas Creek JD (UNCLASSIFIED)

Good afternoon James,
We are finalizing the Mitigation plan for Thomas Creek and in speaking with the EEP project manager, she said that since we don't have any official, finalized permit or letter from the Corps yet, we should consider including a short email statement from the project manager stating that the stream/wetland determinations are approved as per the JD application. I have included dated maps that you can reference if you like. I know this sounds a little casual, but she does understand our situation and says from experience that it's good to have something that shows that the stream/wetland calls were discussed agreed upon at this early stage. She said she'd really just like a sentence or two saying you agree with the findings presented in the JD application and as shown on the stream and wetland maps dated 26 Aug 2014. I'll try and get the same sort of statement from DWR.
Thank you very much for your time James, I appreciate it.
-Scott

-----Original Message-----
From: Lastinger, James C SAW [mailto:James.C.Lastinger@usace.army.mil]
Sent: Thursday, August 28, 2014 8:31 AM
To: Scott King
Subject: RE: Thomas Creek JD (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Scott,

From: Kulz, Eric
To: Scott King
Cc: Burdette, Jennifer a; Baker,Virginia
Subject: RE: Thomas Creek EEP mitigation site
Date: Wednesday, August 27, 2014 12:35:02 PM

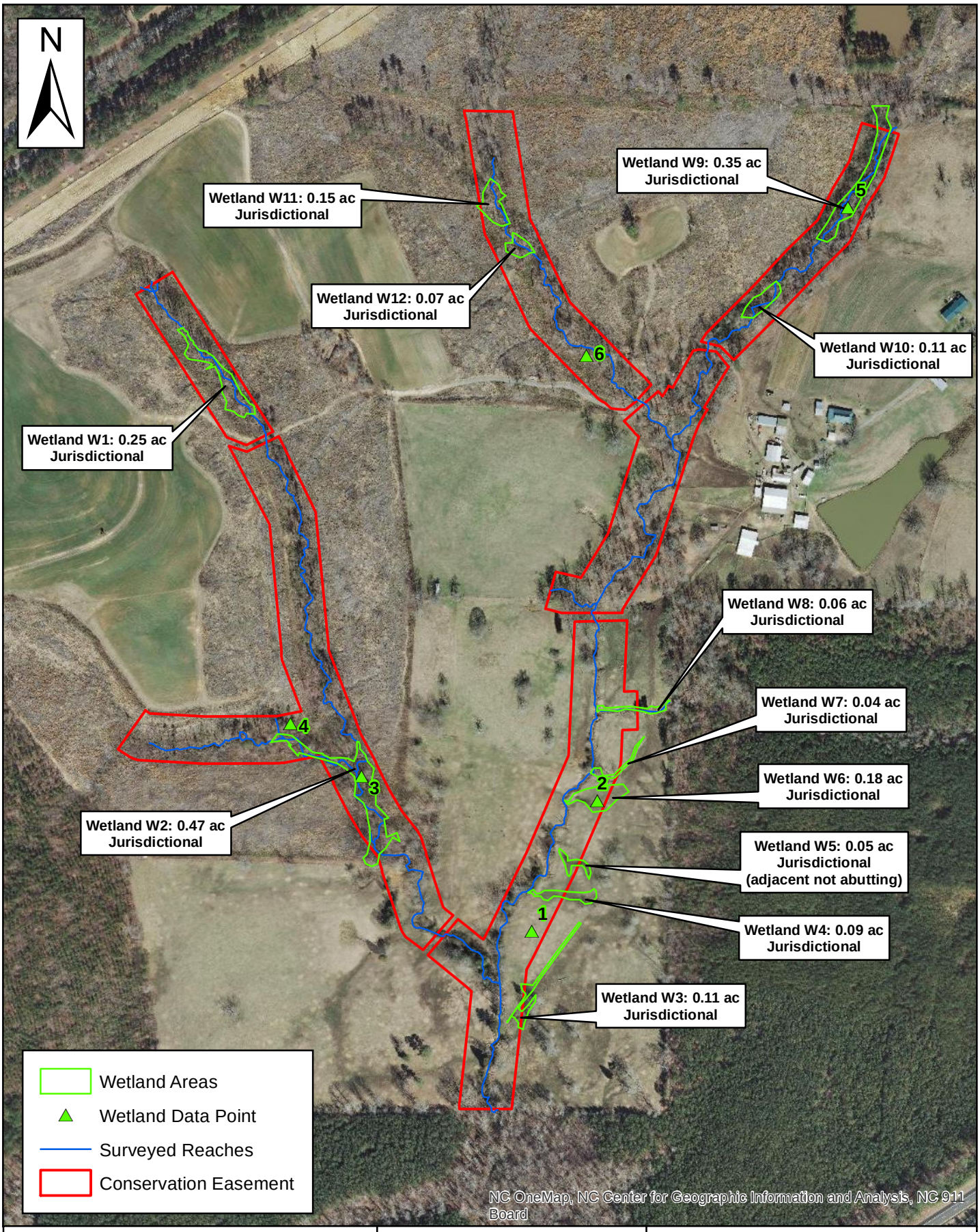
Scott:

Since the site is not in a buffered basin, we are OK with depending on the USACE jurisdictional calls for permitting. I don't see the need for another site visit, and frankly don't think anyone from DWR can get out there any time soon.

Thanks!

From: Scott King [mailto:Scott.King@mbakerintl.com]
Sent: Monday, August 25, 2014 2:37 PM
To: Kulz, Eric
Subject: Thomas Creek EEP mitigation site

Hello Eric,
In the course of getting a wetland/stream JD determination for the Thomas Creek EEP stream restoration mitigation site near New Hill in Wake County, the Corps representative (James Lastinger) declined the need for another field visit as he didn't think there was anything controversial about
the site and was fine with the submitted application and maps. However, for inclusion in our mitigation plan we would also like a letter from DWR regarding the applicability of stream buffer and mitigation-requirement rules. We've usually just met the DWR rep in the field the same day as the Corps, but since we aren't doing that in this case, I was wondering if someone from DWR would like to walk over the site with me one day to confirm? Unless you don't think it warrants a field visit either. At the IRT walkover last October, you, Jennifer Burdette, and Ginny Baker were there from DWR. We're calling all the project streams jurisdictional, but I don't believe they should be subject
to any buffer rules as they're a part of the Cape Fear 04 catalog unit (site flows into Shearon Harris reservoir, which empties into Buckhorn Creek then into the Cape Fear River). Attached is an overview map of the project and easement, along with the original DWR stream forms. Of course I can provide you with any other information you need about the project, just let me know.
Thank you very
much, Scott King
919-219-6339



Baker
Michael Baker Engineering, Inc.
8000 Regency Parkway
Suite 600
Cary, North Carolina 27518
Phone: 919.463.5488
Fax: 919.463.5490

0 250 500 Feet

Wetlands Map
Thomas Creek Site
26 Aug 2014

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Thomas Creek City/County: Wake Sampling Date: 5/29/14

Applicant/Owner: Baker Engineering State: NC Sampling Point: W1

Investigator(s): Scott King Section, Township, Range: –

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 1%

Subregion (LRR or MLRA): P 136 Lat: 35.661198 Long: -78.954182 Datum: NAD 83

Soil Map Unit Name: White Store sandy loam NWI classification: –

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

Are Vegetation X, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X 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 X	**Is the Sampled Area within a Wetland?** Yes ____ No X
Hydric Soil Present?	Yes ____	No X	
Wetland Hydrology Present?	Yes ____	No X	

Remarks:
This area is frequently grazed by cattle, thus the vegetation is highly disturbed (pasture is actively planted and managed as well).

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 X

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

Remarks:
No wetland hydrology indicators observed

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: W1

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. none			
2.			
3.			
4.			
5.			
6.			
7.			
		= Total Cover	
50% of total cover:		20% of total cover:	

Sapling/Shrub Stratum (Plot size:)			
1. none			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
		= Total Cover	
50% of total cover:		20% of total cover:	

Herb Stratum (Plot size: 15')			
1. Festuca arundinacea		80	FACU
2. Trifolium repens		25	FACU
3. Eupatorium capillifollium		10	FACU
4. Ranunculus acris		10	FAC
5. Solanum carolinense		5	FACU
6.			
7.			
8.			
9.			
10.			
11.			
		130 = Total Cover	
50% of total cover: 65		20% of total cover: 26	

Woody Vine Stratum (Plot size:)			
1. none			
2.			
3.			
4.			
5.			
		= Total Cover	
50% of total cover:		20% of total cover:	

Dominance Test worksheet:

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

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0% (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)
- X 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 or equal to 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 X

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

Location is in a planted and managed pasture that is frequently grazed by cattle. Thus, the vegetation here is not natural and significantly impacted.

SOIL Sampling Point: W1

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 %	Type[1]	Loc[2]	Texture	Remarks
0-3"	10YR 5/3	100					loam	
3-7"	10YR 6/3	100					loam	
7-12"	10YR 8/4	80	10YR 6/3	20	C	M	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)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

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)**
- ___ 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 X

Remarks:

Hydric Soil not present

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Thomas Creek City/County: Wake Sampling Date: 5/29/14

Applicant/Owner: Baker Engineering State: NC Sampling Point: W2

Investigator(s): Scott King Section, Township, Range: –

Landform (hillslope, terrace, etc.): depression in floodplain Local relief (concave, convex, none): concave Slope (%): 1%

Subregion (LRR or MLRA): P 136 Lat: 35.662219 Long: -78.95355 Datum: NAD83

Soil Map Unit Name: White Store sandy loam NWI classification: –

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

Are Vegetation X, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X 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 X	No ____
Hydric Soil Present?	Yes X	No ____
Wetland Hydrology Present?	Yes X	No ____

Is the Sampled Area within a Wetland? Yes X No ____

Remarks:
Sample point is within a wetland

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)
- X 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)
- X 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)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

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

Wetland Hydrology Present? Yes X No ____

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

Remarks:
Location is found in a lower-elevation depression that drains into the adjacent creek.

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: W2

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. none			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Sapling/Shrub Stratum (Plot size:)			
1. none			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Herb Stratum (Plot size: 15')			
1. Juncus effusus	50	YES	FACW
2. Eleocharis obtusa	20	YES	OBL
3. Polygonum pennsylvanicum	15	NO	FACW
4. Ranunculus acris	10	NO	FAC
5. Carex stipata	10	NO	OBL
6. Festuca arundinacea	10	NO	FACU
7.			
8.			
9.			
10.			
11.			
	115 = Total Cover		
50% of total cover: 57.5	20% of total cover: 23		

Woody Vine Stratum (Plot size:)			
1. none			
2.			
3.			
4.			
5.			
	= Total Cover		
50% of total cover:	20% of 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
- X 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)
- X 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 or equal to 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 X No ___

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

Area is located in an actively planted and managed pasture for cattle. Thus extensive impacts to vegetative community are expected. Nevertheless, the vegetation found here is clearly hydrophytic.

SOIL

Sampling Point: W2

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 %	Type[1]	Loc[2]	Texture	Remarks
0-9"	10YR 4/1	85	5YR 4/6	15	C	M	silt loam	
9-12"	10YR 6/3	70	5YR 4/6	20	C	M	silt loam	
			10YR 7/6	10	D	M		

[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)
- X 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)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

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)**
- ___ 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 X No ___

Remarks:

Hydric soil is present here

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Thomas Creek City/County: Wake Sampling Date: 5/29/14

Applicant/Owner: Baker Engineering State: NC Sampling Point: W3

Investigator(s): Scott King Section, Township, Range: –

Landform (hillslope, terrace, etc.): valley floodplain Local relief (concave, convex, none): – Slope (%): < 1%

Subregion (LRR or MLRA): P 136 Lat: 35.662598 Long: -78.955917 Datum: NAD83

Soil Map Unit Name: Wehadkee + Bibb soils NWI classification: –

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

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X 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 X No ____	**Is the Sampled Area within a Wetland?** Yes X No ____
Hydric Soil Present?	Yes X No ____	
Wetland Hydrology Present?	Yes X No ____	

Remarks:
This site is located within a wetland.

HYDROLOGY

Wetland Hydrology Indicators:

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

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- X 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)
- X 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)
- X 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 X	Depth (inches): ____
Water Table Present?	Yes X	No ____	Depth (inches): @ 4"
Saturation Present? (includes capillary fringe)	Yes X	No ____	Depth (inches): @ 3"

Wetland Hydrology Present? Yes X No ____

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

Remarks:
Wetland hydrology indicators present here.

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: W3

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Acer rubrum	50	Y	FAC
2. Liquidambar styraciflua	20	–	FAC
3. Carpinus caroliniana	40	Y	FAC
4.			
5.			
6.			
7.			
	110 = Total Cover		
50% of total cover: 55	20% of total cover: 22		

Sapling/Shrub Stratum (Plot size: 30')			
1. Carpinus caroliniana	30	Y	FAC
2. Myrica cerifera (Morella cerifera)	10	–	FAC
3. Acer rubrum	10	–	FAC
4. Pinus taeda	10	–	FAC
5. Sambucus canadensis (nigra)	15	Y	FACU
6.			
7.			
8.			
9.			
	75 = Total Cover		
50% of total cover: 37.5	20% of total cover: 15		

Herb Stratum (Plot size: 15')			
1. Carex lucida	15	Y	OBL
2. Juncus effusus	15	Y	FACW
3. Microstegium vimineum	20	Y	FAC
4. Arisaema triphyllum	10	–	FACW
5. Woodwardia areolata	10	–	FACW
6. Scirpus atrovirens	15	Y	OBL
7. Boehmeria cylindrica	10	–	FACW
8.			
9.			
10.			
11.			
	95 = Total Cover		
50% of total cover: 47.5	20% of total cover: 19		

Woody Vine Stratum (Plot size: 15')			
1. Smilax rotundifolia	25	Y	FAC
2. Rubus argutus	20	Y	FACU
3.			
4.			
5.			
	45 = Total Cover		
50% of total cover: 22.5	20% of total cover: 9		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 8 (A)

Total Number of Dominant Species Across All Strata: 10 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 80% (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
- X 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 or equal to 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 X No ____

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

Hydrophytic vegetation present

SOIL Sampling Point: W3

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 %	Type[1]	Loc[2]	Texture	Remarks
0-6"	10YR 4/1	100					sandy loam	
6-12"	10YR 6/1	90	5YR 5/6	10	C	M	sandy 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)
- X 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)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

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)**
- ___ 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 X No ___

Remarks:

Hydric soil present

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Thomas Creek City/County: Wake Sampling Date: 5/29/14

Applicant/Owner: Baker Engineering State: NC Sampling Point: W4

Investigator(s): Scott King Section, Township, Range: —

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): — Slope (%): 1.5%

Subregion (LRR or MLRA): P 136 Lat: 35.66283 Long: -78.956506 Datum: NAD83

Soil Map Unit Name: Poltton-Lehile Stone complex NWI classification: —

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

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X 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 X	**Is the Sampled Area within a Wetland?** Yes _____ No X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:
Sampling point is not located within a wetland.

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

Wetland Hydrology Present? Yes _____ No X

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

Remarks:
No indicators of wetland hydrology present here

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: W4

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Liriodendron tulipifera	50	Y	FACU
2. Carya cordiformis	50	Y	FACU
3. Acer rubrum	20	–	FAC
4. Nyssa biflora	15	–	FACW
5. Oxydendron arboreum	10	–	UPL
6.			
7.			
	145 = Total Cover		
50% of total cover: 72.5	20% of total cover: 29		

Sapling/Shrub Stratum (Plot size: 30')			
1. Carya cordiformis	30	Y	FACU
2. Acer rubrum	25	Y	FAC
3. Liquidambar styraciflua	10	–	FAC
4. Pinus taeda	15	–	FAC
5. Quercus alba	15	–	FACU
6.			
7.			
8.			
9.			
	95 = Total Cover		
50% of total cover: 47.5	20% of total cover: 19		

Herb Stratum (Plot size: 15')			
1. Polystichum acrostichoides	10	Y	FACU
2. Euonymous americanus	5	–	FAC
3. Hexastylis arifolia	2	–	FAC
4. Parathelypteris noveboracensis	2	–	FAC
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	19 = Total Cover		
50% of total cover: 9.5	20% of total cover: 3.8		

Woody Vine Stratum (Plot size: 15')			
1. Vitis rotundifolia	20	Y	FAC
2. Rubus argutus	20	Y	FACU
3. Campsis radicans	10	–	FAC
4. Lonicera japonica	15	Y	FAC
5.			
	65 = Total Cover		
50% of total cover: 32.5	20% of total cover: 13		

Dominance Test worksheet:

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

Total Number of Dominant Species Across All Strata: 8 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 38% (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 or equal to 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 X

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

Hydrophytic vegetation not present here

SOIL

Sampling Point: W4

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 %	Type[1]	Loc[2]	Texture	Remarks
0-6"	10YR 4/3	100					loam	
6-12"	10YR 6/3	100					sandy 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)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

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)**
- ___ 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** X

Remarks:

Hydric soil not present here

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Thomas Creek City/County: Wake Sampling Date: 6/6/14

Applicant/Owner: Balen Engineering State: NC Sampling Point: WS

Investigator(s): Scott King Section, Township, Range: –

Landform (hillslope, terrace, etc.): valley floodplain Local relief (concave, convex, none): _____ Slope (%): 1%

Subregion (LRR or MLRA): P 136 Lat: 35.666435 Long: -78.951574 Datum: NAD83

Soil Map Unit Name: Wehadkee + Bibb soils NWI classification: –

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

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X 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 X	No _____
Hydric Soil Present?	Yes X	No _____
Wetland Hydrology Present?	Yes X	No _____

Is the Sampled Area within a Wetland? Yes X No _____

Remarks:
This sampling point is within a wetland area.

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:
Wetland hydrology indicators present

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: W5

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Liquidambar styraciflua	40	Y	FAC
2. Acer rubrum	20	Y	FAC
3. Liriodendron tulipifera	10	–	FACU
4.			
5.			
6.			
7.			
	70 = Total Cover		
50% of total cover: 35	20% of total cover: 14		

Sapling/Shrub Stratum (Plot size: 30')			
1. Liquidambar styraciflua	40	Y	FAC
2. Ligustrum sinense	15	–	FACU
3. Quercus phellos	40	Y	FAC
4. Rosa multiflora	20	–	FACU
5. Sambucus canadensis (nigra)	5	–	FAC
6.			
7.			
8.			
9.			
	120 = Total Cover		
50% of total cover: 60	20% of total cover: 24		

Herb Stratum (Plot size: 15')			
1. Juncus effusus	10	Y	FACW
2. Carex stipata	5	–	OBL
3. Lonicera japonica	10	Y	FAC
4. Boehmeria cylindrica	2	–	FACW
5. Vinca minor	2	–	NI
6. Asplenium platyneuron	10	Y	FACU
7.			
8.			
9.			
10.			
11.			
	39 = Total Cover		
50% of total cover: 19.5	20% of total cover: 7.8		

Woody Vine Stratum (Plot size: 15')			
1. Toxicodendron radicans	50	Y	FAC
2. Smilax rotundifolia	30	Y	FAC
3. Campsis radicans	5	–	FAC
4. Parthenocissus quinquefolia	5	–	FACU
5.			
	90 = Total Cover		
50% of total cover: 45	20% of total cover: 18		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 8 (A)

Total Number of Dominant Species Across All Strata: 9 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 89 % (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
- X 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 or equal to 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 X No ___

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

Hydrophytic vegetation is present here

SOIL

Sampling Point: W5

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 %	Type[1]	Loc[2]	Texture	Remarks
0-2"	10YR 5/4	100					silty loam	
2-6"	10YR 5/3	80	5YR 5/6	20	C	M	silty loam	
6-12"	10YR 5/2	70	2.5YR 5/6	30	C	M	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)
- X 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)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

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)**
- ___ 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 X No ___

Remarks:

Hydric soil present here.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Thomas Creek City/County: Wake Sampling Date: 6/6/14

Applicant/Owner: Baker Engineering State: NC Sampling Point: W6

Investigator(s): Scott King Section, Township, Range: –

Landform (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): none Slope (%): < 1%

Subregion (LRR or MLRA): P-136 Lat: 35.665719 Long: -78.953654 Datum: NAD83

Soil Map Unit Name: Wehadkee + Bibb soils NWI classification: –

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

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X 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 X	**Is the Sampled Area within a Wetland?** Yes _____ No X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:
Sampling point is not located within a wetland.

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 X

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

Remarks:
No indicators of hydrology present here.

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: W6

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Pinus taeda	30	Y	FAC
2. Liriodendron tulipifera	25	Y	FACU
3. Acer rubrum	20	–	FAC
4.			
5.			
6.			
7.			
	75 = Total Cover		
50% of total cover: 37.5	20% of total cover: 15		

Sapling/Shrub Stratum (Plot size: 30')			
1. Rosa multiflora	25	Y	FACU
2. Oxydendron arboreum	15	–	UPL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	40 = Total Cover		
50% of total cover: 20	20% of total cover: 8		

Herb Stratum (Plot size: 15')			
1. Parathelypteris noveboracensis	2	–	FAC
2. Carex lurida	5	–	OBL
3. Solidago rugosa	10	Y	FAC
4. Polystichum acrostichoides	2	–	FACU
5. Microstegium vimineum	20	Y	FAC
6.			
7.			
8.			
9.			
10.			
11.			
	39 = Total Cover		
50% of total cover: 19.5	20% of total cover: 7.8		

Woody Vine Stratum (Plot size: 15')			
1. Lonicera japonica	10	–	FAC
2. Rubus argutus	15	Y	FACU
3.			
4.			
5.			
	25 = Total Cover		
50% of total cover: 12.5	20% of total cover: 5		

Dominance Test worksheet:

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

Total Number of Dominant Species Across All Strata: 6 (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	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 or equal to 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 X

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

Although 50% of the dominant species are FAC, the threshold for the dominance test is not met so hydrophytic vegetation is not present here.

SOIL Sampling Point: W6

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 %	Type[1]	Loc[2]	Texture	Remarks
0-4"	10YR 4/3	100					Sandy loam	
4-9"	10YR 5/3	100					Sandy loam	
9-12"	10YR 6/4	90	10YR 5/3	10	C	M	Sandy 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)**
- ___ Red Parent Material (F21) **(MLRA 127, 147)**

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)**
- ___ 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):

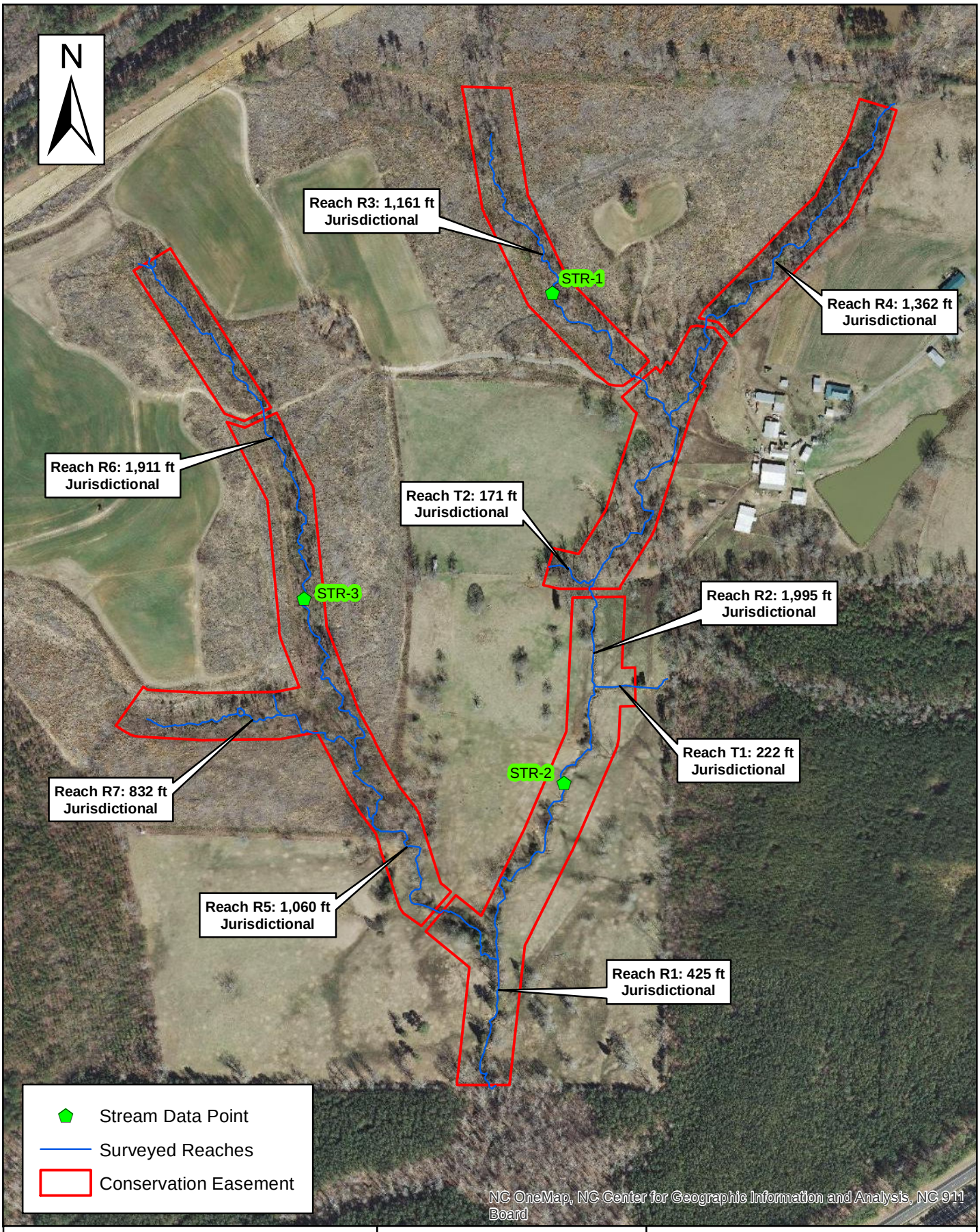
Type: _____

Depth (inches): _____

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

Remarks:

Hydric soil not present here



Baker
Michael Baker Engineering, Inc.
8000 Regency Parkway
Suite 600
Cary, North Carolina 27518
Phone: 919.463.5488
Fax: 919.463.5490

0 250 500 Feet

Streams Map
Thomas Creek Site
26 Aug 2014

Thomas Creek

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

STR 1

Provide the following information for the stream reach under assessment:

1. Applicant's name: Baker Engineering

2. Evaluator's name: Scott King

3. Date of evaluation: 5/22/14

4. Time of evaluation: 10:30 am

5. Name of stream: Thomas Creek trib

6. River basin: Cape Fear

7. Approximate drainage area: ±60 ac

8. Stream order: 1st

9. Length of reach evaluated: 25'

10. County: Wake

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

12. Subdivision name (if any): —

Latitude (ex. 34.872312): 35.666028

Longitude (ex. –77.556611): -78.95396

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

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):_____

14. Proposed channel work (if any):_____

15. Recent weather conditions: Sunny, warm, dry (no rain for 1 week)

16. Site conditions at time of visit: hot, sunny, humid but no rain

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

18. Is there a pond or lake located upstream of the evaluation point? (YES) NO If yes, estimate the water surface area: 1.7 ac farm pond

19. Does channel appear on USGS quad map? (YES) NO

20. Does channel appear on USDA Soil Survey? (YES) NO

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial 10 % Agricultural ___% Forested 90 % Cleared / Logged ___% Other (_____)

22. Bankfull width: 11 ft

23. Bank height (from bed to top of bank): 5 ft

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

25. Channel sinuosity: ___Straight 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): 26 **Comments:**_____

Evaluator's Signature Scott King **Date** 5/22/14

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

STR1

STREAM QUALITY ASSESSMENT WORKSHEET

	#	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	3
	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	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	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	0
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	0
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	2
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	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	2
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	2
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	0
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	1
	21	**Presence of amphibians** (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	0
	22	**Presence of fish** minnows present (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	23	**Evidence of wildlife use** animal burrows (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)						26

* These characteristics are not assessed in coastal streams.

Thomas Creek

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

STR2

Provide the following information for the stream reach under assessment:

1. Applicant's name: Baker Engineering

2. Evaluator's name: Scott King

3. Date of evaluation: 5/22/14

4. Time of evaluation: 12:00 pm

5. Name of stream: Thomas Creek trib

6. River basin: Cape Fear

7. Approximate drainage area: ±170 ac

8. Stream order: 2nd

9. Length of reach evaluated: 25 ft

10. County: Wake

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

12. Subdivision name (if any): —

Latitude (ex. 34.872312): 35.662178

Longitude (ex. -77.556611): -78.953851

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

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):_____

14. Proposed channel work (if any):_____

15. Recent weather conditions: warm, sunny, dry (no rain for 1 week)

16. Site conditions at time of visit: sunny, hot, humid (no rain today)

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

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area: 3.7 ac total: 3 Gas pond

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

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

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial 40% Agricultural 10% Forested 50% Cleared / Logged ___% Other (_____)

22. Bankfull width: 6 ft

23. Bank height (from bed to top of bank): 4 ft

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

25. 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): 20 **Comments:**_____

Evaluator's Signature Scott King **Date** 5/22/14

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STR 2

STREAM QUALITY ASSESSMENT WORKSHEET

	#	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	3
	2	**Evidence of past human alteration** (extensive alteration = 0; no alteration = max points)	0 – 6	0 – 5	0 – 5	0
	3	**Riparian zone** (no buffer = 0; contiguous, wide buffer = max points)	0 – 6	0 – 4	0 – 5	0
	4	**Evidence of nutrient or chemical discharges** (extensive discharges = 0; no discharges = max points)	0 – 5	0 – 4	0 – 4	0
	5	**Groundwater discharge** (no discharge = 0; springs, seeps, wetlands, etc. = max points)	0 – 3	0 – 4	0 – 4	1
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	3
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	1
	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	0
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	0
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	1
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	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	0
	18	**Canopy coverage over streambed** (no shading vegetation = 0; continuous canopy = max points)	0 – 5	0 – 5	0 – 5	0
	19	**Substrate embeddedness** (deeply embedded = 0; loose structure = max)	NA*	0 – 4	0 – 4	0
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** frogs (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** fish (minnows) (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 4	0 – 4	2
	23	**Evidence of wildlife use** (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	0
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						20

* These characteristics are not assessed in coastal streams.

Thomas Creek STR3

USACE AID#_____ DWQ #_____ Site #____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: Balk Engineering

2. Evaluator's name: Scott King

3. Date of evaluation: 5/22/14

4. Time of evaluation: 1:45 pm

5. Name of stream: Thomas Creek trib

6. River basin: Cape Fear

7. Approximate drainage area: ± 30 ac

8. Stream order: 1st

9. Length of reach evaluated: 25 ft

10. County: Wake

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

12. Subdivision name (if any): –

Latitude (ex. 34.872312): 35.663629

Longitude (ex. –77.556611): -78.956352

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

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location):_____

14. Proposed channel work (if any):_____

15. Recent weather conditions: sunny, warm, dry (no rain for 1 week)

16. Site conditions at time of visit: sunny, hot, humid (no rain)

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

18. Is there a pond or lake located upstream of the evaluation point? YES (NO) If yes, estimate the water surface area:_____

19. Does channel appear on USGS quad map? (YES) NO

20. Does channel appear on USDA Soil Survey? YES (NO)

21. Estimated watershed land use: ___% Residential ___% Commercial ___% Industrial 45 % Agricultural 5 % Forested 50 % Cleared / Logged ___% Other (_____)

22. Bankfull width: 4 ft

23. Bank height (from bed to top of bank): 2 ft

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

25. 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): 44 **Comments:**_____

Evaluator's Signature Scott King **Date** 5/22/14

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STR3

STREAM QUALITY ASSESSMENT WORKSHEET

	#	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	3
	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	3
	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	2
	6	**Presence of adjacent floodplain** (no floodplain = 0; extensive floodplain = max points)	0 – 4	0 – 4	0 – 2	2
	7	**Entrenchment / floodplain access** (deeply entrenched = 0; frequent flooding = max points)	0 – 5	0 – 4	0 – 2	3
	8	**Presence of adjacent wetlands** (no wetlands = 0; large adjacent wetlands = max points)	0 – 6	0 – 4	0 – 2	2
	9	**Channel sinuosity** (extensive channelization = 0; natural meander = max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition= 0; little or no sediment = max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogenous = 0; large, diverse sizes = max points)	NA*	0 – 4	0 – 5	0
STABILITY	12	**Evidence of channel incision or widening** (deeply incised = 0; stable bed & banks = max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion = 0; no erosion, stable banks = max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots = 0; dense roots throughout = max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture, livestock, or timber production** (substantial impact =0; no evidence = max points)	0 – 5	0 – 4	0 – 5	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	2
	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	0
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) crawfish (no evidence = 0; common, numerous types = max points)	0 – 4	0 – 5	0 – 5	1
	21	**Presence of amphibians** tadpoles/frogs (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** water snake (no evidence = 0; abundant evidence = max points)	0 – 6	0 – 5	0 – 5	1
Total Points Possible			100	100	100	
TOTAL SCORE (also enter on first page)						44

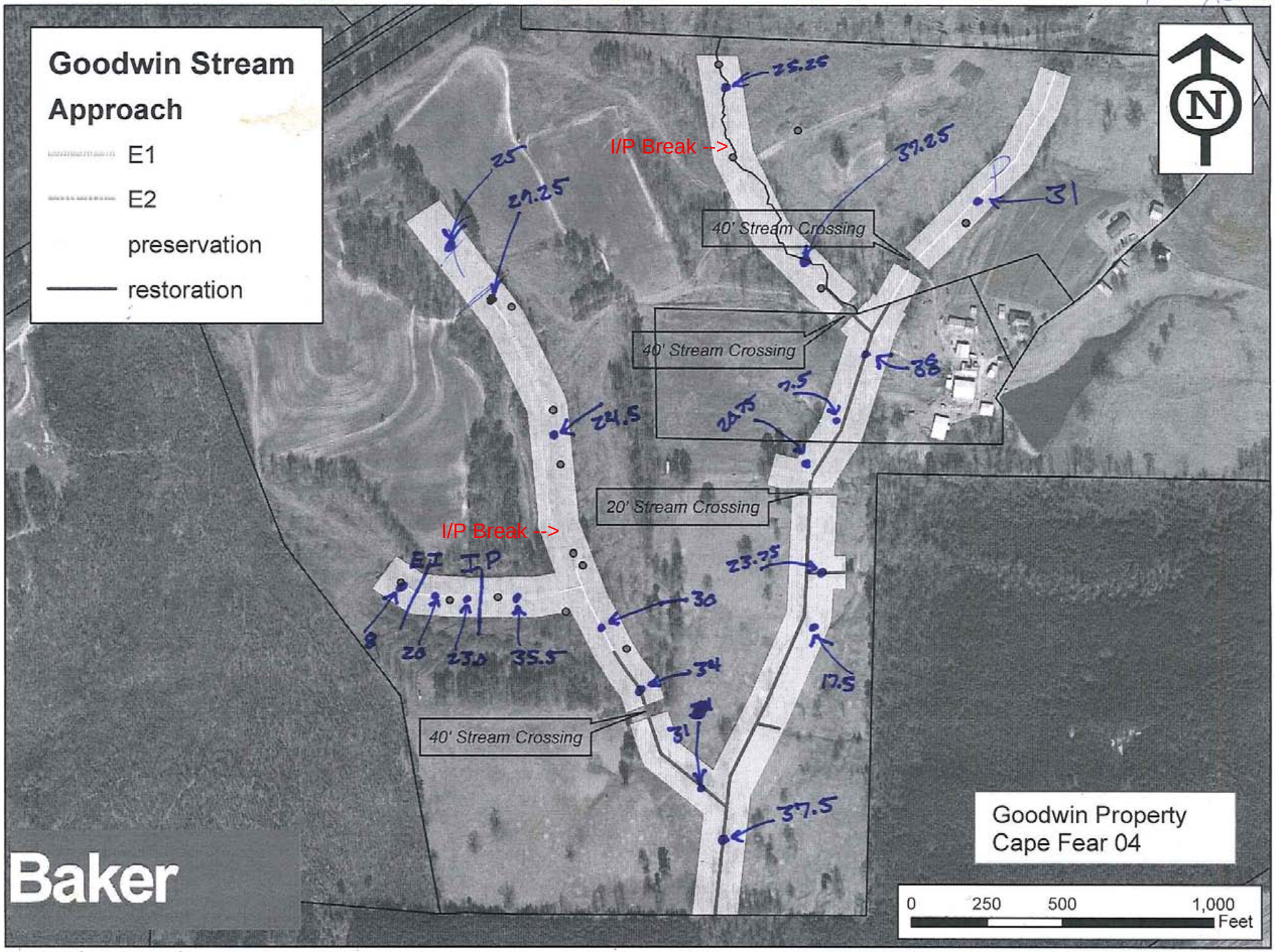
* These characteristics are not assessed in coastal streams.

16.2 NCWAM Forms – Existing Wetlands

NC Wetland Assessment Method (NCWAM) Forms were not included for this project, as the NC Division of Water Resources and the USACE did not require them at the time this project was evaluated.

16.3 NCDWR Stream Classification Forms

5/17/2013 D.H. STR SCORES 4300 Sharon Harris Rd, New Hill



Thomas Creek Intermittent/Perennial Break Descriptions:

Reach R3 I/P Break description:

The break occurs just below the location where an ephemeral tributary (not shown as a surveyed stream on our map, but clearly visible on aerial photos and from topographic lines) joins the primary intermittent channel. The channel deepens from this point down.

Reach R6 I/P Break description:

The break occurs at a head-cut located just below where a small drainage from the concave slope to the east (as identifiable from topographic lines) meets the surveyed channel. Notable stream geomorphic changes are observed above the head-cut in that the channel is shallower and narrower.

R2a/R1

NC DWQ Stream Identification Form Version 4.11

Date: 5/17/2013	**Project/Site:** Goodwin Property	**Latitude:** 35.660276
Evaluator: D. Huneycutt	**County:** Wake	**Longitude:** -78.954516
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 37.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** New Hill *e.g. Quad Name:*

A. Geomorphology (Subtotal = 16.5)	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 bedrock on bottom portion	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

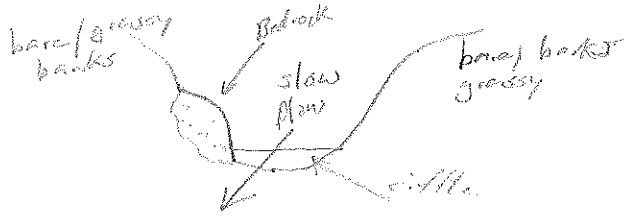
B. Hydrology (Subtotal = 7.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 13.5)				
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: Dragonfly larvae (2), riffle beetle, crayfish, tadpole, water boatman, minnows

Sketch:



Reach 2
below main
confluence

NC DWQ Stream Identification Form Version 4.11

Date: 5/23/2013	**Project/Site:** Goodwin Thomas Crk	**Latitude:** 35.664889
Evaluator: D Huneycutt	**County:** Wake	**Longitude:** -78.952741
Total Points: 38 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** New Hill *e.g. Quad Name:*

A. Geomorphology (Subtotal = 21)	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

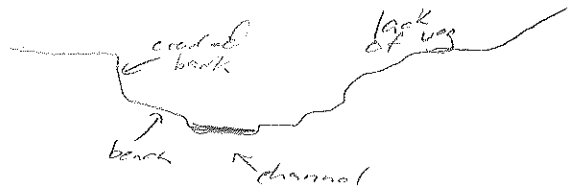
B. Hydrology (Subtotal = 7.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 9.5)				
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: amphipods, isopods,

Sketch:



12
6

21
14.
35

R7
downstream

NC DWQ Stream Identification Form Version 4.11

Date: 5-17-2013	**Project/Site:** Gordon property	**Latitude:** 35.662779
Evaluator: D. Hunycutt	**County:** Wake	**Longitude:** -78.956622
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 35.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* New Hill

A. Geomorphology (Subtotal = 18)	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

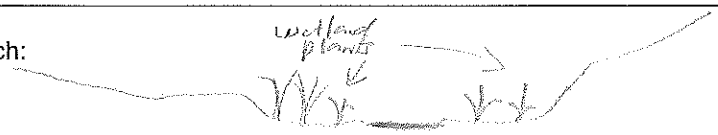
B. Hydrology (Subtotal = 6.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 11)				
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: midge, waterboatman, tadpole

Sketch:



R7 above I break

NC DWQ Stream Identification Form Version 4.11

Date: 5/17/2015	**Project/Site:** Gerlwin property	**Latitude:** 35.662795
Evaluator: D. Hunsucker	**County:** Wake	**Longitude:** -78.957511
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 23	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** New Hill *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

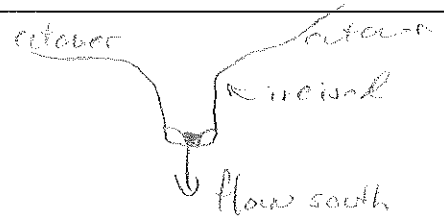
B. Hydrology (Subtotal = 5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 5.5)				
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: no macros observed

Sketch:



R7
mid
(below ephem brk)

NC DWQ Stream Identification Form Version 4.11

Date: 5/17/2013	**Project/Site:** Goodwin property	**Latitude:** 35.662743
Evaluator: D. Huneycutt	**County:** Wake	**Longitude:** -78.957781
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 20	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** New Hill *e.g. Quad Name:*

A. Geomorphology (Subtotal = 9)	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 = 4.5)				
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 = 6.5)				
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: no macros, hydric soil, moist stream bed
top of intermittent reach

Sketch:

turns ephemeral 75' upstream

R17
E
above wetland

NC DWQ Stream Identification Form Version 4.11

Date: 5/17/2013	Project/Site: Goodwin property	Latitude: 35.662885
Evaluator: D. Hunsucker	County: Wake	Longitude: -78.952990
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 8	Stream Determination (circle one) Ephemeral Intermittent Perennial	Other New Hill *e.g. Quad Name:*

A. Geomorphology (Subtotal = 4.5)	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

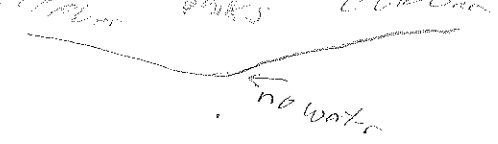
B. Hydrology (Subtotal = 0.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 3.0)				
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: ephemeral channel starts at top of wetland in culvert upstream of wetland is upland and the E channel

Sketch:



R6
above
crossing

NC DWQ Stream Identification Form Version 4.11

Date: 5-17-2013	**Project/Site:** Goodwin property	**Latitude:** 35.665379
Evaluator: D Hunigutt	**County:** Wake	**Longitude:** -78.957037
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 29.25	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** New Hill *e.g. Quad Name:*

A. Geomorphology (Subtotal = 10.5)	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

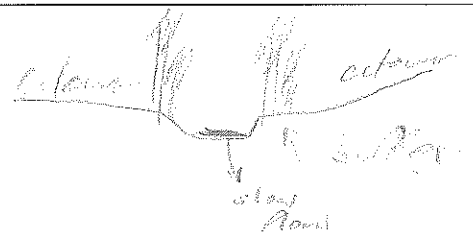
B. Hydrology (Subtotal = 8)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 10.75)				
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: midge, beetle

Sketch:



R6
mid
500' above R7

NC DWQ Stream Identification Form Version 4.11

Date: 5/17/2013	Project/Site: Goodwin property	Latitude: 35.664121
Evaluator: D. Honeycutt	County: Wake	Longitude: -78.956403
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 24.5	Stream Determination (circle one) Ephemeral Intermittent Perennial	Other New Hill *e.g. Quad Name:*

A. Geomorphology (Subtotal = 11)	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 = 3)				
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 = 10.5)				
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: Crayfish, tadpole, beetle, amphipod

Sketch:

R6 top.
Below X-sec
+ below bends

NC DWQ Stream Identification Form Version 4.11

Date: 5/23/2013	**Project/Site:** Goodwin Thomas Crk	**Latitude:** 35.666254
Evaluator: D Hunsucker	**County:** Wake	**Longitude:** -78.957764
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 25	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* New Hill

A. Geomorphology (Subtotal = 8.5)	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

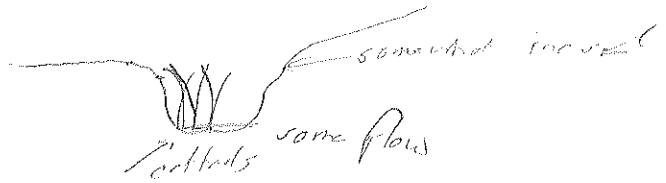
B. Hydrology (Subtotal = 6.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 10)				
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: water beetles, amphipod

Sketch:



R5a
most downstream
on R5

NC DWQ Stream Identification Form Version 4.11

Date: 5/17/2013	Project/Site: Goodwin property	Latitude: 35.660976
Evaluator: D. Huneycutt	County: Wake	Longitude: -78.954707
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 31	Stream Determination (circle one) Ephemeral Intermittent Perennial	Other *e.g. Quad Name:* New Hill

A. Geomorphology (Subtotal = 14)	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 = 10)				
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: crayfish (1), Amphipods, riffle beetle

Sketch:

Sb
above 40' crossing

NC DWQ Stream Identification Form Version 4.11

Date: 5/17/2012	Project/Site: beatum property	Latitude: 35.661760
Evaluator: D. Huneycutt	County: Wake	Longitude: -78.955338
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 34.0	Stream Determination (circle one) Ephemeral Intermittent Perennial	Other *e.g. Quad Name:* New Hill

A. Geomorphology (Subtotal = 18)	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 = 10.0)				
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: juvenile salamanders, beetles, midge

Sketch:

R5b
below R7
confluence

NC DWQ Stream Identification Form Version 4.11

Date: 5/17/2013	**Project/Site:** Goodwin Property	**Latitude:** 35.662553
Evaluator: D. Huneycutt	**County:** Wake	**Longitude:** -78.955912
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 34	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* New Hill

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

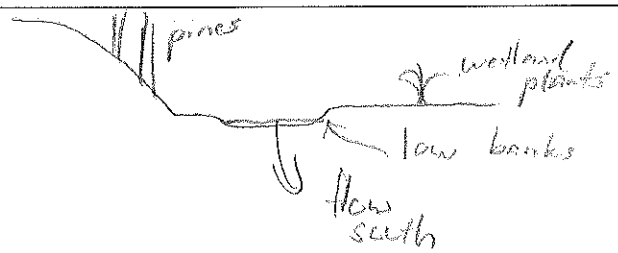
B. Hydrology (Subtotal = 8)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 11)				
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: waterboatman (>5), dragonfly larva, isopod

Sketch:



R4 at Xsec

NC DWQ Stream Identification Form Version 4.11

Date: 5/23/2013	**Project/Site:** Goodwin Thomas Crk	**Latitude:** 35.666468
Evaluator: D. Hunagent	**County:** Wake	**Longitude:** -78.951357
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 31	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** New Hill *e.g. Quad Name:*

A. Geomorphology (Subtotal = 13)	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

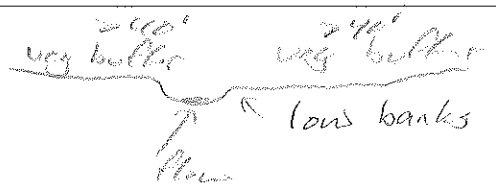
B. Hydrology (Subtotal = 8.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 9.5)				
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: Amphipods, nematode

Sketch:



R3 mid

NC DWQ Stream Identification Form Version 4.11

Date: 5/23/2015	**Project/Site:** Goodwin Thomas Crk	**Latitude:** 35.666103
Evaluator: D. Huneycutt	**County:** Wake	**Longitude:** -78.954148
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 37.25	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* New Hill

A. Geomorphology (Subtotal = 16)	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

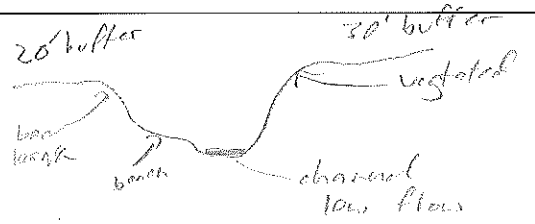
B. Hydrology (Subtotal = 9.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 11.75)				
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: tadpole, baby crawfish, water boatman, nematode, fish, bullfrog

Sketch:



R3 upstream

NC DWQ Stream Identification Form Version 4.11

Date: 5/23/2017	Project/Site: Goodwin Thomas Cole	Latitude: 35.667437
Evaluator: D. Hungerford	County: Wake	Longitude: -78.954806
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 25.25	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	Other New Hill *e.g. Quad Name:*

A. Geomorphology (Subtotal = 11.5)	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 = 5.5)				
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 = 8.25)				
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: nematode, beetle, water boatman

Sketch:

T4

NC DWQ Stream Identification Form Version 4.11

Date: 5/23/2013	**Project/Site:** Goodwin Thomas Crk	**Latitude:** 35.664252
Evaluator: D. Hunnycutt	**County:** Wake	**Longitude:** -78.953349
Total Points: 7.5 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** New Hill *e.g. Quad Name:*

A. Geomorphology (Subtotal = 3)	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

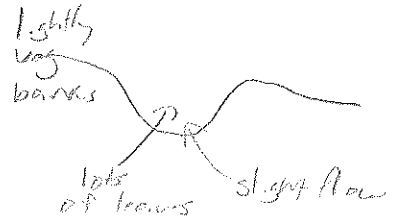
B. Hydrology (Subtotal = 1)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table? No Hydrics	No = 0		Yes = 3	

C. Biology (Subtotal = 3.5)				
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: slightly incised at confluence, no macros or life

Sketch:



13

NC DWQ Stream Identification Form Version 4.11

Date: 5/23/2013	**Project/Site:** Goodwin Thomas Crk	**Latitude:** 35.663968
Evaluator: D. Hungerford	**County:** Wake	**Longitude:** -78.953607
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 20.75	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** New Hill *e.g. Quad Name:*

A. Geomorphology (Subtotal = 6.5)	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

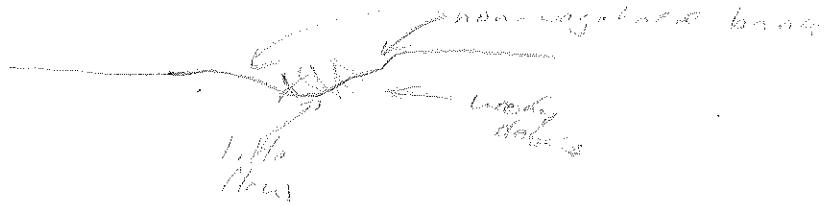
B. Hydrology (Subtotal = 6)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 8.25)				
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: nematodes, beetles only

Sketch:



T2

NC DWQ Stream Identification Form Version 4.11

Date: 5/23/2013	**Project/Site:** Goodwin Thomas Crk	**Latitude:** 35.662917
Evaluator: D. Murray, M	**County:** Wake	**Longitude:** -78.953394
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 23.75	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** New H.11 *e.g. Quad Name:*

A. Geomorphology (Subtotal = 7)	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

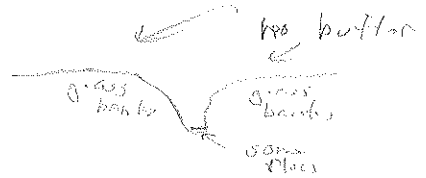
B. Hydrology (Subtotal = 7)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 9.75)				
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: amphipods, beetle, 1 unknown (not EPT)

Sketch:



TI

NC DWQ Stream Identification Form Version 4.11

Date: 5/23/2013	Project/Site: Goodwin Thomas Crk	Latitude: 35.662396
Evaluator: D. Huneycutt	County: Wake	Longitude: -78.953465
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 17.5	Stream Determination (circle one) Ephemeral Intermittent Perennial	Other *e.g. Quad Name:* New Hill

A. Geomorphology (Subtotal = 7)	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 = 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 = 5.5)				
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: no water no macro
form for downstream 20'

Sketch:

16.4 FHWA Categorical Exclusion Form

Baker

Heather Smith February 4, 2014
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Subject: NCEEP stream mitigation project in Wake County.

Dear Ms. Smith,

Please find enclosed two hard copies of the Categorical Exclusion (CE) for the Thomas Creek Restoration Project in Wake County, North Carolina. The project site is located approximately 1.5 miles southwest of the community of New Hill, within North Carolina Department of Environment and Natural Resources (NCDENR) sub-basin 03-06-07 and the targeted local watershed 03030004-020010 of the Cape Fear River Basin.

The proposed project is a full-delivery effort for the North Carolina Ecosystem Enhancement Program (EEP) in response to RFP#: 16-005020. Project goals include the restoration and enhancement of nearly 8,400 feet of stream for the purpose of obtaining stream mitigation credit in the Cape Fear River Basin. The project mitigation plan is under development, but based on estimates following the site visit with the IRT, it is anticipated to include 4,868 feet of Restoration, 248 feet of Enhancement 1, and 3,241 feet of Enhancement 2.

Based on information from the US Fish and Wildlife Service (USFWS) and the North Carolina Wildlife Resources Commission (NCWRC) the following federally listed species have been found in Wake County (see Table 1). As shown in the enclosed copies of letters to these agencies, the proposed project has been found to have no effect on any federally listed threatened or endangered species or the bald eagle. In addition, neither of these agencies has replied with concerns about the project. The enclosed documentation also covers correspondence with the North Carolina Historic Preservation Office (NC-HPO) or the Natural Resources Conservation Service (NRCS).

Table 1. Federally Protected Species for Wake County.

Scientific Name	***Common Name***	***Federal Status***
Alasmidonta heterodon	Dwarf Wedgemussel	E
Rhus michauxii	Michaux's Sumac	E
Picoides borealis	Red-cockaded Woodpecker	E
Haliaeetus leucocephalus	Bald Eagle	BGEPA

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

This project would be considered a "Ground-Disturbing Activity" and the entire CE "checklist" has been completed. Please note that only one set of figures is included in the submittal; identical figures were sent to: USFWS, NCWRC, NC-HPO, and NRCS. The actions associated with the construction of the referenced project have been determined not to individually or cumulatively have a significant effect on the environment. Submission of this CE document fulfills the environmental documentation requirements mandated under the National Environmental Policy Act (NEPA; 40 CFR Parts 1500-1508). If you have any questions, please feel free to contact me at 919-481-5735 or via email at kgilland@mbakercorp.com.

Sincerely,

Ken Gilland, P.G.
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 200
Cary, NC 27518
Phone: (919) 481-5735
Email: kgilland@mbakercorp.com

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information	
Project Name:	Thomas Creek Stream Restoration Site
County Name:	Wake
EEP Number:	96074
Project Sponsor:	Michael Baker Engineering, Inc.
Project Contact Name:	Chris Roessler
Project Contact Address:	8000 Regency Parkway, Suite 600 Cary NC 27518
Project Contact E-mail:	croessler@mbakercorp.com
EEP Project Manager:	Heather Smith (heather.c.smith@ncdenr.gov)

Project Description

The Thomas Creek Restoration Project in Wake County, North Carolina is located approximately 1.5 miles southwest of the community of New Hill, within North Carolina Department of Environment and Natural Resources (NCDENR) sub-basin 03-06-07 and the targeted local watershed 03030004-020010 of the Cape Fear River Basin. The proposed project is a full-delivery effort for the North Carolina Ecosystem Enhancement Program (EEP) in response to RFP#: 16-005020. Project goals include the restoration of approximately 8,400 feet of stream for the purpose of obtaining stream mitigation credit in the Cape Fear River Basin. The project mitigation plan is under development, but based on estimates following the site visit with the IRT, it is anticipated to include 4,868 feet of Restoration, 248 feet of Enhancement 1, and 3,241 feet of Enhancement 2. This project would be considered a "Ground-Disturbing Activity" and the entire CE checklist has been completed.

Date | **EEP Project Manager**

Conditional Approved By:

Date | **For Division Administrator FHWA**

☐ **Check this box if there are outstanding issues**

Final Approval By:

2-13-14

Date | **For Division Administrator FHWA**

Part 2: All Projects Regulation/Question	Response
Coastal Zone Management Act (CZMA)	
1. Is the project located in a CAMA county?	☐ Yes ☑ No
2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)?	☐ Yes ☐ No ☑ N/A
3. Has a CAMA permit been secured?	☐ Yes ☐ No ☑ N/A
4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program?	☐ Yes ☐ No ☑ N/A
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	
1. Is this a "full-delivery" project?	☑ Yes ☐ No
2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial?	☐ Yes ☑ No ☐ N/A
3. As a result of a limited Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☑ No ☐ N/A
4. As a result of a Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☑ N/A
5. As a result of a Phase II Site Assessment, are there known or potential hazardous waste sites within the project area?	☐ Yes ☐ No ☑ N/A
6. Is there an approved hazardous mitigation plan?	☐ Yes ☐ No ☑ N/A
National Historic Preservation Act (Section 106)	
1. Are there properties listed on, or eligible for listing on, the National Register of Historic Places in the project area?	☐ Yes ☑ No
2. Does the project affect such properties and does the SHPO/THPO concur?	☐ Yes ☐ No ☑ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☑ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a "full-delivery" project?	☑ Yes ☐ No
2. Does the project require the acquisition of real estate?	☑ Yes ☐ No ☐ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☐ Yes ☑ No ☐ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☑ Yes ☐ No ☐ N/A

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☐ Yes ☑ No
2. Is the site of religious importance to American Indians?	☐ Yes ☐ No ☑ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☑ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☑ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☑ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☑ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☑ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species?	☑ Yes ☐ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☐ Yes ☑ No ☐ N/A
4. Is the project "likely to adversely affect" the species and/or "likely to adversely modify" Designated Critical Habitat?	☐ Yes ☑ No ☐ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☑ Yes ☐ No ☐ N/A
6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination?	☐ Yes ☐ No ☑ N/A

Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as "territory" by the EBCI?	☐ Yes ☑ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project?	☐ Yes ☐ No ☑ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☑ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☑ Yes ☐ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☑ Yes ☐ No ☐ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☑ Yes ☐ No ☐ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☑ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☑ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☑ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☑ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☑ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☑ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☑ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☑ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☐ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☑ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☑ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☑ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☑ N/A

Baker

Ms. Kristin May
Resource Soil Scientist
530 West Innes Street
Salisbury, NC 28144

January 22, 2014

Subject: Prime and Important Farmland Soils RE: NCEEP Project, Thomas Creek Stream Restoration Site, Wake County, NC

Dear Ms. May:

Enclosed please find a completed copy of the Farmland Conversion Impact Rating form (AD-1006) and associated mapping for the subject site. Thank you for your assistance in developing the form, the final adds to the material you provided. As stated in our previous correspondence, the site is located in Wake County between the Lake Jordan and Shearon Harris Reservoirs, southwest of the New Hill Community, as shown in Figure 1. This stream restoration site proposes to restore Thomas Creek, a tributary to the Shearon Harris Reservoir.

Again, we appreciate your assistance with the project and hope you have a wonderful 2014. I would be glad to provide a hard copy of the final information if it would be better for you. If you have any questions, please feel free to contact me at kgilland@mbakercorp.com or by phone at (919) 481-5735. Thank you again for your assistance in this matter.

Sincerely,

Ken Gilland

Ken Gilland, P.G.
Baker Engineering, NY, Inc.
8000 Regency Parkway, Suite 600
Cary, NC 27518

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 1/6/14
Name Of Project Thomas Creek Stream Restoration Project	Federal Agency Involved FHWA
Proposed Land Use Stream Restoration	County And State Wake, NC
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 1/8/14

Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply -- do not complete additional parts of this form).*	Yes ☑ No ☐	Acres Irrigated none	Average Farm Size 110
Major Crop*(s)* Corn	Farmable Land In Govt. Jurisdiction Acres: 85.4 % 467,992	Amount Of Farmland As Defined in FPPA Acres: 446,451 % 80	
Name Of Land Evaluation System Used Wake County LESA	Name Of Local Site Assessment System	Date Land Evaluation Returned By NRCS 1/8/14	

PART III *(To be completed by Federal Agency)*	Alternative Site Rating Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly	21.2			
B. Total Acres To Be Converted Indirectly				
C. Total Acres In Site	21.2	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information				
A. Total Acres Prime And Unique Farmland	0.2			
B. Total Acres Statewide And Local Important Farmland	11.0			
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted	0.0			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value	84.6			
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*	44	0	0	0

PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points	Site A	Site B	Site C	Site D
1. Area In Nonurban Use		12			
2. Perimeter In Nonurban Use		11			
3. Percent Of Site Being Farmed		12			
4. Protection Provided By State And Local Government		20			
5. Distance From Urban Builtup Area		15			
6. Distance To Urban Support Services		10			
7. Size Of Present Farm Unit Compared To Average		7			
8. Creation Of Nonfarmable Farmland		0			
9. Availability Of Farm Support Services		5			
10. On-Farm Investments		17			
11. Effects Of Conversion On Farm Support Services		0			
12. Compatibility With Existing Agricultural Use		0			
TOTAL SITE ASSESSMENT POINTS	160	109	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100	44	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*	160	109	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	153	0	0	0

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

Reason For Selection:

(See Instructions on reverse side)

This form was electronically produced by National Production Services Staff

Clear Form

Form AD-1006 (10-83)

Baker

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

December 27, 2013

Subject: EEP stream mitigation project in Wake County.

