Logan Creek Stream Restoration Project
Year 5 Monitoring Report

Jackson County, North Carolina

NCDMS Project ID No. 92515; Contract No. D06046-A

Savannah River Basin: 03060101-010020

DWR # 20080879 Ver. 2, SAW ID: 2008-01711

Project Info:	Monitoring Year: 5 of 5 Year of Data Collection: 2019 Year of Completed Construction: May 2015 Submission Date: December 2019
Submitted To:	NCDEQ – Division of Mitigation Services 5 Ravenscroft Drive, Suite 102 Asheville, NC 28801 NCDEQ Contract ID No. D06046-A

Michael Baker
INTERNATIONAL

Innovation Done Right...We Make a Difference

March 6, 2020

NCDEQ - Division of Mitigation Services (DMS)
Attn: Mr. Paul Wiesner, Western Project Management Supervisor
5 Ravenscroft Drive, Suite 102
Asheville, NC 28801

Subject: Response to DMS comments on the Year 5 Monitoring Report Draft review for the Logan Creek Stream Restoration Project; Savannah River Basin - CU# 03060101; Jackson County, North Carolina; NCDMS Project # 92515; Contract No. D06046-A

Dear Mr. Wiesner,

Please find enclosed the final Logan Creek Year 5 Monitoring Report. We have addressed the comments that you submitted on the draft report and our responses to your comments are the following:

- **Section 2.0 - Methodology:** Please review this section. The section notes that monitoring data was collected in October 2018. MY5 is 2019. Please update accordingly.
  This mistake was corrected.
- **Section 2.1 - Vegetation Assessment:** Please QA/QC the third paragraph. Based on Figure 2B, "Stream Relocation" should be updated to "New Trail Alignment". Please also report the trail's approximate average distance from Logan Creek and its approximate minimum distance from Logan Creek. Please also report the trail's approximate width.
  It appears that the reference should have been to the fourth paragraph where the trail was discussed. The wording has been corrected and trail measurements have been added to the discussion.
- **Executive Summary & Section 2.2.1-Morphologic parameters and Channel Stability:** In the report text, please briefly explain why the longitudinal profile for UT8 was not established in MY0. Please note when it was established and the monitoring years that data was collected for the reach. This text should be incorporated with the text noting the additional cross section on the reach.
  The requested discussion of UT8 was added in the Executive Summary, but it was placed in the paragraph where the IRT site visit is discussed and reference was made to this UT. If this is unacceptable, we can modify where this is located.
- **Section 2.2.4 - Project Problem Areas:** In the report text, please note any proposed resolution for the continued structure piping noted at CPA 3-5 during MY5. If no action will be taken, please add that to the report text.

  CPA 3-5 was repaired during February 2020, and this has been noted in the report in Section 2.2.4 and photos added to Table 12.

  .

797 Haywood Road| Suite 201|
Asheville NC 28806
Office: 828.412.6100 | Fax: 828.350.1409

- **Executive Summary & Section 2.2.4 - Project Problem Areas: EA-1** – Why does the landowner continue to mow this area at a 10-foot width? Has there been any discussion with the landowner to cease this mowing? What is the agreed width? Please add additional verbiage to the revised report as necessary. We will discuss this with the NCDEQ Stewardship team during the 2/4/2020 pre-closeout meeting. It is likely that NCDEQ Stewardship will require resolution on this issue with the landowner before accepting the site. They will also likely want a maintenance width agreed upon in writing and signed by the landowner.

  The report was modified so that this area is no longer called an encroachment area in this report. Based on measurements of the trail, the width in this area is only slightly greater than other areas and we believe does not constitute an encroachment. The greater issue, as pointed out, is that a trail width needs to be established in writing and agreed to by all parties. We are developing an infrastructure map that details our findings on the trail and other issues and will work with the Lonesome Valley development and the NC Stewardship Program to establish an agreement for long-term stewardship of these issues. We are also making Lonesome Valley aware of other encroachment issues and asking for their assistance in resolving these. We will communicate any findings or resolutions to DMS. These additional areas are now shown on the CCPV and discussed in the report.

- **Section 2.2.4 - Project Problem Areas:** In the revised report, please indicate when the beaver and associated beaver dams were removed from the site. At a minimum, a scheduled removal date should be included in the revised report. DMS recommends removing beaver dams as soon as possible to avoid potential irregular monitoring data, project damage and additional maintenance. Beaver and beaver dams should be controlled/maintained through IRT project closeout.

  The beaver and their dams have been addressed and this is discussed in Section 2.2.4.

- **Section 2.2.4 - Project Problem Areas and CCPV Sheets:** Section 2.2.4 indicates that existing beaver dams are identified on Figures 2A and 2B; however, the beaver dams are not shown on the CCPV sheets. Please update accordingly.

  Given that these have been taken care of, we are indicating that beavers were found on the site and dealt with. We have removed the callouts for beaver dams, on the CCPV maps.

- **Table 2 – Project Activity and Reporting History:** Please add invasive treatments, beaver removal efforts, and/ or any maintenance activities to the table. Activities from MY1 – MY5 should be included in the table in chronological order.
  Table 2 has been updated with any repairs, invasive vegetation control and beaver control activity and the time period that this activity was done.

- **Table 12 – MY5 Stream Problem Areas and Photos:** DMS recommends updating the table name as most of these areas are not issues in MY5. Suggest "MY1-MY5 Stream Problem Areas". While it is good to track previous issues, please make sure the table notes when the issues were initially identified (monitoring year at a minimum) and when Michael Baker Engineering believes the issues were resolved. It may also be helpful to have a RESOLVED/ ON GOING ISSUE column for clarity. Lastly, please provide recent (Fall/ winter MY5) photos of each area so the reader can observe the current condition of the reported issue/ PA.
  The title of this table has been changed as suggested. We added a new column called status and are showing if the issue is resolved or on going. We added recent photos of each location and have added photos for two new areas that were identified on our recent site visit.

- **Table 9 – Verification of Bankfull or Greater than Bankfull Events:** DMS recommends adding a row for MY1 noting that no bankfull events were recorded in MY1.
  A row for MY1 was added indicating do data was collected that year.
- **Profile of UT8:** The longitudinal profile just shows profile data from MY1 and MY5. A footnote is missing from the graph. Please be consistent with the other graphs. DMS recommends including the profile that shows MY1 compared to MY5 and a separate graph showing all longitudinal profile data collected for the reach over the monitoring term.
  The UT8 profile was corrected so that both the MY1 to MY5 comparison and the profile showing the year to year comparison, are included. The footnote is also shown.

Digital Support File Comments:

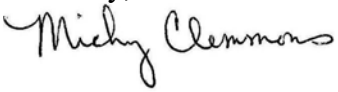
- Logan Creek spatial features do not match the linear feet reported in the asset table. All UT feature lengths currently match. Please provide a spatial feature for Logan Creek that is segmented as it is reported in the asset table, and that properly characterizes the creditable linear feet.
  DMS has commented that they would like the GIS shapefiles for all projects and noted that for some projects the lengths were not matching with the credit/asset table. Baker spoke with DMS Science and Analysis staff about this issue. We are happy to provide processed shapefiles derived from the as-built survey CAD files for all project features. That is, we have taken the final as-built CAD files, converted them into GIS, and modified them so that each feature segment is combined or split by reach or wetland type and that the attribute table is clear and has a length or acre value approximate to the credit/asset table. But due both to rounding issues in length and credit calculations, as well as to inherent program differences between CAD and GIS, some small differences may exist between the two. The as-built CAD files used to create the PE/PLS signed/sealed plan sheets are the legal standard by which we determine all our credits/assets. The GIS shapefiles are secondary files we derive from the CAD to more easily make maps in our reports. While small differences between the two (of a few feet here or there) are likely to occur on some reaches, particularly longer ones and ones with breaks such as for crossings, Baker has not regarded this as of particular importance. The CAD files are what have generated all official feature measurements. DMS accepted that small differences would be acceptable for the creditable features but did want the processed as-built shapefiles for each project and Baker has agreed to provide them.
- CCPV geospatial features submitted cannot be rendered in ArcMap; the files appear to be compromised. Please ensure that these files can be uploaded into ArcMap, and if not, resubmit a new set.
  We are providing updated CCPV features in response to the previous comment; however, we have had no problems using these files.
- The CVS file shows that x y coordinates in prior monitoring years exceed the bounds of the designated plots. Please ensure the proper plot sizes are selected, or correct the x y coordinates. DMS needs these errors corrected before we can upload the data into our database.
  That X/Y portion of the CVS entry tool has always been used for internal purposes at Baker and over the 5 years of monitoring this is the first time that this has been questioned. We have used it to identify the plant plot and individual tree number (e.g. 4-15 means plot 4, plant 15) and not for internal plant location, as CVS does not otherwise provide an easy way to carry over clear plant ID numbering from year to year. Thus, the plot dimensions recorded in CVS

are correct for each veg plot, though we understand that may have been confusing when looking at our X/Y entry data. But using the X/Y coordinate entry this way saves Baker significant time each year during monitoring and helps eliminate errors by reducing confusion. We have long regarded it as a mild flaw in the CVS tool but have found this easy workaround to be a perfectly suitable rectification. Baker spoke with DMS Science and Analysis staff about this issue. They have allowed that for our existing projects we may continue to use the X/Y entry tool for our own purposes but for future projects ask that we enter the X/Y grid plot coordinates as the CVS program originally intended. We will also provide DMS with a copy of our plot maps showing individual plant locations within each plot. And to be clear, the CVS field protocol is being followed throughout our projects with the sole exception of this X/Y grid plot entry tool. All planted stems are identified and marked (and mapped internally) at the as-built stage and tracked and assessed throughout the monitoring phase. We have checked the CVS entry tool submitted to DMS in MY5 and vigor is reported for each year, for each plot and for each plant; it is unclear to us why this comment was made.

