FINAL

Baseline Monitoring Document and As-Built Baseline Report
UT to Mill Swamp Restoration Project

Onslow County, North Carolina

EEP Project ID No. 95019

White Oak River Basin: 03030001-010020

Prepared for:

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

Data Collection Period – August 2013

Submission Date – September 2013

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NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
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TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 EXECUTIVE SUMMARY

Michael Baker Engineering, Inc. (Baker) restored 3,606 linear feet (LF) of perennial stream, 4.0 acres (AC) of riparian wetlands, and enhanced 600 LF of stream along an unnamed tributary (UT) to Mill Swamp in Onslow County, North Carolina (NC) (Figure 1). The UT to Mill Swamp Restoration Project site (project) is located in Onslow County, approximately three miles northwest of the Town of Richlands. The project site is located in the NC Division of Water Quality (NCDWQ) subbasin 03-05-02 and the Targeted Local Watershed (TLW) 03030001-010020 of the White Oak River Basin. The project involved the restoration and enhancement of a Coastal Plain Headwater Small Stream Swamp system (NC WAM 2010, Schafale and Weakley 1990) from impairments within the project area due to past agricultural conversion, cattle grazing, and draining floodplain wetlands by ditching activities.

The project goals directly addressed stressors identified in the White Oak River Basin Restoration Priority Plan (RBRP) such as degraded riparian conditions, channel modification, and excess sediment and nutrient inputs. The primary restoration goals, as outlined in the approved mitigation plan, are described below:

- Create geomorphically stable conditions along the unnamed tributaries across the site,
- Implement agricultural Best Management Practices (BMPs) to reduce nonpoint source inputs to receiving waters,
- Protect and improve water quality by reducing bank erosion, nutrient, and sediment inputs,
- Restore stream and wetland hydrology by connecting historic flow paths and promoting natural flood processes, and
- Restore and protect riparian buffer functions and corridor habitat in perpetuity by establishing a permanent conservation easement.

To accomplish these goals, the following objectives were identified:

- Restore existing incised, eroding, and channelized streams by providing access to their historic floodplains,
- Prevent cattle from accessing the riparian buffer, reducing excessive bank erosion,
- Increase aquatic habitat value by providing more bedform diversity, creating natural scour pools and reducing sediment from accelerated bank erosion,
- Plant native species riparian buffer vegetation along stream bank and floodplain areas, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve bank stability, and shade the stream to decrease water temperature,
- Improve aquatic and terrestrial habitat through improved substrate and in-stream cover, addition of woody debris, and reduction of water temperature, and
- Control invasive species vegetation within the project area and if necessary continue treatments during the monitoring period.

The project as-built condition closely mimics that proposed by the design. Differences are outlined below:

- The Stream and Wetland Mitigation Plan (Mitigation Plan) specified the planting of riparian live stakes during construction; however, due to the time of planting in May 2013 none were installed. During construction, it was determined that live stakes shall be installed during the dormant season.

Any implementation of live stakes, post construction, will be documented in the Post-construction Monitoring Report of the same year.

- Fencing along Reach UT3 was originally proposed along both banks of the reach outside of the conservation easement; however, the landowner decided to use the northern pasture for hay production only, so fencing was installed only on the southern side of the reach to exclude cattle.
- Sweetbay (*Magnolia virginiana*) was substituted for American Holly (*Ilex opaca*) in the understory plantings for the headwater riparian areas.
- Fifty percent of the proposed quantities of Water Oak (*Quercus nigra*) were substituted with Cherrybark Oak (*Quercus pagoda*) for the riparian wetland planting areas.

This report documents the completion of the restoration construction activities and presents as-built monitoring data for the post-construction monitoring period. Table 1 summarizes site conditions before and after restoration, as well as the conditions predicted in the previously approved project Mitigation Plan. Table 1 is located in Appendix A.

2.0 PROJECT GOALS, BACKGROUND AND ATTRIBUTES

2.1 Project Location and Description

The UT to Mill Swamp Restoration Project site (project) is located in Onslow County, NC, approximately three miles northwest of the Town of Richlands, as shown on the Vicinity Map (Figure 1). The project is located in the NC Division of Water Quality (NCDWQ) subbasin 03-05-02 of the White Oak River Basin and hydrologic unit 03030001-010020. The project includes two unnamed headwater tributaries (UTs) to Mill Swamp and areas of previously disturbed wetlands and is located in the Mid-Atlantic Coastal Plain physiographic region.

UT to Mill Swamp (UT1) is a small, perennial headwater stream with a total drainage area of approximately 0.66 square miles. Historically, the area has been extensively drained for silvicultural and agricultural production and cattle grazing. The UTs were ditched to promote drainage from the adjacent farm fields and forested areas, which resulted in channel incision and a disconnection from their relic floodplain. These conditions generally lead to vertical and lateral instability over time and were observed throughout the project area. The riparian vegetation throughout the project is a mix of forested areas and herbaceous grasses that are regularly maintained by mowing and crop production. The upstream portion of the project is mostly wooded with a mature bottomland hardwood swamp forest that has evidence of past channel disturbance.

Based on field evaluations of intermittent/perennial status and use of NCDWQ stream assessment protocols, UT1 is classified as a perennial stream system, while UT3 is considered an intermittent stream reach. Historically, it is likely that the area functioned as a headwater stream and wetland system, with diffuse flow and no clearly defined channel towards the upper reaches. A more defined channel likely existed towards the bottom of the project watershed, due to the increased drainage area and steeper valley slopes.

2.2 Site Directions

To access the site from Raleigh, follow Interstate 40 southeast and take the NC Highway 24 Exit East/ NC Highway 903 North, Exit 373 toward Kenansville and Magnolia. From Exit 373, continue on the Kenansville Bypass for 6 miles before turning right onto NC Highway 24 East. After turning right onto NC Highway 24 (Beulaville Highway), continue for 23 miles before turning left onto US Highway 258 (Kinston Highway). Once on US Highway 258, travel for approximately 1.2 miles before turning right onto Warren Taylor Road. Then proceed 0.5 miles and turn left while heading north through a large field. The site is located where the farm road intersects UT to Mill Swamp at a downstream culvert crossing.

2.3 Project Goals and Objectives

The UT to Mill Swamp Restoration Project was identified as an opportunity to improve water quality and ecological functions within a NC Ecosystem Enhancement Program (NCEEP) Target Local Watershed (TLW). The primary restoration goals of the project are described below:

- Create geomorphically stable conditions along the unnamed tributaries across the site,
- Implement agricultural BMPs to reduce nonpoint source inputs to receiving waters,
- Protect and improve water quality by reducing bank erosion, nutrient and sediment inputs,
- Restore stream and wetland hydrology by connecting historic flow paths and promoting natural flood processes, and
- Restore and protect riparian buffer functions and corridor habitat in perpetuity by establishing a permanent conservation easement.

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

- Restore existing incised, eroding, and channelized streams by providing access to their historic floodplains,
- Prevent cattle from accessing the riparian buffer, reducing excessive bank erosion,
- Increase aquatic habitat value by providing more bedform diversity, creating natural scour pools and reducing sediment from accelerated bank erosion,
- Plant native species riparian buffer vegetation along stream bank and floodplain areas, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve bank stability, and shade the stream to decrease water temperature,
- Improve aquatic and terrestrial habitat through improved substrate and in-stream cover, addition of woody debris, and reduction of water temperature, and
- Control invasive species vegetation within the project area and if necessary continue treatments during the monitoring period.

The project goals directly addressed stressors identified in the White Oak River Basin Restoration Priority Plan (RBRP), such as degraded riparian conditions, channel modification, and excess sediment and nutrient inputs. The proposed natural channel design approach will result in a stable riparian headwater stream and wetland system that will reduce sediment and nutrient loading to the Mill Swamp sub-watershed, while improving water quality conditions that support terrestrial and aquatic species within the White Oak River Basin.

3.0 PROJECT STRUCTURE, RESTORATION TYPE, AND APPROACH

3.1 Project Components

The project area consists of the restoration, and enhancement of two unnamed headwater tributaries (UTs) to Mill Swamp, UT1 and UT3, and areas of previously disturbed riparian headwater wetlands. For design purposes, UT1 was divided into three reaches: UT1a, UT1b, and UT1c. Restoration practices involved raising the existing streambed and reconnecting the stream to the historic floodplain and restoring diffuse flows to abandoned wetland floodplains and hydric soils areas previously drained by ditching activities. The existing ditches within the project area were partially to completely filled to decrease surface and subsurface drainage and raise the local water table. Native species riparian buffer vegetation was established and/or protected at least 50 feet from the top of bank along all project reaches. Lastly, cattle were excluded along the southern portion of UT3 (Station 10+00 to 16+43) through permanent fencing outside of the conservation easement.

3.2 Restoration Approach

Based on the post-construction as-built survey, the project consisted of 3,606 LF of restoration on Reaches UT1b and UT1c, and 600 LF of Enhancement Level I on UT1a. In addition, the project restored a total of 4.0 acres of riparian wetlands. A conservation easement consisting of 19.6 acres will protect and preserve all stream reaches, wetland areas, and riparian buffers in perpetuity.

The revegetation plan for the overall riparian buffer system will consider the combination of existing on-site native species vegetation and riparian communities identified by Schafale and Weakley (1990) that include "Coastal Plain Small Stream Swamp" and "Coastal Plain Bottomland Hardwood". The planting areas were designated by zones on the as-built plan sheets to represent site conditions (Appendix D).

The restoration approach for the project allows stream flows larger than bankfull flows to spread onto the floodplain, dissipating flow energies and reducing stress on streambanks. In-stream structures were used to control streambed grade, reduce streambank stress, and promote bedform sequences and habitat diversity. The in-stream structures consist of root wads, log vanes, log weirs, cover logs, grade control log-jams, and ditch plugs/channel blocks.

Streambanks were stabilized using a combination of erosion control matting, temporary and permanent seeding, and bare-root planting. The sites were planted with native species vegetation as shown in Table 7 (Appendix C) and are protected through a permanent conservation easement. Table 1 and Figure 2 (Appendix A) provide a summary of the project components.

3.2.1 UT1a Enhancement

UT1a began at the upstream project limits and flows southeasterly for approximately 600 feet. The existing unstable channel section was partially to completely filled on a slight downward gradient slope along its length. The approach prevents any potential backwater conditions past the upstream channel limits and will eventually allow the stream to be discharged back onto the historic floodplain. Because of the relatively steep nature of the upper headwater valley (0.008 ft/ft), and the presence of headcuts along the reach, the stream was slightly entrenched and functions as a transitional reach between single and multi-thread channel before reconnecting with its historic floodplain.

3.2.2 UT1b Restoration

At approximately Station 16+00, the UT1b restoration approach considered the USACE and NCDWQ guidance document entitled "*Information Regarding Stream Restoration in the Outer Coastal Plain of North Carolina*." Based on average valley slope (0.0055 ft/ft) and upper catchment drainage area (~80 ac) the channel most likely functioned prior to disturbance as a headwater stream system (Rosgen 'DA' stream type). Therefore, rather than the construction of a defined single thread channel, restoration focused on filling in the drainage ditches and main channel, and restoring the pre-disturbed topography of the valley. The valley bottom was graded to restore the natural microtopographic variability that is common within multi-thread headwater systems. Shallow flow paths were connected to allow initial flow of water toward Reach UT1c. The system will be allowed to form multi-thread channels and diffuse flow patterns on its own over time.

The restoration of UT1b ends near the farm culvert crossing at approximately Station 37+00. At this location, the UT1b channel connects with the proposed single thread channel, which forms the beginning to UT1c, by grading the shallow flow paths, which gradually merge into a broad swale that will connect to the constructed design bankfull width and depth.

3.2.3 UT1c Restoration

A stable cross-section will be achieved by restoring a single thread meandering channel across the abandoned floodplain, increasing the width/depth ratio, and raising the streambed (Rosgen Priority Level I) to restore a channel that is appropriately sized for its increased drainage area. Grading activities were aimed at restoring historic flow patterns and adjacent wetland hydrology by removing past channel spoil and other agricultural land manipulations. The channel was restored to a Rosgen 'C' stream type, and the sinuosity was increased by adding meanders to lengthen the channel and restore bedform diversity. Minimal grade control was required for the project, due to the low channel slope and low potential for channel incision.

3.2.4 Wetland Restoration

The restoration design for the wetland was based on a targeted "Coastal Plain small stream swamp" riparian wetland type, as identified by Schafale and Weakley (1990). Hydrology of this system is palustrine, "intermittently, temporarily, or seasonally flooded", as the restored channel is designed to carry the bankfull flow, and to flood (flow out of its banks) at discharges greater than bankfull.

3.3 Project History, Contacts, and Attribute Data

Baker implemented the project under a full delivery contract with NCEEP to provide stream and wetland mitigation credits in the White Oak River Basin. The chronology of the project is presented in Table 2. The contact information for all designers, contractors, and relevant suppliers is presented in Table 3. Relevant Project background information is presented in Table 4. Tables 2, 3, and 4 are located in Appendix A of this report. As-built stationing is outlined in the Construction Summary, below, and in Table 1 in Appendix A.

3.3.1 Construction Summary

In accordance with the approved Mitigation Plan and regulatory permits, construction began with site preparation, installation of sediment and erosion control measures, and the establishment of staging areas, haul roads, and stockpile areas. Materials were stockpiled as needed for the initial stages of construction. Suitable fill material was harvested from a borrow area and disposed on-site within the existing channel bed and drainage swale fill areas. The construction contractor was River Works, Inc. (River Works) and construction was initiated in April 2013.

Construction began on the upstream portion of UT1 at Station 10+00 and proceeded along UT1a and UT1b by clearing timber and scrub for construction access to the existing area of the UT1a channel. Harvested timber from this area was stockpiled for use as rootwads and log structures. After timber and scrub clearing were complete, backfilling of the existing channel was initiated by returning the historic spoil that was placed along the top of bank back into the UT1 channel. Upon completion of bank grading, pump-around operations were installed and utilized per the Sedimentation and Erosion Control Plan and were followed by the installation of in-stream structures. Once the existing reaches of UT1a and UT1b were backfilled and compacted, work began on grading the new channels. First, the channel for UT1a was tied into the existing channel at the wood line at Station 10+00. After tie-in was complete, the top of bank elevation was determined and the new channel construction began. The bed elevation of UT1a was constructed to tie-in with UT1b. Three log weir structures were installed along UT1a to maintain bed elevations and to dissipate flow energies. The as-built length of UT1a after construction was 600 LF and ends at Station 16+00.

The restoration of UT1b did not involve the construction of a defined single thread channel, but rather the current channelized stream was filled and graded back to natural topographic contours. During the construction of UT1b, the historic spoil piles were placed back into the existing channel and fill material was used to match the bed elevation of UT1a. The entire length UT1b was designed as a multi-thread system; therefore, the construction of a single channel bed was not utilized. Instead, a wider floodplain was graded as to let higher flow energies dissipate across the land surface. In the downstream extent near Station 37+23, an existing culverted crossing was upgraded to carry design flows greater than bankfull. The as-built length of UT1b after construction is 2,093 LF.

Work along UT1c also began with placing the historic spoil back into the existing channel at Stations 37+23 and 52+38. After backfilling was complete, the surrounding land was graded to restore historic flow patterns and adjacent wetland hydrology. Once the UT1c floodplain had been graded, a new single-thread channel was excavated through the low part of the valley. The new channel was restored to a Rosgen “C” stream type and the sinuosity was increased by adding meanders to lengthen the channel and restore bedform diversity. Minimal grade control was installed due to low channel slope and low potential for channel incision. In-stream wooden structures installed on UT1c were log vanes, log weirs, rootwads, cover logs and log-jams. The as-built length of UT1c after construction was 1,513 LF.

Construction on UT3 involved installing three log weirs to dissipate flow energies and provide grade control along active headcuts. The log weirs were installed from Station 18+90 through Station 19+40 to lower the bed elevation of UT3 to match that of UT1b. The eroding channel was filled and then constructed with a braided channel approach to tie-in with UT1b at Station 23+69. UT3 has a constructed as-built length of 479 LF, however the reach is an intermittent stream and no mitigation credit was proposed for the work.

All riparian buffer areas within the project boundaries are a minimum of fifty feet from the top of both stream banks and are protected in perpetuity by a conservation easement that totals 19.6 acres. Fencing was not installed along the conservation easement boundary. However, fencing was installed outside of the easement on the southern side of UT3, to exclude cattle access to the stream. See the as-built plan sheets and Figure 2 for fencing location.

As-built plan sheets/record drawings depict actual surveyed areas with the project area and depict any changes from the construction drawings to what was implemented on-site during construction. The as-built plan sheets/record drawings are located in Appendix D. The as-built results for the project, including restoration and enhancement, areas totaled 4,206 LF of stream and 4.0 AC of wetland and are outlined in Table 1.

Upon completion of stream work within the site, sedimentation and erosion control measures such as pump around operations, temporary stream crossings, rock check dams, and silt fence were removed and all disturbed areas were stabilized with temporary seed and mulch before leaving the site. In addition, the planting of bare-root trees and shrubs, as well as wetland plantings, were completed in June 2013. Baker and River Works met on-site on June 5, 2013 and conducted a punch-list of final items to be performed. River Works demobilized in June 2013 after the final walk through on June 12, 2013.

4.0 PERFORMANCE STANDARDS

Baker has been involved in obtaining recent approvals from the regulatory agencies for several Coastal Plain stream and wetland mitigation plans. The success criteria for the project site will follow the mitigation plans developed for these projects, as well as the Stream Mitigation Guidelines (SMG) (USACE 2003 and NCDWQ 2003) and NCEEP's supplemental guidance document *Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation* dated November 7, 2011. Additionally, the USACE and NCDWQ Guidance Document *Information Regarding Stream Restoration in the Outer Coastal Plain of North Carolina* will be referenced for monitoring purposes.

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 NC Interagency Review Team (NCIRT).

Based on the design approaches, different monitoring methods were proposed for the project reaches. For reaches UT1a and UT1b, which involved the enhancement (bed/bank stabilization) and restoration of the historic flow pattern as a multi-thread headwater stream system to be constructed as a broad or diffuse swale with shallow flow paths, monitoring will focus primarily on visual assessments and flow documentation. For reach UT1c, which involved a more traditional restoration of a single thread channel, geomorphic monitoring approaches follow those recommended by the 2003 SMG and the 2011 NCEEP supplemental guidance. Monitoring 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), dated April 2008.

5.0 MONITORING PLAN AND SUCCESS CRITERIA

5.1 Stream Monitoring – Reach UT1a & UT1b

Geomorphic monitoring of reaches UT1a and UT1b will conducted once a year for seven years following the completion of construction to evaluate the effectiveness of the restoration practices. Since this approach involved the restoration of historic flow patterns and flooding functions in a multi-thread headwater stream system, monitoring efforts will focus on visual observations to document stability and the use of water level monitoring gauges to document saturation and flooding functions. The methods used and any related success criteria are described below for each parameter.

5.1.1 Groundwater Monitoring and Flooding Functions

The occurrence of bankfull events and flooding functions within the monitoring period will be documented by the use of automated water level gauges and photographs. Groundwater levels within the restored headwater valley should approximate the wetland hydroperiods of similar reference sites. Two (2) automated gauges were installed in a transect (4 well transects total), every 500 feet apart along the headwater stream system to demonstrate restoration of groundwater hydrology along the restored headwater valley. The automated loggers are programmed to collect data at a minimum of every 6 hours to groundwater levels. Installation of monitoring stations follow the standard methods found in the SMG document (USACE and NCDWQ 2006).

A surface water flow event will be considered perennial when the flow duration occurs for a minimum of 30 days. Two surface water flow events must be documented within a five-year monitoring period; otherwise, monitoring will continue for seven years or until two flow events have been documented in separate years. Two flow gauges (pressure transducers) were installed to document the occurrence of extended periods of shallow surface ponding, indicative of flow. The gauges should also document flooding connectivity between the restored UT1a and UT1b reaches for at least 30 consecutive days under normal climatic conditions. Additional monitoring or alternative analyses may be necessary in the event of abnormal climatic conditions.

5.1.2 Photo Reference Stations

Visual monitoring of all stream sections will be conducted twice per monitoring year with at least five months in between each site visit. Photographs will be used to visually document system performance. Reference stations will be photographed annually for a minimum of seven years following construction. Photographs will be taken from a height of approximately five to six feet. Permanent markers were established to ensure that the same locations (and view directions) on the site are documented in each monitoring period.

The headwater stream reaches will be photographed longitudinally beginning at the downstream end of the restoration site and moving upstream to the end of the site. Photographs will be taken looking upstream at delineated locations throughout the restored stream valley. The points will be close enough together to provide an overall view of the reach lengths and valley crenulations. The angle of the shot will depend on what angle provides the best view and will be noted and continued in future shots.

Lateral reference photos. Lateral photographs will also be used to evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures subjectively. The same photo station locations used for the upstream shot will be used to capture a valley photo that which will view across the valley towards the buffer. Photo reference stations will be marked and described for future reference to document the development of appropriate vegetation.

A series of photos over time should demonstrate successional maturation of riparian vegetation. When modifications to photo position must be made due to obstructions or other reasons, the position will be noted along with any landmarks and the same position will used in the future. Additional photographs and/or video footage may be taken to document any observed evidence of flooding patterns such as debris/leaf litter, wrack lines, water marks, diffuse flow features, sediment sorting/deposits, shelving, etc.

5.2 Stream Monitoring – Reach UT1c

Geomorphic monitoring of Reach UT1c will be conducted once a year for a minimum of 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 methods used and related success criteria are described below for each parameter.

5.2.1 Bankfull Events and Flooding Functions

The occurrence of bankfull events within the monitoring period will be documented by the use of a crest gauge and photographs. The crest gauge was installed on the floodplain within ten feet of the restored channel. The crest gauge will record the highest watermark between site visits, and the gauge will be checked at each site visit to determine if a bankfull event has occurred. 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 a five-year monitoring period. The two bankfull events must occur in separate years; otherwise, the monitoring will continue until two bankfull events have been documented during the seven year post construction monitoring period.

5.2.2 Cross-Sections

Per the USACE 2003 SMGs, permanent cross-sections were installed at a rate of one cross-section per twenty bankfull widths of restored stream, with approximately 50 percent of cross-sections located at riffles and 50 percent located at pools. Each cross-section is marked on both banks with permanent monuments to establish the exact transect used. A common benchmark will be used for cross-sections and consistently used to facilitate easy comparison of year-to-year data. The cross-section surveys will occur in years one, two, three, five, and seven, and must include measurements of Bank Height Ratio and Entrenchment Ratio. The monitoring survey will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross-sections will be classified using the Rosgen Stream Classification System.

There should be little change in as-built cross-sections. If changes do occur, 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 banks, or decrease in width/depth ratio). Cross-sections will be classified using the Rosgen Stream Classification System, and 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) defined for channels of the design stream type. Given the small channel size, sandy substrate, and large floodplain widths of the proposed steam, bank pins will not be installed unless required by the USACE.

