


BASELINE MONITORING DOCUMENT AND AS-BUILT BASELINE REPORT

FINAL

BUCKWATER MITIGATION SITE

Orange County, NC
NCDEQ Contract No. 006829
DMS Project Number 97084
USACE Action ID Number 2016-00873
NCDWR Project Number 2016-0406

Data Collection Period: January 2019 - May 2019
Draft Submission Date: July 16, 2019
Final Submission Date: September 12, 2019

PREPARED FOR:

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

September 12, 2019

Jeff Schaffer
N.C. Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

RE: Task 6 As-Built Baseline Report - Buckwater Mitigation Site, DMS ID# 97084
Neuse River Basin – CU# 03020201
Orange County, North Carolina
Contract No. 006829

Dear Mr. Schaffer,

We have reviewed the comments on the As-Built Baseline Report for the above referenced project dated August 21, 2019 and have revised the report based on these comments. The revised documents are submitted with this letter. Below are responses to each of your comments. For your convenience, the comments are reprinted with our response in italics.

1) In accordance with RFP#16-006477 (Section 6 paragraph 1), Wildlands must substitute a Monitoring Phase Performance Bond (MPPB) for the original Performance Bond prior to DMS authorizing Wildlands to invoice for payment for the Task 6 deliverable and approval to retire the original Performance Bond. The requirements for the MPPB can be found in Section 6 of RFP#16-006477. Submit a draft of the MPPB to Jeff Jurek for review and approval.

   A digital copy of the draft Monitoring Phase Performance Bond has been reviewed by Jeff Jurek and a final hardcopy has been mailed.

2) Executive Summary, page I - First paragraph states project will restore and enhance 16,558 lf of perennial and intermittent streams. Verify that number. DMS calculation of total lf and that derived from Wildlands' digital copy of Table 1 both indicate this as 16,263 lf.

   After minor revisions to Table 1, the total linear footage is 16,276. The Executive Summary was updated to reflect this change.

3) Table of Contents – Verify page number for Table 2.

   The Table of Contents was updated to show the correct page number for Table 2.

4) Section 1.3.1, page 1-3 - Verify total stream credits. See Comment #6a regarding Appendix 1, Table 1.

   Section 1.3.1 was updated to show the total stream credits out to three decimal places.

5) Section 1.3.2, Table 2 – The treatment approach for Buckwater Creek R4-R6 says "Restoration – Priority 1 and 1.5." Please clarify what is meant by Priority 1.5.

A note was added to Table 2 explaining what is meant by Priority 1.5.

6) Appendix 1
   a) Table 1: Show mitigation credits out to three (3) decimals in accordance with the most recent template for Table 1 and verify that all credit calculations are correct. DMS has noted some discrepancies between our credit calculations and those of Wildlands for EI and EII.

      Mitigation Credits have been shown to three decimal places and all credit calculations have been verified.

      i) See attached shapefile for notes on preferred segmentation of table 1, which will better match the segmentation of the MP.

         Table 1 has been updated using notes from the attached shapefile as a guide.

      ii) Make note of where infrastructure may have been the cause of segmentation in comment.

         Notes were made in the comment column where infrastructure caused segmentation in stream reaches.

      iii) Indicate the extent of work beyond conservation easement for some of the EII segments at 2.5:1.

         The extent of work beyond conservation easement was added to the EII segments.

   b) Table 4: Verify length of reach for T5 & T6 and include planted acreage in the table.

      The length of T5 and T6 has been updated, and planted acreage was added to Table 4.

   c) Table 5: Please differentiate between crest gauge and continuous stage recorder for monitoring overbank frequency and continuous stage recording for measuring days of continuous base flow. For long pro, just please denote that it will be done for MY0 unless needed later for diagnostics.

      Gauges have been differentiated between and the long pro has been denoted that it will be completed only for MY0 unless required during annual monitoring.

7) Appendix 5: Record Drawings
   a) Please provide the As-Built Survey as required by contract and as detailed in the As-built Baseline Monitoring Report Format, Data Requirements, and Content Guidance February 2014. If what was submitted is intended to cover both the As-Built and Record Drawing

requirements, please ensure that is reflected in the document Title/Label, that all required information is included and that the final is signed and sealed by both a PLS and PE.

The Title Sheet was updated to show that the plans incorporate both the As-Built and Record Drawings.

b) Throughout the plan sheets areas denoted as Designed Streambank Grading are greyed out, and areas where as-built streambank grading occurred are simply encompassed within LOD polygons. Please clarify this on Sheet 0.5.

Areas where streambank grading occurred show the LOD and the same hatch pattern that was used for design on the as-built sheets.

c) Sheet 1.2: Note says, "STA 104+58: RIFFLE WAS INSTALLED UPSTREAM." However, riffle is not identified in red.

The designed constructed riffle is on sheet 1.2, but the as-built constructed riffle is on sheet 1.1 and shown in red. A note is shown on both sheet 1.1 and 1.2 documenting the change in this constructed riffle.

d) Sheet 1.65: Note says STA 711+17: LOG SILL NOT INSTALLED AND TWO RIFFLES MADE INTO ONE." The two combined riffles should be identified in red graphically.

The combined constructed riffles are shown in red.

e) Sheet 1.70: Constructed riffle in T9 at its confluence with Buckwater Creek is shown as not being constructed, but was verified during the site visit to have been constructed.

The constructed riffle on T9 was surveyed in September and is shown in the Record Drawings, and in the CAD file of the As-Built Record Drawing.

8) Appendix 6 - Buffer Baseline Monitoring Report - No comments.

9) Digital files
   a) Provide all digital files in the formats and with all components labeled and attributed as required by contract and as detailed in the most recent As-built Baseline Monitoring Report Format, Data Requirements, and Content Guidance.

   All digital files are in the format requested.

   b) Please provide the following items as part of the digital submission.

      i) Please provide CAD file for AB-Record drawing.

A CAD file of the As-Built Record Drawing has been included.

ii) Stream structures need to be represented as points with attribution. Current requirement does not require this for GIS but must be in the CAD at a minimum. WEI prerogative if want to include in CAD only or as GIS.

Stream structures are represented as points in the As-Built CAD Drawing. Tables are included in the drawing with attributes for these points.

iii) Please include groundwater well features. Feature class does not include any shapes.

A groundwater well shapefile has been provided.

iv) Utilities and ROW need to be provided as polygons.

Utilities and ROW shapefiles have been provided as polygons.

c) No shapefile was provided to reflect the credits/creditable stream lengths as listed in Appendix 1, Table 1 associated with the stream mitigation. Provide stream shapes used to derive the asset numbers in Table 1. If any measured shapes do not equal assets in Table 1, include an additional column in the table that includes measured footage.

An as-built stream shapefile has been provided.

If you have any questions, please contact me by phone (919) 851-9986, or by email (jlorch@wildlandseng.com).

Sincerely,

Jason Lorch, *Monitoring Coordinator*

PREPARED BY:

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EXECUTIVE SUMMARY

Wildlands Engineering, Inc. (Wildlands) implemented a full delivery project at the Buckwater Mitigation Site (Site) for the North Carolina Department of Environmental Quality Division of Mitigation Services (DMS) to restore and enhance a total of 16,276 linear feet (LF) of perennial and intermittent streams in Orange County, NC. The Site is expected to generate 12,621.963 stream mitigation units (SMUs) when calculated along stream centerlines. The Site is located approximately 4.5 miles northeast of Hillsborough, NC (Figure 1) in the Neuse River Basin 8-Digit Hydrologic Unit Code (HUC) 03020201 and within a 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 contains Buckwater Creek and 14 unnamed tributaries. Buckwater Creek, T1, T2, T3, T4, T5, T6, T6A, T7, and T9 are all perennial streams, while T4A, T4B, T6B, T7A and T8 are intermittent streams. The Site drains to the Eno River, which flows to Falls Lake, and is classified as water supply waters (WS-IV) and nutrient sensitive waters (NSW). The 51.84 acre site is protected with a permanent conservation easement.

The Site is located within the Neuse River Targeted Local Watershed (TLW) as discussed in the 2010 Neuse River Basin Restoration Priorities (RBRP) (Breeding, 2010), which highlights the importance of riparian buffers for stream restoration projects. Since the 1990s, cattle have activity grazed on three of the Site properties. Anything that is not grazed or in forest, including large residential lots, is used for cultivating hay.

The project goals established in the mitigation plan (Wildlands, 2017) were completed with careful consideration of goals and objectives that were described in the Neuse River RBRP plan. The project goals established include:

- Reconnect channels with floodplains and riparian wetlands to allow a natural flooding regime;
- Improve the stability of stream channels;
- Exclude cattle from project streams;
- Restore and enhance native floodplain and streambank vegetation;
- Improve instream habitat; and
- Permanently protect the Site from harmful land uses.

The project will contribute to achieving goals for the watershed discussed in the Neuse River RBRP and provide ecological benefits within the Neuse River Basin. While benefits such as habitat improvement and geomorphic stability are limited to the project site, others, such as reduced pollutant and sediment loading, have farther reaching effects.

Site construction and planting were completed in April 2019. As-built surveys were conducted between January 2019 and April 2019. Adjustments were made during construction and specific changes are detailed in Section 5.1. Baseline (MY0) profiles and cross-section dimensions closely match the design parameters. A short section along T4A Reach 3 was realigned due to bedrock. Minor stream bank erosion between stations 109+05 - 109+60 and stations 131+10 - 131+50 on Buckwater Reach 4 and stations 314+10 - 315+10 on T3 Reach 2 occurred during heavy rain events that caused significant flows throughout the site before vegetation was well established. Cross-section widths and pool depths occasionally deviate from the design parameters but fall within a normal range of variability for natural streams. The Site has been built as designed and is expected to meet the upcoming monitoring year's performance criteria.

BUCKWATER MITIGATION SITE

Baseline Monitoring Document and As-Built Baseline Report

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TABLES

APPENDICES

Section 1: PROJECT GOALS, BACKGROUND, AND ATTRIBUTES

1.1 Project Location and Setting

The Buckwater Mitigation Site (Site) is located in central Orange County, approximately 4.5 miles northeast of Hillsborough, NC off of Walnut Hill Drive (Figure 1). From Raleigh, NC, take I-40 West towards Durham. Take exit 279B for NC-147 North towards Durham/Downtown. Travel approximately 13 miles and merge onto I-85 South. Travel approximately 2 miles, take exit 170 for US-70 West. In 3.7 miles turn right onto Lawrence Road. Travel 1.4 miles to turn onto St Mary's Road. In 2.5 miles turn right onto Walnut Hill Drive. A conservation easement was recorded on a total of 51.84 acres and includes portions of 11 parcels owned by 9 landowners.

The Site is located in the Neuse River Watershed within the Falls Lake Water Supply Watershed which has been designated a Nutrient Sensitive Water. The project streams drain to the Eno River and eventually into the Falls Lake Reservoir. The Site is within Hydrologic Unit Code (HUC) 03020201030030 and is located within the Neuse River Targeted Local Watershed (TLW) (Figure 1) as identified in the 2010 Neuse River Basin Restoration Priorities (RBRP) (Breeding, 2010). This document highlights the importance of riparian buffers for stream restoration projects. Riparian buffers immobilize and retain nutrients and suspended sediment. The RBRP also supports 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 Site is located in the Carolina Slate Belt of the Piedmont Physiographic Province. The Piedmont Province is characterized by gently rolling, well rounded hills with long low ridges and elevations ranging from 300-1500 feet above sea level. The Site topography and relief are typical for the region. The Carolina Slate Belt consists of heated and deformed volcanic and sedimentary rocks. The area is called "Slate Belt" because of the slatey cleavage of many of the surficial rocks. The region's geology also includes coarse-grained intrusive granites.

Prior to construction activities, the primary degradation on the Site was livestock grazing since before 1938 and channel straightening. Agricultural activity remained high through the 1990s with several thousand beef cattle and three hog houses. Currently, approximately 130 cows graze on three Site properties and land that is not forested is used for cultivating hay. There were several ponds along Buckwater Creek, T3, and T5 that were built between 1938 and 1955. Based off 1955 aerial photography, the top 1,000 feet of Buckwater Creek was straightened. Landowners tried to maintain Lower Buckwater Creek below Walnut Hill Drive as a straighten channel with little success and completely gave up in the 1990s. Table 4 in Appendix 1 and Tables 7a-c in Appendix 4 present the pre-restoration conditions in more detail.

1.2 Project Goals and Objectives

The project is intended to provide numerous ecological benefits within the Neuse River Basin. While benefits such as habitat improvement and geomorphic stability are limited to the project site, others, such as reduced pollutant and sediment loading, have farther reaching effects. Expected improvements to water quality and ecological processes are outlined below as project goals and objectives. These project goals were established and completed with careful consideration of goals and objectives that were described in the RBRP and to meet the DMS mitigation needs while maximizing the ecological and water quality uplift within the watershed.

The project goals established in the mitigation plan (Wildlands, 2017) are described in Table 1:

Table 1: 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

1.3 Project Structure, Restoration Type, and Approach

The final mitigation plan was submitted and accepted by DMS in December 2017. Construction activities were completed by Ecotone, Inc in April 2019. The baseline as-built survey was completed by Kee Mapping and Surveying in April 2019. The planting was completed by Bruton Natural Systems, Inc. in April 2019. Refer to Appendix 1 for detailed project activity, history, contact information, and watershed/site background information.

1.3.1 Project Structure

The project will provide 12,621.936 stream mitigation units (SMUs). Refer to Figure 2 for the Project Component/Asset Map for the stream restoration feature exhibits and Table 1 for the Mitigation Assets and Components information for the Site.

1.3.2 Restoration Type and Approach

The design streams were restored to the appropriate type based on the surrounding landscape, climate, and natural vegetation communities but also with strong consideration to existing watershed conditions. The project consists of the stream restoration activities as described below and shown in Figure 2.

Table 2: Restoration Type and Approach Per Reach – *Buckwater Mitigation Site*

Stream	Reach	Primary Stressors/Impairments	Treatment Approach	Restoration Activity
Buckwater Creek	R1-R3	Incision, erosion, lack of habitat	Enhancement Levels I and II	Grade Control Structures, Streambank Planting
	R4-R6	Incision, erosion, lack of riparian vegetation	Restoration – Priority 1 and 1.5*	Plan, Pattern, Profile, Pond Removal, Fencing,
	R7-R8	Incision, erosion, lack of habitat	Enhancement Level II	Bank Stabilization, Fencing
T1	R1	Incision, erosion, lack of habitat	Enhancement Level I	Grade Control Structures, Planting, Fencing
	R2	Incision, erosion, lack of riparian vegetation	Restoration – Priority 1	Plan, Pattern, Profile, Fencing
T2		Incision, and erosion	Restoration – Priority 1	Plan, Pattern, Profile, Fencing
T3	R1	Lack of riparian vegetation, and livestock access	Enhancement Level II	Fencing, Bank Stabilization, Planting
	R2	Incision, erosion, livestock access, lack of riparian vegetation	Restoration – Priority 1	Plan, Pattern, Profile, Fencing
T4		Incision, erosion, lack of habitat and riparian buffer	Restoration – Priority 1	Plan, Pattern, Profile Fencing
T4A	R1	Farm pond, lack of riparian vegetation	Restoration – Priority 1	Plan, Pattern, Profile, Fencing
	R2	Livestock access	Enhancement Level II	Fencing
	R3	Lack of riparian vegetation	Restoration – Priority 1	Plan, Pattern, Profile, Dam Removal, Fencing
T4B R1		Incision, erosion, cattle access, lack of habitat	Restoration – Priority 1	Plan, Pattern, Profile, Fencing
T5		Incision, erosion, farm pond, lack of riparian buffer, invasive species	Restoration – Priority 1	Plan, Pattern, Profile, Pond Removal, Planting
T6	R1-R2	Incision, erosion, lack of habitat, invasive species	Enhancement Level II	Fencing, Planting
	R3	Incision, erosion, lack of habitat and riparian buffer, invasive species	Enhancement Level I	Grade Control Structures, Invasive Control, Fencing, Planting
T6A		Incision, unstable pond dam, lack of riparian vegetation	Enhancement Level II	Fencing, Planting

Stream	Reach	Primary Stressors/Impairments	Treatment Approach	Restoration Activity
T6B		Incision, erosion	Enhancement Level II	Fencing, Planting
T7	R1	Incision, erosion, lack of riparian vegetation	Enhancement Level I	Grade Control Structures, Fencing, Planting
	R2-R3	Incision, erosion, lack of habitat	Restoration – Priority 1 and 2	Plan, Pattern, Profile, Fencing, Streambank Planting
T7A		Failed pond dam, lack of riparian vegetation	Enhancement Level I	Grade Control Structures, Planting, Fencing
T8		Incision, erosion, lack of habitat	Enhancement Level I	Grade Control Structures Fencing, Planting
T9		Incision	Enhancement Level II	Fencing

*Priority 1.5 refers to a combination of Priority 1 and Priority 2 where the existing channel was raised and the floodplain was graded.

The design approach for this Site utilized a combination of analog and analytical approaches for stream restoration and enhancement. Reference reaches were identified to serve as the basis for design parameters. Channels were sized based on design discharge hydrologic analysis. 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 (Underwood, Foust, Holman Mill, Maney Farm, and Agony Acres Mitigation Sites) and is appropriate for the goals and objectives for this Site.

The morphologic design parameters are shown in Appendix 4, Tables 7a -7c for the restoration reaches, and fall within the ranges specified for C4, E4, and B4 streams (Rosgen, 1996). The specific values for the design parameters were selected based on designer experience and judgment and were verified with morphologic data form reference reach data sets.

1.4 Project History, Contacts, and Attribute Data

The Site was restored by Wildlands through a full delivery contract with DMS. Tables 2, 3, and 4 in Appendix 1 provide detailed information regarding the Project Activity and Reporting History, Project Contacts, and Project Information and Attributes.

Section 2: PERFORMANCE STANDARDS

The stream 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 Stream Mitigation Guidelines issued October 2016 by the North Carolina Interagency Review Team (NCIRT). 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.

2.1 Streams

2.1.1 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. Per guidance, bank height ratios shall not exceed 1.2 and entrenchment ratios shall be at least 2.2 for restored channels to be considered stable. 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.

2.1.2 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.

2.1.3 Substrate

Channel substrate materials will be sampled in eleven 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 Creek Reaches 4-6, T1 Reach 2, T2, T3 Reach 2, T4, T4A Reach 1, T4B Reach 1, T5, and T7 Reach 3.

2.1.4 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.

2.1.5 Hydrology Documentation

The occurrence of bankfull events will be documented throughout the monitoring period. Four bankfull flow events must be documented within the seven-year monitoring period. The four bankfull events must occur in separate years. Stream monitoring will continue until performance standards in the form of four bankfull events in separate years have been documented.

All intermittent streams 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 Reach 1, T4B Reach 1, T6 Reach 2, T7A, and T8.

2.1.6 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
- T4, vicinity of station 414+50 upstream from T3 confluence
- T6 Reach 2, area near crossing

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.

Wildlands installed three monitoring gages at locations shown on a map sent by NCDWR on February 28, 2018. Two are along Buckwater Creek Reach 4 and one is along T1 Reach 2 downstream from St. Mary's Road. The purpose of these gages is to assess potential impacts to existing wetland hydrology from the Buckwater Mitigation Project.

2.2 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 NCIRT. The success criteria interim survival rates are 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 acre at the end of monitoring year 7 (MY7) and trees should average 10 feet in height. Also, no one species shall account for more than 50% of the required number of stems within any vegetation plot.

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

2.3 Visual Assessment

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

2.4 Schedule and Reporting

Monitoring reports will be prepared in the fall of each year of monitoring and submitted to DMS. Based on the DMS Annual Monitoring Report Template (April 2015), the monitoring reports will include the following:

- Project background which includes project objectives, project structure, restoration type and approach, location and setting, history and background;
- Monitoring current condition plan view maps with major project elements noted such as grade control structures, vegetation plots, permanent cross-sections, and crest gauges;

- Photographs showing views of the restored Site taken from fixed point stations;
- Assessment of the stability of the Site based on the cross-sections;
- Vegetative data as described above including the establishment of any undesirable plant species;
- A description of damage by animals or vandalism; and
- Maintenance issues and recommended remediation measures will be detailed and documented.

Section 3: MONITORING PLAN

Monitoring will consist of collecting morphological, vegetative, and hydrologic data to assess the project performance based on the restoration goals and objectives on an annual basis or until performance criteria is met. The performance of the project will be assessed using measurements of the stream channel's dimension, pattern, substrate composition, permanent photographs, vegetation, and surface water hydrology. Any areas with identified high priority problems, such as streambank instability, aggradation/degradation, or lack of vegetation establishment will be evaluated on a case-by-case basis. The problem areas will be visually noted, and remedial actions will be discussed with DMS staff to determine a plan of action. A remedial action plan will be submitted if maintenance is required. The monitoring period will extend seven years beyond completion of construction or until performance criteria have been met.

3.1 Stream

Geomorphic assessments will follow guidelines outlined in the Stream Channel Reference Sites: An Illustrated Guide to Field Techniques (Harrelson et al., 1994), methodologies utilized in the Rosgen stream assessment and classification document (Rosgen, 1994 and 1996), and in the Stream Restoration: A Natural Channel Design Handbook (Doll et al, 2003). Refer to Figure 3a-f in Appendix 2 and Record Drawings in Appendix 5 for monitoring locations discussed below.

3.1.1 Dimension

A total of 36 cross-sections were installed along the stream restoration reaches. Two cross-sections were installed per 1,000 linear feet of stream restoration work, with riffle and pool sections in proportion to DMS guidance. Each cross-section was permanently marked with pins to establish its location. Cross-section surveys include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg to monitor any trends in bank erosion. If moderate bank erosion is observed at a stream reach during the monitoring period, a series of bank pins will be installed in representative areas where erosion is occurring for reaches with a bankfull width of greater than five feet. Bank pins will be installed in at least three locations (one in upper third of the pool, one at the mid-point of the pool, and one in the lower third of the pool). If bank pins are required, they will be monitored by measuring exposed rebar and maintaining pins flush to bank to capture bank erosion progression. Annual cross-section surveys will be conducted in monitoring years one (MY1), two (MY2), three (MY3), five (MY5), and seven (MY7). Photographs will be taken annually of the cross-sections looking upstream and downstream.

3.1.2 Pattern and Profile

Longitudinal profile surveys will not be conducted during the seven year monitoring period unless other indicators during the annual monitoring show a trend toward vertical and lateral instability. If a longitudinal profile is deemed necessary, monitoring will follow standards as described in the DMS Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation (11/7/2011) and the 2003 USACE and NCDWR Stream Mitigation Guidance for the necessary reaches. Stream pattern and profile will be assessed visually as described below in section 3.1.6.

3.1.3 Substrate

A reach-wide pebble count will be performed in 11 reaches (Buckwater Reaches 4-6, T1 Reach 2, T2, T3 Reach 2, T4, T4A, T4B, T5, and T7) during monitoring years 1, 2, 3, 5, and 7 for classification purposes.

3.1.4 Photo Reference Points

A total of 49 permanent photograph reference points were established along the stream reaches after construction. Permanent markers were established so that the same locations and view directions on the Site are photographed each year. Longitudinal stream photographs will be taken looking upstream and downstream once a year to visually document stability. Cross-sectional photos will be taken at each permanent cross-section looking upstream and downstream. Representative digital photos of each permanent photo point will be taken on the same day the stream assessments are conducted. The photographer will make every effort to consistently maintain the same area in each photo over time.

3.1.5 Hydrology Documentation

Seven automated crest gauges were installed on Site (Figure 3a-f, Appendix 2). The crest gauges were installed in surveyed riffle cross-sections on Buckwater Creek Reach 6, T1 Reach 2, T2, T4, T5 (2), T7 R3. Crest gauge data will be downloaded during site visits to determine if a bankfull event has occurred since the last visit. Flow gauge data will also be used to determine if bankfull has occurred. Photographs will be used to document the occurrence of debris lines and sediment deposition as evidence of bankfull events.

Five automated flow gauges were installed in intermittent reaches on Site. The flow gauges were installed in riffles on T4A Reach 1, T4B, T6 Reach 3, T7A, and T8. Flow gauge data will be downloaded during site visits to determine if each reach has 30 days of continuous flow.

3.1.6 Visual Assessment

Visual assessments will be performed along all stream restoration areas on a semi-annual basis by qualified personnel during the seven year monitoring period. Problem areas will be noted such as channel instability (i.e. lateral and/or vertical instability, in-stream structure failure/instability and/or piping, or headcuts), vegetated health (i.e. low stem density, vegetation mortality, invasive species or encroachment), beaver activity, or livestock access. Areas of concern will be mapped and accompanied by a written description in the annual report. Problem areas will be re-evaluated during each subsequent visual assessment. Should remedial actions be required, recommendations will be provided in the annual monitoring report.

3.2 Vegetation

Planted woody vegetation will be monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2006) to monitor and assess the planted woody vegetation. A total of nineteen standard 10 meter by 10 meter vegetation plots were established within the project easement area.

Vegetation plots were randomly established between the conservation easement boundaries and five feet from the top of stream banks. The vegetation plot corners have been marked and are recoverable either through field identification or with the use of a GPS unit. Reference photographs were taken at the origin looking diagonally across the plot to the opposite corner during the baseline monitoring. Subsequent annual assessments following the baseline survey will capture the same reference photograph locations. Species composition, density, and survival rates will be evaluated on an annual basis by plot and for the entire site. Individual plot data will be provided and will include height, density, vigor, damage (if any), and survival. Planted woody stems will be marked annually, as needed, based off of a known origin so they can be found in succeeding monitoring years. Mortality will be determined from the difference between the baseline year's living planted stems and the current year's living planted stems. Vegetation surveys will be conducted in MY1, MY2, MY3, MY5, and MY7.

Section 4: MAINTENANCE AND CONTINGENCY PLAN

Wildlands will perform maintenance as needed at the mitigation site. 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 components and features that require routine maintenance. Routine maintenance should be expected most often in the first two years following site construction and may include one or more of the following components.

4.1 Stream

Stream problem areas will be mapped and included in the Current Condition Plan View (CCPV) as part of the annual stream assessment. Stream problems areas may include bank erosion, structure failure, beaver dams, aggradation/degradation, etc. Routine channel maintenance and repair activities may include chinking of in-stream structures to prevent piping, securing loose coir matting, and supplemental installations of live stakes and other target vegetation along the channel. Areas where storm water runoff flows into the channel may also require maintenance to prevent bank failures and head-cutting.

4.2 Vegetation

Vegetation shall be maintained to ensure the health and vigor of the targeted community. Vegetative problem areas will be mapped and included in the CCPV as part of the annual vegetation assessment. Vegetation problem areas may include planted vegetation not meeting performance criteria, persistent invasive species, barren areas with little to no herbaceous cover, or grass suffocation/crowding of planted stems. 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.

4.3 Site Boundary

Site boundary issues will be mapped and included in the CCPV as part of the annual visual assessment. Site boundaries shall be identified in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries were marked with conservation easement signs attached to metal posts. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.

Section 5: AS-BUILT CONDITION (BASELINE)

The Site construction was completed in April 2019 and as-built surveys were completed in April 2019. The survey included developing an as-built topographic surface, locating the channel boundaries, structures, and cross-sections. For comparison purposes, the baseline monitoring divided the reach assessments in the same way they were established for design parameters.

5.1 As-Built/Record Drawings

A sealed half-size set of record drawings are located in Appendix 5 with the post-construction survey, alignments, structures, and monitoring devices. These include redlines for any significant field adjustments made during construction that differ from the design plans. Station 407+27 through 407+71 along T4A Reach 3 was realigned due to bedrock. Where needed, adjustments were made during construction based on field evaluation.

5.1.1 Buckwater Reach 1

- Station 102+96 riffle was added;
- Station 103+67 riffle was added.

5.1.2 Buckwater Reach 2

- Station 104+58 riffle was installed upstream.

5.1.3 Buckwater Reach 4

- Station 118+86 a log cross vane was installed instead of a log j hook;
- Station 119+44 pool shallow was not installed due to field conditions;
- Station 125+14 brush toe was installed;
- Station 131+36 a riprap outlet was installed;
- Station 132+50 brush toe was installed instead of sod mat;
- Station 133+62 brush toe was installed with the root wads;
- Station 134+34 log sill was not installed due to field conditions.

5.1.4 Buckwater Reach 5

- Station 135+15 a riprap outlet was installed;
- Station 135+39 a log vane was installed instead of a log J hook;
- Station 137+88 a log sill was installed.

5.1.5 Buckwater Reach 6

- Station 141+46 brush toe was installed instead of sod mats;
- Station 142+53 log sill was not installed due to field conditions.

5.1.6 Buckwater Reach 8

- Station 154+67 riffle naturally forms and shifts in this area. No riffle was constructed.

5.1.7 T1 Reach 1

- Station 200+54 brush toe was installed instead of vegetated soil lift;
- Station 201+19 boulder sill was installed instead of a log sill.

5.1.8 T1 Reach 2

- Station 207+54 boulder toe was installed instead of sod mats;

- Station 209+67 brush toe was installed instead of sod mats.

5.1.9 T3 Reach 1

- No log structures installed due to bedrock.

5.1.10 T3 Reach 2

- Station 313+68 brush toe was installed instead of vegetated soil lift;
- Station 314+32 boulder sill installed instead of log sill.

5.1.11 T2

- Station 323+61 brush toe was installed;
- Station 324+44 brush toe was installed;
- Station 327+25 brush toe was installed.

5.1.12 T4A Reach 1

- Station 400+38 sod mats not installed. No sod available.

5.1.13 T4A Reach 2

- Station 405+45 log sill was installed instead of a boulder sill;
- Station 405+56 sod mats not installed. No sod available.

5.1.14 T4A Reach 3

- Station 407+27 through Station 407+71 realigned due to bedrock;
- Station 404+35 boulder toe was installed;
- Station 407+40 riffle and boulder sill not installed due to bedrock;
- Station 408+16 log sill not installed due to field conditions.

5.1.15 T4

- Station 409+98 brush toe was installed;
- Station 410+37 brush toe was installed;
- Station 411+06 brush tow was installed;
- Station 411+98 log sill was installed instead of boulder sill;
- Station 412+25 brush toe was installed;
- Station 413+19 brush toe was installed;
- Station 413+75 brush toe was installed;
- Station 414+53 log sill installed instead of a boulder sill;
- Station 416+89 brush toe was installed;
- Station 417+97 brush toe was installed.

5.1.16 T4B

- Station 450+71 log sill was installed instead of boulder sill;
- Station 450+94 log sill was installed instead of boulder sill;
- Station 451+02 brush toe was installed instead of boulder toe;
- Station 452+75 log sill was installed instead of boulder sill.

5.1.17 T6 Reach 1

- Station 500+27 culvert invert elevation adjusted due to bedrock;

- Station 500+59 constructed riffle was added;
- Station 501+25 log sill not installed due to bedrock;
- Station 503+44 riffle and log sill not installed due to bedrock.

5.1.18 T6 Reach 2

- Station 508+17 riffle and log sill not installed due to bedrock;
- Station 509+40 riffle and log sill not installed due to bedrock;
- Station 509+76 riffle and log sill was added;
- Station 511+94 riffle was not installed due to field conditions;
- Station 512+72 boulder sill and brush toe were not added due to bedrock.

5.1.19 T6 Reach 3

- Station 512+97 log sill not added due to bedrock;
- Station 513+00 riprap added;
- Station 513+18 log sill not installed due to bedrock;
- Station 513+26 brush toe not installed due to bedrock;
- Station 513+52 boulder sill not installed due to bedrock;
- Station 516+65 log sill not installed due to bedrock;
- Station 516+72 brush toe not installed due to bedrock;
- Station 516+98 a log sill was installed instead of a boulder sill;
- Station 517+04 brush toe not installed due to bedrock;
- Station 517+73 a log sill was installed instead of a boulder sill;
- Station 518+15 a log sill was installed instead of a boulder sill;
- Station 518+18 brush toe was not installed due to bedrock.

5.1.20 T5

- Station 518+73 log sill was not installed due to bedrock;
- Station 518+82 brush toe was not installed due to bedrock;
- Station 519+18 brush toe was not installed due to bedrock;
- Station 519+57 brush toe was not installed due to bedrock;
- Station 519+90 log sill not installed due to bedrock;
- Station 519+99 brush toe was not installed due to bedrock;
- Station 520+32 log sill was not installed due to bedrock;
- Station 520+44 brush toe was not installed due to bedrock;
- Station 520+92 boulder sill not installed due to bedrock;
- Station 521+41 log sill not installed due to bedrock;
- Station 521+56 brush toe not installed due to field conditions;
- Station 521+78 log sill not installed due to bedrock;
- Station 522+73 a log sill was installed instead of a boulder sill;
- Station 523+79 brush toe was installed instead of a boulder toe;
- Station 524+08 a log sill was installed instead of a boulder sill;
- Station 529+46 brush toe was installed instead of sod mat;
- Station 530+76 brush toe was installed instead of sod mat;
- Station 531+51 brush toe was installed instead of sod mat;
- Station 532+59 log sill was installed instead of boulder sill;
- Station 531+03 log sill was installed instead of boulder sill.

5.1.21 T6A

- Station 600+28 along this swale, downstream structures were not installed due to bedrock;
- Station 603+12 boulder sill not installed due to bedrock.

5.1.22 T6B

- Station 650+29 log sill was installed instead of boulder sill;
- Station 651+05 boulder sill was not installed due to field conditions;
- Station 651+13 due to field conditions, one riffle was installed instead of two.

5.1.23 T7 Reach 1

- Station 703+04 riffle added;
- Station 703+38 riffle added.

5.1.24 T7 Reach 2

- Station 705+42 log sill installed instead of boulder sill;
- Station 705+70 log sill installed instead of boulder sill;
- Station 706+40 log sill installed instead of boulder sill;
- Station 706+69 log sill installed instead of boulder sill;
- Station 706+80 log sill installed instead of boulder sill;
- Station 707+64 log sill installed instead of boulder sill.

5.1.25 T7 Reach 3

- Station 708+18 log sill installed instead of boulder sill;
- Station 708+53 log sill installed instead of boulder sill;
- Station 709+21 log sill installed instead of boulder sill;
- Station 711+17 log sill not installed, and two riffles made into one.

5.1.26 T8

- Station 801+04 due to site conditions no riffle installed;
- Station 801+07 due to site conditions no boulder sill installed;
- Station 801+75 due to site conditions no brush toe installed;
- Station 801+63 due to site conditions no riffle installed;
- Station 801+66 due to site conditions no boulder sill installed;
- Station 801+70 due to site conditions no brush toe installed;
- Station 801+82 due to site conditions no brush toe installed;
- Station 801+87 due to site conditions no riffle installed;
- Station 801+89 due to site conditions no boulder sill installed;
- Station 804+93 due to site conditions no boulder sill installed;
- Station 805+62 brush toe was not installed to avoid impacting existing vegetation;
- Station 805+81 brush toe was not installed to avoid impacting existing vegetation.

5.2 Baseline Data Assessment

Baseline monitoring (MY0) was conducted between January 2019 and April 2019. The first annual monitoring assessment (MY1) will be completed in late 2019. The streams will be monitored for a total of seven years, with the final monitoring activities concluding in 2025. The close-out for the Site will be conducted in 2026 given the performance criteria have been met.

5.2.1 Morphological State of the Channel

Morphological data for the as-built profile was collected between January 2019 and April 2019. Refer to Appendix 4 for summary data tables and morphological plots, and Appendix 2 for stream photographs.

Profile

The MY0 longitudinal profiles closely match the design profile, except for a short section along T4A Reach 3 that was realigned due to bedrock. Bedrock was also encountered along T6 Reach 3 and T5, altering elevation slightly from design. On the design profiles, pools and riffles were depicted as straight lines with consistent slopes. The as-built surveyed profiles are not as consistent in slope due to natural deposition and scour. Pool and riffle depths and slopes are expected to be maintained near design parameter values. The variations in slope and depth do not constitute a problem or indicate a need for remedial actions and will be assessed visually during the CCPV site walks.

After grading was completed and equipment had been demobilized from the site, but before vegetation was established, there were multiple rain events with significant flows throughout the site. Buckwater Reach 4 had two areas of minor stream bank erosion between stations 109+05 - 109+60 and stations 131+10 - 131+50. Also, on T3 Reach 2 there is one area of stream bank erosion between stations 314+10 - 315+10. Erosion in these areas has not significantly increased since the initial storm event and Wildlands will repair these areas in the summer of 2019.

Dimension

The MY0 channel dimensions fall within specified design parameter ranges. The channels are expected to maintain dimensions of C4/E4 Rosgen type channels. Summary data and cross-section plots of each project reach can be found in Appendix 2.

Pattern

The MY0 pattern metrics fall within the design parameter ranges for all reaches. A few minor changes to design alignments were made during construction due to bedrock. Pattern data will be evaluated in monitoring year five if channel dimensions or profile indicate that significant geomorphic changes have occurred.

Sediment Transport

As-built shear stresses and velocities are similar to design calculations and should reduce the risk of further erosion along the reaches. The as-built condition for each of these reaches indicates an overall increase in substrate particle size (Appendix 4). The substrate data for each constructed reach was compared to the design shear stress parameters from the mitigation plan to assess the potential for bed degradation. The shear stresses calculated for the constructed channels are within the allowable range, which indicates the channel is not at risk to trend toward channel degradation.

5.2.2 Vegetation

The MY0 vegetation survey was completed in April 2019. The MY0 planted stem density is 601 stems per acre, which exceeds the MY3 interim stem density requirement of 320 planted stems per acre. Summary data and photographs of each plot can be found in Appendix 3.

5.2.3 Hydrology

Bankfull events recorded following completion of construction will be reported in the MY1 report.

Section 6: REFERENCES

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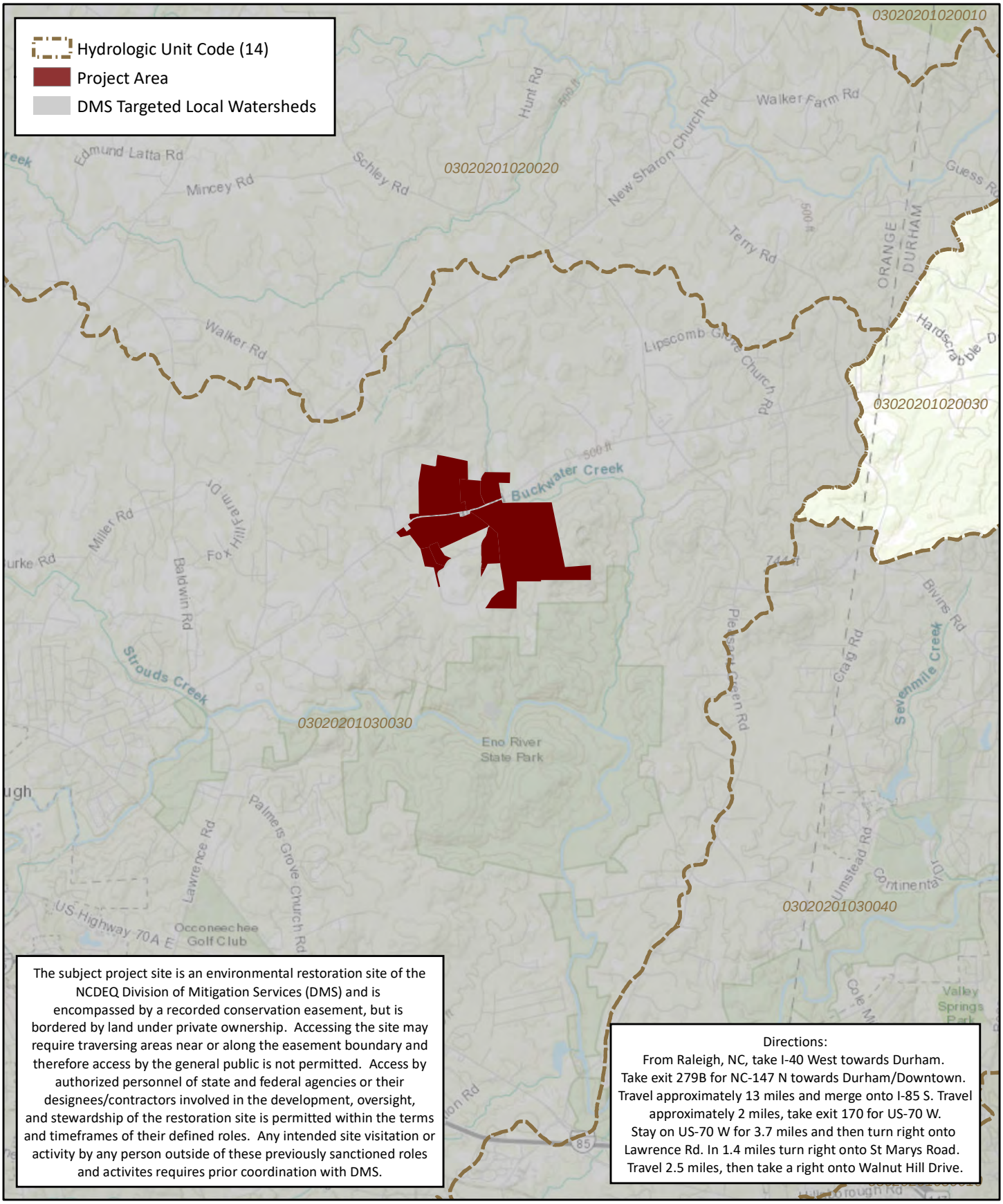
APPENDIX 1. General Figures and Tables



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

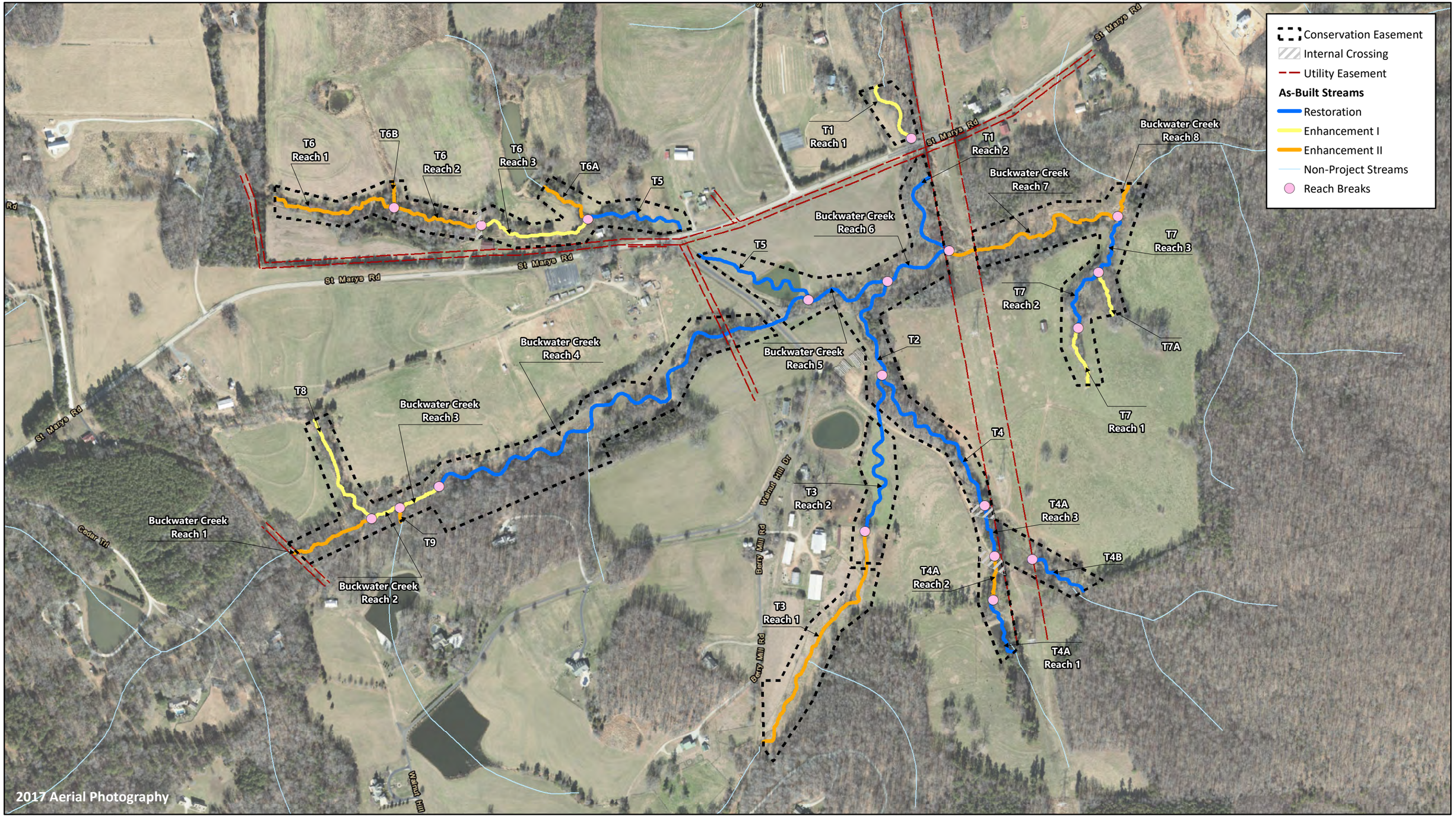
Directions:
From Raleigh, NC, take I-40 West towards Durham. Take exit 279B for NC-147 N towards Durham/Downtown. Travel approximately 13 miles and merge onto I-85 S. Travel approximately 2 miles, take exit 170 for US-70 W. Stay on US-70 W for 3.7 miles and then turn right onto Lawrence Rd. In 1.4 miles turn right onto St Marys Road. Travel 2.5 miles, then take a right onto Walnut Hill Drive.

WILDLANDS ENGINEERING

0 0.5 1 Miles

N

Figure 1. Project Vicinity Map
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019
Orange County, NC



WILDLANDS ENGINEERING

0 450 900 Feet

N

Figure 2. Project Component / Asset Map
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Orange County, NC

Table 1. Mitigation Assets and Components
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

PROJECT COMPONENTS								
Reach ID	**Existing Footage**	**Mitigation Plan Footage**	**Mitigation Category**	**Restoration Level**	**Priority Level**	**Mitigation Ratio (X:1)**	**As-Built Footage**	**Comments**
STREAMS								
Buckwater Reach 1	445	445	Warm	EII	N/A	2.5	433	Grade Control Structures, Bank Repair, Conservation Easement
Buckwater Reach 2	160	160	Warm	EI	P3	1.5	162	Grade Control Structures, Bank Repair, Planted Buffer
Buckwater Reach 3	232	232	Warm	EI	P1.5*	1.5	232	Grade Control Structures, Bank Repair, Planted Buffer
Buckwater Reach 4	2,282	2,067	Warm	R	P1	1.0	2,071	Full Channel Restoration, Planted Buffer, Invasive Control
		30				0.0	29	Utility Crossing
		206	Warm	R	P1	1.0	209	Full Channel Restoration, Planted Buffer
		72				0.0	70	Road Crossing
		194	Warm	R	P1	1.0	198	Full Channel Restoration, Planted Buffer
Buckwater Reach 5	435	486	Warm	R	P1.5*	1.0	485	Full Channel Restoration, Planted Buffer, Invasive Control
Buckwater Reach 6	884	379	Warm	R	P1.5*	1.0	363	Full Channel Restoration, Planted Buffer, Invasive Control
		118				0.0	30	Utility Crossing
Buckwater Reach 7	941	43				0.0	132	Utility Crossing
		891	Warm	EII	N/A	2.5	885	Grade Control Structures, Bank Repair, Enhancement Work Was Completed Beyond The Limits Of The Conservation Easement
Buckwater Reach 8	178	188	Warm	EII	N/A	2.5	185	Bank Repair, Conservation Easement
T1 Reach 1	501	366	Warm	EI	P1.5*	1.5	375	Grade Control Structures, Planted Buffer
		119				0.0	0	Road Crossing
T1 Reach 2	572	123				0.0	244	Utility Crossing
		485	Warm	R	P1	1.0	477	Full Channel Restoration, Planted Buffer
		25				0.0	43	Utility Crossing
T2	548	587	Warm	R	P1	1.0	592	Full Channel Restoration, Planted Buffer
T3 Reach 1	1,303	1,101	Warm	EII	N/A	2.5	1,107	Livestock Exclusion, Grade Control Strucres, Planted Buffer
		30				0.0	29	Road Crossing
		166	Warm	EII	N/A	2.5	167	Livestock Exclusion, Grade Control Structures, Planted Buffer
T3 Reach 2	877	658	Warm	R	P1	1.0	665	Full Channel Restoration, Planted Buffer, Livestock Exclusion
		63					93	Road Crossing
		193	Warm	R	P1	1.0	197	Full Channel Restoration, Planted Buffer, Livestock Exclusion
T4	1,081	961	Warm	R	P1	1.0	956	Full Channel Restoration, Planted Buffer
T4A Reach 1	312	311	Warm	R	P1	1.0	327	Farm Pond Drained, Full Channel Restoration, Planted Buffer
T4A Reach 2	259	175	Warm	EII	N/A	2.5	155	Livestock Exclusion, Grade Control Structures, Conservation Easement
		72				0.0	75	Road Crossing
T4A Reach 3	145	201	Warm	R	P1	1.0	208	Full Channel Restoration, Planted Buffer
		64				0.0	66	Road Crossing
T4B Reach 1	419	345	Warm	R	P1	1.0	346	Full Channel Restoration, Livestock Exclusion
T5	1,291	548	Warm	R	P1	1.0	554	Full Channel Restoration, Planted Buffer, Invasive Control
		167				0.0	0	Road Crossing
		711	Warm	R	P1	1.0	722	Full Channel Restoration, Planted Buffer, Farm Pond Drained
T6 Reach 1	697	695	Warm	EII	N/A	2.5	697	Invasive Control, Bank Repair, Conservation Easement
T6 Reach 2	492	458	Warm	EII	N/A	2.5	458	Invasive Control, Bank Repair, Conservation Easement
		30				0.0	30	Road Crossing
T6 Reach 3	704	620	Warm	EI	P1 & P1.5*	1.5	623	Grade Control Structures, Planted Buffer, Invasive Control
T6A	324	311	Warm	EII	N/A	2.5	313	Grade Control Structures, Bank Repair, Conservation Easement
T6B	136	136	Warm	EII	N/A	2.5	136	Grade Control Structures, Bank Repair, Conservation Easement
T7 Reach 1	317	322	Warm	EI	P1.5*	1.5	320	Grade Control Structures, Planted Buffer
T7 Reach 2	323	363	Warm	R	P1	1.0	367	Full Channel Restoration, Planted Buffer
T7 Reach 3	368	356	Warm	R	P2	1.0	357	Full Channel Restoration, Planted Buffer
T7A	227	242	Warm	EI	P1	1.5	240	Grade Control Structures, Planted Buffer
T8	620	631	Warm	EI	P1	1.5	621	Grade Control Structures, Planted Buffer
T9	73	73	Warm	EII	N/A	2.5	73	Grade Control Structures, Conservation Easement

*Priority 1.5 refers to a combination of Priority 1 and Priority 2 where the existing channel was raised and the floodplain was graded.

PROJECT CREDITS							
Restoration Level	**Stream**			**Riparian Wetland**		**Non-Riparian**	**Coastal Marsh**
	Warm	**Cool**	**Cold**	**Riverine**	**Non-Riverine**		
Restoration	9,051.000						
Enhancement I	1,715.336						
Enhancement II	1,855.600						
Preservation							
Re-Establishment							
Rehabilitation							
Enhancement							
Creation							
Totals	**12,621.936**						

Table 2. Project Activity and Reporting History

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Activity or Report		Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan		December 2017	December 2017
Final Design - Construction Plans		April 2018	April 2018
Construction		April 2018-April 2019	April 2019
Temporary S&E mix applied to entire project area [1]		April 2018-April 2019	April 2019
Permanent seed mix applied to reach/segments [1]		April 2018-April 2019	April 2019
Bare root and live stake plantings for reach/segments		April 2019	April 2019
Baseline Monitoring Document (Year 0)	Stream Survey	April 2019	July 2019
	Vegetation Survey	April 2019	
Year 1 Monitoring	Stream Survey	2019	December 2019
	Vegetation Survey	2019	
Year 2 Monitoring	Stream Survey	2020	December 2020
	Vegetation Survey	2020	
Year 3 Monitoring	Stream Survey	2021	December 2021
	Vegetation Survey	2021	
Year 4 Monitoring	Stream Survey	2022	December 2022
	Vegetation Survey	2022	
Year 5 Monitoring	Stream Survey	2023	December 2023
	Vegetation Survey	2023	
Year 6 Monitoring	Stream Survey	2024	December 2024
	Vegetation Survey	2024	
Year 7 Monitoring	Stream Survey	2025	December 2025
	Vegetation Survey	2025	

[1]Seed and mulch is added as each section of construction is completed.

Table 3. Project Contact Table

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Designer Nicole Macaluso, PE	**Wildlands Engineering, Inc.** 312 West Millbrook Road, Suite 225 Raleigh, NC 27609 919.851.9986
Construction Contractor	**Ecotone, Inc** 2120 High Point Rd Forest Hill, MD 21050
Planting Contractor	**Bruton Natural Systems, Inc** P.O. Box 1197 Fremont, NC 27830
Seeding Contractor	**Ecotone, Inc** 2120 High Point Rd Forest Hill, MD 21050
Seed Mix Sources	**Green Resource, LLC**
Nursery Stock Suppliers **Bare Roots**	**Dykes and Sons Nursery and Greenhouse**
Live Stakes	**Bruton Natural Systems, Inc**
Monitoring Performers	**Wildlands Engineering, Inc.**
Monitoring, POC	Jason Lorch 919.851.9986

Table 4. Project Information and Attributes
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

PROJECT INFORMATION							
Project Name	Buckwater Mitigation Site						
County	Orange County						
Project Coordinates (latitude and longitude)	36° 6' 23.49" N, 79° 1' 29.11" W						
Project Area (acres)	51.84						
Planted Acerage (acres of woody stems planted)	21.80						
PROJECT WATERSHED SUMMARY INFORMATION							
Physiographic Province	Carolina Slate Belt of the Piedmont Physiographic Province						
River Basin	Neuse River						
USGS Hydrologic Unit 8-digit	03020201						
USGS Hydrologic Unit 14-digit	03020201030030						
DWR Sub-basin	03-04-01						
Project Drainiage Area (acres)	2,259						
Project Drainage Area Percentage of Impervious Area	3.9%						
CGIA Land Use Classification	63.9% forested, 32.1% cultivated, 3.9% impervious						
Reaches	**Buckwater**	**T1**	**T2 & T3**	**T4, T4A, & T4B**	**T5 & T6**	**T7 & T7A**	**T8**
Length of Reach (linear feet) - Post-Restoration	5,223	852	2,728	1,992	3,054	1,284	621
Drainage Area (acres)	2,259	1,216	218	77	109	28	21
NCDWR Stream Identification Score	42	37.5	42	40.5	60	30	30.5
NCDWR Water Quality Classification	WS-IV						
Morphological Desription (stream type)	Perennial	Perennial	Perennial	Intermittent	Intermittent	Intermittent	Intermittent
Evolutionary Trend (Simon's Model) - Pre-Restoration	V - Aggradation and Widening		IV- Degradation and Widening				
Underlying Mapped Soils	Appling-Helena, Chewacla loam, Herndon Tarrus Series						
Drainage Class	-			-			
Soil Hydric Status	-			-			
Slope	-			-			
FEMA Classification	Zone AE		Buckwater Floodplain Fringe			N/A	
Native Vegetation Community	Piedmont Bottomland Forest						
Percent Composition Exotic Invasive Vegetation - Post-Restoration	20%						

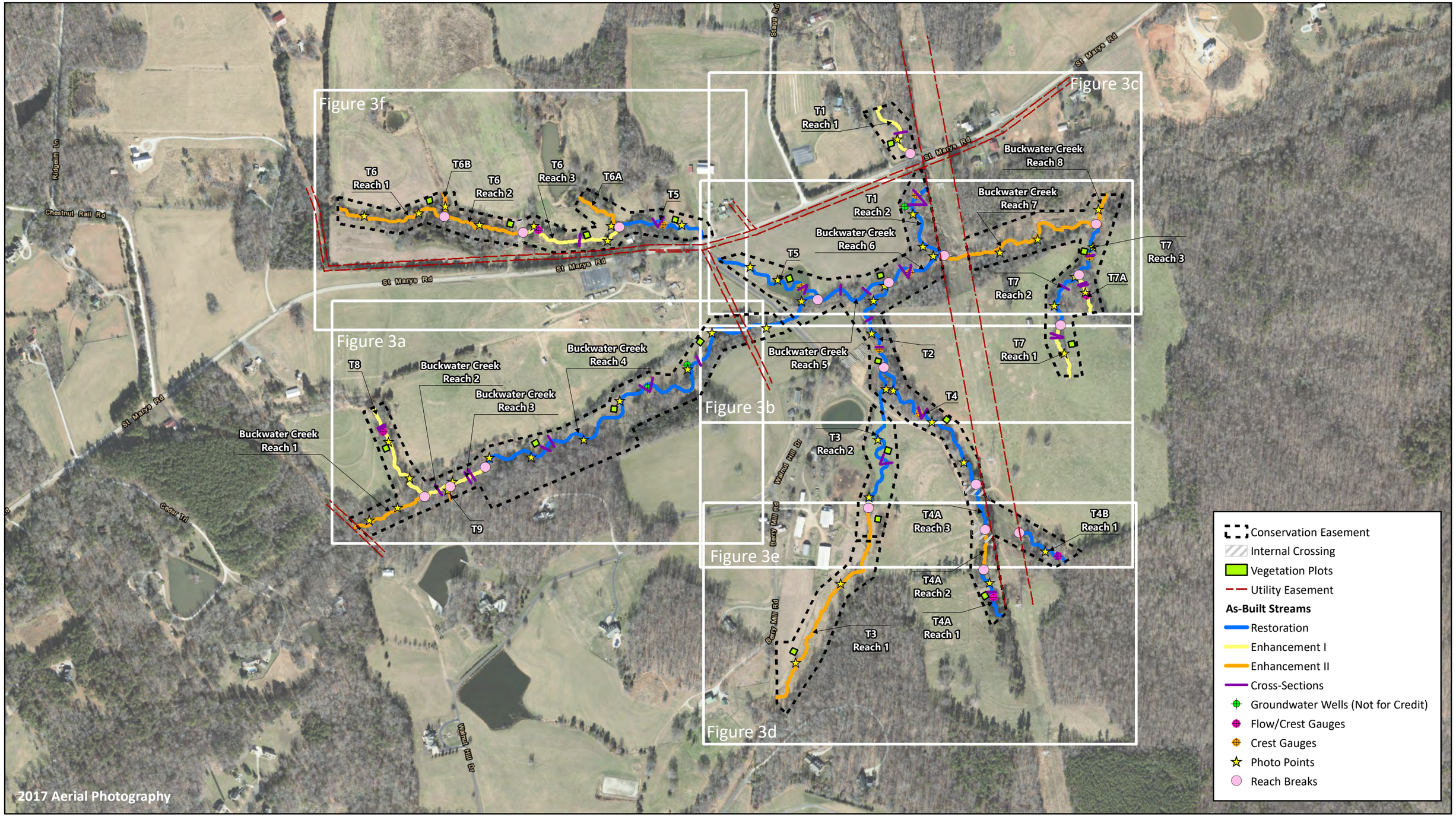
REGULATORY CONSIDERATIONS			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States - Section 404	Yes	Yes	USACE Nationwide Permit No. 27 and DWQ 401 Water Quality Certification No. 4134.
Waters of the United States - Section 401	Yes	Yes	
Division of Land Quality (Dam Safety)	N/A	N/A	N/A
Endangered Species Act	Yes	Yes	Buckwater Mitigation Plan; Wildlands determined "no effect" on Orange County listed endangered species. The USFWS responded on May 5, 2016 stating 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."
Historic Preservation Act	Yes	Yes	Correspondence from SHPO on May 6, 2016 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).
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A
FEMA Floodplain Compliance	Yes	Yes	A CLOMR was approved prior to the start of construction, as well as local floodplain development permit. A LOMR will be prepared within 6 months of completion of construction.
Essential Fisheries Habitat	N/A	N/A	N/A

Table 5. Monitoring Component Summary

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Parameter	Monitoring Feature	Quantity / Length by Reach							Frequency
		Buckwater	T1	T2 & T3	T4, T4A, & T4B	T5 & T6	T7 & T7A	T8	
Dimension	Riffle Cross-Sections	7	2	2	3	3	4	1	Year 1, 2, 3, 5, and 7
	Pool Cross-Sections	5	1	2	1	2	2	1	Year 1, 2, 3, 5, and 7
Pattern	Pattern	N/A							N/A
Profile	Longitudinal Profile	N/A							Year 0 (Unless Required)
Substrate	Reachwide Pebble Count	3	1	2	3	1	1	0	Year 1, 2, 3, 5, and 7
Hydrology	Crest Gauge (Continuous Overbank Flow Recorder)	1	1	1	3	2	2	1	Quarterly
	Flow Gauge (Continuous Base Flow Recorder)	N/A	N/A	N/A	2	1	1	1	Quarterly
Vegetation	CVS Level 2 Vegetation Plots	19							Year 1, 2, 3, 5, and 7
Visual Assessment		Yes							Semi-Annual
Exotic and Nuisance Vegetation									Semi-Annual
Project Boundary									Semi- Annual
Reference Photos	Photographs	49							Annual

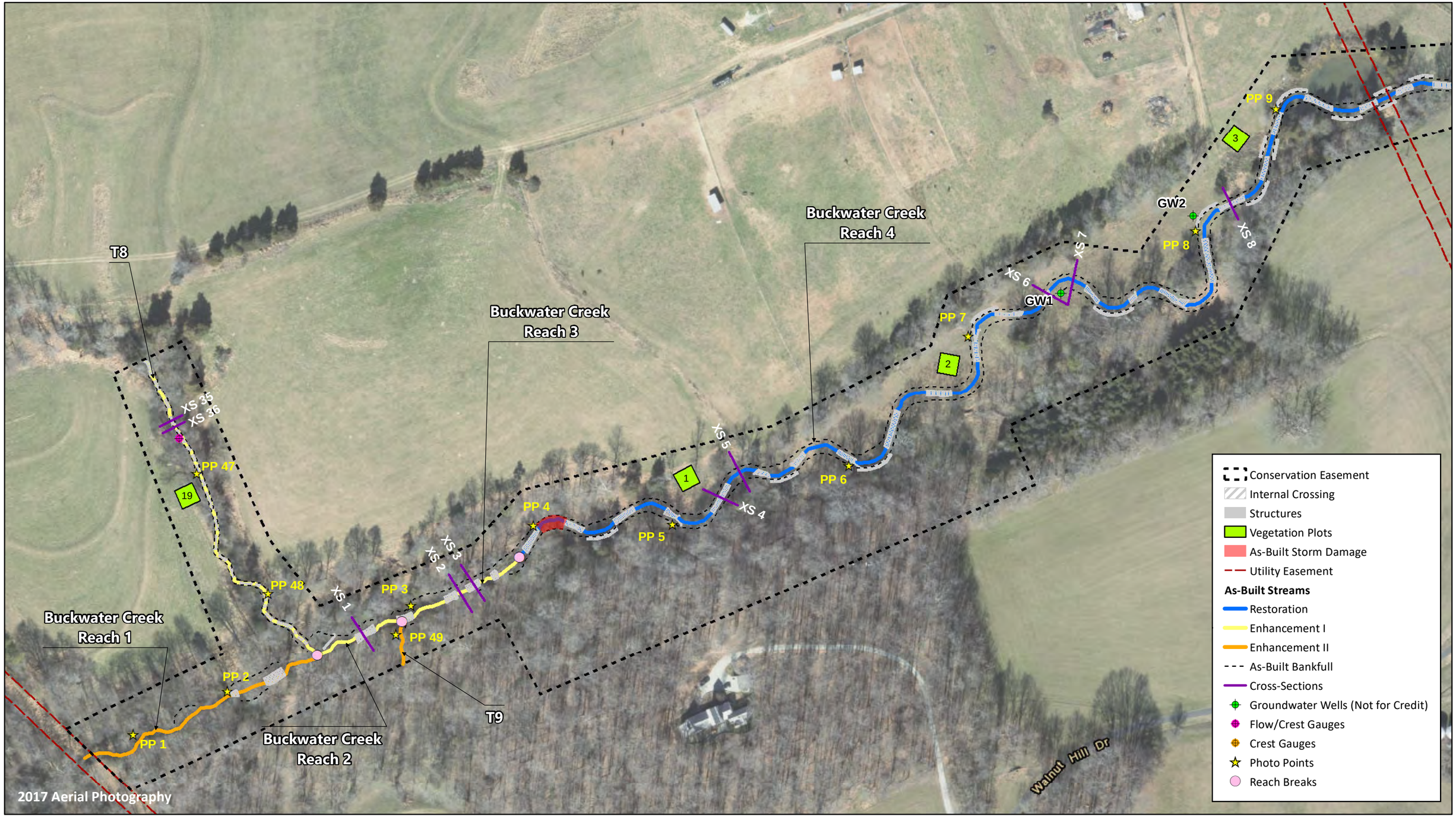
APPENDIX 2. Visual Assessment Data



WILDLANDS ENGINEERING

Figure 3. Monitoring Plan View Key
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Orange County, NC



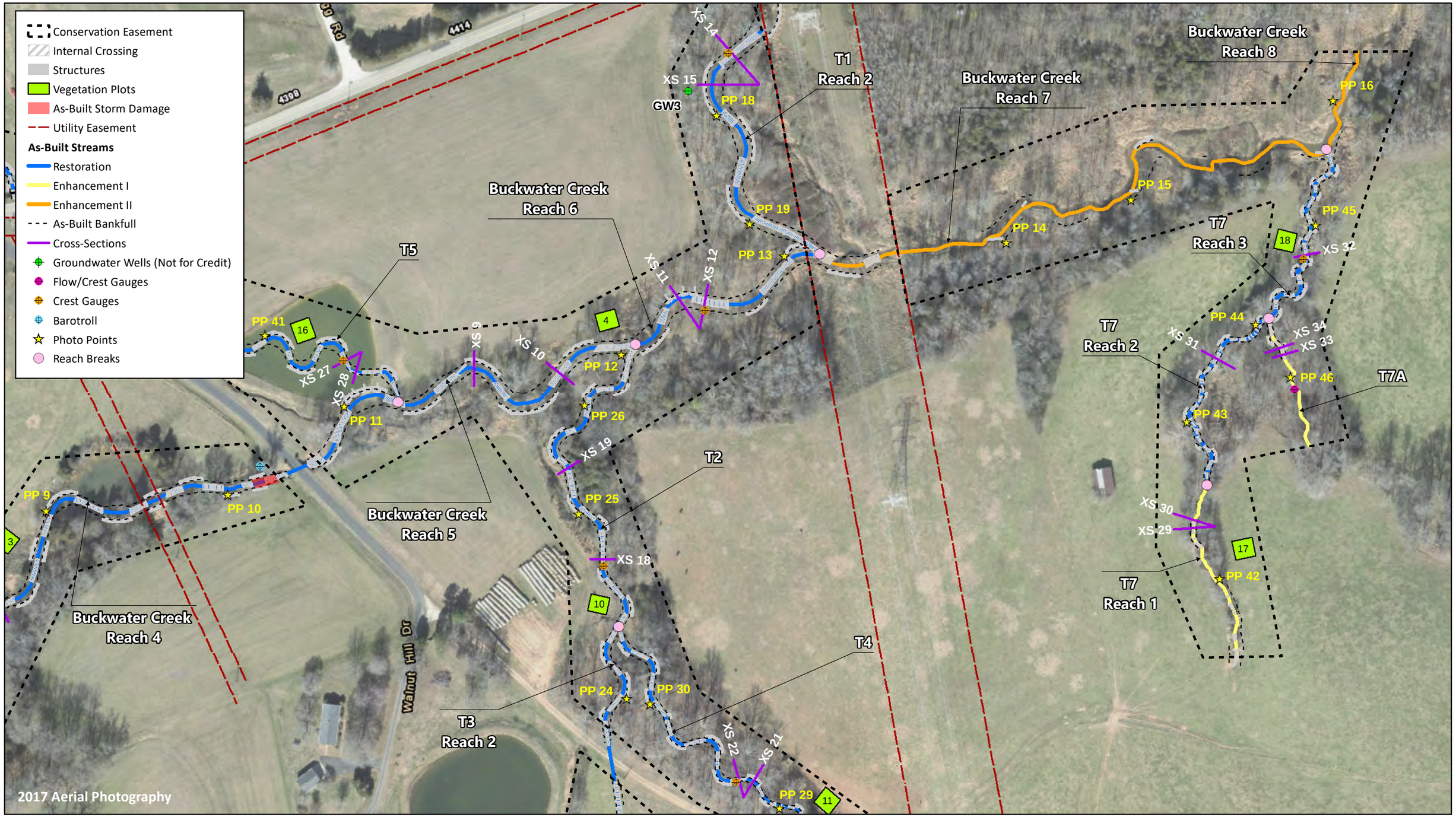
WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 3a. Monitoring Plan View
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Orange County, NC



WILDLANDS ENGINEERING

Figure 3b. Monitoring Plan View
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Orange County, NC

Conservation Easement
Internal Crossing
Structures
Vegetation Plots
As-Built Storm Damage
Utility Easement

As-Built Streams

Restoration
Enhancement I
Enhancement II
As-Built Bankfull
Cross-Sections
Groundwater Wells (Not for Credit)
Flow/Crest Gauges
Crest Gauges
Barotroll
Photo Points
Reach Breaks

T1
Reach 1
XS 13
PP 17
5
St Marys Rd
4500
Stagg Rd
4414
4398
XS 14
XS 15
GW3
PP 18
T1
Reach 2
Buckwater Creek
Reach 7
Buckwater Creek
Reach 8
PP 16
PP 15
PP 14
PP 19
PP 13
PP 45
18
XS 32
T7
Reach 3
T5
Buckwater Creek
Reach 6
Buckwater Creek
Reach 5
PP 40
101
Walnut Hill Dr
PP 41
16
XS 27
XS 28
XS 9
XS 10
XS 11
XS 12
4
PP 12
PP 11
PP 26
XS 19
T2
PP 10
2017 Aerial Photography
PP 44
XS 31
XS 34
XS 33
T7
Reach 2
PP 46
T7A
PP 43

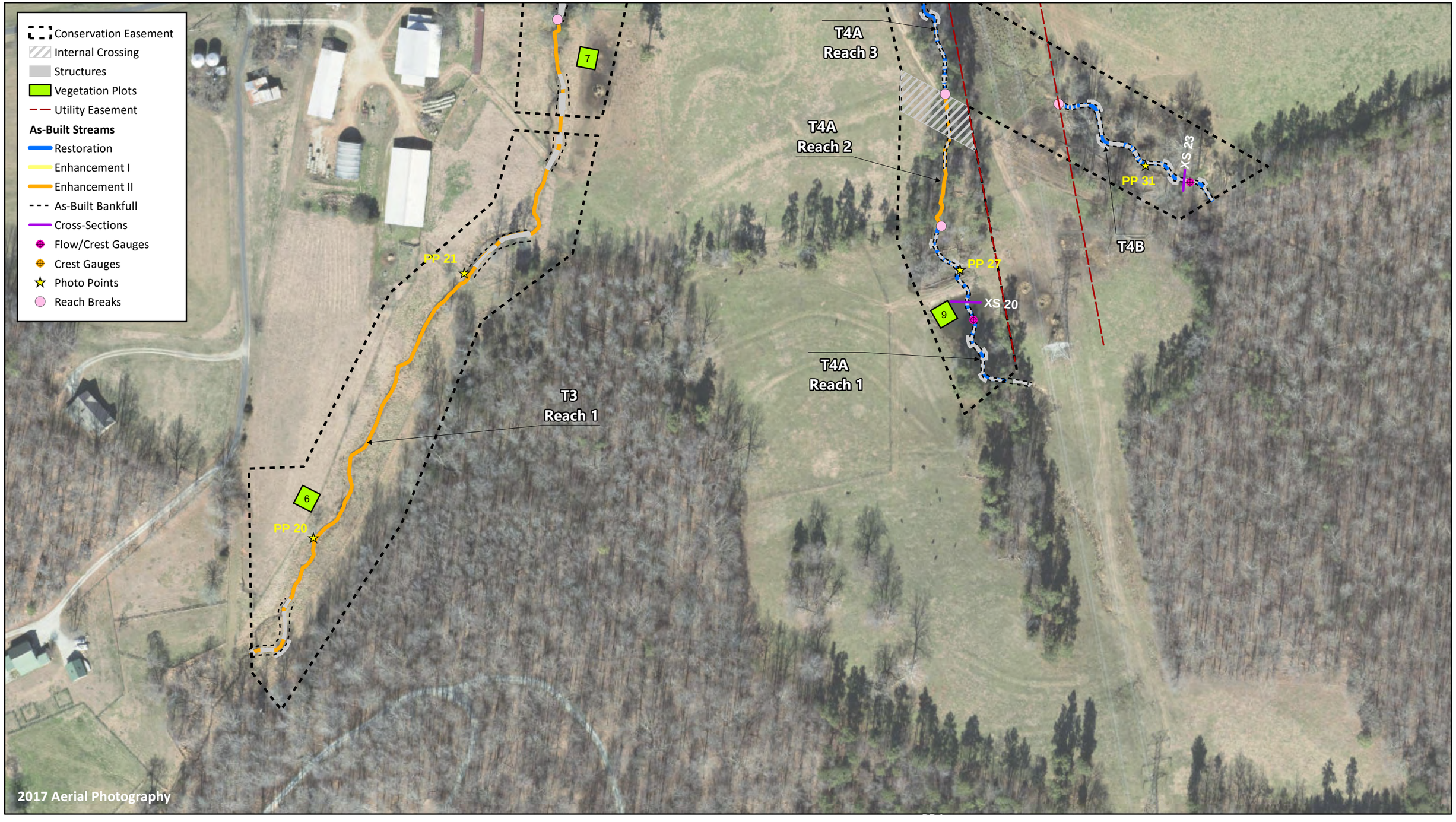
WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 3c. Monitoring Plan View
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Orange County, NC



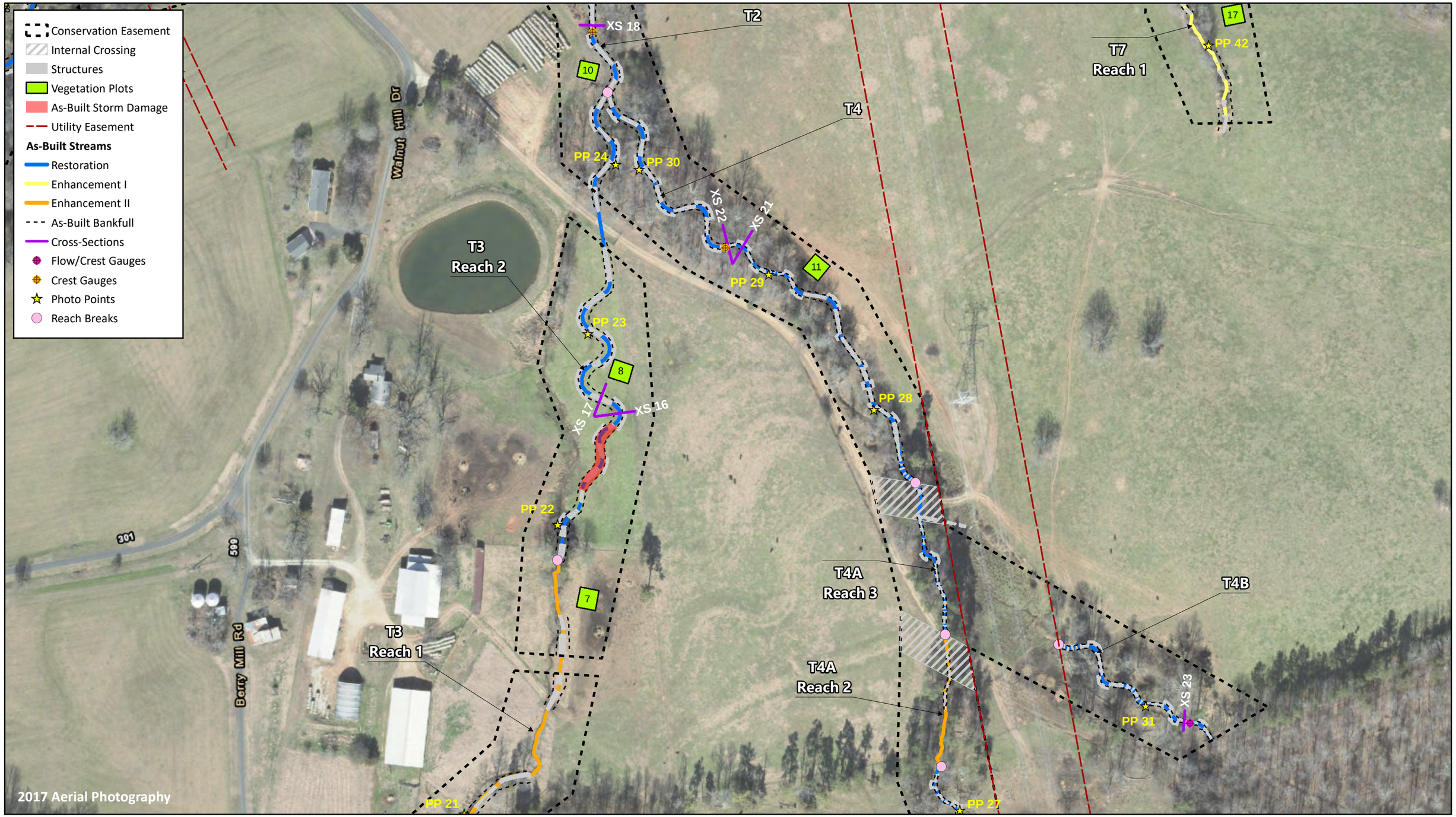
WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 3d. Monitoring Plan View
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Orange County, NC



WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 3e. Monitoring Plan View
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Orange County, NC

WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 3f. Monitoring Plan View
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Orange County, NC

STREAM PHOTOGRAPHS

PHOTO POINT 1 Buckwater R1 – upstream *(12/17/2018)*

PHOTO POINT 1 Buckwater R1 – downstream *(12/17/2018)*

PHOTO POINT 2 Buckwater R1 – upstream *(12/17/2018)*

PHOTO POINT 2 Buckwater R1 – downstream *(12/17/2018)*

PHOTO POINT 3 Buckwater R3 – upstream *(12/17/2018)*

PHOTO POINT 3 Buckwater R3 – downstream *(12/17/2018)*

PHOTO POINT 4 Buckwater R4 – upstream *(12/17/2018)*

PHOTO POINT 4 Buckwater R4 – downstream *(12/17/2018)*

PHOTO POINT 5 Buckwater R4 – upstream *(12/17/2018)*

PHOTO POINT 5 Buckwater R4 – downstream *(12/17/2018)*

PHOTO POINT 6 Buckwater R4 – upstream *(12/17/2018)*

PHOTO POINT 6 Buckwater R4 – downstream *(12/17/2018)*

PHOTO POINT 7 Buckwater R4 – upstream *(12/17/2018)*

PHOTO POINT 7 Buckwater R4 – downstream *(12/17/2018)*

PHOTO POINT 8 Buckwater R4 – upstream *(12/17/2018)*

PHOTO POINT 8 Buckwater R4 – downstream *(12/17/2018)*

PHOTO POINT 9 Buckwater R4 – upstream *(12/17/2018)*

PHOTO POINT 9 Buckwater R4 – downstream *(12/17/2018)*

PHOTO POINT 10 Buckwater R4 – upstream *(05/7/2019)*

PHOTO POINT 10 Buckwater R4 – downstream *(05/7/2019)*

PHOTO POINT 11 Buckwater R4 – upstream *(05/7/2019)*

PHOTO POINT 11 Buckwater R4 – downstream *(05/7/2019)*

PHOTO POINT 12 Buckwater R5 – upstream *(05/7/2019)*

PHOTO POINT 12 Buckwater R5 – downstream *(05/7/2019)*

PHOTO POINT 13 Buckwater R6 – upstream *(05/7/2019)*

PHOTO POINT 13 Buckwater R6 – downstream *(05/7/2019)*

PHOTO POINT 14 Buckwater R7 – upstream *(05/7/2019)*

PHOTO POINT 14 Buckwater R7 – downstream *(05/7/2019)*

PHOTO POINT 15 Buckwater R7 – upstream *(01/21/2019)*

PHOTO POINT 15 Buckwater R7 – downstream *(01/21/2019)*

PHOTO POINT 16 Buckwater R8 – upstream *(01/21/2019)*

PHOTO POINT 16 Buckwater R8 – downstream *(01/21/2019)*

PHOTO POINT 17 T1 Reach 1 – upstream *(01/21/2019)*

PHOTO POINT 17 T1 Reach 1 – downstream *(01/21/2019)*

PHOTO POINT 18 T1 Reach 2 – upstream *(01/21/2019)*

PHOTO POINT 18 T1 Reach 2 – downstream *(01/21/2019)*

	
PHOTO POINT 19 T1 Reach 2 – upstream *(01/21/2019)*	**PHOTO POINT 19 T1 Reach 2 – downstream *(01/21/2019)***
	
PHOTO POINT 20 T3 Reach 1 – upstream *(05/7/2019)*	**PHOTO POINT 20 T3 Reach 1 – downstream *(05/7/2019)***
	
PHOTO POINT 21 T3 Reach 1 – upstream *(05/7/2019)*	**PHOTO POINT 21 T3 Reach 1 – downstream *(05/7/2019)***

PHOTO POINT 22 T3 Reach 2 – upstream *(12/17/2018)*

PHOTO POINT 22 T3 Reach 2 – downstream *(12/17/2018)*

PHOTO POINT 23 T3 Reach 2 – upstream *(01/21/2019)*

PHOTO POINT 23 T3 Reach 2 – downstream *(01/21/2019)*

PHOTO POINT 24 T3 – upstream *(05/7/2019)*

PHOTO POINT 24 T3 – downstream *(05/7/2019)*

	
PHOTO POINT 25 T2 – upstream *(01/21/2019)*	**PHOTO POINT 25 T2 – downstream *(01/21/2019)***
	
PHOTO POINT 26 T2 – upstream *(01/21/2019)*	**PHOTO POINT 26 T2 – downstream *(01/21/2019)***
	
PHOTO POINT 27 T4A Reach 1 – upstream *(02/27/2019)*	**PHOTO POINT 27 T4A Reach 1 – downstream *(02/27/2019)***

PHOTO POINT 28 T4 – upstream *(01/21/2019)*

PHOTO POINT 28 T4 – downstream *(01/21/2019)*

PHOTO POINT 29 T4 – upstream *(01/21/2019)*

PHOTO POINT 29 T4 – downstream *(01/21/2019)*

PHOTO POINT 30 T4 – upstream *(01/21/2019)*

PHOTO POINT 30 T4 – downstream *(01/21/2019)*

	
PHOTO POINT 31 T4B Reach 1 – upstream *(04/3/2019)*	**PHOTO POINT 31 T4B Reach 1 – downstream *(04/3/2019)***
	
PHOTO POINT 32 T6 Reach 1 – upstream *(02/27/2019)*	**PHOTO POINT 32 T6 Reach 1 – downstream *(02/27/2019)***
	
PHOTO POINT 33 T6 Reach 1 – upstream *(02/27/2019)*	**PHOTO POINT 33 T6 Reach 1 – downstream *(02/27/2019)***

PHOTO POINT 34 T6 Reach 2 – upstream *(02/27/2019)*

PHOTO POINT 34 T6 Reach 2 – downstream *(02/27/2019)*

PHOTO POINT 35 T6 Reach 3 – upstream *(02/27/2019)*

PHOTO POINT 35 T6 Reach 3 – downstream *(02/27/2019)*

PHOTO POINT 36 T6 Reach 3 – upstream *(02/27/2019)*

PHOTO POINT 36 T6 Reach 3 – downstream *(02/27/2019)*

PHOTO POINT 37 T6B – upstream *(02/27/2019)*

PHOTO POINT 37 T6B – downstream *(02/27/2019)*

PHOTO POINT 38 T6A – upstream *(02/27/2019)*

PHOTO POINT 38 T6A – downstream *(02/27/2019)*

PHOTO POINT 39 T5 – upstream *(02/27/2019)*

PHOTO POINT 39 T5 – downstream *(02/27/2019)*

	
PHOTO POINT 40 T5 – upstream *(05/7/2019)*	**PHOTO POINT 40 T5 – downstream *(05/7/2019)***
	
PHOTO POINT 41 T5 – upstream *(05/7/2019)*	**PHOTO POINT 41 T5 – downstream *(05/7/2019)***
	
PHOTO POINT 42 T7 Reach 1 – upstream *(01/21/2019)*	**PHOTO POINT 42 T7 Reach 1 – downstream *(01/21/2019)***

PHOTO POINT 43 T7 Reach 2 – upstream *(01/21/2019)*

PHOTO POINT 43 T7 Reach 2 – downstream *(01/21/2019)*

PHOTO POINT 44 T7 Reach 2 – upstream *(01/21/2019)*

PHOTO POINT 44 T7 Reach 2 – downstream *(01/21/2019)*

PHOTO POINT 45 T7 Reach 3 – upstream *(01/21/2019)*

PHOTO POINT 45 T7 Reach 3 – downstream *(01/21/2019)*

	
PHOTO POINT 46 T7A– upstream *(01/21/2019)*	**PHOTO POINT 46 T7A– downstream *(01/21/2019)***
	
PHOTO POINT 47 T8 – upstream *(2/5/2019)*	**PHOTO POINT 47 T8 – downstream *(2/5/2019)***
	
PHOTO POINT 48 T8 – upstream *(2/5/2019)*	**PHOTO POINT 48 T8 – downstream *(2/5/2019)***

	
PHOTO POINT 49 T9 – upstream *(12/17/2018)*	**PHOTO POINT 49 T9 – downstream *(12/17/2018)***

APPENDIX 3. Vegetation Plot Data

Table 6. Planted and Total Stem Counts

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

			Current Plot Data (MY0 2019)														
			97084-01-0001			97084-01-0002			97084-01-0003			97084-01-0004			97084-01-0005		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Aesculus pavia	Red Buckeye	Shrub Tree															
Betula nigra	River Birch	Tree	1	1	1	2	2	2	3	3	3	2	2	2	4	4	4
Fraxinus pennsylvanica	Green Ash	Tree	3	3	3	2	2	2	2	2	2	4	4	4	1	1	1
Liriodendron tulipifera	Tulip Poplar	Tree	2	2	2	2	2	2	1	1	1				3	3	3
Platanus occidentalis	Sycamore	Tree	1	1	1	5	5	5	4	4	4	5	5	5	4	4	4
Quercus alba	White Oak	Tree	2	2	2	1	1	1				1	1	1	1	1	1
Quercus lyrata	Overcup Oak	Tree													2	2	2
Quercus michauxii	Swamp Chestnut Oak	Tree	3	3	3				1	1	1						
Quercus phellos	Willow Oak	Tree	3	3	3				3	3	3						
Quercus shumardii	Shumard Oak	Shrub Tree				3	3	3	1	1	1						
Viburnum dentatum	Arrow-wood	Shrub Tree										2	2	2			
		Stem count	15	15	15	15	15	15	15	15	15	14	14	14	15	15	15
		size (ares)		1			1			1			1			1	
		size (ACRES)		0.02			0.02			0.02			0.02			0.02	
		Species count	7	7	7	6	6	6	7	7	7	5	5	5	6	6	6
		Stems per ACRE	607	607	607	607	607	607	607	607	607	567	567	567	607	607	607

Color for Density

Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%

PnLS: Number of planted stems excluding live stakes
P-all: Number of planted stems including live stakes
T: Total stems

Table 6. Planted and Total Stem Counts

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

			Current Plot Data (MY0 2019)														
			97084-01-0006			97084-01-0007			97084-01-0008			97084-01-0009			97084-01-0010		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Aesculus pavia	Red Buckeye	Shrub Tree	1	1	1	2	2	2				1	1	1			
Betula nigra	River Birch	Tree	1	1	1	1	1	1	2	2	2	2	2	2			
Fraxinus pennsylvanica	Green Ash	Tree	2	2	2	1	1	1	1	1	1				4	4	4
Liriodendron tulipifera	Tulip Poplar	Tree				1	1	1	3	3	3	3	3	3	1	1	1
Platanus occidentalis	Sycamore	Tree	4	4	4	2	2	2	5	5	5	4	4	4	1	1	1
Quercus alba	White Oak	Tree	1	1	1	2	2	2									
Quercus lyrata	Overcup Oak	Tree	2	2	2	1	1	1	1	1	1	3	3	3	6	6	6
Quercus michauxii	Swamp Chestnut Oak	Tree													1	1	1
Quercus phellos	Willow Oak	Tree	3	3	3	3	3	3	2	2	2	2	2	2			
Quercus shumardii	Shumard Oak	Shrub Tree				2	2	2	1	1	1						
Viburnum dentatum	Arrow-wood	Shrub Tree	1	1	1												
		Stem count	15	15	15	15	15	15	15	15	15	15	15	15	13	13	13
		size (ares)		1			1			1			1			1	
		size (ACRES)		0.02			0.02			0.02			0.02			0.02	
		Species count	8	8	8	9	9	9	7	7	7	6	6	6	5	5	5
		Stems per ACRE	607	607	607	607	607	607	607	607	607	607	607	607	526	526	526

Color for Density

Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%

PnLS: Number of planted stems excluding live stakes
P-all: Number of planted stems including live stakes
T: Total stems

Table 6. Planted and Total Stem Counts

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 0 - 2019

			Current Plot Data (MY0 2019)															
			97084-01-0011			97084-01-0012			97084-01-0013			97084-01-0014			97084-01-0015		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Aesculus pavia	Red Buckeye	Shrub Tree	1	1	1	2	2	2							1	1	1
Betula nigra	River Birch	Tree				2	2	2	4	4	4	4	4	4	3	3	3
Fraxinus pennsylvanica	Green Ash	Tree	1	1	1				3	3	3	3	3	3	2	2	2
Liriodendron tulipifera	Tulip Poplar	Tree	1	1	1	4	4	4	1	1	1	3	3	3			
Platanus occidentalis	Sycamore	Tree	2	2	2	3	3	3	4	4	4	2	2	2	4	4	4
Quercus alba	White Oak	Tree															
Quercus lyrata	Overcup Oak	Tree	3	3	3												
Quercus michauxii	Swamp Chestnut Oak	Tree				3	3	3	1	1	1	1	1	1	1	1	1
Quercus phellos	Willow Oak	Tree	3	3	3	1	1	1	2	2	2	1	1	1	1	1	1
Quercus shumardii	Shumard Oak	Shrub Tree													1	1	1
Viburnum dentatum	Arrow-wood	Shrub Tree	4	4	4							1	1	1	2	2	2
		Stem count	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
		size (ares)		1			1			1			1			1	
		size (ACRES)		0.02			0.02			0.02			0.02			0.02	
		Species count	7	7	7	6	6	6	6	6	6	7	7	7	8	8	8
		Stems per ACRE	607	607	607	607	607	607	607	607	607	607	607	607	607	607	607

Color for Density

Exceeds requirements by 10%

Exceeds requirements, but by less than 10%

Fails to meet requirements, by less than 10%

Fails to meet requirements by more than 10%

PnLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems

Table 6. Planted and Total Stem Counts

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 0 - 2019

			Current Plot Data (MY0 2019)												Annual Means		
			97084-01-0016			97084-01-0017			97084-01-0018			97084-01-0019			MY0 (2019)		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Aesculus pavia	Red Buckeye	Shrub Tree				1	1	1	1	1	1				10	10	10
Betula nigra	River Birch	Tree	2	2	2	3	3	3	4	4	4	1	1	1	41	41	41
Fraxinus pennsylvanica	Green Ash	Tree	1	1	1	1	1	1	1	1	1	2	2	2	34	34	34
Liriodendron tulipifera	Tulip Poplar	Tree	2	2	2	1	1	1	2	2	2	2	2	2	32	32	32
Platanus occidentalis	Sycamore	Tree	3	3	3	3	3	3	2	2	2	4	4	4	62	62	62
Quercus alba	White Oak	Tree	2	2	2	1	1	1							11	11	11
Quercus lyrata	Overcup Oak	Tree				2	2	2	2	2	2				22	22	22
Quercus michauxii	Swamp Chestnut Oak	Tree										2	2	2	13	13	13
Quercus phellos	Willow Oak	Tree	4	4	4	1	1	1				4	4	4	33	33	33
Quercus shumardii	Shumard Oak	Shrub Tree							1	1	1				9	9	9
Viburnum dentatum	Arrow-wood	Shrub Tree	1	1	1	2	2	2	2	2	2				15	15	15
		Stem count	15	15	15	15	15	15	15	15	15	15	15	15	282	282	282
		size (ares)		1			1			1			1			19	
		size (ACRES)		0.02			0.02			0.02			0.02			0.47	
		Species count	7	7	7	9	9	9	8	8	8	6	6	6	11	11	11
		Stems per ACRE	607	607	607	607	607	607	607	607	607	607	607	607	601	601	601

Color for Density

Exceeds requirements by 10%

Exceeds requirements, but by less than 10%

Fails to meet requirements, by less than 10%

Fails to meet requirements by more than 10%

PnLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems

VEGETATION PLOT PHOTOGRAPHS

VEG PLOT 1 *(03/14/2019)*

VEG PLOT 2 *(03/14/2019)*

VEG PLOT 3 *(03/14/2019)*

VEG PLOT 4 *(04/24/2019)*

VEG PLOT 5 *(04/24/2019)*

VEG PLOT 6 *(04/24/2019)*

VEG PLOT 7 *(04/24/2019)*

VEG PLOT 8 *(04/24/2019)*

VEG PLOT 9 *(04/24/2019)*

VEG PLOT 10 *(07/02/2019)*

VEG PLOT 11 *(04/24/2019)*

VEG PLOT 12 *(03/14/2019)*

VEG PLOT 13 *(03/14/2019)*

VEG PLOT 14 *(03/14/2019)*

VEG PLOT 15 *(03/14/2019)*

VEG PLOT 16 *(04/24/2019)*

VEG PLOT 17 *(04/24/2019)*

VEG PLOT 18 *(04/24/2019)*

VEG PLOT 19 *(03/14/2019)*

APPENDIX 4. Morphological Summary Data and Plots

Table 7a. Baseline Stream Data Summary
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Buckwater R4 & R5/6

		PRE-RESTORATION CONDITION		REFERENCE REACH DATA						DESIGN				AS-BUILT/BASELINE			
Parameter	**Gage**	**Buckwater Creek Reach 4**	**Buckwater Creek Reach 5/6**	**Franklin Creek**		**Spencer Creek 2**		**Foust Creek**		**Buckwater Creek Reach 4**		**Buckwater Creek Reach 5/6**		**Buckwater Creek Reach 4**		**Buckwater Creek Reach 5/6**	
				Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Dimension and Substrate - Riffle																	
Bankfull Width (ft)		13	15.0	18.2		10.7	11.2	18.5	19.4	17.6		19.0		13.8	17.2	20.5	21.5
Floodprone Width (ft)		17 44	20	---		60	114	49	63	38	87	40	91	150	200	200	
Bankfull Mean Depth		1.5 1.8	1.8	1.2		1.6	1.8	1.3	1.4	1.3		1.6		0.9	1.3	1.5	
Bankfull Max Depth		2.1 2.2	2.3	---		2.1	2.6	1.8	2.1	1.2	1.5	1.2	1.5	1.7	2.2	2.5	2.6
Bankfull Cross Sectional Area (ft^2)	N/A	20.0 24.0	28	21.7		17.8	19.7	23.9	24.1	22.5		29.7		12.5	21.9	30.6	33.6
Width/Depth Ratio		7.3 8.6	8.3	15.2		5.8	7.1	13.9	14.2	14.0		12.0		13.5	15.3	13.8	13.9
Entrenchment Ratio		1.3 3.3	1.3	3.6		5.5	10.2	2.6	3.4	2.5	5.0	2.2	5.0	8.7	14.5	9.3	9.8
Bank Height Ratio		1.6 1.7	2.0	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
D50 (mm)		16.0	18.0	---		---		---		---		---		30.0	37.0	25.6	44.0
Profile																	
Riffle Length (ft)		---	---	---		---		---		---		---		13	60	25	65
Riffle Slope (ft/ft)		---	---	---		0.013		0.015	0.035	0.009	0.022	0.005	0.015	0.001	0.025	0.003	0.016
Pool Length (ft)	N/A	---	---	---		---		---		---		---		46	82	54	94
Pool Max Depth (ft)		2.9 3.1	---	---		3.3		2.5	2.9	2.6	3.8	3.1	4.7	2.6	4.9	3.6	5.2
Pool Spacing (ft)		---	---	---		71		49	91	69	139	40	138	51	130	83	143
Pool Volume (ft^3)																	
Pattern																	
Channel Beltwidth (ft)		24 64	---	---		38	41	N/A		53	150	57	162	53	150	57	162
Radius of Curvature (ft)		19 48	---	---		11	15	N/A		35	53	38	57	35	53	38	57
Rc:Bankfull Width (ft/ft)	N/A	1.4 3.7	---	---		1.3	1.4	N/A		2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Meander Length (ft)		45 250	---	---		46	48	N/A		88	246	95	266	88	246	95	266
Meander Width Ratio		1.8 4.9	---	---		3.4	3.6	N/A		3.0	8.5	3.0	8.5	3.0	8.5	3.0	8.5
Substrate, Bed and Transport Parameters																	
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	N/A	0.33/1.3/4.4/47/85/256	.34/39/7.8/33/71/>2048	8.8/25/68.7/>2048/>2048/>2048		<0.063/3/8.8/42/90/-		---		---		---		0.1/11/33.8/90/154.7/256		0.1/2.68/11.8/81.3/214.7/>2048	
Reach Shear Stress (Competency) lb/ft^2		0.87	0.53							0.57		0.69		0.97		0.54	
Max part size (mm) mobilized at bankfull																	
Stream Power (Capacity) W/m^2																	
Additional Reach Parameters																	
Drainage Area (SM)		1.00	1.60	2.15		0.96		1.37		1.00		1.60		1.00		1.60	
Watershed Impervious Cover Estimate (%)		3.9%	3.9%	---		---		---		3.9%		3.9%		3.9%		3.9%	
Rosgen Classification		E4/G4c	G4c	B4		E4		C4		C4		E4		C4		E4	
Bankfull Velocity (fps)		3.7	4	5.4		4.9	5.4	2.9	3.7	3.6		3.1	3.7	4.3		3.6	
Bankfull Discharge (cfs)		80	110	120		97		88		78		91	100	53		109	
Q-NFF regression																	
Q-USGS extrapolation	N/A																
Q-Mannings																	
Valley Length (ft)		---	---	---		---		---		---		---		1,928		813	
Channel Thalweg Length (ft)		2,282	1,272	---		---		---		2,467		865		2,538		979	
Sinuosity		1.14	1.41	1.18		2.30		1.10		1.30		1.40		1.30		1.40	
Water Surface Slope ($ft/ft)^2$		0.007	0.007	0.023		0.005		0.009		0.007		0.004	0.007	0.007		0.006	
Bankfull Slope (ft/ft)		---	---	---		0.005		---		---		---		0.007		0.006	

(---): Data was not provided
N/A: Not Applicable

Table 7b. Baseline Stream Data Summary
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T2 & T3

		PRE-RESTORATION CONDITION				REFERENCE REACH DATA						DESIGN				AS-BUILT/BASELINE			
Parameter	Gage	T2		T3		UT to Wells		Spencer Creek 3		UT to Varnals Creek		T2		T3		T2		T3	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																			
Bankfull Width (ft)		8.8	11	7.5	13	6.2	8.6	6.3	9.3	9.3	10.5	10.6		9.6		9.1		14.4	
Floodprone Width (ft)		14	49	22	26	16	22	14	125	60	100	23	53	21	48	100		300	
Bankfull Mean Depth		0.9	1.4	0.6	0.8	0.6	1	0.8	1	1.1	1.2	0.8		0.8		0.7		1.1	
Bankfull Max Depth		1.2	1.8	1.1	1.3	0.9	1.4	1	1.2	1.5	1.7	1.2	1.3	0.9	1.1	1.2		2.0	
Bankfull Cross Sectional 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		6.4		15.3	
Width/Depth Ratio		7.9	9.4	9.2	23	6.1	12.6	7.9	9.3	8.1	9.3	13.0		13.0		13.2		13.6	
Entrenchment Ratio		1.3	>5.6	1.7	>3.4	1.9	4.1	1.7	4.3	5.7	10.0	2.2	5.0	2.2	5.0	10.9		20.8	
Bank Height Ratio		1.4	2.0	1.2	1.7	1.0	1.8	1.0		1.0		1.0		1.0		1.0		1.0	
D50 (mm)	N/A	21		45		---		---		---		---		---		48.9		45.0	
Profile																			
Riffle Length (ft)		---		---		---		---		---		---		---		16	61	8	56
Riffle Slope (ft/ft)		---		---		0.017	0.078	0.018	0.034	0.024	0.057	0.019	0.071	0.015	0.038	0.006	0.073	0.004	0.036
Pool Length (ft)		---		---		---		---		---		---		---		12.0	55.0	13.0	65.0
Pool Max Depth (ft)		1.5		1.8		1.6	1.9	1.2	1.8	2.5	2.6	1.7	2.6	1.5	2.3	1.6	3.8	1.7	3.0
Pool Spacing (ft)		---		---		17	63	9	46	8	82	23	93	33	93	27	71	30	81
Pool Volume (ft^3)	N/A																		
Pattern																			
Channel Beltwidth (ft)		---		---		10	35	10	50	15	45	27	90	24	82	27	90	24	82
Radius of Curvature (ft)		---		---		2.3	32	12	85	8	47	21	32	19	29	21	32	19	29
Rc:Bankfull Width (ft/ft)		---		---		0.3	4.0	1.9	9.1	0.6	3.2	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Meander Length (ft)		---		---		35	70	55.0	142.0	16.0	47.0	80	159	72	144	80	159	72	144
Meander Width Ratio	N/A	---		---		4.4	8.8	8.7	15.3	1.1	3.2	2.5	8.5	2.5	8.5	2.5	8.5	2.5	8.5
Substrate, Bed and Transport Parameters																			
Ri%/Ru%/P%/G%/S%																			
SC%/Sa%/G%/C%/B%/Be%																			
d16/d35/d50/d84/d95/d100		.45/4.4/9.7/71.1/183/>208		0.43/11.3/20.9/55.7/110/180		0.1/0.6/4.5/53/96/x		1.87/8.85/11/65/128/x		---		---		---		0.25/16/32.7/80.3/227.6/1024		0.28/10.32/21.5/103.6/193.1/512	
Reach Shear Stress (Competency) lb/ft^2		1.18		1.00		---		---		---		0.8		0.6		0.8		1.1	
Max part size (mm) mobilized at bankfull																			
Stream Power (Capacity) W/m^2	N/A																		
Additional Reach Parameters																			
Drainage Area (SM)		0.34		0.22		0.13		0.37		0.41		0.34		0.22		0.34		0.22	
Watershed Impervious Cover Estimate (%)		0.2%		2.0%		---		---		---		0.2%		2.0%		0.2%		2.0%	
Rosgen Classification		E4/G4c		E4/Incised B4c		C4		E4		B4/E4b		B4/C4		C4		B4/C4		C4	
Bankfull Velocity (fps)		3.1	4.3	3.5	4.2	3.8	5.3	5.0	5.6	4.4	5.2	4.0		3.6		3.1		4.3	
Bankfull Discharge (cfs)		36		26		15		35		54		36		26		20		66	
Q-NFF regression																			
Q-USGS extrapolation																			
Q-Mannings																			
Valley Length (ft)		---		---		---		---		---		---		---		508		729	
Channel Thalweg Length (ft)		543		918		---		---		---		587		851		591		903	
Sinuosity		1.2		1.2		1.4		1.0	1.3	1.2		1.2		1.3		1.2		1.2	
Water Surface Slope ($ft/ft)^2$		0.015		0.018		0.019		0.019	0.022	0.17		0.012	0.02	0.010	0.023	0.017		0.016	
Bankfull Slope (ft/ft)	N/A	---		---		---		---		---		---		---		0.017		0.016	

(---): Data was not provided
N/A: Not Applicable

Table 7c. Baseline Stream Data Summary
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T4 & T5

		PRE-RESTORATION CONDITION				REFERENCE REACH DATA						DESIGN				AS-BUILT/BASELINE			
Parameter	Gage	T4		T5		UT to Wells		Spencer Creek 3		UT to Varnals Creek		T4		T5		T4		T5	
						Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																			
Bankfull Width (ft)		7.2		6.1	8.9	6.2	8.6	6.3	9.3	9.3	10.5	7.6		9.7		6.7		6.1	8.6
Floodprone Width (ft)		9		10	22	16	22	14	125	60	100	11	17	20	46	150		100	200
Bankfull Mean Depth		0.6		0.6		0.6	1	0.8	1	1.1	1.2	0.6		0.7		0.5		0.8	1.0
Bankfull Max Depth		0.8		0.9	1.4	0.9	1.4	1	1.2	1.5	1.7	0.7	0.9	0.8	1.0	1.0		1.1	1.5
Bankfull Cross Sectional Area (ft^2)	N/A	4.8	5.1	6.2	6.3	3.9	6.3	6.6	8.7	10.3	12.3	4.3		6.7		3.6		8.1	8.5
Width/Depth Ratio		11		9.7	13	6.1	12.6	7.9	9.3	8.1	9.3	13.0		14.0		12.3		4.5	8.7
Entrenchment Ratio		1.3		1.6	2.3	1.9	4.1	1.7	4.3	5.7	10.0	1.4	2.2	2.2	5.0	22.3		11.7	33.0
Bank Height Ratio		1.6		2.1	4.1	1.0	1.8	1.0		1.0		1.0		1.0		1.0		1.0	
D50 (mm)		54.0		8.5		---		---		---		---		---		90		37.2	50.3
Profile																			
Riffle Length (ft)		---		---		---		---		---		---		---		20	55	13	40
Riffle Slope (ft/ft)		---		---		0.017	0.078	0.018	0.034	0.024	0.057	0.026	0.103	0.014	0.043	0.001	0.046	0.015	0.023
Pool Length (ft)	N/A	---		---		---		---		---		---		---		9.0	38.0	36.0	71.0
Pool Max Depth (ft)		1.9		---		1.6	1.9	1.2	1.8	2.5	2.6	1.1	1.8	1.4	2.1	1.4	2.7	1.5	3.1
Pool Spacing (ft)		---		---		17	63	9	46	8	82	17	67	20	61	23	66	16	51
Pool Volume (ft^3)																			
Pattern																			
Channel Beltwidth (ft)		---		---		10	35	10	50	15	45	---		29	82	---		29	82
Radius of Curvature (ft)		---		---		2.3	32	12	85	8	47	---		18	28	---		18	28
Rc:Bankfull Width (ft/ft)	N/A	---		---		0.3	4.0	1.9	9.1	0.6	3.2	---		2.0	3.0	---		2.0	3.0
Meander Length (ft)		---		---		35	70	55	142	16	47	---		49	136	---		49	136
Meander Width Ratio		---		---		4.4	8.8	8.7	15.3	1.1	3.2	---		3.0	8.5	---		3.0	8.5
Substrate, Bed and Transport Parameters																			
Ri%/Ru%/P%/G%/S%																			
SC%/Sa%/G%/C%/B%/Be%																			
d16/d35/d50/d84/d95/d100	N/A	.05/8.0/32.0/93.6/157/256		0.16/0.42/4.2/66.8/107/>2048		0.1/0.6/4.5/53/96/x		1.87/8.85/11/65/128/x		---		---		---		0.16/0.55/5.6/107.3/155.5/256		0.16/5.60/17.3/80.3/120.1/180	
Reach Shear Stress (Competency) lb/ft^2		1.09		0.24		---		---		---		0.8		0.4		1.0		0.58	
Max part size (mm) mobilized at bankfull																			
Stream Power (Capacity) W/m^2																			
Additional Reach Parameters																			
Drainage Area (SM)		0.12		0.17		0.13		0.37		0.41		0.12		0.17		0.12		0.17	
Watershed Impervious Cover Estimate (%)		0.0%		1.0%		---		---		---		0.0%		1.0%		0.0%		1.0%	
Rosgen Classification		G4		Incised E4/C4		C4		E4		B4/E4b		B4/C4		B4/C4		B4		C4	
Bankfull Velocity (fps)		3.3	3.6	3	3.4	3.8	5.3	5.0	5.6	4.4	5.2	3.9		3.3		3.4		2.6	
Bankfull Discharge (cfs)		17		21		15		35		54		18		22		70		12	
Q-NFF regression																			
Q-USGS extrapolation	N/A																		
Q-Mannings																			
Valley Length (ft)		---		---		---		---		---		---		---		878		992	
Channel Thalweg Length (ft)		1,081		1,291		---		---		---		961		1,259		982		1,295	
Sinuosity		1.1		1.1		1.4		1.0	1.3	1.2		1.2		1.3		1.1		1.3	
Water Surface Slope $(ft/ft)^2$		0.027		0.015		0.020		0.019	0.022	0.17		0.024		0.013		0.024		0.014	
Bankfull Slope (ft/ft)		---		---		---		---		---		---		---		0.024		0.014	

(---): Data was not provided
N/A: Not Applicable

Table 8. Morphology and Hydraulic Summary (Dimensional Parameters - Cross-Section)

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 0 - 2019

	Buckwater Creek Reach 2								Buckwater Creek Reach 3															
	Cross-Section 1 (Riffle)								Cross-Section 2 (Pool)								Cross-Section 3 (Riffle)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	509.51								508.12								509.71							
Bankfull Width (ft)	20.7								19.6								23.7							
Floodprone Width (ft)	200								N/A								150							
Bankfull Mean Depth (ft)	1.5								2.5								2.3							
Bankfull Max Depth (ft)	2.2								3.4								3.5							
Bankfull Cross Sectional Area (ft^2)	31.9								49.1								55.3							
Bankfull Width/Depth Ratio	13.5								7.9								10.1							
Entrenchment Ratio[2]	9.6								N/A								6.3							
Bankfull Bank Height Ratio[3]	1.0								N/A								1.0							
	Buckwater Creek Reach 4																							
	Cross-Section 4 (Riffle)								Cross-Section 5 (Pool)								Cross-Section 6 (Riffle)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	505.91								506.10								500.92							
Bankfull Width (ft)	17.2								24.8								16.5							
Floodprone Width (ft)	150								N/A								200							
Bankfull Mean Depth (ft)	1.3								2.0								1.1							
Bankfull Max Depth (ft)	2.2								3.4								2.2							
Bankfull Cross Sectional Area (ft^2)	21.9								50.4								17.8							
Bankfull Width/Depth Ratio	13.5								12.2								15.3							
Entrenchment Ratio[2]	8.7								N/A								12.1							
Bankfull Bank Height Ratio[3]	1.0								N/A								1.0							
	Buckwater Creek Reach 4																**Buckwater Creek Reach 5**							
	Cross-Section 7 (Pool)								Cross-Section 8 (Riffle)								Cross-Section 9 (Pool)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	500.69								496.69								488.72							
Bankfull Width (ft)	22.9								13.8								16.4							
Floodprone Width (ft)	N/A								200								N/A							
Bankfull Mean Depth (ft)	1.7								0.9								1.3							
Bankfull Max Depth (ft)	3.7								1.7								2.0							
Bankfull Cross Sectional Area (ft^2)	38.8								12.5								21.7							
Bankfull Width/Depth Ratio	13.6								15.3								12.4							
Entrenchment Ratio[2]	N/A								14.5								N/A							
Bankfull Bank Height Ratio[3]	N/A								1.0								N/A							
	Buckwater Creek Reach 5								**Buckwater Creek Reach 6**															
	Cross-Section 10 (Riffle)								Cross-Section 11 (Pool)								Cross-Section 12 (Riffle)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	488.49								486.68								487.04							
Bankfull Width (ft)	21.5								23.6								20.5							
Floodprone Width (ft)	200								N/A								200							
Bankfull Mean Depth (ft)	1.5								2.2								1.5							
Bankfull Max Depth (ft)	2.5								3.9								2.6							
Bankfull Cross Sectional Area (ft^2)	33.3								52.4								30.6							
Bankfull Width/Depth Ratio	13.9								10.6								13.8							
Entrenchment Ratio[2]	9.3								N/A								9.8							
Bankfull Bank Height Ratio[3]	1.0								N/A								1.0							

[1]For MY1 through MY7 bankfull elevation was calculated using the Standard Measurement of the BHR Monitoring Parameter provided by NCIRT and NCDMS.

