

MITIGATION PLAN

Final

November 2017

BUCKWATER MITIGATION SITE

Orange County, NC
NCDEQ Contract No. 006829
DMS ID No. 97084

Neuse River Basin
HUC 03020201

USACE Action ID No. SAW-2016-00873
RFP #: 16-006447

PREPARED FOR:

NC Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

PREPARED BY:

Wildlands Engineering, Inc.
312 W Millbrook Road, Suite 225
Raleigh, NC 27609
Phone: (919) 851-9986

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

- Federal rule for compensatory mitigation project sites as described in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.8 paragraphs (c)(2) through (c)(14).
- NCDEQ Division of Mitigation Services In-Lieu Fee Instrument signed and dated July 28, 2010.
- This mitigation plan has been written in conformance with 15A NCAC .0295.

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

Contributing Staff:
Chris Roessler, *Project Manager and Designer*
John Hutton, *Principal in Charge*
Nicole Macaluso, PE, CFM *Design Lead*
Greg Turner, PE, *Designer*
Win Taylor, PWS, FPC *Wetland Delineations*
Coy McKenzie, *Construction Documents*
Christine Blackwelder, *Lead Quality Assurance*

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1.0 Introduction

1.1 Site Overview

The Buckwater Mitigation Site (Site) is in Orange County approximately 4.5 miles northeast of Hillsborough (Figure 1). The project is located within the DMS targeted watershed for the Neuse River Basin Hydrologic Unit Code (HUC) 03020201030030 and NC Division of Water Resources (DWR) Subbasin 03-04-01. The site was selected by DMS to provide stream mitigation units (SMUs) and buffer credits in the Neuse River Basin 03020201 (Neuse 01). The project involves the restoration and enhancement of 17,295 existing linear feet of incised and straightened streams from the mainstem of Buckwater Creek and fourteen unnamed tributaries. Restoration and enhancement of these reaches will provide 12,620 SMUs. The project will also restore, enhance, or preserve 36.47 acres of riparian buffer on-site, which will provide 1,108,495 buffer credits. The site will be protected by a 52-acre conservation easement. The Site Protection Instrument detailing the easement is in Appendix 1.

Table 1: Project Attribute Table Part 1 – *Buckwater Mitigation Site*

Project Information	
Project Name	Buckwater Mitigation Site
County	Orange
Project Area (acres)	52
Project Coordinates (latitude and longitude)	36° 6’ 23.49” N, 79° 1’ 29.11” W
Planted Acreage (acres of woody stems planted)	23.4

2.0 Watershed Approach and Site Selection

The 2009 Neuse River Basinwide Water Quality Plan lists major stressors in Subbasin 03-04-01 to be total suspended solids (TSS), nutrients, and chlorophyll α. The 2010 Neuse River Basin Restoration Priorities (RBRP) highlights the importance of riparian buffers for stream restoration projects. Riparian buffers retain and remove nutrients and suspended solids. Of the 123 miles of streams in the Neuse 01 Cataloging Unit (CU), 23% do not have adequate riparian buffers. The RBRP states that “priority [restoration] projects should increase or improve buffers.” Another goal of the RBRP for the Neuse 01 CU is to support the Falls Lake watershed plan. Falls Lake is the receiving water supply water body downstream of the Site and is classified as water supply waters (WS-IV) and nutrient sensitive waters (NSW). The RBRP also states that a goal for the Neuse 01 CU is to “…promote nutrient and sediment reduction in agricultural areas by restoring and preserving wetlands, streams, and riparian buffers.” The Buckwater Mitigation Site was selected because of its location within the targeted watershed and its potential to address the goals of the RBRP through stream restoration and buffer restoration.

Restoration and enhancement of streams on the Site will directly and indirectly address stressors identified in the RBRP by building stable stream banks and restoring a forested buffer. The reaches slated for restoration will also involve restore meandering pattern. The project will slow surface runoff, increase retention times, provide shade to streams, and reconnect the streams to their historic floodplains and riparian wetlands, which should reduce sediment and nutrient loads. The latter contribute to the downstream production of chlorophyll α. In addition, restoration will provide and improve instream and terrestrial (riparian) habitats while improving stream stability and overall hydrology.

3.0 Baseline and Existing Conditions

The Site watershed (Table 2 and Figure 3) is in a northwestern HU of the Neuse 01 CU. It is situated in the rural countryside in Orange County near Hillsborough, NC, upstream of the intense growth and development pressure associated with the Raleigh-Durham metropolitan area. The following sections describe the existing conditions of the watershed and watershed processes, including disturbance and response.

Table 2: Project Attribute Table Part 2 – *Buckwater Mitigation Site*

Project Watershed Summary Information	
Physiographic Province	Piedmont
Ecoregion	Carolina Slate Belt (45c)
River Basin	Neuse River
USGS HUC (8 digit, 14 digit)	03020201, 03020201030030
NCDWR Sub-basin	03-04-01
Project Drainage Area (acres)	2,259
Project Drainage Area Percentage of Impervious Area	0.28%
CGIA Land Use Classification	63.9% forested, 32.1% cultivated, 3.9% developed

3.1 Landscape Characteristics

3.1.1 Physiography and Topography

The site is located in the Piedmont Physiographic Province of North Carolina. The Piedmont is characterized by gently rolling, well rounded hills with long low ridges, with elevations ranging from 300 – 1,500 feet above sea level. Site topography, as indicated on the Hillsborough and Caldwell, NC USGS 7.5 minute topographic quadrangles, includes mostly moderately sloped areas with some steep topography along the upstream reaches (Figure 4). Buckwater Creek has a moderately confined alluvial valley that ranges in width from 115 feet at the upstream end to 100-175 feet in the middle and lower reaches. Buckwater Creek has a moderately-sloped alluvial valley with slopes ranging between 0.6 and 0.9 percent, though it falls to 0.2 to 0.3 percent in the downstream enhancement reaches. T1 has similar valley characteristics to Buckwater Creek with a channel slope of approximately 0.7 percent and valley widths of 80 to 190 feet. T1 has a larger drainage area than Buckwater Creek at their confluence.

The remainder of the project streams are smaller tributaries have steeper and more confined colluvial valleys. Valley slopes exceed 5.5 percent on T7 and T7A but the remaining reaches are between 1.5 and 4.8 percent. Generally, slopes tend to flatten as elevation decreases. Channels closer to the Buckwater Creek floodplain have lower slopes than the headwater reaches. Valley widths are usually at least 50 feet though most channels have either been straightened or are incised so the full valley width is not currently accessed.

Along many of the project streams, wetlands are present. They have formed at the toe of valley slopes and extend longitudinally along the stream channels. The largest wetlands areas may be found along the middle of R6, both T1 reaches, R4 of Buckwater Creek, lower T4, and between T4A and T4B. Smaller wetland pockets may be found along most of the remaining reaches except for middle Buckwater Creek (R5 and R6), lower T5, T8, and T9.

3.1.2 Geology and Soils

The project is located in the Carolina Slate Belt of the Piedmont physiographic province. The Carolina Slate Belt consists of heated and deformed volcanic and sedimentary rocks. Specifically, the proposed project is located in Cenozoic felsic metavolcanic rock (mapped as 'CZfv') of the Carolina Slate Belt. This unit consists of light gray to greenish gray, felsic metavolcanic rock interbedded with mafic and intermediate metavolcanic rock and is composed primarily of feldspar, quartz, sericite, chlorite meta-argillite, and metamudstone (NCGS, 1985). The channel bed material consists of angular Slate Belt rock consistent with the described lithology.

The geology of this area has important effects on Site hydrology, hydraulics, geomorphology, and sediment transport. Streams in the Carolina Slate Belt tend to go dry during late summer and early fall as a result of geologic, topographic, and climatic factors. A study by Giese and Mason (1993) states that the "Carolina slate belt has among the lowest potential for sustaining baseflow in streams" throughout the year as compared to other regions of North Carolina. Median low flows in the Carolina Slate Belt, defined by the study as the 7Q10 (7-day consecutive low flow with a 10-year return frequency, or the lowest stream flow for seven consecutive days that would be expected to occur once in ten years), can be as low as 0.005 $ft^3/s/mi^2$ of drainage area (Giese and Mason, 1993).

Most of the Site streams have spring flow and thus do not exemplify typical low-flow Slate Belt hydrology. However, the Site stream channels exhibit erosion characteristics common to Slate Belt streams. Channels without bank vegetation are abundant and these lack the roughness necessary to reduce channel velocities. High channel velocities and near bank stresses increase bank erosion and bed scour. This condition exacerbates the process of channel incision followed by widening and delivers sediment and its adsorbed nutrients downstream. This process is occurring on many unbuffered streams within the project area, including Buckwater Creek, and T1, T2, T3, T4, T5, and T7.

Site investigations revealed sporadic visible bedrock in pastures or within the channel. With most floodplain soils having depths greater than 80 inches to bedrock, grade control structures will be used in the stream design to prevent incision. There is potential to excavate native materials on site to use in constructed riffles and other grade control structures. The weathered bedrock is present between 50 and 80 inches in the Tarrus silt loam series, which provide a well-mixed substrate with varying size classes. The Tarrus silt loam (TaD and TaE), referred to as the Tatum silt loam in the 1977 Orange County Soil Survey, is present along upper T3 and extends east to T4A.

The Site is located within Ecoregion 45c - Carolina Slate Belt. The Carolina Slate Belt extends from southern Virginia, across the Carolinas, and into Georgia. The mineral-rich metavolcanic and metasedimentary rocks with slatey cleavage are finer-grained and less metamorphosed than most Piedmont regions. Silty and silty clay soils, such as the Georgeville and Herndon series, are typical. Streams tend to run dry in the summer and early fall, and water yields to wells are low as this region contains some of the lowest water-yielding rock units in the Carolinas.

The proposed project is mapped by the Orange County Soil Survey. Project area soils are described below in Table 3. Figure 5 is a soil map of the Site. Most of the stream reaches are on Chewacla soils, with some Appling, Herndon, and Tarrus on the upper end of a few of the reaches. Appling underlies T4, T7, and T7A; Herndon underlies T4B and T8; and Tarrus underlies T3 and T4A. Appling and Herndon soils are prevalent on the uplands around the project site. Chewacla soils frequently flood and are poorly drained, aiding in the maintenance of wetlands; the loamy soil is greater than 80 inches deep. This depth to bedrock provides no natural grade control within the streambeds. Without intervention, channel scour and incision in the form of advancing headcuts would likely continue to degrade the Site streams.

Table 3: Floodplain Soil Types and Descriptions – *Buckwater Mitigation Site*

Soil Name	Description
Appling-Helena	This series consists of well drained and moderately well drained soils that formed on uplands in material that weathered from granite and gneiss. The surface layer is about 9 inches thick of a brown sandy loam. The subsoil extends to a depth of 48-60 inches and contains sandy clay loam, clay, or sandy clay that is yellow at the top and brown at deeper levels.
Chewacla loam	This series is found on flood plains along creeks and rivers. This soil is typically level and somewhat poorly drained, in areas that frequently flood for brief periods. The surface layer is a 6-inch thick brown loam. The subsoil is 46 inches thick, and grades with depth from a mottled yellowish-brown fine sandy loam to mottled yellow-brown-gray clay loam in the middle part, to a mottled gray sandy clay loam at the bottom. The underlying material to a depth of 60 inches is mottled light gray, stratified sandy loam. The permeability is moderate, the available water capacity is medium, and the shrink-swell potential is low. Depth to bedrock is more than 60 inches. Depth to the seasonal high water table is about 6 to 18 inches during late winter and early spring.
Herndon-Tarrus Series	Gently sloping to moderately steep, well drained soils that have a surface layer of silt loam and a subsoil of clay loam, silty clay loam, silty clay, and clay; on uplands. This series is typically well drained with medium runoff potential and no flooding. These soils formed in upland settings mainly from weathered slate. Depth to bedrock is more than 60 inches for the Herndon and 40-60 inches for the Tarrus. Bedrock is exposed on upper T3 where Tarrus soils are mapped.

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

It is Wildlands' experience that small streams in the Slate Belt are low bedload sediment supply systems. These streams commonly have small gravel and sand bed material that is derived from highly weathered parent material. Watersheds with low rolling topography that are largely covered by vegetation will often result in low sediment supply. Without a naturally high bedload supply to drive morphological change, these streams are relatively slow to adjust without watershed disturbance or manipulation.

3.2 Land Use/Land Cover

Land use and land cover were investigated throughout the watershed using historical aerials of the Site and adjacent parcels from 1938-2016 and a watershed reconnaissance survey. The most common historical and current land uses in the watershed are silviculture and agriculture. The Site area has been used for livestock grazing or maintained as managed herbaceous cover since before 1938. The limits of riparian buffers and agricultural land on the Site have remained consistent since about 1982. Prior to then, there was an increase in agricultural activity in the 1940s to 1960s, and a decrease in the agricultural footprint (i.e., land area) in the late 1970s. However, per accounts from the landowners, agricultural activity, including several thousand beef cattle and three hog houses, remained high through the 1990s. Today, approximately 130 cows graze on three Site properties and anything that is not grazed or in forest, including large residential lots, is used for cultivating hay.

There are no signs of impending land use changes or development pressure that would impact the project in the Buckwater watershed. The entire watershed is zoned as Agricultural Residential (AR). This classification requires a minimum lot size of 40,000 square feet and open space ratio of 0.84. The project watershed is located in the Lower Eno Watershed Protection Overlay District where structural BMPs are required where density exceeds one dwelling per acre and the lot impervious limit is 36% without curb and gutter.

According to the Orange County Unified Development Ordinance (UDO) the purpose of the AR District is to assist in the preservation of land suitable, as a result of location, existing farming operations, soils and topography, for agricultural, silvicultural, or horticultural uses and to protect such uses from the adverse effects of incompatible land uses. The UDO states that water distribution and sewage collection mains are not likely within 10-20 years.

Two of the Site landowners have plans to expand their cattle operations in the coming years. The landowner along Buckwater R4 intends to expand his herd from 15 to 50 cows as part of a grass-fed beef business. With the same intention, the landowner along T6 plans to have 40 cows where there are presently none. However, this mitigation project will provide the riparian buffer and livestock exclusion fencing to protect the project streams. Additionally, these landowners value the remaining shade outside of the proposed conservation easement and intend to save these trees and even plant additional ones.

The consistency in land use within the project watershed over the past 78 years indicates that watershed processes affecting hydrology, sediment supply, and nutrient and pollutant delivery have not varied extensively over time. With a lack of developmental pressure, watershed processes and stressors from outside the project limits are likely to remain consistent through closeout of this project. These stressors and processes are discussed further in Section 4, below. First, a review of land use through examination of aerial photography is discussed.

Historical aerial photographs were obtained from the Orange County Soil and Water Conservation office for 1938, 1955, 1966, and 1972. Historical aerials were also obtained from EDR reports for 1975, 1982, and 1993. With the exception that forested areas have expanded slightly, it appears that the land use in the project area has changed very little since 1982.

Aerial photographs from 1938 depict the Site in a cleared condition signifying the land had been used as managed pasture or for crop production. The lack of sinuosity on upper Buckwater Creek, despite an unconfined floodplain, suggests that the channels were straightened for agricultural purposes prior to 1938. The landowners have indicated they tried to maintain Lower Buckwater Creek below Walnut Hill Drive in a narrow corridor to maximize arable land, but gave up in the 1970s on the west end (R5 & R6) and in the 1990s on the east end (R7 & R8). Despite increased sinuosity since then, the channel has incised several feet in this area leading to systemic streambank erosion.

In the 1955 aerial photograph, it is clearly shown that the top 1,000 feet of Buckwater in the project area had been straightened. It is less apparent in the 1938 aerial photograph, but Buckwater Creek probably had been moved and held to the right side of the floodplain upstream from Walnut Hill Drive. This type of work was typically performed during that period with a team of mules and a drag pan.

Several ponds, including those along Buckwater Creek, T3, and T5 were built between 1938 and 1955. The riparian buffer along Buckwater Creek was largely cleared in 1955 but had limited trees in 1966. Terraces were apparently constructed in the 1950s adjacent to T4 and in the 1960s adjacent to T3. A road along T1 crossing Buckwater Creek was abandoned between 1955 and 1966. By 1972, a single line of trees had grown on much of Buckwater Creek. Lower T3 was still a wetland in 1975; since then the channel was moved to the left side of the floodplain and the trees were cleared to convert it to pasture. Also in 1975, the left bank of lower Buckwater was cleared and in agricultural use.

There were essentially no riparian buffers on T1, T4, T7, and lower and middle Buckwater in 1964. Middle Buckwater is upstream of Walnut Hill Drive (i.e., lower Reach 4). Partial riparian buffers were allowed to grow along those reaches sometime before 1975. A 9-acre area just east of T8 was converted from forest to pasture between 1955 and 1964. During this same interval, a riparian buffer was allowed to grow along a 5-acre area on the right bank of upper Buckwater.

The high-voltage utility transmission line (hereafter referred to as 'transmission line') running perpendicular to Buckwater Creek was constructed between 1964 and 1975. This transmission line easement is 150-feet wide and extends upstream (above the project area) along the T1 floodplain for nearly one mile.

In conclusion, stream channel management on the Site has trended toward being less manipulated and more left to natural processes in the past 15 years.

3.3 Existing Vegetation

Streamside vegetation in the cattle pastures consists primarily of grasses such as fescue (*Fescue* spp.) with some soft rush (*Juncus effusus*), straw-colored flatsedge (*Cyperus strigosus*), as well as horse nettle (*Solanum carolinense*) and dog fennel (*Eupatorium capillifolium*). Also present are deer tongue (*Dichanthelium clandestinum*), Japanese stiltgrass (*Microstegium vimineum*), poison ivy (*Toxidendron radicans*), and greenbrier (*Smilax sp.*). Common tree species within the project area include American beech (*Fagus grandifolia*), black walnut (*Juglans nigra*), mockernut hickory (*Carya tomentosa*), red maple (*Acer rubrum*), red cedar (*Juniperus virginiana*), sweet gum (*Liquidambar styraciflua*), and spice bush (*Lindera benzoin*). Invasive species include tree of heaven (*Ailanthus altissima*), Chinese privet (*Ligustrum sinense*), and, to a lesser extent, multiflora rose (*Rosa multiflora*). Tree of heaven is located along T7 and Buckwater Creek near the confluence with T2. Chinese privet is found throughout the project area.

The watershed has likely been periodically logged since humans settled this area around 1800, and many tree species located in surrounding riparian areas are now mid successional. The species in these areas are not necessarily indicative of what would have been on-site before human disturbance.

3.4 Project Resources

On May 26, June 1-3, and June 29, 2016, Wildlands investigated on-site jurisdictional waters of the U.S. within the proposed project easement area. Jurisdictional areas were delineated using the US Army Corps of Engineers (USACE) Routine On-Site Determination Method. This method is defined by the 1987 Corps of Engineers Wetlands Delineation Manual and the subsequent Eastern Mountain and Piedmont Regional Supplement. All jurisdictional waters of the U.S. were located by either conventional survey or sub-meter GPS. Wetland determination forms representative of on-site jurisdictional areas as well as non-jurisdictional upland areas are included in Appendix 2.

The wetland delineation was field reviewed by USACE staff on October 11, 2016 and the preliminary jurisdictional determination was approved on February 16, 2017. There are 70 jurisdictional wetland features located on-site (labeled A - RRR). These wetland features are classified as bottomland hardwood forest or seeps. The wetlands occur in the side slopes and the floodplains that drain to Buckwater Creek and its tributaries. These features exhibit a high water table, pockets of shallow inundation, saturation within the upper 12 inches of the soil profile, and a low chroma matrix. Common hydrophytic vegetation includes sugarberry (*Celtis laevigata*), panicgrass (*Panicum dichotomiflorum*), sycamore (*Platanus occidentalis*), pale persicaria (*Persicaria lapathifolia*), and common rush (*Juncus effusus*). The majority of these areas experience significant impacts from livestock. Wetland determination forms are located Appendix 8.

The Site contains eleven perennial streams: Buckwater Creek, T1, T2, T3, T4, T5, T6, T6A, T7, T8, and T9. It also contains several intermittent streams: T4A, T4B, T6B, and T7A. A summary of the DWR forms is located in Appendix 3; the forms are available upon request. A mitigation viability assessment letter from DWR is also provided in Appendix 3. A summary of the US Army Corps of Engineers (USACE) forms is located in Appendix 4. Stream features are described in more detail in the following text. Table 4 provides a summary of water resources within the project limits. Existing conditions are also illustrated in Figure 6.

Buckwater Creek

Buckwater Creek flows into the project area from an upstream wooded parcel. The mainstem's floodplain is managed as a combination of woodlands and pasture from the upstream project extent to Walnut Hill Drive, and as woodlands from downstream of Walnut Hill Drive to the project terminus. The creek was straightened for agricultural purposes, though it has a wide alluvial floodplain. Upper Buckwater (Reaches 1 – 4) is beginning to meander slightly but is largely relegated to the right side of the floodplain from the project start to Walnut Hill Drive. The upper approximately 600 feet of Buckwater Creek (Reach 1) has gravel and cobble substrate, but below this section fine sediment begins to accumulate on the channel bottom. By 900 feet below the project start, the stream bed is frequently covered with fine sediment. Bank erosion appears to be the primary source of the fine sediment and deposition occurs where the channel slope flattens. The right bank has fairly consistent tree coverage from start to finish on Buckwater Creek. The area beyond the right bank has apparently not been used for pasture or cultivation in some time. The stream is, for the most part, pushed up against the valley slope on the right side.

Downstream from Walnut Hill Drive (Reaches 5 -8), Buckwater Creek has more sinuosity but the bank erosion is severe. The trees beyond the left bank are smaller and early successional species. This area was formerly a hay field but has not been harvested since at least 1975.

Throughout its length in the project area, Buckwater Creek has notable erosion on the outside bends. The banks in many of these locations are vertical and lack vegetation; surficial scour is the primary manifestation, though, particularly in lower Buckwater Creek, mass wasting is also present.

Buckwater Creek does not maintain connection with its floodplain. The stream exhibits relatively high bank height ratios and low width-to-depth ratios throughout due to relatively recent channel incision. Widening, in the form of bank erosion, has commenced but has not progressed to produce higher width-to-depth ratios. Entrenchment ratios begin as moderate (2.1) but decrease to 1.3 upstream from Walnut Hill Drive which persists to the confluence with T1. Buckwater Creek's stream classification is most closely approximated by an incised E4 at the upstream and downstream ends. In between, a G4c is typically the closest approximation.

Much of the floodplain is moderately wide and alluvial. It is actively grazed between T8 and Walnut Hill Drive, a distance of approximately 2,400 feet. Offline ponds are located on the left floodplain both above and below Walnut Hill Drive.

T1

T1 enters the project area from the north as a largely stable creek (see XS 19, a C4 channel in Appendix 5). Upstream of the project area, T1 runs along gravel-based Stagg Road for 1,600 feet and, further upstream, beneath the same high-voltage transmission line for 4,600 feet. Upstream from the transmission line a large pond dams a primary tributary to T1, while another tributary emanates from a forested catchment. Despite the valley limitations, the channel banks are mostly low and moderately stable. Given the lack of riparian buffer in the transmission line easement, the channel could actively meander, creating a high sediment supply. Wildlands expects the T1 sediment load is and would be dominated by gravels, judging from the existing bars and visible streambank material and confirmed by a reachwide pebble count. Thus, sediment load concerns should focus on capacity rather than competency.

Once within the project area, the T1 Reach 1 channel quickly becomes incised and has eroding outside bends for 430 feet before it flows beneath St. Mary's Road. The bridge over T1 was replaced by NCDOT in early 2016. Downstream from St. Mary's Road, the incised channel continues to the south for another 643 feet before it joins the mainstem of Buckwater Creek. There is no riparian buffer on the left bank because of the transmission line. The right bank has a forested buffer and a currently disconnected floodplain that is 5 to 6 feet above the existing channel bottom. There are no headcuts and fine sediment accumulates where the profile flattens.

The stream type within the project area is most nearly classified as an incised E4 above St. Mary's Road and as an incised B4c below the road. The floodprone elevation below St. Mary's, at twice the estimated bankfull elevation, just reaches the relic floodplain on the right bank.

T2

T2 is a 543-foot long reach that begins at the confluence of T3 and T4 and ends at Buckwater Creek, approximately 400 feet downstream from the Walnut Hill Drive crossing. The majority of T2 has a narrow valley and is directly accessed by cattle. Due to frequent cattle access, many of the streambanks are trampled and eroding. Floodplain is available on the upstream and downstream ends of the reach, though an incised channel limits access to the flooplain in most cases. Streambank vegetation, where present, is often Chinese privet (*Ligustrum sinense*). T2 is a G4c-type stream with bank height ratios greater than 2.0 through the middle of the reach and a more stable E4-type in one section of the upstream end.

T3

T3 is a 2,254-foot tributary that flows through existing cattle pasture before joining T4 to form T2. The upper reach, Reach 1, within the project area is 1,336 feet and largely stable. Bedrock provides bed and bank protection in several locations, preventing cattle damage. Isolated bank erosion is evident and the riparian buffer is very sparse, with just a handful of trees present on either bank. T3 Reach 1 is a mostly stable B4 channel, though all segments have cattle access. Cattle impacts are more severe when the rotation puts them in this area, but the stream recovers to some degree once they are removed. The stream's ability to recover is related to the low bank heights and herbaceous vegetation on the streambanks.

Below the upper stable portion of Reach 1 is a headcut that has been arrested by a bedrock knickpoint. Below the knickpoint is a section that has extensive cattle impacts because the primary buildings for the cattle operation are beyond the left bank. Consequently, this is an area where cattle congregate and use the stream channel as a wallow. The banks have been trampled and there is very limited woody riparian vegetation.

The lower one third of T3 is considered Reach 2, which is in an area where the cattle farmer manipulated the stream channel. This conversion happened between 1975 and 1982. The farmer moved the channel to the left side of the pasture and removed the wetland vegetation. A deeper channel has served to increase pasture drainage.

T3 Reach 2 is an E4/incised B4c stream type. The stream type variability is due to the degree of cattle trampling of the streambanks. As a result, channel definition is weak in many areas along T3 and mid-channel bars are common.

T4

T4 is a 1,081-foot reach that is extensively impacted by cattle. It flows from the confluence of T4A and T4B and is constrained by the transmission line easement to the right and a farm road to the left. The lateral constraints are particularly tight at the upstream end of T4. Numerous headcuts are present along T4 and are being prevented from travelling upstream by tree roots. Cattle have trampled the banks and a prime feeding area is located just 15 feet from the right bank. The farm road gets as close as 5 feet from the left bank in the middle of T4.

T4 is a G4c stream type in many locations through which a headcut has migrated. Where headcuts have not occurred, trampled banks and sedimentation are present.

T4A

As with T4, cattle impacts are pervasive along T4A. T4A begins outside of the project area as a steep channel beneath the transmission line before it empties into a farm pond. The pond on T4A has abundant algal growth during the growing season, undoubtedly due to high nutrient inputs from cattle manure. The pond does not have a low flow outlet and the spillway channel is eroding and contains incipient headcuts. Below the pond dam, the channel is weakly defined for about 200 feet due to the pond's influence and cattle trampling. At this point it flows through a culvert beneath a farm access road and empties into a cattle-impacted wetland immediately beneath the transmission line. It joins with T4B within this wetland as weakly defined channels.

Below the farm road crossing T4A is laterally constrained by the power line on the right side and the farm road on the left side. It is, however, in an unconfined valley.

T4B

T4B emanates through a culvert from a forested catchment with preservation-quality stream channels. Impacts are quickly noticeable as it is subject to direct cattle use. Headcuts are numerous and, where present, the channel is incised. Elsewhere, trampled banks and sedimentation are common. This alternating incision and trampling is the case for the upper 419-foot section of T4B. The lower 145-foot section runs through a cattle-trampled wetland with the transmission line easement. The stream type for T4B most closely resembles an F4b channel.

T5

T5 is a spring-augmented reach that begins at the confluence of T6 and T6A, north of St. Mary's Road. Initially, the reach is incised but stable with a bedrock and cobble bottom. However, the uppermost section is situated within a thicket of Chinese privet (*Ligustrum sinense*) and has a barn located within 50 feet of the right bank. Downstream, the channel is confined and runs along the embankment that forms the base for St. Mary's Road. Once below St. Mary's Road, the channel hugs Walnut Hill Drive and, at the bottom, flows through a narrow gap between the road and a spring-fed pond. An active headcut is moving upstream and is currently between the upper end of the pond and St. Mary's Road. Clay substrate has slowed the headcut's advancement. T5 most closely resembles an incised B4c stream type above St. Mary's Road and below the road an incised C4 stream type with very low sinuosity.

T6, T6A, and T6B

T6 is a 1,909-foot reach that begins near a property line, beyond which is a forested area. T6 has stable sections that alternate with incised and eroding sections. The riparian buffer is narrow and sparse in most locations, particularly on the left bank. Bedrock and tree roots serve as knickpoints to arrest headcut progression. T6-R3, below the ford crossing, has factors that limit the riparian buffer beyond the right streambank. Two barns, one at the upstream end and another at the downstream end, and a transmission line easement are within 50 feet of the existing channel. The transmission line easement comes as close as 5 feet from the channel. Because the stream channel generally bends to the left on lower T6, much of the right streambank is vertical and eroding. T6 most closely resembles an incised G4 channel on the upstream end and an incised E4 channel with low sinuosity on the downstream end. T6 and T6A join to form T5.

T6A is a short 296-foot reach that forms below a 1-acre farm pond. A headcut is moving from T6A along the overflow spillway path to the pond dam. Otherwise, the reach is largely stable and has relatively minimal erosion, probably because the pond upstream detains runoff. T6A most closely resembles an incised E4 channel.

T6B is a 102-foot reach that is the downstream end of a cultivated swale. A headcut has migrated up the lower end of T6B from T6. Minor erosion is evident along T6B. Cedar roots are helping to hold the banks together. T6B above the project area is stable but receives runoff from agricultural fields. T6B most closely resembles an incised B4 channel.

T7 and T7A

T7 is a tributary that flows north for 887 feet into Buckwater Creek at the transition from Reach 7 to Reach 8. It begins at a headcut with a spring; as such, it makes an abrupt transition from a pasture swale to a jurisdictional channel. Reach 1 of T7 extends 234 feet and transitions from an incised channel to one that has low bank heights but severe cattle trampling. It most closely resembles an E4 channel that is typically but not always incised.

Deep headcuts in two separate channels mark the transition from Reach 1 to Reach 2. The separate channels are the result of a blockage caused by debris accumulation. T7 Reach 2 has the most severe incision in the project area, as evidenced by bank height ratios of nearly 9. Despite deep incision, lateral bank erosion has progressed more slowly because tree roots are helping to stabilize the banks and the bank material includes clay and weathered bedrock. T7 Reach 3 flattens more than T7 Reach 2 and has less deep incision. Reaches 2 and 3 of T7 are a G4 channel.

T7A is a 229-foot tributary to T7. The lower end of T7A had been dammed but the dam failed when a headcut, emanating from T7, migrated through it. The headcut has not yet advanced through the former pond bed. Upstream from the pond, the channel is incised and bank trampling by cattle is evident. T7A is a G4 channel above the former pond.

T8

T8 is a 634-foot tributary that flows south into Buckwater Creek at the transition from Reach 1 to Reach 2. The full length of T8 is incised; however, an active and deeper headcut is located 270 feet from the confluence. As a result, incision in the lower section of T8 is more pronounced. It is clear from the survey topography that T8 has been moved to the east from its original valley location. T8 most closely resembles an incised E4b stream type with very low sinuosity.

T9

T9 is a tributary that drains through a spring-fed pond outside of the project area. Due to the flow regulation provided by the pond, T9 is stable. It has down cut on the lower end, however, because it drains to incised Buckwater Creek Reach 2. The portion of T9 to be included in this mitigation project will only be the proposed easement width on Buckwater Creek. T9 most closely resembles a F4b stream type in the project area close to Buckwater Creek.

Table 4: Project Attribute Table Part 3 – *Buckwater Mitigation Site*

Parameter	Buckwater - Reach 1	Buckwater - Reach 2 & 3	Buckwater - Reach 4	Buckwater - Reach 5&6	Buckwater - Reach 7&8
Length of Reach (LF)	426	391	2,282	1,272	1,215
Valley Confinement (confined, moderately confined, unconfined)	Moderately Confined to Unconfined	Moderately Confined to Unconfined	Unconfined	Unconfined	Unconfined
Drainage Area (acres)	538	595	640	1,024	2,259
Perennial, Intermittent, Ephemeral	P	P	P	P	P
NCDWR Water Quality Classification	WS-IV				

Stream Classification (Existing and Proposed)	Incised/ Straightened C4/E4	Incised/ Straightened E4	Incised E4/G4c (proposed C4)	G4c (proposed E4)	Incised E4
Evolutionary Trend (Simon)	V - Aggradation and Widening				
FEMA Classification	N/A	N/A	Zone AE (bottom end)	Zone AE	Zone AE

Parameter	**T1 - Reach 1**	**T1 - Reach 2**	**T2**	**T3 - Reach 1**	**T3 - Reach 2**
Length of Reach (LF)	430	643	543	1336	918
Valley Confinement (confined, moderately confined, unconfined)	Unconfined	Unconfined	Unconfined to Confined	Moderately Confined to Unconfined	Unconfined
Drainage Area (acres)	1200	1216	218	109	141
Perennial, Intermittent, Ephemeral	P	P	P	P	P
NCDWR Water Quality Classification	WS-IV				
Stream Classification (Existing and Proposed)	Incised E4	Incised B4c (proposed E4)	E4/G4c (proposed C4/B4)	B4	E4/incised B4c (proposed C4)
Evolutionary Trend (Simon)	V - Aggradation and Widening		IV - Degradation and Widening		
FEMA Classification	Zone AE	Zone AE	Buckwater Floodplain Fringe		N/A

Parameter	**T4**	**T4A**	**T4B**	**T5**	**T6 - Reach 1**
Length of Reach (lf)	1,081	678	419 (in project)	1,291	715
Valley Confinement (confined, moderately confined, unconfined)	Confined to Unconfined	Moderately Confined to Unconfined	Moderately Confined to Unconfined	Confined	Moderately Confined to Unconfined
Drainage Area (acres)	77	17	43	109	32
Perennial, Intermittent, Ephemeral	**P**	**I**	**I**	**P**	**P**
NCDWR Water Quality Classification	WS-IV				
Stream Classification (Existing and Proposed)	G4 (proposed B4 and C4)	pond/E4 (proposed B4)	F4b (proposed C4/B4)	Incised E4/ C4/Incised C4 (proposed B4 and C4)	G4
Evolutionary Trend (Simon)	IV - Degradation and Widening				III - Degradation

FEMA Classification	N/A	N/A	N/A	Buckwater Floodplain Fringe	N/A

Parameter	**T6 - Reaches 2 and 3**	**T6A**	**T6B**
Length of Reach (lf)	1,194	296	102
Valley Confinement (confined, moderately confined, unconfined)	Moderately Confined to Unconfined	Confined to Moderately Confined	Unconfined
Drainage Area (acres)	56	30	8
Perennial, Intermittent, Ephemeral	**P**	**P**	**I**
NCDWR Water Quality Classification	WS-IV		
Stream Classification (Existing and Proposed)	Incised E4	Incised E4	B4
Evolutionary Trend (Simon)	IV - Degradation and Widening	III – Degradation	
FEMA Classification	N/A	N/A	N/A

Parameter	**T7 - Reach 1**	**T7 - Reach 2&3**	**T7A**	**T8**	**T9**
Length of Reach (lf)	234	653	229	634	72
Valley Confinement (confined, moderately confined, unconfined)	Confined to Moderately Confined	Confined to Moderately Confined	Moderately Confined	Moderately Confined	Unconfined
Drainage Area (acres)	17	28	5	21	33
Perennial, Intermittent, Ephemeral	**P**	**P**	**I**	**I/P**	**P**
NCDWR Water Quality Classification	WS-IV				
Stream Classification (Existing and Proposed)	Incised E4	G4 (proposed B4/C4)	G4/Incised E4	Incised E4	F4b
Evolutionary Trend (Simon)	IV - Degradation and Widening				
FEMA Classification	N/A	Buckwater Floodway Fringe	N/A	N/A	N/A

1. The Rosgen classification system (Rosgen, 1994) is for natural streams, while Simon Channel Evolution Model (Simon, 1989) describes a stream's evolutionary process after any disturbance. These channels have been heavily manipulated by livestock and humans and therefore may not fit one Rosgen classification category.
2. Wetland areas are not proposed for mitigation credit.

4.0 Watershed and Channel Disturbance and Response

As discussed above in Section 3.2, the project area surrounding Buckwater Creek was intensively farmed until the 1970s such that very few riparian buffers were present. The streams were straightened and prevented from developing much more than minimal meander bends. The farmers allowed several forested riparian buffers to grow beginning in the 1970s, though the intensity of agricultural activity remained high through the 1990s. These practices have maintained the streams that were channelized and moved to the valley margins prior to 1938 in their current locations. The resulting steeper channel slopes produced increased shear stresses that lead to numerous headcuts and associated degradation. Buckwater Creek and T1 are vertically stable, though the other tributaries have active headcuts. Buckwater Reach 4 has one knickpoint formed by tree roots.

Over time, incision has reduced some of the channel slopes which resulted in decreased stream power. In these locations, aggradation of fine sediment is common. As incision slowed, the channels have begun to widen through streambank scour, mass wasting, and livestock trampling. Streambank erosion is common throughout the project site with few exceptions. Signs of bank sloughing are most pronounced on Lower Buckwater (Reaches 5 and 6) and T5, neither of which are subject to livestock trampling.

Active headcuts are present on T4A, T5, T6, T7, T7A, and T8. Headcuts slowed by tree-root knickpoints are present on T2, T4, T4B, and T6A. Additionally, severe bank erosion of isolated banks is present on all reaches of Buckwater Creek, plus T1, T2, T4, T4B, T5, T7, and T8. Limited to moderate erosion is more typical on T3, T4A, T6, T6B, T7A, and T9.

5.0 Functional Uplift Potential

The potential for functional uplift is described in this section according to the Stream Functions Pyramid (Harman, 2012). The Stream Functions Pyramid describes a hierarchy of five stream functions, each of which supports the functions above it on the pyramid. The five functions in order from bottom to top are hydrology, hydraulics, geomorphology, physicochemical, and biology. Sometimes functions reinforce those below it, particularly on the bottom end.

5.1 Hydrology

The major watershed disturbances, prior to 1938, have been deforestation, stream channelization, and conversion of approximately half of the watershed to agricultural land uses. These alterations in land cover typically result in reductions in rainfall interception and infiltration which lead to some increase in runoff and water yield (Dunne and Leopold, 1978). A primary result of these changes is an increase in peak flows, though the magnitude of this effect is likely to be small in watersheds of this size. Initial increases in water yield usually change over time as vegetation regrows. There are no stream gages within this watershed and, thus, no way to know the degree to which clearing of the land affected this watershed other than to say that water yields have probably increased. However, these changes primarily occurred many decades ago (prior to available aerial photography) and additional clearing in the watershed has been limited. The watershed has adjusted to its rainfall-runoff relationship and is now stable.

Population growth in this rural area is limited by land use zoning and reliance on septic systems. Therefore, future alteration to the land cover and associated effects on hydrology are not expected in the foreseeable future. Considering this, the Site hydrology is functioning.

A stream restoration project performed at a specific Site does not often result in uplift to hydrology (Harman, 2012). However, some of the Buckwater reaches will noticeably increase forested land cover because the conservation easement area comprises more than a nominal portion of the watersheds. Examples include T2 (6.3% of the catchment area will be within the conservation easement), T4 (7.8%), T4A (8.8%), T6 (8.8%), T7 (10.0%), T7A (9.8%), and T8 (6.9%). Though this may not significantly improve the rainfall-runoff relationship, it may offer a degree of protection from future land development, particularly if sheet flow is maintained through the riparian buffer. For the larger streams, Buckwater Creek and T1, the hydrology parameters are independent variables and are clearly not subject to change because of the mitigation project.

Therefore, in general, there is not an opportunity to further improve the hydrology function, but it is expected to remain functioning.

5.2 Hydraulics

Most of the streams on the Site are channelized, incised, and not connected to their floodplains. This has resulted in reduced hydraulic function by the channels. Bank height ratios greater than 1.5 are considered to be highly incised and thus not functioning (Rosgen, 2006; Harman, 2012).

The bank height ratios on Buckwater upstream from T1 range from 1.6 to 2.6 (not functioning). On T1, the bank height ratios are 1.7-1.8 (not functioning). In fact, considering that bank height ratios greater than 1.5 are not functioning, only Buckwater Reaches 7 and 8 (BHR of 1.2-1.3), upper T2 (1.4), and much of T3 (1.2-1.3) are functioning on some level. Fully functioning is indicated by bank height ratios of less than 1.2, so that includes only Buckwater Reaches 7 and 8 and T3 Reach 1.

Entrenchment ratios paint a somewhat better picture. Considering fully functional ratings apply to streams with entrenchment ratios greater than 2.2 for C and E stream types and 1.4 for B stream types, portions of Buckwater Reaches 4, 7, and 8, upper T2, T3 Reach 1, T4A, T5 Reach 2, T6 Reach 2, T6A, T7 Reach 1, T7A, and T8 meet these criteria. Channels that fall in the functioning-at-risk category include portions of upper Buckwater (R1), lower T2, T3 Reach 2, upper T4, T6 Reach 1, and T6A. The remaining channels, including the middle reaches of Buckwater (R2, R3, R4, R5, and R6), T1, T3 Reach 2, lower T4, T4B, T5 Reach 1, upper T6, T7 (R1, R2, and R3), and T9 are, per entrenchment ratio metrics, not functioning for hydraulics.

In all restoration reaches, the channel will be reconstructed and connected to its floodplain so that streamflows above bankfull stage will reach the floodplain. The bank height ratios for all restored reaches will be 1.0 (functioning).

Bankfull flow velocities and shear stress will be decreased to functioning levels. Groundwater exchange and adjacent wetland hydrology will be improved because of the increased frequency of floodplain inundation. Hydraulics will transition from Not Functioning or Functioning-At-Risk to Functioning (Table 4).

5.3 Channel Geomorphology

Past channelization, present downcutting, and on-going sloughing and widening described in Sections 3.4 and 4 assign the Site streams to Stages III, IV, and V of the Simon Channel Evolution Model. Table 4 at the end of Section 3.4 lists the stage for each reach. These stages indicate an unstable condition which comes with active erosion and thus are considered Not Functioning by Harman (2012). The goal of restoration is to achieve a stable condition, either by returning to Stage I through Priority 1 restoration or advancing to Stage VI through Priority 2 restoration. Stages I and VI are considered Functioning with minimal erosion. Late Stage V can be considered Functioning-At-Risk if the stream has begun to construct a floodplain at a lower elevation, but this is not the case for the stream channels on the Site.

There is significant opportunity to improve the geomorphologic function on the Site and move the streams to a stable condition. All restoration reaches will remove incision and active bank erosion. Incision and bank erosion will be greatly decreased on Enhancement Level I reaches. Large woody debris will be added to the Site streams through construction of instream structures and bank revetments, and a riparian buffer will be planted. The geomorphology function will be restored to Functioning on most project streams. Those that are incised but targeted for enhancement are considered Functioning-At-Risk.

5.4 Physicochemical

The 2009 Neuse River Basinwide Water Quality Plan lists the major stressors in subbasin 03-04-01 as TSS, nutrients, and chlorophyll α. Since the watershed land use is like the greater subbasin, the Site likely has similar physicochemical concerns as those stated in the Basinwide Water Quality Plan. Potential sediment sources in the watershed include streambank erosion, bed scour, and runoff from agricultural fields. Potential sources of nutrients within the watershed are the two livestock operations within the project area and runoff containing fertilizers applied to fields in the watershed. The watershed includes two hay-growing operations that entail a spring application of fertilizer. The suspected high nutrient load and lack of shade in some reaches may contribute to elevated levels of chlorophyll α. Wildlands has observed algal blooms on lower Buckwater (R7) and the online pond on T4A which indicate visibly high levels of chlorophyll α.

Wildlands estimated nutrient removal from livestock exclusion and riparian buffer establishment. The annual rate of nutrient removal from buffer establishment is calculated by using the NC Division of Water Quality “Methodology and Calculations for determining nutrient reductions associated with riparian buffer establishment” (1998). This estimates total nitrogen (TN) and total phosphorus (TP) removed from land use change, from nonpoint source runoff filtration, and from periodic overbank flooding. For this calculation, Wildlands considered only restored riparian buffer adjacent to agricultural fields. 6.75 acres that are fertilized and used for hay cultivation will be converted to riparian buffer, equaling TN and TP reductions of 511 pounds and 33 pounds, respectively. Separately, 22.28 acres of restored buffer will exclude cattle. This results in a TN reduction of 1,137 pounds and a TP reduction of 94 pounds. Thus, the project is estimated to annually reduce TN by 1,648 pounds and TP by 127 pounds.

Given its reach and watershed characteristics, DMS is measuring NO_2/NO_3, NH_3^+, TKN, TN, TP, and TSS above and at the bottom of reach T4 pre-construction in order to capture baseline concentrations and loading for these parameters. These will be collected using automated samplers to include both baseflow and stormflow samples. The intent is to gain insight into the magnitude and distribution of these water quality parameters in pastured areas and examine the variance in the distributions to determine the percent change necessary to demonstrate a statistically reliable change ($P<0.05$) (Spooner et al., 2011). Post-construction monitoring for these will be implemented depending upon the levels observed (i.e., how much room for improvement exists) and the variance in the distribution (i.e., how large of a change and how large of a sample size will be needed for statistically reliable detection of change). If these characteristics of the pre-construction distributions indicate a reasonable likelihood of reliable change detection, then post-construction monitoring will proceed. Wildlands and DMS are not seeking any mitigation credit for this monitoring and it is not a component of the mitigation success criteria.

Although it is not mentioned in the Water Quality Plan, fecal coliform is another likely source of pollution within the watershed due to livestock operations. DMS has provided a method for estimating benefits to water quality from livestock exclusion and riparian buffer establishment for stream restoration (NCDMS, 2016). DMS is also collecting fecal coliform samples above and below reaches T3 and T4 prior to construction to gain insight into the magnitude and distribution of fecal coliform contamination in pastured areas. DMS will use the same analyses and approaches described above for nutrients and TSS. Wildlands and DMS are not seeking any mitigation credit for this monitoring and it is not a component of the mitigation success criteria.

A literature review conducted by DMS produced a method (NCDMS, 2016) for estimating fecal load reductions. Wildlands applied this methodology (Appendix 5) and found that an estimated 85 percent reduction in bacteria loading may be achieved by establishing a riparian buffer and an additional 8.5 percent reduction may be achieved by excluding livestock from the stream channels. Wildlands applied this methodology (Appendix 5) and found that an estimated reduction of 2.37 10^{12} colonies per day are achieved from livestock exclusion, considering that there are 127 animal units in the project area. Also, an annual load reduction of 1.48 10^{14} fecal coliform colonies is estimated from nearly 86 acres of existing pasture area due to riparian buffer filtering. This estimate is based on pastures under continual grazing and a reduction in pasture runoff area to about 64 acres (i.e., the difference is in part due to reduced pasture area). The total annual fecal coliform reduction from the project is thus estimated to be 1.01 10^{15} colonies.

Given the current conditions and treatment measures proposed, the current level of physicochemical functioning is estimated to be Not Functioning because of the high nutrient and fecal coliform bacteria loading. It is anticipated that the estimated reductions would raise the Site streams, especially reaches T3 and T4, to a Functioning condition.

There is additional potential to improve the physicochemical function of the project streams. Streamflow will cascade over instream structures which will provide aeration; trees will be planted in the riparian zone to eventually shade and cool streamflow and help filter runoff; and, streambank erosion will be greatly reduced to nearly eliminate large sources of sediment. However, the potential improvements to physicochemical function will not happen immediately and some aspects will not occur until a mature canopy is established.

Post construction monitoring will be conducted by DMS, though, as described above, pre-construction monitoring will inform any post-construction monitoring. DMS monitoring is intended to contribute to a data set that will help inform the restoration community about the efficacy of mitigation practices given the characteristics of a given reach and its drainage and to also inform the level of effort required to reliably detect change. This monitoring shall not be associated with Wildlands mitigation credits.

5.5 Biology

Wildlands conducted cursory assessments using the habitat assessment field data sheet for high gradient streams from EPA's Rapid Bioassessment Protocols (Barbour et al., 1999). The results for two Buckwater reaches and four tributaries (T3, T4, T5, and T7) are shown in Appendix 5. Though this method is dated, it shows the habitat conditions on the Site are, for the most part, marginal. Many locations have well-mixed sand, gravel, and cobble but there are also locations on each reach where embeddedness or scour are evident. For example, T4 alternates between sections with well-mixed rock substrate and those that are embedded by fine sediment. Middle T7 R2 is scoured down to clay hardpan.

Most reaches contain little woody debris and organic material necessary to support diverse macroinvertebrate and fish communities. There are few downed trees or larger woody debris masses that would create habitat features. Most reaches have riffle-pool sequences, but much of stream length is choked with fine sediment, likely lowering dissolved oxygen levels in the substrate and covering the bed habitat. The riparian buffers are narrow and typically protect 50-70% of the streambank length, though T3 and T5 are devoid of trees along the banks.

While fish passage potential is good, there are two impediments. There is a perched culvert on T3 and no culvert through the road at the start of T4 (i.e., the road acts as a porous dam). The culvert below St. Mary's Road on T5 is at grade and fish may pass at higher flows, though the headcut downstream likely is a fish passage impediment. The bridges on T1 (St. Mary's Road) and Buckwater (Walnut Hill Drive) pose no constraints to fish passage.

The riparian zones of the project provide some habitat for terrestrial species, though there is also abundant pasture grass. Mature forest is present along the right bank of Buckwater Creek from the start to the transmission line. Very limited buffer is present on the left bank between T8 and Walnut Hill Dr. However, because no data on the existing communities are available to evaluate the current level of biologic functioning, this function is not rated.

There is opportunity to improve the instream and riparian habitat. Habitat will be improved by adding instream structures with a variety of rock and woody materials, adding woody bank revetments, providing a riparian buffer to shade the stream and improve terrestrial habitat, creating pools of variable depths, and reducing loading of fine sediments. The road crossings will be addressed to improve aquatic organism passage. The biological response of the system will be tied to the habitat improvement. Wildlands will conduct the EPA Rapid Bioassessment Protocol annually during the monitoring period. Even if these functions improve, the ultimate level of improvement in biology may not occur until after the completion of the seven-year monitoring period. Therefore, the proposed functional classification has not been rated.

5.6 Overall Functional Uplift Potential

Overall, the Buckwater Mitigation Site can be considered as somewhere between Functioning-At-Risk and Not Functioning but the functional uplift potential is for it to be reclassified as Functioning. This change in overall classification is mainly related to improvements in hydraulics and geomorphology between the existing and proposed conditions. The hydrology function will not be significantly changed by the project because it is already functioning and watershed-scale reforestation would be required to further improve it. Physicochemical and biological improvements are a likely result of the project. The fecal coliform parameter should improve to Functioning, though it is unclear at this stage if this will be based on the calculations presented in Section 5.4 or if monitoring data will be available to confirm the improvement. The biological function should improve but, similarly, it is unclear if the habitat assessment will be enough to confirm the improvement.

It is safest to assume that the project goals are tied only to hydraulics and geomorphology, but other ancillary benefits are expected.

5.7 Site Constraints to Functional Uplift

As previously discussed, a transmission line crosses the Site through lower Buckwater, and tributaries T4A and T4B. The 150-foot easement associated with the transmission line will be overlain with a conservation easement on T4B. No conservation easement will overlap the transmission line over Buckwater Creek (R7). T4B is stable through this reach so it will be left untouched, including the vegetation, which is mostly herbaceous wetland species. Buckwater Creek will be restored and stabilized through approximately half of the transmission line easement as the design T1 and Buckwater R6 channels drop to existing grade. Only livestakes will be included in the vegetation plan for this area. Livestakes will be planted on and up to 10 feet beyond the top of streambanks, and a permanent herbaceous seed mix will be applied. Another Duke Energy transmission line crosses Buckwater Reach 4 approximately 150 feet upstream from Walnut Hill Drive. Approved low-growing tree species will be planted in this area.

Other breaks in the project include those for St. Mary's Road on both T1 and T5, as well as for Walnut Hill Drive on Buckwater Reach 4, and farm access roads on T3 (two), T4, T4A, and T6. The St. Mary's Road, Walnut Hill Drive, and upper T3 crossings will be external easement breaks, while the others will be included in the conservation easement. Creating an internal crossing in the easement with livestock exclusion fencing protects the stream from livestock access. A summary and table of the easement crossings are provided in Section 8.11 and Table 14.

Mature trees are present on some of the restoration channel floodplains. These have been avoided to the maximum extent practicable in the design. For example, T1 Reach 2 restoration downstream of St. Mary's Road delays turning to the right until it has passed two very large trees. Also, Priority 2 restoration was avoided on this reach, as well as Buckwater Reaches 5 and 6, to save more of the existing forested floodplain.

Culverts on T3, T4A, and T4 will be designed and constructed such that fish passage will be possible.

The stream restoration and enhancement approaches on the Site will allow for the development of stable, functioning streams and there are no other known constraints to the functional uplift than those described above in this section. The degree to which the physicochemical and biology functions can improve on the Site is somewhat limited by upstream water quality and the presence of source communities upstream and downstream of the Site (i.e., benthic macroinvertebrates and fish).

6.0 Regulatory Considerations

Table 5, below, is a summary of regulatory considerations for the Site. These considerations are expanded upon in Sections 6.1-6.3.

Table 5: Project Attribute Table Part 4 – *Buckwater Mitigation Site*

Regulatory Considerations			
Parameters	**Applicable?**	**Resolved?**	**Supporting Docs?**
Water of the United States - Section 401	Yes	Yes	Appendix 4
Water of the United States - Section 404	Yes	Yes	Appendix 4
Endangered Species Act	Yes	Yes	Appendix 6
Historic Preservation Act	Yes	Yes	Appendix 6
Coastal Zone Management Act	No	No	N/A
FEMA Floodplain Compliance	Yes	In Progress	Not Yet Available
Essential Fisheries Habitat	No	N/A	N/A

6.1 Biological and Cultural Resources

A Categorical Exclusion for the Buckwater Mitigation Site was submitted to DMS on May 27, 2016, and approved on June 3, 2016. This document included investigation into the presence of threatened and endangered species on Site protected under The Endangered Species Act of 1973, as well as any historical resources protected under The National Historic Preservation Act of 1966. The biological conclusion for the Site, per the Categorical Exclusion research and response by US Fish and Wildlife Service, is that the, "proposed action [in this project] is not likely to adversely affect any federally listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for listing under the Act." All correspondence with USFWS and a list of Threatened and Endangered Species in Orange County, NC is included in Appendix 6. The conclusion for cultural resources per the Categorical Exclusion research and response by the State Historic Preservation Office is that there are no historic resources that would be affected by this project. For additional information and regulatory communications please refer to the Categorical Exclusion document in Appendix 6.

One item of note is that a Standard Local Operating Procedures for Endangered Species Act Compliance (SLOPES agreement) for the northern long-eared bat was signed by the USACE and the USFWS in January 2017. This was subsequent to the Categorical Exclusion approval for the Site. Wildlands complied with the SLOPES agreement for the NLEB by sending a scoping letter to the USFWS and the USACE. That letter is included in Appendix 6.

6.2 FEMA Floodplain Compliance and Hydrologic Trespass

There are two FEMA mapped streams within the project limits: Buckwater Creek Reaches 4-8 extending from just above Walnut Hill Drive to the downstream limits of the project, as well as the portion of T1 beginning just above St. Mary's Road extending to the confluence with Buckwater Creek. Both these reaches are mapped FEMA Zone AE with floodway, as shown on the Orange County Flood Insurance Rate Map Panel 9895 and in Figure 7. Both sections of Buckwater Creek and T1 are modeled as a detailed study with base flood elevations established and mapped floodway. A Conditional Letter of Map Revision (CLOMR) with detailed hydraulic modeling may be required for this project. We will coordinate with the Orange County Floodplain administrator and FEMA for approval. If required, a Letter of Map Revision (LOMR) will be submitted after the project is constructed to revise the maps to accurately reflect the project. The project has been designed so that any increase in flooding will be contained on the project site and will not extend upstream to the adjacent parcels.

6.3 401/404

Small wetland features are present along most of the Buckwater project streams (see Section 3.4 – Project Resources). The existing jurisdictional wetlands appear in Figure 6. The proposed stream channels are routed away from these features when possible. However, the proposed stream channels often will impact the wetlands when there is no alternative. Any wetlands within the conservation easement and outside of the limits of disturbance will be flagged with safety fence during construction to prevent unintended impacts. This will be denoted in the final construction plans on the Erosion and Sediment Control plan and detail plan sheets, as well as in the project specifications. Floodplain grading will be considered a temporary impact to wetlands. Some wetlands resources will be converted to stream resources. Wildlands expects a net gain of wetland area, as construction of the new channels will fill most of the old channels to the elevation of the existing wetlands and remove dredge spoil along the banks, creating a wider overall floodplain and riparian wetland area.

Table 6 estimates the anticipated impacts to wetland areas on this project. Final impacts will be provided in the Pre-Construction Notification, after proposed floodplain grading has been completed, and will more accurately quantify these data. The numbers below reflect a conservative estimate of potential impacts. Of the 70 individually mapped wetlands, 46 have some type of impact, and 17 have permanent impacts.

Table 6: Estimated Impacts to Project Wetlands – *Buckwater Mitigation Site*

Jurisdictional Feature	Classification	Total Acreage	Permanent (P) Impact		Temporary (T) Impact	
			Type of Activity	Impact Area (acres)	Type of Activity	Impact Area (acres)
Wetlands A-RRR	Bottomland Hardwood Forest and Seeps	5.48	Conversion to Stream Resource	0.40	Floodplain Grading	0.90

Stream impacts have not yet been calculated but, generally, will be temporary. Stream length will be added on most restoration reaches, including T4A, T4B, T4, T2, T3, T5, and Buckwater R4.

7.0 Mitigation Site Goals and Objectives

The project will improve stream functions as described in Section 5 through stream restoration and riparian buffer re-vegetation. Project goals are desired project outcomes and are verifiable through measurement and/or visual assessment. Objectives are activities that will result in the accomplishment of goals. The project will be monitored after construction to evaluate performance as described in Section 10 of this report. The project goals and related objectives are described in Table 7.

Table 7: Mitigation Goals and Objectives – *Buckwater Mitigation Site*

Goal	Objective	Expected Outcomes	Function(s) Supported
Reconnect channels with floodplains and riparian wetlands to allow a natural flooding regime.	Reconstruct stream channels for bankfull dimensions and depth relative to the existing floodplain.	Raise water table and hydrate riparian wetlands. Allow more frequent flood flows to disperse on the floodplain. Support geomorphology and higher level functions.	Hydraulic
Improve the stability of stream channels.	Construct stream channels that will maintain stable cross sections, patterns, and profiles over time.	Significantly reduce sediment inputs from bank erosion. Reduce shear stress on channel boundary. Support all stream functions above hydrology.	Geomorphology
Exclude cattle from project streams.	Install fencing around conservation easements adjacent to cattle pastures.	Reduce and control sediment inputs; reduce and manage nutrient inputs; reduce and manage fecal coliform inputs. Contribute to protection of or improvement to a Water Supply Waterbody. Support Falls Lake recovery plan.	Geomorphology, Physicochemical
Improve instream habitat.	Install habitat features such as constructed riffles, cover/lunker logs, and brush toes into restored/enhanced streams. Add woody materials to channel beds. Construct pools of varying depth.	Increase and diversify available habitats for macroinvertebrates, fish, and amphibians leading to colonization and increase in biodiversity over time. Add complexity including LWD to streams.	Geomorphology (supporting Biology)
Restore and enhance native floodplain and streambank vegetation.	Plant native tree and understory species in riparian zone and plant appropriate species on streambank.	Reduce sediment inputs from bank erosion and runoff. Increase nutrient cycling and storage in floodplain. Provide riparian habitat. Add a source of LWD and organic material to stream. Support all stream functions.	Hydrology (local), Hydraulic, Geomorphology, Physicochemical, Biology
Permanently protect the project site from harmful uses.	Establish conservation easements on the Site.	Protect Site from encroachment on the riparian corridor and direct impact to streams and wetlands. Support all stream functions.	Hydrology (local), Hydraulic, Geomorphology, Physicochemical, Biology

8.0 Design Approach and Mitigation Work Plan

8.1 Design Approach Overview

The design approach for this Site was developed to meet the goals and objectives described in Section 7 which were formulated based on the potential for uplift described in Section 5. The design is also intended to provide the expected outcomes in Section 7, though these are not tied to performance criteria. The project streams planned for restoration will be reconnected with an active floodplain and the channels will be reconstructed with stable dimension, pattern, and profile that will transport the water and sediment delivered to the system. Enhancement Level I stream sections will include dimension and profile adjustments and Enhancement Level II stream sections will include cattle exclusion and bank stabilization. Where buffer restoration or enhancement is needed, the adjacent floodplains and riparian wetlands will be planted with native tree species. Instream structures will be built in the channels to help maintain stable channel morphology and improve aquatic habitat. The project area will be protected in perpetuity by a conservation easement.

The design approach for this Site employed a combination of analog and analytical approaches for stream restoration. Reference reaches were identified to serve as an acceptable range for design parameters. Channels were sized based on design discharge hydrologic analysis and empirical approaches including applying regional curve equations. Designs were then verified and/or modified based on a sediment transport analysis. This approach has been used on many successful Piedmont and Slate Belt restoration projects (e.g., Underwood, Foust, Holman Mill, Maney Farm, and Agony Acres Mitigation Sites) and is appropriate for the goals and objectives for this Site.

8.2 Reference Streams

Reference streams provide geomorphic parameters of a stable system, which can be used to inform design of stable channels of similar stream types in similar landscapes and watersheds. Six reference reaches were identified for this Site and used to support the design of Buckwater Creek and its tributaries (Figure 9). These reference reaches were chosen because of their similarities to the Site streams including drainage area, valley slope, morphology, and bed material. The reference reaches are all located within the Carolina Slate Belt region of the Piedmont. Geomorphic parameters for these reference reaches are summarized located in Appendix 5. The references to be used for the specific streams are shown in Table 8. A description of each reference reach is included below.

Table 8: Stream Reference Data Used in Development of Design Parameters – *Buckwater Mitigation Site*

	Spencer Creek 2	Spencer Creek 3	Foust Creek	UT to Varnals Creek	UT to Wells Creek	Franklin Creek
Stream Type:	**C4/E4**	**E4**	**C4**	**B4/E4**	**C4**	**B4**
Buckwater and T1	X		X			X
T2, T3, T4, T5, T7		X		X	X	X

8.2.1 Spencer Creek Reach 2

Spencer Creek Reach 2 is located in western Montgomery County near Ophir, NC, less than two miles from the Spencer Creek reference site (Buck Engineering, 2004). This site was classified as an E4 stream type and has a drainage area of 0.96 square miles. This reach flows through a mature forest and has a valley slope of 1.1% and a channel slope of 0.47%. The morphological parameters reported for the riffle cross-section include a width to depth ratio from 5.8 to 7.1 and an entrenchment ratio of 5.5 to 10.2. The bed material d_{50} for the reach is 8.8 mm.

8.2.2 Spencer Creek Reach 3

The Spencer Creek Upstream site has a drainage area of 0.37 square miles and the land use within the drainage area is a semi-mature forest. The reach was classified as an E4 stream type with a low sinuosity (1.1 to 1.3). The channel has a width to depth ratio of 7.3 and an entrenchment ratio of 26.3. The reach has a valley slope of 2.2 to 3.1% while the channel slope is 1.9 to 2.2%. The reach consists of 52% riffles and 48% pools. The bed material d_{50} for the reach is 11 mm. Pattern data are included in the dataset.

Wildlands visited the Spencer Creek site in March 2012 and visually confirmed that the land use is unchanged and that the stream is laterally and vertically stable. Spencer Creek exhibits a stable, measurable, meandering pattern. Given the similarities in drainage area, stream type, stream and valley slope, and bed material size, Spencer Creek Upstream is most directly applicable as a reference reach for T2, T3, T4, and T5. Spencer Creek Downstream is similar to upper Buckwater Creek and T1. Both data sets are reference points on the project-specific curve. The pattern data are applicable to all C or E stream types and were used as a viable parameter range for C or E reaches in this project.

8.2.3 Foust Creek

The Foust Creek reference reach is located approximately 600 feet upstream of the northernmost conservation easement boundary on the Foust Creek Mitigation Site in Alamance County, NC. It was identified by Wildlands in the Foust Creek Mitigation Site 2014 Mitigation Plan (Wildlands Engineering, 2014). Foust Creek has a gravel bed and a valley slope of 0.75%. The Foust Creek reference reach is classified as a Rosgen C4 stream type. This reach flows through a mature forest and although it is stable it lacks sinuosity. The reach consists of 38% riffles and 62% pools. It was used in this project to inform the cross-section and profile parameters. Foust Creek is like the mainstem of Buckwater and T1.

8.2.4 UT to Varnals Creek

The UT to Varnals Creek reference reach is in south central Alamance County, NC near the Cane Creek Mountains. The site was identified by Arcadis and used as a reference reach for the Wells Creek Stream Restoration Site (Arcadis, 2002). Wildlands visited UT to Varnals Creek in September 2014 and visually confirmed that the land use is unchanged from reported conditions and that the stream is laterally and vertically stable. Wildlands conducted a detailed morphological survey in October 2014. UT to Varnals Creek near the Wildlands survey has a drainage area of 0.41 square miles and is classified as a Rosgen B4/E4b stream type for most of the reach. UT to Varnals Creek has a similar channel (0.017) and valley slope (0.020) to T2, T3, and lower T5. The reach consists of 44% riffles and 56% pools.

8.2.5 UT to Wells Creek

The UT to Wells Creek reference reach is located in south central Alamance County, NC near the Cane Creek Mountains and just southwest of UT to Varnals Creek. The site was identified by Arcadis and used as a reference reach for the Wells Creek Stream Restoration Site (Arcadis, 2002). Wildlands visited UT to Wells Creek in September 2014 and visually confirmed that the land use is unchanged from reported conditions and that the stream is laterally and vertically stable. UT to Wells Creek has a drainage area of 0.13 square miles and is classified as a Rosgen C4 stream type for the majority of the reach. UT to Wells Creek has a similar channel (0.020) and valley slope (0.028) to the Buckwater tributaries T3, T4, and T6.

8.2.6 Franklin Creek

Franklin Creek is a tributary to the Eno River located less than two miles southwest from the Buckwater Mitigation Site. Franklin Creek is located off Jack Franklin Road on a western boundary of the Eno River State Park. The site was identified by Wildlands to serve as a B channel reference reach for the Buckwater Mitigation Site. Wildlands conducted a detailed morphological survey on July 1, 2016. Franklin Creek at the Wildlands survey has a drainage area of 2.15 square miles and is classified as a Rosgen B4 stream over the surveyed reach. Franklin Creek has a similar channel (0.023) and valley slope

(0.027) to T2, T3, T4, and lower T5. It was only used for the discharge analysis and the broader design parameters (i.e., width-to-depth ratio, sinuosity, riffle slopes) for this mitigation project.

8.3 Design Channel Morphological Parameters

Reference reaches were a primary source of information to develop the pattern and profile design parameters for the streams. Ranges of pattern parameters were developed within the reference reach parameter ranges with some exceptions based on best professional judgement and knowledge from previous projects. For example, radius of curvature ratio is kept above 1.9 on all reaches and meander width ratio is kept above 2.9 in the moderately confined to unconfined valleys of the Buckwater site. Wildlands has found these minimum ratios to support stable geometry. Design B channels did not follow the stream pattern design ratios.

Reference ranges were also used to inform the design of the cross-sections on the streams. The streams were designed with pool widths to be approximately 1.35 times the width of riffles to provide adequate point bars and riffle pool transition zones. Designer experience was used for pool design as well. Pool depths were designed to be a minimum of 2.0 times deeper than riffles to provide habitat variation. Cross-section parameters such as area, depth, and width were designed based on the design discharge and stable bank slopes. The width to depth ratio was increased beyond some of the reference parameters to provide stable bank slopes prior to the establishment of a vegetated streambank. A summary of morphological parameters for several Site reaches, including Buckwater R4 and R5/6 and T2, T3, T4, and T5, are listed in Tables 9, 10, and 11. Complete morphological tables for existing, reference, and proposed conditions are provided in Appendix 5.

Table 9: Summary of Morphological Parameters for Buckwater Creek – *Buckwater Mitigation Site*

Parameter	Existing Parameters		Reference Parameters			Proposed Parameters	
	Buckwater Reach 4	Buckwater Reach 5/6	Franklin Creek	Spencer Creek 2	Foust Creek	Buckwater Reach 4	Buckwater Reach 5/6
Valley Width (ft)	200	170	100	-	-	200	170
Contributing Drainage Area (acres)	640	1,024	1,376	614	883	640	1,024
Channel/Reach Classification	incised E4/G4c	G4c	B4	E4	C4	C4	E4
Design Discharge Width (ft)	13	15	18.2	10.7 - 11.2	18.5 - 19.4	17.2	18.2
Design Discharge Depth (ft)	1.65	1.8	1.2	1.6 – 1.8	1.3 - 1.4	1.3	1.6
Design Discharge Area (ft^2)	22	28	21.7	17.8 – 19.7	23.9 - 24.1	21.7	29.4
Design Discharge Velocity (ft/s)	3.7	4	5.4	4.9 – 5.4	2.9 - 3.7	3.6	3.1/3.7
Design Discharge (cfs)	80	110	120	97	88	78	91/110
Water Surface Slope	0.0074	0.007	0.023	0.0047	0.009	0.0072	0.004/0.007
Sinuosity	1.14	1.41	1.18	2.3	1.1	1.31	1.42
Width/Depth Ratio	7.3	8.3	15.2	5.8 – 7.1	13.9 - 14.2	13.6	11.3
Bank Height Ratio	1.65	2.0	1.0	1.0	1.0	1.0	1.0

Entrenchment Ratio	1.3 - >3.3	1.3	3.6	5.5 - >10.2	2.6 - 3.4	1.8 - 5	2.2 - 5
d16 / d35 / d50 / d84 / d95 / d100	0.33, 1.3, 4.4, 47, 85, 256	0.34, 3.9, 7.8, 33, 71, >2048,	8.8, 25, 68.7, >2048, >2048, >2048	<0.063, 3, 8.8, 42, 90, x	-	-	-

Table 10: Summary of Morphological Parameters for T2 and T3 – *Buckwater Mitigation Site*

Parameter	**Existing Parameters**		**Reference Parameters**			**Proposed Parameters**	
	T2	**T3**	**UT to Wells**	**Spencer Creek 3**	**UT to Varnals**	**T2**	**T3**
Valley Width (ft)	40 - 80	60 - 85	-	-	-	40 - 80	60 - 85
Contributing Drainage Area (acres)	218	141	83	237	262	218	141
Channel/Reach Classification	E4/G4c	E4/ Incised B4c	C4	E4	B4/E4b	B4/C4	C4
Design Discharge Width (ft)	8.8 - 11	7.5 - 13	6.2 - 8.6	6.3 - 9.3	9.3 - 10.5	10.6	9.6
Design Discharge Depth (ft)	0.9 – 1.4	0.6 – 0.8	0.6 - 1.0	1.0 - 1.2	1.1 - 1.2	0.8	0.8
Design Discharge Area (ft^2)	8.3 - 15	6.2 – 7.5	3.9 - 6.3	6.6 - 8.7	10.3 - 12.3	8.9	7.3
Design Discharge Velocity (ft/s)	3.1 – 4.3	3.5 – 4.2	3.8 - 5.3	5.0 - 5.6	4.4 - 5.2	4.0	3.6
Design Discharge Discharge (cfs)	36	26	15	35	54	36	26
Water Surface Slope	0.015	0.018	0.0199	0.019 - 0.022	0.017	0.012 – 0.020	0.010 – 0.023
Sinuosity	1.17	1.16	1.41	1.0 - 1.30	1.20	1.21	1.29
Width/Depth Ratio	7.9 – 9.4	9.2 - 23	6.1 - 12.6	7.9 - 9.3	8.1 - 9.3	13	13
Bank Height Ratio	1.4 – 2.0	1.2 - 1.7	1.0 - 1.8	1.0	1.0	1.0	1.0
Entrenchment Ratio	1.3 – >5.6	1.7 - >3.4	1.9 - 4.1	1.7 - 4.3	5.7 - 10	2.0 - 5	2.2 - 5
d16 / d35 / d50 / d84 / d95 / d100	0.45, 4.4, 9.7, 71.1, 183, >2048	0.43, 11.3, 20.9, 55.7, 110, 180	0.1, 0.6, 4.5, 53, 96, x	1.87, 8.85, 11, 64, 128, x	Not available	-	-

Table 11: Summary of Morphological Parameters for T4 and T5 – *Buckwater Mitigation Site*

Parameter	Existing Parameters		Reference Parameters			Proposed Parameters	
	T4	T5	UT to Wells	Spencer Creek 3	UT to Varnals	T4	T5
Valley Width (ft)	71 - 106	40 - 110	-	-	-	71 - 106	40 - 110
Contributing Drainage Area (acres)	77	109	83	237	262	77	109
Channel/Reach Classification	G4	Incised E4/C4	C4	E4	B4/E4b	B4	C4
Design Discharge Width (ft)	7.2 - 8.9	8.9 - 9.3	6.2 - 8.6	6.3 - 9.3	9.3 - 10.5	7.5	9.2
Design Discharge Depth (ft)	0.57 - 0.70	0.7	0.6 - 1.0	1.0 - 1.2	1.1 - 1.2	0.6	0.7
Design Discharge Area (ft^2)	4.8 - 5.1	6.2 - 6.3	3.9 - 6.3	6.6 - 8.7	10.3 - 12.3	4.5	6.7
Design Discharge Velocity (ft/s)	3.3 - 3.6	3.0 - 3.4	3.8 - 5.3	5.0 - 5.6	4.4 - 5.2	3.9	3.3
Design Discharge Discharge (cfs)	17	21	15	35	54	18	22
Water Surface Slope	0.027	0.015	0.0199	0.019 - 0.022	0.017	0.0235	0.0127
Sinuosity	1.10	1.10	1.41	1.0 - 1.30	1.20	1.11	1.18
Width/Depth Ratio	11 - 16.	13 - 14	6.1 - 12.6	7.9 - 9.3	8.1 - 9.3	12.9	12.6
Bank Height Ratio	1.6 - 3.2	1.4 - 1.9	1.0 - 1.8	1.0	1.0	1.0	1.0
Entrenchment Ratio	1.3 - 1.7	2.3 - >3.7	1.9 - 4.1	1.7 - 4.3	5.7 - 10	1.8 - 5	2.2 - 5
d16 / d35 / d50 / d84 / d95 / d100	0.5, 8.0, 32.0, 93.6, 157, 256	0.16, 0.42, 4.2, 66.8, 107, >2048	0.1, 0.6, 4.5, 53, 96, x	1.87, 8.85, 11, 64, 128, x	Not available	-	-

8.3.1 Restoration Reaches

The following section includes brief descriptions of the design approach for the Site reaches proposed for restoration. Invasive species treatment and riparian buffer planting with native hardwood vegetation will be conducted in all project reaches.

Buckwater R4 is an incised E4/G4c channel that has been moved to the right side of the valley. The bank height ratios are moderately high (1.6-1.7) but it has uplift potential through connection with a floodplain and achieving stable pattern. A C4 channel with a width-to-depth ratio of 14 is targeted for Buckwater Reach 4 (R4). Buckwater R5/R6 is incised and actively eroding. An E4 channel with a width-to-depth ratio of 11 is proposed for both reaches. Due to the low slope and topographic constraints, a lower width-to-depth ratio is proposed to minimize floodplain grading and promote sediment transport.

T1-R2 is an incised B4c stream that runs along the transmission line easement. It is incised with a bank height ratio of 1.8 and has been moved to the left side of the valley. An E4 channel with a width-to-depth ratio of 11 is proposed for T1-R2. As with Buckwater R5-R6, due to the low slope and topographic constraints, a low width-to-depth ratio is proposed to minimize floodplain grading and promote sediment transport.

T2 begins at the confluence of T3 and T4 along a floodplain before entering a constricted valley and ending as an incised channel cutting perpendicularly through the Buckwater Creek floodplain. A C4 stream is proposed for the upper and lower ends, which have ample available floodplain, while the middle section is proposed to be a B4 channel. The Buckwater floodplain is available on the downstream end. A width-to-depth ratio of 13 is targeted for all sections with the main difference being the meander width ratio and sinuosity applied to the design.

T3-R2 has been moved to the left side of the valley and exhibits bank height ratios of 1.2 to 1.7 with minimal floodplain access. Wildlands proposes to build a C4 channel with a width-to-depth ratio of 13 that will meander across the existing floodplain.

T4 is a steeper tributary that runs north between a farm road and the transmission line easement. T4 has heavy impacts from cattle trampling and bank height ratios that range from 1.6 to 3.2. It is a G4c stream type. A B4 channel with W/D of 13 is proposed for much of T4's length. Towards the downstream end, meandering pattern indicative of a C-type stream is proposed.

T4A and T4B are headwater tributaries to T4. T4A-R1 has a degraded inline farm pond that has abundant algae during the growing season. Wildland proposes a B4 step pool channel to replace the pond and dam. After meandering through a wet forested area (T4A-R2, see below), T4A flows through a culvert beneath a farm road and into an herbaceous wetland immediately below the transmission line. Wildlands proposes to divert T4A-R3 to a forested alignment between the road and the power lines. The channel will be slightly perched above the existing wetlands.

T4B is a steep and incised stream with several headcuts. The headcuts are currently being restrained by tree roots. Wildlands proposes a B4/C4 channel with pattern where topography allows and step pools where dropping grade is essential.

T5 begins at the confluence of T6 and T6A and is briefly stable, though within a privet thicket and lacking desired buffer width, before it becomes incised and then flows immediately adjacent to St. Mary's Road and Walnut Hill Drive for the majority of its length. Headcuts are progressing slowly up T5 with resistance offered by clay and hardpan substrate. Wildlands proposes Priority 1 restoration for T5 with a width-to-depth ratio of 12. Stream pattern will be attainable on the upstream and downstream ends, with a lapse of restoration and the conservation easement in the middle due the St. Mary's Road culvert and location of Walnut Hill Drive in the center of the valley. The project and T5 will have a gap in restoration and the conservation easement for the first 100 feet below St. Mary's Road due to the exceptionally narrow valley and another power easement. A farm pond will be removed to achieve a wide floodplain on the downstream end of T5-R2 where it ties in to Buckwater R5.

T7-R2 begins where deep existing headcuts abut the lower stable section of T7-R1. T7-R2 has the most severe incision in the project area with a bank height ratio of 8.9. Wildlands proposes Priority 1 restoration to put the channel on the existing floodplain as a B4 stream with a width-to-depth ratio of 14. Priority 2 is proposed for T7-R3 at the lower end below the confluence with T7A to connect with Buckwater Creek. Priority 2 is feasible because cattle have worn deep paths into the streambanks on the lower end, thus reducing the amount of cut to form a floodplain bench.

8.3.2 Enhancement I Reaches

Buckwater R2 and R3, upper T1, upper T7, T7A, T8 are incised and undergoing widening; however, it is feasible to stabilize them in place using Enhancement I practices.

Buckwater R2 begins at the confluence of Buckwater R1 and T8 where it is incised and subject to severe bank erosion where the flow vectors point at the streambank. Buckwater R3 begins just downstream at the confluence with T9. It is a straighter reach and the profile begins to flatten, as evidenced by accumulation of fine sediment on the channel bottom. Enhancement I is proposed for Buckwater R2 and R3 to stabilize the worst streambanks and to gradually raise the streambed in preparation for downstream restoration on R4.

T1-R1 is a large stream channel with a drainage area of about 1,200 acres. It is stable immediately upstream of the project area but then becomes incised and has severe erosion on the outside stream bends before it reaches the culvert at St. Mary's Road. Enhancement I is proposed for T1-R1 to stabilize the eroding outside streambanks and to gradually raise the streambed in preparation for downstream restoration. The bed will be raised by installing constructed riffles in the straight sections of the reach.

T6-R3 was originally proposed for Enhancement II treatment practices because bedrock limits further incision and cattle are not present. However, upon further examination of the buffer limitations (described in Section 3.4) and instability of the existing channel, Wildlands now proposes Enhancement I for this reach. Most of the channel length will be restored so that at least 50 feet of buffer will be established and streambank erosion will be halted. The restoration will begin as Priority 2, transitioning to Priority 1. Because the channel is now incised, further functional uplift is expected. If the channel were left in place, it is conceivable that it may migrate outside of the conservation easement because the transmission line easement is within 5 feet of an actively eroding streambank. Livestock are not currently present but are planned, so Wildlands will establish exclusion fencing on the north boundary of the conservation easement. A short section of the reach will be left as is (i.e., no treatment), so Enhancement I is now proposed for mitigation credit.

T7-R1 emanates from a spring at the base of a headcut in a steep pasture. It is initially incised but then has lower bank height ratios before connecting to the restoration reach T7-R2. Wildlands proposes to cut a floodplain bench along the upper section of T7-R1 so that the spring is not buried and the jurisdictional channel will be maintained.

T7A is a short reach with a 5-acre drainage area. It emanates from a spring and travels as a B4 channel until it empties into a relic pond bed. The pond dam failed when a headcut migrated through it. Enhancement I is proposed to repair streambanks and stably connect T7A to restored T7. The dam will be removed.

T8 transitions from a non-jurisdictional headwater reach to a jurisdictional channel at the project boundary. It is apparent from the existing contours that the channel was moved out of the valley to the east and is essentially straight. Because of active headcuts, T8 alternates between being a relatively stable channel to one that has downcut with minimal widening or where widening is underway. Wildlands proposes Enhancement I to implement a variety of treatments geared towards stabilizing the profile and stemming bank erosion. In one location, the channel will be moved off its existing alignment because erosion here is severe. T8 will be enhanced as a B channel step-pool system.

8.3.3 Enhancement II Reaches

Buckwater R1, R7, and R8, T3 R1, T4A R2, T5 R1, T6, T6A, T6B, and T9 are also incised but are generally stable except for more isolated instances of bank erosion. Similarly, there are relatively few headcuts on these reaches and those headcuts that are present are slowed by hardpan bottom or tree roots.

Buckwater R1 begins below a small utility easement and flows through an incised channel amid a mature riparian forest. Several outside bends are actively eroding and these will be stabilized.

Buckwater R7 and R8 are downstream from the transmission line easement. The channel is large here and in the process of widening, as evidenced by active erosion of the outside meander bends. These banks are proposed to be stabilized using Enhancement II practices such as sloping banks, bioengineering, and installing vane structures.

T3-R1 is a largely stable channel that flows through active cow pastures. Two steep drops are maintained by bedrock and bank erosion is limited in the upstream area to two locations and in the downstream area to where cows have trampled the banks. Enhancement II practices are proposed to stabilize the streambanks and install livestock exclusion fencing. Approximately 100 feet of channel realignment will be conducted at the beginning of the reach to attain 50-foot buffers.

T4A-R2 connects R1, which is the dammed farm pond, and R3, which runs adjacent to the transmission line easement. T4A-R2 is stable and replete with floodplain wetlands. Wildlands will install fencing to exclude livestock from this reach.

T6-R1 begins at a property line below a utility easement. It is stable upstream from the project area and near the start of the jurisdictional channel. T6-R1 and R2 are incised, though they alternate between laterally stable and unstable sections. There are abundant knickpoints with bedrock grade control and only one active headcut within a pond bed where the dam has failed. Wildlands proposes Enhancement II practices, including bank sloping, bioengineering, and vane structures, to stabilize the worst eroding streambanks and active headcut. Livestock are not currently present but are planned, so Wildlands will establish exclusion fencing on the north boundary of the conservation easement.

T6A is located below a large farm pond. It is incised but has bedrock grade control. The most concerning aspect of T6A is that the pond overflow channel has an active 3-foot headcut near its confluence with T6A. The headcut and an eroding streambank will be stabilized to earn Enhancement Level II credit for the reach. Livestock are not currently present but are planned, so Wildlands will establish exclusion fencing on the west boundary of the conservation easement.

Finally, T6B is a short headwater reach that enters T6 from the north. It drains agricultural fields and is jurisdictional below a headcut located approximately 40 feet upstream from T6. Two headcuts will be stabilized and a riparian buffer established for Enhancement II credit. Livestock are not currently present but are planned, so Wildlands will establish exclusion fencing along the T6B conservation easement boundary.

T9 is a 72-foot reach that extends the width of the conservation easement for Buckwater R2-R3. Buckwater will be raised as part of an Enhancement Level I approach and T9 will be similarly raised to connect with Buckwater. Bank stabilization will be implemented around the confluence.

Narrow and deeper channels are common in Slate Belt reference reaches; however, the reference channels have established vegetation that maintain stability on steeper streambanks. The design channels will begin with 2.5:1 or 3:1 riffle side slopes that will be more stable without established vegetation. Constructing channels with higher width-to-depth ratios and flatter side slopes will allow for sediment deposition on the banks and bank protection as the streambank vegetation establishes. The complete design morphological parameters for all Buckwater reaches are located in Appendix 5 and summaries of key parameters for six selected reaches are shown in Tables 9, 10, and 11.

8.4 Design Discharge Analysis

Multiple methods were used to develop bankfull discharge estimates for each of the project restoration reaches: the NC Rural Piedmont Regional Curve (Harman et al., 1999), NC Piedmont/Mountain Regional

Curve (Walker, unpublished), a Wildlands Regional USGS Flood Frequency Analysis, a Site Specific Reference Reach Curve, existing bankfull indicators using Manning's equation, and data from previous successful design projects. The resulting values were compared and best professional judgment was used to determine the specific design discharge for each restoration reach.

8.4.1 Published Regional Curve Data

Discharge was estimated using the published NC Rural Piedmont Curve (Harman et al., 1999) as well as the updated curve for rural Piedmont and mountain streams, also known as the Walker Curve (Walker, unpublished).

8.4.2 Wildlands Regional USGS Flood Frequency Analysis

Wildlands developed a regional flood frequency analysis tool that tailored the USGS 2009 publication *Magnitude and Frequency of Rural Floods in the Southeastern United States, through 2006* to the Piedmont of North Carolina (Gotvald et al., 2009). Of the 103 stations referenced in the publication, 23 were used in the development of the tool. To fill gaps in data, six additional stations were added by Wildlands to represent streams with drainage areas less than one square mile. The Hosking and Walls homogeneity test was performed to identify the most appropriate gages based on homogeneity (Hosking and Wallis, 1993). The six additional gages used were:

- USGS 0209736050 – Battle Branch near Chapel Hill, NC (DA = 0.42 mi^2)
- USGS 02085020 – Stoney Creek tributary near Hillsborough, NC (DA = 0.8 mi^2)
- USGS 02085190 – North Fork Little River tributary near Rougemont, NC (DA = 1.02 mi^2)
- USGS 02101030 – Flat River tributary near Willardville, NC (DA = 1.14 mi^2)
- USGS 0210166029 – Dial Creek near Bahama, NC (DA = 4.73 mi^2)
- USGS 0208524090 – Mountain Creek at SR 1617 near Bahama, NC (DA = 7.97 mi^2)

The data from these 29 gage stations were used to develop flood frequency curves for the 1.2-year,1.5-year, 1.8-year, and 2.0-year recurrence interval discharges. These relationships can be used to estimate discharge of those recurrence intervals for ungaged streams in the same hydrologic region, and were solved for each project reach's discharge with the drainage area as the input.

8.4.3 Existing Bankfull Indicators (Manning's Equation)

Stable riffle cross sections on the Site and near it were surveyed to estimate discharge using Manning's equation. These included two riffle cross sections that have obvious bankfull indicators on or near the Site, including a point bar on T1 upstream from the project and a riffle on upper T7. In addition, riffle cross sections were surveyed on four stream channels near and in the Eno River State Park, approximately 1.5 miles southwest of the Buckwater Site. One of these stream channels was the Franklin Creek reference reach, previously described in Section 8.2.6. The other three stream channels are located on the parallel tributary east of Franklin Creek, within the Eno River State Park.

The highest quality bankfull indicators, such as top of bank, were identified in the field during this survey. Manning's equation was used to calculate a corresponding discharge survey data for channel slope. Thus, six discharge estimates were added to the site specific Regional Curve.

8.4.4 Site Specific Reference Reach Curve

Wildlands developed a site specific regional curve using 12 points: the six reference reaches identified in Section 8.2, the five reaches/sections identified in Section 8.4.3, as well as an additional reference reach discharge point (UT to Rocky Creek) to balance the distribution across drainage areas. UT to Rocky Creek is a reference-quality Slate Belt stream channel in Montgomery County that has been used in other Wildlands mitigation projects. The drainage areas for these 12 points range from 0.039 to 2.16 square miles. This compares well with the drainage area of the Site restoration reaches, which range from 0.03 to 1.88 square miles.

Each reference reach was surveyed to develop information for analyzing drainage area-discharge relationships. Stable cross-sectional dimensions and channel slopes were used to compute a bankfull discharge with the Manning's equation for each of these twelve reaches. The resulting discharge values were plotted with drainage area and a site specific regression equation was developed. The R^2 value for this equation is 0.9246.

8.4.5 Design Discharge Analysis Summary

The overarching design goal is to build stable channels that move their sediment supply without aggrading or degrading. The floodplains should be accessed by streamflow on an approximately 1.5-year return interval.

The results of the design discharge analysis provided a range of discharge values. The NC Rural Piedmont Regional Curve produces a higher estimate than the Walker Curve by approximately 50%, on average. The USGS gage analysis produced discharge estimates such that the 1.5-year event was typically larger than the NC Rural Piedmont Regional Curve regression calculation, while typically the 1.2-year event was larger than the Walker Curve regression calculation. The Site Specific Reference Reach Curve yielded discharges that were approximately 10% less than the NC Rural Piedmont Regional Curve and fell between the 1.2-year and 1.5-year events. For recent mitigation projects, Wildlands design discharge selections have been relatively closer to the Walker Curve and have been more frequently flooded than may be preferred. Consequently, Wildlands selected a weighted design discharge by using 50% weight from the Site Specific Reference Reach Curve, 30% from the Piedmont Regional Curve, and 20% from the Alan Walker Curve. The products of this weighted design discharge were 1-3% below that of the Site Specific Reference Reach Curve.

Buckwater Reaches 5 and 6 will require a Priority 1.5 approach whereby the floodplain will be cut approximately 1.2 feet below existing grade. Priority 1 restoration could not be attained because of the following constraints:

1. The reach begins at a bridge through which the restored channel must not be raised much above existing grade to maintain required discharge conveyance;
2. It is a short reach of 945 valley feet that should maintain a channel slope of approximately 0.4% to transport sediment.

Enhancement approaches were considered as alternatives for each of these reaches. Buckwater R5/R6 is deeply incised and experiencing severe bank scour and even mass wasting in several locations. Bank height ratios are approximately 2.0. Thus, sustainable bank stabilization would require deep benching (i.e., significant cut), so beginning with a newly constructed channel that minimizes the amount of floodplain disturbance was determined to be the preferred alternative. Topsoil will be stockpiled and re-applied to the ground surface once channel construction is complete.

Table 12 gives a summary of the discharge analysis. The grayed cells in Table 11 reflect that the USGS Peak Discharge Estimation for NC Rural Piedmont is for catchments larger than that 0.25 square miles, and so it technically does not apply for project reaches with drainage areas below that size. Figure 10 illustrates the design discharge data.

Table 12: Summary of Design Discharge Analysis – *Buckwater Mitigation Site*

		Buckwater - R7&R8	Buckwater -R6	Buckwater - R5	Buckwater - R4	Buckwater - R2&R3	Buckwater - R1
DA (acres)		2259	1024	787	640	595	538
DA (sq. mi.)		3.53	1.58	1.23	1.03	0.93	0.84
NC Rural Piedmont Regional Curve (cfs)		221	124	103	91	84	79
Alan Walker Curve (cfs)		150	80	66	57	53	49
USGS Peak Discharge Estimation for NC Rural Piedmont (cfs)	1.2-year event	197	109	90	79	74	68
	1.5-year event	274	154	128	113	105	97
	2.0-year event	363	204	171	150	140	130
Site Specific Reference Reach Curve (cfs)		204	114	95	83	77	72
Selected Design Discharge (cfs)		198	110	91	80	74	69

		T1 - R1	T1 - R2	T2	T3-R1	T3-R2	T4
DA (acres)		1200	1216	218	109	141	77
DA (sq. mi.)		1.86	1.88	0.34	0.17	0.22	0.12
NC Rural Piedmont Regional Curve (cfs)		139	140	41	25	30	19
Alan Walker Curve (cfs)		91	91	24	14	17	11
USGS Peak Discharge Estimation for NC Rural Piedmont (cfs)	1.2-year event	123	124	35	21	25	16
	1.5-year event	173	174	51	31	37	24
	2.0-year event	229	231	68	41	50	32
Site Specific Reference Reach Curve (cfs)		128	129	37	22	27	17
Selected Design Discharge (cfs)		125	125	36	21	26	17

		T4A	T4B	T5-R1	T5-R2a (above Rd.)	T5-R2b (at outlet)	T6-R1
DA (acres)		17	43	96	96	109	32
DA (sq. mi.)		0.027	0.067	0.150	0.150	0.170	0.050
NC Rural Piedmont Regional Curve (cfs)		6.5	13	23	23	25	10
Alan Walker Curve (cfs)		3.2	6.6	13	13	14	5.3
USGS Peak Discharge Estimation for NC Rural Piedmont (cfs)	1.2-year event	5	11	19	19	21	9
	1.5-year event	8	16	28	28	31	13
	2.0-year event	11	21	38	38	41	17
Site Specific Reference Reach Curve (cfs)		5.8	11	20	20	22	9.2
Selected Design Discharge (cfs)		5.5	11	19	19	21	8.7

		T6-R2	T6A	T6B	T7 - R3	T7 - R1&R2	T7A
DA (acres)		58	30	8.0	28	17	5
DA (sq. mi.)		0.088	0.047	0.013	0.044	0.027	0.008
NC Rural Piedmont Regional Curve (cfs)		15	9.8	3.8	9.4	6.5	2.7
Alan Walker Curve (cfs)		8.3	5.0	1.8	4.8	3.2	1.3
USGS Peak Discharge Estimation for NC Rural Piedmont (cfs)	1.2-year event	13	8	3.0	8	5	2.0
	1.5-year event	19	12	5	12	8	3
	2.0-year event	26	16	6	16	11	5
Site Specific Reference Reach Curve (cfs)		14	8.7	3.3	8.4	5.8	2.4
Selected Design Discharge (cfs)		13	8.3	3.1	8.0	5.5	2.6

		T8	T9
DA (acres)		21	33
DA (sq. mi.)		0.033	0.052
NC Rural Piedmont Regional Curve (cfs)		7.6	11
Alan Walker Curve (cfs)		3.8	5.5
USGS Peak Discharge Estimation for NC Rural Piedmont (cfs)[1]	1.2-year event	6	9
	1.5-year event	9	13
	2.0-year event	13	18
Site Specific Reference Reach Curve (cfs)		6.7	9.4
Selected Design Discharge (cfs)		6.4	8.9

[1]USGS Peak Discharge Estimation for NC Rural Piedmont grayed for catchments smaller than those on which the regression equation was developed. Wildlands Rural Piedmont Discharge Calculator used for DAs<0.25 sq. mi.

8.5 Sediment Transport Analysis

As discussed in Section 3.1.2, small Slate Belt streams are generally low bedload systems. To confirm that the streams on this Site are low bedload streams, Wildlands performed a qualitative assessment of the sediment load volume and sources in the project watershed. For this project, the watershed was assessed through aerial photography and field reconnaissance to characterize past and current land cover and potential sediment sources.

To begin, Buckwater Creek enters the Site in stable condition and with low sediment supply. It has a largely forested catchment with mature and wide riparian buffers upstream from the Site. One of the major tributaries drains through a pond and the riparian buffers are consistently wide and of good quality. It would be difficult to include the upstream reaches in a mitigation project with even an Enhancement Level II approach. Bank erosion is limited and there is no sign of abundant sediment supply, either washload or bedload.

As described in Section 3.4, T1 has a more concerning watershed condition, largely because it will always lack riparian buffer due to a transmission line running over the T1 floodplain for nearly one mile. This setting, at its nearest point, is located approximately 2,500 feet upstream from the project area. Despite the valley limitations, the channel banks are mostly low and stable. There is some concern that the channel could further meander, creating a higher sediment supply. The T1 sediment load is and would be dominated by gravels, judging from a reachwide pebble count, as well as existing bars and visible streambank material. Thus, further sediment transport concerns for this reach should focus on capacity rather than competency.

There is one prominent sediment source *within* the Site: streambank erosion and bed scour. On-site streams were visually inspected numerous times between 2014 and 2016 to qualitatively assess bank erosion and aggradation and degradation within the channels. Site streams exhibited evidence of on-going fluvial erosion of streambanks. There was some evidence of fine sediment deposition and accumulation throughout the reaches, particularly on T4 and Buckwater R3 and R4, indicating that aggradation is somewhat of an issue. These areas are located where the profile flattens and stream power declines. Sediment accumulates to a depth no greater than 6 to 12 inches, so it appears to wash downstream and be replaced by the next sediment-moving storm. Once the project is constructed, on-site sediment sources will be addressed by stabilizing streambanks. The design will also more uniformly distribute stream power and reduce shear stress in the channels.

Degradation is also a concern. Active headcuts and knickpoints are present in many of the project reaches. T4 and T4B alternate between knickpoints held by tree roots and accumulation of fine sediment immediately above them. The profile is a stair step sequence where the knickpoints contain most of the drop before a flatter bedform ensues, with levelling from fine sediment deposition. Middle T7 has active headcuts and its sediment is readily transported due to a steep slope and a deep, narrow channel. T7 R2 exhibits bedload scour, while T7 R3 shows bedload deposition just below the confluence with T7A.

Another potential source of erosion is runoff from agricultural fields within the project area. There are no row crops; however, hay pastures are seed drilled in rows and washoff of fine sediment from these areas is possible. It appears to be minimal, though, because there are no rills forming in these areas and any transport would need to be overland sheet flow. Additionally, cattle pastures have denuded areas that may serve as sediment sources. These are present but not so bad that they form gullies and become major sources. Farm roads are another potential source and though washouts are present, they run to riparian buffers where runoff disperses and deposits gravel and finer sediment.

The watershed assessment indicates that the bedload supply, unlike the washload, is relatively low and that the project streams are not capacity limited. The focus of sediment transport analysis for this design was to verify that the designed channels will be stable over time and can pass sediment from the watershed. Competence and capacity analyses were performed on the restoration reaches to aid in the development of the final channel designs.

8.5.1 Competence Analysis

Competence analyses were performed iteratively during design for each of the restoration reaches by comparing shear stress associated with the design bankfull discharge, proposed channel dimensions, and proposed channel slopes with the size distribution of the existing bed load. The analysis used standard equations based on a methodology using the Shields (1936) curve and Andrews (1980) equation described by Rosgen (2001). Channel slope and design dimensions were varied until the resulting design verified that the stream reach could move the bedload supplied to the stream. The results of the analysis are shown in Table 13.

Table 13: Results of Competence and Capacity Analysis – *Buckwater Mitigation Site*

	Buckwater - R5/6	Buckwater - R4	T1	T2	T3	T4	T5	T7
Dbkf (ft)	1.6	1.3	1.8	0.8	0.8	0.6	0.7	0.3
Schan (ft/ft)	0.0075	0.0075	0.005	0.015	0.013	0.023	0.0092	0.039
Exist. Shear Stress, t (lb/sq ft)	0.53	0.87	1.23	1.18	1.00	1.09	0.24	3.65
Dgn Bankfull Shear Stress, t (lb/sq ft)	0.69	0.57	0.52	0.77	0.60	0.80	0.40	0.79
Dmax Bar/ Subpavement (mm)	66.5	45.7	51.6	96.3	64.0	72.1	87.8	65.4
Dcrit (ft)	0.87	1.5	0.55	0.68	0.81	1.8	4.1	0.21
Scrit (ft/ft)	0.0033	0.0084	0.0021	0.0129	0.0132	0.0688	0.0538	0.0274
Movable particle size (mm)	115.1	100.6	93.8	124.9	104.0	129.4	77.6	127.6
Predicted Shear Stress to move Dmax	0.32	0.20	0.23	0.54	0.31	0.36	0.83	0.32
Dgn Unit Stream Power (W/sq m)	41.9	29.9	27.9	44.6	30.4	44.4	16.3	40.2
Exist. Unit Stream Power (W/sq m)	30.6	62.3	96.7	89.5	65.4	77.6	26.3	366.8
Existing Conditions[1]	Agg.	Agg.	Agg.[2]	Deg.	Deg.	Deg.	Deg.	Deg.

[1] Agg. is aggrading. Deg. Is degrading.
[2]T1 is mostly widening, with minimal aggradation.

The initial competence analysis was based on the material size naturally found in the stream to mimic potential bed load. The results were used to inform further design of the reach. Given that the proposed bankfull shear stress is high enough to move largest subpavement particle in most channels, the design incorporates rock and wood step structures to provide grade control and increase roughness within the channel. Riffles with larger materials, such as chunky riffles, were also integrated into the design as grade control. A second competence analysis was done to size the proposed D_{50} and D_{100} for the constructed riffles on all stream reaches. Riffle materials were sized so that the constructed channels will not produce enough shear stress to entrain the largest particles in these structures. This will ensure a stable pavement while allowing for bedload transport to be active.

8.5.2 Capacity Analysis

Table 13 lists the estimated design and existing stream power for each of the primary restoration stream channels. As shown, stream power declines in all but Buckwater R5/R6. The increase in stream power in these reaches is not concerning because it is a relatively small increase. Especially at a drainage area of one square mile there should be transportable material coming from upstream to replace the gravels that will be moved during storm events.

Given the observations of potential for increased sediment supply from the T1 watershed, consideration should be given to stream power in the design stage. The design T1 stream power of 27.9 W/m^2 remains high enough to transport a possible increase in sediment load due to future upstream channel erosion through the transmission line corridor. Wildlands measured cross sections and channel slopes in two locations between the project area and the transmission line reach. In these locations stream power is estimated to be 23.7 and 16.6 W/m^2, so anything that can be transported through these areas should be transported through T1 R2 (i.e., design reach stream power is higher than the stream power in upstream transport-limiting sections). If incision increased upstream from the Site, it would reduce the channel slope and associated transport capacity.

Additionally, T1 is designed as an E channel with a width-to-depth ratio of 11. The side slopes on the inside of meander bends will be sloped at 4:1 or 4.5:1. Point bars will form on these inside bends and will act as sediment storage locations. The potential erosion upstream of the project area may act as a beneficial sediment source that will help to maintain these point bars.

8.6 Project Implementation

This section provides narrative detail on the restoration or enhancement approaches for each of the project reaches. All project reaches will include the establishment of the following:

1. A conservation easement protecting the project from uses that would damage it
2. A riparian buffer that consists of native hardwood species at a density to meet success criteria
3. Livestock exclusion where applicable.
4. Invasive species treatment.

Table 14 lists the primary stressors for each project reach and the approach Wildlands will use to restore or enhance it. Priority I restoration is a frequently employed approach. It will raise the water table, improve hydrologic connection to the riparian wetlands, and allow for frequent inundation of the floodplain and a reduction of shear stress on the channel.

Table 14: Functional Impairments and Restoration Approach – *Buckwater Mitigation Site*

Resource	Primary Stressors/Impairments	Treatment Approach
Buckwater R1-R3	Incision, erosion, lack of habitat	Enhancement Levels I and II
Buckwater R4-R6	Incision, erosion, lack of riparian vegetation	Restoration – Priority 1 and 1.5
Buckwater R7-R8	Incision, erosion, lack of habitat	Enhancement Level II
T1 R1	Incision, erosion, lack of habitat	Enhancement Level I
T1 R2	Incision, erosion, lack of riparian vegetation	Restoration – Priority 1
T2	Incision and erosion	Restoration – Priority 1
T3 R1	Lack of riparian vegetation and livestock access	Enhancement Level II
T3 R2	Incision, erosion, livestoke access, lack of riparian vegetation	Restoration – Priority 1
T4	Incision, erosion, lack of habitat and riparian buffer	Restoration – Priority 1
T4A R1	Farm pond, lack of riparian vegetation	Restoration – Priority 1
T4A R2	Livestock access	Enhancement Level II
T4A R3	Lack of riparian vegetation	Restoration – Priority 1
T4B R1	Incision, erosion, cattle access, hack of habitat	Restoration – Priority 1
T5	Incision, erosion, farm pond, lack of riparian buffer, invasive species	Restoration – Priority 1
T6 R1-R2	Incision, erosion, lack of habitat, invasive species	Enhancement Level II
T6 R3	Incision, erosion, lack of habitat and riparian buffer, invasive species	Enhancement Level I
T6A	Incision, unstable pond dam, lack of riparian vegetation	Enhancement Level II
T6B	Incision, erosion	Enhancement Level II
T7 R1	Incision, erosion, lack of riparian vegetation	Enhancement Level I

Resource	Primary Stressors/Impairments	Treatment Approach
T7 R2-R3	Incision, erosion, lack of habitat	Restoration – Priority 1 and 2
T7A	Failed pond dam, lack of riparian vegetation	Enhancement Level I
T8	Incision, erosion, lack of habitat	Enhancement Level I
T9	Incision	Enhancement Level II

8.7 Reach Specific Implementation

This section provides additional design details on the restoration reaches that were not provided in Section 8.3.1.

Buckwater Creek has been separated into eight reaches for the restoration design, separated by confluences with other channels or changes in mitigation approach. Reach 1 is slated for Enhancement Level II practices to stabilize eroding streambanks. Access will be carefully done to avoid impacts to the existing mature riparian forest. Enhancement Level I is targeted for Reaches 2 and 3 to prepare the channel for Priority Level 1 restoration in Reach 4. As above, the worst streambank erosion will be stabilized and these areas will be accessed carefully. Constructed riffles will be installed near the locations where bank erosion is addressed to minimize impacts due to site access. A particularly severe erosion problem immediately downstream from the Buckwater confluence with T8 will be fixed by installing a vane structure to divert streamflow toward the center of the channel. A steep riffle and flow vectors are presently pointed directly at the left streambank.

Priority 1 restoration will commence at Reach 4. Due to the Level I enhancement immediately upstream, this should be a seamless transition with no backwater effect. The proposed stream will be realigned to the low point in the existing valley and to avoid jurisdictional wetlands to the extent practicable. A relic dam laid across the Buckwater valley serves as a design constraint approximately midway through Reach 4. The landowner's grandfather built a portion of this dam with hand-laid rock, so the channel will be routed to the northern edge of the valley, away from the existing channel and historical dam features. The northern half of this dam will be removed, leaving the historic part to the south. A farm pond occupies much of the floodplain at the lower end of Reach 4. This pond will be removed and the channel will be routed through this area. Additional specifics on pond drainage are included in the construction notes in the plans (Appendix 7, Sheet 0.5). The profile will need to drop at the downstream end to tie to existing grade at the Walnut Hill Road bridge. The restoration design for Reach 4 consists of 42% riffles and 58% pools, and has sinuosity of 1.31. The valley slope and width are suitable for a moderately high level of sinuosity.

Reach 5 begins at the bridge and continues as Reach 6 below the confluence with T2. Reaches 5 and 6 will implement Priority 1.5 restoration for reasons described in Section 8.4.5. The approach will include a channel slope of 0.4 percent and lowering the floodplain by 1.2 feet across much of the restored belt width. The profile will be transitioned back to existing grade within the transmission line easement; this serves to maintain the highest priority restoration for as long as possible. The restoration design for Reach 5 and 6 also consists of 43% riffles and 57% pools with sinuosity of 1.39 on Reach 5 and 1.45 on Reach 6.

Once at grade, Enhancement II practices are proposed for Buckwater Reaches 7 and 8. Here, the vertical eroding outside bends will be stabilized using a variety of measures, including bank grading, revetments, and toe protection.

T1 is divided into two reaches with the new NCDOT culvert at St. Mary's Road serving as the transition. T1 R1 on the upstream end is targeted for Level I Enhancement practices whereby the streambed will be raised with constructed riffles and eroding streambanks will be stabilized. Below St. Mary's Rd, Priority 1 restoration is proposed for T1 R2. The stream channel will be turned away from the high transmission power line to provide a forested riparian buffer. The buffer is already present and the design focus is to maintain as much as of it as feasible. The channel slope will be 0.5 percent and the floodplain will be lowered by 0.35 feet across much of the restored belt width. T1 R2 will stably tie to Buckwater R6 just west of the transmission line and the channel transitions to existing grade within the transmission line easement. The restoration design for T1 consists of 53% riffles and 47% pools, and sinuosity of 1.27.

T2 begins at the confluence of T3 and T4, both of which are proposed for Priority 1 restoration. T2 has ample floodplain width initially and will incorporate C channel pattern to use it. The valley constricts within 150 feet, at which point a B channel design is required to dissipate energy. Once T2 reaches the Buckwater floodplain, it is feasible for it to meander again as a C channel until it connects with Buckwater Creek. Putting T2 on the Buckwater floodplain increases stream length and provides further channel/floodplain interaction. The design sinuosity for T2 is 1.21.

T3 is proposed for Enhancement II practices on the upstream two thirds and Priority 1 restoration on the downstream third. The upper section is primarily stable though cows have access to the stream. The middle section has livestock bank trampling but is not incised or subject to much erosion due to alluvial processes. Livestock exclusion fencing and isolated bank grading are proposed for T3 R1. T3 R2 has been moved to the left side of the valley and Priority 1 restoration will return it to the low point of the valley and re-establish floodplain wetlands. C channel geometry is feasible on T3 R2 but steeper valley sections will necessitate riffles that include log drops and coarser material. Such structures will reinforce channel stability and provide habitat diversity. The restoration design for T3 and T2 consists of 54% riffles and 46% pools. The design sinuosity for T3 is 1.29.

Figure 8 in Appendix 5 shows that three ponds within the Site will be removed. The pond west of T3 R2 will remain; however, existing maintenance of the outfall and dam mowing will be possible because the proposed conservation easement does not overlap these areas. The pond above T6A will also remain and part of the mitigation work is to stabilize a head cut at the lower end of the overflow channel. Most of the dam on this pond is not currently mowed, but the conservation easement will not prevent it from maintained.

T4 begins just below a valley wide wetland feature formed below the transmission line and above a farm road. Priority 1 restoration is proposed to maximize the available buffer between a farm road and the power easement. It will require B channel geometry and a steep section at the upper end. A short existing jurisdictional channel with a spring at a headcut will be incorporated in the restored T4 channel. The new channel will include a pool facet at the spring so that bank deterioration does not occur. The valley flattens and widens on the lower end of T4; Wildlands has implemented a C channel design in this area. The overall design sinuosity for T4 is 1.2. The restoration design for T4A and T4 consists of 65% riffles and 35% pools.

T4A will include restoration reaches on either end and an enhancement reach focused on cattle exclusion in the middle. T4A-R1 has a degraded inline farm pond that has abundant algae during the growing season. Wildland proposes a B4 step pool channel to replace the pond and dam. A wetland area should form outside of the restored stream channel within the pond area. T4A-R3 will consist of the creation of a new channel that flows in an existing forested patch situated between the transmission line and a farm road. This work will consist of Priority 1 restoration and the channel will be perched on a lower valley side slope. This is necessary to avoid either clearing and grading the restored channel path, or filling the wetland below the power line. A small berm will be constructed along the right bank of this reach to prevent channel avulsion. The design sinuosity for T4A is 1.2 in the pond removal section and 1.05 in Reach 3.

T4A and T4B are headwater tributaries to T4. T4A-R1 has a degraded inline farm pond that has abundant algal growth much of the year. Wildland proposes B4 step pool channel to replace the pond and dam. After meandering through a wet forested area (T4A-R2, see below), T4A flows through a culvert beneath a farm road and into an herbaceous wetland immediately below the high transmission power lines. Wildlands proposes to divert T4A-R3 to a forest path between the road and the power lines. The channel will be perched above the existing wetlands.

T4B is a steep and incised stream with several headcuts. Wildlands proposes Priority 1 restoration to reconstruct the T4B channel so that it can access available floodplain topography and stably drop in steep sections. T4B will meander slightly in sections where this is feasible and cascade in two sections as a B channel where the valley is very steep. The restoration design for T4B consists of 67% riffles and 33% pools. The design sinuosity for T4B is 1.15.

T5 will continue from the restored T6-R3 channel. Previously, in the proposal stage, a short Enhancement II reach was proposed, largely focused on invasive species treatment. However, two factors make this 80-foot section of channel better suited to restoration. First, the channel is in a privet thicket and clearing and grubbing would be helpful to the long-term success of treating this invasive. Second, desired buffer width is not attainable without moving the channel because of a barn structure beyond the right bank. As such, continuing Priority 1 restoration from T6-R3 is proposed. C channel pattern is feasible above St. Mary Road with floodplain grading. This is necessary to move the channel away from the St. Mary's Road embankment. Once through the St. Mary's Road culvert, the T5 channel is highly constricted by Walnut Hill Drive on the right bank and a hillslope beyond the left bank. There is also a utility easement in this vicinity. Once the valley opens slightly on the left (east), the T5 channel is moved in that direction. The farm pond to be removed on the lower end of T5 is fed by a spring within the pond; post construction, the spring will be located within the conservation easement. It is expected that jurisdictional wetlands will form here, creating an interconnected stream and wetland complex. The restoration design for T5 consists of 53% riffles and 47% pools, and sinuosity of 1.18.

For T7-R2, Wildlands proposes Priority 1 restoration to put the channel on the existing floodplain as a B4 stream with a width-to-depth ratio of 14. Priority 2 is proposed for the lower end (T7-R3) below the confluence with T7A to connect with Buckwater Creek. This will enable a more gradual profile and connection to a floodplain. The restoration design for T7 consists of 66% riffles and 34% pools. The design sinuosity is 1.2 for Reach 2 and 1.15 for Reach 3.

8.8 Additional Project Implementation Benefits

One of the secondary objectives of this project will be to improve aquatic organism passage through the site. The culvert through the farm road on T3 is perched above the channel on the downstream end. As part of the Priority 1 restoration, this culvert will be moved to the south and will be designed to allow for aquatic organism passage. T4 begins below a farm road crossing where the culvert has been completely buried and does not function. This culvert will be replaced and designed to allow for aquatic organism passage. However, the profile below the T4 culvert is necessarily steep to match the valley and the channel above the culvert is intermittent so aquatic organism passage may be limited regardless of the culvert.

The Site is connected to a wooded parcel at the upstream and downstream ends of Buckwater. Also, T3 and T4B connect through existing forested areas to the Eno River State Park. Once a riparian buffer is established on-site, mammalian, reptilian, and avian species will likely migrate to the newly forested area.

The Site streams and the beds will be comprised of riffle-pool sequences with occasional log and rock drop structures. In-stream structures will include various types of constructed riffles, log sills, boulder sills, and J-hooks. The structures will reinforce channel stability and serve as habitat features. The riffles will also incorporate woody brush material and logs. The diverse range of constructed riffle types will provide grade control, diversity of habitat, and will create varied flow vectors. Log J-hooks will deflect flow vectors away from banks while adding to habitat diversity. Log sills will be used to allow for small grade drops across pools and provide extra grade control. At select outer meander bends, the channel banks will be constructed with brush toe revetments to reduce erosion potential, encourage pool maintenance, and provide varied pool habitat. Sod mats will also be used along some outer meander bends and along both banks of in-line pools to provide immediate bank protection. Due to the limited availability of sod containing native herbaceous vegetation on site, it will be used minimally, where most beneficial. The concept plan for Site restoration is illustrated in Figure 8.

Wildlands has completed several projects within the Slate Belt and has found that riffle grade control material can be harvested from weathered parent material on valley side slopes to mitigate for the natural lack of grade control. Wildlands compares the size of the mined rock to the size of moveable material from the sediment transport calculations to determine if supplemental rock from a quarry is needed. Per soil descriptions, the Tarrus silt loam (TaD), located along T3 and extending to T4B, contains weathered bedrock beginning at a depth of 50 inches. This area will be used to source rock for habitat and grade control structures during construction. This method, along with the introduction of woody debris, has been successful at providing a heterogeneous mixture of riffle material that increases channel roughness and improves channel hydraulics and geomorphology. The gradation of material provides varied pore spaces within the riffles and structures, which benefits hyporheic exchange processes and niche habitat formation.

8.9 Vegetation and Planting Plan

The long-term objective of the planting plan is to establish a thriving native riparian buffer. This restored buffer will improve riparian habitat, help maintain the stability of restored streams, and provide temperature-reducing shade, as well as a source for LWD and organic material to the streams. Except in areas where mature native trees are established, the Site will be planted to the extents of the conservation easement. Riparian buffers will be seeded and planted with early to end successional native vegetation. The specific species composition to be planted was selected based on the community type, observation of occurrence of species in riparian buffers adjacent to the Site, and best professional judgement on species establishment and anticipated Site conditions in the early years following project implementation. Species chosen for the planting plan are listed on Sheet 2.0 of the preliminary design plans located in Appendix 7. The plans also contain guidance on planting zones.

All riparian planting activities will commence in concurrence with the stream mitigation activities and not before. Therefore, the mitigation area where buffer mitigation credits are being generated may be altered slightly depending on the final stream bank design. The planted areas will be surveyed and information provided in the As-Built report.

The riparian areas will be planted with bare root seedlings, where possible, from the top of bank to a minimum of 100 feet. In addition, the top of banks will be planted with live stakes and the channel toe will be planted with herbaceous species. Live stakes will not be planted within channels with bankfull widths of less than eight feet due to the small size of the channel. This includes T4, T4A, T4B, T7, T7A, and T8. Live stakes will be planted one to two feet beyond the top of bank on such small channels. Permanent seed will be spread on streambanks, floodplain areas, and all disturbed areas within the project easement.

To help ensure tree growth and survival, soil amendments may be added to areas of the where overburden material is removed. Soil tests will be performed in areas of cut, and fertilizer or lime will be applied based on the results. Additionally, topsoil will be stockpiled, reapplied, and disked before permanent seeding and planting activities take place.

Species planted as bare roots will be planted at 12-foot by 6-foot spacing for an initial density of 605 stems per acre. The targeted density after monitoring year 3 is 320 stems per acre. Live stakes will be planted on channel banks at 6-foot spacing. No live stakes will be installed below base flow elevation.

Invasive species within the riparian buffers will be treated or removed at the time of construction. The extent of invasive species coverage will be monitored, mapped, and treated as necessary throughout the required monitoring period. Please refer to Appendix 8 for the invasive species plan. Additional monitoring and maintenance issues regarding vegetation are in Sections 9 and 10 and Appendix 9.

8.10 Riparian Buffer Mitigation

Beyond creating stream mitigation credits (SMUs), the Site will also generate riparian buffer credits (BMUs) for the Neuse 01 in accordance with 15A NCAC 02B .0295. Figure 11 shows the areas for calculation of Riparian Buffer Credits. Riparian areas will be planted, where possible, from the top of bank to a minimum of 100 feet. Buffer mitigation credits will be generated through buffer restoration, enhancement through cattle exclusion, and preservation. Diffuse flow will be maintained in the buffers (i.e., lateral ditches will be filled, etc.). Table 19 in Section 13.0 shows the tabulation of Riparian Buffer Credits. Riparian Buffer Credits provide in Table 19 are based on proposed stream design and are not final until the as-built survey is complete.

DMS reserves the right to convert available buffer credits to nutrient offset credits for all riparian areas proposed for buffer credits except those generating credits from enhancement and preservation, as indicated by the site viability letter provided by NC DWR (Appendix 3).

8.11 Stream Crossings

Table 15 summarizes the proposed crossings on the Site. The crossings are mostly included in the easement except for the three road crossings (Buckwater R4, T1, and T5) and one farm crossing. The farm crossing on T3 is an important farm crossing to the barn and so it will be left open to livestock access. However, the crossing will be fenced with charged, high tensile wire. All crossings will be fenced and gated. Cattle will not have access to the live streams when moving through the crossings.

The crossings have been designed to allow for fish passage and aquatic habitat continuity. Culvert pipes will be buried 6 to 12 inches to allow for a natural stream bed through the crossing. Many existing culverts on site have vertical profile steps at the outfalls, posing a challenge to fish passage. This project will help to improve aquatic passage and stream habitat by replacing these perched culverts and allowing for a continuous stream bed habitat.

Table 15: Crossings Summary – *Buckwater Mitigation Site*

Reach	Crossing Location (STA)	Crossing Type	Within Conservation Easement?
Buckwater R4	132+00	bridge	No
T1 R1	205+00	bridge	No
T3 R1	311+20	culvert	No
T4A R2	405+50	culvert	Yes
T4A R3	408+50	culvert	Yes
T5	525+00	culvert	No
T6 R2	512+30	ford	Yes

8.12 Project Risk and Uncertainties

The land use surrounding much of the project has cattle operations so there is potential for accidental livestock access. There are three breaks in the easement for the maintenance of overhead utility lines. This area may be mowed or maintained periodically by Duke Energy. Due to the rural nature of the area, there is very little risk that changes in land use upstream in the project watershed would alter the hydrology or sediment supply to the degree that the project is put at risk. See Section 3.2 for a description of zoning for this area.

Three potential risks are listed and addressed below.

1. An increase in sediment supply to T1 is possible if the channel upstream from the project area begins to meander below the transmission line. The proposed channel design on T1 has higher stream power than the existing stream power upstream from the project area, as measured in two locations, along Stagg Road and directly beneath the transmission line. Thus, sediment transport capacity is limited upstream from the project area and anything that reaches the project area should be transportable.
2. The proposed stream power on Buckwater R5/R6 is higher than the existing stream power. This is primarily due to the slight increase in channel slope. Both the existing and proposed stream power are moderate so a change in the sediment transport dynamics is very unlikely.
3. Some of the project reaches, including T4, T4A, T4B, and T7 are very steep, with valley slopes ranging from 2.67% (T4) to 5.7% (T7). These have been designed either as B channels that dissipate energy vertically without meander geometry, or include sections of such B channels to match the valley topography. These channels and sections will incorporate step pools and/or riffle cascades to stably drop the profile.

9.0 Performance Standards

The stream and buffer performance standards for the project will follow approved performance standards presented in the DMS Mitigation Plan Template (version 2.3, 12/18/2014), the Annual Monitoring Template (April 2015), and the Stream Mitigation Guidelines issued April 2003 by the USACE and DWR. Annual monitoring and semi-annual site visits will be conducted to assess the condition of the finished project. Specific performance standard components are proposed for stream morphology, hydrology, and vegetation. Performance standards for streams will be evaluated throughout the seven-year post-construction monitoring. If all performance standards have been successfully met and two bankfull events have occurred during separate years, Wildlands will propose to terminate stream and/or vegetation monitoring after monitoring year seven.

9.1 Streams

Uncertainty is inherent in any stream design. Therefore, the degree to which bankfull estimates and the associated design criteria accommodates the effective discharge and the sediment supply is not adequately understood until the monitoring is completed.

9.1.1 Dimension

Riffle cross sections on the restoration reaches should be largely stable and should show minor changes in bankfull area, maximum depth ratio, and width-to-depth ratio. Riffle cross sections should largely fall within the parameters defined for channels of that stream classification. If any changes do occur, these changes will be evaluated to assess whether the stream channel is showing signs of instability. Indicators of instability include a vertically incising thalweg or eroding channel banks. Changes in the channel that indicate a movement toward stability or enhanced habitat include a decrease in the width-to-depth ratio in meandering channels or an increase in pool depth. Remedial action would not be taken if channel changes indicate a movement toward stability.

9.1.2 Pattern and Profile
Visual assessments and photo documentation should indicate that streams are remaining stable and do not indicate a trend toward vertical or lateral instability.

9.1.3 Substrate
Channel substrate materials will be sampled in ten reaches with the pebble count method. Restoration reaches should show maintenance of coarser substrate in the riffles than in the pools. A reach-wide pebble count will be performed in the following reaches each monitoring year for classification purposes and to show that the riffles remain coarser than the pools: Buckwater R4-R5, T1 R2, T2, T3 R2, T4, T4A, T4B, T5, and T7.

9.1.4 Photo Documentation
Photographs should illustrate the Site's vegetation and morphological stability on an annual basis. Cross-section photos should demonstrate no excessive erosion or degradation of the banks. Longitudinal photos should indicate the absence of persistent of mid-channel bars or vertical incision. Grade control structures should remain stable. Deposition of sediment on the bank side of vane arms is preferable. Maintenance of scour pools on the channel side of vane arms is expected.

9.1.5 Stream Hydrology
The occurrence of bankfull events and geomorphically significant events will be documented throughout the monitoring period. Two bankfull flow events must be documented within the seven-year monitoring period. The two bankfull events must occur in separate years. Also, two geomorphically significant events must be documented during the monitoring period. For these purposes, a geomorphically significant event is a flow event that is greater than or equal to 66% of the two-year discharge. These events may occur in the same year. Stream monitoring will continue until performance standards in the form of two bankfull events in separate years and two additional geomorphically significant events have been documented.

All intermittent reaches proposed for restoration as well as areas proposed for relocation through uplands (to meet buffer widths) must demonstrate a minimum of 30 days of continuous flow on an annual basis during the monitoring period. A minimum of 30 days of continuous flow is targeted for T4A, T4B, T6 R2, and T8.

9.2 Wetlands
Wildlands will re-delineate the following wetlands during MY4 or MY5:

- Buckwater Reaches 3 & 4
    - Vicinity of station 111+00 near start of restoration
    - Vicinity of station 119+00 upstream from relic dam
    - Vicinity of station 121+00 downstream from relic dam
    - Vicinity of station 125+00 between relic dam and pond
- T1 Reach 2, vicinity of station 207+50
- T6 Reach 2, area near crossing
- T4 Reach 1, vicinity of station 414+50 upstream from T3 confluence

Wildlands will re-delineate these wetlands for informational purposes only. The re-delineation results are not proposed to be tied to success criteria nor stream crediting. It is expected that the project will result in a net increase in wetland area and quality. These specific areas to be re-delineated are more unknown and will be monitored to inform future work.

9.3 Vegetation

Vegetative performance for riparian buffers associated with the stream restoration component of the project (buffer widths 0 – 50 feet) will be in accordance with the Stream Mitigation Guidelines issued October 2016 by the USACE. The success criteria are interim survival rates of 320 planted stems per acre at the end of monitoring year three (MY3) and 260 stems per acre at the end of monitoring year 5 (MY5). Final survival rates should be at least 210 stems per acres at the end of monitoring year 7 (MY7). The expected buffer planting areas are shown in Figure 12. Areas outside of the buffer planting areas currently have trees, but will be planted as needed following construction activities to achieve the target density. For volunteer species to be considered for future inclusion, they must be species listed in the approved planting plan.

Vegetative performance for buffer restoration areas will be in accordance with 15A NCAC 02B .0295(n)(2)(B), (E) and (n)(4) (effective November 1, 2015). The final vegetative success criteria for the NCDWR buffer restoration areas will be the survival of 260 planted stems per acre at the end of the required monitoring period (MY5) (no interim success criteria required).

The extent of invasive species coverage will be monitored and treated as necessary throughout the required monitoring period.

9.4 Visual Assessments

Visual assessments should support the specific performance standards for each metric as described above.

10.0 Monitoring Plan

The Site monitoring plan has been developed to ensure that the required performance standards are met and project goals and objectives are achieved. Annual monitoring data will be reported using the DMS Annual Monitoring Reporting Template (April 2015). The monitoring report shall provide project data chronology that will facilitate an understanding of project status and trends, ease population of DMS databases for analysis and research purposes, and assist in close-out decision making.

Using the DMS As-Built Baseline Monitoring Report Template (February 2014), a baseline monitoring document and as-built record drawings of the project will be developed within 60 days of the planting completion and monitoring installation on the restored site. Monitoring reports will be prepared in the fall of each monitoring year and submitted to DMS by November 30. These reports will be based on the DMS Annual Monitoring Template (April 2015) and Closeout Report Template (March 2015). Closeout monitoring period for stream mitigation credits will be seven years beyond completion of construction or until performance standards have been met. As determined by DWR, riparian buffer mitigation credits will closeout after five years beyond completion of construction or until performance standards have been met.

Table 16, below, describes how the monitoring plan is set up to verify project goals and objectives have been achieved.

Table 16: Monitoring Plan – *Buckwater Mitigation Site*

Goal	Treatment	Performance Standards	Monitoring Metric	Outcome	Likely Functional Uplift
Reconnect channels with floodplains and riparian wetlands to allow a natural flooding regime.	Reconstruct stream channels with appropriate bankfull dimensions and depth relative to the existing floodplain. Remove overburden to reconnect with adjacent wetlands.	Two bankfull events and two geomorphically significant events within monitoring period.	Crest gauges and/or pressure transducers on T1, T2, T3, T4, T4A, T4B, T5, T7, T8, and Buckwater R4 recording flow elevations.	Multiple bankfull and geomorphically significant events within monitoring period.	Dispersion of high flows on the floodplain, increase in biogeochemical cycling within the system, and recharging of riparian wetlands.
Improve stability of stream channels.	Construct stream channels that will maintain stable cross-sections, patterns, and profiles over time.	Entrenchment ratio stays over 2.2 and bank height ratio below 1.2 with visual assessments showing progression towards stability.	Cross-section monitoring and visual inspections.	Stable stream channels with entrenchment ratios over 2.2 and bank height ratios below 1.2.	Reduction in sediment inputs from bank erosion, reduction of shear stress, and improved overall hydraulic function.
Exclude cattle from project streams.	Install fencing around conservation easements adjacent to cattle pastures.	CE fencing will be maintained if cattle are present. Cattle are not accessing the mitigation site.	Visual inspections of fencing and buffer vegetation.	Fencing and buffer vegetation undisturbed by livestock.	Reduce and control sediment inputs; Reduce and manage nutrient inputs; Contribute to protection of or improvement to a Water Supply Waterbody.
Improve instream habitat.	Install habitat features such as constructed riffles, lunker logs, and brush toes into restored/ enhanced streams. Add woody materials to channel beds. Construct pools of varying depth.	There is no required performance standard for this metric.	Complete EPA Rapid Bioassessment Protocol score for aquatic instream habitat.	The Bioassessment score for instream aquatic habitat would progress from a poor condition to a good or excellent condition over time.	Increase in available habitat niches for macroinvertebrates and fish leading to an increase in biodiversity over time.
Restore and enhance native floodplain and streambank vegetation.	Plant native tree and understory species in riparian zones and plant appropriate species on streambanks.	Survival rate of 320 stems per acre at MY3, 260 planted stems per acre at MY5, and 210 stems per acre at MY7. For buffer credit	One hundred square meter vegetation plots will be placed on 2% of the planted area of the project and	Planted stem densities will be at or above 210 planted stems per acre at MY7, with volunteer trees	Reduction in floodplain sediment inputs from runoff, increased bank stability, increased LWD and organic material in streams, increased

Goal	Treatment	Performance Standards	Monitoring Metric	Outcome	Likely Functional Uplift
		areas, survival rate of 260 stems per acre at MY5.	monitored annually.	growing on Site as well.	biogeochemical cycling in floodplain, and improved riparian habitat.
Permanently protect the Site from harmful uses.	Establish conservation easements on the Site.	Prevent easement encroachment.	Visually inspect the perimeter of the Site to ensure no easement encroachment is occurring.	No harmful encroachment into the conservation easement.	Protection of the Site from encroachment into the conservation easement.
Maintain stream hydrology	Prevent loss of stream hydrology after restoring or relocating intermittent reaches.	Demonstrate a minimum of 30 days continuous flow on an annual basis.	Install gages to monitor stream flow.	No loss of jurisdictional stream channel function.	Stream hydrology maintained, buffer width added, and water table raised.

10.1 Monitoring Components

Project monitoring components are listed in more detail in Table 17 and are displayed in Figure 13. The approximate locations of the proposed vegetation plots and groundwater gage monitoring components are illustrated in Figure 13.

Table 17: Monitoring Components – *Buckwater Mitigation Site*

Parameter	Monitoring Feature	Quantity/ Length by Reach			Frequency	Notes
		Restoration	Enhancement I	Enhancement II		
Dimension	Riffle Cross Sections	12	6	N/A	Year 0, 1, 2, 3, 5, and 7	1
	Pool Cross Section	9	4	N/A		
Pattern	Pattern	N/A	N/A	N/A	Year 0	2
Profile	Longitudinal Profile	N/A	N/A	N/A	Year 0	
Substrate	Reach wide (RW), Riffle (RF) 100 pebble count	10	N/A	N/A	Year 0, 1, 2, 3, 5, and 7	
		N/A	N/A	N/A		
Hydrology	Crest Gage/ Transducer	9	2	N/A	Semi- Annual	3
Vegetation	CVS Level 2	19			Year 0, 1, 2, 3, 5, and 7	4
Visual Assessment		Y	Y	Y	Semi-Annual	
Exotic and nuisance vegetation					Semi-Annual	5

Project Boundary					Semi-Annual	6
Reference Photos	Photographs	26	7	16	Annual	

1. Cross sections will be permanently marked with rebar to establish location. Surveys will include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg.
2. Pattern and profile will be assessed visually during semi-annual site visits. Longitudinal profile will be collected during as-built baseline monitoring survey only, unless observations indicate lack of stability and profile survey is warranted in additional years.
3. Crest gages and/or transducers will be inspected quarterly or semi-annually, evidence of bankfull events will be documented with a photo when possible. Transducers, if used, will be set to record stage once every 2 hours. The transducer will be inspected and downloaded semi-annually.
4. Vegetation monitoring will follow CVS protocols. Separate monitoring reports will be submitted to NCDMS and NCDWR.
5. Locations of exotic and nuisance vegetation will be mapped.
6. Locations of vegetation damage, boundary encroachments, etc. will be mapped.

11.0 Long-Term Management Plan

Upon approval for close-out by the NC IRT the site will be transferred to the North Carolina Department of Environmental Quality (NCDEQ) Stewardship Program. This party shall serve as conservation easement holder and long-term steward for the property and will conduct periodic inspection of the site to ensure that restrictions required in the conservation easement are upheld. Funding will be supplied by the responsible party on a yearly basis until such time an endowment is established. The NCDEQ Stewardship Program is developing an endowment system within the non-reverting, interest-bearing Conservation Lands Conservation Fund Account. The use of funds from the Endowment Account will be governed by North Carolina General Statue GS 113A-232(d)(3). Interest gained by the endowment fund may be used for stewardship, monitoring, stewardship administration, and land transaction costs, if applicable.

The Stewardship Program will periodically install signage as needed to identify boundary markings as needed. Any livestock or associated fencing or permanent crossings will be the responsibility the owner of the underlying fee to maintain.

Table 18: Long-Term Management Plan – *Buckwater Mitigation Site*

Long-Term Management Activity	Long-Term Manager Responsibility	Landowner Responsibility
Signage will be installed and maintained along the Site boundary to denote the area protected by the recorded conservation easement.	The long-term steward will be responsible for inspecting the Site boundary and for maintaining or replacing signage to ensure that the conservation easement area is clearly marked.	The landowner shall report damaged or missing signs to the long-term manager, as well as contact the long-term manager if a boundary needs to be marked, or clarification is needed regarding a boundary location. If land use changes in future and fencing is required to protect the easement, the landowner is responsible for installing appropriate approved fencing.
The Site will be protected in its entirety and managed under the terms outlined in the recorded conservation easement.	The long-term manager will be responsible for conducting annual inspections and for undertaking actions that are reasonably calculated to swiftly correct the conditions constituting a breach. The USACE, and their	The landowner shall contact the long-term manager if clarification is needed regarding the restrictions associated with the recorded conservation easement.

Long-Term Management Activity	Long-Term Manager Responsibility	Landowner Responsibility
	authorized agents, shall have the right to enter and inspect the Site and to take actions necessary to verify compliance with the conservation easement.	

12.0 Adaptive Management Plan

Upon completion of Site construction, Wildlands will implement the post-construction monitoring defined in Sections 9 and 10. Project maintenance will be performed during the monitoring years to address minor issues as necessary (Appendix 10). If, during annual monitoring it is determined the Site's ability to achieve Site performance standards are jeopardized, Wildlands will notify the DMS of the need to develop a Plan of Corrective Action. Once the Plan of Corrective Action is prepared and finalized Wildlands will:

- Notify the USACE as required by the Nationwide 27 permit general conditions;
- Notify DWR as required per .0295;
- Revise performance standards, maintenance requirements, and monitoring requirements as necessary and/or required by the USACE;
- Obtain other permits as necessary;
- Implement the Corrective Action Plan; and
- Provide the USACE a Record Drawing of Corrective Actions. This document shall depict the extent and nature of the work performed.

13.0 Determination of Credits

The final stream and buffer credits proposed for the Site are listed in Table 19. Stream mitigation crediting follows the original Neuse 01 DMS RFP #16-006477, the Buckwater Mitigation Site proposal, and the subsequent IRT site visit on April 5, 2016. The credit ratios and mitigation areas for buffer credits were approved by NCDWR in a letter dated June 13, 2016.

After the initial design phase, approximately 10% of the project length had buffers less than the required 50-foot standard width for Piedmont streams. However, Wildlands identified several locations to reduce this amount to 4.7%. The changes included making the T3 R2 crossing perpendicular to the stream, as well as completing sections of channel realignment on Enhancement II reaches, including T3, T4A, and Buckwater R8. Additionally, the alignment changes to T6 and upper T5 provided 50-foot buffers.

Since the project length with less than 50-foot riparian buffers will be less than 5%, credit adjustments for buffer widths will not be required.

The credit release schedule is in Appendix 11.

Table 19: Project Asset Table – Buckwater Mitigation Site

Mitigation Credits								
	Stream		Riparian Wetland		Non-Riparian Wetland		Riparian Buffer	
Type	R	RE	R	RE	R	RE	R	RE
Totals	12,620	N/A	N/A	N/A	N/A	N/A	1,068,926	39,569

Project Reach ID	Existing Footage (LF)	Proposed Stationing/ Location	Approach (P1, P2, etc)	Restoration (R) or Restoration Equivalent (RE)	Restoration Footage or Acreage	Mitigation Ratio	Proposed Credit
Buckwater R1	445	100+17 to 104+62	EII	R	445	2.5	178
Buckwater R2	160	104+62 to 106+22	EI	R	160	1.5	107
Buckwater R3	232	106+22 to 108+54	EI	R	232	1.5	155
Buckwater R4	2,282	108+54 to 129+21	P1	R	2,067	1.0	2,067
		129+21 to 129+51	-	-	30	0	0
		129+51 to 131+57	P1	R	206	1.0	206
		131+57 to 132+29	-	-	72	0	0
		132+29 to 134+23	P1	R	194	1.0	194
Buckwater R5	435	134+23 to 139+09	P1.5	R	486	1.0	486
Buckwater R6	884	139+09 to 142+88	P1.5	R	379	1.0	379
Buckwater R6		142+88 to 144+06	-	-	118	0	0
Buckwater R7	941	144+06 to 144+50	-	-	43	0	0
Buckwater R7		144+50 to 153+41	EII	R	891	2.5	356
Buckwater R8	178	153+41 to 155+29	EII	R	188	2.5	75
T1 R1	501	200+00 to 203+66	EI	R	366	1.5	244
		203+66 to 204+85	-	-	119	0	0
T1 R2	572	204+85 to 206+08	-	-	123	0	0
		206+08 to 210+93	P1	R	485	1.0	485
		210+93 to 211+17	-	-	25	0	0
T2	548	322+41 to 328+28	P1	R	587	1.0	587
T3 R1	1,303	300+00 to 311+01	EII	R	1101	2.5	440
		311+01 to 311+31	-	-	30	0	0
		311+31 to 312+97	EII	R	166	2.5	66
T3 R2	877	312+97 to 319+55	P1	R	658	1.0	658
		319+55 to 320+48	-	-	63	0	0
		320+48 to 322+41	P1	R	193	1.0	193
T4	1,081	408+67 to 418+28	P1	R	961	1.0	961
T4A R1	312	400+44 to 403+55	P1	R	311	1.0	311
T4A R2	259	403+55 to 405+30	EII	R	175	2.5	70
		405+30 to 406+02	-	-	72	0	0
T4A R3	145	406+02 to 408+03	P1	R	201	1.0	201

Project Components							
Project Reach ID	Existing Footage (LF)	Proposed Stationing/ Location	Approach (P1, P2, etc)	Restoration (R) or Restoration Equivalent (RE)	Restoration Footage or Acreage	Mitigation Ratio	Proposed Credit
		408+03 to 408+67	-	-	64	0	0
T4B R1	419	450+00 to 453+45	P1	R	345	1.0	345
T4B R2	145	453+45 to 455+63	-	-	218	0	0
T5	1,291	518+64 to 524+12	P1	R	548	1.0	548
		524+12 to 525+79	-	-	167	0	0
		525+79 to 532+90	P1	R	711	1.0	711
T6 R1	697	500+61 to 507+56	EII	R	695	2.5	278
T6 R2	492	507+56 to 512+14	EII	R	458	2.5	183
		512+14 to 512+44	-	-	30	0	0
T6 R3	704	512+44 to 518+64	EI	R	620	1.5	413
T6A	324	600+00 to 603+11	EII	R	311	2.5	124
T6B	136	650+00 to 651+36	EII	R	136	2.5	54
T7 R1	317	700+95 to 704+17	EI	R	322	1.5	215
T7 R2	323	704+17 to 707+80	P1	R	363	1.0	363
T7 R3	368	707+80 to 711+36	P2	R	356	1.0	356
T7A	227	750+00 to 752+42	EI	R	242	1.5	161
T8	620	800+00 to 806+31	EI	R	631	1.5	421
T9	73	900+56 to 901+29	EII	R	73	2.5	29

Riparian Buffer Mitigation Credits								
Buffer Component	Mitigation Type	Buffer Width (ft)	Restoration Square Footage*	Credit Ratio	Mitigation Credits	or	Nutrient Offset Credits Nitrogen (lbs)	Nutrient Offset Credits Phosphorus (lbs)
Buffer Area A	Restoration	TOB - 100	943,139	1	943,139		49,216.01	3,169.78
Buffer Area B	Restoration	101 - 200	2,902	3	967		151.44	9.75
Buffer Area C	Enhancement – Cattle Exclusion	TOB - 100	249,640	2	124,820			
Buffer Area D	Preservation	TOB - 100	395,691	10	39,569			
TOTALS			1,591,372		1,108,495		49,367.45	3,179.53

*The area of preservation credit within a buffer mitigation site shall comprise no more than 25% of the total area of buffer mitigation in accordance with 15A NCAC 2B .0295 (o)(5).

Component Summation					
Restoration Level	**Stream (LF)**	**Riparian Wetland (Acres)**	**Non-Riparian Wetland (AC)**	**Buffer (sq.ft.)**	**Upland (AC)**
Restoration	16,675*	N/A	N/A	1,195,681	N/A
Restoration Equivalent	N/A	N/A	N/A	395,691	N/A

*Total project stream length including internal easement crossings and utility crossings where easement is purchased; these crossings are not included in any of the credit calculations. Restoration footage from creditable sections above equals 16,275 LF.

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Appendix 1

Site Protection Instrument

1.0 Site Protection Instrument

The land required for construction, management, and stewardship of this mitigation project includes portions of the parcels listed in Table 1. This area totals 51.83 acres. The deed book and page number listed are for the agreements on an option to purchase a conservation easement. A conservation easement will be recorded on the parcels and includes streams being restored along with their corresponding riparian buffers.

Table 1: Site Protection Instrument – *Buckwater Mitigation Site*

Landowner	PIN	County	Site Protection Instrument	Memo of Option Deed Book and Page Number	Acreage to be Protected
Darin and Katie Little	9895069322	Orange	CE	DB: RB6024 PG: 539-544	1.30
Darin and Katie Little	9895065083	Orange	CE	DB: RB6024 PG: 539-544	0.70
Bacon Family Farmlands, LLC	9895079332	Orange	CE	DB: RB6008 PG: 500-504	12.45
Bacon Family Limited Partnership II	9895194280	Orange	CE	DB: RB6008 PG: 505-510	3.29
Bacon Family Limited Partnership II	9895086826	Orange	CE	DB: RB6008 PG: 505-510	3.42
Doug and Pat Crabtree	9895269592	Orange	CE	DB: RB6028 PG: 346-351	4.90
Kandace Gotwals	9895258426	Orange	CE	DB: RB6029 PG: 559-563	1.36
Donna Mayfield and Dave Sheets	9895282714	Orange	CE	DB: RB6020 PG: 38-45	0.78
Donna Mayfield and Dave Sheets	9895464642	Orange	CE	DB: RB6020 PG: 38-45	22.46
Pelham and Mary Jacobs	9895289864	Orange	CE	DB: RB6029 PG: 553-558	1.17
Robert and Cynthia Hoglen	9895387522	Orange	TCE	DB: RB6226 PG: 292-299*	0.00

*Agreement for a temporary construction easement

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

Appendix 2

Approved JD and Wetland JD Forms

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action Id. **SAW-2016-00873** County: **Orange County** U.S.G.S. Quad: **Hillsborough**

NOTIFICATION OF JURISDICTIONAL DETERMINATION

Applicant/Agent:	**Wildlands Engineering, Inc.** **Mr. Win Taylor**
Address:	**497 Bramson Court, Suite 104** **Mt. Pleasant, South Carolina 29464**

Size (acres)	**49**	Nearest Town	**Hillsborough**
Nearest Waterway	**Buckwater Creek**	River Basin	**Neuse River**
USGS HUC	**03020201**	Coordinates	Latitude: **36.10653** Longitude: **-79.02489**

Location description: **The Buckwater Mitigation Site is identified as an approximate 49 acre tract of land, located on Orange, North Carolina Parcels: 9895099042, 9895269592, 9895256668, 9895258436, 9895381829, 9895079332, 9895069322, and 9895065083, 9895476632, and 9895282714. These parcels are located along St. Mary's Road, Hillsborough, North Carolina.**

Indicate Which of the Following Apply:

A. Preliminary Determination

X There are waters, including wetlands, on the above described project area, that may be subject to Section 404 of the Clean Water Act (CWA)(33 USC § 1344) and/or Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403). The waters, including wetlands, have been delineated, and the delineation has been verified by the Corps to be sufficiently accurate and reliable. Therefore this preliminary jurisdiction determination may be used in the permit evaluation process, including determining compensatory mitigation. For purposes of computation of impacts, compensatory mitigation requirements, and other resource protection measures, a permit decision made on the basis of a preliminary JD will treat all waters and wetlands that would be affected in any way by the permitted activity on the site as if they are jurisdictional waters of the U.S. This preliminary determination is not an appealable action under the Regulatory Program Administrative Appeal Process (Reference 33 CFR Part 331). However, you may request an approved JD, which is an appealable action, by contacting the Corps district for further instruction.

_ There are wetlands on the above described property, that may be subject to Section 404 of the Clean Water Act (CWA)(33 USC § 1344) and/or Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403). However, since the waters, including wetlands, have not been properly delineated, this preliminary jurisdiction determination may not be used in the permit evaluation process. Without a verified wetland delineation, this preliminary determination is merely an effective presumption of CWA/RHA jurisdiction over all of the waters, including wetlands, at the project area, which is not sufficiently accurate and reliable to support an enforceable permit decision. We recommend that you have the waters of the U.S. on your property delineated. As the Corps may not be able to accomplish this wetland delineation in a timely manner, you may wish to obtain a consultant to conduct a delineation that can be verified by the Corps.

B. Approved Determination

_ There are Navigable Waters of the United States within the above described property subject to the permit requirements of Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403) and Section 404 of the Clean Water Act (CWA)(33 USC § 1344). Unless there is a change in law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

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

_ We recommend you have the waters of the U.S. on your property delineated. As the Corps may not be able to accomplish this wetland delineation in a timely manner, you may wish to obtain a consultant to conduct a delineation that can be verified by the Corps.

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

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

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

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

Placement of dredged or fill material within waters of the US, including wetlands, without a Department of the Army permit may constitute a violation of Section 301 of the Clean Water Act (33 USC § 1311). Placement of dredged or fill material, construction or placement of structures, or work within navigable waters of the United States without a Department of the Army permit may constitute a violation of Sections 9 and/or 10 of the Rivers and Harbors Act (33 USC § 401 and/or 403). If you have any questions regarding this determination and/or the Corps regulatory program, please contact **Ms. Samantha Dailey at (919) 554-4884, ext. 22 or Samantha.J.Dailey@usace.army.mil.**

C. **Basis For Determination: On August 22, 2016, Wildlands Engineering, Inc. submitted a preliminary jurisdictional determination (JD) to our office for review. Representatives from the United States Army Corps of Engineers (Corps) and Wildlands Engineering, Inc. participated in an on-site field verification conducted on October 11, 2016. During this investigation the Corps requested additional information required to accuracy describe and delineate waters within the Buckwater Mitigation Site. Final revisions were received by our office on October 27, 2016.**

Based on a review of the August 22, 2016 report submitted to our office, on-site field verification on October 11, 2016, and final revisions received on October 27, 2016, this office has determined that 15,737 linear feet of perennial stream channel, 1,236 linear feet of intermittent stream channel, 6.68 acres of wetland, and 1.35 acres of open water are present within the Buckwater Mitigation Site project boundary. Refer to the enclosed Preliminary Jurisdictional Determination Form and Figure 3 Site Maps for a detailed summary of waters on-site.

D. Remarks:

E. Attention USDA Program Participants

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

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

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

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

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR part 331.5, and that it has been received by the Division Office within 60 days of the date of the NAP. Should you decide to submit an RFA form, it must be received at the above address by ________________.
It is not necessary to submit an RFA form to the Division Office if you do not object to the determination in this correspondence.

Corps Regulatory Official: DAILEY.SAMANTHA.J.1387567948 Digitally signed by DAILEY.SAMANTHA.J.1387567948 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=DAILEY.SAMANTHA.J.1387567948 Date: 2017.02.16 08:58:42 -05'00'

Date: **February 16, 2017** Expiration Date: **N/A**

The Wilmington District is committed to providing the highest level of support to the public. To help us ensure we continue to do so, please complete our Customer Satisfaction Survey, located online at http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0.

