BASELINE MONITORING DOCUMENT AND AS-BUILT BASELINE REPORT

Final

CROOKED CREEK #2 RESTORATION PROJECT

Union County, NC
NCDEQ Contract D09126S
DMS Project Number 94687

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EXECUTIVE SUMMARY

Wildlands Engineering (Wildlands) completed a design bid build project at the Crooked Creek #2 Mitigation Site (Site) for the North Carolina Division of Mitigation Services (DMS) to restore and enhance 6,147 linear feet (LF) of perennial streams, enhance 1.0 acre of existing wetlands, restore and create 11.6 acres of wetlands, and restore and enhance 70,936 square feet (SF) of riparian buffer in Union County, NC. The Site is expected to generate 3,489.6 stream mitigation units (SMUs), 8.6 wetland mitigation units (WMUs), and 1.3 buffer mitigation units (BMU) for the Goose Creek watershed (Table 1). The Site is located off NC Highway 218 in the northern portion of Union County, NC in the Yadkin Pee-Dee River Basin; eight-digit Cataloging Unit (CU) 03040105 and the 14-digit Hydrologic Unit Code (HUC) 03040105040010 (Figure 1). The project streams consist of two unnamed tributaries to Crooked Creek, UT1 and UT2, and two reaches of the Crooked Creek mainstem (Reach A and Reach B) (Figure 2). Crooked Creek flows into the Rocky River 4 miles northeast of the site near Love Mill Road at the Stanly County line. The adjacent land to the streams and wetlands is primarily maintained for agricultural and residential uses.

The Site is within a Targeted Local Watershed (TLW) in the Lower Yadkin Pee-Dee River Basin Restoration Priority Plan (RBRP) (NCEEP, 2009). The Site is also located within the Goose Creek and Crooked Creek Local Watershed Plan (LWP). The final watershed management plan (WMP) for Goose Creek and Crooked Creek was completed in July 2012 (NCEEP, 2012). The stressors to watershed function identified in the WMP were sediment pollution and increases in peak stream flows resulting in impairments to aquatic habitat and aquatic life. Stream enhancement and restoration is identified as the best management opportunity to offset these impacts. Other stressors identified included nonpoint source runoff, degraded terrestrial habitat, and disconnected floodplains. Wetland enhancement and restoration is identified as the best management opportunity to offset impacts related to these stressors. The wetland portion of the project was identified as a specific priority in the Project Atlas that accompanies the 2012 WMP.

The project goals established in the mitigation plan (Wildlands, 2013) were completed with careful consideration of goals and objectives that were described in the RBRP and to address stressors identified in the LWP. The following project goals established include:

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

The Site construction and as-built survey and construction was completed in 2015. Planting and baseline monitoring activities occurred in January through February 2016. Minimal 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. Cross section widths and pool depths occasionally exceed design parameters 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 success criteria.

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APPENDICES

Section 1: PROJECT GOALS, BACKGROUND AND ATTRIBUTES

1.1 Project Location and Setting

The Site is located off NC Highway 218 in the northern portion of Union County, NC (Figure 1). The Site was originally located within three tracts of land. One tract of land is owned by Reuben and Lorna Price (PIN 08153002J) and the other two tracts are owned by Logan and Mildred Tucker, (PIN 08153002H, 08153009C). A conservation easement has been recorded on a 54.9-acre parcel purchased in 2011 by the State of North Carolina (PIN 08153002L) comprised of portions of the original three tracts. (Deed Book 5665, Page 823).

The Site is located in the Yadkin Pee-Dee River Basin; eight-digit Cataloging Unit (CU) 03040105 and the 14-digit Hydrologic Unit Code (HUC) 03040105040010 (Figure 1). Located in the Carolina Slate Belt of the Piedmont Physiographic Province (USGS, 1998), the project watershed includes primarily agricultural forested, and developed land. The drainage area for the project site is 24,619 acres. From US-74 East, take 27 East/Albemarle Road. Travel on Albemarle Road approximately 8 miles to Interstate 485. Take Interstate 485 South (Inner Loop) for approximately 3 miles to exit 44 for NC Highway 218 toward Mint Hill. Turn left off ramp on to NC218 and follow for approximately 7 miles. The project site is located approximately 0.85 miles after US 601/Concord Highway on the right hand side of the road.

The North Carolina Division of Water Resources (NCDWR) assigns best usage classifications to State Waters that reflect water quality conditions and potential resource usage. Crooked Creek (NCDWR Index No. 13-17-20) is the main tributary of the project and is at least a fourth order stream. UT1 and UT2 are first order streams that flow into Crooked Creek. Crooked Creek has been classified as Class C waters. Class C waters are protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture, and other uses. Crooked Creek and its UTs are located within Yadkin Pee-Dee River Subbasin (NCDWR Subbasin 03-07-12).

The site is located within a Targeted Local Watershed (TLW) in the Lower Yadkin Pee-Dee River Basin Restoration Priority Plan (RBRP) (NCEEP, 2009). The Site is also located within the Goose Creek and Crooked Creek Local Watershed Plan (LWP). The final watershed management plan (WMP) for Goose Creek and Crooked Creek was completed in July 2012 (NCEEP, 2012). The stressors to watershed function identified in the WMP were sediment pollution and increases in peak stream flows resulting in impairments to aquatic habitat and aquatic life. Stream enhancement and restoration is identified as the best management opportunity to offset these impacts. Other stressors identified included nonpoint source runoff, degraded terrestrial habitat, and disconnected floodplains. Wetland enhancement and restoration is identified as the best management opportunity to offset impacts related to these stressors. The wetland portion of the project was identified as a specific priority in the Project Atlas that accompanies the 2012 WMP.

Prior to construction activities, the streams on the Site had been channelized to provide drainage for surrounding pasture. The adjacent floodplain wetland areas had been cleared and ditched. Land use activities resulted in bank instability due to erosion and livestock access, lack of riparian buffer, and altered hydrology. Incision, lateral erosion, and widening resulted in degraded aquatic and benthic habitat, reduction in quality and acreage of riparian wetlands, and lowered dissolved oxygen levels in the stream. Table 4 in Appendix 1 and Table 6 in Appendix 2 present the pre-restoration conditions in more detail.

1.2 Project Goals and Objectives

This mitigation site is intended to provide numerous ecological benefits within the Yadkin Pee-Dee Basin. While many of these benefits are limited to the Crooked Creek project area, others, such as pollutant removal, reduced sediment loading, and improved aquatic and terrestrial habitat, have farther-reaching effects. Expected improvements to water quality and ecological processes are outlined below as project goals and objectives. These project goals established were completed with careful consideration of goals and objectives that were described in the RBRP and to address stressors identified in the LWP while also meeting the DMS mitigation needs.

The project specific goals of the Crooked Creek #2 Stream and Wetland Mitigation Site included the following:

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

The project objectives have been defined as follows:

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

1.3 Project Structure, Restoration Type and Approach

The final mitigation plan was submitted and accepted by the DMS in August of 2013. Construction activities were completed in April 2015 by North State Environmental, Inc. Allied Surveying completed the as-built survey in 2015 and Wildlands engineering completed the baseline monitoring activities in February 2016. Planting was completed by Keller Environmental, Inc. in February 2016. Minimal adjustments were made during construction and field adjustments made during construction are described in further detail in section 5.1. Please refer to Appendix 1 for detailed project activity, history, contact information, and watershed/site background information.

1.3.1 Project Structure

The project is expected to provide 3489.6 SMUs, 8.6 WMUs, and 1.3 BMUs. These project components and mitigation credits reflect assets developed in the final IRT-approved project mitigation plan and

subsequently permitted. Please refer to Figure 2 for the project component/asset map for the stream and wetland feature exhibits and Table 1 for the project component and mitigation credit 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 thorough consideration to existing watershed conditions and trajectory. The project includes stream restoration and enhancement as well as wetland enhancement, restoration and creation, and buffer restoration and enhancement. The specific proposed stream and wetland buffer types are described below.

The stream restoration portion of this project includes one reach on one stream; UT1. This restoration reach enters the Site from a farm field north of the site and extends to the confluence Crooked Creek. The stream restoration design was developed based on reference conditions, representing streams within the Southern Piedmont Belt region with similar drainage areas, valley slopes, morphology, and bed material. The restoration reaches were designed as threshold channels. This design approach was determined to be appropriate due to the low bedload supply and the desire to establish an immobile channel boundary. The channels were not intended to be fully alluvial and are not expected to migrate laterally over time. Various types of constructed riffles were installed to provide grade control and address excess shear stress.

The stream enhancement portion of this project includes three reaches, on two streams; Crooked Creek Reach A and B and UT2. Enhancement II consisted of cattle exclusion, extensive invasive species removal, and planting riparian vegetation to encourage bank stabilization. Along UT2, stream banks were also graded, stabilized, and vegetated to prevent further erosion.

The wetland enhancement portion of this projects includes two jurisdictional features (noted Wetland AA and Wetland CC in the mitigation plan) within Zone A and Zone B. The wetland restoration portion of this project includes an area of drained hydric soils within Zone A. The wetland creation portion of this project includes poorly drained soils within Zone B.

Buffer restoration and enhancement was also implemented near the confluence of UT1 with Crooked Creek. These areas were planted with native hardwood tree species and will follow a fertilization plan that meets or exceeds the Site Specific Water Quality Management Plan for the Goose Creek Watershed (SSWQMP, 2009).

In addition to the above credited site work, an overflow channel that is fed by Crooked Creek upstream of the project limits was re-routed to flow back into Crooked Creek. Originally, this overflow channel connected to UT1 before flowing back into Crooked Creek. The overflow connector cross section was designed based on the dimensions of the surveyed cross sections collected on UT1 downstream of the confluence. No credit was sought for this work.

1.4 Project History, Contacts and Attribute Data

The Site was restored by Wildlands through a design-bid-build 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 Baseline Information and Attributes.

Section 2: PERFORMANCE STANDARDS

The stream and wetland performance criteria for the Site follow approved performance criteria presented in the Crooked Creek #2 Mitigation Plan (August 2013). Annual monitoring and semi-annual site visits will be conducted to assess the condition of the finished project. The stream restoration/enhancement reaches (Crooked Creek Reach 1, Crooked Creek Reach 2, UT1, and UT2) of the project were assigned specific performance criteria components for stream morphology, hydrology, and vegetation. Wetland enhancement, restoration and creation areas were assigned specific performance criteria for wetland hydrology, and vegetation. Performance criteria will be evaluated throughout the seven-year post-construction monitoring. If all performance criteria have been successfully met and two bankfull events have occurred during separate years, Wildlands may propose to DMS to terminate stream and/or vegetation monitoring after year five pending little to no prevalent invasive species issues. An outline of the performance criteria components follows.

2.1 Stream

2.1.1 Dimension

Shallow cross-sections on the restoration reaches should be stable and should show little change in bankfull area, maximum depth ratio, and width-to-depth ratio. Per DMS 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. Shallow cross-sections should fall within the parameters defined for channels of the appropriate Rosgen stream type. If any changes do occur, these changes will be evaluated to assess whether the stream channel is showing signs of instability. Indicators of instability include trends in vertical incision or bank erosion. 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

Annual longitudinal profile surveys will not be conducted during the seven-year monitoring period unless other indicators during the annual monitoring indicate a trend toward vertical and lateral instability. Visual indicators for the stream restoration reaches should show that the bedform features are remaining stable. Substrate

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

2.1.3 Photo Documentation

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

2.1.4 Bankfull Documentation

Two bankfull flow events must be documented on the restoration reaches within the seven-year monitoring period. The two bankfull events must occur in separate years. Stream monitoring will continue until success criteria in the form of two bankfull events in separate years have been

documented. Bankfull events will be documented using crest gages, photographs, and visual assessments such as debris lines.

2.2 Vegetation

The final vegetative success criteria will be the survival of 210 planted stems per acre in the planted riparian and wetland corridor at the end of the required monitoring period (MY7). The interim measure of vegetative success for the Site will be the survival of at least 320 planted stems per acre at the end of the third monitoring year and at least 260 stems per acre at the end of the fifth year of monitoring. Planted vegetation must average 10 feet in height in each plot at the end of the seventh year of monitoring. If this performance standard is met by MY5 and stem density is trending towards success (i.e., vigor), monitoring of vegetation on the Site may be terminated provided written approval is provided by the USACE in consultation with the NC Interagency Review Team (IRT). The extent of invasive species coverage will also be monitored and controlled as necessary throughout the required monitoring period (year five or seven).

2.3 Wetlands

The target performance criteria for wetland hydrology will be a free groundwater surface within 12 inches of the ground surface for 16 consecutive days (7.5 percent) of the defined 227 day growing season for Union County (March 23 through November 4) under typical precipitation conditions. This success criterion was determined through model simulations of post restoration conditions and comparison to an immediately adjacent existing wetland system. If a particular groundwater monitoring gage does not meet the success criteria for a given monitoring year, rainfall patterns will be analyzed and the hydrograph will be compared to that of the reference well to assess whether atypical weather conditions occurred during the monitoring period.

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 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 Map of major project elements including such items as grade control structures, vegetation plots, permanent cross-sections, crest gages, and monitoring wells with current stream, vegetation, and wetland conditions;
- Photographs showing views of the restored Site taken from fixed point stations;
- Project asset stability and easement encroachment assessment based on the cross-section surveys and semi-annual visual assessments;
- Vegetative data as described above including the identification of any invasion by undesirable plant species;
- Groundwater gage attainment;
- A description of damage by animals or vandalism;
- Maintenance issues and recommended remediation measures will be detailed and documented; and
- Wildlife observations.

Section 3: MONITORING PLAN

Monitoring will consist of collecting morphological, vegetative, and hydrological data to assess the project success based on the restoration goals and objectives on an annual basis or until success criteria is met. The success of the project will be assessed using measurements of the stream channel's dimension, substrate composition, permanent photographs, vegetation, surface water hydrology, and groundwater hydrology. Any areas with identified high priority problems, such as streambank instability, aggradation/degradation, insufficient groundwater hydroperiod, 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. Refer to Table 5 in Appendix 1 for monitoring component summary.

3.1 Stream

Geomorphic assessments 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 documents (Rosgen, 1994 and 1996), and in the Stream Restoration: A Natural Channel Design Handbook (Doll et al., 2003). Please refer to Figure 3 in Appendix 1 for monitoring locations discussed below.

3.1.1 Dimension

In order to monitor the channel dimension, four permanent cross-sections were installed along the stream restoration reach. Two cross sections were installed per 1,000 linear feet along the stream restoration reaches, with riffle and pool sections in proportion to DMS guidance. Each cross-section is permanently marked with rebar installed in concrete and 1/2 inch PVC pipes. Cross-section surveys include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg. If moderate bank erosion is observed at a stream reach during the monitoring period, an array of bank pins will be installed in representative areas where erosion is occurring for reaches with a bankfull width of greater than three feet. Annual cross section survey (if applicable) will be conducted for seven years following construction. 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 indicate 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 was conducted for classification purposes on the restoration reach (UT1). Pebble counts will also be conducted at permanent riffle cross-sections. The pebble counts will be conducted annually for seven years following construction and compared with data from previous years.

3.1.4 Photo Reference Points

A total of 34 permanent photographic reference points were established within the project stream and wetland areas after construction. Photographs will be taken once a year to visually document stability for seven years following construction. Permanent markers were established so that the same locations

and view directions on the site are monitored each year. Photographs will be used to monitor restoration and enhancement of stream and wetland areas as well as vegetation plots. The photographer will make every effort to maintain the same area in each photo over time. Reference photos will also be taken for each of the vegetation plots and cross-sections, and will be repeated annually. The representative digital photo(s) shall be taken when the annual stream and vegetation surveys are conducted.

3.1.5 Hydrology Documentation

Bankfull events will be documented using crest gages, photographs, and visual assessments such as debris lines. Three hydrology monitoring stations with crest gages were installed; one on Crooked Creek Reach 1, one on UT1, and one on UT2. The gages were installed within surveyed riffle cross-sections. The gages will be checked at each site visit to determine if a bankfull event has occurred. Photographs will be used to document the occurrence of debris lines and sediment deposition.

3.1.6 Visual Assessment

Visual assessments will be performed in the field along all stream and wetland areas on a semi-annual basis during the seven-year monitoring period. Problem areas will be noted such as channel instability (i.e. lateral and/or vertical instability, in-stream structure failure/instability and/or piping, headcuts), vegetated health (i.e. low stem density, vegetation mortality, invasive species or encroachment), beaver activity, or livestock access. Areas of concern will be mapped, photographed, and described through 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 12 vegetation plots were established within the project easement area. All of the plots were established as standard 10 meter by 10 meter squares. Please refer to Figure 3 in Appendix 1 for the vegetation monitoring locations.

Vegetation plots were randomly established within the planted stream and wetland restoration areas to capture the heterogeneity of the designed vegetative communities. The vegetation plot corners have been marked and are recoverable either through field identification or with the use of a GPS unit. Reference photographs at the origin looking diagonally across the plot to the opposite corner were taken during the baseline monitoring in February 2016. Subsequent annual assessments following 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 diameter, height, density, vigor, damage (if any), and percent 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.

3.3 Wetlands

In order to monitor the wetland areas, 10 groundwater monitoring gages were established within the Site using logging hydrology pressure transducers. Generally, the gages were installed at appropriate locations so that the data collected will provide an indication of groundwater levels throughout the wetland project area. All gages were set to record the ground water level two times per day. An onsite rain gage will record daily rainfall and will be utilized to assess whether typical weather conditions

occurred during the monitoring period. If a particular gage does not meet the performance standard for a given monitoring year, rainfall patterns will be analyzed and the hydrograph will be compared to that of the reference wetlands to assess whether atypical weather conditions occurred during the monitoring period. Permanent photograph reference points were established at 3 locations to visually document wetland Zone A and Zone B. Permanent markers were established so that the same locations and view directions on the Site are photographed each year. Please refer to Figure 3 in Appendix 1 for the hydrological monitoring and photo station locations.

Section 4: AS-BUILT CONDITION (BASELINE)

The Site construction and as-built surveys were completed in 2015. The survey included developing an as-built topographic surface, locating the channel boundaries, and structures. For comparison purposes, during the baseline assessments, reaches were divided into assessment reaches in the same way that they were established for design parameters: Crooked Creek Reach A, Crooked Creek Reach B, UT1, and UT2.

4.1 Record Drawings

A sealed half-size record drawing is located in Appendix 5 that includes redlines for any significant field adjustments made during construction that were different from the design plans. Minor stream adjustments made during construction were associated with, instream habitat improvement, necessary avoidance of existing vegetation and erosion prevention measures. Specific changes are detailed below:

4.1.1 Crooked Creek Reach 1

- UT1 Overflow connector alignment shifted 15 ft to the west to avoid 5 ft diameter hardwood tree missed during prior survey;
- Additional Invasive plant removal over all non-planted areas. (Change order #2).

4.1.2 Crooked Creek Reach 2

- Additional Invasive plant removal over all non-planted areas. (Change order #2).

4.1.3 UT1

- Station 100+25 – 101+25 (approx.): added a 85 LF barbed wire fence to replace 80 LF chain link fence removed during the construction of UT1;
- Station 116+15 – 117+00 (approx.): installed additional coir matting to floodplain;
- Additional Invasive plant removal over all non-planted areas. (Change order #2).

4.1.4 UT2

- Station 303+45: installed boulder step pool at outlet of the Wetland CC confluence with UT2 (Change Order #1);
- Additional Invasive plant removal over all non-planted areas. (Change order #2).

4.2 Baseline Data Assessment

Baseline monitoring (MY0) was conducted in January and February 2016 with the vegetation data collection occurring in February 2016 immediately following planting. The first annual monitoring assessment (MY1) will be completed in the fall of 2016. The streams and wetlands will be monitored for a total of seven years, with the final monitoring activities to be conducted in 2023. The close-out for the Site will be conducted in 2024 given the success criteria is met. As part of the closeout process, DMS will evaluate the Site at the end of the fifth year monitoring period to determine whether or not the site is eligible to closeout following MY5. If the Site is meeting success criteria, DMS will propose to the IRT to proceed with the closeout process.