- Please provide a final revised GIS shapefile for the nature/walking trail located within the conservation easement. This GIS shapefile will be provided to NCDEQ Stewardship as part of the proposed closeout/ acceptance package. The property owner should understand that the trail cannot be moved in the future. A "not to exceed" trail width should be established with the landowner and documented with both DMS and DEQ stewardship prior to project closeout. *The GIS shapefile for the nature trail is included with the submitted GIS files. It has been updated to show all segments of the trail. We are working with the NCDEQ Stewardship Program to document all important infrastructure at this site. We will be submitting an infrastructure map to them with this information. In conjunction with this map, a document will be prepared and submitted to the property owner that indicates the location of these items, that states infrastructure cannot be added in the future, per the deed of easement, and that establishes the width of the Nature Trail.*

If you have any questions or find any issues that need to be addressed, please contact me directly at (828) 412-6100. I am submitting an invoice for this task to Ms. Debby Davis in the Raleigh DMS Office and will be providing you an email copy.

Sincerely,



Micky Clemmons,
Project Manager
Michael Baker Engineering, Inc.

Logan Creek Stream Restoration Project
Year 5 Monitoring Report

Jackson County, North Carolina

NCDMS Project ID Number – 92515

Report Prepared and Submitted by Michael Baker Engineering, Inc.
797 Haywood Road, Suite 201
Asheville, NC 28806

NC Professional Engineering License # F-1084

TABLE OF CONTENTS

APPENDICES

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 (Appendix A). 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 Targeted Local Watershed 03060101-010020 (Horsepasture River) and within the North Carolina Division of Water Resources (NCDWR) sub-basin formerly known as 03-06-01-01 (Keowee River Subbasin). The Horsepasture River is a National Wild and Scenic River and a state-designated Natural and Scenic River. The project involved the restoration, enhancement, and preservation of a stable channel and a Montane Alluvial/Montane Oak-Hickory Forest system (NCWAM 2010, Schafale and Weakley 1990) from impairments within the project area due to past agricultural conversion including orchard development, trout hatchery development, mink farming and more recently single-family home development.

The project goals directly address stressors identified in the Savannah River Basin Restoration Priority Plan (RBRP) (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 site.
- 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 actions were taken:

- 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.

During Monitoring Year 5 (MY5), our monitoring activities indicated that the planted acreage was functioning well with most banks, benches and floodplain areas developing a diverse herbaceous community and having good growth of planted trees. There were no new Vegetative Problem Areas identified during 2019. The Encroachment Area (EA-1) that was noted in 2016 is still maintained as a part of the nature trail; however, no new trees in Vegetation (Veg) Plot 3 have been affected since MY3. Despite the impacts to the trees in the plot, Veg Plot 3 still meets minimum success criteria for MY5. Because the plot meets the success criteria we are not asking Lonesome Valley to move the nature trail in this area.

The 11 channel problem areas (CPAs) noted in previous year's monitoring reports, did not show further erosion or degradation during 2019, and no new CPAs were noted in MY5. Most of the previously listed sites exhibited further stabilization during MY5. Updated photos of all previous CPAs can be found in Appendix D.

As noted in the Baseline report, eight (8) vegetation monitoring plots were installed at this site after construction, with seven (7) being installed along the restoration reach (Logan Creek, Reach 1) and one (1) being installed along the enhancement reach (Logan Creek, Reach 2). The location of these vegetation monitoring plots can be seen on Figures 2A-C. The average density of total planted stems following the MY5 growing season is 602 stems per acre (SPA). The average density of volunteer trees across all 8 vegetation plots was 405 SPA. The total average density of all planted and volunteer stems in MY5 was 1,007 SPA.

Stream geomorphological stability and performance during MY5 was assessed by surveying thirteen (13) cross-sections (8 on Logan Creek, 2 on UT3, 2 on UT6 and 1 on UT8) and a profile of Logan Creek, UT3, UT6 and UT8, evaluating the bed particle size with 3 riffle pebble counts and by observation and replicating channel location photographs. An additional cross-section was added on UT8 during MY2 surveying so there are cross-sections on all restored tributaries and reported in subsequent years. Cross-sections of all the channels indicated that there was very little change in the cross-sections during MY5. The average particle size observed in MY5 pebble counts was within the range of what has been observed in previous monitoring years, with a slight shift towards a decrease in particle size. No observed changes indicate any instability. The Visual Morphological Stability Assessment indicates that the Site is stable and performing well. All structures but one (CPA 3-5) are functioning as designed during MY5. The structures that were piping in MY3 have filled in and are no longer piping. Overall, channel morphology is responding as designed and meeting project goals.

An Interagency Review Team (IRT) site visit to Logan Creek was held on March 28, 2018. Because this project began before the IRT was established and members had never visited the site, it was felt that other visits in the area offered a good opportunity for the IRT to see this site. The visit allowed IRT members to see UT7 (EII) and UT8 (R) which were added after the Mitigation Plan was produced but was included in the As-Built (MY0) report. A profile of UT8 was not taken for MY0 because of the short length of this channel; however, the need for this data was recognized in MY1 and it was collected and reported in MY2 and in subsequent reports (MY2-MY5). The MY0 report did indicate that we would seek restoration credit for UT3, UT6 and UT8. The IRT was also able to view the nature trail that is partially within the easement area. IRT members did not find any issues with the two unnamed tributaries. There was concern with how close the nature trail was in one location, near a meander that was less than 10 feet from the stream bank. Michael Baker contacted the Lonesome Valley development on July 17, 2018 and requested that the trail be moved away from the stream. Lonesome Valley responded the next day, saying that they would address the issue. The trail was moved away from the creek in the area of concern and in one additional location where it was close. Trees were transplanted in MY5 in the original path of the nature trail and vegetation is well established.

Summary information/data related to the Site and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report Appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report and in the Mitigation Plan available on the NCDMS website. All raw data supporting the tables and figures in the appendices are available from NCDMS upon request.

2.0 METHODOLOGY

The monitoring plan for the Site includes criteria to evaluate the success of the stream and vegetation components of the project. The methodology and report template used to evaluate these components adheres to the NCDMS monitoring guidance document dated December 1, 2009 and other mitigation guidance (NCEEP

2009 and USACE 2003), which will continue to serve as the template for subsequent monitoring years. The specific locations of monitoring features: vegetation plots, permanent cross-sections and profiles, and the crest gauge location, are shown on the Current Conditions Plan View (CCPV) sheets found in Appendix A.

Vegetation monitoring plots, pebble counts, and site photo points were monitored in October 2019. Site surveys for channel cross-sections, photos and profiles were also conducted in October 2019.

2.1 Vegetation Assessment

To determine if success criteria are achieved, vegetation monitoring quadrants (veg plots) were installed and monitored in accordance with the CVS-NCEEP Protocol for Recording Vegetation, Version 4.1 (CVS 2007 and Lee *et al* 2007). The vegetation monitoring plots are a minimum of two percent of the planted portion of the Site with eight plots established randomly within the planted riparian buffer, per CVS Monitoring Level 2. No veg plots were established within the undisturbed forested areas along the northern part of the project or within the undisturbed forested areas along Reach 2 of Logan Creek and UT5. A small area was disturbed within this enhancement reach (R2) so that structures and channel repairs could be made during construction in April of 2015. Veg Plot 1 is located in this area where bare root trees and herbaceous vegetation were planted. The sizes of individual quadrants are 100 square meters for woody species and 1 square meter for herbaceous vegetation. Herbaceous vegetation quadrants were established in one corner of the larger woody vegetation plots and monitored by comparative photographs taken each year.

Trees surviving within vegetation monitoring plots were visually accessed during MY5. All vegetation was found to be in good condition. All plots indicated that most trees were growing and in good to excellent condition and herbaceous vegetation was well established and growing well. The average density of total planted stems following the MY5 growing season is 602 stems per acre (SPA) with a range from 364 SPA to 890 SPA. The average density of volunteer trees was 405 SPA and the density ranged from 0 to 1,133 SPA. The overall average, including both planted and volunteer stems, was 1,007 SPA. With an average planted density of 602 stems per acre, the Site meets the final success criteria of having 260 stems per acre by the end of MY5.

The invasive multiflora rose (R*osa multiflora*) that was noted in previous years was treated in previous years and again in May and August of 2019. As of MY5 monitoring (October 2019), the multiflora rose is largely under control and no new growth areas have been noted. No other areas of concern regarding the existing vegetation were noted along Logan Creek or any of the tributaries. Year 5 vegetation assessment information is provided in Appendix C.

