As-Built Baseline Monitoring Report
Logan Creek Stream Restoration Project

Jackson County, North Carolina

DMS Project ID No. 92515, Contract No. D06046

Savannah River Basin: 03060101-010020

Prepared for:
NC Department of Environmental Quality
Division of Mitigation Services (DMS)
1652 Mail Service Center
Raleigh, North Carolina 27699-1652

Data Collection Period – May 2015

Submission Date – November 2015

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TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY 1

2.0 PROJECT GOALS, BACKGROUND, AND ATTRIBUTES 2

2.1 Project Location and Description 2
2.2 Site Directions 3
2.3 Project Goals and Objectives 3

3.0 PROJECT STRUCTURE, RESTORATION TYPE, AND APPROACH 4

3.1 Project Components 4
3.2 Restoration Approach 4
3.2.1 Logan Creek Mainstem R1 Restoration and R2 Enhancement I 5
3.2.2 UT3-R2, UT6 and UT8 Restoration 6
3.2.3 UT1, UT2, UT3-Reach 1, UT4 and UT7 Enhancement II 6
3.2.4 UT5 Preservation 6
3.3 Project History, Contacts, and Attribute Data 6
3.3.1 Construction Summary 7

4.0 PERFORMANCE STANDARDS 9

5.0 MONITORING PLAN AND SUCCESS CRITERIA 9

5.1 Stream Monitoring – Logan Creek, UT3 and UT6 9
5.1.1 Hydrology: Bankfull Events and Flooding Functions 9
5.1.2 Cross-sections 9
5.1.3 Pattern 10
5.1.4 Longitudinal Profile 10
5.1.5 Bed Material Analyses 10
5.1.6 Photo Reference Stations 10
5.2 Vegetation Monitoring 11

6.0 AS-BUILT DATA DOCUMENTATION 12

6.1 Stream Data 12
6.2 Vegetation Data 12
6.3 Areas of Concern 12

7.0 MAINTENANCE AND CONTINGENCY PLANS 13

7.1 Streams 13
7.2 Vegetation 13
7.3 Site Boundary 14

8.0 REFERENCES 14

LIST OF TABLES

Table	**1**	Project Components and Mitigation Credits
Table	**2**	Project Activity and Reporting History
Table	**3**	Project Contacts
Table	**4**	Project Attributes
Table	**5**	Baseline Stream Summary
Table	**6**	Morphology and Hydraulic Monitoring Summary
Table	**7**	Vegetation Species Planted Across the Restoration Site
Table	**8**	Stem Count for Each Species Arranged by Plot

LIST OF FIGURES

Figure	**1**	Project Vicinity Map
Figure	**2**	Restoration Summary Map

LIST OF APPENDICES

Appendix	**A**	Figures 1 - 3, Tables 1 - 4
Appendix	**B**	Morphological Summary Data (Tables 5 and 6), Cross-section Plots, Profile Plots, and Pebble Count Data and Plots.
Appendix	**C**	Vegetation Data (Tables 7 and 8), Vegetation Plot Photo Log, Raw Vegetation Data
Appendix	**D**	As-Built Plan Sheets/Record Drawings
Appendix	**E**	Photo-ID Log

1.0 EXECUTIVE SUMMARY

Michael Baker Engineering, Inc. (Baker) restored, enhanced or preserved 5,110 linear feet (LF) of perennial stream channel along Logan Creek and eight unnamed tributaries (UT1,UT2, UT3, UT4, UT5, UT6, UT7 and UT8) in Jackson County, NC resulting in the delivery of 4,329 Stream Mitigation Units (SMUs). The nearest town, Cashiers, is approximately five miles west of the Logan Creek Project site. The site lies in the Savannah River Basin within the North Carolina Division of Water Resources (NCDWR) sub-basin 03-06-01-01 (Keowee River Subbasin) and local watershed unit 03060101-010020.

The project goals directly address stressors identified in the Savannah River Basin Restoration Priority Plan (RBRP) (EEP/DMS 2001 and updated 2008) such as habitat degradation, inadequate riparian buffer cover, channel modification, and excess nutrient and sediment loading. The primary restoration goals, as outlined in the approved mitigation plan, are described below:

- Create geomorphically stable stream channels within the Logan Creek project.
- Protect stable areas as well as mature trees and other desirable vegetation.
- Improve water quality within the Logan Creek project area through reduction of bank erosion, improved nutrient and sediment removal, and stabilization of streambanks.
- Improve aquatic and terrestrial habitat.

To accomplish these goals, we recommend the following actions:

- Restore the existing eroding or over-wide stream reaches by creating a stable channel that has access to its floodplain.
- Improve in-stream habitat by providing a more diverse bedform with riffles and pools, creating deeper pools, providing woody debris for habitat, moving sand deposits through the reach and reducing bank erosion.
- Establish native stream bank and floodplain vegetation to increase storm water runoff filtering capacity, improve bank stability, provide shading to decrease water temperature, provide cover, improve wildlife habitat and protect this area with a permanent conservation easement.
- Improve terrestrial habitat by increasing the density of tree species that root deeply, by thinning the thick stands of rhododendron within the easement area and planting a more diverse native plant community.

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

- Six unnamed tributaries (UTs) or parts of the tributaries were originally described in the mitigation plan as being restored using an Enhancement I approach. During construction, it was determined that the level of work needed would better be described as an Enhancement II approach, for the tributaries or parts of tributaries (UT1, UT2, part of UT3, and UT4) described in the original mitigation plan. We also identified two additional tributaries that were not accounted for in the mitigation plan and required work. UT7 is a 54 LF reach of stream channel that was enhanced to connect an existing vernal pool, wetland complex to the new channel and we are requesting Enhancement II credit for this tributary. UT8 is a 45 LF reach of channel that was constructed to connect this existing stream to the new channel. Since this was new channel construction, we are requesting Restoration credit for this channel. All of these changes are shown in Appendix A, Table 1 and in Appendix D, Plansheets.

- In the Executive Summary of the Logan Creek Stream Restoration Mitigation Plan, as updated and submitted to the Division of Mitigation Services in May 2013, there was an explanation of the actions that have affected the linear footage of steam available at this site for mitigation. In that explanation, we stated that there are 5,131 linear feet available for mitigation work. This was an incorrect number. The actual number of linear feet available for use at this site is 5,110 linear feet (USACOE 2011).
- Due to the limitation on the number of feet available at this site, not all of the stream length on UT5, contained within the conservation easement, will be included for stream crediting.
- The original proposed bare-root and live-stake species list contained over 40 different species of trees and shrubs. The actual plantings included 14 species primarily from this original list and these plants are shown in Appendix C, Table 7. The only planted species that was not on this original list was Northern red oak - *Quercus rubra*.

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

2.0 PROJECT GOALS, BACKGROUND AND ATTRIBUTES

2.1 Project Location and Description

The Logan Creek Stream Restoration Project site is located approximately three miles northeast of Cashiers in Jackson County, North Carolina, as shown in the Project Site Vicinity Map (Appendix A, Figure 1). The Logan Creek Stream Restoration Project area lies within cataloging unit 03060101010020 and DENR sub-basin 03-13-02 of the Savannah River Basin. The project site includes a segment of Logan Creek and eight unnamed tributaries to Logan Creek.

The Logan Creek mitigation project streams drain a watershed that is predominantly forested and is being developed for single-family homes with large lots. Land use at the project site is characteristic of the greater watershed. Recent land use of the site has been open hay fields and forestry. Historically, the site was used for pasture, timbering, commercial trout rearing and as a mink farm. Potential for land use change in the area adjacent to the conservation easement is low given that the watershed is a relatively new "low impact development" and the new landowners are in part purchasing property for the low density housing that this development offers.

Past intensive agricultural use of the property led to channel modification, dredging, riparian buffer removal, wetland conversion, and ditching. Pasture development adjacent to the project stream reach had resulted in unstable conditions with only grass to provide stream bank stabilization. Maintenance of the pasture area, as well as the new home sites being developed, likely contributes nutrients to the stream system as runoff carries fertilizer and pet waste into the streams. The resulting stream instability has resulted in significant prior and on-going erosion and sedimentation, as well as potential nutrient loading to tributaries, Logan Creek, and to the Savannah River downstream.

Logan Creek is shown as a "blue-line" stream on the USGS topographic quadrangle for the site, while the various tributaries are not shown. Based on field evaluations using NCDWR stream assessment protocols, all of the stream channels proposed for restoration, enhancement, or preservation are perennial, as indicated in the stream mitigation plan.

2.2 Site Directions

To reach the project site from Asheville, follow Interstate 26 East and take NC-280 at Exit 40. From the exit, turn right onto NC-280 and continue to the intersection with US-276/US-64 at Brevard. Continue west on US-64 past Rosman and Lake Toxaway traveling towards Cashiers. The entrance to the Lonesome Valley Development is 0.5 miles past the community of Sapphire, NC on US-64. The project site extends south from the confluence of Logan Creek and an unnamed tributary (Right Prong Logan Creek) downstream to a road culvert at US 64. The site is accessible from US 64 at the Lonesome Valley Company, Inc. development and from the community roads.

2.3 Project Goals and Objectives

The Logan Creek Stream Restoration Project was identified as an opportunity to improve water quality and ecological functions within a NC Division of Mitigation Services (NCDMS, formerly NC Ecosystem Enhancement Program (EEP)) Target Local Watershed (TLW).

The primary restoration goals of the project are described below:

- Create geomorphically stable stream channels within the Logan Creek project.
- Protect stable areas as well as mature trees and other desirable vegetation.
- Improve water quality within the Logan Creek project area through reduction of bank erosion, improved nutrient and sediment removal, and stabilization of streambanks.
- Improve aquatic and terrestrial habitat.

To accomplish these goals, the following objectives were implemented:

- Restored the existing eroding or over-wide stream reaches by creating a stable channel that has access to its floodplain.
- Improved in-stream habitat to provide a more diverse bedform with riffles and pools, creating deeper pools, providing woody debris for habitat, moving sand deposits through the project reach and reducing bank erosion.
- Established native stream bank and floodplain vegetation to increase storm water runoff filtering capacity, improve bank stability, provide shading to decrease water temperature, provide cover, improve wildlife habitat and protect this area with a permanent conservation easement.
- Improved terrestrial habitat by increasing the density of tree species that root deeply, by thinning the thick stands of rhododendron within the easement area and planting a more diverse native plant community.

The project goals directly addressed stressors identified in the Savannah RBRP such as habitat degradation, inadequate riparian buffer cover, channel modification, and excess nutrient and sediment loading. The implemented natural channel design approach will result in a stable riparian headwater stream system that will reduce sediment and nutrient loading to the Logan Creek sub-watershed, while improving water quality conditions that support terrestrial and aquatic species within the Savannah River Basin.

3.0 PROJECT STRUCTURE, RESTORATION TYPE, AND APPROACH

3.1 Project Components

Within the project area, a segment of Logan Creek and eight unnamed tributaries to Logan Creek were restored, enhanced or preserved. For design purposes, Logan Creek through the project site was divided into two reaches, with a longer upstream Reach 1 that was improved using a Restoration approach and a shorter downstream Reach 2 that was improved using an Enhancement I approach. Each unnamed tributary was designated as a UT and named UT1 to UT8. Only UT3 was divided into two reaches designated as Reach 1 (Enhancement II) and Reach 2 (Restoration). UT1, UT2, UT4 and UT7 were all improved using an Enhancement II approach. UT5 is a high quality stream that is being preserved. UT6 and UT8 both require Restoration to connect them to the new mainstem channel. Additionally, there are small areas of jurisdictional wetlands and vernal pools within the easement; however, we are not requesting mitigation credit for these areas. Figure 2 in Appendix A illustrates the locations of these streams.

Restoration practices within Reach 1 involved stabilizing the channel laterally, removing up valley meanders and avulsions, narrowing reaches of over widened channel and reconnecting the stream to the historic floodplain. The existing channels had excessive erosion and were meandering up-valley in many areas causing avulsions and further erosion. This condition was replaced by a meandering channel that was constructed at a stable width and meander length. Existing wetlands were retained and connected to the restored channel and additional vernal pools were created. Native, riparian buffer vegetation was established and protected for at least 30 feet from the top of bank along all project reaches. Similar practices were performed on the various UTs that were restored as well.

The Enhancement I reach (Reach 2) on the mainstem had a homogeneous sand bed that was very shallow and offered little variability in habitat. There were also areas of lateral instability due to debris jams. Functionality of this reach was improved by installing structures that would develop pools and move the sand bed load through the reach. Unstable stream banks were repaired to establish the design stream width. All work through this reach was done with as little impact to the existing vegetation as possible. Areas where disturbance was unavoidable were planted with trees and herbaceous vegetation in the same way as was done for the Restoration reach. Lastly, the stream corridor has been protected with a conservation easement that is 30 feet from the top of bank along all streams.

3.2 Restoration Approach

Based on the post-construction as-built survey, the project consists of 3,444 LF of restoration on Logan Creek-Reach 1, UT3-Reach2, UT6 and UT8. One 1,038 LF reach on Logan Creek-Reach 2 was enhanced using an Enhancement Level I approach. Five unnamed tributaries (UT1, UT2, UT3-Reach 1, UT4 and UT7) were improved using an Enhancement II approach for a total of 341 LF. Lastly, 287 LF of UT5 was preserved to maintain the existing high quality habitat along this reach. The conservation easement along UT5 actually includes an additional 274 LF of stream channel that cannot be included for crediting but is protected as well. A conservation easement has been established over 12.71 acres of land that includes the project site and will protect and preserve all stream reaches, wetland areas, vernal pools and riparian buffers in perpetuity.

The revegetation plan for the overall riparian buffer system considered the combination of existing on-site native vegetation species and the riparian communities identified by Schafale and Weakley (1990) that are included in the ecological community described as “Montane Alluvial Forest and a Montane Oak-Hickory Forest”. Planting areas were not designated by zones on the project plan sheets (Appendix D) to represent site conditions. Alternatively, observations were made of site wetness during planting and species that matched the observed wetness were planted in areas that provided the best conditions.

The restoration approach for the project allows stream flows larger than bankfull flows to spread onto the floodplain, dissipating flow energies, reducing stress on streambanks and hydrating wetland areas. In-stream

structures were used to control streambed grade, reduce streambank stress, and promote bedform riffle-pool sequences and habitat diversity. The in-stream structures consist of root wads, log vanes, log weirs, cover logs, log cross-vanes, toewood bank revetment, geo-lifts and ditch plugs/channel blocks.

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

3.2.1 Logan Creek Mainstem R1 Restoration and R2 Enhancement I

The project site on Logan Creek mainstem begins approximately 20 LF downstream of the Lonesome Valley developments "Trout Pond" outfall canal and continues downstream to the box culverts under US-64. This mainstem reach was divided into two project Reaches based on the restoration approach employed. Logan Creek Reach 1 (R1) is a Restoration reach and begins at the upstream project limit and continues south for 3,184 feet ending just above a bridge on E. Valley Drive. Within R1, one stream crossing has been cut out of the easement. Logan Creek Reach 2 (R2) is an Enhancement I reach that begins just below the bridge on E. Valley Drive and continues south 1,038 feet to the NCDOT right-of-way.

Logan Creek R1 begins in a forested section of the reach where beaver activity and flooding had caused extensive lateral instability. The channel was meandering with beaver dams, logjams and excessive sand deposition causing meanders to extend up-valley with excessive erosion. In areas where the primary riparian vegetation was rhododendron, the shallow root system of this species was easily under mined by bank erosion causing more extensive woody debris jams, over-widening and erosion. Around the present Station 11+00 and continuing to the end of R1, the right bank has been cleared and is maintained as a meadow. Erosion was extensive all along this right bank. To address these issues a Restoration approach was taken. The channel was realigned to develop a down valley meandering pattern with channel banks that have the correct bankfull width and depth while allowing access by flows to the floodplain at bankfull. Rhododendron was removed or cut back to the ground and hardwood trees were planted to provide bank stabilization with vegetation that provides much greater rooting depth. Meanders were stabilized with bank treatments (toewood, geolifts or artificial undercut banks) that reduced erosion and provided habitat improvements for the resident trout population. Woody debris was found throughout this reach and was incorporated back into the stream when possible to improve habitat while avoiding instability.

Logan Creek R2 begins below the bridge on E. Valley Drive and continues south to US-64 for another 1,038 feet. This reach had a stable meandering pattern with thick riparian vegetation. Bank instability was present at a limited number of locations. The reach did have extensive woody debris jams but lateral instability was not as extensive as that found at the beginning of R1. These jams caused extensive deposition of sand through this reach, limiting pool habitat and streambed variability. Our approach to R2 was to use an Enhancement approach with the goal of restoring unstable banks, removing woody debris jams and adding structures to the channel that would increase pool habitat and the ability for the channel to move sand through the reach; all while limiting impacts to the existing riparian vegetation. Over-wide areas were stabilized by removing woody debris jams and reestablishing the correct bankfull width at three locations through this reach. Log vanes, log weirs and a hanging cover log were installed through the reach to improve habitat and move sand through the reach. Because our concern was to move sand and develop pools in a sandy substrate we tried the unique approach of not sealing the vanes and weirs so that water could actually go under the logs causing deeper habitat and moving sand downstream. While not a typical practice, it has been very effective in accomplishing our goals on this reach.

3.2.2 UT3-R2, UT6, and UT8 Restoration

Restoration of the mainstem of Logan Creek involved moving its alignment. This caused a change in the confluence location of three tributaries to Logan Creek. This required a Restoration approach to develop new channel length that extended these unnamed tributaries to a new confluence with the mainstem. UT3 begins at the conservation easement and flows 40 LF (R1, Enhancement II reach) before beginning Reach 2 (Restoration begins) where we had to construct 138 LF of new channel to extend this tributary to the mainstem at Station 12+80. This reach was constructed as a small step-pool channel that followed the left bank of the old mainstem alignment to a constructed confluence. A number of boulder step structures were used to drop grade across this new channel and at the confluence. UT6 has a single reach that begins in a wetland complex that crosses the conservation easement line and flows 127 LF to the mainstem. Like UT3, it was extended to the new alignment of the mainstem. Grade changes were made over a couple of small boulder step structures within the reach and at the confluence (mainstem Station 8+73) with much of the drop of this channel occurring at the confluence. Stream banks are very low and the low grade across the reach enhances the hydrology of the associated wetlands around the reach. UT8 is a small stream that drains a relatively large wetland complex close to the beginning of Logan Creek R1 (at mainstem Station 1+11). The extension of this channel was relatively short (45 LF) because Logan Creek was not moved far from its original alignment at this point. The channel grade was dropped over two log sills and the stream width and depth copied that found on the existing, stable channel that entered the floodplain from the wetland complex.

3.2.3 UT1, UT2, UT3-Reach 1, UT4 and UT7 Enhancement II

Five unnamed tributaries of Logan Creek were improved with an Enhancement II approach. Originally, we planned to use an Enhancement I approach on these tributaries; however, once we began construction it became apparent that minimal structural improvement was needed on these reaches. Most of these channels were in good condition and did not need any bank treatments, realignment or channel modifications. We did protect these channels within the conservation easement over lengths that varied from 40 to 92 LF. The confluence of each channel was stabilized with the addition of a structure or structures that provided grade control. The riparian area along the channel was planted with herbaceous seed and with bare rooted trees were needed.

3.2.4 UT5 Preservation

UT5 is the largest unnamed tributary that enters Logan Creek along the project reach and within the project conservation easement. This tributary has its confluence with Logan Creek at Station 36+60 and 511 LF of this tributary is located within the project conservation easement. This tributary is well vegetated with an understory of rhododendron and an overstory of hardwood trees throughout its riparian zone, which extends out from the top of bank for more than 100 LF. Much of this area is protected by the conservation easement; however, there is some riparian area that is not protected under the project conservation easement, but it is protected by a well easement. This easement requires that this space be protected from any kind of development to protect ground water. Due to a regulatory limitation on the number of linear feet of stream that are available for mitigation on this property, only 287 LF of this tributary are included for mitigation crediting.

3.3 Project History, Contacts, and Attribute Data

Baker implemented the project under a full delivery contract with NCDMS to provide stream mitigation credits in the Savannah River Basin. The chronology of the project is presented in Table 2. The contact information

for all designers, contractors, and relevant suppliers is presented in Table 3. Relevant Project background and attribute information is presented in Table 4. Tables 2, 3, and 4 are located in Appendix A of this report. As-built stationing is presented in Table 1 in Appendix A and is shown in Appendix D on the plan sheets.

3.3.1 Construction Summary

In accordance with the approved Mitigation Plan and regulatory permits, construction began with site preparation, installation of a construction entrance, sediment and erosion control measures, and the establishment of a staging area, haul roads, and stockpile areas. The construction contractor was River Works, Inc. (River Works) and construction was initiated in June 2014. Materials were stockpiled as needed at the staging area. Suitable fill material was brought to the site and stockpiled in an area that was away from live streams and surrounded by a silt fence. Fill material was used on-site to fill the abandoned, existing channel and along the channel top of bank in some areas where the existing elevation was lower than bankfull. Rain and wet conditions were a constant issue during the construction period; however, the sandy soils allowed for good drainage over most of the reach and these interruptions were usually of short durations.

Construction began at the upstream beginning of the project, Station 0+00, and progressed downstream. Unnamed tributaries were worked on as work progressed to them. Due to the beaver dams and overbank flow associated with these dams over the upper 300 feet of the channel, a stable access path was established to reach the upper limits of the project. Channel grading involved removing blockages and establishing the design channel width, depth and slope. This work was done primarily from the right bank to limit impacts to existing vegetation along the left bank. Low existing areas along the floodplain that made establishing the required width or depth impossible were filled to establish the correct elevations. Work continued downstream through a forested buffer area along the upper 1100 feet of R1. As the designed channel was established and the old channel or parts of the old channel abandoned these were filled with fill material stockpiled on site near the upstream entrance. The waterlogged woody debris found throughout the old channel was utilized as much as possible by placing it in the new channel where is could be “locked” in place using other structure or habitat features in the channel.

Due to the timing of construction, live vegetation material was not available for installation in toewood or geolift revetments placed along the meander bends. Because we were dissatisfied with the bare appearance of the coir lifts used to construct outer meander bends we began utilizing the native live material that was being destroyed when bank grading was done. We were unsure if this vegetation would survive, but felt that it was better to use it and have it not survive, than to have nothing in the lifts. The doghobble incorporated in these lifts turned brown after being moved but it often re-sprouted from the roots and along with other species like yellowroot made a well-stabilized bank. This practice actually produced a living mass of native vegetation along these meanders and provided a good alternative to live stake material and disposing of this onsite living material.

Construction of the mainstem channel continued downstream following the accepted plan. As tributaries were encountered, they were addressed. All UTs, except UT5, required that the confluence with the mainstem be stabilized because they were dropping over a short distance to the mainstem elevation. This was done by installing grade control log or boulder structures at these confluences. UTs 3, 6 and 8 had significant reaches of constructed channel built to extend them to the newly constructed mainstem. These extended UT channels were aligned to fall with the valley to the point they intersected the mainstem channel and had a low sinuosity. Grade across these new channels was stabilized by dropping over two to four boulder or log, grade control structures. All tributaries were planted with both the native seed mixture, live stakes and bare root trees within the conservation easement.

Construction of the mainstem and all contributing UTs along Reach 1 of Logan Creek were completed by November 1, 2014. Logan Creek supports a reproducing brown and rainbow trout population and during permitting, the trout moratorium was applied to this project. In early October, it was apparent that we would need to work to the end of the month to complete all work within Reach 1. We requested that the applied moratorium not begin until the end of October and this request was approved by the NC Wildlife Resources Commission and by the US Army Corps of Engineers. This request was primarily needed due to delays caused by the extreme wet weather experienced during construction. Using this extension, we were able to complete all in channel work by November 1 and completed floodplain work such as grading, seeding and mulching by the middle of November.

Upon completion of stream work within the site, sedimentation and erosion control measures such as pump around operations, temporary stream crossings, and silt fence were removed. As grading was completed on all the stream channels the bare ground was seeded with a native riparian seed mix and with millet or rye (depending on the season). The bare ground was then mulched with wheat straw. On the channels the sloping banks were covered with coir matting after seeding, which was pinned in place with wooden stakes. Live stakes were installed in the stream banks after the channel was constructed and live, bare rooted trees were planted throughout the entire easement area in January 2015.

Logan Creek Reach 2 was restored using an Enhancement I approach. This 1,038 LF reach was started after April 15, 2015 when the Trout Moratorium ended. Our approach through this reach was to construct structures that would cause convergence of stream flows and move the sand that had accumulated along the channel bed downstream. There were a few areas of varying length, where the channel was over-wide with eroding banks, this was usually caused by accumulated log and debris jams. Log and debris jams were removed throughout the reach, and where needed the channel was repaired to establish the appropriate channel width and the bank stabilized using the removed woody debris. All of this work was accomplished while having a minimal impact on existing trees, shrubs and herbaceous vegetation. Wherever the ground was disturbed, it was seeded with native riparian seed mix, millet and covered with straw mulch. Some livestakes and bare-root trees were planted within this reach but the need for this vegetation was minimal due to our ability to preserve most of the natural, existing vegetation. This Enhancement Reach was completed by May 12, 2015.