Dear Ms. Gledhill-Earley,

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

The Thomas Creek site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel and/or wetland impacts. Several sections of channel have been identified as significantly degraded by past channelization and agricultural practices.

No architectural structures or archeological artifacts have been observed or noted during preliminary surveys of the site for restoration purposes. As shown in the enclosed map generated through HPOWEB, the nearest NRHP-listed site to the project area is the Allie Lawrence Farm (1981)(WA1097), which is approximately 2,070 feet to the northeast of the project terminus. We ask that you review this site based on the attached information to determine the presence of any historic properties.

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

Sincerely,

Ken Gilland

Ken Gilland, P.G.
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 600
Cary, NC 27518

Phone: (919) 481-5735
Email: kgilland@mbakercorp.com

North Carolina Department of Cultural Resources

State Historic Preservation Office

Ramona M. Bartos, Administrator

Governor Pat McCrory
Secretary Susan Kluttz

Office of Archives and History
Deputy Secretary Kevin Cherry

January 16, 2014

Ken Gilland
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 600
Cary, NC 27518

Re: Thomas Creek Stream Mitigation, Wake County, ER 13-3040

Dear Mr. Gilland:

Thank you for your letter of December 27, 2013, concerning the above project.

We have conducted a review of the project and are aware of no historic resources which would be affected by the project. Therefore, we have no comment on the project as proposed.

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

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

Sincerely,

Renee Gledhill-Earley

for Ramona M. Bartos

Baker

Gary Jordan
US Fish and Wildlife Service
Raleigh Field Office
P.O. Box 33726
Raleigh, NC 27636

December 27, 2013

Subject: EEP stream mitigation project in Wake County

Dear Mr. Jordan,

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

The Thomas Creek site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel and/or wetland impacts. Several sections of channel have been identified as significantly degraded by past channelization and agricultural practices.

We have already obtained an updated species list for Wake County from your web site (http://www.fws.gov/raleigh/species/cntylist/wake.html). The listed species are shown in Table 1.

Scientific Name	Common Name	Federal Status
Haliaeetus leucocephalus	Bald Eagle	BGPA
Picoides borealis	Red-cockaded Woodpecker	Endangered
Alasmidonta heterodon	Dwarf Wedgemusel	Endangered
Rhus michauxii	Michaux's Sumac	Endangered

Based on our review and field surveys, we have developed the following conclusions on the potential effects of this project on federally listed species:

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

Adult bald eagles can be identified by their large white head and short white tail. The body plumage is dark-brown to chocolate-brown in color. In flight, bald eagles can be identified by their flat wing soar. Eagle nests are found in close proximity to water (within 0.5 mile) with a clear flight path to the water, in the largest living tree in an area, and having an open view of the surrounding land.

Human disturbance can cause an eagle to abandon otherwise suitable habitat. The breeding season for the bald eagle begins in December or January. Fish are the major food source for bald eagles. Other sources include coots, herons, and wounded ducks. Food may be live or carrion.

Biological Conclusion: No Effect

A desktop-GIS assessment of the project study area, as well as the area within a 1.13 mile radius (1.0 mile plus 660 feet) of the project limits, was performed on December 20, 2013 using Google Earth color aerials. Shearon Harris Lake is large enough and sufficiently open to be considered a potential feeding source and is within 1-mile of the project study area. Since there was foraging habitat within the review area, a survey of the project study area and the area within 660 feet of the project limits was conducted. No nests or large dominant trees were observed. Due to the lack of habitat and minimal impact anticipated for this project, it has been determined that this project will not affect this species.

***Picoides borealis* (Red-Cockaded Woodpecker)**
Federal Status: Endangered
Animal Family: Picidae
Federally Listed: October 13, 1970

The red-cockaded woodpecker once occurred from New Jersey to southern Florida and west to eastern Texas. It occurred inland in Kentucky, Tennessee, Arkansas, Oklahoma, and Missouri. The red-cockaded woodpecker is now found only in coastal states of its historic range and inland in southeastern Oklahoma and southern Arkansas. In North Carolina moderate populations occur in the sandhills and southern coastal plain. The few populations found in the Piedmont and northern Coastal Plain are believed to be relics of former populations.

The red-cockaded woodpecker is approximately 8 inches long with a wingspan of 14 inches. Plumage includes black and white horizontal stripes on its back, with white cheeks and under parts. Its flanks are streaked black. The cap and stripe on the throat and side of neck are black, with males having a small red spot on each side of the cap. Eggs are laid from April through June. Maximum clutch size is seven eggs with an average of three to five.

Red-cockaded woodpeckers are found in open pine stands that are between 80 and 120 years old. Longleaf pine stands are most commonly utilized. Dense stands are avoided. A forested stand must contain at least 50% pine, lack a thick understory, and be contiguous with other stands to be appropriate habitat for the red-cockaded woodpecker. These birds forage in pine and pine hardwood stands, with preference given to pine trees that are 10 inches or larger in diameter. The foraging range of the red cockaded woodpecker is up to 500 acres. The acreage must be contiguous with suitable nesting sites. While other woodpeckers bore out cavities in dead trees where the wood is rotten and soft, the red-cockaded woodpecker is the only one that excavates cavities exclusively in living pine trees. The older pines favored by the red-cockaded woodpecker often suffer from a fungus called red heart disease which attacks the center of the trunk, causing the inner wood to become soft. Cavities generally take 1 to 3 years to excavate. The red-cockaded woodpecker feeds mainly on beetles, ants, roaches, caterpillars, wood-boring insects and spiders, and occasionally fruits and berries.

Biological Conclusion: No Effect

Suitable habitat for the red-cockaded woodpecker does not exist in the study area, therefore, a half mile survey was not conducted. It was concluded that the project will not affect this species.

***Alasmidonta heterodon* (Dwarf wedgemussel)**
Federal Status: Endangered
Animal Family: Unionidae

The dwarf wedgemussel is a small freshwater mussel with a trapezoidal-shaped shell that is usually less then 1.7 inches in length and is brown to yellowish brown in color. It is historically known to exist from New Brunswick, Canada to North Carolina. Documented populations in N.C. have occurred in Johnston, Wake, Orange, Nash, Wilson, Granville, Person, Vance, Franklin and Warren Counties.

The dwarf wedgemussel inhabits creeks and rivers close to the banks, under overhangs, and around submerged logs. It is also known to live on firm substrate of sand, gravel, and muddy sand with a slow to moderate current, and requires clean water that is well oxygenated and nearly silt free. Hosts for the dwarf wedgemussel larvae (glochidia) that have been identified include the tessellated darter (*Etheostoma olmstedi*), Johnny darter (*E. nigrum*), and mottled sculpin (*Cottus bairdi*).

Biological Conclusion: No Effect

Thomas Creek is not in the Neuse or Tar River drainage basins, which are the only known drainages that support dwarf wedgemussel populations. it has been determined that this project will not affect this species.

(Rhus michauxii) Michaux's Sumac
Federal Status: Endangered
Plan Family: Anacardiaceae

Michaux's sumac is a densely pubescent rhizomatus shrub that grows 0.7 to 3.3 feet in height. The narrowly winged or wingless rachis supports nine to thirteen sessile, oblong-lanceolate leaflets that are 1.6 to 3.6 inches long, 0.8 to 2 inches wide, acute, and acuminate. The bases of the leaves are rounded and their edges are simple or doubly serrate. Plants flower in June, producing a terminal, erect, dense cluster of four to five greenish-yellow to white flowers. The plant also produces fruit, a red drupe, through the months of August to October.

This plant occurs in rocky or sandy open woods and roadsides. It is dependent on disturbance (mowing, clearing, fire) to maintain the openness of its habitat. It grows in open habitat where it can get full sunlight and is often found with other members of its genus as well as with poison ivy. Michaux's sumac is endemic to the inner Coastal Plain and Piedmont physiographic provinces of North Carolina.

Biological Conclusion: No Effect

Suitable habitat for Michaux's sumac is present in the study area along roadside shoulders and cleared tracks. Surveys were conducted by Baker biologists throughout areas of suitable habitat on September 17, 2013. No individuals of Michaux's sumac were observed. it has been determined that this project will not affect this species.

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

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

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

Sincerely,

Ken Gilland

Ken Gilland, P.G.
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 600
Cary, NC 27518

Phone: (919) 481-5735
Email: kgilland@mbakercorp.com

cc:
Perry Sugg, NCEEP

Baker

Shari L. Bryant
North Carolina Wildlife Resources Commission
Division of Inland Fisheries
1721 Mail Service Center
Raleigh, NC 27699

December 27, 2013

Subject: EEP stream mitigation project in Wake County

Dear Ms. Deaton,

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

The Thomas Creek site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel and/or wetland impacts. Several sections of channel have been identified as significantly degraded by past channelization and agricultural practices.

We have already obtained an updated species list for Alamance County from your web site (http://portal.ncdenr.org/web/nhp/database-search). The listed species are shown in Table 1.

Scientific Name	Common Name	Federal Status
Haliaeetus leucocephalus	Bald Eagle	BGPA
Picoides borealis	Red-cockaded Woodpecker	Endangered
Alasmidonta heterodon	Dwarf Wedgemusel	Endangered
Rhus michauxii	Michaux's Sumac	Endangered

Based on our review and field surveys, we have developed the following conclusions on the potential effects of this project on federally listed species:

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

Adult bald eagles can be identified by their large white head and short white tail. The body plumage is dark-brown to chocolate-brown in color. In flight, bald eagles can be identified by their flat wing soar. Eagle nests are found in close proximity to water (within 0.5 mile) with a clear flight path to the water, in the largest living tree in an area, and having an open view of the surrounding land.

Human disturbance can cause an eagle to abandon otherwise suitable habitat. The breeding season for the bald eagle begins in December or January. Fish are the major food source for bald eagles. Other sources include coots, herons, and wounded ducks. Food may be live or carrion.

Biological Conclusion: No Effect

A desktop-GIS assessment of the project study area, as well as the area within a 1.13 mile radius (1.0 mile plus 660 feet) of the project limits, was performed on December 20, 2013 using Google Earth color aerials. Shearon Harris Lake is large enough and sufficiently open to be considered a potential feeding source and is within 1-mile of the project study area. Since there was foraging habitat within the review area, a survey of the project study area and the area within 660 feet of the project limits was conducted. No nests or large dominant trees were observed. Due to the lack of habitat and minimal impact anticipated for this project, it has been determined that this project will not affect this species.

***Picoides borealis* (Red-Cockaded Woodpecker)**
Federal Status: Endangered
Animal Family: Picidae
Federally Listed: October 13, 1970

The red-cockaded woodpecker once occurred from New Jersey to southern Florida and west to eastern Texas. It occurred inland in Kentucky, Tennessee, Arkansas, Oklahoma, and Missouri. The red-cockaded woodpecker is now found only in coastal states of its historic range and inland in southeastern Oklahoma and southern Arkansas. In North Carolina moderate populations occur in the sandhills and southern coastal plain. The few populations found in the Piedmont and northern Coastal Plain are believed to be relics of former populations.

The red-cockaded woodpecker is approximately 8 inches long with a wingspan of 14 inches. Plumage includes black and white horizontal stripes on its back, with white cheeks and under parts. Its flanks are streaked black. The cap and stripe on the throat and side of neck are black, with males having a small red spot on each side of the cap. Eggs are laid from April through June. Maximum clutch size is seven eggs with an average of three to five.

Red-cockaded woodpeckers are found in open pine stands that are between 80 and 120 years old. Longleaf pine stands are most commonly utilized. Dense stands are avoided. A forested stand must contain at least 50% pine, lack a thick understory, and be contiguous with other stands to be appropriate habitat for the red-cockaded woodpecker. These birds forage in pine and pine hardwood stands, with preference given to pine trees that are 10 inches or larger in diameter. The foraging range of the red cockaded woodpecker is up to 500 acres. The acreage must be contiguous with suitable nesting sites. While other woodpeckers bore out cavities in dead trees where the wood is rotten and soft, the red-cockaded woodpecker is the only one that excavates cavities exclusively in living pine trees. The older pines favored by the red-cockaded woodpecker often suffer from a fungus called red heart disease which attacks the center of the trunk, causing the inner wood to become soft. Cavities generally take 1 to 3 years to excavate. The red-cockaded woodpecker feeds mainly on beetles, ants, roaches, caterpillars, wood-boring insects and spiders, and occasionally fruits and berries.

Biological Conclusion: No Effect

Suitable habitat for the red-cockaded woodpecker does not exist in the study area, therefore, a half mile survey was not conducted. It was concluded that the project will not affect this species.

***Alasmidonta heterodon* (Dwarf wedgemussel)**
Federal Status: Endangered
Animal Family: Unionidae

The dwarf wedgemussel is a small freshwater mussel with a trapezoidal-shaped shell that is usually less then 1.7 inches in length and is brown to yellowish brown in color. It is historically known to exist from New Brunswick, Canada to North Carolina. Documented populations in N.C. have occurred in Johnston, Wake, Orange, Nash, Wilson, Granville, Person, Vance, Franklin and Warren Counties.

The dwarf wedgemussel inhabits creeks and rivers close to the banks, under overhangs, and around submerged logs. It is also known to live on firm substrate of sand, gravel, and muddy sand with a slow to moderate current, and requires clean water that is well oxygenated and nearly silt free. Hosts for the dwarf wedgemussel larvae (glochidia) that have been identified include the tessellated darter (*Etheostoma olmstedi*), Johnny darter (*E. nigrum*), and mottled sculpin (*Cottus bairdi*).

Biological Conclusion: No Effect

Thomas Creek is not in the Neuse or Tar River drainage basins, which are the only known drainages that support dwarf wedgemussel populations. it has been determined that this project will not affect this species.

(Rhus michauxii) Michaux's Sumac
Federal Status: Endangered
Plan Family: Anacardiaceae

Michaux's sumac is a densely pubescent rhizomatus shrub that grows 0.7 to 3.3 feet in height. The narrowly winged or wingless rachis supports nine to thirteen sessile, oblong-lanceolate leaflets that are 1.6 to 3.6 inches long, 0.8 to 2 inches wide, acute, and acuminate. The bases of the leaves are rounded and their edges are simple or doubly serrate. Plants flower in June, producing a terminal, erect, dense cluster of four to five greenish-yellow to white flowers. The plant also produces fruit, a red drupe, through the months of August to October.

This plant occurs in rocky or sandy open woods and roadsides. It is dependent on disturbance (mowing, clearing, fire) to maintain the openness of its habitat. It grows in open habitat where it can get full sunlight and is often found with other members of its genus as well as with poison ivy. Michaux's sumac is endemic to the inner Coastal Plain and Piedmont physiographic provinces of North Carolina.

Biological Conclusion: No Effect

Suitable habitat for Michaux's sumac is present in the study area along roadside shoulders and cleared tracks. Surveys were conducted by Baker biologists throughout areas of suitable habitat on September 17, 2013. No individuals of Michaux's sumac were observed. it has been determined that this project will not affect this species.

If we have not heard from you in 30 days we will assume that our species list is correct and that NCWRC does not have any information relevant to this project at the current time.

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

Sincerely,

Ken Gilland, P.G.
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 600
Cary, NC 27518

Phone: (919) 481-5735
Email: kgilland@mbakercorp.com

cc:
Perry Sugg, NCEEP

North Carolina Wildlife Resources Commission

Gordon Myers, Executive Director

15 January 2014

Ken Gilland
Michael Baker Engineering, Inc.
8000 Regency Parkway, Suite 600
Cary, NC 27518

Subject: EEP Stream Mitigation Project in Wake County

Dear Mr. Gilland:

Biologists with the North Carolina Wildlife Resources Commission (NCWRC) have reviewed the subject information. Our comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667e) and North Carolina General Statutes (G.S. 113-131 et seq.).

The proposed project would provide in-kind mitigation for unavoidable stream and/or wetland impacts. Several sections of channel throughout the site have been identified as significantly degraded from past channelization and agricultural activities. The project site includes Thomas Creek, a tributary to Shearon Harris Reservoir in the Cape Fear River basin.

It appears NCWRC game lands are located adjacent to and immediately downstream of the project site. It does not appear the proposed project will directly impact these game lands. However, if any direct impacts to the game lands are proposed, then we ask the applicant to contact the NCWRC to develop measures to minimize these impacts.

Stream restoration projects often improve water quality and aquatic habitat. Establishing native, forested buffers in riparian areas will help protect water quality, improve aquatic and terrestrial habitats, and provide a travel corridor for wildlife species. Provided measures are taken to minimize erosion and sedimentation from construction/restoration activities, we do not anticipate the project to result in significant adverse impacts to aquatic and terrestrial wildlife resources.

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

Thank you for the opportunity to review this proposed project. If we can provide further assistance, please contact our office at (336) 449-7625 or shari.bryant@ncwildlife.org.

Sincerely,

Shari L. Bryant
Piedmont Region Coordinator
Habitat Conservation Program

cc: Vann Stancil, NCWRC

AFFIDAVIT OF PUBLICATION

STATE OF NORTH CAROLINA
COUNTY OF WAKE

Ad Number
0000870014

Advertiser Name: MICHAEL BAKER ENGINEERING
Address: 8000 REGENCY PARKWAY, SUITE 600
CARY, NC 27518

Before the undersigned, a Notary Public of Wake County North Carolina, duly commissioned and authorized to administer oaths, affirmations, etc., personally appeared DEBORAH MAHAFFEY, who being duly sworn or affirmed, according to law, doth depose and say that he or she is Accounts Receivable Specialist of The News & Observer a corporation organized and doing business under the Laws of the State of North Carolina, and publishing a newspaper known as The News & Observer, in the City of Raleigh, Wake County and State aforesaid, the said newspaper in which such notice, paper, document, or legal advertisement was published was, at the time of each and every such publication, a newspaper meeting all of the requirements and qualifications of Section 1-597 of the General Statutes of North Carolina and was a qualified newspaper within the meaning of Section 1-597 of the General Statutes of North Carolina, and that as such he or she makes this affidavit; and is familiar with the books, files and business of said corporation and by reference to the files of said publication the attached advertisement for MICHAEL BAKER ENGINEERING was inserted in the aforesaid newspaper on dates as follows:

01/24/2014,01/29/2014

NOTICE OF AN OPPORTUNITY FOR AN INFORMATIONAL PUBLIC MEETING ON THE USE OF PROPERTY FOR THE RESTORATION OF STREAMS

Wake County

Michael Baker Engineering, Inc. proposes to acquire a preservation easement on a 21.1-acre tract of land in Wake County, NC, southwest of the New Hill community. The purpose of using this property is to provide mitigation for unavoidable impacts to streams that will result from existing or future development in this area. The project will restore Thomas Creek, a tributary to Shearon Harris Reservoir.

Anyone desiring that an informational public meeting be held for this proposed action may make such a request by registered letter to Michael Baker Engineering, Inc., at 8000 Regency Parkway, Suite 600 Cary, NC 27518. Request must be made by February 24, 2014. If additional information is required, please contact Ken Gilland at 919-481-5735.

The Ecosystem Enhancement Program reserves the right to determine if a public meeting will be held.

N&O: January 24, 29, 2014

TIMOTHY R WINSLOW
Notary Public
Wake County
NORTH CAROLINA

Deborah Mahaffey
DEBORAH MAHAFFEY, Accounts Receivable Specialist
Wake County, North Carolina

Sworn to and subscribed before me
This 30th day of January, 2014

My Commission Expires: 06/04/2018

Timothy R Winslow
Notary Signature

Michael Baker
INTERNATIONAL

February 4, 2015

Subject: EEP stream mitigation project in Wake County

***Picoides borealis* (Red-Cockaded Woodpecker)**
Federal Status: Endangered
Animal Family: Picidae
Federally Listed: October 13, 1970

The red-cockaded woodpecker once occurred from New Jersey to southern Florida and west to eastern Texas. It occurred inland in Kentucky, Tennessee, Arkansas, Oklahoma, and Missouri. The red-cockaded woodpecker is now found only in coastal states of its historic range and inland in southeastern Oklahoma and southern Arkansas. In North Carolina moderate populations occur in the sandhills and southern coastal plain. The few populations found in the Piedmont and northern Coastal Plain are believed to be relics of former populations.

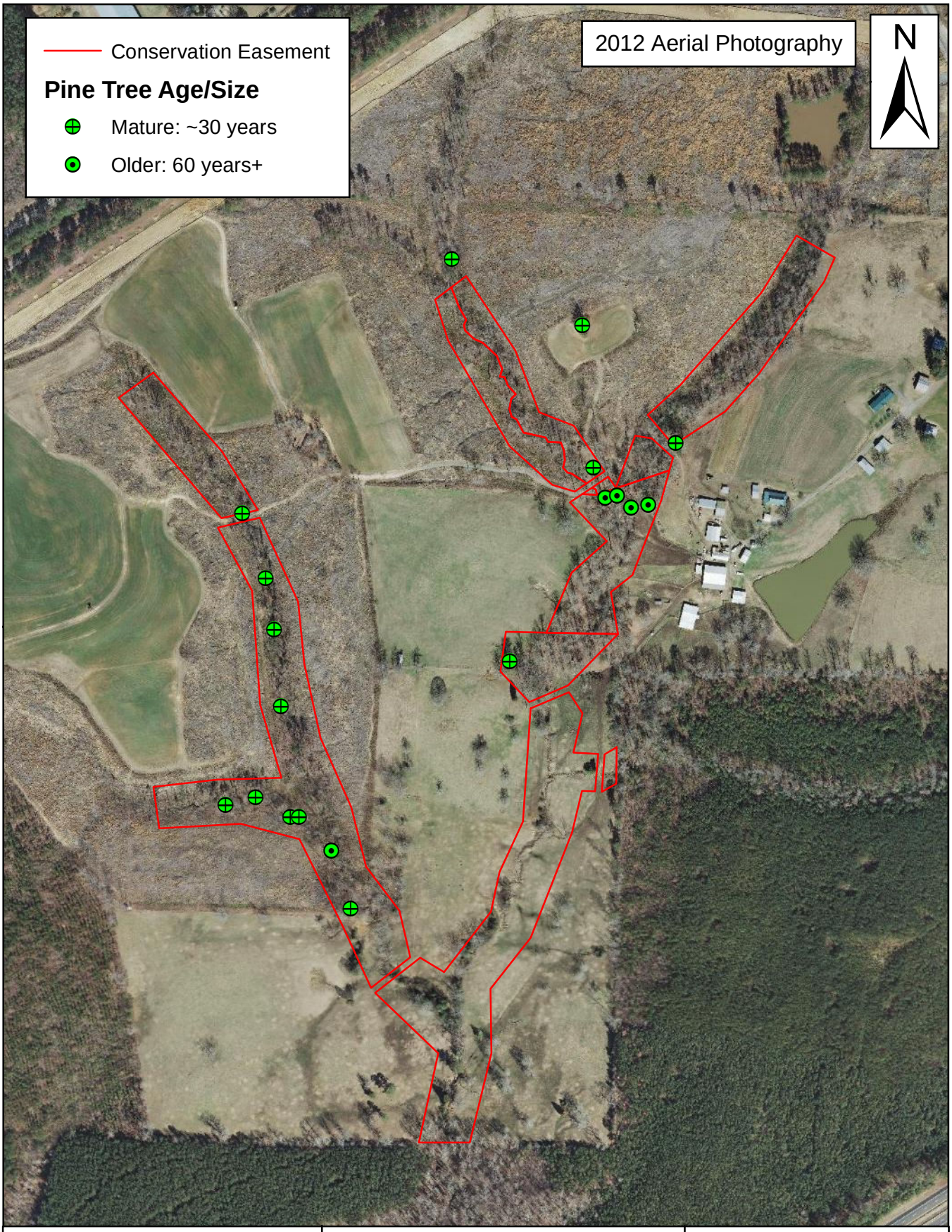
The red-cockaded woodpecker is approximately 8 inches long with a wingspan of 14 inches. Plumage includes black and white horizontal stripes on its back, with white cheeks and under parts. Its flanks are streaked black. The cap and stripe on the throat and side of neck are black, with males having a small red spot on each side of the cap. Eggs are laid from April through June. Maximum clutch size is seven eggs with an average of three to five.

Red-cockaded woodpeckers are found in open pine stands that are between 80 and 120 years old. Longleaf pine stands are most commonly utilized. Dense stands are avoided. A forested stand must contain at least 50% pine, lack a thick understory, and be contiguous with other stands to be appropriate habitat for the red-cockaded woodpecker. These birds forage in pine and pine hardwood stands, with preference given to pine trees that are 10 inches or larger in diameter. The foraging range of the red cockaded woodpecker is up to 500 acres. The acreage must be contiguous with suitable nesting sites. While other woodpeckers bore out cavities in dead trees where the wood is rotten and soft, the red-cockaded woodpecker is the only one that excavates cavities exclusively in living pine trees. The older pines favored by the red-cockaded woodpecker often suffer from a fungus called red heart disease which attacks the center of the trunk, causing the inner wood to become soft. Cavities generally take 1 to 3 years to excavate. The red-cockaded woodpecker feeds mainly on beetles, ants, roaches, caterpillars, wood-boring insects and spiders, and occasionally fruits and berries.

Biological Conclusion: No Effect

A survey for suitable habitat for the red-cockaded woodpecker was conducted for the entire study area on February 4, 2015. No such habitat was found. No mature pine stands were observed anywhere on the project area, and only five individual trees of appropriate age were discovered (see map for details). Each was inspected and determined not to have any excavated cavities. Thus, it was concluded that the project will not affect this species. As

suitable habitat for the red-cockaded woodpecker does not exist within the study area, a half mile survey was not conducted.



Michael Baker INTERNATIONAL

0 250 500 Feet

Red-Cockaded Woodpecker Survey
Thomas Creek Site
4Feb2015

16.5 FEMA Compliance - NCEEP Floodplain Requirements Checklist

The topography of the site and location in the upper watershed supports the design without creating the potential for hydrologic trespass. The site is not located in a FEMA mapped area and therefore a hydraulic analysis is not required to obtain a “No-Rise/No-Impact” certification. Baker notified the Wake County Floodplain Manager about the project. The NCEEP Floodplain Checklist was provided to the Wake County Floodplain Manager along with applicable figures and information from this report. Wake County has requirements for a flood study and permit fees if culverts are installed. Consequently, Baker has decided that ford crossings will be used, which do not require flood studies or permit fees.

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. State NFIP Engineer), NC Floodplain Mapping Unit (attn. State NFIP Coordinator) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Thomas Creek Restoration Project
Name if stream or feature:	Thomas Creek
County:	Wake
Name of river basin:	Cape Fear
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Wake County
DFIRM panel number for entire site:	3720060800 (0608)
Consultant name:	Chris Roessler Michael Baker Engineering, Inc.
Phone number:	919-481-5737
Address:	8000 Regency Parkway, Suite 600 Cary, NC 27518

Design Information

Michael Baker Engineering, Inc. proposes to restore 4,748 linear feet (LF) of stream, and enhance 2,874 LF of stream along Thomas Creek and several of its tributaries. The project site is located approximately 1.5 miles southwest of New Hill, NC (see Figure 1). The project site is located in the NC Division of Water Quality subbasin 03-06-07 and the NC Ecosystem Enhancement Program's Targeted Local Watershed 03030004-020010 of the Cape Fear River Basin. The purpose of the project is to restore and/or enhance stream and riparian buffer functions and improve area water quality where impaired stream channel flows through the site. The project will provide numerous water quality and ecological benefits within the Thomas Creek and Harris Lake watersheds, and the Cape Fear River Basin. A recorded conservation easement consisting of approximately 20.1 acres will protect all stream reaches and riparian buffers in perpetuity.

Reach	**Length**	**Priority**
Reach R1	*266 LF*	*Restoration*
Reach R2	*2,087*	*Restoration*
Reach R3	*130 LF (upstream) and* *929 LF (downstream*	*Enhancement II* *Restoration*
Reach R4	*336 LF*	*Restoration*
Reach R5	*142 LF (upstream) and* *897 LF (downstream*	*Enhancement II* *Restoration*
Reach R6	*210 LF (upstream) and* *1,598 LF (downstream)*	*Enhancement I* *Enhancement II*
Reach R7	*286 LF*	*Enhancement II*
Reach T1	*233 LF*	*Restoration*
Reach T2	*158 LF*	*Enhancement II*

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

☐ Yes ☒ No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☐ Detailed Study

☐ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation:

Check if applies:

☐ AE Zone

☐ Floodway ☐ Non-Encroachment ☒ None ☐ A Zone ☐ Local Setbacks Required ☐ No Local Setbacks Required
If local setbacks are required, list how many feet:
Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks? ☐ Yes ☒ No
Land Acquisition (Check) ☐ State owned (fee simple) ☐ Conservation easment (Design Bid Build) ☑ Conservation Easement (Full Delivery Project) Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)
Is community/county participating in the NFIP program? ☒ Yes ☐ No Note: if community is not participating, then all requirements should be addressed to NFIP (attn: State NFIP Engineer, (919) 715-8000)
Name of Local Floodplain Administrator: Betsy Pearce Phone Number: 919-856-7541

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 (CLOMR)

☐ Other Requirements

List other requirements:

Comments:

Name: Chris Roessler Signature:

Title: Technical Manager Date: 8/28/2014

WAKE COUNTY NORTH CAROLINA
Environmental Services

TEL 919 856 7400
FAX 919 743 4772

Water Quality Division
336 Fayetteville Street • Raleigh, NC 27602
www.wakegov.com

Wake County Flood Study Checklist

Under County ordinance, encroachments into Special Flood Hazard Areas (SFHA) require Permit and Certification Requirements per Article 14, Flood Hazard Areas, of the Unified Development Ordinance (UDO). The purpose of a Flood Study Report is to promote the public health, safety and general welfare by reducing public and private losses caused by flood conditions in SFHA. This checklist shows what information needs to be provided and what issues need to be addressed when preparing a Flood Study Report. All items listed may not be applicable to each site, nor is the list all-inclusive. It is meant to serve as a guide for the engineer preparing a Flood Study Report.

Part 1 - For all Flood Studies

	Delineate Crossings and Label On Map (1"equals no more than 100') & Drawings
	Provide flood study report narrative describing study objectives and include a summary of findings
	Existing and proposed watershed, sub-watershed, and land use boundaries with supporting Zoning overlaid. Wake County requires Flood Study reports to be designed for upstream built out conditions.
	Include all assumption for supporting methodology used for determining Cubic Feet per Second (Q100).
	Drainage area worksheets delineating upstream drainage area in Acres.
	Existing and proposed Tc/Tt flow paths used to calculate pre/post development flows.
	Show/label all flood encroachment information, including field surveyed cross-sections referenced to station locations, proposed culvert inverts, profile view, plan view, back slopes, all elevations, channel slope and sum of disturbed areas are required.
	Indicate the location and establishment of a temporary or permanent benchmark, note must be NAVD 88 for all SFHA's.
	Documentation supporting applicant's choice of Manning "n" values for channel and/or over bank.
	A velocity dissipater design specifying length, width, mean stone diameter, outlet velocity and detail is required for each culvert.
	Note the Minimum Finished Floor Elevation on lots that are affected by the SFHA 100yr floodplain . Example FFE = 268.4'
	Should flood study design incorporate overtopping of ***PRIVATE*** driveway, specify stabilization scope and type of downstream embankment. *Overtopping shall not exceed 0.5 feet.*
	Place an *(asterisk) on all lots affected with flood hazards and add note to plans " * - Before Acquiring a Building Permit for Lots Marked with an " ***** " the Builder May Need to Obtain a Flood Hazard Permit from County Zoning Administration. The Builders Engineer, Architect of Surveyor Must Certify on Any Permit That All Flood Hazard Requirements Are Met. There Shall be No Filling or the Erection of Permanent Structures in the Areas of Wake County Flood Hazard Soils or Federal Emergency Management Agency Flood Zones.
	For submerged culverts to meet 404/401 certification, adjust the effective flow area in HEC-RAS report to reflect this condition.
	Summarize the pre-construction and the post-construction BFE at the upstream and downstream property lines before and after the proposed encroachment.
	Should flood study report prove offsite backwater, applicant must secure and record any necessary backwater encroachment easements. For on-site backwater, label backwater area with flood elevation plus 1'.
	Overlay and Label Future Conditions / 500 year FEMA Floodplain.
	Submit draft flood study as built compliance document.
	Signature, Date And Professional Seal: for all Material to be reviewed.

Part 2A For Minor Flood Studies (Drainage area less than 100 acres)

	Inlet and Outlet Control Head Water computations and elevations for all culverts
	Delineate HW/D backwater area plus 1 (one) foot rise and label as Q100 backwater easement and label FFE on all affected lots with Special Flood Hazard Areas.
	Use of Bureau of Public Roads Culvert chart for inlet and outlet computations provided for review

Part 2B For Major Flood Studies (Drainage area greater than 100 acres).

	Inlet and Outlet Control Head Water computations and elevations for all culverts
	Delineate HW/D backwater area plus 1 (one) foot rise and label as Q100 backwater easement and label FFE on all affected lots with Special Flood Hazard Areas.
	Provide Standard Step Method or equivalent computations and field surveyed cross sections locations on construction plans.

From: Betsy.Pearce@wakegov.com [mailto:Betsy.Pearce@wakegov.com]
Sent: Friday, September 05, 2014 11:15 AM
To: Chris Roessler
Subject: RE: EEP checklist for Thomas Creek

if you do a ford, you do not need the flood studies - I then just ask for a record plat showing the fords and noting that a flood study may be required in the future in order to install pipes or bridges

Betsy Pearce, CFM, CPSWQ
Environmental Engineer / Consultant
Cape Fear Watershed Manager
Wake County Environmental Services
336 Fayetteville St / PO Box 550
Raleigh, NC 27602
919-856-7541 Office
919-856-2747 Fax
919-868-6414 Mobile
betsy.pearce@wakegov.com

From: Chris Roessler <Croessler@mbakerintl.com>
To: "Betsy.Pearce@wakegov.com" <Betsy.Pearce@wakegov.com>,
Date: 09/05/2014 11:10 AM
Subject: RE: EEP checklist for Thomas Creek

Thank you, Betsy. One question - if we elect to not use a culvert (instead use a ford crossing), would we not have to do the flood study? - Chris

Chris Roessler | Technical Manager | Michael Baker Engineering, Inc., a unit of Michael Baker International
8000 Regency Parkway, Suite 600 | Cary, NC 27518 | [D] 919-481-5737 | [M] 919-624-0905
croessler@mbakerintl.com | www.mbakerintl.com

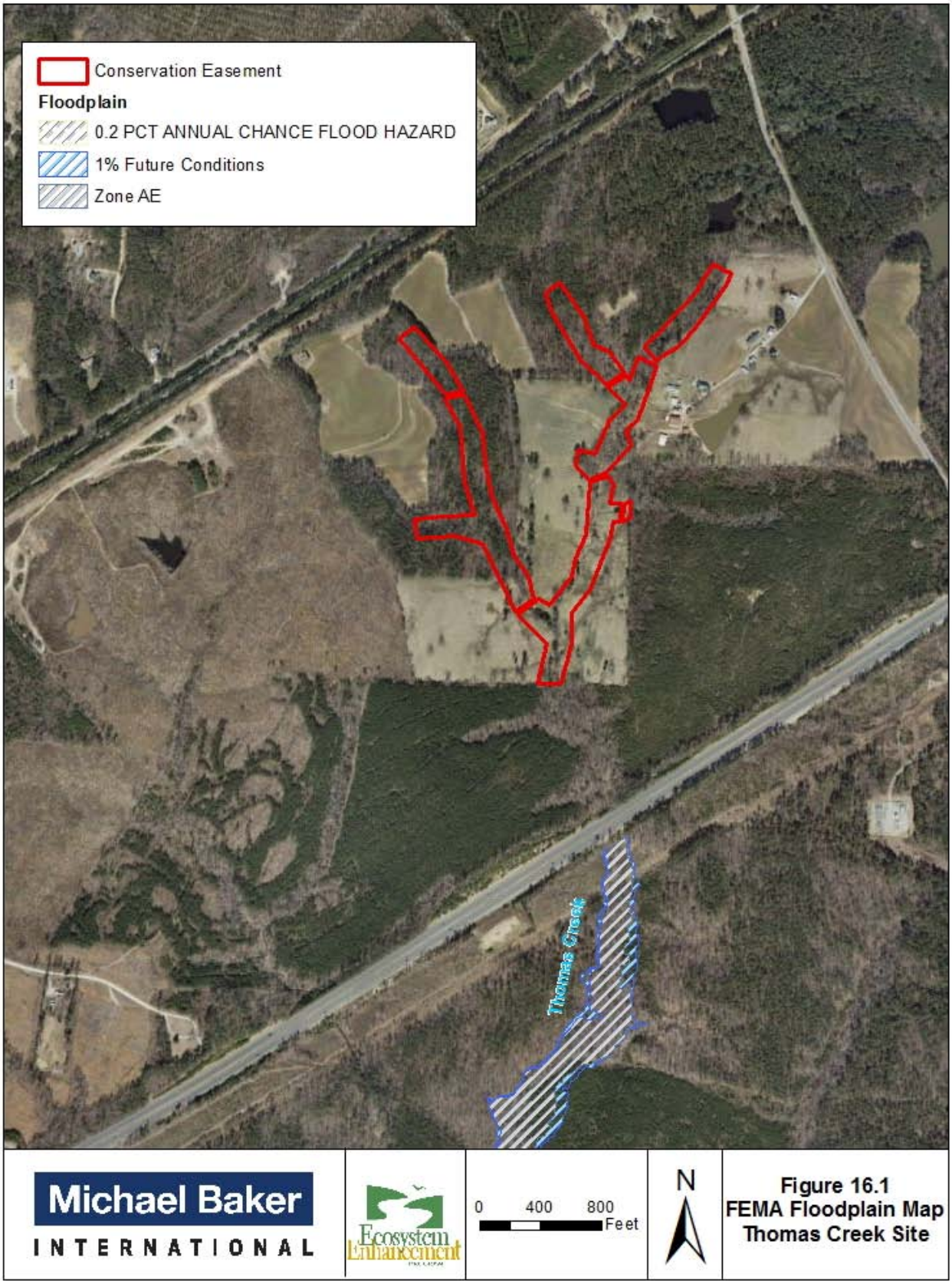
-----Original Message-----
From: Betsy.Pearce@wakegov.com [mailto:Betsy.Pearce@wakegov.com]
Sent: Friday, September 05, 2014 10:03 AM
To: Chris Roessler
Subject: Re: EEP checklist for Thomas Creek

Chris,

Requirements for flood permit for each crossing - Minor <100 acres of drainage = $500 Major >=100 acres of drainage = $1000 (See attached file: Flood Study checklist_2012.pdf)

Betsy Pearce, CFM, CPSWQ
Environmental Engineer / Consultant
Cape Fear Watershed Manager
Wake County Environmental Services
336 Fayetteville St / PO Box 550
Raleigh, NC 27602
919-856-7541 Office
919-856-2747 Fax
919-868-6414 Mobile
betsy.pearce@wakegov.com

Figure 16.1 FEMA Floodplain Map



17.0 APPENDIX C - MITIGATION WORK PLAN DATA AND ANALYSES

17.1 Channel Morphology

17.1.1 Existing Conditions Assessment

17.1.1.1 Reach Classification

The project channels are small, perennial and intermittent streams with a total drainage area of approximately 0.275 square miles for Reaches R2, T2, T1, R3, and R4, and 0.097 square miles for Reaches R5, R6, and R7 (Figure 2.2). The combined, total watershed area at the bottom of Reach R1 is 0.384 square miles. Historically, the project streams have been negatively impacted due to agricultural conversion and cattle grazing. The main stem of Thomas Creek (Reaches R1, R2, & R3) is sparsely vegetated, and some sections have become extremely unstable and are actively incising and widening.

For analysis purposes, Baker labeled the existing unnamed tributaries Reach R1, R3, R4, R5, R6, R7, T1, and T2. The existing reach locations are shown on Figures 2.2, 2.3, 2.4, 2.5, 2.6, 3.1, 17.2, and 17.4. The main stem begins at the northernmost project boundary as Reach R3 and flows south towards a farm access road towards the confluence with Reach R4. During field verification with the USACE of intermittent or perennial status and subsequent site visits with NCEEP, Reaches R1, R2, lower R3, R4, R5, and lower R7 were determined to be a perennial stream based on a minimum score of 30 for perennial streams and/or the presence of biological indicators using the NCDWR Determination of the Origin of Perennial Streams stream assessment protocols and guidelines (DWQ, 2010; see NCDWR stream forms in Appendix B). The remaining project reaches (upper R3, R6, upper R7, T1, and T2) were similarly determined to be intermittent.

Baker staff conducted geomorphic field assessments that included an existing conditions survey and photographic documentation to evaluate and document the impacts of past land use management practices and current site conditions for each project stream reach. Data collected on the reaches included representative cross sections, longitudinal profiles, and sediment samples. The following paragraphs summarize these findings and the results were used to assign the geomorphic conditions for the project stream reaches. Sections 7 and 17 further describe the restoration approaches proposed to achieve functional uplift and improve overall watershed health.

Reach R1

Reach R1 extends upstream from the downstream extent of the project at the property line to the confluence between Reach R2 and Reach R5. Its valley length is approximately 365 feet in length. Reach R1 has a drainage area of 247 acres. Cattle have direct access to this reach. Reach R1 is significantly incised and moderately high bank height ratios, which typically exceed 2.0. At the downstream end of the reach, this incision has reached bedrock; however, without protective measures in place the incision may continue to migrate upstream. Further bank scour and channel widening are also likely to continue if left unaddressed. Evidence of active bank erosion along Reach R1 was observed along approximately 90 percent of the reach, predominantly in the form of surficial scour. Cattle access to Reach R1 and are causing localized erosion at several crossings. Though there are some isolated mature trees along the streambanks, approximately 70 percent or more of the reach has no trees on at least one of the streambanks. Baker plans to incorporate the mature trees into restoration design where feasible.

Based on existing conditions, Reach R1 is classified as an incised “Bc” Rosgen stream type, due to a moderate entrenchment ratio of 1.8. The surveyed bank height ratio, however, was 2.5, which is indicative of severe incision.

The bed material in Reach R1 is mostly composed of sand with less than 4 percent silt/clay and 1 percent gravel.

Cattle have access to all of Reach R1.

Reach R2

Reach R2 begins at the confluence of Reaches R3 and R4 and directly upstream from Reach R1. It flows southward through actively grazed pasture to its confluence with Reach R5. The existing length of Reach R2 is 1,995 feet in length. Reach R2 has drainage areas of 176 acres at the downstream end. Cattle use the reach often for watering and loafing and have extensively trampled the streambanks. Reach R2 has been significantly degraded through the removal of the riparian buffer, cattle access, and relocation of the channel to the right side of the valley floor. According to the landowner, whose family purchased the property in 1915, the stream was moved in the 1800s to accommodate farming of the floodplain. The hummocky floodplain along Reach R2 appears to show where the excavated material was deposited.

Reach R2 lacks bedform diversity, with riffles constituting less than approximately 20 percent of the channel. There are very minimal coarse gravel accumulations (i.e., 4 percent of total) in the riffles; it is essentially a sand bed system. The degree of incision along Reach R2 varies according to the presence of headcuts and bedrock knickpoints, but the bank height ratio is frequently greater than 1.5. Evidence of active bank erosion along Reach R2 varies considerably, from 60 percent at the top, to a low of 30 percent in the middle, and back to 90 percent on the lower one third. This erosion is in the form of surficial scour. Currently, mass wasting is not evident.

The lower two thirds of Reach R2 have buffers consisting of active cattle pasture along both banks, with mid-successional or mature trees largely scattered or absent. Most often, the streambank cover is limited to fescue and other typical pasture grasses and forbs. In addition, multiflora rose (*Rosa multiflora*) is abundant on the streambanks in this section of the reach. The buffer in the top third of the reach includes a mature forest stand but cattle have removed all smaller vegetation through grazing, resulting in an unnaturally open understory. As such, more than 80 percent of the lengths on both banks have longitudinal breaks or interruptions of the existing tree line in lengths greater than 20 feet. The entire length of Reach R2 is actively subject to water quality stressors, mainly in the form of direct livestock access.

Based on existing conditions, Reach R2 has a Rosgen stream type classification of “F” in the upstream segment and “Gc” in the downstream segment, with bank height ratios of 3.3 and 2.2, respectively. Existing conditions cross sectional survey of theupper portion of Reach R2 show a bank height ratio of 3.3 and an entrenchment ratio of 1.4, while lower portion of Reach R2 has a bank height ratio of 2.2, as well as an entrenchment ratio of 1.4.

Cattle have access to all of Reach R2.

Reach R3

Reach R3 originates south of Old US Highway 1, just upstream of where it enters the northern sector of the project property. The drainage area for Reach R3 is 62 acres. Due to logging in 2011, the mature riparian buffer is less than 50 feet wide along the entire length of both streambanks, and often less than 20 feet. However, successional trees and/or understory species are present along the entire length, less the two existing stream

crossings. Invasive vegetation is present throughout the reach, but not abundant. The upper portion of Reach R3 (above Station 11+30) is generally stable; however, conditions are likely to be threatened if downstream headcuts are allowed to continue migrating upstream. The lower 940 feet of Reach R3 is incised with bank height ratios above 2.0. Channel scour is typical along 30 to 40 percent of this section of the reach, mainly in sections where tree roots are not present to provide streambank protection. Bedform diversity is lacking due to a low percentage of riffles. The floodplain along R3 does not appear to have been historically altered.

Based on existing conditions, Reach R3 has a Rosgen stream type classification of "G" in the middle segment and "Bc" in the downstream segment, with bank height ratios of 2.3 and 3.2, respectively.

Cattle do not have access to Reach R3 and the floodplain has not apparently been altered.

Reach R4

Reach R4 begins at the northern property line just downstream from the confluence of two small drainages in the northeast end of the project site. The drainage area for Reach R4 is 37 acres. The upper 870-foot section of Reach R4 is very stable and will be used as a reference reach for the project (see Section 17.1.3). The lower 336-foot segment of Reach R4 is incised and laterally unstable channel due to a headcut that has migrated upstream to this point . The buffer on the lower left bank narrows to approximately 20 to 30 feet and invasive species vegetation are somewhat abundant. The surveyed bank height ratio is 3.0. The buffer remains largely adequate north of the lower parcel line (and barbed wire fence) but very minimal south of the line. Active channel scour is evident in approximately 40 percent of the downstream segment.

The bed material in Reach R4 is mostly composed of sand with less than 7 percent silt/clay and 2 percent gravel.

Reach R4 has a Rosgen stream type classification of "E" in the upstream reference segment and "Bc" in the downstream segment, with bank height ratios of 1.0 and 3.0, respectively.

Reach R5

Reach R5 begins at the confluence of Reaches R6 and R7 and flows downstream for 1,016 feet to its confluence with Reach R2 to form Reach R1. The drainage area for Reach R5 is 63 acres. Reach R5 is divided by a headcut leaving the upstream segment stable and the downstream segment an unstable. The upstream segment of Reach R5 is 143 feet long. Active channel scour is less than 10 percent in this segment and the riparian buffer is of moderate to high quality with adequate width and a combination of overstory and understory vegetation species. The unstable downstream segment of Reach R5 is 873 feet in length. It is mostly incised and contains three active headcuts, including the one mentioned above. Active channel scour is approximately 70 percent on either bank for most of the lower portion of this segment and decreases to about 30 percent towards the top. A headcut originatesfrom Reach R1 and stops at an existing stream crossing. There are some areas of channel widening in this lowest section, though for the most part the channel is narrow and deep. Another headcut located about 50 feet upstream from the ford crossing is slowly migrating because tree roots are impeding its progress.

The lower 660 feet of Reach R5 is located within an active cattle pasture. The riparian buffer within this section is of poor quality with only minimal width and canopy diversity. Cattle access in the upper 380 feet of lower section of Reach R5 is restricted by fencing; therefore this section has a wider, more natural and intact riparian buffer with

adequate canopy diversity. However, the channel incision in the lower portion of this reach is so severe that the tree stability along the channel is threatened.

Reach R5 has a Rosgen stream type classification of "C" in the stable upstream segment and "Bc" in the unstable downstream segment, with bank height ratios of 1.0 and 2.4, respectively.

Reach R5 is also a sand bed stream with 3.4 percent silt/clay, 1.3 percent gravel, and the remainder sand.

Cattle have access to the lower two-thirds of Reach R5.

Reach R6

Reach R6 begins at the confluence of several drainage swales in the northwest quadrant of the project property and extends 1,828 feet downstream to the confluence with Reach R7, where Reach R5 begins. The drainage area for Reach R6 is 32 acres. The riparian buffer on the lower approximately 300 feet of Reach R6 is of adequate width and quality. However, for the upper 1,500 feet of Reach R6, the riparian buffer is roughly only 20 to 30 feet wide on each side of the channel.

Reach R6 begins upstream of several migrating headcuts. The small drainages converge into an incised and eroding channel that runs for 210 feet. This upstream segment consists of approximately 70 percent bank scour. Though the riparian buffer throughout the reach remains narrow, the incised channel transitions into a stable section where riparian wetlands are present. Moving downstream, channel instability resumes along the middle segment of Reach R6. Here, the channel is incised, but bank scour is limited to approximately 30 percent due to protection provided by tree roots. Moderate incision is present in the upper portion of the lower 300 feet of Reach R6. The remainder of the reach is not incised. Bank scour throughout this portion is minimal and approximately 10 percent.

Reach R6 has a Rosgen stream type classification of "G" in the unstable upstream segment and "Bc" in the unstable middle segment, with bank height ratios of 4.4 and 2.9 and entrenchment ratios of 1.4 and 1.5, respectively. Cross sections were not surveyed in the upstream or downstream stable segments but bank height ratio assessments indicate the upper area is not incised (BHR < 1.1) while the lower area ranges from not incised to minimally incised (BHR ~ 1.2). Enhancement activities will be targeted for the whole reach, with actual work on the channel limited to the upper 210-foot segment.

Cattle do not have access to any of Reach R6.

Reach R7

Reach R7 originates on the western edge of the project property and extends 636 feet downstream to the confluence with Reach R6. The drainage area for Reach R7 is 14 acres and is fed by a spring and a wetland just upstream of the project area. The project reach begins at a headcut that has migrated through the middle segment of R7 and caused severe incision, particularly in the upper 100 feet. The project work will begin on Reach R7 by stabilizing this headcut and continuing with enhancement activities focused on stabilization for the next 360 feet. The riparian buffer on the lower half of Reach R7 is of adequate quality though it is often less than 50 feet in width. The buffer on the upper half, however, is overly narrow with an estimated width of only 20 to 30 feet on each side of the channel.

Channel bank scour is limited to 20 percent, resulting from temporary protection provided by tree roots, as well as limited and isolated bench formation. A cross section

was surveyed in the middle segment of Reach R7, which indicates a Rosgen stream classification of “Bc” with a bank height ratio of 4.2.

The bed material for Reach R7 is mostly sand, with 8.5% silt/clay and 0.5% gravel. Cattle do not have access to this reach.

Reach T1

Reach T1 is a tributary that enters the middle of Reach R2. It has a drainage area of approximately 49 acres, draining through a farm pond and subsequently through adjacent forested land owned by Progress Energy. Approximately 253 feet of Reach T1 are included in the project. It is located in active pasture and has almost no trees along its banks. Buffer vegetation is largely limited to fescue and other typical pasture grasses. Bank scour is evident along approximately 40 percent of the channel length. A cross section was surveyed and indicates a Rosgen stream classification of “Bc” with a bank height ratio of 2.6.

Cattle have access to all of Reach T1.

Reach T2

Reach T2 is a tributary that emanates from a spring and enters the upper segment of Reach R2. All 171 feet of Reach T2 is included in the project. Cattle use the channel as a wallow and much of its length is impacted by trampling. A headcut has mirated upstream through Reach T2 from Reach R2, though tree roots have prevented major lateral degradation. Bank scour is estimated at 30 percent. A cross section was surveyed and indicates a Rosgen stream classification of “Bc” with a bank height ratio of 3.6.

Cattle have access to all of Reach T2.

Table 17.1 Representative Existing Conditions Geomorphic Data for Project Reaches: Stream Channel Classification Level II
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Parameter	Reach R1	Reach R2		
	XSR1	XSR2a	XSR2b	XSR2c
Existing Reach Length (ft)	397	1,995		
Drainage Area (sq. mi.)	0.384	0.275 / 0.153 / x		
Bankfull Discharge, Q_{bkf} (cfs)*	44.6	35.0 / 22.9 / x		
Feature Type	Riffle	Riffle	Riffle	Pool
Rosgen Stream Type	B5c	G5c	F5	-
Bankfull Width (W_{bkf}) (ft)	9.0	6.5	9.4	7.5
Bankfull Mean Depth, (d_{bkf}) (ft)	1.26	1.19	0.64	2.09
Width to Depth Ratio (W_{bkf}/d_{bkf})	7.2	5.4	14.8	3.4
Cross-Sectional Area, A_{bkf} (sq ft)	11.2	7.7	6.0	15.7
Bankfull Max Depth (d_{mbkf}) (ft)	1.94	1.59	1.39	2.58
Floodprone Width (W_{fpa}) (ft)	16.2	9.03	13.2	78
Entrenchment Ratio (W_{fpa}/W_{bkf}) (ft)	1.8	1.4	1.4	11.1
Bank Height Ratio**	2.5	2.2	3.3	-
Longitudinal Stationing of Cross-Section Along Existing Thalweg (ft)	43+00	35+65	21+75	24+60
Bankfull Mean Velocity, V_{bkf}= (Q_{bkf}/A_{bkf}) (ft/s)	3.9	3.9	3.8	-
Channel Materials (Particle Size Index – d50)***				
d_{16} / d_{35} / d_{50} / d_{84} / d_{95} (mm)	0.15 / 0.27 / 0.34 / 0.75 / 1.39	0.11 / 0.22 / 0.32 /0.85 / 1.89		
Average Valley Slope (ft/ft)	0.0050	0.0098		
Average Water Surface Slope (S)	0.0028	0.0082		
Average Channel Sinuosity (K)****	1.18	1.17		

*Bankfull discharge estimated using published NC Piedmont Regional Curve (Harman et al., 1999)
**High bank height ratios (values greater than 2.0 indicate systemwide self-recovery is unlikely)
***Sediment samples taken along main stem only (Reaches R4 & R5) given shorter reach lengths, proximity to upstream impoundments, and similar substrate material.
****Additional meander geometry information such as meander width, meander length, and radius of curvature were not measured. The channel exhibits minimal pattern since it has been straightened/channelized, and/or is classified as a step-pool channel.

Parameter	Reach R3		Reach R4	Reach R5
	XSR3a	XSR3b	XSR4a	XSR5a
Existing Reach Length (ft)	1,067		327	1,020
Drainage Area (sq. mi.)	0.106 / 0.064		0.056	0.097
Bankfull Discharge, Q_{bkf} (cfs)*	16.5 / 12.2		11.1	16.5
Feature Type	Riffle	Riffle	Riffle	Riffle
Rosgen Stream Type	B5c	B5c	B5c	B5c
Bankfull Width (W_{bkf}) (ft)	5.3	4.5	4.5	4.4
Bankfull Mean Depth, (d_{bkf}) (ft)	0.8	0.67	0.7	1.04
Width to Depth Ratio (W_{bkf}/d_{bkf})	6.5	6.7	6.4	4.2
Cross-Sectional Area, A_{bkf} (sq ft)	4.3	3.0	3.1	4.5
Bankfull Max Depth (d_{mbkf}) (ft)	1.54	1.03	1.44	1.55
Floodprone Width (W_{fpa}) (ft)	9.5	6.7	9.9	7.8
Entrenchment Ratio (W_{fpa}/W_{bkf}) (ft)	1.8	1.5	2.2	1.8
Bank Height Ratio**	3.2	2.3	3.0	2.4
Longitudinal Stationing of Cross-Section Along Existing Thalweg (ft)	15+60	11+00	21+15	36+80
Bankfull Mean Velocity, V_{bkf}= (Q_{bkf}/A_{bkf}) (ft/s)	3.8	4.1	3.6	3.7
Channel Materials (Particle Size Index – d50)***				
d_{16} / d_{35} / d_{50} / d_{84} / d_{95} (mm)	0.14 / 0.29 / 0.41 / 1.16 / 3.05		-	-
Average Valley Slope (ft/ft)	0.0182		0.0105	0.0133
Average Water Surface Slope (S)	0.0150		0.0121	0.0177
Average Channel Sinuosity (K)****	1.22		1.16	1.42

*Bankfull discharge estimated using NC Piedmont Regional Curve (Harman et al., 1999)
**High bank height ratios (values greater than 2.0 indicate systemwide self-recovery is unlikely)
***Sediment samples were taken at representative riffles along main stem
****Additional meander geometry information such as meander width, meander length, and radius of curvature were not measured. The channel exhibits minimal pattern since it has been straightened/channelized, and/or is classified as a step-pool channel.

Parameter	Reach R5		Reach R6	
	XSR5b	XSR5c	XSR6b	XSR6c
Existing Reach Length (ft)	1,020		1,828	
Drainage Area (sq. mi.)	0.083		0.050	0.019
Bankfull Discharge, Q_{bkf} (cfs)*	14.4		10.2	5.1
Feature Type	Riffle	Pool	Riffle	Riffle
Rosgen Stream Type	C5	-	B5c	G5c
Bankfull Width (W_{bkf}) (ft)	8.9	5.9	4.3	3.2
Bankfull Mean Depth, (d_{bkf}) (ft)	0.4	2.11	0.59	0.55
Width to Depth Ratio (W_{bkf}/d_{bkf})	23.6	2.8	0.86	5.8
Cross-Sectional Area, A_{bkf} (sq ft)	3.4	12.5	2.5	1.8
Bankfull Max Depth (d_{mbkf}) (ft)	0.83	2.58	0.86	0.9

Floodprone Width (W_{fpa}) (ft)	>30	99	6.5	4.5
Entrenchment Ratio (W_{fpa}/W_{bkf}) (ft)	5.4	16.8	1.5	1.4
Bank Height Ratio**	1.0	1.0	2.9	4.4
Longitudinal Stationing of Cross-Section Along Existing Thalweg (ft)	29+10	34+00	23+00	11+25
Bankfull Mean Velocity, V_{bkf}= (Q_{bkf}/A_{bkf}) (ft/s)	4.2	-	4.1	2.8
Channel Materials (Particle Size Index – d50)***				
d_{16} / d_{35} / d_{50} / d_{84} / d_{95} (mm)	0.15 / 0.30 / 0.40 / 0.86 / 1.48	-	-	-
Average Valley Slope (ft/ft)	0.0134		0.025	0.0361
Average Water Surface Slope (S)	0.0177		0.0148	0.025
Average Channel Sinuosity (K)****	1.31		1.13	1.13

*Bankfull discharge estimated using NC Piedmont Regional Curve (Harman et al., 1999)
**High bank height ratios (values greater than 2.0 indicate systemwide self-recovery is unlikely)
***Sediment samples were taken at representative riffles along main stem (Reaches R4 & R5)
****Additional meander geometry information such as meander width, meander length, and radius of curvature were not measured. The channel exhibits minimal pattern since it has been straightened/channelized, and/or is classified as a step-pool channel.

Parameter	**Reach R7**	**Reach T1**	**Reach T2**
	XSR7	**XST1**	**XST2**
Existing Reach Length (ft)	646	242	171
Drainage Area (sq. mi.)	0.022	0.077	0.008
Bankfull Discharge, Q_{bkf} (cfs)*	5.7	14.0	2.7
Feature Type	Riffle	Riffle	Riffle
Rosgen Stream Type	B5	B5c	B5c
Bankfull Width (W_{bkf}) (ft)	3.6	7.2	2.1
Bankfull Mean Depth, (d_{bkf}) (ft)	0.43	0.39	0.38
Width to Depth Ratio (W_{bkf}/d_{bkf})	8.4	18.6	5.6
Cross-Sectional Area, A_{bkf} (sq ft)	1.6	2.8	0.8
Bankfull Max Depth (d_{mbkf}) (ft)	0.64	0.66	0.6
Floodprone Width (W_{fpa}) (ft)	5.4	10.8	3.4
Entrenchment Ratio (W_{fpa}/W_{bkf}) (ft)	1.5	1.5	1.6
Bank Height Ratio**	4.2	2.6	2.3
Longitudinal Stationing of Cross-Section Along Existing Thalweg (ft)	14+15	11+50	10+95
Bankfull Mean Velocity, V_{bkf}= (Q_{bkf}/A_{bkf}) (ft/s)	3.6	5.0	3.4
Channel Materials (Particle Size Index – d50)***			
d_{16} / d_{35} / d_{50} / d_{84} / d_{95} (mm)	0.12 / 0.29 / 0.43 / 0.87 / 1.39	-	-
Average Valley Slope (ft/ft)	0.036	0.0120	0.0417
Average Water Surface Slope (S)	0.025	0.0203	0.0414
Average Channel Sinuosity (K)****	1.11	1.09	1.17

17.1.1.2 Valley Classification

The project site is located in southwest Wake County within the Piedmont hydrophysiographic region of North Carolina. Undisturbed Piedmont valleys in this region are generally classified as Valley Type 'VII' (Rosgen, 2006), although it is understaood this classification does not describe specific landforms within the provinces through the mid-Atlantic/southeast region. The province is characterized by broad, rolling, interstream divides across variable steep slopes along well-defined drainage ways. The underlying geologic unit of the project area consists of sandstone interbedded with siltstone (Trcs/si2) within the Triassic Basin geologic formation and Level III Ecoregion (Geologic Map of North Carolina, NC Geological Survey, 1998). The area receives moderately high rainfall amounts with precipitation averaging 46.9 inches per year (NRCS, 1970).