5.2.3 Pattern

The plan view measurements such as sinuosity, radius of curvature, meander width ratio will be taken on newly constructed meanders for the as-built baseline conditions of the first year of monitoring 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.

5.2.4 Bank Stability Assessments

Bank Erodibility Hazard Index (BEHI) and Near Bank Stress (NBS) assessments will be conducted along the entire length of UT1 in Year 5 of post-construction monitoring and compared with pre-construction conditions. Stabilization measures implemented during construction should significantly decrease sediment loading throughout the entire project area; therefore, resulting in lower BEHI and NBS scores and a reduction in sediment load estimates (Rosgen, 1996 and 2001).

5.2.5 Longitudinal Profile

A longitudinal profile was surveyed for the entire length of channel immediately after construction to document as-built baseline conditions for the first year of monitoring only. The survey was tied to a permanent benchmark and measurements included thalweg, water surface, bankfull, and top of low bank. Each of these measurements were 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 conducted during subsequent monitoring years unless channel instability has been documented or remedial actions/repairs are required by the USACE or NCEEP.

5.2.6 Bed Material Analyses

Since the streams through the project site are dominated by sand-size particles, pebble count procedures would not show a significant change in bed material size or distribution over the monitoring period; therefore, bed material analyses will not be conducted for this project.

5.2.7 Photo Reference Stations

Visual monitoring of all stream sections will be conducted twice per monitoring year with at least five months in between each site visit. Photographs will be used to visually document system performance. Reference stations will be photographed annually for a minimum of seven years following construction. Photographs will be taken from a height of approximately five to six feet. Permanent markers will be established to ensure that the same locations (and view directions) on the site are documented in each monitoring period.

Lateral reference photos. Reference photo transects will be taken at each permanent cross-section. Photographs will be taken of both banks at each cross-section. The survey tape will be centered in the photographs of the bank. The water line will be located in the lower edge of the frame, and as much of the bank as possible will be included in each photo. Photographers should make an effort to consistently maintain the same area in each photo over time.

Structure photos. Photographs will be taken of grade control structures along the restored stream, and will be limited to log weirs or steps. Photographers will make every effort to consistently maintain the same area in each photo over time.

5.3 Wetland Monitoring

5.3.1 Groundwater Data Collection

Groundwater monitoring wells were installed in the wetland mitigation area to document hydrologic conditions of the restored wetland area. Groundwater monitoring wells were installed to evaluate restoration of groundwater hydrology during each growing season, for seven years of hydrologic monitoring, or until success criteria have been met, whichever occurs later. At least three (3) automated gauges were installed in a transect, every 500 feet within the restored wetland area to demonstrate groundwater hydrology perpendicular to the flow of the valley, as well as to document flow duration. To meet the hydrologic success criteria, the monitoring gauge data must show that for each normal year within the monitoring period, the site has been inundated or saturated for a certain hydroperiod. The targeted hydroperiod will be based on the range of wetness conditions for the type of wetland system to be restored and comparable hydrology of a nearby reference wetland site.

5.3.2 Hydrology

In order to determine if the hydrologic success criteria are achieved, automated groundwater-monitoring stations were installed across the restored site and monitored year-round. Groundwater monitoring stations will follow the USACE standard methods found in the WRP Technical Notes ERDC TN-WRAP-00-02, (July 2000). In the event that there are years of normal precipitation during the monitoring period, and the data for those years do not show that the site has been inundated or saturated for the appropriate hydroperiod during the normal precipitation year, the review agencies may require remedial action. Baker will provide any required remedial action and continue to monitor hydrology on the site until it displays that the site has been inundated or saturated for the appropriate hydroperiod.

The objective is for the monitoring data to show the site exhibits an increased frequency of flooding. Groundwater levels will be compared to pre-restoration conditions and reference conditions. The success criteria for riparian wetland hydrology will be met when the site is saturated within 12 inches of the soil surface for 12 percent of the growing season (~243 days) or twenty-nine (29) or more consecutive days during the growing season, during a period when antecedent precipitation has been normal or drier than normal for a minimum frequency of 5 years in 10 (USACE, 2010 and 2005).

In order to determine if the rainfall is normal for the given year, a rainfall gauge was installed on the site to compare precipitation amounts using tallied data obtained from the Onslow County WETS Station and from the automated weather station at Albert Ellis Airport (KOAJ-AWOS), approximately twelve miles south of the site. Data from the Jacksonsville station can be obtained from the CRONOS Database located on the State Climate Office of North Carolina’s website. If a normal year of precipitation does not occur during the first seven years of monitoring, Baker will continue to monitor hydrology on the site until it documents that the site has been inundated or saturated for the appropriate hydroperiod.

If the rainfall data for any given year during the monitoring period are abnormal, it is possible that the desired hydrology for the site may not meet specific success criteria.

However, reference wetland data will be assessed to determine if there is a positive correlation between the underperformance of the project site and the natural hydrology of the reference site(s).

5.3.3 Photo Reference Stations

Visual monitoring of all stream sections will be conducted twice per monitoring year with at least five months in between each site visit. Photographs will be used to visually document system performance and identify areas of low stem density, invasive species vegetation, beaver activity, or other areas of concern. Reference stations will be photographed twice a year for a minimum of seven years following construction. Photographs will be taken from a height of approximately five to six feet. Permanent markers were established to ensure that the same locations (and view directions) on the site are documented in each monitoring period.

5.4 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 were installed and will be monitored across the restoration site in accordance with the CVS-NCEEP Protocol for Recording Vegetation, Version 4.1 (2007). The vegetation monitoring plots are a minimum of 2 percent of the planted portion of the site with six (6) plots established randomly within the planted riparian buffer areas per Monitoring Levels 1 and 2. No monitoring quadrants were established within the undisturbed wooded areas of reach UT1a and UT1b. The size of individual quadrants are 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 were 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 (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 IRT.

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 grasses, will be seeded/planted throughout the site as necessary. 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.

6.0 AS-BUILT DATA DOCUMENTATION

Stream, wetland, and vegetation components will be monitored for seven years post-construction to evaluate project success, unless the site demonstrates complete success by Year 5 and no areas of concern have been identified. The specific locations of vegetation plots, permanent cross-sections, crest gauges, and wetland gauges are shown on the as-built plan sheets. Photo reference stations were installed along UT1 and UT3. Their physical locations and photo direction are also depicted on the as-built plan sheets in Appendix D.

6.1 Stream Data

For monitoring stream success criteria, eight (8) permanent cross-sections and one (1) crest gauge were installed on UT1c, while eighteen (18) photo reference stations were installed throughout the project area. The permanent cross-sections will be used to monitor channel dimension and bank stability over time. The crest gauge will be used to document the occurrence of bankfull events. In addition, a longitudinal survey was completed for the restored stream channels to provide a base-line for evaluating changes in bed conditions over time. The as-built permanent cross-sections (with photos) and as-built longitudinal data as well as the quantitative pre-construction, reference reach, and design data used to determine restoration approach are provided in Appendix B. As-built data will be used for comparison to post-construction monitoring data. The locations of the permanent cross-sections and the crest gauge are shown on the as-built plan sheets in Appendix D. Photographs are provided in Appendix E.

6.2 Hydrology Data

A total of eighteen (18) groundwater monitoring gauges were installed throughout the project site, eight (8) along UT1a and UT1b and ten (10) along UT1c. Groundwater gauges will document water table hydrology throughout the seven-year monitoring period and will be compared to pre-restoration and reference conditions. Locations of the groundwater gauges are depicted in the as-built plan sheets in Appendix D.

Additionally, two (2) flow gauges (pressure transducers) were installed along UT1b. These devices were installed to document the occurrence of extended periods of shallow surface ponding, indicative of flow. Locations of the groundwater gauges are depicted in the as-built plan sheets in Appendix D

6.3 Vegetation Data

Bare-root trees and shrubs were planted within restoration and enhancement areas of the conservation easement. A minimum 50-foot buffer was established and/or protected along all stream reaches. Planting of bare-root trees and shrubs, as well as wetland plantings, were completed in June 2013. Additionally, Sweetbay (*Magnolia virginiana*) was substituted for American Holly (*Ilex opaca*) in the understory plantings of the headwater riparian areas. Fifty percent of the proposed quantities of Water Oak (*Quercus nigra*) were substituted with Cherrybark oak (*Quercus pagoda*) in the riparian wetland planting areas.

The approved Mitigation Plan specified the planting of riparian live stakes during construction; however, due to the time of planting in May and June 2013, none were installed. During construction, it was determined that live stakes shall be installed during the Fall 2013 dormant season. Species planted are summarized in Tables 7 and 8 in Appendix C.

The Mitigation Plan for the site specifies that the number of quadrants required shall be based on the CVS-NCEEP monitoring guidance (2007). The total number of quadrants was calculated using the CVS-NCEEP Entry Tool Database version 2.2.7 (CVS-NCEEP, 2007). The sizes of individual quadrants are 100 square meters. A total of six (6) vegetation plots were installed throughout the project site. The initial planted density within each of the vegetation monitoring plots is provided in Table 9. The average density of planted bare root stems, based on the data from the six vegetation monitoring plots, is 693 stems per acre. The locations of the vegetation plots are shown on the as-built plan sheets in Appendix D.

6.4 Areas of Concern

No areas of concern were noted during the Baseline Monitoring field survey and data collection.

7.0 MAINTENANCE AND CONTINGENCY PLANS

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

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

The site will be monitored on a regular basis and as well as a physical inspection of the site 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. Maintenance issues and recommended remediation measures will be detailed and documented in the post-construction monitoring reports. Factors that may have caused any maintenance needs, including any of the conditions listed above, shall be discussed. Routine maintenance will be most likely in the first two years following site construction and may include the following components as described below.

7.1 Streams

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 bank failures and head-cutting until vegetation becomes established.

7.2 Wetland

Routine wetland maintenance and repair activities may include securing of loose coir fiber matting and supplemental installations of target vegetation within the wetland. Areas of concentrated stormwater and floodplain flows that intercept the wetland may also require maintenance to prevent scour.

7.3 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 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 and Consumer Services (NCDA&CS) rules and regulations.

7.4 Site Boundary

Site boundaries have been demarcated in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries can 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.

7.5 Culverted Farm Road Crossing

The permanent road crossing within the site may be maintained only as allowed by the recorded Conservation Easement, deed restrictions, rights of way, or corridor agreements.

8.0 REFERENCES

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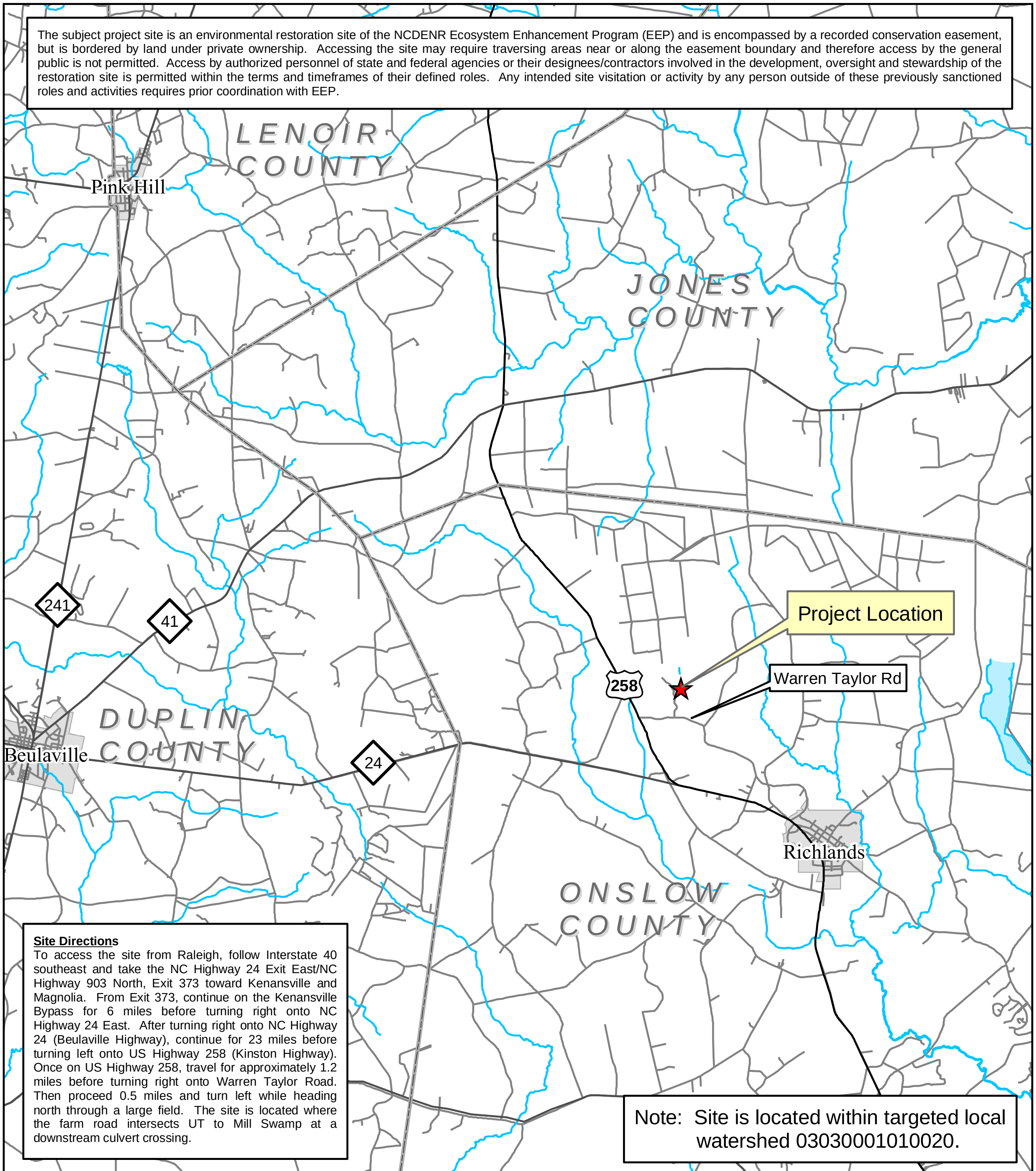
APPENDIX A

Figures 1 - 3, Tables 1 - 4

The subject project site is an environmental restoration site of the NCDENR Ecosystem Enhancement Program (EEP) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight and stewardship of the restoration site is permitted within the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activities requires prior coordination with EEP.

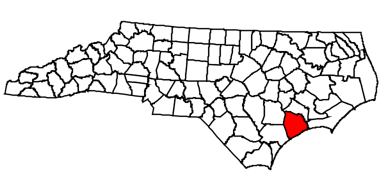


Site Directions

To access the site from Raleigh, follow Interstate 40 southeast and take the NC Highway 24 Exit East/NC Highway 903 North, Exit 373 toward Kenansville and Magnolia. From Exit 373, continue on the Kenansville Bypass for 6 miles before turning right onto NC Highway 24 East. After turning right onto NC Highway 24 (Beulaville Highway), continue for 23 miles before turning left onto US Highway 258 (Kinston Highway). Once on US Highway 258, travel for approximately 1.2 miles before turning right onto Warren Taylor Road. Then proceed 0.5 miles and turn left while heading north through a large field. The site is located where the farm road intersects UT to Mill Swamp at a downstream culvert crossing.

Note: Site is located within targeted local watershed 03030001010020.

EEP Project # 95019



Onslow County

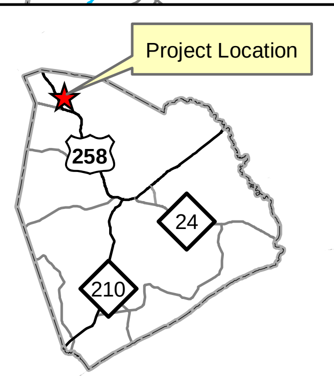
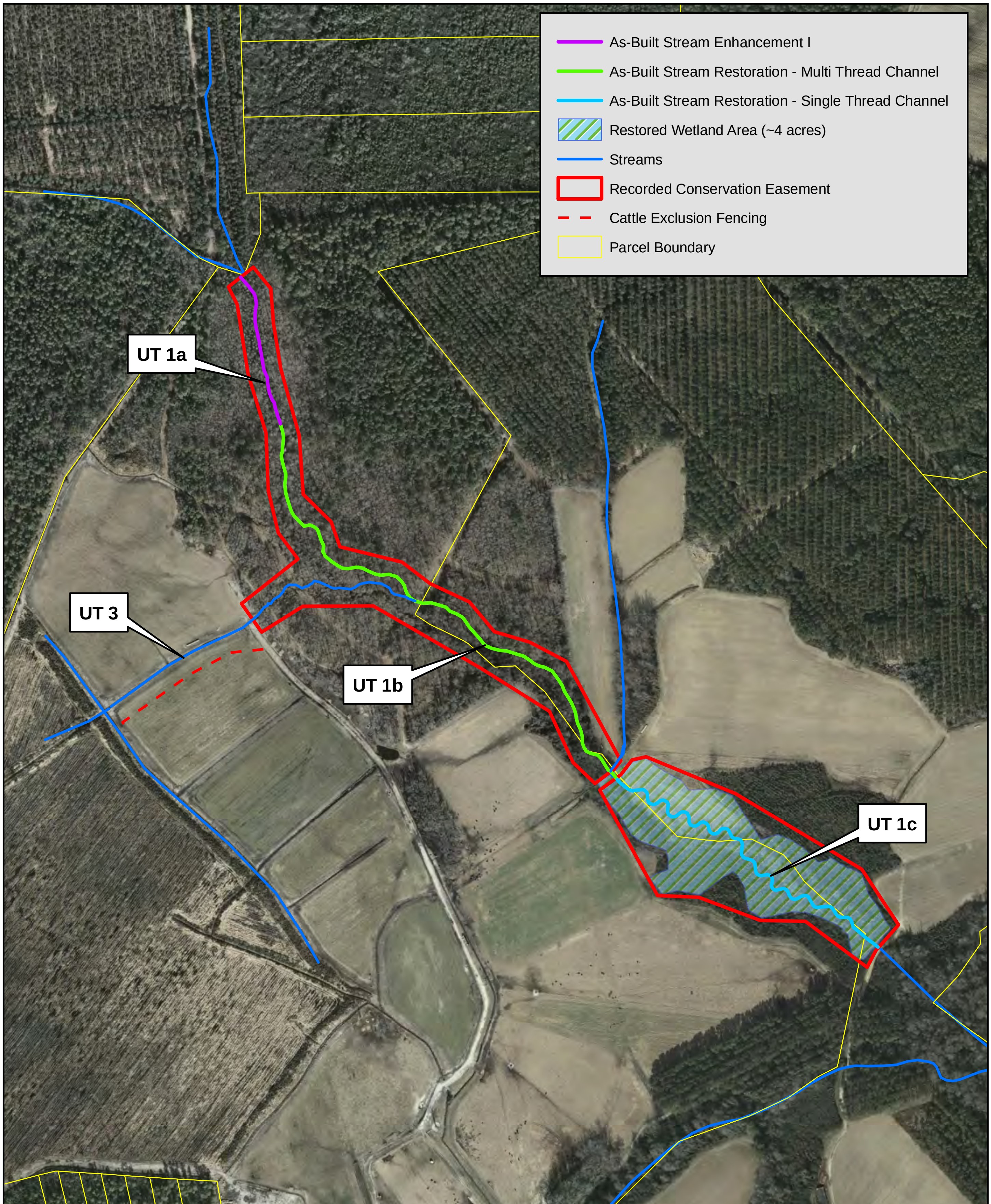


Figure 1
Project Vicinity Map
UT to Mill Swamp Site

N

0 0.5 1 2 3 Miles



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

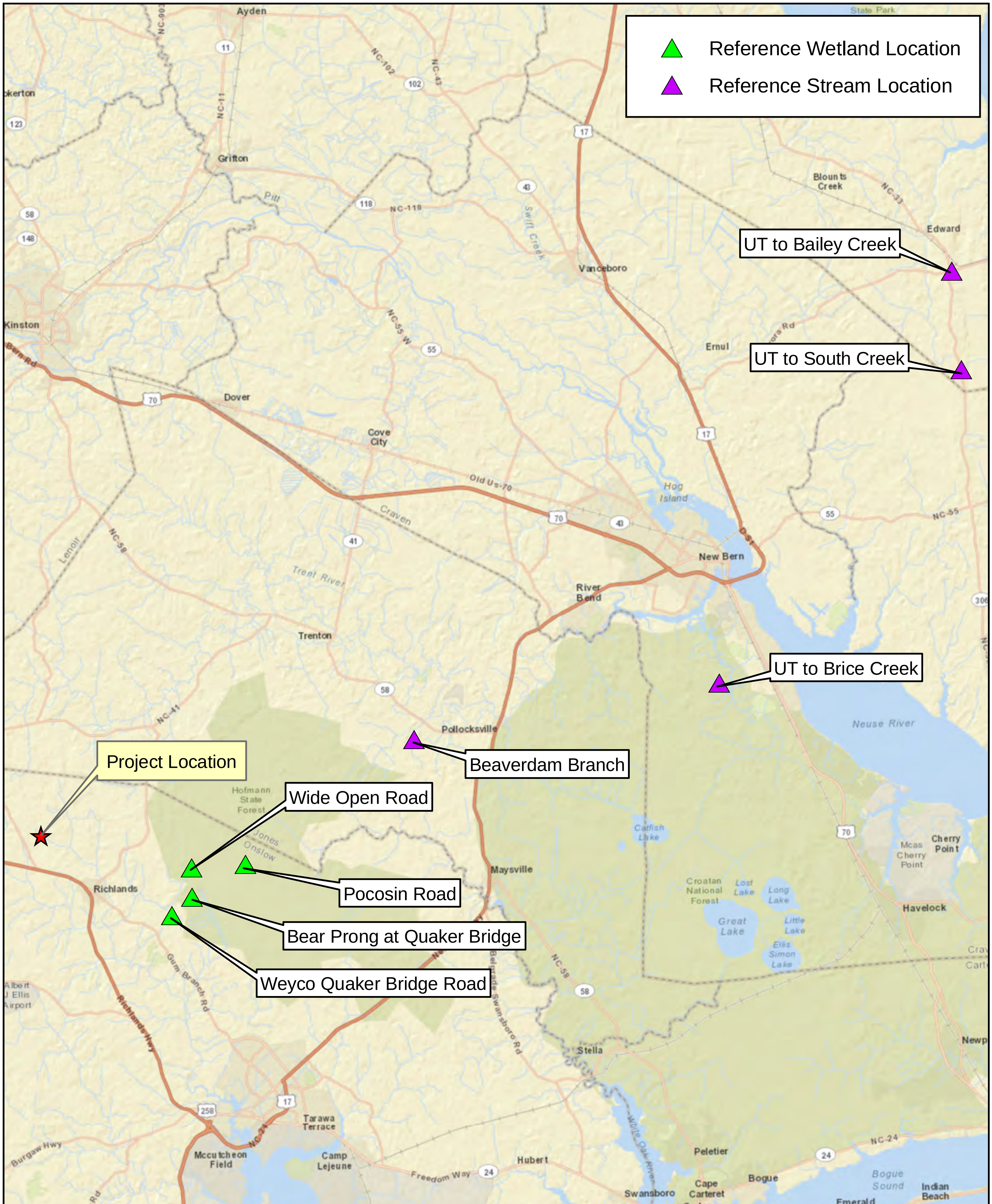
Ecosystem Enhancement Program

0 250 500 Feet

N

EEP Project # 95019

Figure 2
Restoration Summary Map
UT to Mill Swamp Site
Onslow County, NC



Baker

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Suite 600
Cary, North Carolina 27518
Phone: 919.463.5488
Fax: 919.463.5490