All riparian buffer areas within the project boundaries are protected for a minimum of thirty feet from the top of both stream banks and are protected in perpetuity by a conservation easement that totals 12.71 acres. Fencing was not installed along the conservation easement boundary because there will be no livestock on the property and because the owners/developers of the property are extremely concerned with aesthetic appeal of the property. To appease the landowners concerns regarding the aesthetics of marking the easement boundary, Baker has worked with DMS Stewardship to mark the easement in the least stark method while still being unambiguous. Through the meadow along much of the right bank, the easement was marked using boulders placed at each turn. Posts and signs will be used within the forested areas. However, the easement does allow for the installation of other marking methods and even a fence in the future, if this becomes necessary.

As-built plan sheets/record drawings depict actual surveyed areas with the project area and depict any changes from the construction drawings to what was implemented on-site during construction. The as-built plan sheets/record drawings are located in Appendix D. The as-built results for the project, including Restoration, Enhancement and Preservation areas, totaled 5,110 LF of stream. The total 5,110 LF of stream was all that was available for this project at this site, as determined by the US Army Corps of Engineers after stream footage originally optioned by

Baker was used by the landowners for their permitting needs (USACOE 2011). The length and area for individual reaches are summarized in Appendix A, Table 1.

Baker and River Works met on-site on November 4, 2014, and prepared a preliminary punch-list of final items to be performed for the Logan Creek Reach 1, and associated UTs. The needs were minimal and River Works demobilized from the site on November 6, 2014. Work on the Enhancement Reach (Reach 2) was done using a mid-size excavator and hand labor, so mobilization and demob were carried out quickly and completed by May 12, 2015. A project completion site review and site walk with DMS was held on June 2, 2015

4.0 PERFORMANCE STANDARDS

Baker has been involved in obtaining recent approvals from the regulatory agencies for several Mountain stream and wetland mitigation plans. The success criteria for the project site will follow the mitigation plans developed for these projects, as well as the Stream Mitigation Guidelines (SMG) (USACE 2003). Post-restoration monitoring for stream mitigation work will be conducted for five years post construction. Stream monitoring will annually collect, evaluate and report on stream dimension (cross-sections), pattern (longitudinal survey), profile (profile survey), and will provide observational information through photographic documentation. Monitoring shall be consistent with the requirements described in the Federal Rule for compensatory mitigation sites in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.5 paragraphs (a) and (b), dated April 2008.

5.0 MONITORING PLAN AND SUCCESS CRITERIA

5.1 Stream Monitoring – Logan Creek, UT3, and UT6

Geomorphic monitoring of both reaches on Logan Creek, UT3 and UT6 will be conducted once a year for five years following the completion of construction to evaluate the effectiveness of the restoration practices and following existing guidance (USACE 2003). Monitored stream parameters include stream dimension (cross-sections), pattern (planimetric survey), profile (longitudinal profile survey), and visual observation with photographic documentation. The methods used and related success criteria are described below for each parameter.

5.1.1 Hydrology:Bankfull Events and Flooding Functions

The occurrence of bankfull events within the monitoring period will be documented by the use of a crest gauge and photographs. The crest gauge will record the highest watermark between site visits, and the gauge will be checked at each site visit to determine if a bankfull event has occurred. Photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits.

Two bankfull flow events must be documented within a five-year monitoring period. The two bankfull events must occur in separate years; otherwise, the monitoring will continue until two bankfull events have been documented during the five-year post construction monitoring period.

5.1.2 Cross-Sections

Per the USACE 2003 SMGs, permanent cross-sections were installed at a rate of one cross-section per twenty bankfull widths of restored stream, with approximately 50 percent of cross-sections located at riffles and 50 percent located at pools. Each cross-section is marked on both banks with permanent monuments to establish the exact transect used. A common benchmark will be used for cross-sections and consistently used to facilitate easy comparison of year-to-year data. Cross-section surveys will occur annually and will include measurements of Bank Height Ratio and Entrenchment Ratio. The

monitoring survey will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross-sections will be classified using the Rosgen Stream Classification System (Rosgen 1994 and 1996).

Minor change in as-built cross-sections should be expected but not significant, major changes. Any change to the cross-sections will be documented in the survey data and evaluated to determine if the change represents a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross-sections will be classified using the Rosgen Stream Classification System, and all monitored cross-sections should fall within the quantitative parameters (i.e. BHR no more than 1.2 and ER no less than 2.2) defined for channels of the design stream type. Given the small channel size, sandy substrate, and large floodplain widths of the proposed steam, bank pins will not be installed unless required by the USACE.

5.1.3 Pattern

Plan view measurements such as sinuosity, radius of curvature, and meander width ratio will be measured on the newly constructed meanders to establish the as-built baseline condition and again after one year of monitoring or if a significant change is observed. Subsequent visual monitoring will be conducted twice a year, at least five months apart, to document any changes or excessive lateral movement in the plan view of the restored channel.

5.1.4 Longitudinal Profile

A longitudinal profile was surveyed on Logan Creek, UT3-R2 and UT6 after construction to document as-built baseline conditions. The survey was tied to a permanent benchmark and measurements included thalweg, water surface, bankfull, and top of low bank. Each of these measurements were taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. The longitudinal profile should show that the bedform features installed are consistent with intended design stream type. The longitudinal profiles will be replicated each year.

5.1.5 Bed Material Analyses

Bed material analysis will consist of pebble counts taken in the same riffles during annual geomorphic surveys of the project site. Sample sites will be selected to represent conditions on the mainstem. These samples, combined with evidence provided by changes in cross-section and profile data will reveal changes in sediment transport and bed gradation that occur over time as the stream adjusts to upstream sediment loads and cross-sections evolve into a more permanent stable dimension. Significant changes in bed load composition will be evaluated with respect to stream stability and watershed changes.

5.1.6 Photo Reference Stations

Photographs will be used to document restoration success. Reference photo points have been photographed after construction and will be continued annually for at least five years. Photographs will be taken from a height of approximately five to six feet. Photo points have been mapped and markers established at each point. Reference photographs will be carried into the field to ensure that the same locations (and view directions) of the site are duplicated in each monitoring period.

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

Structure photos. Photographs will be taken of grade control structures along the restored stream and will be limited to boulder and log steps. Photographers will make every effort to maintain consistent areas in each photo over time.

Photographs will be used to evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures subjectively. Lateral photos should not indicate excessive erosion or continuing degradation of the banks. A series of photos over time should indicate successive maturation of riparian vegetation.

5.2 Vegetation Monitoring

Successful restoration of the vegetation on a site is dependent upon hydrologic restoration, planting of preferred canopy species, and volunteer regeneration of the native plant community. In order to determine if successful restoration of vegetation is achieved, vegetation-monitoring quadrants have been installed and will be monitored across the restoration site in accordance with the CVS-NCEEP Protocol for Recording Vegetation, Version 4.1 (Lee et. al. 2007). Vegetation will be monitored using eight (8) plots established randomly within the planted riparian buffer per CVS-NCEEP monitoring protocol for Levels 1 and 2. The size of individual quadrants is generally 100 square meters for woody tree species and 1 square meter for herbaceous vegetation.

Vegetation monitoring will occur in the fall, prior to the loss of leaves if possible. Individual quadrant data will be provided and will include species diameter, height, density, and coverage quantities. Relative values will be calculated, and importance values will be determined. Individual seedlings were marked so that they can be found in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings.

At the end of the first full growing season between September 1st and December 30th, species composition, stem density, and survival will be evaluated. Vegetation plots shall be monitored for five years until the final success criteria are achieved. The restored site will be evaluated between September and November using the Carolina Vegetation Survey Entry Tool (CVS 2007). The interim measure of vegetative success for the site will require the survival of at least 320 planted trees per acre at the end of year three of the monitoring period. The final vegetative success criteria at year 5 will be the survival of no less than 260 planted trees per acre.

Measuring species density and height alone may be inadequate for assessing plant community health. For this reason, the vegetation monitoring plan will incorporate the evaluation of native volunteer species, and the presence of invasive species vegetation to assess overall vegetative success.

Baker will provide required remedial action on a case-by-case basis, such as: replanting more wet/drought tolerant species, conducting beaver management/dam removal, and removing undesirable/invasive species vegetation, and will continue to monitor vegetation performance until the corrective actions demonstrate that the site is trending towards or meeting the standard requirement. Existing mature woody vegetation will be visually monitored during annual site visits to document any mortality, due to construction activities or changes to the water table that may negatively affect existing forest cover or favorable buffer vegetation. Additionally, herbaceous vegetation, primarily native grasses, will be seeded/planted throughout the site as necessary. At the end of construction, ground cover at the project site was complying with the NC Erosion and Sedimentation Control Ordinance.

6.0 AS-BUILT DATA DOCUMENTATION

Stream and vegetation components will be monitored for five years post-construction to evaluate project success. The specific locations of vegetation plots and permanent cross-sections, are shown on the as-built plan sheets. Photo Point reference stations were installed along all of the project channels. The location of each photo reference point is also depicted on the as-built plan sheets in Appendix D.

6.1 Stream Data

For monitoring stream success criteria, eleven (11) permanent cross-sections (8 on Logan Creek, 2 on UT6, and 1 on UT3) were installed. We intended to be include an additional cross-section on UT3; however, the surveyors failed to pick it up. This cross-section will be added during YR1 monitoring and with future monitoring. This will bring the total number of cross-sections to twelve (12). One (1) crest gauge has been installed on the mainstem to indicate when stream flows are greater than bankfull. The permanent cross-sections will be used to monitor channel dimension and bank stability over time. Thirty three (33) photo reference points were installed throughout the project area (23 photo points on Logan Creek, one photo point on each UT (total of 7 photo points) except UT5, which has 3 photo points). The total number of cross-sections installed to monitor this project site is slightly more than the number proposed in the Logan Creek Mitigation Plan, from a proposed ten cross-sections to eleven reported here and twelve in future monitoring reports. Additionally, a longitudinal survey was completed for the restored stream channels to provide a baseline for evaluating changes in bed conditions over time. The as-built permanent cross-sections (with photos) and as-built longitudinal data as well as the quantitative pre-construction, reference reach, and design data used to determine restoration approach are provided in Appendix B. As-built data will be used for comparison to post-construction monitoring data. The locations of the permanent cross-sections and photo points are shown on the as-built plan sheets in Appendix D. Photographs from each photo point are provided in Appendix E.

6.2 Vegetation Data

Bare-root trees and shrubs were planted within restoration and enhancement areas of the conservation easement. The only locations not planted were areas that had existing trees, with a dense over-story and existing thick ground vegetation. A minimum 30-foot buffer was established and/or protected along all stream reaches. Planting of bare-root trees and shrubs and live stake planting was completed in January 2015, with minor additions made in May. The original proposed bare-root and live-stake species list contained over forty different species of trees and shrubs; however, the actual plantings included fourteen (14) of these species. Species planted at the Logan Creek site are summarized in Table 7 of Appendix C.

The Mitigation Plan for the site specifies that the number of quadrants required shall be based on the CVS-NCEEP monitoring guidance (Lee et. al. 2007). The total number of quadrants was calculated using the CVS-NCEEP Entry Tool Database version 2.2.7 (CVS, 2007). The size of individual quadrants is 100 square meters. Eight (8) vegetation plots were installed throughout the project site. The initial, average density of planted bare root stems, based on the data from the eight vegetation monitoring plots, is 860 stems per acre (Table 8 of Appendix C). The locations of the vegetation plots are shown on the as-built plan sheets in Appendix D.

6.3 Areas of Concern

There are no areas of concern within the stream channel associated with this new construction. There are three issues associated with the floodplain that are of concern. Near Station 24+50 on the mainstem, the landowners have installed a drainage pipe that extends into the easement and carries storm drainage into the easement. We have communicated with them, explaining that this is violation of the easement agreement. DMS has given them ninety days to remove this pipe and repair their impacts to the easement. Near Station 28+00 a small hole has developed on the floodplain due to soil settling around toewood that was installed in

the bank. Stormwater also stands in this area and contributes to this subsidence as water infiltrates the ground. We have marked this location and will be filling this hole. Lastly, there are some minor areas where maintenance workers are mowing slightly into the easement along the meadow area. We have spoken to the developer about this and they are notifying the maintenance workers and moving them further away from the easement line.

7.0 MAINTENANCE AND CONTINGENCY PLANS

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

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

The site will be monitored on a regular basis, including a physical inspection of the site at least once a year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Maintenance issues and recommended remediation measures will be detailed and documented in the post-construction monitoring reports. Factors that may have caused any maintenance needs, including any of the conditions listed above, shall be discussed in monitoring reports. Routine maintenance will be the most likely need in the first two years following site construction and may include the following components as described below.

7.1 Streams

Routine channel maintenance and repair activities may include modifying in-stream structures to prevent piping, securing loose coir matting, and supplemental installations of live stakes and other target vegetation along the project reaches. Areas of concentrated stormwater and floodplain flows that intercept the channel may also require maintenance to prevent bank failures and head-cutting until vegetation becomes well established.

7.2 Vegetation

Vegetation will be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, seeding, pruning, and fertilizing. Exotic invasive plant species will be controlled by mechanical and/or chemical methods. Any invasive plant species control requiring herbicide application will be performed in accordance with NC Department of Agriculture and Consumer Services (NCDA&CS) rules and regulations.

7.3 Site Boundary

Site boundaries are being demarcated in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries can be identified by fence, marker, bollard, post, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.

8.0 REFERENCES

Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.5 (a) and (b).

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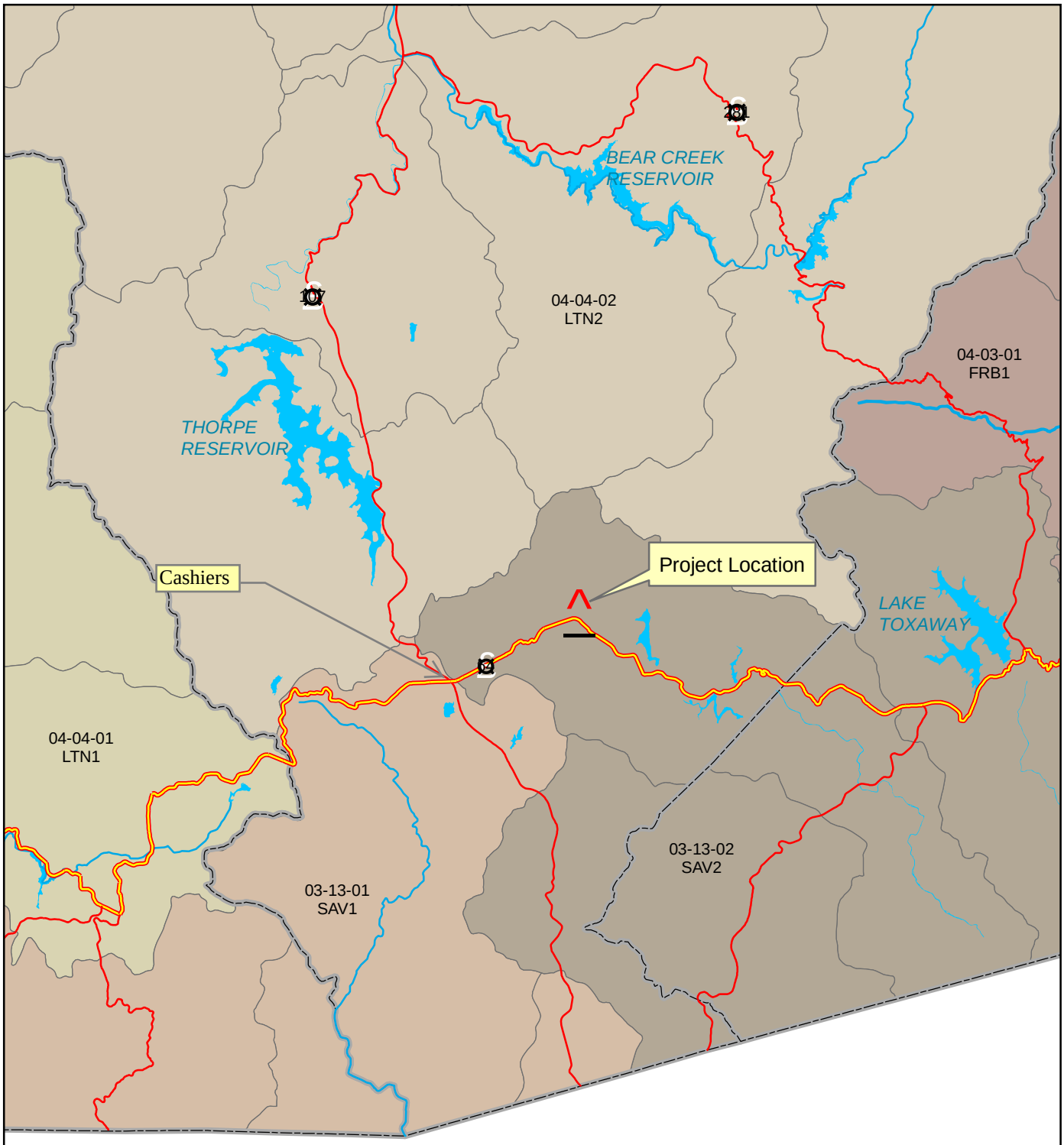
APPENDIX A

Figures 1 - 2, Tables 1 - 4



Jackson County, NC

Counties
NCDWQ Sub-basin
USGS Hydrologic Unit

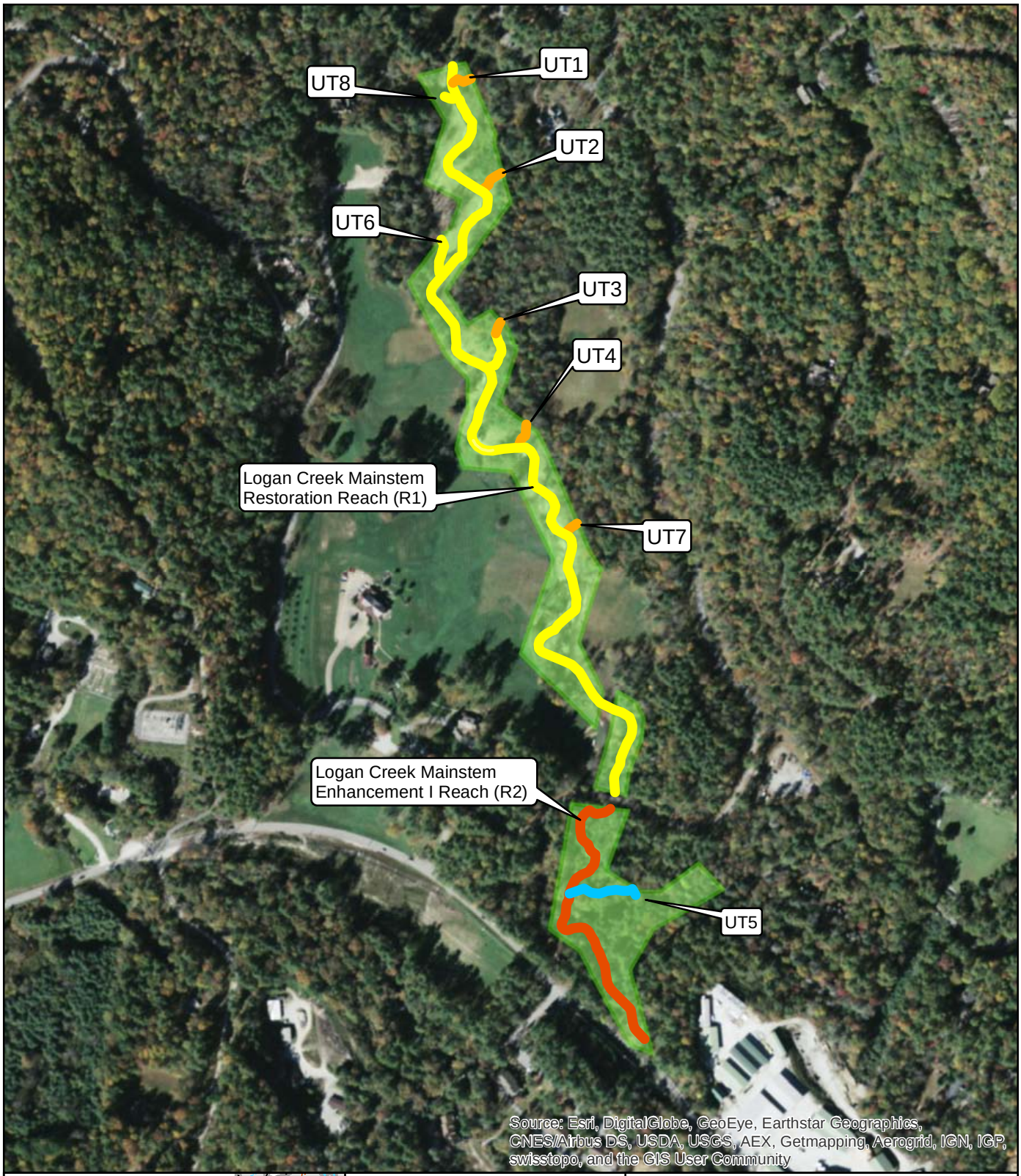
0 1 2 3 Miles

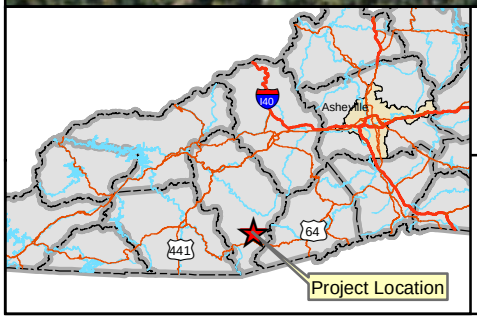
Fig 1. Project Location Map

Logan Creek Stream Restoration

Division of Mitigation Services

Michael Baker INTERNATIONAL





Legend

- Restoration
- Enhancement I
- Enhancement II
- Preservation
- CE Boundary

0 250 500 Feet

N

Fig 2. Asset Map showing existing project reaches, tributaries and type of restoration.
Logan Creek Stream Restoration

Division of Mitigation Services

Michael Baker INTERNATIONAL

Table 1. Project Components and Mitigation Credits

Logan Creek Restoration Project: DMS Project ID No. 92515

Mitigation Credits

	Stream				Riparian Wetland	Non-riparian Wetland	Buffer	Nitrogen Nutrient Offset	Phosphorus Nutrient Offset
Type	R	EI	EII	P					
Totals	3,444 SMU	692 SMU	136 SMU	57 SMU					

Project Components

Project Component or Reach ID	Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration/ Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio
STREAMS						
Logan Creek						
Reach 1	0+00 to 31+84	3134 LF	Restoration - PI	3,134 SMU	3,134 LF	1:1
Reach 2	32+43 to 42+81	1038 LF	Enhancement I	692 SMU	1,038 LF	1.5:1
UT1	0+00 to 0+71	71 LF	Enhancement II	28 SMU	71 LF	2.5:1
UT2	0+00 to 0+92	92 LF	Enhancement II	37 SMU	92 LF	2.5:1
UT3						
Reach 1	0+00 to 0+40	40 LF	Enhancement II	16 SMU	40 LF	2.5:1
Reach 2	0+40 to 1+78	138 LF	Restoration - PI	138 SMU	138 LF	1:1
UT4	0+00 to 0+84	84 LF	Enhancement II	34 SMU	84 LF	2.5:1
UT5	0+00 to 2+87	287 LF	Preservation	57 SMU	287 LF	5:1
UT6	0+00 to 1+27	127 LF	Restoration - PI	127 SMU	127 LF	1:1
UT7	0+00 to 0+54	54 LF	Enhancement II	21 SMU	54 LF	2.5:1
UT8	0+00 to 0+45	45 LF	Restoration - P1	45 SMU	45 LF	1:1

Component Summation

Restoration Level	Stream (LF)	Riparian Wetland (AC)		Non-riparian Wetland (AC)	Buffer (SF)	Upland (AC)
Restoration	3,444					
Enhancement I	1,038					
Enhancement II	341					
Creation						
Preservation	287					
High Quality Preservation						

BMP Elements

Element		Location	Purpose/Function	Notes

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

Table 2. Project Activity and Reporting History
Logan Creek Restoration Project: DMS Project ID No. 92515

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Mitigation Plan Prepared	Jun-07	06 - 07	Apr-08
Mitigation Plan Amended	Apr-13	N/A	May-13
MItigation Plan Approved	N/A	N/A	Jun-13
Final Design – (at least 90% complete)	N/A	N/A	May-13
Construction Begins	N/A	N/A	Jun-14
Temporary S&E mix applied to entire project area	N/A	N/A	Jan-15*
Permanent seed mix applied to entire project area	N/A	N/A	Jan-15*
Planting of live stakes	N/A	N/A	Jan-15
Planting of bare root trees	N/A	N/A	Jan-15
End of Construction	N/A	N/A	May-15**
Survey of As-built conditions (Year 0 Monitoring-baseline)	N/A	Mar-15	Aug-15
As-Built Baseline Report	N/A	N/A	Nov-15
Year 1 Monitoring	Dec-15	N/A	N/A
Year 2 Monitoring	Dec-16	N/A	N/A
Year 3 Monitoring	Dec-17	N/A	N/A
Year 4 Monitoring	Dec-18	N/A	N/A
Year 5 Monitoring	Dec-19	N/A	N/A

* Began seeding with the start of construction June, 2014 and site was seeded multiple times with a final entire area overseeding at the time the bare root trees were planted.