Concerns about the walking trail that parallels the stream were raised by the Interagency Review Team (IRT) during a walkthrough in March 2018. The IRT pointed out one area where the trail was within approximately 10 feet of the stream along the outside of a meander bend near station 19+50. This issue was raised with the Lonesome Valley maintenance personnel, and during MY4 field work it was noted that the trail had been moved away from the stream (called out as Trail Relocation in Figure 2B of the CCPV). In MY5 trees and shrubs were transplanted into the area of the previous trail location. To better describe the location of this trail we measured the distance from the creek every 200 linear feet down the trail from the upstream end and found that the trail on average is 48 feet from the top of bank (range is 6' to 105', n=14) and averages 6.6 feet in width (n=12). The narrowest distance off the top of bank was 6 feet and that was at the back of a point bar on a meander, so the creek was a greater distance from the trail and is stable. The maintenance staff also moved the trail crossing of UT4 upstream away from Logan Creek, where it appeared to be closer than 10 feet. This area is also called out in Figure 2B.

2.2 Stream Assessment

The restoration approach for the Logan Creek Site included the restoration of channels to a stable morphology that allows for the transport of water and sediment through the Site and allows stream flows larger than

bankfull flows to spread onto the floodplain. Stream monitoring efforts focus on visual observations, a crest gauge to document bankfull flooding events, surveying established stream cross-sections and channel profiles to assess channel stability and pebble counts to assess if proper sediment transport is taking place.

Stream survey data was collected to a minimum of Class C Vertical and Class A Horizontal Accuracy using Leica TS06 Total Station and was georeferenced to the NAD83 State Plane Coordinate System, FIPS3200 in US Survey Feet, which was derived from the As-built Survey.

2.2.1 Morphologic Parameters and Channel Stability

Cross-sections were classified using the Rosgen Stream Classification System (Rosgen 1994) and all cross-sections were evaluated to determine if they meet design expectations. Cross-sections were also compared to cross-section plots from previous monitoring years to evaluate changes in the cross sections. Morphological survey data is presented in Appendix D.

A longitudinal profile was surveyed for the entire length of Logan Creek, UT3 and UT6, and UT8 to document changes during MY5. The survey was tied to a permanent benchmark and measurements included thalweg, water surface, 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.

Stream geomorphological stability and performance during MY5 was assessed by surveying thirteen (13) cross-sections (8 on Logan Creek, 2 on UT3, 2 on UT6 and 1 on UT8) and a profile of these channels as described above. The bed particle size was evaluated with three riffle pebble counts and by observation and replicating channel location photographs. Cross-sections and profiles of all the channels indicated that there was very little change in the channel during MY5. The Visual Morphological Stability Assessment indicates that the Site is stable and performing at 89 to 100 percent for all parameters. The last structure on UT8 was piping during MY5 surveying (CPA 3-5); however, this was repaired during the winter (February 2020). Overall, channel morphology is responding as designed and meeting project goals.

Pebble count data for MY5 indicates a slight shift to smaller particle sizes but is well within the range of observed data as compared to previous monitoring years. The channel had a mean D50 of 16.5 mm during baseline sampling, 36.9 mm during MY1, 22.2 mm in MY2, 26.8 mm in MY3, 34.0 mm in MY4, and 23.7 mm in MY5. This represents a general coarsening of particle size since baseline sampling.

2.2.2 Hydrology

A crest gauge was installed on the floodplain at the bankfull elevation along the right top of bank on Logan Creek at approximate Station 30+00. There were three bankfull events recorded on the crest gauge during MY5. The crest gauge indicated a water depth on the floodplain of 19.5 inches during the first event, 5.2 inches during the second event, and 1.5 inches during the third event. Crest gauge readings are presented in Appendix D.

2.2.3 Photographic Documentation

Reference transects were photographed at each permanent cross-section. A survey tape is normally centered in the photograph when the tape is used to identify the transect. The water line was located in the lower area of the frame, and as much of the bank as possible included in each photograph. Photographs were taken at specific photo points established along each channel during Year 5 monitoring. Photographs from these points are replicated each year and used to document changes along the channel. Points were selected to include grade control structures as well as other structural components installed during construction. Annual photographs from the established photo points are shown in Appendix D.

2.2.4 Project Problem Areas

Project problem areas fall into three types: Vegetation Problem Areas (VPA), Encroachment Areas (EA), and Channel Problem Areas (CPA). All observed problem areas are shown on the CCPV maps. There were no VPAs identified during MY5. Vegetation was well established across the entire project site.

One structure was piping during MY5 monitoring (CPA 3-5). This structure was repaired during February 2020 and is no longer piping. Other structures that were noted as piping in the past have filled in naturally and are no longer piping.

No new erosion areas were noted in MY5. Some of the areas of erosion that were called out in previous years (CPA 2-1, CPA 2-2, CPA 2-4, CPA 2-5, CPA 2-6, CPA 3-1, CPA 3-2, and CPA 3-3) have stabilized and are becoming vegetated. The remaining areas of erosion (CPA 3-4, CPA 2-3) have not completely stabilized but have not gotten worse in MY5 and are supporting vegetation.

An area called EA-1 in past reports is the alignment of the nature trail that passes along the outside margin of Vegetation Plot 3, since no trees in the plot have been affected since MY2 we are not calling this an encroachment area in MY5. Path maintenance in this area is only slightly wider than the trail is in other areas. We are working with the landowners and the NC Stewardship Program to define the width of the nature trail maintenance. Despite the proximity of the trail to the plot, Veg Plot 3 still meets minimum success criteria for MY5. EA-2 is a small triangular area that is being mowed by an adjacent landowner. EA-3 is a trail from an adjoining home to the easement area down a steep slope and then utilizes a foot bridge that the development placed but later abandoned. This foot bridge was supposed to be removed. We will be contacting the developer to work with these landowners to correct these encroachments and if immediate action is not taken, we will place fence post on the easement line or other obstacles in the encroachment area, to limit access.

Two beaver dams were noted during the survey in October of MY5. We contacted the Lonesome Valley development about Michael Baker working with APHIS to remove the beavers and found out that the development was already taking care of the issue. During follow-up visits, between October 2019 and February 2020, we found that the beaver and their dams have been removed.

All issues discussed above reference the CCPV mapping and the Stream Problem Area table included in Appendix D and the e-File data with associated photos.

3.0 REFERENCES

Carolina Vegetation Survey (CVS) and NC Ecosystem Enhancement Program (NCEEP). 2007. CVS-NCEEP Data Entry Tool v. 2.3.1. University of North Carolina, Raleigh, NC.

Lee, M., Peet R., Roberts, S., Wentworth, T. 2007. CVS-NCEEP Protocol for Recording Vegetation, Version 4.1.

Harman, W.A., D.E. Wise, M.A. Walker, R. Morris, M.A. 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.

North Carolina Ecosystem Enhancement Program (NCEEP). 2008. Savannah River Basin Restoration Priorities. December 2008. https://files.nc.gov/ncdeq/Mitigation%20Services/Watershed_Planning/Savannah_River_Basin/Savannah_RBRP_hcb_22dec08.pdf

North Carolina Ecosystem Enhancement Program (NCEEP). 2009. Guidance and Content Requirements for EEP Monitoring Reports Version 1.2.1. December 1, 2009.

NC Wetland Functional Assessment Team (WFAT). 2010. North Carolina Wetland Assessment Manual (NC WAM) User Manual, Version 4.1. Dated October 2010.

NC Wetlands Restoration Program (NCWRP). 2001. Watershed Restoration Plan for the Savannah River Basin.

Rosgen, D. L. 1994. A Classification of Natural Rivers. Catena 22:169-199.

Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina, third approximation. North Carolina Natural Heritage Program. Division of Parks and Recreation, NCDENR. Raleigh, NC.

United States Army Corps of Engineers (USACE). 2003. Stream Mitigation Guidelines, April 2003, U.S. Army Corps of Engineers. Wilmington District.

Appendix A

Project Vicinity Map and Background Tables

Includes:

Figure 1. Project Vicinity Map and Directions

Figure 2. Current Condition Plan View (CCPV) – MY5, Overview Map

Figure 2A. CCPV MY5, North Area

Figure 2B. CCPV MY5, Middle Area

Figure 2C. CCPV MY5, South Area

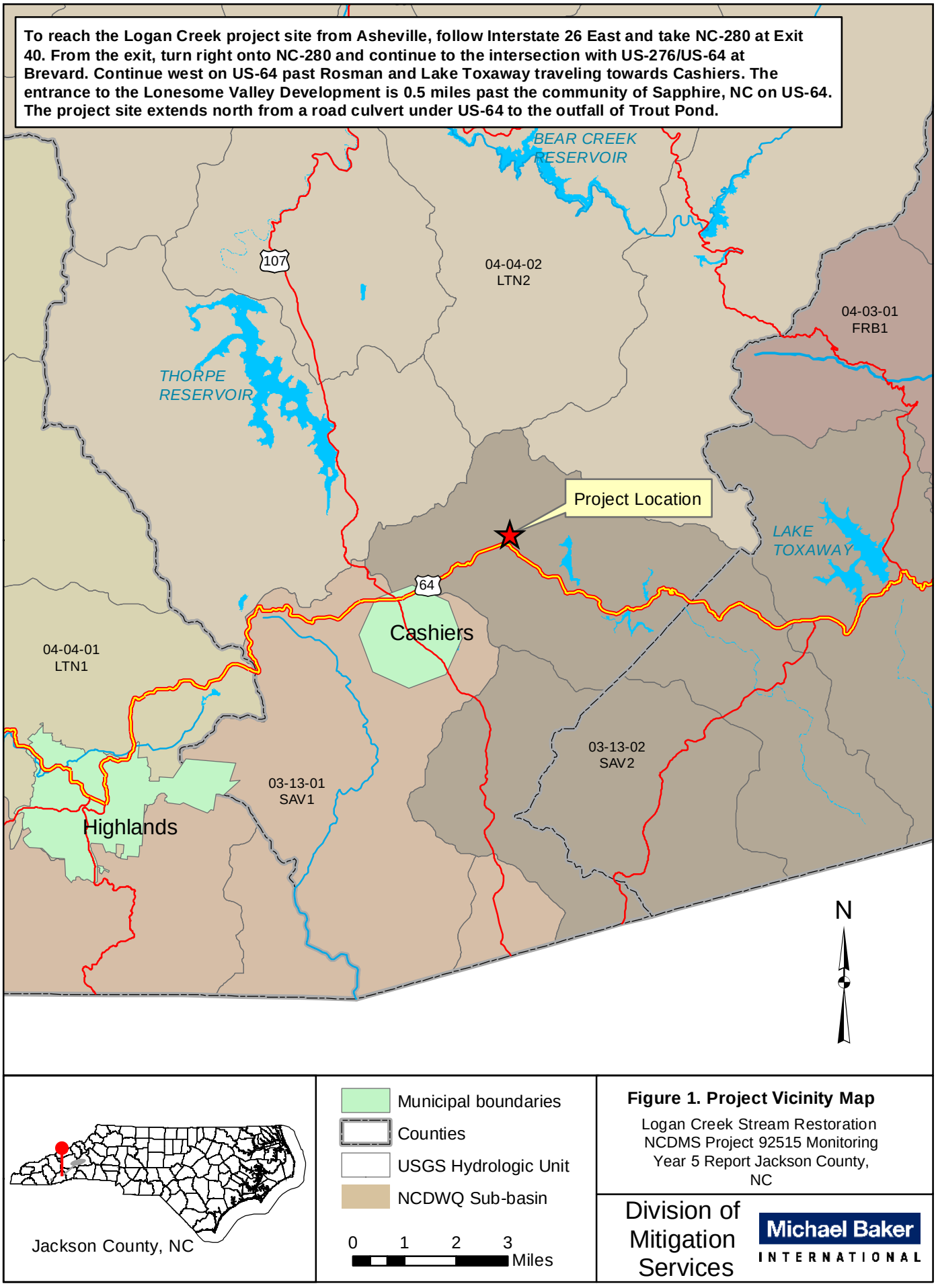
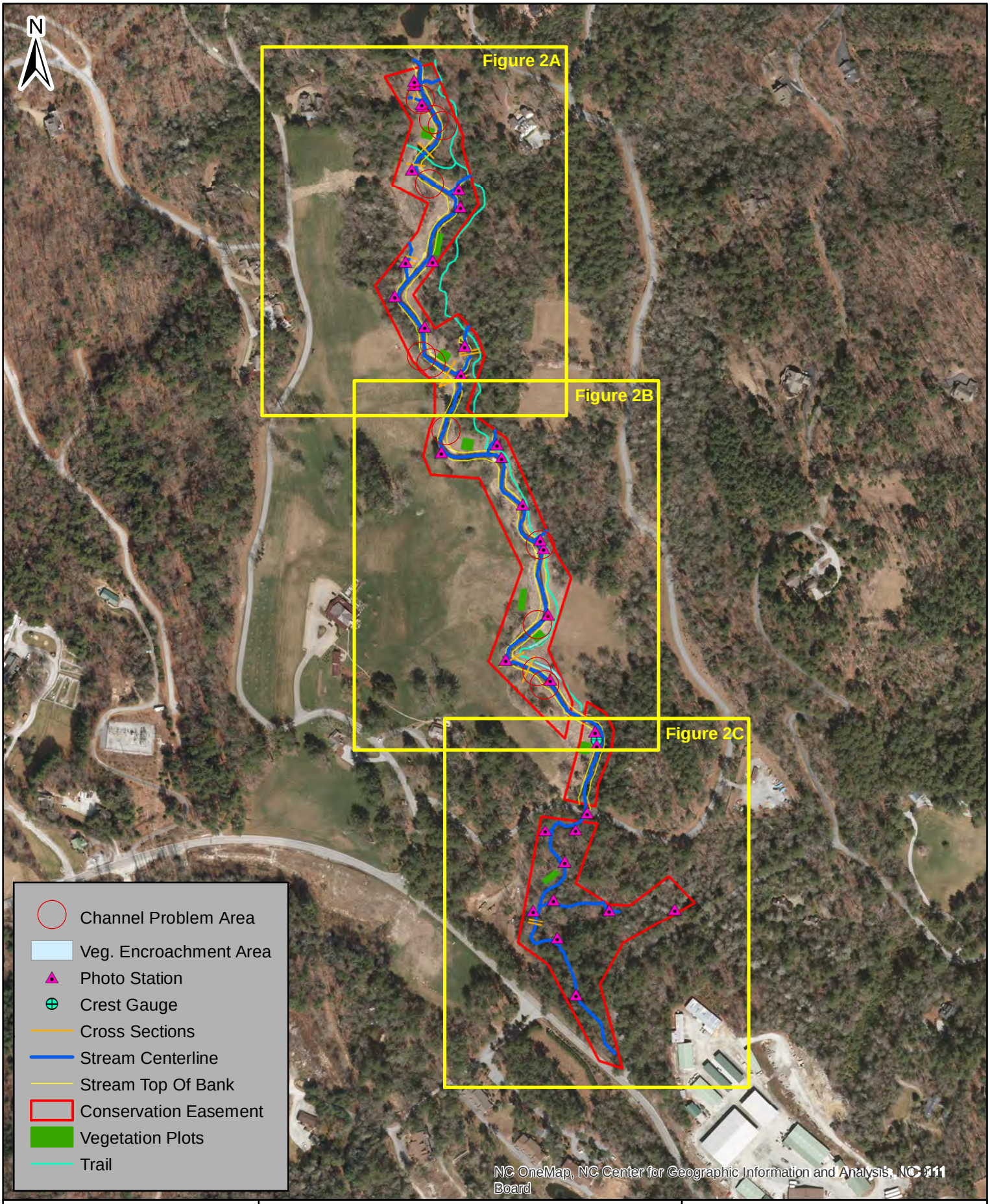


Figure 1. Project Vicinity Map

Logan Creek Stream Restoration
NCDMS Project 92515 Monitoring
Year 5 Report Jackson County, NC

Division of Mitigation Services

Michael Baker INTERNATIONAL



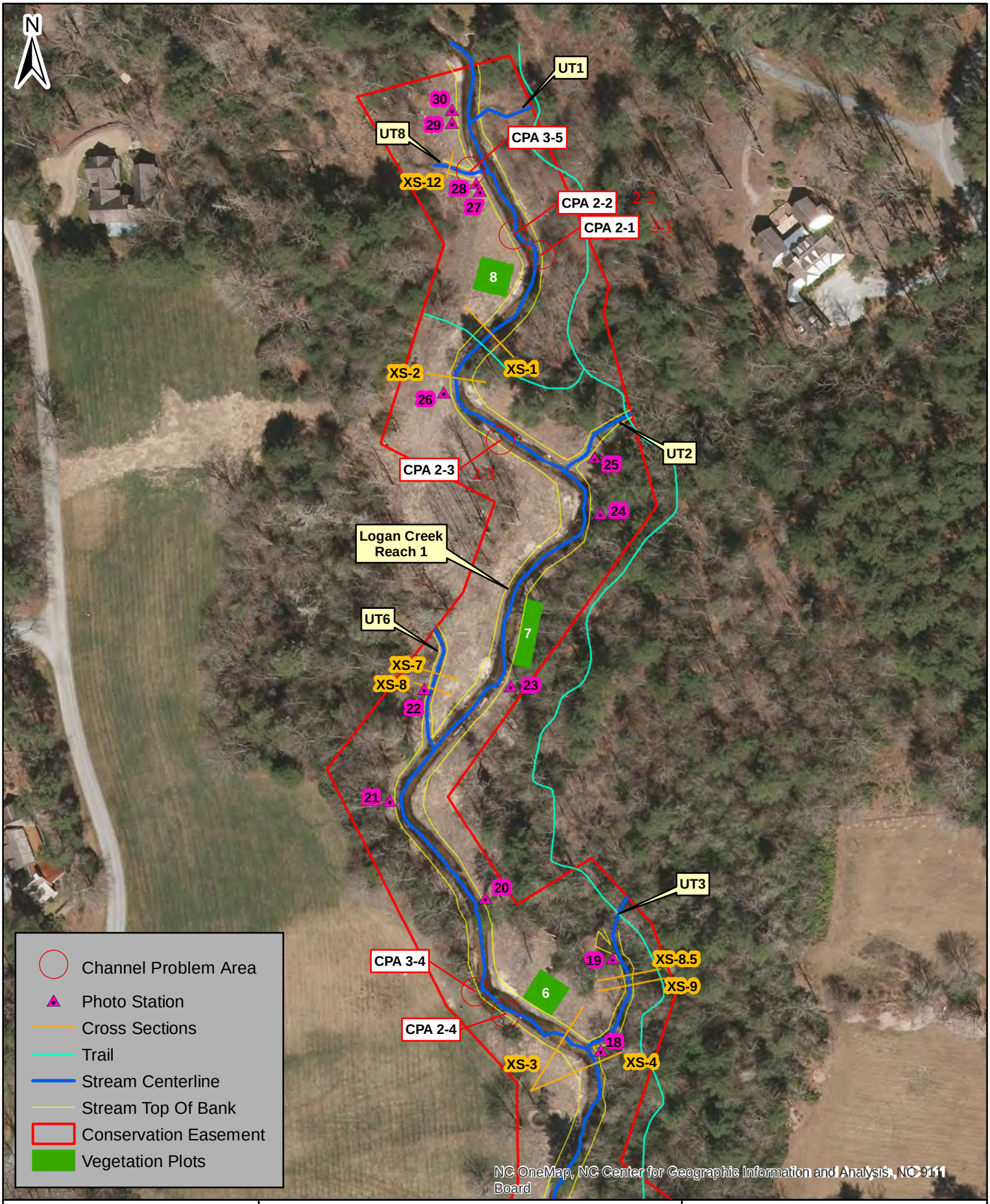
Michael Baker INTERNATIONAL

0 400 800 Feet

1 inch = 400 feet

DMS Project # 92515

Figure 2 - Overview
Current Conditions Plan View
Monitoring Year 5
Logan Creek Site



