



August 12, 2016

Mr. Harry Tsomides
NC Department of Environmental Quality
Division of Mitigation Services
5 Ravenscroft Dr., Suite 102
Asheville, NC 28801

RE: Glade Creek II Restoration Project Baseline Monitoring Report
Draft Report Comment Response/Final Report Submittal for DMS
DMS Project #92343
New River Basin – CU# 05050001; Allegheny County, NC

Dear Mr. Tsomides:

Wildlands Engineering, Inc. (Wildlands) has reviewed the Division of Mitigation Services (DMS) comments and observations from the Glade Creek II Restoration Project Draft Baseline Monitoring Report. The following are Wildlands responses to your comments and observations from the report noted in *italics* lettering.

1. Cover Page – Title should read “As-Built Baseline Monitoring Report”; also list DWR # 09-0049 and USACE Action ID 2009-00589 on cover page.

Wildlands Response: These changes have been made.

2. Executive Summary – First sentence, change to “[Wildlands] completed design and construction management on a design-bid build project at...”

Wildlands Response: The first sentence has been updated to reflect Wildlands reference to the full company name; Wildlands Engineering, Inc. (Wildlands).

3. Section 2 –

(1) May want to add an introductory sentence explaining this project as pre-instrument (instituted prior to 7/28/2010).

Wildlands Response: The introduction paragraph has been revised to include the following note clarifying this project is pre-instrument project.

“The Glade Creek Stream Restoration Project was instituted prior to 7/28/2010; therefore, the Site will be monitored for five years post-construction.”



(2) Section 2.1.2 - Should we make mention of pattern monitoring as mitigation plan committed to, and as referenced on page 4-2 about pattern evaluation if other parameters show problems? The narrative only references profile features.

Wildlands Response: Pattern and Profile data has been updated in Sections 2 and 3 and in Table 5.

(3) Section 2.2 - Five year success criteria is incorrect (260 not 320); 8 foot height requirement is unnecessary for a pre-instrument project.

Wildlands Response: This change has been made; however, the 2008 Restoration Plan, Section 8.1. Vegetation states "The survival rate will be based on 320 stems/acre for trees after five years of planting."

4. Section 3 – (1) Section 3.1.2 – mention bank pins, this is something we should add on to the project if bank erosion becomes enough of a problem. (2) Section 3.1.6 – delete last sentence about recommending remedial actions.

Wildlands Response: These edits have been made.

5. Section 4 – Section 4.2 - (1) change last sentence in first paragraph to "The mitigation close out for the site is planned for 2021". (2) Section 4.2.1 bankfull events – why not list the bank full events observed or recorded to date since the completion of construction?

Wildlands Response: The first paragraph in section 4.2 has been updated as requested. No changes were made to Section 4.2.1; crest gages were installed during the as-built monitoring field work. No indicators were noted while on site, such as wrack lines to document bankfull events following construction (prior to gage installation). Wildlands will report all recorded bankfull events (if applicable) in the Year 1 monitoring report.

6. Figure 1 – project location should be outline of the easement, not shaded in red; make roadways and text features more prominent.

Wildlands Response: Figure 1 has been updated.

7. Figures 2 and 3 – (1) UT preservation reach is not accurate; 332 l.f. restoration would be from STA 0+00 to 3+32; preservation reach would be upstream of that.

Wildlands response: Figures 2 and 3 reflect what is reported in Table 1 (FINAL) and the restoration plan addendum. The stationing for UT to Glade Creek Reach 1 and the asset designation for UT to Glade Creek Reach 2 were incorrectly reported in Table 1 (as noted below in comment 8). Table 1 has been updated to match the asset figure, record drawing and reflect the DMS comment #8 below.

(2) show locations of 2 installed gates.

Wildlands Response: The gate locations have been added to Figures 2 and 3.



8. Table 1 – (1) Please calculate the surveyed thalweg length under the power line and apply a 50% reduction to the E1 assets, and calculate the thalweg length across the ford crossing cutout and remove completely from the assets; modify footnote and assets accordingly in Table 1 and elsewhere as applicable. (2) Restoration assets in components section incorrectly listed as Preservation (ratio and assets are correct, just a mis-titled designation).

Wildlands Response: (1) Credits have been adjusted in Table and throughout the report per request above. (2) The asset designation for UT to Glade Creek Reach 2 has been corrected to state Restoration.

9. Table 2 – MY2 through MY5 scheduled deliveries should be November not December. MY1 deliverable may carry over into December to allow the 6 months minimum time between MY0 and MY1 data collections.

Wildlands Response: The correction has been made to Table 2. The as-built was conducted in January 2016. Per the contract, the MY1 delivery date is December 2016, with monitoring being conducted at the end of October/beginning of November.

10. Table 5 – (1) The mitigation plan states a commitment to pattern measurement of Radius of curvature in Year 1 and sinuosity and MWR annually. There should be a footnote indicating Rc will be observed visually for changes at MY1 and pattern will be observed visually (annually) for lateral migration. (2) Footnote abbreviations for RE, R, etc.

Wildlands Response: (1) Footnote now reflected on Table 5. (2) Abbreviation not needed; error was corrected to reflect Riffle Cross Section.

11. Table 8 – How did we end up with contractor-planted species not part of the approved planting plan such as red maple and river birch? Were these approved substitutions or did the contractor act on their own? In any event, deviations from the contracted planting plan should be included as a redlined table (species and quantities) or polygon (planting area) in the record drawings.

Wildlands Response: Wildlands did not approve any substitutes to the planted species list on the plans nor was Wildlands made aware of the contractor's plan to do this. It's hard to tell the species of a bare root stem when it's dormant, so Wildlands did not recognize any deviations during field walks. No changes have been made to the report or record drawings.

Enclosed please find four (4) hard copies of the Final Baseline/As-Built Monitoring Report and one (1) CD with the final electronic files for DMS distribution. Please contact me at 704-332-7754 x110 if you have any questions.

Sincerely,

Kirsten Y. Gimbert
Project Manager
kgimbert@wildlandseng.com



AS-BUILT BASELINE MONITORING REPORT

FINAL

GLADE CREEK II RESTORATION PROJECT

Alleghany County, NC
SCO Project ID 07-07088-01
DMS Project Number 92343
DWR Number 09-0049
USACE Action ID 2009-00589

Data Collection Period: May 2016
Draft Submission Date: June 30, 2016
Final Submission Date: August 12, 2016

PREPARED FOR:



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Division of Mitigation Services
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EXECUTIVE SUMMARY

Wildlands Engineering, Inc. (Wildlands) completed a design-bid-build project at the Glade Creek II Restoration Site (Site) for the North Carolina Division of Mitigation Services (DMS) in Alleghany County, NC. The project components included restoring and enhancing 2,560 linear feet (LF) and preserving 103 LF of perennial stream, restoring 0.16 acre of wetlands, and preserving 0.84 acre of existing wetland. Riparian buffers were also established by removing exotic invasive plants and installing a variety of native vegetation. The Site is expected to generate 2,202 stream mitigation units (SMUs) and 0.33 wetland mitigation units (WMUs) for the Glade Creek watershed (Table 1). The Site is located off US Highway 21 in the northern portion of Alleghany County, NC in the New River Basin, eight-digit Cataloging Unit (CU) 05050001 and the 14-digit Hydrologic Unit Code (HUC) 05050001030020 (Figure 1). The project streams consist of one unnamed tributary, UT to Glade Creek, and two reaches along Glade Creek mainstem (Reach 1 and Reach 2) (Figure 2). Glade Creek flows into the Little River 4 miles northeast of the site near Fox Trot Lane in the Town of Hooker, Alleghany County. The land adjacent to the streams and wetlands is primarily maintained for forestry production of White Pine trees.

The Glade Creek II Restoration Project is located within an DMS Targeted Local Watershed (TLW) (Brush Creek, HUC 05050001030020, as documented within the 2009 River Basin Restoration Priorities (RBRP) for the New River Basin. Furthermore, the project site is located within a priority subwatershed for stream and wetland restoration (and habitat protection), Middle Glade Creek, as identified within 2006 Local Watershed Plan and Preliminary Project Atlas for Little River and Brush Creek. Primary stressors within the Brush Creek TLW and the Middle Glade Creek subwatershed include stream channelization, livestock access, degraded riparian buffers, and Christmas tree farming. Glade Creek is also classified as trout water and the project will help improve trout habitat in the watershed.

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

- Improve water quality by repairing eroding stream banks and establishing riparian buffers;
- Improve the community structure of the buffers;
- Improve stream function and habitat by re-establishing stream-to-floodplain connections;
- Restore long-term stability through the restoration of channel dimension, pattern and profile;
- Improve in-stream habitat using in-stream structures; and
- Remove exotic invasive plant species.

The Site construction was completed between December 2015 and April 2016. The as-built survey was completed in May 2016. Planting was completed in February 2016. Baseline monitoring activities occurred in May 2016. Minimal adjustments were made during construction and specific changes are detailed in Section 5.1. Baseline (MY0) profiles and cross-section (XS) dimensions closely match the design parameters. Cross-section widths and pool depths occasionally exceed design parameters, but are within a normal range of variability. The Site has been built as designed and is expected to meet the upcoming monitoring year's success criteria.



GLADE CREEK II RESTORATION PROJECT
As-Built Baseline Monitoring Report

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Section 1: PROJECT GOALS, BACKGROUND, AND ATTRIBUTES

1.1 Project Location and Setting

The Site is located along Fox Ridge Road, off of US Highway 21 in Glade Valley, Alleghany County, NC (Figure 1). The Site is located on a tract of land owned by Sharon W. Beck (PIN 3999493540). A 12.8-acre conservation easement on the tract was purchased in 2008 by the State of North Carolina (Deed Book 320, Page 1445). The Site is located in the New River Basin, eight-digit Cataloging Unit (CU) 05050001 and the 14-digit Hydrologic Unit Code (HUC) 05050001030020 (Figure 1). Located in the Blue Ridge Belt (USGS,2016), Blue Ridge physiographic province, the project watershed includes primarily agricultural and forest land uses. The drainage area for the project site is 8.0 square miles.

The North Carolina Division of Water Resources (NCDWR) assigns best usage classifications to State Waters that reflect water quality conditions and potential resource usage. Glade Creek (NCDWR Index No. 10-9-9) is the main stream on the Site and is a third order stream. UT to Glade Creek is a first order stream that flows into Glade Creek. Glade Creek has been classified as Class C and Trout waters. Class C waters are protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture, and other uses. A trout water classification is intended to protect freshwaters for natural trout propagation and survival of stocked trout on a year round basis. Glade Creek and UT to Glade are located within the New River Sub-basin 05-07-03. (NCDWR, 2011).

The Glade Creek II Restoration Project is located within an DMS Targeted Local Watershed (Brush Creek, HUC 05050001030020, as documented within the 2009 River Basin Restoration Priorities (RBRP) for the New River Basin. Furthermore, the project site is located within a priority subwatershed for stream and wetland restoration (and habitat protection) – Middle Glade Creek -- as identified within W.K. Dickson's 2006 Local Watershed Plan and Preliminary Project Atlas for Little River and Brush Creek. Primary stressors within the Brush Creek TLW and the Middle Glade Creek subwatershed include stream channelization, livestock access, degraded riparian buffers and Christmas tree farming. Protection and maintenance of bog turtle habitat is another local watershed management goal. Glade Creek is also classified as trout water and is therefore subject to trout buffer rules administered by the NC Division of Land Resources (DLR).

Prior to construction, the streams had been impacted by historic agricultural practices, silviculture and valley filling. In addition, there was widespread bank erosion, especially along the outside meander bends, and mid-channel deposition. The wetlands had been impacted by vegetation clearing, exotic invasive plant species, and the valley fill buried hydric soils.

1.2 Project Goals and Objectives

This mitigation site is intended to provide numerous ecological benefits within the New River Basin and addresses habitat degradation, which is the primary water quality stressor described in the New River Basin Restoration Priorities Plan (2009). While many of the benefits are limited to the immediate 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 were met by giving careful consideration to the goals and objectives described in the RBRP.

The project specific goals of the Glade Creek II Restoration Project Site included the following:

- Improve water quality by repairing eroding stream banks and establishing riparian buffers;
- Improve the community structure of the buffers;
- Improve stream function and habitat by re-establishing stream-to-floodplain connections;



- Restore long-term stability through the restoration of channel dimension, pattern and profile;
- Improve in-stream habitat using in-stream structures; and
- Remove exotic invasive plant species.

The project objectives have been defined as follows:

- Restoration of approximately 2,089 LF of Glade Creek;
- Restoration of 332 LF of the UT to Glade Creek;
- Preservation of 129 LF of the UT to Glade Creek;
- Restoration of 0.16 acre of wetland by improving hydrologic connections;
- Preservation of 0.84 acre of existing jurisdictional wetland; and
- Establishment of riparian buffers by removing exotic invasive plants and installing a variety of native vegetation.

1.3 Project Structure, Restoration Type and Approach

The final mitigation plan, in the form of an addendum, was submitted and accepted by the DMS in January of 2013. Construction activities were completed in December 2015 by Carolina Environmental Contracting, Inc. Storm repairs prior to project closeout were completed in April 2016. Turner Land Surveying completed the as-built survey in January 2016 and the storm repairs were judged to have not resulted in changes that would warrant a revised as-built survey. Planting was completed by Keller Environmental, Inc. in February 2016. Wildlands completed the MYO activities in May 2016. Some design adjustments were made during construction and these adjustments are described in further detail in section 4.1. Appendix 1 includes detailed project activity, history, contact information, and watershed/site background information.

1.3.1 Project Structure

The project is expected to provide 2,202 SMUs and 0.33 WMUs. These project components and mitigation credits reflect assets developed in the final Interagency Review Team (IRT) approved project mitigation plan. Figure 2 is a project component/asset map for the stream and wetland features Table 1 lists the project component and mitigation credit information for the Site.

1.3.2 Restoration Type and Approach

The project streams were restored to the appropriate type based on the surrounding landscape, climate, and natural vegetation communities, and with thorough consideration of existing watershed conditions and trajectory. The project includes stream restoration, enhancement, and preservation as well as wetland restoration and preservation. The specific stream and wetland approaches employed for the project are described below.

The stream restoration portion of this project includes two reaches; Glade Creek Reach 1 and UT Glade Creek Reach 2. The Glade Creek restoration reach enters the Site from a partially cleared area west of the Site, extending past the confluence with UT to Glade Creek downstream approximately midway along the project stream. The stream restoration design was developed based on reference conditions, representing streams within the Blue Ridge Belt region with similar drainage areas, valley slopes, morphology, and bed material. The restoration reaches were designed as alluvial channels due to the relatively high bedload supply. In-stream structures were selected for grade control and bank protection in the form of constructed riffles, geolifts/brush mattresses, log vanes and step structures.

Enhancement level I practices were employed on Glade Creek Reach 2; these included stream bank and floodplain grading, in-stream structures, bioengineering bank treatments, and transplanting of on-site woody vegetation. Reach 1 of the UT to Glade Creek was preserved.



The wetland restoration portion of this project includes one jurisdictional feature (noted Wetland D in the mitigation plan) and the wetland preservation includes three areas (noted as Wetland A, B and C). Wetland D had potential for wetland restoration through a combination of limited valley fill removal, planting, and increased hydrologic inputs from re-routing UT. In conjunction with the restoration efforts on the UT to Glade Creek, surface deposits in the wetland D area were removed and hydrologic connections were created between the wetland D area and the UT and wetland B. The planting included appropriate wetland vegetation in these areas.

1.4 Project History, Contacts and Attribute Data

The Site was restored 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 Glade Creek II Restoration Plan (December 2008). Annual monitoring and semi-annual site visits will be conducted to assess the condition of the finished project. The stream restoration and enhancement reaches (Glade Creek and UT to Glade Creek) of the project were assigned specific performance criteria components for stream morphology, hydrology, and vegetation. Wetland restoration areas were assigned specific performance criteria for wetland hydrology, and vegetation. The Glade Creek Stream Restoration Project was instituted prior to 7/28/2010; therefore, the Site will be monitored for five years post-construction. An outline of the performance criteria components described in the restoration plan (2008) follows.

2.1 Stream

2.1.1 Dimension

Permanent cross sections were established in the frequency of one for every 20 bankfull widths along the length of the reach. Cross-section sites were selected such that approximately half are placed in riffles and half placed in pools. Measurements of W/D ratio, entrenchment ratio, and low bank height ratio will be monitored yearly.

2.1.2 Pattern and Profile

Longitudinal profile surveys will be conducted annually during the five-year monitoring period. Measurements on slope (average, pool, riffle) and pool-to-pool spacing will be collected. Pattern measurements will include sinuosity and meander width ratio and will be performed yearly. Measurements of radius of curvature will be monitored on newly constructed meanders for the first year only (MY0). The visual indicators along the stream restoration reaches should show that the bedform features are remaining stable.

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 Substrate

Reachwide and riffle pebble counts will be measured where appropriate within the Site. The D50 and D84 particle size diameter percentiles will be monitored to assure an increase in coarseness in riffles and an increase in fineness in pools.