** Construction of the majority of the site was completed by November 1, 2014 after a 2 week extension of the trout moratorium. The Enhancement Reach was done after April 15, 2015 (Trout Moratorium ends) and was completed by May 12, 2015.

Table 3. Project Contacts Table	
Logan Creek Restoration Project: DMS Project ID No. 92515	
Designer	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201 Asheville, NC 28806 Contact: Micky Clemmons, Tel. 828-412-6100
Construction Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Planting Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seeding Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seed Mix Sources	Green Resources (seed), Tel. 336-855-6363
Nursery Stock Suppliers	ArborGen Inc. (trees), 843-528-3204 Dykes and Son (trees), 931-668-8833
Monitoring Performers	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201 Asheville, NC 28806
	Contact:
Stream Monitoring Point of Contact	Micky Clemmons, Tel. 828-412-6100
Vegetation Monitoring Point of Contact	Micky Clemmons, Tel. 828-412-6100

Table 4. Project Attributes			
Logan Creek Restoration Project: DMS Project ID No. 92515			
Project Information			
Project Name	Logan Creek Stream Restoration Project		
County	Jackson		
Project Area (acres)	12.71		
Project Coordinates (latitude and longitude)	Latitude 35.132803° Longitude -83.061046°		
Watershed Summary Information			
Physiographic Province	Blue Ridge		
River Basin	Savannah River Basin		
USGS Hydrologic Unit 8-digit and 14-digit	03060101 / 03060101010020		
DWQ Sub-basin	Keowee River: 0306010101		
Project Drainage Area (AC)	Mainstem 1353.5 at beginning to 1714 at end, UT1, UT4, UT6, UT7 & UT8 <13, UT2 = 26; UT3 = 32, UT5 = 128.		
Project Drainage Area Percentage of Impervious Area	<2%		
USGA Land Use Classification	Deciduous Forest (76%)		
	Evergreen Forest (8%)		
	Pasture Land (4.6%)		
NCDMS Land Use Classification for this Hydrologic Unit	Forest (91%)	Shrub (1%)	
	Developed (6%)	Other (.5%)	
	Agriculture (1.5%)		
Stream Reach Summary Information			
Parameters	**Mainstem - Reach 1**	**Mainstem - Reach 2**	
Length of Reach (LF)	3,134	1,038	
Valley Classification (Rosgen)	VIII	VIII	
Drainage Area (AC)	1,557	1,714	
NCDWQ Stream Identification Score	52.5	52.5	
NCDWQ Water Quality Classification	C; TR: +HQW	C; TR: +HQW	
Morphological Description (Rosgen stream type)	C-E	C-E	
Evolutionary Trend	C→E	C→E	
Underlying Mapped Soils	NkA	SaC	
Drainage Class	Poorly drained to very poorly drained soils	Very deep, well drained, mod permeable soils	
Soil Hydric Status	Non-Hydric	Non-Hydric	
Average Channel Slope (ft/ft)	0.004	0.007	
FEMA Classification	Zone AE	Zone AE	
Native Vegetation Community	Mixed Forested/Rhododendron and grassland	Mixed Forested/Rhododendron and grassland	
Percent Composition of Exotic/Invasive Vegetation[2]	<1%	<1%	

Parameters	**UT5**	**UT3**		**6 other small UTs in R1**
		R1	**R2**	
Length of Reach (LF)	287	40	138	45 - 127
Valley Classification (Rosgen)	II	II		II
Drainage Area (AC)	136	32		.02 to .04
NCDWQ Stream Identification Score	48	41.5		40.5 - 32.5
NCDWQ Water Quality Classification	C; TR: +HQW	C; TR: +HQW		C; TR: +HQW
Morphological Description (Rosgen stream type)	E	B		E - B
Evolutionary Trend	E	B		B→C→E
Underlying Mapped Soils	NkA, CwA & SaC	NkA, SaC		NkA, SaC
Drainage Class	Somewhat poorly to well drained	Somewhat poorly to well drained		Somewhat poorly to well drained
Soil Hydric Status	Site-specific	Site-specific		Site-specific
Average Channel Slope (ft/ft)	N/A	0.012		0.0134 (UT6)

Regulatory Considerations			
Regulation	**Applicable**	**Resolved**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	Yes	Permit: Action ID #2008-01711
Waters of the United States – Section 401	Yes	Yes	Permit: WQC #3885
Endangered Species Act	No	Yes	Categorical Exclusion
Historic Preservation Act	No	Yes	Categorical Exclusion
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	Yes	No-Rise Cert	Categorical Exclusion
Essential Fisheries Habitat	No	N/A	N/A

Notes:
1. See Figure 2.5 of Mitigation Plan for key to soil series symbols.
3. USGS Land Use Data (2001) used rather than CGIA Land Use Classification data which is more dated (1996)

APPENDIX B

Morphological Summary Data (Tables 5 and 6), Cross-section Plots, Profile Plots, Pebble Count Plots

Table 5. Baseline Stream Summary
Logan Creek Restoration Project; DMS Project ID No. 92515

Logan Creek Mainstem																												
Parameter	**USGS Gauge**	**Regional Curve Interval [1]**			**Pre-Existing Condition[1]**						**Reference Reach Data**						**Design**						**As-built**					
											Right Prong Logan Creek																	
Dimension and Substrate - Riffle		NC Mtn. Regional Curve			Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	26.4	28.3	-	22.9	27.3	23.8	38.7	6.6	4	-	16.7	-	-	-	-	-	26.0	-	-	-	-	23.6	24.3	24.1	25.2	0.7	3
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	35.0	-	-	-	-	-	150.00	-	-	-	-	-	<150	-	-	-	-
BF Mean Depth (ft)	-	1.4	1.5	-	1.50	2.2	2.4	2.60	0.4	4	-	1.06	-	-	-	-	-	2.3	-	-	-	-	2.1	2.3	2.2	2.6	0.2	3
BF Max Depth (ft)	-	-	-	-	3.4	3.6	3.5	3.8	0.2	4	-	1.54	-	-	-	-	-	4.0	-	-	-	-	3.1	3.4	3.4	3.7	0.2	3
BF Cross-sectional Area (ft^2)	-	37.5	42.7	-	55.8	58.0	58.4	59.5	1.36	4	-	17.7	-	-	-	-	-	58.5	-	-	-	-	51.7	56.0	53.2	63.0	5.0	3
Width/Depth Ratio	-	-	-	-	8.9	13.6	9.8	25.7	7.01	4	-	15.8	-	-	-	-	-	12	-	-	-	-	9.2	10.7	10.8	12.0	1.1	3
Entrenchment Ratio	-	-	-	-	3.4	11.3	12.0	17.8	5.83	4	-	2.0	-	-	-	-	-	5.8	-	-	-	-	2.9	3.6	3.9	4.0	0.5	3
Bank Height Ratio	-	-	-	-	1	1.2	1.1	1.5	0.2	4	-	1.2	-	-	-	-	-	1.0	-	-	-	-	1.0	1.00	1.00	1.0	0.0	3
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	12.4	-	-	-	-	-	-	-	-	-	-
Pattern																												
Channel Beltwidth (ft)	-	-	-	-	194	216	217	252	18.13	7	-	80	-	-	-	-	65	-	-	140	-	-	130.0	193.2	190.0	258.0	41.5	6
Radius of Curvature (ft)	-	-	-	-	23	32	30	46	8.6	5	-	23	-	-	-	-	28	-	-	75	-	-	44.0	63.9	66.1	104.0	17.2	9
Rc:Bankfull width (ft/ft)	-	-	-	-	0.85	1.19	1.11	1.7	0.32	5	-	1.38	-	-	-	-	1.1	-	-	2.9	-	-	1.80	2.60	2.70	4.30	0.71	9
Meander Wavelength (ft)	-	-	-	-	120	177	197	239	46.75	5	-	150	-	-	-	-	118	-	-	236	-	-	145.0	236.7	244.5	321.0	48.1	12
Meander Width Ratio	-	-	-	-	4.44	6.56	7.3	8.85	1.73	5	-	4.8	-	-	-	-	2.5	-	-	5.4	-	-	6.0	9.7	10.1	13.2	2.0	12
Profile																												
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Riffle Slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.019	-	-	-	-	0.003	-	-	0.007	-	-	-	-	-	-	-	-
Pool Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pool Spacing (ft)	-	-	-	-	-	-	-	-	-	-	-	75	-	-	-	-	94	-	-	165	-	-	-	-	-	-	-	-
Pool Max Depth (ft)	-	-	-	-	2.9	3.8	4.0	4.5	0.64	3	-	2.28	-	-	-	-	-	6.00	-	-	-	-	5.2	5.3	5.2	5.4	0.1	3
Pool Volume (ft^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																												
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	0.8 / 5.8 / 12.4 / 35.4 / 169.6						-	-	-	-	-	-	-	-	-	-	-	-	mean 5.1 / 10.9 / 16.5 / 34.8 / 55.9					
Reach Shear Stress (competency) lb/ft^2	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m^2	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																												
Drainage Area (SM)	-	2.1 to 2.67			2.1 at upper end of project to 2.67 towads end of project						-	0.83	-	-	-	-	2.1 at upper end of project to 2.67 towads end of project						2.1 at upper end of project to 2.67 towads end of project					
Impervious cover estimate (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.67	-	-	-	-	-	2.67	-	-	-	-
Rosgen Classification	-	-	-	-	-	C4 to E4	-	-	-	-	-	C4	-	-	-	-	-	C4	-	-	-	-	-	C4	-	-	-	-
BF Velocity (fps)	-	-	-	-	-	-	-	-	-	-	-	3.55	-	-	-	-	-	4.31	-	-	-	-	-	4.33	-	-	-	-
BF Discharge (cfs)	-	205.7	237.0		-	-	-	-	-	-	-	98	-	-	-	-	-	271.5	-	-	-	-	-	242.6	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)	-	-	-	-	-	4,700	-	-	-	-	-	-	-	-	-	-	-	4,101	-	-	-	-	-	4,172	-	-	-	-
Sinuosity	-	-	-	-	-	-	-	-	-	-	-	2.01	-	-	-	-	-	1.3	-	-	-	-	-	1.31	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.0079	-	-	-	-	-	0.0035	-	-	-	-	-	0.0039	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.016	-	-	-	-	-	0.0047	-	-	-	-	-	0.0052	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1. Harman, W.A., D.E Wise, M.A. Walker, R. Morris, MA Cantrell, M. Clemmons, G.D. Jennings, D.R. Clinton, J.M. Patterson. 2000. Bankfull Regional Curves for North Carolina Mountain Streams. In: AWRA Conference Proceedings, D.L. Kane, editor. American Water Resources Specialty Conference on Water Resources in Extreme Environments. Anchorage, Alaska.

Table 5. Baseline Stream Summary
Logan Creek Restoration Project; DMS Project ID No. 92515

UT3, UT6 and UT8																											
Parameter	**USGS Gauge**	**Regional Curve Interval [1]**			**Pre-Existing Condition[1]**						**Reference Reach Data**						**Design**						**As-built**					
											Morgan Creek																	
Dimension and Substrate - Riffle		NC Mtn./NC Pied. Rural			Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	5.3	4.1	-	-	-	-	-	-	-	-	16.7	-	-	-	-	-	6.0	-	-	-	-	6.1	6.2	6.2	6.3	0.06	2
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	35.0	-	-	-	-	-	-	-	-	-	-	-	>27	-	-	-	-
BF Mean Depth (ft)	-	0.4	0.5	-	-	-	-	-	-	-	-	1.06	-	-	-	-	-	0.7	-	-	-	-	0.7	0.7	0.7	0.8	0.02	2
BF Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	1.54	-	-	-	-	-		-	-	-	-	1.1	1.2	1.2	1.2	0.0	2
BF Cross-sectional Area (ft²)	-	1.9	4.1	-	-	-	-	-	-	-	-	17.7	-	-	-	-	-	4.2	-	-	-	-	4.5	4.6	4.6	4.6	0.1	2
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	15.8	-	-	-	-	-		-	-	-	-	8.1	8.4	8.4	8.7	0.3	2
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-	-	-	-	-	4.3	5.5	5.5	6.6	1.2	2
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	1.0	1.0	1.0	1.0	0.0	2
d50 (mm)	-	-	-	-	-		-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pattern																											
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-	-	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	-	-	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Width Ratio	-	-	-	-	-	-	-	-	-	-	-	4.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profile																											
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0	31.8	19.0	77.0	26.3	4	14.3	18.7	14.9	30.5	6.9	4
Riffle Slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.019	-	-	-	-	0.0052	0.0107	0.0106	0.017	0.0041	4	0.0000	0.0078	0.0118	0.0140	0.0084	4
Pool Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.0	-	-	0	4	6.5	11.6	7.9	21.4	5.7	5
Pool Spacing (ft)	-	-	-	-	-	-	-	-	-	-	-	75	-	-	-	-	18.0	22.7	24.0	26.0	3.4	3	22.2	39.0	42.4	48.8	10.2	4
Pool Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	2.28	-	-	-	-	-	1.2	-	-	-	-	1.7	-	-	-	-	1
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																											
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				-			-	-	-	-	-	-
Reach Shear Stress (competency) lb/f²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																											
Drainage Area (SM)	-	0.025 to 0.08			0.025 to 0.08				-	-	-	0.83	-	-	-	-	-	-	-	-	-	-	0.025 to 0.08			-	-
Impervious cover estimate (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	-	-	-	-	-	-	C4	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
BF Velocity (fps)	-	-	-	-	-	-	-	-	-	7	-	3.55	-	-	-	-	-	-	-	-	-	-	-	4.27	-	-	-	-
BF Discharge (cfs)	-	7.8	18.3		-	-	-	-	-	-	-	98	-	-	-	-	-	-	-	-	-	-	-	212.2	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)	-	-	-	-	-	75	-	-	-	-	-	-	-	-	-	-	-	311.0	-	-	-	-	-	350	-	-	-	-
Sinuosity	-	-	-	-	-	-	-	-	-	-	-	2.01	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.0079	-	-	-	-	-	-	-	-	-	-	-	0.0043	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.016	-	-	-	-	-	-	-	-	-	-	-	0.004	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.2	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1. Harman, W.A., D.E Wise, M.A. Walker, R. Morris, MA Cantrell, M. Clemmons, G.D. Jennings, D.R. Clinton, J.M. Patterson. 2000. Bankfull Regional Curves for North Carolina Mountain Streams. In: AWRA Conference Proceedings, D.L. Kane, editor. American Water Resources Specialty Conference on Water Resources in Extreme Environments. Anchorage, Alaska.

Table 6. Morphology and Hydraulic Monitoring Summary
Logan Creek Restoration Project: DMS Project ID No. 92515

Logan Creek (4,172 LF)																									
	Cross-section X-1, Station 3+10 (Riffle), Restoration Reach							Cross-section X-2, Station 3+70 (Pool), Restoration Reach							Cross-section X-3, Station 12+57 (Riffle), Restoration Reach							Cross-section X-4, Station 13+00 (Pool)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	24.1							25.9							25.2							27.6						
BF Mean Depth (ft)	2.6							2.5							2.1							2.3						
Width/Depth Ratio	9.2							10.5							12.0							12.1						
BF Cross-sectional Area (ft^2)	63.0							63.9							53.2							62.8						
BF Max Depth (ft)	3.7							5.2							3.1							5.2						
Width of Floodprone Area (ft)	>70							>60							>100							>100						
Entrenchment Ratio	2.9							2.3							3.9							3.6						
Bank Height Ratio	1.0							1.1							1.0							1.0						
Wetted Perimeter (ft)	29.3							30.9							29.5							32.2						
Hydraulic Radius (ft)	2.1							2.1							1.8							2.0						
Based on current/developing bankfull feature																												
BF Width (ft)																												
BF Mean Depth (ft)																												
Width/Depth Ratio																												
BF Cross-sectional Area (ft^2)																												
BF Max Depth (ft)																												
Width of Floodprone Area (ft)																												
Entrenchment Ratio																												
Bank Height Ratio																												
Wetted Perimeter (ft)																												
Hydraulic Radius (ft)																												
Cross Sectional Area between end pins (ft^2)	-							-																				
d50 (mm)	-							-																				

	Cross-section X-5, Station 25+43 (Pool), Restoration Reach							Cross-section X-6, Station 26+09 (Riffle), Restoration Reach							Cross-section 10, Station 37+05 (Pool), Enhancement Reach							Cross-section 11, Station 37+20 (Riffle), Enhancement Reach						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	21.34							23.64							31.0							29.2						
BF Mean Depth (ft)	3.0							2.19							2.1							2.1						
Width/Depth Ratio	7.12							10.81							14.4							14.0						
BF Cross-sectional Area (ft^2)	63.9							51.70							66.6							60.7						
BF Max Depth (ft)	5.35							3.39							3.5							2.9						
Width of Floodprone Area (ft)	>80							>95							>60							>54						
Entrenchment Ratio	4.4							4.0							4.2							4.5						
Bank Height Ratio	1.0							1.0							1.0							1.1						
Wetted Perimeter (ft)	27.3							28.0							35.2							33.4						
Hydraulic Radius (ft)	2.3							1.8							1.9							1.8						
Based on current/developing bankfull feature																												
BF Width (ft)																												
BF Mean Depth (ft)																												
Width/Depth Ratio																												
BF Cross-sectional Area (ft^2)																												
BF Max Depth (ft)																												
Width of Floodprone Area (ft)																												
Entrenchment Ratio																												
Bank Height Ratio																												
Wetted Perimeter (ft)																												
Hydraulic Radius (ft)																												
Cross Sectional Area between end pins (ft^2)	-							-							-							-						
d50 (mm)	-							-							-							-						

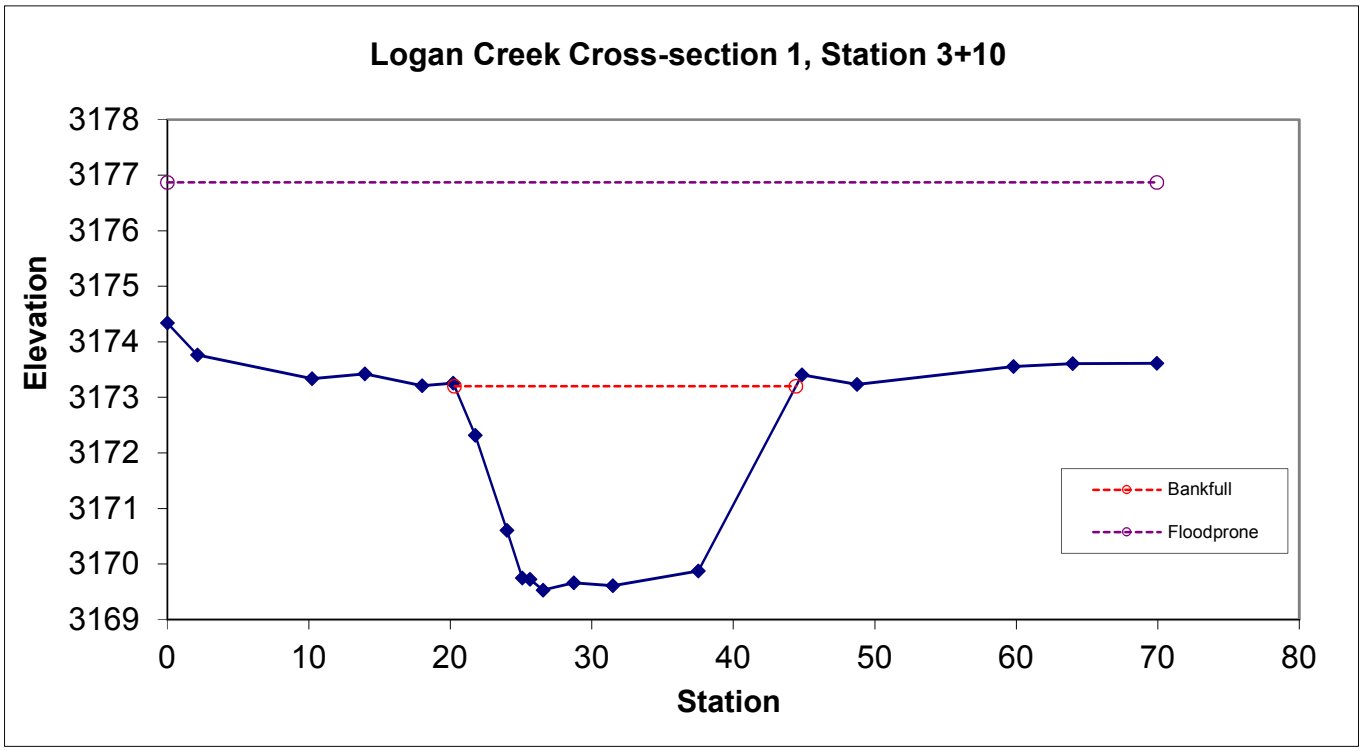
Table 6. Morphology and Hydraulic Monitoring Summary
Logan Creek Restoration Project: DMS Project ID No. 92515

UT3 (178 LF)																									
	Cross-section X-9, Station 0+95 (Riffle)																								
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																									
BF Width (ft)	6.25																								
BF Mean Depth (ft)	0.72																								
Width/Depth Ratio	8.73																								
BF Cross-sectional Area (ft²)	4.50																								
BF Max Depth (ft)	1.2																								
Width of Floodprone Area (ft)	26.80																								
Entrenchment Ratio	4.30																								
Bank Height Ratio	1.0																								
Wetted Perimeter (ft)	7.7																								
Hydraulic Radius (ft)	0.6																								
Based on current/developing bankfull feature																									
BF Width (ft)																									
BF Mean Depth (ft)																									
Width/Depth Ratio																									
BF Cross-sectional Area (ft²)																									
BF Max Depth (ft)																									
Width of Floodprone Area (ft)																									
Entrenchment Ratio																									
Bank Height Ratio																									
Wetted Perimeter (ft)																									
Hydraulic Radius (ft)																									
Cross Sectional Area between end pins (ft²)	-							-																	
d50 (mm)	-							-																	

UT6 (127 LF)																									
	Cross-section X-7, Station 0+58 (Pool)							Cross-section X-8, Station 0+73 (Riffle)																	
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																									
BF Width (ft)	9.78							6.14																	
BF Mean Depth (ft)	1.03							0.76																	
Width/Depth Ratio	9.47							8.12																	
BF Cross-sectional Area (ft²)	10.1							4.6																	
BF Max Depth (ft)	1.69							1.14																	
Width of Floodprone Area (ft)	> 50							> 50																	
Entrenchment Ratio	3.8							6.6																	
Bank Height Ratio	1.0							1.0																	
Wetted Perimeter (ft)	11.8							7.7																	
Hydraulic Radius (ft)	0.9							0.6																	
Based on current/developing bankfull feature																									
BF Width (ft)																									
BF Mean Depth (ft)																									
Width/Depth Ratio																									
BF Cross-sectional Area (ft²)																									
BF Max Depth (ft)																									
Width of Floodprone Area (ft)																									
Entrenchment Ratio																									
Bank Height Ratio																									
Wetted Perimeter (ft)																									
Hydraulic Radius (ft)																									
Cross Sectional Area between end pins (ft²)	-							-							-							-						
d50 (mm)	-							-							-							-						

Permanent Cross-section 1
(As-Built Data - collected May, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	63	24.12	2.61	3.67	9.23	1	2.9	3173.2	3173.26