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL		
Applicant: **Wildlands Engineering, Inc.** **Mr. Win Taylor**	File Number: **SAW-2016-00873**	Date: **February 16, 2017**
Attached is:		See Section below
☐ INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)		A
☐ PROFFERED PERMIT (Standard Permit or Letter of permission)		B
☐ PERMIT DENIAL		C
☐ APPROVED JURISDICTIONAL DETERMINATION		D
☒ PRELIMINARY JURISDICTIONAL DETERMINATION		E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.
- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the district engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT		
REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)		
ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.		
POINT OF CONTACT FOR QUESTIONS OR INFORMATION:		
If you have questions regarding this decision and/or the appeal process you may contact: **District Engineer, Wilmington Regulatory Division** **Raleigh Regulatory Field Office** **Attn: Samantha Dailey** **3331 Heritage Trade Drive, Suite 105** **Wake Forest, North Carolina 27587**	If you only have questions regarding the appeal process you may also contact: Mr. Jason Steele, Administrative Appeal Review Officer CESAD-PDO U.S. Army Corps of Engineers, South Atlantic Division 60 Forsyth Street, Room 10M15 Atlanta, Georgia 30303-8801 Phone: (404) 562-5137	
RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.		
__________________________________ Signature of appellant or agent.	Date:	Telephone number:

For appeals on Initial Proffered Permits send this form to:

District Engineer, Wilmington Regulatory Division, Attn: Samantha Dailey, 69 Darlington Avenue, Wilmington, North Carolina 28403

For Permit denials, Proffered Permits and Approved Jurisdictional Determinations send this form to:

Division Engineer, Commander, U.S. Army Engineer Division, South Atlantic, Attn: Mr. Jason Steele, Administrative Appeal Officer, CESAD-PDO, 60 Forsyth Street, Room 10M15, Atlanta, Georgia 30303-8801
Phone: (404) 562-5137

APPENDIX 2

PRELIMINARY JURISDICTIONAL DETERMINATION FORM

BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR PRELIMINARY JURISDICTIONAL DETERMINATION (JD): February 15, 2017

B. NAME AND ADDRESS OF PERSON REQUESTING PRELIMINARY JD:
Applicant/Agent: **Wildlands Engineering, Inc.**
Mr. Win Taylor
Address: **497 Bramson Court, Suite 104**
Mt. Pleasant, South Carolina 29464

C. DISTRICT OFFICE, FILE NAME, AND NUMBER: Wilmington, Buckwater Mitigation Site, Wildlands Engineering, Inc., Orange County, SAW-2016-00873

D. PROJECT LOCATION(S) AND BACKGROUND INFORMATION:
(USE THE ATTACHED TABLE TO DOCUMENT MULTIPLE WATERBODIES AT DIFFERENT SITES)
State: **NC** County/parish/borough: **Orange** City: **Hillsborough**
Center coordinates of site (lat/long in degree decimal format): Lat. **36.10653°N**, Long. **79.02489° W**.
Universal Transverse Mercator:
Name of nearest water body: **Buckwater Creek**

E. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLIES):
☒ Office (Desk) Determination. Date: **February 15, 2017**
☒ Field Determination. Date(s): **October 11, 2016**

TABLE OF AQUATIC RESOURCES IN REVIEW AREA WHICH "MAY BE" SUBJECT TO REGULATORY JURISDICTION

Site Number	Latitude (°N)	Latitude (°W)	Estimated Amount of Aquatic Resources in Review Area		Type of aquatic resource (i.e. wetland vs. non-wetland)	Geographic authority to which the aquatic resource "may be" subject (i.e. Section 404 or Section 10/404)
			Linear Feet	Acres		
Buckwater Creek	36.10699400	-79.022464	5,674		non-wetland	Section 404
T1	36.10809600	-79.022127	1073		non-wetland	Section 404
T2	36.10611400	-79.022918	548		non-wetland	Section 404
T3	36.10484000	-79.023228	2254		non-wetland	Section 404
T4	36.10523800	-79.022583	950		non-wetland	Section 404
T4A	36.10298300	-79.021016	404		non-wetland	Section 404
T4B	36.10322300	-79.020275	415		non-wetland	Section 404
T4C	36.10322300	-79.020275	81		non-wetland	Section 404
T5	36.10699400	-79.025261	1,291		non-wetland	Section 404
T6	36.10784000	-79.030495	1,951		non-wetland	Section 404
T6A	36.10826400	-79.028309	296		non-wetland	Section 404
T6B	36.10815600	-79.031213	103		non-wetland	Section 404
T7	36.10697000	-79.019547	1,008		non-wetland	Section 404
T7A	36.10694000	-79.01906	233		non-wetland	Section 404

T8	36.10455260	-79.032183	620		wetland	Section 404
T9	36.10385500	-79.030895	72		wetland	Section 404
Wetland A	36.10310100	-79.020186		0.063	wetland	Section 404
Wetland B	36.10308800	-79.020031		0.019	wetland	Section 404
Wetland C	36.10333300	-79.020459		0.009	wetland	Section 404
Wetland D	36.10333000	-79.020847		0.646	wetland	Section 404
Wetland E	36.10402700	-79.020989		0.058	wetland	Section 404
Wetland F	36.10445400	-79.021475		0.026	wetland	Section 404
Wetland G	36.10301900	-79.021054		0.029	wetland	Section 404
Wetland H	36.10260700	-79.021132		0.029	wetland	Section 404
Wetland I	36.10258200	-79.021065		0.022	wetland	Section 404
Wetland J	36.10294800	-79.021028		0.058	wetland	Section 404
Wetland K	36.10512100	-79.022486		0.102	wetland	Section 404
Wetland L	36.10530900	-79.022812		0.062	wetland	Section 404
Wetland M	36.10568700	-79.023		0.024	wetland	Section 404
Wetland N	36.10793200	-79.019092		0.019	wetland	Section 404
Wetland O	36.10686000	-79.019587		0.004	wetland	Section 404
Wetland P	36.10830500	-79.018921		0.015	wetland	Section 404
Wetland Q	36.10807000	-79.019013		0.013	wetland	Section 404
Wetland R	36.10806400	-79.019632		0.035	wetland	Section 404
Wetland S	36.10807200	-79.019928		0.01	wetland	Section 404
Wetland T	36.10794500	-79.020362		0.025	wetland	Section 404
Wetland U	36.10778100	-79.020744		0.01	wetland	Section 404
Wetland V	36.10759200	-79.021248		0.019	wetland	Section 404
Wetland W	36.10842200	-79.022431		0.309	wetland	Section 404
Wetland X	36.10660500	-79.019626		0.07	wetland	Section 404
Wetland Y	36.10612400	-79.019593		0.004	wetland	Section 404
Wetland Z	36.10705500	-79.019157		0.025	wetland	Section 404
Wetland AA	36.10790300	-79.029896		0.307	wetland	Section 404
Wetland BB	36.10824800	-79.031452		0.021	wetland	Section 404
Wetland CC	36.10814500	-79.031848		0.017	wetland	Section 404
Wetland DD	36.10804800	-79.031603		0.182	wetland	Section 404
Wetland EE	36.10776500	-79.030428		0.547	wetland	Section 404
Wetland FF	36.10822400	-79.026632		0.185	wetland	Section 404
Wetland GG	36.10845700	-79.027608		0.067	wetland	Section 404
Wetland HH	36.10815700	-79.028102		0.01	wetland	Section 404
Wetland II	36.10818400	-79.028267		0.003	wetland	Section 404
Wetland JJ	36.10811500	-79.028117		0.015	wetland	Section 404
Wetland KK	36.10799500	-79.0296		0.038	wetland	Section 404
Wetland LL	36.10431800	-79.029522		0.012	wetland	Section 404
Wetland MM	36.10360600	-79.031549		0.154	wetland	Section 404

Wetland NN	36.10327100	-79.032123		0.277	wetland	Section 404
Wetland OO	36.10666300	-79.025502		0.233	wetland	Section 404
Wetland PP	36.10602200	-79.026352		1.064	wetland	Section 404
Wetland QQ	36.10522700	-79.027793		0.38	wetland	Section 404
Wetland RR	36.10460600	-79.029948		0.13	wetland	Section 404
Wetland SS	36.10445500	-79.030352		0.006	wetland	Section 404
Wetland TT	36.10967400	-79.02263		0.487	wetland	Section 404
Wetland UU	36.10467200	-79.023418		0.142	wetland	Section 404
Wetland VV	36.10437200	-79.023255		0.04	wetland	Section 404
Wetland WW	36.10397700	-79.023131		0.026	wetland	Section 404
Wetland XX	36.10378100	-79.023251		0.052	wetland	Section 404
Wetland YY	36.10380800	-79.023115		0.01	wetland	Section 404
Wetland ZZ	36.10344200	-79.023255		0.034	wetland	Section 404
Wetland AAA	36.10350900	-79.023207		0.009	wetland	Section 404
Wetland BBB	36.10313300	-79.023251		0.028	wetland	Section 404
Wetland CCC	36.10319300	-79.023266		0.005	wetland	Section 404
Wetland DDD	36.10264300	-79.023462		0.028	wetland	Section 404
Wetland EEE	36.10260300	-79.023704		0.011	wetland	Section 404
Wetland FFF	36.10232400	-79.023887		0.016	wetland	Section 404
Wetland GGG	36.10244000	-79.023814		0.003	wetland	Section 404
Wetland HHH	36.10233200	-79.02394		0.005	wetland	Section 404
Wetland III	36.10199000	-79.024096		0.038	wetland	Section 404
Wetland JJJ	36.10189200	-79.024223		0.019	wetland	Section 404
Wetland KKK	36.10160000	-79.024411		0.015	wetland	Section 404
Wetland LLL	36.10145600	-79.0244		0.003	wetland	Section 404
Wetland MMM	36.10130200	-79.024531		0.009	wetland	Section 404
Wetland NNN	36.10090200	-79.024825		0.003	wetland	Section 404
Wetland OOO	36.10081900	-79.024964		0.02	wetland	Section 404
Wetland PPP	36.10072400	-79.02497		0.007	wetland	Section 404
Wetland QQQ	36.10068400	-79.025023		0.007	wetland	Section 404
Wetland RRR	36.10644600	-79.027707		0.314	wetland	Section 404
Pond 1	36.10706100	-79.024671		0.778	Open water	Section 404
Pond 2	36.10646100	-79.02582		0.396	Open water	Section 404
Pond 3	36.10229500	-79.020926		0.18	Open water	Section 404

1. The Corps of Engineers believes that there may be jurisdictional aquatic resources in the review area, and the requestor of this PJD is hereby advised of his or her option to request and obtain an approved JD (AJD) for that review area based on an informed decision after having discussed the various types of JDs and their characteristics and circumstances when they may be appropriate.

2. In any circumstance where a permit applicant obtains an individual permit, or a Nationwide General Permit (NWP) or other general permit verification requiring "pre-construction notification" (PCN), or requests verification for a non-reporting NWP or other general permit, and the permit applicant has not requested an AJD for the activity, the permit applicant is hereby made aware that: (1) the permit applicant has elected to seek a permit authorization based on a PJD, which does not make an official determination of jurisdictional aquatic resources; (2) the applicant has the option to request an AJD before accepting the terms

and conditions of the permit authorization, and that basing a permit authorization on an AJD could possibly result in less compensatory mitigation being required or different special conditions; (3) the applicant has the right to request an individual permit rather than accepting the terms and conditions of the NWP or other general permit authorization; (4) the applicant can accept a permit authorization and thereby agree to comply with all the terms and conditions of that permit, including whatever mitigation requirements the Corps has determined to be necessary; (5) undertaking any activity in reliance upon the subject permit authorization without requesting an AJD constitutes the applicant's acceptance of the use of the PJD; (6) accepting a permit authorization (e.g., signing a proffered individual permit) or undertaking any activity in reliance on any form of Corps permit authorization based on a PJD constitutes agreement that all aquatic resources in the review area affected in any way by that activity will be treated as jurisdictional, and waives any challenge to such jurisdiction in any administrative or judicial compliance or enforcement action, or in any administrative appeal or in any Federal court; and (7)whether the applicant elects to use either an AJD or a PJD, the JD will be processed as soon as practicable. Further, an AJD, a proffered individual permit (and all terms and conditions contained therein), or individual permit denial can be administratively appealed pursuant to 33 C.F.R. Part 331. If, during an administrative appeal, it becomes appropriate to make an official determination whether geographic jurisdiction exists over aquatic resources in the review area, or to provide an official delineation of jurisdictional aquatic resources in the review area, the Corps will provide an AJD to accomplish that result, as soon as is practicable. This PJD finds that there *"may be"* waters of the U.S. and/or that there *"may be"* navigable waters of the U.S. on the subject review area, and identifies all aquatic features in the review area that could be affected by the proposed activity, based on the following information:

SUPPORTING DATA. Data reviewed for preliminary JD (check all that apply): Checked items should be included in subject file. Appropriately reference sources below where indicated for all checked items:

☒ Maps, plans, plots or plat submitted by or on behalf of the PJD requestor: **Wildlands Engineering, Inc., submitted a Jurisdictional Determination Request on August 22, 2016, with revisions received on October 27, 2016.**
☒ Data sheets prepared/submitted by or on behalf of the PJD requestor.
☒ Office concurs with data sheets/delineation report.
☐ Office does not concur with data sheets/delineation report.
☐ Data sheets prepared by the Corps: .
☐ Corps navigable waters' study: .
☐ U.S. Geological Survey Hydrologic Atlas: .
☐ USGS NHD data.
☐ USGS 8 and 12 digit HUC maps.
☒ U.S. Geological Survey map(s). Cite scale & quad name: **1:24K, NC-Hillsborough**
☒ USDA Natural Resources Conservation Service Soil Survey. Citation: **Web Soil Survey: October 2016**.
☒ National wetlands inventory map(s). Cite name: **Corps of Engineers SimSuite – October 2016**.
☐ State/Local wetland inventory map(s): .
☐ FEMA/FIRM maps: .
☐ 100-year Floodplain Elevation is: (National Geodetic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date): .
or ☐ Other (Name & Date): .
☐ Previous determination(s). File no. and date of response letter: .
☐ Other information (please specify): .

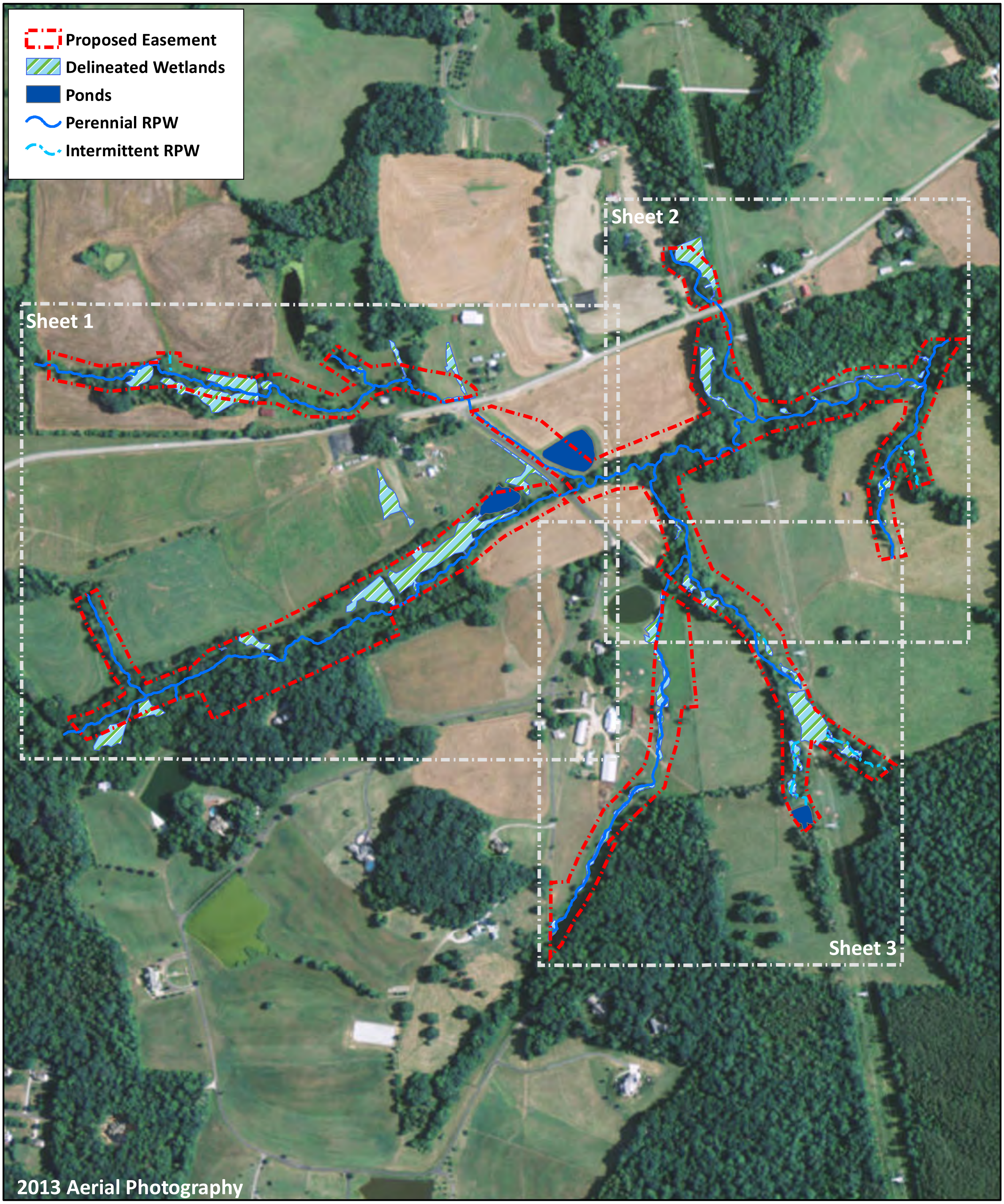
IMPORTANT NOTE: The information recorded on this form has not necessarily been verified by the Corps and should not be relied upon for later jurisdictional determinations[1].

DAILEY.SAMANTHA.J.1387567948
Digitally signed by DAILEY.SAMANTHA.J.1387567948
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=DAILEY.SAMANTHA.J.1387567948
Date: 2017.02.16 08:56:12 -05'00'

Signature and date of Regulatory Project Manager (REQUIRED)

Signature and date of person requesting preliminary JD (REQUIRED, unless obtaining the signature is Impracticable)

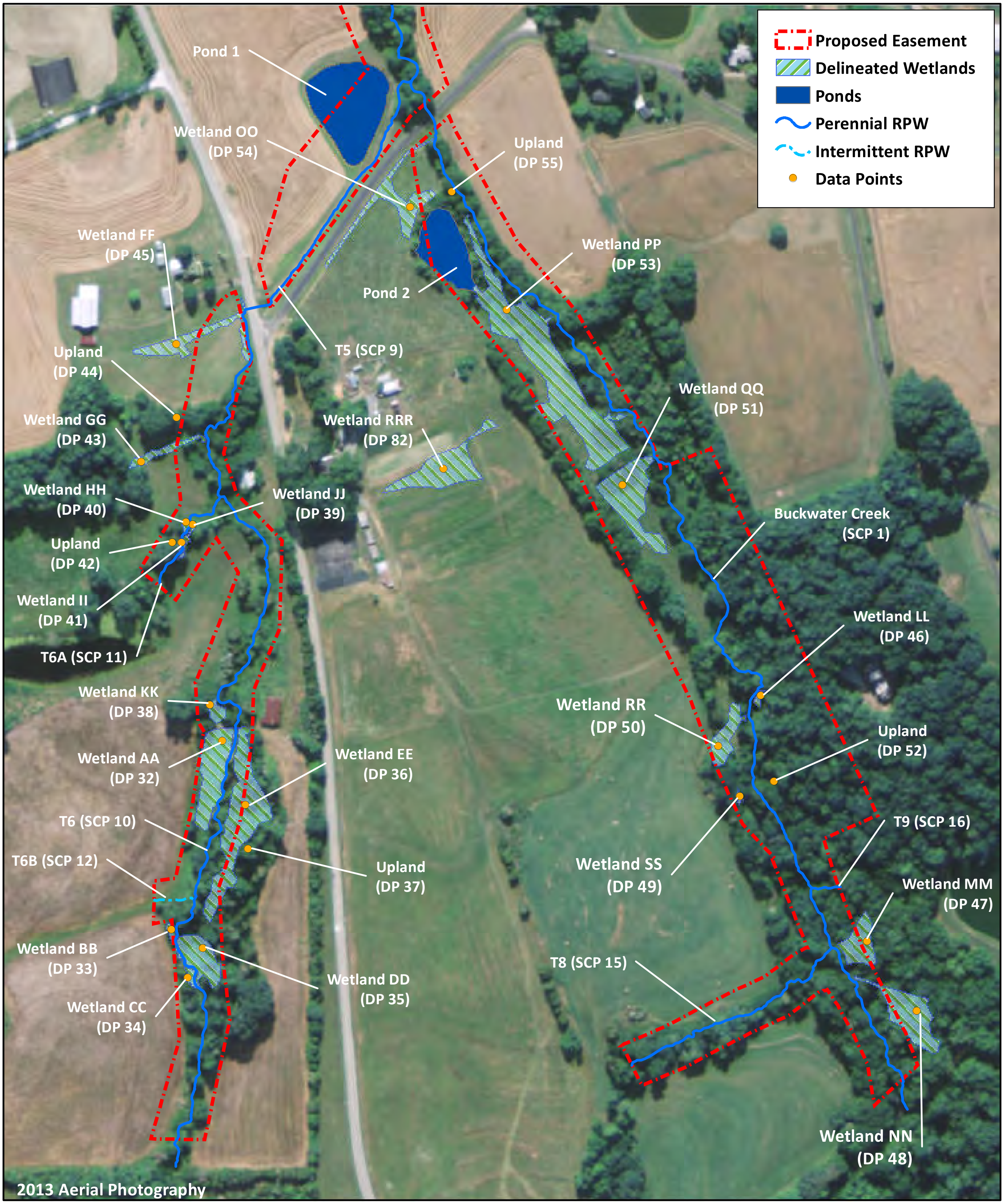
[1] Districts may establish timeframes for requestor to return signed PJD forms. If the requestor does not respond within the established time frame, the district may presume concurrence and no additional follow up is necessary prior to finalizing an action.



WILDLANDS ENGINEERING

Figure 3 Site Map
Buckwater Mitigation Site
Neuse 03020201

Orange County, NC



WILDLANDS ENGINEERING

Figure 3 Site Map - Sheet 1
Buckwater Mitigation Site
Neuse 03020201

Orange County, NC

WILDLANDS ENGINEERING

0 200 400 Feet

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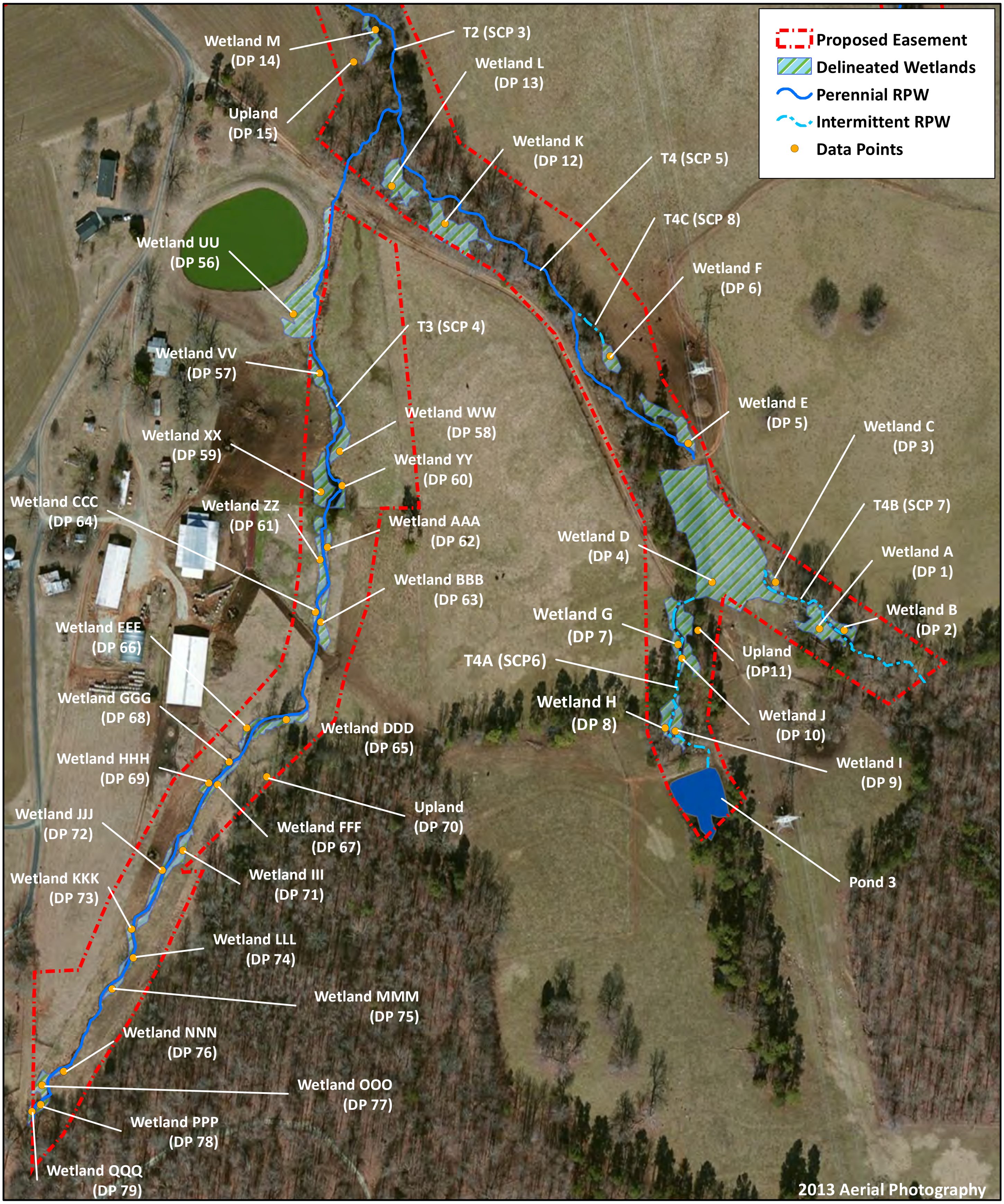
Figure 3 Site Map - Sheet 2
Buckwater Mitigation Site
Neuse 03020201

Orange County, NC



WILDLANDS ENGINEERING

Figure 3 Site Map - Sheet 3
Buckwater Mitigation Site
Neuse 03020201

Orange County, NC

August 16, 2016

Ms. Samantha Dailey
US Army Corps of Engineers
Raleigh Regulatory Field Office
3331 Heritage Trade Drive, Suite 105
Wake Forest, North Carolina 27587

Subject: **Preliminary Jurisdictional Delineation and Request for Verification**
Buckwater Mitigation Site
Orange County, North Carolina

Dear Ms. Dailey:

Wildlands Engineering, Inc. (Wildlands) is requesting written verification from the U.S. Army Corps of Engineers (USACE) regarding the extent of jurisdictional features within the subject project area. The Buckwater Mitigation Site is located off of St. Mary's Road northeast of the Town of Hillsborough in northeastern Orange County, NC (Figures 1 and 2). The Buckwater Mitigation Site has been accepted as a full delivery stream mitigation project for the North Carolina Department of Environment and Natural Resources Division of Mitigation Services. To date, a draft mitigation plan is being developed and Wildlands is currently in the process of finalizing easement boundaries and landowner coordination.

Methodology

On May 26; June 1, 2, 3, and 29, 2016 Wildlands delineated jurisdictional waters of the U.S. within the proposed project easement area. Jurisdictional areas were delineated using the USACE Routine On-Site Determination Method. This method is defined by the 1987 Corps of Engineers Wetlands Delineation Manual and subsequent Eastern Mountain and Piedmont Regional Supplement. Wetland Determination Data Forms representative of on-site jurisdictional wetland areas as well as non-jurisdictional upland areas have been enclosed (DP1-DP82).

Jurisdictional stream channels were classified according to USACE and NCDWR guidance. NCDWR Stream Classification Forms and USACE Stream Quality Assessment Worksheets representative of on-site stream channels are enclosed (SCP1-SCP15).

Jurisdictional Waters

The results of the on-site field investigation indicate that there are 15 jurisdictional stream channels located within the proposed project area which are unnamed tributaries to Buckwater Creek, hereafter referred to as Buckwater Creek, T1, T2, T3, T4, T4A, T4B, T5, T6, T6A, T6B, T7, T7A, T8, and T9. There are 70 jurisdictional wetland areas were identified within the proposed project area (Wetlands A – RRR) and are located within the floodplains of the onsite streams (Figure 3 Sheets 1 - 3). The project drains to Buckwater Creek (NCDWR Index No. 27-2-12 which is classified as Class WS-IV, Nutrient Sensitive Waters (NSW) waters. On-site stream channels are located within NCDWR Subbasin 03-04-01 of the Cape Fear River Basin (HU# 03020201). Approximate linear footage and acreage of on-site jurisdictional waters are summarized in Table 1.

Table 1. Summary of On-Site Jurisdictional Waters

Jurisdictional Feature	Classification	Length (LF)	Acreage	Watershed (ac)	NCDWQ Stream Scores	USACE Stream Scores
Buckwater Creek	Perennial RPW	5,674	-	2,316	42	50
T1	Perennial RPW	1,073	-	1,205	37.5	43
T2	Perennial RPW	548	-	204	42	43
T3	Perennial RPW	2,254	-	129	37	37
T4	Perennial RPW	527		75	40.5	44
T4	Intermittent RPW	554	-	75	-	44
T4A	Intermittent RPW	556	-	25	22.25	48
T4B	Intermittent RPW	564	-	35	25.5	46
T5	Perennial RPW	1,291	-	115	32.5	29
T6	Perennial RPW	1,951	-	28	31	60
T6A	Perennial RPW	296	-	30	33.5	56
T6B	Intermittent RPW	103	-	8	27	51
T7	Perennial RPW	1,008	-	28	30	36
T7A	Intermittent RPW	233	-	3	23.5	41
T8	Perennial RPW	620	-	19	30.5	29
T9	Perennial RPW	72	-	41	31.5	58
Wetland A	Seep	-	0.063	-	-	-
Wetland B	Seep	-	0.019	-	-	-
Wetland C	Seep	-	0.009	-	-	-
Wetland D	Seep	-	0.595	-	-	-
Wetland E	Seep	-	0.058	-	-	-
Wetland F	Seep	-	0.043	-	-	-
Wetland G	Seep	-	0.029	-	-	-
Wetland H	Seep	-	0.029	-	-	-
Wetland I	Seep	-	0.022	-	-	-
Wetland J	Seep	-	0.058	-	-	-
Wetland K	Seep	-	0.102	-	-	-
Wetland L	Seep	-	0.062	-	-	-
Wetland M	Seep	-	0.024	-	-	-
Wetland N	Bottomland Hardwood Forest	-	0.019	-	-	-
Wetland O	Bottomland Hardwood Forest	-	0.004	-	-	-
Wetland P	Bottomland Hardwood Forest	-	0.015	-	-	-
Wetland Q	Bottomland Hardwood Forest	-	0.013	-	-	-
Wetland R	Bottomland Hardwood Forest	-	0.035	-	-	-
Wetland S	Bottomland Hardwood Forest	-	0.010	-	-	-
Wetland T	Bottomland Hardwood Forest	-	0.025	-	-	-
Wetland U	Bottomland Hardwood Forest	-	0.010	-	-	-

Jurisdictional Feature	Classification	Length (LF)	Acreage	Watershed (ac)	NCDWQ Stream Scores	USACE Stream Scores
Wetland V	Bottomland Hardwood Forest	-	0.019	-	-	-
Wetland W	Seep	-	0.309	-	-	-
Wetland X	Seep	-	0.070	-	-	-
Wetland Y	Seep	-	0.004	-	-	-
Wetland Z	Seep	-	0.025	-	-	-
Wetland AA	Seep	-	0.307	-	-	-
Wetland BB	Seep	-	0.021	-	-	-
Wetland CC	Seep	-	0.017	-	-	-
Wetland DD	Seep	-	0.182	-	-	-
Wetland EE	Seep	-	0.547	-	-	-
Wetland FF	Seep	-	0.185	-	-	-
Wetland GG	Seep	-	0.067	-	-	-
Wetland HH	Seep	-	0.010	-	-	-
Wetland II	Seep	-	0.003	-	-	-
Wetland JJ	Seep	-	0.015	-	-	-
Wetland KK	Seep	-	0.038	-	-	-
Wetland LL	Seep	-	0.012	-	-	-
Wetland MM	Seep	-	0.154	-	-	-
Wetland NN	Seep	-	0.277	-	-	-
Wetland OO	Seep	-	0.233	-	-	-
Wetland PP	Seep	-	1.064	-	-	-
Wetland QQ	Seep	-	0.380	-	-	-
Wetland RR	Seep	-	0.130	-	-	-
Wetland SS	Seep	-	0.006	-	-	-
Wetland TT	Bottomland Hardwood Forest	-	0.487	-	-	-
Wetland UU	Seep	-	0.142	-	-	-
Wetland VV	Seep	-	0.040	-	-	-
Wetland WW	Seep	-	0.026	-	-	-
Wetland XX	Seep	-	0.052	-	-	-
Wetland YY	Seep	-	0.010	-	-	-
Wetland ZZ	Seep	-	0.034	-	-	-
Wetland AAA	Seep	-	0.009	-	-	-
Wetland BBB	Seep	-	0.028	-	-	-
Wetland CCC	Seep	-	0.005	-	-	-
Wetland DDD	Seep	-	0.028	-	-	-
Wetland EEE	Seep	-	0.011	-	-	-
Wetland FFF	Seep	-	0.016	-	-	-
Wetland GGG	Seep	-	0.003	-	-	-
Wetland HHH	Seep	-	0.005	-	-	-
Wetland III	Seep	-	0.038	-	-	-
Wetland JJJ	Seep	-	0.019	-	-	-
Wetland KKK	Seep	-	0.015	-	-	-
Wetland LLL	Seep	-	0.003	-	-	-
Wetland MMM	Seep	-	0.009	-	-	-

Jurisdictional Feature	Classification	Length (LF)	Acreage	Watershed (ac)	NCDWQ Stream Scores	USACE Stream Scores
Wetland NNN	Seep	-	0.003	-	-	-
Wetland OOO	Seep	-	0.020	-	-	-
Wetland PPP	Seep	-	0.007	-	-	-
Wetland QQQ	Seep	-	0.007	-	-	-
Wetland RRR	Seep	-	0.314	-	-	-
Pond 1	-	-	0.778	-	-	-
Pond 2	-	-	0.396	-	-	-
Pond 3	-	-	0.180	-	-	-

Perennial Streams

There are 11 perennial relatively permanent waters (RPW) located within the project easement area including Buckwater Creek, T1, T2, T3, T4 (downstream), T5, T6, T6A, T7, T8, and T9 (Figure 3 Sheets 1 - 3). Throughout the project area, these perennial channels have varying degrees of impacts associated with existing cattle operations and past land use practices. As a result, these reaches have varying degrees of degraded channel beds and banks as well as riparian communities. On-site perennial channels exhibited strong continuity of channel bed and bank, strong particle size substrate distribution, and moderately to strongly defined riffle-pool sequences. Biological sampling within these reaches resulted in a weak to moderate presence of benthic macroinvertebrates. Scores on the USACE Stream Quality Assessment Form ranged from 29 to 60 out of a possible 100 points. The scores on the NCDWR Stream Classification Form ranged from 30 to 42 out of 61.5 possible points, indicating perennial status (SCP1, SCP2, SCP3, SCP 4, SCP5, SCP8, SCP9, SCP10, SCP12, SCP14 and SCP15).

Intermittent Streams

There are five intermittent RPW channels located within the project easement area including T4 (upstream), T4A, T4B, T6B, and T7A (Figure 3 Sheets 1 - 3). Throughout the project area, the majority of these channels have been significantly impacted by cattle. As a result, degraded channel beds and banks as well as riparian communities are persistent along these reaches. These reaches are primarily small headwater systems stemming from groundwater seeps. The channels exhibited absent to moderate baseflow conditions and weakly to moderately defined riffle-pool sequences. Scores on the USACE Stream Quality Assessment Form ranged from 41 to 51 out of a possible 100 points. The scores on the NCDWR Stream Classification Form ranged from 22.25 to 27 out of 61.5 possible points, indicating intermittent status (SCP5, SCP 6, SCP7, SCP 11 and SCP13).

Wetlands

There are 70 jurisdictional wetlands located within the project area (Figure 3 Sheets 1 - 3). These wetland features were classified as seeps or bottomland hardwood forest using the North Carolina Wetland Assessment Method (NCWAM) classification key and the evaluator's best professional judgment. The wetlands occur in the side slopes and floodplains that drain to the on-site stream channels. The majority of these features exhibited a high water table, pockets of shallow inundation, saturation within the upper 12 inches of the soil profile, and a low chroma matrix. Common hydrophytic vegetation includes sugarberry (*Celtis laevigata*), panicgrass (*Panicum dichotomiflorum*), sycamore (*Platanus occidentalis*), pale persicaria (*Persicaria lapathifolia*), and common rush (*Juncus effusus*). The majority of these areas experience significant impacts from livestock. Wetland Determination Data Forms representative of onsite wetlands and the associated upland points are enclosed.

Table 1 shows the acreage of on-site jurisdictional wetland areas.

Soils

Soil types within the riparian corridors include Appling sandy loam 2 to 6 percent slopes (ApB), Appling sandy loam 6 to 10 percent slopes (ApC), Chewacla loam (Ch), Helena sandy loam (HeB), Herndon silt loam (HrB), Herndon silt loam (HrC), and Tatum silt loam (TaD). Appling sandy loam soils are on broad nearly level to gently sloping ridges and on sloping to moderately steep side slopes between intermittent and permanent streams in the southern Piedmont. These soils are well drained with medium to rapid runoff. Chewacla loam soils are found on the floodplains and are poorly drained and frequently flooded. Helena sandy loam soils are typically found at the toe of the slope, summits, and heads of drains. These soils are moderately well drained with moderate to high runoff. Herndon silt loam soils are typically well drained with low runoff. Herndon silt loam soils are on gently sloping to moderately steep piedmont uplands. These soils are well drained with medium runoff. Tatum silt loam soils are typically associated with ridges and are well drained with medium runoff and no flooding. On-site soils are mapped in Figure 4.

Please do not hesitate to contact me at 843-277-6221 or at wtaylor@wildlandseng.com should you have any questions regarding this request for preliminary jurisdictional verification.

Sincerely,

Win Taylor
Senior Environmental Scientist

ATTACHMENT

PRELIMINARY JURISDICTIONAL DETERMINATION FORM

<u>BACKGROUND INFORMATION</u>

A. REPORT COMPLETION DATE FOR PRELIMINARY JURISDICTIONAL DETERMINATION (JD): August 16, 2016

B. NAME AND ADDRESS OF PERSON REQUESTING PRELIMINARY JD:
Win Taylor
497 Bramson Court, Suite 104
Mt. Pleasant, SC 29464

C. DISTRICT OFFICE, FILE NAME, AND NUMBER: Raleigh Regulatory Field Office

D. PROJECT LOCATION(S) AND BACKGROUND INFORMATION:
The Buckwater Mitigation Site is located off of Schley Road northeast of the Town of Hillsborough in northeastern Orange County, NC. The Buckwater Mitigation Site has been accepted as a full delivery stream mitigation project for the North Carolina Department of Environment and Natural Resources Division of Mitigation Services. To date, a draft mitigation plan is being developed and Wildlands is currently in the process of finalizing easement boundaries and landowner coordination. The project will involve the restoration and enhancement of approximately 16,180 linear feet of stream.

(USE THE ATTACHED TABLE TO DOCUMENT MULTIPLE WATERBODIES AT DIFFERENT SITES)

State: NC County/parish/borough: Orange City: Hillsborough

Center coordinates of site (lat/long in degree decimal format):
Lat. 36.107619, Long. 79.026497
Universal Transverse Mercator:
Name of nearest waterbody: Buckwater Creek

Identify (estimate) amount of waters in the review area:

Non-wetland waters: 17,298 linear feet: 3 - 15 width (ft) and/or acres.
Cowardin Class: Unconsolidated Bottom - Streambed
Stream Flow: Perennial & Intermittent
Wetlands: 6.64 acres.
Cowardin Class: Palustrine Emergent / Scrub Shrub / Forested Wetland

Name of any water bodies on the site that have been identified as Section 10 waters:
Tidal: N/A
Non-Tidal: N/A

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

☐ Office (Desk) Determination. Date:

☐ Field Determination. Date(s):

1. The Corps of Engineers believes that there may be jurisdictional waters of the United States on the subject site, and the permit applicant or other affected party who requested this preliminary JD is hereby advised of his or her option to request and obtain an approved jurisdictional determination (JD) for that site. Nevertheless, the permit applicant or other person who requested this preliminary JD has declined to exercise the option to obtain an approved JD in this instance and at this time.

2. In any circumstance where a permit applicant obtains an individual permit, or a Nationwide General Permit (NWP) or other general permit verification requiring "pre-construction notification" (PCN), or requests verification for a non-reporting NWP or other general permit, and the permit applicant has not requested an approved JD for the activity, the permit applicant is hereby made aware of the following: (1) the permit applicant has elected to seek a permit authorization based on a preliminary JD, which does not make an official determination of jurisdictional waters; (2) that the applicant has the option to request an approved JD before accepting the terms and conditions of the permit authorization, and that basing a permit authorization on an approved JD could possibly result in less compensatory mitigation being required or different special conditions; (3) that the applicant has the right to request an individual permit rather than accepting the terms and conditions of the NWP or other general permit authorization; (4) that the applicant can accept a permit authorization and thereby agree to comply with all the terms and conditions of that permit, including whatever mitigation requirements the Corps has determined to be necessary; (5) that undertaking any activity in reliance upon the subject permit authorization without requesting an approved JD constitutes the applicant's acceptance of the use of the preliminary JD, but that either form of JD will be processed as soon as is practicable; (6) accepting a permit authorization (e.g., signing a proffered individual permit) or undertaking any activity in reliance on any form of Corps permit authorization based on a preliminary JD constitutes agreement that all wetlands and other water bodies on the site affected in any way by that activity are jurisdictional waters of the United States, and precludes any challenge to such jurisdiction in any administrative or judicial compliance or enforcement action, or in any administrative appeal or in any Federal court; and (7) whether the applicant elects to use either an approved JD or a preliminary JD, that JD will be processed as soon as is practicable. Further, an approved JD, a proffered individual permit (and all terms and conditions contained therein), or individual permit denial can be administratively appealed pursuant to 33 C.F.R. Part 331, and that in any administrative appeal, jurisdictional issues can be raised (see 33 C.F.R. 331.5(a)(2)). If, during that administrative appeal, it becomes necessary to make an official determination whether CWA jurisdiction exists over a site, or

to provide an official delineation of jurisdictional waters on the site, the Corps will provide an approved JD to accomplish that result, as soon as is practicable. This preliminary JD finds that there *"may be"* waters of the United States on the subject project site, and identifies all aquatic features on the site that could be affected by the proposed activity, based on the following information:

**SUPPORTING DATA. Data reviewed for preliminary JD (check all that apply - **checked items should be included in case file and, where checked and requested, appropriately reference sources below):

☒ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: Wildlands Engineering.

☒ Data sheets prepared/submitted by or on behalf of the applicant/consultant. Wildlands Engineering

- ☐ Office concurs with data sheets/delineation report.
- ☐ Office does not concur with data sheets/delineation report.

☐ Data sheets prepared by the Corps: .

☐ Corps navigable waters' study: .

☒ U.S. Geological Survey Hydrologic Atlas: .

- ☐ USGS NHD data.
- ☐ USGS 8 and 12 digit HUC maps.

☒ U.S. Geological Survey map(s). Cite scale & quad name: 7.5 Minute Hillsborough and Caldwell Quadrangles.

☒ USDA Natural Resources Conservation Service Soil Survey. Citation: Orange County Soils.

☐ National wetlands inventory map(s). Cite name: .

☐ State/Local wetland inventory map(s): .

☐ FEMA/FIRM maps: .

☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)

☒ Photographs: ☒ Aerial (Name & Date): 2014.

or ☒ Other (Name & Date): .

☐ Previous determination(s). File no. and date of response letter: .

☐ Other information (please specify): .

IMPORTANT NOTE: The information recorded on this form has not necessarily been verified by the Corps and should not be relied upon for later jurisdictional determinations.

______________________	8/16/2016
Signature and date of Regulatory Project Manager (REQUIRED)	Signature and date of person requesting preliminary JD (REQUIRED, unless obtaining the signature is impracticable)

Table 1. Summary of On-Site Jurisdictional Waters

Jurisdictional Feature	Latitude	Longitude	Cowardin Class	Estimated Amount of Aquatic Resource in Review Area	Class of Aquatic Resource
Buckwater Creek	36.107619	79.026497	Riverine-Unconsolidated Bottom	5,674	Perennial RPW
T1	36.107619	79.026497	Riverine-Unconsolidated Bottom	1,073	Perennial RPW
T2	36.107619	79.026497	Riverine-Unconsolidated Bottom	548	Perennial RPW
T3	36.104840	79.023228	Riverine-Unconsolidated Bottom	2,254	Perennial RPW
T4	36.105238	79.022583	Riverine-Unconsolidated Bottom	527	Perennial RPW
T4	36.104051	79.021308	Intermittent Riverine	554	Intermittent RPW
T4A	36.102983	79.021016	Intermittent Riverine	556	Intermittent RPW
T4B	36.103223	79.020275	Intermittent Riverine	564	Intermittent RPW
T5	36.106994	79.025261	Riverine-Unconsolidated Bottom	1,291	Perennial RPW
T6	36.107840	79.030495	Riverine-Unconsolidated Bottom	1,951	Perennial RPW
T6A	36.108264	79.028309	Riverine-Unconsolidated Bottom	296	Perennial RPW
T6B	36.108156	79.031213	Intermittent Riverine	103	Intermittent RPW
T7	36.106970	79.019547	Riverine-Unconsolidated Bottom	1,008	Perennial RPW
T7A	36.106940	79.019060	Intermittent Riverine	233	Intermittent RPW
T8	36.1045526	79.032183	Riverine-Unconsolidated Bottom	620	Perennial RPW
T9	36.103855	79.030895	Riverine-Unconsolidated Bottom	72	Perennial RPW

Jurisdictional Feature	Latitude	Longitude	Cowardin Class	Estimated Amount of Aquatic Resource in Review Area	Class of Aquatic Resource
Wetland A	36.103101	79.020186	Palustrine-Forested	0.063	Non-Section 10 – Wetland
Wetland B	36.103088	79.020031	Palustrine-Forested	0.019	Non-Section 10 – Wetland
Wetland C	36.103333	79.020459	Palustrine-Emergent	0.009	Non-Section 10 – Wetland
Wetland D	36.103330	79.020847	Palustrine-Emergent	0.595	Non-Section 10 – Wetland
Wetland E	36.104027	79.020989	Palustrine-Emergent	0.058	Non-Section 10 – Wetland
Wetland F	36.104454	79.021475	Palustrine-Emergent	0.043	Non-Section 10 – Wetland
Wetland G	36.103019	79.021054	Palustrine-Forested	0.029	Non-Section 10 – Wetland
Wetland H	36.102607	79.021132	Palustrine-Forested	0.029	Non-Section 10 – Wetland
Wetland I	36.102582	79.021065	Palustrine-Forested	0.022	Non-Section 10 – Wetland
Wetland J	36.102948	79.021028	Palustrine-Forested	0.058	Non-Section 10 – Wetland
Wetland K	36.105121	79.022486	Palustrine-Forested	0.102	Non-Section 10 – Wetland
Wetland L	36.105309	79.022812	Palustrine-Forested	0.062	Non-Section 10 – Wetland
Wetland M	36.105309	79.0222812	Palustrine-Forested	0.024	Non-Section 10 – Wetland
Wetland N	36.107932	79.019092	Palustrine-Emergent	0.019	Non-Section 10 – Wetland
Wetland O	36.106860	79.019587	Palustrine-Emergent	0.004	Non-Section 10 – Wetland
Wetland P	36.108305	79.018921	Palustrine-Emergent	0.015	Non-Section 10 – Wetland
Wetland Q	36.108070	79.019013	Palustrine-Emergent	0.013	Non-Section 10 – Wetland

Jurisdictional Feature	Latitude	Longitude	Cowardin Class	Estimated Amount of Aquatic Resource in Review Area	Class of Aquatic Resource
Wetland R	36.108064	79.019632	Palustrine-Emergent	0.035	Non-Section 10 – Wetland
Wetland S	36.108072	79.019928	Palustrine-Emergent	0.010	Non-Section 10 – Wetland
Wetland T	36.107945	79.020362	Palustrine-Emergent	0.025	Non-Section 10 – Wetland
Wetland U	36.107781	79.020744	Palustrine-Emergent	0.010	Non-Section 10 – Wetland
Wetland V	36.107592	79.021248	Palustrine-Emergent	0.019	Non-Section 10 – Wetland
Wetland W	36.108422	79.022431	Palustrine-Forested	0.309	Non-Section 10 – Wetland
Wetland X	36.106605	79.019626	Palustrine-Forested	0.070	Non-Section 10 – Wetland
Wetland Y	36.106124	79.019593	Palustrine-Forested	0.004	Non-Section 10 – Wetland
Wetland Z	36.107055	79.019157	Palustrine-Forested	0.025	Non-Section 10 – Wetland
Wetland AA	36.107903	79.029896	Palustrine-Emergent	0.307	Non-Section 10 – Wetland
Wetland BB	36.108248	79.031452	Palustrine-Scrub/Shrub	0.021	Non-Section 10 – Wetland
Wetland CC	36.108145	79.031848	Palustrine-Scrub/Shrub	0.017	Non-Section 10 – Wetland
Wetland DD	36.108048	79.031603	Palustrine-Emergent	0.182	Non-Section 10 – Wetland
Wetland EE	36.107765	79.030428	Palustrine-Forested	0.547	Non-Section 10 – Wetland
Wetland FF	36.108224	79.026632	Palustrine-Emergent	0.185	Non-Section 10 – Wetland
Wetland GG	36.108457	79.027608	Palustrine-Scrub/Shrub	0.067	Non-Section 10 – Wetland
Wetland HH	36.108157	79.028102	Palustrine-Scrub/Shrub	0.010	Non-Section 10 – Wetland

Jurisdictional Feature	Latitude	Longitude	Cowardin Class	Estimated Amount of Aquatic Resource in Review Area	Class of Aquatic Resource
Wetland II	36.108184	79.028267	Palustrine-Forested	0.003	Non-Section 10 – Wetland
Wetland JJ	36.108115	79.028117	Palustrine-Scrub/Shrub	0.015	Non-Section 10 – Wetland
Wetland KK	36.107995	79.029600	Palustrine-Forested	0.038	Non-Section 10 – Wetland
Wetland LL	36.104318	79.029522	Palustrine-Forested	0.012	Non-Section 10 – Wetland
Wetland MM	36.103606	79.031549	Palustrine-Forested	0.154	Non-Section 10 – Wetland
Wetland NN	36.103271	79.032123	Palustrine-Forested	0.277	Non-Section 10 – Wetland
Wetland OO	36.106663	79.025502	Palustrine-Emergent	0.233	Non-Section 10 – Wetland
Wetland PP	36.106022	79.026352	Palustrine-Emergent	1.064	Non-Section 10 – Wetland
Wetland QQ	36.105227	79.027793	Palustrine-Emergent	0.380	Non-Section 10 – Wetland
Wetland RR	36.104606	79.029948	Palustrine-Emergent	0.130	Non-Section 10 – Wetland
Wetland SS	36.104455	79.030352	Palustrine-Emergent	0.006	Non-Section 10 – Wetland
Wetland TT	36.109674	79.022630	Palustrine-Forested	0.487	Non-Section 10 – Wetland
Wetland UU	36.104672	79.023418	Palustrine-Scrub/Shrub	0.142	Non-Section 10 – Wetland
Wetland VV	36.104372	79.023255	Palustrine-Emergent	0.040	Non-Section 10 – Wetland
Wetland WW	36.103977	79.023131	Palustrine-Emergent	0.026	Non-Section 10 – Wetland
Wetland XX	36.103781	79.023251	Palustrine-Emergent	0.052	Non-Section 10 – Wetland
Wetland YY	36.103808	79.023115	Palustrine-Emergent	0.010	Non-Section 10 – Wetland

Jurisdictional Feature	Latitude	Longitude	Cowardin Class	Estimated Amount of Aquatic Resource in Review Area	Class of Aquatic Resource
Wetland ZZ	36.103442	79.023255	Palustrine-Emergent	0.034	Non-Section 10 – Wetland
Wetland AAA	36.103509	79.023207	Palustrine-Emergent	0.009	Non-Section 10 – Wetland
Wetland BBB	36.103133	79.023251	Palustrine-Emergent	0.028	Non-Section 10 – Wetland
Wetland CCC	36.103193	79.023266	Palustrine-Emergent	0.005	Non-Section 10 – Wetland
Wetland DDD	36.102643	79.023462	Palustrine-Emergent	0.028	Non-Section 10 – Wetland
Wetland EEE	36.102603	79.023704	Palustrine-Emergent	0.011	Non-Section 10 – Wetland
Wetland FFF	36.102324	79.023887	Palustrine-Emergent	0.016	Non-Section 10 – Wetland
Wetland GGG	36.102440	79.023814	Palustrine-Emergent	0.003	Non-Section 10 – Wetland
Wetland HHH	36.102332	79.023940	Palustrine-Emergent	0.005	Non-Section 10 – Wetland
Wetland III	36.101990	79.024096	Palustrine-Emergent	0.038	Non-Section 10 – Wetland
Wetland JJJ	36.101892	79.024223	Palustrine-Emergent	0.019	Non-Section 10 – Wetland
Wetland KKK	36.101600	79.024411	Palustrine-Emergent	0.015	Non-Section 10 – Wetland
Wetland LLL	36.101456	79.02440	Palustrine-Emergent	0.003	Non-Section 10 – Wetland
Wetland MMM	36.101302	79.024531	Palustrine-Emergent	0.009	Non-Section 10 – Wetland
Wetland NNN	36.100902	79.024825	Palustrine-Emergent	0.003	Non-Section 10 – Wetland
Wetland OOO	36.100819	79.024964	Palustrine-Emergent	0.020	Non-Section 10 – Wetland
Wetland PPP	36.100724	79.024970	Palustrine-Emergent	0.007	Non-Section 10 – Wetland

Jurisdictional Feature	Latitude	Longitude	Cowardin Class	Estimated Amount of Aquatic Resource in Review Area	Class of Aquatic Resource
Wetland QQQ	36.100684	79025023	Palustrine-Emergent	0.007	Non-Section 10 – Wetland
Wetland RRR	36.106446	79.027707	Palustrine-Emergent	0.314	Non-Section 10 – Wetland
Pond 1	36.107061	79.024671	Lacustrine Limnetic	0.778	Non-Section 10 – Wetland
Pond 2	36.106461	79.025820	Lacustrine Limnetic	0.396	Non-Section 10 – Wetland
Pond 3	36.102295	79.020926	Lacustrine Limnetic	0.180	Non-Section 10 – Wetland

Appendix 3

DWR Stream Identification Forms

1.0 DWR Stream Classification

The results of the DWR Stream Classification Forms are listed in the table below. DWR forms can be found in this appendix and in the digital submission to DMS. DWR forms were completed by Wildlands for the Buckwater stream reaches.

Table 1: DWR Form Summary – *Buckwater Mitigation Site*

Stream	Geomorphology Score	Hydrology Score	Biology Score	Total Score
Buckwater	21.5	10	10.5	42
T1	17.5	10	10	37.5
T2	23	9.5	9.5	42
T3	17	10	10	37
T4	20.5	10	10	40.5
T4 (I/P divide)	9	5.5	6	20.5
T4A	12.5	6.5	3.25	22.25
T4B	12.5	6	7	25.5
T5	15.5	8.5	8.5	32.5
T6	13.5	9.5	8	31
T6A	13.5	9.5	8.5	31.5
T6B	11.5	8.5	7	27
T7	12.5	9.5	8	30
T7A	11.5	5.5	6.5	23.5
T8	16	7.5	7	30.5
T9	13.5	9	10	32.5

NC DWQ Stream Identification Form Version 4.11

DP1

Date: 9/3/2011	Project/Site: Buckwater	Latitude:
Evaluator: KB	County: Orange	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 42	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* Buckwater

A. Geomorphology (Subtotal = 21.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

B. Hydrology (Subtotal = 10)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 10.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch:

DP14

NC DWQ Stream Identification Form Version 4.11

Date: 9/3/2015	**Project/Site:** Budwater	**Latitude:**
Evaluator: KB	**County:** Orange	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 37.5	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* T1

A. Geomorphology (Subtotal = 17.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

B. Hydrology (Subtotal = 10)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 10)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 10/1/2015	Project/Site: Buckwater	Latitude: 36.105691
Evaluator: KB	County: Orange	Longitude: 79.022904
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 42	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* T2

A. Geomorphology (Subtotal = 23)

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

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

B. Hydrology (Subtotal = 9.5)

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

C. Biology (Subtotal = 9.5)

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

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

Notes:

Sketch: Scored downstream of confluence of two perennial tributaries

NC DWQ Stream Identification Form Version 4.11

DP6

Date: 9/3/2015	Project/Site: Buckwater	Latitude: 36.10661 N
Evaluator: KB	County: Orange	Longitude: 79.02507 W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 37	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	Other *e.g. Quad Name:* T3

A. Geomorphology (Subtotal = 20)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

Spring fed

B. Hydrology (Subtotal = 10)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 10)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch: Strong flow through large cobble. Caddisfly, mayfly (abundant)

NC DWQ Stream Identification Form Version 4.11

DP13

Date: 9/3/2015	Project/Site: Buckwater	Latitude: 36.10977 N
Evaluator: KB	County: Orange	Longitude: 79.02179 W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 40.5	Stream Determination (circle one) Ephemeral Intermittent Perennial	Other *e.g. Quad Name:* T4 I/P break

A. Geomorphology (Subtotal = 20.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

B. Hydrology (Subtotal = 10)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 10)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch: Starts at headcut in pasture. Upstream areas are heavily trampled by cattle and sediment has backed up at headcut

T4 I/P break just downstream from road crossing

NC DWQ Stream Identification Form Version 4.11

Date: 10/11/2016	**Project/Site:** Buckwater	**Latitude:** 36.104483
Evaluator: WT	**County:** Orange	**Longitude:** -79.021484
Total Points: Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 20.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** e.g. Quad Name:

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

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

B. Hydrology (Subtotal = 5.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

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

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

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 9/3/2015	Project/Site: Buckwater	Latitude: 36.10175
Evaluator: KB	County: Orange	Longitude: 79.02034
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 22.25	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* TYA

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

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

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

C. Biology (Subtotal = 3.25)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch: Stream becomes intermittent below farm pond.

Scored 16.75 (Ephemeral) above pond.

DP 12

NC DWQ Stream Identification Form Version 4.11

Date: 9/3/2011	Project/Site: Backwater A	Latitude: 36.10292 N
Evaluator: KB	County: Orange	Longitude: 79.01971 W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 25.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* T4B

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

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

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

C. Biology (Subtotal = 7)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 10/1/2015	Project/Site: Buckwater	Latitude: 36.107300
Evaluator: KB	County: Orange	Longitude: 79.025273
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 32.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* TS

A. Geomorphology (Subtotal = 15.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

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

C. Biology (Subtotal = 8.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch: Scoured downstream of St. Mary's Rd in maintained field.

DP4

NC DWQ Stream Identification Form Version 4.11

Date: 9/3/2015	Project/Site: Buckwater	Latitude: 36.10820 N
Evaluator: KB	County: Orange	Longitude: 79.03328 W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 31	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* T6

A. Geomorphology (Subtotal = 13.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

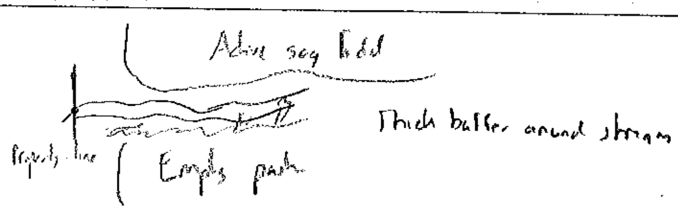
B. Hydrology (Subtotal = 9.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 8)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes: Caddisfly, crawfish (2)

Sketch:



NC DWQ Stream Identification Form Version 4.11

DPS

Date: 9/3/2015	Project/Site: Buckwater	Latitude:
Evaluator: KB	County: Orange	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 33.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* T6A

A. Geomorphology (Subtotal = 13.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

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

C. Biology (Subtotal = 10.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch: Below pond. Did not examine culvert structure

NC DWQ Stream Identification Form Version 4.11

Date: 10/1/2011	Project/Site: Buckwater	Latitude: 36.108134
Evaluator: KB	County: Orange	Longitude: 79.031232
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 27	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* TCB

A. Geomorphology (Subtotal = 11.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

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

C. Biology (Subtotal = 7)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch: Stream originates at seep in maintained field. when stream meets woodline bed and bank becomes prominent and overall geomorphology increases

DP9

NC DWQ Stream Identification Form Version 4.11

Date: 9/3/2015	Project/Site: Buckwater	Latitude: 36.10674 N
Evaluator: KB	County: Orange	Longitude: 79.01857 W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 30	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* T7

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

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

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

C. Biology (Subtotal = 8)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch: 2 seeps at top with large headcut. Stream is heavily stressed by cattle presence. Sediment load is extremely high.

NC DWQ Stream Identification Form Version 4.11

DP10 - UT4A Top

Date: 9/3/2011	Project/Site: Buckwater	Latitude: 36.10664
Evaluator: KB	County: Orange	Longitude: 79.01906
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 23.5	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* T7A

A. Geomorphology (Subtotal = 11.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

B. Hydrology (Subtotal = 5.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 6.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

DB · UTS trp

Date: 9/3/15	Project/Site: Buckwater	Latitude:
Evaluator: KB	County: Orange	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 30.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* T8

A. Geomorphology (Subtotal = 16)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

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

C. Biology (Subtotal = 7)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes: Water beetles, caddisflies

Sketch:

NC DWQ Stream Identification Form Version 4.11

DPZ

Date: 9/3/2015	**Project/Site:** Buckwater	**Latitude:**
Evaluator: KB	**County:** Orange	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 31.5	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** T9 *e.g. Quad Name:*

A. Geomorphology (Subtotal = 13.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

B. Hydrology (Subtotal = 9)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 10)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch: Water originates at upstream spring fed pond, 16" culvert piped from pond to stream bed

NC DWQ Stream Identification Form Version 4.11 T4A

Date: 10/11/2016	**Project/Site:** Buckwater	**Latitude:** 36.104483
Evaluator: WT	**County:** Orange	**Longitude:** -79.021484
Total Points: Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 20.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** e.g. Quad Name:

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

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

B. Hydrology (Subtotal = 5.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

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

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

Notes:

Sketch:

PAT MCCRORY
Governor

DONALD R. VAN DER VAART
Secretary

S. JAY ZIMMERMAN
Director

June 13, 2016

John Hutton
Wildlands Engineering, Inc.
312 West Millbrook Rd, Suite 225
Raleigh, NC 27609
(via electronic mail)

DWR Project # 2016-0406

Re: Site Viability for Buffer Mitigation & Nutrient Offset – Buckwater Mitigation Site
Off St. Mary's Rd on Walnut Hill Dr, Hillsborough, NC
Orange County

Dear Mr. Hutton,

On May 24, 2016, Katie Merritt, with the Division of Water Resources (DWR), assisted staff with Wildlands Engineering Inc. (WEI) at the proposed Buckwater Mitigation Site (Site) in Hillsborough, NC. The Site is located in the Upper Falls Watershed of the Neuse River Basin within the 8-digit Hydrologic Unit Code 03020201. The Site is being proposed as part of a full-delivery stream restoration project for the Division of Mitigation Services (RFP #16-006477). The Interagency Review Team (IRT) has visited this site. At your request, Ms. Merritt, performed a site assessment of features onsite to determine suitability for buffer and nutrient offset mitigation. Features are more accurately shown in the attached maps signed by Ms. Merritt on June 6, 2016. If approved, mitigating this site could provide stream mitigation credits, riparian buffer credits and/or nutrient offset credits.

Ms. Merritt's evaluation of the features from Top of Bank (TOB) out to 200' for buffer and nutrient offset mitigation pursuant to 15A NCAC 02B .0295 (effective November 1, 2015) and Rule 15A NCAC 02B .0240 is provided in the table below:

Feature	Classification	[1]Subject to Buffer Rule	Adjacent Land uses	Buffer Credit Viable	Nutrient Offset Viable at 2,273 lbs/acre	Mitigation Type
T1	Stream	Yes	Mostly closed canopy of native hardwoods; Some areas of open cropland	Yes	Yes (non-forested cropland areas only)	Forested Areas = Preservation per 15A NCAC 02B .0295 (o)(5) Non-forested cropland = Restoration
T2	Stream	Yes	Mostly closed canopy of native hardwoods w/ cattle grazing; Some areas of open pasture	Yes	Yes (non-forested pasture areas only)	Forested Areas = Enhancement per 15A NCAC 02B .0295 (o)(6) Open Pasture = Restoration

Feature	Classification	[1]Subject to Buffer Rule	Adjacent Land uses	Buffer Credit Viable	Nutrient Offset Viable at 2,273 lbs/acre	Mitigation Type
T3	Stream	Yes	Cattle/pasture	Yes	Yes	Restoration
T4	Stream	Yes	Left Bank = Farm Rd and narrow canopy; Right Bank = Mostly closed canopy of native hardwoods w/ cattle grazing and some areas of open pasture	Yes	Yes (non-forested pasture areas along Right bank only)	Forested Areas = Enhancement per 15A NCAC 02B .0295 (o)(6); no credits for buffer widths less than 20' Open Pasture = Restoration Notes: Farm Rd along left bank is proposed to stay
T4A	Streams	Yes	Closed canopy of native hardwoods w/ cattle grazing; open pasture around pond	Yes	Yes (open pasture around pond (pond will be breached)	Forested Areas = Enhancement per 15A NCAC 02B .0295 (o)(6) Open Pasture = Restoration
T4B	Stream	Yes	Closed canopy of native hardwoods w/ cattle grazing	Yes	No	Enhancement per 15A NCAC 02B .0295 (o)(6)
T5	Stream	Yes	Hay crop for cultivation; small area of Closed canopy hardwoods	Yes	Yes (non-forested areas only)	Forested Areas = Preservation per 15A NCAC 02B .0295 (o)(5) Cropland fields = Restoration *Note: Ditches & swales need to be eliminated or removed from credit*
T6, T6A	Stream	Yes	Closed canopy of native hardwoods w/ adjacent fallow crop fields	Yes	Yes (non-forested areas only)	Forested Areas = Preservation per 15A NCAC 02B .0295 (o)(5) Cropland fields = Restoration
T6 B	Stream	No	Closed canopy of native hardwoods w/ adjacent fallow crop fields	Yes	Yes (non-forested areas only)	Forested Areas = Preservation per 15A NCAC 02B .0295 (o)(4) Cropland fields = Restoration
T7, T7A	Stream	Yes	Mostly closed canopy of native hardwoods w/ cattle grazing; Some areas of open pasture	Yes	Yes (non-forested areas only)	Forested Areas = Enhancement per 15A NCAC 02B .0295 (o)(6) Open Pasture = Restoration
T8	Stream	No	Narrow forested fringe w/ adjacent fallow crop field	Yes	Yes (non-forested areas only)	Forested Areas = Preservation per 15A NCAC 02B .0295 (o)(4) Cropland fields = Restoration
T9 (not assessed)						

Feature	Classification	[1]Subject to Buffer Rule	Land uses	Buffer Credit Viable	Nutrient Offset Viable at 2,273 lbs/acre	Mitigation Type
Buckwater Creek (see attached map)	Stream	Yes	Mostly closed canopy of native hardwoods w/ cattle grazing along some portions of left bank; Hay crop for cultivation in non-forested areas	Yes	Yes (non-forested areas only)	Forested Areas = Preservation per 15A NCAC 02B .0295 (o)(5) Hay fields & Pasture = Restoration Other Areas (see map) = Enhancement

[1]Subjectivity calls were determined using the 1:24,000 scale quadrangle topographic map prepared by USGS and the most recent printed version of the soil survey map prepared by the NRCS

Maps showing the project site and the features are provided and signed by Ms. Merritt on June 7, 2016. This letter should be provided in all future mitigation plans for this Site. In addition, all vegetative plantings, performance criteria and other mitigation requirements for riparian restoration, enhancement and preservation must follow the requirements in 15A NCAC 02B .0295 to be eligible for buffer and/or nutrient offset credits. In addition, Neuse Buffer mitigation credits generated from Preservation at this site are not able to be transferred into nutrient offset credits.

For any areas depicted as not being viable for nutrient offset credit above, one could propose a different measure, along with supporting calculations and sufficient detail to support estimates of load reduction for review by the DWR, to determine viability for nutrient offset according to 15A NCAC 02B .0240. Please contact Katie Merritt at (919)-807-6371 if you have any questions regarding this correspondence.

Sincerely,

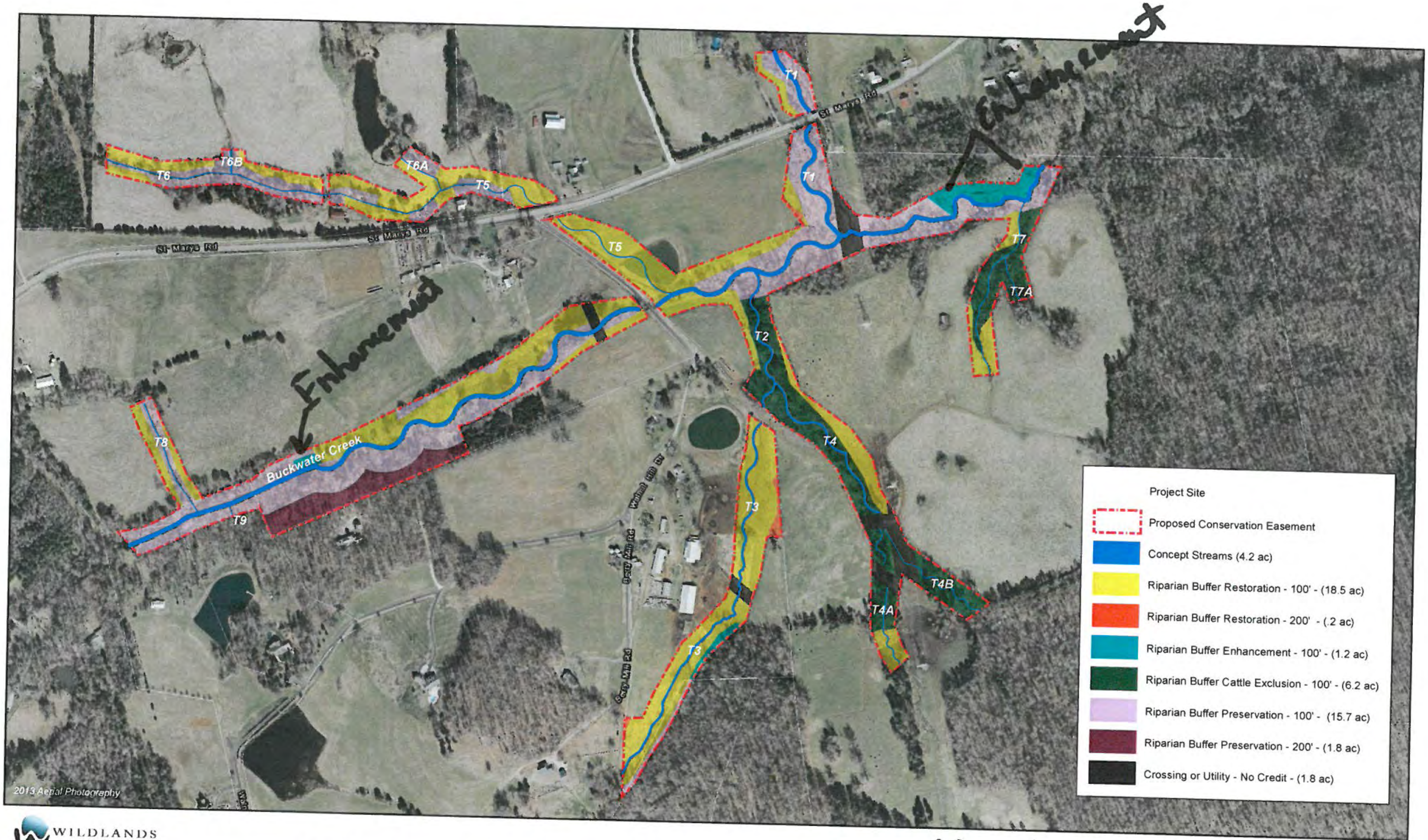
Jeff A. Burdith

for Karen Higgins, Supervisor
401 and Buffer Permitting Branch

KAH/*km*

Attachments: Site Aerial Concept Map, Orange County Soil Survey

cc: File Copy (Katie Merritt)
DMS – Jeff Schaffer (via electronic mail)

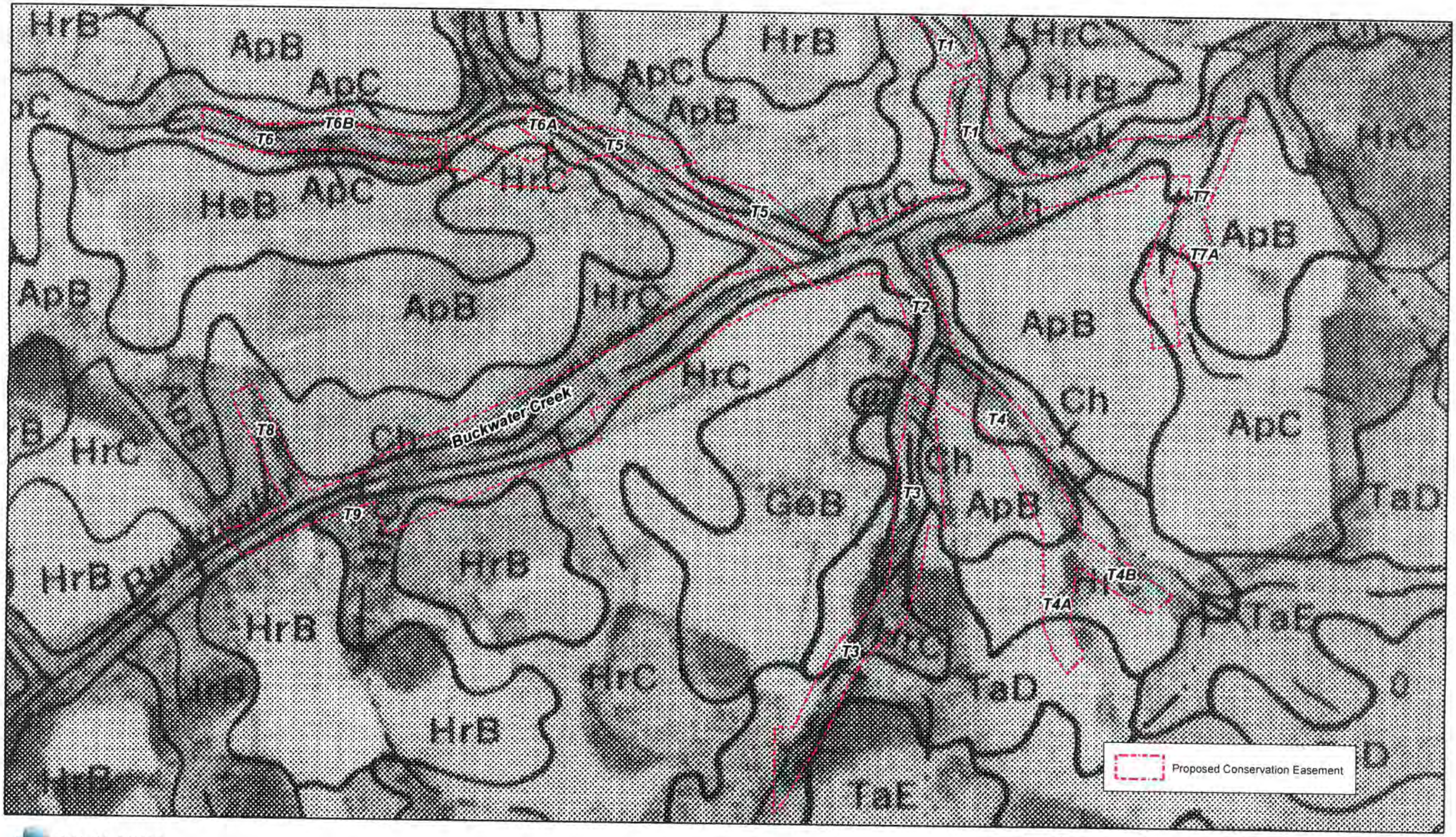


WILDLANDS ENGINEERING

DWR# 2016-0406
KYM 6/7/16

Figure 1 Riparian Buffer Concept Map
Buckwater Mitigation Site
Neuse River Basin 03020201
Orange County, NC

aeckardt 5/25/2016



WILDLANDS ENGINEERING

Figure 2 USDA Soil Survey of Orange County (1977)
Buckwater Mitigation Site
Neuse River Basin 03020201
Orange County, NC

aeckardt 5/25/2016

DWR# 2016-0406

Kym 6/7/16

Appendix 4

USACE Assessment Forms

Table 6: Wetland Summary Information – Buckwater Mitigation Site

Parameter	A	B	C	D	E	F	G
Size of Wetland (acres)	0.063	0.019	0.009	0.595	0.058	0.043	0.029
Wetland Type	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Herndon	Herndon	Herndon	Herndon	Appling	Appling	Herndon
Drainage Class	Well Drained	Well Drained	Well Drained	Well Drained	Well Drained	Well Drained	Well Drained
Soil Hydric Status	No	No	No	No	No	No	No
Source of Hydrology	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep
Approx. % Temp Impact	35%	50%	10%	5%	10%	50%	10%
Approx % Perm Impact	15%	25%	0%	0%	10%	50%	0%

Parameter	H	I	J	K	L	M	N
Size of Wetland (acres)	0.029	0.022	0.058	0.102	0.062	0.024	0.019
Wetland Type	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Tatum	Tatum	Tatum	Appling	Chewacla	Chewacla	Chewacla
Drainage Class	Well Drained	Well Drained	Well Drained	Well Drained	Poorly Drained	Poorly Drained	Poorly Drained
Soil Hydric Status	No	No	No	No	Yes	Yes	Yes
Source of Hydrology	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Groundwater Overbank Flooding
Approx. % Temp Impact	15%	20%	10%	40%	40%	75%	10%
Approx % Perm Impact	5%	5%	0%	20%	20%	15%	0%

Parameter	O	P	Q	R	S	T	U
Size of Wetland (acres)	0.004	0.015	0.013	0.035	0.01	0.025	0.01
Wetland Type	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Appling	Herndon	Chewacla	Chewacla	Chewacla	Herndon	Chewacla
Drainage Class	Well Drained	Well Drained	Poorly Drained	Poorly Drained	Poorly Drained	Well Drained	Poorly Drained
Soil Hydric Status	No	No	Yes	Yes	Yes	No	Yes
Source of Hydrology	Groundwater Overbank Flooding	Groundwater Overbank Flooding	Groundwater Overbank Flooding	Groundwater Overbank Flooding	Groundwater Overbank Flooding	Groundwater Overbank Flooding	Groundwater Overbank Flooding
Approx. % Temp Impact	85%	0%	0%	10%	10%	10%	10%
Approx % Perm Impact	15%	0%	0%	0%	0%	0%	0%
Parameter	**V**	**W**	**X**	**Y**	**Z**	**AA**	**BB**
Size of Wetland (acres)	0.019	0.309	0.07	0.004	0.025	0.307	0.021
Wetland Type	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Chewacla	Chewacla	Appling	Appling	Appling	Chewacla	Appling
Drainage Class	Poorly Drained	Poorly Drained	Well Drained	Well Drained	Well Drained	Poorly Drained	Well Drained
Soil Hydric Status	Yes	Yes	No	No	No	Yes	No
Source of Hydrology	Groundwater Overbank Flooding	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep
Approx. % Temp Impact	10%	45%	25%	10%	10%	10%	10%
Approx % Perm Impact	0%	25%	25%	0%	0%	0%	0%

Parameter	CC	DD	EE	FF	GG	HH	II
Size of Wetland (acres)	0.017	0.182	0.547	0.185	0.067	0.01	0.003
Wetland Type	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Chewacla	Chewacla	Appling	Appling	Appling	Chewacla	Chewacla
Drainage Class	Poorly Drained	Poorly Drained	Well Drained	Well Drained	Well Drained	Poorly Drained	Poorly Drained
Soil Hydric Status	Yes	Yes	No	No	No	Yes	Yes
Source of Hydrology	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep
Approx. % Temp Impact	10%	10%	10%	15%	10%	10%	10%
Approx % Perm Impact	0%	0%	0%	5%	0%	0%	0%

Parameter	JJ	KK	LL	MM	NN	OO	PP
Size of Wetland (acres)	0.015	0.038	0.012	0.154	0.154	0.233	0.015
Wetland Type	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Herndon	Chewacla	Chewacla	Herndon	Herndon	Chewacla	Chewacla
Drainage Class	Well Drained	Poorly Drained	Poorly Drained	Well Drained	Well Drained	Poorly Drained	Poorly Drained
Soil Hydric Status	No	Yes	Yes	No	No	Yes	Yes
Source of Hydrology	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep
Approx. % Temp Impact	10%	10%	0%	10%	0%	0%	25%
Approx % Perm Impact	0%	0%	0%	0%	0%	0%	15%

Parameter	QQ	RR	SS	TT	UU	VV	WW
Size of Wetland (acres)	0.38	0.13	0.006	0.487	0.142	0.04	0.026
Wetland Type	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Chewacla	Herndon	Herndon	Chewacla	Herndon	Herndon	Chewacla
Drainage Class	Poorly Drained	Well Drained	Well Drained	Poorly Drained	Well Drained	Well Drained	Poorly Drained
Soil Hydric Status	Yes	No	No	Yes	No	No	Yes
Source of Hydrology	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Groundwater Overbank Flooding	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep
Approx. % Temp Impact	40%	50%	100%	10%	0%	0%	100%
Approx % Perm Impact	30%	25%	0%	0%	0%	0%	0%

Parameter	XX	YY	ZZ	AAA	BBB	CCC	DDD
Size of Wetland (acres)	0.052	0.01	0.034	0.009	0.028	0.005	0.028
Wetland Type	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Chewacla	Chewacla	Chewacla	Chewacla	Tatum	Chewacla	Herndon
Drainage Class	Poorly Drained	Poorly Drained	Poorly Drained	Poorly Drained	Well Drained	Poorly Drained	Well Drained
Soil Hydric Status	Yes	Yes	Yes	Yes	No	Yes	No
Source of Hydrology	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep
Approx. % Temp Impact	60%	100%	10%	10%	0%	0%	0%
Approx % Perm Impact	20%	0%	0%	0%	0%	0%	0%

Parameter	**EEE**	**FFF**	**GGG**	**HHH**	**III**	**JJJ**	**KKK**
Size of Wetland (acres)	0.011	0.016	0.003	0.005	0.038	0.019	0.015
Wetland Type	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Herndon	Herndon	Herndon	Herndon	Tatum	Herndon	Tatum
Drainage Class	Well Drained	Well Drained	Well Drained	Well Drained	Well Drained	Well Drained	Well Drained
Soil Hydric Status	No	No	No	No	No	No	No
Source of Hydrology	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep
Approx. % Temp Impact	0%	0%	0%	0%	0%	0%	0%
Approx % Perm Impact	0%	0%	0%	0%	0%	0%	0%
Parameter	**LLL**	**MMM**	**NNN**	**OOO**	**PPP**	**QQQ**	**RRR**
Size of Wetland (acres)	0.003	0.009	0.003	0.02	0.007	0.007	0.314
Wetland Type	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine	Riparian Riverine
Mapped Soil Series	Tatum	Tatum	Tatum	Tatum	Tatum	Tatum	Herndon
Drainage Class	Well Drained	Well Drained	Well Drained	Well Drained	Well Drained	Well Drained	Well Drained
Soil Hydric Status	No	No	No	No	No	No	No
Source of Hydrology	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep	Hillside Groundwater Seep
Approx. % Temp Impact	0%	0%	0%	0%	0%	0%	0%
Approx % Perm Impact	0%	0%	0%	0%	0%	0%	0%

Appendix 5

Data, Analysis, Supplementary Information, Figures, and Maps

Appendix 5

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F. Nutrient Loading
G. Habitat Assessment

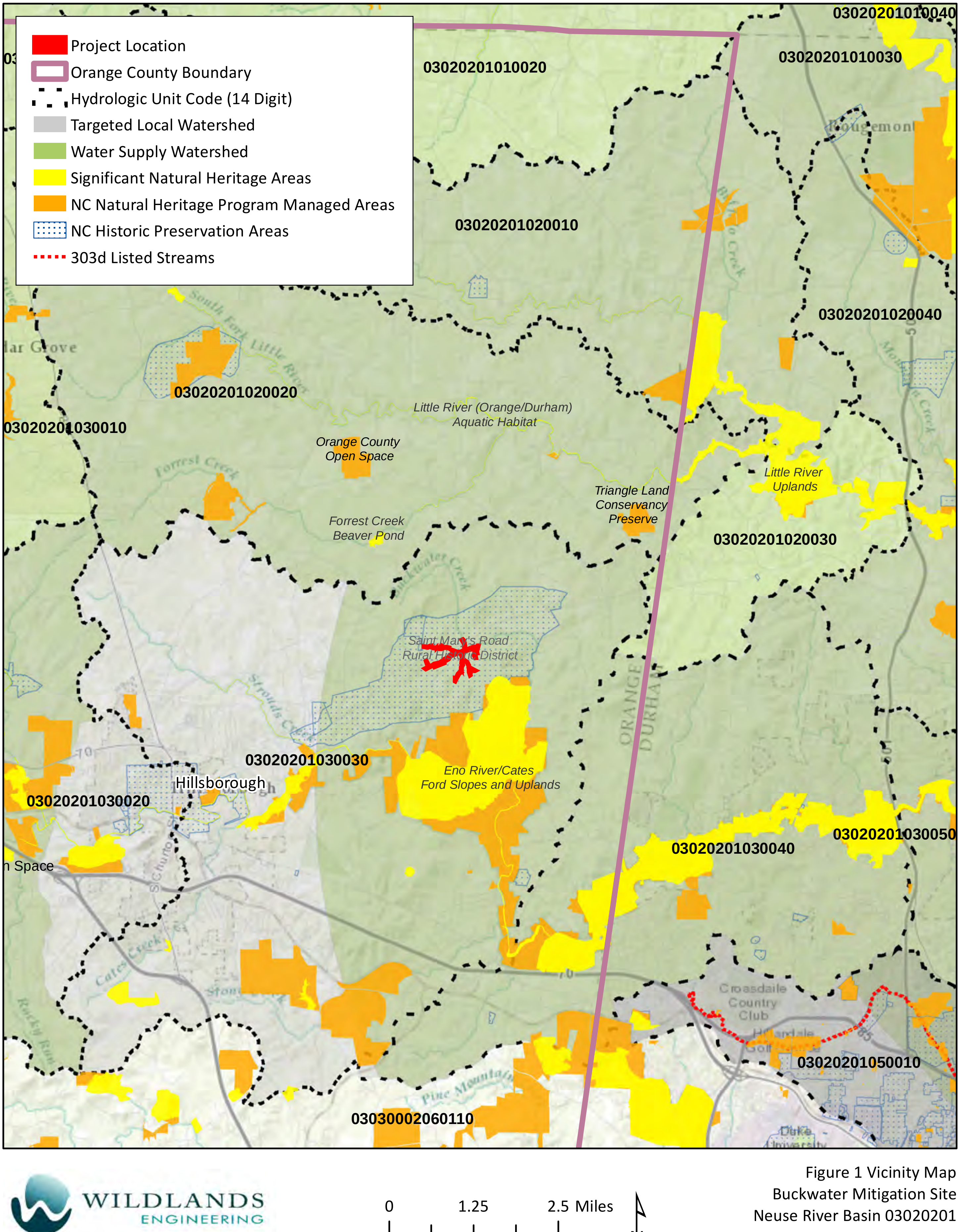

Figure 1 Vicinity Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC

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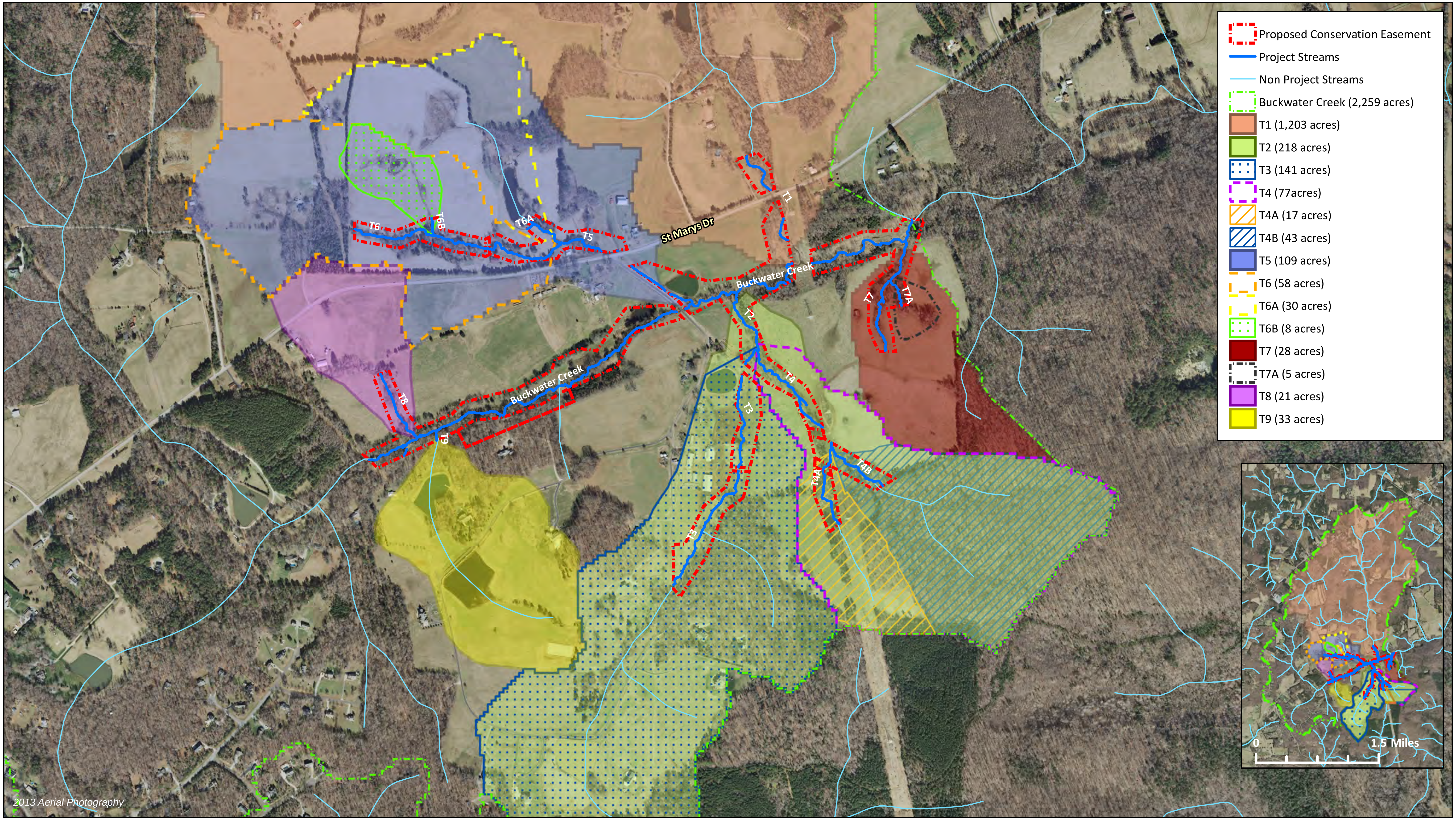
Figure 2 Site Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC



WILDLANDS ENGINEERING

0 1,000 2,000 3,000 Feet

N

Figure 3 Watershed Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC

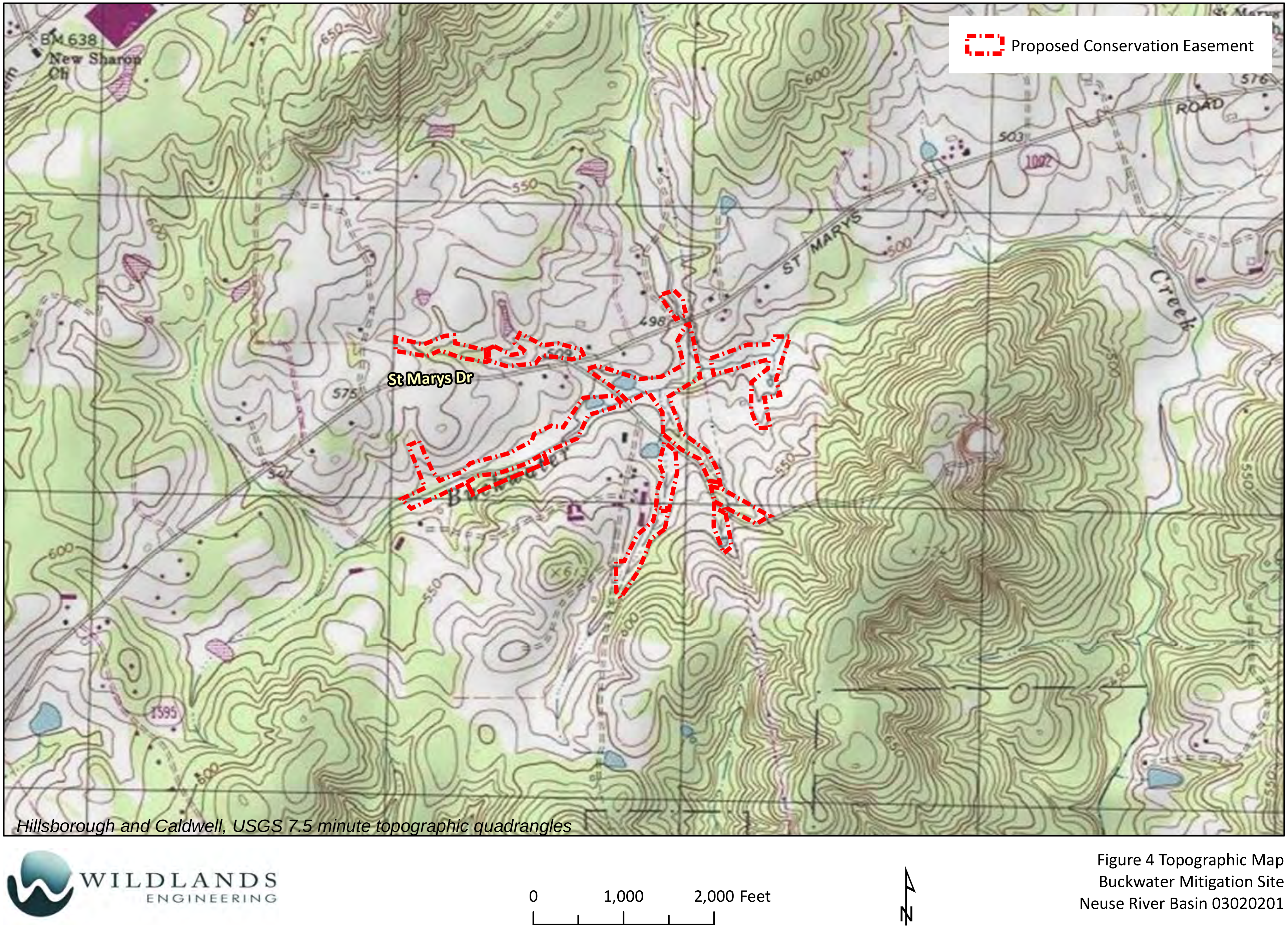


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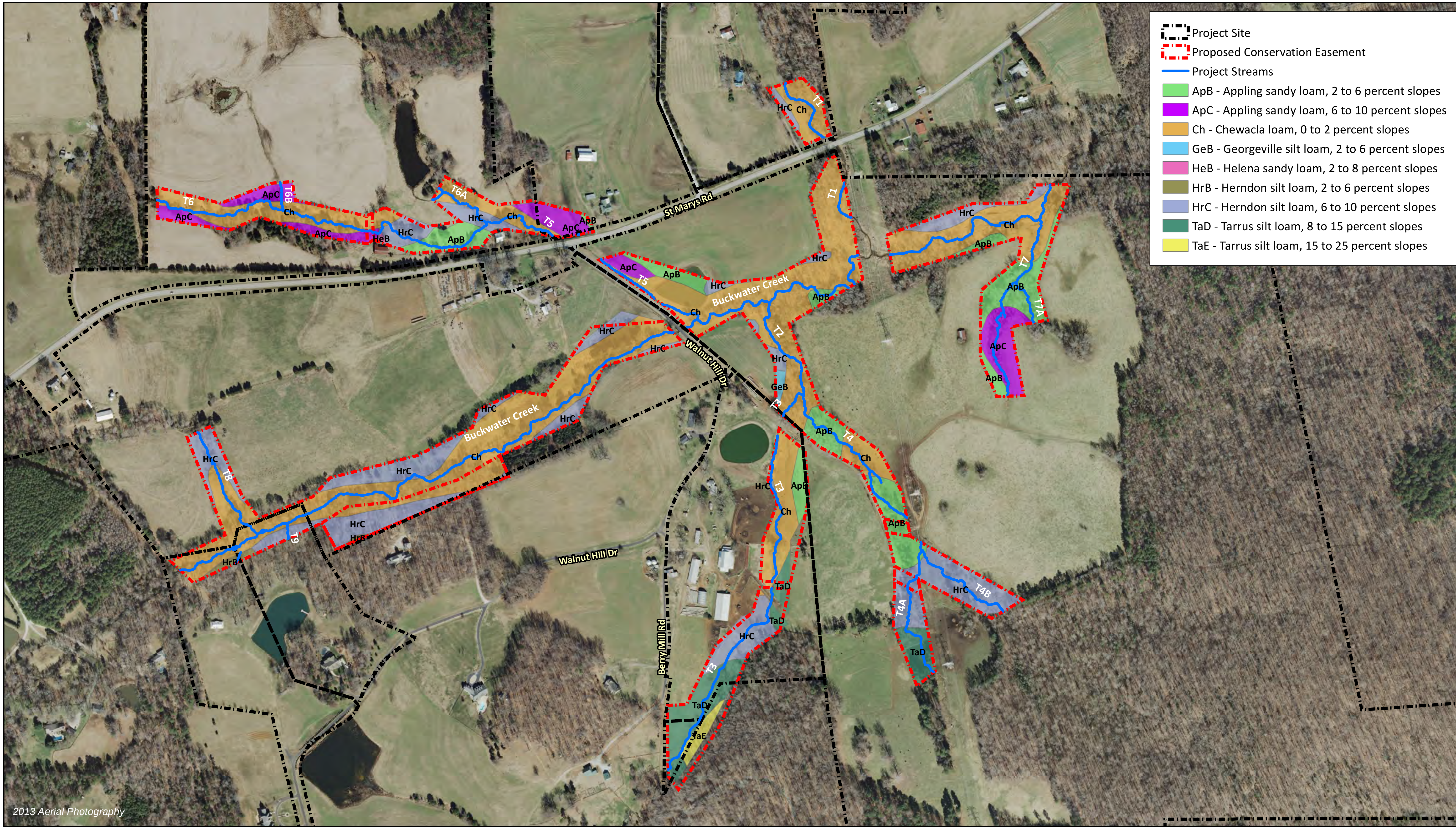
Figure 4 Topographic Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC



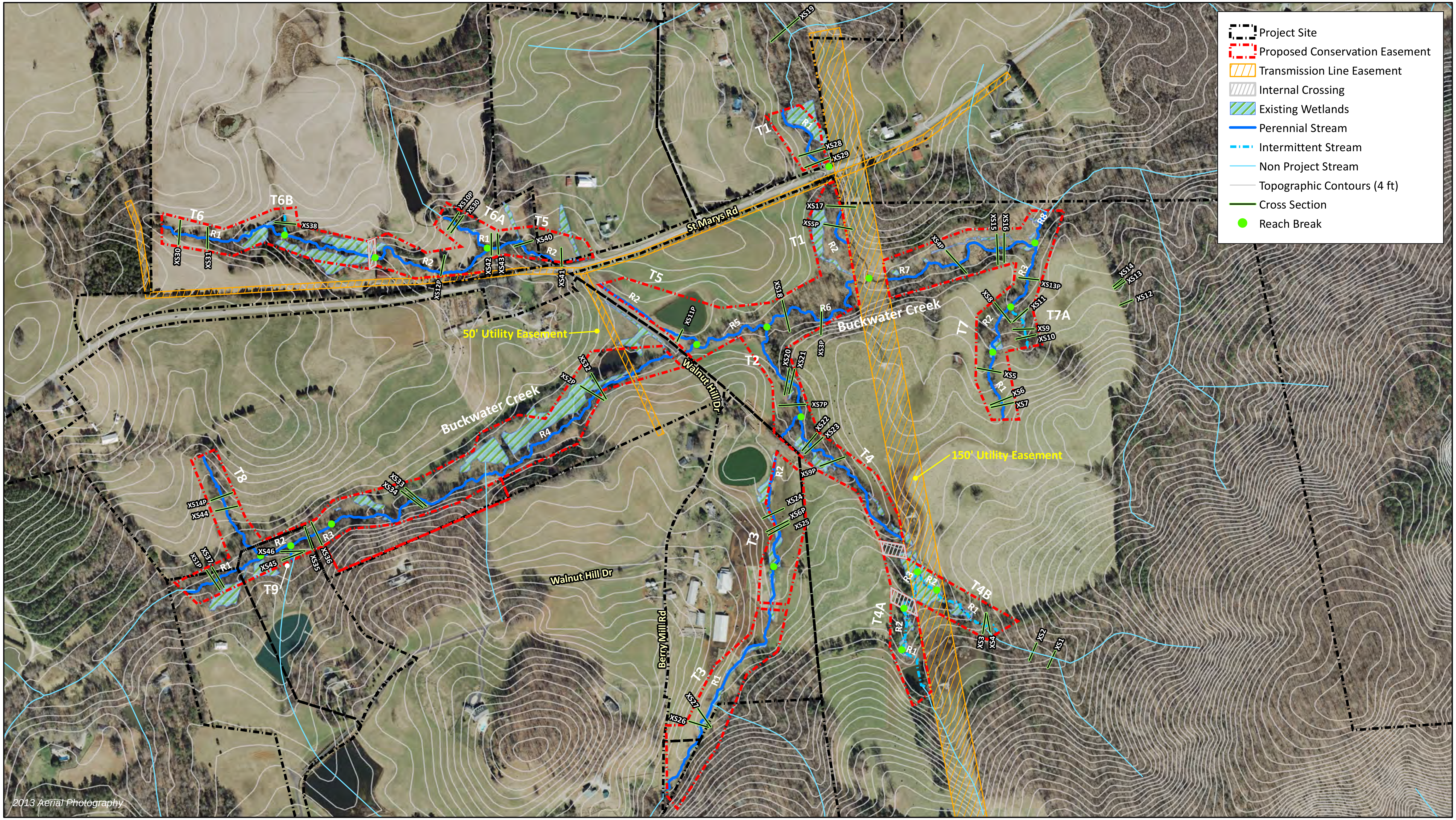
WILDLANDS ENGINEERING

0 500 1,000 Feet

N

Figure 5 Soils Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC

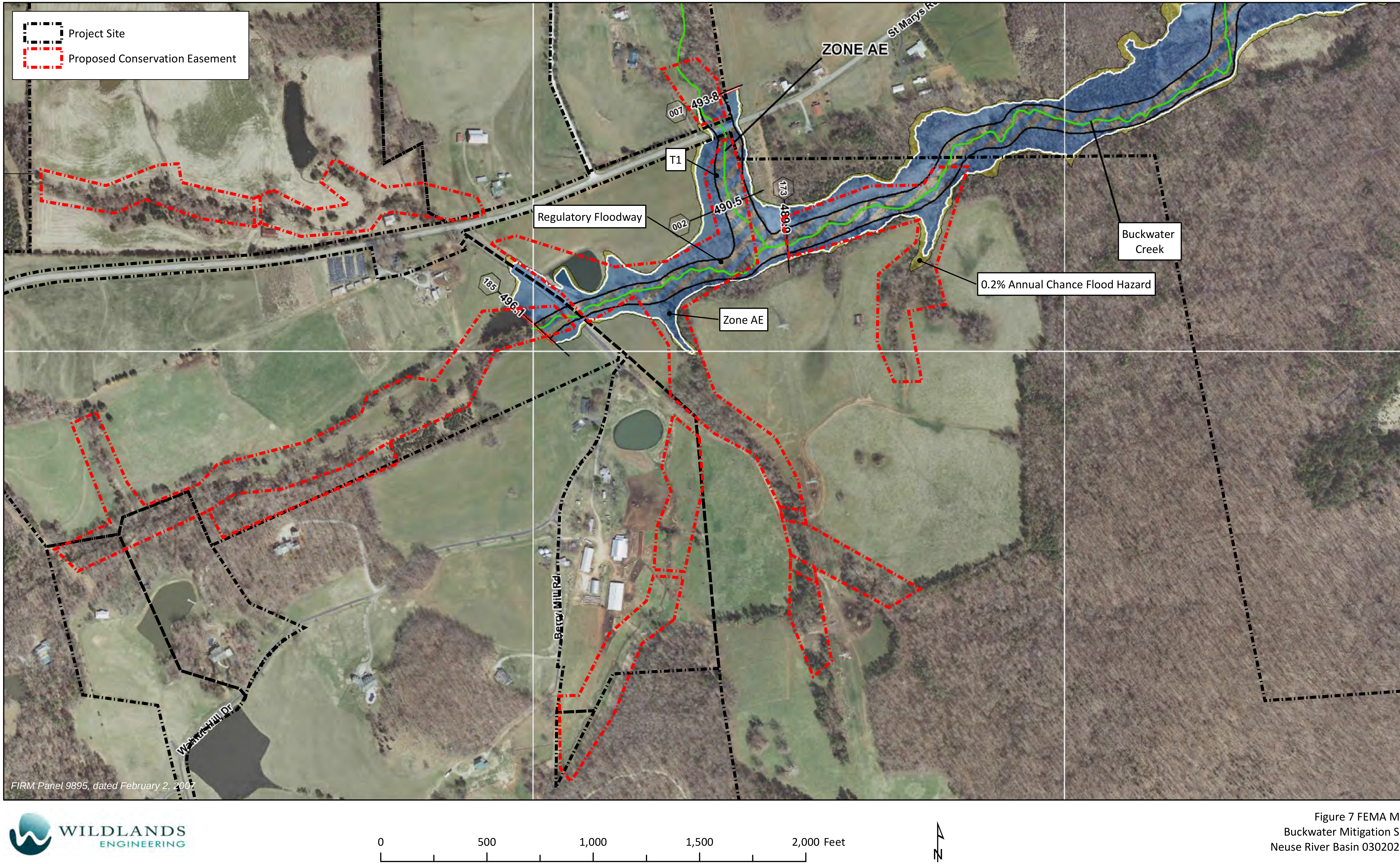


0 500 1,000 Feet

N

Figure 6 Existing Conditions Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC



WILDLANDS ENGINEERING

Figure 7 FEMA Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC

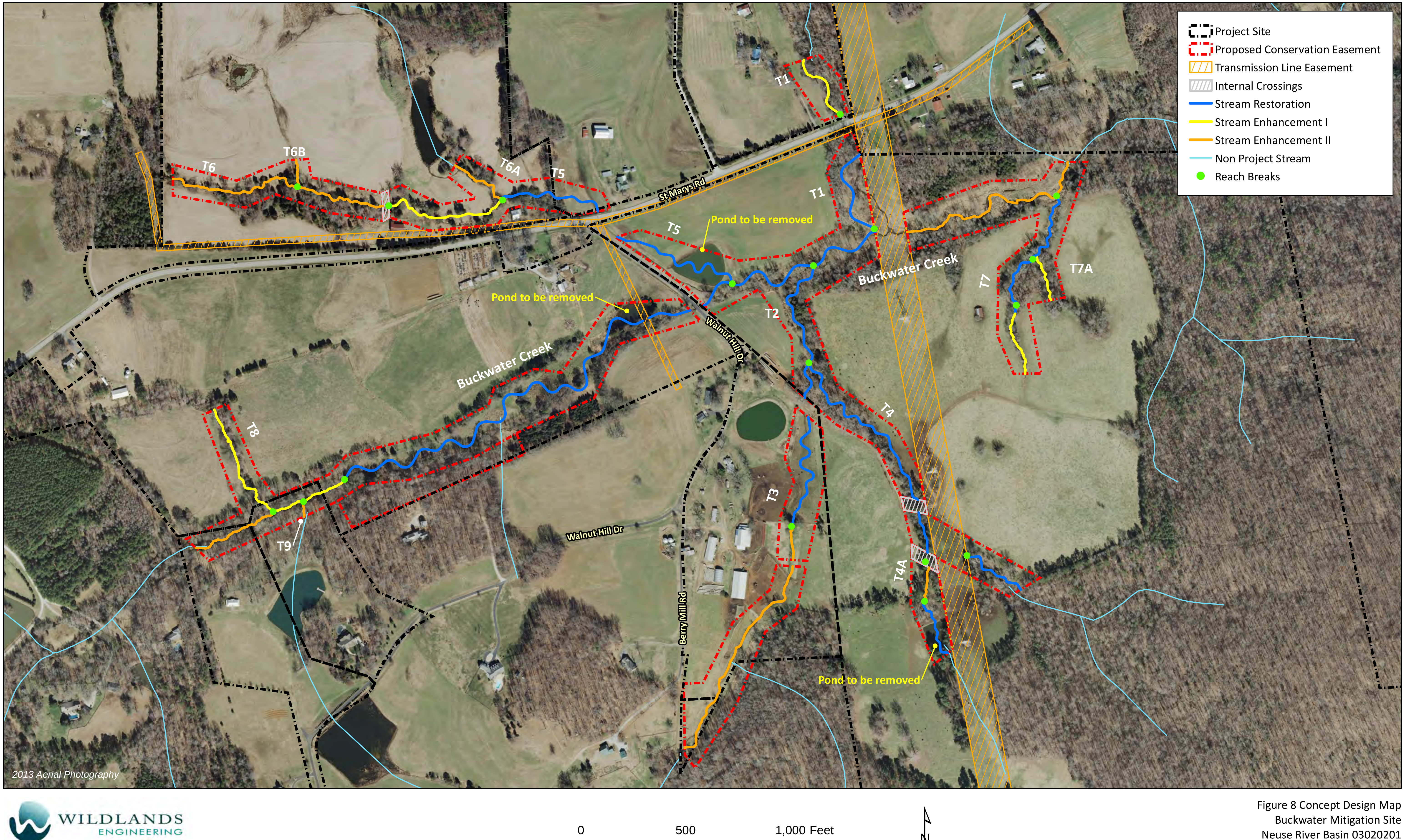


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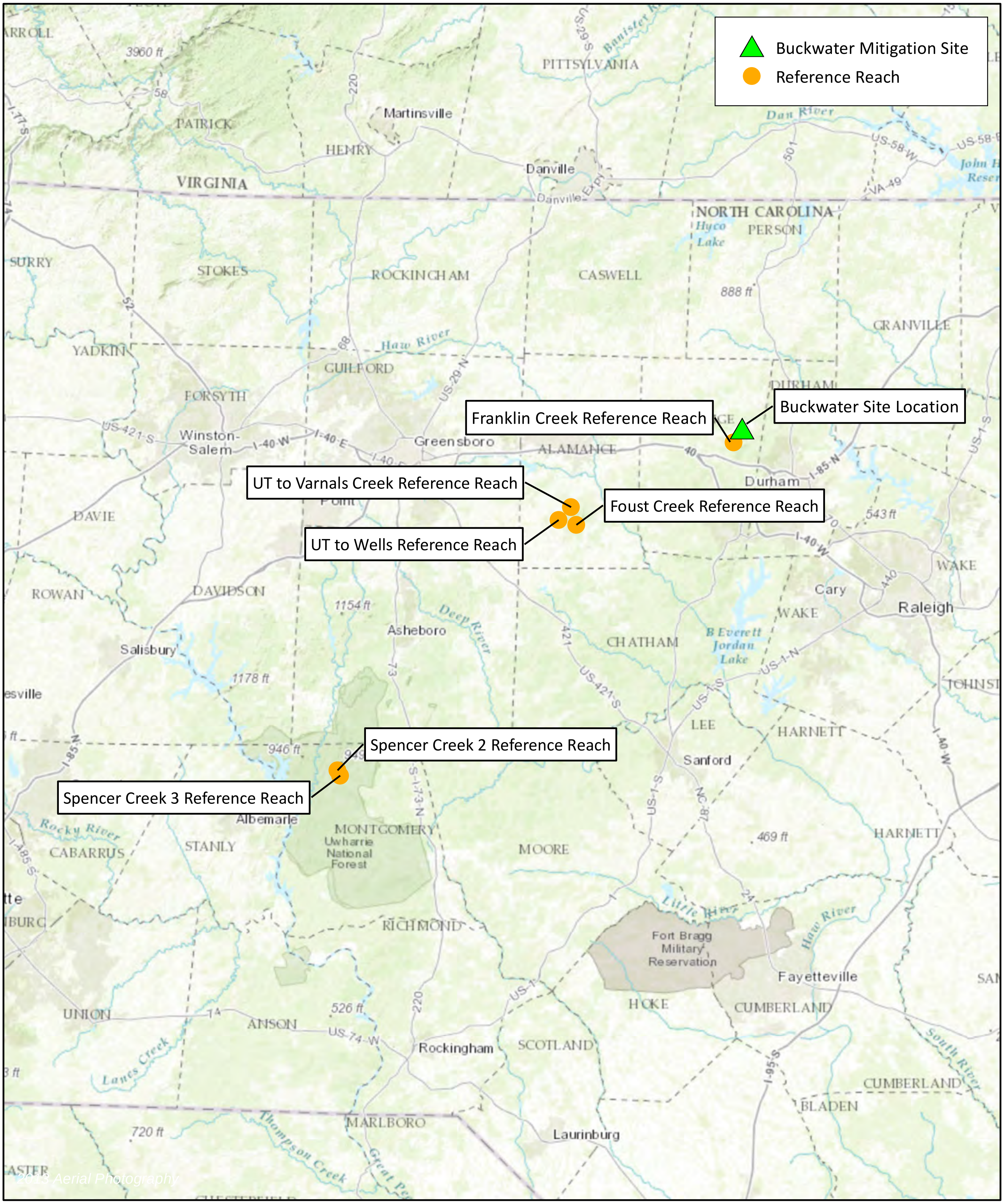
Figure 8 Concept Design Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC



WILDLANDS ENGINEERING

Figure 9 Reference Reach Vicinity Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC

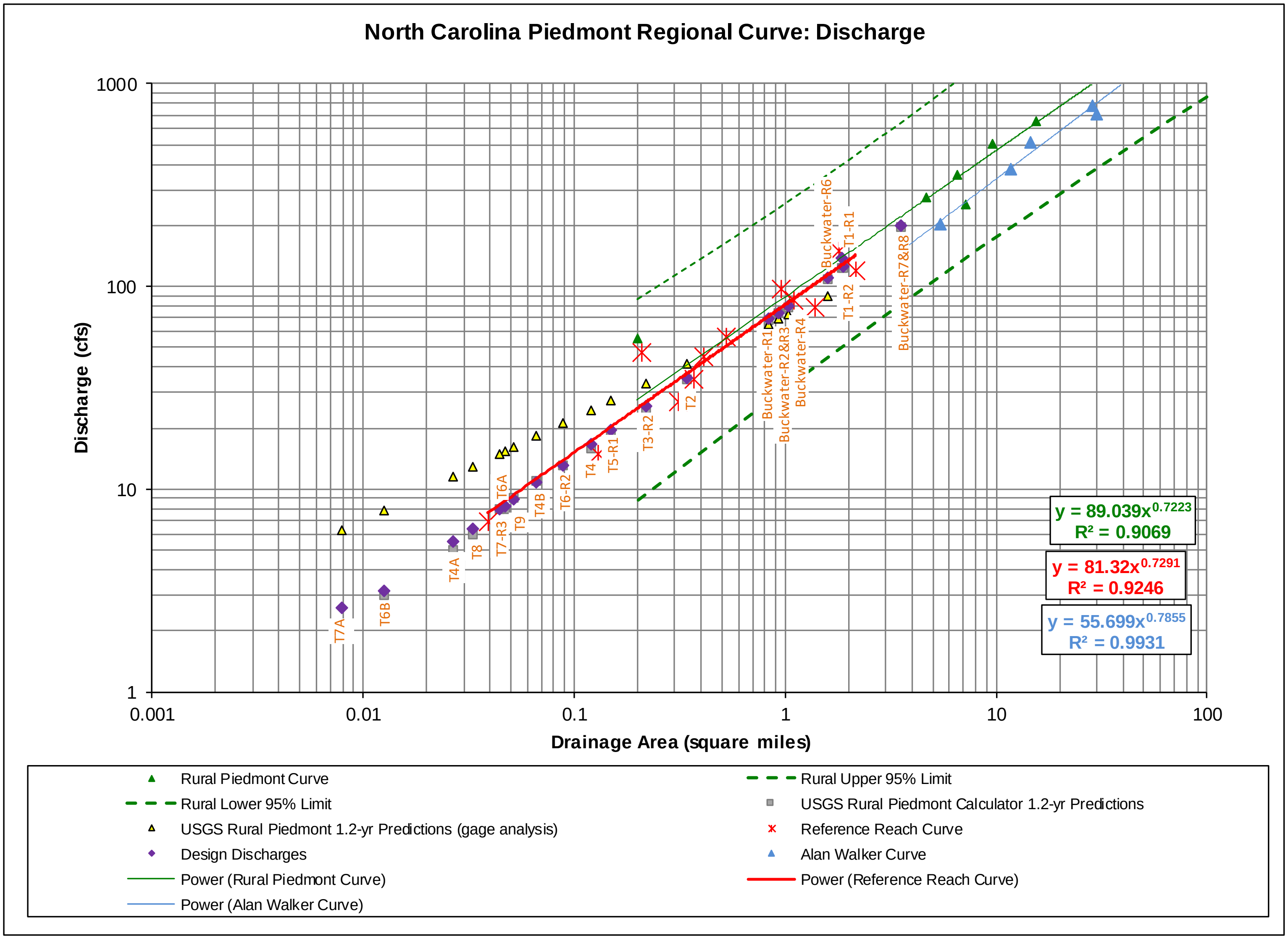


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Figure 10 Discharge Analysis
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC

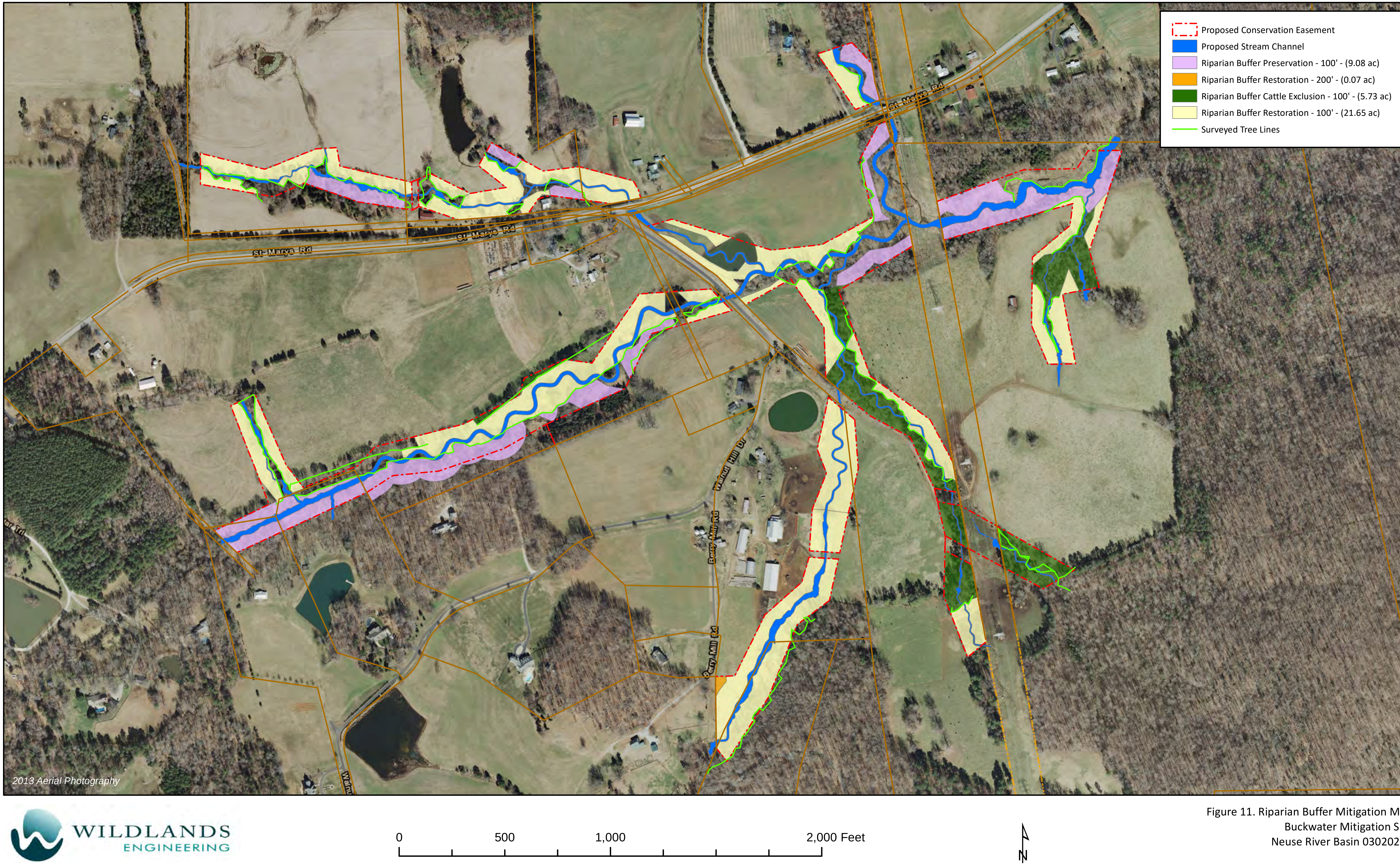

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Figure 11. Riparian Buffer Mitigation Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC

WILDLANDS ENGINEERING

Figure 12 Riparian Buffer Concept Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC

WILDLANDS ENGINEERING

Figure 13 Monitoring Components Map
Martin Dairy Mitigation Site
Neuse River Basin 03020201

Orange County, NC


INQUIRY #: 4593176.5
YEAR: 2012
= 500'
N
EDR

INQUIRY #: 4593176.5

YEAR: 2012

= 500'

N

EDR


INQUIRY #: 4593176.5
YEAR: 2005
= 500'
N
EDR


INQUIRY #: 4593176.5
YEAR: 2005
= 500'
N
EDR

INQUIRY #: 4593176.5

YEAR: 1993

= 500'

N

EDR

INQUIRY #: 4593176.5

YEAR: 1993

= 500'

N


INQUIRY #: 4593176.5
YEAR: 1982
= 500'
N
EDR

INQUIRY #: 4593176.5

YEAR: 1982

= 500'

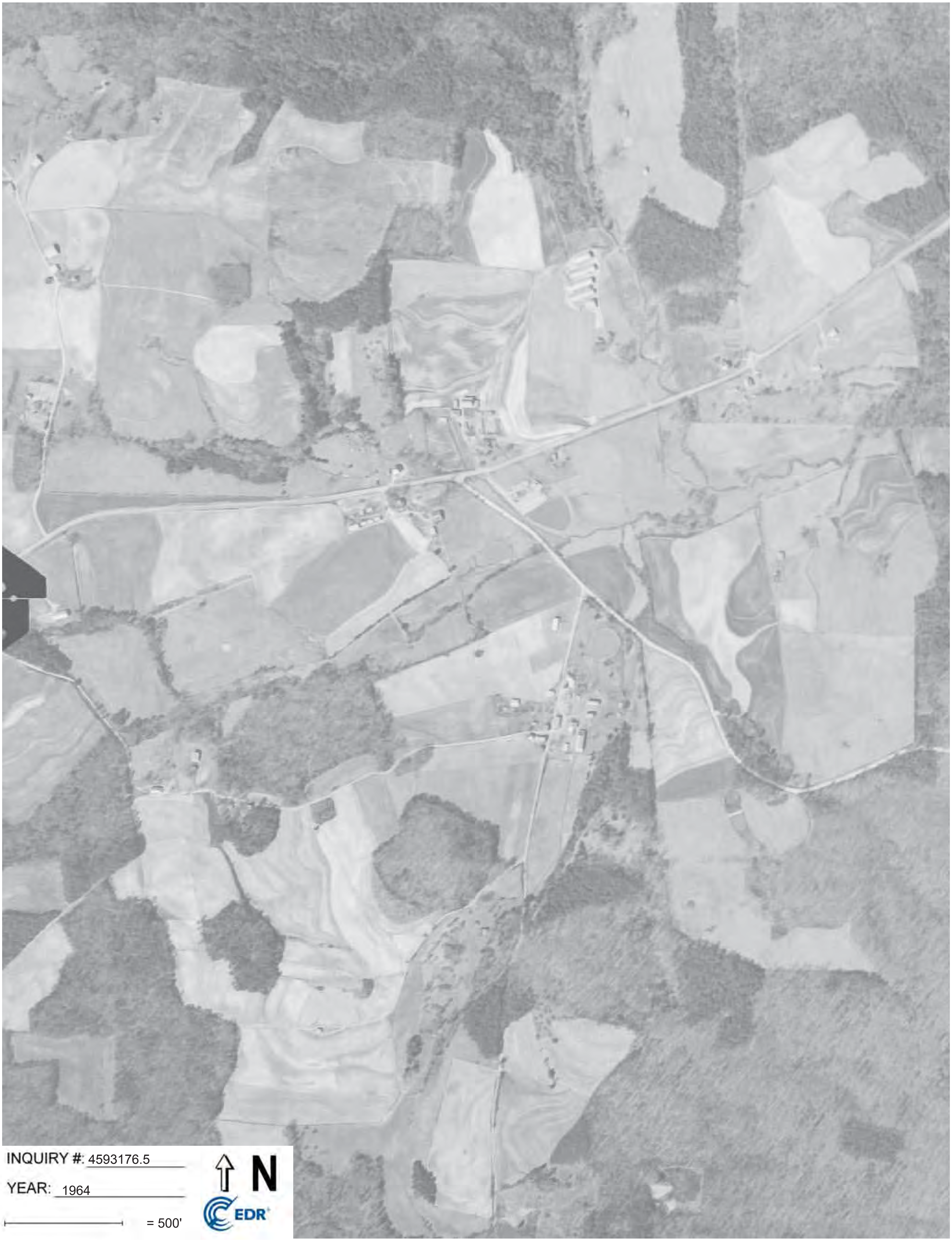
N

EDR


INQUIRY #: 4593176.5
YEAR: 1975
= 500'
N
EDR


INQUIRY #: 4593176.5
YEAR: 1975
= 500'
N
EDR

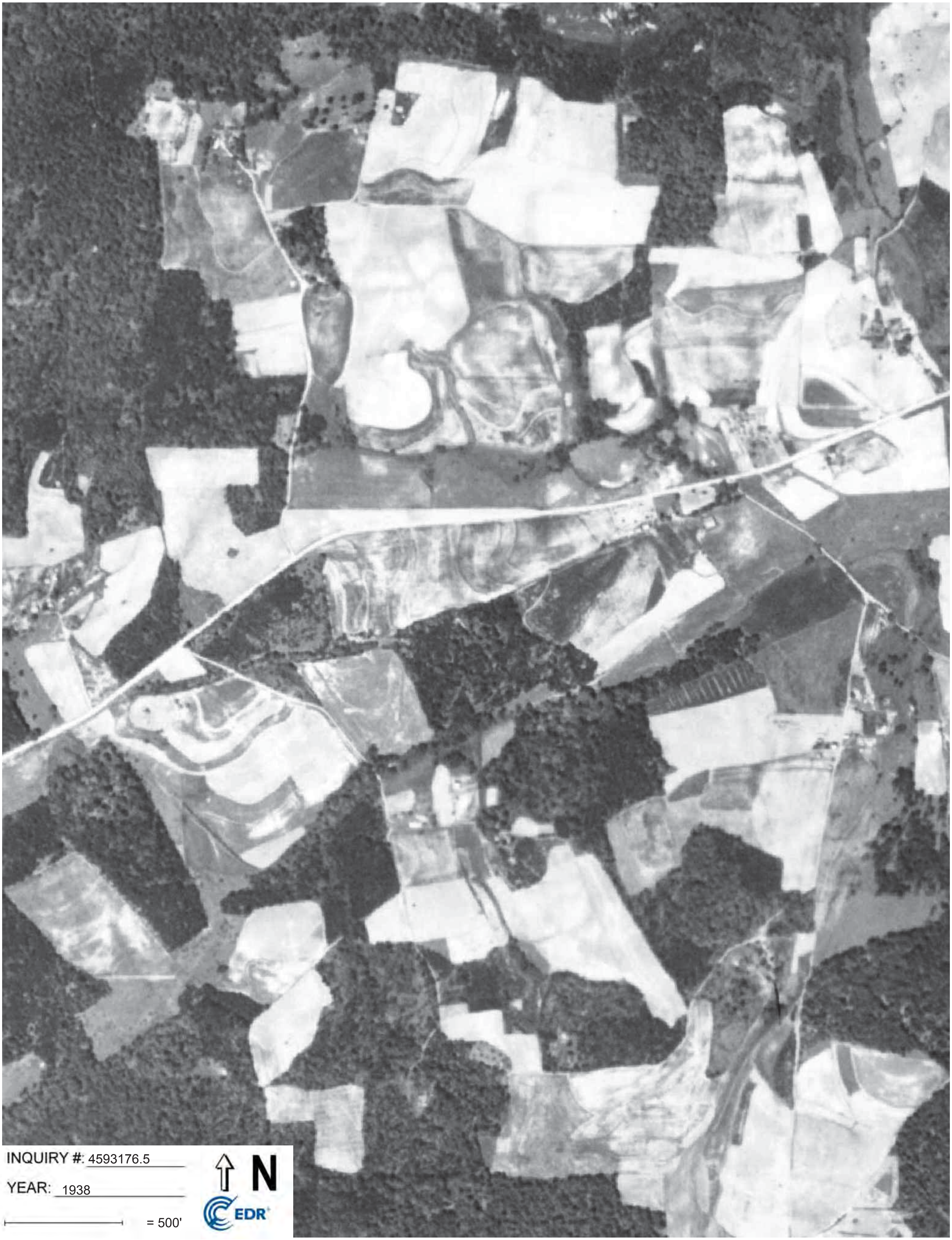

YEAR: 1966
N
Buckwater Mitigation Site



INQUIRY #: 4593176.5
YEAR: 1964
= 500'
N
EDR


INQUIRY #: 4593176.5
YEAR: 1955
= 500'
N
EDR

INQUIRY #: 4593176.5
YEAR: 1955
= 500'
N
EDR



INQUIRY #: 4593176.5

YEAR: 1938

= 500'

N

EDR


INQUIRY #: 4593176.5
YEAR: 1938
= 500'
N
EDR

Buckwater Creek (R3)

Buckwater Creek (R4)

Buckwater Creek (R5)

Buckwater Creek (R7)

T1

T2

T3

T3

T4

Pond on T4A R1

T4A R2

T4B

T5

T6 (R3)

T6A

T7

T7A

T8

T9

Buckwater Existing Conditions Geomorphic Parameters

Parameter	Notation	Units	Buckwater Creek - Reach 1		Buckwater Creek - Reach 2&3		Buckwater Creek - Reach 4		Buckwater Creek - Reach 5&6		Buckwater Creek - Reach 7&8	
			min	max	min	max	min	max	min	max	min	max
stream type			incised E4		G4c		incised E4/G4c		G4c		incised E4	
drainage area	DA	sq mi	0.84		0.93		1.0		1.6		3.5	
bankfull cross-sectional area	A_{bkf}	SF	19		22		20	24	28		54	80
avg velocity during bankfull event	v_{bkf}	fps	3.7		3.4		3.4	3.9	4.0		2.5	3.9
Cross-Section												
width at bankfull	w_{bkf}	feet	11		14		13		15		22	29
maximum depth at bankfull	d_{max}	feet	2.1		1.9		2.1	2.2	2.3		3.2	3.8
mean depth at bankfull	d_{bkf}	feet	1.6		1.6		1.5	1.8	1.8		2.4	2.7
bankfull width to depth ratio	w_{bkf}/d_{bkf}		6.8		8.3		7.3	8.6	8.3		9.0	11
low bank height		feet	3.4		4.8		3.5	3.7	4.6		4.0	4.5
bank height ratio	BHR		1.6		2.5		1.6	1.7	2.0		1.2	1.3
floodprone area width	w_{fpa}	feet	24		18		17	>44	20		>43	>56
entrenchment ratio	ER		2.1		1.4		1.3	>3.3	1.3		>1.5	>2.6
Slope												
valley slope	S_{valley}	feet/ foot	0.0091		0.0060		0.0093		0.0061		0.0022	
channel slope	$S_{channel}$	feet/ foot	0.0087		0.0074		0.0074		0.0063		0.0024	
Profile												
Bkf pool cross-sectional area	A_{pool}	SF	29		28		30	33	51.2		77	
pool area ratio	A_{pool}/A_{bkf}		1.6		1.3		1.3	1.6	1.9		1.0	1.4
max pool depth at bankfull	d_{pool}	feet	2.7		2.3		2.9	3.1	3.7		5.0	
pool depth ratio	d_{pool}/d_{bkf}		1.7		1.4		1.6	2.1	2.1		1.9	2.1
pool width at bankfull	w_{pool}	feet	16		15		16	18	16.6		30	
pool width ratio	w_{pool}/w_{bkf}		1.4		1.1		1.2	1.3	1.1		1.0	1.4
Pattern												
sinuosity	K		1.1		1.04		1.14		1.31		1.17	
belt width	w_{blt}	feet	NA		NA		24	64	38	67	46	107
meander width ratio	w_{blt}/w_{bkf}		NA		NA		1.8	4.9	2.5	4.4	2.1	5.0
meander length	L_m	feet	NA		NA		75	250	69	112	178	289
meander length ratio	L_m/w_{bkf}		NA		NA		5.7	19	4.6	7.4	8.3	13
linear wavelength	LW		NA		NA		61	186	42	101	133	220
linear wavelength ratio	LW/w_{bkf}		NA		NA		4.6	14	2.8	6.7	6.2	10
radius of curvature	R_c	feet	NA		NA		19	48	20	60	25	60
radius of curvature ratio	R_c/ w_{bkf}		NA		NA		1.4	3.7	1.3	4.0	1.2	2.8

Buckwater Existing Conditions Geomorphic Parameters

Parameter	Notation	Units	T1 - Reach 1*		T1 - Reach 2		T2		T3 - Reach 1		T3 - Reach 2	
			min	max	min	max	min	max	min	max	min	max
stream type			incised E4		incised B4c		E4/G4c		B4		E4/incised B4	
drainage area	DA	sq mi	1.9		1.9		0.34		0.17		0.22	
bankfull cross-sectional area	A_{bkf}	SF	27	27	35		8.3	15	6.8		6.2	7.5
avg velocity during bankfull event	v_{bkf}	fps	4.5	5.4	3.6		3.1	4.3	3.1		3.5	4.2
Cross-Section												
width at bankfull	w_{bkf}	feet	13	22	21		8.8	11	13		7.5	13
maximum depth at bankfull	d_{max}	feet	2.4	3.0	2.2		1.2	1.8	1.1		1.1	1.3
mean depth at bankfull	d_{bkf}	feet	1.2	2.0	1.7		0.90	1.4	0.51		0.60	0.82
bankfull width to depth ratio	w_{bkf}/d_{bkf}		6.5	18	12		7.9	9.4	26		9.2	23
low bank height		feet	2.4	5.3	4.0		1.7	3.5	1.5		1.6	1.8
bank height ratio	BHR		1.0	1.7	1.8		1.4	2.0	1.3		1.2	1.7
floodprone area width	w_{fpa}	feet	18	>54	31.0		14	>49	25		22	26
entrenchment ratio	ER		1.3	>4.0	1.8		1.3	>5.6	1.9		1.7	3.4
Slope												
valley slope	S_{valley}	feet/ foot	0.0064		0.0080		0.022		0.020		0.017	
channel slope	$S_{channel}$	feet/ foot	0.0066		0.0076		0.015		0.021		0.018	
Profile												
Bkf pool cross-sectional area	A_{pool}	SF	47		43		8.1		8.5		10	
pool area ratio	A_{pool}/A_{bkf}		1.7		1.2		0.55	1.0	1.3		1.4	1.7
max pool depth at bankfull	d_{pool}	feet	3.0		3.4		**1.5**		**2.0**		1.8	
pool depth ratio	d_{pool}/d_{bkf}		1.5	2.5	2.0		1.1	1.7	3.9		2.2	3.0
pool width at bankfull	w_{pool}	feet	**19**		**19**		**7.1**		**14**		**14**	
pool width ratio	w_{pool}/w_{bkf}		0.9	1.4	0.91		0.66	0.81	1.1		1.1	1.9
Pattern												
sinuosity	K		1.20		1.13		1.17		1.11		1.16	
belt width	w_{blt}	feet	87		115		NA		NA		NA	
meander width ratio	w_{blt}/w_{bkf}		6.5		5.6		NA		NA		NA	
meander length	L_m	feet	233		307		NA		NA		NA	
meander length ratio	L_m/w_{bkf}		11	18	15		NA		NA		NA	
linear wavelength	LW		195		301		NA		NA		NA	
linear wavelength ratio	LW/w_{bkf}		8.9	15	15		NA		NA		NA	
radius of curvature	R_c	feet	33	57	38	44	NA		NA		NA	
radius of curvature ratio	R_c/ w_{bkf}		2.5	4.3	1.8	2.1	NA		NA		NA	

Buckwater Existing Conditions Geomorphic Parameters

Parameter	Notation	Units	T4		T4A		T4B		T5 - Reach 1		T5 - Reach 2	
			min	max	min	max	min	max	min	max	min	max
stream type			G4c		E4		F4b		Incised E4		C4/incised C4	
drainage area	DA	sq mi	0.12		0.027		0.067		0.15		0.17	
bankfull cross-sectional area	A_{bkf}	SF	4.8	5.1			2.7		3.8		6.2	6.3
avg velocity during bankfull event	v_{bkf}	fps	3.3	3.6			4.0		4.9		3.0	3.4
Cross-Section												
width at bankfull	w_{bkf}	feet	7.2		8.9				6.0		6.1	8.9
maximum depth at bankfull	d_{max}	feet	0.80		1.1				0.60		0.90	1.4
mean depth at bankfull	d_{bkf}	feet	0.57		0.70				0.50		0.60	
bankfull width to depth ratio	w_{bkf}/d_{bkf}		11		16				13		9.7	13
low bank height		feet	1.8		2.7				2.7		1.9	1.9
bank height ratio	BHR		1.6		3.2				4.5		2.1	1.4
floodprone area width	w_{fpa}	feet	9.0		15				7.3		10	22
entrenchment ratio	ER		1.3		1.7				1.2		1.6	2.3
Slope												
valley slope	S_{valley}	feet/ foot	0.027		0.035		0.043		0.0146		0.016	
channel slope	$S_{channel}$	feet/ foot	0.027		0.031		0.033		0.0092		0.015	
Profile												
Bkf pool cross-sectional area	A_{pool}	SF	12				2.7		6.2		13	
pool area ratio	A_{pool}/A_{bkf}		2.4	2.5			1.0		1.6		2.0	2.0
max pool depth at bankfull	d_{pool}	feet	1.9				0.80		1.4		2.1	
pool depth ratio	d_{pool}/d_{bkf}		2.7	3.3			1.6		2.3		3.0	
pool width at bankfull	w_{pool}	feet	11				5.2		6.6		9.5	
pool width ratio	w_{pool}/w_{bkf}		1.3	1.6			0.87		1.1		1.0	1.1
Pattern												
sinuosity	K		1.15		1.16		1.15		1.11		1.11	
belt width	w_{blt}	feet	NA		NA		NA		28	31	NA	
meander width ratio	w_{blt}/w_{bkf}		NA		NA		NA		4.6	5.1	NA	
meander length	L_m	feet	NA		NA		NA		35	90	NA	
meander length ratio	L_m/w_{bkf}		NA		NA		NA		5.7	15	NA	
linear wavelength	LW		NA		NA		NA		32	83	NA	
linear wavelength ratio	LW/w_{bkf}		NA		NA		NA		5.2	14	NA	
radius of curvature	R_c	feet	NA		NA		NA		12	26	NA	
radius of curvature ratio	R_c/ w_{bkf}		NA		NA		NA		2.0	4.2	NA	

Buckwater Existing Conditions Geomorphic Parameters

Parameter	Notation	Units	T6 - Reach 1		T6 - Reach 2		T6A		T6B		T7 - Reach 1	
			min	max	min	max	min	max	min	max	min	max
stream type			G4		incised E4		incised E4		incised E4		incised E4	
drainage area	DA	sq mi	0.05		0.09		0.047		0.013		0.027	
bankfull cross-sectional area	A_{bkf}	SF	2.5		3.1		1.7		1.2		1.7	2.0
avg velocity during bankfull event	v_{bkf}	fps	3.4		4.2		4.9		2.7		3.3	3.8
Cross-Section												
width at bankfull	w_{bkf}	feet	3.7		4.0		3.0		3.5		3.9	
maximum depth at bankfull	d_{max}	feet	0.90		1.00		0.80		0.44		0.60	0.80
mean depth at bankfull	d_{bkf}	feet	0.70		0.80		0.60		0.33		0.40	0.50
bankfull width to depth ratio	w_{bkf}/d_{bkf}		5.2		5.2		5.3		11		7.5	9.4
low bank height		feet	2.8		3.2		4.1		1.6		1.7	2.6
bank height ratio	BHR		3.1		3.1		5.2		3.6		2.1	4.2
floodprone area width	w_{fpa}	feet	5.1		11		8.0		5.4		7.2	>58
entrenchment ratio	ER		1.4		2.7		2.7		1.5		1.8	>15
Slope												
valley slope	S_{valley}	feet/ foot	0.029		0.028		0.047		0.040		0.040	
channel slope	$S_{channel}$	feet/ foot	0.023		0.024		0.034		0.033		0.026	
Profile												
Bkf pool cross-sectional area	A_{pool}	SF	3.4				2.9				2.2	
pool area ratio	A_{pool}/A_{bkf}		1.4				1.7				1.1	1.3
max pool depth at bankfull	d_{pool}	feet	0.90				0.90				1.4	
pool depth ratio	d_{pool}/d_{bkf}		1.3				1.5				2.8	3.5
pool width at bankfull	w_{pool}	feet	4.4				5.2				5.1	
pool width ratio	w_{pool}/w_{bkf}		1.2				1.7				1.3	
Pattern												
sinuosity	K		1.15		1.16		1.15		1.04		1.13	
belt width	w_{blt}	feet	18	23	NA		10.0		NA		NA	
meander width ratio	w_{blt}/w_{bkf}		4.9	6.2	NA		3.3		NA		NA	
meander length	L_m	feet	52	70	NA		79.0		NA		NA	
meander length ratio	L_m/w_{bkf}		14	19	NA		26.3		NA		NA	
linear wavelength	LW		47	65	NA		60.0		NA		NA	
linear wavelength ratio	LW/w_{bkf}		13	18	NA		20.0		NA		NA	
radius of curvature	R_c	feet	17	28	NA		10.0		NA		NA	
radius of curvature ratio	R_c/ w_{bkf}		4.6	7.6	NA		3.3		NA		NA	

Buckwater Existing Conditions Geomorphic Parameters

Parameter	Notation	Units	T7 - Reach 2&3		T7A		T8		T9	
			min	max	min	max	min	max	min	max
stream type			incised E4		G4/incised E4		Incised E4		F4b	
drainage area	DA	sq mi	0.044		0.0080		0.033		0.052	
bankfull cross-sectional area	A_{bkf}	SF	1.5		0.80	1.0	1.8		2.6	
avg velocity during bankfull event	v_{bkf}	fps	3.6		2.6	3.4	3.5		3.4	
Cross-Section										
width at bankfull	w_{bkf}	feet	3.7		3.0	3.7	1.8		6.2	
maximum depth at bankfull	d_{max}	feet	0.50		0.30	0.50	1.4		0.57	
mean depth at bankfull	d_{bkf}	feet	0.40		0.20	0.30	1.0		0.42	
bankfull width to depth ratio	w_{bkf}/d_{bkf}		9.1		8.8	18	1.7		15	
low bank height		feet	4.9		1.5		3.3		3.2	
bank height ratio	BHR		8.9		2.8	5.4	2.4		5.7	
floodprone area width	w_{fpa}	feet	5.7		4.5	4.6	8.0		7.6	
entrenchment ratio	ER		1.5		1.2	1.6	4.5		1.2	
Slope										
valley slope	S_{valley}	feet/ foot	0.038		0.056		0.040		0.010	
channel slope	$S_{channel}$	feet/ foot	0.035		0.053		0.037		0.028	
Profile										
Bkf pool cross-sectional area	A_{pool}	SF	1.9		1.3		3.9		2.3	
pool area ratio	A_{pool}/A_{bkf}		1.3		1.3	1.6	2.2		0.88	
max pool depth at bankfull	d_{pool}	feet	0.70		0.40		1.5		0.90	
pool depth ratio	d_{pool}/d_{bkf}		1.8		1.3	2.0	1.5		2.1	
pool width at bankfull	w_{pool}	feet	4.1		5.4		3.2		4.0	
pool width ratio	w_{pool}/w_{bkf}		1.1		1.5	1.8	1.8		0.65	
Pattern										
sinuosity	K		1.15		1.18		1.10		1.03	
belt width	w_{blt}	feet	NA		NA		NA		NA	
meander width ratio	w_{blt}/w_{bkf}		NA		NA		NA		NA	
meander length	L_m	feet	NA		NA		NA		NA	
meander length ratio	L_m/w_{bkf}		NA		NA		NA		NA	
linear wavelength	LW		NA		NA		NA		NA	
linear wavelength ratio	LW/w_{bkf}		NA		NA		NA		NA	
radius of curvature	R_c	feet	NA		NA		NA		NA	

Reference Reach Geomorphic Parameters – Buckwater Mitigation Site

			Spencer Creek 2		Foust Creek		Spencer Creek 3		UT to Varnals Creek		UT to Wells		UT to Wells (Agony)	
Parameter	**Notation**	**Units**	**min**	**max**	**min**	**max**	**min**	**max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
stream type			E4		C4		E4		B		C4/1		C4/1	
drainage area	DA	sq mi	0.96		1.38		0.37		0.41		0.13		0.13	
bankfull discharge	Q_{bkf}	cfs	97		79		35		54.0		25.2		15.0	
bankfull cross-sectional area	A_{bkf}	SF	17.8	19.7	23.9	24.1	6.6	8.7	10.3	12.3	5.3		3.9	6.3
average velocity during bankfull event	v_{bkf}	fps	4.9	5.4	2.9	3.7	5	5.6	4.4	5.2	5.3		3.8	
Cross-Section														
width at bankfull	w_{bkf}	feet	10.7	11.2	18.5	19.4	6.3	9.3	9.3	10.5	8.0		6.2	8.6
maximum depth at bankfull	d_{max}	feet	2.1	2.6	1.8	2.1	1	1.2	1.5	1.7	0.9	1.4	0.6	1.4
mean depth at bankfull	d_{bkf}	feet	1.6	1.8	1.3	1.4	0.8	1.0	1.1	1.2	0.4	1.0	0.6	1.0
bankfull width to depth ratio	w_{bkf}/d_{bkf}		5.8	7.1	13.9	14.2	7.9	9.3	8.1	9.3	7.0	26.0	6.1	12.6
depth ratio	d_{max}/d_{bkf}		1.3	1.4	1.4	1.6	1.2	1.3	1.4	1.4	1.4	2.2	0.8	1.8
bank height ratio	BHR		1.0		1.0	1.0	1.0	1.0	1.0		1.4	2.5	1.0	1.8
floodprone area width	w_{fpa}	feet	60	>114	49	63	14	125	60	100	16	22	15	25
entrenchment ratio	ER		5.5	>10.2	2.6	3.4	1.7	4.3	5.7	10	2.0	3.4	1.9	4.1
Slope														
valley slope	S_{valley}	ft/ft	0.0109		0.0095		0.022	0.031	0.020		0.028		0.028	
channel slope	$S_{channel}$	ft/ft	0.0047		0.0090		0.019	0.022	0.017		0.0197		0.0199	
Profile														
riffle slope	S_{riffle}	ft/ft	0.013		0.015	0.035	0.0184	0.0343	0.024	0.057	0.017	0.078	0.016	0.085
riffle slope ratio	$S_{riffle}/S_{channel}$		2.8		1.7	3.9	1	1.6	4.2	10.0	0.9	4.0	0.8	4.3
pool slope	S_{pool}	ft/ft	0.001	0.001	0.0008	0.003	0.0007	0.014	0.00	0.015	0.0	0.008	0.000	0.009
pool slope ratio	$S_{pool}/S_{channel}$		0.15	0.19	0.09	0.38	0.00	0.60	0.00	2.63	0.00	0.40	0.00	0.43
pool-to-pool spacing	$L_{p\text{-}p}$	feet	71		49	91	9	46	7.8	82	17	63	17	63
pool spacing ratio	$L_{p\text{-}p}/w_{bkf}$		6.3	6.6	2.6	4.7	1.4	4.9	0.5	5.6	2.1	7.9	2.3	8.8
pool cross-sectional area at bankfull	A_{pool}	SF	24.5		29.2	34.9	6.5	9.8	22.0	22.7	6.2	8.9	6.2	9.0
pool area ratio	A_{pool}/A_{bkf}		1.2	1.4	1.2	1.4	1	1.1	1.8	1.9	1.2	1.7	1.2	1.7
maximum pool depth at bankfull	d_{pool}	feet	3.3		2.5	2.9	1.2	1.8	2.5	2.6	1.6	1.9		

			Spencer Creek 2		Foust Creek		Spencer Creek 3		UT to Varnals Creek		UT to Wells		UT to Wells (Agony)	
Parameter	**Notation**	**Units**	**min**	**max**	**min**	**max**	**min**	**max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
pool depth ratio	d_{pool}/d_{bkf}		1.8	2.0	1.9	2.1	1.5	1.8	3.0	3.1	2.3	2.7		
pool width at bankfull	w_{pool}	feet	17.5		15.3	20.5	6	12	15.1	18.6	6.0	10.0	7.1	10.5
pool width ratio	w_{pool}/w_{bkf}		1.6		0.8	1.1	1.0	1.3	1.0	1.3	0.9	1.5	1.0	1.5
Pattern														
sinuosity	K		2.32		1.05		1.0	1.3	1.20		1.4		1.41	
belt width	w_{blt}	feet	38	41	N/A		10	50	15	45	10	35	10	35
meander width ratio	w_{blt}/w_{bkf}		3.4	3.6	N/A		1.6	5.4	1.0	3.0	1.3	4.4	1.4	4.9
linear wavelength (formerly meander length)	L_m	*feet*	46	48	N/A		55	142	16	47	35	70	35	70
linear wavelength ratio (formerly meander length ratio)	L_m/w_{bkf}		4.1	4.4	N/A		8.7	15.3	1.1	3.2	4.4	8.8	4.9	9.8
meander length	L_m	feet	--	--	N/A		53	178	--	--	--	--	--	--
meander length ratio	L_m/w_{bkf}		--	--	N/A		8.4	19.1	--	--	--	--	--	--
radius of curvature	R_c	feet	11	15	N/A		12	85	8.3	47	2.3	32	2	32
radius of curvature ratio	R_c/ w_{bkf}		1.3	1.4	N/A		1.9	9.1	0.57	3.2	0.3	4.0	0.32	4.5
Sediment														
d_{50} Description			Fine Gravel				Medium Gravel							
Reach Wide	d_{16}	mm	< 0.062				1.866				0.1			
	d_{35}	mm	3				8.85				0.6			
	d_{50}	mm	8.8				11				4.5			
	d_{84}	mm	42				64				53			
	d_{95}	mm	90				128				96			

Proposed Geomorphic Parameters – Buckwater Mitigation Site

	Notation	Units	Buckwater R4		Buckwater R5		Buckwater R6		T1		T2		T3	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
stream type			C4		E4		E4		E4		B4		C4	
drainage area	DA	*sq mi*	1.03		1.23		1.58		1.88		0.34		0.22	
design discharge	Q	*cfs*	80		91		110		125		36		26	
bankfull cross-sectional area	A_{bkf}	*SF*	22.1		29.4		29.4		33.9		8.9		7.3	
avg velocity during bankfull event	v_{bkf}	*fps*	3.6		3.1		3.7		3.7		4.0		3.6	
Cross-Section														
width at bankfull	w_{bkf}	*feet*	17.6		18.2		18.2		19.4		10.6		9.6	
maximum depth at bankfull	d_{max}	*feet*	1.8	1.9	2.0	2.4	2.0	2.5	2.1	2.6	1.1	1.3	1.0	1.1
mean depth at bankfull	d_{bkf}	*feet*	1.3		1.6		1.6		1.8		0.8		0.8	
bankfull width to depth ratio	w_{bkf}/d_{bkf}		14		11		11		11		13		13	
max depth ratio	d_{max}/d_{bkf}	*feet*	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5
bank height ratio	BHR		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.0	1.0	1.0	1.0
floodprone area width	w_{fpa}	*feet*	38	87	40	91	40	91	55	125	23	53	21	48
entrenchment ratio	ER		2.2	5.0	2.2	5.0	2.2	5.0	2.2	5.0	2.2	5.0	2.2	5.0
Slope														
valley slope	S_{valley}	*feet/ foot*	0.0093		0.0062		0.0085		0.0055		0.0190		0.0163	
channel slope	S_{chnl}	*feet/ foot*	0.0072	0.0078	0.0040		0.0040	0.0087	0.004	0.005	0.0152	0.0165	0.013	0.015
Profile														
riffle slope	S_{riffle}	*feet/ foot*	0.009	0.018	0.005	0.011	0.009	0.013	0.007	0.013	0.019	0.033	0.015	0.034
riffle slope ratio	S_{riffle}/S_{chnl}		1.2	2.8	1.2	2.8	1.2	2.8	1.5	2.8	1.2	2.2	1.2	2.7
pool slope	S_p	*feet/ foot*	0.000	0.000	0.000	0.001	0.000	0.002	0.000	0.001	0.000	0.002	0.000	0.002
pool slope ratio	S_p/S_{chnl}		0.00	0.10	0.00	0.20	0.00	0.20	0.00	0.20	0.00	0.10	0.00	0.10
pool-to-pool spacing	L_{p-p}	*feet*	69	139	40	138	38	129	107	159	23	93	33	93
pool spacing ratio	L_{p-p}/w_{bkf}		3.9	7.9	2.2	7.6	2.2	7.4	5.5	8.2	2.2	8.8	3.4	9.7
pool cross-sectional area	A_{pool}	*SF*	27	55	35	73	35	74	41	85	11	17	8.8	18