[2]Entrenchment Ratio is the flood prone width divided by the bankfull width.

[3]Bank Height Ratio is the bank height divided by the max depth of the bankfull channel.

Table 8. Morphology and Hydraulic Summary (Dimensional Parameters - Cross-Section)

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 0 - 2019

	T1 Reach 1								T1 Reach 2															
	Cross-Section 13 (Riffle)								Cross-Section 14 (Riffle)								Cross-Section 15 (Pool)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	488.81								487.70								487.21							
Bankfull Width (ft)	22.0								20.8								27.0							
Floodprone Width (ft)	150								200								N/A							
Bankfull Mean Depth (ft)	1.4								1.6								1.6							
Bankfull Max Depth (ft)	2.4								2.5								3.2							
Bankfull Cross Sectional Area (ft^2)	31.5								20.8								42.2							
Bankfull Width/Depth Ratio	15.4								13.2								17.3							
Entrenchment Ratio[2]	6.8								9.6								N/A							
Bankfull Bank Height Ratio[3]	1.0								1.0								N/A							

	T3 Reach 2								T2															
	Cross-Section 16 (Pool)								Cross-Section 17 (Riffle)								Cross-Section 18 (Riffle)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	505.82								505.31								494.17							
Bankfull Width (ft)	12.7								14.4								9.1							
Floodprone Width (ft)	N/A								300								100							
Bankfull Mean Depth (ft)	1.4								1.1								0.7							
Bankfull Max Depth (ft)	2.5								2.0								1.2							
Bankfull Cross Sectional Area (ft^2)	17.6								15.3								6.4							
Bankfull Width/Depth Ratio	9.1								13.6								13.2							
Entrenchment Ratio[2]	N/A								20.8								10.9							
Bankfull Bank Height Ratio[3]	N/A								1.0								1.0							

	T2								T4A Reach 1								T4							
	Cross-Section 19 (Pool)								Cross-Section 20 (Riffle)								Cross-Section 21 (Pool)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	491.10								539.53								502.51							
Bankfull Width (ft)	13.9								3.3								7.4							
Floodprone Width (ft)	N/A								20								N/A							
Bankfull Mean Depth (ft)	1.0								0.4								0.9							
Bankfull Max Depth (ft)	1.9								0.7								1.6							
Bankfull Cross Sectional Area (ft^2)	13.6								1.3								6.7							
Bankfull Width/Depth Ratio	14.3								8.4								9.3							
Entrenchment Ratio[2]	N/A								6.0								N/A							
Bankfull Bank Height Ratio[3]	N/A								1.0								N/A							

	T4								T4B Reach 1								T6 Reach 3							
	Cross-Section 22 (Riffle)								Cross-Section 23 (Riffle)								Cross-Section 24 (Riffle)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	502.09								540.79								517.07							
Bankfull Width (ft)	6.7								4.3								8.8							
Floodprone Width (ft)	150								25								100							
Bankfull Mean Depth (ft)	0.5								0.5								0.8							
Bankfull Max Depth (ft)	1.0								0.8								1.3							
Bankfull Cross Sectional Area (ft^2)	3.6								2.1								7.1							
Bankfull Width/Depth Ratio	12.3								8.4								10.8							
Entrenchment Ratio[2]	22.3								5.9								11.4							
Bankfull Bank Height Ratio[3]	1.0								1.0								1.0							

[1]For MY1 through MY7 bankfull elevation was calculated using the Standard Measurement of the BHR Monitoring Parameter provided by NCIRT and NCDMS.

[2]Entrenchment Ratio is the flood prone width divided by the bankfull width.

[3]Bank Height Ratio is the bank height divided by the max depth of the bankfull channel.

Table 8. Morphology and Hydraulic Summary (Dimensional Parameters - Cross Section)

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Monitoring Year 0 - 2019

	T5																							
	Cross Section 25 (Riffle)								Cross Section 26 (Pool)								Cross Section 27 (Riffle)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	504.92								504.17								491.22							
Bankfull Width (ft)	8.6								8.7								6.1							
Floodprone Width (ft)	100								N/A								200							
Bankfull Mean Depth (ft)	1.0								1.0								0.8							
Bankfull Max Depth (ft)	1.5								1.8								1.1							
Bankfull Cross Sectional Area (ft^2)	8.5								8.5								8.1							
Bankfull Width/Depth Ratio	8.7								9.0								4.5							
Entrenchment Ratio[2]	11.7								N/A								33.0							
Bankfull Bank Height Ratio[3]	1.0								N/A								1.0							
	T5								T7 Reach 1															
	Cross Section 28 (Pool)								Cross Section 29 (Riffle)								Cross Section 30 (Pool)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	490.75								506.31								505.68							
Bankfull Width (ft)	9.3								10.0								8.6							
Floodprone Width (ft)	N/A								100								N/A							
Bankfull Mean Depth (ft)	1.6								0.7								0.9							
Bankfull Max Depth (ft)	2.5								1.0								1.5							
Bankfull Cross Sectional Area (ft^2)	15.2								7.4								7.5							
Bankfull Width/Depth Ratio	5.7								13.5								9.8							
Entrenchment Ratio[2]	N/A								10.0								N/A							
Bankfull Bank Height Ratio[3]	N/A								1.0								N/A							
	T7 Reach 2								T7 Reach 3								T7A							
	Cross Section 31 (Riffle)								Cross Section 32 (Riffle)								Cross Section 33 (Riffle)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	493.84								485.52								490.11							
Bankfull Width (ft)	8.2								9.5								5.8							
Floodprone Width (ft)	100								25								50							
Bankfull Mean Depth (ft)	0.6								0.5								0.6							
Bankfull Max Depth (ft)	0.9								0.9								1.0							
Bankfull Cross Sectional Area (ft^2)	4.6								5.2								3.3							
Bankfull Width/Depth Ratio	14.8								17.6								10.2							
Entrenchment Ratio[2]	12.2								2.6								8.6							
Bankfull Bank Height Ratio[3]	1.0								1.0								1.0							
	T7A								T8															
	Cross Section 34 (Pool)								Cross Section 35 (Riffle)								Cross Section 36 (Pool)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	489.85								529.20								528.62							
Bankfull Width (ft)	10.5								5.1								6.1							
Floodprone Width (ft)	N/A								100								N/A							
Bankfull Mean Depth (ft)	0.9								0.5								1.1							
Bankfull Max Depth (ft)	2.0								0.7								1.7							
Bankfull Cross Sectional Area (ft^2)	9.4								2.6								6.7							
Bankfull Width/Depth Ratio	11.6								9.8								5.5							
Entrenchment Ratio[2]	N/A								19.8								N/A							
Bankfull Bank Height Ratio[3]	N/A								1.0								N/A							

[1]For MY1 through MY7 bankfull elevation was calculated using the Standard Measurement of the BHR Monitoring Parameter provided by NCIRT and NCDMS.

[2]Entrenchment Ratio is the flood prone width divided by the bankfull width.

[3]Bank Height Ratio is the bank height divided by the max depth of the bankfull channel.

Longitudinal Profile Plots

Buckwater Mitigation Site

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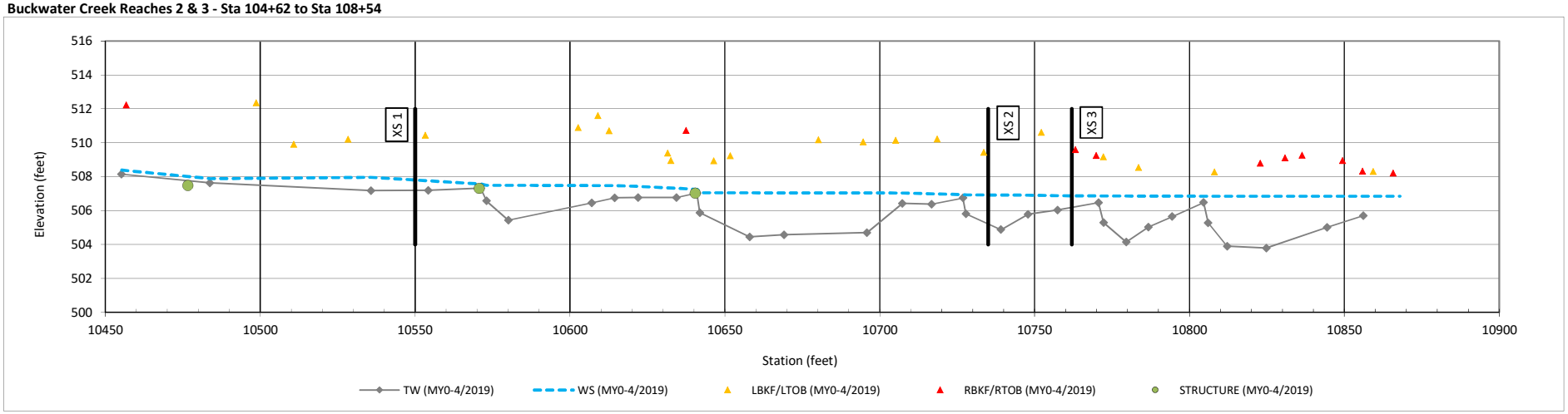
Monitoring Year 0 - 2019

Buckwater Creek Reaches 2 & 3 - Sta 104+62 to Sta 108+54



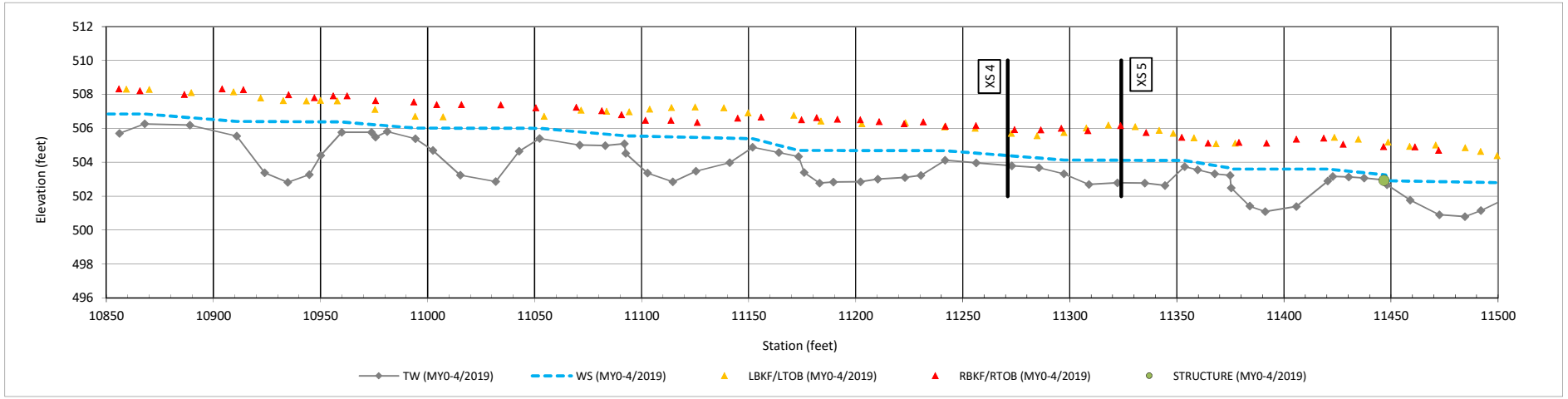
Longitudinal Profile Plots

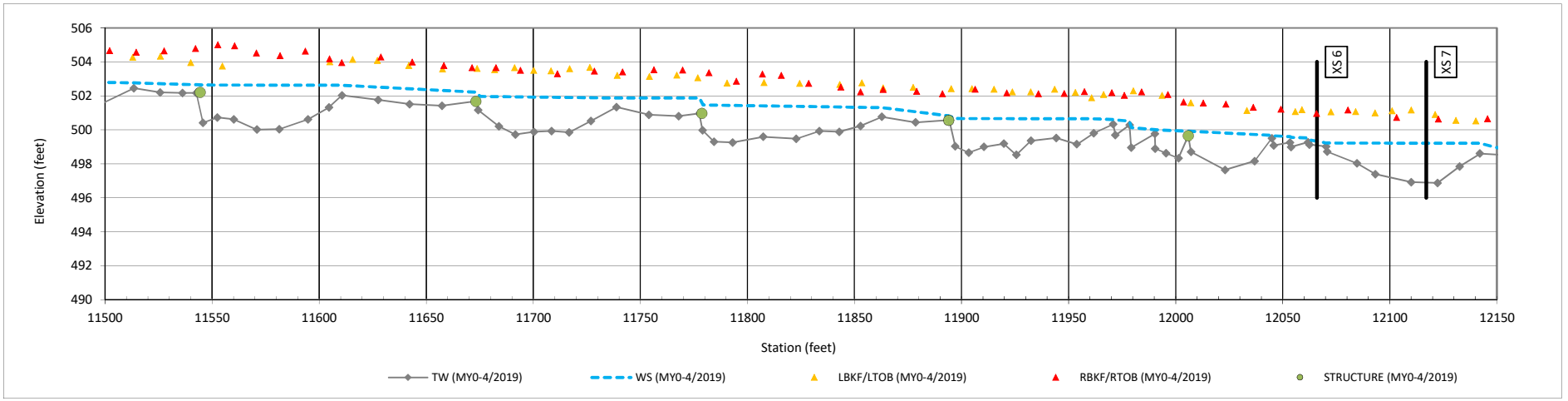
Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 0 - 2019

Buckwater Creek Reach 4 - Sta 108+54 to Sta 134+23





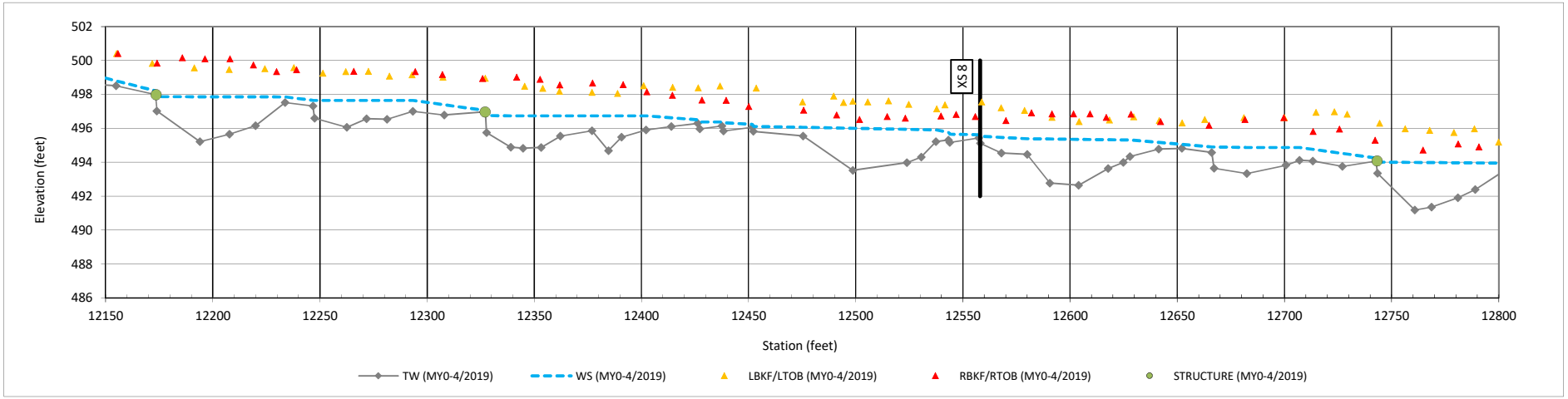
Longitudinal Profile Plots

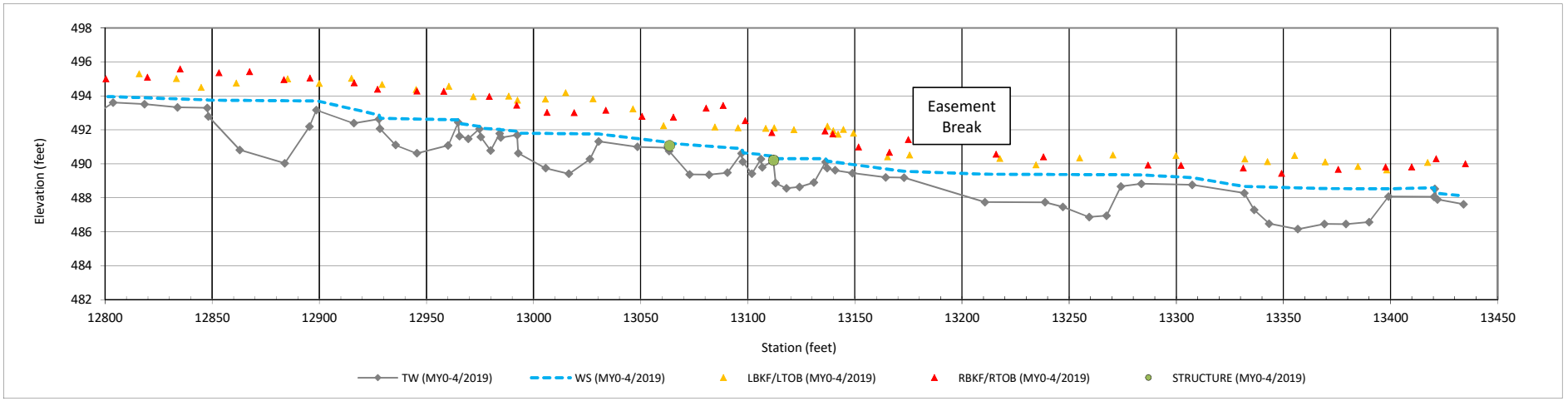
Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 0 - 2019

Buckwater Creek Reach 4 - Sta 108+54 to Sta 134+23





Longitudinal Profile Plots

Buckwater Mitigation Site

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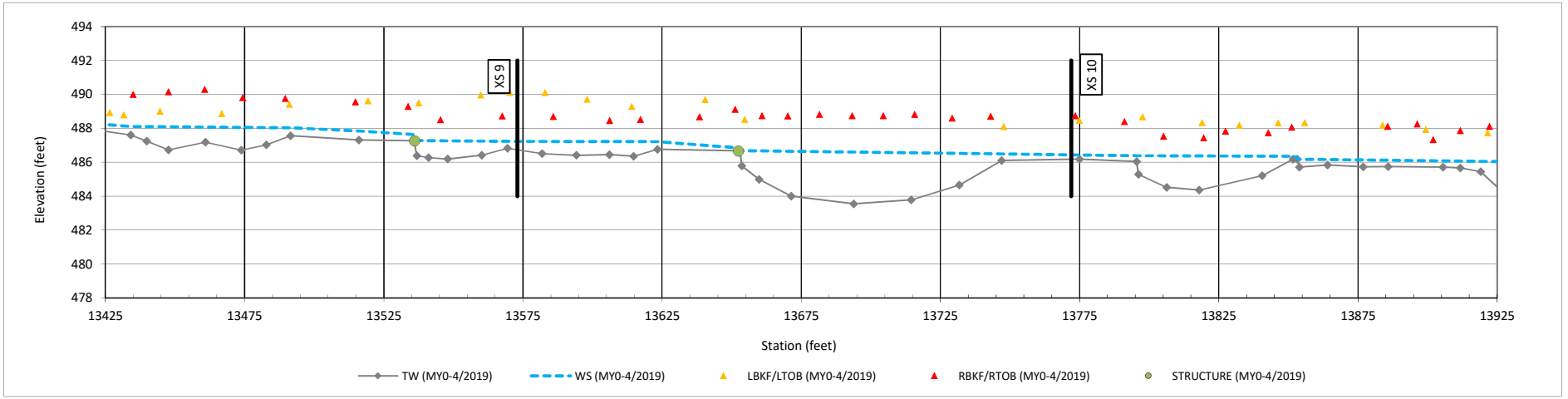
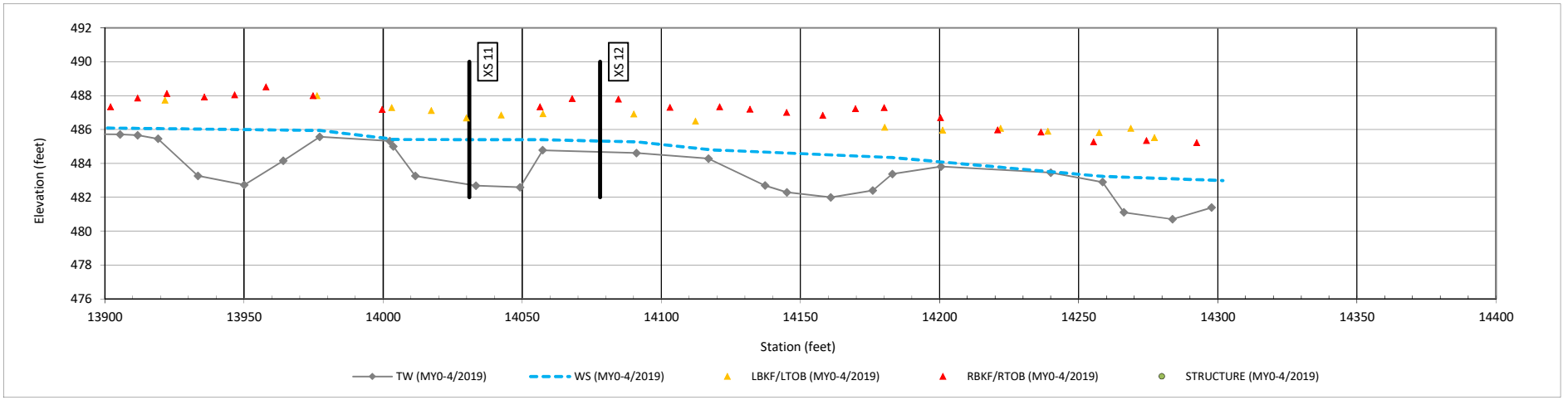
Buckwater Creek Reach 5 - Sta 134+23 to Sta 139+09



Buckwater Creek Reach 6 - Sta 139+09 to Sta 142+88



Longitudinal Profile Plots

Buckwater Mitigation Site
DMS Project No. 97084
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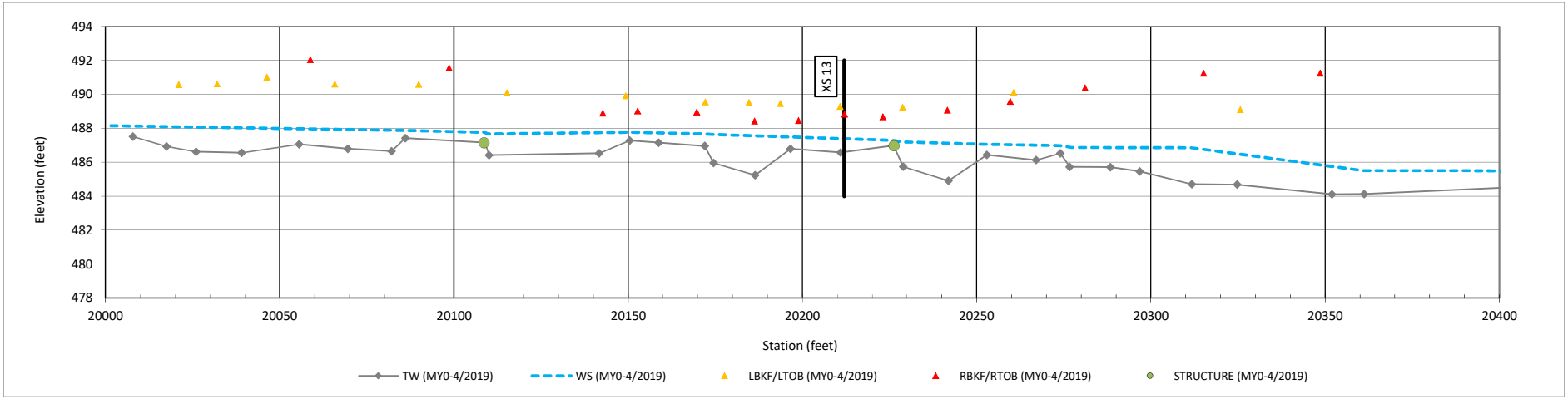
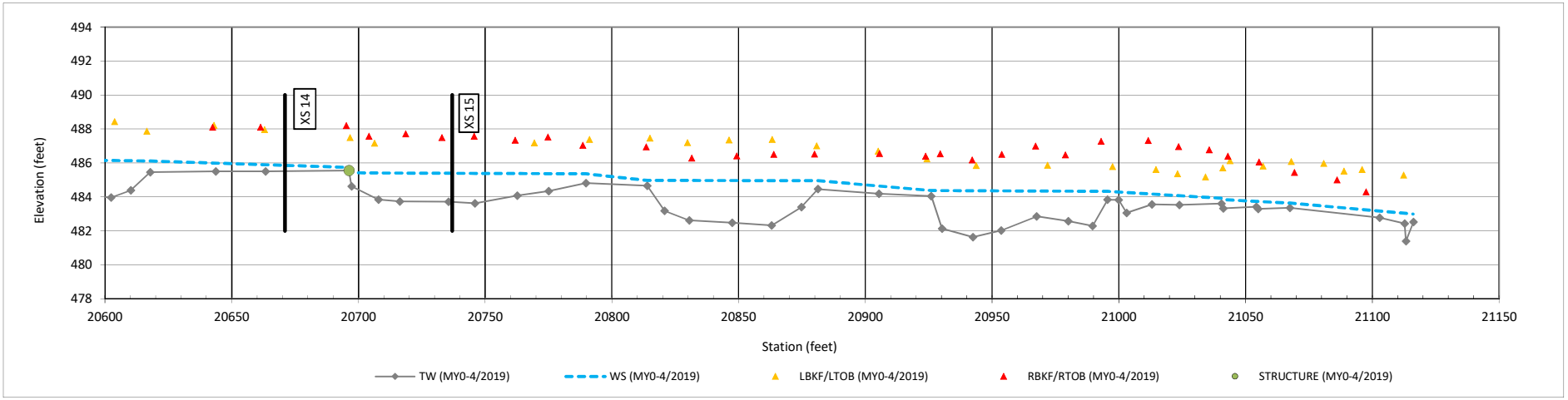
T1 Reach 1 - Sta 200+00 to Sta 203+66



T1 Reach 2 - Sta 206+08 to Sta 211+17



Longitudinal Profile Plots

Buckwater Mitigation Site
DMS Project No. 97084
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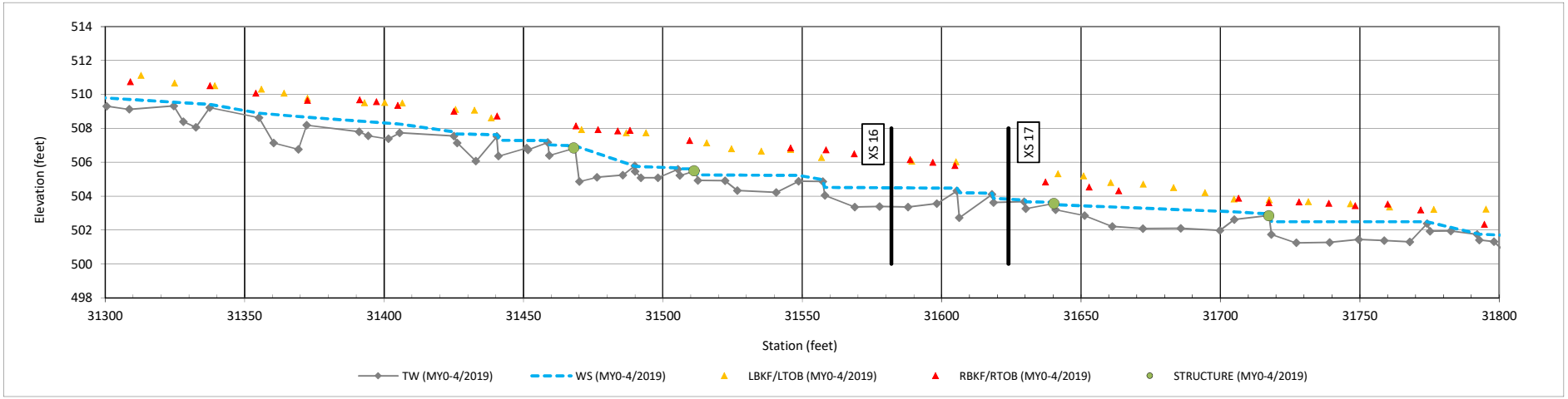
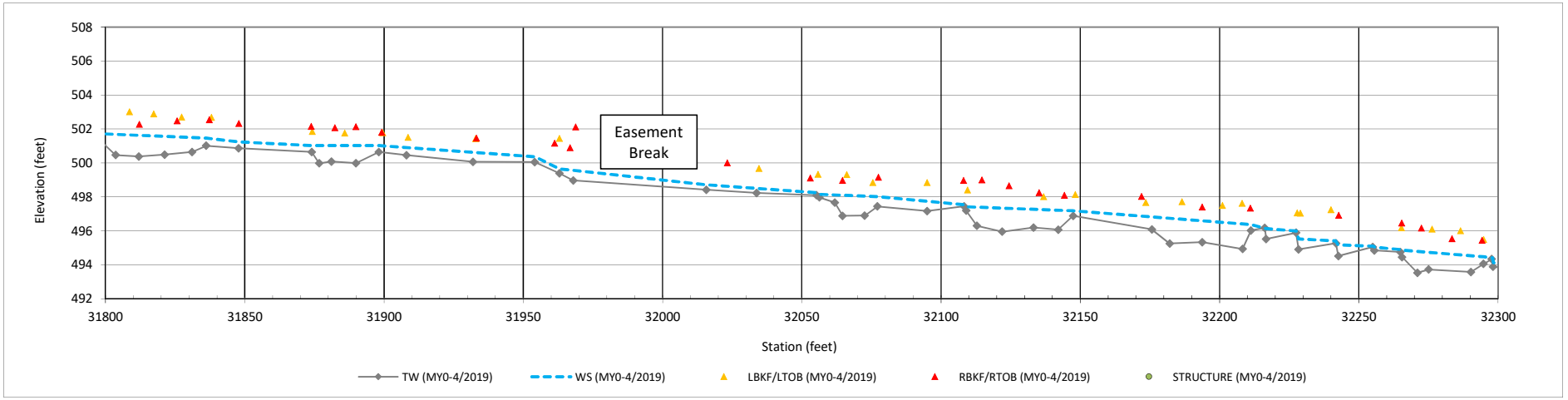
T3 Reach 2 - Sta 313+00 to Sta 322+50





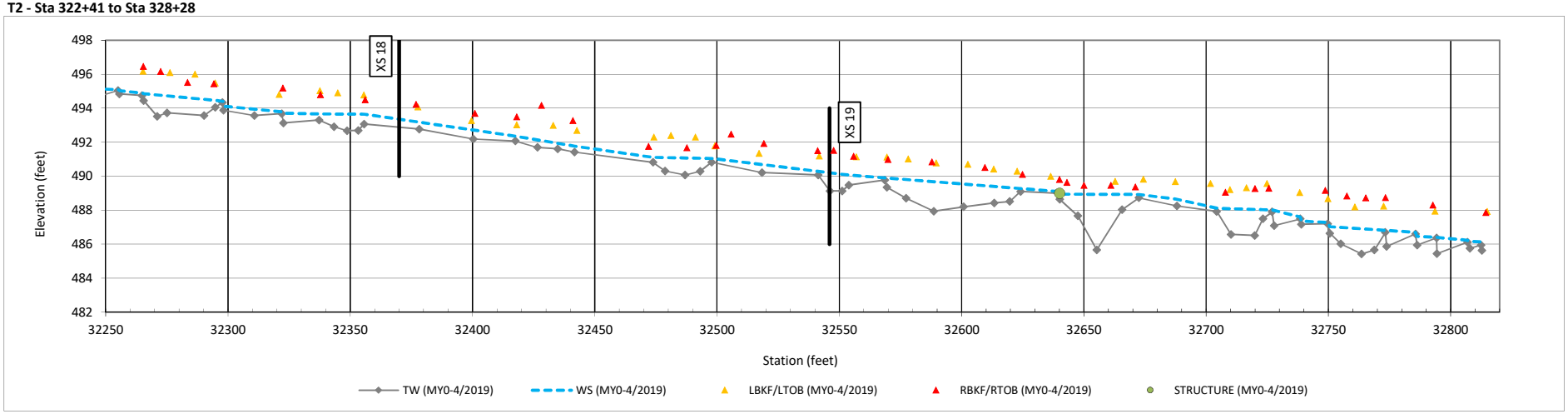
Longitudinal Profile Plots

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 0 - 2019

T2 - Sta 322+41 to Sta 328+28



Longitudinal Profile Plots

Buckwater Mitigation Site
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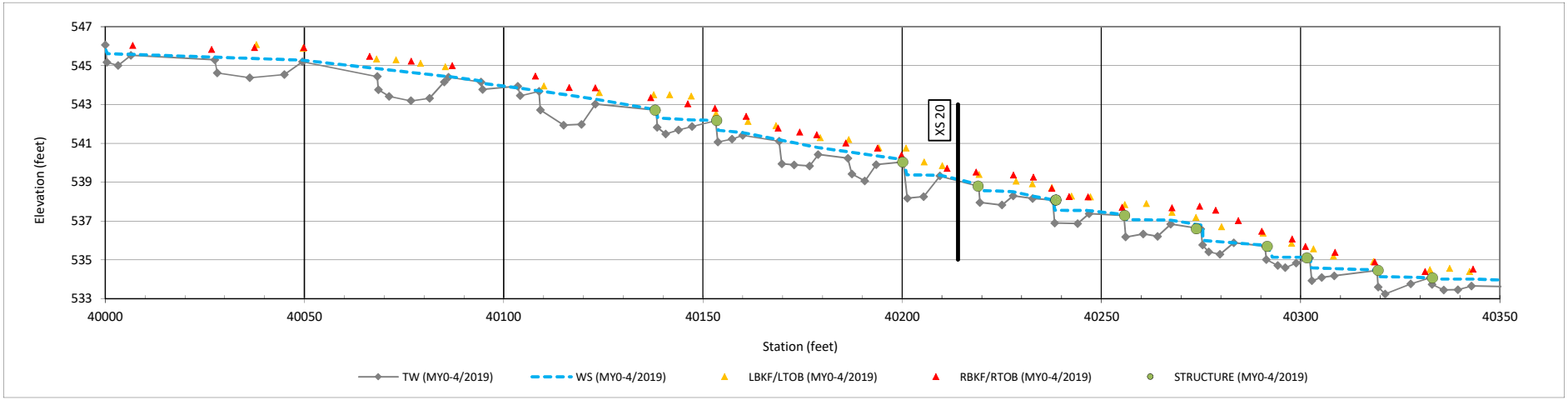
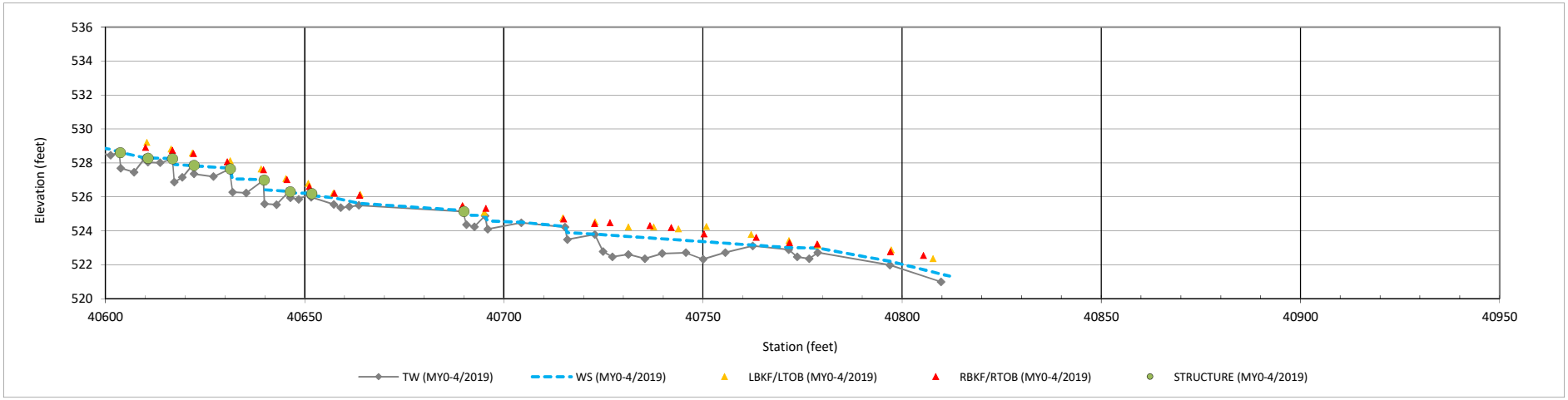
T4A Reach 1 - Sta 400+44 to Sta 403+55



T4A Reach 3 - Sta 406+02 to Sta 408+03



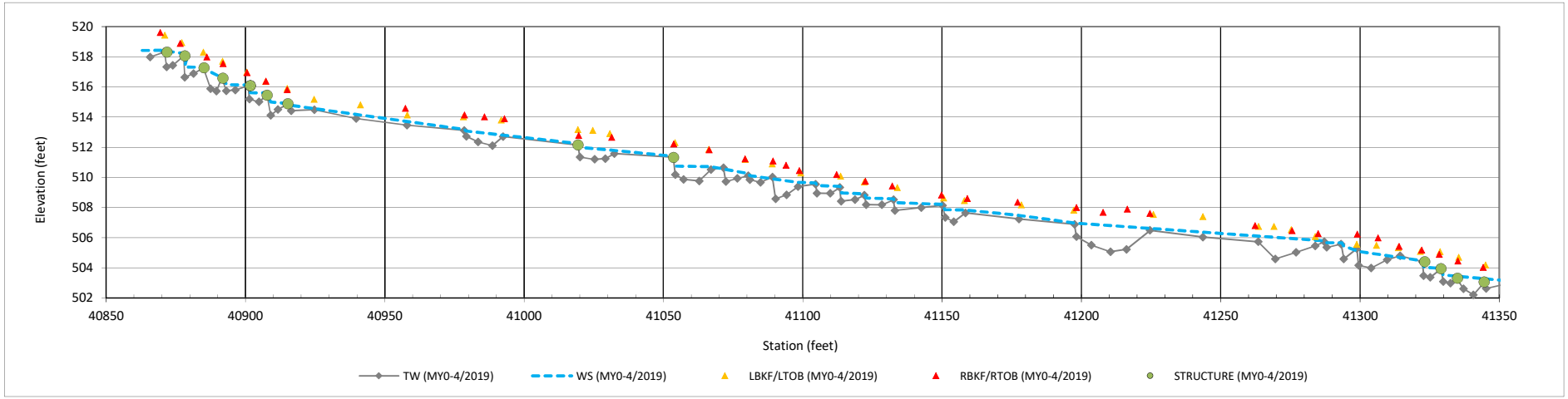
Longitudinal Profile Plots

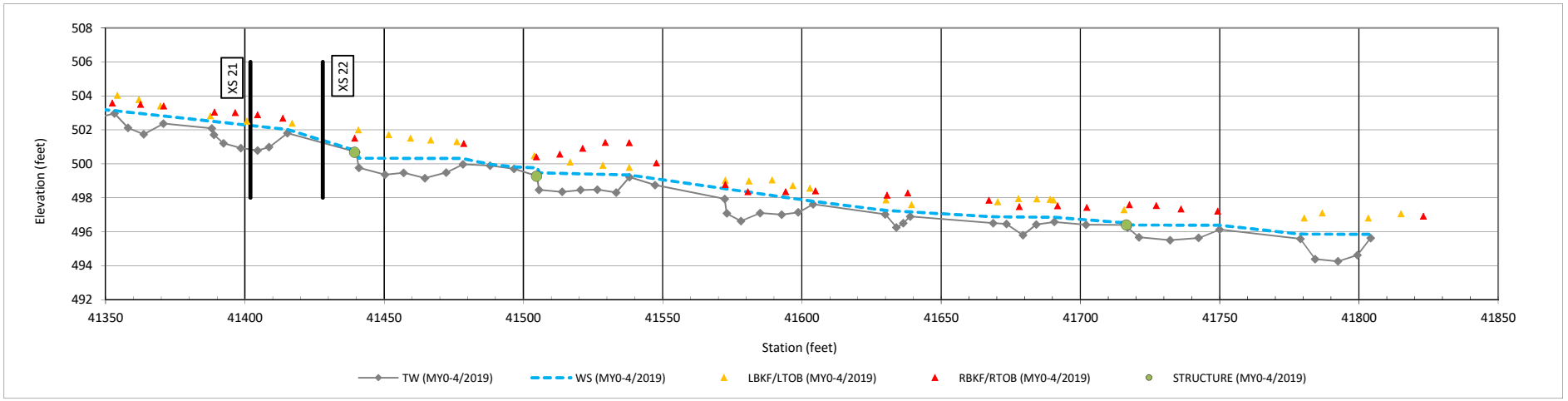
Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 0 - 2019

T4 - Sta 408+67 to Sta 418+28





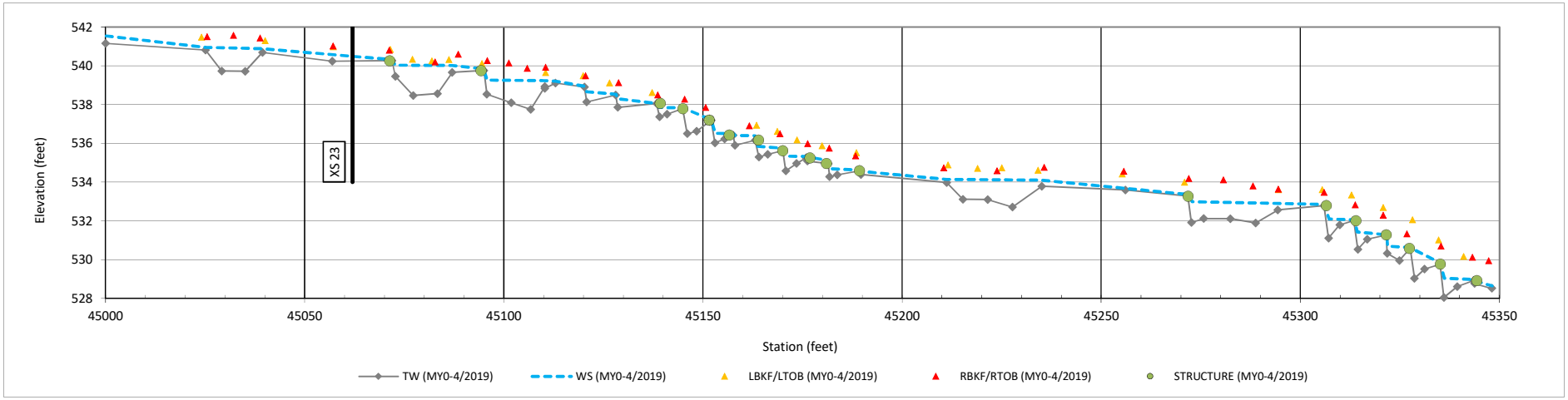
Longitudinal Profile Plots

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 0 - 2019

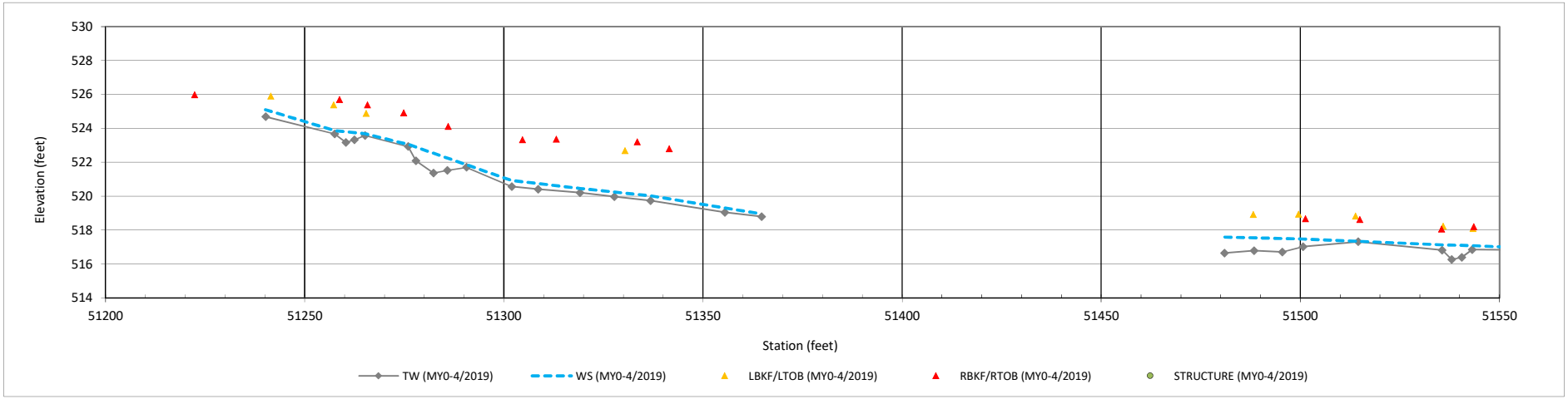
T4B Reach 1 - Sta 450+00 to Sta 453+45

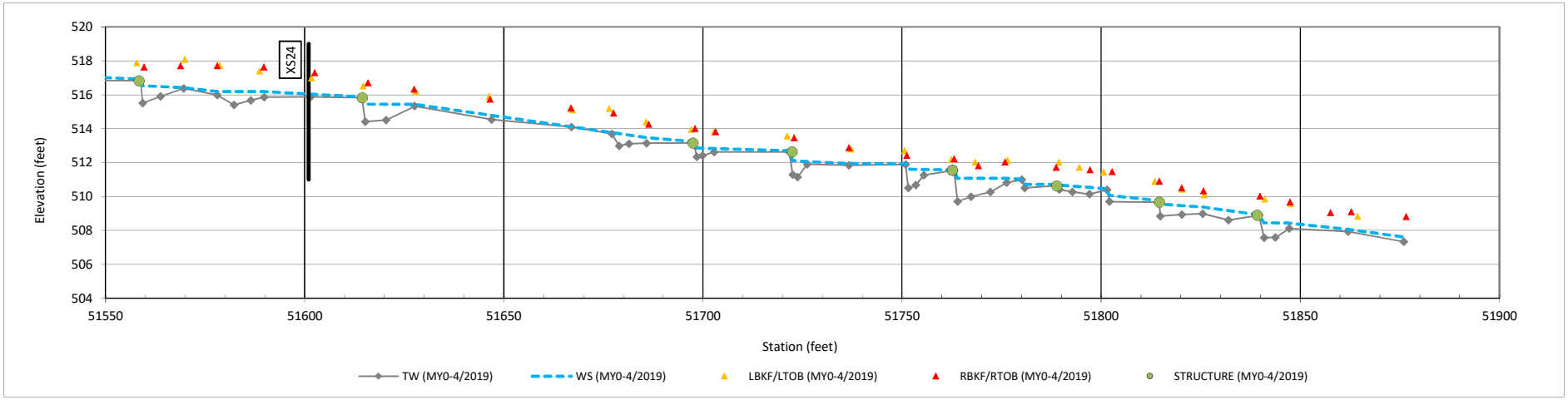


Longitudinal Profile Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T6 Reach 3 - Sta 512+44 to Sta 518+64





Longitudinal Profile Plots

Buckwater Mitigation Site
DMS Project No. 97084
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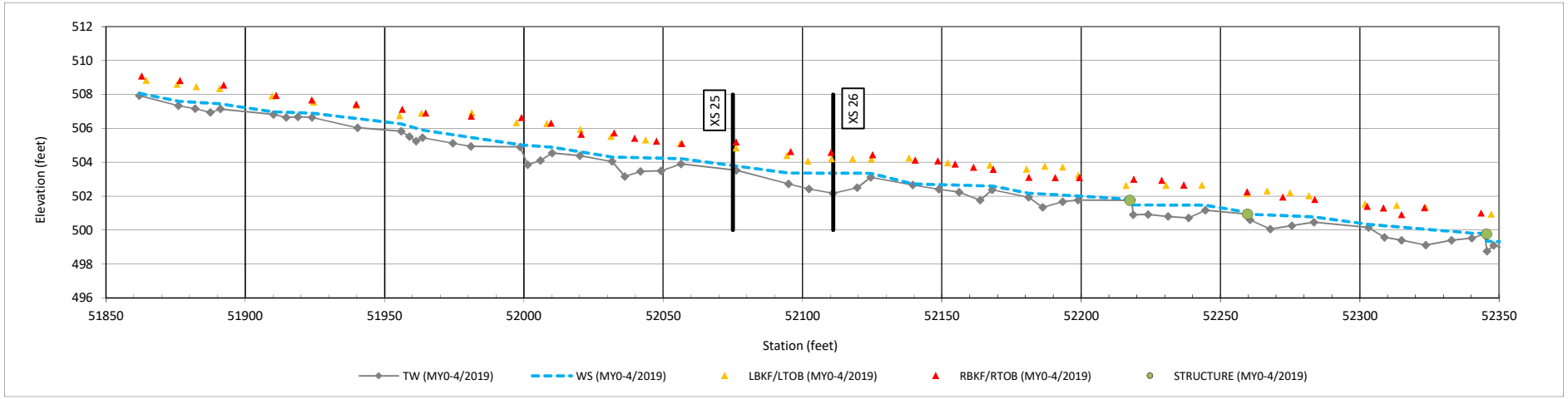
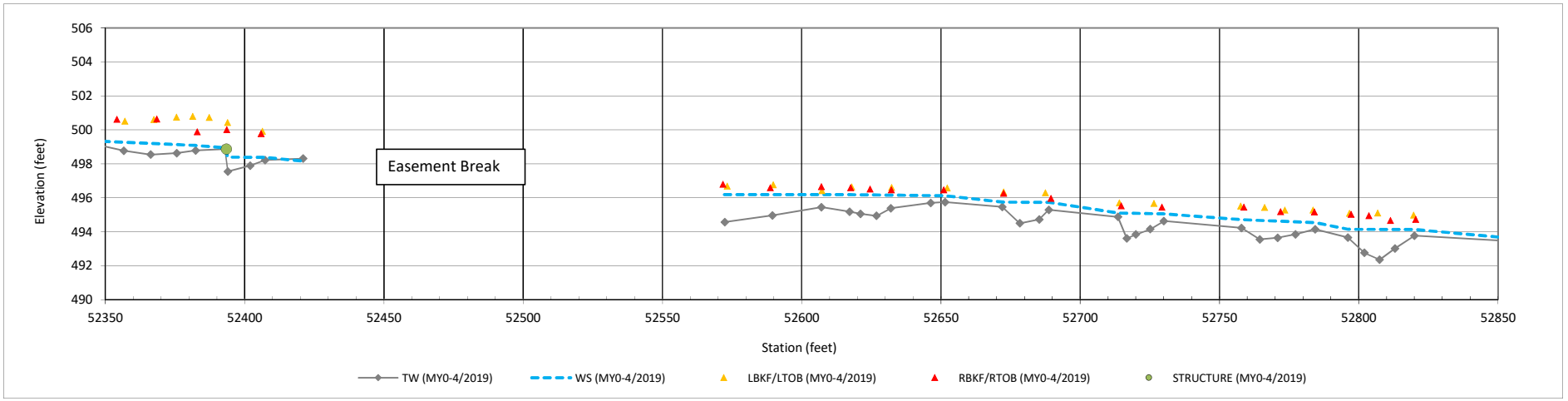
T5 - Sta 518+64 to Sta 532+90





Longitudinal Profile Plots

Buckwater Mitigation Site

DMS Project No. 97084

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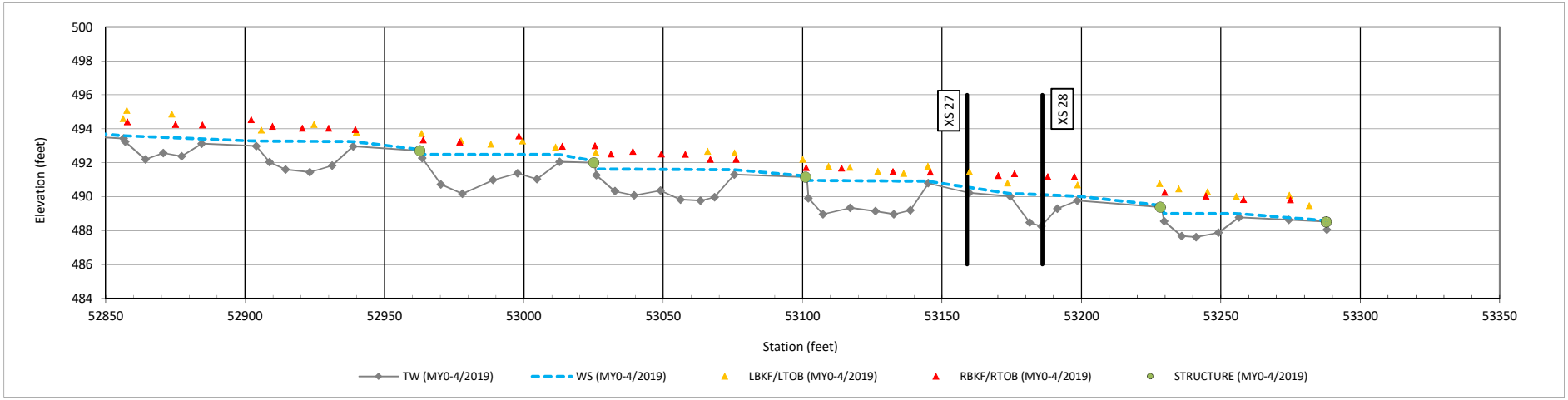
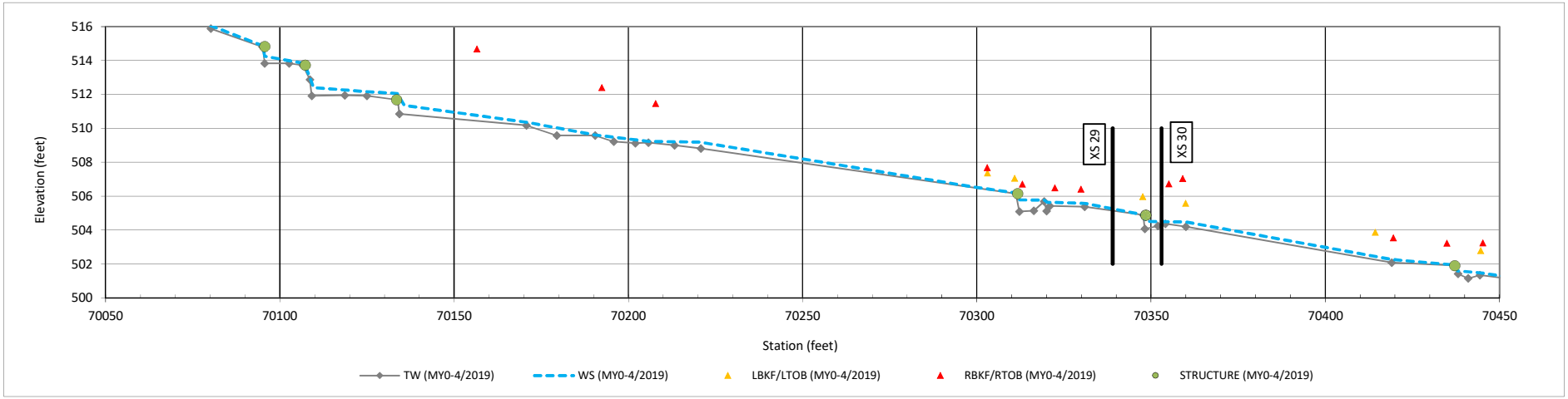
T5 - Sta 518+64 to Sta 532+90



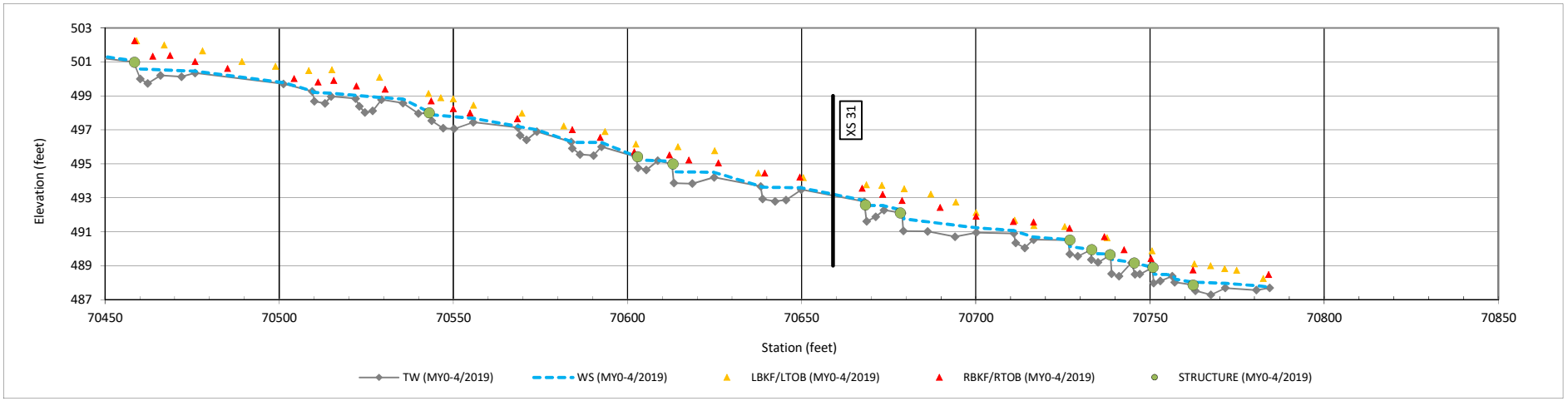
Longitudinal Profile Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T7 Reach 1 - Sta 700+95 to Sta 704+17



T7 Reach 2 - Sta 704+17 to Sta 707+80



Longitudinal Profile Plots

Buckwater Mitigation Site
DMS Project No. 97084
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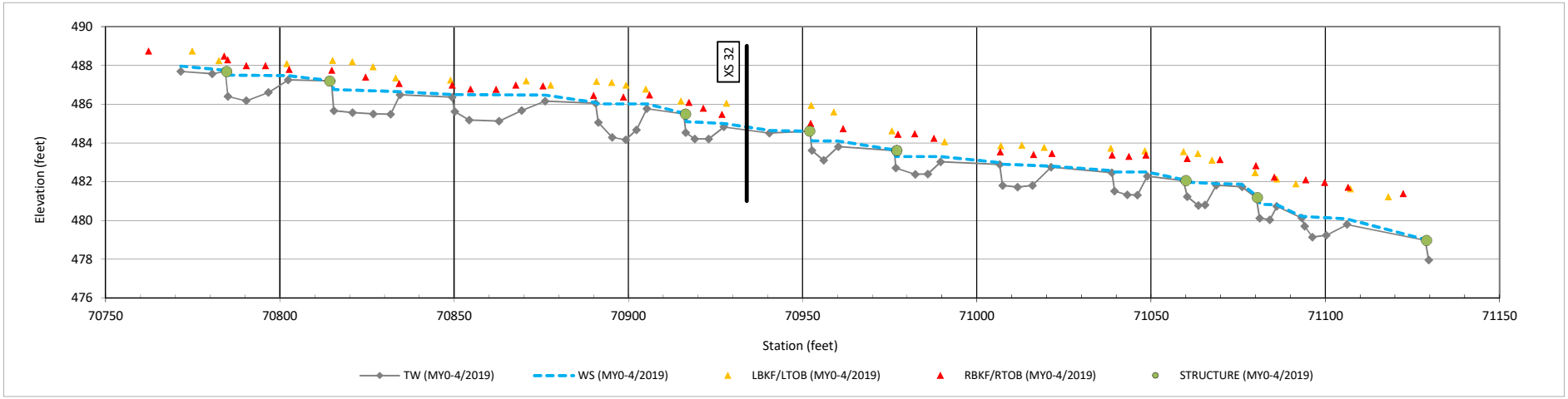
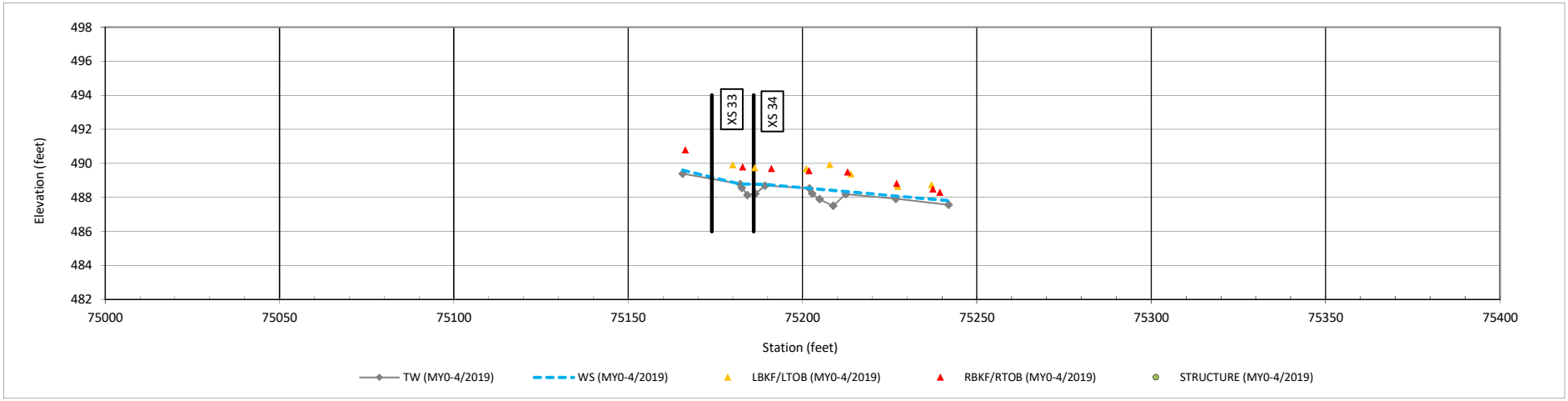
T7 Reach 3 - Sta 707+80 to Sta 711+36



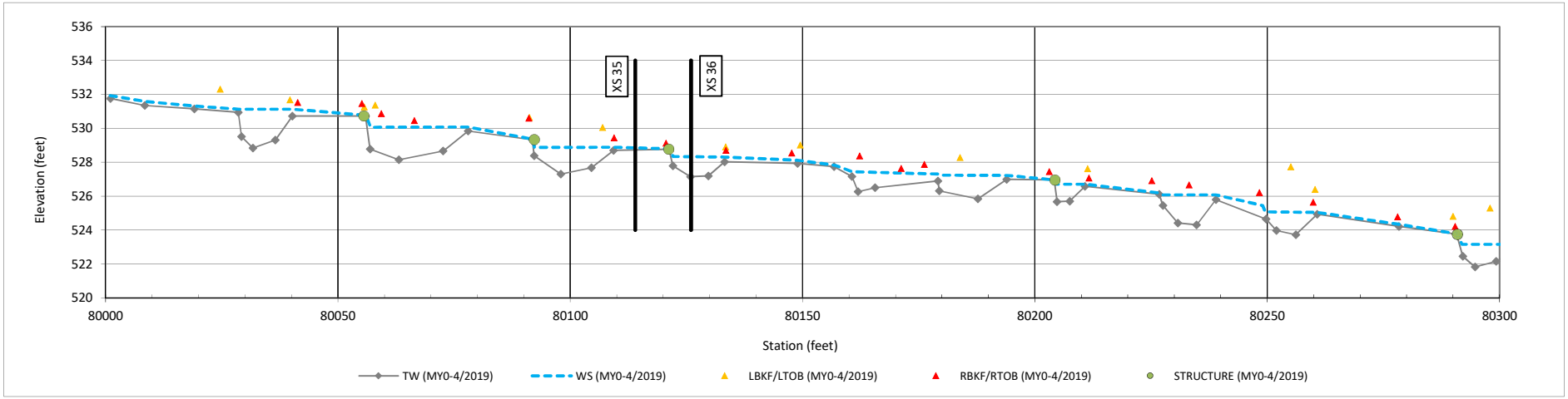
T7A - Sta 750+00 to Sta 752+42

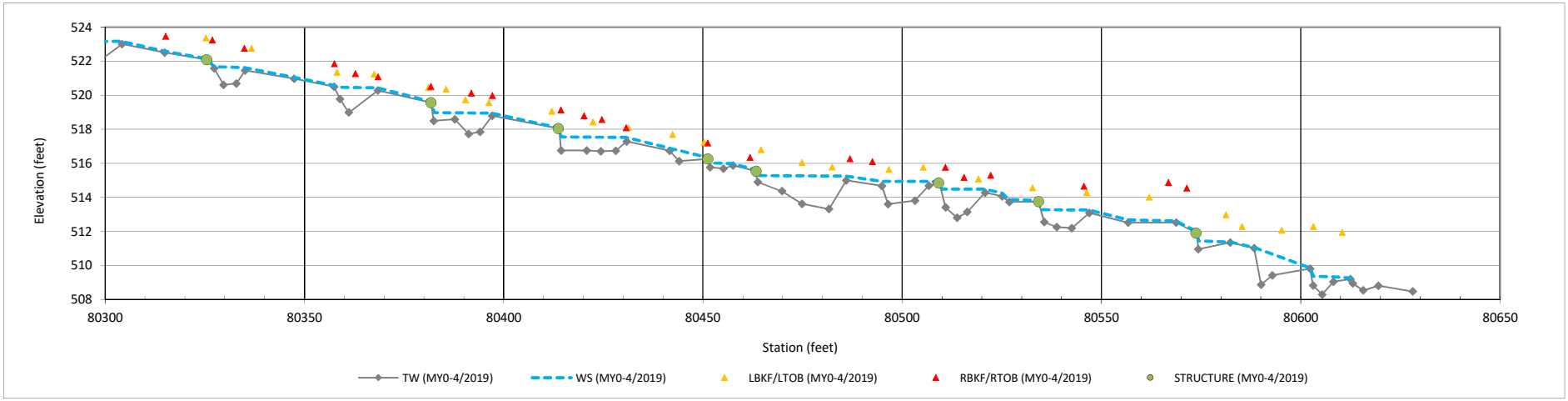


Longitudinal Profile Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T8 - Sta 800+00 to Sta 806+31

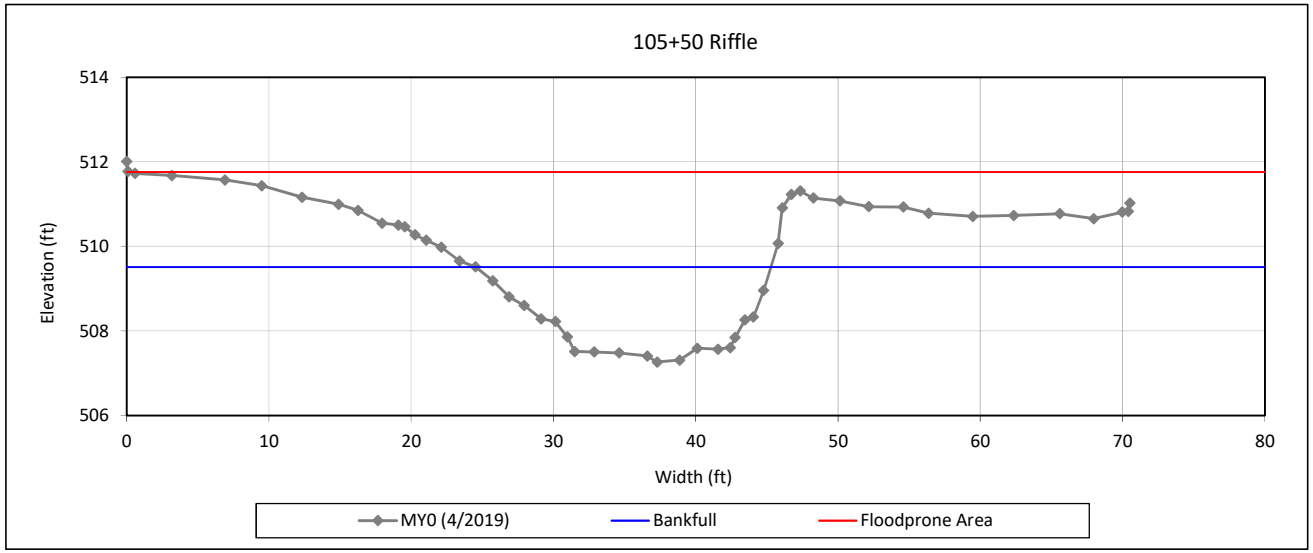




Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 1 - Buckwater Creek Reach 2



Bankfull Dimensions

31.9	x-section area (ft.sq.)
20.7	width (ft)
1.5	mean depth (ft)
2.2	max depth (ft)
21.8	wetted perimeter (ft)
1.5	hydraulic radius (ft)
13.5	width-depth ratio
200.0	W flood prone area (ft)
9.6	entrenchment ratio
1.0	low bank height ratio

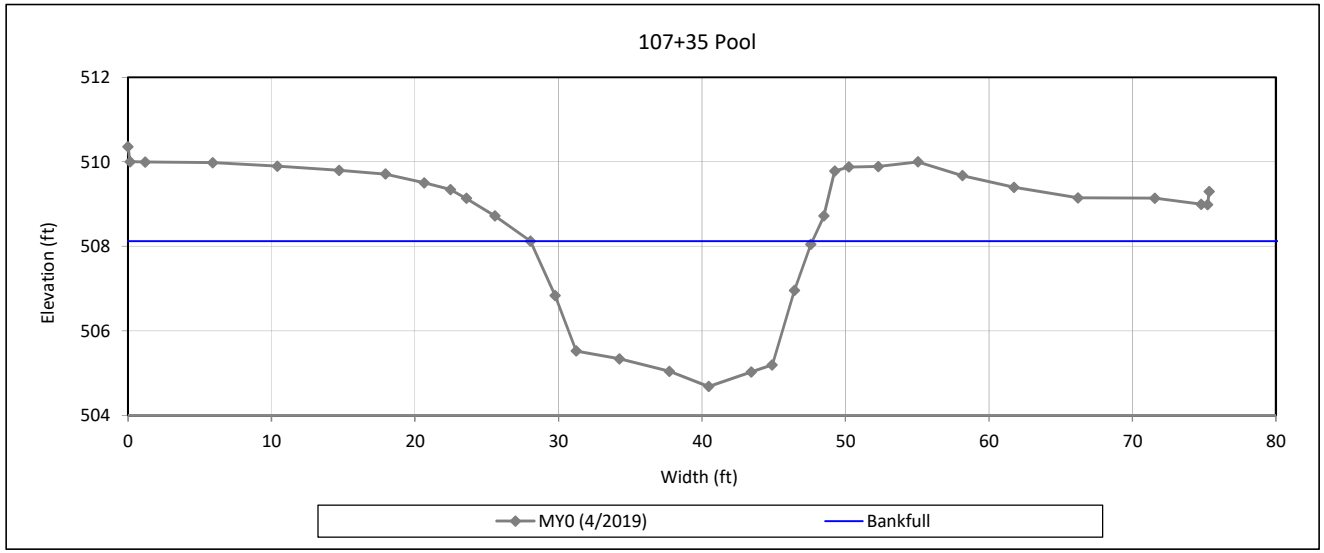
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 2 - Buckwater Creek Reach 3



Bankfull Dimensions	
49.1	x-section area (ft.sq.)
19.6	width (ft)
2.5	mean depth (ft)
3.4	max depth (ft)
21.9	wetted perimeter (ft)
2.2	hydraulic radius (ft)
7.9	width-depth ratio

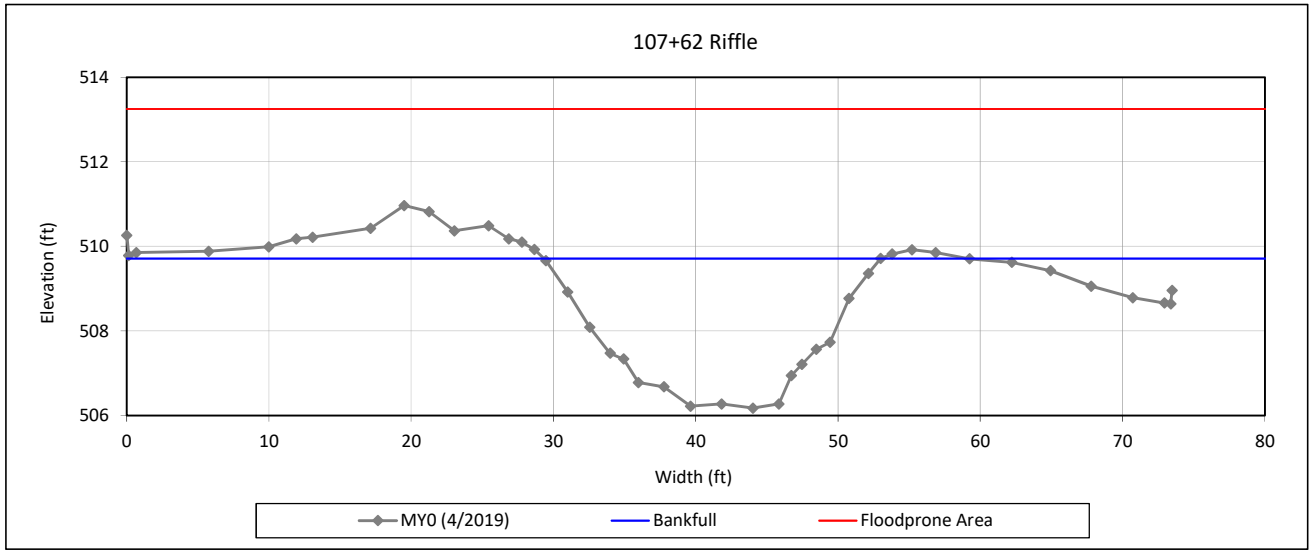
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 3 - Buckwater Creek Reach 3



Bankfull Dimensions

55.3	x-section area (ft.sq.)
23.7	width (ft)
2.3	mean depth (ft)
3.5	max depth (ft)
25.3	wetted perimeter (ft)
2.2	hydraulic radius (ft)
10.1	width-depth ratio
150.0	W flood prone area (ft)
6.3	entrenchment ratio
1.0	low bank height ratio

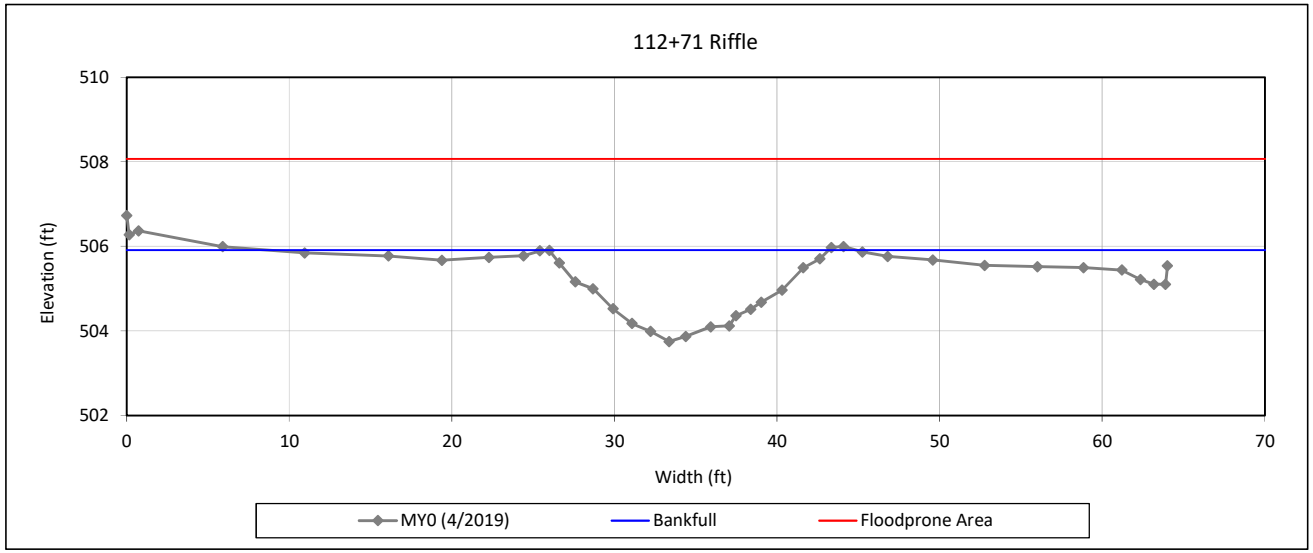
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 4 - Buckwater Creek Reach 4



Bankfull Dimensions

21.9	x-section area (ft.sq.)
17.2	width (ft)
1.3	mean depth (ft)
2.2	max depth (ft)
17.9	wetted perimeter (ft)
1.2	hydraulic radius (ft)
13.5	width-depth ratio
150.0	W flood prone area (ft)
8.7	entrenchment ratio
1.0	low bank height ratio

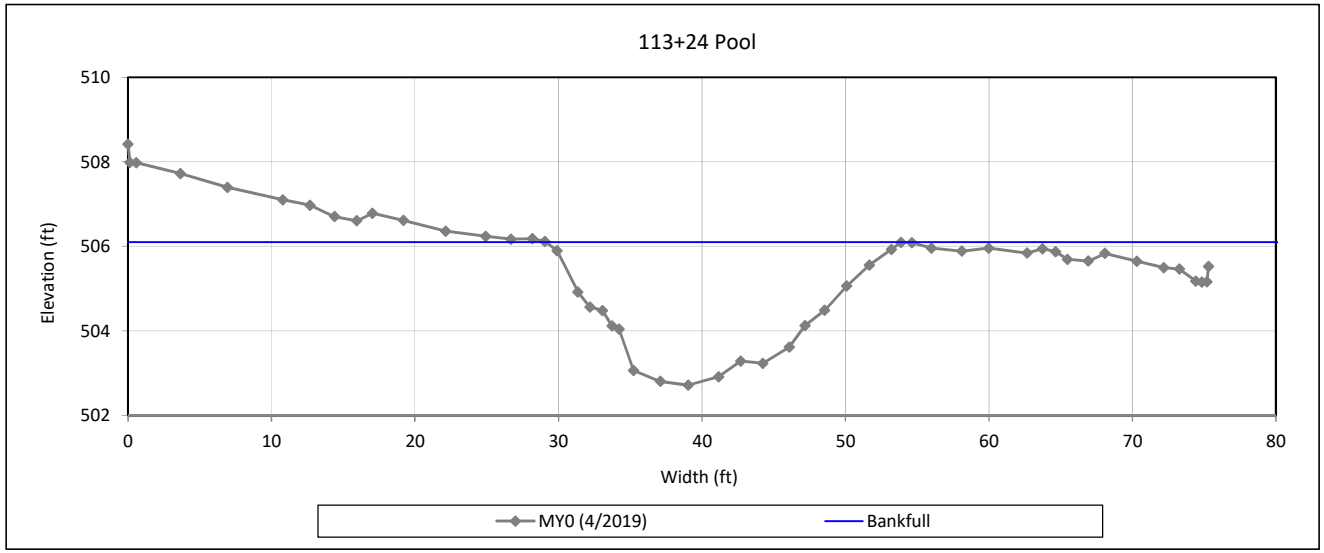
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 5 - Buckwater Creek Reach 4



Bankfull Dimensions	
50.4	x-section area (ft.sq.)
24.8	width (ft)
2.0	mean depth (ft)
3.4	max depth (ft)
26.2	wetted perimeter (ft)
1.9	hydraulic radius (ft)
12.2	width-depth ratio

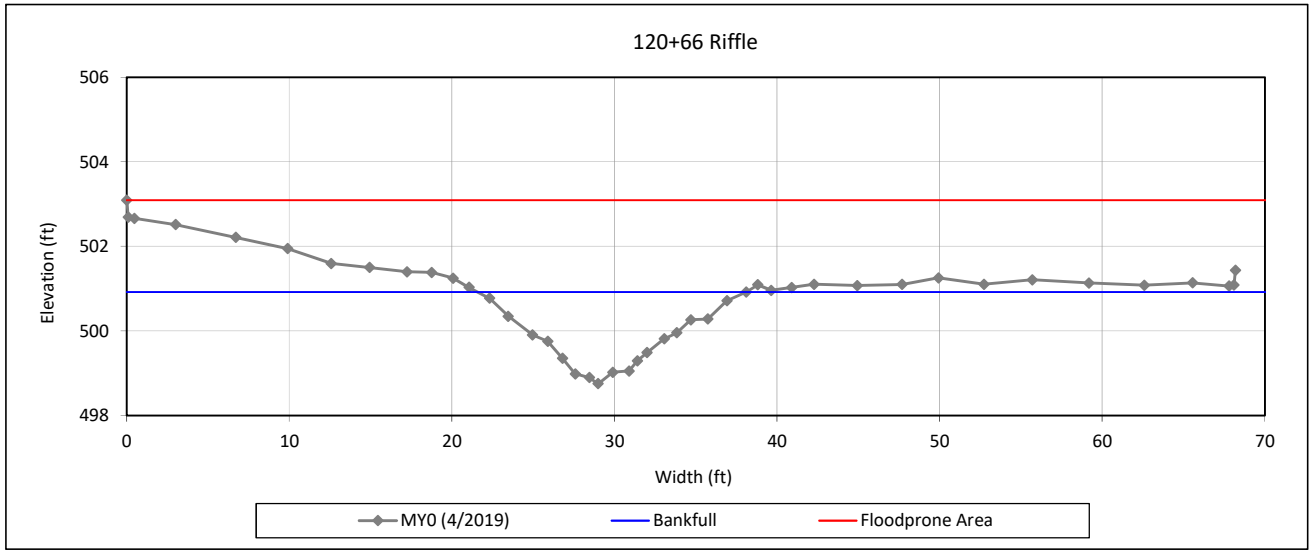
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 6 - Buckwater Creek Reach 4



Bankfull Dimensions

17.8	x-section area (ft.sq.)
16.5	width (ft)
1.1	mean depth (ft)
2.2	max depth (ft)
17.2	wetted perimeter (ft)
1.0	hydraulic radius (ft)
15.3	width-depth ratio
200.0	W flood prone area (ft)
12.1	entrenchment ratio
1.0	low bank height ratio

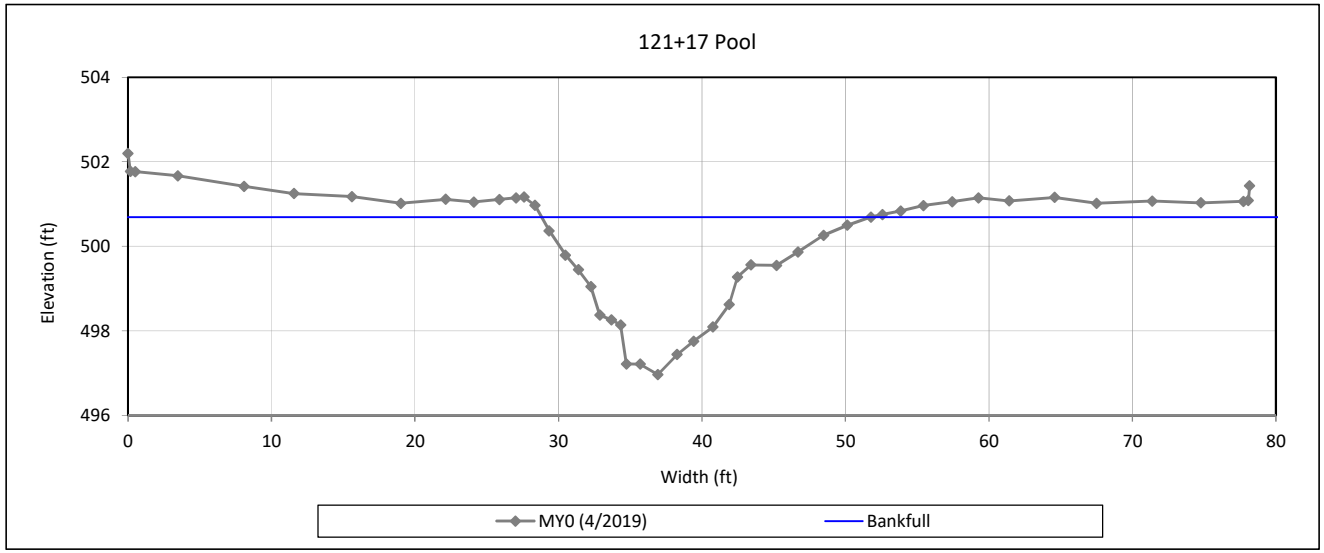
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 7 - Buckwater Creek Reach 4



Bankfull Dimensions	
38.8	x-section area (ft.sq.)
22.9	width (ft)
1.7	mean depth (ft)
3.7	max depth (ft)
25.0	wetted perimeter (ft)
1.6	hydraulic radius (ft)
13.6	width-depth ratio

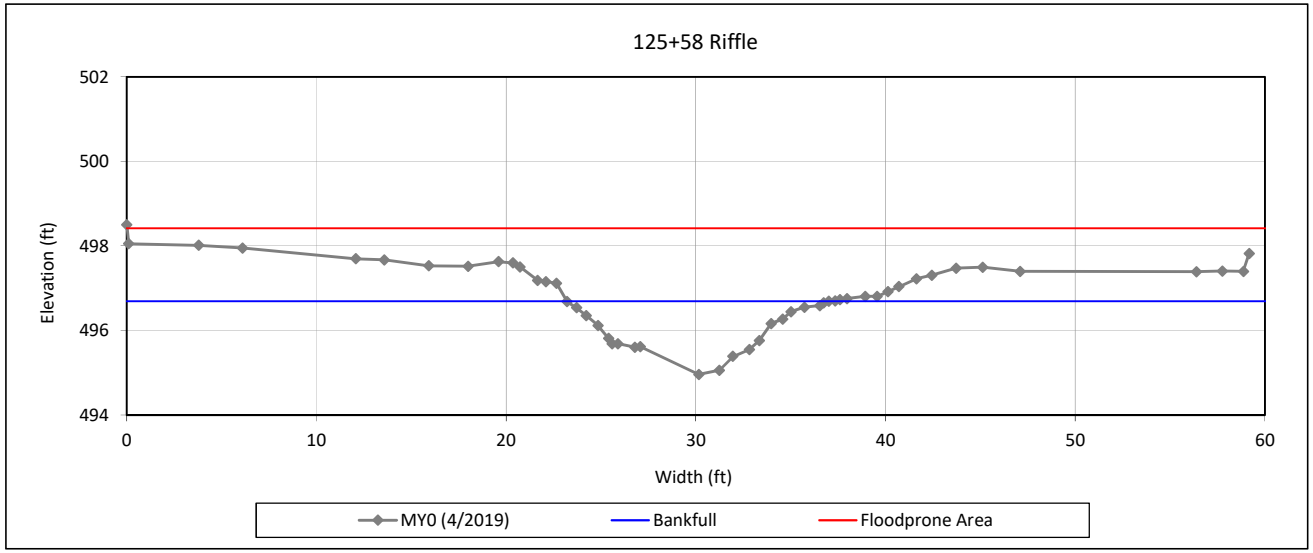
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 8 - Buckwater Creek Reach 4



Bankfull Dimensions

12.5	x-section area (ft.sq.)
13.8	width (ft)
0.9	mean depth (ft)
1.7	max depth (ft)
14.4	wetted perimeter (ft)
0.9	hydraulic radius (ft)
15.3	width-depth ratio
200.0	W flood prone area (ft)
14.5	entrenchment ratio
1.0	low bank height ratio

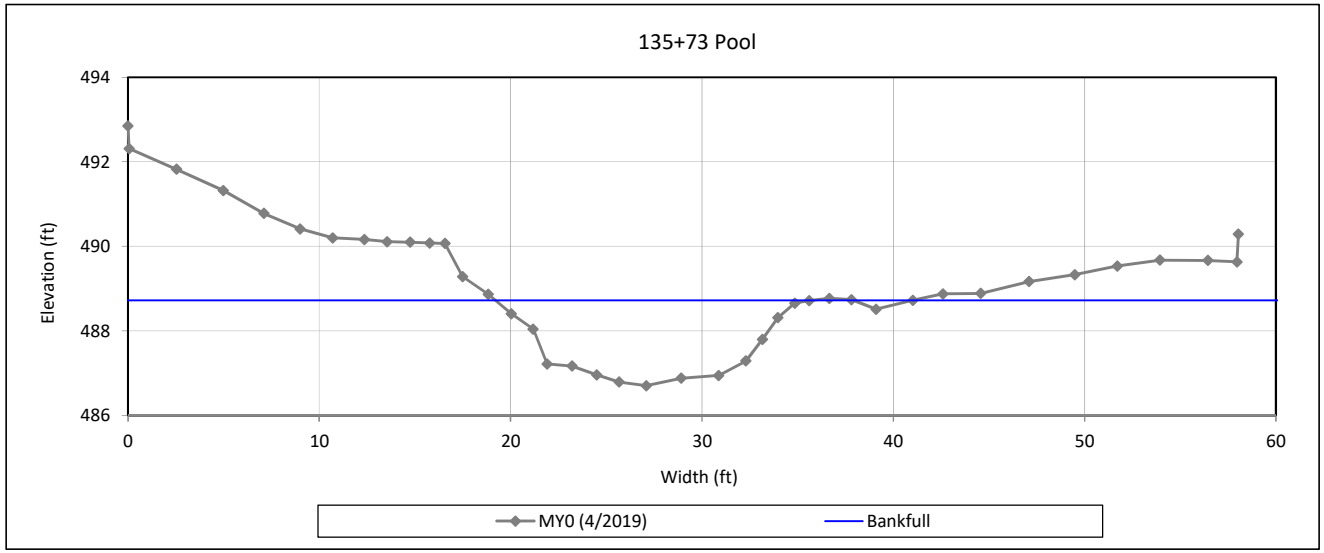
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 9 - Buckwater Creek Reach 5



Bankfull Dimensions	
21.7	x-section area (ft.sq.)
16.4	width (ft)
1.3	mean depth (ft)
2.0	max depth (ft)
17.3	wetted perimeter (ft)
1.3	hydraulic radius (ft)
12.4	width-depth ratio

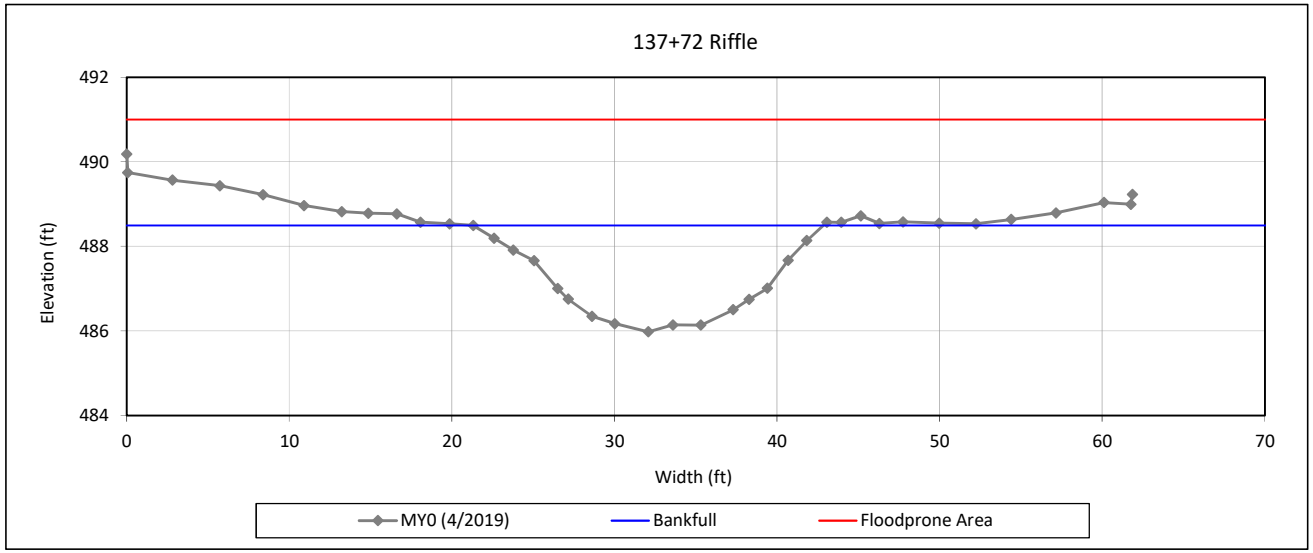
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 10 - Buckwater Creek Reach 5



Bankfull Dimensions

33.3	x-section area (ft.sq.)
21.5	width (ft)
1.5	mean depth (ft)
2.5	max depth (ft)
22.3	wetted perimeter (ft)
1.5	hydraulic radius (ft)
13.9	width-depth ratio
200.0	W flood prone area (ft)
9.3	entrenchment ratio
1.0	low bank height ratio

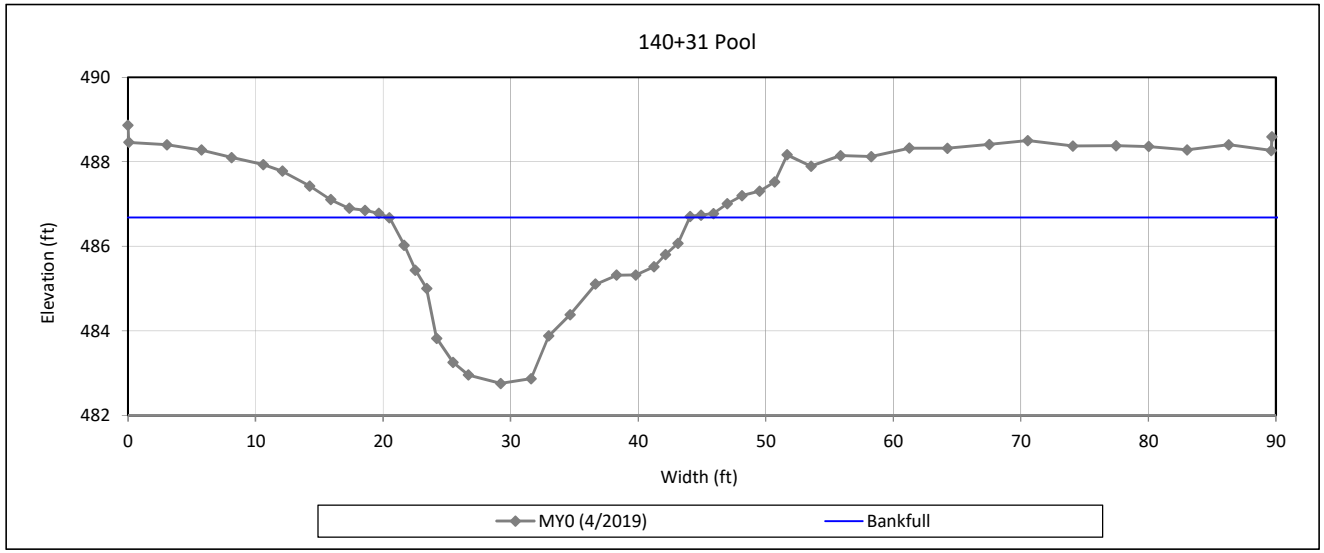
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 11 - Buckwater Creek Reach 6



Bankfull Dimensions	
52.4	x-section area (ft.sq.)
23.6	width (ft)
2.2	mean depth (ft)
3.9	max depth (ft)
25.6	wetted perimeter (ft)
2.0	hydraulic radius (ft)
10.6	width-depth ratio

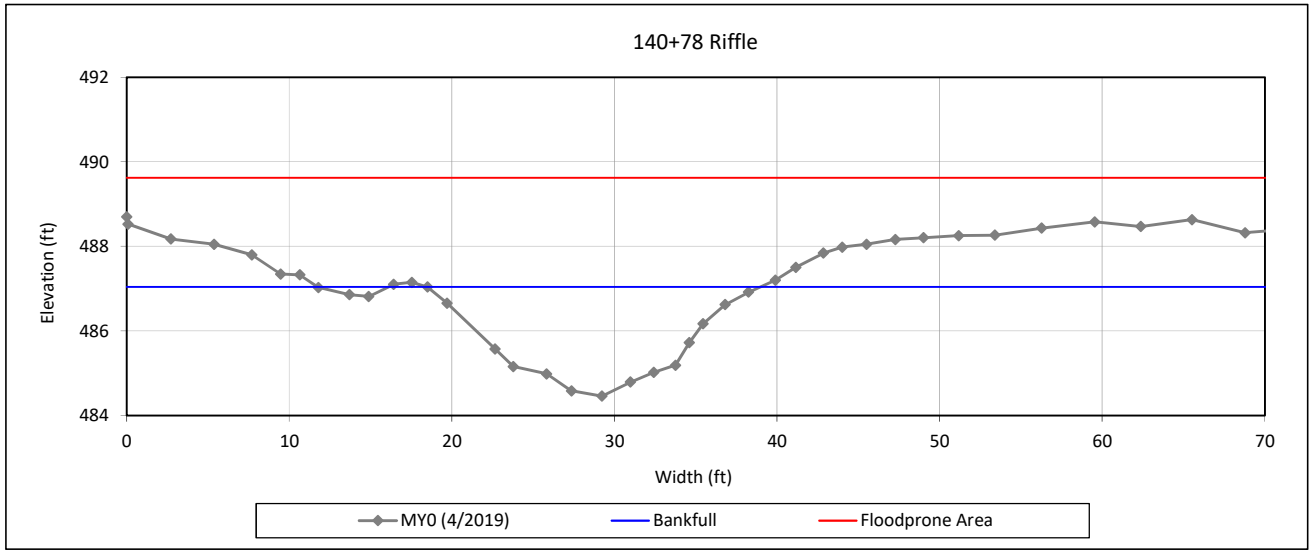
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 12 - Buckwater Creek Reach 6



Bankfull Dimensions

30.6	x-section area (ft.sq.)
20.5	width (ft)
1.5	mean depth (ft)
2.6	max depth (ft)
21.3	wetted perimeter (ft)
1.4	hydraulic radius (ft)
13.8	width-depth ratio
200.0	W flood prone area (ft)
9.8	entrenchment ratio
1.0	low bank height ratio

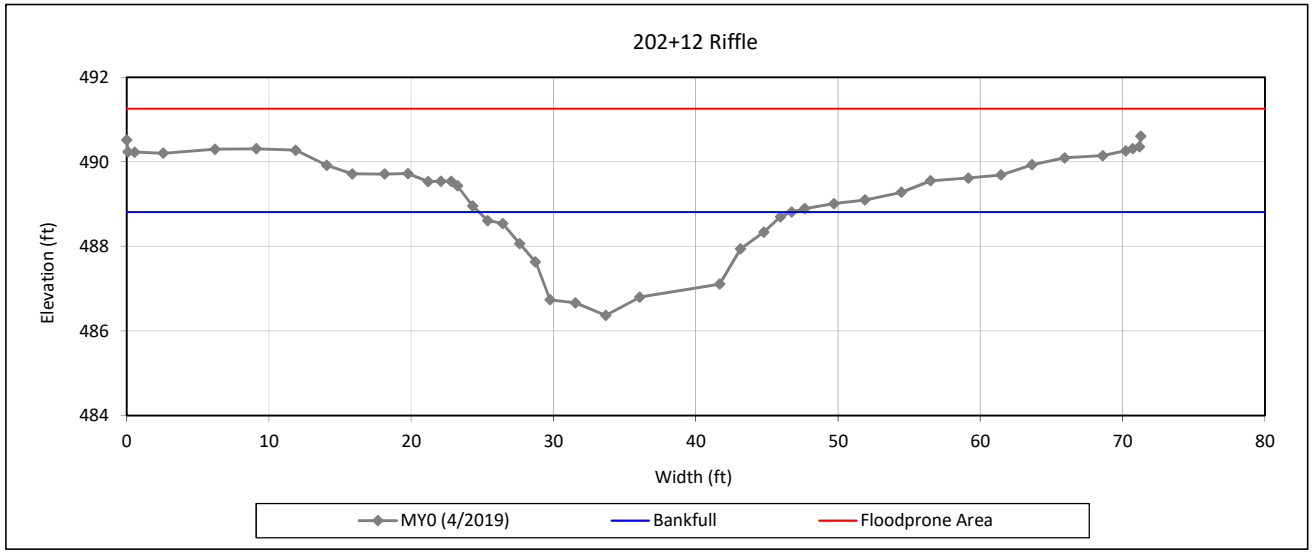
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 13 - T1 Reach 1



Bankfull Dimensions

31.5	x-section area (ft.sq.)
22.0	width (ft)
1.4	mean depth (ft)
2.4	max depth (ft)
22.9	wetted perimeter (ft)
1.4	hydraulic radius (ft)
15.4	width-depth ratio
150.0	W flood prone area (ft)
6.8	entrenchment ratio
1.0	low bank height ratio