17.1.1.3 Channel Morphology and Stability Assessment

Baker performed general topographic and planimetric surveying of the project site and produced a 1-foot contour map based on survey data in order to create plan set base mapping (see Section 18.0, Appendix D). Fourteen representative cross sections and longitudinal profiles were also surveyed to assess the current condition and overall stability of the stream channels. The existing riffle cross-section data and locations are shown in Figure 17.1 and compared with the Rosgen Channel Stability Assessment shown in Table 17.2. The representative existing riffle cross sections have a typical Bank Height Ratio (BHR) of greater than 1.5. Some of the cross-section data illustrate the presence of existing berms or overburden from channelization and the lack of natural floodplain deposits.

Consistent bankfull indicators were challenging to find in the field, though in the end they became more evident. The indicators tended to agree with the bankfull cross-sectional area estimates from the NC Rural Piedmont Regional Curve and in some cases were slightly smaller (i.e., approximately 10%) than the regional curve (Reaches R1, R2, R5). Thus, for the most part, Baker used the regional curve to size the channels but sized them down slightly if the bankfull indicators were consistent and suggested a smaller cross-sectional area was more appropriate.

The longitudinal profiles show the channel slopes vary from 0.0082 to 0.018 ft/ft and have average valley slopes of 0.0098 to 0.025 ft/ft with several long riffle sections and infrequently spaced pools. The sinuosity for the reaches is typically between 1.1 and 1.2, a result of prior straightening/channelization and valley morphology. Long sections of the project reaches are moderately entrenched and unstable as shown on the cross-section data. This likely indicates a movement toward a more unstable condition (e.g., downcutting, streambank erosion), especially in portions of the reach where numerous active headcuts are present (vertical instability) or streambanks are actively eroding (lateral instability).

Table 17.2 Rosgen Channel Stability Assessment Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074	
Stability Rating	**Bank Height Ratio (BHR)**
Stable (low risk of degradation)	1.0 - 1.05
Moderately unstable	1.06 - 1.3
Unstable (high risk of degradation)	1.3 - 1.5
Highly unstable	> 1.5
Notes: (Rosgen, 2001)	

The channel stability assessment incorporated qualitative and quantitative site observations using detailed topographic data collected for the project. Conclusions reached from these methods were used to define overall channel stability and determine appropriate restoration approaches for the site. The reaches were identified as perennial and intermittent streams that originate from a watershed that is predominantly forested with agricultural land and two homes with associated farm buildings comprising the remaining land use. Due to past channel manipulation, a majority of the reaches are moderately to severely incised as evidenced by bank height ratios greater than 1.5.

Figure 17.1 Existing Cross Section Locations for Project Reaches

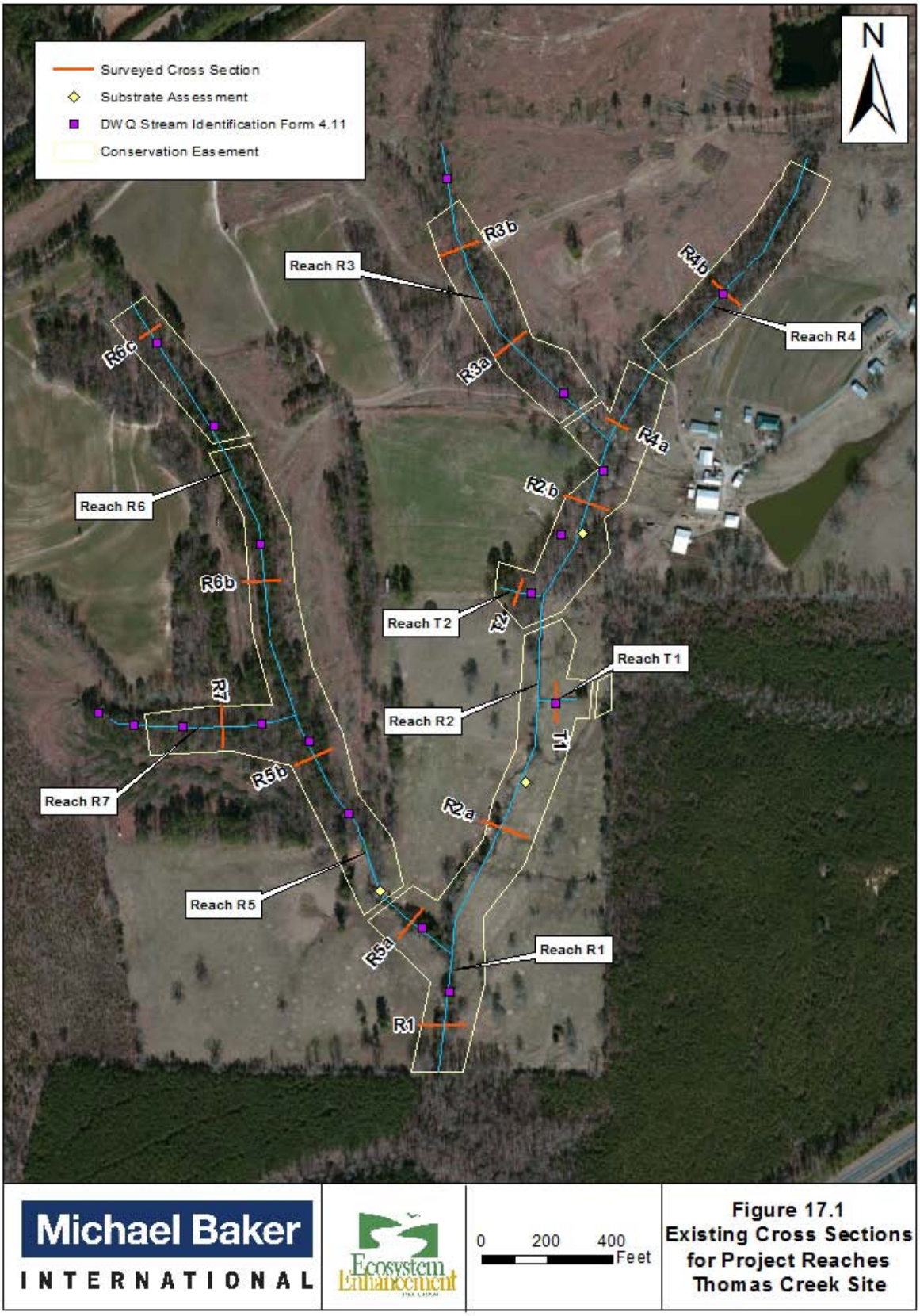
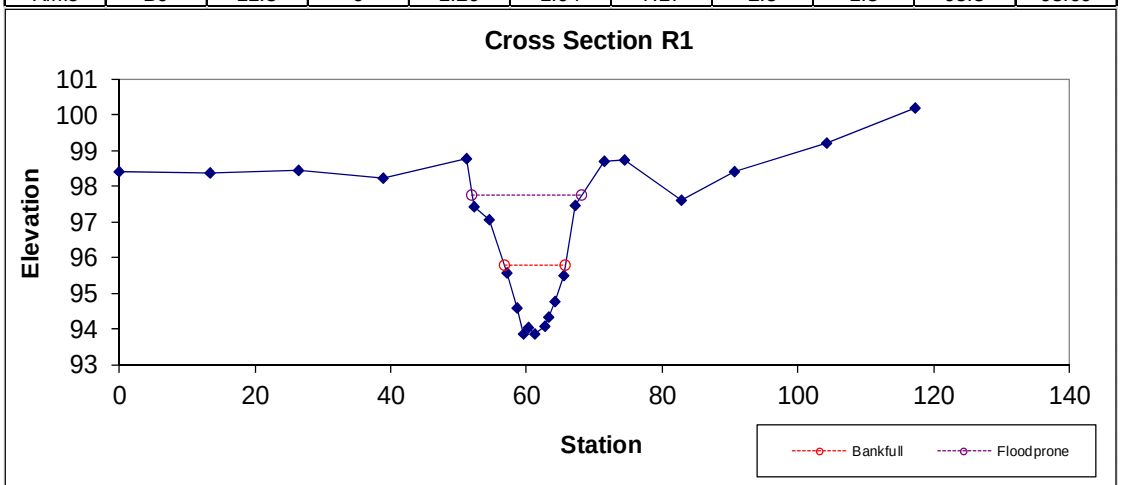
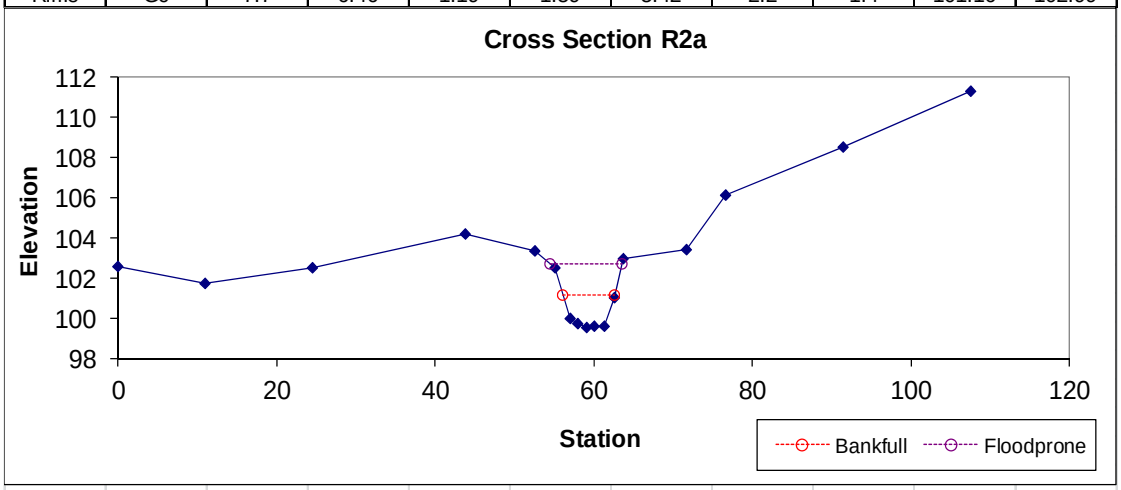


Figure 17.2 Existing Cross Sections for Project Reaches

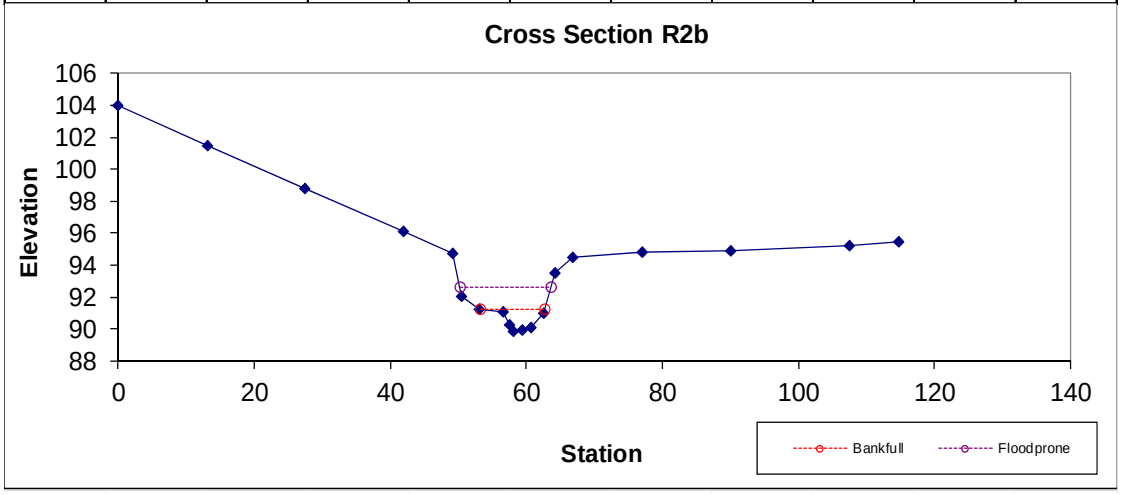
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Bc	11.3	9	1.26	1.94	7.17	2.5	1.8	95.8	98.69



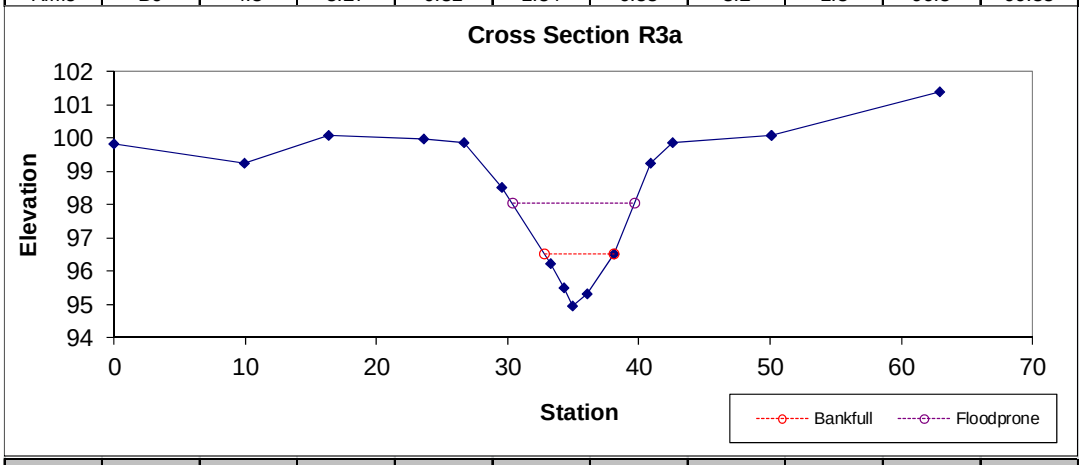
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Gc	7.7	6.46	1.19	1.59	5.42	2.2	1.4	101.16	102.99



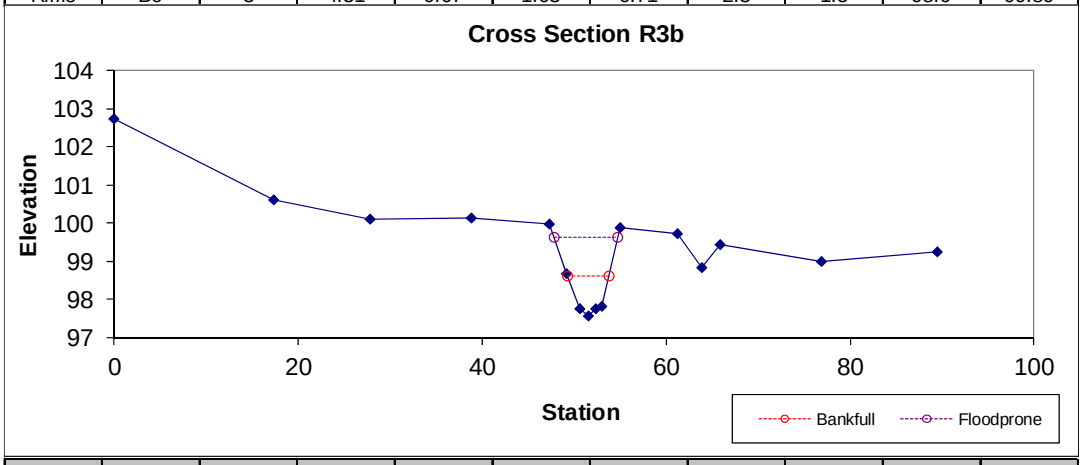
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	F	6	9.43	0.64	1.39	14.84	3.3	1.4	91.22	94.46



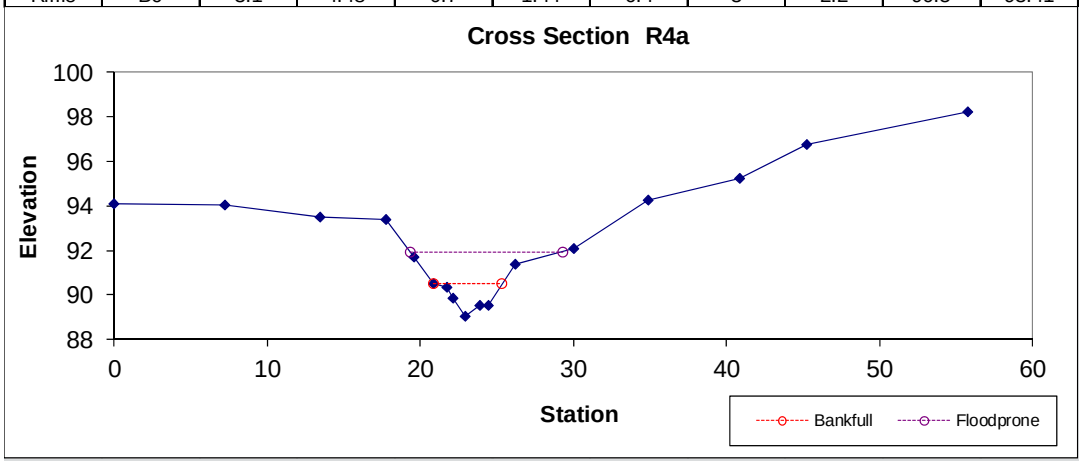
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Bc	4.3	5.27	0.81	1.54	6.53	3.2	1.8	96.5	99.85



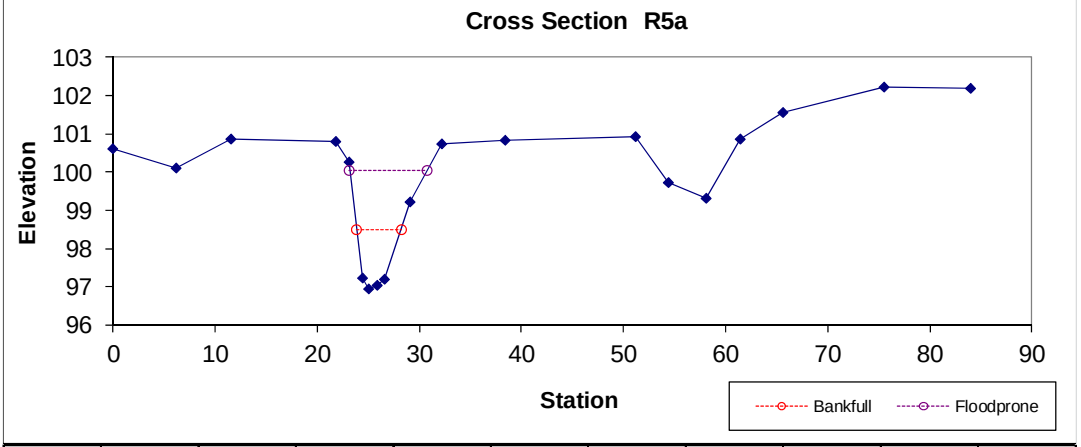
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Bc	3	4.51	0.67	1.03	6.71	2.3	1.5	98.6	99.89



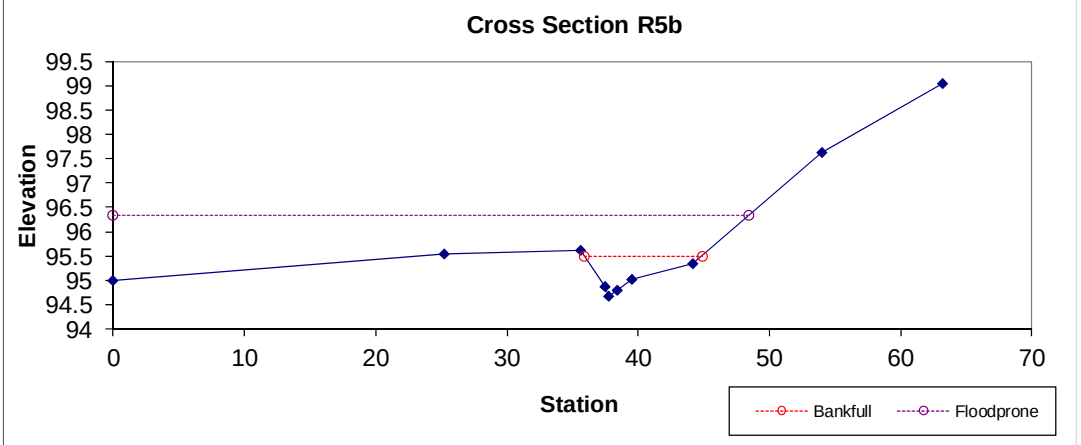
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Bc	3.1	4.48	0.7	1.44	6.4	3	2.2	90.5	93.41



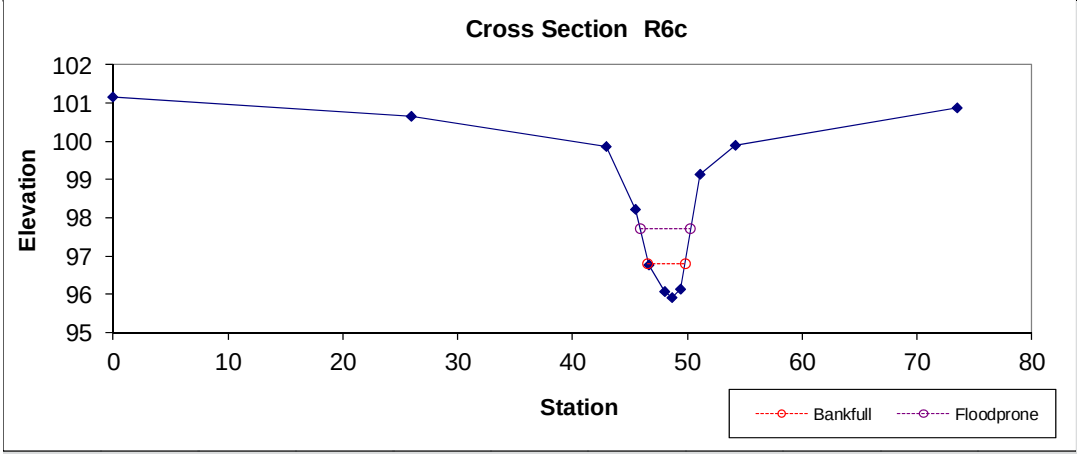
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Bc	4.5	4.35	1.04	1.55	4.18	2.4	1.8	98.5	100.73



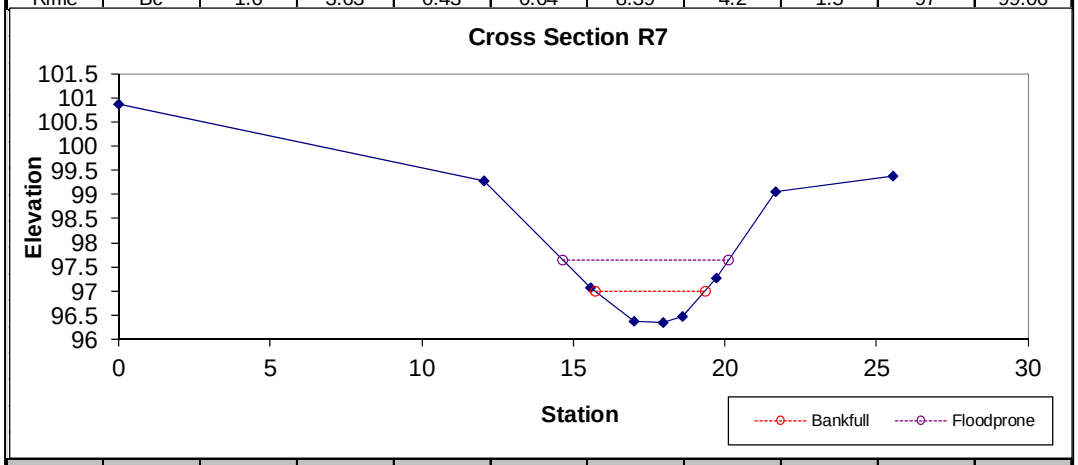
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Cc	3.4	8.95	0.38	0.83	23.57	0.8	5.4	95.5	95.34



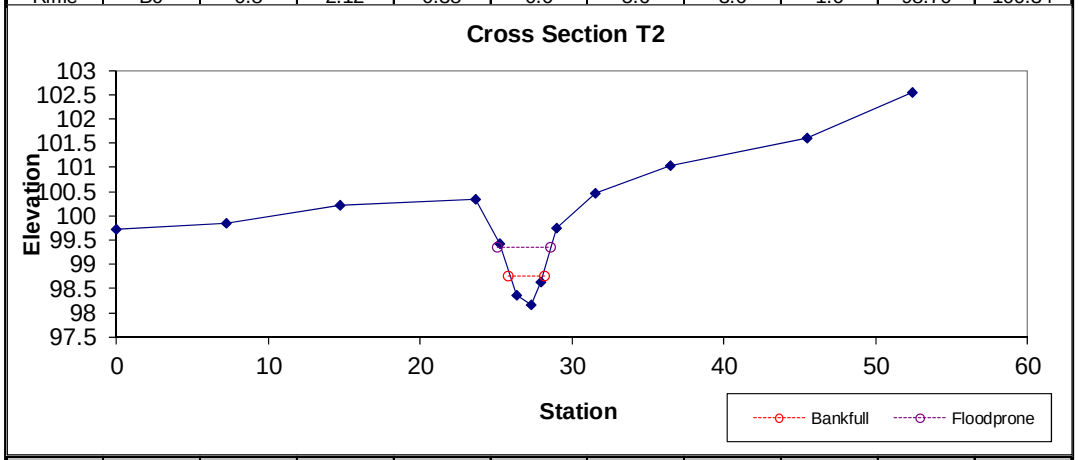
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	G	1.8	3.21	0.55	0.9	5.79	4.4	1.4	96.8	99.86



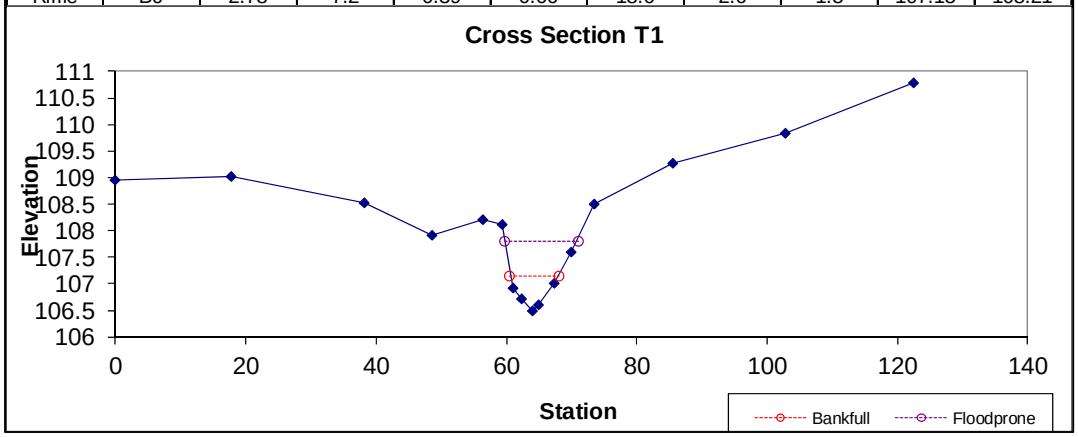
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Bc	1.6	3.63	0.43	0.64	8.39	4.2	1.5	97	99.06



Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Bc	0.8	2.12	0.38	0.6	5.6	3.6	1.6	98.76	100.34



Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Bc	2.78	7.2	0.39	0.66	18.6	2.6	1.5	107.15	108.21



17.1.1.4 Bank Erosion Prediction (BEHI/NBS)

Sedimentation from streambank erosion is a significant pollutant to water quality and aquatic habitat. Predicting streambank erosion rates and annual sediment yields using the Bank Assessment for Non-point source Consequences of Sediment (BANCS) method (Rosgen 1996, 2001a) considers two streambank erodibility estimation tools: the Bank Erosion Hazard Index (BEHI), and Near Bank Stress (NBS). This rating method is used to describe existing streambank conditions and statistically quantify the erosion potential of a stream reach in feet/year. Since it is an estimation/prediction method, the intent is to be used as a relative comparison for pre- and post-restoration conditions.

Published curve data were initially developed from sites in Colorado with varying sediment sources, vegetation, and fluvial geomorphic processes characteristic of that region. Although the published BEHI/NBS curve is not directly applicable to piedmont streams in North Carolina, it can provide a framework to develop similar relations in other hydrophysiographic regions. Therefore, Baker used local unpublished NC piedmont BEHI and NBS ratings (obtained through personal communication with NRCS, Walker, 2011) to estimate sediment loss and support field observations and streambank height measurements taken during existing conditions assessment.

The BEHI/NBS estimates for the existing conditions (pre-construction) were determined in the field. The majority of BEHI ratings varied from 'low' to 'moderate' with a few middle sections rating on the 'high' category based on changes in the velocity gradient and shear stress, and depth of incision. This is typical of a partially degraded stream system with active streambank erosion in localized areas. After stabilizing streambanks using the proposed restoration measures, post-construction BEHI/NBS estimates typically predict a significant decrease in sediment loading throughout the entire project area, especially considering the limited sediment supply entering the system from the upstream drainages.

17.1.1.5 Channel Evolution

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

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

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

1. Pre-modified
2. Channelized
3. Degradation
4. Degradation and widening

5. Aggradation and widening
6. Quasi-equilibrium.

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

The project reaches are predominantly in Stages 4 or 5 of the Simon Channel Evolution Model. This indicates that the floodplain connection has been severely compromised by vertical degradation and the channels will likely experience continued erosion prior to the channel form stabilizing on its own (Stage 6 – Quasi-equilibrium). Whether a given reach is in Stage 4 or 5 largely depends on when the headcut passed through; if it has been recently then the channel is likely to be in Stages 3 or 4, while if widening has already occurred then it is likely to be in Stage 5. Reaches that are in Stage 5 include R1 and upper R2. Reaches that are in Stage 4 include lower R2 and R6. The remaining reaches (R3, R4, R5, R7, and T1) are somewhere between Stages 4 and 5, with typically the downstream end in Stage 5 and the upstream end in Stage 4. This is not always the case, however, as Reach R5 (lower restoration section) continues to degrade and widen at the downstream end, while the upstream end is generally aggrading and widening.

Where Reaches are in Stage 5, Priority 2 restoration tends to be more appropriate to advance the channel to Stage 6. In other reaches, Priority 1 restoration can essentially move the channel back more or less to Stage 1.

17.1.2 Proposed Morphological Conditions

After examining the assessment data collected at the site and exploring the potential for restoration, an approach was developed that would address restoration and enhancement of stream functions within the project area while minimizing disturbance to existing wooded areas and protecting existing, ACOE-verified jurisdictional wetlands. Prior to impacts from past channel manipulation, topography and soils on the site indicate that the project area most likely functioned in the past as a small tributary stream system with associated hillslope seep wetlands, eventually flowing into the larger Thomas Creek system.

Therefore, a design approach was formulated to restore and/or enhance this type of system. First, an appropriate stream type for the valley type, slope, and desired stream functions was selected and designed to improve historic flow patterns within the project area. Then a design plan was developed in order improve the floodplain hydrology and base flow interaction impaired by current cattle impacts, active degradation, and other agricultural land manipulations.

17.1.2.1 Proposed Design Approach and Criteria Selection

For design purposes, the stream channels used the same nine reach labels as the existing reaches: R1, R2, R3, R4, R5, R6, R7, T1, and T2 (see Figure 17.3). Selection of a general restoration approach was the first step in selecting design criteria for all reaches. The approach was based on the potential for restoration as determined during the site assessment. Next, specific design parameters were developed so that plan view layout, cross-section dimensions, and a longitudinal profile could be implemented for developing construction documents. The design philosophy is to use these parameters as conservative values for the selected stream types and to allow natural variability in stream dimension, facet slope, and bed features to form over long periods under the processes of flooding, re-colonization of vegetation, and local watershed influences.

The Thomas Creek project includes several headwater reaches that are steeper and have narrow valleys. Often this setting may be associated with Bc stream types. However, the entrenchment ratio on the restored channels will be greater than 2.2, which makes either an E or a C channel. Though the channels will no longer be incised or entrenched, narrower valley widths and boundary conditions prevented pattern adjustments commonly associated with C or E meander geometry. This typically translates to shorter riffles with higher slopes, and thus higher stream power. Higher stream power is ameliorated to some extent by increasing the width-to-depth ratios than the nearby reference reach. Additionally, constructing higher width-to-depth ratios (11-14) will put less stress on the newly constructed streambanks. Grade control structures were incorporated to maintain stability despite steeper riffle slopes. The radii of curvature ratios of between 2 and 3 were followed, so structures are less common in the channel bends.

After selecting an appropriate design approach for the site based on field assessments and functional lift potential, proposed stream design values and design criteria were selected using common reference ratios and guidelines (Harman, Starr, 2011). Table 17.3 presents the design parameters used for the proposed reaches. Following initial application of the design criteria, Baker staff made detailed refinements to accommodate the existing valley type and channel morphology. This step minimizes unnecessary disturbance of the riparian area, can help reduce the number of in-stream structures, and allows for some natural channel adjustment following construction. The design plans have been tailored to produce a cost and resource efficient design that corresponds to the tools of construction.

One overarching design comment about the Thomas Creek site is warranted since there are generally steep valley slopes combined with sand bed streams. This makes grade control challenging because there is higher stream power and shear stress, but not adequate bed material size or resistance to match those erosive forces. Consequently, the risk of channel degradation is exceedingly high. Stability in the reference reaches is primarily maintained through a combination of appropriate/natural meander geometry, and, more importantly, extensive mature tree roots running along and beneath the streambed. Meander geometry can help flatten channel slopes and is achievable through the design process, but mature tree roots in the streambed are generally not achievable at the early stages right after construction.

Baker has considered this design challenge and offers the following solution. First, frequent grade control is necessary. Limiting this to the riffle sections is preferred since this is where most gradient is typically lost in a stream. Second, using more natural grade control to mimic reference reach conditions is preferred. This favors woody material in the form of log jam constructed riffles, log rollers, and log weirs. These structures will be used in perennial streams (submersion prevents rapid breakdown of wood by fungi) and

where woody material is available (i.e., within a particular reach if clearing is needed to implement restoration/enhancement). However, in more intermittent streams and in locations where trees are not abundant (lower Reach R2), more rock material may be incorporated to build constructed riffles and step pools. These structures are necessary to maintain grade control given the steeper channel/riffle slopes and sandy bed material. Baker has investigated other sources of wood, such as nearby slash piles on Duke Energy land, but in the absence of sufficient woody material for structures, rock will be substituted.

Reach R1 Restoration

Reach R1 is significantly incised, though the top-of-bank width varies from quite narrow towards the confluence of Reaches R1 and R2, to rather wide at cattle crossings in the middle of the reach. A Priority Level II restoration approach will be initiated at the upper end of Reach R1in order to return the channel to the existing grade within approximately 250 feet at the downstream extent of the project. The lower part of Reach R1 has incised to an existing bedrock feature and the streambanks are actively eroding.

The restored channel will be constructed along the existing channel, and will be designed initially as a Rosgen 'C' stream type as it is lowered to meet bedrock at the downstream end. In-stream structures such as constructed riffles will be installed to control grade, dissipate scour energies, and eliminate the potential for upstream channel incision. Additionally, log vanes and weirs will be incorporated for step-pool formation, bank stability, and habitat diversity.

The design width/depth ratio for the channel will be 14, and over time, the channel may narrow due to deposition of sediment and streambank vegetation growth. Channel narrowing should not risk downcutting because any narrowing would be in response to stabilizing processes (i.e., tree establishment, point bar formation). The bankfull floodplain bench would provide energy dissipation when that is needed to maintain channel stability.

Channel banks will be graded to stable, 2:1 or flatter slopes, bankfull benches will be incorporated to further promote stability, and riparian vegetation will be re-established to the confluence.

Riparian buffers in excess of 50 feet will be restored or protected along all of Reach R1. No stream crossing or breaks in the easement are proposed along this reach. Invasive species control will be conducted.

Reach R2 Restoration

Work along Reach R2 will involve a combination of Priority Level I and II restoration approaches to provide floodplain reconnection and promote long-term channel stability. Presently, the reach is incised and eroding. The upper end is overly wide and initial bench formation has ensued in some areas. Mature hardwood trees are abundant for the first 600 feet of existing channel, after which the channel enters pasture and hugs the right side of the valley for 1,300 feet.

To preserve the existing canopy and improve the floodplain width of a stabilizing channel, Priority Level II restoration is proposed for the upstream portion of Reach R2. In this upper section of Reach R2, the design will target a Rosgen 'C5' stream type and will be built as a nested channel with a width/depth ratio of 14 and an entrenchment ratio of greater than 2.2.

Once Reach R2 begins the channelized section that flows through pasture, Priority Level I restoration will be implemented. This reach will be designed as a Rosgen 'C5' stream

type, though initially the valley is narrower and thus the pattern is more typical of a 'B5c' stream type. The design width/depth ratio for the channel will be 14 with 2.5:1 riffle side slopes, and over time, the channel may narrow due to sediment deposition and streambank vegetation growth. Channel narrowing should not risk downcutting because any narrowing would be in response to stabilizing processes (i.e., tree establishment, point bar formation). The bankfull floodplain would provide energy dissipation when that is needed to maintain channel stability.

This approach will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved channel function through improved aquatic habitat, more frequent overbank flooding, restoration of riparian and terrestrial habitats, exclusion of cattle and associated pollutants, and decreased erosion and sediment loss from streambank erosion.

Mapped jurisdictional wetlands in the lower Reach R2 floodplain will be either protected during the construction process or enhanced through the grading activities. Wetland enhancement may be achieved by raising the streambed and thus increasing the hydro period, as well as the wetted area. Additionally, wetland vegetation will be improved.

Riparian buffers in excess of 50 feet will be restored along all of Reach R2. One stream crossing and break in the easement is proposed along Reach R2, at the transition from Priority Level II to Priority Level I. Invasive species control will be conducted.

Reach R3 Restoration

After an initial 130-foot section of Level II Enhancement (supplement buffer planting and invasive species removal only), work along Reach R3 will involve a combination of Priority Level I and II restoration approaches to provide floodplain reconnection and promote long-term channel stability. In its existing condition, the reach is incised and actively eroding. The landowner had much of the timber along Reach R3 harvested in 2011; therefore, restoration activities can be conducted with minimal impact to existing mature trees. These techniques will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved channel function through improved aquatic habitat, more frequent overbank flooding, restoration of riparian and terrestrial habitats, and decreased sedimentation from streambank erosion. Appropriate bedform diversity in this case may be defined as riffle/pool sequences according to calculated pool-to-pool spacing and facet slopes, which lead to a stable longitudinal profile and diverse microhabitat for aquatic organisms.

This reach will be designed as a Rosgen 'E/C' stream type. The design width/depth ratio for the channel will be 12 to account for a steeper valley slope and to reduce stress on the streambanks. A higher width-to-depth ratio yields a relatively higher channel width and lower depth, which reduces stream power. Meander geometry of a stable E/C stream type is possible given the narrower valley width; consequently, additional grade control structures will be installed to maintain channel stability.

Mapped jurisdictional wetlands in the upper Reach R3 floodplain will be either protected during the construction process or enhanced through the grading activities. Wetland enhancement may be achieved by raising the stream bed and thus increasing the hydro period, as well as the wetted area. Additionally, wetland vegetation will be improved. Invasive species control will be conducted.

Riparian buffers in excess of 50 feet will be restored along all of Reach R3. One stream crossing/easement break is proposed along Reach R3. An existing ford crossing will be enhanced. Cattle do not and will not have access to this crossing.

A slight change to the approach for Reach R3 was made from the IRT site visit on October 9, 2013. The project work will begin farther downstream with Level II Enhancement based on jurisdictional channel considerations (i.e, channel definition upstream weakens) and the presence of a headcut where restoration now begins.

Reach R4 Restoration and Enhancement

Work on Reach R4 will involve restoration approaches on a 330-foot section of the downstream end to its confluence with Reach R3.

The primary source of impairment for Reach R4 is incision caused by a headcut that has migrated up from Reach R2. An existing ford crossing has stopped the migration of the headcut; consequently, immediately upstream from it Reach R4 is highly stable and has been used as a reference reach. The upper 870-foot section of Reach R4 will be included as an Enhancement Level II reach. The riparian buffers are largely adequate but will be supplementally planted so that they are at least 50 feet wide. The fence along the eastern edge, where cows have access, will be replaced. Per agreement with the IRT, invasive species control will not be conducted in upper Reach R4.

Along the downstream end of Reach R4, the channel is in poor condition due to incision. This reach section will be restored through using Priority Level II restoration and the use of log jams and constructed riffles to control grade, dissipate energies, and eliminate the potential for upstream channel incision. Channel banks will be graded to stable slopes, and bioengineering measures will be incorporated to further promote stability and re-establishment of riparian vegetation. This section of Reach R4 will be designed as a Rosgen 'C5' stream type. The design width/depth ratio for the channel will be 13. Floodplain benches will be incorporated to increase the entrenchment ratio to greater than 2.2, thus reducing stress on the restored channel.

Riparian buffers in excess of 50 feet will be restored along all of Reach R4. The existing ford crossing above the project reach will be maintained as a ford crossing since livestock will not have access to it. Additionally, an existing downstream bridge crossing will be removed. Invasive species control will be conducted in lower Reach R4.

Reach R5 Enhancement and Restoration

Work on Reach R5 will continue the enhancement approach (planting, invasives species control, and easement establishment) from lower Reaches R6 and R7. This work will extend to the top 142 feet of Reach R5, at which point the approach will switch to Priority Level I restoration, beginning at an active headcut. The first 200 feet of the Priority I section is in a forested area and the lower 700 feet are in active pasture. The benefits of this approach include: floodplain reconnection; limited impact to desirable native species trees along the existing channel; and full restoration of a natural channel pattern and appropriate stream functions.

Lower Reach R5 will be designed as a Rosgen 'C5' stream type with a width/depth ratio of 13 and 2.5:1 riffle side slopes. Log structures to maintain pools and grade control will be employed. The new channel will be constructed both off-line from and on-line with the existing channel. Existing mature trees will be preserved wherever possible. At the downstream end of the reach, minimal floodplain benching will be required. Though the restored reach will be elevated by more than two feet from the existing channel, benching will be required in the lower 150 feet to match the elevation of proposed Reach R2.

Mapped jurisdictional wetlands in the upper Reach R5 floodplain will be either protected during the construction process or enhanced through the grading activities. Wetland enhancement may be achieved by raising the stream bed and thus increasing the hydro period. Additionally, wetland vegetation will be improved.

Riparian buffers in excess of 50 feet will be restored along all of Reach R5. The existing stream crossing near the downstream end of Reach R5 will be replaced and improved as part of the proposed project. A ford crossing with gates will be installed to provide access across the stream. The new crossing will be fenced along the sides to exclude cattle from entering the restored stream. Finally, invasive species control will be conducted.

Reach R6 Enhancement

Work on Reach R6 will involve two distinct enhancement approaches. The upstream, 210-foot segment is incised, degraded, and widening; as such, Level I Enhancement will be employed to lower the bank angles and create floodplain benching. The proposed channel dimension will include a width-to-depth ratio of 14 with 2.5:1 riffle side slopes, allowing the channel to narrow as vegetation establishes. Combined with planting of native riparian buffer, this will eliminate future channel erosion on the reach and enable long-term stability.

In the proposal stage, Baker had proposed Priority Level I restoration for this upper segment of Reach R6. The concept was to make this segment similar to a reference-quality segment just below it. However, the survey revealed that the incised segment is much steeper (valley slope is 0.037 ft/ft) than the reference segment and this is likely the cause of the instability. As such, it is not feasible to recreate the reference segment and more of a stabilization (enhancement) approach will be targeted.

Below the upstream, degraded section, the mitigation approach will transition to Enhancement Level II that focuses on easement establishment, invasive species control, and buffer planting; no channel work is proposed. Though the bank height ratios exceed 2.0 in some locations, the IRT felt that it is important to maintain the existing vegetation and the smaller stream channel size is such that further erosion is likely to be limited, plus the benefit of doing further work is limited.

One existing stream crossing on upper Reach R6 will be maintained and left out of the conservation easement. The crossing will remain in its current condition since it is stable and cattle do not have access to it.

Portions of the riparian buffer along Reach R6 have been cleared as part of the 2011 timber harvest, increasing the importance of planting the appropriate riparian species. Design parameters for upper Reach R6 will be consistent with comparable ‘Bc’ stream types for the project. Design parameters for this section are included in Table 17.3, but not for the downstream end of Reach R6 because only Enhancement Level II approaches will be considered and dimension, pattern, and profile will have no adjustments.

Reach R7 Enhancement

Similar to Reach R6, work on Reach R7 includes two different enhancement approaches. The upstream segment is degrading and very steep with a channel slope in the first 160 feet of 0.044 ft/ft, so the approach is to stabilize the head cuts and channel gradient, as well as the unstable side slopes on the upper 350 feet of Reach R7. This work will involve installing constructed riffles, log weirs, and rock step structures, bank sloping and matting, and riparian buffer planting. Rock structures, though not natural in a sand bed system, provide some insurance because they are not subject to rotting before grade stabilizing vegetation can become established.

Wetlands are located just above the project reach and the aim is to prevent the headcut from migrating through and degrading this aquatic resource. This work is proposed at an Enhancement Level II credit ratio (2.5:1).

The lower 286-foot segment of Reach R7 is mostly stable with floodplain benches developing in many locations. The work here will be similar to lower Reach R6 and upper Reach R5, including easement establishment, invasive species control, and riparian buffer planting. No stream crossings are planned for Reach R7.

Reach T1 Enhancement

Work on Reach T1 will include Enhancement Level I because it involves a combination approaches, including restoration at the downstream end to tie into the Thomas Creek floodplain (Reach R2). As discussed with the NCIRT at the preliminary site visit, Reach T1 appears to have been moved from its original location so that it is now flowing perpendicular to Thomas Creek. After this meeting, the initial intent was to do restoration by routing the flow through the relic channel. However, because of the property boundary location, it is not feasible to reroute the streamflow to the relic channel while also including a 50-foot buffer and a necessary cattle crossing (i.e., there is limited available space in this area). Consequently, the channel will be enhanced in its existing location by initially fencing out an undisturbed wetland area, installing a step-pool sequence, and transitioning to a meandering channel that is constructed off line until its confluence with the mainstem (Reach R2).

This reach will be designed as a Rosgen 'C5' stream. The design width/depth ratio for the channel will be 13, and over time, the channel will likely narrow due to fine sediment deposition and streambank vegetation growth.

These techniques will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved channel function through improved aquatic habitat, more frequent overbank flooding, restoration of riparian and terrestrial habitats, exclusion of cattle and associated pollutants, and decreased erosion and sediment loss from streambank erosion.

Mapped jurisdictional wetlands along Reach T1 will be protected at the upper end. Below the crossing, they will be enhanced through the construction process by incorporating them as floodplain benches, raising the stream bed, and thus increasing the hydro period. Additionally, wetland vegetation will be improved.

Riparian buffers in excess of 50 feet will be restored along all of Reach T1. One stream crossing/ break in the easement is proposed along upper Reach T1. An eroding existing ford crossing will be improved by adding channel rock and fencing will be installed to exclude cattle from the easement area. Finally, invasive species control will be conducted.

Reach T2 Enhancement

Work on Reach T2 will include Level II Enhancement to maintain channel stability and exclude cattle. This approach has been changed from the IRT site visit when Level I Enhancement at 1:1 credit was proposed, because less work is needed to stabilize the channel than anticipated. The Reach T2 channel has two locations with steep drops in elevation which would likely become headcuts if tree roots were not there to prevent that. Furthermore, the channel lacks any pool habitat. Thus, Baker proposes to incorporate grade control structures to stabilize the headcuts and form pools that provide increased bedform diversity.

Riparian buffers in excess of 50 feet will be restored along all of Reach T2. Cattle, which currently use this channel as a favorite wallow area, will be permanently excluded. No stream crossings are proposed on this reach. Finally, invasive species control will be conducted.

Table 17.3 Natural Channel Design Criteria for Project Reaches

Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Parameter	Composite Reference Values		Design Values		Rationale
	Reach R1	Reach R2	Reach R1	Reach R2 upper/lower	
Rosgen Stream Type	C5	C5	C5	C5	Note 1
Bankfull Discharge, Qbkf (cfs)	-	-	44.6	23.0/29.7	Note 2
Bankfull Mean Velocity, Vbkf (ft/s)	3.5 - 5	3.5 – 5	4.0	3.8/3.9	V=Q/A
Bankfull Riffle XSEC Area, Abkf (sq ft)	-	-	11.2	6.0/7.7	Note 7
Bankfull Riffle Width, Wbkf (ft)	-	-	12.5	9.2/10.4	$\sqrt{Abkf * W / D}$
Bankfull Riffle Mean Depth, Dbkf (ft)	-	-	0.9	0.7/0.7	d=A/W
Width to Depth Ratio, W/D (ft/ft)	12 – 18	10 - 15	14	14/14	Note 3
Width Floodprone Area, Wfpa (ft)	-	-	>25	>18	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.4 – 2.2	> 2.2	>2.2	>2.2	Note 4
Riffle Max Depth @ bkf, Dmax (ft)	-	-	1.1	0.8/1.0	
Riffle Max Depth Ratio, Dmax/Dbkf	1.2 – 1.4	1.1 – 1.4	1.2	1.2/1.4	Note 5
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0 – 1.1	1.0 – 1.1	1.0	1.0	Note 6
Meander Length, Lm (ft)	-	-	105	75 – 107	Note 7
Meander Length Ratio, Lm/Wbkf	7 – 14	7 – 14	8.4	7.8 – 11.1	Note 7
Radius of Curvature, Rc (ft)	-	-	25 - 35	17–26/20-30	Note 7
Rc Ratio, Rc/Wbkf *	2 - 3	2 - 3	2 – 2.8	2 - 3	Note 7
Belt Width, Wblt (ft)	-	-	30	32 – 45	Note 7
Meander Width Ratio, Wblt/Wbkf	3.5 - 8	3.5 - 8	2.4	3.3 – 4.7	Note 7
Sinuosity, K (TW length/ Valley length)	1.1 – 1.3	1.2 – 1.5	1.22	1.20	Note 7
Valley Slope, Sval (ft/ft)	.005 –.015	.002 – 0.01	.01	.01	Sval / K
Channel Slope, Schan (ft/ft)	-	-	0.022	0.0047/0.0083	
Average Slope Riffle, Srif (ft/ft)	-	-	0.028	0.0094/0.02	
Riffle Slope Ratio, Srif/Schan	1.2 – 1.5	1.2 – 1.5	1.3	2.0/2.4	Note 8
Slope Pool, Spool (ft/ft)	-	-	0.0001	0.0006/0.0014	
Pool Slope Ratio, Spool/Schan	0.0 – 0.2	0.0 – 0.2	0.0	0.16/0.1	Note 8
Pool Max Depth, Dmaxpool (ft)	-	-	2.4	1.7/1.9	
Pool Max Depth Ratio, Dmaxpool/Dbkf	1.2 – 2.5	1.2 – 2.5	2.2	2.4/2.7	Note 7
Pool Width, Wpool (ft)	-	-	17.5	12.0/14.5	
Pool Width Ratio, Wpool/Wbkf	1.1 – 1.7	1.1 – 1.7	1.4	1.3/1.4	Note 9
Pool-Pool Spacing, Lps (ft)	-	-	24 – 60	25-55/45-75	
Pool-Pool Spacing Ratio, Lps/Wbkf	3.5 - 7	3.5 - 7	3.6 -5.5	2.7–6.0/ 4.3–7.2	Note 7

Notes:

1 A 'C' stream type is appropriate for a lower slopes (generally less than 0.015 ft/ft), wider alluvial valleys (generally greater than 100 ft). A 'Bc' stream type is appropriate for higher slopes (generally greater than 0.015 ft/ft), in more confined valleys. The channel dimension was based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, as well as sediment transport analyses and past project evaluation.

2 Bankfull discharge analysis was estimated using Manning's equation (n = 0.04) to represent post-construction conditions.

3 The W/D ratio was selected based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, as well as sediment transport analyses and past project evaluation.

4 Required for Rosgen stream classification.

5 Ratio was based on past project evaluation of similar design channels as well NC Piedmont reference reach streams.

6 A bank height ratio near 1.0 ensures that all flows greater than bankfull will spread onto a floodplain. This minimizes shear stress in the channel and maximizes floodplain functionality, resulting in lower risk of channel instability.

7 Design Values were chosen based on small piedmont stream reference reach data and past project evaluation.

8 Due to the small channel sizes, facet slopes were not calculated for the proposed design. Past project experience has shown that these minor changes in slope between bedform features form naturally within the constructed channel, provided that the overall design channel slope is maintained after construction.

9 Design Values were chosen based on reference reach comparison and past project evaluation. It is more conservative to design a pool wider than the riffle. Over time, the pool width may narrow from sediment deposits and vegetation growth, which is considered to be a positive evolutionary step towards stability.

Parameter	Composite Reference Values		Design Values		Rationale
	Reach R3	Reach R4	Reach R3	Reach R4	
Rosgen Stream Type	E/C5	C5	E/C5	C5	Note 1
Bankfull Discharge, Qbkf (cfs)	-	-	16.5	11.1	Note 2
Bankfull Mean Velocity, Vbkf (ft/s)	3.5 - 5	3.5 - 5	3.8	3.6	V=Q/A
Bankfull Riffle XSEC Area, Abkf (sq ft)	-	-	4.1	3.1	Note 7
Bankfull Riffle Width, Wbkf (ft)	-	-	7.0	6.3	$\sqrt{Abkf * W / D}$
Bankfull Riffle Mean Depth, Dbkf (ft)	-	-	0.7	0.5	d=A/W
Width to Depth Ratio, W/D (ft/ft)	10 - 14	10 - 14	12 (11 – 13)	13 (12 -14)	Note 3
Width Floodprone Area, Wfpa (ft)	-	-	>16	>13	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	>2.2	> 2.2	>2.2	>2.1	Note 4
Riffle Max Depth @ bkf, Dmax (ft)	-	-	0.7	0.6	
Riffle Max Depth Ratio, Dmax/Dbkf	1.2 – 1.4	1.1 – 1.4	1.2	1.2	Note 5
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0 – 1.1	1.0 – 1.1	1.0	1.0	Note 6
Meander Length, Lm (ft)	-	-	70 - 80	60 - 75	Note 7
Meander Length Ratio, Lm/Wbkf	5 - 12	7 - 14	9 – 11.5	9.5 - 12	Note 7
Radius of Curvature, Rc (ft)	-	-	15 – 21	12 - 18	Note 7
Rc Ratio, Rc/Wbkf *	2 - 3	2 - 3	2 – 2.7	2 – 3	Note 7
Belt Width, Wblt (ft)	-	-	18 - 28	20 - 29	Note 7
Meander Width Ratio, Wblt/Wbkf	3.5 - 10	3.5 - 8	2.6 – 4.0	3.2 – 4.6	Note 7

Sinuosity, K (TW length/ Valley length)	1.2 – 1.5	1.2 – 1.5	1.2	1.13	Note 7
Valley Slope, Sval (ft/ft)	0.005 – 0.015	0.005 – 0.015	0.0182	0.024	
Channel Slope, Schan (ft/ft)	-	-	0.015	0.017	
Average Slope Riffle, Srif (ft/ft)	-	-	0.031	0.029	
Riffle Slope Ratio, Srif/Schan	1.1 – 2.0	1.1 – 2.0	2.1	1.7	Note 8
Slope Pool, Spool (ft/ft)	-	-	0.005	0.005	
Pool Slope Ratio, Spool/Schan	0.0 – 0.4	0.0 – 0.4	0.3	0.2	Note 8
Pool Max Depth, Dmaxpool (ft)	-	-	1.5	1.1	
Pool Max Depth Ratio, Dmaxpool/Dbkf	1.2 – 2.5	1.2 – 2.5	2.5	2.2	Note 7
Pool Width, Wpool (ft)	-	-	10.0	8.5	
Pool Width Ratio, Wpool/Wbkf	1.1 – 1.5	1.1 – 1.5	1.3	1.4	Note 9
Pool-Pool Spacing, Lps (ft)	-	-	28 - 48	28 - 43	
Pool-Pool Spacing Ratio, Lps/Wbkf	2 – 6	2 – 6	3.7 – 6.3	4.6 – 7.0	Note 7

Notes:

1 A 'C' stream type is appropriate for a lower slopes (generally less than 0.015 ft/ft), wider alluvial valleys (generally greater than 100 ft). A 'Bc' stream type is appropriate for higher slopes (generally greater than 0.015 ft/ft), in more confined valleys. The channel dimension was based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, as well as sediment transport analyses and past project evaluation.

2 Bankfull discharge analysis was estimated using Manning's equation (n = ~0.04) to represent post-construction conditions.

3 The W/D ratio was selected based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, as well as sediment transport analyses and past project evaluation.

4 Required for Rosgen stream classification.

5 Ratio was based on past project evaluation of similar design channels as well NC Piedmont reference reach streams.

6 A bank height ratio near 1.0 ensures that all flows greater than bankfull will spread onto a floodplain. This minimizes shear stress in the channel and maximizes floodplain functionality, resulting in lower risk of channel instability.

7 Design Values were chosen based on small piedmont stream reference reach data and past project evaluation.

8 Due to the small channel sizes, facet slopes were not calculated for the proposed design. Past project experience has shown that these minor changes in slope between bedform features form naturally within the constructed channel, provided that the overall design channel slope is maintained after construction.

9 Design Values were chosen based on reference reach comparison and past project evaluation. It is more conservative to design a pool wider than the riffle. Over time, the pool width may narrow from sediment deposits and vegetation growth, which is considered to be a positive evolutionary step towards stability.

Parameter	**Composite Reference Values**		**Design Values**		**Rationale**
	Reach R5	**Reach R6**	**Reach R5**	**Reach R6**	
Rosgen Stream Type	C5	B5c	C5	B5c	Note 1
Bankfull Discharge, Qbkf (cfs)	-	-	12.0	5.0	Note 2
Bankfull Mean Velocity, Vbkf (ft/s)	3.5 - 5	4 – 6	3.3	3.3	V=Q/A
Bankfull Riffle XSEC Area, Abkf (sq ft)	-	-	3.6	1.5	Note 7
Bankfull Riffle Width, Wbkf (ft)	-	-	6.8	4.6	$\sqrt{Abkf * W / D}$

Bankfull Riffle Mean Depth, Dbkf (ft)	-	-	0.5	0.3	d=A/W
Width to Depth Ratio, W/D (ft/ft)	10 - 14	12 – 18	13	14	Note 3
Width Floodprone Area, Wfpa (ft)	-	-	>16	>9	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	> 2.2	1.4 – 2.2	>2.3	>2.0	Note 4
Riffle Max Depth @ bkf, Dmax (ft)	-	-	0.7	0.4	
Riffle Max Depth Ratio, Dmax/Dbkf	1.1 – 1.4	1.2 – 1.4	1.4	1.3	Note 5
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0 – 1.1	1.0 – 1.1	1.0	1.0	Note 6
Meander Length, Lm (ft)	-	N/a	60 - 90	N/a	Note 7
Meander Length Ratio, Lm/Wbkf	7 - 14	N/a	8.8 – 13.2	N/a	Note 7
Radius of Curvature, Rc (ft)	-	N/a	14 - 20	N/a	Note 7
Rc Ratio, Rc/Wbkf *	2 - 3	N/a	2 - 3	N/a	Note 7
Belt Width, Wblt (ft)	-	N/a	28 - 45	N/a	Note 7
Meander Width Ratio, Wblt/Wbkf	3.5 - 8	N/a	4.1 – 6.6	N/a	Note 7
Sinuosity, K (TW length/ Valley length)	1.2 – 1.5	1.1 – 1.3	1.42	1.05	Note 7
Valley Slope, Sval (ft/ft)	0.005 – 0.015	0.005 – 0.015	0.0134	0.033	
Channel Slope, Schan (ft/ft)	-	-	0.0124	0.030	
Average Slope Riffle, Srif (ft/ft)	-	-	0.0265	0.040	
Riffle Slope Ratio, Srif/Schan	1.1 – 2.0	1.1 – 1.8	2.1	1.3	Note 8
Slope Pool, Spool (ft/ft)	-	-	0.0025	0.02	
Pool Slope Ratio, Spool/Schan	0.0 – 0.4	0.0 – 0.4	0.2	0.7	Note 8
Pool Max Depth, Dmaxpool (ft)	-	-	1.3	1.0	
Pool Max Depth Ratio, Dmaxpool/Dbkf	1.2 – 2.5	1.2 – 2.5	2.6	3.3	Note 7
Pool Width, Wpool (ft)	-	-	9.0	6.0	
Pool Width Ratio, Wpool/Wbkf	1.1 – 1.5	1.1 – 1.5	1.32	1.3	Note 9
Pool-Pool Spacing, Lps (ft)	-	-	25 – 55	N/a	
Pool-Pool Spacing Ratio, Lps/Wbkf	3.5 – 7	2 – 6	3.7 – 8.1		Note 7

Notes:

1 A 'C' stream type is appropriate for a lower slopes (generally less than 0.015 ft/ft), wider alluvial valleys (generally greater than 100 ft). A 'Bc' stream type is appropriate for higher slopes (generally greater than 0.015 ft/ft), in more confined valleys. The channel dimension was based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, as well as sediment transport analyses and past project evaluation.