Ecosystem Enhancement PROGRAM

0 3 6 Miles

EEP Project # 95019

N

Figure 3
Reference Sites
Location Map
UT to Mill Swamp Site
Onslow County, NC

Table 1. Project Components and Mitigation Credits

UT to Mill Swamp Restoration Project: EEP Project No ID. 95019

Mitigation Credits								
	Stream	**Riparian Wetland**		**Non-riparian Wetland**		**Buffer**	**Nitrogen Nutrient Offset**	**Phosphorus Nutrient Offset**
Type	R, E1	R	E					
Totals	4,006 SMU	4.0 WMU	0					

Project Components						
Project Component or Reach ID	**Stationing/ Location**	**Existing Footage/ Acreage**	**Approach**	**Restoration/ Restoration Equivalent**	**Restoration Footage or Acreage**	**Mitigation Ratio**
Reach UT1a	10+00 – 16+00	600 LF	Enhancement Level I	400 SMU	600 LF	1.5:1
Reach UT1b	16+00 – 36+93	2,131 LF	Headwater Restoration	2,093 SMU	2,093 LF	1:1
Reach UT1c	37+24 – 52+37	1,350 LF	Single thread Restoration	1,513 SMU	1,513 LF	1:1
Reach UT3	10+00 – 23+69	1,060 LF	Cattle Exclusion	N/A	N/A	N/A
Wetland Area #1	See plan sheets	0.0 AC	Restoration	4.0 WMU	4.0 AC	1:1

Component Summation						
Restoration Level	**Stream (LF)**	**Riparian Wetland (AC)**		**Non-riparian Wetland (AC)**	**Buffer (SF)**	**Upland (AC)**
		Riverine	Non-Riverine			
Restoration	3,606	4.0				
Enhancement I	600					
Enhancement II						
Creation						
Preservation						
High Quality Preservation						

BMP Elements			
Element	Location	Purpose/Function	Notes

BMP Elements: BR= Bioretention Cell; SF= Sand Filter; SW= Stormwater Wetland; WDP= Wet Detention Pond; DDP= Dry Detention Pond; FS= Filter Strip; S= Grassed Swale; LS= Level Spreader; NI=Natural Infiltration Area

Table 2. Project Activity and Reporting History			
UT to Mill Swamp Restoration Project: EEP Project No ID. 95019			
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Mitigation Plan Prepared	N/A	N/A	Aug-12
Mitigation Plan Amended	N/A	N/A	Sep-12
MItigation Plan Approved	N/A	N/A	Nov-12
Final Design – (at least 90% complete)	N/A	N/A	Mar-13
Construction Begins	N/A	N/A	Apr-13
Temporary S&E mix applied to entire project area	N/A	N/A	N/A
Permanent seed mix applied to entire project area	N/A	N/A	Jun-13
Planting of live stakes	Fall/Winter 2013	N/A	N/A
Planting of bare root trees	N/A	N/A	Jun-13
End of Construction	N/A	N/A	Jun-13
Survey of As-built conditions (Year 0 Monitoring-baseline)	N/A	Aug-13	Aug-13
Year 1 Monitoring	Dec-13	N/A	N/A
Year 2 Monitoring	Dec-14	N/A	N/A
Year 3 Monitoring	Dec-15	N/A	N/A
Year 4 Monitoring	Dec-16	N/A	N/A
Year 5 Monitoring	Dec-17	N/A	N/A
Year 6 Monitoring	Dec-18	N/A	N/A
Year 7 Monitoring	Dec-19	N/A	N/A

Table 3. Project Contacts Table UT to Mill Swamp Restoration Project: EEP Project ID No. 95019	
Designer	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 Contact: Kayne Van Stell, Tel. 919-481-5730
Construction Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Planting Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seeding Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seed Mix Sources	Green Resources, Tel. 336-855-6363
Nursery Stock Suppliers	Mellow Marsh Farm, 919-742-1200 ArborGen, 843-528-3204 Superior Tree, 850-971-5159
Monitoring Performers	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 Contact:
Stream Monitoring Point of Contact	Dwayne Huneycutt, Tel. 919-481-5745
Vegetation Monitoring Point of Contact	Dwayne Huneycutt, Tel. 919-481-5745
Wetland Monitoring Point of Contact	Dwayne Huneycutt, Tel. 919-481-5745

Table 4. Project Attributes
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Project Information	
Project Name	UT to Mill Swamp Restoration Project
County	Onslow
Project Area (acres)	19.6
Project Coordinates (latitude and longitude)	34.9377 N, -77.5897 W

Watershed Summary Information	
Physiographic Province	Inner Coastal Plain
River Basin	White Oak
USGS Hydrologic Unit 8-digit and 14-digit	03030001 / 03030001010020
DWQ Sub-basin	03-05-02
Project Drainage Area (AC)	421 (d/s main stem UT1)
Project Drainage Area Percentage of Impervious Area	<1%
CGIA Land Use Classification	2.01.03.99, Other Hay, Rotation, or Pasture; 413
NCEEP Land Use Classification for UT to Mill Swamp Watershed (White Oak River Basin Restoration Priorities, 2010)	Forest (52%)
	Agriculture (44%)
	Impervious Cover (0.6%)

Stream Reach Summary Information		
Parameters	**Reach UT1**	**Reach UT3**
Length of Reach (LF)	4,091	1,060
Valley Classification (Rosgen)	X	X
Drainage Area (AC)	421	23
NCDWQ Stream Identification Score	40.5	21
NCDWQ Water Quality Classification	C; NSW	C; NSW
Morphological Description (Rosgen stream type)	G/F (Channelized Headwater System)	Intermittent Ditch (N/A)
Evolutionary Trend	Gc→F	Intermittent Ditch (N/A)
Underlying Mapped Soils	Mk, St, Ly, FoA	Mk, St
Drainage Class	Poorly drained, somewhat poorly drained	Poorly drained, somewhat poorly drained
Soil Hydric Status	Hydric	Hydric
Average Channel Slope (ft/ft)	0.0041	0.0058
FEMA Classification	N/A	N/A
Native Vegetation Community	Coastal Plain Small Stream Swamp	Coastal Plain Small Stream Swamp
Percent Composition of Exotic/Invasive Vegetation	~10%	<5%

Wetland Summary Information	
Parameters	**Wetland 1 (Non-Jurisdictional W1)**
Size of Wetland (AC)	4.0
Wetland Type	Riparian Riverine
Mapped Soil Series	Mk (Muckalee), St (Stallings), Ly (Lynchburg)
Drainage Class	Poorly drained, somewhat poorly drained
Soil Hydric Status	Hydric
Source of Hydrology	Groundwater
Hydrologic Impairment	Partially (disconnected floodplain from ditches and channel incision)
Native Vegetation Community	Coastal Plain Small Stream Swamp, Successional
Percent Composition of Exotic/Invasive Vegetation	~5%

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

Source: White Oak River Basin Restoration Priorities, 2010 (http://www.nceep.net/services/restplans/FINAL%20RBRP%20White%20Oak%2020110523.pdf)

APPENDIX B

Morphological Summary Data

(Tables 5 and 6), Cross-section Plots, Profile Plots

Table 5. Baseline Stream Summary
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Reach UT1c (1,513 LF)

Parameter	USGS Gauge	Regional Curve Interval (Harman et al, 1999)*			Pre-Existing Condition[1]					
Dimension and Substrate - Riffle		LL	UL	Eq.	Min	Mean	Med	Max	SD	n
BF Width (ft)	-----	23.0	80.0	9.9	6.8	-----	-----	8.7	-----	2
Floodprone Width (ft)	-----	-----	-----	-----	8.2	-----	-----	11.8	-----	2
BF Mean Depth (ft)	-----	2.3	5.8	1.3	0.8	-----	-----	1.0	-----	2
BF Max Depth (ft)	-----	-----	-----	-----	1.1	-----	-----	1.4	-----	2
BF Cross-sectional Area (ft^2)	-----	80.0	300.0	16.2	5.6	-----	-----	8.6	-----	2
Width/Depth Ratio	-----	-----	-----	-----	8	-----	-----	9	-----	2
Entrenchment Ratio	-----	-----	-----	-----	1.2	-----	-----	1.4	-----	2
Bank Height Ratio	-----	-----	-----	-----	4.2	-----	-----	2.8	-----	2
d50 (mm)	-----	-----	-----	-----	-----	0.25	-----	-----	-----	1[2]
Pattern										
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rc:Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Profile										
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	1.1	-----	-----	1.16	-----	2
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters										
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----			0.10 / 0.15 / 0.25 / 1.2 / 2.7[2]			
Reach Shear Stress (competency) lb/f^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters										
Drainage Area (SM)	-----	-----	-----	-----	-----	-----	-----	0.66	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----		-----	-----	-----	-----	-----
Rosgen Classification	-----	-----	-----	-----	-----	Gc	-----	-----	-----	-----
BF Velocity (fps)	-----	-----	-----	-----	0.8	-----	-----	1.2	-----	2
BF Discharge (cfs)	-----	290.0	2000.0	66.0	-----	6.48	-----	-----	-----	-----
35	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel length (ft)[2]	-----	-----	-----	-----	-----	4091	-----	-----	-----	-----
Sinuosity	-----	-----	-----	-----	-----	1.13	-----	-----	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	-----	-----	-----	-----	0.0045	-----	-----	-----	2
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

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

[1] Existing conditions survey data is compiled for the entire UT1 Reach within the project limits.

[2] Bulk samples taken since pebble count procedure is not applicable for sand-bed streams.

[3] Values were chosen based on sand-bed reference reach data and past project evaluations.

[4] Composite reference reach information from Johannah Creek, Johnston County; Panther Branch, Brunswick County; Rocky Swamp, Halifax County; and Beaver Dam Branch, Jones County

Table 5. Baseline Stream Summary
UT to Mill Swamp Restoration Project: EEP Project ID No. 950

Reach UT1c (1,513 LF)												
Parameter	**Reference Reach(es) Data**											
	Beaverdam Branch						**NC Coastal Plain Composite Data[4]**					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Floodprone Width (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Mean Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	24	-----	-----	-----	2	7.8	-----	-----	95.9	-----	-----
Width/Depth Ratio	11	-----	-----	17	-----	2	8	-----	-----	14	-----	-----
Entrenchment Ratio	10	-----	-----	11	-----	2	4	-----	-----	13	-----	-----
Bank Height Ratio	1.0	-----	-----	1.3	-----	2	1.0	-----	-----	1.3	-----	-----
d50 (mm)	-----	0.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rc:Bankfull width (ft/ft)	1.8	-----	-----	2.4	-----	-----	1.5	-----	-----	3.0	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	2.0	-----	-----	6.3	-----	-----
Profile												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
d16 / d35 / d50 / d84 / d95			0.3 / 0.4 / 0.5 / 0.9 / 1.2				-----	-----	-----	-----	-----	-----
Reach Shear Stress (competency) lb/f^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters												
Drainage Area (SM)	-----	-----	-----	3.0	-----	-----	1.0	-----	-----	19.5	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	C5c	-----	-----	-----	-----	-----	E5/C5	-----	-----	-----	-----
BF Velocity (fps)	-----	1.5	-----	-----	-----	-----	1.0	-----	-----	1.4	-----	-----
BF Discharge (cfs)	-----	37	-----	-----	-----	-----	10	-----	-----	127	-----	-----
35	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel length (ft)[2]	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sinuosity	-----	1.66	-----	-----	-----	-----	1.22	-----	-----	1.77	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	0.0004	-----	-----	-----	-----	0.0004	-----	-----	0.0022	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Table 5. Baseline Stream Summary
UT to Mill Swamp Restoration Project: EEP Project ID No. 950

Reach UT1c (1,513 LF)												
Parameter	**Design**						**As-built**					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-----	10.3	-----	-----	-----	1	10.1	-----	-----	13.8	-----	4
Floodprone Width (ft)	-----	>100	-----	-----	-----	1	80.1	-----	-----	105.0	-----	4
BF Mean Depth (ft)	-----	0.7	-----	-----	-----	1	0.6	-----	-----	1.2	-----	4
BF Max Depth (ft)	-----	1.0	-----	-----	-----	1	1.1	-----	-----	2.0	-----	4
BF Cross-sectional Area (ft^2)	-----	7.6	-----	-----	-----	1	7.5	-----	-----	12.3	-----	4
Width/Depth Ratio	-----	14	-----	-----	-----	1	8.3	-----	-----	19.4	-----	4
Entrenchment Ratio	-----	>10	-----	-----	-----	1	7.9	-----	-----	9.4	-----	4
Bank Height Ratio	-----	1.0	-----	-----	-----	1	1.0	-----	-----	1.1	-----	4
d50 (mm)	-----	0.25	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern												
Channel Beltwidth (ft)	35	-----	-----	60	-----	-----[3]	38.0	79.0	-----	120.0	-----	-----
Radius of Curvature (ft)	20	-----	-----	30	-----	-----[3]	21.0	26.0	-----	31.0	-----	-----
Rc:Bankfull width (ft/ft)	2.0	-----	-----	3.0	-----	-----[3]	38.0	79.0	-----	120.0	-----	-----
Meander Wavelength (ft)	80	-----	-----	110	-----	-----[3]	72.0	104.0	-----	124.0	-----	-----
Meander Width Ratio	3.5	-----	-----	6.0	-----	-----[3]	3.5	6.0	-----	8.0	-----	-----
Profile												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Riffle Slope (ft/ft)	0.004	-----	-----	0.010	-----	-----	0.0046	0.0043	-----	0.0039	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----						-----
Pool Spacing (ft)	30	-----	-----	80	-----	-----	41	-----	72	57	-----	-----
Pool Max Depth (ft)	-----	1.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
Reach Shear Stress (competency) lb/f^2	-----	0.149	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	4.181	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters												
Drainage Area (SM)	-----	-----	-----	0.66	-----	-----	-----	-----	-----	0.66	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classification	-----	C5	-----	-----	-----	-----	-----	C5	-----	-----	-----	-----
BF Velocity (fps)	-----	1.76	-----	-----	-----	-----	-----	3.0	-----	-----	-----	-----
BF Discharge (cfs)	-----	12.9	-----	-----	-----	-----	-----	340.0	-----	-----	-----	-----
35	-----	-----	-----	-----	-----	-----	-----	3523	-----	-----	-----	-----
Channel length (ft)[2]	-----	1453	-----	-----	-----	-----	-----	4238	-----	-----	-----	-----
Sinuosity	-----	1.24	-----	-----	-----	-----	-----	1.20	-----	-----	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	0.0038	-----	-----	-----	-----	-----	0.0042	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0054	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Table 6. Morphology and Hydraulic Monitoring Summary
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Reach UT1c (1,513 LF)

	Cross-section X-1 (Riffle)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
BF Width (ft)	11.9						
BF Mean Depth (ft)	0.6						
Width/Depth Ratio	18.9						
BF Cross-sectional Area (ft²)	7.5						
BF Max Depth (ft)	1.4						
Width of Floodprone Area (ft)	104.5						
Entrenchment Ratio	8.8						
Bank Height Ratio	1.0						
Wetted Perimeter (ft)	13.2						
Hydraulic Radius (ft)	0.6						
Based on current/developing bankfull feature							
BF Width (ft)							
BF Mean Depth (ft)							
Width/Depth Ratio							
BF Cross-sectional Area (ft²)							
BF Max Depth (ft)							
Width of Floodprone Area (ft)							
Entrenchment Ratio							
Bank Height Ratio							
Wetted Perimeter (ft)							
Hydraulic Radius (ft)							
Cross Sectional Area between end pins (ft²)	-						
d50 (mm)	-						

	Cross-section X-2 (Pool)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
BF Width (ft)	15.4						
BF Mean Depth (ft)	1.1						
Width/Depth Ratio	14.4						
BF Cross-sectional Area (ft²)	16.6						
BF Max Depth (ft)	2.4						
Width of Floodprone Area (ft)	107.9						
Entrenchment Ratio	7.0						
Bank Height Ratio	1.0						
Wetted Perimeter (ft)	17.6						
Hydraulic Radius (ft)	0.9						
Based on current/developing bankfull feature							
BF Width (ft)							
BF Mean Depth (ft)							
Width/Depth Ratio							
BF Cross-sectional Area (ft²)							
BF Max Depth (ft)							
Width of Floodprone Area (ft)							
Entrenchment Ratio							
Bank Height Ratio							
Wetted Perimeter (ft)							
Hydraulic Radius (ft)							
Cross Sectional Area between end pins (ft²)	-						
d50 (mm)	-						

	Cross-section X-3 (Pool)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
BF Width (ft)	21.3						
BF Mean Depth (ft)	0.6						
Width/Depth Ratio	33.9						
BF Cross-sectional Area (ft²)	13.4						
BF Max Depth (ft)	1.5						
Width of Floodprone Area (ft)	117.0						
Entrenchment Ratio	5.5						
Bank Height Ratio	1.0						
Wetted Perimeter (ft)	22.5						
Hydraulic Radius (ft)	0.6						
Based on current/developing bankfull feature							
BF Width (ft)							
BF Mean Depth (ft)							
Width/Depth Ratio							
BF Cross-sectional Area (ft²)							
BF Max Depth (ft)							
Width of Floodprone Area (ft)							
Entrenchment Ratio							
Bank Height Ratio							
Wetted Perimeter (ft)							
Hydraulic Radius (ft)							
Cross Sectional Area between end pins (ft²)							
d50 (mm)							

	Cross-section X-4 (Riffle)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
BF Width (ft)	11.2						
BF Mean Depth (ft)	0.7						
Width/Depth Ratio	16.5						
BF Cross-sectional Area (ft²)	7.5						
BF Max Depth (ft)	1.1						
Width of Floodprone Area (ft)	104.5						
Entrenchment Ratio	9.4						
Bank Height Ratio	1.1						
Wetted Perimeter (ft)	12.5						
Hydraulic Radius (ft)	0.6						
Based on current/developing bankfull feature							
BF Width (ft)							
BF Mean Depth (ft)							
Width/Depth Ratio							
BF Cross-sectional Area (ft²)							
BF Max Depth (ft)							
Width of Floodprone Area (ft)							
Entrenchment Ratio							
Bank Height Ratio							
Wetted Perimeter (ft)							
Hydraulic Radius (ft)							
Cross Sectional Area between end pins (ft²)							
d50 (mm)							

	Cross-section X-5 (Riffle)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
BF Width (ft)	13.8						
BF Mean Depth (ft)	0.7						
Width/Depth Ratio	19.4						
BF Cross-sectional Area (ft²)	9.9						
BF Max Depth (ft)	1.3						
Width of Floodprone Area (ft)	112.3						
Entrenchment Ratio	8.1						
Bank Height Ratio	1.0						
Wetted Perimeter (ft)	15.3						
Hydraulic Radius (ft)	0.6						
Based on current/developing bankfull feature							
BF Width (ft)							
BF Mean Depth (ft)							
Width/Depth Ratio							
BF Cross-sectional Area (ft²)							
BF Max Depth (ft)							
Width of Floodprone Area (ft)							
Entrenchment Ratio							
Bank Height Ratio							
Wetted Perimeter (ft)							
Hydraulic Radius (ft)							
Cross Sectional Area between end pins (ft²)	-						
d50 (mm)	-						

	Cross-section X-6 (Pool)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
BF Width (ft)	15.1						
BF Mean Depth (ft)	0.8						
Width/Depth Ratio	20.1						
BF Cross-sectional Area (ft²)	11.3						
BF Max Depth (ft)	1.8						
Width of Floodprone Area (ft)	114.3						
Entrenchment Ratio	7.6						
Bank Height Ratio	1.0						
Wetted Perimeter (ft)	16.6						
Hydraulic Radius (ft)	0.7						
Based on current/developing bankfull feature							
BF Width (ft)							
BF Mean Depth (ft)							
Width/Depth Ratio							
BF Cross-sectional Area (ft²)							
BF Max Depth (ft)							
Width of Floodprone Area (ft)							
Entrenchment Ratio							
Bank Height Ratio							
Wetted Perimeter (ft)							
Hydraulic Radius (ft)							
Cross Sectional Area between end pins (ft²)	-						
d50 (mm)	-						

	Cross-section 7 (Pool)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
BF Width (ft)	15.5						
BF Mean Depth (ft)	1.1						
Width/Depth Ratio	14.5						
BF Cross-sectional Area (ft²)	16.7						
BF Max Depth (ft)	2.0						
Width of Floodprone Area (ft)	132.4						
Entrenchment Ratio	8.5						
Bank Height Ratio	1.0						
Wetted Perimeter (ft)	17.7						
Hydraulic Radius (ft)	0.9						
Based on current/developing bankfull feature							
BF Width (ft)							
BF Mean Depth (ft)							
Width/Depth Ratio							
BF Cross-sectional Area (ft²)							
BF Max Depth (ft)							
Width of Floodprone Area (ft)							
Entrenchment Ratio							
Bank Height Ratio							
Wetted Perimeter (ft)							
Hydraulic Radius (ft)							
Cross Sectional Area between end pins (ft²)	-						
d50 (mm)	-						

	Cross-section X-8 (Riffle)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation							
BF Width (ft)	10.1						
BF Mean Depth (ft)	1.2						
Width/Depth Ratio	8.3						
BF Cross-sectional Area (ft²)	12.3						
BF Max Depth (ft)	2.0						
Width of Floodprone Area (ft)	80.1						
Entrenchment Ratio	7.9						
Bank Height Ratio	1.1						
Wetted Perimeter (ft)	12.5						
Hydraulic Radius (ft)	1.0						
Based on current/developing bankfull feature							
BF Width (ft)							
BF Mean Depth (ft)							
Width/Depth Ratio							
BF Cross-sectional Area (ft²)							
BF Max Depth (ft)							
Width of Floodprone Area (ft)							
Entrenchment Ratio							
Bank Height Ratio							
Wetted Perimeter (ft)							
Hydraulic Radius (ft)							
Cross Sectional Area between end pins (ft²)	-						
d50 (mm)	-						