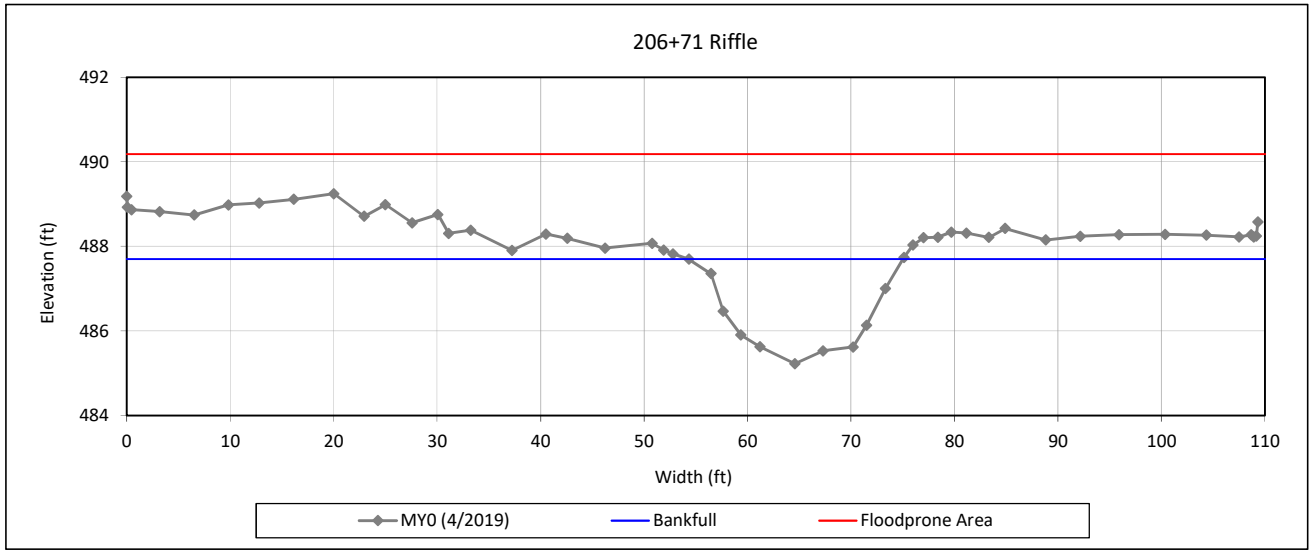
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 14 - T1 Reach 2



Bankfull Dimensions

32.7	x-section area (ft.sq.)
20.8	width (ft)
1.6	mean depth (ft)
2.5	max depth (ft)
21.7	wetted perimeter (ft)
1.5	hydraulic radius (ft)
13.2	width-depth ratio
200.0	W flood prone area (ft)
9.6	entrenchment ratio
1.0	low bank height ratio

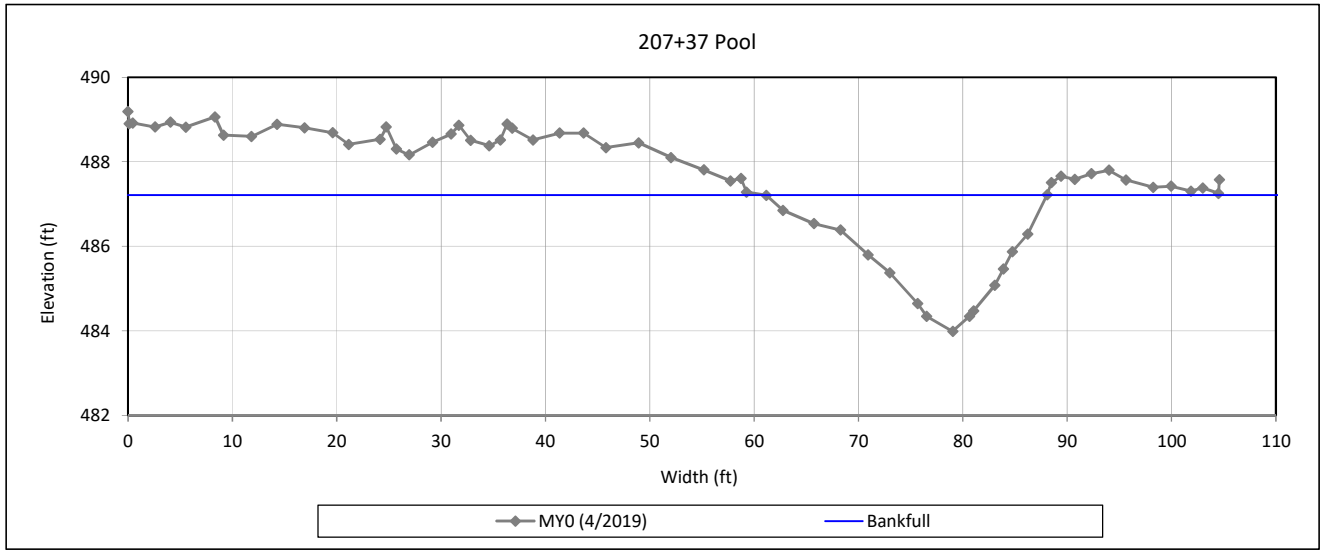
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 15 - T1 Reach 2



Bankfull Dimensions	
42.2	x-section area (ft.sq.)
27.0	width (ft)
1.6	mean depth (ft)
3.2	max depth (ft)
27.9	wetted perimeter (ft)
1.5	hydraulic radius (ft)
17.3	width-depth ratio

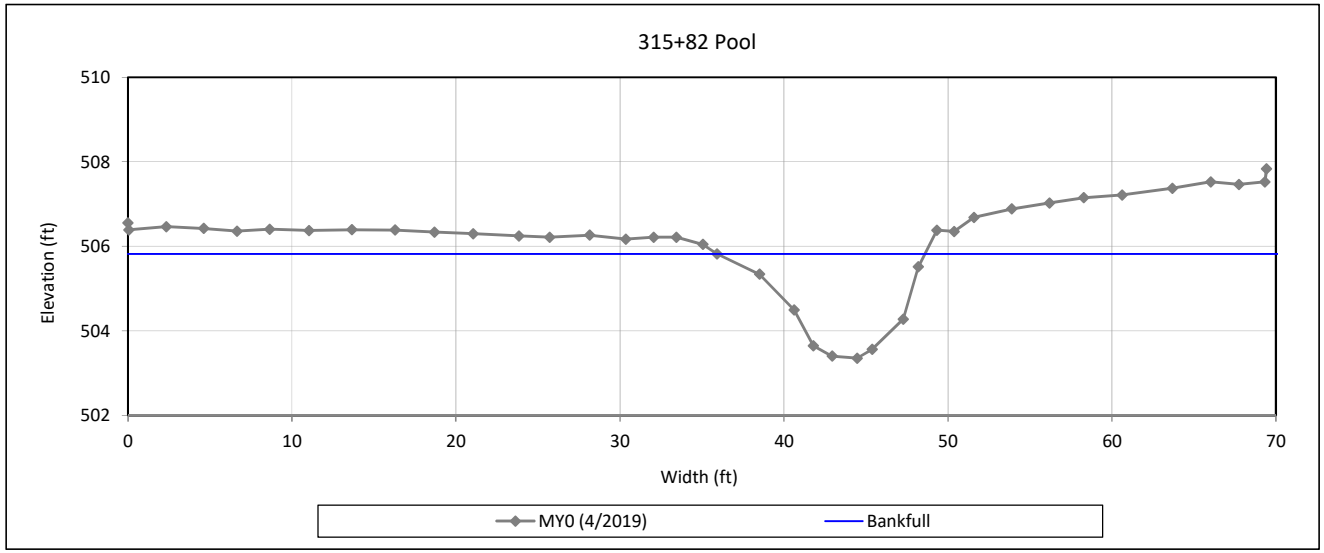
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 16 - T3 Reach 2



Bankfull Dimensions	
17.6	x-section area (ft.sq.)
12.7	width (ft)
1.4	mean depth (ft)
2.5	max depth (ft)
14.0	wetted perimeter (ft)
1.3	hydraulic radius (ft)
9.1	width-depth ratio

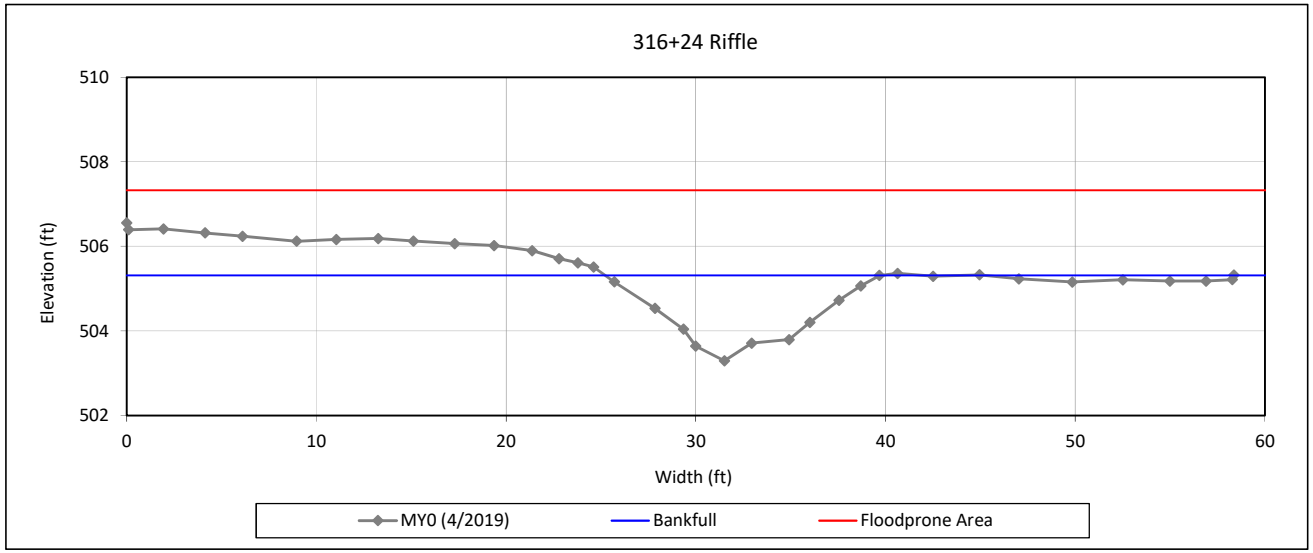
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 17 - T3 Reach 2



Bankfull Dimensions

15.3	x-section area (ft.sq.)
14.4	width (ft)
1.1	mean depth (ft)
2.0	max depth (ft)
15.1	wetted perimeter (ft)
1.0	hydraulic radius (ft)
13.6	width-depth ratio
300.0	W flood prone area (ft)
20.8	entrenchment ratio
1.0	low bank height ratio

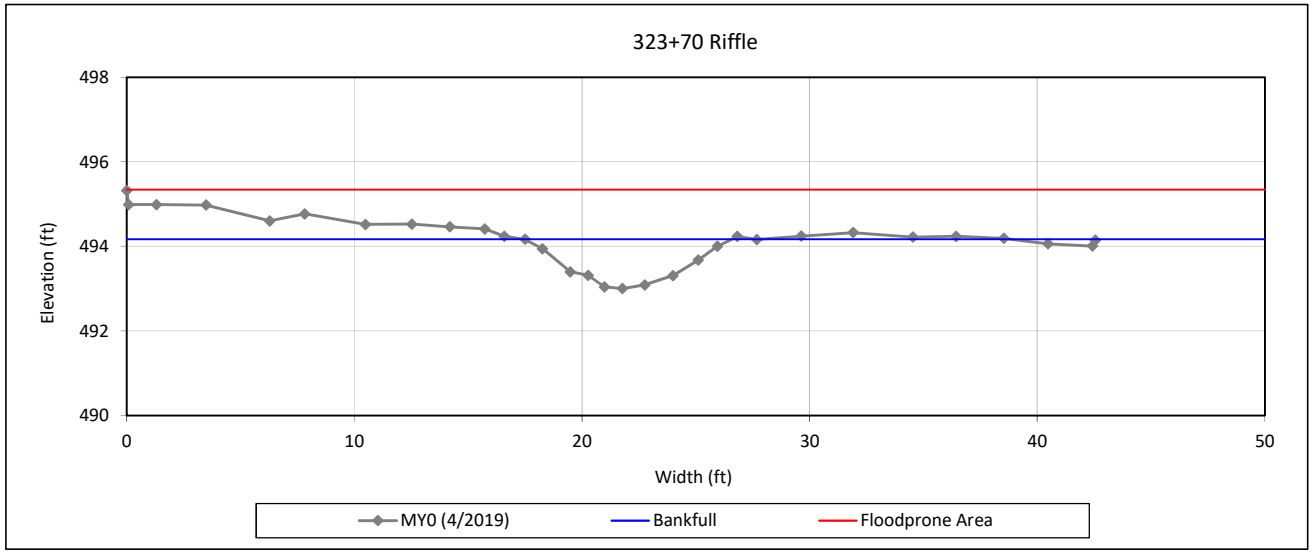
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 18 - T2



Bankfull Dimensions

6.4	x-section area (ft.sq.)
9.1	width (ft)
0.7	mean depth (ft)
1.2	max depth (ft)
9.5	wetted perimeter (ft)
0.7	hydraulic radius (ft)
13.2	width-depth ratio
100.0	W flood prone area (ft)
10.9	entrenchment ratio
1.0	low bank height ratio

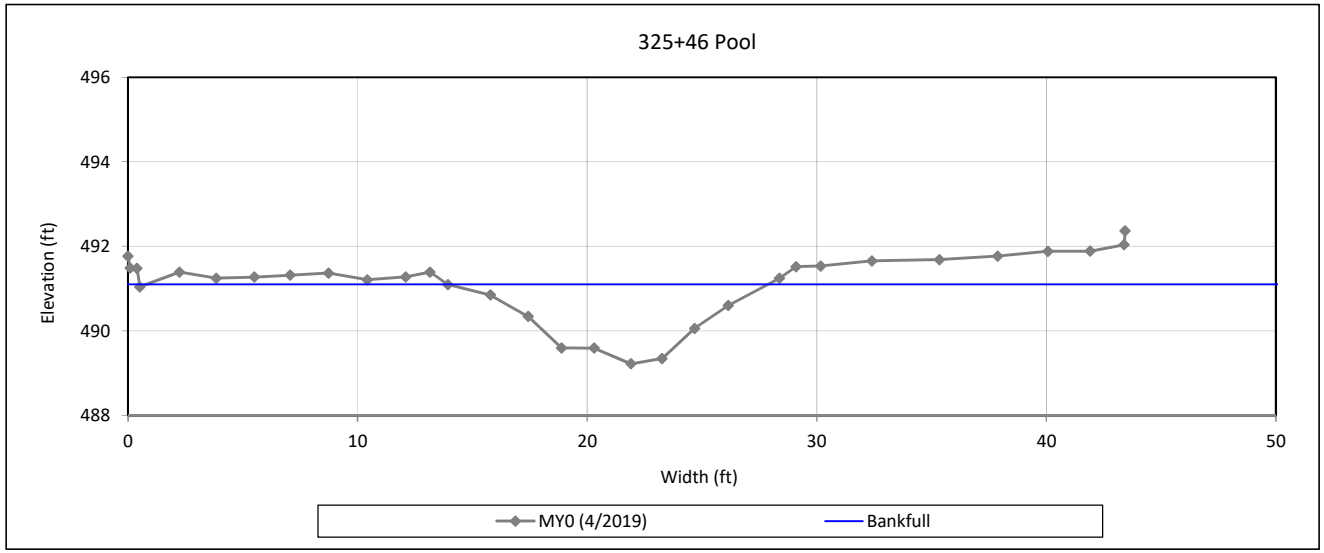
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 19 - T2



Bankfull Dimensions	
13.6	x-section area (ft.sq.)
13.9	width (ft)
1.0	mean depth (ft)
1.9	max depth (ft)
14.6	wetted perimeter (ft)
0.9	hydraulic radius (ft)
14.3	width-depth ratio

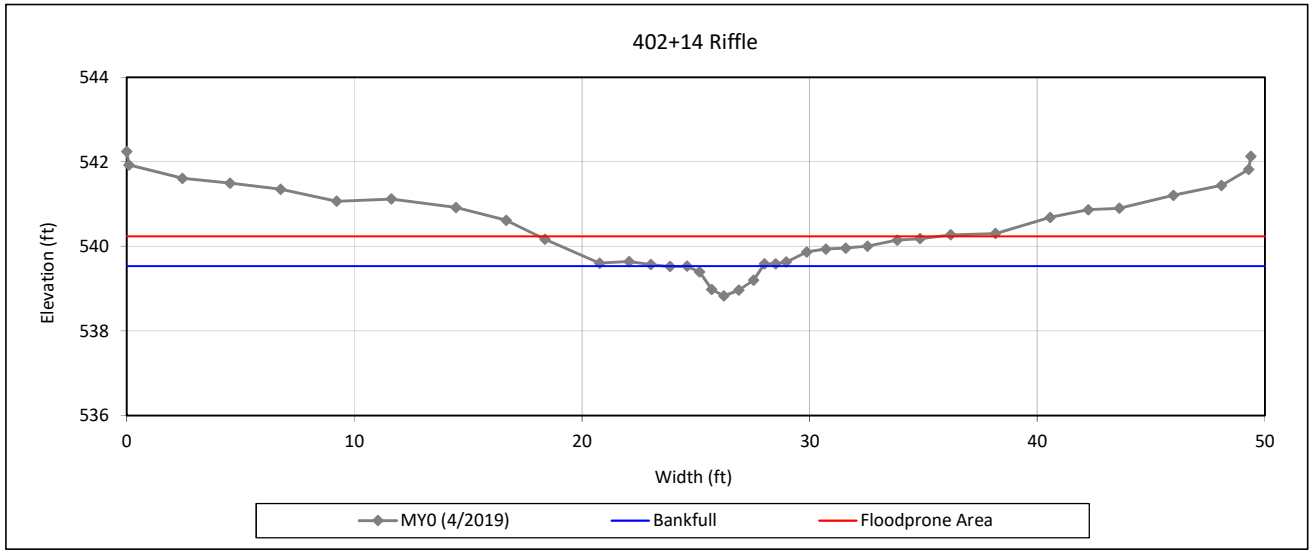
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 20 - T4A Reach 1



Bankfull Dimensions

1.3	x-section area (ft.sq.)
3.3	width (ft)
0.4	mean depth (ft)
0.7	max depth (ft)
3.7	wetted perimeter (ft)
0.4	hydraulic radius (ft)
8.4	width-depth ratio
20.0	W flood prone area (ft)
6.0	entrenchment ratio
1.0	low bank height ratio

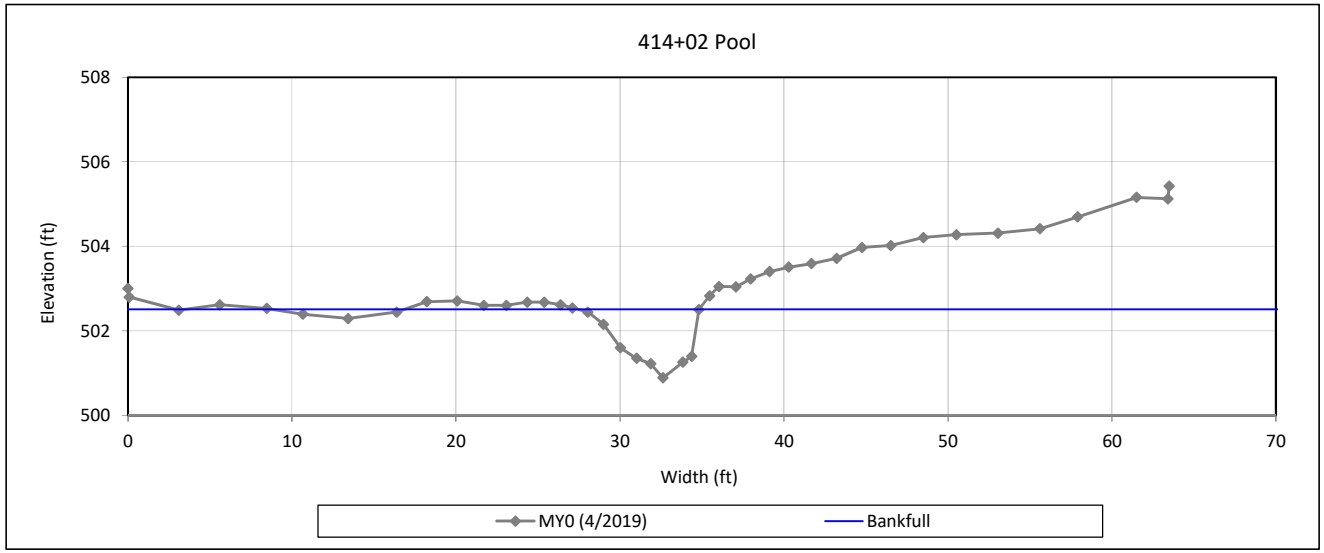
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 21 - T4



Bankfull Dimensions	
6.7	x-section area (ft.sq.)
7.4	width (ft)
0.9	mean depth (ft)
1.6	max depth (ft)
8.6	wetted perimeter (ft)
0.8	hydraulic radius (ft)
8.3	width-depth ratio

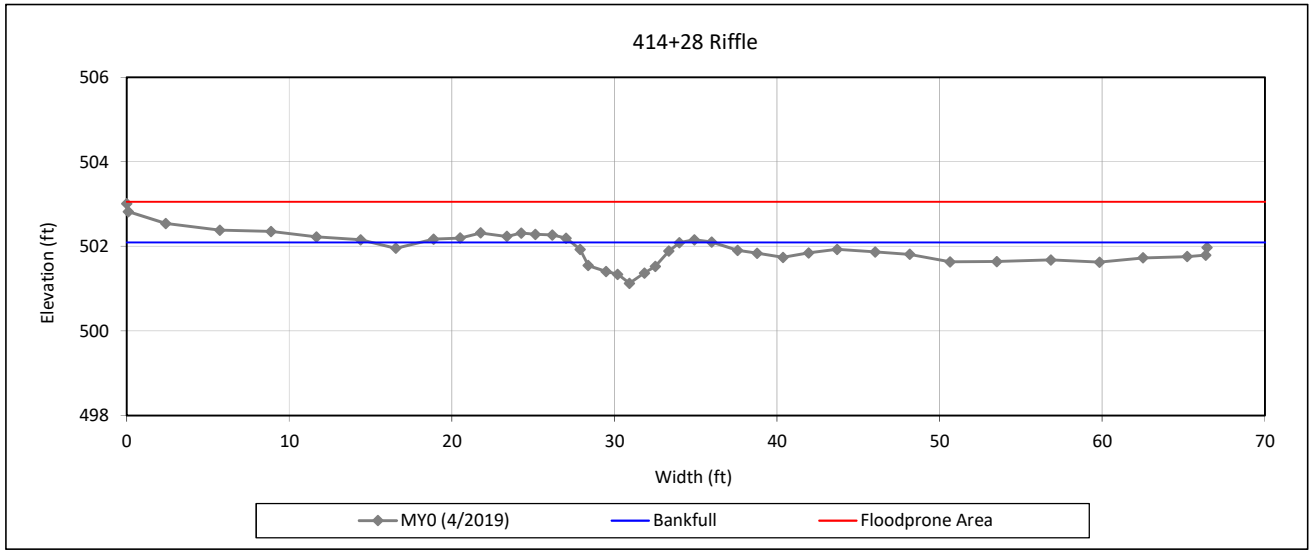
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 22 - T4



Bankfull Dimensions

3.6	x-section area (ft.sq.)
6.7	width (ft)
0.5	mean depth (ft)
1.0	max depth (ft)
7.0	wetted perimeter (ft)
0.5	hydraulic radius (ft)
12.3	width-depth ratio
150.0	W flood prone area (ft)
22.5	entrenchment ratio
1.0	low bank height ratio

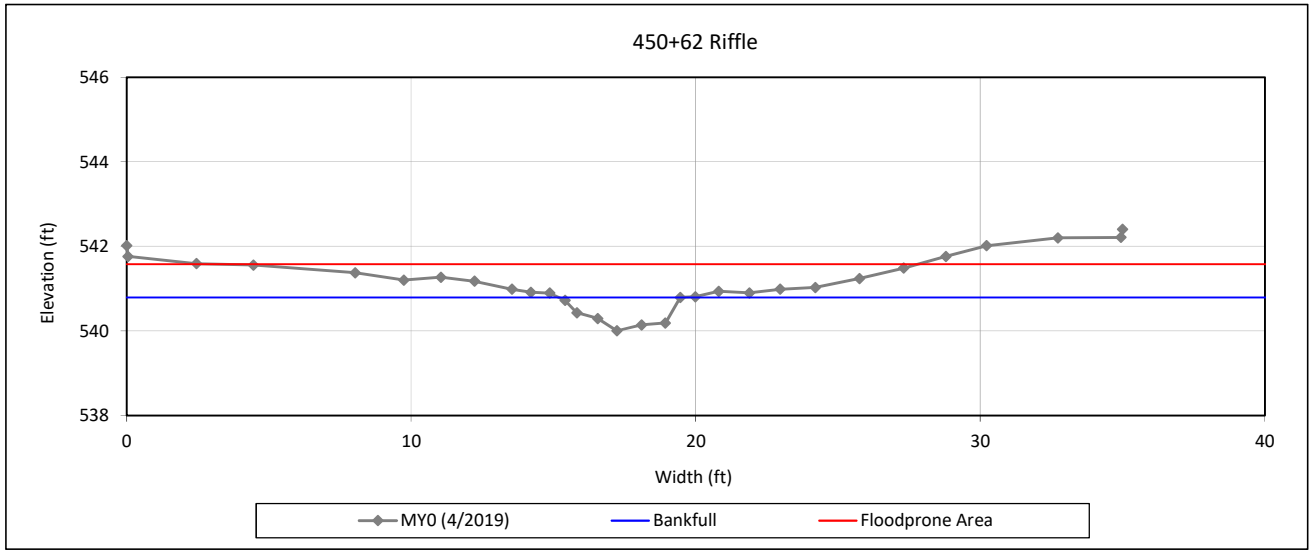
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 23 - T4B Reach 1



Bankfull Dimensions

2.1	x-section area (ft.sq.)
4.3	width (ft)
0.5	mean depth (ft)
0.8	max depth (ft)
4.7	wetted perimeter (ft)
0.5	hydraulic radius (ft)
8.4	width-depth ratio
25.0	W flood prone area (ft)
5.9	entrenchment ratio
1.0	low bank height ratio

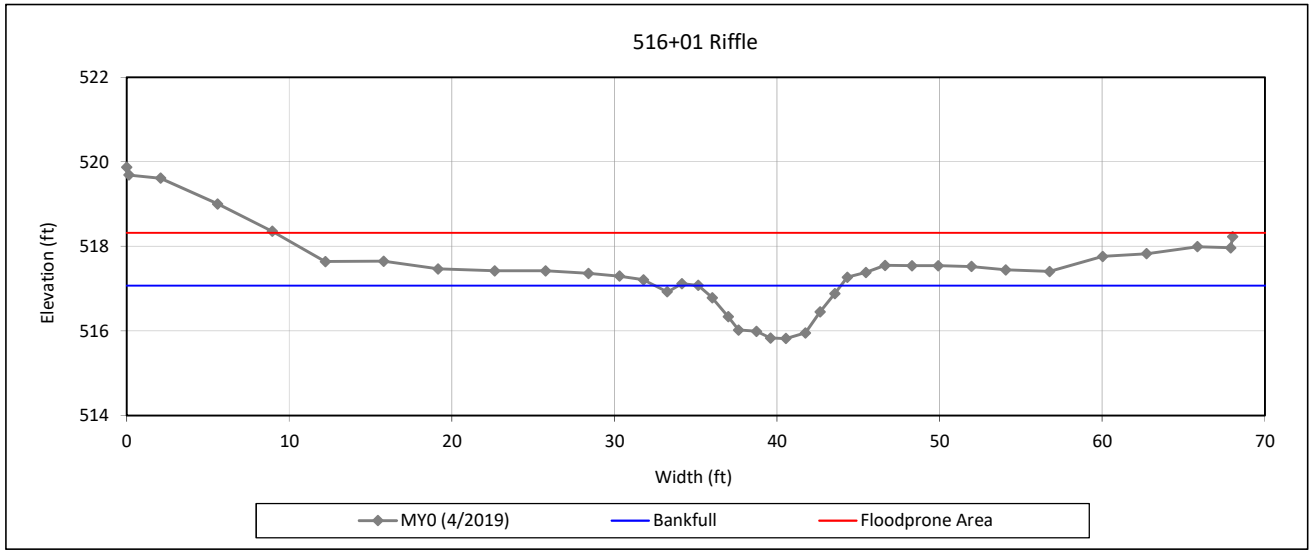
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 24 - T6 Reach 3



Bankfull Dimensions

7.1	x-section area (ft.sq.)
8.8	width (ft)
0.8	mean depth (ft)
1.3	max depth (ft)
9.3	wetted perimeter (ft)
0.8	hydraulic radius (ft)
10.8	width-depth ratio
100.0	W flood prone area (ft)
11.4	entrenchment ratio
1.0	low bank height ratio

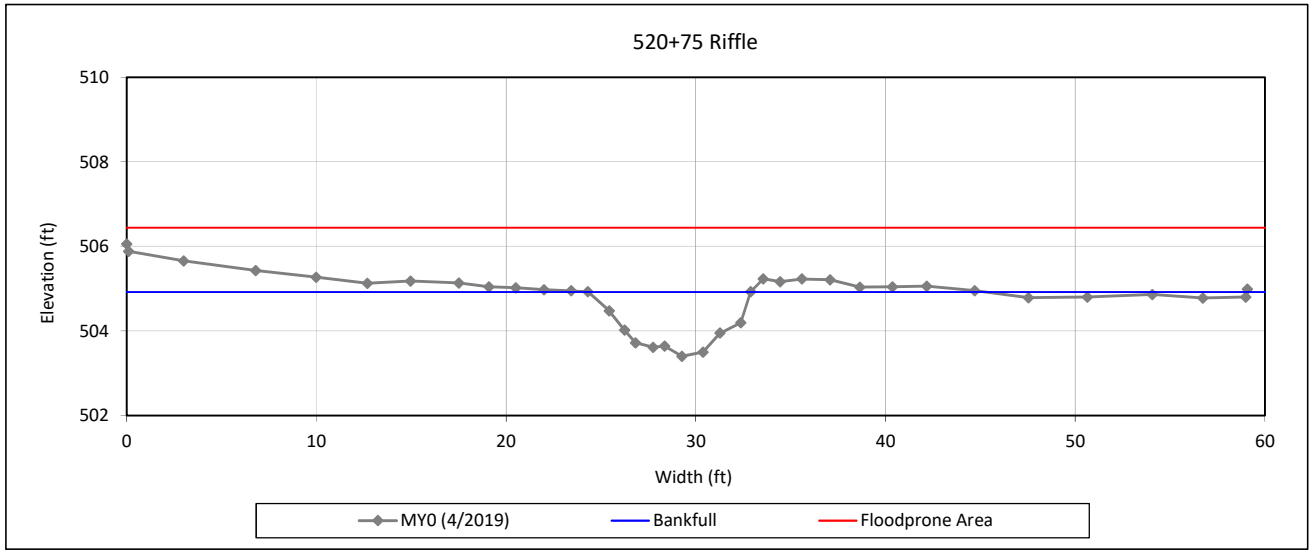
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 25 - T5



Bankfull Dimensions

8.5	x-section area (ft.sq.)
8.6	width (ft)
1.0	mean depth (ft)
1.5	max depth (ft)
9.4	wetted perimeter (ft)
0.9	hydraulic radius (ft)
8.7	width-depth ratio
100.0	W flood prone area (ft)
11.7	entrenchment ratio
1.0	low bank height ratio

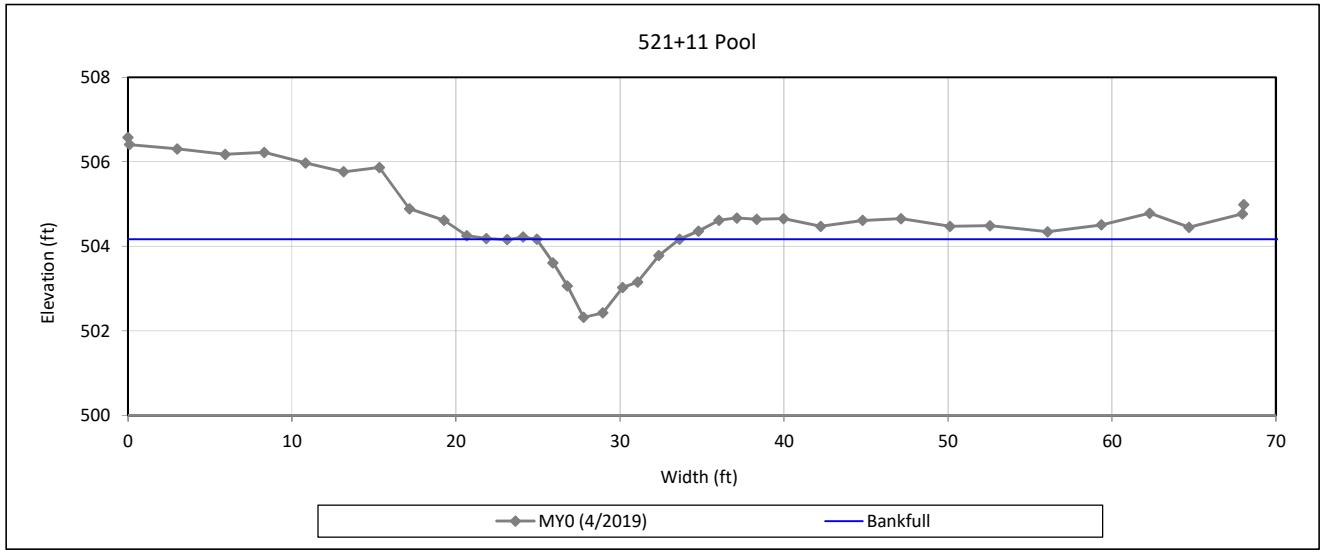
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 26 - T5



Bankfull Dimensions	
8.5	x-section area (ft.sq.)
8.7	width (ft)
1.0	mean depth (ft)
1.8	max depth (ft)
9.6	wetted perimeter (ft)
0.9	hydraulic radius (ft)
9.0	width-depth ratio

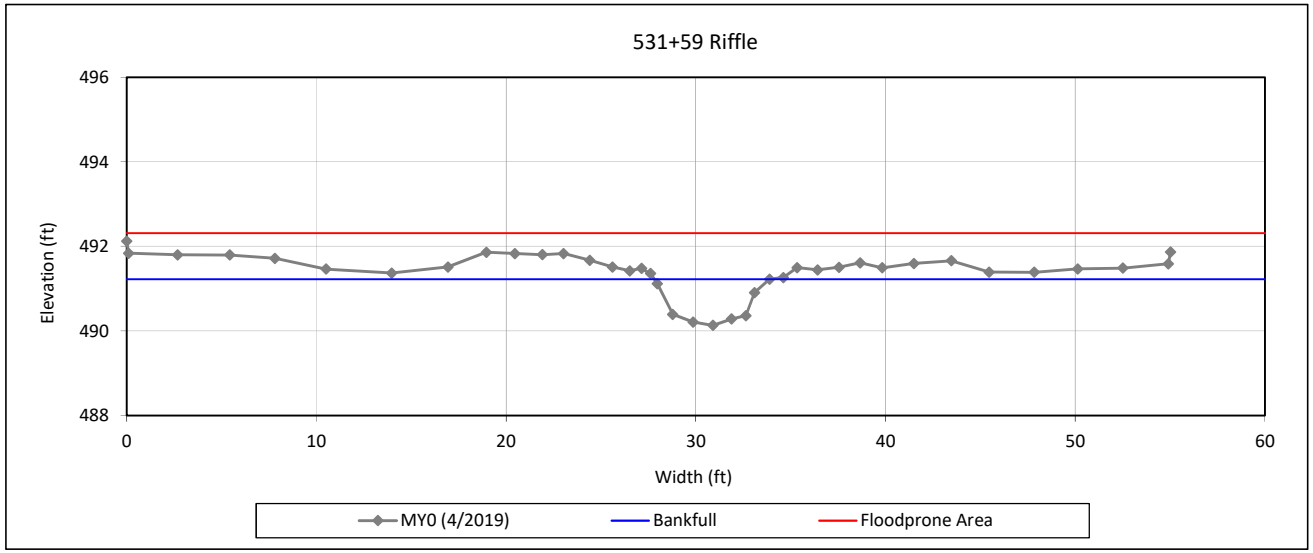
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 27 - T5



Bankfull Dimensions

4.5	x-section area (ft.sq.)
6.1	width (ft)
0.8	mean depth (ft)
1.1	max depth (ft)
6.7	wetted perimeter (ft)
0.7	hydraulic radius (ft)
8.1	width-depth ratio
200.0	W flood prone area (ft)
33.0	entrenchment ratio
1.0	low bank height ratio

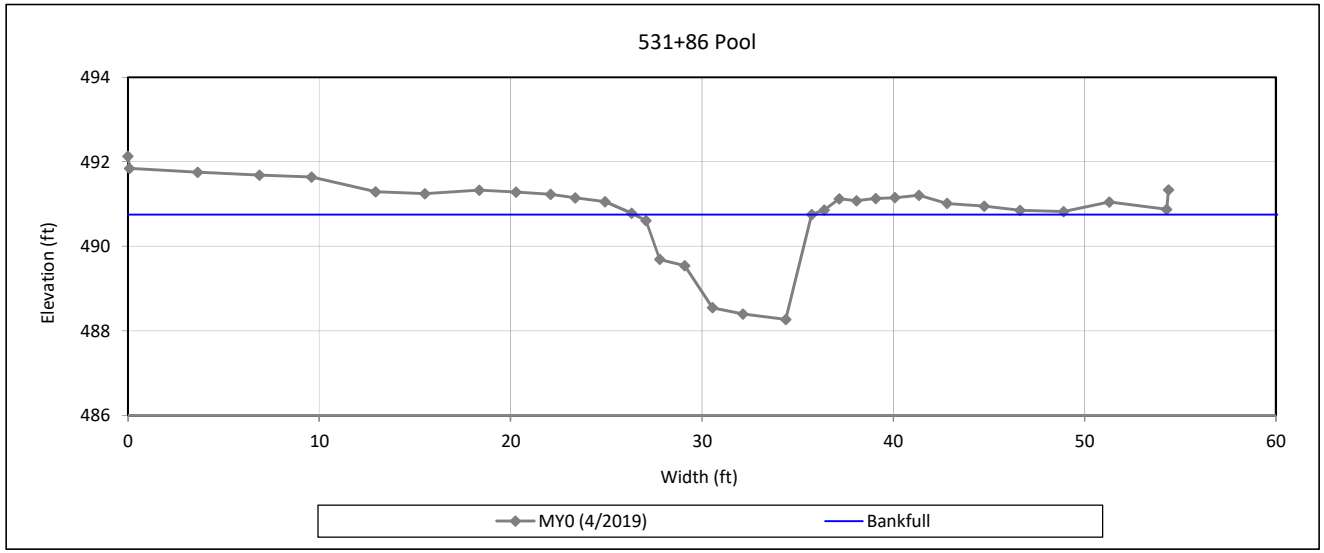
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 28 - T5



Bankfull Dimensions	
15.2	x-section area (ft.sq.)
9.3	width (ft)
1.6	mean depth (ft)
2.5	max depth (ft)
11.6	wetted perimeter (ft)
1.3	hydraulic radius (ft)
5.7	width-depth ratio

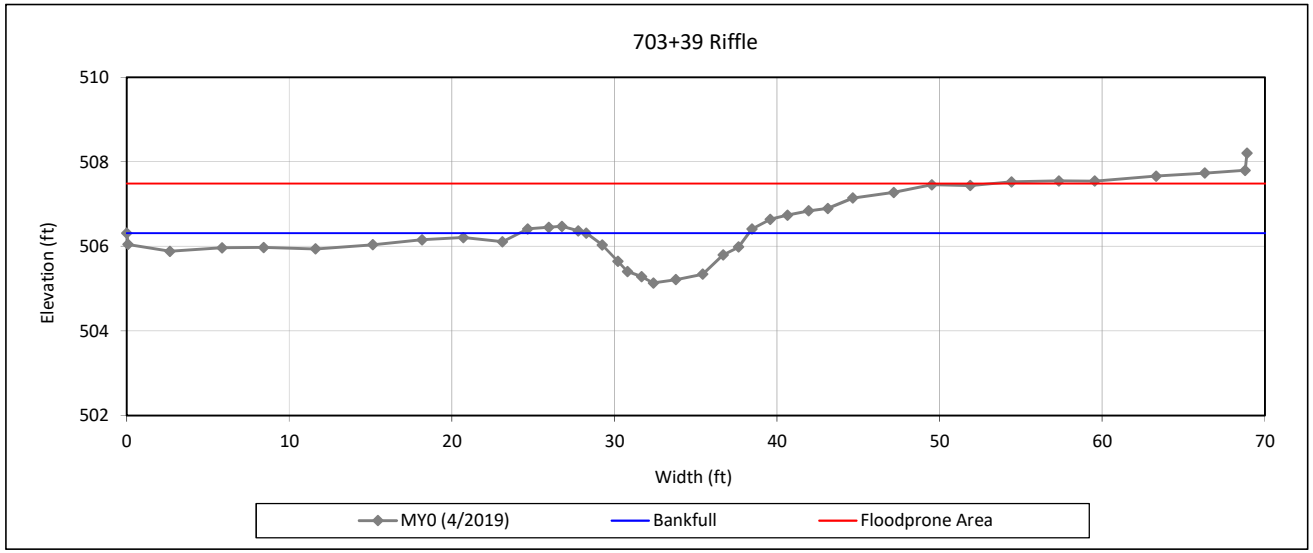
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 29 - T7 Reach 1



Bankfull Dimensions

7.4	x-section area (ft.sq.)
10.0	width (ft)
0.7	mean depth (ft)
1.2	max depth (ft)
10.4	wetted perimeter (ft)
0.7	hydraulic radius (ft)
13.5	width-depth ratio
100.0	W flood prone area (ft)
10.0	entrenchment ratio
1.0	low bank height ratio

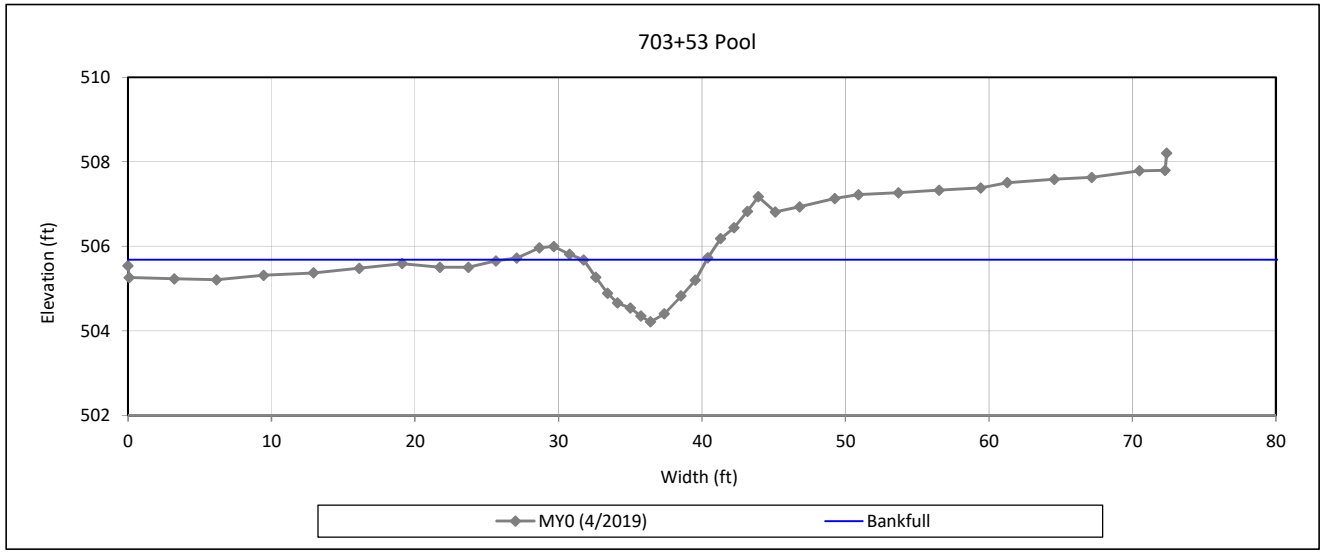
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 30 - T7 Reach 1



Bankfull Dimensions	
7.5	x-section area (ft.sq.)
8.6	width (ft)
0.9	mean depth (ft)
1.5	max depth (ft)
9.2	wetted perimeter (ft)
0.8	hydraulic radius (ft)
9.8	width-depth ratio

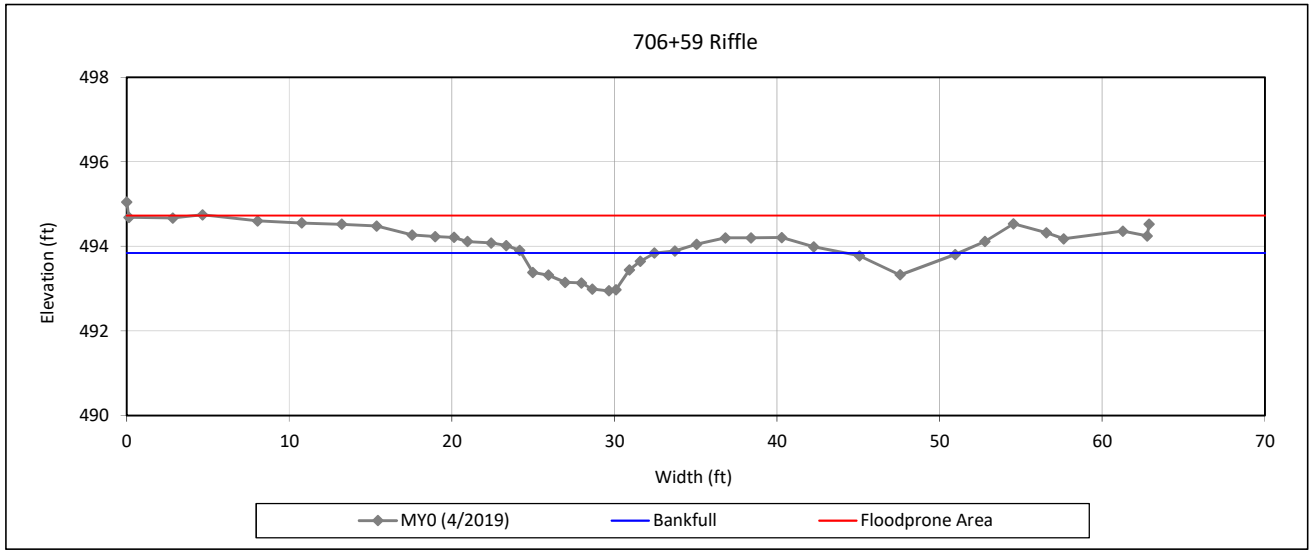
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 31 - T7 Reach 2



Bankfull Dimensions

4.6	x-section area (ft.sq.)
8.2	width (ft)
0.6	mean depth (ft)
0.9	max depth (ft)
8.6	wetted perimeter (ft)
0.5	hydraulic radius (ft)
14.8	width-depth ratio
100.0	W flood prone area (ft)
12.2	entrenchment ratio
1.0	low bank height ratio

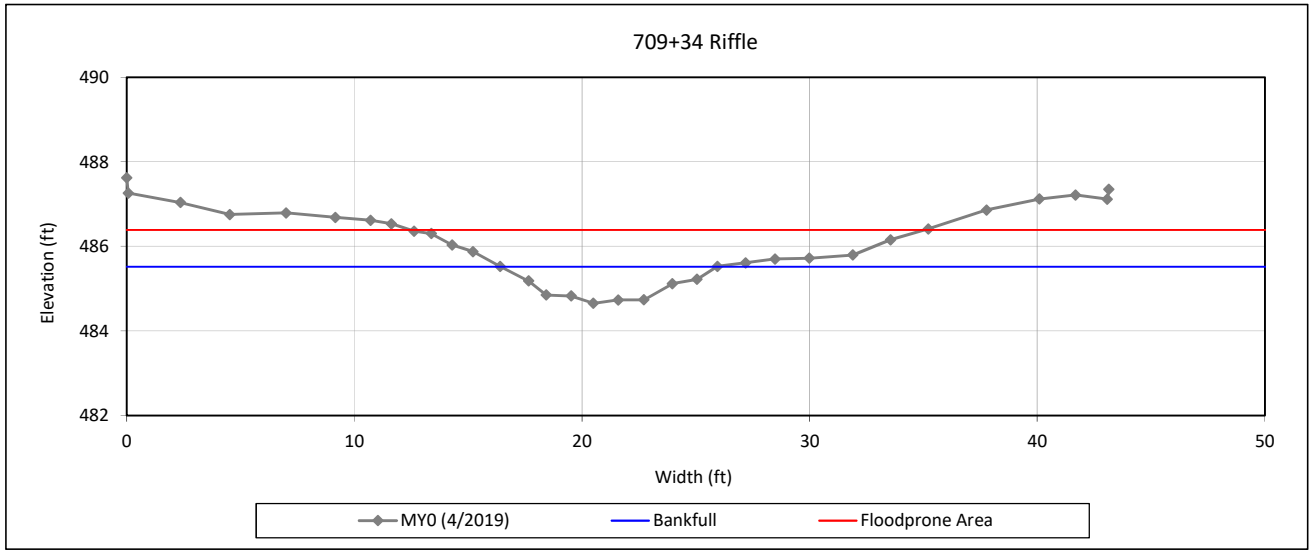
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 32 - T7 Reach 3



Bankfull Dimensions

5.2	x-section area (ft.sq.)
9.5	width (ft)
0.5	mean depth (ft)
0.9	max depth (ft)
9.8	wetted perimeter (ft)
0.5	hydraulic radius (ft)
17.6	width-depth ratio
25.0	W flood prone area (ft)
2.6	entrenchment ratio
1.0	low bank height ratio

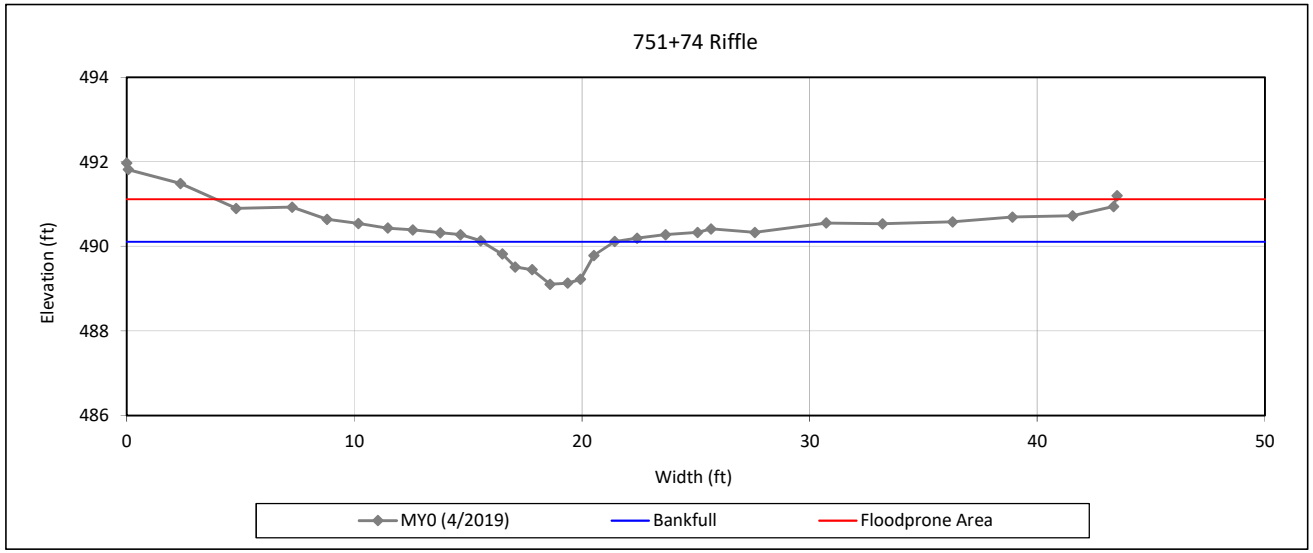
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 33 - T7A



Bankfull Dimensions

3.3	x-section area (ft.sq.)
5.8	width (ft)
0.6	mean depth (ft)
1.0	max depth (ft)
6.3	wetted perimeter (ft)
0.5	hydraulic radius (ft)
10.2	width-depth ratio
50.0	W flood prone area (ft)
8.6	entrenchment ratio
1.0	low bank height ratio

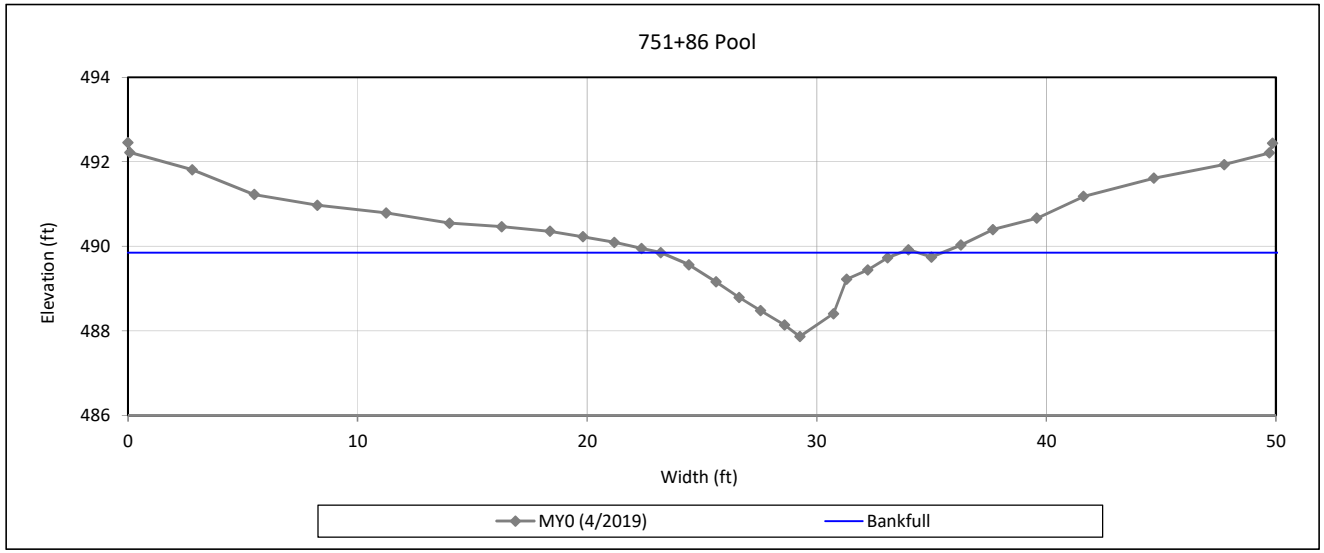
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 34 - T7A



Bankfull Dimensions	
9.4	x-section area (ft.sq.)
10.5	width (ft)
0.9	mean depth (ft)
2.0	max depth (ft)
11.4	wetted perimeter (ft)
0.8	hydraulic radius (ft)
11.6	width-depth ratio

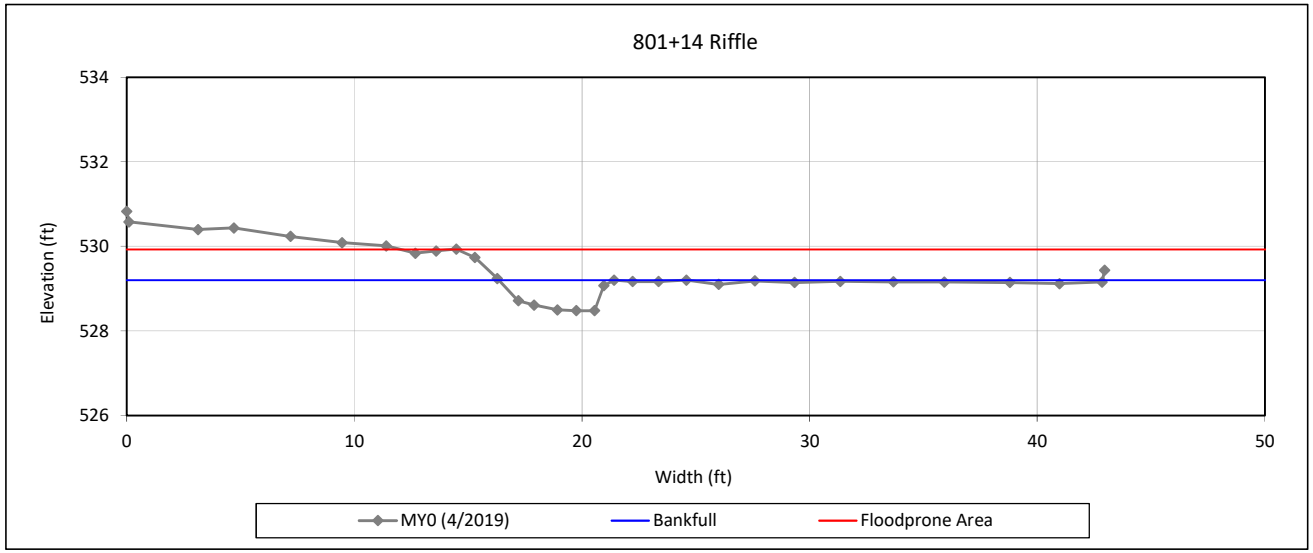
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 35 - T8



Bankfull Dimensions

2.6	x-section area (ft.sq.)
5.1	width (ft)
0.5	mean depth (ft)
0.7	max depth (ft)
5.5	wetted perimeter (ft)
0.5	hydraulic radius (ft)
9.8	width-depth ratio
100.0	W flood prone area (ft)
19.8	entrenchment ratio
1.0	low bank height ratio

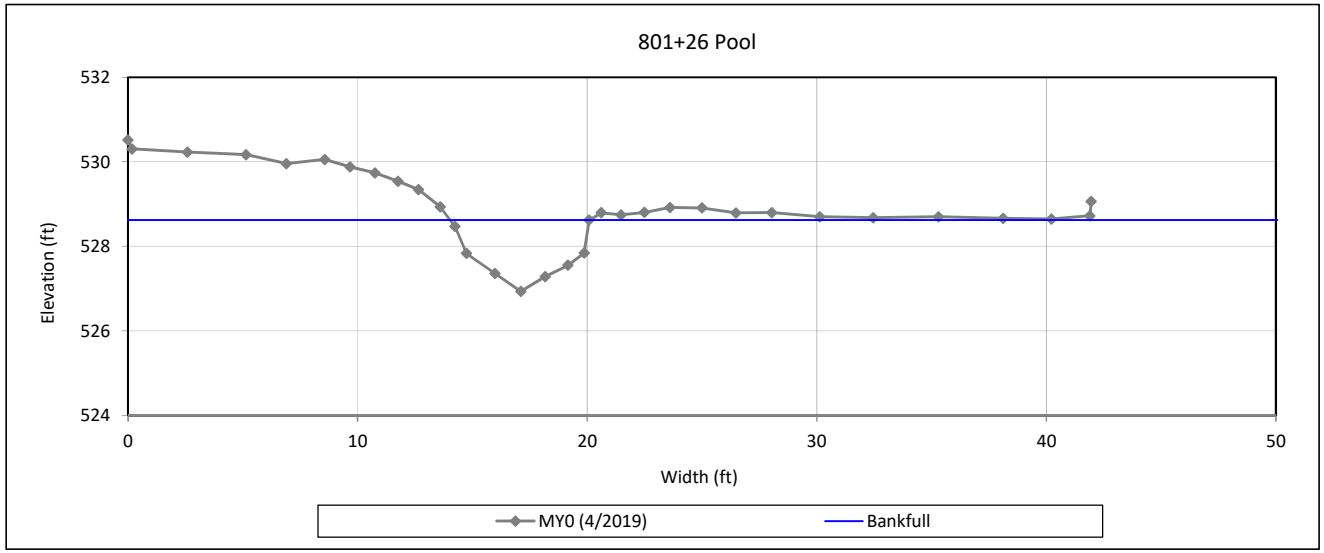
Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Cross-Section 36 - T8



Bankfull Dimensions	
6.7	x-section area (ft.sq.)
6.1	width (ft)
1.1	mean depth (ft)
1.7	max depth (ft)
7.3	wetted perimeter (ft)
0.9	hydraulic radius (ft)
5.5	width-depth ratio

Survey Date: 4/2019
Field Crew: Kee Mapping & Surveying

View Downstream

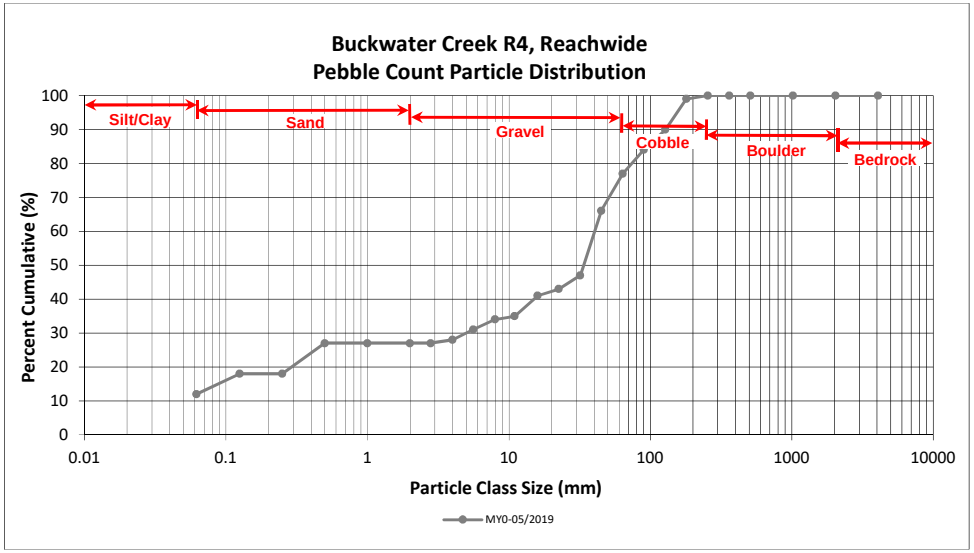
Reachwide Pebble Count Plots

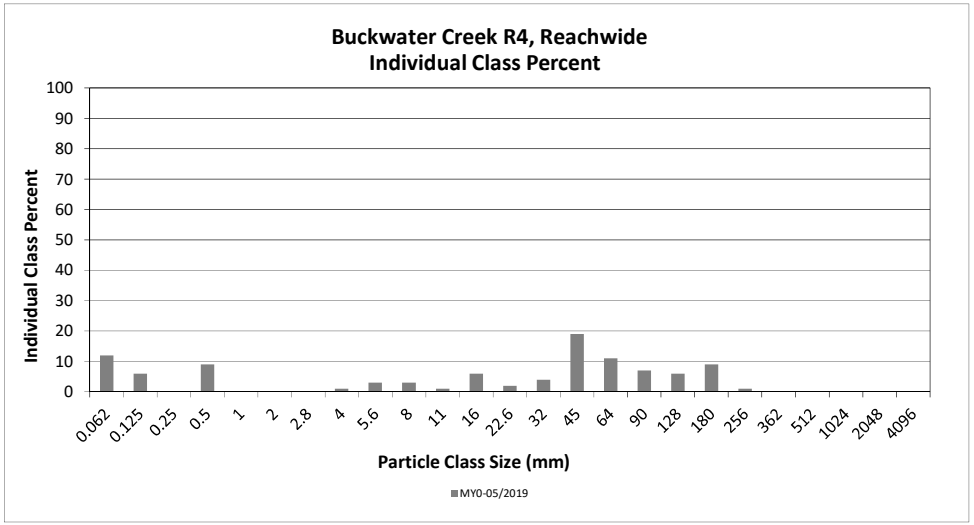
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Buckwater Creek R4, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	2	10	12	12	12
SAND	Very fine	0.062	0.125		6	6	6	18
	Fine	0.125	0.250					18
	Medium	0.25	0.50		9	9	9	27
	Coarse	0.5	1.0					27
	Very Coarse	1.0	2.0					27
GRAVEL	Very Fine	2.0	2.8					27
	Very Fine	2.8	4.0		1	1	1	28
	Fine	4.0	5.6	2	1	3	3	31
	Fine	5.6	8.0	2	1	3	3	34
	Medium	8.0	11.0		1	1	1	35
	Medium	11.0	16.0	3	3	6	6	41
	Coarse	16.0	22.6		2	2	2	43
	Coarse	22.6	32	2	2	4	4	47
	Very Coarse	32	45	16	3	19	19	66
	Very Coarse	45	64	7	4	11	11	77
COBBLE	Small	64	90	6	1	7	7	84
	Small	90	128	5	1	6	6	90
	Large	128	180	4	5	9	9	99
	Large	180	256	1		1	1	100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.10
D_{35} =	11.00
D_{50} =	33.8
D_{84} =	90.0
D_{95} =	154.7
D_{100} =	256.0





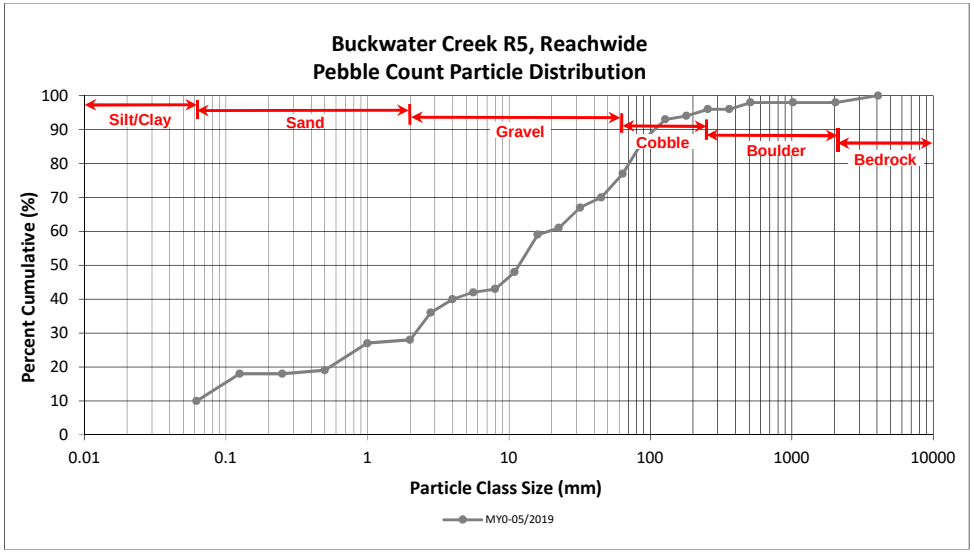
Reachwide Pebble Count Plots

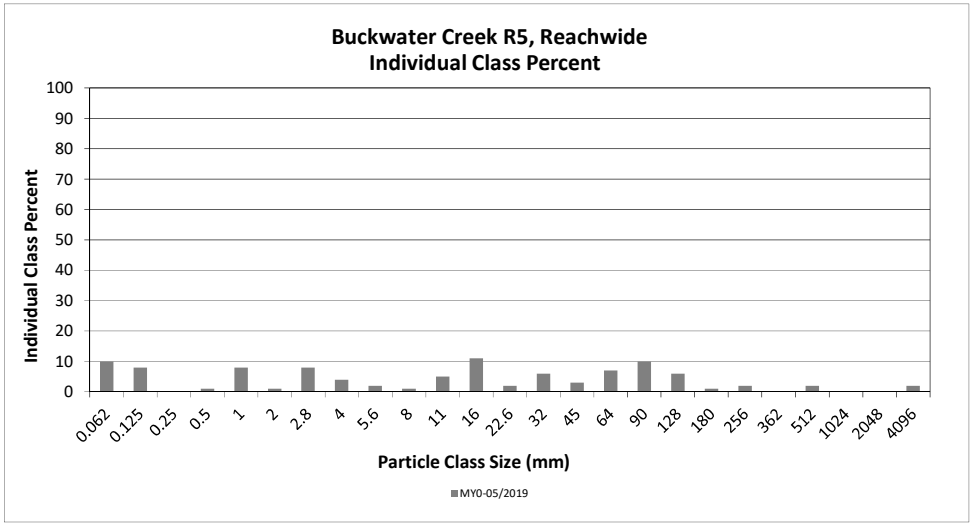
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Buckwater Creek R5, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	1	9	10	10	10
SAND	Very fine	0.062	0.125		8	8	8	18
	Fine	0.125	0.250					18
	Medium	0.25	0.50		1	1	1	19
	Coarse	0.5	1.0		8	8	8	27
	Very Coarse	1.0	2.0		1	1	1	28
GRAVEL	Very Fine	2.0	2.8	1	7	8	8	36
	Very Fine	2.8	4.0	2	2	4	4	40
	Fine	4.0	5.6	2		2	2	42
	Fine	5.6	8.0	1		1	1	43
	Medium	8.0	11.0	3	2	5	5	48
	Medium	11.0	16.0	7	4	11	11	59
	Coarse	16.0	22.6	2		2	2	61
	Coarse	22.6	32	4	2	6	6	67
	Very Coarse	32	45	3		3	3	70
	Very Coarse	45	64	7		7	7	77
COBBLE	Small	64	90	7	3	10	10	87
	Small	90	128	5	1	6	6	93
	Large	128	180	1		1	1	94
	Large	180	256	2		2	2	96
BOULDER	Small	256	362					96
	Small	362	512	2		2	2	98
	Medium	512	1024					98
	Large/Very Large	1024	2048					98
BEDROCK	Bedrock	2048	>2048		2	2	2	100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.10
D_{35} =	2.68
D_{50} =	11.8
D_{84} =	81.3
D_{95} =	214.7
D_{100} =	>2048





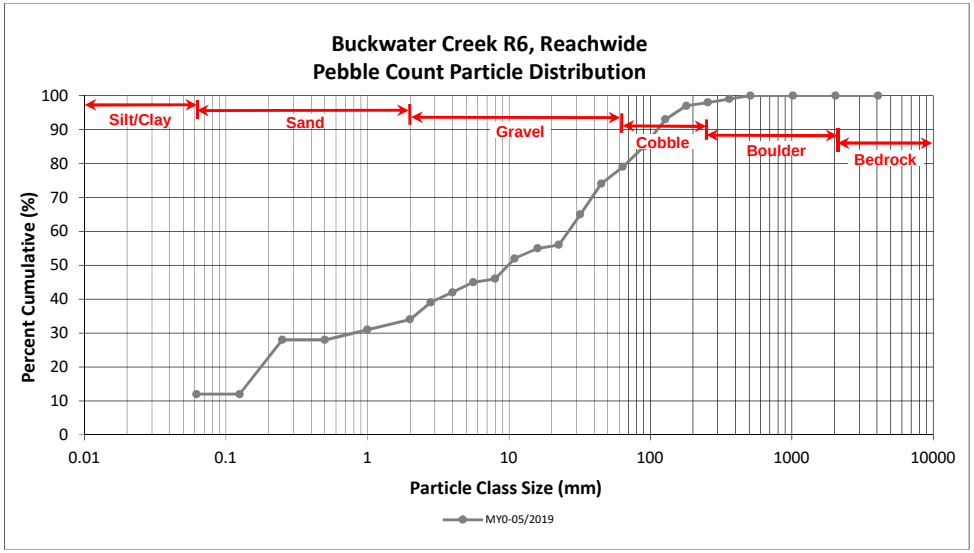
Reachwide Pebble Count Plots

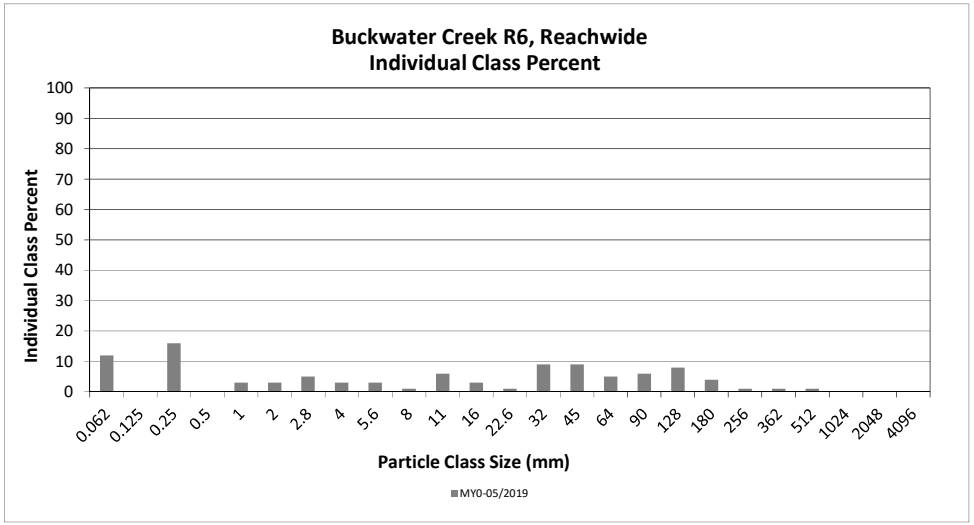
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

Buckwater Creek R6, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	2	10	12	12	12
SAND	Very fine	0.062	0.125					12
	Fine	0.125	0.250	2	14	16	16	28
	Medium	0.25	0.50					28
	Coarse	0.5	1.0		3	3	3	31
	Very Coarse	1.0	2.0	1	2	3	3	34
GRAVEL	Very Fine	2.0	2.8	3	2	5	5	39
	Very Fine	2.8	4.0		3	3	3	42
	Fine	4.0	5.6	2	1	3	3	45
	Fine	5.6	8.0	1		1	1	46
	Medium	8.0	11.0	4	2	6	6	52
	Medium	11.0	16.0	3		3	3	55
	Coarse	16.0	22.6	1		1	1	56
	Coarse	22.6	32	8	1	9	9	65
	Very Coarse	32	45	5	4	9	9	74
	Very Coarse	45	64	2	3	5	5	79
COBBLE	Small	64	90	6		6	6	85
	Small	90	128	6	2	8	8	93
	Large	128	180	2	2	4	4	97
	Large	180	256	1		1	1	98
BOULDER	Small	256	362		1	1	1	99
	Small	362	512	1		1	1	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.15
D_{35} =	2.14
D_{50} =	9.9
D_{84} =	85.0
D_{95} =	151.8
D_{100} =	512.0





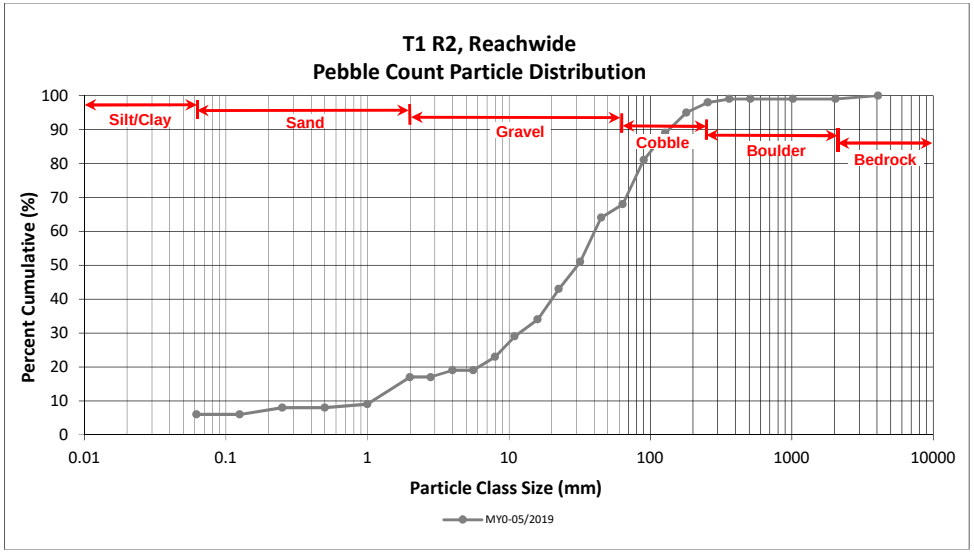
Reachwide Pebble Count Plots

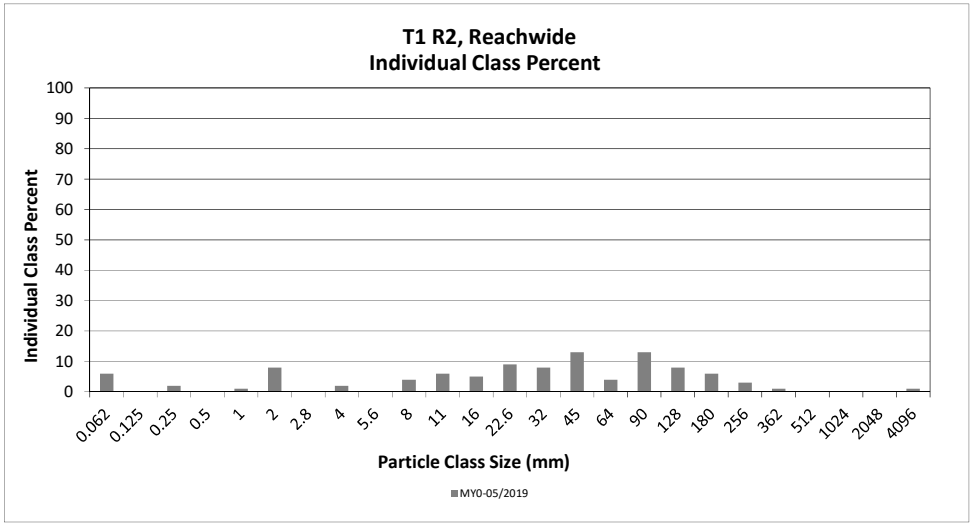
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T1 R2, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		6	6	6	6
SAND	Very fine	0.062	0.125					6
	Fine	0.125	0.250		2	2	2	8
	Medium	0.25	0.50					8
	Coarse	0.5	1.0		1	1	1	9
	Very Coarse	1.0	2.0	4	4	8	8	17
GRAVEL	Very Fine	2.0	2.8					17
	Very Fine	2.8	4.0	1	1	2	2	19
	Fine	4.0	5.6					19
	Fine	5.6	8.0	2	2	4	4	23
	Medium	8.0	11.0	3	3	6	6	29
	Medium	11.0	16.0	1	4	5	5	34
	Coarse	16.0	22.6	4	5	9	9	43
	Coarse	22.6	32	3	5	8	8	51
	Very Coarse	32	45	9	4	13	13	64
	Very Coarse	45	64	2	2	4	4	68
COBBLE	Small	64	90	13		13	13	81
	Small	90	128	8		8	8	89
	Large	128	180	6		6	6	95
	Large	180	256	3		3	3	98
BOULDER	Small	256	362	1		1	1	99
	Small	362	512					99
	Medium	512	1024					99
	Large/Very Large	1024	2048					99
BEDROCK	Bedrock	2048	>2048		1	1	1	100
			Total	**60**	**40**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	1.83
D_{35} =	16.63
D_{50} =	30.6
D_{84} =	102.7
D_{95} =	180.0
D_{100} =	>2048





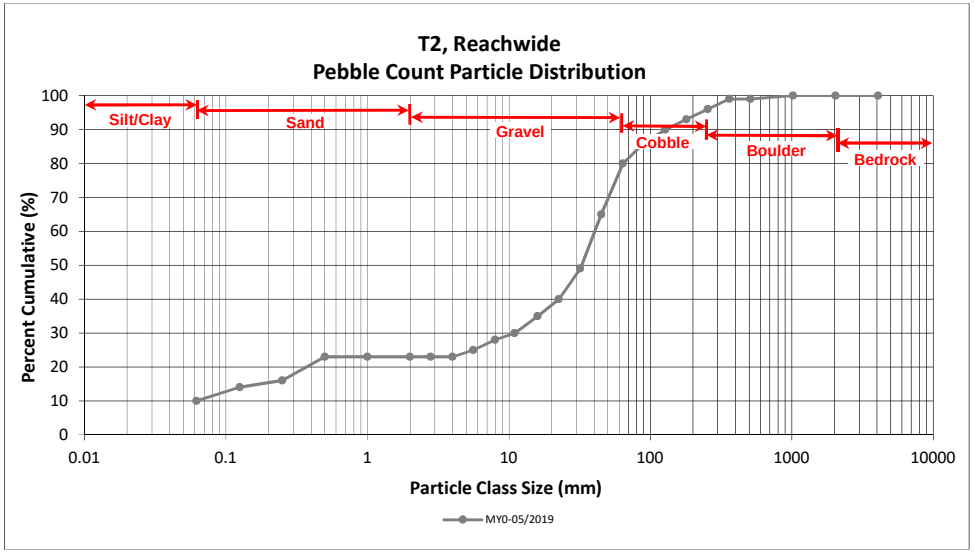
Reachwide Pebble Count Plots

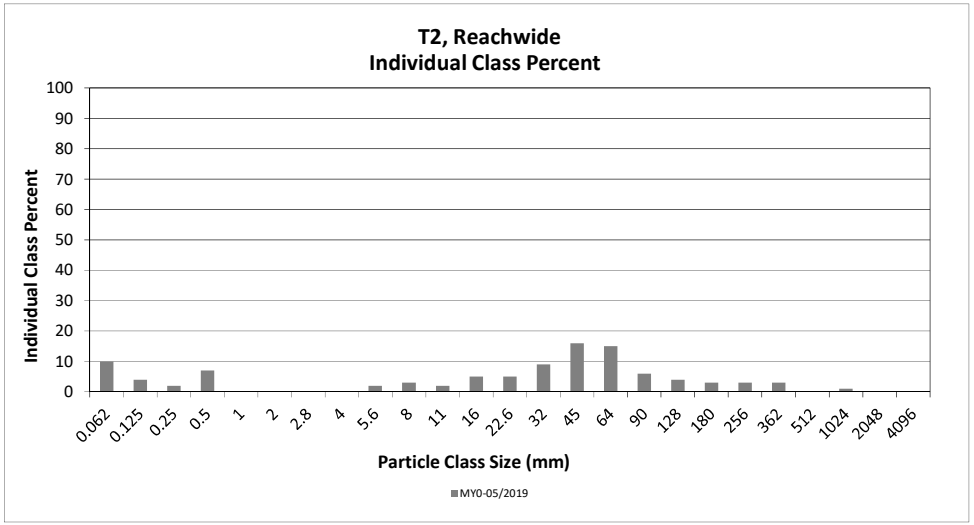
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T2, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		10	10	10	10
SAND	Very fine	0.062	0.125		4	4	4	14
	Fine	0.125	0.250		2	2	2	16
	Medium	0.25	0.50	1	6	7	7	23
	Coarse	0.5	1.0					23
	Very Coarse	1.0	2.0					23
GRAVEL	Very Fine	2.0	2.8					23
	Very Fine	2.8	4.0					23
	Fine	4.0	5.6	2		2	2	25
	Fine	5.6	8.0	2	1	3	3	28
	Medium	8.0	11.0		2	2	2	30
	Medium	11.0	16.0	1	4	5	5	35
	Coarse	16.0	22.6	3	2	5	5	40
	Coarse	22.6	32	2	7	9	9	49
	Very Coarse	32	45	9	7	16	16	65
	Very Coarse	45	64	10	5	15	15	80
COBBLE	Small	64	90	6		6	6	86
	Small	90	128	4		4	4	90
	Large	128	180	3		3	3	93
	Large	180	256	3		3	3	96
BOULDER	Small	256	362	3		3	3	99
	Small	362	512					99
	Medium	512	1024	1		1	1	100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.25
D_{35} =	16.00
D_{50} =	32.7
D_{84} =	80.3
D_{95} =	227.6
D_{100} =	1024.0





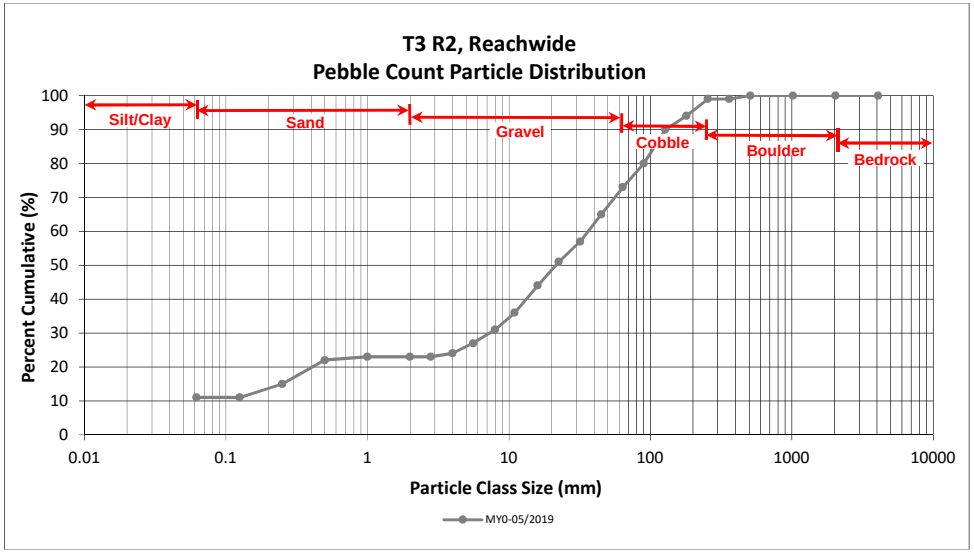
Reachwide Pebble Count Plots

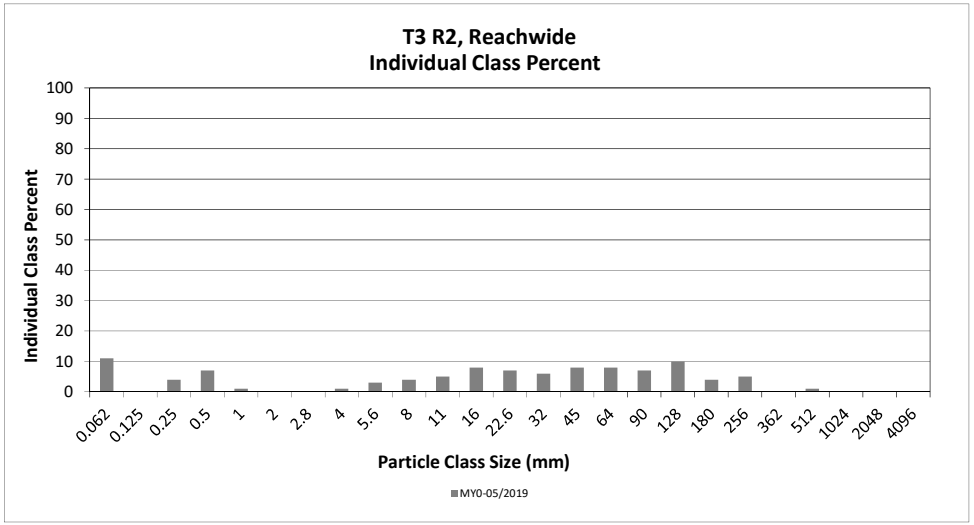
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T3 R2, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	1	10	11	11	11
SAND	Very fine	0.062	0.125					11
	Fine	0.125	0.250		4	4	4	15
	Medium	0.25	0.50		7	7	7	22
	Coarse	0.5	1.0		1	1	1	23
	Very Coarse	1.0	2.0					23
GRAVEL	Very Fine	2.0	2.8					23
	Very Fine	2.8	4.0		1	1	1	24
	Fine	4.0	5.6	1	2	3	3	27
	Fine	5.6	8.0	1	3	4	4	31
	Medium	8.0	11.0	3	2	5	5	36
	Medium	11.0	16.0	3	5	8	8	44
	Coarse	16.0	22.6	4	3	7	7	51
	Coarse	22.6	32	6		6	6	57
	Very Coarse	32	45	8		8	8	65
	Very Coarse	45	64	8		8	8	73
COBBLE	Small	64	90	7		7	7	80
	Small	90	128	10		10	10	90
	Large	128	180	3	1	4	4	94
	Large	180	256	4	1	5	5	99
BOULDER	Small	256	362					99
	Small	362	512	1		1	1	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**60**	**40**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.28
D_{35} =	10.32
D_{50} =	21.5
D_{84} =	103.6
D_{95} =	193.1
D_{100} =	512.0





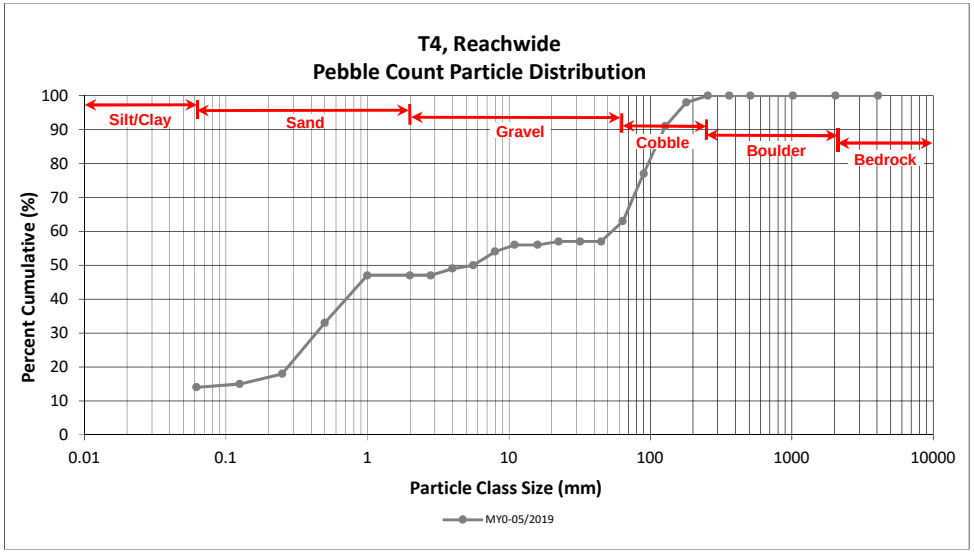
Reachwide Pebble Count Plots

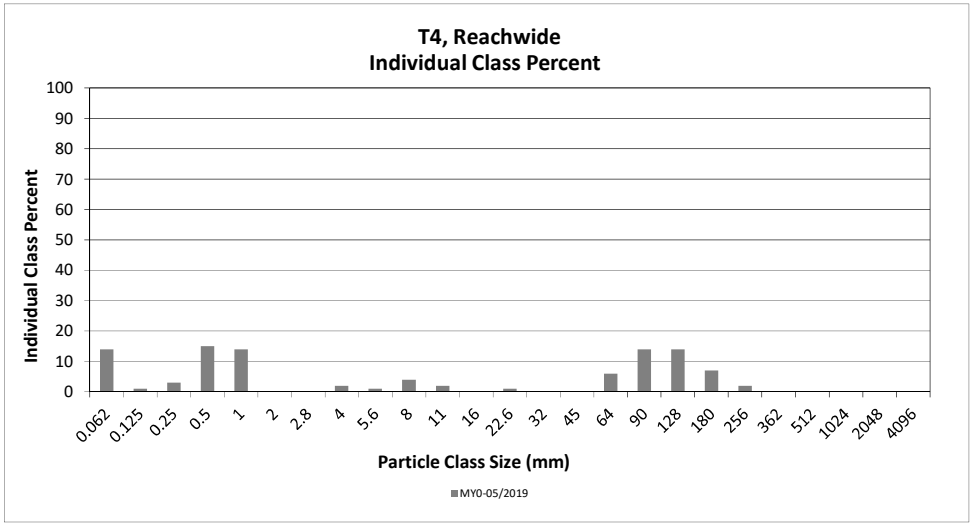
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T4, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	3	11	14	14	14
SAND	Very fine	0.062	0.125		1	1	1	15
	Fine	0.125	0.250		3	3	3	18
	Medium	0.25	0.50	1	14	15	15	33
	Coarse	0.5	1.0	1	13	14	14	47
	Very Coarse	1.0	2.0					47
GRAVEL	Very Fine	2.0	2.8					47
	Very Fine	2.8	4.0	1	1	2	2	49
	Fine	4.0	5.6		1	1	1	50
	Fine	5.6	8.0	2	2	4	4	54
	Medium	8.0	11.0	2		2	2	56
	Medium	11.0	16.0					56
	Coarse	16.0	22.6	1		1	1	57
	Coarse	22.6	32					57
	Very Coarse	32	45					57
	Very Coarse	45	64	6		6	6	63
COBBLE	Small	64	90	11	3	14	14	77
	Small	90	128	14		14	14	91
	Large	128	180	6	1	7	7	98
	Large	180	256	2		2	2	100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.16
D_{35} =	0.55
D_{50} =	5.6
D_{84} =	107.3
D_{95} =	155.5
D_{100} =	256.0





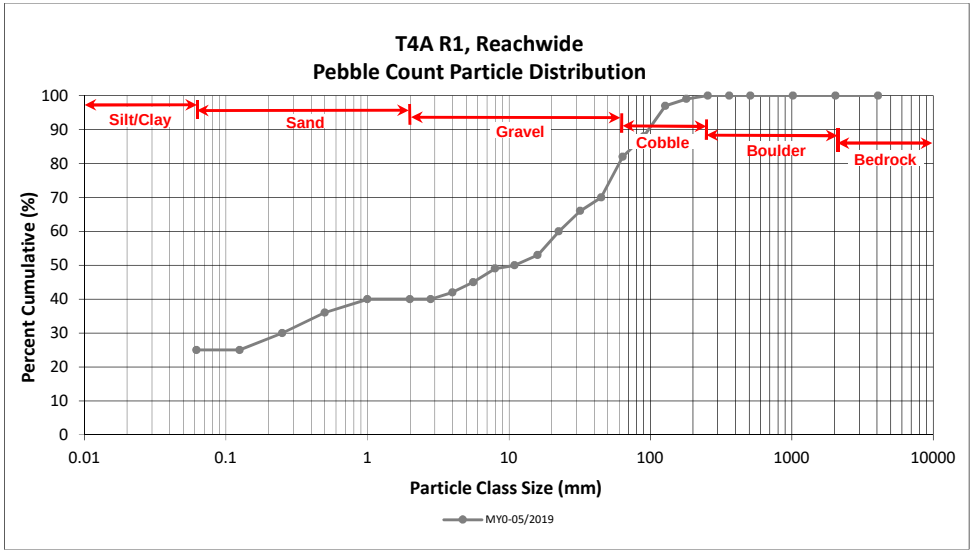
Reachwide Pebble Count Plots

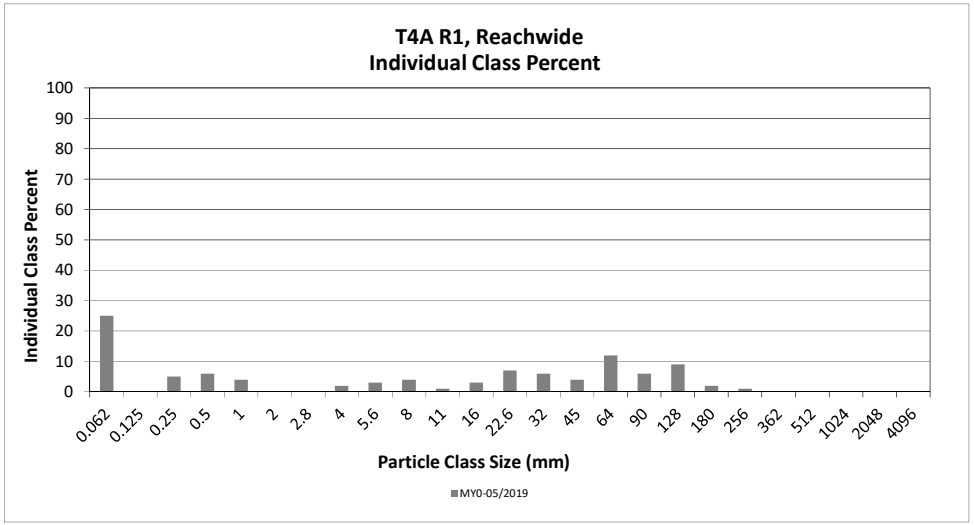
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T4A R1, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	4	21	25	25	25
SAND	Very fine	0.062	0.125					25
	Fine	0.125	0.250	1	4	5	5	30
	Medium	0.25	0.50		6	6	6	36
	Coarse	0.5	1.0	1	3	4	4	40
	Very Coarse	1.0	2.0					40
GRAVEL	Very Fine	2.0	2.8					40
	Very Fine	2.8	4.0		2	2	2	42
	Fine	4.0	5.6	1	2	3	3	45
	Fine	5.6	8.0	2	2	4	4	49
	Medium	8.0	11.0	1		1	1	50
	Medium	11.0	16.0	3		3	3	53
	Coarse	16.0	22.6	5	2	7	7	60
	Coarse	22.6	32	3	3	6	6	66
	Very Coarse	32	45	4		4	4	70
	Very Coarse	45	64	8	4	12	12	82
COBBLE	Small	64	90	6		6	6	88
	Small	90	128	8	1	9	9	97
	Large	128	180	2		2	2	99
	Large	180	256	1		1	1	100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	Silt/Clay
D_{35} =	0.45
D_{50} =	11.0
D_{84} =	71.7
D_{95} =	118.4
D_{100} =	256.0





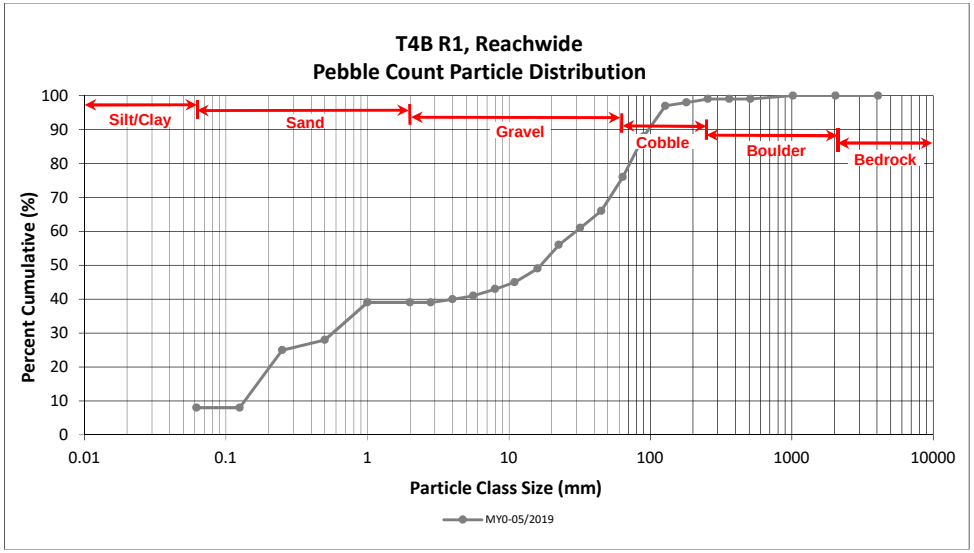
Reachwide Pebble Count Plots

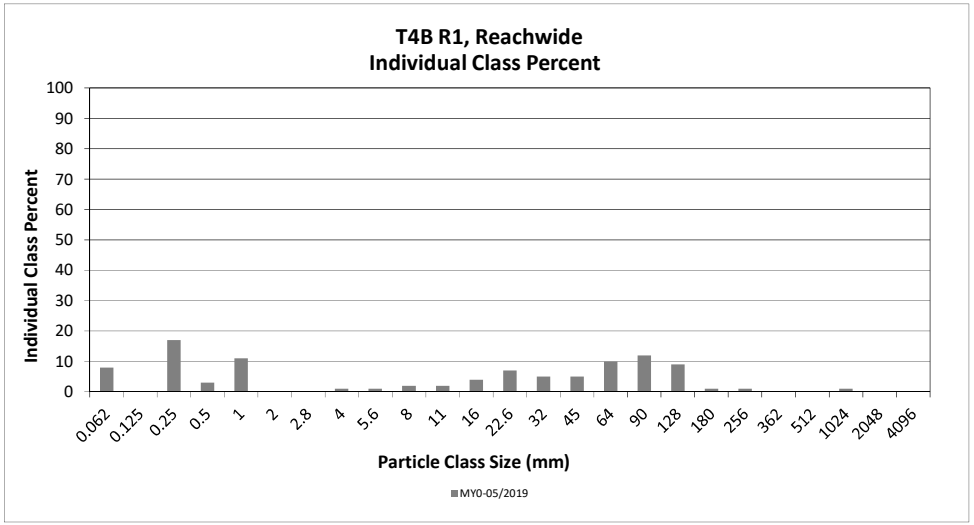
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T4B R1, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		8	8	8	8
SAND	Very fine	0.062	0.125					8
	Fine	0.125	0.250		17	17	17	25
	Medium	0.25	0.50		3	3	3	28
	Coarse	0.5	1.0	3	8	11	11	39
	Very Coarse	1.0	2.0					39
GRAVEL	Very Fine	2.0	2.8					39
	Very Fine	2.8	4.0	1		1	1	40
	Fine	4.0	5.6		1	1	1	41
	Fine	5.6	8.0	2		2	2	43
	Medium	8.0	11.0	1	1	2	2	45
	Medium	11.0	16.0		4	4	4	49
	Coarse	16.0	22.6	6	1	7	7	56
	Coarse	22.6	32	1	4	5	5	61
	Very Coarse	32	45	5		5	5	66
	Very Coarse	45	64	9	1	10	10	76
COBBLE	Small	64	90	11	1	12	12	88
	Small	90	128	8	1	9	9	97
	Large	128	180	1		1	1	98
	Large	180	256	1		1	1	99
BOULDER	Small	256	362					99
	Small	362	512					99
	Medium	512	1024	1		1	1	100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.17
D_{35} =	0.78
D_{50} =	16.8
D_{84} =	80.3
D_{95} =	118.4
D_{100} =	1024.0





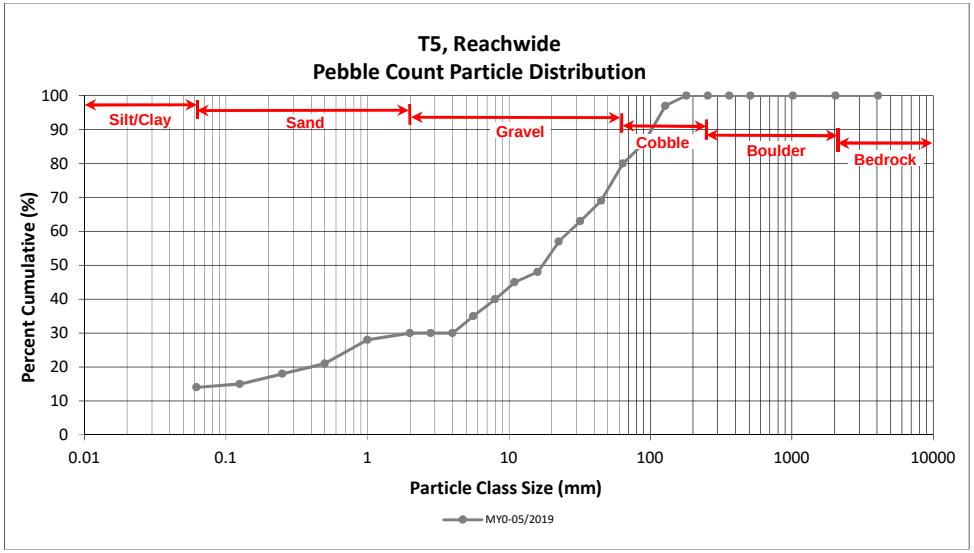
Reachwide Pebble Count Plots

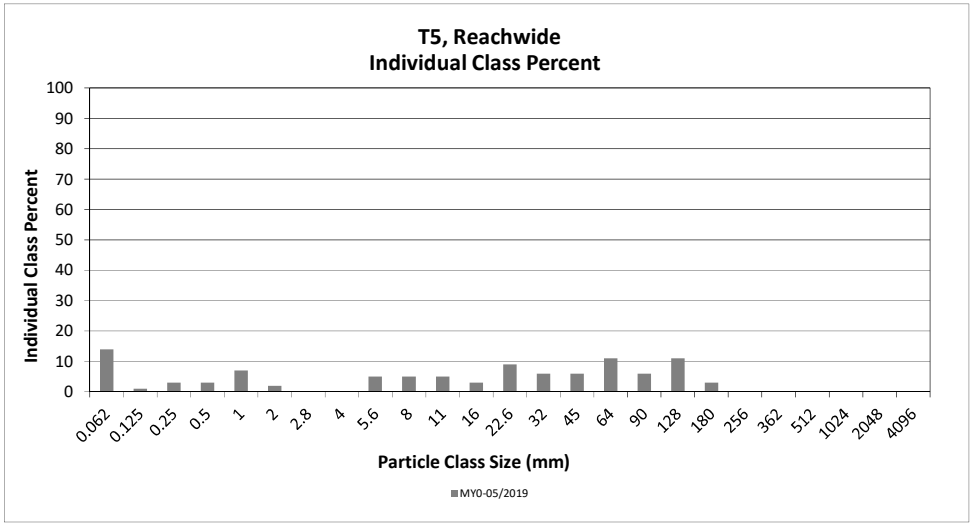
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T5, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	2	12	14	14	14
SAND	Very fine	0.062	0.125		1	1	1	15
	Fine	0.125	0.250		3	3	3	18
	Medium	0.25	0.50		3	3	3	21
	Coarse	0.5	1.0	2	5	7	7	28
	Very Coarse	1.0	2.0	1	1	2	2	30
GRAVEL	Very Fine	2.0	2.8					30
	Very Fine	2.8	4.0					30
	Fine	4.0	5.6	1	4	5	5	35
	Fine	5.6	8.0	1	4	5	5	40
	Medium	8.0	11.0	1	4	5	5	45
	Medium	11.0	16.0	1	2	3	3	48
	Coarse	16.0	22.6	5	4	9	9	57
	Coarse	22.6	32	3	3	6	6	63
	Very Coarse	32	45	5	1	6	6	69
	Very Coarse	45	64	11		11	11	80
COBBLE	Small	64	90	4	2	6	6	86
	Small	90	128	10	1	11	11	97
	Large	128	180	3		3	3	100
	Large	180	256					100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.16
D_{35} =	5.60
D_{50} =	17.3
D_{84} =	80.3
D_{95} =	120.1
D_{100} =	180.0





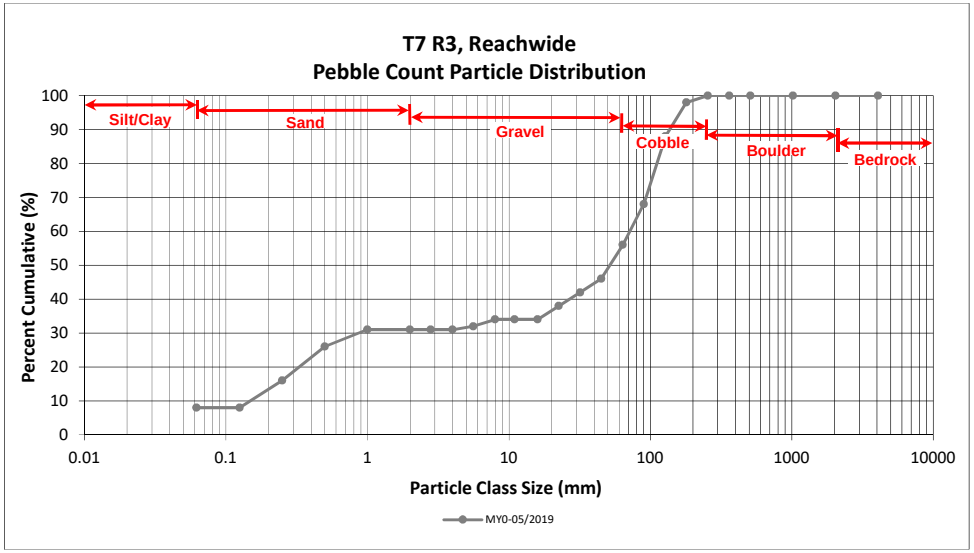
Reachwide Pebble Count Plots

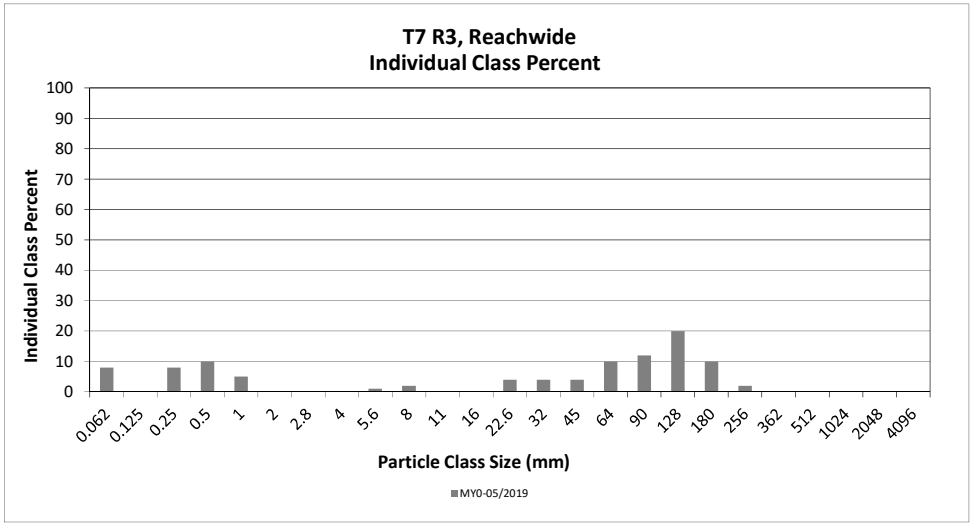
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 0 - 2019

T7 R3, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	2	6	8	8	8
SAND	Very fine	0.062	0.125					8
	Fine	0.125	0.250		8	8	8	16
	Medium	0.25	0.50	2	8	10	10	26
	Coarse	0.5	1.0	1	4	5	5	31
	Very Coarse	1.0	2.0					31
GRAVEL	Very Fine	2.0	2.8					31
	Very Fine	2.8	4.0					31
	Fine	4.0	5.6	1		1	1	32
	Fine	5.6	8.0	1	1	2	2	34
	Medium	8.0	11.0					34
	Medium	11.0	16.0					34
	Coarse	16.0	22.6	4		4	4	38
	Coarse	22.6	32	3	1	4	4	42
	Very Coarse	32	45	3	1	4	4	46
	Very Coarse	45	64	10		10	10	56
COBBLE	Small	64	90	8	4	12	12	68
	Small	90	128	19	1	20	20	88
	Large	128	180	6	4	10	10	98
	Large	180	256		2	2	2	100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**60**	**40**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.25
D_{35} =	17.44
D_{50} =	51.8
D_{84} =	119.3
D_{95} =	162.5
D_{100} =	256.0



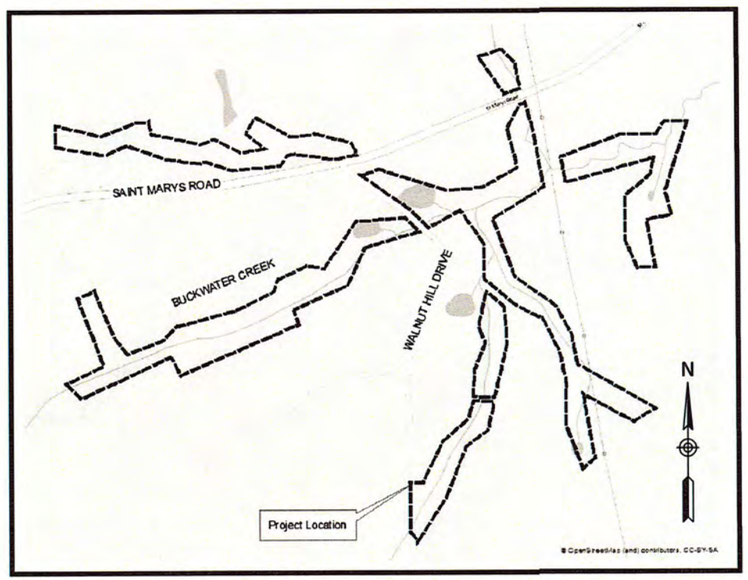


APPENDIX 5. Record Drawings

BEFORE YOU DIG!
CALL 1-800-632-4949
N.C. ONE-CALL CENTER
IT'S THE LAW!