2 Bankfull discharge analysis was estimated using Manning's equation (n = ~0.04) to represent post-construction conditions.

3 The W/D ratio was selected based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, as well as sediment transport analyses and past project evaluation.

4 Required for Rosgen stream classification.

5 Ratio was based on past project evaluation of similar design channels as well NC Piedmont reference reach streams.

6 A bank height ratio near 1.0 ensures that all flows greater than bankfull will spread onto a floodplain. This minimizes shear stress in the channel and maximizes floodplain functionality, resulting in lower risk of channel instability.

7 Design Values were chosen based on small piedmont stream reference reach data and past project evaluation.

8 Due to the small channel sizes, facet slopes were not calculated for the proposed design. Past project experience has shown that these minor changes in slope between bedform features form naturally within the constructed channel, provided that the overall design channel slope is maintained after construction.

9 Design Values were chosen based on reference reach comparison and past project evaluation. It is more conservative to design a pool wider than the riffle. Over time, the pool width may narrow from sediment deposits and vegetation growth, which is considered to be a positive evolutionary step towards stability.

Parameter	Composite Reference Values		Design Values		Rationale
	Reach R7	Reach T1	Reach R7	Reach T1	
Rosgen Stream Type	B5c	B5c	B5c	B5c	Note 1
Bankfull Discharge, Qbkf (cfs)	-	-	5.0	13.9	Note 2
Bankfull Mean Velocity, Vbkf (ft/s)	4 – 6	4 – 6	3.33	3.66	V=Q/A
Bankfull Riffle XSEC Area, Abkf (sq ft)	-	-	1.5	3.8	Note 7
Bankfull Riffle Width, Wbkf (ft)	-	-	4.6	7.0	$\sqrt{Abkf * W / D}$
Bankfull Riffle Mean Depth, Dbkf (ft)	-	-	0.3	0.6	d=A/W
Width to Depth Ratio, W/D (ft/ft)	12 – 18	12 – 18	14	13	Note 3
Width Floodprone Area, Wfpa (ft)	-	-	N/a		
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.4 – 2.2	1.4 – 2.2	N/a		Note 4
Riffle Max Depth @ bkf, Dmax (ft)	-	-	0.4	0.7	
Riffle Max Depth Ratio, Dmax/Dbkf	1.2 – 1.4	1.2 – 1.4	1.3	1.17	Note 5
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0 – 1.1	1.0 – 1.1	1.0	1.0	Note 6
Meander Length, Lm (ft)	N/a	N/a	N/a	N/a	Note 7
Meander Length Ratio, Lm/Wbkf	N/a	N/a	N/a	N/a	Note 7
Radius of Curvature, Rc (ft)	N/a	N/a	N/a	13.5 – 18	Note 7
Rc Ratio, Rc/Wbkf *	N/a	N/a	N/a	2.0 – 2.6	Note 7
Belt Width, Wblt (ft)	N/a	N/a	N/a	N/a	Note 7
Meander Width Ratio, Wblt/Wbkf	N/a	N/a	N/a	N/a	Note 7

Sinuosity, K (TW length/ Valley length)	1.1 – 1.3	1.1 – 1.3	1.11	1.16	Note 7
Valley Slope, Sval (ft/ft)	0.005 – 0.015	0.005 – 0.015	0.036	0.005	Sval / K
Channel Slope, Schan (ft/ft)	-	-	0.032	0.004	
Average Slope Riffle, Srif (ft/ft)	-	-	N/a	0.0135	
Riffle Slope Ratio, Srif/Schan	1.1 – 1.8	1.1 – 1.8	N/a	3.4	Note 8
Slope Pool, Spool (ft/ft)	-	-	N/a	0.0001	
Pool Slope Ratio, Spool/Schan	0.0 – 0.4	0.0 – 0.4	N/a	0.0	Note 8
Pool Max Depth, Dmaxpool (ft)	-	-	1.0	1.4	
Pool Max Depth Ratio, Dmaxpool/Dbkf	1.2 – 2.5	1.2 – 2.5	3.3	2.0	Note 7
Pool Width, Wpool (ft)	-	-	6.0	9.0	
Pool Width Ratio, Wpool/Wbkf	1.1 – 1.5	1.1 – 1.5	1.3	1.32	Note 9
Pool-Pool Spacing, Lps (ft)	-	-	N/a	25 -42	
Pool-Pool Spacing Ratio, Lps/Wbkf	2 – 6	2 – 6	N/a	3.7 – 6.2	Note 7

Notes:

1 A ‘C’ stream type is appropriate for a lower slopes (generally less than 0.015 ft/ft), wider alluvial valleys (generally greater than 100 ft). A ‘Bc’ stream type is appropriate for higher slopes (generally greater than 0.015 ft/ft), in more confined valleys. The channel dimension was based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, as well as sediment transport analyses and past project evaluation.

2 Bankfull discharge analysis was estimated using Manning’s equation (n = ~0.04) to represent post-construction conditions.

3 The W/D ratio was selected based on relationships of W/D ratio to slope in NC Piedmont reference reach streams, as well as sediment transport analyses and past project evaluation.

4 Required for Rosgen stream classification.

5 Ratio was based on past project evaluation of similar design channels as well NC Piedmont reference reach streams.

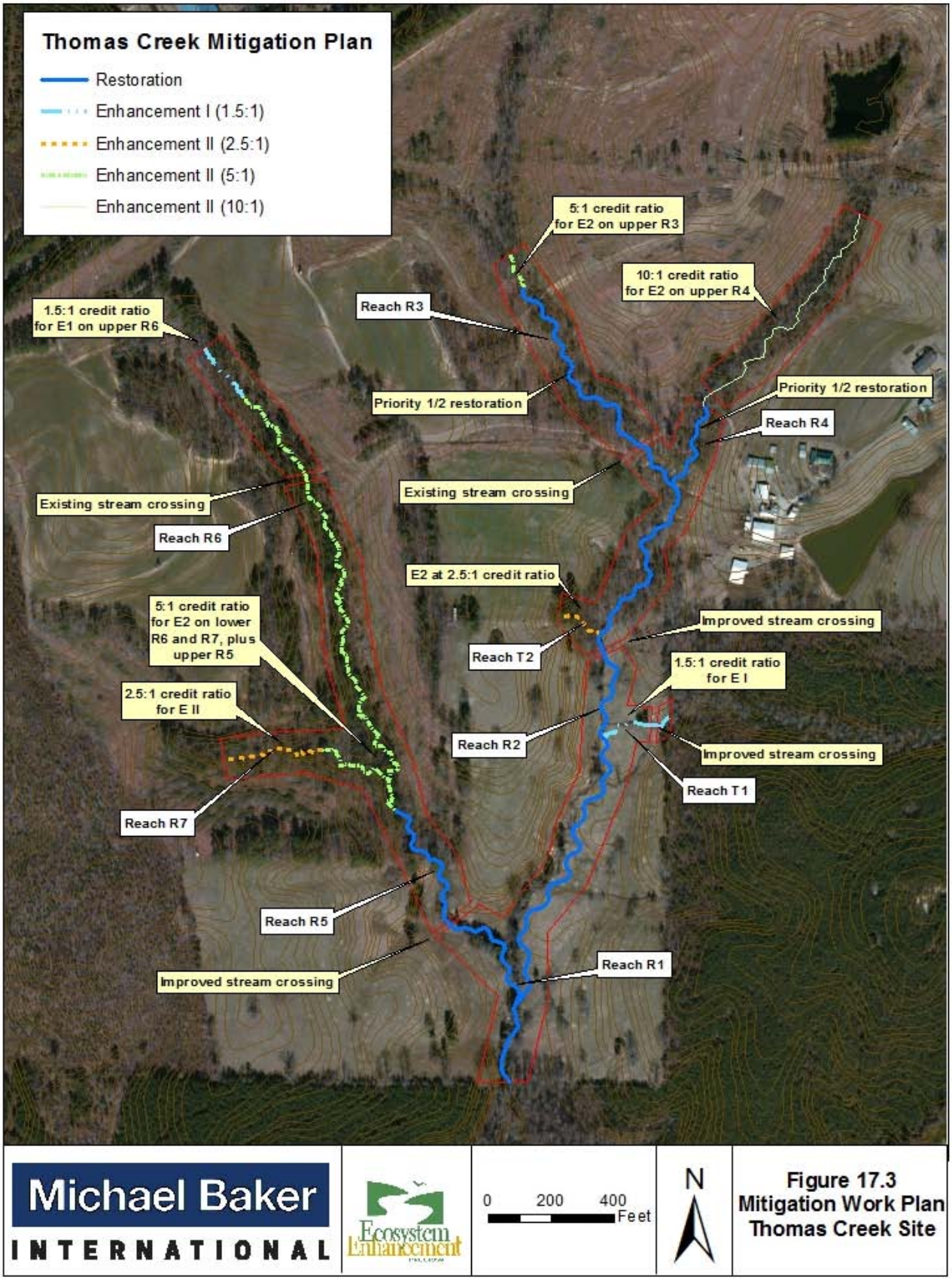
6 A bank height ratio near 1.0 ensures that all flows greater than bankfull will spread onto a floodplain. This minimizes shear stress in the channel and maximizes floodplain functionality, resulting in lower risk of channel instability.

7 Design Values were chosen based on small piedmont stream reference reach data and past project evaluation.

8 Due to the small channel sizes, facet slopes were not calculated for the proposed design. Past project experience has shown that these minor changes in slope between bedform features form naturally within the constructed channel, provided that the overall design channel slope is maintained after construction.

9 Design Values were chosen based on reference reach comparison and past project evaluation. It is more conservative to design a pool wider than the riffle. Over time, the pool width may narrow from sediment deposits and vegetation growth, which is considered to be a positive evolutionary step towards stability.

Figure 17.3 Mitigation Work Plan



17.1.3 Reference Reach Data Indicators

Reference reach surveys are valuable tools used for comparison. The morphologic data obtained such as dimension, pattern, and profile can be used as a template for design of a stable stream in a similar valley type with similar bed material, as well as with similar watershed land use. In order to extract the morphological relationships observed in a stable system, dimensionless ratios are developed from the surveyed reference reach. These ratios can be applied to a stream design to allow the designer to 'mimic' the natural, stable form of the target channel type.

While reference reach data can be a useful aid in designing channel dimension, pattern, and profile, there are limitations in smaller stream systems. The flow patterns and channel formation for most reference reach quality streams is often controlled by slope, drainage areas and large trees and/or other deep rooted vegetation. Some meander geometry parameters, such as radius of curvature, are particularly affected by vegetation control. Pattern ratios observed in reference reaches may not be applicable or are often adjusted in the design criteria to create more conservative designs that are less likely to erode after construction, before the permanent vegetation is established. Often the best reference data is from adjacent stable stream reaches, or reaches within the same watershed.

Baker selected two nearby reference reaches, the Little Beaver Creek reference reach and Thomas Creek upper Reach R4, as shown on Figure 17.4. The Little Beaver Creek reference reach is located three miles northeast of the Thomas Creek property and is also located within the Triassic Basin. The surveyed reach is located to the north of Fairfield Lane, Lots 19 and 20, and begins approximately 900 feet upstream from the Ecosystem Enhancement Program's Little Beaver Creek mitigation project. The drainage area is approximately 198 acres or 0.30 square miles. The watershed has a two percent slope and the landuse is similar to what Thomas Creek will become after it has been restored; namely, mostly forested with few pasture areas and limited development (i.e., low imperviousness).

Earth Tech, Inc. surveyed the Little Beaver Creek reference reach in July 2002, recording dimension, pattern, and profile for 360 linear feet of stream channel (Earth Tech, 2003). The bankfull dimensions were 14.4 feet for width and 0.85 feet for mean depth. It is classified as a Rosgen 'C5' stream type that is suitable as a reference for the lower reaches of the Thomas Creek project, including R1 and lower R2, and to a lesser extent, R5.

The second reference reach is on the Thomas Creek project property. The restoration segment of Reach R4 is on the downstream end. An existing ford crossing has stopped the migration of a headcut that started in Reach R2; consequently, upstream from the crossing Reach R4 is of reference quality.

Reach R4 begins at the northern property line just downstream from the confluence of two small drainages in the northeast end of the project property. The drainage area for Reach R4 is 37 acres. The bankfull dimensions were 3.5 feet for width and 0.8 feet for mean depth, which equates to a width-to-depth ratio of 4.4. Upper Reach R4 is a Rosgen "E" stream type with bank height ratio of 1.0, which makes somewhat suitable for use as a reference reach for the upper reaches of the Thomas Creek project, including Reaches R3, lower R4, lower R5, and T1. The valley slope for upper Reach R4 is 0.015, which is quite steep for an E stream type. The sinuosity is 1.3, which reduces the channel slope. Tree roots and stems are provide grade control and bank stability. The design channels will target higher width to depth ratios than upper Reach R4 to reduce stress on streambanks that lack mature vegetation.

One difference between upper Reach R4 (reference reach) and Reaches R3 and lower R4 (restoration reaches) is that the valley width for the reference reach is noticeably wider. This difference is important because it prevents the restoration reaches from achieving the same meander geometry as the reference reach.

These data helped to provide a basis for evaluating the valley slope and topography of the project site and determining the stream systems that may have been present historically and/or how they may have been influenced by changes within the watershed.

The reference reaches fall within the same climatic, topographical, physiographic, and ecological region as the Thomas Creek restoration site. These systems exist as smaller intermittent/perennial streams in which flows tend to be relatively steady, with floods of short duration, and seasonal periods of low or even no flow. Upper Reach R4 is more on the intermittent end while the Little Beaver Creek reference reach is more on the perennial end of the continuum.

The wooded portions of the site consist of a combination of Dry-Mesic Oak-Hickory Forest in the uplands with Piedmont/Mountain Alluvial Forest and Bottomland Forest in the lower areas and floodplains on the site (Schafale and Weakley, 1990). See Section 17.4 for further description of the existing Thomas Creek site vegetation. The vegetation community at nearby Little Beaver Creek is representative of native species found throughout the Thomas Creek site.

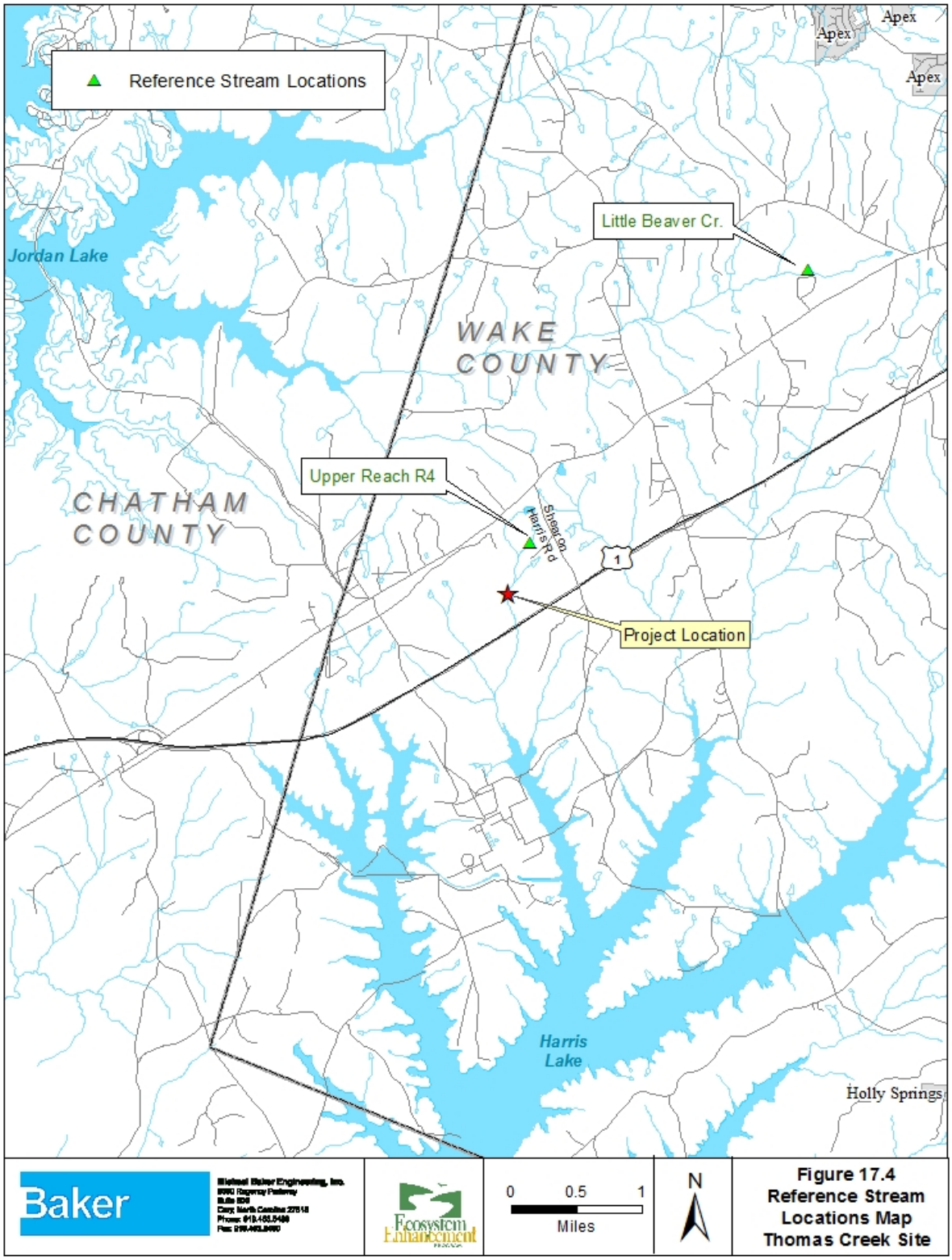
The primary soil series mapped at the Little Beaver reference site is Wehadkee silt loam (WnA) and can be generally described as poorly drained alluvial loam found on floodplains (NRCS, 1970). As described in section 2.1, the soils on upper Reach R4 and the rest of the Thomas Creek project area are Wehadkee and Bibb series. Thus, the reference site soils are essentially the same as the project site soils. Both the Wehadkee and Bibb have slow to ponded surface runoff. Infiltration is fair for the Wehadkee and good for the Bibb (sandy loam in top 4 to 12 inches), owing to slightly more sand in surface layer.

Table 17.4 Reference Reach Parameters Used to Inform Design Ratios

Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Parameter	Little Beaver Creek		Thomas Creek R4	
	MIN	MAX	MIN	MAX
Drainage Area, DA (sq mi)	0.3		0.05	
Stream Type (Rosgen)	C5		E5	
Bankfull Discharge, Qbkf (cfs)	40		10	
Bankfull Width, Wbkf (ft)	14.4		3.5	
Bankfull Riffle Cross-Sectional Area, Abkf (sq ft)	12.3		2.7	
Bankfull Mean Velocity, Vbkf (ft/s)	3.3		3.7	
Width to Depth Ratio, W/D (ft/ft)	15.6	18.4	4.5	5.6
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	8.9	13.6	12.3	12.3
Riffle Max Depth Ratio, Dmax/Dbkf	2.2	2.5	1.6	1.7
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	1.0	1.0	1.1
Meander Length Ratio, Lm/Wbkf	3.2	4.7	6.7	10.8
Rc Ratio, Rc/Wbkf	0.76	1.3	2.6	4.7
Meander Width Ratio, Wblt/Wbkf	0.35	1.5	5.4	8.1
Sinuosity, K	1.2		1.3	
Valley Slope, Sval (ft/ft)	0.0061		0.015	
Channel Slope, Schan (ft/ft)	0.0051		0.012	
Pool Max Depth Ratio, Dmaxpool/Dbkf	3.3	3.3	0.9	1.5
Pool Width Ratio, Wpool/Wbkf	1.3	1.3	1.2	1.5
Pool-Pool Spacing Ratio, Lps/Wbkf	1.0	3.3	2.7	5.4
d16 (mm)	0.175		0.13	
d35 (mm)	0.375		0.34	
d50 (mm)	1.0		0.52	
d84 (mm)	13.6		1.19	
d95 (mm)	19.3		1.79	

Figure 17.4 Reference Streams Location Map



17.2 Bankfull Verification Analysis

17.2.1 Bankfull Stage and Discharge

Bankfull stage and its corresponding discharge are the primary variables used to develop a natural channel design. The bankfull stage corresponds with the discharge that fills a channel to the elevation of the active floodplain and represents a breakpoint between processes of channel formation and floodplain development. Numerous definitions exist of bankfull stage and methods for its identification in the field (Wolman and Leopold, 1957; Nixon, 1959; Schumm, 1960; Kilpatrick and Barnes, 1964; and Williams, 1978). The bankfull discharge, which also corresponds with the dominant discharge or effective discharge, is considered to be a peak flow, along with the range of flows, that moves the most sediment over time in stable alluvial channels and helps form the shape and size of the active channel.

The correct identification of bankfull stage in the humid Southeast can be especially difficult and subjective because of dense understory vegetation and a long history of channel modification and subsequent adjustment in channel morphology. Field indicators commonly include the back of point bars, significant breaks in slope, changes in vegetation, the highest scour line, or the top of the streambank (Leopold, 1994). The most consistent bankfull indicators for streams in the Piedmont of North Carolina are the backs of point bars, breaks in slope at the front of flat bankfull benches, or the top of the streambanks (Harman et al., 1999).

Upon completion of the geomorphic field survey, accurate identification of bankfull stage and corresponding discharge could not be made in all reach sections throughout the site due to incised/impaired channel conditions. Although, some field indicators were apparent in portions of Reaches R2, R4, and R5, with lower streambank heights and discernible scour features, the reliability of the indicators was inconsistent due to the altered condition of the stream channels. For this reason, regional curve relationships (based on drainage areas) were used to develop the bankfull discharge estimates for the project reaches. The curve relationships were compared to stable representative cross sections on-site to select an appropriate design discharge estimate.

17.2.2 Bankfull Hydraulic Geometry Relationships (Regional Curve Predictions)

Hydraulic geometry relationships are often used to predict channel morphology features and their corresponding dimensions. The stream channel hydraulic geometry theory developed by Leopold and Maddock (1953) describes the interrelations between dependent variables such as width, depth, and area as functions of independent variables such as watershed area or discharge. These rainfall/runoff relationships can be developed at a single cross section or across many stations along a reach (Merigliano, 1997). Hydraulic geometry relationships are empirically derived and can be developed for a specific river or extrapolated to a watershed in the same physiographic region with similar rainfall/runoff relationships (FISRWG, 1998).

Regional curves developed by Dunne and Leopold (1978) relate bankfull channel dimensions to drainage area. A primary purpose for developing regional curves is to aid in identifying bankfull stage and dimension in ungaged watersheds, as well as to help estimate the bankfull dimension and discharge for natural channel designs (Rosgen, 1994). Gage station analyses throughout the United States have shown that the bankfull discharge has an average return interval of 1.5 years or 66.7% annual exceedence probability on the maximum annual series (Dunne and Leopold, 1978; Leopold, 1994).

Regional curves are available for a range of stream types and physiographic provinces. The published NC Rural Piedmont Regional Curve (Harman et al., 1999) and the updated NC Piedmont Regional Curve developed by the Natural Resources Conservation Service (Walker, 2012) were used for comparison with other site-specific methods of estimating

bankfull discharge. Baker has successfully implemented a significant number of stream restoration projects in North Carolina using the published curve data and has produced "mini-curves" specific to many of these projects. The NC Rural Piedmont Regional curve equations developed from the studies are shown below in Table 17.5.

Table 17.5 NC Rural Piedmont Regional Curve Equations
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

NC Piedmont Rural Regional Curve Equations (Harman et al., 1999)		**NC Piedmont Rural Regional Curve Equations (Revised NC Rural Piedmont Regional Curve (Walker, 2012)**	
$Q_{bkf} = 66.57\ A_w^{0.89}$	R^2=0.97	$Q_{bkf} = 58.26\ A_w^{0.78}$	R^2=0.99
$A_{bkf} = 21.43\ A_w^{0.68}$	R^2=0.95	$A_{bkf} = 15.65 A_w^{0.69}$	R^2=0.99
$W_{bkf} = 11.89\ A_w^{0.43}$	R^2=0.81	$W_{bkf} = 11.64\ A_w^{0.46}$	R^2=0.98
$D_{bkf} = 1.50\ A_w^{0.32}$	R^2=0.88	$D_{bkf} = 1.15\ A_w^{0.28}$	R^2=0.96

Based on observations made in small rural piedmont streams, a growing number of data points provide supporting evidence for the selection of bankfull indicators that produce smaller dimensions and flow rates than the published regional curve data. However, that does not appear to be the case for all the Thomas Creek project reaches.

As a comparison of a representative stable cross section (2b) identified within upper Reach R2, the NC Piedmont Regional Curve estimates a bankfull cross-sectional area (A_{bkf}) of approximately 6.0 sf and a bankfull discharge (Q_{bkf}) of approximately 11.1 cfs for a 0.153 mi^2 watershed. The revised rural piedmont regional curve estimates the A_{bkf} of 4.3 sf and the Q_{bkf} of 13.5 cfs. The existing surveyed channel dimension has cross-sectional area at the top-of-streambank/bankfull indicator of 5.6 sf. Similarly, for the representative stable cross section (4b) in upper Reach R4, the NC Piedmont Regional Curve estimates a bankfull cross-sectional area (A_{bkf}) of approximately 3.1 sf and a bankfull discharge (Q_{bkf}) of approximately 11.1 cfs for a 0.056 mi^2 watershed. The revised piedmont regional curve estimates the A_{bkf} of 2.1 sf and the Q_{bkf} of 6.2 cfs. The existing surveyed channel dimension has cross-sectional area at the top-of-streambank/bankfull indicator of 2.7 sf.

Other measurements were taken around the Thomas Creek project area with similar results; the published (1999) Piedmont regional curve was generally close to the bankfull area from field measurements (see Table 17.6). In one case, the measured bankfull area was larger than that estimated by the regional curve. Thus, it appears that published Piedmont regional curve is generally useful for the smaller Triassic basin streams that are part of the Thomas Creek project.

Table 17.6 Comparison of Bankfull Areas
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Reach	DA (sq mi)	Estimate from 1999 Regional Curve (sq ft)	Measured At Bankfull Indicator (sq ft)
R1	0.384	11.2	12.0
R2_lower	0.219	7.7	7.5
R2_upper	0.153	6.0	5.6
R4	0.056	3.1	2.7, 3.1
R5	0.083	4.0	3.4, 3.75

Note: drainage areas in this table apply to cross section locations, not the outlet point of each reach.

17.2.3 Conclusions for Channel Forming Discharge

As described above in Section 17.2.1, Rosgen's stream classification system (Rosgen, 1996) depends on the proper field identification of consistent geomorphic features related to the active floodplain. Although bankfull stage verification was not possible in the field for all reaches under current conditions, the cross-section data used for the above regional curve comparison are within an acceptable range of values given the existing channel conditions, geologic features, and flow regime/dentritic drainage patterns.

Table 17.7 provides a bankfull discharge analysis based on the bankfull regional curves, the Manning's equation discharges calculated from the representative cross sections for each reach, and the bankfull design discharge estimations based on the proposed design cross sections for all project reaches.

Manning's roughness (*n*) was estimated using the USGS paper "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Floodplains" (Arcement and Schneider, 1989). Although selecting a Manning's roughness coefficient can be somewhat subjective, the goals was to select a design value representative of a sand bed channel immediately after construction with some influence from debris, meandering, and minimal vegetation (e.g, livestakes, log jams, log vanes, herbaceous growth, etc.). The stream power is higher and the sediment supply should be lower for this system, so a conservative *n* value was chosen. Considering additional bedform roughness will be created (e.g., log jams, constructed riffles), over time the roughness should increase as vegetation establishes so that *n* values may range from 0.07 to greater than 0.10.

Table 17.7 Bankfull Discharge Analysis Summary

Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Estimating Method	Bankfull Velocity (ft/sec)	Bankfull Discharge (cfs)
	Reach R1	
NC Rural Piedmont Regional Curve[1]	4.0	44.6
NRCS NC Rural Piedmont Regional Curve[2]	3.4	27.6
Friction Factor to Relative Roughness Ratio method[3]	6.0	67.8
Manning's "n" from friction factor and relative roughness[3]	4.9	55.0
Manning's "n" from stream type[3]	3.4	38.0
Design Estimate	4.1	47.0
	Reach R2	
NC Rural Piedmont Regional Curve[1]	3.9	29.7
NRCS NC Rural Piedmont Regional Curve[2]	3.2	17.8
Friction Factor to Relative Roughness Ratio method[3]	4.3	33.3
Manning's "n" from friction factor and relative roughness[3]	3.6	27.5
Manning's "n" from stream type[3]	2.5	19.0
Design Estimate	3.7	30.0
	Reach R3	
NC Rural Piedmont Regional Curve[1]	3.8	16.5
NRCS NC Rural Piedmont Regional Curve[2]	3.0	9.4
Friction Factor to Relative Roughness Ratio method[3]	4.0	17.3
Manning's "n" from friction factor and relative roughness[3]	3.5	15.0
Manning's "n" from stream type[3]	2.4	10.4
Design Estimate	3.7	16.0
	Reach R4	
NC Rural Piedmont Regional Curve[1]	3.6	11.1
NRCS NC Rural Piedmont Regional Curve[2]	3.0	6.2
Friction Factor to Relative Roughness Ratio method[3]	3.1	9.7
Manning's "n" from friction factor and relative roughness[3]	2.8	8.7
Manning's "n" from stream type[3]	1.9	6.0
Design Estimate	3.3	10.0
	Reach R5	
NC Rural Piedmont Regional Curve[1]	3.7	14.7
NRCS NC Rural Piedmont Regional Curve[2]	3.4	9.4
Friction Factor to Relative Roughness Ratio method[3]	4.0	14.4
Manning's "n" from friction factor and relative roughness[3]	3.5	12.5
Manning's "n" from stream type[3]	3.1	8.6
Design Estimate	3.9	14.0

Notes:

[1] NC Piedmont Regional Curve (Harman et al., 1999).

[2] Revised NC Rural Piedmont Regional Curve developed by NRCS (Walker, 2012).

[3] WARSSS, 2006 spreadsheet. Bankfull discharge estimates vary based on Manning's Equation for the riffle cross section. Bankfull stage roughness estimates (*n*-values) ranged from approximately 0.035 to 0.055 based on channel slopes, depth, bed material size, and vegetation influence.

17.3 Sediment Transport Analysis

17.3.1 Background and Methodology

The purpose of a sediment transport analysis is to ensure that the stream restoration design creates a stable channel that does not aggrade or degrade over time. The overriding assumption is that the site streams should be transporting the total sediment load delivered from upstream sources. The ability of the stream to transport its total sediment load can be quantified through two measures: sediment transport competency (force) and sediment transport capacity (power). Lane (1955) describes a generalized relationship of stream stability and dynamic equilibrium wherein the product of sediment load and sediment size is proportional to the product of stream slope and discharge.

Sediment transport capacity is a stream's ability to move a mass of sediment through a cross-section dimension, and is a measurement of stream power, often expressed in units of watts/square meter (Watts/meter^2). Transport competency is a stream's ability to move particles of a given size and is a measurement of force, often expressed as units of pounds per square foot (lbs/ft2). A stream's competency is estimated in terms of the relationship between critical and actual depth, at a given slope, and occurs when the critical depth produces enough shear stress to move the largest (d100) particle size.

In sand bed streams, such as Thomas Creek and its tributaries, sediment transport capacity is the critical analysis. The total volume of sediment transported through a cross section consists of bedload plus suspended load fractions. Suspended load is normally composed of fine sand, silt, and clay particles transported in the water column. The bedload generally includes relatively larger particles, such as coarser sand and finer gravel, which are mobilized by rolling, sliding, or bouncing (saltating) along the bed.

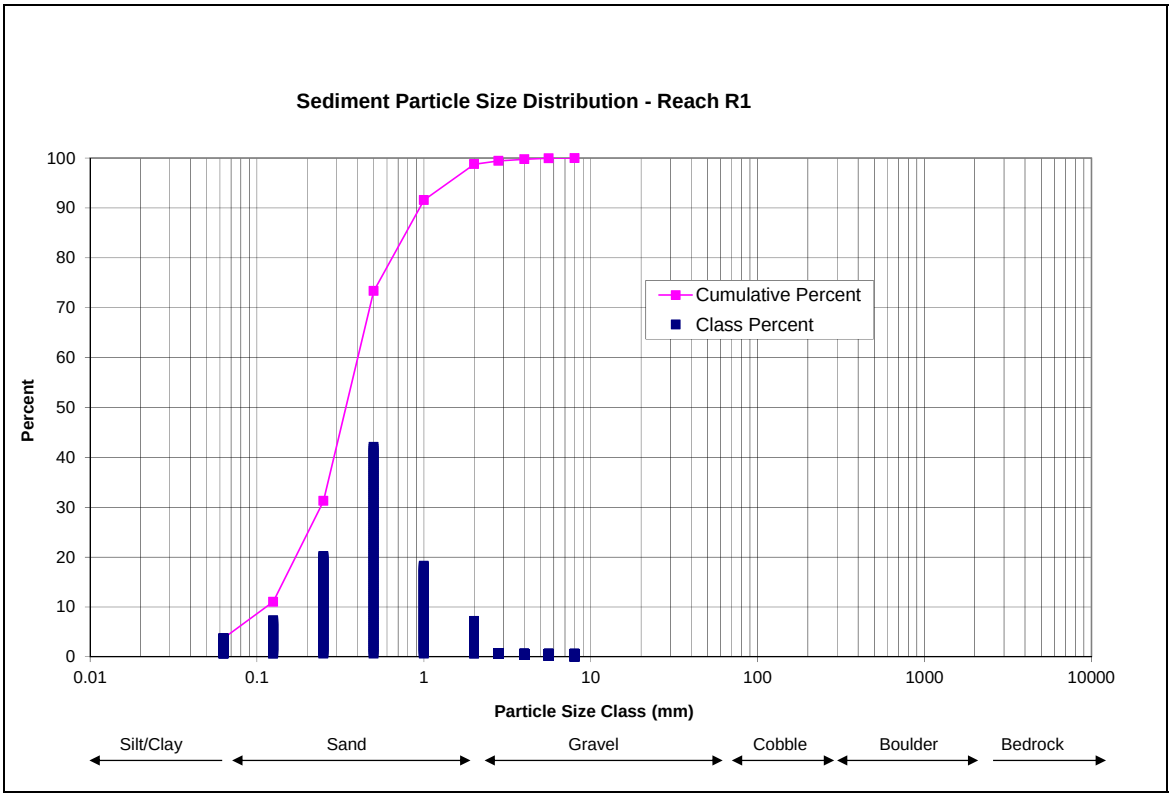
Given the steeper slopes of the project reaches, there is ample stream power (i.e., capacity) to move the sediment load and very little risk of aggradation. Baker developed a HEC-RAS model for Reach R3 and found that stream power remains high in the proposed conditions, particularly at the lower end of the riffles. Thus, to guard against degradation, very frequent constructed threshold riffles that are immobile have been included in the design. This is one of the recommendations from a study of Piedmont sand bed streams conducted by Buck Engineer (now Baker) for NCEEP (Buck Engineering, 2007). The watershed does not appear to be sediment supply limited, so material that is transported from riffle beds may be replaced by sediment supply from upstream. However, given the high stream power and channel stabilization measures (which will reduce sediment supply) undertaken as part of this project, incorporating frequent grade control in the riffles provides insurance against channel degradation. Additionally, should the watershed further develop, riffle grade control will protect against a flashier hydrologic response.

17.3.2 Sampling Data Results

Sediment samples, consisting of bulk samples across the active channel bed, were collected along the project reaches and dry sieved in a lab to obtain a sediment size distribution. The sample locations are shown on Figure 17.1. The sieve data shown in Figure 17.5 show that all samples have a d50 in the 0.25-0.5 mm range, indicating that the dominant bed material in the stream channel is medium sand under current conditions. Additionally, the largest particles are fine to medium gravel in all cases, with the largest particles less than 16 mm.

It should be noted that the modified Wolman pebble count (Rosgen, 1994) is not appropriate for sand-bed systems; therefore, a bulk sample procedure was only used to characterize the bed material for all of the Thomas Creek sediment samples. All of the reaches contain sand, silt, and muck stream bottom due to the parent soil and cattle impacts. Gravel composes approximately one (R1, R5, R7) to eight (R3) percent of the substrate in all locations.

Figure 17.5 Sediment Particle Size Distribution



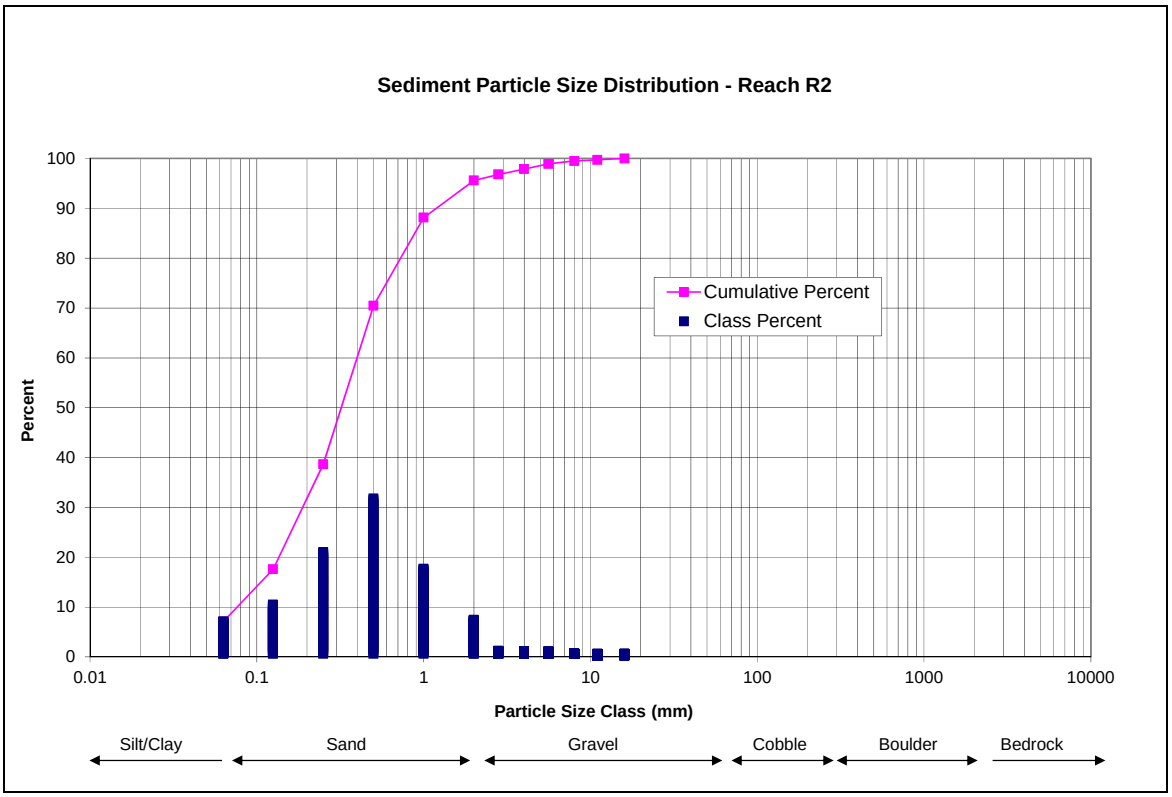
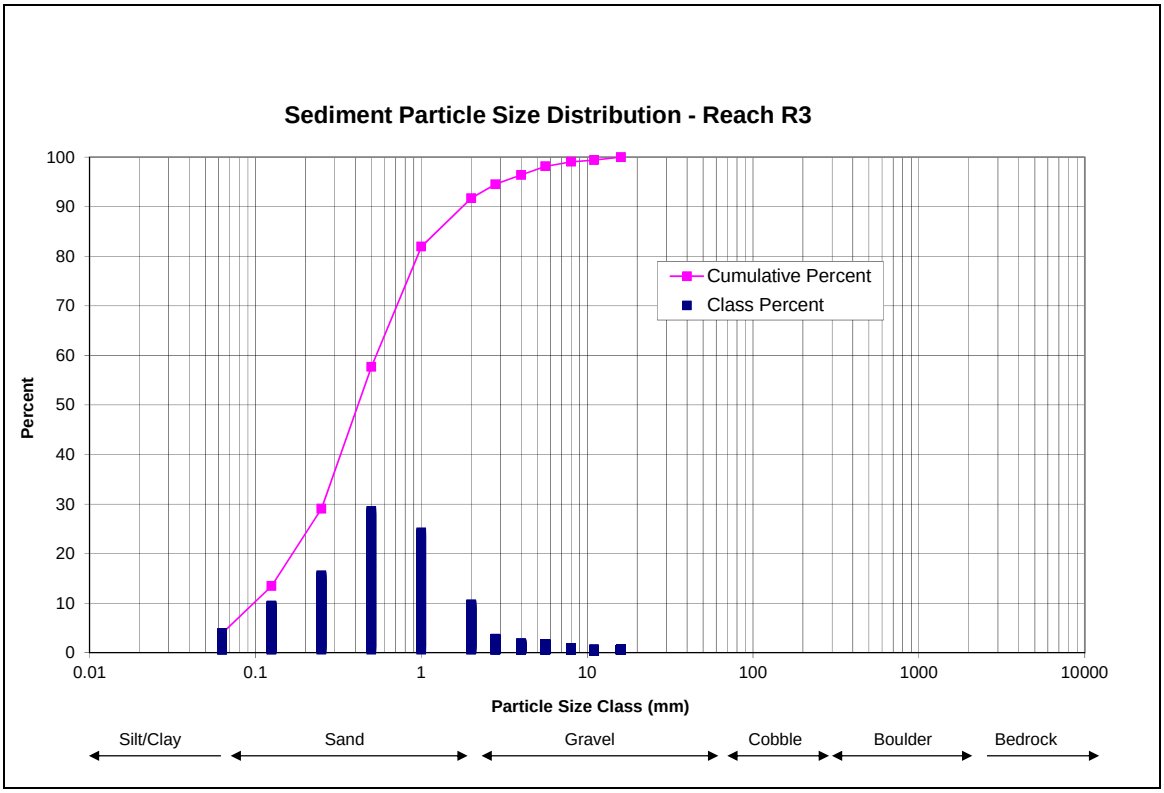


Figure 17.5 Sediment Particle Size Distribution (Continued)



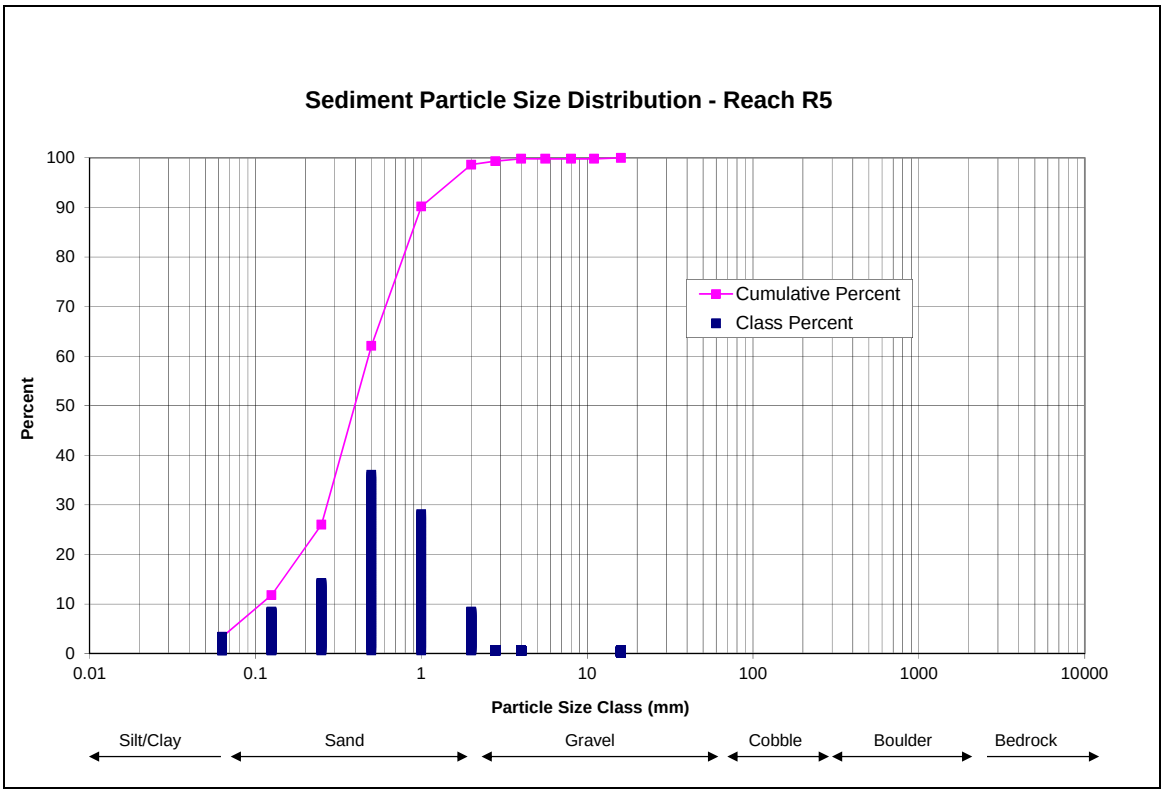
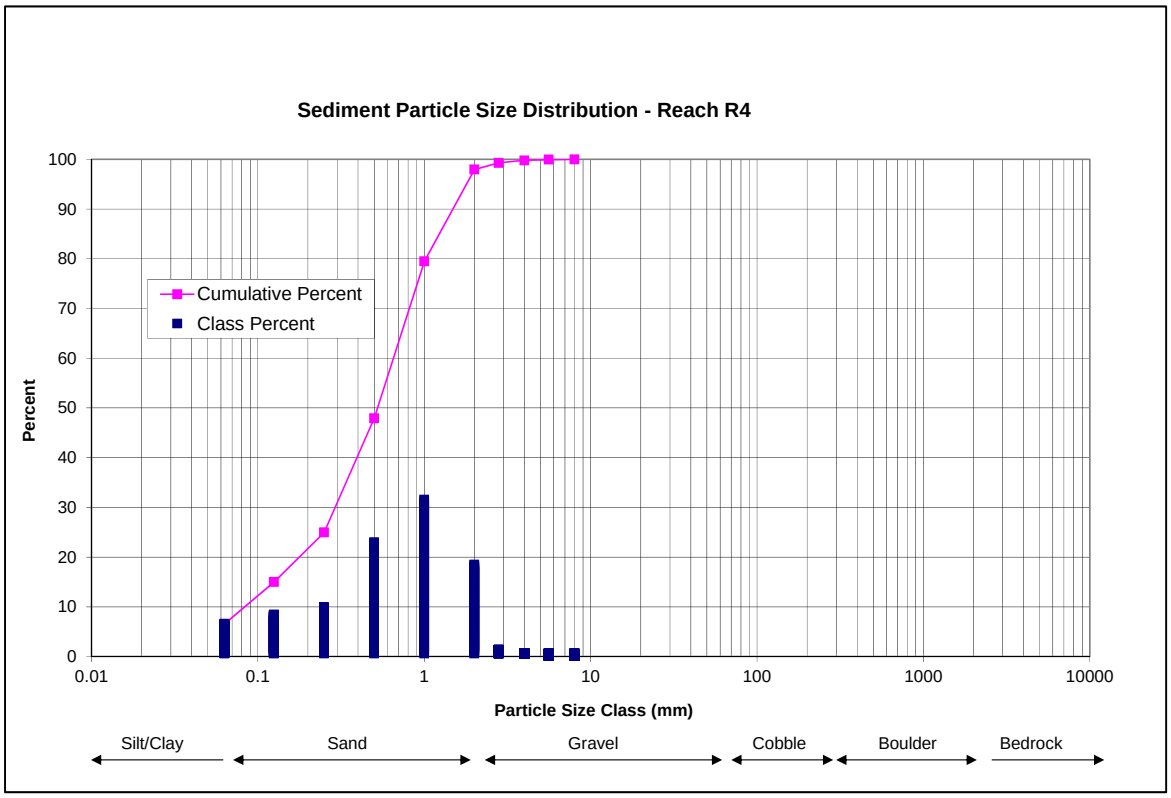


Figure 17.5 Sediment Particle Size Distribution (Continued)



17.3.3 Predicted Channel Response

The existing streams have sand beds, with a few localized sections of bedrock that control grade. Based on field observations and position within the upper watershed, the streams receive mostly fine materials from bank erosion and minimal sediment loading from the upstream drainage. Further investigations confirmed that the sediment supply from upstream sources is limited during larger storm events due to impoundments (farm ponds), smaller headwater drainages, and controlling vegetative cover. While it is predicted that the restoration and enhancement efforts will reduce localized stream bed/bank erosion, the channels still must transport smaller bedload material from upstream sources while maintaining stream bed/bank stability.

Sediment transport competency/entrainment and capacity were compared for the existing channels and the design conditions for restored stream systems. Table 17.8 shows bankfull boundary shear stress and stream power values for existing and design conditions. Bankfull boundary shear stress and stream power values are somewhat lower for the proposed conditions than the existing conditions, because the design channels are wider and shallower than the existing, generally incised channels. The proposed conditions are still high enough, however, to move the expected sediment load.

Using another sediment transport competency comparison, boundary shear stress was plotted on Shield's Curve to estimate the largest moveable particle. Not surprisingly, in all reaches, as shown in Table 17.8, the Shield's Curve predicts the mobility of particles much larger than the d100 observed in the existing bulk samples. However, the Shield's Curve also informs the size of the d100 in the design constructed riffle. This competency analysis ensures that the d100 of the proposed riffle material will not mobilize at the design discharge.

As a design consideration, the proposed substrate material mix (riffle armor) will contain particle sizes larger than those predicted to move based on the Shield's Curve to achieve vertical stability immediately after construction. The site has both steep (> 0.02 ft/ft) and flatter channel slopes throughout the tributaries and the main stem. In general, the proposed design channels with riffle slopes greater than 1% will be constructed using larger particles. Any concerns regarding further channel degradation and vertical stability will be addressed by installing a combination of grade control structures such as constructed riffles and log/rock step pools.

The prediction calculations shown on Table 17.8 include shear stress, tractive force, and critical dimensionless shear stress, which help to determine a particle size class (e.g., sand, gravel, cobble) that is mobile, or entrained, under various flow conditions (WARSS, 2006).

Table 17.8 Boundary Shear Stress and Stream Power for Existing and Proposed Conditions

Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Parameter	Reach R1 Existing Conditions	Reach R1 Proposed Conditions	Reach R2 Existing Conditions	Reach R2 Proposed Conditions
Bankfull Discharge Estimate, Q (cfs)	46	46	30	30
Bankfull XS Area (square feet)	11.2	11.2	7.7	7.7
Mean Bankfull Velocity (ft/sec)	4.1	4.1	3.8	3.8
Bankfull Width, W (feet)	9.0	12.5	6.5	10.4
Bankfull Mean Depth, D (feet)	1.3	0.9	1.2	0.7
Width to Depth Ratio, w/d (feet/ foot)	7.2	14.0	5.4	14.0
Wetted Perimeter (feet)	11.5	14.3	8.9	11.9
Hydraulic Radius, R (feet)	0.98	0.78	0.87	0.65
Channel Slope (feet/foot)	0.016	0.016	0.009	0.0080
Boundary Shear Stress, τ (lbs/ft^2)	1.24	0.89	0.65	0.38
Subpavement d_{100} (mm)	6.8	6.8	13.5	13.5
Largest Moveable Particle (mm) per Modified Shield's Curve	300	210	170	100
Predicted Critical Depth (feet)	0.08	0.08	0.11	0.11
Predicted Critical Slope (feet/ foot)	0.001	0.001	0.001	0.001
Stream Power (W/m^2)	73.4	52.8	36.9	13.1

Table 17.8 cont. Boundary Shear Stress and Stream Power for Existing and Proposed Conditions

Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Parameter	Reach R3 Existing Conditions	Reach R3 Proposed Conditions	Reach R4 Existing Conditions	Reach R4 Proposed Conditions
Bankfull Discharge Estimate, Q (cfs)	16	16	10	10
Bankfull XSC Area (square feet)	4.4	4.4	3.1	3.1
Mean Bankfull Velocity (ft/sec)	3.6	3.6	3.2	3.2
Bankfull Width, W (feet)	5.3	7.8	4.5	6.3
Bankfull Mean Depth, D (feet)	0.8	0.6	0.7	0.5
Width to Depth Ratio, W/D (ft/ft)	6.5	14.0	6.4	13.0
Wetted Perimeter (feet)	6.9	8.9	5.9	7.3
Hydraulic Radius, R (feet)	0.62	0.48	0.53	0.43
Channel Slope (feet/foot)	0.015	0.014	0.012	0.013
Boundary Shear Stress, τ (lbs/ft^2)	0.76	0.56	0.52	0.40
Subpavement d_{100} (mm)	13.5	13.5	6.8	6.8
Largest Moveable Particle (mm) per Modified Shield's Curve	190	140	140	100
Predicted Critical Depth (feet)	0.16	0.16	0.2	0.18
Predicted Critical Slope (feet/ foot)	0.003	0.004	0.003	.005
Stream Power (W/m^2)	38.6	24.5	36.3	23.3
Parameter	**Reach R5 Existing Conditions**	**Reach R5 Proposed Conditions**		
Bankfull Discharge Estimate, Q (cfs)	14	14		
Bankfull XSC Area (square feet)	3.6	3.6		
Mean Bankfull Velocity (ft/sec)	3.9	3.9		
Bankfull Width, W (feet)	4.1	6.8		
Bankfull Mean Depth, D (feet)	1.0	0.5		
Width to Depth Ratio, W/D (ft/ft)	4.2	13.0		
Wetted Perimeter (feet)	6.4	7.9		
Hydraulic Radius, R (feet)	0.69	0.46		
Channel Slope (feet/foot)	0.015	0.012		

Table 17.8 cont. Boundary Shear Stress and Stream Power for Existing and Proposed Conditions Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074				
Parameter	**Reach R5 Existing Conditions**	**Reach R5 Proposed Conditions**		
Boundary Shear Stress, τ (lbs/ft2)	0.84	0.37		
Subpavement d100 (mm)	13.5	13.5		
Largest Moveable Particle (mm) per Modified Shield's Curve	200	100		
Predicted Critical Depth (feet)	0.16	0.15		
Predicted Critical Slope (feet/ foot)	0.003	0.005		
Stream Power (W/m2)	43.4	22.4		

17.4 Existing Vegetation Assessment

The riparian areas within and adjacent to the proposed project area consists of mature successional forest, pasture, agricultural fields, and maintained/disturbed pine forest, as described by Schafale and Weakley (1990). Historic land management surrounding the project area has been primarily for agricultural and silvicultural purposes and the significant removal of native tree species vegetation in the riparian zone (lower R5, lower R2, and R1). The wooded portions of the site consist of a combination of Dry-Mesic Oak-Hickory Forest in the uplands with Piedmont/Mountain Alluvial Forest and Bottomland Forest in the lower areas and floodplains on the site (Schafale and Weakley, 1990). The riparian buffer along upper Reach R2 lacks much understory vegetation due to extensive livestock use and grazing. The riparian buffer areas overall ranged from somewhat disturbed to very disturbed and a general description of each community follows.

17.4.1 Maintained/Disturbed

This community is primarily located in the fields adjacent to the upper portions of the project area along Reaches R3 and R6. Past harvesting for silviculture is clearly evident in these areas with abandoned logging roads and old woody debris piles present. Early successional vegetation such as sweetgum (*Liquidambar styraciflua*), loblolly pine (*Pinus taeda*), and red maple (*Acer rubrum*) dominate, with a thick shrub understory of similar species along with multiflora rose (*Rosa multiflora*) and goldenrod (*Solidago spp.*), as well as vines including blackberry (*Rubus spp*.), greenbriar (*Smilax rotundifolia*), poison ivy (*Toxicodendron radicans*), and muscadine grape (*Vitis rotundifolia*).

17.4.2 Agricultural Fields and Pasture Areas

This community covers approximately 30-40 percent of the project area. Currently, the pasture areas are used for cattle grazing. The vegetation within open fields and pasture areas is primarily comprised of fescues, clovers, and scattered weeds consisting of dog fennel (*Eupatorium capillifolium*), horse-nettle (*Solanum carolinense*), buttercup (*Ranunculus spp.*), and thistle (*Cirsium vulgare*). The wetland areas found within the pasture contain these plants as well, but also include a variety of wetter species such as shallow sedge (*Carex lurida*), awl-fruit sedge (*Carex stipata*), soft rush (*Juncus effusus*), blunt spikerush (*Eleocharis obtuse*), and smartweed (*Polygonum pennsylvaticum*). In the narrow, wooded riparian areas within the pastures and fields, the canopy is dominated by white oak (*Quercus alba*), red

maple (*Acer rubrum*), red cedar (*Juniperus virginiana*), and sweetgum (*Liquidambar styraciflua*), with a relatively sparse understory consisting of sweetgum (*Liquidambar styraciflua*), red cedar (*Juniperus virginiana*), American holly (*Ilex opaca*), and loblolly pine (*Pinus taeda*). Woody shrub and vine species include Chinese privet (*Ligustrum sinense*), blackberry (*Rubus spp.*), and greenbrier (*Smilax rotundifolia*).

17.4.3 Dry-Mesic Oak-Hickory Forest/Alluvial and Bottomland Forest

These forested areas comprise approximately 60-70 percent of the project area, mostly in the upper reaches. The canopy and understory is dominated by tulip poplar (*Liriodendron tulipifera*), white oak (Quercus alba), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), northern red oak (*Quercus rubra*), loblolly pine (*Pinus taeda*), mockernut hickory (Carya tomentosa), and pignut hickory (Carya glabra), but also includes some black gum (Nyssa sylvatica), sourwood (*Oxydendrum arboretum*), water oak (*Quercus nigra*), ironwood (*Carpinus caroliniana*), black cherry (Prunus serotina), winged elm (*Ulmus alata*), American holly (*Ilex opaca*), and mulberry (*Morus rubra*). Woody shrubs are relatively sparse and generally just include younger specimens of the overstory species. Vines and herbaceous species found here include blackberry (*Rubus spp.*), greenbriar (*Smilax rotundifolia*), poison ivy (*Toxicodendron radicans*), and muscadine grape (*Vitis rotundifolia*), along with multiflora rose (*Rosa multiflora*), strawberry bush (*Euonymus americanus*), little brown jugs (*Hexastylis arifolia*), Christmas fern (*Polystichum acrosticoides*), blueberry (*Vaccinium spp.*), New York fern (*Parathelypteris noveboracensis*), and goldenrod (*Solidago spp.*).

In the floodplains and lower portions of these forested areas, the vegetation shifts to species more characteristic of piedmont alluvial and bottomland forests. The canopy and understory here includes species such as sycamore (*Platanus occidentalis*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), willow oak (*Quercus phellos*), and shagbark hickory (*Carya ovata*), in addition to the sweetgum (*Liquidambar styraciflua*), tulip poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum*), and loblolly pine (*Pinus taeda*) commonly observed elsewhere on site. A dense and diverse shrub and herbaceous layer is also present here with species such as wax myrtle (*Myrica cerifera*), ironwood (*Carpinus caroliniana*), water oak (*Quercus nigra*), Chinese privet (*Ligustrum sinense*), elderberry (*Sambuca canadensis*), blueberry (*Vaccinium spp.*), spicebush (*Lindera benzoin*), Joe-pye weed (*Eupatorium purpureum*), netted chain fern (*Woodwardia aerolata*), sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmundastrum cinnamomeum*), royal fern (*Osmunda regalis*), soft rush (*Juncus effusus*), shallow sedge (*Carex lurida*), green bulrush (*Scirpus atrovirens*), jewelweed (*Impatiens capensis*), false-nettle (*Boehmeria cylindrical*), and Jack-in-the-pulpit (*Arisaema triphyllum*). Numerous vines such as poison ivy (*Toxicodendron radicans*), greenbriar (*Smilax rotundifolia*), cat-briar (*Smilax bona-nox*), multiflora rose (*Rosa multiflora*), Virginia creeper (*Parthenocissus quinquefolia*), blackberry (*Rubus spp.*), and honeysuckle (*Lonicera japonica*) are also common in these areas.