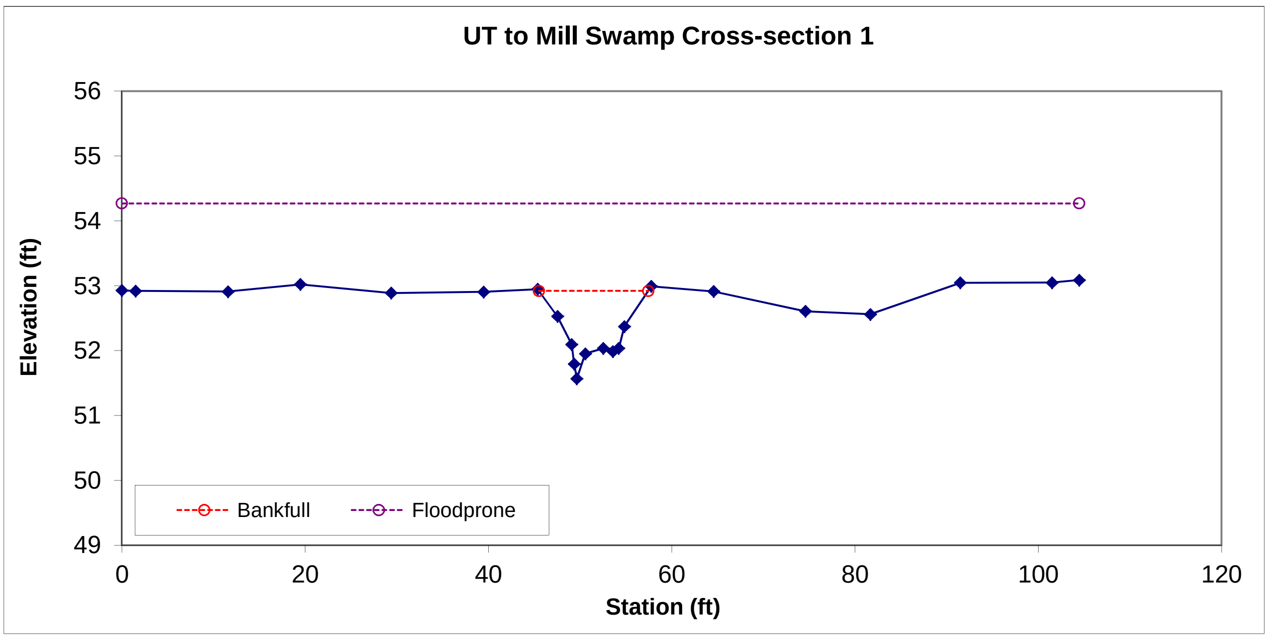
Permanent Cross-section 1

(As-Built Data - collected August 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	7.5	11.92	0.63	1.35	18.86	1	8.8	52.92	52.95

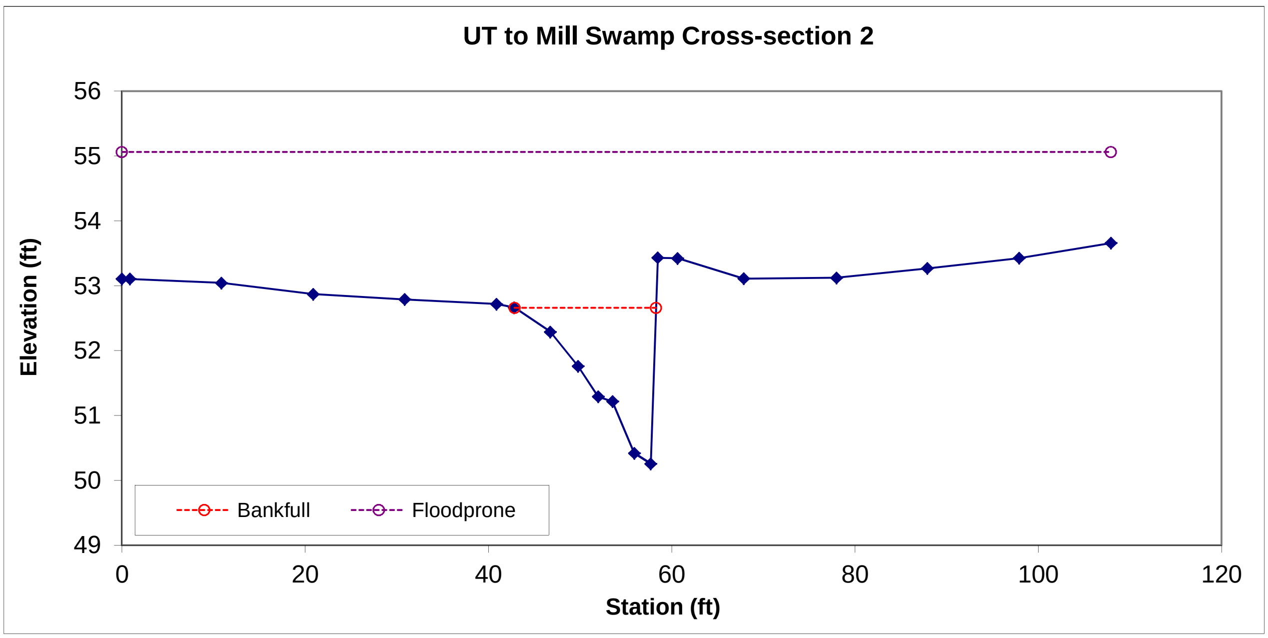


Permanent Cross-section 2
(As-Built Data - collected August 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		16.6	15.43	1.07	2.4	14.36	1	7	52.66	52.66



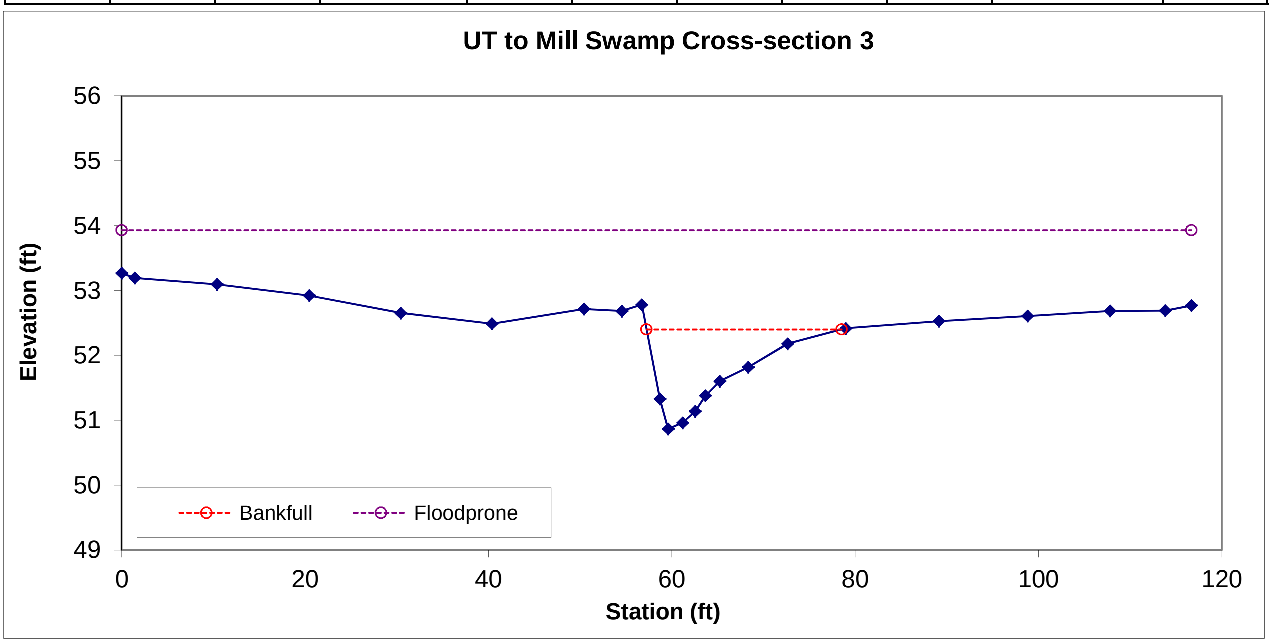
Permanent Cross-section 3

(As-Built Data - collected August 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		13.4	21.28	0.63	1.53	33.88	1	5.5	52.4	52.42



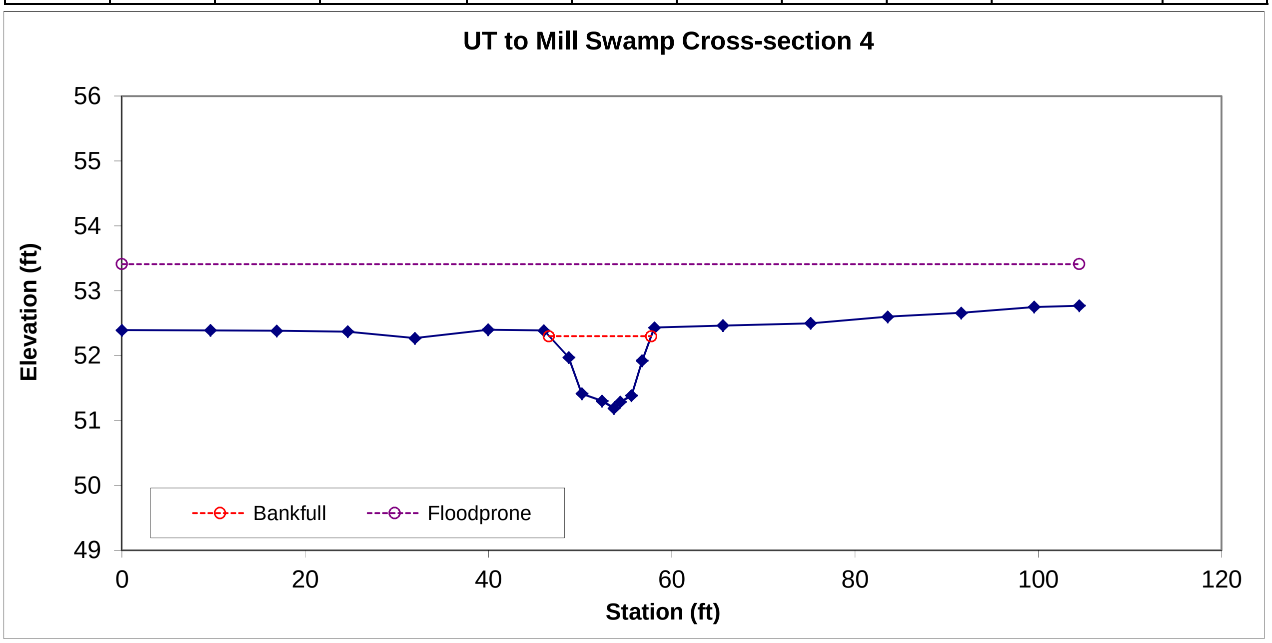
Permanent Cross-section 4

(As-Built Data - collected August 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	7.5	11.15	0.67	1.11	16.52	1.1	9.4	52.3	52.39



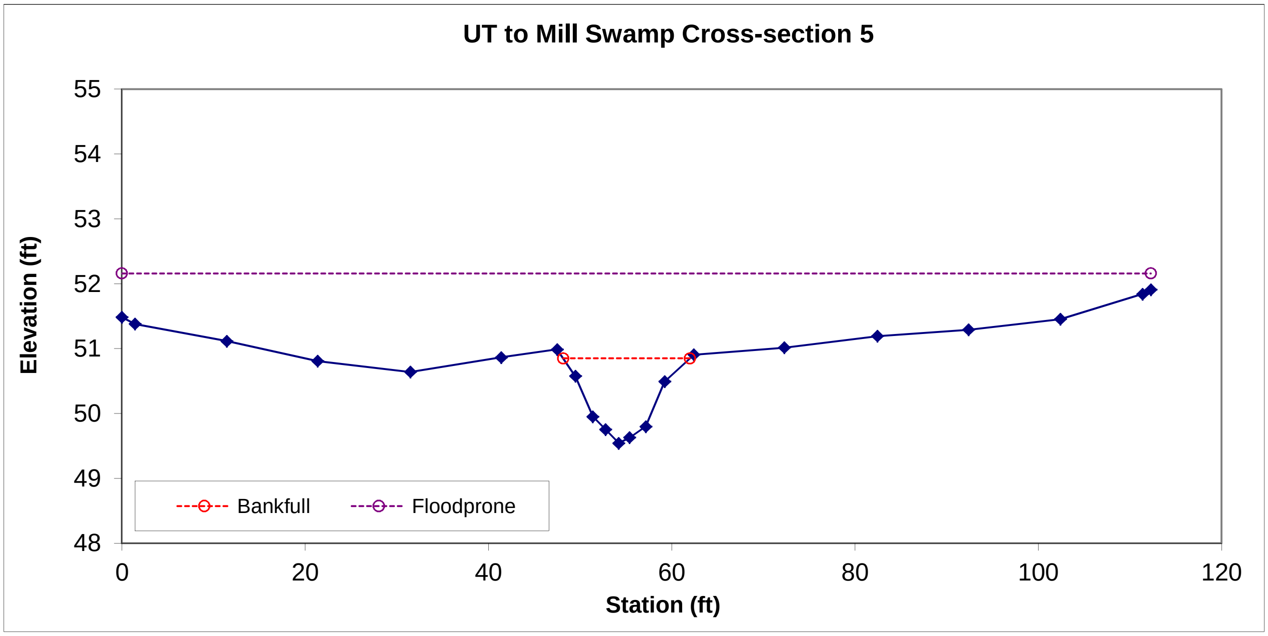
Permanent Cross-section 5

(As-Built Data - collected August 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	9.9	13.83	0.71	1.31	19.41	1	8.1	50.85	50.91

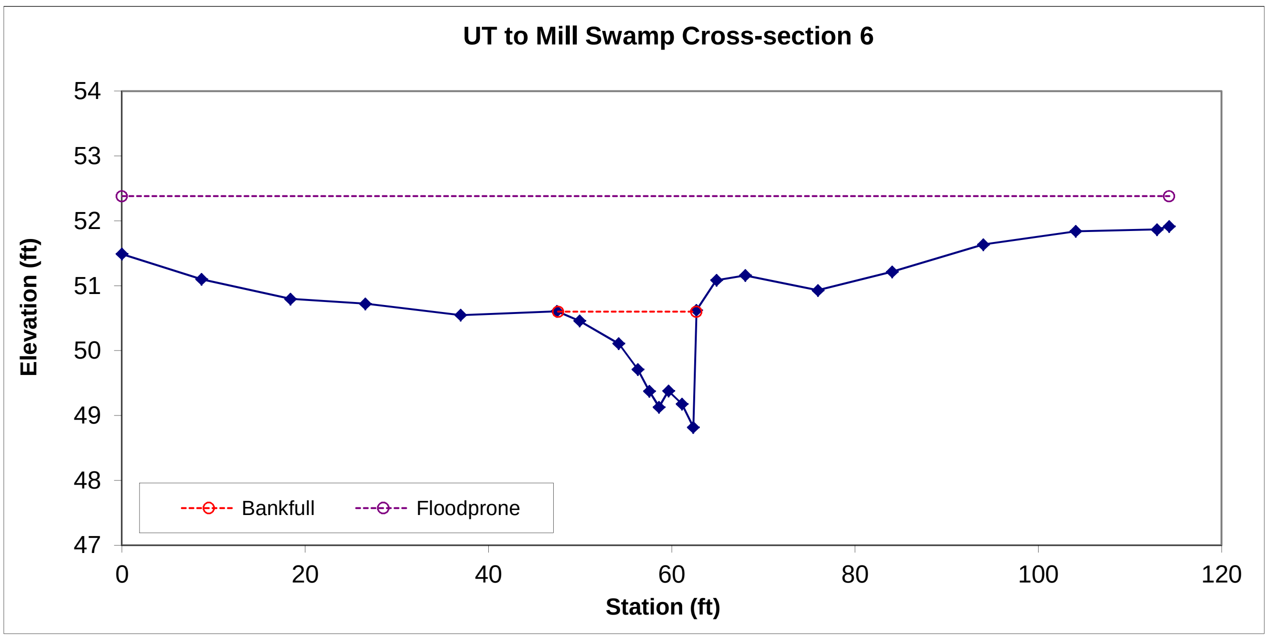


Permanent Cross-section 6
(As-Built Data - collected August 2013)


Looking at the Left Bank


Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		11.3	15.08	0.75	1.78	20.1	1	7.6	50.6	50.61

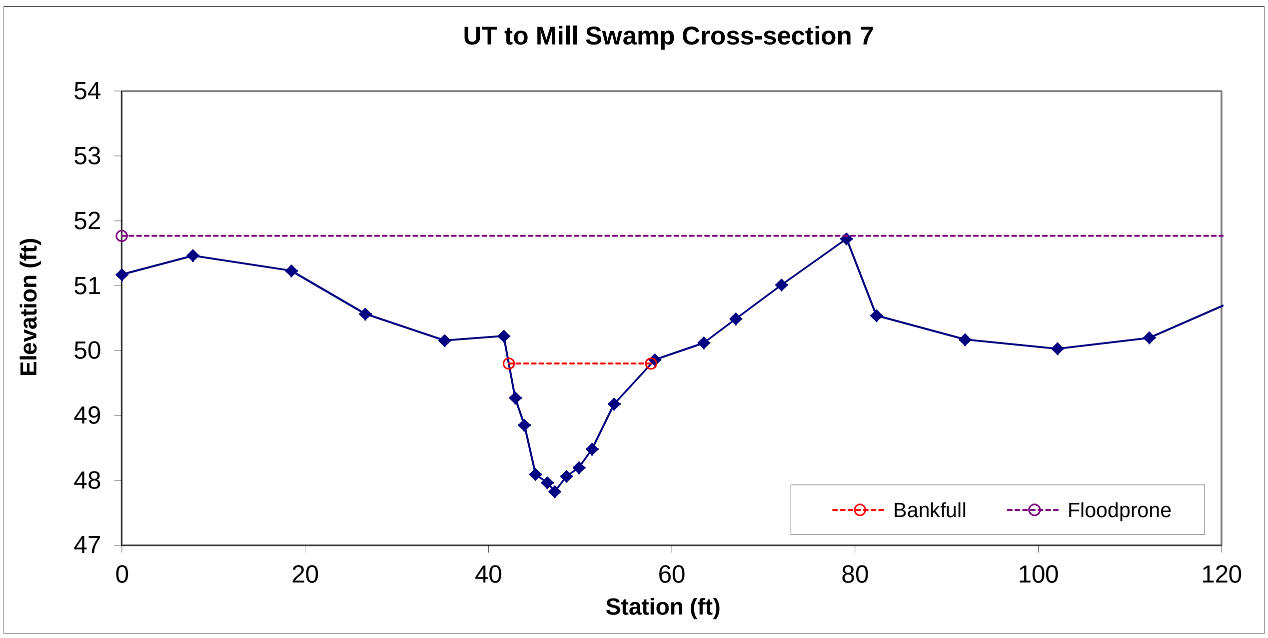


Permanent Cross-section 7
(As-Built Data - collected August 2013)


Looking at the Left Bank


Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		16.7	15.54	1.07	1.97	14.47	1	8.5	49.8	49.86

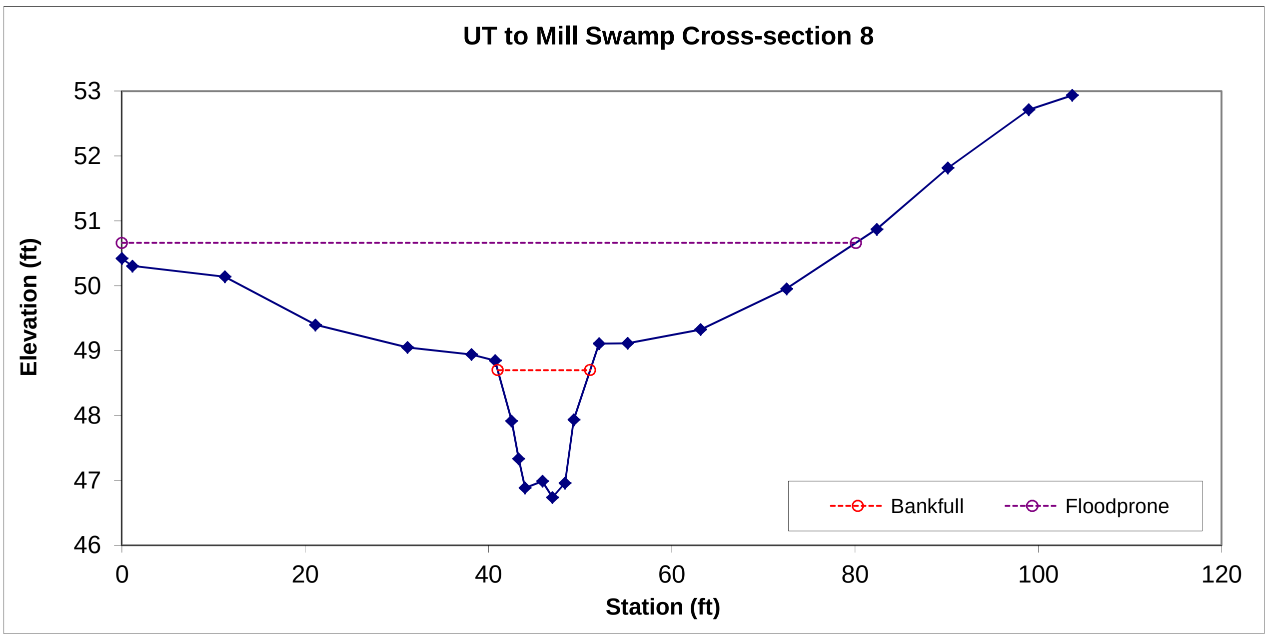


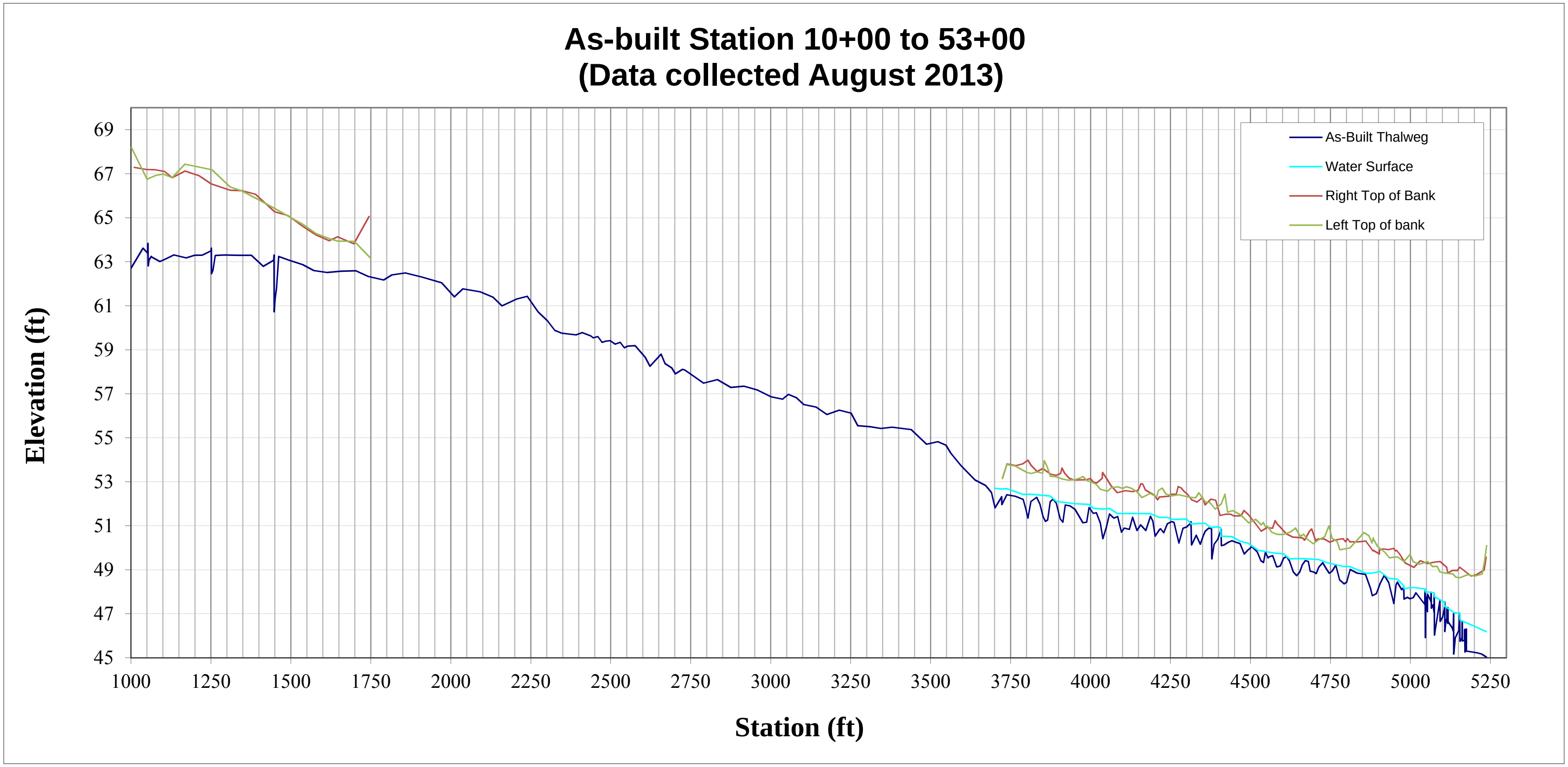
Permanent Cross-section 8
(As-Built Data - collected August 2013)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	12.3	10.08	1.22	1.96	8.28	1.1	7.9	48.7	48.85