Buckwater Mitigation Site

Neuse River Basin 03020201
Orange County, North Carolina
for
NCDEQ Division of Mitigation Services



Vicinity Map
Not to Scale

CERTIFICATE OF SURVEY AND ACCURACY

I, DREW VAN DUINKERKEN , CERTIFY THAT THE GROUND TOPOGRAPHIC SURVEY PORTION OF THIS PROJECT WAS COMPLETED UNDER MY DIRECT SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY DIRECT SUPERVISION; THAT THE RECORD DRAWINGS WERE PREPARED BY WILDLANDS ENGINEERING, INC. FROM DIGITAL FILES PROVIDED BY KEE MAPPING AND SURVEYING, PA AS SHOWN ON AN AS-BUILT SURVEY FOR "WILDLANDS ENGINEERING, INC., BUCKWATER MITIGATION SITE", JOB #: 1810129-AB, DATED: SEPTEMBER 11, 2019; THAT THIS SURVEY WAS PERFORMED AT THE 95% CONFIDENCE LEVEL TO MEET THE FEDERAL GEOGRAPHIC DATA COMMITTEE STANDARDS AND TO MEET THE REQUIREMENTS OF A TOPOGRAPHIC SURVEY TO THE ACCURACY OF CLASS A HORIZONTAL AND CLASS C VERTICAL WHERE APPLICABLE; THAT THE ORIGINAL DATA WAS OBTAIN BETWEEN THE DATES OF 1/14/19 - 09/06/19 ; THAT THE CONTOURS SHOWN AS BROKEN LINES MAY NOT MEET THE STATED STANDARD; THAT ALL COORDINATES ARE BASED ON NAD 83 (NSRS 2011) AND ALL ELEVATIONS ARE BASED ON NAVD 88; THAT THIS MAP MEETS THE SPECIFICATIONS FOR TOPOGRAPHIC SURVEYS AS STATED IN TITLE 21, CHAPTER 56, SECTION .1606; THAT THIS MAP WAS NOT PREPARED IN ACCORDANCE WITH G.S. 47-30, AS AMENDED AND DOES NOT REPRESENT AN OFFICIAL BOUNDARY SURVEY.

WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 12TH DAY OF SEPTEMBER , 2019.

DREW VAN DUINKERKEN, PLS L-5010

NORTH CAROLINA PROFESSIONAL SEAL L-5010 LAND SURVEYOR DREW VAN DUINKERKEN

FINAL AS-BUILT AND RECORD DRAWINGS SEPTEMBER 9, 2019

Stream Origins

Stream	Latitude	Longitude
Buckwater Creek	N 36º 06' 12.03"	W 79º 01' 58.42"
T1	N 36º 06' 35.12"	W 79º 01' 22.97"
T3	N 36º 06' 02.67"	W 79º 01' 29.82"
T4A	N 36º 06' 07.29"	W 79º 01' 14.34"
T4B	N 36º 06' 10.15"	W 79º 01' 10.30"
T6	N 36º 06' 29.57"	W 79º 02' 00.32"
T6A	N 36º 06' 30.15"	W 79º 01' 43.18"
T6B	N 36º 06' 30.42"	W 79º 01' 52.43"
T7	N 36º 06' 20.39"	W 79º 01' 10.08"
T7A	N 36º 06' 23.86"	W 79º 01' 08.58"
T8	N 36º 06' 18.60"	W 79º 01' 57.23"
T9	N 36º 06' 13.04"	W 79º 01' 51.99"

Sheet Index

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 Millns, 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

WILDLANDS ENGINEERING
312 W. Millbrook Road, Ste 225
Raleigh, NC 27609
Tel: 919.851.9986
Firm License No. F-0831

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLNS

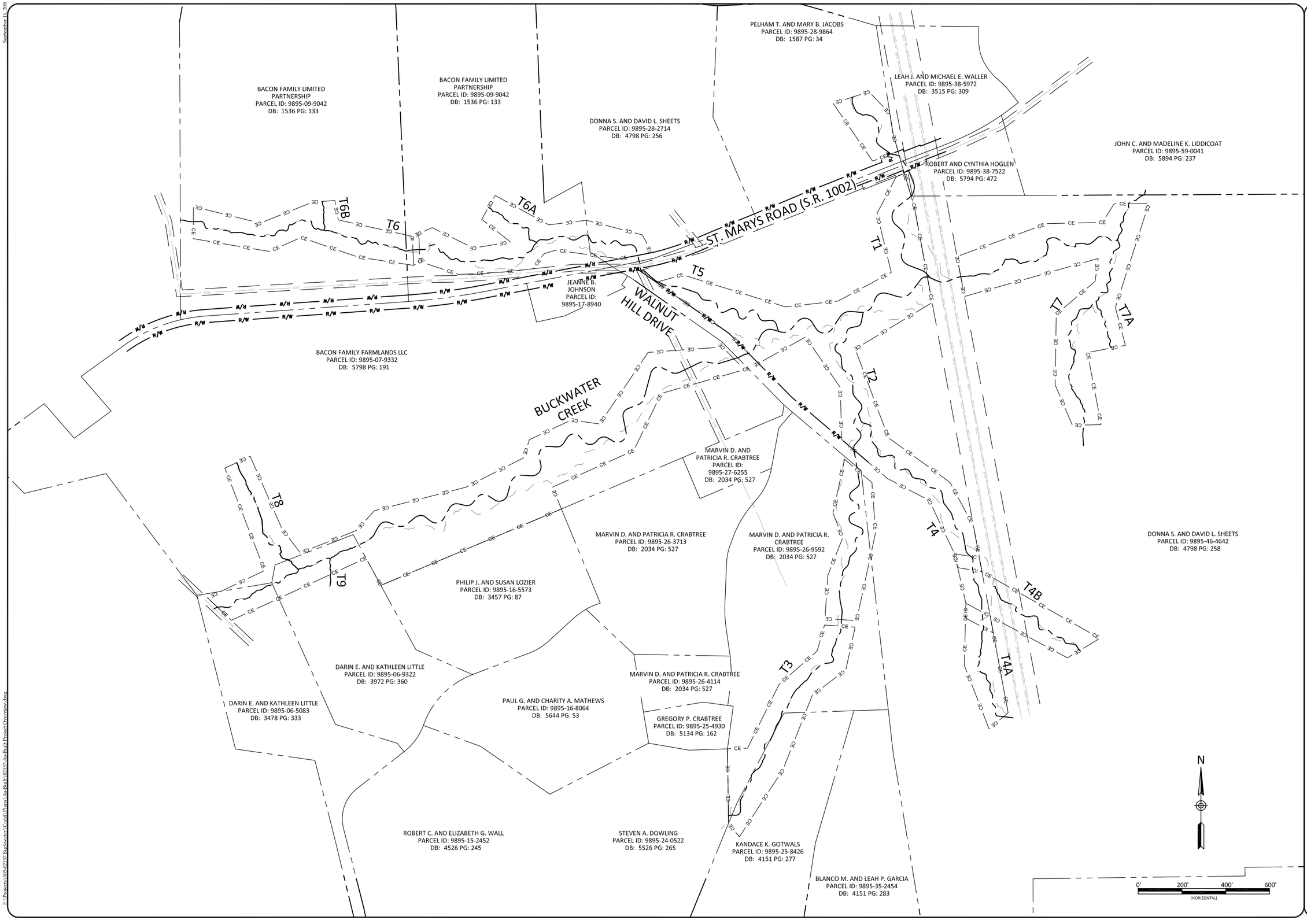
Buckwater Mitigation Site
Orange County, North Carolina

Title Sheet

Revisions:

Date: 07.01.2019
Job Number: 005-02157
Project Engineer: NMM
Drawn By: CAW
Checked By: ITL

Sheet 0.1



September 11, 2019

F:\Projects\005-02157 Buckwater Creek\Plans\As-Built\02157-As-Built Project Overview.dwg

WILDLANDS ENGINEERING
312 W. Millbrook Road, Ste 225
Raleigh, NC 27609
Tel: 919.851.9986
Firm License No. F-0831

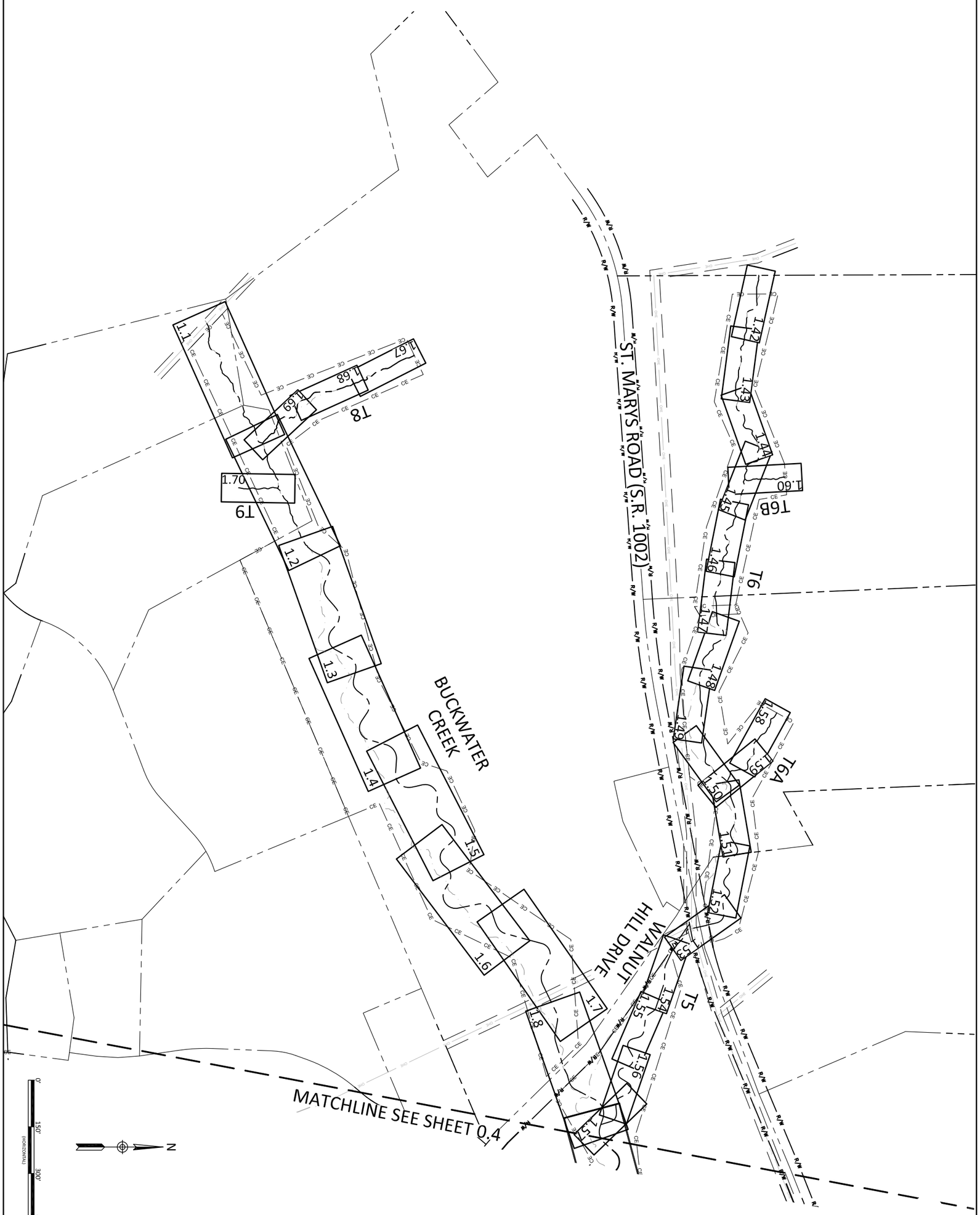
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 037445 NICOLE MACALUSO

Buckwater Mitigation Site
Orange County, North Carolina
Project Overview

Revisions:

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTE

Sheet 0.2



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Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

0.3

Sheet

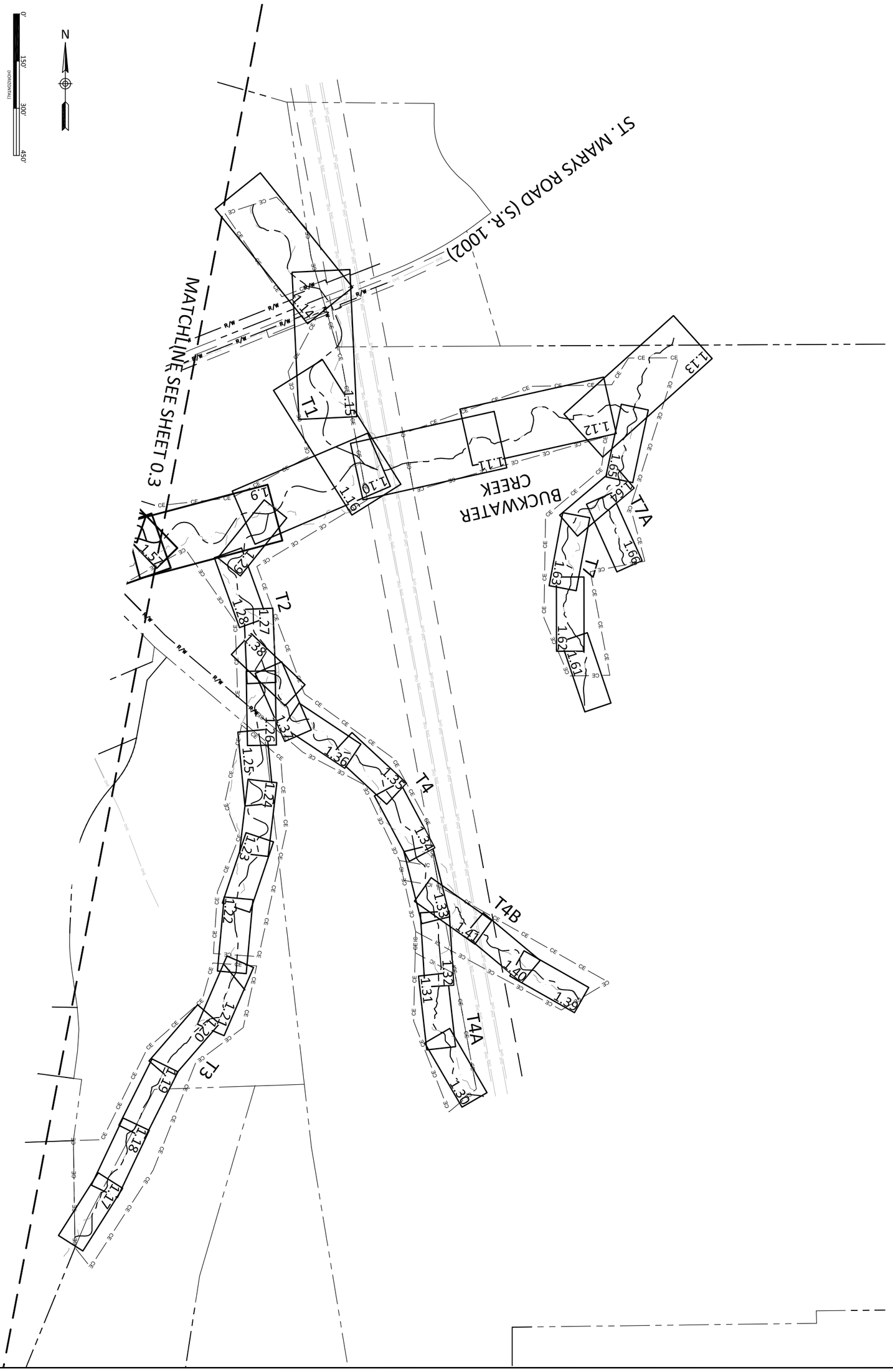
Revisions:

Buckwater Mitigation Site
Orange County, North Carolina

Project Overview

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 9/4/19

WILDLANDS ENGINEERING
312 W. Millbrook Road, Ste 225
Raleigh, NC 27609
Tel: 919.851.9986
Firm License No. F-0831



Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

Revisions:

0.4

Sheet

Buckwater Mitigation Site
Orange County, North Carolina

Project Overview

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 9/4/19

WILDLANDS ENGINEERING
312 W. Millbrook Road, Ste 225
Raleigh, NC 27609
Tel: 919.851.9986
Firm License No. F-0831

September 11, 2019

Existing Features

- Existing Property Boundary
- Existing Right-of-way (R/W)
- Existing Utility Easement
- Existing Gas Easement (G)
- Existing Overhead Electric Utility Line (OHE)
- Existing Gas Line (GAS)
- Existing Fiber Optic Cable Line (FOC)
- Existing Tree Line
- Existing Tree
- Existing Utility Pole
- Existing Wetlands
- Existing Bedrock
- Existing Farm Road

Design Features

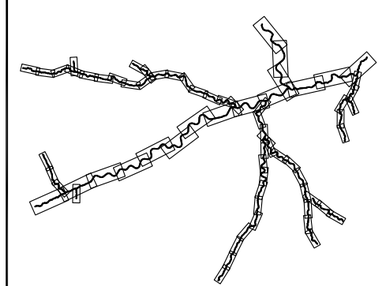
- Designed BANKFULL
- Designed 5' Major Contour (540)
- Designed 1' Minor Contour
- Designed Thalweg (10+00)
- Designed Farm Road Realignment
- Designed Riffle
- Designed Log Sill
- Designed Angled Log Sill
- Designed Log Vane
- Designed Log J-Hook
- Designed Root Wad
- Designed Rock Step Pools
- Designed Vegetated Soil Lift
- Designed Brush Toe
- Designed Boulder Toe
- Designed Boulder Sill
- Designed Transplanted Sod Mats
- Designed Permanent Culvert Crossing
- Designed Permanent Ford Crossing
- Designed Lunker Log
- Designed Rock Cascade
- Designed Stream Bank Grading

As-Built Features

- Conservation Easement (CE)
- Internal Crossing (IC)
- As-Built Stream Alignment - Restoration
- As-Built Stream Alignment - Enhancement I
- As-Built Stream Alignment - Enhancement II
- As-Built Stream Alignment - Not For Credit
- Limits of Disturbance (LOD)
- Cross section
- As-Built Bankfull
- As-Built 5' Major Contour (540)
- As-Built 1' Minor Contour
- As-Built Fence (X)
- As-Built Riffle
- As-Built Log Sill
- As-Built Angled Log Sill
- As-Built Log Vane
- As-Built Log J-Hook
- As-Built Root Wad
- As-Built Rock Step Pools
- As-Built Vegetated Soil Lift
- As-Built Brush Toe
- As-Built Boulder Toe
- As-Built Boulder Sill
- As-Built Transplanted Sod Mats
- As-Built Permanent Culvert Crossing
- As-Built Permanent Ford Crossing
- As-Built Lunker Log
- As-Built Rock Cascade
- As-Built Vernal Pool
- As-Built Streambank Grading

- VP# Vegtation Plot
- Gauge
- Photo Point

Sheet Index



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NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 037445 NICOLE MACALUSO

Buckwater Mitigation Site
Orange County, North Carolina
General Notes and Symbols

Revisions:

Date:	07.01.2019
Job Number:	005-021157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

Sheet 0.5

F:\Projects\005-021157 Buckwater\Cadd\Plans\As-Built\021157-As-Built General Notes and Symbols.dwg

NOTE:

1. STA 102+96 RIFFLE WAS ADDED.
2. STA 103+67 RIFFLE WAS ADDED (SEE NOTE 1 SHEET 1.2).

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NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO

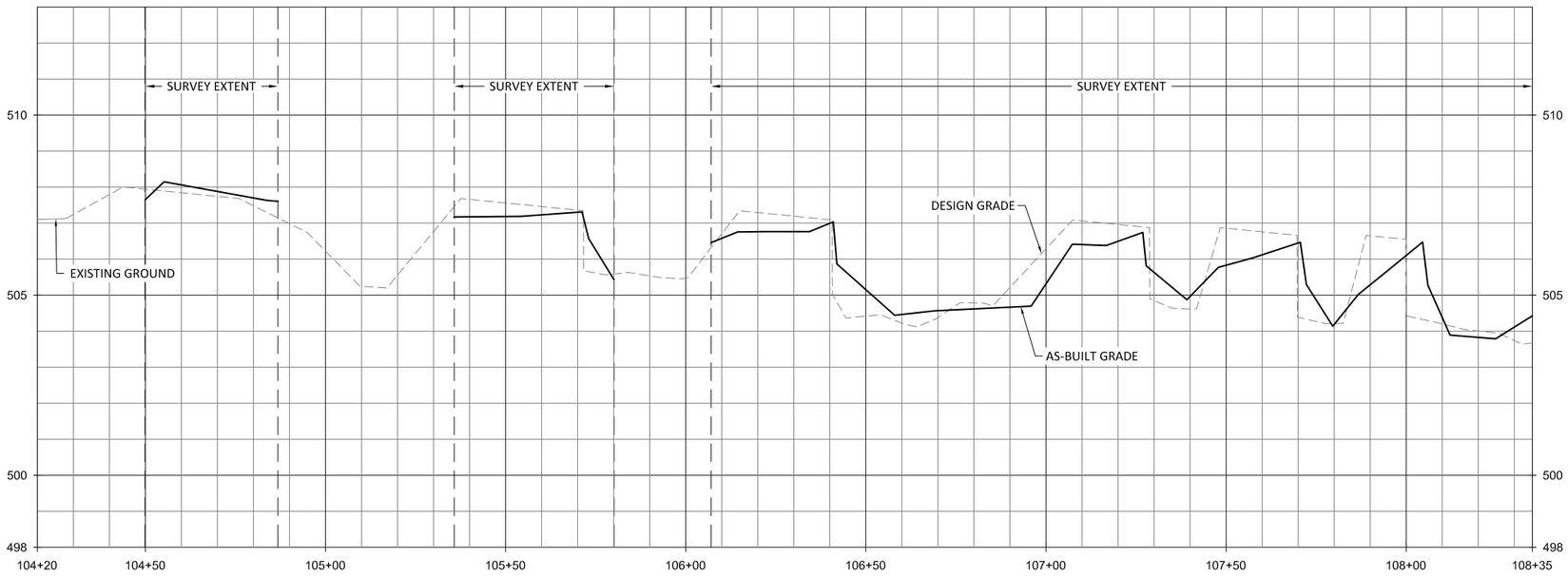
Buckwater Mitigation Site
Orange County, North Carolina

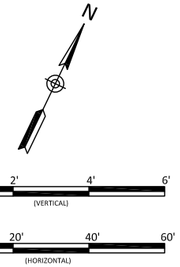
Buckwater Creek Reach 1
Stream Plan and Profile

Revisions:

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

Sheet 1.1





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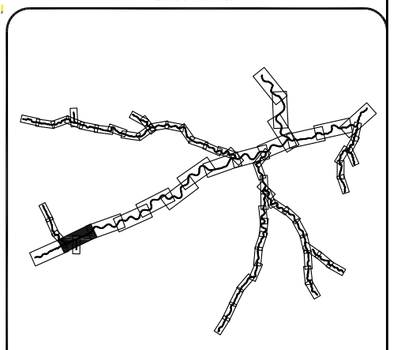

NOTE:

1. STA 104+58: RIFFLE WAS INSTALLED UPSTREAM (SEE NOTE 2 SHEET 1.1).

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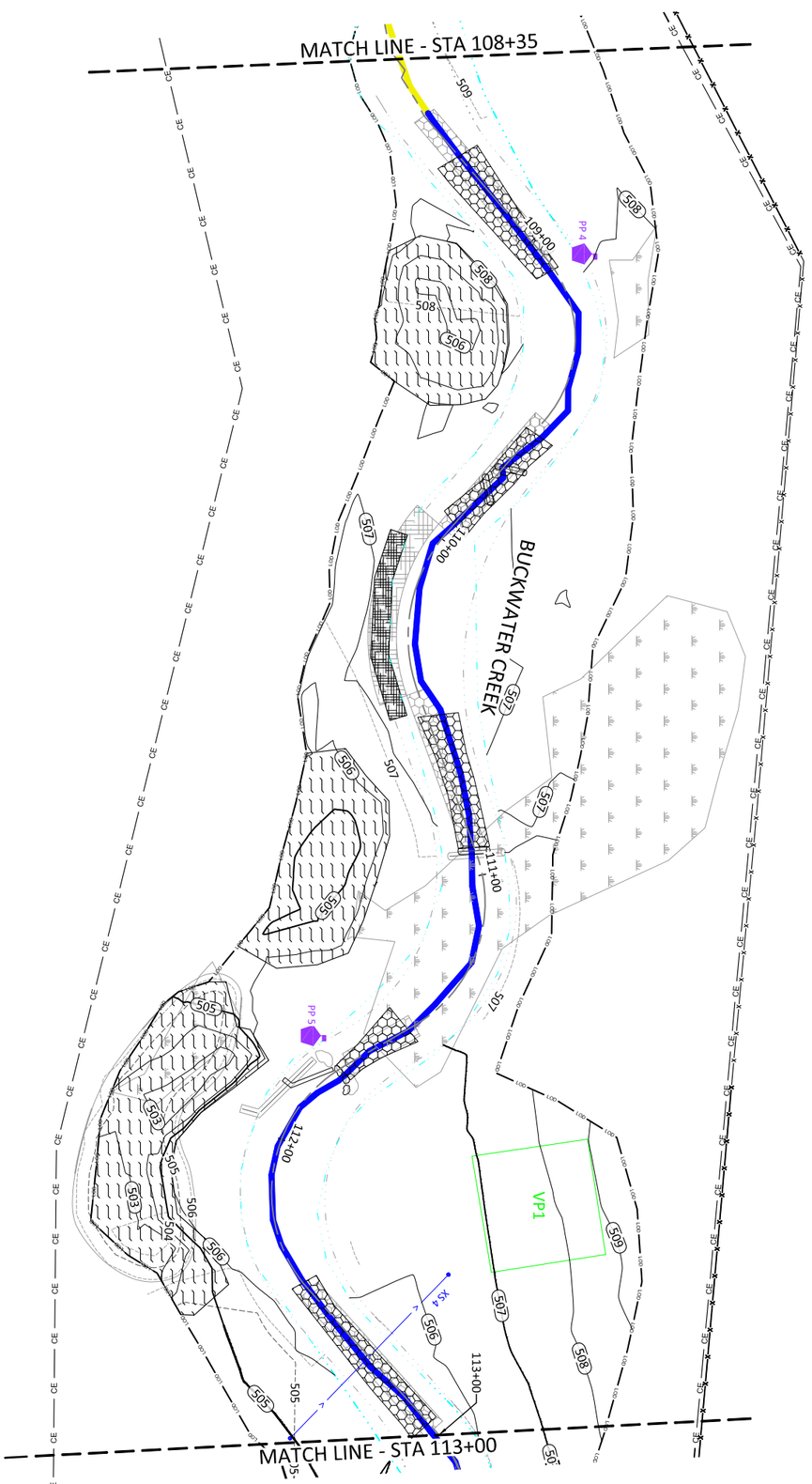
Buckwater Mitigation Site
Orange County, North Carolina

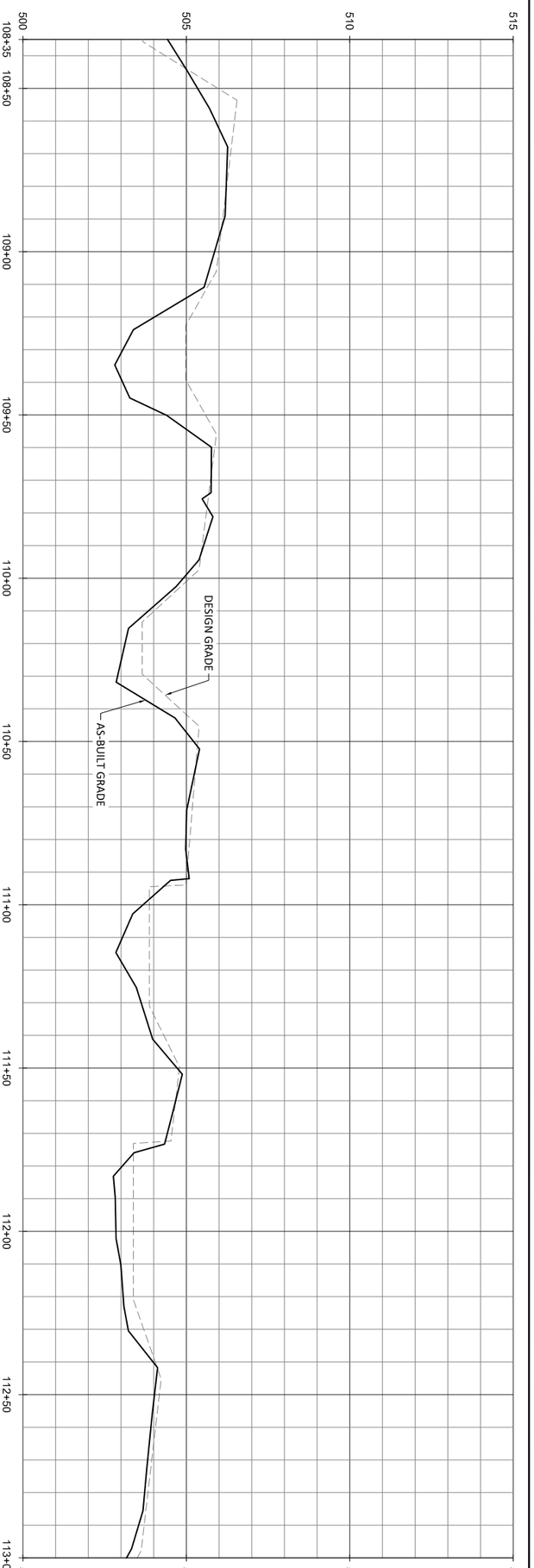
Buckwater Creek Reaches 1, 2 & 3
Stream Plan and Profile

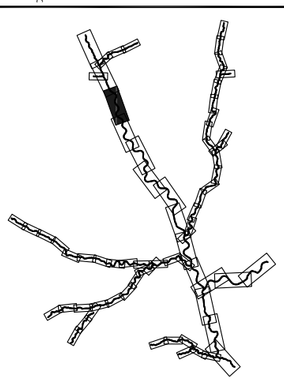
Revisions:

Date: 07.01.2019
Job Number: 005-02157
Project Engineer: NMM
Drawn By: CAW
Checked By: JTL

Sheet 1.2







Sheet Index

0' 20' 40' 60' (HORIZONTAL)

0' 2' 4' 6' (VERTICAL)

N

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

1.3
Sheet

Revisions:

Buckwater Mitigation Site
Orange County, North Carolina

Buckwater Creek Reaches 3 & 4
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 037445 NICOLE MACALUSO MILLS 9/4/19

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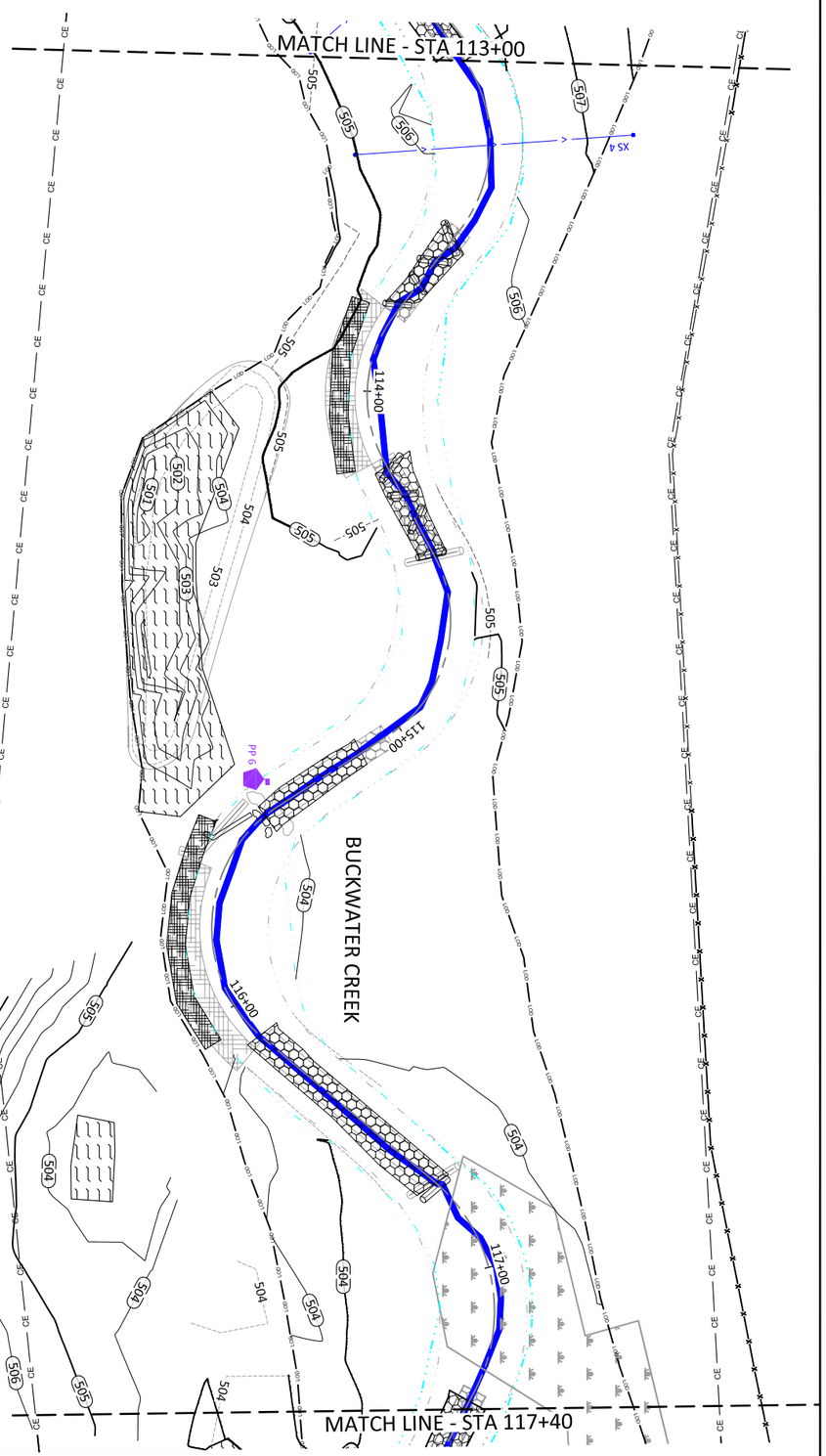

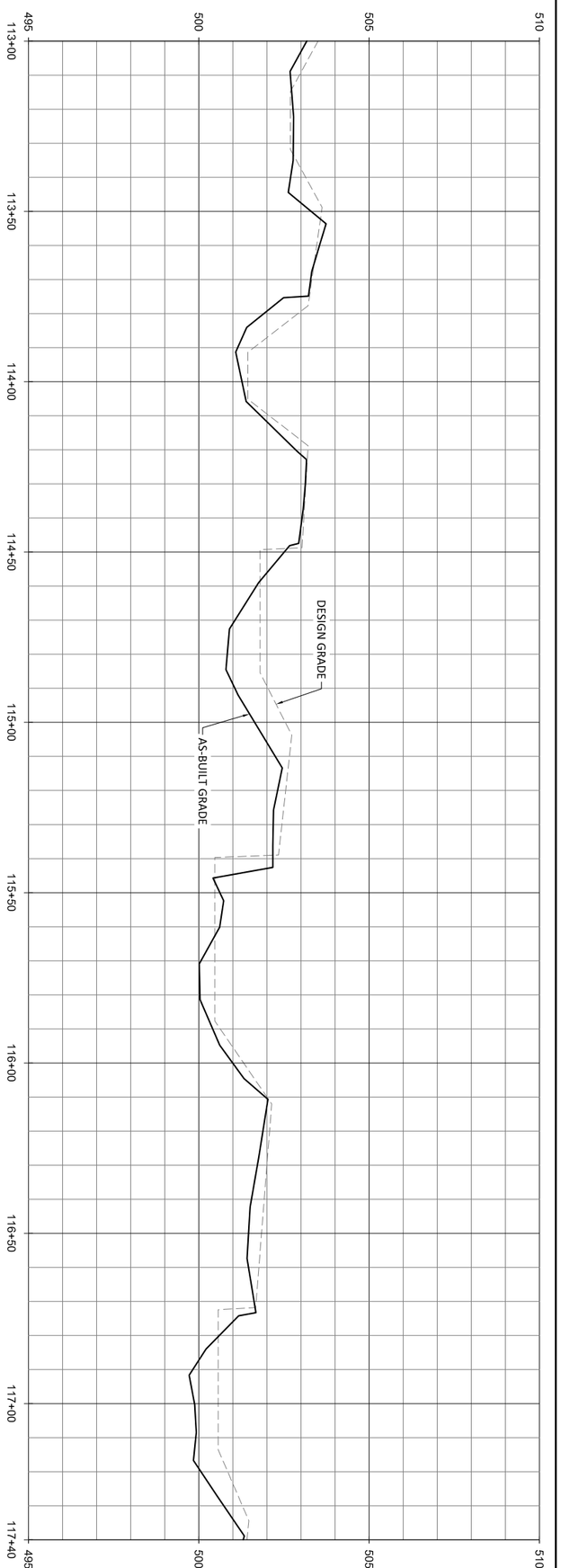

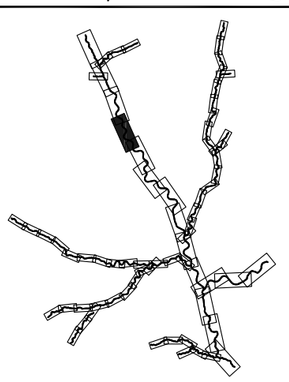

Sheet Index

0' 20' 40' 60' (HORIZONTAL)

0' 2' 4' 6' (VERTICAL)

N

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

1.4
Sheet

Revisions:

Buckwater Mitigation Site
Orange County, North Carolina

Buckwater Creek Reach 4
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 037445 NICOLE MACALUSO MILLS 7/1/19

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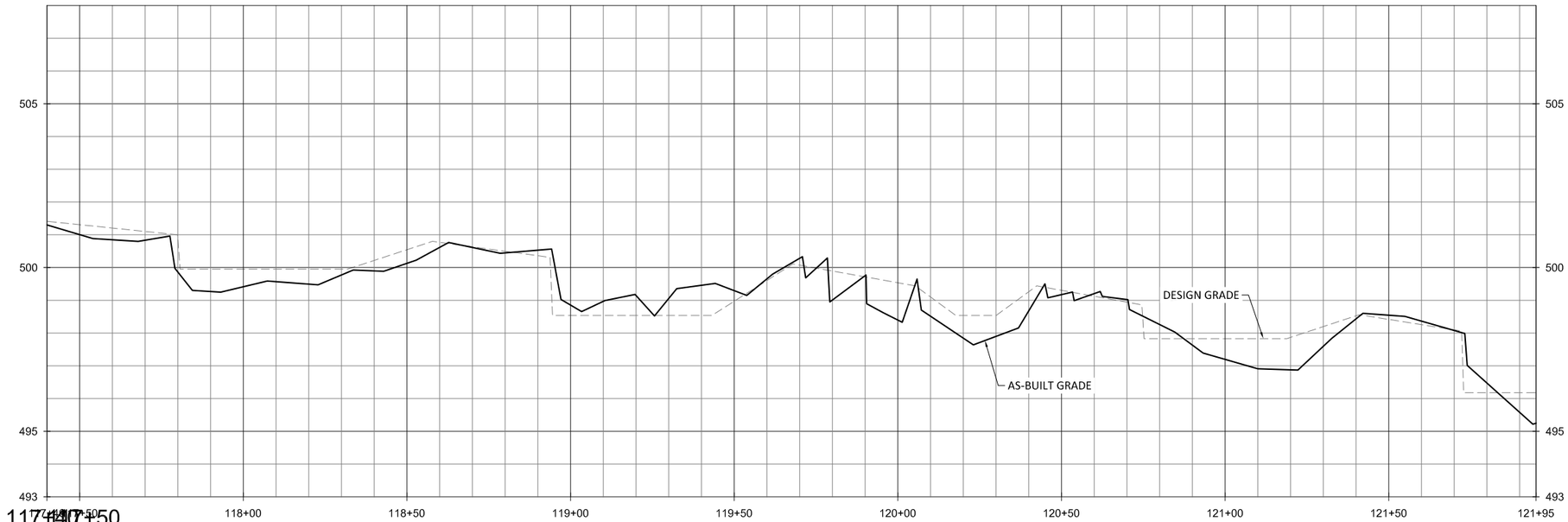

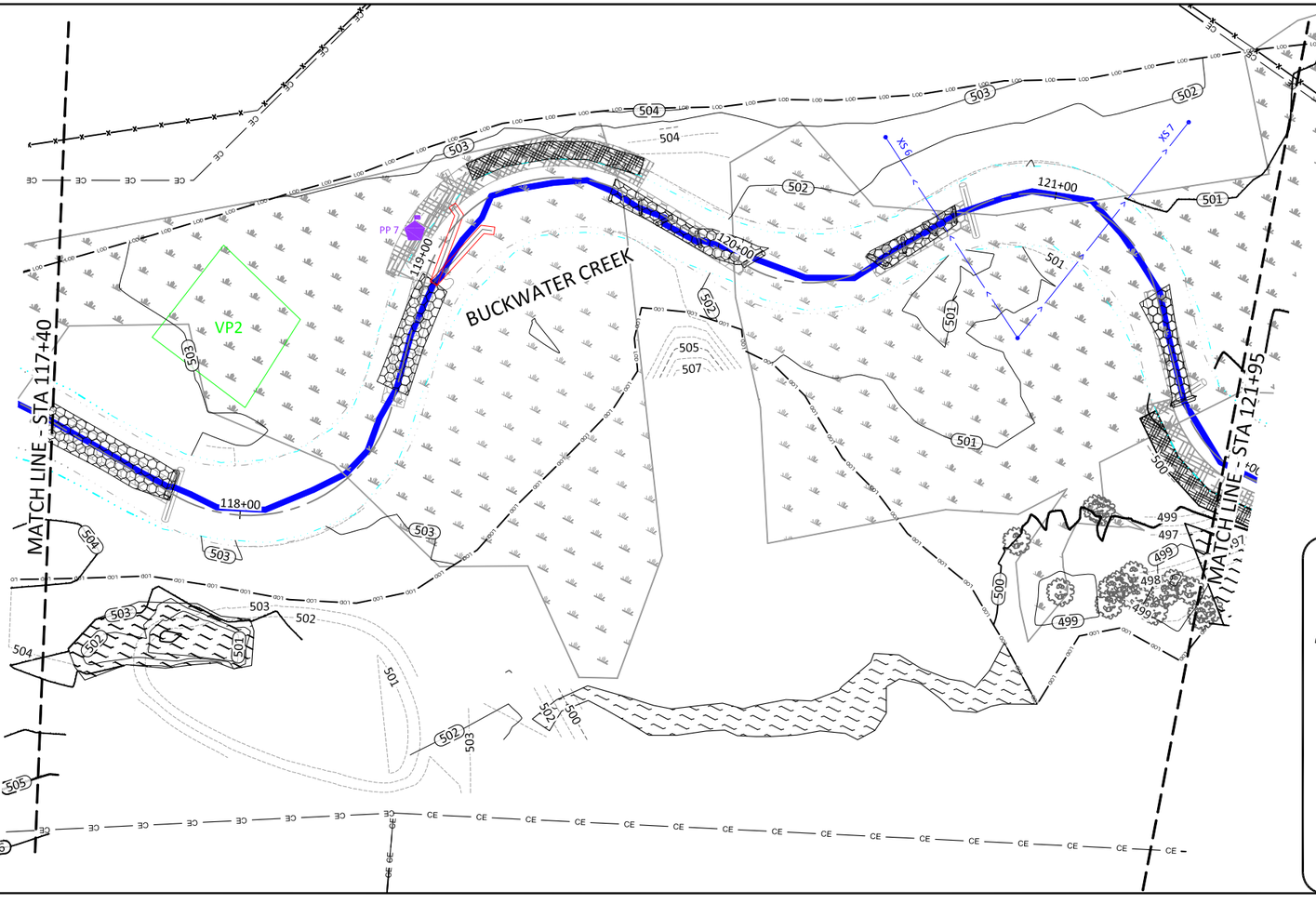

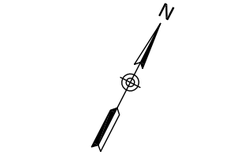

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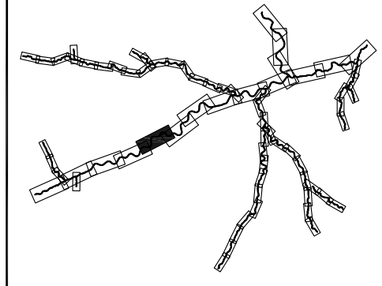

NOTE:

1. STA 118+86: A LOG CROSS VANE WAS INSTALLED INSTEAD OF A LOG J HOOK.
2. STA 119+44: POOL SHALLOW NOT INSTALLED DUE TO FIELD CONDITIONS.

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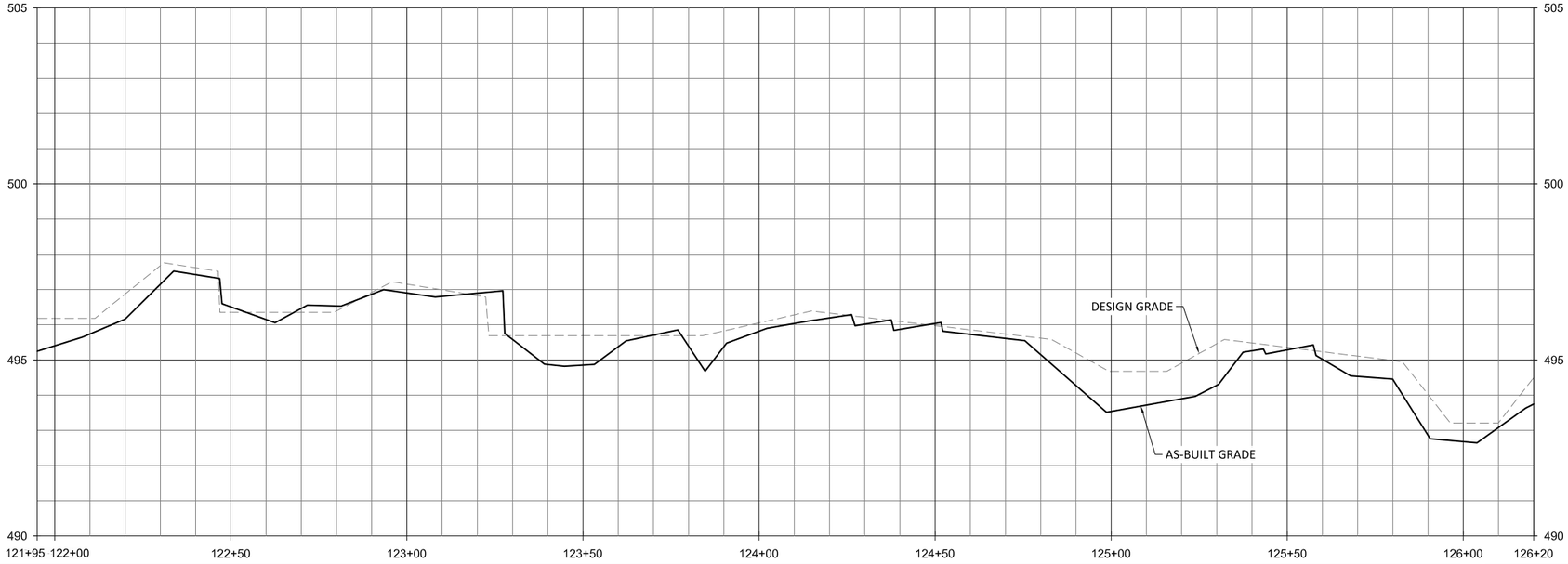
Buckwater Mitigation Site
Orange County, North Carolina

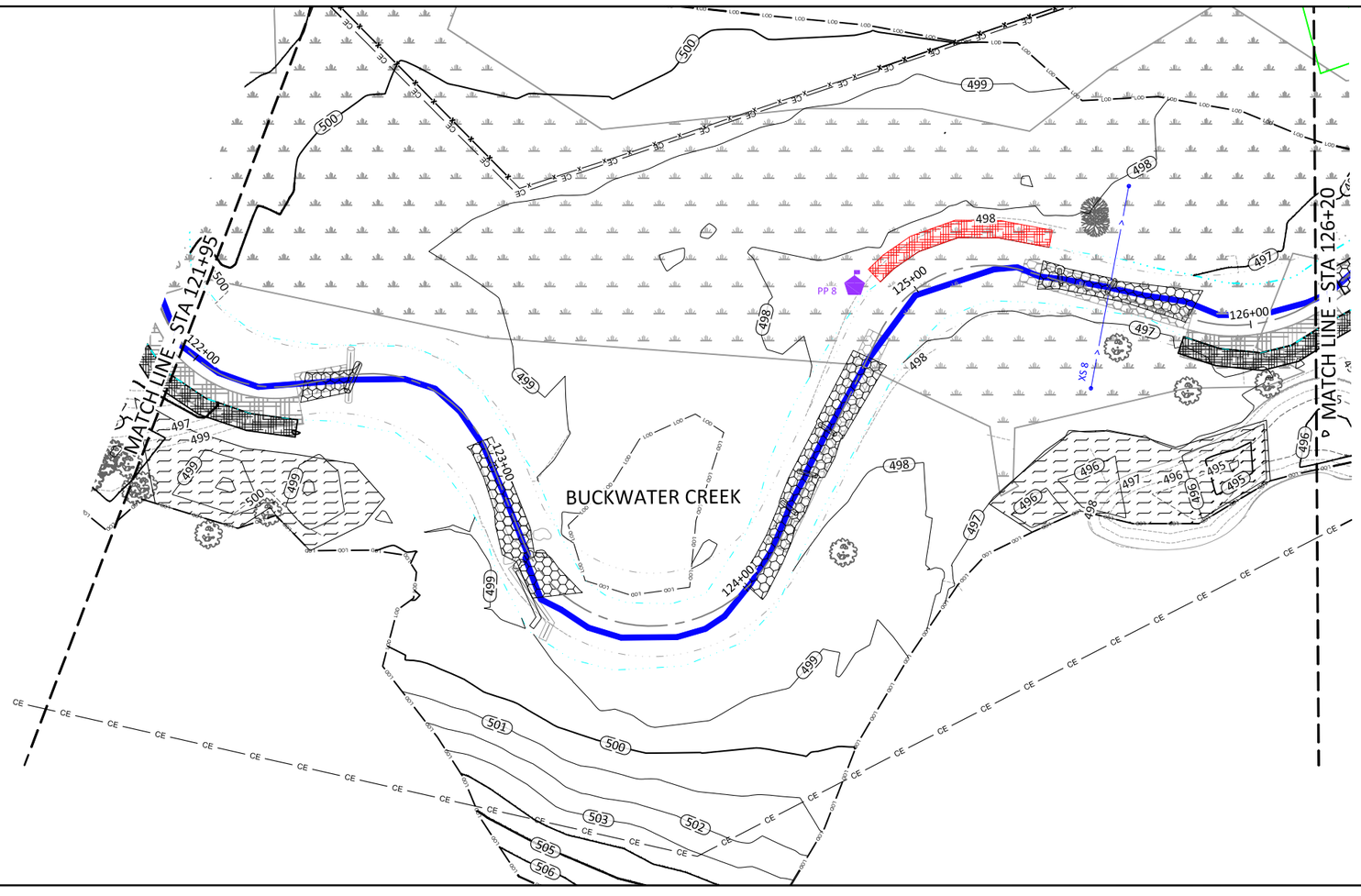
Buckwater Creek Reach 4
Stream Plan and Profile

Revisions:

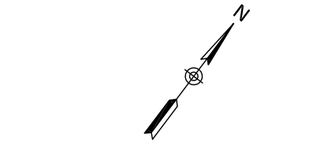
Date: 07.01.2019
Job Number: 005-02157
Project Engineer: NMM
Drawn By: CAW
Checked By: JTL

Sheet 1.5





NOTE:
1. STA 125+14: BRUSH TOE WAS INSTALLED.



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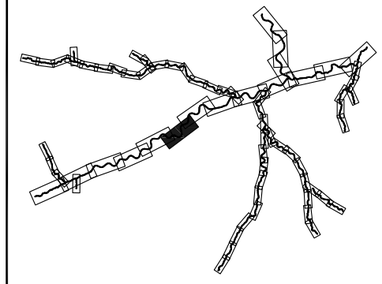

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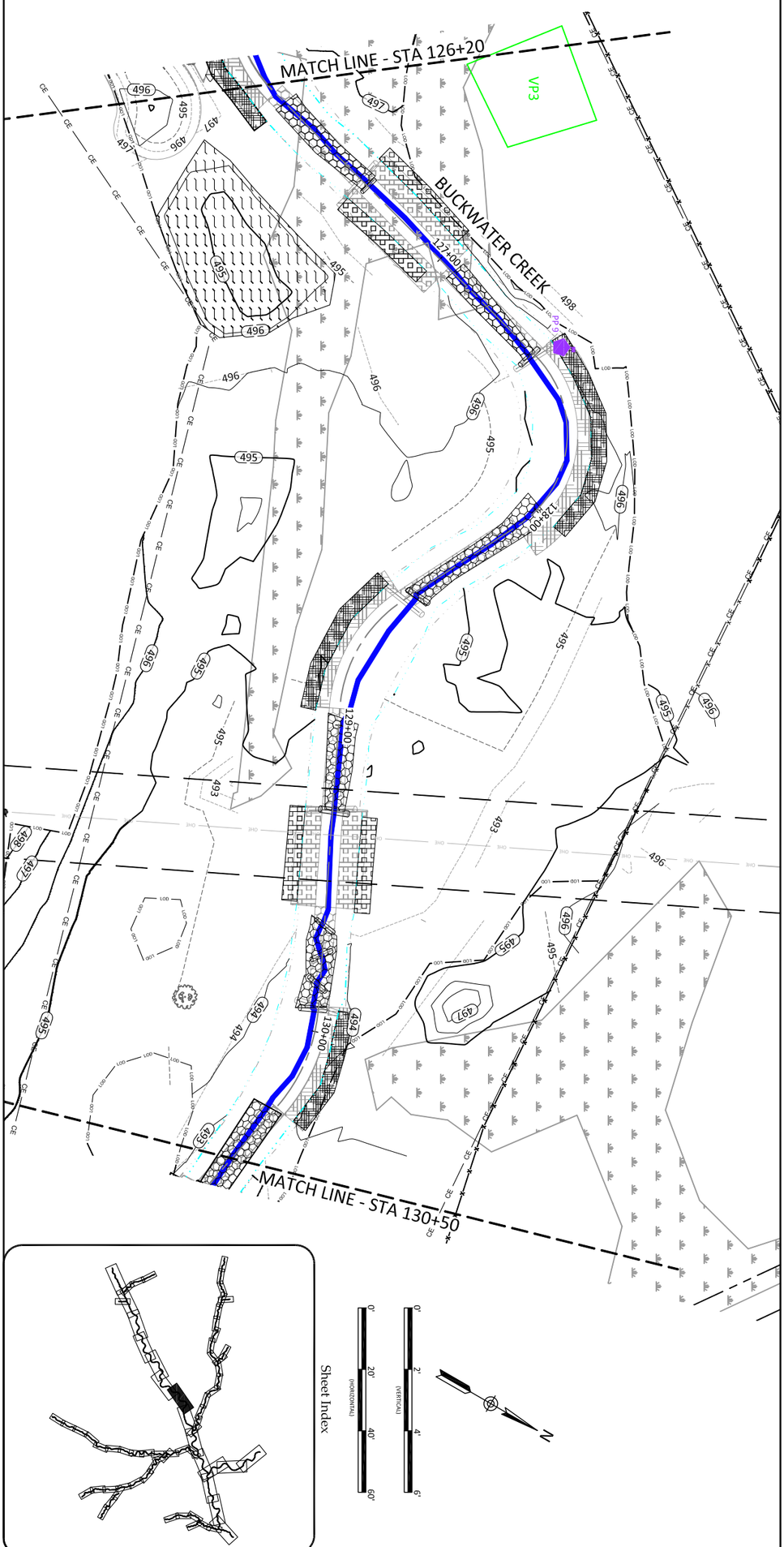
Buckwater Mitigation Site
Orange County, North Carolina

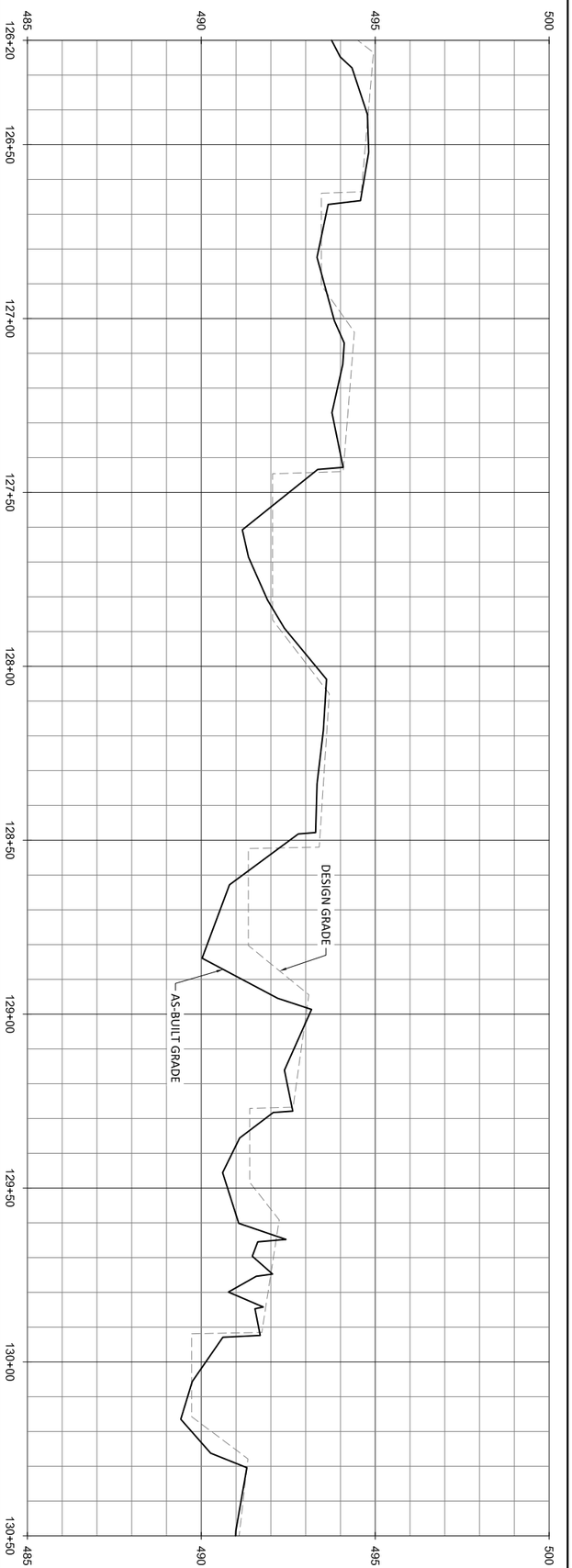
Buckwater Creek Reach 4
Stream Plan and Profile

Revisions:

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

Sheet 1.6





Sheet Index

0' 20' 40' 60' HORIZONTAL

0' 2' 4' 6' VERTICAL

N

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

1.7
Sheet

Revisions:

Buckwater Mitigation Site
Orange County, North Carolina

Buckwater Creek Reach 4
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 7/1/19

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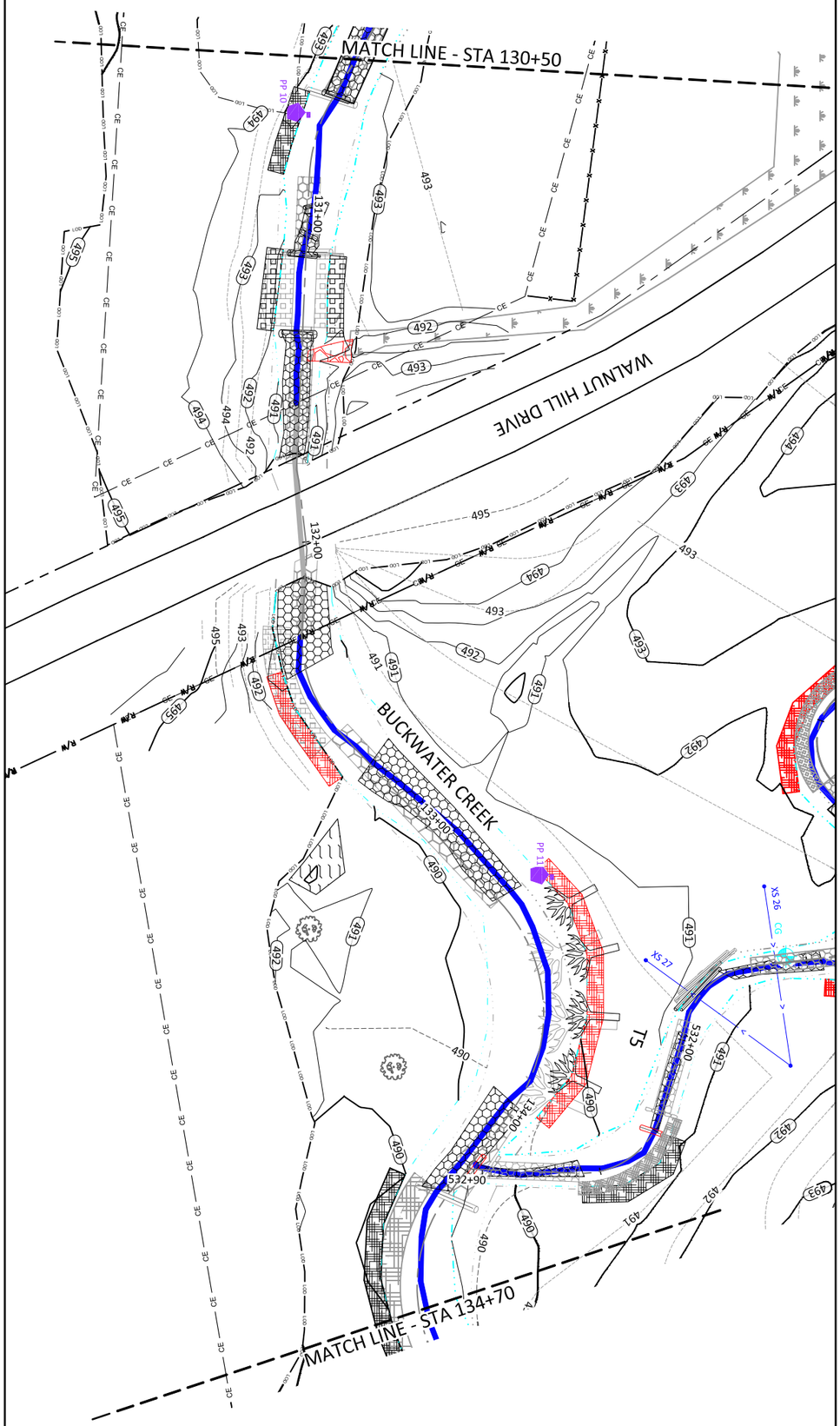

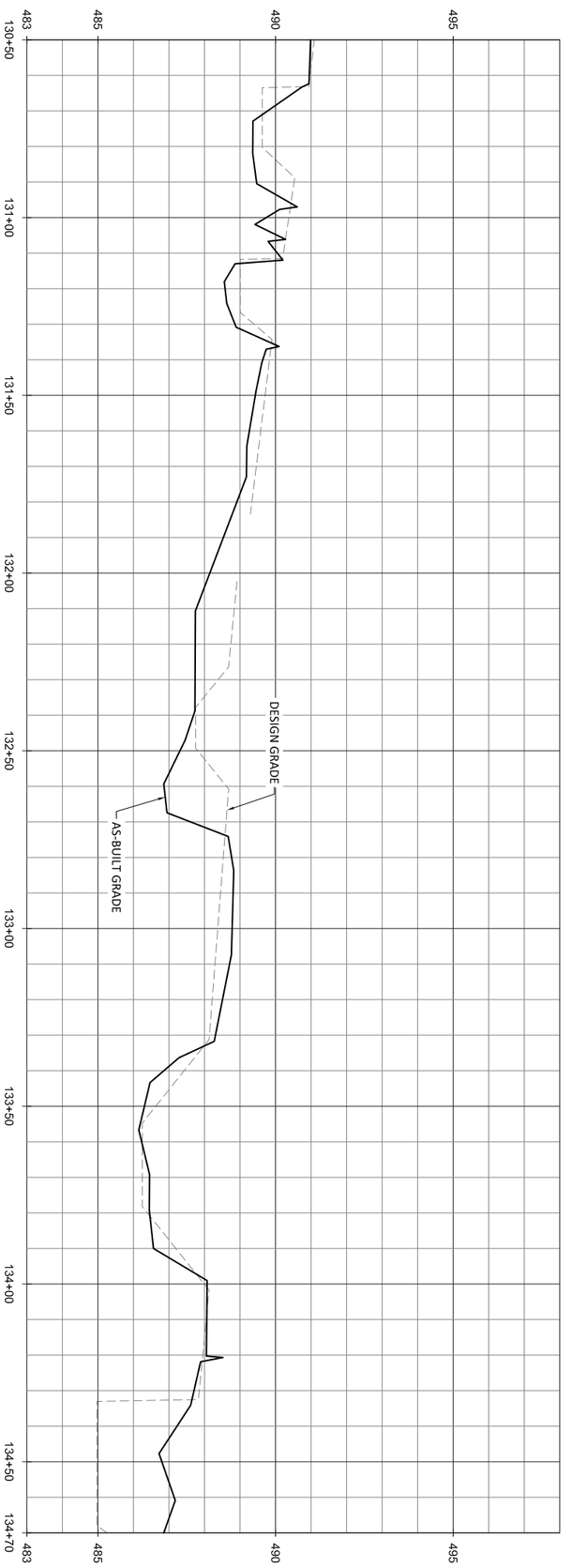

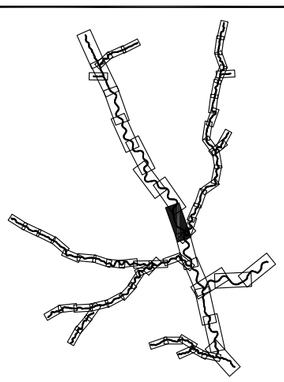

Sheet Index

0' 20' 40' 60' (HORIZONTAL)

0' 2' 4' 6' (VERTICAL)

N

NOTE:
1. STA 131+36: A RIPRAP OUTLET WAS INSTALLED.
2. STA 132+50: BRUSH TOE WAS INSTALLED INSTEAD OF SOD MAT.
3. STA 133+62: BRUSH TOE WAS ADDED WITH THE ROOT WADS.
4. STA 134+34: LOG SILL WAS NOT INSTALLED DUE TO FIELD CONDITIONS.

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

1.8
Sheet

Revisions:

Buckwater Mitigation Site
Orange County, North Carolina

Buckwater Creek Reaches 4 & 5
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 037445 NICOLE MACALUSO MILLS 9/4/19

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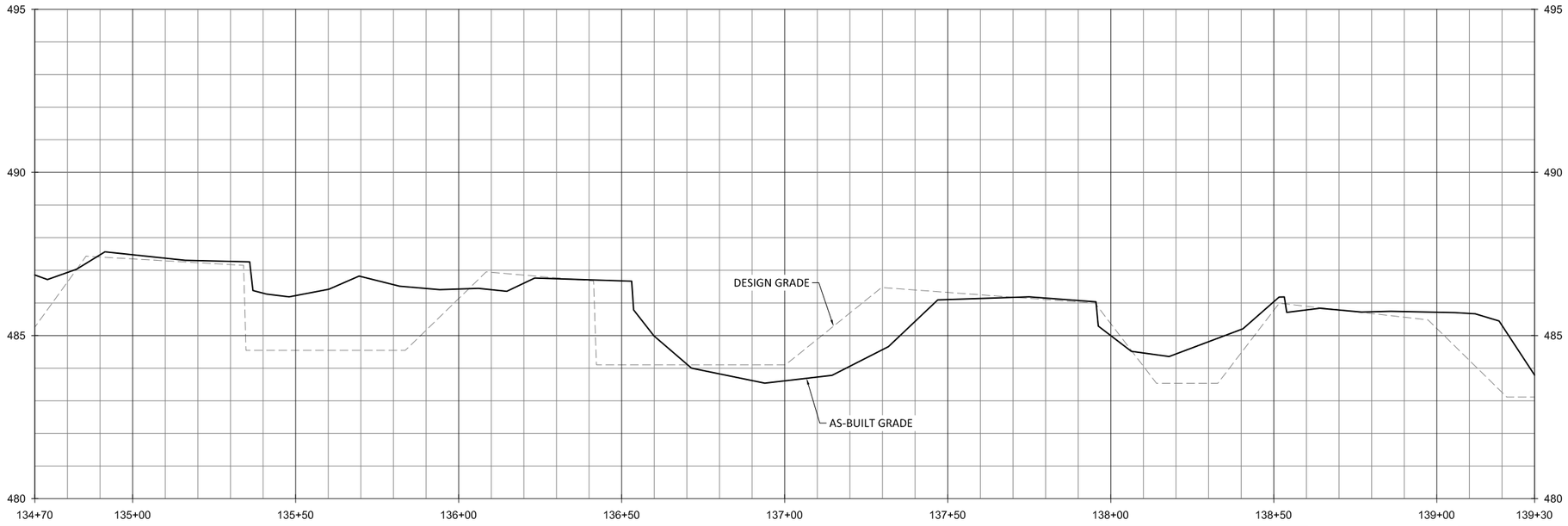

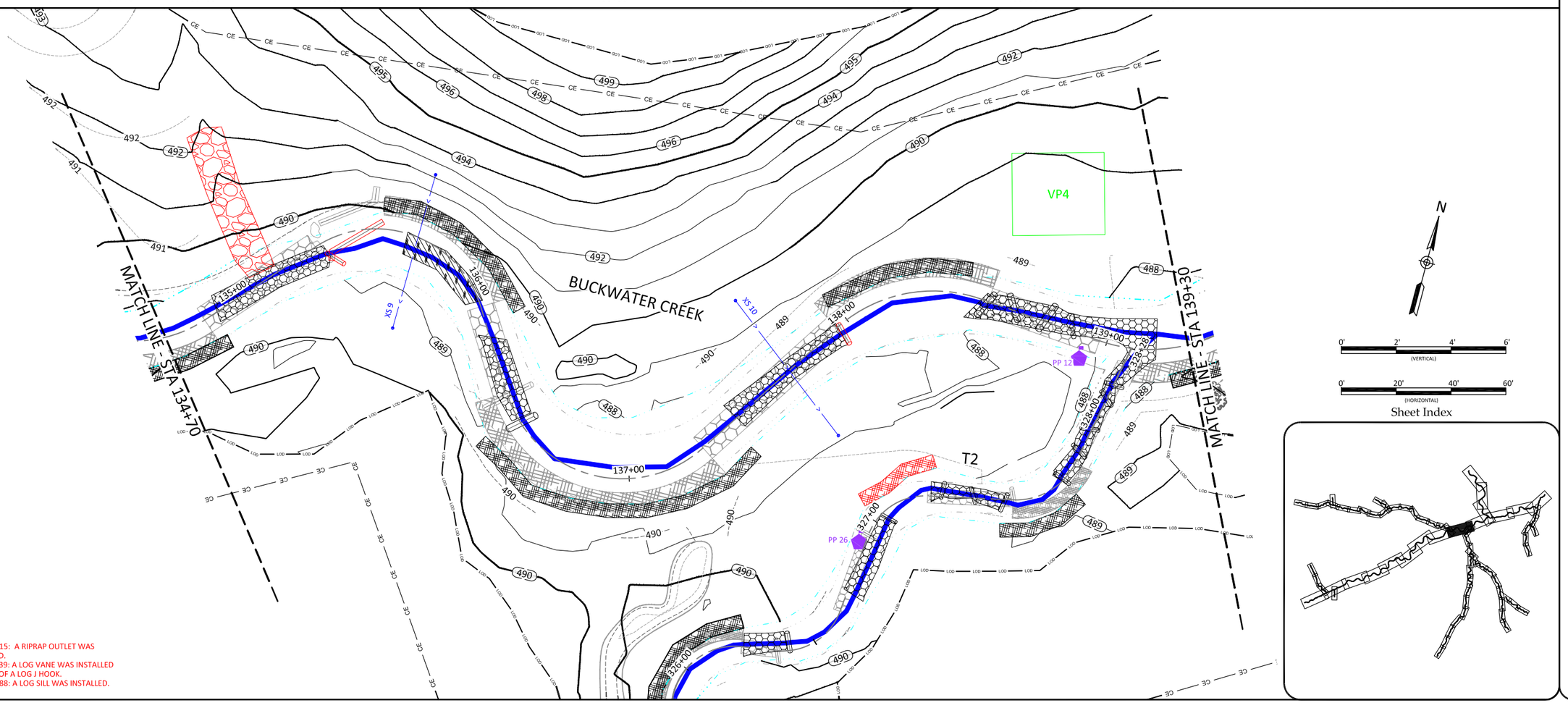

NOTE:

1. STA 135+15: A RIPRAP OUTLET WAS INSTALLED.
2. STA 135+39: A LOG VANE WAS INSTALLED INSTEAD OF A LOG J HOOK.
3. STA 137+88: A LOG SILL WAS INSTALLED.

N

0' 2' 4' 6' (VERTICAL)

0' 20' 40' 60' (HORIZONTAL)

Sheet Index

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NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO

Buckwater Mitigation Site
Orange County, North Carolina

Buckwater Creek Reaches 5 & 6
Stream Plan and Profile

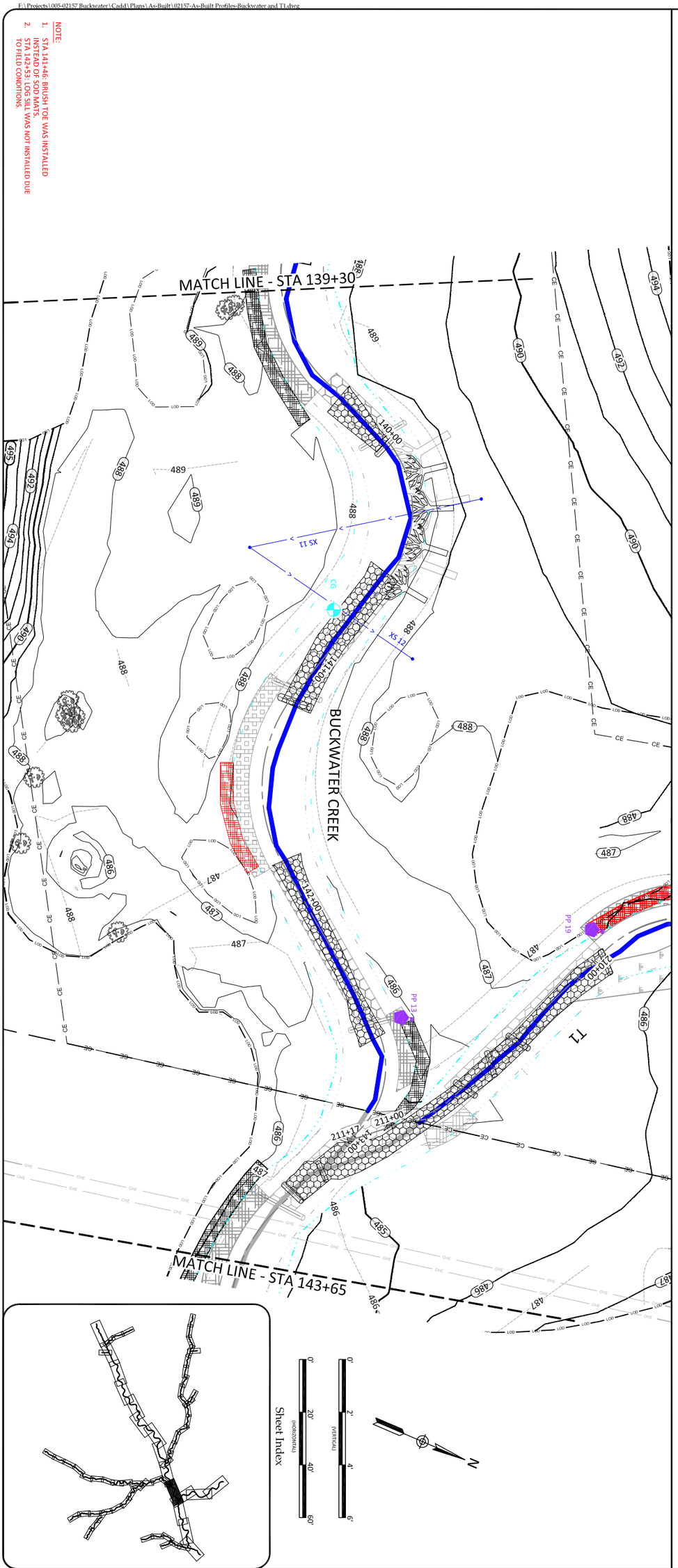
Revisions:

Date: 07.01.2019
Job Number: 005-02157
Project Engineer: NMM
Drawn By: CAW
Checked By: JTL

Sheet 1.9

E:\Projects\005-02157 Buckwater\Gis\d1\Plans\As-Built\02157-As-Built Profile-Buckwater and T1.dgn
September 11, 2019

NOTE:
1. STA 141+46: BRUSH TOE WAS INSTALLED TO FIELD CONDITIONS.
2. STA 142+53: LOG SILL WAS NOT INSTALLED DUE TO FIELD CONDITIONS.

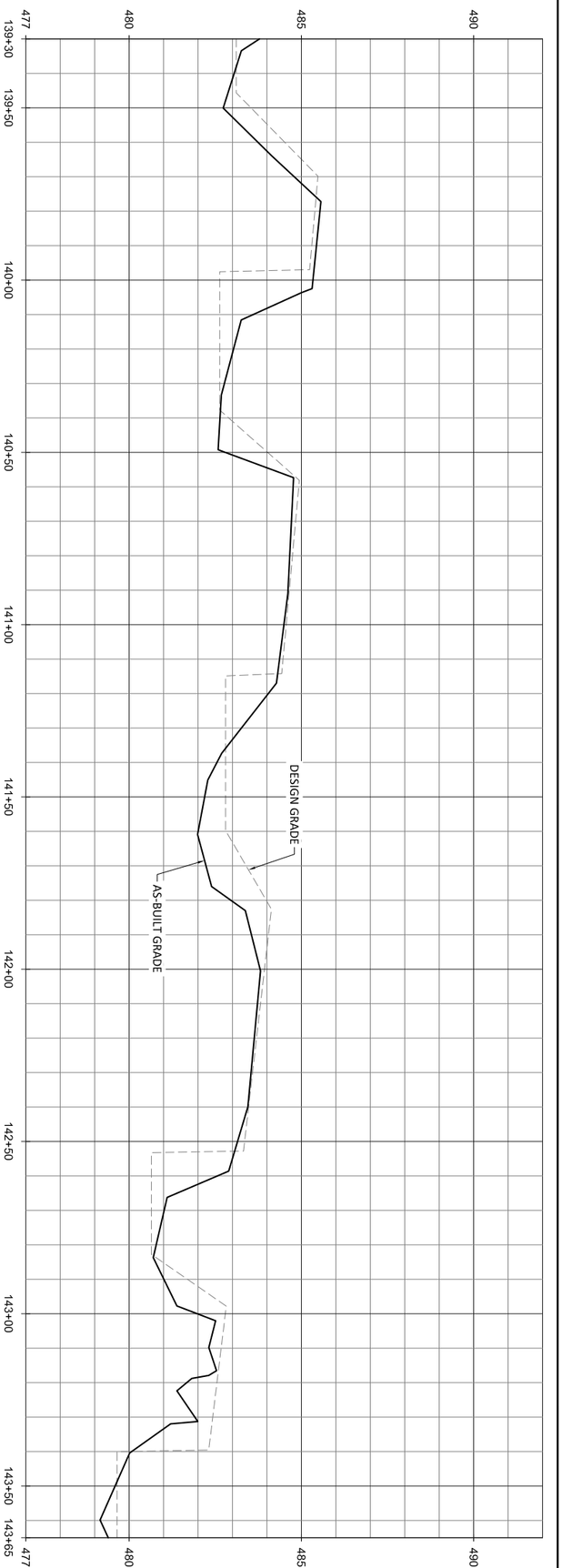


Sheet Index

0 20' 40' 60' (HORIZONTAL)

0 2' 4' 6' (VERTICAL)

N



Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

1.10
Sheet

Revisions:

Buckwater Mitigation Site
Orange County, North Carolina

Buckwater Creek Reach 6
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 7/1/19

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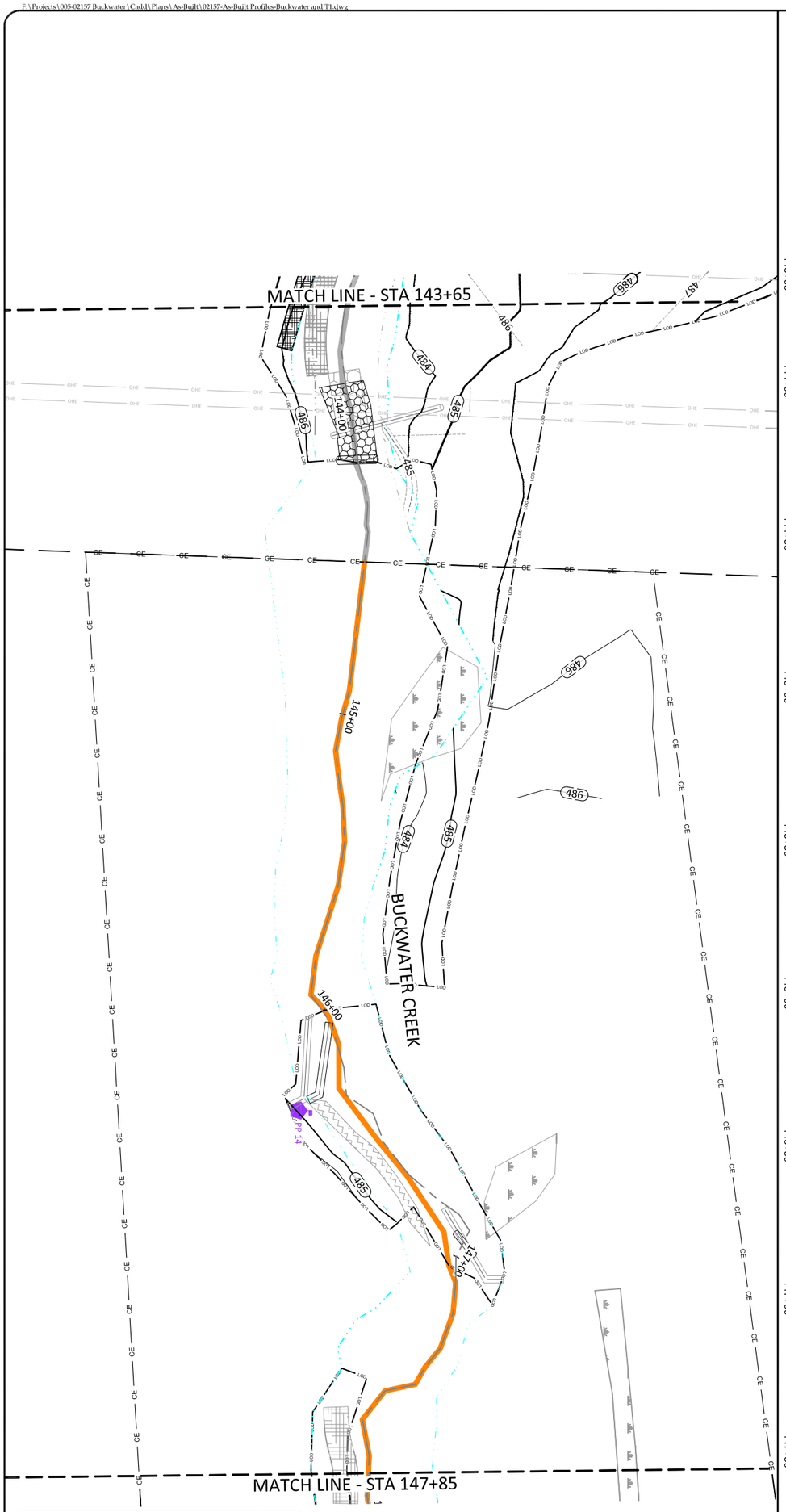

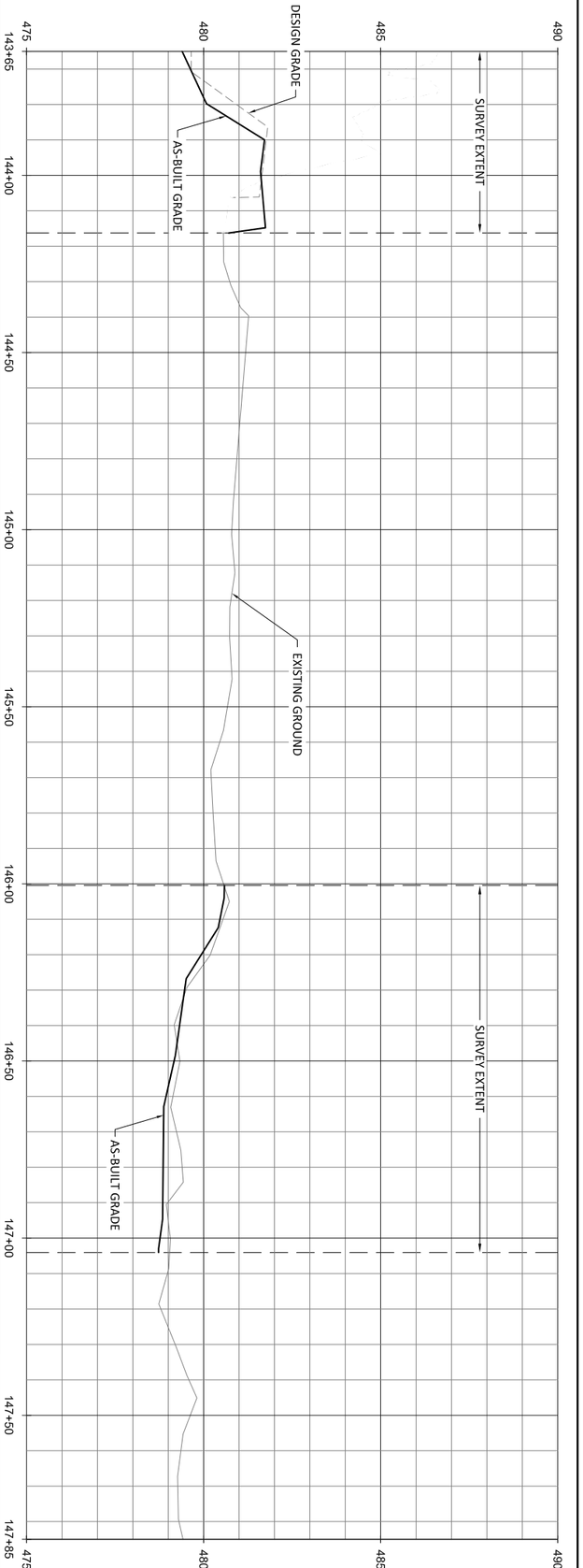

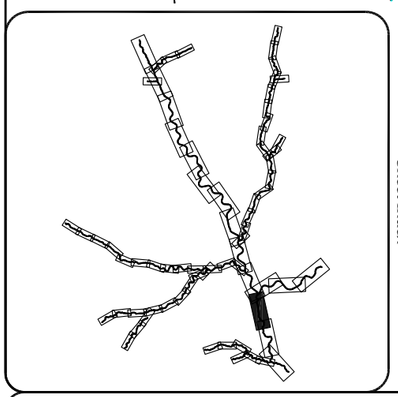

Sheet Index

0' 20' 40' 60' (HORIZONTAL)

0' 2' 4' 6' (VERTICAL)

N

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

1.11
Sheet

Revisions:

Buckwater Mitigation Site
Orange County, North Carolina

Buckwater Creek Reaches 6 & 7
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 7/1/19

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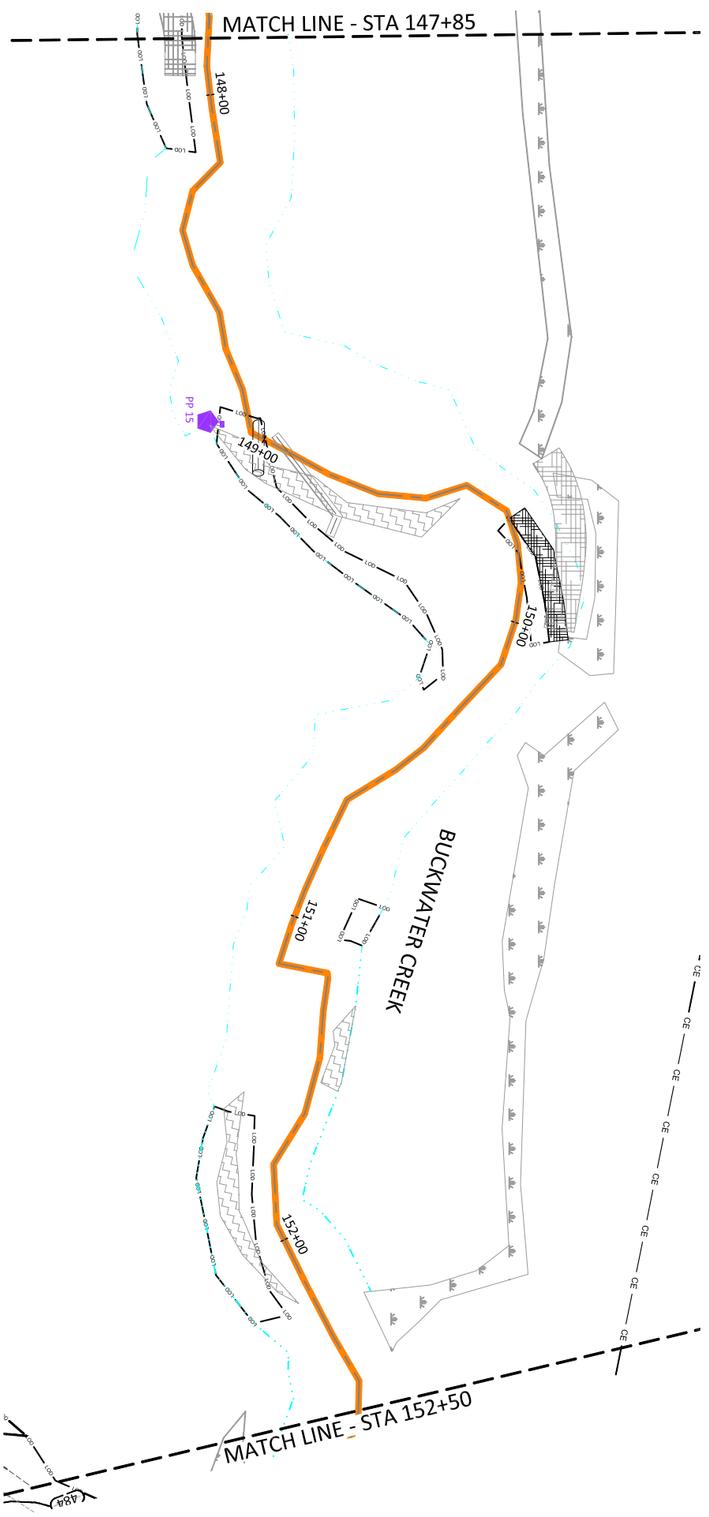

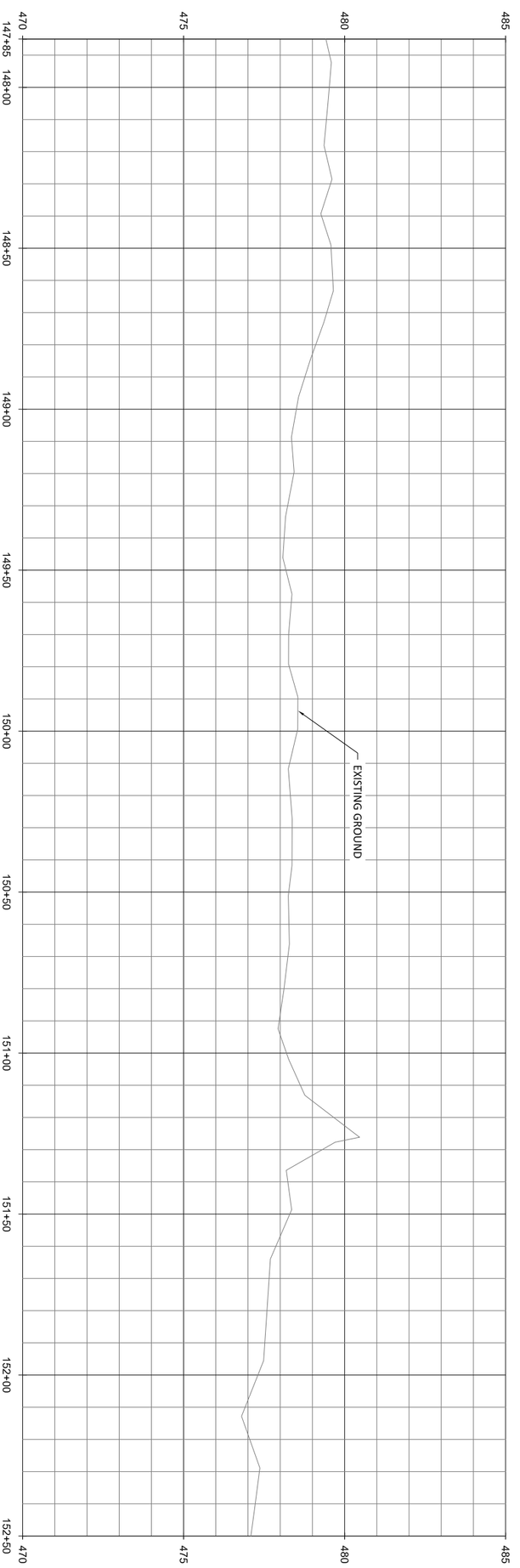

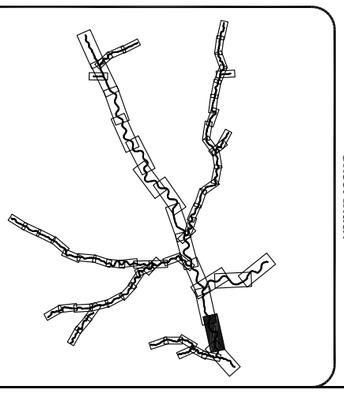

Sheet Index

0' 20' 40' 60' (HORIZONTAL)

0' 2' 4' 6' (VERTICAL)

N

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

Revisions:

1.12

Sheet

Buckwater Mitigation Site
Orange County, North Carolina

Buckwater Creek Reach 7
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 7/9/19

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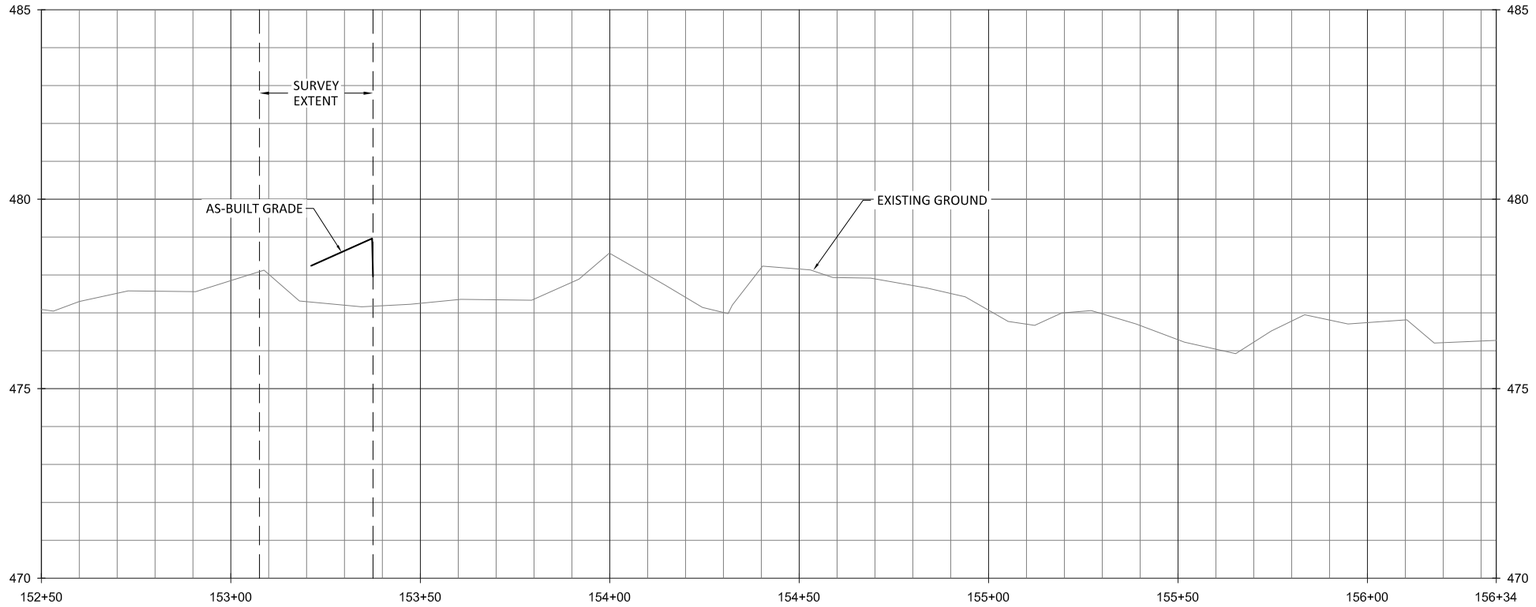
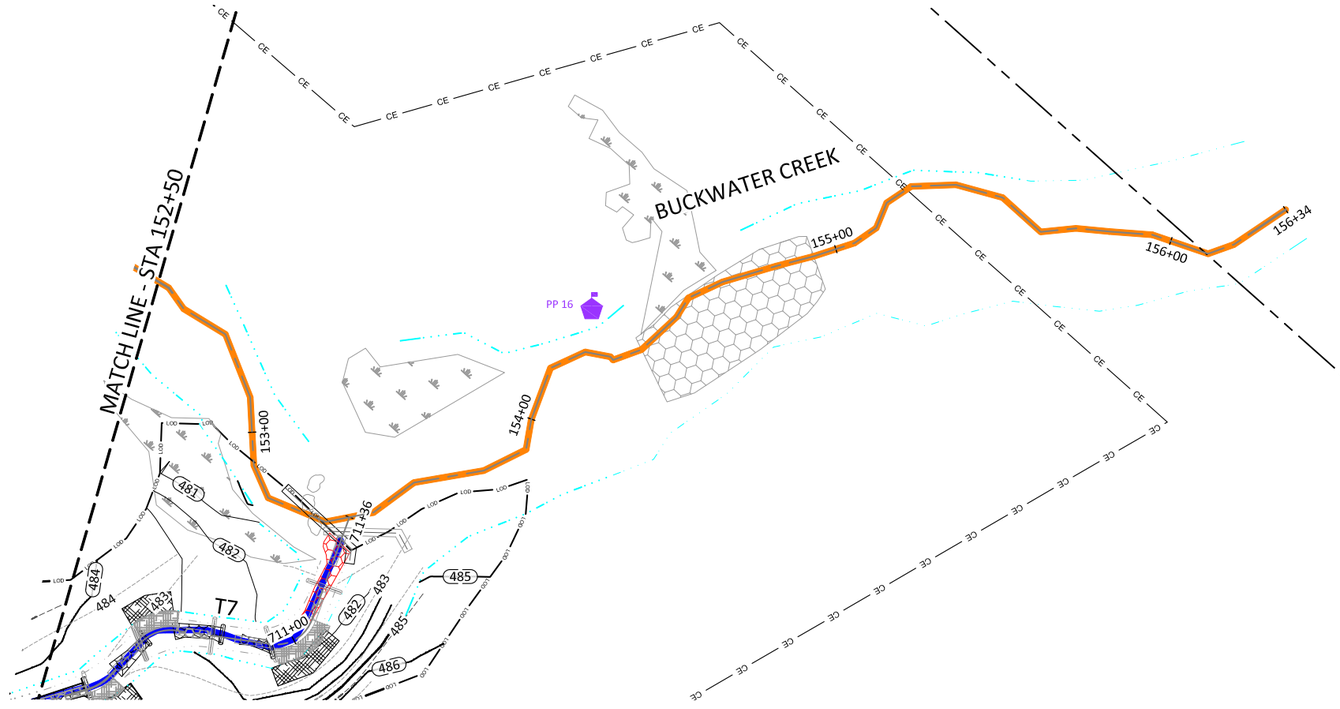
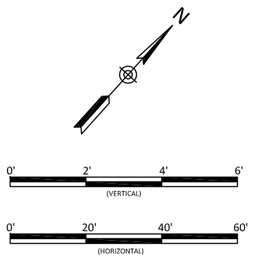




NOTE:

1. STA 154+67: RIFFLE NATURALLY FORMS AND SHIFTS IN THIS AREA. NO RIFFLE WAS CONSTRUCTED.



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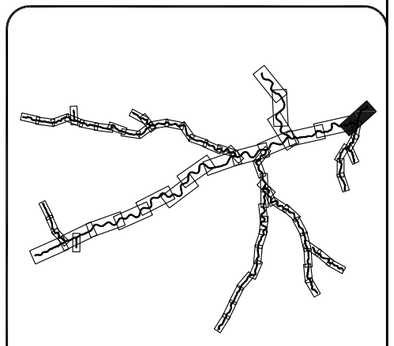

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Buckwater Mitigation Site
Orange County, North Carolina

Buckwater Creek Reaches 7 & 8
Stream Plan and Profile

Revisions:

Date: 07.01.2019
Job Number: 005-02157
Project Engineer: NMM
Drawn By: CAW
Checked By: JTL

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NOTE:

1. STA 200+54: BRUSH TOE WAS INSTALLED INSTEAD OF VEGETATED SOIL LIFT.
2. STA 201+19: BOULDER SILL WAS INSTALLED INSTEAD OF A LOG SILL.