4.2.1 Morphological State of the Channel

Morphological data for the as-built profile was collected in January-February 2016. Please refer to Appendix 2 for summary data tables, morphological plots, and stream photographs.

Profile

The baseline (MY0) profiles closely match the profile design parameters. On the design profiles, riffles were depicted as straight lines with consistent slopes. However, at some locations the riffle profiles within the as-built survey are not consistent in slope due to the installation of structures and woody debris within the streambed. The water surface slope was used to calculate all riffle slopes. Maximum riffle slopes exceed design parameters within a short section of UT1 to bring the bed elevation down in the approach to the Crooked Creek confluence. Additionally, maximum pool depths typically exceed design parameters and are expected to trend towards the design depths as a result of natural deposition over time. These variations in riffle slope and pool depths do not constitute a problem or indicate a need for remedial actions and will be assessed visually during the CCPV site walks.

Dimension

The baseline (MY0) dimension numbers closely match the design parameters within acceptable ranges of variation. These are reflected in the cross sections as a larger maximum pool depth. We anticipate that over time pools may accumulate with fine sediment and organic matter. This accumulation of sediment within pools would not be seen as an indicator of instability.

Pattern

The baseline (MY0) pattern metrics fell within acceptable ranges of the design parameters for all three reaches. Pattern data will be evaluated in MY5 if there are any indicators through the profile or dimension assessments that significant geomorphic adjustments have occurred.

Bankfull Events

Bankfull events recorded following completion of constructions will be reported in the Year 1 monitoring report.

4.2.2 Vegetation

The baseline (MY0) average planted density is 526 stems per acre, which exceeds the interim measure of vegetative success of at least 320 planted stems per acre at the end of the third monitoring year. Volunteer stems were noted in several of the plots, but are not included in the calculated average planted density. The average stem density with volunteers included (total stem density) is 772 stems per acre. Summary data and photographs of each plot can be found in Appendix 3.

4.2.3 Wetlands

Wetland photos collected at the permanent photo points during the baseline (MY0) data collection efforts can be found in Appendix 5. Groundwater gage data will be reported in the annual monitoring reports.

Section 5: REFERENCES

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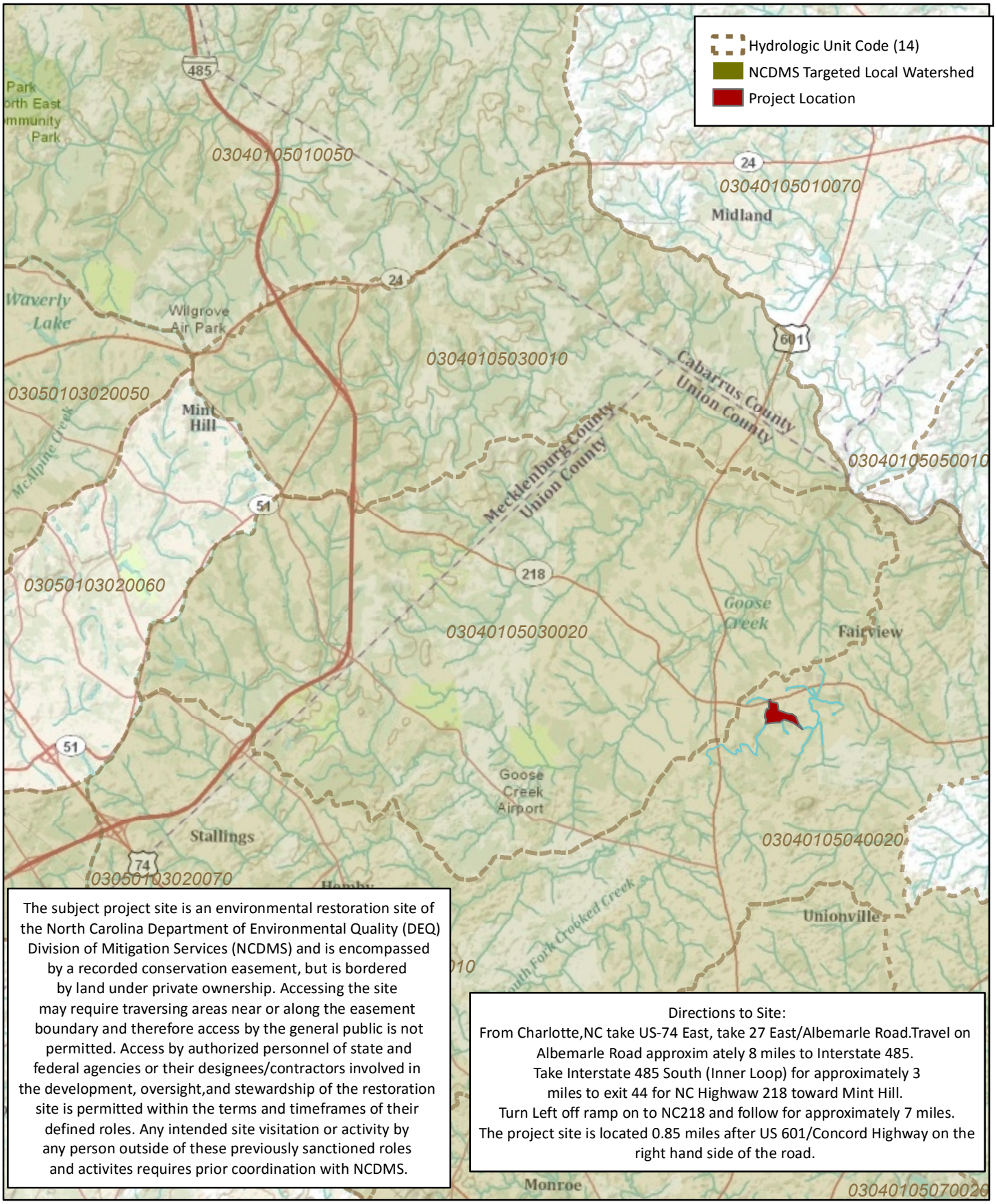
APPENDIX 1. General Tables and Figures



The subject project site is an environmental restoration site of the North Carolina Department of Environmental Quality (DEQ) Division of Mitigation Services (NCDMS) 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 NCDMS.

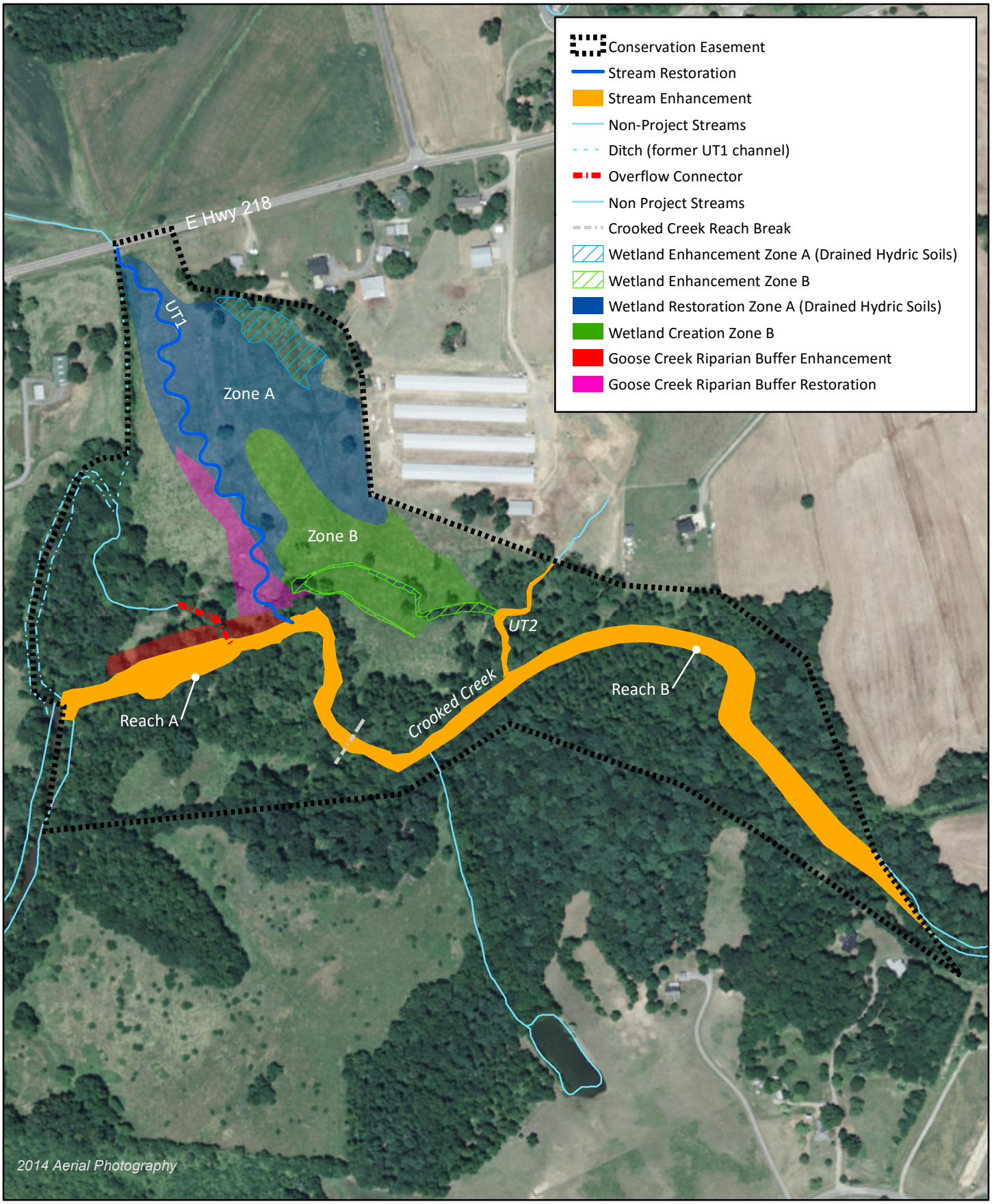
Directions to Site:
From Charlotte,NC take US-74 East, take 27 East/Albemarle Road.Travel on Albemarle Road approxim ately 8 miles to Interstate 485.
Take Interstate 485 South (Inner Loop) for approximately 3 miles to exit 44 for NC Highwaw 218 toward Mint Hill.
Turn Left off ramp on to NC218 and follow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

WILDLANDS ENGINEERING

0 0.5 1 Mile

N

Figure 1. Project Vicinity Map
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 0 - 2016
Union County, NC



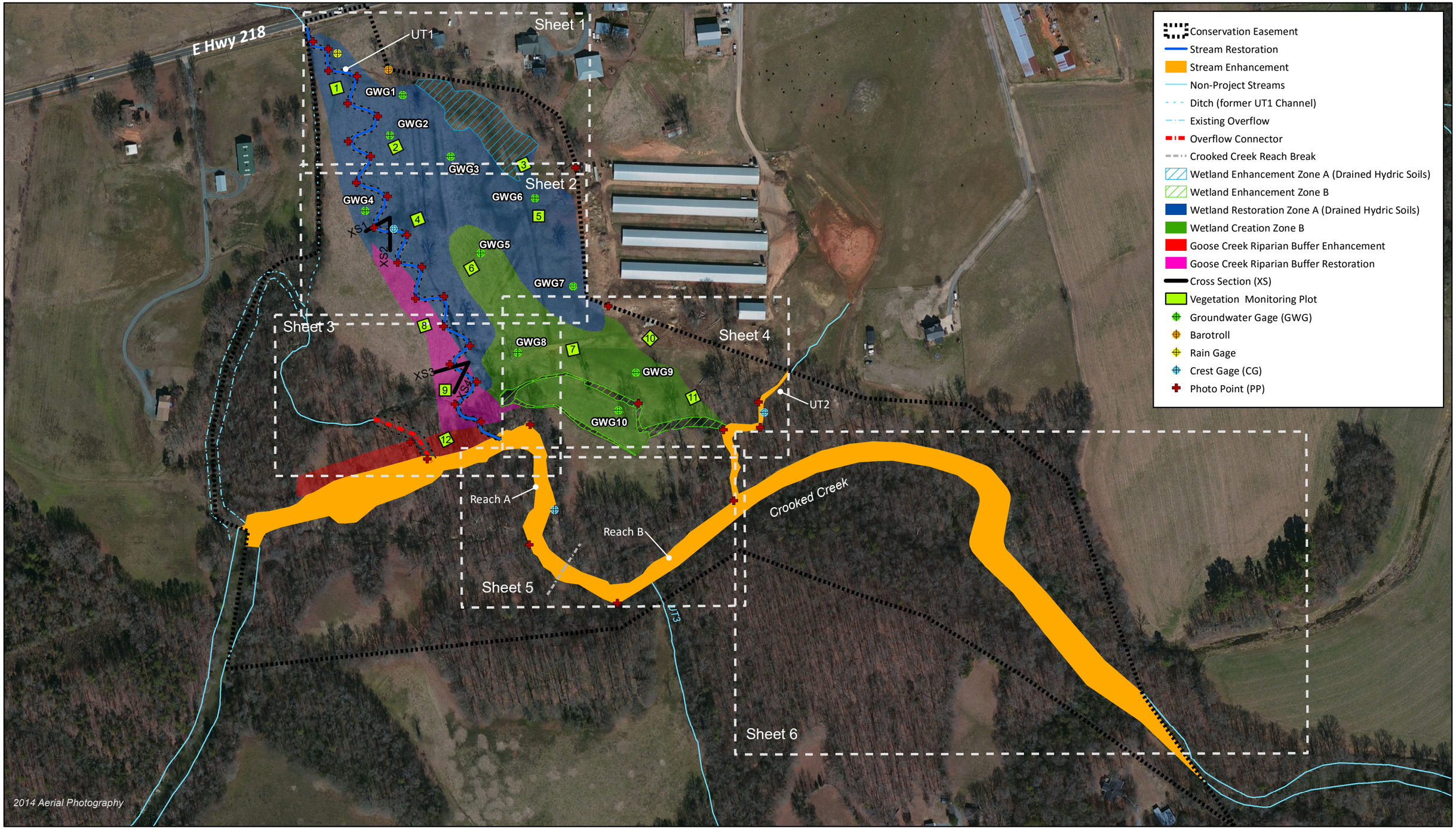
WILDLANDS ENGINEERING

0 200 400 Feet

N

Figure 2. Project Component/Asset Map
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 0 - 2016

Union County, NC



WILDLANDS ENGINEERING

0 125 250 500 Feet

N

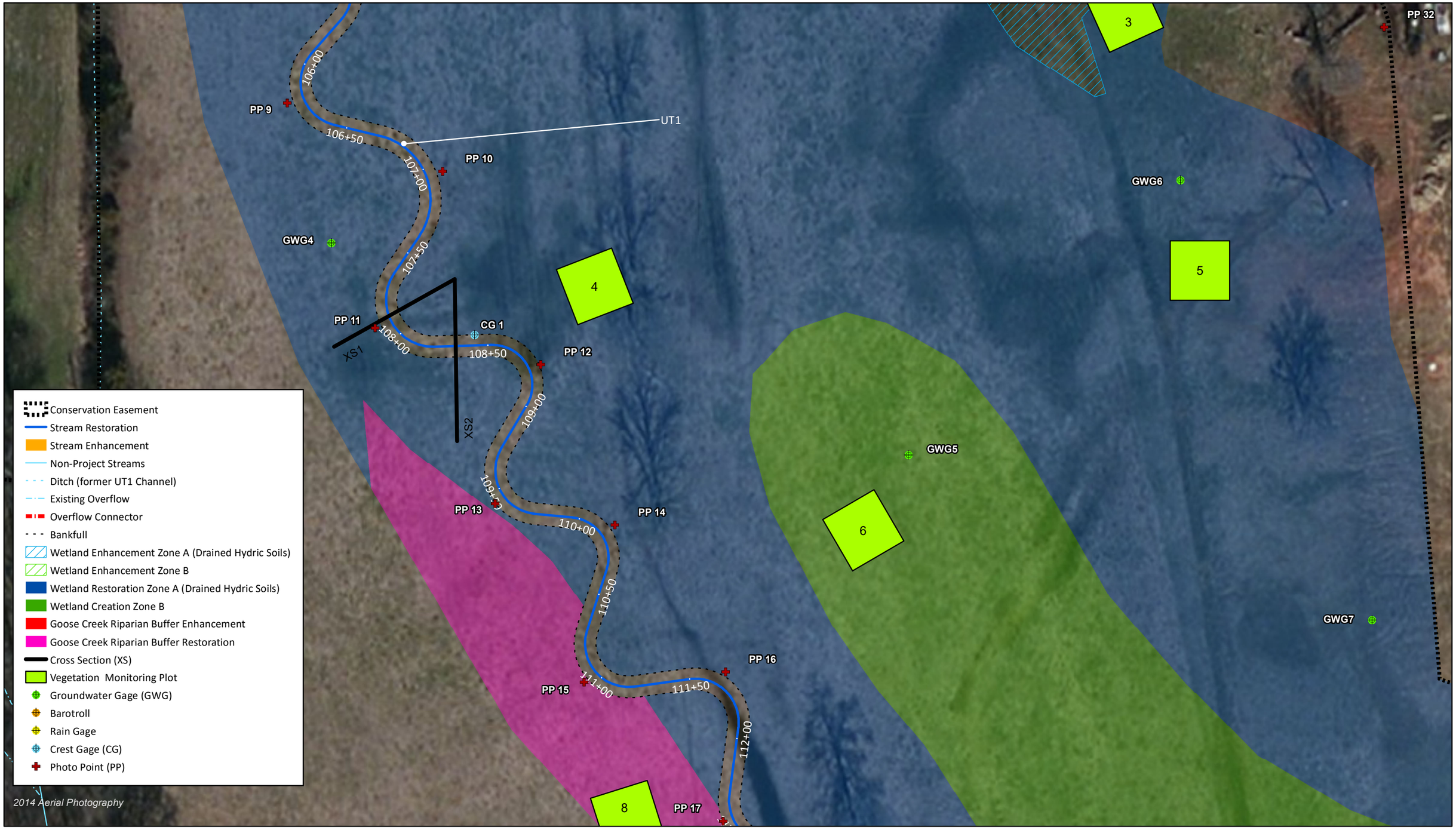
Figure 3.0 Monitoring Plan View (Key)
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 0 - 2016
Union County, NC

WILDLANDS ENGINEERING

0 25 50 100 Feet

N

Figure 3.1 Monitoring Plan View (Sheet 1)
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 0 - 2016
Union County, NC