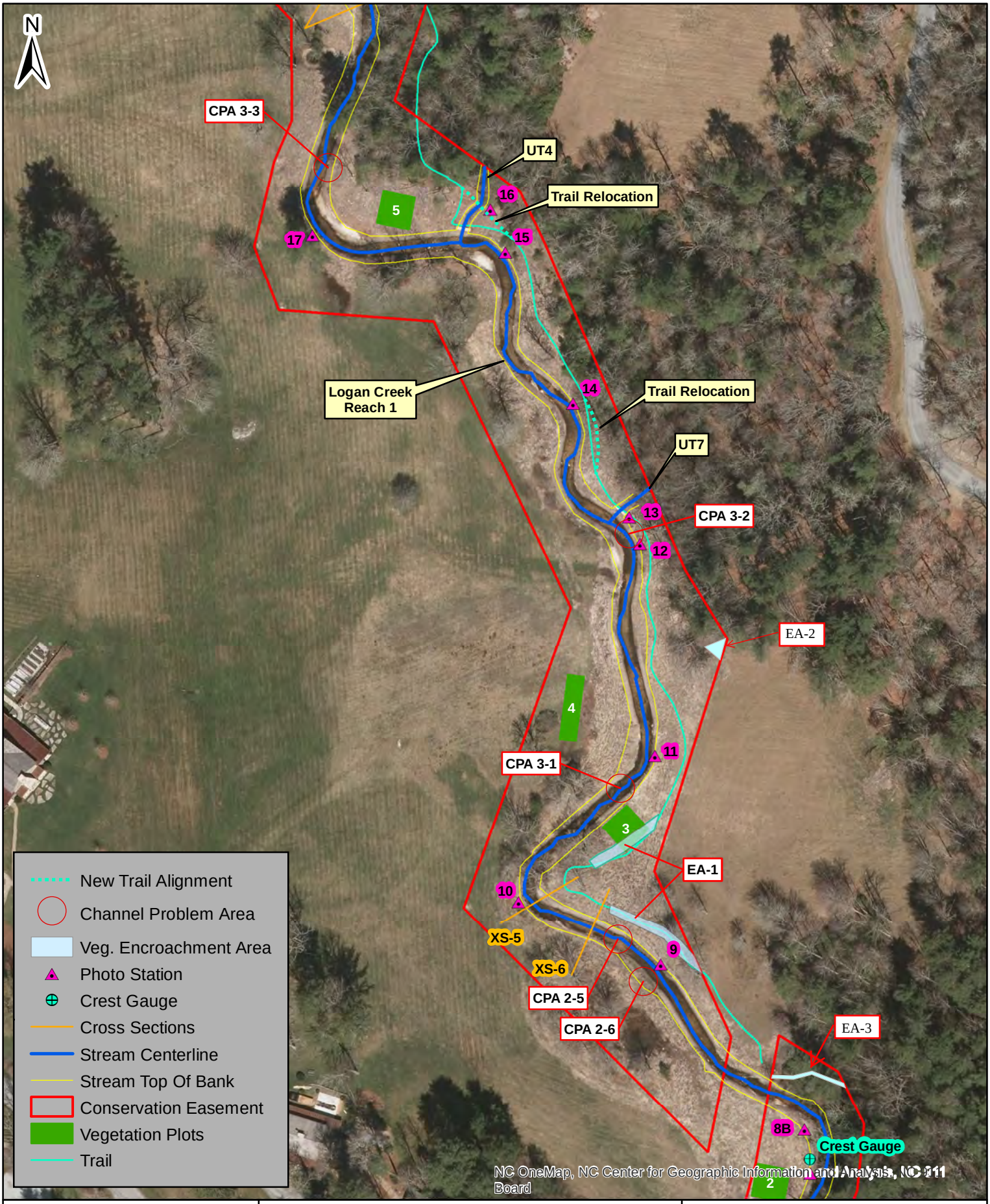
Michael Baker INTERNATIONAL

0 125 250 Feet

1 inch = 125 feet

DMS Project # 92515

Figure 2A - North Area
Current Conditions Plan View
Monitoring Year 5
Logan Creek Site



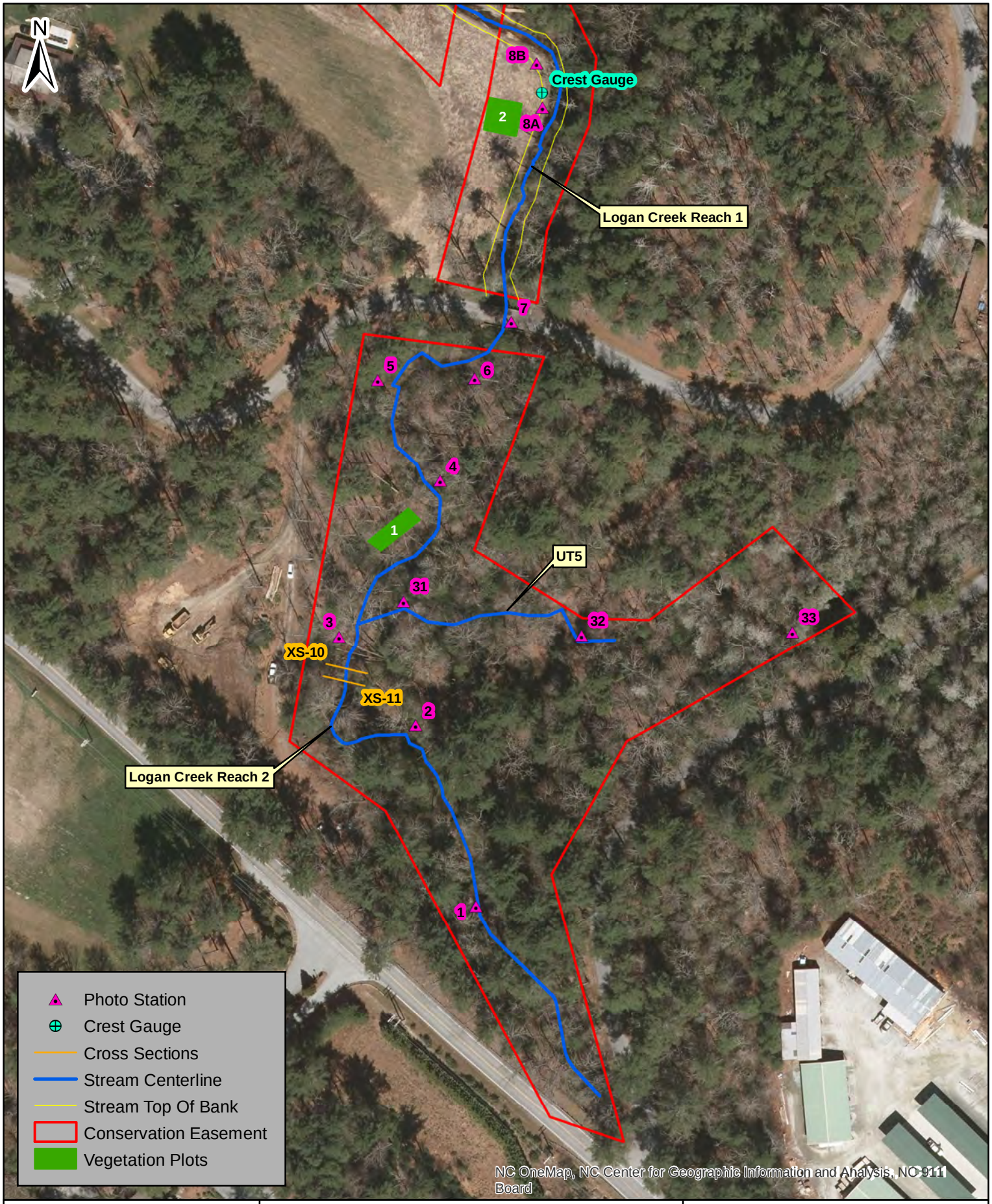
Michael Baker INTERNATIONAL

0 125 250 Feet

1 inch = 125 feet

DMS Project # 92515

Figure 2B - Middle Area
Current Conditions Plan View
Monitoring Year 5
Logan Creek Site