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Buckwater Mitigation Site
Orange County, North Carolina

T1 Reach 1
Stream Plan and Profile

Revisions:

Date: 07.01.2019
Job Number: 005-02157
Project Engineer: NMM
Drawn By: CAW
Checked By: JTL

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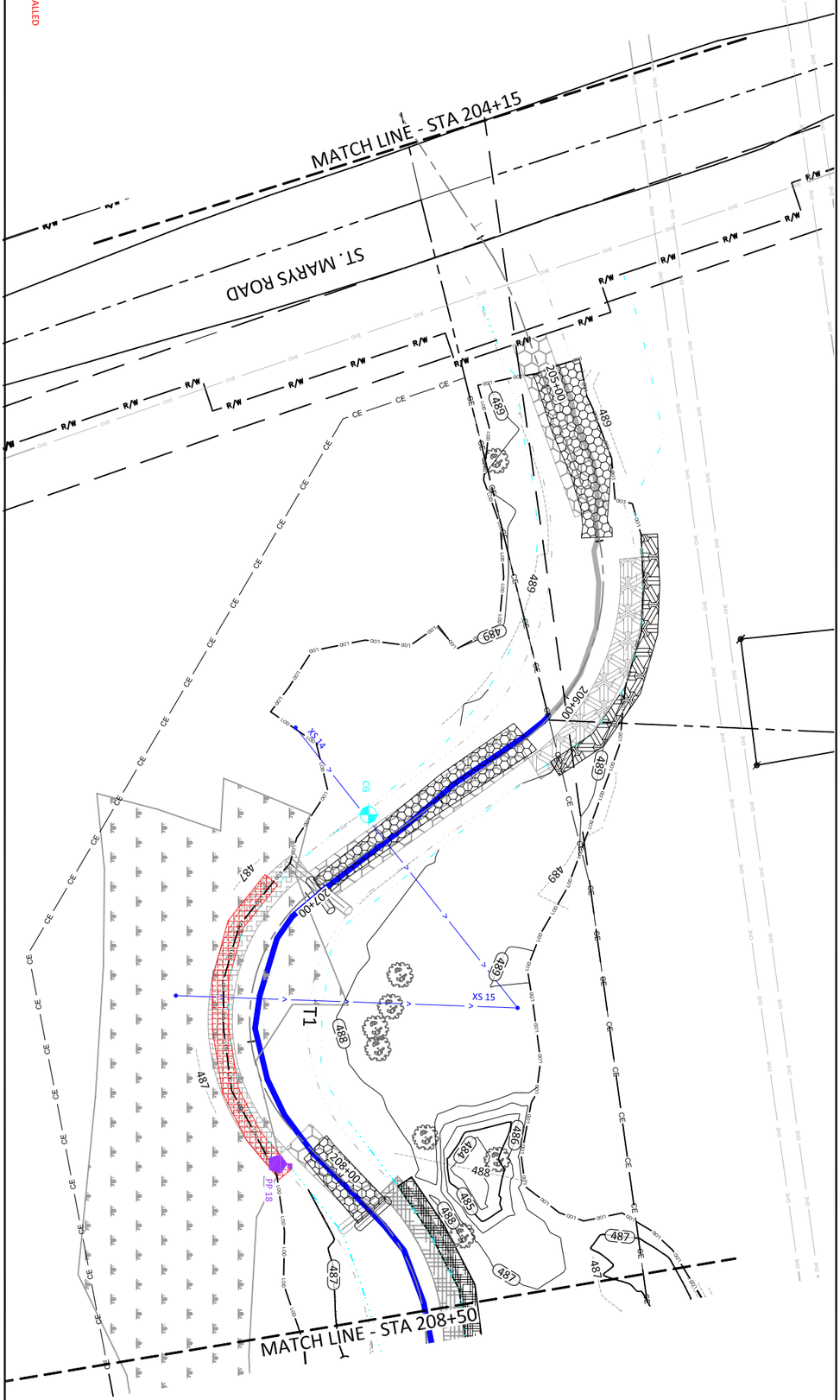
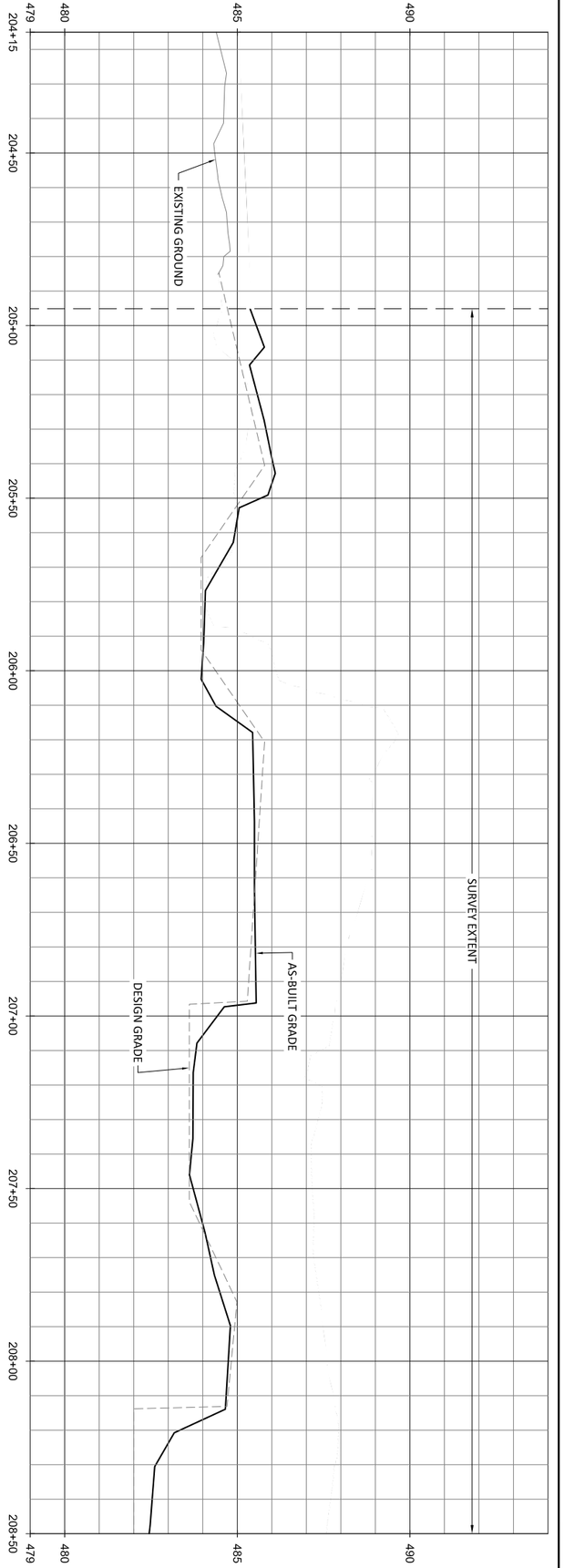
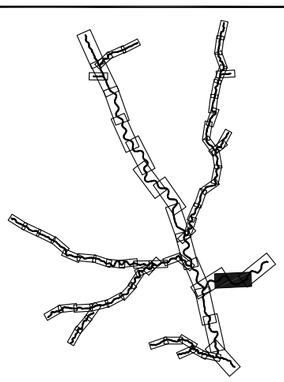
NOTE:
1. STA 207+56- BOULDER TOE WAS INSTALLED INSTEAD OF SOD MATS.







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0' 20' 40' 60' (HORIZONTAL)

0' 2' 4' 6' (VERTICAL)

N

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Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

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Buckwater Mitigation Site
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T1 Reaches 1 & 2
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 7/1/19

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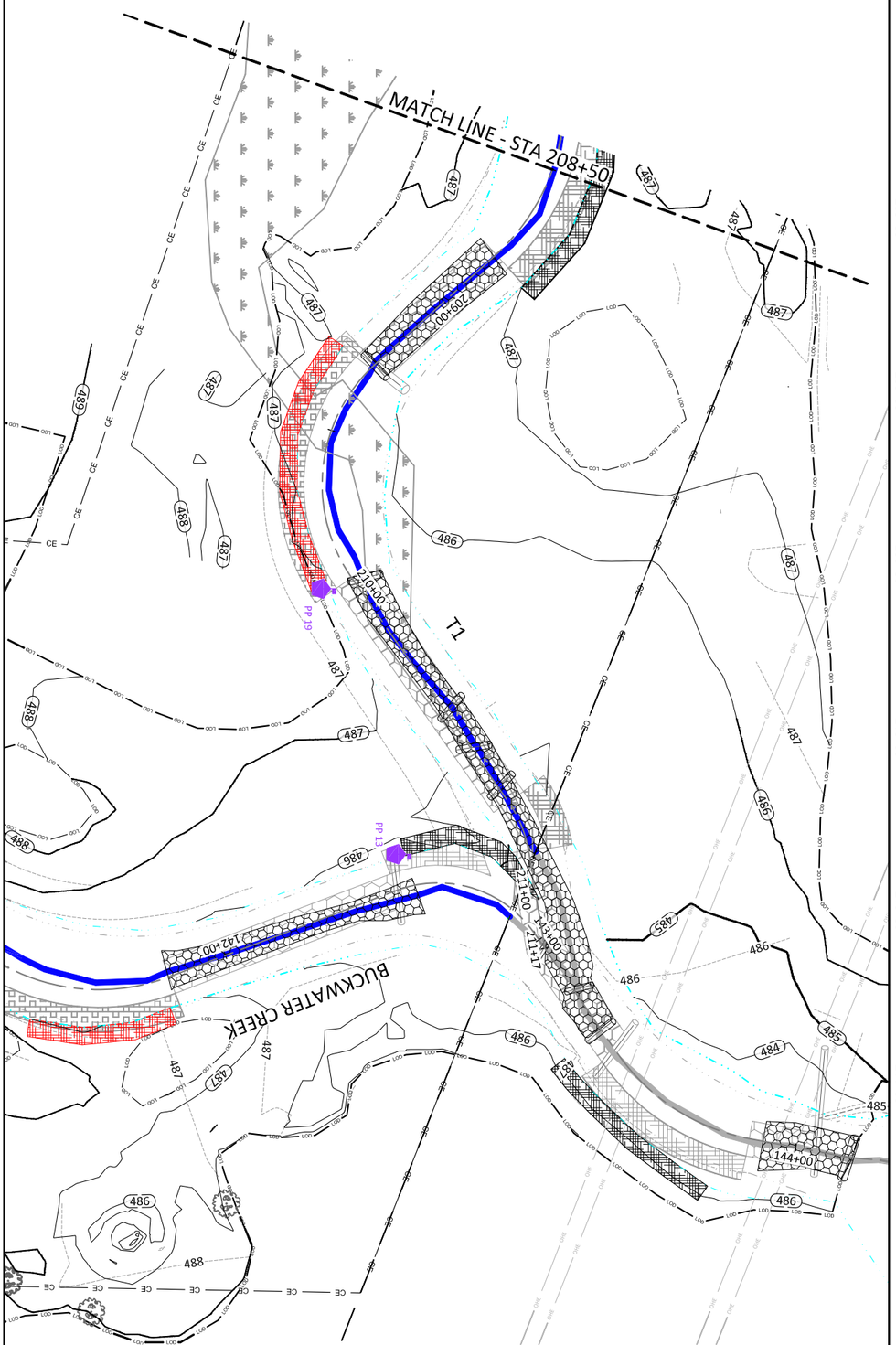
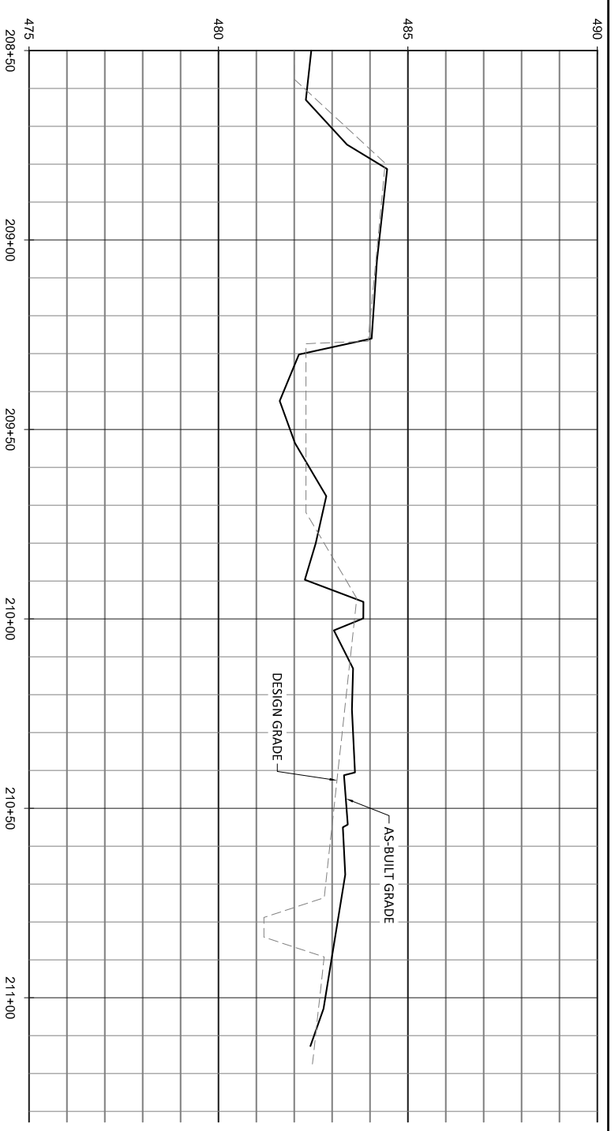
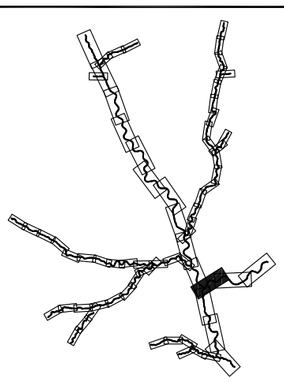
NOTE:
1. STA 209+67: BRUSH TOE WAS INSTALLED INSTEAD OF SOD MATS.







Sheet Index

0' 20' 40' 60' (HORIZONTAL)

0' 2' 4' 6' (VERTICAL)

N

Date: 07.01.2019
Job Number: 005-02157
Project Engineer: NMM
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T1 Reach 2
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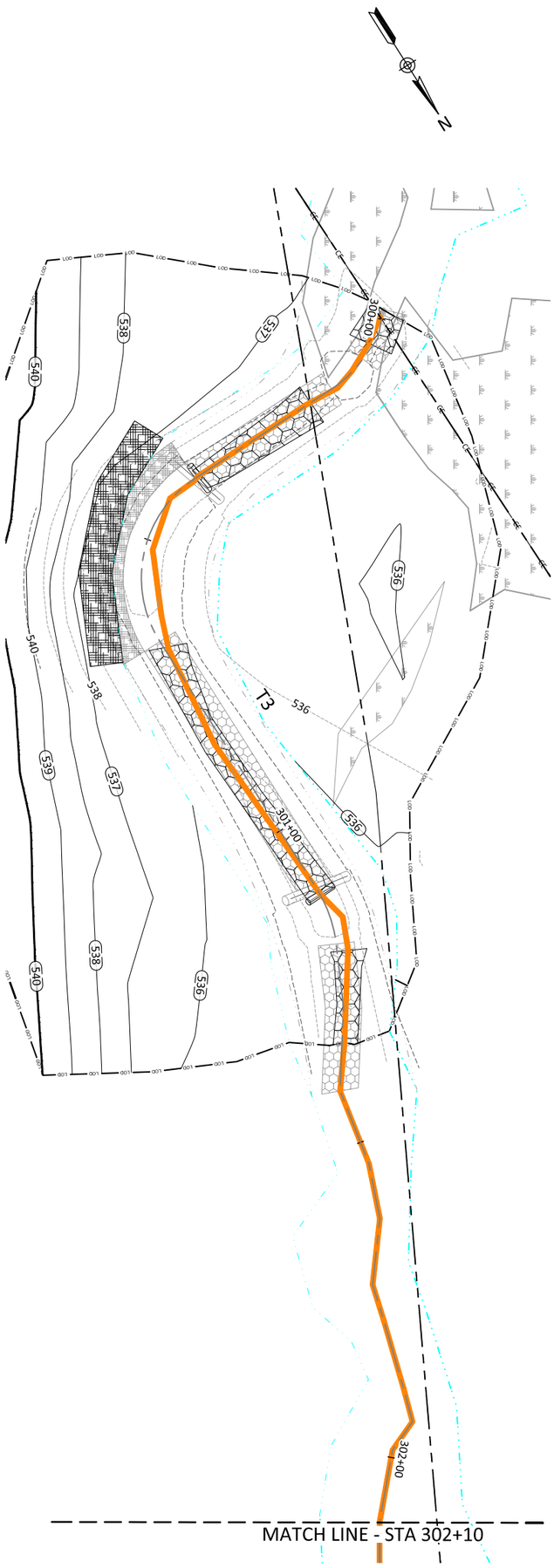

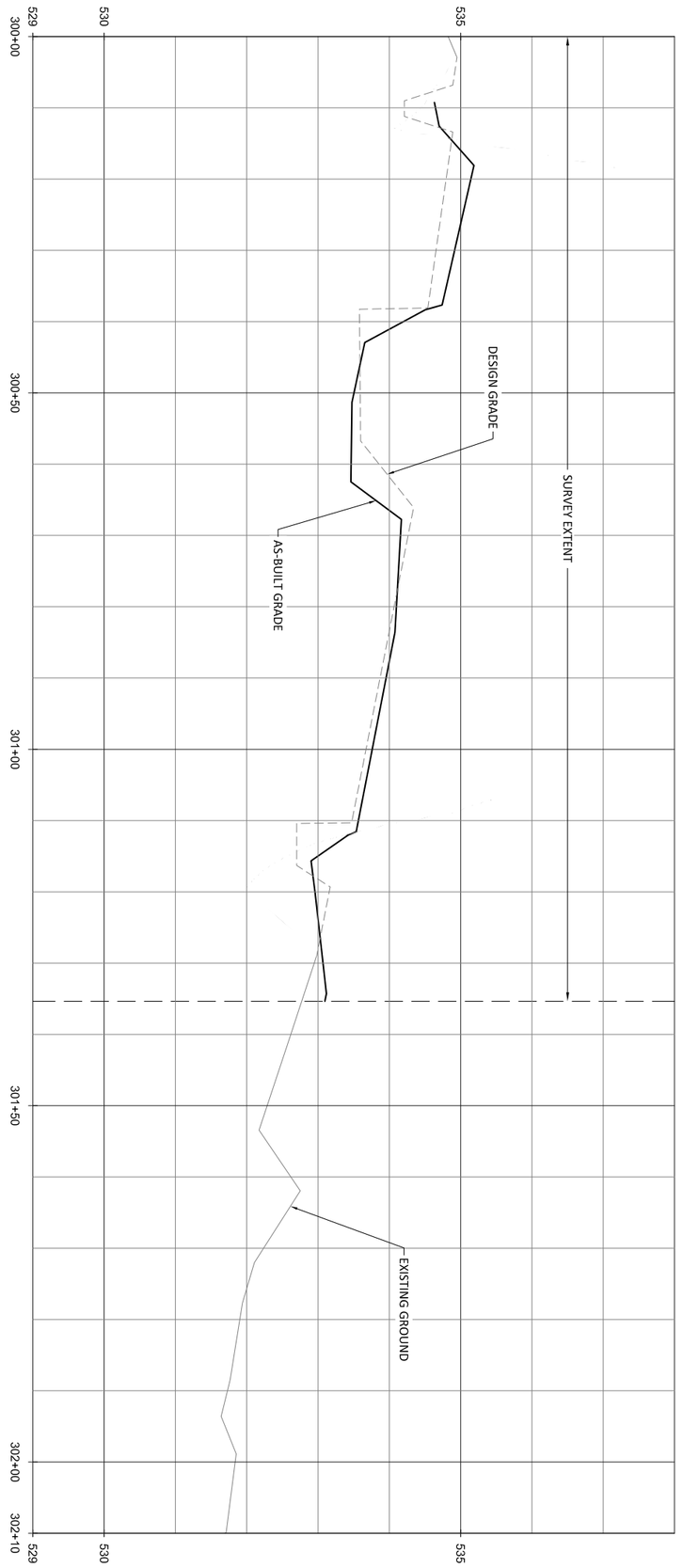

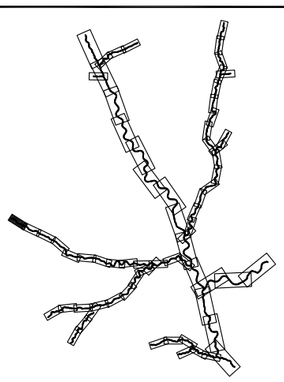

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HORIZONTAL 0' 10' 20' 30'

VERTICAL 0' 1' 2' 3'

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T3 Reach 1
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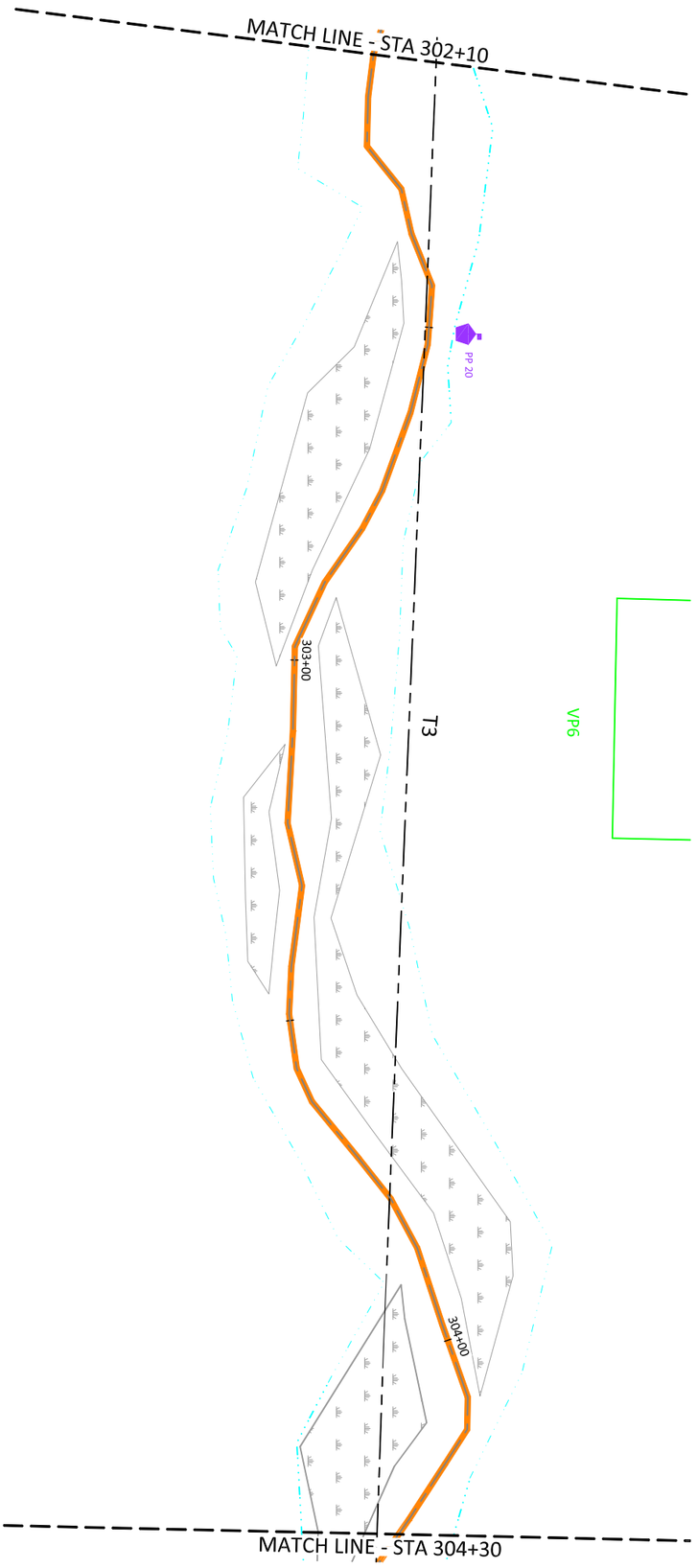

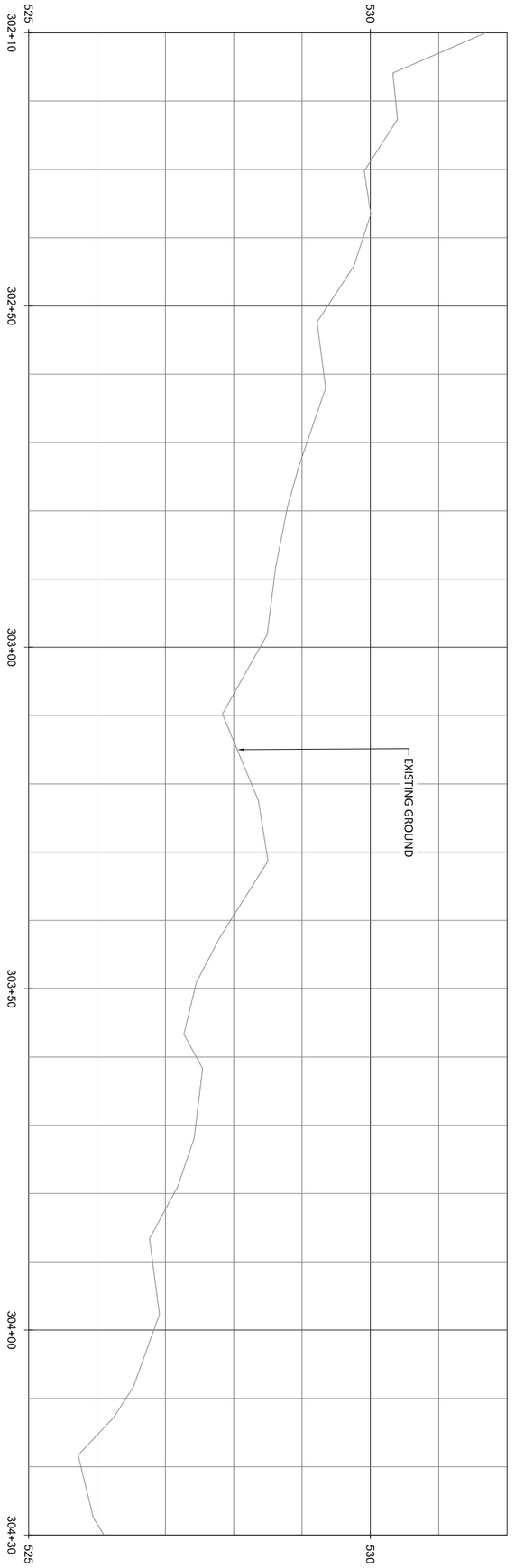

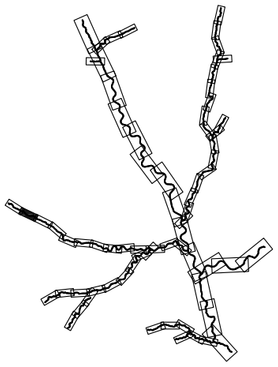

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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

N

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T3 Reach 1
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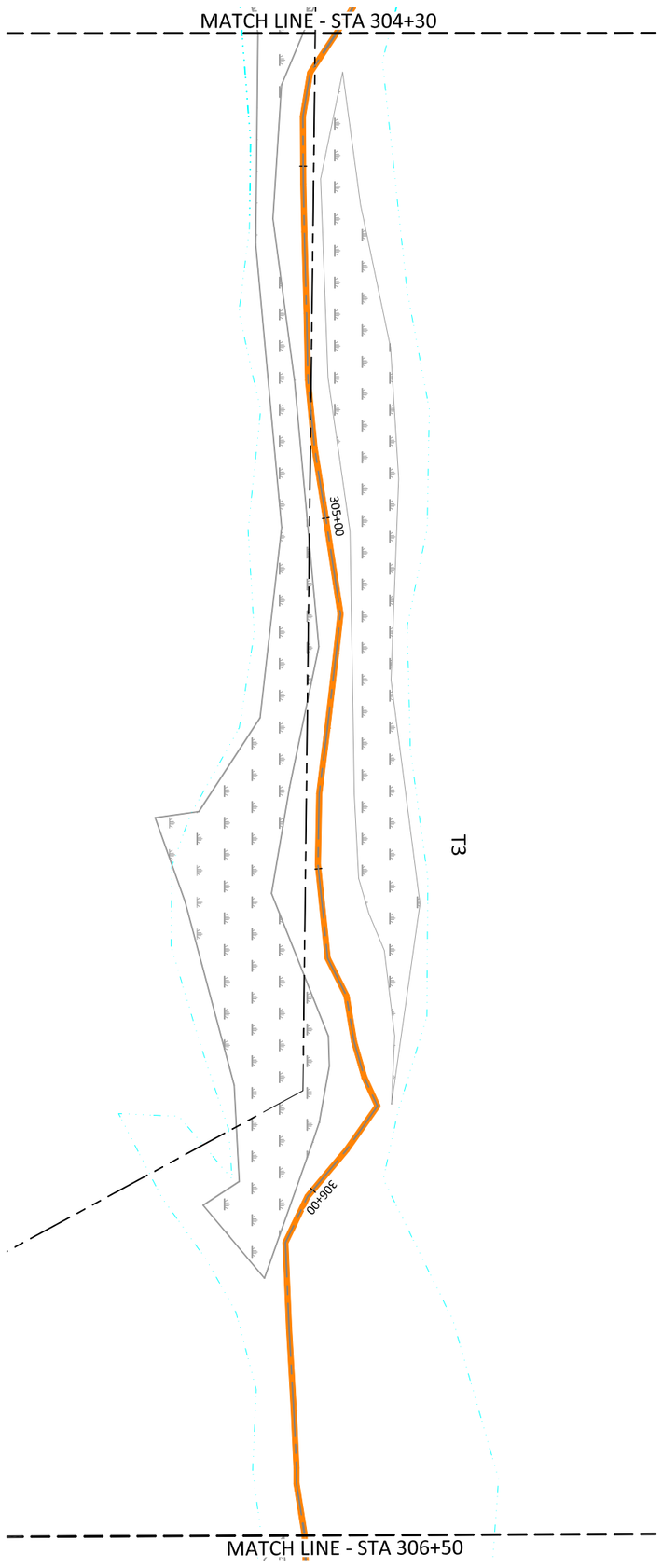

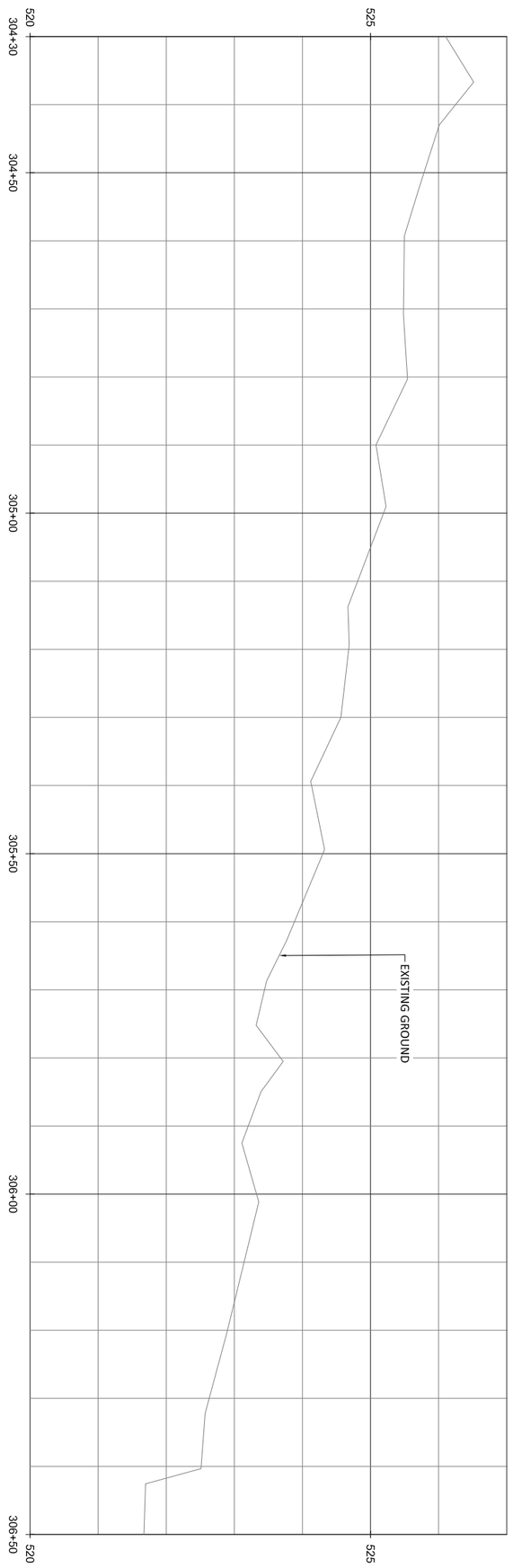

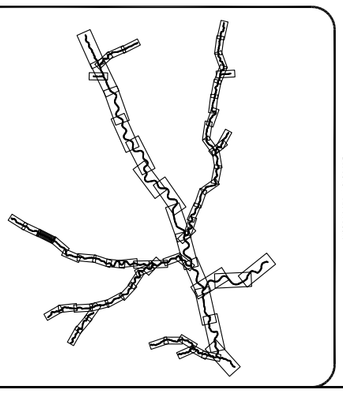

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0' 10' 20' 30' HORIZONTAL

0' 1' 2' 3' VERTICAL

N

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NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 9/9/19

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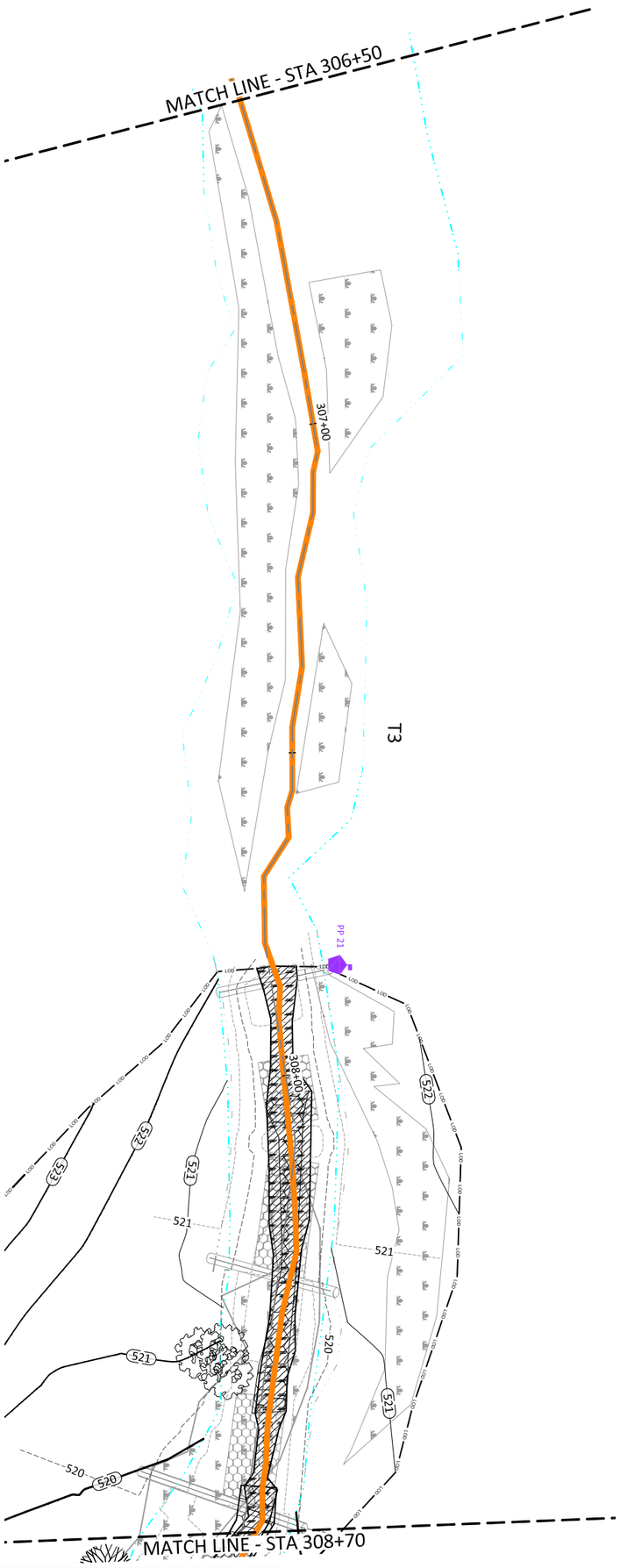
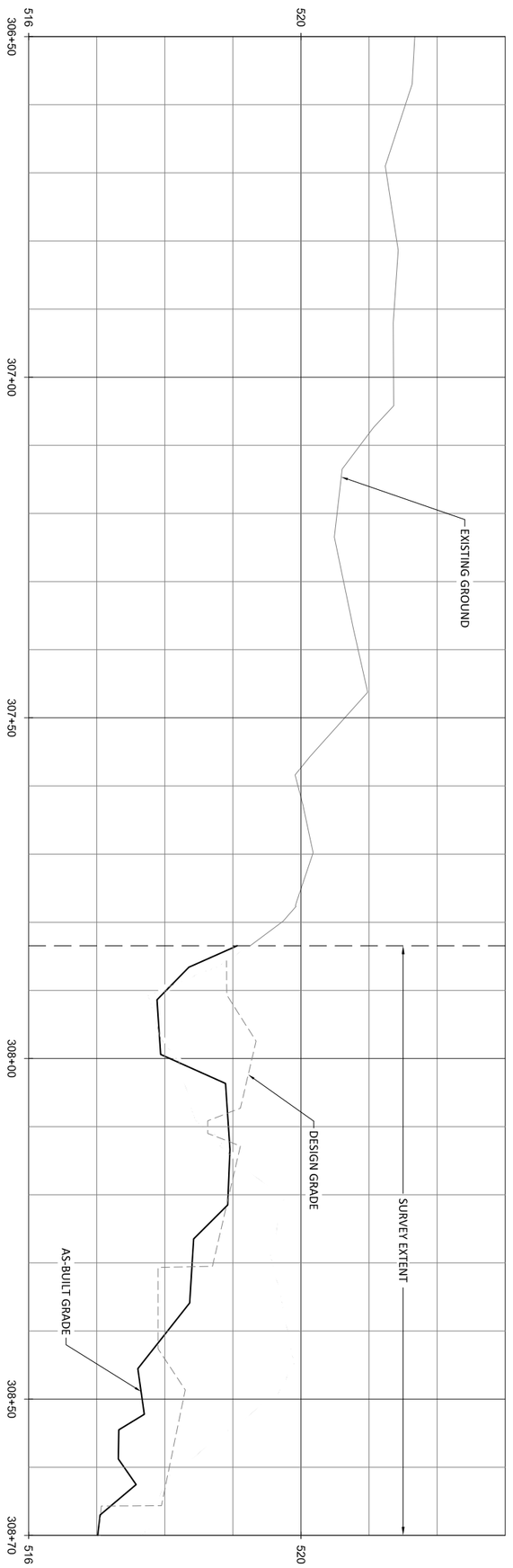
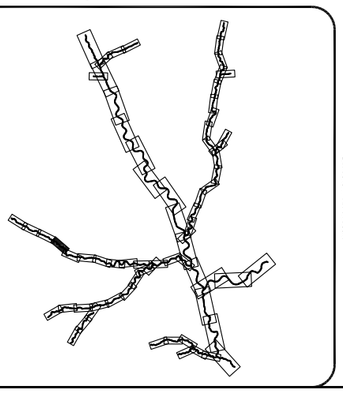
NOTE:
1. NO LOG STRUCTURES INSTALLED DUE TO BEDROCK.







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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

N

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Buckwater Mitigation Site
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T3 Reach 1
Stream Plan and Profile

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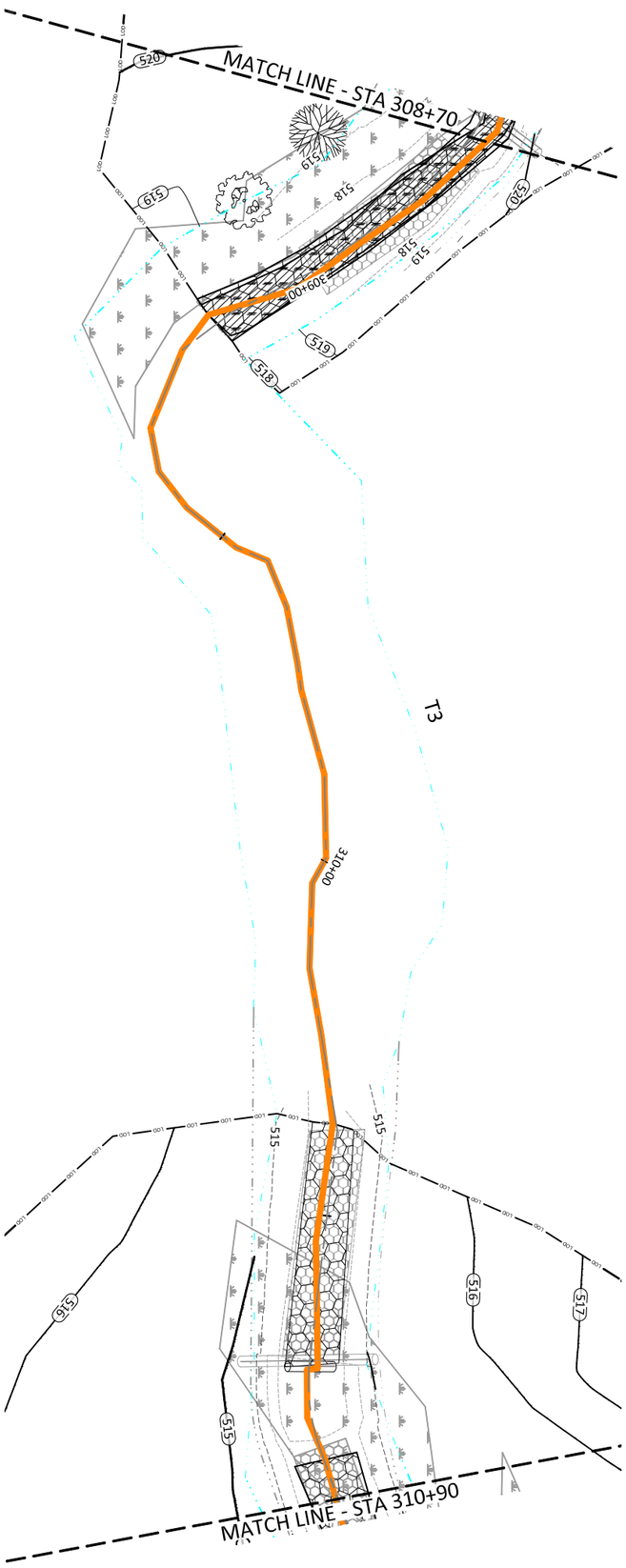

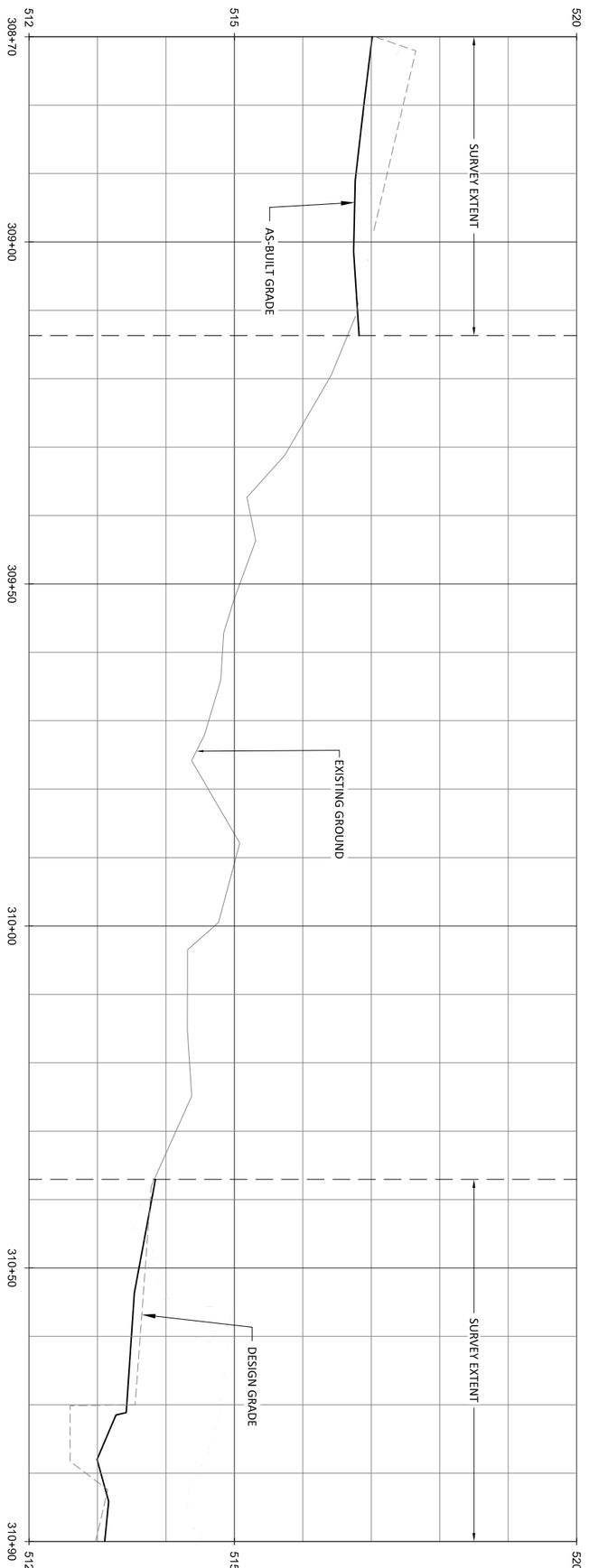

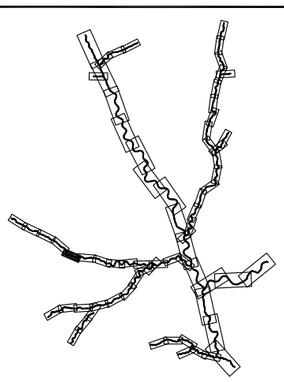

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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

N

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Drawn By:	CAW
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Buckwater Mitigation Site
Orange County, North Carolina

T3 Reach 1
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 7/9/19

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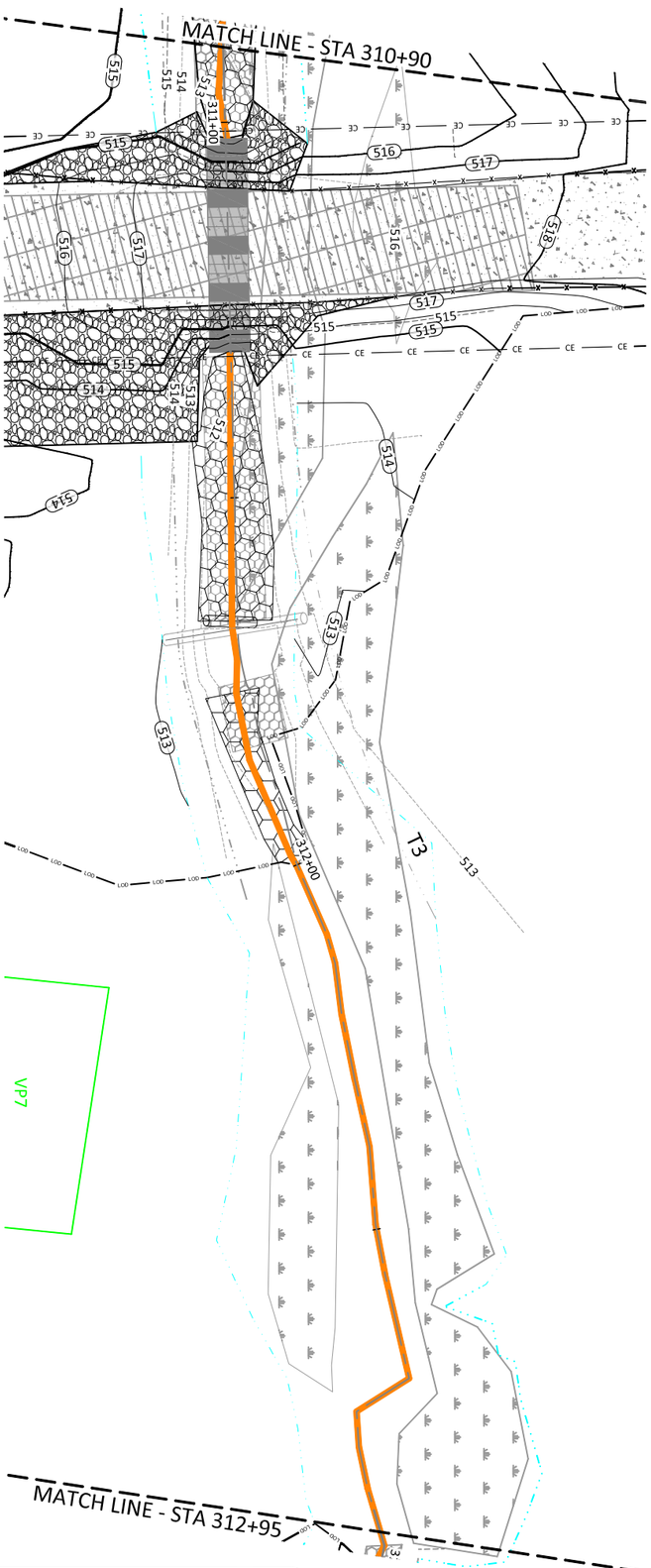

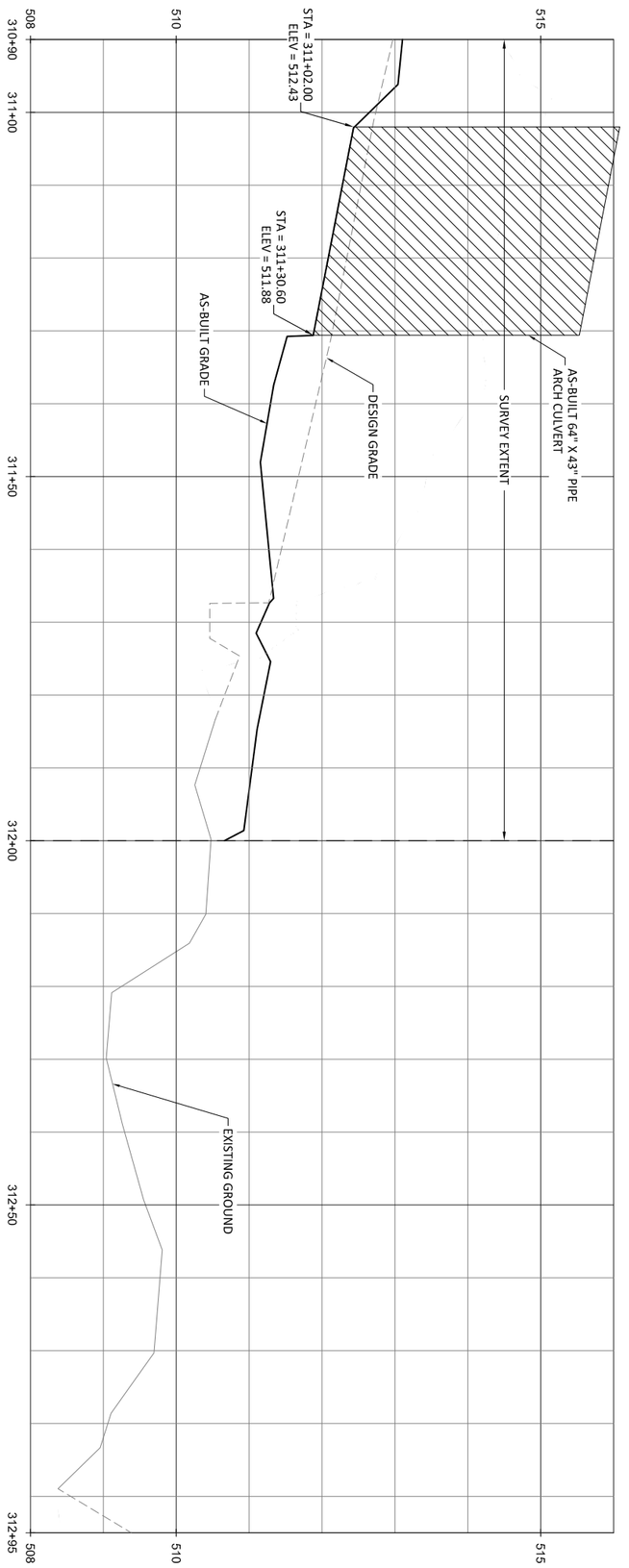

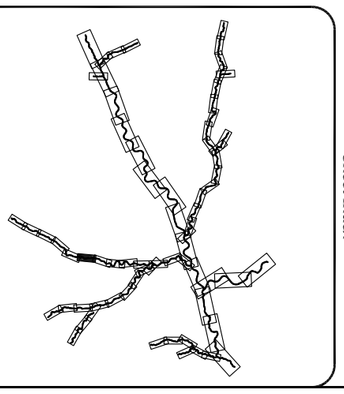

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0' 10' 20' 30' HORIZONTAL

0' 1' 2' 3' VERTICAL

N

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Buckwater Mitigation Site
Orange County, North Carolina

T3 Reach 1
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 037445 NICOLE MACALUSO MILLS 7/9/19

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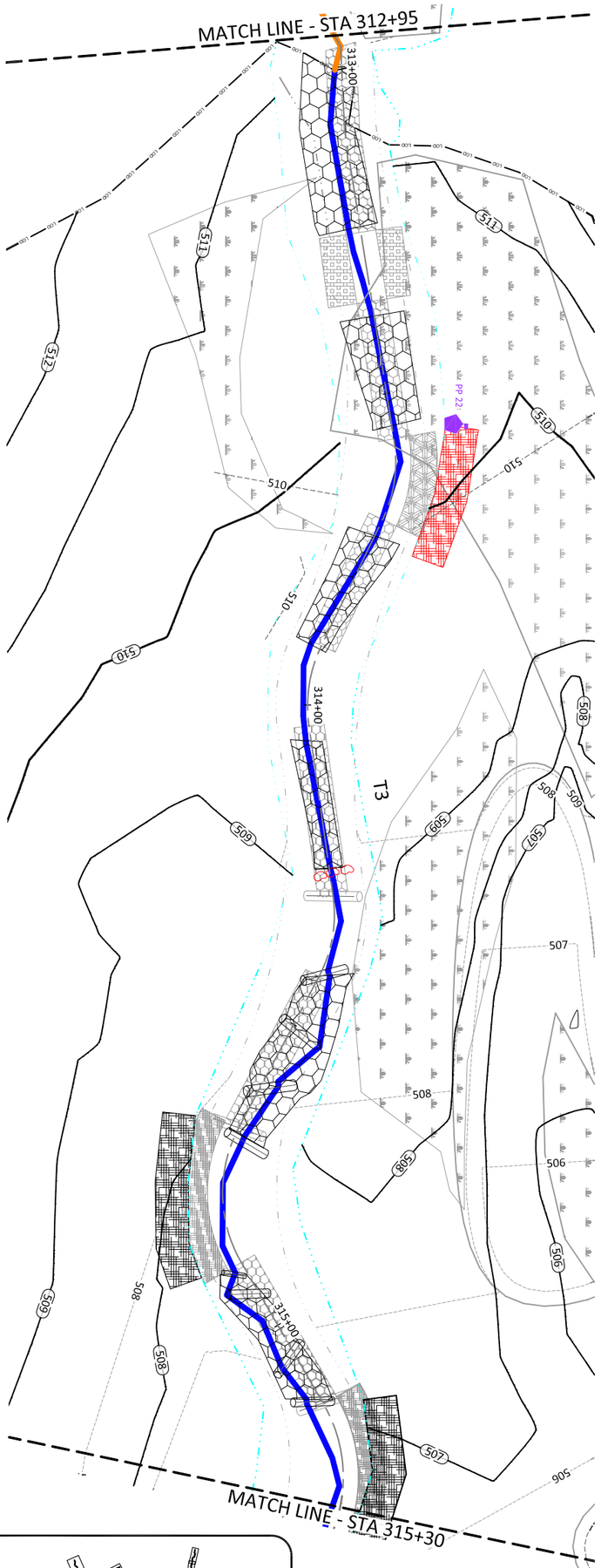
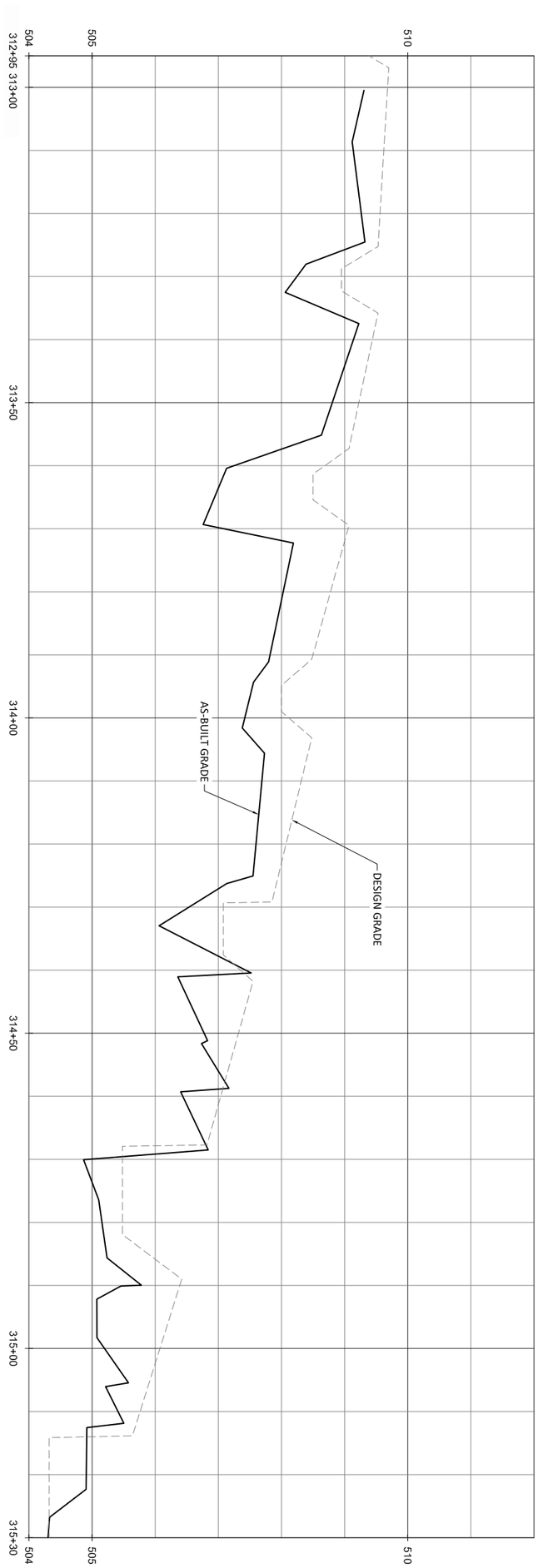
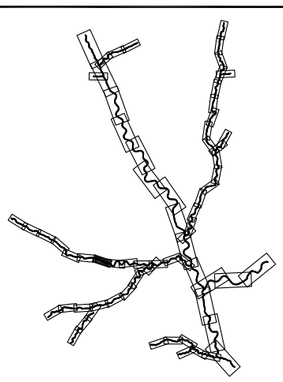




NOTE:
1. STA 313+68: BRUSH TOE WAS INSTALLED INSTEAD OF VEGETATED SOIL LIFT.
2. STA 314+32: BOULDER SILL INSTALLED INSTEAD OF LOG SILL.



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0' 10' 20' 30' (HORIZONTAL)
0 1 2 3 (VERTICAL)

N

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Buckwater Mitigation Site
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T3 Reaches 1 & 2
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 037445 NICOLE MACALUSO MILLS 7/9/19

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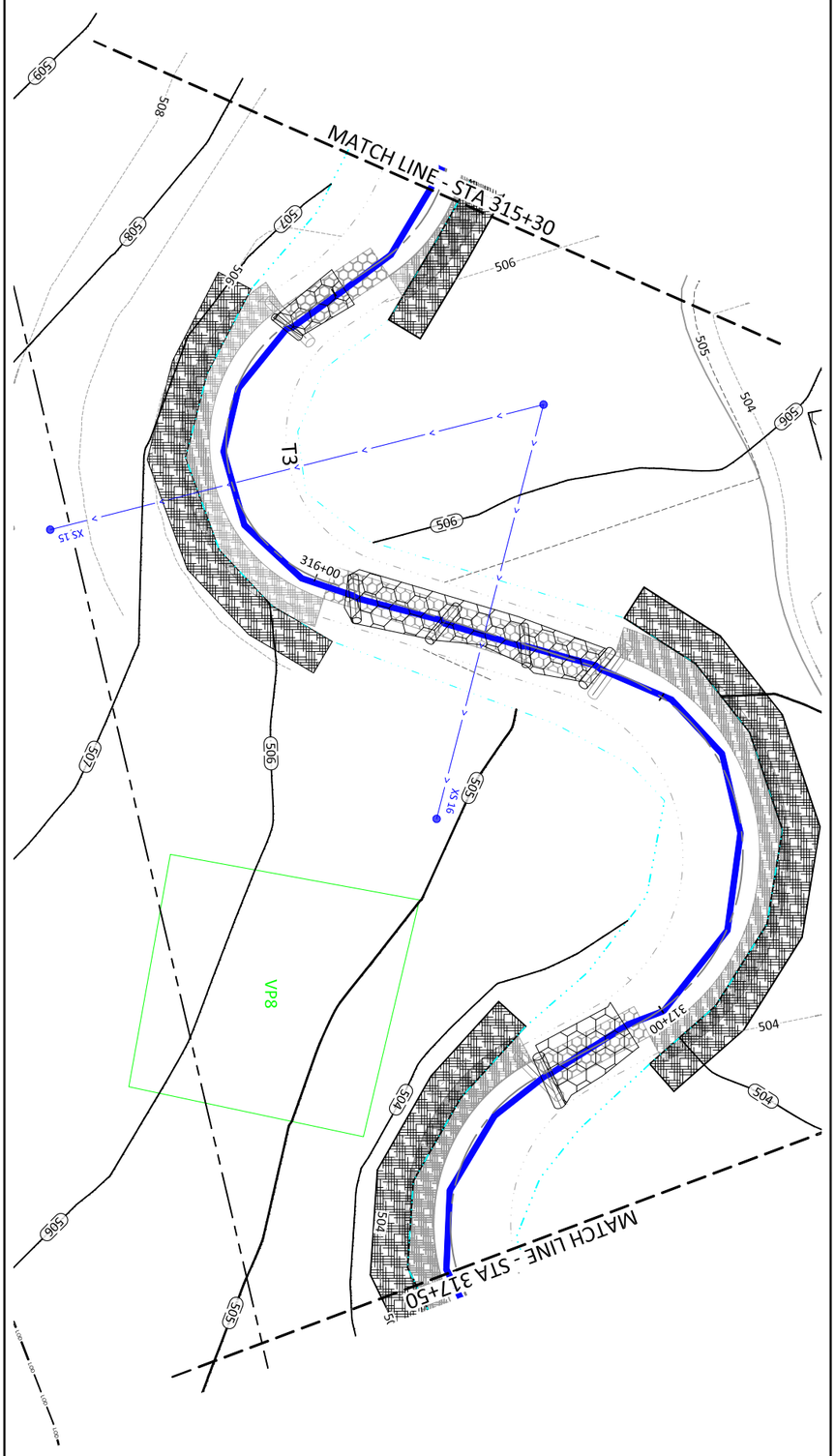

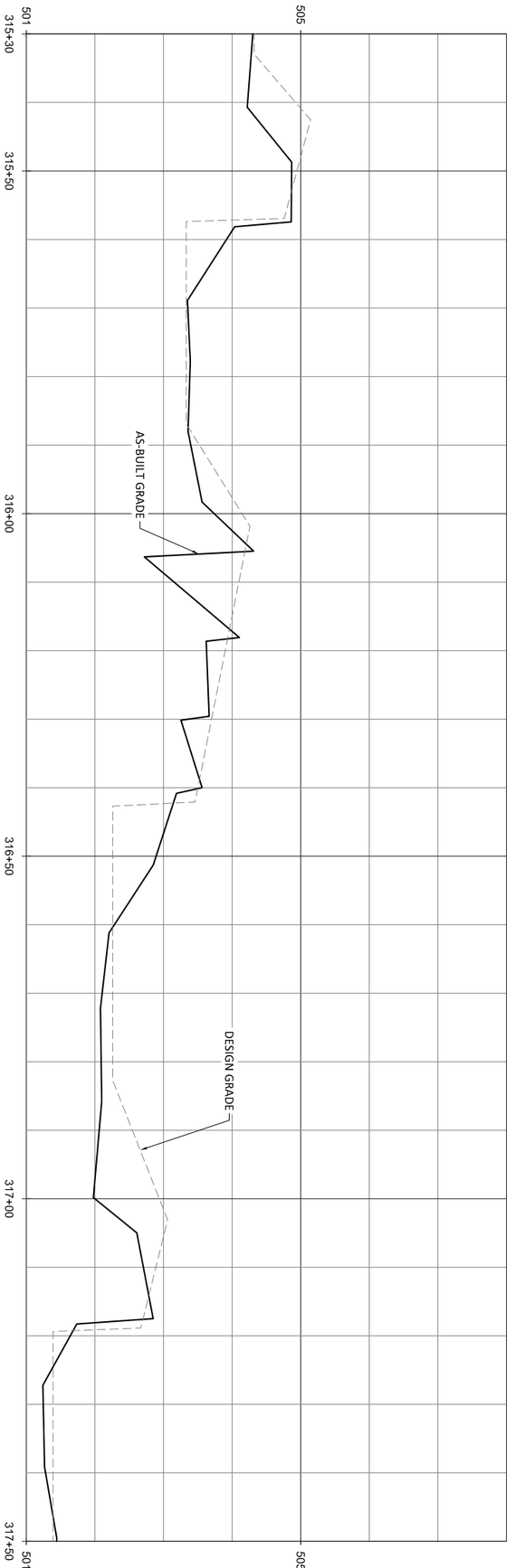

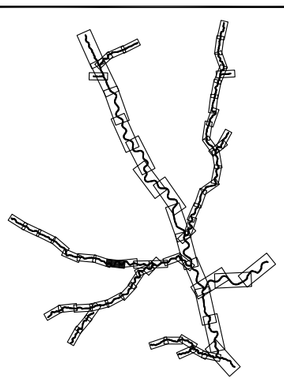

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0' 10' 20' 30' HORIZONTAL

0' 1' 2' 3' VERTICAL

N

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Buckwater Mitigation Site
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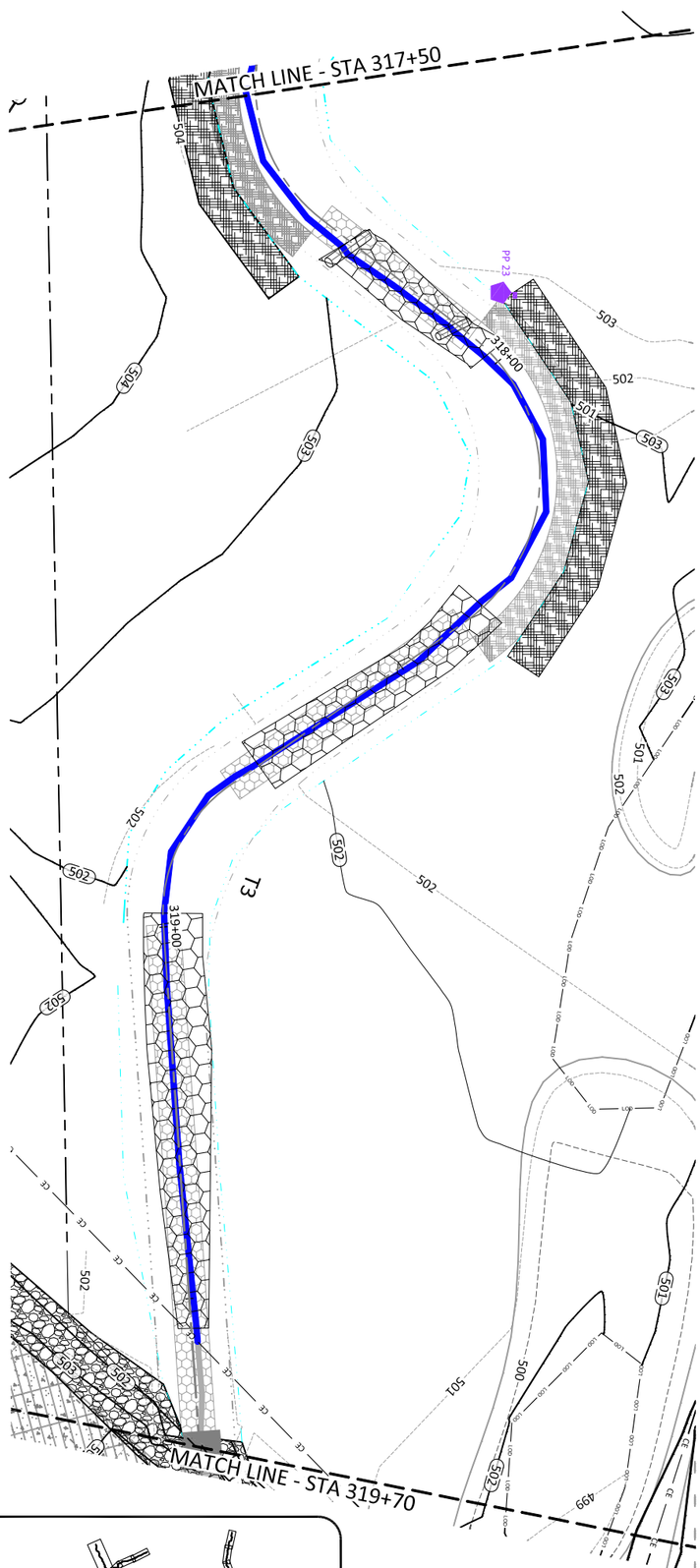

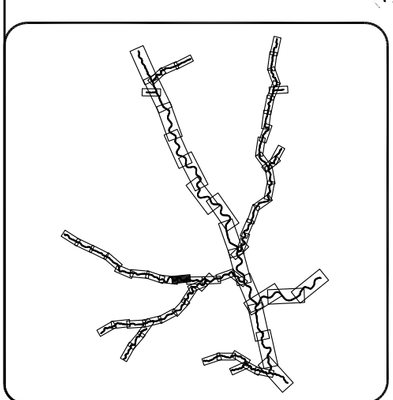

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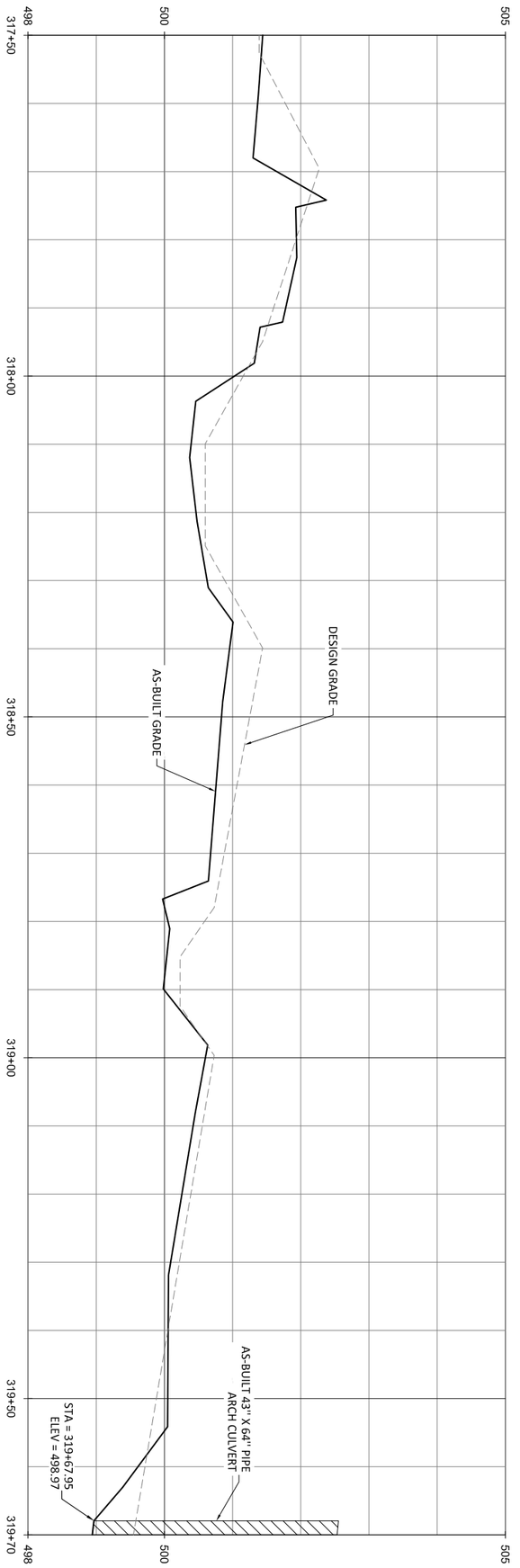
0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

N



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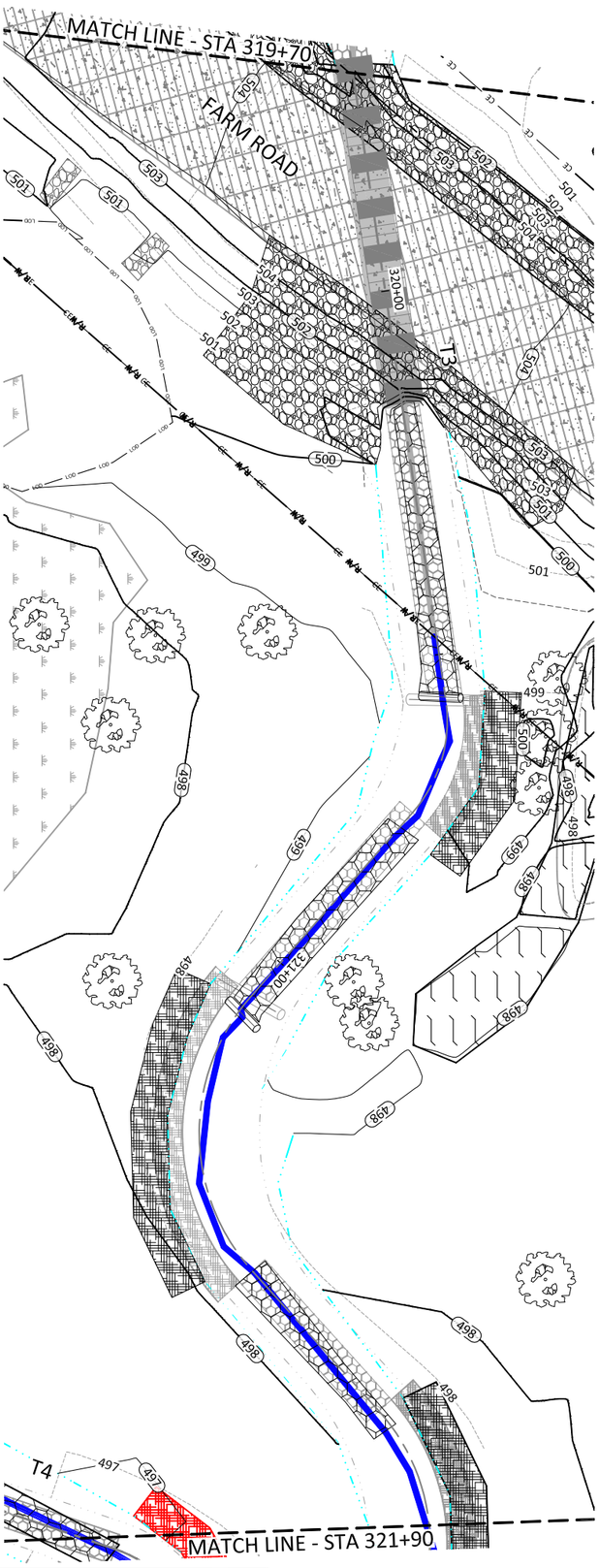

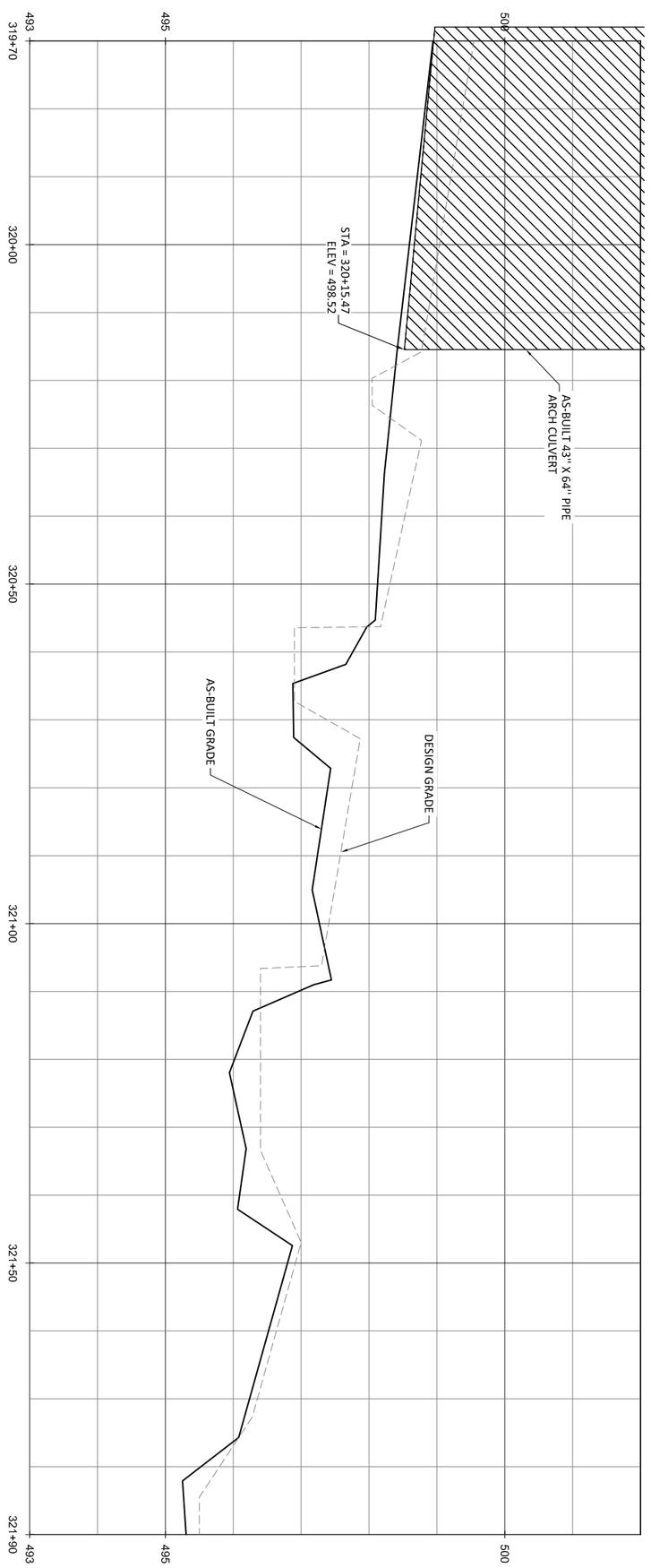

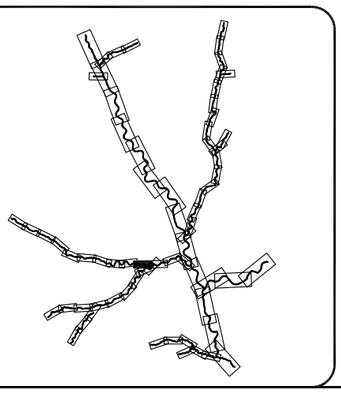

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0' 10' 20' 30' HORIZONTAL

0' 1' 2' 3' VERTICAL

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Date:	07.01.2019
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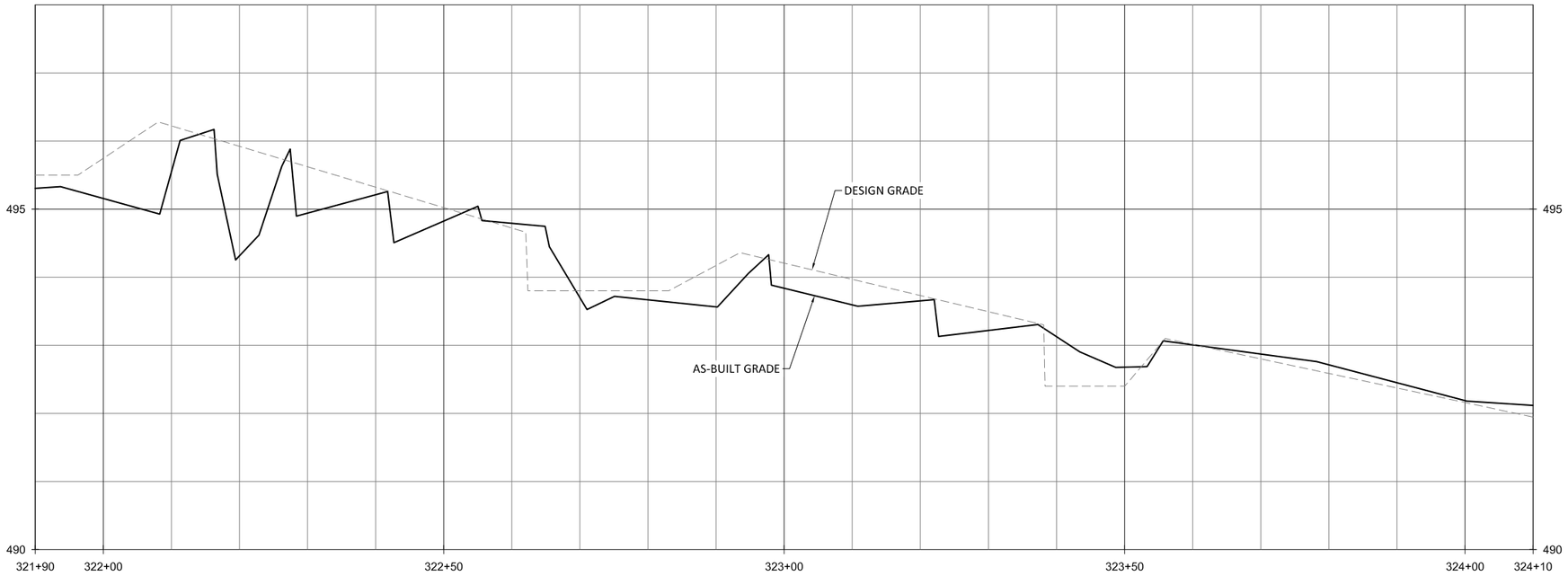

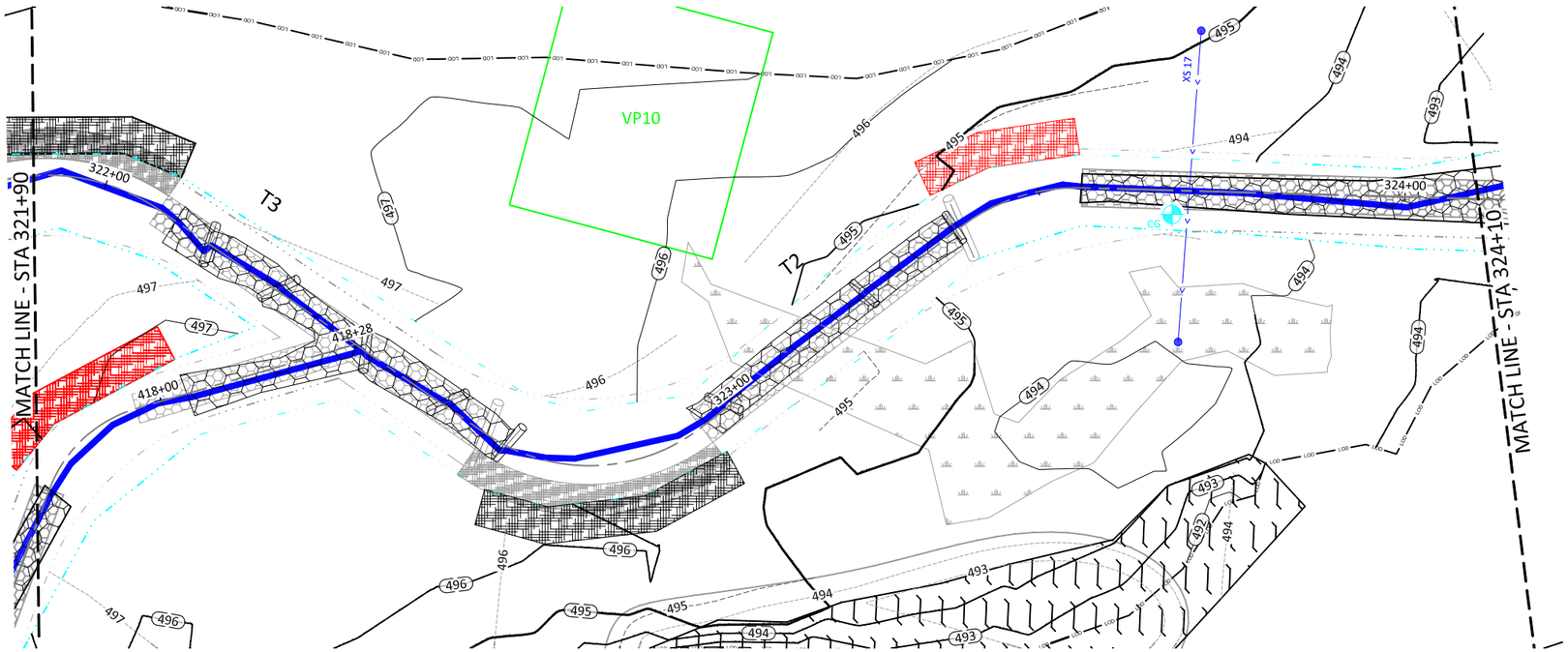

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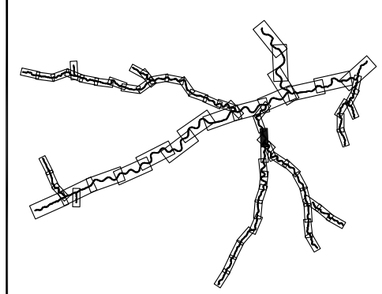

NOTE:

1. STA 323+61: BRUSH TOE WAS INSTALLED .

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NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO

Buckwater Mitigation Site
Orange County, North Carolina

T3 Reach 2 & T2
Stream Plan and Profile

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Job Number: 005-02157
Project Engineer: NMM
Drawn By: CAW
Checked By: JTL

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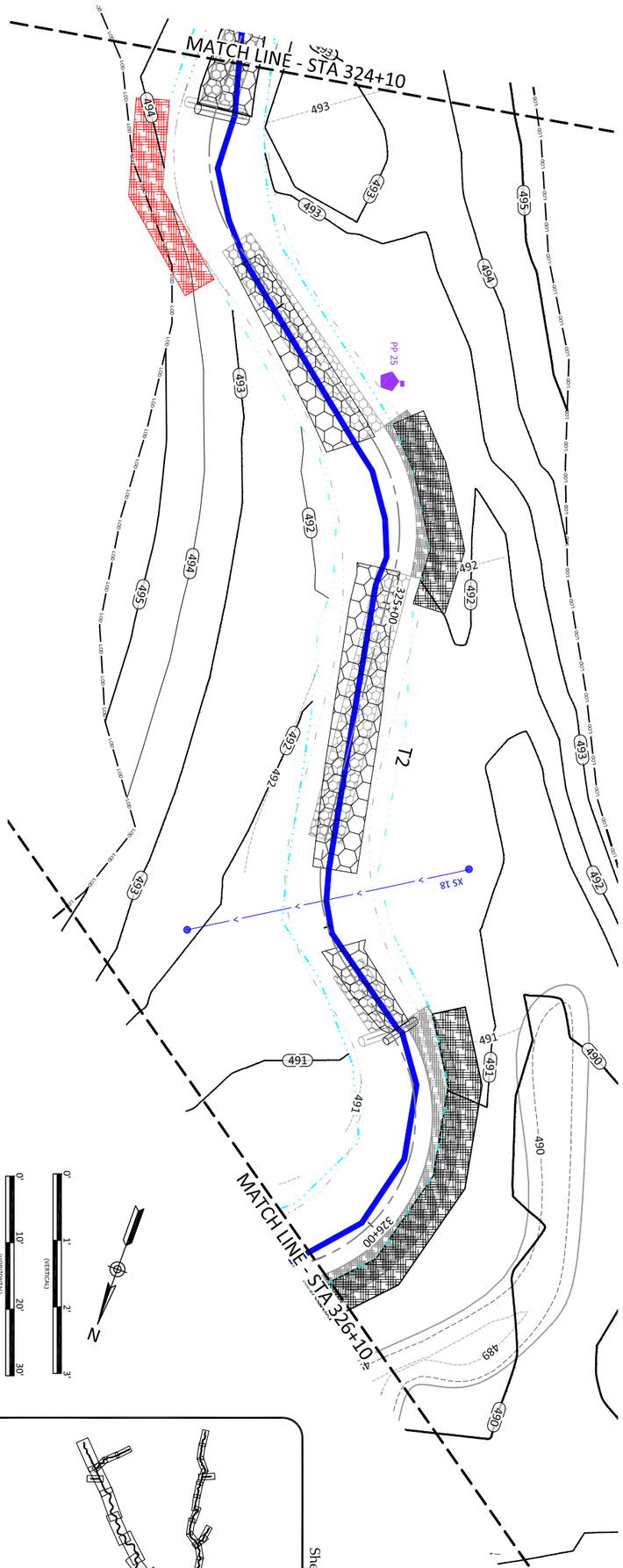
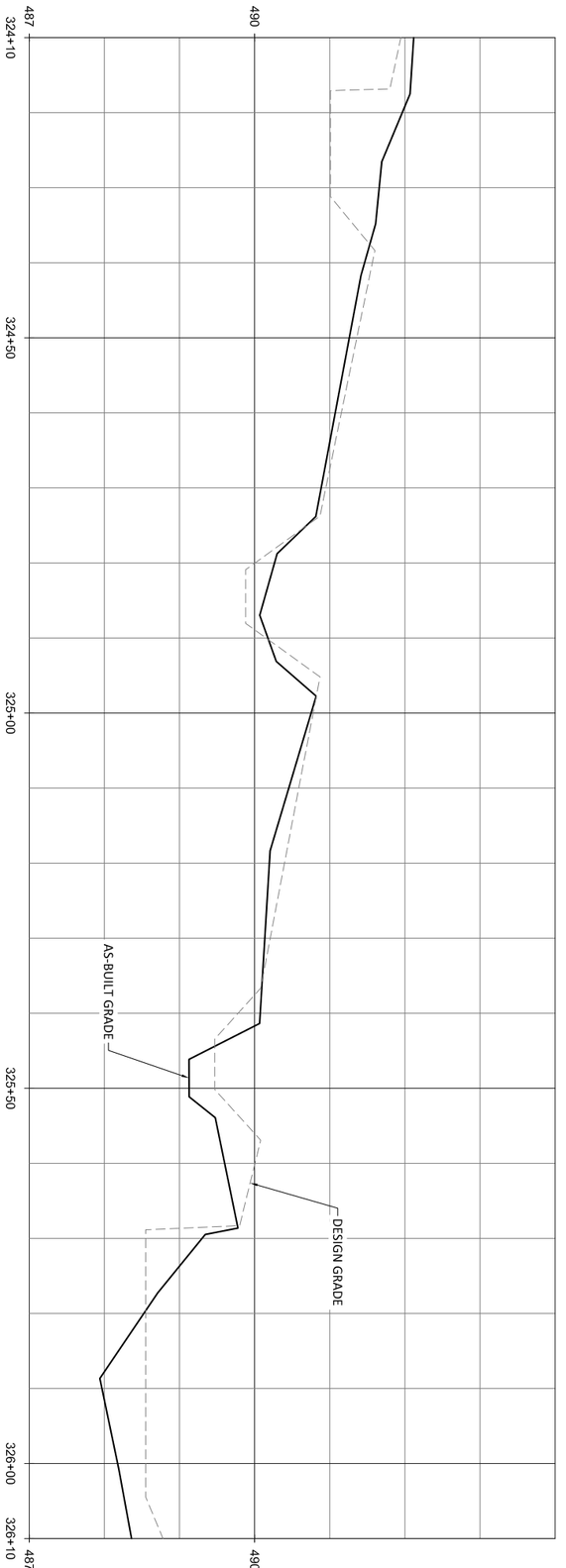
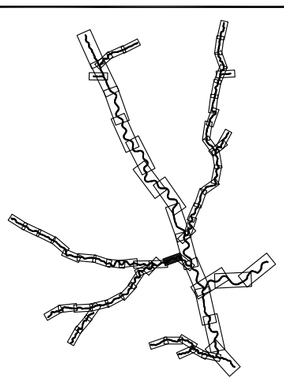
NOTE:
1. STA 324+44: BRUSH TOE WAS INSTALLED .







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Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

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Buckwater Mitigation Site
Orange County, North Carolina

T2
Stream Plan and Profile

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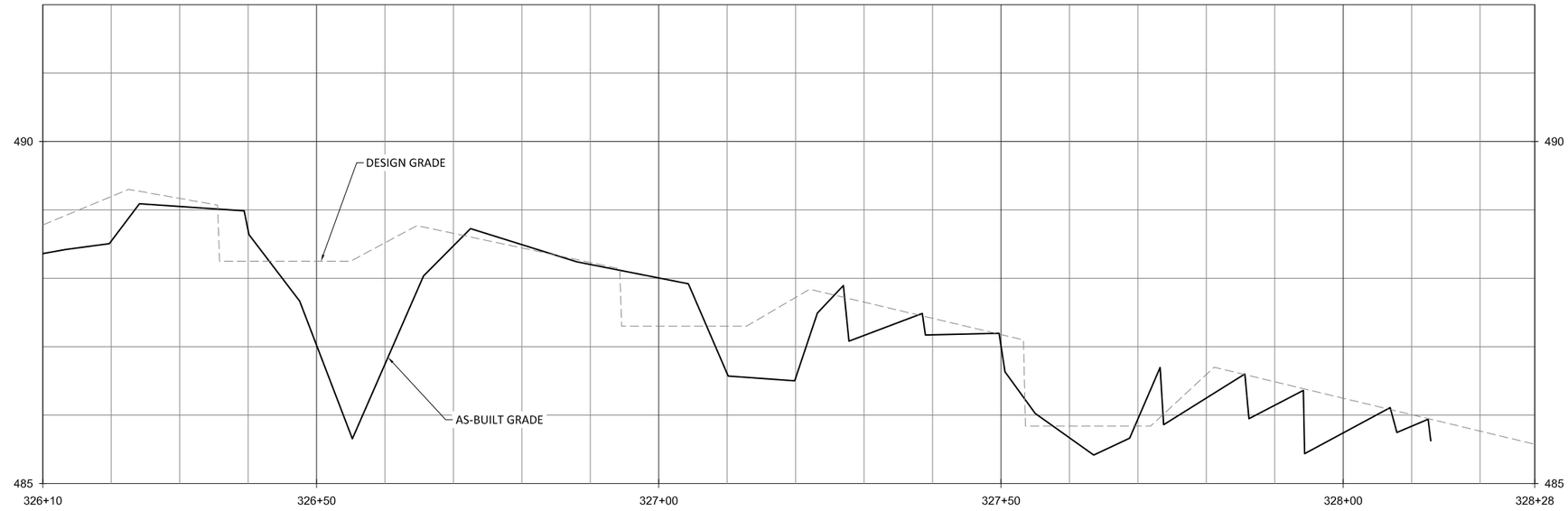
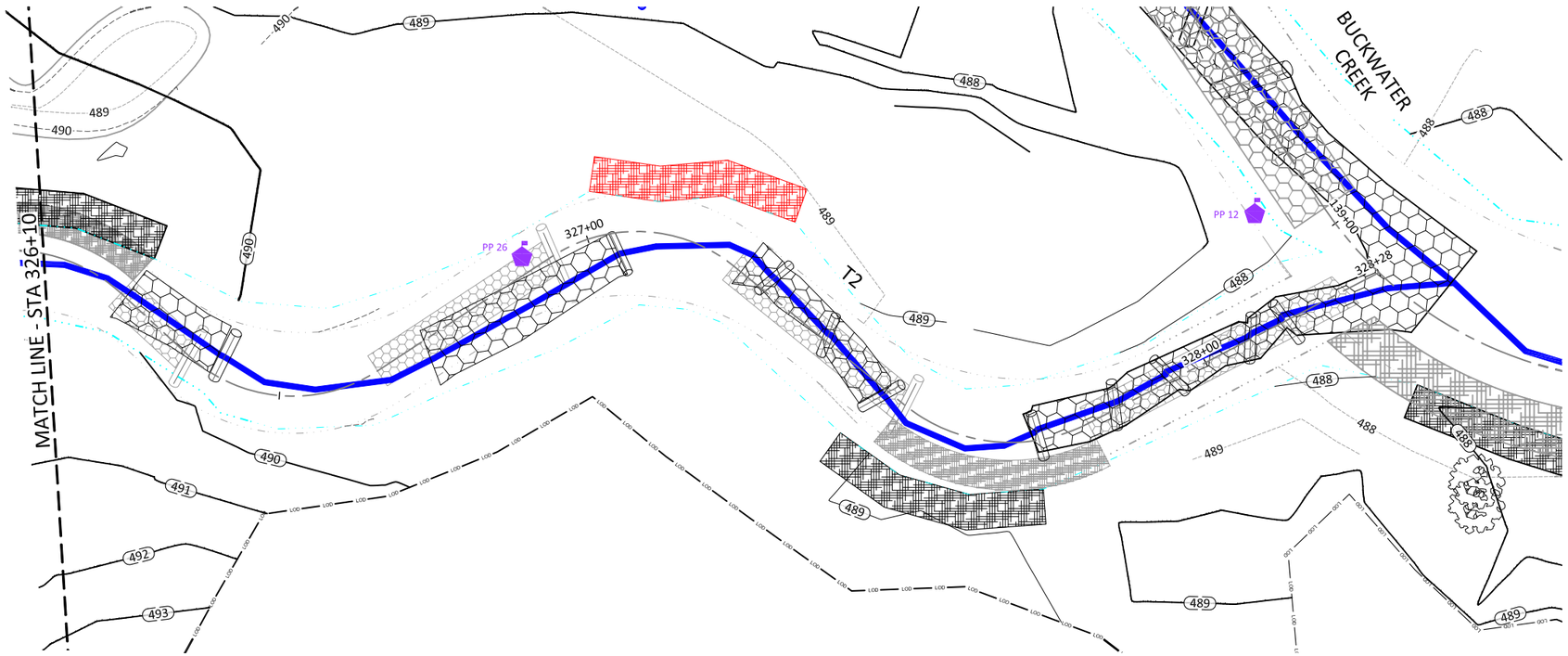
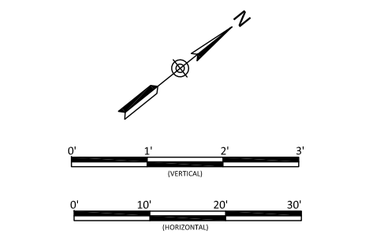




NOTE:
1. STA 327+25: BRUSH TOE WAS INSTALLED .



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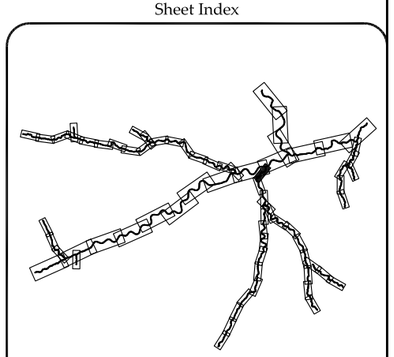

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Buckwater Mitigation Site
Orange County, North Carolina

T2
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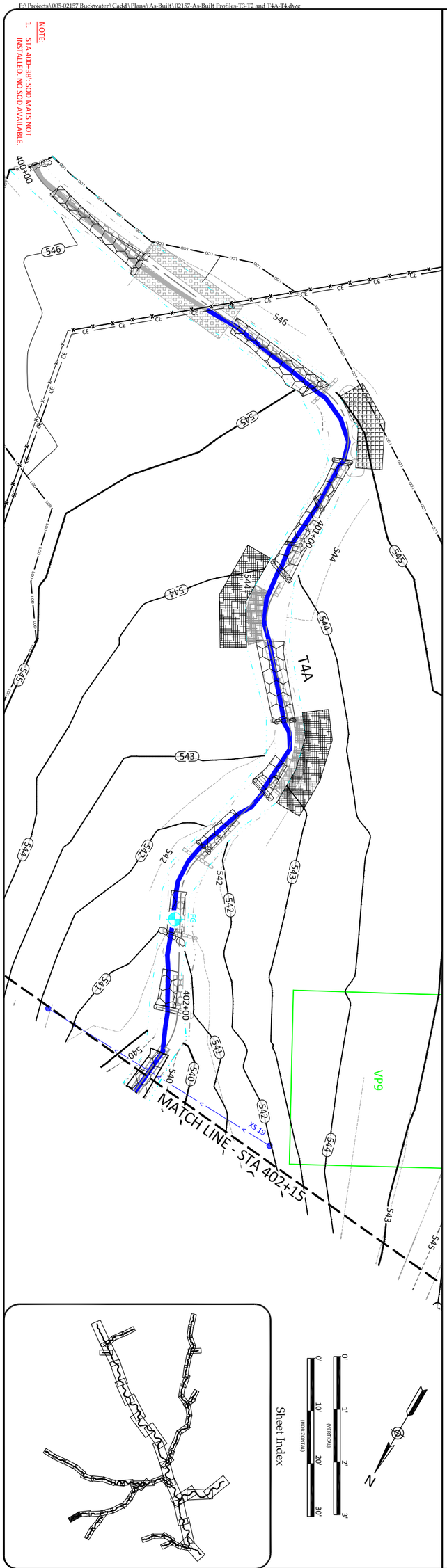
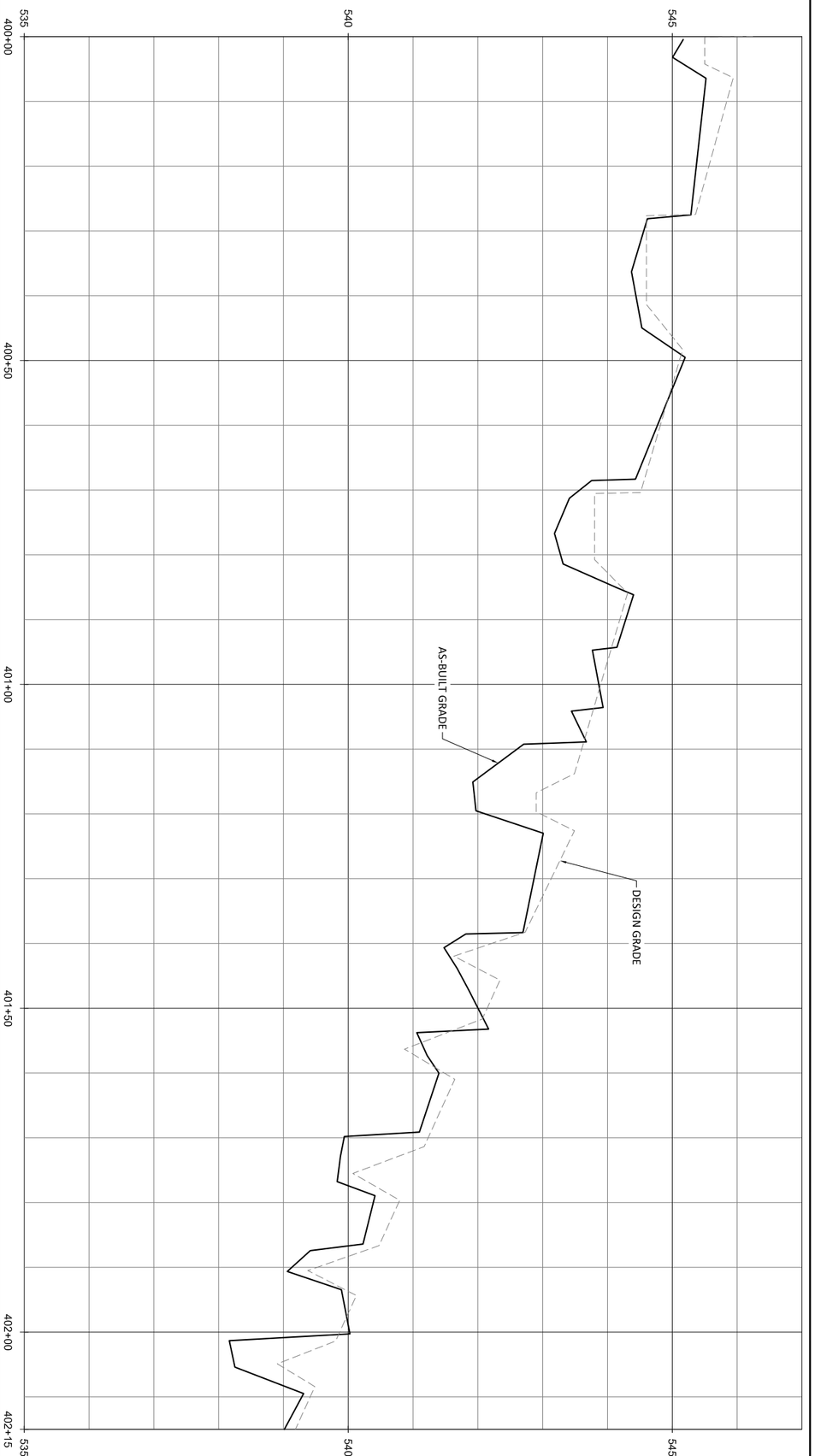
NOTE:
1. STA 400+38: SOD MATS NOT INSTALLED. NO SOD AVAILABLE.