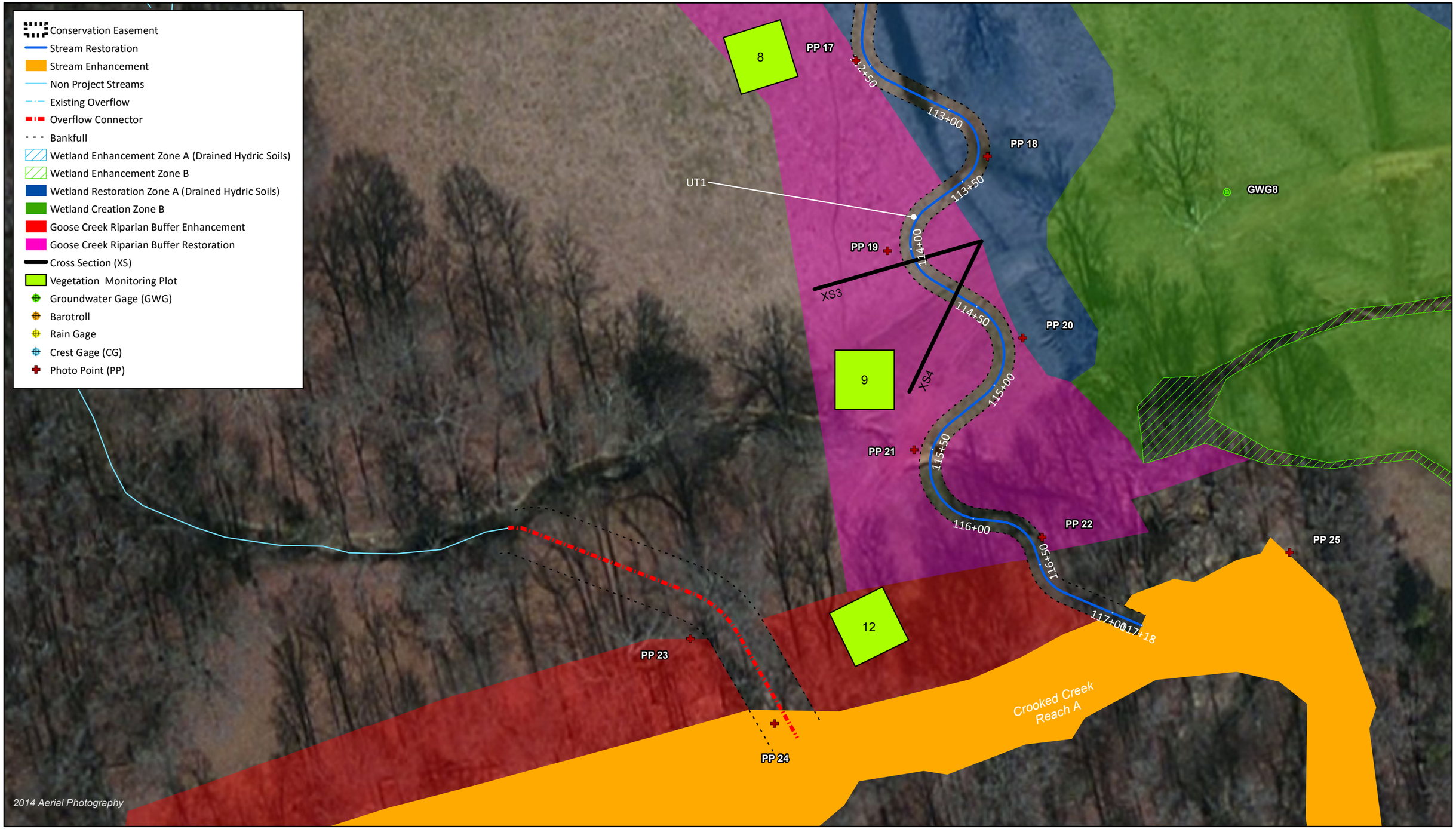


WILDLANDS ENGINEERING

0 25 50 100 Feet

N

Figure 3.2 Monitoring Plan View (Sheet 2)
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 0 - 2016
Union County, NC

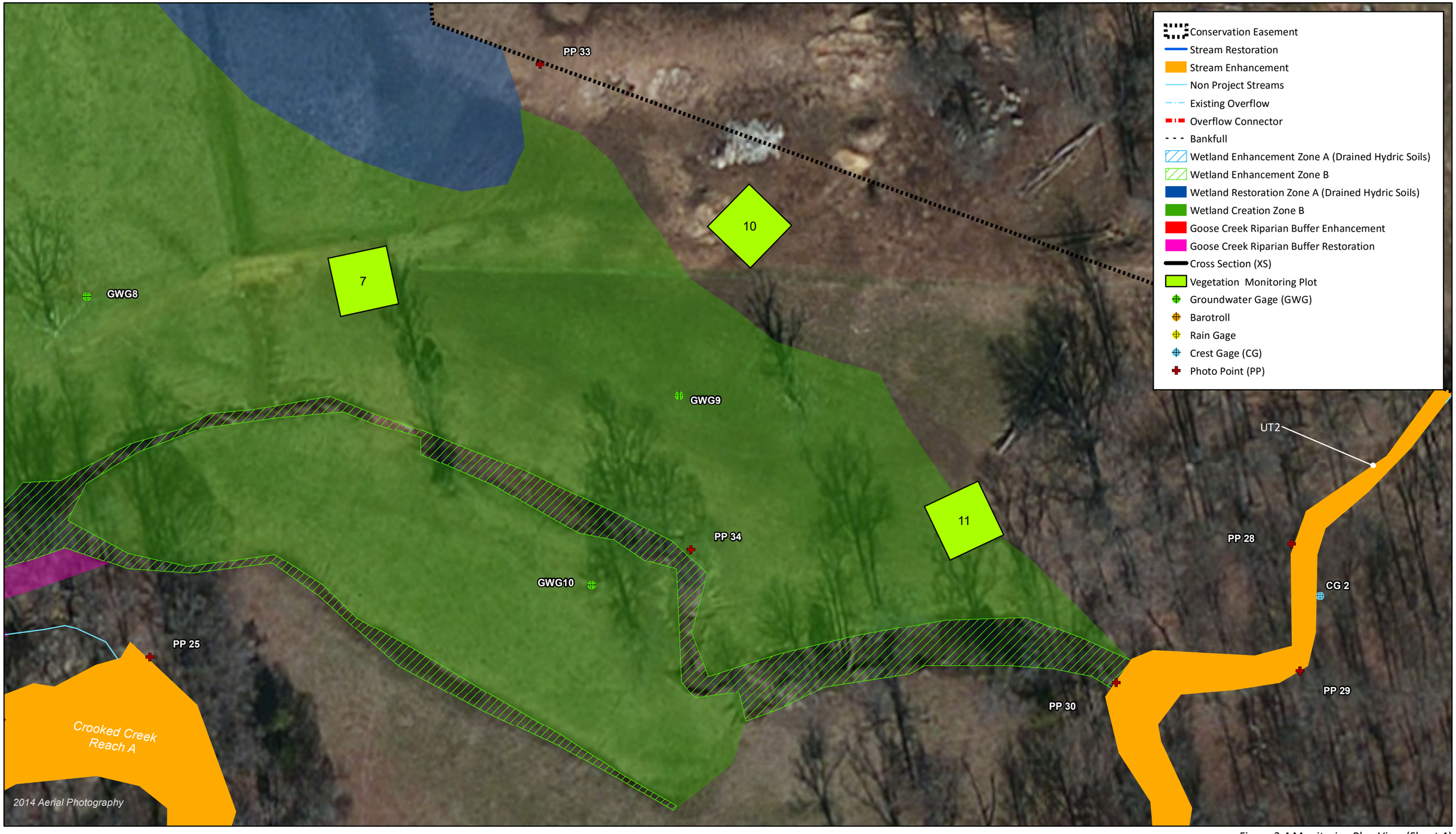


WILDLANDS ENGINEERING

0 25 50 100 Feet

N

Figure 3.3 Monitoring Plan View (Sheet 3)
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 0 - 2016
Union County, NC



WILDLANDS ENGINEERING

0 25 50 100 Feet

N

Figure 3.4 Monitoring Plan View (Sheet 4)
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 0 - 2016
Union County, NC

WILDLANDS ENGINEERING

0 25 50 100 Feet

N

Figure 3.5 Monitoring Plan View (Sheet 5)
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 0 - 2016
Union County, NC

WILDLANDS ENGINEERING

0 50 100 200 Feet

N

Figure 3.6 Monitoring Plan View (Sheet 6)
Crooked Creek #2 Restoration Project
DMS Project No. 94687
Monitoring Year 0 - 2016
Union County, NC

Table 1. Project Components and Mitigation Credits

Crooked Creek #2 Stream and Wetland Mitigation Site

DMS Project No. 94687

Monitoring Year 0 - 2016

MITIGATION CREDITS									
	Stream		Riparian Wetland		Non-Riparian Wetland		Buffer	Nitrogen Nutrient	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	3,489.6	N/A	8.0	0.6	N/A	N/A	1.3	N/A	

PROJECT COMPONENTS							
Reach ID	As-Built Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration or Restoration Equivalent	Restoration Footage/ Acreage	Mitigation Ratio	Credits (SMU/ WMU)
STREAMS							
Crooked Creek Reach A	200+00-228+29	1,555 LF	N/A	Enhancement II	1,555	2.5:1	622.0
Crooked Creek Reach B		2,404 LF	N/A	Enhancement II	2,404	2.5:1	961.6
UT1	100+00-117+18	1,762 LF	P1	Restoration	1,718	1:1	1,718.0
UT2	300+00-305+60	470 LF	N/A	Enhancement II	470	2.5:1	188.0
WETLANDS							
Zone A (Drained Hydric Soils)	N/A	0.7 AC		Enhancement	0.7	2:1	0.4
Zone A (Drained Hydric Soils)	N/A	N/A		Restoration	6.7	1:1	6.7
Zone B	N/A	0.3 AC		Enhancement	0.3	2:1	0.2
Zone B	N/A	N/A		Creation	3.9	3:1	1.3
BUFFER							
Goose Creek Buffer	N/A	0.6 AC		Enhancement	0.6	3:1	0.2
Goose Creek Buffer	N/A	N/A		Restoration	1.1	1:1	1.1

COMPONENT SUMMATION						
Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	1,718	6.7			45,735	
Enhancement		1.0			25,201	
Enhancement I						
Enhancement II	4,429					
Creation		3.9				

Table 2. Project Activity and Reporting History

Crooked Creek #2 Stream and Wetland Mitigation Site
DMS Project No. 94687
Monitoring Year 0 - 2016

Activity or Report	Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan	June 2011	August 2013
Final Design - Construction Plans	August 2011	April 2014
Construction	January 2015 - April 2015	January 2015 - April 2015
Temporary S&E mix applied to entire project area [1]	January 2015 - March 2015	January 2015 - March 2015
Permanent seed mix applied to reach/segments	January 2015 - March 2015	January 2015 - March 2015
Bare root and live stake plantings for reach/segments	January 2016	January 2016
Baseline Monitoring Document (Year 0)	January - February 2016	May 2016
Year 1 Monitoring	2016	November 2016
Year 2 Monitoring	2017	November 2017
Year 3 Monitoring	2018	November 2018
Year 4 Monitoring	2019	November 2019
Year 5 Monitoring	2020	November 2020
Year 6 Monitoring	2021	November 2021
Year 7 Monitoring	2022	November 2022

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

Table 3. Project Contact Table

Crooked Creek #2 Stream and Wetland Mitigation Site (NCDMS Project No. 94687)
Monitoring Year 0 - 2016

Designer Aaron Early, PE, CFM	**Wildlands Engineering, Inc.** 1430 South Mint Street, Suite 104 Charlotte, NC 28203 704.332.7754
Construction Contractor	**North State Environmental, Inc.** 2889 Lowery Street Winston Salem, NC 27101
Planting Contractor	**Keller Environmental** 7921 Haymarket Lane Raleigh, NC 27615
Seeding Contractor	**North State Environmental, Inc.** 2889 Lowery Street Winston Salem, NC 27101
Seed Mix Sources	**Green Resource, LLC**
Nursery Stock Suppliers **Bare Roots** **Live Stakes**	**Dykes & Son Nursery** 825 Maude Etter Rd. McMinnville, TN 37110
Monitoring Performers	**Wildlands Engineering, Inc.**
Monitoring, POC	Kirsten Gimbert 704.332.7754, ext. 110

Table 4. Project Information and Attributes
Crooked Creek #2 Stream and Wetland Mitigation Site
DMS Project No. 94687
Monitoring Year 0 - 2016

PROJECT INFORMATION	
Project Name	Crooked Creek #2 Restoration Project
County	Union County
Project Area (acres)	54.94
Project Coordinates (latitude and longitude)	34° 58' 54.78"N, 080° 31' 25.79"W

PROJECT WATERSHED SUMMARY INFORMATION	
Physiographic Province	Carolina Slate Belt of the Piedmont Physiographic Province
River Basin	Yadkin
USGS Hydrologic Unit 8-digit	03040105
USGS Hydrologic Unit 14-digit	03040105040010
DWR Sub-basin	03-07-12
Project Drainiage Area (acres)	24,619
Project Drainage Area Percentage of Impervious Area	28%
CGIA Land Use Classification	Agriculture 38%, Forested 29%, Developed 28%, Wetlands 3%, and Herbaceous Upland 2%

Parameters	Crooked Creek Reach A	Crooked Creek Reach B	UT1	UT2	
Length of reach (linear feet) - Post-Restoration	1,555	2,404	1,718	195	275
Drainage area (acres)	24,619		153	51	
NCDWR stream identification score	52		34.5	24.5	38
NCDWR Water Quality Classification	C				
Morphological Desription (stream type)	P	P	P	I	P
Evolutionary trend (Simon's Model) - Pre- Restoration	N/A	N/A	Stage III	Stage IV	
Underlying mapped soils	Chewacala silt loam 0-2% slopes (ChA)	Chewacala silt loam 0-2% slopes (ChA)	Chewacala silt loam 0-2% slopes (ChA)	Badin channery silt loam 8-15% slopes (BaC)	
Drainage class	Somewhat poorly drained	Somewhat poorly drained	Somewhat poorly drained	Well drained	
Soil hydric status	Type B (inclusions)	Type B (inclusions)	Type B (inclusions)	N/A	
Slope	0.0022		0.0047	0.0050	
FEMA classification	Zone AE	Zone AE	no regulated floodplain	no regulated floodplain	
Native vegetation community	Piedmont Bottomland forest				
Percent composition exotic invasive vegetation -Post-Restoration	5%	5%	60%	5%	

REGULATORY CONSIDERATIONS			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States - Section 404	X	X	USACE Nationwide Permit No.27 and DWQ 401 Water Quality Certification No. 3885. Action ID # 2011-02201
Waters of the United States - Section 401	X	X	
Division of Land Quality (Erosion and Sediment Control)	X	X	NPDES Construction Stormwater General Permit NCG010000
Endangered Species Act	X	X	Crooked Creek #2 Mitigation Plan; Wildlands determined "no effect" on Union County listed endangered species. June 21, 2011 email correspondence from USFWS indicating no listed species occur on site.
Historic Preservation Act	X	X	No historic resources were found to be impacted (letter from SHPO dated 6/23/2011).
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A
FEMA Floodplain Compliance	X	X	Crooked Creek is a mapped Zone AE floodplain with defined base flood elevations. Base flood elevations have been defined and the floodway has been delineated; (FEMA Zone AE, FIRM panel 5540).
Essential Fisheries Habitat	N/A	N/A	N/A

Table 5. Monitoring Component Summary
Crooked Creek #2 Stream and Wetland Mitigation Site
DMS Project No. 94687
Monitoring Year 0 - 2016

Parameter	Monitoring Feature	Quantity / Length by Reach					Frequency
		Crooked Creek Reach A	Crooked Creek Reach B	UT1	UT2	Wetlands	
Dimension	Riffle Cross-Section	N/A	N/A	2	N/A	N/A	Annual
	Pool Cross-Section	N/A	N/A	2	N/A	N/A	
Pattern	Pattern	N/A	N/A	N/A	N/A	N/A	N/A
Profile	Longitudinal Profile	N/A	N/A	N/A	N/A	N/A	Year 0
Substrate	Reach Wide / Riffle 100 Pebble Count	N/A	N/A	1 / 2	N/A	N/A	Annual
Hydrology	Crest Gage	1		1	1	N/A	Quarterly
Hydrology	Groundwater Gages	N/A	N/A	N/A	N/A	10	Quarterly
Vegetation	Vegetation Plots	12					Annual
Visual Assessment	All Streams	Y	Y	Y	Y	Y	Semi-Annual
Exotic and nuisance vegetation							Semi-Annual
Project Boundary							Semi-Annual
Reference Photos	Photo Points	34					Annual

APPENDIX 2. Morphological Summary Data and Plots

Table 6. Baseline Stream Data Summary
Crooked Creek #2 Stream and Wetland Mitigation Site
DMS Project No. 94687
Monitoring Year 0 - 2016

UT1

		PRE-RESTORATION CONDITION				REFERENCE REACH DATA				DESIGN		AS-BUILT/BASELINE	
Parameter	**Gage**	**UT1 Reach 1**		**UT1 Reach 2**		**UT to Lyle Creek**		**Spencer Creek 1**		**UT1**		**UT1**	
		Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Dimension and Substrate - Shallow													
Bankfull Width (ft)	N/A	17.7		10.9		7.0	8.6	8.7		12.0		11.7	12.6
Floodprone Width (ft)		500		539		45	49	229		44+		83+	89+
Bankfull Mean Depth		0.5		0.7		0.5		1.2		0.7		0.6	
Bankfull Max Depth		1.3		1.0		1.0	1.1	1.9		1.0		1.1	
Bankfull Cross-sectional Area (ft^2)		8.6		7.8		3.5	4.1	10.6		8.7		7.3	7.5
Width/Depth Ratio		36.4		15.3		14.9	18.3	7.3		16.6		18.9	21.1
Entrenchment Ratio		28.2		49.3		5.7	6.4	26.3		2.2+		2.2+	
Bank Height Ratio		1.4		2.9		0.6	0.9	1.0		1.0		1.0	
D50 (mm)		3.1		---								0.3	35.9
Riffle Length (ft)	N/A					---		---		---		12	50
Riffle Slope (ft/ft)		*		*		0.0055	0.0597	0.0100	0.0670	0.0045	0.0080	0.0004	0.0193
Pool Length (ft)						---		---		---		17.8	65.4
Pool Max Depth (ft)		0.76	1.27	0.76	1.27	1.3		2.5		1.5	2.1	1.1	3.0
Pool Spacing (ft)		20	74	20	74	15	28	13	47	42	84	36	99
Pool Volume (ft^3)													
Pattern													
Channel Beltwidth (ft)	N/A	---		115	543	21		24	52	30	72	30	72
Radius of Curvature (ft)		61.2	170.6	61.2	170.6	19	32	5	22	22	48	22	48
Rc:Bankfull Width (ft/ft)		3.5	9.6	3.5	9.6	2.7	3.7	0.6	2.5	1.8	4.0	1.8	4.0
Meander Length (ft)		---		163	400	39	44	54	196	72	132	102	135
Meander Width Ratio		---		10.5	49.7	2.4	3	2.8	6.0	2.5	6.0	2.5	6.0
Substrate, Bed and Transport Parameters													
Ri%/Ru%/P%/G%/S%	N/A												
SC%/Sa%/G%/C%/B%/Be%													
d16/d35/d50/d84/d95/d100		-/-/3.1/8.6/11.0/16.0		---		-/0.1/0.2/0.5/4.0/8.0		0.1/3.0/8.8/77/180/-				SC/SC/0.1/19/90/256	
Reach Shear Stress (Competency) lb/ft^2		---		---						0.012		0.11	0.12
Max part size (mm) mobilized at bankfull													
Stream Power (Capacity) W/m^2													
Additional Reach Parameters													
Drainage Area (SM)	N/A	0.24		N/A		0.25		0.50		0.24		0.24	
Watershed Impervious Cover Estimate (%)		<1%		<1%		---		---		<1%		<1%	
Rosgen Classification		N/A[1]		N/A[1]		C5/6		E4/C4		C4		C4	
Bankfull Velocity (fps)		3.5		4.1		4.7		---		3.4		2.2	
Bankfull Discharge (cfs)		30		N/A[2]		18		---		30		16	
Q-NFF regression (2-yr)		50		N/A[2]									
Q-USGS extrapolation (1.2-yr)		17	40	N/A[2]									
Q-Mannings		24		N/A[2]									
Valley Length (ft)		---		---		---		---		1,353		1,353	
Channel Thalweg Length (ft)		1,789				---		---		1,718		1,718	
Sinuosity		1.0		1.5		1.1		1.1		1.3		1.3	
Water Surface Slope (ft/ft)[2]		0.0071		0.0034		0.004		0.0132		0.0032		0.0034	
Bankfull Slope (ft/ft)		0.0066		0.0058		0.009		0.0139		0.0041		0.0036	