2.1.5 Bankfull Documentation

Two bankfull flow events must be documented on the restoration reaches within the five-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 260 planted stems per acre in the planted riparian and wetland corridor at the end of the required monitoring period. The extent of invasive species coverage will also be monitored and controlled as necessary throughout the required monitoring period.

2.3 Wetlands

The target performance criteria for wetland hydrology will be a free groundwater surface within 12 inches of the ground surface for 21 consecutive days (12.5 percent) of the defined 167 day growing season for Alleghany County (April 26 through October 11). The growing season was determined from the long-term records from the National Weather Service provided in the WETS table for nearby Ashe County (WETS temperature data and thus growing season data was not available for Alleghany County). If the 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 reference wetlands 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; and
- Wildlife observations.



Section 3: MONITORING PLAN

Monitoring will consist of collecting morphological, vegetative, and hydrological data to assess the project performance based on the restoration goals and objectives on an annual basis or until success criteria are met. The performance of the project will be assessed using measurements of the stream channel's dimension, substrate composition, reference photographs, vegetation, surface water hydrology, and groundwater hydrology. Any areas with identified high priority problems, such as streambank instability, aggradation/degradation, insufficient groundwater hydro period, or lack of vegetation establishment will be evaluated on a case-by-case basis. The problem areas will be visually noted and mapped and included with annual reports. Table 5 in Appendix 1 includes a 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). Figure 3 in Appendix 1 shows monitoring locations discussed below.

3.1.1 Dimension

In order to monitor the channel dimension, five permanent cross-sections were installed along the stream restoration reaches. 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. Annual cross-section surveys will be conducted for five 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 be conducted annually during the five-year monitoring period along Glade Creek Reach 1 and UT Glade Creek Reach 2. Measurements will be collected to calculate slope (average, pool, riffle) and pool-to-pool spacing. Annual pattern measurements will include sinuosity and meander width ratio. Measurements of radius of curvature will only be reported in MYO. Radius of curvature will be visual assessed during annual site walks. Should bank erosion develop in excess of 5% of the reach length (restoration and enhancement I reaches only), bank pins will be installed following DMS protocol.

3.1.3 Substrate

Reachwide pebble counts were conducted for classification purposes on the restoration reaches; Glade Creek Reach 1 and UT Glade Creek Reach 2. Wetted perimeter riffle pebble counts were also conducted at permanent riffle cross-sections. The pebble counts will be conducted annually for five years following construction and compared with data from previous years.

3.1.4 Photo Reference Points

A total of nine 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 five 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 photographs 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. Two crest gages were installed; one on Glade Creek at cross-section 2 and one on UT to Glade Creek at cross-section 5. The gages will be checked during each site visit to determine if a bankfull event or greater has occurred. Photographs will also be used as applicable 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 five-year monitoring period. Problem areas 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 will be noted. 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.

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 six 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 May 2016. Subsequent annual assessments 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, one groundwater monitoring gage was established within the restoration area using logging hydrology pressure transducers. The gage was installed at an appropriate location so that the data collected will provide an indication of groundwater levels throughout the wetland restoration area. The gage is set to record the ground water level two times per day. If the 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 reference wetlands to assess whether atypical weather conditions occurred during the monitoring period. A permanent photograph reference point was



established to visually document the wetland restoration area (Zone D) each year. Figure 3 in Appendix 1 shows the hydrological monitoring and photo station locations.

Section 4: AS-BUILT CONDITION (BASELINE)

The Site construction was completed between December 2015 and April 2016. The as-built survey was completed in May 2016. The survey scope of work 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: Glade Creek Reach 1, Glade Creek Reach 2, and UT Glade Creek Reach 2.

4.1 Record Drawings

A sealed half-size record drawing is included in Appendix 5 and includes redlines with any significant field adjustments made during construction. 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 Glade Creek Reach 1

- Omitted Geolifts near Station 12+11(XS1);
- Added stone outlet for wetland overflow near Station 15+00;
- Omitted Log Vane near Station 19+00; and
- Geolift changed to Brush Mattress between Stations 19+00 and 20+00.

4.1.2 Glade Creek Reach 2

- Brush Mattress extended 20 ft downstream at Station 27+00 and Omitted Brush Mattress between Station 28+00 and 29+00; and
- Geolift added at Station 30+00.

4.1.3 Wetlands

- Wetland grading was adjusted based on field conditions (moved the lip of the wetland slightly up valley to match the top of bank of UT to Glade Creek).

4.2 Baseline Data Assessment

Baseline monitoring (MY0) was conducted in May 2016. 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 five years, with the final monitoring activities to be conducted in 2020. The mitigation close out for the site is planned for 2021.

4.2.1 Morphological State of the Channel

Morphological data for the as-built profiles were collected in May 2016. Appendix 2 includes summary data tables, morphological plots, and stream photographs.

Profile

The MY0 profile is based on the as-built thalweg, whereas the design profile is based on the design alignment on the record drawings. 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 with the design due to the installation of structures and the presence of debris within

the streambed. Overall, slopes from head of riffle to tail of riffle and riffle length closely matched the design profile.

Additionally, maximum pool depths typically matched or were within ± 0.5 ft of design parameters and are expected to trend towards the design depths as a result of natural deposition or scour over time. These slight 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 annual site walks.

Dimension

The MY0 dimension numbers closely match the design parameters within acceptable ranges of variation. These are reflected in the cross-sections as a larger maximum as-built pool depth and riffle depth. We anticipate that over time pools may accumulate some fine sediment and organic matter. This accumulation of sediment within pools is not considered an indicator of instability.

Pattern

The MY0 pattern metrics fell within acceptable ranges of the design parameters for both restoration reaches.

Bankfull Events

Bankfull events recorded following completion of constructions will be reported in the year one monitoring report.

4.2.2 Vegetation

The MY0 average planted density is 742 stems per acre, which exceeds the measure of vegetative success of at least 320 planted stems per acre at the end of the fifth monitoring year. Summary data and photographs of each plot can be found in Appendix 3.

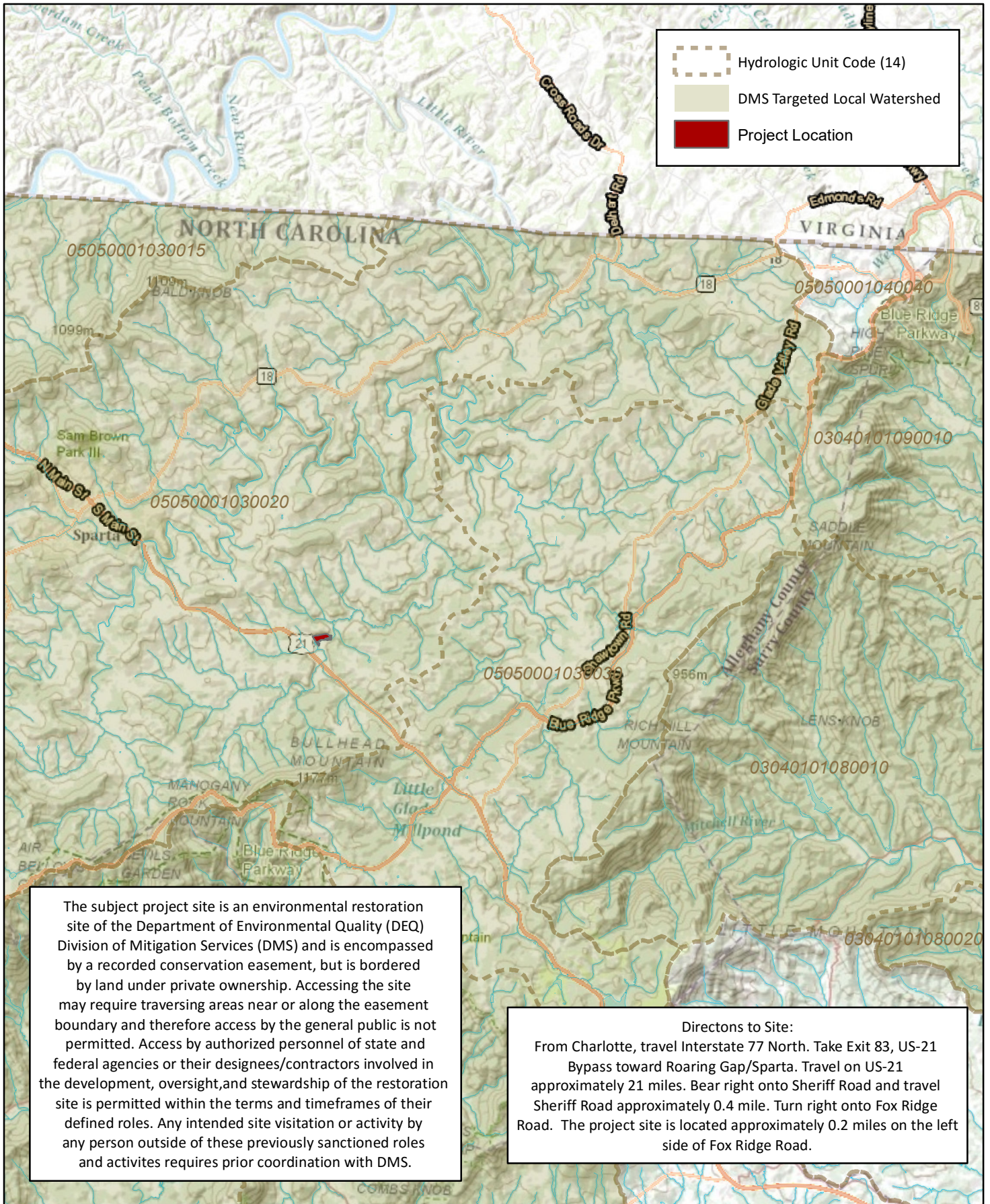


Section 5: REFERENCES

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APPENDIX 1. Tables and Figures



Hydrologic Unit Code (14)
 DMS Targeted Local Watershed
 Project Location

The subject project site is an environmental restoration site of the Department of Environmental Quality (DEQ) 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 activities requires prior coordination with DMS.

Directions to Site:
 From Charlotte, travel Interstate 77 North. Take Exit 83, US-21 Bypass toward Roaring Gap/Sparta. Travel on US-21 approximately 21 miles. Bear right onto Sheriff Road and travel Sheriff Road approximately 0.4 mile. Turn right onto Fox Ridge Road. The project site is located approximately 0.2 miles on the left side of Fox Ridge Road.

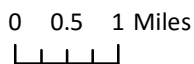


Figure 1 Project Vicinity Map
 Glade Creek II Restoration Project
 DMS Project No. 92343
 Monitoring Year 0 - 2016



Figure 2 Project Component Map
 Glade Creek II Restoration Project
 DMS Project No. 92343
 Monitoring Year 0 - 2016



2014 Aerial Photograph
















-  Conservation Easement
-  Wetland Preservation
-  Wetland Restoration
-  Stream Restoration
-  Stream Enhancement I
-  Stream Preservation
-  Non-Project Streams
-  Reach Breaks
-  Cross Sections (XS)
-  Bankfull
-  Gates
-  Vegetation Plots
-  Photo Points
-  Crest Gage (CG)
-  Grounwater Gage (GWG)

Table 1. Project Components and Mitigation Credits

Glade Creek II Restoration Project
 DMS Project No.92343
 Monitoring Year 0 - 2016

MITIGATION CREDITS								
	Stream		Riparian Wetland	Non-Riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	R	RE			
Totals	2,182	21	0.16	N/A	0.17	N/A		N/A
PROJECT COMPONENTS								
Reach ID	As-Built Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration (R) or Restoration Equivalent (RE)	Restoration Footage/Acreage	Mitigation Ratio	Credits (SMU/WMU)	
STREAMS								
Glade Creek Reach 1	10+00 - 21+70	1170 LF	P2	Restoration (R)	1,170	1:1	1170	
Glade Creek Reach 2*	21+70-26+41; 26+86-29+69; 30+59-32+60	955 LF	P2	Enhancement I (R)	1,000	1.5:1	652	
Glade Creek Reach 2	26+41-26+86	45 LF	P2	Enhancement I (R)	45	3:1	15	
UT to Glade Creek Reach 1	10+00 - 11+03	103 LF	N/A	Preservation (RE)	103	5:1	21	
UT to Glade Creek Reach 2	11+03 - 14+48	345 LF	P1/2	Restoration (R)	345	1:1	345	
WETLANDS								
Wetland A, B, C	N/A	0.84 AC	N/A	Preservation (RE)	0.84	5:1	0.17	
Wetland D	N/A	0.16 AC	N/A	Restoration (R)	0.16	1:1	0.16	
COMPONENT SUMMATION								
Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (square feet)	Upland (acres)		
		Riverine	Non-Riverine					
Restoration	1,432	0.16						
Preservation	129			0.84				
Enhancement I	1,020							
Enhancement II								
Creation								

* Stream Enhancement I credit reduced; 90 LF removed at break in conservation easement and 45 LF reduced by 50% at overhead power easement.

Table 2. Project Activity and Reporting History

Glade Creek II Restoration Project
 DMS Project No.92343
Monitoring Year 0 - 2016

Activity or Report	Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan	December 2008	December 2008
Mitigation Plan Addendum	January 2013	January 2013
Final Design - Construction Plans	January 2015	January 2015
Construction	December 2015 - April 2016	April 2016
Temporary S&E mix applied to entire project area ¹	December 2015 - April 2016	April 2016
Permanent seed mix applied to reach/segments ¹	December 2015 - April 2016	April 2016
Bare root and live stake plantings for reach/segments	February 2016	February 2016
Baseline Monitoring Document (Year 0)	May 2016	June 2016
Year 1 Monitoring	Fall 2016	December 2016
Year 2 Monitoring	2017	December 2017
Year 3 Monitoring	2018	December 2018
Year 4 Monitoring	2019	December 2019
Year 5 Monitoring	2020	December 2020

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

Table 3. Project Contact Table

Glade Creek II Restoration Project
 DMS Project No.92343
Monitoring Year 0 - 2016

Designer Andrew Bick, PE, CFM	Wildlands Engineering, Inc. 167-B Haywood Rd. Asheville, NC 28806 828.774.5547
Construction Contractor	Carolina Environmental Contracting, Inc. PO Box 1905 Mt. Airy NC 27030
Planting Contractor	Keller Environmental 7921 Haymarket Lane Raleigh, NC 27615
Seeding Contractor	Carolina Environmental Contracting, Inc. PO Box 1905 Mt. Airy NC 27030
Seed Mix Sources	Carolina Environmental Contracting, Inc.
Wetland Enhancement Nursery Stock Suppliers Bare Roots Live Stakes Plugs	---
Monitoring Performers	Wildlands Engineering, Inc.
Monitoring, POC	Kirsten Gimbert 704.332.7754, ext. 110

--- Data not provided

Table 4. Project Information and Attributes

Glade Creek II Restoration Project

DMS Project No.92343

Monitoring Year 0 - 2016

PROJECT INFORMATION				
Project Name	Glade Creek II Restoration Project			
County	Allegheny			
Project Area (acres)	14.00			
Project Coordinates (latitude and longitude)	36° 28' 37.0878"N, -81° 3' 42.7896"W			
PROJECT WATERSHED SUMMARY INFORMATION				
Physiographic Province	Blue Ridge Mountains			
River Basin	New River			
USGS Hydrologic Unit 8-digit	05050001			
USGS Hydrologic Unit 14-digit	05050001030030			
DWR Sub-basin	05-07-03			
Project Drainage Area (acres)	5,120			
Project Drainage Area Percentage of Impervious Area	<1%			
CGIA Land Use Classification	61% Forested, 35% Agriculture/Livestock, 3% Residential/Commercial			
REACH SUMMARY INFORMATION				
Parameters	Glade Creek Reach 1	Glade Creek Reach 2	UT to Glade Creek Reach 1	UT to Glade Creek Reach 2
Length of reach (linear feet) - Post-Restoration	1,200	1,074	129	197
Drainage area (acres)		5,120		13
NCDWR stream identification score		47		31
NCDWR Water Quality Classification		C; Tr		
Morphological Description (stream type)		C4		B4
Evolutionary trend (Simon's Model) - Pre- Restoration	---	---	---	---
Underlying mapped soils	Suncook and Chandler			
Drainage class	---	---	---	---
Soil hydric status	---	---	---	---
Slope	---	---	---	---
FEMA classification	no regulated floodplain		no regulated floodplain	
Native vegetation community	Acidic Cove Forest and Mesix Mixed Hardwood Forest			
Percent composition exotic invasive vegetation -Post-Restoration	0%		0%	
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. 3885. Action ID # 2009-00589	
Waters of the United States - Section 401	Yes	Yes		
Division of Land Quality (Erosion and Sediment Control)	Yes	Yes	NPDES Construction Stormwater General Permit NCG010000	
Endangered Species Act	Yes	Yes	Glade Creek II Restoration Project; Ward Consulting determined "no affect" on Allegheny County listed endangered species	
Historic Preservation Act	Yes	Yes	No recommendations received.	
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A	
FEMA Floodplain Compliance	N/A	N/A	The upper portion of Glade Creek is not currently mapped as a regulated flood zone	
Essential Fisheries Habitat	N/A	N/A	N/A	