As-built Station 10+00 to 53+00
(Data collected August 2013)
Elevation (ft)
Station (ft)
As-Built Thalweg
Water Surface
Right Top of Bank
Left Top of bank
69
67
65
63
61
59
57
55
53
51
49
47
45
1000
1250
1500
1750
2000
2250
2500
2750
3000
3250
3500
3750
4000
4250
4500
4750
5000
5250

APPENDIX C

Vegetation Data (Tables 7 and 8)

Table 7. Vegetation Species Planted Across the Restoration Site UT to Mill Swamp Restoration Project: EEP Project ID No. 95019			
Botanical Name	**Common Name**	**% Planted by Species**	**Total Number of Stems**
Headwater Riparian Buffer Plantings - Overstory 9' x 12' spacing - 403 stems/Acre			
Fraxinus pennsylvanica	Green Ash	10%	200
Quercus michauxii	Swamp Chestnut Oak	20%	400
Nyssa biflora	Swamp Black Gum	25%	500
Liriodendron tulipifera	Tulip Poplar	10%	200
Quercus lyrata	Overcup Oak	15%	300
Quercus nigra	Water Oak	20%	400
Understory Headwater Riparian Buffer Plantings - Understory 18' x 15' spacing - 161 stems/Acre			
Clethra alnifolia	Sweet Pepperbush	15%	120
Cyrilla racimiflora	Titi	20%	160
Itea virginica	Sweetspire	15%	120
Magnolia virginiana	Sweet Bay Magnolia	15%	120
Lyonia lucida	Fetterbush	20%	160
Persea palustris	Red bay	15%	120
Riparian Wetland Buffer Plantings – Overstory 9'x 12' spacing - 403 stems/Acre			
Liriodendron tulipifera	Tulip Poplar	15%	480
Nyssa biflora	Swamp Black Gum	15%	480
Quercus michauxii	Swamp Chestnut Oak	15%	480
Quercus lyrata	Overcup Oak	15%	480
Quercus nigra	Water Oak	15%	240
Quercus phellos	Willow Oak	7.5%	240
Quercus pagoda	Cherrybark Oak	7.5%	320
Ulmus americana	American Elm	15%	480
Riparian Wetland Buffer Plantings – Understory 18'x 15' spacing - 161 stems/Acre			
Cyrilla racimiflora	Titi	20%	260
Itea virginica	Sweetspire	10%	130
Leucothoe racemosa	Swamp Doghobble	10%	130
Carpinus caroliniana	Ironwood	15%	190
Magnolia virginiana	Sweet Bay Magnolia	20%	258
Persea palustris	Red bay	10%	130
Vaccineum corymbosum	Highbush Blueberry	15%	190
Riparian Live Stake Plantings			
Cephalanthus occidentalis	Buttonbush	0%	None
Salix nigra	Black Willow	0%	None
Salix sericea	Silky Willow	0%	None
Sambucus canadensis	Elderberry	0%	None
Note: Riparian Live Stakes will be planted as needed in the Fall (dormant season) of 2013			

Table 8. Stem Count for Each Species Arranged by Plot
UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Tree Species	Plots					
	1	2	3	4	5	6
Carpinus caroliniana				3	1	
Clethra alnifolia						
Cyrilla racimiflora						
Fraxinus pennsylvanica						
Itea virginica	1					1
Leucothoe racemosa						
Liriodendron tulipifera	4					3
Lyonia lucida						
Magnolia virginiana						
Nyssa biflora	1	1	2	4	1	2
Quercus lyrata	3	1	1	1	4	1
Quercus michauxii	3	4	7	1	5	
Quercus nigra	1	2		2		
Quercus pagoda		2		2	2	1
Quercus phellos	1	1	1	5	3	2
Persea palustris	2	2				2
Ulmus americana				1		3
Vaccineum corymbosum					1	
Unknown	2	2	5		2	2
Stems/plot	18	15	16	19	19	17
Stems/acre	720	600	640	760	760	680
Total Stems/ Acre for Year 0 As-Built (Baseline Data)	**693**					

APPENDIX D

As-Built Plan Sheets/Record Drawings

STATE	BAKER PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
NC	124578	1	14

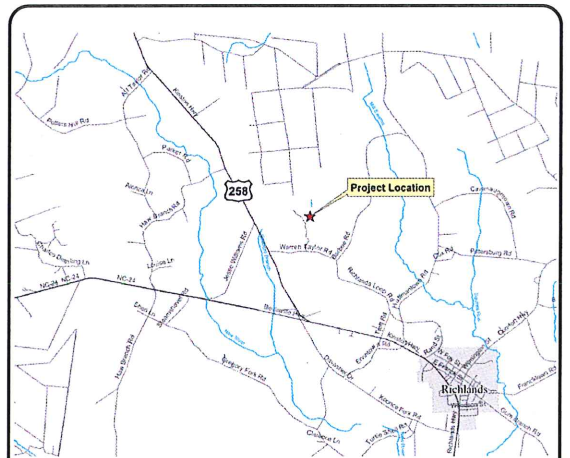
PROJECT: 124578 UT TO MILL SWAMP

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

ONSLOW COUNTY

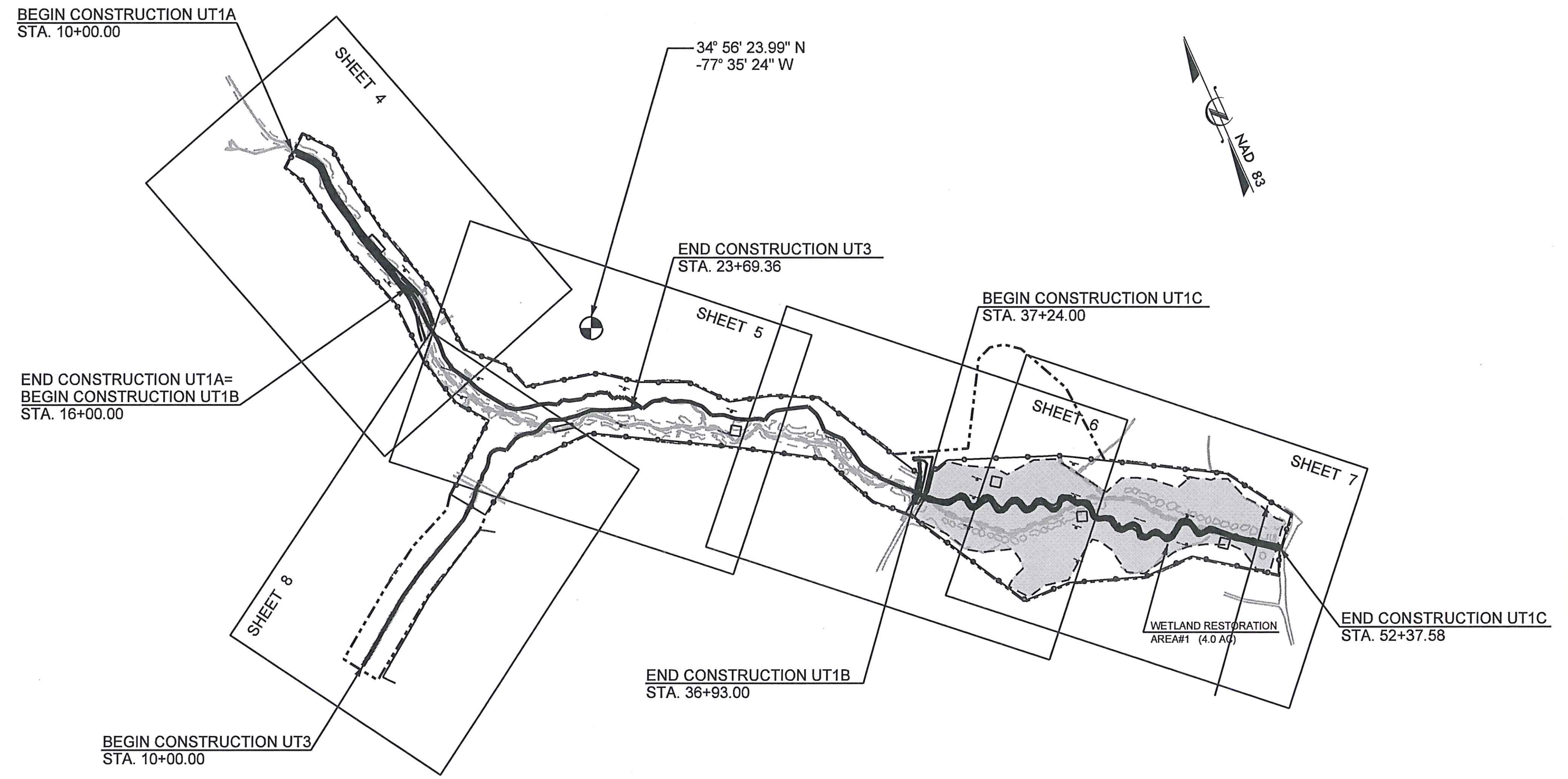
LOCATION: APPROX. 3 MILES NORTHWEST OF THE TOWN OF RICHLANDS

TYPE OF WORK: AS-BUILT PLANS FOR STREAM AND WETLAND RESTORATION AND ENHANCEMENT



VICINITY MAP
N.T.S

INDEX OF SHEETS



NCEEP ID NO. 95019

DWQ PROJECT #20120916
PCN APPLICATION RECORDED 01/03/13
APPROVAL DATE 02/08/13

GRAPHIC SCALES

40 20 0 40 80
PLANS

40 20 0 40 80
PROFILE (HORIZONTAL)

5 0 5 10
PROFILE (VERTICAL)

PROJECT SUMMARY

EXISTING STREAM LENGTH UT1 (TOTAL)	=	4,081 FEET
AS-BUILT ENHANCEMENT STREAM LENGTH UT1A	=	600 FEET
AS-BUILT RESTORATION STREAM LENGTH UT1B	=	2,093 FEET
AS-BUILT RESTORATION STREAM LENGTH UT1C	=	1,513 FEET
AS-BUILT STREAM LENGTH UT3	=	1,369 FEET
AS-BUILT WETLAND RESTORATION AREA #1 (RIPARIAN)	=	4.0 ACRES

PREPARED FOR THE OFFICE OF:

Ecosystem Enhancement PROGRAM

NCDENR
ECOSYSTEM ENHANCEMENT PROGRAM
1652 MAIL SERVICE CENTER
RALEIGH, NC 27699-1652

NCEEP CONTACT: KRISTIN MIGUEZ
PROJECT MANAGER

PREPARED IN THE OFFICE OF:

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

JUNE 2013
COMPLETION DATE:

WILLIAM SCOTT HUNT, III, PE
PROJECT ENGINEER

KAYNE VAN STELL
PROJECT MANAGER

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 22967 WILLIAM SCOTT HUNT, III
09.19.2013

SIGNATURE: P.E.

Baker

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

2/26/03

STREAM CONVENTIONAL SYMBOLS

SUPERCEDES SHEET 1-B

- ROOT WAD
- LOG VANE
- LOG WEIR
- LOG ROLLER
- GRADE CONTROL LOG JAM
- PERMANENT STREAM CROSSING
- VEG PLOT
- CE CONSERVATION EASEMENT
- 210 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- LIMITS OF DISTURBANCE
- DITCH PLUG
- CHANNEL FILL
- BAKER CONTROL POINT
- FLOW GAUGE
- WELL PIN
- PHOTO POINT

GENERAL NOTES

1. CONSTRUCTION BEGAN IN APRIL 2013 AND WAS COMPLETED JUNE 2013.
2. VEGETATION PLANTING WAS COMPLETED IN JUNE 2013.

STANDARD SPECIFICATIONS

NORTH CAROLINA
EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL
MARCH 2009

- 6.06 TEMPORARY GRAVEL CONSTRUCTION ENTRANCE
- 6.60 TEMPORARY SEDIMENT TRAP
- 6.62 TEMPORARY SILT FENCE
- 6.63 TEMPORARY ROCK DAM
- 6.70 TEMPORARY STREAM CROSSING

VEGETATION SELECTION

The following table lists the vegetation selection for the project site. Total planting area was approximately 12 acres based on areas disturbed during construction. Actual placement of species and densities were determined prior to site planting and vary based on apparent wetness of planting locations per the vegetation specialist.

Botanical Name	Common Name	% Planted by Species	Total Number of Stems
Headwater Riparian Buffer Plantings - Overstory 9' x 12' spacing - 403 stems/Acre			
Fraxinus pennsylvanica	Green Ash	10%	200
Quercus michauxii	Swamp Chestnut Oak	20%	400
Nyssa biflora	Swamp Black Gum	25%	500
Liriodendron tulipifera	Tulip Poplar	10%	200
Quercus lyrata	Overcup Oak	15%	300
Quercus nigra	Water Oak	20%	400
Understory Headwater Riparian Buffer Plantings - Understory 18' x 15' spacing - 161 stems/Acre			
Clethra alnifolia	Sweet Pepperbush	15%	120
Cyrilla racimiflora	Titi	20%	160
Itea virginica	Sweetspire	15%	120
Magnolia virginiana	Sweet Bay Magnolia	15%	120
Lyonia lucida	Fetterbush	20%	160
Persea palustris	Red bay	15%	120
Riparian Wetland Buffer Plantings – Overstory 9' x 12' spacing - 403 stems/Acre			
Liriodendron tulipifera	Tulip Poplar	15%	480
Nyssa biflora	Swamp Black Gum	15%	480
Quercus michauxii	Swamp Chestnut Oak	15%	480
Quercus lyrata	Overcup Oak	15%	480
Quercus nigra	Water Oak	15%	240
Quercus phellos	Willow Oak	7.5%	240
Quercus pagoda	Cherrybark Oak	7.5%	320
Ulmus americana	American Elm	15%	480
Riparian Wetland Buffer Plantings – Understory 18' x 15' spacing - 161 stems/Acre			
Cyrilla racimiflora	Titi	20%	260
Itea virginica	Sweetspire	10%	130
Leucothoe racemosa	Swamp Doghobble	10%	130
Carpinus caroliniana	Ironwood	15%	190
Magnolia virginiana	Sweet Bay Magnolia	20%	258
Persea palustris	Red bay	10%	130
Vaccineum corymbosum	Highbush Blueberry	15%	190
Riparian Live Stake Plantings (Reach UT1c)			
Cephalanthus occidentalis	Buttonbush	0%	None
Salix nigra	Black Willow	0%	None
Salix sericea	Silky Willow	0%	None
Sambucus canadensis	Elderberry	0%	None
Note: Riparian Live Stakes will be planted as needed in the Fall (dormant season) of 2013			

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

Permanent herbaceous seed mixtures for the project site were planted throughout the floodplain and riparian buffer areas. Permanent seed mixtures were applied with temporary seed, as defined in the construction specifications.

Scientific Name	Common Name	% Planted By Species	Total lbs per Acre	Wetland Tolerance
Andropogon gerardii	Big blue stem	10%	1.50	FAC
Andropogon glomeratus	Bushy blue stem	10%	1.50	FACW+
Carex lupulina	Hop sedge	10%	2.25	OBL
Carex vulpinoidea	Fox sedge	10%	2.25	OBL
Elymus virginicus	Virginia wild rye	10%	1.50	FAC
Juncus effusus	Soft rush	15%	2.25	FACW+
Panicum virgatum	Switchgrass	10%	1.50	FAC+
Polygonum pensylvanicum	Smartweed	5%	0.75	FACW
Schizachyrium scoparium	Little blue stem	10%	0.75	FACU
Sorghastrum nutans	Indiangrass	10%	0.75	FACU
	Total	**100%**	**15.0**	

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
09.19.2013

9/19/2013
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PROJECT REFERENCE NO.	SHEET NO.
124578	1-B

2/26/03

*S.U.E = SUBSURFACE UTILITY ENGINEER

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

CONVENTIONAL SYMBOLS

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
09.19.2013

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 — 23
- 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
- Well
- 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
- Proposed Right of Way Line with Iron Pin and Cap Marker
- Proposed Right of Way Line with Concrete or Granite Marker
- Existing Control of Access
- Proposed Control of Access
- 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
- Designated U/G Water Line (S.U.E.*)
- 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.

8/22/2013
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BAKER PROJECT REFERENCE NO.	SHEET NO.
124578	2

PROJECT ENGINEER

Baker

Michael Baker Engineering Inc.
8000 Regency Parkway, Suite 600
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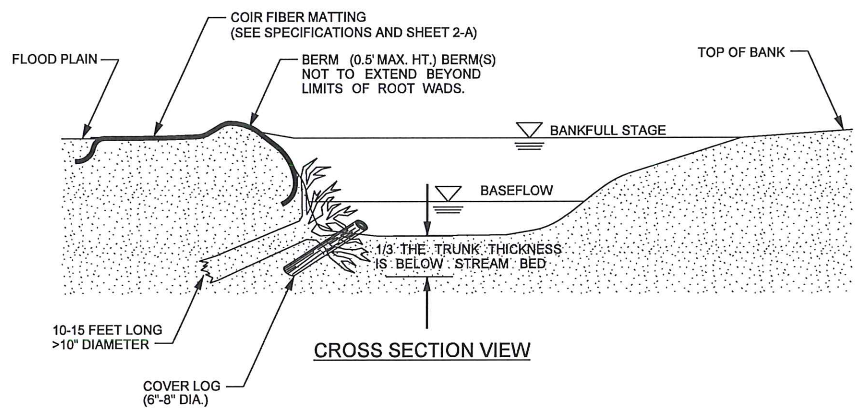
Phone: 919.463.5488
Fax: 919.463.5490
License #: F-1084

2/26/03

ROOT WADS

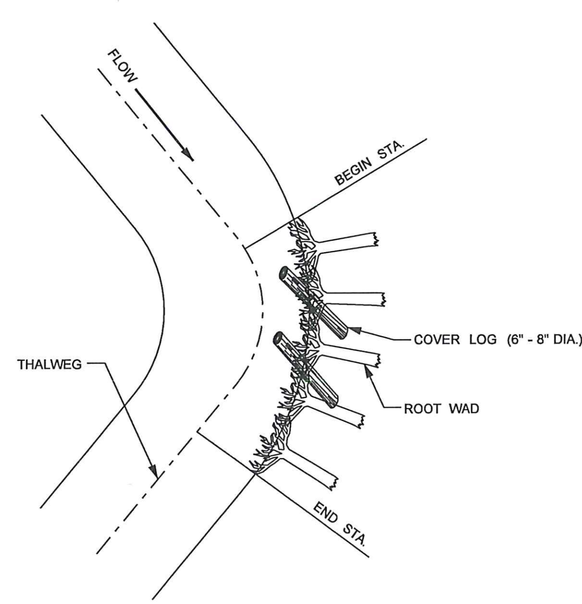
ROOT WADS WITHOUT TRANSPLANTS

USE IF TRANSPLANTS ARE NOT AVAILABLE ON-SITE



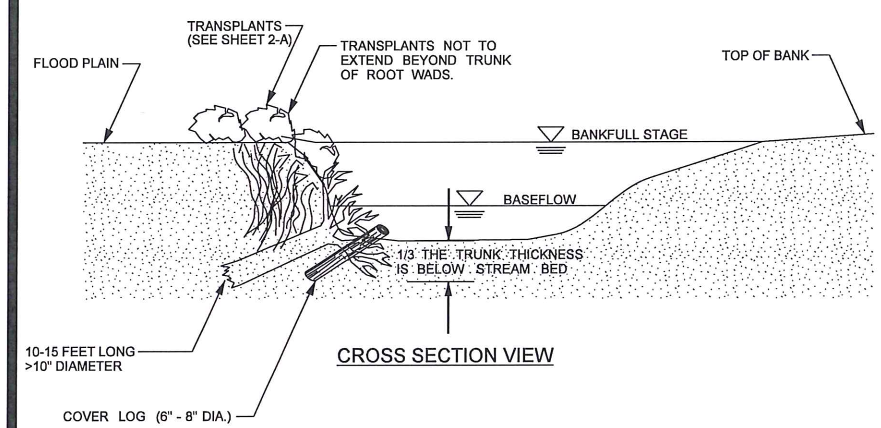
CROSS SECTION VIEW

PLAN VIEW



ROOT WADS WITH TRANSPLANTS

USE IF TRANSPLANTS ARE AVAILABLE ON-SITE



CROSS SECTION 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.