17.4.4 Invasive Species Vegetation

The primary invasive species vegetation present on the project site are primarily Chinese privet (*Ligustrum sinense*) and multiflora rose (*Rosa multiflora*), which were found interspersed throughout the riparian buffer areas. Invasive species vegetation will be sprayed, cut and painted, or grubbed in areas infested within the easement. Treatments will be conducted to control the invasive species vegetation with the easement during the monitoring period as needed.

17.5 Site Wetlands

17.5.1 Jurisdictional Wetland Assessment

The proposed project area was reviewed for the presence of wetlands and waters of the United States in accordance with the provisions on Executive Order 11990, the Clean Water Act, and subsequent federal

regulations. Wetlands have been defined by the USACE as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 CFR 328.3(b) and 40 CFR 230.3 (t)). The areas in the project boundaries that displayed one or more wetland characteristics were reviewed to determine the presence of wetlands. The wetland characteristics included:

1. Prevalence of hydrophytic vegetation.
2. Permanent to periodic inundation or saturation.
3. Hydric soils.

On June 5, 2007, the USACE and US Environmental Protection Agency (USEPA) issued joint guidance for their field offices for Clean Water Act jurisdictional determinations in response to the Supreme Court's decision in the consolidated cases of Rapanos v. United States and Carabell v. United States (USEPA and USACE, 2007). Based on this guidance, the agencies will assert jurisdiction over the following waters:

- Traditional navigable waters (TNWs)
- Wetlands adjacent to TNWs
- Non-navigable tributaries of TNWs that are considered relatively permanent waters (RPWs). Such tributaries flow year-round or exhibit continuous flow for at least 3 months.
- Wetlands that directly abut RPWs.

The agencies will decide jurisdiction over the following waters based on a standardized analysis to determine whether they have a significant nexus with a traditional navigable water:

- Non-navigable tributaries that are not relatively permanent waters (non-RPWs)
- Wetlands adjacent to non-RPWs
- Wetlands that are adjacent to but do not directly abut an RPW.

The significant nexus analysis is fact-specific and assesses the flow characteristics of a tributary and the functions performed by all its adjacent wetlands to determine if they significantly affect the physical, chemical, and biological integrity of downstream TNWs. A significant nexus exists when a tributary, in combination with its adjacent wetlands, has more than a speculative or insubstantial effect on the physical, chemical, or biological integrity of a TNW.

The USACE and USEPA will apply the significant nexus standard within the limits of jurisdiction specified by the Supreme Court decision in the case of Solid Waste Agency of Northern Cook County (SWANCC) v. US Army Corps of Engineers. Under the SWANCC decision, the USACE and USEPA cannot regulate isolated wetlands and waters that lack links to interstate commerce sufficient to serve as a basis for jurisdiction under the Clean Water Act. Though isolated wetlands and waters are not regulated by the USACE, within the state of North Carolina isolated wetlands and waters are considered "waters of the state" and are regulated by the NCDWR under the isolated wetlands rules (15A NCAC 2H .1300).

Following a desktop review of the National Wetland Inventory (NWI), NRCS soil survey, and USGS quadrangle maps, the project area was evaluated for potential impacts to jurisdictional wetlands. Baker wetland scientists conducted a field survey of the project area in May 2014 to investigate potential wetlands within hydric soils areas and confirm the perennial and intermittent streams in the project area. In total, the field survey identified twelve separate wetland areas containing hydric soil indicators and a predominance of hydrophytic vegetation and wetland hydrology. These areas were identified, flagged, and mapped, as described in Section 16.1. Wetland data forms are also provided in Section 16.1. The wetland areas located in the pasture along stream reaches R1 and R2 exhibited marginal hydrologic indicators and are dominated with herbaceous species subject to active cattle grazing. The remaining wetlands were located along stream floodplains and/or within depressional areas. These areas were

confirmed by the USACE in July 2014, and the proposed mitigation plan for the site will seek to enhance and avoid disturbance of these wetland areas wherever possible.

17.5.2 Wetland Impacts and Considerations

It is likely that small wetland seeps were historically present in some of these locations after evaluating existing topography, soils, hydrology and hydrophytic vegetation within the project reaches. The original plant community located in these wetlands was most likely indicative of other wetlands in the region, but past and current agricultural land use practices have altered the composition of the plant community currently present. Wetland stressors, such as cattle grazing and periodic logging operations, have altered the vegetative composition and hydrological connections within the project area. The main stem was likely moved and/or deepened to capture various sources of seepage in this portion of the project area to increase land available for agricultural use, which exacerbated channel incision and exerts a drainage effect on the adjacent fields.

After completing the proposed stream restoration practices, the identified wetland areas will likely experience a more natural hydrology and flooding regime, and the riparian buffer areas in these locations will be planted with native woody vegetation species that are more tolerant of wetter conditions. The design approach will also enhance any potential areas of adjacent fringe or marginal wetlands through higher water table conditions (elevated stream profile) and a more frequent over-bank flooding regime. Stream profiles will be raised along various reach sections, which will lead to higher water table conditions adjacent to the channels and more frequent out-of-bank flooding of adjacent wetland areas. Additionally, the exclusion of cattle from large portions of the riparian buffer will allow for the rehabilitation of soil structure that has been degraded and compacted by years of cattle grazing.

17.5.3 Climatic Conditions

The average growing season (defined as the period in which air temperatures are maintained above 28° Fahrenheit at a frequency of 5 years in 10) for the project locale is 220 days (http://www.ces.ncsu.edu/hil/hil-709.html). The area experiences an average annual rainfall of 46.60 inches (NRCS, 1970) as shown on Table 17.9. During 2013, a wet year, the NOAA Apex SW weather station (GHCND:US1NCWK0084) recorded 49.51 inches of rain.

In much of the southeastern US, average rainfall exceeds average evapotranspiration losses and these areas experience a moisture excess during most years. Excess water leaves a site by groundwater flow, surface runoff, channelized surface flow, or deep seepage. Annual losses due to deep seepage, or percolation of water to confined aquifer systems, are usually small and are not considered a significant loss pathway for excess water. Although groundwater flow can be significant in some systems, most excess water is lost via surface and shallow subsurface flow.

Table 17.9 Comparison of Monthly Rainfall Amounts for Project Site vs. Long-term Averages
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Month-Year	Observed Monthly Precipitation (in)	Average Monthly Precipitation (in)	Deviation of Observed from Average (in)
Jan-2013	3.15	3.3	-0.15
Feb-2013	4.01	3.5	+0.51
Mar-2013	1.43	3.7	-2.27
Apr-2013	4.96	3.8	+1.16
May-2013	2.54	3.8	-1.26
Jun-2013	10.82	3.9	+6.92
Jul-2013	6.06	5.9	+0.16

Table 17.9 Comparison of Monthly Rainfall Amounts for Project Site vs. Long-term Averages Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074			
Month-Year	**Observed Monthly Precipitation (in)**	**Average Monthly Precipitation (in)**	**Deviation of Observed from Average (in)**
Aug-2013	2.80	5.4	-2.60
Sept-2013	3.76	4.6	-0.84
Oct-2013	0.90	2.8	-1.90
Nov-2013	3.19	3.0	+0.19
Dec-2013	5.89	3.2	+2.69
Sum	49.51	**46.9**	**+2.61**

17.5.4 Soil Characterization

Soils at the project site were initially determined using NRCS soil survey data for Wake County (1970). The areas proposed for stream restoration and enhancement are mapped as Wehadkee and Bibb soils. Wehadkee and Bibb are predominantly hydric soils. All project reaches are underlain by Wehadkee and Bibb soils; however, the soil data layer projection does not line up correctly with the floodplain and the overlap between the reaches and the soil type is not correct. Nevertheless, the soil description and existing topography indicate that the floodplains for each of the reaches should be Wehadkee and Bibb. Figure 2.3 shows soil conditions throughout the project area and the soil descriptions are shown on Table 17.10.

Table 17.10 NRCS Soil Series (Wake County Soil Survey, USDA-SCS, 1970) Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074			
Soil Name	**Landform**	**Hydric Soil**	**Description**
Bibb	Depressions	Yes	Poorly drained soils formed in floodplains or upland depressions. Slope ranges from 0 to 2%. Permeability is moderate to moderately rapid.
Wehadkee	Depressions	Yes	Poorly drained soils formed on floodplains. Slope ranges from 0 to 2%. Permeability moderate to moderately rapid.

17.5.5 Plant Community Characterization

Based on historical aerials and the landowner's verification, a majority of the proposed stream restoration area is comprised of pasture land, narrow tree canopy and successional vegetation. Historically, the surrounding pasture areas have been used for cattle production. Current canopy and understory vegetation within the existing delineated wetlands are dominated by tulip poplar (*Liriodendron tulipifera*), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and loblolly pine (*Pinus taeda*), with some green ash (*Fraxinus pennsylvanica*), sycamore (*Platanus occidentalis*), and American elm (*Ulmus americana*). Common shrub species include elderberry (*Sambuca canadensis*), Chinese privet (*Ligustrum sinense*), ironwood (*Carpinus caroliniana*), and multiflora rose (*Rosa multiflora*). Herbaceous and vine species primarily consist of jewelweed (*Impatiens capensis*), Jack-in-the-pulpit (*Arisaema triphyllum*), false nettle (*Boehmeria cylindrical*), netted chain fern

(*Woodwardia aerolata*), greenbrier (*Smilax rotundifolia*), blackberry (Rubus spp.), and poison ivy (*Toxicodendron radicans*).

17.5.6 Proposed Riparian Vegetation Plantings

The vegetative components of this restoration project include streambank, floodplain, and transitional upland planting and described as the riparian buffer zone. These planting boundaries will be comprised of species found within native plant communities as described in Section 17.4 and are shown on the revegetation plan sheets in Section 18, Appendix D. In addition to the riparian buffer zone, any areas of the site that lack diversity, are disturbed or adversely impacted by the construction process, will be planted.

Bare-root trees, live stakes, and permanent seedlings will be planted within designated areas of the conservation easement. A minimum 50-foot buffer will be established along all proposed streambanks (100 foot total minimum width) for all of the stream reaches within the project boundary. In many areas, the buffer width will be in excess of 50 feet along one or both streambanks (more than 100 foot total width) and will encompass adjacent jurisdictional wetland areas. In general, bare-root vegetation will be planted at a total target density of 680 stems per acre. Planting will be conducted during the dormant season, with all trees installed between the last week of November and the third week of April.

Selected species for hardwood revegetation planting are presented in Table 17.10. Tree species selected for restoration and enhancement areas will be weakly tolerant to tolerant of flooding. Weakly tolerant species are able to survive and grow in areas where the soil is saturated or flooded for relatively short periods. Moderately tolerant species are able to survive in soils that are saturated or flooded for several months during the growing season. Flood tolerant species are able to survive on sites in which the soil is saturated or flooded for extended periods during the growing season (WRP, 1997).

Observations will be made during construction of the site regarding the relative wetness of areas to be planted as compared to the revegetation plan. The planting zone will be determined based on these comparisons, and planted species will be matched according to their wetness tolerance and the anticipated wetness of the planting area.

Once trees are transported to the site, they will be planted within two days. Disturbed soils across the site will be prepared by sufficiently loosening to a depth of four inches prior to planting as described in the technical specifications. Heavily compacted soils (e.g., hardpan or areas that have experienced heavy cattle or equipment use) will be loosened to a depth of eight to ten inches by disking or ripping to prepare for tree planting. In any areas where excavation depths exceed ten inches, topsoil shall be separated from rocks, brush, or foreign materials, stockpiled, and placed back over these areas to a depth of eight inches to achieve design grades and create a soil base for vegetation. Trees will be planted by manual labor using a dibble bar, mattock, planting bar, or other approved method. Planting holes for the trees will be sufficiently deep to allow the roots to spread out and down without "J-rooting." Soil will be loosely compacted around trees once they have been planted to prevent roots from drying out.

Live stakes will be installed at a minimum of 40 stakes per 1,000 square feet and stakes will be spaced two to three feet apart in meander bends and six to eight feet apart in the riffle sections using triangular spacing along the streambanks between the toe of the streambank and bankfull elevation. Site variations may require slightly different spacing.

Permanent seed mixtures will be applied to all disturbed areas of the project site. Table 17.11 lists the species, mixtures, and application rates that will be used. A mixture is provided that is suitable for streambank, floodplain, and adjacent wetland areas. Mixtures will also include temporary seeding (rye grain or browntop millet) to allow for application with mechanical broadcast spreaders. To provide rapid growth of herbaceous ground cover and biological habitat value, the permanent seed mixture specified will be applied to all disturbed areas outside the streambanks of the restored stream channel.

The species provided are deep-rooted and have been shown to proliferate along restored stream channels, providing long-term stability.

Temporary seeding will be applied to all disturbed areas of the site that are susceptible to erosion. These areas include constructed streambanks, access roads, side slopes, and spoil piles. If temporary seeding is applied from November through April, rye grain will be used and applied at a rate of 130 pounds per acre. If applied from May through October, temporary seeding will consist of browntop millet, applied at a rate of 40 pounds per acre.

Final species selection may change due to refinement or availability at the time of planting. If species substitution is required, the planting Contractor will submit a revised planting list to Baker for approval prior to the procurement of plant stock.

Table 17.11 Proposed Bare-Root and Live Stake Species
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Botanical Name	Common Name	% Planted by Species	Wetland Tolerance
Riparian Buffer Plantings - 8' x 8' spacing - 680 stems/Acre			
Overstory Species			
Fraxinus pennsylvanica	Green Ash	12%	FACW
Betula nigra	River Birch	9%	FACW
Liriodendron tulipifera	Tulip Poplar	9%	FAC
Quercus pagoda	Cherrybark Oak	6%	FACW
Quercus michauxii	Swamp Chestnut Oak	9%	FACW-
Diospyros virginiana	Persimmon	6%	FAC
Platanus occidentalis	American Sycamore	9%	FACW-
Understory Species			
Carpinus caroliniana	American Hornbeam	15%	FAC
Viburnum dentatum	Arrowwood Viburnum	15%	FAC
Asimina triloba	Paw Paw	10%	FAC
Riparian Live Stake Plantings			
Salix nigra	Black Willow	10%	OBL
Sambucus canadensis	Elderberry	20%	FACW-
Salix sericea	Silky Willow	30%	OBL
Cornus amomum	Silky Dogwood	40%	FACW+

Table 17.11 Proposed Permanent Seed Mixture
Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Botanical Name	Common Name	% Planted by Species	Density (lbs/ac)	Wetland Tolerance
Andropogon gerardii	Big blue stem	10%	1.50	FAC
Dichanthelium clandestinum	Deer tongue	15%	1.50	FACW
Carex crinata	Fringed sedge	10%	2.25	FACW+
Elymus virginicus	Virginia wild rye	15%	1.50	FAC
Juncus effusus	Soft rush	10%	2.25	FACW+

Panicum virgatum	Switchgrass	15%	1.50	FAC+
Schizachyrium scoparium	Little blue stem	15%	0.75	FACU
Sorghastrum nutans	Indiangrass	10%	0.75	FACU
	Total	100%	15.00	

17.6 Site Construction

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

A general construction sequence is provided below and included on the plan set for the Thomas Creek Restoration Project. The site construction, including grading and planting activities, will be conducted using common machinery, tools, equipment and techniques for successfully implementing the project.

1. Contractor shall contact North Carolina "One Call" Center (1.800.632.4949) before any excavation.
2. Contractor shall prepare stabilized construction entrances and haul roads as indicated on the plans.
3. The Contractor shall mobilize equipment, materials, prepare staging area(s) and stockpile area(s) as shown on the plans.
4. Construction traffic shall be restricted to the area denoted as "Limits of Disturbance" or "Haul Roads" on the plans.
5. The Contractor shall install temporary rock dams at locations indicated on the plans.
6. The Contractor shall install temporary silt fence around the staging area(s). Temporary silt fencing will also be placed around the temporary stockpile areas as material is stockpiled throughout the construction period.
7. The Contractor shall install all temporary and permanent stream crossings as shown on the plans in accordance with the NC Erosion and Sediment Control Planning and Design Manual. The existing channel and ditches on site will remain open during the initial stages of construction to allow for drainage and to maintain site accessibility.
8. The Contractor shall construct only the portion of channel that can be completed and stabilized within the same day.
9. The Contractor shall apply temporary seed and mulch to all disturbed areas at the end of each work day.
10. The Contractor shall clear and grub an area adequate to construct the stream channel and grading operations after all Sedimentation and Erosion Control practices have been installed and approved. In general, the Contractor shall work from upstream to downstream and in-stream structures and channel fill material shall be installed using a pump-around or flow diversion measure as shown on the plans.
11. The Contractor will begin construction by excavating channel fill material in areas for Reach R3. The Contractor may fill ditches which do not contain any water during the grading operations. Along ditches with water or stream reaches, excavated material should be stockpiled in areas shown on the plans. In any areas where excavation depths will exceed 10 inches, topsoil shall be separated, stockpiled and placed back over these areas to a depth of eight inches to achieve design grades and create a soil base for vegetation according to the plans and specifications.
12. Contractor shall begin construction on stream Reaches R3 at Station 11+30 and proceed in a downstream direction until the upstream portion of Reach R2. The Contractor shall excavate the channel to design grades in all areas except within 10 feet of the top of existing streambanks.
13. After excavating the channel to design grades, install in-stream structures, grassing, matting, and transplants in this section, and ready the channel to accept flow per approval by the Engineer.

14. Water will be turned into the constructed channel once the area in and around the new channel has been stabilized. Immediately begin plugging, filling, and grading the abandoned channel, as indicated on plans, moving in a downstream direction to allow for drainage of the old channels. No water shall be turned into any section of channel prior to the channel being completely stabilized with all structures installed.
15. The new channel sections shall remain open on the downstream end to allow for drainage during rain events.
16. Any grading activities adjacent to the stream channel shall be completed prior to turning water into the new stream channel segments. Grading activities shall not be performed within 10 feet of the new stream channel banks. The Contractor shall NOT grade or roughen any areas where excavation activities have not been completed.
17. Once a stream work phase is complete, apply temporary seeding, permanent seeding, and mulching to any areas disturbed during construction. Apply permanent seeding mixtures, as shown on the vegetation plan. Temporary seeding shall be applied in all areas susceptible to erosion (i.e. disturbed ditch banks, steep slopes, and spoil areas) such that ground cover is established within 15 working days following completion of any phase of grading. Permanent ground cover shall be established for all disturbed areas within 15 working days or 90 calendar days (whichever is shorter) following completion of construction.
18. Contractor shall improve and construct the existing farm road crossings by installing ford crossings, stabilizing side slopes, and modifying the farm road bed elevations according to the plans and specifications.
19. All disturbed areas should be seeded and mulched before leaving the project. Remove temporary stream crossings and any in-stream temporary rock dams. All waste material must be removed from the project site.
20. The Contractor shall treat areas of invasive species vegetation throughout the project area according to the plans and specifications prior to demobilization.
21. The Contractor shall plant woody vegetation and live stakes, according to planting details and specifications. The Contractor shall complete the reforestation (bare-root planting) phase of the project and apply permanent seeding at the appropriate time of the year.
22. The Contractor shall ensure that the site is free of trash and leftover materials prior to demobilization of equipment from the site.

17.6.2 In-stream Structures and Other Construction Elements

A variety of in-stream structures are proposed for the Thomas Creek Restoration Project site. Structures such as grade control j-hook vanes, log vanes, rock cross vanes, grade control log jams, constructed riffles, root wads, log weirs, boulder steps, and cover logs will be used to stabilize the newly-restored streams and improve habitat functions. Woody debris will be harvested through the construction of this project and incorporated whenever possible. Table 17.12 summarizes the use of in-stream structures at the site.

Table 17.12 Proposed In-Stream Structure Types and Locations Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074	
Structure Type	**Location**
Root Wads	In locations along outside of meander bends or against one streambank in straight reaches to increase pool diversity and provide refugium for fish.
Grade Control J-Hook Vanes	In locations where grade control is necessary to prevent to prevent possible downcutting or headcut migration, and stream bed/bank erosion.
Log Vanes	Located throughout various meander bends to prevent to prevent possible streambank erosion.
Log Weirs / Step Pools	In locations where grade control is necessary to prevent to prevent possible downcutting or headcut migration, and bed erosion.
Cover Logs / Toe Wood	Located along outside bends or against one streambank in straight reaches to increase pool diversity and provide refugium for fish.
Constructed Riffles	In locations where grade control is necessary to prevent possible downcutting or headcut migration, and bed erosion.
Grade Control Log Jams	In locations where grade control is necessary to prevent possible downcutting or headcut migration, and bed erosion.
Ditch Plug / Channel Block	Installed along some or all of remnant channel segments to prevent subsurface flow.
Vegetation Transplants	In locations outside of meander bends to increase streambank stability and cover.
Vegetated Geolift	In locations outside of meander bends to create and/or increase streambank stability and reduce near bank stress.

Root Wads

Root wads are placed at the toe of the streambank along the outside of meander bends for the creation of habitat and for streambank protection. Root wads include the root mass or root ball of a tree plus a portion of the trunk. They are used to armor a streambank and reduce near bank stress by deflecting stream flows away from the streambank. In addition to streambank protection, they provide structural support to the streambank and habitat for fish and other aquatic animals. They also serve as a food source for aquatic insects. Root wads will be placed throughout the project reaches primarily to improve aquatic habitat and provide cover.

Grade Control J-Hook Vanes

Grade control j-hook vanes are utilized to provide grade control and protect the streambanks. These vanes may be constructed out of logs and/or rock boulders. The structure arms turn water away from the streambanks and re-direct flow energies toward the center of the channel. In addition to providing stability to streambanks, grade control j-hook vanes also promote pool scour and provide structure within the pool habitat. Grade control j-hooks have two to three boulders placed in a hook shape at the upstream end of the vane. The primary difference between regular j-hooks and grade control j-hooks is the way that the “hook” part of the structure is constructed. Regular j-hooks are constructed to have gaps between the header boulders in the hook to promote flow convergence. Grade control j-hooks do not have gaps between the header boulders in the hook and also have a boulder sill built from the outside of the hook over to the opposite streambank such that the structure can serve as a grade control feature. Grade control j-hooks still promote scour in the downstream pool, thus providing habitat benefit.

Log Vanes

A log vane is used to provide cover for aquatic organisms in the downstream scour pool and with a potential secondary benefit of protecting streambanks by reducing near-bank stress and redirecting flow vectors away from the streambank. The length of a single vane structure can span one-half to two-thirds

the bankfull channel width. Vanes are located just downstream of the point where the stream flow intersects the streambank at an acute angle in a meander bend.

Log Weirs / Step Pools

Log weirs and step pools are used to provide grade control as well as provide a secondary pool habitat benefit for aquatic organisms. A log weir consists of two logs stacked (a header log and a footer log) and installed perpendicular to the direction of flow. This center structure sets the invert elevation of the streambed. A step pool sequence or log/rock "rollers" are also commonly used in confined settings where sinuosity is less than 1.2 and in drainage areas less than 3 square miles, and located based on pool-to-pool spacing ratios. They can be used as floodplain interceptors to intercept concentrated floodplain flows from swales, ditches, low points, oxbow pond or vernal pool drains, etc. and to drain such flow to the restored channel in a stable and natural manner.

Toe Wood with Cover Logs

Toe wood structures are typically constructed in meandering streams using a combination of native materials such as logs, branches, brush, live cuttings, sods mats, transplants, and soil. The structure helps ensure long-term stability against eroding banks and can enhance aquatic and terrestrial habitat within the pool area by establishing a source of detritus and large woody debris. The structures are located along the outer meander bends and should cover at least the lower half of the bank such that the toe wood is submerged and saturated to avoid premature deterioration. The upper bank contains live cuttings in combination with sod mats, live stakes, transplants, or geolifts to cover the toe wood up to the bankfull stage.

A cover log is placed along the outside of a meander bend to provide habitat in the pool area. It is most often installed in conjunction with root wads. The log is buried into the outside stream bank of the meander bend; the opposite end extends through the deepest part of the pool and may be buried in the inside of the meander bend, in the bottom of the point bar. The placement of the cover log near the bottom of the stream bank slope on the outside of the bend encourages scour in the pool. This increased scour provides a deeper pool for bedform variability.

Constructed Riffles

A constructed riffle is installed by placing coarse bed material (gravel, cobble, and small boulders) in the stream at specific riffle locations along the profile. The purpose of this structure is to provide initial grade control and establish riffle habitat within the restored channel. Wood material can also be incorporated with rock for these structures, and function in a similar way as natural riffles; the surfaces and interstitial spaces are crucial to the life cycles of many aquatic macroinvertebrate species.

Ditch Plug / Channel Block

A compacted earth plug will be installed by filling the existing ditch to prevent subsurface flows and improve site hydrology. The fill material used for ditch plugs shall come from a nearby borrow area and be free of debris, rocks, trash, etc. and shall consist of compactable soil material.

Grade Control Log Jams

A grade control log jam is created by placing woody material in the stream at specific riffle locations along the profile. The purpose of this structure is to provide initial grade control and establish riffle habitat within the restored channel, prior to the formation of a stabilized streambed. These structures can be substituted for traditional constructed riffles using rock material, in a similar way as natural riffles; the surfaces and interstitial spaces are crucial to the life cycles of many aquatic species.

Vegetation Transplants

Vegetation transplants will be identified before starting construction as viable candidates (species and size) for uprooting and relocation. Areas that must be cleared will maximize the harvesting of

transplants; transplants will be taken from other areas as suitable to enhance the rapid development of vegetative growth along the constructed channel.

Vegetated Geolift

Geolifts are a bioengineering measure used to stabilize streambanks. Geolifts are most commonly used along the outside of stream meander bends. They are essentially a series of large overlapping soil "burritos," or "lifts", constructed using coir fiber erosion control matting and native soils. Live cutting materials, or whips, from specific woody native species plants are planted in the layers between the lifts. A stone or woody brush toe base is typically installed to provide protection at the toe of the streambank and to provide a foundation for the geolifts. The geolifts are installed on top of the base material to comprise the entire restored streambank up to the bankfull channel elevation. Geolifts can be used to effectively stabilize restored streambanks for all sizes of streams simply by varying the number of lifts required to form the streambank.

18.0 APPENDIX D - PROJECT PLAN SHEETS

STATE	BAKER PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
NC	135794	1	
NCEEP ID No. 96074			

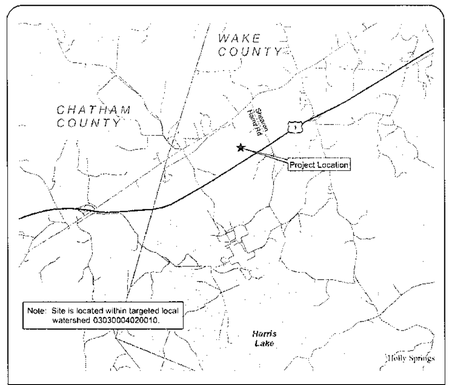
NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

WAKE COUNTY

LOCATION: 1.5 MILES SOUTHWEST OF THE COMMUNITY OF NEW HILL
TYPE OF WORK: STREAM RESTORATION AND ENHANCEMENT

THOMAS CREEK

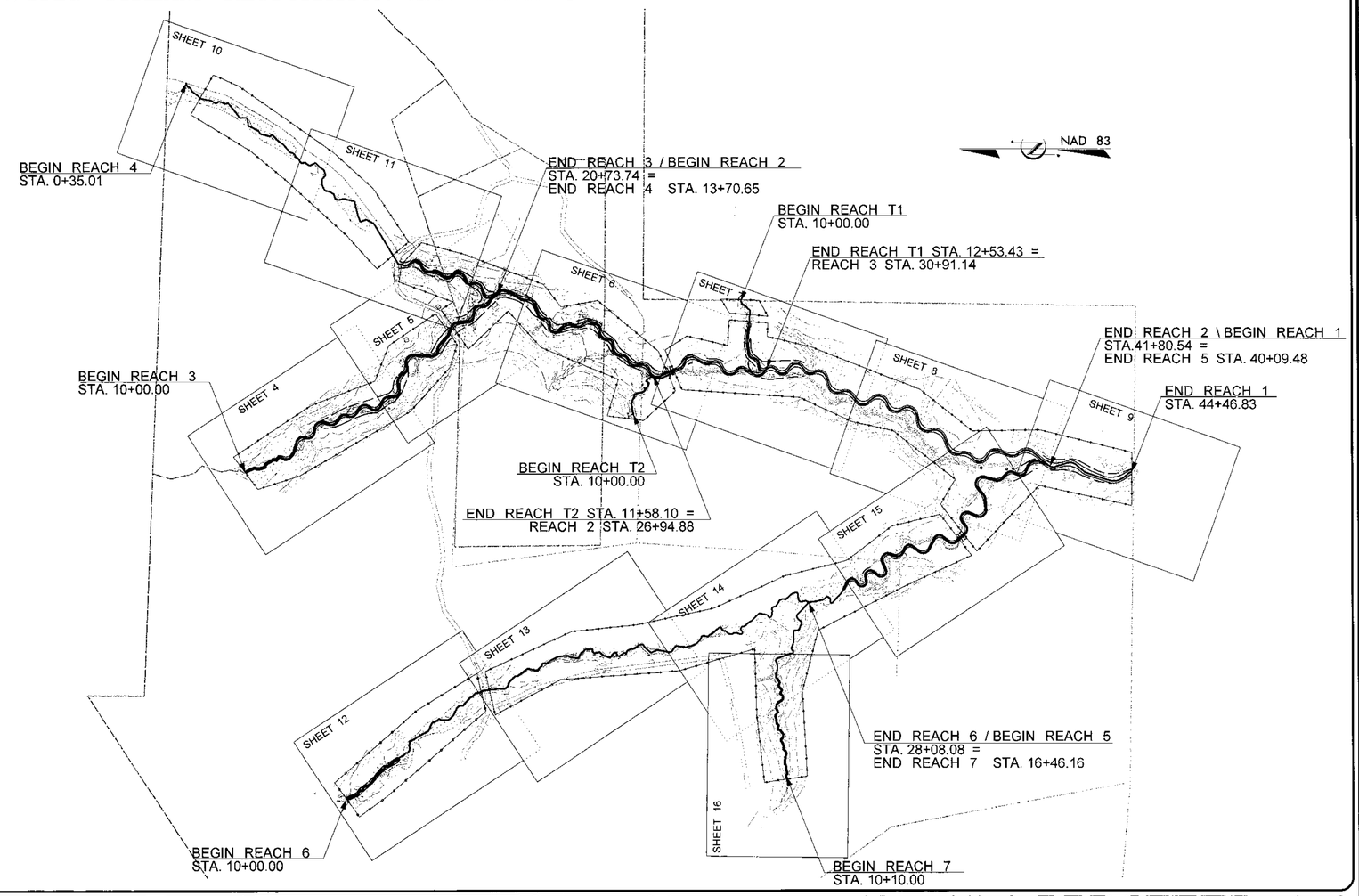
PROJECT: 135794



VICINITY MAP

INDEX OF SHEETS

1 ..... TITLE SHEET
1-A ..... STREAM CONVENTIONAL SYMBOLS, GENERAL NOTES, STANDARD SPECIFICATIONS, VEGETATION SELECTION
1-B ..... CONVENTIONAL SYMBOLS
2 - 2-E ..... DETAILS
3 ..... GENERAL CONSTRUCTION SEQUENCE
4 - 16 ..... PLAN VIEW
17 - 21 ..... PROFILES
22 - 27 ..... REVEGETATION PLAN
EC1 - EC8 ..... EROSION & SEDIMENTATION CONTROL PLAN



GRAPHIC SCALES

20 0 20 40
PLANS

20 0 20 40
PROFILE (HORIZONTAL)

4 0 4 8
PROFILE (VERTICAL)

STREAM LENGTH SUMMARY

REACH NAME	EXISTING LENGTH (LF)	PROPOSED LENGTH (LF)
REACH 1	397	266
REACH 2	1,995	1,089
REACH 3	1,067	1,231
REACH 4	1,197	1,201
REACH 5	1,022	1,828
REACH 6	1,828	1,808
REACH 7	646	646
REACH T1	242	253
REACH T2	171	158
TOTAL	8,565	8,480

PREPARED FOR THE OFFICE OF:

Ecosystem Enhancement PROGRAM

NCDENR
ECOSYSTEM ENHANCEMENT PROGRAM
1652 MAIL SERVICE CENTER
RALEIGH, NC 27699–1652

CONTACT: JEFF SCHAFFER
PROJECT MANAGER

PREPARED IN THE OFFICE OF:

Michael Baker INTERNATIONAL
Michael Baker Engineering Inc.
8000 Regency Parkway, Suite 600
Cary, NORTH CAROLINA 27518
Phone: 919.463.5488
Fax: 919.463.5490
License #: F-1084

LETTING DATE:

WILLIAM SCOTT HUNT, III, PE
PROJECT ENGINEER

CHRIS ROESSLER
PROJECT MANAGER

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

SIGNATURE: *P.E.*

STREAM CONVENTIONAL SYMBOLS

SUPERCEDES SHEET 1-B

- ROCK J-HOOK
- ROCK VANE
- OUTLET PROTECTION
- ROCK CROSS VANE
- DOUBLE DROP ROCK CROSS VANE
- SINGLE WING DEFLECTOR
- DOUBLE WING DEFLECTOR
- TEMPORARY SILT CHECK
- ROOT WAD
- LOG J-HOOK
- GRADE CONTROL LOG J-HOOK
- LOG VANE
- LOG WEIR
- GRADE CONTROL LOG JAM
- LOG CROSS VANE
- LOG ROLLER
- CONSTRUCTED RIFFLE
- BOULDER CLUSTER
- ROCK STEP POOL
- LOG STEP POOL
- VERNAL POOL
- SAFETY FENCE
- TF — TAPE FENCE
- FP — 100 YEAR FLOOD PLAIN
- CE — CONSERVATION EASEMENT
- 435 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LIMITS OF DISTURBANCE
- PROPERTY LINE
- FOOT BRIDGE
- TEMPORARY STREAM CROSSING
- PERMANENT FORD STREAM CROSSING
- TRANSPLANTED VEGETATION
- TREE REMOVAL
- TREE PROTECTION
- DITCH PLUG/CHANNEL BLOCK
- CHANNEL FILL
- BRUSH MATTRESS
- GEOLIFT WITH BRUSH TOE

**NOTE: ALL ITEMS ABOVE MAY NOT BE USED ON THIS PROJECT

GENERAL NOTES

1. THE CONTRACTOR IS REQUIRED TO INSTALL IN-STREAM STRUCTURES USING A TRACK HOE WITH A HYDRAULIC THUMB OF SUFFICIENT SIZE TO PLACE BOULDERS (3'x2'x2'), LOGS AND ROOTWADS.
2. WORK IS BEING PERFORMED AS AN ENVIRONMENTAL RESTORATION PLAN. THE CONTRACTOR SHOULD MAKE ALL REASONABLE EFFORTS TO REDUCE SEDIMENT LOSS AND MINIMIZE DISTURBANCE OF THE SITE WHILE PERFORMING THE CONSTRUCTION WORK.
3. CONSTRUCTION IS SCHEDULED TO BEGIN SPRING OF 2015.
4. CONTRACTOR SHOULD CALL NORTH CAROLINA "ONE-CALL" BEFORE EXCAVATION STARTS. (1-800-632-4949)
5. ENGINEER WILL FLAG TREES TO BE SAVED PRIOR TO CONSTRUCTION.

PROJECT REFERENCE NO.	SHEET NO.
135794	1-A

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

APPROVED BY:

09.06.15

DATE:

Michael Baker INTERNATIONAL
Michael Baker Engineering Inc.
8000 Regency Parkway, Suite 600
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Phone: 919.463.5488
Fax: 919.463.5490
License #: F-1084

NCEEP ID No. 96074

STANDARD SPECIFICATIONS

NORTH CAROLINA
EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL
MARCH 2009 (REV 2013)

6.05 TREE PROTECTION

6.06 TEMPORARY GRAVEL CONSTRUCTION ENTRANCE

6.24 RIPARIAN AREA SEEDING

6.60 TEMPORARY SEDIMENT TRAP

6.62 TEMPORARY SILT FENCE

6.63 TEMPORARY ROCK DAM

6.70 TEMPORARY STREAM CROSSING

VEGETATION SELECTION

Proposed Bare-Root and Live Stake Species

Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Botanical Name	Common Name	% Planted by Species	Wetland Tolerance
Riparian Buffer Plantings - 8' x 8' spacing - 680 stems/Acre			
Overstory Species			
Fraxinus pennsylvanica	Green Ash	12%	FACW
Betula nigra	River Birch	9%	FACW
Liriodendron tulipifera	Tulip Poplar	9%	FAC
Quercus pagoda	Cherrybark Oak	6%	FACW
Quercus michauxii	Swamp Chestnut Oak	9%	FACW-
Diospyros virginiana	Persimmon	6%	FAC
Platanus occidentalis	American Sycamore	9%	FACW-
Understory Species			
Carpinus caroliniana	American Hornbeam	15%	FAC
Viburnum dentatum	Arrowwood Viburnum	15%	FAC
Asimina triloba	Paw Paw	10%	FAC

Riparian Live Stake Plantings			
Salix nigra	Black Willow	10%	OBL
Sambucus canadensis	Elderberry	20%	FACW-
Salix sericea	Silky Willow	30%	OBL
Cornus amomum	Silky Dogwood	40%	FACW+

Proposed Permanent Seed Mixture

Thomas Creek Restoration Project Stream Mitigation Plan - NCEEP Project No. 96074

Botanical Name	Common Name	% Planted by Species	Density (lbs/ac)	Wetland Tolerance
Andropogon gerardii	Big blue stem	10%	1.5	FAC
Dichanthelium clandestinum	Deer tongue	15%	1.5	FACW
Carex crinata	Fringed sedge	10%	2.25	FACW+
Elymus virginicus	Virginia wild rye	15%	1.5	FAC
Juncus effusus	Soft rush	10%	2.25	FACW+
Panicum virgatum	Switchgrass	15%	1.5	FAC+
Schizachyrium scoparium	Little blue stem	15%	0.75	FACU
Sorghastrum nutans	Indiangrass	10%	0.75	FACU
	Total	100%	15	

Temporary Seed Mixture

The following table lists temporary seed mix for the project site. All disturbed areas were stabilized using mulch and temporary seed as defined in the construction specifications.

Planting Dates	Species Name	Rate (lbs./acre)
September to March	Rye Grain (Cool Season)	130
April to August	Browntop Millet (Warm Season)	40

2/26/03
3/5/2015
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PROJECT REFERENCE NO.	SHEET NO.
135794	1-B
NCEEP ID No. 96074	

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER

APPROVED BY:

03.06.15

DATE:

*S.U.E = SUBSURFACE UTILITY ENGINEER

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

CONVENTIONAL SYMBOLS

BOUNDARIES AND PROPERTY:

- State Line
- County Line
- Township Line
- City Line
- Reservation Line
- Property Line
- Existing Iron Pin — EIP
- Property Corner
- Property Monument — ECM
- Parcel/Sequence Number — 123
- Existing Fence Line
- Proposed Woven Wire Fence
- Proposed Chain Link Fence
- Proposed Barbed Wire Fence
- Existing Wetland Boundary — WLB
- Proposed Wetland Boundary — WLB
- Existing Endangered Animal Boundary — EAB
- Existing Endangered Plant Boundary — EPB

BUILDINGS AND OTHER CULTURE:

- Gas Pump Vent or U/G Tank Cap
- Sign — S
- Well — W
- Small Mine
- Foundation
- Area Outline
- Cemetery
- Building
- School
- Church
- Dam

HYDROLOGY:

- Stream or Body of Water
- Hydro, Pool or Reservoir
- Jurisdictional Stream — JS
- Buffer Zone 1 — BZ 1
- Buffer Zone 2 — BZ 2
- Flow Arrow
- Disappearing Stream
- Spring
- Wetland
- Proposed Lateral, Tail, Head Ditch — FLOW
- False Sump

RAILROADS:

- Standard Gauge — CSX TRANSPORTATION
- RR Signal Milepost — MILEPOST 35
- Switch — SWITCH
- RR Abandoned
- RR Dismantled

RIGHT OF WAY:

- Baseline Control Point
- Existing Right of Way Marker
- Existing Right of Way Line
- Proposed Right of Way Line — RW
- Proposed Right of Way Line with Iron Pin and Cap Marker — RW
- Proposed Right of Way Line with Concrete or Granite Marker — RW
- Existing Control of Access — CA
- Proposed Control of Access — CA
- Existing Easement Line — E
- Proposed Temporary Construction Easement — E
- Proposed Temporary Drainage Easement — TDE
- Proposed Permanent Drainage Easement — PDE
- Proposed Permanent Utility Easement — PUE
- Proposed Temporary Utility Easement — TUE
- Proposed Permanent Easement with Iron Pin and Cap Marker

ROADS AND RELATED FEATURES:

- Existing Edge of Pavement
- Existing Curb
- Proposed Slope Stakes Cut — C
- Proposed Slope Stakes Fill — F
- Proposed Wheel Chair Ramp — WCR
- Existing Metal Guardrail
- Proposed Guardrail
- Existing Cable Guiderail
- Proposed Cable Guiderail
- Equality Symbol
- Pavement Removal

VEGETATION:

- Single Tree
- Single Shrub
- Hedge
- Woods Line
- Orchard
- Vineyard — Vineyard

EXISTING STRUCTURES:

MAJOR:

- Bridge, Tunnel or Box Culvert — CONC
- Bridge Wing Wall, Head Wall and End Wall — CONC WW

MINOR:

- Head and End Wall — CONC HW
- Pipe Culvert
- Footbridge
- Drainage Box: Catch Basin, DI or JB — CB
- Paved Ditch Gutter
- Storm Sewer Manhole — S
- Storm Sewer — S

UTILITIES:

POWER:

- Existing Power Pole
- Proposed Power Pole
- Existing Joint Use Pole
- Proposed Joint Use Pole
- Power Manhole — P
- Power Line Tower
- Power Transformer
- U/G Power Cable Hand Hole — HH
- H-Frame Pole
- Recorded U/G Power Line — P
- Designated U/G Power Line (S.U.E.*) — P

TELEPHONE:

- Existing Telephone Pole
- Proposed Telephone Pole
- Telephone Manhole — T
- Telephone Booth
- Telephone Pedestal — T
- Telephone Cell Tower
- U/G Telephone Cable Hand Hole — HH
- Recorded U/G Telephone Cable — T
- Designated U/G Telephone Cable (S.U.E.*) — T
- Recorded U/G Telephone Conduit — TC
- Designated U/G Telephone Conduit (S.U.E.*) — TC
- Recorded U/G Fiber Optics Cable — T FO
- Designated U/G Fiber Optics Cable (S.U.E.*) — T FO

WATER:

- Water Manhole — W
- Water Meter
- Water Valve
- Water Hydrant
- Recorded U/G Water Line — W
- Designated U/G Water Line (S.U.E.*) — W
- Above Ground Water Line — A/G Water

TV:

- TV Satellite Dish
- TV Pedestal — C
- TV Tower
- U/G TV Cable Hand Hole — HH
- Recorded U/G TV Cable — TV
- Designated U/G TV Cable (S.U.E.*) — TV
- Recorded U/G Fiber Optic Cable — TV FO
- Designated U/G Fiber Optic Cable (S.U.E.*) — TV FO

GAS:

- Gas Valve
- Gas Meter
- Recorded U/G Gas Line — G
- Designated U/G Gas Line (S.U.E.*) — G
- Above Ground Gas Line — A/G Gas

SANITARY SEWER:

- Sanitary Sewer Manhole
- Sanitary Sewer Cleanout
- U/G Sanitary Sewer Line — SS
- Above Ground Sanitary Sewer — A/G Sanitary Sewer
- Recorded SS Forced Main Line — FSS
- Designated SS Forced Main Line (S.U.E.*) — FSS

MISCELLANEOUS:

- Utility Pole
- Utility Pole with Base
- Utility Located Object
- Utility Traffic Signal Box — S
- Utility Unknown U/G Line — ?UTL
- U/G Tank; Water, Gas, Oil
- A/G Tank; Water, Gas, Oil
- U/G Test Hole (S.U.E.*)
- Abandoned According to Utility Records — AATUR
- End of Information — E.O.I.

revised 02/02/00

3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	2

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER

APPROVED BY:

03-06-15

DATE:

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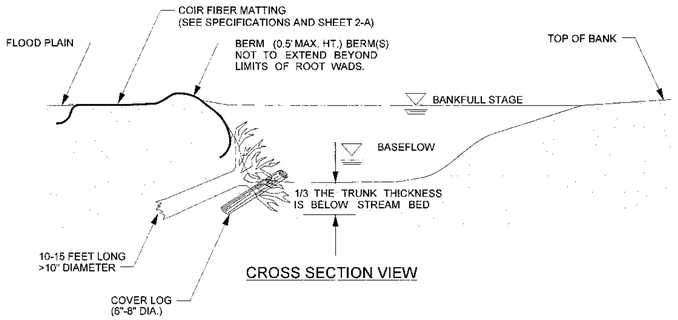
NCEEP ID No. 96074

ROOT WADS

ROOT WADS WITHOUT TRANSPLANTS

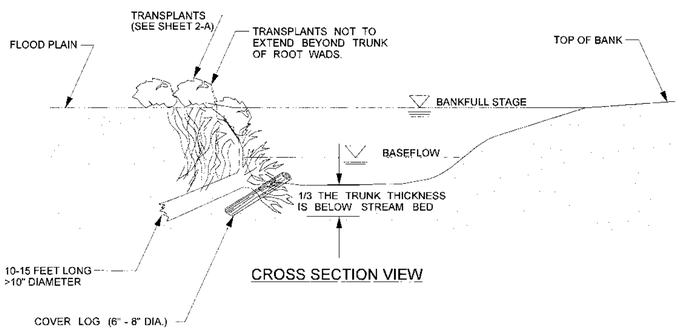
USE IF TRANSPLANTS ARE NOT AVAILABLE ON-SITE



CROSS SECTION VIEW

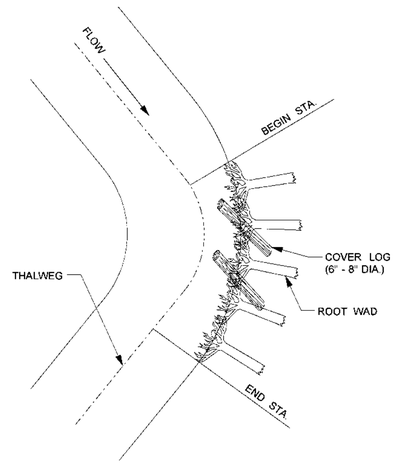
ROOT WADS WITH TRANSPLANTS

USE IF TRANSPLANTS ARE AVAILABLE ON-SITE



CROSS SECTION VIEW

PLAN VIEW



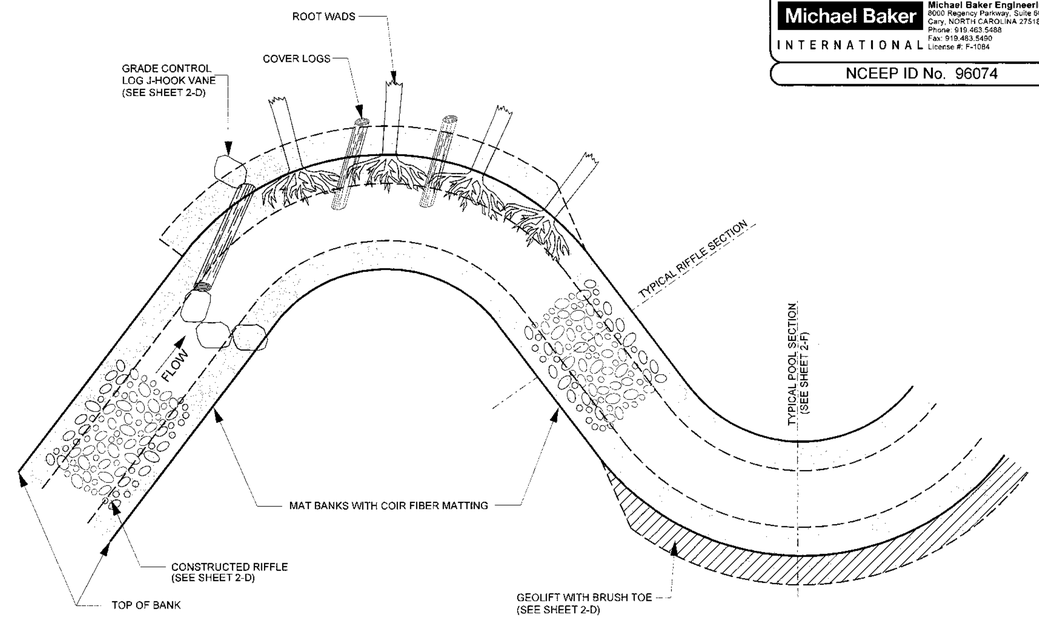
NOTES:

1. INSTALLATION USING THE TRENCHING METHOD REQUIRES THAT A TRENCH BE EXCAVATED FOR THE LOG PORTION OF THE ROOT WAD. ONE-THIRD OF THE ROOT WAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS OR CHANNEL BOTTOM.
2. THE NUMBER OF ROOTWADS ESTIMATED MAY VARY DEPENDING ON THE ROOTMASS SIZE. IN GENERAL, ROOTWADS SHOULD PROTECT THE OUTER MEANDER BEND AS SHOWN. SEE STRUCTURE TABLE FOR APPROXIMATE STATION AND LOCATION.
3. INSTALL COVER LOGS BETWEEN ROOTWADS TO PROVIDE HABITAT ONLY WHEN AVAILABLE FROM ON-SITE HARVESTING.

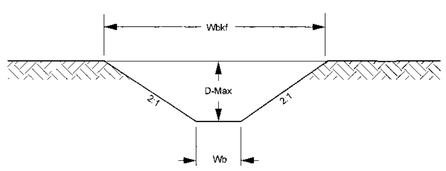
TYPICAL STRUCTURE PLACEMENT

STRUCTURE NOTES:

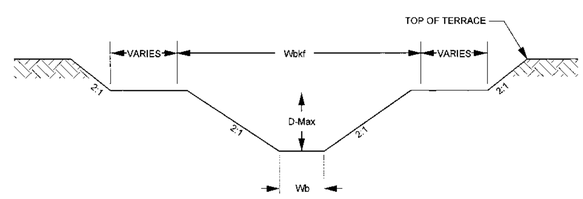
1. GENERALLY CONSTRUCTED RIFFLES, ROOT WADS, LOG VANES AND COIR FIBER MATTING WILL BE INSTALLED IN THE LOCATION AND SEQUENCE AS SHOWN.
2. ANY CHANGES TO NUMBER OR LOCATION OF STRUCTURES DURING CONSTRUCTION MUST BE APPROVED BY THE DESIGN ENGINEER.
3. COIR FIBER MATTING TO BE INSTALLED ON ALL RESTORED STREAMBANKS, FLOODPLAIN BENCHING, AND TERRACE SLOPES AS DESCRIBED IN THE TECHNICAL SPECIFICATIONS.



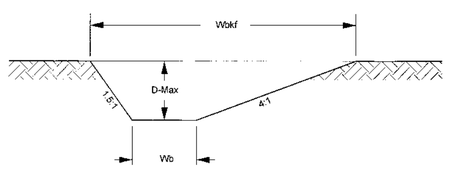
TYPICAL RIFFLE, POOL, AND BANKFULL BENCH CROSS-SECTIONS



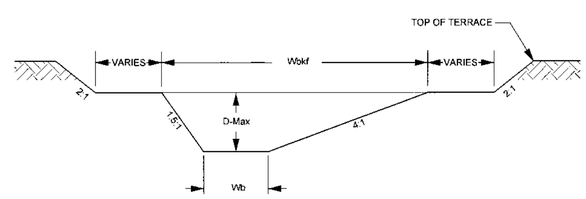
RIFFLE



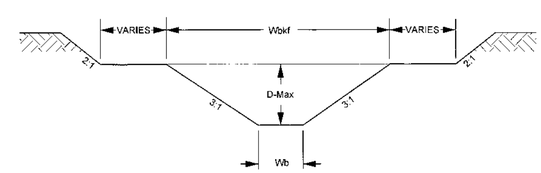
RIFFLE WITH BANKFULL BENCH



POOL



POOL WITH BANKFULL BENCH



STEP - POOL

R1		R2-Top		R2-Bottom *		
RIFFLE	POOL	RIFFLE	POOL	RIFFLE	POOL	
12.5	17.5	9.2	12.0	10.4	13.7	WIDTH OF BANKFULL (Wbkf)
1.1	2.4	0.8	1.7	1.0	1.9	MAXIMUM DEPTH (D-Max)
14.0	12.4	14.0	11.6	14.0	11.7	WIDTH TO DEPTH RATIO (Wbkf / D)
11.2	24.7	6.0	12.5	7.7	16.1	BANKFULL AREA (Abkf)
8.2	3.1	6.0	2.7	5.5	3.3	BOTTOM WIDTH (Wb)

R3		R4		R5 *		
RIFFLE	POOL	RIFFLE	POOL	RIFFLE	POOL	
7.0	10.0	6.3	8.5	6.8	9.0	WIDTH OF BANKFULL (Wbkf)
0.7	1.5	0.6	1.1	0.7	1.3	MAXIMUM DEPTH (D-Max)
12.0	11.3	13.0	12.0	13.0	11.5	WIDTH TO DEPTH RATIO (Wbkf / D)
4.1	8.8	3.1	6.0	3.6	7.1	BANKFULL AREA (Abkf)
4.0	1.8	3.9	2.5	3.3	1.9	BOTTOM WIDTH (Wb)

R6 / R7 *		T1		T2		
RIFFLE	POOL	RIFFLE	POOL	RIFFLE	POOL	
4.6	6.7	7.0	9.0	3.5	6.0	WIDTH OF BANKFULL (Wbkf)
0.4	1.0	0.7	1.4	0.4	0.8	MAXIMUM DEPTH (D-Max)
14.0	11.4	13.0	10.5	12.0	11.8	WIDTH TO DEPTH RATIO (Wbkf / D)
1.5	4.0	3.8	7.7	1.0	3.0	BANKFULL AREA (Abkf)
2.4	1.2	4.4	2.0	2.0	1.6	BOTTOM WIDTH (Wb)

* USE 2.5:1 RIFFLE SIDE SLOPE

NOTES:

1. DURING CONSTRUCTION CORNERS OF DESIGN CHANNEL WILL BE ROUNDED AND A THALWEG WILL BE SHAPED PER DIRECTION OF ENGINEER.
2. POOLS SHOWN ABOVE ARE LEFT POOLS FOR MEANDER CHANNELS.

2/26/03
3/4/2015
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135794	2-A

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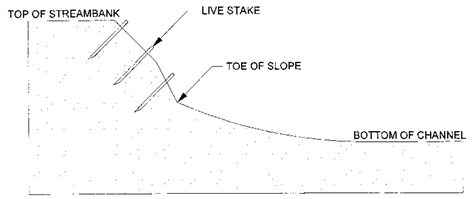
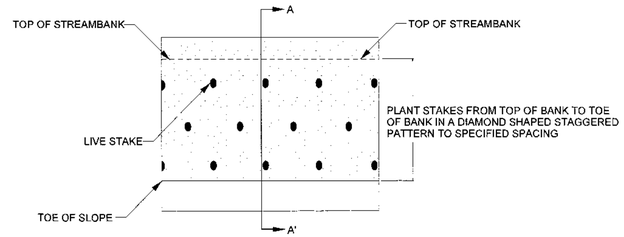
EEP ID No. 96074

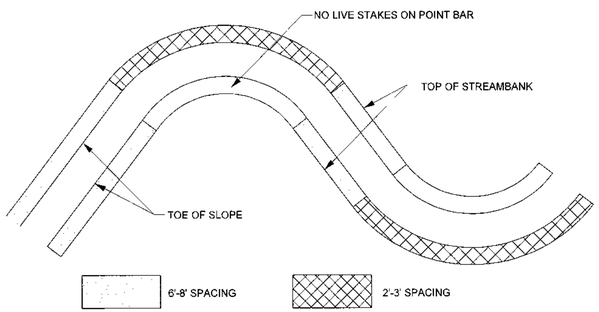
LIVE STAKING



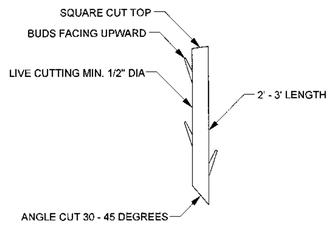
SECTION A - A'



PLAN VIEW



LIVE STAKE SPACING PLAN VIEW

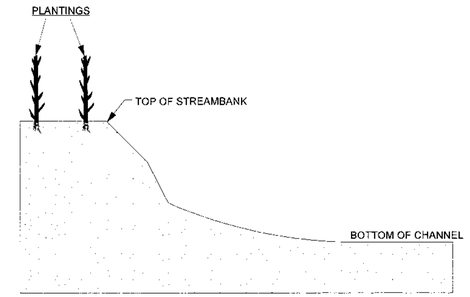


LIVE STAKE DETAIL

NOTES:

1. STAKES SHOULD BE CUT AND INSTALLED ON THE SAME DAY.
2. DO NOT INSTALL STAKES THAT HAVE BEEN SPLIT.
3. STAKES MUST BE INSTALLED WITH BUDS POINTING UPWARDS.
4. STAKES SHOULD BE INSTALLED PERPENDICULAR TO BANK.
5. STAKES SHOULD BE 1/2 TO 2 INCHES IN DIAMETER AND 2 TO 3 FT LONG.
6. STAKES SHOULD BE INSTALLED LEAVING 1/5 OF STAKE ABOVE GROUND.

PLANTING SPECIFICATIONS

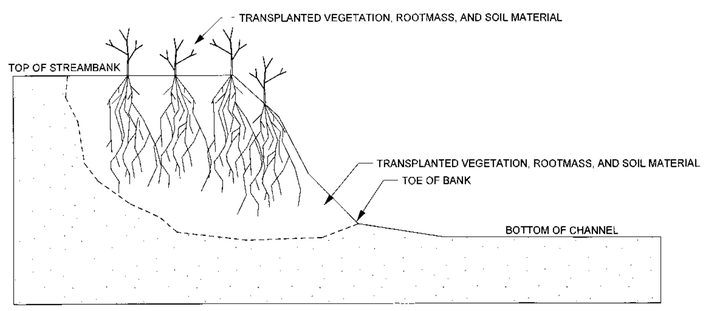


CROSS SECTION VIEW OF BARE ROOT PLANTING

NOTES:

1. PLANT BARE ROOT SHRUBS AND TREES TO THE WIDTH OF THE BUFFER/PLANTING ZONE AS SHOWN ON THE PLANS.
2. ALLOW FOR 6-10 FEET BETWEEN PLANTINGS, DEPENDING ON SIZE.
3. LOOSEN COMPACTED SOIL.
4. PLANT IN HOLES MADE BY A MATTOCK, DIBBLE, PLANTING BAR, OR OTHER APPROVED MEANS.
5. PLANT IN HOLES DEEP AND WIDE ENOUGH TO ALLOW THE ROOTS TO SPREAD OUT AND DOWN WITHOUT J-ROOTING.
6. KEEP ROOTS MOIST WHILE DISTRIBUTING OR WAITING TO PLANT BY MEANS OF WET CANVAS, BURLAP, OR STRAW.
7. HEEL-IN PLANTS IN MOIST SOIL OR SAWDUST IF NOT PROMPTLY PLANTED UPON ARRIVAL TO PROJECT SITE.

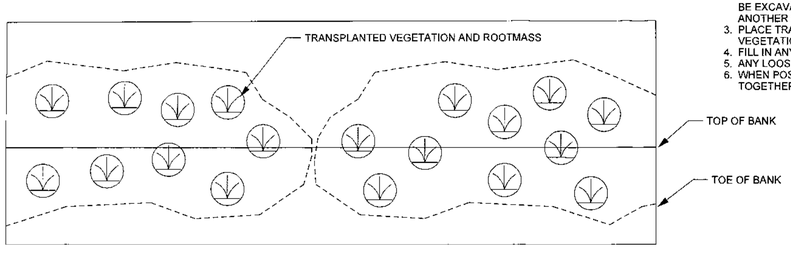
TRANSPLANTED VEGETATION



CROSS SECTION VIEW

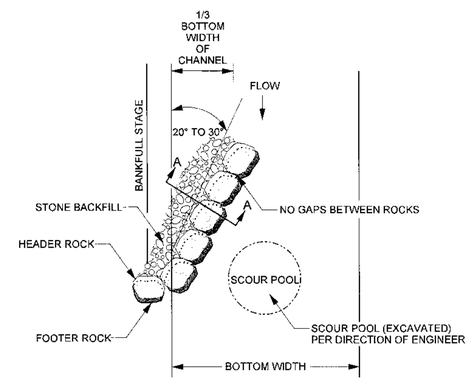
NOTES:

1. EXCAVATE A HOLE IN THE BANK TO BE STABILIZED THAT WILL ACCOMMODATE THE SIZE OF TRANSPLANT TO BE PLACED. BEGIN EXCAVATION AT THE TOE OF THE BANK.
2. EXCAVATE THE ENTIRE ROOT MASS AND AS MUCH ADDITIONAL SOIL MATERIAL AS POSSIBLE. IF ENTIRE ROOT MASS CAN NOT BE EXCAVATED AT ONCE, THE TRANSPLANT IS TOO LARGE AND ANOTHER SHOULD BE SELECTED.
3. PLACE TRANSPLANT IN THE BANK TO BE STABILIZED SO THAT VEGETATION IS ORIENTATED VERTICALLY.
4. FILL IN ANY HOLES AROUND THE TRANSPLANT AND COMPACT.
5. ANY LOOSE SOIL LEFT IN THE STREAM SHOULD BE REMOVED.
6. WHEN POSSIBLE, PLACE MULTIPLE TRANSPLANTS CLOSE TOGETHER SUCH THAT THEY TOUCH.