SC: Silt/Clay <0.062 mm diameter particles
(---): Data was not provided
N/A: Not Applicable
N/A[1]: The rosgen classification system is for natural streams. These channels have been heavily manipulated by man and therefore the Rosgen classification system is not applicabl
N/A[2]: Donstream of the confluence with overflow channel, hydraulic regime not appliec
*: Channel was dry during survey, slope was calculated using channel thalweg

Table 7. Morphology and Hydraulic Summary (Dimensional Parameters - Cross-Section)

Crooked Creek #2 Stream and Wetland Mitigation Site

DMS Project No. 94687

Monitoring Year 0 - 2016

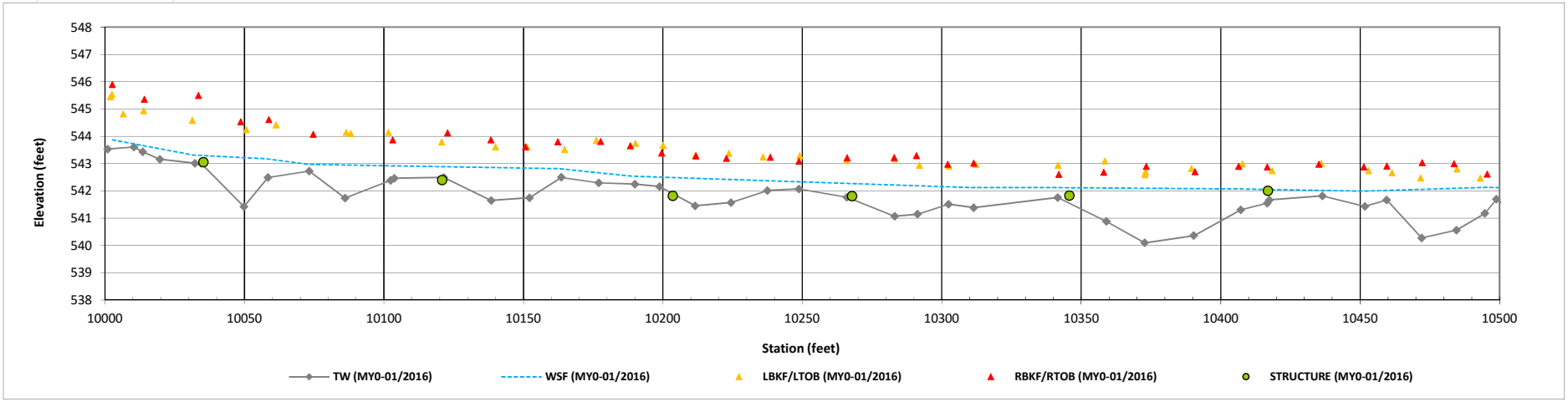
	Cross-Section 1, UT1 (Pool)						Cross-Section 2, UT1 (Riffle)						Cross-Section 3, UT1 (Pool)						Cross-Section 4, UT1 (Riffle)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
based on fixed bankfull elevation	541.8						542.1						539.7						539.8					
Bankfull Width (ft)	13.3						11.7						12.6						12.6					
Floodprone Width (ft)	---						200+						---						200+					
Bankfull Mean Depth (ft)	0.7						0.6						1.0						0.6					
Bankfull Max Depth (ft)	1.5						1.1						2.4						1.1					
Bankfull Cross-Sectional Area (ft^2)	8.7						7.3						12.6						7.5					
Bankfull Width/Depth Ratio	20.4						18.9						12.7						21.1					
Bankfull Entrenchment Ratio	---						2.2+						---						11.9					
Bankfull Bank Height Ratio	1.0						1.0						1.0						1.0					

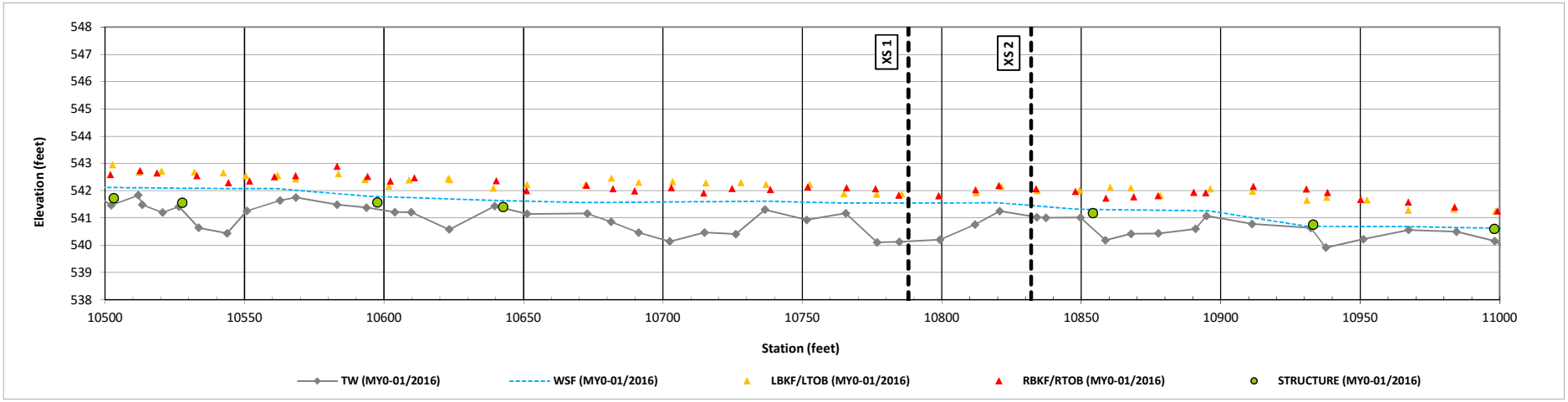
Longitudinal Profile Plots

Crooked Creek #2 Stream and Wetland Mitigatin Site (DMS Project No. 94687)

Monitoring Year 0 - 2016

UT1 (STA 100+00 - 117+18)



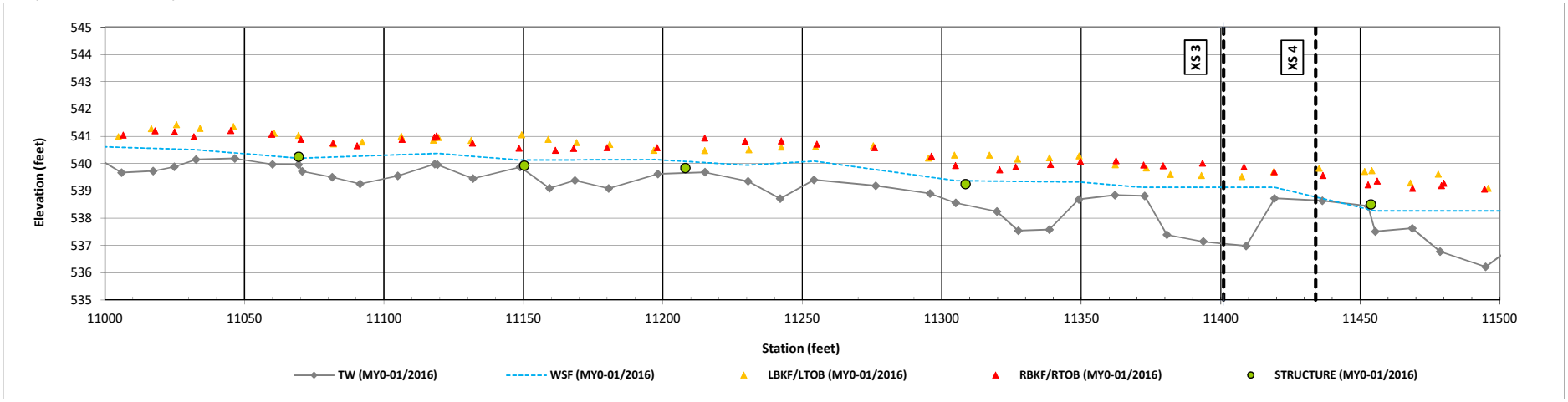


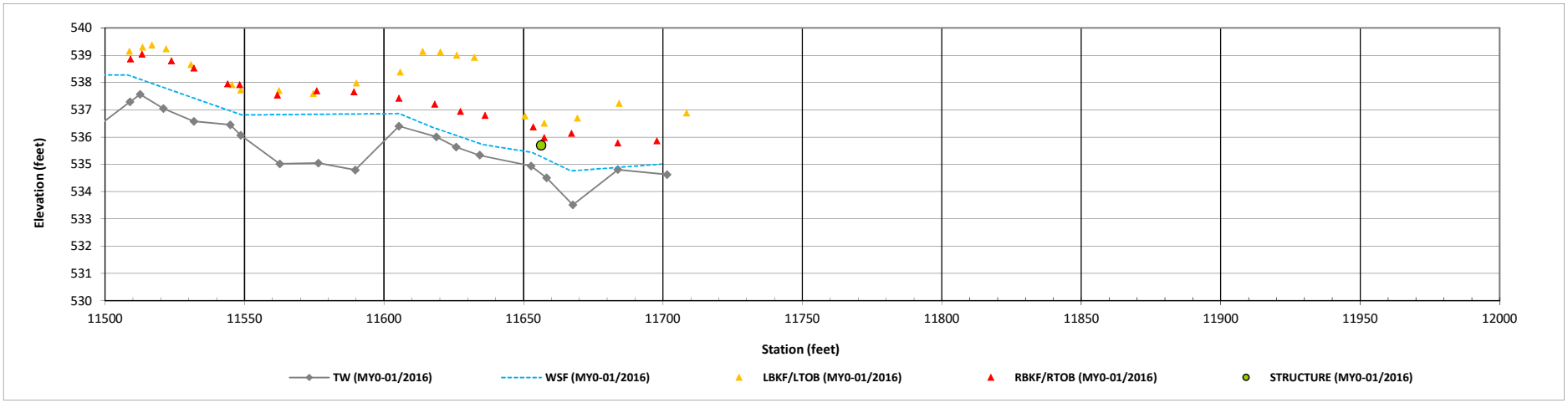
Longitudinal Profile Plots

Crooked Creek #2 Stream and Wetland Mitigatin Site (DMS Project No. 94687)

Monitoring Year 0 - 2016

UT1 (STA 100+00 - 117+18)



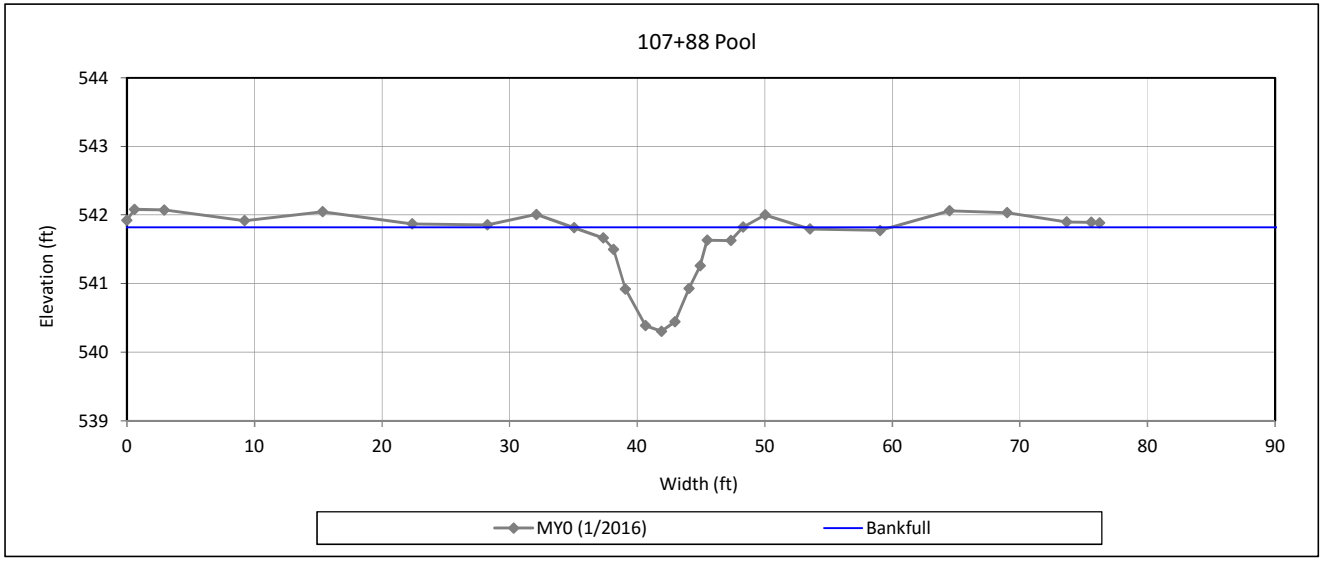


Cross Section Plots

Crooked Creek #2 Stream and Wetland Mitigation Site (DMS Project No. 94687)

Monitoring Year 0 - 2016

Cross Section 1-UT1



Bankfull Dimensions	
8.7	x-section area (ft.sq.)
13.3	width (ft)
0.7	mean depth (ft)
1.5	max depth (ft)
13.9	wetted perimeter (ft)
0.6	hydraulic radius (ft)
20.4	width-depth ratio

Survey Date: 1/2016
Field Crew: Wildlands Engineering

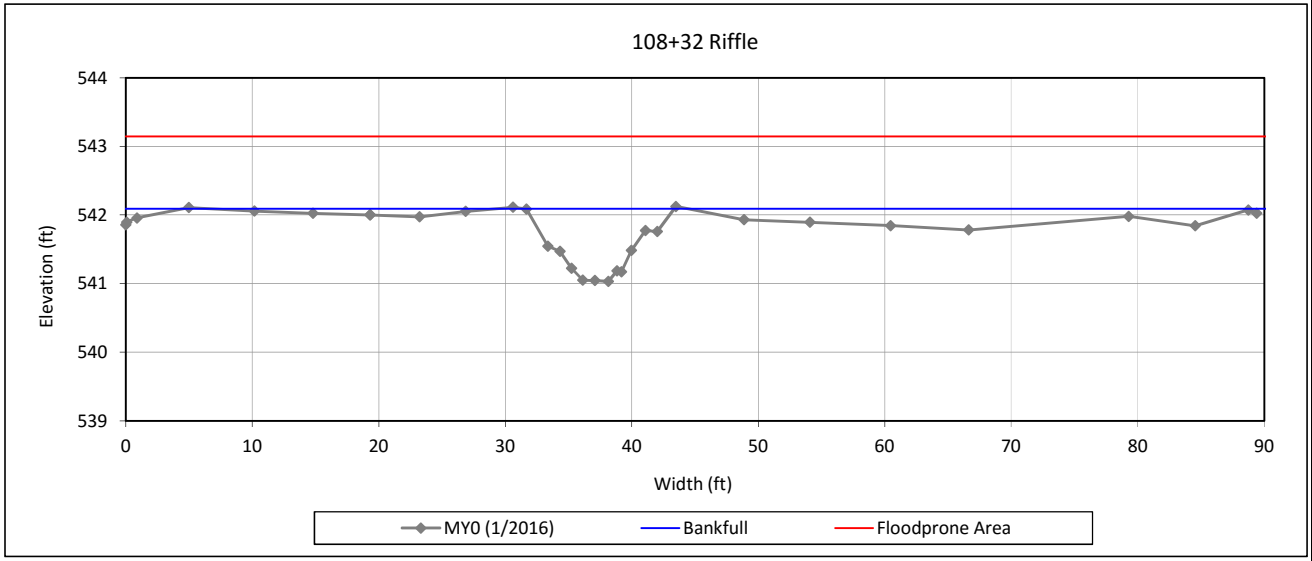
View Downstream

Cross Section Plots

Crooked Creek #2 Stream and Wetland Mitigation Site (DMS Project No. 94687)

Monitoring Year 0 - 2016

Cross Section 2-UT1



Bankfull Dimensions	
7.3	x-section area (ft.sq.)
11.7	width (ft)
0.6	mean depth (ft)
1.1	max depth (ft)
12.0	wetted perimeter (ft)
0.6	hydraulic radius (ft)
18.9	width-depth ratio
150.0	W flood prone area (ft)
12.8	entrenchment ratio
1.0	low bank height ratio

Survey Date: 1/2016
Field Crew: Wildlands Engineering

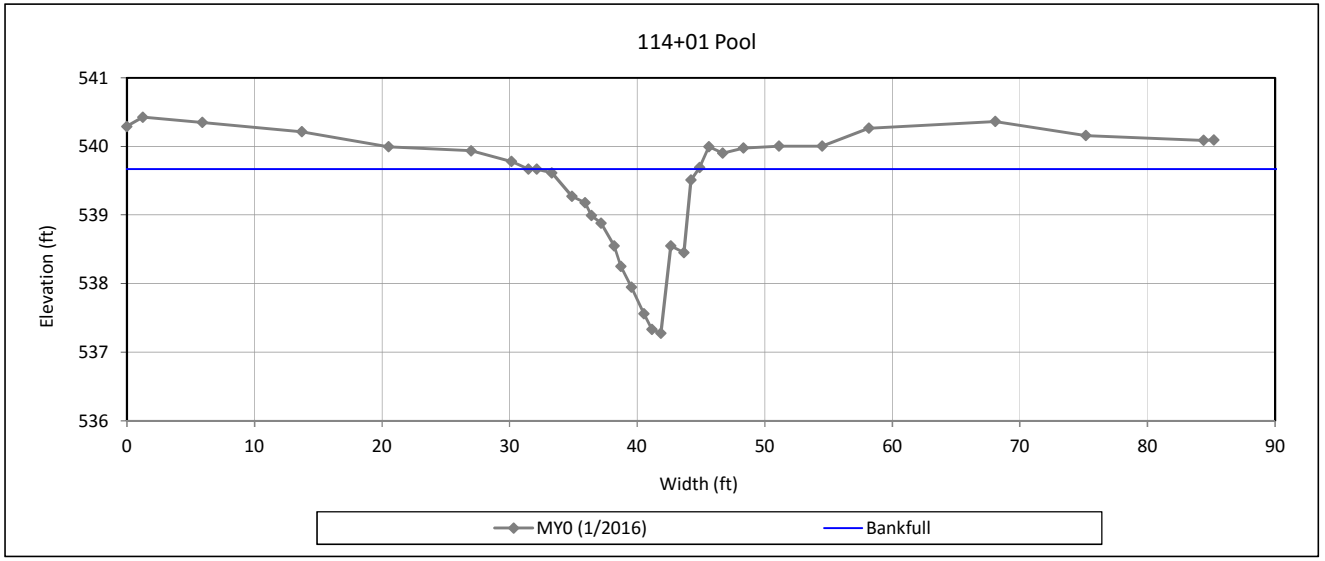
View Downstream

Cross Section Plots

Crooked Creek #2 Stream and Wetland Mitigation Site (DMS Project No. 94687)

Monitoring Year 0 - 2016

Cross Section 3-UT1



Bankfull Dimensions	
12.6	x-section area (ft.sq.)
12.6	width (ft)
1.0	mean depth (ft)
2.4	max depth (ft)
14.4	wetted perimeter (ft)
0.9	hydraulic radius (ft)
12.7	width-depth ratio