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0' 10' 20' 30' HORIZONTAL
0' 1' 2' 3' VERTICAL

N

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Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

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Orange County, North Carolina

T4A Reach 1
Stream Plan and Profile

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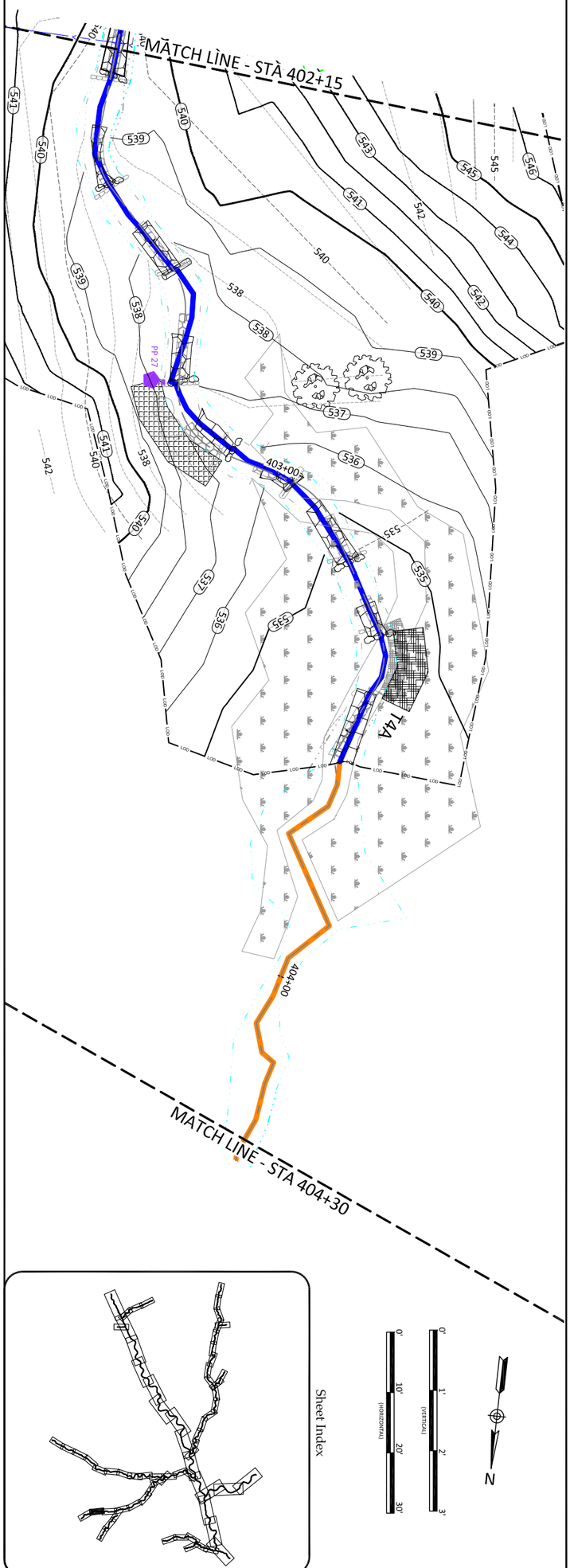

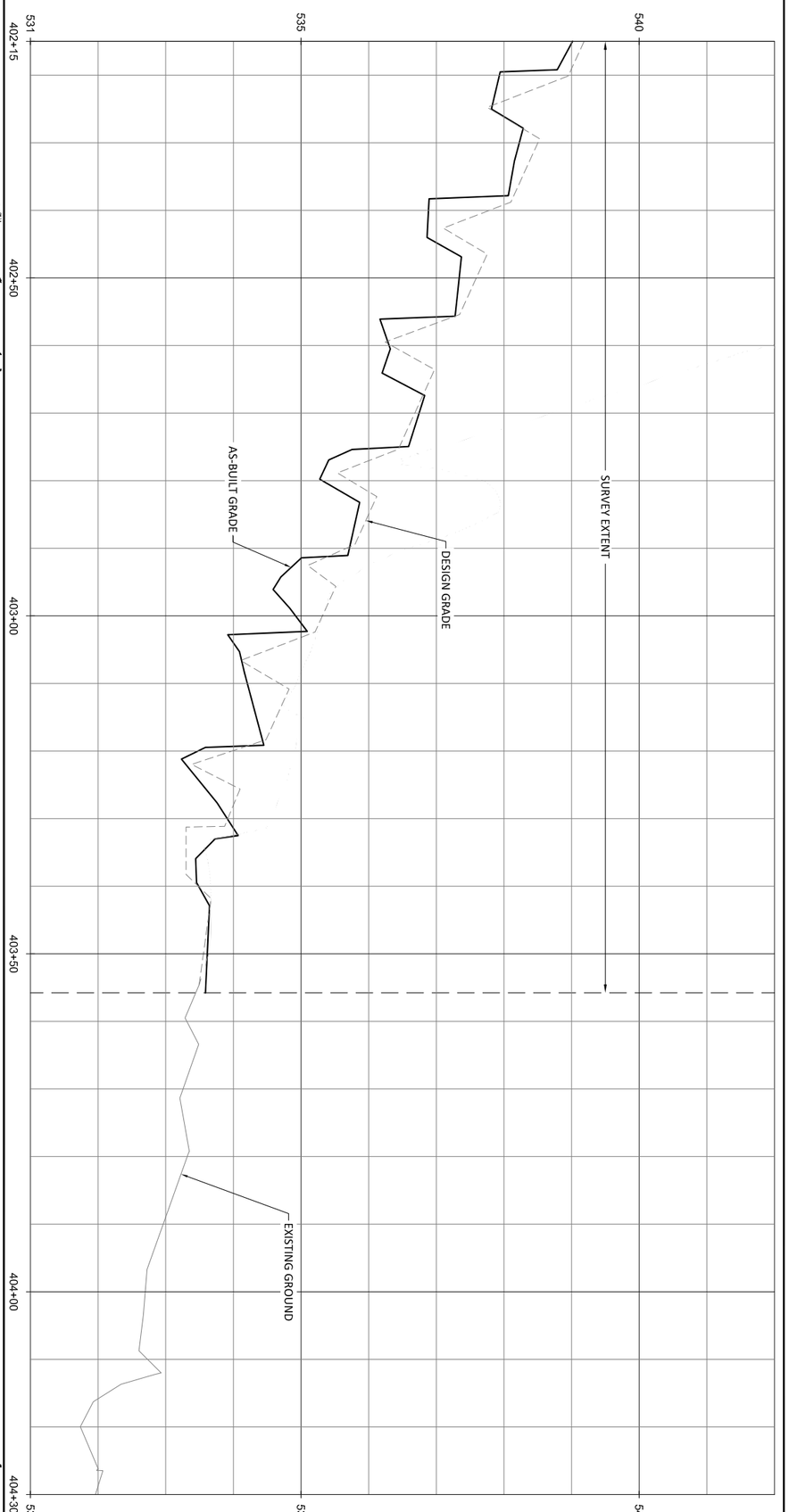

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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

N

Date:	07.01.2019
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Orange County, North Carolina

T4A Reaches 1 & 2
Stream Plan and Profile

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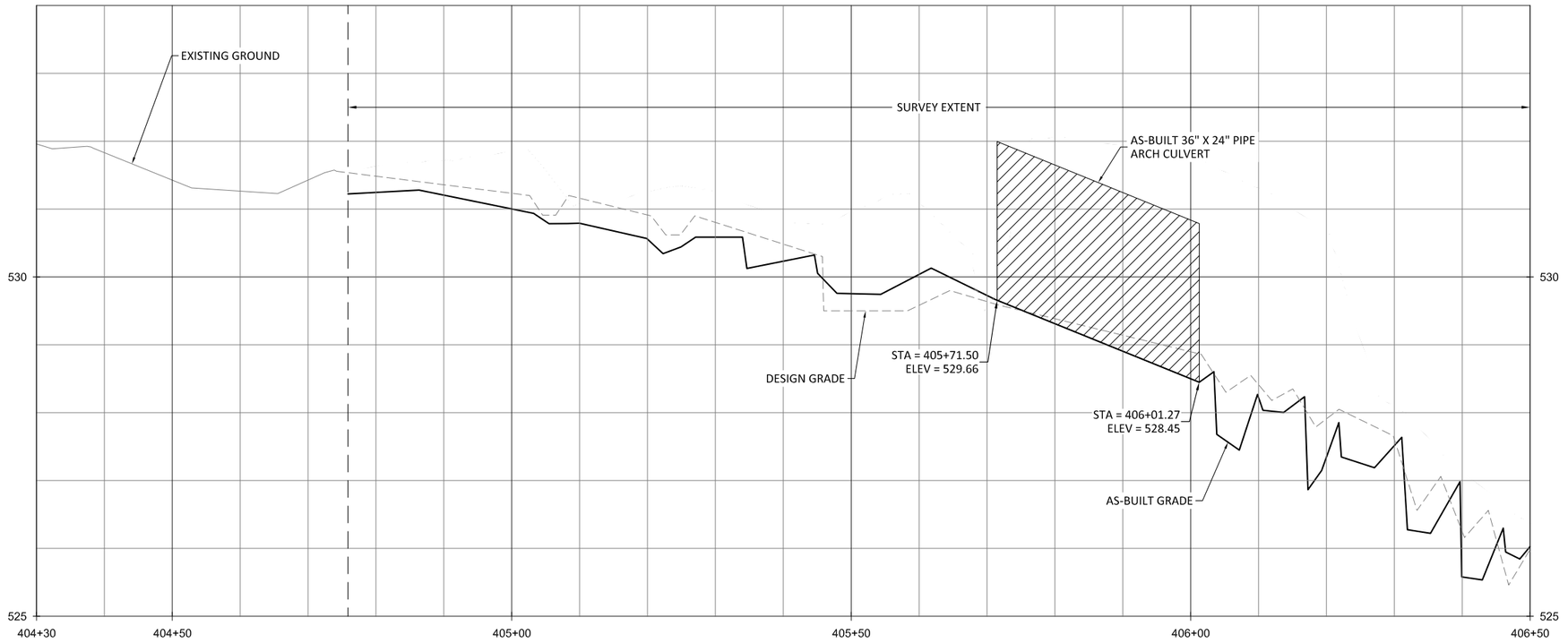
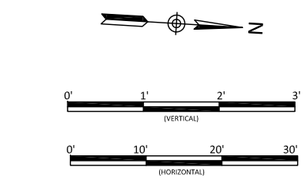


NOTE:

1. STA 405+45: LOG SILL WAS INSTALLED INSTEAD OF A BOULDER SILL.
2. STA 405+56: SOD MATS NOT INSTALLED. NO SOD AVAILABLE.



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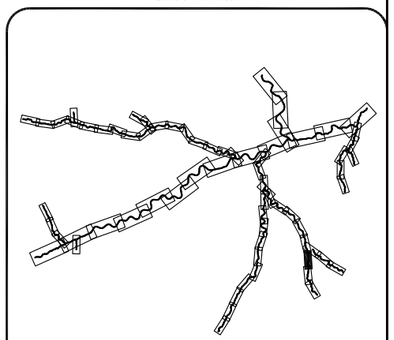

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Buckwater Mitigation Site
Orange County, North Carolina

T4A Reaches 2 & 3
Stream Plan and Profile

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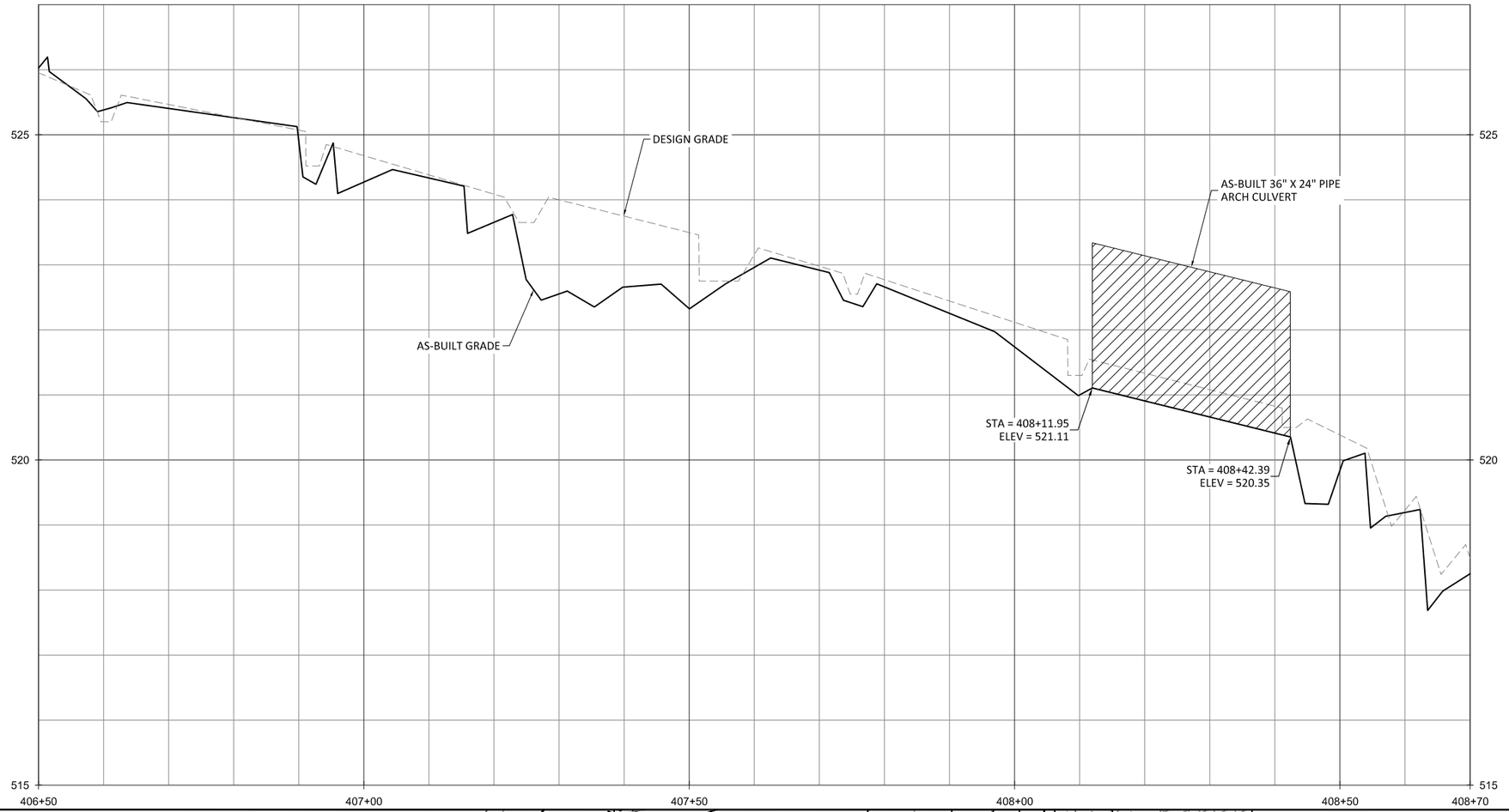
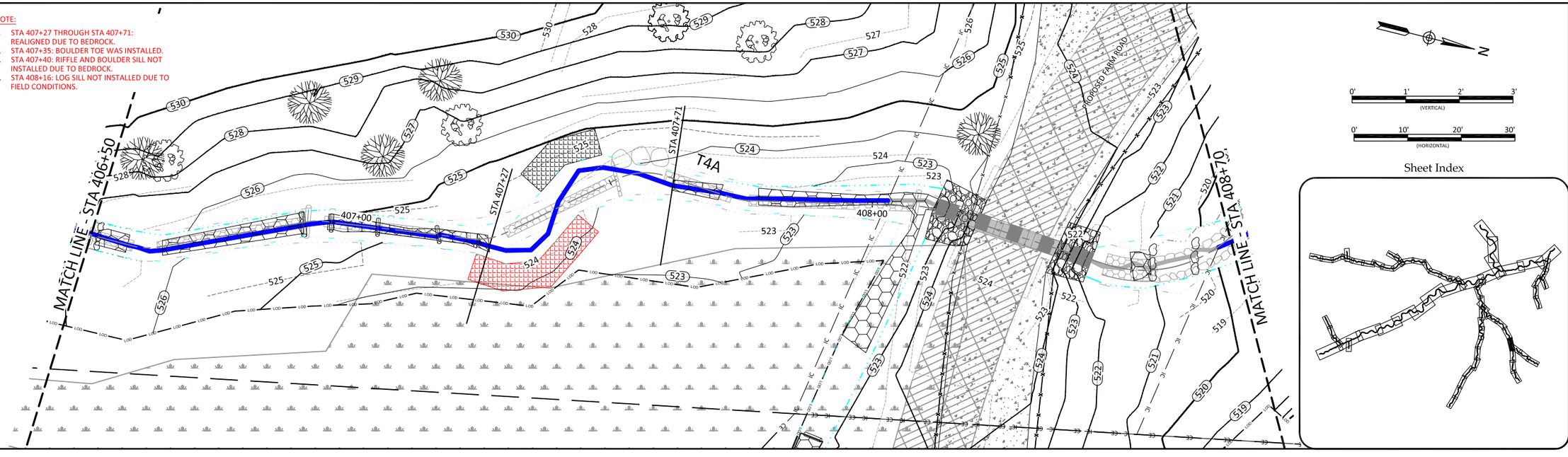


NOTE:

1. STA 407+27 THROUGH STA 407+71: REALIGNED DUE TO BEDROCK.
2. STA 407+35: BOULDER TOE WAS INSTALLED.
3. STA 407+40: RIFFLE AND BOULDER SILL NOT INSTALLED DUE TO BEDROCK.
4. STA 408+16: LOG SILL NOT INSTALLED DUE TO FIELD CONDITIONS.



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Buckwater Mitigation Site
Orange County, North Carolina

T4A Reach 3 & T4
Stream Plan and Profile

Revisions:

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Drawn By: CAW
Checked By: JTL

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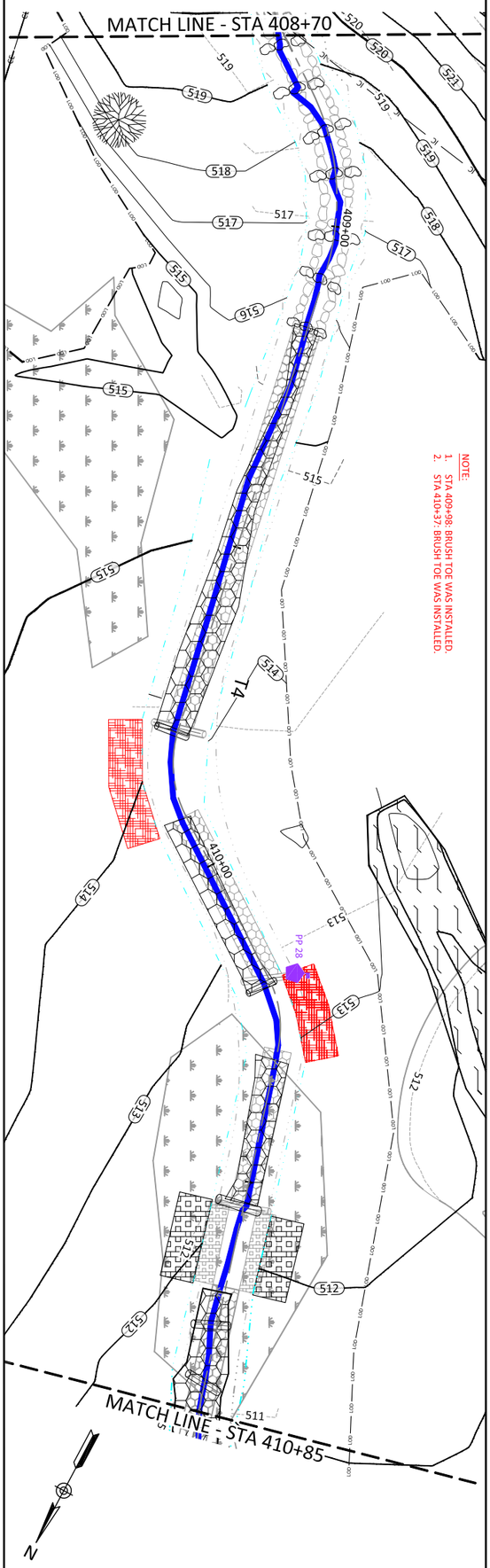
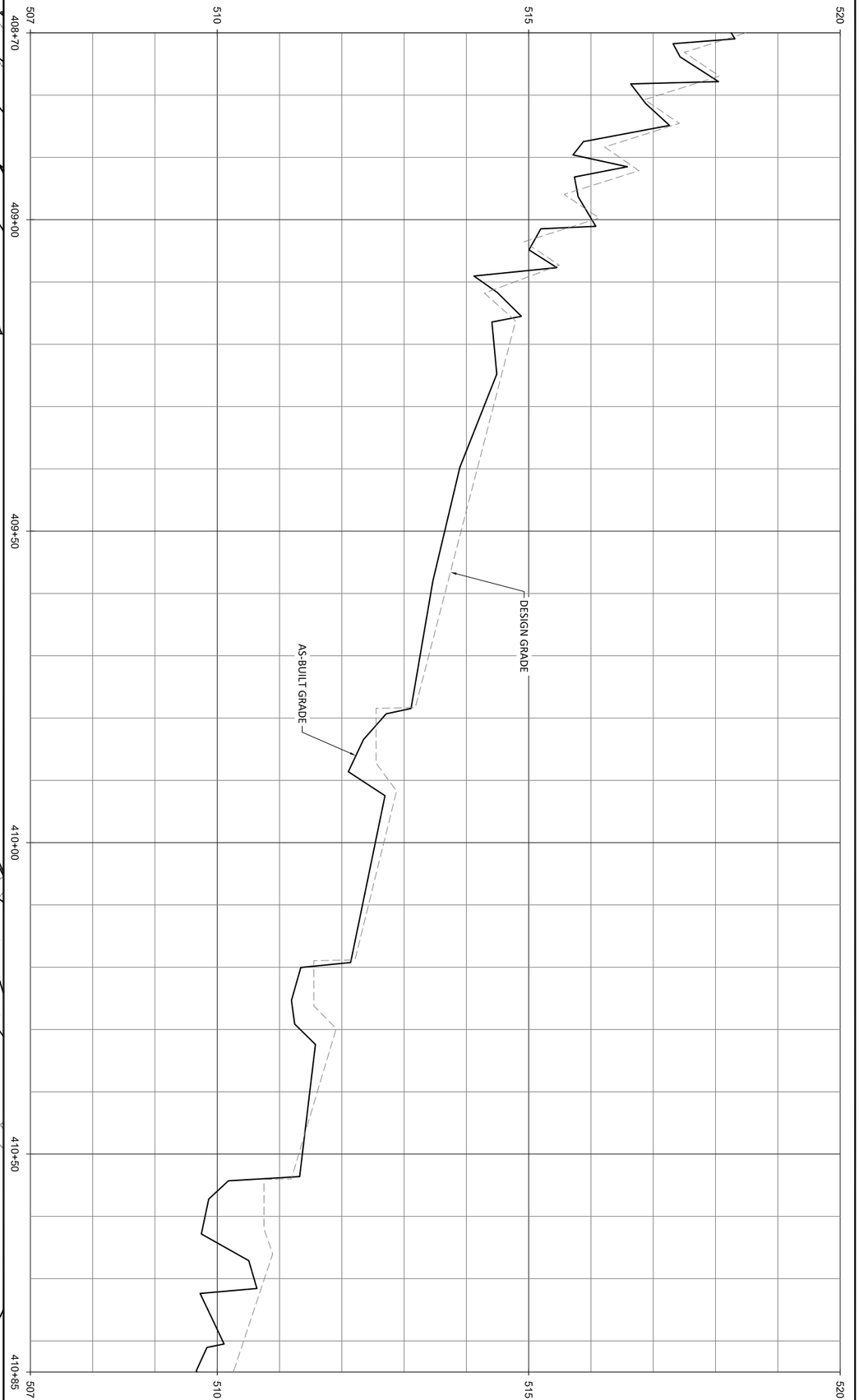
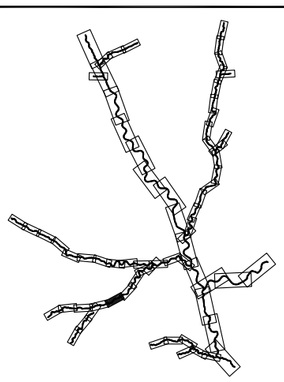


NOTE:
1. STA 409+98: BRUSH TOE WAS INSTALLED.
2. STA 410+37: BRUSH TOE WAS INSTALLED.





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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

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Buckwater Mitigation Site
Orange County, North Carolina

T4
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 7/1/19

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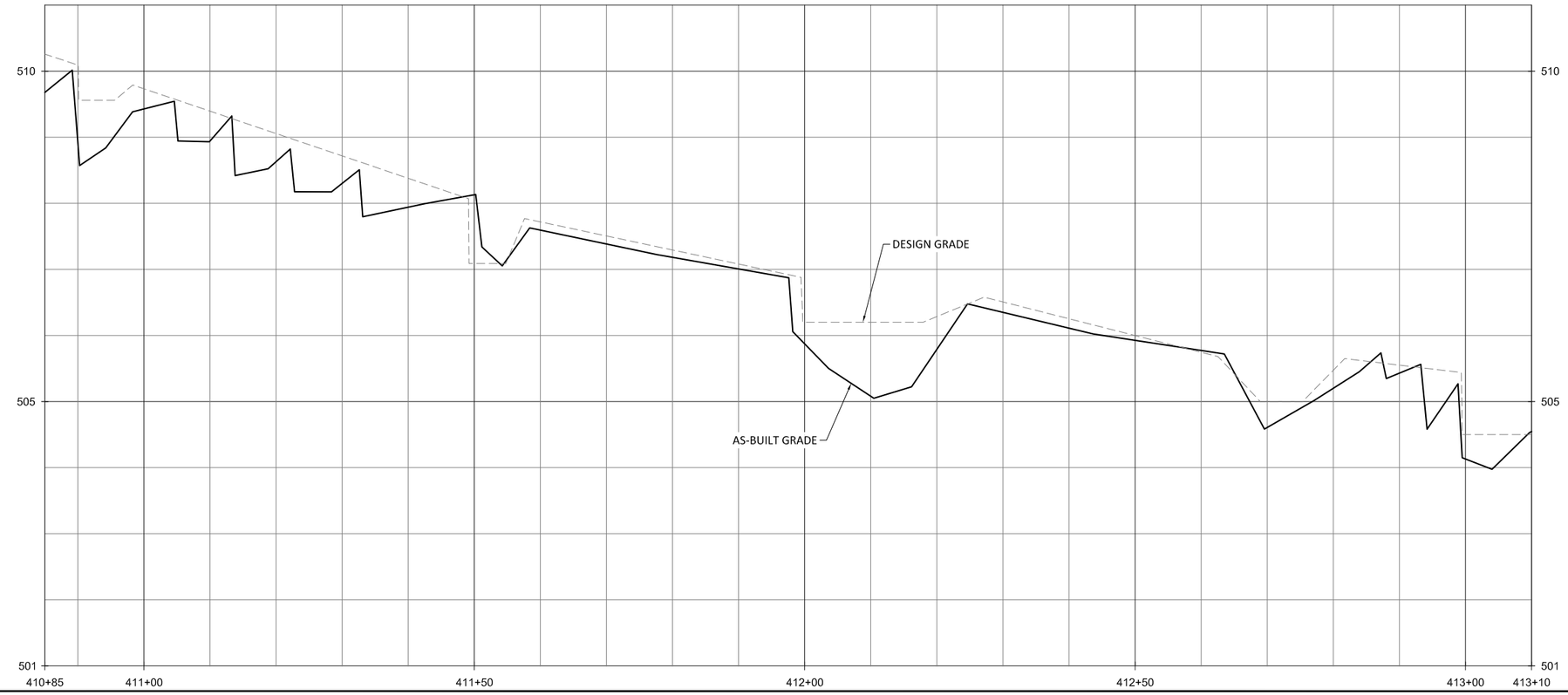
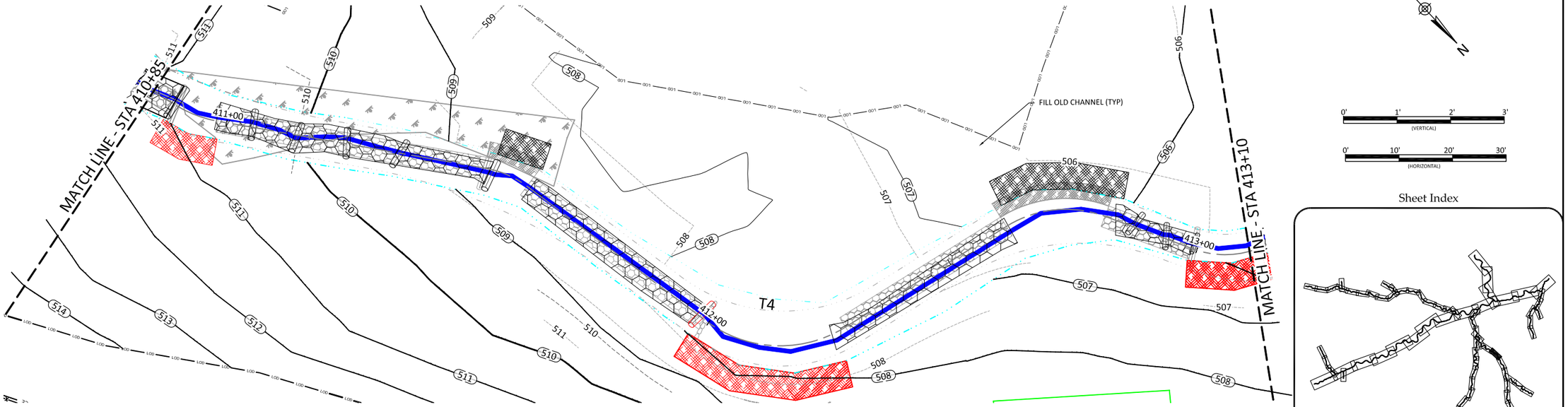
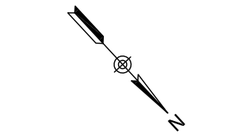




NOTE:

1. STA 411+06: BRUSH TOE WAS INSTALLED.
2. STA 411+98: LOG SILL WAS INSTALLED INSTEAD OF BOULDER SILL.
3. STA 412+25: BRUSH TOE WAS INSTALLED.
4. STA 413+19: BRUSH TOE WAS INSTALLED.



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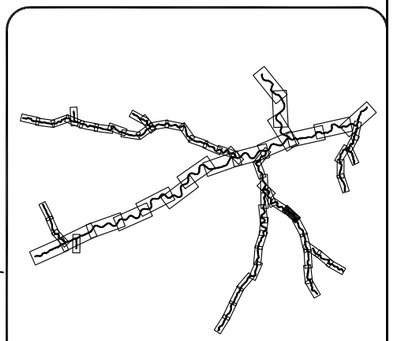

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Buckwater Mitigation Site
Orange County, North Carolina

T4

Stream Plan and Profile

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Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

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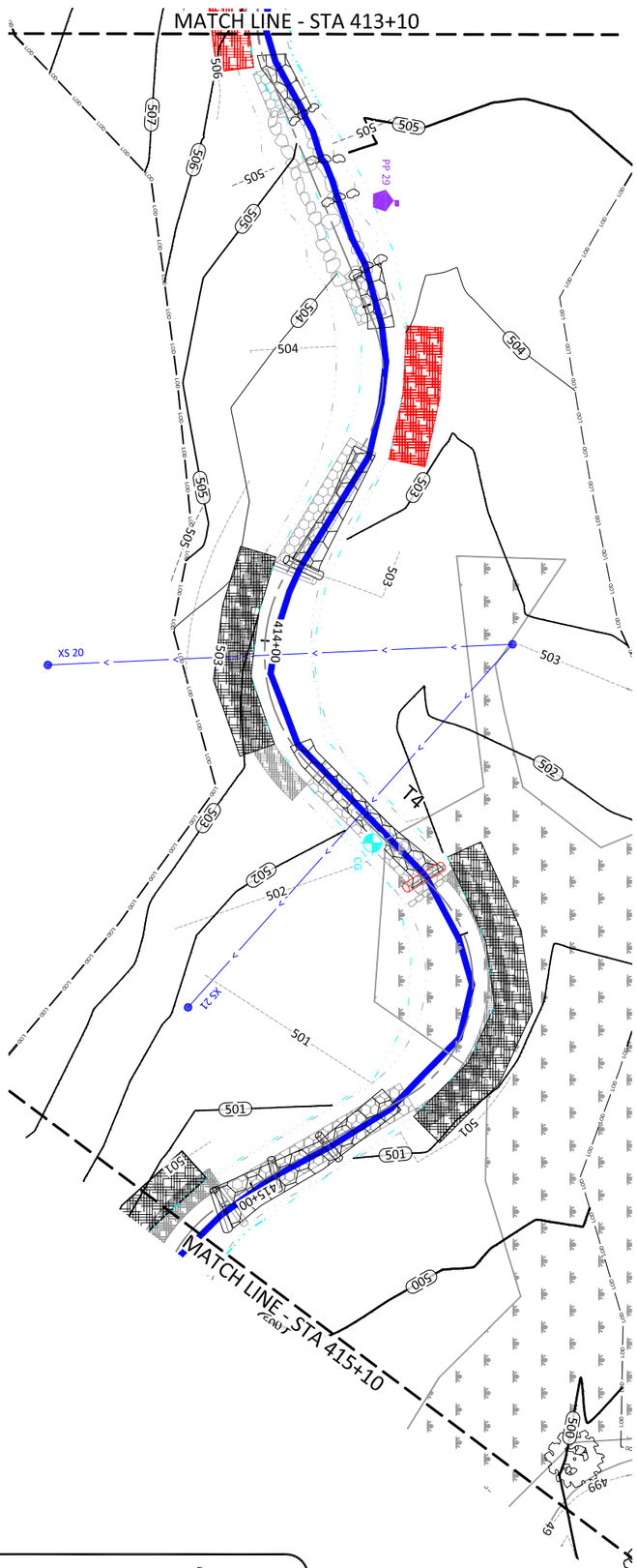
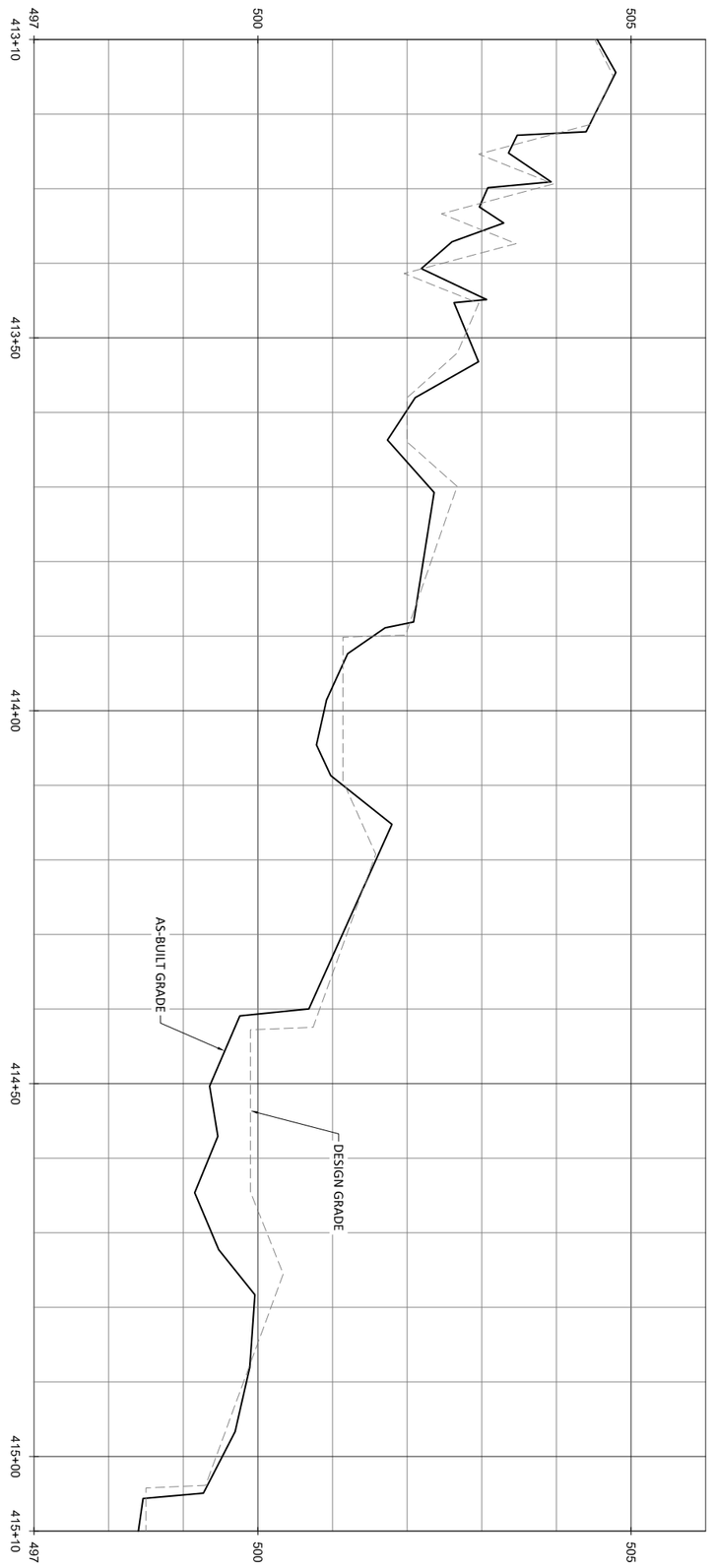
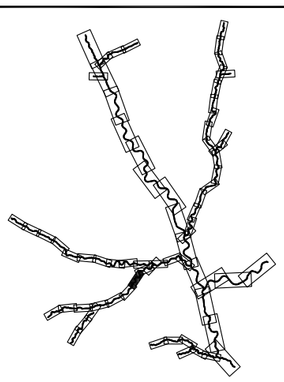
NOTE:
1. STA 413+75: BRUSH TOE WAS INSTALLED.
2. STA 414+53: LOG SILL INSTALLED INSTEAD OF A BOULDER SILL.







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0' 10' 20' 30' (HORIZONTAL)

0 1 2 3 (VERTICAL)

N

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Checked By:	JTL

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T4
Stream Plan and Profile

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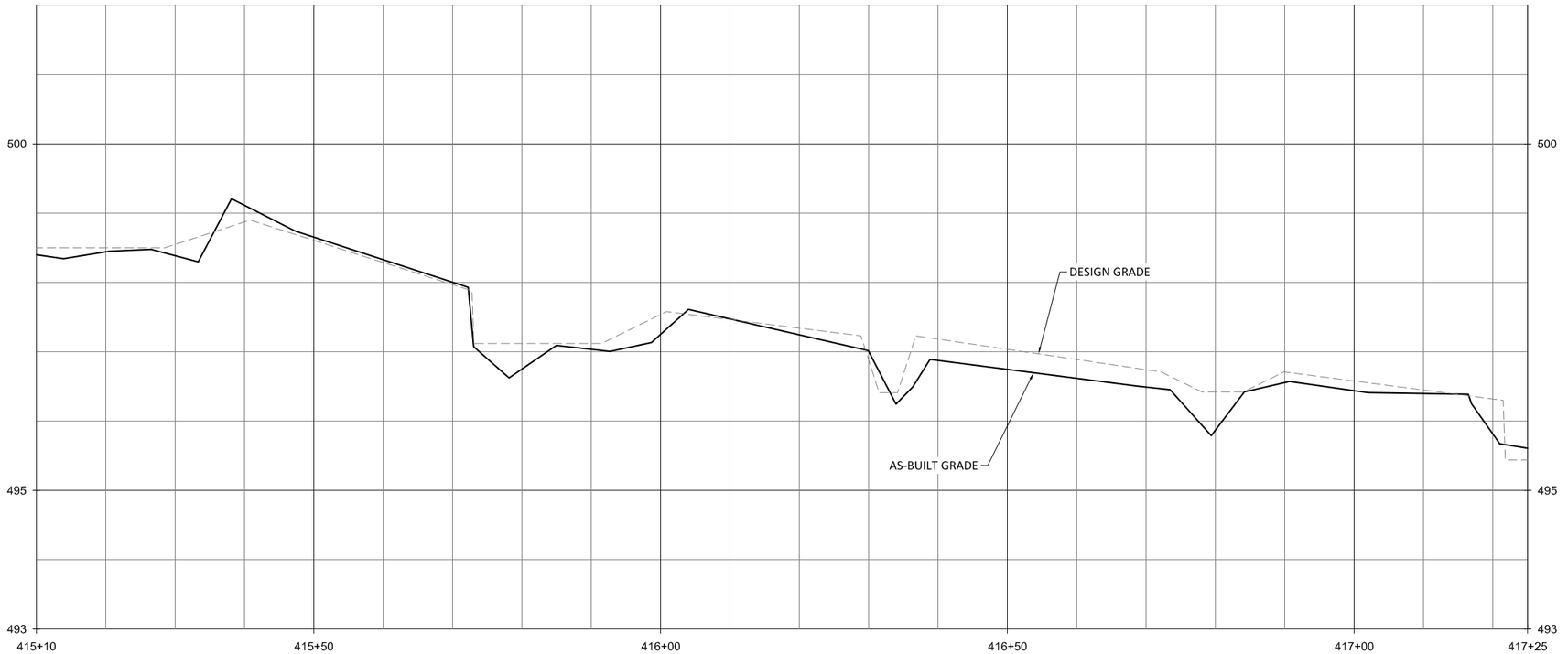
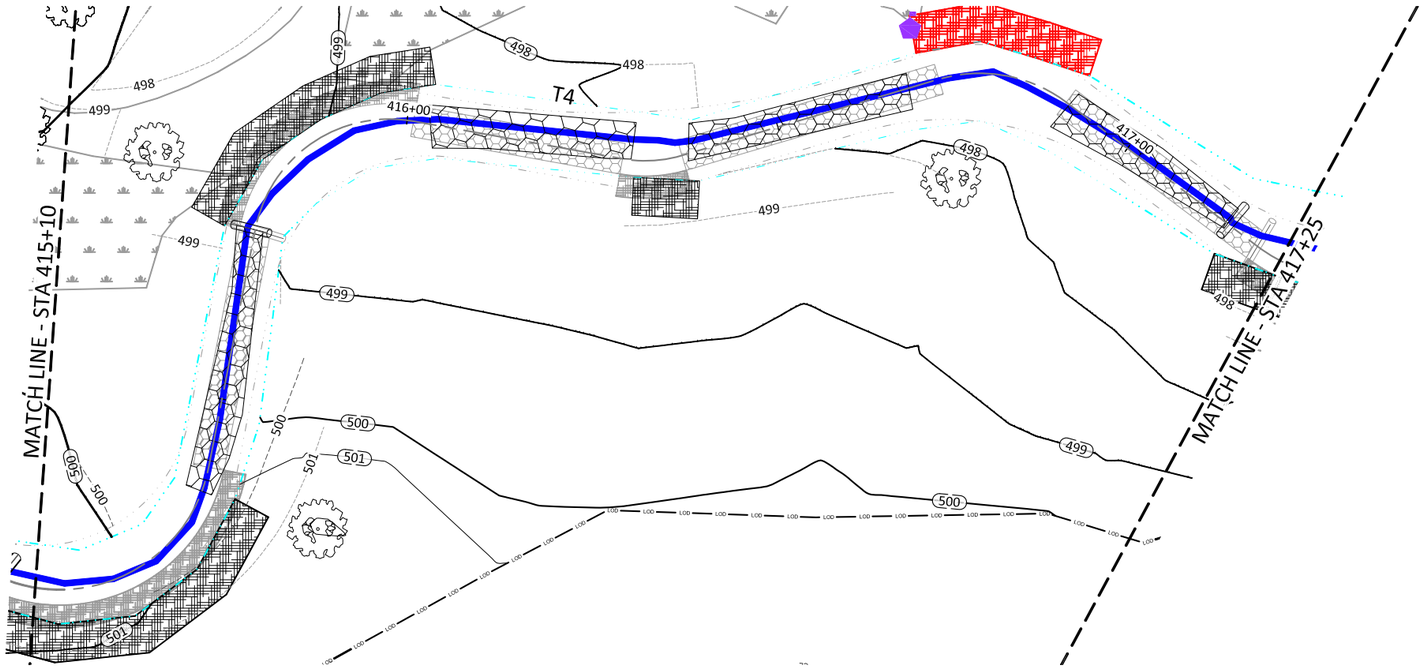
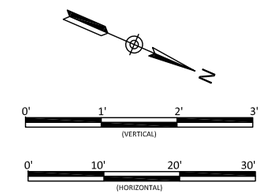




NOTE:

1. STA 416+89: BRUSH TOE WAS INSTALLED.



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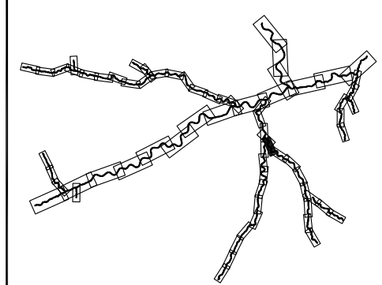

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Buckwater Mitigation Site
Orange County, North Carolina

T4
Stream Plan and Profile

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Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
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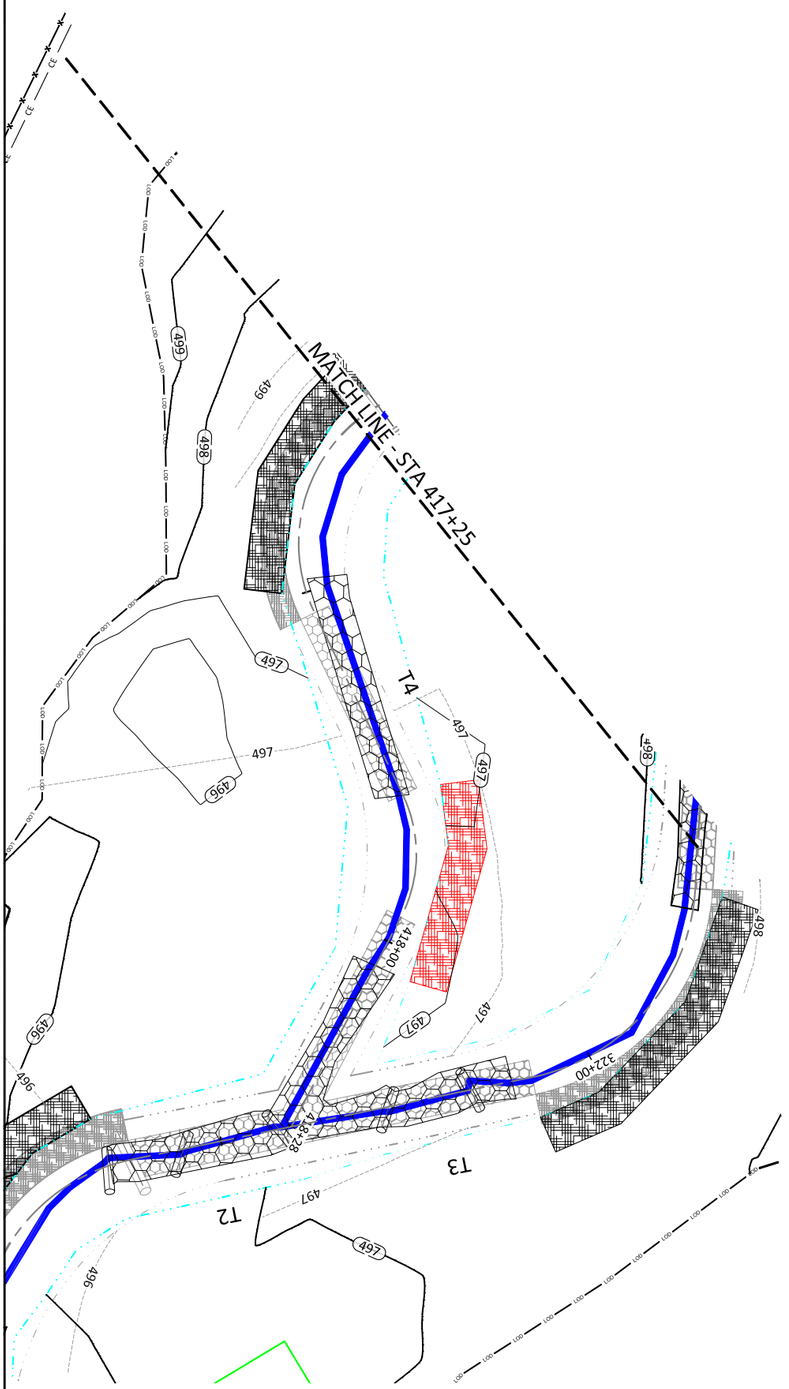
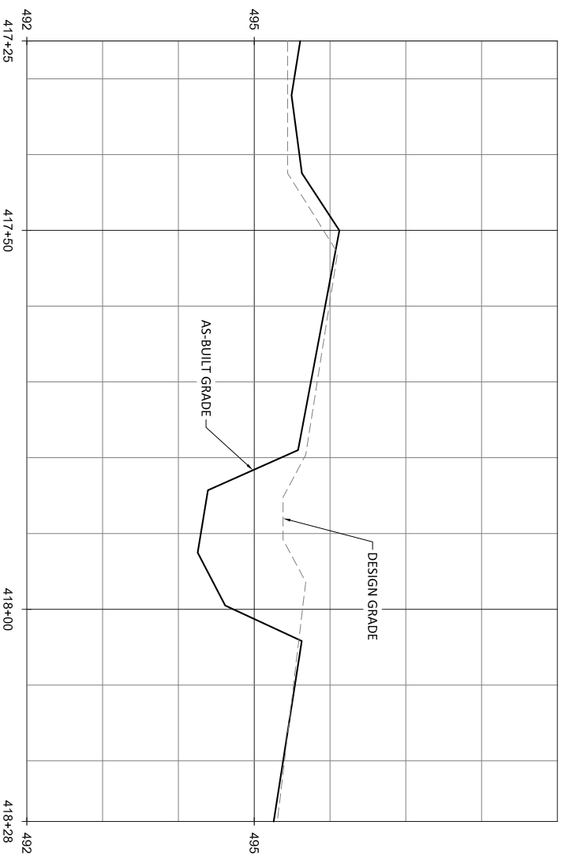
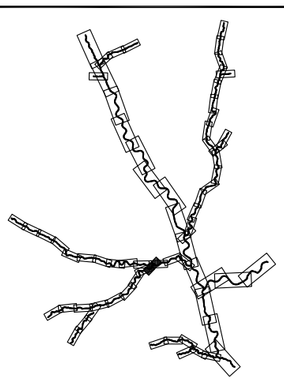
NOTE:
1. STA 417+97: BRUSH TOE WAS INSTALLED.







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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

N

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Orange County, North Carolina

T4
Stream Plan and Profile

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NOTE:

1. STA 450+71: LOG SILL WAS INSTALLED INSTEAD OF BOULDER SILL.
2. STA 450+94: LOG SILL WAS INSTALLED INSTEAD OF BOULDER SILL.
3. STA 451+02: BRUSH TOE WAS INSTALLED INSTEAD OF BOULDER TOE,

0' 1' 2' 3' (VERTICAL)

0' 10' 20' 30' (HORIZONTAL)

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Buckwater Mitigation Site
Orange County, North Carolina

T4B Reach 1
Stream Plan and Profile

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Drawn By: CAW
Checked By: JTL

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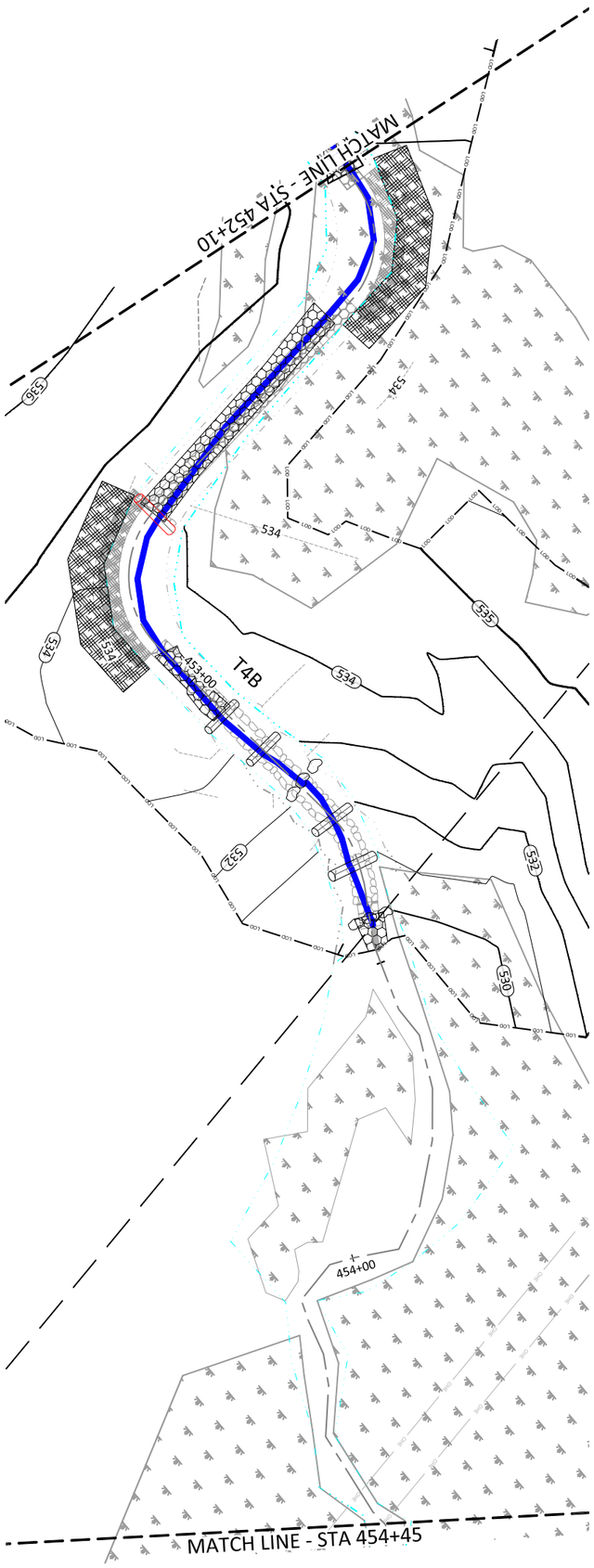
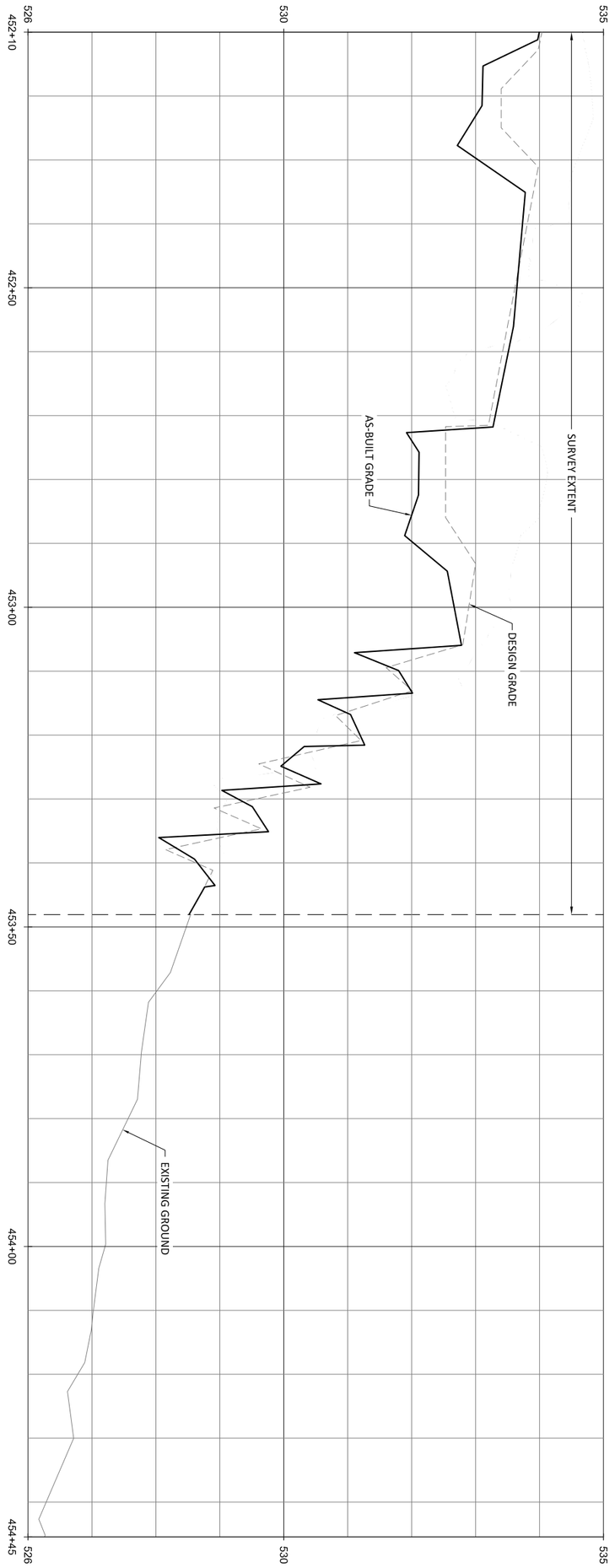
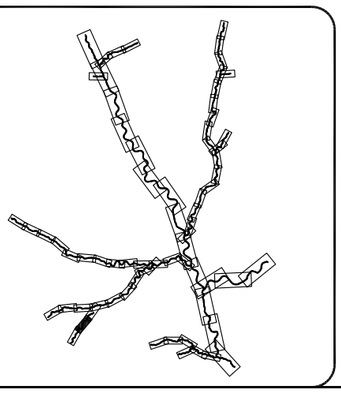
NOTE:
1. STA 452+75: LOG SILL WAS INSTALLED INSTEAD OF BOULDER SILL







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0' 10' 20' 30' HORIZONTAL

0' 1' 2' 3' VERTICAL

N

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Drawn By:	CAW
Checked By:	JTL

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Buckwater Mitigation Site
Orange County, North Carolina

T4B Reaches 1 & 2
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 9/9/19

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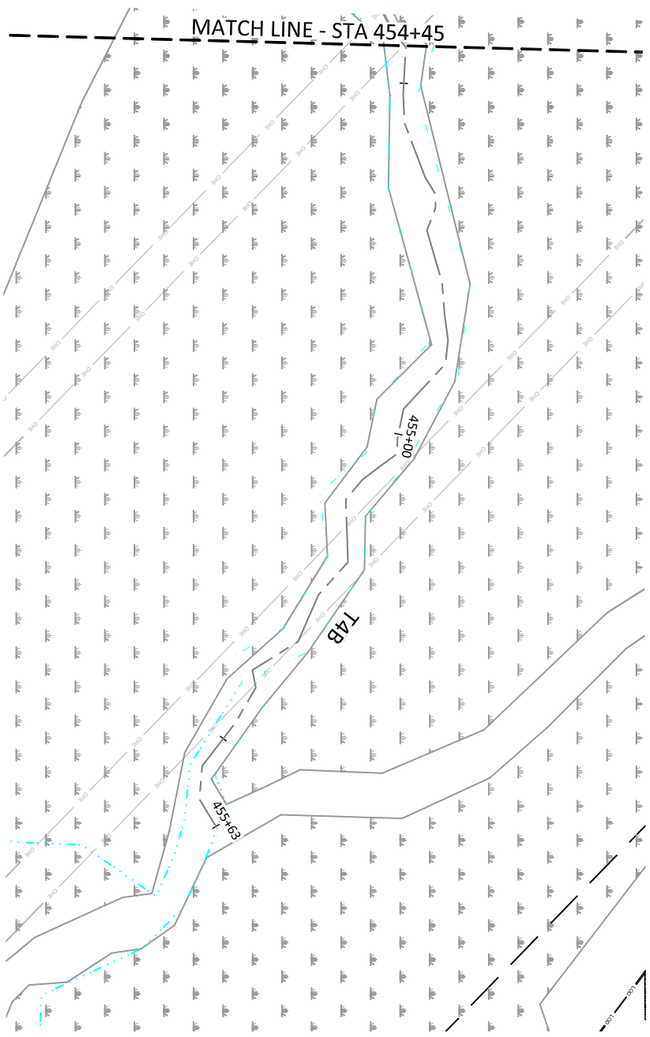

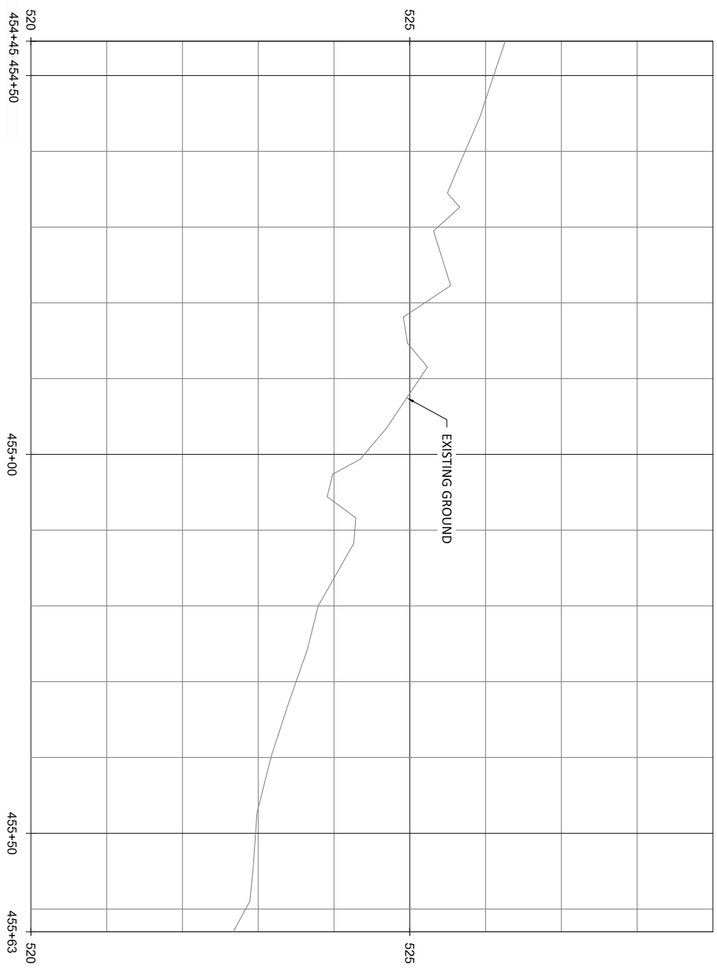

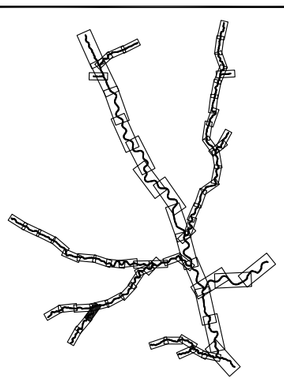

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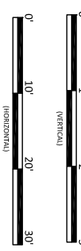

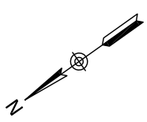

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Job Number:	005-02157
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T4B Reach 2
Stream Plan and Profile

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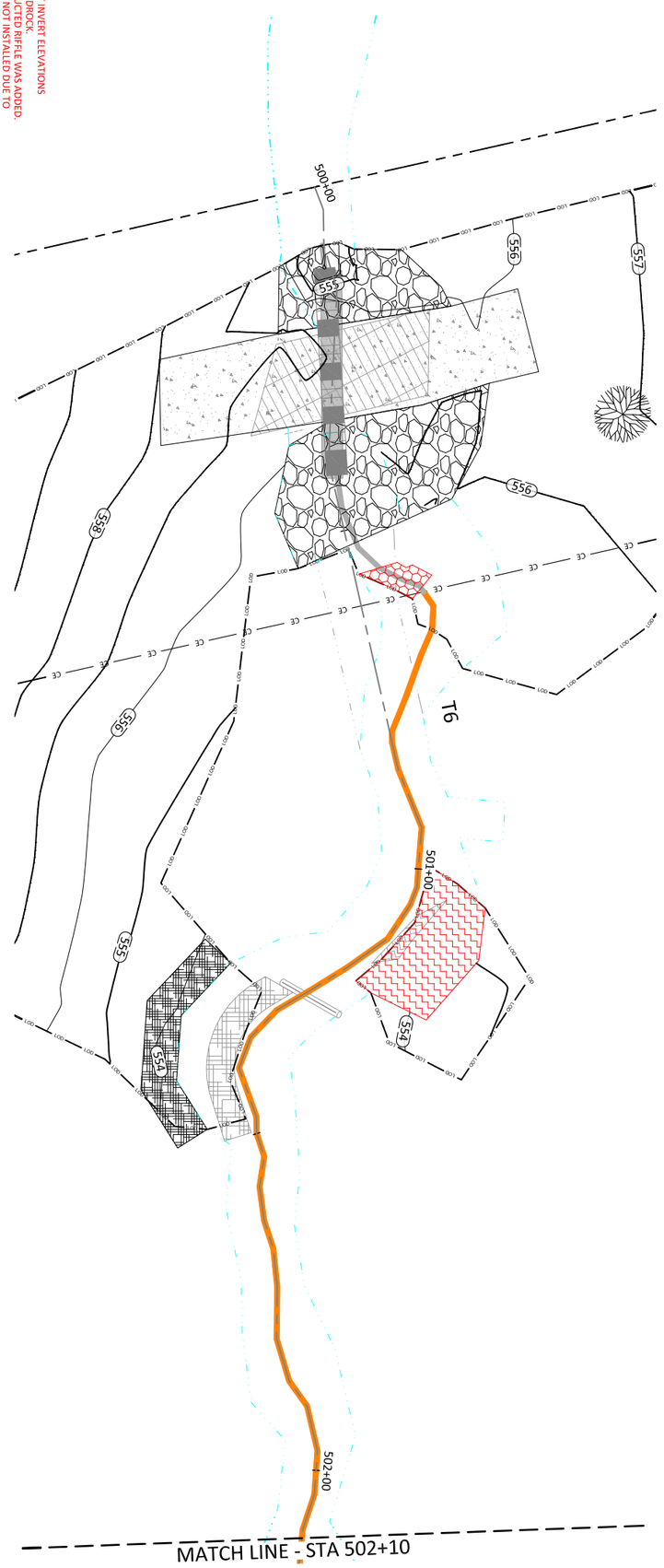
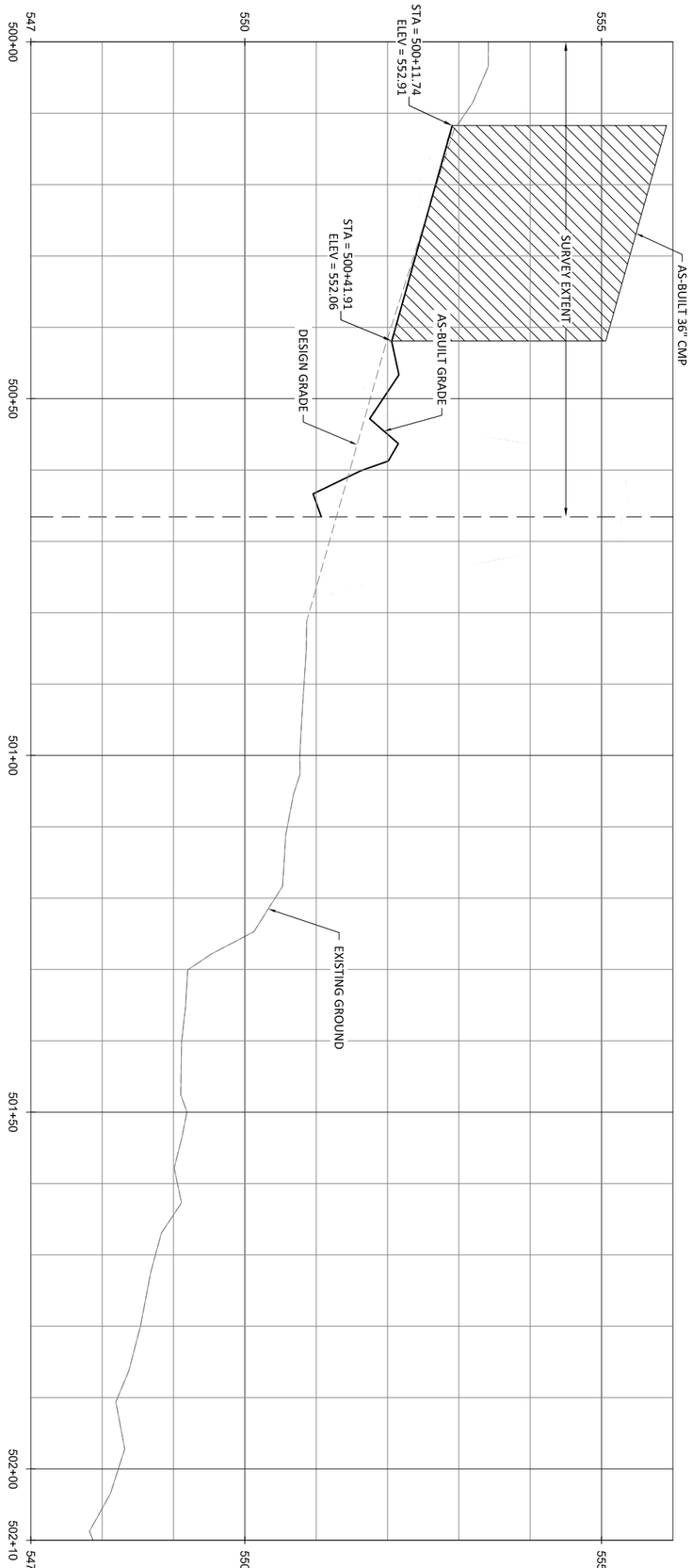
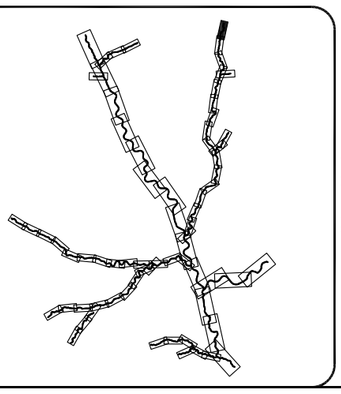
NOTE:
1. STA 500+27: CULVERT INVERT ELEVATIONS ADJUSTED DUE TO BEDROCK.
2. STA 500+55: CONCRETE RIFFLE WAS ADDED.
3. STA 501+25: LOG SILL NOT INSTALLED DUE TO BEDROCK.







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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' -2' (VERTICAL)

N

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Buckwater Mitigation Site
Orange County, North Carolina

T6 Reach 1
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 9/9/19

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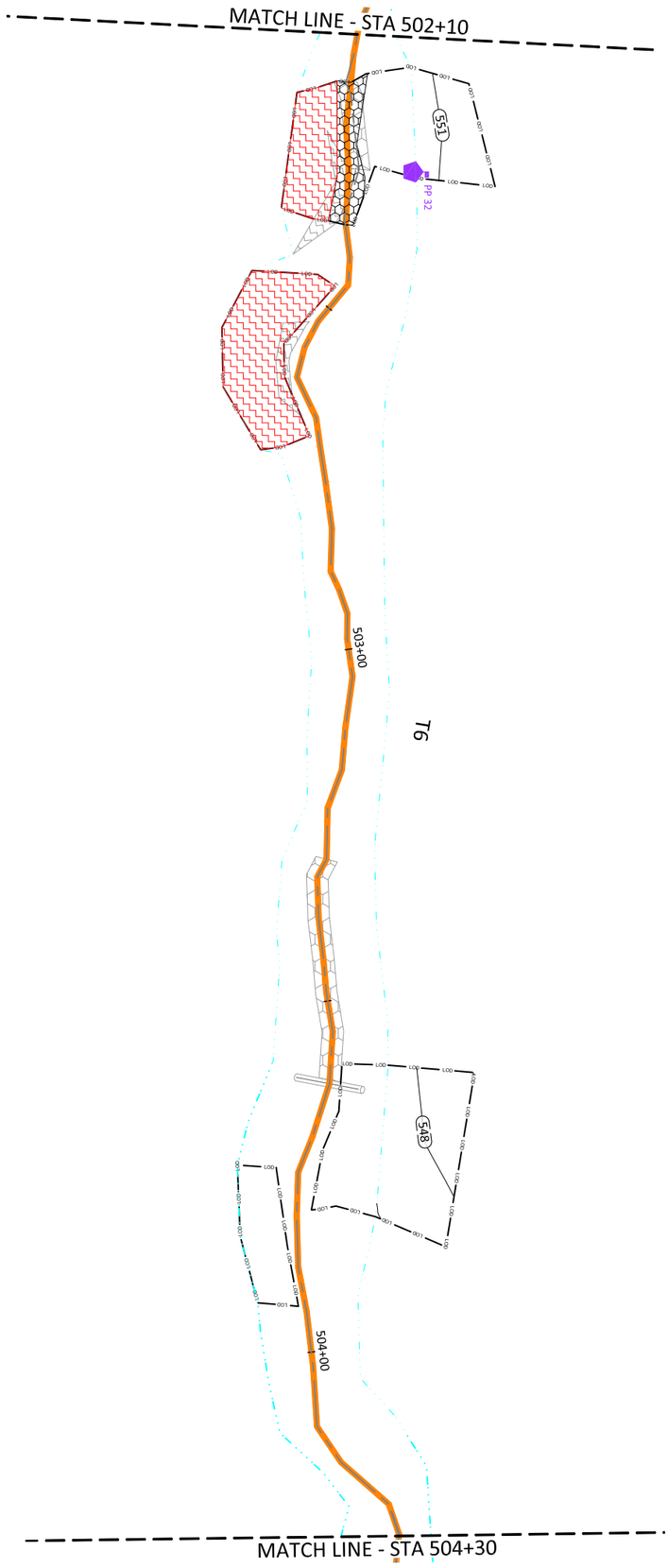
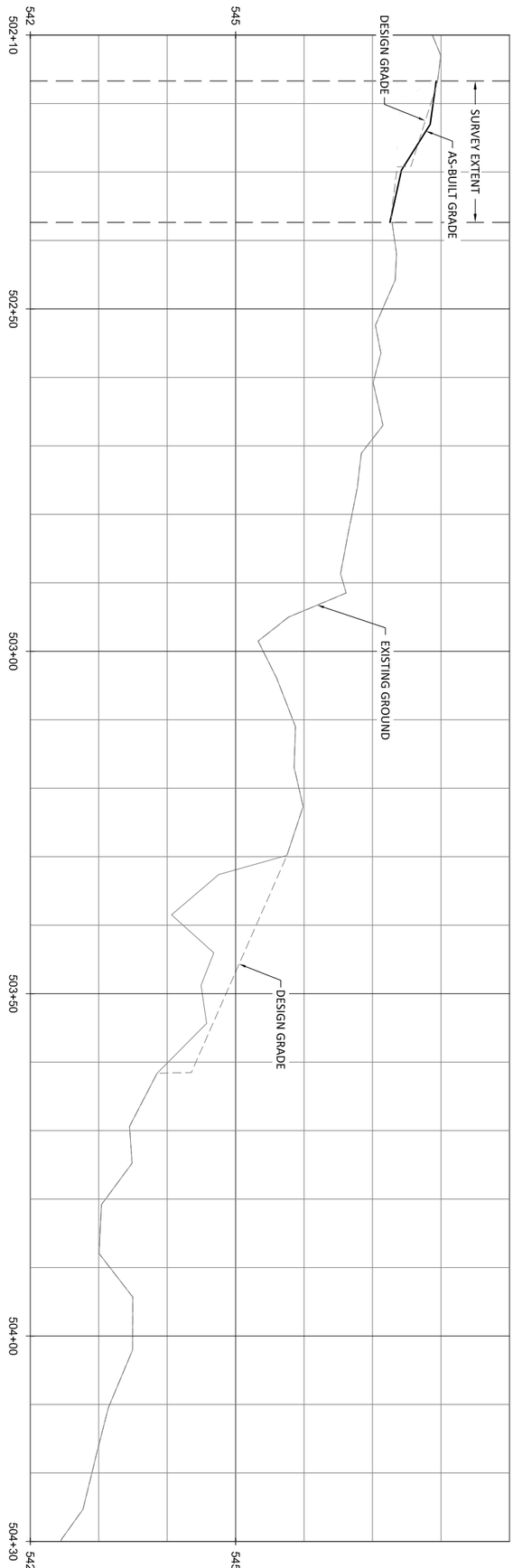
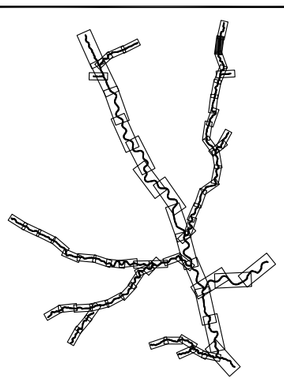
NOTE:
1. STA 503+44: RIFFLE AND LOG SILL NOT INSTALLED DUE TO BEDROCK.







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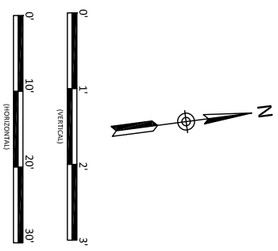

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Buckwater Mitigation Site
Orange County, North Carolina

T6 Reach 1
Stream Plan and Profile

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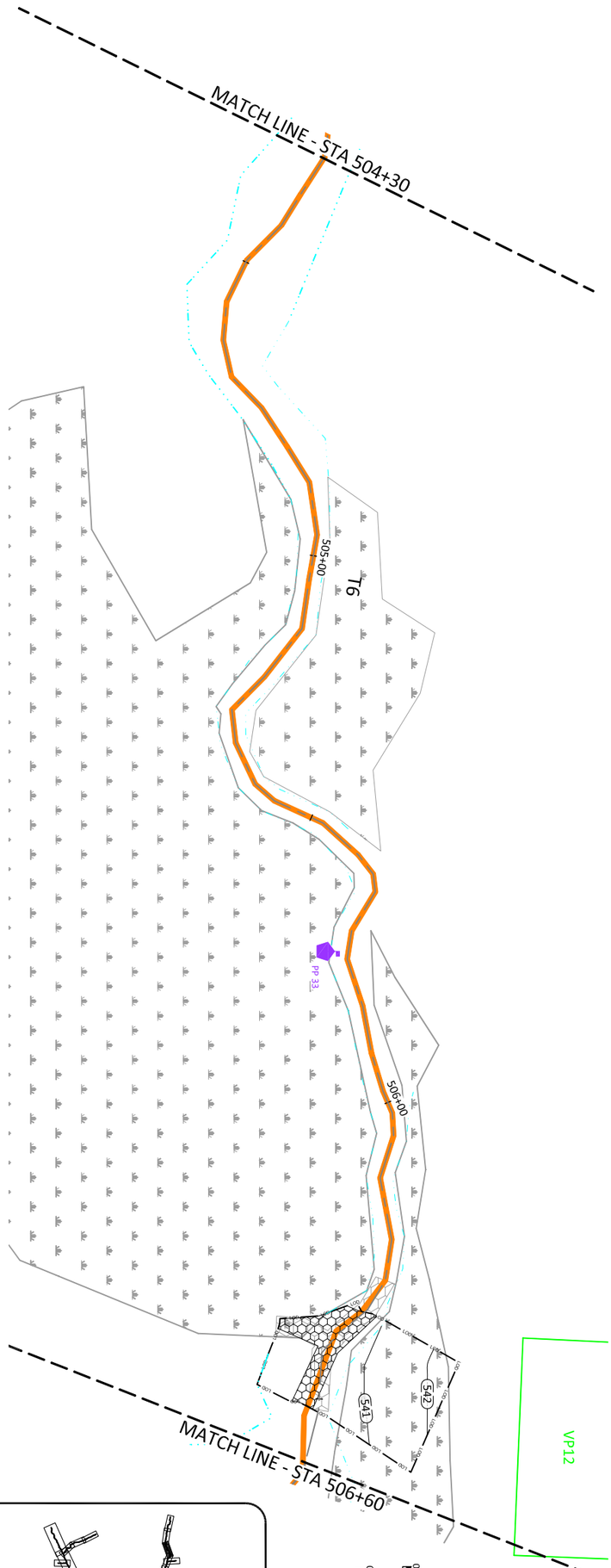

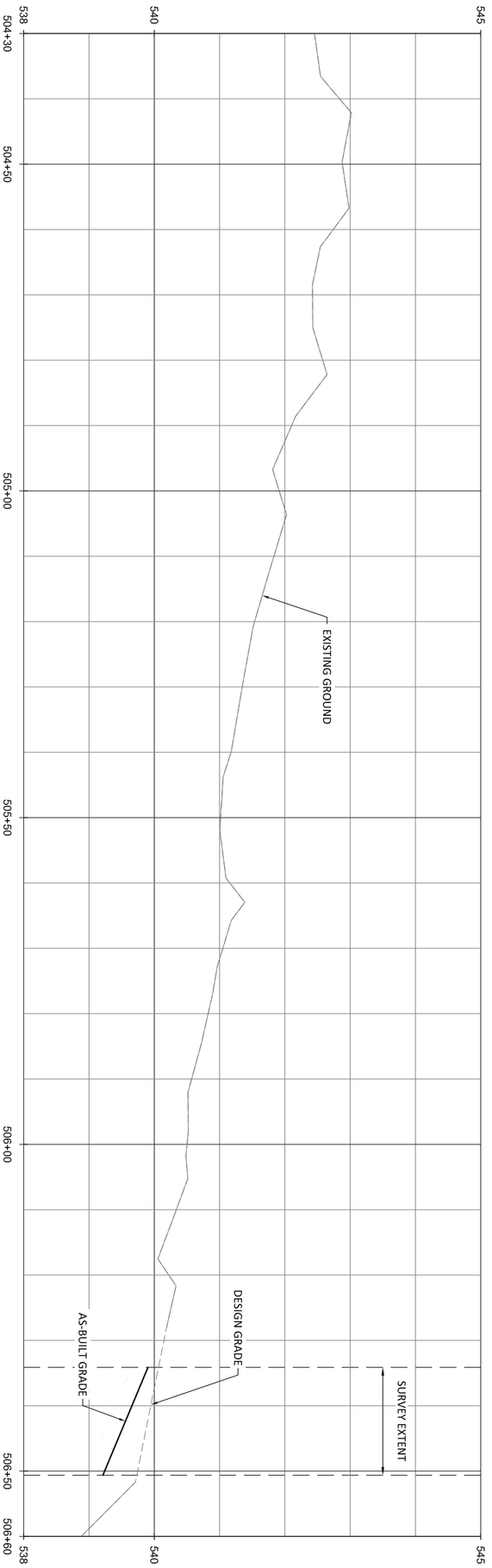

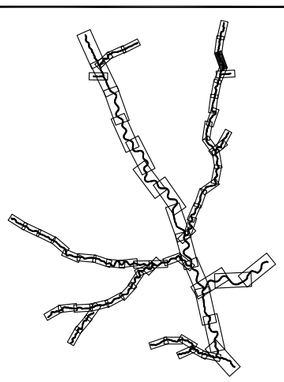

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Buckwater Mitigation Site
Orange County, North Carolina

T6 Reach 1
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS

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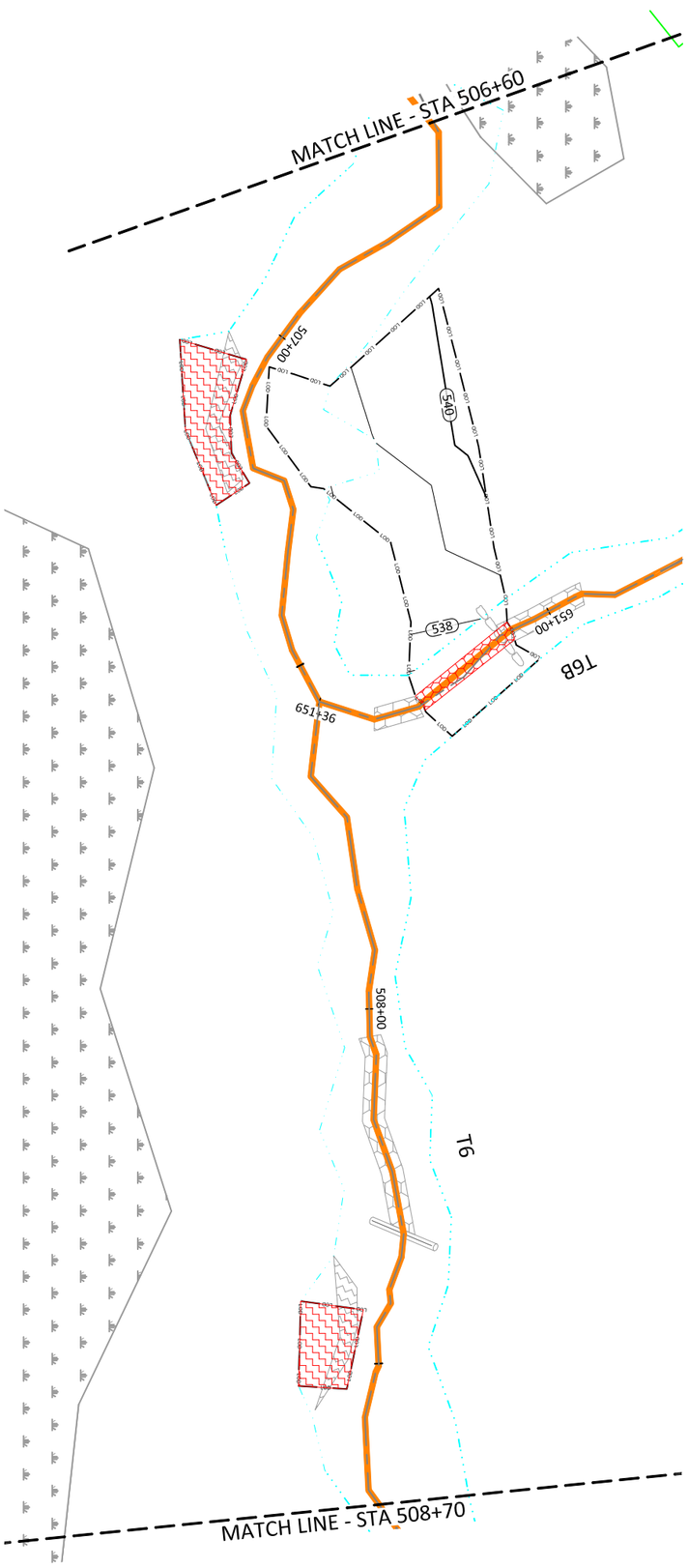
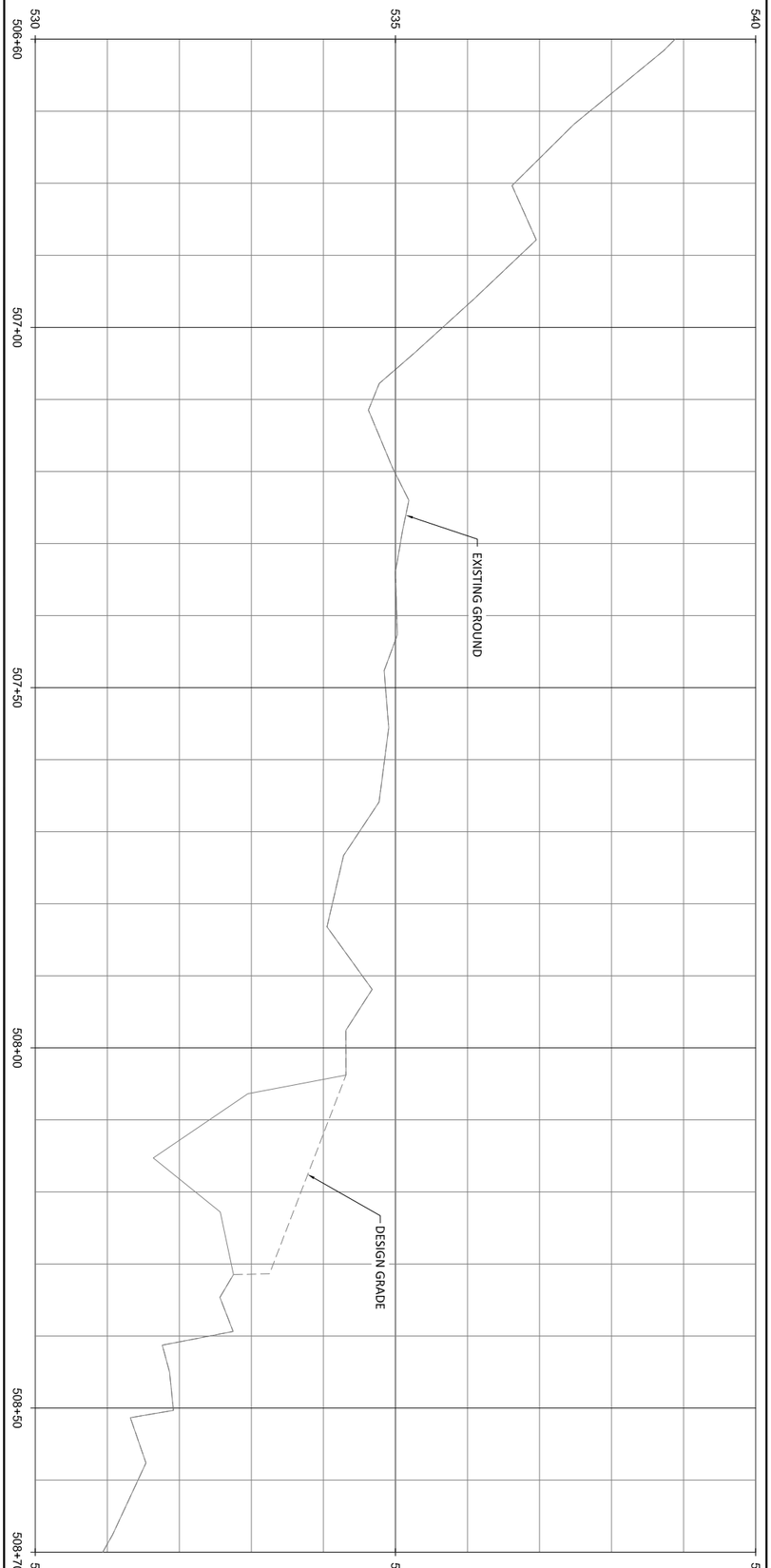
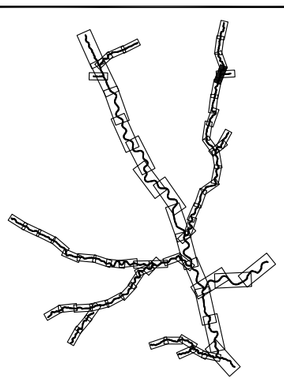
NOTE:
1. STA 508+17: RIFFLE AND LOG SILL NOT INSTALLED DUE TO BEDROCK.







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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

N

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Buckwater Mitigation Site
Orange County, North Carolina

T6 Reaches 1 & 2
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS

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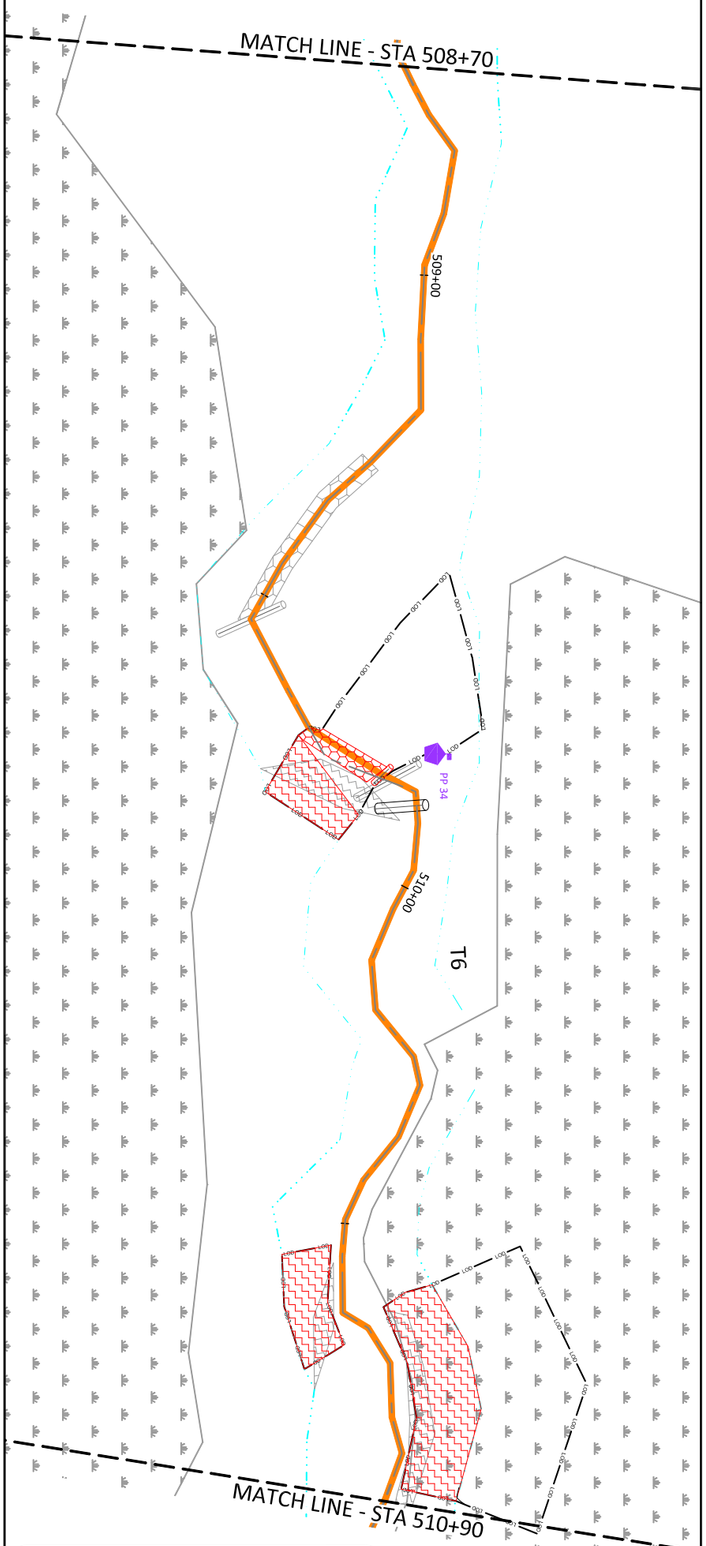
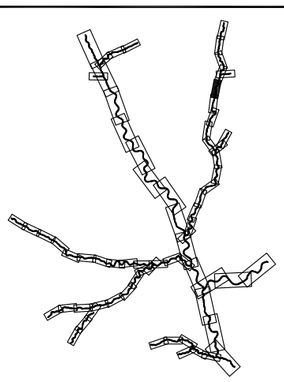
NOTE:
1. STA 508+40: RIFFLE AND LOG SILL NOT INSTALLED DUE TO BEDROCK.
2. STA 509+76: RIFFLE AND LOG SILL WAS ADDED.





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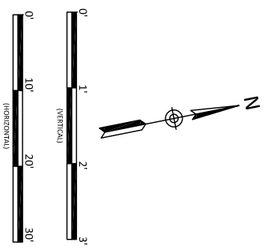

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Drawn By:	CAW
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Buckwater Mitigation Site
Orange County, North Carolina

T6 Reach 2
Stream Plan and Profile

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N

0' 1' 2' 3'
(VERTICAL)

0' 10' 20' 30'
(HORIZONTAL)

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NOTE:
1. STA 511+94: RIFFLE WAS NOT INSTALLED DUE TO FIELD CONDITIONS.
2. STA 512+72: BOULDER SILL AND BRUSH TOE WERE NOT ADDED DUE TO BEDROCK.
3. STA 512+97: LOG SILL NOT ADDED DUE TO BEDROCK.
4. STA 513+00: RIPRAP ADDED.

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Buckwater Mitigation Site
Orange County, North Carolina

T6 Reaches 2 & 3
Stream Plan and Profile

Revisions:

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Job Number: 005-02157
Project Engineer: NMM
Drawn By: CAW
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NOTE:

1. STA 513+18: LOG SILL NOT INSTALLED DUE TO BEDROCK.
2. STA 513+26: BRUSH TOE NOT INSTALLED DUE TO BEDROCK.
3. STA 513+52: BOULDER SILL NOT INSTALLED DUE TO BEDROCK.

0' 1' 2' 3' (VERTICAL)

0' 10' 20' 30' (HORIZONTAL)

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Buckwater Mitigation Site
Orange County, North Carolina

T6 Reach 3
Stream Plan and Profile

Revisions:

Date: 07.01.2019
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Project Engineer: NMM
Drawn By: CAW
Checked By: JTL

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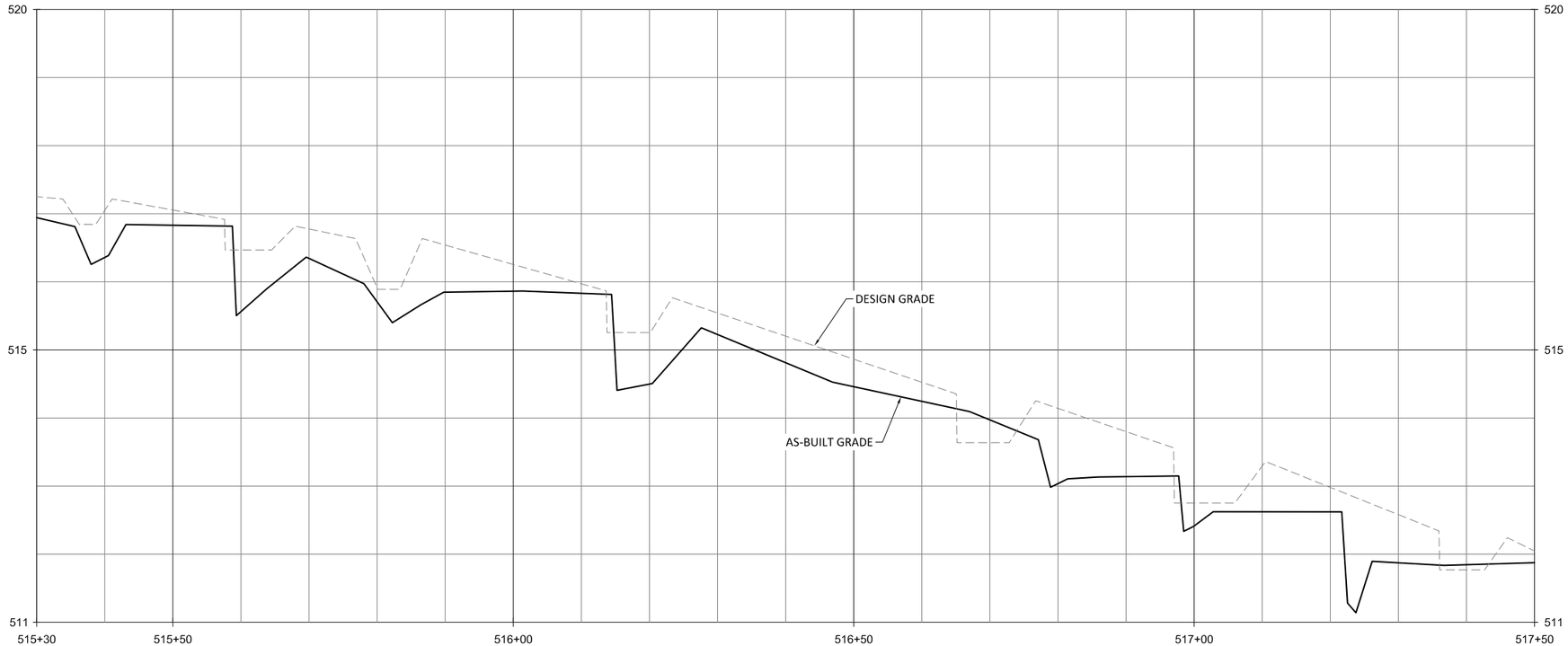

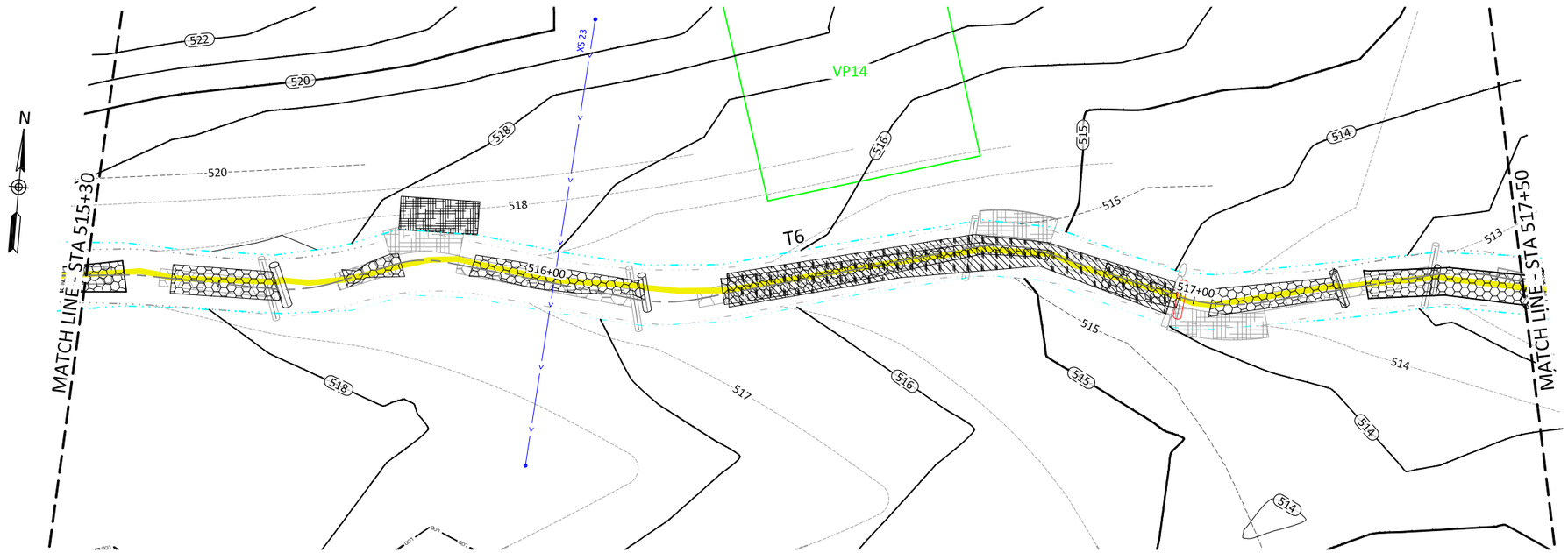

NOTE:

1. STA 516+65: LOG SILL NOT INSTALLED DUE TO BEDROCK.
2. STA 516+72: BRUSH TOE NOT INSTALLED DUE TO BEDROCK.
3. STA 516+98: A LOG SILL WAS INSTALLED INSTEAD OF A BOULDER SILL.
1. STA 517+04: BRUSH TOE NOT INSTALLED DUE TO BEDROCK.

0' 1' 2' 3' (VERTICAL)

0' 10' 20' 30' (HORIZONTAL)

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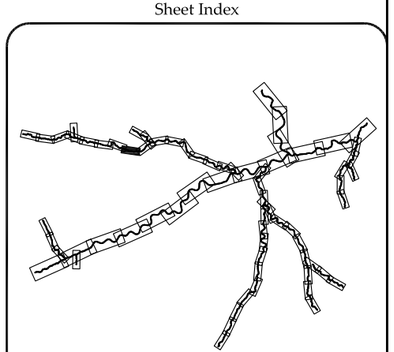

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Buckwater Mitigation Site
Orange County, North Carolina

T6 Reach 3
Stream Plan and Profile

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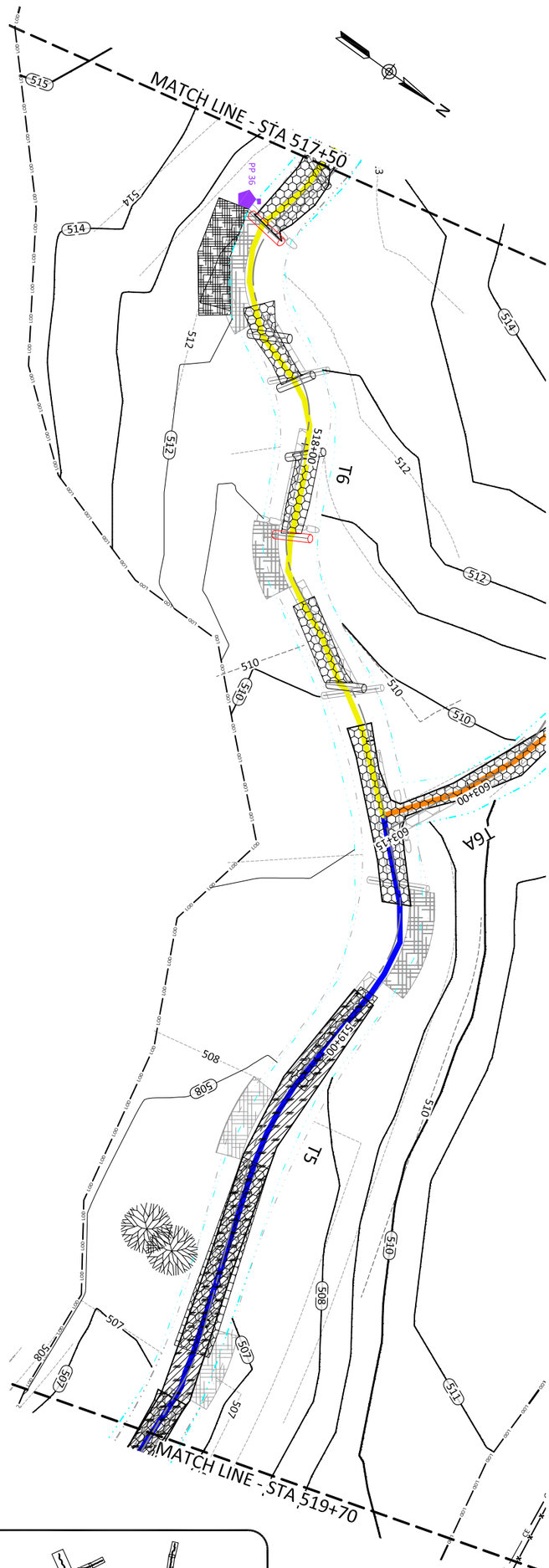

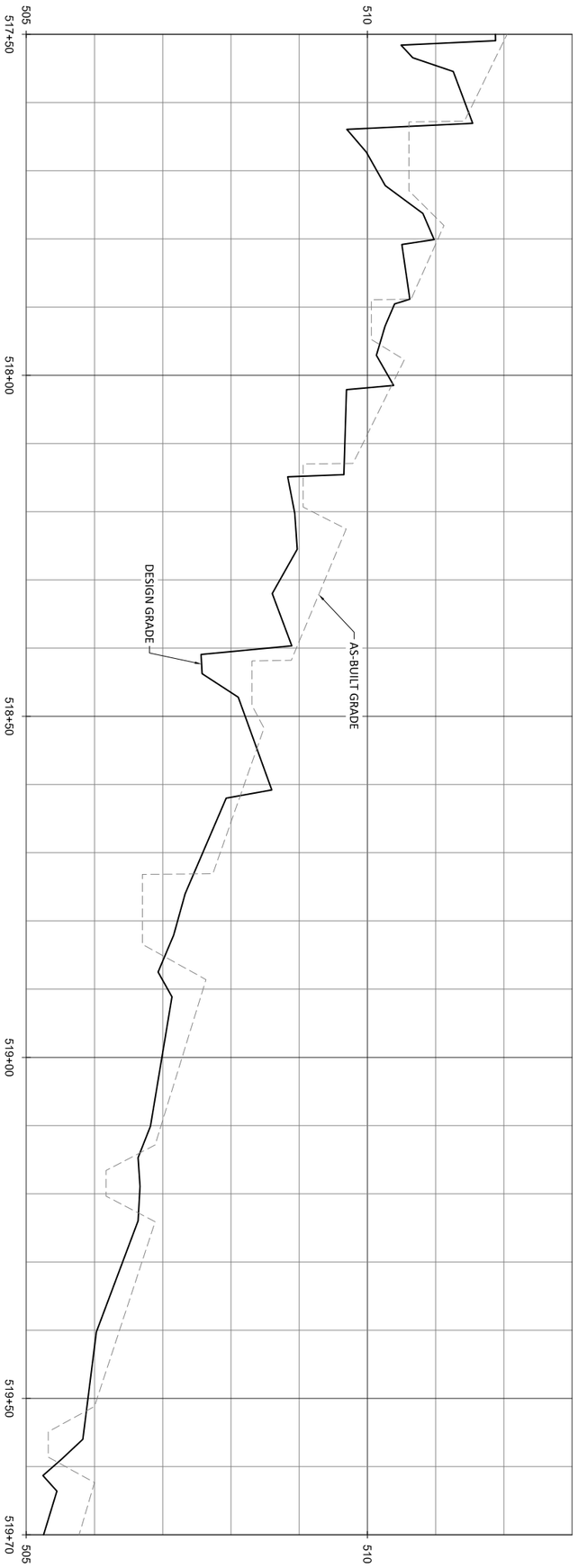

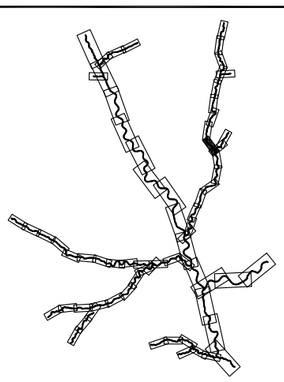

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0' 10' 20' 30' (HORIZONTAL)

0 1" 2" 3" (VERTICAL)

NOTE:
1. STA 517+73: A LOG SILL WAS INSTALLED INSTEAD OF A BOULDER SILL.
2. STA 518+15: A LOG SILL WAS INSTALLED INSTEAD OF A BOULDER SILL.
3. STA 518+18: BRUSH TOE WAS NOT INSTALLED DUE TO BEDROCK.
4. STA 518+32: A LOG SILL WAS NOT INSTALLED DUE TO BEDROCK.
5. STA 518+82: BRUSH TOE WAS NOT INSTALLED DUE TO BEDROCK.
6. STA 519+18: BRUSH TOE WAS NOT INSTALLED DUE TO BEDROCK.
7. STA 519+57: BRUSH TOE WAS NOT INSTALLED DUE TO BEDROCK.