Michael Baker INTERNATIONAL

0 125 250 Feet

1 inch = 125 feet

DMS Project # 92515

Figure 2C - South Area
Current Conditions Plan View
Monitoring Year 5
Logan Creek Site

Appendix B
General Project Tables

Includes:

Table 1. Project Components and Mitigation Credits
Figure 3. Project Asset Map
Table 2. Project Activity and Reporting History
Table 3. Project Contacts
Table 4. Project Attributes

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	3,441 SMU	692 SMU	136 SMU	58 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	3,131 SMU	3,131 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	290 LF	Preservation	58 SMU	290 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

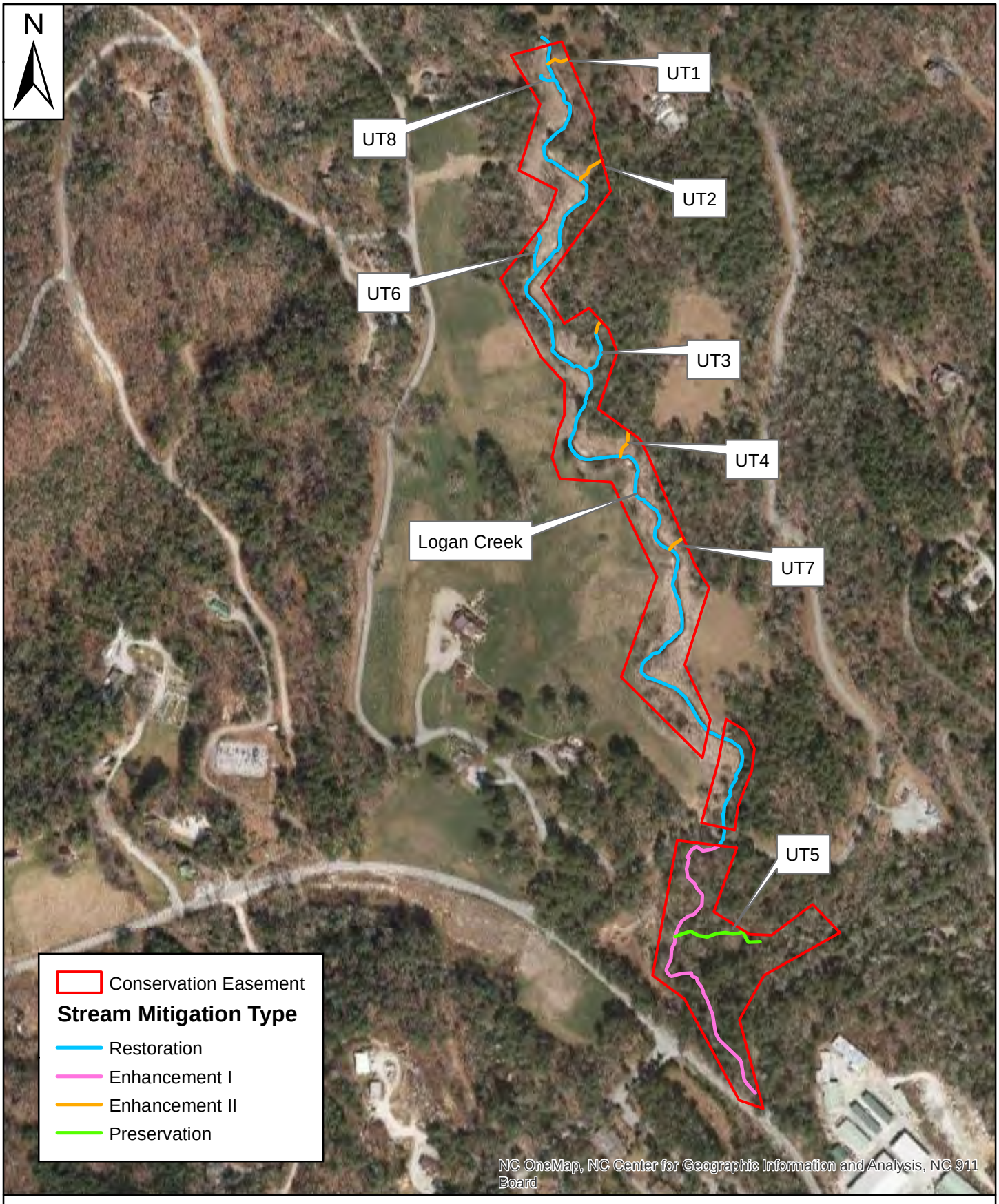
Component Summation

Restoration Level	Stream (LF)	Riparian Wetland (AC)		Non-riparian Wetland (AC)	Buffer (SF)	Upland (AC)
Restoration	3,441					
Enhancement I	1,038					
Enhancement II	341					
Creation						
Preservation	290					
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



Michael Baker INTERNATIONAL

0 200 400 600 800 1,000 Feet

DMS Project # 92515

Figure 3
Stream Asset Map
Monitoring Year 5
Logan Creek Site

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 bare root trees and live stakes	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	Apr-15	Nov-15
Year 1 Monitoring	N/A	Mar-16	Apr-16
Year 2 Monitoring	Dec-16	Nov-16	Dec-16
Flood repair of piping, scour repair (hand tools)			May-17
Invasive Vegetation Control			Jul-17
Minor bank scour repair and add live stakes (hand tools)			Oct-17
Year 3 Monitoring	Dec-17	Oct-17	Dec-17
Trail relocations done			Apr-18
Year 4 Monitoring	Dec-18	Oct-18	Nov-18
Added livestakes and trees to old trail, treated invasive veg			May-19
Treated invasive veg.			Aug-19
Year 5 Monitoring	Dec-19	Oct-18	Mar-20
Beavers and dams removed by landowner			Nov-Dec, 20
Repaired piping of log structure on UT-8			Feb-20

* 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 (when Trout Moratorium ends) and was completed by May 12, 2015.

Table 3. Project Contacts	
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: Stephen Carroll, Tel. 919-428-8368
Planting Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Stephen Carroll, Tel. 919-428-8368
Seeding Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Stephen Carroll, Tel. 919-428-8368
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 and Vegetation Monitoring	Micky Clemmons, Tel. 828-412-6100
Monitoring Surveyor	Kee Mapping and Surveying P.O. Box 2566 Asheville, NC 28802 Contact: Brad Kee, License #C-3039; Phone: 828-575-9021

Table 4. Project Attributes			
Logan Creek Restoration Project: DMS Project ID No. 92515			
Project Information			
Project Name	Logan Creek Mitigation 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		
DWR 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**	**UT3**
			R1 **R2**
Length of Reach (LF)	3,134	1,038	40 138
Valley Classification (Rosgen)	VIII	VIII	II
Drainage Area (AC)	1,557	1,714	32
NCDWR Stream Identification Score	52.5	52.5	41.5
NCDWR Water Quality Classification	C; TR: +HQW	C; TR: +HQW	C; TR: +HQW
Morphological Description (Rosgen stream type)	C-E	C-E	B
Evolutionary Trend	C→E	C→E	B
Underlying Mapped Soils	NkA	SaC	NkA, SaC
Drainage Class	Poorly drained to very poorly drained soils	Very deep, well drained, mod permeable soils	Somewhat poorly to well drained
Soil Hydric Status	Non-Hydric	Non-Hydric	Site-specific
Average Channel Slope (ft/ft)	0.004	0.007	0.012
FEMA Classification	Zone AE	Zone AE	None
Native Vegetation Community	Mixed Forested/Rhododendron and grassland	Mixed Forested/Rhododendron and grassland	Mixed Forested/Rhododendron and grassland
Percent Composition of Exotic/Invasive Vegetation[2]	<1%	<1%	<1%
Parameters	**UT3**	**UT6**	**6 other small UTs in R1**
	R1 **R2**		
Length of Reach (LF)	40 138	127	45 - 127
Valley Classification (Rosgen)	II	II	II
Drainage Area (AC)	32	32	.02 to .04
NCDWR Stream Identification Score	41.5	41.5	40.5 - 32.5
NCDWR Water Quality Classification	C; TR: +HQW	C; TR: +HQW	C; TR: +HQW
Morphological Description (Rosgen stream type)	B	B	E - B
Evolutionary Trend	B	B	B→C→E
Underlying Mapped Soils	NkA, 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)	0.012	0.012	0.0134 (UT6)
FEMA Classification	None	None	None
Native Vegetation Community	Mixed Forested/Rhododendron and grassland	Mixed Forested/Rhododendron and grassland	Mixed Forested/Rhododendron and grassland
Percent Composition of Exotic/Invasive Vegetation[2]	<1%	<1%	<1%
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	Certification, June 27, 2016
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 C

Vegetation Assessment Data

Includes:

Table 5 Vegetation Plot Mitigation Success Summary
Table 6 CVS Vegetation Metadata
Table 7 Stem Count Arranged by Plot and Species
Figure 4 Vegetation Monitoring Plot Photos
Figure 4.1 Trail Relocation Photos - MY5
Table 7.1 Vegetative Problem Areas (e-file)
Table 7.2 Vegetation Condition Assessment at Logan Creek (e-file)