Survey Date: 2/2016
Field Crew: Wildlands Engineering

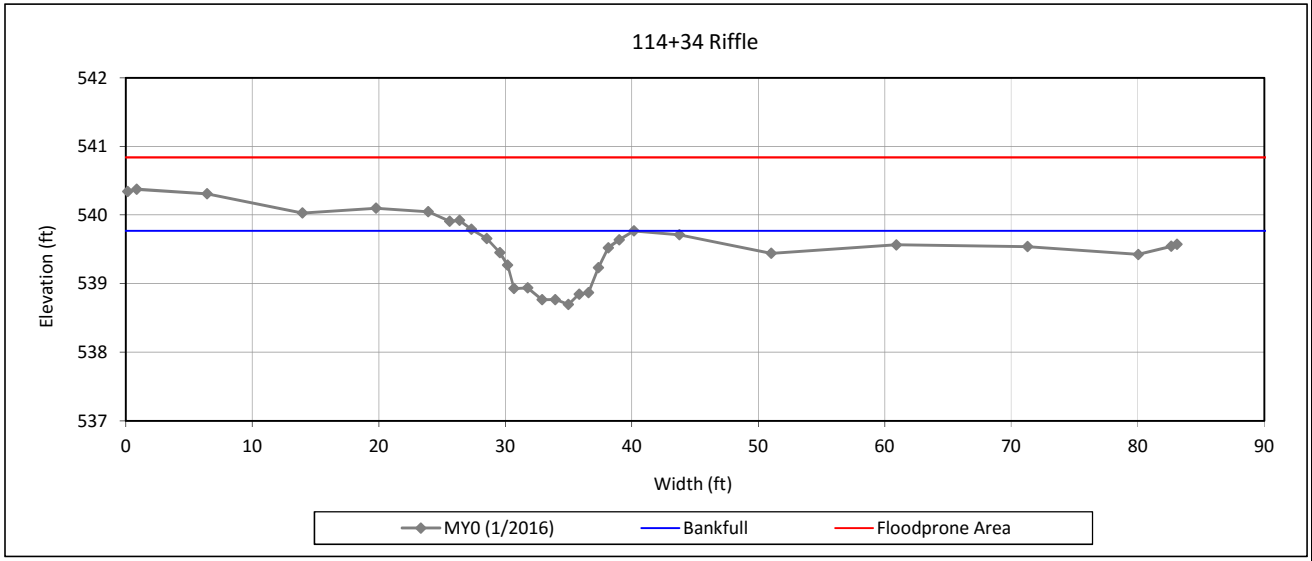
View Downstream

Cross Section Plots

Crooked Creek #2 Stream and Wetland Mitigation Site (DMS Project No. 94687)

Monitoring Year 0 - 2016

Cross Section 4-UT1



Bankfull Dimensions	
7.5	x-section area (ft.sq.)
12.6	width (ft)
0.6	mean depth (ft)
1.1	max depth (ft)
13.0	wetted perimeter (ft)
0.6	hydraulic radius (ft)
21.1	width-depth ratio
150.0	W flood prone area (ft)
11.9	entrenchment ratio
1.0	low bank height ratio

Survey Date: 2/2016
Field Crew: Wildlands Engineering

View Downstream

Reachwide and Cross Section Pebble Count Plots

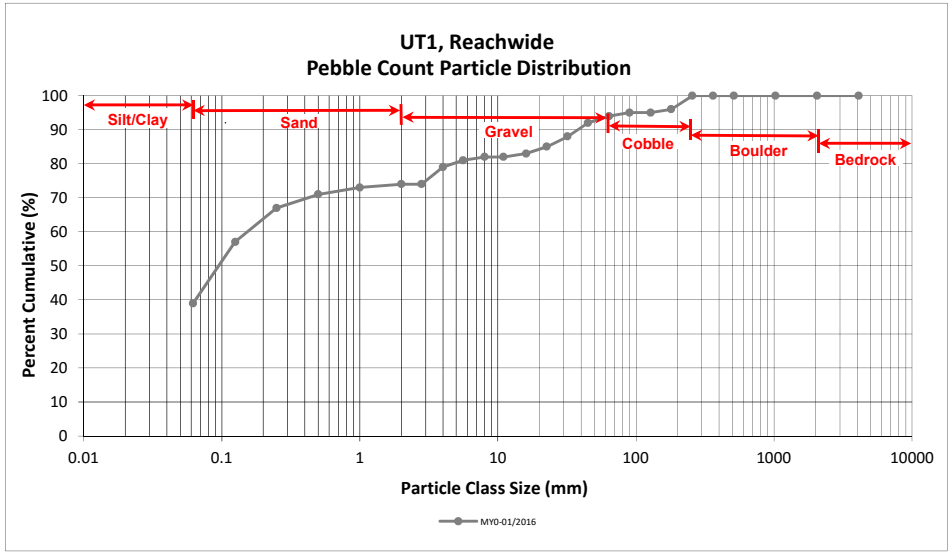
Crooked Creek #2 Stream and Wetland Mitigation Site (DMS Project No. 94687)

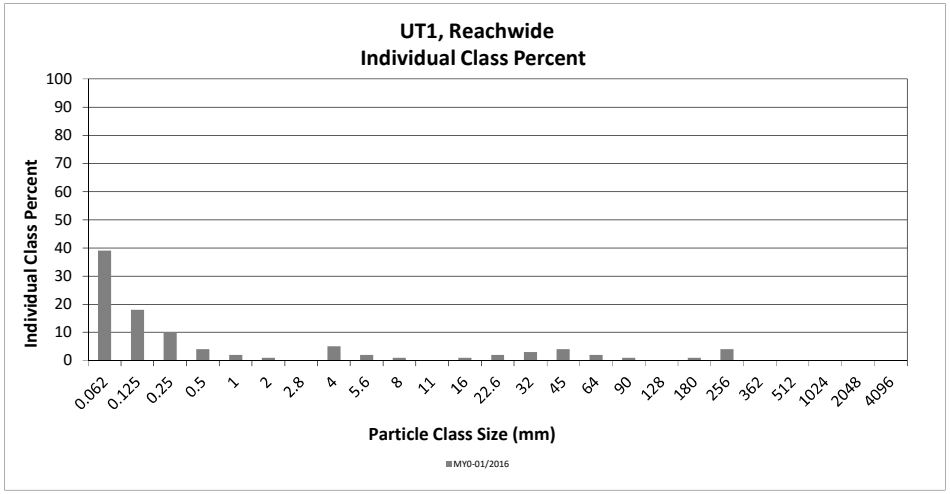
Monitoring Year 0 - 2016

UT1, 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	17	22	39	39	39
SAND	Very fine	0.062	0.125	5	13	18	18	57
	Fine	0.125	0.250	3	7	10	10	67
	Medium	0.25	0.50	3	1	4	4	71
	Coarse	0.5	1.0	1	1	2	2	73
	Very Coarse	1.0	2.0		1	1	1	74
GRAVEL	Very Fine	2.0	2.8					74
	Very Fine	2.8	4.0	2	3	5	5	79
	Fine	4.0	5.6	1	1	2	2	81
	Fine	5.6	8.0		1	1	1	82
	Medium	8.0	11.0					82
	Medium	11.0	16.0	1		1	1	83
	Coarse	16.0	22.6	2		2	2	85
	Coarse	22.6	32	3		3	3	88
	Very Coarse	32	45	4		4	4	92
	Very Coarse	45	64	2		2	2	94
COBBLE	Small	64	90	1		1	1	95
	Small	90	128					95
	Large	128	180	1		1	1	96
	Large	180	256	4		4	4	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} =	Silt/Clay
D_{50} =	0.1
D_{84} =	19.0
D_{95} =	90.0
D_{100} =	256.0





Reachwide and Cross Section Pebble Count Plots

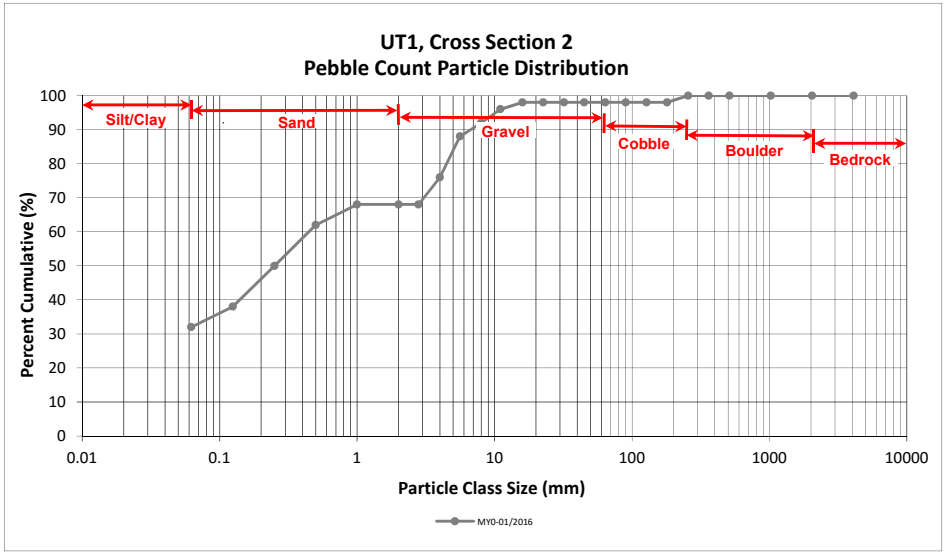
Crooked Creek #2 Stream and Wetland Mitigation Site (DMS Project No. 94687)

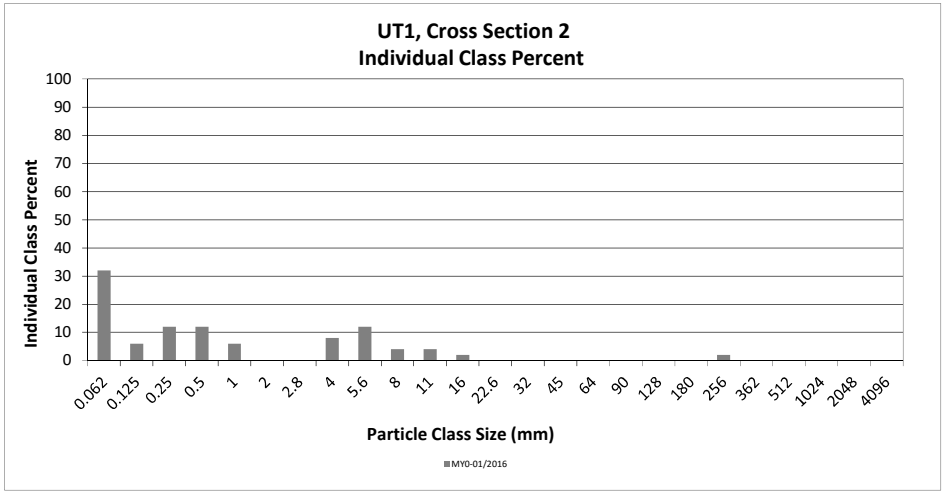
Monitoring Year 0 - 2016

UT1, Cross Section 2

Particle Class		Diameter (mm) min	Diameter (mm) max	Riffle 100-Count	Summary: Class Percentage	Summary: Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	32	32	32
SAND	Very fine	0.062	0.125	6	6	38
	Fine	0.125	0.250	12	12	50
	Medium	0.25	0.50	12	12	62
	Coarse	0.5	1.0	6	6	68
	Very Coarse	1.0	2.0			68
GRAVEL	Very Fine	2.0	2.8			68
	Very Fine	2.8	4.0	8	8	76
	Fine	4.0	5.6	12	12	88
	Fine	5.6	8.0	4	4	92
	Medium	8.0	11.0	4	4	96
	Medium	11.0	16.0	2	2	98
	Coarse	16.0	22.6			98
	Coarse	22.6	32			98
	Very Coarse	32	45			98
	Very Coarse	45	64			98
COBBLE	Small	64	90			98
	Small	90	128			98
	Large	128	180			98
	Large	180	256	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	**100**	**100**	**100**

Cross Section 2	
Channel materials (mm)	
D_{16} =	Silt/Clay
D_{35} =	0.09
D_{50} =	0.3
D_{84} =	5.0
D_{95} =	10.2
D_{100} =	256.0





Reachwide and Cross Section Pebble Count Plots

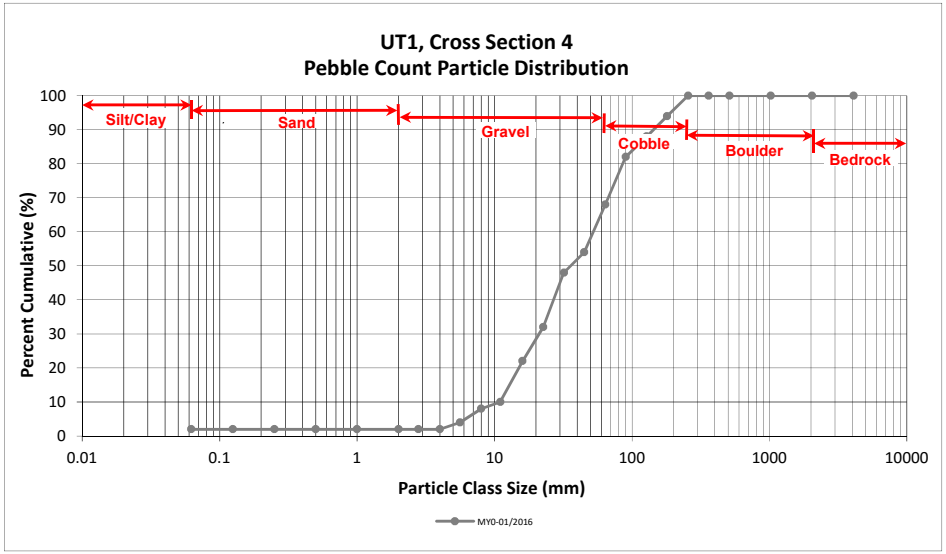
Crooked Creek #2 Stream and Wetland Mitigation Site (DMS Project No. 94687)

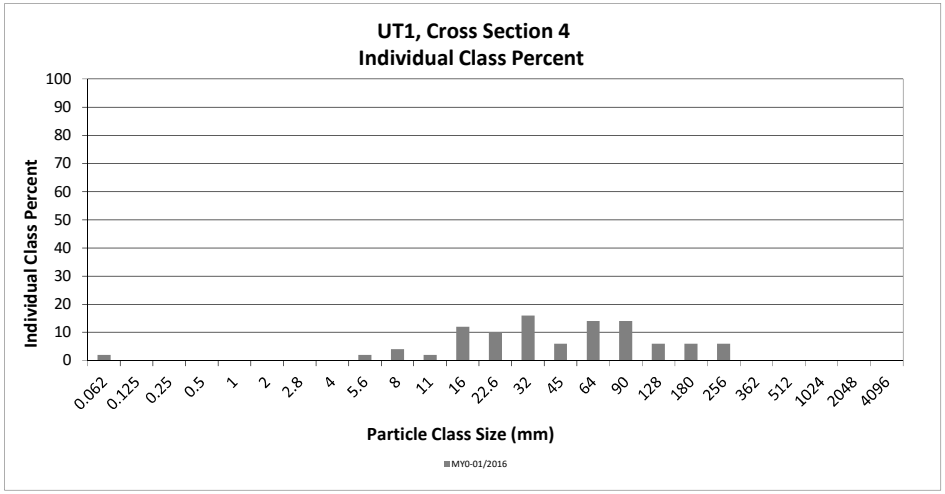
Monitoring Year 0 - 2016

UT1, Cross Section 4

Particle Class		Diameter (mm) min	Diameter (mm) max	Riffle 100-Count	Summary: Class Percentage	Summary: Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	2	2	2
SAND	Very fine	0.062	0.125			2
	Fine	0.125	0.250			2
	Medium	0.25	0.50			2
	Coarse	0.5	1.0			2
	Very Coarse	1.0	2.0			2
GRAVEL	Very Fine	2.0	2.8			2
	Very Fine	2.8	4.0			2
	Fine	4.0	5.6	2	2	4
	Fine	5.6	8.0	4	4	8
	Medium	8.0	11.0	2	2	10
	Medium	11.0	16.0	12	12	22
	Coarse	16.0	22.6	10	10	32
	Coarse	22.6	32	16	16	48
	Very Coarse	32	45	6	6	54
	Very Coarse	45	64	14	14	68
COBBLE	Small	64	90	14	14	82
	Small	90	128	6	6	88
	Large	128	180	6	6	94
	Large	180	256	6	6	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	**100**	**100**	**100**

Cross Section 4	
Channel materials (mm)	
D_{16} =	13.27
D_{35} =	24.12
D_{50} =	35.9
D_{84} =	101.2
D_{95} =	190.9
D_{100} =	256.0





Stream Photographs

	
Photo Point 1 – looking upstream (02/22/2016)	Photo Point 1 – looking downstream (02/22/2016)
	
Photo Point 2 – looking upstream (02/22/2016)	Photo Point 2 – looking downstream (02/22/2016)
	
Photo Point 3 – looking upstream (02/22/2016)	Photo Point 3 – looking downstream (02/22/2016)

	
Photo Point 4 – looking upstream (02/22/2016)	Photo Point 4 – looking downstream (02/22/2016)
	
Photo Point 5 – looking upstream (02/22/2016)	Photo Point 5 – looking downstream (02/22/2016)
	
Photo Point 6 – looking upstream (02/22/2016)	Photo Point 6 – looking downstream (02/22/2016)

	
Photo Point 7 – looking upstream (02/22/2016)	Photo Point 7 – looking downstream (02/22/2016)
	
Photo Point 8 – looking upstream (02/22/2016)	Photo Point 8 – looking downstream (02/22/2016)
	
Photo Point 9 – looking upstream (02/22/2016)	Photo Point 9 – looking downstream (02/22/2016)

	
Photo Point 10 – looking upstream (02/22/2016)	Photo Point 10 – looking downstream (02/22/2016)
	
Photo Point 11 – looking upstream (02/22/2016)	Photo Point 11 – looking downstream (02/22/2016)
	
Photo Point 12 – looking upstream (02/22/2016)	Photo Point 12 – looking downstream (02/22/2016)

	
Photo Point 13 – looking upstream (02/22/2016)	Photo Point 13 – looking downstream (02/22/2016)
	
Photo Point 14 – looking upstream (02/22/2016)	Photo Point 14 – looking downstream (02/22/2016)
	
Photo Point 15 – looking upstream (02/22/2016)	Photo Point 15 – looking downstream (02/22/2016)

	
Photo Point 16 – looking upstream (02/22/2016)	Photo Point 16 – looking downstream (02/22/2016)
	
Photo Point 17 – looking upstream (02/22/2016)	Photo Point 17 – looking downstream (02/22/2016)
	
Photo Point 18 – looking upstream (02/22/2016)	Photo Point 18 – looking downstream (02/22/2016)

	
Photo Point 19 – looking upstream (02/22/2016)	Photo Point 19 – looking downstream (02/22/2016)
	
Photo Point 20 – looking upstream (02/22/2016)	Photo Point 20 – looking downstream (02/22/2016)
	
Photo Point 21 – looking upstream (02/22/2016)	Photo Point 21 – looking downstream (02/22/2016)

	
Photo Point 22 – looking upstream (02/22/2016)	Photo Point 22 – looking downstream (02/22/2016)
	
Photo Point 23 – looking upstream (02/22/2016)	Photo Point 23 – looking downstream (02/22/2016)
	
Photo Point 24 – looking upstream (02/22/2016)	Photo Point 24 – looking downstream (02/22/2016)

	
Photo Point 25 – looking upstream (02/22/2016)	Photo Point 25 – looking downstream (02/22/2016)
	
Photo Point 26 – looking upstream (02/22/2016)	Photo Point 26 – looking downstream (02/22/2016)
	
Photo Point 27 – looking upstream (02/22/2016)	Photo Point 27 – looking downstream (02/22/2016)

Photo Point 28 – looking upstream (02/22/2016)

Photo Point 28 – looking downstream (02/22/2016)

Photo Point 29 – looking upstream (02/22/2016)

Photo Point 29 – looking downstream (02/22/2016)

Photo Point 30 – looking downstream to UT2 (02/22/2016)

Photo Point 31 – looking upstream Crooked Creek (02/22/2016)

Photo Point 31 – looking downstream (02/22/2016)

Photo Point 31 – looking upstream UT2 (02/22/2016)

APPENDIX 3. Vegetation Plot Data

Table 8. Planted and Total Stem Counts
Crooked Creek #2 Stream and Wetland Mitigatin Site
DMS Project No. 94687
Monitoring Year 0 - 2016