--- Data not provided

Table 5. Monitoring Component Summary

Glade Creek II Restoration Project

DMS Project No.92343

Monitoring Year 0 - 2016

Parameter	Monitoring Feature	Quantity/ Length by Reach			Frequency
		Glade Creek	UT to Glade Creek	Wetlands	
Dimension	RE	2	1	D	Annual
	Pool Cross Section	1	1	N/A	
Pattern	Pattern	N/A	N/A	N/A	
Profile	Longitudinal Profile	Yes	Yes	N/A	Annual
Substrate	Reach Wide (RW) / Riffle 100 Pebble Count (RF)	RW-1, RF 1	RW-1, RF-1	N/A	Annual
Stream Hydrology	Crest Gage	1	1	N/A	Semi-Annual
Wetland Hydrology	Groundwater Gages	N/A	N/A	Enhancement I (R)	Semi-Annual
Vegetation	CVS Level 2	6			Annual
Visual Assessment	All Streams	Y	Y	Y	Semi-Annual
Exotic and nuisance vegetation					Semi-Annual
Project Boundary					Semi-Annual
Reference Photos	Photographs	9			Annual

APPENDIX 2. Morphological Summary Data and Plots

Table 6. Baseline Stream Data Summary

Glade Creek II Restoration Project

DMS Project No.92343

Monitoring Year 0 - 2016

Parameter	Gage	PRE-RESTORATION CONDITION				REFERENCE REACH DATA				DESIGN				AS-BUILT/BASELINE				
		Glade Creek		UT to Glade Creek		Glade Creek Restoration		UT to Little Pine Trib 1		Glade Creek		UT to Glade Creek		Glade Creek		UT to Glade Creek		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Dimension and Substrate - Shallow																		
Bankfull Width (ft)	N/A	17.7	38.5	5.2	9.9	36.3	48.8	6.2	11.1	33		5.4		34.6	37.4	5.3		
Floodprone Width (ft)		47	115	7	12	69	118	14	46	99	165	22.0	33.0	106.4	110.9	61.1		
Bankfull Mean Depth		2.6	2.1	0.3	0.5	0.9	1.3	0.9	0.5	2.3		0.3		1.9	2.2	0.5		
Bankfull Max Depth		2.9	4.1	0.5	0.8	1.9	1.9	0.8	1.6	3.0		0.4		2.9	3.2	0.9		
Bankfull Cross-sectional Area (ft ²)		46.9	79.0	2.1	5.1	45.6	64.1	3.8	5.1	76.5		1.7		70.2	77.1	2.4		
Width/Depth Ratio		6.7	18.8	17.3	26.8	40.3	37.2	6.9	24.2	14.2		17.4		15.5	19.9	11.8		
Entrenchment Ratio		2.7	3.1	1.2	1.5	1.9	2.4	2.3	4.1	3.0	5.0	4.0	6.0	2.8	3.2	11.4		
Bank Height Ratio		1.1	1.7	0.0	0.0	1.0	1.0	1.0	2.1	1.0		1.0		1.0		1.0		
D50 (mm)		28.0	31.0	7	7	44.0	47.0	7.0	7.0	28	31	7.0		90.0		32.0		
Riffle Length (ft)		N/A													33	57	6.8	32.6
Riffle Slope (ft/ft)														0.0087	0.0271	0.0193	0.0964	
Pool Length (ft)										5				64.0	197.8	8.8	32.9	
Pool Max Depth (ft)	4.4		6.6	0.8		5.0		0.7	1.5	3.3	4.1	0.8	1.0	3.8	5.9	1.5		
Pool Spacing (ft)														107	353	33.0	70.0	
Pool Volume (ft ³)																		
Pattern																		
Channel Beltwidth (ft)	N/A	60	240	7	16	---	---	19	26	112	205	17		155	282	75.0		
Radius of Curvature (ft)		21	114	---	---	---	---	30		59.0	99.0	30		59.0	99.0	30		
Rc:Bankfull Width (ft/ft)		1.2	3.0	---	---	---	---	3.2	5.9	1.8	3.0	5.5-6.0		1.8	3.0	5.5-6.0		
Meander Length (ft)				---	---	---	---	---	---	---	---	---	---	230	620	150		
Meander Width Ratio		3.4	6.2	1.3	1.6	---	---	2.5	3.5	3.4	6.2	3.1	7.0	3.4	6.2	3.1	7.0	
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/-						1/26.47/42.3/128/180/>2048		0.11/0.63/13.3/176/241.4/>2048		
Reach Shear Stress (Competency) lb/ft ²		---		---						0.48		0.52	0.82	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	8.00		0.02		4.60		0.05		8.00		0.02		8.00		0.02		
Watershed Impervious Cover Estimate (%)																		
Rosgen Classification		E4/C4		F4/B4		C4		C4/B4		C4		B4		C4		B4		
Bankfull Velocity (fps)		3.8	5.3	3.8	4.9	3.1	4.4	4.5	6.1	3.9	4.7							
Bankfull Discharge (cfs)		250	300	8	25	200	23	300	8									
Q-NFF regression (2-yr)		493		5		352												
Q-USGS extrapolation (1.2-yr)		561		4		335												
Q-Mannings		213	320	8	153	228												
Valley Length (ft)		---		---		---		---		1,322		280		1,322		280		
Channel Thalweg Length (ft)		1200		197		---		---		2,120		197		2,120		326		
Sinuosity		1.68		1.04		1.18		1.09		1.68		1.14		1.60		1.16		
Water Surface Slope (ft/ft) ²		0.0038		0.048		0.0049		0.0473		0.0038		0.0440		0.0031		0.0397		
Bankfull Slope (ft/ft)		---		---		---		---		---		---		0.0031		0.0326		

SC: Silt/Clay <0.062 mm diameter particles

(---): Data was not provided

N/A: Not Applicable

N/A¹: The Rosgen classification system is for natural streams. These channels have been heavily manipulated by man and therefore the Rosgen classification system is not applicable

N/A²: Downstream of the confluence with overflow channel, hydraulic regime not applicable

*: Channel was dry during survey, slope was calculated using channel thalweg

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

Glade Creek II Restoration Project

DMS Project No.92343

Monitoring Year 0 - 2016

	Cross-Section 1, Glade Creek (Riffle)						Cross-Section 2, Glade Creek (Riffle)						Cross-Section 3, Glade Creek (Pool)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
<i>based on fixed bankfull elevation</i>																		
Bankfull Width (ft)	37.4						34.6						31.9					
Floodprone Width (ft)	106						110.9						---					
Bankfull Mean Depth (ft)	1.9						2.2						2.8					
Bankfull Max Depth (ft)	2.9						3.2						4.2					
Bankfull Cross-Sectional Area (ft ²)	70.2						77.1						89.0					
Bankfull Width/Depth Ratio	19.9						15.5						11.5					
Bankfull Entrenchment Ratio	2.8						3.2						---					
Bankfull Bank Height Ratio	1.0						1.0						1.0					
	Cross-Section 4, UT to Glade Creek (Pool)						Cross-Section 5, UT to Glade Creek (Riffle)											
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5						
<i>based on fixed bankfull elevation</i>																		
Bankfull Width (ft)	5.3						5.3											
Floodprone Width (ft)	---						61.1											
Bankfull Mean Depth (ft)	0.9						0.5											
Bankfull Max Depth (ft)	1.5						0.9											
Bankfull Cross-Sectional Area (ft ²)	4.7						2.4											
Bankfull Width/Depth Ratio	6.0						11.8											
Bankfull Entrenchment Ratio	---						11.4											
Bankfull Bank Height Ratio	1.1						1.0											

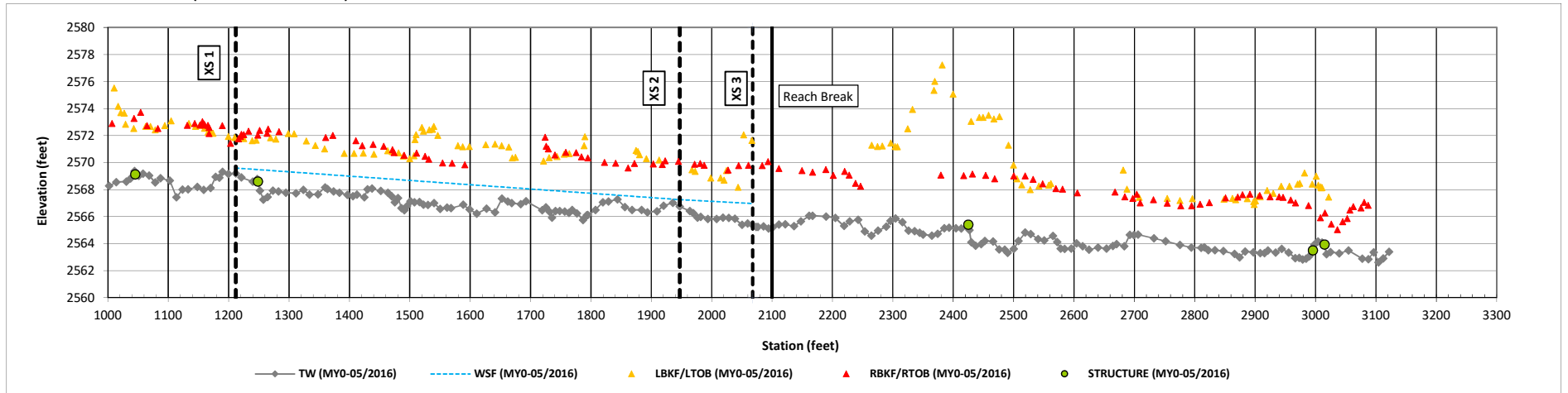
Longitudinal Profile Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 0 - 2016

Glade Creek II Reach 1 and 2 (STA 10+00 - STA 31+20)



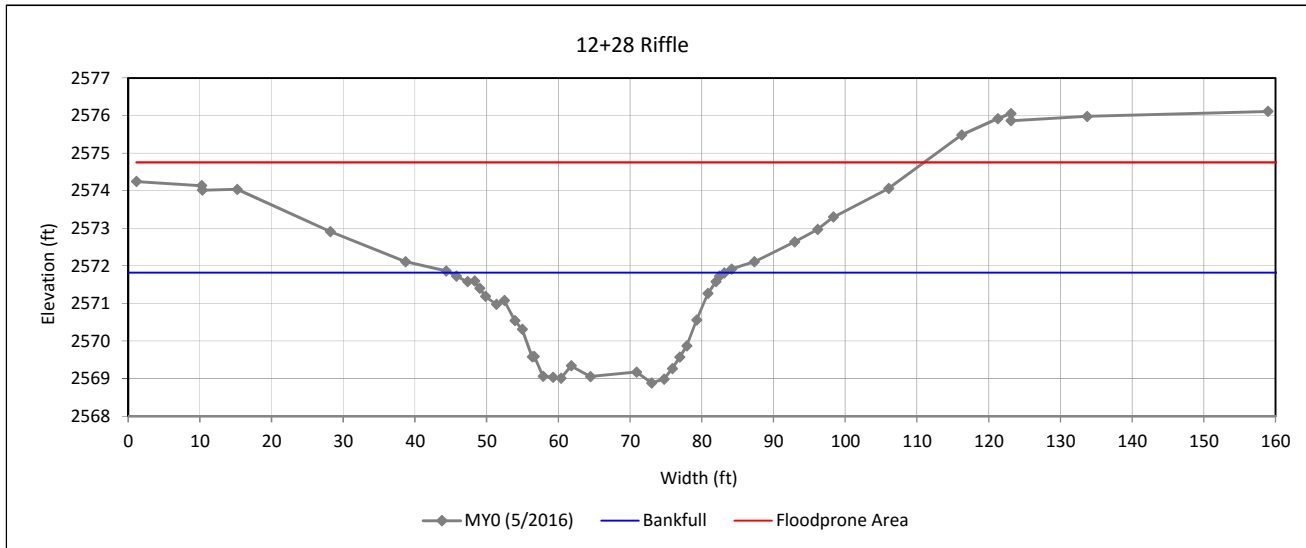
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 0 - 2016

Cross-Section XS1- Glade Creek



Bankfull Dimensions

70.2	x-section area (ft.sq.)
37.4	width (ft)
1.9	mean depth (ft)
2.9	max depth (ft)
38.4	wetted perimeter (ft)
1.8	hydraulic radius (ft)
19.9	width-depth ratio
106.4	W flood prone area (ft)
2.8	entrenchment ratio
1.0	low bank height ratio

Survey Date: 5/2016

Field Crew: Wildlands Engineering



View Downstream

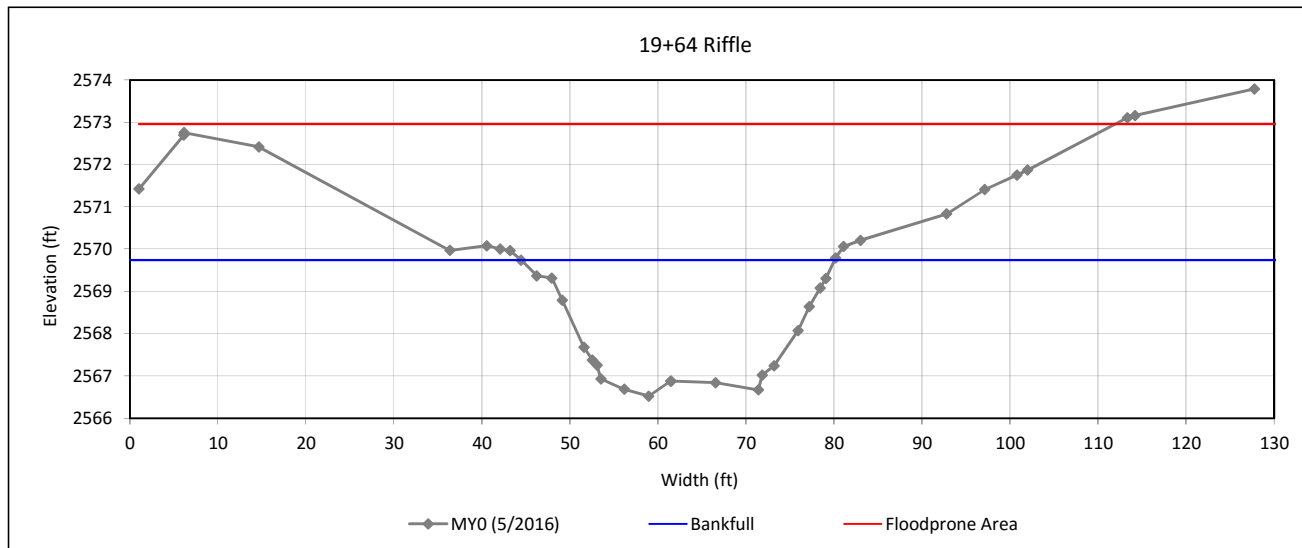
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 0 - 2016

Cross-Section XS2 - Glade Creek



Bankfull Dimensions

77.1	x-section area (ft.sq.)
34.6	width (ft)
2.2	mean depth (ft)
3.2	max depth (ft)
35.7	wetted perimeter (ft)
2.2	hydraulic radius (ft)
15.5	width-depth ratio
110.9	W flood prone area (ft)
3.2	entrenchment ratio
1.0	low bank height ratio

Survey Date: 5/2016

Field Crew: Wildlands Engineering



View Downstream

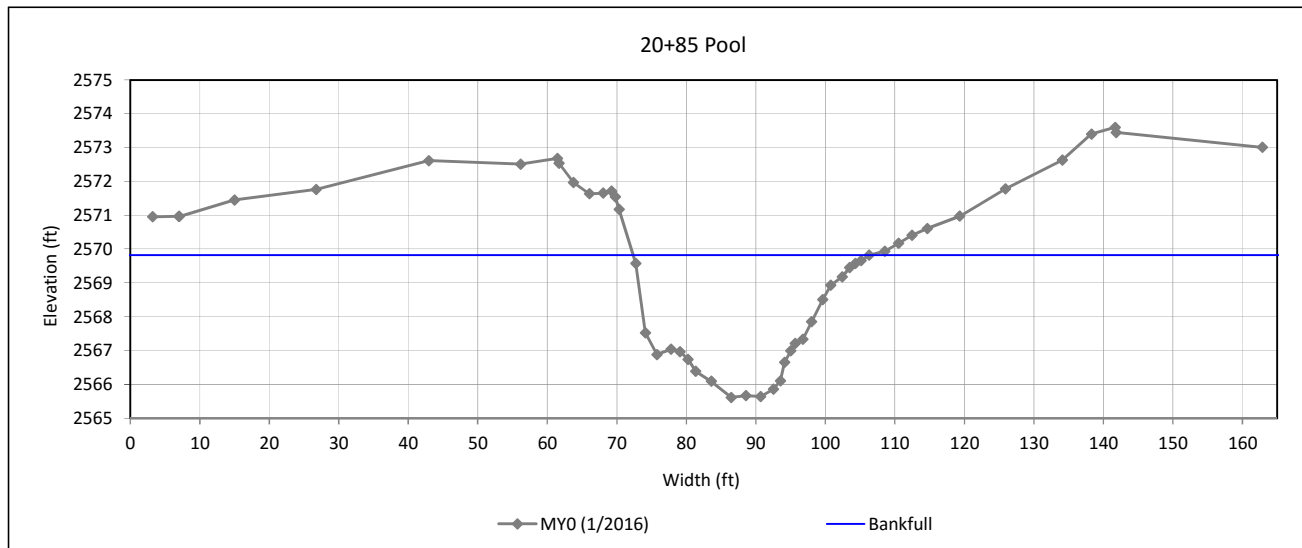
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 0 - 2016