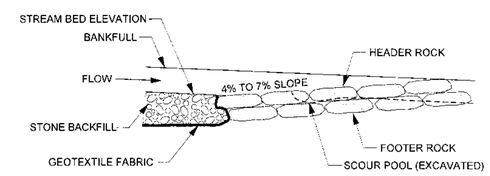


PLAN VIEW

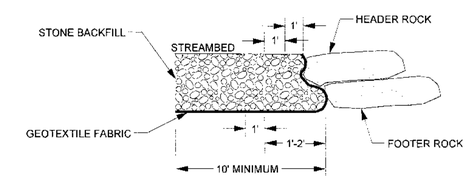
ROCK VANE



PLAN VIEW



PROFILE VIEW



SECTION A - A

NOTES FOR ALL VANE STRUCTURES:

1. INSTALL GEOTEXTILE FABRIC BEGINNING AT THE TOP OF THE HEADER ROCKS AND EXTEND DOWNWARD TO THE DEPTH OF THE BOTTOM FOOTER ROCK, AND THEN UPSTREAM TO A MINIMUM OF TEN FEET.
2. DIG A TRENCH BELOW THE BED FOR FOOTER ROCKS AND PLACE FILL ON UPSTREAM SIDE OF VANE ARM, BETWEEN THE ARM AND STREAMBANK.
3. START AT BANK AND PLACE FOOTER ROCKS FIRST AND THEN HEADER (TOP) ROCK.
4. CONTINUE WITH STRUCTURE, FOLLOWING ANGLE AND SLOPE SPECIFICATIONS.
5. AN EXTRA ROCK CAN BE PLACED IN SCOUR POOL FOR HABITAT IMPROVEMENT.
6. USE HAND PLACED STONE TO FILL GAPS ON UPSTREAM SIDE OF HEADER AND FOOTER ROCKS.
7. AFTER ALL STONE BACKFILL HAS BEEN PLACED, FILL IN THE UPSTREAM SIDE OF THE STRUCTURE WITH ON-SITE ALLUVIUM TO THE ELEVATION OF THE TOP OF THE HEADER ROCK.
8. START SLOPE AT 2/3 TO 1 TIMES THE BANKFULL STAGE.

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03.06.13

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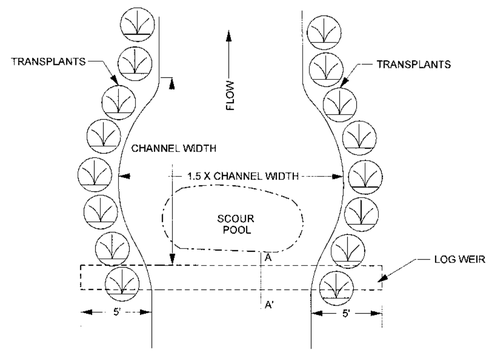
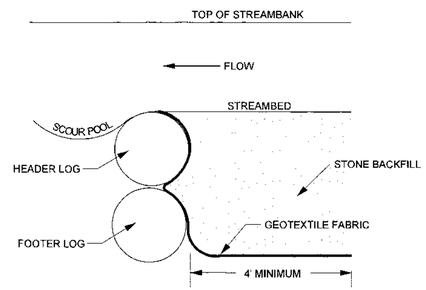
License #: F-1084

NCEEP ID No. 96074

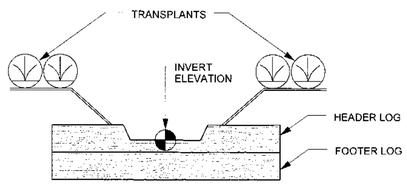
LOG WEIR



PLAN VIEW



SECTION A-A'

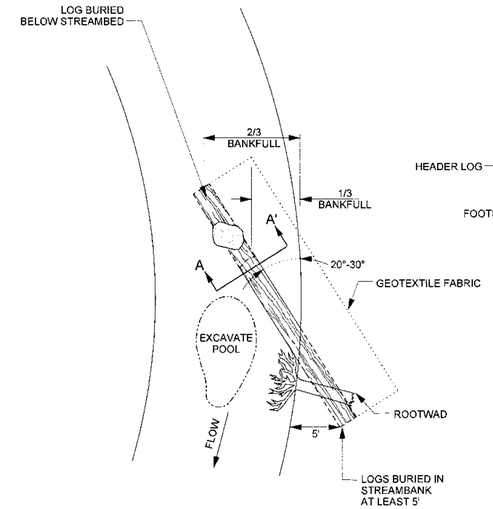


CROSS SECTION VIEW

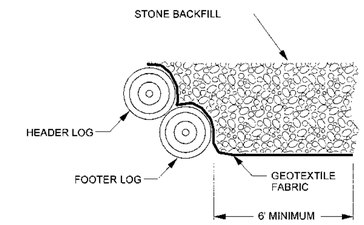
NOTES:

1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG. GEOTEXTILE FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG
3. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG APPROXIMATLEY 3 INCHES ABOVE THE INVERT ELEVATION.
4. CUT A NOTCH IN THE HEADER LOG APPROXIMATLEY 50 PERCENT OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION.
5. USE GEOTEXTILE FABRIC TO SEAL GAPS BETWEEN LOGS.
6. PLACE TRANSPLANTS FROM TOE OF STREAMBANK TO TOP OF STREAMBANK.

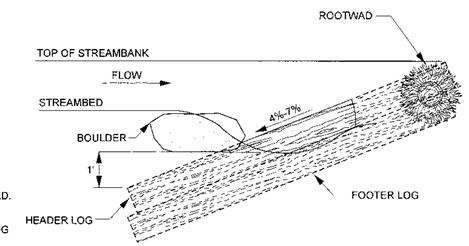
LOG VANE



PLAN VIEW



SECTION A - A'

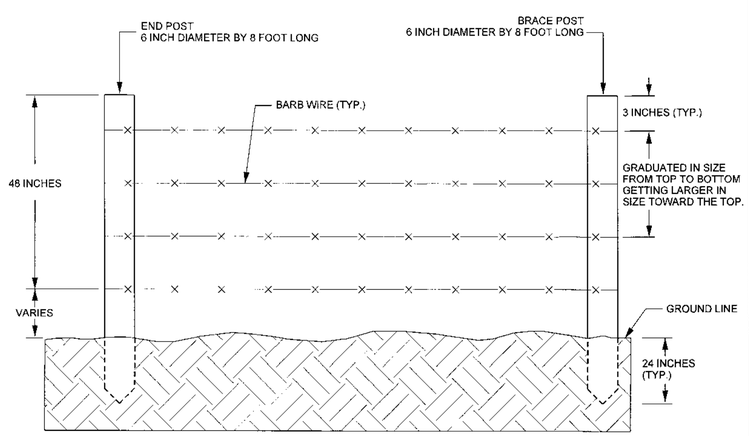


PROFILE VIEW

NOTES:

1. LOGS SHOULD BE AT LEAST 10" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. BOULDERS MUST BE OF SUFFICIENT SIZE TO ANCHOR LOGS.
3. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOGS.
4. ROOTWADS SHOULD BE PLACED BENEATH THE HEADER LOG AND PLACED SO THAT IT LOCKS THE HEADER LOG INTO THE BANK. SEE ROOTWAD DETAIL.
5. BOULDER SHOULD BE PLACED ON TOP OF HEADER LOG FOR ANCHORING.
6. GEOTEXTILE FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.
7. TRANSPLANTS CAN BE USED INSTEAD OF ROOTWADS, PER DIRECTION OF ENGINEER.

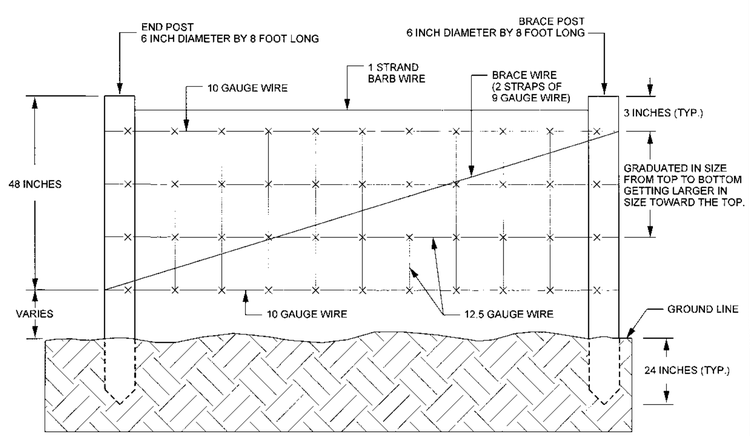
BARB WIRE FIELD FENCE



NOTE:

1. END POSTS SHALL BE INSTALLED AT A SPACING OF 10-15 FEET.

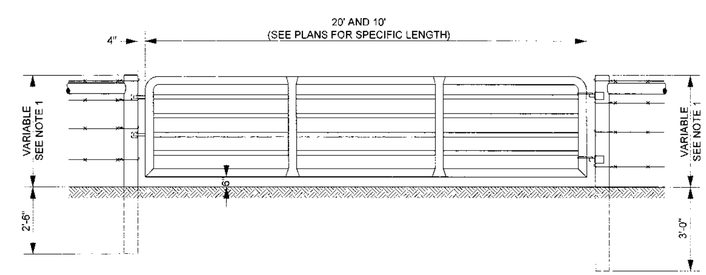
WOVEN WIRE FIELD FENCE



NOTE:

1. END POSTS SHALL BE INSTALLED AT A SPACING OF 8 FEET BETWEEN POSTS, NOT ON CENTER.
2. DUAL WOODEN POST TURN NEEDED IF CHANGE IN FENCE ANGLE IS >20 DEGREES.
3. LINE POSTS SPACED LESS THAN 16.5 FEET APART.

STEEL FRAME GATES



NOTES:

1. POST HEIGHT DIMENSION SHALL BE THE SAME AS REQUIRED FOR THE ADJACENT FENCE.
2. CONSTRUCT AN END OR STRESS PANEL, AS REQUIRED IN THE SPECIFICATION, ON EACH SIDE OF GATE.
3. HINGES AND LOCKS SHALL BE INSTALLED AS SPECIFIED BY GATE MANUFACTURER.

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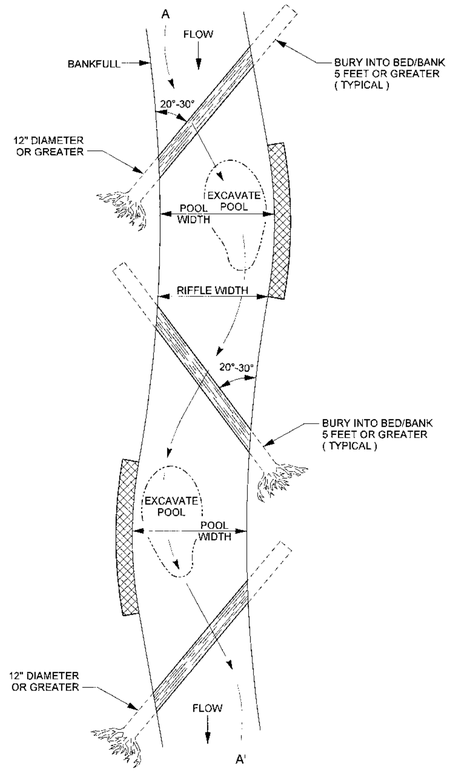
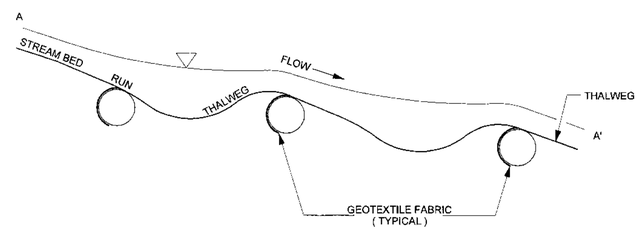
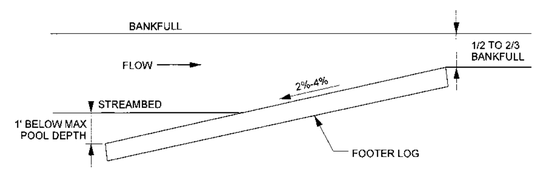
LOG STEP POOL



PLAN VIEW



SECTION A - A'

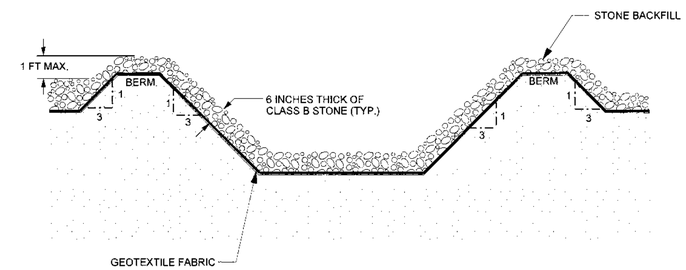


PROFILE VIEW

NOTES:

1. LOGS WITHOUT ROOT MASS MAY BE USED IF APPROVED BY PROJECT ENGINEER.

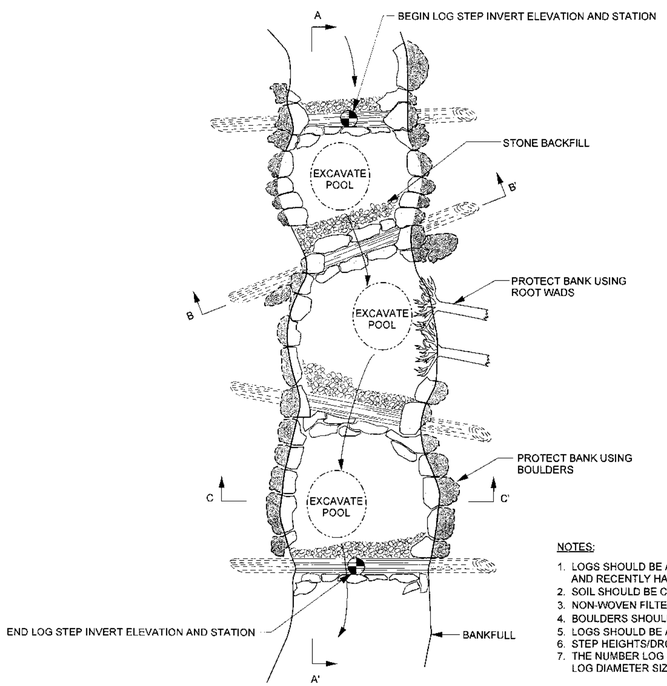
PERMANENT FORD STREAM CROSSING



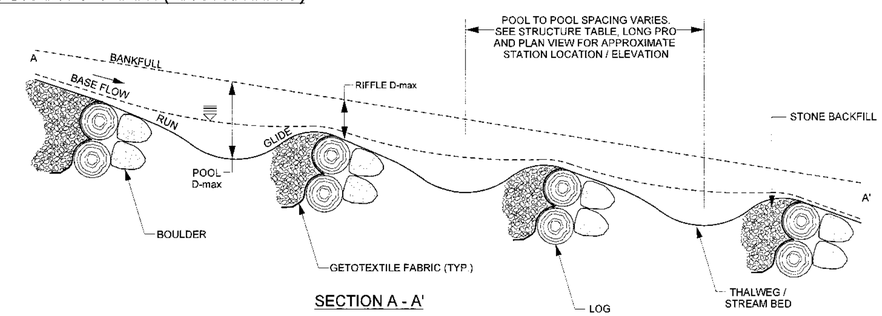
NOTES:

1. CONSTRUCT STREAM CROSSING WHEN FLOW IS LOW.
2. HAVE ALL NECESSARY MATERIALS AND EQUIPMENT ON-SITE BEFORE WORK BEGINS.
3. MINIMIZE CLEARING AND EXCAVATION OF STREAMBANKS. DO NOT EXCAVATE CHANNEL BOTTOM. COMPLETE ONE SIDE BEFORE STARTING ON THE OTHER SIDE.
4. INSTALL STREAM CROSSING AT RIGHT ANGLE TO THE FLOW.
5. GRADE SLOPES TO A 3:1 SLOPE. TRANSPLANT SOD FROM ORIGINAL STREAMBANK ONTO SIDE SLOPES.
6. MAINTAIN CROSSING SO THAT RUNOFF IN THE CONSTRUCTION ROAD DOES NOT ENTER EXISTING CHANNEL.
7. A STABILIZED PAD OF STONE BACKFILL, 6 INCHES THICK, LINED WITH GEOTEXTILE FABRIC, SHALL BE USED OVER THE BERM AND ACCESS SLOPES.
8. WIDTH OF THE CROSSING SHALL BE SUFFICIENT TO ACCOMMODATE THE LARGEST VEHICLE CROSSING THE CHANNEL.
9. CONTRACTOR SHALL DETERMINE AN APPROPRIATE RAMP ANGLE ACCORDING TO EQUIPMENT UTILIZED.

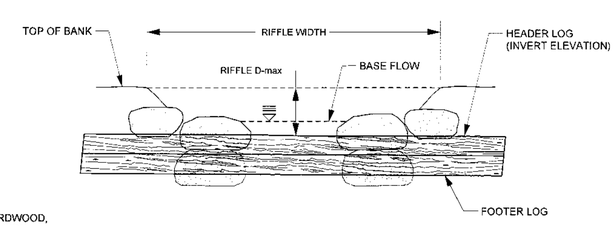
LOG AND ROCK STEP POOL (OR ROLLER)



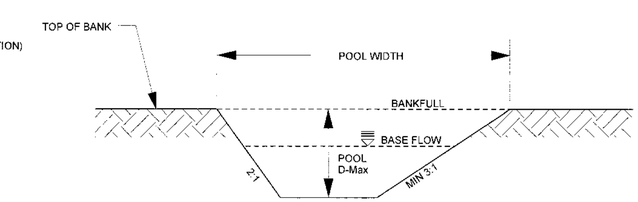
PLAN VIEW



SECTION A - A'



SECTION B - B'



SECTION C - C'

NOTES:

1. LOGS SHOULD BE AT LEAST 10" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED AND EXTENDING INTO THE BANK 5' ON EACH SIDE.
2. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOG.
3. NON-WOVEN FILTER FABRIC SHOULD BE NAILED/STAPLED TO THE LOG BELOW THE BACKFILL.
4. BOULDERS SHOULD BE 3' X 2' X 2' AND PLACED ON TOP OF HEADER LOG FOR ANCHORING.
5. LOGS SHOULD BE ANGLED 60° - 70° FROM THE STREAM BANK AND CROSS SLOPES SHOULD NOT EXCEED 2%.
6. STEP HEIGHTS/DROPS SHALL NOT EXCEED 0.4 FT AND POOL DEPTHS NOT TO EXCEED 1.8 FT.
7. THE NUMBER LOG STEPS MAY VARY BETWEEN BEGIN AND END STATIONING DEPENDING ON LOG DIAMETER SIZE. SEE LONGITUDINAL PROFILE AND STRUCTURE TABLE FOR STATION AND ELEVATION.

3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	2-D

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER III

APPROVED BY:

03.06.15

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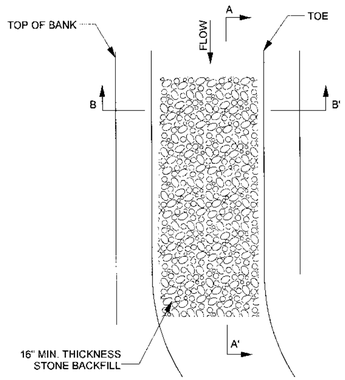
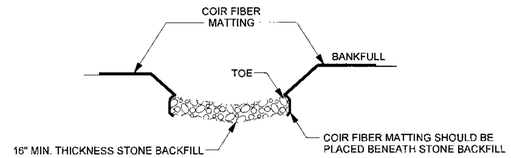
NCEEP ID No. 96074

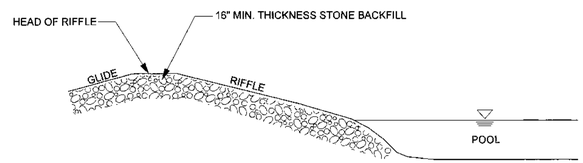
CONSTRUCTED RIFFLE



PLAN VIEW



SECTION B - B'



PROFILE A - A'

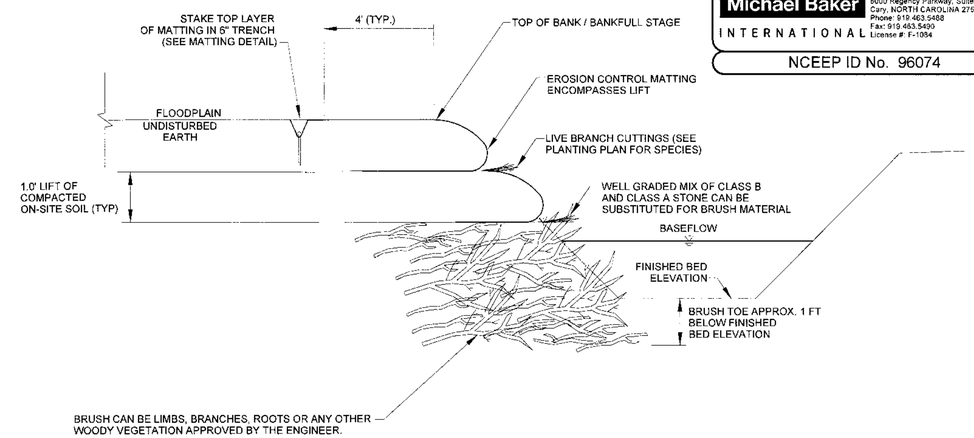
NOTES:

1. DIG A TRENCH BELOW THE BED FOR THE STONE BACKFILL.
2. FILL TRENCH WITH STONE BACKFILL.

GEOLIFT WITH BRUSH TOE

NOTES:

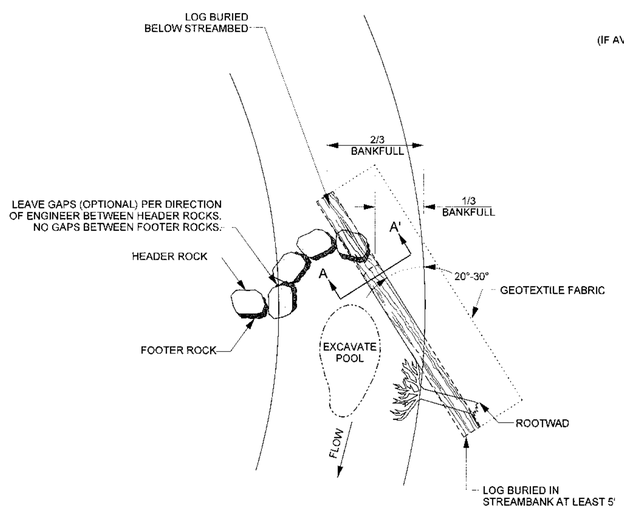
1. LIVE BRANCH CUTTINGS SHALL BE THE SAME SPECIES AS THE LIVE STAKES AND SHALL BE INSTALLED DURING VEGETATION DORMANCY.
2. LIVE BRANCH CUTTINGS SHALL BE INSTALLED AT A DENSITY OF 20-30 CUTTINGS PER LINEAR FOOT AND A MAXIMUM DIAMETER OF 2.5 INCHES.
3. NUMBER OF SOIL LIFTS MAY VARY, IN GENERAL LIFTS SHALL EXTEND TO THE TOP OF BANK OR BANKFULL STAGE.
4. GEOLIFTS TO BE INSTALLED IN CHANNEL SECTIONS ALONG SIDE SLOPES STEEPER THAN 2:1 AND/OR ADJACENT TO HILL SLOPES.



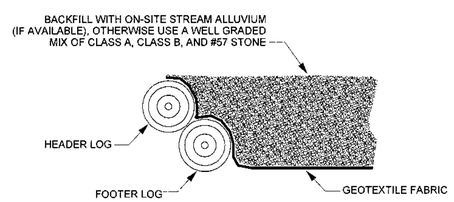
NOTES:

1. WHEN GEOLIFTS ARE BUILT ABOVE ROOTWAD CLUSTER, USE LARGE STONE BACKFILL BEHIND ROOT MASS TO BUILT FOUNDATION.

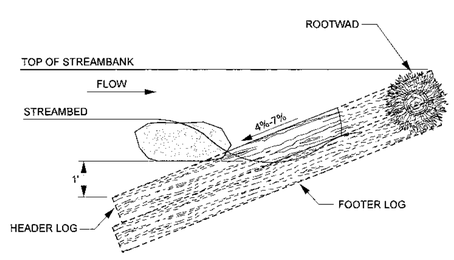
GRADE CONTROL LOG J-HOOK VANE



PLAN VIEW



SECTION A - A'

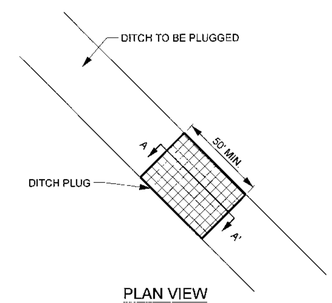


PROFILE VIEW

NOTES:

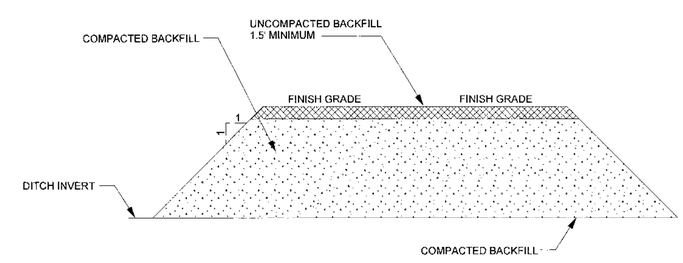
1. LOGS SHOULD BE AT LEAST 10" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOG.
3. ROOTWADS SHOULD BE PLACED BENEATH THE HEADER LOG AND PLACED SO THAT IT LOCKS THE HEADER LOG INTO THE BANK. SEE ROOTWAD DETAIL.
4. BOULDERS SHOULD BE PLACED ON TOP OF HEADER LOG FOR ACHORING.
5. GEOTEXTILE FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.
6. TRANSPLANTS CAN BE USED INSTEAD OF ROOWADS, PER DIRECTION OF ENGINEER.

DITCH PLUG



PLAN VIEW

NOTE:
COMPACT BACKFILL USING ON-SITE HEAVY EQUIPMENT IN 10 INCH LIFTS.



SECTION A - A'

2/26/03

5/4/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	2-E

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

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03.06.15

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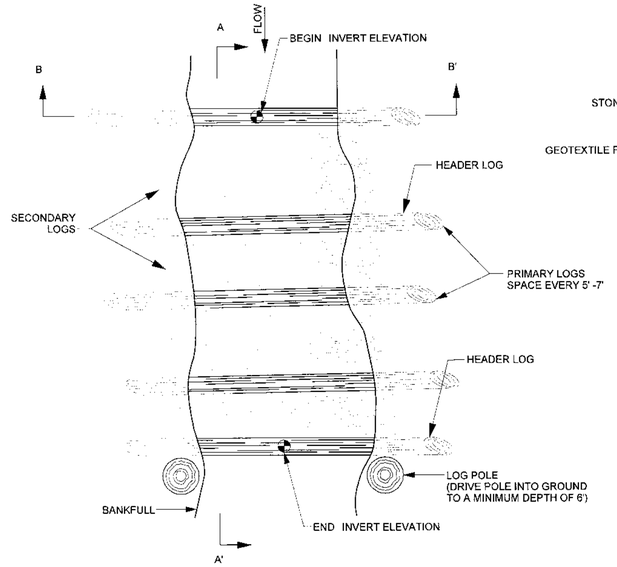
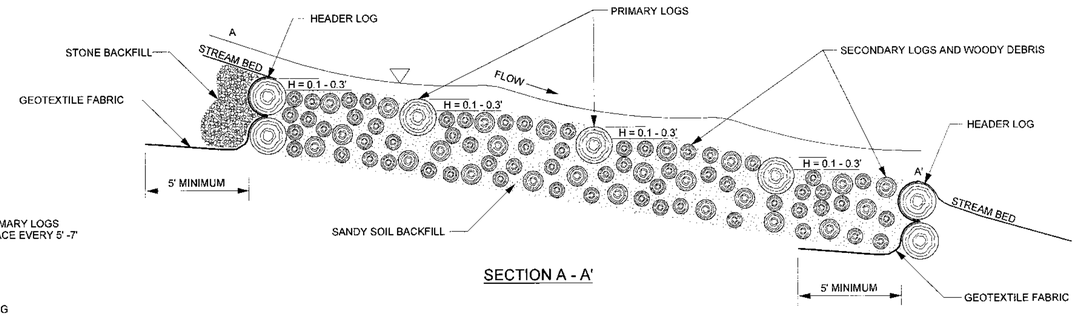
NCEEP ID No. 96074

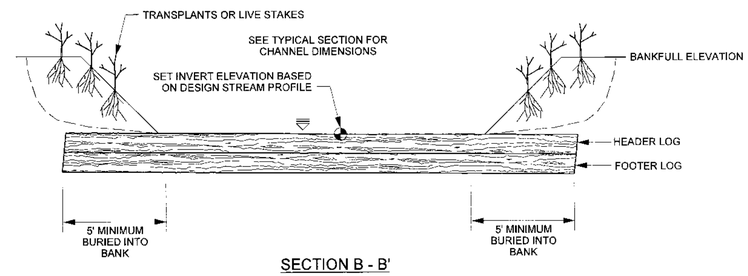
GRADE CONTROL LOG JAM



PLAN VIEW



SECTION A - A'

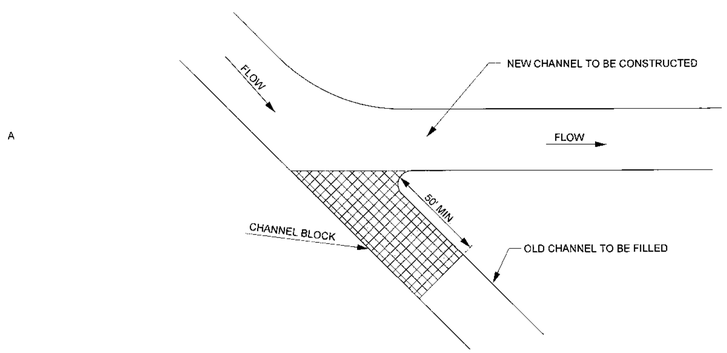


SECTION B - B'

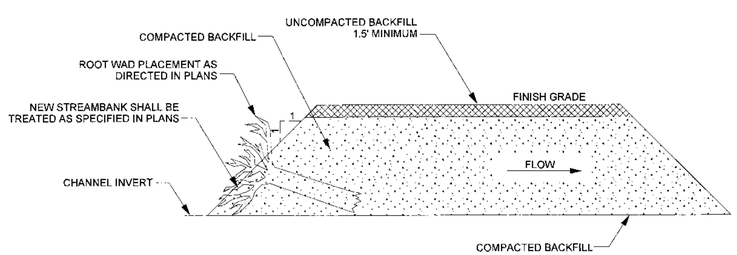
NOTES:

1. PRIMARY LOGS SHOULD BE AT LEAST 10" OR MORE IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD PREFERRED, AND RECENTLY HARVESTED AND EXTENDING INTO THE BANK 5' ON EACH SIDE.
2. SECONDARY LOGS SHOULD BE AT LEAST 1" IN DIAMETER AND NO LARGER THAN 10", AND EXTEND INTO THE BANK 2 FEET ON EACH SIDE. WOOD MATERIAL SHALL BE VARYING DIAMETER TO ALLOW MATERIAL TO BE COMPACTED.
3. VERTICAL POSTS SHOULD BE AT LEAST 10" IN DIAMETER AND SHOULD BE DRIVEN INTO THE GROUND A MINIMUM OF 6'.
4. FILTER FABRIC SHOULD BE NAILED TO THE HEADER LOG BELOW THE BACKFILL.
5. ROOTWADS AND COIR FIBER MATTING CAN BE USED INSTEAD OF TRANSPLANTS OR LIVE STAKES, PER DIRECTION OF ENGINEER.
6. AFTER TRENCH HAS BEEN EXCAVATED A LAYER OF SECONDARY LOGS AND WOODY DEBRIS SHOULD BE PLACED WITH MINIMAL GAPS. A LAYER OF ON-SITE ALLUVIUM SHOULD BE APPLIED TO FILL VOIDS BETWEEN SECONDARY LOGS BEFORE ADDITIONAL LAYERS ARE PLACED.

CHANNEL BLOCK



PLAN VIEW



PROFILE VIEW

2/26/03

3/5/2013
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PROJECT REFERENCE NO.	SHEET NO.
135794	3

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

APPROVED BY:

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NCEEP ID No. 96074

GENERAL CONSTRUCTION SEQUENCE

MICHAEL BAKER ENGINEERING, INC. WILL PROVIDE CONSTRUCTION OBSERVATION DURING THE CONSTRUCTION PHASE OF THIS PROJECT. THE FOLLOWING CONSTRUCTION SEQUENCE SHALL BE USED DURING IMPLEMENTATION OF THE PLAN. CONTRACTOR SHALL REFER TO THE APPROVED EROSION AND SEDIMENTATION CONTROL PLAN FOR SPECIFIC CONSTRUCTION SEQUENCE ITEMS AND SHALL BE RESPONSIBLE FOR FOLLOWING THE APPROVED PLANS AND PERMIT CONDITIONS.

1. CONTRACTOR SHALL CONTACT NORTH CAROLINA "ONE CALL" CENTER (1.800.632.4949) BEFORE ANY EXCAVATION.
2. CONTRACTOR SHALL PREPARE STABILIZED CONSTRUCTION ENTRANCES AND HAUL ROADS AS INDICATED ON THE PLANS.
3. THE CONTRACTOR SHALL MOBILIZE EQUIPMENT, MATERIALS, PREPARE STAGING AREA(S) AND STOCKPILE AREA(S) AS SHOWN ON THE PLANS.
4. CONSTRUCTION TRAFFIC SHALL BE RESTRICTED TO THE AREA DENOTED AS "LIMITS OF DISTURBANCE" OR "HAUL ROADS" ON THE PLANS.
5. THE CONTRACTOR SHALL INSTALL TEMPORARY ROCK DAMS AT LOCATIONS INDICATED ON THE PLANS.
6. THE CONTRACTOR SHALL INSTALL TEMPORARY SILT FENCE AROUND THE STAGING AREA(S). TEMPORARY SILT FENCING WILL ALSO BE PLACED AROUND THE TEMPORARY STOCKPILE AREAS AS MATERIAL IS STOCKPILED THROUGHOUT THE CONSTRUCTION PERIOD.
7. THE CONTRACTOR SHALL INSTALL ALL TEMPORARY AND PERMANENT STREAM CROSSINGS AS SHOWN ON THE PLANS IN ACCORDANCE WITH THE NC EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL. THE EXISTING CHANNEL AND DITCHES ON SITE WILL REMAIN OPEN DURING THE INITIAL STAGES OF CONSTRUCTION TO ALLOW FOR DRAINAGE AND TO MAINTAIN SITE ACCESSIBILITY.
8. THE CONTRACTOR SHALL CONSTRUCT ONLY THE PORTION OF CHANNEL THAT CAN BE COMPLETED AND STABILIZED WITHIN THE SAME DAY.
9. THE CONTRACTOR SHALL APPLY TEMPORARY SEED AND MULCH TO ALL DISTURBED AREAS AT THE END OF EACH WORK DAY.
10. THE CONTRACTOR SHALL CLEAR AND GRUB AN AREA ADEQUATE TO CONSTRUCT THE STREAM CHANNEL AND GRADING OPERATIONS AFTER ALL EROSION AND SEDIMENTATION CONTROL PRACTICES HAVE BEEN INSTALLED AND APPROVED. IN GENERAL, THE CONTRACTOR SHALL WORK FROM DOWNSTREAM TO UPSTREAM AND IN-STREAM STRUCTURES AND CHANNEL FILL MATERIAL SHALL BE INSTALLED USING A PUMP-AROUND OR FLOW DIVERSION MEASURE AS SHOWN ON THE PLANS.
11. THE CONTRACTOR WILL BEGIN CONSTRUCTION BY EXCAVATING CHANNEL FILL MATERIAL IN AREAS OF REACH R1 TO BE USED TO FILL REACH R2. THE CONTRACTOR MAY FILL DITCHES WHICH DO NOT CONTAIN ANY WATER DURING THE GRADING OPERATIONS. ALONG DITCHES WITH WATER OR STREAM REACHES, EXCAVATED MATERIAL SHOULD BE STOCKPILED IN AREAS SHOWN ON THE PLANS. IN ANY AREAS WHERE EXCAVATION DEPTHS WILL EXCEED 10 INCHES, TOPSOIL SHALL BE STOCKPILED AND PLACED BACK OVER THESE AREAS TO A DEPTH OF EIGHT INCHES TO ACHIEVE DESIGN GRADES AND CREATE A SOIL BASE FOR VEGETATION.
12. CONTRACTOR SHALL BEGIN CONSTRUCTION ON STREAM REACH R1 AT STATION 44+46 AND PROCEED IN AN UPSTREAM DIRECTION UNTIL THE CONFLUENCE OF REACHES R2 AND R5. THIS SECTION OF DESIGN CHANNEL WILL BE CONSTRUCTED ONLINE AND WILL EMPLOY A PUMP AROUND OPERATION.
13. AFTER COMPLETING REACH R1, WILL BEGIN WORK ON REACH R2 FOLLOWED BY REACH R5. WORK WILL CONTINUE IN AN UPSTREAM DIRECTION. THIS SECTION OF DESIGN CHANNEL WILL BE CONSTRUCTED OFFLINE AND IN THE DRY, SINCE IT WILL BE EXCAVATED THROUGH THE FIELD AREAS. THE CONTRACTOR SHALL EXCAVATE THE CHANNEL TO DESIGN GRADES IN ALL AREAS EXCEPT WITHIN 10 FEET OF THE TOP OF EXISTING STREAM BANKS.
14. AFTER EXCAVATING THE CHANNEL TO DESIGN GRADES, INSTALL IN-STREAM STRUCTURES, GRASSING, MATTING, AND TRANSPLANTS IN THIS SECTION, AND READY THE CHANNEL TO ACCEPT FLOW PER APPROVAL BY THE ENGINEER.
15. WATER WILL BE TURNED INTO THE CONSTRUCTED CHANNEL ONCE THE AREA IN AND AROUND THE NEW CHANNEL HAS BEEN STABILIZED. IMMEDIATELY BEGIN PLUGGING, FILLING, AND GRADING THE ABANDONED CHANNEL, AS INDICATED ON PLANS, MOVING IN A DOWNSTREAM DIRECTION TO ALLOW FOR DRAINAGE OF THE OLD CHANNELS. NO WATER SHALL BE TURNED INTO ANY SECTION OF CHANNEL PRIOR TO THE CHANNEL BEING COMPLETELY STABILIZED WITH ALL STRUCTURES INSTALLED.
16. THE NEW CHANNEL SECTIONS SHALL REMAIN OPEN ON THE DOWNSTREAM END TO ALLOW FOR DRAINAGE DURING RAIN EVENTS.
17. ANY GRADING ACTIVITIES ADJACENT TO THE STREAM CHANNEL SHALL BE COMPLETED PRIOR TO TURNING WATER INTO THE NEW STREAM CHANNEL SEGMENTS. GRADING ACTIVITIES SHALL NOT BE PERFORMED WITHIN 10 FEET OF THE NEW STREAM CHANNEL BANKS. THE CONTRACTOR SHALL NOT GRADE OR ROUGHEN ANY AREAS WHERE EXCAVATION ACTIVITIES HAVE NOT BEEN COMPLETED.
18. ONCE A STREAM WORK PHASE IS COMPLETE, APPLY TEMPORARY SEEDING, PERMANENT SEEDING, AND MULCHING TO ANY AREAS DISTURBED DURING CONSTRUCTION. APPLY PERMANENT SEEDING MIXTURES, AS SHOWN ON THE VEGETATION PLAN. TEMPORARY SEEDING SHALL BE APPLIED IN ALL AREAS SUSCEPTIBLE TO EROSION (I.E. DISTURBED DITCH BANKS, STEEP SLOPES, AND SPOIL AREAS) SUCH THAT GROUND COVER IS ESTABLISHED WITHIN 15 WORKING DAYS FOLLOWING COMPLETION OF ANY PHASE OF GRADING. PERMANENT GROUND COVER SHALL BE ESTABLISHED FOR ALL DISTURBED AREAS WITHIN 15 WORKING DAYS OR 90 CALENDAR DAYS (WHICHEVER IS SHORTER) FOLLOWING COMPLETION OF CONSTRUCTION.
19. CONTRACTOR SHALL IMPROVE AND CONSTRUCT THE EXISTING FARM ROAD CROSSINGS (REACH R5 NEAR STATION 35+00, REACH R2 NEAR STATION 27+50, AND REACH T1 NEAR STATION 10+60) BY INSTALLING PERMANENT FORD CROSSINGS, STABILIZING SIDE SLOPES, AND MODIFYING THE FARM ROAD BED ELEVATIONS ACCORDING TO THE PLANS AND SPECIFICATIONS. THE FARM ROAD CROSSINGS ON REACHES R3, R4, AND R6 MAY BE LEFT UNCHANGED.
20. ALL DISTURBED AREAS SHOULD BE SEEDED AND MULCHED BEFORE LEAVING THE PROJECT. REMOVE TEMPORARY STREAM CROSSINGS AND ANY IN-STREAM TEMPORARY ROCK DAMS. ALL WASTE MATERIAL MUST BE REMOVED FROM THE PROJECT SITE.
21. THE CONTRACTOR SHALL TREAT AREAS OF INVASIVE SPECIES VEGETATION THROUGHOUT THE PROJECT AREA ACCORDING TO THE PLANS AND SPECIFICATIONS PRIOR TO DEMOBILIZATION.
22. THE CONTRACTOR SHALL PLANT WOODY VEGETATION AND LIVE STAKES, ACCORDING TO PLANTING DETAILS AND SPECIFICATIONS. THE CONTRACTOR SHALL COMPLETE THE REFORESTATION (BARE-ROOT PLANTING) PHASE OF THE PROJECT AND APPLY PERMANENT SEEDING AT THE APPROPRIATE TIME OF THE YEAR.
23. THE CONTRACTOR SHALL ENSURE THAT THE SITE IS FREE OF TRASH AND LEFTOVER MATERIALS PRIOR TO DEMOBILIZATION OF EQUIPMENT FROM THE SITE.

2/25/03
3/6/2013
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	4

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HINTON III

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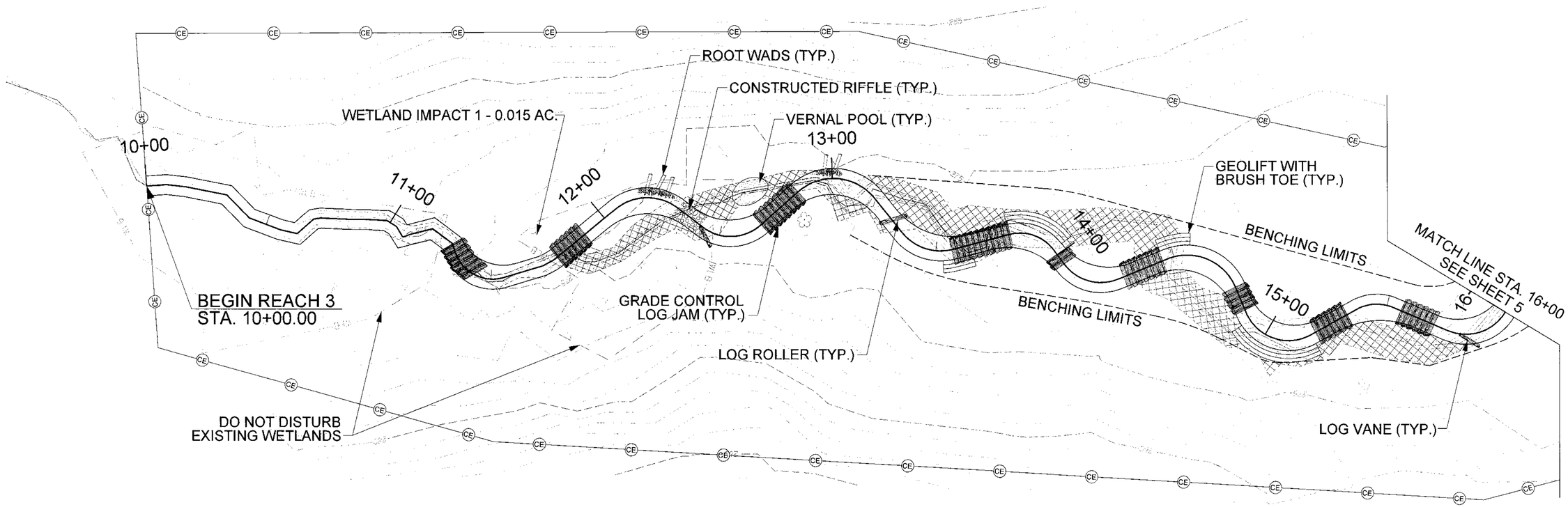
NCEEP ID NO. 96074

NAD 83

NOTE:

REACH 3 STA. 10+00.00 TO STA. 11+30.00
INVASIVE/EXOTIC SPECIES VEGETATION REMOVAL AND PLANTING ONLY,
SEE REVEGETATION PLAN.



FILL EXISTING CHANNEL

DITCH PLUG / CHANNEL BLOCK

THOMAS CREEK
PLAN VIEW
REACH 3

20 10 0 20 40
SCALE (FT)

2/26/03

3/6/2013
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	5

PROJECT ENGINEER

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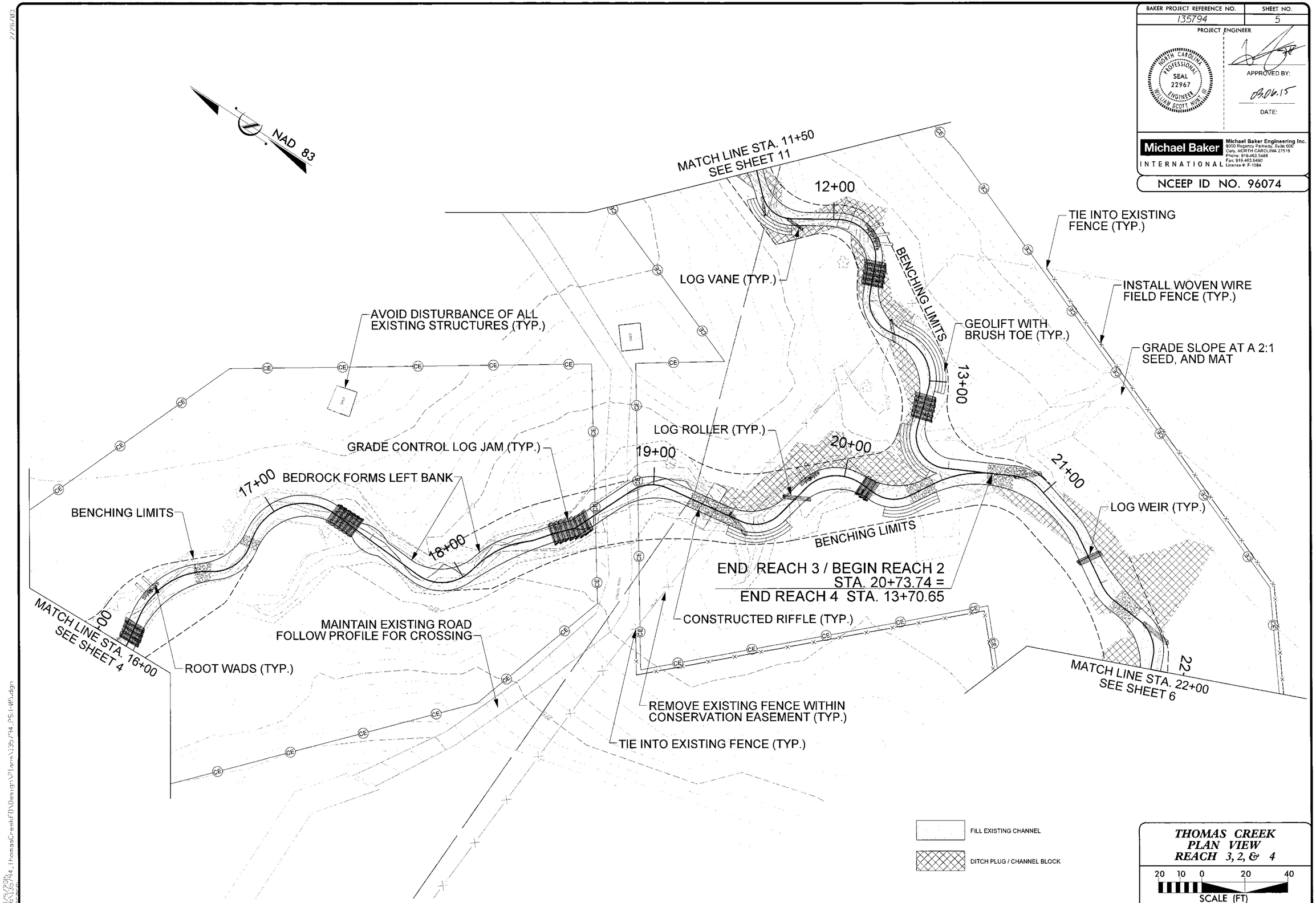

THOMAS CREEK
PLAN VIEW
REACH 3, 2, & 4

20 10 0 20 40
SCALE (FT)

2/12/2015

3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	6

PROJECT ENGINEER

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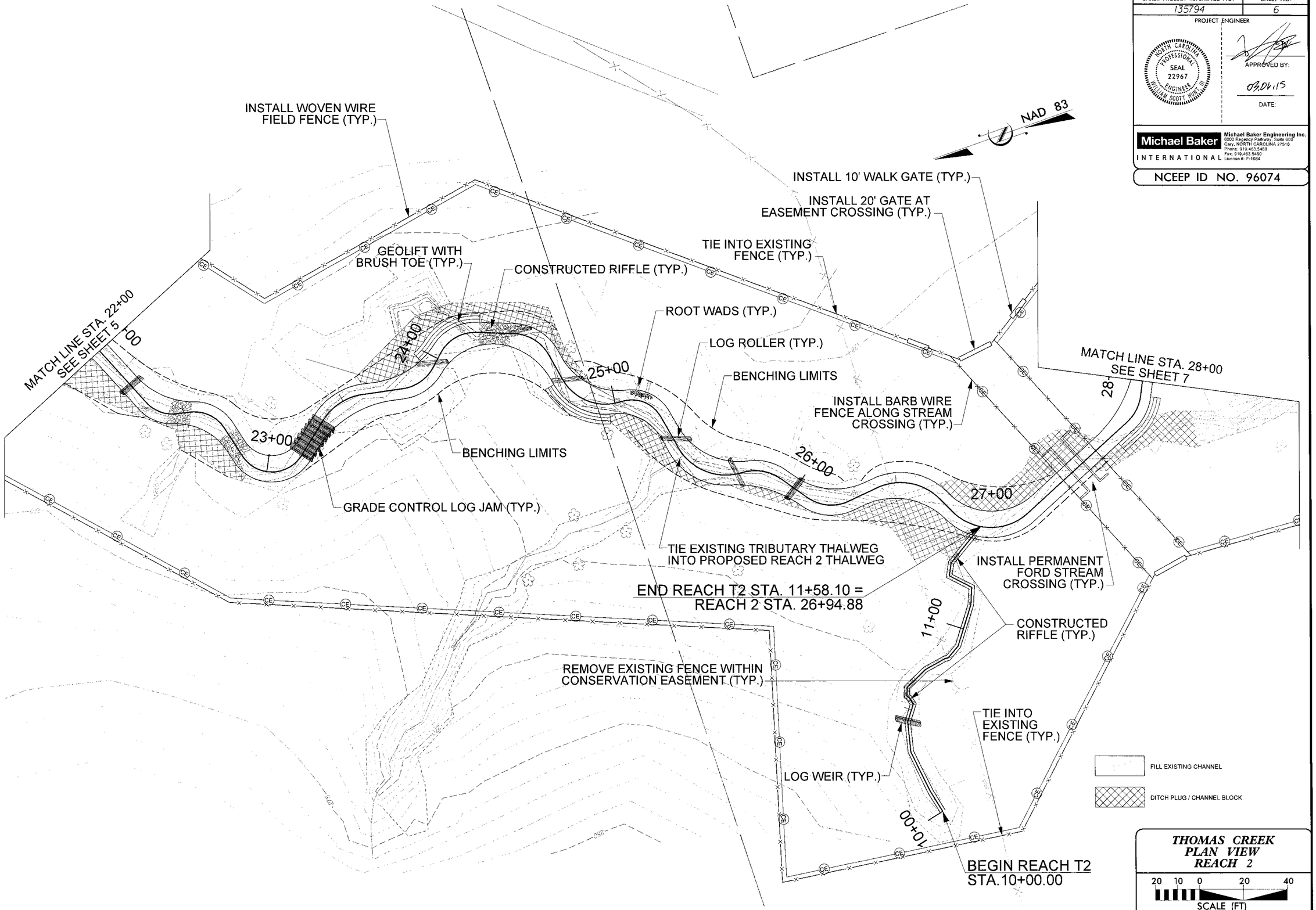
NCEEP ID NO. 96074



THOMAS CREEK PLAN VIEW REACH 2

2/26/03

3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	7

PROJECT ENGINEER

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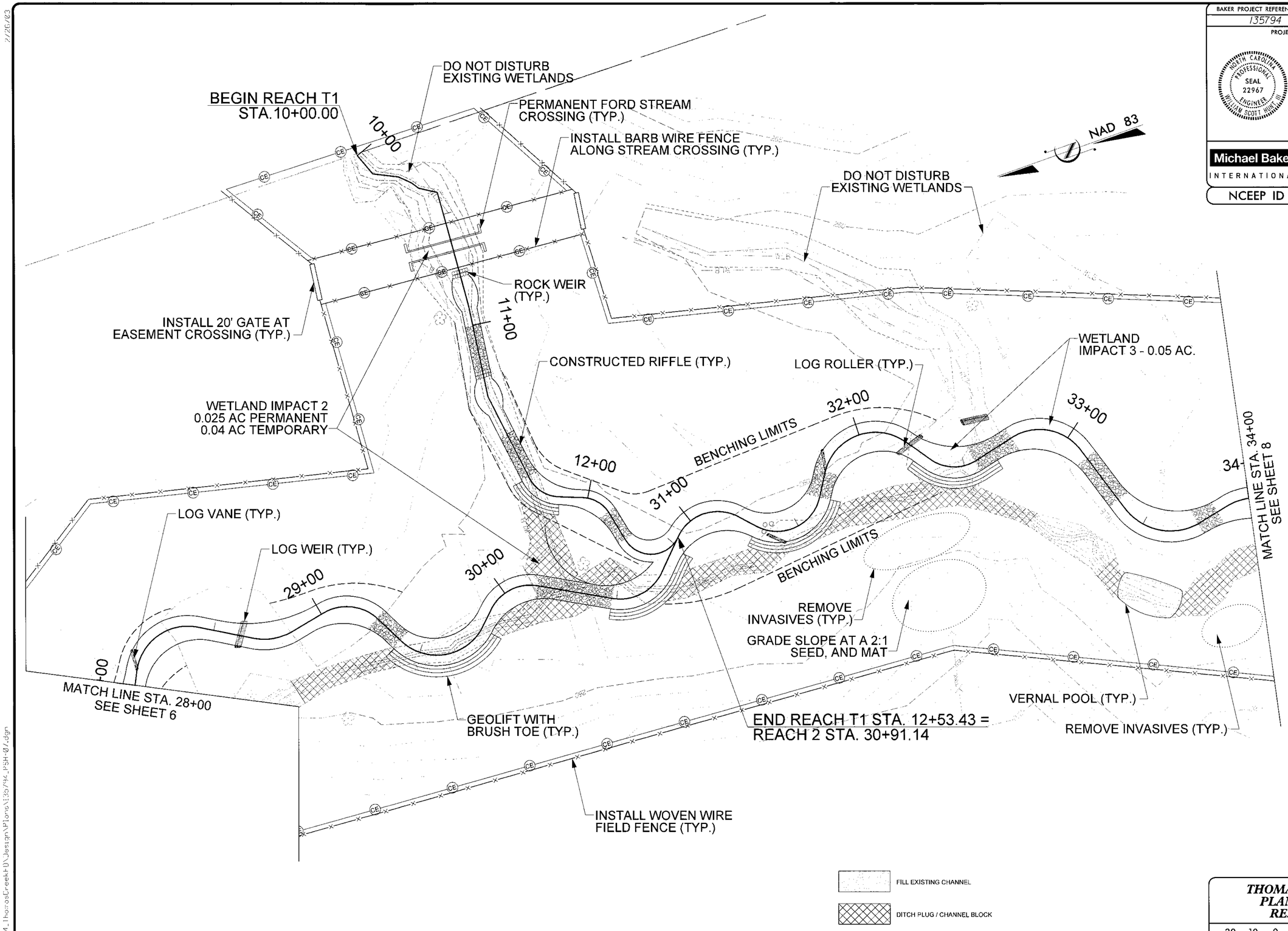

THOMAS CREEK
PLAN VIEW
REACH 2

20 10 0 20 40
SCALE (FT)

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	8

PROJECT ENGINEER

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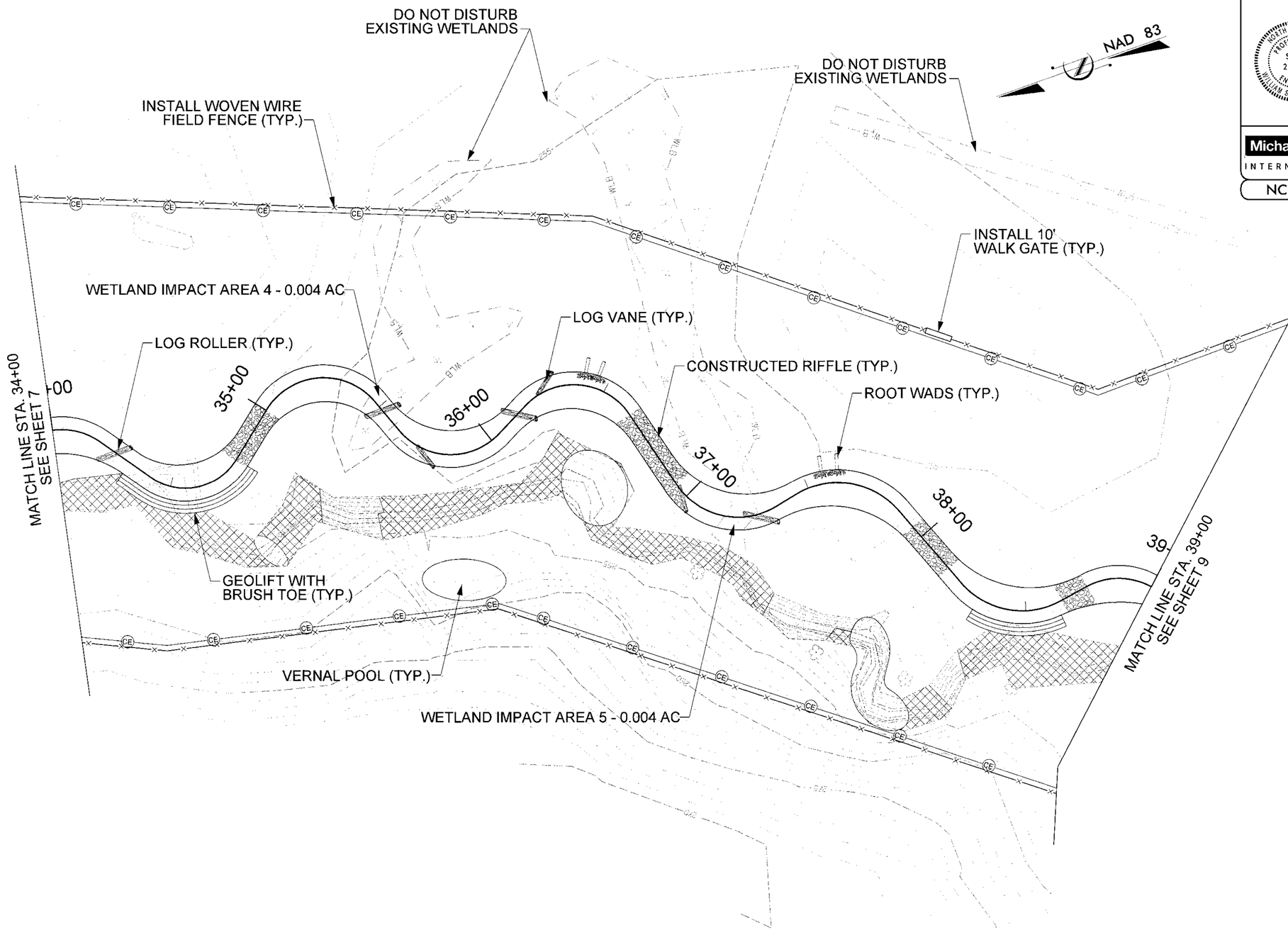
License #: F-1084

NCEEP ID NO. 96074



FILL EXISTING CHANNEL

DITCH PLUG / CHANNEL BLOCK

THOMAS CREEK
PLAN VIEW
REACH 2

20 10 0 20 40
SCALE (FT)

2/25/03

3/6/2015
R:\135794_ThomasCreek\DNDesign\Plans\135794_PSH-08.dgn

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	9

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT III

APPROVED BY:

07.06.15

DATE:

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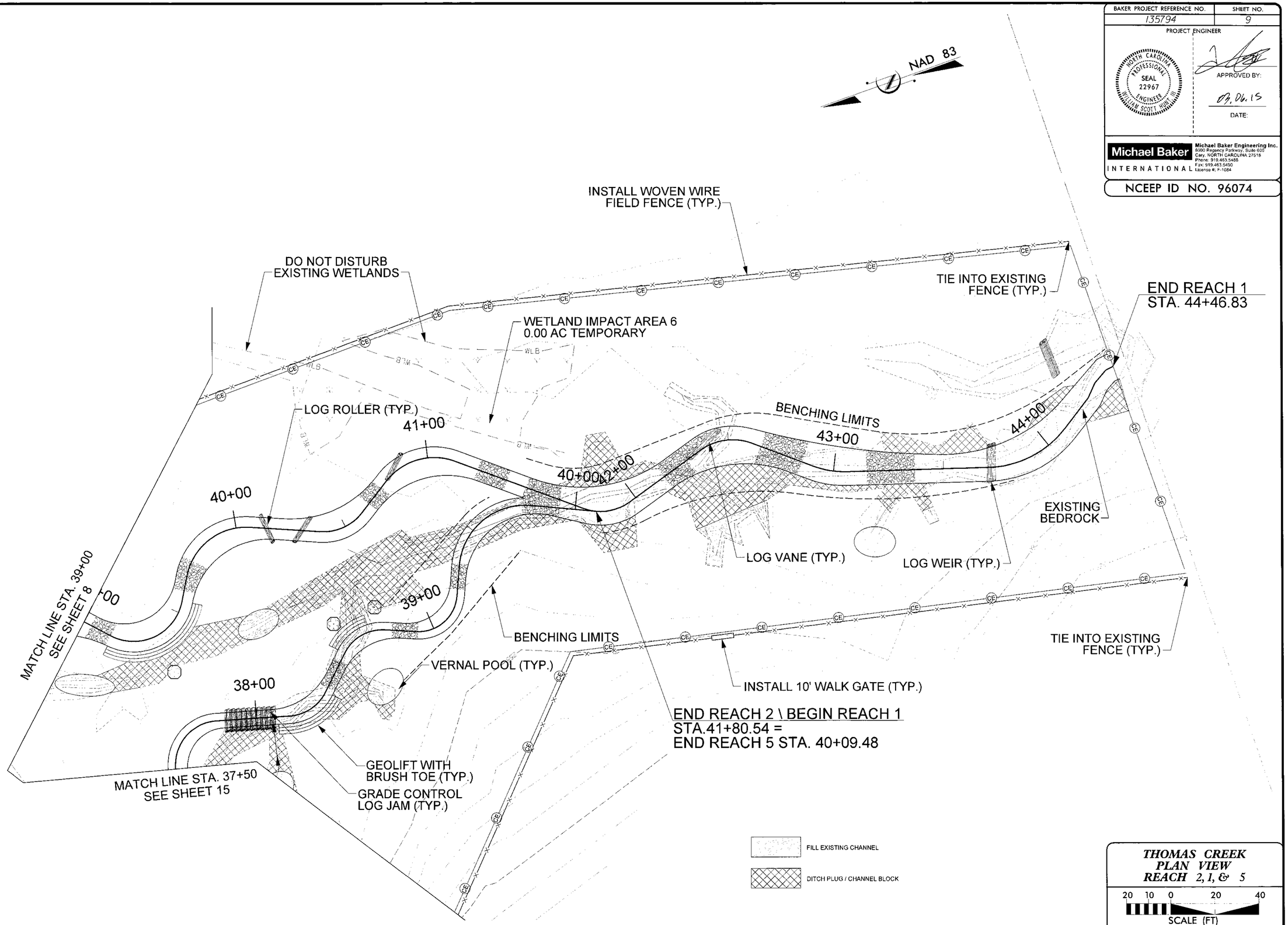
NCEEP ID NO. 96074



THOMAS CREEK
PLAN VIEW
REACH 2, 1, & 5

20 10 0 20 40
SCALE (FT)

2/26/03

3/3/2015
R:\135794_ThomasCreek\D\Design\Plans\135794_PH-09.dgn

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	10

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT

APPROVED BY:

03.06.15

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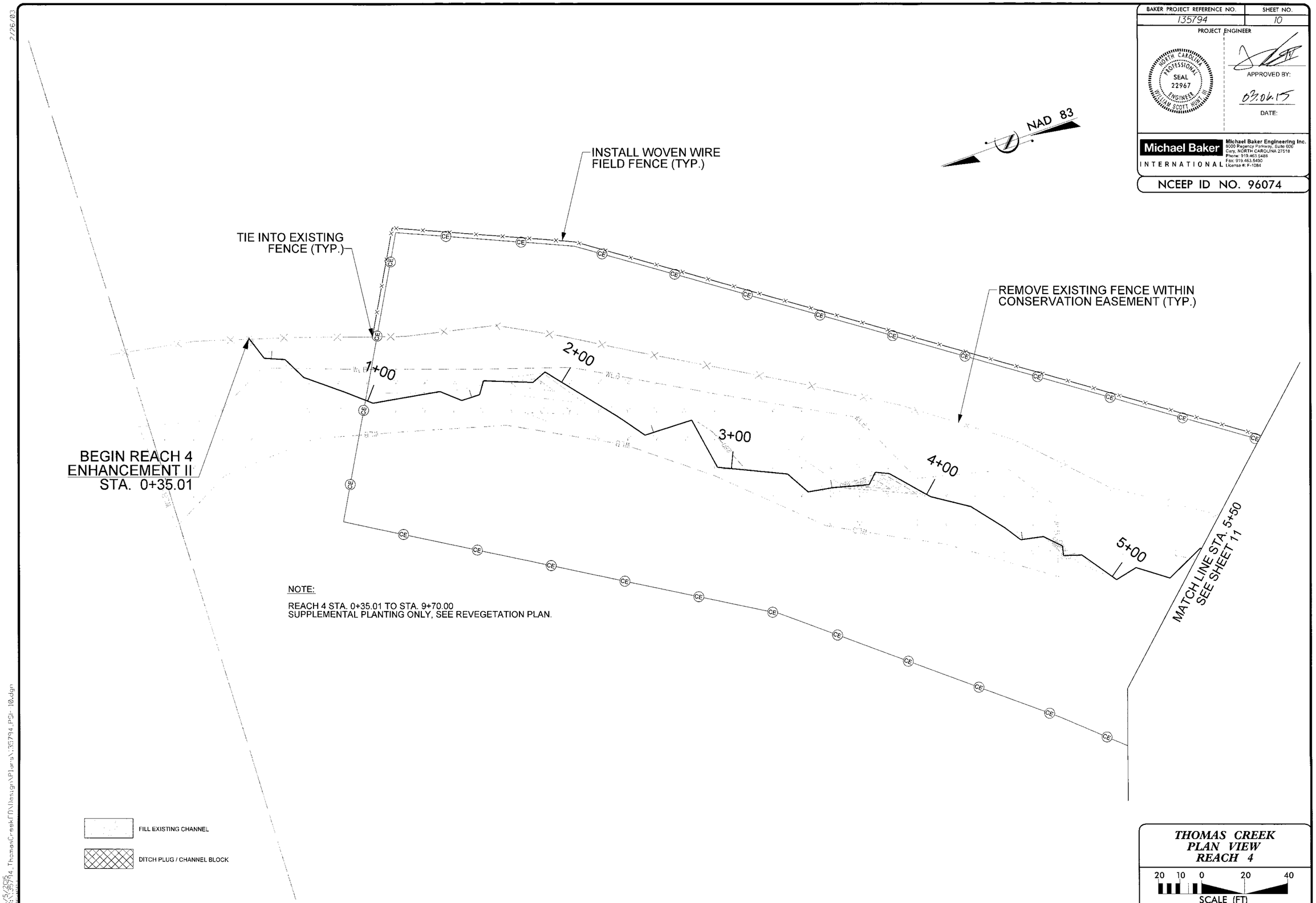
NCEEP ID NO. 96074



NOTE:

REACH 4 STA. 0+35.01 TO STA. 9+70.00
SUPPLEMENTAL PLANTING ONLY, SEE REVEGETATION PLAN.