			Current Plot Data (MY0 2016)																				
			Vegetation Plot 1			Vegetation Plot 2			Vegetation Plot 3			Vegetation Plot 4			Vegetation Plot 5			Vegetation Plot 6			Vegetation Plot 7		
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**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Acer negundo	Box Elder	Tree																					4
Acer rubrum	Red Maple	Tree	1	1	1							3	3	3									
Betula nigra	River Birch, Red Birch	Tree				3	3	3										3	3	3			
Cornus florida	Flowering Dogwood	Shrub Tree																					
Carpinus caroliniana	Ironwood	Tree																					
Diospyros virginiana	American Persimmon,	Tree	3	3	3							6	6	6							3	3	3
Fraxinus pennsylvanica	Green Ash, Red Ash	Tree						1			4						19			4			12
Juglans nigra	Black Walnut	Tree																					
Liquidambar styraciflua	Sweet Gum, Red Gum	Tree						1															1
Liriodendron tulipifera	Tulip poplar	Tree																					
Nyssa sylvatica	Sour Gum, Black Gum,	Tree	1	1	1	1	1	1													2	2	2
Platanus occidentalis	Sycamore, Plane-tree	Tree	5	5	5	3	3	3				1	1	1				4	4	4			
Quercus sp.	Oak	Tree	7	7	7	5	5	5				2	2	2				4	4	4	7	7	7
Taxodium distichum	Bald-cypress	Tree							6	6	6				10	10	10						
Ulmus alata	Winged Elm	Tree																					
Stem count			17	17	17	12	12	14	6	6	10	12	12	12	10	10	29	11	11	15	12	12	29
size (ares)			1			1			1			1			1			1			1		
size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
Species count			5	5	5	4	4	6	1	1	2	4	4	4	1	1	2	3	3	4	3	3	6
Stems per ACRE			688	688	688	486	486	567	243	243	405	486	486	486	405	405	1174	445	445	607	486	486	1174

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%
Volunteer species included in total

PnoLS: Number of Planted stems excluding live stakes
P-all: Number of planted stems including live stakes
T: Total Stems

Table 8. Planted and Total Stem Counts
Crooked Creek #2 Stream and Wetland Mitigatin Site
DMS Project No. 94687
Monitoring Year 0 - 2016

			Current Plot Data (MY0 2016)															Annual Summary		
			Vegetation Plot 8			Vegetation Plot 9			Vegetation Plot 10			Vegetation Plot 11			Vegetation Plot 12			MY0 (2016)		
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**	**PnoLS**	**P-all**	**T**
Acer negundo	Box Elder	Tree															13			17
Acer rubrum	Red Maple	Tree	3	3	3	7	7	7										14	14	14
Betula nigra	River Birch, Red Birch	Tree	2	2	2	1	1	1	3	3	3	5	5	5	1	1	1	18	18	18
Cornus florida	Flowering Dogwood	Shrub Tree															2			2
Carpinus caroliniana	Ironwood	Tree													6	6	6	6	6	6
Diospyros virginiana	American Persimmon,	Tree	7	7	7	4	4	4	4	4	4							27	27	27
Fraxinus pennsylvanica	Green Ash, Red Ash	Tree									5									45
Juglans nigra	Black Walnut	Tree			1															1
Liquidambar styraciflua	Sweet Gum, Red Gum	Tree															2			4
Liriodendron tulipifera	Tulip poplar	Tree															2			2
Nyssa sylvatica	Sour Gum, Black Gum,	Tree	1	1	1				2	2	2							7	7	7
Platanus occidentalis	Sycamore, Plane-tree	Tree	2	2	2			1										15	15	16
Quercus sp.	Oak	Tree	4	4	4	4	4	4	5	5	5	12	12	12	3	3	3	53	53	53
Taxodium distichum	Bald-cypress	Tree																16	16	16
Ulmus alata	Winged Elm	Tree															1			1
Stem count			19	19	20	16	16	17	14	14	19	17	17	17	10	10	30	156	156	229
size (ares)			1			1			1			1			1			12		
size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.30		
Species count			6	6	7	4	4	5	4	4	5	2	2	2	3	3	8	8	8	15
Stems per ACRE			769	769	809	647	647	688	567	567	769	688	688	688	405	405	1214	526	526	772

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%
Volunteer species included in total

PnoLS: Number of Planted stems excluding live stakes
P-all: Number of planted stems including live stakes
T: Total Stems

Vegetation Photographs

	
Vegetation Plot 1 – (02/17/2016)	Vegetation Plot 2 – (02/17/2016)
	
Vegetation Plot 3 – (02/22/2016)	Vegetation Plot 4 – (02/17/2016)
	
Vegetation Plot 5 – (02/22/2016)	Vegetation Plot 6 – (02/17/2016)

	
Vegetation Plot 7 – (02/17/2016)	Vegetation Plot 8 – (02/17/2016)
	
Vegetation Plot 9 – (02/17/2016)	Vegetation Plot 10 – (02/17/2016)
	
Vegetation Plot 11 – (02/22/2016)	Vegetation Plot 12 – (02/17/2016)

APPENDIX 4. Baseline Wetland Photo Documentation

Wetland Photographs

	
Photo Point 30 –Wetland CC outlet upstream (02/22/2016)	Photo Point 30 –Wetland CC outlet downstream (02/22/2016)
	
Photo Point 32 – overview upstream at Wetland AA (02/22/2016)	Photo Point 32 – overview downstream at Zone A (02/22/2016)
	
Photo Point 33 – overview upstream at Zone A & B (02/22/2016)	Photo Point 33 - overview downstream at Zone B (02/22/2016)

	
Photo Point 34 – looking upstream at Wetland CC (02/22/2016)	Photo Point 34 – looking downstream at Wetland CC (02/22/2016)

APPENDIX 5. Record Drawings

Crooked Creek #2 Restoration Project

Union County, North Carolina

for

NCDENR Division of Mitigation Services

Vicinity Map
Not to Scale

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

RECORD DRAWINGS
ISSUED JULY 15, 2015

Sheet Index

Project Directory

Engineering:
Wildlands Engineering, Inc
License No. F-0831
1430 South Mint Street
Suite 104
Charlotte, NC 28203
Aaron S. Earley, PE
704-332-7754

Owner:
NCDENR Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

WILDLANDS
Engineering
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. F-0831

NORTH CAROLINA PROFESSIONAL SEAL 029340 ENGINEER AARON S. EARLEY 7-15-15

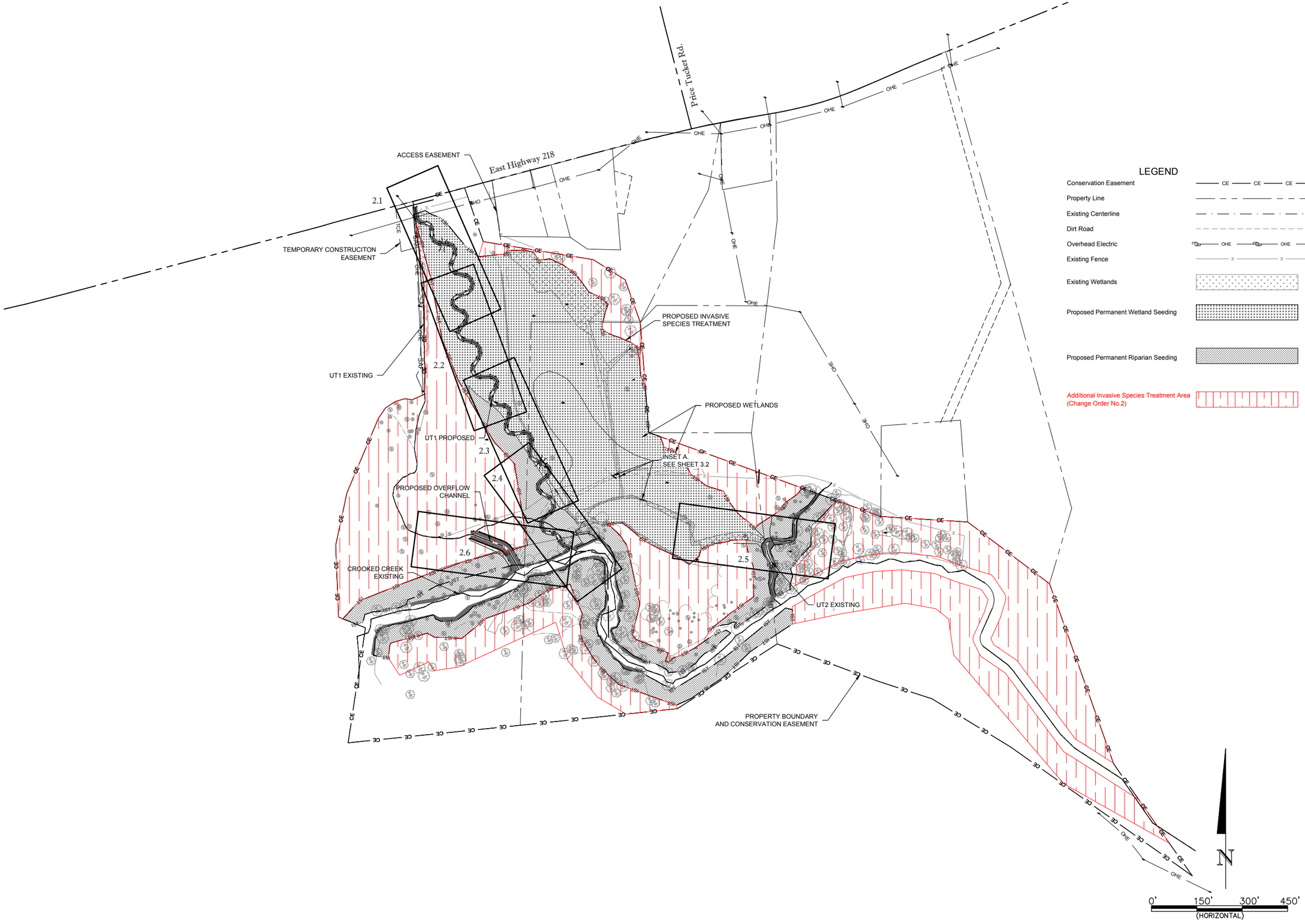
RECORD DRAWINGS - SCO PROJECT # 09-0751301

Crooked Creek #2 Restoration Project
Union County, North Carolina
Cover Sheet

Revisions:

Date:	July 15, 2015
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	AA

Sheet 0.1



LEGEND

- Conservation Easement
- Property Line
- Existing Centerline
- Dirt Road
- Overhead Electric
- Existing Fence
- Existing Wetlands
- Proposed Permanent Wetland Seeding
- Proposed Permanent Riparian Seeding
- Additional Invasive Species Treatment Area (Change Order No.2)

RECORD DRAWINGS - SCO PROJECT # 09-0751301

WILDLANDS
ENGINEERING
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Tel: 704.332.7754
Fax: 704.332.3306
Firm License No. P-0831

NORTH CAROLINA PROFESSIONAL SEAL 028340 ENGINEER AARON S. EARLEY 7-15-15

Crooked Creek #2 Restoration Project
Union County, North Carolina

Project Overview

Date:	July 15, 2015
Job Number:	095-00132
Project Engineer:	AME
Drawn By:	ACC
Checked By:	AE

Revisions:

Sheet 0.2

General Construction Notes for all Reaches

All erosion and sediment control practices shall comply with the North Carolina Erosion and Sediment Control Planning and Design Manual

1) Contractor will install pump-around systems to divert flow while working in live, flowing channels. The Contractor shall operate and maintain the pump-around system 24 hours a day unless all disturbed areas within the pump-around work area can be stabilized by the end of the work day. Contractor shall not remove pump-around systems and advance to the next work area until the current work area is completed and stabilized.

2) No material from the off-line proposed stream channel excavation many be backfilled into the adjacent existing stream channel until the newly-constructed proposed stream section is completed, stabilized, and the stream flow has been diverted into it, not even if that section of old/ existing stream is being pumped.

3) In areas without a pump-around system, Contractor shall disturb only as much channel bank as can be stabilized with temporary seeding, mulch and erosion control matting by the end of each work day.

4) When crossing an active section of new or old stream channel, a Timber Mat shall be installed according to the details and specifications.

5) All graded areas with slopes steeper than 3:1 will be stabilized within seven working days. All other areas will be stabilized within 14 days.

6) Locations for staging and stockpile areas and stream crossings have been provided on the Plans. Additional or alternative staging and/or stockpile areas and stream crossings may be used by the Contractor provided that all practices comply with the North Carolina Erosion and Sediment Control Planning and Design manual and are approved by the Engineer prior to implementation.

7) Various types of constructed riffles are specified on the plans. Contractor shall build the specific types of constructed riffles at locations shown on the plans. Changes in constructed riffle type must be approved by the Engineer.

8) Contractor is to make every effort to avoid damaging or removing existing trees.

9) Under no circumstances will the Contractor exceed the limits of disturbance shown on the plans.

The Crooked Creek #2 Restoration Project construction will follow the construction sequence protocol as described below, unless otherwise noted.

Initial Site Preparation

10) Contact North Carolina "ONE CALL" Center (1.800.632.4949) before any excavation.

11) Contact Land Quality (704-663-1699) before any work begins on the project and notify them of the start date.

12) Mobilize equipment and materials to the Site.

13) Identify and establish construction entrance, staging and stockpile areas, haul roads, silt fencing, tree protection fencing and temporary stream crossings as indicated on the Plans for work areas. Note: all construction traffic will enter the site from the construction entrance show on the Plans at NC Highway 218.

14) All haul roads shall be monitored for sediment loss on a daily basis. In the event of sediment loss, silt fence or other acceptable sediment and erosion control practices shall be installed. Silt fence outlets shall be located at points of low elevation or a minimum spacing of 150 ft.

15) Set up temporary facilities, locate equipment within the staging area, and stockpile materials needed for the initial stages of construction within the stockpile area(s).

16) Install and maintain an onsite rain gauge and log book to record the rainfall amounts and dates. Complete the self-inspection as required by DENR permit.

UT1 Channel Construction Notes

1) Construction of UT 1 is to be done in the dry, constructing the proposed channel from upstream to downstream starting off-line at approximately STA100+60 at the northern portion of the Site along NC Highway 218.

2) As work progresses, remove and stockpile the top 3 inches of soil from the active grading area. Stockpiled topsoil shall be kept separate for onsite replacement prior to floodplain seeding.

3) Remove all non-native and invasive vegetation prior to beginning the channel construction.

4) Where feasible, more than one offline section may be constructed concurrently. Offline sections shall be tied online sequentially from downstream to upstream.

5) Construct the proposed stream channel to the grade specified in the cross sections and profile. Transfer coarse material from abandoned channel riffles to new channel riffles utilizing a pump around on the existing UT1 when doing so.

6) Grade the adjacent floodplain and wetland area according to grades shown on the plan.

7) Install structures (log vane, j hook rock vane, riffles, log sills, brush sills, etc.) and in-bank bioengineering such brush toe after channel grading is completed.

8) Seed (with appropriate seed mix) and straw mulch areas where the coir fiber matting is to be installed.

9) Install coir fiber matting according to specifications, using coir fiber matting ECC-2B or equivalent from STA 100+00 to STA 114+20.71 and coir fiber matting C-600 or equivalent from STA 114+20.71 to the confluence with Crooked Creek at STA 117+17.53.

10) Install coir fiber matting ECC-2B or equivalent on the 2(H):1(V) slope transition from floodplain to upland on the right side of UT1 approximate corresponding stations 115+45.00 - 117+17.53.

11) Install a pump around at the upstream end of site between the culvert and existing UT1, installing channel dikes as necessary, in order to complete tie-in grading of the proposed UT1 from the offline section to the culvert.

12) Upon completion of UT1 and stabilization, turn water into newly constructed UT1 and remove pump around.

13) Backfill abandoned channel sections with stockpiled soil according to the grades shown on the Plans. Non-native and invasive vegetation (e.g. privet, multiflora rose, and Japanese honeysuckle) shall be removed from the existing channel prior to backfilling.

14) Prepare floodplain for seeding by applying stockpiled topsoil to the floodplain between bankfull elevation and the grading limits, ripping, and raking/ smoothing. Seed and mulch. Any areas within the conservation easement that have not been graded shall be treated according to the planting plan.

15) Plant live stakes and herbaceous plugs on stream banks according to planting details and specifications.

Overflow Channel Construction Notes

16) Install a pump around system between the existing UT1 and Crooked Creek (UT1 existing STA 113+40) and install Channel Plug as shown on the Plans.

17) Construct the proposed Overflow Channel to the grades and profile shown on the Plans.

18) Install structures (e.g. constructed riffle and rock sills) after channel grading is completed.

19) Seed (with appropriate seed mix) and straw mulch areas where the coir fiber matting is to be installed.

20) Install coir fiber matting C-600 or equivalent

21) Upon completion of the Overflow Channel, turn water into the newly constructed Overflow Channel and remove the pump around.

22) Backfill the abandoned channel between the Overflow Channel and newly constructed UT1 east of the Overflow Channel with stockpiled soils according to the grades shown on the Plans. Non-native invasive vegetation (i.e. privet, multiflora rose, and Japanese honeysuckle) shall be removed from the existing channel prior to backfilling.

23) Plant live stakes on stream banks according to the planting details and specifications.

Wetland Construction Notes

1) Finalize floodplain and wetland grading, removing haul roads as necessary.

2) Prepare floodplain for seeding by applying stockpiled topsoil to the floodplain between bankfull elevation and the grading limits, ripping, and raking/ smoothing. Seed and mulch.

3) Install Channel Plug in the ditch in the southeast section of the site at the confluence with UT2 according to sheet 2.6 of the Plans.

4) Backfill channel with stockpiled soils according to the grades shown on the Plans. Non-native invasive vegetation (i.e. privet, multiflora rose, and Japanese honeysuckle) shall be removed from the existing channel prior to backfilling.

5) Seed and straw mulch disturbed areas of the backfilled channel and seed according to plans and specifications.

Construction Demobilization

6) Remove temporary stream crossings.

7) The Contractor shall ensure that the site is free of trash and leftover materials prior to demobilization of equipment from the site.

8) Complete the removal of any additional stockpiled material from the site.

9) Demobilize grading equipment from the site.

10) All rock and other stockpiled materials must be removed from the limits of disturbance and conservation easement. All areas outside the conservation easement shall be returned to pre-project conditions or better.

11) Seed, mulch, and stabilize staging areas, stockpile areas, haul roads, and construction entrances. Pasture seed mix is to be applied to areas of disturbance outside of the conservation easement and disturbed areas that do not fall within the riparian or wetland planting zones shown in the planting plan. Remove all temporary fencing.