Cross-Section XS3 - Glade Creek



Bankfull Dimensions

89.0	x-section area (ft.sq.)
31.9	width (ft)
2.8	mean depth (ft)
4.2	max depth (ft)
34.1	wetted perimeter (ft)
2.6	hydraulic radius (ft)
11.5	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
0.0	low bank height ratio

Survey Date: 5/2016

Field Crew: Wildlands Engineering



View Downstream

Reachwide and Cross Section Pebble Count Plots

Glade Creek II Restoration Project

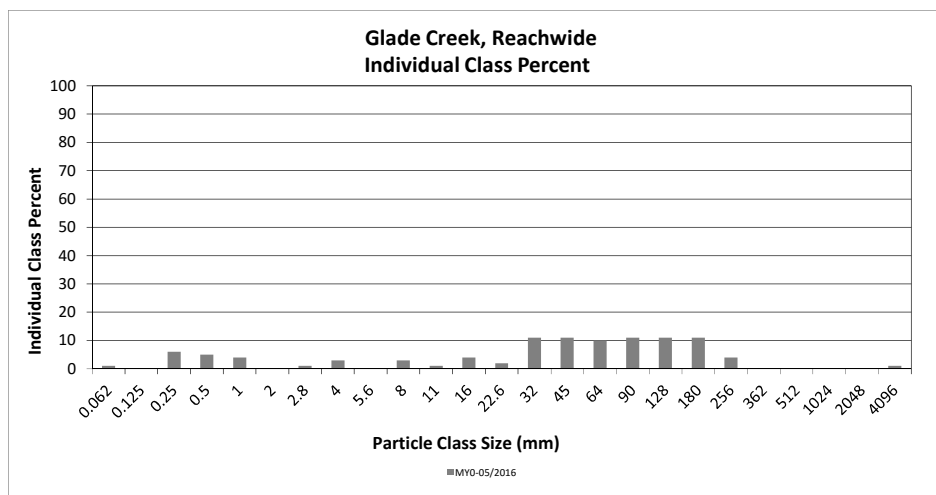
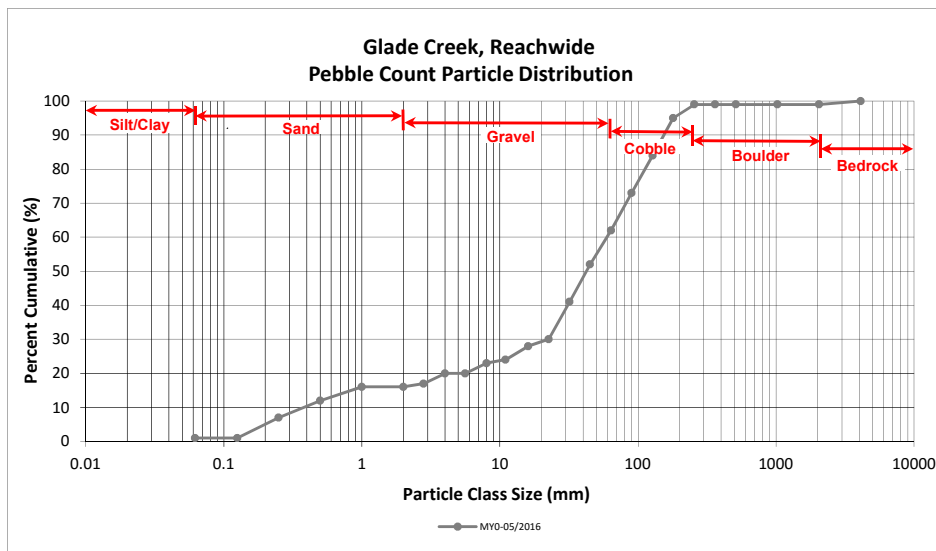
DMS Project No. 92343

Monitoring Year 0 - 2016

Glade Creek, 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		1	1	1
SAND	Very fine	0.062	0.125					1
	Fine	0.125	0.250	1	5	6	6	7
	Medium	0.25	0.50		5	5	5	12
	Coarse	0.5	1.0		4	4	4	16
	Very Coarse	1.0	2.0					16
GRAVEL	Very Fine	2.0	2.8		1	1	1	17
	Very Fine	2.8	4.0	1	2	3	3	20
	Fine	4.0	5.6					20
	Fine	5.6	8.0		3	3	3	23
	Medium	8.0	11.0	1		1	1	24
	Medium	11.0	16.0		4	4	4	28
	Coarse	16.0	22.6	1	1	2	2	30
	Coarse	22.6	32	6	5	11	11	41
	Very Coarse	32	45	6	5	11	11	52
	Very Coarse	45	64	9	1	10	10	62
COBBLE	Small	64	90	7	4	11	11	73
	Small	90	128	5	6	11	11	84
	Large	128	180	8	3	11	11	95
	Large	180	256	3	1	4	4	99
BOULDER	Small	256	362					99
	Small	362	512					99
	Medium	512	1024					99
	Large/Very Large	1024	2048					99
BEDROCK	Bedrock	2048	>2048	1		1	1	100
Total				50	50	100	100	100

Reachwide Channel materials (mm)	
D ₁₆ =	1.00
D ₃₅ =	26.47
D ₅₀ =	42.3
D ₈₄ =	128.0
D ₉₅ =	180.0
D ₁₀₀ =	>2048



Reachwide and Cross Section Pebble Count Plots

Glade Creek II Restoration Project

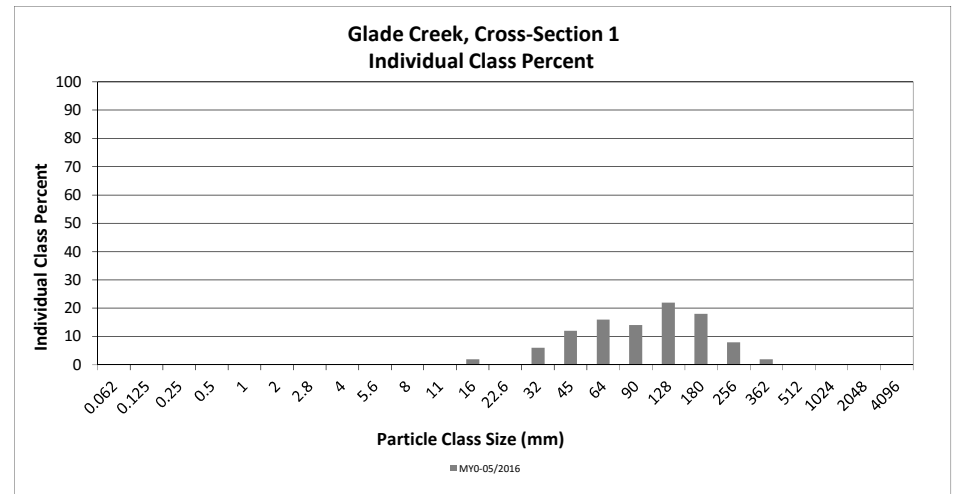
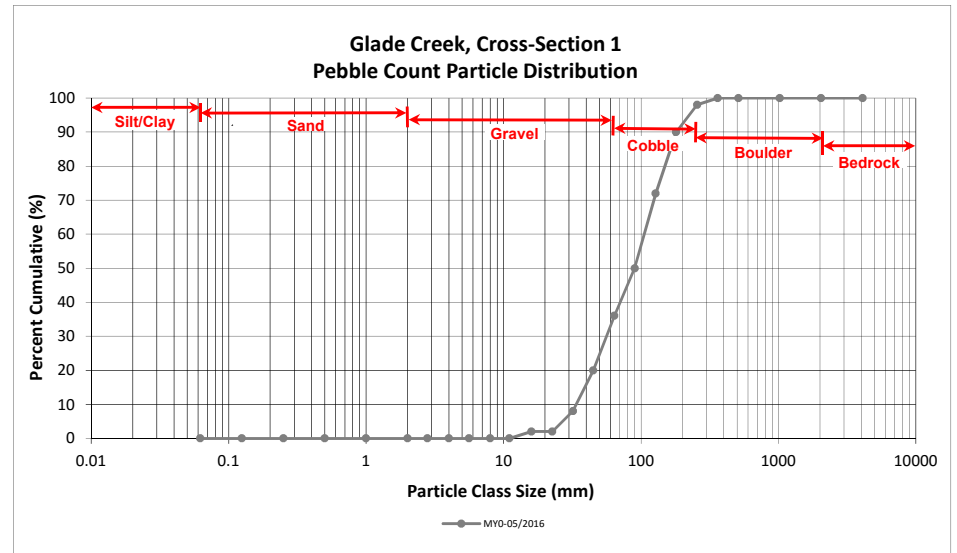
DMS Project No. 92343

Monitoring Year 0 - 2016

Glade Creek, Cross-Section 1

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50			0
	Coarse	0.5	1.0			0
	Very Coarse	1.0	2.0			0
GRAVEL	Very Fine	2.0	2.8			0
	Very Fine	2.8	4.0			0
	Fine	4.0	5.6			0
	Fine	5.6	8.0			0
	Medium	8.0	11.0			0
	Medium	11.0	16.0	2	2	2
	Coarse	16.0	22.6			2
	Coarse	22.6	32	6	6	8
	Very Coarse	32	45	12	12	20
Very Coarse	45	64	16	16	36	
COBBLE	Small	64	90	14	14	50
	Small	90	128	22	22	72
	Large	128	180	18	18	90
	Large	180	256	8	8	98
BOULDER	Small	256	362	2	2	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 1	
Channel materials (mm)	
D ₁₆ =	40.17
D ₃₅ =	62.61
D ₅₀ =	90.0
D ₈₄ =	160.7
D ₉₅ =	224.3
D ₁₀₀ =	362.0



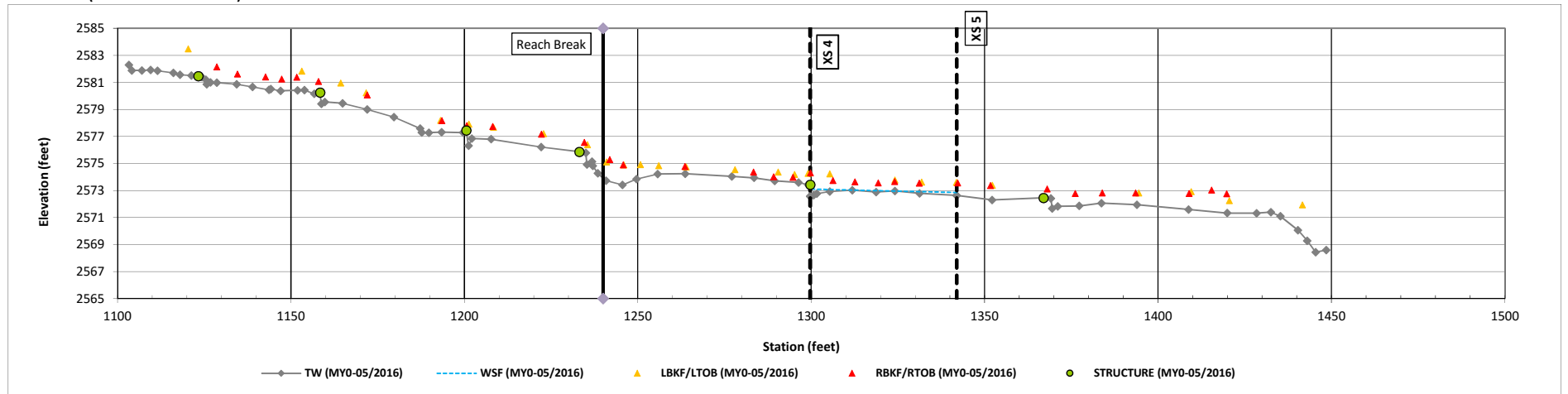
Longitudinal Profile Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 0 - 2016

UT to Glade (STA 11+00 - STA 14+61)



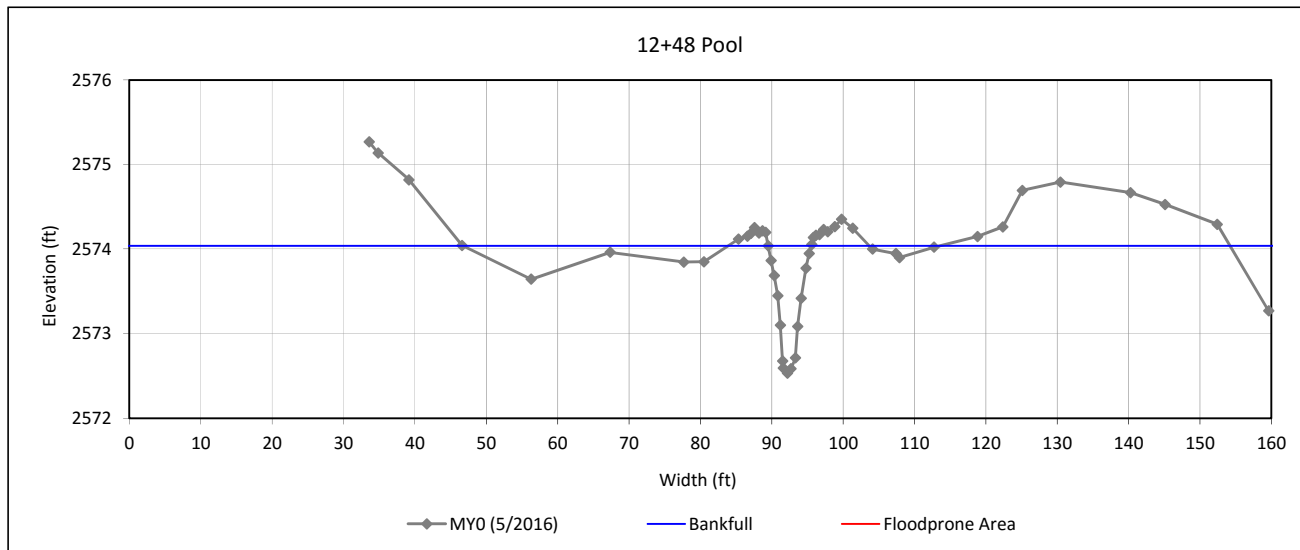
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 0 - 2016

Cross-Section XS4-UT



Bankfull Dimensions

4.7	x-section area (ft.sq.)
5.3	width (ft)
0.9	mean depth (ft)
1.5	max depth (ft)
6.2	wetted perimeter (ft)
0.8	hydraulic radius (ft)
6.0	width-depth ratio
150.0	W flood prone area (ft)
28.3	entrenchment ratio
1.1	low bank height ratio

Survey Date: 5/2016

Field Crew: Wildlands Engineering



View Downstream

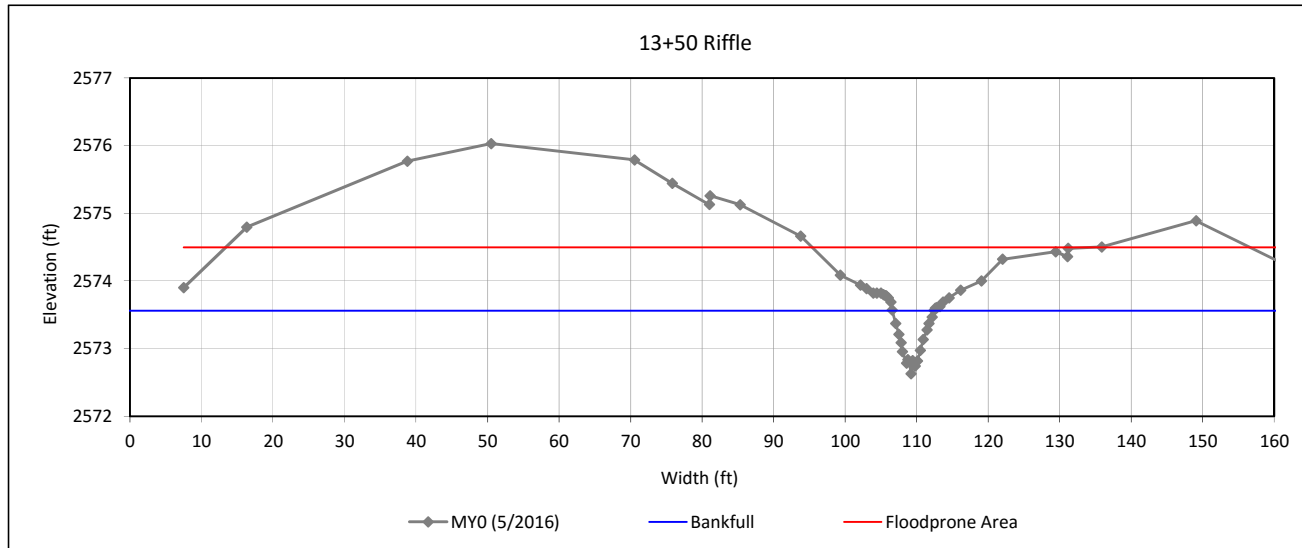
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 0 - 2016