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Buckwater Mitigation Site
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T6 Reach 3 & T5
Stream Plan and Profile

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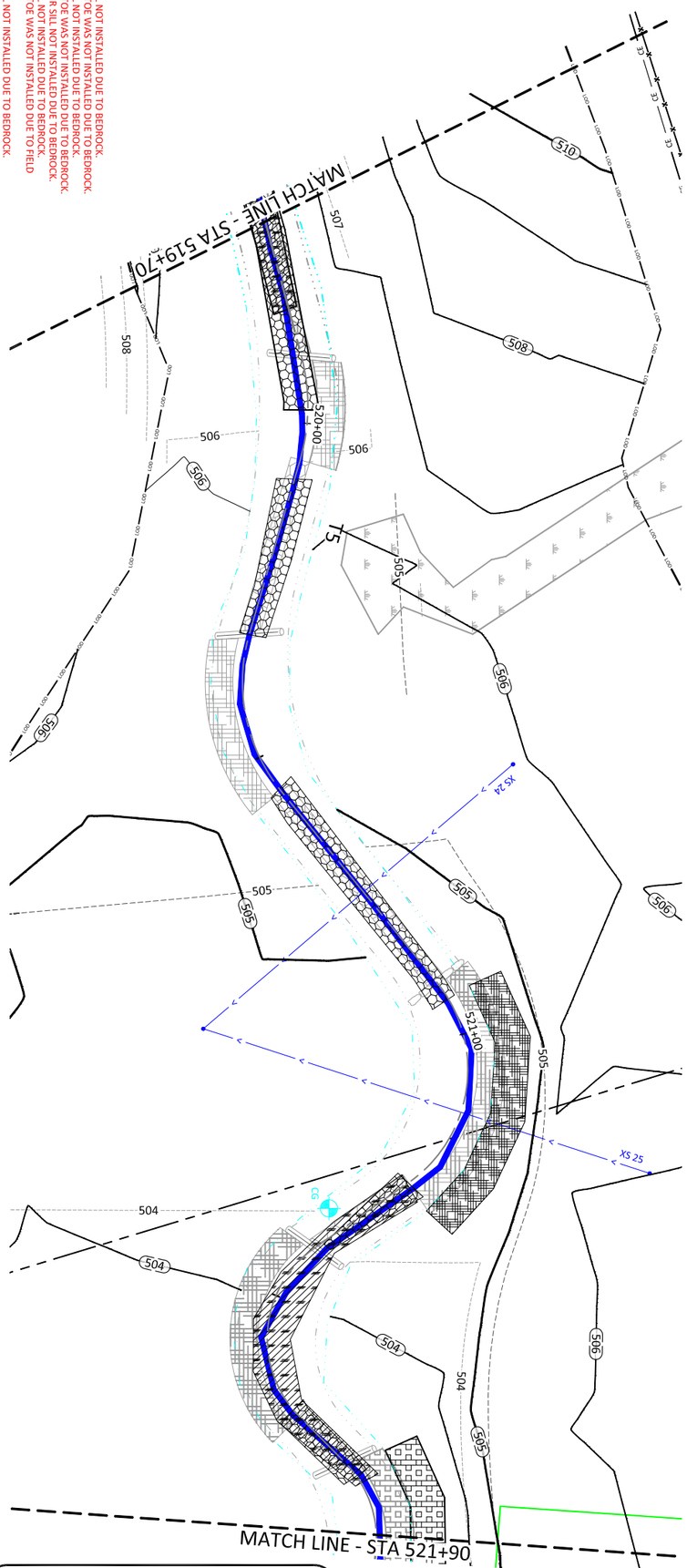
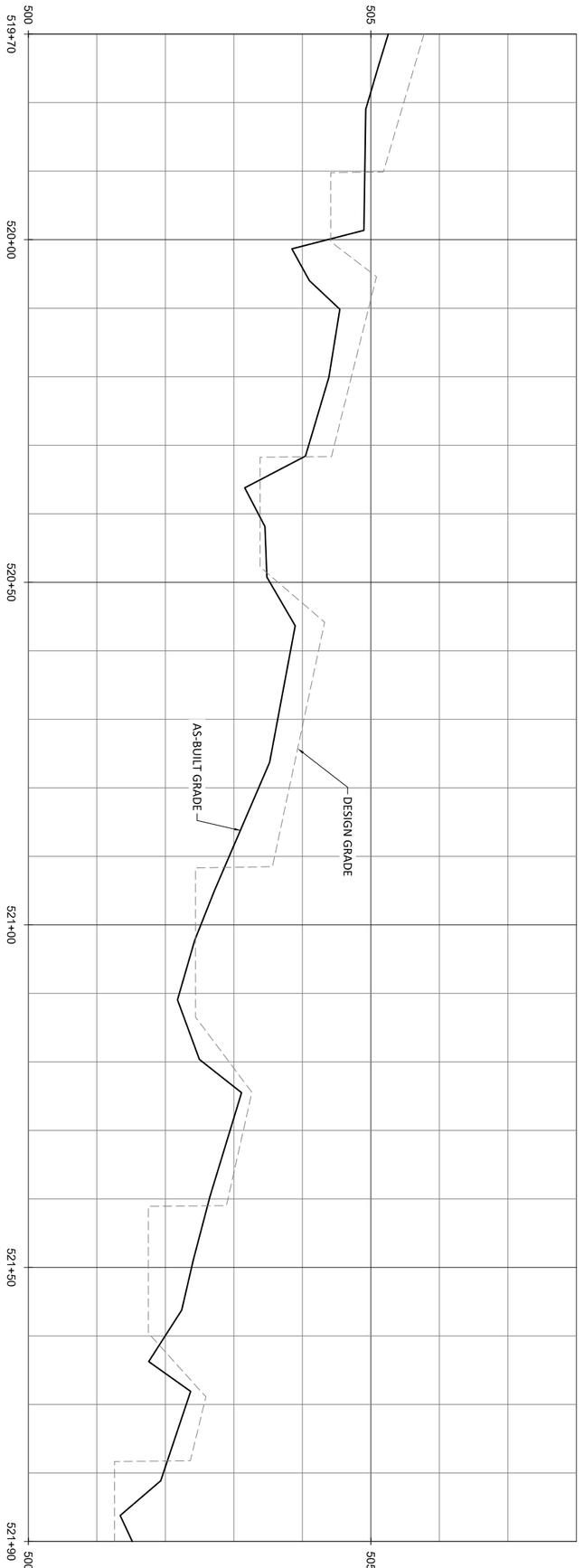
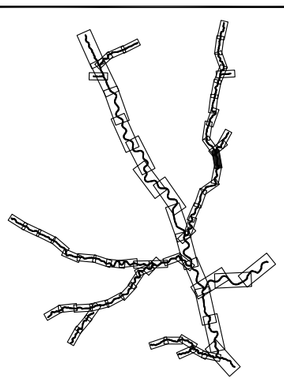
NOTE:
1. STA 519+90: LOG SILL NOT INSTALLED DUE TO BEDROCK.
2. STA 519+99: BRUSH TOE WAS NOT INSTALLED DUE TO BEDROCK.
3. STA 520+32: LOG SILL NOT INSTALLED DUE TO BEDROCK.
4. STA 520+44: BRUSH TOE WAS NOT INSTALLED DUE TO BEDROCK.
5. STA 520+92: BOULDER SILL NOT INSTALLED DUE TO BEDROCK.
6. STA 521+41: LOG SILL NOT INSTALLED DUE TO BEDROCK.
7. STA 521+68: BRUSH TOE WAS NOT INSTALLED DUE TO FIELD CONDITIONS.
8. STA 521+78: LOG SILL NOT INSTALLED DUE TO BEDROCK.







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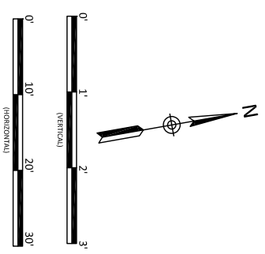

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Drawn By:	CAW
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Buckwater Mitigation Site
Orange County, North Carolina

T5
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS

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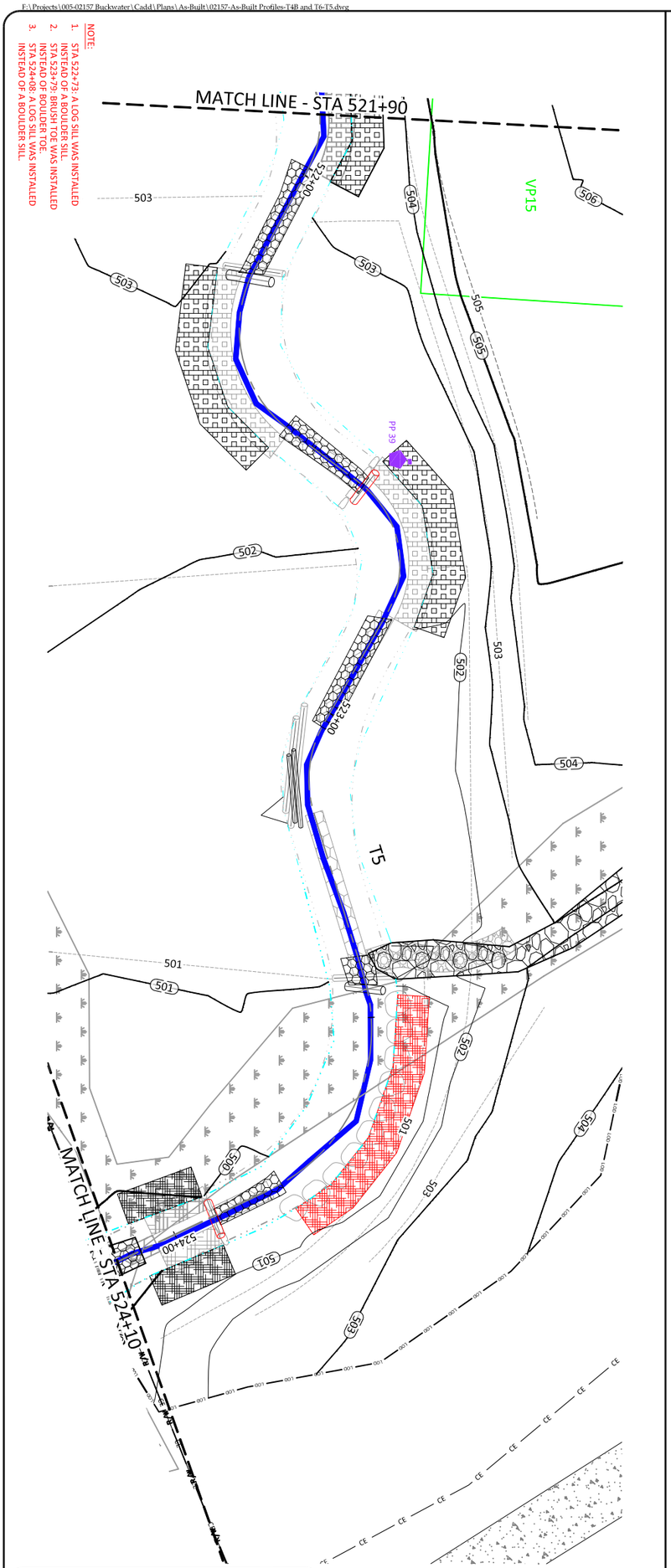
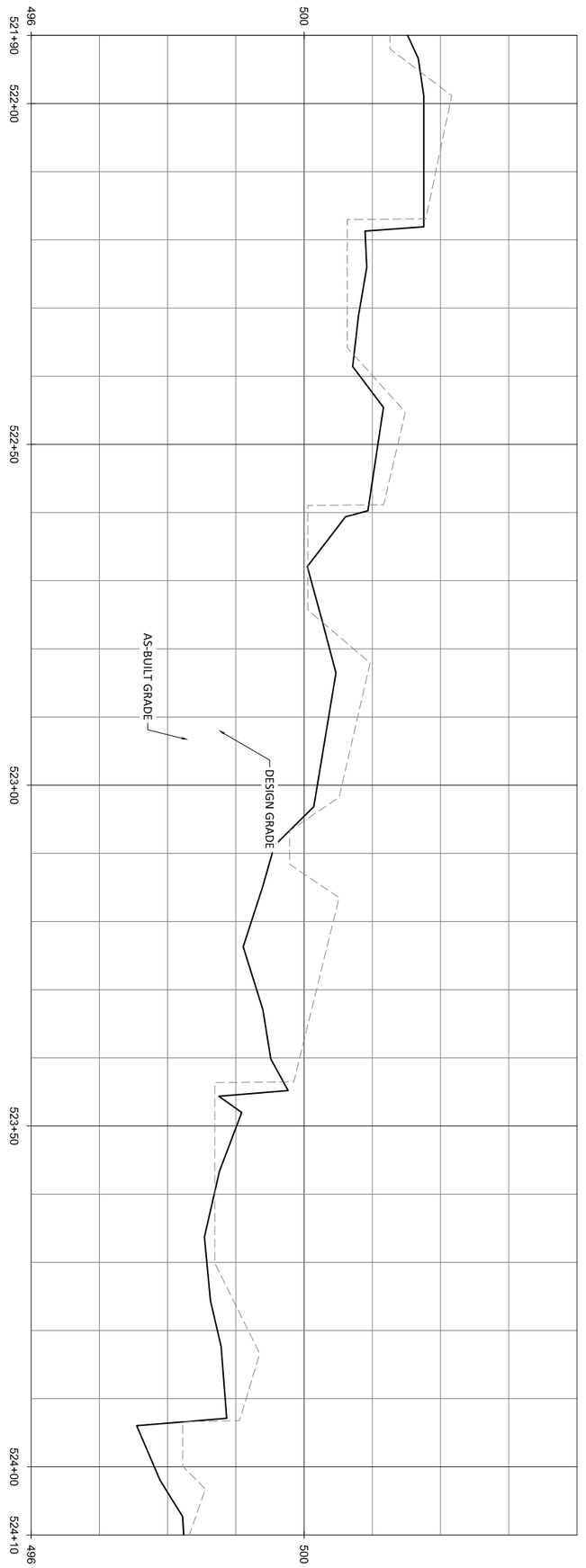
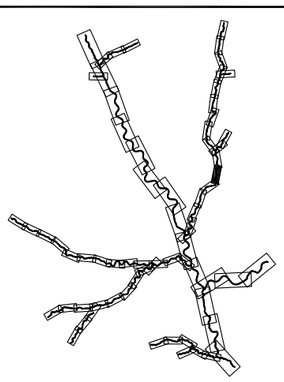
NOTE:
1. STA 522+73: A LOG SILL WAS INSTALLED INSTEAD OF A BOULDER SILL.
2. STA 523+79: BRUSH TOE WAS INSTALLED INSTEAD OF A BOULDER SILL.
3. STA 524+08: A LOG SILL WAS INSTALLED INSTEAD OF A BOULDER SILL.







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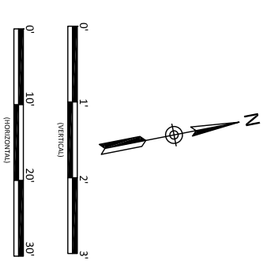

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Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

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Buckwater Mitigation Site
Orange County, North Carolina

T5
Stream Plan and Profile

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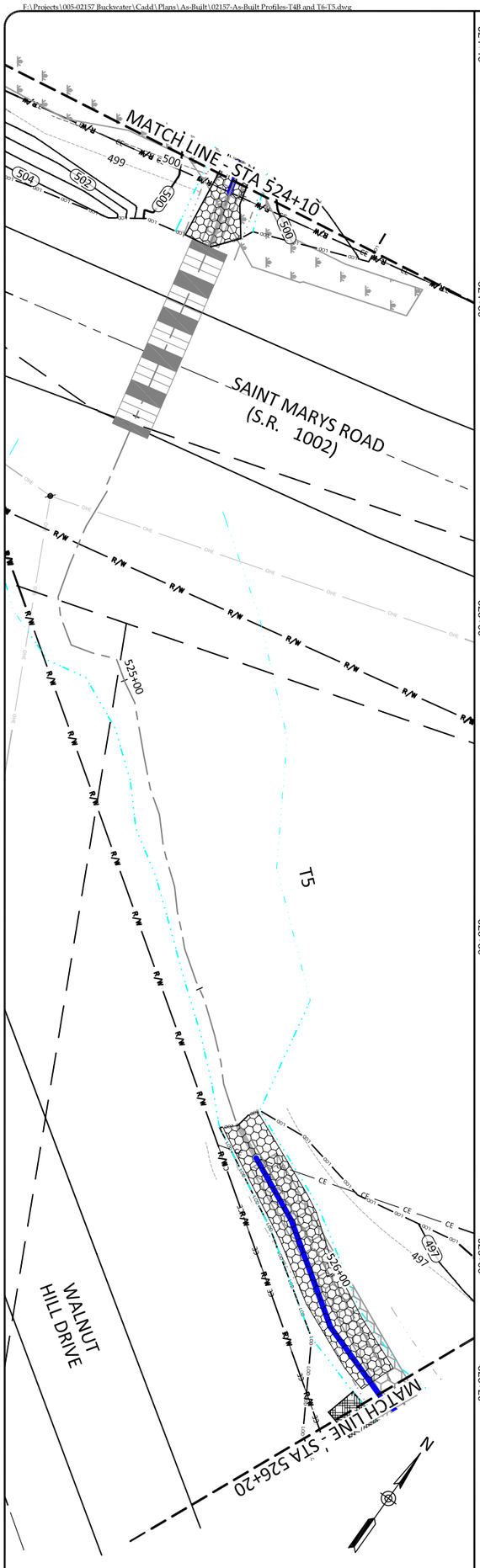

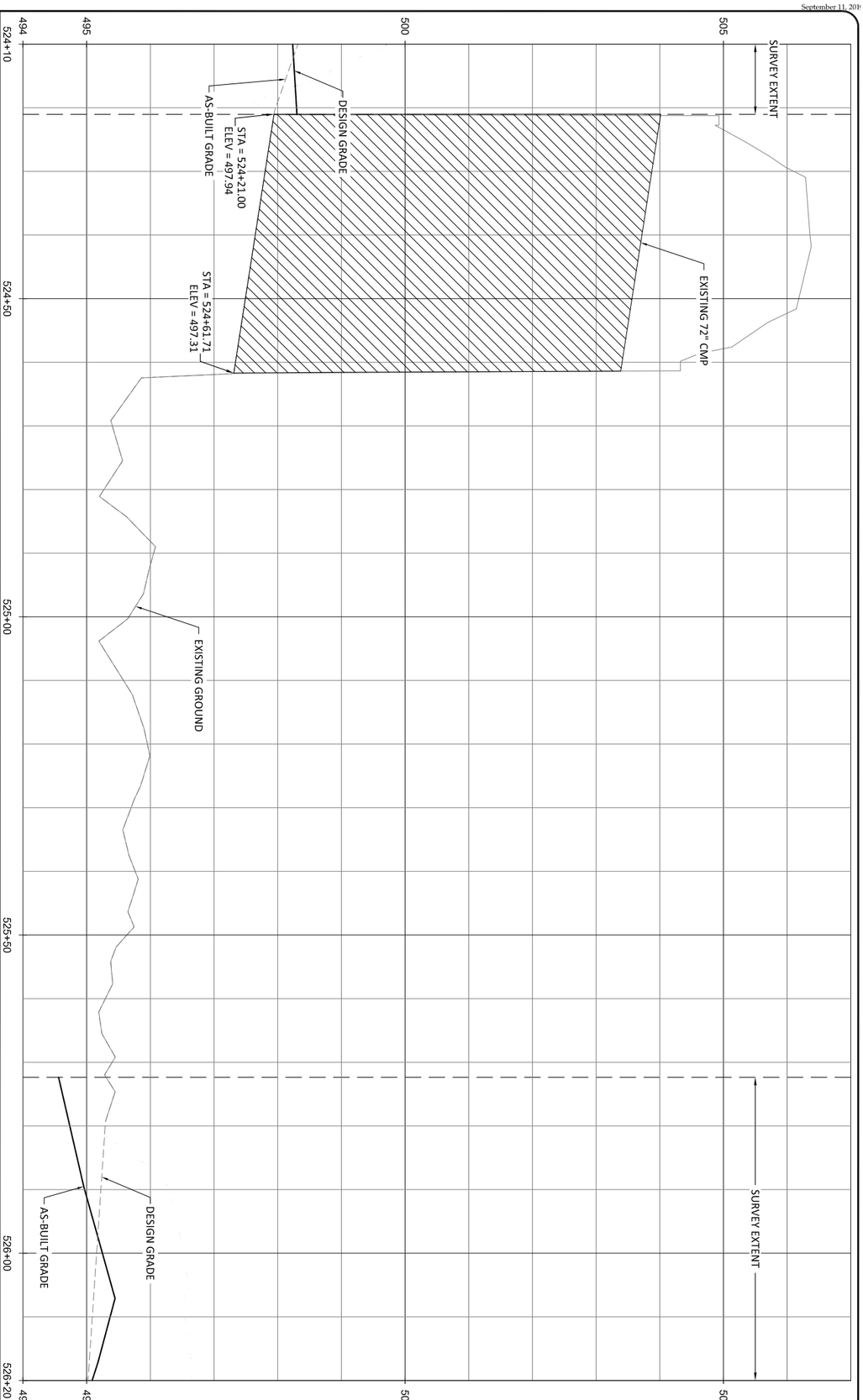

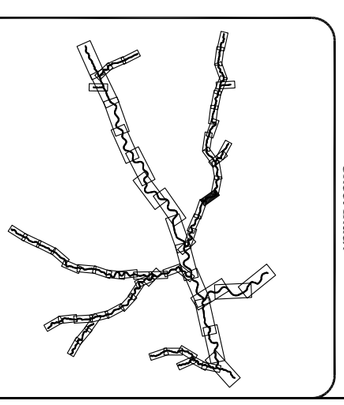

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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

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NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 7/9/19

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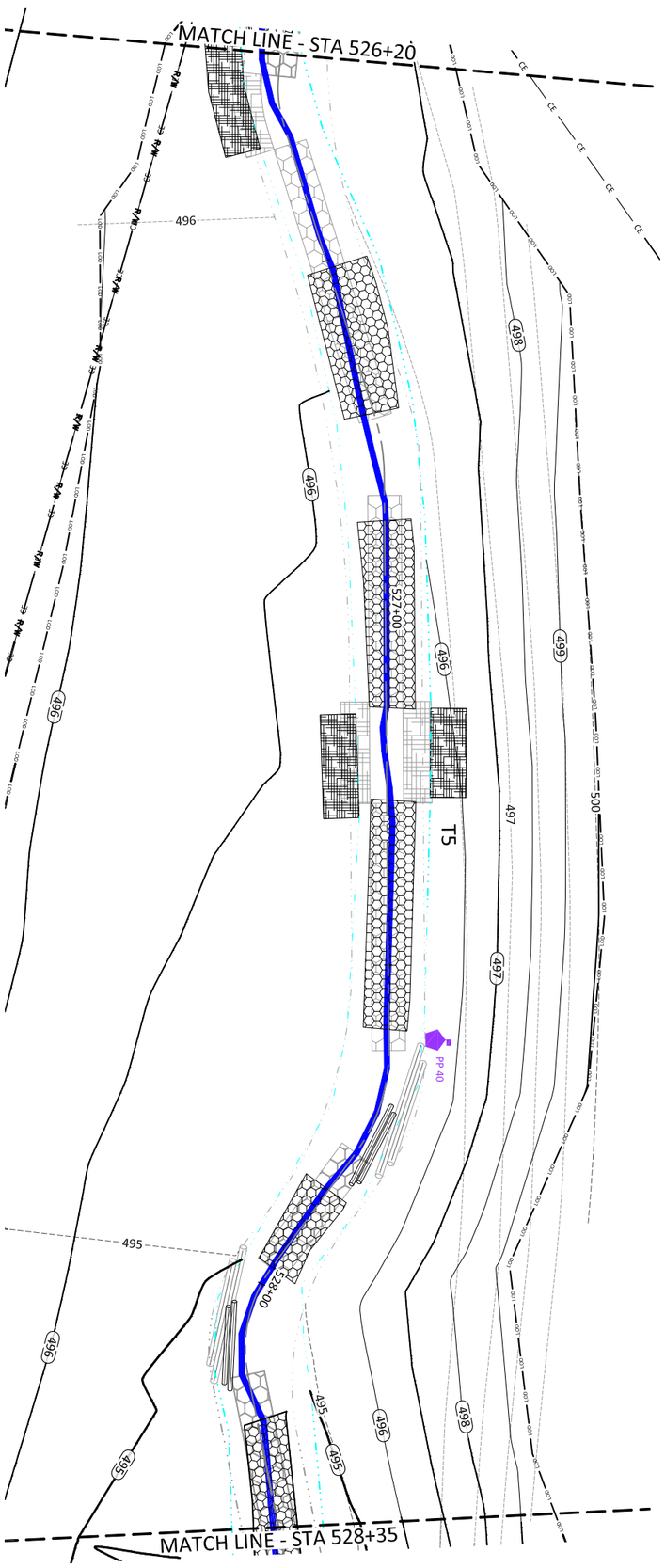
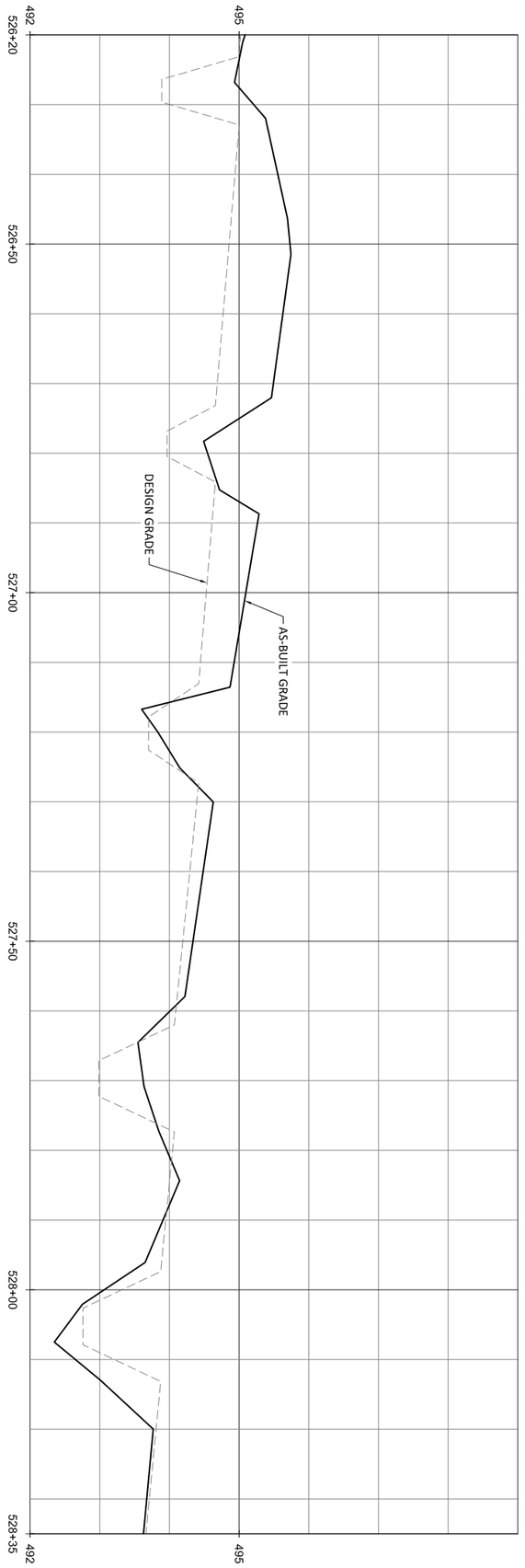
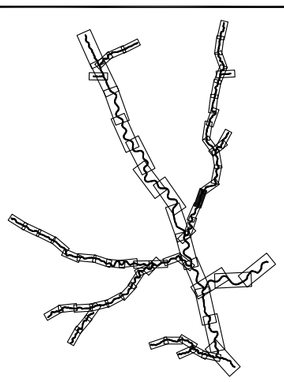
Firm License No. F-0831







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HORIZONTAL 0' 10' 20' 30'

VERTICAL 0' 1' 2' 3'

N

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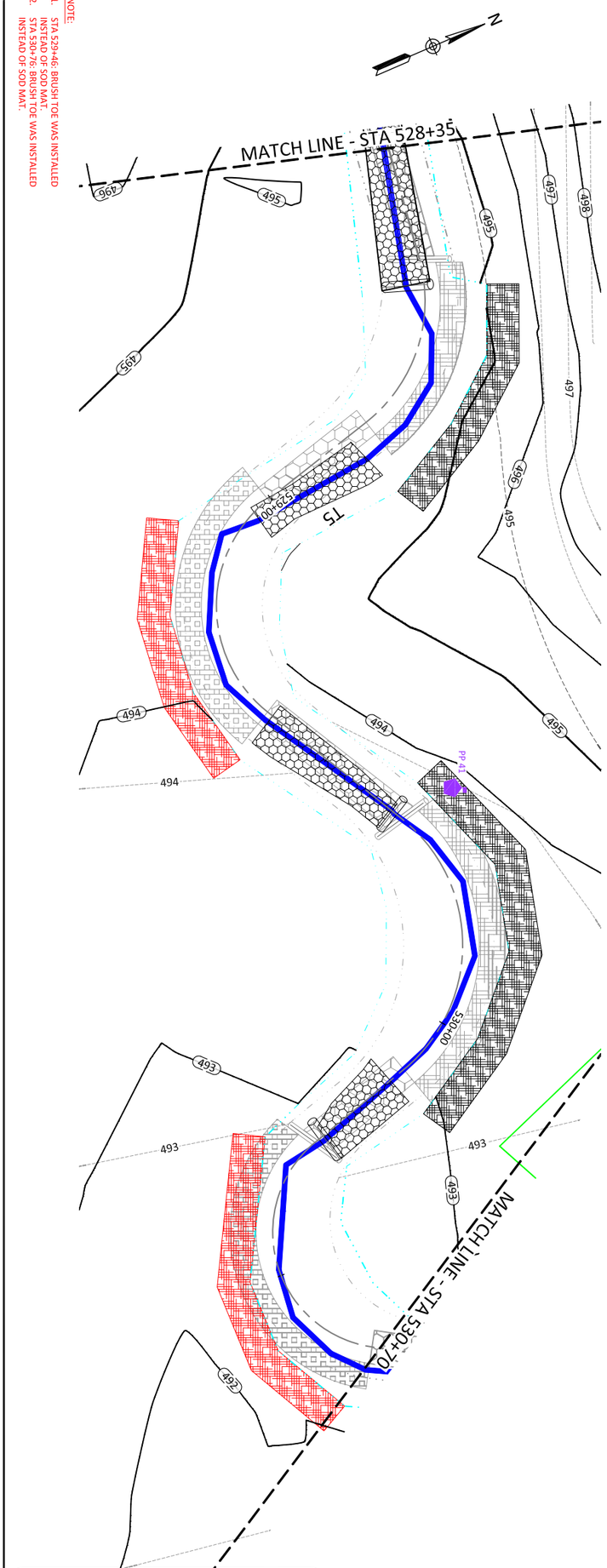
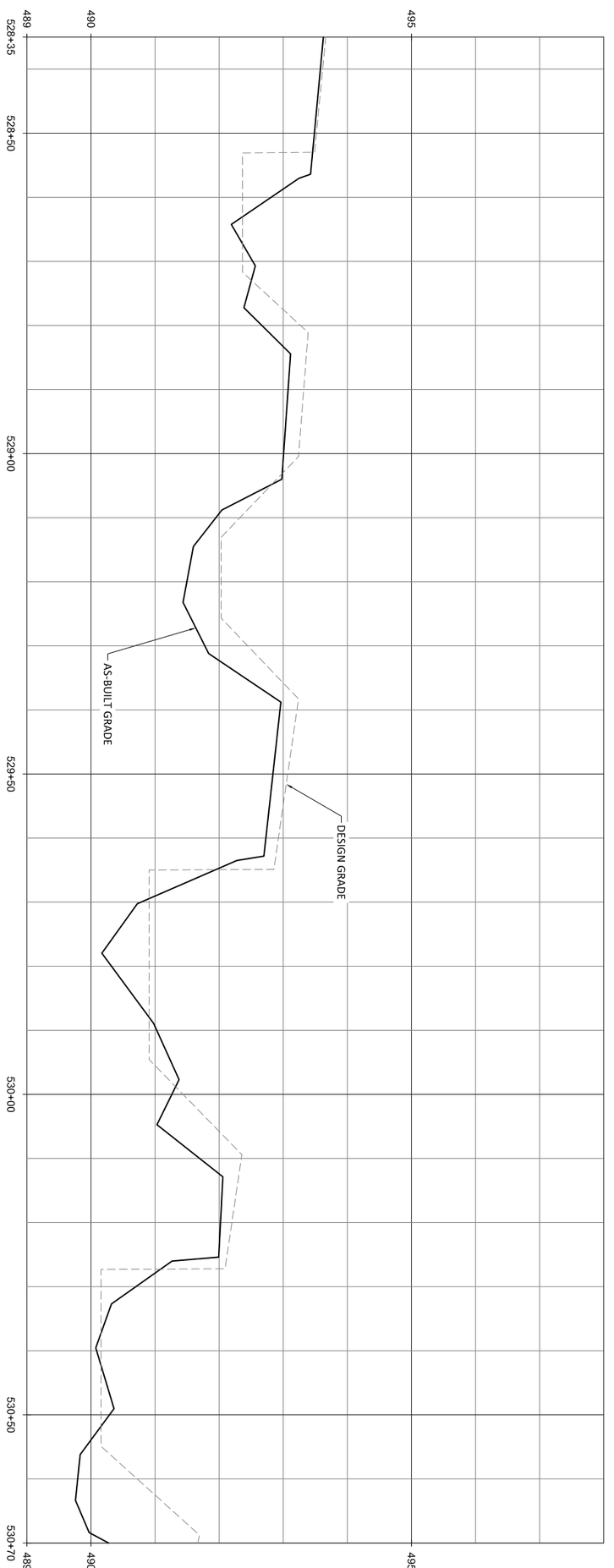
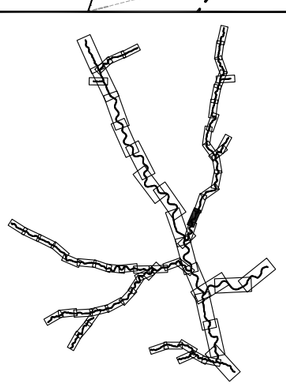
NOTE:
1. STA 529+46: BRUSH TOE WAS INSTALLED INSTEAD OF SOD MAT.
2. STA 530+76: BRUSH TOE WAS INSTALLED INSTEAD OF SOD MAT.







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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

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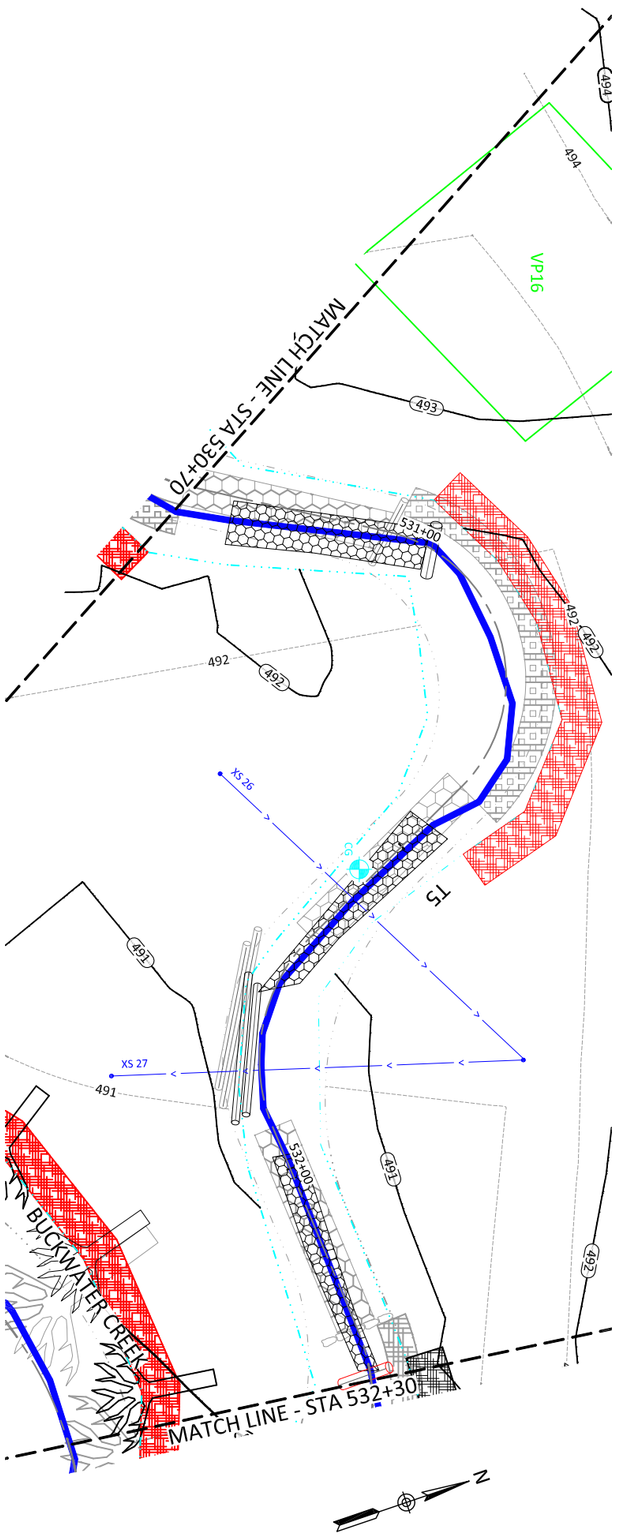
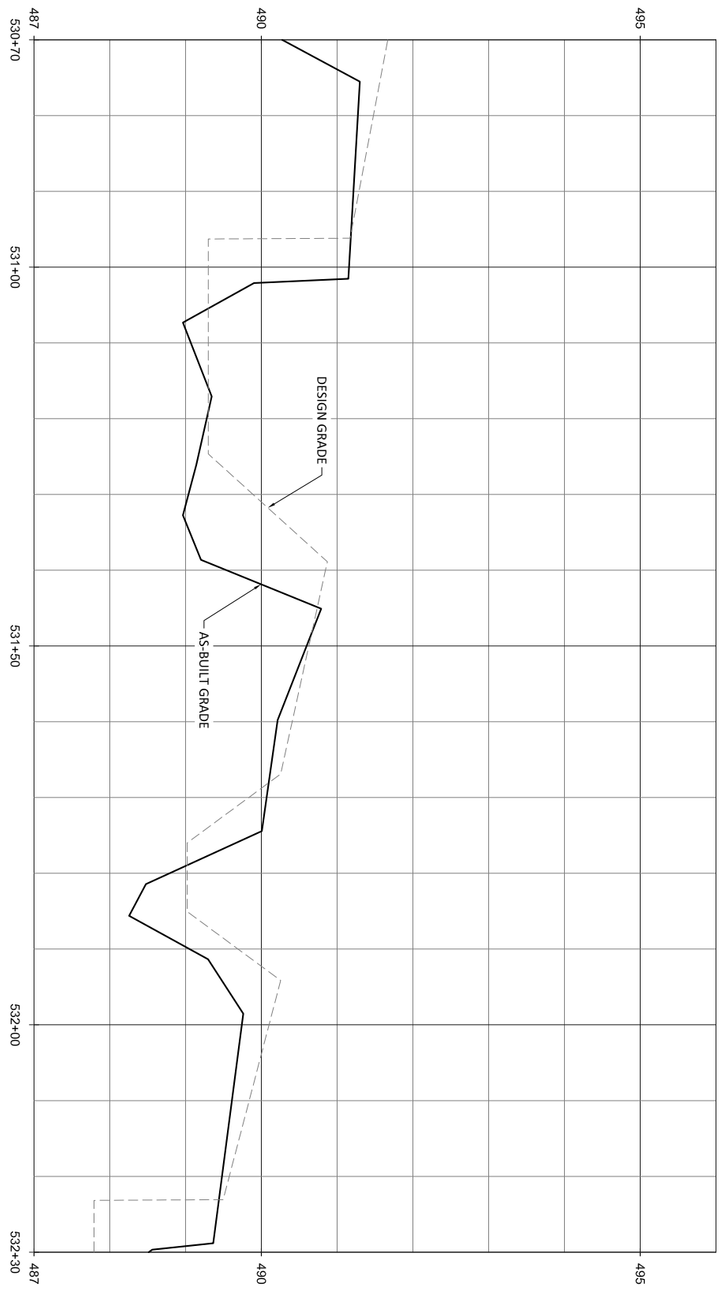
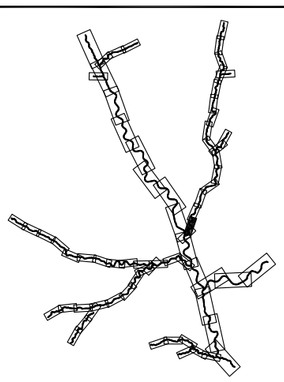
NOTE:
1. STA 531+51: BRUSH TOE WAS INSTALLED
2. STA 532+59: LOG SILL WAS INSTALLED INSTEAD OF BOULDER SILL







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0' 10' 20' 30' HORIZONTAL

0' 1' 2' 3' VERTICAL

Date:	07.01.2019
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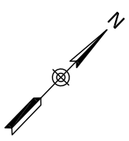
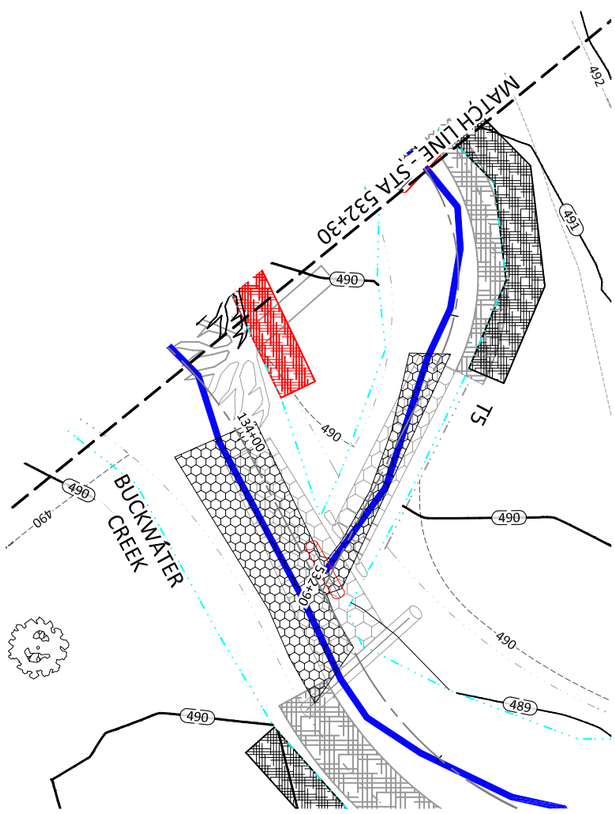
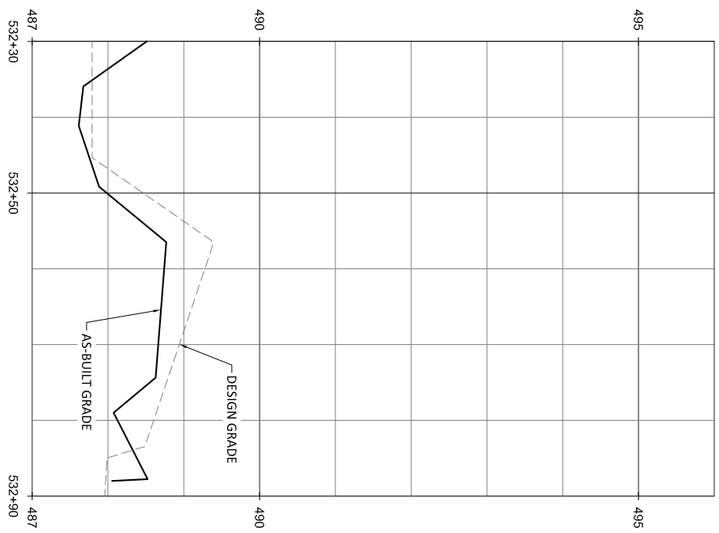
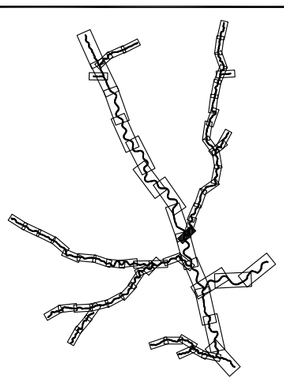
NOTE:
1. STA 531+03 LOG SILL WAS INSTALLED INSTEAD OF BOULDER SILL









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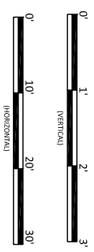

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Orange County, North Carolina

T5
Stream Plan and Profile

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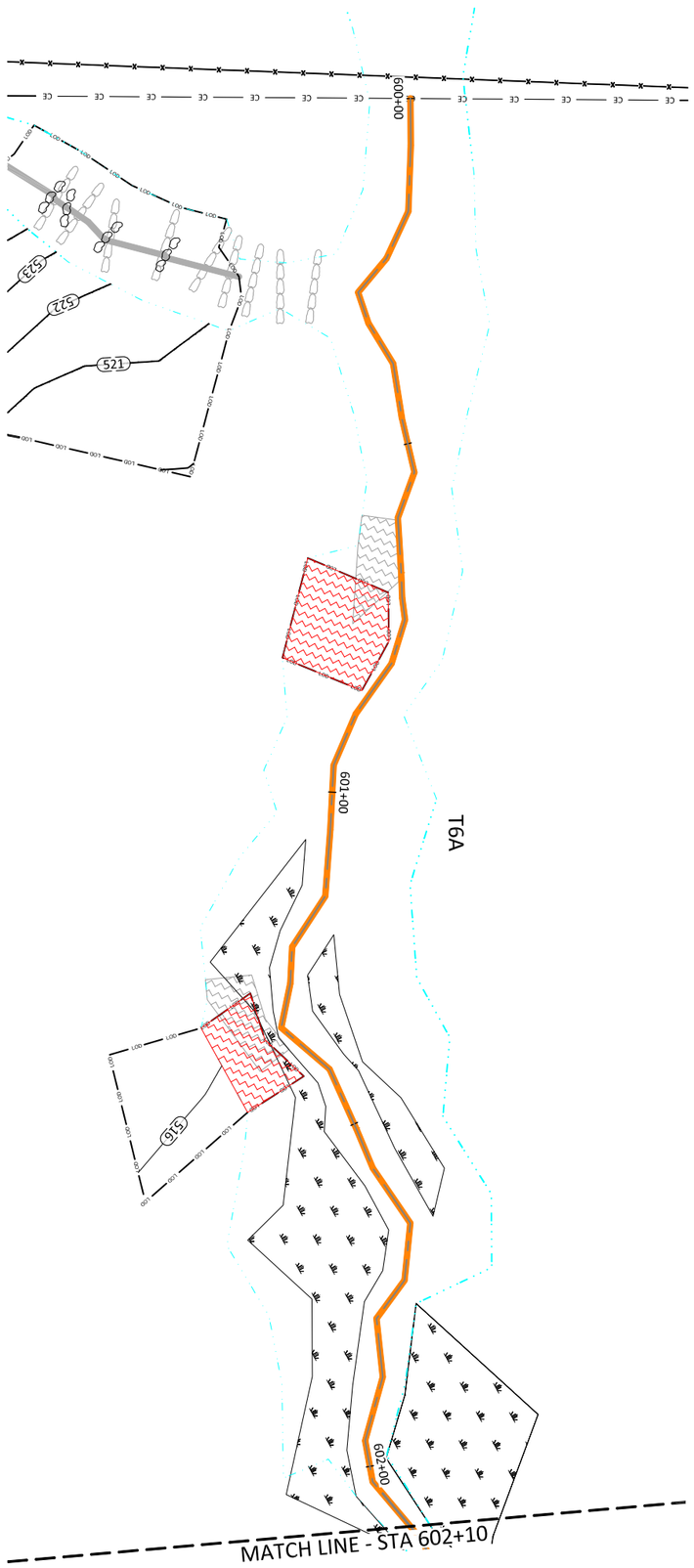
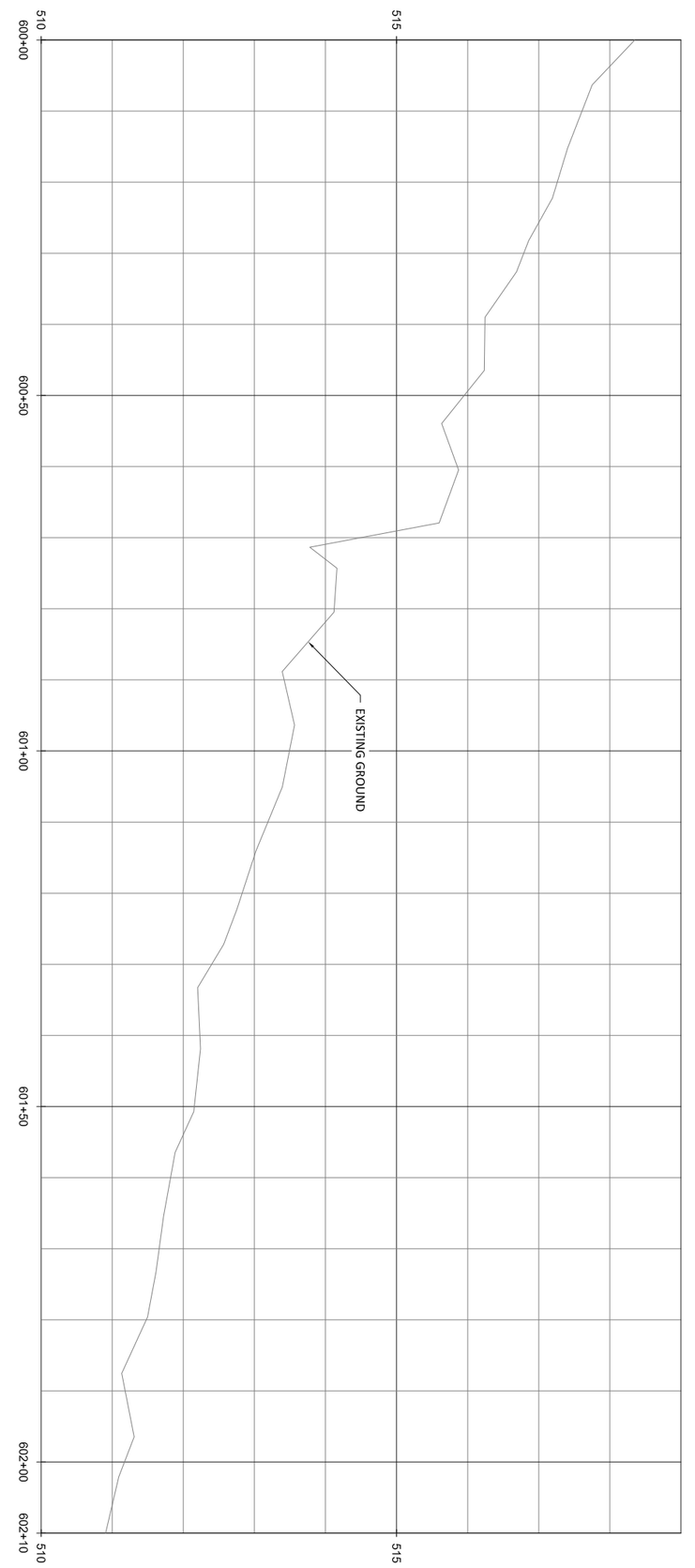
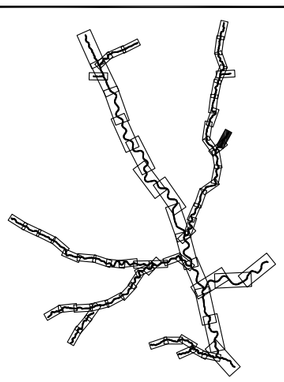
NOTE:
1. STA 600+28: ALONG THIS SWALE, DOWNSTREAM STRUCTURES WERE NOT INSTALLED DUE TO BEDROCK.







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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

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Buckwater Mitigation Site
Orange County, North Carolina

T6A
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLER 7/1/19

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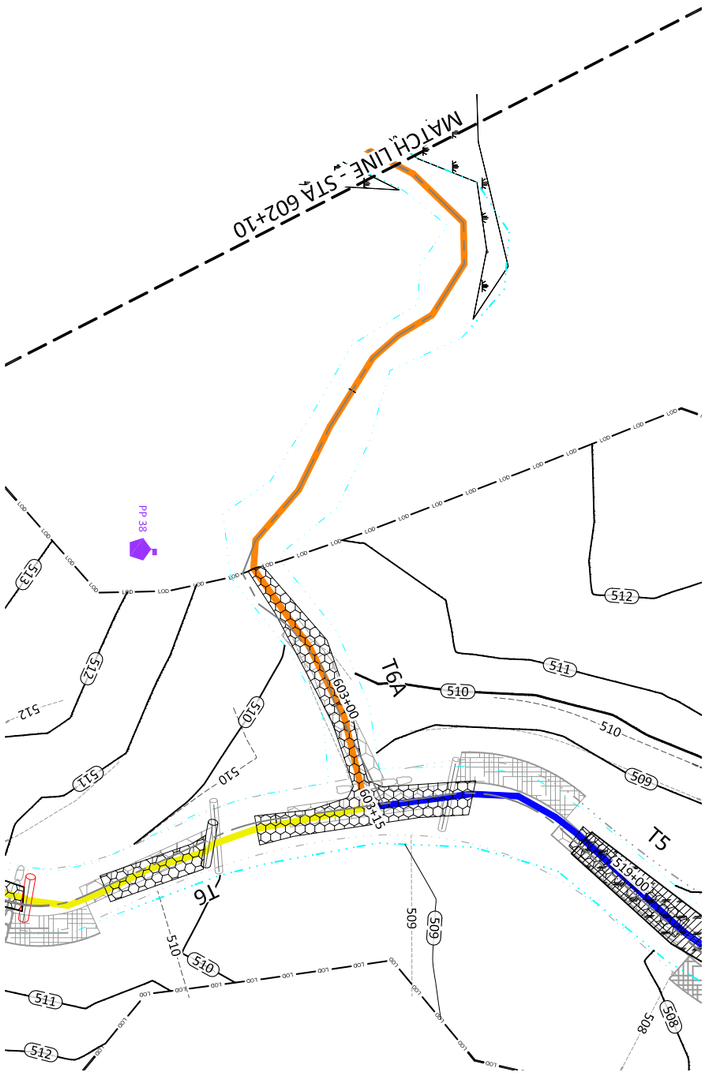
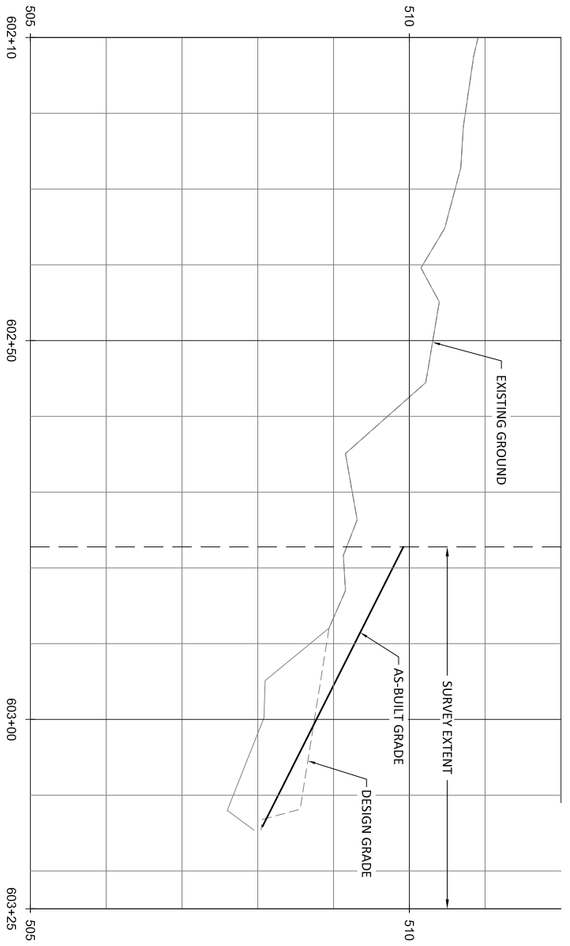
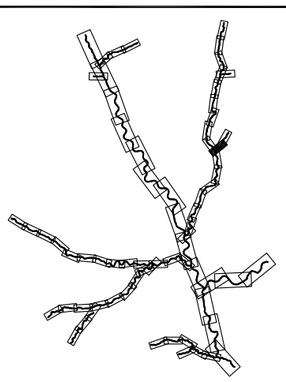
NOTE:
1. STA 603+12: BOULDER SILL NOT INSTALLED DUE TO BEDROCK.







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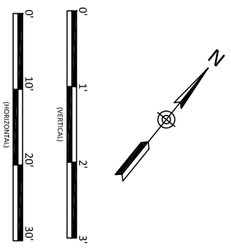

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Buckwater Mitigation Site
Orange County, North Carolina

T6A
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS 9/9/19

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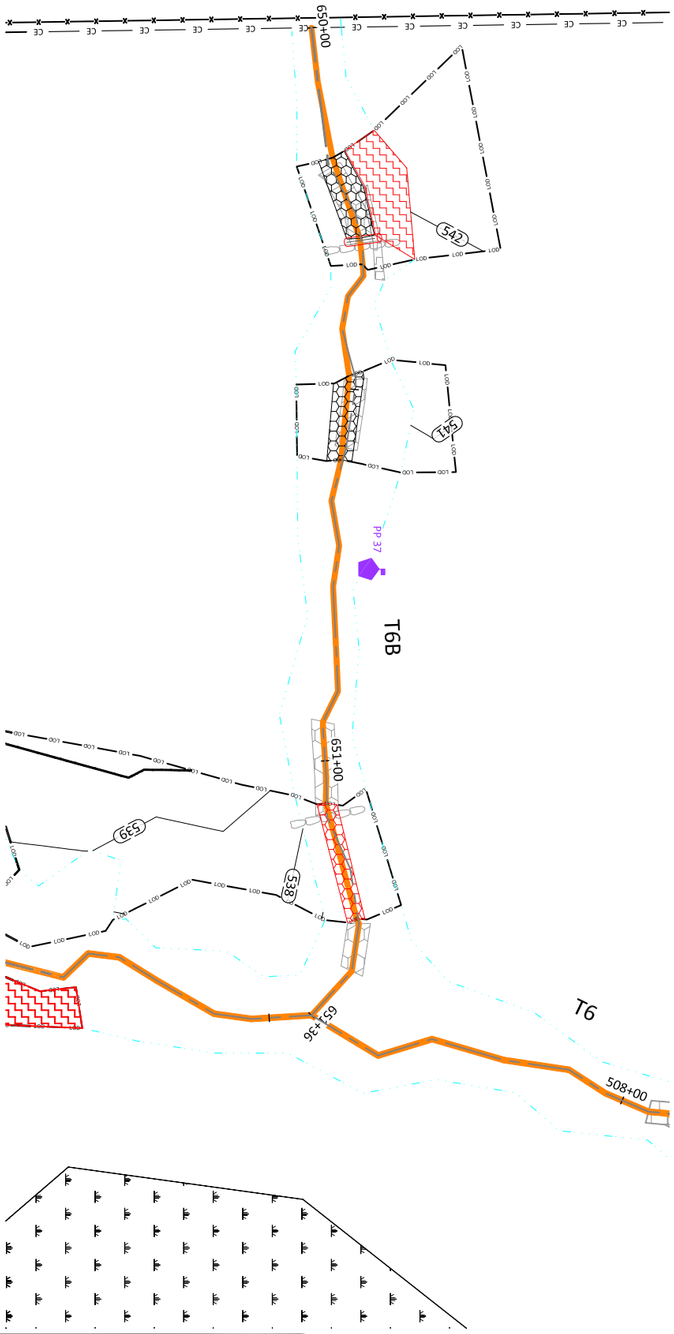
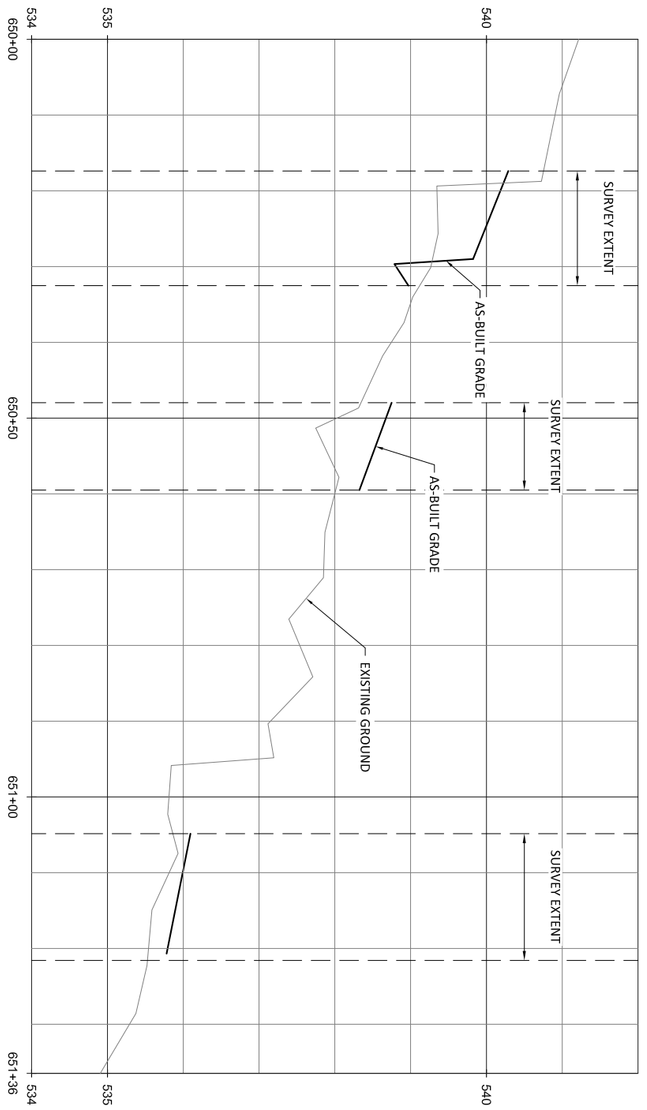
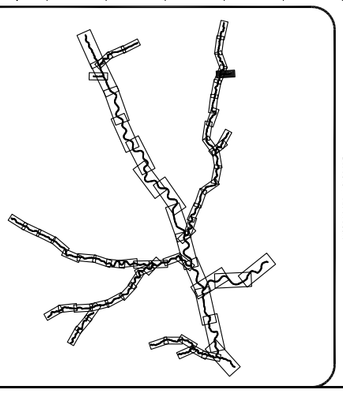
NOTE:
1. STA 650+29: LOG SILL WAS INSTALLED INSTEAD OF BOULDER SILL.
2. STA 651+05: BOULDER SILL WAS NOT INSTALLED DUE TO FIELD CONDITIONS.
3. STA 651+13: DUE TO FIELD CONDITIONS, ONE RIFFLE WAS INSTALLED INSTEAD OF TWO.







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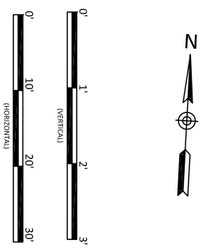

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Buckwater Mitigation Site
Orange County, North Carolina

T6B
Stream Plan and Profile

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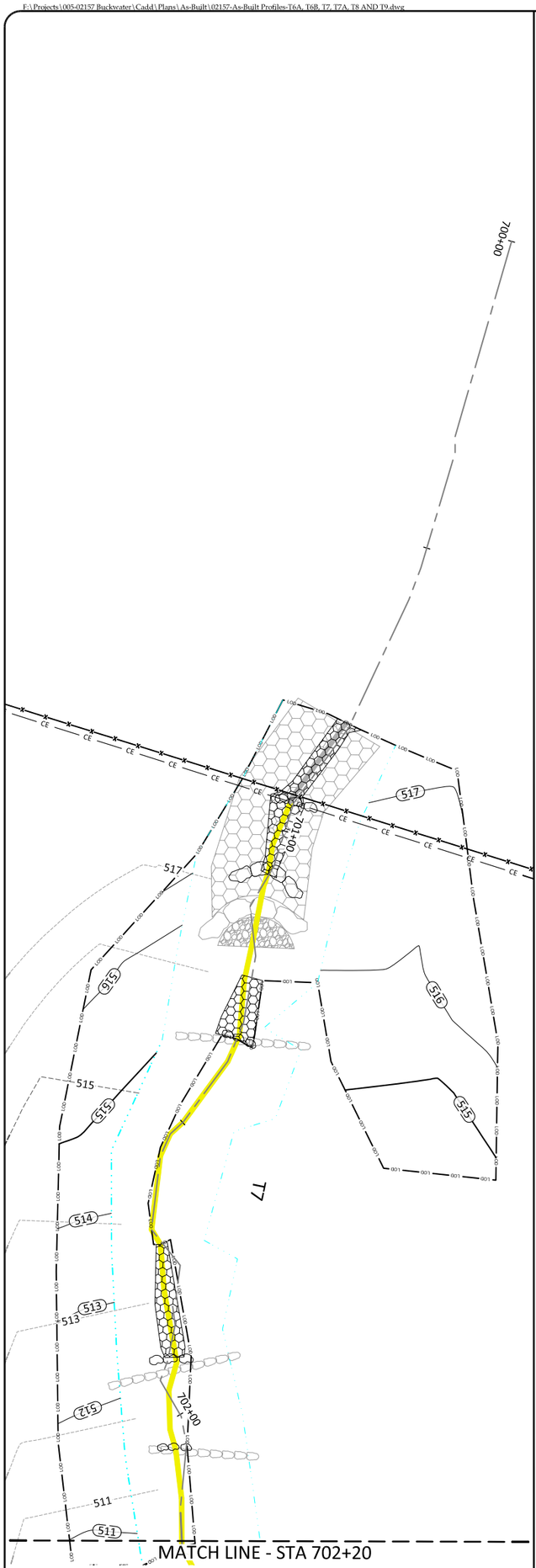

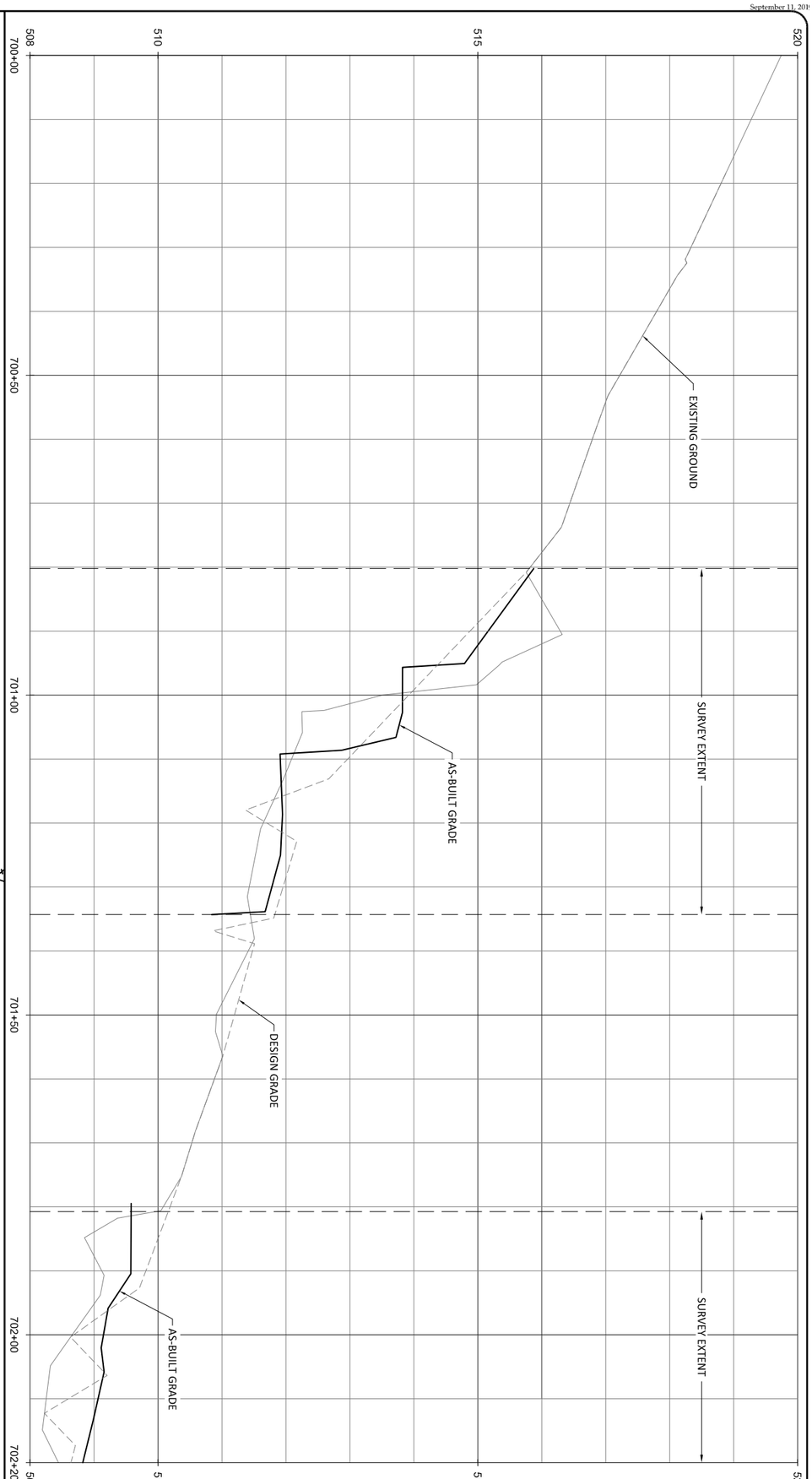

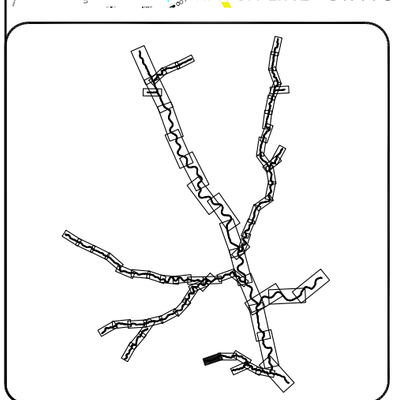

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0' 10' 20' 30' HORIZONTAL

0' 1' 2' 3' VERTICAL

N

Date:	07.01.2019
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Buckwater Mitigation Site
Orange County, North Carolina

T7 Reach 1
Stream Plan and Profile

NORTH CAROLINA PROFESSIONAL SEAL 037445 ENGINEER NICOLE MACALUSO MILLS

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NOTE:
1. STA 703+04: RIFFLE ADDED.
2. STA 703+38: RIFFLE ADDED.

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Buckwater Mitigation Site
Orange County, North Carolina

T7 Reaches 1 & 2
Stream Plan and Profile

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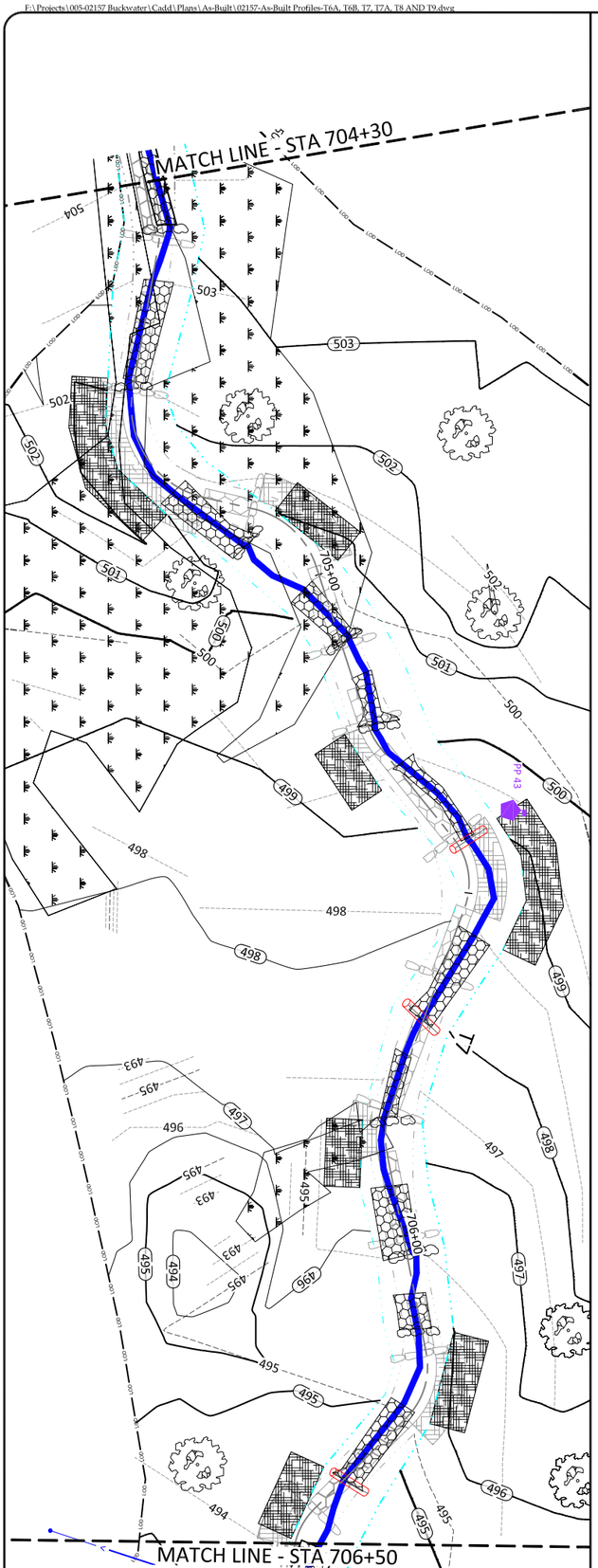
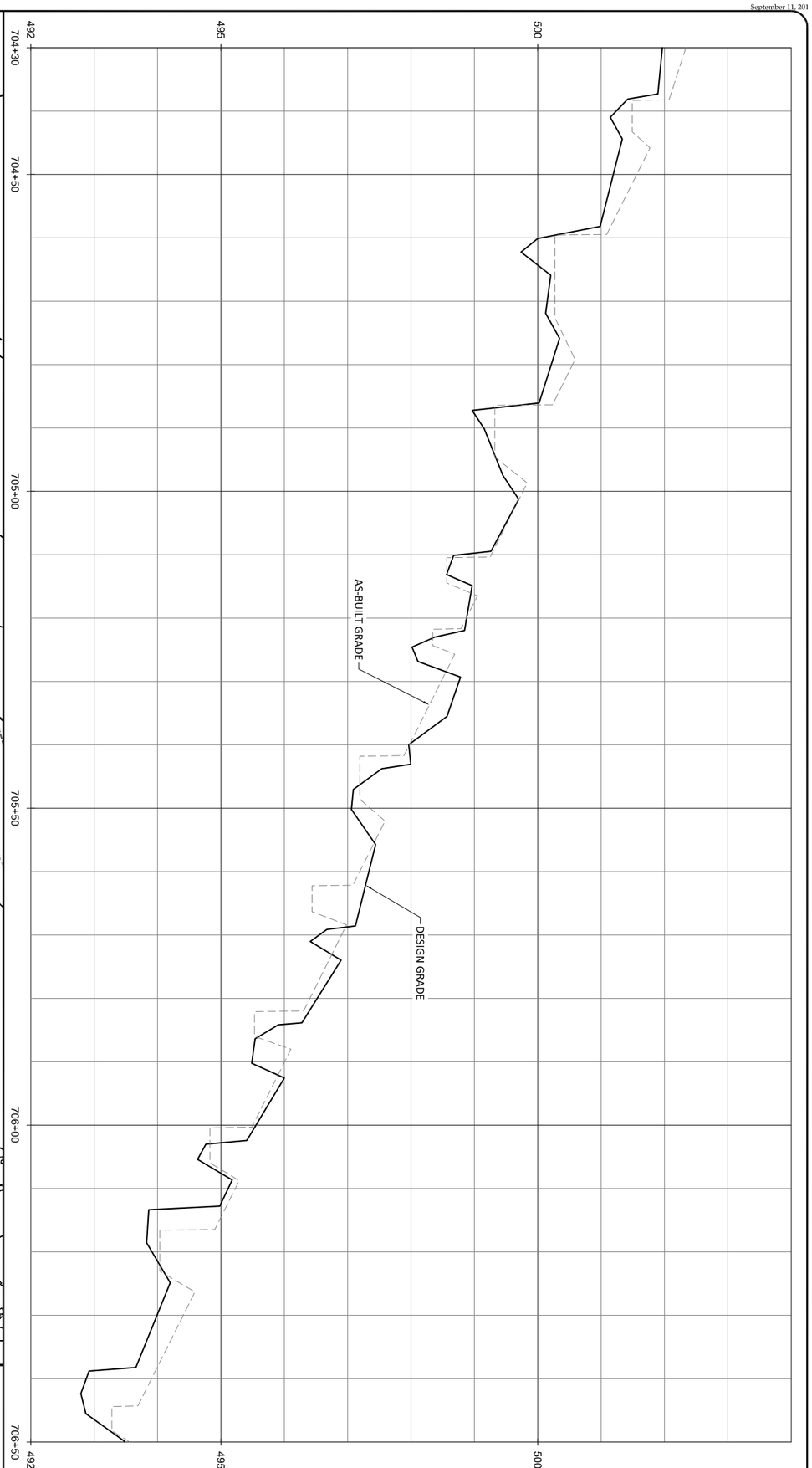
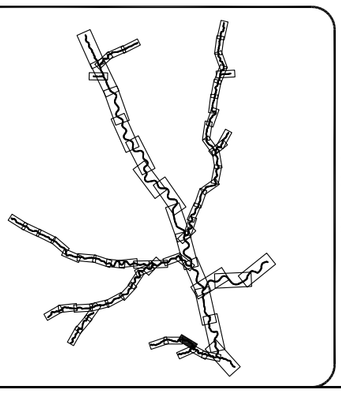




NOTE:
1. STA 705+42: LOG SILL INSTALLED INSTEAD OF BOULDER SILL.
2. STA 705+70: LOG SILL INSTALLED INSTEAD OF BOULDER SILL.
3. STA 706+40: LOG SILL INSTALLED INSTEAD OF BOULDER SILL.



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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

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Job Number:	005-02157
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Orange County, North Carolina

T7 Reach 2
Stream Plan and Profile

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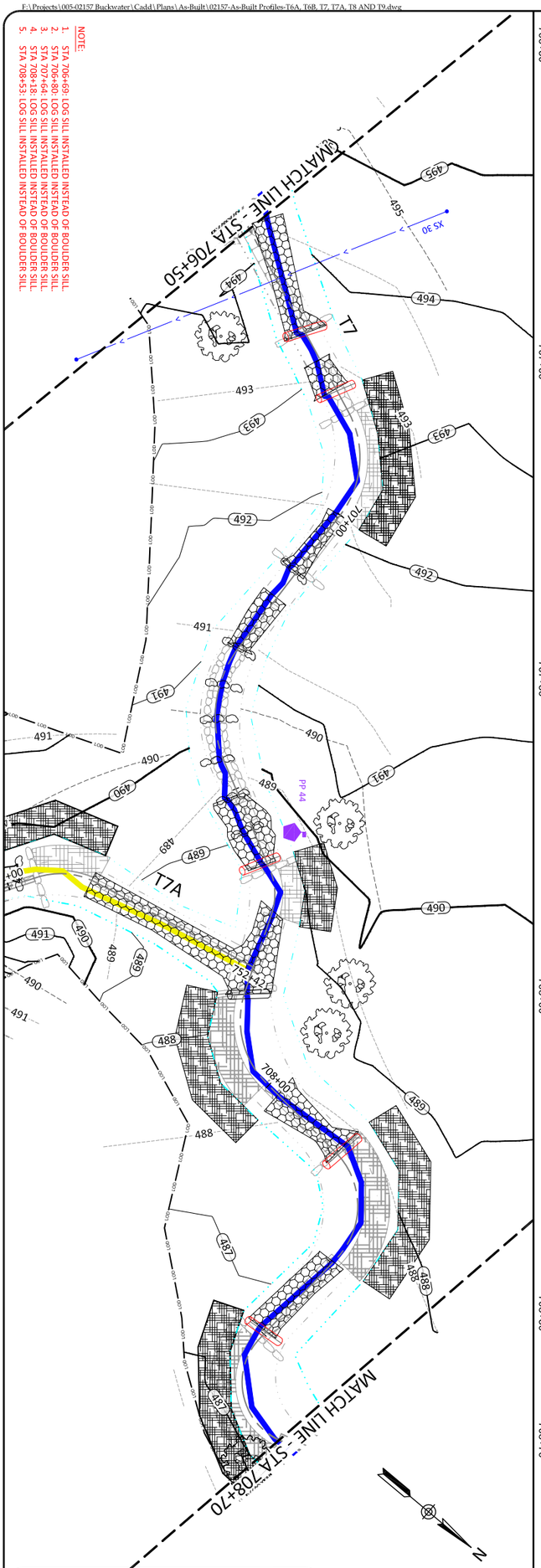
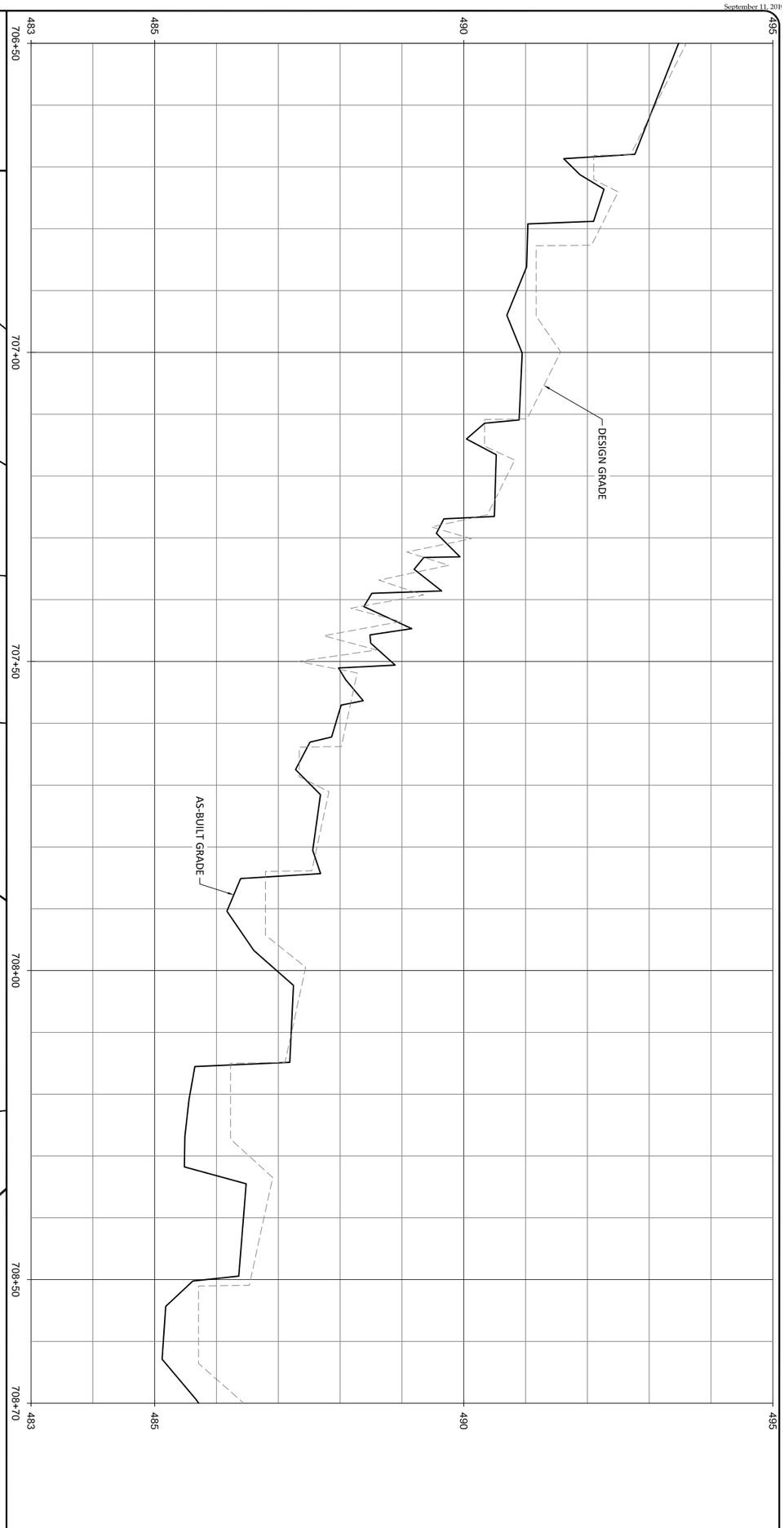
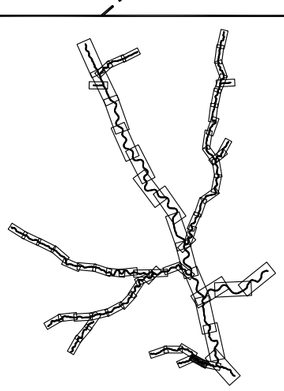
NOTE:
1. STA 706+69: LOG SILL INSTALLED INSTEAD OF BOULDER SILL
2. STA 706+80: LOG SILL INSTALLED INSTEAD OF BOULDER SILL
3. STA 707+48: LOG SILL INSTALLED INSTEAD OF BOULDER SILL
4. STA 708+18: LOG SILL INSTALLED INSTEAD OF BOULDER SILL
5. STA 708+53: LOG SILL INSTALLED INSTEAD OF BOULDER SILL







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0 10' 20' 30' (HORIZONTAL)
0' 1' 2' 3' (VERTICAL)

Date:	07.01.2019
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T7 Reaches 2 & 3
Stream Plan and Profile

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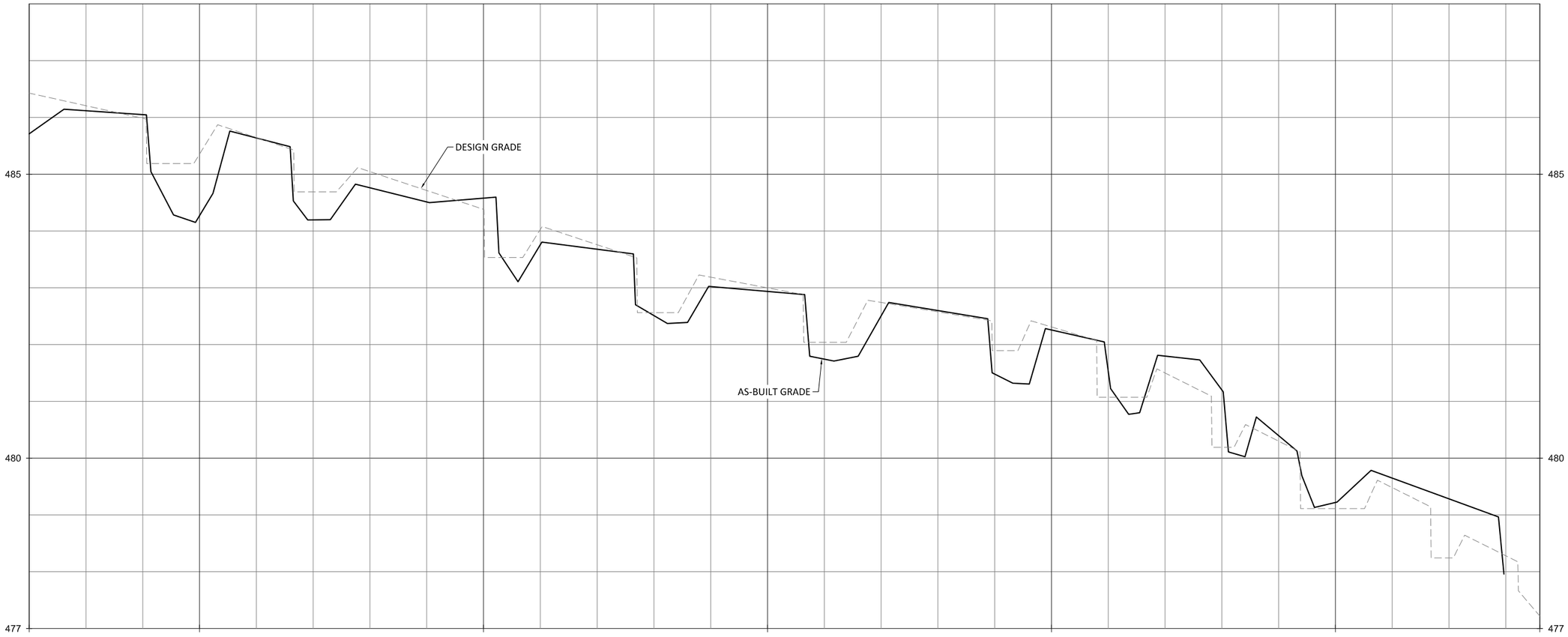

NOTE:

1. STA 709+21: LOG SILL INSTALLED INSTEAD OF BOULDER SILL.
2. STA 711+17: LOG SILL NOT INSTALLED AND TWO RIFFLES MADE INTO ONE.

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Buckwater Mitigation Site

Orange County, North Carolina

T7 Reach 3
Stream Plan and Profile

Revisions:

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Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

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Buckwater Mitigation Site
Orange County, North Carolina

T7A
Stream Plan and Profile

Revisions:

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

Sheet 1.66

NOTE:

1. STA 801+04: DUE TO SITE CONDITIONS NO RIFFLE INSTALLED.
2. STA 801+07: DUE TO SITE CONDITIONS NO BOULDER SILL INSTALLED.
3. STA 801+75: DUE TO SITE CONDITIONS NO BRUSH TOE INSTALLED.
4. STA 801+63: DUE TO SITE CONDITIONS NO RIFFLE INSTALLED.
5. STA 801+66: DUE TO SITE CONDITIONS NO BOULDER SILL INSTALLED.
6. STA 801+70: DUE TO SITE CONDITIONS NO BRUSH TOE INSTALLED.
7. STA 801+82: DUE TO SITE CONDITIONS NO BRUSH TOE INSTALLED.
8. STA 801+87: DUE TO SITE CONDITIONS NO RIFFLE INSTALLED.
9. STA 801+89: DUE TO SITE CONDITIONS NO BOULDER SILL INSTALLED.

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Buckwater Mitigation Site

Orange County, North Carolina

T8

Stream Plan and Profile

Revisions:

Date: 07.01.2019
Job Number: 005-02157
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Buckwater Mitigation Site
Orange County, North Carolina

T8
Stream Plan and Profile

Revisions:

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
Checked By:	JTL

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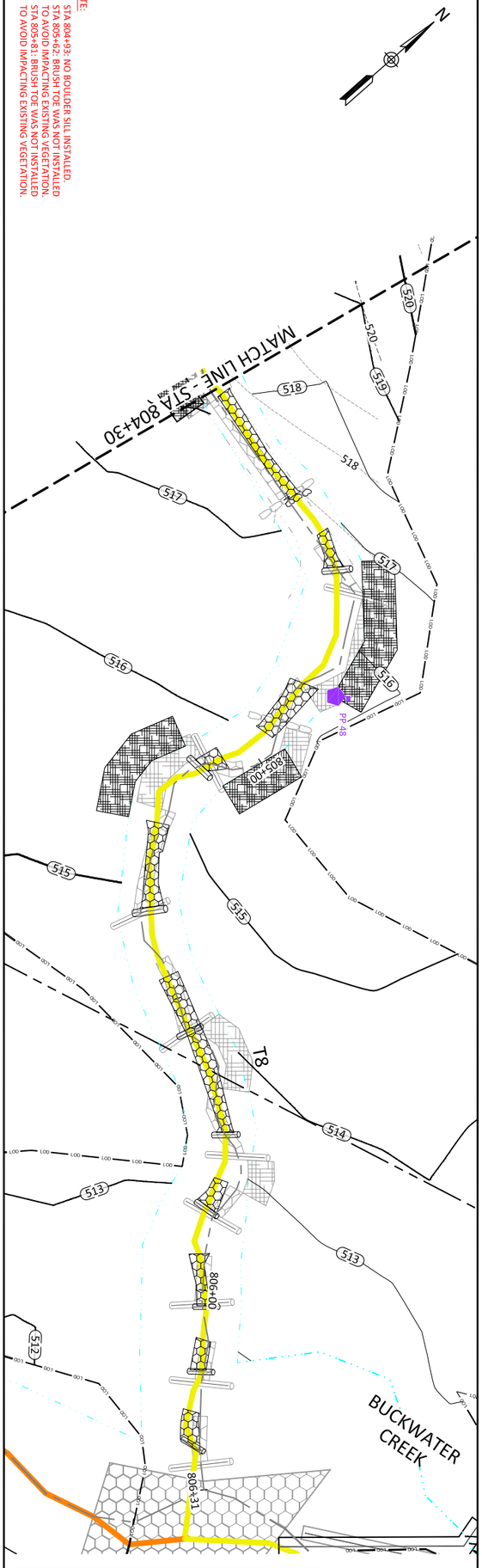
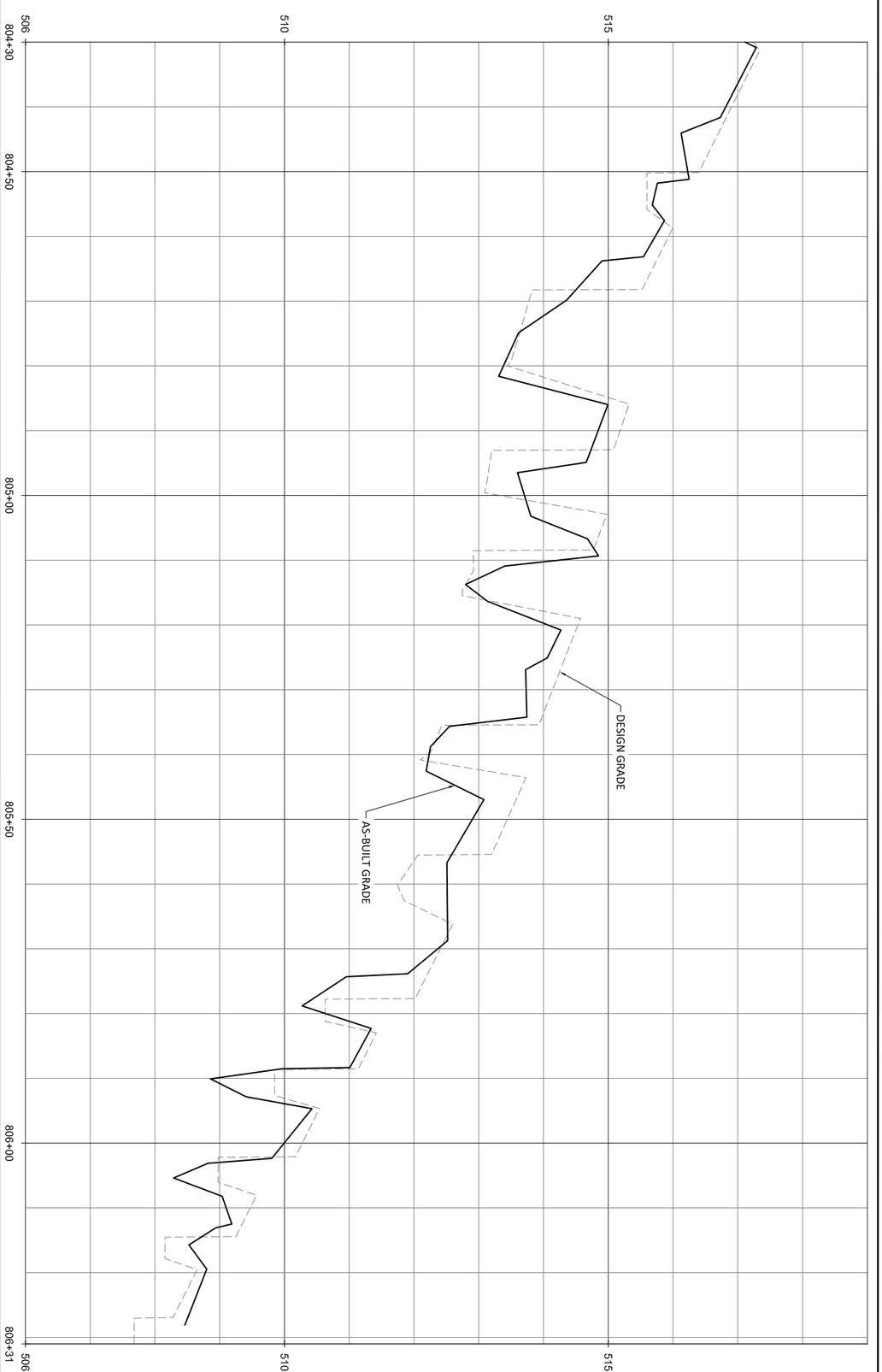
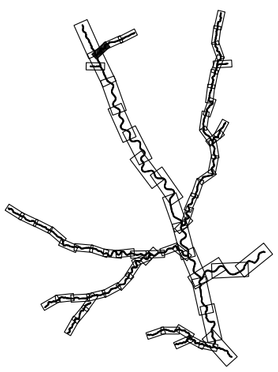
NOTE:
1. STA 804+93: NO BOULDER SILL INSTALLED.
2. STA 805+42: BRUSH TOE WAS NOT INSTALLED
3. STA 805+81: BRUSH TOE WAS NOT INSTALLED TO AVOID IMPACTING EXISTING VEGETATION.