Existing Property Line
Existing Thalweg
Existing Ditch
Existing Major Contour (100)
Existing Minor Contour
Existing Tree Line
Existing Tree
Existing Paved Road
Existing Overhead Electric with Easement (OHE)
Existing Power Pole
Existing Easement (E)
Existing Fence (X)
Existing Sanitary Sewer
Existing Culvert Pipe
Existing Wetland
Existing Ground Water Gauge

Proposed Channel Centerline (10+00)
Proposed Bankfull
Proposed Major Contour (100)
Proposed Minor Contour
Proposed Conservation Easement (CE)
Proposed Silt Fence ([x])
Proposed Safety Fence (SAF)
Proposed Limits of Disturbance (LOD)
Proposed Invasive Species Treatment (IST)
Proposed Temporary Construction Easement (TCE)

Proposed Log Vane
See Detail 2, Sheet 5.3

Proposed Construction Entrance
See Detail 3, Sheet 5.7

Proposed Brush Toe
See Detail 2, Sheet 5.4

Proposed Log Sill
See Detail 1, Sheet 5.3

Proposed Brush Sill
See Detail 4, Sheet 5.3

Proposed Angled Log Step Pool
See Detail 1, Sheet 5.2

Proposed Rock J-Hook
See Detail 2, Sheet 5.2

Proposed Boulder Sill
See Detail 3, Sheet 5.2

Proposed Silt Fence Outlet
See Detail 1, Sheet 5.5

Proposed Construction Route (Haul Road)

Proposed Temporary Stream Crossing
See Detail 4, Sheet 5.6

Proposed Constructed Riffle
See Details 1-4, Sheet 5.1

Proposed Channel Plug
See Detail 4, Sheet 5.7

Proposed Livestaking
See Detail 2, Sheet 5.5

Proposed Permanent Riparian Seeding

Proposed Permanent Wetland Seeding

Proposed Stockpile Area

Proposed Pump Around System
See Detail 1, Sheet 5.4

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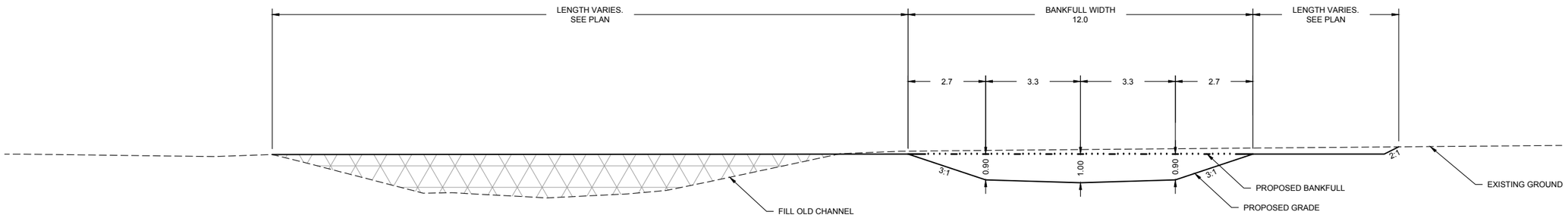
NORTH CAROLINA PROFESSIONAL SEAL 020340 ENGINEER AARON S. EARLEY 7-15-15

Crooked Creek #2 Restoration Project
Union County, North Carolina
General Notes and Symbols

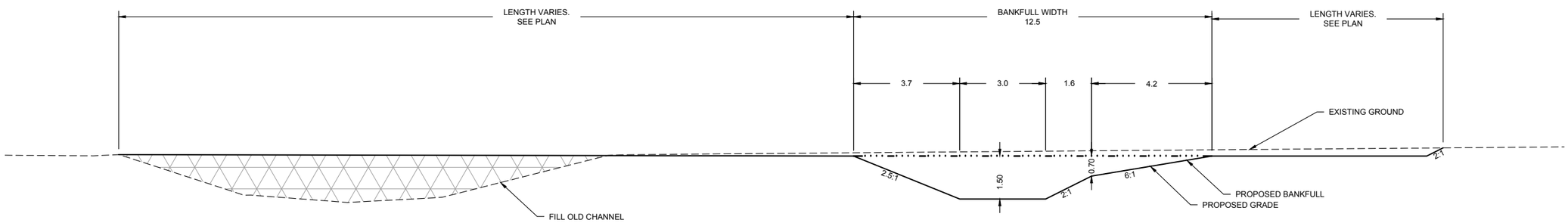
Revisions:

Date: July 15, 2015
Job Number: 005-02127
Project Engineer: ASE
Drawn By: JCK
Checked By: AA

Sheet 0.3



UT1- Typical Section: Riffle
Sta: 100+00 to 117+18
Not To Scale



UT1 - Typical Section: Pool
Sta: 100+00 to 117+18
Not To Scale

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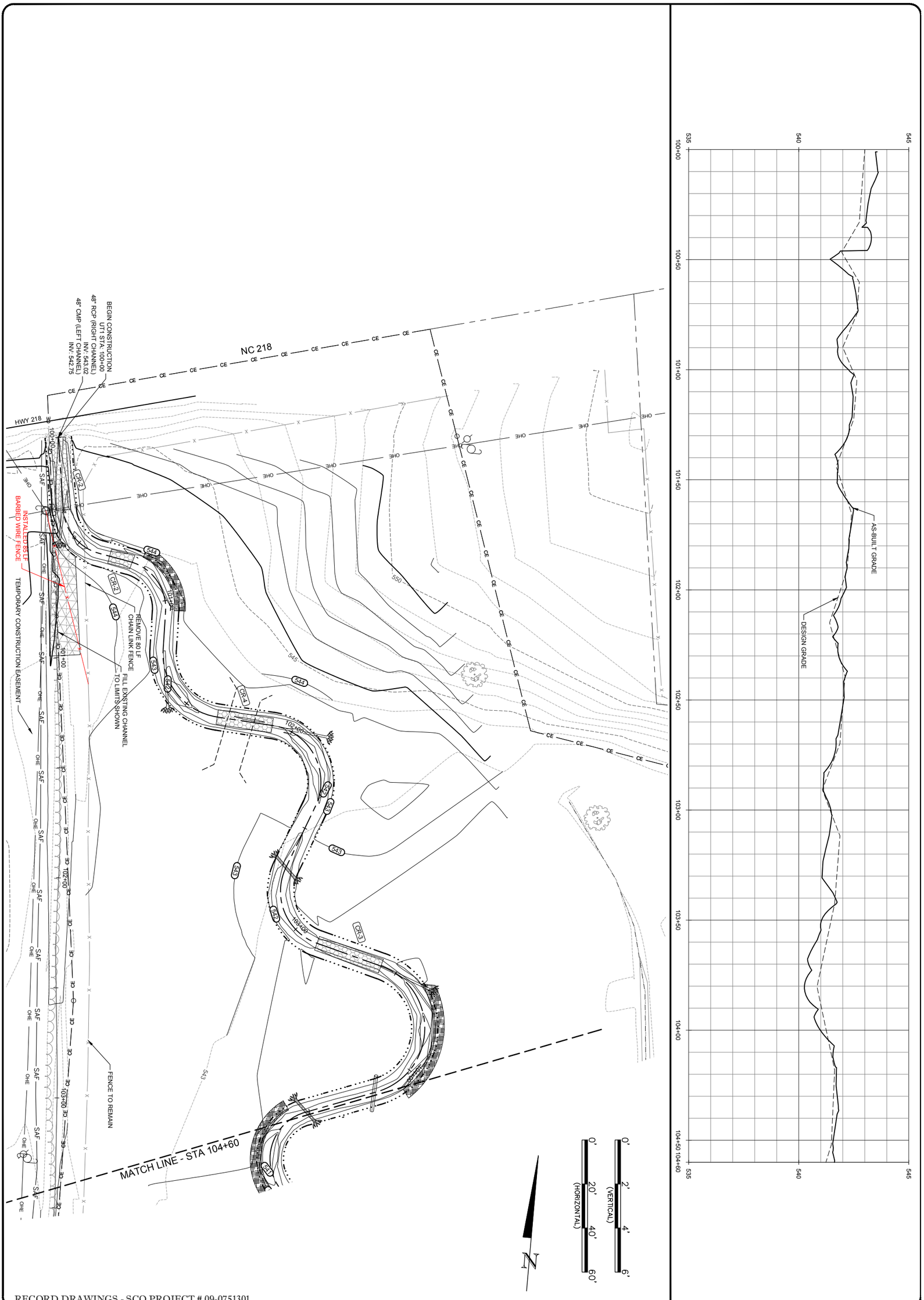
NORTH CAROLINA PROFESSIONAL SEAL 029340 ENGINEER AARON S. EARLEY 7-15-15

Crooked Creek #2 Restoration Project
Union County, North Carolina
Typical Sections

Date: July 15, 2015
Job Number: 095-0217
Project Engineer: ASE
Drawn By: JCK
Checked By: AA

Revisions:

Sheet 1.1



RECORD DRAWINGS - SCO PROJECT # 09-0751301

Date:	July 15, 2015
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	AA

Revisions:

2.1

Sheet

Crooked Creek #2 Restoration Project
Union County, North Carolina

UT 1 Restoration
As-Built Stream Plan & Profile

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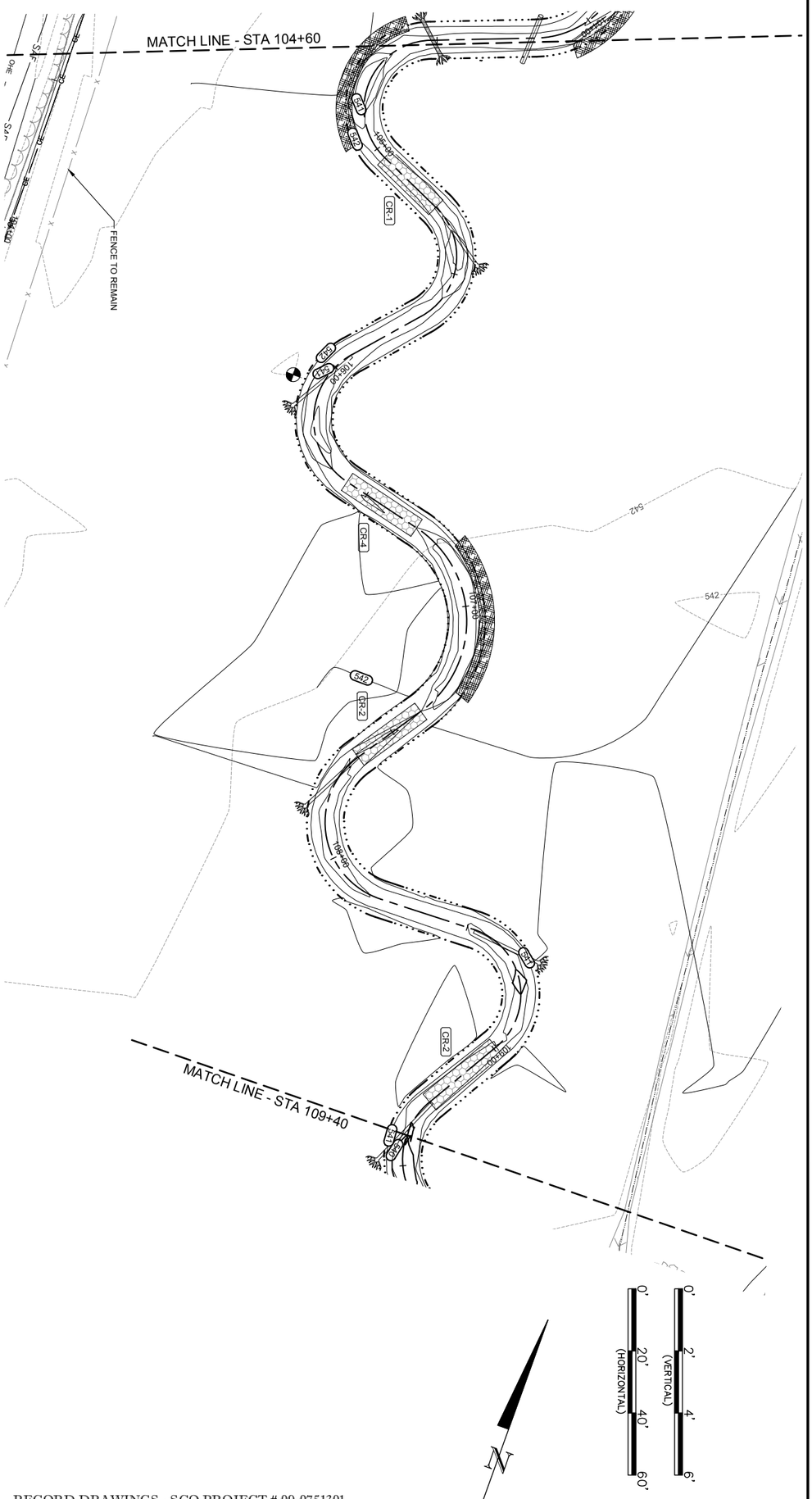

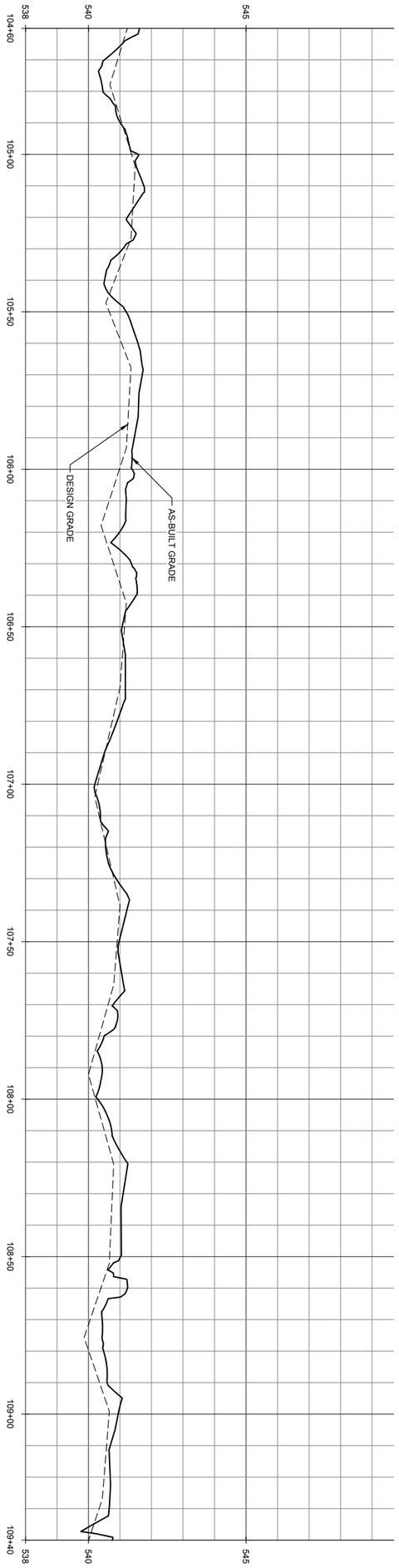

RECORD DRAWINGS - SCO PROJECT # 09-0751301

Date:	July 15, 2015
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	AA

2.2
Sheet

Revisions:

Crooked Creek #2 Restoration Project
Union County, North Carolina

UT 1 Restoration
As-Built Stream Plan & Profile

NORTH CAROLINA PROFESSIONAL SEAL 029340 ENGINEER JASON S. EMERY

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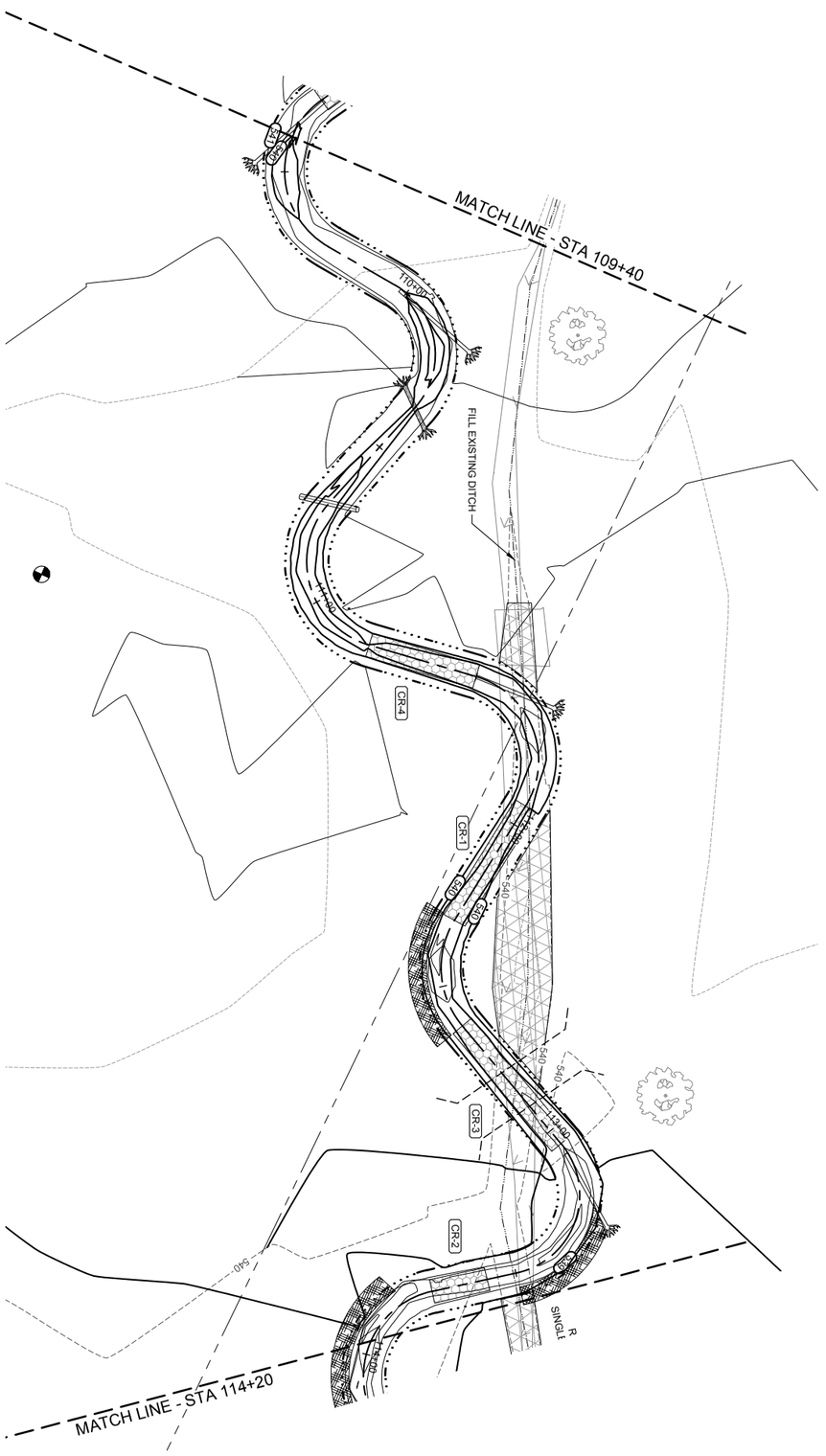

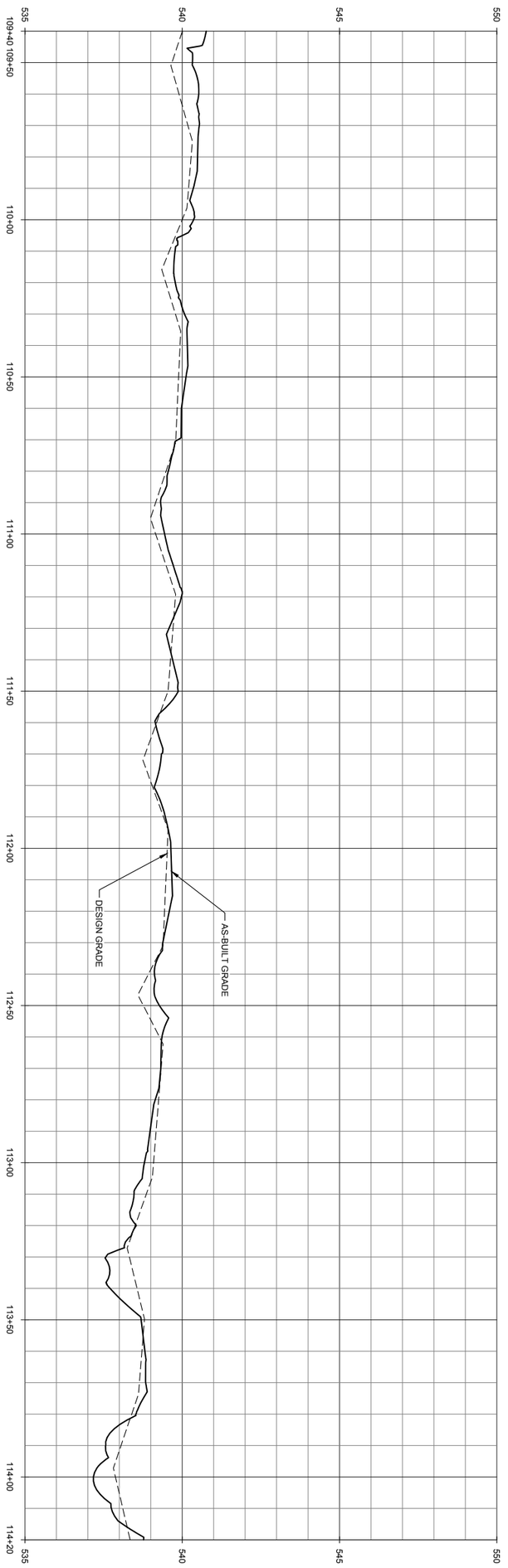

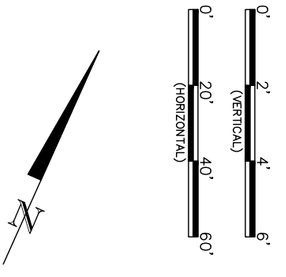

RECORD DRAWINGS - SCO PROJECT # 09-0751301

Date:	July 15, 2015
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	AA

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Revisions:

Crooked Creek #2 Restoration Project
Union County, North Carolina

UT 1 Restoration
As-Built Stream Plan & Profile

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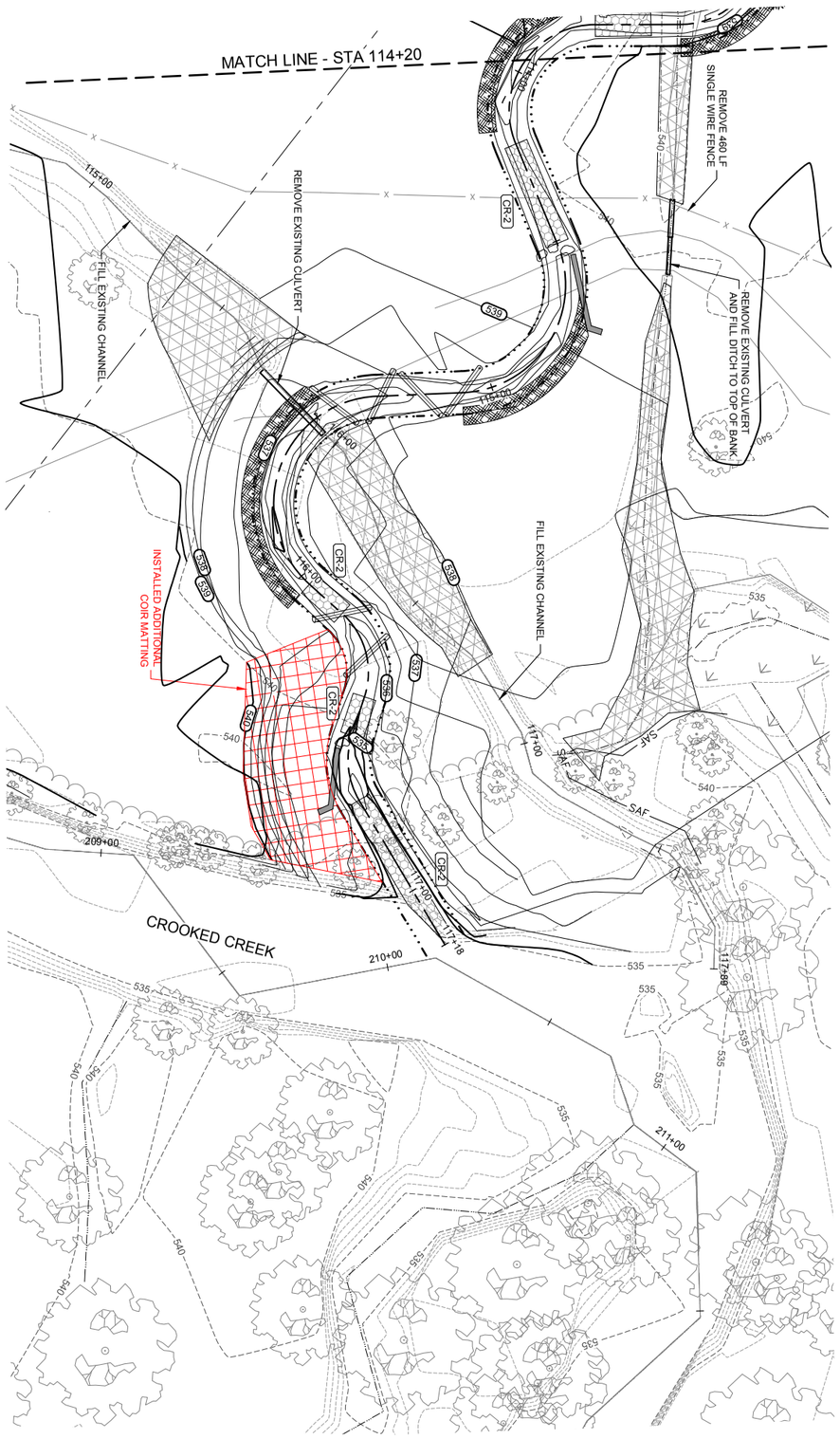

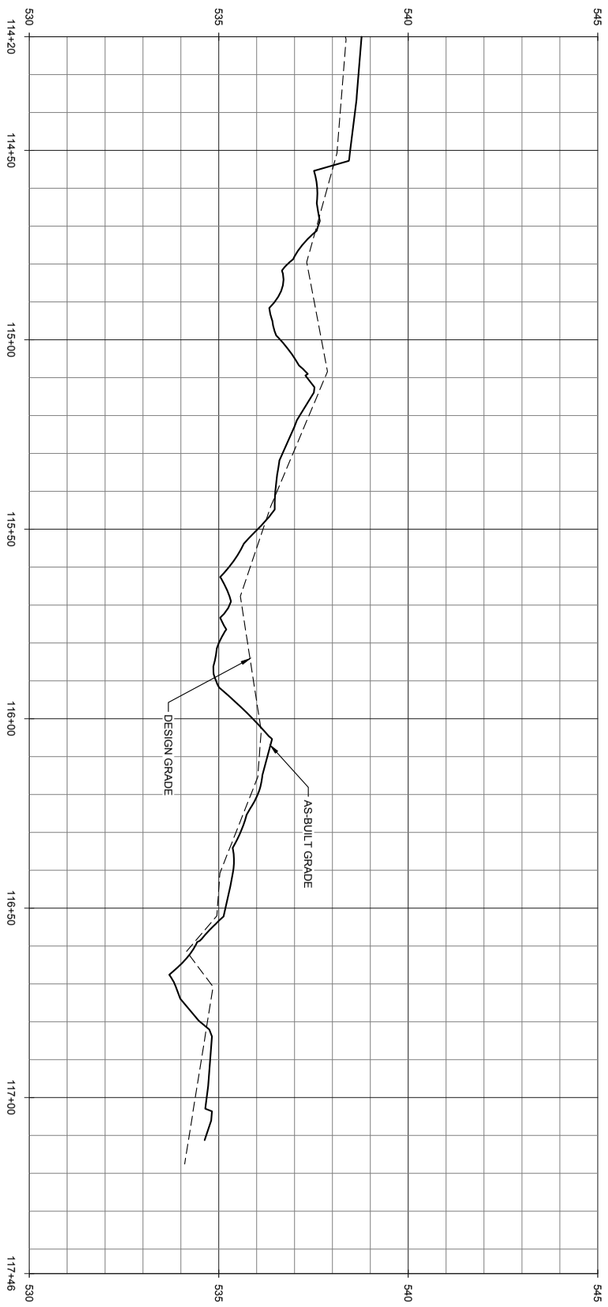

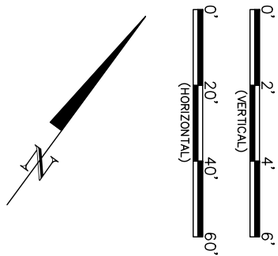

RECORD DRAWINGS - SCO PROJECT # 09-0751301

Date:	July 15, 2015
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
Checked By:	AA

Revisions:

2.4

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Crooked Creek #2 Restoration Project
Union County, North Carolina

UT 1 Restoration
As-Built Stream Plan & Profile

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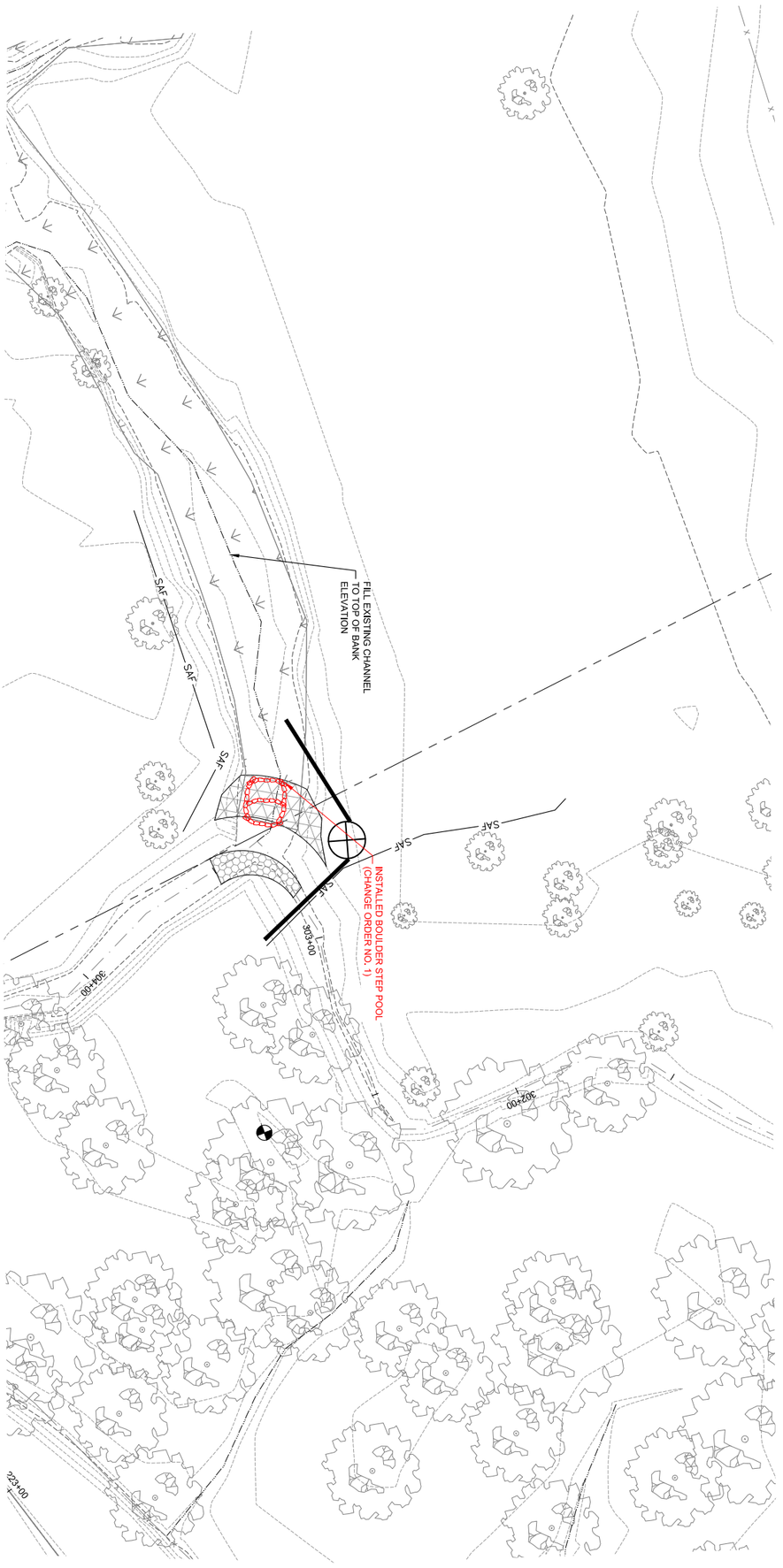

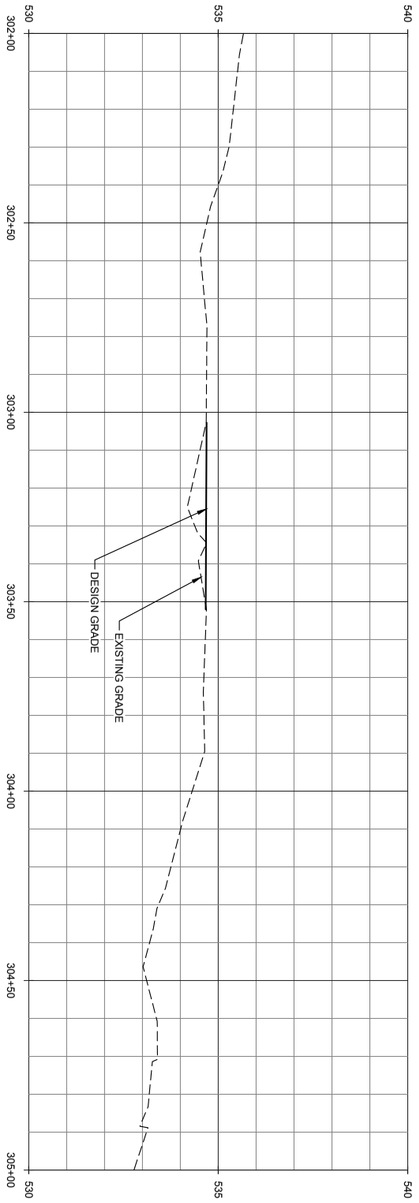

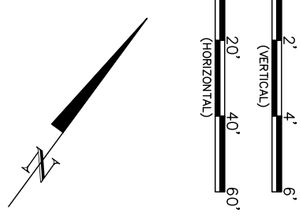

RECORD DRAWINGS - SCO PROJECT # 09-0751301

Date:	July 15, 2015
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
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Revisions:

Crooked Creek #2 Restoration Project
Union County, North Carolina

UT2
As-Built Stream Plan & Profile

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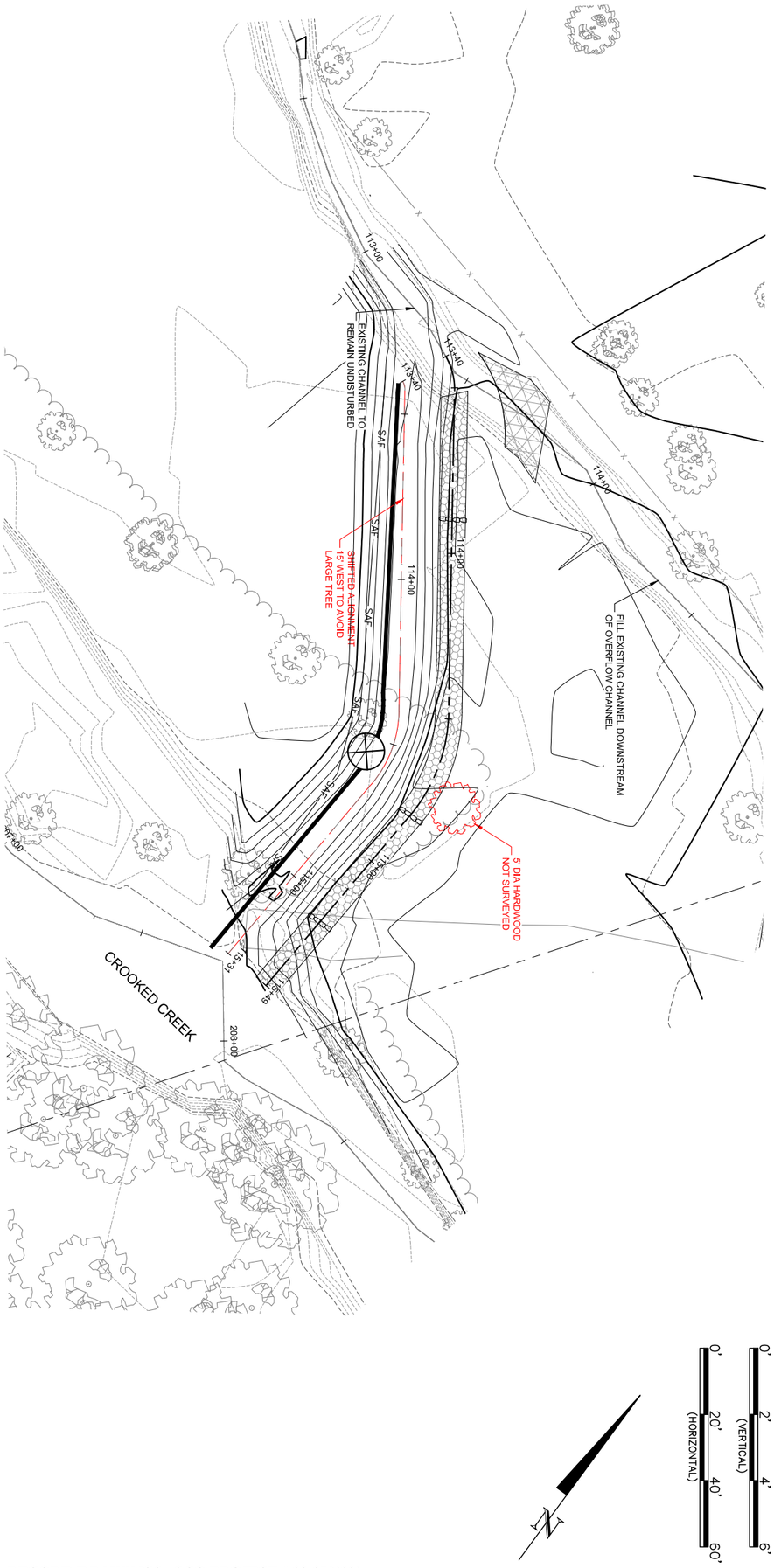

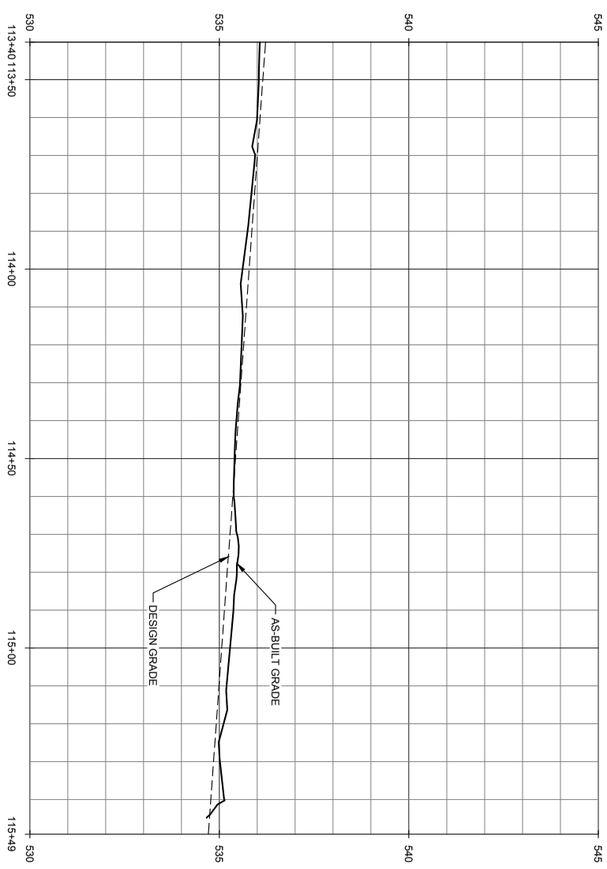

RECORD DRAWINGS - SCO PROJECT # 09-0751301

Date:	July 15, 2015
Job Number:	005-02127
Project Engineer:	ASE
Drawn By:	JCK
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Crooked Creek #2 Restoration Project
Union County, North Carolina

Overflow Channel
As-Built Stream Plan & Profile

NORTH CAROLINA PROFESSIONAL SEAL 029340 ENGINEER JOHN S. ENNIS

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