Cross-Section XS5-UT



Bankfull Dimensions

2.4	x-section area (ft.sq.)
5.3	width (ft)
0.5	mean depth (ft)
0.9	max depth (ft)
5.7	wetted perimeter (ft)
0.4	hydraulic radius (ft)
11.8	width-depth ratio
61.1	W flood prone area (ft)
11.4	entrenchment ratio
1.0	low bank height ratio

Survey Date: 5/2016

Field Crew: Wildlands Engineering



View Downstream

Reachwide and Cross Section Pebble Count Plots

Glade Creek II Restoration Project

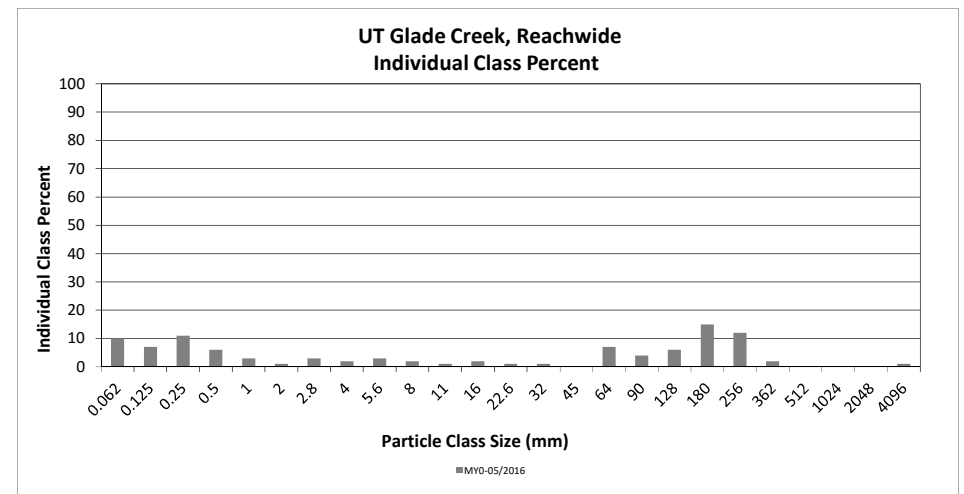
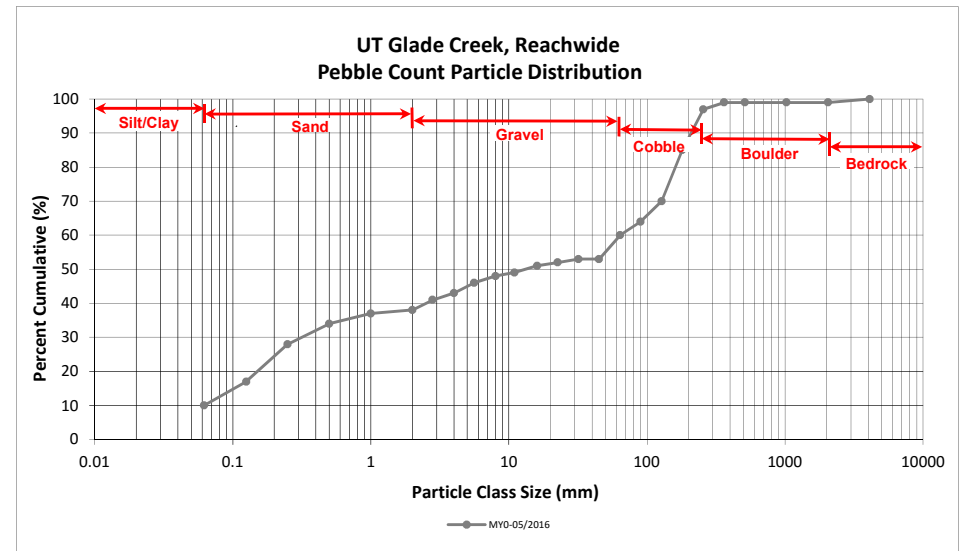
DMS Project No. 92343

Monitoring Year 0 - 2016

UT Glade Creek, 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	8	10	10	10
SAND	Very fine	0.062	0.125	4	3	7	7	17
	Fine	0.125	0.250	8	3	11	11	28
	Medium	0.25	0.50	3	3	6	6	34
	Coarse	0.5	1.0	1	2	3	3	37
	Very Coarse	1.0	2.0		1	1	1	38
GRAVEL	Very Fine	2.0	2.8	2	1	3	3	41
	Very Fine	2.8	4.0	1	1	2	2	43
	Fine	4.0	5.6	2	1	3	3	46
	Fine	5.6	8.0	1	1	2	2	48
	Medium	8.0	11.0		1	1	1	49
	Medium	11.0	16.0	1	1	2	2	51
	Coarse	16.0	22.6	1		1	1	52
	Coarse	22.6	32		1	1	1	53
	Very Coarse	32	45					53
	Very Coarse	45	64	6	1	7	7	60
COBBLE	Small	64	90	4		4	4	64
	Small	90	128	6		6	6	70
	Large	128	180	15		15	15	85
	Large	180	256	11	1	12	12	97
BOULDER	Small	256	362	2		2	2	99
	Small	362	512					99
	Medium	512	1024					99
	Large/Very Large	1024	2048					99
BEDROCK	Bedrock	2048	>2048					100
Total				70	30	100	100	100

Reachwide Channel materials (mm)	
D ₁₆ =	0.11
D ₃₅ =	0.63
D ₅₀ =	13.3
D ₈₄ =	176.0
D ₉₅ =	241.4
D ₁₀₀ =	>2048



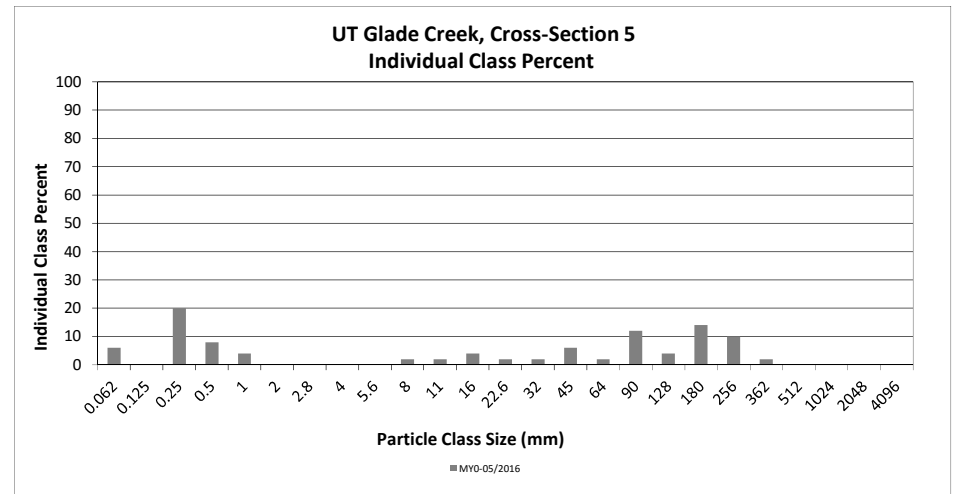
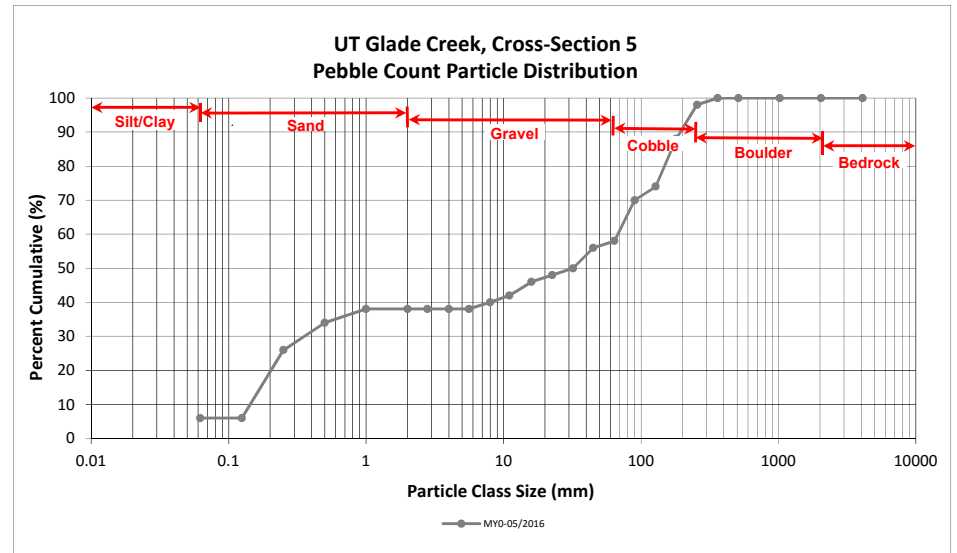
Reachwide and Cross Section Pebble Count Plots

Glade Creek II Restoration Project
 DMS Project No. 92343
 Monitoring Year 0 - 2016

UT Glade Creek, Cross-Section 5

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	6	6	6
SAND	Very fine	0.062	0.125			6
	Fine	0.125	0.250	20	20	26
	Medium	0.25	0.50	8	8	34
	Coarse	0.5	1.0	4	4	38
	Very Coarse	1.0	2.0			38
GRAVEL	Very Fine	2.0	2.8			38
	Very Fine	2.8	4.0			38
	Fine	4.0	5.6			38
	Fine	5.6	8.0	2	2	40
	Medium	8.0	11.0	2	2	42
	Medium	11.0	16.0	4	4	46
	Coarse	16.0	22.6	2	2	48
	Coarse	22.6	32	2	2	50
	Very Coarse	32	45	6	6	56
	Very Coarse	45	64	2	2	58
COBBLE	Small	64	90	12	12	70
	Small	90	128	4	4	74
	Large	128	180	14	14	88
	Large	180	256	10	10	98
BOULDER	Small	256	362	2	2	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 5 Channel materials (mm)	
D ₁₆ =	0.18
D ₃₅ =	0.59
D ₅₀ =	32.0
D ₈₄ =	163.3
D ₉₅ =	230.3
D ₁₀₀ =	362.0



Stream Photographs



Photo Point 1 – looking upstream UT Glade Creek (05/06/2016)



Photo Point 1 – looking downstream UT Glade Creek (05/06/2016)



Photo Point 2 – looking upstream UT Glade Creek (05/06/2016)



Photo Point 2 – looking upstream Glade Creek (05/06/2016)



Photo Point 2 – looking downstream Glade Creek (05/06/2016)



Photo Point 3 – looking upstream Glade Creek (05/06/2016)



Photo Point 3 – looking downstream Glade Creek (05/06/2016)



Photo Point 4 – looking upstream Glade Creek (05/06/2016)



Photo Point 4 – looking downstream Glade Creek (05/06/2016)



Photo Point 5 – looking upstream Glade Creek (05/06/2016)

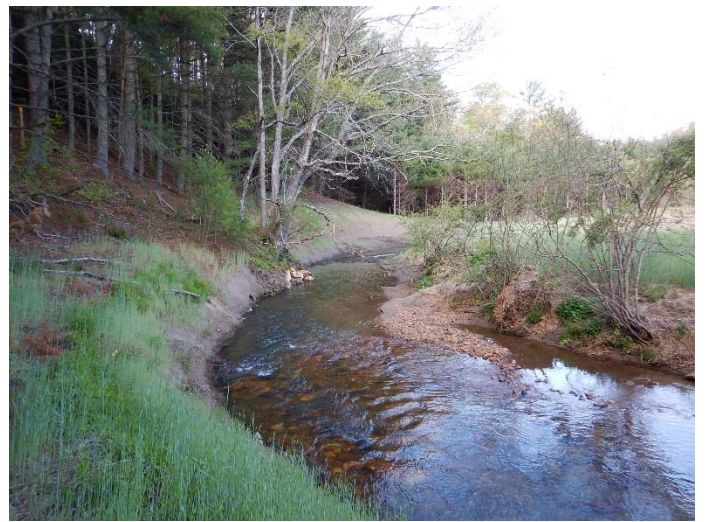


Photo Point 5 – looking downstream Glade Creek (05/06/2016)



Photo Point 6 – looking upstream Glade Creek (05/06/2016)



Photo Point 6 – looking downstream Glade Creek (05/06/2016)



Photo Point 7 – looking upstream Glade Creek (05/06/2016)



Photo Point 7 – looking downstream Glade Creek (05/06/2016)



Photo Point 8 – looking upstream Glade Creek (05/06/2016)



Photo Point 8 – looking downstream Glade Creek (05/06/2016)



Photo Point 9 – looking upstream Glade Creek (05/06/2016)



Photo Point 9 – looking downstream Glade Creek (05/06/2016)

APPENDIX 3. Vegetation Plot Data

Table 8. Planted and Total Stem Counts

Glade Creek II Restoration Project
 DMS Project No.92343
Monitoring Year 0 - 2016

Scientific Name	Common Name	Species Type	Current Plot Data (MYO 2016)																		Annual Means		
			92343-WEI-0001			92343-WEI-0002			92343-WEI-0003			92343-WEI-0004			92343-WEI-0005			92343-WEI-0006			MYO (2016)		
			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 rubrum	Red Maple	Tree	6	6	6																6	6	6
Alnus serrulata	Tag Alder, Smooth Alder, Hazel Alder	Shrub Tree				3	3	3	1	1	1	3	3	3	2	2	2	8	8	8	17	17	17
Betula nigra	River Birch, Red Birch	Tree				1	1	1	1	1	1	1	1	1				1	1	1	4	4	4
Diospyros virginiana	American Persimmon, Possumwood	Tree				3	3	3				3	3	3	3	3	3	2	2	2	11	11	11
Fraxinus pennsylvanica	Green Ash, Red Ash	Tree	3	3	3																3	3	3
Hamamelis virginiana	Witch-hazel	Shrub Tree				2	2	2	1	1	1	2	2	2	2	2	2				7	7	7
Liriodendron tulipifera	Tulip Poplar	Tree				4	4	4	13	13	13	3	3	3	5	5	5	3	3	3	28	28	28
Platanus occidentalis	Sycamore, Plane-tree	Tree	6	6	6	4	4	4	6	6	6	2	2	2	3	3	3	1	1	1	22	22	22
Sambucus canadensis	Common Elderberry	Shrub Tree				1	1	1				1	1	1	3	3	3				5	5	5
Ulmus americana	American Elm	Tree				2	2	2	3	3	3	2	2	2							7	7	7
		Stem count size (ares)	15	15	15	20	20	20	25	25	25	17	17	17	18	18	18	15	15	15	110	110	110
			1			1			1			1			1			1			6		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.15		
		Species count	3	3	3	8	8	8	6	6	6	8	8	8	6	6	6	5	5	5	10	10	10
		Stems per ACRE	607	607	607	809	809	809	1012	1012	1012	688	688	688	728	728	728	607	607	607	742	742	742

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%

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 - (05/02/2016)



Vegetation Plot 2 - (05/02/2016)



Vegetation Plot 3 - (05/02/2016)



Vegetation Plot 4 - (05/02/2016)



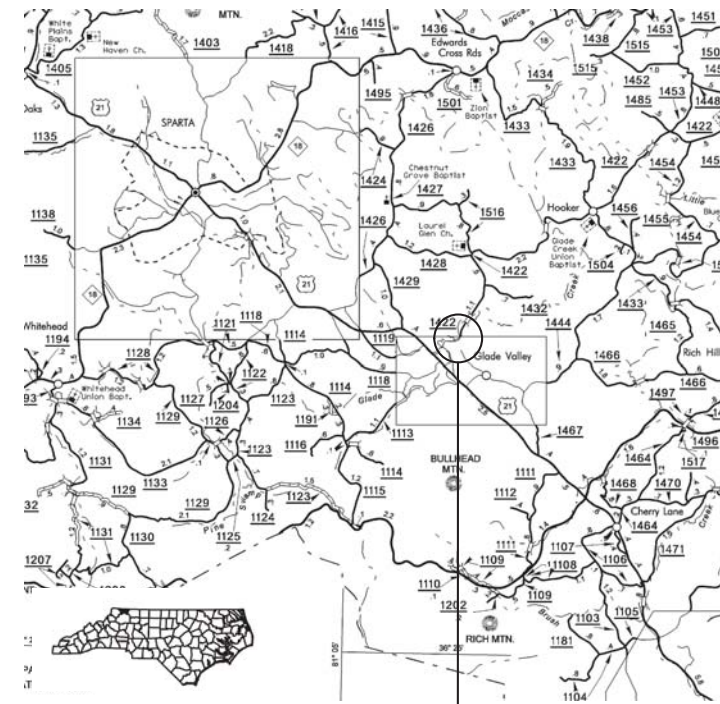
Vegetation Plot 5 - (05/02/2016)



Vegetation Plot 6 - (05/02/2016)

APPENDIX 4. Record Drawings

SCO PROJECT ID 07-07088-04A



VICINITY MAP
NOT TO SCALE

INDEX OF SHEETS

- 1: TITLE
- 2: NOTES, SYMBOLS AND TABLES
- 3-7: STREAM PLAN AND PROFILE
- 8: WETLAND GRADING PLAN
- 9: PLANTING PLAN
- 10: CROSS SECTIONS

GRAPHIC SCALES



PLAN (EXCEPT AS NOTED)



PROFILE (HORZ.)