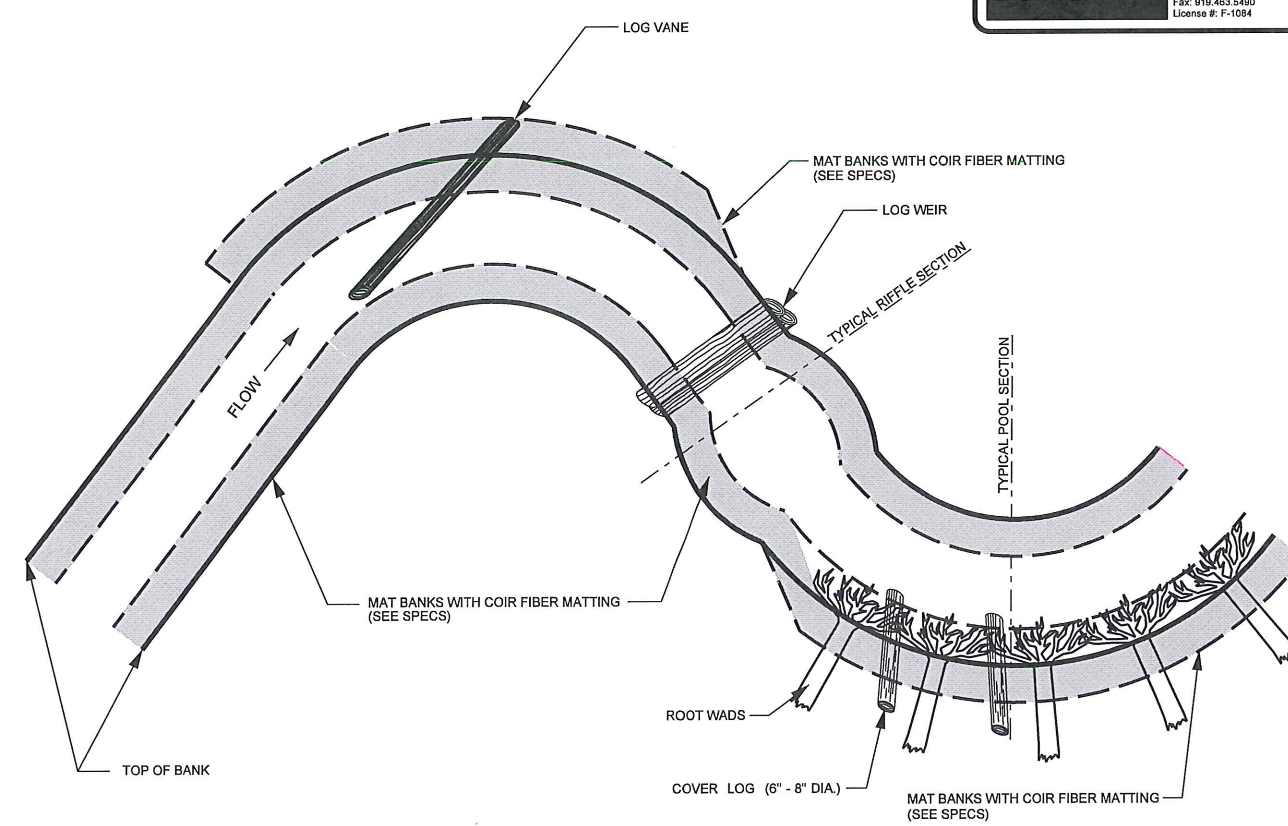
TYPICAL STRUCTURE PLACEMENT

STRUCTURE NOTES:

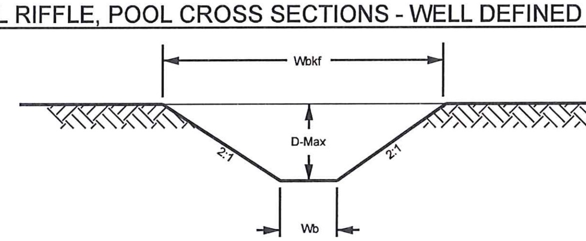
1. GENERALLY LOG WEIRS, ROOT WADS, LOG VANES AND COIR FIBER MATTING WILL BE INSTALLED IN THE LOCATION AND SEQUENCE AS SHOWN.
2. ADDITIONAL STRUCTURES OR CHANGES TO STRUCTURE LOCATIONS MAY BE MADE BY THE DESIGN ENGINEER DURING CONSTRUCTION.

NOTES:

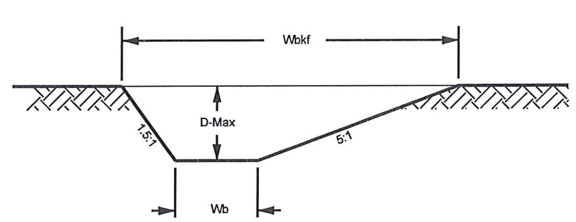
1. COIR FIBER MATTING TO BE INSTALLED ON ALL RESTORED STREAMBANKS EXCEPT ON POINT BARS.
2. IF ROOT WADS DO NOT COVER ENTIRE SLOPE ON OUTSIDE OF MEANDER BENDS, COIR FIBER MATTING IS NEEDED.
3. ROOT WADS SHALL BE ANGLED APPROXIMATELY 90° TOWARDS THE STREAMBANK.



TYPICAL RIFFLE, POOL CROSS SECTIONS - WELL DEFINED CHANNEL



RIFFLE



POOL

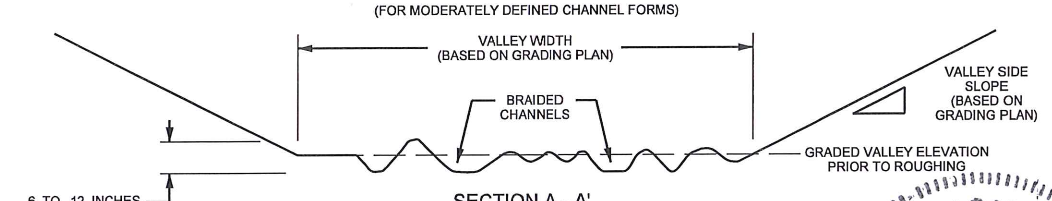
NOTES:

1. DURING CONSTRUCTION CORNERS OF DESIGN CHANNEL WILL BE ROUNDED AND A THALWEG WILL BE SHAPED PER THE DETAILS AND SPECIFICATIONS.
2. POOLS SHOWN ABOVE ARE LEFT POOLS ONLY.
3. REACH UT1A AND UT1B WILL BE CONSTRUCTED PER THE PROPOSED GRADING PLAN AND AS SHOWN ON TYPE 2 VALLEY DETAIL.

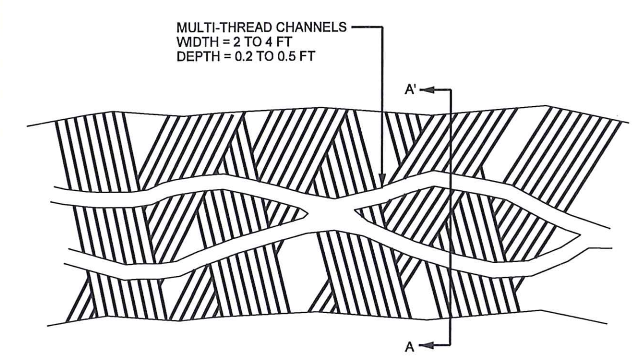
UT1C		
RIFFLE	POOL	
10.3	14.3	WIDTH OF BANKFULL (Wbkf)
1.0	1.6	MAXIMUM DEPTH (D-Max)
14.0	14.0	WIDTH TO DEPTH RATIO (Wbkf / D)
7.6	14.6	BANKFULL AREA (Abkf)
5.5	3.9	BOTTOM WIDTH (Wb)

TYPE 2 VALLEY

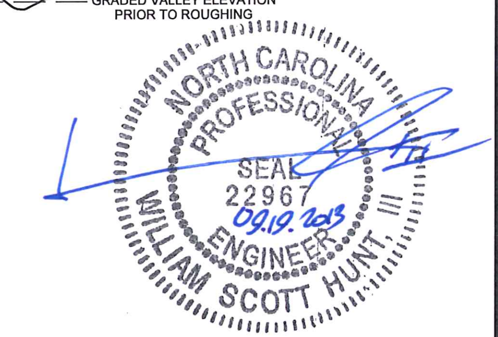
(FOR MODERATELY DEFINED CHANNEL FORMS)



SECTION A - A'



PLAN VIEW OF MICROTOPOGRAPHIC PATTERN



NOTES:

1. GRADE VALLEY TO DESIGN CONTOURS SHOWN ON GRADING PLAN.
2. MICROTOPOGRAPGHY IS TYPICALLY CREATED USING STANDARD TILLAGE EQUIPMENT CONFIGURED TO FORM MOUNDS AND FURROWS OF APPROPRIATE SIZE. ALTERNATIVE CONSTRUCTION METHODS SHALL BE APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION.
3. MULTI-THREAD CHANNEL ALIGNMENT WILL BE BE LOCATED BY ENGINEER FOLLOWING COMPLETION OF THE CHANNEL FILL AND MICROTOPOGRAPGIC ROUGHING.
4. MULTI-THREAD CHANNELS WILL BE SHAPED TO FORM SMOOTH TRANSITIONS.
5. UPON COMPLETION OF BRAIDED CHANNEL FEATURES, APPLY MULCH TEMPORARY SEED, AND PERMANENT SEED TO THE CONSTRUCTED VALLEY ACCORDING TO SEDIMENT AND EROSION CONTROL SPECIFICATIONS.

9/19/2013
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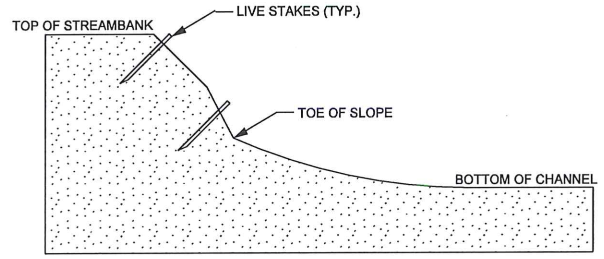
2/26/03

BAKER PROJECT REFERENCE NO.	SHEET NO.
124578	2-A

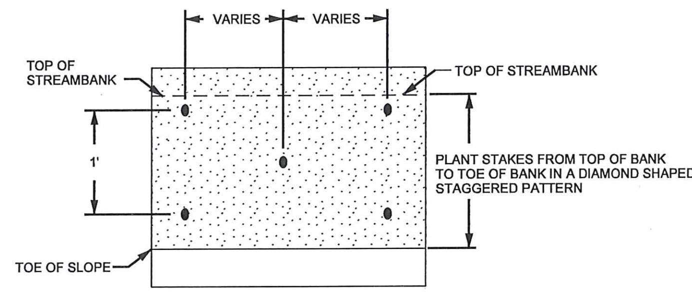
PROJECT ENGINEER

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

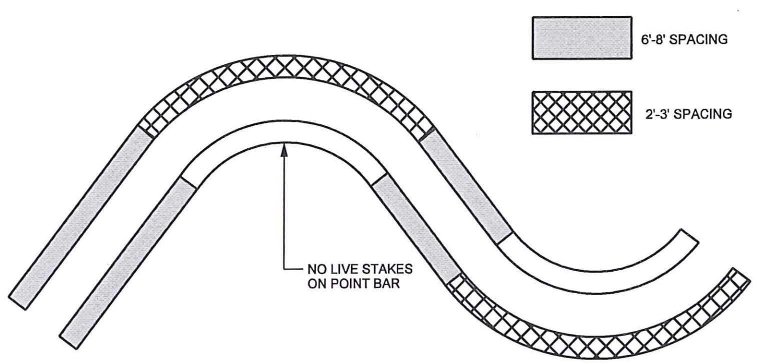
LIVE STAKING



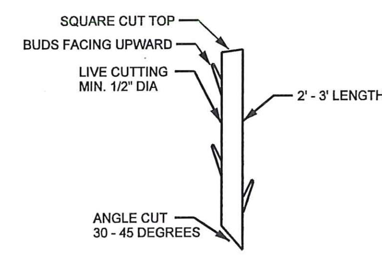
CROSS SECTION VIEW



PLAN VIEW



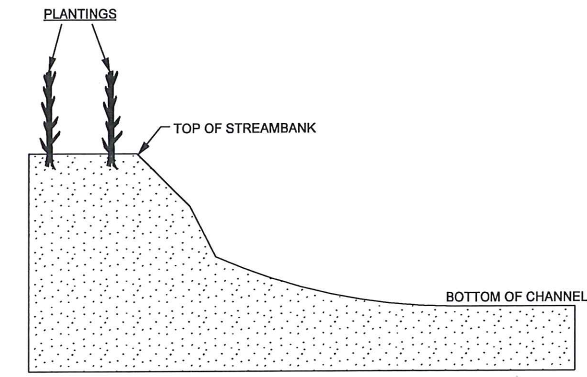
PLAN VIEW



LIVE STAKE DETAIL

NOTES:
1. STAKES PRODUCED FROM ON-SITE 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.
7. DO NOT LIVE STAKE POINT BARS ALONG MEANDER BENDS.

PLANTING SPECIFICATIONS



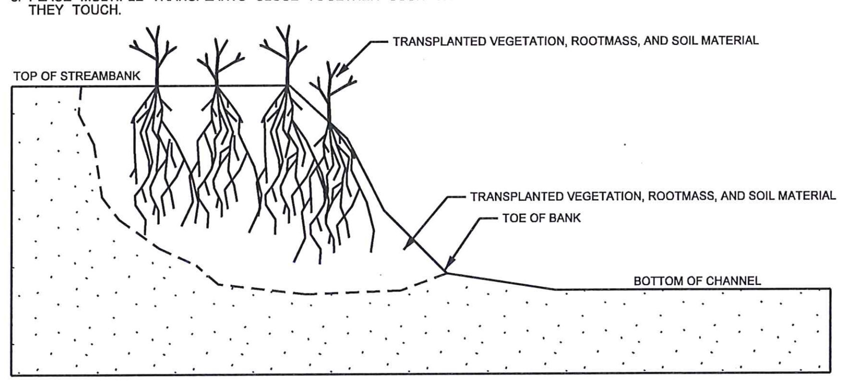
CROSS SECTION VIEW OF BARE ROOT PLANTING

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.

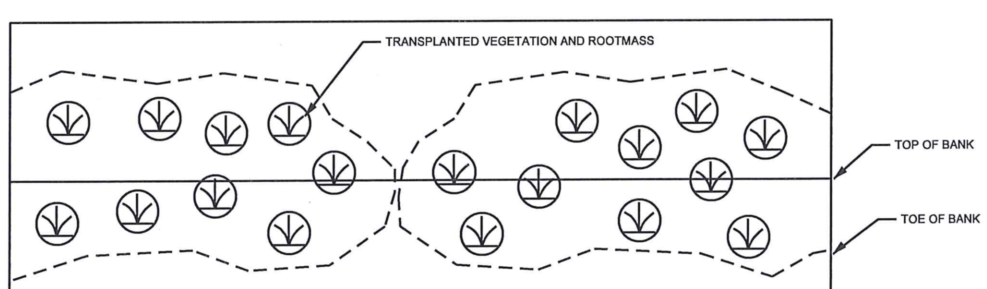
TRANSPLANTED VEGETATION

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 TRANSPLANT USING A FRONT END LOADER. EXCAVATE THE ENTIRE ROOT MASS AND AS MUCH ADDITIONAL SOIL MATERIAL AS POSSIBLE. IF ENTIRE ROOT MASS CAN NOT BE EXCAVATED IN ONE BUCKET LOAD, 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. PLACE MULTIPLE TRANSPLANTS CLOSE TOGETHER SUCH THAT THEY TOUCH.



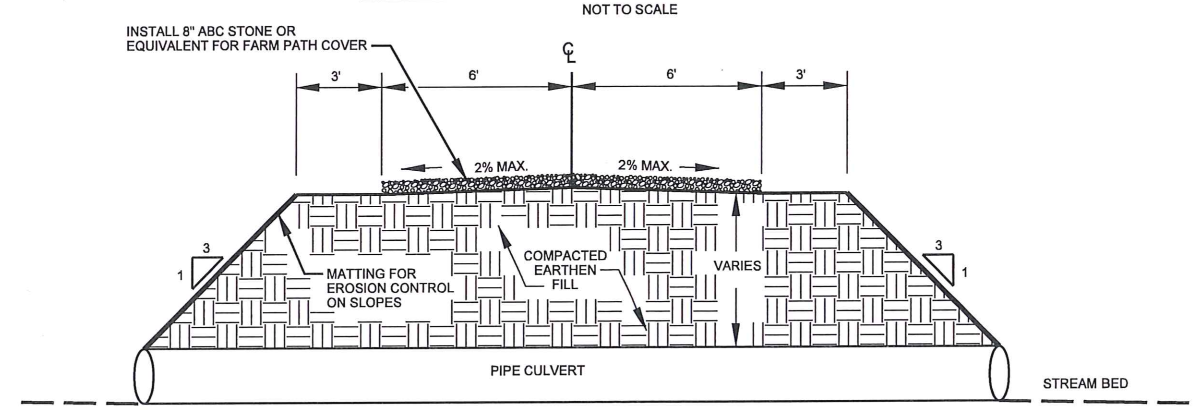
CROSS SECTION VIEW



PLAN VIEW

PERMANENT ROAD CULVERT CROSSING

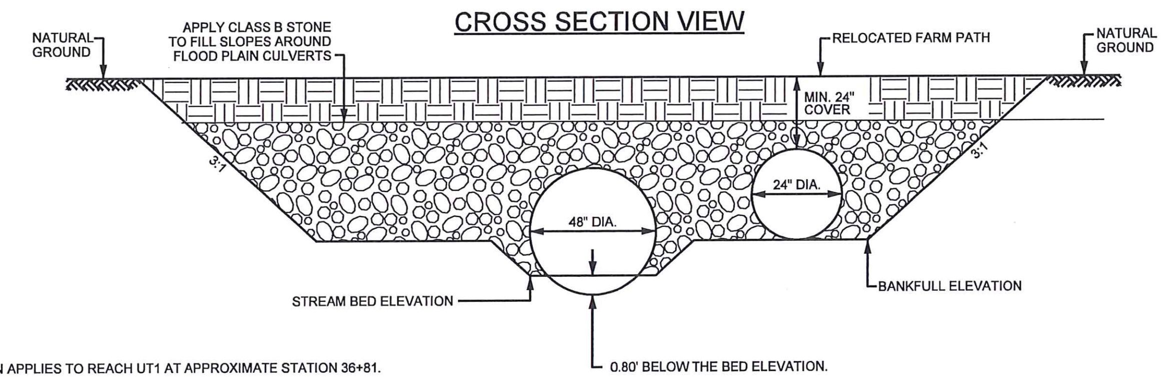
NOT TO SCALE



NOTES:

1. INSTALL PIPE CULVERT IN ACCORDANCE WITH DETAIL SPECIFICATIONS.
2. INSTALL COIR FIBER MATTING FOR EROSION CONTROL ALONG FILL SLOPES.

CROSS SECTION VIEW



NOTES:

1. TYPICAL SECTION APPLIES TO REACH UT1 AT APPROXIMATE STATION 36+81.
2. CULVERTS ARE TO BE EVENLY SPACED.
3. MINIMUM OF 24" COVER FOR ALL PIPES.

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BAKER PROJECT REFERENCE NO.	SHEET NO.
124578	2-B

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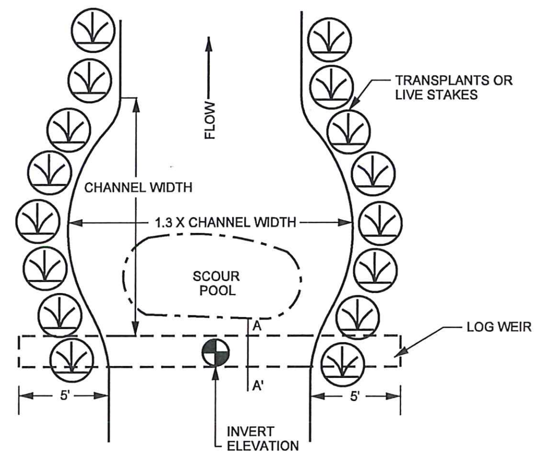
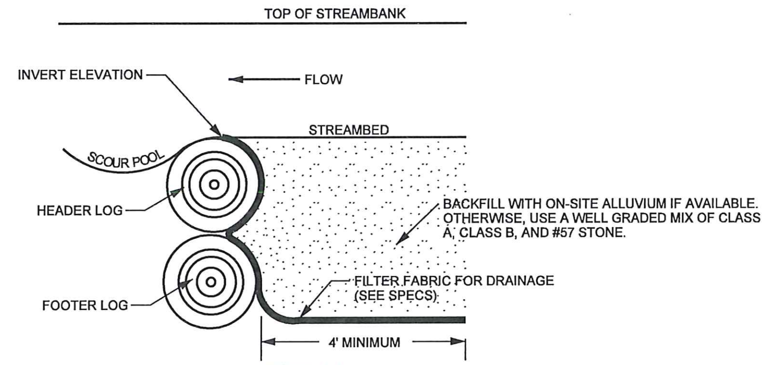
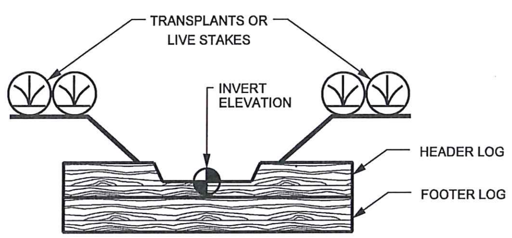
LOG WEIR



PLAN VIEW



SECTION A-A'

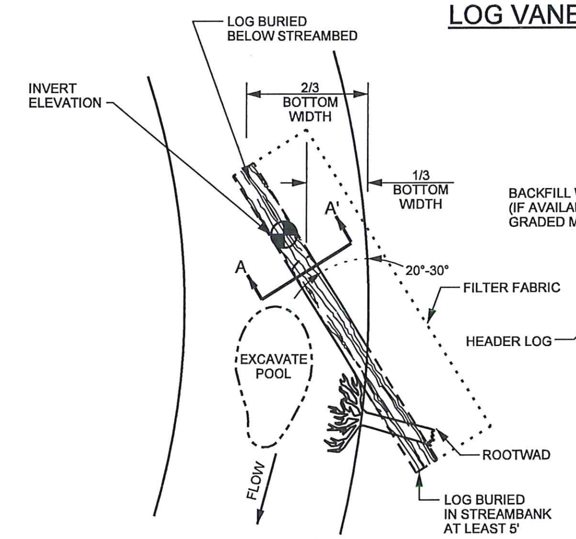


CROSS SECTION VIEW

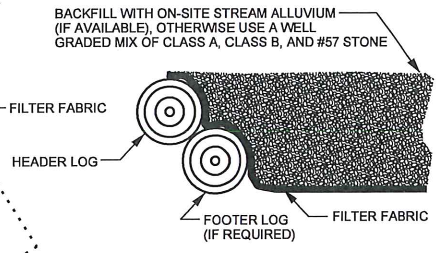
NOTES:

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. FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG.
3. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
4. CUT A NOTCH IN THE HEADER LOG APPROXIMATLEY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL NOT EXCEED 3 INCHES IN DEPTH.
5. USE FILTER FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
6. PLACE TRANSPLANTS FROM TOE OF STREAMBANK TO TOP OF STREAMBANK.