	Notation	Units	Buckwater R4		Buckwater R5		Buckwater R6		T1		T2		T3	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
pool area ratio	A_{pool}/A_{bkf}		1.2	2.5	1.2	2.5	1.2	2.5	1.2	2.5	1.2	1.9	1.2	2.5
maximum pool depth	d_{pool}	*feet*	2.6	3.9	3.7	4.5	3.7	4.5	3.9	4.8	1.7	2.6	1.6	2.2
pool depth ratio	d_{pool}/d_{bkf}		2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.1	2.0	3.1
pool width at bankfull	w_{pool}	*feet*	21	28	22	29	22	29	26	28	13	16	12	14
pool width ratio	w_{pool}/w_{bkf}		1.2	1.6	1.2	1.6	1.2	1.6	1.2	1.6	1.2	1.5	1.2	1.5
Pattern														
sinuosity	K		1.31		1.39		1.45		1.3		1.2		1.29	
belt width	w_{blt}	*feet*	49	111	60	104	67	77	62	100	25	52	22	66
meander width ratio	w_{blt}/w_{bkf}		2.6	3.8	3.3	5.7	3.7	4.2	3.2	5.2	2.4	4.9	2.3	6.9
linear wavelength (formerly meander length)	LW	*feet*	135	211	173	227	181	219	193	208	67	143	70	133
linear wavelength ratio (formerly meander length ratio)	LW/w_{bkf}		7.7	12.0	9.5	12.5	9.9	12.0	10.0	10.7	6.3	13.5	7.3	13.9
meander length	L_m	*feet*	153	251	205	252	204	248	221	266	103	157	66	165
meander length ratio	L_m/W_{bkf}		8.7	14.2	11.3	13.9	11.2	13.6	11.4	13.7	9,7	14.8	6.9	17.2
radius of curvature	R_c	*feet*	35	52	40	53	41	57	47	62	23	26	20	28
radius of curvature ratio	$R_c/\ w_{bkf}$		2.0	3.0	2.2	2.9	2.3	3.1	2.4	3.2	2.2	2.5	2.1	2.9

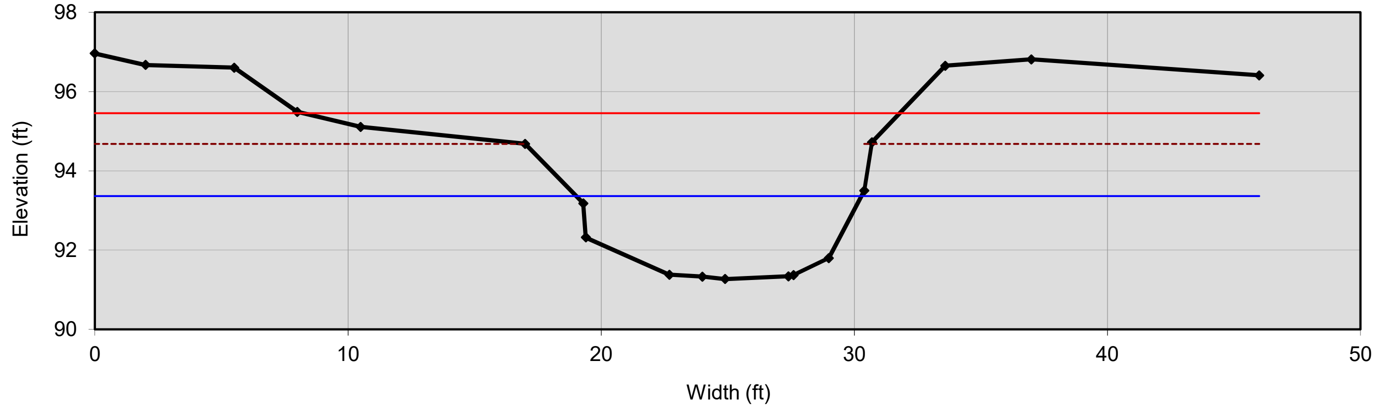
Proposed Geomorphic Parameters – Buckwater Mitigation Site

	Notation	Units	T4		T4A		T4B		T5		T7 R2		T7 R3	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
stream type			B4		B4a		B4		C4		B4		B4	
drainage area	DA	*sq mi*	0.12		0.03		0.07		0.17		0.03		0.04	
design discharge	Q	*cfs*	17		5.5		11		21		5.5		8	
bankfull cross-sectional area	A_{bkf}	*SF*	4.5		1.7		2.8		6.7		1.6		2.9	
average velocity during bankfull event	v_{bkf}	*fps*	3.9		3.4		4		3.3		3.5		2.9	
Cross-Section														
width at bankfull	w_{bkf}	*feet*	7.6		5.2		6.4		9.2		4.7		6.3	
maximum depth at bankfull	d_{max}	*feet*	0.7	0.9	0.4	0.5	0.5	0.6	0.9	1.1	0.4	0.5	0.6	0.7
mean depth at bankfull	d_{bkf}	*feet*	0.6		0.3		0.4		0.7		0.3		0.5	
bankfull width to depth ratio	w_{bkf}/d_{bkf}		13		16		15		13		14		14	
max depth ratio	d_{max}/d_{bkf}	*feet*	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.5
bank height ratio	BHR		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
floodprone area width	w_{fpa}	*feet*	17	38	11	26	14	32	20	46	10	24	14	32
entrenchment ratio	ER		2.2	5.0	2.2	5.0	2.2	5.0	2.2	5.0	2.2	5.0	2.2	5.0
Slope														
valley slope	S_{valley}	*feet/ foot*	0.0260		0.048/0.040		0.0480		0.0150		0.0445		0.0200	
channel slope	S_{chnl}	*feet/ foot*	0.022	0.024	0.036	0.042	0.036	0.041	0.0115	0.0125	0.035	0.041	0.017	0.01820
Profile														
riffle slope	S_{riffle}	*feet/ foot*	0.026	0.103	0.043	0.181	0.043	0.176	0.014	0.043	0.042	0.176	0.020	0.078
riffle slope ratio	S_{riffle}/S_{chnl}		1.2	4.3	1.2	4.3	1.2	4.3	1.2	3.4	1.2	4.3	1.2	4.3
pool slope	S_p	*feet/ foot*	0.000	0.005	0.000	0.008	0.000	0.008	0.000	0.001	0.000	0.008	0.000	0.004
pool slope ratio	S_p/S_{chnl}		0.00	0.20	0.00	0.20	0.00	0.20	0.00	0.10	0.00	0.20	0.00	0.20
pool-to-pool spacing	L_{p-p}	*feet*	17	67	11	46	14	56	20	61	10	41	14	55
pool spacing ratio	L_{p-p}/w_{bkf}		2.2	8.8	2.2	8.8	2.2	8.8	2.2	6.6	2.2	8.8	2.2	8.8

	Notation	Units	T4		T4A		T4B		T5		T7 R2		T7 R3	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
pool cross-sectional area	A_{pool}	*SF*	5.4	8.6	2.1	3.3	3.3	5.2	8.0	16.8	1.9	3.1	3.5	5.6
pool area ratio	A_{pool}/A_{bkf}		1.2	1.9	1.2	1.9	1.2	1.9	1.2	2.5	1.2	1.9	1.2	1.9
maximum pool depth	d_{pool}	*feet*	1.7	2.6	0.7	1.0	0.9	1.3	1.5	2.2	0.7	1.1	0.9	1.4
pool depth ratio	d_{pool}/d_{bkf}		2.0	3.1	2.0	3.1	2.0	3.1	2.0	3.1	2.0	3.1	2.0	3.1
pool width at bankfull	w_{pool}	*feet*	9.1	11	6.2	7.8	7.7	9.6	11	15	5.6	7.1	7.6	9.5
pool width ratio	w_{pool}/w_{bkf}		1.2	1.5	1.2	1.5	1.2	1.5	1.2	1.6	1.2	1.5	1.2	1.5
Pattern														
sinuosity	K		1.2		1.15		1.15		1.18		1.20		1.15	
belt width	w_{blt}	*feet*	N/A	N/A	N/A	N/A	N/A	N/A	28	78	N/A	N/A	N/A	N/A
meander width ratio	w_{blt}/w_{bkf}		N/A	N/A	N/A	N/A	N/A	N/A	3.0	8.5	N/A	N/A	N/A	N/A
linear wavelength (formerly meander length)	LW	*feet*	N/A	N/A	N/A	N/A	N/A	N/A	28	122	N/A	N/A	N/A	N/A
linear wavelength ratio (formerly meander length ratio)	LW/w_{bkf}		N/A	N/A	N/A	N/A	N/A	N/A	4.1	13.3	N/A	N/A	N/A	N/A
meander length	L_m	*feet*	N/A	N/A	N/A	N/A	N/A	N/A	46	129	N/A	N/A	N/A	N/A
meander length ratio	L_m/W_{bkf}		N/A	N/A	N/A	N/A	N/A	N/A	5.0	14.0	N/A	N/A	N/A	N/A
radius of curvature	R_c	*feet*	N/A	N/A	N/A	N/A	N/A	N/A	18	28	N/A	N/A	N/A	N/A
radius of curvature ratio	R_c/ w_{bkf}		N/A	N/A	N/A	N/A	N/A	N/A	2.0	3.0	N/A	N/A	N/A	N/A

Buckwater Reach 1

XSP-1 - Riffle



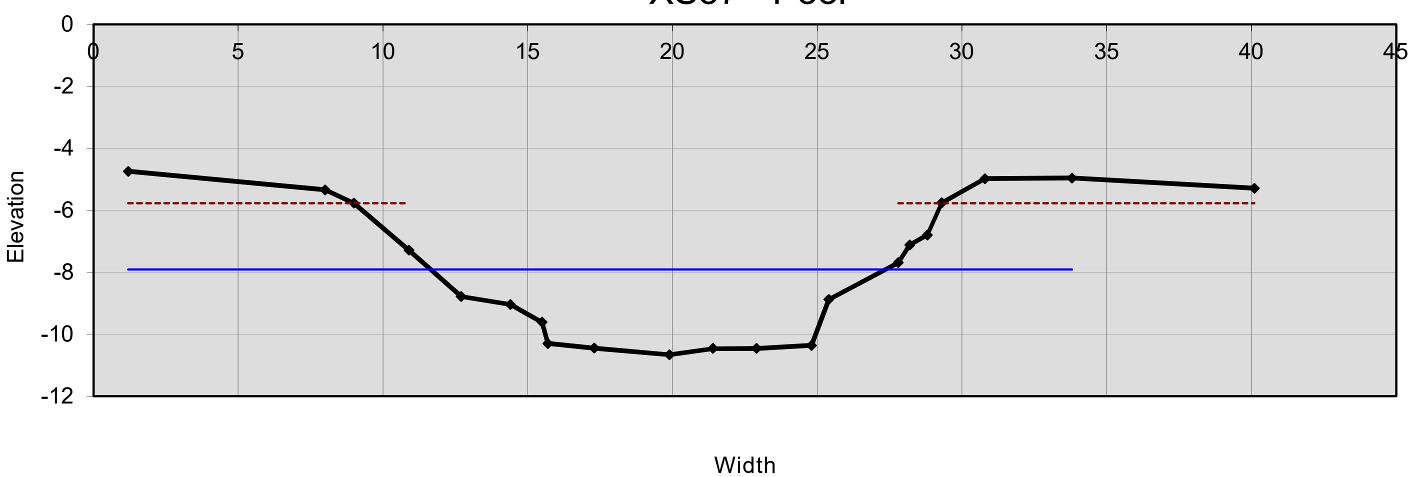
Elevation (ft)

Bankfull Dimensions	
18.6	x-section area (ft.sq.)
11.3	width (ft)
1.6	mean depth (ft)
2.1	max depth (ft)
13.0	wetted parimeter (ft)
1.4	hydrualic radius (ft)
6.8	width-depth ratio

Flood Dimensions	
23.5	W flood prone area (ft)
2.1	entrenchment ratio
3.4	low bank height (ft)
1.6	low bank height ratio

Materials	
16	D50 Riffle (mm)
64	D84 Riffle (mm)
27	threshold grain size (mm):

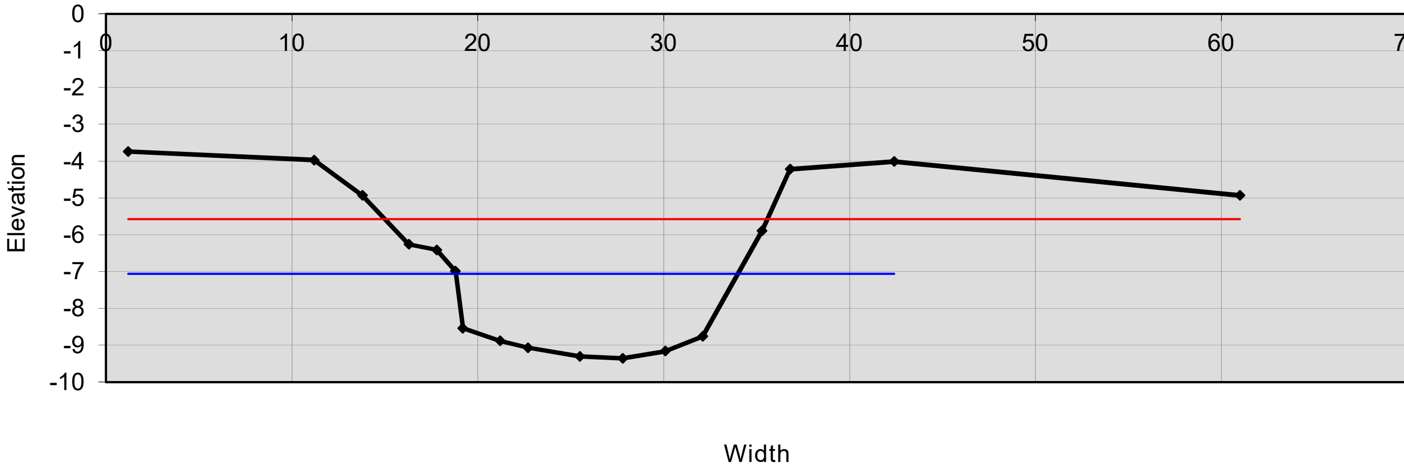
XS37 - Pool



Bankfull Dimensions	
29.4	x-section area (ft.sq.)
15.7	width (ft)
1.9	mean depth (ft)
2.7	max depth (ft)
17.9	wetted parimeter (ft)
1.6	hyd radi (ft)
8.4	width-depth ratio

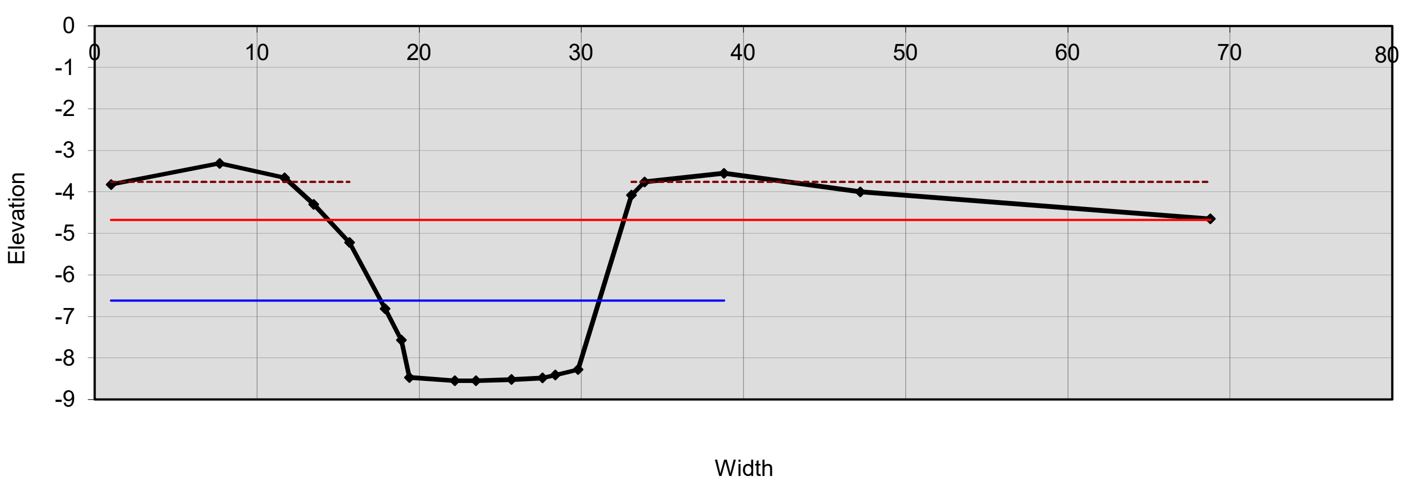
Buckwater Reach 2 & Reach 3

XS35 - Pool



Bankfull Dimensions	
28.1	x-section area (ft.sq.)
15.2	width (ft)
1.9	mean depth (ft)
2.3	max depth (ft)
17.1	wetted parimeter (ft)
1.6	hyd radi (ft)
8.2	width-depth ratio

XS36 - Riffle

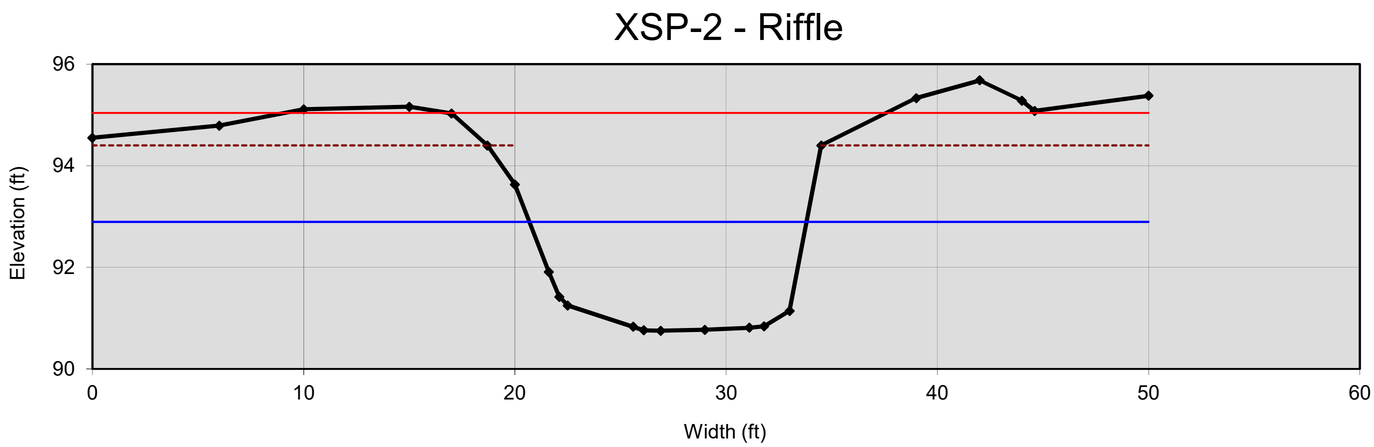


Bankfull Dimensions	
21.9	x-section area (ft.sq.)
13.5	width (ft)
1.6	mean depth (ft)
1.9	max depth (ft)
15.1	wetted parimeter (ft)
1.4	hyd radi (ft)
8.3	width-depth ratio

Flood Dimensions	
18.2	W flood prone area (ft)
1.4	entrenchment ratio
4.8	low bank height (ft)
2.5	low bank height ratio

Materials	
16	D50 Riffle (mm)
64	D84 Riffle (mm)
22	threshold grain size (mm):

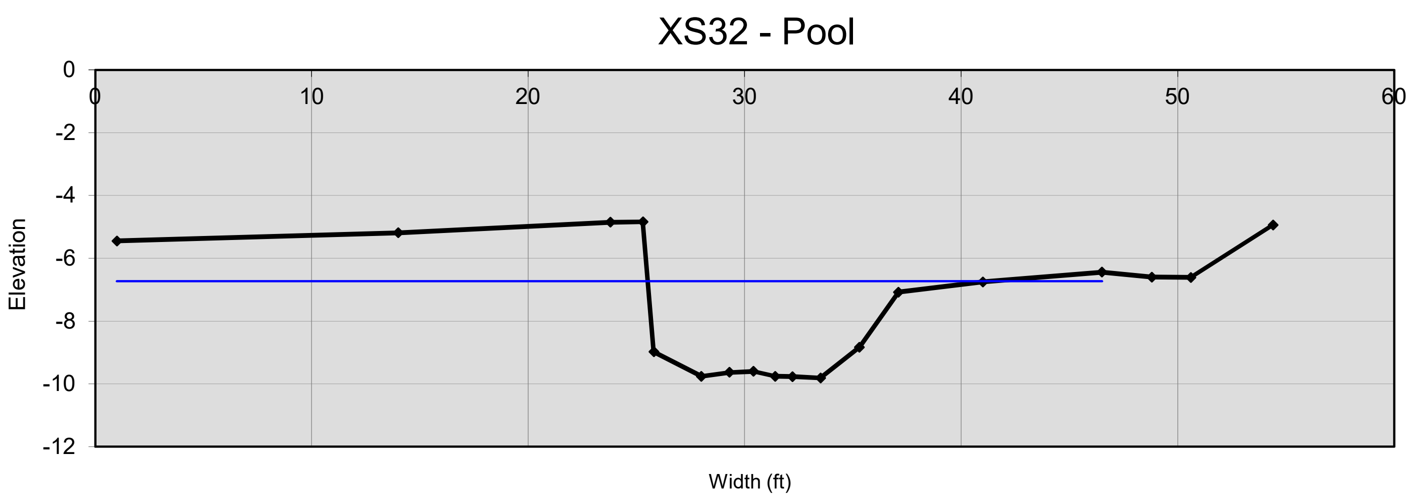
Buckwater Reach 4



Bankfull Dimensions	
23.6	x-section area (ft.sq.)
13.1	width (ft)
1.8	mean depth (ft)
2.1	max depth (ft)
15.0	wetted parimeter (ft)
1.6	hydrualic radius (ft)
7.3	width-depth ratio

Flood Dimensions	
17.0	W flood prone area (ft)
1.3	entrenchment ratio
3.7	low bank height (ft)
1.7	low bank height ratio

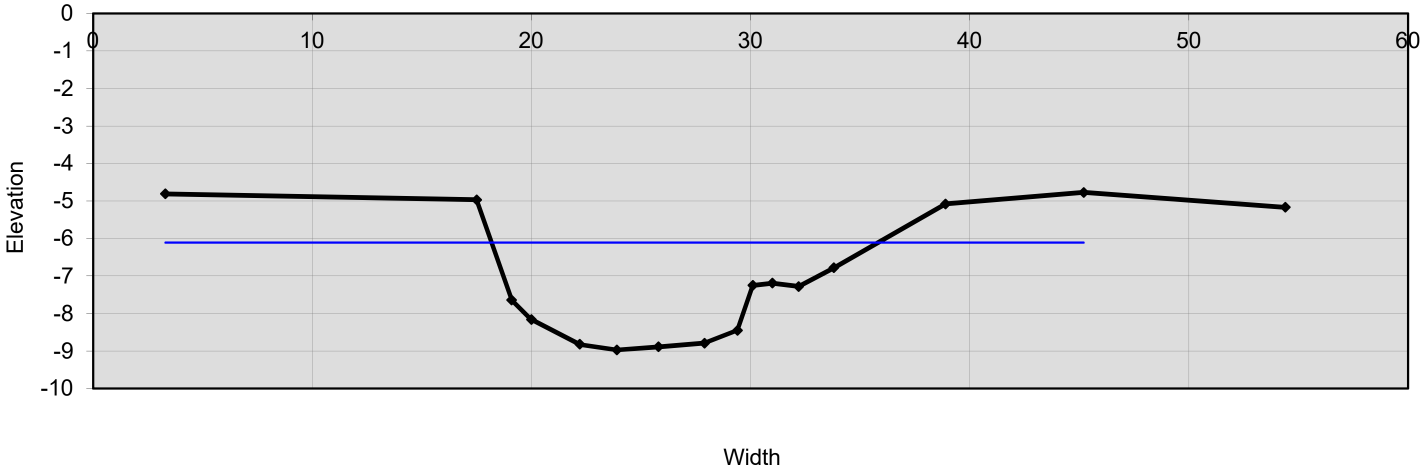
Materials	
16	D50 Riffle (mm)
64	D84 Riffle (mm)
22	threshold grain size (mm):



Bankfull Dimensions	
30.0	x-section area (ft.sq.)
15.8	width (ft)
1.9	mean depth (ft)
3.1	max depth (ft)
18.9	wetted parimeter (ft)
1.6	hyd radi (ft)
8.3	width-depth ratio

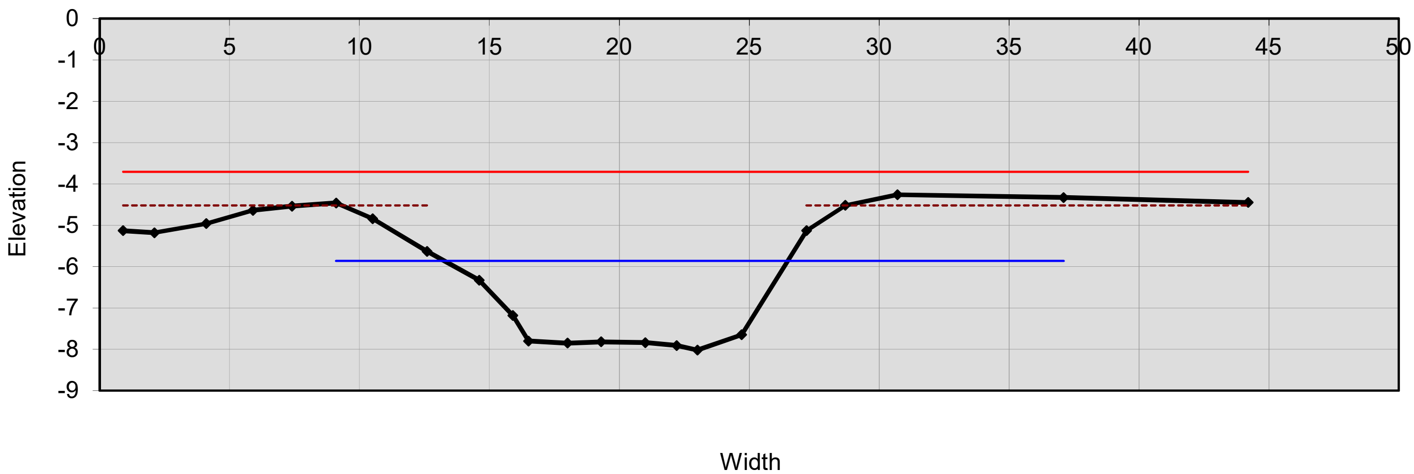
Buckwater Reach 4

XS33 - Pool



Bankfull Dimensions	
32.8	x-section area (ft.sq.)
17.6	width (ft)
1.9	mean depth (ft)
2.9	max depth (ft)
19.6	wetted parimeter (ft)
1.7	hyd radi (ft)
9.5	width-depth ratio

XS34 - Riffle



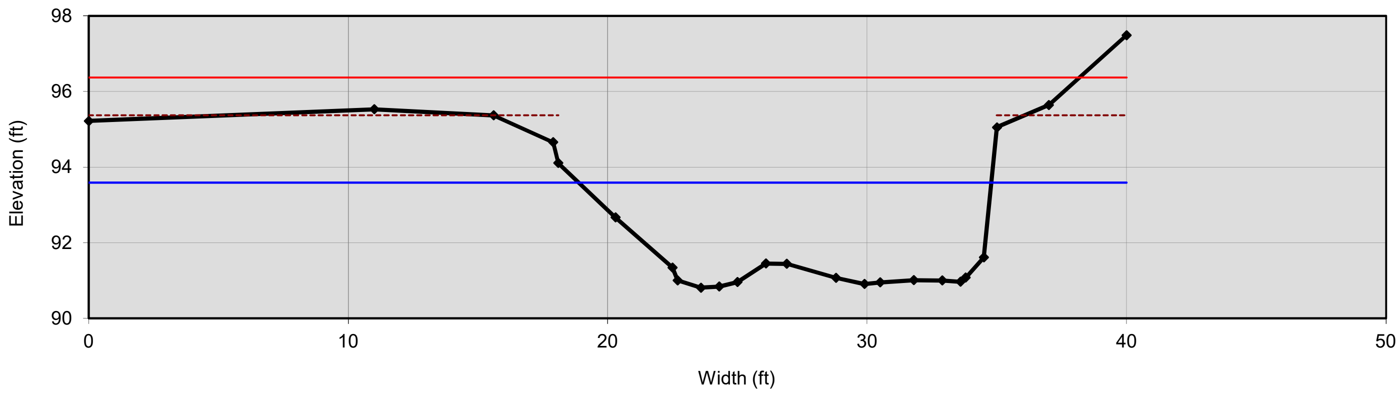
Bankfull Dimensions	
20.3	x-section area (ft.sq.)
13.2	width (ft)
1.5	mean depth (ft)
2.2	max depth (ft)
14.6	wetted parimeter (ft)
1.4	hyd radi (ft)
8.6	width-depth ratio

Flood Dimensions	
	W flood prone area (ft)
	entrenchment ratio
3.5	low bank height (ft)
1.6	low bank height ratio

Materials	
16	D50 Riffle (mm)
64	D84 Riffle (mm)
31	threshold grain size (mm):

Buckwater Reach 5 & Reach 6

XSP-3 - Riffle



Bankfull Dimensions

34.5	x-section area (ft.sq.)
15.9	width (ft)
2.2	mean depth (ft)
2.8	max depth (ft)
18.8	wetted parimeter (ft)
1.8	hydraulic radius (ft)
7.3	width-depth ratio

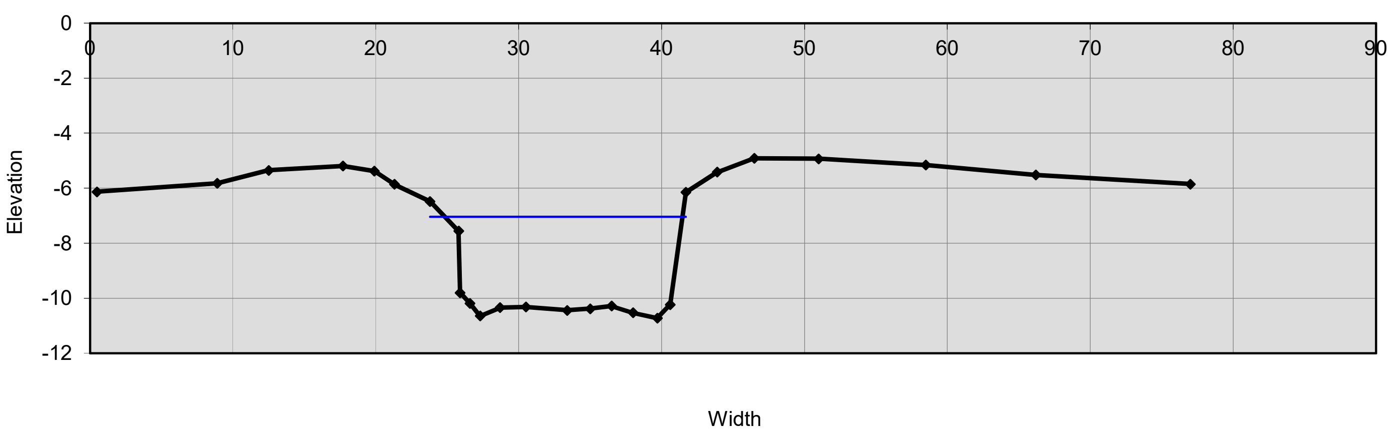
Flood Dimensions

20.0	W flood prone area (ft)
1.3	entrenchment ratio
4.6	low bank height (ft)
1.6	low bank height ratio

Materials

18	D50 Riffle (mm)
39	D84 Riffle (mm)
18	threshold grain size (mm):

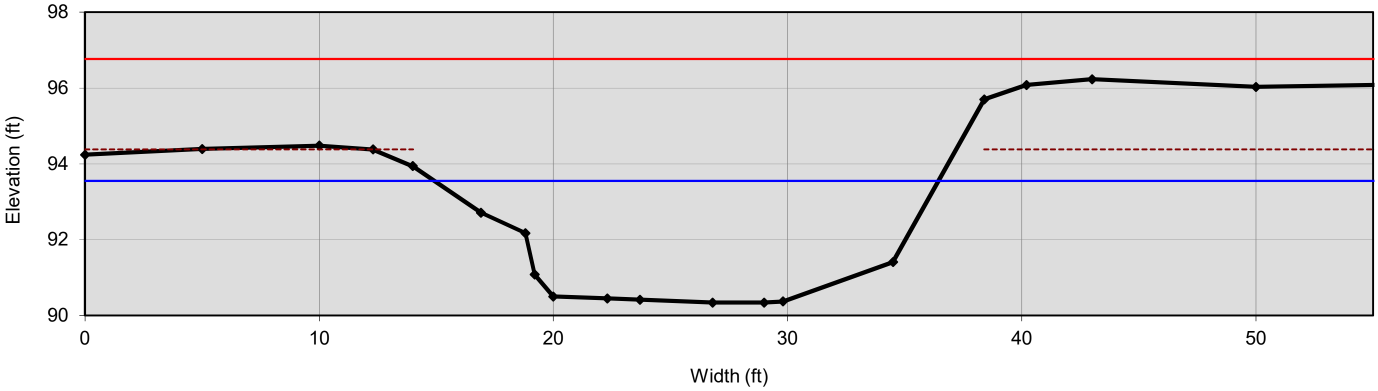
XS18 - Pool



21.8	wetted parimeter (ft)
2.4	hyd radi (ft)
5.4	width-depth ratio

Buckwater Reach 7 & Reach 8

XSP-4 - Pool

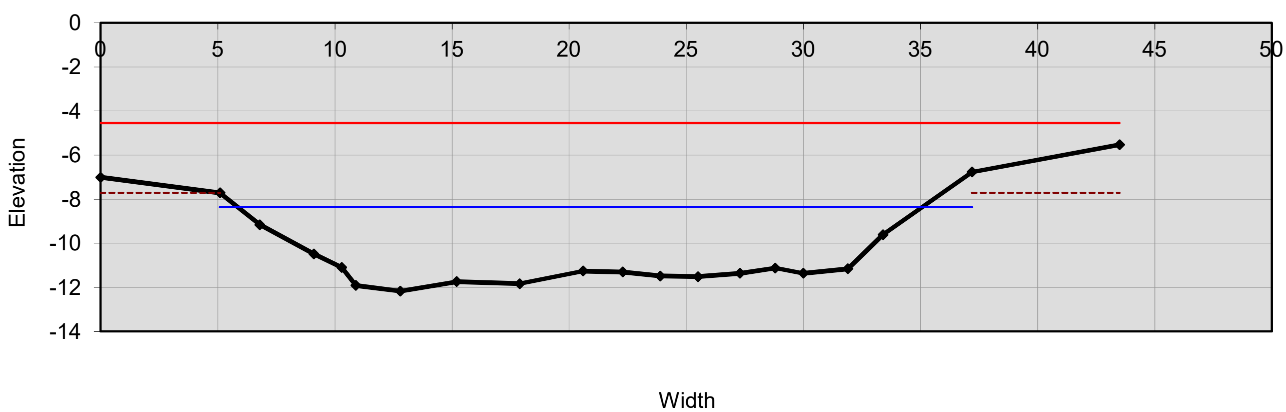


Bankfull Dimensions	
51.4	x-section area (ft.sq.)
21.5	width (ft)
2.4	mean depth (ft)
3.2	max depth (ft)
23.8	wetted parimeter (ft)
2.2	hydrualic radius (ft)
9.0	width-depth ratio

Flood Dimensions	
---	W flood prone area (ft)
---	entrenchment ratio
4.0	low bank height (ft)
1.3	low bank height ratio

Materials	
18	D50 Riffle (mm)
39	D84 Riffle (mm)
25	threshold grain size (mm):

XS15 - Riffle

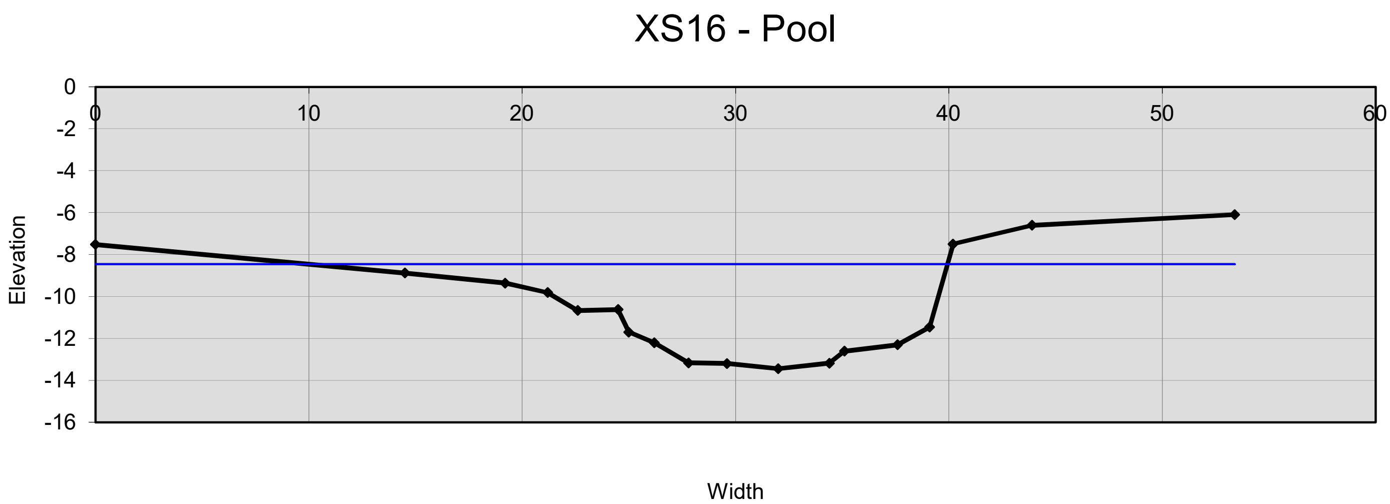


Bankfull Dimensions	
79.8	x-section area (ft.sq.)
29.2	width (ft)
2.7	mean depth (ft)
3.8	max depth (ft)
31.7	wetted parimeter (ft)
2.5	hyd radi (ft)
10.7	width-depth ratio

Flood Dimensions	
>50	W flood prone area (ft)
>2.2	entrenchment ratio
4.5	low bank height (ft)
1.2	low bank height ratio

Materials	
18	D50 (mm)
38	D84 (mm)
10	threshold grain size (mm):

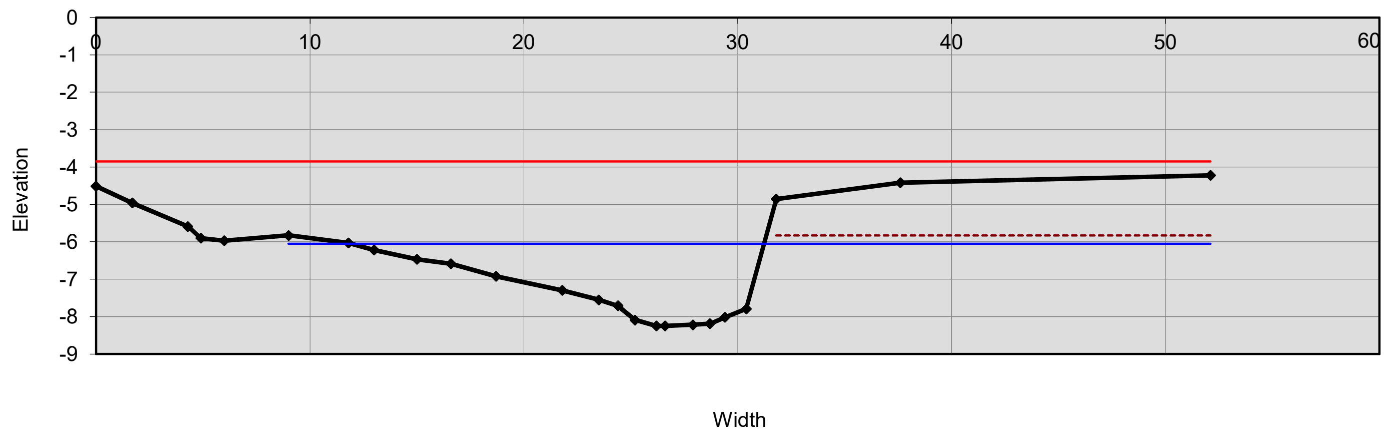
Buckwater Reach 7 & Reach 8



Bankfull Dimensions	
76.5	x-section area (ft.sq.)
29.9	width (ft)
2.6	mean depth (ft)
5.0	max depth (ft)
34.0	wetted parimeter (ft)
2.2	hyd radi (ft)
11.7	width-depth ratio

T1 Reach 1

XS19 - Riffle

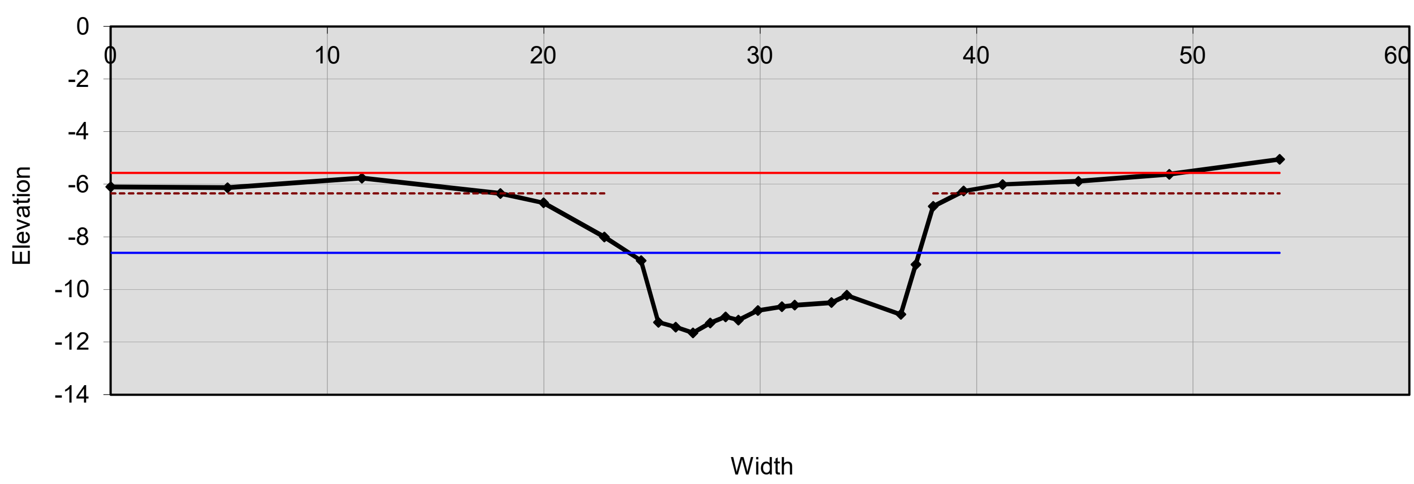


Bankfull Dimensions	
23.0	x-section area (ft.sq.)
19.3	width (ft)
1.2	mean depth (ft)
2.2	max depth (ft)
20.7	wetted parimeter (ft)
1.1	hyd radi (ft)
16.2	width-depth ratio

Flood Dimensions	
>60	W flood prone area (ft)
>3.0	entrenchment ratio
2.4	low bank height (ft)
1.1	low bank height ratio

Materials	
21	D50 Riffle (mm)
83	D84 Riffle (mm)
58	threshold grain size (mm):

XS28 - Riffle



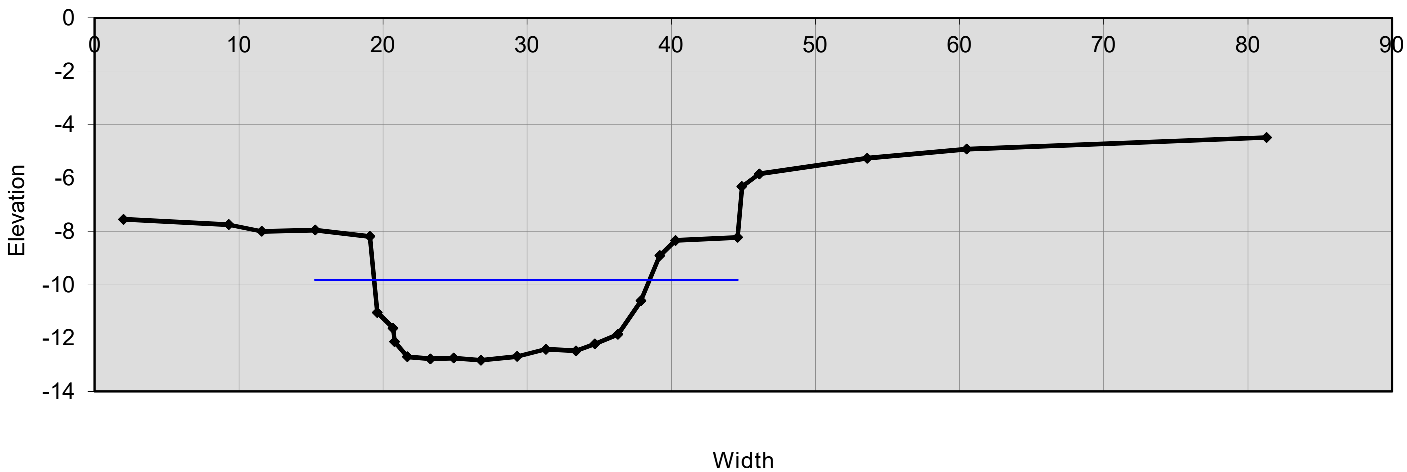
Bankfull Dimensions	
27.4	x-section area (ft.sq.)
13.4	width (ft)
2.0	mean depth (ft)
3.0	max depth (ft)
17.2	wetted parimeter (ft)
1.6	hyd radi (ft)
6.5	width-depth ratio

Flood Dimensions	
---	W flood prone area (ft)
---	entrenchment ratio
5.3	low bank height (ft)
1.7	low bank height ratio

Materials	
21	D50 Riffle (mm)
83	D84 Riffle (mm)
39	threshold grain size (mm):

T1 Reach 1

XS29 - Pool

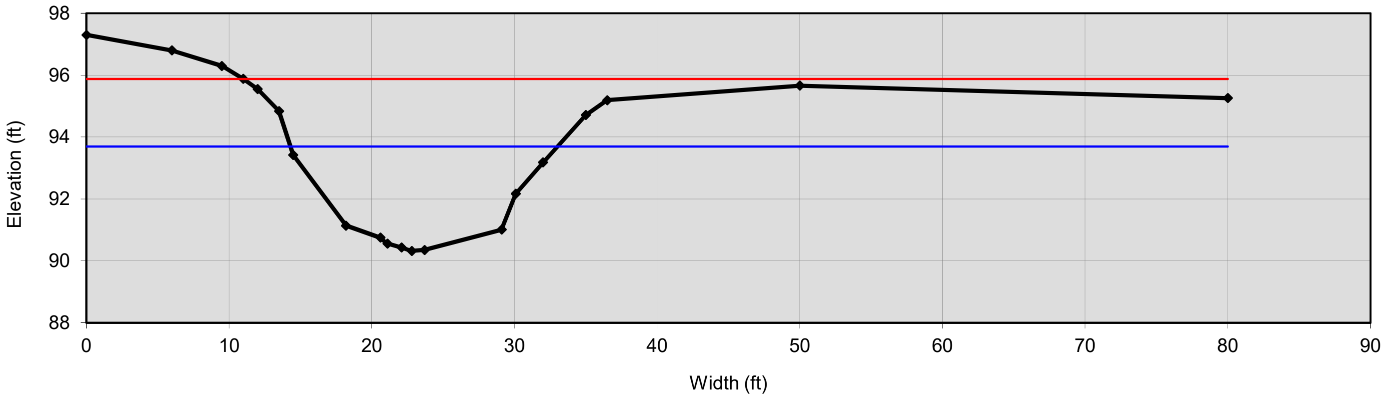


Bankfull Dimensions

47.0	x-section area (ft.sq.)
19.1	width (ft)
2.5	mean depth (ft)
3.0	max depth (ft)
21.8	wetted parimeter (ft)

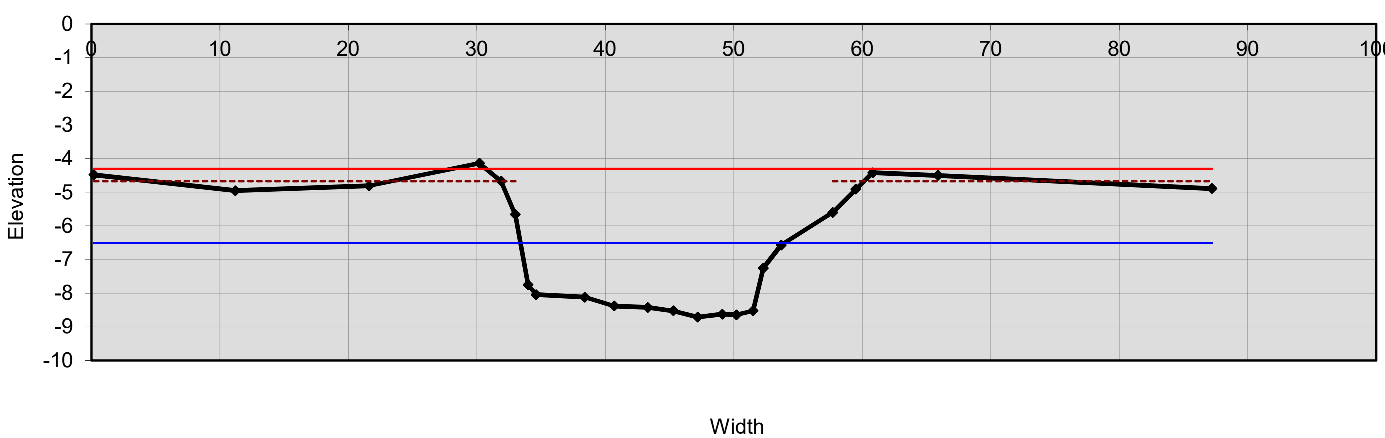
T1 Reach 2

XSP-5 - Pool



Bankfull Dimensions	
42.5	x-section area (ft.sq.)
18.7	width (ft)
2.3	mean depth (ft)
3.4	max depth (ft)
20.5	wetted parimeter (ft)
2.1	

XS17 - Riffle



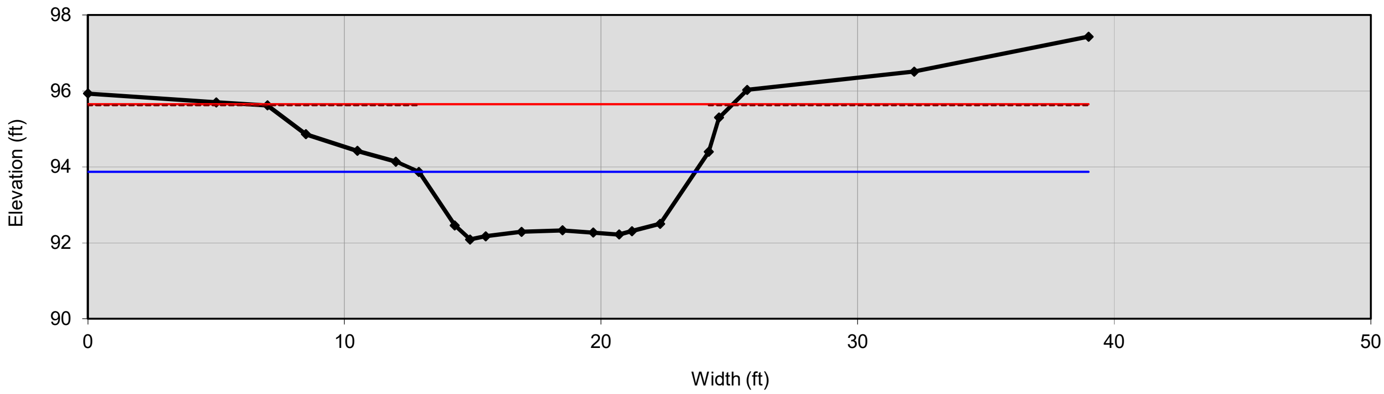
Bankfull Dimensions	
34.8	x-section area (ft.sq.)
20.6	width (ft)
1.7	mean depth (ft)
2.2	max depth (ft)
22.3	wetted parimeter (ft)
1.6	hyd radi (ft)
12.1	width-depth ratio

Flood Dimensions	
31.0	W flood prone area (ft)
1.5	entrenchment ratio
4.0	low bank height (ft)
1.8	low bank height ratio

Materials	
21	D50 Riffle (mm)
83	D84 Riffle (mm)
25	threshold grain size (mm):

T2

XSP-7 - Pool

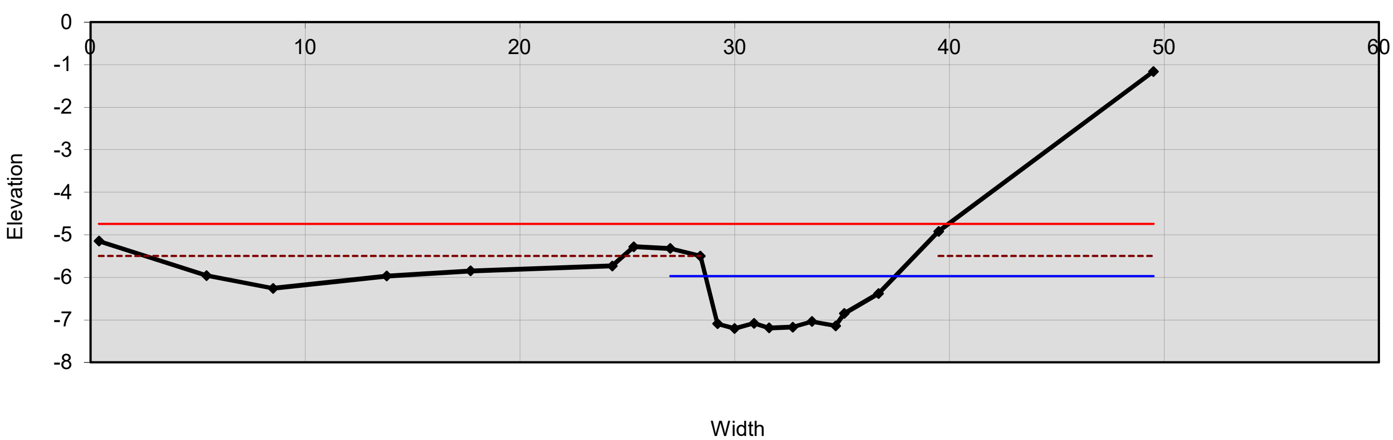


Bankfull Dimensions	
14.6	x-section area (ft.sq.)
10.8	width (ft)
1.4	mean depth (ft)
1.8	max depth (ft)
12.1	wetted parimeter (ft)
1.2	hydraulic radius (ft)
7.9	width-depth ratio

Flood Dimensions	
14.0	W flood prone area (ft)
1.3	entrenchment ratio
3.5	low bank height (ft)
2.0	low bank height ratio

Materials	
15	D50 Riffle (mm)
73	D84 Riffle (mm)
20	threshold grain size (mm):

XS20 - Riffle

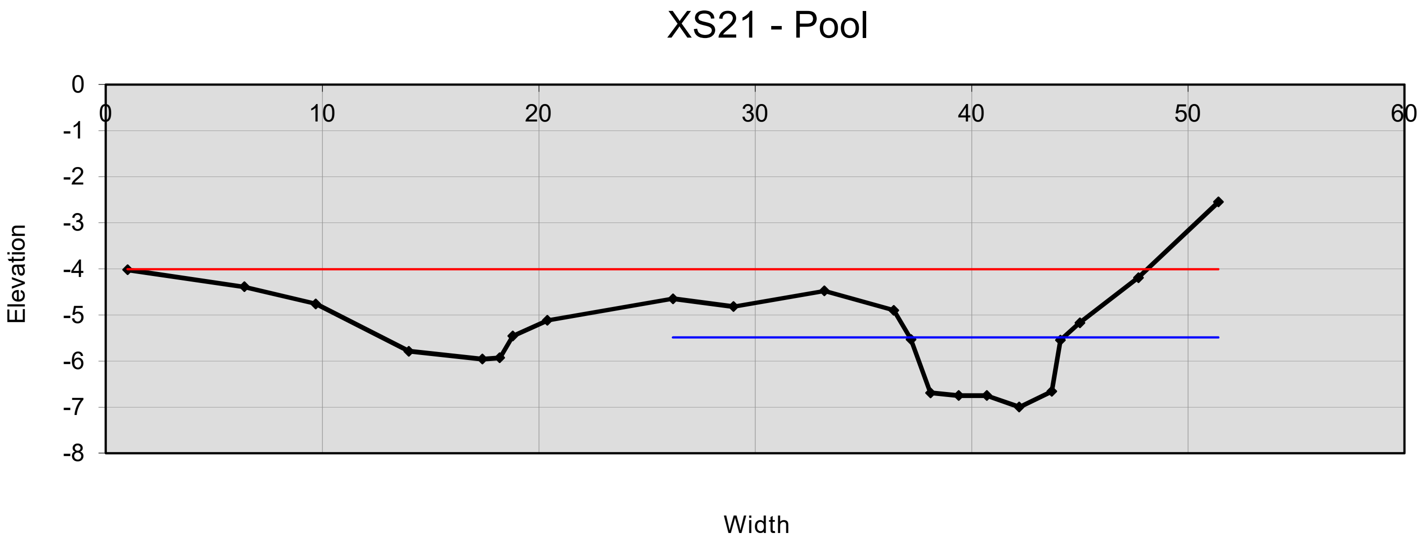


Bankfull Dimensions	
8.3	x-section area (ft.sq.)
8.8	width (ft)
0.9	mean depth (ft)
1.2	max depth (ft)
9.8	wetted parimeter (ft)
0.8	hyd radi (ft)
9.4	width-depth ratio

Flood Dimensions	
40.0	W flood prone area (ft)
4.5	entrenchment ratio
1.7	low bank height (ft)
1.4	low bank height ratio

Materials	
15	D50 Riffle (mm)
73	D84 Riffle (mm)
44	threshold grain size (mm):

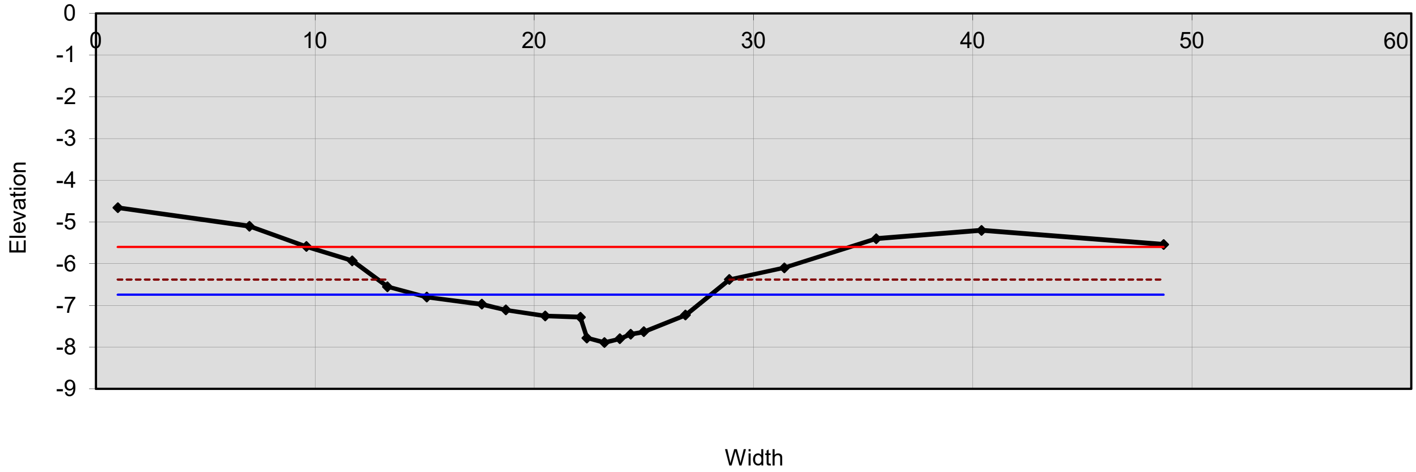
T2



Bankfull Dimensions	
8.1	x-section area (ft.sq.)
7.1	width (ft)
1.1	mean depth (ft)
1.5	max depth (ft)
8.5	wetted parimeter (ft)
1.0	hyd radi (ft)
6.2	width-depth ratio

T3 Reach 1

XS26 - Riffle

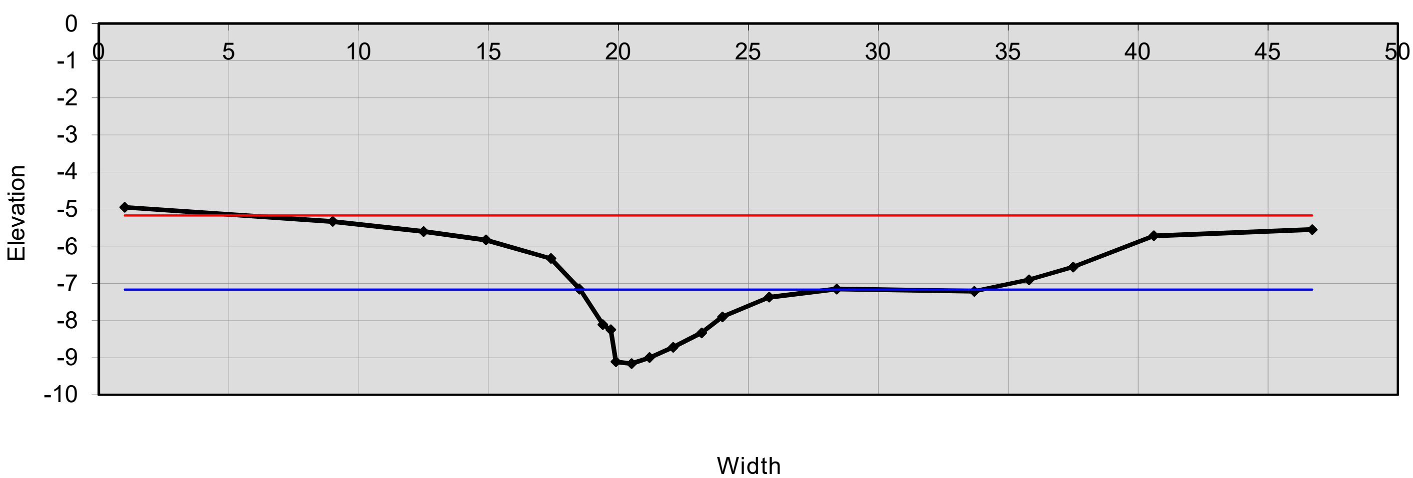


Bankfull Dimensions	
6.8	x-section area (ft.sq.)
13.3	width (ft)
0.51	mean depth (ft)
1.1	max depth (ft)
13.8	wetted parimeter (ft)
0.5	hyd radi (ft)
26.1	width-depth ratio

Flood Dimensions	
24.7	W flood prone area (ft)
1.9	entrenchment ratio
1.51	low bank height (ft)
1.32	low bank height ratio

Materials	
45	D50 Riffle (mm)
100	D84 Riffle (mm)
27	threshold grain size (mm):

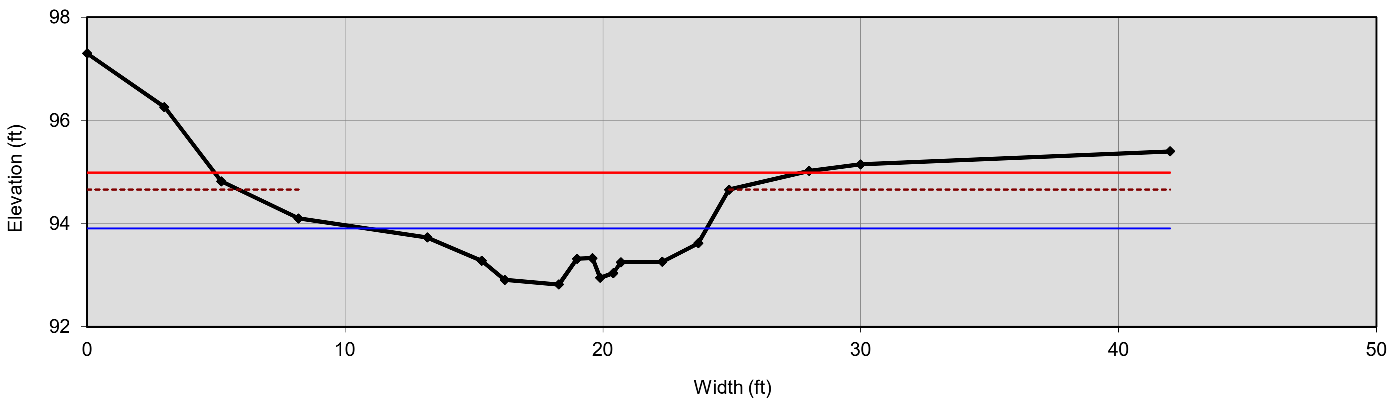
XS27 - Pool



Bankfull Dimensions	
8.5	x-section area (ft.sq.)
14.0	width (ft)
0.6	mean depth (ft)
2.0	max depth (ft)
15.4	wetted parimeter (ft)
0.6	hyd radi (ft)

T3 Reach 2

XSP-6 - Riffle

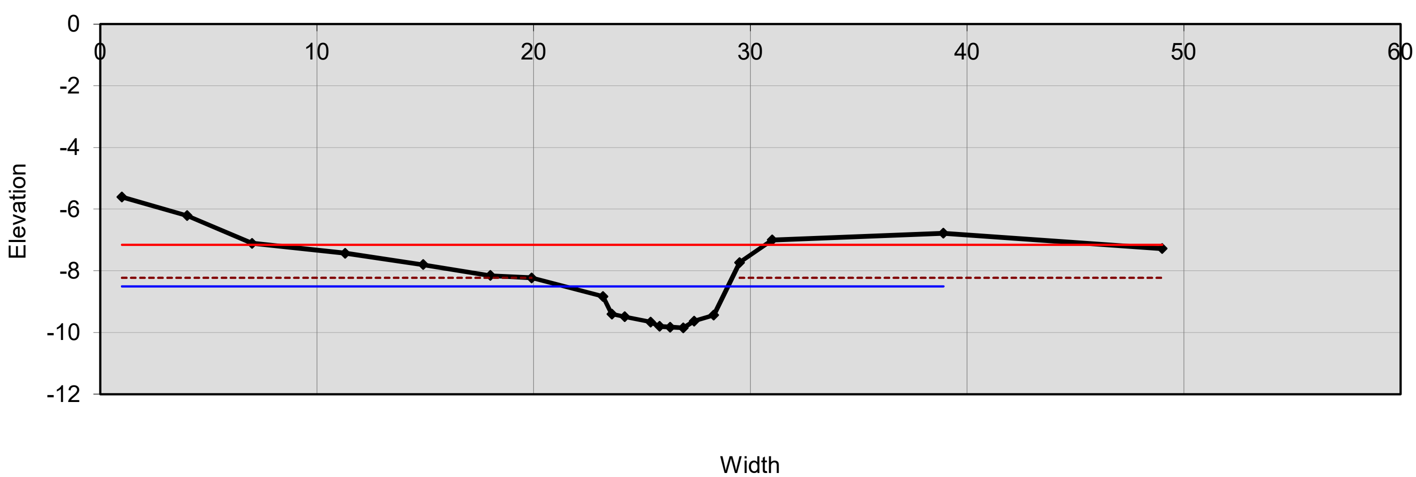


Bankfull Dimensions	
7.5	x-section area (ft.sq.)
13.2	width (ft)
0.6	mean depth (ft)
1.1	max depth (ft)
13.9	wetted parimeter (ft)
0.5	hydraulic radius (ft)
23.1	width-depth ratio

Flood Dimensions	
22.0	W flood prone area (ft)
1.7	entrenchment ratio
1.8	low bank height (ft)
1.7	low bank height ratio

Materials	
31	D50 Riffle (mm)
74	D84 Riffle (mm)
32	threshold grain size (mm):

XS24 - Riffle

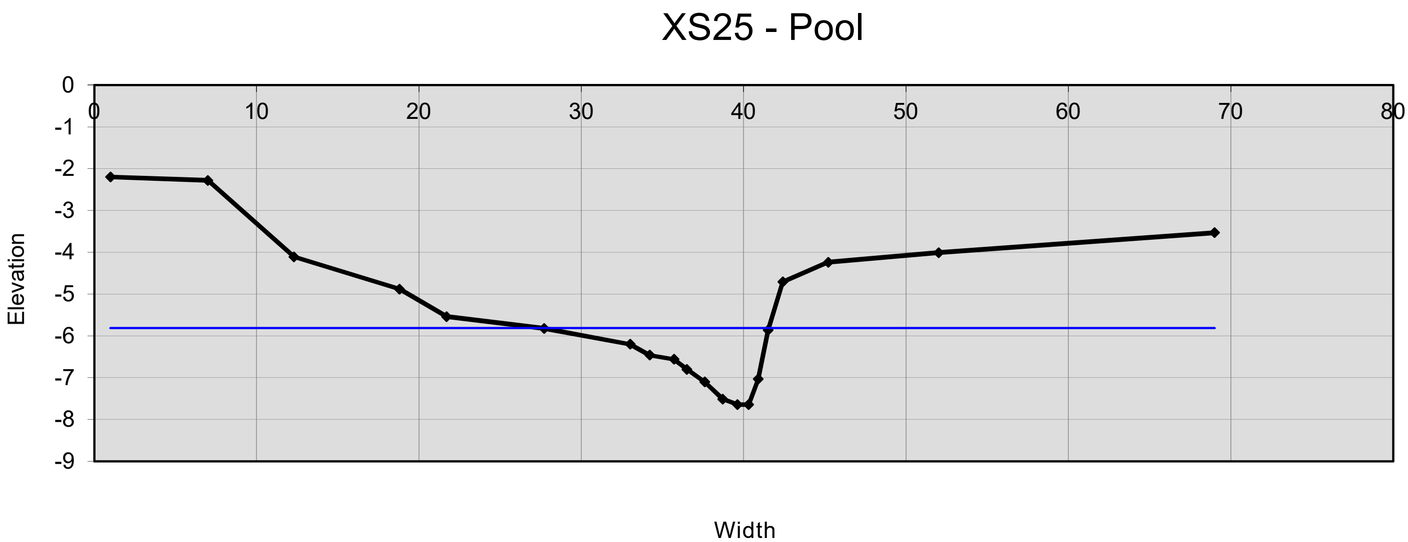


Bankfull Dimensions	
6.2	x-section area (ft.sq.)
7.5	width (ft)
0.82	mean depth (ft)
1.3	max depth (ft)
8.5	wetted parimeter (ft)
0.7	hyd radi (ft)
9.2	width-depth ratio

Flood Dimensions	
25.5	W flood prone area (ft)
3.4	entrenchment ratio
1.62	low bank height (ft)
1.20	low bank height ratio

Materials	
31	D50 Riffle (mm)
74	D84 Riffle (mm)
43	threshold grain size (mm):

T3 Reach 2

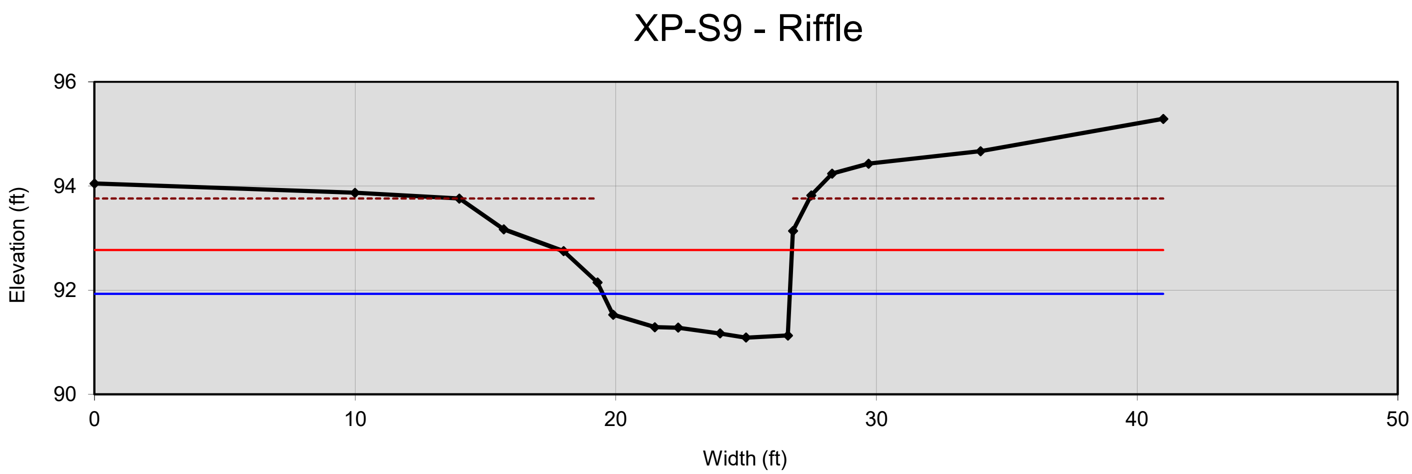


Bankfull Dimensions

10.4	x-section area (ft.sq.)
14.0	width (ft)
0.7	mean depth (ft)
1.8	max depth (ft)
15.2	wetted parimeter (ft)
0.7	hyd radi (ft)
18.7	width-depth ratio

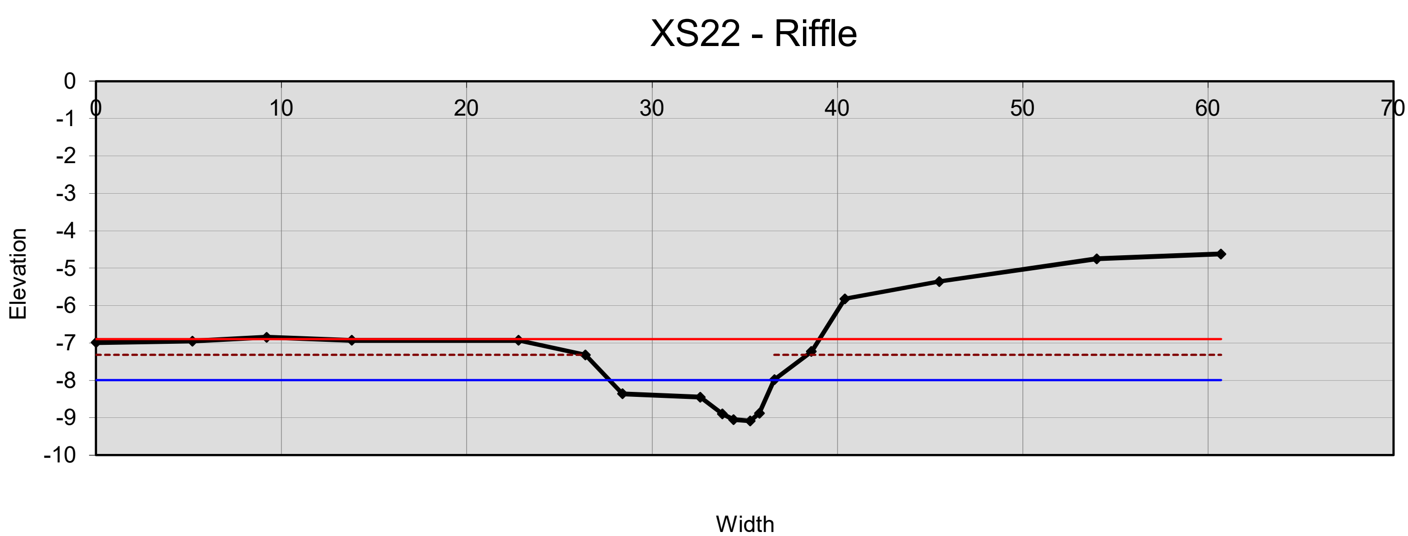
T4

XP-S9 - Riffle



Bankfull Dimensions		Flood Dimensions		Materials	
4.8	x-section area (ft.sq.)	9.0	W flood prone area (ft)	54	D50 Riffle (mm)
7.2	width (ft)	1.3	entrenchment ratio	120	D84 Riffle (mm)
0.7	mean depth (ft)	2.7	low bank height (ft)	34	threshold grain size (mm):
0.8	max depth (ft)	3.2	low bank height ratio		
8.1	wetted parimeter (ft)				
0.6	hydrualic radius (ft)				
10.8	width-depth ratio				

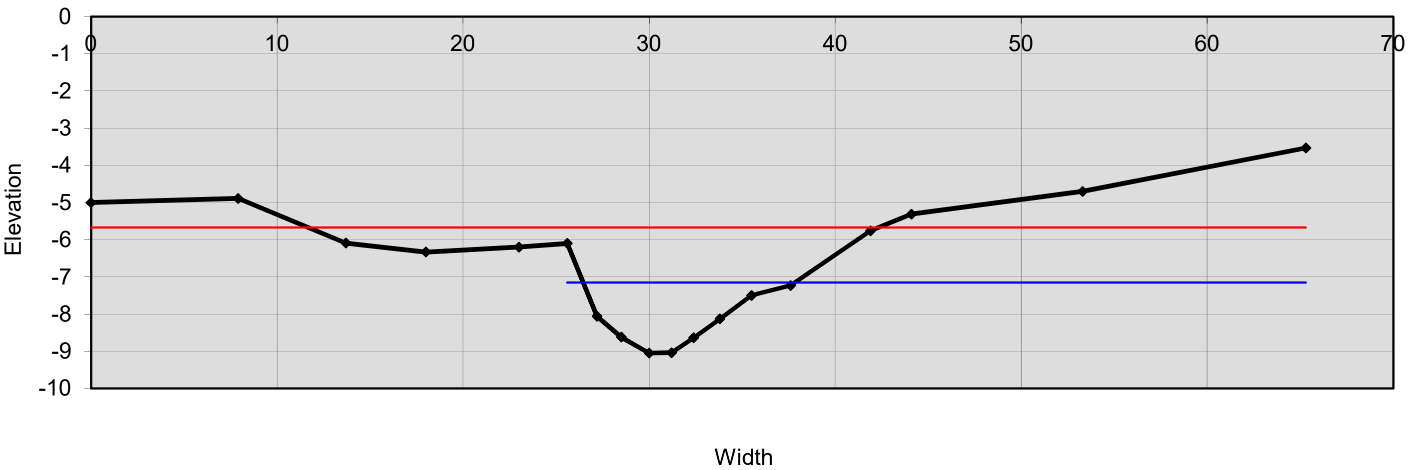
XS22 - Riffle



Bankfull Dimensions		Flood Dimensions		Materials	
5.1	x-section area (ft.sq.)	15.0	W flood prone area (ft)	54	D50 Riffle (mm)
8.9	width (ft)	1.7	entrenchment ratio	120	D84 Riffle (mm)
0.57	mean depth (ft)	1.8	low bank height (ft)	30	threshold grain size (mm):
1.1	max depth (ft)	1.6	low bank height ratio		
9.5	wetted parimeter (ft)				
0.5	hyd radi (ft)				
15.6	width-depth ratio				

T4

XS23 - Pool



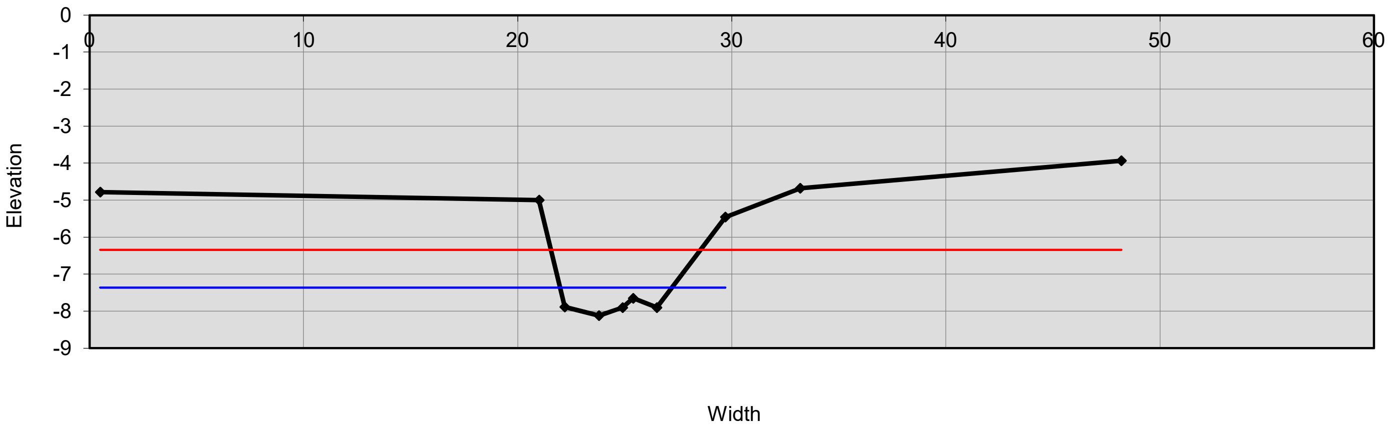
Bankfull Dimensions	
12.0	x-section area (ft.sq.)
11.4	width (ft)
1.1	mean depth (ft)
1.9	max depth (ft)
12.3	wetted parimeter (ft)
1.0	hyd radi (ft)
10.8	width-depth ratio

Flood Dimensions	
30.7	W flood prone area (ft)
2.7	entrenchment ratio
---	low bank height (ft)
---	low bank height ratio

Materials	
54	D50 Riffle (mm)
120	D84 Riffle (mm)
56	threshold grain size (mm):

T4B

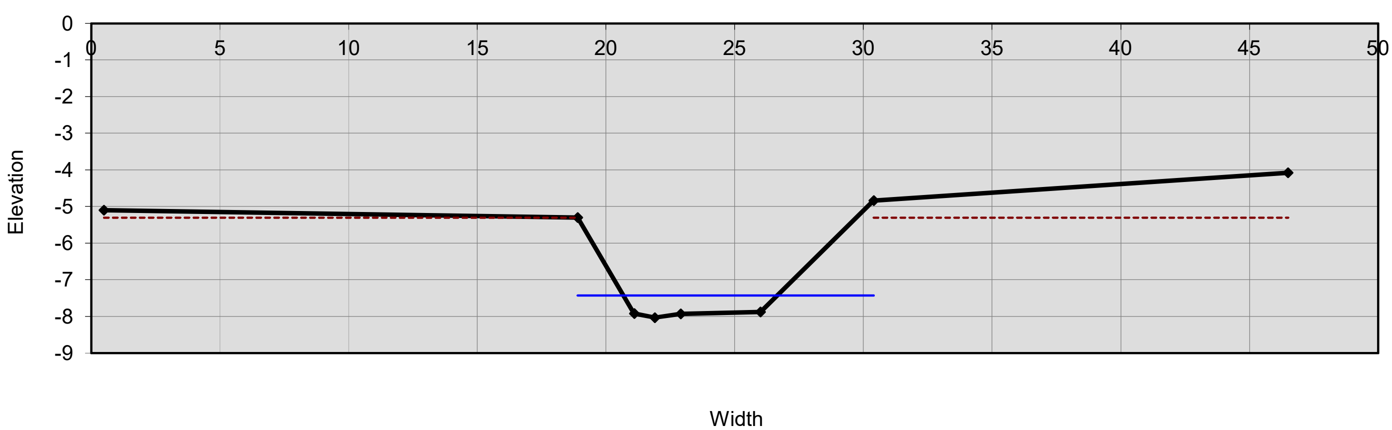
XS3 - Pool



Bankfull Dimensions	
2.7	x-section area (ft.sq.)
5.2	width (ft)
0.5	mean depth (ft)
0.8	max depth (ft)
5.9	wetted parimeter (ft)
0.5	hyd radi (ft)
10.3	width-depth ratio

Flood Dimensions	
7.0	W flood prone area (ft)
1.3	entrenchment ratio
---	low bank height (ft)
---	low bank height ratio

XS4 - Riffle



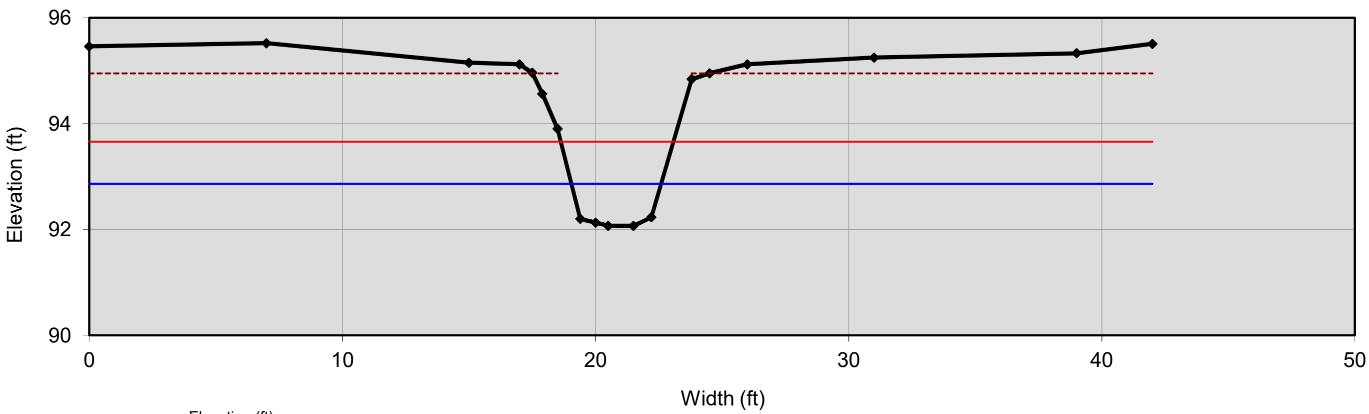
Bankfull Dimensions	
2.7	x-section area (ft.sq.)
6.0	width (ft)
0.5	mean depth (ft)
0.6	max depth (ft)
6.4	wetted parimeter (ft)
0.4	hyd radi (ft)
13.1	width-depth ratio

Flood Dimensions	
7.3	W flood prone area (ft)
1.2	entrenchment ratio
2.7	low bank height (ft)
4.5	low bank height ratio

Materials	
17	D50 Riffle (mm)
87	D84 Riffle (mm)
48	threshold grain size (mm):

T4B

XS8 - Riffle



Elevation (ft)

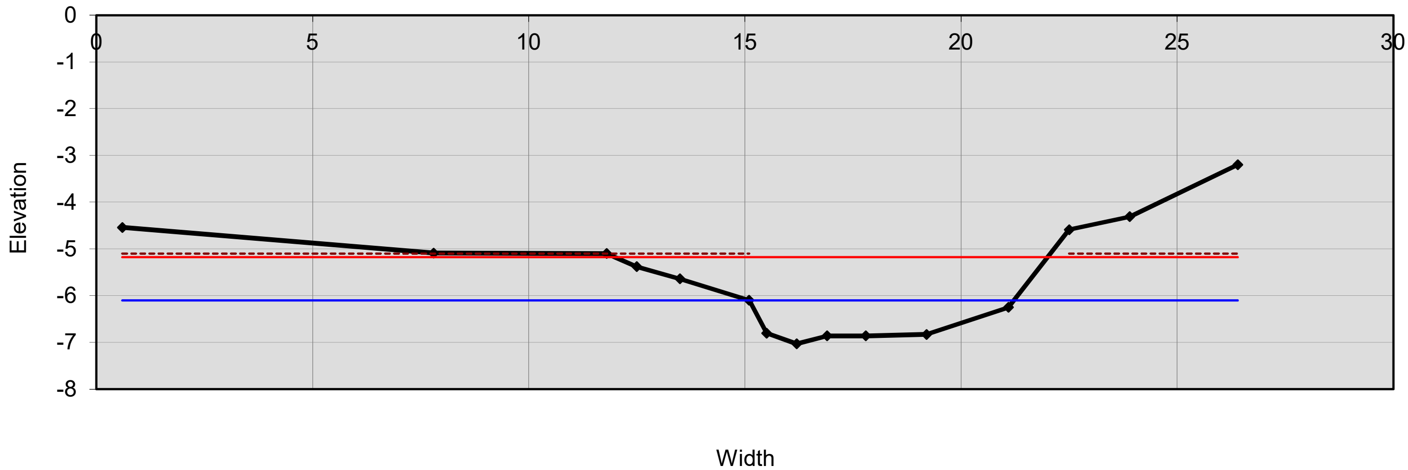
Bankfull Dimensions	
2.3	x-section area (ft.sq.)
3.5	width (ft)
0.7	mean depth (ft)
0.8	max depth (ft)
4.3	wetted parimeter (ft)
0.5	hydrualic radius (ft)
5.4	width-depth ratio

Flood Dimensions	
5.0	W flood prone area (ft)
1.4	entrenchment ratio
2.9	low bank height (ft)
3.6	low bank height ratio

Materials	
17	D50 Riffle (mm)
87	D84 Riffle (mm)
60	threshold grain size (mm):

T5 Reach 1

XS42 - Riffle

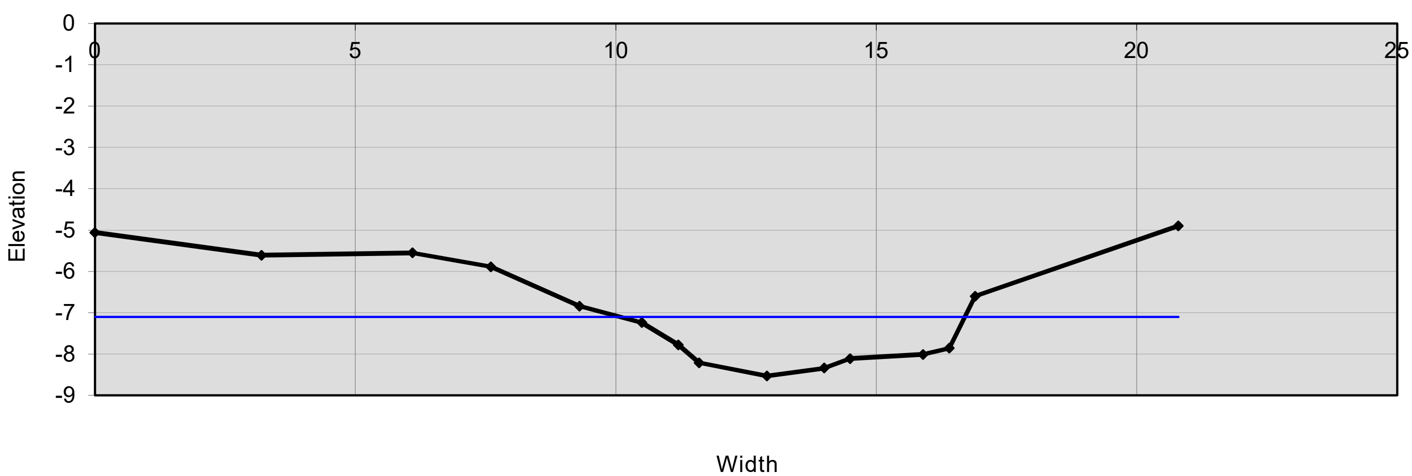


Bankfull Dimensions	
3.8	x-section area (ft.sq.)
6.12	width (ft)
0.6	mean depth (ft)
0.9	max depth (ft)
6.7	wetted parimeter (ft)
0.6	hyd radi (ft)
9.7	width-depth ratio

Flood Dimensions	
10.0	W flood prone area (ft)
1.6	entrenchment ratio
1.9	low bank height (ft)
2.1	low bank height ratio

Materials	
12	D50 Riffle (mm)
86	D84 Riffle (mm)
65	threshold grain size (mm):

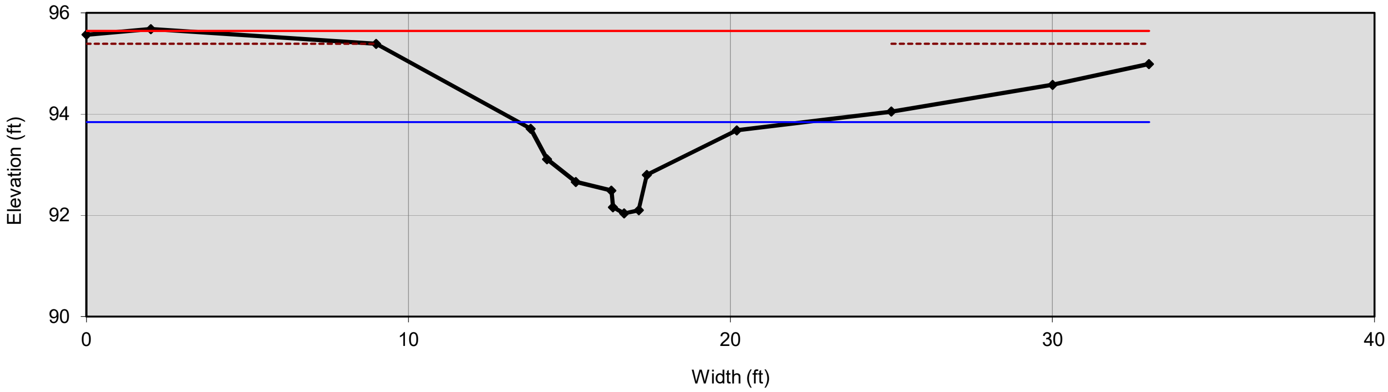
XS43 - Pool



Bankfull Dimensions	
6.2	x-section area (ft.sq.)
6.6	width (ft)
0.9	mean depth (ft)
1.4	max depth (ft)
7.7	wetted parimeter (ft)
0.8	hyd radi (ft)
7.0	width-depth ratio

T5 Reach 2

XSP-11 - Riffle

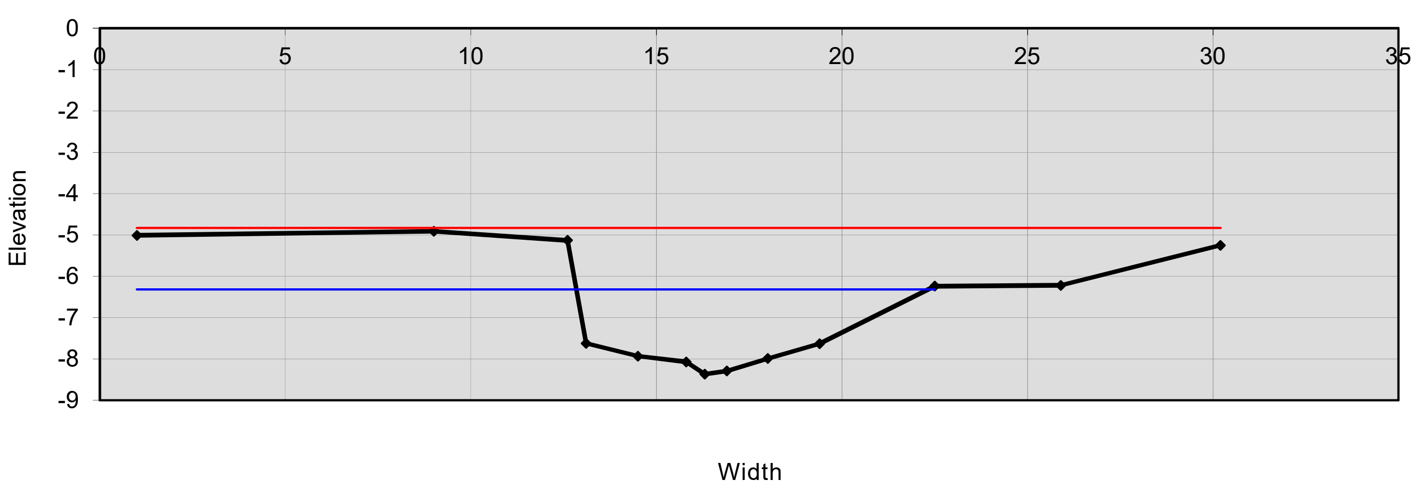


Bankfull Dimensions	
6.2	x-section area (ft.sq.)
8.9	width (ft)
0.7	mean depth (ft)
1.8	max depth (ft)
10.2	wetted parimeter (ft)
0.6	hydrualic radius (ft)
12.8	width-depth ratio

Flood Dimensions	
37.0	W flood prone area (ft)
4.2	entrenchment ratio
3.3	low bank height (ft)
1.9	low bank height ratio

Materials	
8.5	D50 Riffle (mm)
22	D84 Riffle (mm)
30	threshold grain size (mm):

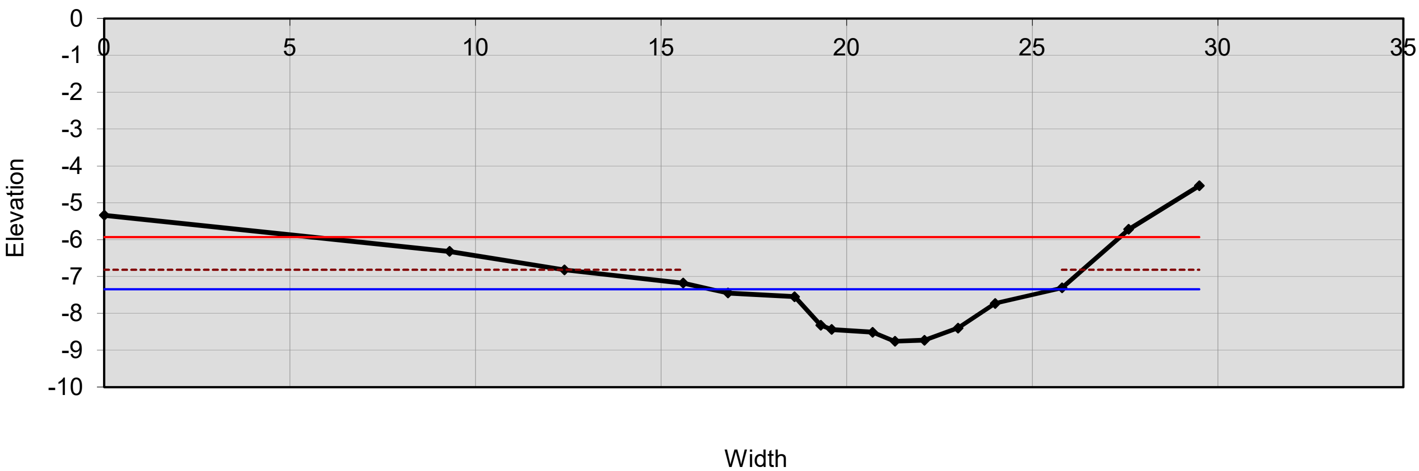
XS40 - Pool



Bankfull Dimensions	
12.6	x-section area (ft.sq.)
9.5	width (ft)
1.3	mean depth (ft)
2.1	max depth (ft)
11.1	wetted parimeter (ft)
1.1	hyd radi (ft)
7.2	width-depth ratio

T5 Reach 2

XS41 - Riffle



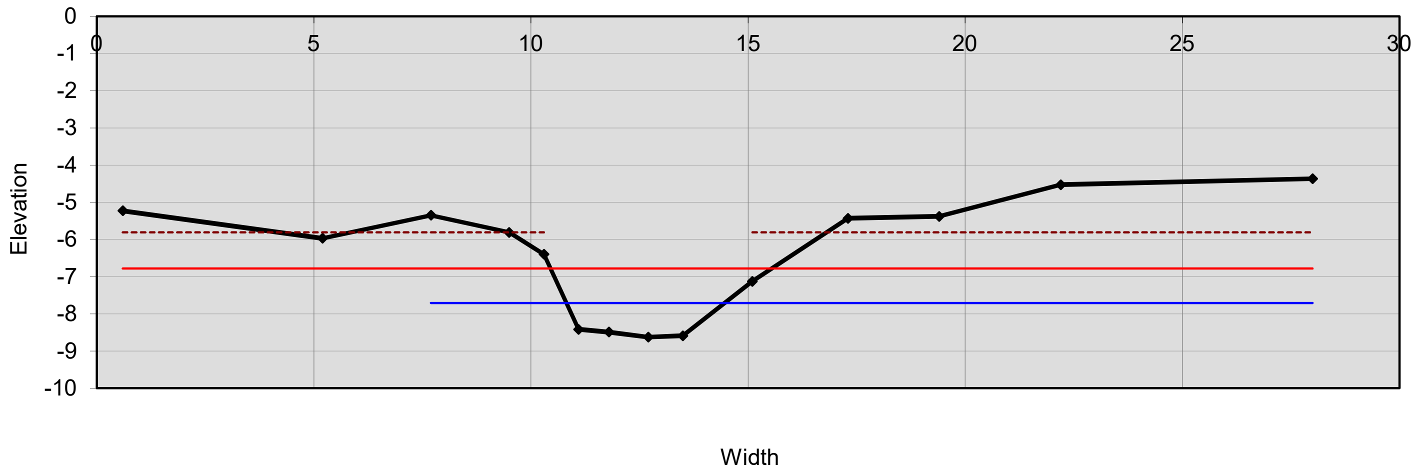
Bankfull Dimensions	
6.3	x-section area (ft.sq.)
9.3	width (ft)
0.7	mean depth (ft)
1.4	max depth (ft)
10.0	wetted parimeter (ft)
0.6	hyd radi (ft)
13.8	width-depth ratio

Flood Dimensions	
21.7	W flood prone area (ft)
2.3	entrenchment ratio
1.9	low bank height (ft)
1.37	low bank height ratio

Materials	
8.5	D50 Riffle (mm)
22	D84 Riffle (mm)
24	threshold grain size (mm):

T6 Reach 1

XS30 - Riffle

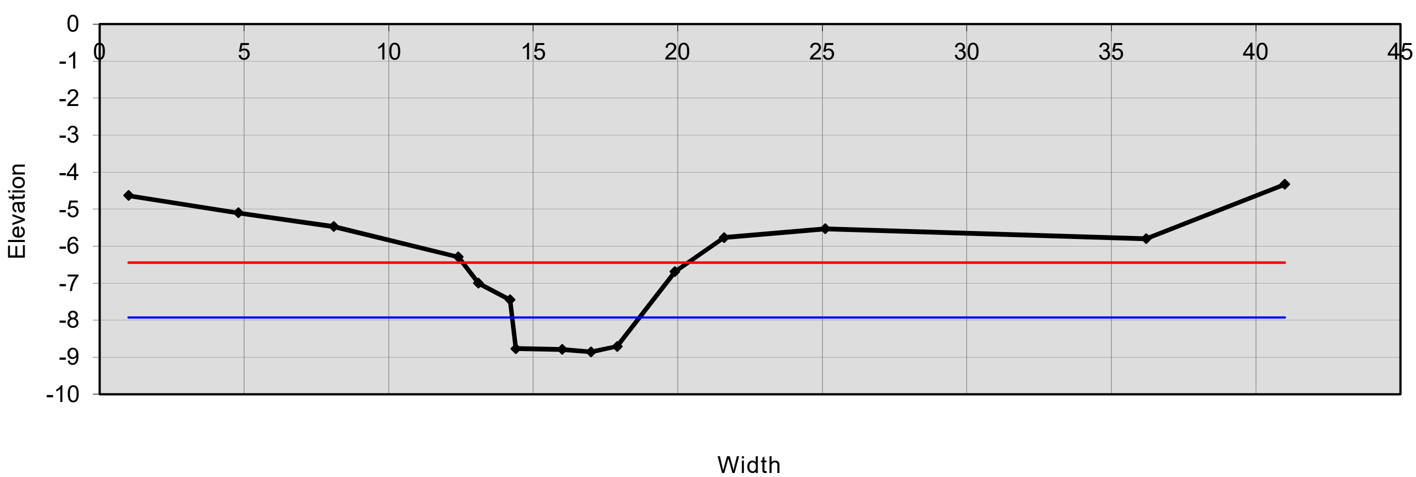


Bankfull Dimensions	
2.5	x-section area (ft.sq.)
3.7	width (ft)
0.70	mean depth (ft)
0.9	max depth (ft)
4.5	wetted parimeter (ft)
0.6	hyd radi (ft)
5.2	width-depth ratio

Flood Dimensions	
5.1	W flood prone area (ft)
1.4	entrenchment ratio
2.8	low bank height (ft)
3.1	low bank height ratio

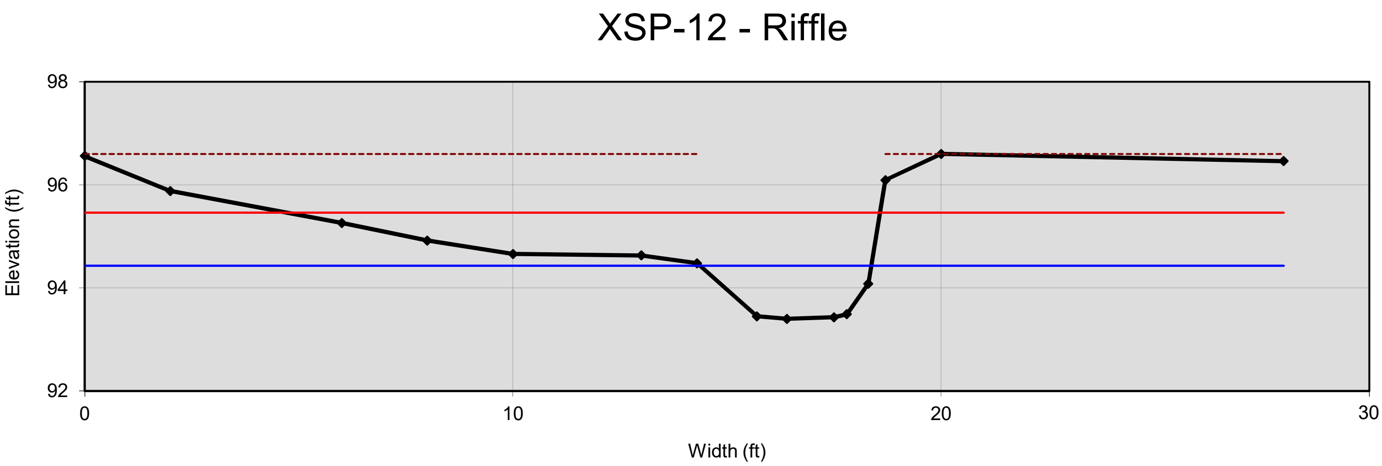
Materials	
40	D50 Riffle (mm)
78	D84 Riffle (mm)
32	threshold grain size (mm):

XS31 - Pool



Bankfull Dimensions	
3.4	x-section area (ft.sq.)
4.4	width (ft)
0.8	mean depth (ft)
0.9	max depth (ft)
5.5	wetted parimeter (ft)
0.6	hyd radi (ft)
5.7	width-depth ratio

T6 Reach 2



Bankfull Dimensions	
3.1	x-section area (ft.sq.)
4.0	width (ft)
0.8	mean depth (ft)
1.0	max depth (ft)
4.9	wetted parimeter (ft)
0.6	hydraulic radius (ft)
5.2	width-depth ratio

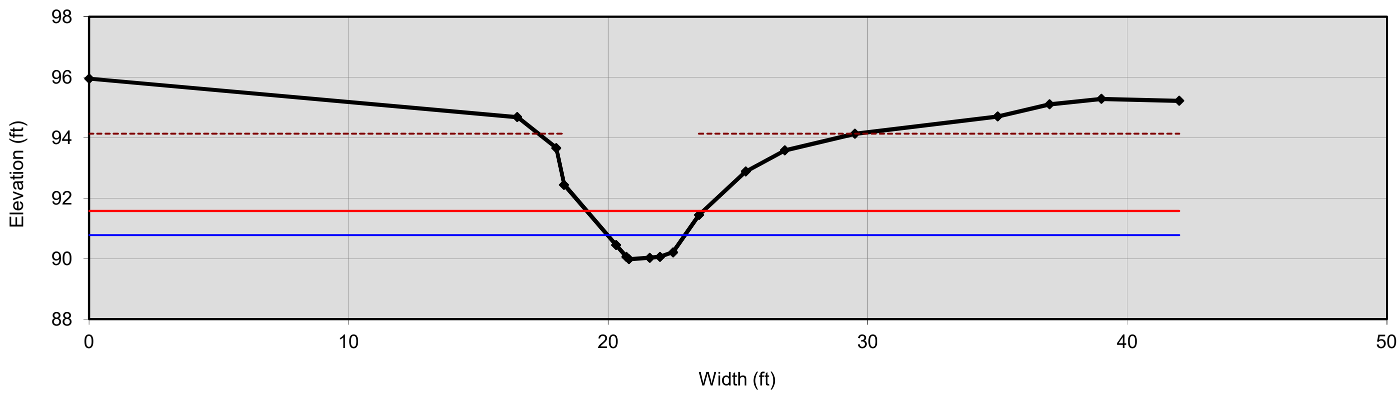
Flood Dimensions	
11.0	W flood prone area (ft)
2.7	entrenchment ratio
3.2	low bank height (ft)
3.1	low bank height ratio

Materials	
40	D50 Riffle (mm)
78	D84 Riffle (mm)
45	threshold grain size (mm):

Rosgen Stream Type	
b	Missing: , , Sinuosity, D50,

T6A

XSP-10 - Riffle

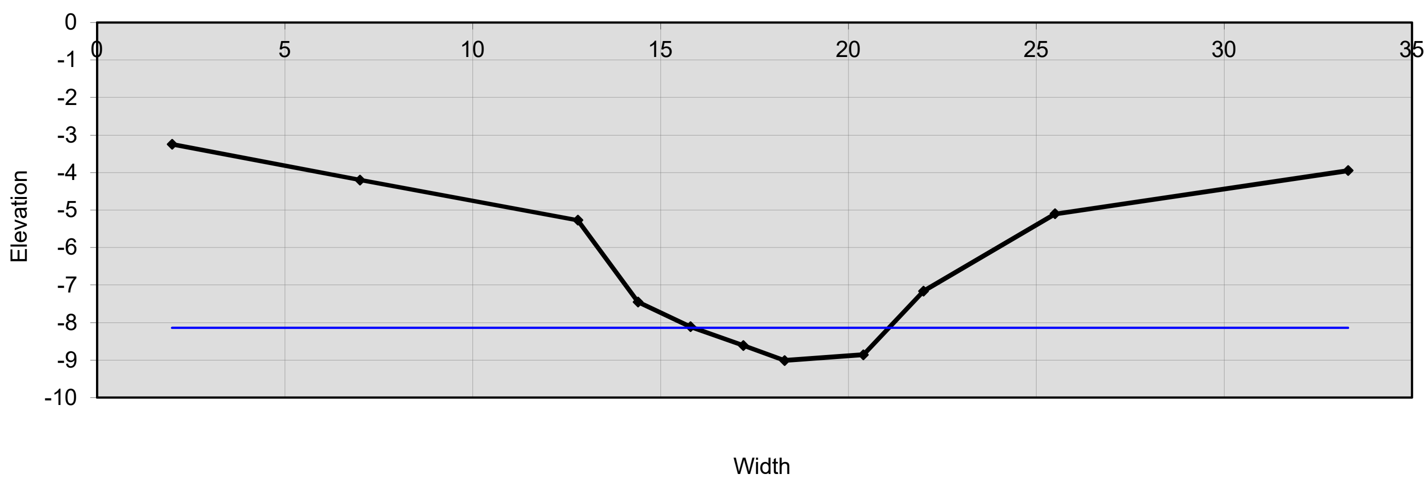


Bankfull Dimensions	
1.7	x-section area (ft.sq.)
3.0	width (ft)
0.6	mean depth (ft)
0.8	max depth (ft)
3.6	wetted parimeter (ft)
0.5	hydraulic radius (ft)
5.3	width-depth ratio

Flood Dimensions	
8.0	W flood prone area (ft)
2.7	entrenchment ratio
4.1	low bank height (ft)
5.2	low bank height ratio

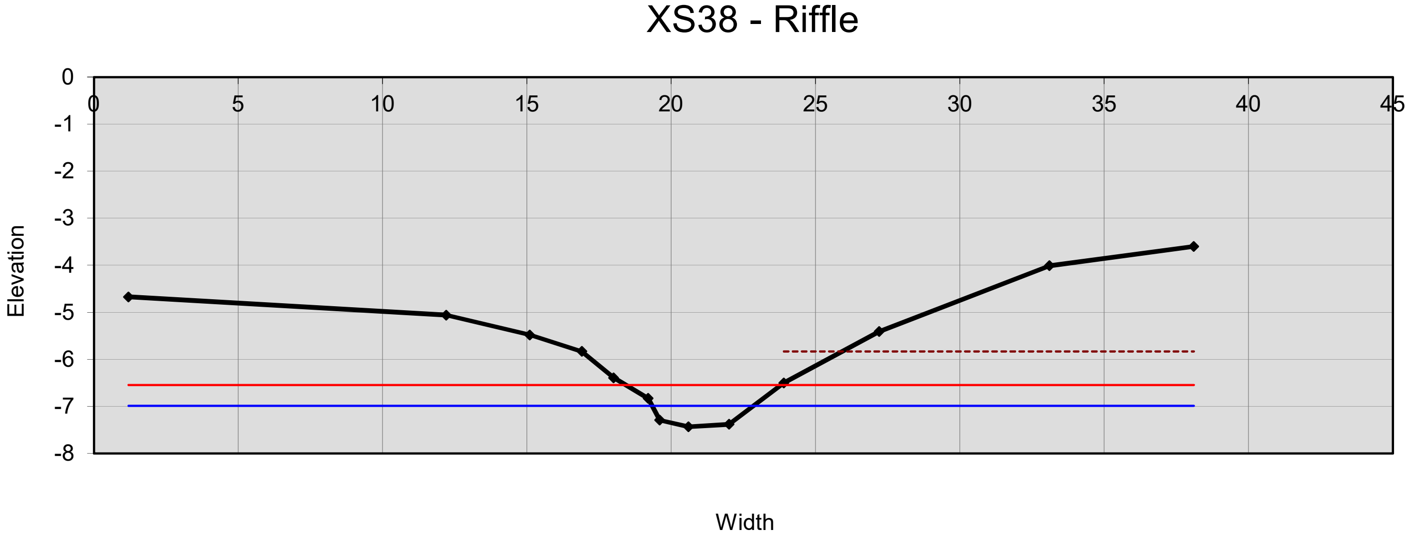
Materials	
3.6	D50 Riffle (mm)
27	D84 Riffle (mm)
67	threshold grain size (mm):

XS39 - Pool



Bankfull Dimensions	
2.9	x-section area (ft.sq.)
5.2	width (ft)
0.6	mean depth (ft)
0.9	max depth (ft)
5.7	wetted parimeter (ft)
0.5	hyd radi (ft)
9.1	width-depth ratio

T6B



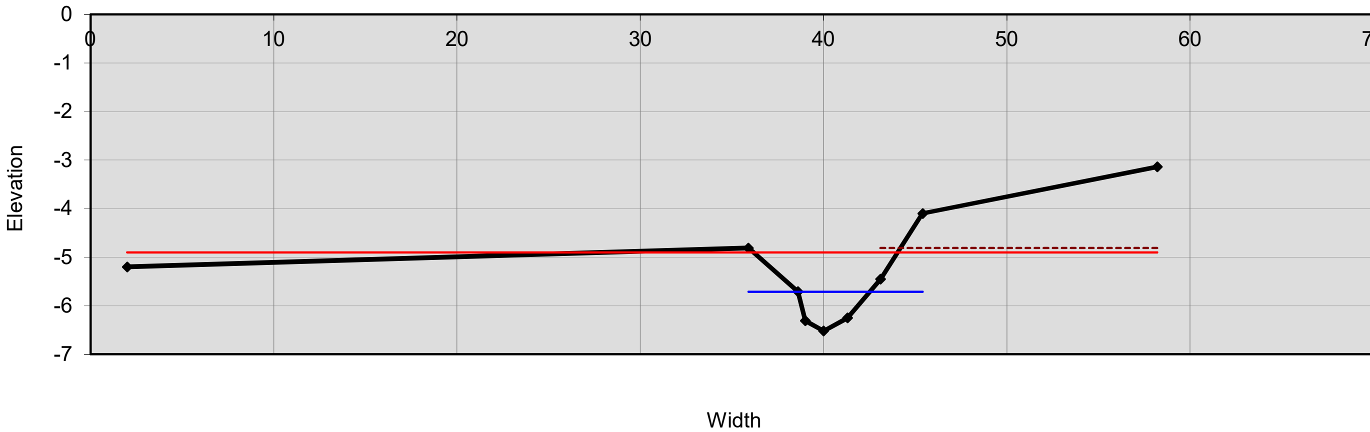
Bankfull Dimensions	
1.2	x-section area (ft.sq.)
3.5	width (ft)
0.33	mean depth (ft)
0.44	max depth (ft)
3.7	wetted parimeter (ft)
0.3	hyd radi (ft)
10.6	width-depth ratio

Flood Dimensions	
5.4	W flood prone area (ft)
1.5	entrenchment ratio
1.6	low bank height (ft)
3.6	low bank height ratio

Materials	
0.5	D50 Riffle (mm)
14	D84 Riffle (mm)
23	threshold grain size (mm):

T7 Reach 1

XS5 - Riffle

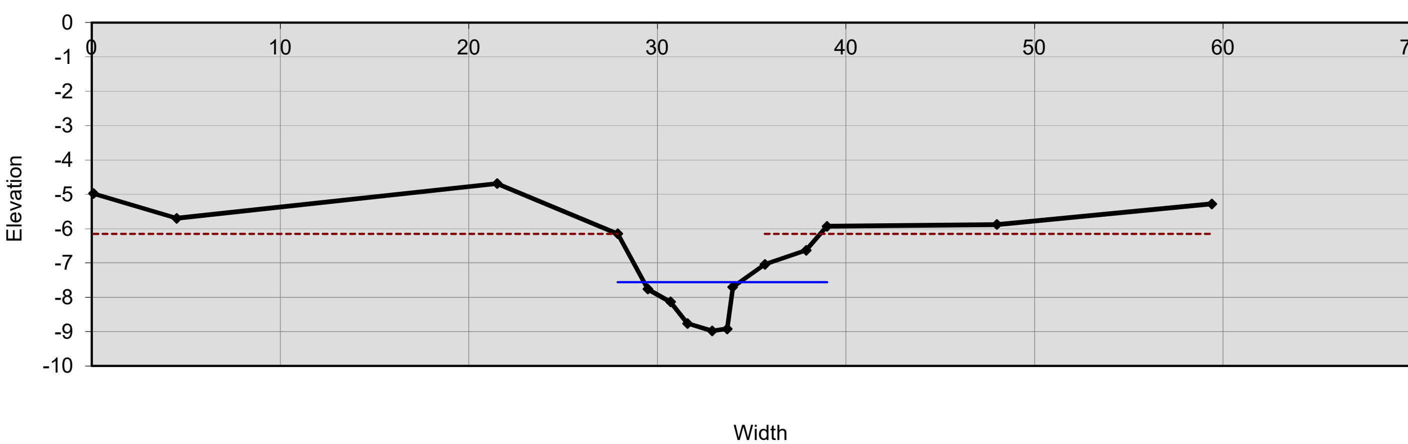


Bankfull Dimensions	
2.0	x-section area (ft.sq.)
3.9	width (ft)
0.5	mean depth (ft)
0.8	max depth (ft)
4.4	wetted parimeter (ft)
0.5	hyd radi (ft)
7.5	width-depth ratio

Flood Dimensions	
8.1	W flood prone area (ft)
2.1	entrenchment ratio
1.7	low bank height (ft)
2.1	low bank height ratio

Materials	
6.3	D50 Riffle (mm)
14	D84 Riffle (mm)
41	threshold grain size (mm):

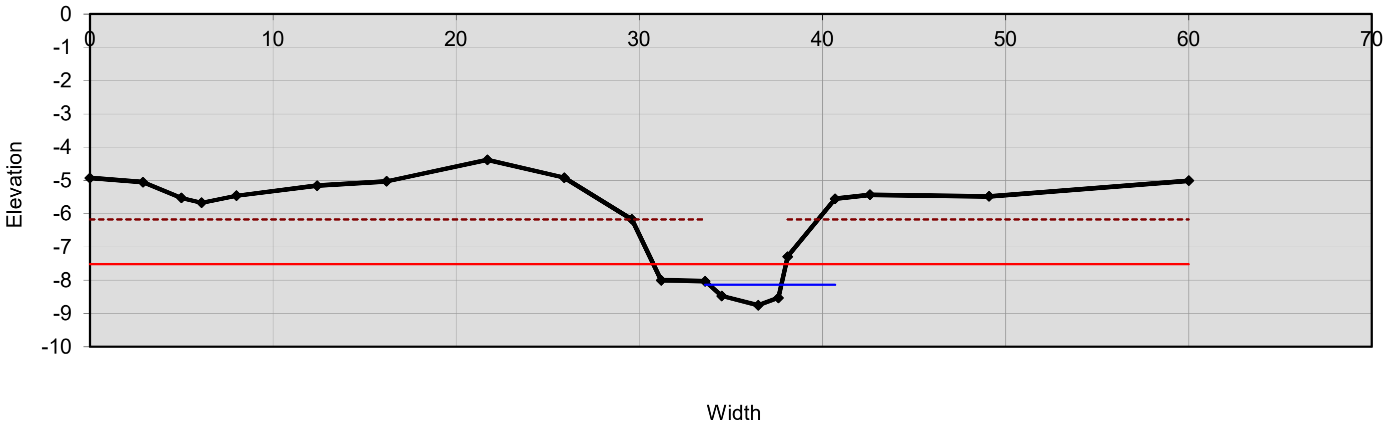
XS6 - Pool



Bankfull Dimensions	
4.3	x-section area (ft.sq.)
5.1	width (ft)
0.9	mean depth (ft)
1.4	max depth (ft)
6.4	wetted parimeter (ft)
0.7	hyd radi (ft)
5.9	width-depth ratio

T7 Reach 1

XS7 - Riffle



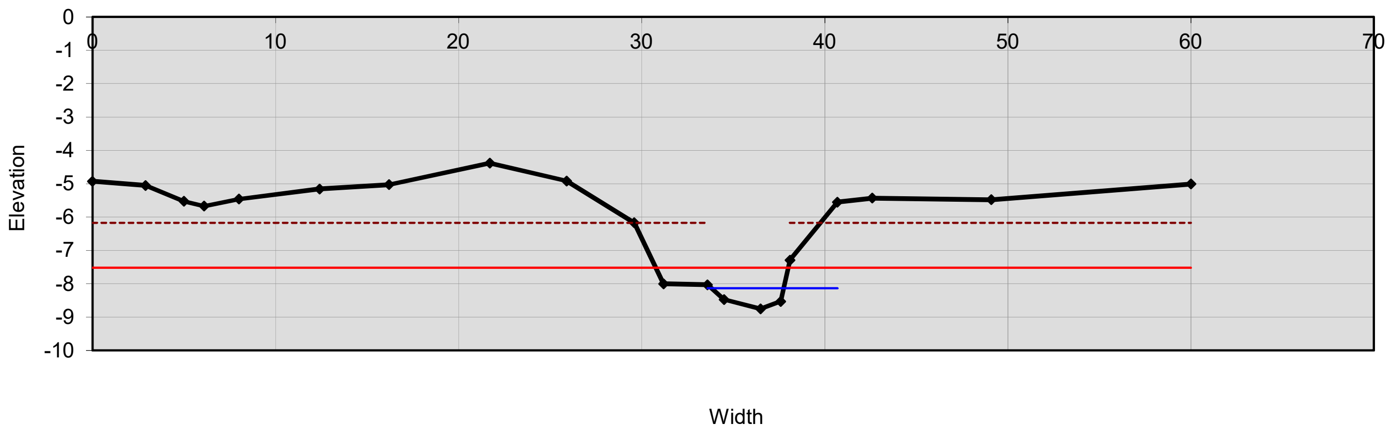
Bankfull Dimensions	
1.7	x-section area (ft.sq.)
3.9	width (ft)
0.4	mean depth (ft)
0.6	max depth (ft)
4.3	wetted parimeter (ft)
0.4	hyd radi (ft)
9.4	width-depth ratio

Flood Dimensions	
7.2	W flood prone area (ft)
1.8	entrenchment ratio
2.6	low bank height (ft)
4.2	low bank height ratio

Materials	
6.3	D50 Riffle (mm)
14	D84 Riffle (mm)
34	threshold grain size (mm):

T7 Reach 2

XS7 - Riffle

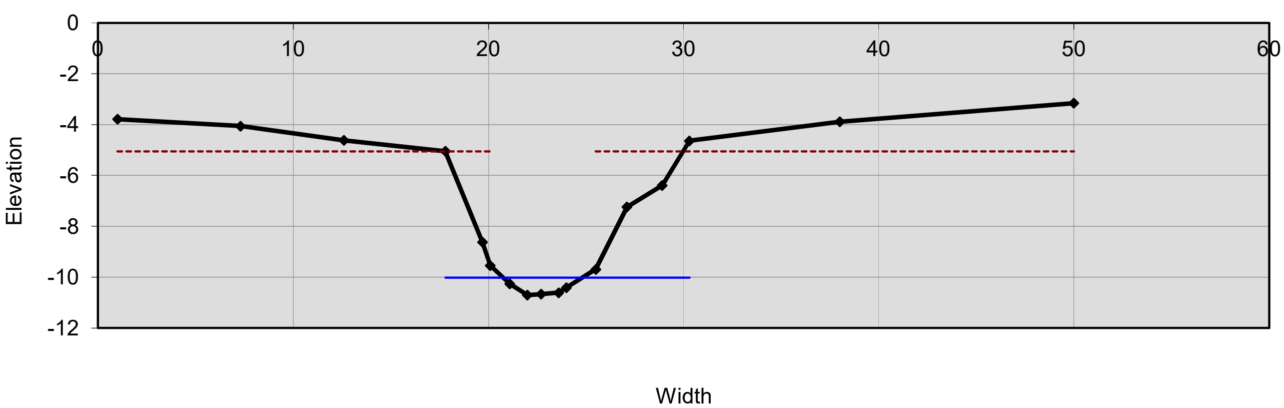


Bankfull Dimensions	
1.7	x-section area (ft.sq.)
3.9	width (ft)
0.4	mean depth (ft)
0.6	max depth (ft)
4.3	wetted parimeter (ft)
0.4	hyd radi (ft)
9.4	width-depth ratio

Flood Dimensions	
7.2	W flood prone area (ft)
1.8	entrenchment ratio
2.6	low bank height (ft)
4.2	low bank height ratio

Materials	
6.3	D50 Riffle (mm)
14	D84 Riffle (mm)
34	threshold grain size (mm):

XS8 - Pool

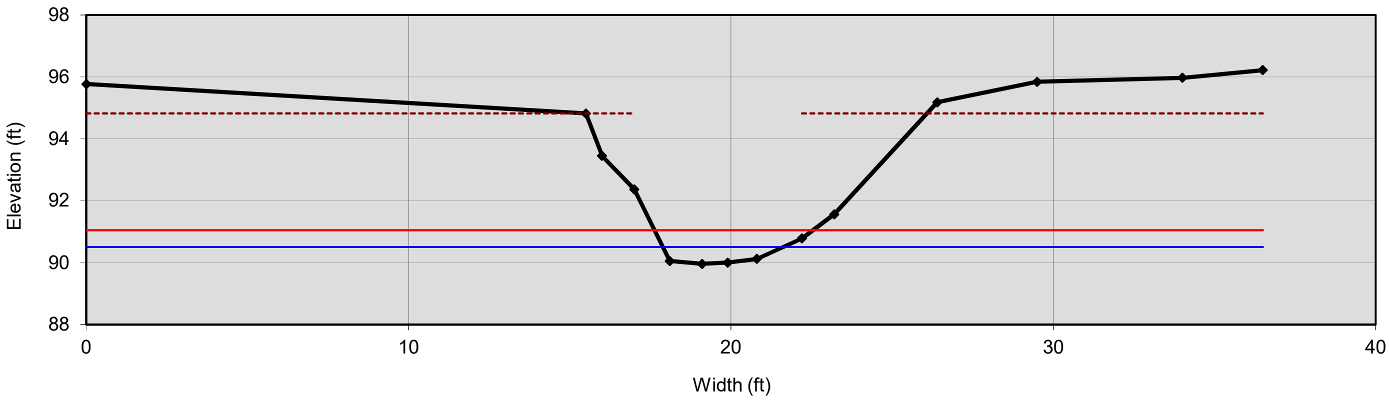


Bankfull Dimensions	
1.9	x-section area (ft.sq.)
4.1	width (ft)
0.5	mean depth (ft)
0.7	max depth (ft)
4.4	wetted parimeter (ft)
0.4	hyd radi (ft)
8.9	width-depth ratio

Flood Dimensions	
	W flood prone area (ft)
---	entrenchment ratio
5.7	low bank height (ft)
8.2	low bank height ratio

T7 Reach 2

XSP-13 - Riffle



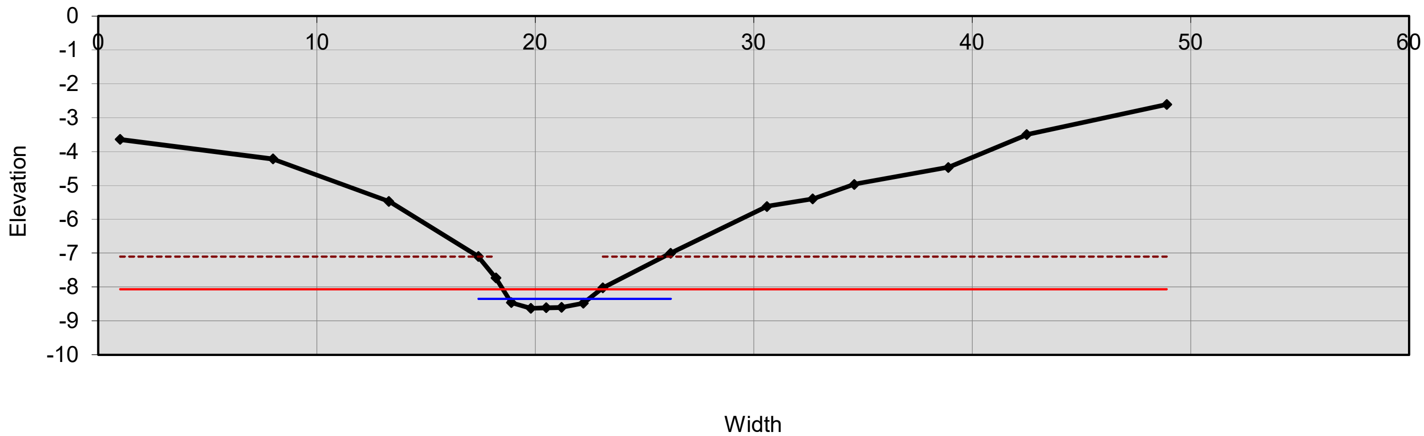
Bankfull Dimensions	
1.5	x-section area (ft.sq.)
3.7	width (ft)
0.4	mean depth (ft)
0.5	max depth (ft)
4.1	wetted parimeter (ft)
0.4	hydraulic radius (ft)
9.1	width-depth ratio

Flood Dimensions	
5.7	W flood prone area (ft)
1.5	entrenchment ratio
4.9	low bank height (ft)
8.9	low bank height ratio

Materials	
27	D50 Riffle (mm)
66	D84 Riffle (mm)
40	threshold grain size (mm):

T7A

XS9 - Riffle

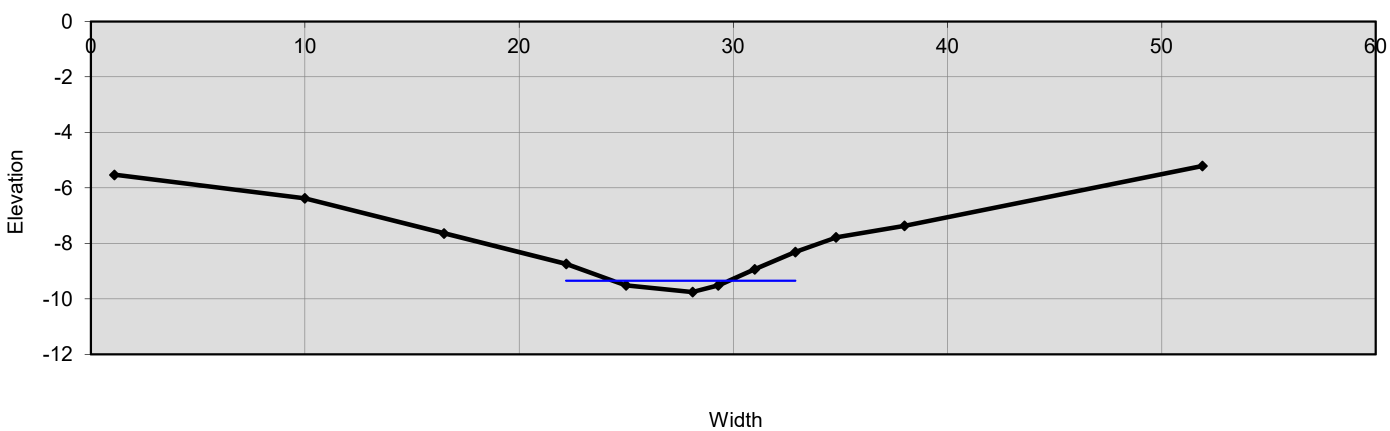


Bankfull Dimensions	
0.8	x-section area (ft.sq.)
3.7	width (ft)
0.2	mean depth (ft)
0.3	max depth (ft)
3.8	wetted parimeter (ft)
0.2	hyd radi (ft)
17.6	width-depth ratio

Flood Dimensions	
4.5	W flood prone area (ft)
1.2	entrenchment ratio
1.5	low bank height (ft)
5.4	low bank height ratio

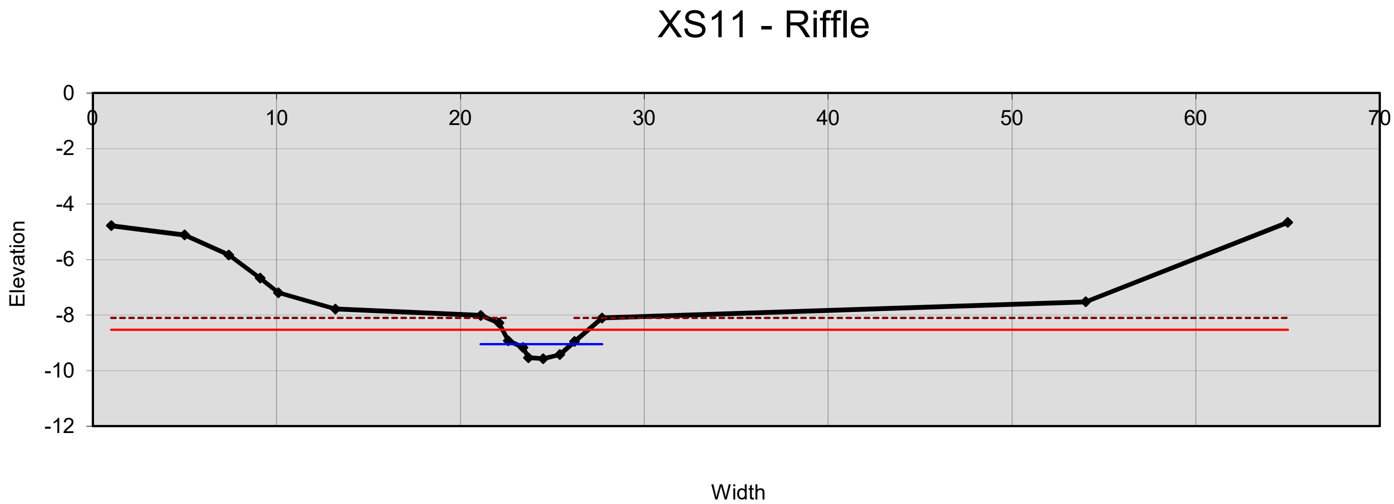
Materials	
18	D50 Riffle (mm)
2300	D84 Riffle (mm)
43	threshold grain size (mm):

XS10 - Pool



Bankfull Dimensions	
1.3	x-section area (ft.sq.)
5.4	width (ft)
0.2	mean depth (ft)
0.4	max depth (ft)
5.5	wetted parimeter (ft)
0.2	hyd radi (ft)
22.0	width-depth ratio

T7A



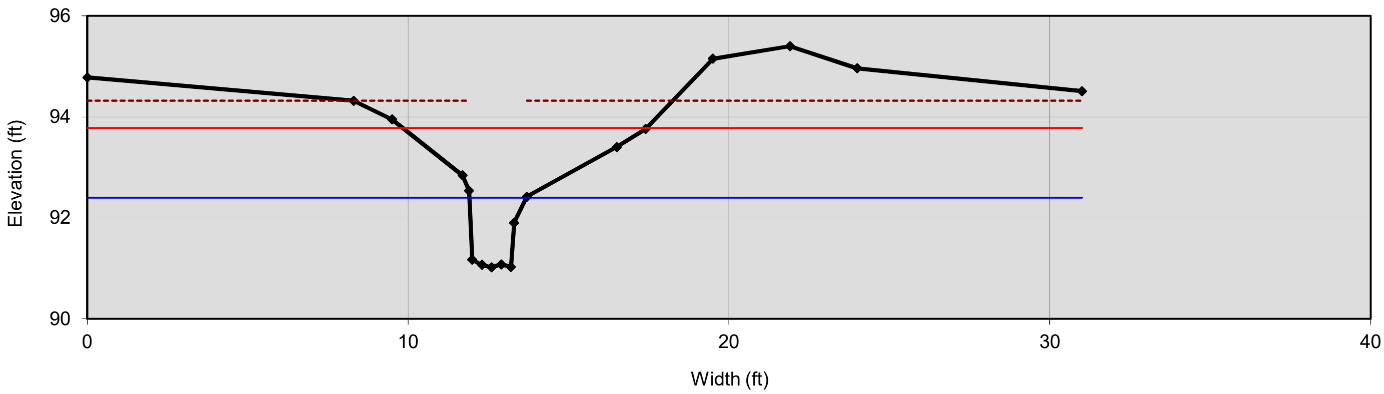
Bankfull Dimensions	
1.0	x-section area (ft.sq.)
3.0	width (ft)
0.3	mean depth (ft)
0.5	max depth (ft)
3.3	wetted parimeter (ft)
0.3	hyd radi (ft)
8.8	width-depth ratio

Flood Dimensions	
4.6	W flood prone area (ft)
1.6	entrenchment ratio
1.5	low bank height (ft)
2.8	low bank height ratio

Materials	
18	D50 Riffle (mm)
2300	D84 Riffle (mm)
22	threshold grain size (mm):

T8

XSP-14 - Riffle



Bankfull Dimensions	
1.8	x-section area (ft.sq.)
1.8	width (ft)
1.0	mean depth (ft)
1.4	max depth (ft)
4.0	wetted parimeter (ft)
0.5	hydraulic radius (ft)
1.7	width-depth ratio

Flood Dimensions	
8.0	W flood prone area (ft)
4.5	entrenchment ratio
3.3	low bank height (ft)
2.4	low bank height ratio

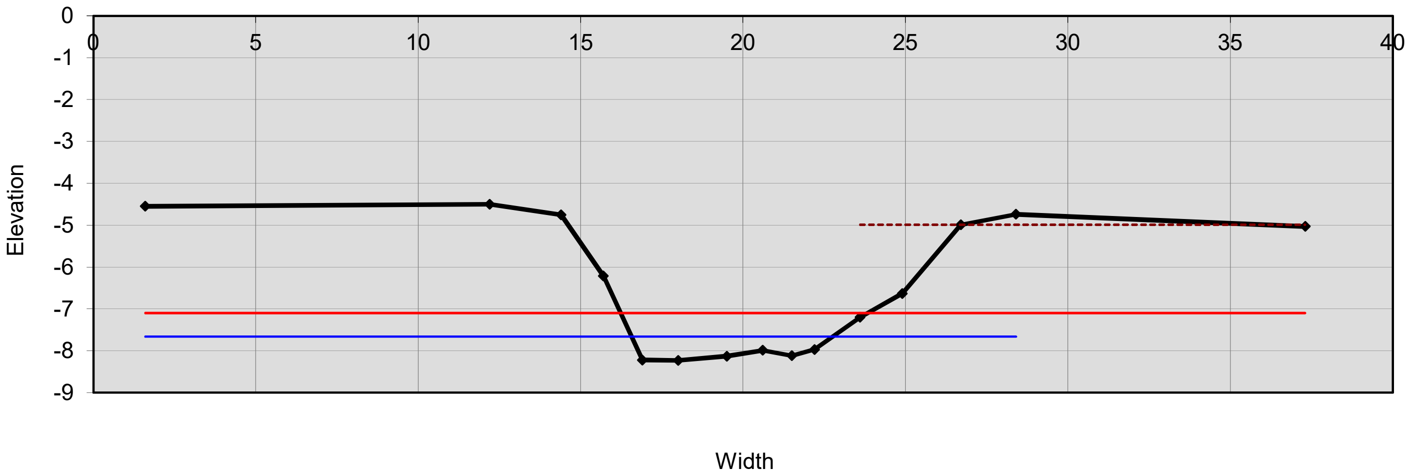
Materials	
59	D50 Riffle (mm)
100	D84 Riffle (mm)
35	threshold grain size (mm):

XS44 - Pool

Bankfull Dimensions	
3.9	x-section area (ft.sq.)
3.2	width (ft)
1.2	mean depth (ft)
1.5	max depth (ft)
5.3	wetted parimeter (ft)
0.7	hyd radi (ft)
2.5	width-depth ratio

T9

XS45 - Riffle

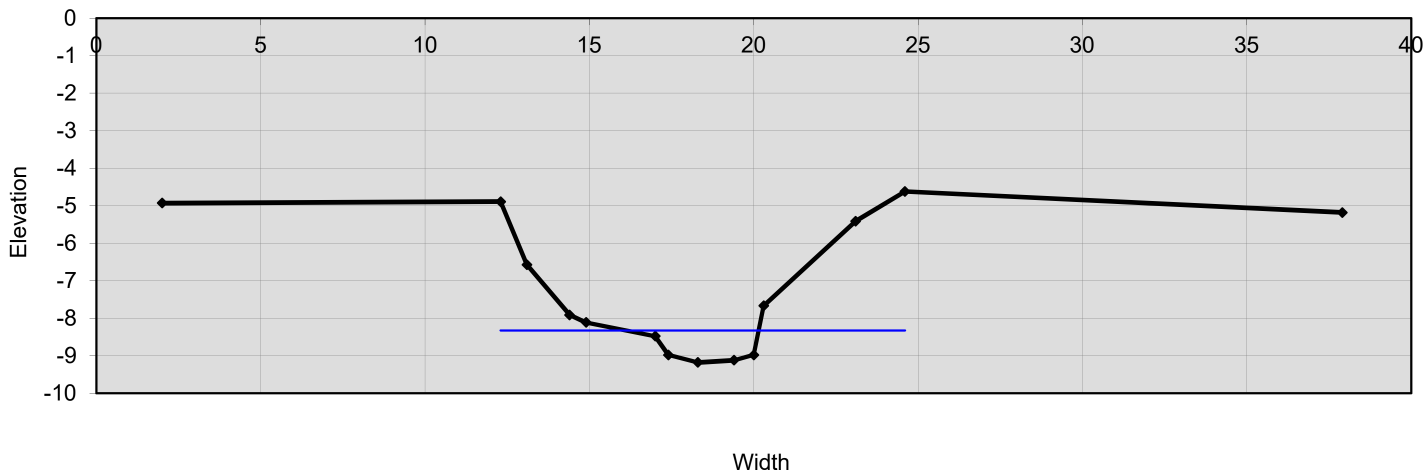


Bankfull Dimensions	
2.6	x-section area (ft.sq.)
6.2	width (ft)
0.42	mean depth (ft)
0.57	max depth (ft)
6.6	wetted parimeter (ft)
0.4	hyd radi (ft)
14.6	width-depth ratio

Flood Dimensions	
7.6	W flood prone area (ft)
1.2	entrenchment ratio
3.2	low bank height (ft)
5.7	low bank height ratio

Materials	
76	D50 Riffle (mm)
120	D84 Riffle (mm)
35	threshold grain size (mm):

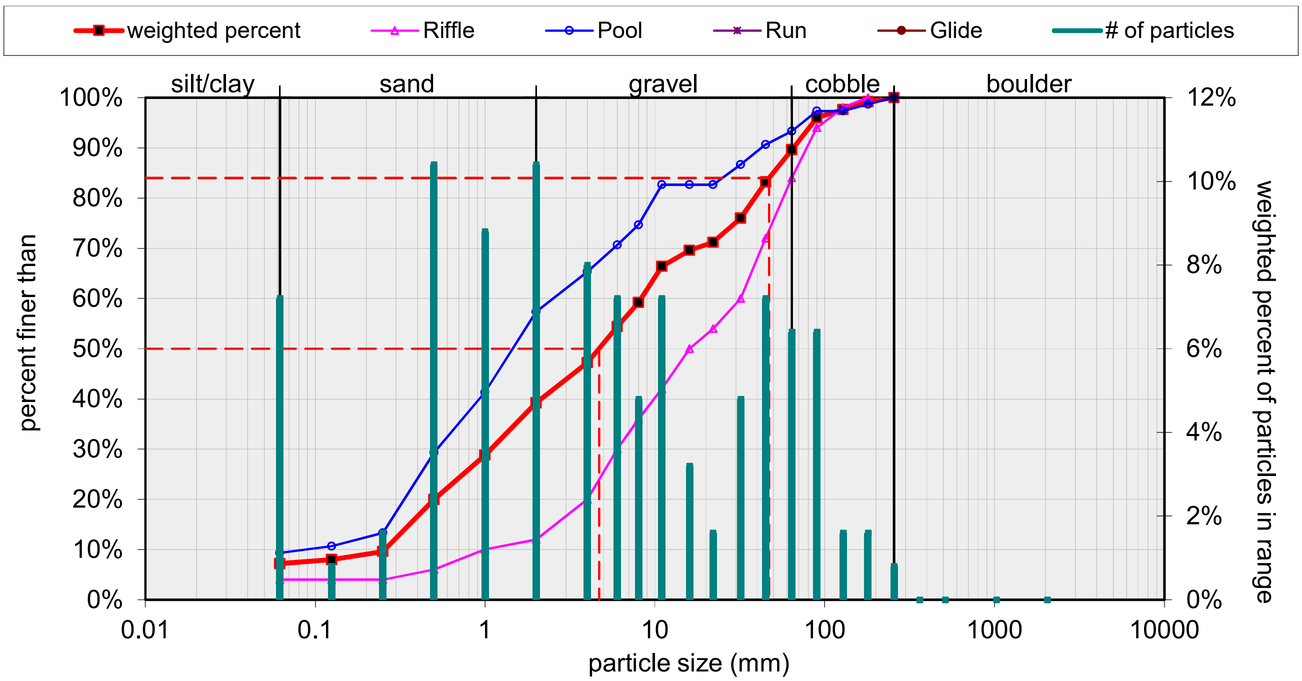
XS46 - Pool



Bankfull Dimensions	
2.3	x-section area (ft.sq.)
4.0	width (ft)
0.6	mean depth (ft)
0.9	max depth (ft)
4.9	wetted parimeter (ft)
0.5	hyd radi (ft)
7.1	width-depth ratio

Weighted pebble count by bed features -- Buckwater Upstream Reach 4

40% riffle 60% pool

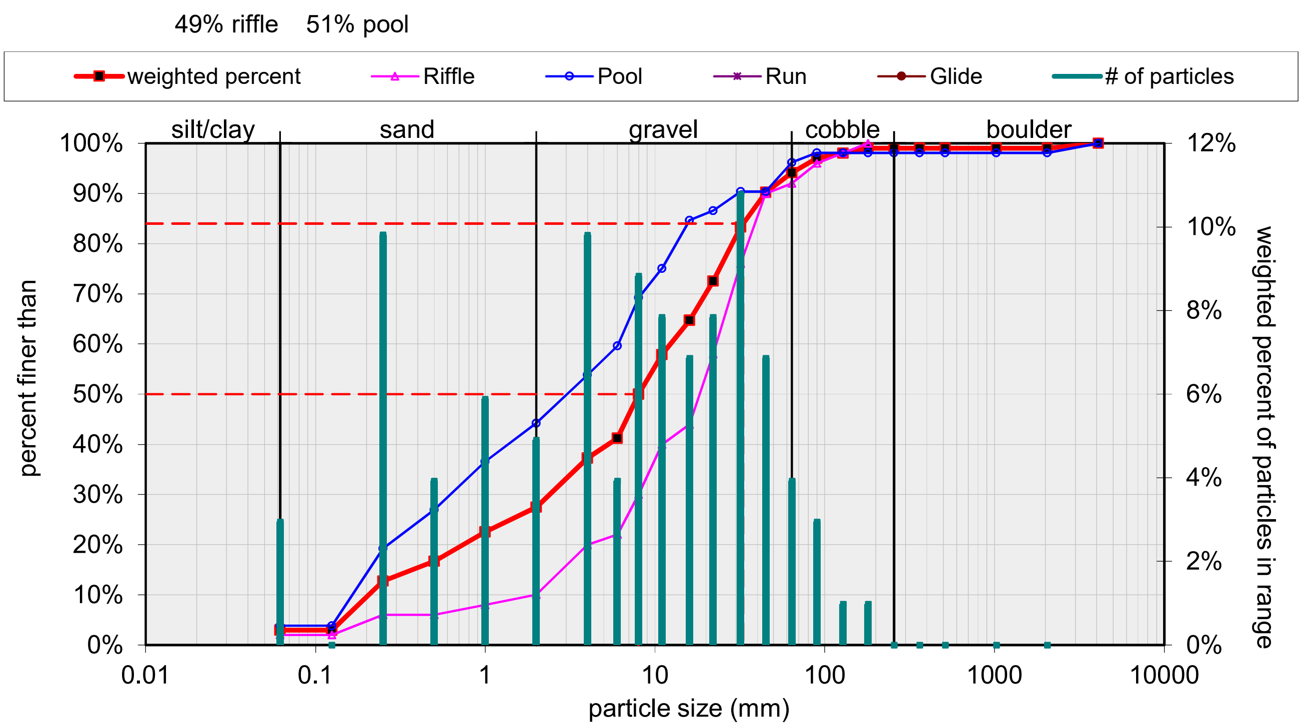


Size (mm)	
D16	0.38
D35	1.5
D50	4.7
D65	10
D84	47
D95	85

Size Distribution	
mean	4.2
dispersion	11.2
skewness	-0.03

Type	
silt/clay	7%
sand	32%
gravel	50%
cobble	10%
boulder	0%

Weighted pebble count by bed features -- Buckwater Downstream Reach 5 & Reach 6



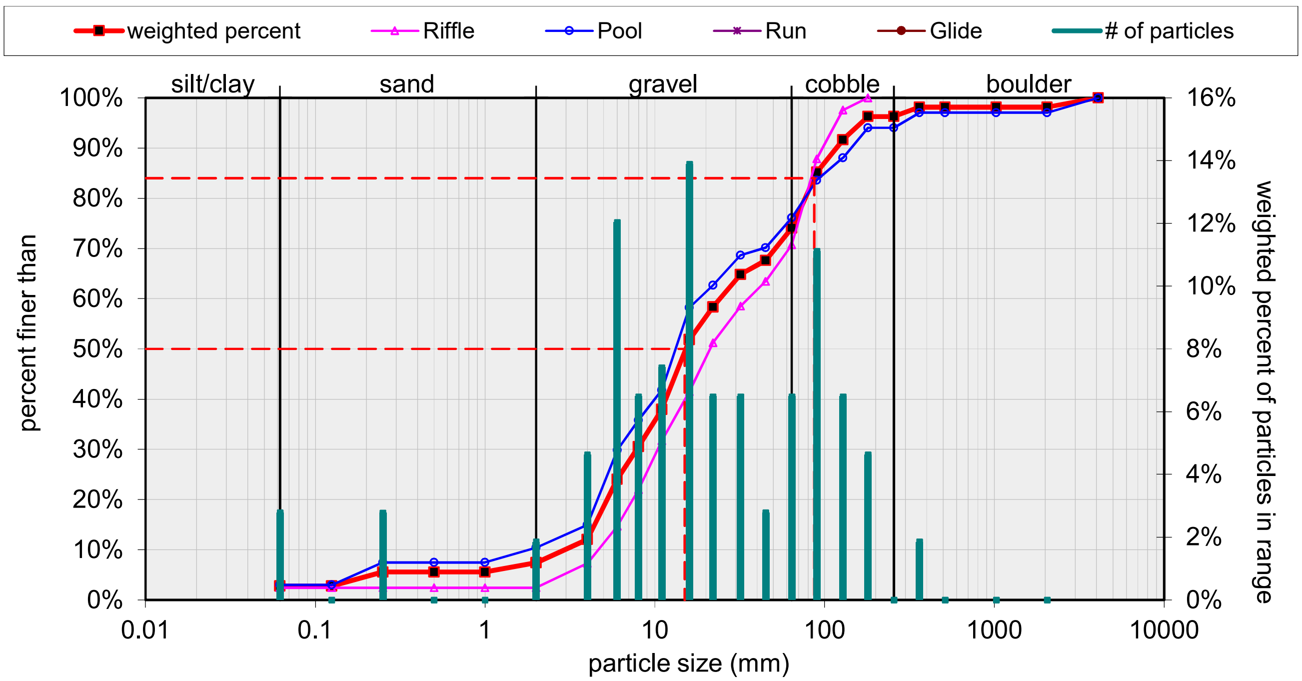
Size (mm)	
D16	0.44
D35	3.4
D50	8
D65	16
D84	33
D95	71