THOMAS CREEK
PLAN VIEW
REACH 4

20 10 0 20 40
SCALE (FT)

2/26/03

3/5/2015
R:\135794_ThomasCreekFD\Design\Plans\135794_PSI-10.dgn

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	11

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HINE, III

APPROVED BY:

03.06.15

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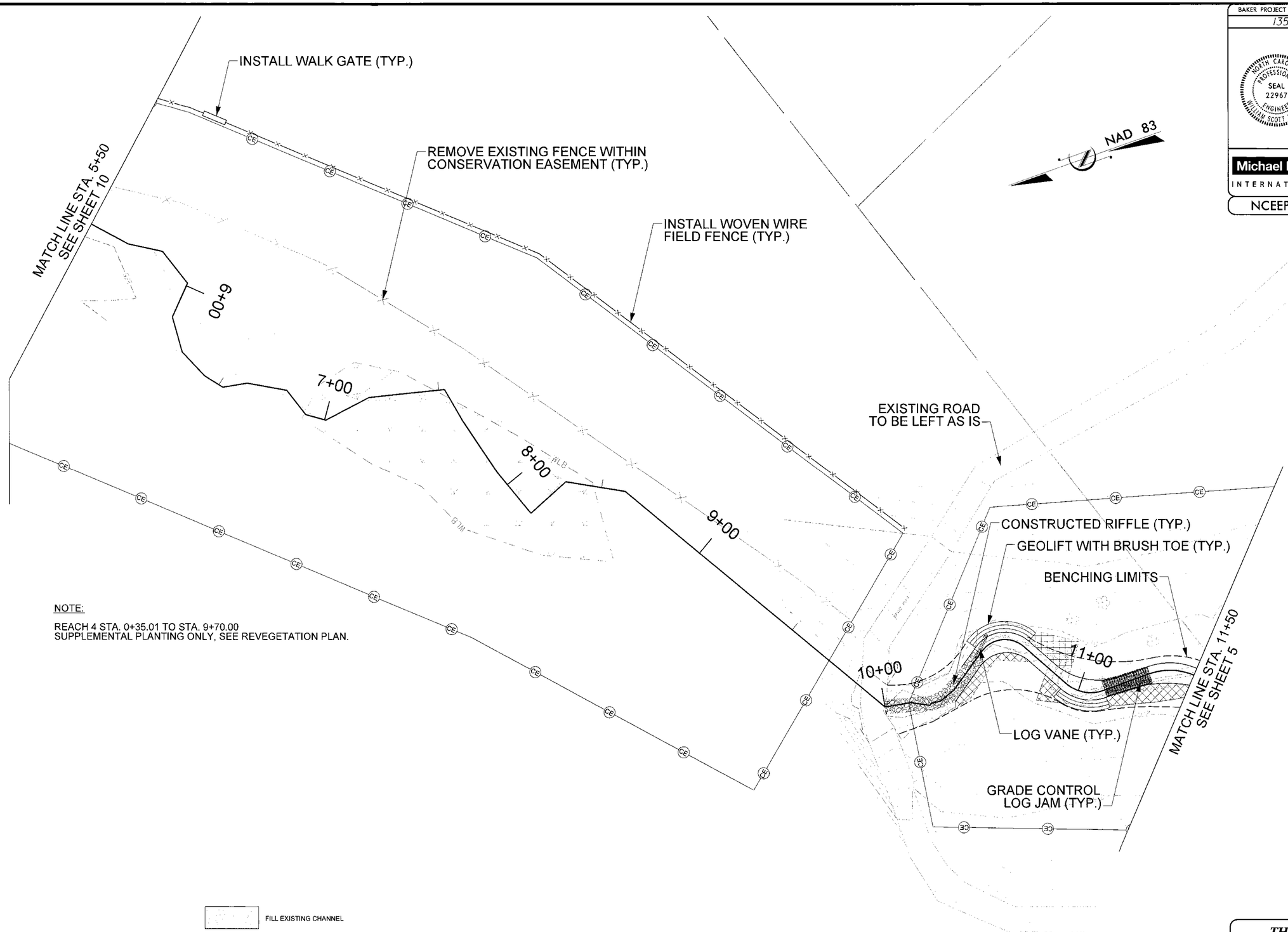
NCEEP ID NO. 96074



NOTE:

REACH 4 STA. 0+35.01 TO STA. 9+70.00
SUPPLEMENTAL PLANTING ONLY, SEE REVEGETATION PLAN.

FILL EXISTING CHANNEL

DITCH PLUG / CHANNEL BLOCK

THOMAS CREEK
PLAN VIEW
REACH 4

20 10 0 20 40
SCALE (FT)

2/26/03

3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	12

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT III

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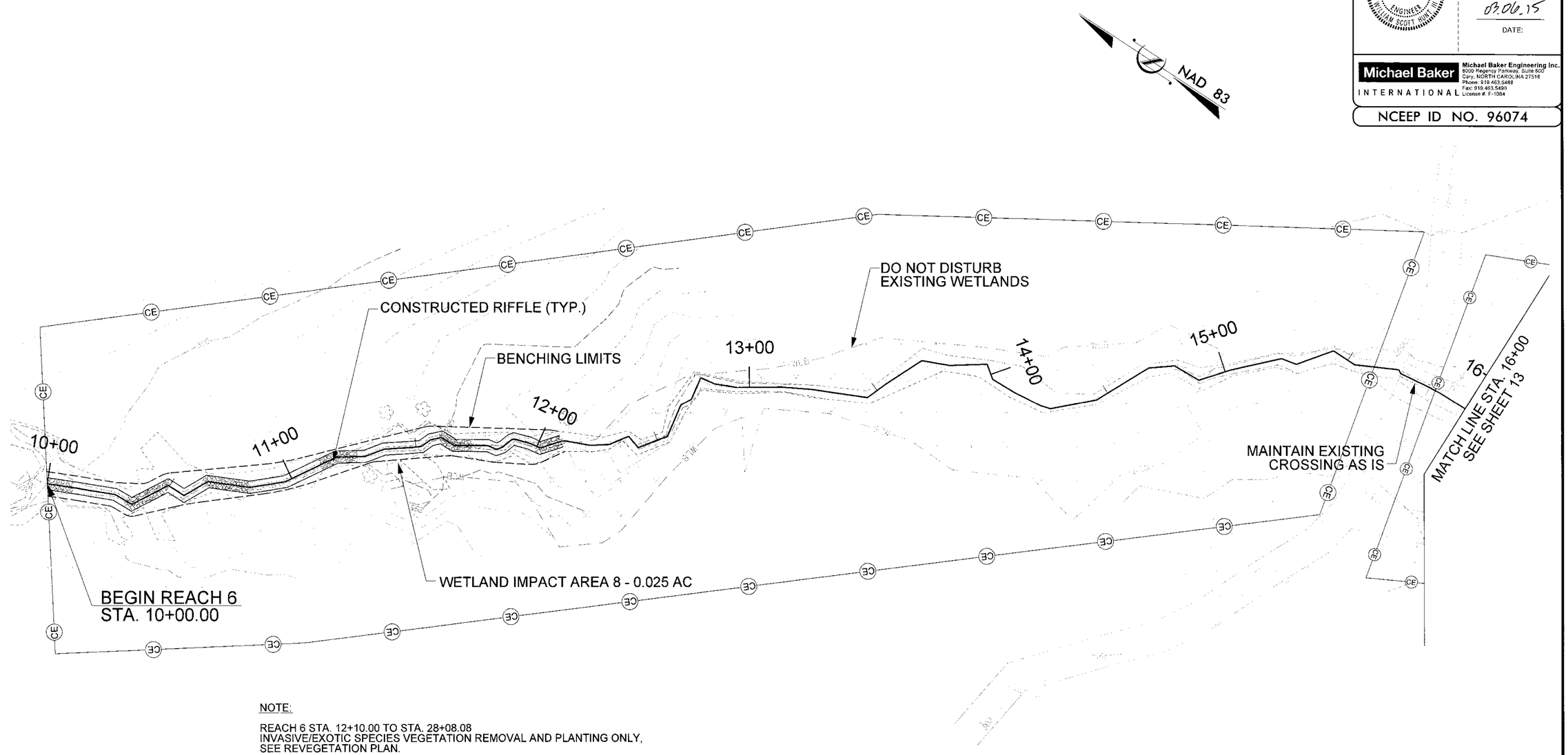
NCEEP ID NO. 96074



NOTE:

REACH 6 STA. 12+10.00 TO STA. 28+08.08
INVASIVE/EXOTIC SPECIES VEGETATION REMOVAL AND PLANTING ONLY,
SEE REVEGETATION PLAN.

FILL EXISTING CHANNEL

DITCH PLUG / CHANNEL BLOCK

THOMAS CREEK
PLAN VIEW
REACH 6

20 10 0 20 40
SCALE (FT)

2/26/03

3/5/2015
R:\135794_ThomasCreek\FDN\Design\Plans\135794_PSH-12.dgn

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	13

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT

APPROVED BY:

03.06.15

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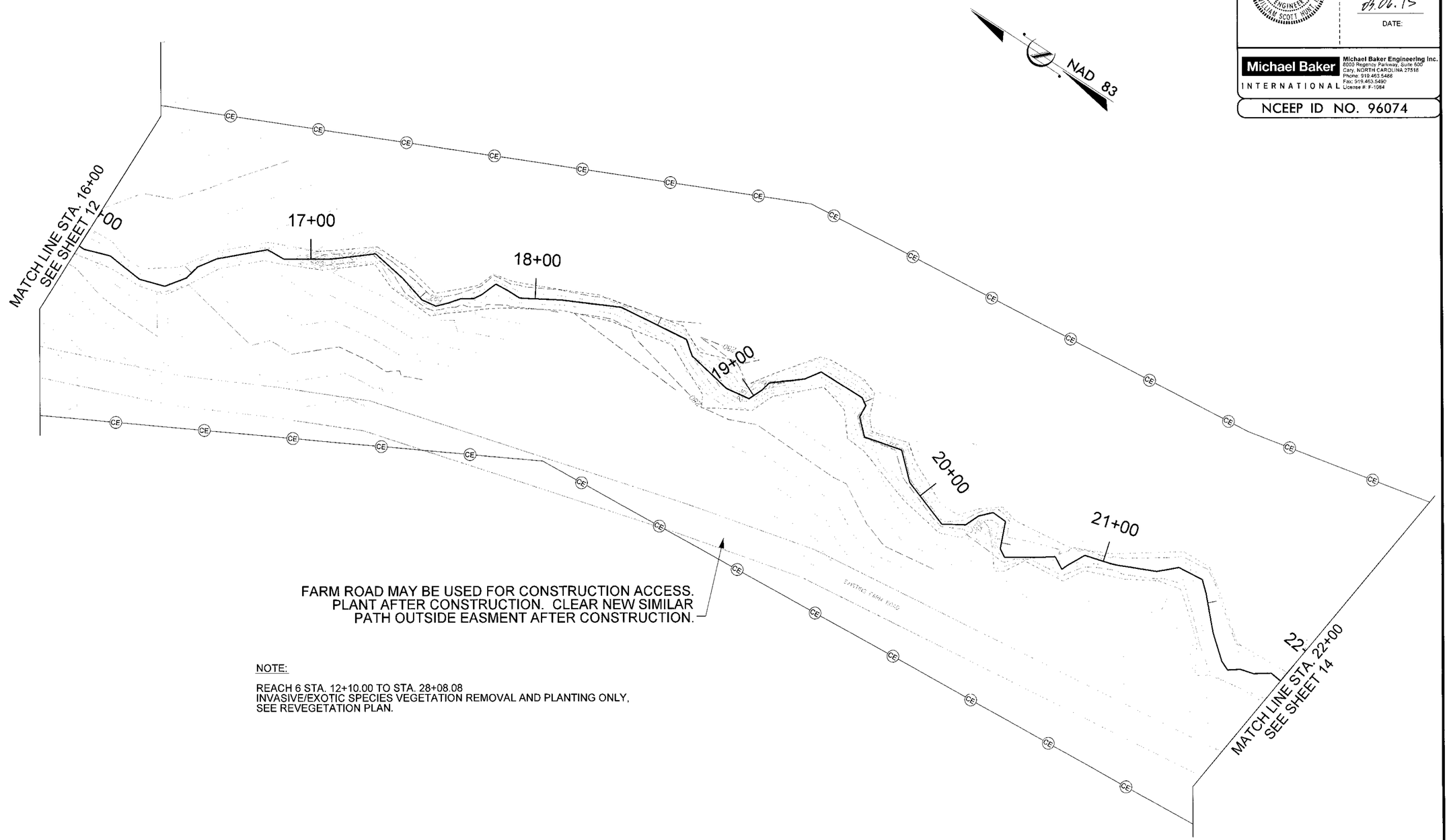
NCEEP ID NO. 96074



FARM ROAD MAY BE USED FOR CONSTRUCTION ACCESS. PLANT AFTER CONSTRUCTION. CLEAR NEW SIMILAR PATH OUTSIDE EASMENT AFTER CONSTRUCTION.

NOTE:

REACH 6 STA. 12+10.00 TO STA. 28+08.08
INVASIVE/EXOTIC SPECIES VEGETATION REMOVAL AND PLANTING ONLY,
SEE REVEGETATION PLAN.

FILL EXISTING CHANNEL

DITCH PLUG / CHANNEL BLOCK

THOMAS CREEK
PLAN VIEW
REACH 6

20 10 0 20 40
SCALE (FT)

2/26/03

3/5/2003
R:\135794 ThomasCreekFD\Design\Plans\135794_PSH_13.dgn

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	14

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER III

APPROVED BY:

03.06.15

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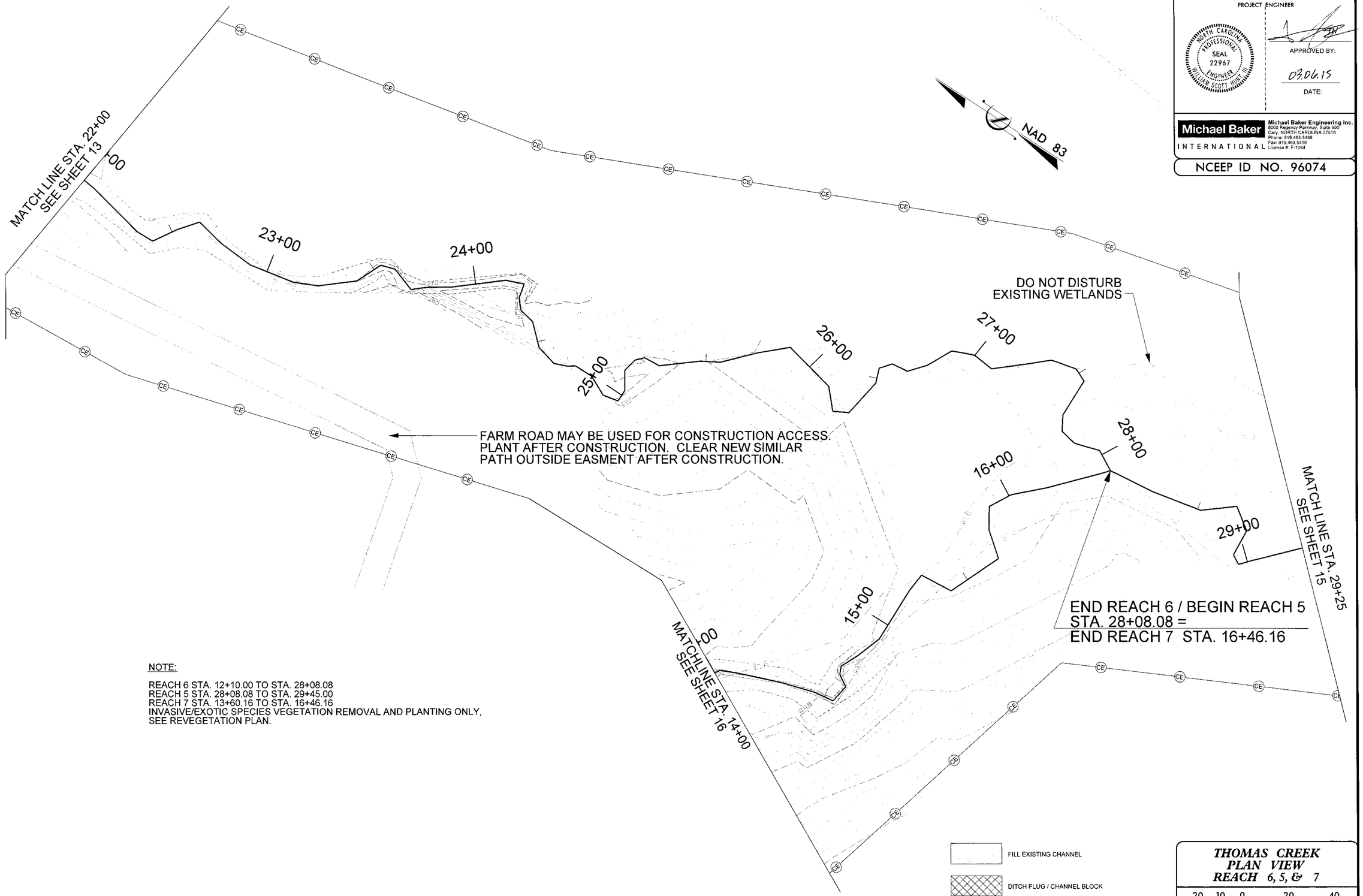
NCEEP ID NO. 96074



NOTE:

REACH 6 STA. 12+10.00 TO STA. 28+08.08
REACH 5 STA. 28+08.08 TO STA. 29+45.00
REACH 7 STA. 13+60.16 TO STA. 16+46.16
INVASIVE/EXOTIC SPECIES VEGETATION REMOVAL AND PLANTING ONLY,
SEE REVEGETATION PLAN.

THOMAS CREEK
PLAN VIEW
REACH 6, 5, & 7

20 10 0 20 40
SCALE (FT)

2/26/03

3/6/2015
R:\135794_ThomasCreekFD\Design\Plans\135794_PSH 14.dgn

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	15

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER

APPROVED BY:

09.06.15

DATE:

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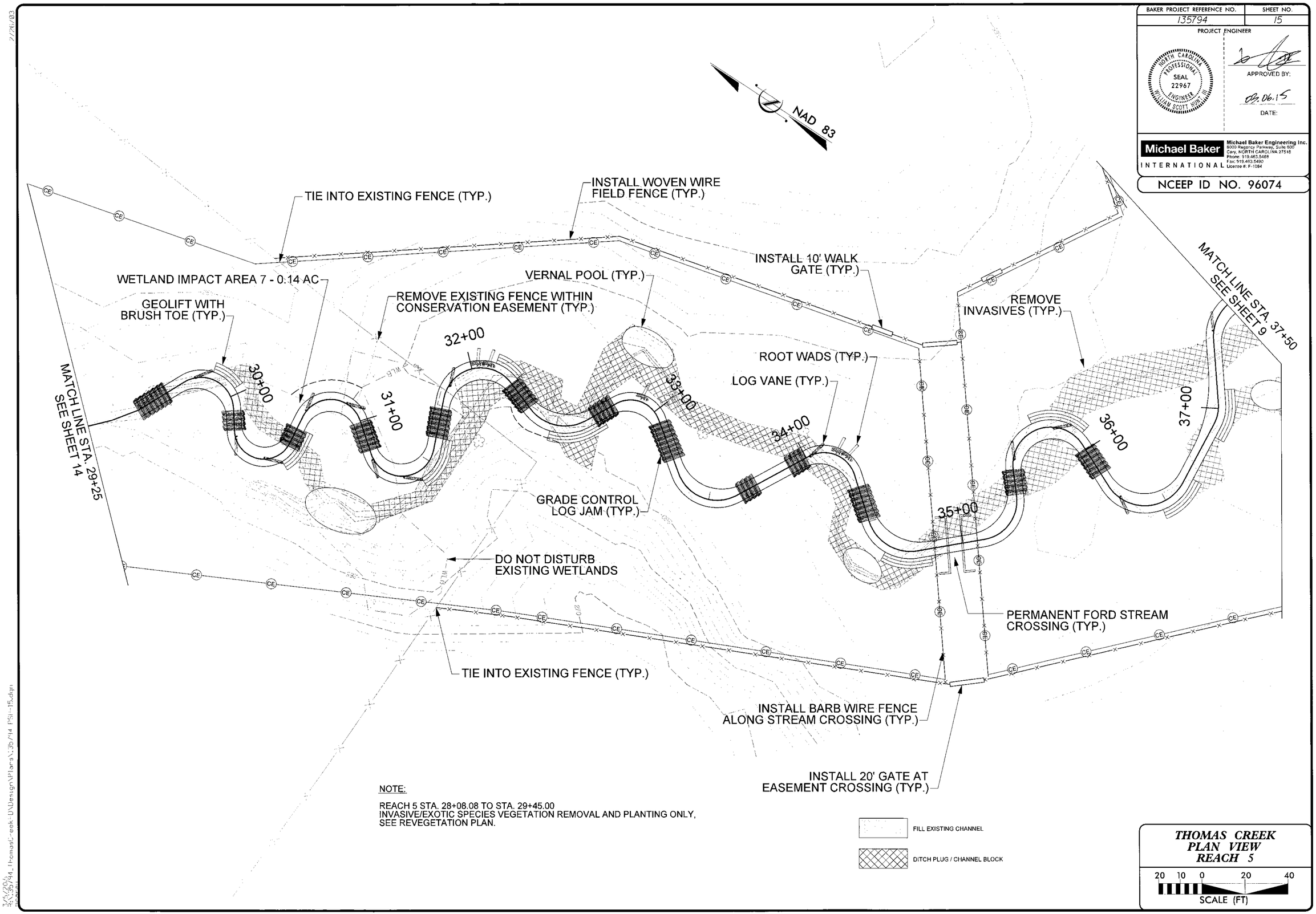
Cary, NORTH CAROLINA 27518
Phone: 919.463.5488
Fax: 919.463.5490
License #: F-1084

NCEEP ID NO. 96074



NOTE:

REACH 5 STA. 28+08.08 TO STA. 29+45.00
INVASIVE/EXOTIC SPECIES VEGETATION REMOVAL AND PLANTING ONLY,
SEE REVEGETATION PLAN.

THOMAS CREEK
PLAN VIEW
REACH 5

20 10 0 20 40
SCALE (FT)

2/26/03

3/5/2015
H:\135794_Thomas Creek - D\Design\Plans\135794 PSI-15.dgn

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	16

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER III

APPROVED BY:

03.06.15

DATE:

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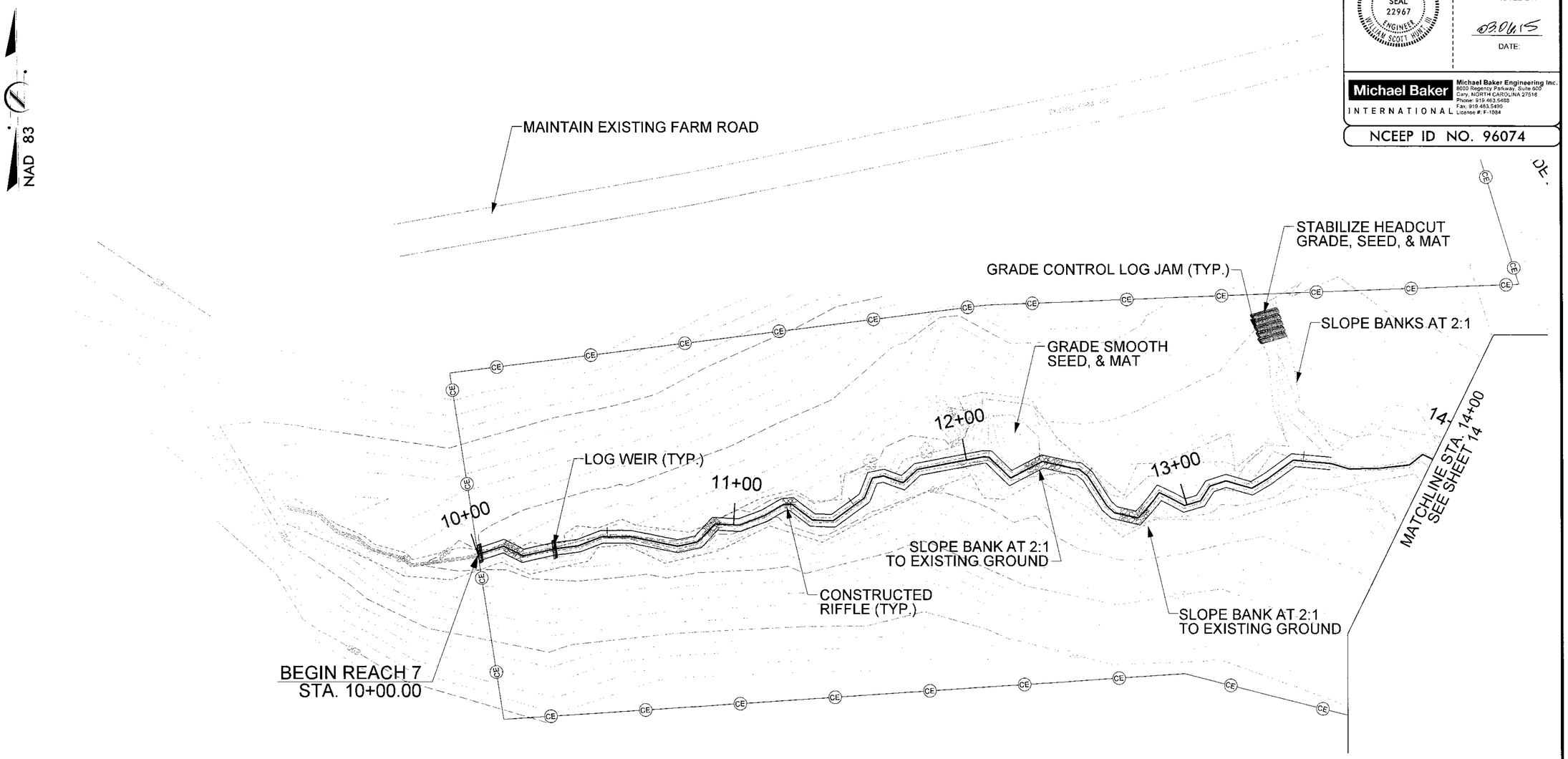
Cary, NORTH CAROLINA 27518
Phone: 919.463.5488
Fax: 919.463.5490
License #: F-1084

NCEEP ID NO. 96074



NOTE:

REACH 7 STA. 13+60.16 TO STA. 16+46.16
INVASIVE/EXOTIC SPECIES VEGETATION REMOVAL AND PLANTING ONLY, SEE REVEGETATION PLAN.

FILL EXISTING CHANNEL

DITCH PLUG / CHANNEL BLOCK

THOMAS CREEK
PLAN VIEW
REACH 7

20 10 0 20 40
SCALE (FT)

2/26/03

2/26/2013
R:\135794_ThomasCreek\0\Design\Plans\135794_PSH-E.dgn

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	17

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER III

APPROVED BY:

03.06.15

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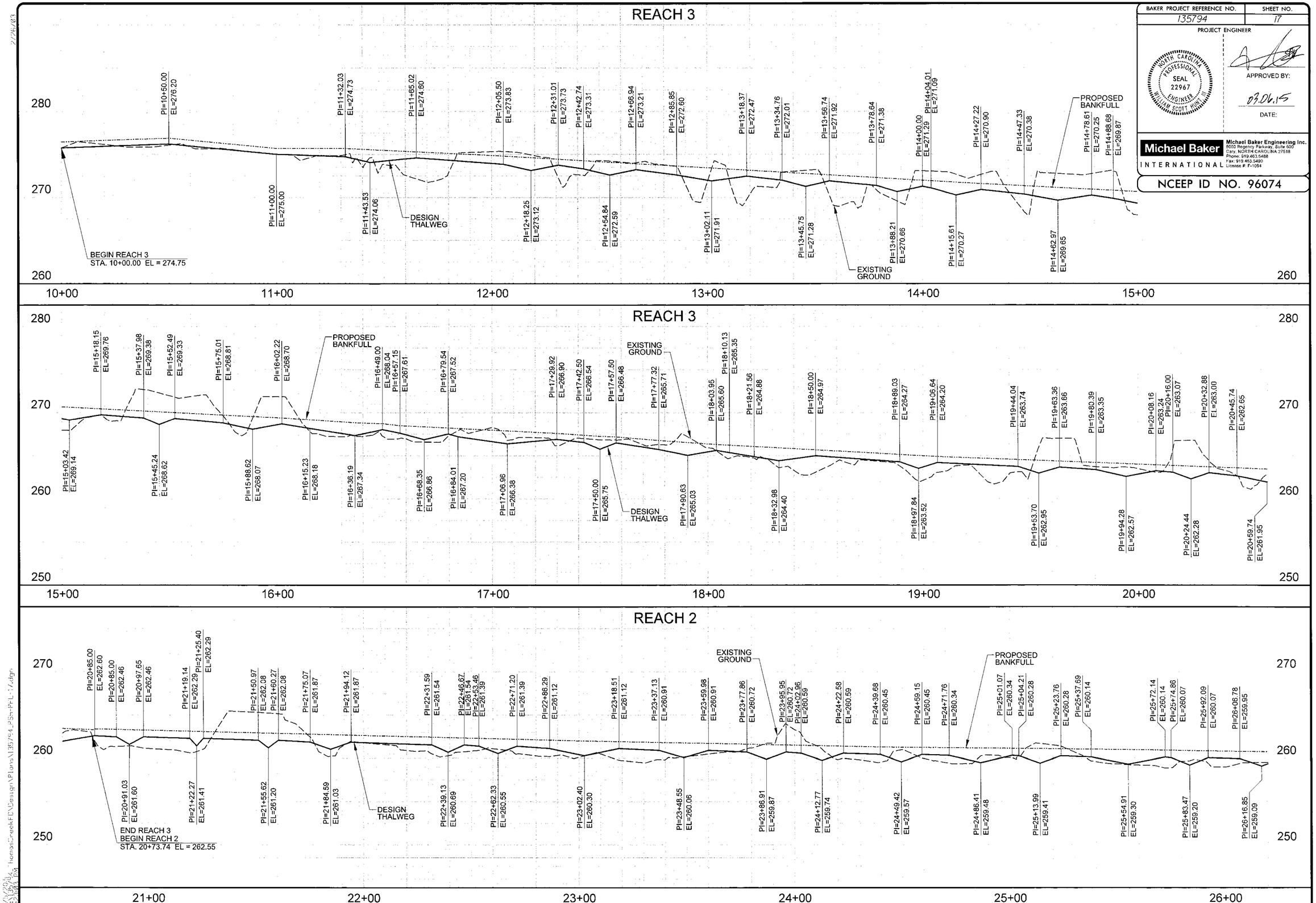
NCEEP ID NO. 96074



BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	18

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER III

APPROVED BY:

03.06.15

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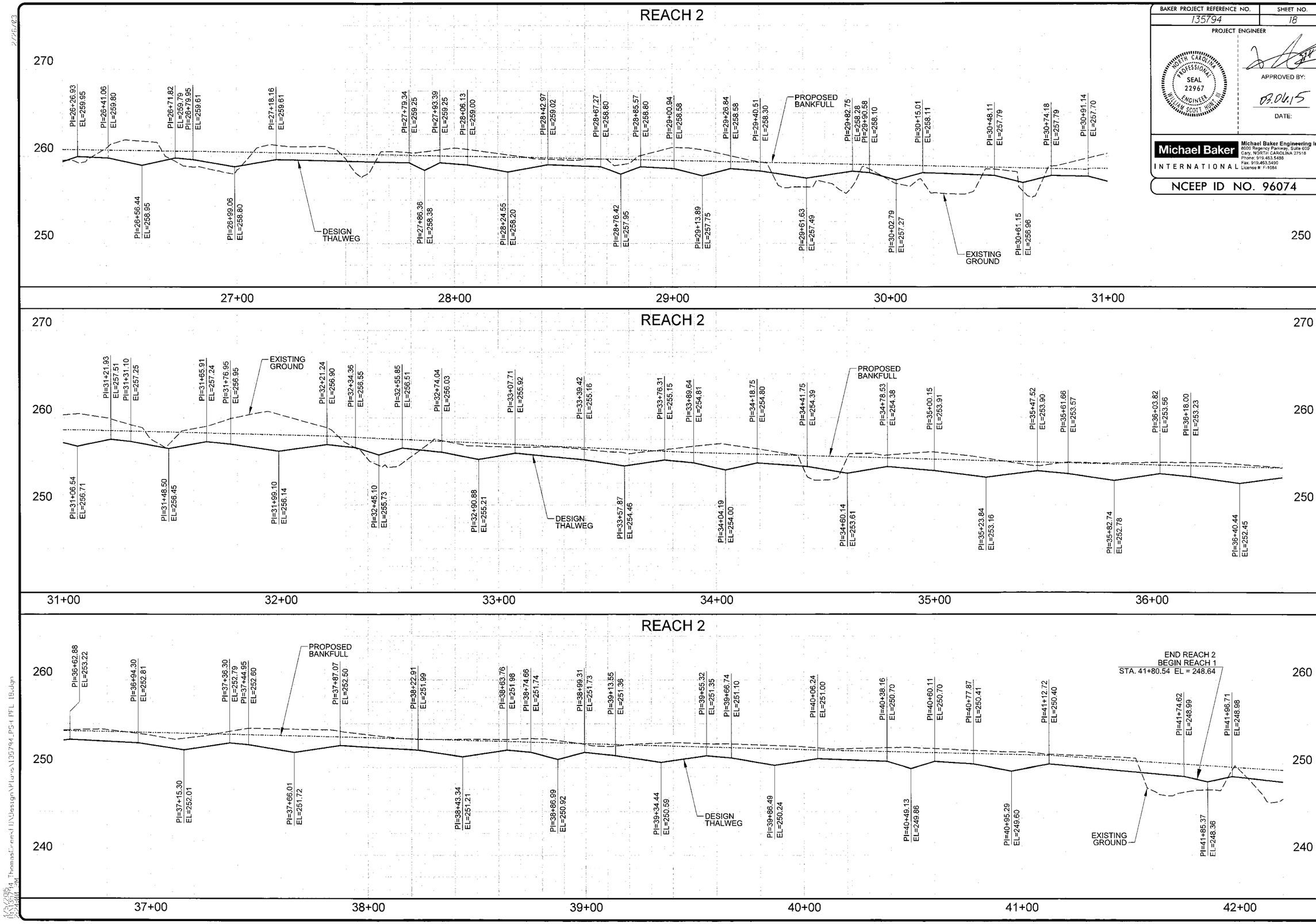
NCEEP ID NO. 96074



BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	19

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER III

APPROVED BY:

03.06.15

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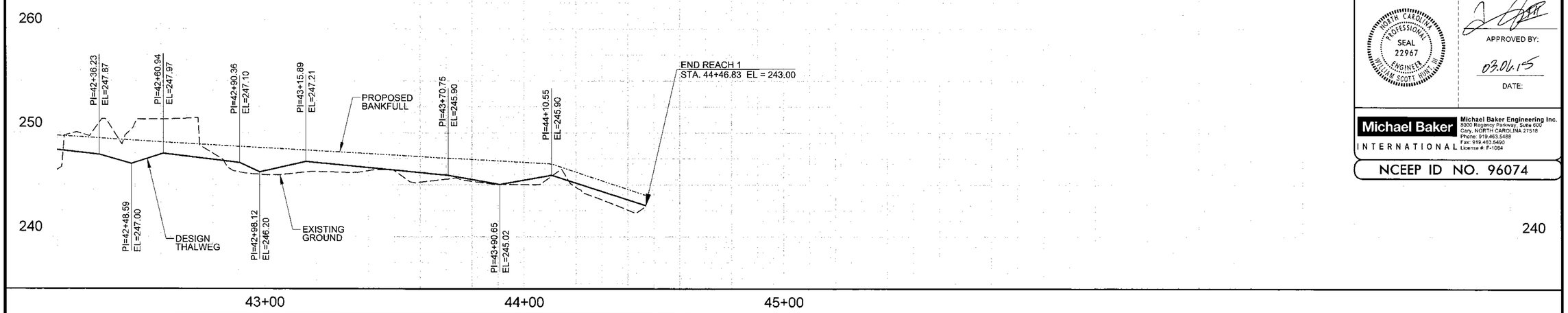
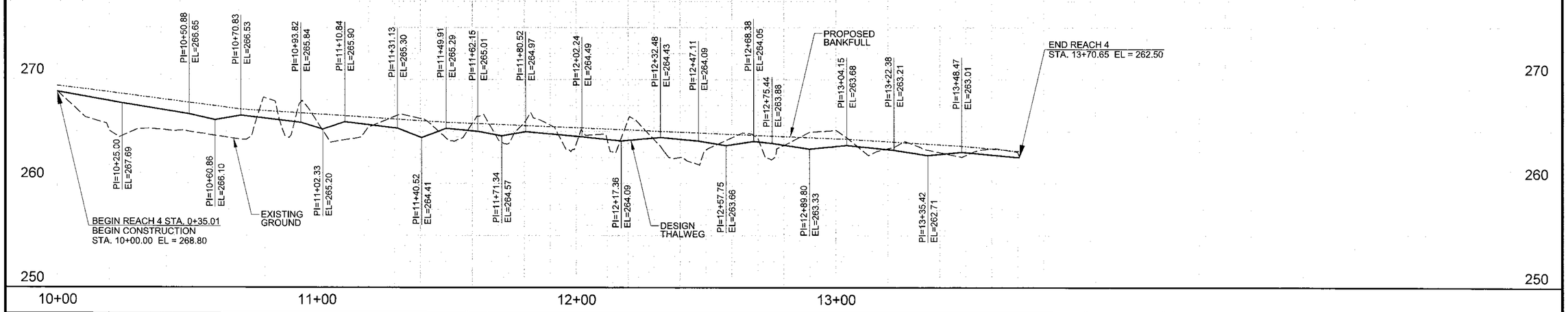
NCEEP ID NO. 96074

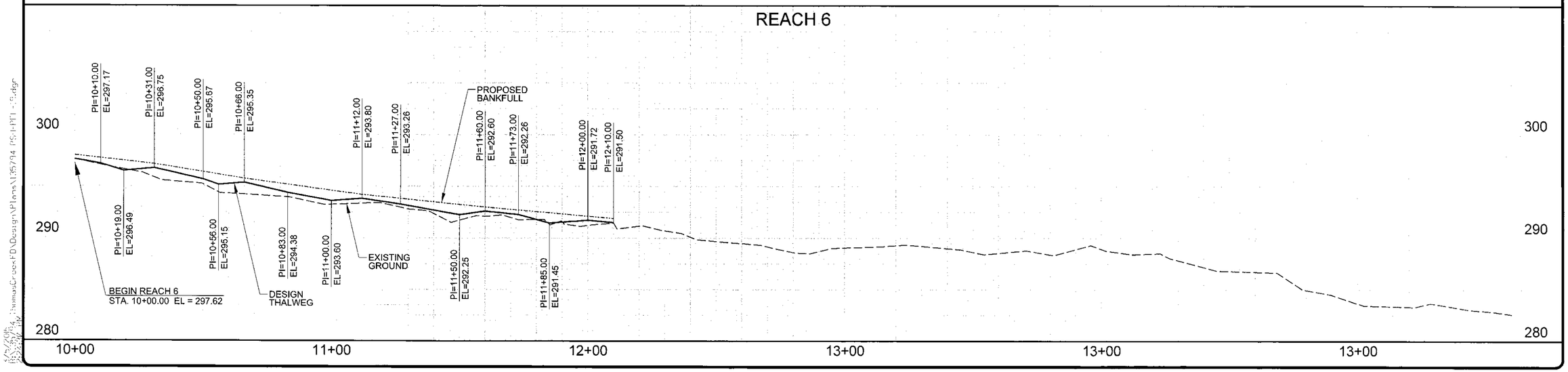
REACH 1



REACH 4



REACH 6



NCEEP ID NO. 96074

BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	20

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER

APPROVED BY:

08.06.15

DATE:

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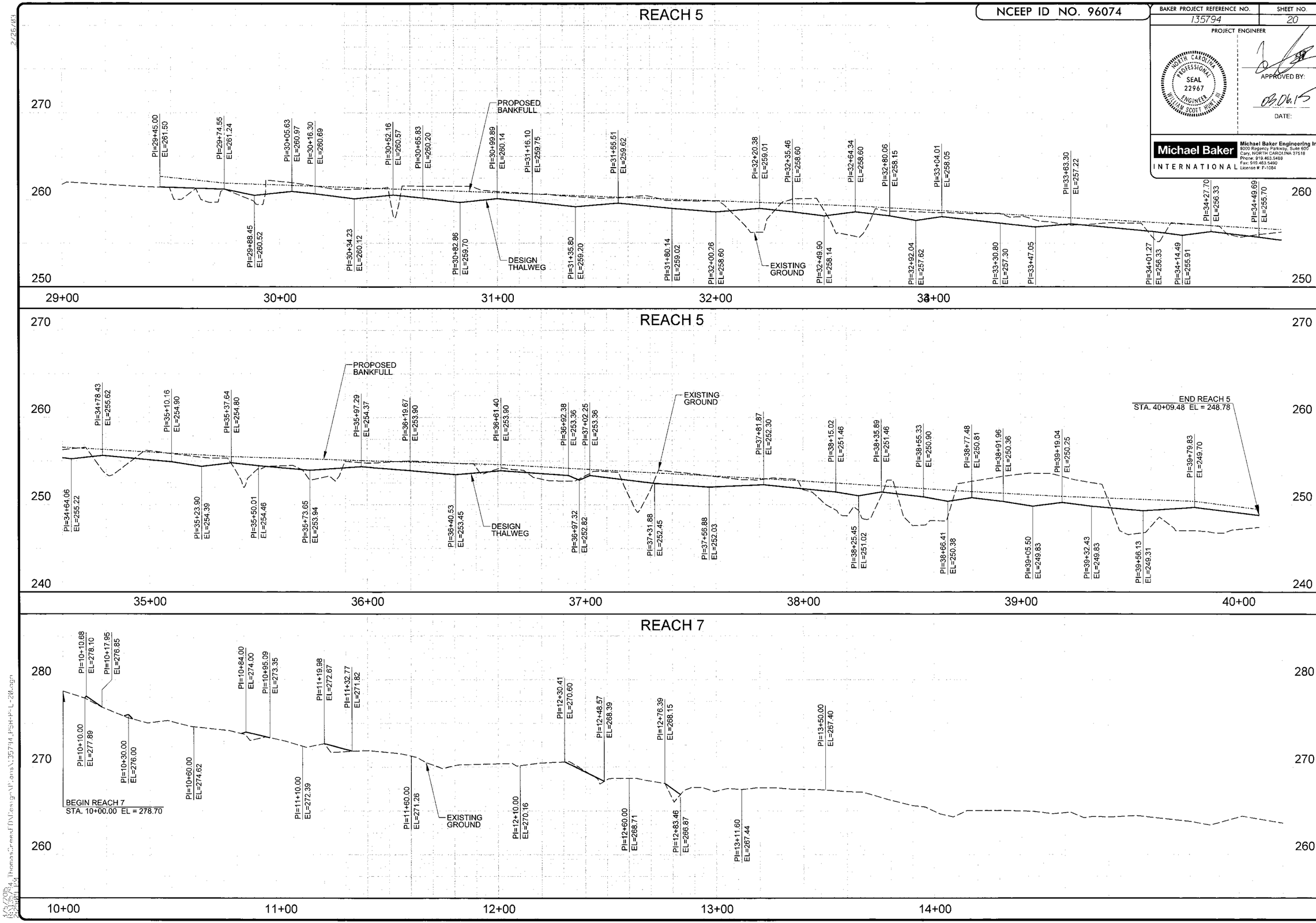
License #: F-1084



BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	21

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER III

APPROVED BY:

03.06.15

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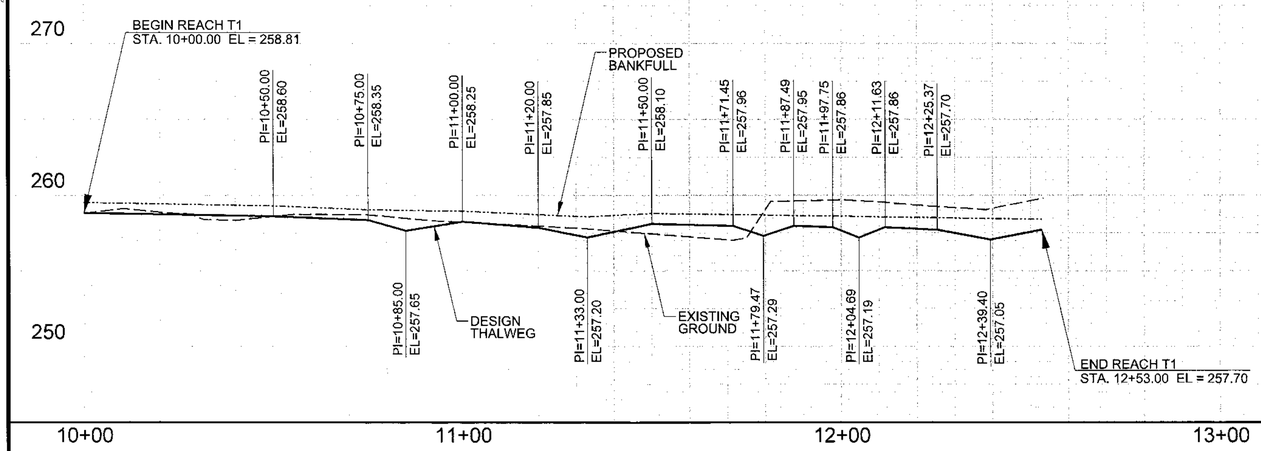
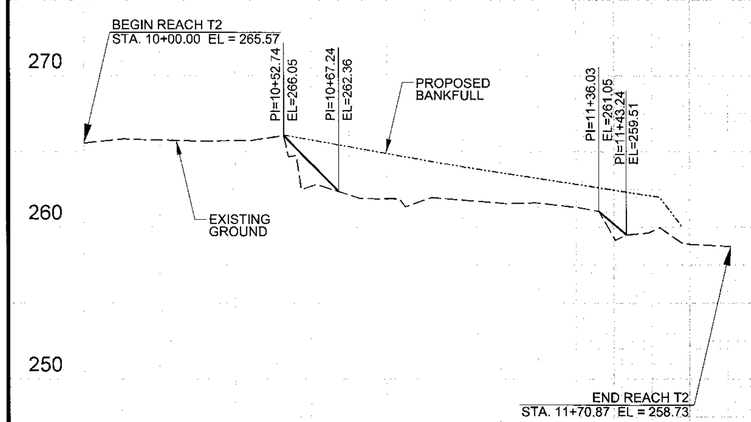
License #: F-1084

NCEEP ID NO. 96074

REACH T1



REACH T2



BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	22

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT

APPROVED BY:

03.06.15

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License #: F-1084

NCEEP ID NO. 96074

RIPARIAN BUFFER PLANTING = APPROX. 14.0 ACRES

NOTES:
1. SEE SHEET 1-A FOR VEGETATION SELECTION.
2. EXISTING WOODED AREAS SHALL NOT BE DISTURBED DURING CONSTRUCTION AND SHALL NOT BE PLANTED.

THOMAS CREEK REVEGEGATION PLAN

40 20 0 40 80
SCALE (FT)

2/26/03

3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	23

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT III

APPROVED BY:

03.06.15

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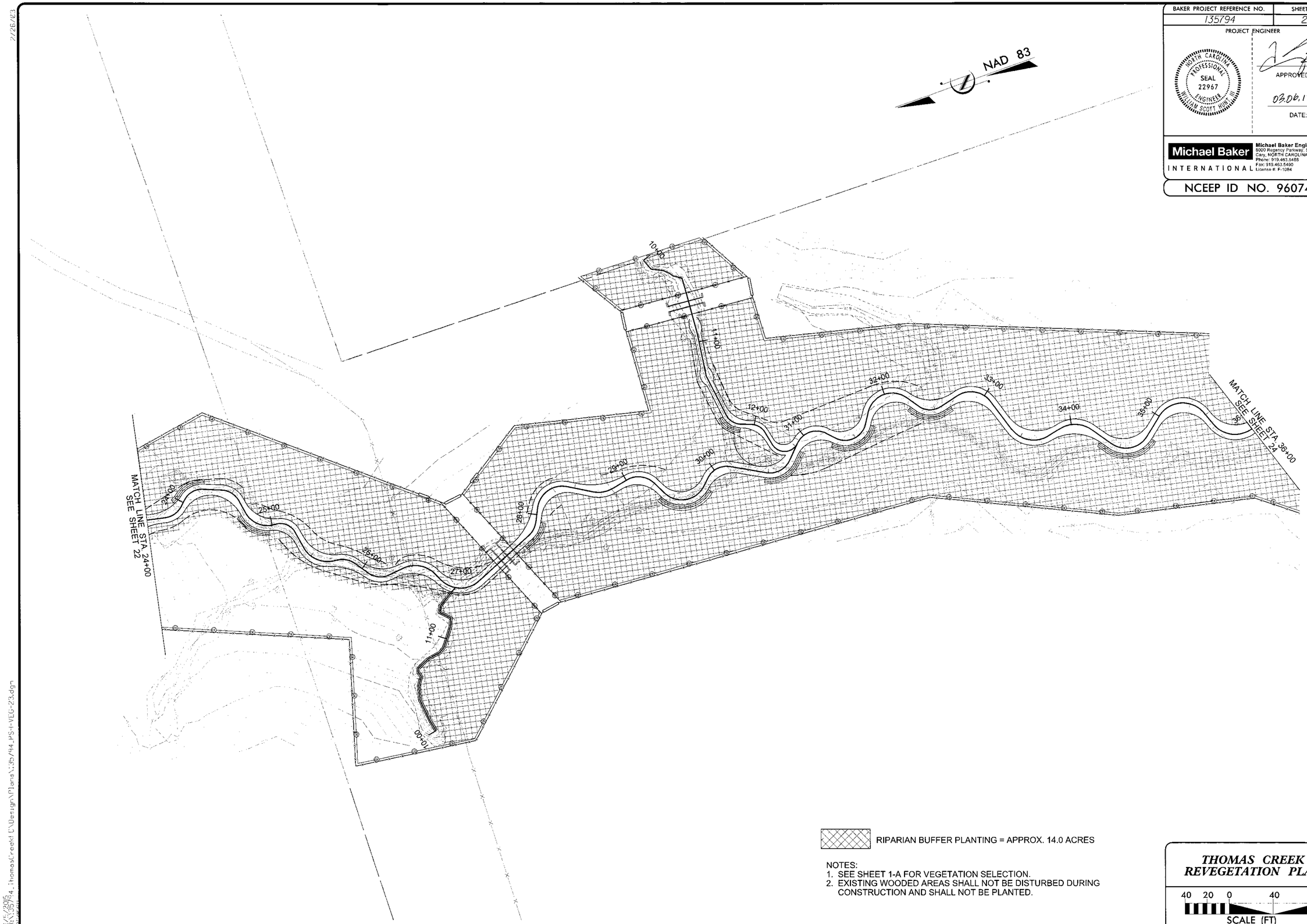
License #: F-1084

NCEEP ID NO. 96074



RIPARIAN BUFFER PLANTING = APPROX. 14.0 ACRES

NOTES:
1. SEE SHEET 1-A FOR VEGETATION SELECTION.
2. EXISTING WOODED AREAS SHALL NOT BE DISTURBED DURING CONSTRUCTION AND SHALL NOT BE PLANTED.

THOMAS CREEK REVEGETATION PLAN

40 20 0 40 80

SCALE (FT)

2/26/03

5/5/2005
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	24

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER III

APPROVED BY:

03.06.15

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Phone: 919.463.5488
Fax: 919.463.5490
License #: F-1084

NCEEP ID NO. 96074

RIPARIAN BUFFER PLANTING = APPROX. 14.0 ACRES

NOTES:
1. SEE SHEET 1-A FOR VEGETATION SELECTION.
2. EXISTING WOODED AREAS SHALL NOT BE DISTURBED DURING CONSTRUCTION AND SHALL NOT BE PLANTED.