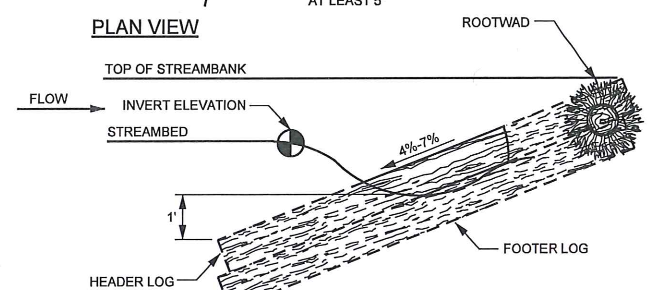
LOG VANE



PLAN VIEW



SECTION A - A'

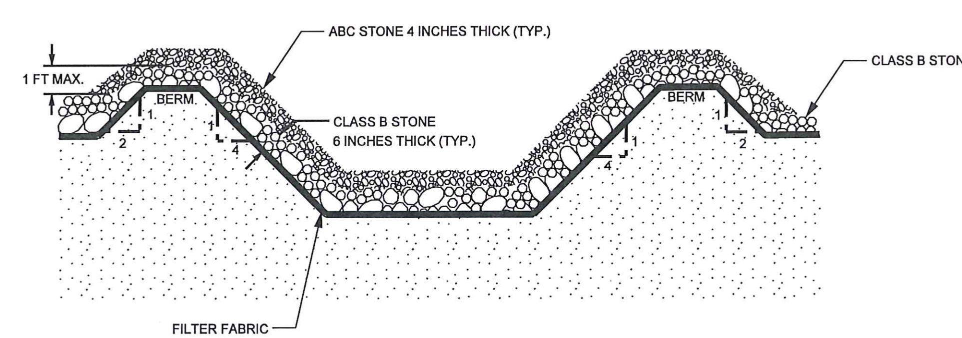


PROFILE VIEW

NOTES:

1. LOGS SHOULD BE AT LEAST 10" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. 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. FILTER FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.

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 4:1 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 CLASS B STONE, 1 FOOT THICK, LINED WITH FILTER FABRIC FOR DRAINAGE SHALL BE USED OVER THE BERM AND ACCESS SLOPES. ABC STONE APPROXIMATLEY 4 INCHES THICK ADDED TO TOP LAYER.
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.

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BAKER PROJECT REFERENCE NO.	SHEET NO.
124578	2-C

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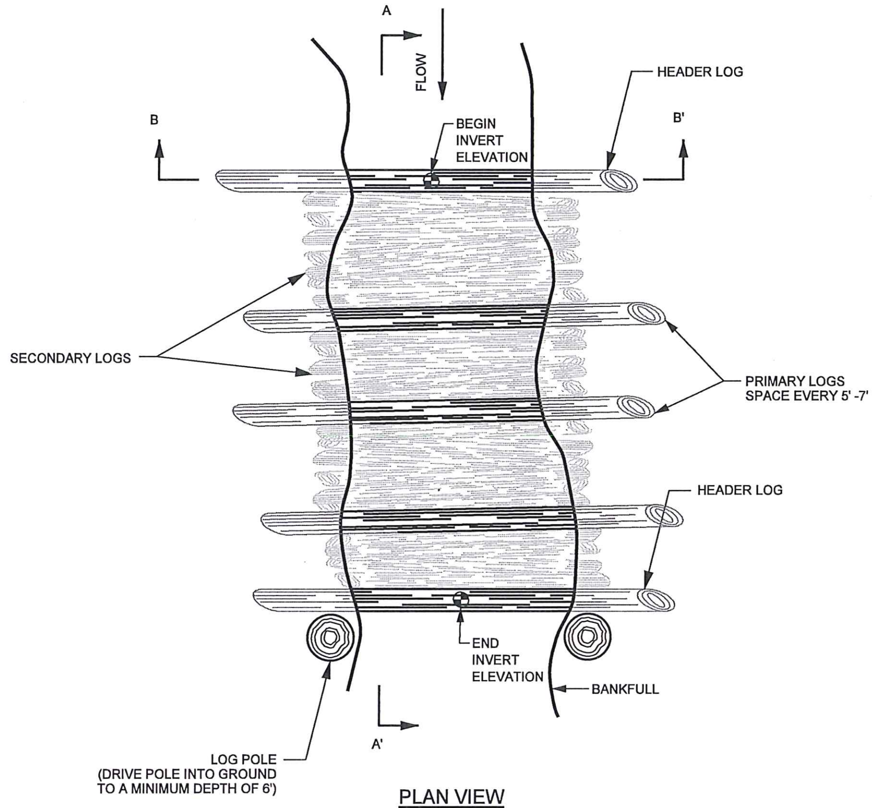
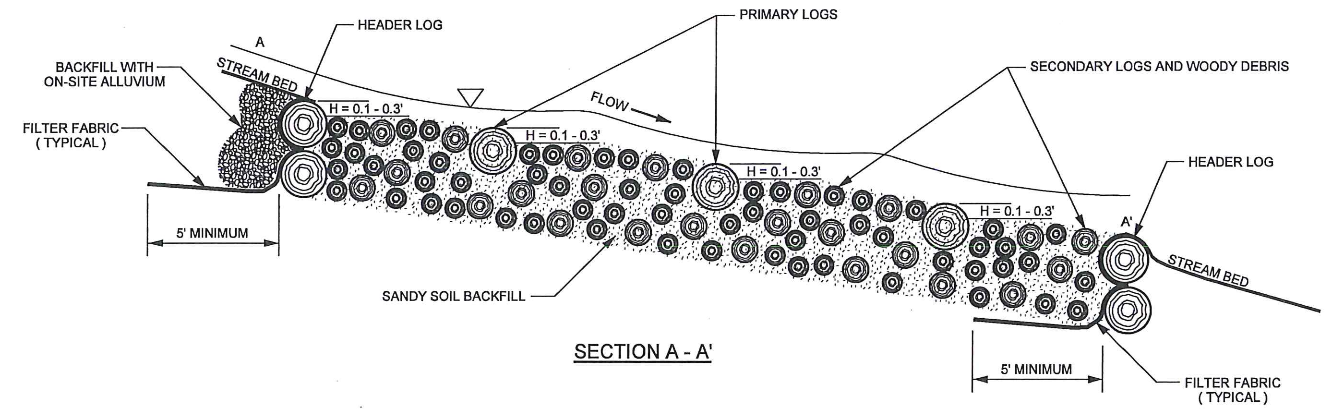
09.19.2013

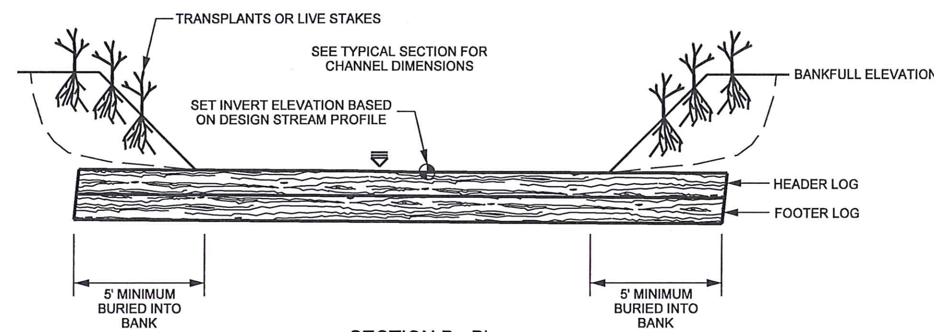
GRADE CONTROL LOG JAM



PLAN VIEW



SECTION A - A'

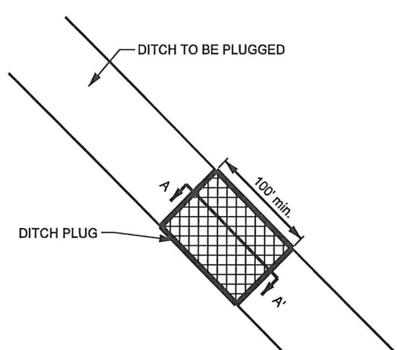


SECTION B - B'

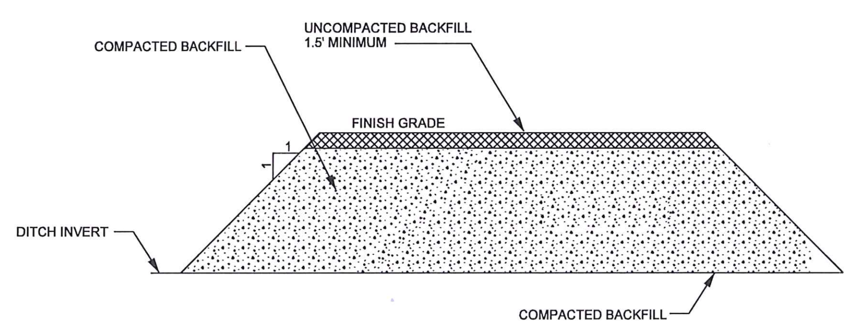
NOTES:

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.

DITCH PLUG



PLAN VIEW

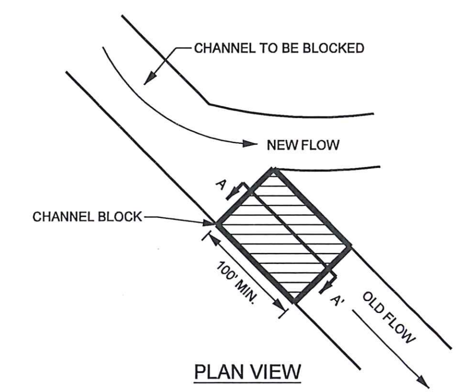


SECTION A - A'

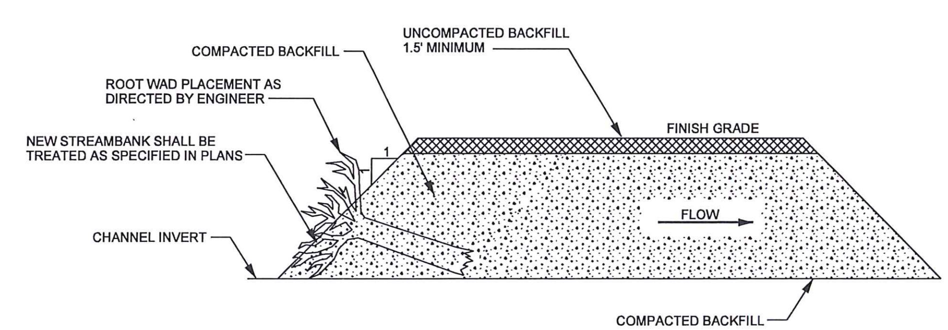
NOTES:

1. COMPACT BACKFILL USING ON-SITE HEAVY EQUIPMENT IN 10 INCH LIFTS.
2. FILL DITCH TO TOP OF BANKS OR AS DIRECTED BY ENGINEER.

CHANNEL BLOCK



PLAN VIEW



NOTES:

1. COMPACT BACKFILL USING ON-SITE HEAVY EQUIPMENT IN 10 INCH LIFTS.
2. FILL DITCH TO TOP OF BANKS OR AS DIRECTED BY ENGINEER.

2/26/03

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BAKER PROJECT REFERENCE NO.	SHEET NO.
124578	3

PROJECT ENGINEER

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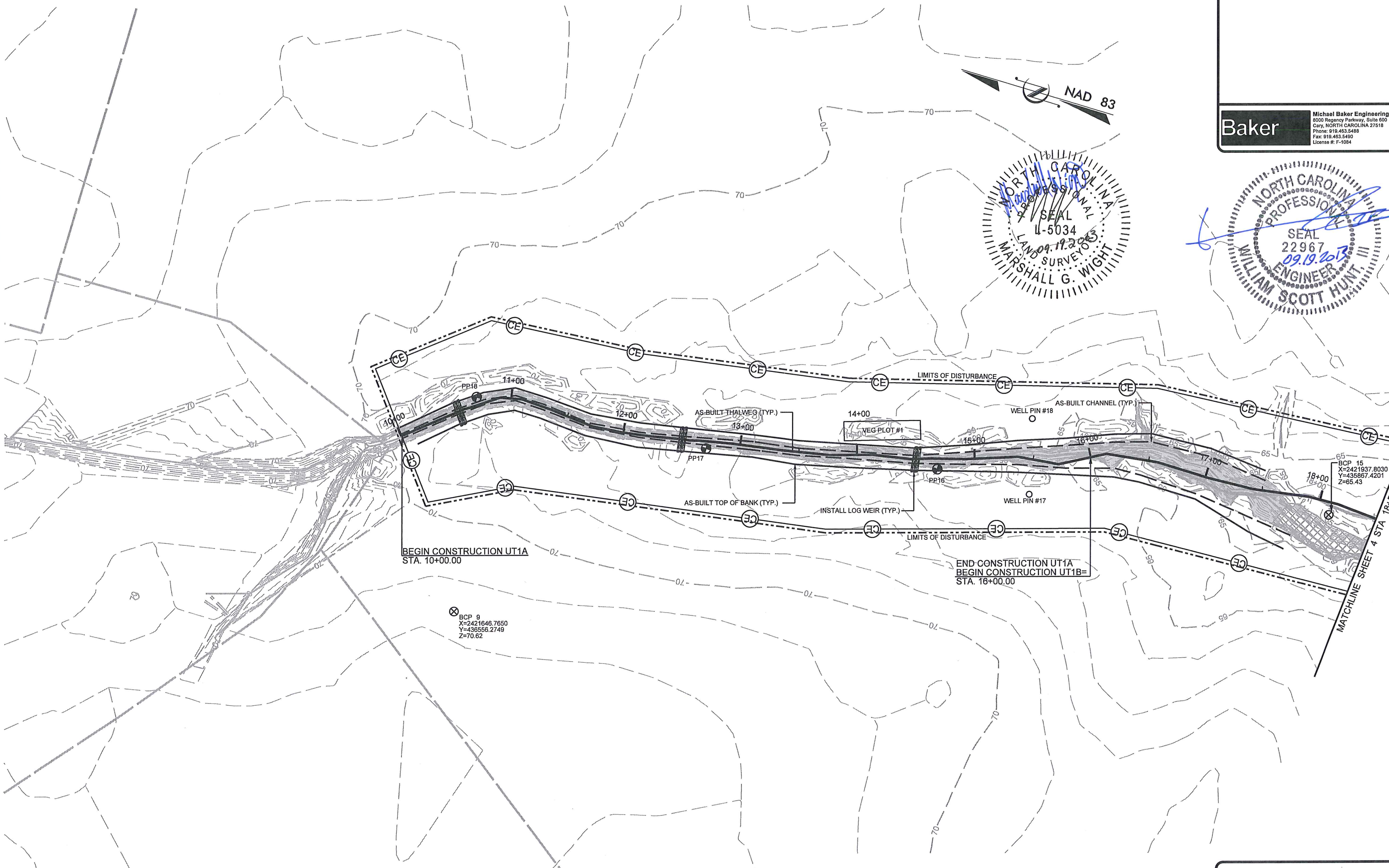

FILLED EXISTING CHANNEL

PLUGGED DITCH

NOTES:
1. REACHES UT1A AND UT1B WERE CONSTRUCTED BY RESTORING VALLEY TOPOGRAPHY.
2. CONTOURS SHOWN ARE PRE-RESTORATION.

UT TO MILL SWAMP
AS-BUILT PLAN

40 20 0 40 80
SCALE (FT)

2/26/03

9/19/2013
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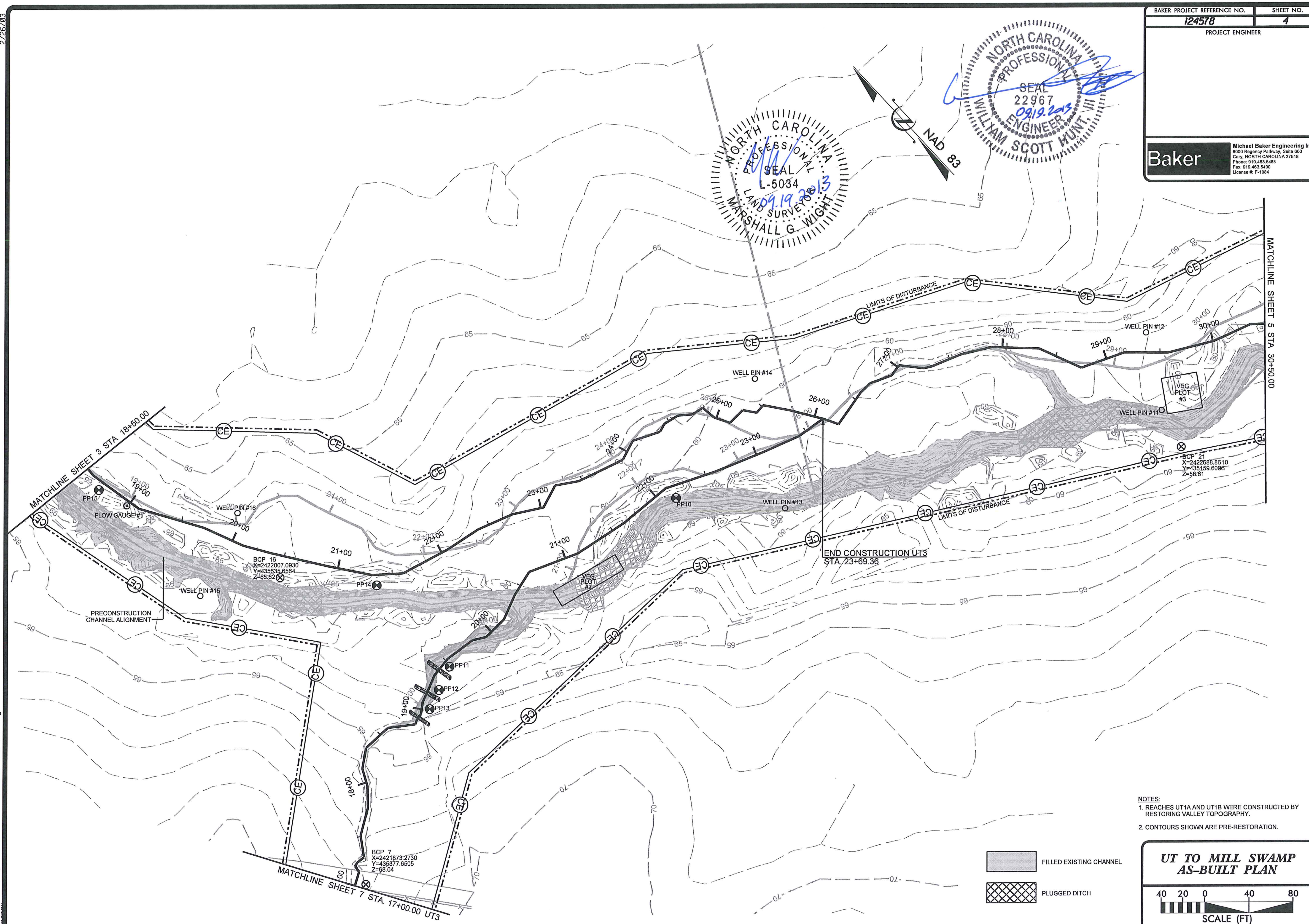

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SHEET NO. 4
PROJECT ENGINEER
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MATCHLINE SHEET 3 STA 18+50.00
MATCHLINE SHEET 5 STA 30+50.00
MATCHLINE SHEET 7 STA. 17+00.00 UT3
LIMITS OF DISTURBANCE
END CONSTRUCTION UT3
STA. 23+69.36
FLOW GAUGE #1
PRECONSTRUCTION CHANNEL ALIGNMENT
WELL PIN #11
WELL PIN #12
WELL PIN #13
WELL PIN #14
WELL PIN #15
WELL PIN #16
VEG PLOT #2
VEG PLOT #3
PP10
PP11
PP12
PP13
PP14
PP15
BCP 16
X=2422007.0930
Y=435635.6564
Z=65.62
BCP 21
X=2422688.8610
Y=435159.6096
Z=58.61
BCP 7
X=2421873.2730
Y=435377.6505
Z=68.04
NOTES:
1. REACHES UT1A AND UT1B WERE CONSTRUCTED BY RESTORING VALLEY TOPOGRAPHY.
2. CONTOURS SHOWN ARE PRE-RESTORATION.
FILLED EXISTING CHANNEL
PLUGGED DITCH
UT TO MILL SWAMP
AS-BUILT PLAN
SCALE (FT)
2/26/03
9/19/2013
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124578	5

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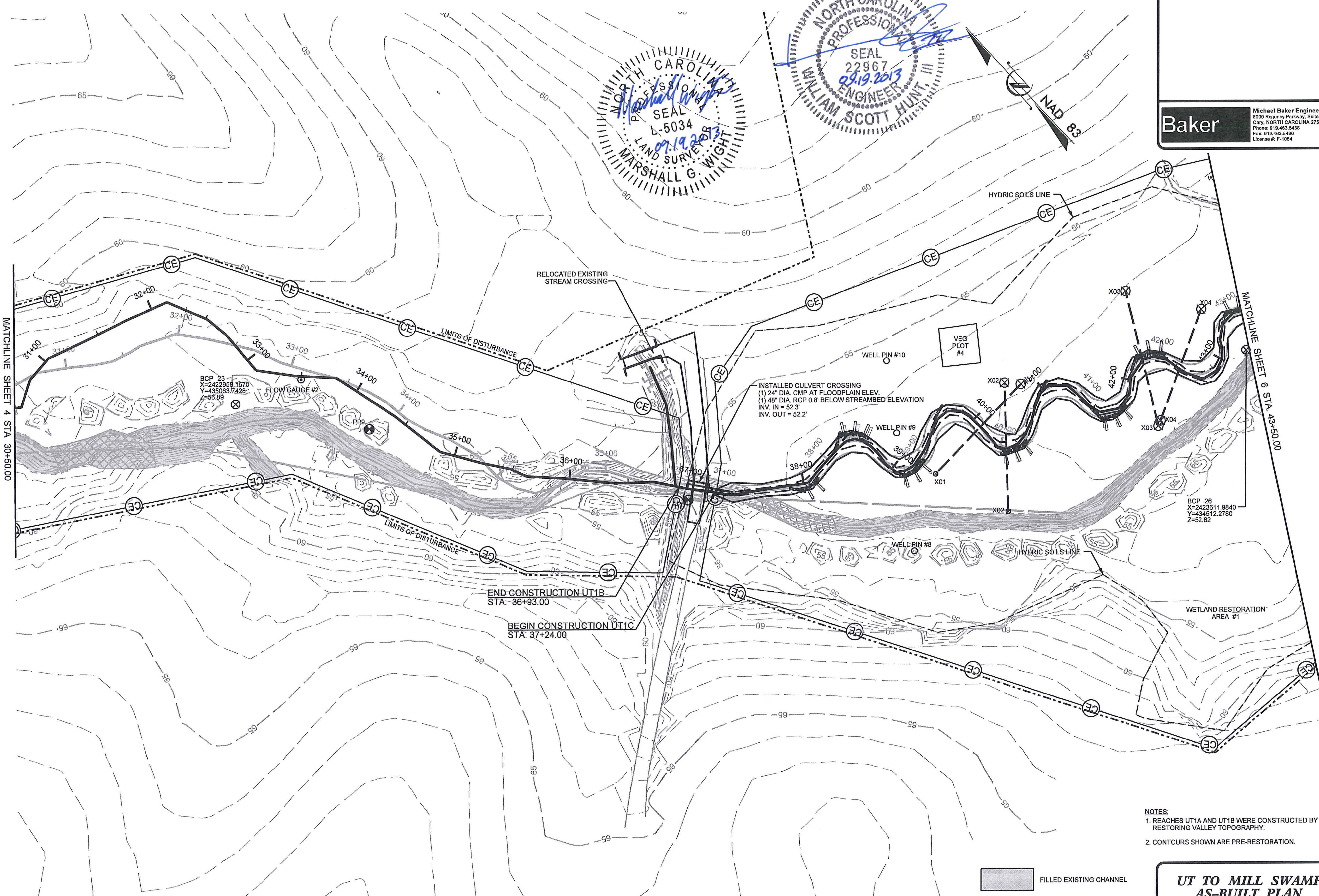

NOTES:
1. REACHES UT1A AND UT1B WERE CONSTRUCTED BY RESTORING VALLEY TOPOGRAPHY.
2. CONTOURS SHOWN ARE PRE-RESTORATION.