Size Distribution	
mean	3.8
dispersion	11.2
skewness	-0.24

Type	
silt/clay	3%
sand	25%
gravel	67%
cobble	5%
boulder	1%

Weighted pebble count by bed features --- T1 Reachwide

38% riffle 62% pool



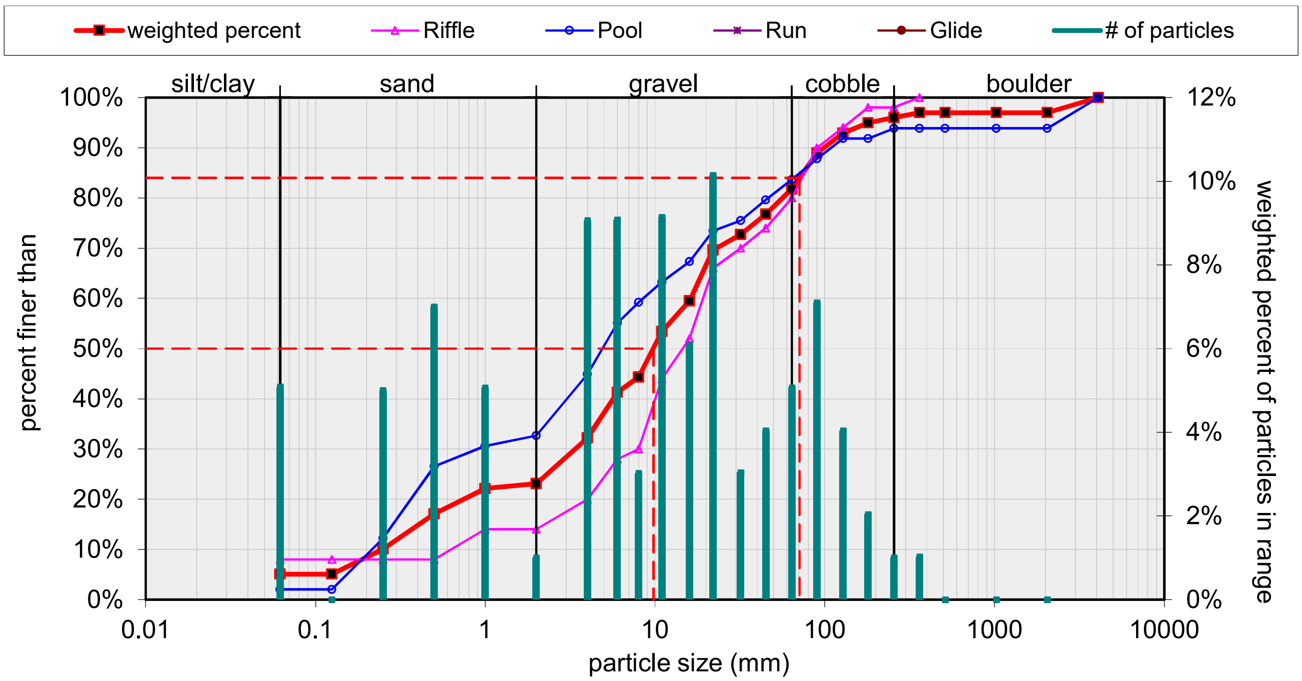
Size (mm)	
D16	4.6
D35	9.7
D50	15
D65	33
D84	87
D95	160

Size Distribution	
mean	20.0
dispersion	4.5
skewness	0.11

Type	
silt/clay	3%
sand	5%
gravel	67%
cobble	22%
boulder	4%

Weighted pebble count by bed features --- T2 Reachwide

51% riffle 49% pool



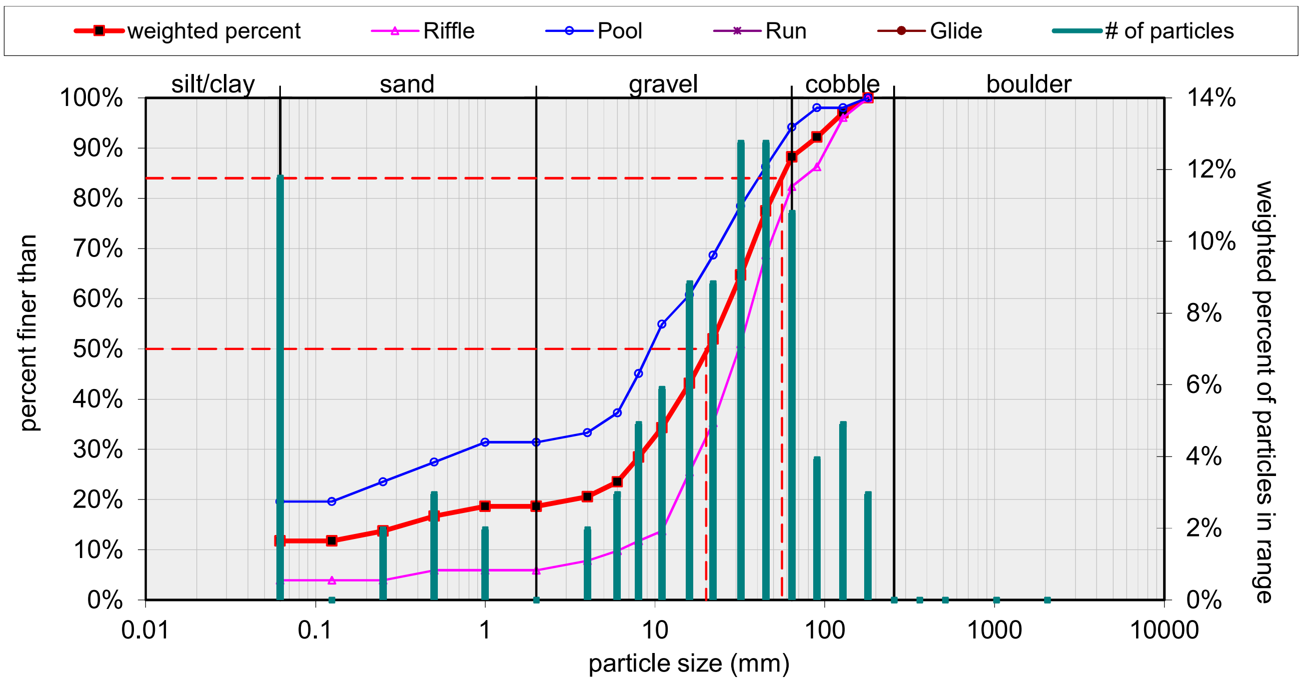
Size (mm)	
D16	0.45
D35	4.5
D50	9.8
D65	19
D84	71
D95	180

Size Distribution	
mean	5.7
dispersion	14.5
skewness	-0.16

Type	
silt/clay	5%
sand	18%
gravel	59%
cobble	14%
boulder	4%

Weighted pebble count by bed features --- T3 Reach 2

50% riffle 50% pool



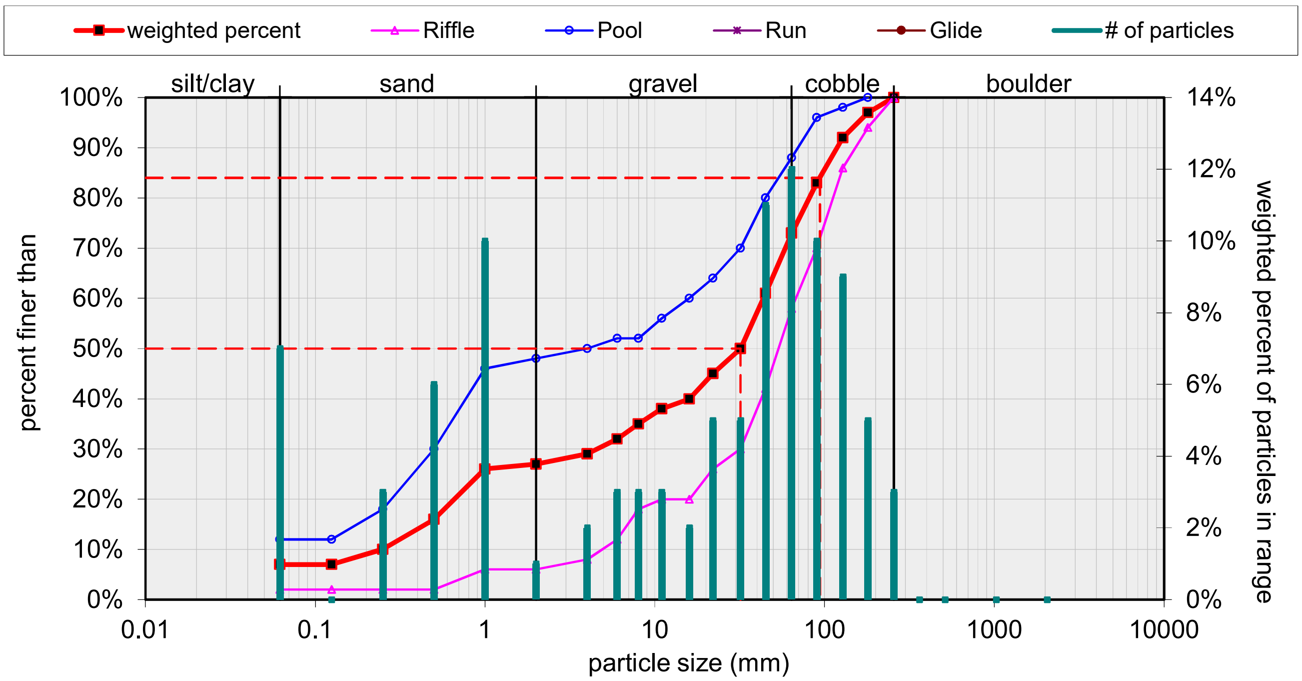
Size (mm)	
D16	0.43
D35	11
D50	20
D65	32
D84	56
D95	110

Size Distribution	
mean	4.9
dispersion	24.7
skewness	-0.42

Type	
silt/clay	12%
sand	7%
gravel	70%
cobble	12%
boulder	0%

Weighted pebble count by bed features --- T4 Reachwide

50% riffle 50% pool



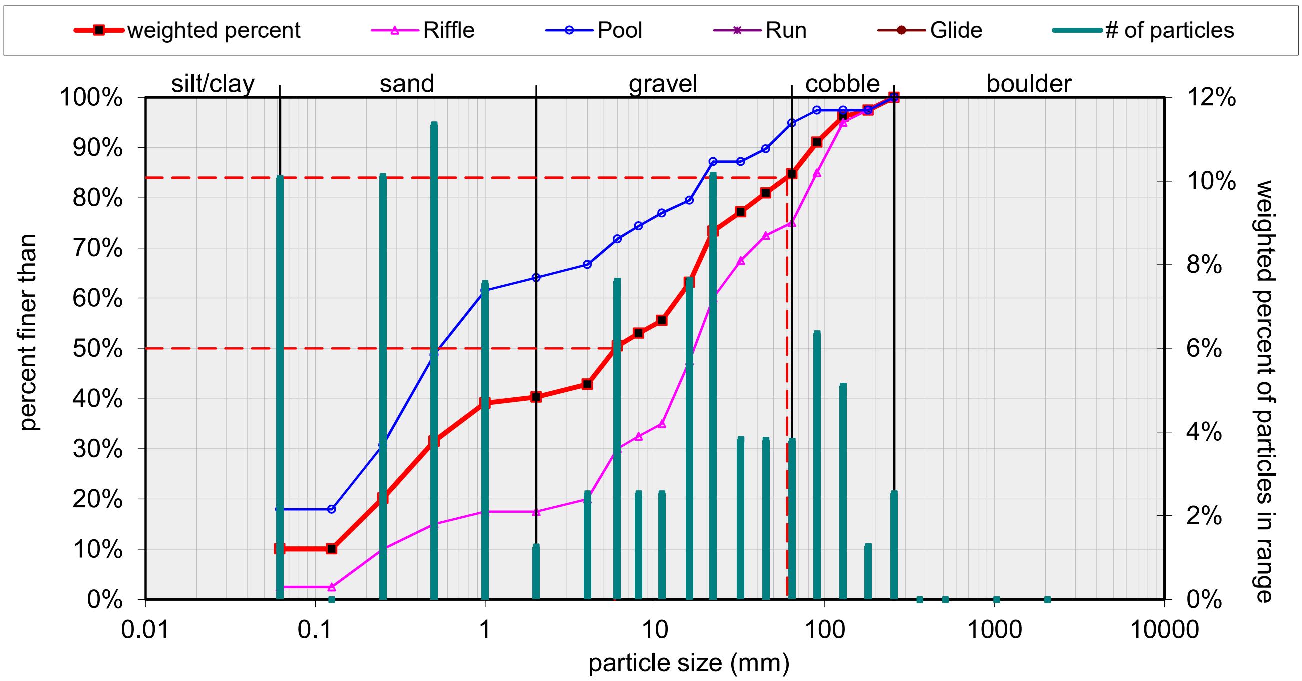
Size (mm)	
D16	0.5
D35	8
D50	32
D65	51
D84	94
D95	160

Size Distribution	
mean	6.9
dispersion	33.5
skewness	-0.44

Type	
silt/clay	7%
sand	20%
gravel	46%
cobble	27%
boulder	0%

Weighted pebble count by bed features --- T4B Reachwide

51% riffle   49% pool



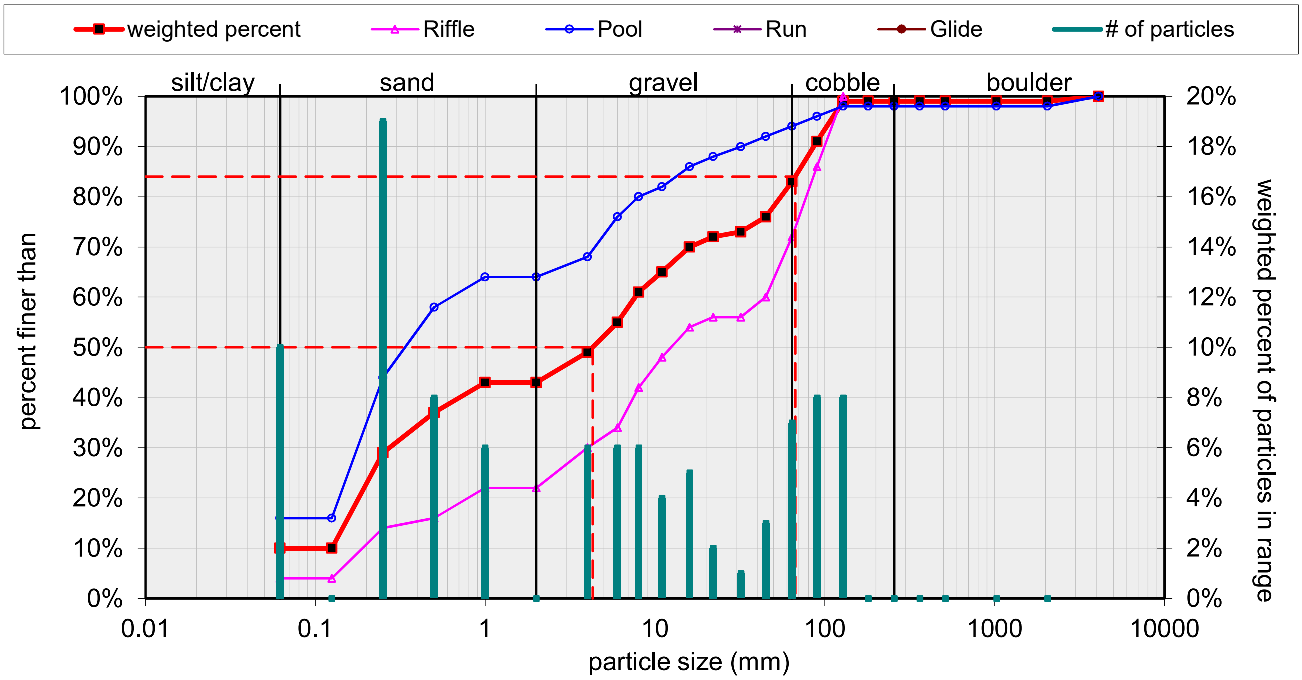
Size (mm)	
D16	0.19
D35	0.69
D50	5.8
D65	17
D84	60
D95	120

Size Distribution	
mean	3.4
dispersion	20.4
skewness	-0.15

Type	
silt/clay	10%
sand	30%
gravel	44%
cobble	15%
boulder	0%

Weighted pebble count by bed features --- T5 Reach 1

50% riffle 50% pool



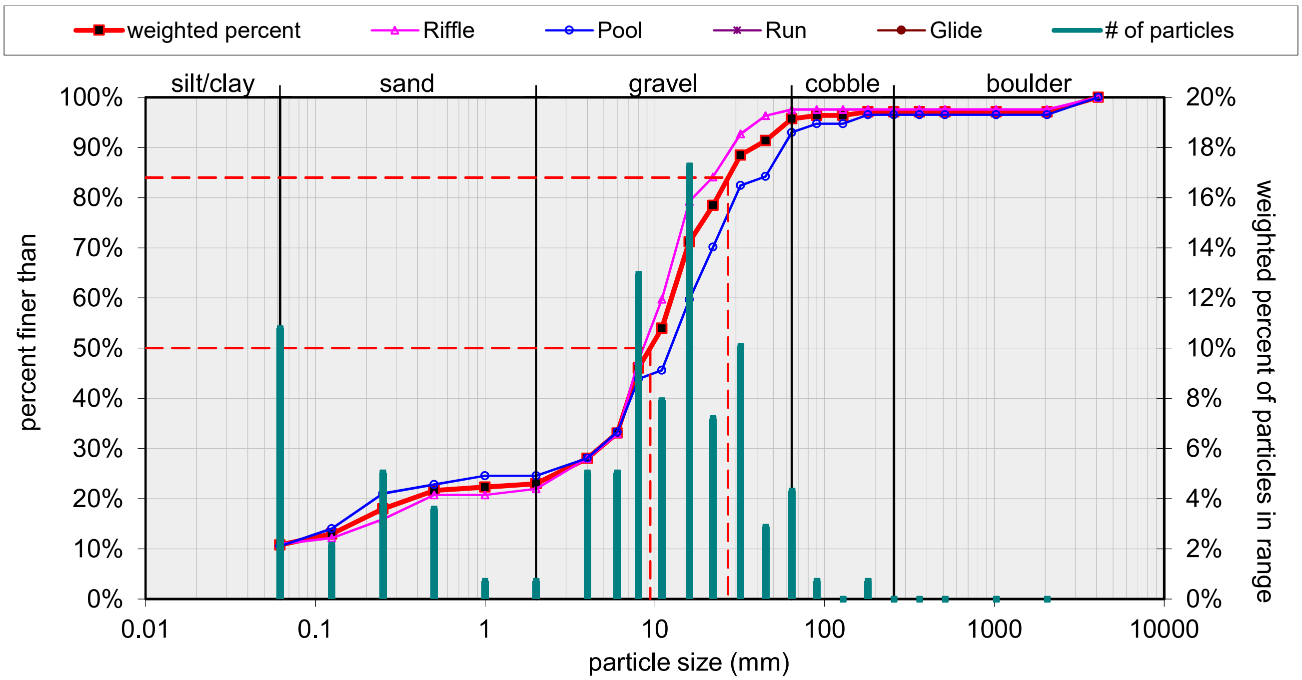
Size (mm)	
D16	0.16
D35	0.42
D50	4.3
D65	11
D84	67
D95	110

Size Distribution	
mean	3.3
dispersion	21.2
skewness	-0.07

Type	
silt/clay	10%
sand	33%
gravel	40%
cobble	16%
boulder	1%

Weighted pebble count by bed features --- T5 Reach 2

59% riffle 41% pool



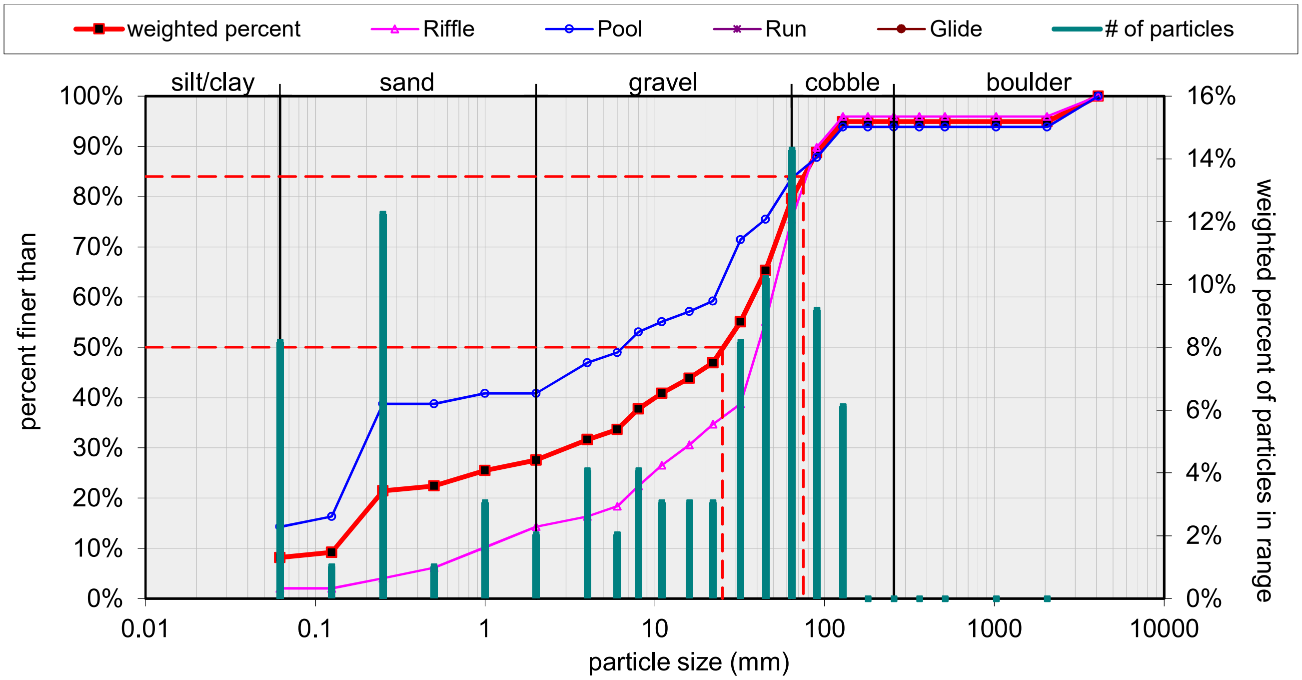
Size (mm)	
D16	0.19
D35	6.3
D50	9.4
D65	14
D84	27
D95	61

Size Distribution	
mean	2.3
dispersion	26.2
skewness	-0.42

Type	
silt/clay	11%
sand	12%
gravel	73%
cobble	1%
boulder	3%

Weighted pebble count by bed features --- T6 Reachwide

50% riffle 50% pool



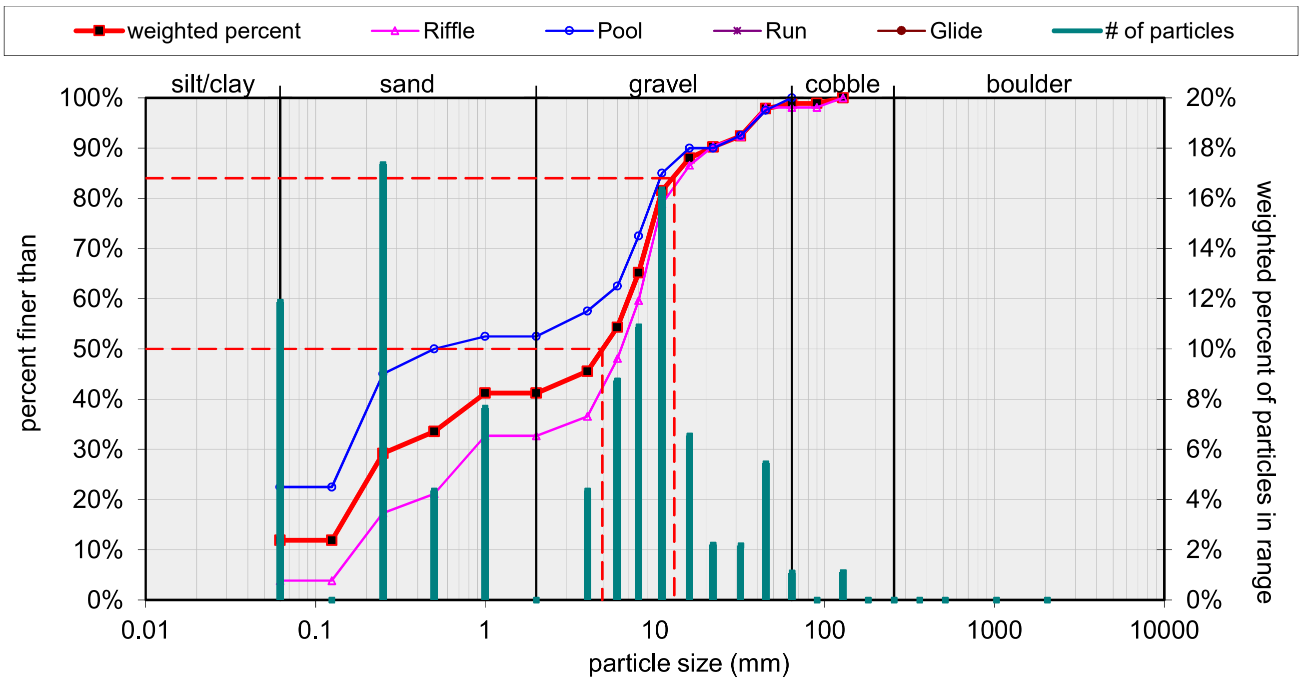
Size (mm)	
D16	0.18
D35	6.6
D50	25
D65	45
D84	75
D95	2100

Size Distribution	
mean	3.7
dispersion	70.9
skewness	-0.51

Type	
silt/clay	8%
sand	19%
gravel	52%
cobble	15%
boulder	5%

Weighted pebble count by bed features --- T7 Reach 1

57% riffle 43% pool



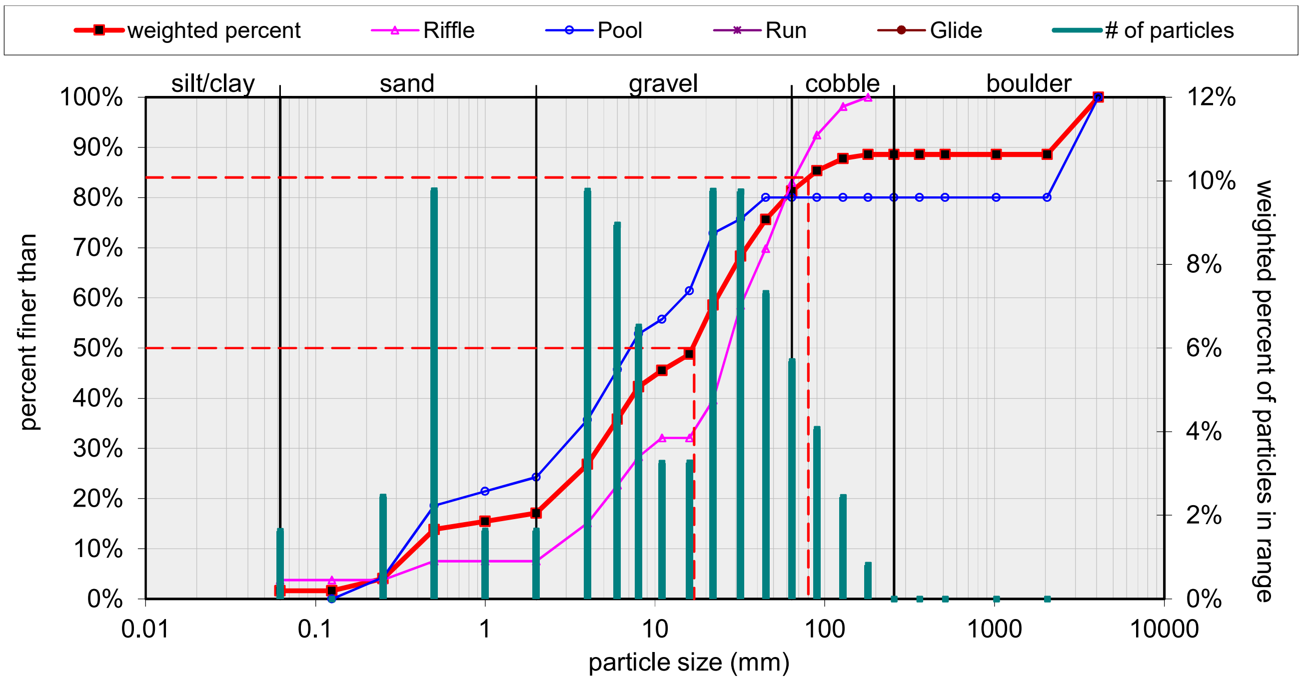
Size (mm)	
D16	0.15
D35	0.57
D50	4.9
D65	8
D84	13
D95	38

Size Distribution	
mean	1.4
dispersion	17.7
skewness	-0.39

Type	
silt/clay	12%
sand	29%
gravel	58%
cobble	1%
boulder	0%

Weighted pebble count by bed features --- T7 Reach 2

43% riffle 57% pool



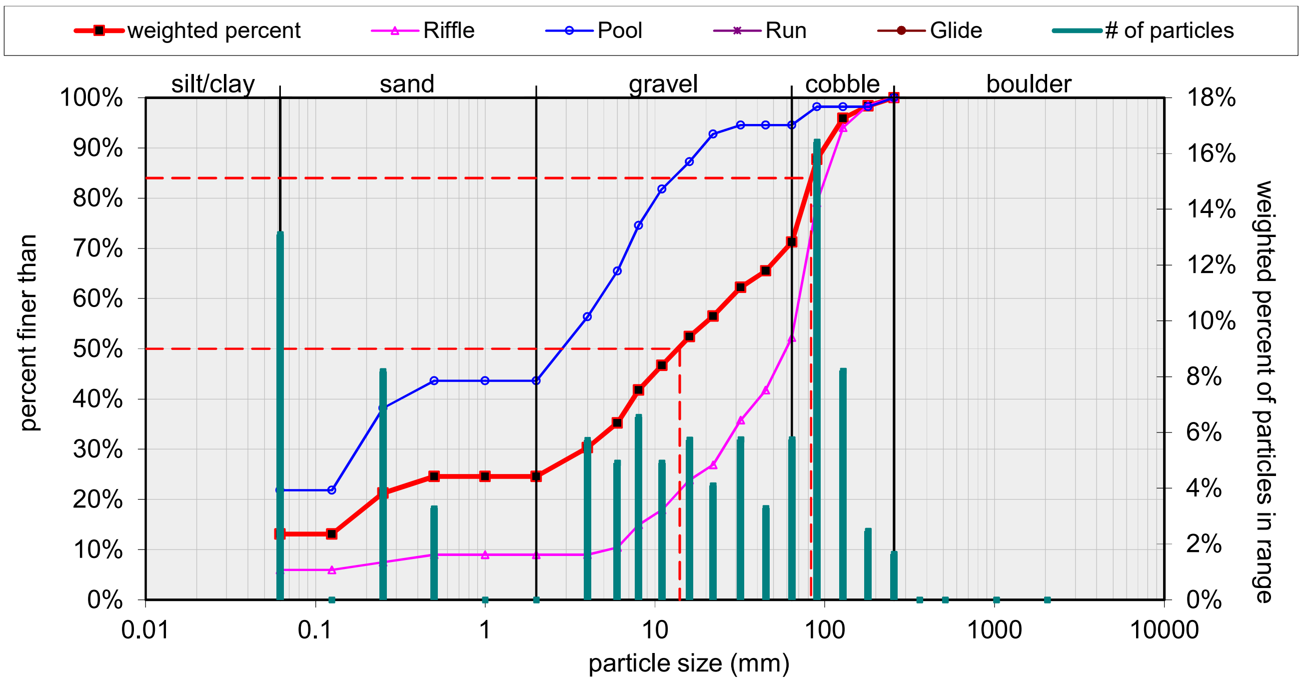
Size (mm)	
D16	1.3
D35	5.8
D50	17
D65	28
D84	80
D95	3000

Size Distribution	
mean	10.2
dispersion	8.9
skewness	-0.17

Type	
silt/clay	2%
sand	15%
gravel	64%
cobble	7%
boulder	11%

Weighted pebble count by bed features --- T8 Reachwide

55% riffle 45% pool



Size (mm)	
D16	0.16
D35	5.9
D50	14
D65	43
D84	83
D95	120

Size Distribution	
mean	3.6
dispersion	46.7
skewness	-0.35

Type	
silt/clay	13%
sand	11%
gravel	47%
cobble	29%
boulder	0%

Fecal Coliform Reduction

Estimating the amount of fecal coliform prevented from entering stream due to livestock exclusion

	2.37E+12	colonies reduced per day	not about exclusion area, only about animal units.
	8.67E+14	colonies reduced per year	
Animal Units	127	ben 15, doug 112	

Estimating fecal coliform reduction due to riparian buffer filtration

Runoff volume before mitigation

37.76	Q - accumulated direct runoff (in)
5.27	S - potential maximum retention

how much B, how much D soils? Only Chewacla are D (estimate 25% Chewacla)

% of total calc buffer		Chewacla	For only where cows are present.	CN by reach
30	Buckwater	15%		63.4
5	T2	60%		71.9
25	T3	30%		66.2
15	T4	60%		71.9
5	T4A	0%		60.5
5	T4B	0%		60.5
15	T7	15%		63.4
100			overall	65.5

Runoff volume after mitigation

37.17	Q - accumulated direct runoff (in)
5.87	S - potential maximum retention

how much B, how much D soils? Only Chewacla are D (estimate 25% Chewacla)

% of total		Chewacla	For only where cows are present.	CN by reach
30	Buckwater	8%		61.5
5	T2	60%		68.0
25	T3	30%		63.2
15	T4	60%		69.4
5	T4A	0%		58.0
5	T4B	0%		58.0
15	T7	15%		61.1
100			overall	63.0

Draw area in pasture that will be subject to these runoff estimates.

Before		acres		Q (in)	S		Q (gallons)	Annual load	Load reduction (colonies)	Load reduction (%)
Area A	Ben	26.2	Buckwater	37.25	5.79		2.65E+07	5.02E+13		
Area B	Doug west	45.3	T2, T3, T4, T4A, T4B	38.15	4.87	67.24	4.69E+07	8.89E+13		
Area C	Doug east	14.1	T7	37.25	5.79		1.43E+07	2.70E+13		
		85.6						1.66E+14		
After				**Q (in)**	**S**		**Q (gallons)**			
Area A	Ben	21	Buckwater	36.80	6.26		2.10E+07	5.96E+12	4.42E+13	88.1%
Area B	Doug west	31.8	T2, T3, T4, T4A, T4B	37.50	5.53	64.38	3.24E+07	9.20E+12	7.97E+13	89.7%
Area C	Doug east	10.9	T7	36.69	6.37		1.09E+07	3.09E+12	2.39E+13	88.6%
		63.7						1.82E+13	1.48E+14	

concentration is 1.894*10^6 for pastures under continual year-round grazing.

1.01E+15 total load reduction (colonies) from exclusion and buffer filtration

Buckwater Mitigation Site Nutrient Removal Calculations

Use the dominant land use so livestock exclusion where this applies (acc. Greg Melia).
Use agricultural runoff filtration where hay is grown. Use dominant land use on lateral drainages.
Don't double count livestock exclusion and nutrient removal from agricultural runoff.
Some area is mostly fallow/buffer so no nutrient removal there.

Cattle Exclusion

22.275	total area (acres) of restored riparian buffers inside of livestock exclusion fences. CE as of 22Nov2016
1136.9	TN (51.04 lbs per acre)
94.2	TP (3.23 lbs per acre)

Agriculture

6.75	total area (acres) of restored riparian buffers adjacent to agricultural fields (where hay is grown)
511.4	TN (77.75 lbs per acre)
32.9	TP (54.88 lbs per acre)

Total nutrient removal

1648.4	TN	lbs
127.2	TP	lbs

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME Buckwater R4	LOCATION
STATION #________ RIVERMILE________	STREAM CLASS
LAT ________ LONG ________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE 11/23 TIME ________ AM PM / REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

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HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score __________

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

R5

STREAM NAME McClusker R6	LOCATION
STATION # ________ RIVERMILE ________	STREAM CLASS
LAT ________ LONG ________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE 11/23 TIME ________ AM PM — REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score __________

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME T3		LOCATION	
STATION # ________ RIVERMILE ________		STREAM CLASS	
LAT ________ LONG ________		RIVER BASIN	
STORET #		AGENCY	
INVESTIGATORS			
FORM COMPLETED BY		DATE 11/23 TIME ________ AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score ________

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME 74	LOCATION	
STATION # ______ RIVERMILE ______	STREAM CLASS	
LAT ______ LONG ______	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE 1/23 TIME ______ AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score ________

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME 15	LOCATION
STATION # ________ RIVERMILE ________	STREAM CLASS
LAT ________ LONG ________	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY CF, GT	DATE 1/23 TIME ________ AM PM
	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. V. little substrate
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score __________

Appendix 6

Approved FHWA Categorical Exclusion Form

Categorical Exclusion Form for Ecosystem Enhancement Program Projects

Version 1.4

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

Part 1: General Project Information	
Project Name:	Buckwater Mitigation Site
County Name:	Orange County
EEP Number:	97084
Project Sponsor:	Wildlands Engineering, Inc
Project Contact Name:	Andrea S. Eckardt
Project Contact Address:	1430 South Mint Street, Suite 104, Charlotte, NC 28203
Project Contact E-mail:	aeckardt@wildlandseng.com
EEP Project Manager:	Jeff Schaffer

Project Description

The Buckwater Mitigation Site is a stream mitigation project located 4.5 miles northeast of Hillsborough in Orange County, NC. The project includes Buckwater Creek and 14 unnamed tributaries for a total of more than 16,000 linear feet of stream. Much of the site is currently used for cattle pasture or hay fields, with some areas in forest. The project will provide stream mitigation units to the Division of Mitigation Services in the Neuse River Basin (03020201).

For Official Use Only

Reviewed By:

6/3/2016
Date

Jeff Schaffer
EEP Project Manager

Conditional Approved By:

Date

For Division Administrator FHWA

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

Final Approval By:

6-2-16
Date

[signature]
For Division Administrator FHWA

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

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

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

Buckwater Mitigation Site
Categorical Exclusion

SUMMARY

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides a Federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment.

As the Buckwater Mitigation Site is a full-delivery project; an EDR Radius Map Report with Geocheck was ordered for the site through Environmental Data Resources, Inc on April 15, 2016. Neither the target property nor the adjacent properties were listed in any of the Federal, State, or Tribal environmental databases searched by EDR. The assessment revealed no evidence of any "recognized environmental conditions" in connection with the target property. The Executive Summary of the EDR report is included in the Appendix. The full report is available if needed.

National Historic Preservation Act (Section 106)

The National Historic Preservation Act declares a national policy of historic preservation to protect, rehabilitate, restore, and reuse districts, sites, buildings, structures, and objects significant in American architecture, history, archaeology, and culture, and Section 106 mandates that federal agencies take into account the effect of an undertaking on a property that is included in, or is eligible for inclusion in, the National Register of Historic Places.

Wildlands Engineering, Inc. (Wildlands) requested review and comment from the State Historic Preservation Office (SHPO) with respect to any archeological and architectural resources related to the Buckwater Mitigation Site on April 15, 2016, including the National Register-eligible Saint Mary's Rural Historic District (OR1456) in which a portion of the project parcels are located within. SHPO responded on May 6, 2016 and stated the project would "have no effect on the archaeological potential of the Saint Mary's Road Rural Historic District" and the project "will not adversely affect" the Saint Mary's Road Rural Historic District nor the adjacent Holden-Roberts Farm (OR0673). All correspondence related to Section 106 is included in the Appendix.

Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)

These acts, collectively known as the Uniform Act, provide for uniform and equitable treatment of persons displaced from their homes, businesses, non-profit associations, or farms by federal and federally-assisted programs, and establish uniform and equitable land acquisition policies.

Buckwater Mitigation Site is a full-delivery project that includes land acquisition. Notification of the fair market value of the project property and the lack of condemnation authority by Wildlands was included in the signed option agreements for the project properties. Copies of the relevant section of the option agreements are included in the Appendix.

Endangered Species Act (ESA)

Section 7 of the ESA requires federal agencies, in consultation with and with the assistance of the Secretary of the Interior or of Commerce, as appropriate, to ensure that actions they authorize, fund or carry out are not likely to jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of critical habitat for these species.

The Orange County listed endangered species include the bald eagle (*Haliaeetus leucocephalus*) (BGPA), dwarf wedgemussel (*Alasmidonta* heterodon), smooth coneflower (*Echinacea laevigata*) and the Michaux's sumac (*Rhus michauxii*). The USFWS does not currently list any Critical Habitat Designations for any of the Federally-listed species within Orange County. Wildlands requested review and comment from the United States Fish and Wildlife Service (USFWS) on April 15, 2016 in respect to the Buckwater

Mitigation Site and its potential impacts on threatened or endangered species. USFWS responded on May 5, 2016 and stated the “proposed action is not likely to adversely affect any federally listed endangered or threatened species, their formally designated critical habitat or species currently proposed for listing under the Act”. All correspondence with USFWS is included in the Appendix.

As a result of a pedestrian survey conducted on August 25-26, 2015, no individual species, suitable habitat or critical habitat were found to exist for the bald eagle, dwarf wedgemussel, or Michaux’s sumac. Wildlands determined that the project would have “no effect” on those listed species. Because there are areas of suitable habitat for the smooth coneflower within the project area, a second survey was conducted May 26, 2016, when the flowering occurs, to confirm no potential individual species exist on the site. Based on the second survey, Wildlands determined the project would also have “no effect” on the smooth coneflower.

Farmland Protection Policy Act (FPPA)

The FPPA requires that, before taking or approving any federal action that would result in conversion of farmland, the agency must examine the effects of the action using the criteria set forth in the FPPA, and, if there are adverse effects, must consider alternatives to lessen them.

The Buckwater Mitigation Site includes the conversion of prime farmland. As such, Form AD-1006 has been completed and submitted to the Natural Resources Conservation Service (NRCS). The completed form and correspondence documenting its submittal is included in the Appendix.

Fish and Wildlife Coordination Act (FWCA)

The FWCA requires consultation with the USFWS and the appropriate state wildlife agency on projects that alter or modify a water body. Reports and recommendations prepared by these agencies document project effects on wildlife and identify measures that may be adopted to prevent loss or damage to wildlife resources.

The Buckwater Mitigation Site includes stream restoration. Wildlands requested comment on the project from both the USFWS and the North Carolina Wildlife Resources Commission (NCWRC) on April 15, 2016. NCWRC responded on May 3, 2016 and the USFWS responded on May 5, 2016. Neither agency had any objections to the project. All correspondence with the two agencies is included in the Appendix.

Migratory Bird Treaty Act (MBTA)

The MBTA makes it unlawful for anyone to kill, capture, collect, possess, buy, sell, trade, ship, import, or export any migratory bird. The indirect killing of birds by destroying their nests and eggs is covered by the MBTA, so construction in nesting areas during nesting seasons can constitute a taking.

Wildlands requested comment on the Buckwater Stream Mitigation Site from the USFWS in regards to migratory birds on April 15, 2016. USFWS responded on May 5, 2016, but had no comments regarding migratory birds. All correspondence with USFWS is included in the Appendix.

Buckwater Mitigation Site
Categorical Exclusion

APPENDIX

Buckwater Mitigation Site
2909 St. Marys Road
Hillsborough, NC 27278

Inquiry Number: 4593176.2s
April 15, 2016

The EDR Radius Map™ Report with GeoCheck®

EDR® Environmental Data Resources Inc

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

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GEOCHECK ADDENDUM

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

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-13) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

TARGET PROPERTY INFORMATION

ADDRESS

2909 ST. MARYS ROAD
HILLSBOROUGH, NC 27278

COORDINATES

Latitude (North):	36.1069170 - 36˚ 6' 24.90''
Longitude (West):	79.0233140 - 79˚ 1' 23.93''
Universal Tranverse Mercator:	Zone 17
UTM X (Meters):	677928.3
UTM Y (Meters):	3997415.5
Elevation:	488 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property Map:	5947925 HILLSBOROUGH, NC
Version Date:	2013
North Map:	5947438 CALDWELL, NC
Version Date:	2013
Northeast Map:	5945265 ROUGEMONT, NC
Version Date:	2013
Southeast Map:	5945261 NORTHWEST DURHAM, NC
Version Date:	2013

AERIAL PHOTOGRAPHY IN THIS REPORT

Portions of Photo from:	20120531
Source:	USDA

MAPPED SITES SUMMARY

Target Property Address:
2909 ST. MARYS ROAD
HILLSBOROUGH, NC 27278

Click on Map ID to see full detail.

MAP ID	SITE NAME	ADDRESS	DATABASE ACRONYMS	RELATIVE ELEVATION	DIST (ft. & mi.) DIRECTION

NO MAPPED SITES FOUND

EXECUTIVE SUMMARY

TARGET PROPERTY SEARCH RESULTS

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

DATABASES WITH NO MAPPED SITES

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

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

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

Federal Delisted NPL site list

Delisted NPL - National Priority List Deletions

Federal CERCLIS list

FEDERAL FACILITY - Federal Facility Site Information listing
SEMS - Superfund Enterprise Management System

Federal CERCLIS NFRAP site list

SEMS-ARCHIVE - Superfund Enterprise Management System Archive

Federal RCRA CORRACTS facilities list

CORRACTS - Corrective Action Report

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF - RCRA - Treatment, Storage and Disposal

Federal RCRA generators list

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

Federal institutional controls / engineering controls registries

LUCIS - Land Use Control Information System
US ENG CONTROLS - Engineering Controls Sites List

EXECUTIVE SUMMARY

US INST CONTROL - - - - - - - - - Sites with Institutional Controls

Federal ERNS list

ERNS - Emergency Response Notification System

State- and tribal - equivalent NPL

NC HSDS - - - - - - - - - - - - - - - - - - Hazardous Substance Disposal Site

State- and tribal - equivalent CERCLIS

SHWS - Inactive Hazardous Sites Inventory

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

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

State and tribal leaking storage tank lists

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

State and tribal registered storage tank lists

FEMA UST - - - - - - - - - - - - - - - - - Underground Storage Tank Listing
UST - Petroleum Underground Storage Tank Database
AST - AST Database
INDIAN UST - - - - - - - - - - - - - - - - Underground Storage Tanks on Indian Land

State and tribal institutional control / engineering control registries

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

State and tribal voluntary cleanup sites

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

State and tribal Brownfields sites

BROWNFIELDS - - - - - - - - - - - - - Brownfields Projects Inventory

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS - - - - - - - - - A Listing of Brownfields Sites

Local Lists of Landfill / Solid Waste Disposal Sites

HIST LF - Solid Waste Facility Listing

SWRCY - Recycling Center Listing
INDIAN ODI - Report on the Status of Open Dumps on Indian Lands
ODI - Open Dump Inventory
DEBRIS REGION 9 - Torres Martinez Reservation Illegal Dump Site Locations

Local Lists of Hazardous waste / Contaminated Sites

US HIST CDL - Delisted National Clandestine Laboratory Register
US CDL - National Clandestine Laboratory Register

Local Land Records

LIENS 2 - CERCLA Lien Information

Records of Emergency Release Reports

HMIRS - Hazardous Materials Information Reporting System
SPILLS - Spills Incident Listing
IMD - Incident Management Database
SPILLS 90 - SPILLS 90 data from FirstSearch
SPILLS 80 - SPILLS 80 data from FirstSearch

Other Ascertainable Records

RCRA NonGen / NLR - RCRA - Non Generators / No Longer Regulated
FUDS - Formerly Used Defense Sites
DOD - Department of Defense Sites
SCRD DRYCLEANERS - State Coalition for Remediation of Drycleaners Listing
US FIN ASSUR - Financial Assurance Information
EPA WATCH LIST - EPA WATCH LIST
2020 COR ACTION - 2020 Corrective Action Program List
TSCA - Toxic Substances Control Act
TRIS - Toxic Chemical Release Inventory System
SSTS - Section 7 Tracking Systems
ROD - Records Of Decision
RMP - Risk Management Plans
RAATS - RCRA Administrative Action Tracking System
PRP - Potentially Responsible Parties
PADS - PCB Activity Database System
ICIS - Integrated Compliance Information System
FTTS - FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
MLTS - Material Licensing Tracking System
COAL ASH DOE - Steam-Electric Plant Operation Data
COAL ASH EPA - Coal Combustion Residues Surface Impoundments List
PCB TRANSFORMER - PCB Transformer Registration Database
RADINFO - Radiation Information Database
HIST FTTS - FIFRA/TSCA Tracking System Administrative Case Listing
DOT OPS - Incident and Accident Data
CONSENT - Superfund (CERCLA) Consent Decrees
INDIAN RESERV - Indian Reservations
FUSRAP - Formerly Utilized Sites Remedial Action Program
UMTRA - Uranium Mill Tailings Sites
LEAD SMELTERS - Lead Smelter Sites
US AIRS - Aerometric Information Retrieval System Facility Subsystem

US MINES	Mines Master Index File
FINDS	Facility Index System/Facility Registry System
COAL ASH	Coal Ash Disposal Sites
DRYCLEANERS	Drycleaning Sites
Financial Assurance	Financial Assurance Information Listing
NPDES	NPDES Facility Location Listing
UIC	Underground Injection Wells Listing
ECHO	Enforcement & Compliance History Information
FUELS PROGRAM	EPA Fuels Program Registered Listing

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR MGP	EDR Proprietary Manufactured Gas Plants
EDR Hist Auto	EDR Exclusive Historic Gas Stations
EDR Hist Cleaner	EDR Exclusive Historic Dry Cleaners

EDR RECOVERED GOVERNMENT ARCHIVES

Exclusive Recovered Govt. Archives

RGA HWS	Recovered Government Archive State Hazardous Waste Facilities List
RGA LF	Recovered Government Archive Solid Waste Facilities List
RGA LUST	Recovered Government Archive Leaking Underground Storage Tank

SURROUNDING SITES: SEARCH RESULTS

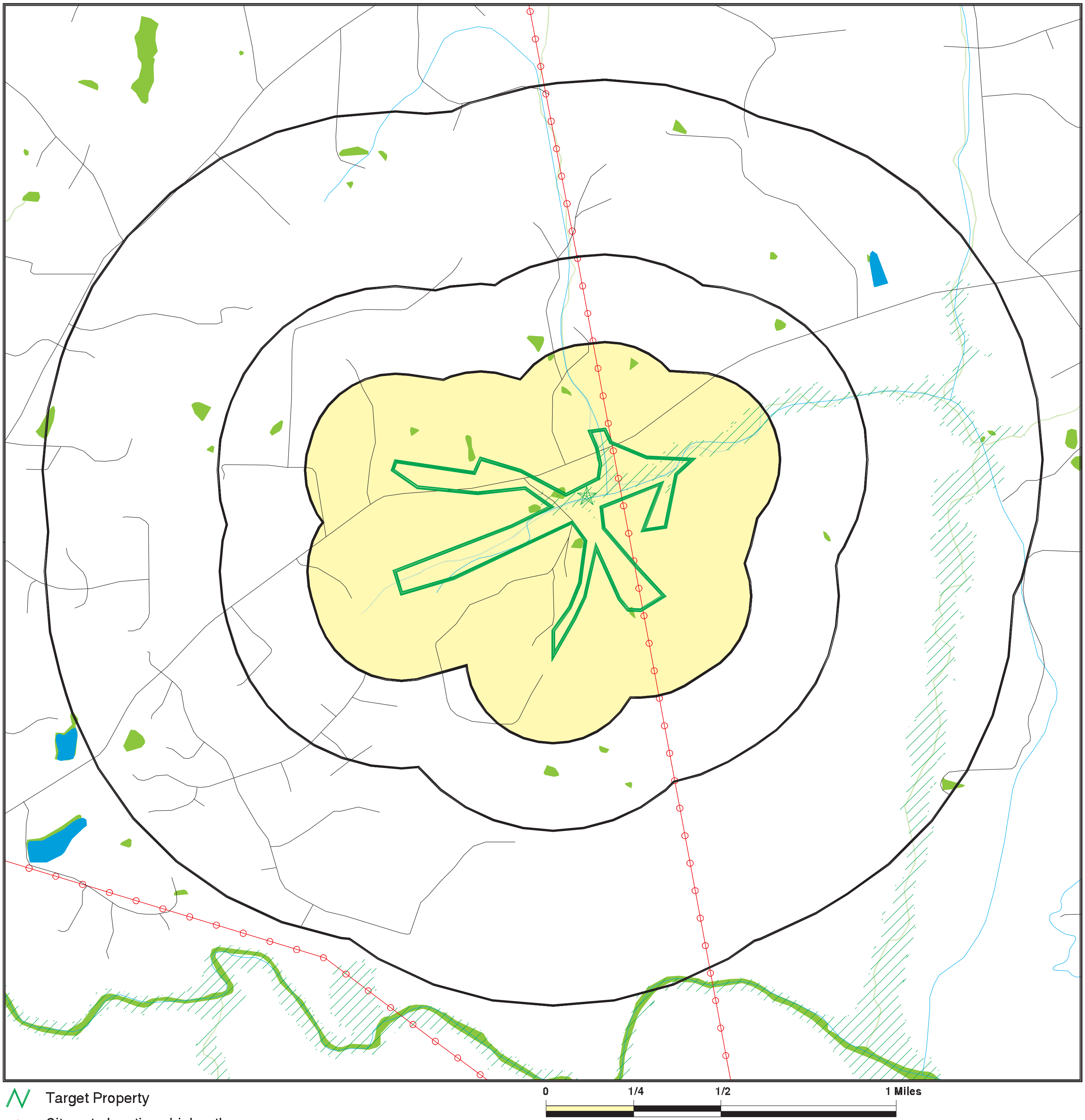
Surrounding sites were not identified.

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

EXECUTIVE SUMMARY

There were no unmapped sites in this report.

OVERVIEW MAP - 4593176.2S

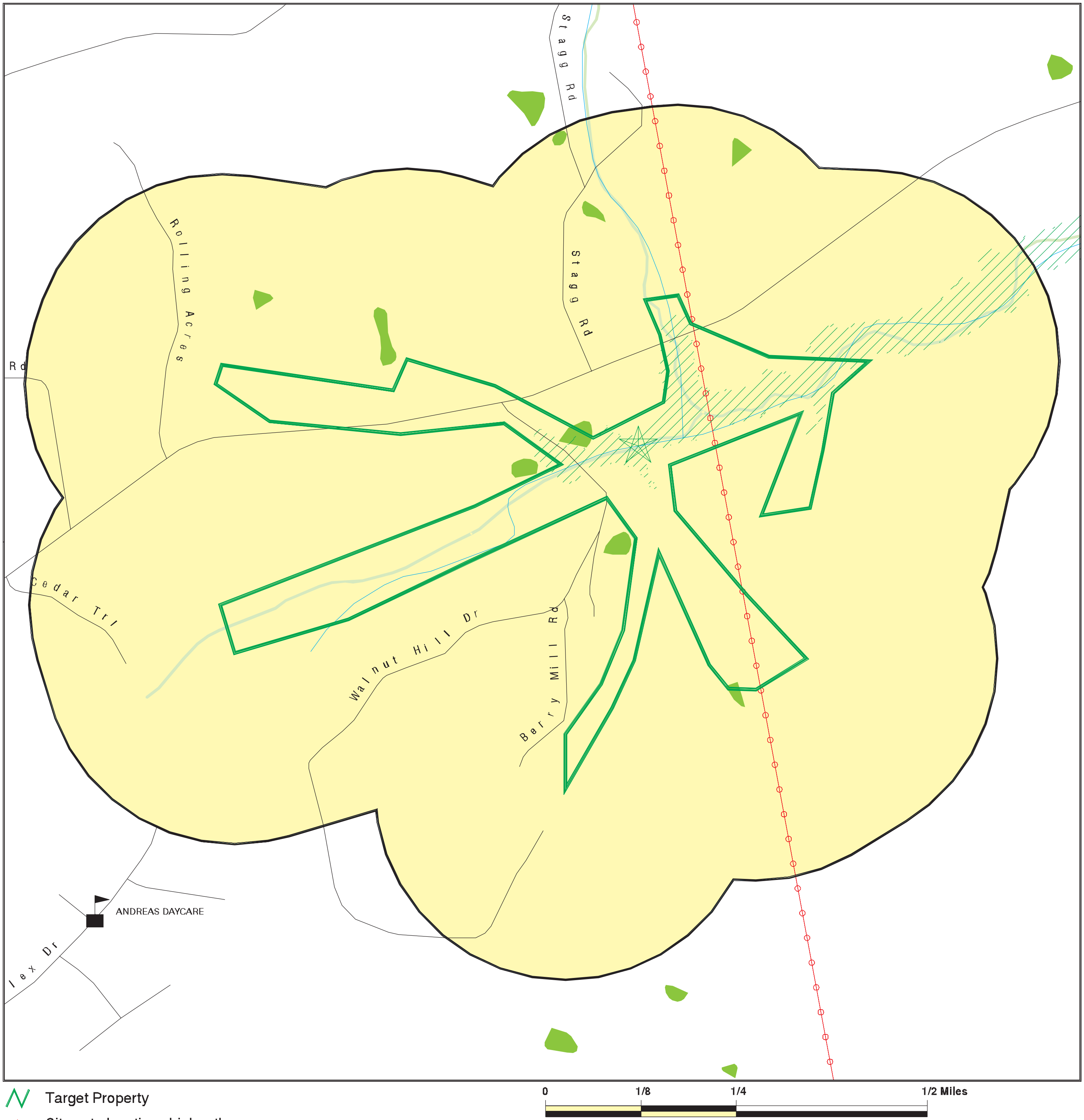


- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- National Priority List Sites
- Dept. Defense Sites
- Indian Reservations BIA
- Power transmission lines
- 100-year flood zone
- 500-year flood zone
- National Wetland Inventory
- State Wetlands
- Hazardous Substance Disposal Sites

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME: Buckwater Mitigation Site	CLIENT: Wildlands Eng, Inc.
ADDRESS: 2909 St. Marys Road	CONTACT: Ian Eckardt
Hillsborough NC 27278	INQUIRY #: 4593176.2s
LAT/LONG: 36.106917 / 79.023314	DATE: April 15, 2016 11:45 am

DETAIL MAP - 4593176.2S



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- Sensitive Receptors
- National Priority List Sites
- Dept. Defense Sites
- Indian Reservations BIA
- Power transmission lines
- 100-year flood zone
- 500-year flood zone
- National Wetland Inventory
- State Wetlands
- Hazardous Substance Disposal Sites

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME: Buckwater Mitigation Site ADDRESS: 2909 St. Marys Road Hillsborough NC 27278 LAT/LONG: 36.106917 / 79.023314	CLIENT: Wildlands Eng, Inc. CONTACT: Ian Eckardt INQUIRY #: 4593176.2s DATE: April 15, 2016 11:46 am

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
STANDARD ENVIRONMENTAL RECORDS								
Federal NPL site list								
NPL	1.000		0	0	0	0	NR	0
Proposed NPL	1.000		0	0	0	0	NR	0
NPL LIENS	TP		NR	NR	NR	NR	NR	0
Federal Delisted NPL site list								
Delisted NPL	1.000		0	0	0	0	NR	0
Federal CERCLIS list								
FEDERAL FACILITY	0.500		0	0	0	NR	NR	0
SEMS	0.500		0	0	0	NR	NR	0
Federal CERCLIS NFRAP site list								
SEMS-ARCHIVE	0.500		0	0	0	NR	NR	0
Federal RCRA CORRACTS facilities list								
CORRACTS	1.000		0	0	0	0	NR	0
Federal RCRA non-CORRACTS TSD facilities list								
RCRA-TSDF	0.500		0	0	0	NR	NR	0
Federal RCRA generators list								
RCRA-LQG	0.250		0	0	NR	NR	NR	0
RCRA-SQG	0.250		0	0	NR	NR	NR	0
RCRA-CESQG	0.250		0	0	NR	NR	NR	0
Federal institutional controls / engineering controls registries								
LUCIS	0.500		0	0	0	NR	NR	0
US ENG CONTROLS	0.500		0	0	0	NR	NR	0
US INST CONTROL	0.500		0	0	0	NR	NR	0
Federal ERNS list								
ERNS	TP		NR	NR	NR	NR	NR	0
State- and tribal - equivalent NPL								
NC HSDS	1.000		0	0	0	0	NR	0
State- and tribal - equivalent CERCLIS								
SHWS	1.000		0	0	0	0	NR	0
State and tribal landfill and/or solid waste disposal site lists								
SWF/LF	0.500		0	0	0	NR	NR	0
OLI	0.500		0	0	0	NR	NR	0
State and tribal leaking storage tank lists								
LAST	0.500		0	0	0	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
LUST	0.500		0	0	0	NR	NR	0
INDIAN LUST	0.500		0	0	0	NR	NR	0
LUST TRUST	0.500		0	0	0	NR	NR	0
State and tribal registered storage tank lists								
FEMA UST	0.250		0	0	NR	NR	NR	0
UST	0.250		0	0	NR	NR	NR	0
AST	0.250		0	0	NR	NR	NR	0
INDIAN UST	0.250		0	0	NR	NR	NR	0
State and tribal institutional control / engineering control registries								
INST CONTROL	0.500		0	0	0	NR	NR	0
State and tribal voluntary cleanup sites								
INDIAN VCP	0.500		0	0	0	NR	NR	0
VCP	0.500		0	0	0	NR	NR	0
State and tribal Brownfields sites								
BROWNFIELDS	0.500		0	0	0	NR	NR	0
ADDITIONAL ENVIRONMENTAL RECORDS								
Local Brownfield lists								
US BROWNFIELDS	0.500		0	0	0	NR	NR	0
Local Lists of Landfill / Solid Waste Disposal Sites								
HIST LF	0.500		0	0	0	NR	NR	0
SWRCY	0.500		0	0	0	NR	NR	0
INDIAN ODI	0.500		0	0	0	NR	NR	0
ODI	0.500		0	0	0	NR	NR	0
DEBRIS REGION 9	0.500		0	0	0	NR	NR	0
Local Lists of Hazardous waste / Contaminated Sites								
US HIST CDL	TP		NR	NR	NR	NR	NR	0
US CDL	TP		NR	NR	NR	NR	NR	0
Local Land Records								
LIENS 2	TP		NR	NR	NR	NR	NR	0
Records of Emergency Release Reports								
HMIRS	TP		NR	NR	NR	NR	NR	0
SPILLS	TP		NR	NR	NR	NR	NR	0
IMD	0.500		0	0	0	NR	NR	0
SPILLS 90	TP		NR	NR	NR	NR	NR	0
SPILLS 80	TP		NR	NR	NR	NR	NR	0
Other Ascertainable Records								
RCRA NonGen / NLR	0.250		0	0	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
FUDS	1.000		0	0	0	0	NR	0
DOD	1.000		0	0	0	0	NR	0
SCRD DRYCLEANERS	0.500		0	0	0	NR	NR	0
US FIN ASSUR	TP		NR	NR	NR	NR	NR	0
EPA WATCH LIST	TP		NR	NR	NR	NR	NR	0
2020 COR ACTION	0.250		0	0	NR	NR	NR	0
TSCA	TP		NR	NR	NR	NR	NR	0
TRIS	TP		NR	NR	NR	NR	NR	0
SSTS	TP		NR	NR	NR	NR	NR	0
ROD	1.000		0	0	0	0	NR	0
RMP	TP		NR	NR	NR	NR	NR	0
RAATS	TP		NR	NR	NR	NR	NR	0
PRP	TP		NR	NR	NR	NR	NR	0
PADS	TP		NR	NR	NR	NR	NR	0
ICIS	TP		NR	NR	NR	NR	NR	0
FTTS	TP		NR	NR	NR	NR	NR	0
MLTS	TP		NR	NR	NR	NR	NR	0
COAL ASH DOE	TP		NR	NR	NR	NR	NR	0
COAL ASH EPA	0.500		0	0	0	NR	NR	0
PCB TRANSFORMER	TP		NR	NR	NR	NR	NR	0
RADINFO	TP		NR	NR	NR	NR	NR	0
HIST FTTS	TP		NR	NR	NR	NR	NR	0
DOT OPS	TP		NR	NR	NR	NR	NR	0
CONSENT	1.000		0	0	0	0	NR	0
INDIAN RESERV	1.000		0	0	0	0	NR	0
FUSRAP	1.000		0	0	0	0	NR	0
UMTRA	0.500		0	0	0	NR	NR	0
LEAD SMELTERS	TP		NR	NR	NR	NR	NR	0
US AIRS	TP		NR	NR	NR	NR	NR	0
US MINES	0.250		0	0	NR	NR	NR	0
FINDS	TP		NR	NR	NR	NR	NR	0
COAL ASH	0.500		0	0	0	NR	NR	0
DRYCLEANERS	0.250		0	0	NR	NR	NR	0
Financial Assurance	TP		NR	NR	NR	NR	NR	0
NPDES	TP		NR	NR	NR	NR	NR	0
UIC	TP		NR	NR	NR	NR	NR	0
ECHO	TP		NR	NR	NR	NR	NR	0
FUELS PROGRAM	0.250		0	0	NR	NR	NR	0

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
EDR MGP	1.000		0	0	0	0	NR	0
EDR Hist Auto	0.125		0	NR	NR	NR	NR	0
EDR Hist Cleaner	0.125		0	NR	NR	NR	NR	0

EDR RECOVERED GOVERNMENT ARCHIVES

Exclusive Recovered Govt. Archives

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
RGA HWS	TP		NR	NR	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
RGA LF	TP		NR	NR	NR	NR	NR	0
RGA LUST	TP		NR	NR	NR	NR	NR	0
- Totals --		0	0	0	0	0	0	0

NOTES:

TP = Target Property

NR = Not Requested at this Search Distance

Sites may be listed in more than one database

MAP FINDINGS

Map ID Direction Distance Elevation	Site	Database(s)	EDR ID Number EPA ID Number

NO SITES FOUND

WILDLANDS
ENGINEERING

April 15, 2016

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

Subject: Buckwater Mitigation Site
Orange County, North Carolina

Dear Ms. Gledhill-Earley,

Wildlands Engineering, Inc. requests review and comment on any possible issues that might emerge with respect to archaeological or cultural resources associated with the Buckwater Mitigation Site. A USGS site map and aerial map with approximate project area are enclosed.

The Site is located within Saint Mary's Road Rural Historic District according to The National Register with the State Historic Preservation Office (SHPO). The project is also located in close proximity to two Historic Places: the Bacon Farm (OR0693) and the Walnut Hill Farm (OR1428) according to SHPO.

The Buckwater Mitigation Site is being developed to provide in-kind mitigation for unavoidable stream channel impacts. Several sections of channel have been identified as significantly degraded. The project will include stream restoration and enhancement. The site has historically been disturbed due to agricultural use, particularly for livestock production and row crops.

We ask that you review this site based on the attached information to determine the presence of any historic properties.

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

Sincerely,

Ruby M. Davis

Ruby M. Davis
Environmental Scientist
rdavis@wildlandseng.com

North Carolina Department of Natural and Cultural Resources

State Historic Preservation Office

Ramona M. Bartos, Administrator

Governor Pat McCrory
Secretary Susan Kluttz

Office of Archives and History
Deputy Secretary Kevin Cherry

May 6, 2016

Ruby M. Davis
Wildlands Engineering
1430 South Mint Street, Suite 104
Charlotte, NC 28203
rdavis@wildlandseng.com

Re: Buckwater Mitigation Site, Orange County, ER 16-0696

Dear Ms. Davis:

Thank you for your letter of April 15, 2016, concerning the above project.

In 1999 the St. Mary's Road Corridor was surveyed at a reconnaissance level to produce the report, "An archaeological context for St. Mary's Road Corridor, Orange County, North Carolina." Dr. Linda F. Stine and the late Thomas Hargrove documented 23 archaeological sites, 31OR480** through 31OR503** in a survey that traveled from the intersection of St. Mary's Road and US 70 east to St. Mary's School/Chapel. Archaeological sites (all from the historic period) include the Ayr Mount Plantation Complex, farmsteads, old road remnants, evidence of saw mill activity, quarrying, and a cemetery.

Eight sites—31OR484**, 31OR485**, 31OR486**, 31OR487**, 31OR488**, 31OR493**, 31OR494**, and 31OR495**; are within one-half mile of the project parcels. Of these, 31OR484** and 31OR485**, have been evaluated as not eligible for the National Register of Historic Places. The rest are unassessed. None of these sites will be affected by the stream restoration and enhancement planned for the red-outlined project area.

From the report, it is impossible to determine exactly what land was covered in the reconnaissance survey. It appears that some of it must have been.

Given the disturbances from livestock production and row corps, we consider it unlikely that significant archaeological sites will be affected by the proposed project. We, therefore, have no comment on the project as proposed and consider that it will have no effect on the archaeological potential of the Saint Mary's Road Rural Historic District.

Because of the long-time use of the area; however, we do urge caution as mitigation activities proceed. Please cease work and contact us if artifacts or cultural features are encountered.

Location: 109 East Jones Street, Raleigh NC 27601 **Mailing Address**: 4617 Mail Service Center, Raleigh NC 27699-4617 **Telephone/Fax**: (919) 807-6570/807-6599

Although work will occur within the boundaries of the National Register-eligible Saint Mary's Rural Historic District (OR1456), and adjacent to the National Register-listed Holden-Roberts Farm (OR0673), it appears the proposed in-kind mitigation, stream restoration, and enhancement will not adversely affect these historic properties.

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

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

Sincerely,

Renee Gledhill-Earley

for Ramona M. Bartos

TO OPTIONOR: David L. Sheets
104 Summit Wood Ct.
Holly Springs, NC 27540
e-mail: flavordave@gmail.com

And

Donna S. Mayfield
5032 Westhaven Lane
Trinity, NC 27370-9657
e-mail: ncmayfields@gmail.com

Notice of change of address shall be given by written notice in the manner described in this paragraph.

3.5 **Assignment.** Optionee has the right to assign this agreement without the consent of Optionor. No assignment shall be effective unless the assignee has delivered to Optionor a written assumption of Optionee's obligations under this agreement. Optionor hereby releases Optionee from any obligations under this agreement arising after the effective date of any assignment of this agreement by Optionee. Optionor has the right to assign this agreement to a future LLC that holds the Property.

3.6 **Value of Conservation Easement; No Power of Eminent Domain.** In accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Optionee hereby notifies Optionor that: (i) Optionee believes that the fair market value of the Conservation Easement is an amount equal to the Purchase Price; and (ii) Optionee does not have the power of eminent domain.

3.7 **Modification; Waiver.** No amendment of this agreement will be effective unless it is in writing and signed by the parties. No waiver of satisfaction of a condition or failure to comply with an obligation under this agreement will be effective unless it is in writing and signed by the party granting the waiver, and no such waiver will constitute a waiver of satisfaction of any other condition or failure to comply with any other obligation.

3.8 **Attorneys' Fees.** If either party commences an action against the other to interpret or enforce any of the terms of this agreement or because of the breach by the other party of any of the terms of this agreement, the losing party shall pay to the prevailing party reasonable attorneys' fees, expenses, court costs, litigation costs and any other expenses incurred in connection with the prosecution or defense of such action, whether or not the action is prosecuted to a final judgment.

3.9 **Memorandum of Option Agreement.** Concurrently with the signing of this agreement, Optionee and Optionor agree to sign a Memorandum of Option which will be recorded against the Property in the Register of Deeds of the County stated in paragraph A within five days after the Effective Date.

3.10 **Landowner Authorization.** Concurrently with the signing of this agreement, Optionor agrees to sign the NCDMS Landowner Authorization Form in the form of exhibit C.

3.11 **Liability Insurance**. Within thirty business days following execution of a contract between Optionee and the State of North Carolina for Optionee's response to Request for Proposal # 16-006477 issued June 24, 2015,, Optionee will provide Optionor with a certificate of insurance naming Optionor as an additional insured.

JWH DSM AMM

TO OPTIONOR: Darin and Kathleen Little
601 Walnut Hill Dr.
Hillsborough, NC 27278
e-mail: darinlittle@aol.com

Notice of change of address shall be given by written notice in the manner described in this paragraph.

3.3 **Assignment.** Optionee has the right to assign this agreement without the consent of Optionor. No assignment shall be effective unless the assignee has delivered to Optionor a written assumption of Optionee's obligations under this agreement. Optionor hereby releases Optionee from any obligations under this agreement arising after the effective date of any assignment of this agreement by Optionee.

3.4 **Value of Conservation Easement; No Power of Eminent Domain.** In accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Optionee hereby notifies Optionor that: (i) Optionee believes that the fair market value of the Conservation Easement is an amount equal to the Purchase Price; and (ii) Optionee does not have the power of eminent domain.

3.5 **Modification; Waiver.** No amendment of this agreement will be effective unless it is in writing and signed by the parties. No waiver of satisfaction of a condition or failure to comply with an obligation under this agreement will be effective unless it is in writing and signed by the party granting the waiver, and no such waiver will constitute a waiver of satisfaction of any other condition or failure to comply with any other obligation.

3.6 **Attorneys' Fees.** If either party commences an action against the other to interpret or enforce any of the terms of this agreement or because of the breach by the other party of any of the terms of this agreement, the losing party shall pay to the prevailing party reasonable attorneys' fees, expenses, court costs, litigation costs and any other expenses incurred in connection with the prosecution or defense of such action, whether or not the action is prosecuted to a final judgment.

3.7 **Memorandum of Option Agreement.** Concurrently with the signing of this agreement, Optionee and Optionor agree to sign a Memorandum of Option which will be recorded against the Property in the Register of Deeds of the County stated in paragraph A within five days after the Effective Date.

3.8 **Landowner Authorization.** Concurrently with the signing of this agreement, Optionor agrees to sign the NCDMS Landowner Authorization Form in the form of exhibit C.

3.9 **Entire Agreement.** Each party acknowledges they are not relying on any statements made by the other party, other than in this agreement, regarding the subject matter of this agreement. Neither party will have a basis for bringing any claim for fraud in connection with any such statements.

3.10 **Mutual Agreement.** This is a mutually negotiated agreement and regardless of which party was more responsible for its preparation, this agreement shall be construed neutrally between the parties.

3.11 **Governing Law.** The laws of the State of North Carolina, without giving effect to its principles of conflicts of law, govern all matters arising out of this agreement.

JWH Optionee
TDL Optionor KMW Optionor

Optionor: Pelham Jacobs

3.3 **Assignment.** Optionee has the right to assign this agreement without the consent of Optionor. No assignment shall be effective unless the assignee has delivered to Optionor a written assumption of Optionee's obligations under this agreement. Optionor hereby releases Optionee from any obligations under this agreement arising after the effective date of any assignment of this agreement by Optionee.

3.4 **Value of Conservation Easement; No Power of Eminent Domain.** In accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Optionee hereby notifies Optionor that: (i) Optionee believes that the fair market value of the Conservation Easement is an amount equal to the Purchase Price; and (ii) Optionee does not have the power of eminent domain.

3.5 **Modification; Waiver.** No amendment of this agreement will be effective unless it is in writing and signed by the parties. No waiver of satisfaction of a condition or failure to comply with an obligation under this agreement will be effective unless it is in writing and signed by the party granting the waiver, and no such waiver will constitute a waiver of satisfaction of any other condition or failure to comply with any other obligation.

3.6 **Attorneys' Fees.** If either party commences an action against the other to interpret or enforce any of the terms of this agreement or because of the breach by the other party of any of the terms of this agreement, the losing party shall pay to the prevailing party reasonable attorneys' fees, expenses, court costs, litigation costs and any other expenses incurred in connection with the prosecution or defense of such action, whether or not the action is prosecuted to a final judgment.

3.7 **Memorandum of Option Agreement.** Concurrently with the signing of this agreement, Optionee and Optionor agree to sign a Memorandum of Option which will be recorded against the Property in the Register of Deeds of the County stated in paragraph A within five days after the Effective Date.

3.8 **Landowner Authorization.** Concurrently with the signing of this agreement, Optionor agrees to sign the NCDMS Landowner Authorization Form in the form of exhibit C.

3.9 **Entire Agreement.** Each party acknowledges they are not relying on any statements made by the other party, other than in this agreement, regarding the subject matter of this agreement. Neither party will have a basis for bringing any claim for fraud in connection with any such statements.

3.10 **Mutual Agreement.** This is a mutually negotiated agreement and regardless of which party was more responsible for its preparation, this agreement shall be construed neutrally between the parties.

3.11 **Governing Law.** The laws of the State of North Carolina, without giving effect to its principles of conflicts of law, govern all matters arising out of this agreement.

3.12 **Counterparts.** This agreement may be signed in counterparts, each of which shall be deemed an original, but all of which, together, constitute one and the same instrument. A signed copy of this agreement delivered by electronic mail in portable document format (".pdf" format) shall have the same legal effect as delivery of an original signed copy of this agreement.

Each party is signing this agreement on the date stated below that party's signature.

3.3 **Assignment.** Optionee has the right to assign this agreement without the consent of Optionor. No assignment shall be effective unless the assignee has delivered to Optionor a written assumption of Optionee's obligations under this agreement. Optionor hereby releases Optionee from any obligations under this agreement arising after the effective date of any assignment of this agreement by Optionee.

3.4 **Value of Conservation Easement; No Power of Eminent Domain.** In accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Optionee hereby notifies Optionor that: (i) Optionee believes that the fair market value of the Conservation Easement is an amount equal to the Purchase Price; and (ii) Optionee does not have the power of eminent domain.

3.5 **Modification; Waiver.** No amendment of this agreement will be effective unless it is in writing and signed by the parties. No waiver of satisfaction of a condition or failure to comply with an obligation under this agreement will be effective unless it is in writing and signed by the party granting the waiver, and no such waiver will constitute a waiver of satisfaction of any other condition or failure to comply with any other obligation.

3.6 **Attorneys' Fees.** If either party commences an action against the other to interpret or enforce any of the terms of this agreement or because of the breach by the other party of any of the terms of this agreement, the losing party shall pay to the prevailing party reasonable attorneys' fees, expenses, court costs, litigation costs and any other expenses incurred in connection with the prosecution or defense of such action, whether or not the action is prosecuted to a final judgment.

3.7 **Memorandum of Option Agreement.** Concurrently with the signing of this agreement, Optionee and Optionor agree to sign a Memorandum of Option which will be recorded against the Property in the Register of Deeds of the County stated in paragraph A within five days after the Effective Date.

3.8 **Landowner Authorization.** Concurrently with the signing of this agreement, Optionor agrees to sign the NCDMS Landowner Authorization Form in the form of exhibit C.

3.9 **Entire Agreement.** Each party acknowledges they are not relying on any statements made by the other party, other than in this agreement, regarding the subject matter of this agreement. Neither party will have a basis for bringing any claim for fraud in connection with any such statements.

3.10 **Mutual Agreement.** This is a mutually negotiated agreement and regardless of which party was more responsible for its preparation, this agreement shall be construed neutrally between the parties.

3.11 **Governing Law.** The laws of the State of North Carolina, without giving effect to its principles of conflicts of law, govern all matters arising out of this agreement.

3.12 **Counterparts.** This agreement may be signed in counterparts, each of which shall be deemed an original, but all of which, together, constitute one and the same instrument. A signed copy of this agreement delivered by electronic mail in portable document format (".pdf" format) shall have the same legal effect as delivery of an original signed copy of this agreement.

[SIGNATURE PAGE FOLLOWS]

deemed properly delivered: (a) upon receipt when hand delivered during normal business hours; (b) upon the day of delivery if the notice has been deposited in an authorized receptacle of the United States Postal Service as first-class, registered or certified mail, postage prepaid, with a return receipt requested; (c) one business day after the notice has been deposited with either FedEx or United Parcel Service to be delivered by overnight delivery; or (d) if sent by email, upon receipt of an acknowledgement email sent to the sender's email address in which the party receiving the email notice acknowledges having received that email. An automatic "read receipt" is not acknowledgement for purposes of this section 3.2. The addresses of the parties to receive notices are as follows:

TO OPTIONEE:	Wildlands Engineering, Inc. 1430 S. Mint Street, Suite 104 Charlotte, North Carolina 28203 Attention: Lee Knight Caffery e-mail: lcaffery@wildlandseng.com
TO OPTIONOR:	Doug and Pat Crabtree 4211 St. Mary's Rd. Hillsborough, NC 27278

Notice of change of address shall be given by written notice in the manner described in this paragraph.

3.4 **Assignment.** Optionee has the right to assign this agreement without the consent of Optionor. No assignment shall be effective unless the assignee has delivered to Optionor a written assumption of Optionee's obligations under this agreement. Optionor hereby releases Optionee from any obligations under this agreement arising after the effective date of any assignment of this agreement by Optionee.

3.5 **Value of Conservation Easement; No Power of Eminent Domain.** In accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Optionee hereby notifies Optionor that: (i) Optionee believes that the fair market value of the Conservation Easement is an amount equal to the Purchase Price; and (ii) Optionee does not have the power of eminent domain.

3.6 **Modification; Waiver.** No amendment of this agreement will be effective unless it is in writing and signed by the parties. No waiver of satisfaction of a condition or failure to comply with an obligation under this agreement will be effective unless it is in writing and signed by the party granting the waiver, and no such waiver will constitute a waiver of satisfaction of any other condition or failure to comply with any other obligation.

3.7 **Attorneys' Fees.** If either party commences an action against the other to interpret or enforce any of the terms of this agreement or because of the breach by the other party of any of the terms of this agreement, the losing party shall pay to the prevailing party reasonable attorneys' fees, expenses, court costs, litigation costs and any other expenses incurred in connection with the prosecution or defense of such action, whether or not the action is prosecuted to a final judgment.

3.8 **Memorandum of Option Agreement.** Concurrently with the signing of this agreement, Optionee and Optionor agree to sign a Memorandum of Option which will be recorded against the Property in the Register of Deeds of the County stated in paragraph A within five days after the Effective Date.

JWH Optionee
MDC Optionor PRC Optionor

Optionor: Bacon Family Limited Partnership II

3.5 **Value of Conservation Easement; No Power of Eminent Domain.** In accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Optionee hereby notifies Optionor that: (i) Optionee believes that the fair market value of the Conservation Easement is an amount equal to the Purchase Price; and (ii) Optionee does not have the power of eminent domain.

3.6 **Modification; Waiver.** No amendment of this agreement will be effective unless it is in writing and signed by the parties. No waiver of satisfaction of a condition or failure to comply with an obligation under this agreement will be effective unless it is in writing and signed by the party granting the waiver, and no such waiver will constitute a waiver of satisfaction of any other condition or failure to comply with any other obligation.

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3.9 **Landowner Authorization.** Concurrently with the signing of this agreement, Optionor agrees to sign the NCDMS Landowner Authorization Form in the form of exhibit C.

3.10 **Entire Agreement.** Each party acknowledges they are not relying on any statements made by the other party, other than in this agreement, regarding the subject matter of this agreement. Neither party will have a basis for bringing any claim for fraud in connection with any such statements.

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Each party is signing this agreement on the date stated below that party's signature.

[SIGNATURE PAGE FOLLOWS]

JWH Optionee
ABH Optionor MEC Optionor

3.4 **Assignment.** Optionee has the right to assign this agreement without the consent of Optionor. No assignment shall be effective unless the assignee has delivered to Optionor a written assumption of Optionee's obligations under this agreement. Optionor hereby releases Optionee from any obligations under this agreement arising after the effective date of any assignment of this agreement by Optionee.

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3.7 **Attorneys' Fees.** If either party commences an action against the other to interpret or enforce any of the terms of this agreement or because of the breach by the other party of any of the terms of this agreement, the losing party shall pay to the prevailing party reasonable attorneys' fees, expenses, court costs, litigation costs and any other expenses incurred in connection with the prosecution or defense of such action, whether or not the action is prosecuted to a final judgment.

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[SIGNATURE PAGE FOLLOWS]

JWH Optionee
BJ Optionor ____ Optionor
BJ

April 15, 2016

Dale Suiter
US Fish and Wildlife Service
Raleigh Field Office
PO Box 33726
Raleigh, NC 27636

Subject: Buckwater Mitigation Site
Orange County, North Carolina

Dear Mr. Suiter,

Wildlands Engineering, Inc. requests review and comment on any possible issues that might emerge with respect to endangered species, migratory birds or other trust resources associated with the proposed Buckwater Mitigation Site. A USGS map and aerial map showing the approximate project area are enclosed. The topographic figure was prepared from the Hillsborough, 7.5-Minute USGS Topographic Quadrangles.

The Buckwater Mitigation Site is being developed to provide in-kind mitigation for unavoidable stream channel impacts. Several sections of channel have been identified as significantly degraded. The project will include stream restoration and enhancement. The site has historically been disturbed due to agricultural use, particularly for livestock production and row crops.

According to your website (http://ecos.fws.gov/tess_public/reports/species-by-current-range-county), the bald eagle (*Haliaeetus leucocephalus*), dwarf wedgemussel (*Alasmidonta* heterodon), smooth coneflower (*Echinacea laevigata*) and the Michaux's sumac (*Rhus* michauxii) are the federally-listed species in Orange County. We are requesting that you provide any known information on these species.

If we have not heard from you in 30 days we will assume that you do not have any comments regarding associated laws and that you do not have any information relevant to this projects at the current time.

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

Sincerely,

Ruby M. Davis
Environmental Scientist

Attachment:
USGS Topographic Map and Aerial Map

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh ES Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

May 5, 2016

Ruby Davis
Wildlands Engineering
1430 South Mint Street, Suite 104
Charlotte, NC 28203

Re: Buckwater Mitigation Site – Orange County, NC

Dear Mrs. Davis:

This letter is to inform you that a list of all federally-protected endangered and threatened species with known occurrences in North Carolina is now available on the U.S. Fish and Wildlife Service's (Service) web page at http://www.fws.gov/raleigh. Therefore, if you have projects that occur within the Raleigh Field Office's area of responsibility (see attached county list), you no longer need to contact the Raleigh Field Office for a list of federally-protected species.

Our web page contains a complete and frequently updated list of all endangered and threatened species protected by the provisions of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)(Act), and a list of federal species of concern[1] that are known to occur in each county in North Carolina.

Section 7 of the Act requires that all federal agencies (or their designated non-federal representative), in consultation with the Service, insure that any action federally authorized, funded, or carried out by such agencies is not likely to jeopardize the continued existence of any federally-listed endangered or threatened species. A biological assessment or evaluation may be prepared to fulfill that requirement and in determining whether additional consultation with the Service is necessary. In addition to the federally-protected species list, information on the species' life histories and habitats and information on completing a biological assessment or evaluation and can be found on our web page at http://www.fws.gov/raleigh. Please check the web site often for updated information or changes.

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[1] The term "federal species of concern" refers to those species which the Service believes might be in need of concentrated conservation actions. Federal species of concern receive no legal protection and their designation does not necessarily imply that the species will eventually be proposed for listing as a federally endangered or threatened species. However, we recommend that all practicable measures be taken to avoid or minimize adverse impacts to federal species of concern.

If your project contains suitable habitat for any of the federally-listed species known to be present within the county where your project occurs, the proposed action has the potential to adversely affect those species. As such, we recommend that surveys be conducted to determine the species' presence or absence within the project area. The use of North Carolina Natural Heritage program data should not be substituted for actual field surveys.

If you determine that the proposed action may affect (i.e., likely to adversely affect or not likely to adversely affect) a federally-protected species, you should notify this office with your determination, the results of your surveys, survey methodologies, and an analysis of the effects of the action on listed species, including consideration of direct, indirect, and cumulative effects, before conducting any activities that might affect the species. If you determine that the proposed action will have no effect (i.e., no beneficial or adverse, direct or indirect effect) on federally listed species, then you are not required to contact our office for concurrence (unless an Environmental Impact Statement is prepared). However, you should maintain a complete record of the assessment, including steps leading to your determination of effect, the qualified personnel conducting the assessment, habitat conditions, site photographs, and any other related articles.

With regard to the above-referenced project, we offer the following remarks. Our comments are submitted pursuant to, and in accordance with, provisions of the Endangered Species Act.

Based on the information provided and other information available, it appears that the proposed action is not likely to adversely affect any federally-listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for listing under the Act at these sites. We believe that the requirements of section 7(a)(2) of the Act have been satisfied for your project. Please remember that obligations under section 7 consultation must be reconsidered if: (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is subsequently modified in a manner that was not considered in this review; or, (3) a new species is listed or critical habitat determined that may be affected by the identified action.

However, the Service is concerned about the potential impacts the proposed action might have on aquatic species. Aquatic resources are highly susceptible to sedimentation. Therefore, we recommend that all practicable measures be taken to avoid adverse impacts to aquatic species, including implementing directional boring methods and stringent sediment and erosion control measures. An erosion and sedimentation control plan should be submitted to and approved by the North Carolina Division of Land Resources, Land Quality Section prior to construction. Erosion and sedimentation controls should be installed and maintained between the construction site and any nearby down-gradient surface waters. In addition, we recommend maintaining natural, vegetated buffers on all streams and creeks adjacent to the project site.

The North Carolina Wildlife Resources Commission has developed a Guidance Memorandum (a copy can be found on our website at (http://www.fws.gov/raleigh) to address and mitigate secondary and cumulative impacts to aquatic and terrestrial wildlife resources and water quality. We recommend that you consider this document in the development of your projects and in completing an initiation package for consultation (if necessary).

We hope you find our web page useful and informative and that following the process described above will reduce the time required, and eliminate the need, for general correspondence for species' lists. If you have any questions or comments, please contact Kathy Matthews of this office at (919) 856-4520 ext. 27.

Sincerely,

Kathy H. Matthews
for Pete Benjamin
Field Supervisor

List of Counties in the Service's Raleigh Field Office Area of Responsibility

Alamance
Beaufort
Bertie
Bladen
Brunswick
Camden
Carteret
Caswell
Chatham
Chowan
Columbus
Craven
Cumberland
Currituck
Dare
Duplin
Durham
Edgecombe
Franklin
Gates
Granville
Greene
Guilford
Halifax
Harnett
Hertford
Hoke
Hyde
Johnston
Jones
Lee
Lenoir
Martin
Montgomery
Moore
Nash
New Hanover
Northampton
Onslow
Orange
Pamlico
Pasquotank
Pender
Perquimans
Person
Pitt
Randolph
Richmond
Robeson
Rockingham
Sampson
Scotland
Tyrrell
Vance
Wake
Warren
Washington
Wayne
Wilson

Natural Resources
Conservation Service

North Carolina
State Office

4407 Bland Road
Suite 117
Raleigh, NC 27609
Voice 919-873-2171
Fax 844-325-6833

May 23, 2016

Mr. Ian Eckardt
Environmental Scientist
Wildlands Engineering, Inc.
1430 S. Mint St, Suite 104
Charlotte, NC 28203

Dear Mr. Eckardt

Thank you for your email dated April 14, 2016, Subject: AD1006 Form - Buckwater Mitigation Site - Orange County, NC. The following guidance is provided for your information.

Projects are subject to the Farmland Protection Policy Act (FPPA) requirements if they may irreversibly convert farmland (directly or indirectly) to non-agricultural use and are completed by a federal agency or with assistance from a federal agency. Farmland means prime or unique farmlands as defined in section 1540(c)(1) of the FPPA or farmland that is determined by the appropriate state or unit of local government agency or agencies with concurrence of the Secretary of Agriculture to be farmland of statewide local importance.

For the purpose of FPPA, farmland includes prime farmland, unique farmland, and land of statewide or local importance. Farmland subject to FPPA requirements does not have to be currently used for cropland. It can be forestland, pastureland, cropland, or other land, but not water or urban built-up land.

Farmland does not include land already in or committed to urban development or water storage. Farmland *already in* urban development or water storage includes all such land with a density of 30 structures per 40-acre area. Farmland already in urban development also includes lands identified as *urbanized area* (UA) on the Census Bureau Map, or as urban area mapped with a *tint overprint* on the United States Geological Survey (USGS) topographical maps, or as *urban-built-up* on the United States Department of Agriculture (USDA) Important Farmland Maps.

The area in question meets one or more of the above criteria for Farmland. Farmland area will be affected or converted. Enclosed is the Farmland Conversion Impact Rating form AD1006 with PARTS II, IV and V completed by NRCS. The corresponding agency will need to complete the evaluation, according to the Code of Federal Regulation 7CFR 658, Farmland Protection Policy Act.

If you have any questions, please contact Milton Cortes, Assistant State Soil Scientist at 919-873-2171 or by email: milton.cortes@nc.usda.gov.

Again, thank you for inquiry. If we can be of further assistance, please do not hesitate to contact us.

Sincerely,

MILTON CORTES Digitally signed by MILTON CORTES
DN: c=US, o=U.S. Government, ou=Department of Agriculture, cn=MILTON CORTES, 0.9.2342.19200300.100.1.1=12001000080173
Date: 2016.05.22 11:35:22 -04'00'

Milton Cortes
Assistant State Soil Scientist

cc:
Kent Clary, State Soil Scientist, NRCS, Raleigh, NC

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 4/14/16
Name Of Project Buckwater Mitigation Site	Federal Agency Involved FHWA - NCDMS
Proposed Land Use Stream Restoration	County And State Orange County, NC
PART II *(To be completed by NRCS)*	Date Request Received By NRCS

Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply -- do not complete additional parts of this form).*	Yes ☑	No ☐	Acres Irrigated - N/A	Average Farm Size 88 acres
Major Crop*(s)* CORN	Farmable Land In Govt. Jurisdiction Acres: 245, 406 % 96		Amount Of Farmland As Defined in FPPA Acres: 203, 636 % 90	
Name Of Land Evaluation System Used Orange Co. LESA	Name Of Local Site Assessment System none		Date Land Evaluation Returned By NRCS May 23, 2016 By Email	

PART III *(To be completed by Federal Agency)*		Alternative Site Rating			
		Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly		49.0			
B. Total Acres To Be Converted Indirectly					
C. Total Acres In Site		49.0	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland		33.8			
B. Total Acres Statewide And Local Important Farmland		14.9			
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted		0.02390			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value		61.0			
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*		86			
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points				
1. Area In Nonurban Use	15	14			
2. Perimeter In Nonurban Use	10	10			
3. Percent Of Site Being Farmed	20	15			
4. Protection Provided By State And Local Government	20	20			
5. Distance From Urban Builtup Area	0	0			
6. Distance To Urban Support Services	0	0			
7. Size Of Present Farm Unit Compared To Average	10	10			
8. Creation Of Nonfarmable Farmland	25	0			
9. Availability Of Farm Support Services	5	5			
10. On-Farm Investments	20	15			
11. Effects Of Conversion On Farm Support Services	25	0			
12. Compatibility With Existing Agricultural Use	10	0			
TOTAL SITE ASSESSMENT POINTS	160	89	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100	86			
Total Site Assessment *(From Part VI above or a local site assessment)*	160	89	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	175	0	0	0

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

Reason For Selection:

WILDLANDS
ENGINEERING

April 15, 2016

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

Subject: Buckwater Mitigation Site
Orange County, North Carolina

Dear Ms. Deaton,

Wildlands Engineering, Inc. requests review and comment on any possible issues that might emerge with respect to fish and wildlife issues associated with the proposed Buckwater Mitigation Site. A USGS map and aerial map showing the approximate project area are enclosed. The topographic figure was prepared from the Hillsborough, 7.5-Minute USGS Topographic Quadrangles.

The Buckwater Mitigation Site is being developed to provide in-kind mitigation for unavoidable stream channel impacts. Several sections of channel have been identified as significantly degraded. The project will include stream restoration and enhancement. The site has historically been disturbed due to agricultural use, particularly for livestock production and row crops.

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

Sincerely,

Ruby M. Davis

Ruby M. Davis
Environmental Scientist

Attachment:
USGS Topographic Map
Aerial Map

1430 South Mint Street, Suite 104, Charlotte, NC 28203 ◦ (P) 704-332-7754 ◦ (F) 704-332-3306

North Carolina Wildlife Resources Commission

Gordon Myers, Executive Director

3 May 2016

Ms. Ruby M. Davis
Wildlands Engineering
1430 South Mint Street, Suite 104
Charlotte, NC 28203

Subject: Buckwater Mitigation Site, Orange County, North Carolina

Dear Ms. Davis:

Biologists with the North Carolina Wildlife Resources Commission (NCWRC) have reviewed the subject information. Our comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667e) and North Carolina General Statutes (G.S. 113-131 et seq.).

The proposed project includes stream restoration and enhancement. Several sections of channel have been identified as significantly degraded. The site has been used for livestock production and row crops. The mitigation site will provide in-kind mitigation for unavoidable stream impacts.

The project site includes Buckwater Creek and its tributaries in the Neuse River basin. The Natural Heritage Natural Area – Eno River/Cates Ford Slopes and Uplands, and the Eno River State Park are located near the project boundaries.

Stream restoration projects often improve water quality and aquatic habitat. We offer the following recommendations to minimize impacts to aquatic and terrestrial wildlife resources.

- Restoration activities should be designed to avoid impacts to any existing forested riparian buffers.
- Establishing native, forested buffers in riparian areas will help protect water quality, improve aquatic and terrestrial habitats, and provide a travel corridor for wildlife species.
- Measures should be used to minimize erosion and sedimentation from construction or restoration activities.

Mailing Address: Habitat Conservation • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 707-0220 • **Fax:** (919) 707-0028

3 May 2016
Buckwater Mitigation Site

Thank you for the opportunity to review this proposed project. If we can provide further assistance, please contact our office at (336) 449-7625 or shari.bryant@ncwildlife.org.

Sincerely,

Shari L Bryant

Shari L. Bryant
Western Piedmont Coordinator
Habitat Conservation Division

WILDLANDS
ENGINEERING

May 1, 2017

John Hammond
US Fish and Wildlife Service
Raleigh Field Office
P.O. Box 33726
Raleigh, NC 27636-3726

Subject: **Buckwater Mitigation Site and NLEB SLOPES agreement**
Orange County, North Carolina

Dear Mr. Hammond,

The purpose of this letter is to request comment from the USFWS specifically to the recent status change of the Northern long-ear bat (*Myotis septentrionalis).* Wildlands Engineering Inc. has been contracted by the Division of Mitigation Services to design the Buckwater Mitigation Project, which is located 4.5 miles northeast of Hillsborough in Orange County. The project includes the Buckwater Creek and 14 unnamed tributaries for a total of more than 16,000 linear feet of stream. Much of the site is currently used as cattle pasture or for growing hay, with some areas in forest. Tree cutting and clearing is proposed on approximately 4-5 acres out of 54 acres that will be placed in a conservation easement. Wildlands sought to avoid forested areas and trees greater than 18 inches in diameter during the stream restoration design process. During construction, Wildlands will make efforts to not take any more trees than necessary. Cleared vegetation will be used in the stream work, allowed to decay within the easement area, or burned on site. There will be no percussive activities as defined in the January 2017 SLOPES agreement. Additionally, construction activities will be avoided beneath two bridges within the project area.

According to the USFWS shapefile (https://www.fws.gov/raleigh/NLEB_RFO.html), there are no confirmed hibernation or maternity sites in this county. However, due to the size of this project, the location, the existing natural habitat on site, and that there are other species on the official species list, we would like to address the NLEB for this project.

Please review the attached maps and provide comments on any possible issues that might emerge with respect to the newly listed bat and this project. If we have not heard from you in 30 days, we will assume that you do not have any comments regarding associated laws and that you do not have any information relevant to this project at the current time.

WILDLANDS
ENGINEERING

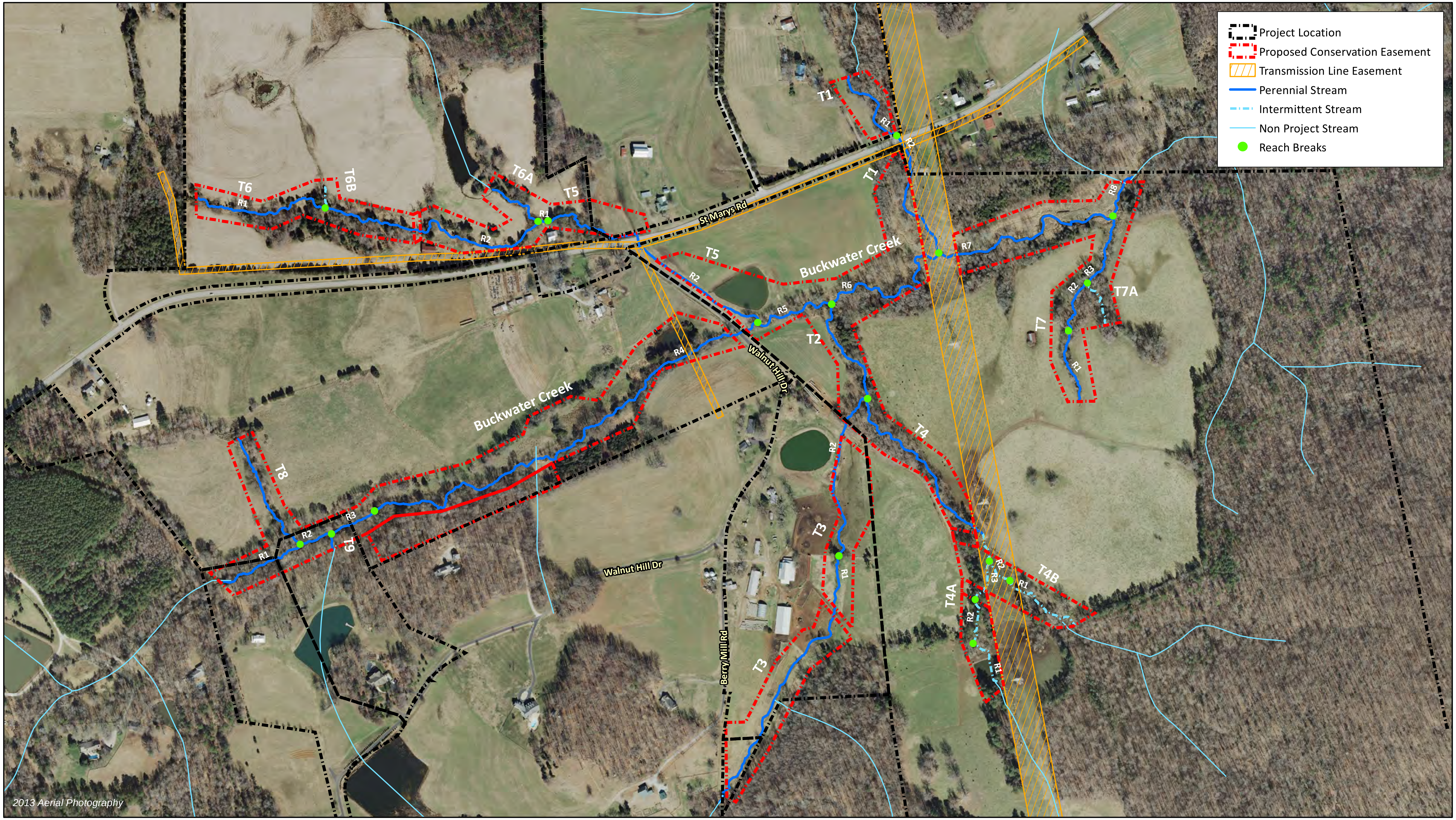
We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

Sincerely,

Ruby Davis
Environmental Scientist

Cc:
Jeff Schaffer, NC Division of Mitigation Services
Andrea Hughes, US Army Corps of Engineers
Chris Roessler, Wildlands Engineering

Attachments:
Site Map and Concept Design Map



WILDLANDS ENGINEERING

0 500 1,000 Feet

N

Figure 2 Site Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC

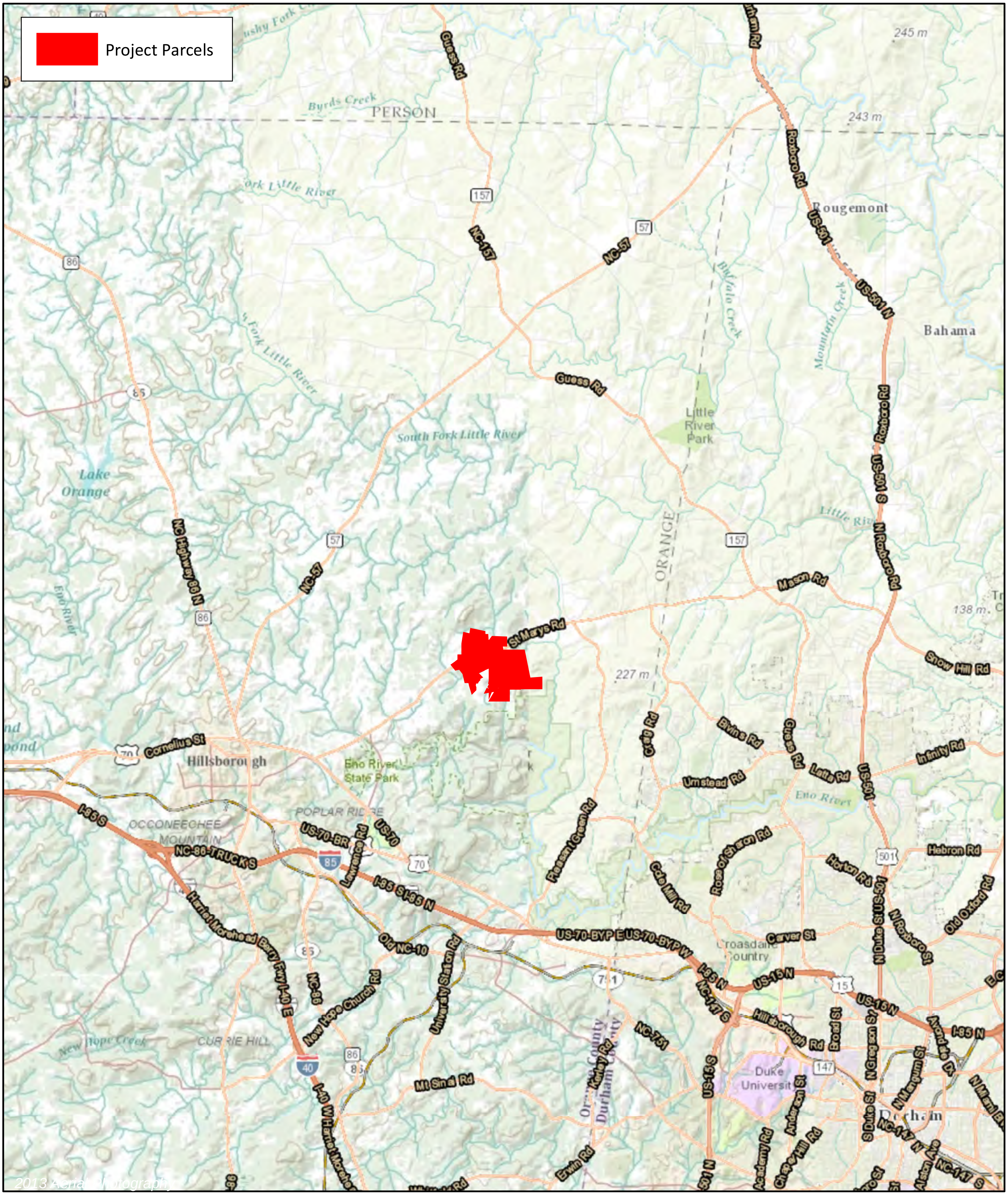
WILDLANDS ENGINEERING

Figure 8 Concept Design Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC

Buckwater Mitigation Site
Categorical Exclusion

FIGURES



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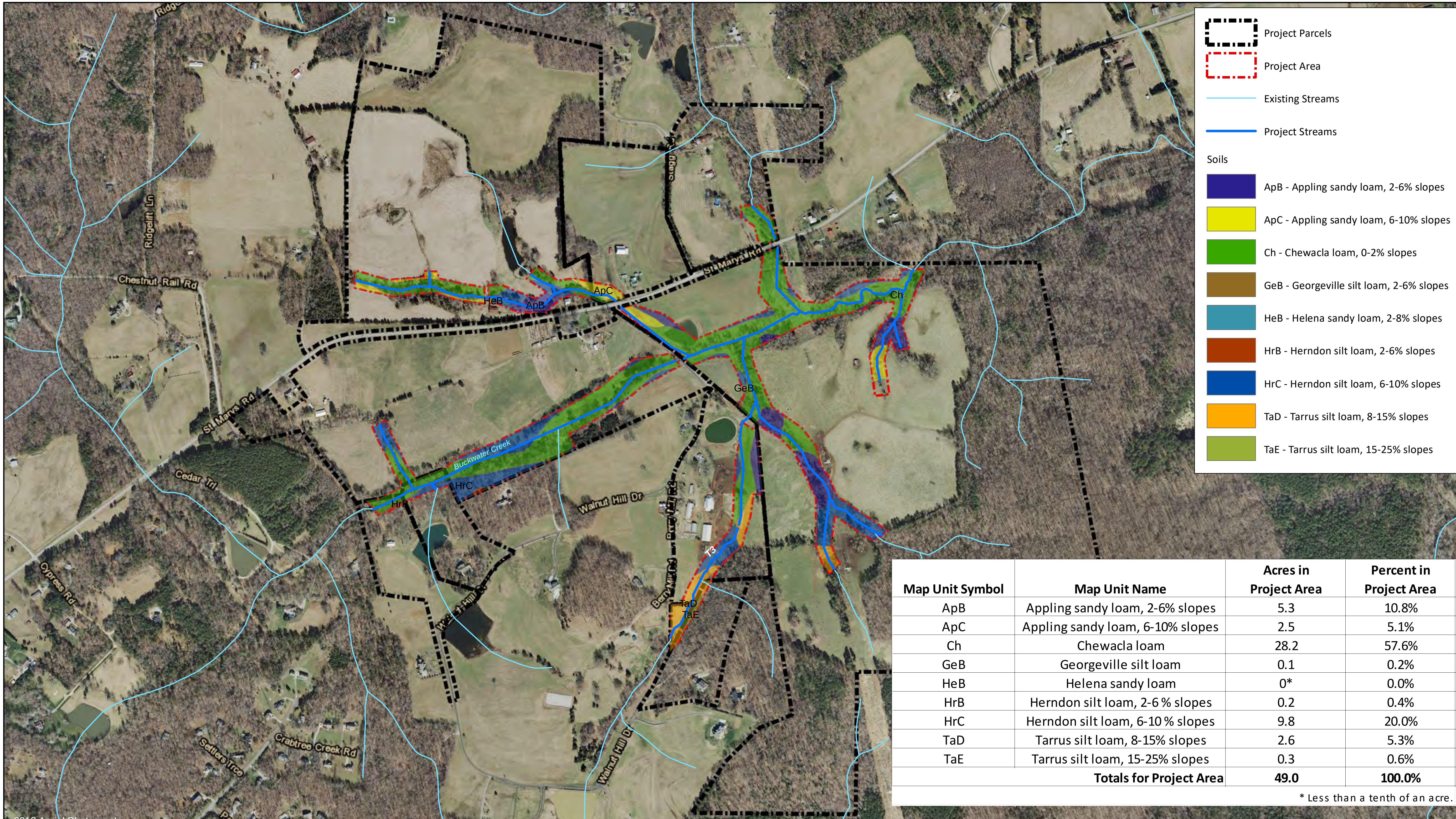
Vicinity Map
Buckwater Mitigation Site
Neuse River Basin 03020201
Orange County, NC



Map Unit Symbol	Map Unit Name	Acres in Project Area	Percent in Project Area
ApB	Appling sandy loam, 2-6% slopes	5.3	10.8%
ApC	Appling sandy loam, 6-10% slopes	2.5	5.1%
Ch	Chewacla loam	28.2	57.6%
GeB	Georgeville silt loam	0.1	0.2%
HeB	Helena sandy loam	0*	0.0%
HrB	Herndon silt loam, 2-6 % slopes	0.2	0.4%
HrC	Herndon silt loam, 6-10 % slopes	9.8	20.0%
TaD	Tarrus silt loam, 8-15% slopes	2.6	5.3%
TaE	Tarrus silt loam, 15-25% slopes	0.3	0.6%
	Totals for Project Area	**49.0**	**100.0%**

* Less than a tenth of an acre.

WILDLANDS ENGINEERING

Soils Map
Buckwater Mitigation Site
Neuse River Basin 03020201

Orange County, NC

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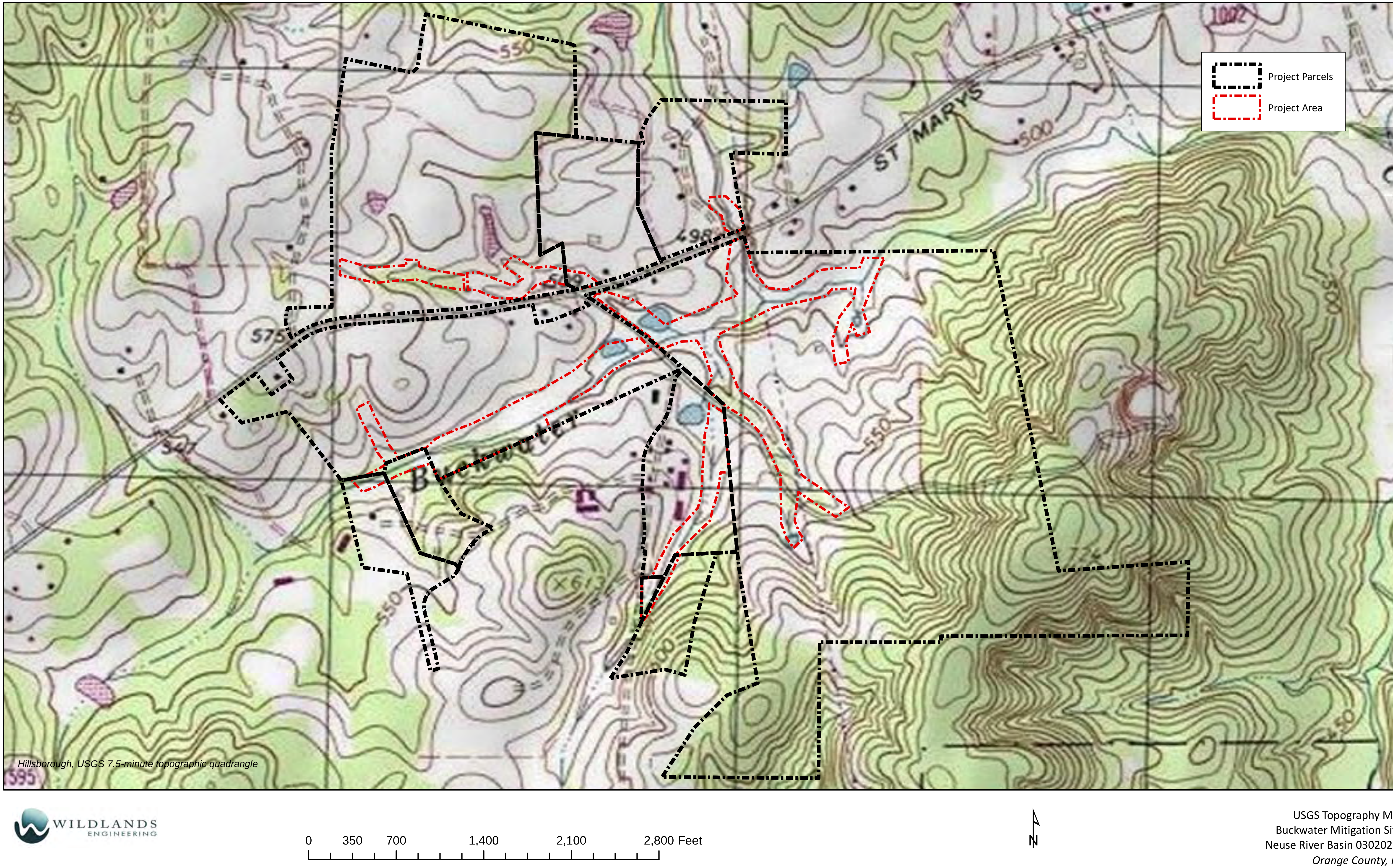
0 350 700 1,400 2,100 2,800 Feet

N

Overview Site Map
Buckwater Mitigation Site
Neuse River Basin 03020201
Orange County, NC

rdavis 4/11/2016



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USGS Topography Map
Buckwater Mitigation Site
Neuse River Basin 03020201
Orange County, NC

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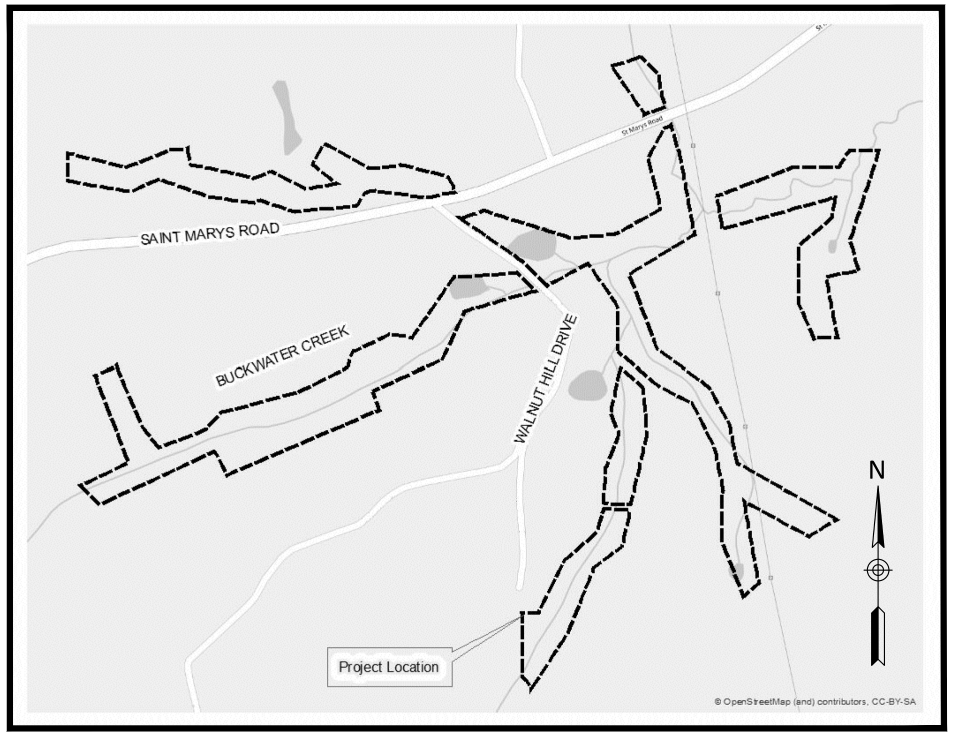
Appendix 7

Plan Sheets

Buckwater Mitigation Site

Neuse River Basin 03020201
Orange County, North Carolina
for
NCDEQ Division of Mitigation Services



Vicinity Map
Not to Scale

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N.C. ONE-CALL CENTER
IT'S THE LAW!

PRELIMINARY PLANS
Issued May 2017

Stream Origins

Stream	Latitude	Longitude
Buckwater Creek	N 36° 06' 12.03"	W 79° 01' 58.42"
T1	N 36° 06' 35.12"	W 79° 01' 22.97"
T3	N 36° 06' 02.67"	W 79° 01' 29.82"
T4A	N 36° 06' 07.29"	W 79° 01' 14.34"
T4B	N 36° 06' 10.15"	W 79° 01' 10.30"
T6	N 36° 06' 29.57"	W 79° 02' 00.32"
T6A	N 36° 06' 30.15"	W 79° 01' 43.18"
T6B	N 36° 06' 30.42"	W 79° 01' 52.43"
T7	N 36° 06' 20.39"	W 79° 01' 10.08"
T7A	N 36° 06' 23.86"	W 79° 01' 08.58"
T8	N 36° 06' 18.60"	W 79° 01' 57.23"
T9	N 36° 06' 13.04"	W 79° 01' 51.99"

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Fencing Plan	Not Included
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Project Directory

Engineering:
Wildlands Engineering, Inc.
License No. F-0831
312 West Millbrook Road, Suite 225
Raleigh, NC 27609
Chris Roessler, Project Manager
Nicole Macaluso, PE
919-851-9986

Surveying:
Kee Mapping & Surveying, PA
111 Central Avenue
Asheville, NC 28801
Brad Kee, PLS
828-645-8275

Owner:
NCDEQ Division of
Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652
Jeff Schaffer
919-707-8308

NCDEQ Contract No. 006829

DMS ID No. 97084

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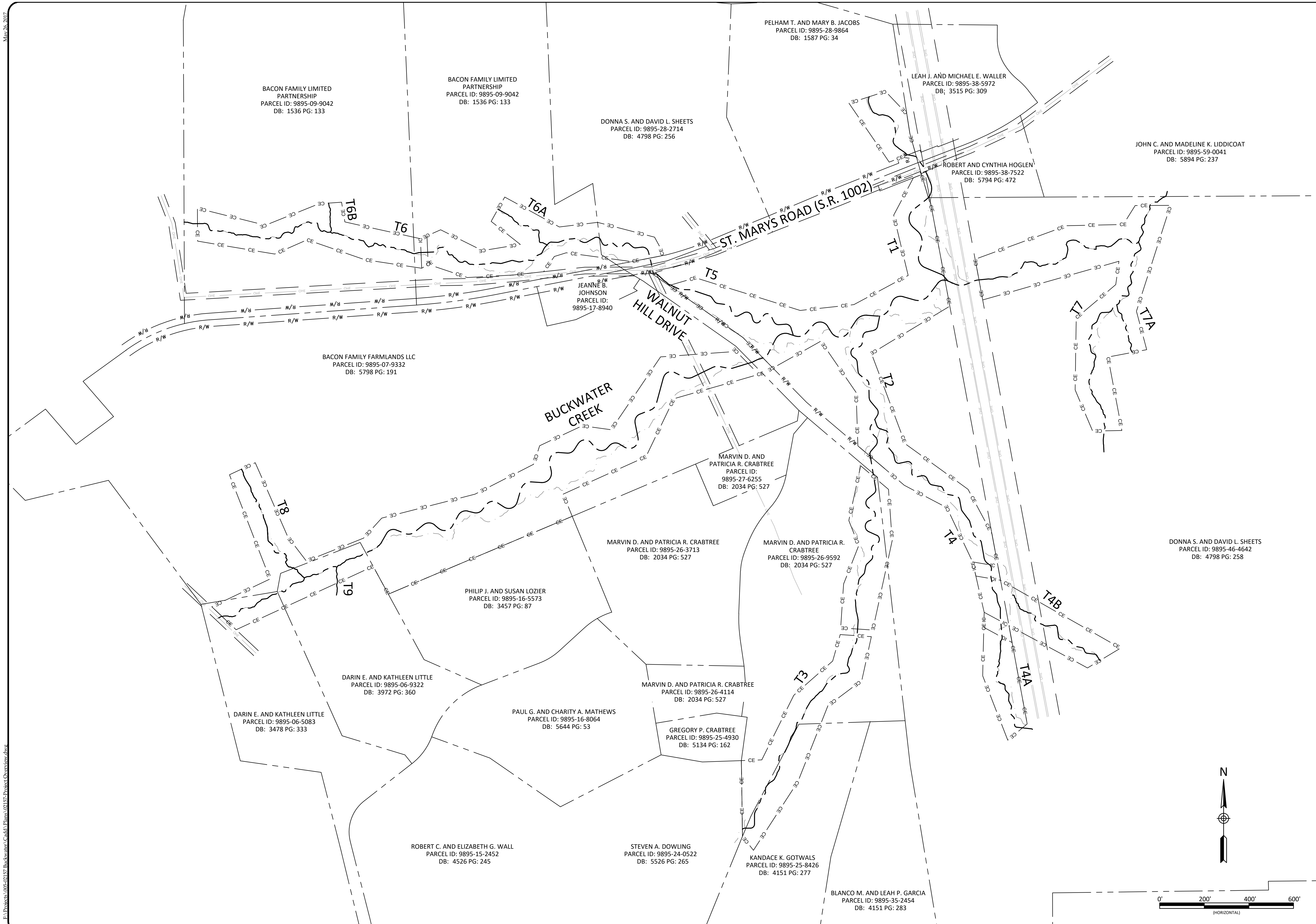
Buckwater Mitigation Site
Orange County, North Carolina

Title Sheet

Revisions:

Date: 05.26.2017
Job Number: 005-02157
Project Engineer: NNM
Drawn By: CLM
Checked By: JWH

Sheet 0.1



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Orange County, North Carolina

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Sheet 0.2

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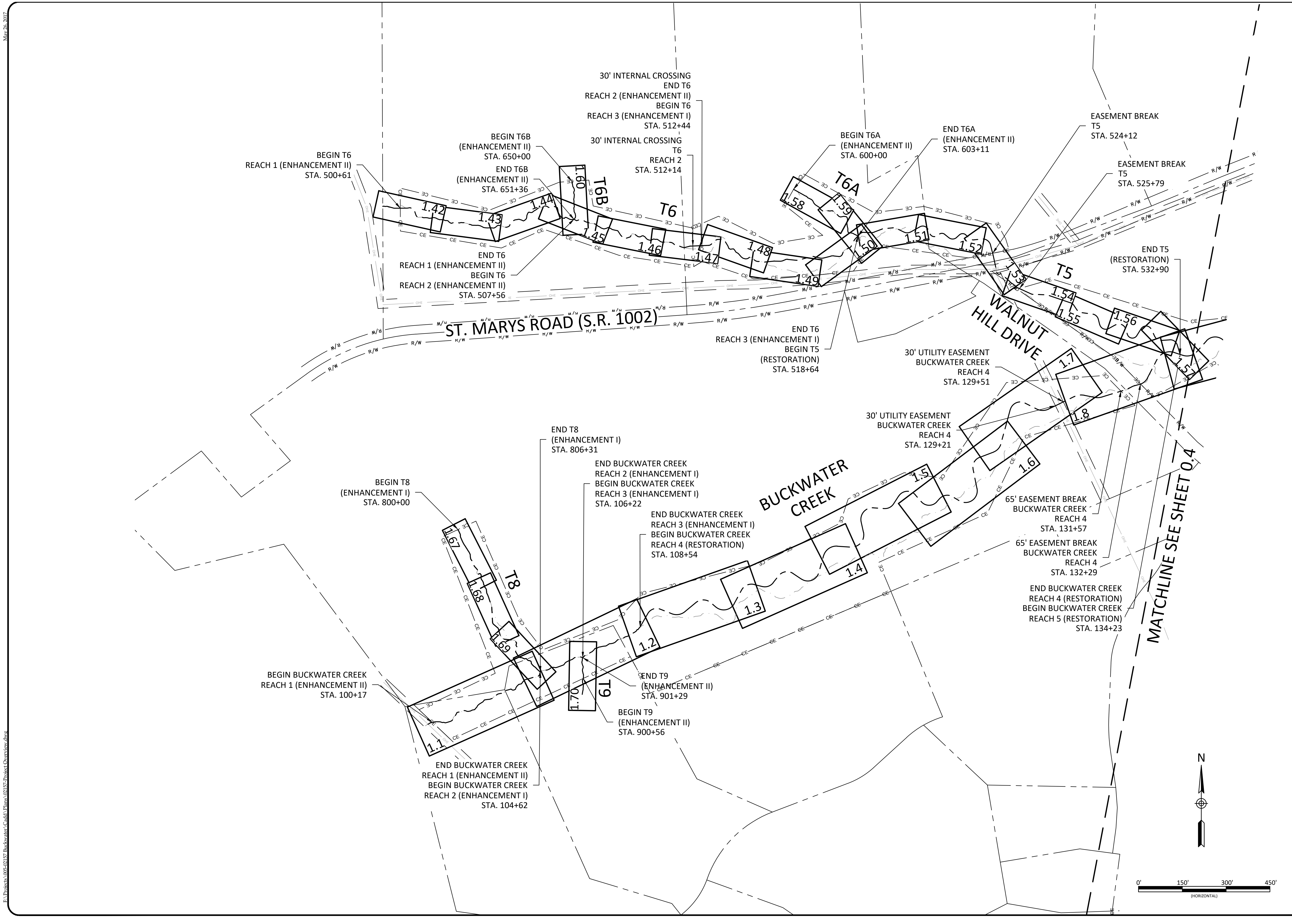

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Project Overview

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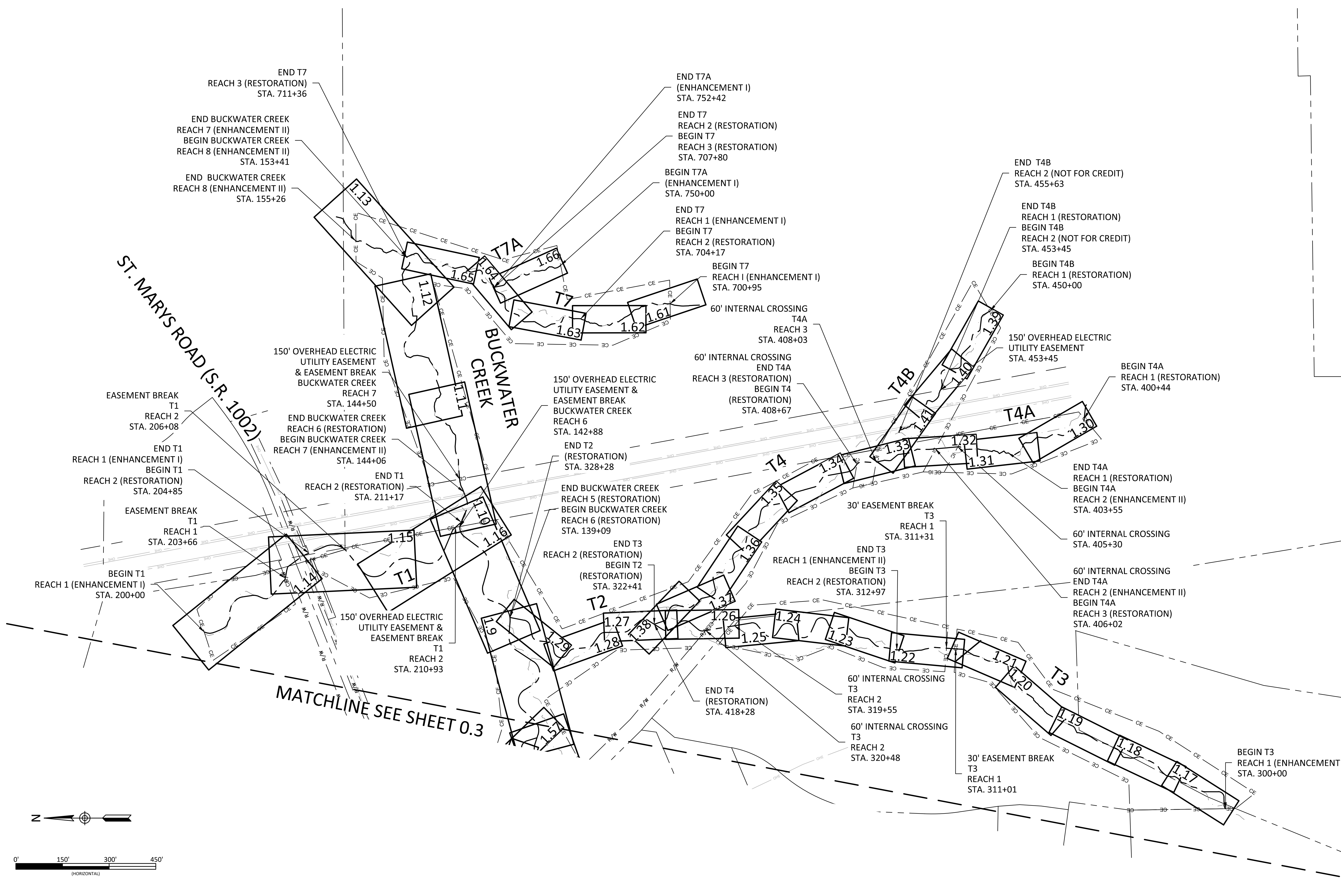

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Orange County, North Carolina

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0.4

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General Construction Notes:

1. All erosion and sediment control practices shall comply with the North Carolina Erosion and Sediment Control Planning and Design Manual.
2. Contractor will install pump-around systems to divert flow while working in live, flowing channels. The Contractor shall operate and maintain the pump-around system 24 hours a day until all disturbed areas are stabilized. Contractor shall not remove pump-around systems and advance to the next work area until the current work area is completed and stabilized. The disturbed area within the pump around must be stabilized with temporary seeding, mulch and erosion control matting by the end of each work day. No material from the off-line proposed stream channel excavation may be backfilled into the adjacent existing stream channel until the newly-constructed proposed stream section is completed, stabilized, and the stream flow has been diverted into it, not even if that section of old/ existing stream is being pumped.
3. If flow is not sufficient at the time of construction to cause sedimentation to downstream waters, pump-around operations will not be required , as per the approval of the Engineer. In these cases, rock silt check dams will be installed near the downstream extent of the work area for the current phase. Contractor shall disturb only as much channel bank as can be stabilized with temporary seeding, mulch, and erosion control matting by the end of each work day.
4. Clearing and grubbing activities shall not extend more than 150 linear feet ahead of in-stream work.
5. When crossing an active section of new or old stream channel, a Timber Mat shall be installed according to the details and specifications.
6. All graded areas with slopes steeper than 3:1 will be stabilized within seven (7) working days. All other areas will be stabilized within 14 working days.
7. Locations for staging and stockpile areas and temporary stream crossings have been provided on the Plans. Additional or alternative staging and/or stockpile areas and stream crossings may be used by the Contractor provided that all practices comply with the North Carolina Erosion and Sediment Control Planning and Design Manual and that the areas are approved by the Designer prior to implementation.
8. Vegetation located on site to be used as transplant material (juncus, small trees, and sod mats) shall not be disturbed until Contractor is prepared to install transplants.
9. Various types of constructed riffles are specified on the plans. Contractor shall build the specific types of constructed riffles at locations shown on the Plans. Changes in constructed riffle type must be approved by the Designer.
10. Fertilizer and soil amendment is discussed in the permanent seeding specification. Lime and fertilizer may be applied to assist with grass establishment in some disturbed areas. The limits of applications will be determined by the Engineer in the field.
11. Contractor is to make every effort to avoid damaging or removing existing trees.
12. Under no circumstances will the Contractor exceed the limits of disturbance as shown on the Plans.

Initial Site Preparation

1. Contact North Carolina “One Call” Center (1.800.632.4949) before any excavation.
2. Contact Division of Energy, Mineral and Land Resources (252-946-6481) before any work begins on the project and notify them of the start date.
3. Mobilize equipment and materials to the Site.
4. Identify and establish construction entrance, staging and stockpile areas, haul roads, silt fence, tree protection fencing, safety fencing, and temporary stream crossings as indicated on the Plans for work areas.
5. All haul roads shall be monitored for sediment loss daily. In the event of sediment loss, silt fence or other acceptable sediment and erosion control practices, such as straw wattles, shall be installed. Silt fence outlets shall be located at points of low elevation or a minimum spacing of 150 ft.
6. Set up temporary facilities, locate equipment within the staging area, and stockpile materials needed for the initial stages of construction within the stockpile area(s).
7. Install and maintain an onsite rain gauge and log book to record the rainfall amounts and dates. Complete the self-inspection as required by NCDEQ permit. Permit, rainfall log, Erosion and Sediment Control Plan, and completed inspection forms shall be maintained on site at all times.

Pond Dewatering

1. Dewatering of 3 onsite ponds to be initiated in advance of stream construction activities.
2. For each pond, dig ditch along toe of hillslope where seepage is occurring to allow direct flow to pond outlet.
3. Notch existing pond dam, over-excavate outlet and backfill with gravel to form a check dam - this will allow water to flow through and sediment to be detained.
4. After dewatering, backfill new channel corridor with dry, compactable dirt prior to stream construction.

Stream Construction

1. Install temporary livestock fencing as necessary to secure project area prior to construction. Conservation easement may be installed prior to construction to reduce or eliminate the need for temporary fencing.
2. Perform any necessary clearing and grubbing in phases as work progresses. Bank vegetation and vegetation immediately adjacent to live channels shall be left undisturbed as long as possible. Remove all non-native and invasive vegetation prior to beginning the channel construction.
3. Construction of all channels are to be done in the dry. Construction should generally progress from upstream to downstream to prevent sediment runoff from upstream construction affecting completed downstream reaches. Use a pump around as shown on the plans and discussed in the General Notes.
4. Construction sequencing shall be determined by the Contractor and the Contractor shall provide a schedule to the Engineer prior to commencement.
5. Where feasible, more than one offline section may be constructed concurrently. Offline sections shall be tied online sequentially from downstream to upstream.
6. As work progresses, remove and stockpile the top three inches of soil from the active grading area. Stockpiled topsoil shall be kept separate for onsite replacement prior to floodplain seeding.
7. Construct the proposed stream channel to the grade specified in the cross-sections and profile. Transfer coarse material from abandoned channel riffles to new channel riffles utilizing a pump-around when doing so.
8. Grade the adjacent floodplain area according to grades shown on the plan.
9. Install in-stream structures (riffles, log and rock sills, log vanes, root wads, boulder toe) and in-bank bioengineering such as brush toe and sod mats after channel grading is completed according to details and specifications.
10. Sod mats may be used in lieu of coir fiber matting, where available, to stabilize all stream banks on site as the preferential stabilization method. Coir fiber matting may be used where sod mats are not available or if coir fiber matting is preferred at the discretion of the Designer.
11. Seed (with specified temporary and permanent seed mix) and straw mulch areas where the coir fiber matting is to be installed.
12. Install coir fiber matting according to plans and specifications.
13. If at any time, circumstances should arise where water has been turned into the new channel and additional work must be done on the floodplain, erosion control devices will be installed to protect the new channel from sedimentation.
14. Backfill abandoned channel sections with stockpiled soil according to the grades shown on the Plans. Non-native and invasive vegetation (e.g. Chinese privet and multiflora rose) shall be removed from the existing channel prior to backfilling.
15. Prepare floodplain for seeding by applying stockpiled topsoil to the floodplain between bankfull elevation and the grading limits, ripping, and raking/smoothing. Seed with specified temporary and permanent seed mix and mulch. Any areas within the conservation easement that have not been graded shall be treated according to the planting plan.

Construction Demobilization

1. Remove temporary stream crossings, stockpile areas, and erosion and sediment control devices. Note: Permanent vegetation must be established before measures can be removed.
2. The Contractor shall ensure that the site is free from trash and leftover materials prior to demobilization of equipment from the site.
3. Complete the removal of any additional stockpiled material from the site.
4. Demobilize grading equipment from the site.
5. Seed, mulch, and stabilize haul roads. Refer to Section 3 for seeding specifications and locations.