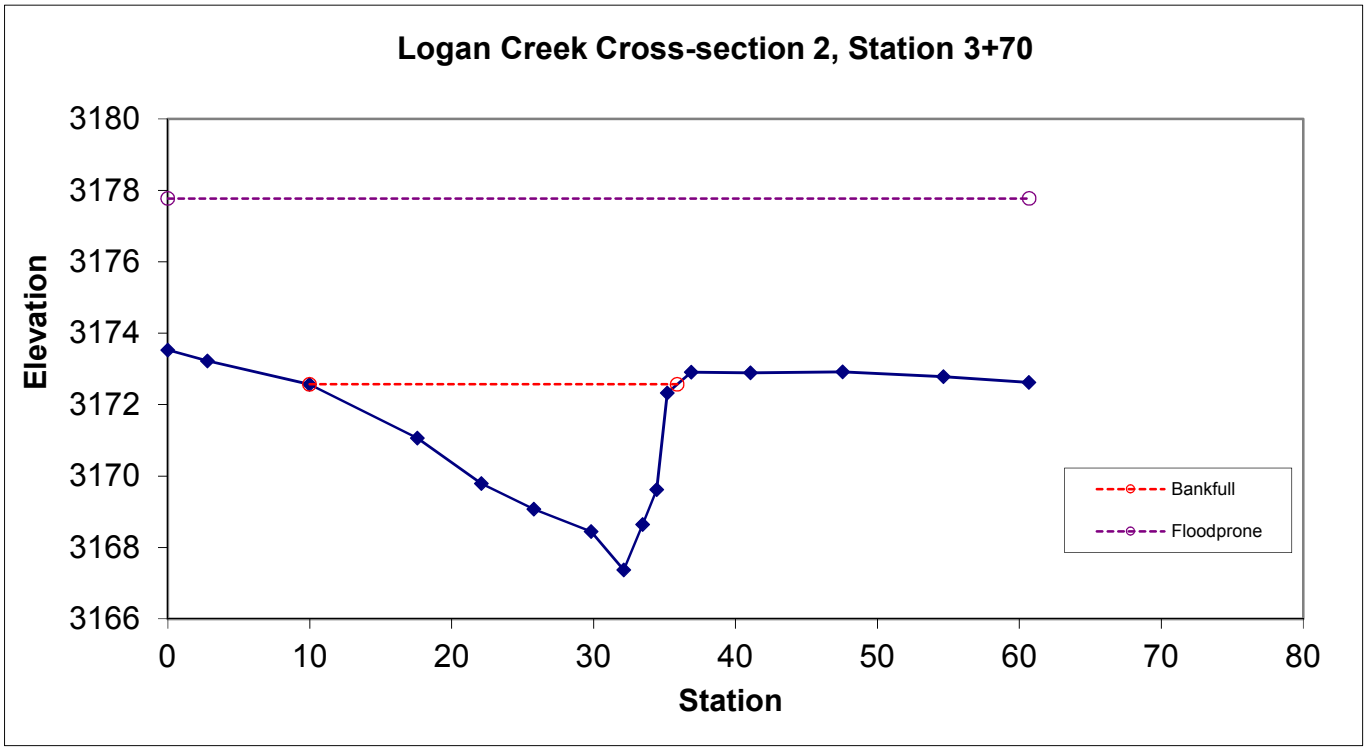


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 2
(As-Built Data - collected May, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		63.9	25.91	2.47	5.2	10.5	1.1	2.3	3172.57	3172.91

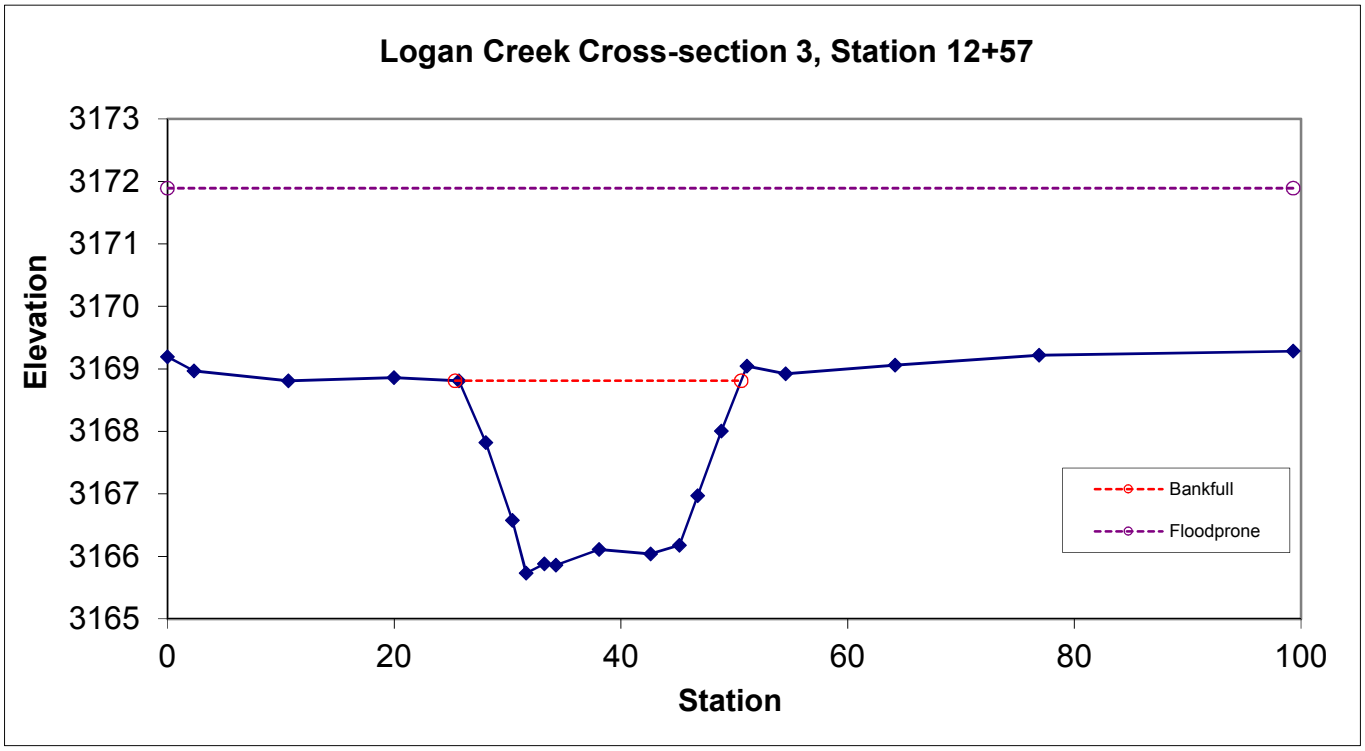


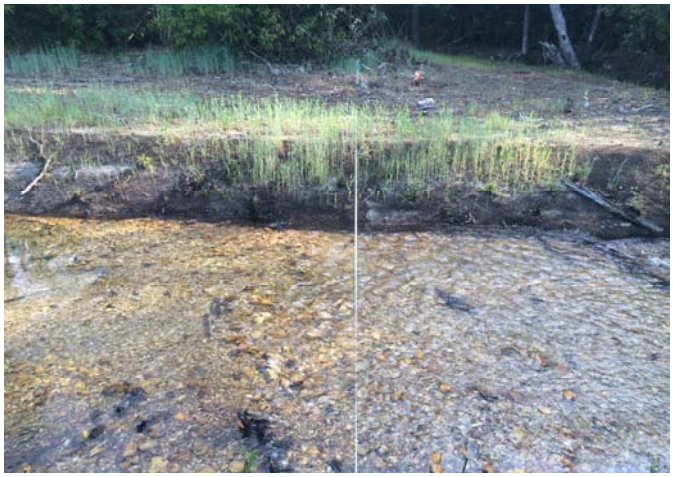
Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 3
(As-Built Data - collected May, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	53.2	25.23	2.11	3.08	11.97	1	3.9	3168.81	3168.86



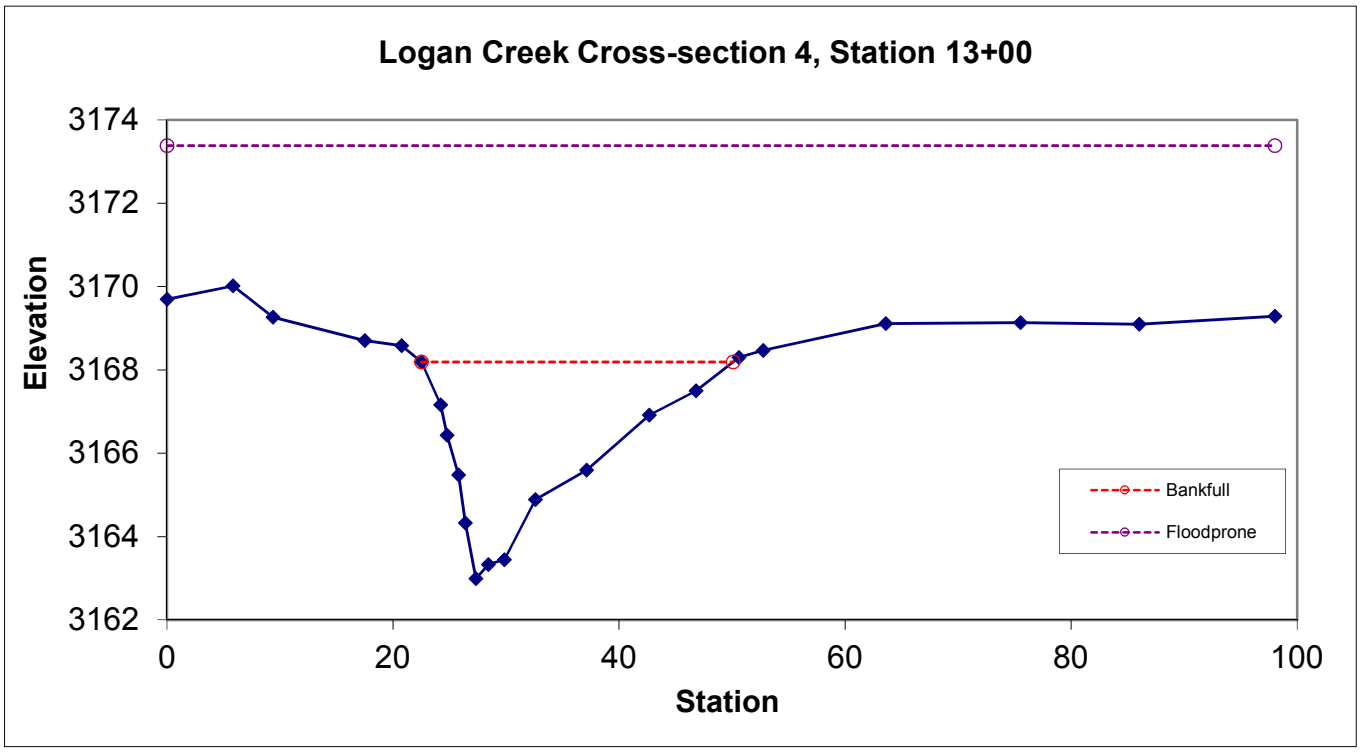


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 4
(As-Built Data - collected May, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		62.8	27.59	2.28	5.2	12.11	1	3.6	3168.19	3168.29

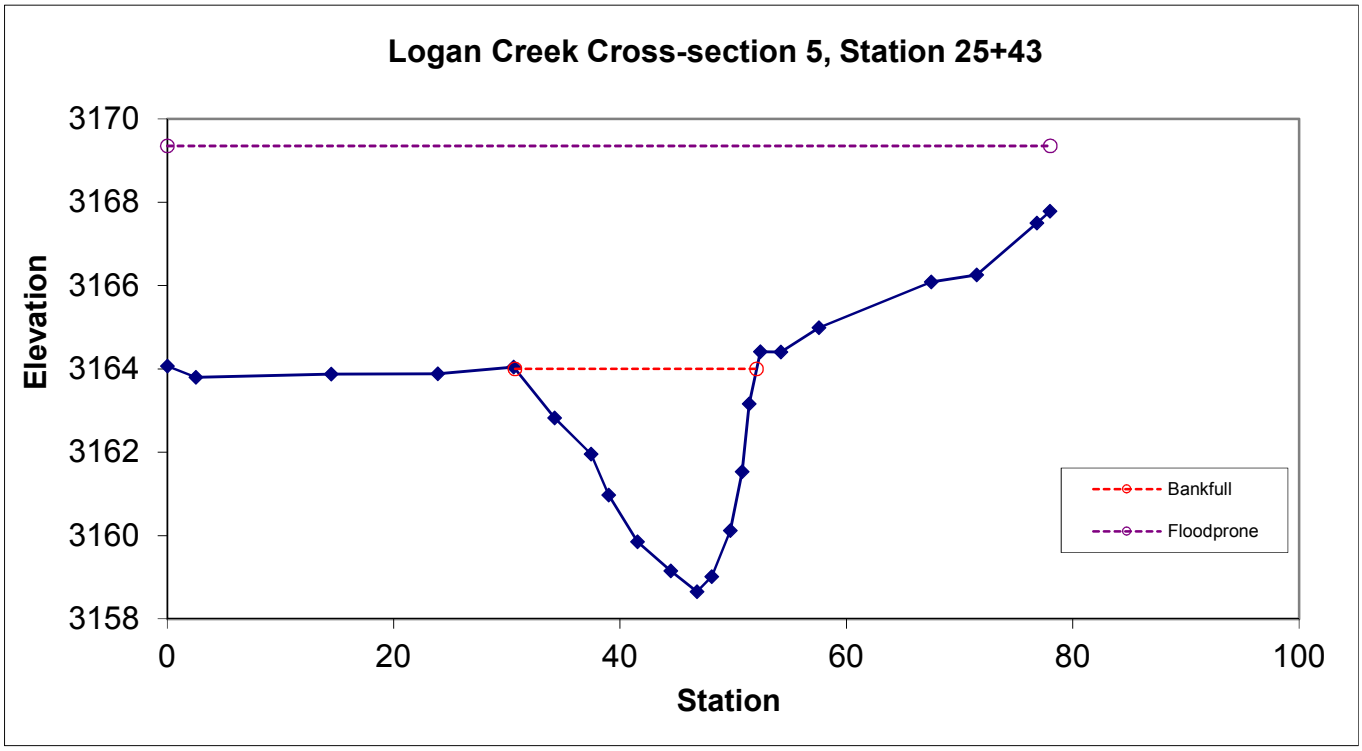


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 5
(As-Built Data - collected May, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		63.9	21.34	3	5.35	7.12	1	4.4	3164	3164.04

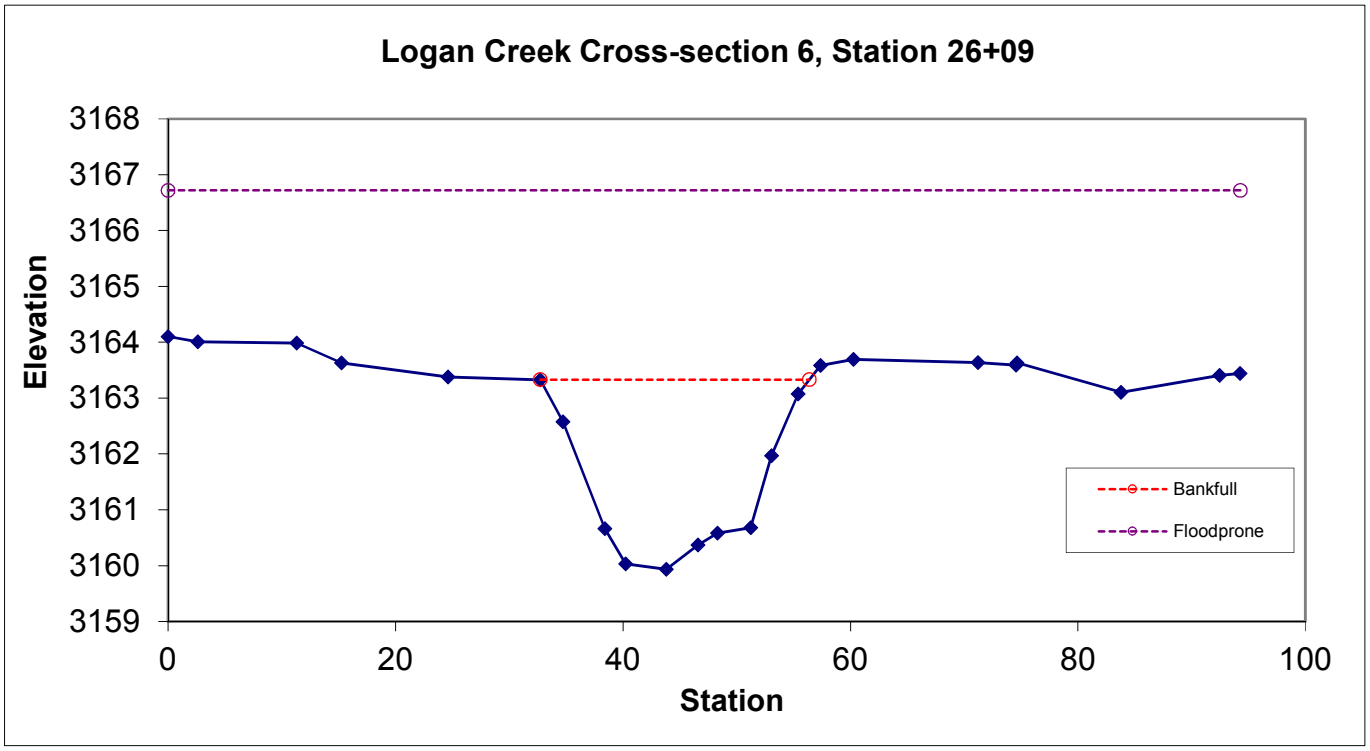


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 6
(As-Built Data - collected May, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	51.7	23.64	2.19	3.39	10.81	1	4	3163.33	3163.38

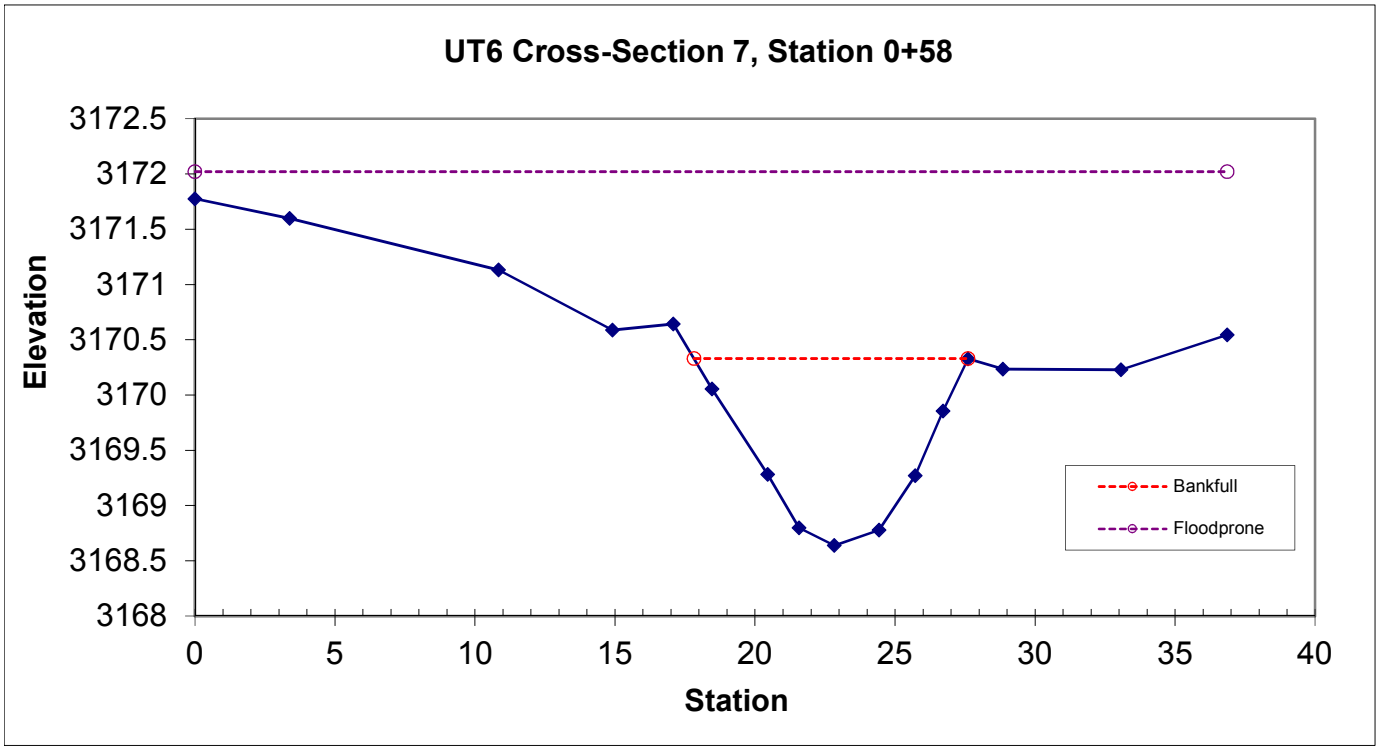


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 7
(As-Built Data - collected May, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		10.1	9.78	1.03	1.69	9.47	1	3.8	3170.33	3170.33

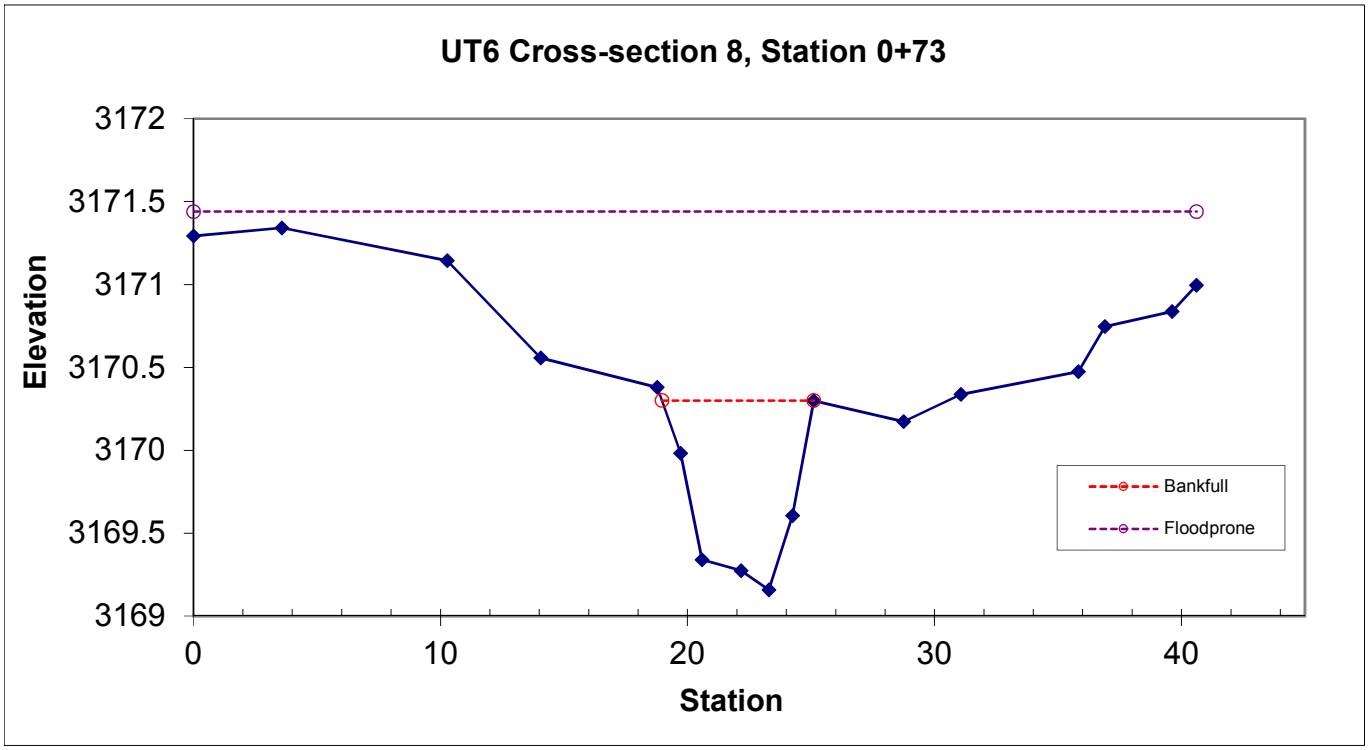


Looking at the Left Bank

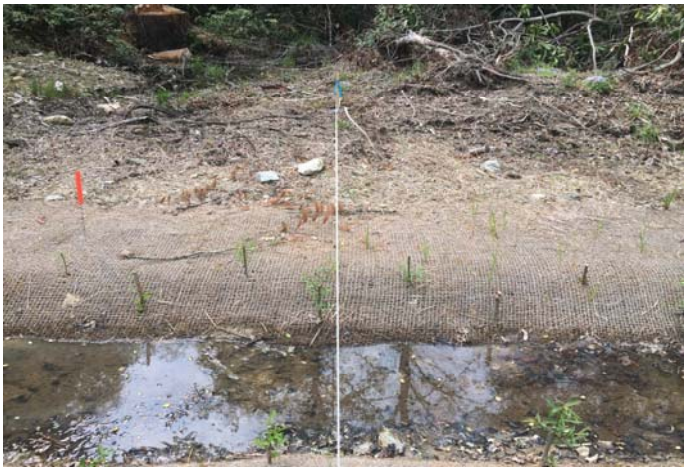
Looking at the Right Bank

Permanent Cross-section 8
(As-Built Data - collected May, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	4.6	6.14	0.76	1.14	8.12	1	6.6	3170.3	3170.3