FILLED EXISTING CHANNEL

PLUGGED DITCH

UT TO MILL SWAMP
AS-BUILT PLAN

40 20 0 40 80
SCALE (FT)

2/26/03

9/19/2013
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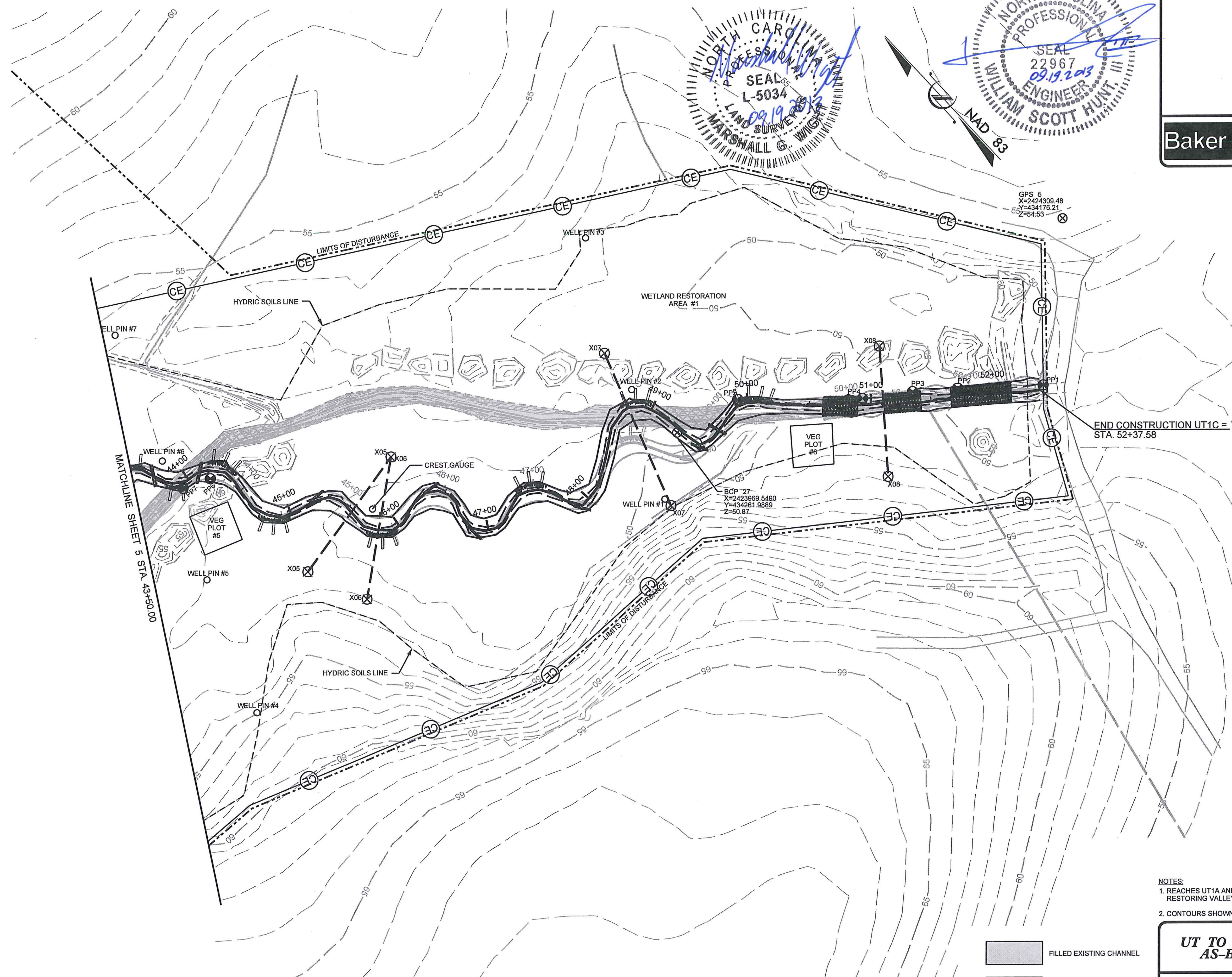

NOTES:
1. REACHES UT1A AND UT1B WERE CONSTRUCTED BY RESTORING VALLEY TOPOGRAPHY.
2. CONTOURS SHOWN ARE PRE-RESTORATION.

FILLED EXISTING CHANNEL

PLUGGED DITCH

UT TO MILL SWAMP AS-BUILT PLAN

40 20 0 40 80
SCALE (FT)

2/26/03

9/19/2013
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BAKER PROJECT REFERENCE NO.	SHEET NO.
124578	7

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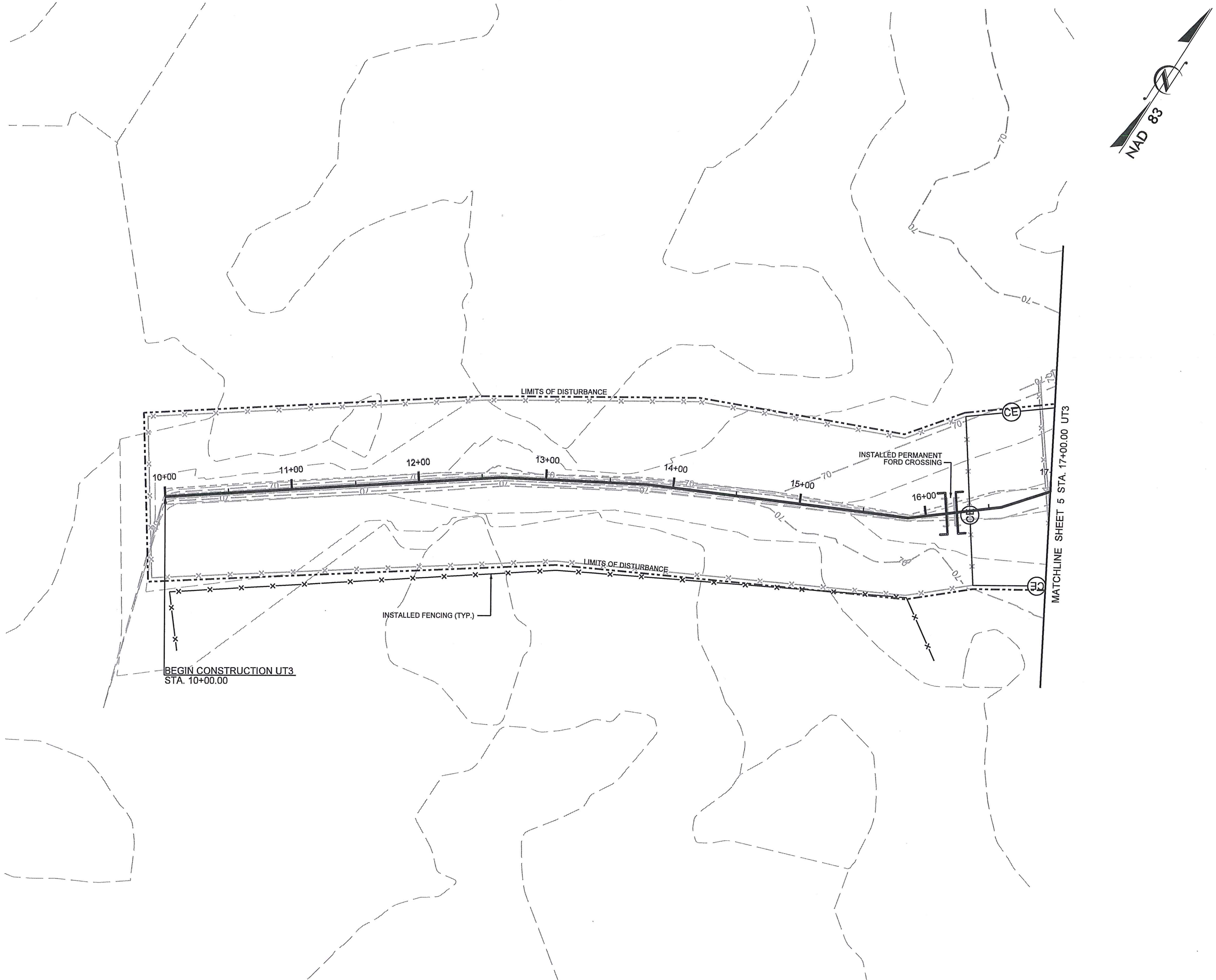

NOTE:
NO CONSTRUCTION ACTIVITIES WERE PERFORMED ALONG UT3 OTHER THAN FENCE INSTALLATION AND STREAM CROSSING FROM STATION 10+00 TO 16+34.

UT TO MILL SWAMP
AS-BUILT PLAN

40 20 0 40 80
SCALE (FT)

9/19/2013
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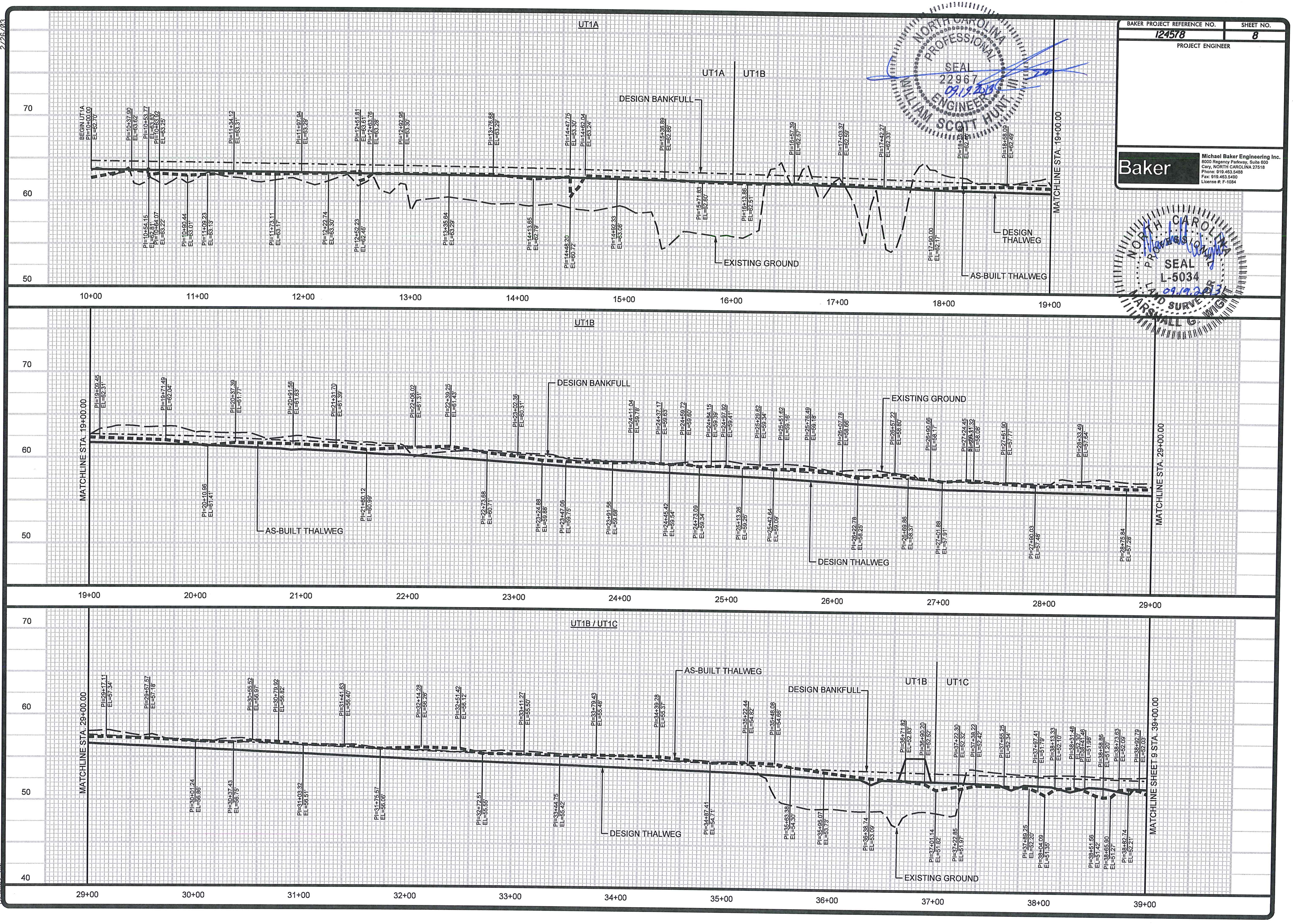

BAKER PROJECT REFERENCE NO.
124578
SHEET NO.
8
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NORTH CAROLINA PROFESSIONAL SEAL L-5034 LAND SURVEYOR MARSHALL G. WIGHT
09.19.2013
UT1A
UT1A
UT1B
DESIGN BANKFULL
BEGIN UT1A
EXISTING GROUND
DESIGN THALWEG
AS-BUILT THALWEG
MATCHLINE STA. 19+00.00
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
UT1B
MATCHLINE STA. 19+00.00
DESIGN BANKFULL
EXISTING GROUND
AS-BUILT THALWEG
DESIGN THALWEG
MATCHLINE STA. 29+00.00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
29+00
UT1B / UT1C
MATCHLINE STA. 29+00.00
AS-BUILT THALWEG
DESIGN BANKFULL
UT1B
UT1C
DESIGN THALWEG
EXISTING GROUND
MATCHLINE SHEET 9 STA. 39+00.00
29+00
30+00
31+00
32+00
33+00
34+00
35+00
36+00
37+00
38+00
39+00
70
60
50
40
2/26/03
9/19/2013
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BAKER PROJECT REFERENCE NO.	SHEET NO.
124578	9

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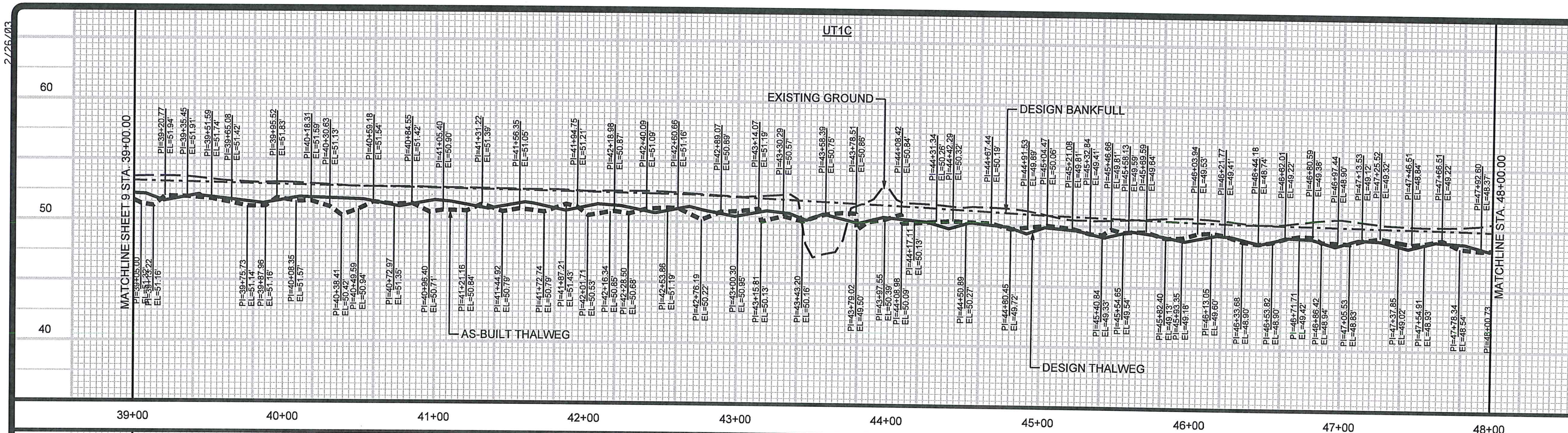
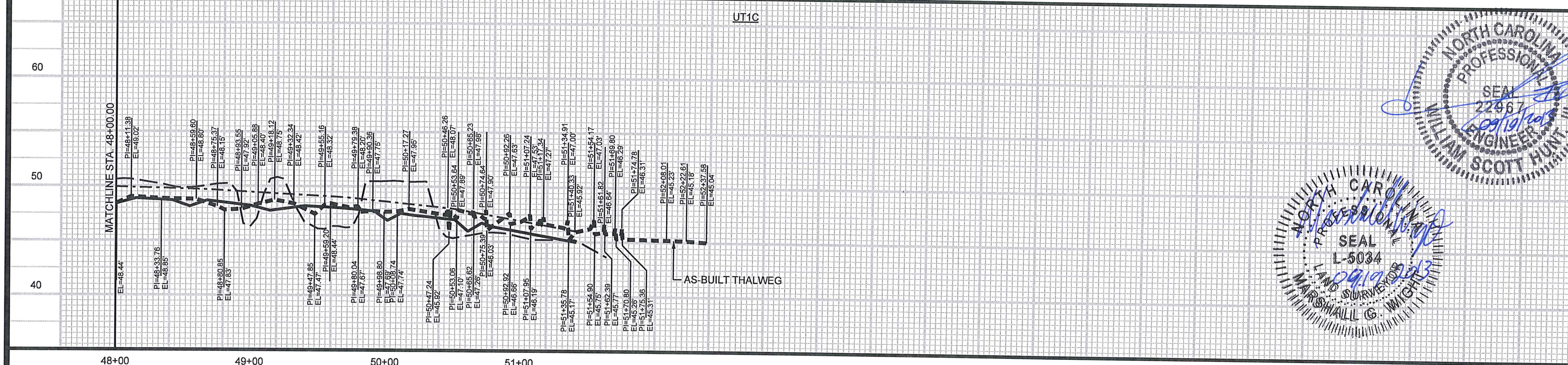
Fax: 919.463.5490
License #: F-1084





NORTH CAROLINA PROFESSIONAL SEAL 22467 ENGINEER WILLIAM SCOTT HUNT, III

09/19/2013

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

09/19/2013

2/26/03

9/19/2013
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APPENDIX E

Photo-ID Log


Photo Point 1, UT1c – Station 52+37 (August 13, 2013)


Photo Point 2, UT1c – Station 51+60 (August 13, 2013)


Photo Point 3, UT1c – Station 51+40 (August 13, 2013)


Photo Point 4, UT1c – Station 50+90 (August 13, 2013)


Photo Point 5, UT1c – Station 49+90 (August 13, 2013)


Photo Point 6, UT1c – Station 44+25 (August 13, 2013)

Photo Point 7, UT1c – Station 44+00 (August 13, 2013)

Photo Point 8 (Upstream), UT1b – Station 37+00 (August 13, 2013)

Photo Point 9 (Upstream), UT1b – Station 34+25 (August 13, 2013)

Photo Point 9 (East), UT1b – Station 34+25 (August 13, 2013)

Photo Point 10 (Upstream), UT1b – Station 22+15 (August 13, 2013)

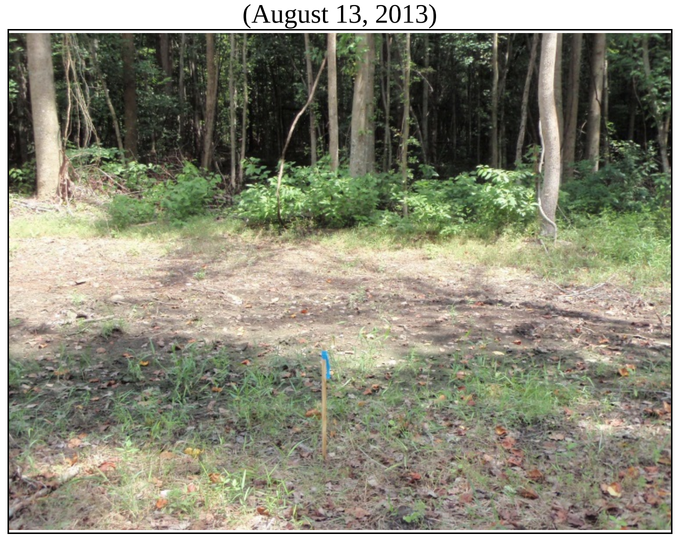

Photo Point 10 (North), UT1b – Station 22+15 (August 13, 2013)

Photo Point 11, UT3 – Station 19+40 (August 13, 2013)

Photo Point 12, UT3 – Station 19+25 (August 13, 2013)

Photo Point 13, UT3 – Station 19+10 (August 13, 2013)

Photo Point 14 (Upstream), UT1b – Station 21+20 (August 13, 2013)

Photo Point 14 (Northeast), UT1b – Station 21+20 (August 13, 2013)

Photo Point 15 (Upstream), UT1b – Station 18+75 (August 13, 2013)

Photo Point 15 (east), UT1b – Station 18+75
(August 13, 2013)

Photo Point 16, UT1a – Station 14+60 (August 13, 2013)

Photo Point 17, UT1a – Station 12+75 (August 13, 2013)

Photo Point 18, UT1a – Station 10+60 (August 13, 2013)

Photo Point 8, UT1b (June 12, 2013)

Photo Point 8, UT1b (August 13, 2013)

Photo Point 10 area, UT1b (June 12, 2013)

Photo Point 10, UT1b (August 13, 2013)

Photo Point 15 area, UT1b (June 12, 2013)

Photo Point 15, UT1b (August 13, 2013)

Photo Point 17 area, UT1a (June 12, 2013)

Photo Point 17, UT1a (August 13, 2013)