THOMAS CREEK REVEGETATION PLAN

40 20 0 40 80
SCALE (FT)

2/26/03

3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	25

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

APPROVED BY:

03.06.15

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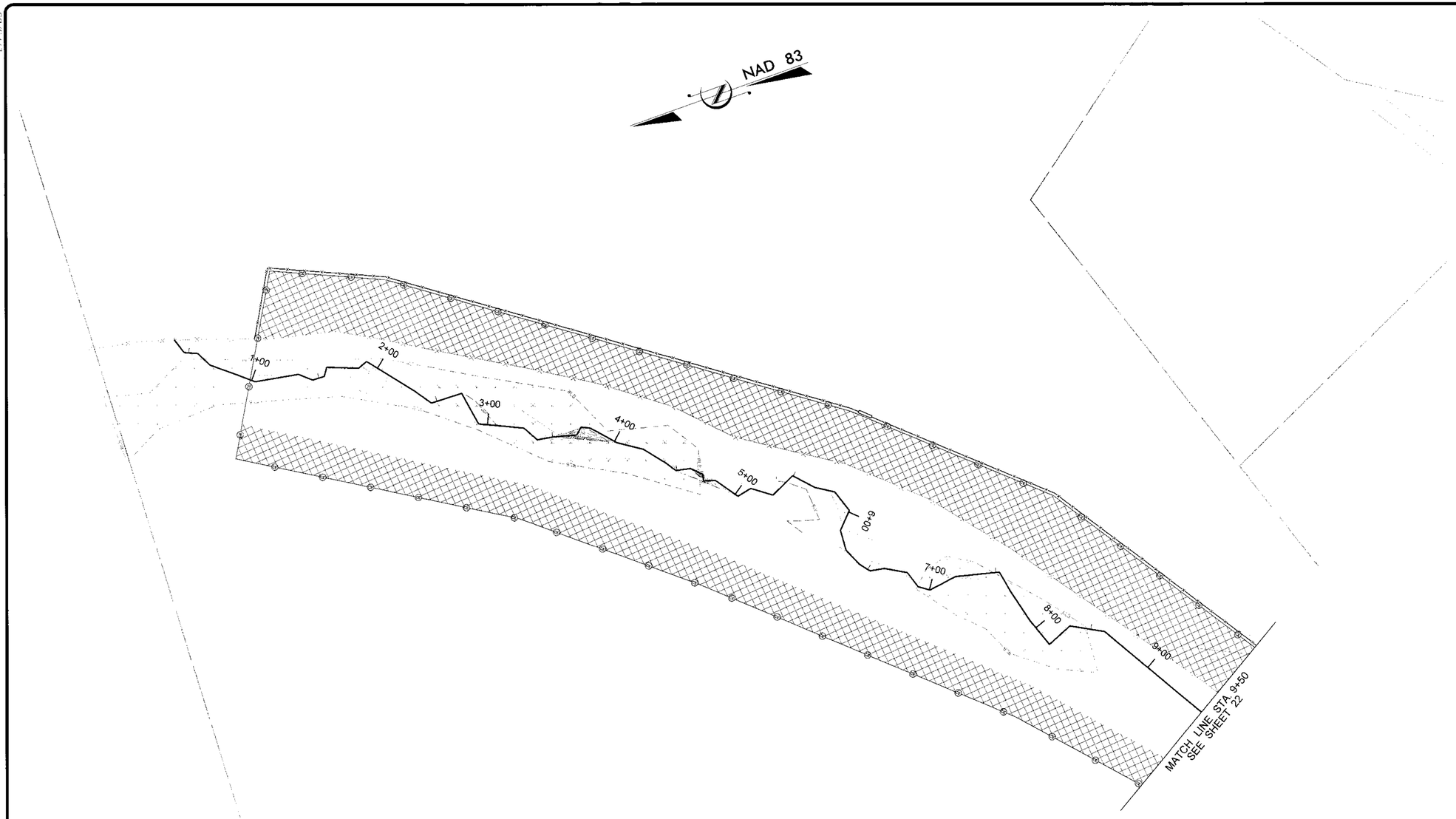
License #: F-1084

NCEEP ID NO. 96074



RIPARIAN BUFFER PLANTING = APPROX. 14.0 ACRES

NOTES:
1. SEE SHEET 1-A FOR VEGETATION SELECTION.
2. EXISTING WOODED AREAS SHALL NOT BE DISTURBED DURING CONSTRUCTION AND SHALL NOT BE PLANTED.
3. NO INVASIVES REMOVAL IN THIS AREA.

THOMAS CREEK REVEGETATION PLAN

40 20 0 40 80
SCALE (FT)

2/25/03
3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	26

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT III

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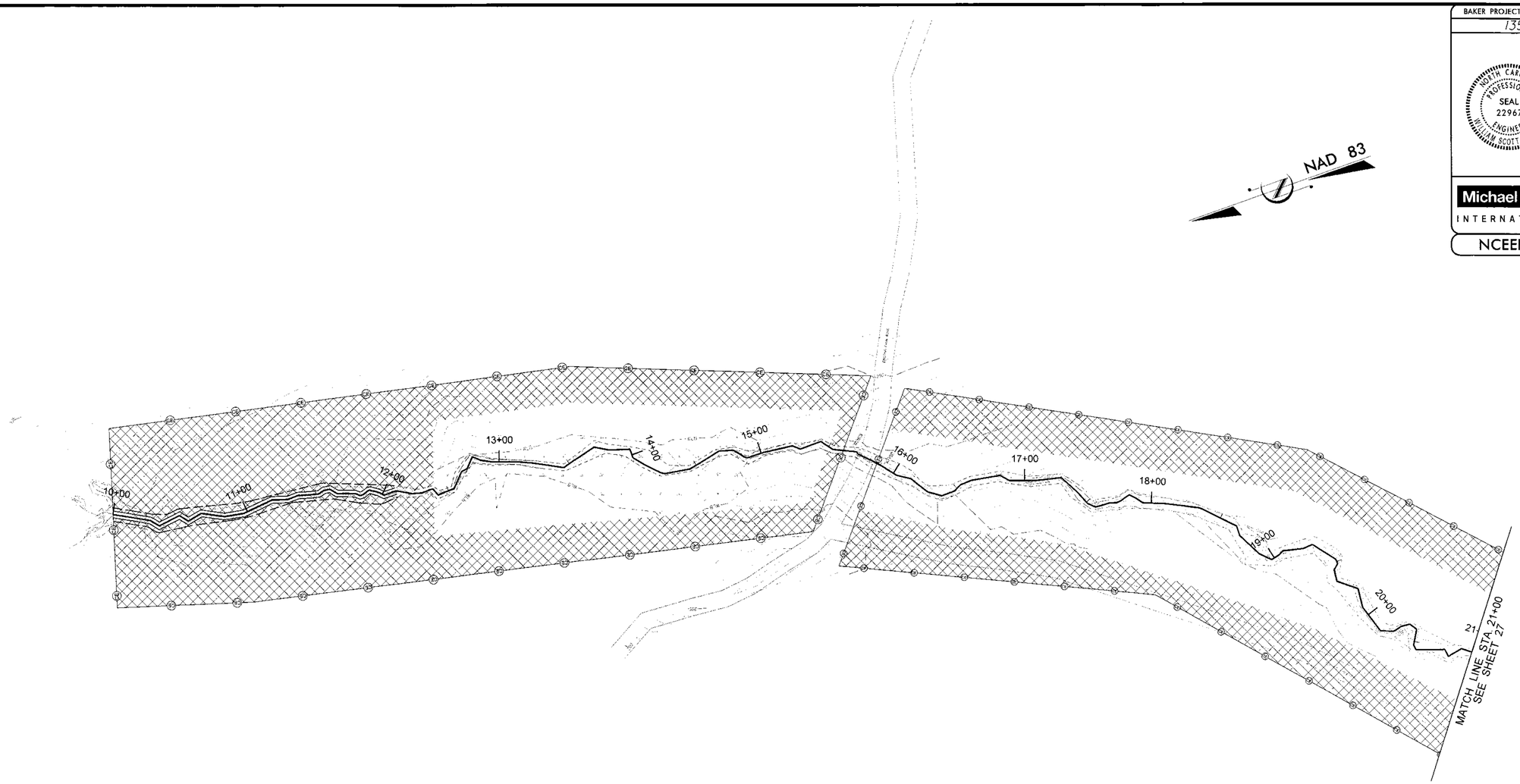
License #: F-1084

NCEEP ID NO. 96074



RIPARIAN BUFFER PLANTING = APPROX. 14.0 ACRES

NOTES:
1. SEE SHEET 1-A FOR VEGETATION SELECTION.
2. EXISTING WOODED AREAS SHALL NOT BE DISTURBED DURING CONSTRUCTION AND SHALL NOT BE PLANTED.

THOMAS CREEK REVEGETATION PLAN

40 20 0 40 80
SCALE (FT)

2/26/03

3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	27

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNTER III

APPROVED BY:

03.06.15

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License #: F-1084

NCEEP ID NO. 96074

RIPARIAN BUFFER PLANTING = APPROX. 14.0 ACRES

NOTES:
1. SEE SHEET 1-A FOR VEGETATION SELECTION.
2. EXISTING WOODED AREAS SHALL NOT BE DISTURBED DURING CONSTRUCTION AND SHALL NOT BE PLANTED.

THOMAS CREEK REVEGETATION PLAN

40 20 0 40 80

SCALE (FT)

2/26/03

3/5/2015
R:\135794 ThomasCreek\D\Design\Plans\135794_PSH-V1-27.dgn

STATE	BAKER PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
NC	135794	1	9
NCEEP ID No. 96074			

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

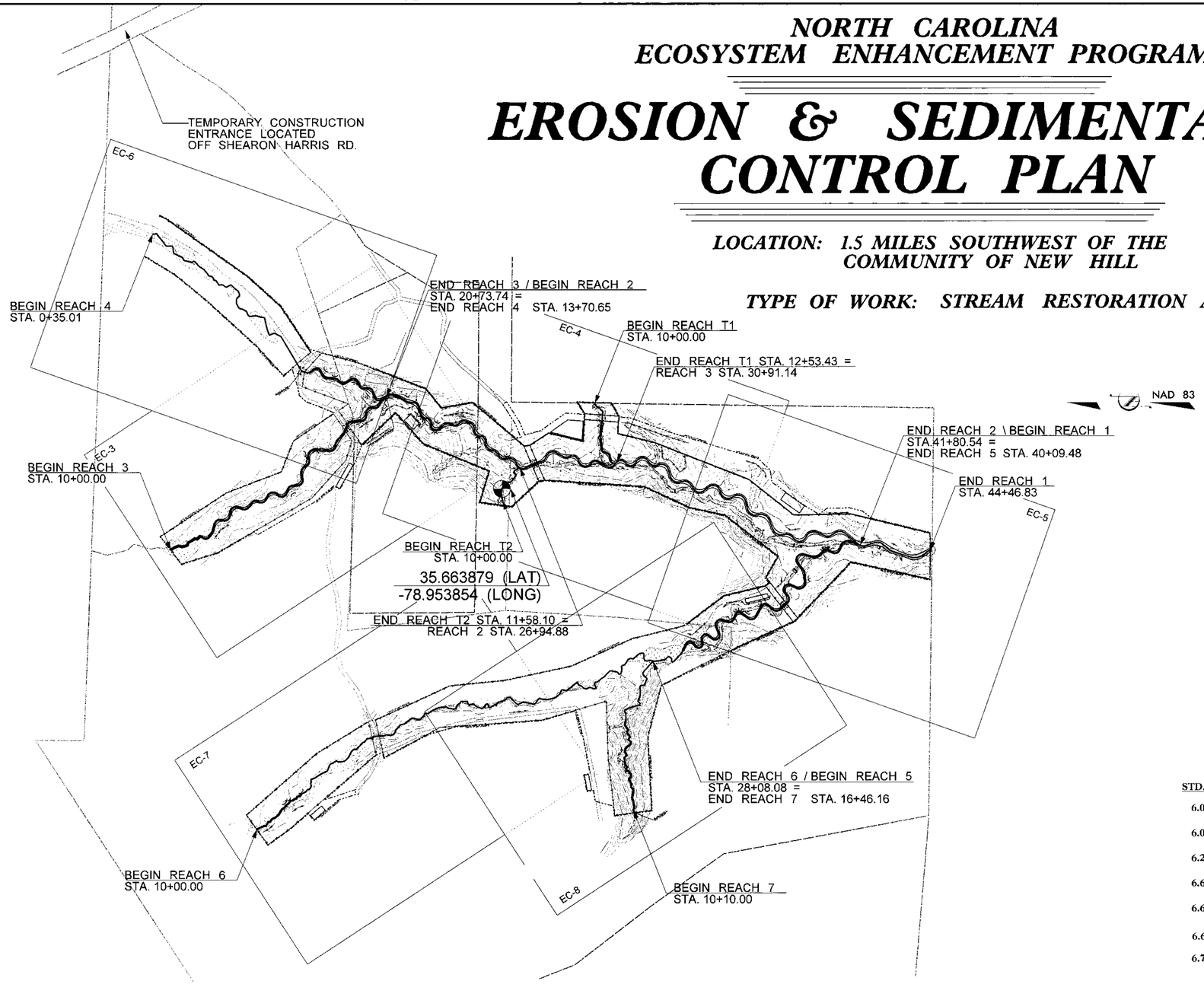
EROSION & SEDIMENTATION CONTROL PLAN

LOCATION: 1.5 MILES SOUTHWEST OF THE COMMUNITY OF NEW HILL

TYPE OF WORK: STREAM RESTORATION AND ENHANCEMENT

THOMAS CREEK

PROJECT: 135794



STD. NO.	DESCRIPTION	SYMBOL
6.05	TREE PROTECTION	
6.06	TEMPORARY GRAVEL CONSTRUCTION ENTRANCE/EXIT	
6.24	RIPARIAN AREA SEEDING	
6.60	TEMPORARY SEDIMENT TRAP	
6.62	TEMPORARY SILT FENCE	
6.63	TEMPORARY ROCK DAM	
6.70	TEMPORARY STREAM CROSSING	

GRAPHIC SCALES

40 20 0 40 80

PLANS

THIS PROJECT CONTAINS EROSION & SEDIMENTATION CONTROL PLANS FOR ALL PHASES OF CONSTRUCTION.

TOTAL DISTURBED AREA = 26.4 Acres

PROJECT STANDARDS

THE FOLLOWING STANDARDS AS THEY APPEAR IN THE "NC EROSION & SEDIMENTATION CONTROL PLANNING AND DESIGN MANUAL" AND ARE APPLICABLE TO THIS PROJECT AND BY REFERENCE HEREBY ARE CONSIDERED PART OF THE PLANS.

6.05	TREE PROTECTION
6.06	TEMPORARY GRAVEL CONSTRUCTION ACCESS
6.24	RIPARIAN AREA SEEDING
6.60	TEMPORARY SEDIMENT TRAP
6.62	SILT FENCE
6.63	TEMPORARY ROCK DAM
6.70	TEMPORARY STREAM CROSSING

PREPARED IN THE OFFICE OF:

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LETTING DATE:

WILLIAM SCOTT HUNT, III, PE
PROJECT ENGINEER

CHRIS ROESSLER
PROJECT MANAGER

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

SIGNATURE: P.E.

PROJECT REFERENCE NO.	SHEET NO.
135794	EC-2

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT III

APPROVED BY:

03.04.15

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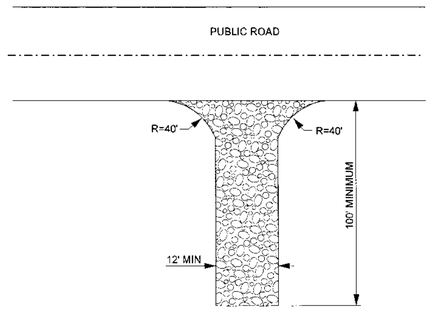
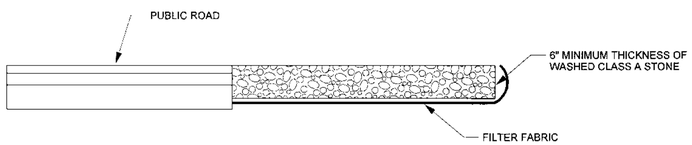
NCEEP ID No. 96074

TEMPORARY GRAVEL CONSTRUCTION ENTRANCE /EXIT

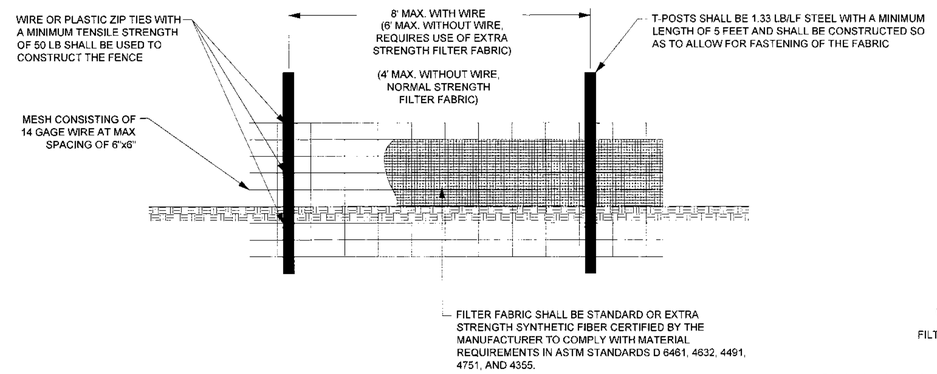


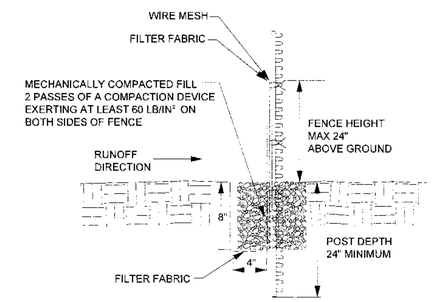


NOTES:

SPECIFICATION NO. 5.06 - CONSTRUCTION ACCESS "N.C. EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL MARCH 2009"

TEMPORARY SILT FENCE

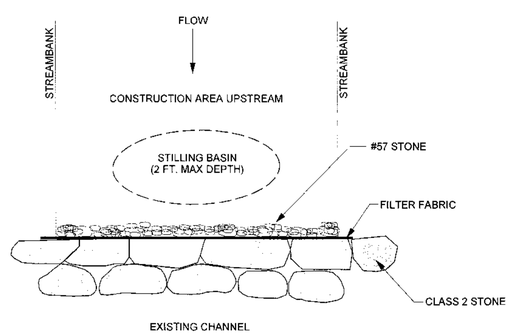




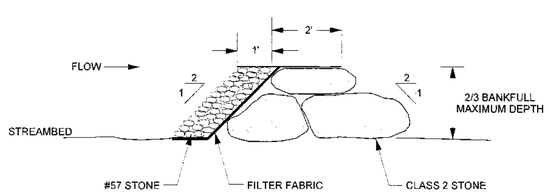
NOTES:

1. AVOID JOINTS, UNAVOIDABLE JOINTS MUST HAVE 4' OF CLOTH OVERLAP AND SHOULD TIE INTO THE NEXT ADJACENT POST.
2. PLACE ON CONTOUR EXCEPT ENDS WHICH SHOULD BE 1' ABOVE GRADE TO PREVENT CUT AROUND.
3. WRAP APPROX. 6" OF FABRIC AROUND END POSTS AND SECURE WITH TIES.
4. REMOVE ONCE AREA IS STABLE.
5. CONTRACTOR SHALL SIDE CAST SPOIL MATERIAL FROM TRENCHING FOR SILT FENCE ONTO HIGH GROUND OR ONTO THE PERMITTED WETLAND IMPACT SIDE TO AVOID UNPERMITTED WETLAND IMPACTS.

TEMPORARY ROCK DAM



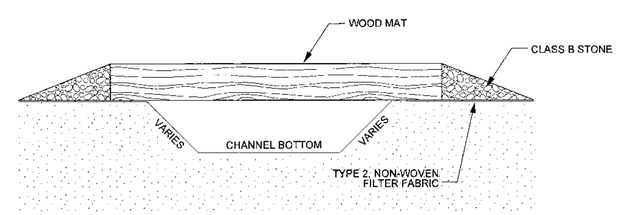
PLAN VIEW



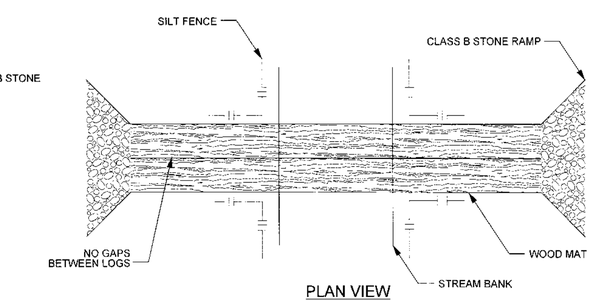
CROSS SECTION

NOTES:
CLEAN OUT STILLING BASIN OF TRAPPED SEDIMENT PRIOR TO REMOVAL.

TEMPORARY STREAM CROSSING - WOOD MAT



CROSS SECTION



PLAN VIEW

NOTES:

1. CONSTRUCT STREAM CROSSING WHEN FLOW IS LOW.
2. HAVE ALL NECESSARY MATERIALS AND EQUIPMENT ON-SITE BEFORE WORK BEGINS.
3. MINIMIZE CLEARING AND EXCAVATION OF STREAMBANKS. DO NOT EXCAVATE CHANNEL BOTTOM.
4. LINE STREAMBANK AND ACCESS RAMP AREA WITH NON-WOVEN FILTER FABRIC.
5. INSTALL STREAM CROSSING AT RIGHT ANGLE TO THE FLOW.
6. TRANSPLANT SOD FROM ORIGINAL STREAMBANK ONTO SIDE SLOPES FOR LATER USE.
7. MAINTAIN CROSSING SO THAT RUNOFF IN THE CONSTRUCTION ROAD DOES NOT ENTER EXISTING CHANNEL BY INSTALLING SILT FENCE ON ALL FOUR CORNERS ADJACENT TO THE STREAM. SEE SILT FENCE DETAIL.
8. STABILIZE AN ACCESS RAMP OF CLASS B STONE TO THE EDGE OF THE MUD MAT.
9. THE WOOD MAT SHALL BE OF SUFFICIENT SIZE AND WIDTH TO SUPPORT THE LARGEST VEHICLE CROSSING THE CHANNEL.
10. CONTRACTOR SHALL DETERMINE AN APPROPRIATE RAMP ANGLE ACCORDING TO EQUIPMENT UTILIZED. RECOMMENDED AT A 5:1 SLOPE.

PROJECT REFERENCE NO.	SHEET NO.
135794	EC-2A

PROJECT ENGINEER

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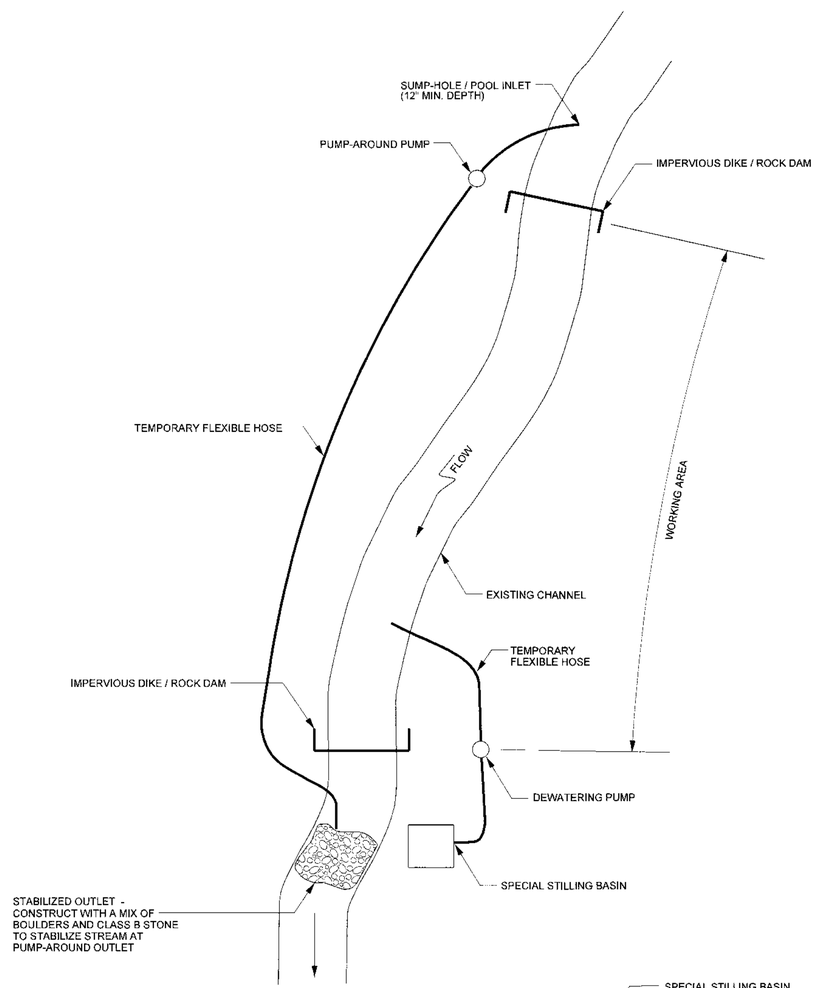
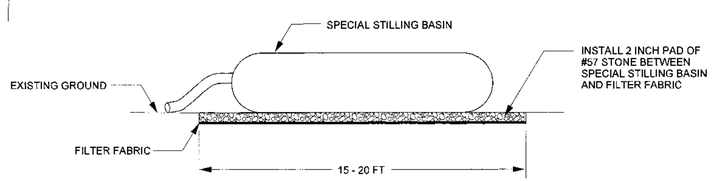
TYPICAL PUMP-AROUND OPERATION





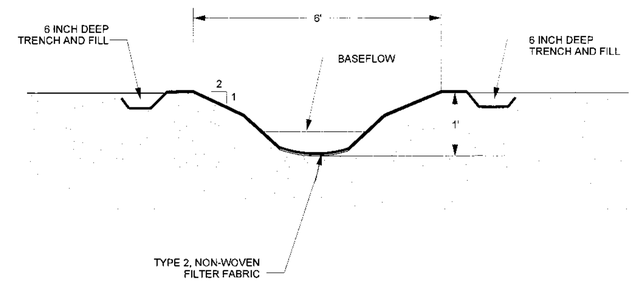
SEQUENCE OF CONSTRUCTION FOR TYPICAL PUMP-AROUND

1. INSTALL STABILIZED OUTLET AT THE DOWNSTREAM END OF THE DESIGNATED PROJECT WORKING AREA.
2. THE CONTRACTOR WILL INSTALL THE PUMP-AROUND PUMP AND THE TEMPORARY FLEXIBLE HOSE THAT WILL CONVEY THE BASE FLOW FROM UPSTREAM OF THE WORK SITE TO THE SPECIAL STILLING BASIN OR STABILIZED OUTLET.
3. INSTALL UPSTREAM IMPERVIOUS DIKE AND BEGIN PUMPING OPERATIONS FOR STREAM DIVERSION.
4. INSTALL THE DOWNSTREAM IMPERVIOUS DIKE AND PUMPING APPARATUS IF NEEDED TO DEWATER THE ENTRAPPED AREA. THE PUMP AND HOSE FOR THIS PURPOSE SHALL BE OF SUFFICIENT SIZE TO DEWATER THE WORK AREA. THIS WATER WILL FLOW INTO A SPECIAL STILLING BASIN.
5. THE CONTRACTOR WILL PERFORM STREAM RESTORATION WORK IN ACCORDANCE WITH THE PLAN AND FOLLOWING THE GENERAL CONSTRUCTION SEQUENCE.
6. THE CONTRACTOR WILL EXCAVATE ANY ACCUMULATED SILT AND DEWATER BEFORE REMOVAL OF THE IMPERVIOUS DIKE. REMOVE IMPERVIOUS DIKES, PUMPS, AND TEMPORARY FLEXIBLE HOSE STARTING WITH THE DOWNSTREAM DIKE FIRST.
7. THE CONTRACTOR WILL COMPLETE ALL GRADING AND STABILIZATION IN ONE DAY WITHIN THE PUMP-AROUND AREA BETWEEN THE IMPERVIOUS DIKES.
8. ONCE THE WORKING AREA IS COMPLETED, REMOVE THE SPECIAL STILLING BASIN AND STABILIZED OUTLET AND STABILIZE DISTURBED AREAS WITH SEED AND MULCH.

NOTES:

1. EXCAVATION SHALL BE PERFORMED IN ONLY DRY SECTIONS OF CHANNEL.
2. IMPERVIOUS DIKES SHOULD BE USED TO ISOLATE WORK AREAS FROM STREAM FLOW.
3. THE CONTRACTOR SHALL NOT DISTURB MORE AREA THAN CAN BE STABILIZED IN ONE WORKING DAY.
4. THE PUMP-AROUND PUMP SHOULD ADEQUATELY CONVEY BASEFLOW CONDITIONS OF THE STREAM.

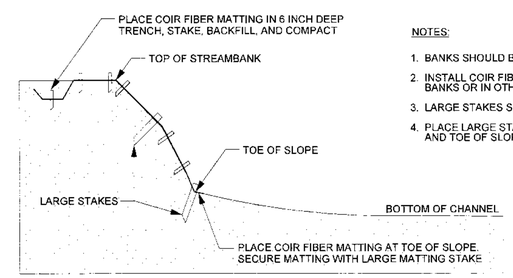
TEMPORARY DIVERSION CHANNEL



NOTES:

1. DIMENSIONS OF DIVERSION CHANNEL MAY BE ALTERED TO FIT SLOPE CONDITIONS.
2. ALIGN SEAMS OF FILTER FABRIC TO OVERLAP IN THE DIRECTION OF FLOW.
3. MAX SIDE SLOPE 2:1.
4. SEE TECHNICAL SPECIFICATIONS FOR FILTER FABRIC MATERIAL.

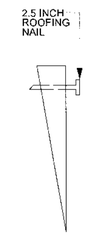
EROSION CONTROL MATTING



CROSS SECTION VIEW

NOTES:

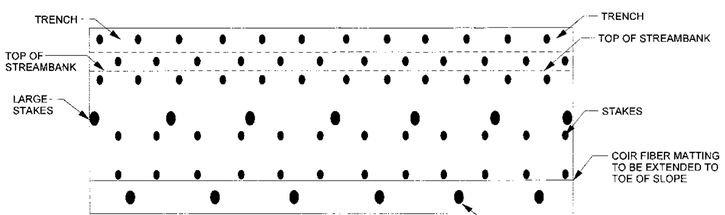
1. BANKS SHOULD BE SEEDED PRIOR TO PLACEMENT OF MATTING.
2. INSTALL COIR FIBER MATTING PER SPECIFICATIONS ALONG STREAM BANKS OR IN OTHERS LOCATIONS SPECIFIED BY ENGINEER.
3. LARGE STAKES SHOULD NOT BE SPACED FURTHER THAN 36" APART.
4. PLACE LARGE STAKES ALONG ALL SEAMS, IN THE CENTER OF BANK, AND TOE OF SLOPE.



TYPICAL LARGE MATTING STAKE

THE WOOD STAKE SHALL HAVE THE FOLLOWING DIMENSIONS:

LEG LENGTH	17.00 IN (43.18 CM) (TAPERED TO POINT)
WIDTH	1.5 IN (3.81 CM)
THICKNESS	1.5 IN (3.81 CM)



PLAN VIEW

TYPICAL SMALL MATTING STAKE

THE WOOD STAKE SHALL HAVE THE FOLLOWING DIMENSIONS:

LEG LENGTH	11.00 IN (27.94 CM)
HEAD WIDTH	1.25 IN (3.18 CM)
HEAD THICKNESS	0.40 IN (1.02 CM)
LEG WIDTH	0.60 IN (1.52 CM) (TAPERED TO POINT)
LEG THICKNESS	0.40 IN (1.02 CM)
TOTAL LENGTH	12.00 IN (30.48 CM)

2/26/03
3/5/03
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	EC-3

PROJECT ENGINEER

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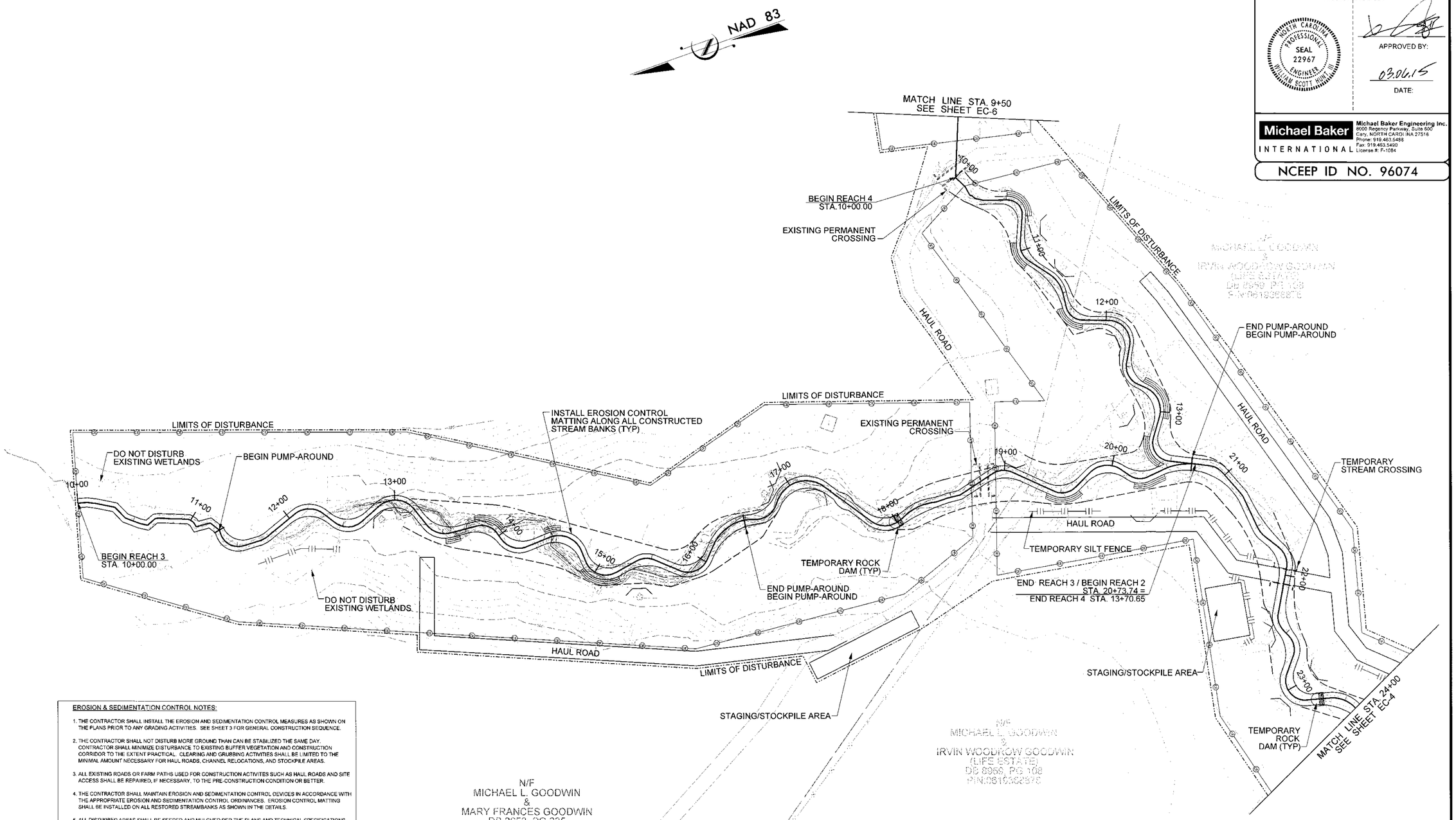

EROSION & SEDIMENTATION CONTROL NOTES:

1. THE CONTRACTOR SHALL INSTALL THE EROSION AND SEDIMENTATION CONTROL MEASURES AS SHOWN ON THE PLANS PRIOR TO ANY GRADING ACTIVITIES. SEE SHEET 3 FOR GENERAL CONSTRUCTION SEQUENCE.
2. THE CONTRACTOR SHALL NOT DISTURB MORE GROUND THAN CAN BE STABILIZED THE SAME DAY. CONTRACTOR SHALL MINIMIZE DISTURBANCE TO EXISTING BUFFER VEGETATION AND CONSTRUCTION CORRIDOR TO THE EXTENT PRACTICAL. CLEARING AND GRUBBING ACTIVITIES SHALL BE LIMITED TO THE MINIMAL AMOUNT NECESSARY FOR HAUL ROADS, CHANNEL RELOCATIONS, AND STOCKPILE AREAS.
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5. ALL DISTURBED AREAS SHALL BE SEEDED AND MULCHED PER THE PLANS AND TECHNICAL SPECIFICATIONS. TEMPORARY SEEDING SHALL BE PLACED ON ALL DISTURBED AREAS WITHIN 24 HOURS AND ALL SLOPES STEEPER THAN 3:1 SHALL BE STABILIZED WITH GROUND COVER AS SOON AS PRACTICABLE WITHIN 7 CALENDAR DAYS. ALL OTHER DISTURBED AREAS AND SLOPES FLATTER THAN 3:1 SHALL BE STABILIZED WITHIN 14 CALENDAR DAYS FROM THE LAST LAND-DISTURBING ACTIVITY. PERMANENT SEEDING SHALL BE PLACED ON ALL DISTURBED AREAS WITHIN 15 WORKING DAYS OR 90 CALENDAR DAYS (WHICHEVER COMES FIRST) FOLLOWING CONSTRUCTION COMPLETION. SEE SHEET 1-A FOR VEGETATION SELECTION.
6. THE CONTRACTOR MUST ESTABLISH TEMPORARY VEGETATION IN ACCORDANCE WITH THE PLANS AND TECHNICAL SPECIFICATIONS BEFORE TURNING WATER INTO THE NEW STREAM CHANNEL SEGMENTS.
7. THE CONTRACTOR SHALL WORK IN THE DRY AND UTILIZE A PUMP-AROUND OPERATION OR FLOW DIVERSION MEASURE AS SHOWN ON THE PLAN SHEETS.
8. THE ENGINEER MUST APPROVE ALL GRADING ACTIVITIES AND GROUNDCOVER STABILIZATION PRIOR TO RIPARIAN VEGETATION PLANTING.

THOMAS CREEK EROSION CONTROL PLAN

40 20 0 40 80

SCALE (FT)

2/26/03

3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	EC-4

PROJECT ENGINEER

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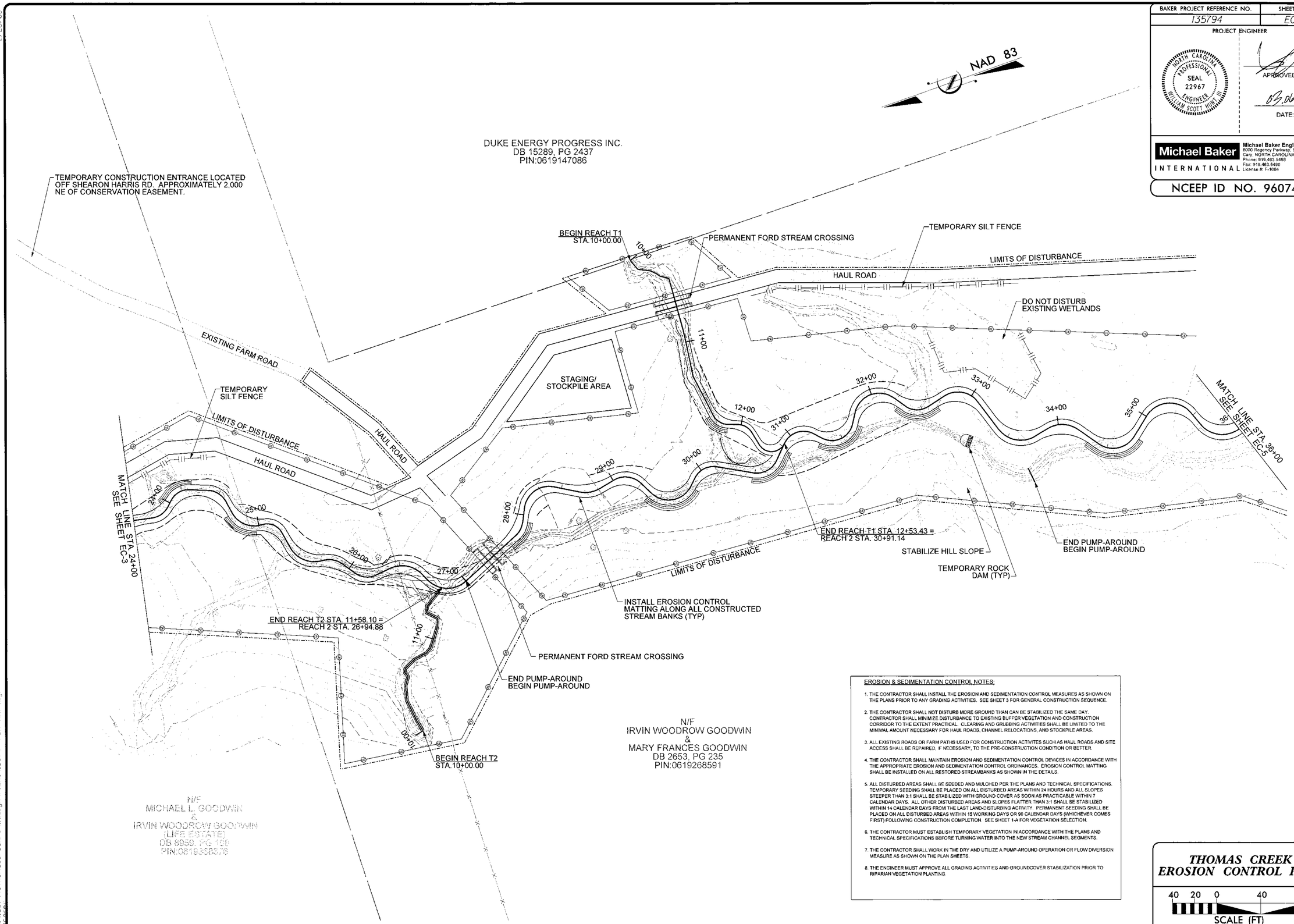

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THOMAS CREEK EROSION CONTROL PLAN

40 20 0 40 80

SCALE (FT)

2/26/03

3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	EC-5

PROJECT ENGINEER

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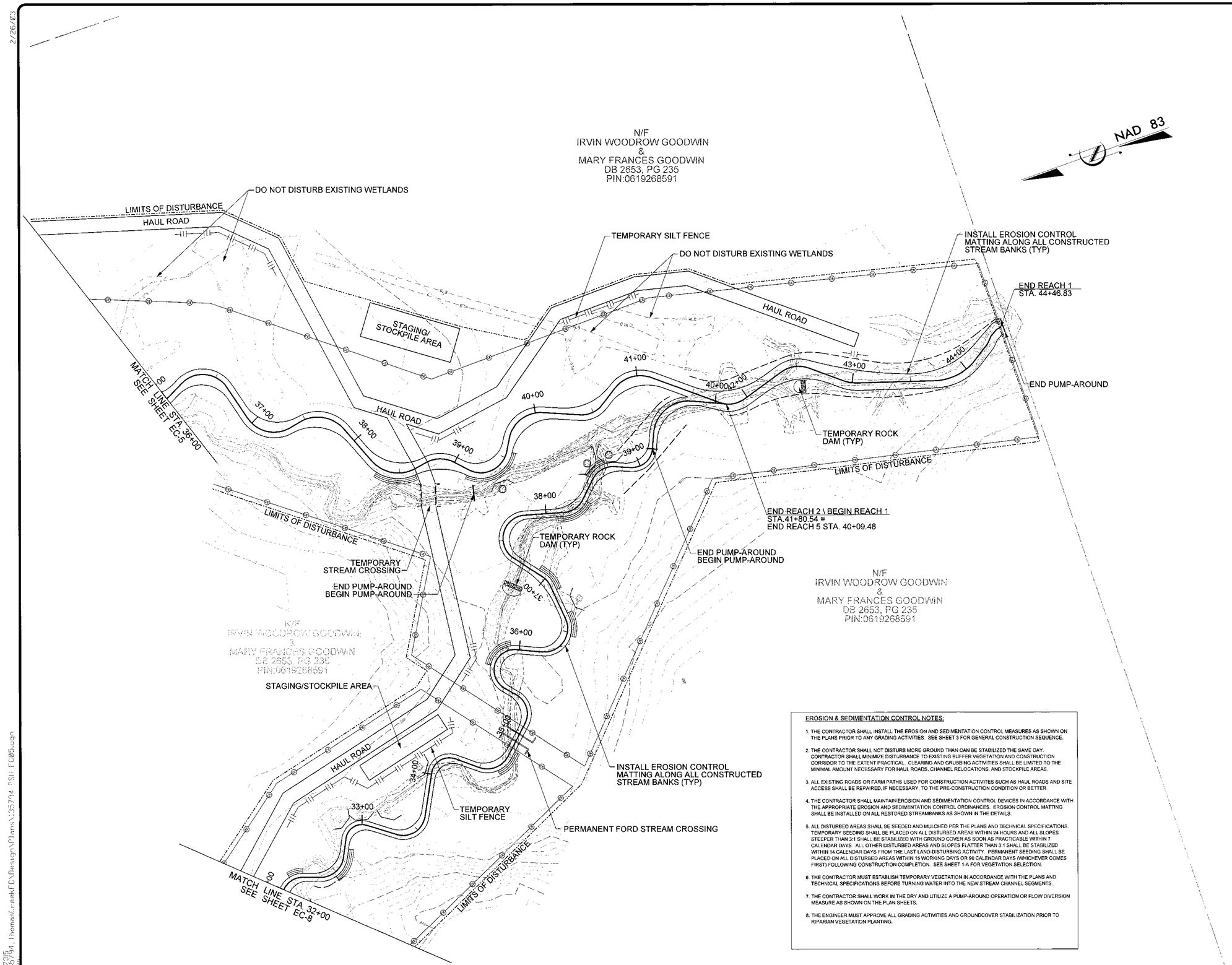

EROSION & SEDIMENTATION CONTROL NOTES:

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THOMAS CREEK EROSION CONTROL PLAN

40 20 0 40 80
SCALE (FT)

2/26/03

3/5/03
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	EC-6

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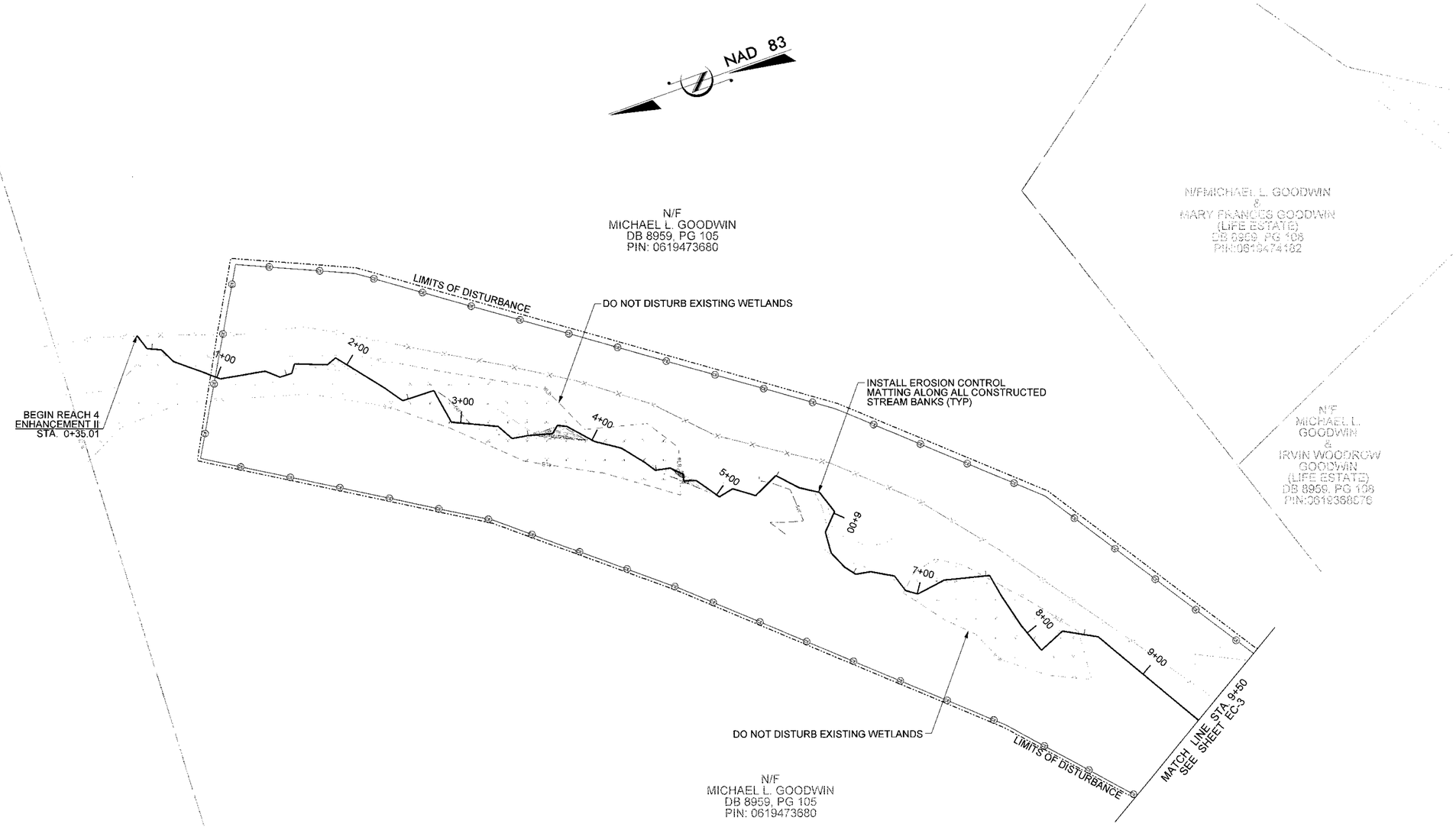

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5. ALL DISTURBED AREAS SHALL BE SEEDED AND MULCHED PER THE PLANS AND TECHNICAL SPECIFICATIONS. TEMPORARY SEEDING SHALL BE PLACED ON ALL DISTURBED AREAS WITHIN 24 HOURS AND ALL SLOPES STEEPER THAN 3:1 SHALL BE STABILIZED WITH GROUND COVER AS SOON AS PRACTICABLE WITHIN 7 CALENDAR DAYS. ALL OTHER DISTURBED AREAS AND SLOPES FLATTER THAN 3:1 SHALL BE STABILIZED WITHIN 14 CALENDAR DAYS FROM THE LAST LAND-DISTURBING ACTIVITY. PERMANENT SEEDING SHALL BE PLACED ON ALL DISTURBED AREAS WITHIN 15 WORKING DAYS OR 90 CALENDAR DAYS (WHICHEVER COMES FIRST) FOLLOWING CONSTRUCTION COMPLETION. SEE SHEET 1-A FOR VEGETATION SELECTION.

6. THE CONTRACTOR MUST ESTABLISH TEMPORARY VEGETATION IN ACCORDANCE WITH THE PLANS AND TECHNICAL SPECIFICATIONS BEFORE TURNING WATER INTO THE NEW STREAM CHANNEL SEGMENTS.

7. THE CONTRACTOR SHALL WORK IN THE DRY AND UTILIZE A PUMP-AROUND OPERATION OR FLOW DIVERSION MEASURE AS SHOWN ON THE PLAN SHEETS.

8. THE ENGINEER MUST APPROVE ALL GRADING ACTIVITIES AND GROUNDCOVER STABILIZATION PRIOR TO RIPARIAN VEGETATION PLANTING.

THOMAS CREEK EROSION CONTROL PLAN

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SCALE (FT)

2/26/03

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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	EC-7

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HINE III

APPROVED BY:

03.06.15

DATE:

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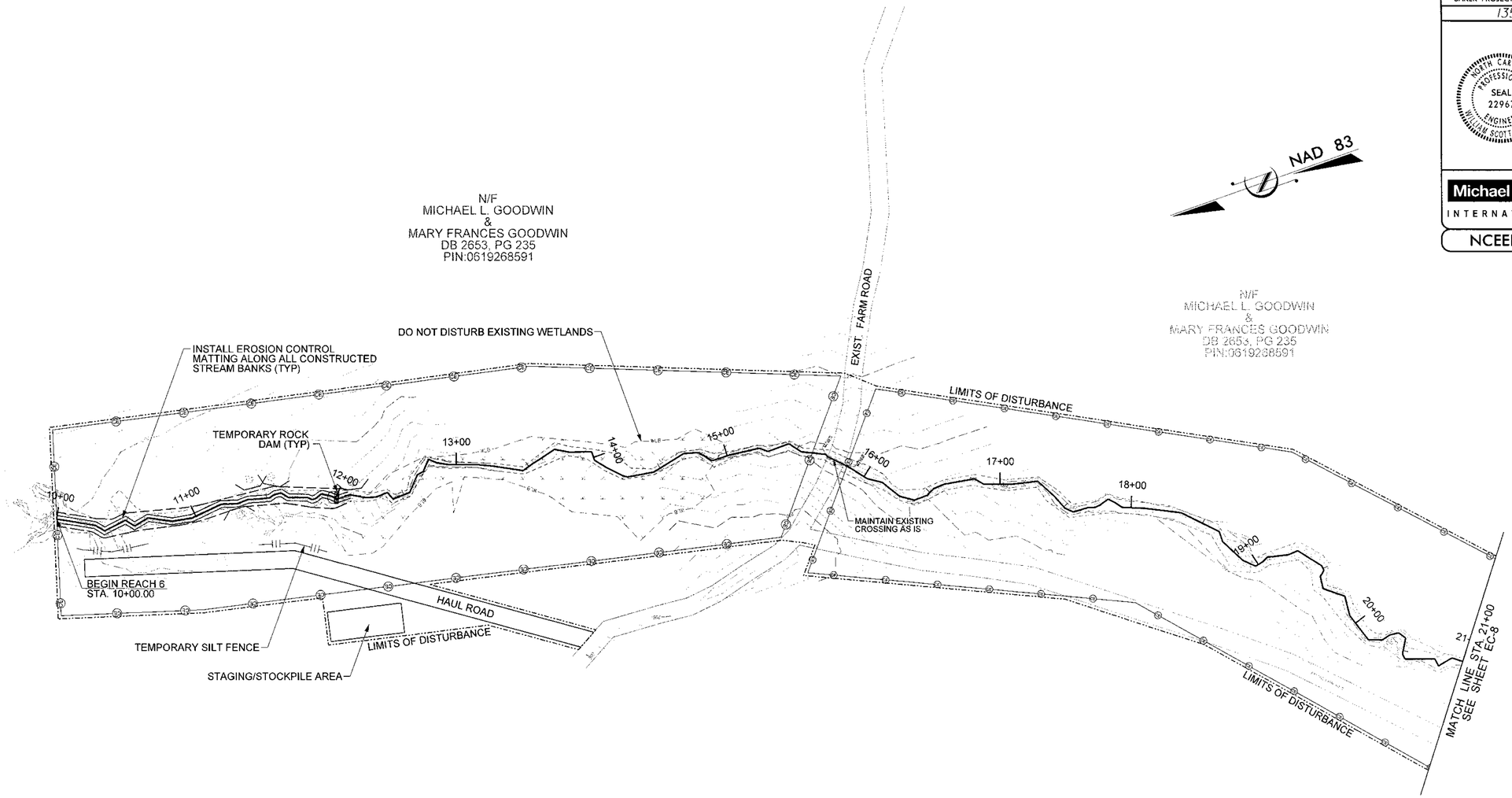

EROSION & SEDIMENTATION CONTROL NOTES:

1. THE CONTRACTOR SHALL INSTALL THE EROSION AND SEDIMENTATION CONTROL MEASURES AS SHOWN ON THE PLANS PRIOR TO ANY GRADING ACTIVITIES. SEE SHEET 3 FOR GENERAL CONSTRUCTION SEQUENCE.
2. THE CONTRACTOR SHALL NOT DISTURB MORE GROUND THAN CAN BE STABILIZED THE SAME DAY. CONTRACTOR SHALL MINIMIZE DISTURBANCE TO EXISTING BUFFER VEGETATION AND CONSTRUCTION CORRIDOR TO THE EXTENT PRACTICAL. CLEARING AND GRUBBING ACTIVITIES SHALL BE LIMITED TO THE MINIMAL AMOUNT NECESSARY FOR HAUL ROADS, CHANNEL RELOCATIONS, AND STOCKPILE AREAS.
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N/F
MICHAEL L. GOODWIN
&
MARY FRANCES GOODWIN
DB 2653, PG 235
PIN:0619268591

THOMAS CREEK EROSION CONTROL PLAN

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SCALE (FT)

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3/5/2015
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BAKER PROJECT REFERENCE NO.	SHEET NO.
135794	EC-8

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HINE, III

APPROVED BY:

03.06.15

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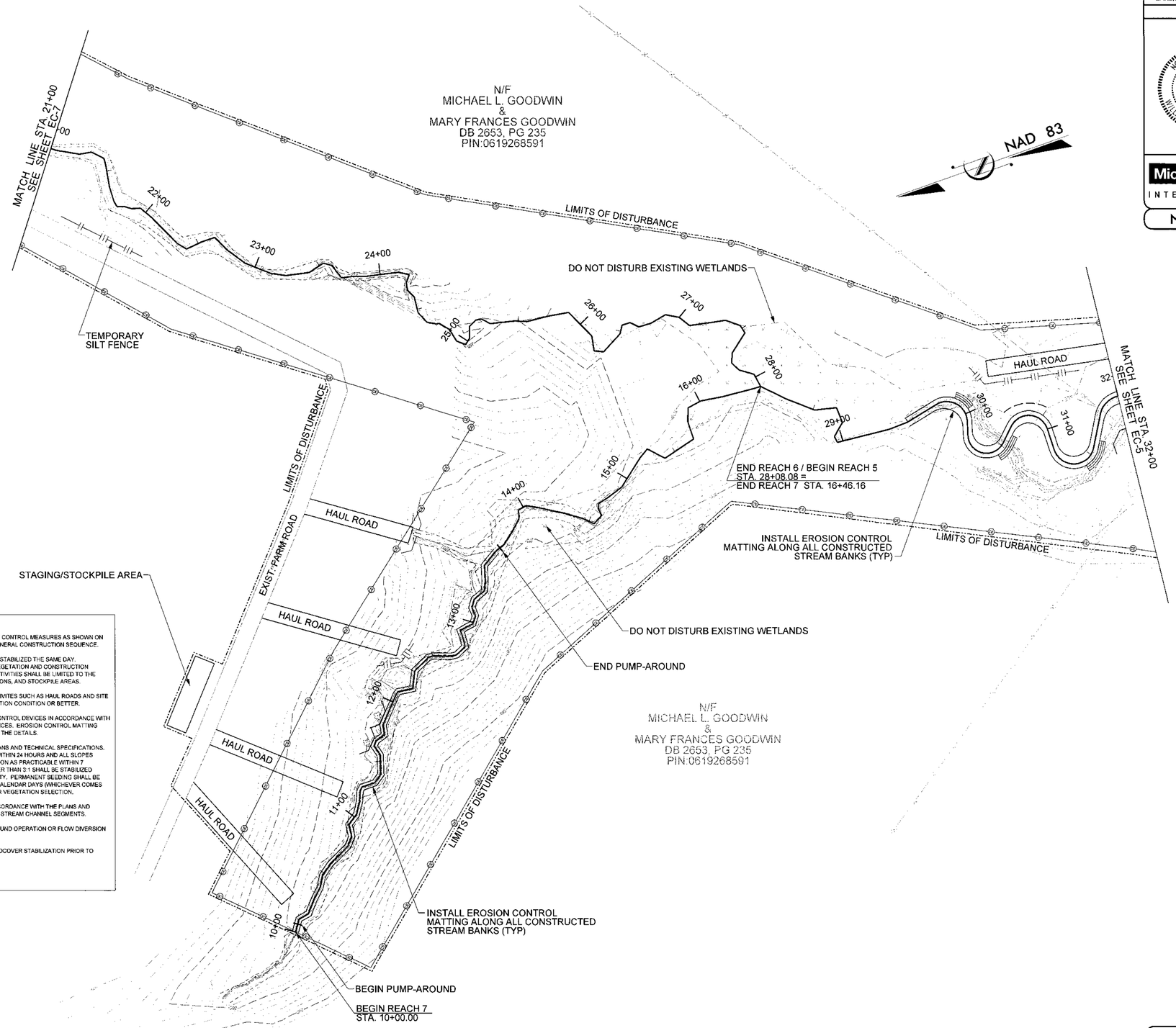

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THOMAS CREEK EROSION CONTROL PLAN

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