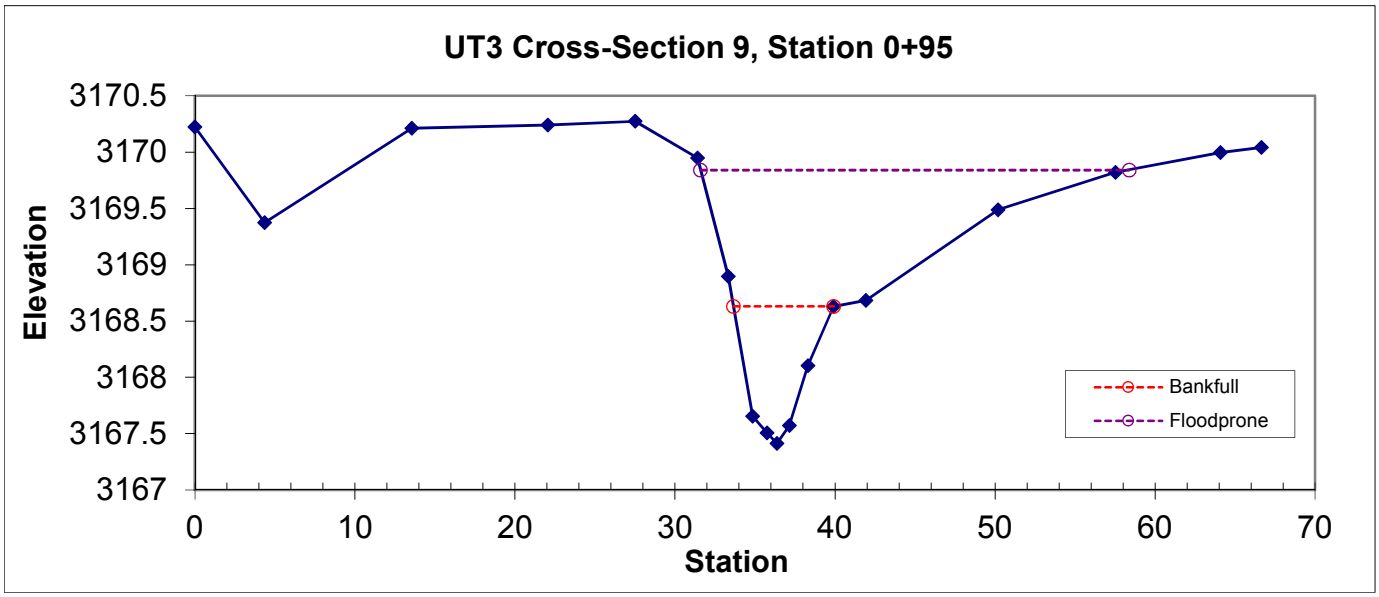
Looking at the Left Bank



Looking at the Right Bank

Permanent Cross-section 9
(As-Built Data - collected May, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	4.5	6.25	0.72	1.22	8.73	1	4.3	3168.63	3168.63

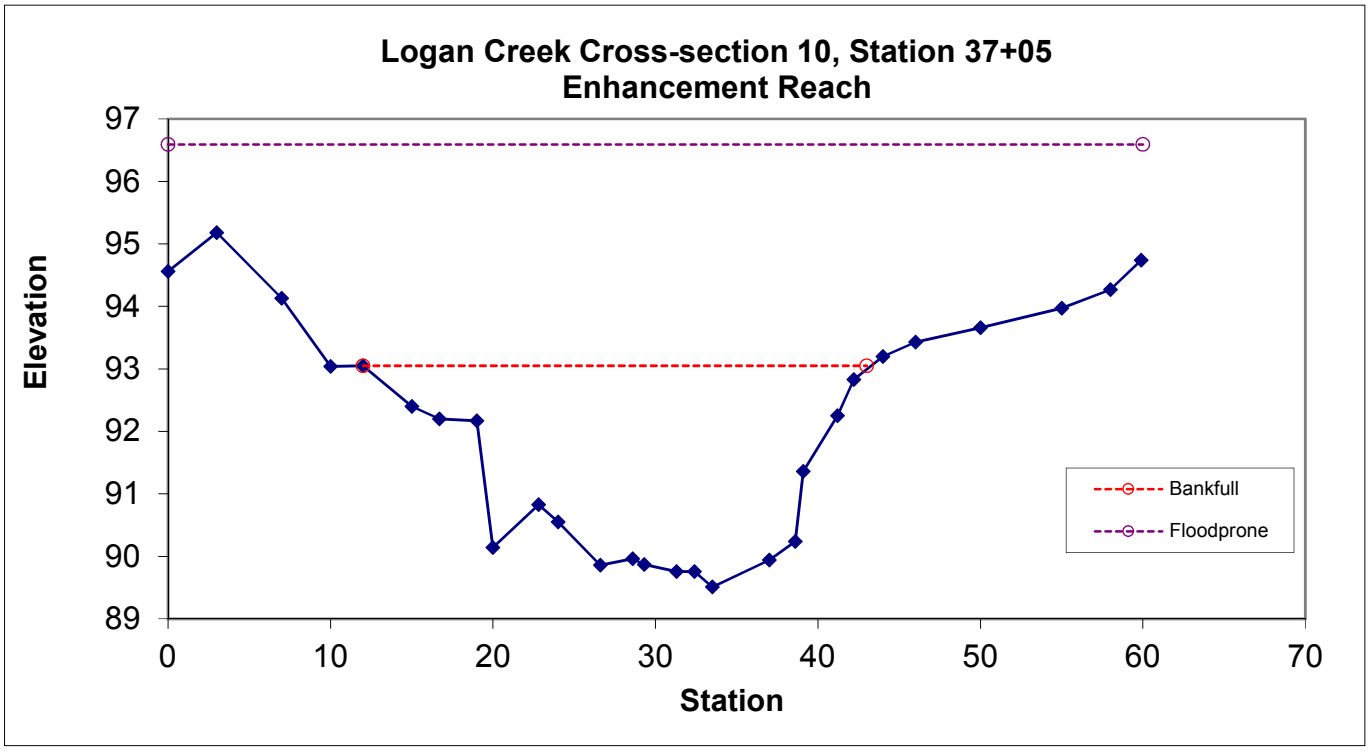



Looking at the Left Bank


Looking at the Right Bank

Permanent Cross-section 10
(As-Built Data - collected October, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		66.6	31	2.1	3.5	14.4	1.0	4.2	93.05	93.2

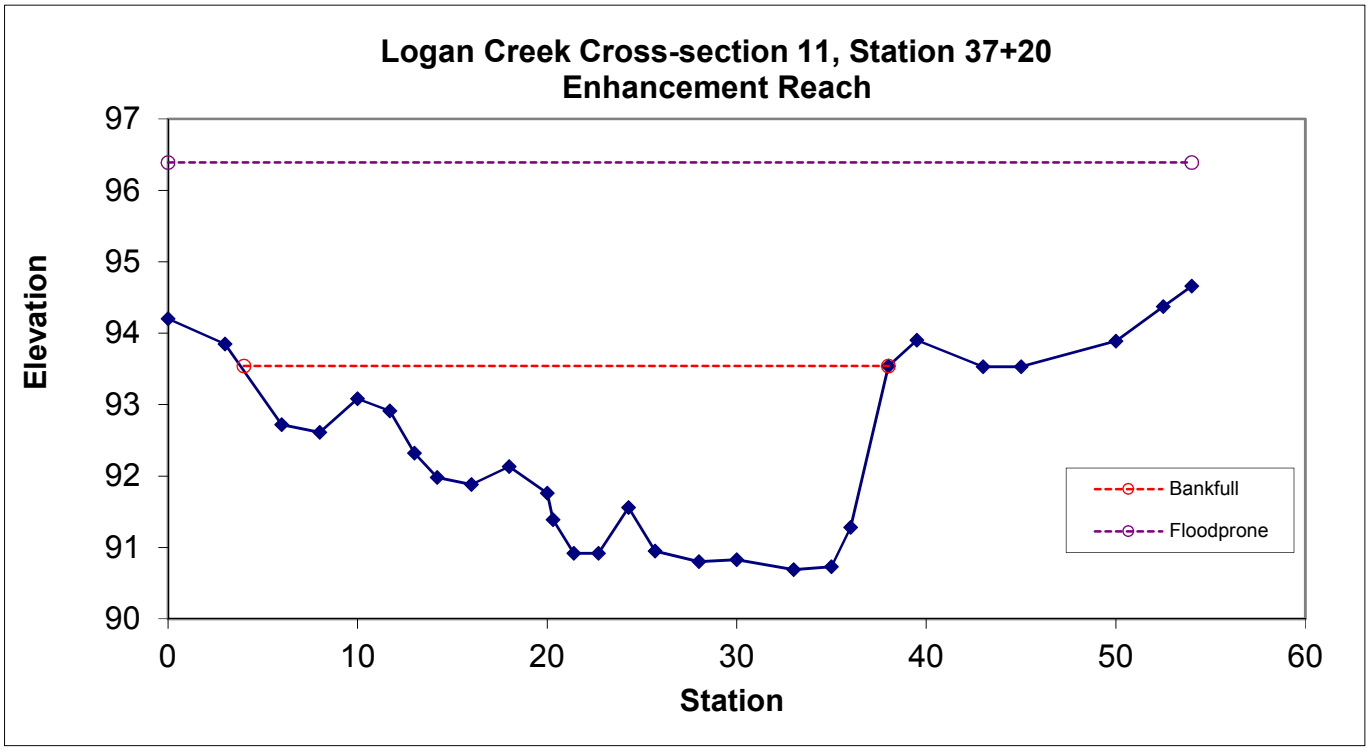


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 11
(As-Built Data - collected October, 2015)

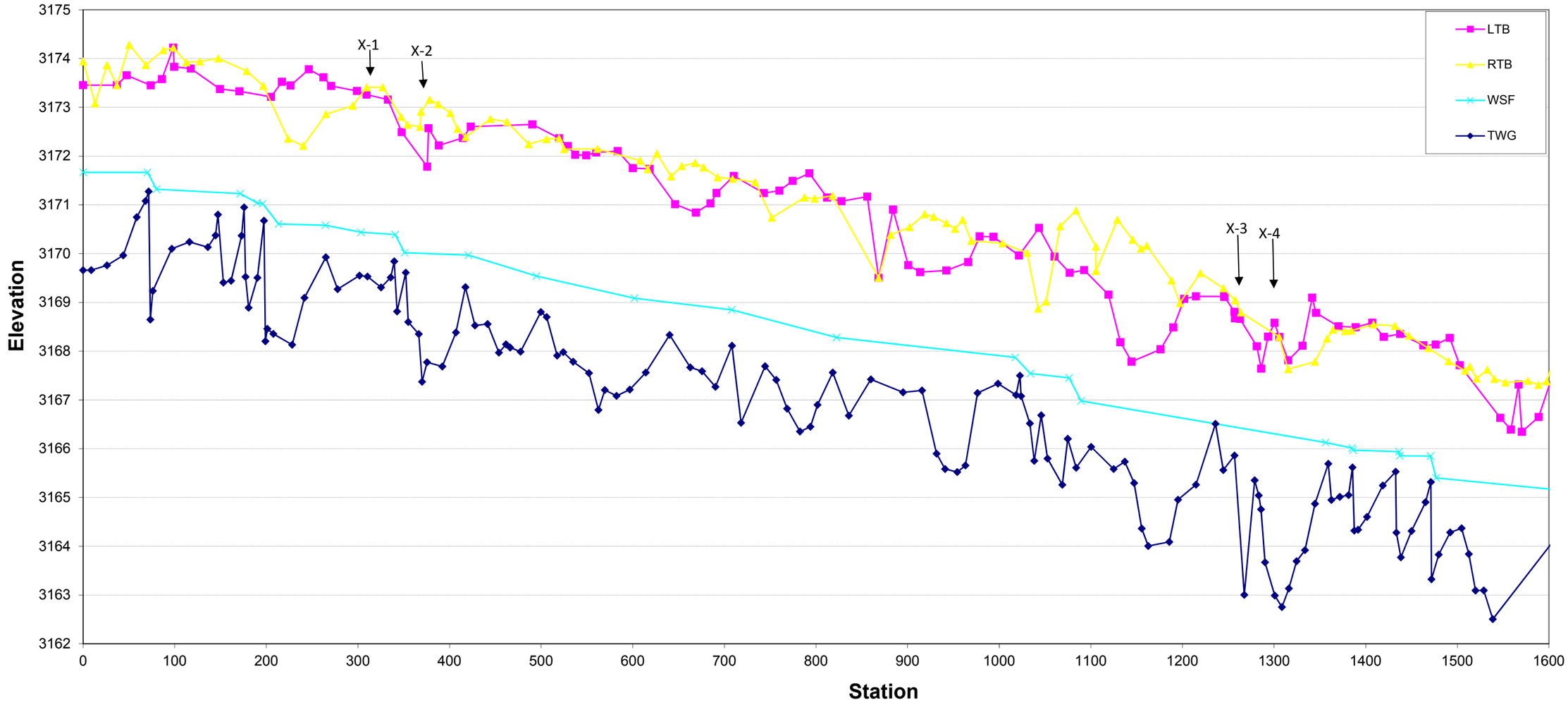
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle		60.73	29.2	2.1	2.9	14	1.1	4.5	93.54	93.85



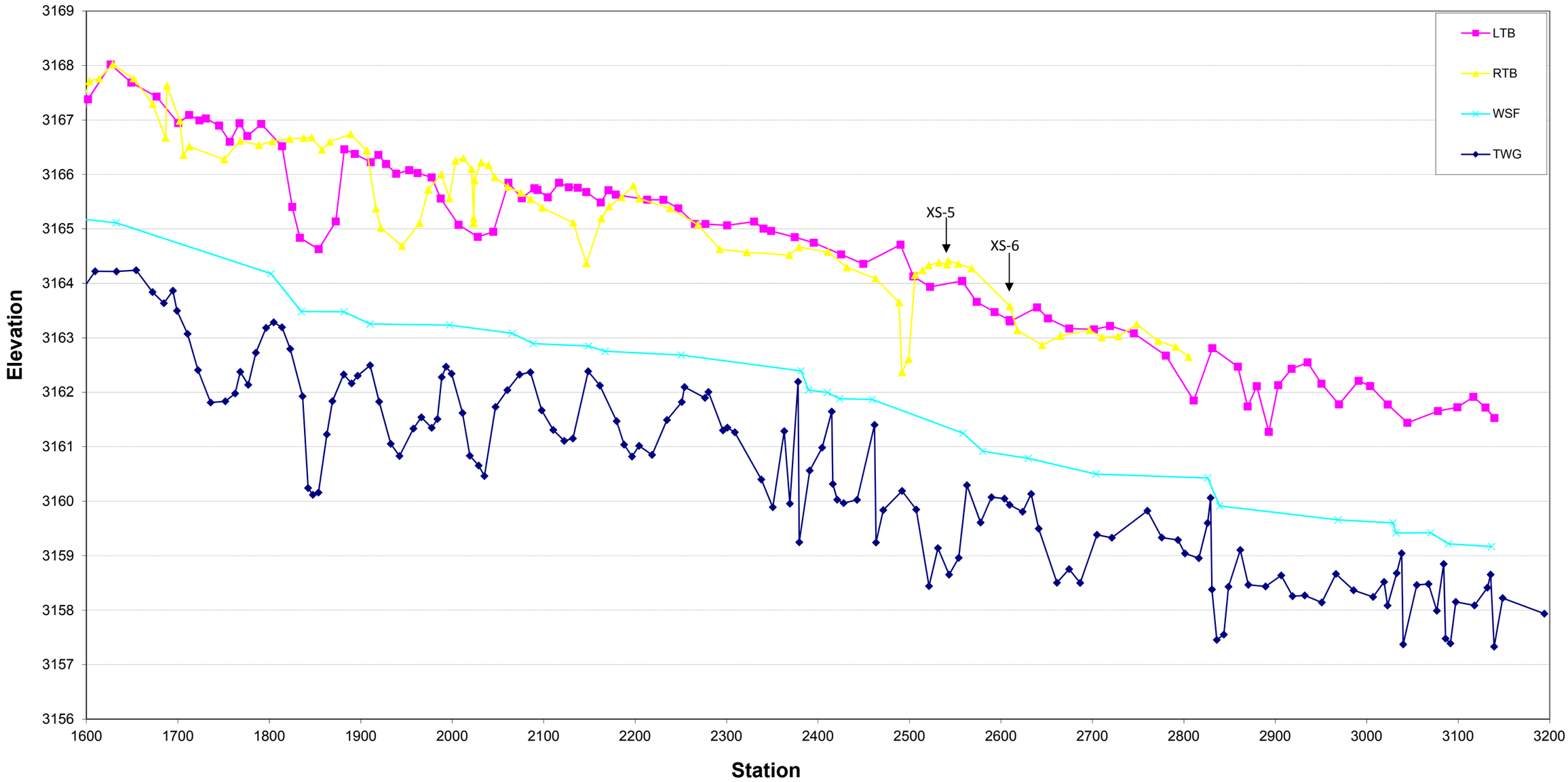
Looking at the Left Bank

Looking at the Right Bank

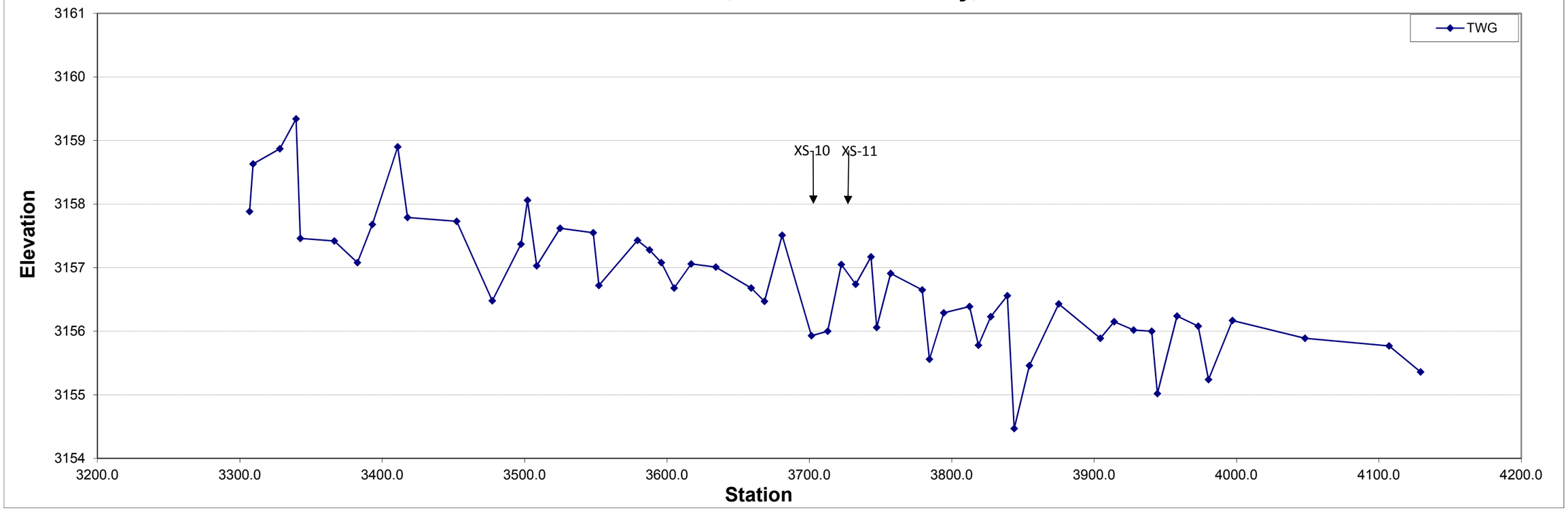
As-built Profile of Logan Creek, Station 0+00 to 16+00
Data collected May, 2015

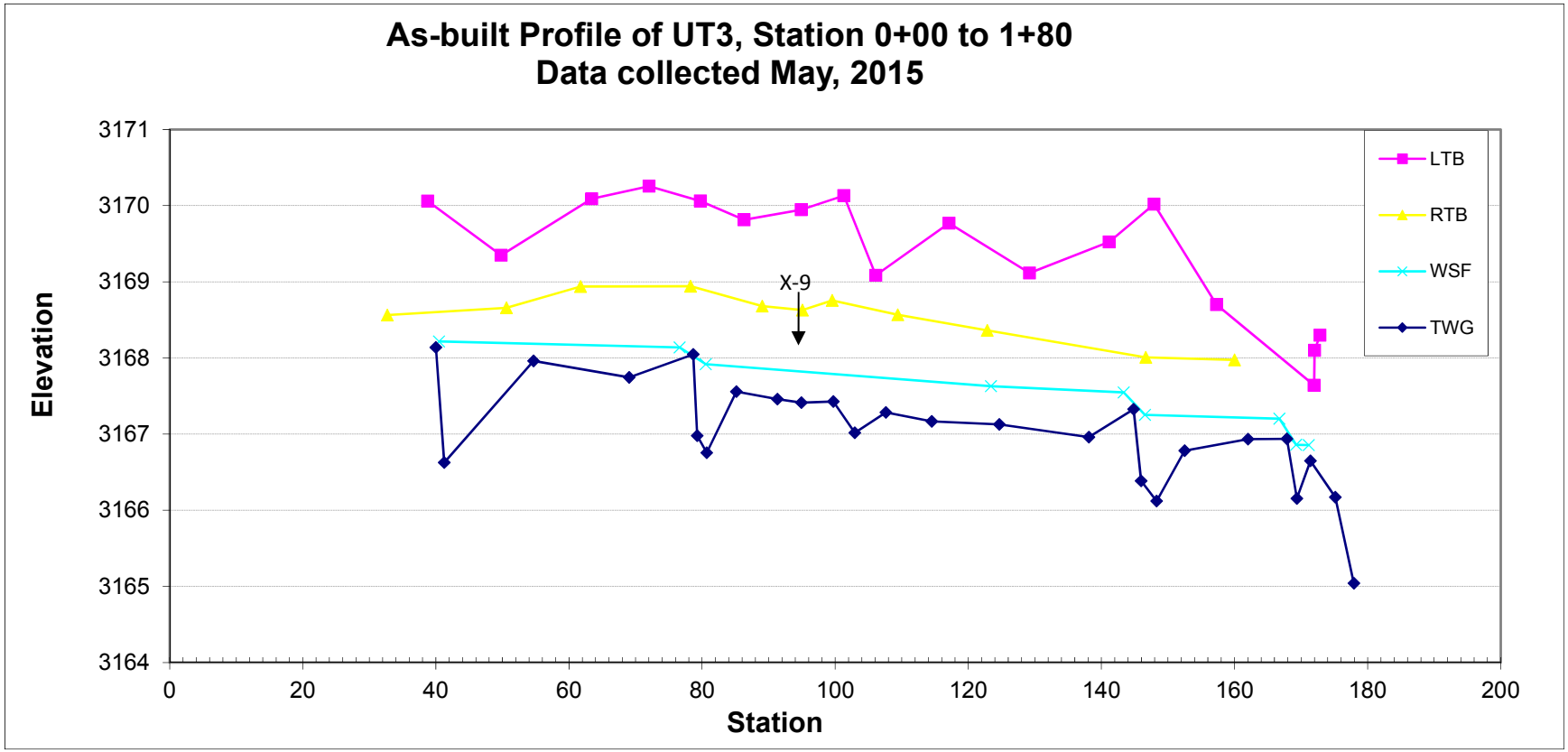


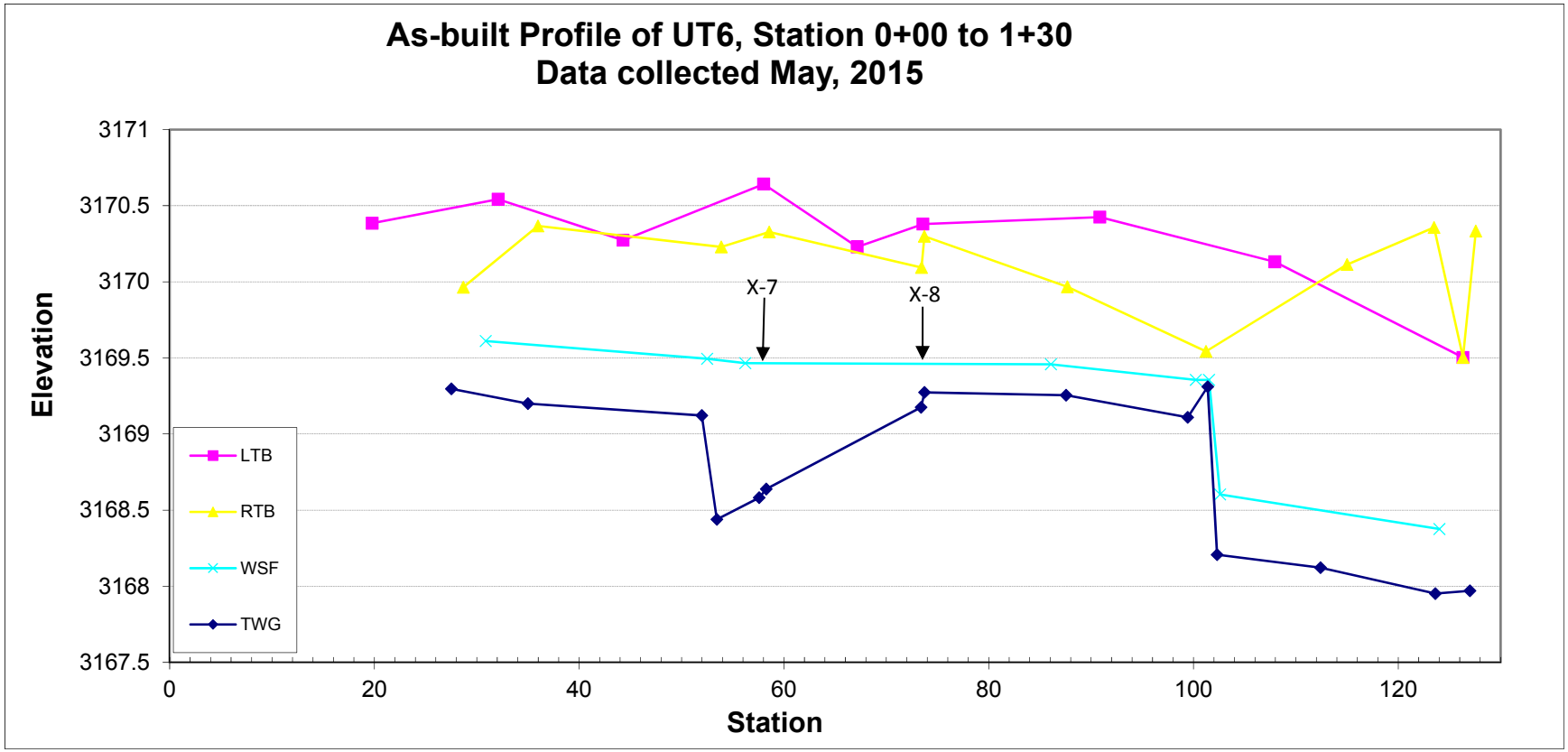
As-built Profile of Logan Creek, Station 16+00 to 32+00
Data collected May, 2015