Table 5. Vegetation Plot Mitigation				
Success Summary (2019, MY5)				
Plot #	**Stream/ Wetland Stems[1]**	**Volunteers[2]**	**Total[3]**	**Success Criteria Met?**
1	647	81	728	Yes
2	364	283	647	Yes
3	405	526	931	Yes
4	526	243	769	Yes
5	850	971	1821	Yes
6	607	1133	1740	Yes
7	890	0	890	Yes
8	526	0	526	Yes
Project Avg	**602**	**405**	**1,007**	**Yes**
Stem Class	**Characteristics**			
[1]Stream/ Wetland Stems	Native planted woody stems. Includes shrubs, does NOT include live stakes. No vines			
[2]Volunteers	Native woody stems. Not planted. No vines.			
[3]Total	Planted + volunteer native woody stems. Includes live stakes. Excl. exotics. Excl. vines.			
This color indicates that the number includes volunteer stems				
Indicates that the stems per acre exceeds requirements by 10%				
Indicates that the stems per acre exceeds requirements, but by less than 10%				

Table 6. Vegetation Metadata

Logan Creek Stream and Restoration Project - Project #92515

Report Prepared By	Holland Youngman
Date Prepared	11/1/2019 14:05
database name	92515_Logan_cvs-eep-entrytool-v2.3.1_MY5.mdb
database location	L:\projects\109243 - Logan Creek\Monitoring\YR5 Monitoring\2.0 - Monitoring Data\App C - Vegetation\Veg Data
computer name	ASHELHYOUNGMAN
file size	45764608

DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.

PROJECT SUMMARY----------	
Project Code	92515
project Name	Logan Creek
Description	This Project will restore or enhance 4823 linear feet (LF) of stream along Logan Creek.
River Basin	Savannah
length(ft)	5110
stream-to-edge width (ft)	30
area (sq m)	28481.19
Required Plots (calculated)	8
Sampled Plots	8

Table 7. Stem Count Arranged by Plot
Project: Logan Creek, DMS Project 392515

			Current Plot Data (MY5 2019)																				
			92515-01-0001			92515-01-0002			92515-01-0003			92515-01-0004			92515-01-0005			92515-01-0006			92515-01-0007		
Scientific Name	**Common Name**	**Species Type**	**P**	**V**	**T**	**P**	**V**	**T**	**P**	**V**	**T**	**P**	**V**	**T**	**P**	**V**	**T**	**P**	**V**	**T**	**P**	**V**	**T**
Alnus serrulata	hazel alder	Shrub				3		3	6	10	16	2		2	7		7	3		3	6		6
Betula nigra	river birch	Tree							1		1	3		3	3		3	1		1	1		1
Diospyros virginiana	common persimmon	Tree				1		1				1		1	4		4	1		1	5		5
Fraxinus pennsylvanica	green ash	Tree				1		1	1		1	4	1	5	2		2	8		8	3		3
Hamamelis virginiana	American witchhazel	Tree	5	2	7																		
Leucothoe fontanesiana	highland doghobble	Shrub																					
Lindera benzoin	northern spicebush	Shrub	2		2																		
Liriodendron tulipifera	tuliptree	Tree				1	7	8		3	3	1	5	6		24	24	1	28	29	4		4
Nyssa sylvatica	blackgum	Tree							2		2				2		2				1		1
Oxydendrum arboreum	sourwood	Tree																					
Pinus strobus	eastern white pine	Tree																					
Quercus alba	white oak	Tree				3		3				1		1	2		2						
Quercus rubra	northern red oak	Tree										1		1	1		1	1		1	2		2
Robinia pseudoacacia	black locust	Tree																					
Sambucus canadensis	Common Elderberry	Shrub																					
Unknown		Shrub or Tree																					
Viburnum dentatum	southern arrowwood	Shrub	9		9																		
		Stem count	16	2	18	9	7	16	10	13	23	13	6	19	21	24	45	15	28	43	22	0	22
		size (ares)		1			1			1			1			1			1			1	
		size (ACRES)		0.02			0.02			0.02			0.02			0.02			0.02			0.02	
		Species count	3	1	3	5	1	5	4	2	5	7	2	7	7	1	8	6	1	6	7	0	7
		Stems per ACRE	647	81	728	364	283	647	405	526	931	526	243	769	850	971	1821	607	1133	1740	890	0	890

P = Planted — This color indicates that the number includes volunteer stems
V = Volunteer — Indicates that the stems per acre exceeds requirements by 10%
T = Total — Indicates that the stems per acre exceeds requirements, but by less than 10%

Table 7. Stem Count Arranged by Plot, continued
Project: Logan Creek, DMS Project 392515

			Current Plot Data (MY5 2019)			Annual Means																	
			92515-01-0008			MY5 (2019)			MY4 (2018)			MY3 (2017)			MY2 (2016)			MY1 (2015)*			MY0 (2015)*		
Scientific Name	**Common Name**	**Species Type**	**P**	**V**	**T**	**P**	**V**	**T**	**P**	**V**	**T**	**P**	**V**	**T**	**P**	**V**	**T**	**P**	**V**	**T**	**P**	**V**	**T**
Alnus serrulata	hazel alder	Shrub	5		5	32	10	42	32	10	42	32	25	57	32	30	62	32		32	33		33
Betula nigra	river birch	Tree	2		2	11		11	12		12	11		11	12		12	11		11	13		13
Diospyros virginiana	common persimmon	Tree	1		1	13		13	16		16	16		16	18		18	20		20	24		24
Fraxinus pennsylvanica	green ash	Tree	2		2	21	1	22	22		22	22		22	23		23	24		24	24		24
Hamamelis virginiana	American witchhazel	Tree				5	2	7	5		5	7		7	9		9	11		11			
Leucothoe fontanesiana	highland doghobble	Shrub										1		1	3		3	3		3	4		4
Lindera benzoin	northern spicebush	Shrub				2		2	2		2	2		2	2		2	2		2			
Liriodendron tulipifera	tuliptree	Tree	2		2	9	67	76	11	65	76	10	35	45	9	55	64	11		11	17		17
Nyssa sylvatica	blackgum	Tree	1		1	6		6	6		6	7		7	8		8	9		9	20		20
Oxydendrum arboreum	sourwood	Tree														2	2						
Pinus strobus	eastern white pine	Tree														14	14						
Quercus alba	white oak	Tree				6		6	6		6	7		7	7		7	6		6	6		6
Quercus rubra	northern red oak	Tree				5		5	9		9	9		9	10		10	12		12	13		13
Robinia pseudoacacia	black locust	Tree														1	1						
Sambucus canadensis	Common Elderberry	Shrub																	1	1			
Unknown		Shrub or Tree																			7		7
Viburnum dentatum	southern arrowwood	Shrub				9		9	11		11	11		11	11		11	11		11	9		9
		Stem count	13	0	13	119	80	199	132	75	207	135	60	195	144	102	246	152	1	153	170	0	170
		size (ares)		1			8			8			8			8			8			8	
		size (ACRES)		0.02			0.20			0.20			0.20			0.20			0.20			0.20	
		Species count	6	0	6	11	4	11	11	2	11	12	2	12	12	5	15	12	1	13	11	0	11
		Stems per ACRE	526	0	526	602	405	1007	668	379	1047	683	304	986	728	516	1244	769	5	774	860	0	860

P = Planted — This color indicates that the number includes volunteer stems
V = Volunteer — Indicates that the stems per acre exceeds requirements by 10%
T = Total — Indicates that the stems per acre exceeds requirements, but by less than 10%

*MY0 was completed in spring 2015 after the trout moratorium, MY1 data was collected after the growing season in the winter 2015. This corrects an inaccurate date show on previous reports.

Figure 4. Vegetation Monitoring Plot Photos
DMS Project #92515

Photo 1. Vegetation Plot 1 – Tree photo (October 23, 2019).

Photo 2. Vegetation Plot 1 – Herbaceous photo (October 23, 2019).

Photo 3. Vegetation Plot 2 – Tree photo (October 23, 2019).

Photo 4. Vegetation Plot 2 – Herbaceous photo (October 23, 2019).

Photo 5. Vegetation Plot 3 – Tree photo (October 23, 2019).

Photo 6. Vegetation Plot 3 – Herbaceous photo (October 23, 2019).

Logan Creek Site - Vegetation Plot Photos,
DMS Project #92515 - continued

Photo 7. Vegetation Plot 4 – Tree photo (October 23, 2019).

Photo 8. Vegetation Plot 4 – Herbaceous photo (October 23, 2019).

Photo 9. Vegetation Plot 5 – Tree photo (October 23, 2019).

Photo 10, Vegetation Plot 5 – Herbaceous photo (October 23, 2019).

Photo 11. Vegetation Plot 6 – Tree photo (October 23, 2019).

Photo 12. Vegetation Plot 6 – Herbaceous photo (October 23, 2019).

Logan Creek Site - Vegetation Plot Photos,
DMS Project #92515 - continued

Photo 13. Vegetation Plot 7 – Tree photo (October 23, 2019).

Photo 14. Vegetation Plot 7 – Herbaceous photo (October 23, 2019).

Photo 15. Vegetation Plot 8 – Tree photo (October 23, 2019).

Photo 16. Vegetation Plot 8 – Herbaceous photo (October 23, 2019).