Existing Features

- R/W — Existing Property Boundary
- Existing Right-of-way
- Existing Utility Easement
- G — Existing Gas Easement
- OHE — Existing Overhead Electric Utility Line
- GAS — Existing Gas Line
- FOC — Existing Fiber Optic Cable Line
- 540 — Existing 5' Major Contour
- Existing 1' Minor Contour
- Existing Thalweg
- X — Existing Fence
- Existing Wetlands
- Existing Bedrock
- Existing Pond
- Existing Farm Road
- Existing Tree Line
- Existing Tree
- Existing Utility Pole
- Existing Debris

Proposed Features

- CE — Proposed Conservation Easement
- IC — Proposed Internal Crossing
- 10+00 — Proposed Stream Alignment
- Proposed Bankfull
- 540 — Proposed 5' Major Contour
- Proposed 1' Minor Contour
- Proposed Approximate Floodplain Bench
- CR-NM — Proposed Native Material Constructed Riffle, See Detail 1, Sheet 5.1
- CR-WD — Proposed Woody Riffle, See Detail 2, Sheet 5.1
- CR-ALR — Proposed Angled Log Riffle, See Detail 3, Sheet 5.1
- CR-CH — Proposed Chunky Riffle, See Detail 4, Sheet 5.1
- CR-LRC — Proposed Log-Rock Cascade Riffle, See Detail 1, Sheet 5.2
- Proposed Log Sill, See Detail 2, Sheet 5.2
- Proposed Angled Log Sill, See Detail 3, Sheet 5.2
- Proposed Log Vane, See Detail 4, Sheet 5.2
- Proposed Log J-Hook, See Detail 1, Sheet 5.3
- Proposed Root Wad, See Detail 2, Sheet 5.3
- Proposed Rock Cascade with Pools, See Detail 3, Sheet 5.3
- Proposed Vegetated Soil Lift, See Detail 4, Sheet 5.3
- Proposed Brush Toe, See Details 1 and 2, Sheet 5.4
- Proposed Boulder Toe, See Detail 1, Sheet 5.5
- Proposed Boulder Sill, See Detail 2, Sheet 5.5
- Proposed Transplanted Sod Mats, See Detail 3, Sheet 5.5
- Proposed Culvert
- Proposed Permanent Ford Crossing, See Detail 5, Sheet 5.5
- SAF — Proposed Tree Protection Fencing, See Detail 1, Sheet 5.6

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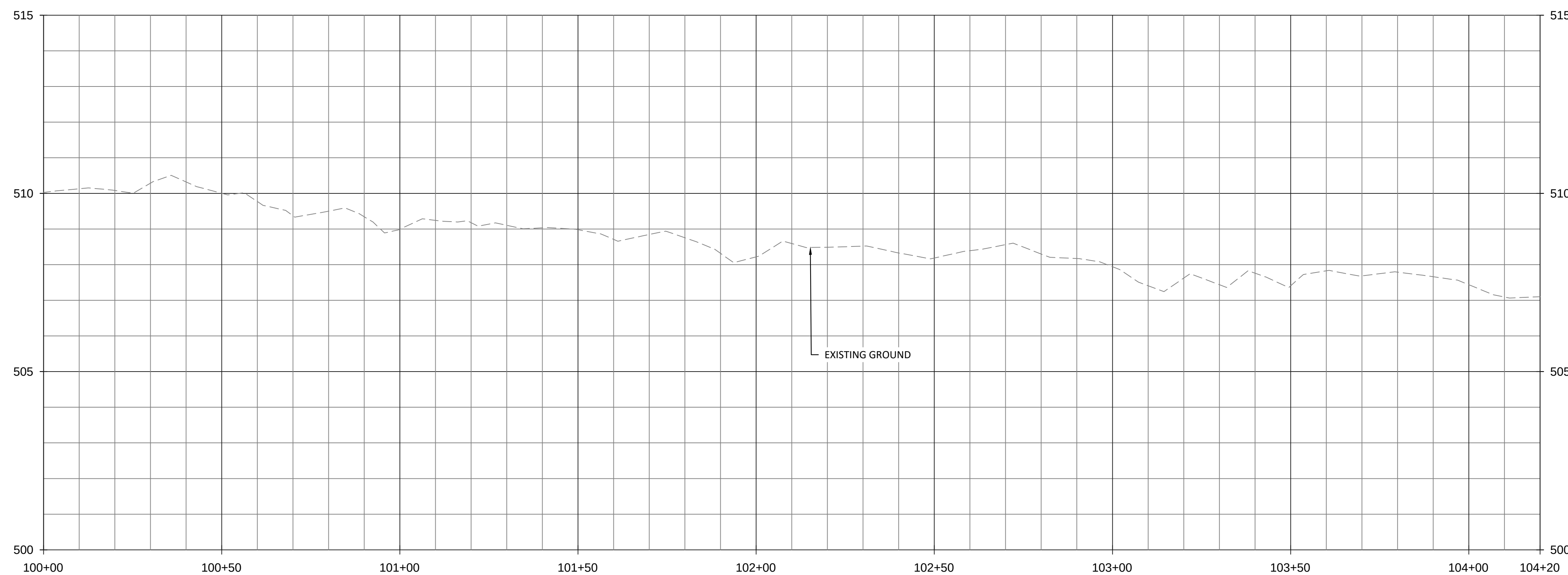
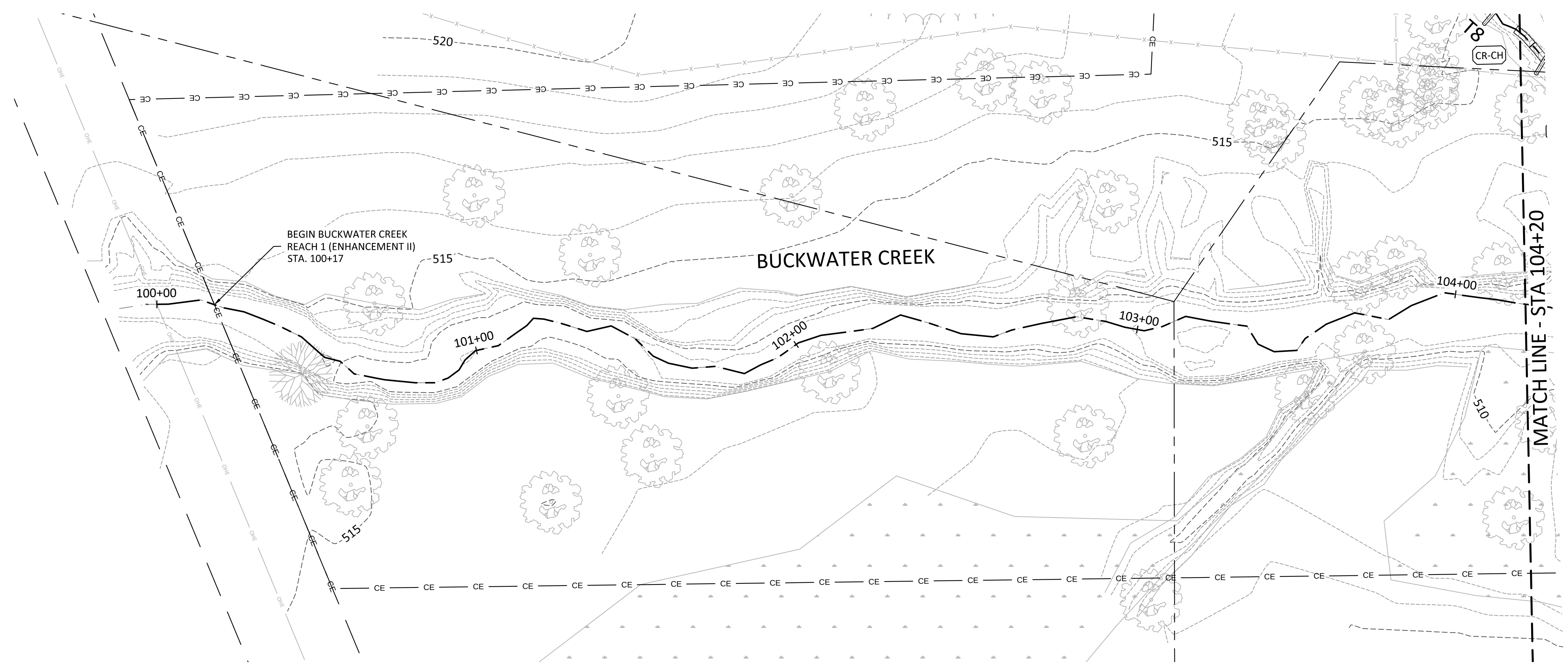
Buckwater Mitigation Site
Orange County, North Carolina
General Notes and Symbols

Revisions:

Date: 05.26.2017
Job Number: 005-02157
Project Engineer: NMM
Drawn By: CLM
Checked By: JWH

Sheet 0.5





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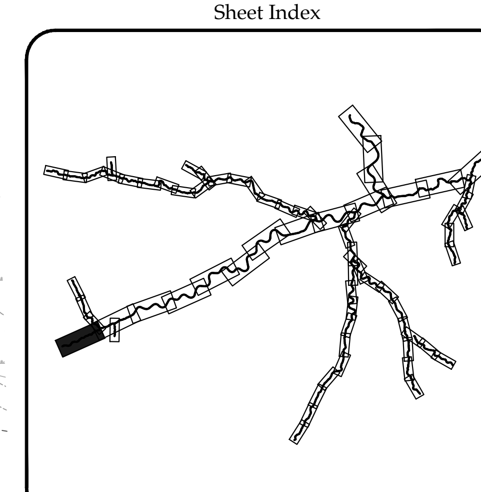

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Buckwater Mitigation Site
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Buckwater Creek Reach 1
Stream Plan and Profile

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Job Number:	005-02157
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Checked By:	JWH

Sheet 1.1

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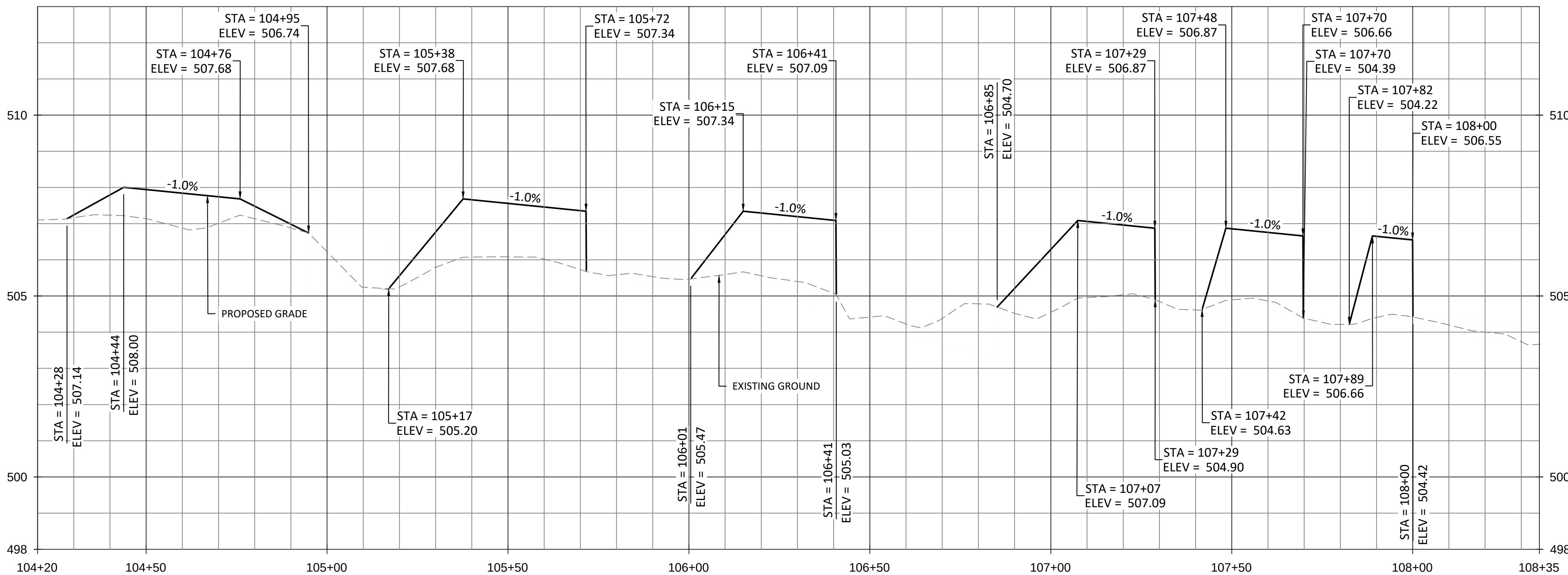

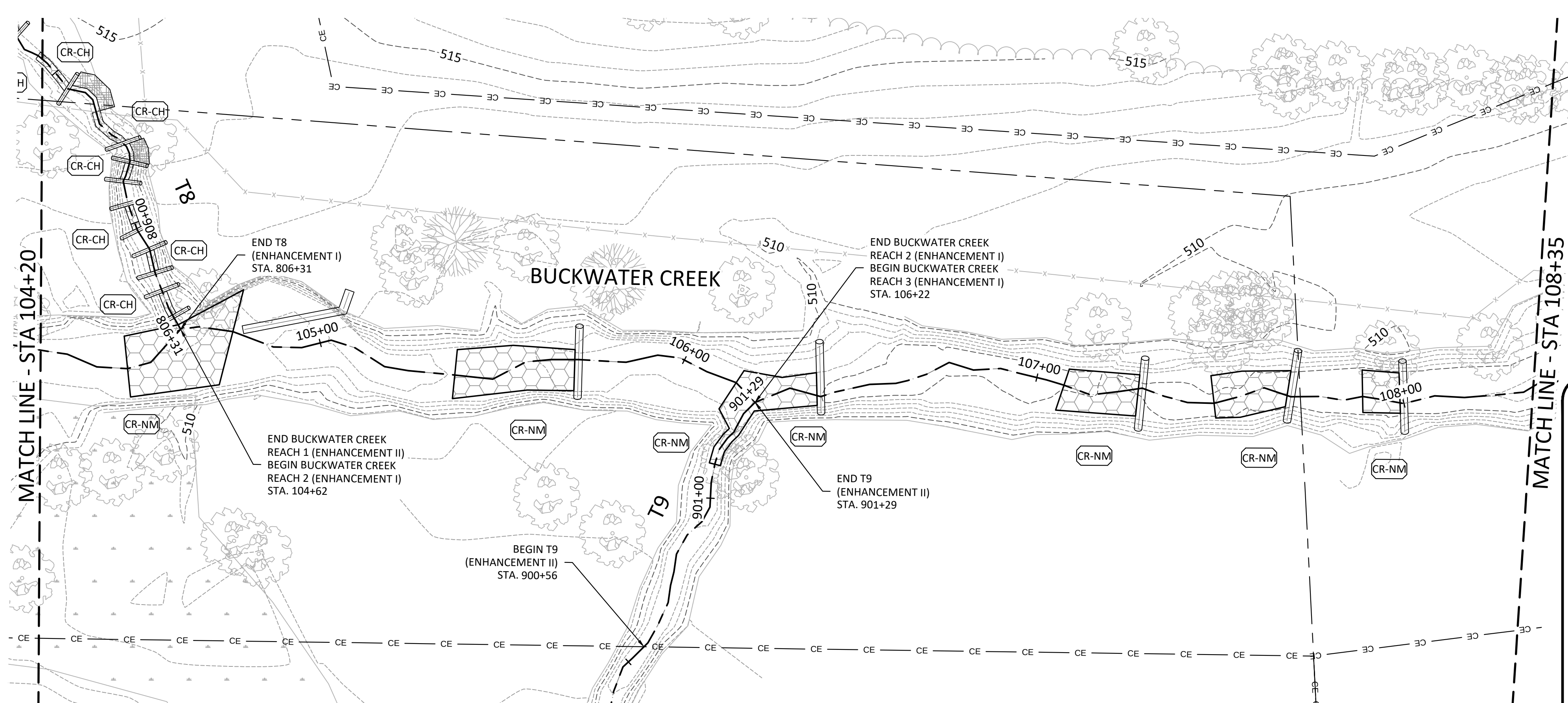

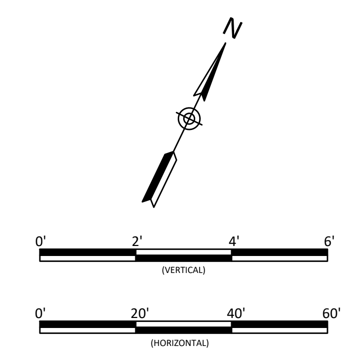

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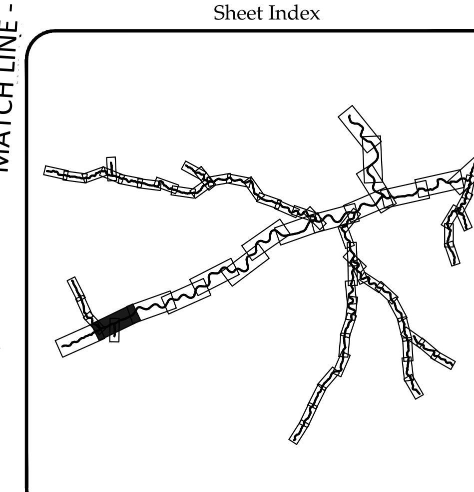

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Buckwater Creek Reaches 1, 2 & 3
Stream Plan and Profile

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Sheet
1.2

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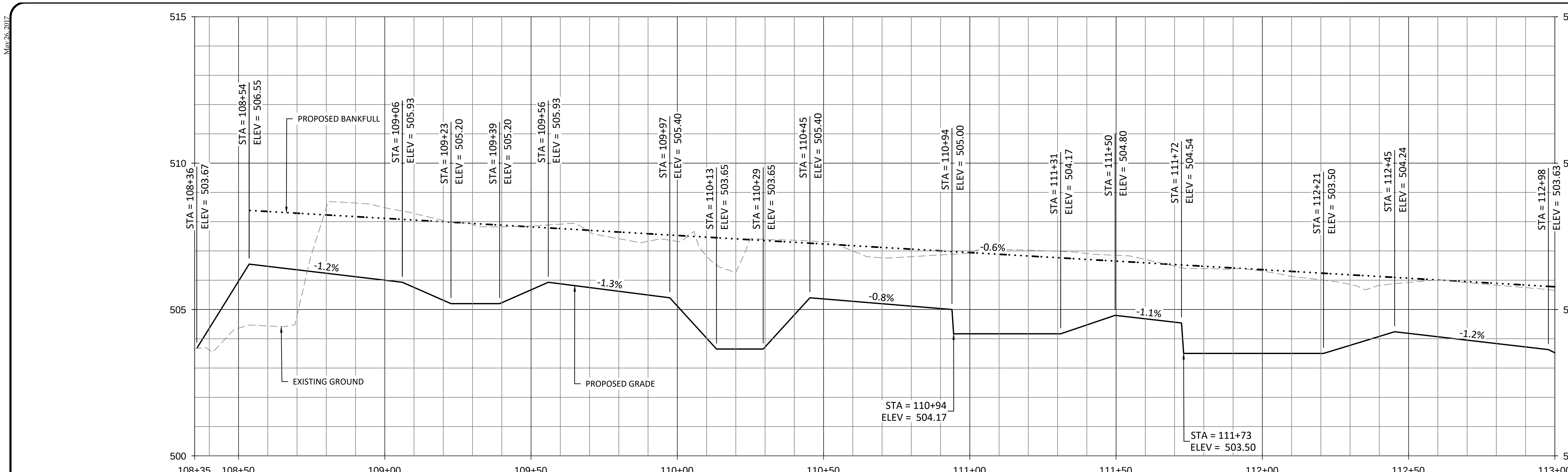

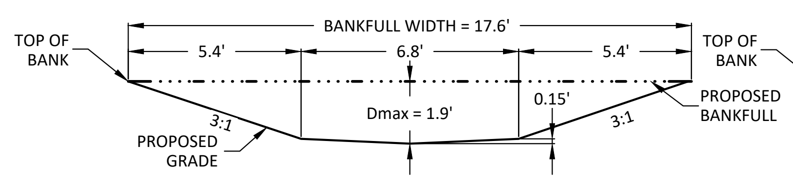

BUCKWATER CREEK REACH 4 - TYPICAL SECTION: RIFFLE
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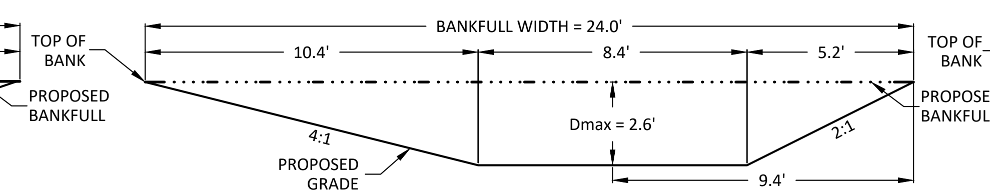
SCALE: 1" = 3'



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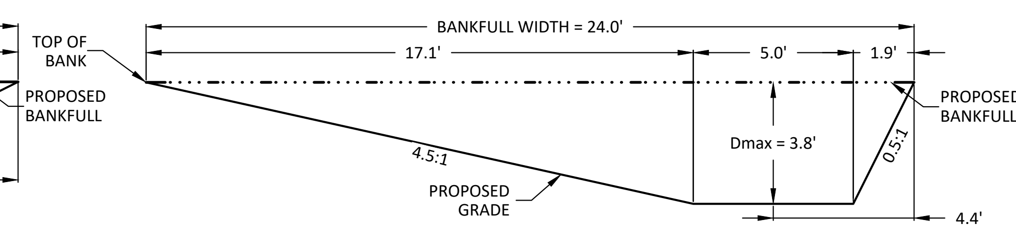

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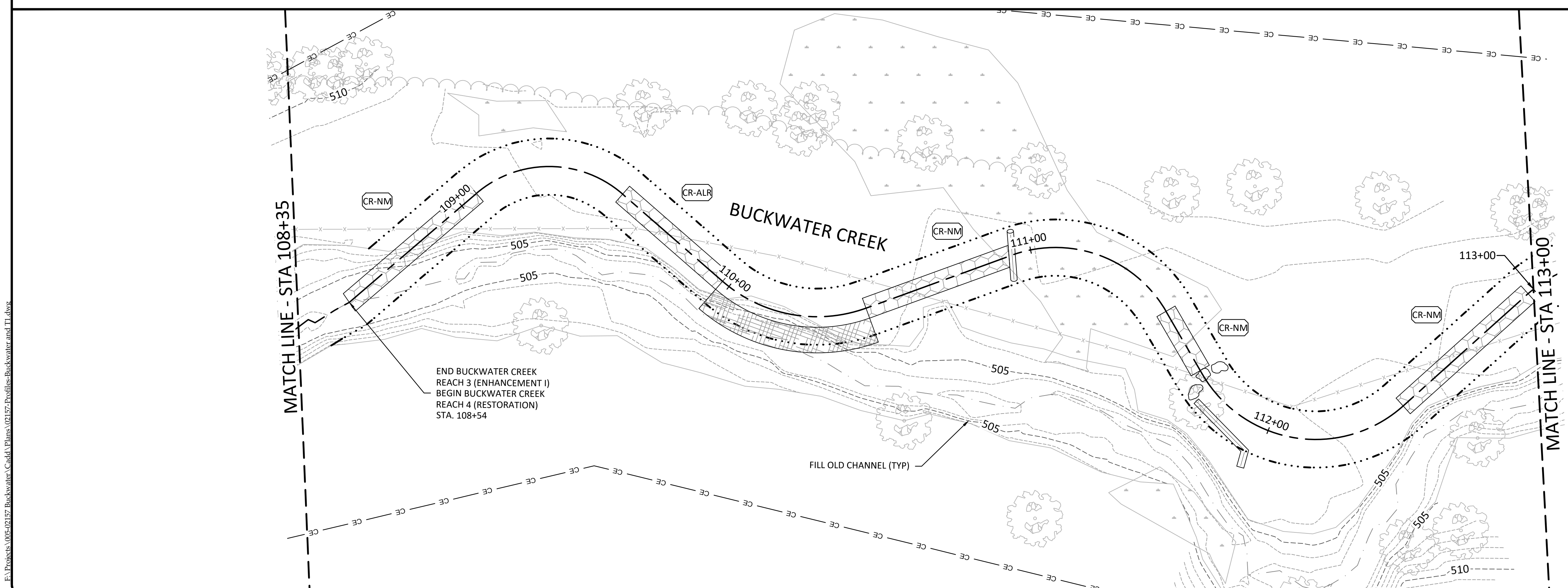

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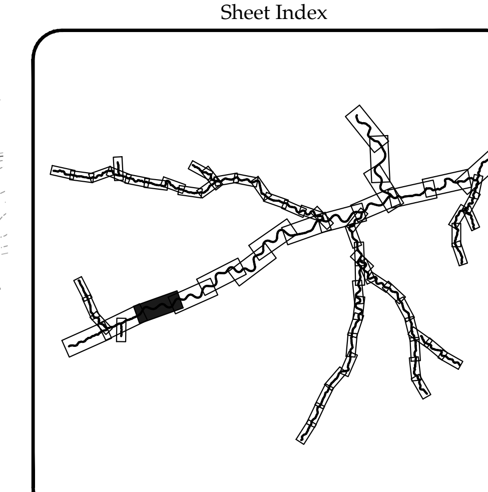

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Buckwater Creek Reaches 3 & 4
Stream Plan and Profile

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Sheet 1.3

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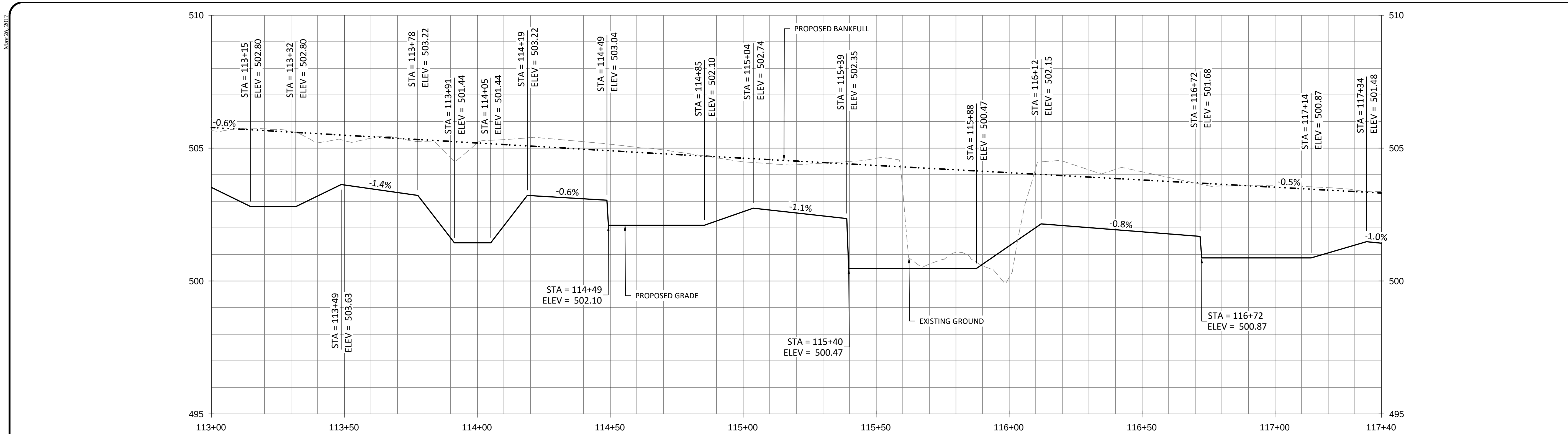

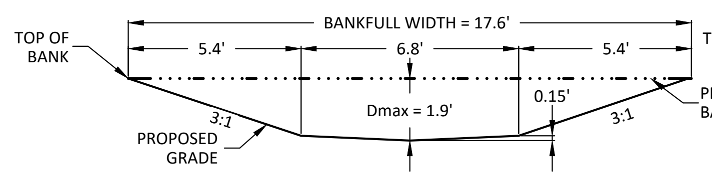

BUCKWATER CREEK REACH 4 - TYPICAL SECTION: RIFFLE
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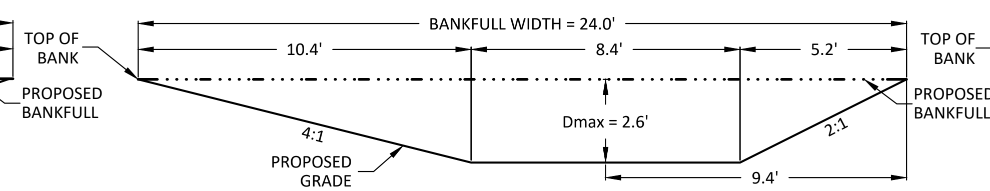

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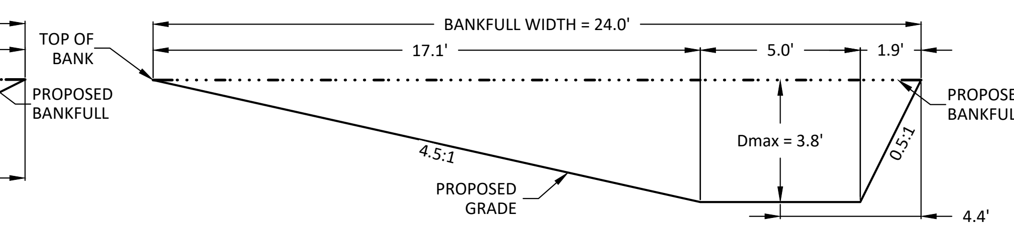

BUCKWATER CREEK REACH 4 - TYPICAL SECTION: POOL WITH STRUCTURE
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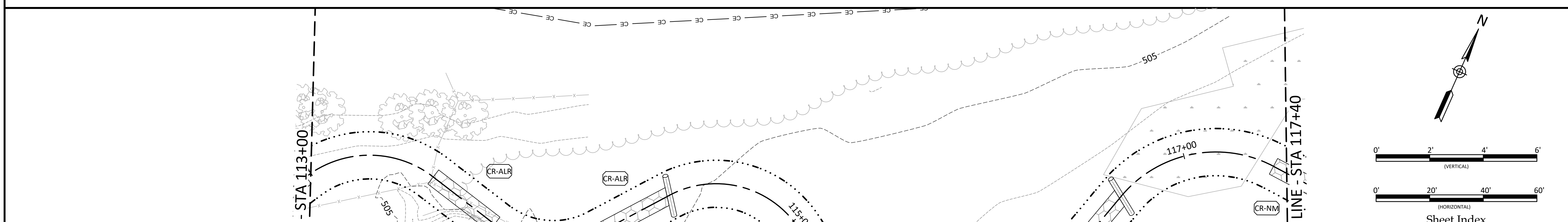

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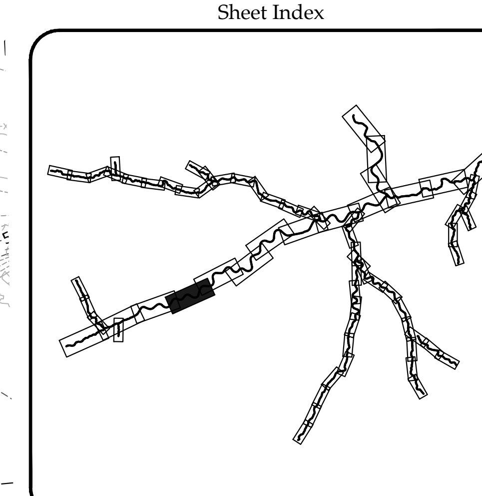

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Orange County, North Carolina

Buckwater Creek Reach 4
Stream Plan and Profile

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Checked By:	JWH

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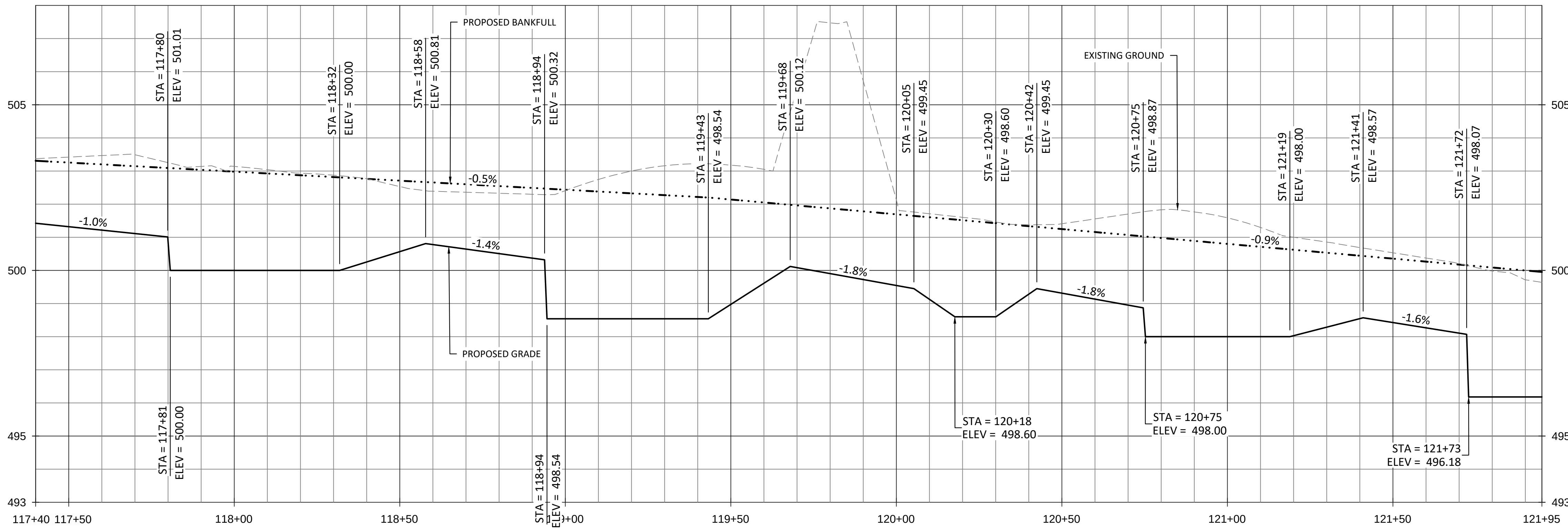
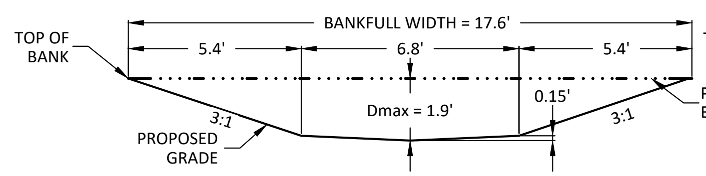
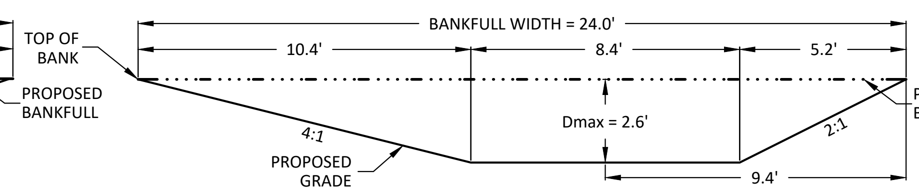
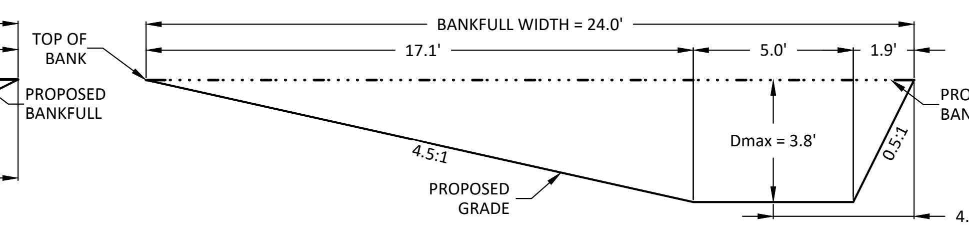




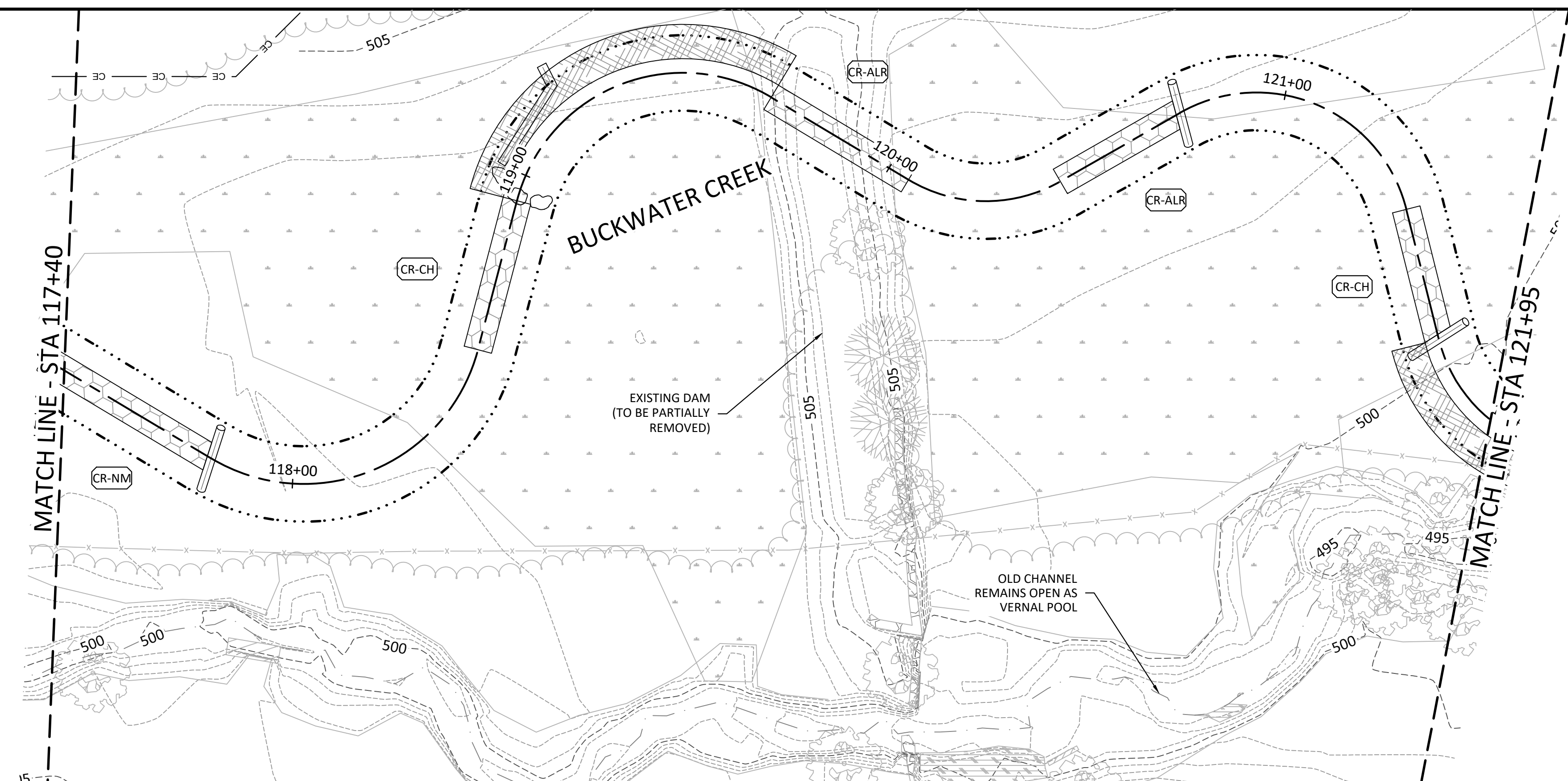
BUCKWATER CREEK REACH 4 - TYPICAL SECTION:
RIFFLE
STA: 108+54 TO 134+23
SCALE: 1" = 3'



BUCKWATER CREEK REACH 4 - TYPICAL SECTION:
SHALLOW POOL
STA: 108+54 TO 134+23
SCALE: 1" = 3'



BUCKWATER CREEK REACH 4 - TYPICAL SECTION:
POOL WITH STRUCTURE
STA: 108+54 TO 134+23
SCALE: 1" = 3'



N

0' 2' 4' 6'
(VERTICAL)

0' 20' 40' 60'
(HORIZONTAL)

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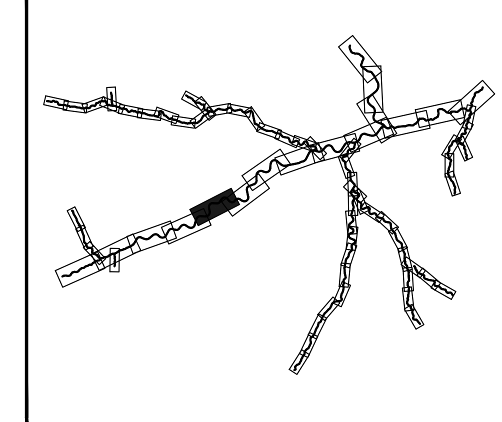

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Orange County, North Carolina

Buckwater Creek Reach 4
Stream Plan and Profile

Revisions:

Date:	05.26.2017
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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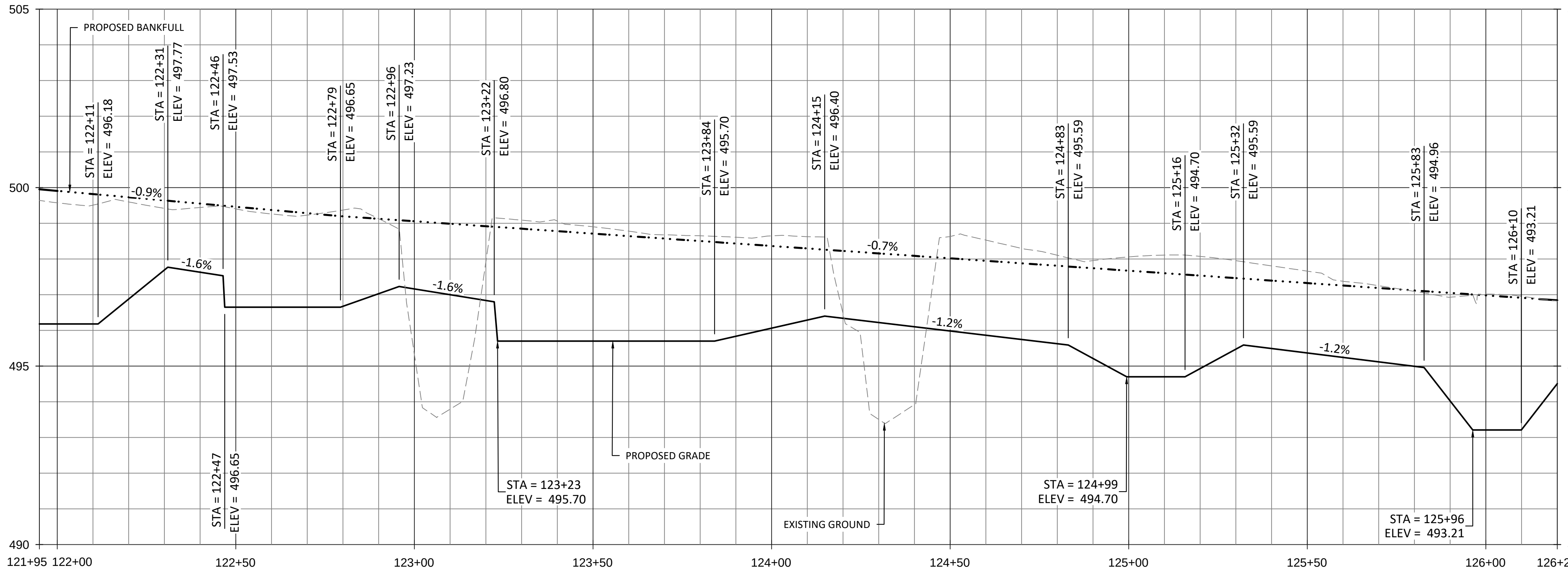
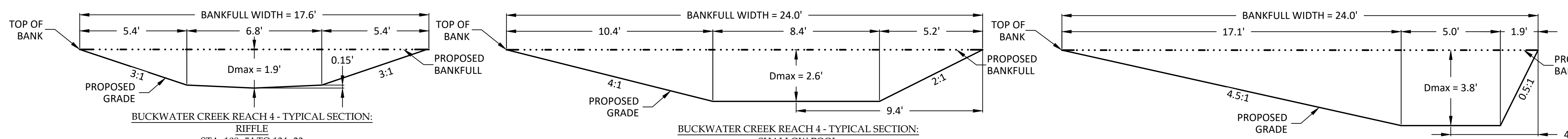
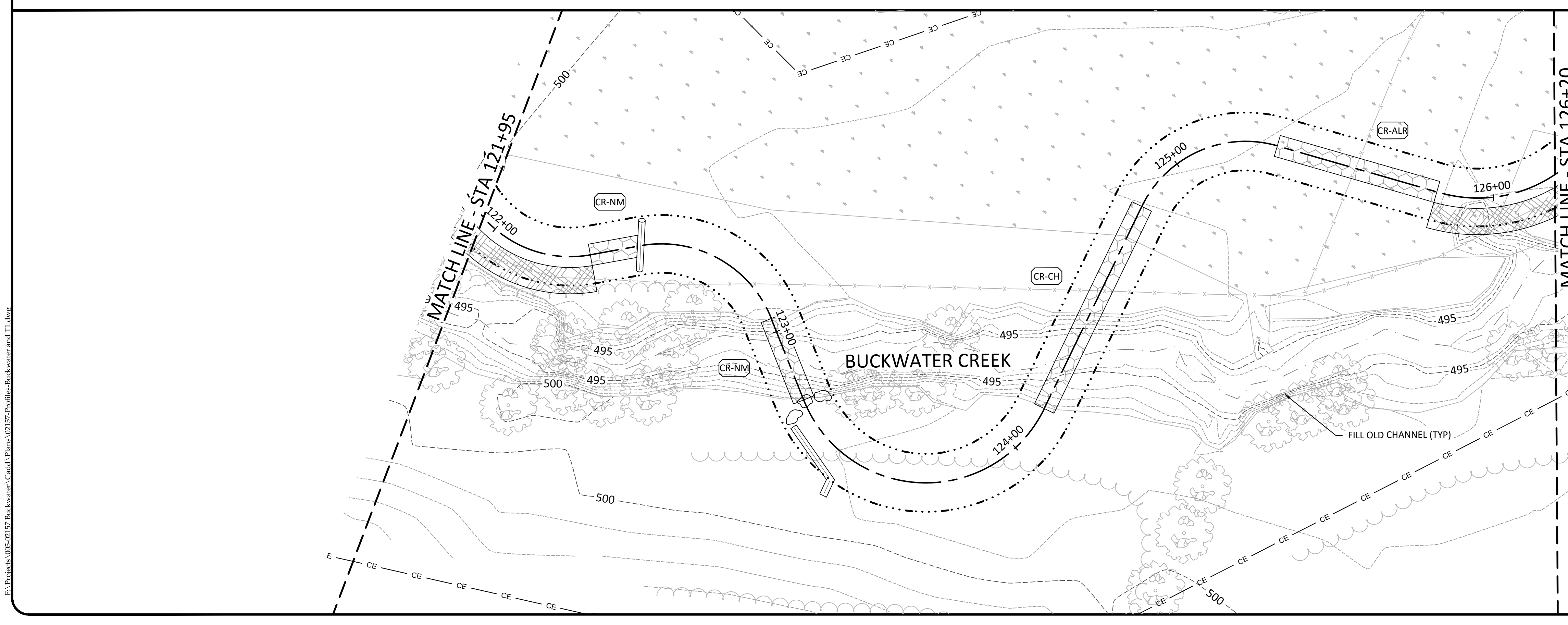


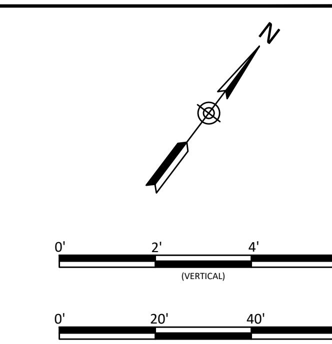


BUCKWATER CREEK REACH 4 - TYPICAL SECTION: RIFFLE
STA: 108+54 TO 134+23
SCALE: 1" = 3'

BUCKWATER CREEK REACH 4 - TYPICAL SECTION: SHALLOW POOL
STA: 108+54 TO 134+23
SCALE: 1" = 3'

BUCKWATER CREEK REACH 4 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 108+54 TO 134+23
SCALE: 1" = 3'





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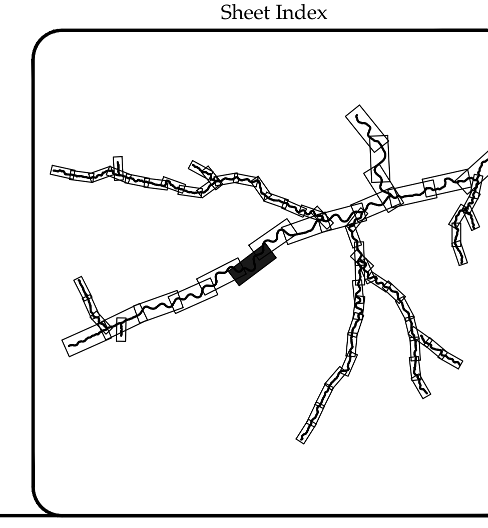

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Buckwater Creek Reach 4
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Drawn By:	CLM
Checked By:	JWH

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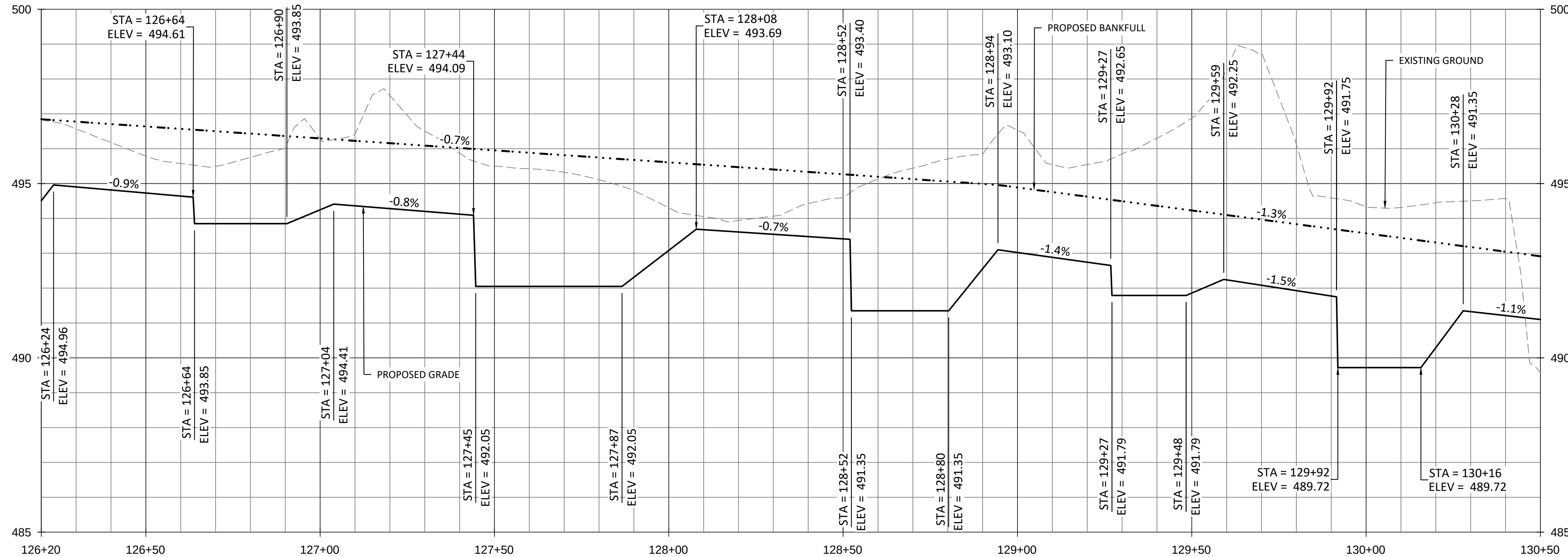
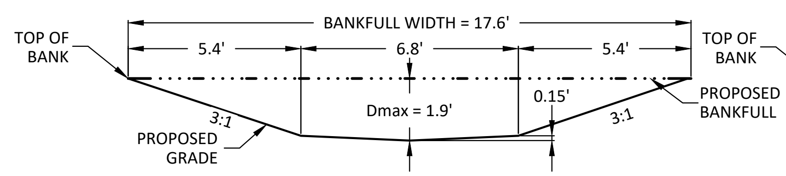
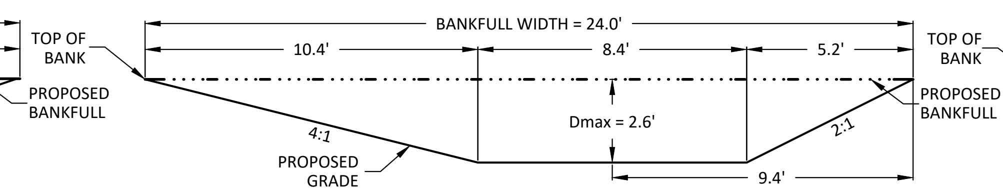
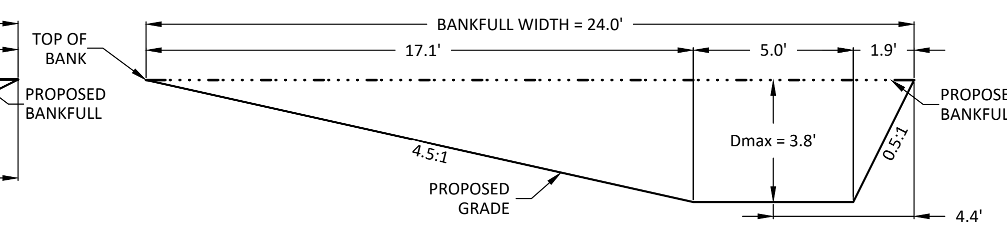




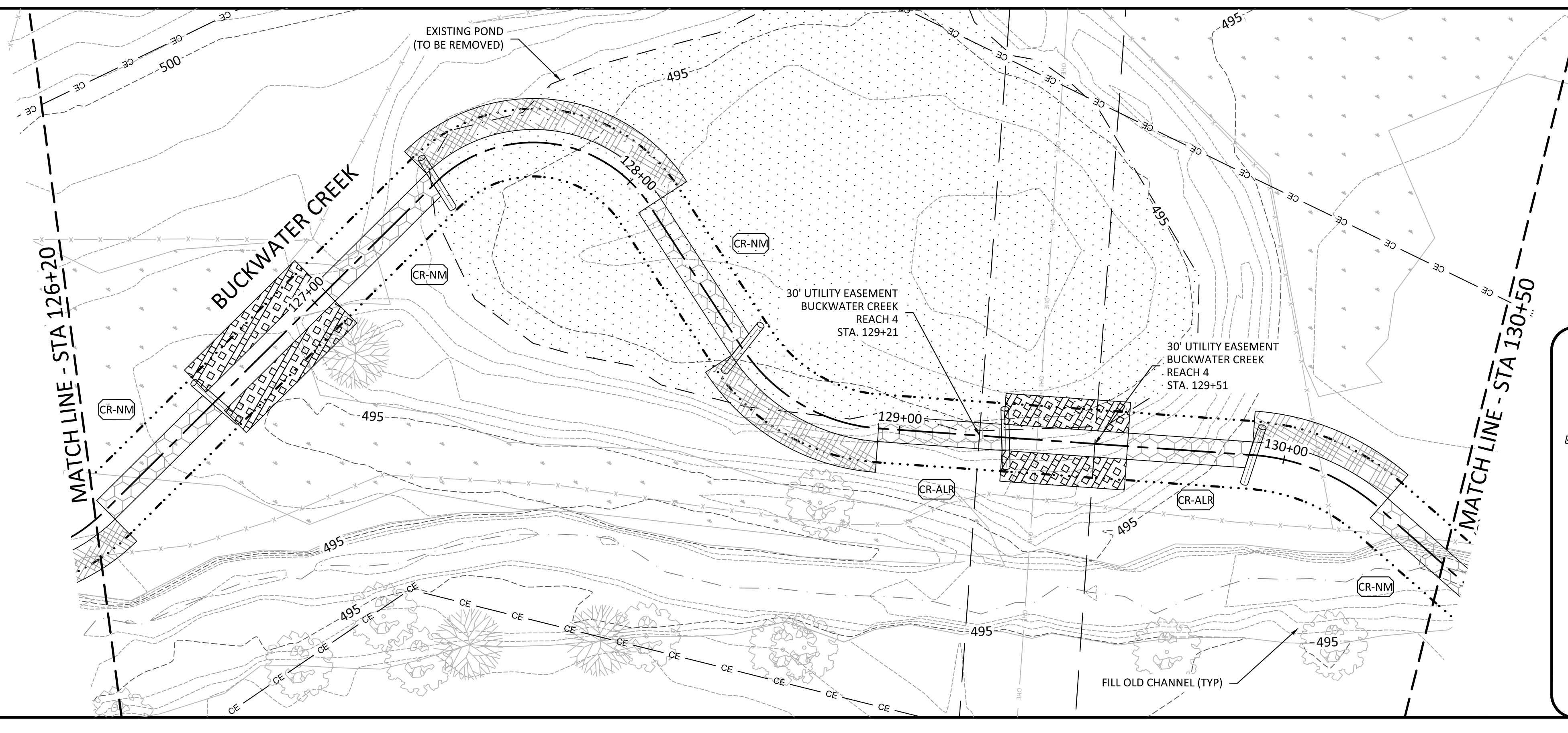
BUCKWATER CREEK REACH 4 - TYPICAL SECTION: RIFFLE
STA: 108+54 TO 134+23
SCALE: 1" = 3'

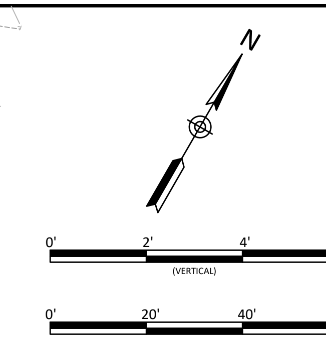


BUCKWATER CREEK REACH 4 - TYPICAL SECTION: SHALLOW POOL
STA: 108+54 TO 134+23
SCALE: 1" = 3'



BUCKWATER CREEK REACH 4 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 108+54 TO 134+23
SCALE: 1" = 3'





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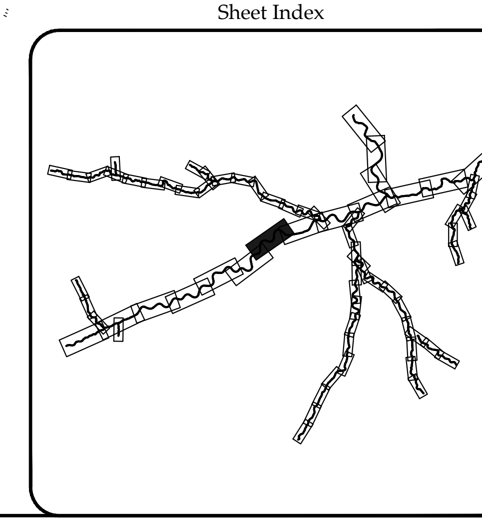

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Buckwater Creek Reach 4
Stream Plan and Profile

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Drawn By:	CLM
Checked By:	JWH

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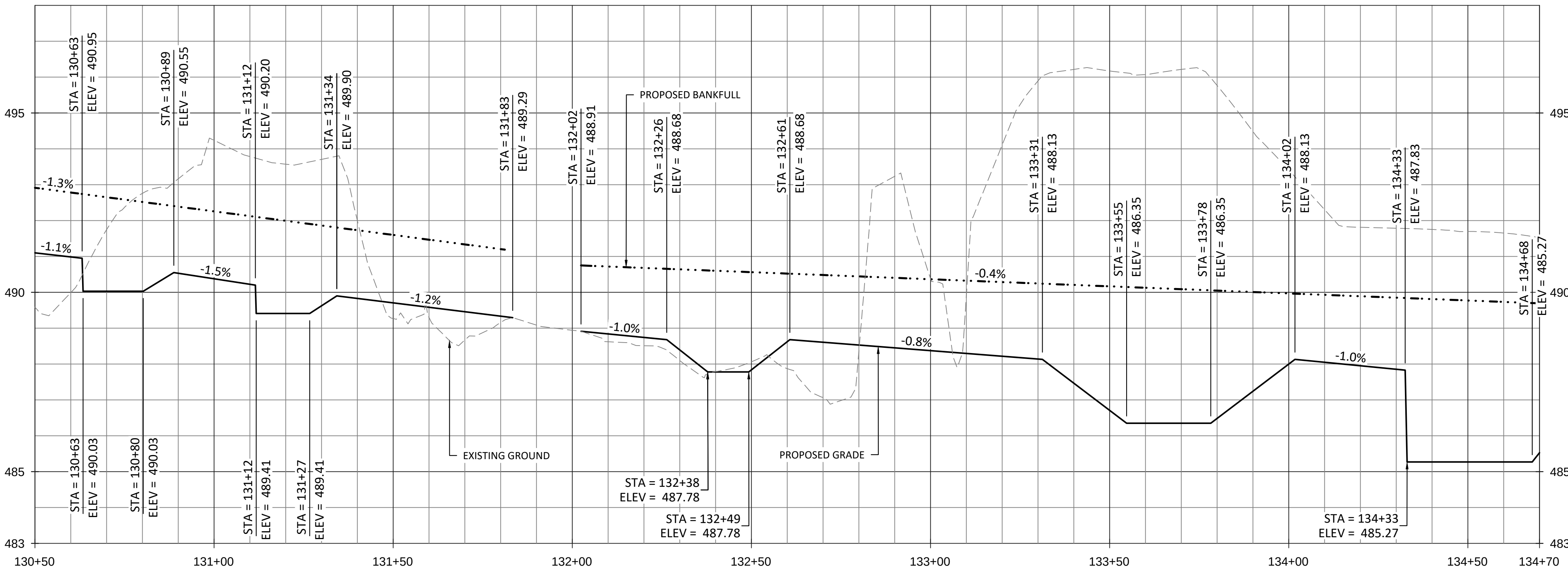

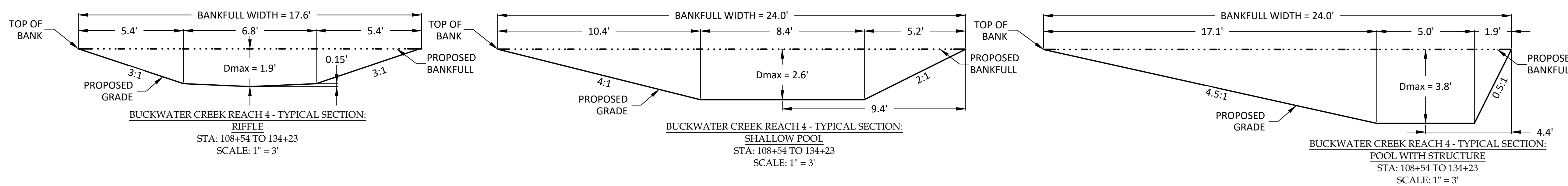

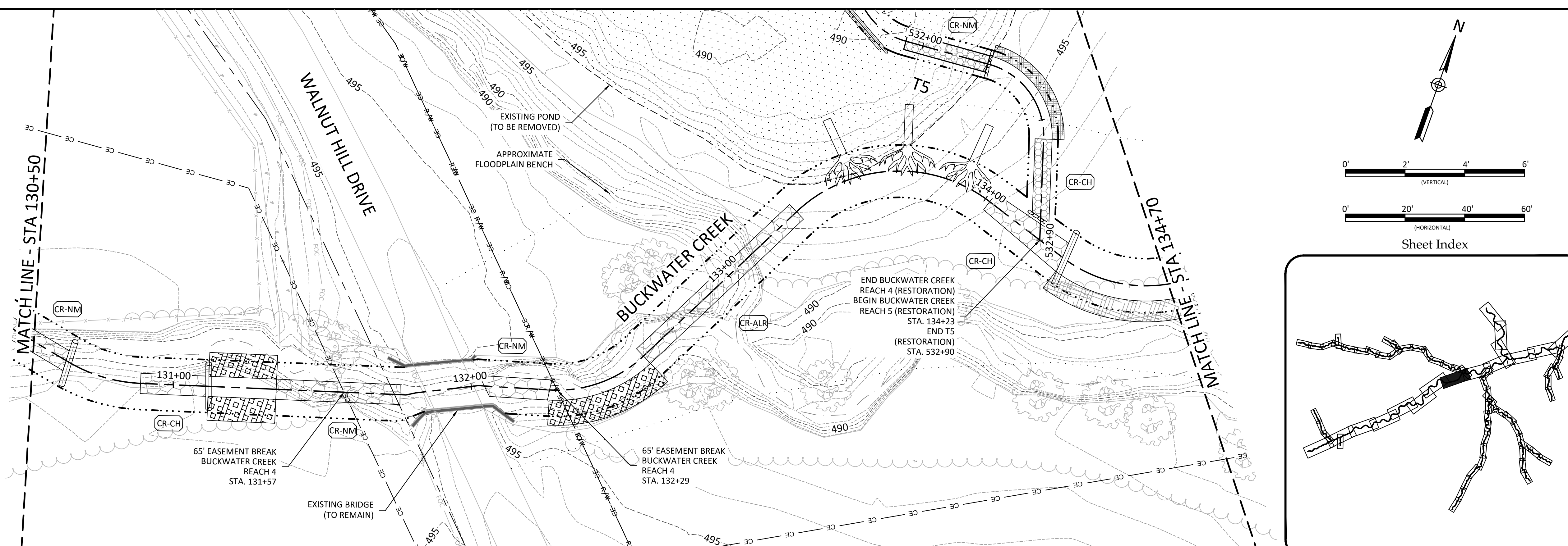

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Buckwater Mitigation Site
Orange County, North Carolina

Buckwater Creek Reaches 4 & 5
Stream Plan and Profile

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Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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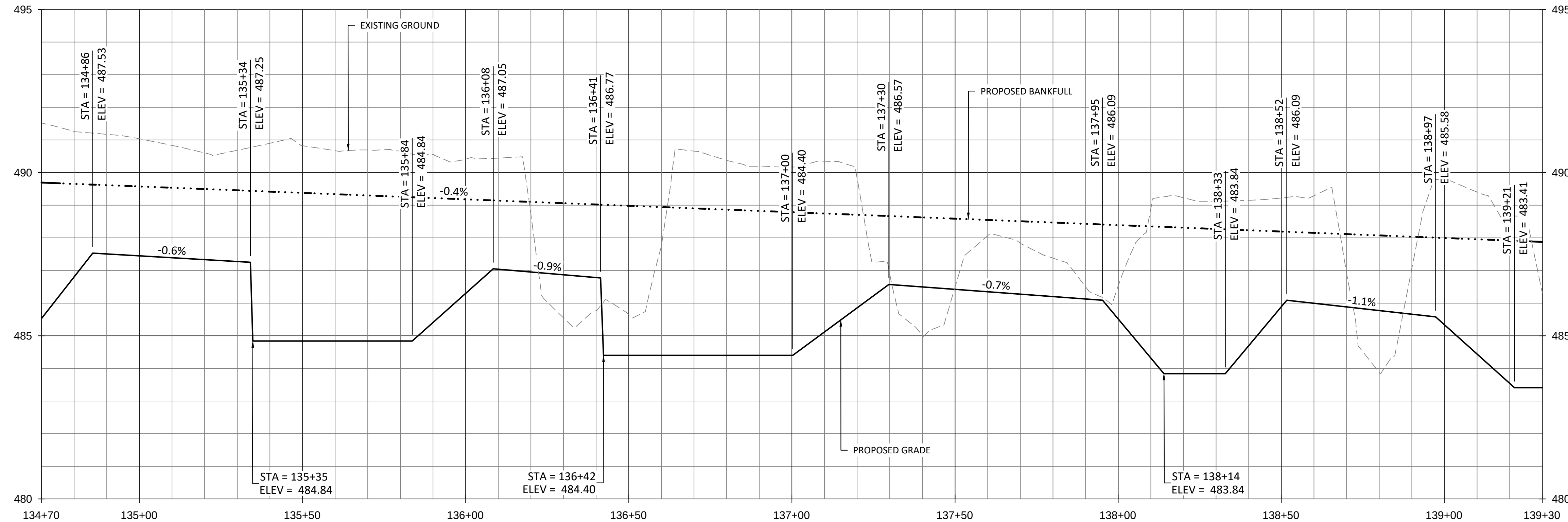
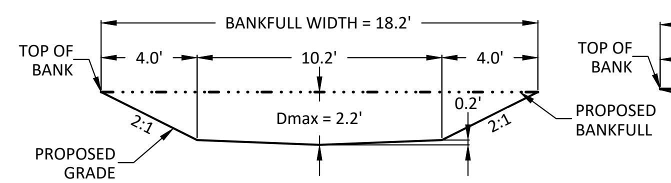
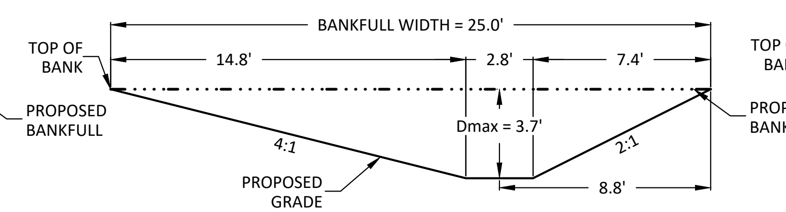
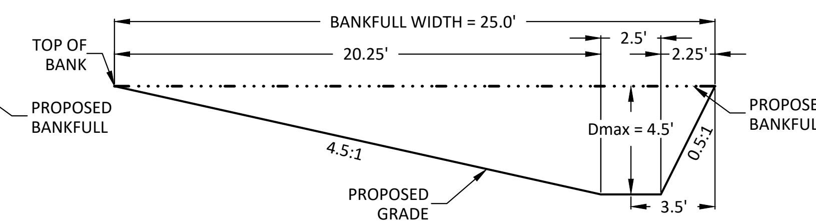




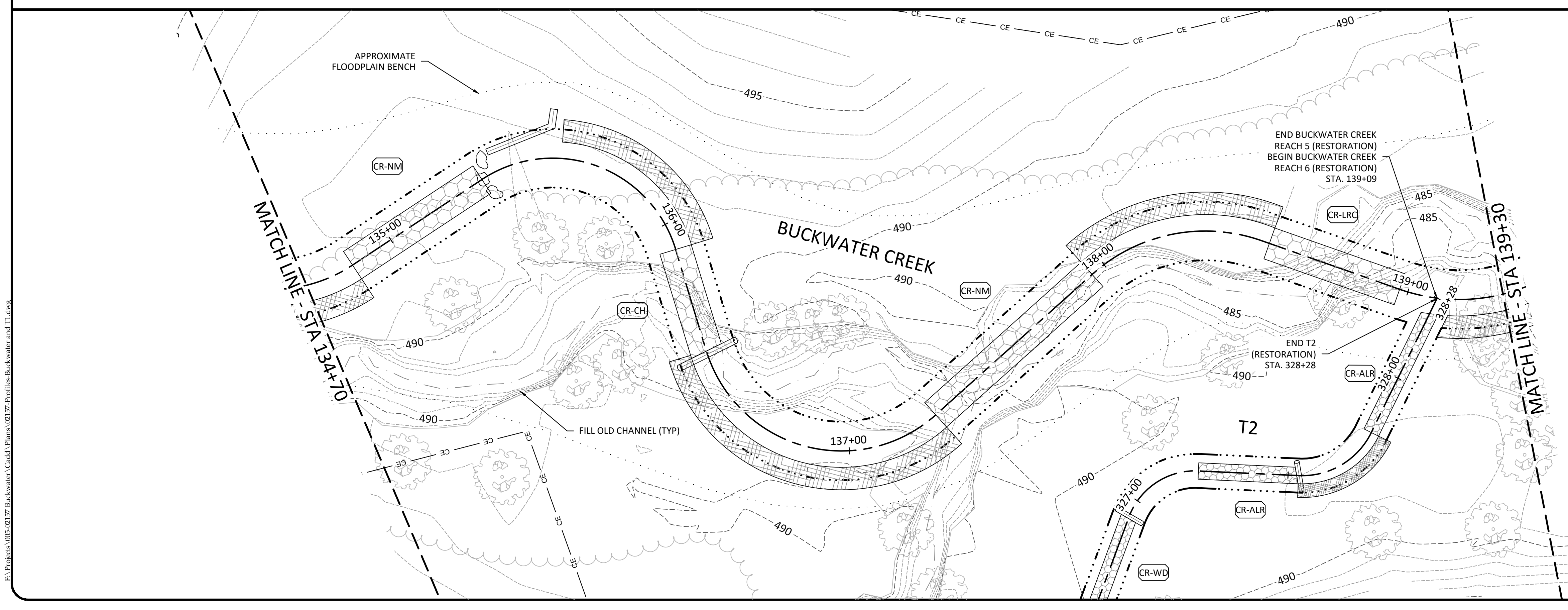
BUCKWATER CREEK REACHES 5 & 6 - TYPICAL SECTION: RIFFLE
STA: 134+23 TO 144+06
SCALE: 1" = 4'



BUCKWATER CREEK REACHES 5 & 6 - TYPICAL SECTION: SHALLOW POOL
STA: 134+23 TO 144+06
SCALE: 1" = 4'



BUCKWATER CREEK REACHES 5 & 6 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 134+23 TO 144+06
SCALE: 1" = 4'



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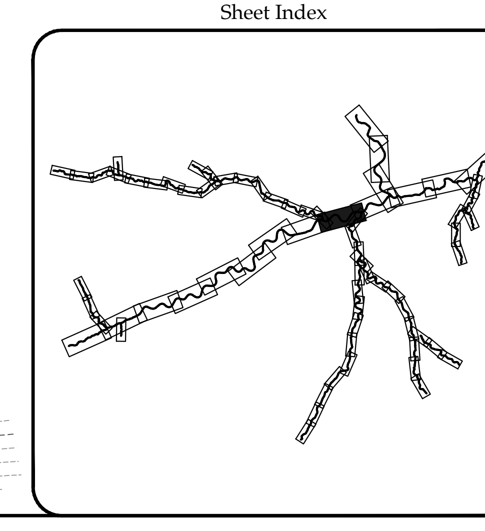

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Buckwater Creek Reaches 5 & 6
Stream Plan and Profile

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Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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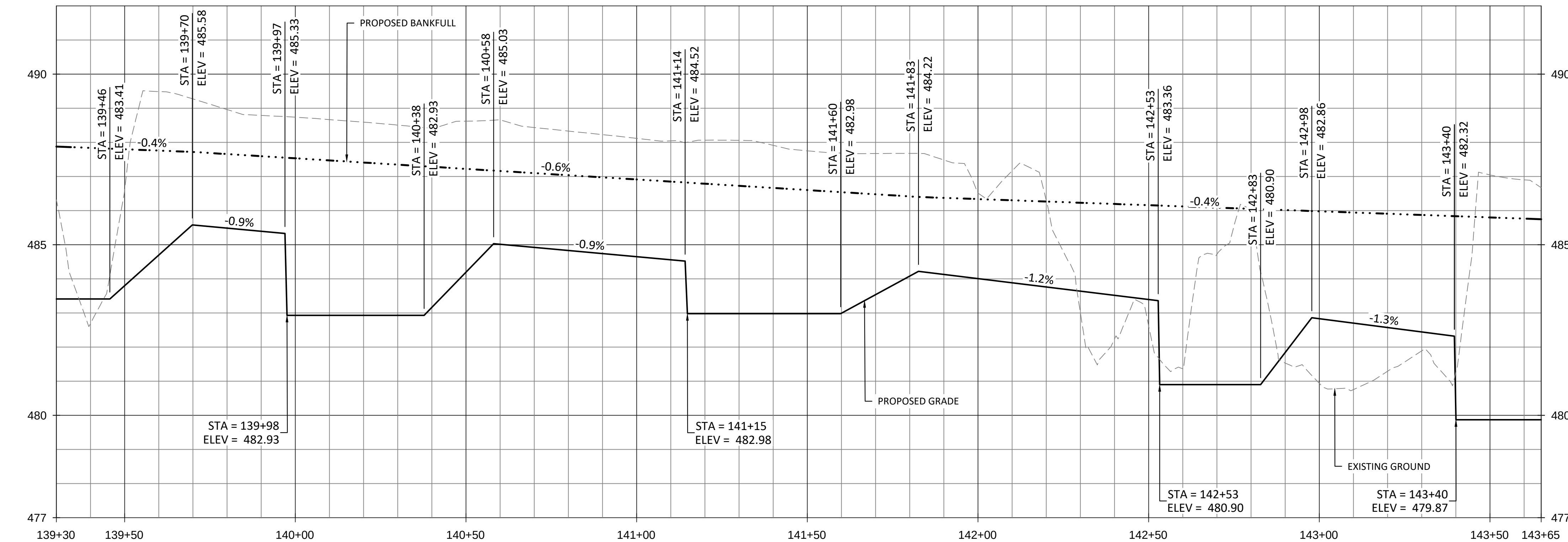

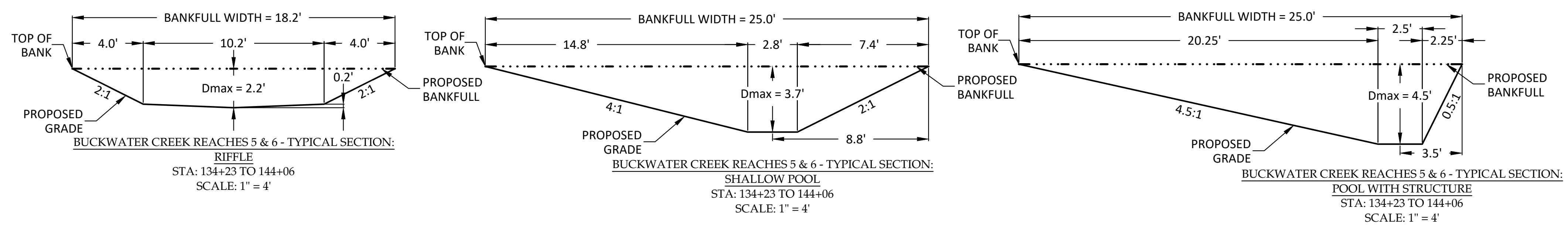

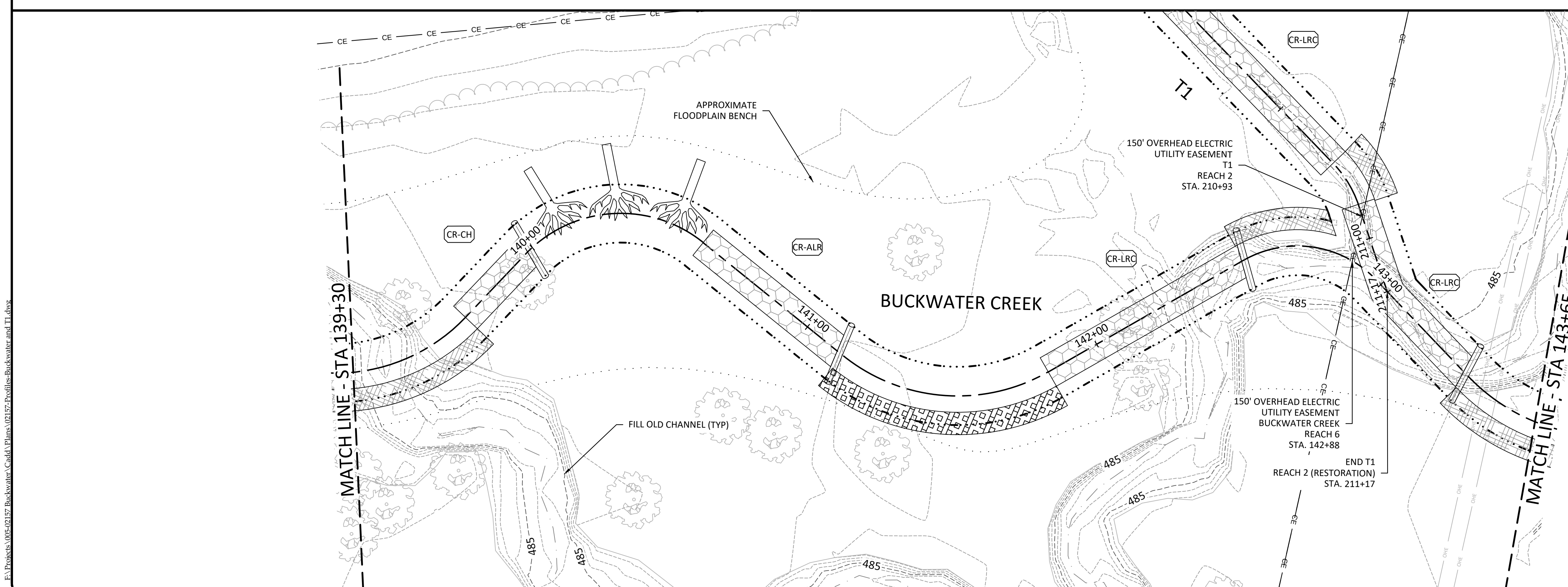

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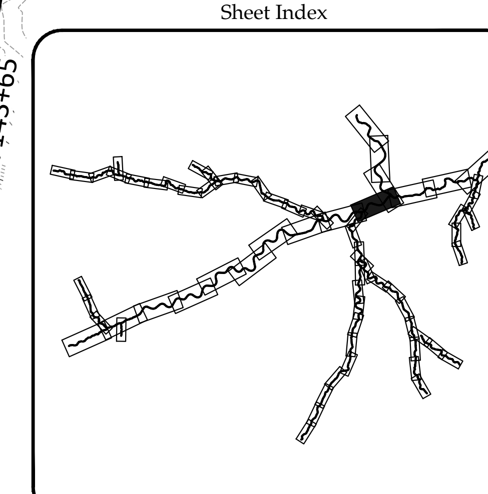

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Buckwater Mitigation Site
Orange County, North Carolina

Buckwater Creek Reach 6
Stream Plan and Profile

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Drawn By:	CLM
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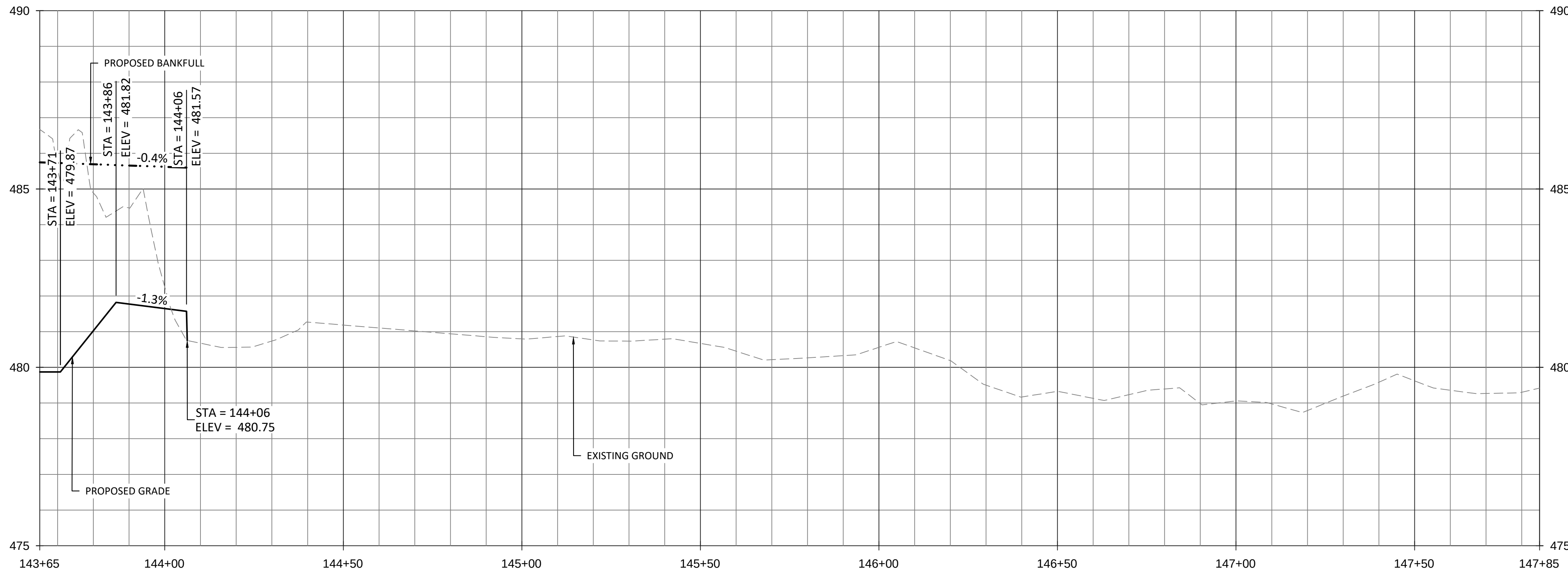
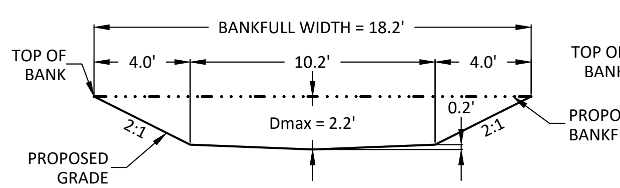
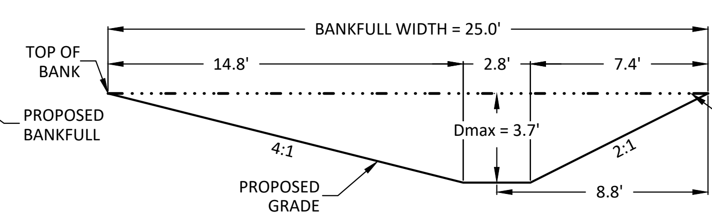
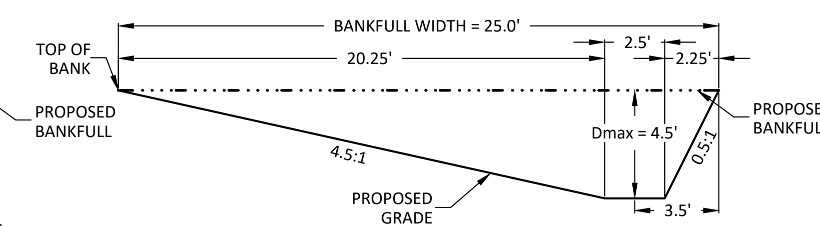




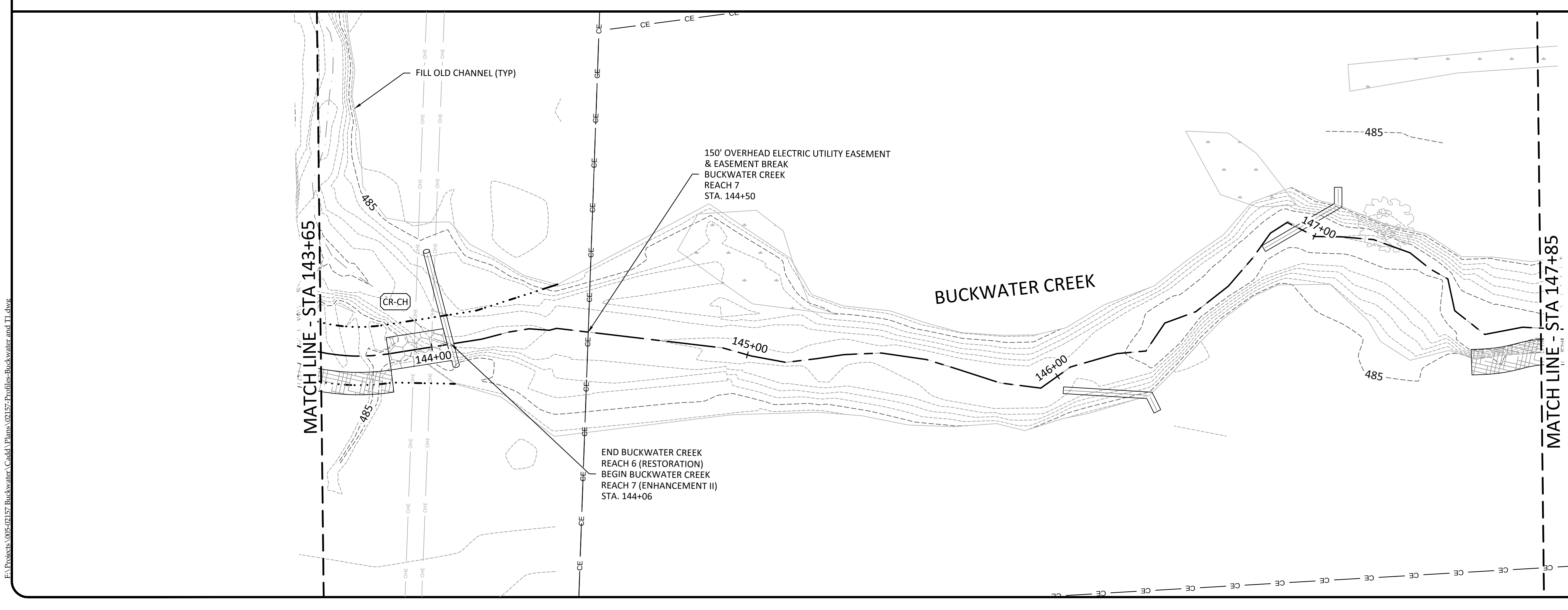
BUCKWATER CREEK REACHES 5 & 6 - TYPICAL SECTION: RIFFLE
STA: 134+23 TO 144+06
SCALE: 1" = 4'



BUCKWATER CREEK REACHES 5 & 6 - TYPICAL SECTION: SHALLOW POOL
STA: 134+23 TO 144+06
SCALE: 1" = 4'



BUCKWATER CREEK REACHES 5 & 6 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 134+23 TO 144+06
SCALE: 1" = 4'



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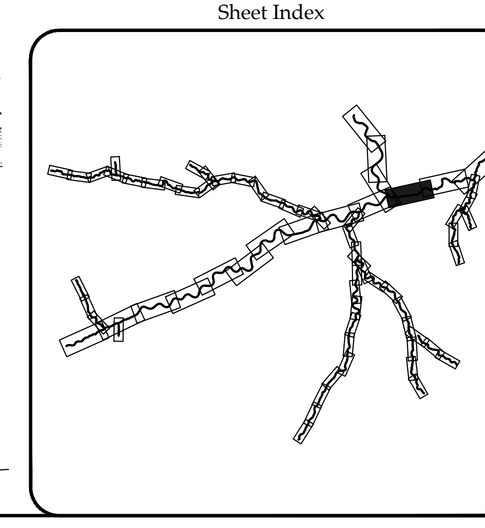

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Buckwater Creek Reaches 6 & 7
Stream Plan and Profile

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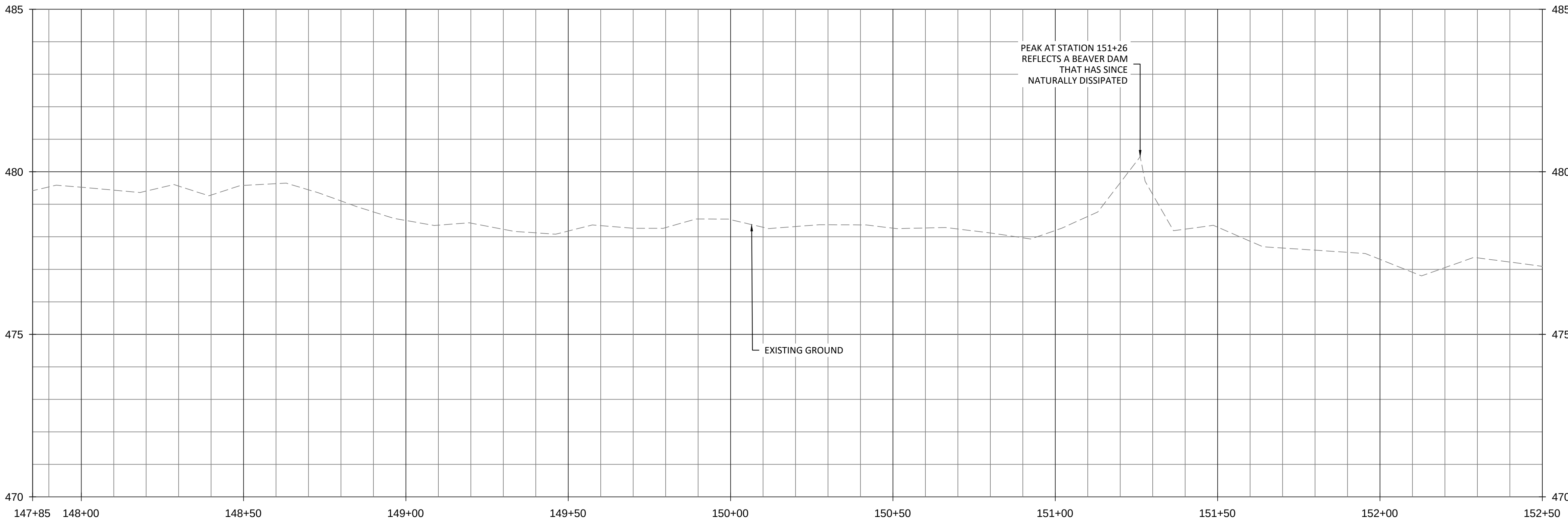

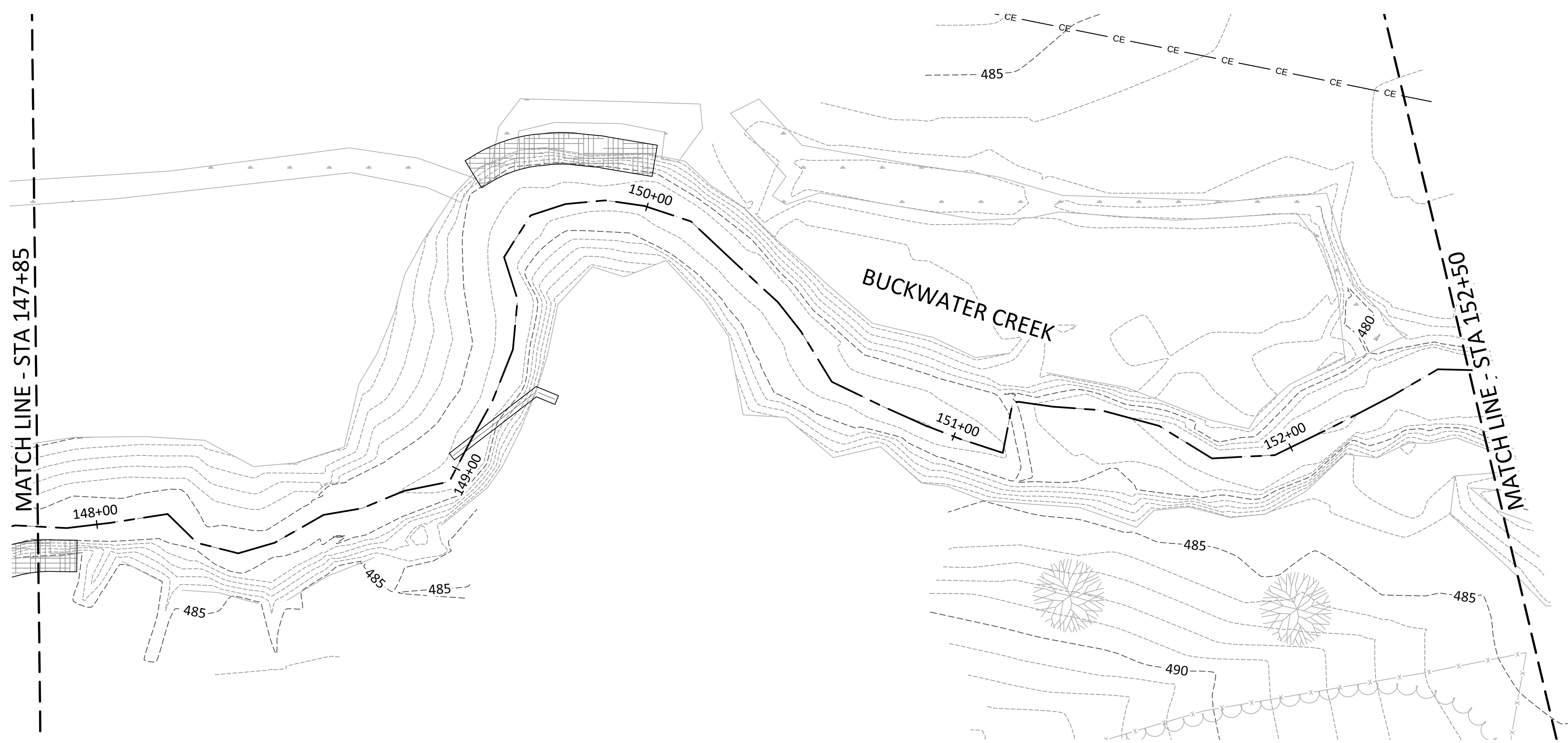

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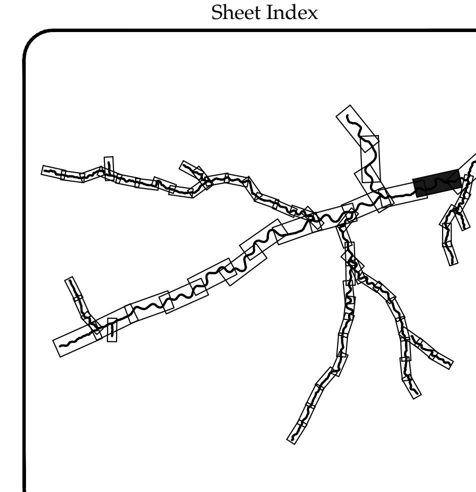

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Buckwater Creek Reach 7
Stream Plan and Profile

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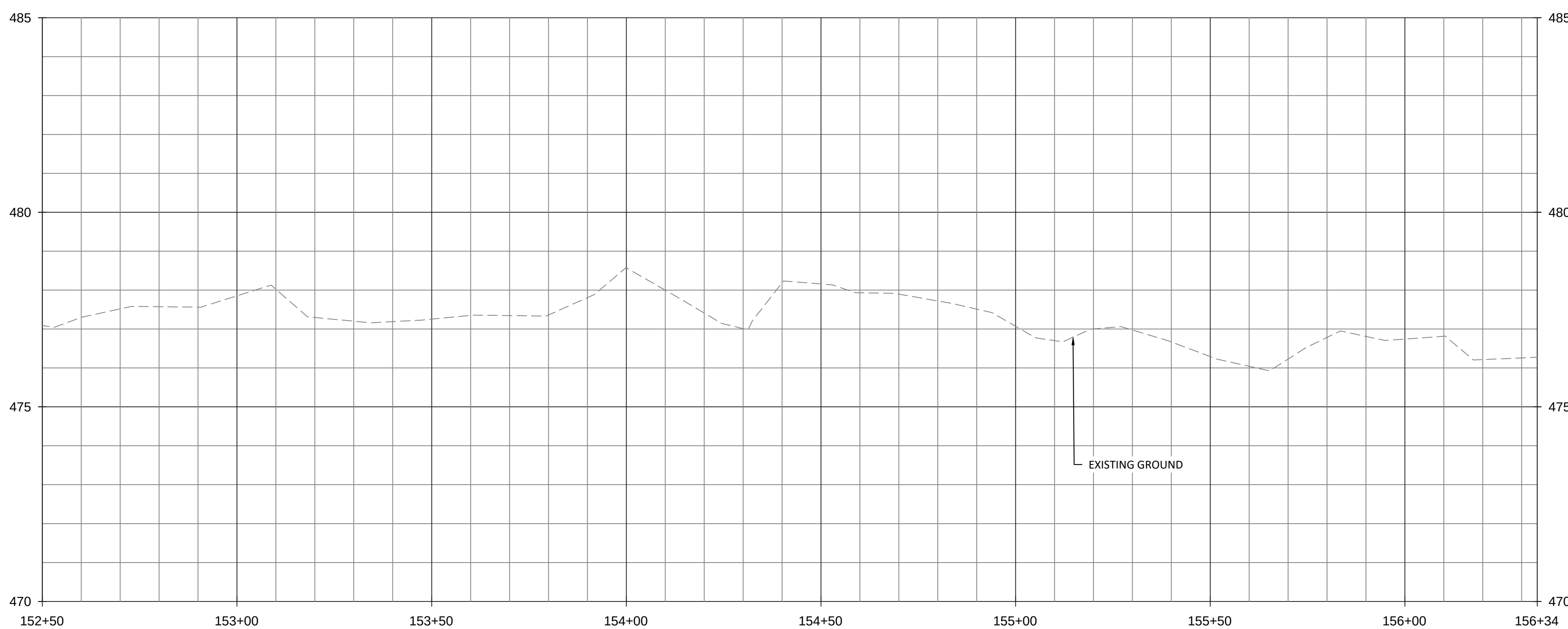
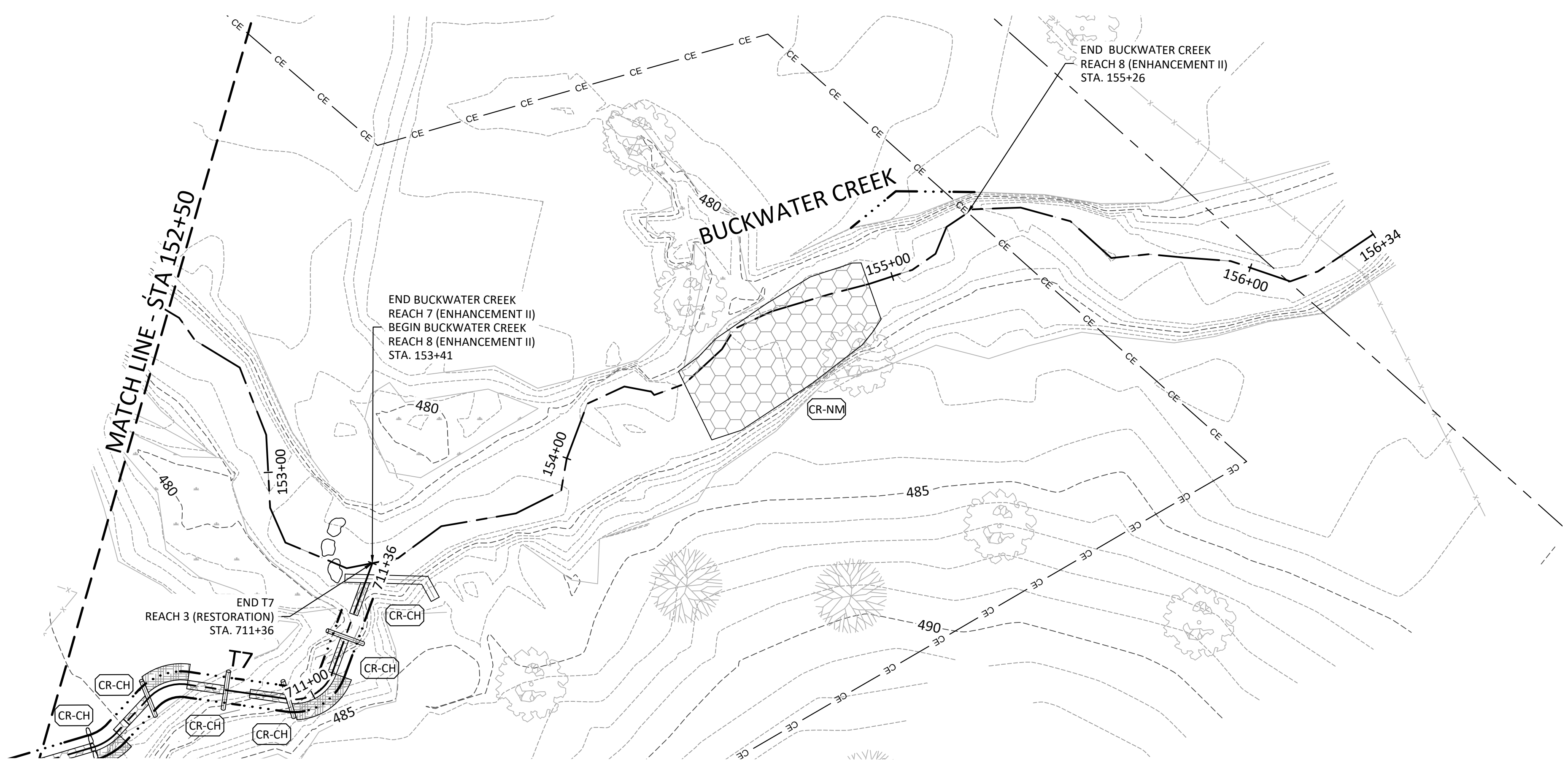


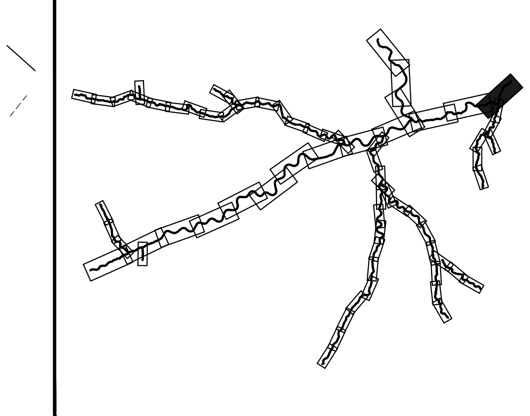


N

0' 2' 4' 6'
(VERTICAL)

0' 20' 40' 60'
(HORIZONTAL)

Sheet Index



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Buckwater Creek Reaches 7 & 8
Stream Plan and Profile

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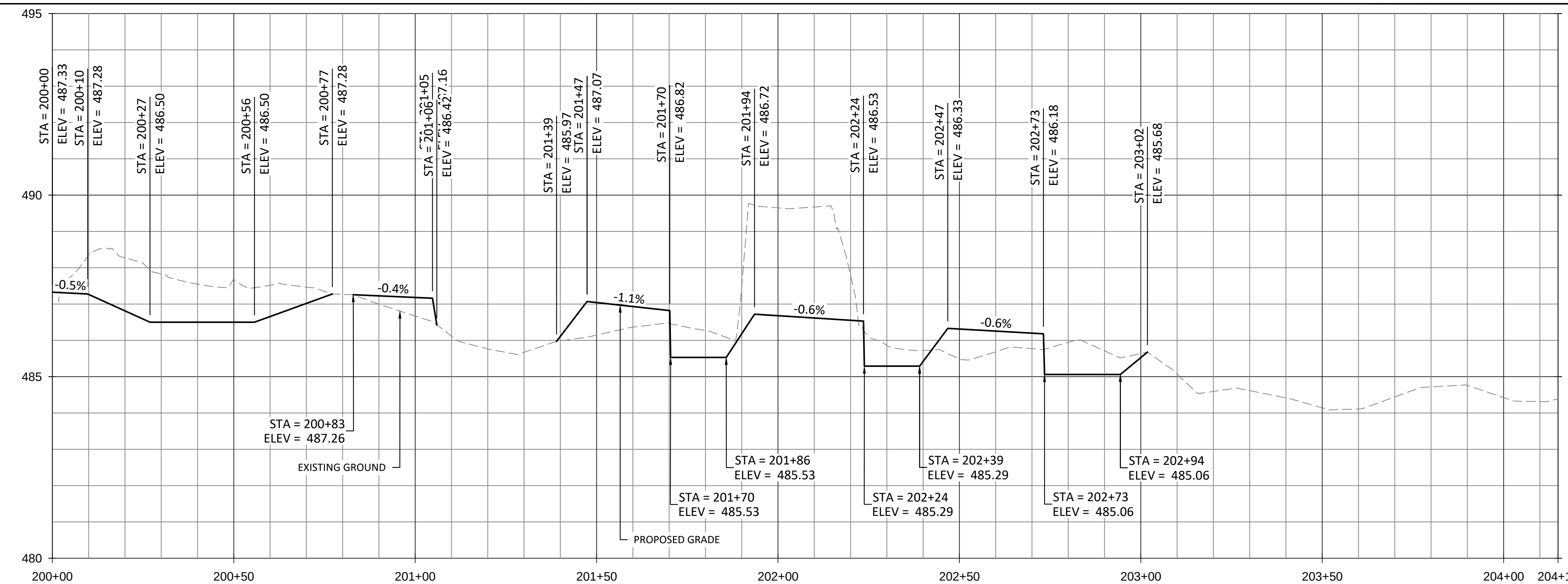
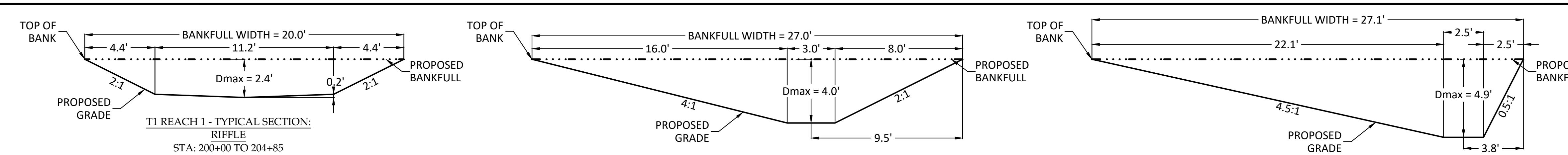
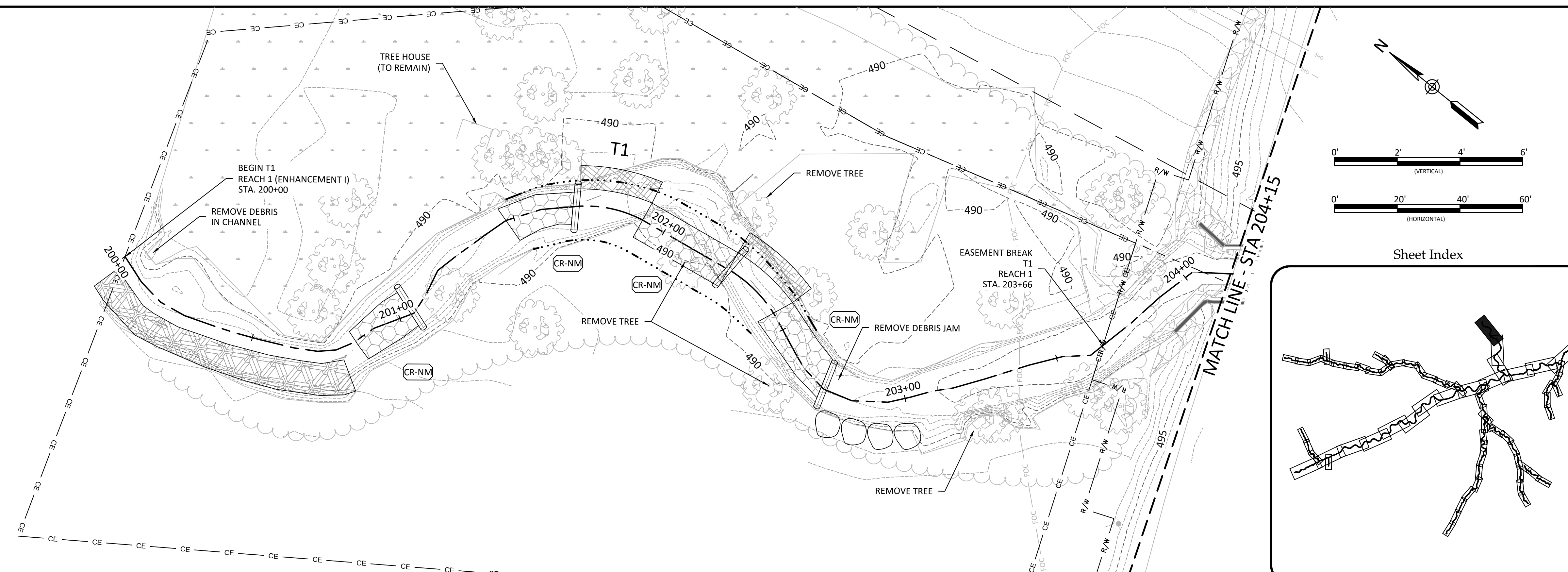




T1 REACH 1 - TYPICAL SECTION:
RIFFLE
STA: 200+00 TO 204+85
SCALE: 1" = 4'

T1 REACH 1 - TYPICAL SECTION:
SHALLOW POOL
STA: 200+00 TO 204+85
SCALE: 1" = 4'

T1 REACH 1 - TYPICAL SECTION:
POOL WITH STRUCTURE
STA: 200+00 TO 204+85
SCALE: 1" = 4'



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T1 Reach 1
Stream Plan and Profile

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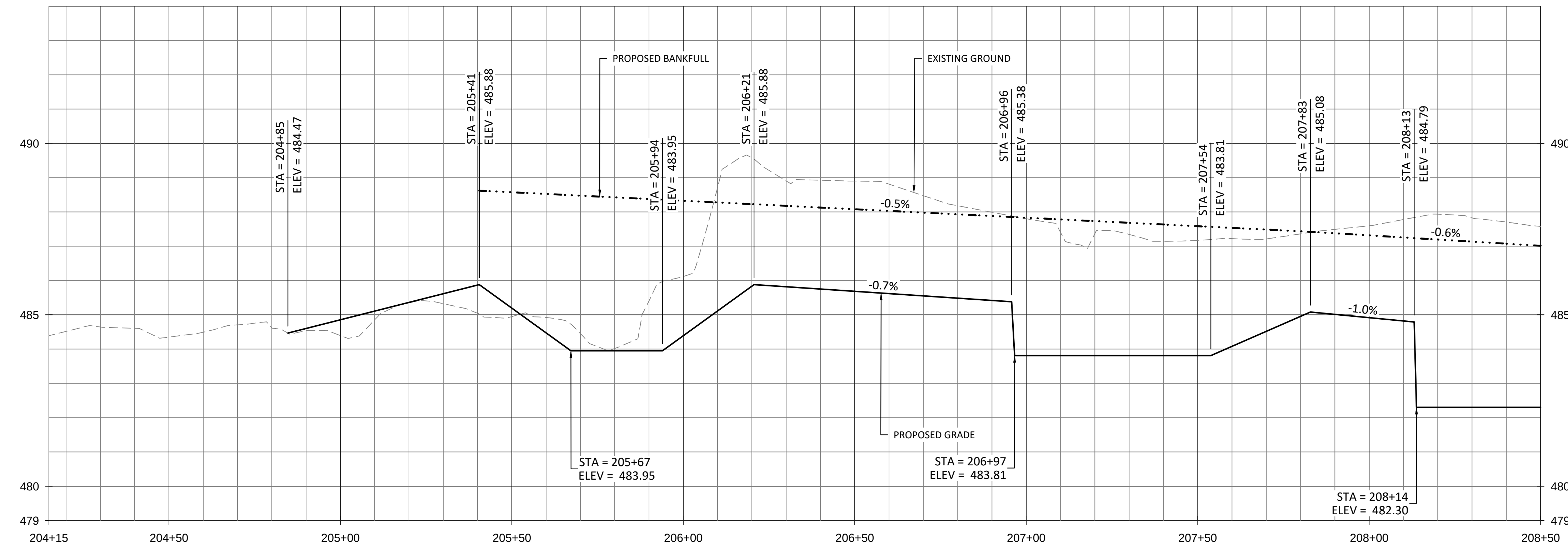
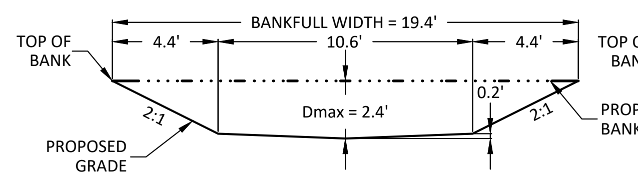
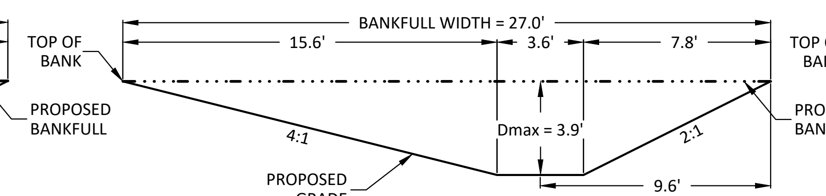
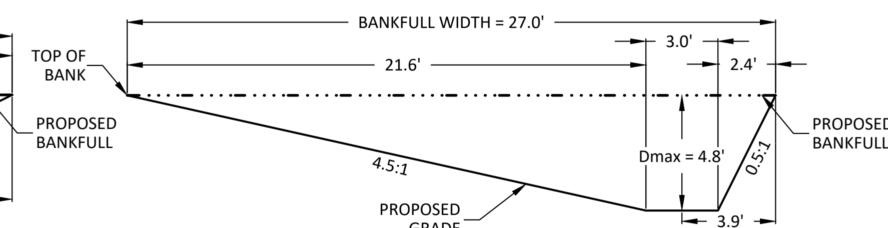




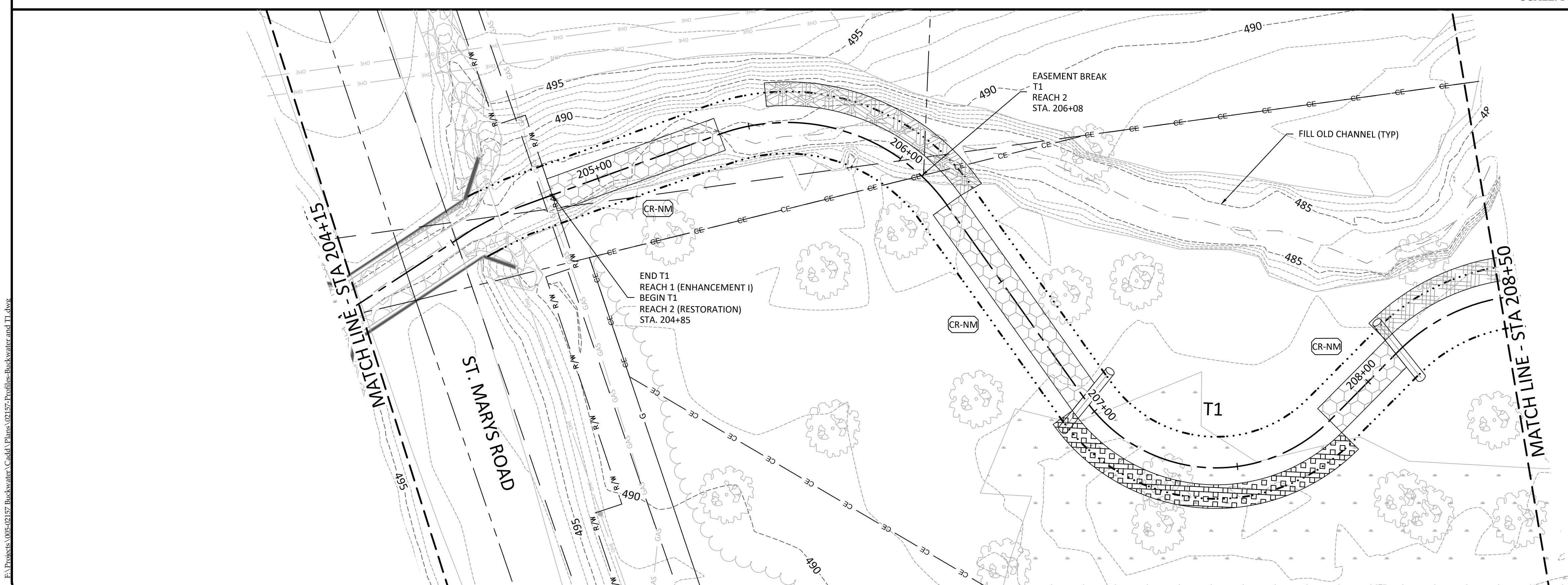
T1 REACH 2 - TYPICAL SECTION: RIFFLE
STA: 204+85 TO 211+17
SCALE: 1" = 4'



T1 REACH 2 - TYPICAL SECTION: SHALLOW POOL
STA: 204+85 TO 211+17
SCALE: 1" = 4'



T1 REACH 2 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 204+85 TO 211+17
SCALE: 1" = 4'



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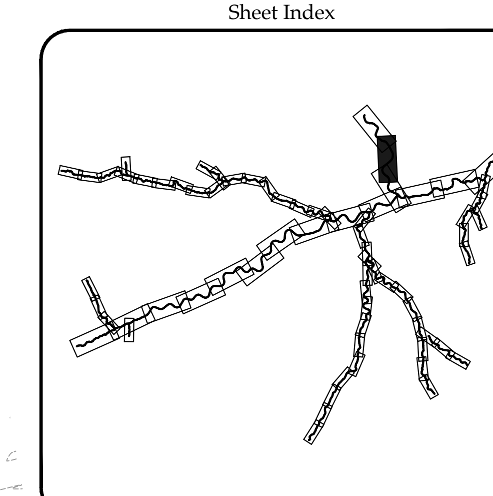

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Buckwater Mitigation Site
Orange County, North Carolina

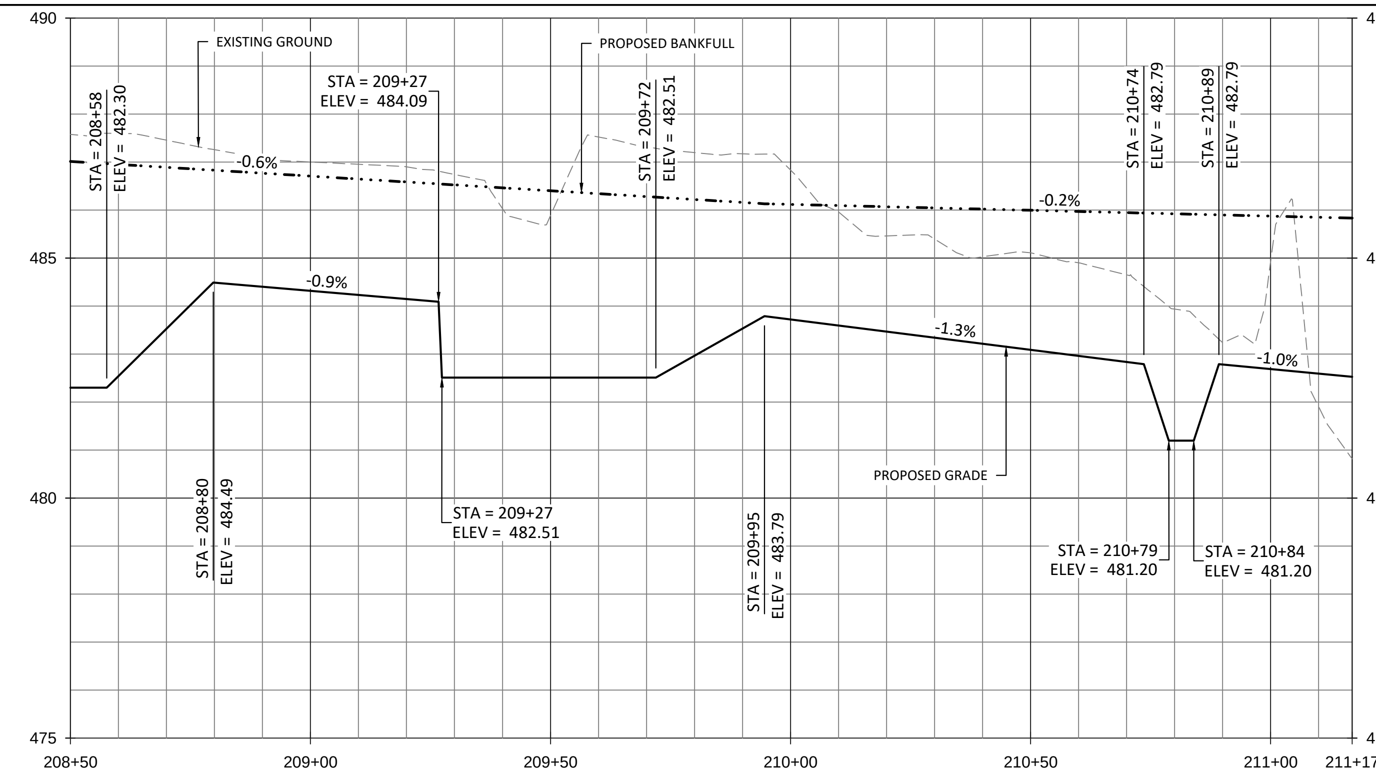
T1 Reaches 1 & 2
Stream Plan and Profile

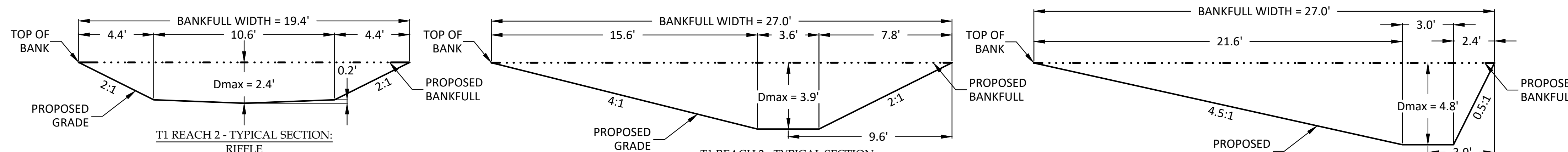
Revisions:

Date:	05.26.2017
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

Sheet 1.15

F:\Projects\005-02157 Buckwater\Cadd\Plans\02157-Profile-Buckwater and T1.dwg

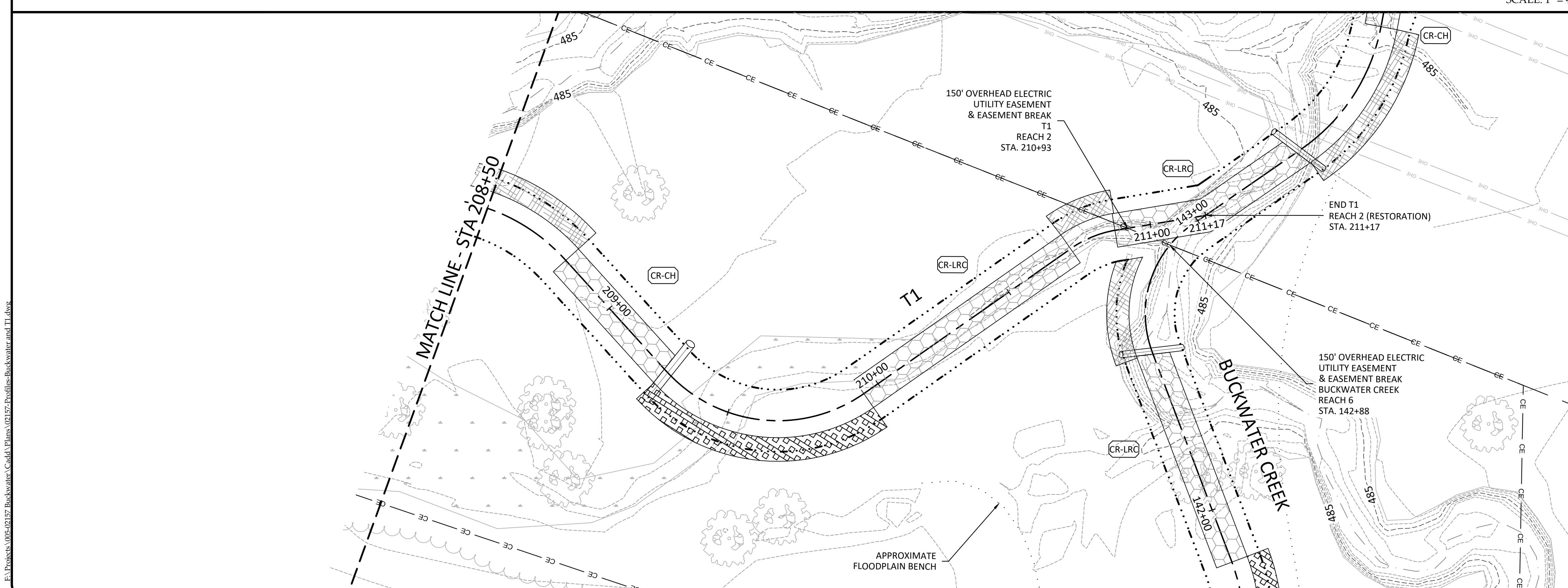


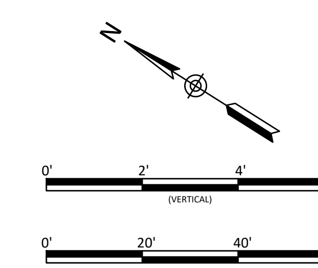


T1 REACH 2 - TYPICAL SECTION: RIFFLE
STA: 204+85 TO 211+17
SCALE: 1" = 4'

T1 REACH 2 - TYPICAL SECTION: SHALLOW POOL
STA: 204+85 TO 211+17
SCALE: 1" = 4'

T1 REACH 2 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 204+85 TO 211+17
SCALE: 1" = 4'





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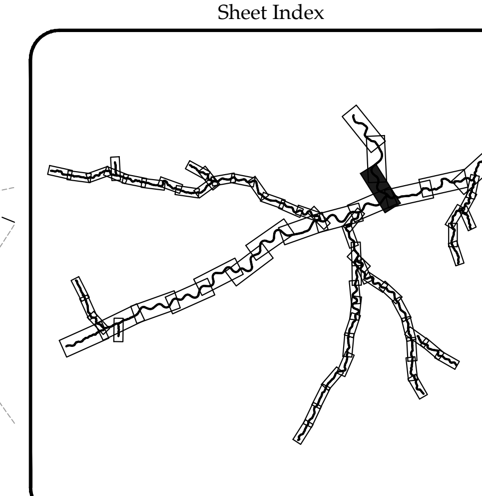

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Buckwater Mitigation Site
Orange County, North Carolina

T1 Reach 2
Stream Plan and Profile

Revisions:

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Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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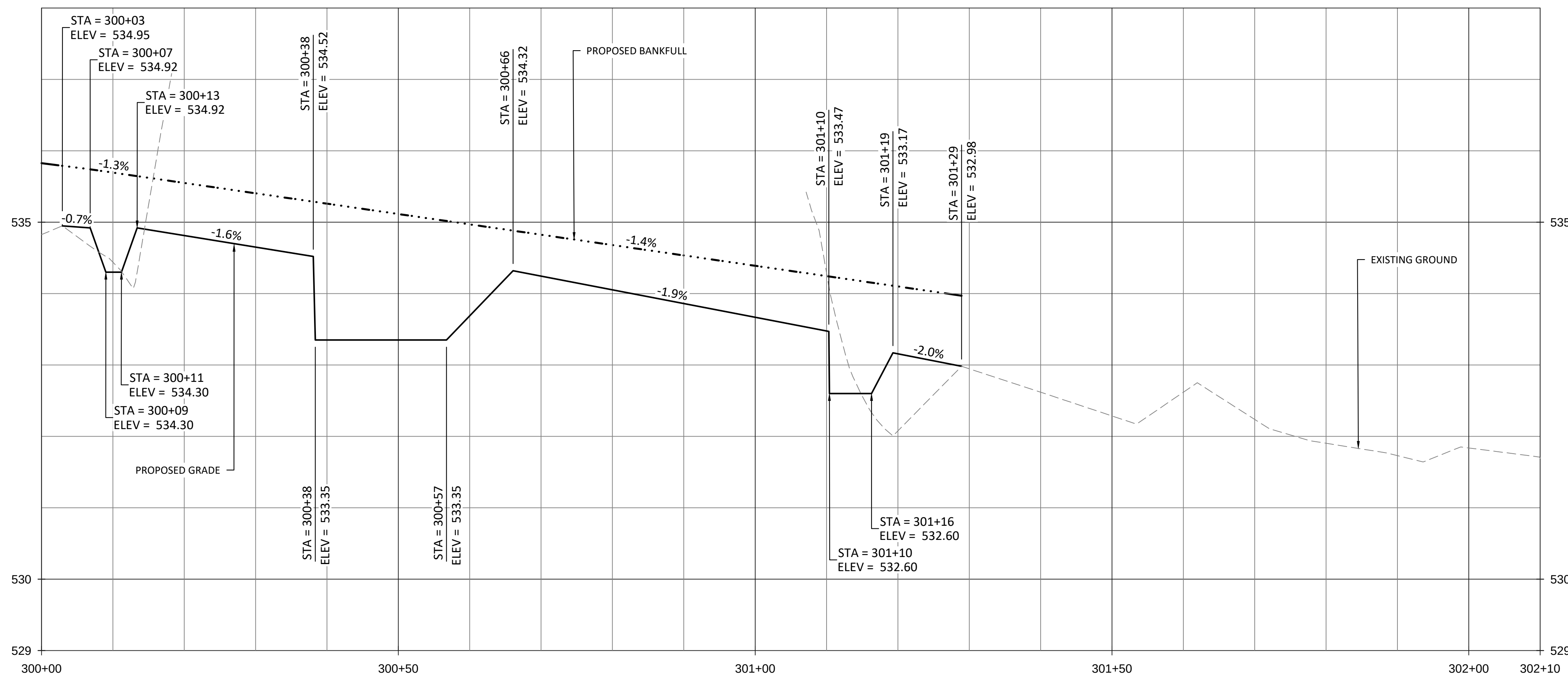

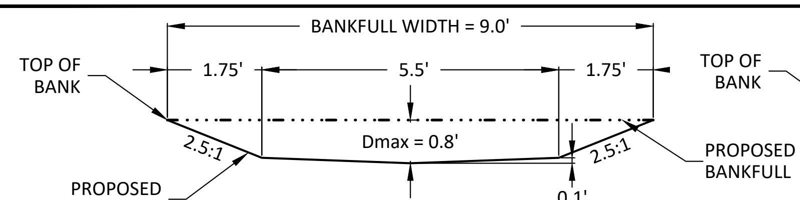

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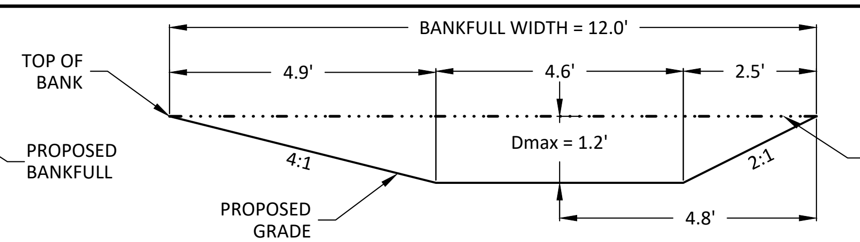
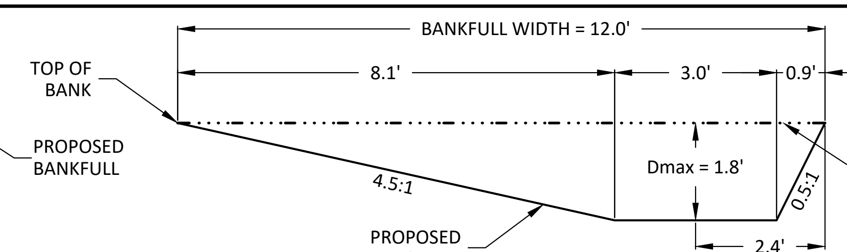
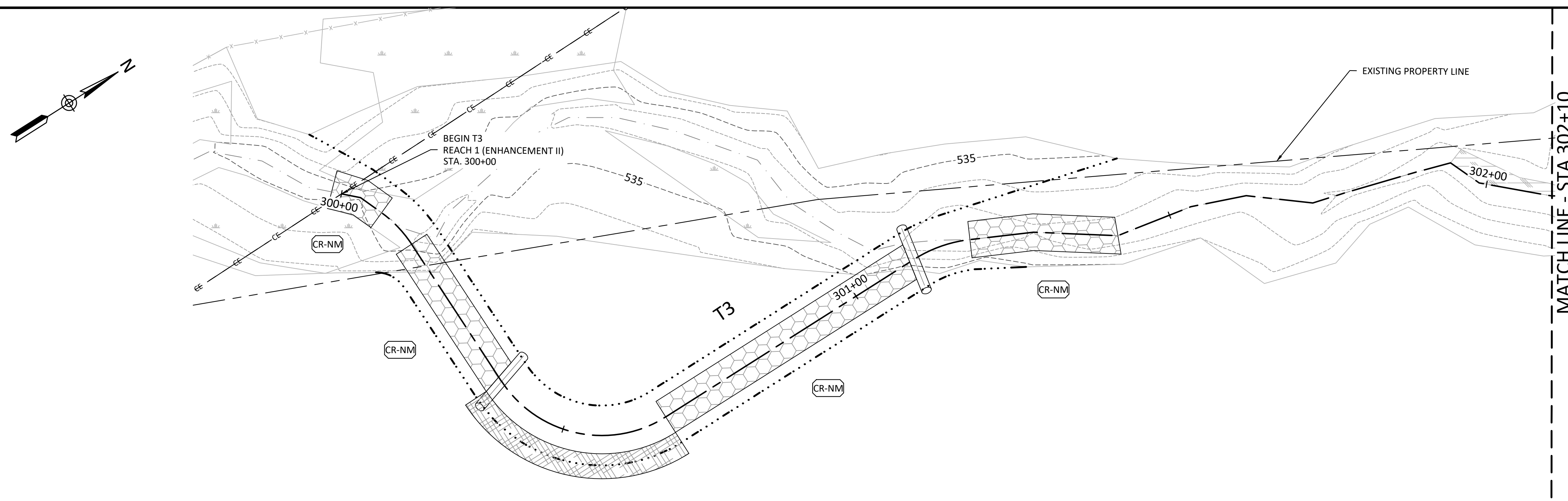
SCALE: 1" = 2'



T3 REACH 1 - TYPICAL SECTION: SHALLOW POOL
STA: 300+00 TO 301+29
SCALE: 1" = 2'



T3 REACH 1 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 300+00 TO 301+29
SCALE: 1" = 2'



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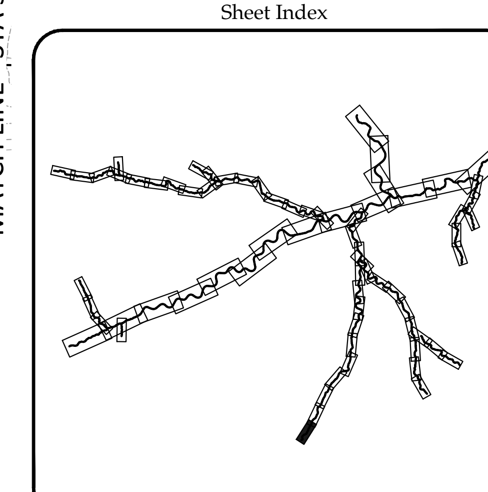

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T3 Reach 1
Stream Plan and Profile

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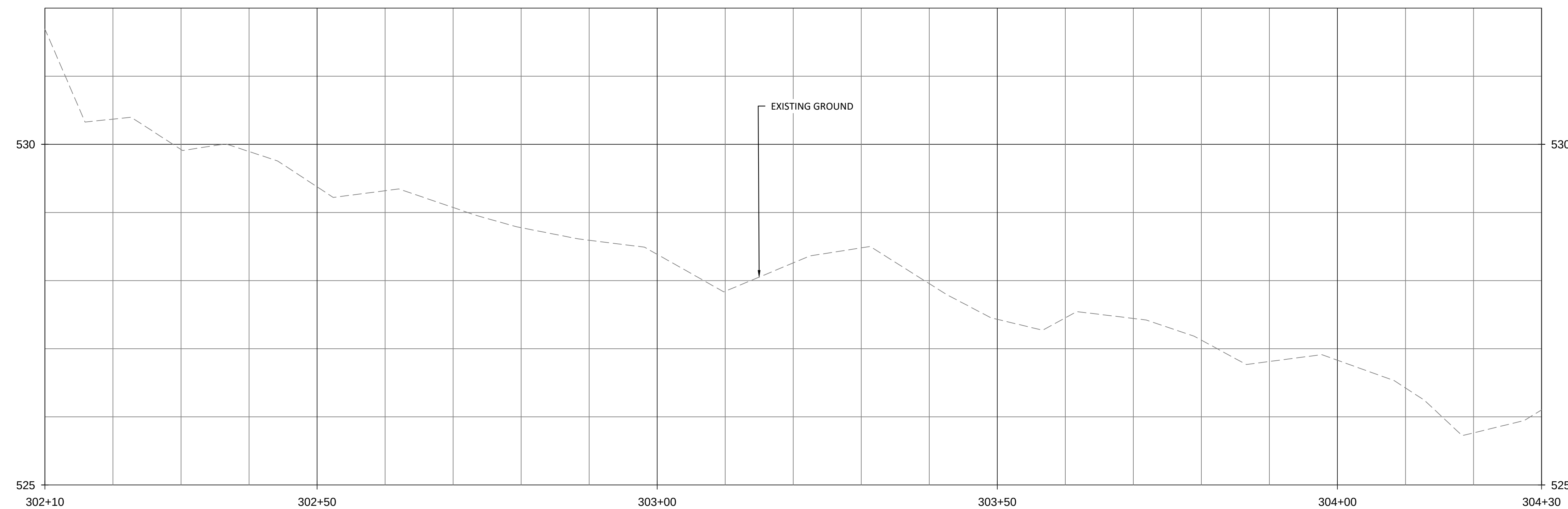

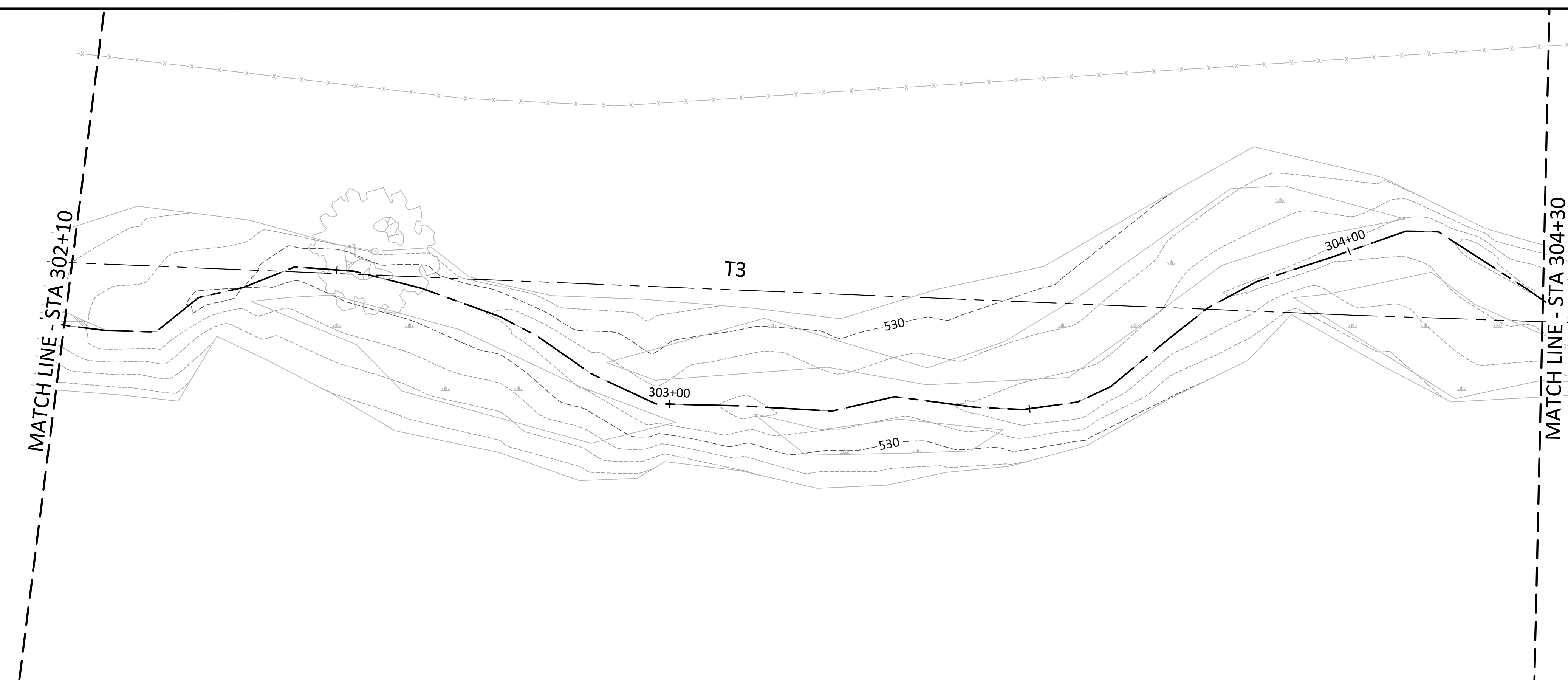

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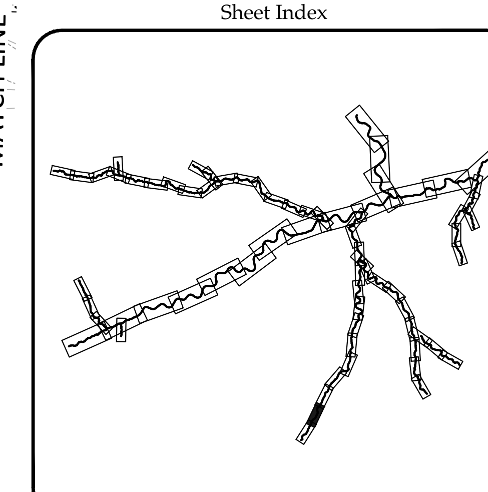

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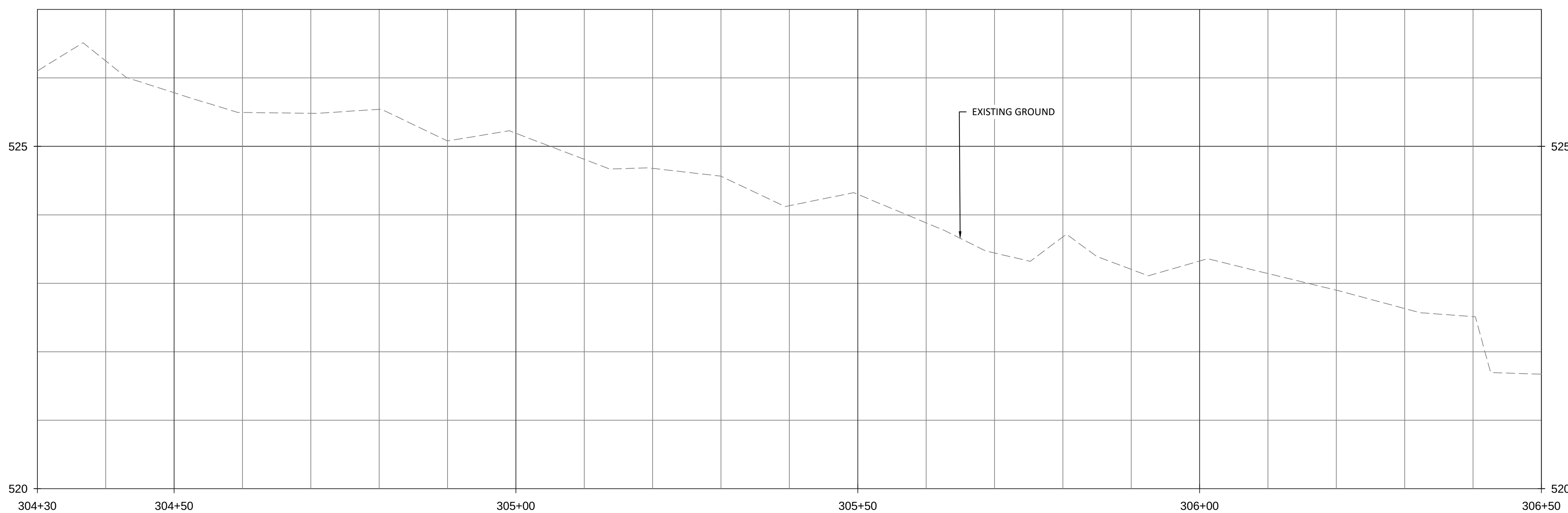

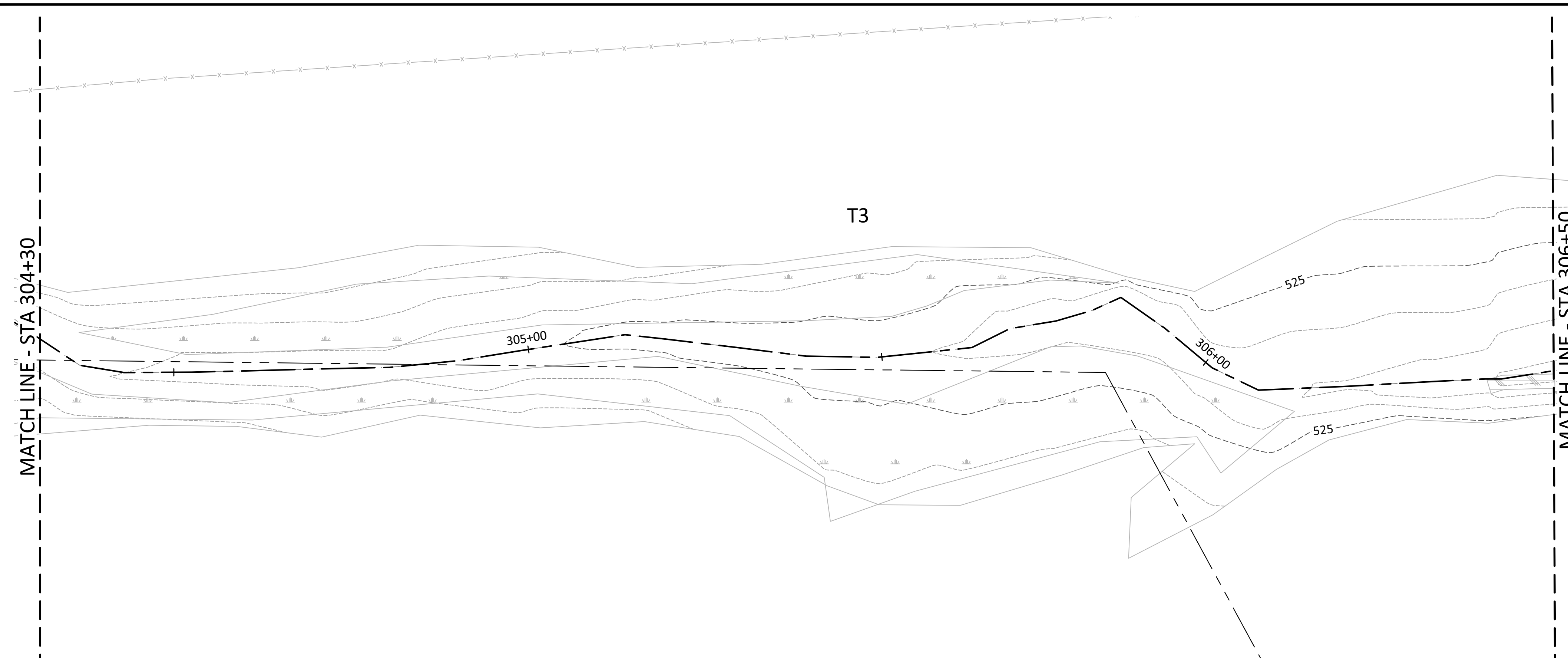

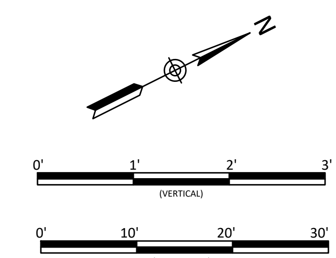

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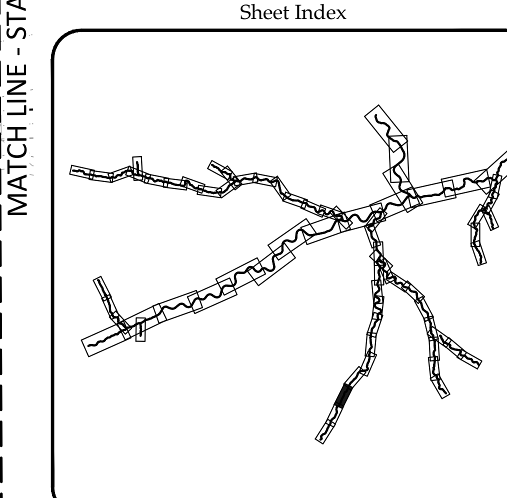

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T3 Reach 1
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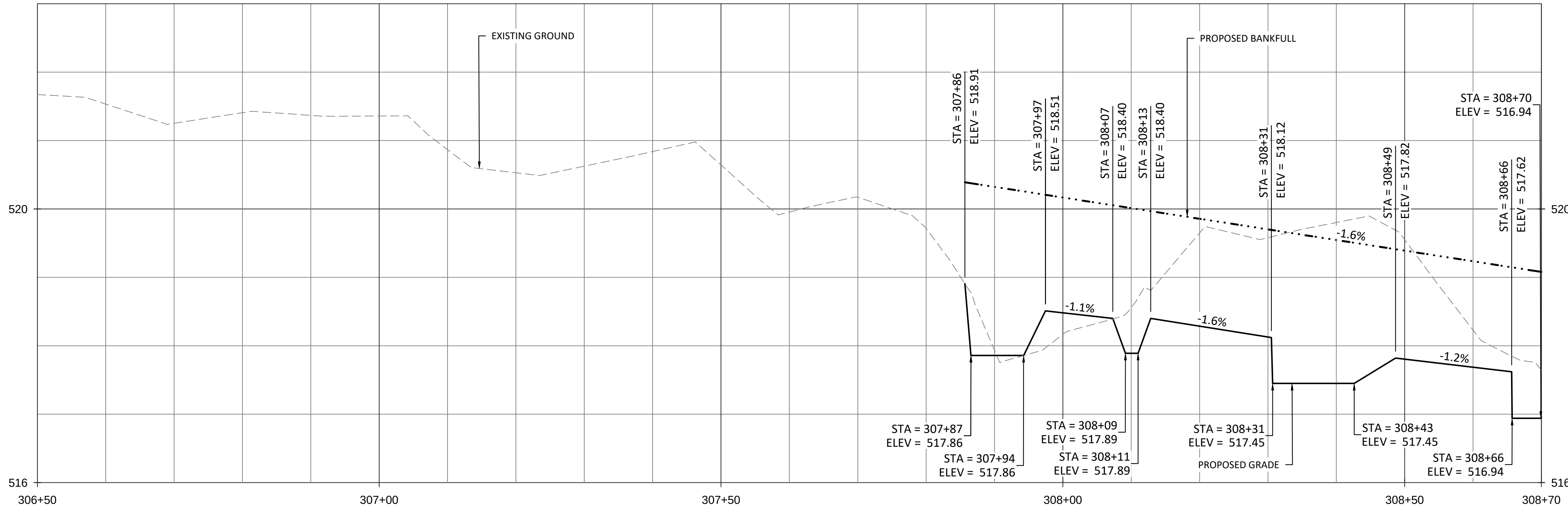
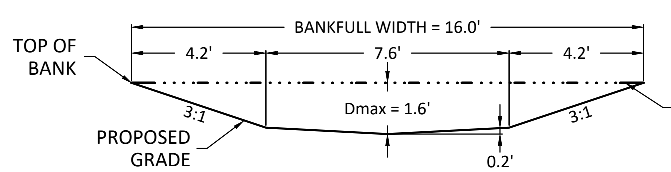
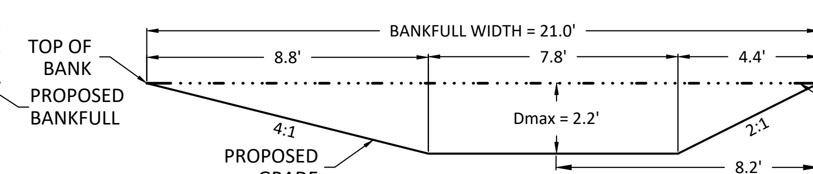
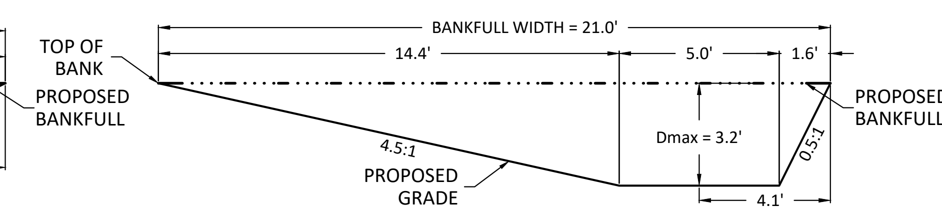




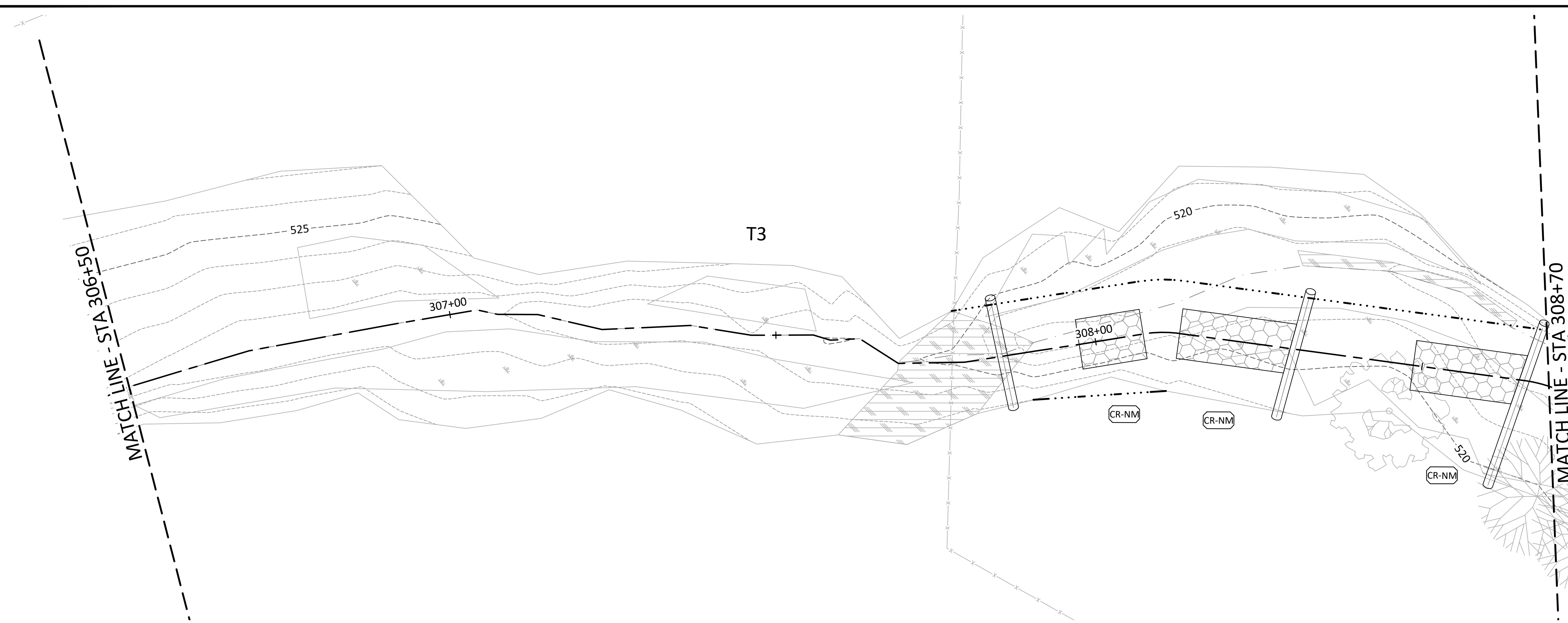
T3 REACH 1 - TYPICAL SECTION: RIFFLE
STA: 307+86 TO 311+83
SCALE: 1" = 3'

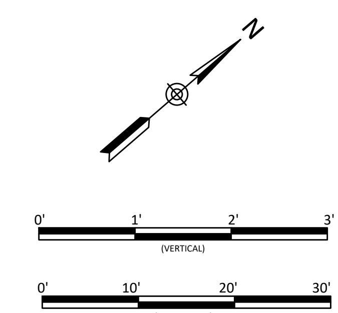


T3 REACH 1 - TYPICAL SECTION: SHALLOW POOL
STA: 307+86 TO 311+83
SCALE: 1" = 3'



T3 REACH 1 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 307+86 TO 311+83
SCALE: 1" = 3'





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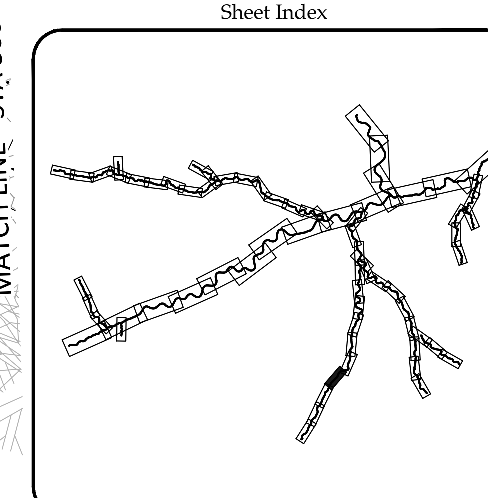

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Buckwater Mitigation Site
Orange County, North Carolina

T3 Reach 1
Stream Plan and Profile

Revisions:

Date:	05.26.2017
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Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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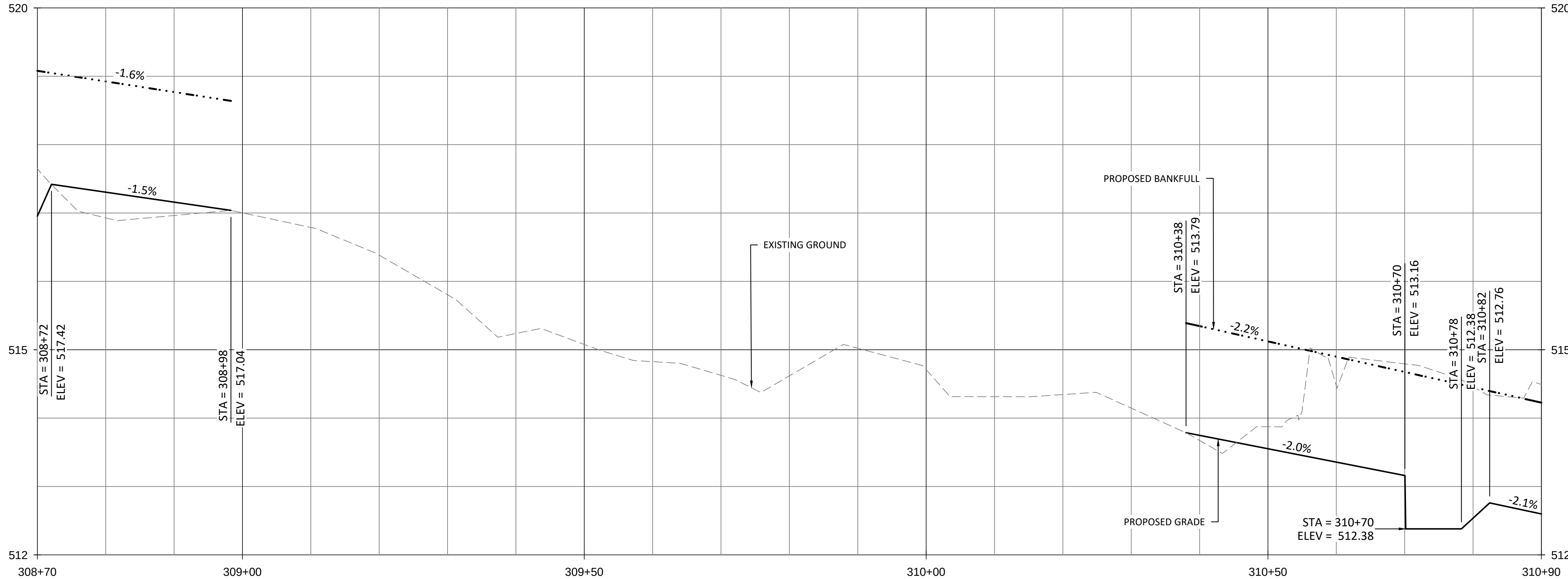
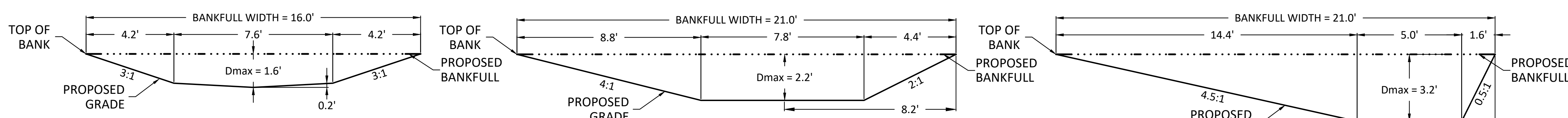
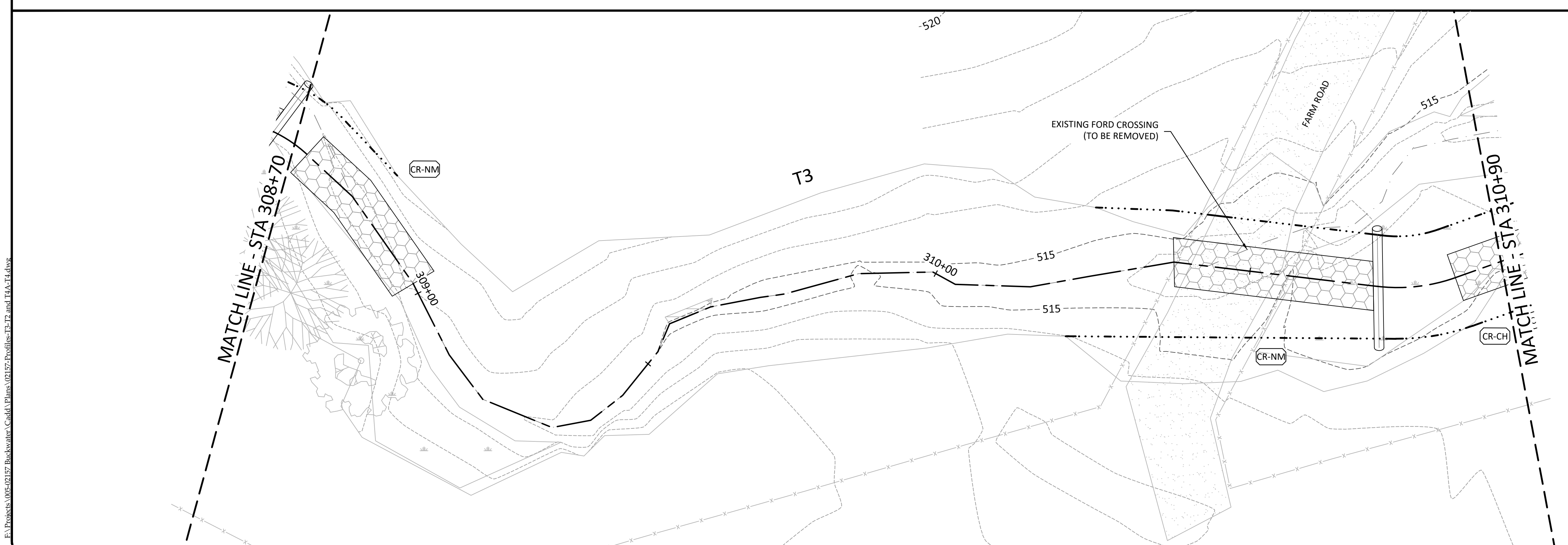




T3 REACH 1 - TYPICAL SECTION: RIFFLE
STA: 307+86 TO 311+83
SCALE: 1" = 3'

T3 REACH 1 - TYPICAL SECTION: SHALLOW POOL
STA: 307+86 TO 311+83
SCALE: 1" = 3'

T3 REACH 1 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 307+86 TO 311+83
SCALE: 1" = 3'



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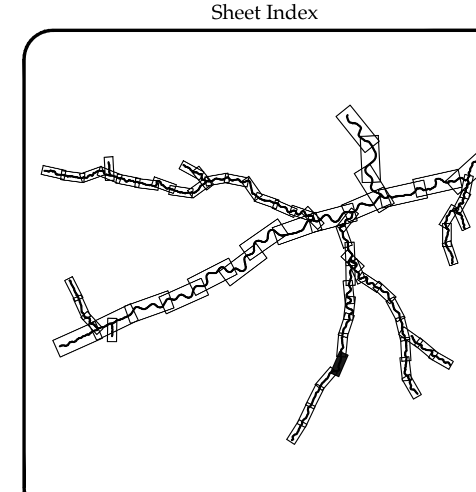