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0' 10' 20' 30' (HORIZONTAL)

0' 1' 2' 3' (VERTICAL)

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
Drawn By:	CAW
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Orange County, North Carolina

T8
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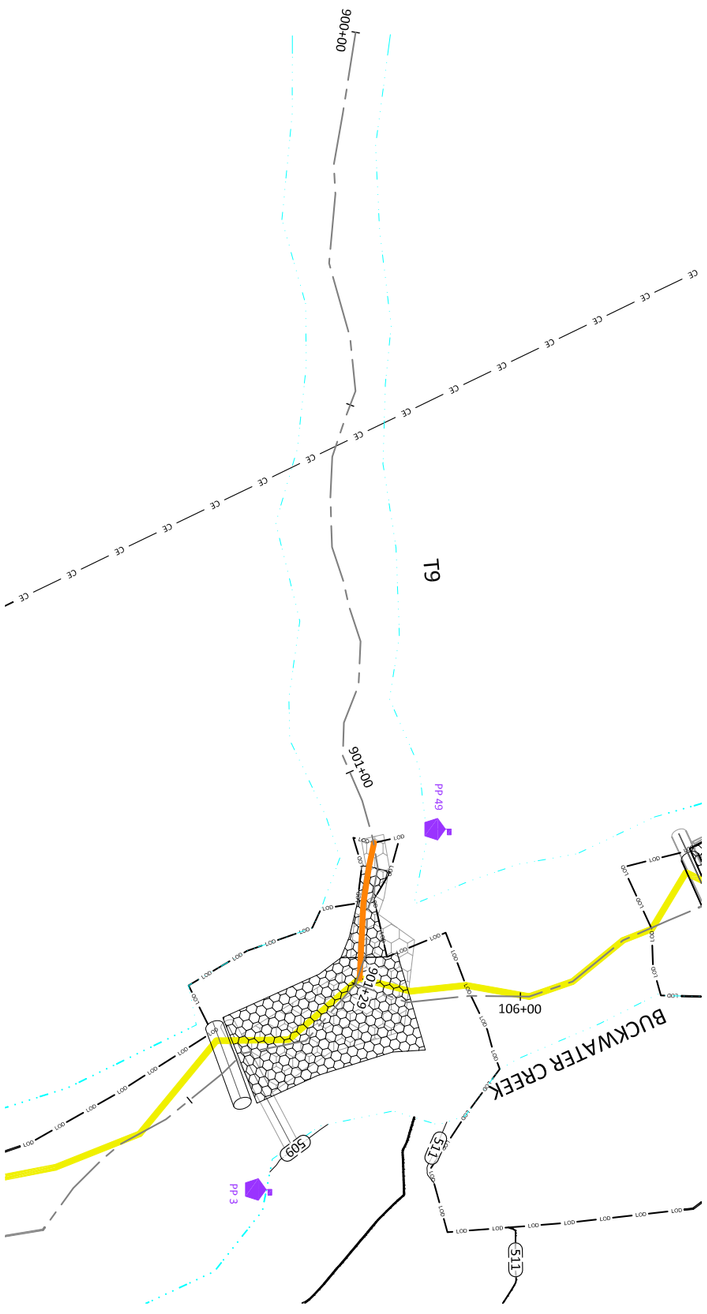

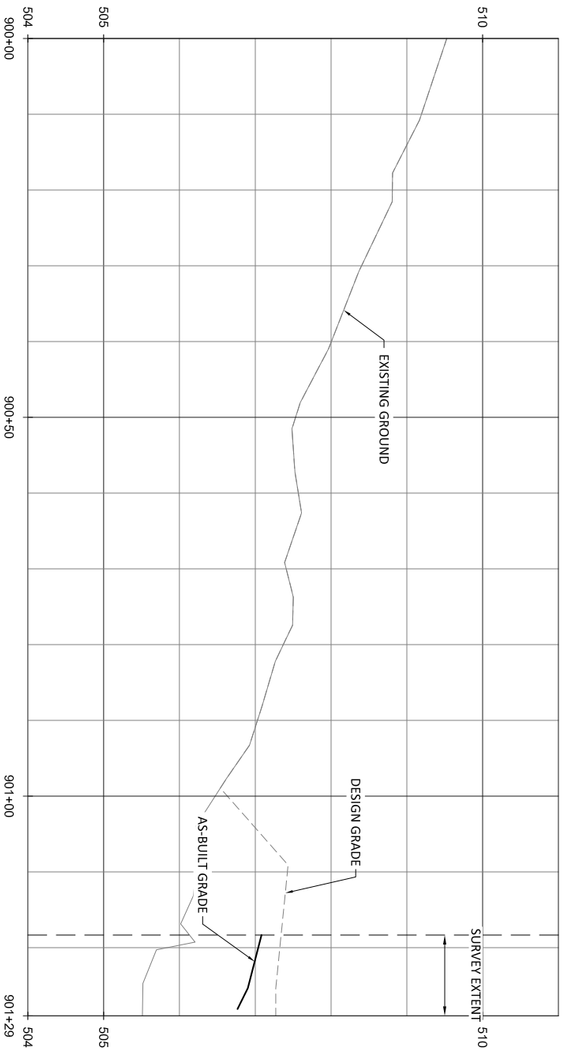

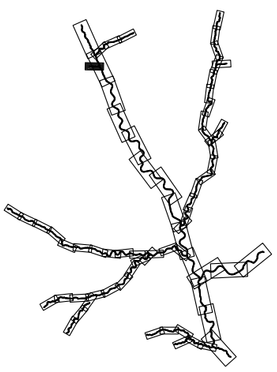

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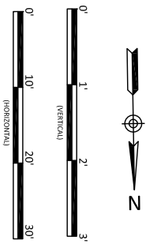

Date:	07.01.2019
Job Number:	005-02157
Project Engineer:	NMM
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Buckwater Mitigation Site
Orange County, North Carolina

T9
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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

Streambank Planting Zone

Live Stakes					
Species	**Common Name**	**Indiv. Spacing**	**Min. Size**	**Stratum**	**% of Stems**
Salix nigra	Black Willow	3-6 ft.	0.5"-1.5" cal.	Shrub	15%
Cornus ammomum	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 - 23.6 Acres

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 t.	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 ammomum	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	6.8-8.9	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)	Percentage
All Year	*Festuca arundinacea*	Tall Fescue	Herb	40	70%
All Year	*Festuca rubra*	Creeping Red Fescue	Herb	40	10%
All Year	*Dactylis glomerata*	Orchardgrass	Herb	40	20%
					100%

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: 07.01.2019
Job Number: 005-02157
Project Engineer: NMM
Drawn By: CAW
Checked By: JTL

Sheet 2.0

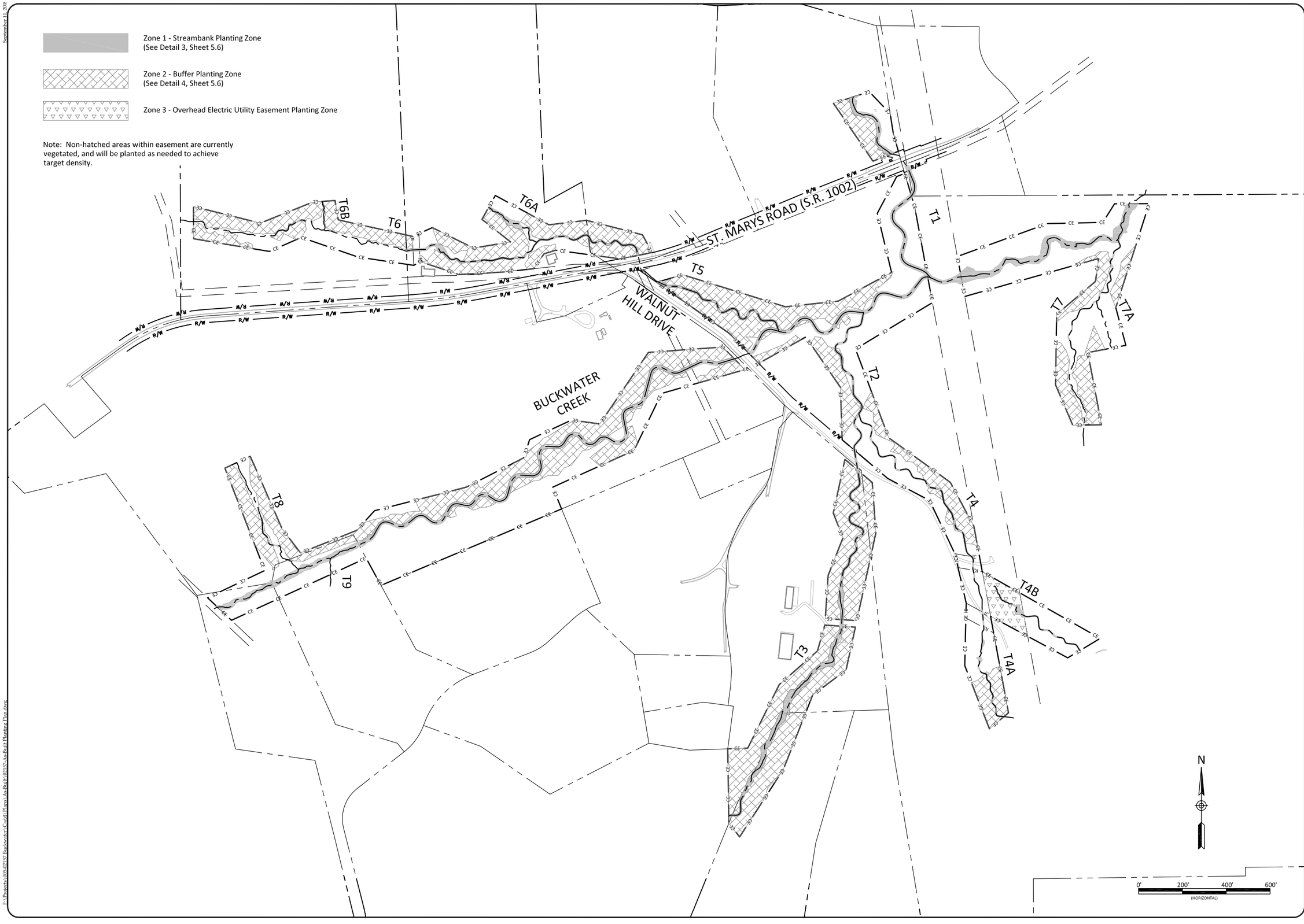
September 11, 2019

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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Buckwater Mitigation Site
Orange County, North Carolina

Planting Plan

Revisions:

Date: 07.01.2019
Job Number: 005-02157
Project Engineer: NMM
Drawn By: CAW
Checked By: JTE

Sheet 2.1

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APPENDIX 6. Buffer Baseline Monitoring Report

Buffer Baseline Monitoring Report

July 16, 2019

BUCKWATER MITIGATION SITE

Orange County, NC
NCDEQ Contract No. 006829
DMS ID No. 97084
DWR Project Number 2016-0406 v2

Neuse River Basin
HUC 03020201

RFP #: 16-006477

PREPARED FOR:

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

BUFFER BASELINE MONITORING REPORT

BUCKWATER MITIGATION SITE

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

Neuse River Basin
HUC 03020201

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 West Millbrook Road, Suite 225
Raleigh, NC 27609
Phone: (919) 851-9986

This Baseline Monitoring Plan has been written in conformance with the requirements of the following:

- 15A NCAC 02B .0295 Mitigation Program Requirements for Protection and Maintenance of Riparian Buffers.
- NCDEQ Division of Mitigation Services In-Lieu Fee Instrument signed and dated July 28, 2010.

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

Contributing Staff:

Chris Roessler, *Project Manager*
John Hutton, *Principal in Charge*
Jason Lorch, *Baseline Monitoring Plan*
Daniel Taylor, *Construction Administrator*
Carolyn Lanza, *Monitoring Lead*
Andrea Eckardt, *Lead Quality Assurance*

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APPENDICES

1.0 Mitigation Project Summary

The Buckwater Mitigation Site (Site) is a buffer restoration project located approximately 4.5 miles northeast of Hillsborough in Orange County, NC (Figure 1). Figure 2 depicts the service area of the Site. The Site is comprised of 51.84 acres along Buckwater Creek and several unnamed tributaries to the Neuse River Watershed (Figure 3). The majority of the site is used for cattle pasture or hay fields, with some riparian areas in forest. St. Mary's Road crosses the Site; while to the south, the project parcels directly abuts to the Eno River State Park, a NC Natural Heritage Program Managed Area, and to the Eno River/Cates Ford Slopes and Uplands, which is a Natural Heritage Area. The Site is expected to generate 1,099,775.073 riparian buffer credits.

The Site is located within the Hydrologic Unit Code (HUC) 03020201030030 and North Carolina Department of Water Resources (NCDWR) Sub-basin 03-04-01. Buckwater Creek and fourteen unnamed tributaries on the Site drain to the Eno River, which flows to Falls Lake. Falls Lake is classified as water supply waters (WS-IV) and nutrient sensitive waters (NSW).

1.1 Project Goals

The major goals of the proposed buffer restoration project are to provide ecological and water quality enhancements to the Neuse River Watershed within the Falls Lake Water Supply Watershed by creating a functional riparian corridor and restoring the riparian buffer. The proposed project supports specific goals identified in the 2010 Neuse River Basin Restoration Priorities Plan (RBRP) for the Neuse River Targeted Local Watershed (TLW). This document highlights the importance of riparian buffers for stream restoration projects. Riparian buffers immobilize and retain nutrients and suspended sediment. The RBRP also supports 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). Specific enhancements to water quality and ecological processes are outlined below:

- Decrease nutrient levels - Nutrient input will be decreased by filtering runoff from the agricultural fields through restored native buffer zones. The off-site nutrient input will also be absorbed on-site by dispersing flood flows through native vegetation, thereby reducing nutrient inputs to waters of the Neuse River Basin.
- Decrease sediment input - Sediment from off-site sources will be deposited on restored floodplain areas where native vegetation will slow overland flow velocities, thereby reducing sediment inputs to waters of Falls Lake.
- Create appropriate terrestrial habitat - Buffer areas will be restored by removing invasive vegetation and planting native vegetation. Improve wildlife habitat; restoring degraded riparian buffers.
- Permanently protect the Site from harmful uses - Establish a conservation easement on the Site. Protect aquatic habitat; protecting water supply waters.

1.2 Pre-construction Site Conditions

The buffer restoration project includes 51.84 acres of cattle pasture, hay fields, and riparian forest along Buckwater Creek and fourteen unnamed tributaries that drain into the Neuse River Basin. Based on historical aerial photographs several ponds were built along Buckwater Creek between 1938 and 1955. By 1955, Buckwater Creek's riparian buffer had been largely cleared, with limited tree growth into 1966. A single line of trees had grown along Buckwater Creek prior to construction.

The Site contains Buckwater Creek and fourteen unnamed tributaries to Buckwater Creek. Buckwater Creek, T1, T2, T3, T4, T5, T6, T6A, T7, T8, and T9 are all perennial streams, while T4A, T4B, T6B, and T7A are intermittent streams. The Buffer project attributes are listed in Table 1, located in Appendix 1.

On May 24, 2016, NCDWR conducted on-site determinations to review features and land use within the project boundary. The resulting NCDWR site viability letter and map confirming the Site as suitable for riparian buffer and nutrient offset mitigation is located in Appendix 2. Buckwater Creek and thirteen tributaries are appropriate for buffer and nutrient offset mitigation as related to the rules set forth in the Neuse Buffer Mitigation Rules: Mitigation Program Requirements for Protection and Maintenance of Riparian Buffers (15A NCAC 02B .0295) and Neuse River Basin: Nutrient Sensitive Waters Management Strategy: Protection and Maintenance of Existing Riparian Buffers (15A NCAC 02B .0233).

2.0 Determination of Credits

In addition to buffer restoration on subject streams, per the Consolidated Buffer Mitigation Rules (15A NCAC 02B 0.0295 (o)), alternative mitigation is proposed on the Site in the form of preservation of forested buffer on subject streams. The proposed project is in compliance with these rules in the following ways:

Preservation on Subject Streams (15A NCAC 02B .0295 (o)(5):

- The buffer width is at least 30 feet from the stream.
- The area meets the requirements of 15A NCAC 02R 0.0403(c)(7), (8), and (11) with no known structures, infrastructure, hazardous substances, solid waste, or encumbrances within the mitigation boundary.
- Preservation mitigation is being requested on no more than 25% of the total buffer mitigation area (Table 2, Appendix 1).

Mitigation credits are presented in Tables 2a and 2b and Figure 3 in Appendix 1 and are based upon the as-built survey included in Appendix 3.

3.0 Baseline Summary

The Wildlands Team restored high quality riparian buffers along numerous unnamed tributaries on the Site. The buffer and nutrient offset mitigation took place in conjunction with Buckwater Stream Mitigation. The project design ensured that no adverse impacts to wetlands or existing riparian buffers occurred. Figure 3 illustrates the conceptual design for the Site. Detailed descriptions of the proposed restoration activity follow in Sections 3.1 through 3.5. General site photographs are included in Appendix 4.

3.1 Parcel Preparation

Prior to stream construction, the Parcel was intensively farmed, mostly through livestock production, causing stream erosion. Stream channelization also occurred to maximize the land use. Two ponds were removed during the stream construction, while several streams were restored and/or enhanced. The approved permits are included in Appendix 6. During stream construction, invasive plants were targeted and removed to reduced native competition. After construction of the streams was completed the haul roads were ripped and seeded to reduce soil compaction. Lime and fertilizer were added to areas to help establish vegetation on the Site.

3.2 Riparian Area Restoration Activities

The revegetation plan for the buffer restoration area included permanent seeding and planting bare root trees. These revegetation efforts were coupled with the select treatment of invasive species to

control their population. The species composition planted was selected based on the desired community type, occurrence of species in riparian buffers adjacent to the Site, and best professional judgement. The total number of tree species planted across the buffer areas are as follows: tulip poplar (*Liriodendron tulipifera*) 2,764 stems, willow oak (*Quercus phellos*) 1,842 stems, American sycamore (*Platanus occidentalis*) 3,686 stems, river birch (*Betula nigra*) 2,764 stems, green ash (*Fraxinus pennsylvanica*) 3,132 stems, swamp chestnut oak (*Quercus michauxii*) 1,014 stems, red buckeye (Aesculus pavia)184 stems, white oak (*Quercus alba*) 922 stems, Allegheny serviceberry (*Amelanchier laevis*) 184 stems, Shumard oak (*Quercus shumardii*) 920 stems, and arrow-wood (*Viburnum dentatum*) 184 stems. In total, 17,596 stems were planted across the buffer areas of the site.

Trees were planted at a density sufficient to meet the performance standards outlined in the Rule 15A NCAC 02B .0295 of 260 trees per acre at the end of five years. No one tree species planted was greater than 50% of the established stems. An appropriate seed mix was applied as necessary to provide temporary ground cover for soil stabilization and reduction of sediment loss during rain events in disturbed areas. This was followed by an appropriate permanent seed mixture. Tree planting was completed in April 2019.

Vegetation management and herbicide applications were implemented as needed during tree establishment in the restoration areas to prevent establishment of invasive species that could compete with the planted native species.

3.3 Riparian Area Enhancement Activities

Fencing was used to exclude cattle in the buffer enhancement areas as allowed by 15A NCAC 02B .0296(o). The enhancement area will be protected in perpetuity under a conservation easement.

3.4 Riparian Area Preservation Activities

No work was done in the buffer preservation areas, as allowed under 15A NCAC 02B .0295(o). The preservation area will be protected in perpetuity under a conservation easement.

4.0 Annual Monitoring and Performance Criteria

The performance criteria for the Site follows approved performance criteria presented in the guidance documents outlined in RFP 16-006477 and the Consolidated Buffer Rule (15A NCAC 02B .0295). Annual monitoring and semi-annual site visits will be conducted to assess the condition of the finished project. The buffer restoration project has been assigned specific performance criteria components for vegetation. Performance criteria will be evaluated throughout the five-year post-construction monitoring. An outline of the performance criteria and monitoring components follows, and vegetation plots are depicted in Figures 4a-b and included in Table 3, located in Appendix 1.

4.1 Vegetation

Performance Standards for the Site will be based on the health and survival of a minimum density of 260 trees per acre after five years of monitoring, and no one species may comprise more than 50 percent of stems. Height, visual assessment of damage, and vigor will be used as indicators of overall health. Desirable volunteer species may be included to meet the success criteria upon DWR approval. The extent of invasive species coverage will also be monitored and treated as necessary throughout the required five year monitoring period.

Nineteen vegetation monitoring quadrants were installed across the Site to measure the survival of the planted stems (Figures 4a-b). Vegetation monitoring will follow the CVS-EEP Level 2 Protocol for Recording Vegetation (2008). Reference photographs of the vegetation plots and Site will be taken during the annual vegetation assessments. Appendix 5 includes the baseline (MY0) vegetation plot photographs and the planted and total stem counts.

4.2 Overview Photos

Photographs will be taken within the project area once a year to visually document stability for five years following construction.

4.3 Visual Assessments

Visual assessments should support the specific performance standards for each metric as described above. Visual assessments will be performed within the Site on a semi-annual basis during the five-year monitoring period. Problem areas with vegetative health will be noted (e.g. low stem density, vegetation mortality, invasive species, or encroachment). Areas of concern will be mapped and photographed accompanied by a written description in the annual report. Problem areas will be re-evaluated during each subsequent visual assessment

4.4 Annual Reporting Performance Criteria

Using the Division of Mitigation Services (DMS) Riparian Buffer and Nutrient Offset Buffer Baseline and Annual Monitoring Report Template version 2.0 (May 2017), monitoring reports will be prepared in the fall of each monitoring year and submitted to DMS. Annual monitoring reports will be based on the above referenced DMS Template (May 2017). The monitoring period will extend five years beyond completion of construction or until performance criteria have been met.

4.5 Maintenance and Contingency Plans

The parcel has been properly and accurately marked by adding witness posts with easement placards every 100 ft and at every corner of the easement. Adaptive management will be performed during the monitoring years to address minor issues as necessary. If, during annual monitoring it is determined the Site's ability to achieve Site performance standards are jeopardized, Wildlands will notify the members of DMS/NCDWR and work with the DMS/NCDWR to develop contingency plans and remedial actions. Any actions implemented will be designed to achieve the success criteria specified previously and will include a work schedule and updated monitoring criteria (if applicable).

5.0 References

Breeding, R. 2010. Neuse River Basin Restoration Priorities. North Carolina Ecosystem Enhancement Program.

Lee, Michael T. Peet, Robert K., Steven D. Wentworth, Thomas R. 2008. CVS-EEP Protocol for Recording Vegetation Version 4.2. http://cvs.bio.unc.edu/protocol/cvs-eep-protocol-v4.2-lev1-2.pdf

Natural Resources Conservation Service (NRCS). Web Soil Survey of Orange County. http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

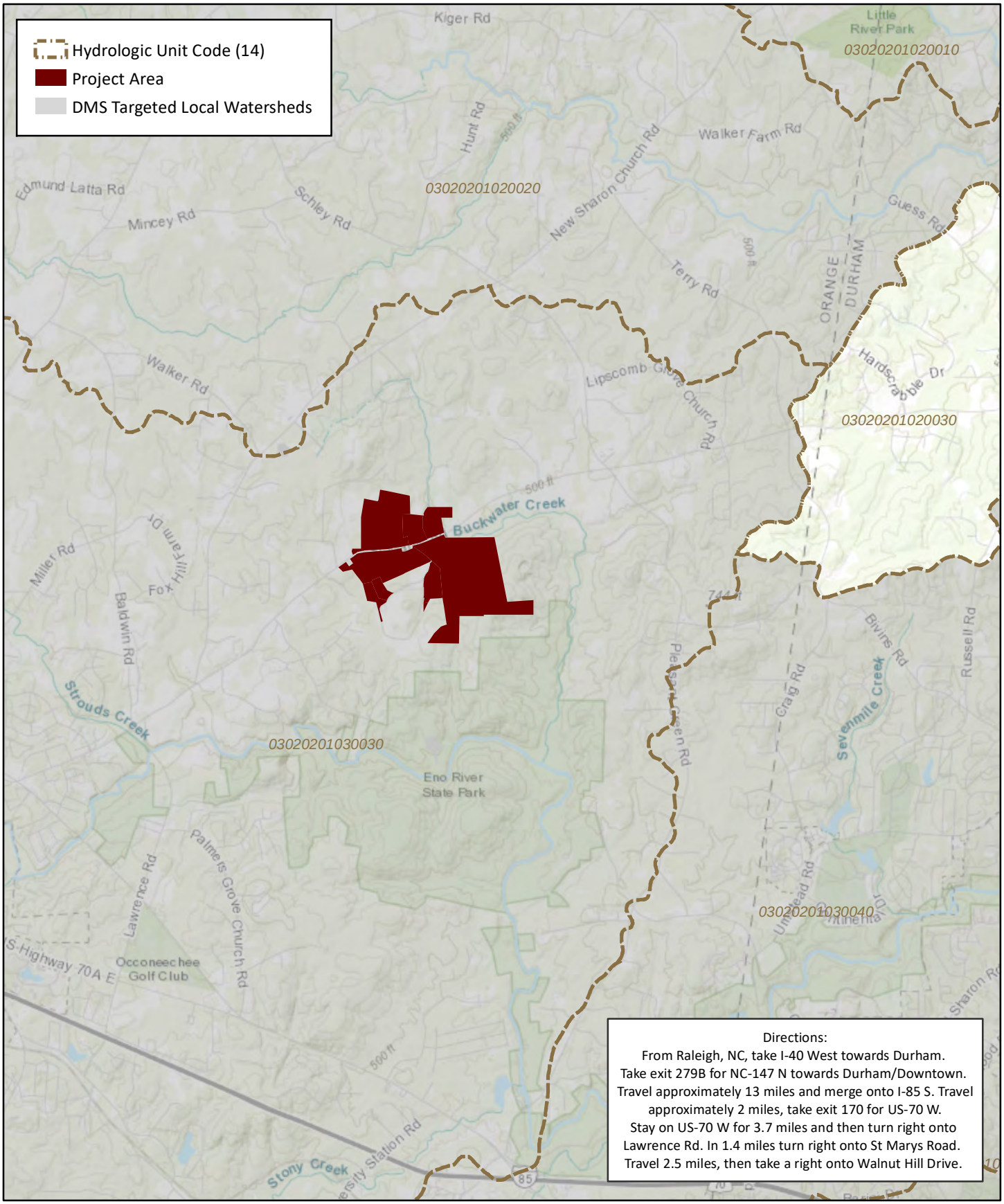
http://portal.ncdenr.org/c/document_library/get_file?uuid=864e82e8-725c-415e-8ed9-c72dfcb55012&groupId=60329

North Carolina Division of Environmental Quality, Division of Water Resources (NCDWR) 2011. Surface Water Classifications. http://deq.nc.gov/about/divisions/water-resources/planning/classification-standards/classifications

North Carolina Department of Environmental Quality, Division of Mitigation Services (NCDMS), 2017. Riparian Buffer and Nutrient Offset Buffer Baseline and Annual Monitoring Report Template version 2.0

Wildlands Engineering, Inc. (2017). Buckwater Mitigation Project Mitigation Plan. DMS, Raleigh, NC.

APPENDIX 1



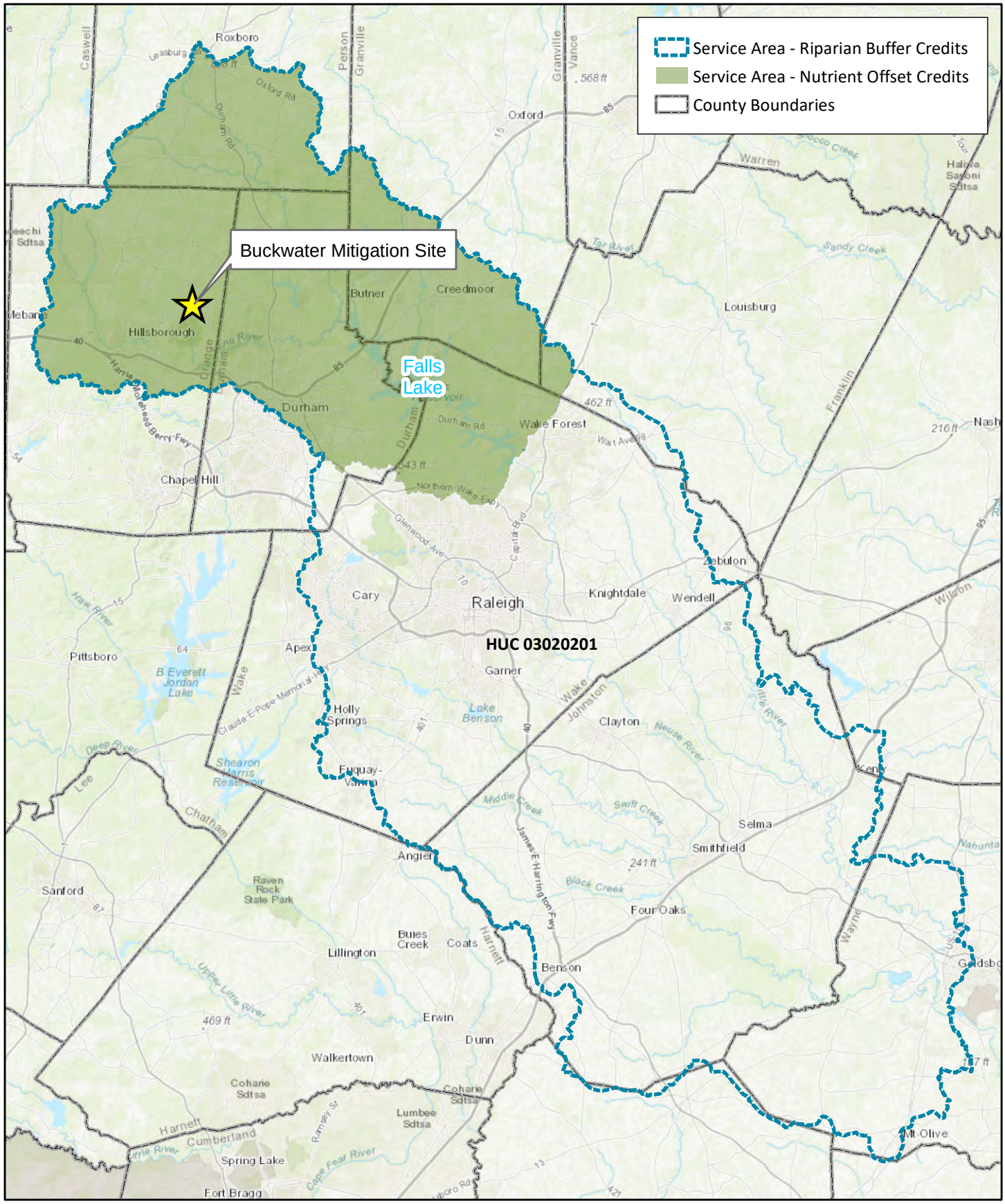
WILDLANDS ENGINEERING

0 0.5 1 Miles

N

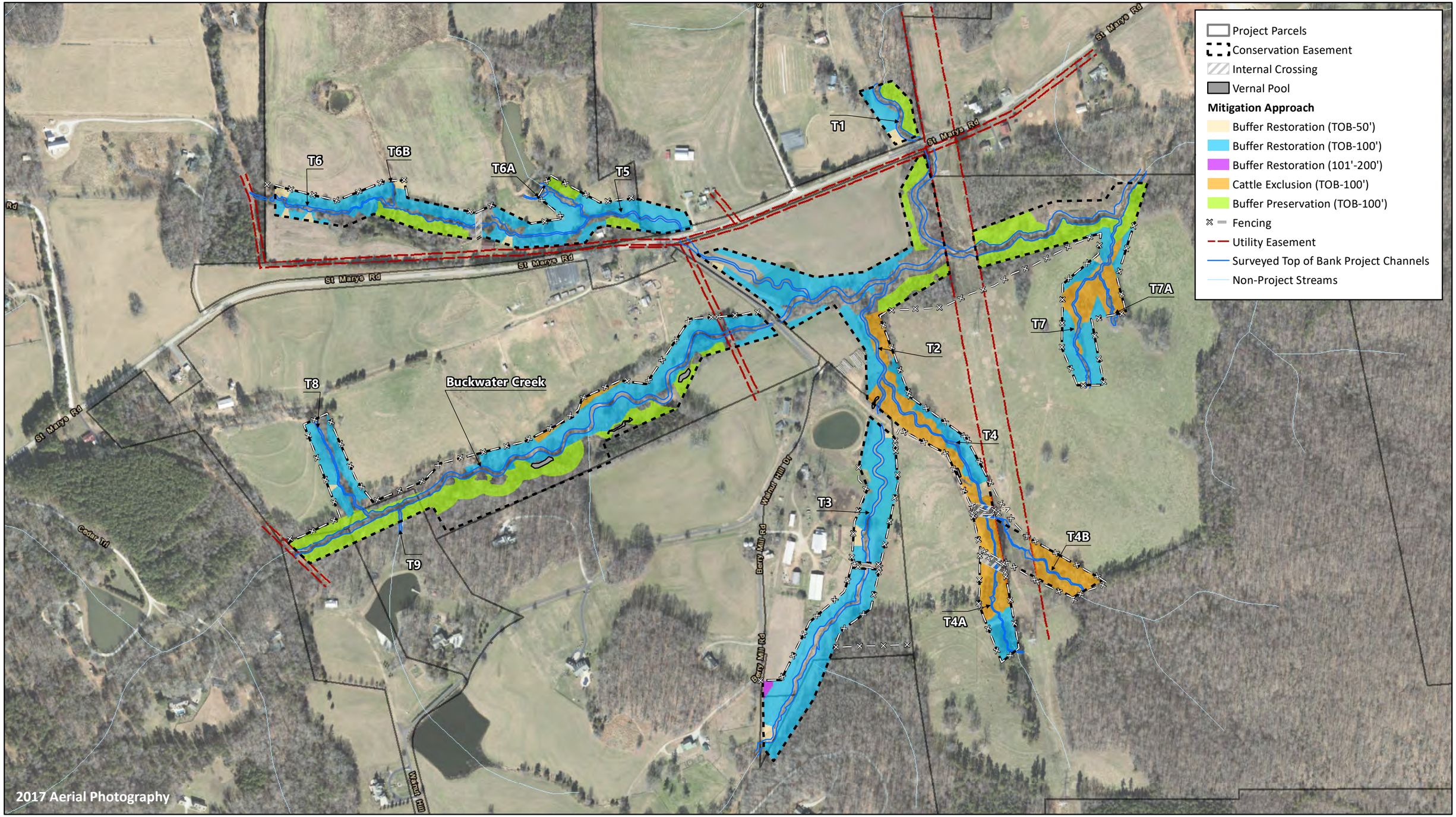
Figure 1. Project Vicinity Map
Buckwater Mitigation Site (MY0)
Baseline Monitoring Report
Neuse River Basin (03020201)

Orange County, NC



WILDLANDS ENGINEERING

Figure 2. Service Area
Buckwater Mitigation Site
Baseline Monitoring Report (MY0)
Neuse River Basin (03020201)
Orange County, NC



WILDLANDS ENGINEERING

0 450 900 Feet

N

Figure 3. Project Component / Asset Map
Buckwater Mitigation Site
Baseline Monitoring Report (MY0)
Neuse River Basin (03020201)

Orange County, NC

Figure 4a

Figure 4b

Conservation Easement
Internal Crossing
Vernal Pool

Mitigation Approach

Buffer Restoration (TOB-50')
Buffer Restoration (TOB-100')
Buffer Restoration (101'-200')
Cattle Exclusion (TOB-100')
Buffer Preservation (TOB-100')
Vegetation Plots
Fencing
Utility Easement
Surveyed Top of Bank Project Channels
Non-Project Streams

T1
T2
T3
T4
T4A
T4B
T5
T6
T6A
T6B
T7
T7A
T8
T9
Buckwater Creek
St Marys Rd
Berry Mill Rd
Walnut Hill Dr
Cedar Trl

2017 Aerial Photography

WILDLANDS ENGINEERING

0 450 900 Feet

N

Figure 4. Monitoring Plan View Key
Buckwater Mitigation Site
Baseline Monitoring Report (MY0)
Neuse River Basin (03020201)

Orange County, NC

Conservation Easement
Internal Crossing
Vernal Pool

Mitigation Approach

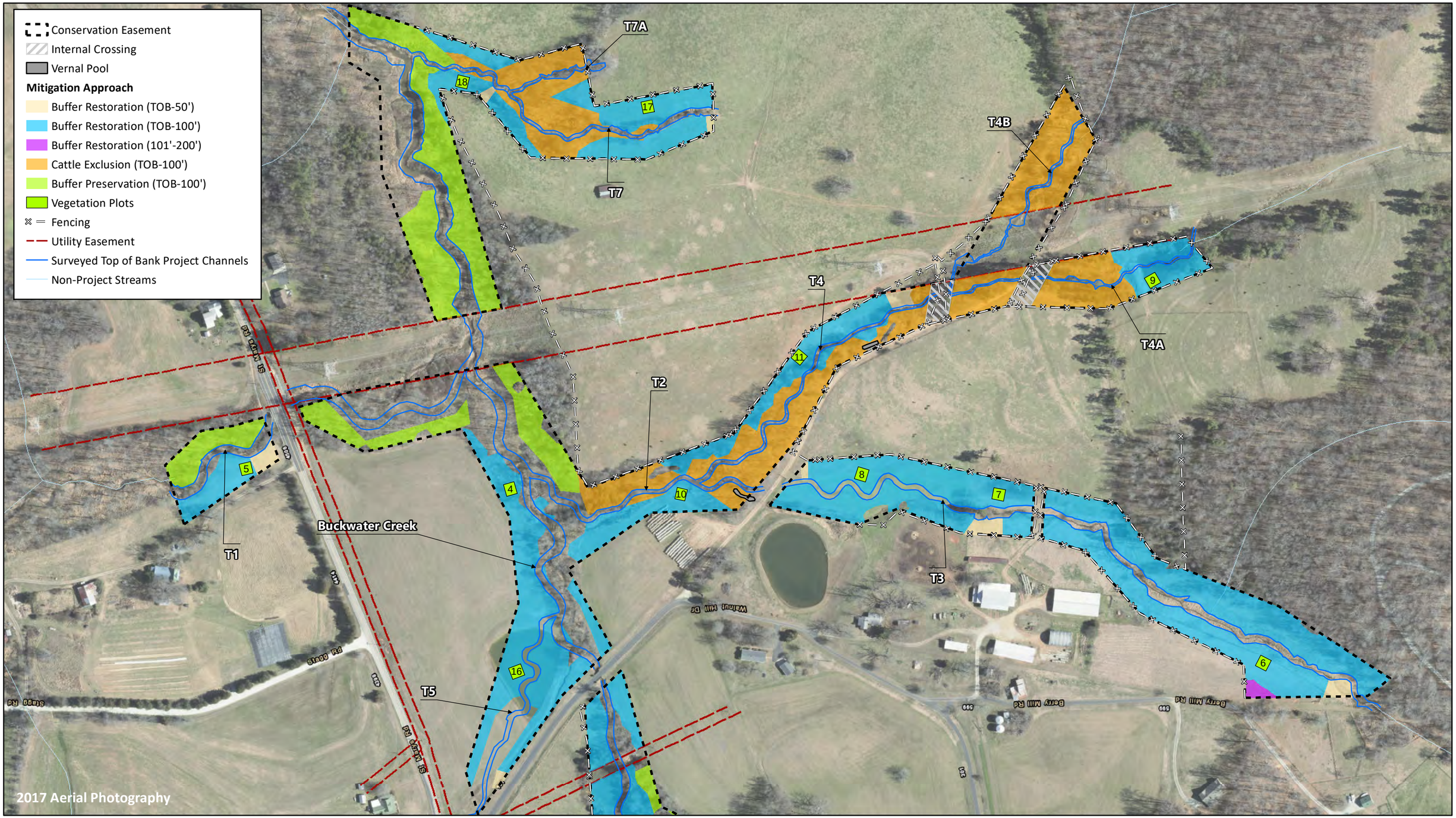
Buffer Restoration (TOB-50')
Buffer Restoration (TOB-100')
Buffer Restoration (101'-200')
Cattle Exclusion (TOB-100')
Buffer Preservation (TOB-100')
Vegetation Plots
Fencing
Utility Easement
Surveyed Top of Bank Project Channels
Non-Project Streams

T5
T6A
T6B
T6
T8
T9
Buckwater Creek
15
14
13
12
3
2
1
19
St Marys Rd
Walnut Hill Dr
2017 Aerial Photography

WILDLANDS ENGINEERING

0 250 500 Feet

Figure 4a. Monitoring Plan View
Buckwater Mitigation Site
Baseline Monitoring Report (MY0)
Neuse River Basin (03020201)
Orange County, NC



WILDLANDS ENGINEERING

0 250 500 Feet

Figure 4b. Monitoring Plan View
Buckwater Mitigation Site
Baseline Monitoring Report (MY0)
Neuse River Basin (03020201)

Orange County, NC

Table 1. Buffer Project Attributes

Buckwater Mitigation Site

Monitoring Year 0 - 2019

Project Name	Buckwater Mitigation Site
Hydrologic Unit Code	03020201030030
River Basin	Neuse
Geographic Location (Lat, Long)	36° 6' 23.49"N, 79° 1' 29.11"W
Site Protection Instrument (DB/PG)	RB6024/539-544; RB6008/500-504; RB6008/505-510; RB6028/346-351; RB6029/559-563; RB6020/38-45; RB6029/553-558
Total Credits (BMU)	1,099,775.073
Types of Credits	Riparian Buffer
Mitigation Plan Date	Dec-17
Initial Planting Date	Apr-19
Baseline Report Date	Jul-19
MY1 Report Date	Nov-19
MY2 Report Date	Nov-20
MY3 Report Date	Nov-21
MY4 Report Date	Nov-22
MY5 Report Date	Nov-23

Table 2a. Buffer Project Areas and Assets

Buckwater Mitigation Site

Monitoring Year 0 - 2019

Location	Jurisdictional Streams	Method	Feature Name	Min-Max Buffer Width (ft)	Total Area (sf)*	Creditable Area (sf)	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits
Rural	Subject	Restoration	Buffer Area E	20-29	27,683	27,683	1	75%	1.33333	20,762.302
Rural	Subject	Restoration	Buffer Area A	0-100	919,068	919,068	1	100%	1.00000	919,068.000
Rural	Subject	Restoration	Buffer Area B	101-200	2,899	2,899	1	33%	3.03030	956.671
Rural	Subject	Cattle Exclusion	Buffer Area C	0-100	242,491	242,491	2	100%	2.00000	121,245.500
				SUBTOTALS		**1,192,141**				**1,062,032.473**
			ELIGIBLE PRESERVATION AREA			**397,380**				
Location	**Jurisdictional Streams**	**Method**	**Feature Name**	**Min-Max Buffer Width (ft)**	**Total Area (sf)***	**Creditable Area (sf)**	**Initial Credit Ratio (x:1)**	**% Full Credit**	**Final Credit Ratio (x:1)**	**Riparian Buffer Credits**
Rural	Subject	Preservation	Buffer Area D	0-100	377,426	377,426	10	100%	10.00000	37,742.600
				SUBTOTALS		**377,426**				**37,742.600**
				TOTALS		**1,569,567**				**1,099,775.073**

*Differences in total area compared to the total area listed in the Mitigation Plan are due to the increased accuracy of the surveyed tree lines and the installation of vernal pools during stream construction.

Table 2b. Nutrient Offset Project Areas and Assets Available Upon Conversion

Buckwater Mitigation Site

Monitoring Year 0 - 2019

Riparian Width	Credit Type	Mitigation Type	Feature Name	Credit Ratio	Mitigation Area from Survey (ac)	Mitigation Area from Survey (sq ft)	Credited Acerage	Generated Credits per Acre	Generated Credits (lb)
101' - 200'	Nitrogen	Restoration (TOB'-100)	Buffer Area A	1:1	21.10	919,068	21.10	2,273.02	**47,958.196**
		Restoration (101'-200)	Buffer Area B	1:1	0.07	2,899	0.07		**151.274**
	Phosphorous	Restoration (TOB'-100)	Buffer Area A	1:1	21.10	919,608	21.10	146.40	**3,088.879**
		Restoration (101'-200)	Buffer Area B	1:1	0.07	2,899	0.07		**9.743**
								Total Nitrogen Credits	**48,109.470**
								Total Phosphorous Credits	**3,098.622**

Table 3. Monitoring Components

Buckwater Mitigation Site

Monitoring Year 0 - 2019

Parameter	Monitoring Feature	Quantity	Frequency
Vegetation	CVS Level 2	19	Year 1-5
Visual Assessment		Y	Semi-Annual
Exotic and Nuisance Vegetation		Y	Semi-Annual
Project Boundary		Y	Semi-Annual
Overview Photos	Photographs	6	Year 1-5

APPENDIX 2

Water Resources
ENVIRONMENTAL QUALITY

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.

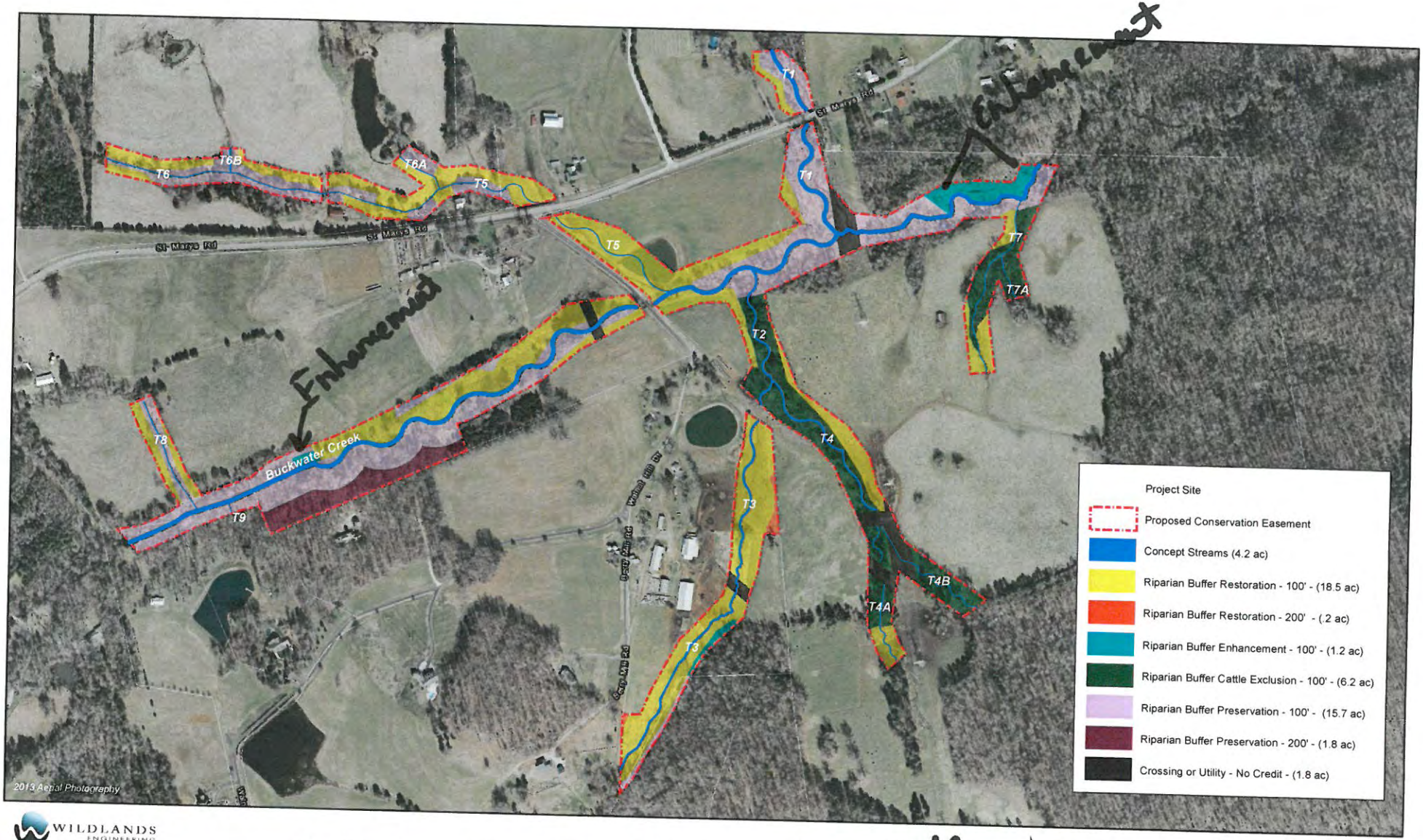
For any areas depicted as not being viable for nutrient offset credit above, one could propose a different measure, along with supporting calculations and sufficient detail to support estimates of load reduction for review by the DWR, to determine viability for nutrient offset according to 15A NCAC 02B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

Sincerely,

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)

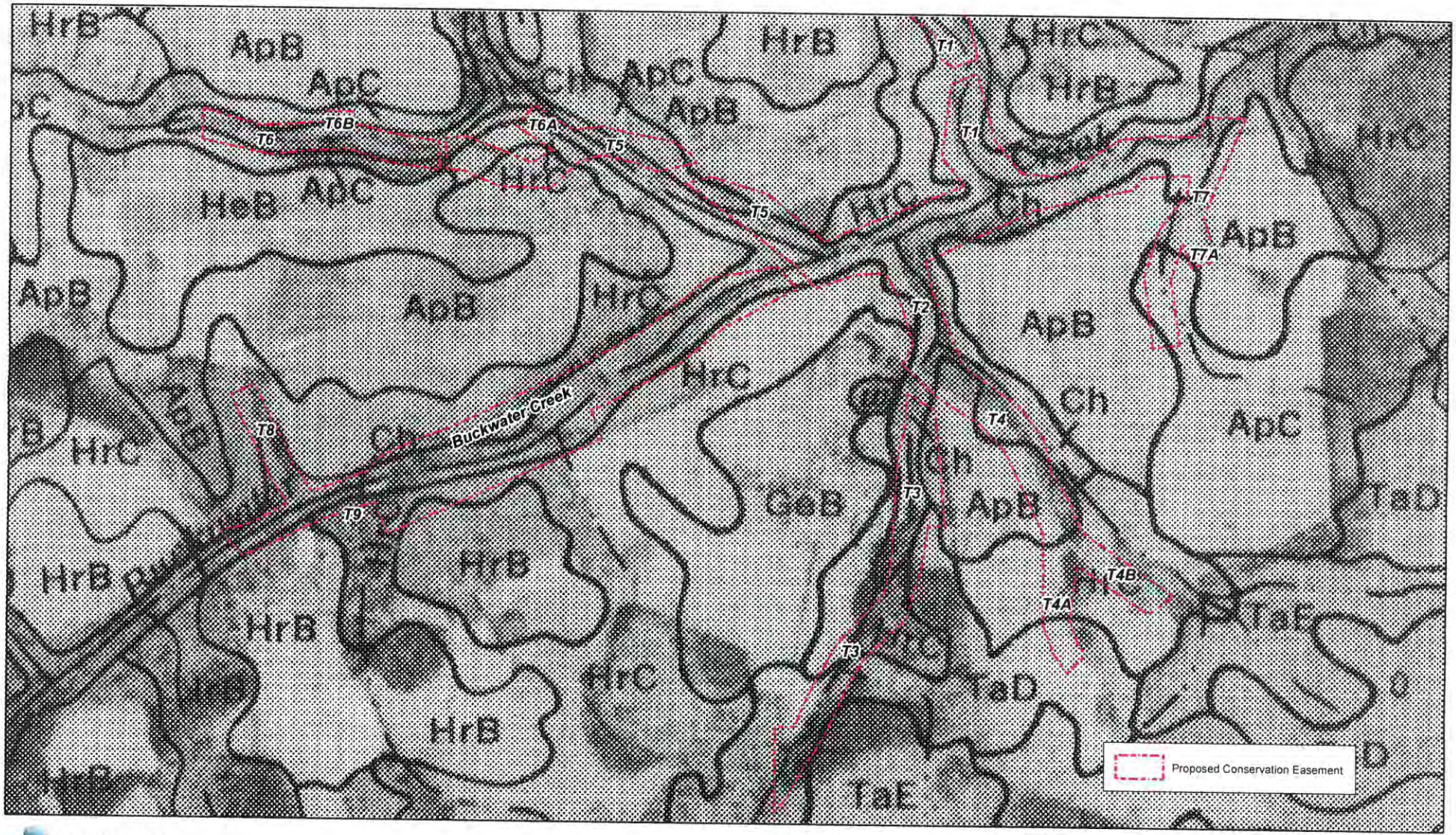


WILDLANDS ENGINEERING

DWR# 2016-0406
KPM 6/7/16

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

aeckardt 5/25/2016



WILDLANDS

0 200 400 800 1,200 1,600 Feet

N

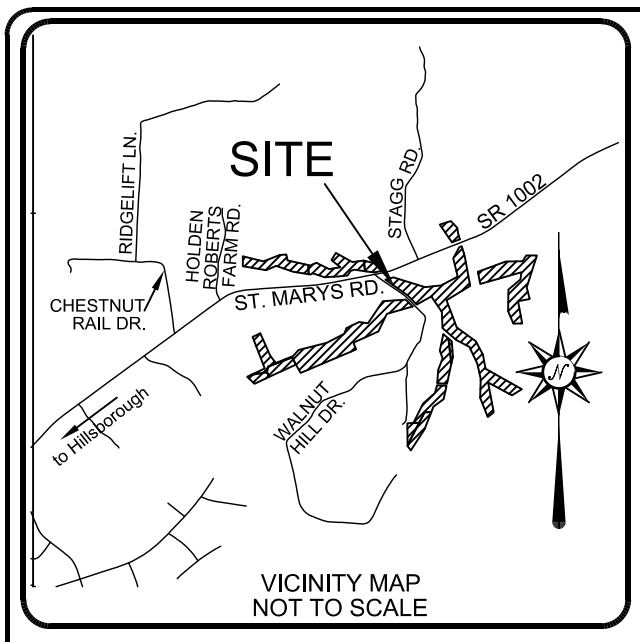
Figure 2 USDA Soil Survey of Orange County (1977)
Buckwater Mitigation Site
Neuse River Basin 03020201
Orange County, NC

aeckardt 5/25/2016

DWR# 2016-0406 Kym 6/7/16

APPENDIX 3

BUCKWATER MITIGATION SITE



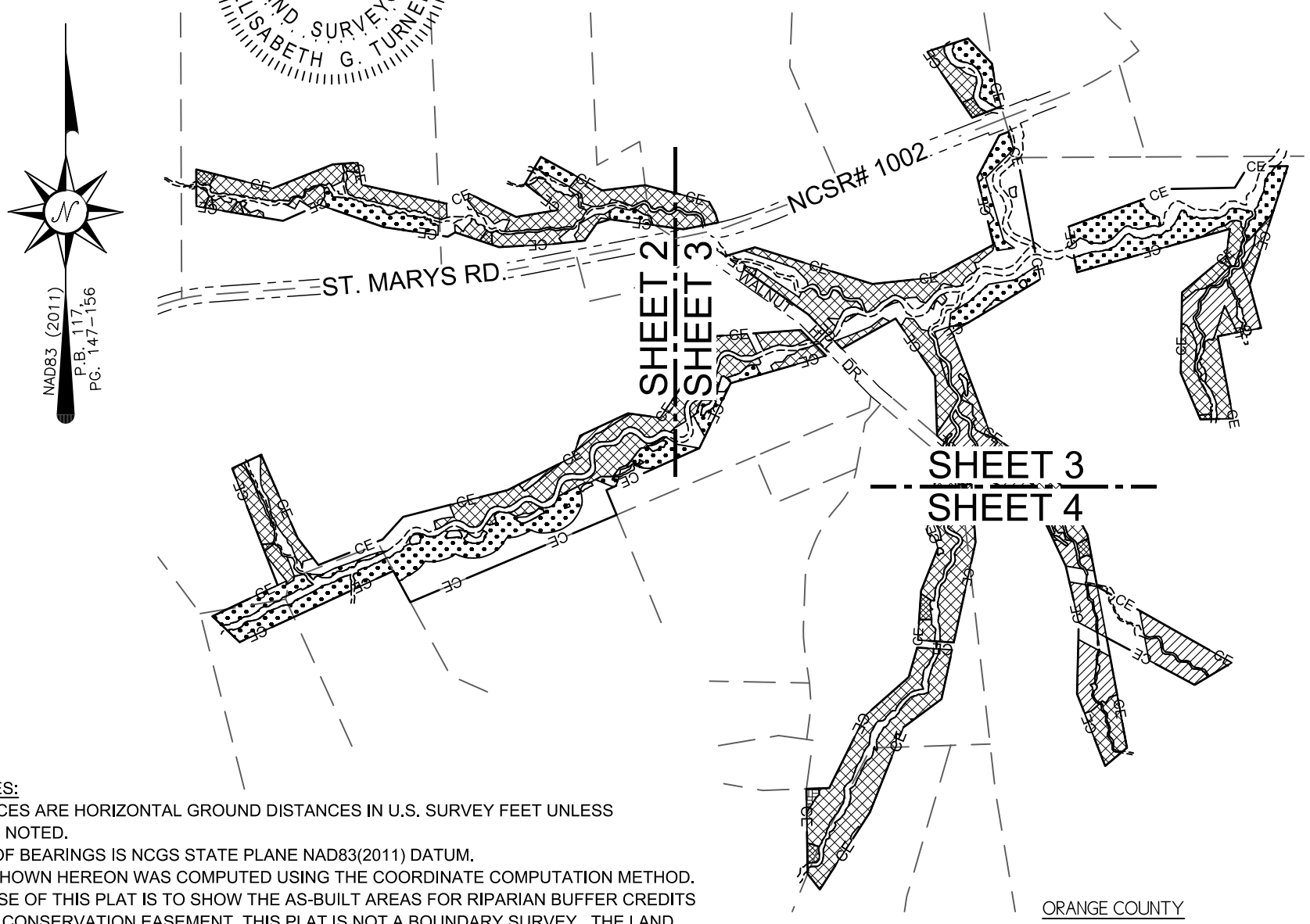
VICINITY MAP
NOT TO SCALE

	Riparian Buffer:	SQ. FT.	Acres
	Buffer Restoration 0'-49' (Min. 30')	27,683	0.63
	Buffer Restoration 0'-100' (Min. 50')	919,068	21.10
	Buffer Restoration 100'-200'	2,899	0.07
	Cattle Exclusion 0'-100'	242,491	5.57
	Buffer Preservation 0'-100'	377,426	8.66
	NO CREDIT AREA	688,538	15.81
	Total CE Area	**2,258,105**	**51.84**

I, ELISABETH G. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, CERTIFY THAT THIS BUFFER MAP WAS DRAWN UNDER MY SUPERVISION, IS AN ACCURATE CALCULATION OF THE BUFFER AREAS AND IS BASED ON THE AS-BUILT CONDITIONS SURVEYED BY OTHERS AND PROVIDED BY THE ENGINEER EXCEPT WHERE OTHERWISE NOTED HEREON, AND THAT THE EASEMENT BOUNDARY IS BASED ON PLAT BOOK 117 , PG 147-156 RECORDED IN ORANGE COUNTY REGISTER OF DEEDS OFFICE, WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 9th DAY OF JULY, 2019.

NORTH CAROLINA PROFESSIONAL SEAL L-4440 LAND SURVEYOR ELISABETH G. TURNER

ELISABETH G. TURNER, P.L.S. #L-4440



GENERAL NOTES:

1. ALL DISTANCES ARE HORIZONTAL GROUND DISTANCES IN U.S. SURVEY FEET UNLESS OTHERWISE NOTED.
2. THE BASIS OF BEARINGS IS NCGS STATE PLANE NAD83(2011) DATUM.
3. THE AREA SHOWN HEREON WAS COMPUTED USING THE COORDINATE COMPUTATION METHOD.
4. THE PURPOSE OF THIS PLAT IS TO SHOW THE AS-BUILT AREAS FOR RIPARIAN BUFFER CREDITS WITHIN THE CONSERVATION EASEMENT. THIS PLAT IS NOT A BOUNDARY SURVEY. THE LAND PARCELS AND THEIR BOUNDARIES AFFECTED BY THIS CONSERVATION EASEMENT ARE NOT CHANGED BY THIS PLAT.
5. LINES NOT SURVEYED ARE SHOWN AS A DASHED LINETYPE AND WERE TAKEN FROM INFORMATION REFERENCED ON THE FACE OF THIS PLAT.
6. SUBJECT TO ALL EASEMENTS, RIGHT OF WAYS, AND/OR ENCUMBRANCES THAT MAY AFFECT THE PROPERTY(S).
7. SEE CONSERVATION EASEMENT MAP RECORDED IN PLAT BOOK 117, PAGES 146-156 IN THE ORANGE COUNTY, NC REGISTER OF DEEDS OFFICE.
8. STREAM TOP OF BANK LINES PROVIDED BY WILDLANDS ENGINEERING TAKEN FROM AS-BUILT TOPOGRAPHIC SURVEY BY OTHERS.

ORANGE COUNTY

PARCEL ID #: 9895-08-6826
PARCEL ID #: 9895-19-4280
PARCEL ID #: 9895-28-2714
PARCEL ID #: 9895-28-9864
PARCEL ID #: 9895-07-9332
PARCEL ID #: 9895-06-5083
PARCEL ID #: 9895-06-9322
PARCEL ID #: 9895-26-9592
PARCEL ID #: 9895-25-6668
PARCEL ID #: 9895-25-8426
PARCEL ID #: 9895-46-4642

600' 0' 600' 1200'

SCALE: 1 inch = 600 feet (11x17)

THIS MAP IS NOT FOR RECORDATION, SALES, OR CONVEYANCES AND DOES NOT COMPLY WITH G.S. 47-30 MAPPING REQUIREMENTS.

SHEET 1 of 4

SCALE: 1" = 600'
FILE: BUCKWATER BUFFER_AB_F
PROJECT: 19-017
REVIEWED BY: EGT
DRAWN BY: EGT
SURVEYED BY: N/A
DATE: 09/09/2019

AS-BUILT SURVEY OF BUFFER AREAS FOR

WILDLANDS ENGINEERING, INC.

BUCKWATER MITIGATION SITE

DMS # 97084 NEUSE RIVER BASIN

ENO TOWNSHIP ORANGE COUNTY NORTH CAROLINA

REVISIONS, DATE AND INITIAL:

TURNER LAND SURVEYING
P.O. BOX 148
SWANNANOA, NC 28778
P-0702 (919) 827-0745
TurnerLandSurveying.com
Certified DBE/WBE

I, ELISABETH G. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, CERTIFY THAT THIS BUFFER MAP WAS DRAWN UNDER MY SUPERVISION, IS AN ACCURATE CALCULATION OF THE BUFFER AREAS AND IS BASED ON THE AS-BUILT CONDITIONS SURVEYED BY OTHERS AND PROVIDED BY THE ENGINEER EXCEPT WHERE OTHERWISE NOTED HEREON, AND THAT THE EASEMENT BOUNDARY IS BASED ON PLAT BOOK 117 , PG 147-156 RECORDED IN ORANGE COUNTY REGISTER OF DEEDS OFFICE, WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 9th DAY OF JULY, 2019.

ELISABETH G. TURNER, P.L.S. #L-4440

NORTH CAROLINA PROFESSIONAL SEAL L-4440 LAND SURVEYOR ELISABETH G. TURNER

Riparian Buffer:	SQ. FT.	Acres
Buffer Restoration 0'-49' (Min. 30')	27,683	0.63
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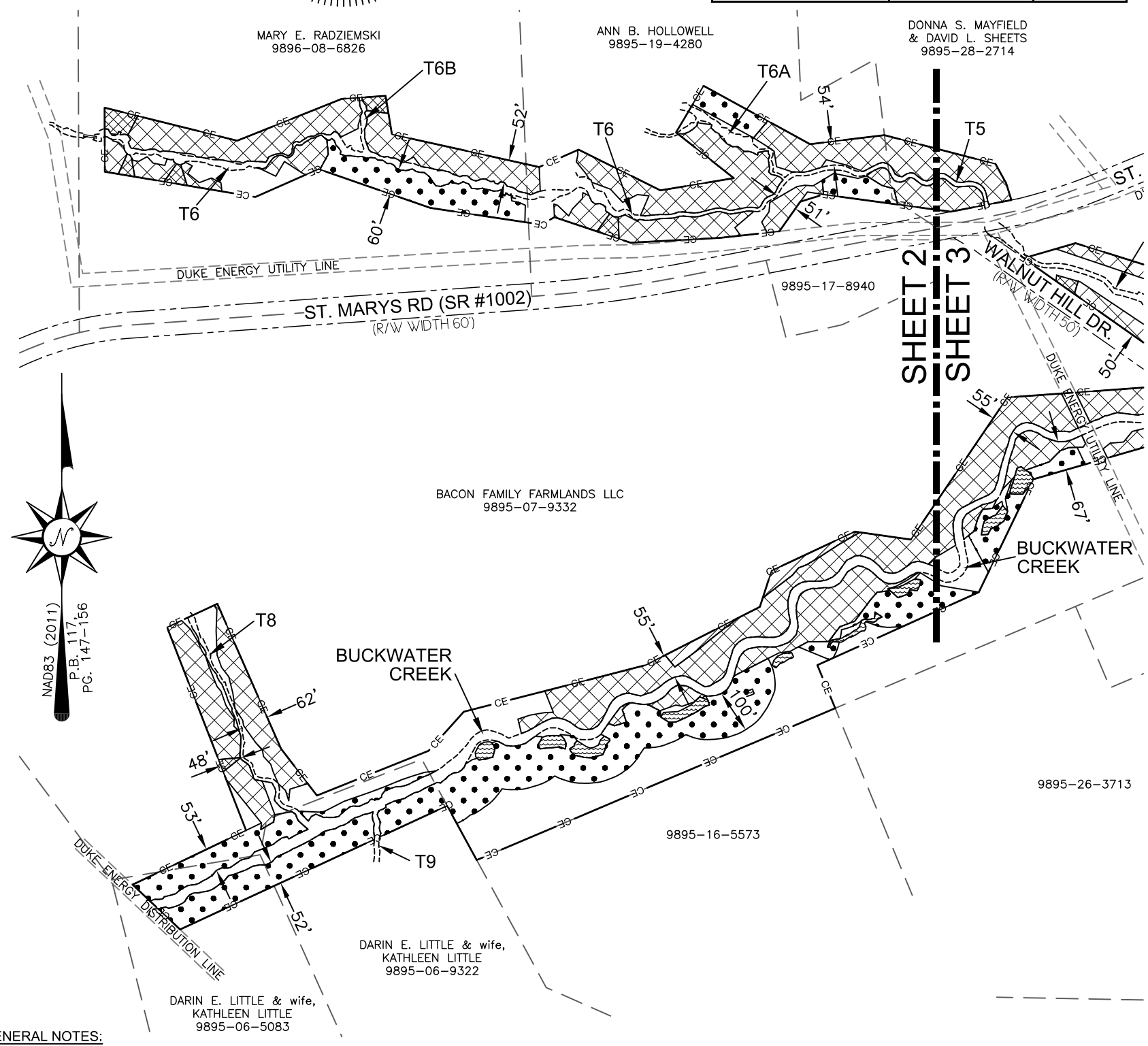

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8. STREAM TOP OF BANK LINES PROVIDED BY WILDLANDS ENGINEERING TAKEN FROM AS-BUILT TOPOGRAPHIC SURVEY BY OTHERS.

300' 0' 300' 600'

SCALE: 1 inch = 300 feet (11x17)

LEGEND:

- CE — CONSERVATION EASEMENT (BY OTHERS)
- PROPERTY LINE (SURVEYED BY OTHERS)
- UTILITY EASEMENT
- RIGHT OF WAY
- VERNAL POOLS

ORANGE COUNTY

PARCEL ID #: 9895-08-6826
PARCEL ID #: 9895-19-4280
PARCEL ID #: 9895-28-2714
PARCEL ID #: 9895-28-9864
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SHEET 2 of 4

SCALE: 1" = 300'
FILE: BUCKWATER BUFFER_AB_F
PROJECT: 19-017
REVIEWED BY: EGT
DRAWN BY: EGT
SURVEYED BY: N/A
DATE: 06/21/2019

AS-BUILT SURVEY OF BUFFER AREAS FOR

WILDLANDS ENGINEERING, INC.

BUCKWATER MITIGATION SITE

DMS # 97084 NEUSE RIVER BASIN

ENO TOWNSHIP ORANGE COUNTY NORTH CAROLINA

REVISIONS, DATE AND INITIAL:

TURNER LAND SURVEYING
P.O. BOX 148
SWANNANOA, NC 28778
P-0702 (919) 827-0745
TurnerLandSurveying.com
Certified DBE/WBE

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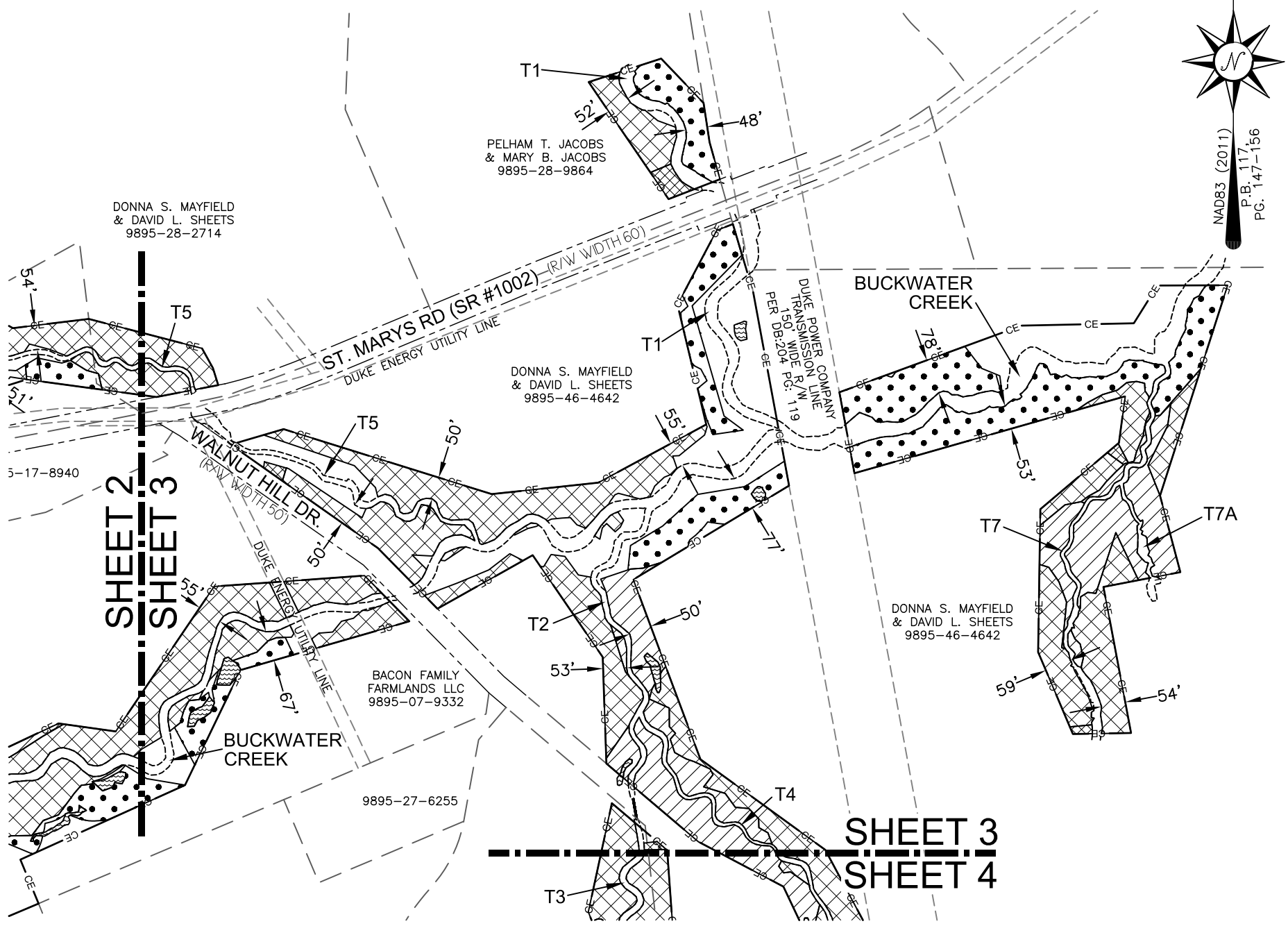

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2. THE BASIS OF BEARINGS IS NCGS STATE PLANE NAD83(2011) DATUM.
3. THE AREA SHOWN HEREON WAS COMPUTED USING THE COORDINATE COMPUTATION METHOD.
4. THE PURPOSE OF THIS PLAT IS TO SHOW THE AS-BUILT AREAS FOR RIPARIAN BUFFER CREDITS WITHIN THE CONSERVATION EASEMENT. THIS PLAT IS NOT A BOUNDARY SURVEY. THE LAND PARCELS AND THEIR BOUNDARIES AFFECTED BY THIS CONSERVATION EASEMENT ARE NOT CHANGED BY THIS PLAT.
5. LINES NOT SURVEYED ARE SHOWN AS A DASHED LINETYPE AND WERE TAKEN FROM INFORMATION REFERENCED ON THE FACE OF THIS PLAT.
6. SUBJECT TO ALL EASEMENTS, RIGHT OF WAYS, AND/OR ENCUMBRANCES THAT MAY AFFECT THE PROPERTY(S).
7. SEE CONSERVATION EASEMENT MAP RECORDED IN PLAT BOOK 117, PAGES 146-156 IN THE ORANGE COUNTY, NC REGISTER OF DEEDS OFFICE.
8. STREAM TOP OF BANK LINES PROVIDED BY WILDLANDS ENGINEERING TAKEN FROM AS-BUILT TOPOGRAPHIC SURVEY BY OTHERS.

LEGEND:
- CE — CONSERVATION EASEMENT (BY OTHERS)
- PROPERTY LINE (SURVEYED BY OTHERS)
- UTILITY EASEMENT
- RIGHT OF WAY
- VERNAL POOLS

ORANGE COUNTY
PARCEL ID #: 9895-08-6826
PARCEL ID #: 9895-19-4280
PARCEL ID #: 9895-28-2714
PARCEL ID #: 9895-28-9864
PARCEL ID #: 9895-07-9332
PARCEL ID #: 9895-06-5083
PARCEL ID #: 9895-06-9322
PARCEL ID #: 9895-26-9592
PARCEL ID #: 9895-25-6668
PARCEL ID #: 9895-25-8426
PARCEL ID #: 9895-46-4642

300' 0' 300' 600'

SCALE: 1 inch = 300 feet (11x17)

THIS MAP IS NOT FOR RECORDATION, SALES, OR CONVEYANCES AND DOES NOT COMPLY WITH G.S. 47-30 MAPPING REQUIREMENTS.

SHEET 3 of 4

SCALE: 1" = 300'
FILE: BUCKWATER BUFFER_AB_F
PROJECT: 19-017
REVIEWED BY: EGT
DRAWN BY: EGT
SURVEYED BY: N/A
DATE: 06/21/2019

AS-BUILT SURVEY OF BUFFER AREAS FOR
WILDLANDS ENGINEERING, INC.
BUCKWATER MITIGATION SITE
DMS # 97084 NEUSE RIVER BASIN
ENO TOWNSHIP ORANGE COUNTY NORTH CAROLINA

REVISIONS, DATE AND INITIAL:

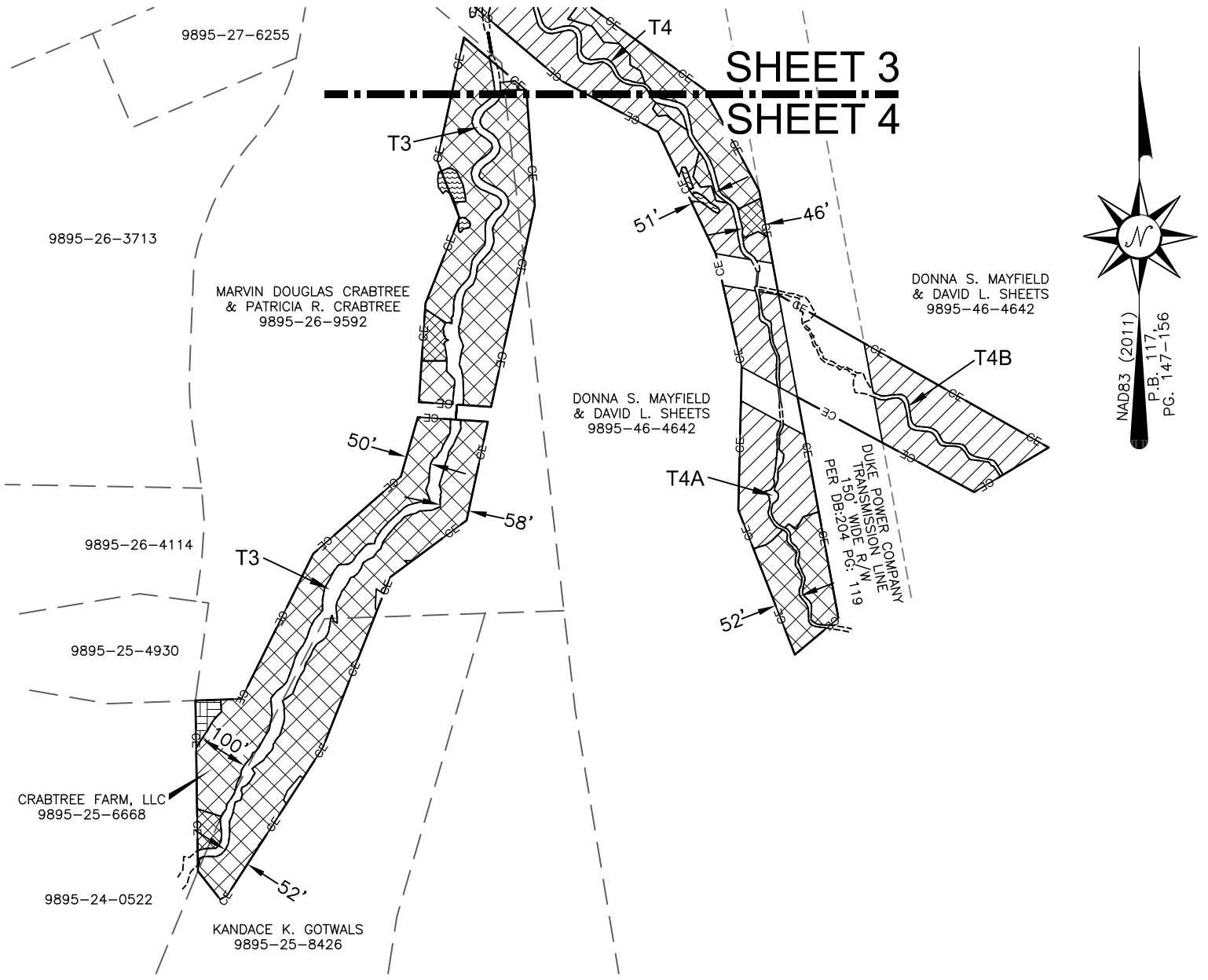
TURNER LAND SURVEYING
P.O. BOX 148
SWANNANOA, NC 28778
P-0702 (919) 827-0745
TurnerLandSurveying.com
Certified DBE/WBE

I, ELISABETH G. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, CERTIFY THAT THIS BUFFER MAP WAS DRAWN UNDER MY SUPERVISION, IS AN ACCURATE CALCULATION OF THE BUFFER AREAS AND IS BASED ON THE AS-BUILT CONDITIONS SURVEYED BY OTHERS AND PROVIDED BY THE ENGINEER EXCEPT WHERE OTHERWISE NOTED HEREON, AND THAT THE EASEMENT BOUNDARY IS BASED ON PLAT BOOK 117 , PG 147-156 RECORDED IN ORANGE COUNTY REGISTER OF DEEDS OFFICE, WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 9th DAY OF JULY, 2019.

ELISABETH G. TURNER, P.L.S. #L-4440

NORTH CAROLINA PROFESSIONAL SEAL L-4440 LAND SURVEYOR ELISABETH G. TURNER

Riparian Buffer:	SQ. FT.	Acres
Buffer Restoration 0'-49' (Min. 30')	27,683	0.63
Buffer Restoration 0'-100' (Min. 50')	919,068	21.10
Buffer Restoration 100'-200'	2,899	0.07
Cattle Exclusion 0'-100'	242,491	5.57
Buffer Preservation 0'-100'	377,426	8.66
NO CREDIT AREA	688,538	15.81
Total CE Area	**2,258,105**	**51.84**



GENERAL NOTES:

1. ALL DISTANCES ARE HORIZONTAL GROUND DISTANCES IN U.S. SURVEY FEET UNLESS OTHERWISE NOTED.
2. THE BASIS OF BEARINGS IS NCGS STATE PLANE NAD83(2011) DATUM.
3. THE AREA SHOWN HEREON WAS COMPUTED USING THE COORDINATE COMPUTATION METHOD.
4. THE PURPOSE OF THIS PLAT IS TO SHOW THE AS-BUILT AREAS FOR RIPARIAN BUFFER CREDITS WITHIN THE CONSERVATION EASEMENT. THIS PLAT IS NOT A BOUNDARY SURVEY. THE LAND PARCELS AND THEIR BOUNDARIES AFFECTED BY THIS CONSERVATION EASEMENT ARE NOT CHANGED BY THIS PLAT.
5. LINES NOT SURVEYED ARE SHOWN AS A DASHED LINETYPE AND WERE TAKEN FROM INFORMATION REFERENCED ON THE FACE OF THIS PLAT.
6. SUBJECT TO ALL EASEMENTS, RIGHT OF WAYS, AND/OR ENCUMBRANCES THAT MAY AFFECT THE PROPERTY(S).
7. SEE CONSERVATION EASEMENT MAP RECORDED IN PLAT BOOK 117, PAGES 146-156 IN THE ORANGE COUNTY, NC REGISTER OF DEEDS OFFICE.
8. STREAM TOP OF BANK LINES PROVIDED BY WILDLANDS ENGINEERING TAKEN FROM AS-BUILT TOPOGRAPHIC SURVEY BY OTHERS.

LEGEND:

- CE — CONSERVATION EASEMENT (BY OTHERS)
- PROPERTY LINE (SURVEYED BY OTHERS)
- UTILITY EASEMENT
- RIGHT OF WAY
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ORANGE COUNTY

PARCEL ID #: 9895-08-6826
PARCEL ID #: 9895-19-4280
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SHEET 4 of 4

SCALE: 1" = 300'
FILE: BUCKWATER BUFFER_AB_F
PROJECT: 19-017
REVIEWED BY: EGT
DRAWN BY: EGT
SURVEYED BY: N/A
DATE: 06/21/2019

AS-BUILT SURVEY OF BUFFER AREAS FOR

WILDLANDS ENGINEERING, INC.

BUCKWATER MITIGATION SITE

DMS # 97084 NEUSE RIVER BASIN

ENO TOWNSHIP ORANGE COUNTY NORTH CAROLINA

REVISIONS, DATE AND INITIAL:

TURNER LAND SURVEYING
P.O. BOX 148
SWANNANOA, NC 28778
P-0702 (919) 827-0745
TurnerLandSurveying.com
Certified DBE/WBE

APPENDIX 4

Overview Photographs

APPENDIX 5

Table 4. Planted and Total Stem Counts

Buckwater Mitigation Site

Monitoring Year 0 - 2019

			Current Plot Data (MY0 2019)														
			97084-01-0001			97084-01-0002			97084-01-0003			97084-01-0004			97084-01-0005		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Aesculus pavia	Red Buckeye	Shrub Tree															
Betula nigra	River Birch	Tree	1	1	1	2	2	2	3	3	3	2	2	2	4	4	4
Fraxinus pennsylvanica	Green Ash	Tree	3	3	3	2	2	2	2	2	2	4	4	4	1	1	1
Liriodendron tulipifera	Tulip Poplar	Tree	2	2	2	2	2	2	1	1	1				3	3	3
Platanus occidentalis	Sycamore	Tree	1	1	1	5	5	5	4	4	4	5	5	5	4	4	4
Quercus alba	White Oak	Tree	2	2	2	1	1	1				1	1	1	1	1	1
Quercus lyrata	Overcup Oak	Tree													2	2	2
Quercus michauxii	Swamp Chestnut Oak	Tree	3	3	3				1	1	1						
Quercus phellos	Willow Oak	Tree	3	3	3				3	3	3						
Quercus shumardii	Shumard Oak	Shrub Tree				3	3	3	1	1	1						
Viburnum dentatum	Arrow-wood	Shrub Tree										2	2	2			
		Stem count	15	15	15	15	15	15	15	15	15	14	14	14	15	15	15
		size (ares)	1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02		
		Species count	7	7	7	6	6	6	7	7	7	5	5	5	6	6	6
		Stems per ACRE	607	607	607	607	607	607	607	607	607	567	567	567	607	607	607

Color for Density

Exceeds requirements by 10%

Exceeds requirements, but by less than 10%

Fails to meet requirements, by less than 10%

Fails to meet requirements by more than 10%

PnLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems

Table 4. Planted and Total Stem Counts

Buckwater Mitigation Site

Monitoring Year 0 - 2019

			Current Plot Data (MY0 2019)															
			97084-01-0006			97084-01-0007			97084-01-0008			97084-01-0009			97084-01-0010		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Aesculus pavia	Red Buckeye	Shrub Tree	1	1	1	2	2	2				1	1	1			
Betula nigra	River Birch	Tree	1	1	1	1	1	1	2	2	2	2	2	2			
Fraxinus pennsylvanica	Green Ash	Tree	2	2	2	1	1	1	1	1	1				4	4	4
Liriodendron tulipifera	Tulip Poplar	Tree				1	1	1	3	3	3	3	3	3	1	1	1
Platanus occidentalis	Sycamore	Tree	4	4	4	2	2	2	5	5	5	4	4	4	1	1	1
Quercus alba	White Oak	Tree	1	1	1	2	2	2									
Quercus lyrata	Overcup Oak	Tree	2	2	2	1	1	1	1	1	1	3	3	3	6	6	6
Quercus michauxii	Swamp Chestnut Oak	Tree													1	1	1
Quercus phellos	Willow Oak	Tree	3	3	3	3	3	3	2	2	2	2	2	2			
Quercus shumardii	Shumard Oak	Shrub Tree				2	2	2	1	1	1						
Viburnum dentatum	Arrow-wood	Shrub Tree	1	1	1												
		Stem count	15	15	15	15	15	15	15	15	15	15	15	15	13	13	13
		size (ares)		1			1			1			1			1	
		size (ACRES)		0.02			0.02			0.02			0.02			0.02	
		Species count	8	8	8	9	9	9	7	7	7	6	6	6	5	5	5
		Stems per ACRE	607	607	607	607	607	607	607	607	607	607	607	607	526	526	526

Color for Density

Exceeds requirements by 10%

Exceeds requirements, but by less than 10%

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Fails to meet requirements by more than 10%

PnLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems

Table 4. Planted and Total Stem Counts

Buckwater Mitigation Site

Monitoring Year 0 - 2019

			Current Plot Data (MY0 2019)														
			97084-01-0011			97084-01-0012			97084-01-0013			97084-01-0014			97084-01-0015		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Aesculus pavia	Red Buckeye	Shrub Tree	1	1	1	2	2	2							1	1	1
Betula nigra	River Birch	Tree				2	2	2	4	4	4	4	4	4	3	3	3
Fraxinus pennsylvanica	Green Ash	Tree	1	1	1				3	3	3	3	3	3	2	2	2
Liriodendron tulipifera	Tulip Poplar	Tree	1	1	1	4	4	4	1	1	1	3	3	3			
Platanus occidentalis	Sycamore	Tree	2	2	2	3	3	3	4	4	4	2	2	2	4	4	4
Quercus alba	White Oak	Tree															
Quercus lyrata	Overcup Oak	Tree	3	3	3												
Quercus michauxii	Swamp Chestnut Oak	Tree				3	3	3	1	1	1	1	1	1	1	1	1
Quercus phellos	Willow Oak	Tree	3	3	3	1	1	1	2	2	2	1	1	1	1	1	1
Quercus shumardii	Shumard Oak	Shrub Tree													1	1	1
Viburnum dentatum	Arrow-wood	Shrub Tree	4	4	4							1	1	1	2	2	2
		Stem count	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
		size (ares)	1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02		
		Species count	7	7	7	6	6	6	6	6	6	7	7	7	8	8	8
		Stems per ACRE	607	607	607	607	607	607	607	607	607	607	607	607	607	607	607

Color for Density

Exceeds requirements by 10%

Exceeds requirements, but by less than 10%

Fails to meet requirements, by less than 10%

Fails to meet requirements by more than 10%

PnLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems

Table 4. Planted and Total Stem Counts

Buckwater Mitigation Site

Monitoring Year 0 - 2019

			Current Plot Data (MY0 2019)												Annual Means		
			97084-01-0016			97084-01-0017			97084-01-0018			97084-01-0019			MY0 (2019)		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Aesculus pavia	Red Buckeye	Shrub Tree				1	1	1	1	1	1				10	10	10
Betula nigra	River Birch	Tree	2	2	2	3	3	3	4	4	4	1	1	1	41	41	41
Fraxinus pennsylvanica	Green Ash	Tree	1	1	1	1	1	1	1	1	1	2	2	2	34	34	34
Liriodendron tulipifera	Tulip Poplar	Tree	2	2	2	1	1	1	2	2	2	2	2	2	32	32	32
Platanus occidentalis	Sycamore	Tree	3	3	3	3	3	3	2	2	2	4	4	4	62	62	62
Quercus alba	White Oak	Tree	2	2	2	1	1	1							11	11	11
Quercus lyrata	Overcup Oak	Tree				2	2	2	2	2	2				22	22	22
Quercus michauxii	Swamp Chestnut Oak	Tree										2	2	2	13	13	13
Quercus phellos	Willow Oak	Tree	4	4	4	1	1	1				4	4	4	33	33	33
Quercus shumardii	Shumard Oak	Shrub Tree							1	1	1				9	9	9
Viburnum dentatum	Arrow-wood	Shrub Tree	1	1	1	2	2	2	2	2	2				15	15	15
		Stem count	15	15	15	15	15	15	15	15	15	15	15	15	282	282	282
		size (ares)	1			1			1			1			19		
		size (ACRES)	0.02			0.02			0.02			0.02			0.47		
		Species count	7	7	7	9	9	9	8	8	8	6	6	6	11	11	11
		Stems per ACRE	607	607	607	607	607	607	607	607	607	607	607	607	601	601	601

Color for Density

Exceeds requirements by 10%

Exceeds requirements, but by less than 10%

Fails to meet requirements, by less than 10%

Fails to meet requirements by more than 10%

PnLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems

VEGETATION PLOT PHOTOGRAPHS

VEG PLOT 1 *(03/14/2019)*

VEG PLOT 2 *(03/14/2019)*

VEG PLOT 3 *(03/14/2019)*

VEG PLOT 4 *(04/24/2019)*

VEG PLOT 5 *(04/24/2019)*

VEG PLOT 6 *(04/24/2019)*

VEG PLOT 7 *(04/24/2019)*

VEG PLOT 8 *(04/24/2019)*

VEG PLOT 9 *(04/24/2019)*

VEG PLOT 10 *(07/02/2019)*

VEG PLOT 11 *(04/24/2019)*

VEG PLOT 12 *(03/14/2019)*

VEG PLOT 13 *(03/14/2019)*

VEG PLOT 14 *(03/14/2019)*

VEG PLOT 15 *(03/14/2019)*

VEG PLOT 16 *(04/24/2019)*

VEG PLOT 17 *(04/24/2019)*

VEG PLOT 18 *(04/24/2019)*

VEG PLOT 19 *(03/14/2019)*

APPENDIX 6

Water Resources
Environmental Quality

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
LINDA CULPEPPER
Interim Director

March 6, 2018

DWR # 16-0406v2
Orange County

NC Division of Mitigation Services
Attn: Lin Xu
217 West Jones Street
Raleigh, NC 27699

Subject: APPROVAL OF 401 WATER QUALITY CERTIFICATION WITH ADDITIONAL CONDITIONS

Buckwater Mitigation Site

Dear Mr. Xu:

You have our approval for the impacts listed below for the purpose described in your application dated January 12, 2018, received by the Division of Water Resources January 16, 2018. These impacts are covered by the attached Water Quality General Certification Number 4134 and the conditions listed below. This certification is associated with the use of Nationwide Permit Number 27once it is issued to you by the U.S. Army Corps of Engineers. Please note that you should get any other federal, state or local permits before proceeding with your project, including those required by (but not limited to) Sediment and Erosion Control, Non-Discharge, and Water Supply Watershed regulations.

This approval requires you to follow the conditions listed in the enclosed certification(s) or general permit and the following additional conditions:

1. The following impacts are hereby approved provided that all of the other specific and general conditions of the Certification are met. No other impacts are approved, including incidental impacts. [15A NCAC 02H .0506(b) and/or (c)]

Type of Impact	Amount Approved (units) Permanent	Amount Approved (units) Temporary
404/401 Wetlands		
W1	0 (acres)	0.027 (acres)
W2	0	0.015
W3	0	0.013
W4	0	0.003
Wa	0.036	0
W5	0	0.028
W6	0	0.015
W7	0	0.004
W8	0	0.006
W9	0.011	0
W10	0	0.063
W11	0	0.014
W12	0	0.006
W13	0	0.01
W14	0	0.025
W15	0.028	0
W16	0	0.014
W17	0	0.022
W18	0.020	0
W19	0.207	0
W20	0.052	0

W21	0	0.024
W22	0.058	0
W23	0	0.104
W24	0	0.030
W27	0	0.188
W28	0.053	0
W29	0	0.058
W30	0.032	0
W31	0	0.086
W32	0	0.087
W33	0.043	0
W34	0.069	0
W35	0.030	
W36	0	0.048
W37	0.006	0
W38	0.003	0
W39	0.002	0
W40	0	0.048
W41	0	0.010
W42	0	0.012
W43	0.003	0
W44	0	0.008
W45	0.022	0
W46	0	0.003
W47	0	0.002
W48	0.002	0

W49	0.041	0
W50	0	0.030
W51	0.006	0
W52	0	0.018
W53	0	0.013
W54	0	0.015
W55	0	0.025
W56	0.014	0
W57	0	0.024
W58	0.017	0
W59	0	0.004
W60	0.064	0
W61	0.004	0
W62	0.014	0
W63	0.027	0
W64	0	0.011
W65	0	0.028
W66	0	0.021
W67	0.015	0
W68	0	0.029
W69	0.038	0
W70	0	0.143
W71	0.037	0
W72	0.026	0
W73	0.010	0
W74	0	0.027

W75	0.049	0
W76	0.029	0
W77	0	0.012
W78	0	0.014
W79	0.006	0
Total	1.074 acres	1.387 Acres
Stream		
S1	68 (linear feet)	0 (linear feet)
S2	0	323
S3	0	157
S4	0	136
S5	0	258
S6	198	0
S7	0	175
S8	402	0
S9	0	128
S10	550	0
S11	0	473
S12	0	323
S13	123	0
S14	0	175
S15	0	393
S16	0	25
S17	2,128	0
S18	590	0

S19	0	134
S20	435	0
S21	837	0
S22	567	0
S23	0	339
S24	0	445
S25	0	205
S26	0	206
S27	126	0
S28	368	0
S29	0	130
S30	104	0
S31	0	285
S32	356	0
S33	548	0
S34	528	0
S35	0	423
S36	81	0
S37	0	73
S38	148	0
S38a	97	0
S39	123	0
S40	346	0
S41	0	634
S42	55	0
S43	0	153

S44	85	0
Total	8,863 Linear feet	5,593 Linear feet
Open Waters		
O1	0.396 (acres)	0 (acres)
O2	0.778	0
O3	0.180	0
Total	1.354 acres	0 acres

2. This approval is for the purpose and design described in your application. The plans and specifications for this project are incorporated by reference as part of the Certification. If you change your project, you must notify the Division and you may be required to submit a new application package with the appropriate fee. If the property is sold, the new owner must be given a copy of this approval letter and General Certification(s)/Permit/Authorization and is responsible for complying with all conditions. [15A NCAC 02H .0507(d)(2)]

3. The issuance of the 401 Water Quality Certification for the restoration/enhancement project does not represent an approval of credit yield for the project. [15A NCAC 02H .0500(h)]

4. You have our approval for your proposed final stream enhancements/restorations plan. The stream restorations/enhancements must be constructed, maintained, and monitored according to the plans approved by this Office and this Certificate of Coverage. Any repairs or adjustments to the site must be made according to the approved plans or must receive written approval from this Office to make the repairs or adjustments. [15A NCAC 02H .0506(h)

This approval and its conditions are final and binding unless contested. [G.S. 143-215.5]

This Certification can be contested as provided in Articles 3 and 4 of General Statute 150B by filing a written petition for an administrative hearing to the Office of Administrative Hearings (hereby known as OAH) **within sixty (60) calendar days**.

A petition form may be obtained from the OAH at http://www.ncoah.com/ or by calling the OAH Clerk's Office at (919) 431-3000 for information. A petition is considered filed when the original and one (1) copy along with any applicable OAH filing fee is received in the OAH during normal office hours (Monday through Friday between 8:00am and 5:00pm, excluding official state holidays).

The petition may be faxed to the OAH at (919) 431-3100, provided the original and one copy of the petition along with any applicable OAH filing fee is received by the OAH within five (5) business days following the faxed transmission.

Mailing address for the OAH:

If sending via US Postal Service:	*If sending via delivery service (UPS, FedEx, etc):*
Office of Administrative Hearings	Office of Administrative Hearings
6714 Mail Service Center	1711 New Hope Church Road
Raleigh, NC 27699-6714	Raleigh, NC 27609-6285

One (1) copy of the petition must also be served to Department of Environmental Quality:

William F. Lane, General Counsel
Department of Environmental Quality
1601 Mail Service Center
Raleigh, NC 27699-1601

This letter completes the review of the Division under section 401 of the Clean Water Act. Please contact Mac Haupt at 919-807-6476 or mac.haupt@ncdenr.gov if you have any questions or concerns.

Sincerely,

Karen Higgins

Karen Higgins, Supervisor
401 & Buffer Permitting Branch

Enclosures: GC 4134

cc: Chris Roessler, Wildlands Engineering
Andrea Hughes, USACE Raleigh Regulatory Field Office
Danny Smith, DWR Raleigh Regional Office 401 file
DWR 401 & Buffer Permitting Branch file

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U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action ID: **SAW-2016-00873** County: **Orange** USGS Quad: **Hillsborough**

GENERAL PERMIT (REGIONAL AND NATIONWIDE) VERIFICATION

Applicant: **NC Division of Mitigation Services**
Attn: Mr. Tim Baumgartner
Address: **217 West Jones Street, Suite 3000A**
Raleigh, North Carolina 27603

Size and location of property (water body, road name/number, town, etc.): **The 49-acre mitigation site is located adjacent to St. Mary's Road, east of its intersection with Dumont Drive, in Orange County, North Carolina. The project area is located on Orange County parcel numbers: 989509942, 9895269592, 9895258436, 9895381829, 9895079332, 9895069322, 9895065083, 9895476632, and 9895282714.**

Site Coordinates: **36.10653 ºN, -79.02489 ºW** Waterway: **Buckwater Creek** River Basin: **Neuse River**

Description of project area and activity: **The Nationwide 27 permit authorizes mechanized land clearing, excavation, and the placement of fill material associated with restoration and enhancement activities involving 14,135 linear feet of Buckwater Creek and its unnamed tributaries, 2.226 acres of riparian wetlands and 1.354 acres of open water (conversion of 3 ponds). Temporary construction access under NWP 33 will impact 0.107 acre of riparian wetlands. See page 2 for details regarding impacts.**

Applicable Law: ☒ Section 404 (Clean Water Act, 33 USC 1344)
☐ Section 10 (Rivers and Harbors Act, 33 USC 403)
Authorization: Nationwide or Regional General Permit Number(s): **27, 33**

SEE ATTACHED NATIONWIDE CONDITIONS AND SPECIAL CONDITIONS ON PAGE 2 OF THIS FORM

Your work is authorized by the above referenced permit provided it is accomplished in strict accordance with the attached conditions and your submitted application received January 16, 2018 and additional information received on March 15, 2018. Any violations of the attached conditions or deviation from your submitted plans may subject the permittee to a stop work order, a restoration order and/or appropriate legal action.

- This verification will remain valid until the expiration date identified below unless the nationwide authorization is modified, suspended or revoked. If, prior to the expiration date identified below, the nationwide permit authorization is reissued and/or modified, this verification will remain valid until the expiration date identified below, provided it complies with all requirements of the modified nationwide permit. If the nationwide permit authorization expires or is suspended, revoked, or is modified, such that the activity would no longer comply with the terms and conditions of the nationwide permit, activities which have commenced (i.e., are under construction) or are under contract to commence in reliance upon the nationwide permit, will remain authorized provided the activity is completed within twelve months of the date of the nationwide permit's expiration, modification or revocation, unless discretionary authority has been exercised on a case-by-case basis to modify, suspend or revoke the authorization.
- Activities subject to Section 404 (as indicated above) may also require an individual Section 401 Water Quality Certification. You should contact the NC Division of Water Resources (telephone 919-807-6300) to determine Section 401 requirements.
- For activities occurring within the twenty coastal counties subject to regulation under the Coastal Area Management Act (CAMA), prior to beginning work you must contact the N.C. Division of Coastal Management in Morehead City, NC, at (252) 808-2808. This Department of the Army verification does not relieve the permittee of the responsibility to obtain any other required Federal, State or local approvals/permits.
- If there are any questions regarding this verification, any of the conditions of the Permit, or the Corps of Engineers regulatory program, please contact Andrea Hughes at telephone (919) 554-4884 x 59.

Corps Regulatory Official: HUGHES.ANDREA.WADE.1258339165 Digitally signed by HUGHES.ANDREA.WADE.1258339165 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=HUGHES.ANDREA.WADE.1258339165 Date: 2018.03.15 16:25:50 -04'00' Date:
Expiration Date of Nationwide Permit Verification: **March 18, 2022**

Table 1. Authorized discharge of fill material into waters of the United States in association with the Buckwater Mitigation Site (SAW-2016-00873).

Impact Number/ Aquatic Resource ID	NWP #	Flow Regime or Cowardin Class	Fill Length of Stream (lf)	Fill acreage of wetland (ac)	Fill acreage of Open Waters (ac)	Duration of Fill Material	Regulated Discharge/ Activity
W2,W3 Wetland AA	27	Riparian	N/A	0.028	N/A	Temporary	Excavation/ Placement of Fill
W1 Wetland BB	27	Riparian	N/A	0.027	N/A	Temporary	Excavation/ Placement of Fill
W4 Wetland EE	27	Riparian	N/A	0.003	N/A	Temporary	Excavation/ Placement of Fill
W9 Wetland FF	27	Riparian	N/A	0.011	N/A	Temporary	Excavation/ Placement of Fill
W8 Wetland GG	27	Riparian	N/A	0.006	N/A	Temporary	Excavation/ Placement of Fill
W6 Wetland II	27	Riparian	N/A	0.015	N/A	Temporary	Excavation/ Placement of Fill
W5 Wetland KK	27	Riparian	N/A	0.028	N/A	Temporary	Excavation/ Placement of Fill
W16 Wetland LL	27	Riparian	N/A	0.014	N/A	Temporary	Excavation/ Placement of Fill
W11 Wetland MM	27	Riparian	N/A	0.014	N/A	Temporary	Excavation/ Placement of Fill
W32 Wetland OO	27	Riparian	N/A	0.087	N/A	Temporary	Excavation/ Placement of Fill
W21-23,W27-31 Wetland PP	27	Riparian	N/A	0.603	N/A	Temporary	Excavation/ Placement of Fill
W17-20 Wetland QQ	27	Riparian	N/A	0.301	N/A	Temporary	Excavation/ Placement of Fill
W14-15 Wetland RR	27	Riparian	N/A	0.053	N/A	Temporary	Excavation/ Placement of Fill
W12 Wetland SS	27	Riparian	N/A	0.006	N/A	Temporary	Excavation/ Placement of Fill
W35-37 Wetland TT	27	Riparian	N/A	0.084	N/A	Temporary	Excavation/ Placement of Fill
W70 Wetland UU	27	Riparian	N/A	0.143	N/A	Temporary	Excavation/ Placement of Fill
W71 Wetland VV	27	Riparian	N/A	0.037	N/A	Temporary	Excavation/ Placement of Fill
W72b Wetland XX	27	Riparian	N/A	0.052	N/A	Temporary	Excavation/ Placement of Fill
W73 Wetland YY	27	Riparian	N/A	0.010	N/A	Temporary	Excavation/ Placement of Fill
W74 Wetland ZZ	27	Riparian	N/A	0.027	N/A	Temporary	Excavation/ Placement of Fill
W76 Wetland DDD	27	Riparian	N/A	0.029	N/A	Temporary	Excavation/ Placement of Fill

W77 Wetland EEE	27	Riparian	N/A	0.012	N/A	Temporary	Excavation/ Placement of Fill
W78 Wetland OOO	27	Riparian	N/A	0.014	N/A	Temporary	Excavation/ Placement of Fill
W79 Wetland PPP	27	Riparian	N/A	0.006	N/A	Temporary	Excavation/ Placement of Fill
W68 Wetland A	27	Riparian	N/A	0.029	N/A	Temporary	Excavation/ Placement of Fill
W69 Wetland B	27	Riparian	N/A	0.038	N/A	Temporary	Excavation/ Placement of Fill
W61 Wetland D	27	Riparian	N/A	0.004	N/A	Temporary	Excavation/ Placement of Fill
W58-59 Wetland F	27	Riparian	N/A	0.021	N/A	Temporary	Excavation/ Placement of Fill
W64 Wetland G	27	Riparian	N/A	0.011	N/A	Temporary	Excavation/ Placement of Fill
W66 Wetland H	27	Riparian	N/A	0.021	N/A	Temporary	Excavation/ Placement of Fill
W67 Wetland I	27	Riparian	N/A	0.015	N/A	Temporary	Excavation/ Placement of Fill
W65 Wetland J	27	Riparian	N/A	0.028	N/A	Temporary	Excavation/ Placement of Fill
W55-57 Wetland K	27	Riparian	N/A	0.063	N/A	Temporary	Excavation/ Placement of Fill
W53-54 Wetland L	27	Riparian	N/A	0.028	N/A	Temporary	Excavation/ Placement of Fill
W51-52 Wetland M	27	Riparian	N/A	0.024	N/A	Temporary	Excavation/ Placement of Fill
W44 Wetland N	27	Riparian	N/A	0.008	N/A	Temporary	Excavation/ Placement of Fill
W47-48 Wetland O	27	Riparian	N/A	0.004	N/A	Temporary	Excavation/ Placement of Fill
W42-43 Wetland P	27	Riparian	N/A	0.015	N/A	Temporary	Excavation/ Placement of Fill
W45-46 Wetland Z	27	Riparian	N/A	0.025	N/A	Temporary	Excavation/ Placement of Fill
W72a Wetland WW	27	Riparian	N/A	0.026	N/A	Temporary	Excavation/ Placement of Fill
W49-50 Wetland X	27	Riparian	N/A	0.071	N/A	Temporary	Excavation/ Placement of Fill
W33-34 Wetland W	27	Riparian	N/A	0.112	N/A	Temporary	Excavation/ Placement of Fill
W38 Wetland U	27	Riparian	N/A	0.003	N/A	Temporary	Excavation/ Placement of Fill
W41 Wetland R	27	Riparian	N/A	0.010	N/A	Temporary	Excavation/ Placement of Fill
W40 Wetland S	27	Riparian	N/A	0.048	N/A	Temporary	Excavation/ Placement of Fill

W39 Wetland T	27	Riparian	N/A	0.012	N/A	Temporary	Excavation/ Placement of Fill
S2-S3, S5, S7 T6	27	Perennial	913	N/A	N/A	Temporary	Excavation
S8, S10 T6	27	Perennial	952	N/A	N/A	Temporary	Fill
S4 T6B	27	Perennial	136	N/A	N/A	Temporary	Excavation
S9 T6A	27	Intermittent	128	N/A	N/A	Temporary	Excavation
S11 BC R1	27	Perennial	473	N/A	N/A	Temporary	Excavation
S12-S14 T8	27	Perennial	621	N/A	N/A	Temporary	Fill
S15 BC R2/R3	27	Perennial	393	N/A	N/A	Temporary	Fill
S16 T9	27	Perennial	25	N/A	N/A	Temporary	Excavation
S17,S19-S21 BC R4/R5	27	Perennial	3534	N/A	N/A	Temporary	Fill/Excavation
S18 T5	27	Perennial	590	N/A	N/A	Temporary	Fill
S22-S23 T1 R1/R2	27	Perennial	906	N/A	N/A	Temporary	Fill/Excavation
S24-S26 BC R7	27	Perennial	856	N/A	N/A	Temporary	Excavation
S27 BC R8	27	Perennial	126	N/A	N/A	Temporary	Fill
S28-S29 T7A	27	Intermittent	498	N/A	N/A	Temporary	Fill/Excavation
S30-S31 T7	27	Perennial	389	N/A	N/A	Temporary	Fill/Excavation
S32 T2	27	Perennial	356	N/A	N/A	Temporary	Fill
S33-S35 T4	27	Perennial	1499	N/A	N/A	Temporary	Fill
S36- S37,S38,S38a T4A	27	Intermittent	399	N/A	N/A	Temporary	Fill/Excavation
S39 T4B	27	Perennial	123	N/A	N/A	Temporary	Excavation
S40-S41,S43- S44 T3	27	Perennial	1218	N/A	N/A	Temporary	Fill/Excavation
O1 Pond 2	27	Open Water	N/A	N/A	0.396	Temporary	Fill/Excavation
O2 Pond 1	27	Open Water	N/A	N/A	0.778	Temporary	Fill/Excavation

O3 Pond 3	27	Open Water	N/A	N/A	0.18	Temporary	Fill/Excavation
W7 Wetland GG	33	Riparian	N/A	0.004	N/A	Temporary	Construction Access
W10 Wetland FF	33	Riparian	N/A	0.063	N/A	Temporary	Construction Access
W13 Wetland RR	33	Riparian	N/A	0.01	N/A	Temporary	Construction Access
W24 Wetland PP	33	Riparian	N/A	0.030	N/A	Temporary	Construction Access
		TOTALS*	**14,135 LF**	**2.333 AC**	**1.354 AC**		

*****Impacts are associated with stream and wetland restoration and enhancement activities and are expected to result in a net increase in waters of the US.

SPECIAL CONDITIONS

1. **The permittee understands and agrees that the document entitled "Final Mitigation Plan – Buckwater Mitigation Site" dated January 2018, and additional information submitted March 15, 2018 associated with wetland hydrologic monitoring, is incorporated and made part of this permit. Execution of the work and terms given in the approved mitigation plan and additional information listed above are a condition of this permit.**

2. **This Nationwide Permit verification does not imply approval of the suitability of this property for compensatory mitigation for any particular project. The use of any portion of this site as compensatory mitigation for a particular project will be determined during the permit review process for that project.**

COMPLIANCE CERTIFICATION

Action ID Number: **SAW-2016-00873** **County: Orange**

Permittee: **NC Division of Mitigation Services**
Attention: Mr. Tim Baumgartner

Project Name: **NCDMS Buckwater Mitigation Site**

Date Verification Issued: **March 15, 2018**

Project Manager: **Andrea W. Hughes**

Upon completion of the activity authorized by this permit and any mitigation required by the permit, sign this certification and return it to the following address:

US ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT
Mitigation Office, Regulatory Division
Attn: Andrea Hughes
3331 Heritage Trade Drive, Suite 105
Wake Forest, North Carolina 27857

Please note that your permitted activity is subject to a compliance inspection by a U. S. Army Corps of Engineers representative. Failure to comply with any terms or conditions of this authorization may result in the Corps suspending, modifying or revoking the authorization and/or issuing a Class I administrative penalty, or initiating other appropriate legal action.

I hereby certify that the work authorized by the above referenced permit has been completed in accordance with the terms and condition of the said permit, and required mitigation was completed in accordance with the permit conditions.

_____ _____

Signature of Permittee **Date**