As-built Thalweg Profile of Logan Creek Enhancement Reach, Station 32+00 to 42+00, Data collected May, 2015




As-built Profile of UT3, Station 0+00 to 1+80
Data collected May, 2015
Elevation
3171
3170
3169
3168
3167
3166
3165
3164
0
20
40
60
80
100
120
140
160
180
200
Station
X-9
LTB
RTB
WSF
TWG

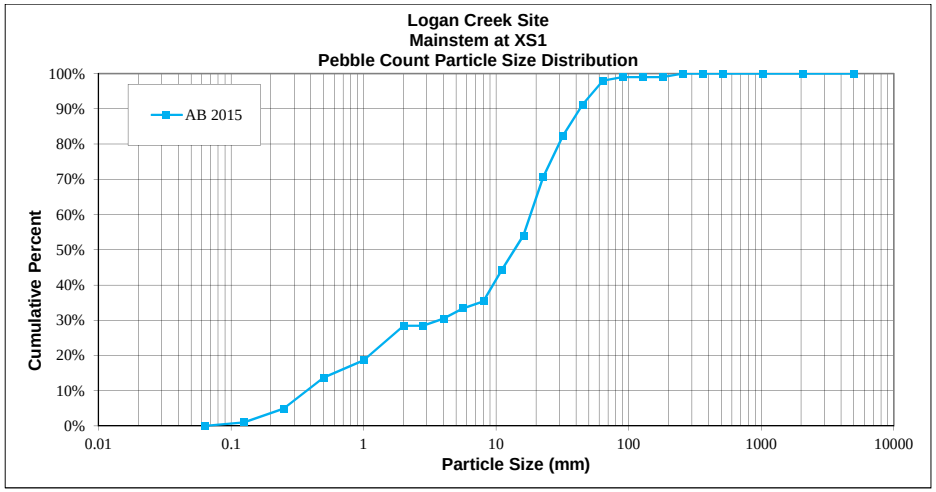

As-built Profile of UT6, Station 0+00 to 1+30
Data collected May, 2015
Elevation
3171
3170.5
3170
3169.5
3169
3168.5
3168
3167.5
0
20
40
60
80
100
120
Station
X-7
X-8
LTB
RTB
WSF
TWG

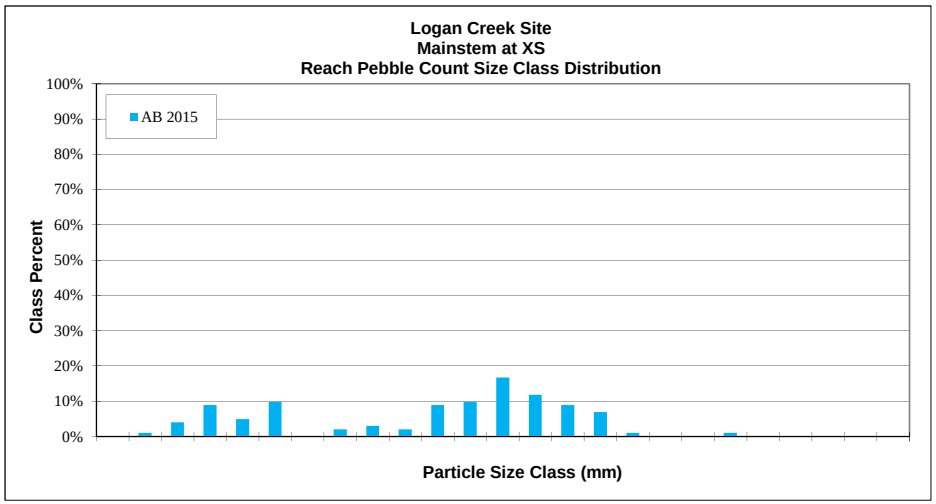
Cross-Section Pebble Count (MS); Monitoring AB
Logan Creek Mitigation Project, DMS #92515

SITE OR PROJECT:	Logan Cr
REACH/LOCATION:	Riffle at XS1
FEATURE:	Riffle

			AB 2015			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125	1	1%	1%	0.125
	Fine	.125 - .25	4	4%	5%	0.25
	Medium	.25 - .50	9	9%	14%	0.50
	Coarse	.50 - 1.0	5	5%	19%	1.0
	Very Coarse	1.0 - 2.0	10	10%	28%	2.0
Gravel	Very Fine	2.0 - 2.8			28%	2.8
	Very Fine	2.8 - 4.0	2	2%	30%	4.0
	Fine	4.0 - 5.6	3	3%	33%	5.6
	Fine	5.6 - 8.0	2	2%	35%	8.0
	Medium	8.0 - 11.0	9	9%	44%	11.0
	Medium	11.0 - 16.0	10	10%	54%	16.0
	Coarse	16 - 22.6	17	17%	71%	22.6
	Coarse	22.6 - 32	12	12%	82%	32
	Very Coarse	32 - 45	9	9%	91%	45
	Very Coarse	45 - 64	7	7%	98%	64
Cobble	Small	64 - 90	1	1%	99%	90
	Small	90 - 128			99%	128
	Large	128 - 180			99%	180
	Large	180 - 256	1	1%	100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			102	100%		

Summary Data			
Channel materials			
D16 =	0.7	D84 =	34.1
D35 =	7.6	D95 =	54.8
D50 =	13.8	D100 =	180 - 256



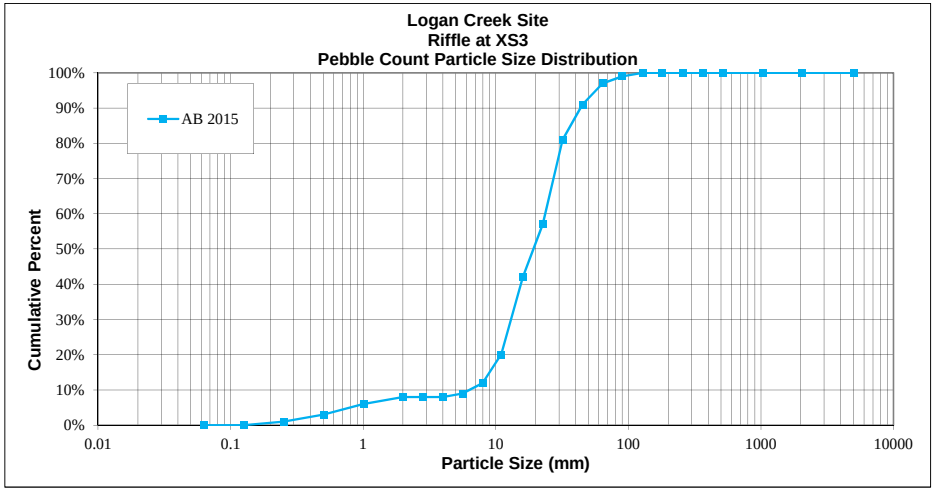


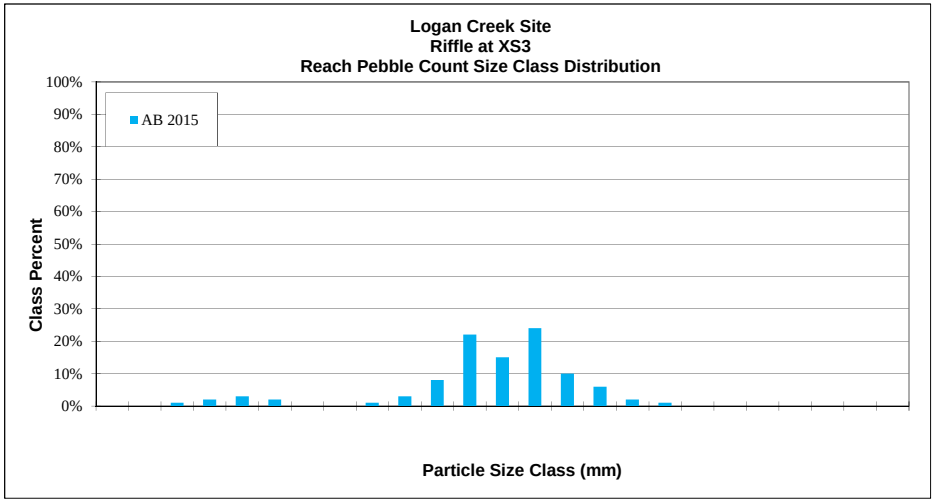
Cross-Section Pebble Count (MS); Monitoring AB
Logan Creek Mitigation Project, DMS # 92515

SITE OR PROJECT:	Logan Cr
REACH/LOCATION:	Riffle at XS3
FEATURE:	Riffle

			AB 2015			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125			0%	0.125
	Fine	.125 - .25	1	1%	1%	0.25
	Medium	.25 - .50	2	2%	3%	0.50
	Coarse	.50 - 1.0	3	3%	6%	1.0
	Very Coarse	1.0 - 2.0	2	2%	8%	2.0
Gravel	Very Fine	2.0 - 2.8			8%	2.8
	Very Fine	2.8 - 4.0			8%	4.0
	Fine	4.0 - 5.6	1	1%	9%	5.6
	Fine	5.6 - 8.0	3	3%	12%	8.0
	Medium	8.0 - 11.0	8	8%	20%	11.0
	Medium	11.0 - 16.0	22	22%	42%	16.0
	Coarse	16 - 22.6	15	15%	57%	22.6
	Coarse	22.6 - 32	24	24%	81%	32
	Very Coarse	32 - 45	10	10%	91%	45
	Very Coarse	45 - 64	6	6%	97%	64
Cobble	Small	64 - 90	2	2%	99%	90
	Small	90 - 128	1	1%	100%	128
	Large	128 - 180			100%	180
	Large	180 - 256			100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			100	100%		

Summary Data			
Channel materials			
D16 =	9.4	D84 =	35.4
D35 =	14.2	D95 =	56.9
D50 =	19.2	D100 =	90 - 128



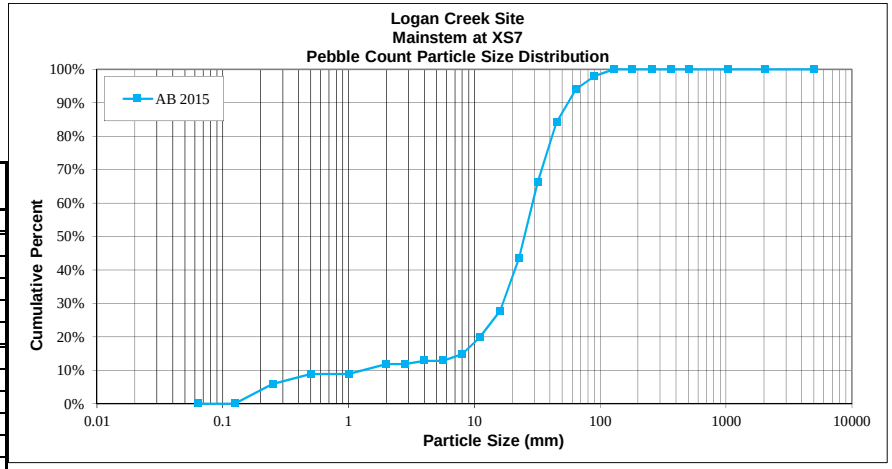


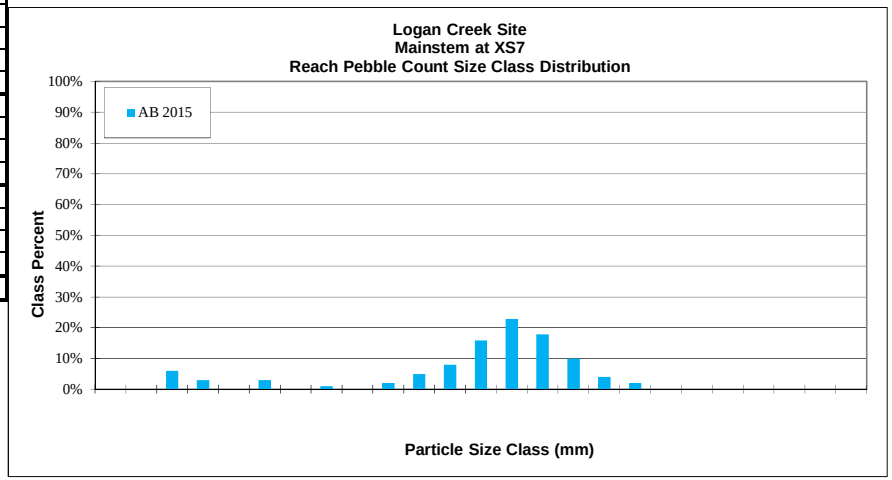
Cross-Section Pebble Count; Monitoring AB
Logan Creek Mitigation Project, DMS # 92515

SITE OR PROJECT:	Logan Creek
REACH/LOCATION:	XS7
FEATURE:	Riffle

			AB 2015			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125			0%	0.125
	Fine	.125 - .25	6	6%	6%	0.25
	Medium	.25 - .50	3	3%	9%	0.50
	Coarse	.50 - 1.0			9%	1.0
	Very Coarse	1.0 - 2.0	3	3%	12%	2.0
Gravel	Very Fine	2.0 - 2.8			12%	2.8
	Very Fine	2.8 - 4.0	1	1%	13%	4.0
	Fine	4.0 - 5.6			13%	5.6
	Fine	5.6 - 8.0	2	2%	15%	8.0
	Medium	8.0 - 11.0	5	5%	20%	11.0
	Medium	11.0 - 16.0	8	8%	28%	16.0
	Coarse	16 - 22.6	16	16%	44%	22.6
	Coarse	22.6 - 32	23	23%	66%	32
	Very Coarse	32 - 45	18	18%	84%	45
	Very Coarse	45 - 64	10	10%	94%	64
Cobble	Small	64 - 90	4	4%	98%	90
	Small	90 - 128	2	2%	100%	128
	Large	128 - 180			100%	18000%
	Large	180 - 256			100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			101	100%		

Summary Data			
Channel materials			
D16 =	8.6	D84 =	44.9
D35 =	18.8	D95 =	69.4
D50 =	24.9	D100 =	90 - 128





APPENDIX C

Vegetation Data (Tables 7 and 8), Vegetation Plot Photo Log, Raw Vegetation Data

Table 7. Vegetation Species Planted Across the Restoration Site Logan Creek Restoration Project: DMS Project ID No. 92515			
Botanical Name	**Common Name**	**% Planted by Species**	**Total Number of Stems**
Riparian Tree Plantings 760 Stems/Acre			
Betula nigra	River Birch	16%	800
Diospyros virginica	Persimmon	16%	800
Fraxinus pennsylvanica	Green Ash	13%	600
Liriodendron tulipfera	Tulip poplar	16%	800
Nyssa sylvatica	Blackgum	13%	600
Quercus alba	White oak	13%	600
Quercus rubra	Northern red oak	13%	600
		Total	4,800
Riparian Shrub Plantings 880 Stems/Acre			
Alnus serrulata	Tag Alder	87%	1000
Leucothoe fontanesiana	Highland doghobble	9%	100
Viburnum dentatum	Southern arrowwood	4%	50
		Total	1,150
Riparian Live Stake Plantings			
Cornus amomum	Silky Dogwood	35%	1,750
Physocarpus opulifolius	Ninebark	15%	750
Salix sericea	Silky Willow	30%	1,500
Sambucus canadensis	Elderberry	20%	1,000
		Total	5,000

Table 8. Stem Count for Each Species Arranged by Plot
Logan Creek Restoration Project: DMS Project ID No. 92515

Tree Species			Current Plot Data (MY0 2015)																Annual Means	
			92515-01-0001		92515-01-0002		92515-01-0003		92515-01-0004		92515-01-0005		92515-01-0006		92515-01-0007		92515-01-0008		MY0 (2015)	
Scientific Name	Common Name	Species Type	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Alnus serrulata	hazel alder	Shrub			4	4	6	6	2	2	7	7	4	4	5	5	5	5	33	33
Betula nigra	river birch	Tree					1	1	4	4	3	3	1	1	2	2	2	2	13	13
Diospyros virginiana	common persimmon	Tree	14	14							3	3			6	6	1	1	24	24
Fraxinus pennsylvanica	green ash	Tree			1	1	4	4	4	4	2	2	8	8	3	3	2	2	24	24
Leucothoe fontanesiana	highland doghobble	Shrub			2	2					1	1			1	1			4	4
Liriodendron tulipifera	tuliptree	Tree			1	1	1	1	3	3			4	4	5	5	3	3	17	17
Nyssa sylvatica	blackgum	Tree	1	1	2	2	4	4	2	2	4	4	4	4	2	2	1	1	20	20
Quercus alba	white oak	Tree			3	3			2	2	1	1							6	6
Quercus rubra	northern red oak	Tree					4	4	2	2	1	1	4	4	2	2			13	13
Viburnum dentatum	southern arrowwood	Shrub	9	9															9	9
Unknown		Tree	1	1	2	2	1	1							1	1	2	2	7	7
		Stem count	25	25	15	15	21	21	19	19	22	22	25	25	27	27	16	16	170	170
		size (ares)	1		1		1		1		1		1		1		1		8	
		size (ACRES)	0.02		0.02		0.02		0.02		0.02		0.02		0.02		0.02		0.20	
		Species count	4	4	7	7	7	7	7	7	8	8	6	6	9	9	7	7	11	11
		Stems per ACRE	1012	1012	607	607	850	850	769	769	890	890	1012	1012	1093	1093	647	647	860	860

Exceeds requirements by 10%
P = Planted
T = Total
No Volunteers at this point.

Logan Creek Site Vegetation Plot Photos

Photo 1. Vegetation Plot 1 – Tree photo.

Photo 2. Vegetation Plot 1 – Herbaceous photo.

Photo 3. Vegetation Plot 2 – Tree photo.

Photo 4. Vegetation Plot 2 – Herbaceous photo.

Photo 5. Vegetation Plot 3 – Tree photo.

Photo 6. Vegetation Plot 3 – Herbaceous photo.

Logan Creek Site Vegetation Plot Photos - continued

Photo 7. Vegetation Plot 4 – Tree photo.

Photo 8. Vegetation Plot 4 – Herbaceous photo.

Photo 9. Vegetation Plot 5 – Tree photo.

Photo Point 10, Vegetation Plot 5 – Herbaceous photo.

Photo 11. Vegetation Plot 6 – Tree photo.

Photo 12. Vegetation Plot 6 – Herbaceous photo.

Logan Creek Site Vegetation Plot Photos - continued

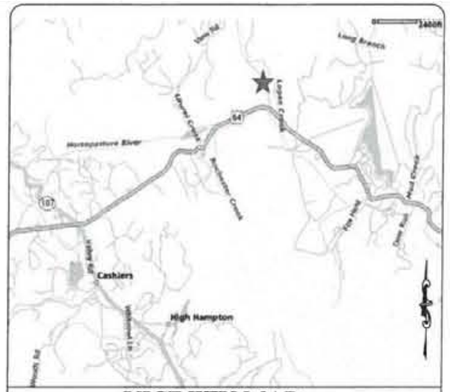
Photo 13. Vegetation Plot 7 – Tree photo.

Photo 14. Vegetation Plot 7 – Herbaceous photo.

Photo 15. Vegetation Plot 8 – Tree photo.

Photo 16. Vegetation Plot 8 – Herbaceous photo.

DMS PROJECT: 92515 LOGAN CREEK RESTORATION PROJECT



VICINITY MAP
NOT TO SCALE

DIVISION OF MITIGATION SERVICES

Logan Creek Restoration Project

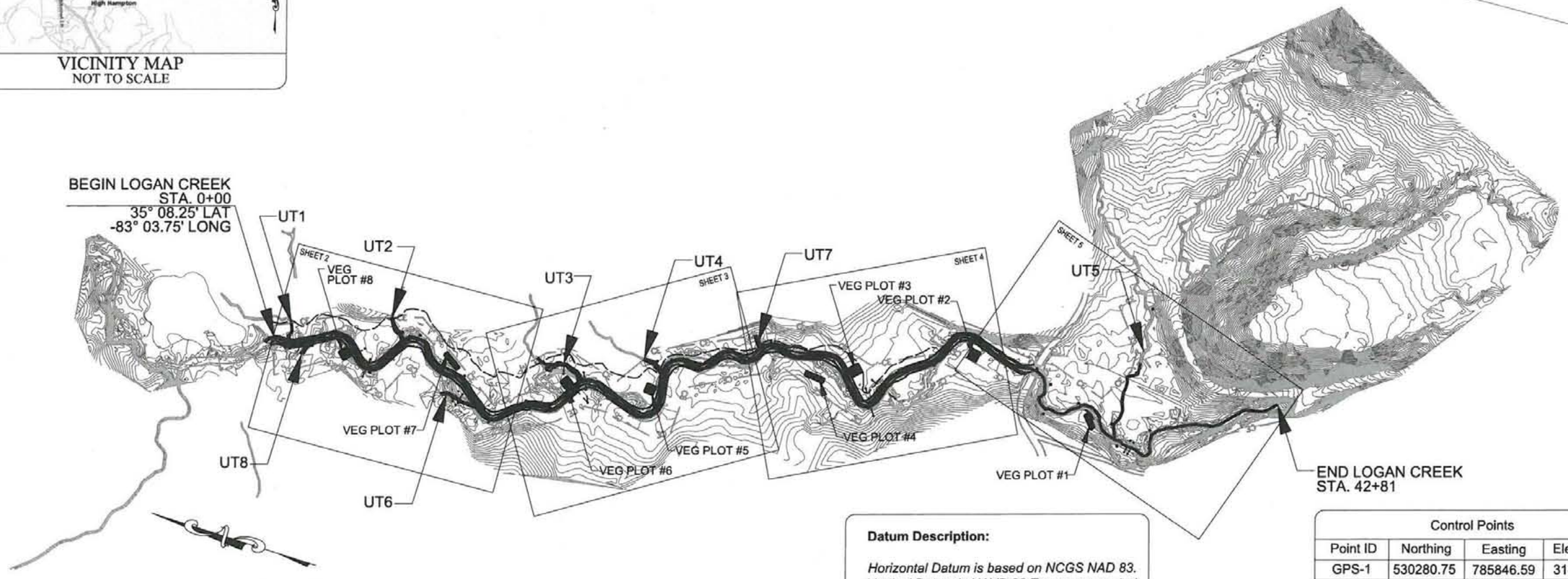
Jackson County, North Carolina

Type of Work: AS - BUILT PLAN

STATE	BAKER PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
NC	109243	1	11
NCDMS PROJECT NO. 92515			
NCDMS CONTRACT NO. D06046			

INDEX OF SHEETS

1 ..... Title
2-5 ..... Plan
6-11 ..... Profiles



Datum Description:

Horizontal Datum is based on NCGS NAD 83. Vertical Datum is NAVD 88.Temporary control points are present on site and will be used to establish grade and position .