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T3 Reach 1
Stream Plan and Profile

Date:	05.26.2017
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Project Engineer:	NMM
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Revisions:

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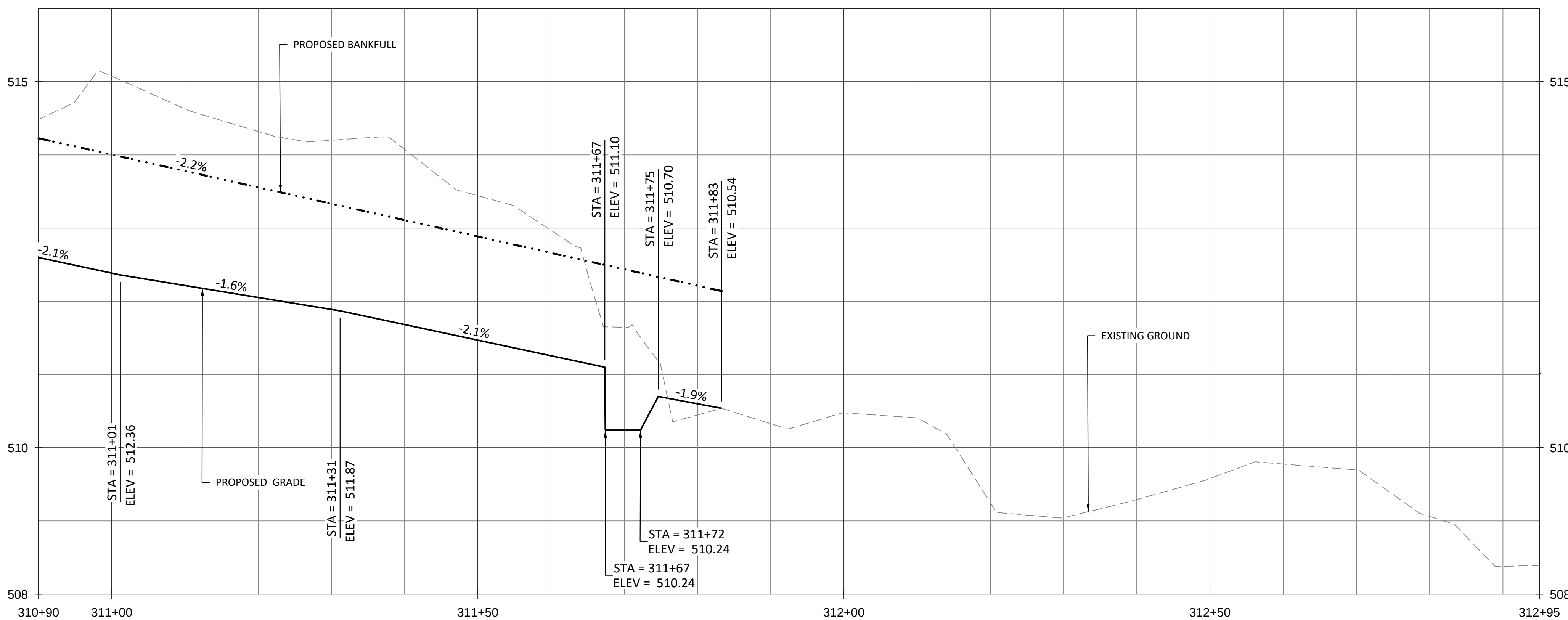
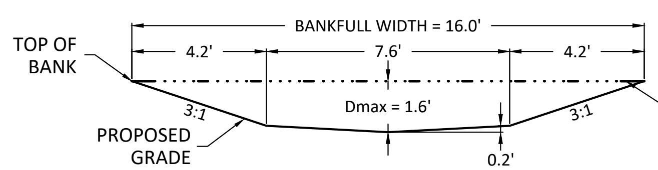
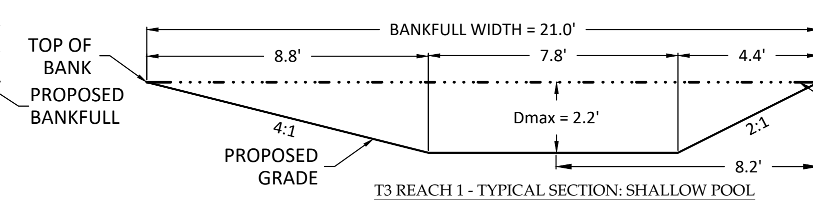
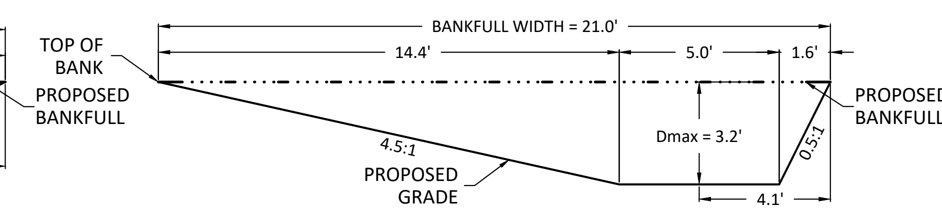




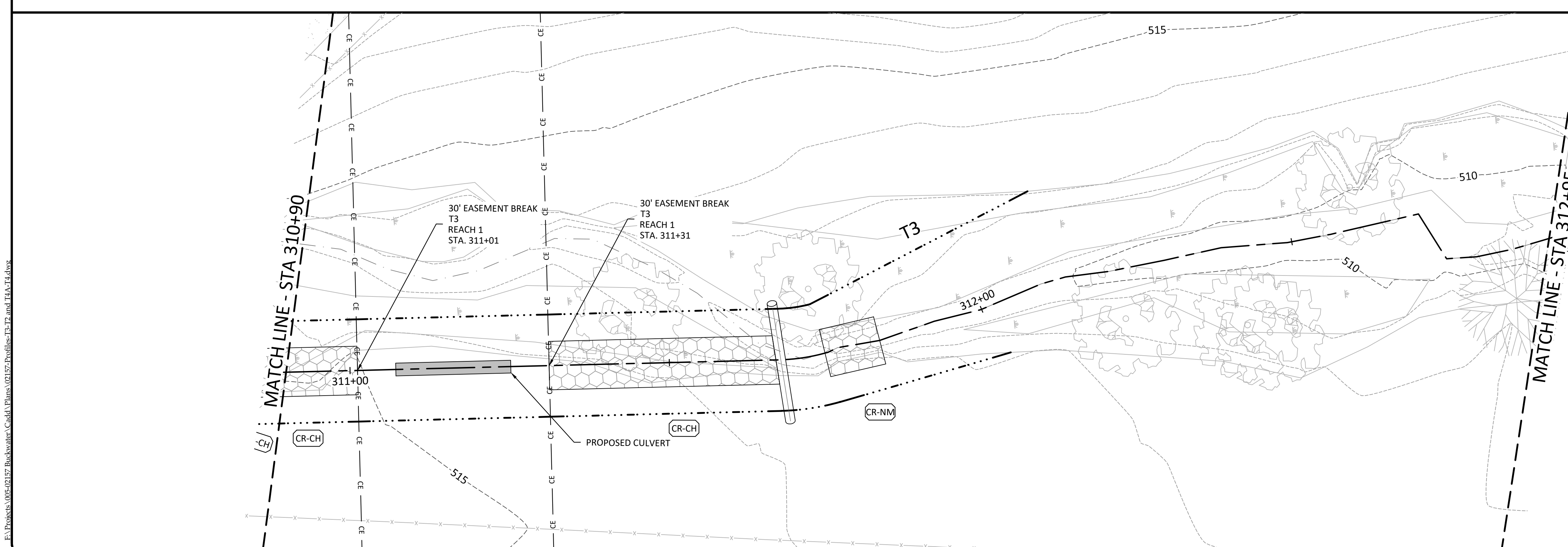
T3 REACH 1 - TYPICAL SECTION: RIFFLE
STA: 307+86 TO 311+83
SCALE: 1" = 3'

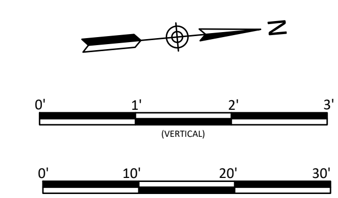


T3 REACH 1 - TYPICAL SECTION: SHALLOW POOL
STA: 307+86 TO 311+83
SCALE: 1" = 3'



T3 REACH 1 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 307+86 TO 311+83
SCALE: 1" = 3'





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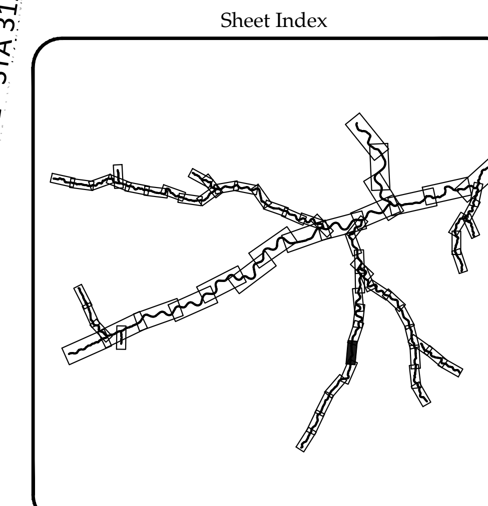

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T3 Reach 1
Stream Plan and Profile

Revisions:

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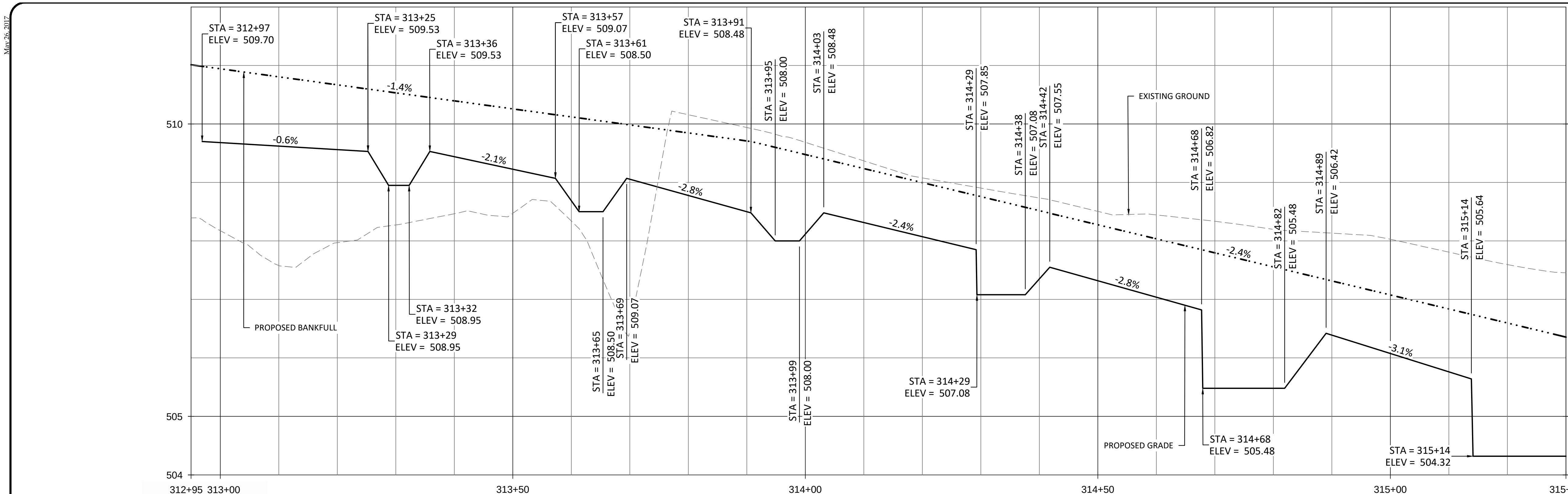

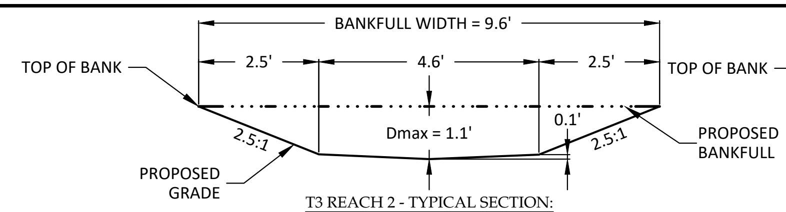

T3 REACH 2 - TYPICAL SECTION: RIFFLE
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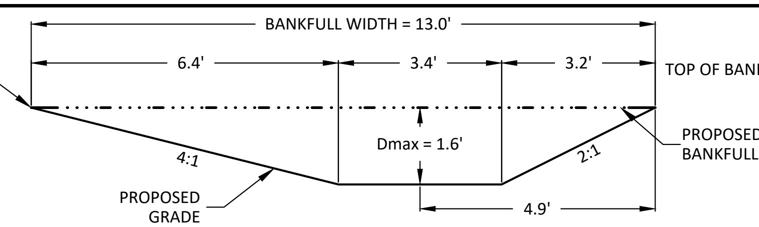
SCALE: 1" = 2'



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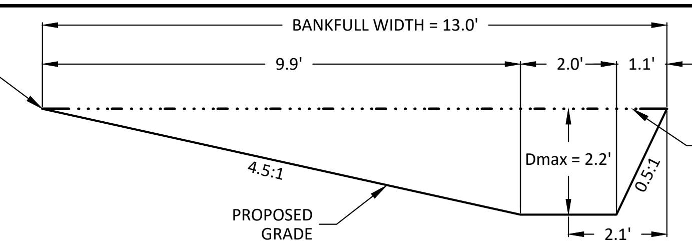
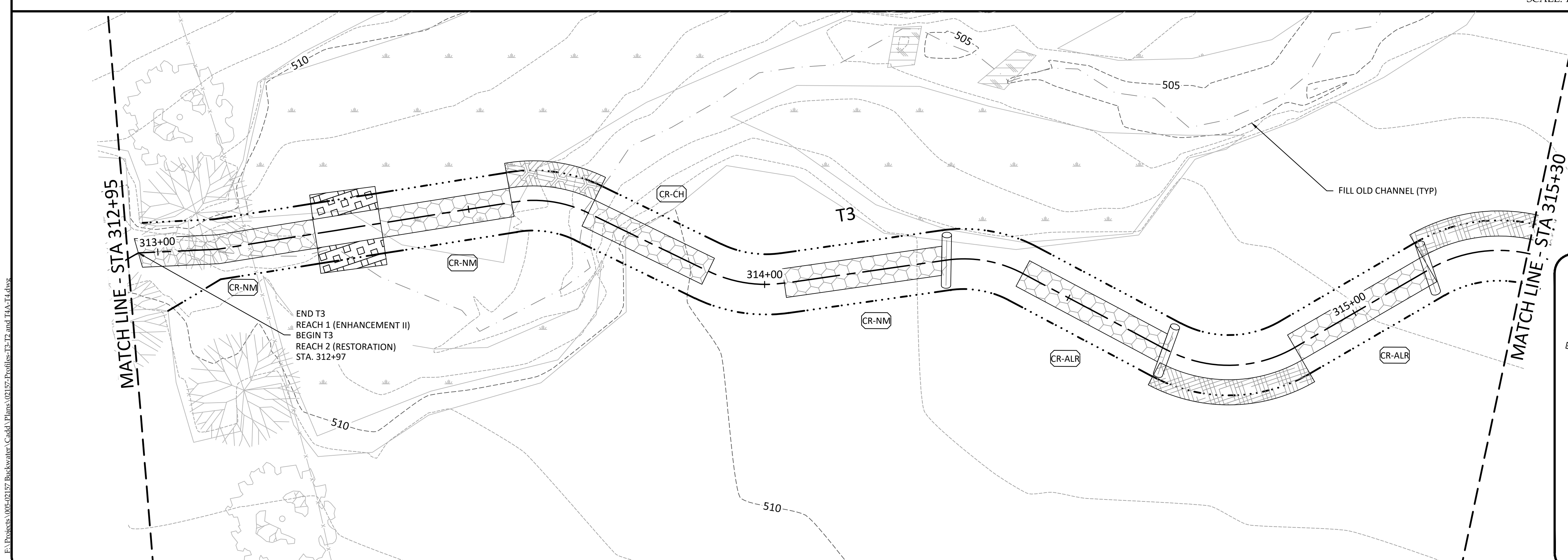


T3 REACH 2 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 312+97 TO 322+41
SCALE: 1" = 2'



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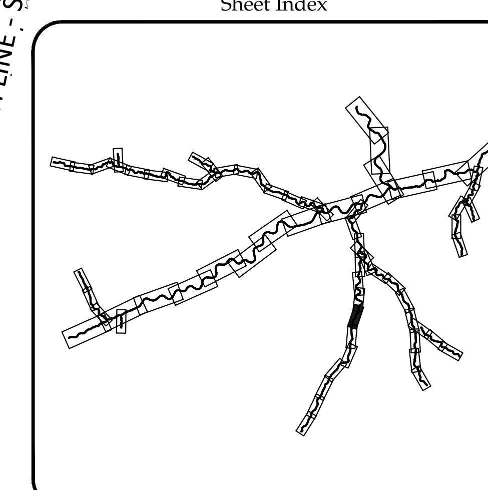

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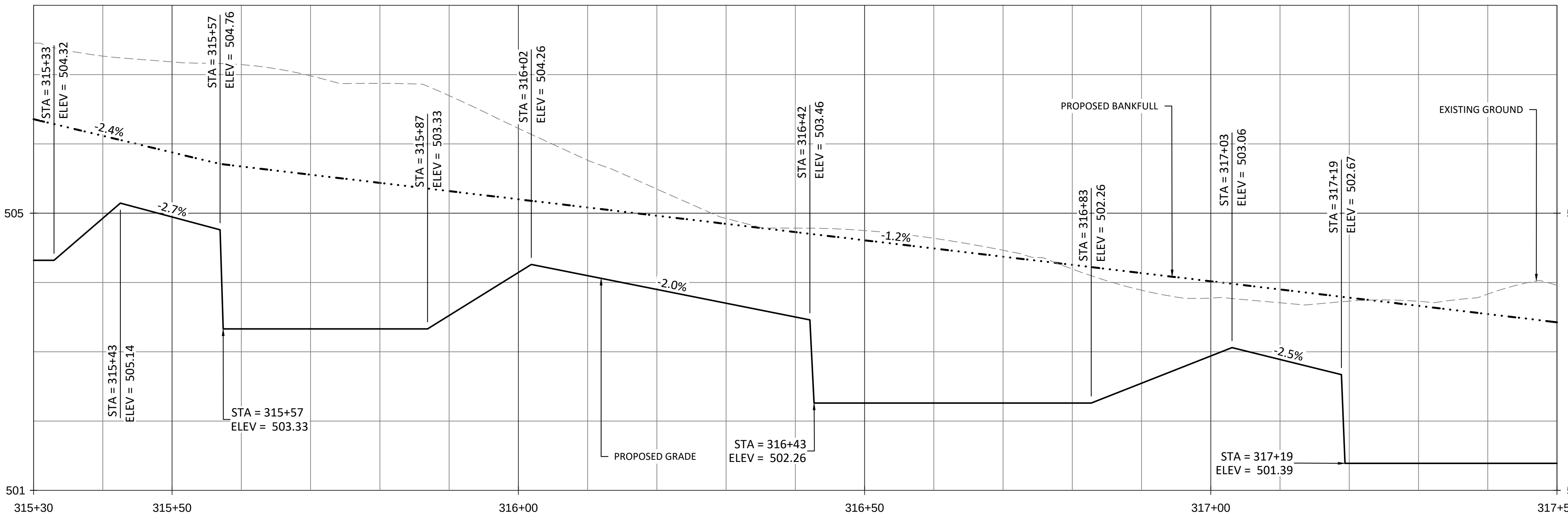

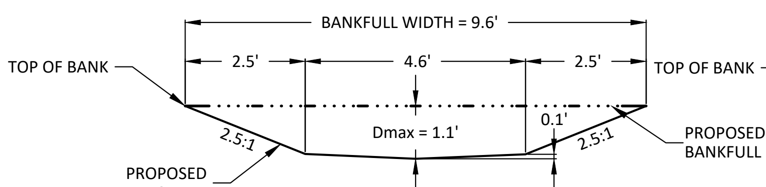

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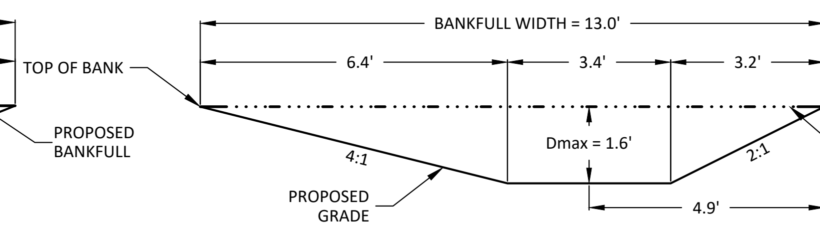

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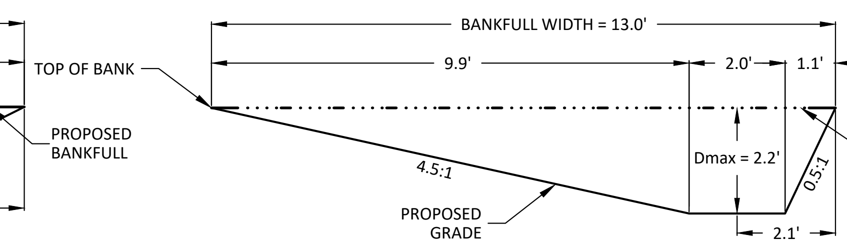

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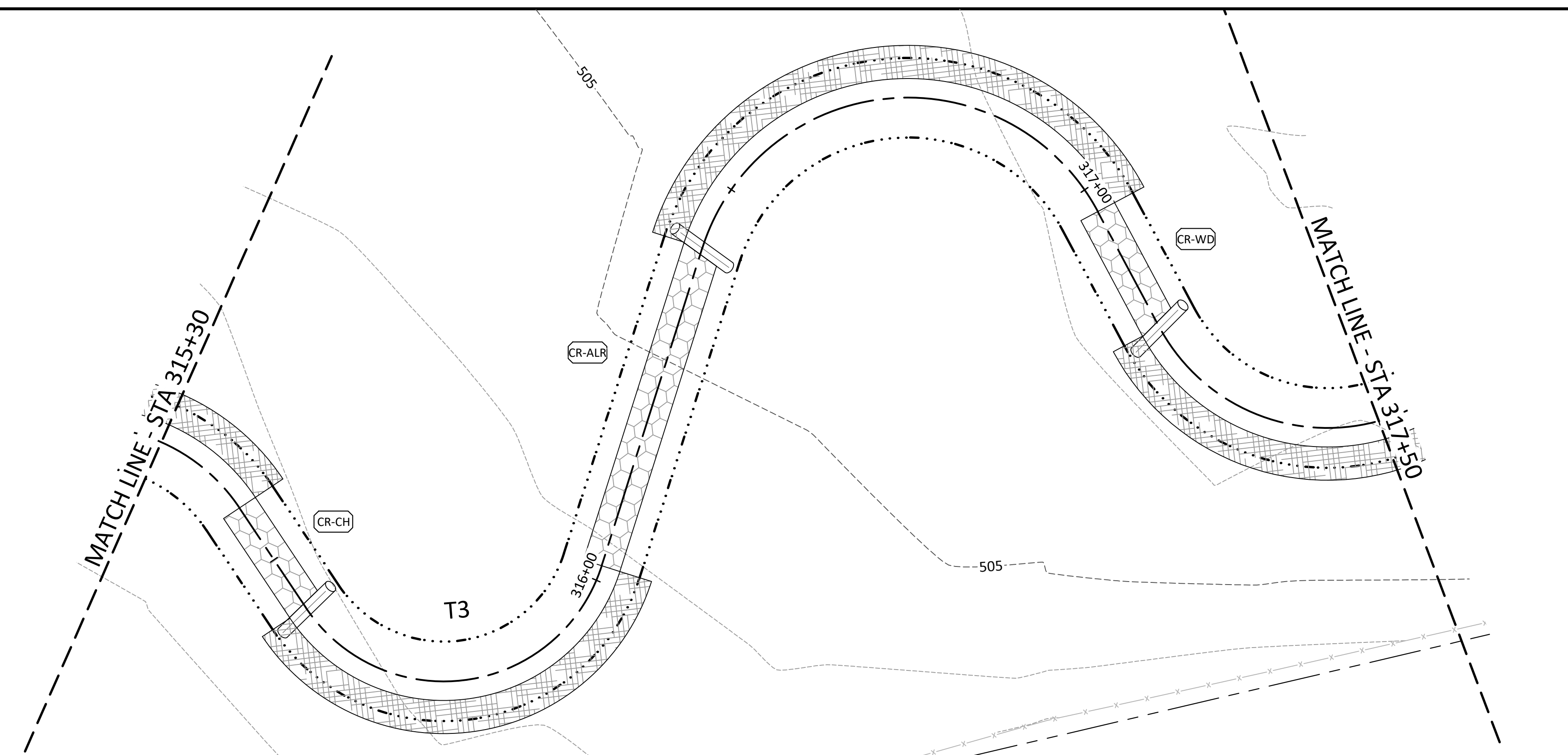
SCALE: 1" = 2'



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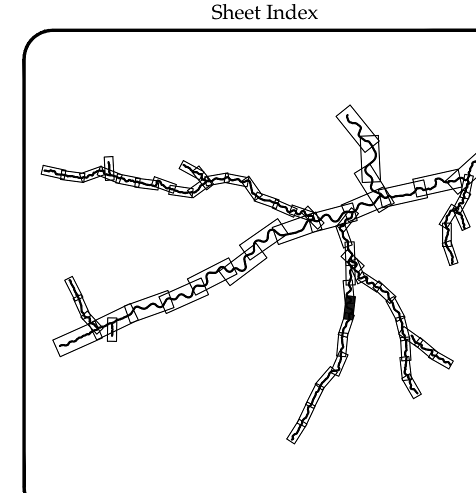

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T3 Reach 2
Stream Plan and Profile

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Drawn By: CLM
Checked By: JWH

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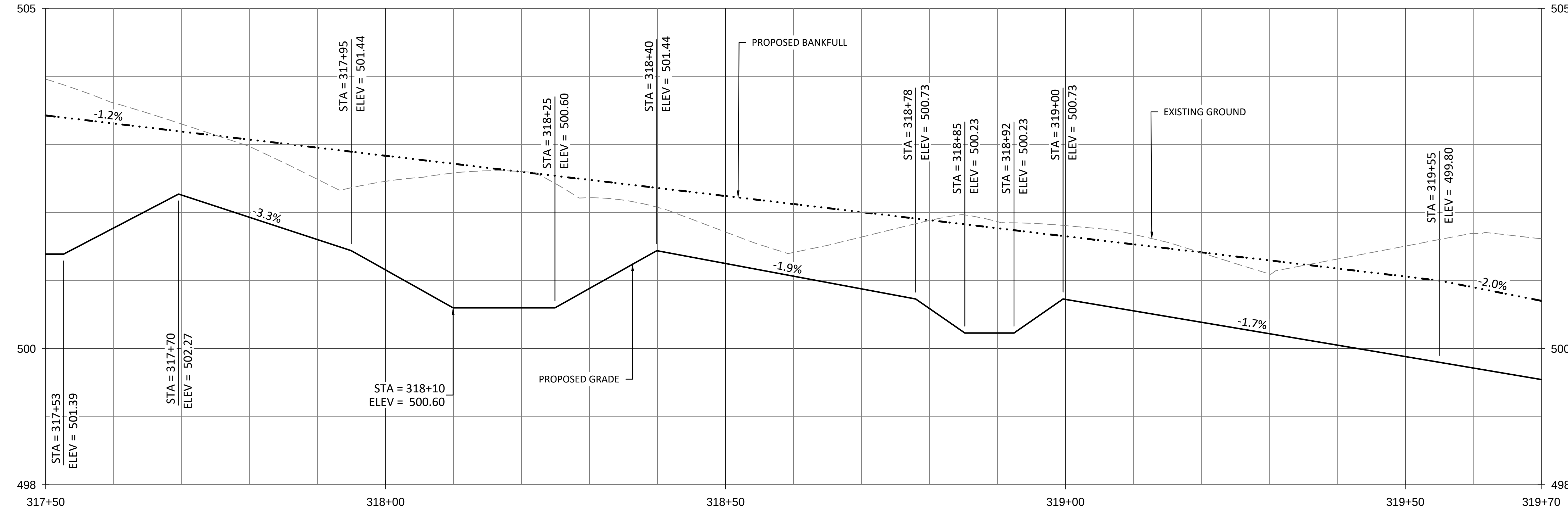

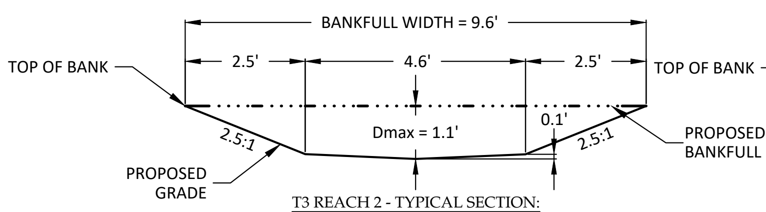

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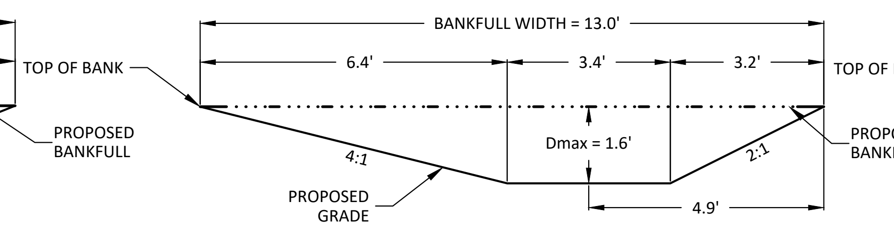
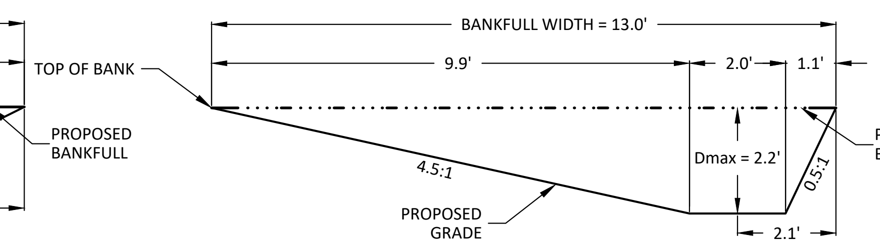
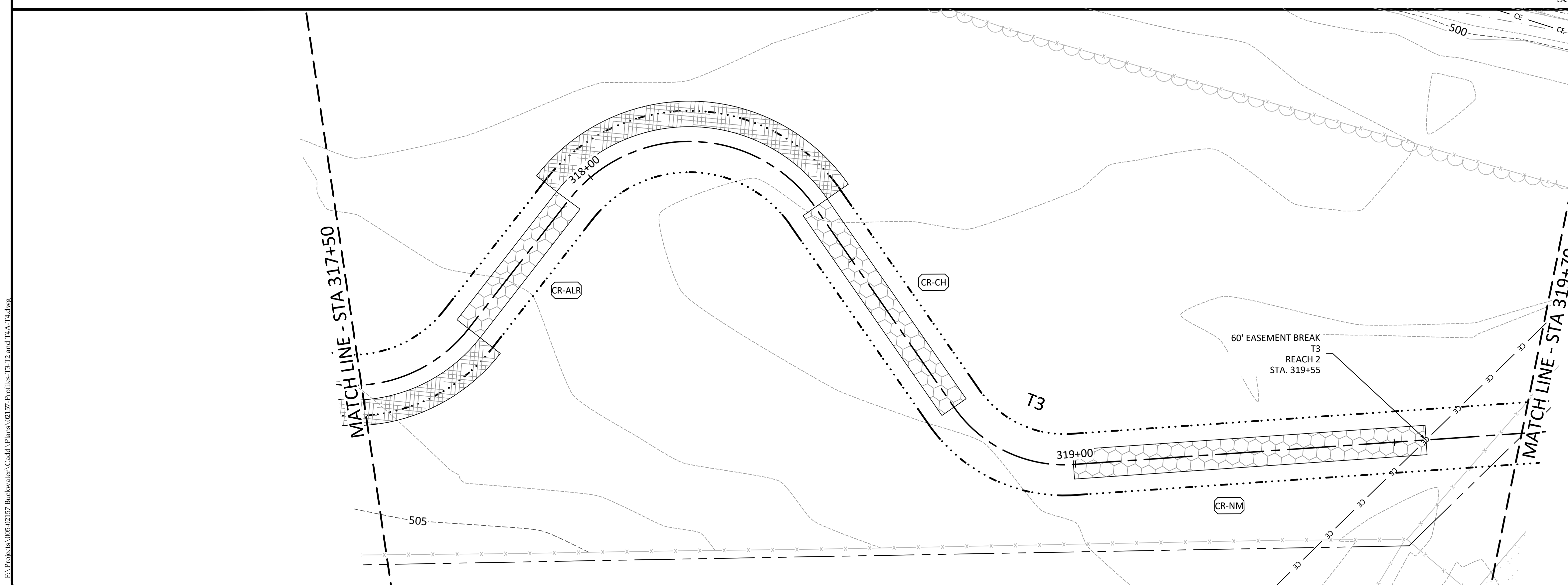
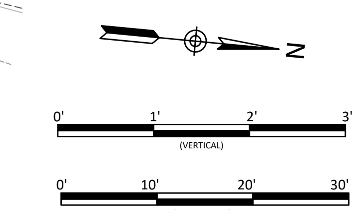


T3 REACH 2 - TYPICAL SECTION: SHALLOW POOL
STA: 312+97 TO 322+41
SCALE: 1" = 2'



T3 REACH 2 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 312+97 TO 322+41
SCALE: 1" = 2'





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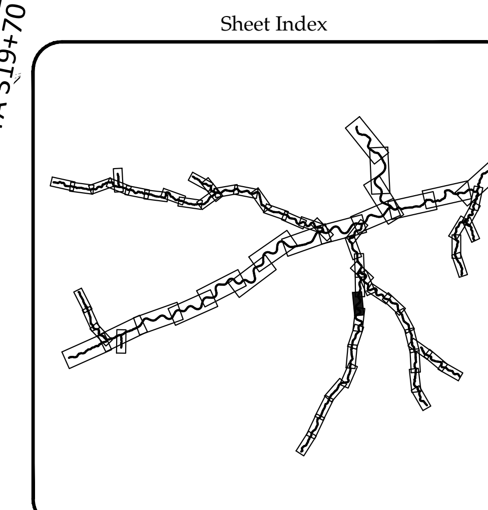

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Orange County, North Carolina

T3 Reach 2
Stream Plan and Profile

Revisions:

Date:	05.26.2017
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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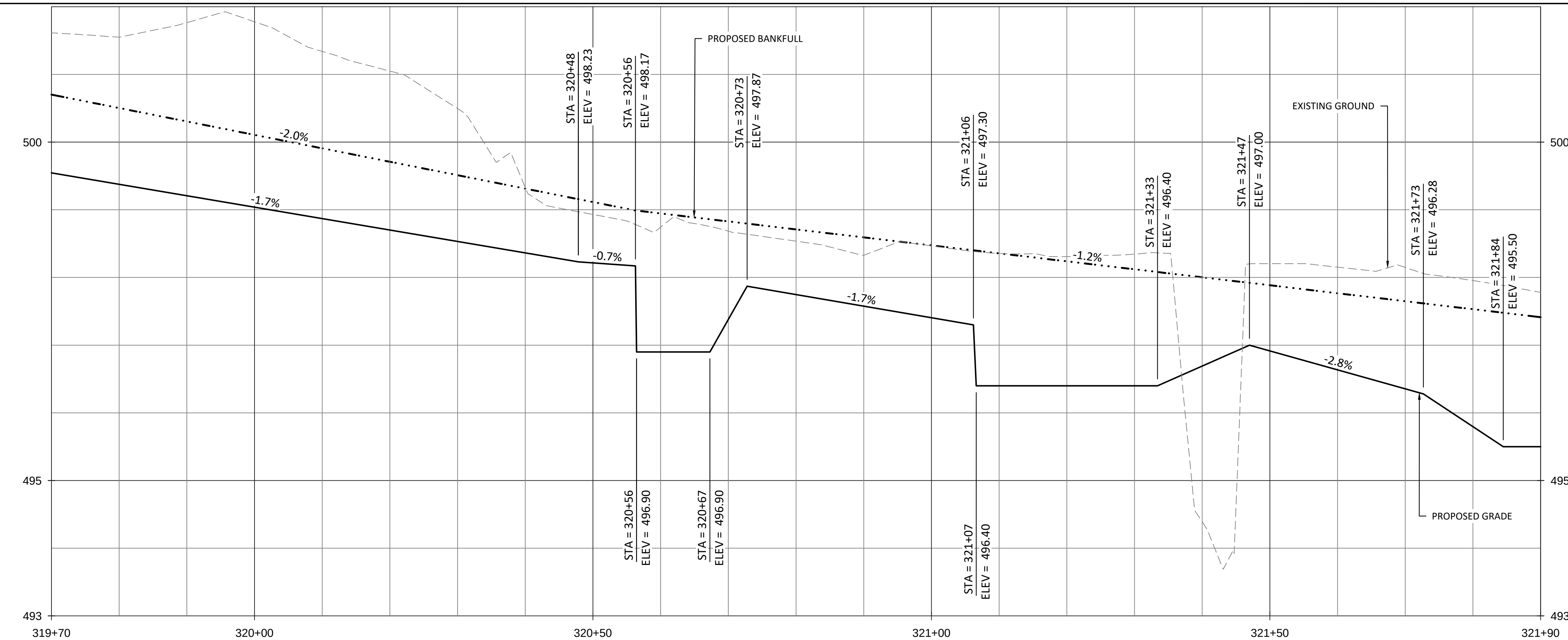
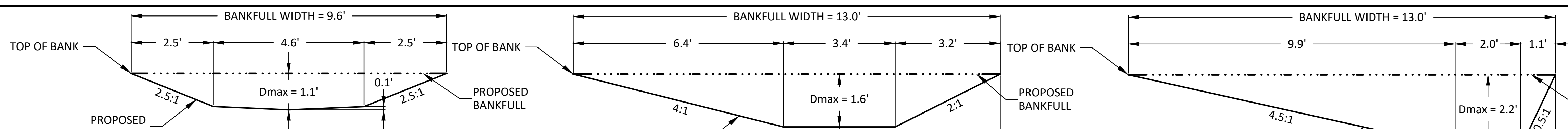
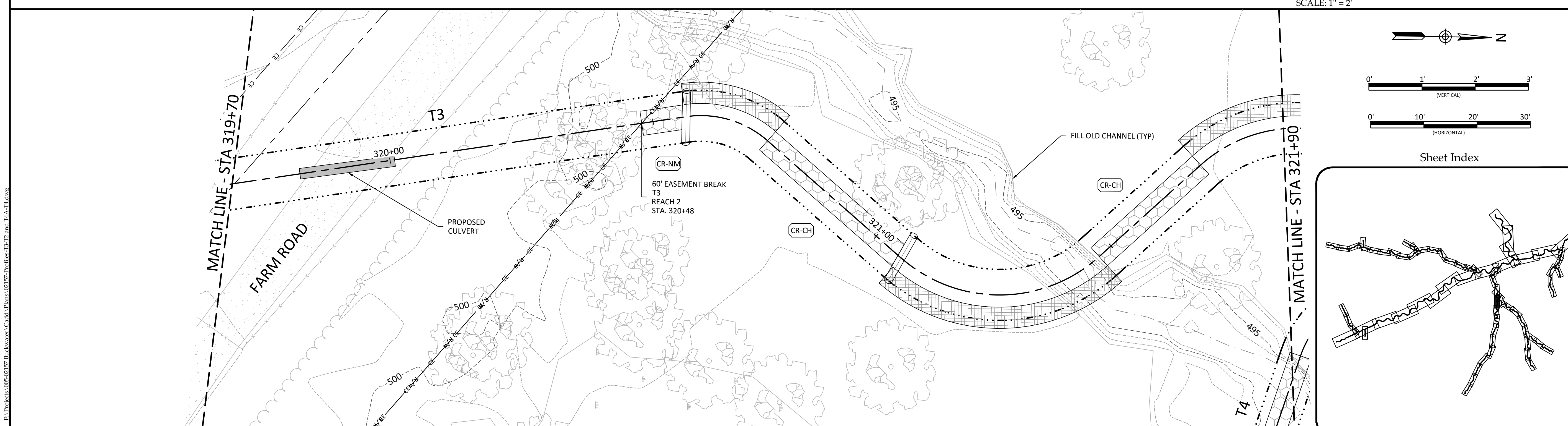




T3 REACH 2 - TYPICAL SECTION: RIFFLE
STA: 312+97 TO 322+41
SCALE: 1" = 2'

T3 REACH 2 - TYPICAL SECTION: SHALLOW POOL
STA: 312+97 TO 322+41
SCALE: 1" = 2'

T3 REACH 2 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 312+97 TO 322+41
SCALE: 1" = 2'



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T3 Reach 2
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Project Engineer:	NMM
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Checked By:	JWH

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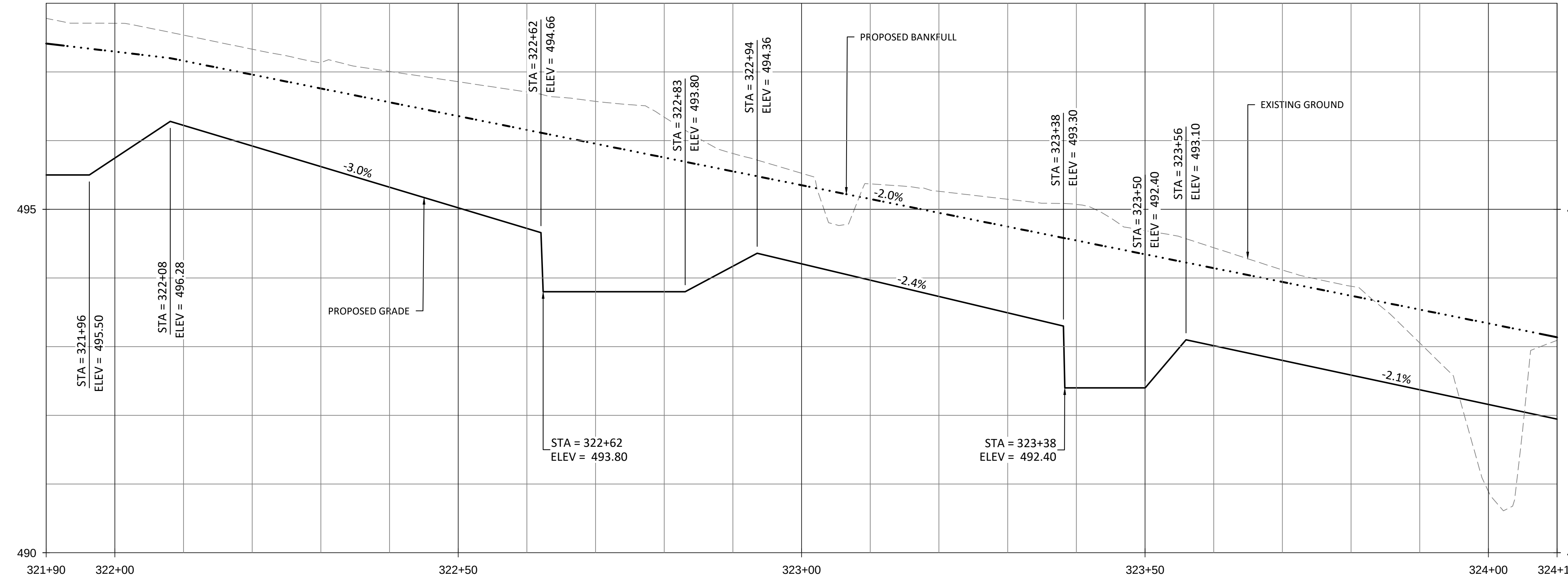
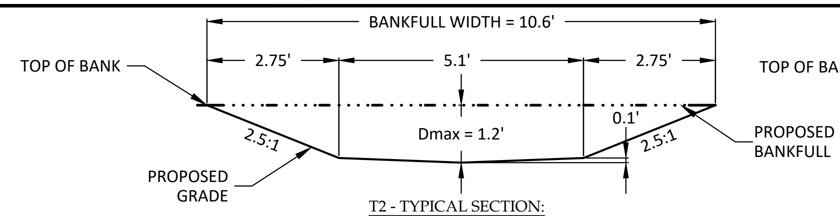
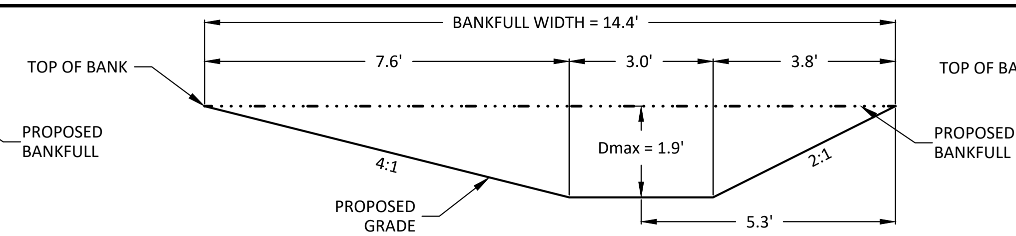




T2 - TYPICAL SECTION:
RIFFLE
STA: 322+41 TO 328+28
SCALE: 1" = 2'



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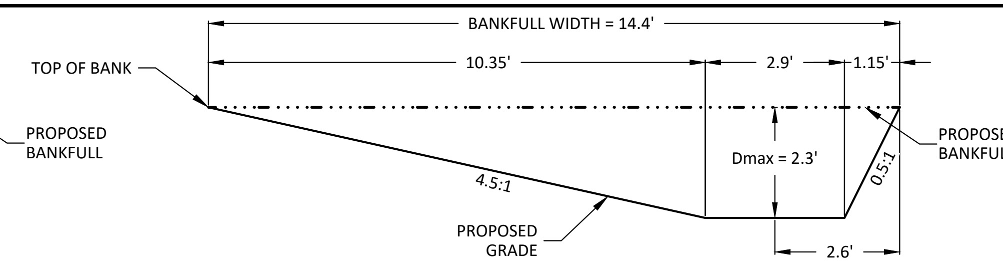
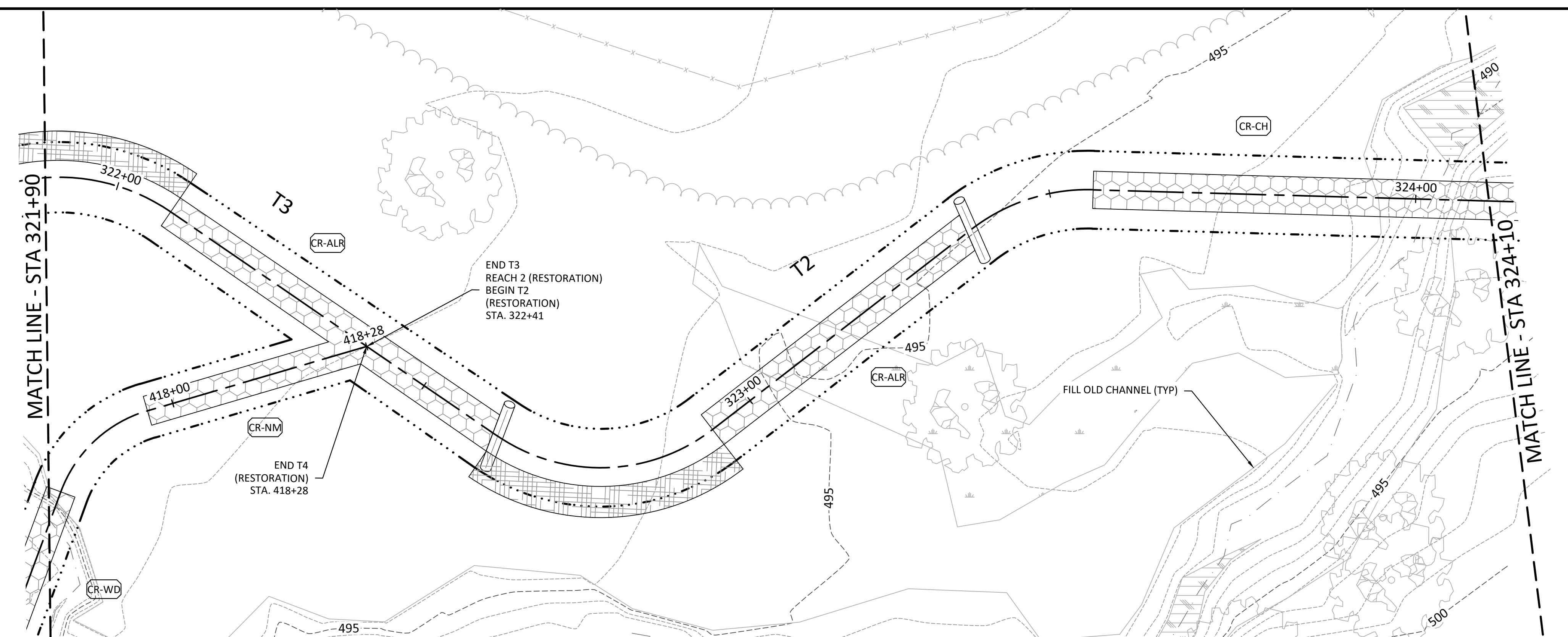
SHALLOW POOL
STA: 322+41 TO 328+28
SCALE: 1" = 2'



T2 - TYPICAL SECTION:
POOL WITH STRUCTURE
STA: 322+41 TO 328+28
SCALE: 1" = 2'



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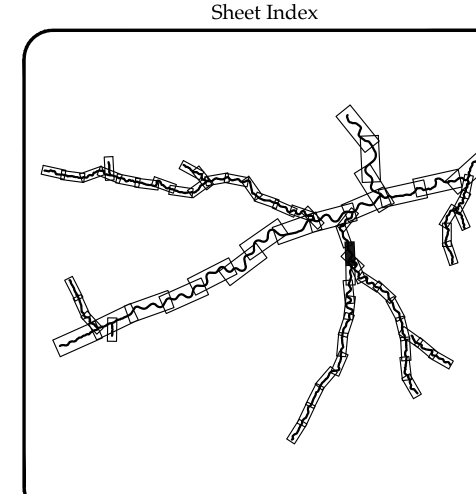

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T3 Reach 2 & T2
Stream Plan and Profile

Revisions:

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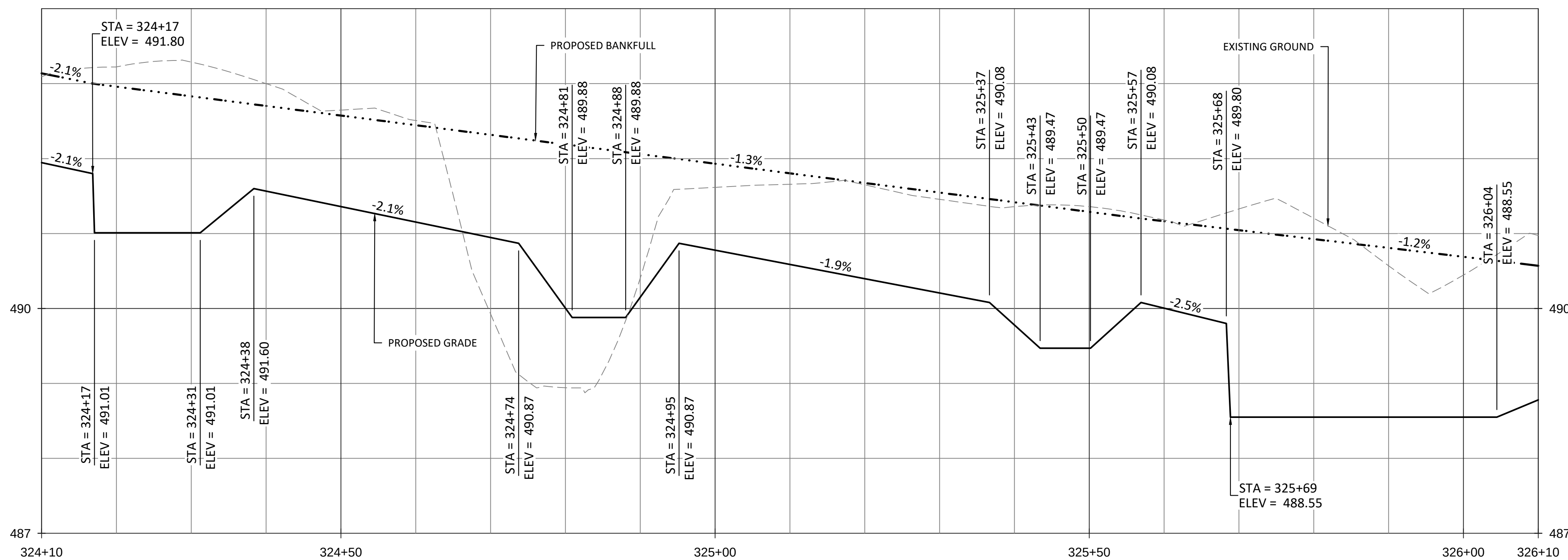

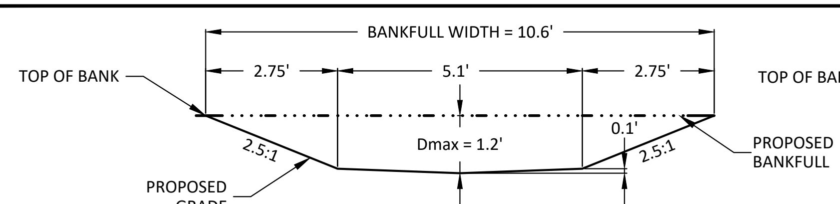

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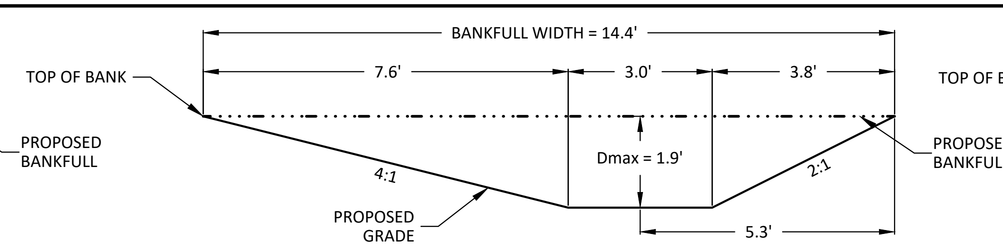

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STA: 322+41 TO 328+28
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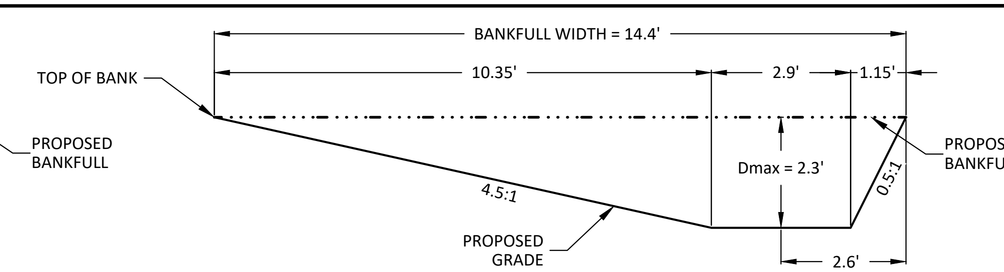
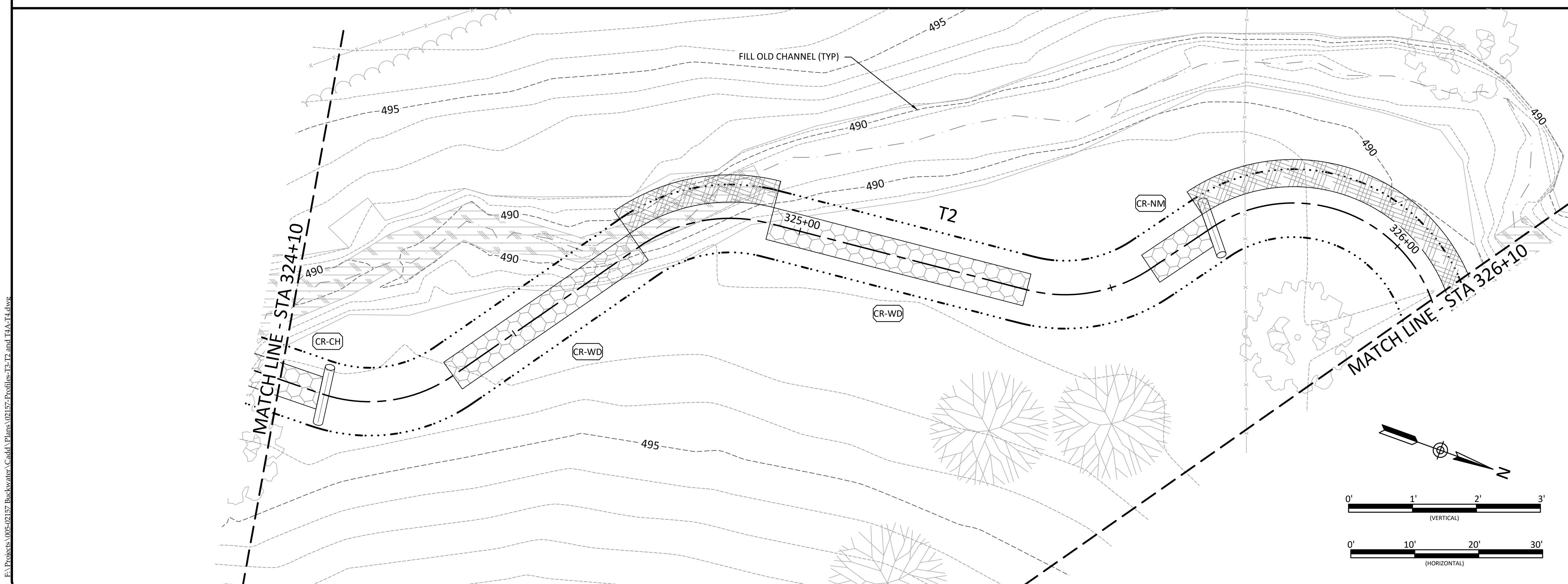


T2 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 322+41 TO 328+28
SCALE: 1" = 2'



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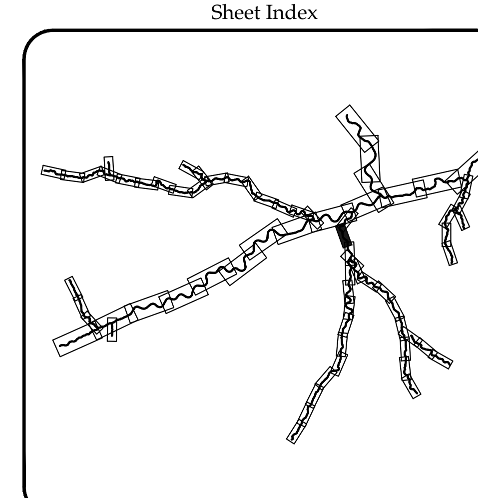

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T2
Stream Plan and Profile

Revisions:

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Drawn By:	CLM
Checked By:	JWH

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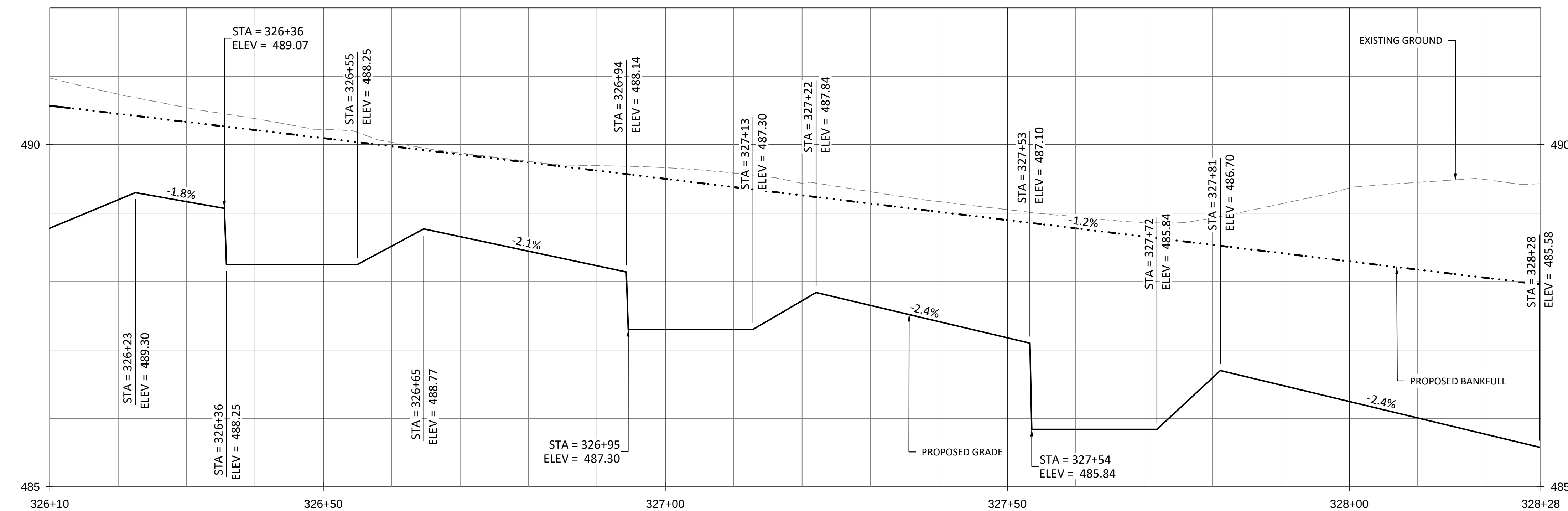

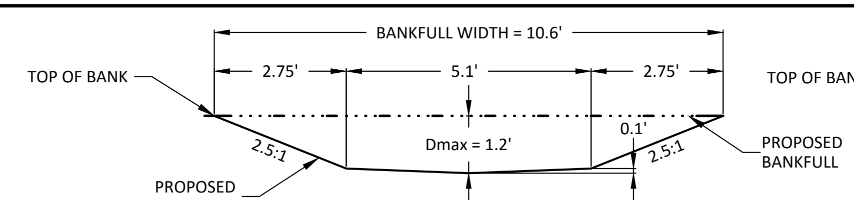

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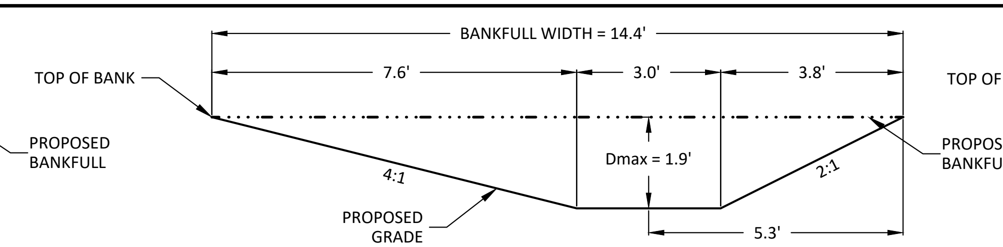
STA: 322+41 TO 328+28
SCALE: 1" = 2'



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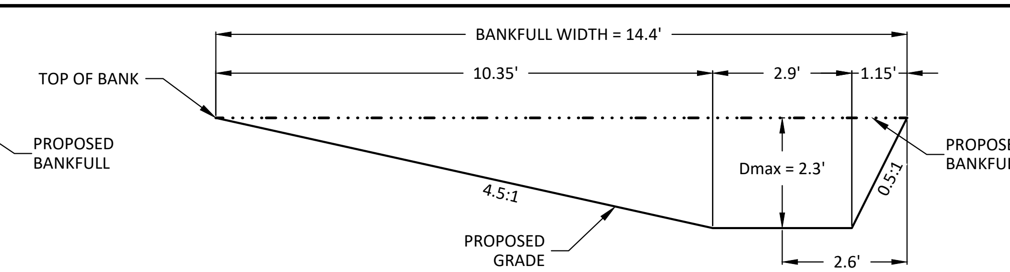
STA: 322+41 TO 328+28
SCALE: 1" = 2'



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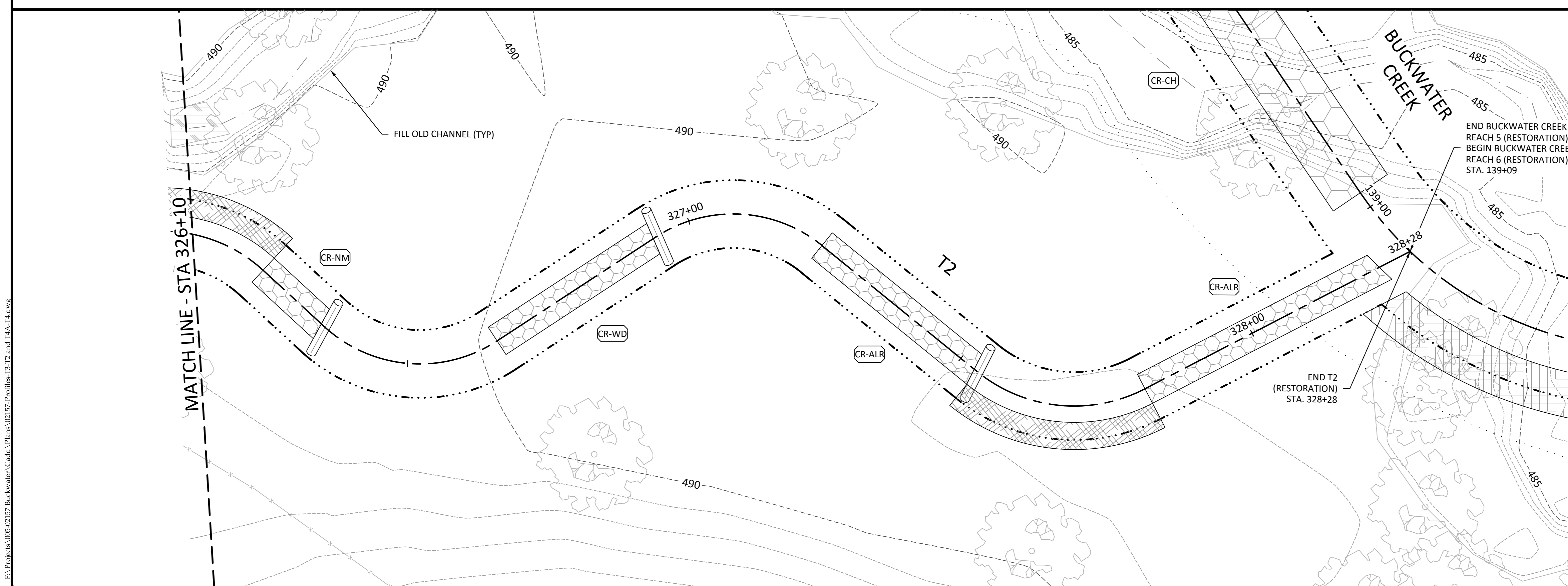
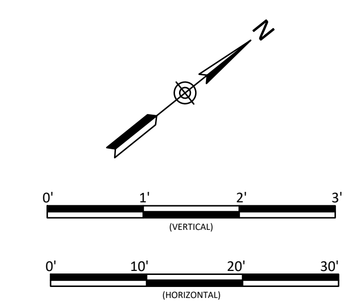
STA: 322+41 TO 328+28
SCALE: 1" = 2'





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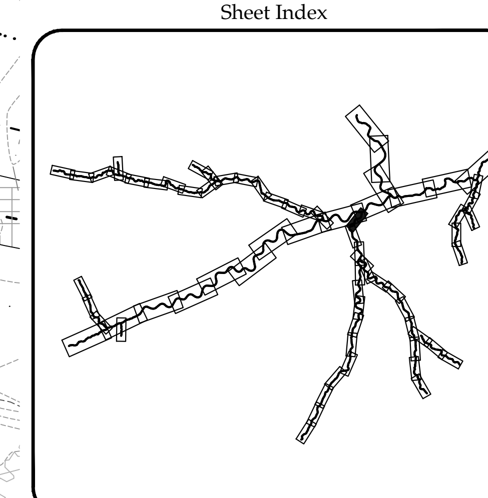

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Orange County, North Carolina

T2
Stream Plan and Profile

Revisions:

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Checked By:	JWH

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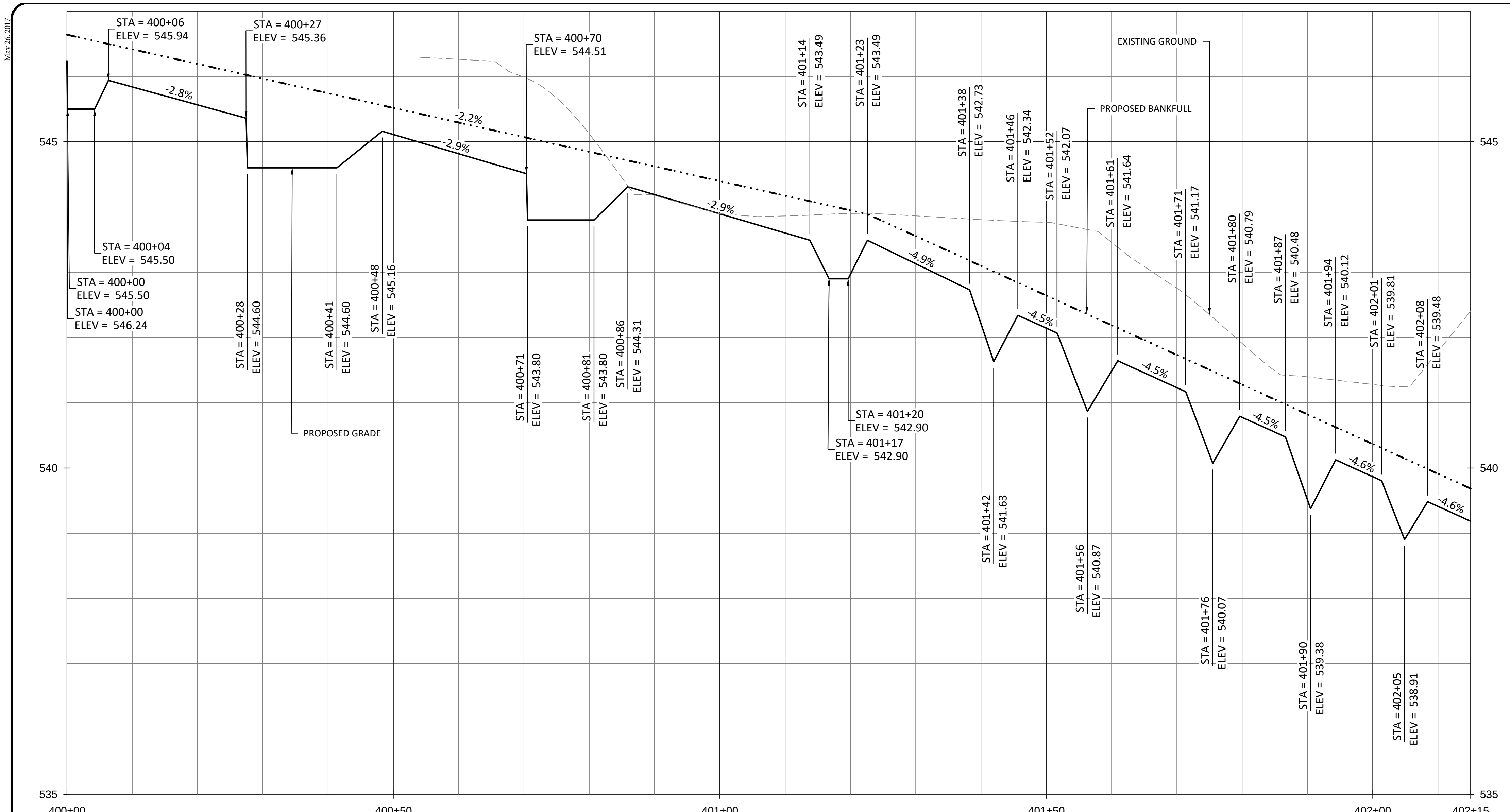

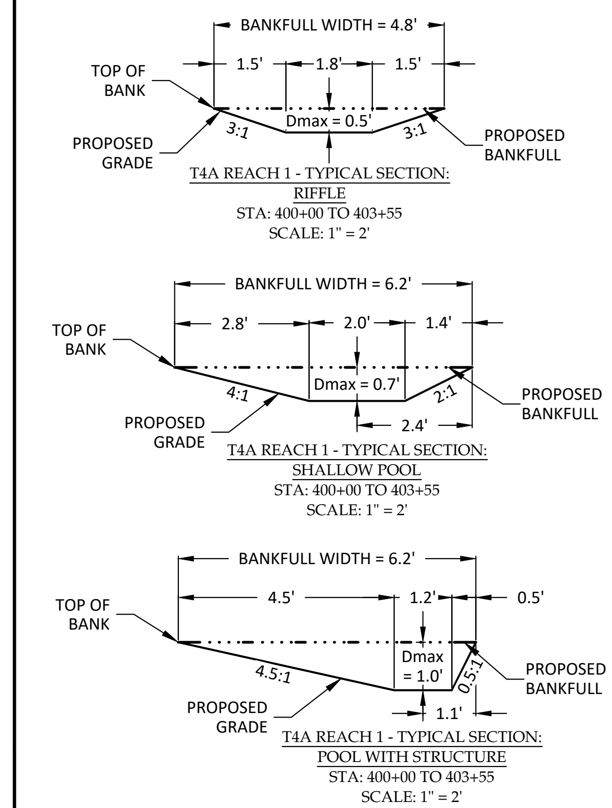

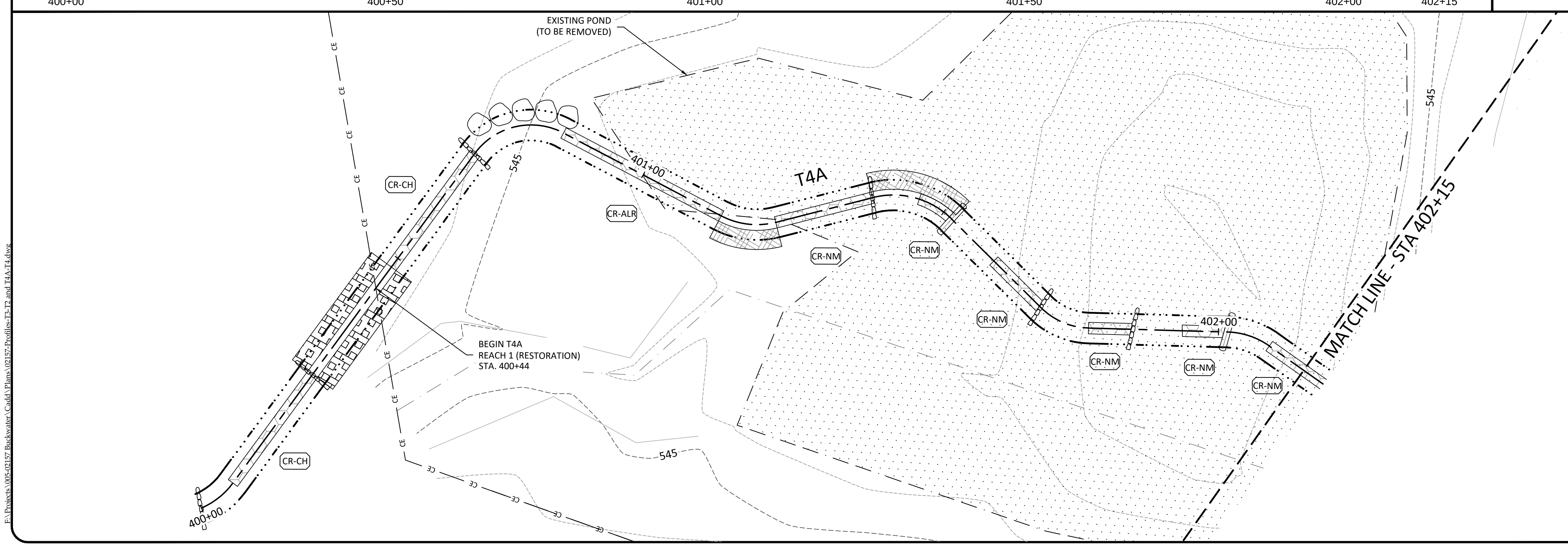

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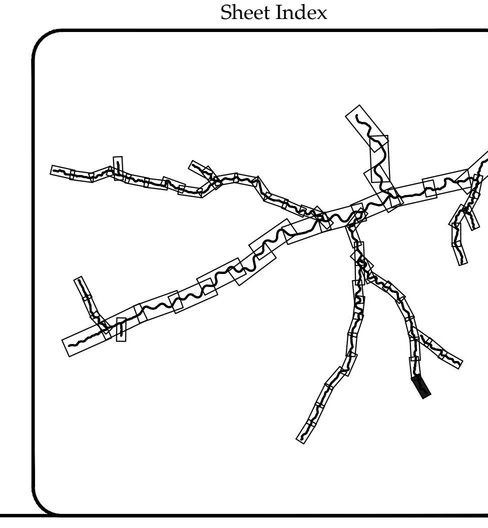

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T4A Reach 1
Stream Plan and Profile

Revisions:

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Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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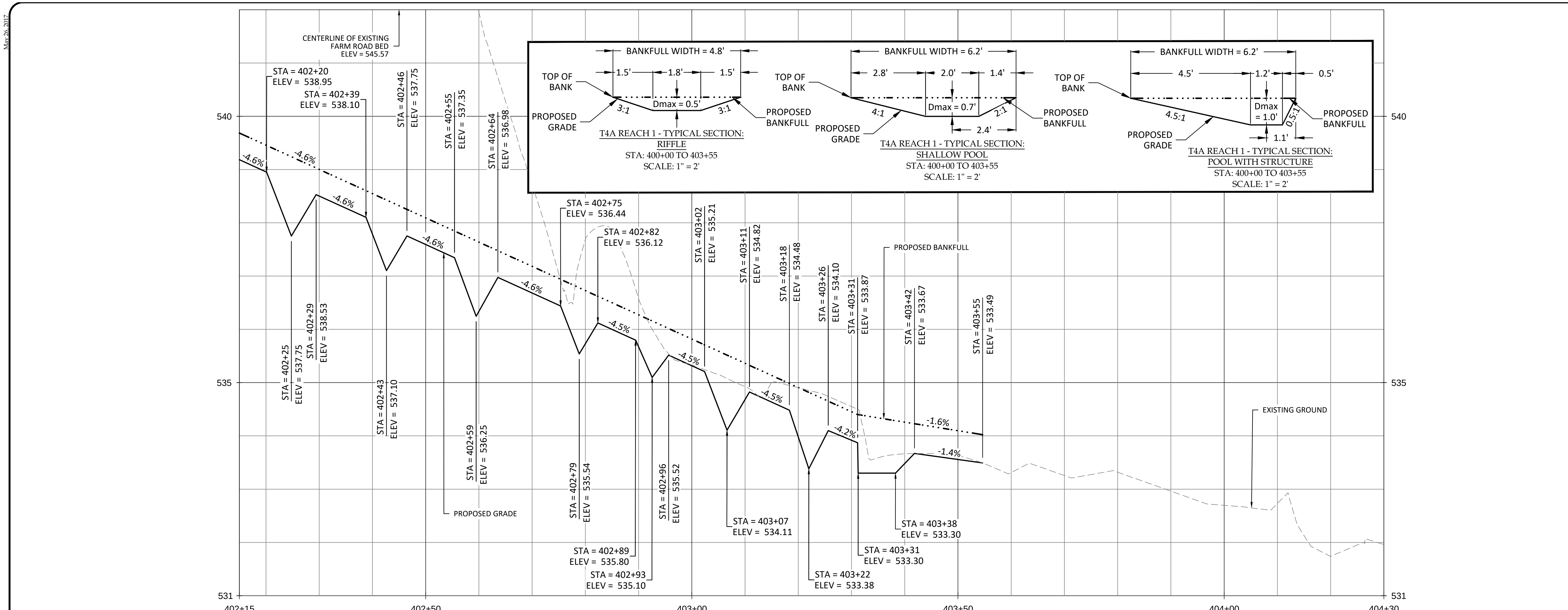

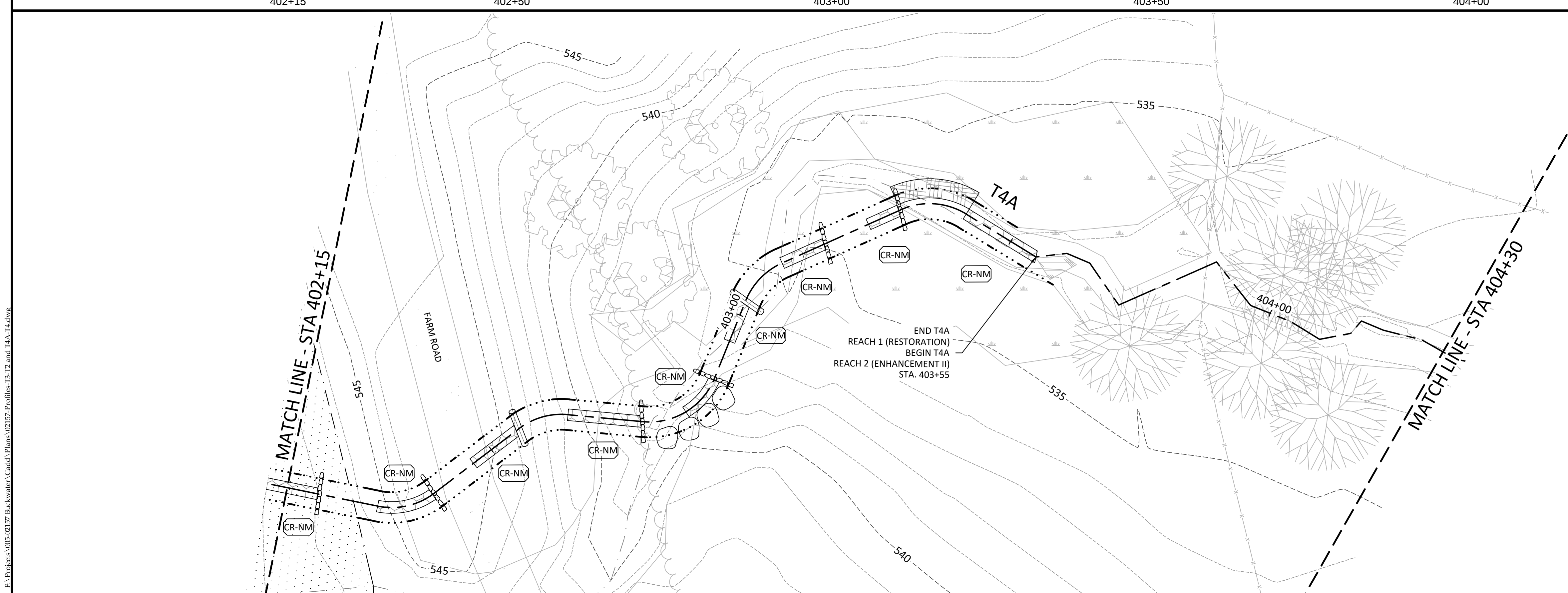

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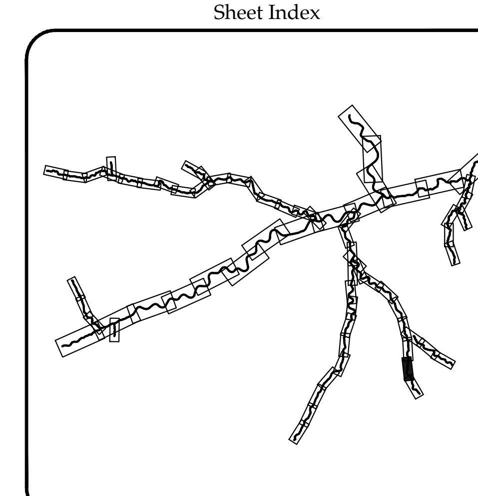

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Orange County, North Carolina

T4A Reaches 1 & 2
Stream Plan and Profile

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Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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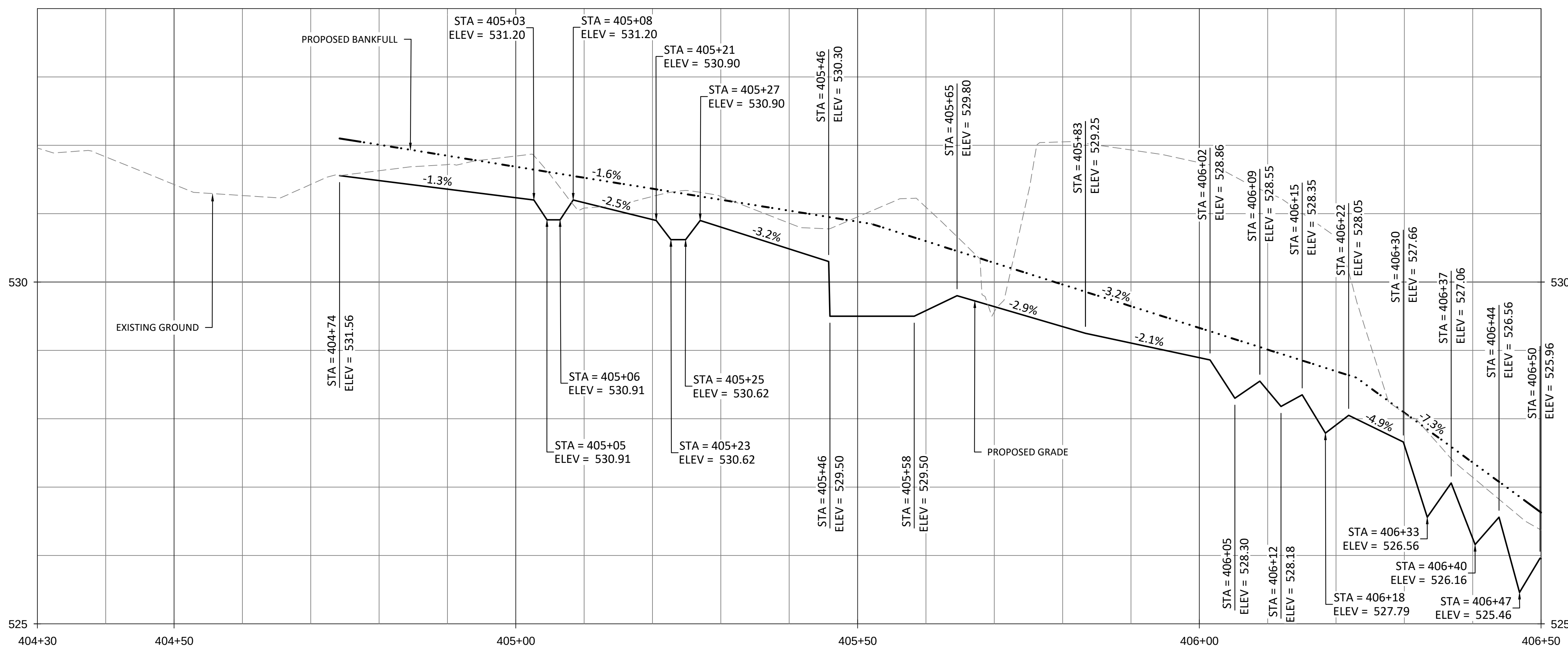

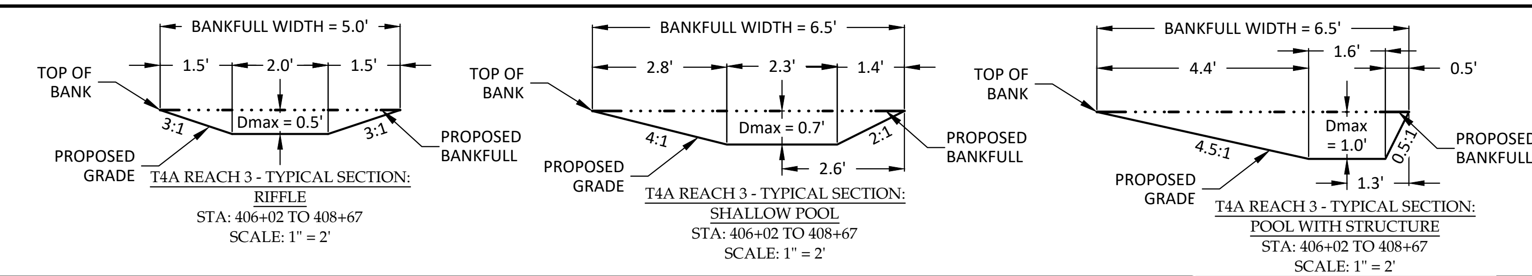

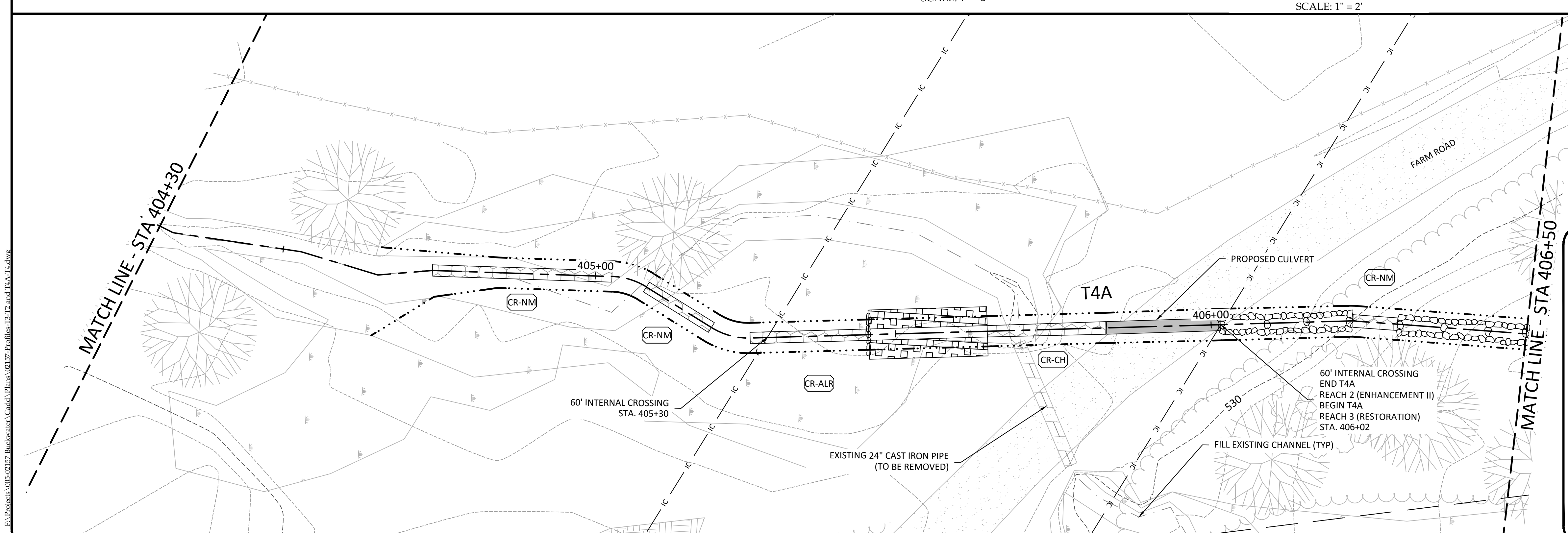

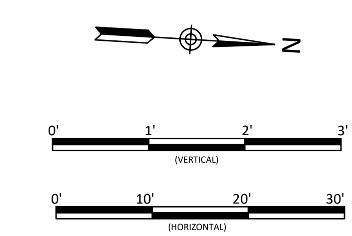

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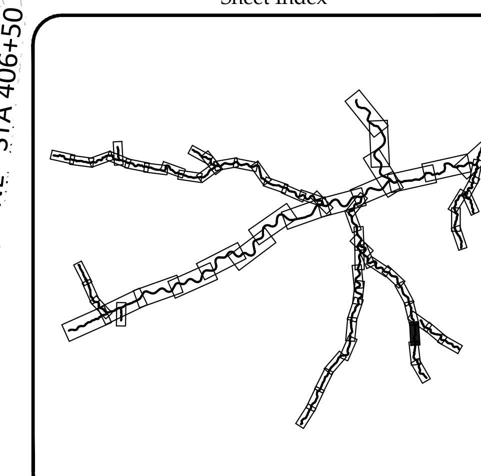

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Orange County, North Carolina

T4A Reaches 2 & 3
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Drawn By:	CLM
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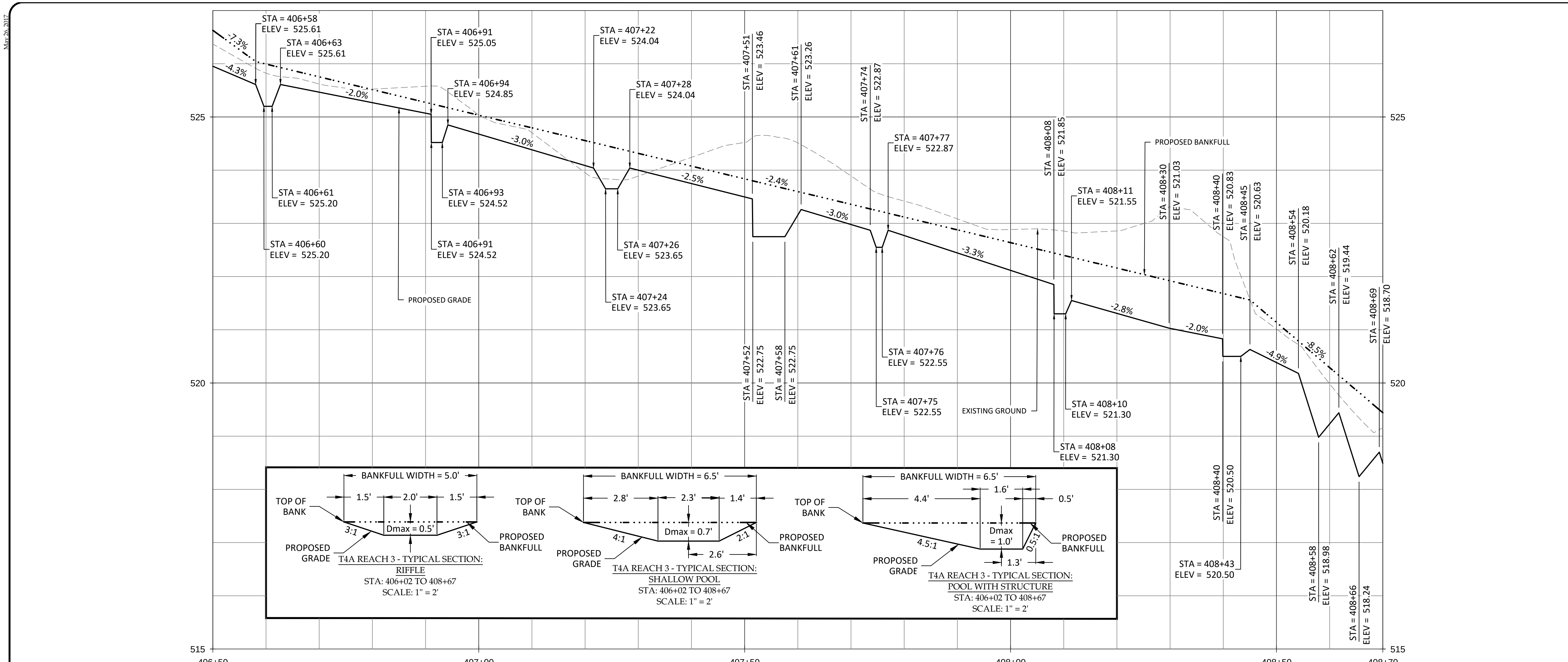

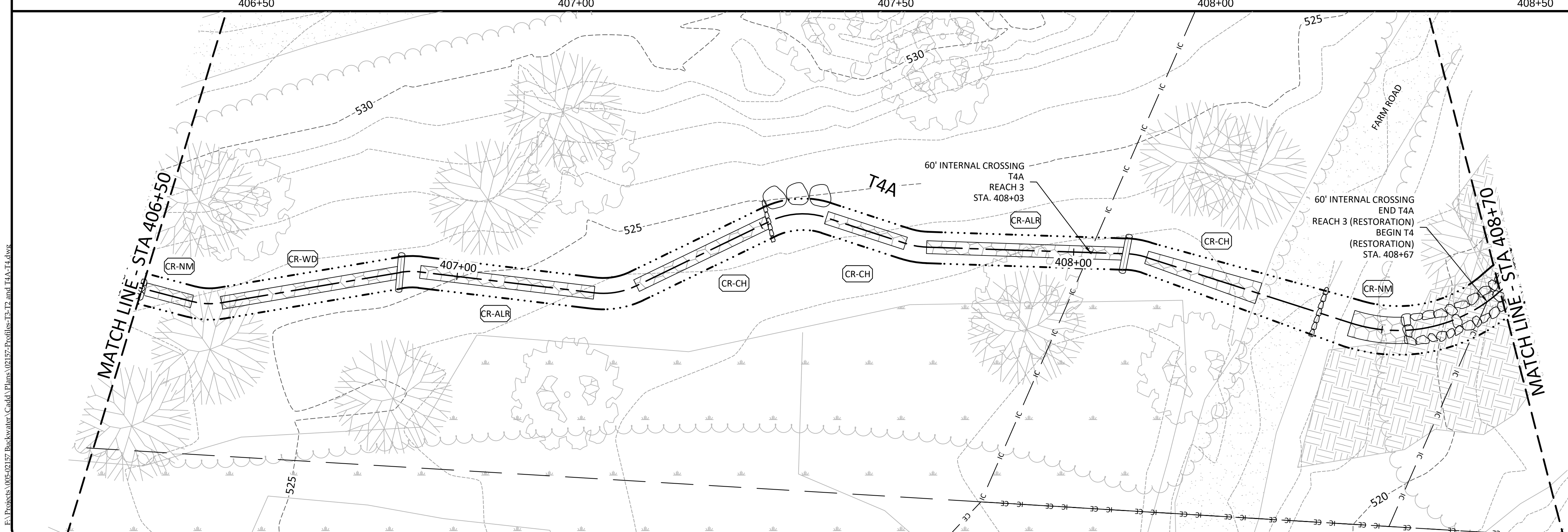

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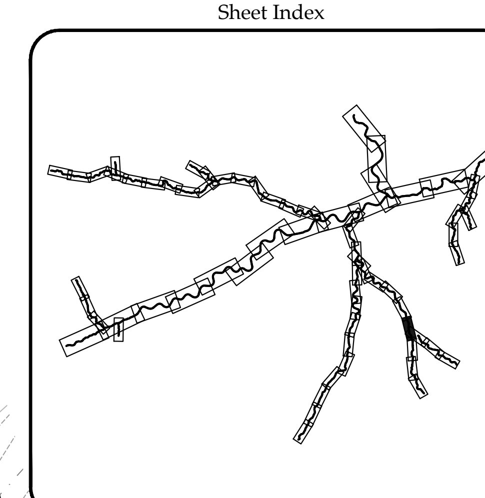

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T4A Reach 3 & T4
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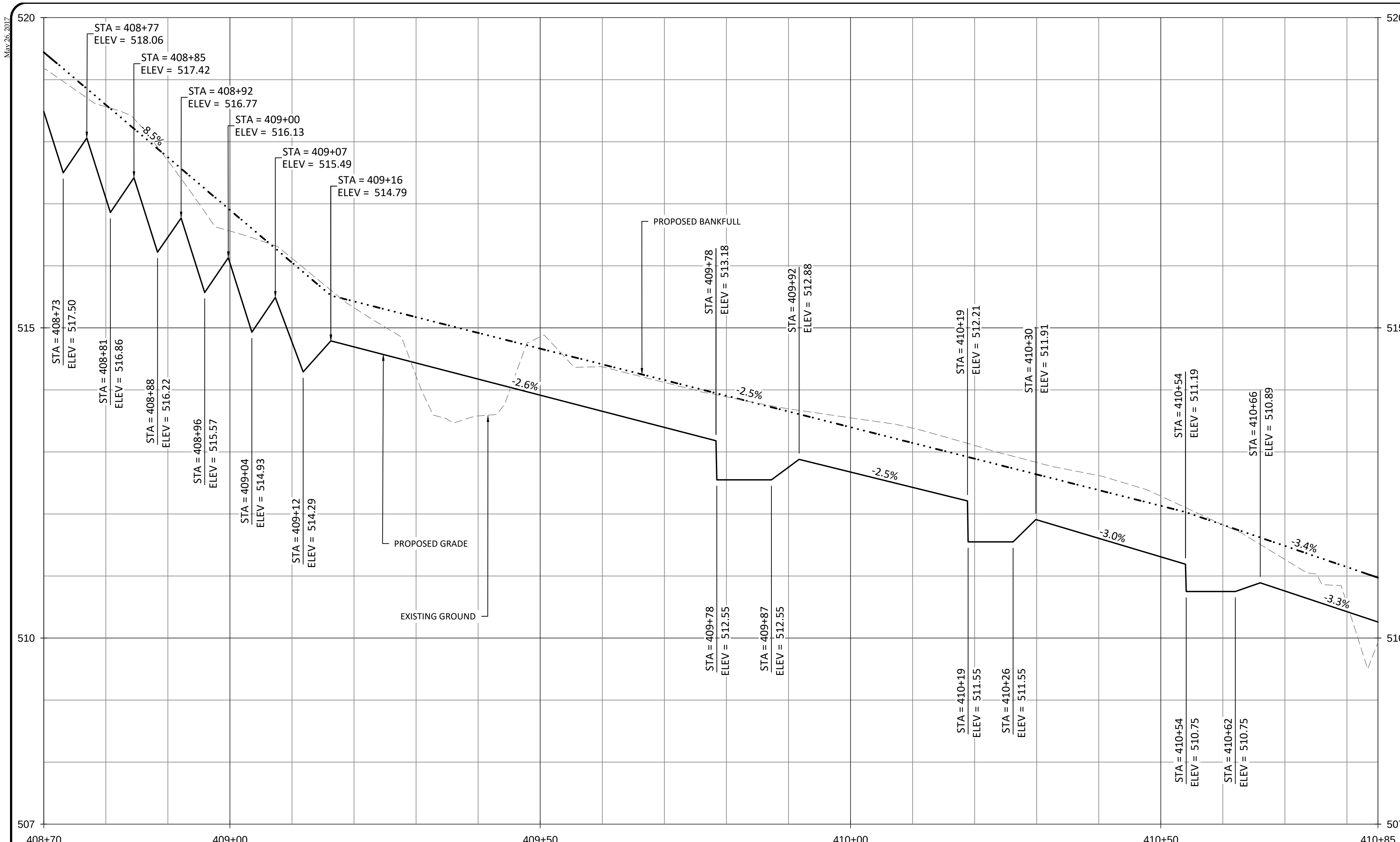
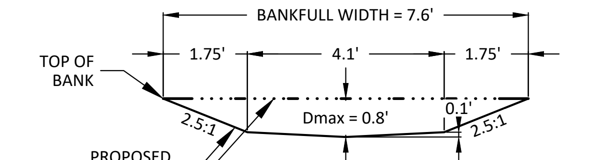
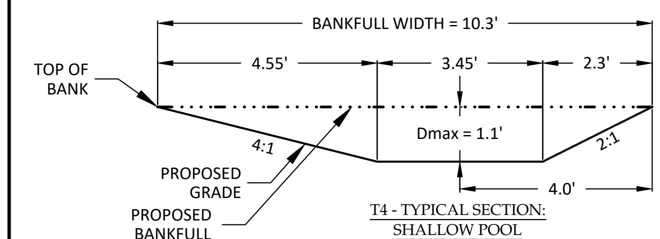




T4 - TYPICAL SECTION: RIFFLE
STA: 408+67 TO 418+28
SCALE: 1" = 2'



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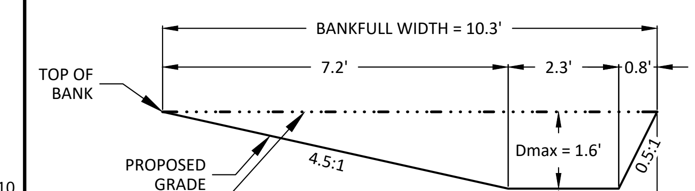
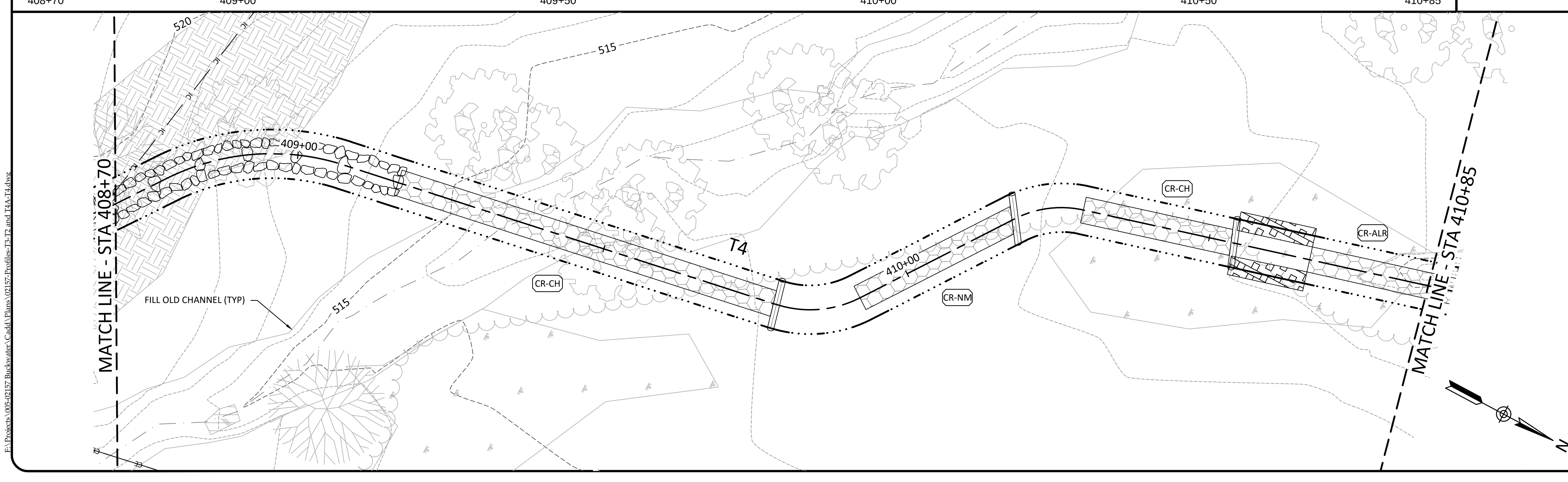


T4 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 408+67 TO 418+28
SCALE: 1" = 2'



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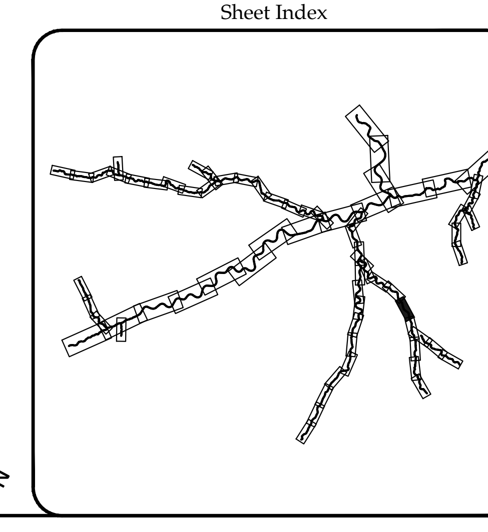

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T4
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Checked By:	JWH

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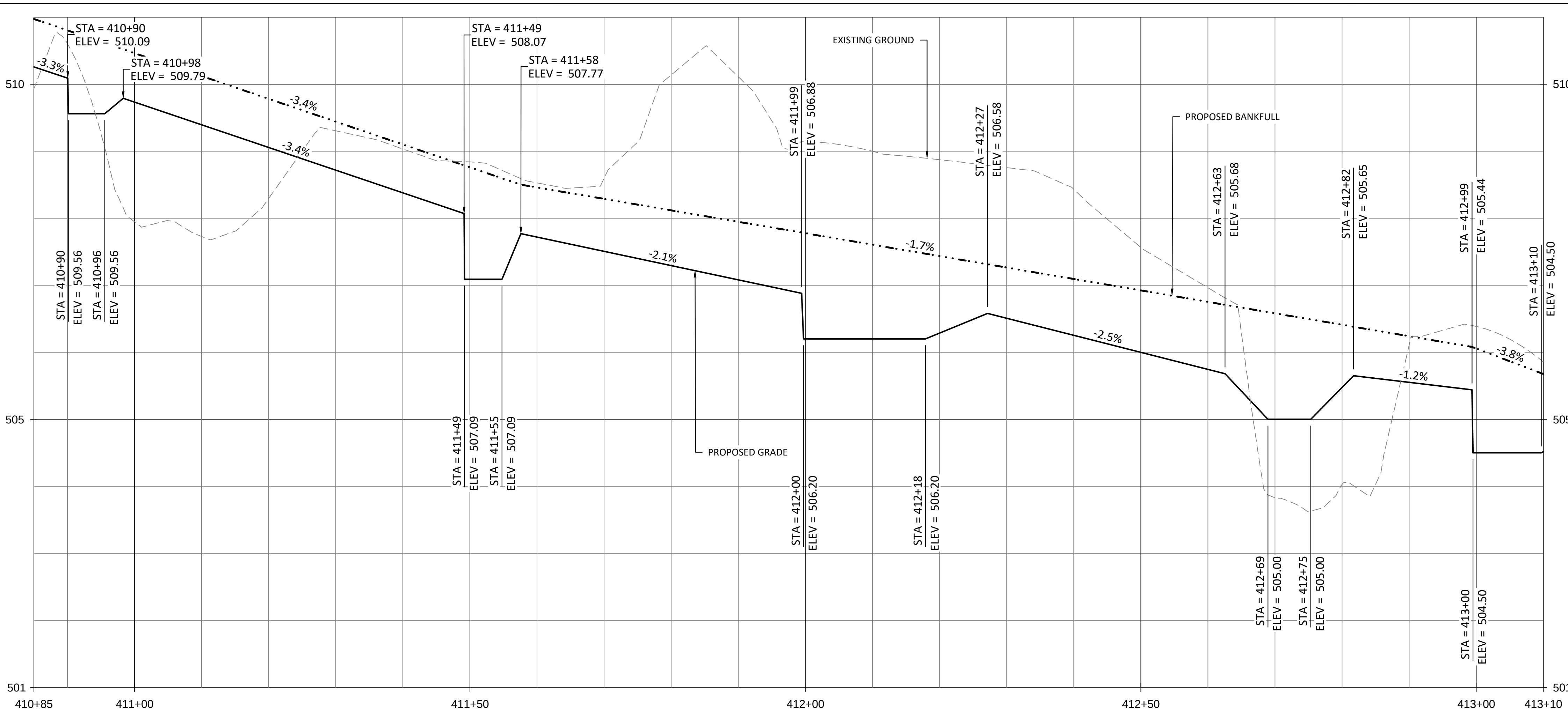

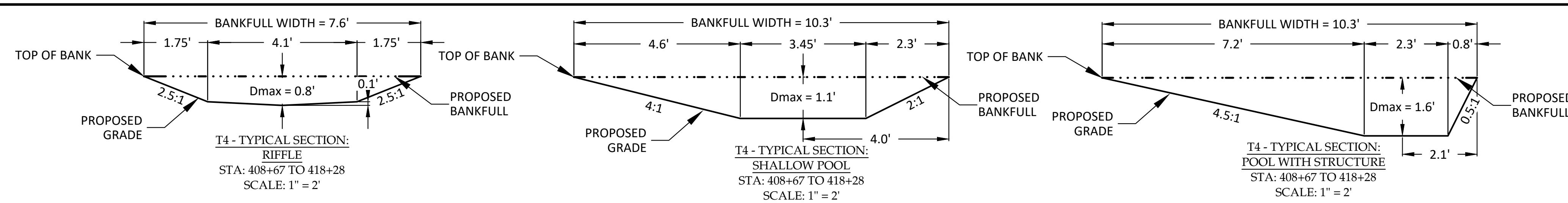

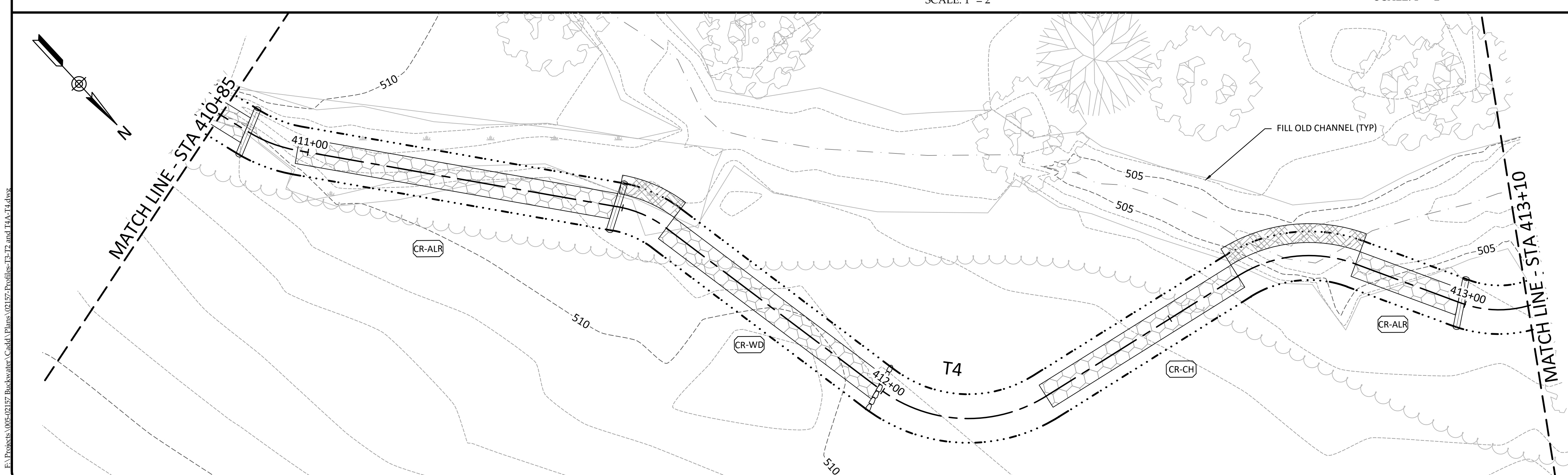

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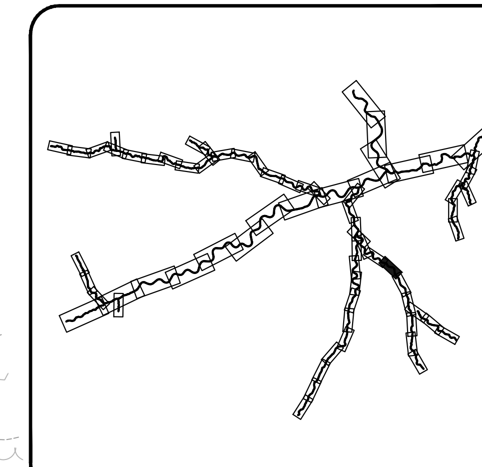

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Checked By:	JWH

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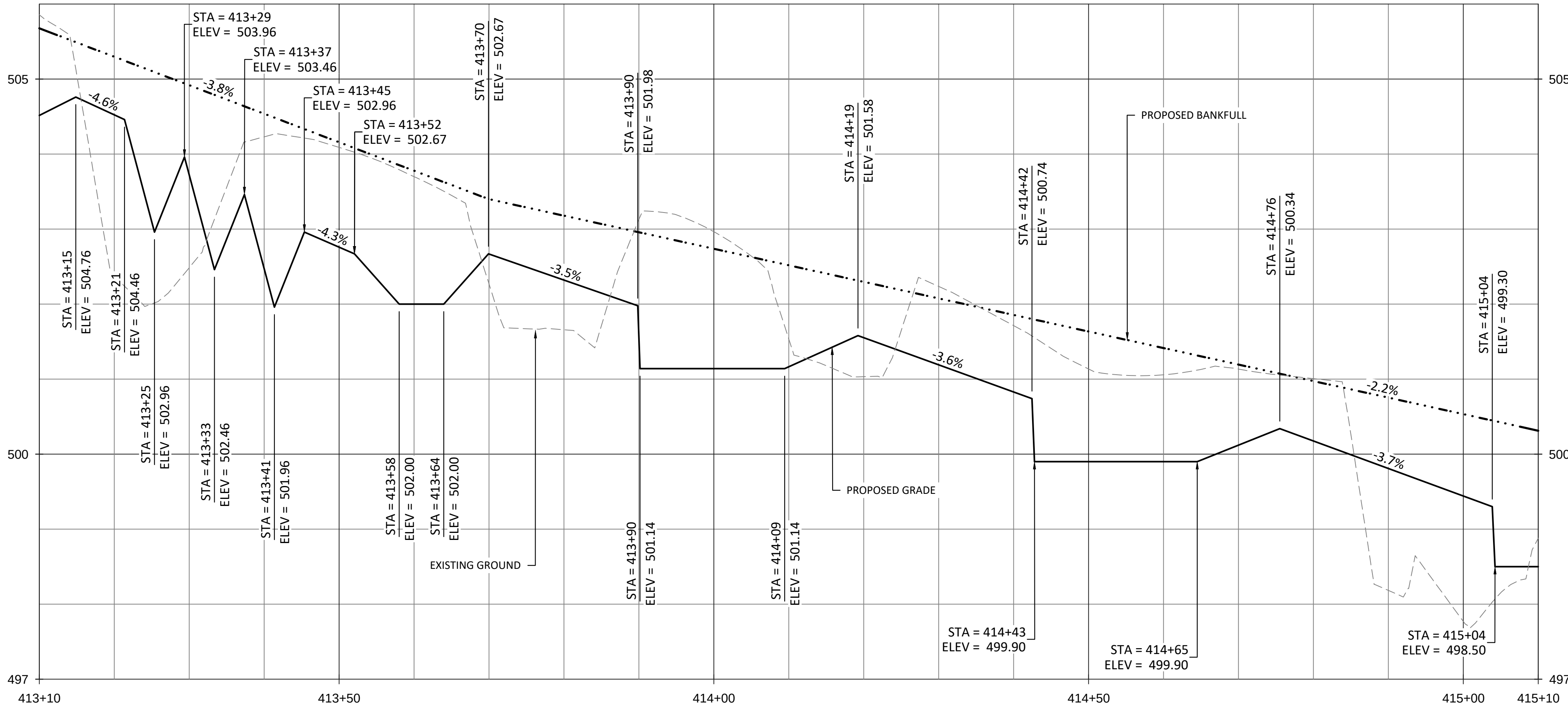

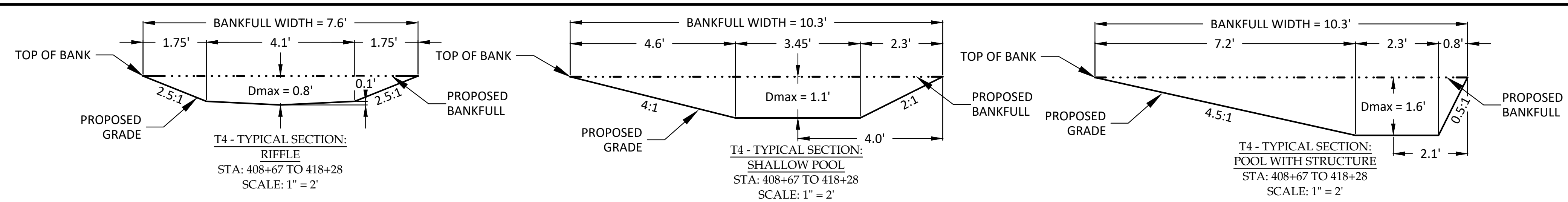

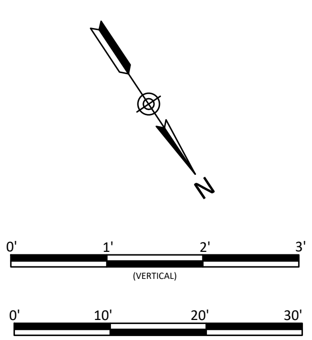

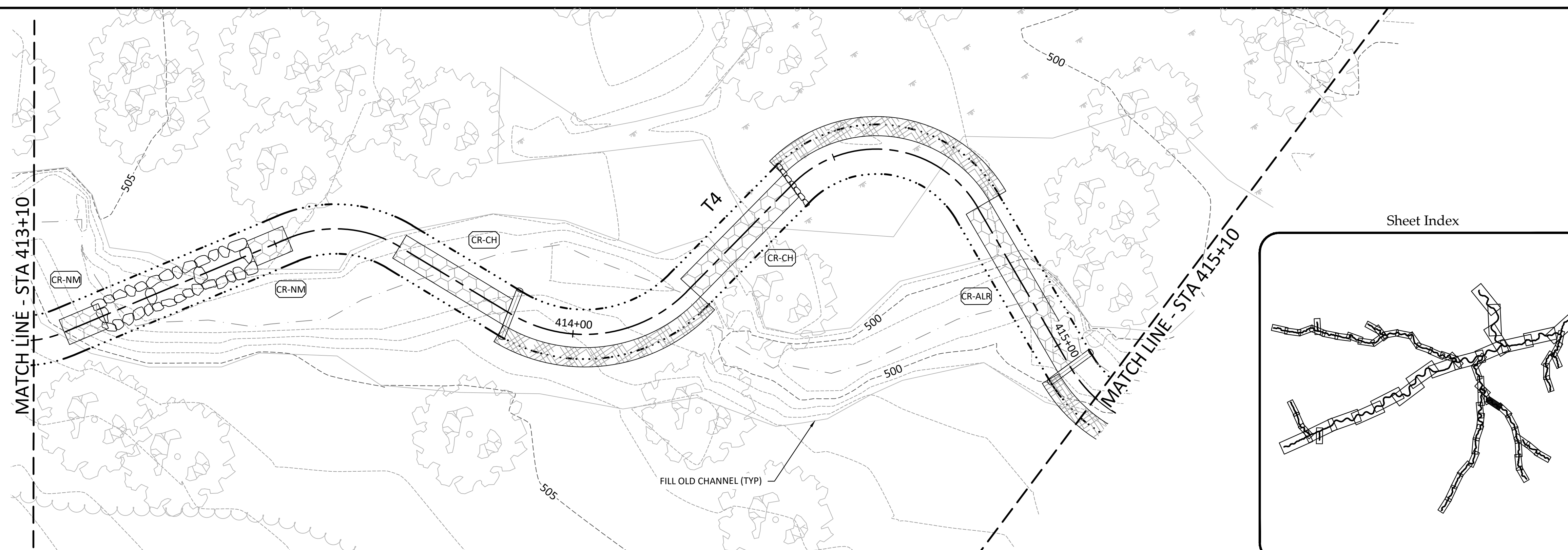

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Buckwater Mitigation Site
Orange County, North Carolina

T4
Stream Plan and Profile

Revisions:

Date: 05.26.2017
Job Number: 005-02157
Project Engineer: NMM
Drawn By: CLM
Checked By: JWH

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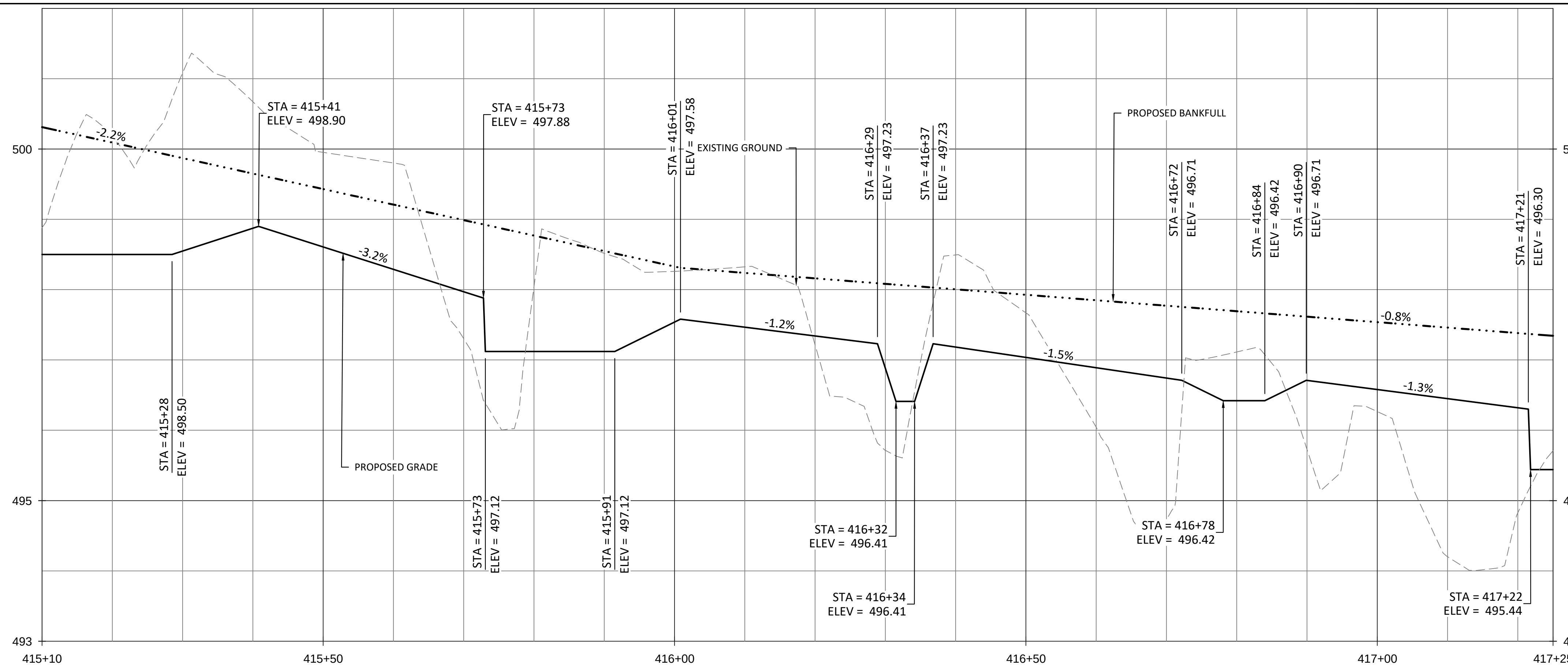
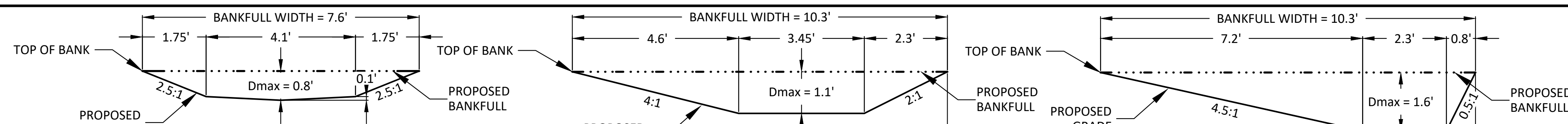
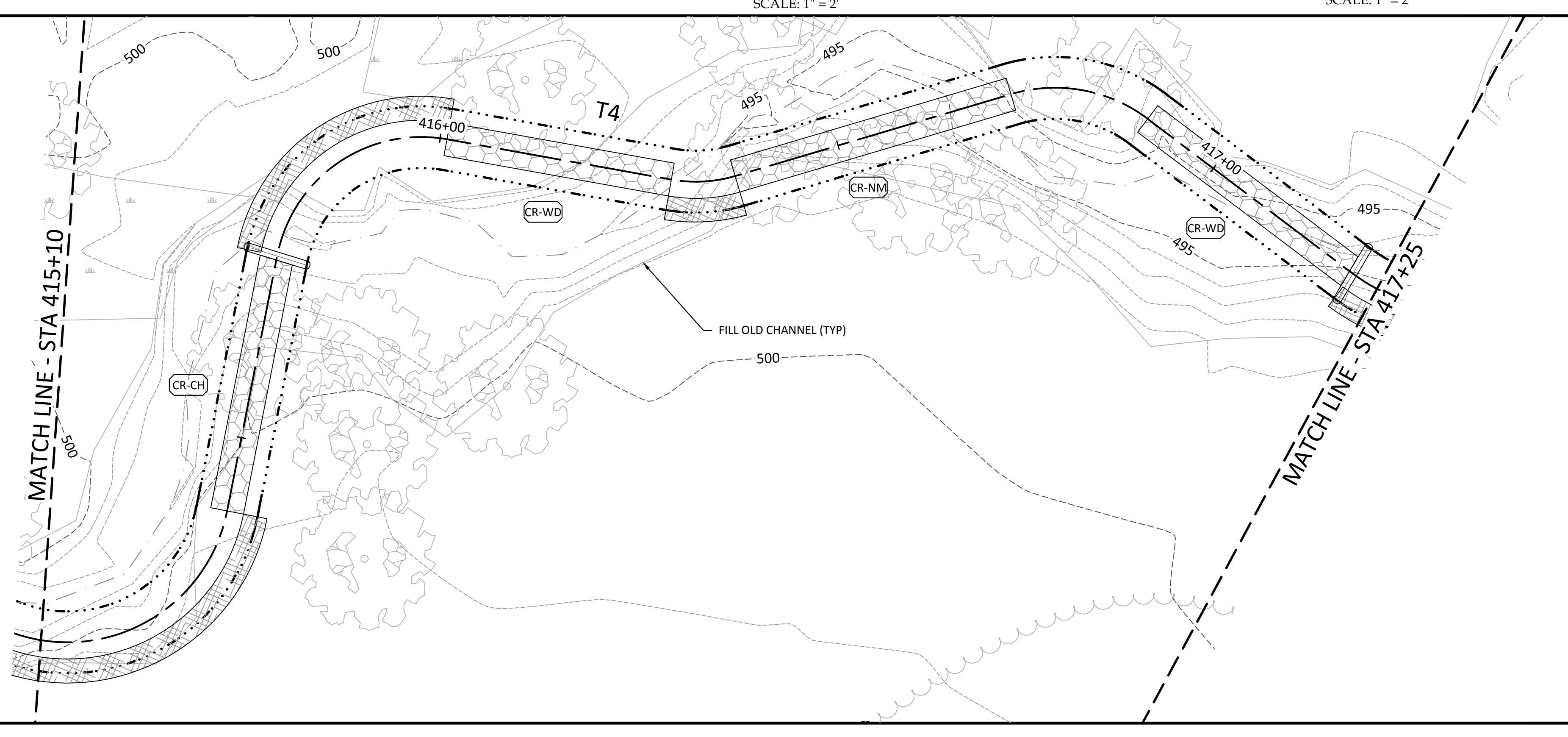




T4 - TYPICAL SECTION: RIFFLE
STA: 408+67 TO 418+28
SCALE: 1" = 2'

T4 - TYPICAL SECTION: SHALLOW POOL
STA: 408+67 TO 418+28
SCALE: 1" = 2'

T4 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 408+67 TO 418+28
SCALE: 1" = 2'



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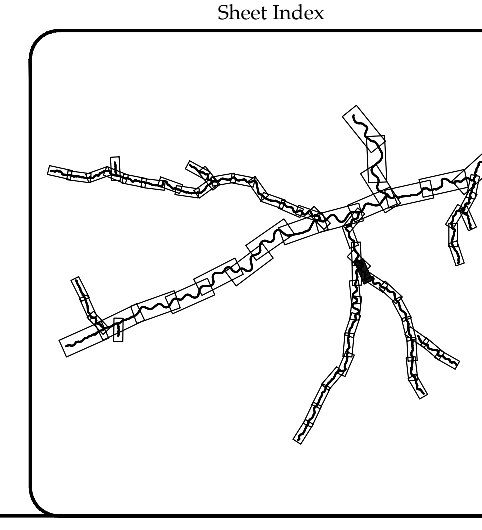

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T4
Stream Plan and Profile

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Job Number:	005-02157
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Drawn By:	CLM
Checked By:	JWH

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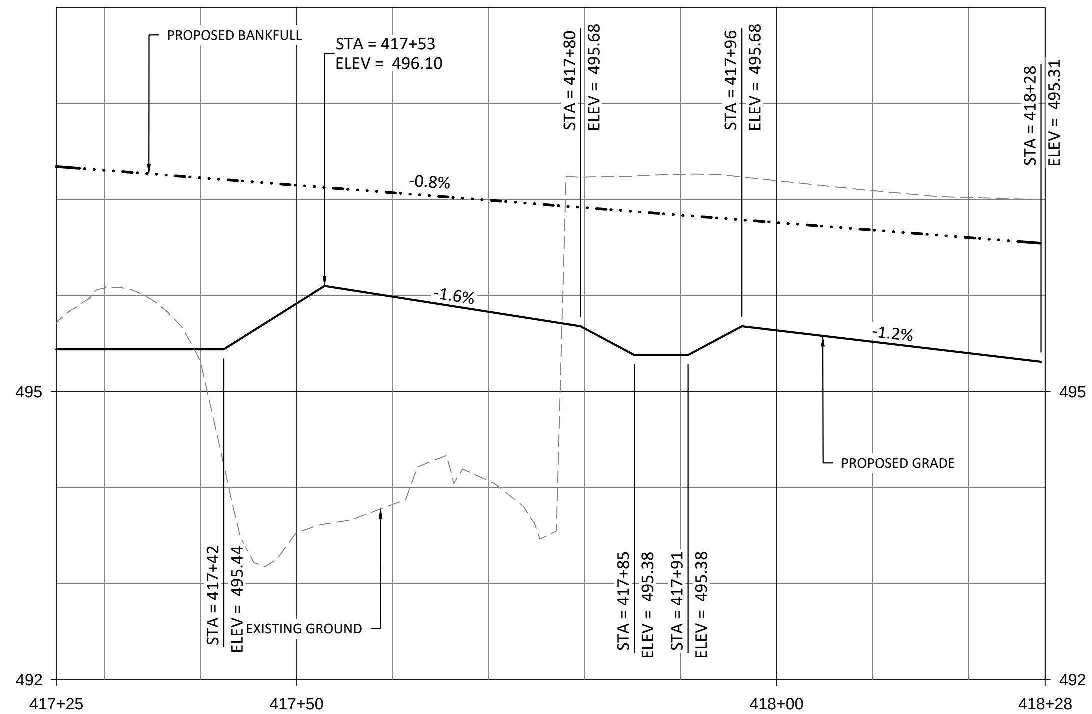

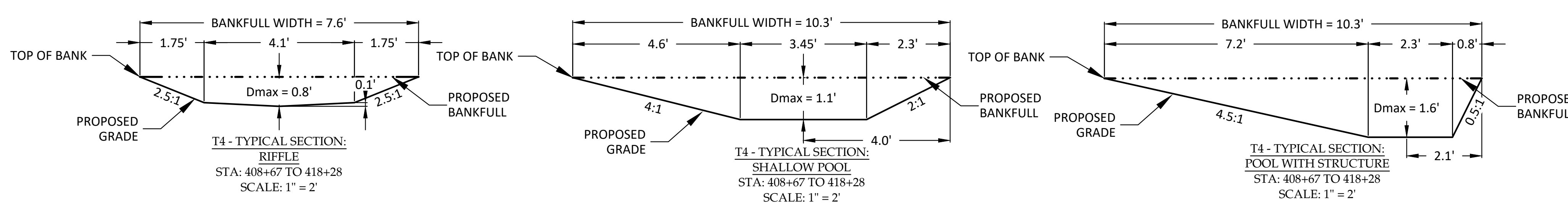

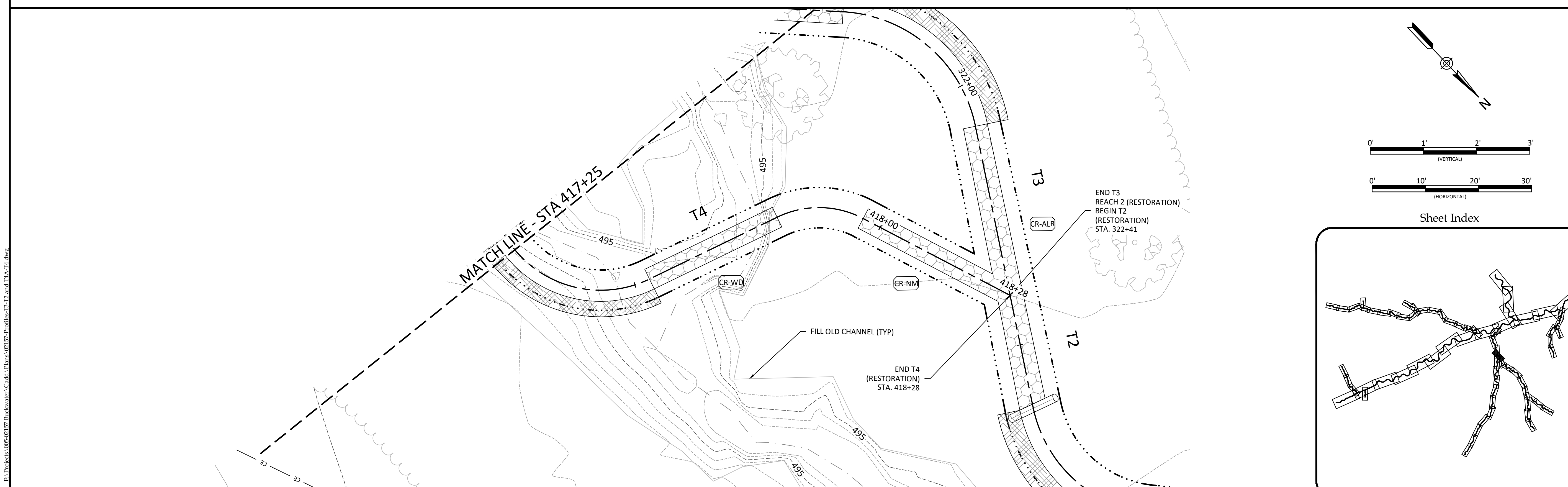

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T4
Stream Plan and Profile

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Drawn By:	CLM
Checked By:	JWH

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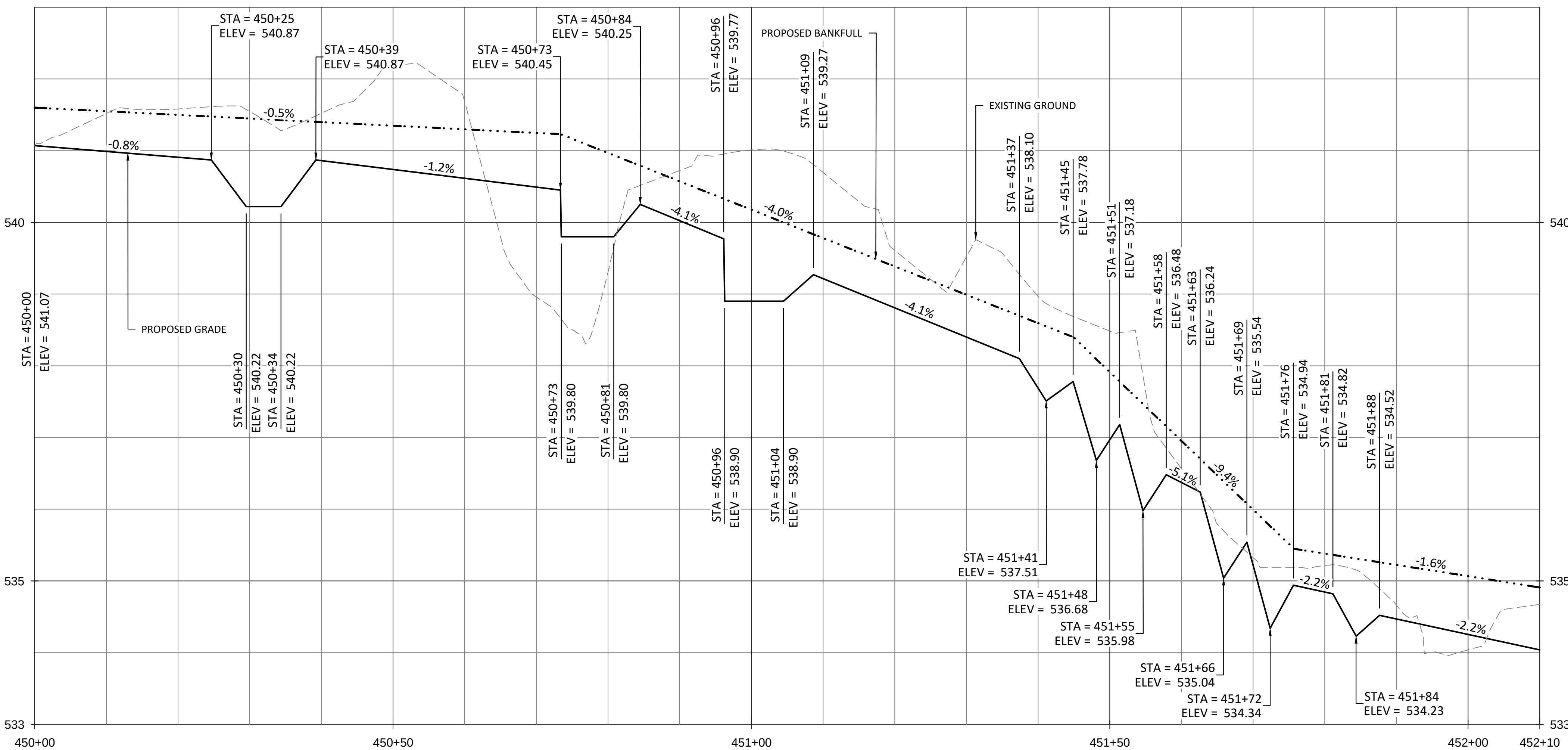

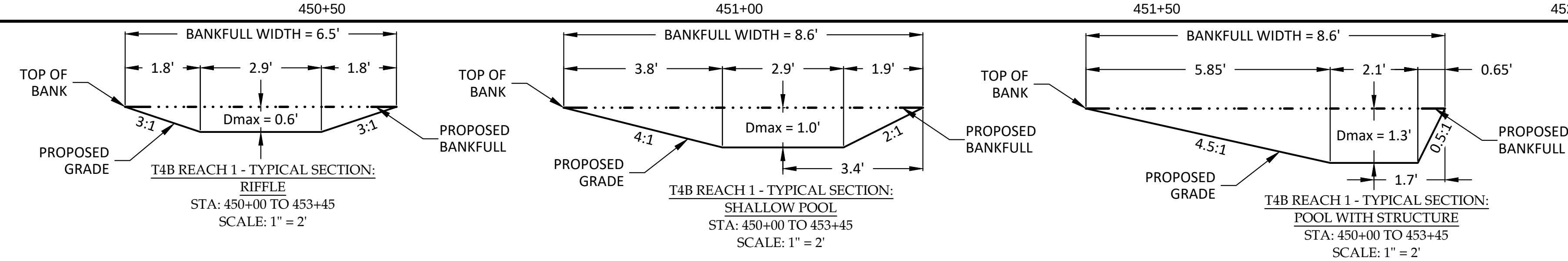

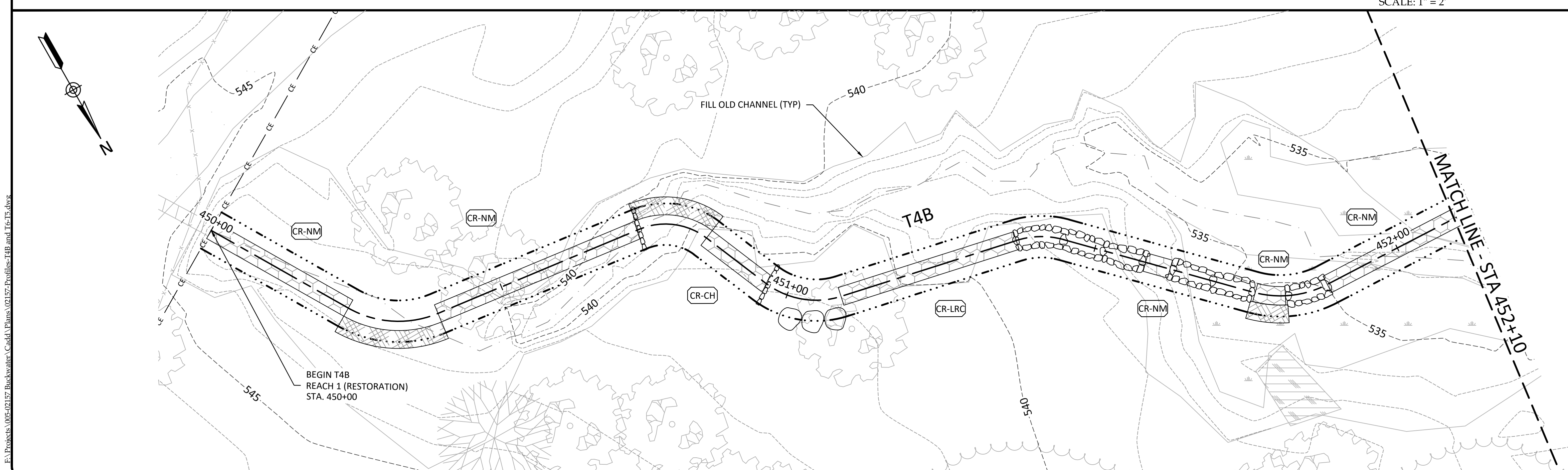

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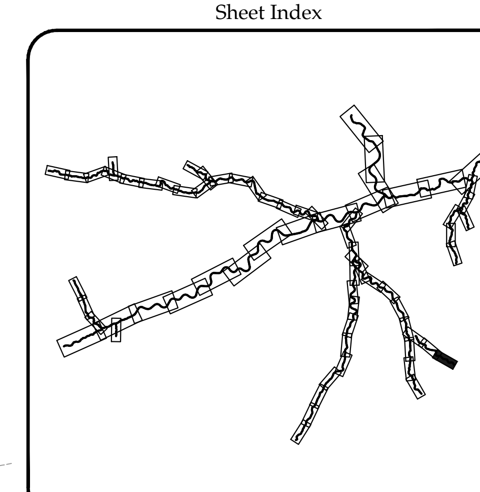

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T4B Reach 1
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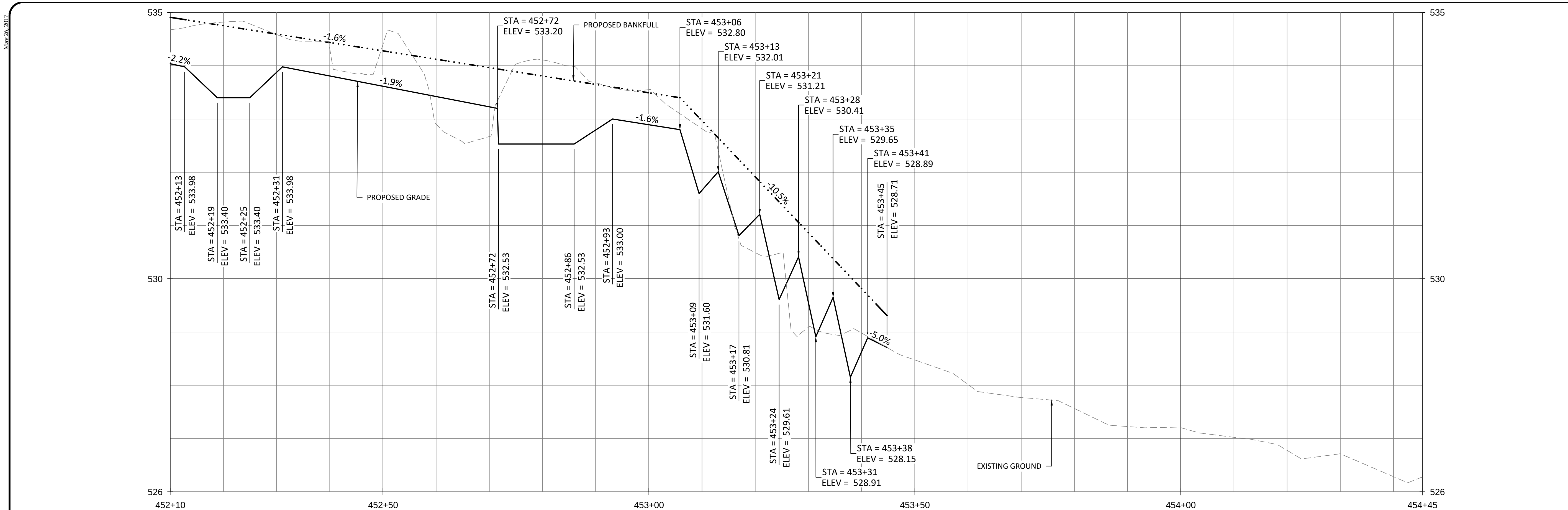

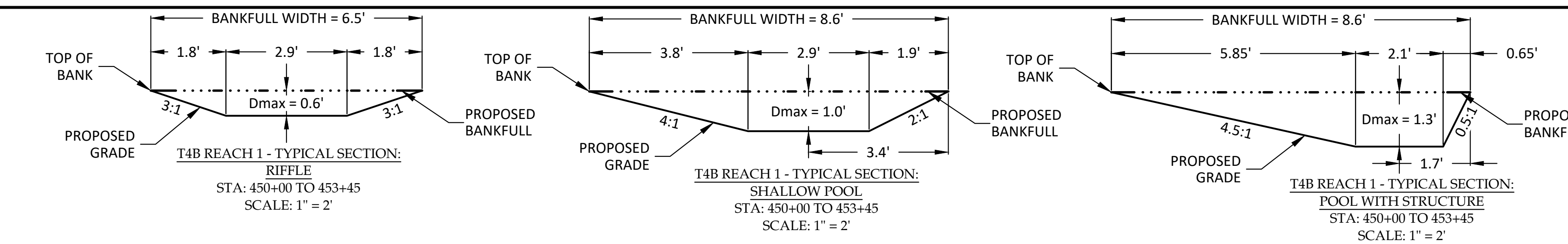

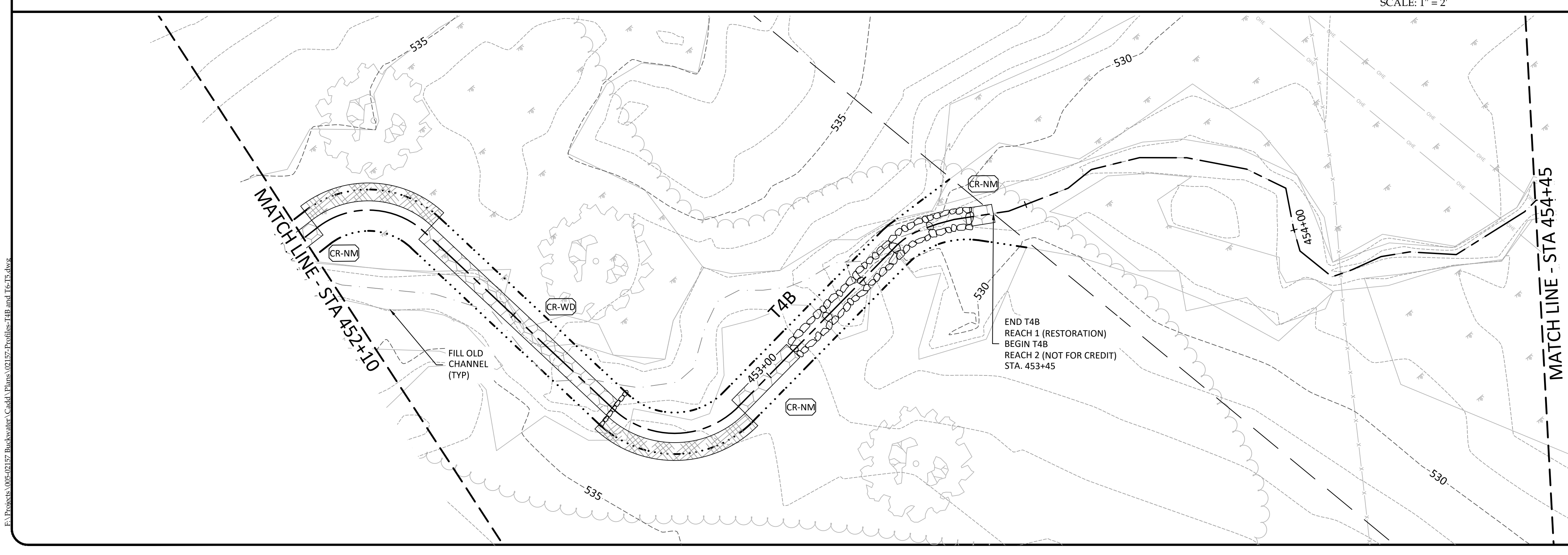

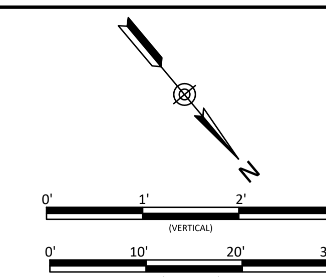

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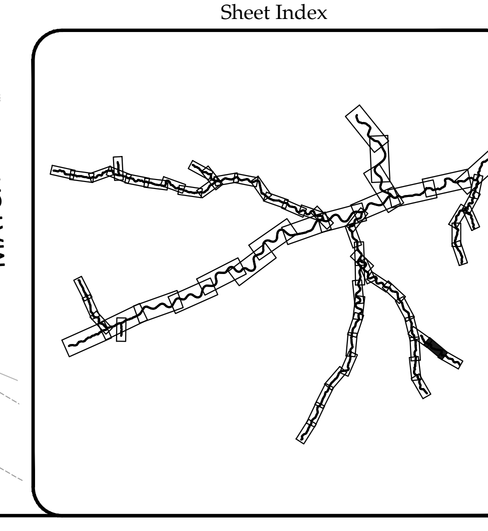