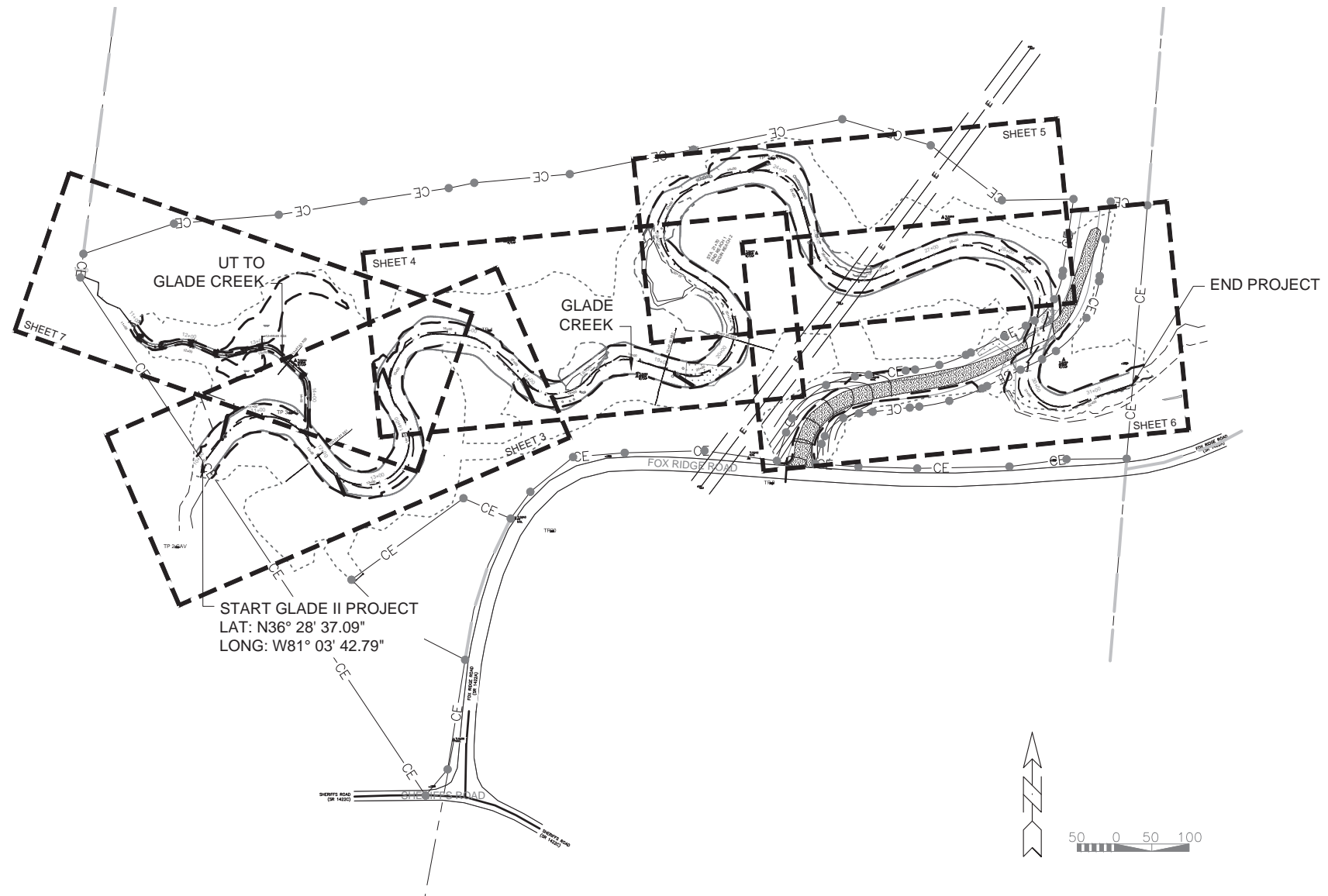
PROFILE (VERT.)

SITE

RECORD DRAWINGS

GLADE CREEK II RESTORATION PROJECT

STREAM NAMES: GLADE CREEK AND ONE UNNAMED TRIBUTARY
LOCATION: ALLEGHANY COUNTY, NORTH CAROLINA



NCDMS PROJECT NO. 92343

Prepared By:
WILDLANDS
ENGINEERING, INC.
167-B Haywood Road
Asheville, North Carolina 28806
Phone: 828.774.4547
wildlandseng.com

Prepared for:
NCDEQ - Division of
Mitigation Services

DMS PROJECT MANAGER

REVIEW COORDINATOR

WILDLANDS
ENGINEERING, INC.
167-B Haywood Road
Asheville, NC 28806
Tel: 828.774.5547
Firm License No. F-0831



Glade Creek II Restoration Project Record Drawings
Allegheny County, North Carolina

Title Sheet

Date	Job Number	Project Engineer	Drawn By	Checked By
May 3, 2016	005-02151	ADB	RCP	ADB

1

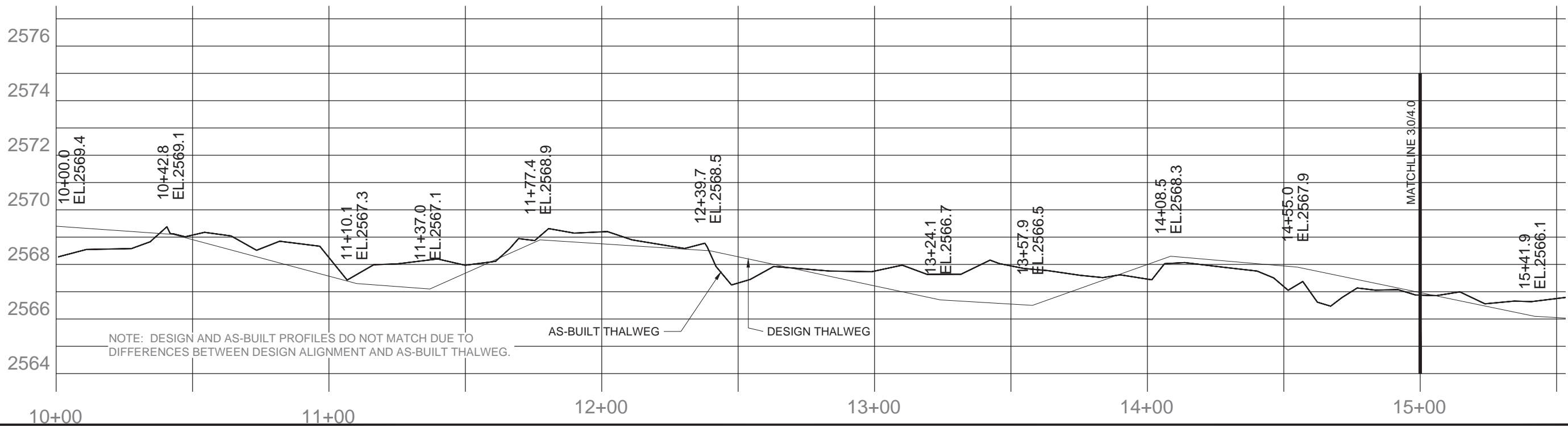
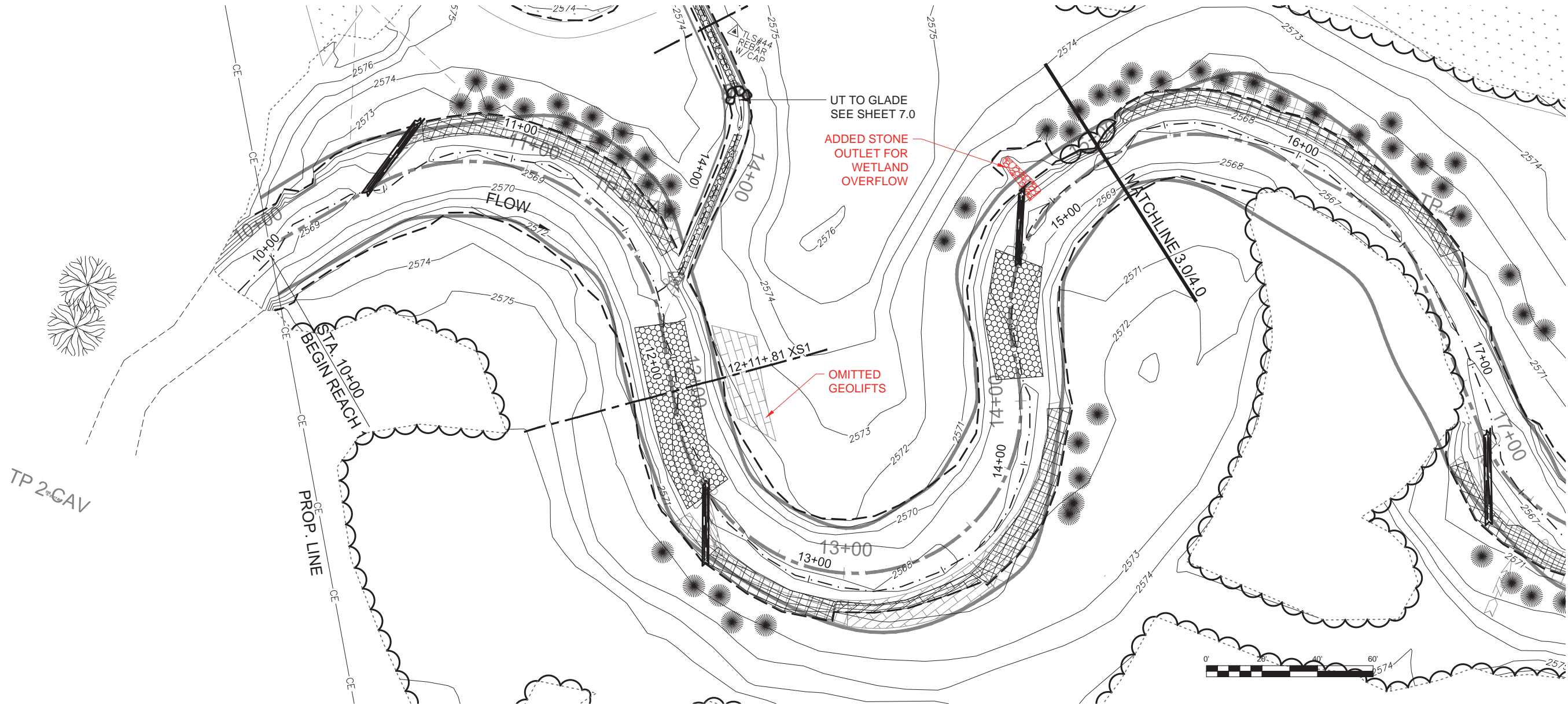
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LEGEND

	AS-BUILT		DESIGN
MINOR CONTOUR (1')			
TOP OF BANK			
STREAM ALIGNMENT			
GEOLIFT WITH CHANNEL PLUG			
BRUSH MATTRESS			
CONSTRUCTED RIFFLE			
LOG VANE			
STEP STRUCTURE			
RIPRAP SURGE PROTECTION			
PARCEL			
FENCE			
OVERHEAD POWER EASEMENT			
BEDROCK			
WETLAND			
CONSERVATION EASEMENT			
MATURE TREE			
TRANSPLANTS			
TREE LINE			
		STREAM ALIGNMENT	
		TOP OF BANK	
		WETLAND GRADING	
		GEOLIFT WITH CHANNEL PLUG	
		BRUSH MATTRESS	
		CONSTRUCTED RIFFLE	
		LOG VANE	
		STEP STRUCTURE	

DESIGN MORPHOLOGY DATA			
Reach	Glade Creek	UT to Glade Reach 1	UT to Glade Reach 2
Riffle Max. Depth (ft)	3.0	0.4	0.5
Riffle Width (ft)	33.0	5.4	5.0
Riffle W/D Ratio	14.2	17.4	12.5
Pool Max. Depth (ft)	5.0	0.8	1.0
Pool Width (ft)	42.5	7.8	9.0
Riffle Area (ft ²)	76.5	1.7	2.0
Pool Area (ft ²)	131.3	4.3	6.0
Slope (ft/ft)	0.003	0.043	0.023

Revisions:



Glade Creek II Restoration Project Record Drawings
 Alleghany County, North Carolina

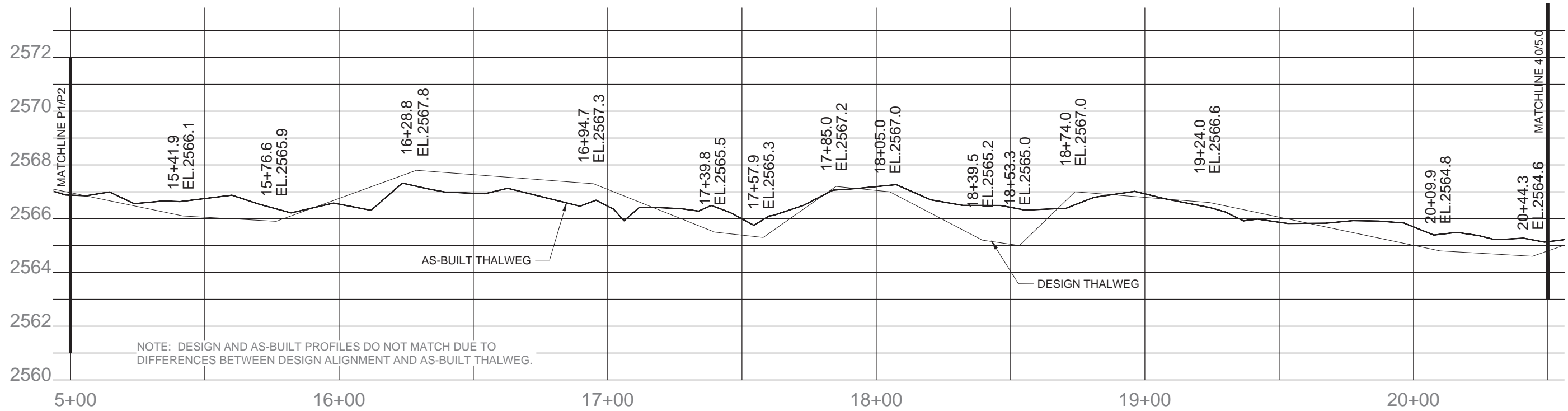
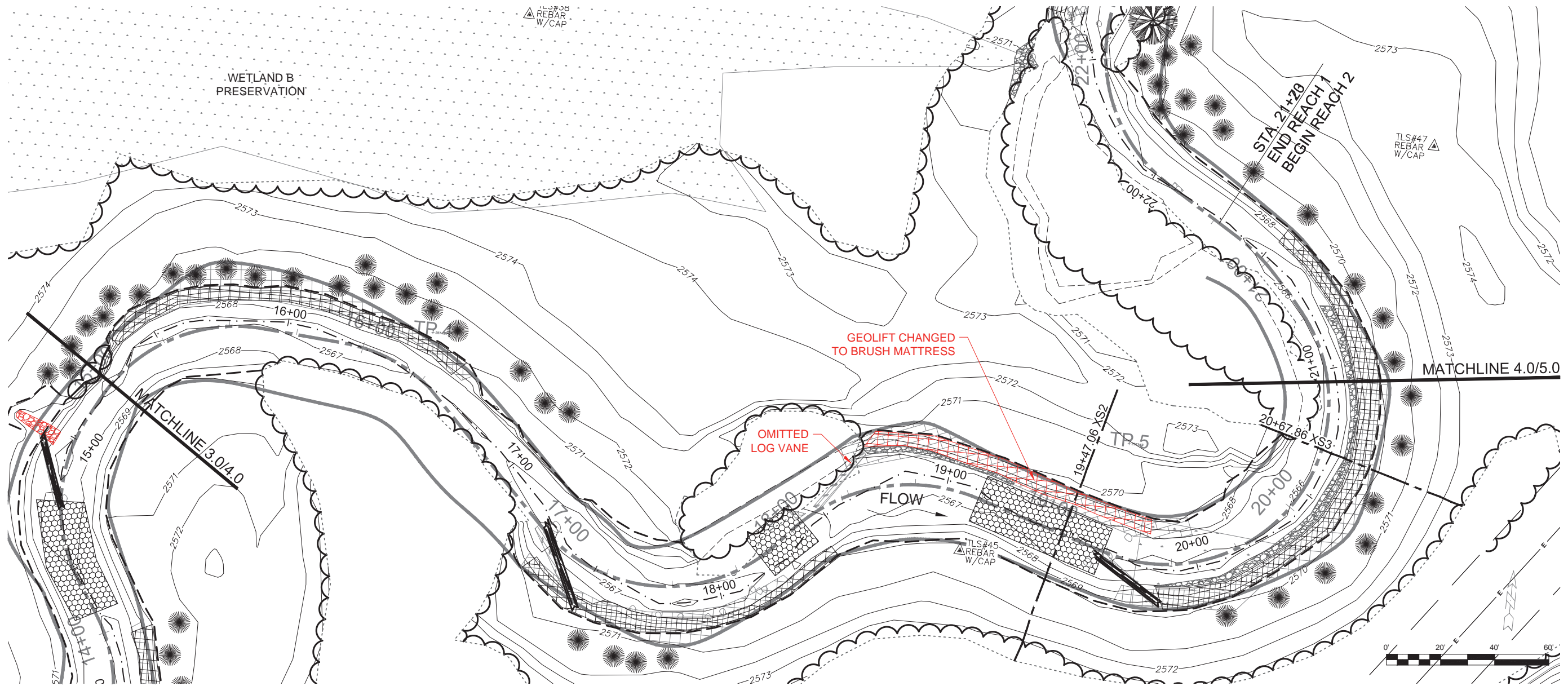
Glade Creek
 Stream Plan and Profile