Control Points

Point ID	Northing	Easting	Elevation
GPS-1	530280.75	785846.59	3182.10
GPS-2	529915.74	785744.60	3178.44
CP-11	527873.24	786038.59	3171.04
CP-12	527629.79	786223.16	3163.74

GRAPHIC SCALES

30 0 30 60
PLANS

20 0 20 40
PROFILE (HORIZONTAL)

2 0 2 4
PROFILE (VERTICAL)

DESIGN SUMMARY

NAME		STATIONS	LINEAR FT.	TYPE	SMU
Logan Creek	R1	0+00 - 31+84	3134	Restoration	3,134
	R2	32+43 - 42+81	1038	Enhancement I	692
UT1		0+00 - 0+71	71	Enhancement II	28
UT2		0+00 - 0+92	92	Enhancement II	37
UT3	R1	0+00 - 0+40	40	Enhancement II	16
	R2	0+40 - 1+78	138	Restoration	138
UT4		0+00 - 0+84	84	Enhancement II	34
UT5		0+00 - 2+87	287	Preservation	57
UT6		0+00 - 1+27	127	Restoration	127
UT7		0+00 - 0+54	54	Enhancement II	21
UT8		0+00 - 0+45	45	Restoration	45
			5,110		4,329

PREPARED FOR THE OFFICE OF:

NCDEQ
DIVISION OF MITIGATION SERVICES

1652 MAIL SERVICE CENTER
RALEIGH, N.C. 27699-1652

NCEEP PROJECT MGR.: PAUL WIESNER

NCEEP REVIEW COORDINATOR: LIN XU

PREPARED IN THE OFFICE OF:

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JACOB M. BYERS, PE
PROJECT ENGINEER

MICKY CLEMMONS, PROJECT MANAGER
PROJECT MANAGER

10/28/2015
DATE

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 039201 ENGINEER JACOB M. BYERS
4/6/16

SIGNATURE: *P.E.*

EXISTING NATURE TRAIL

BEGIN UT2 STA. 0+00

BEGIN UT1 STA. 0+00

END UT1 STA. 0+71

PHOTO POINT #25

PHOTO POINT #24

VEG PLOT #7

PHOTO POINT #23

END UT2 STA. 0+92

MATCHLINE STA. 10+00 SHEET 3

PHOTO POINT #27

PHOTO POINT #28

VEG PLOT #8

PHOTO POINT #29

PHOTO POINT #30

END UT8 STA. 0+45

BEGIN UT8 STA. 0+00

PHOTO POINT #26

PHOTO POINT #22

BEGIN UT6 STA. 0+00

PHOTO POINT #21

END UT6 1+27

BEGIN LOGAN CREEK STA. 0+00

LOG SILL

LOG VANE / CROSS VANE

J HOOK LOG VANE

LOG STEP

N

30 0 30 60

SCALE (FT)

NORTH CAROLINA PROFESSIONAL SEAL 039201 ENGINEER JACOB M. BYERS 12/4/15

NORTH CAROLINA PROFESSIONAL SEAL L-5034 LAND SURVEYOR MARSHALL G. WIGHT 10-28-15

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Michael Baker INTERNATIONAL

LOGAN CREEK RESTORATION PROJECT
CASHIERS, NORTH CAROLINA

AS-BUILT PLAN

Prepared for:
NCDEQ
DIVISION OF MITIGATION SERVICES
1652 MAIL SERVICE CENTER
RALEIGH, NC 27699-1652

Project No. 109243

Date: 10/28/2015

NCDMS ID No. 92515

DESIGNED:
DRAWN:
APPROVED:

Drawing No. 2 of 11

LOG SILL

LOG VANE / CROSS VANE

J HOOK LOG VANE

LOG STEP

BEGIN UT3 STA. 0+00

BEGIN UT4 STA. 0+00

END UT3 STA. 1+78

END UT4 STA. 0+84

MATCHLINE STA. 10+00 SHEET 2

MATCHLINE STA. 20+50 SHEET 4

PHOTO POINT #20

PHOTO POINT #19

PHOTO POINT #18

PHOTO POINT #17

PHOTO POINT #16

PHOTO POINT #15

PHOTO POINT #14

VERNAL POOL

VEG PLOT #6

VEG PLOT #5

EXISTING NATURE TRAIL

X-9

X-3

X-4

X-3 & X-4

SA

0+00

1+00

10+00

11+00

12+00

13+00

14+00

15+00

16+00

18+00

19+00

20+00

N

30 0 30 60

SCALE (FT)

NORTH CAROLINA PROFESSIONAL SEAL 039201 ENGINEER JACOB M. BYERS

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LOGAN CREEK RESTORATION PROJECT
CASHIERS, NORTH CAROLINA

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Prepared for:
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DIVISION OF MITIGATION SERVICES
1652 MAIL SERVICE CENTER
RALEIGH, NC 27699-1652

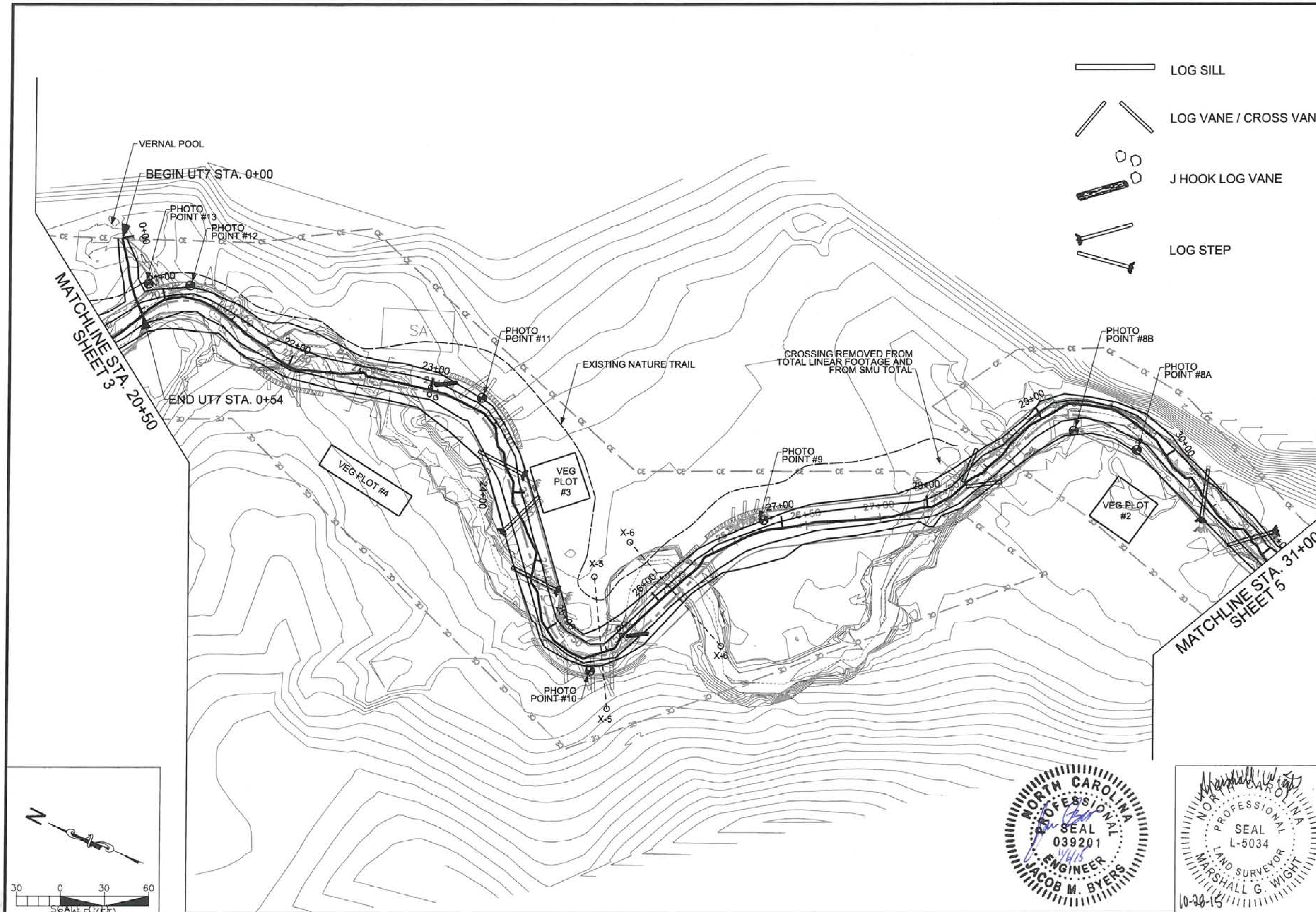
Project No. 109243

Date: 10/28/2015

NCDMS ID No. 92515

DESIGNED:
DRAWN:
APPROVED:

Drawing No. 3 of 11



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RALEIGH, NC 27699-1652

Project No. 109243
Date: 10/28/2015
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DESIGNED:
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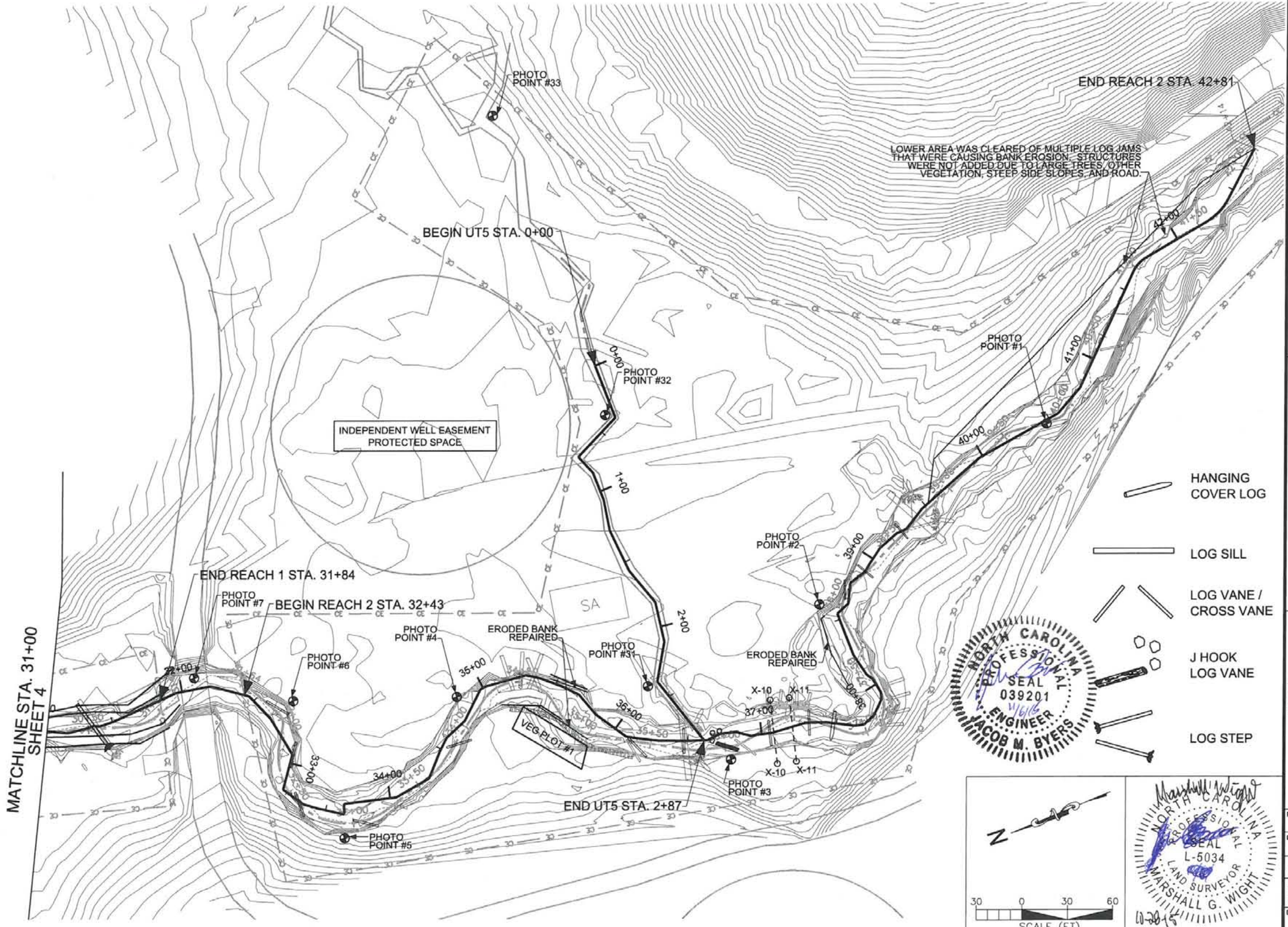
APPROVED:
Drawing No.
4 of 11



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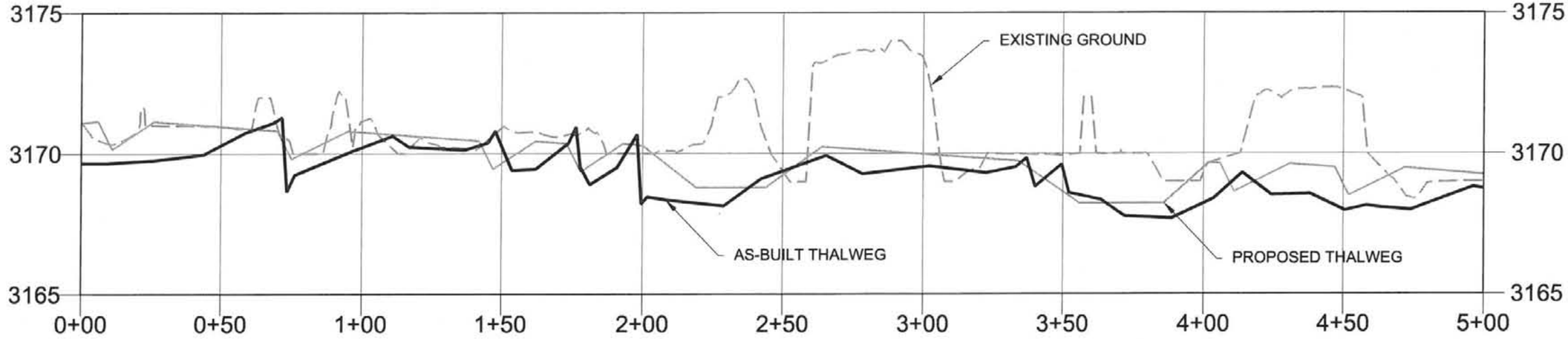
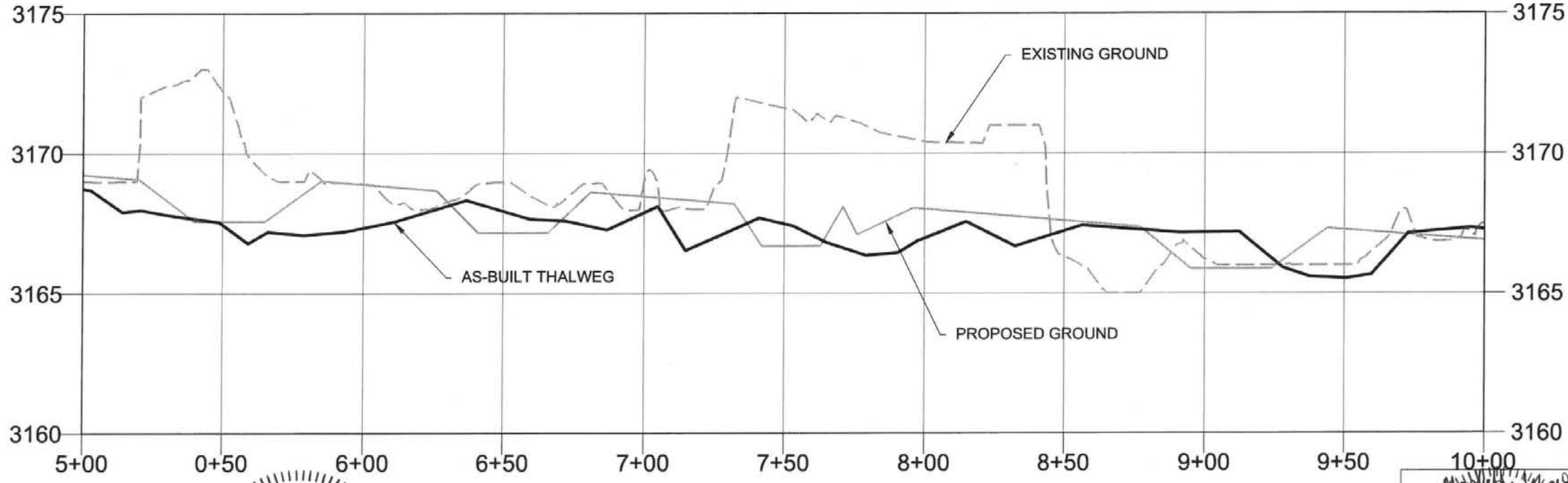
Project No.	109243
Date:	10/28/2015
NCDMS ID No.	92515
DESIGNED:	
DRAWN:	
APPROVED:	
Drawing No.	5 of 11





LOGAN CREEK PROFILE
0+00 - 10+00

LEGEND OF PROFILES
- PROPOSED THALWEG
- AS-BUILT THALWEG
- EXISTING GROUND

20 0 20 40
PROFILE (HORIZONTAL)

2 0 2 4
PROFILE (VERTICAL)

NORTH CAROLINA PROFESSIONAL SEAL 039201 ENGINEER JACOB M. BYERS 11/6/15

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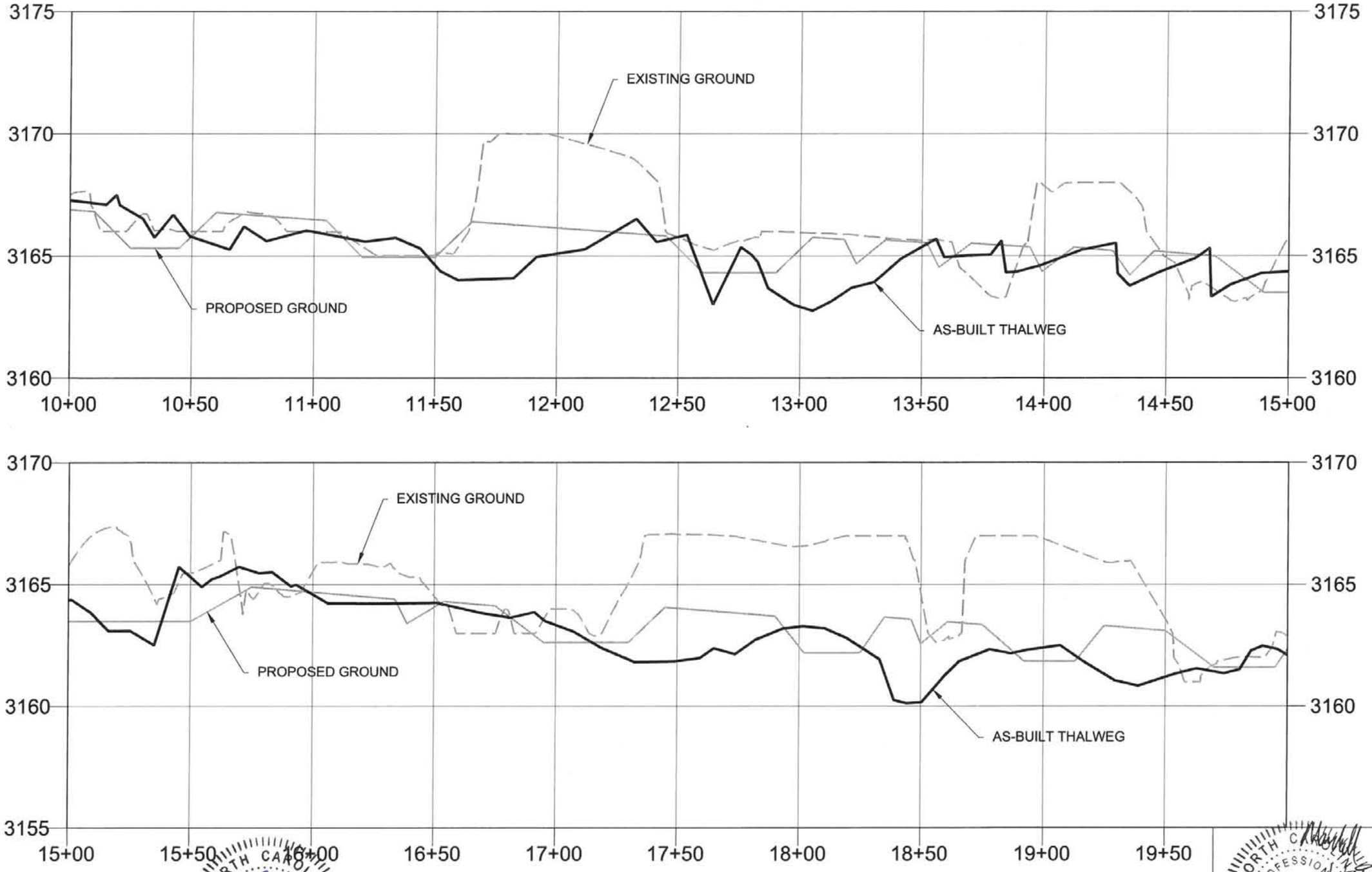
Project No. 109243
Date: 10/28/2015
NCDMS ID No. 92515
DESIGNED:
DRAWN:
APPROVED:
Drawing No. 6 of 11



20 0 20 40
PROFILE (HORIZONTAL)

2 0 2 4
PROFILE (VERTICAL)