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T4B Reaches 1 & 2
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Checked By:	JWH

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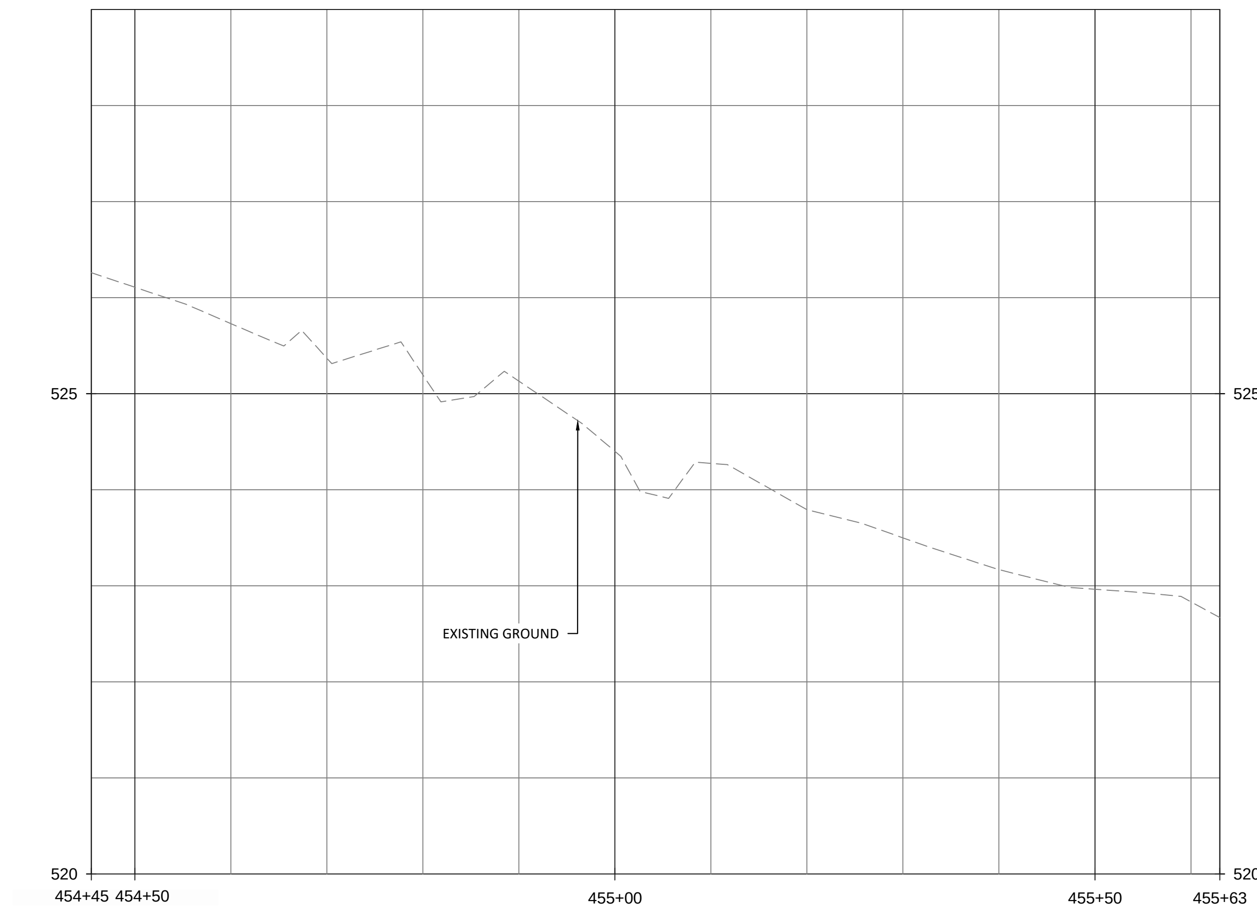

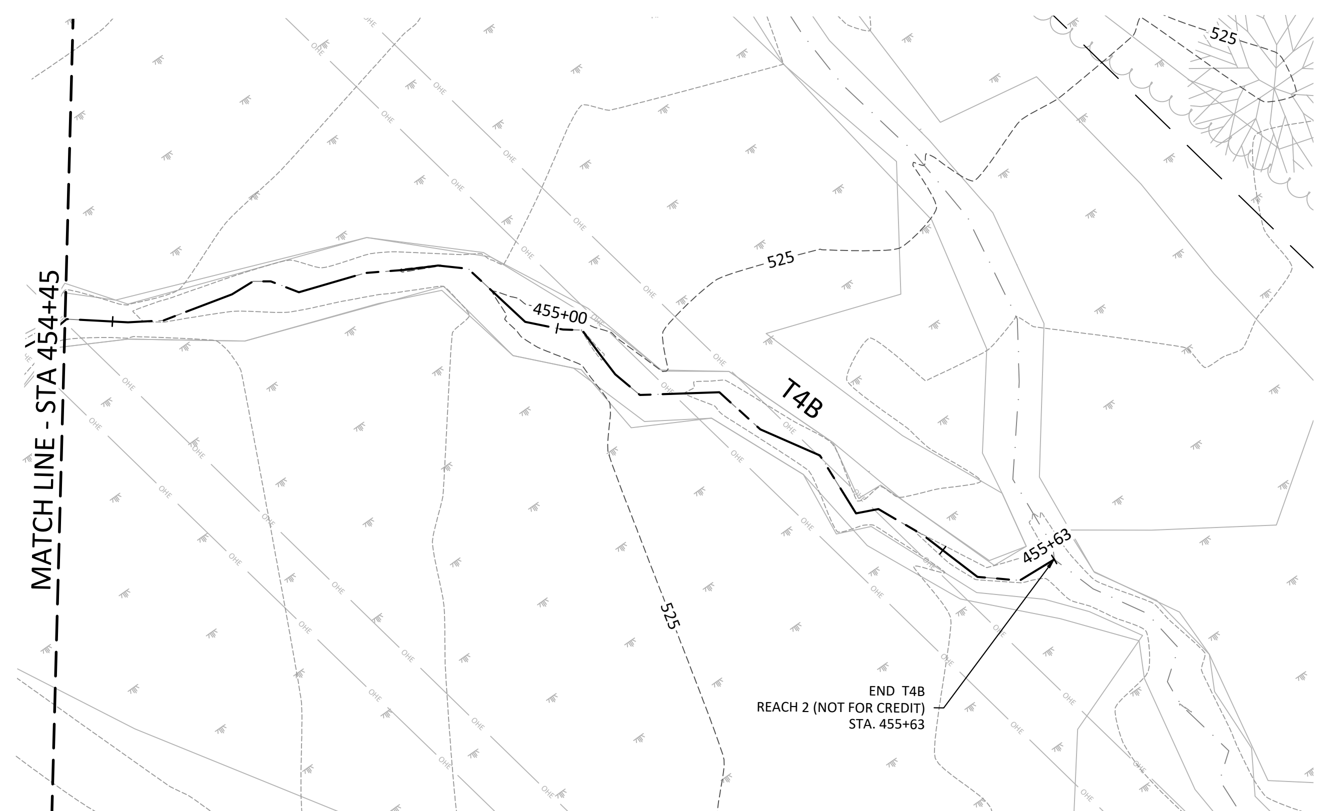

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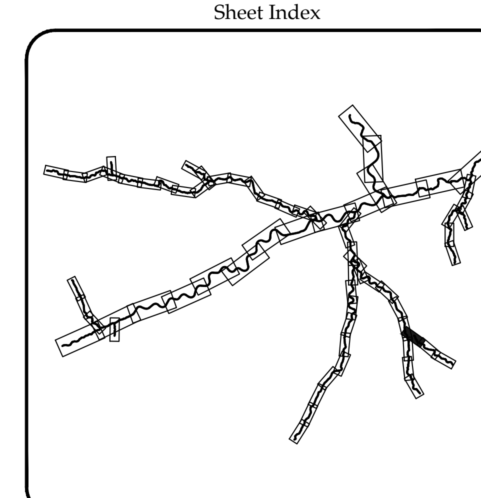

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T4B Reach 2
Stream Plan and Profile

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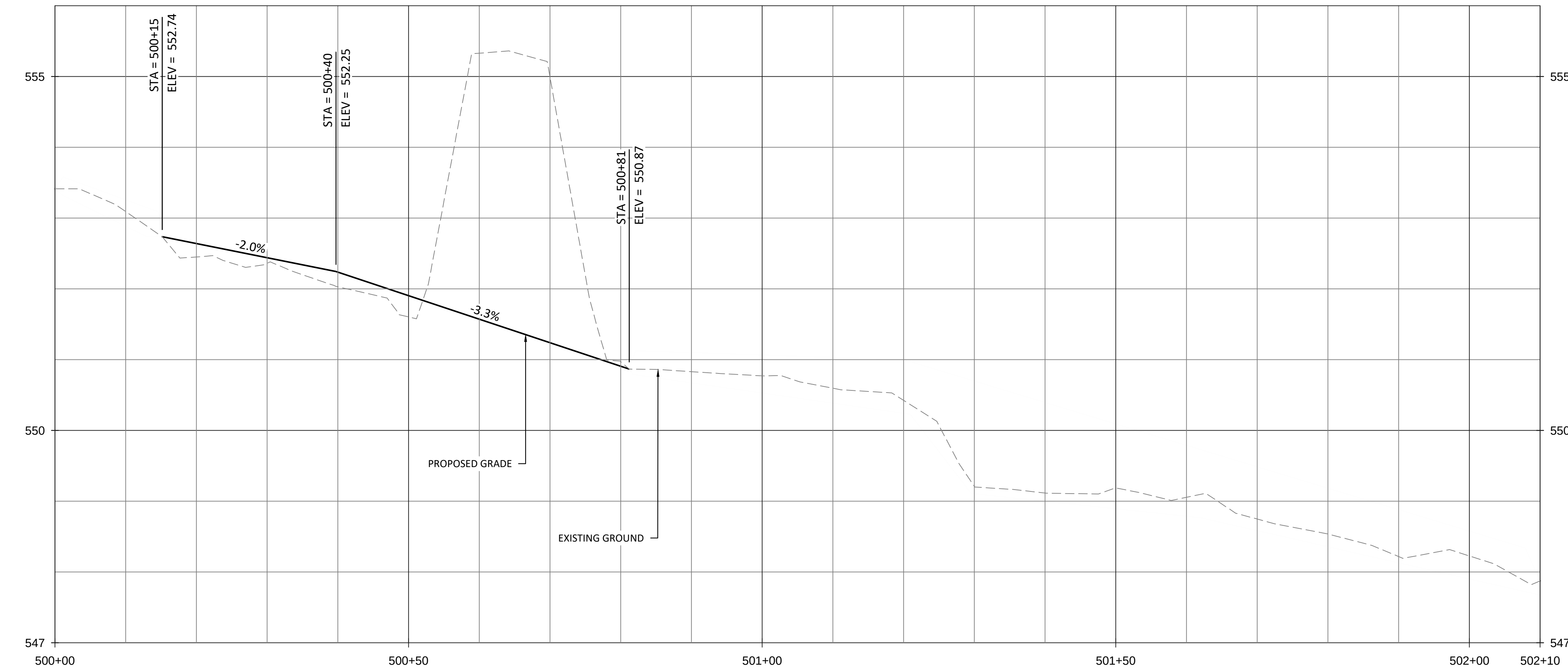

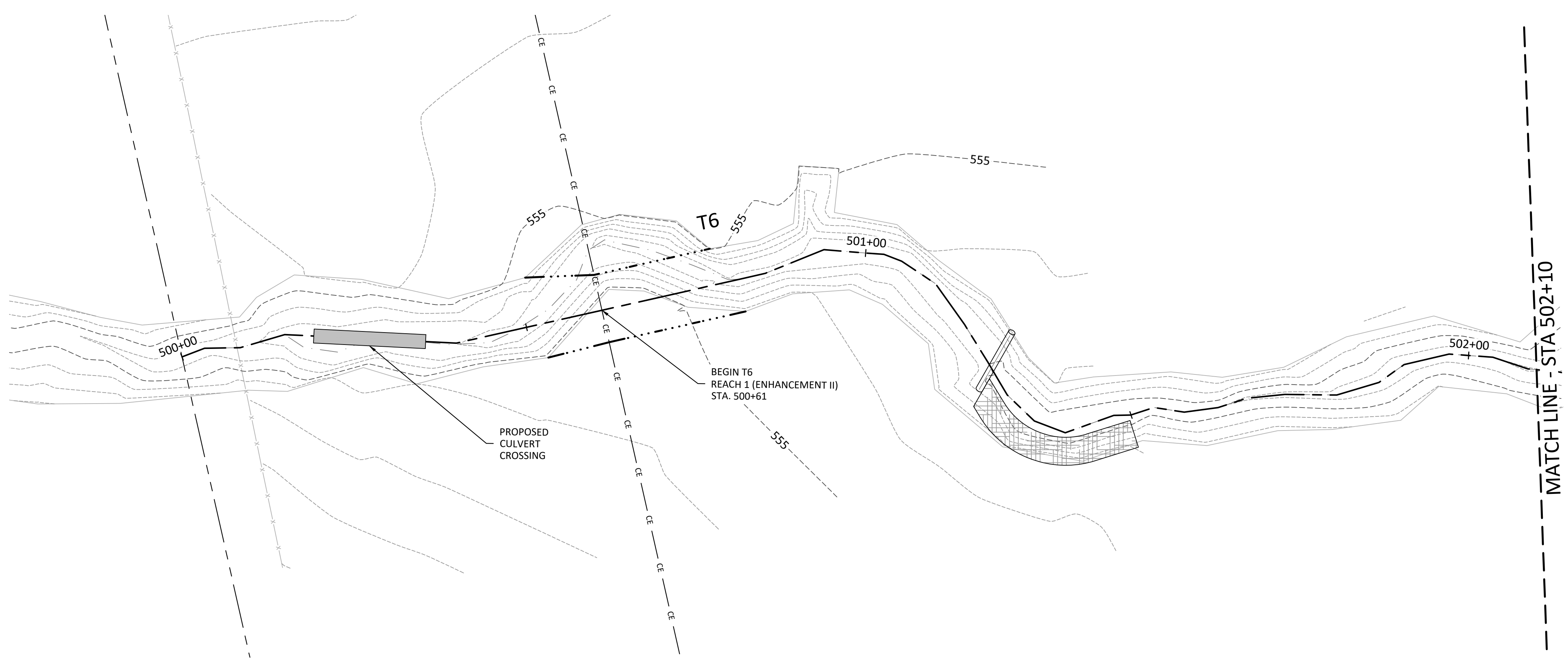

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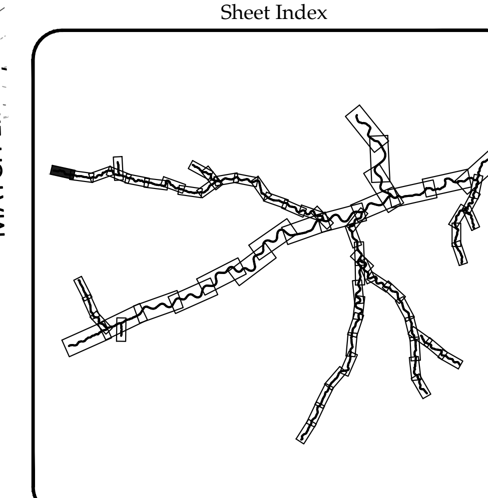

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T6 Reach 1
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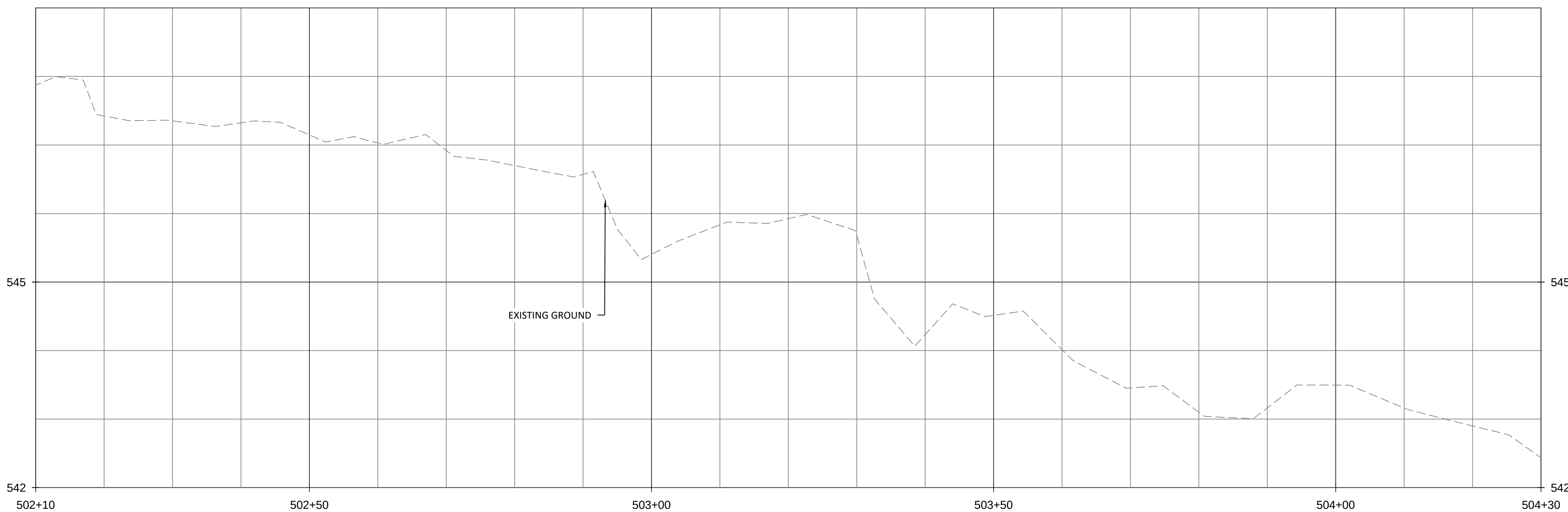

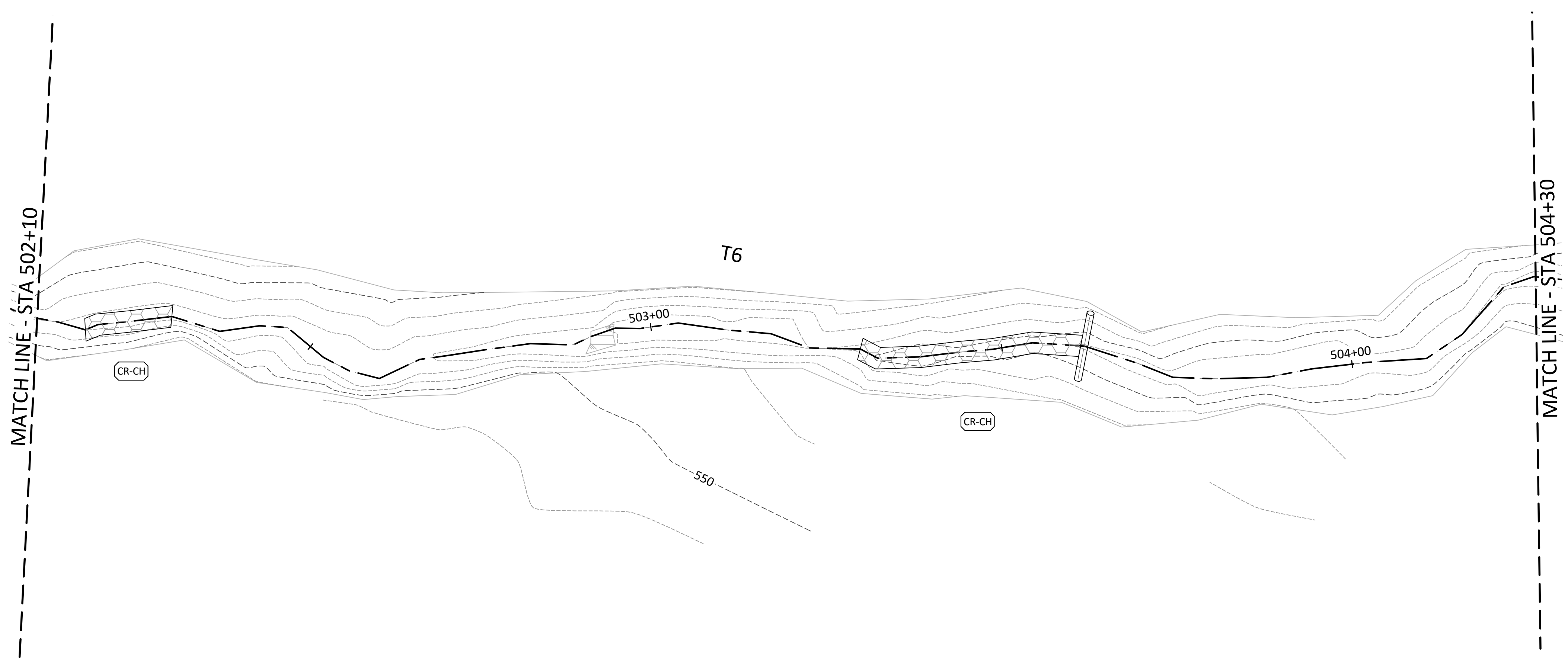

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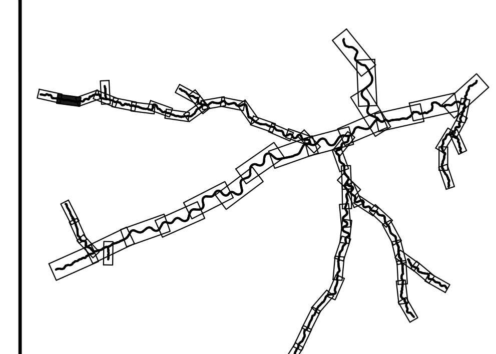

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Orange County, North Carolina

T6 Reach 1
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Checked By:	JWH

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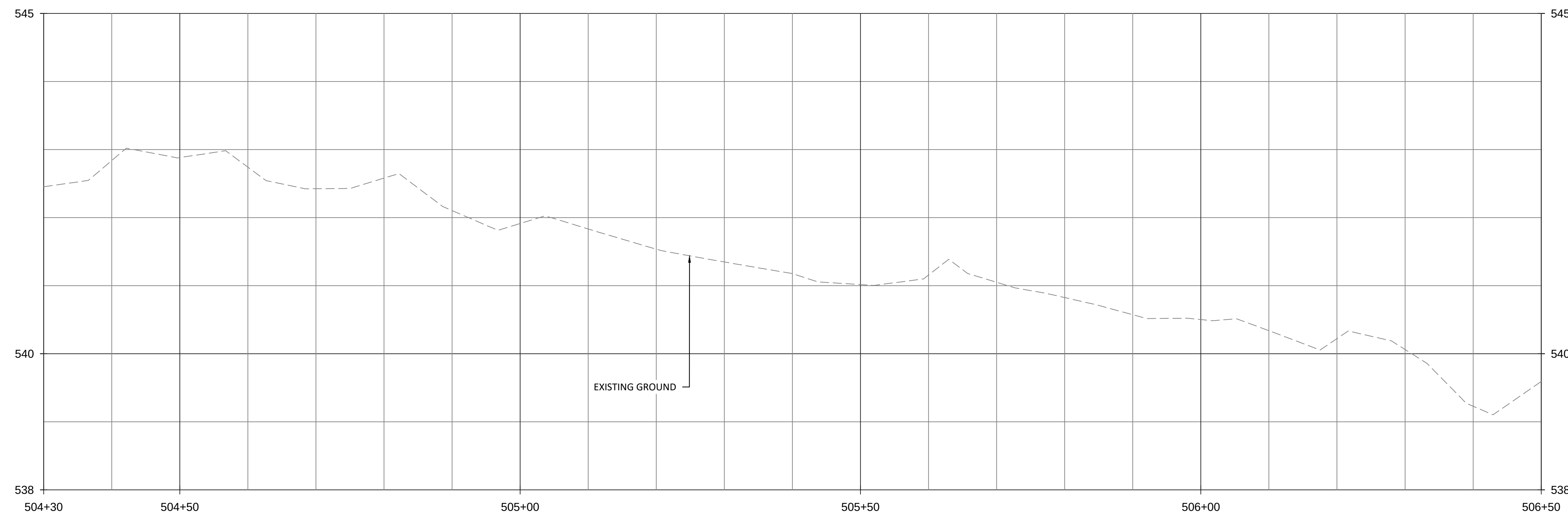

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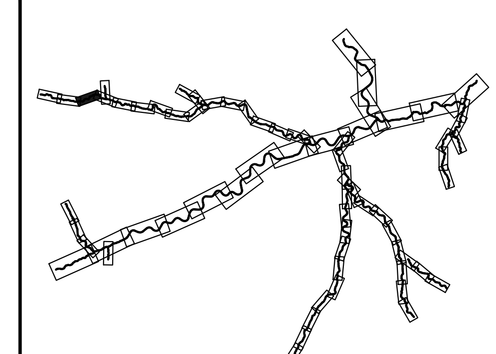

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Orange County, North Carolina

T6 Reach 1
Stream Plan and Profile

Revisions:

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Job Number:	005-02157
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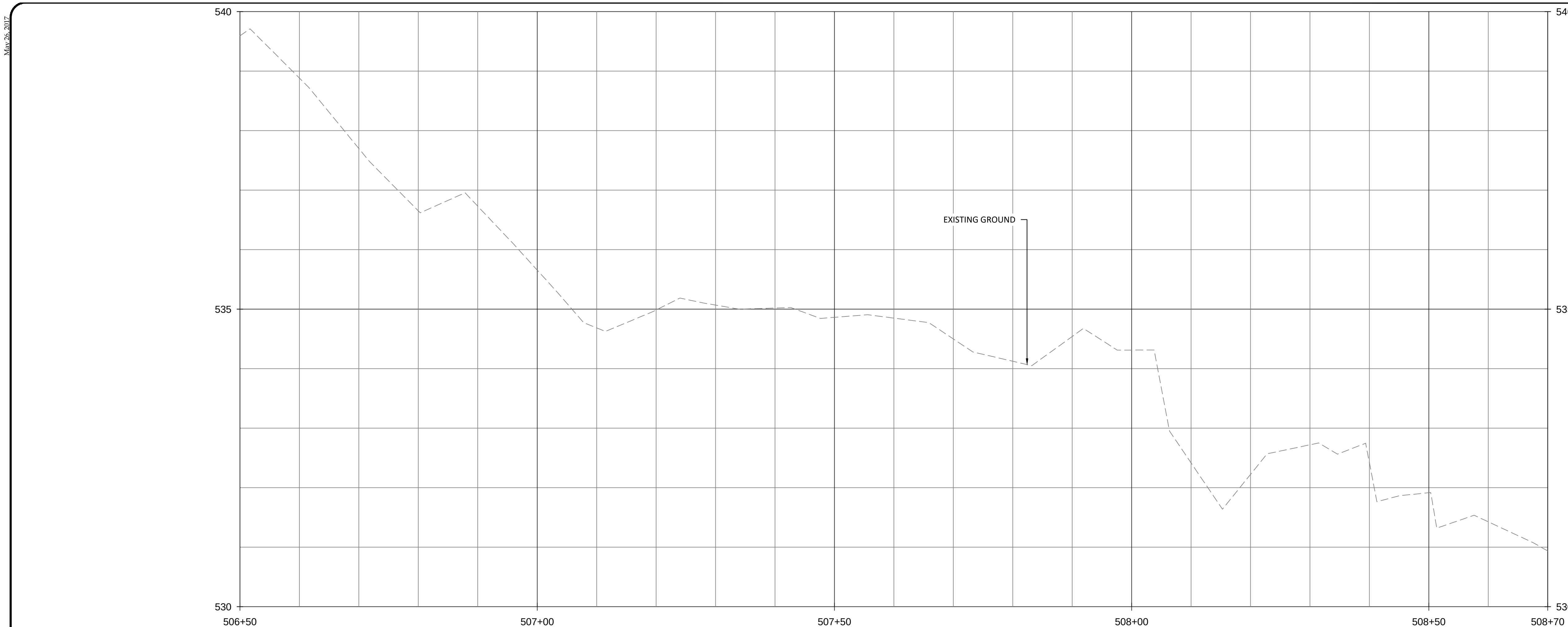

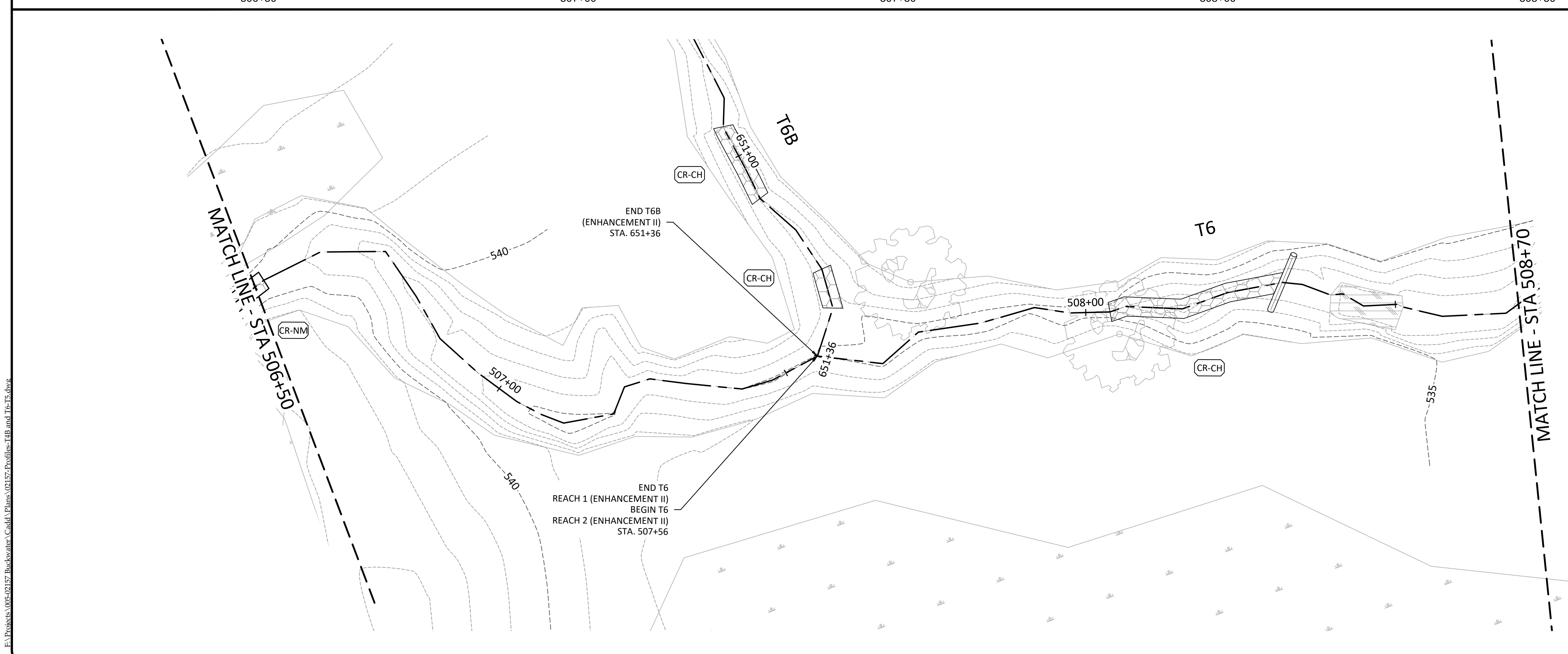

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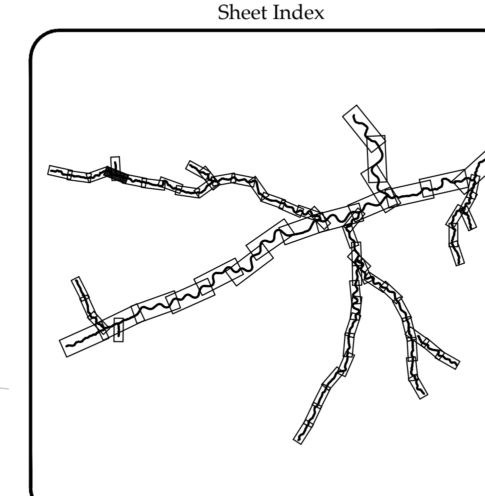

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Orange County, North Carolina

T6 Reaches 1 & 2
Stream Plan and Profile

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Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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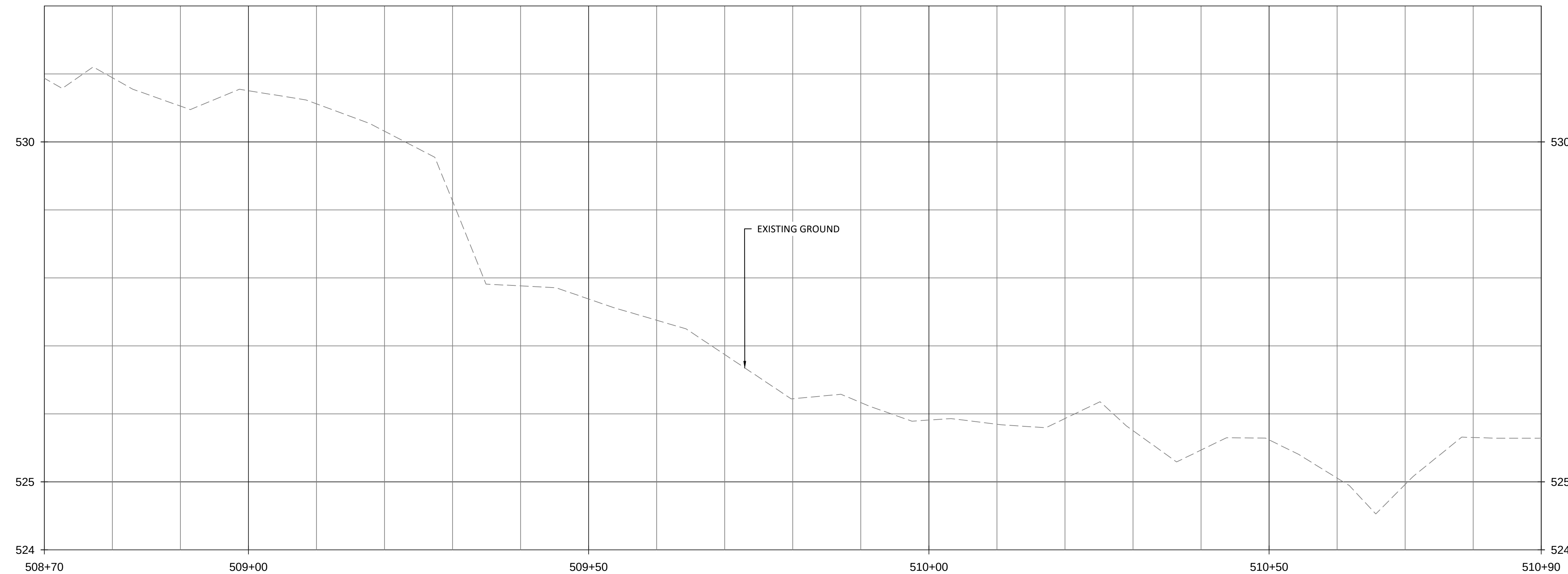

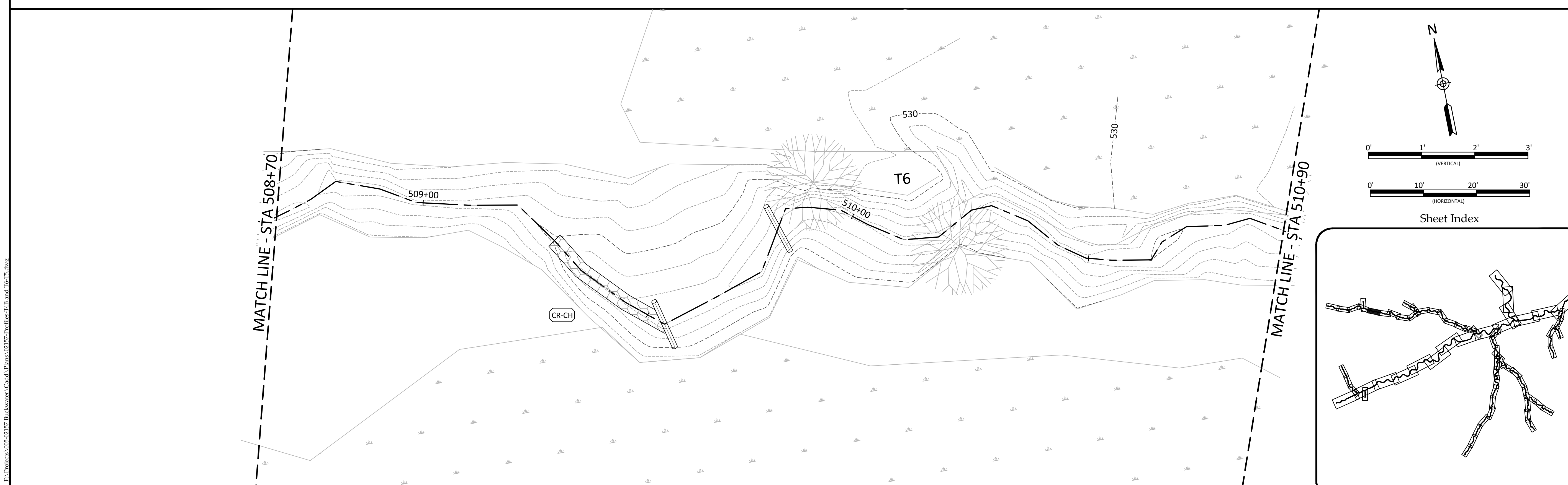

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T6 Reach 2
Stream Plan and Profile

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Drawn By:	CLM
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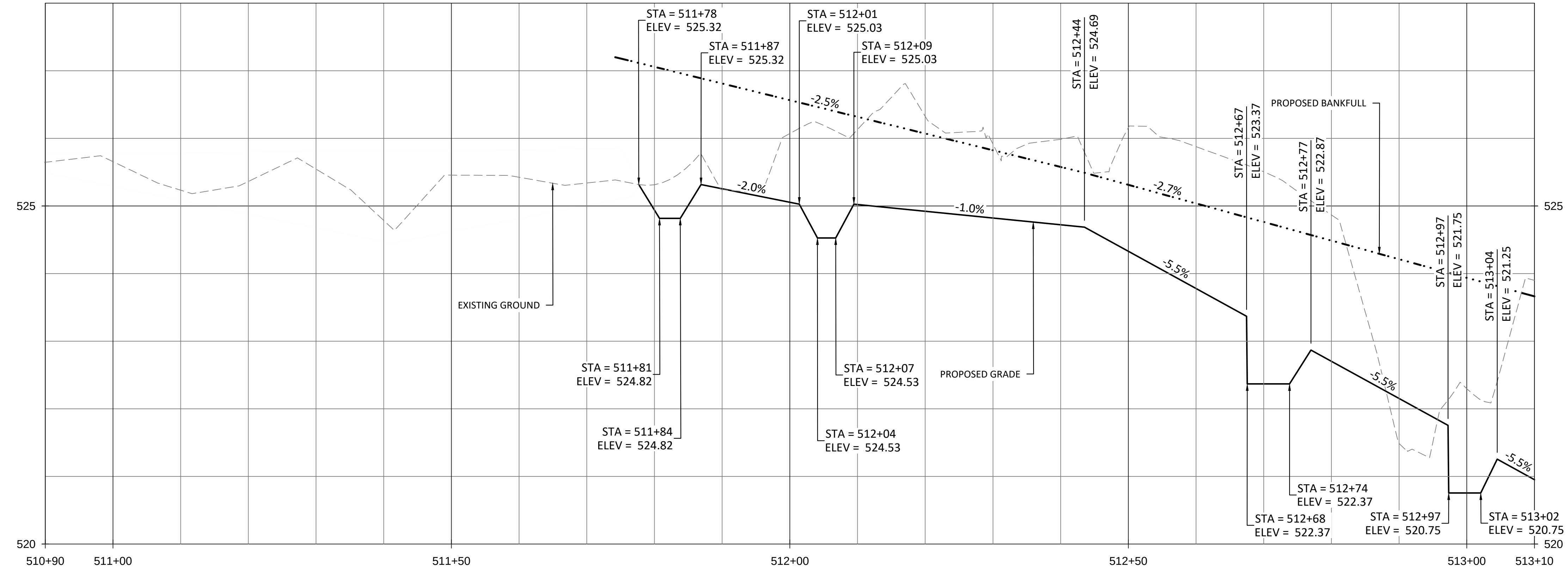

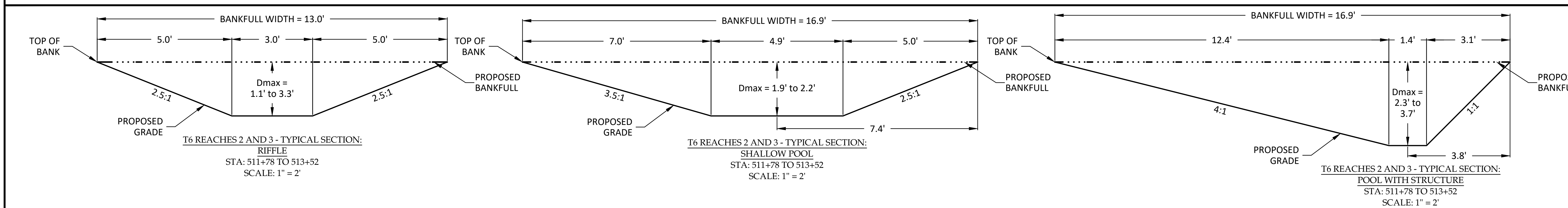

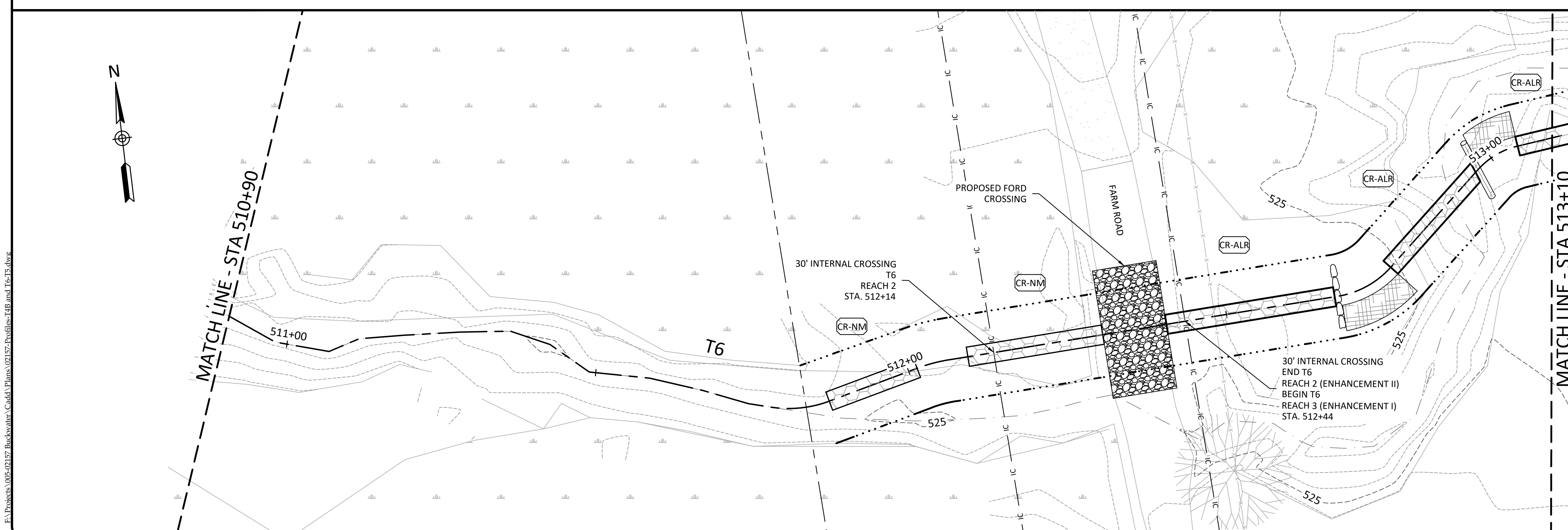

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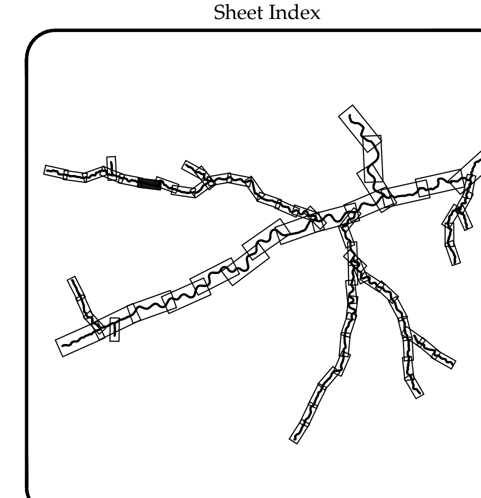

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Orange County, North Carolina

T6 Reaches 2 & 3
Stream Plan and Profile

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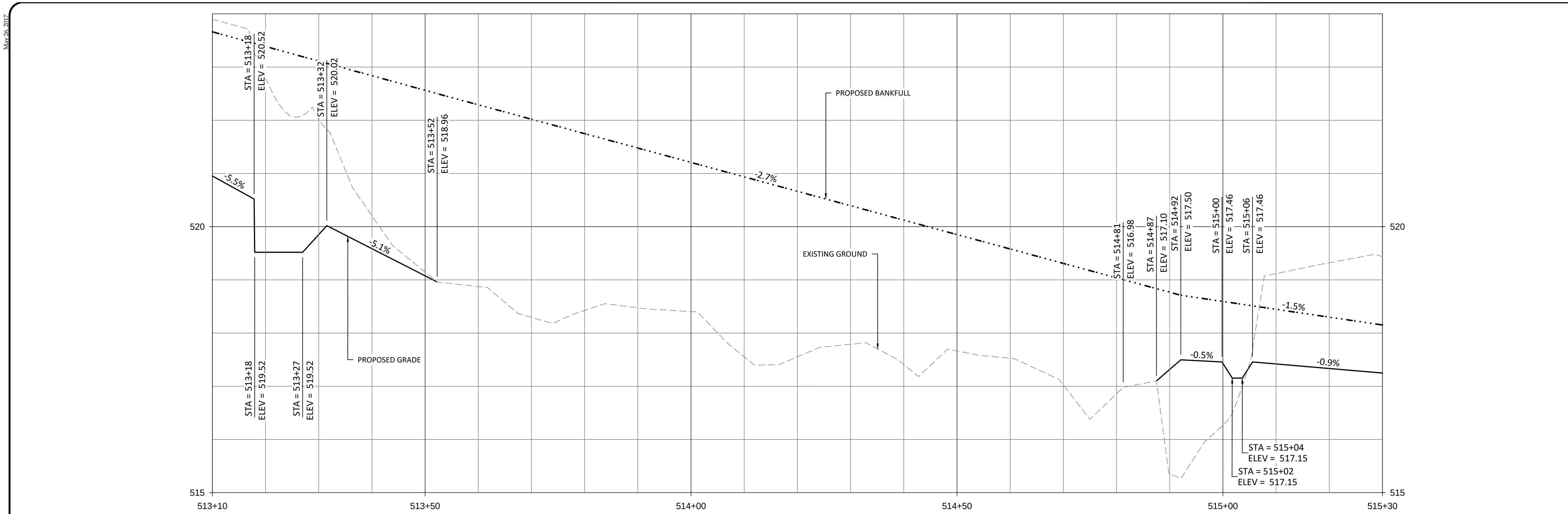
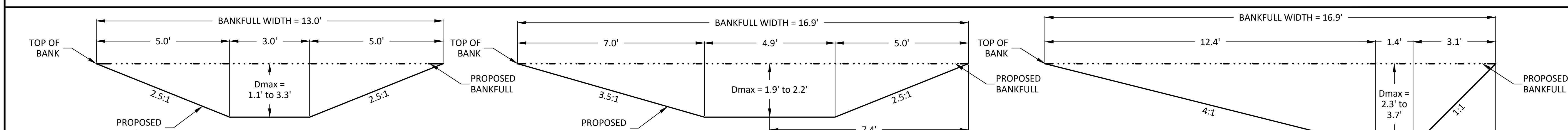
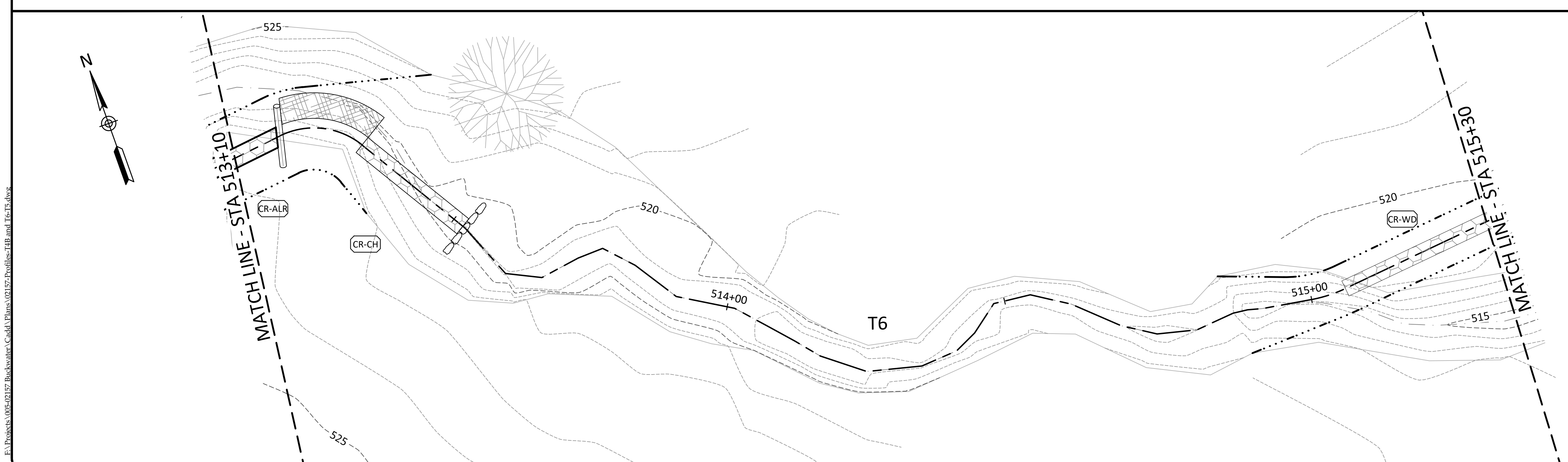




T6 REACHES 2 AND 3 - TYPICAL SECTION: RIFFLE
STA: 511+78 TO 513+52
SCALE: 1" = 2'

T6 REACHES 2 AND 3 - TYPICAL SECTION: SHALLOW POOL
STA: 511+78 TO 513+52
SCALE: 1" = 2'

T6 REACHES 2 AND 3 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 511+78 TO 513+52
SCALE: 1" = 2'



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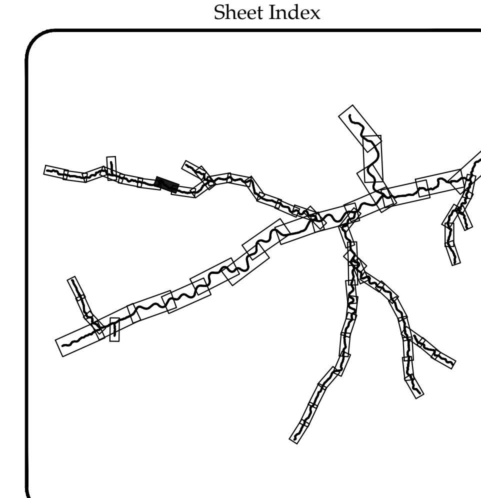

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T6 Reach 3
Stream Plan and Profile

Revisions:

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Drawn By:	CLM
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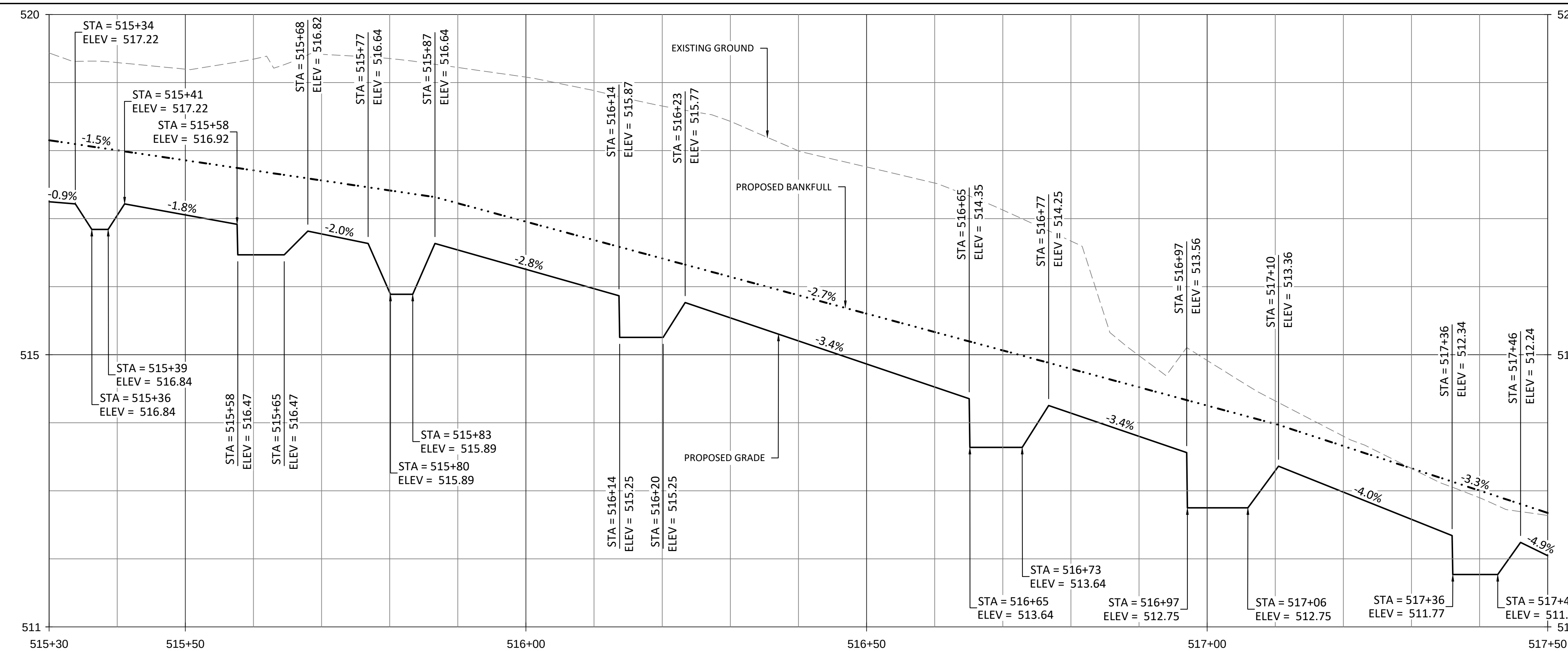
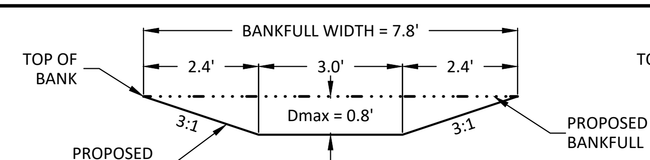
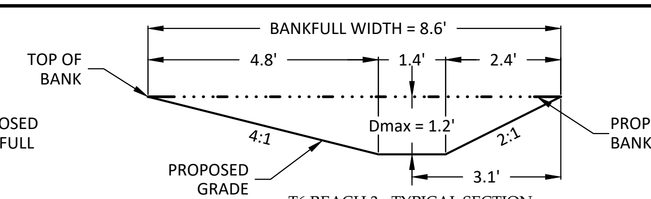
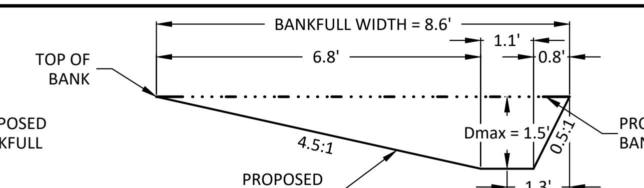




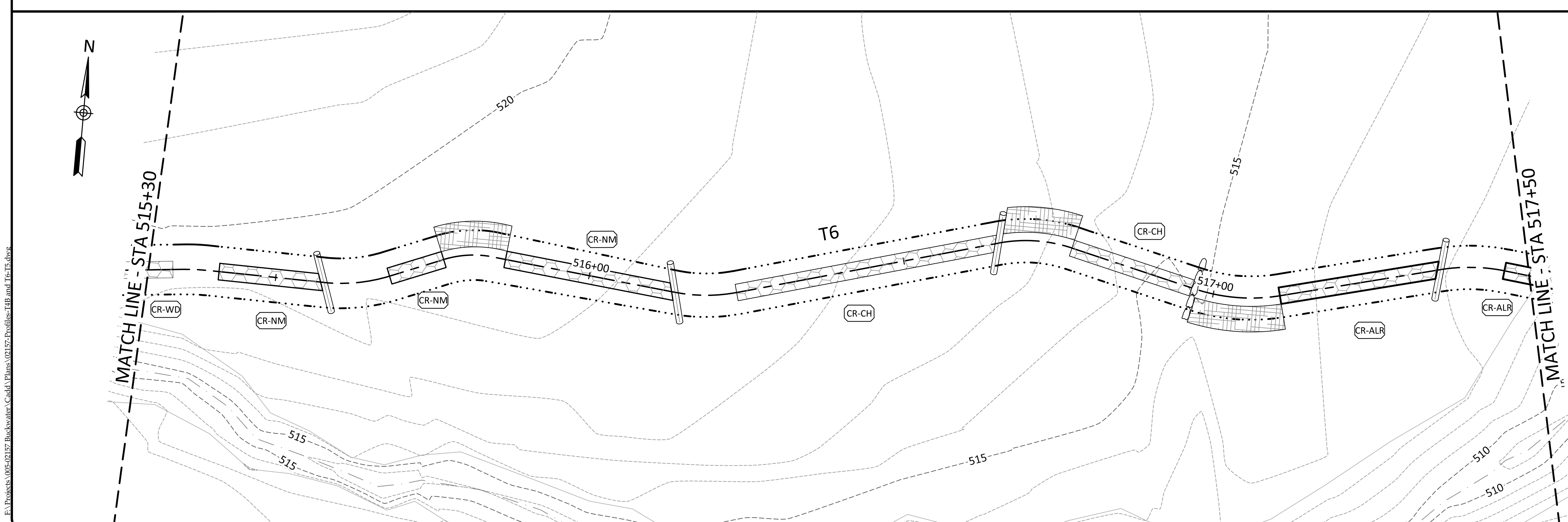
T6 REACH 3 - TYPICAL SECTION: RIFFLE
STA: 514+92 TO 515+87
SCALE: 1" = 2'



T6 REACH 3 - TYPICAL SECTION: SHALLOW POOL
STA: 514+92 TO 515+87
SCALE: 1" = 2'



T6 REACH 3 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 514+92 TO 515+87
SCALE: 1" = 2'



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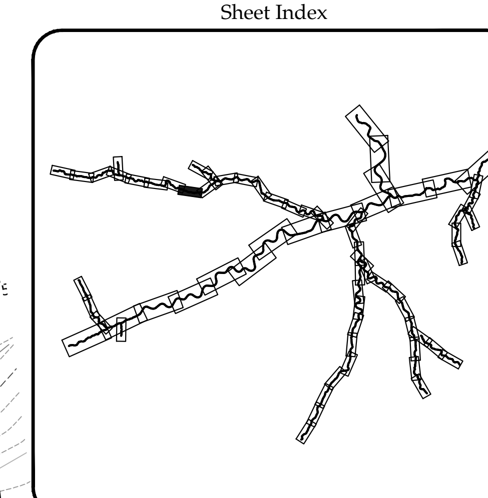

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T6 Reach 3
Stream Plan and Profile

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Drawn By:	CLM
Checked By:	JWH

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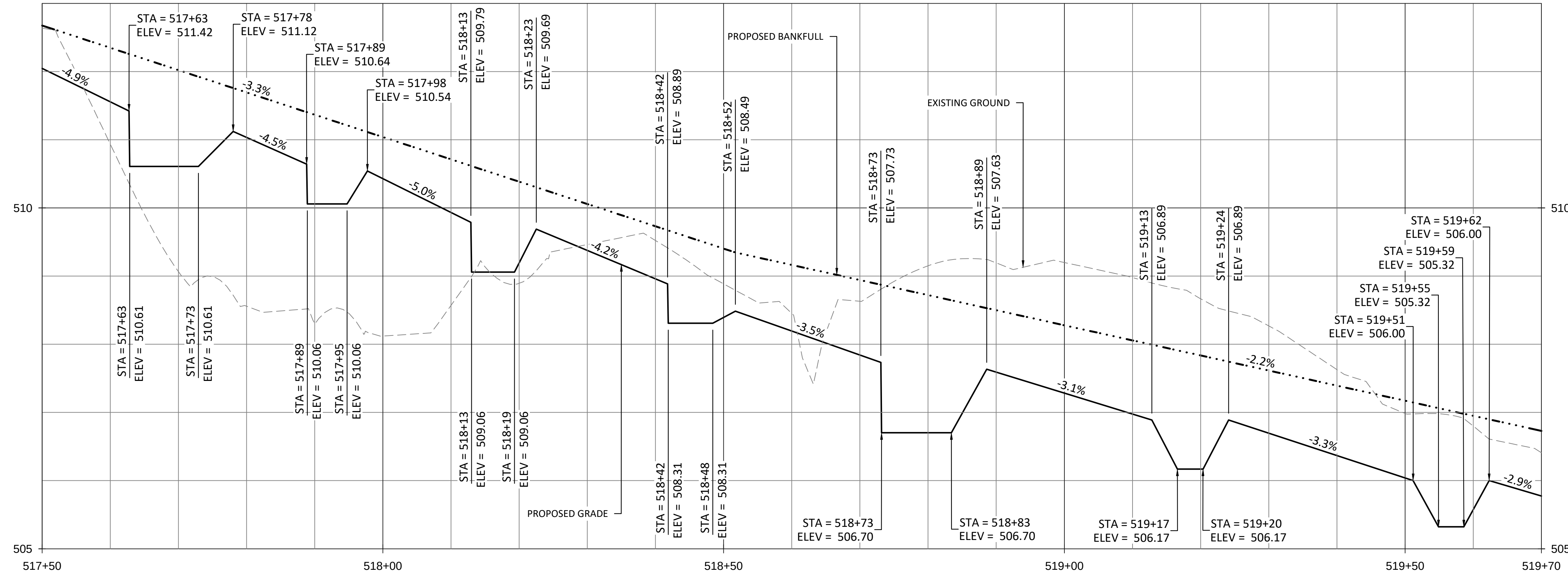
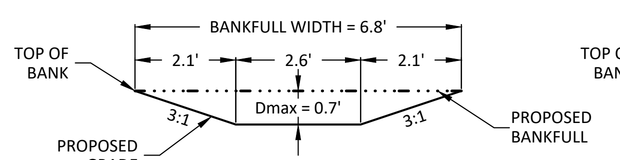
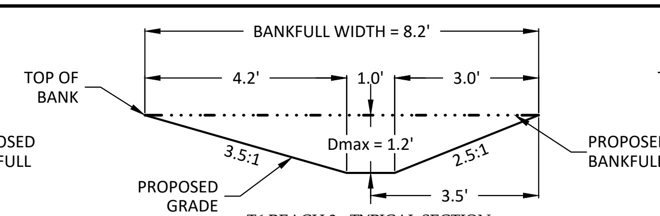
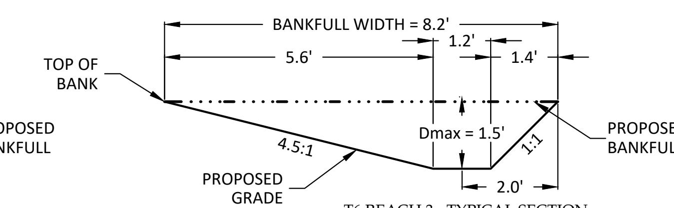




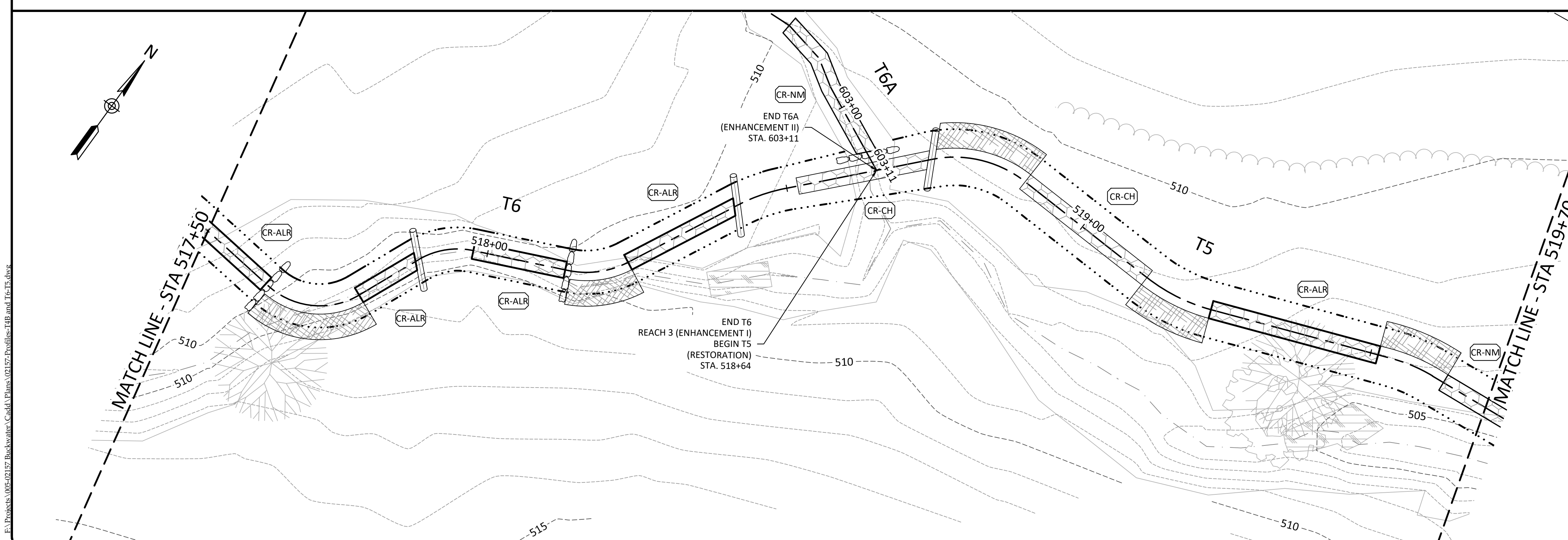
T6 REACH 3 - TYPICAL SECTION: RIFFLE
STA: 515+87 TO 518+52
SCALE: 1" = 2'



T6 REACH 3 - TYPICAL SECTION: SHALLOW POOL
STA: 515+87 TO 518+52
SCALE: 1" = 2'



T6 REACH 3 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 515+87 TO 518+52
SCALE: 1" = 2'



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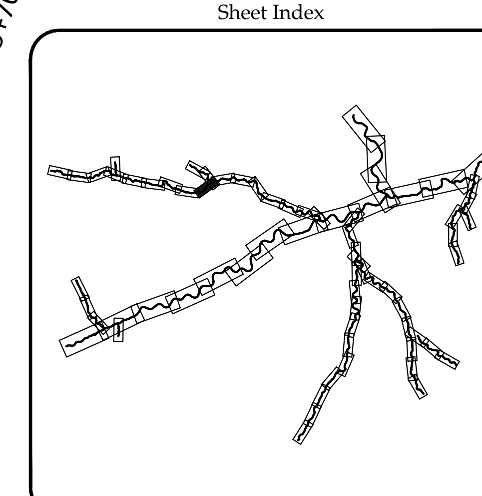

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Orange County, North Carolina

T6 Reach 3 & T5
Stream Plan and Profile

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Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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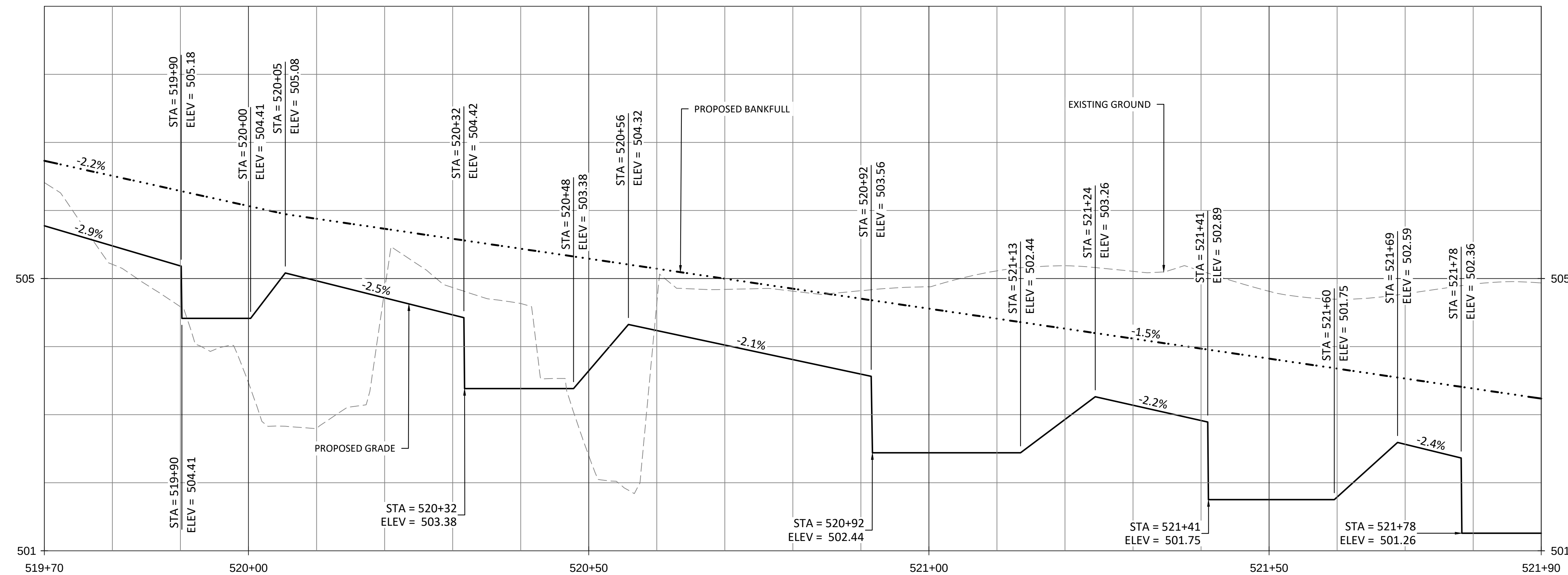
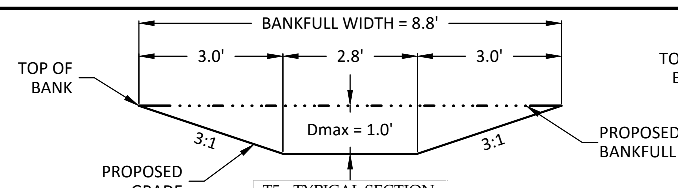
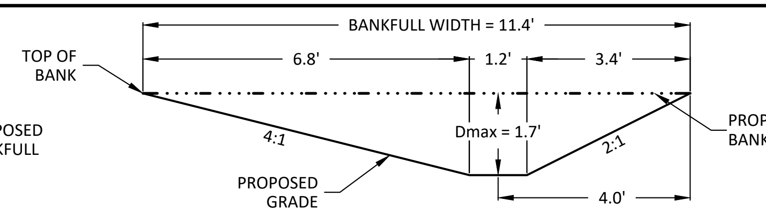




T5 - TYPICAL SECTION: RIFFLE
STA: 518+52 TO 524+21
SCALE: 1" = 2'



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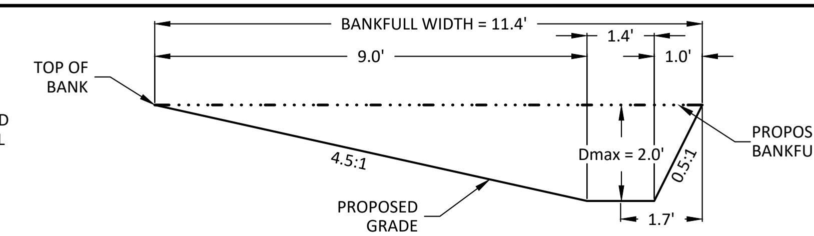
STA: 518+52 TO 524+21
SCALE: 1" = 2'



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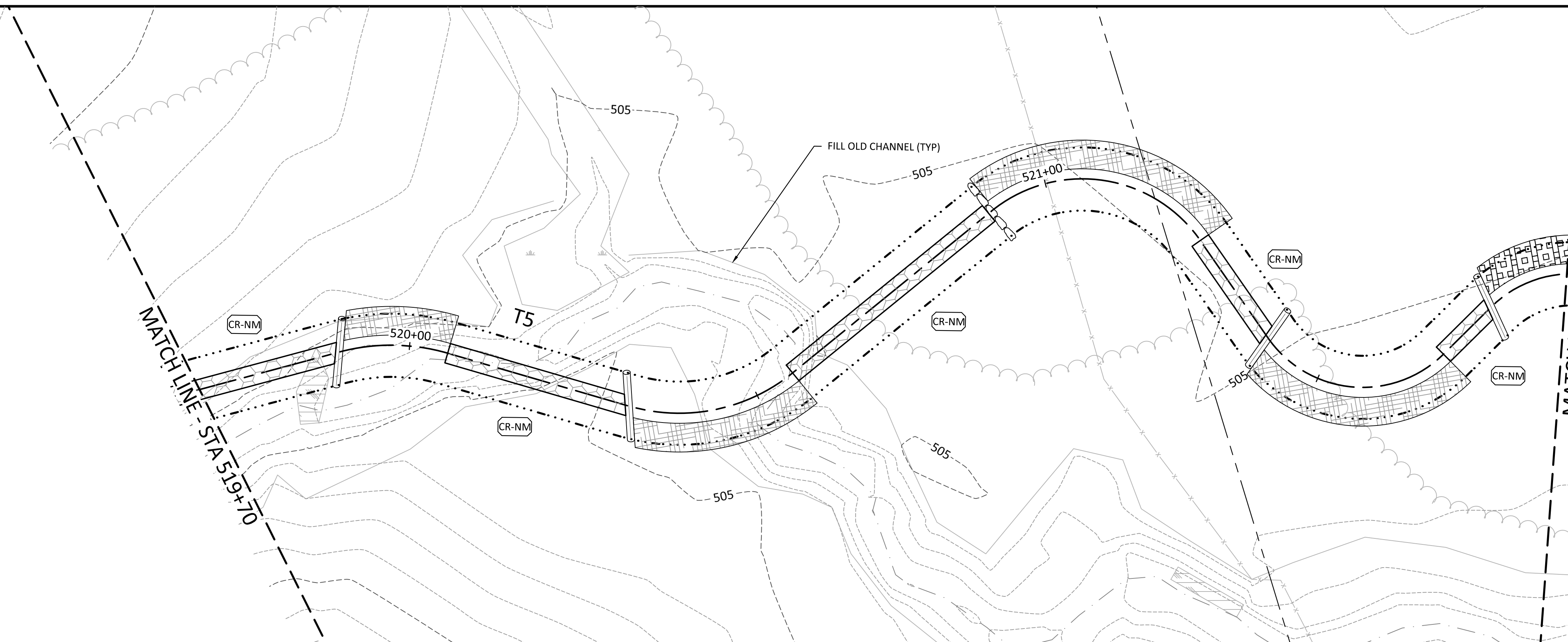
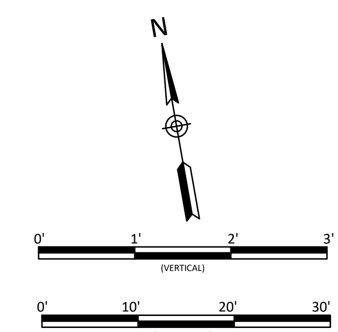
STA: 518+52 TO 524+21
SCALE: 1" = 2'





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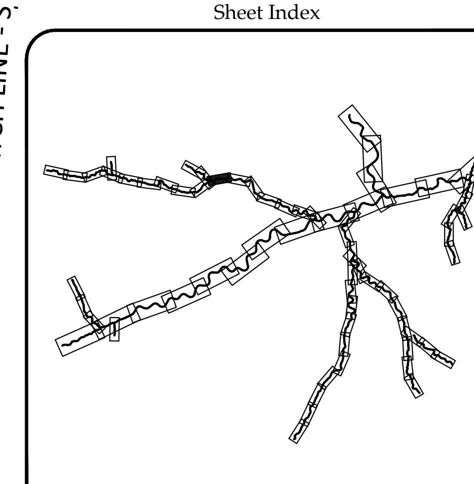

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T5
Stream Plan and Profile

Revisions:

Date:	05.26.2017
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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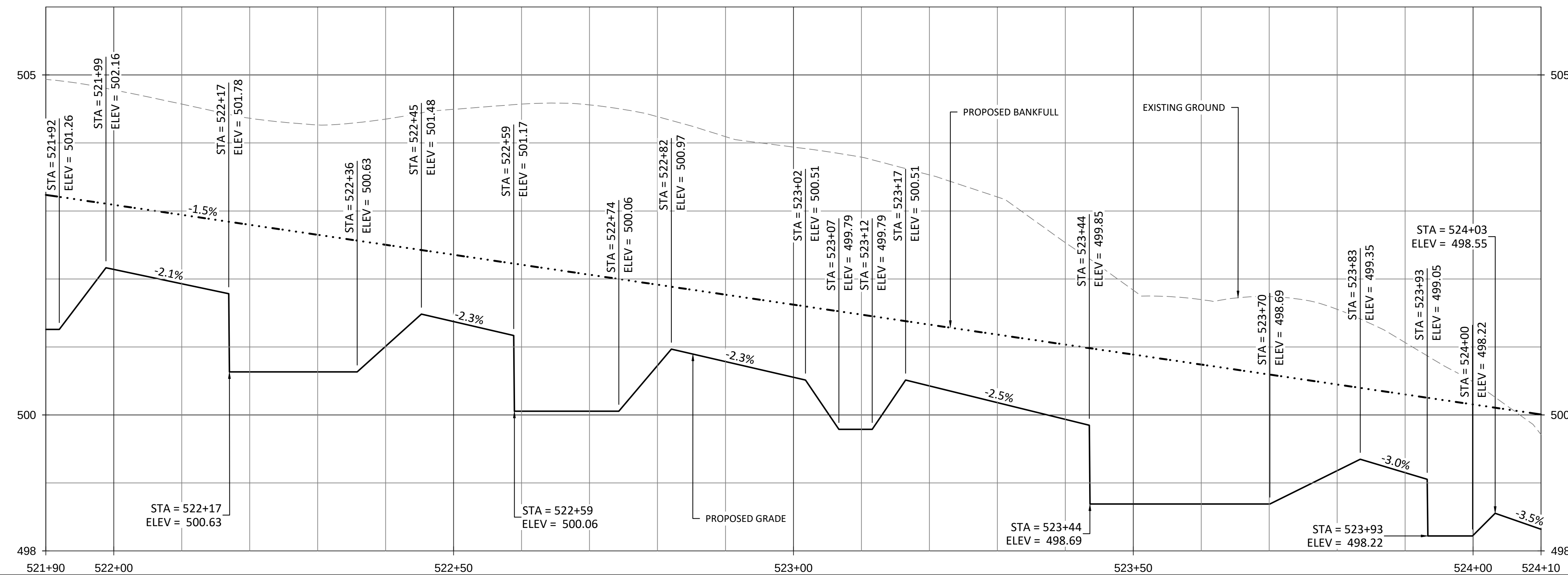
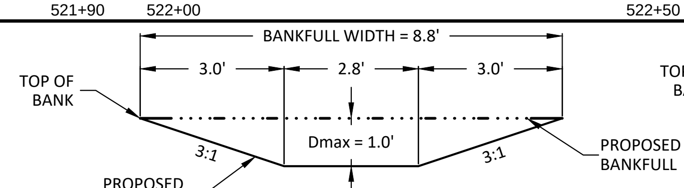
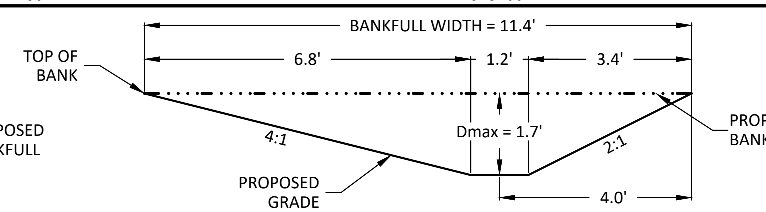
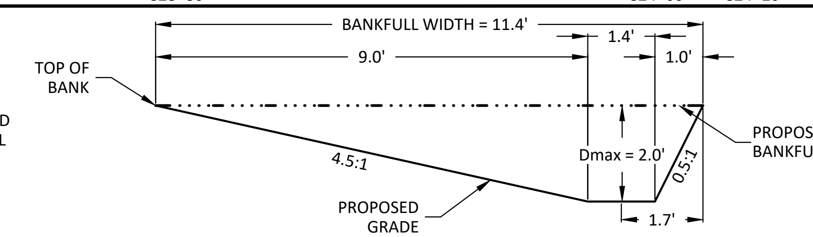




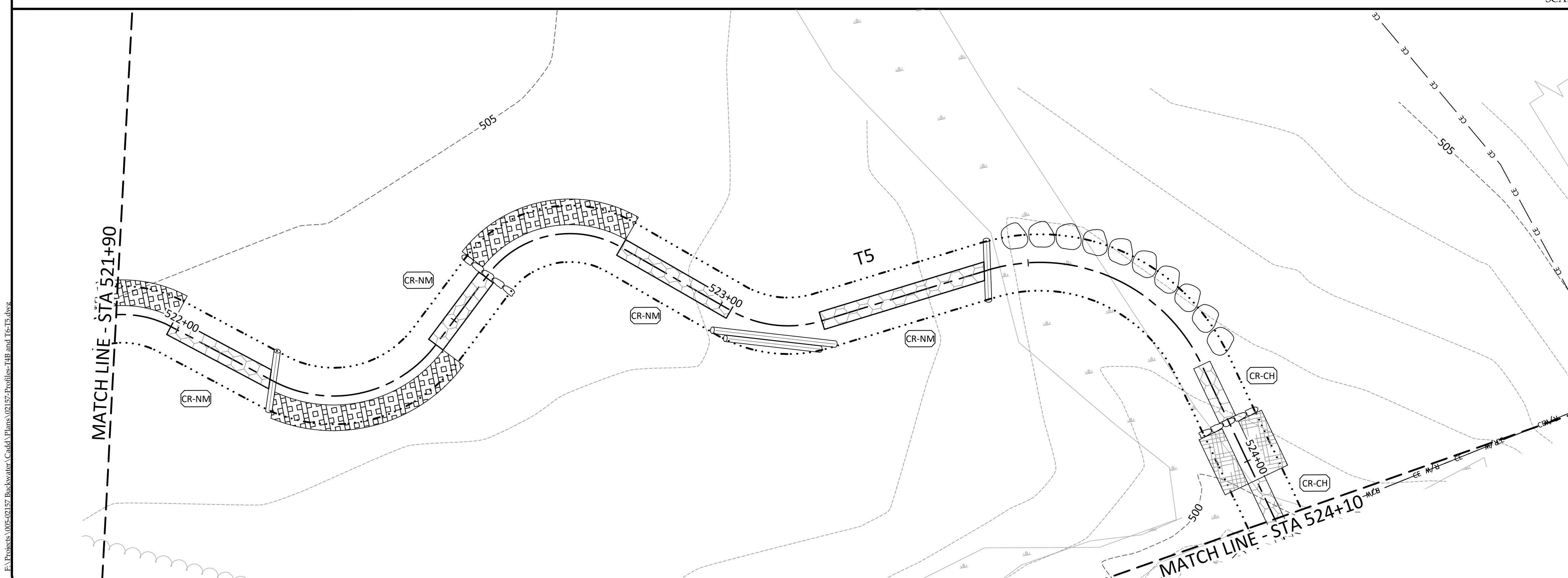
T5 - TYPICAL SECTION: RIFFLE
STA: 518+52 TO 524+21
SCALE: 1" = 2'



T5 - TYPICAL SECTION: SHALLOW POOL
STA: 518+52 TO 524+21
SCALE: 1" = 2'



T5 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 518+52 TO 524+21
SCALE: 1" = 2'



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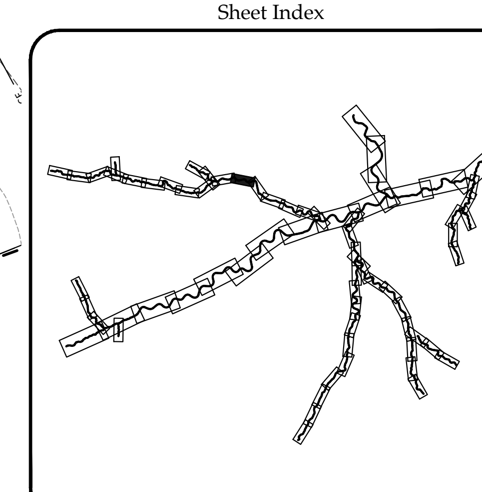

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T5
Stream Plan and Profile

Revisions:

Date:	05.26.2017
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Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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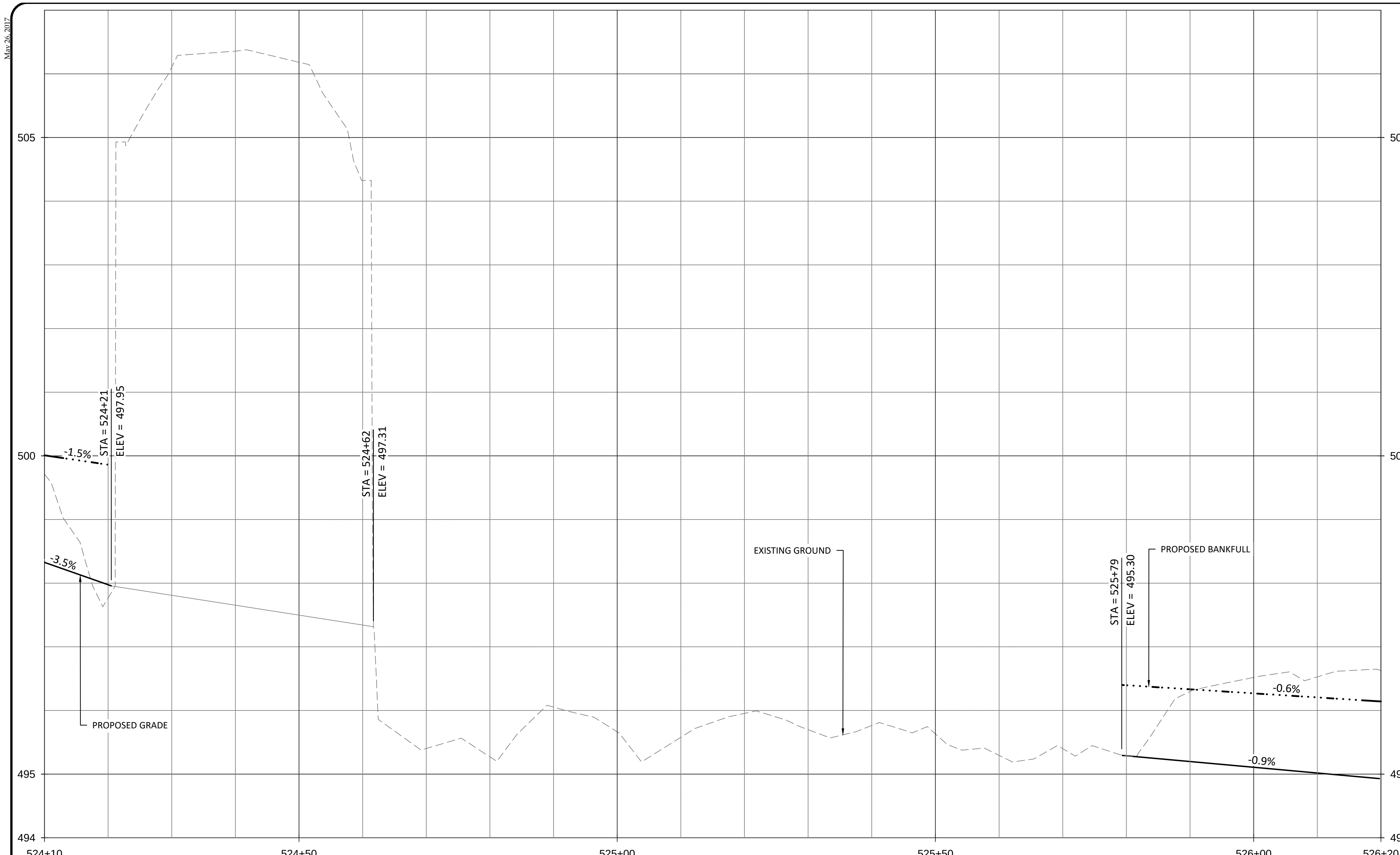
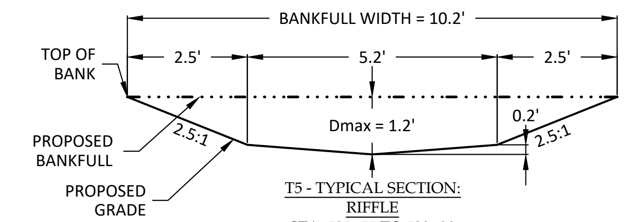
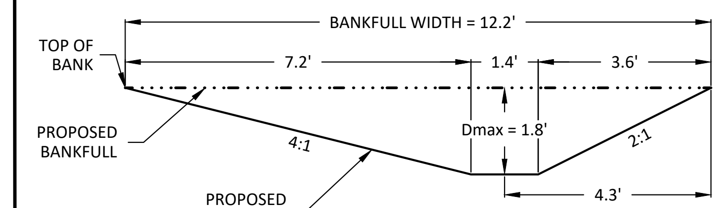
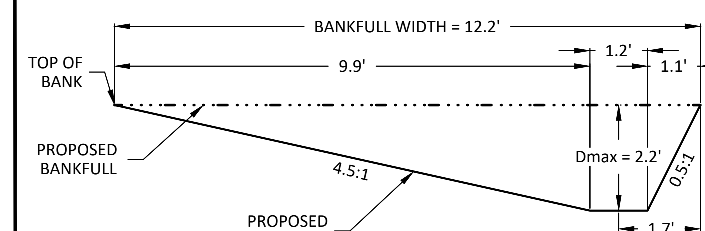




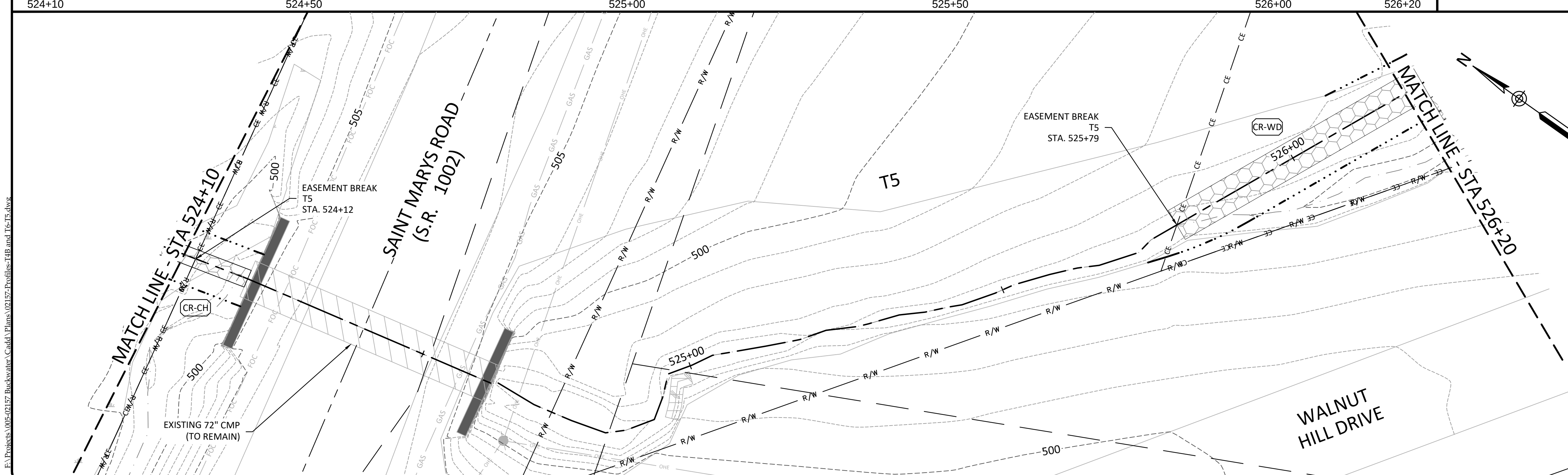
T5 - TYPICAL SECTION: RIFFLE
STA: 525+75 TO 529+38
SCALE: 1" = 2'

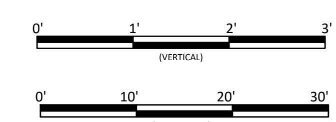


T5 - TYPICAL SECTION: SHALLOW POOL
STA: 525+75 TO 529+38
SCALE: 1" = 2'



T5 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 525+75 TO 529+38
SCALE: 1" = 2'





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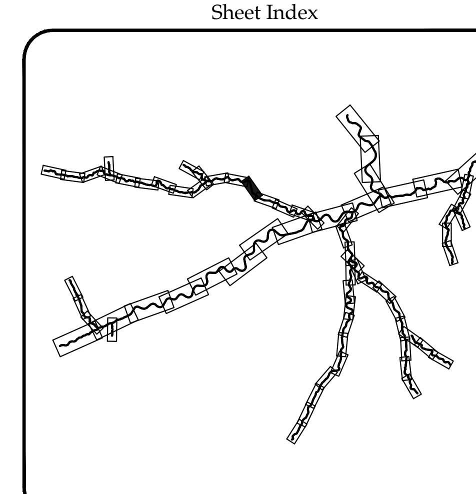

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T5
Stream Plan and Profile

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Date:	05.26.2017
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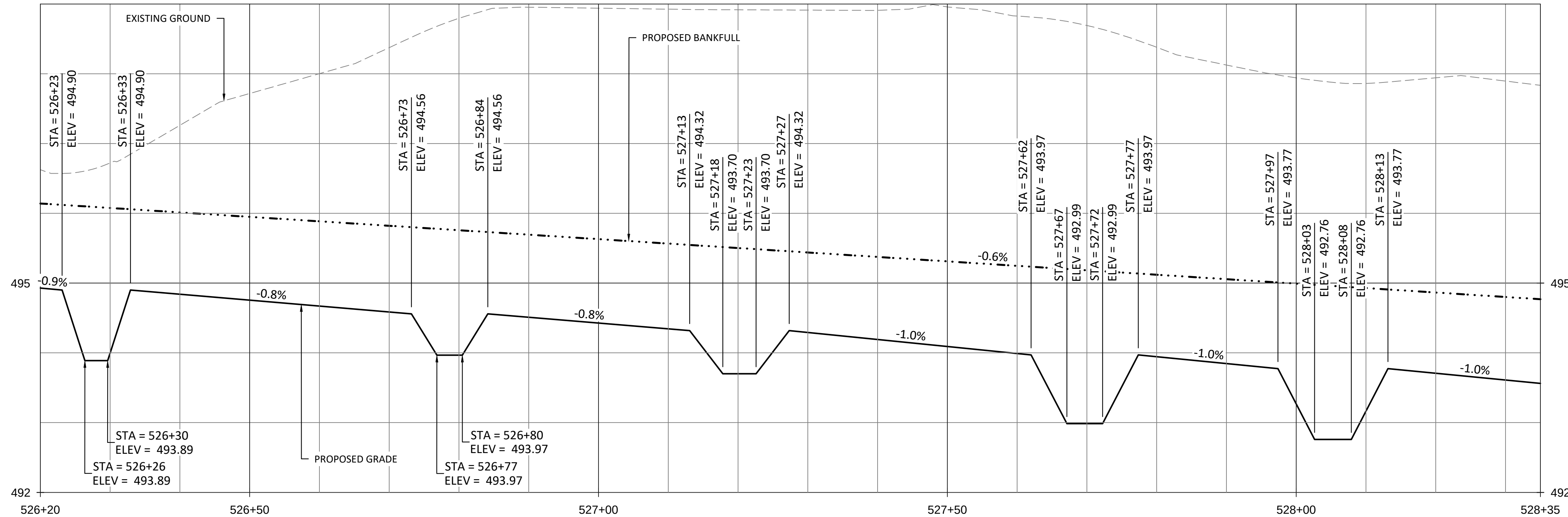

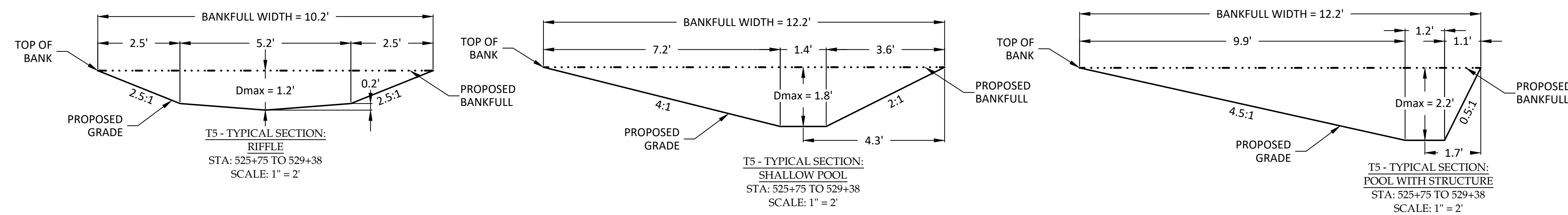

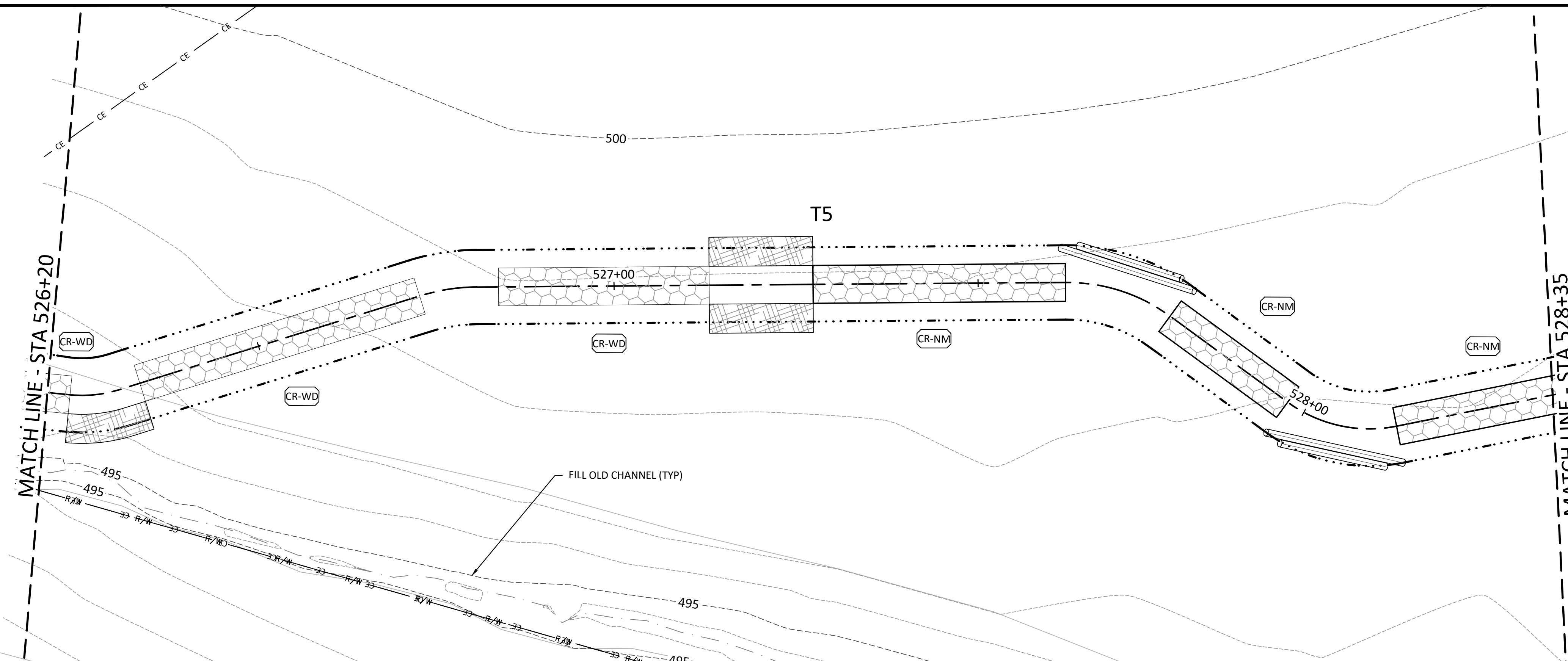

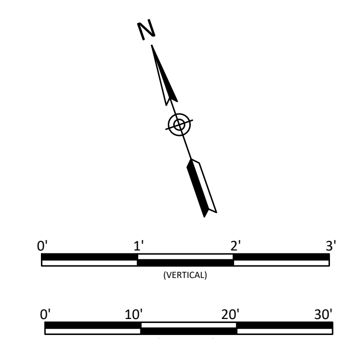

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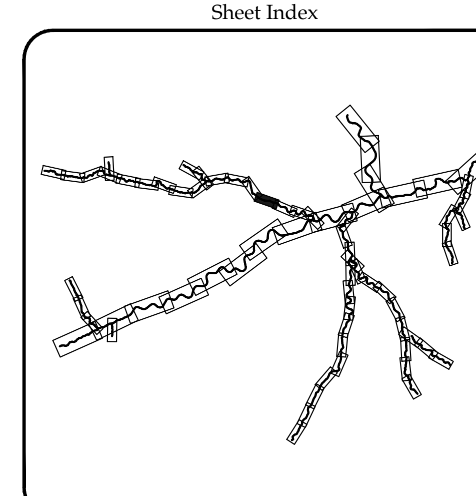

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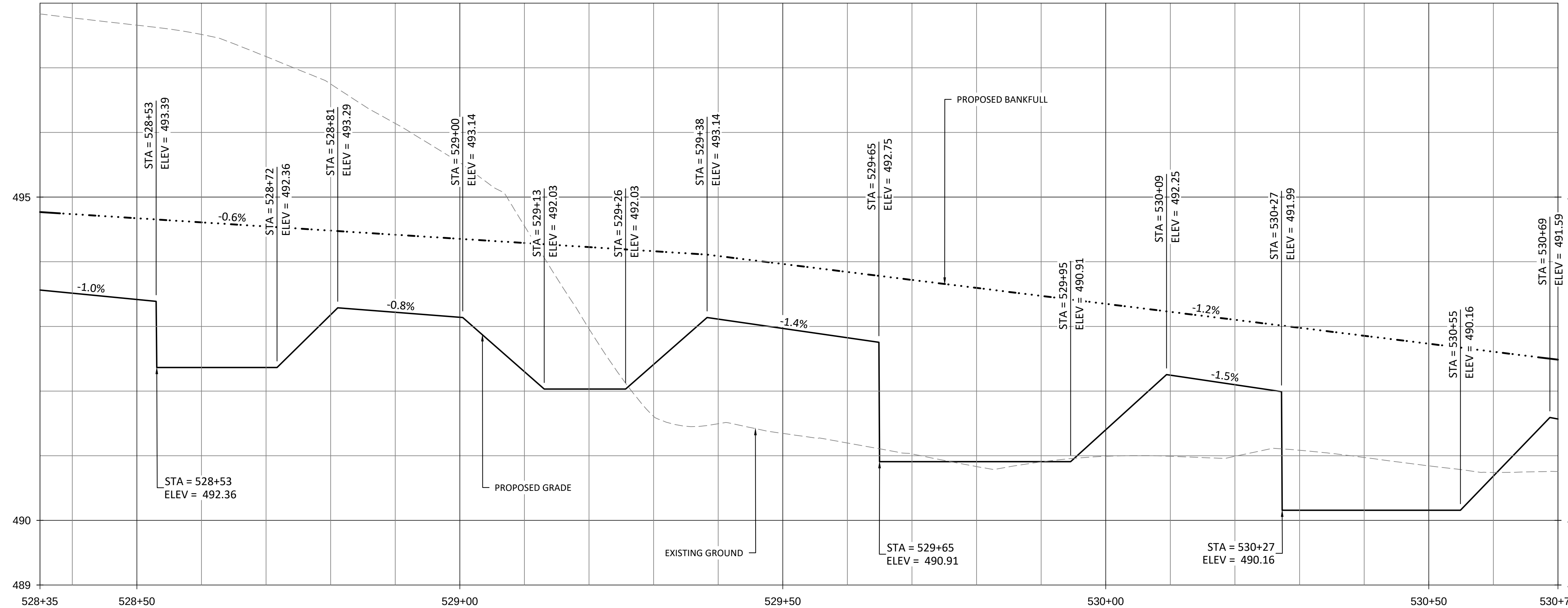
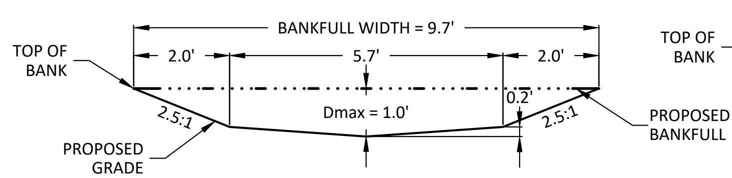
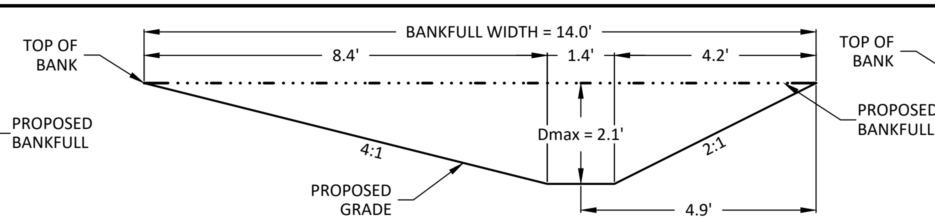
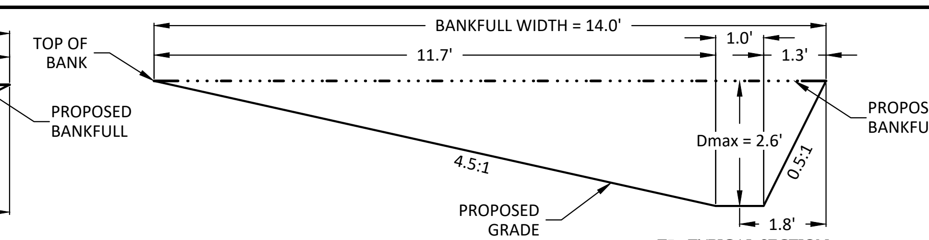




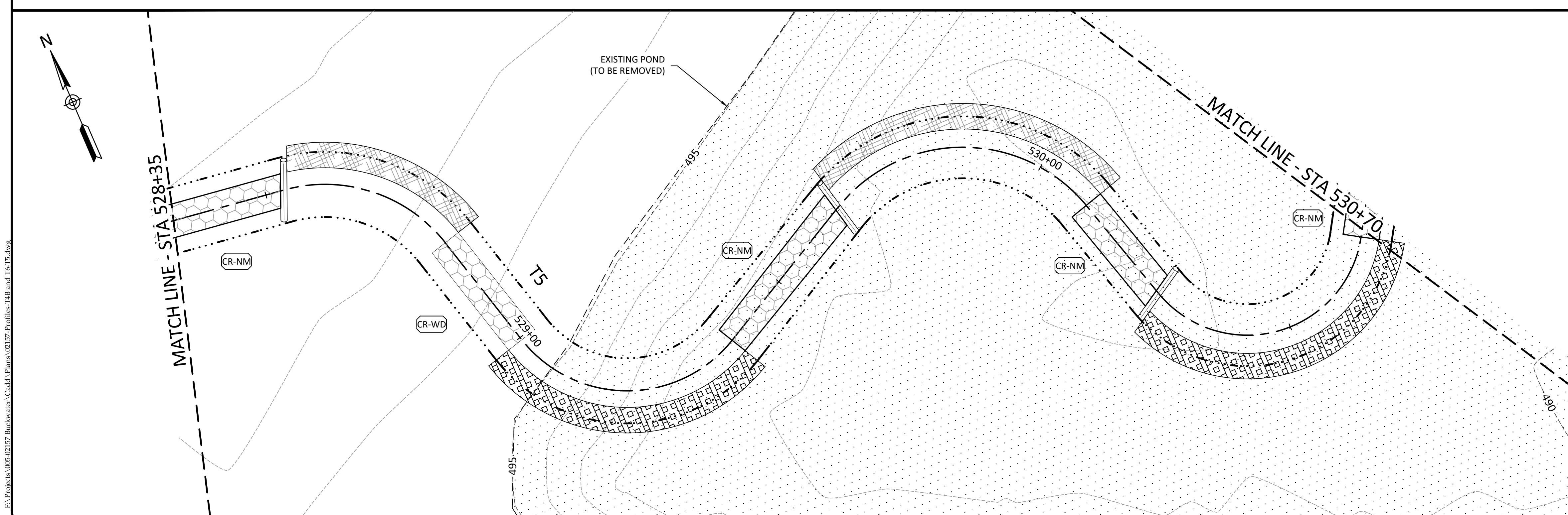
T5 - TYPICAL SECTION:
RIFFLE
STA: 529+38 TO 532+90
SCALE: 1" = 2'

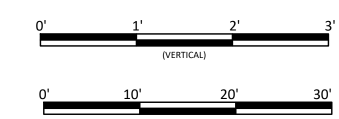


T5 - TYPICAL SECTION:
SHALLOW POOL
STA: 529+38 TO 532+90
SCALE: 1" = 2'



T5 - TYPICAL SECTION:
POOL WITH STRUCTURE
STA: 529+38 TO 532+90
SCALE: 1" = 2'





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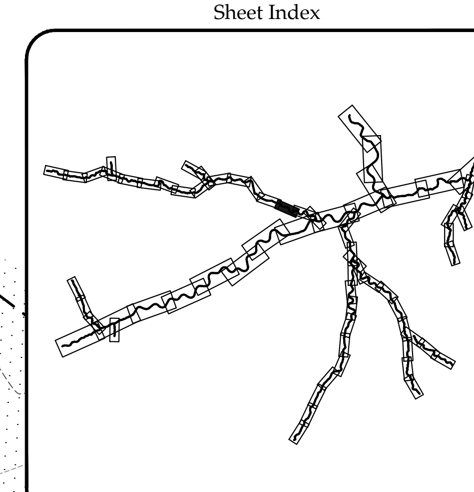

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T5
Stream Plan and Profile

Date:	05.26.2017
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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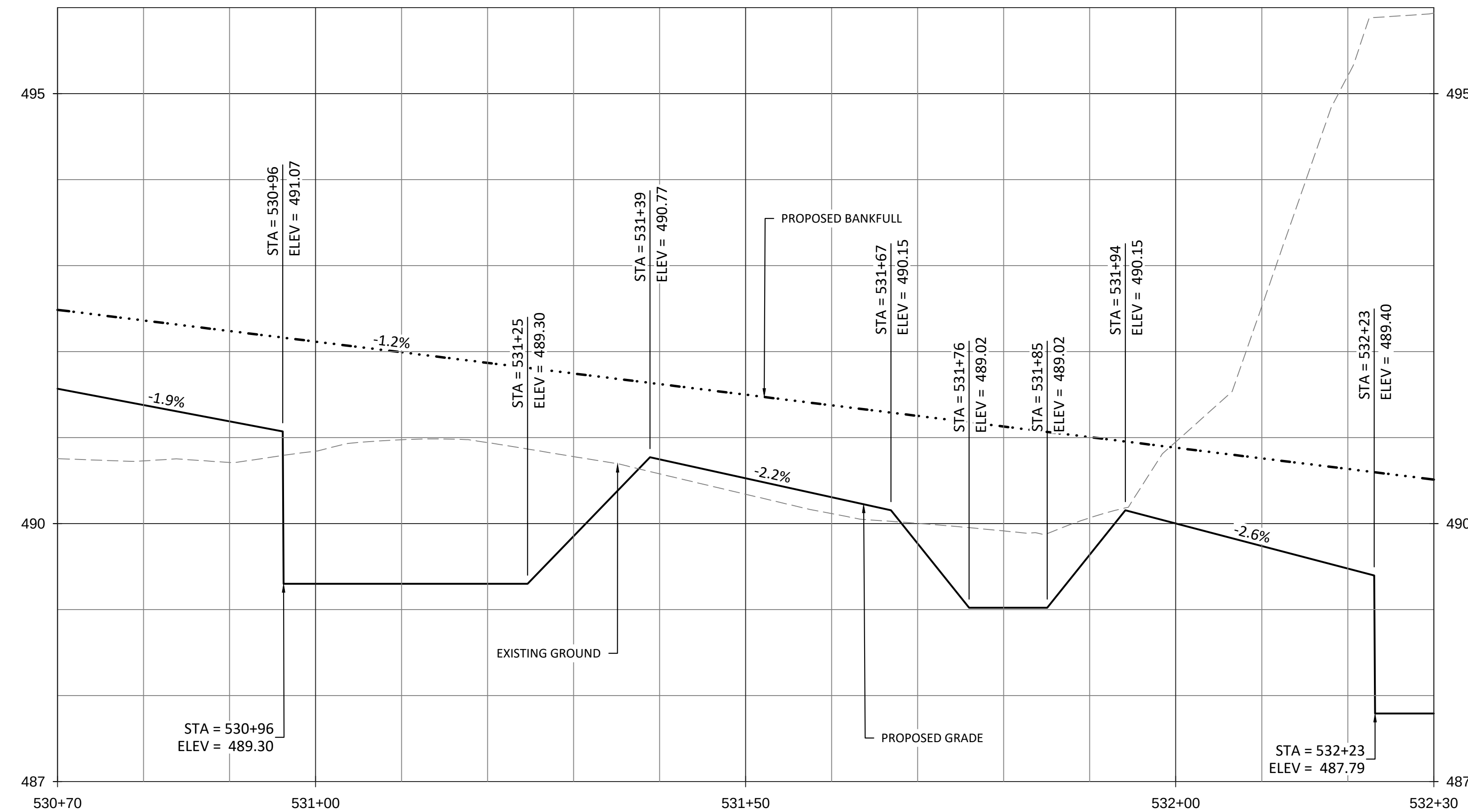

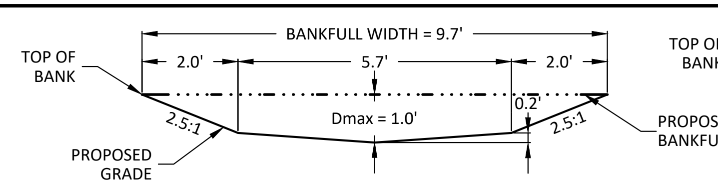

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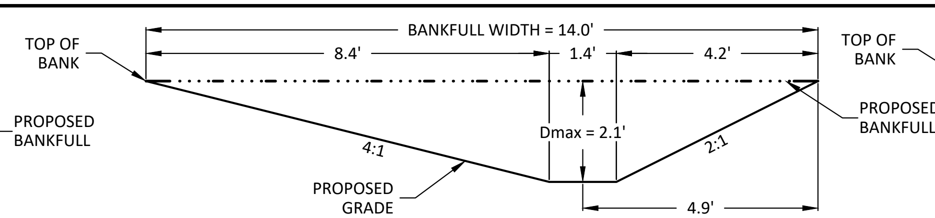
STA: 529+38 TO 532+90
SCALE: 1" = 2'



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STA: 529+38 TO 532+90
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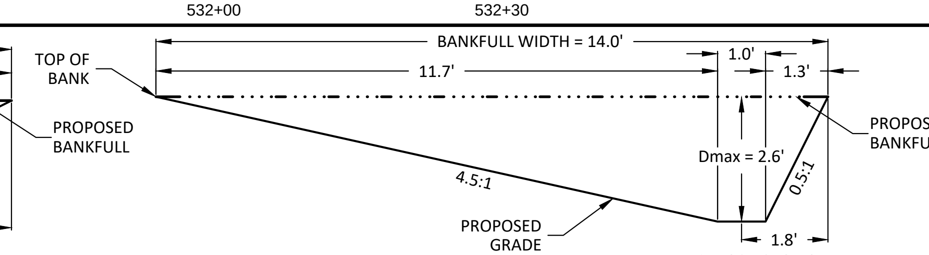
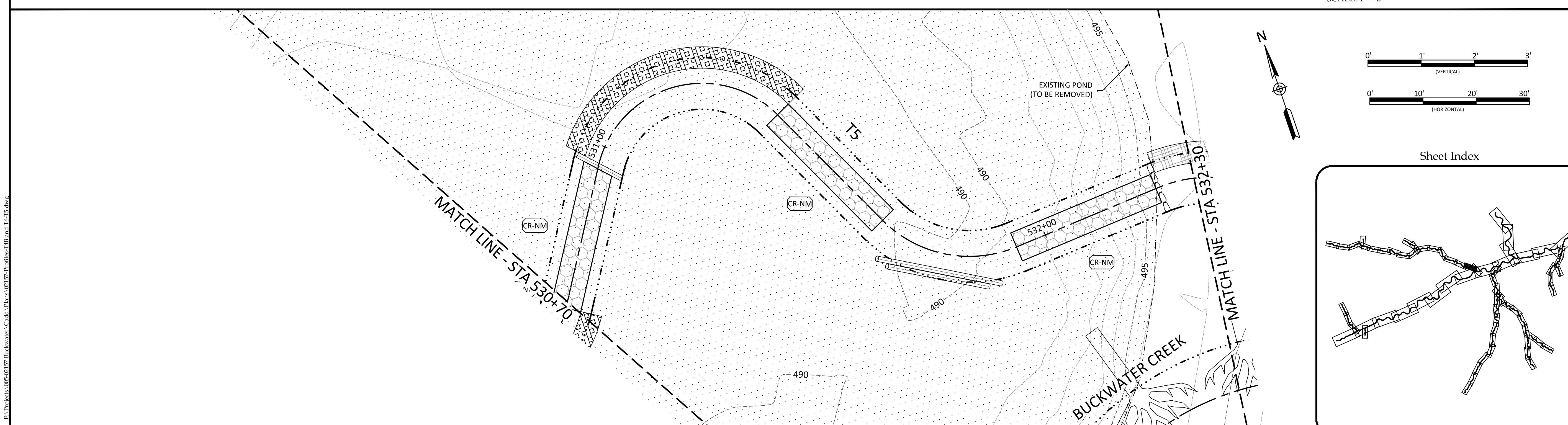


T5 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 529+38 TO 532+90
SCALE: 1" = 2'



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T5
Stream Plan and Profile

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Checked By:	JWH

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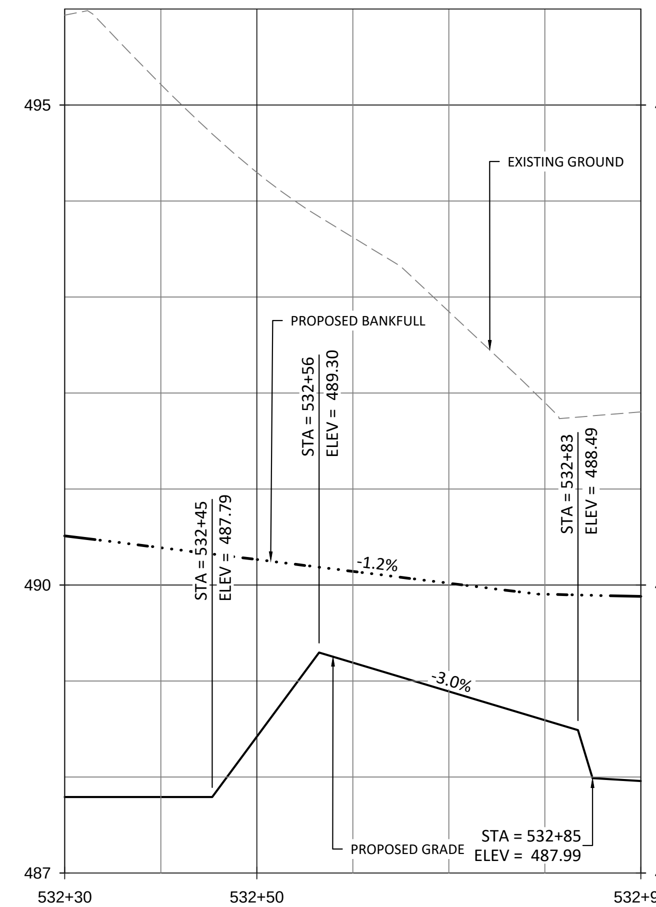
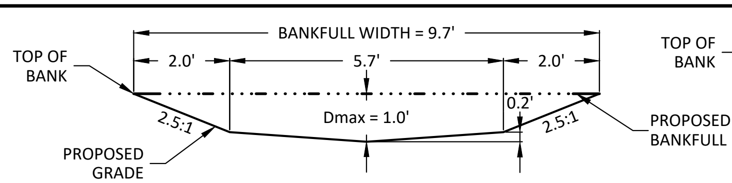
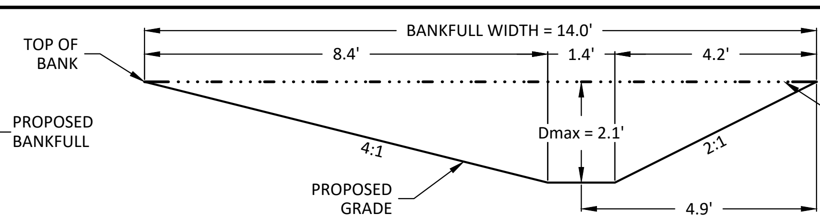
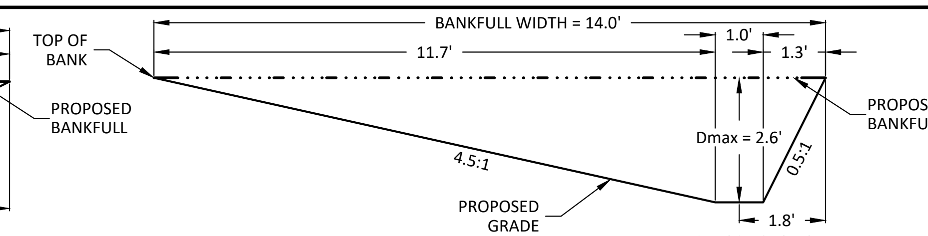




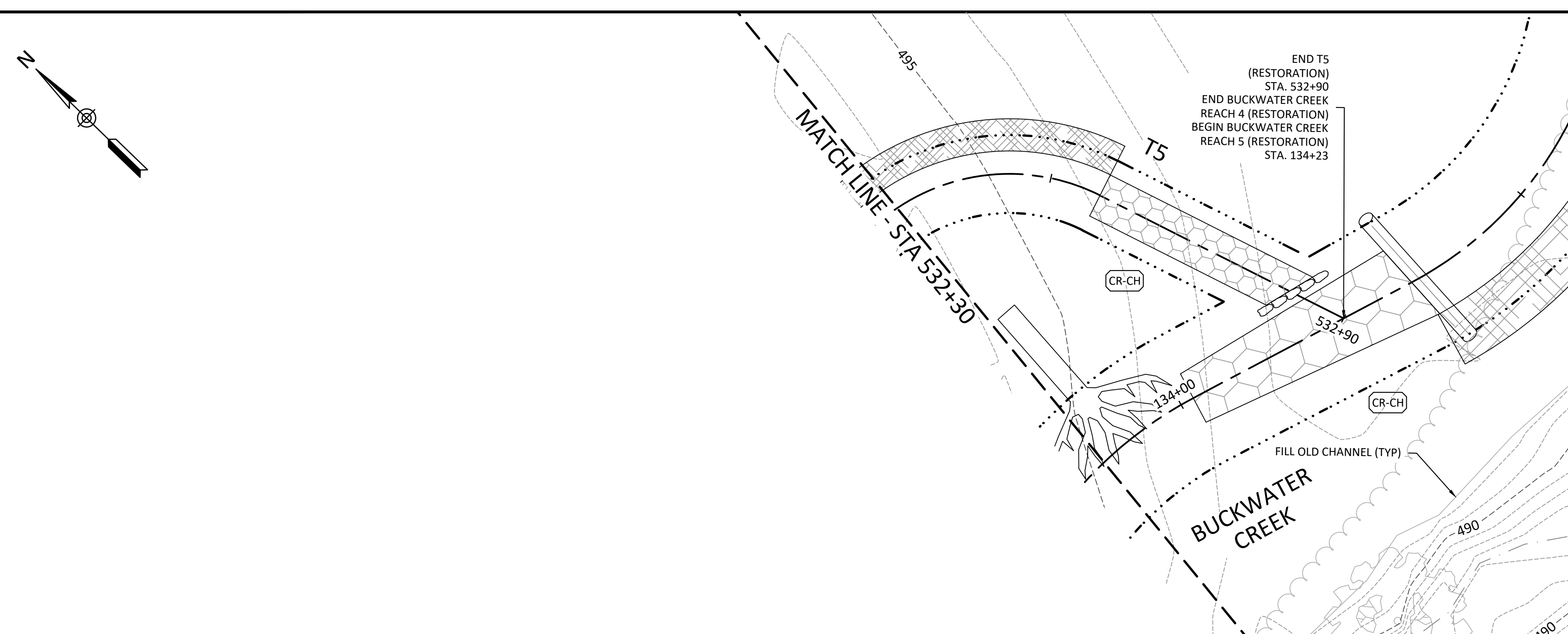
T5 - TYPICAL SECTION: RIFFLE
STA: 529+38 TO 532+90
SCALE: 1" = 2'

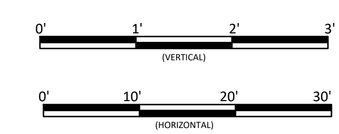


T5 - TYPICAL SECTION: SHALLOW POOL
STA: 529+38 TO 532+90
SCALE: 1" = 2'



T5 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 529+38 TO 532+90
SCALE: 1" = 2'





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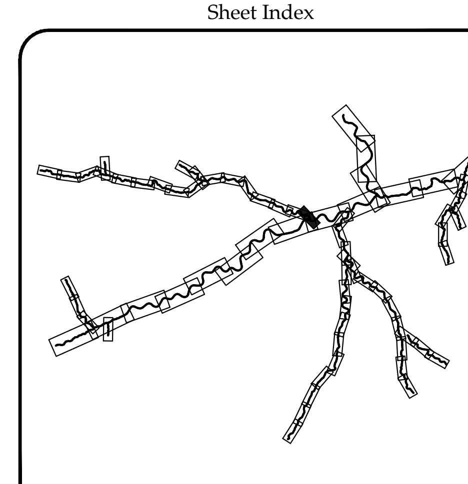

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T5
Stream Plan and Profile

Date:	05.26.2017
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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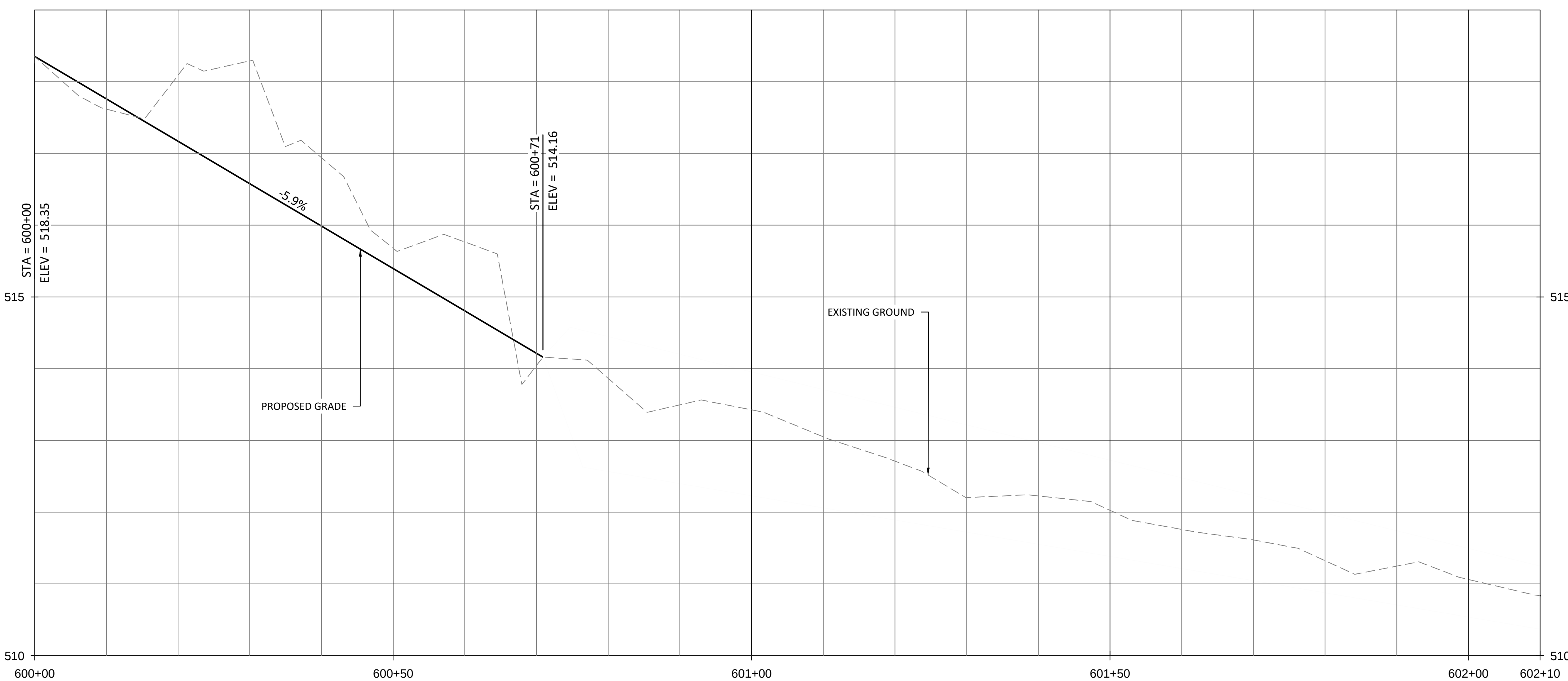

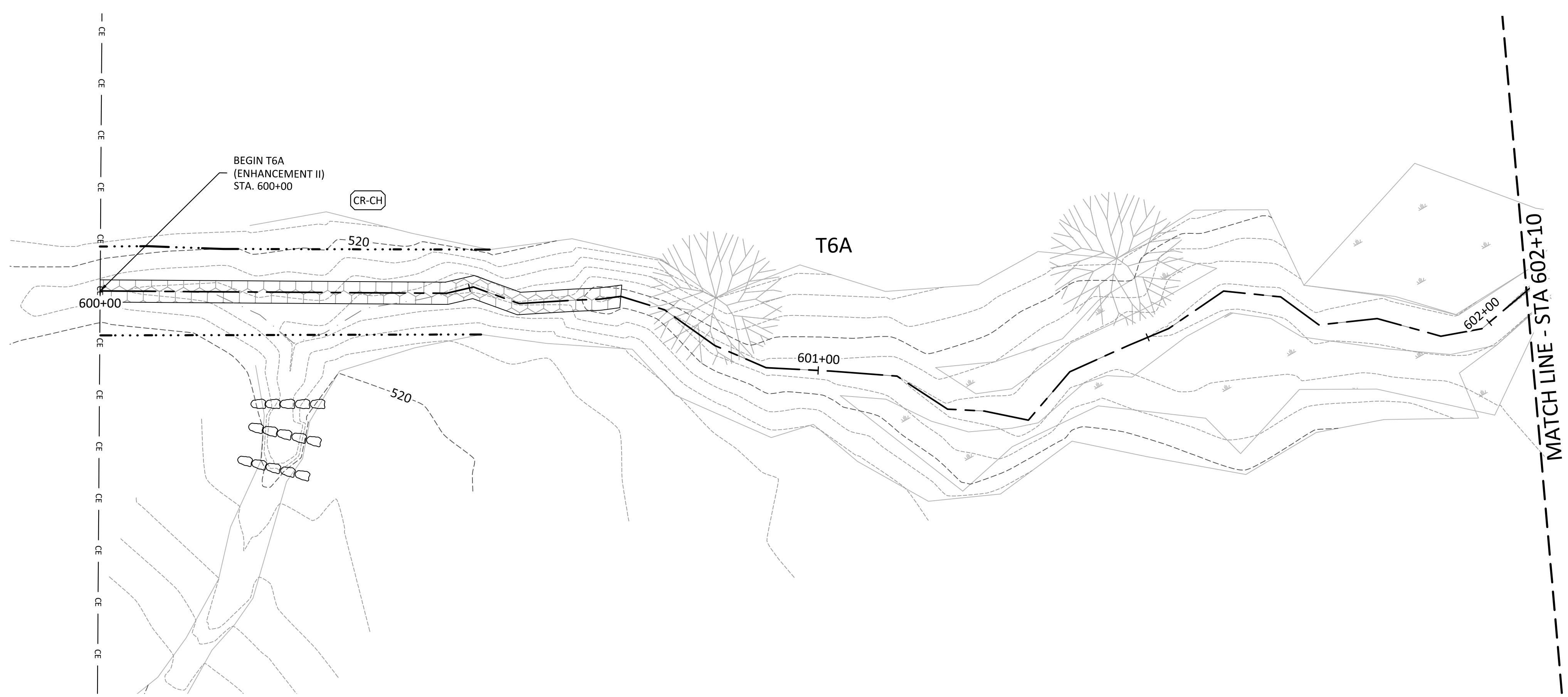

N

0' 1' 2' 3'
(VERTICAL)

0' 10' 20' 30'
(HORIZONTAL)

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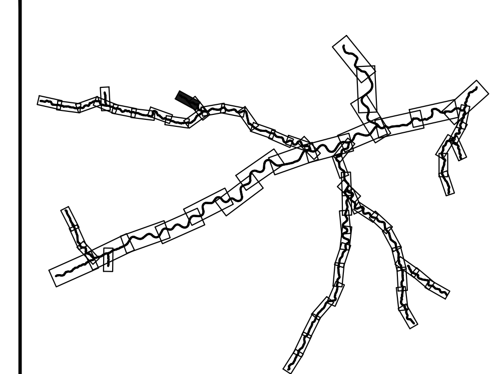

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T6A
Stream Plan and Profile

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Date:	05.26.2017
Job Number:	005-02157
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Drawn By:	CLM
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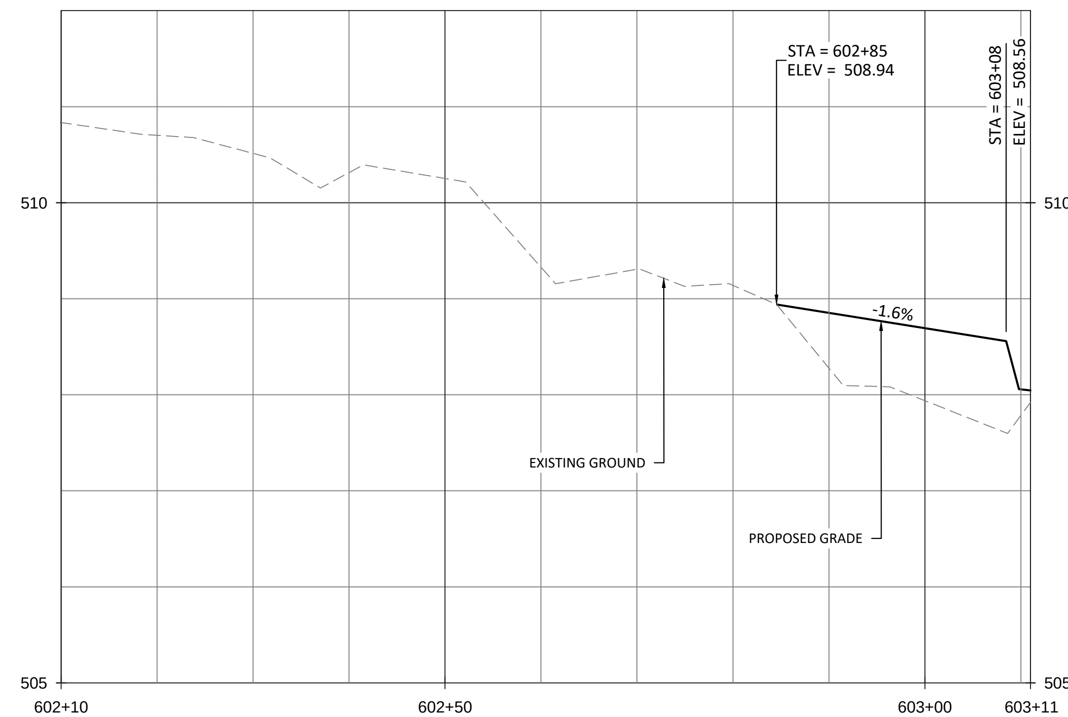

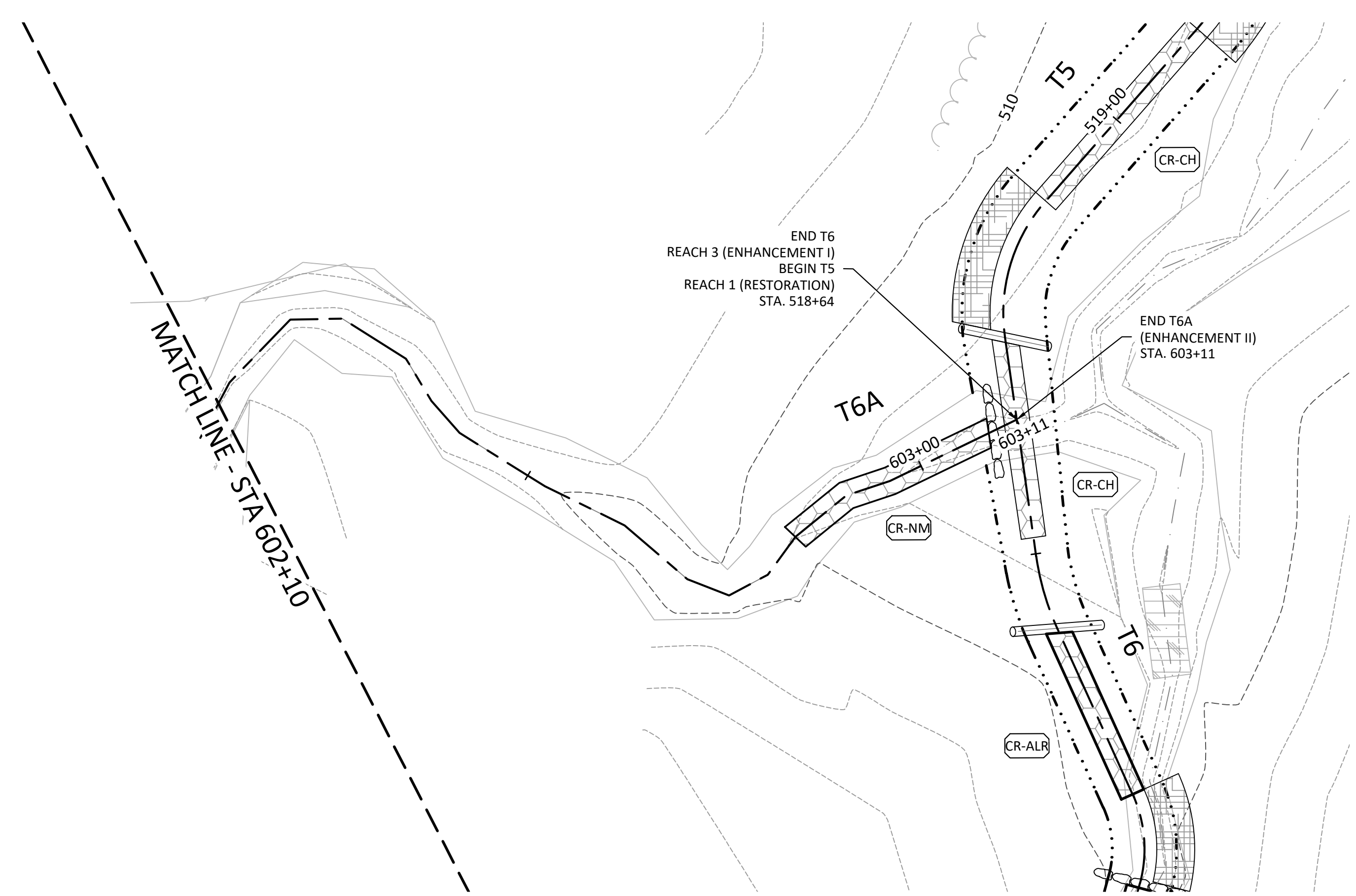

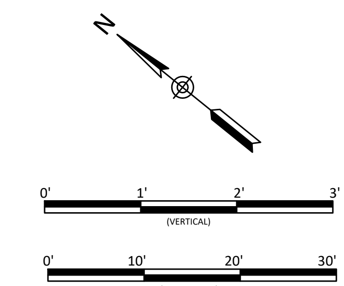

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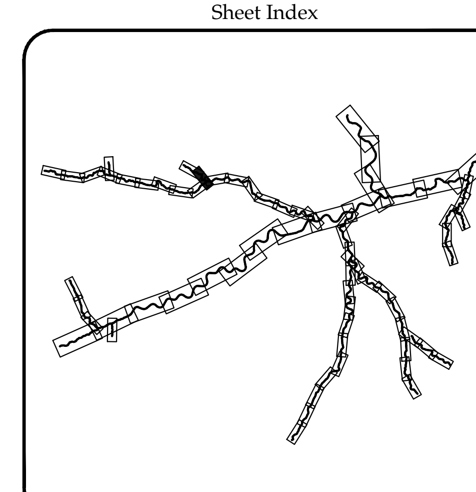

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T6A
Stream Plan and Profile

Revisions:

Date:	05.26.2017
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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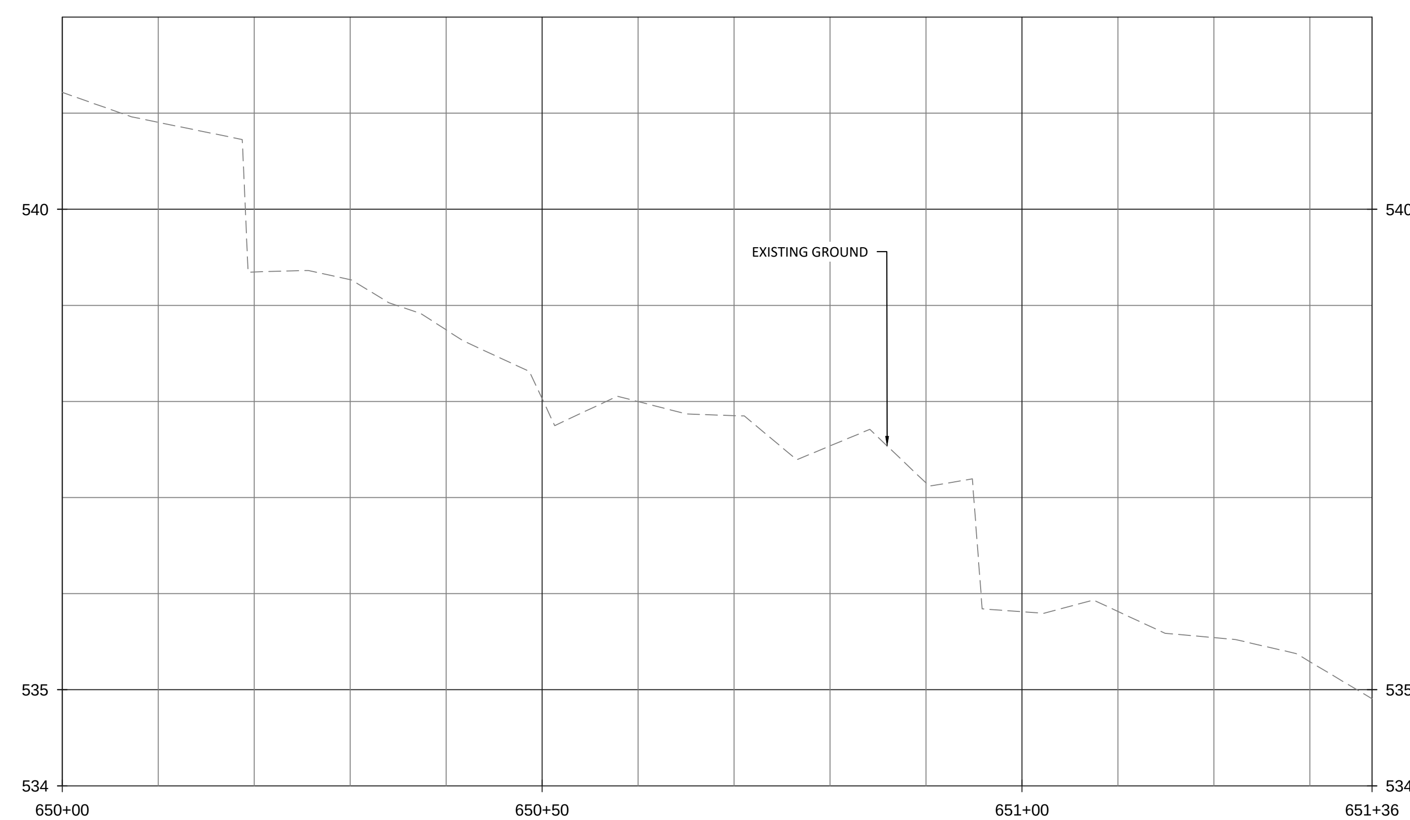

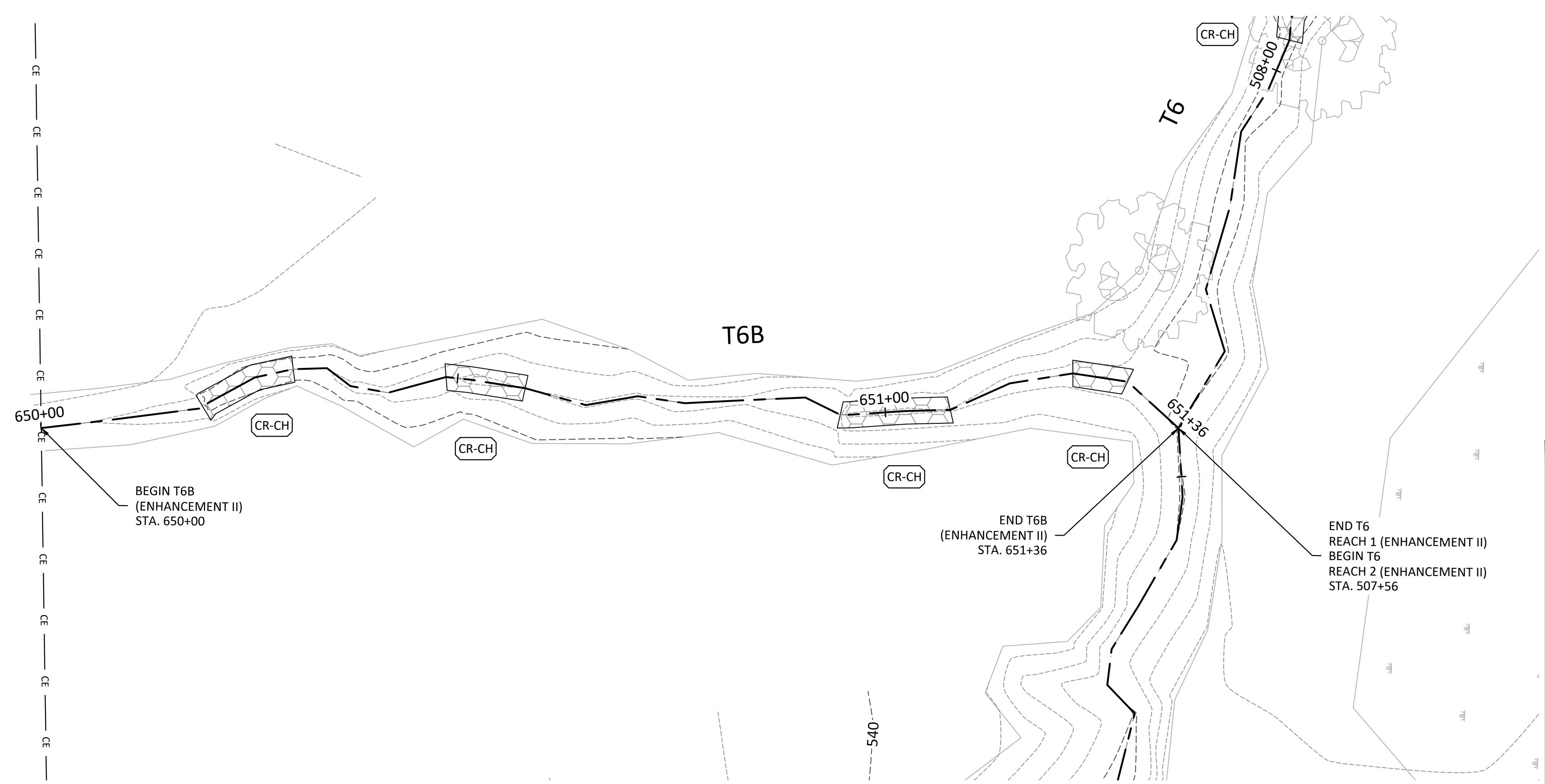

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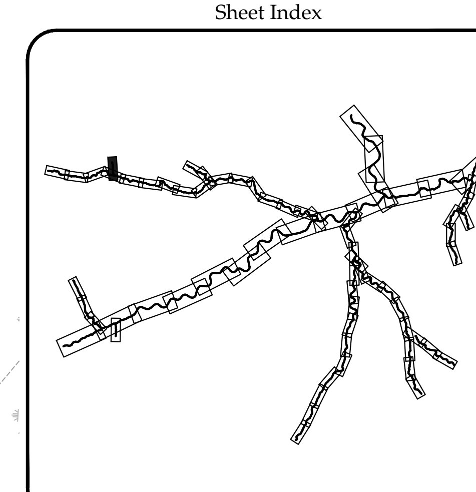

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T6B
Stream Plan and Profile

Revisions:

Date:	05.26.2017
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CLM
Checked By:	JWH