Revisions:	

Date:	May 3, 2016
Job Number:	005-02151
Project Engineer:	ADB
Drawn By:	RCP
Checked By:	ADB

3

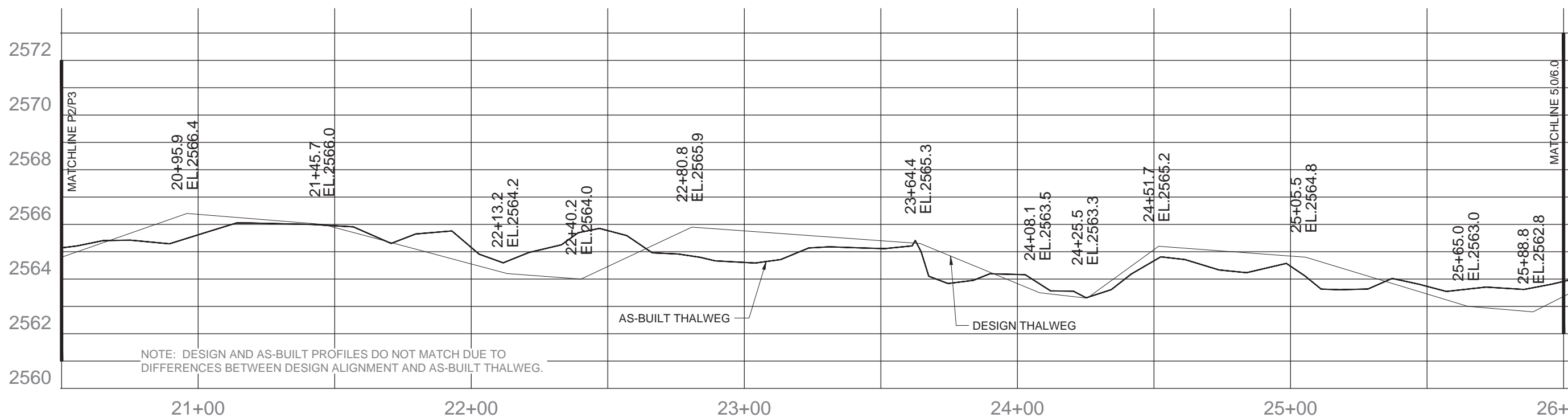
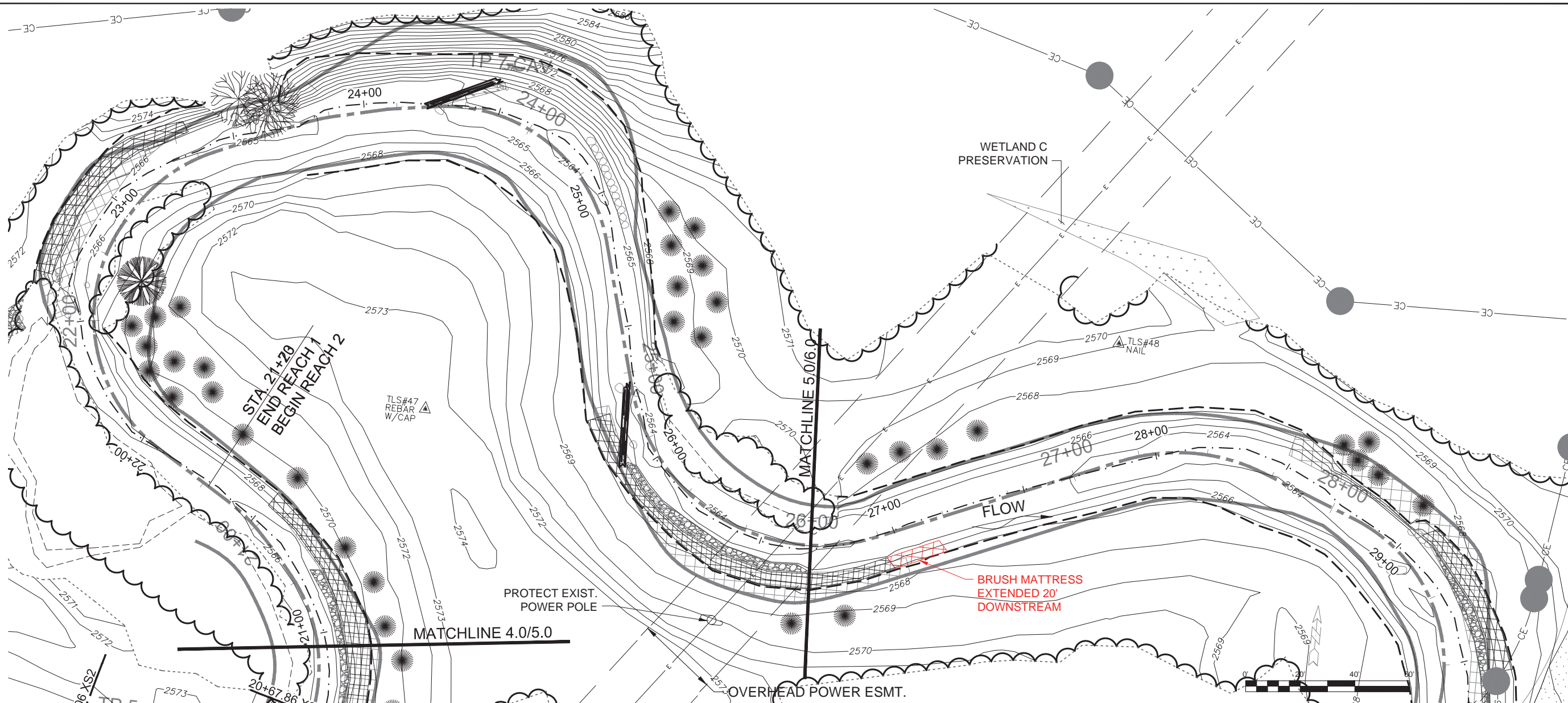
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NOTE: DESIGN AND AS-BUILT PROFILES DO NOT MATCH DUE TO DIFFERENCES BETWEEN DESIGN ALIGNMENT AND AS-BUILT THALWEG.

Revisions:

Date: May 3, 2016
 Job Number: 005-02151
 Project Engineer: ADB
 Drawn By: RCP
 Checked By: ADB

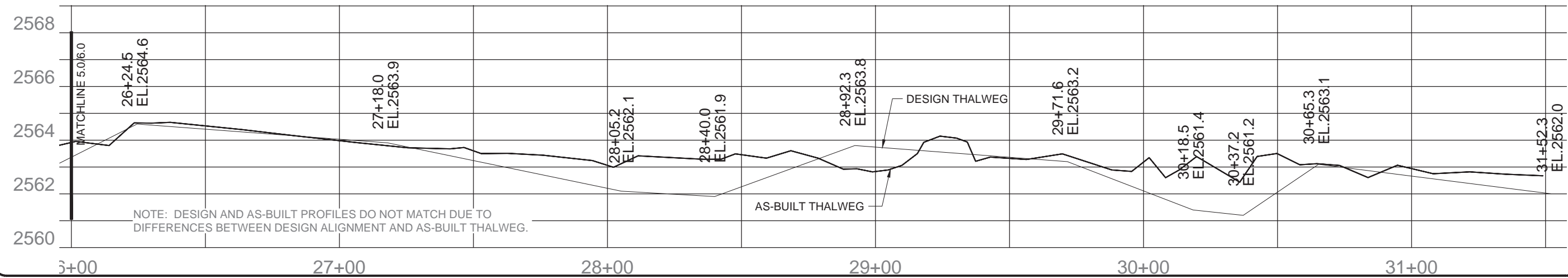
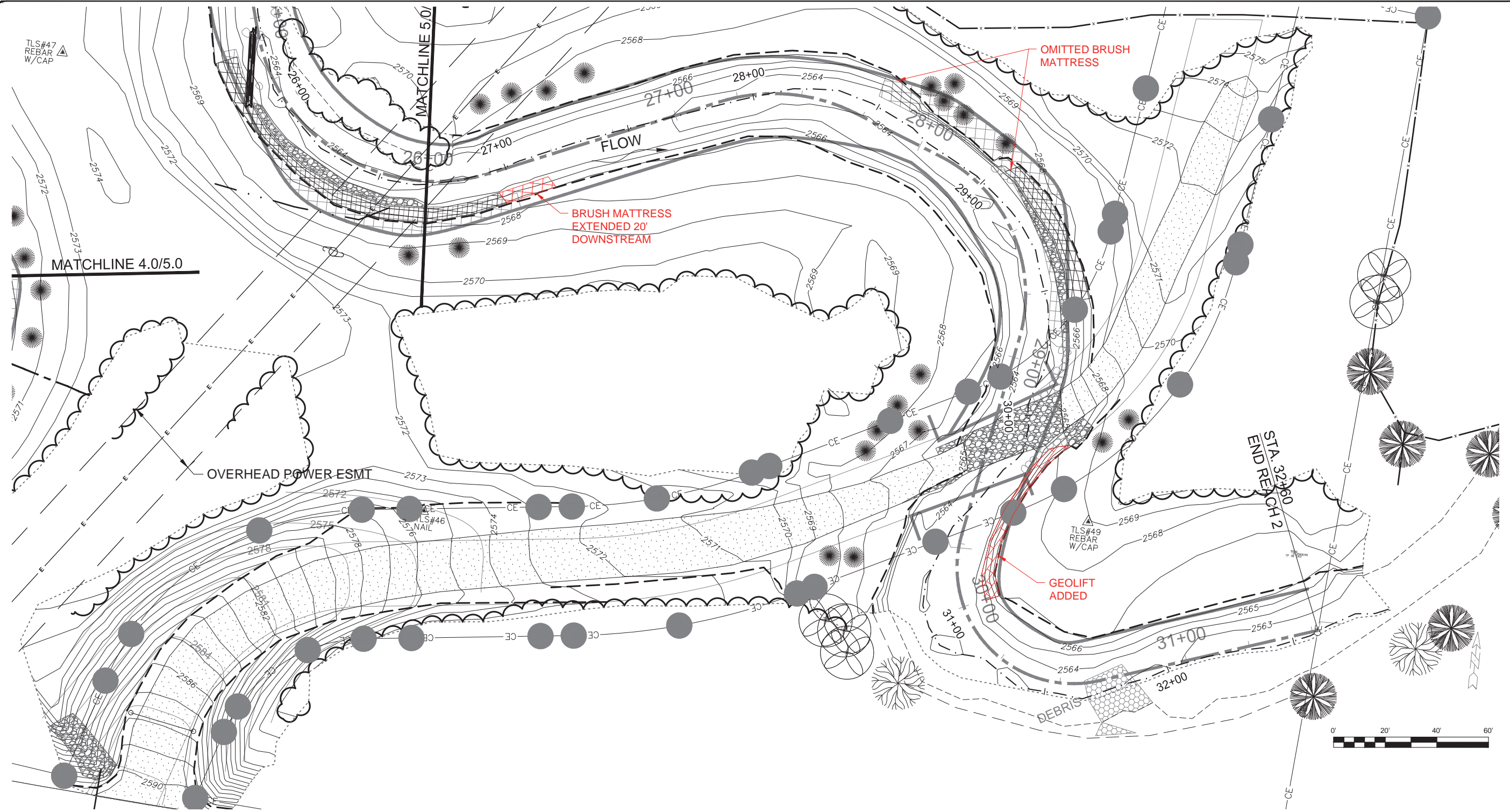


Glade Creek II Restoration Project Record Drawings
 Allegheny County, North Carolina

Glade Creek
 Stream Plan and Profile


Revisions:

Date: May 3, 2016
 Job Number: 005-02151
 Project Engineer: ADB
 Drawn By: RCP
 Checked By: ADB




NOTE: DESIGN AND AS-BUILT PROFILES DO NOT MATCH DUE TO DIFFERENCES BETWEEN DESIGN ALIGNMENT AND AS-BUILT THALWEG.





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ANDREW D. WILLIAMS
ENGINEER
22209
5/15/16

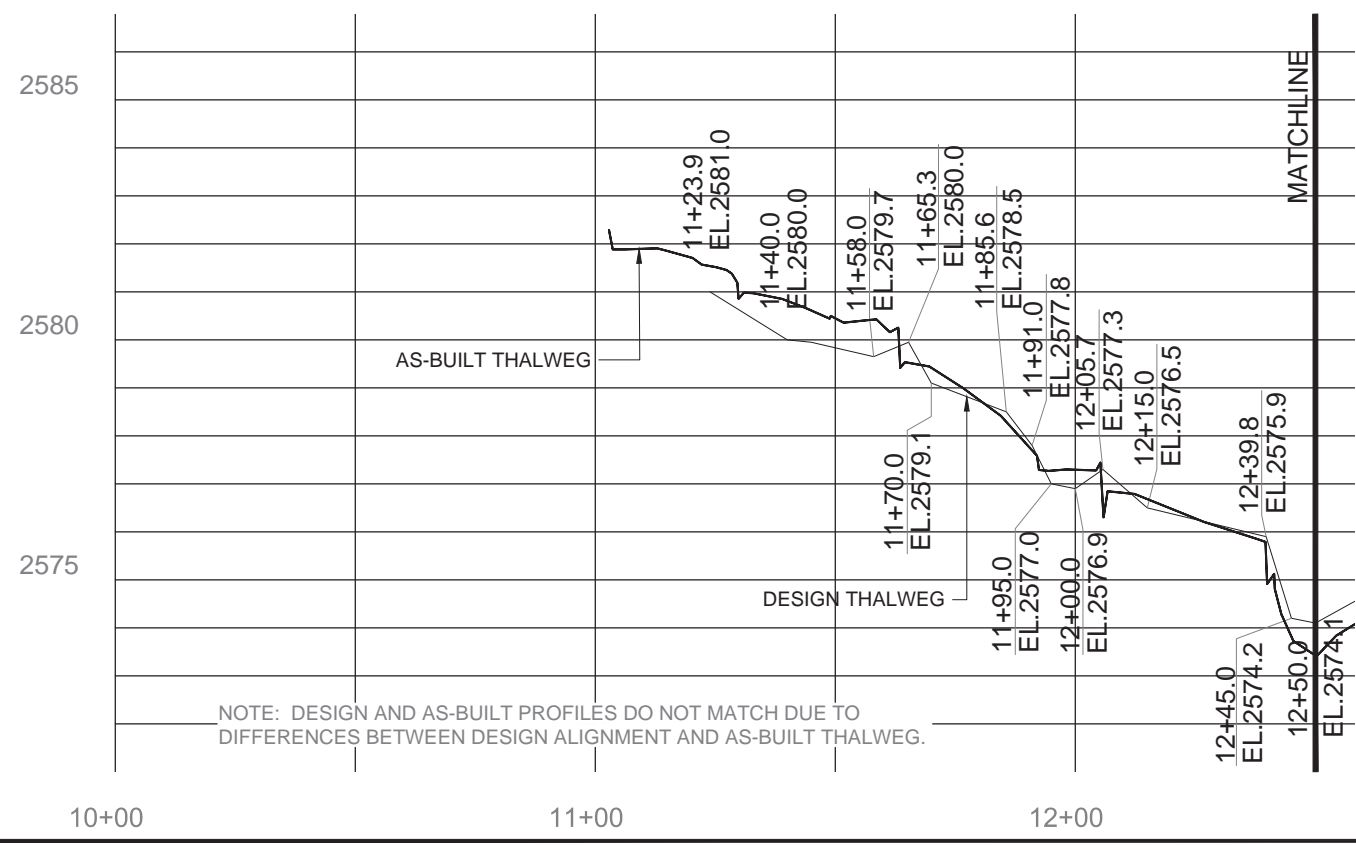
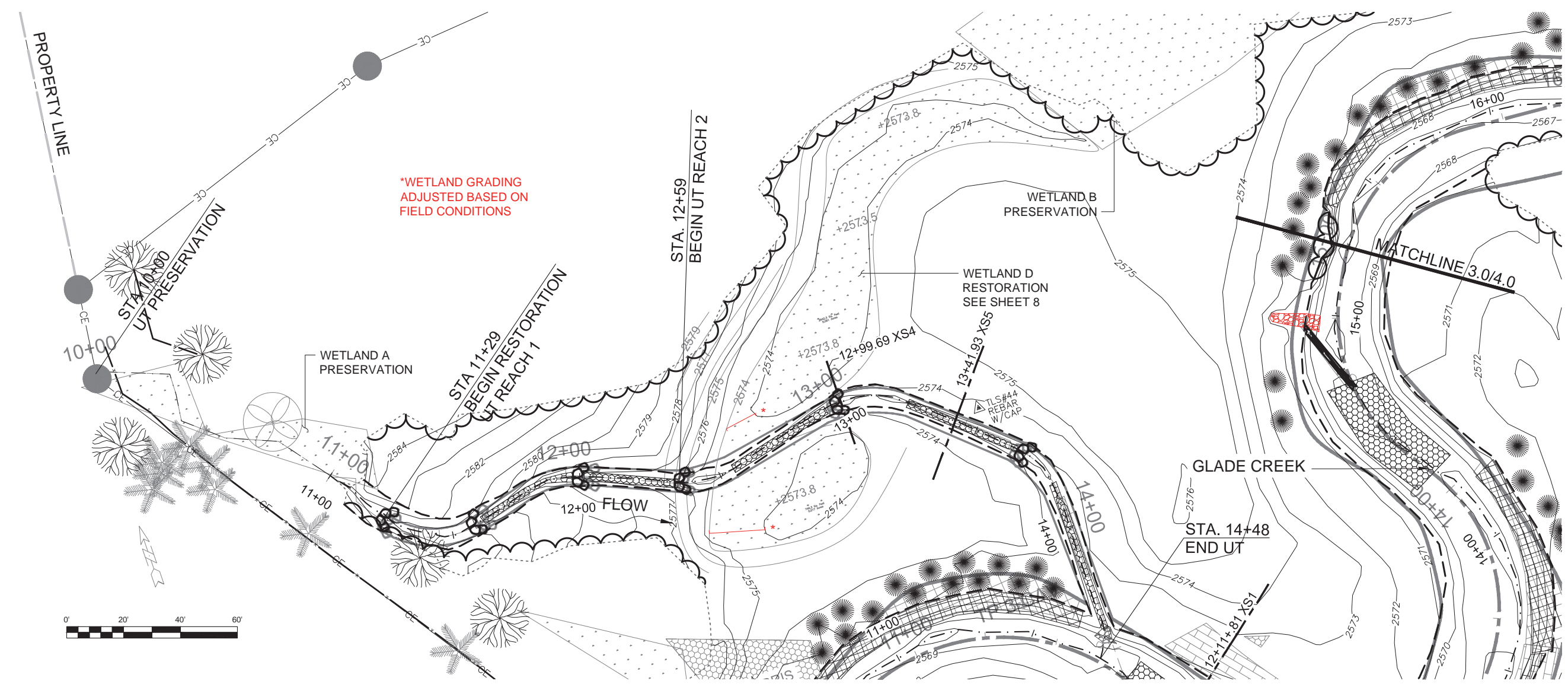
Glade Creek II Restoration Project Record Drawings
Allegheny County, North Carolina