NORTH CAROLINA PROFESSIONAL SEAL 039201 ENGINEER JACOB M. BYERS 11/6/15

LOGAN CREEK PROFILE
10+00 - 20+00

LEGEND OF PROFILES
- PROPOSED THALWEG
- AS-BUILT THALWEG
- EXISTING GROUND

NORTH CAROLINA PROFESSIONAL SEAL L-5034 LAND SURVEYOR MARSHALL G. WIGHT 10-28-15

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AS-BUILT PLAN

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Project No. 109243
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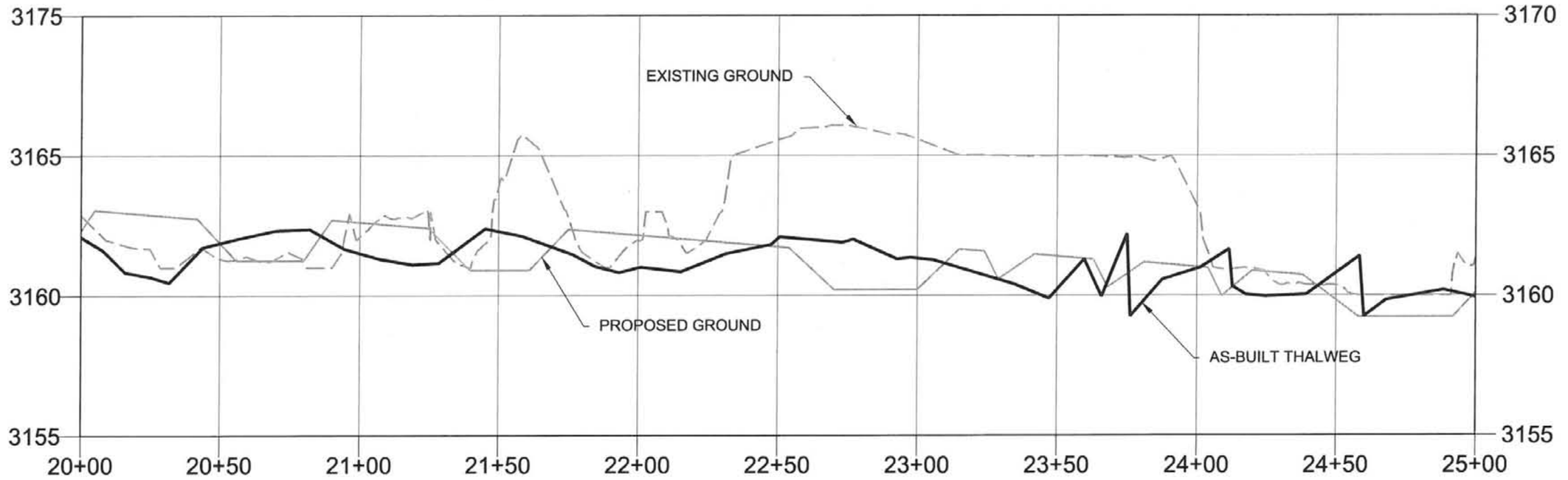
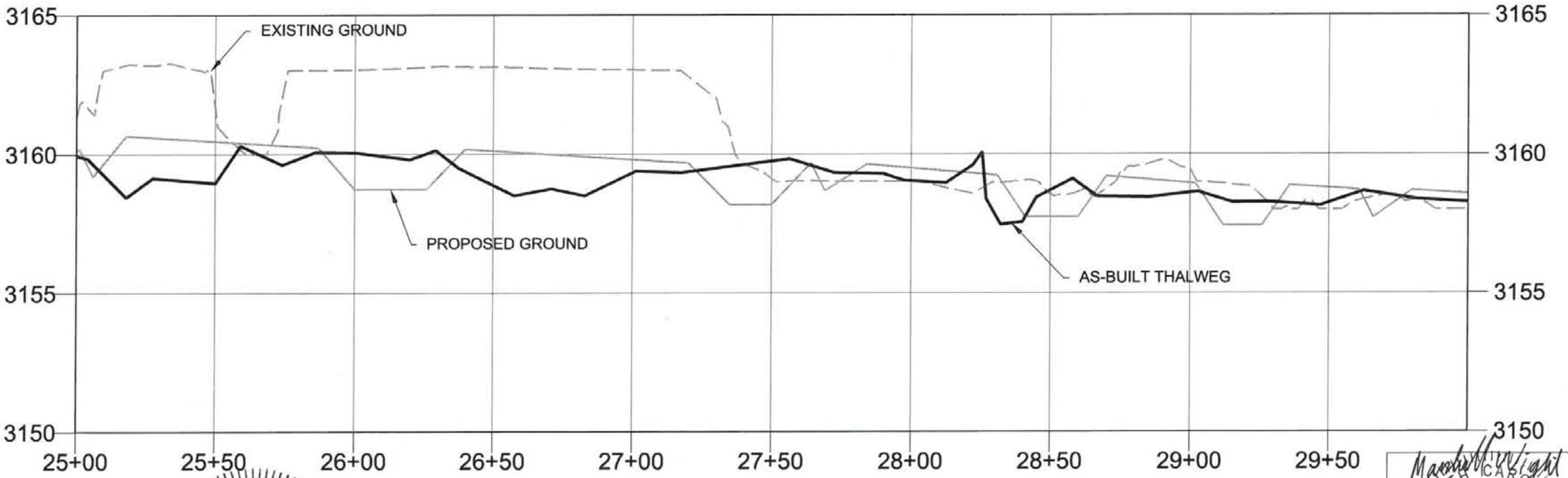
APPROVED:
Drawing No. 7 of 11





20 0 20 40
PROFILE (HORIZONTAL)

2 0 2 4
PROFILE (VERTICAL)

NORTH CAROLINA PROFESSIONAL SEAL 039201 ENGINEER JACOB M. BYERS

LOGAN CREEK PROFILE
20+00 - 30+00

LEGEND OF PROFILES
- PROPOSED THALWEG
- AS-BUILT THALWEG
- EXISTING GROUND

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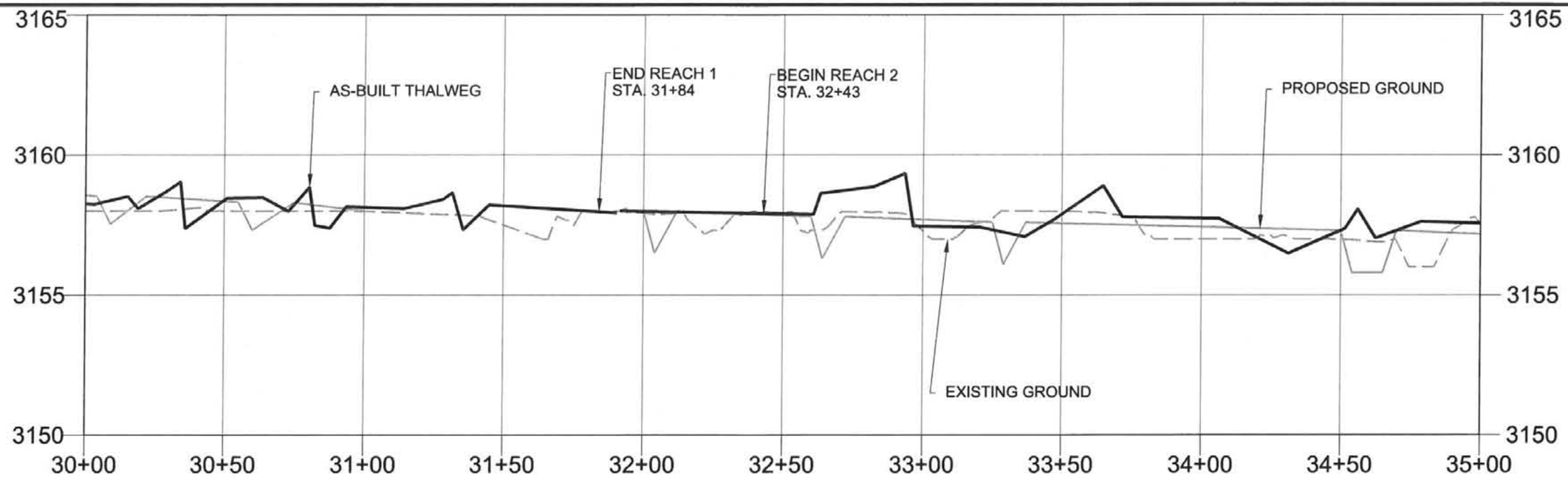
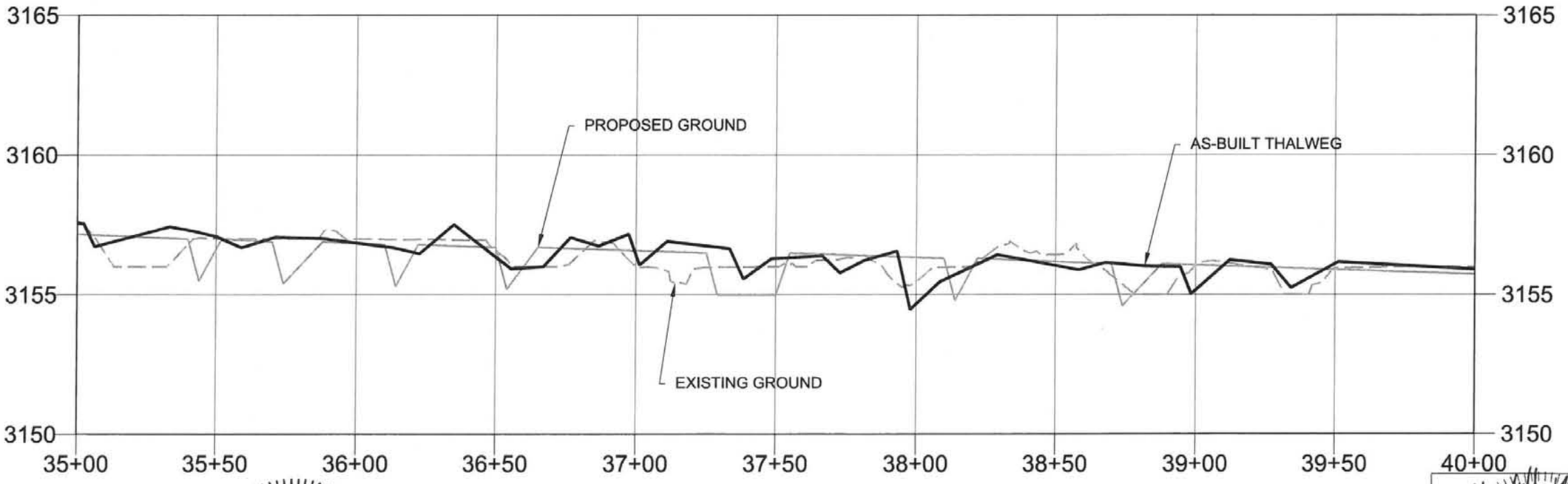
APPROVED:
Drawing No. 8 of 11





20 0 20 40
PROFILE (HORIZONTAL)

2 0 2 4
PROFILE (VERTICAL)

NORTH CAROLINA PROFESSIONAL SEAL 039201 ENGINEER JACOB M. BYERS

LOGAN CREEK PROFILE
30+00 - 40+00

LEGEND OF PROFILES
- PROPOSED THALWEG
- AS-BUILT THALWEG
- EXISTING GROUND

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LOGAN CREEK RESTORATION PROJECT
CASHIERS, NORTH CAROLINA
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Prepared for:
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Project No. 109243
Date: 10/28/2015
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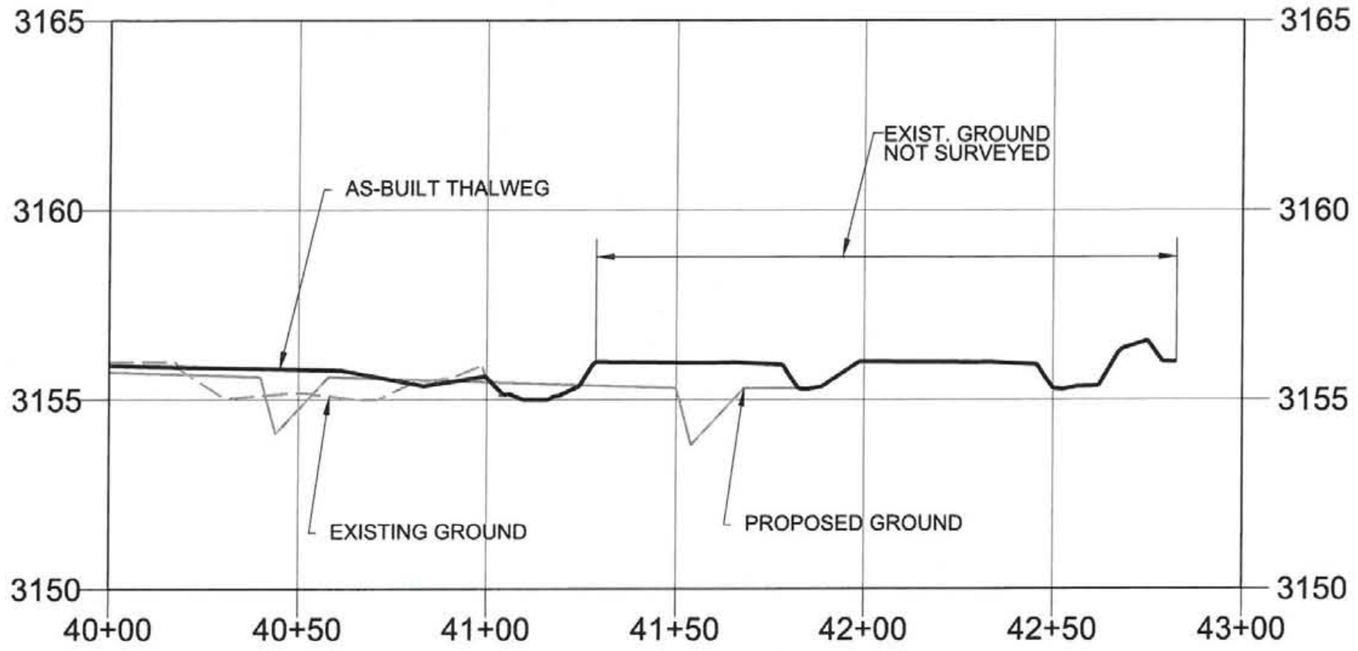
Drawing No. 9 of 11



LEGEND OF PROFILES

- PROPOSED THALWEG
- AS-BUILT THALWEG
- EXISTING GROUND
- EXISTING GROUND NOT SURVEYED

20 0 20 40
PROFILE (HORIZONTAL)

2 0 2 4
PROFILE (VERTICAL)

LOGAN CREEK PROFILE
40+00 - 42+81

NORTH CAROLINA PROFESSIONAL SEAL 039201 ENGINEER JACOB M. BYERS 11/6/15

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Project No. 109243
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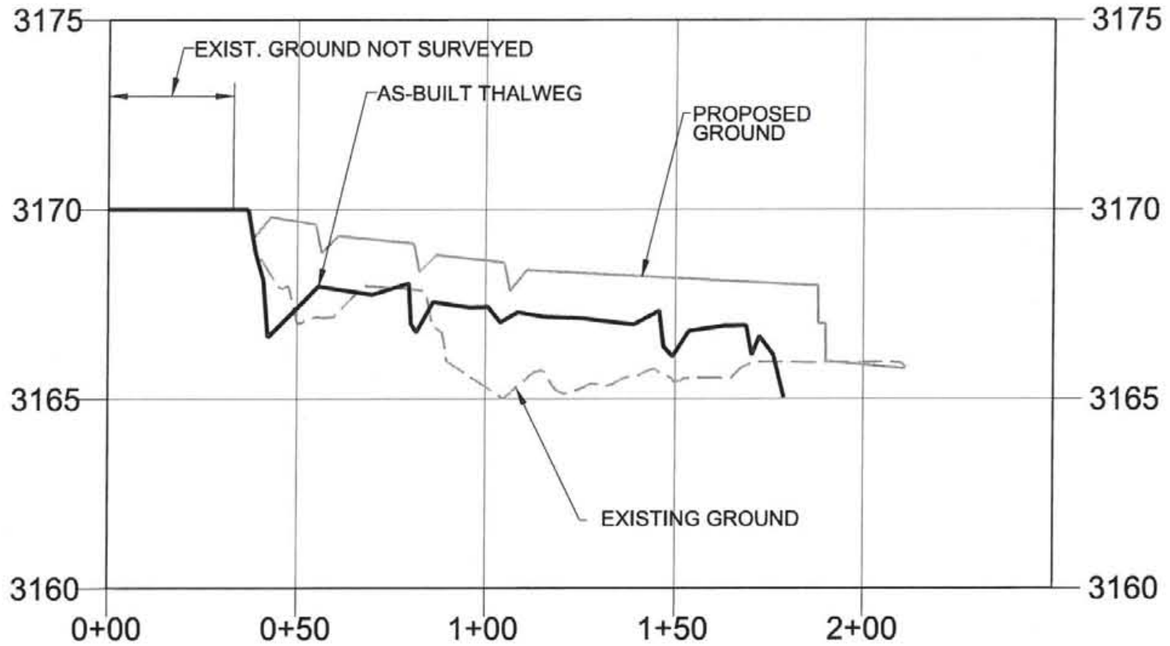
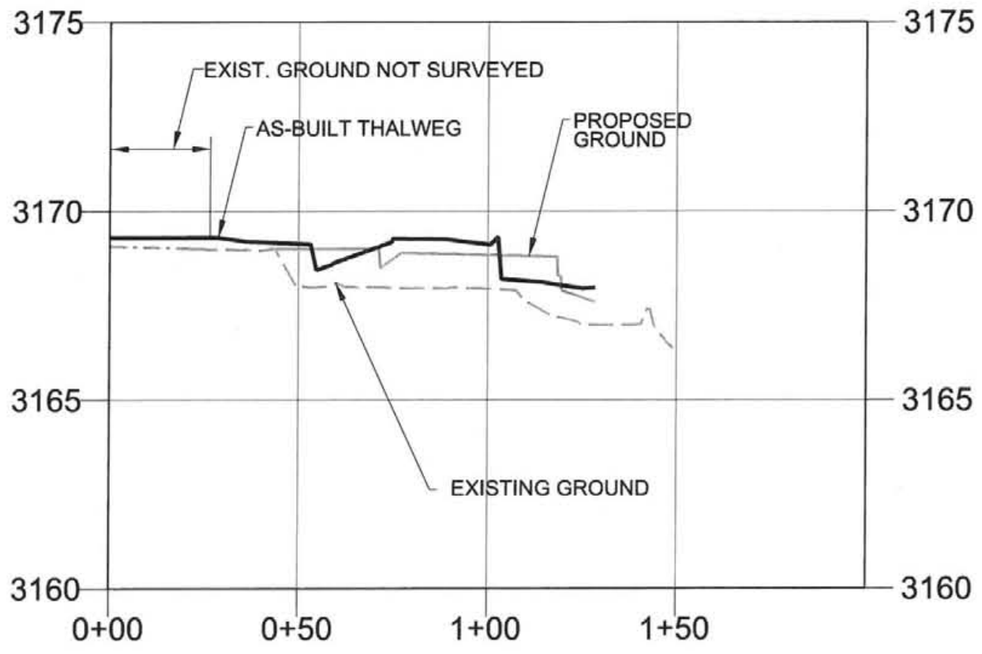
Drawing No. 10 of 11



UT3 PROFILE
0+00 - 1+78



UT6 PROFILE
0+00 - 1+27

LEGEND OF PROFILES

- PROPOSED THALWEG
- AS-BUILT THALWEG
- EXISTING GROUND
- EXISTING GROUND NOT SURVEYED

20 0 20 40
PROFILE (HORIZONTAL)

2 0 2 4
PROFILE (VERTICAL)

NORTH CAROLINA PROFESSIONAL SEAL 039201 ENGINEER JACOB M. BYERS 11/6/15

NORTH CAROLINA PROFESSIONAL SEAL L-5034 LAND SURVEYOR MARSHALL G. WIGHT 10-28-15

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LOGAN CREEK RESTORATION PROJECT
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RALEIGH, NC 27699-1652

Project No. 109243
Date: 10/28/2015
NCDMS ID No. 92515
DESIGNED:
DRAWN:
APPROVED:
Drawing No. 11 of 11

APPENDIX E

Log of Photo Points on Logan Creek,
and each unnamed tributary.

Logan Creek Stream Restoration Photo Points
(Stationing is the approximate location)

Photo 1. Logan Creek Photo Point 1 – Station 40+45 (August 2015) upstream view from right bank.

Photo 2. Logan Creek Photo Point 1 – Station 40+45 (August 2015) downstream view from right bank.

Photo 3. Logan Creek Photo Point 2 – Station 38+60 (August 2015) downstream view from left bank.

Photo 4. Logan Creek Photo Point 2 – Station 38+60 (August 2015) upstream view from left bank.

Photo 5. Logan Creek Photo Point 3 – Station 36+75 (August 2015) upstream view from right bank.

Photo 6. Logan Creek Photo Point 3 – Station 36+75 (August 2015) downstream view from right bank.

Photo 7. Logan Creek Photo Point 4 – Station 34+80 (August 2015) downstream from left bank.

Photo 8. Logan Creek Photo Point 4 – Station 34+80 (August 2015) upstream from left bank.

Photo 9. Logan Creek Photo Point 5 – Station 33+60 (August 2015) upstream from right bank.

Photo Point 10, Logan Creek Photo Point 5 – Station 33+60 (August 2015) downstream from right bank.

Photo 11. Logan Creek Photo Point 6 – Station 32+70 (August 2015) downstream view from left bank.

Photo 12. Logan Creek Photo Point 6 – Station 32+70 (August 2015) upstream view from left bank.

Photo 13. Logan Creek Photo Point 7 – Station 32+15 (August 2015) downstream view from bridge.

Photo 14. Logan Creek Photo Point 7 – Station 32+00 (August 2015) upstream view from bridge.

Photo 15. Logan Creek Photo Point 8a – Station 29+75 (August 2015) downstream view from right bank.

Photo 16. Logan Creek Photo Point 8b – Station 29+25 (August 2015) upstream view from right bank.

Photo 17. Logan Creek Photo Point 9 – Station 26+75 (August 2015) downstream view from left bank.

Photo 18. Logan Creek Photo Point 9 – Station 26+75 (August 2015) upstream view from left bank.

Photo 19. Logan Creek Photo Point 10 – Station 25+25 (August 2015) upstream view from right bank.

Photo 20. Logan Creek Photo Point 10 – Station 25+25 (August 2015) downstream view from right bank.

Photo 21. Logan Creek Photo Point 11 – Station 23+20 (August 2015) downstream view from left bank.

Photo 22. Logan Creek Photo Point 11 – Station 23+20 (August 2015) upstream view from left bank.

Photo 23. Logan Creek Photo Point 12 – Station 21+20 (August 2015) downstream view from left bank.

Photo 24. Logan Creek Photo Point 12 – Station 21+20 (August 2015) upstream view from left bank.

Photo 25. UT7 Photo Point 13 – (August 2015) upstream view from left bank.

Photo 26. UT7 Photo Point 13 – (August 2015) downstream view from left bank.

Photo 27. Logan Creek Photo Point 14 – Station 19+45 (August 2015) downstream view from left bank.

Photo 28. Logan Creek Photo Point 14 – Station 19+45 (August 2015) upstream view from left bank.

Photo 29. Logan Creek Photo Point 15 – Station 17+45 (August 2015) downstream view from left bank.

Photo 30. Logan Creek Photo Point 15 – Station 17+45 (August 2015) upstream view from left bank.

Photo 31. UT4 Photo Point 16 – Station 0+40
(August 2015) downstream view from left bank.

Photo 32. UT4 Photo Point 16 – Station 0+40
(August 2015) upstream view from left bank.

Photo 32. Logan Creek Photo Point 17 – Station 15+50
(August 2015) upstream view from right bank.

Photo 33. Logan Creek Photo Point 17 – Station 15+50
(August 2015) downstream view from right bank.

Photo 34. Logan Creek Photo Point 18 – Station 12+90
(August 2015) downstream view from left bank.

Photo 35. Logan Creek Photo Point 18 – Station 12+90
(August 2015) upstream view from left bank.

Photo 36. UT3 Photo Point 19 – Station 00+60 (August 2015) upstream from left bank.

Photo 37. UT3 Photo Point 19 – Station 00+60 (August 2015) downstream from left bank.

Photo 38. UT3 Photo Point 19 – Station 00+60 (August 2015) upstream from left bank to vernal pool.

Photo 39. Intentionally left blank.

Photo 40. Logan Creek Photo Point 20 – Station 10+60 (August 2015) downstream view from left bank.

Photo 41. Logan Creek Photo Point 20 – Station 10+60 (August 2015) upstream view from left bank.

Photo 42. Logan Creek Photo Point 21 – Station 9+40 (August 2015) upstream view from right bank.

Photo 43. Logan Creek Photo Point 21 – Station 9+40 (August 2015) downstream view from right bank.

Photo 44. Logan Creek Photo Point 22 – Station 0+75 (August 2015) upstream view from right bank.

Photo 45. Logan Creek Photo Point 22 – Station 0+75 (August 2015) downstream view from right bank.

Photo 46. Logan Creek Photo Point 23 – Station 7+70 (August 2015) downstream view from left bank.

Photo 47. Logan Creek Photo Point 23 – Station 7+70 (August 2015) upstream view from left bank.

Photo 48. Logan Creek, Photo Point 24 – Station 5+70 (August 2015) downstream view from left bank.

Photo 49. Logan Creek, Photo Point 24 – Station 5+70 (August 2015) upstream view from left bank.

Photo 50. UT2, Photo Point 25 – Station 0+65 (August 2015) upstream view from left bank.

Photo 51. UT2, Photo Point 25 – Station 0+65 (August 2015) downstream view from left bank.

Photo 52. Logan Creek, Photo Point 26 – Station 3+80 (August 2015) upstream view from right bank.

Photo 53. Logan Creek, Photo Point 26 – Station 3+80 (August 2015) downstream view from right bank.

Photo 54. Logan Creek, Photo Point 27 – Station 1+12 (August 2015) upstream view from right bank.

Photo 55. Logan Creek, Photo Point 27 – Station 1+12 (August 2015) downstream view from right bank.

Photo 56. UT2, Photo Point 28 – Station 1+10 (August 2015) upstream view from right bank and confluence.

Photo 57. UT1, Photo Point 29 – Station 0+50 (August 2015) view upstream and confluence.

Photo 58. Logan Creek, Photo Point 30 – Station 0+50 (August 2015) upstream view from right bank.

Photo 59. Logan Creek, Photo Point 30 – Station 0+50 (August 2015) downstream view from right bank.

Photo 60. UT8 - Preservation, Photo Point 31 – Station 1+80 (August 2015) downstream view from mid-channel to confluence.

Photo 61. UT8 - Preservation, Photo Point 31 – Station 1+80 (August 2015) upstream view from mid-channel to confluence.

Photo 62. UT8 - Preservation, Photo Point 32 – (August 2015) downstream view from right bank.

Photo 63. UT8 - Preservation, Photo Point 32 – (August 2015) upstream view from right bank.

Photo 64. UT8 - Preservation, Photo Point 33 – (August 2015) downstream view from right bank.

Photo 65. UT8 - Preservation, Photo Point 33 – (August 2015) downstream view from right bank.

Photo 64. UT8 - Preservation, Photo Point 33 – (August 2015) upstream view from right bank.