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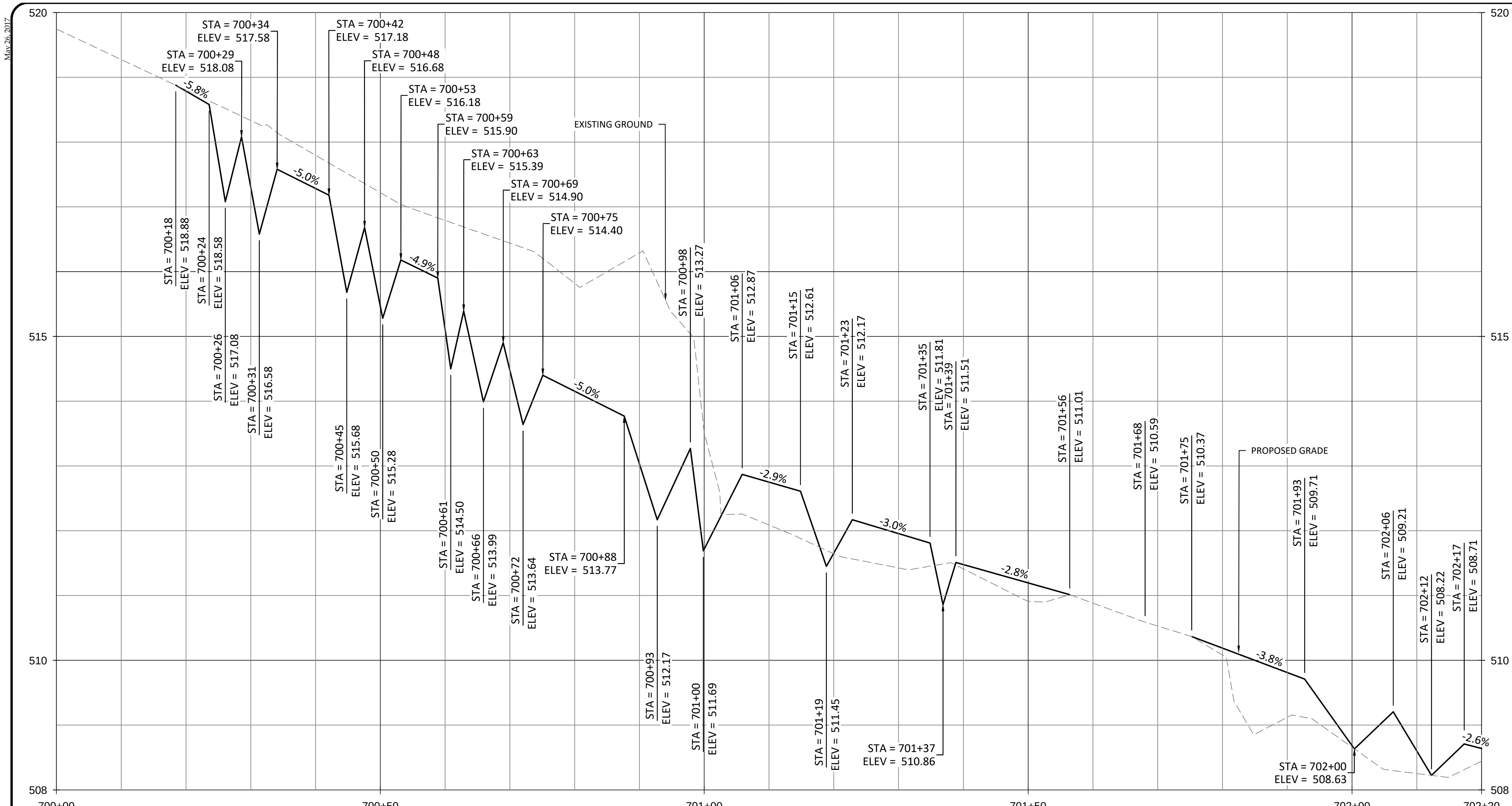
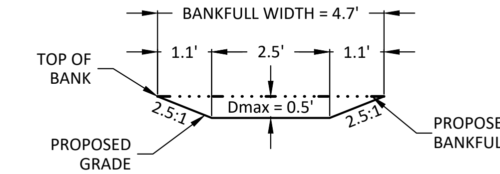
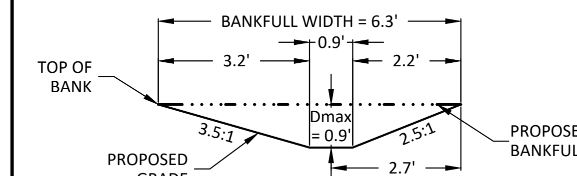
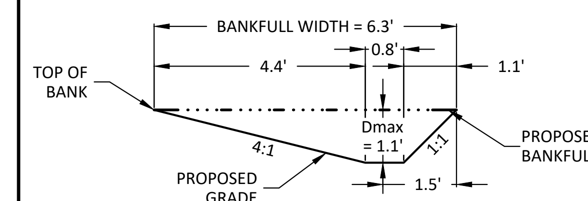




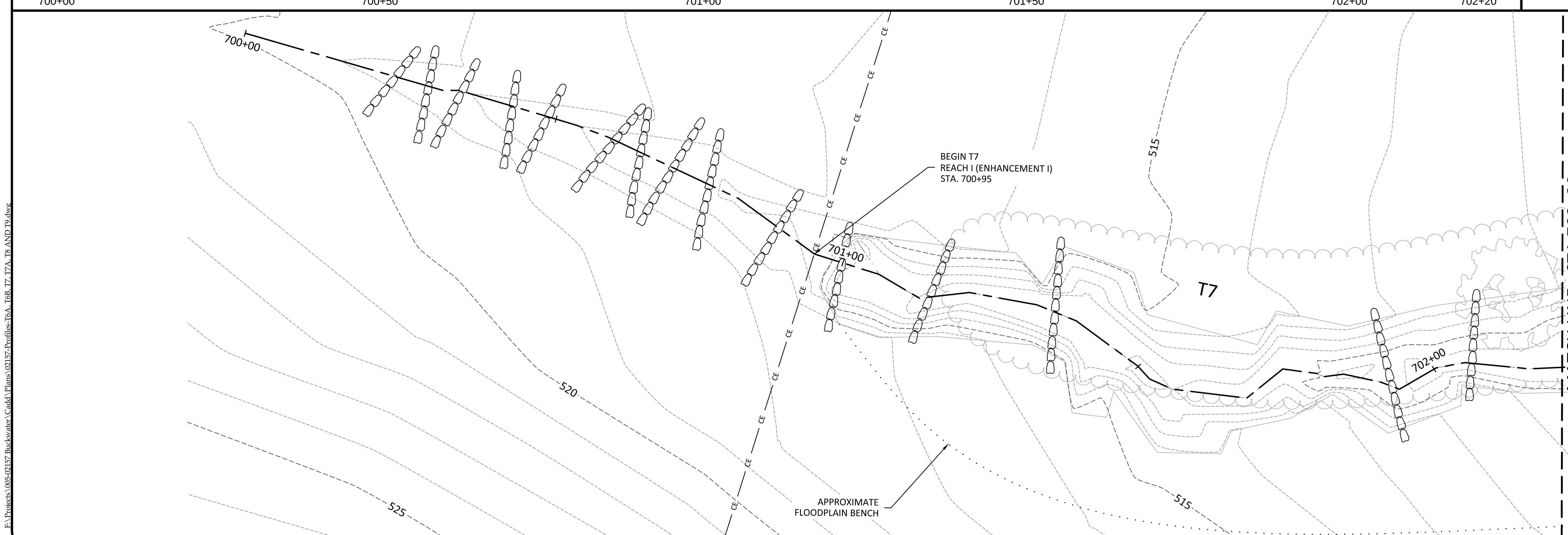
T7 REACH 1 - TYPICAL SECTION: RIFFLE
STA: 700+00 TO 704+17
SCALE: 1" = 2'

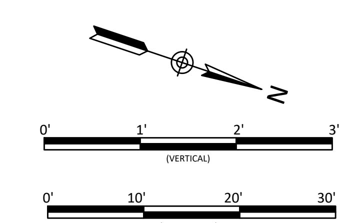


T7 REACH 1 - TYPICAL SECTION: SHALLOW POOL
STA: 700+00 TO 704+17
SCALE: 1" = 2'



T7 REACH 1 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 700+00 TO 704+17
SCALE: 1" = 2'





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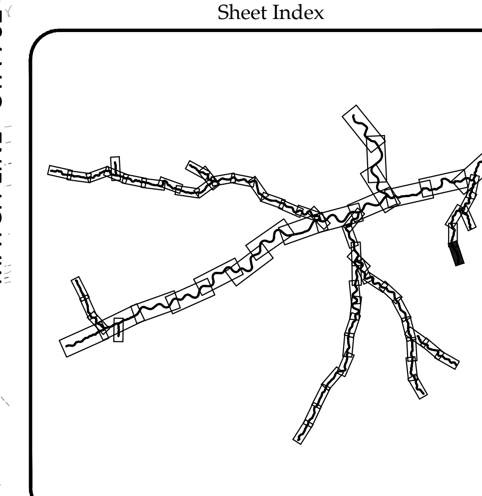

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T7 Reach 1
Stream Plan and Profile

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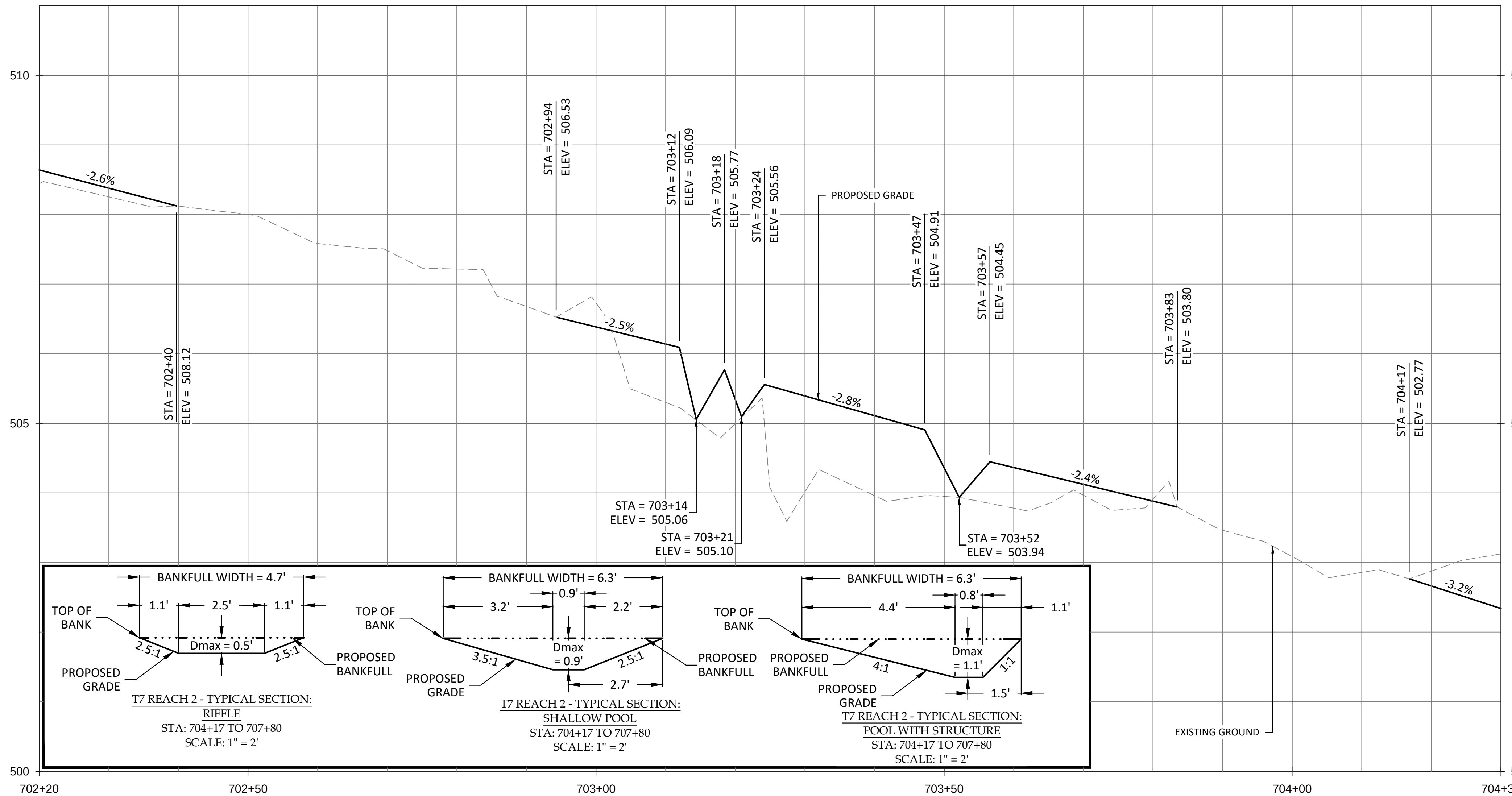

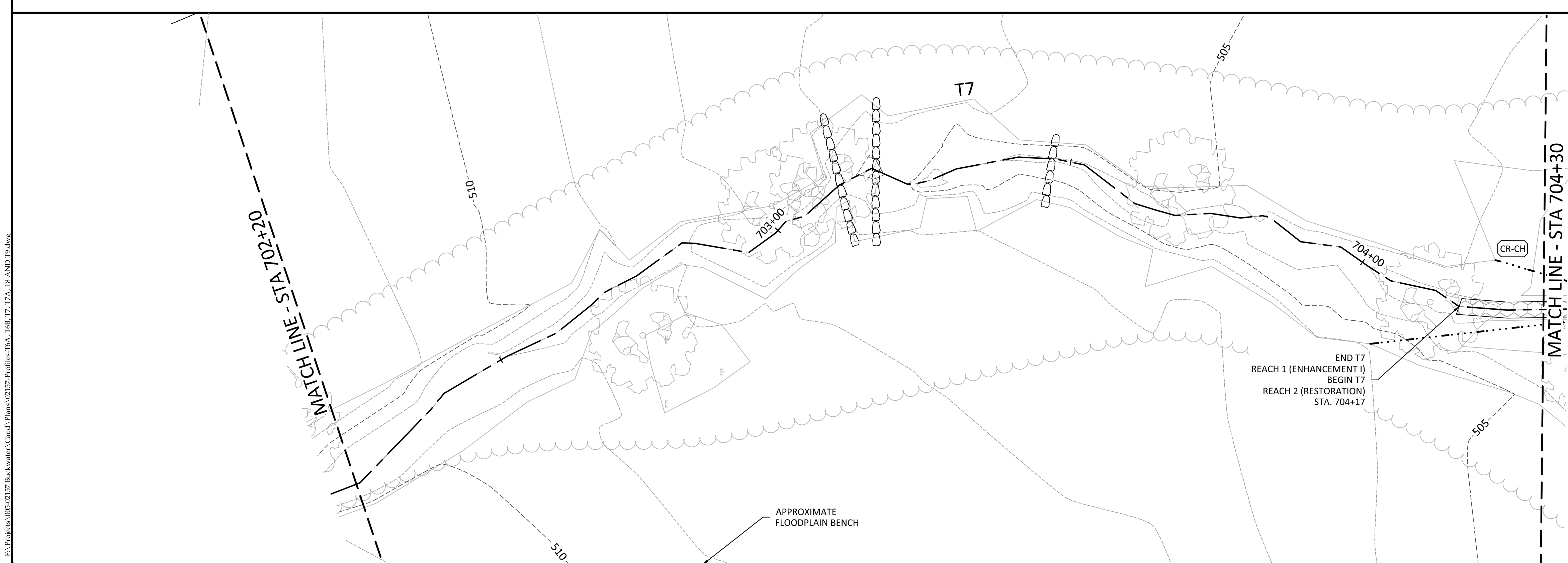

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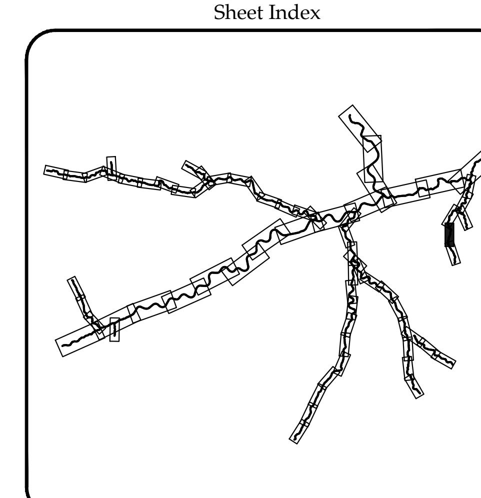

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T7 Reaches 1 & 2
Stream Plan and Profile

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Drawn By:	CLM
Checked By:	JWH

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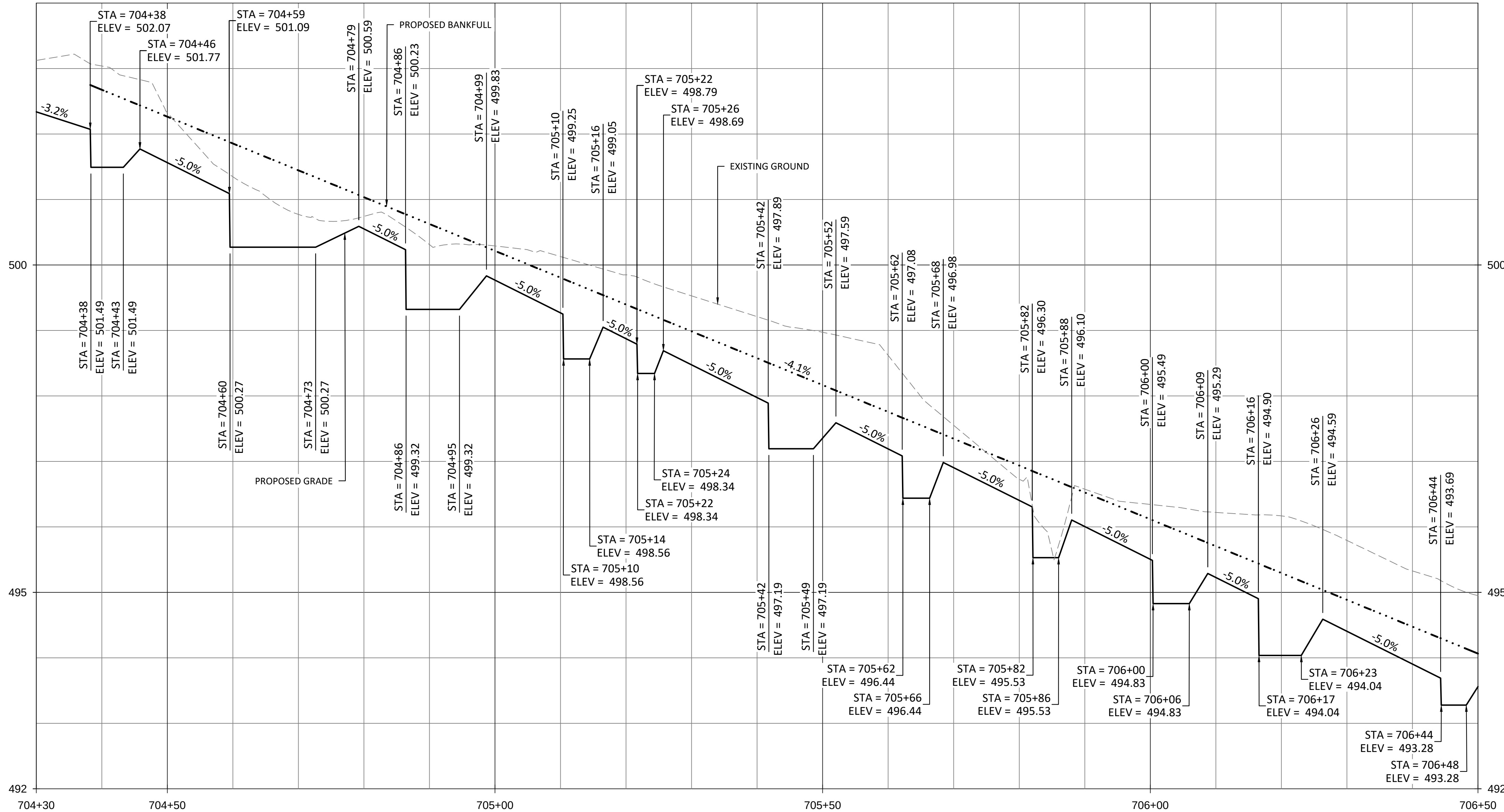
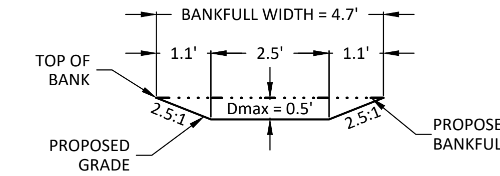
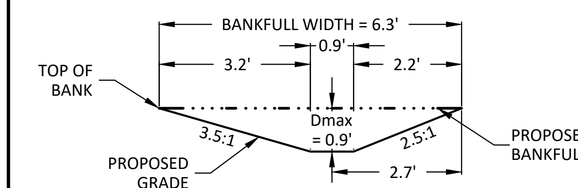
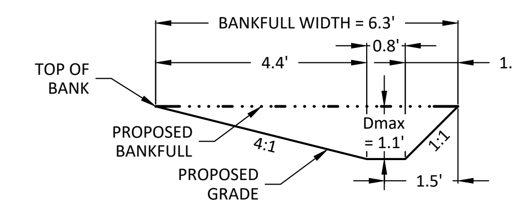




T7 REACH 2 - TYPICAL SECTION: RIFFLE
STA: 704+17 TO 707+80
SCALE: 1" = 2'



T7 REACH 2 - TYPICAL SECTION: SHALLOW POOL
STA: 704+17 TO 707+80
SCALE: 1" = 2'



T7 REACH 2 - TYPICAL SECTION: POOL WITH STRUCTURE
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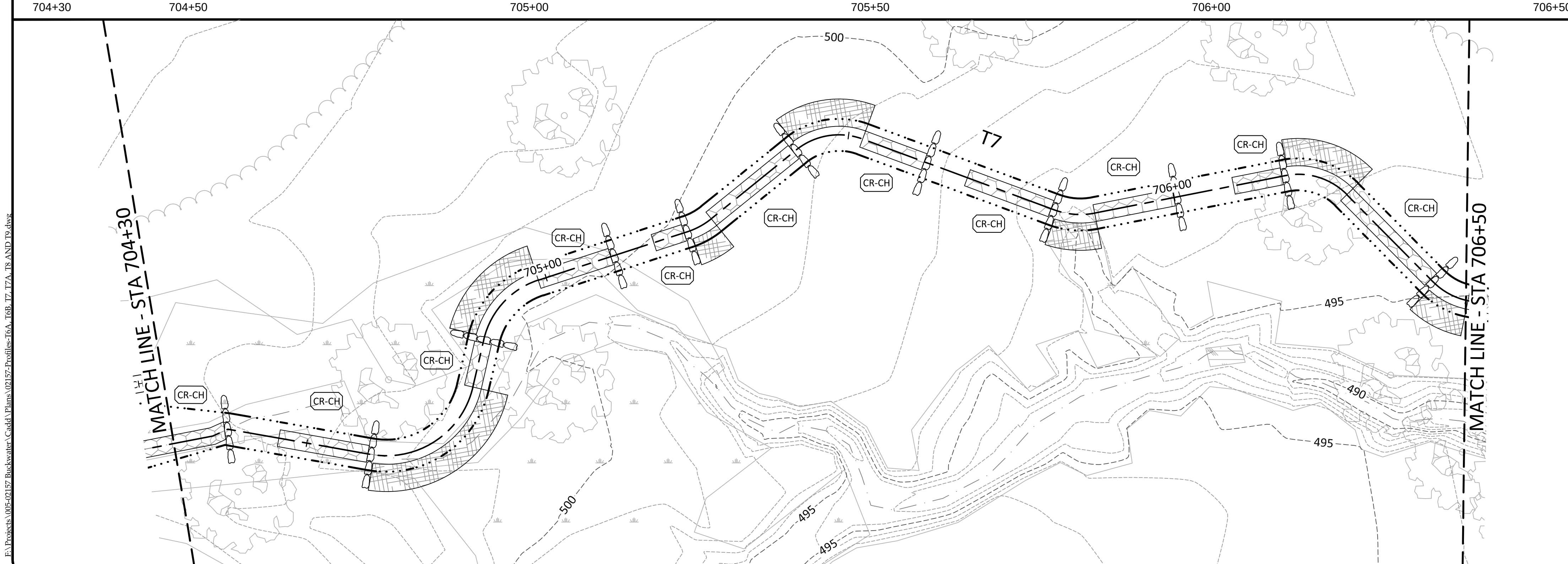
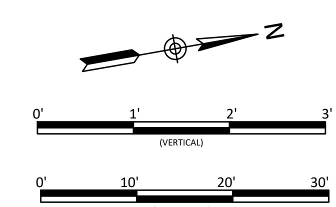
SCALE: 1" = 2'





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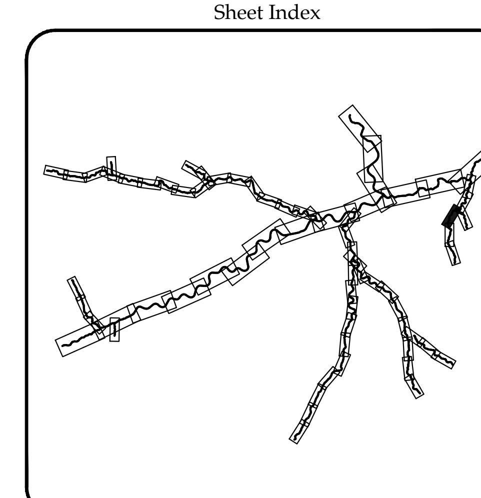

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T7 Reach 2
Stream Plan and Profile

Revisions:

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Checked By:	JWH

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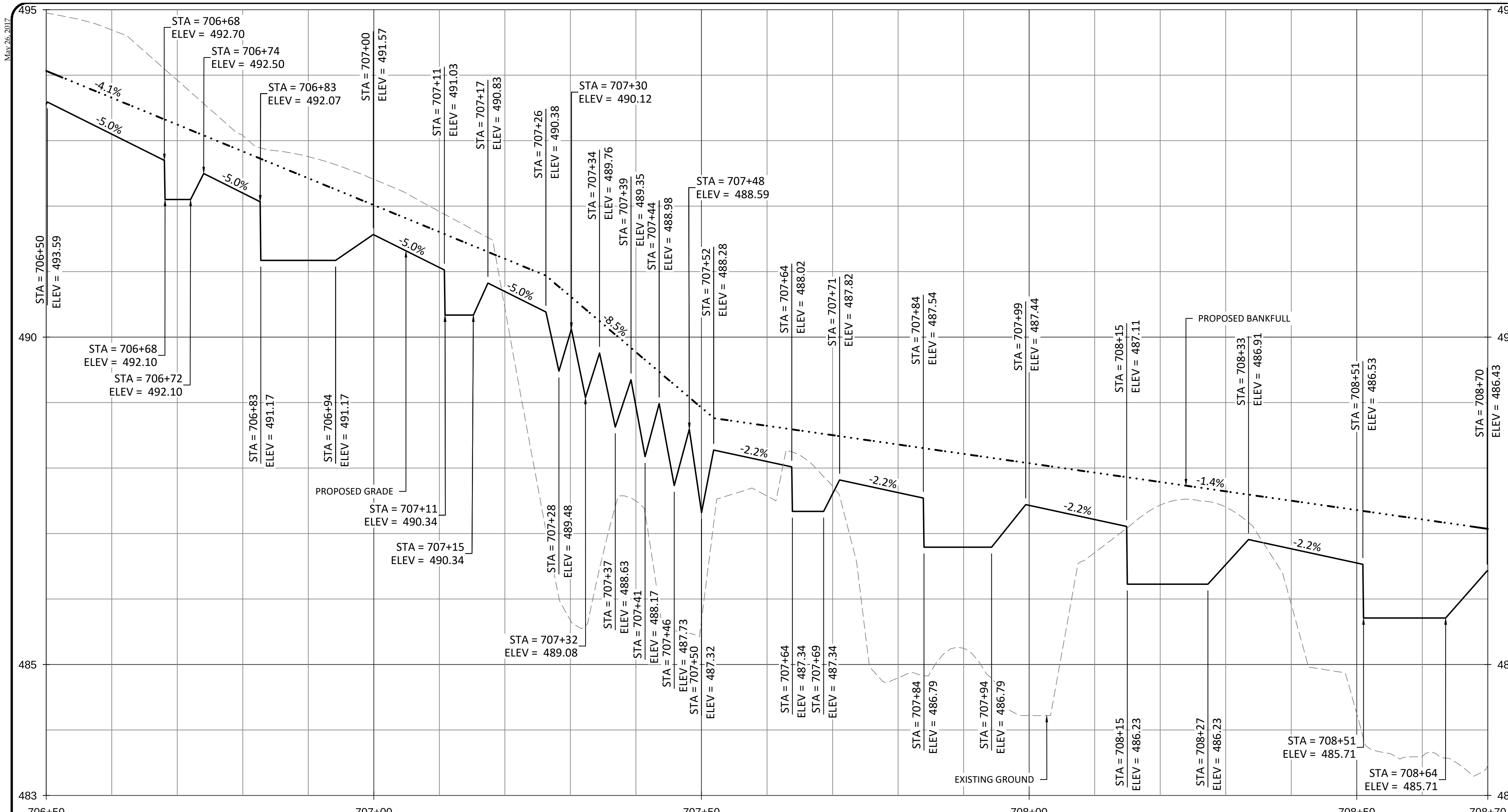
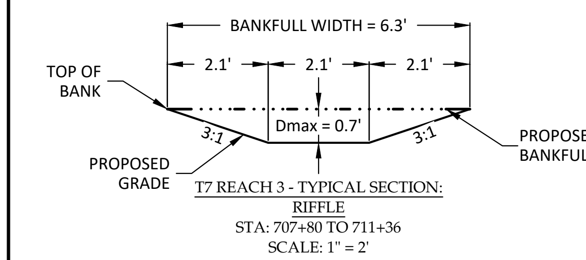
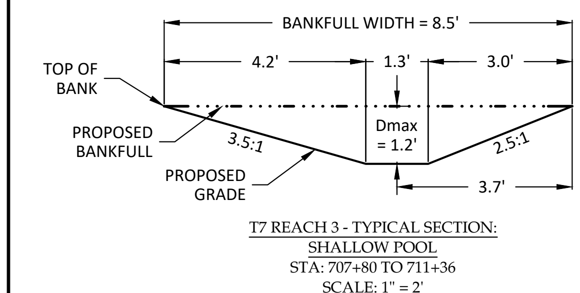
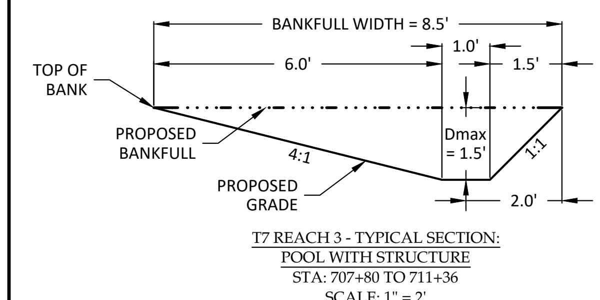


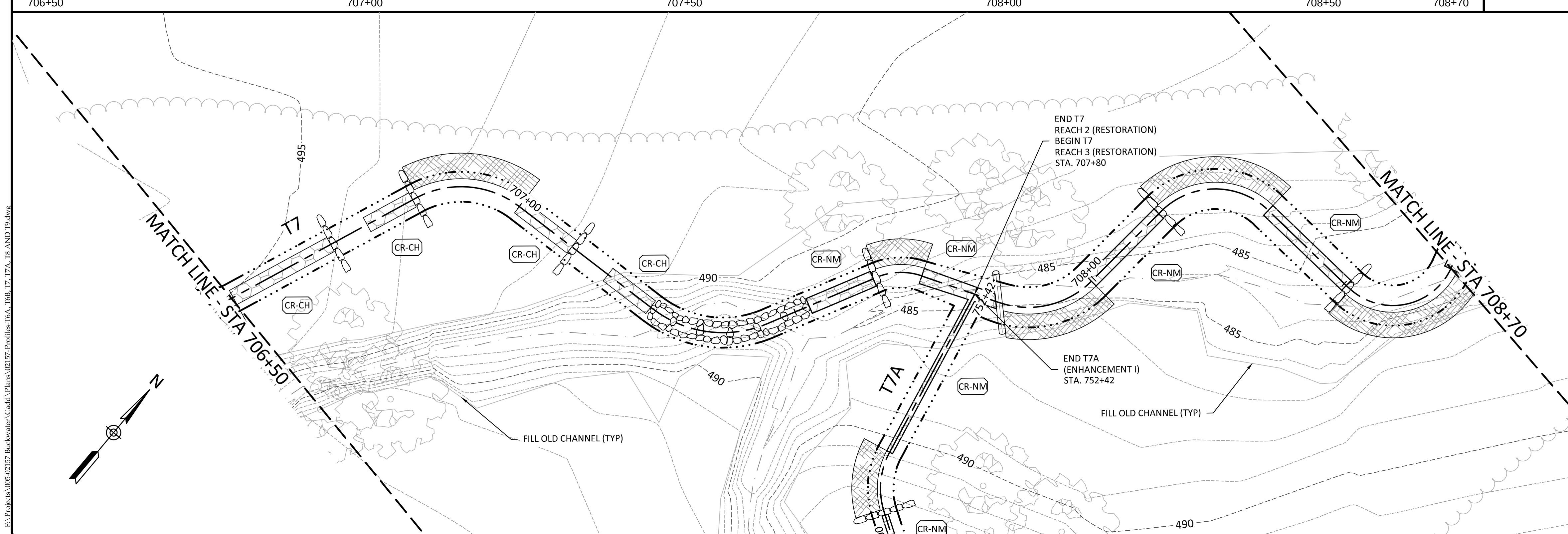






0' 1' 2' 3'
(VERTICAL)

0' 10' 20' 30'
(HORIZONTAL)



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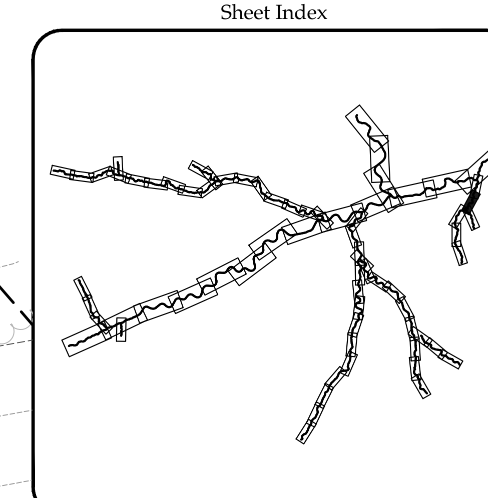

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T7 Reaches 2 & 3
Stream Plan and Profile

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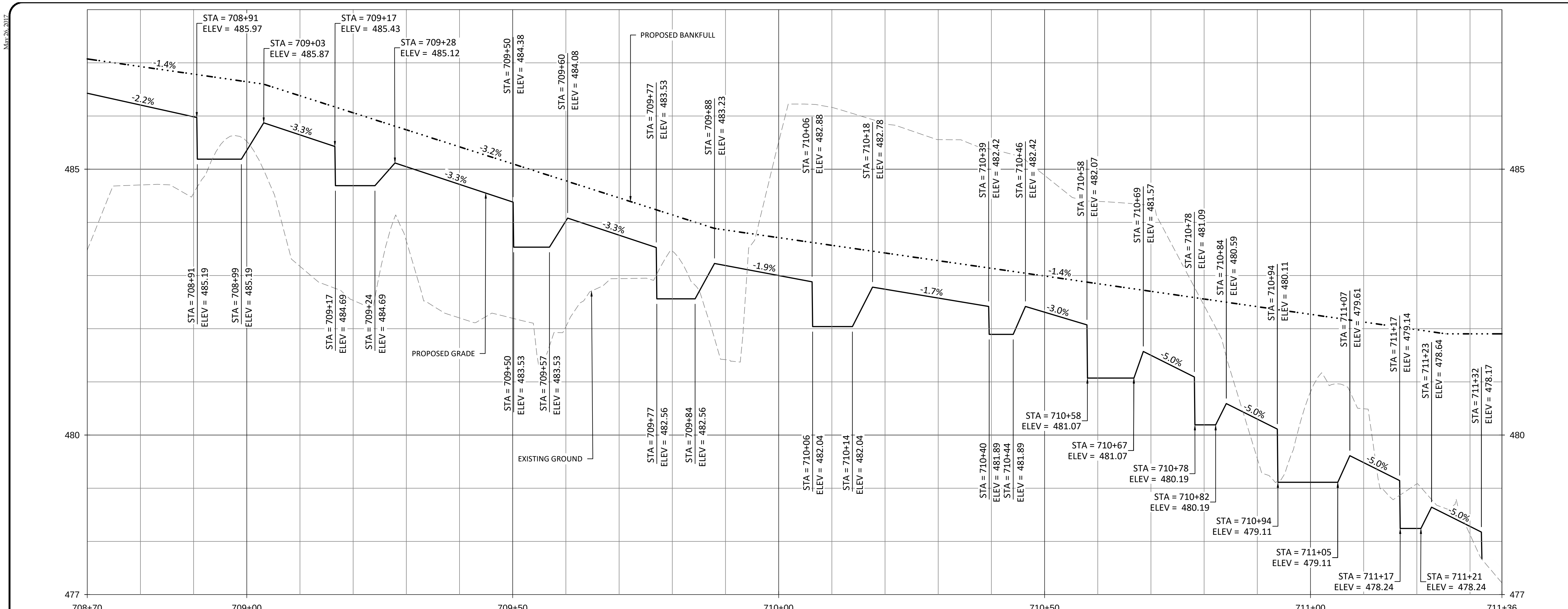
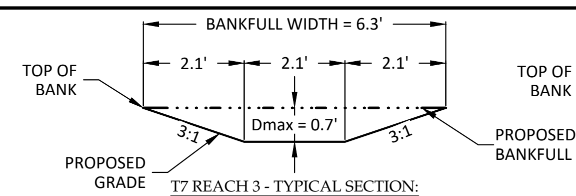
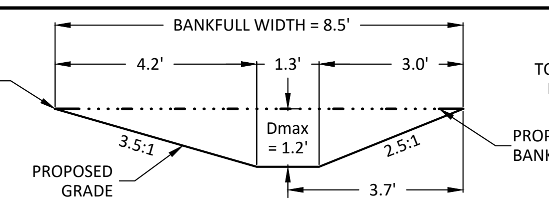




T7 REACH 3 - TYPICAL SECTION: RIFFLE
STA: 707+80 TO 711+36
SCALE: 1" = 2'



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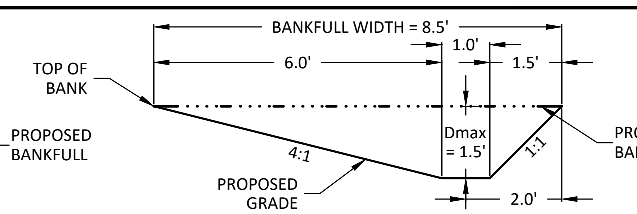
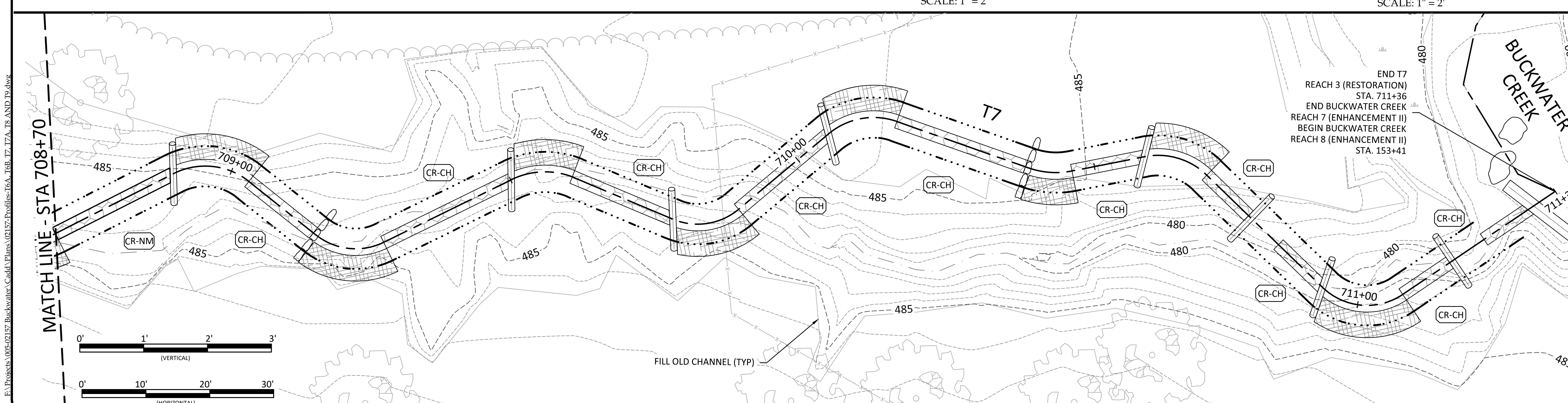
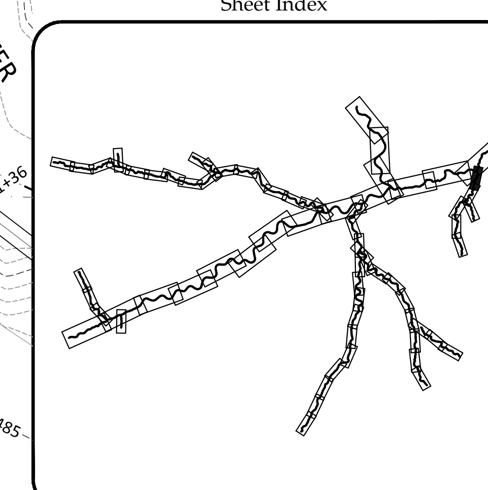
STA: 707+80 TO 711+36
SCALE: 1" = 2'



T7 REACH 3 - TYPICAL SECTION: POOL WITH STRUCTURE
STA: 707+80 TO 711+36
SCALE: 1" = 2'

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T7 Reach 3
Stream Plan and Profile

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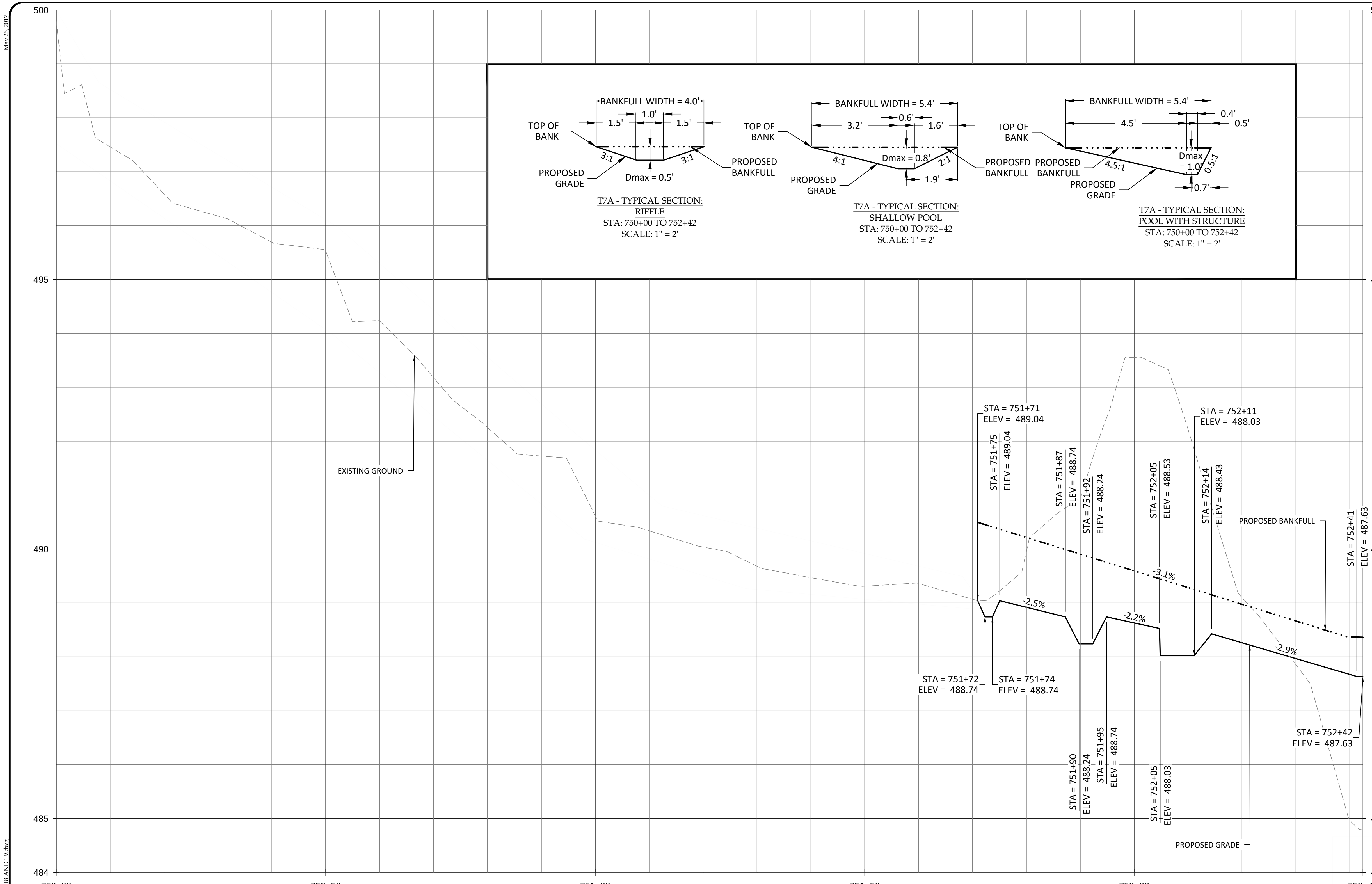

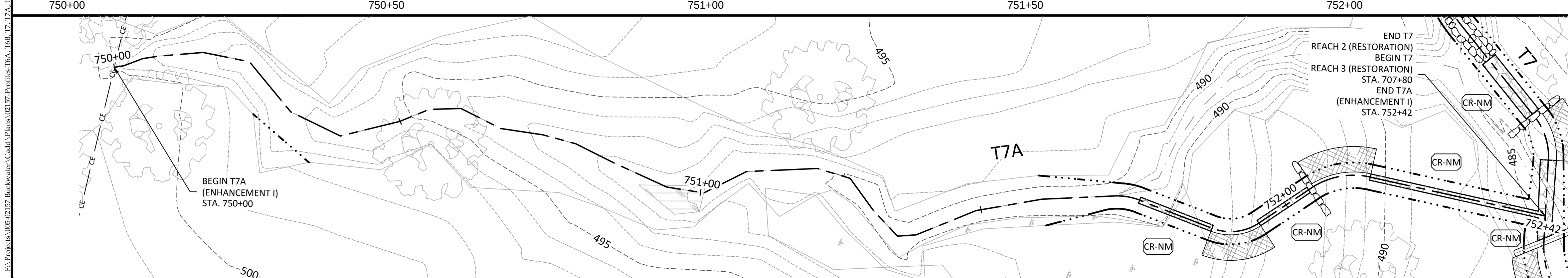

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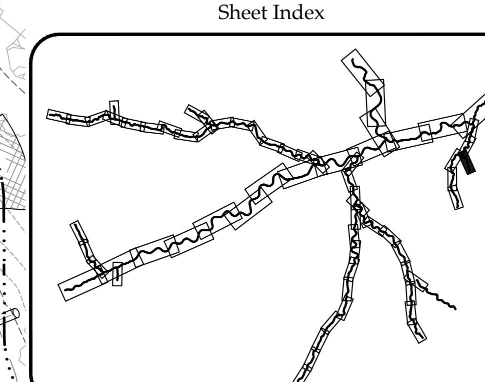

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T7A
Stream Plan and Profile

Revisions:

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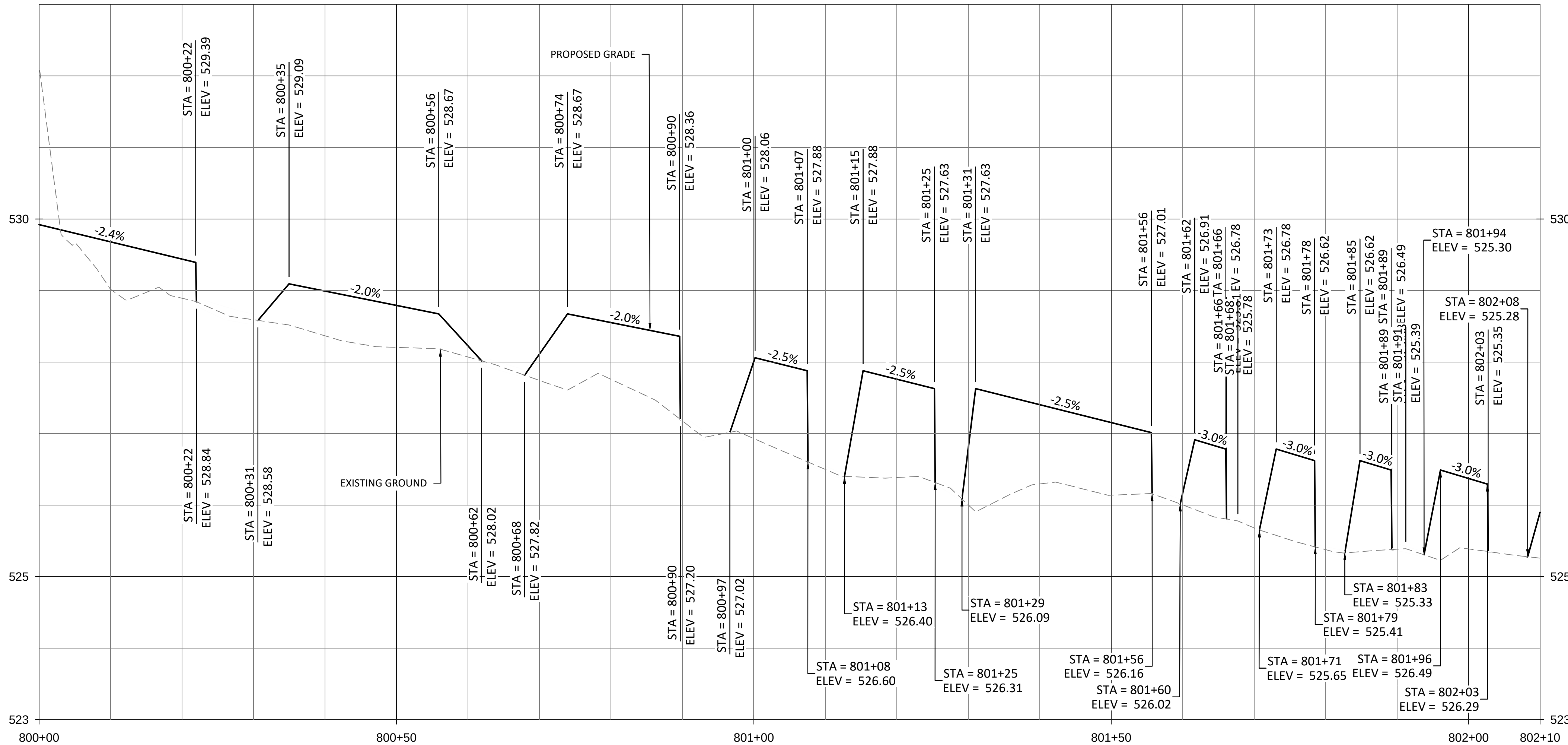
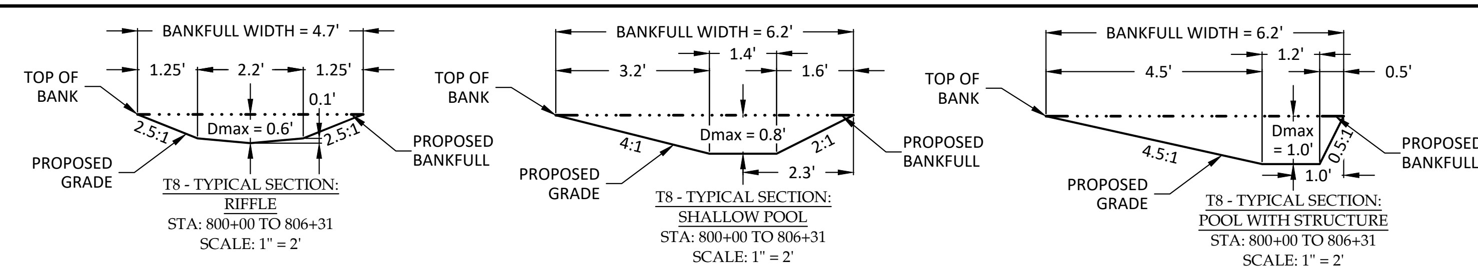
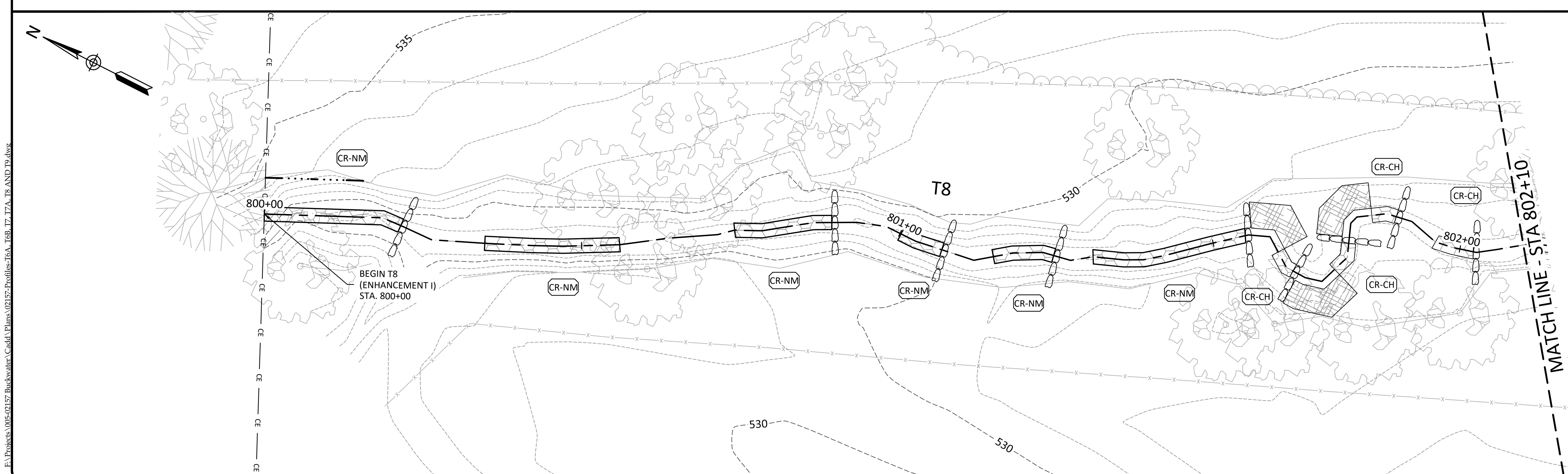
May 26, 2017







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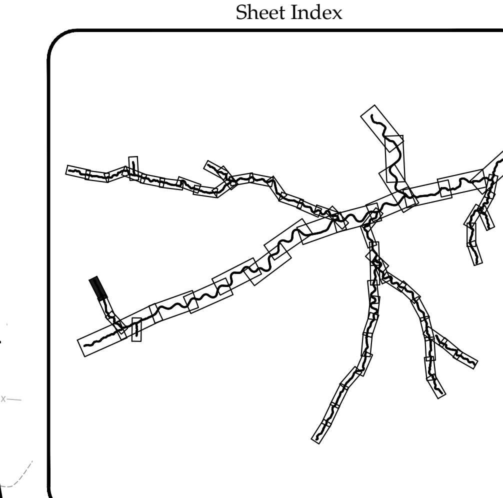

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T8
Stream Plan and Profile

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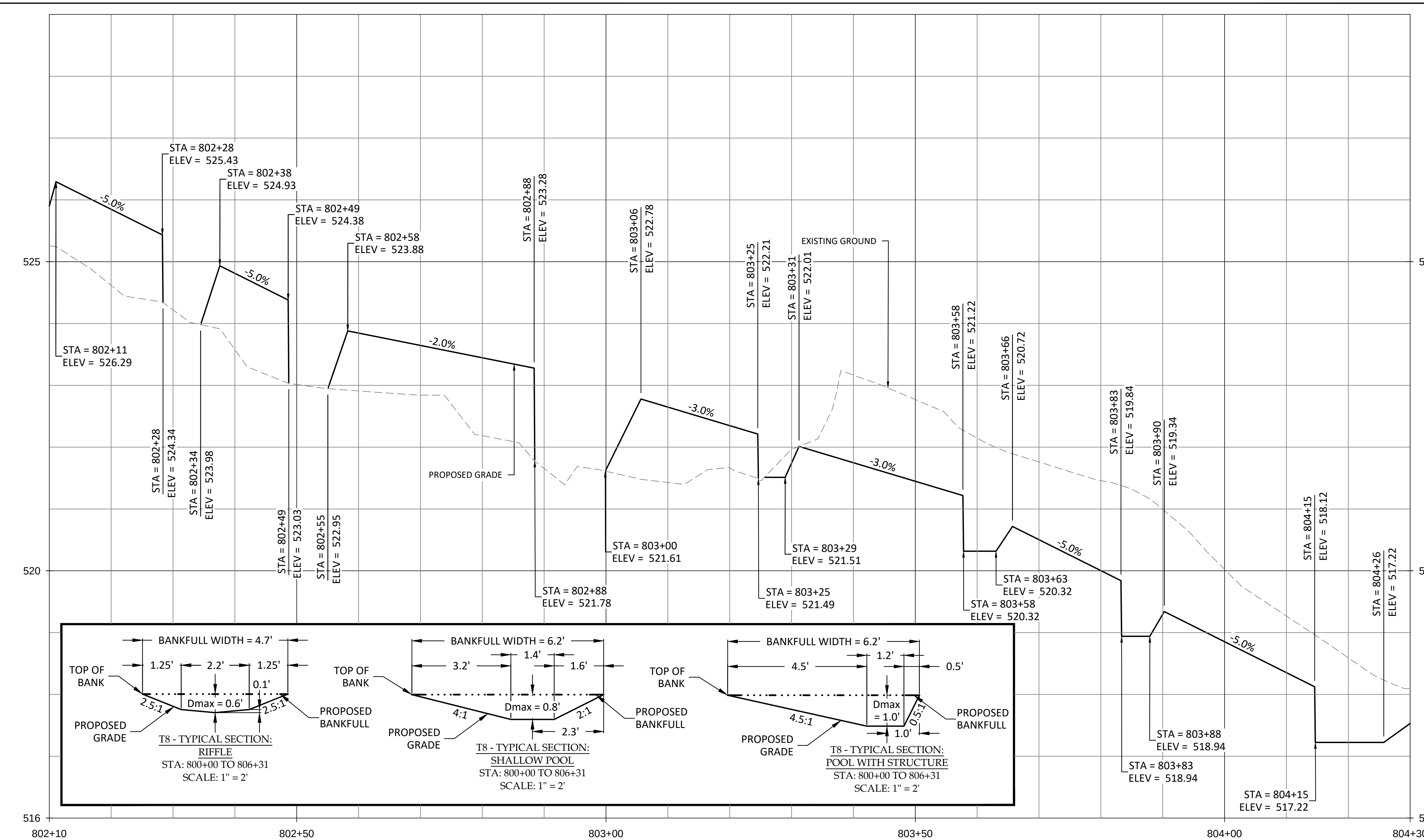

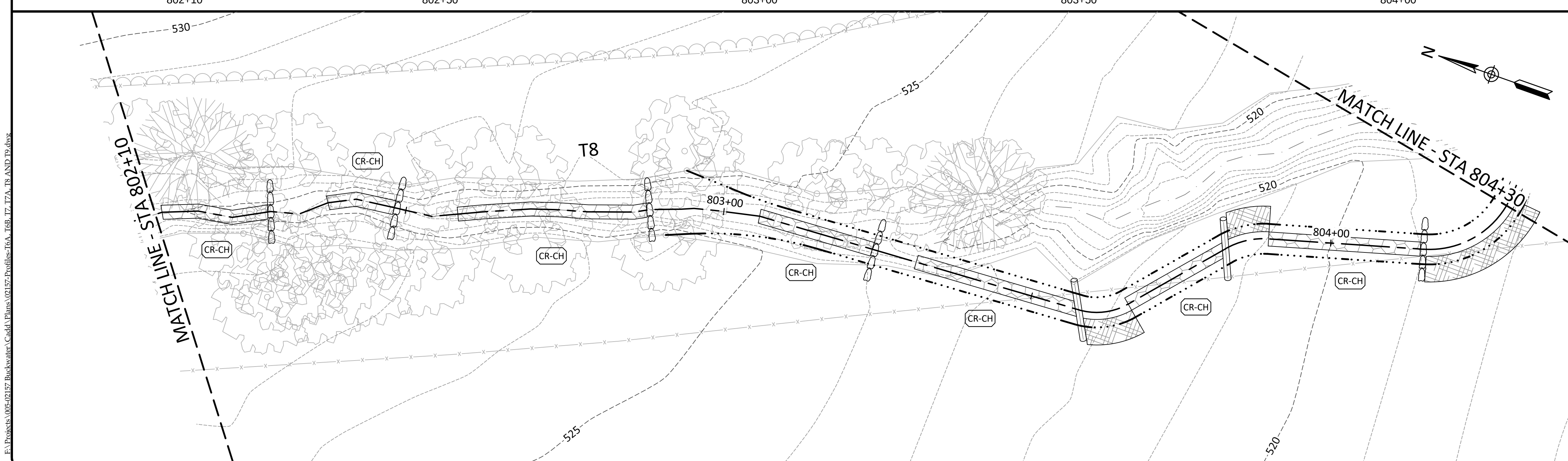

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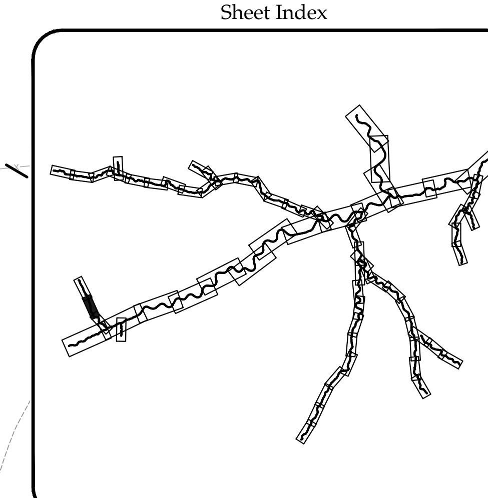

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T8
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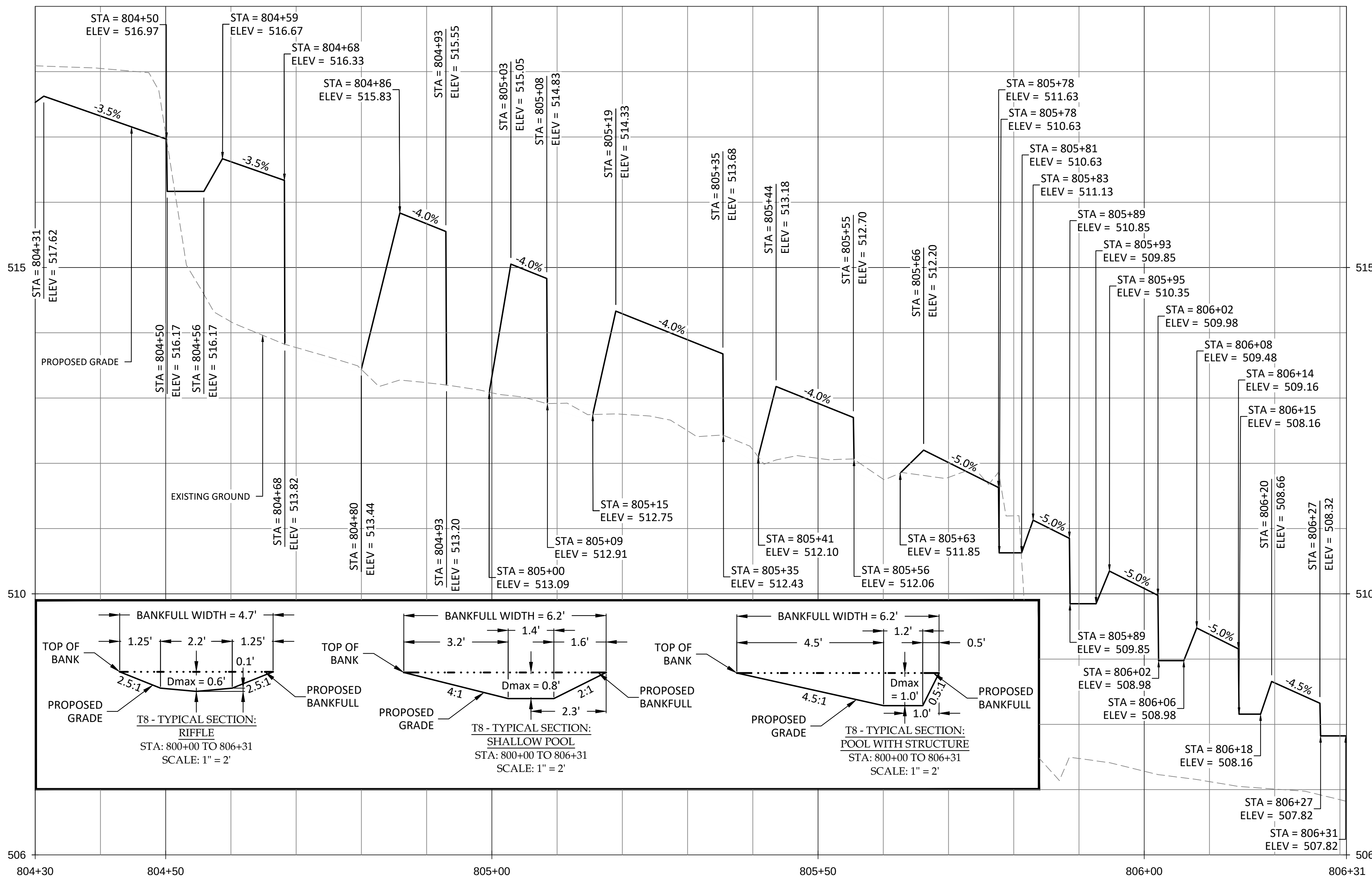

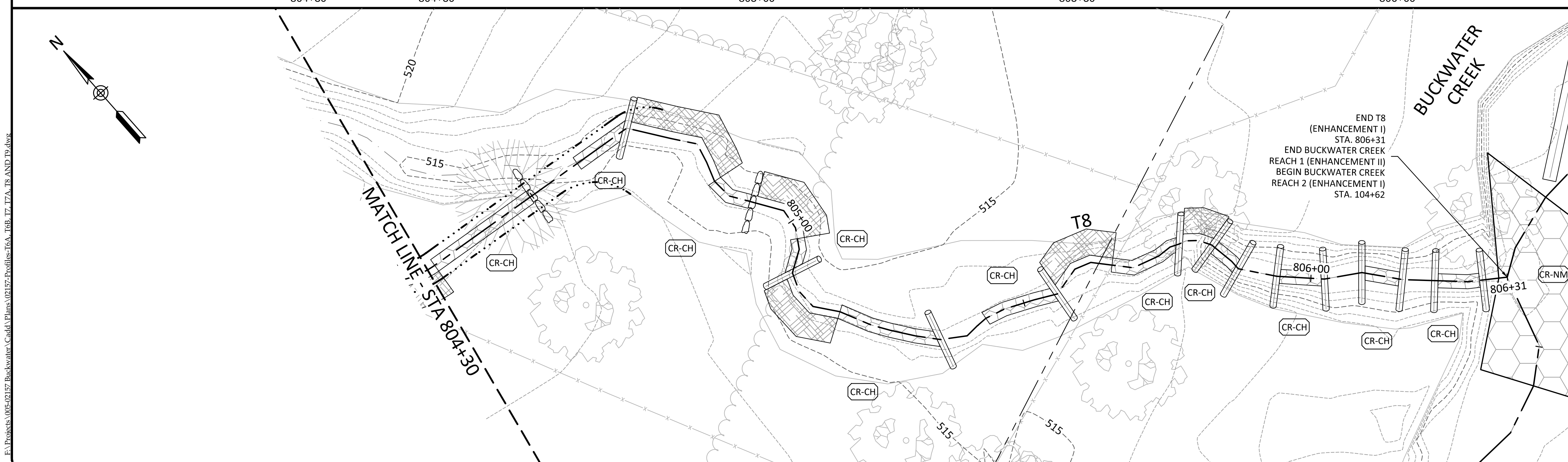

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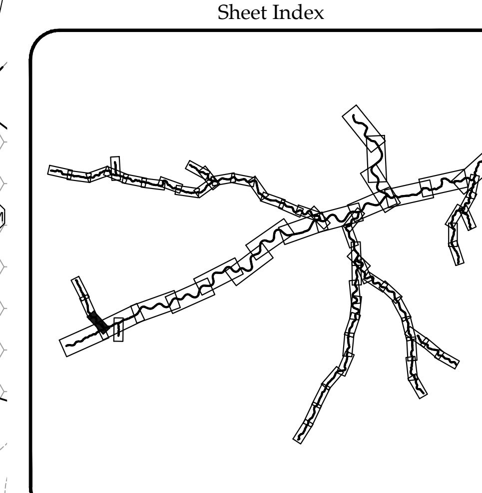

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T8
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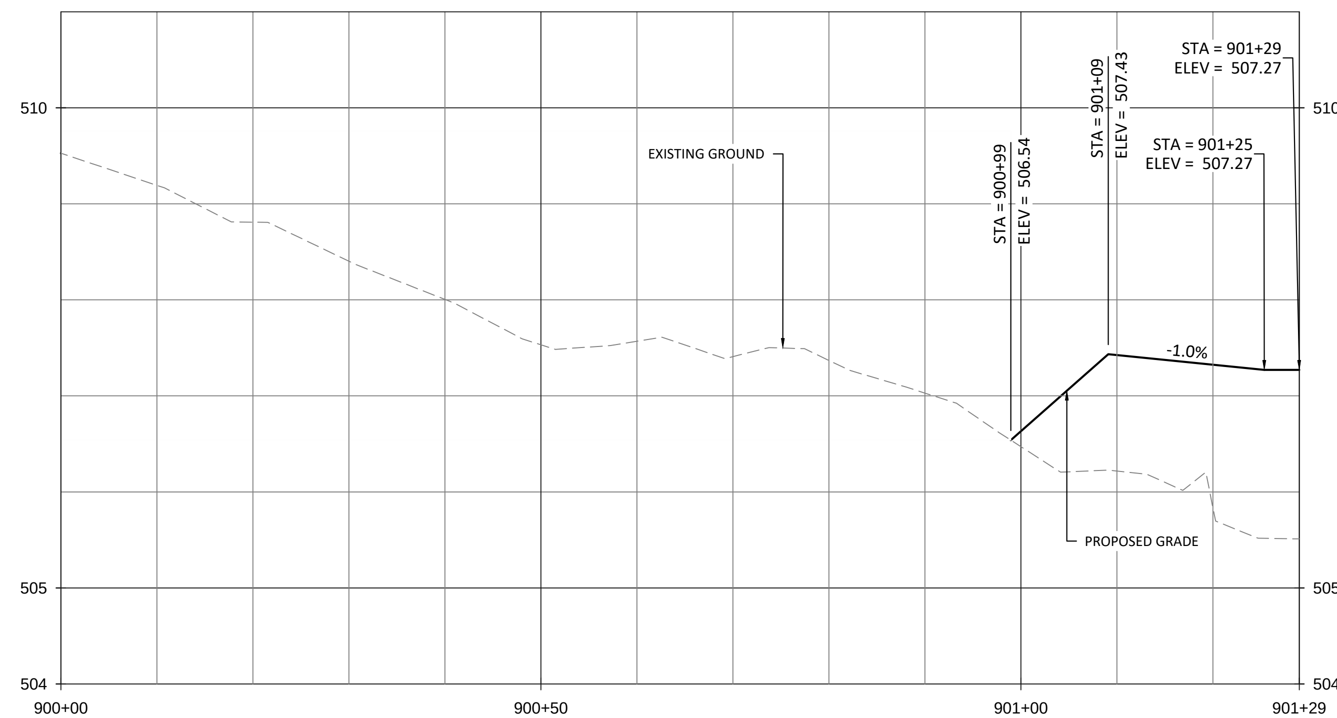

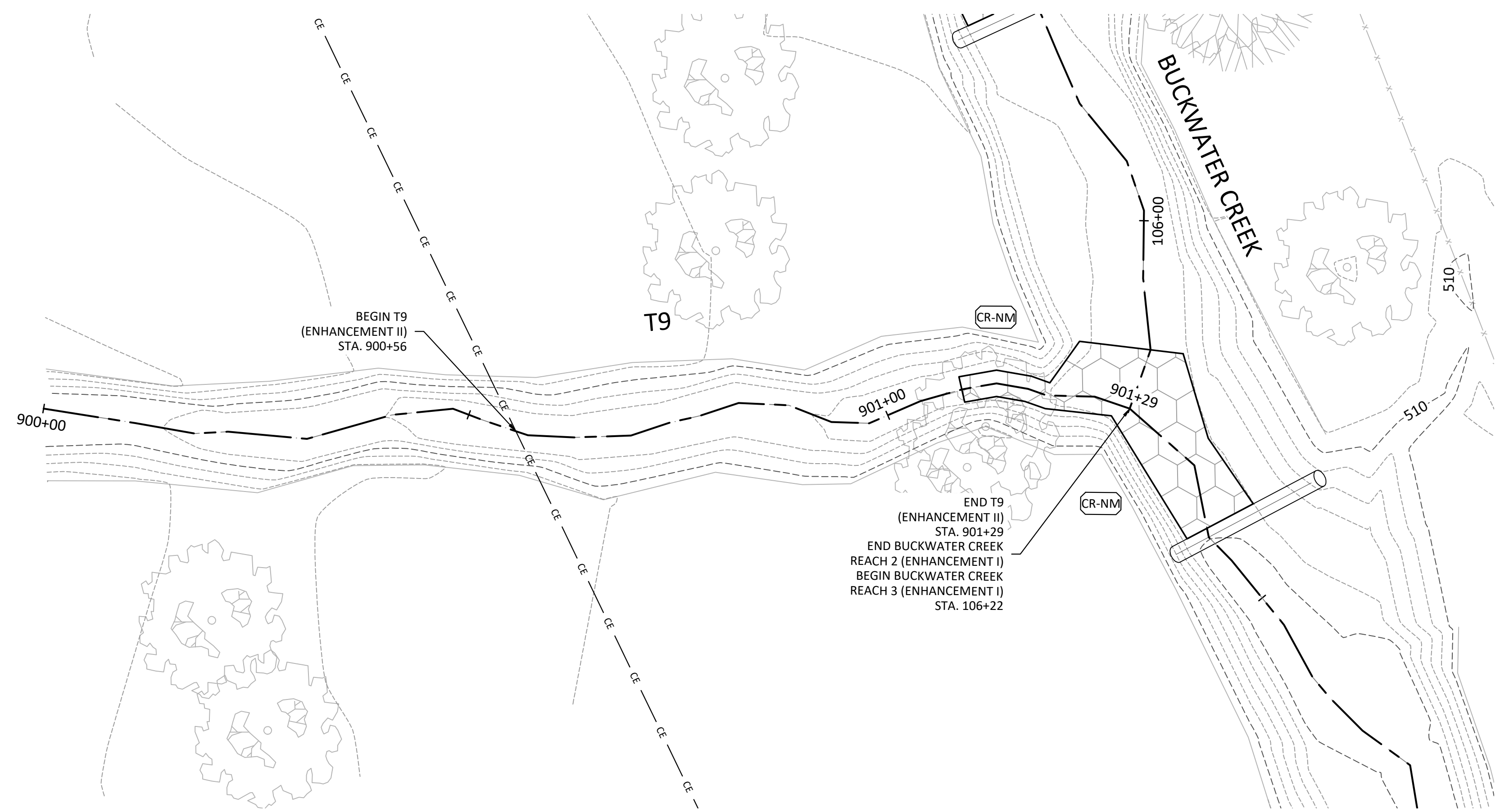

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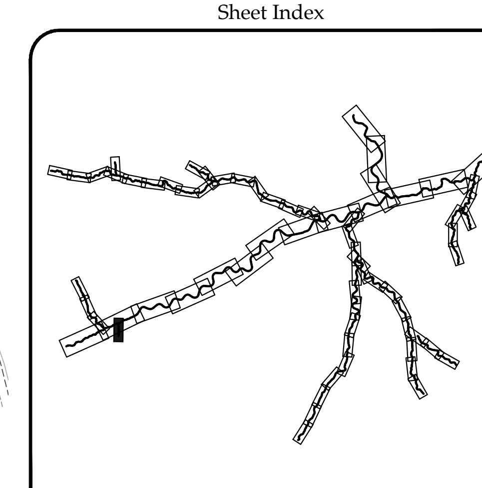

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Orange County, North Carolina

T9
Stream Plan and Profile

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October 10, 2017

Zone 1 - Streambank Planting Zone
(See Detail 3, Sheet 5.6)

Zone 2 - Buffer Planting Zone
(See Detail 4, Sheet 5.6)

Zone 3 - Overhead Electric Utility Easement Planting Zone

Streambank Planting Zone

Species	Common Name	Indiv. Spacing	Min. Size	Stratum	% of Stems
Live Stakes					
Salix nigra	Black Willow	3-6 ft	0.5 - 1.5 cal	Shrub	15%
Cornus amomum	Silky Dogwood	3-6 ft	0.5 - 1.5 cal	Shrub	45%
Salix sericea	Silky Willow	3-6 ft	0.5 - 1.5 cal	Shrub	40%
					100%
Herbaceous Plugs					
Juncus effusus	Common Rush	4 ft	1.0 - 2.0 plug	Herb	40%
Carex alata	Broadwing Sedge	4 ft	1.0 - 2.0 plug	Herb	40%
Panicum virgatum	Switchgrass	4 ft	1.0 - 2.0 plug	Herb	20%
					100%

Buffer Planting Zone

Bare Root

Species	Common Name	Max Spacing	Indiv. Spacing	Min. Caliper Size	Stratum	# of Stems
Quercus phellos	Willow Oak	12 ft	6-12 ft	0.25 - 1.0	Canopy	10%
Platanus occidentalis	Sycamore	12 ft	6-12 ft	0.25 - 1.0	Canopy	20%
Betula nigra	River Birch	12 ft	6-12 ft	0.25 - 1.0	Canopy	15%
Quercus michauxii	Swamp Chestnut Oak	12 ft	6-12 ft	0.25 - 1.0	Canopy	10%
Liriodendron tulipifera	Tulip Poplar	12 ft	6-12 ft	0.25 - 1.0	Canopy	15%
Quercus alba	White Oak	12 ft	6-12 ft	0.25 - 1.0	Canopy	5%
Quercus shumardii	Shumard Oak	12 ft	6-12 ft	0.25 - 1.0	Canopy	5%
Fraxinus pennsylvanica	Green Ash	12 ft	6-12 ft	0.25 - 1.0	Canopy	17%
**Viburnum nudum*	Possumhaw Viburnum	24 ft	12-24 ft	0.25 - 1.0	Understory	1%
**Amelanchier laevis*	Allegheny Serviceberry	24 ft	12-24 ft	0.25 - 1.0	Understory	1%
**Aesculus pavia*	Red Buckeye	24 ft	12-24 ft	0.25 - 1.0	Understory	1%
						100%

Overhead Electric Utility Easement Planting Zone

Live Stakes

Species	Common Name	Indiv. Spacing	Min. Size	Stratum	% of Stems
Cornus amomum	Silky Dogwood	6-12 ft	0.5 - 1.5 cal	Shrub	50%
Salix sericea	Silky Willow	6-12 ft	0.5 - 1.5 cal	Shrub	50%
					100%

Zones 1, 2 and 3

Permanent Riparian Seeding

Pure Live Seed (20 lbs / acre)

Approved Date	Species Name	Common Name	Stratum	Density (lbs/acre)	pH	Percentage
All Year	*Panicum rigidulum*	Redtop Panicgrass	Herb	1.5	5.0-7.5	5%
All Year	*Agrostis hyemalis*	Winter Bentgrass	Herb	3.0	5.0-7.5	15%
All Year	*Chasmanthium latifolium*	River Oats	Herb	2.0	5.0-7.0	10%
All Year	*Rudbeckia hirta*	Blackeyed Susan	Herb	1.0	6.0-7.0	5%
All Year	*Coreopsis lanceolata*	Lanceleaf Coreopsis	Herb	1.0	6.0-7.0	5%
All Year	*Carex vulpinoidea*	Fox Sedge	Herb	4.0	6.8-6.9	20%
All Year	*Panicum clandestinum*	Deertongue	Herb	3.4	4.0-7.5	24%
All Year	*Elymus virginicus*	Virginia Wild Rye	Herb	3.0	5.0-7.4	15%
All Year	*Asclepias syrica*	Common Milkweed	Herb	0.2	5.5-7.3	1%
						100%

Permanent Seeding Outside Easement

Approved Date	Species Name	Common Name	Stratum	Density (lbs/acre)
All Year	*Festuca arundinacea*	Tall Fescue	Herb	40

Temporary Seeding

Pure Live Seed

Approved Date	Species Name	Common Name	Stratum	Density (lbs/acre)
Aug 15 - May 1	*Secale cereale*	Rye Grain	Herb	140
May 1 - Aug 15	*Setaria italica*	German Millet	Herb	50

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Buckwater Mitigation Site
Orange County, North Carolina
Planting Tables

Revisions:

Date: 05.26.2017
Job Number: 005-02157
Project Engineer: NMM
Drawn By: CLM
Checked By: JWH

Sheet 2.0

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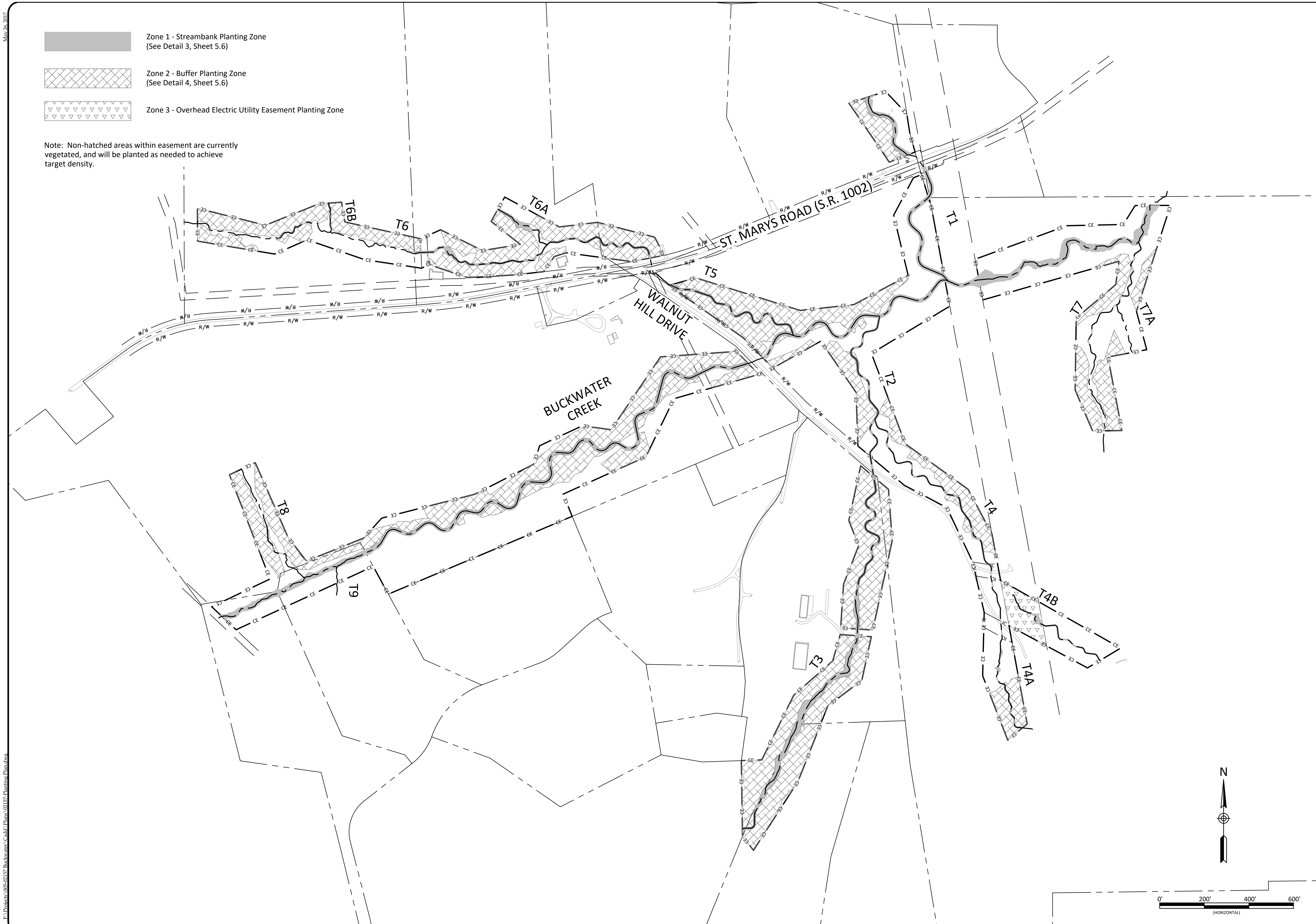
Zone 1 - Streambank Planting Zone
(See Detail 3, Sheet 5.6)

Zone 2 - Buffer Planting Zone
(See Detail 4, Sheet 5.6)

Zone 3 - Overhead Electric Utility Easement Planting Zone

Note: Non-hatched areas within easement are currently vegetated, and will be planted as needed to achieve target density.



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Orange County, North Carolina

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May 26, 2017

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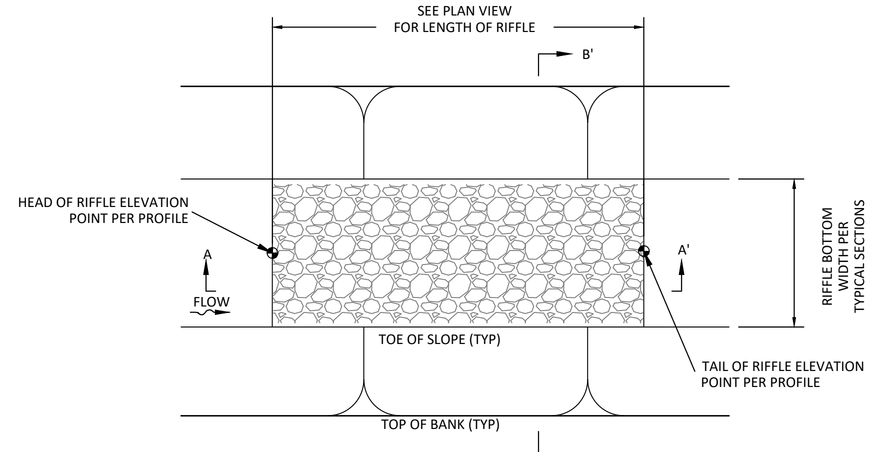
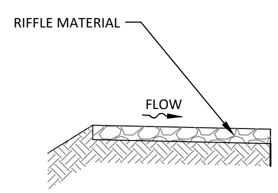
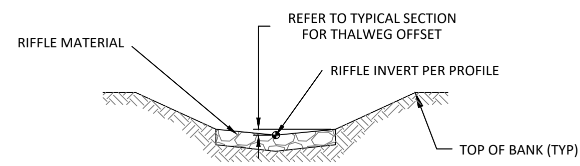


Plan View



Profile A-A'



Section B-B'

NOTE:

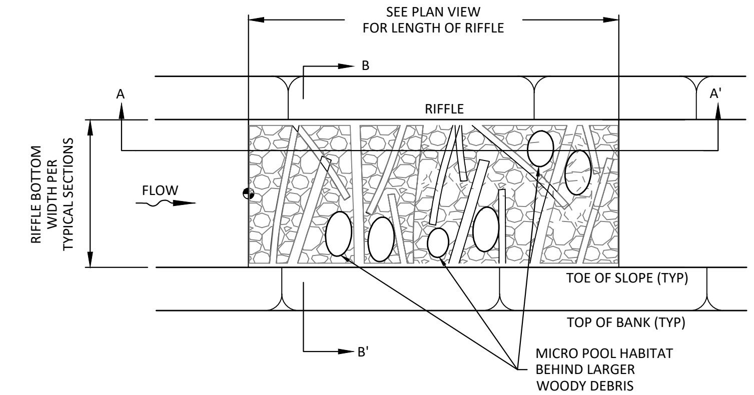
1. REFER TO RIFFLE MATERIAL TABLE ON THIS SHEET FOR RIFFLE MATERIAL SIZING.

1/5.1 Native Material Constructed Riffle
Not to Scale

RIFFLE MATERIAL TABLE

REACH	BOTTOM WIDTH (FT)	RIFFLE THICKNESS (IN)	RIFFLE MATERIAL STONE SIZE (% OF MATRIX)
Buckwater Creek Reaches 2 and 3	8-16	16	CLASS A (30%), CLASS B (70%)
Buckwater Creek Reach 4	6.6	16	CLASS A (30%), CLASS B (70%)
Buckwater Creek Reach 5	12.4	16	CLASS A (30%), CLASS B (70%)
Buckwater Creek Reach 6	12.6	16	CLASS A (30%), CLASS B (70%)
Buckwater Creek Reach 7	22	16	CLASS A (30%), CLASS B (70%)
T1 Reach 1	11 18	16	CLASS A (30%), CLASS B (70%)
T1 Reach 2	13.8	16	CLASS A (30%), CLASS B (70%)
T2	5.1	12	CLASS A (100%)
T3 Reach 1	4.4	12	CLASS A (100%)
T3 Reach 2	4.6	12	CLASS A (100%)
T4	3.9	12	CLASS A (100%)
T4A Reach 1	1.9	12	CLASS A (100%)
T4A Reach 3	7.0	12	CLASS A (100%)
T4B Reach 1	2.9	12	CLASS A (100%)
T5 Reach 1	4.7	12	CLASS A (100%)
T5 Reach 2	4.7	12	CLASS A (100%)
T7 Reaches 1 and 2	2.5	12	CLASS A (100%)
T7 Reach 3	2.1	12	CLASS A (100%)
T7A	1.9	12	CLASS A (100%)
T8	2.2	12	CLASS A (100%)

NOTES:
1. All riffle material shall be compacted in lifts at a thickness not to exceed Dmax.



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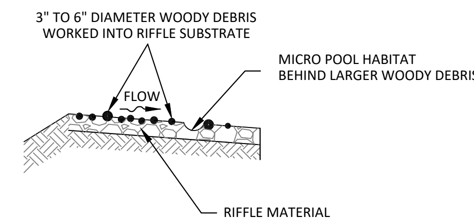
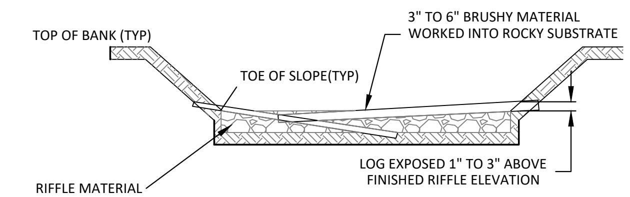


Section A-A'

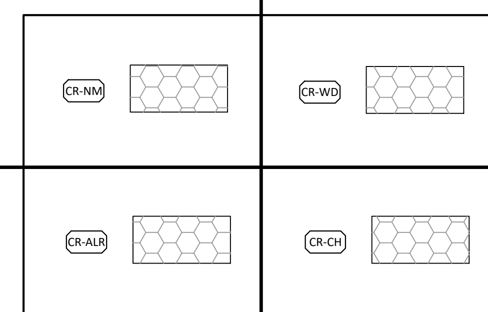


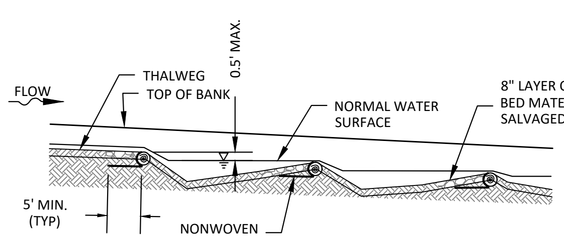
Section B-B'

2/5.1 Woody Riffle
Not to Scale

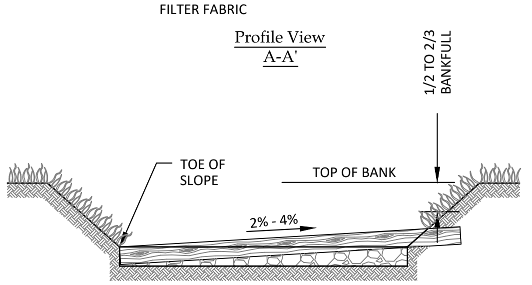
NOTES:

1. USE SMALLER DIAMETER WOOD FOR SMALLER CHANNELS.
2. WOOD SHALL COMPRISE 20% TO 50% OF THE RIFFLE SURFACE AREA.
3. REFER TO RIFFLE MATERIAL TABLE ON THIS SHEET FOR RIFFLE MATERIAL SIZING.

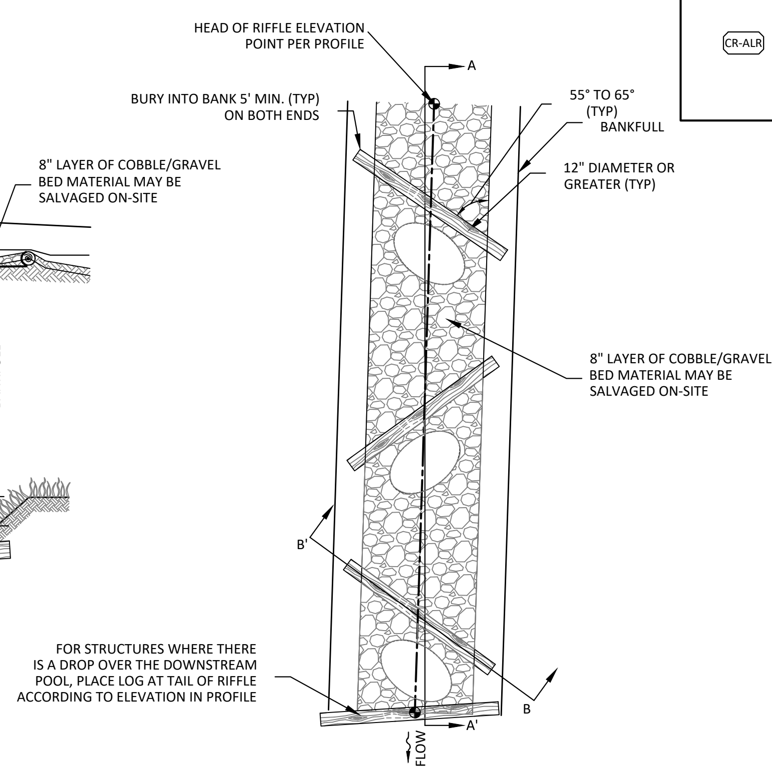




Profile View
A-A'



Log Section B-B'

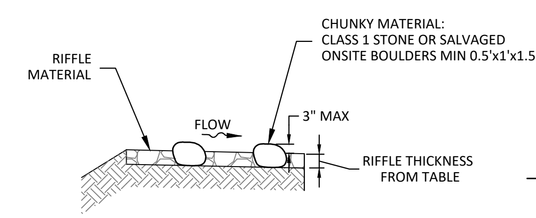


Plan View

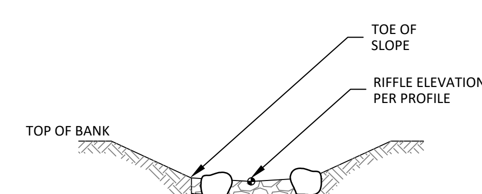
NOTE:

1. BOULDER MATERIAL CAN BE SUBSTITUTED IN PLACE OF ANGLED LOGS WITH APPROVAL OF ENGINEER.
2. MINIMUM LOG DIAMETER 12".
3. MINIMUM ONE LOG PER 10 LF OF RIFFLE LENGTH OR ONE LOG PER 0.3' OF DROP, WHICHEVER IS LESSER DISTANCE.
4. REFER TO RIFFLE MATERIAL TABLE ON THIS SHEET FOR RIFFLE MATERIAL SIZING.

3/5.1 Angled Log Riffle
Not to Scale



Profile A-A'



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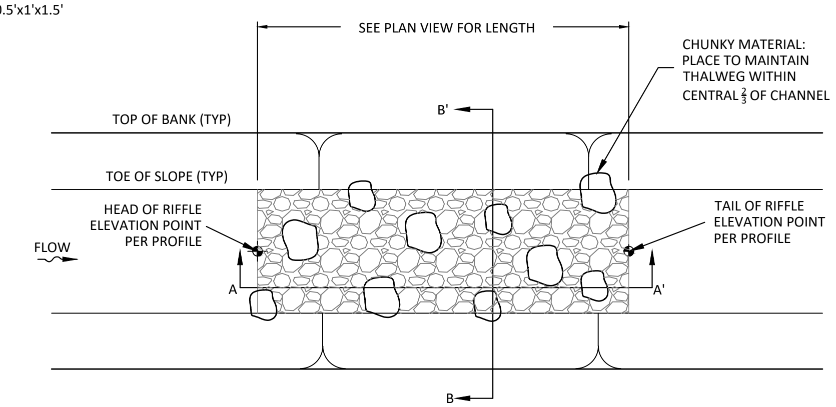

Plan View

NOTES:

1. CHUNKY MATERIAL ELEVATION SHALL BE 0" TO 3" ABOVE RIFFLE MATERIAL BASED ON ENGINEER'S DISCRETION.
2. REFER TO RIFFLE MATERIAL TABLE ON THIS SHEET FOR RIFFLE MATERIAL SIZING.

4/5.1 Chunky Riffle
Not to Scale

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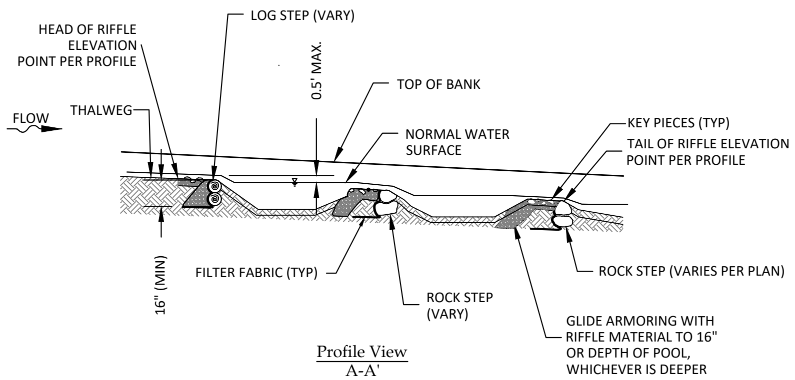
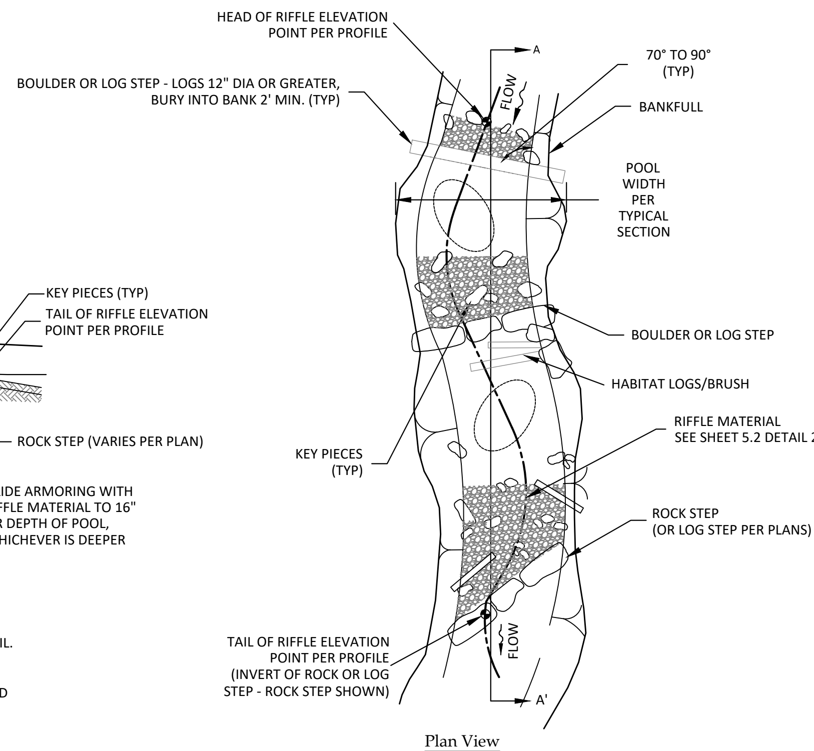
March 7, 2012



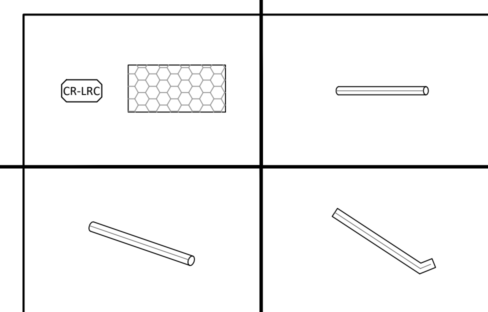
Profile View
A-A'

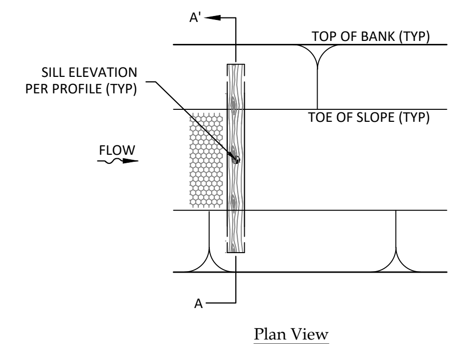


Plan View

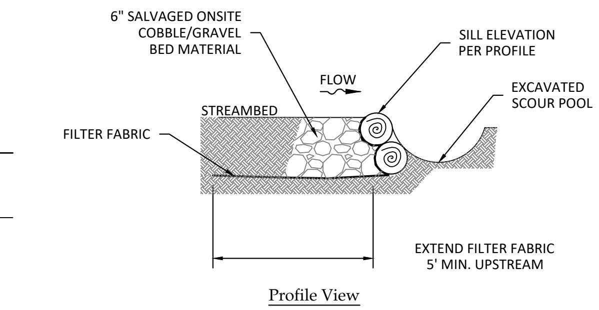
NOTES:
1. 1. CONSTRUCT GRADE DROPS IN CASCADE BASED ON ROCK AND LOG STEP DETAIL.
2. 2. VARY THE SEQUENCE, TYPE AND ORIENTATION OF STEPS (DROPS). USE ROCK STEP DETAIL AS A GUIDE FOR VARIATIONS IN ORIENTATION/CONFIGURATION.
3. 3. KEY PIECES ARE LOWER MOBILITY STONE THAT PROVIDE GRADE CONTROL AND TOE PROTECTION. USE CLASS 1 STONE OR SALVAGED ONSITE BOULDERS MIN 0.5'x1'x1.5'. JAZZ LOGS SHOULD BE WORKED IN AS EQUIVALENT OF KEY PIECES.
4. 4. ROCK STEP OR LOG STEP AT END OF CASCADE RIFFLE PAID SEPARATE. THESE ARE DEPICTED ON PLAN VIEW.
5. 5. NUMBER OF INTERNAL STEPS (INCLUDING STEPS AT THE BEGINNING OF A CASCADE SEQUENCE) VARIES BASED ON LENGTH AND SLOPE. RIFFLES SHALL BE 1.2 - 1.8 TIMES THE AVERAGE CHANNEL SLOPE. STEP DROPS SHALL BE BETWEEN 0.2-0.5' MEASURED AT THE WATER SURFACE.
6. 6. FOOTER ROCK OR LOG SHOWN. FOOTER ONLY REQUIRED WHEN MINIMUM UNFOOTERED DIMENSION OF ROCK OR LOG IS NOT MET. A MINIMUM OF 16" OF RIFFLE MATERIAL SHALL BE PLACED OVER FILTER FABRIC TO PROTECT.
7. REFER TO RIFFLE MATERIAL TABLE ON THIS SHEET FOR RIFFLE MATERIAL SIZING.

1/5.2 Log-Rock Cascade Riffle
Not to Scale





Plan View



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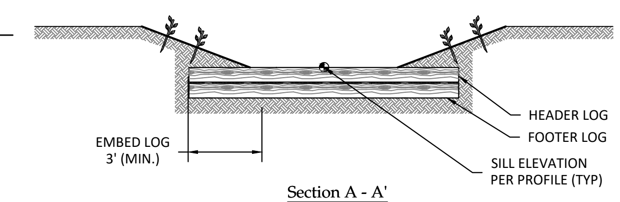
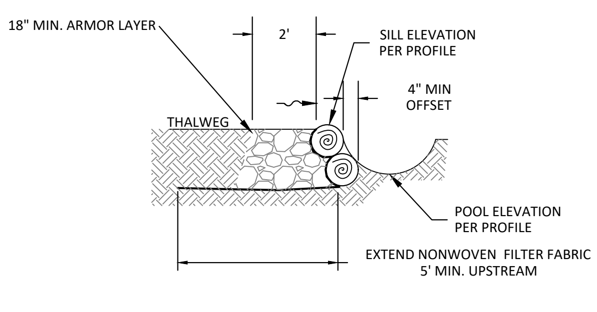


Section A - A'

2/5.2 Log Sill
Not to Scale



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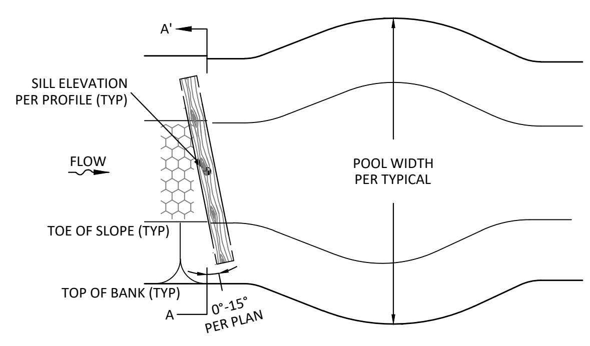
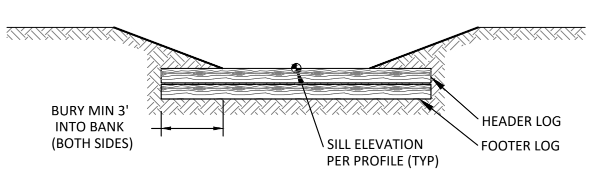


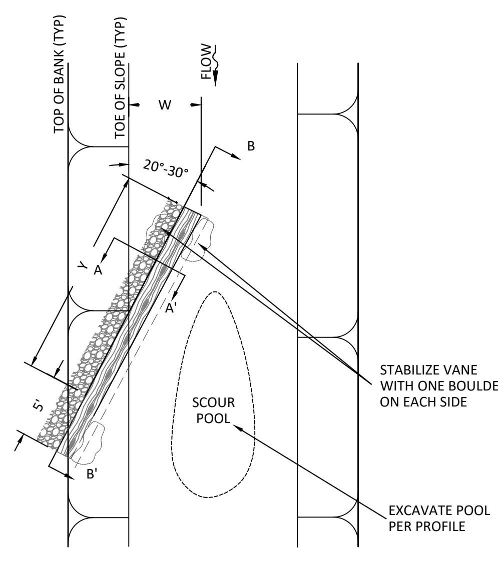
Plan View



Section A-A'

NOTES:
1. LOGS SHALL BE 12" DIA. MIN. AND BE OF A HARDWOOD SPECIES.
2. A SINGLE LOG OF 18" MIN DIAMETER MAY BE USED AT ENGINEER'S DIRECTION.

3/5.2 Angled Log Sill
Not to Scale



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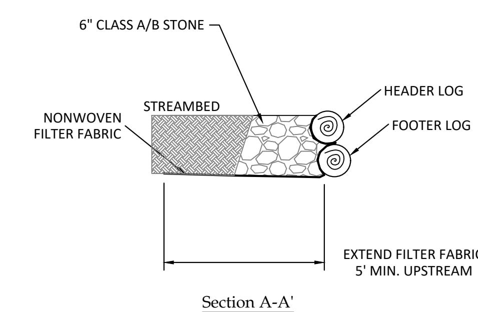
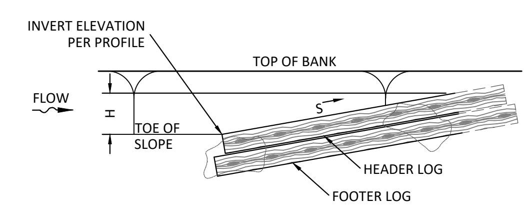


Section A-A'



Profile B - B'

4/5.2 Log Vane
Not to Scale

NOTE:
1. STABILIZATION BOULDER TO BE USED ON BUCKWATER CREEK AND T1 ONLY, AND MAY BE REMOVED PER ENGINEER'S DISCRETION.

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Sheet

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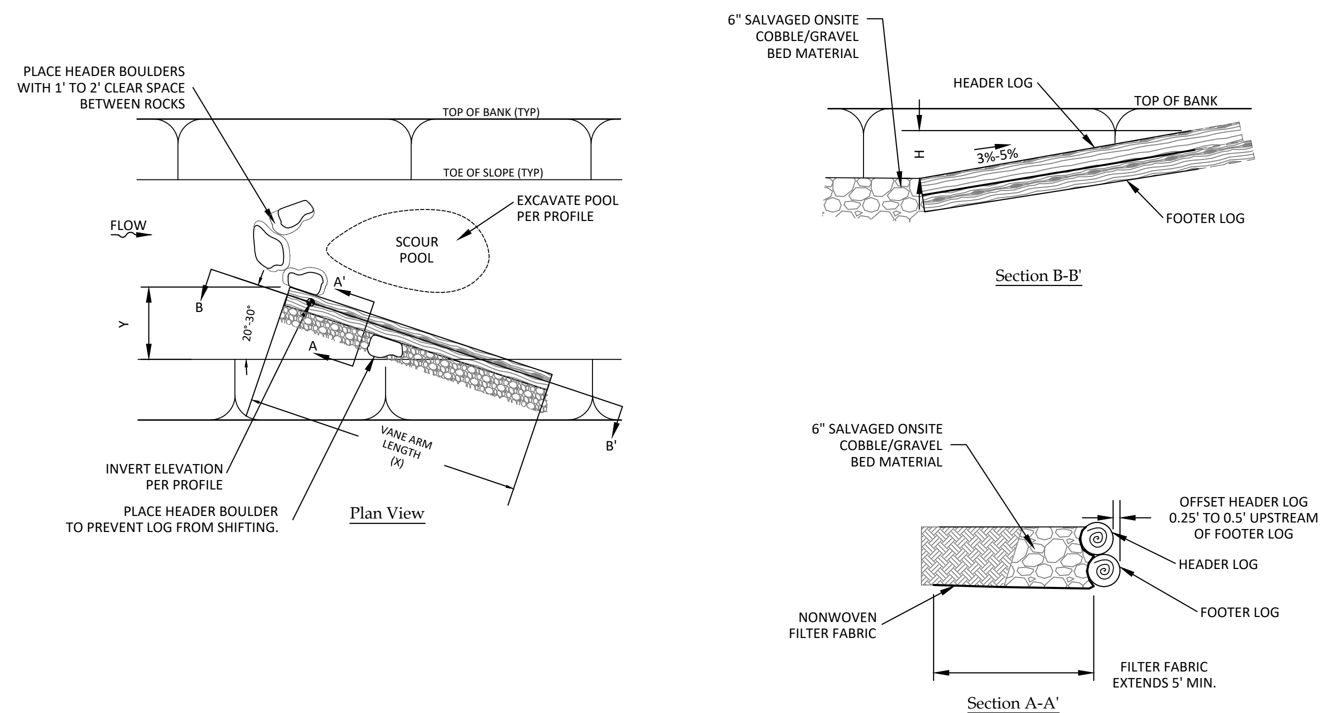
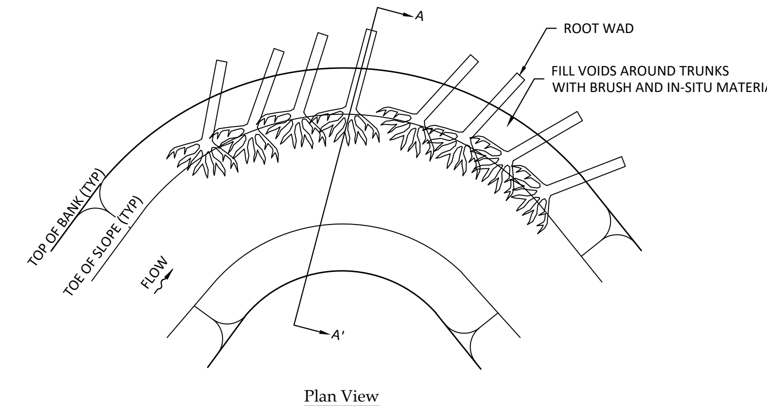
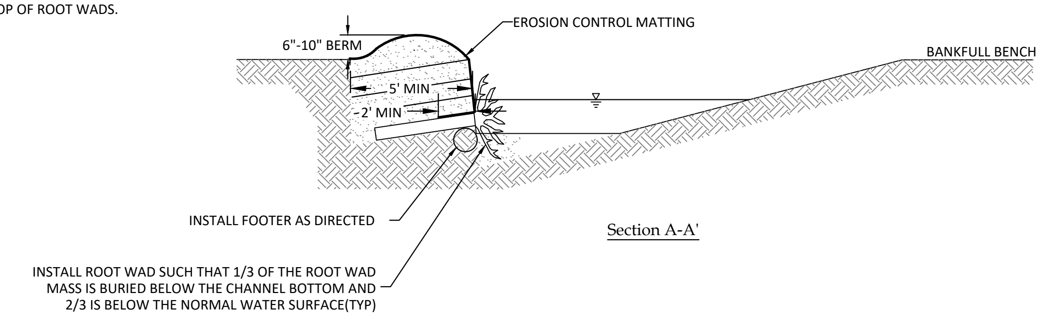


1
5.3
Log J-Hook
Not to Scale

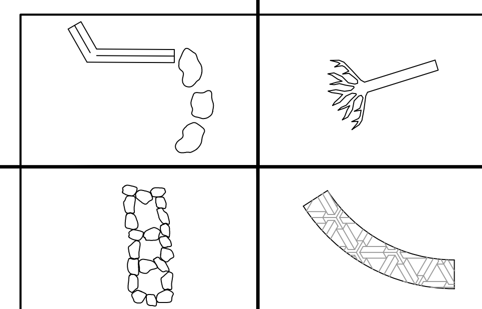
ROOT WAD INSTALLATION:

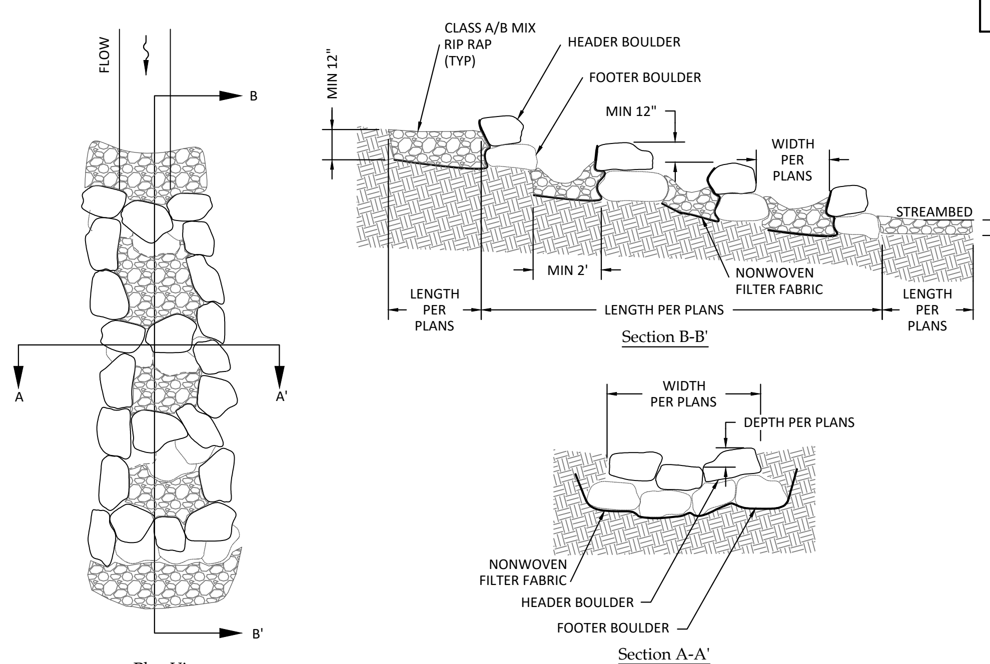
1. PLACE ONE ROOTWAD MEETING SPECIFICATION PER EACH SYMBOL SHOWN ON PLANS.
2. EXCAVATE A TRENCH SUCH THAT ⅓ OF THE ROOTMASS IS BELOW THE CHANNEL BOTTOM.
3. PLACE FOOTER MATERIAL OR LOG IF OVEREXCAVATION IS NECESSARY.
4. PLACE ROOT WAD IN TRENCH.
5. FILL VOIDS AROUND TRUNKS WITH BRUSH AND IN-SITU MATERIAL
6. INSTALL 12" LIFTS WRAPPED IN COIR MATTING ON TOP OF ROOT WADS.



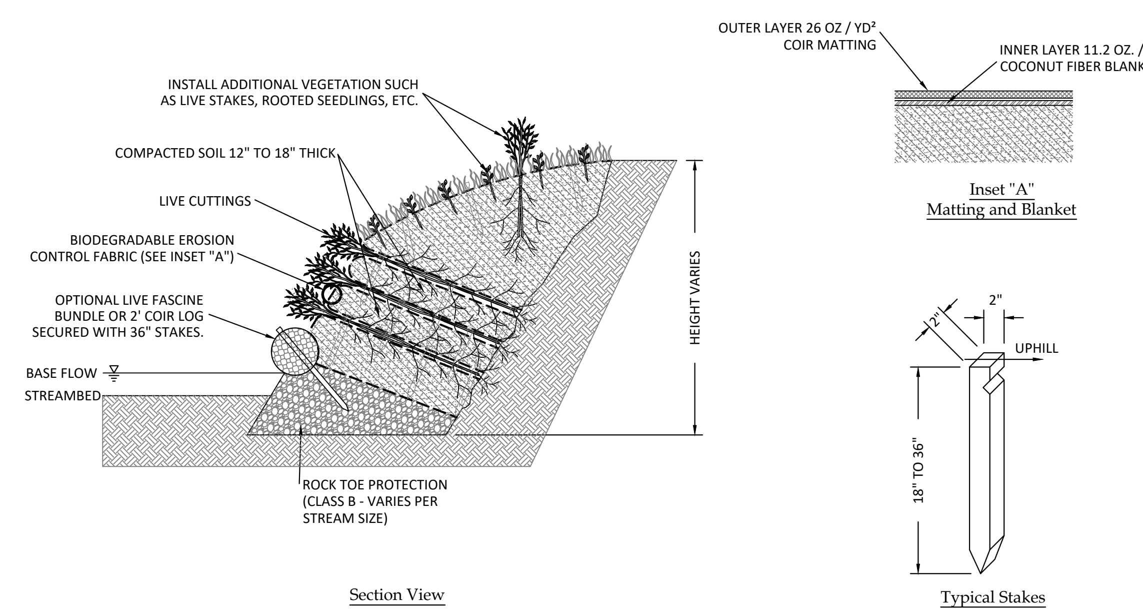


2
5.3
Root Wad
Not to Scale





3
5.3
Rock Cascade with Pools
Not to Scale



NOTE:

1. ROOTED/LEAFED CONDITION OF THE LIVING PLANT MATERIAL IS NOT REPRESENTATIVE OF THE TIME OF INSTALLATION.
2. BOTTOM OF FIRST COMPACTED EARTH LIFT TO BE PLACED 6" ABOVE NORMAL BASEFLOW.
3. NUMBER OF COMPACTED EARTH LIFTS TO VARY DEPENDING ON DESIGN TOP OF BANK HEIGHT.

4
5.3
Vegetated Soil Lift
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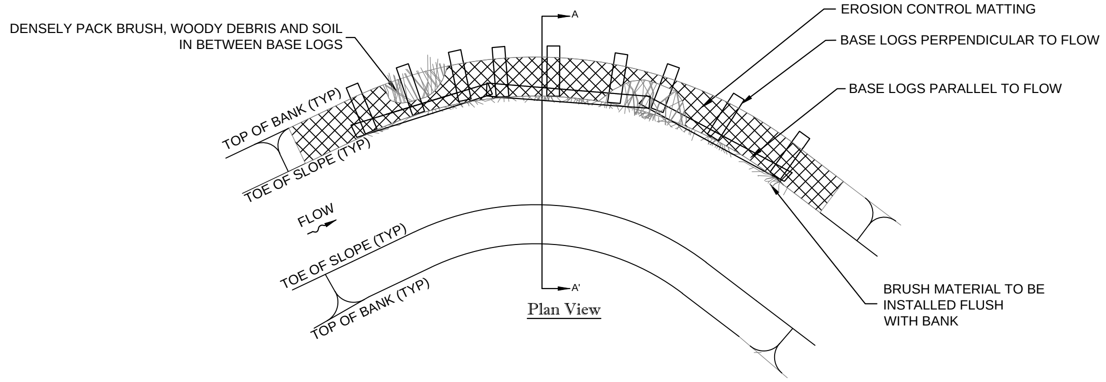
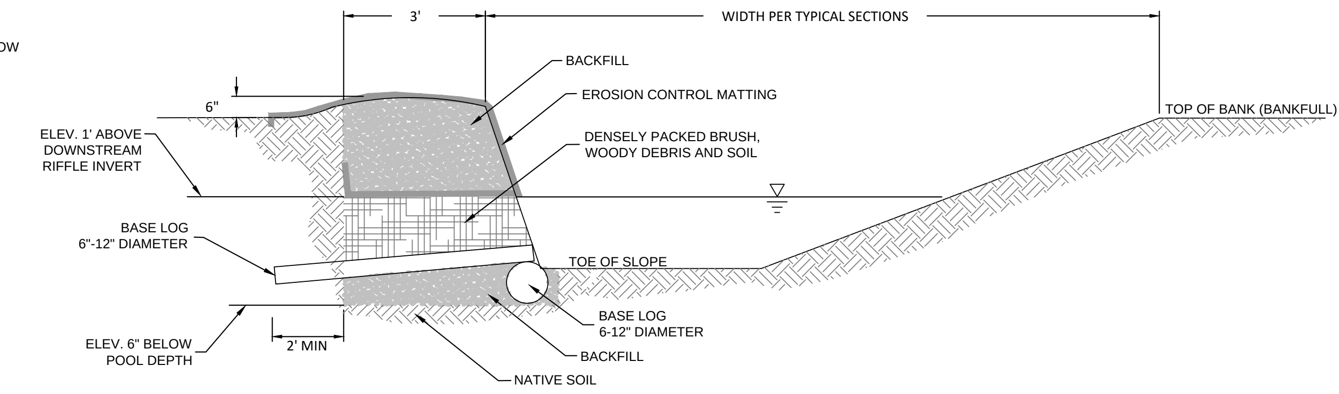


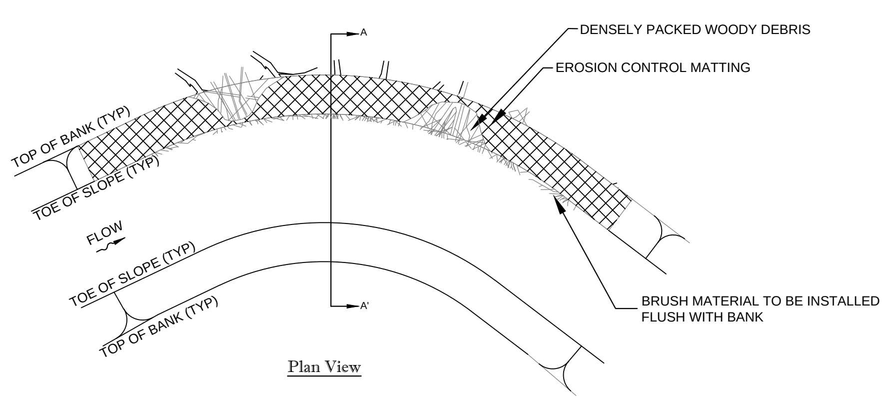
Plan View



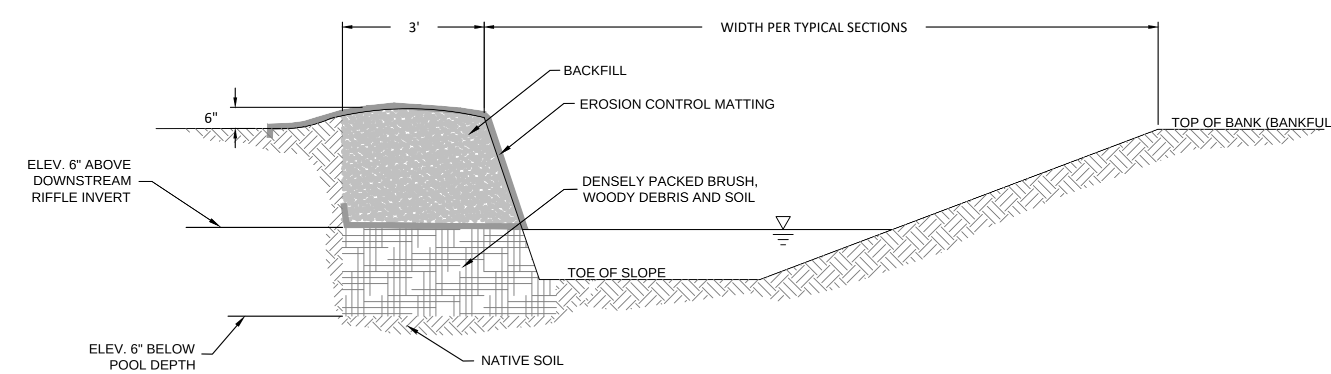
Section A-A'

1 / 5.4 Brush Toe - Buckwater Creek and T1
Not to Scale

NOTES:
1. OVEREXCAVATE 3' OUTSIDE OF TOP OF BANK (BANKFULL).
2. INSTALL BASE LOGS PARALLEL TO FLOW AT TOE OF SLOPE. DIAMETER 6"-12".
3. INSTALL BASE LOGS PERPENDICULAR TO FLOW AT INTERVALS ALONG BANK, RESTING ON TOP OF PARALLEL BASE LOGS. BASE LOGS SHALL BE 6"-12" DIAMETER.
4. INSTALL A DENSE LAYER OF BRUSH/WOODY DEBRIS, WHICH SHALL CONSIST OF SMALL BRANCHES AND ROOTS COLLECTED ON-SITE AND SOIL TO FILL ANY VOID SPACE. LIGHTLY COMPACT BRUSH/WOODY DEBRIS LAYER.
5. BRUSH SHOULD BE ALIGNED SO STEMS ARE ROUGHLY PARALLEL AND IS INSTALLED POINTING SLIGHTLY UPSTREAM.
6. INSTALL MATTING OVER BRUSH/WOODY DEBRIS.
7. INSTALL EARTH BACKFILL OVER BRUSH/WOODY LAYER ACCORDING TO TYPICAL SECTION DIMENSIONS.
8. SEED, MULCH AND INSTALL EROSION CONTROL MATTING AND BANK STABILIZATION PER PLANS.



Plan View



Section A-A'

2 / 5.4 Brush Toe - T2-T9
Not to Scale

NOTES:
1. OVEREXCAVATE 3' OUTSIDE OF TOP OF BANK (BANKFULL).
2. INSTALL A DENSE LAYER OF BRUSH/WOODY DEBRIS, WHICH SHALL CONSIST OF SMALL BRANCHES AND ROOTS COLLECTED ON-SITE AND SOIL TO FILL ANY VOID SPACE. LIGHTLY COMPACT BRUSH/WOODY DEBRIS LAYER.
3. BRUSH SHOULD BE ALIGNED SO STEMS ARE ROUGHLY PARALLEL AND IS INSTALLED POINTING SLIGHTLY UPSTREAM.
4. INSTALL MATTING OVER BRUSH/WOODY DEBRIS.
5. INSTALL EARTH BACKFILL OVER BRUSH/WOODY LAYER ACCORDING TO TYPICAL SECTION DIMENSIONS.
6. SEED, MULCH AND INSTALL EROSION CONTROL MATTING AND BANK STABILIZATION PER PLANS.

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Raleigh, NC 27609
Tel: 919.851.9986
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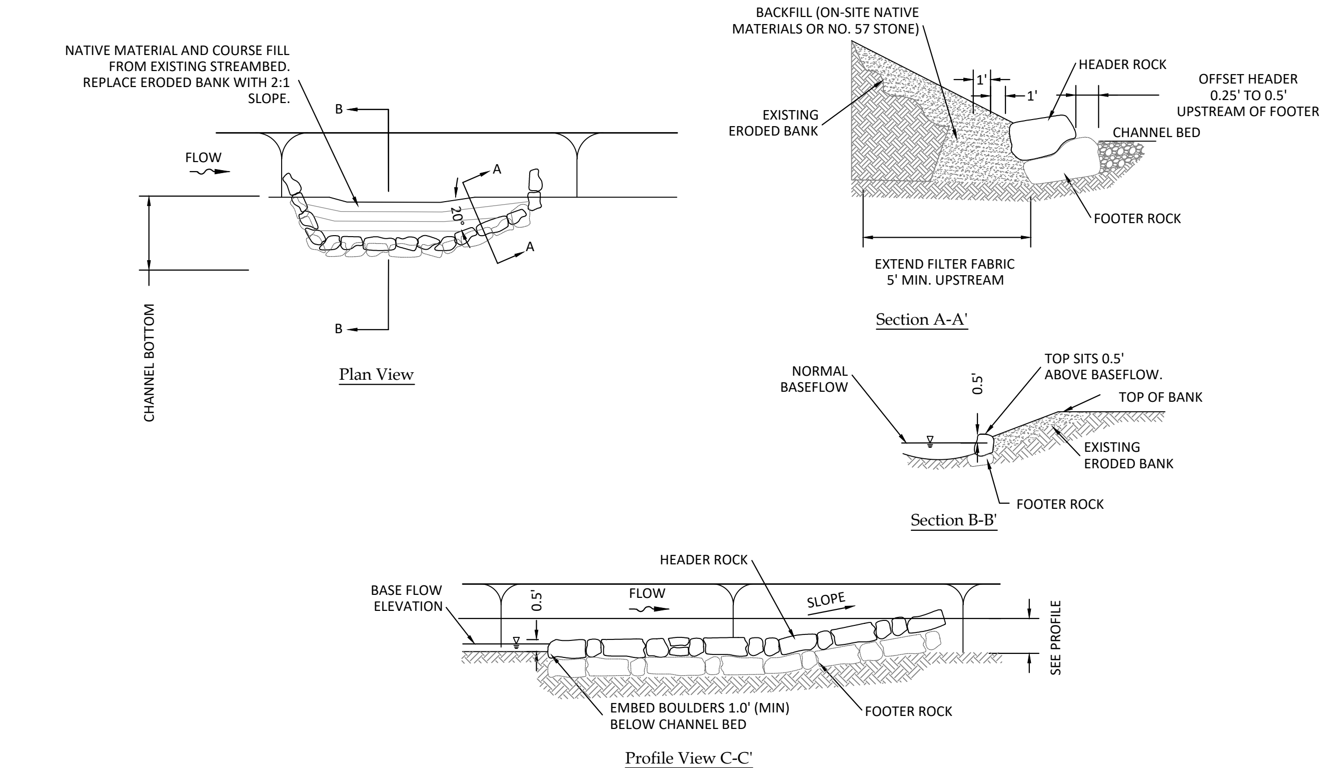
Checked By:	JWH

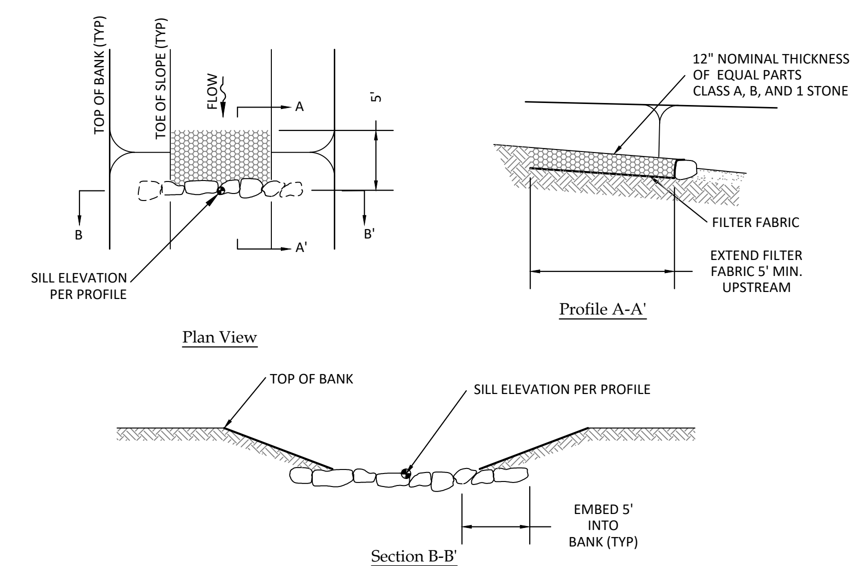
5.4
Sheet



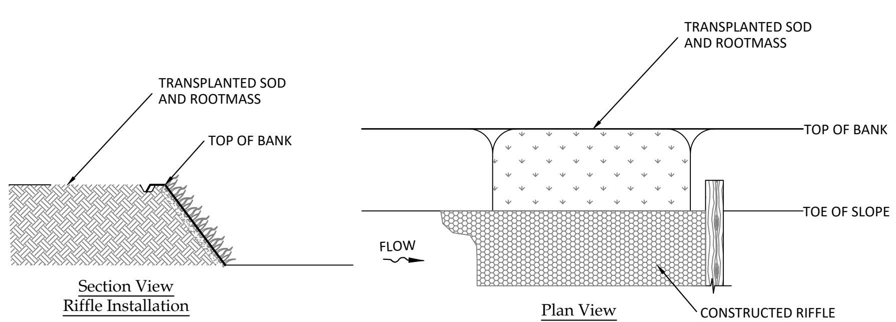
NOTE:

1. FOR STREAM BEDS WITH COARSE SUBSTRATE, PROVIDE FOOTER ROCKS.

1/5.5 **Boulder Toe**
Not to Scale



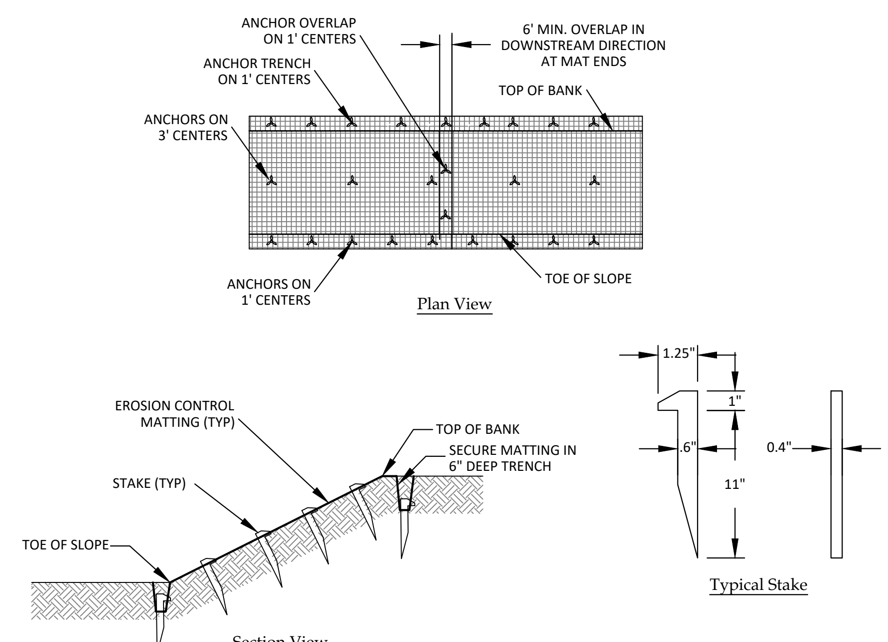
2/5.5 **Boulder Sill**
Not to Scale



NOTES:

1. PREPARE THE BANK WHERE THE SOD MAT WILL BE TRANSPLANTED BY RAKING & FERTILIZING.
2. EXCAVATE TRANSPLANT SOD MATS WITH A WIDE BUCKET AND AS MUCH ADDITIONAL SOIL MATERIAL AS POSSIBLE.
3. PLACE TRANSPLANT ON THE BANK TO BE STABILIZED.
4. SECURE WITH SOD STAPLES.
5. FILL IN ANY HOLES AROUND THE TRANSPLANT AND COMPACT.
6. ANY LOOSE SOIL LEFT IN THE STREAM SHOULD BE REMOVED.
7. PLACE MULTIPLE TRANSPLANTS CLOSE TOGETHER SUCH THAT THEY TOUCH.

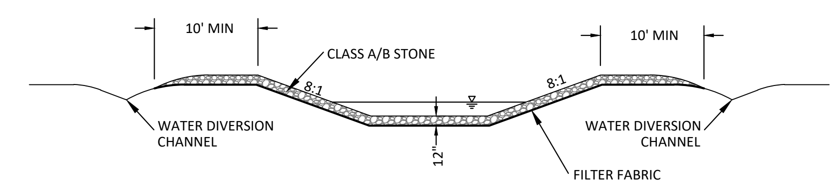
3/5.5 **Transplanted Sod Mats**
Not to Scale



NOTE:

1. PER SPECIFICATIONS, ALL EROSION CONTROL MATTING SHALL BE COMPOSED OF NATURAL FIBERS.

4/5.5 **Erosion Control Matting**
Not to Scale



NOTES:

1. FORD CROSSING SHALL BE INSTALLED PERPENDICULAR TO CHANNEL BANKS.
2. MAINTAIN DIVERSION CHANNEL TO INSURE RUNOFF DOES NOT ENTER CHANNEL.

5/5.5 **Permanent Ford Crossing**
Not to Scale

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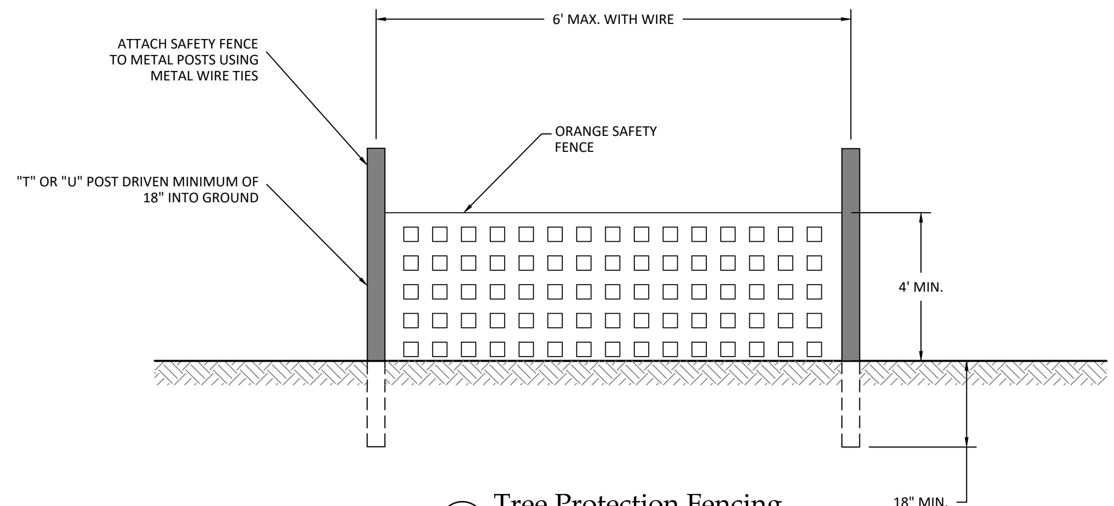
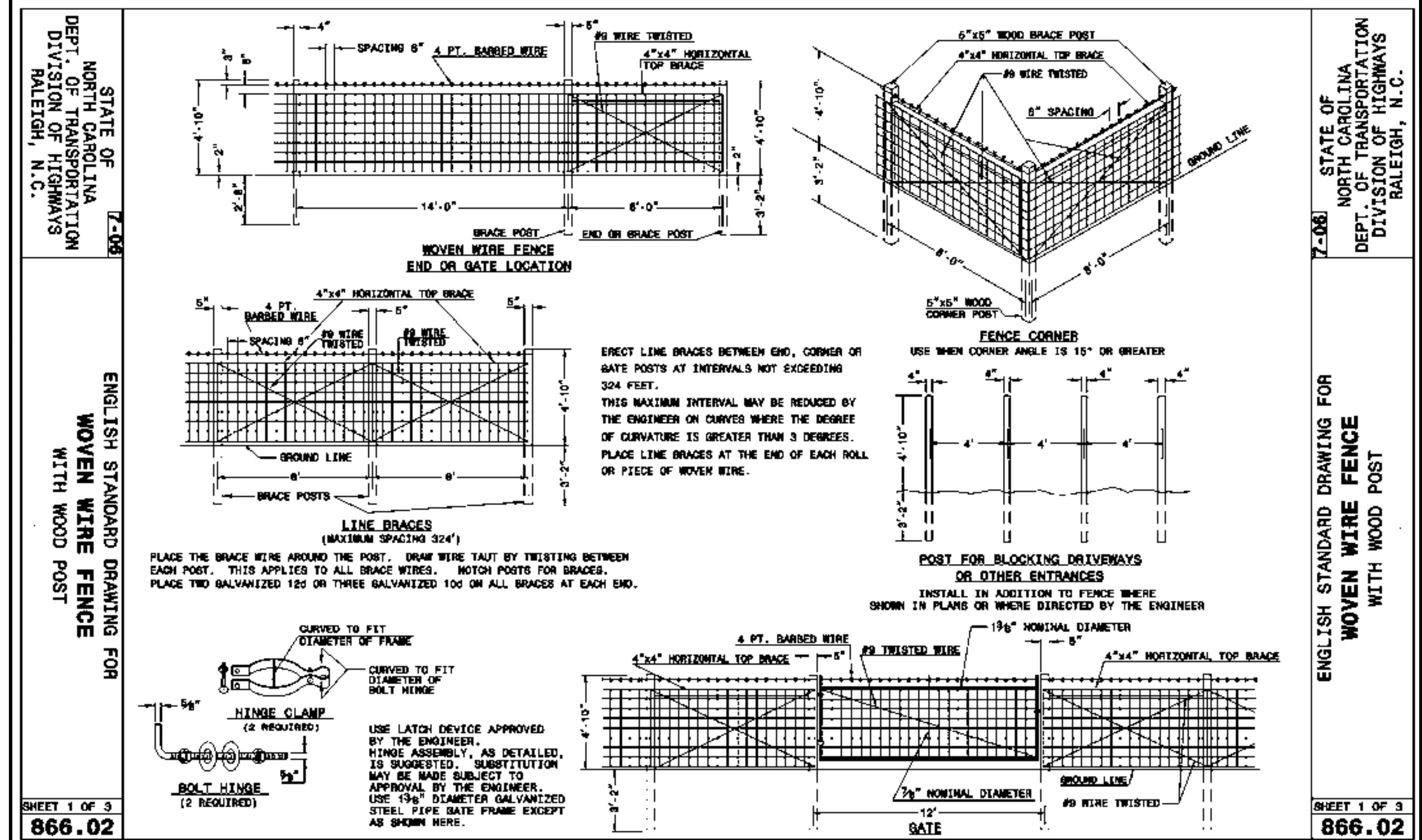
Sheet 5.5

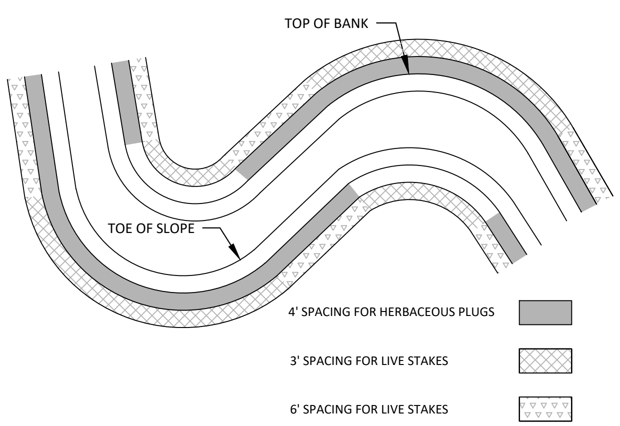
MATERIAL SPECIFICATIONS		
PHYSICAL PROPERTY	TESTS	REQUIREMENTS
MATERIAL	N/A	POLYETHYLENE
RECOMMENDED COLOR	N/A	"INTERNATIONAL ORANGE"
TENSILE YIELD	ASTM D638	AVE. 2000 LBS. PER 4' WIDE
ULTIMATE TENSILE STRENGTH	ASTM D638	AVE. 2900 LBS. PER 4' WIDE
ELONGATION AT BREAK (%)	ASTM D638	GREATER THAN 1000%
CHEMICAL RESISTANCE	N/A	INERT TO MOST CHEMICALS AND ACIDS



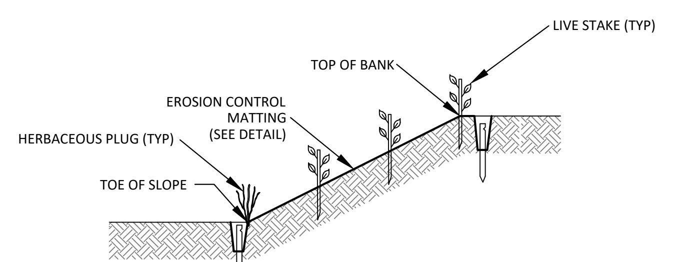
1 / 5.6 Tree Protection Fencing
Not to Scale



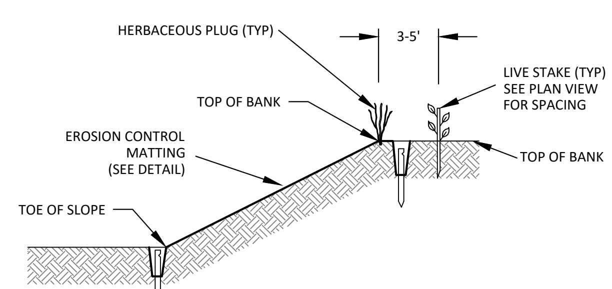
2 / 5.6 Woven Wire Fence - Permanent CE Fencing
Not to Scale



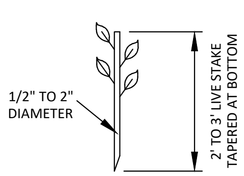
Plan View



Section View - Buckwater Creek and T1



Section View - T2-T9

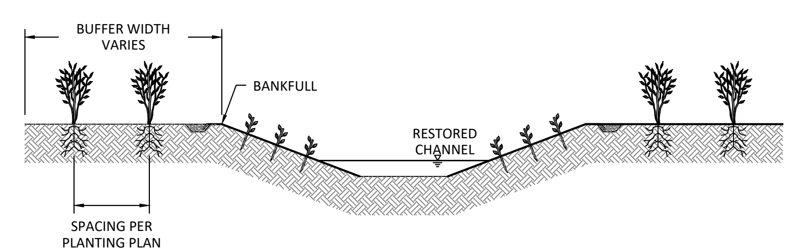


Live Stake Detail

NOTE:

1. LIVE STAKES TO BE PLANTED IN AREAS AS SHOWN ON PLANS AND AS DIRECTED BY THE ENGINEER.

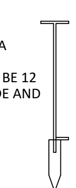
3 / 5.6 Live Staking & Herbaceous Plugs
Not to Scale



Section View

DIBBLE BAR

PLANTING BAR SHALL HAVE A BLADE WITH A TRIANGULAR CROSS-SECTION, AND SHALL BE 12 INCHES LONG, 4 INCHES WIDE AND 1 INCH THICK AT CENTER.

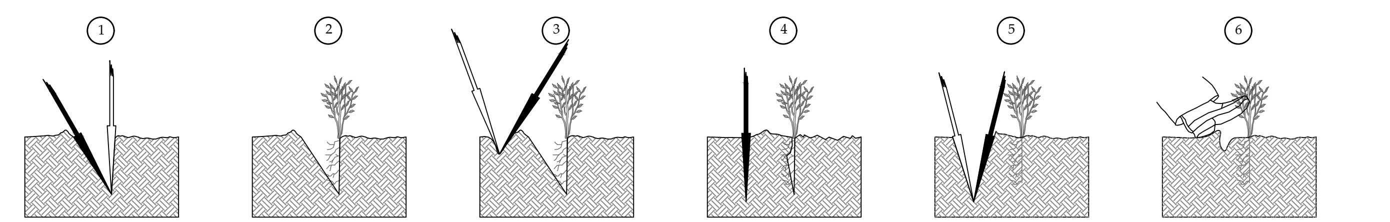


ROOTING PRUNING

ALL ROOTS SHALL BE PRUNED TO AN APPORIATE LENGTH TO PREVENT J-ROOTING.

NOTES:

1. ALL SOILS WITHIN THE BUFFER PLANTING AREA SHALL BE DISKED, AS REQUIRED, PRIOR TO PLANTING.
2. ALL PLANTS SHALL BE PROPERLY HANDLED PRIOR TO INSTALLATION TO INSURE SURVIVAL.



1. INSERT THE DIBBLE, OR SHOVEL, STRAIGHT DOWN INTO THE SOIL TO THE FULL DEPTH OF THE BLADE AND PULL BACK ON THE HANDLE TO OPEN THE PLANTING HOLE. (DO NOT ROCK THE SHOVEL BACK AND FORTH AS THIS CAUSES SOIL IN THE PLANTING HOLE TO BE COMPACTED, INHIBITING ROOT GROWTH.

2. REMOVE THE DIBBLE, OR SHOVEL, AND PUSH THE SEEDLING ROOTS DEEP INTO THE PLANTING HOLE. PULL THE SEEDLING BACK UP TO THE CORRECT PLANTING DEPTH (THE ROOT COLLAR SHOULD BE 1 TO 3 INCHES BELOW THE SOIL SURFACE). GENTLY SHAKE THE SEEDLING TO ALLOW THE ROOTS TO STRAIGHTEN OUT. DO NOT TWIST OR SPIN THE SEEDLING OR LEAVE THE ROOTS J-ROOTED.

3. INSERT THE DIBBLE, OR SHOVEL, SEVERAL INCHES IN FRONT OF THE SEEDLING AND PUSH THE BLADE HALFWAY INTO THE SOIL. TWIST AND PUSH THE HANDLE FORWARD TO CLOSE THE TOP OF THE SLIT TO HOLD THE SEEDLING IN PLACE.

4. PUSH THE DIBBLE, OR SHOVEL, DOWN TO THE FULL DEPTH OF THE BLADE.

5. PULL BACK ON THE HANDLE TO CLOSE THE BOTTOM OF THE PLANTING HOLD. THEN PUSH FORWARD TO CLOSE THE TOP, ELIMINATING AIR POCKETS AROUND THE ROOT.

6. REMOVE THE DIBBLE, OR SHOVEL, AND CLOSE AND FIRM UP THE OPENING WITH YOUR HEEL. BE CAREFUL TO AVOID DAMAGING THE SEEDLING.

4 / 5.6 Bare Root Planting
Not to Scale

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March 7, 2012
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Appendix 8

Invasive Species Plan

1.0 Invasive Species Plan

The presence of invasive species on the Buckwater Mitigation Site is pervasive, though much of them are located near the streambanks. The most prevalent species, Chinese privet (*Lagustrum sinese*), is spread throughout the project area. It is particularly abundant along lower T6, upper T5, Buckwater R4, T2, and T4. Tree of heaven (*Ailanthus altisimma*) is present along T7, T6, Buckwater R5, and other locations. Multiflora rose (*Rosa multiflora*) is also scattered along the existing stream banks, but in much lower quantities.

The goal of this project is to treat and remove as much existing invasive species as possible before and during construction. Chinese privet was treated in June 2016 and Tree of heaven was treated in August 2016. Post construction, the presence and extents of invasive species will be monitored. Treatment of invasive species will continue as necessary throughout the life of the project to ensure project stability and success of the riparian and streambank vegetation.

Appendix 9

Maintenance Plan

1.0 Maintenance Plan

The site shall be monitored on a regular basis and a physical inspection of the site shall be conducted a minimum of once per year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance should be expected most often in the first two (2) years following site construction and may include the following:

Table1: Maintenance Plan – *Buckwater Mitigation Site*

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

Appendix 10

Credit Release Schedule

1.0 Credit Release Schedule

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

Table A: Credit Release Schedule – Stream Credits – *Buckwater Mitigation Site*

Credit Release Milestone	Credit Release Activity	Interim Release	Total Released
1	Site Establishment (includes all required criteria)	0%	0%
2	Completion of all initial physical and biological improvements made pursuant to the Mitigation Plan	30%	30%
3	Year 1 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	40%
4	Year 2 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	50%
5	Year 3 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	60%
6	Year 4 monitoring report demonstrates that channels are stable and interim performance standards have been met	5%	65% (75%*)
7	Year 5monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	75% (85%*)
8	Year 6 monitoring report demonstrates that channels are stable and interim performance standards have been met	5%	80% (90%*)
9	Year 7 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	90% (100%*)

*10% reserve credits to be held back until the bankfull performance standard has been met.

1.1 Initial Allocation of Released Credits

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

a. Approval of the final Mitigation Plan.
b. Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property.
c. Completion of project construction (the initial physical and biological improvements to the mitigation site) pursuant to the mitigation plan; per the DMS Instrument, construction means that a mitigation site has been constructed in its entirety, to include planting, and an as-built

report has been produced. As-built reports must be sealed by an engineer prior to project closeout, if appropriate but not prior to the initial allocation of released credits.

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

1.2 Subsequent Credit Releases

All subsequent credit releases must be approved by the DE, in consultation with the IRT, based on a determination that required performance standards have been achieved. For stream projects a reserve of 10% of a site's total stream credits shall be released after two bankfull events have occurred, in separate years, provided the channel is stable and all other performance standards are met. In the event that less than two bankfull events occur during the monitoring period, release of these reserve credits shall be at the discretion of the IRT. As projects approach milestones associated with credit release, the DMS will submit a request for credit release to the DE along with documentation substantiating achievement of criteria required for release to occur. This documentation will be included with the annual monitoring report.

Appendix 11

Financial Assurance

1.0 Financial Assurances

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