Glade Creek
Stream Plan and Profile

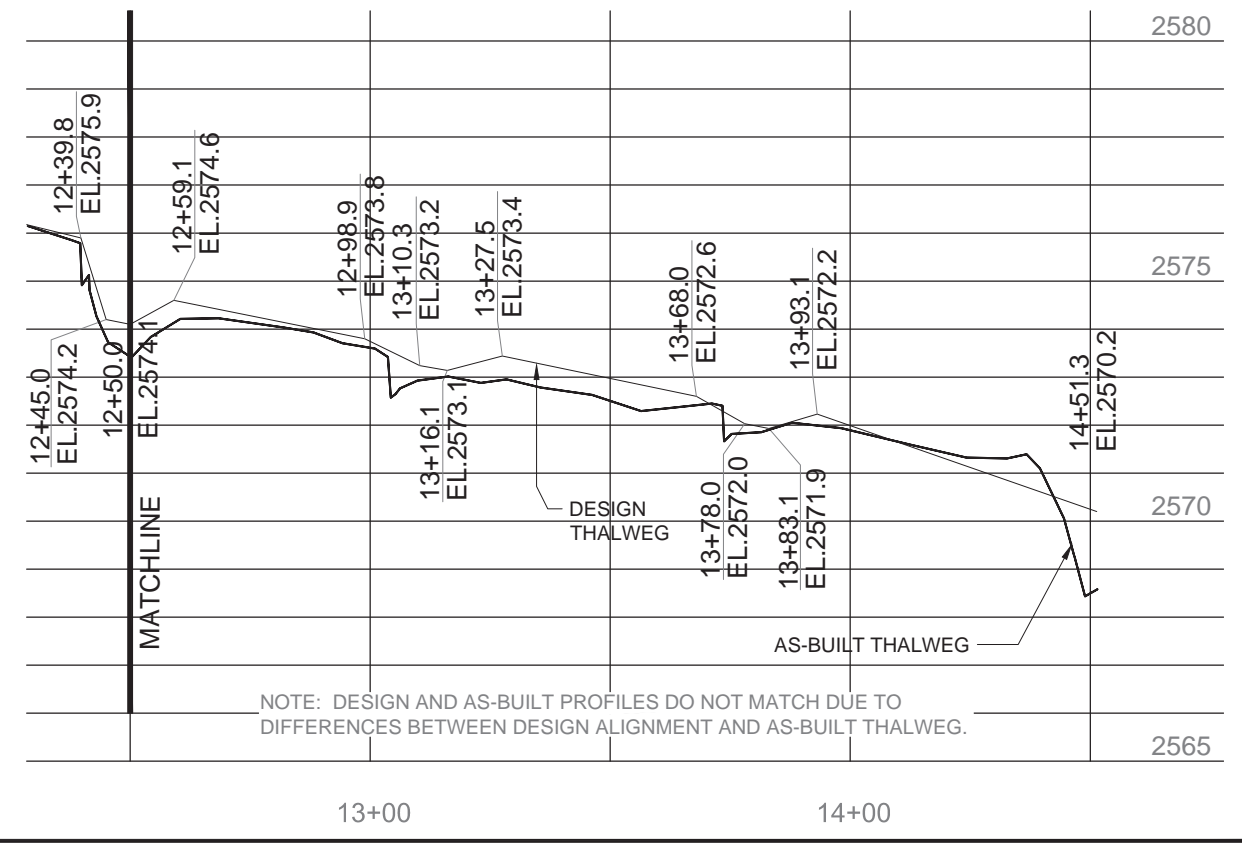
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Date: May 3, 2016
Job Number: 005-02151
Project Engineer: ADB
Drawn By: RCP
Checked By: ADB

Revisions:



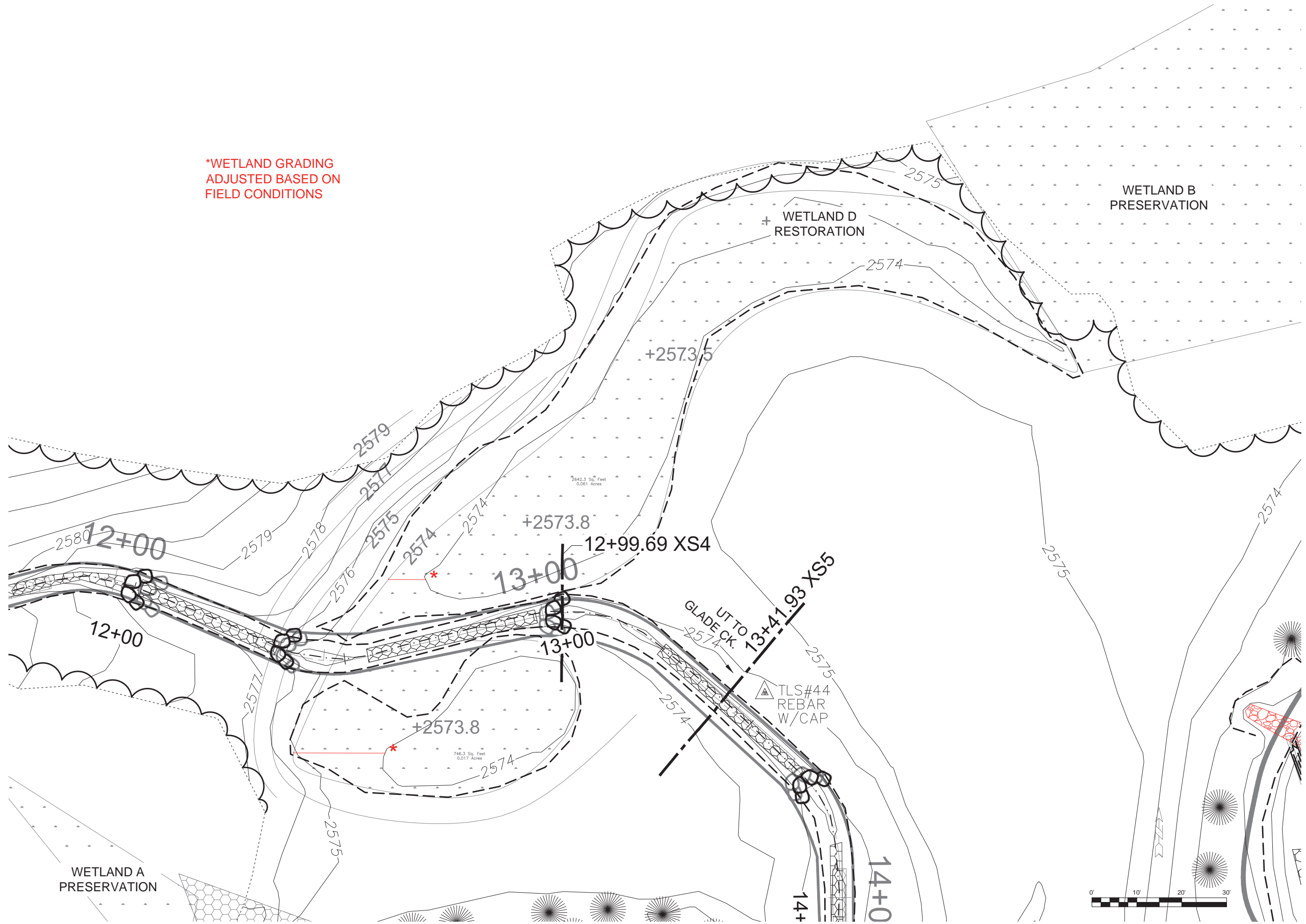
NOTE: DESIGN AND AS-BUILT PROFILES DO NOT MATCH DUE TO DIFFERENCES BETWEEN DESIGN ALIGNMENT AND AS-BUILT THALWEG.



NOTE: DESIGN AND AS-BUILT PROFILES DO NOT MATCH DUE TO DIFFERENCES BETWEEN DESIGN ALIGNMENT AND AS-BUILT THALWEG.

Revisions:

*WETLAND GRADING
ADJUSTED BASED ON
FIELD CONDITIONS



Glade Creek II Restoration Project Record Drawings
Alleghany County, North Carolina

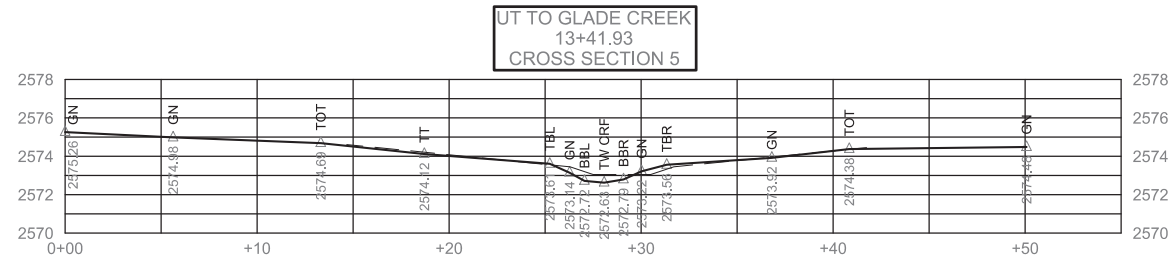
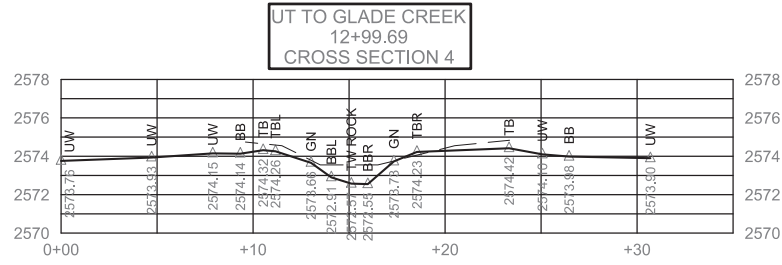
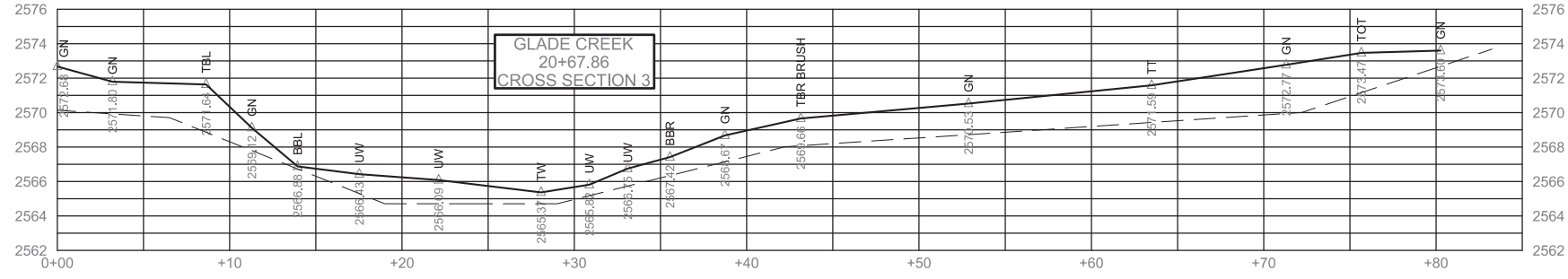
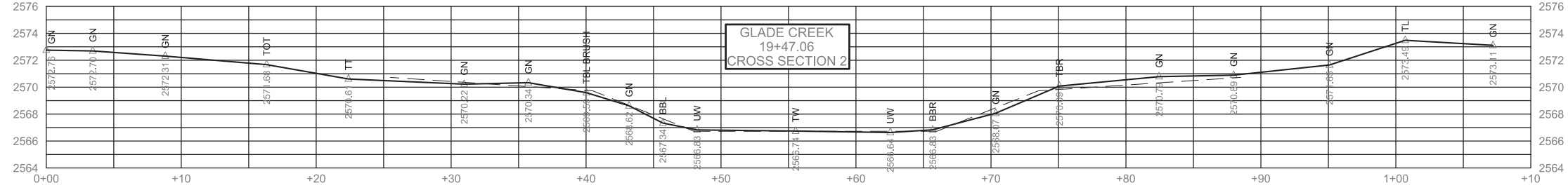
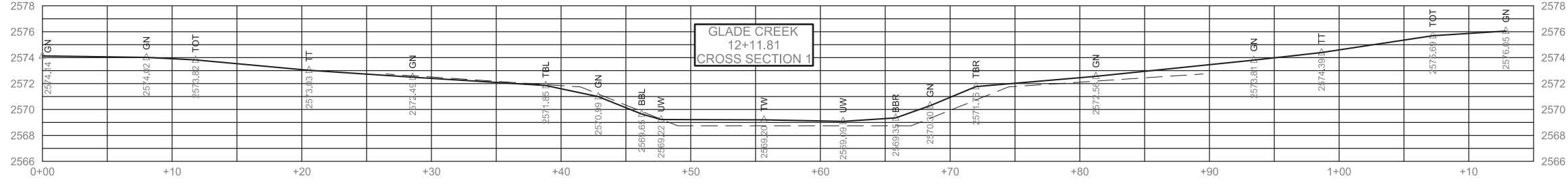
Wetland D
Wetland Grading

Revisions:

Date:	May 3, 2016
Job Number:	005-02151
Project Engineer:	ADB
Drawn By:	RCP
Checked By:	ADB

CROSS SECTIONS 1-5

LEGEND:
 TW-THALWEG
 TBL/TBR-LEFT/RIGHT TOP OF BANK
 BBL/BBR-LEFT/RIGHT BANK TOE
 TOT-TOP OF TERRACE
 TT-TERRACE TOE
 GN-GROUND
 UW-UNDER WATER
 DESIGN GRADE - - - - -
 AS-BUILT GRADE _____
 NOTE: CROSS SECTIONS RUN LEFT TO RIGHT FACING DOWNSTREAM



Revisions:

Date:	May 3, 2016
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Project Engineer:	AJB
Drawn By:	RCP
Checked By:	AJB