Figure 4.1 Trial Relocation Photos – MY5
DMS Project #92515

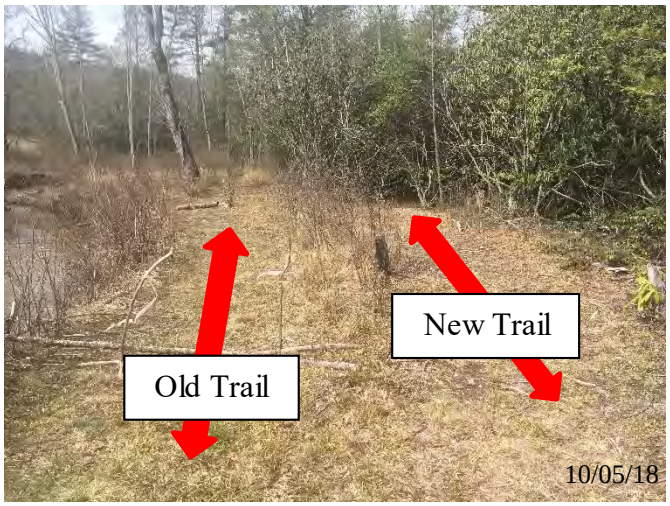


Photo 17. Original Trail Relocation 1 facing upstream– Trail was relocated away from the stream.

Photo 18. Updated Conditions Trail Relocation 1 facing upstream– Trail was relocated away from stream.

Table 7.1 Vegetative Problem Areas MY5			
Feature Category	**Station #/Range**	**Probable Cause**	**Photo #**
Bare Bank	None		
Bare Bench	None		
Bare Flood Plain	None		
Invasive /Exotic Populations	None		

Table 7.2 Vegetation Condition Assessment

Planted Acreage[1]	7.49					
Vegetation Category	**Definitions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Planted Acreage**
1. Bare Areas	None	0.1 acres	Pattern and Color	0	0.00	0.0%
2. Low Stem Density Areas	None	0.1 acres	Pattern and Color	0	0.00	0.0%
			Total	0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	None	0.25 acres	Pattern and Color	0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2]	12.71					
Vegetation Category	**Definitions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Easement Acreage**
4. Invasive Areas of Concern[4]	None	1000 SF	Pattern and Color	0	0.00	0.0%
5. Easement Encroachment Areas[3]	There was one Encroachment Area (EA-1) noted in 2016 along the nature trail, in the area of stations 23+00 to 28+00. A new maintenance staff person had the nature trail mowed; however, a wider area was mowed than we verbally agreed should be maintained. The width was 10-12 feet wide, while we had agreed to a width of 4-6 feet wide, which approximates the width of the previously existing nature trail. We discussed this with staff at Lonesome Valley and they agreed to address this issue with the trail maintenance staff, and to be sure they know the proper width for future maintenance. During MY5 monitoring, it was noted that the trail is now being mowed at the appropriate width of 4-6 feet, and runs adjacent to but does not encroach upon the neighboring vegetation plot.	none	Light Blue	2	0.014	0.11%

1 = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

2 = The acreage within the easement boundaries.

3 = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by EEP such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likley trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where Isolated specimens are found, particularly ealry in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolzing invasives polygons, particularly for situations where the conditon for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.

Appendix D

Stream Assessment Data

Includes:

Figure 5. Stream Photos by Channel and Station
Table 8. Visual Morphological Stability Assessment
Table 9. Verification of Bankfull or Greater than Bankfull Events
Figure 6. Cross-Sections with Annual Overlays
Figure 7. Longitudinal Profiles with Annual Overlays
Figure 8. Pebble Count Plots with Annual Overlays
Table 10. Monitoring Year 5 Stream Summary
Table 11. Morphology and Hydraulic Monitoring Summary
Table 12. MY5 Stream Problem Areas and Photos (e-file)

Figure 5. Logan Creek Stream Restoration project
Photo Points - Monitoring Year 5, (Stationing is approximate)

Photo 1. Logan Creek Photo Point 1 – Station 40+45 (October 23, 2019) upstream view from right bank.

Photo 2. Logan Creek Photo Point 1 – Station 40+45 (October 23, 2019) downstream view from right bank.

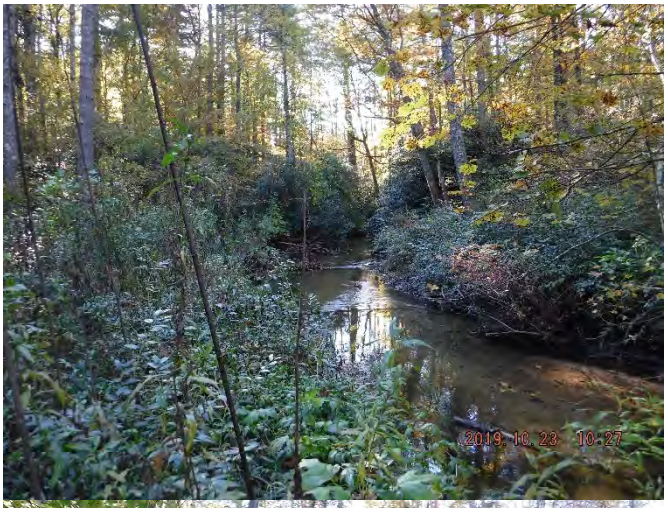


Photo 3. Logan Creek Photo Point 2 – Station 38+60 (October 23, 2019) downstream view from left bank.

Photo 4. Logan Creek Photo Point 2 – Station 38+60 (October 23, 2019) upstream view from left bank.

Photo 5. Logan Creek Photo Point 3 – Station 36+75 (October 23, 2019) upstream view from right bank.

Photo 6. Logan Creek Photo Point 3 – Station 36+75 (October 23, 2019) downstream view from right bank.

Photo 7. Logan Creek Photo Point 4 – Station 34+80 (October 23, 2019) downstream from left bank.

Photo 8. Logan Creek Photo Point 4 – Station 34+80 (October 23, 2019) upstream from left bank.

Photo 9. Logan Creek Photo Point 5 – Station 33+60 (October 23, 2019) upstream from right bank.

Photo 10. Logan Creek Photo Point 5 – Station 33+60 (October 23, 2019) downstream from right bank.

Photo 11. Logan Creek Photo Point 6 – Station 32+70 (October 23, 2019) downstream view from left bank.

Photo 12. Logan Creek Photo Point 6 – Station 32+70 (October 23, 2019) upstream view from left bank.

Photo 13. Logan Creek Photo Point 7 – Station 32+15 (October 23, 2019) downstream view from bridge.

Photo 14. Logan Creek Photo Point 7 – Station 32+00 (October 23, 2019) upstream view from bridge.

Photo 15. Logan Creek Photo Point 8a – Station 29+75 (October 23, 2019) downstream view from right bank.

Photo 16. Logan Creek Photo Point 8b – Station 29+25 (October 23, 2019) upstream view from right bank.

Photo 17. Logan Creek Photo Point 9 – Station 26+75 (October 23, 2019) downstream view from left bank.

Photo 18. Logan Creek Photo Point 9 – Station 26+75 (October 23, 2019) upstream view from left bank.

Photo 19. Logan Creek Photo Point 10 – Station 25+25 (October 23, 2019) upstream view from right bank.

Photo 20. Logan Creek Photo Point 10 – Station 25+25 (October 23, 2019) downstream view from right bank.

Photo 21. Logan Creek Photo Point 11 – Station 23+20 (October 23, 2019) downstream view from left bank.

Photo 22. Logan Creek Photo Point 11 – Station 23+20 (October 23, 2019) upstream view from left bank.

Photo 23. Logan Creek Photo Point 12 – Station 21+20 (October 23, 2019) downstream view from left bank.

Photo 24. Logan Creek Photo Point 12 – Station 21+20 (October 23, 2019) upstream view from left bank.

Photo 25. UT7 Photo Point 13 – (October 23, 2019) upstream view from left bank.

Photo 26. UT7 Photo Point 13 – (October 23, 2019) downstream view from left bank.

Photo 27. Logan Creek Photo Point 14 – Station 19+45 (October 23, 2019) downstream view from left bank.

Photo 28. Logan Creek Photo Point 14 – Station 19+45 (October 23, 2019) upstream view from left bank.

Photo 29. Logan Creek Photo Point 15 – Station 17+45 (October 23, 2019) downstream view from left bank.

Photo 30. Logan Creek Photo Point 15 – Station 17+45 (October 23, 2019) upstream view from left bank.

Photo 31. UT4 Photo Point 16 – Station 0+40 (October 23, 2019) downstream view from left bank.

Photo 32. UT4 Photo Point 16 – Station 0+40 (October 23, 2019) upstream view from left bank.

Photo 33. Logan Creek Photo Point 17 – Station 15+50 (October 23, 2019) upstream view from right bank.

Photo 34. Logan Creek Photo Point 17 – Station 15+50 (October 23, 2019) downstream view from right bank.

Photo 35. Logan Creek Photo Point 18 – Station 12+90 (October 23, 2019) downstream view from left bank.

Photo 36. Logan Creek Photo Point 18 – Station 12+90 (October 23, 2019) upstream view from left bank.

Photo 37. UT3 Photo Point 19 – Station 00+60 (October 23, 2019) upstream from left bank.

Photo 38. UT3 Photo Point 19 – Station 00+60 (October 23, 2019) downstream from left bank.

Photo 39. UT3 Photo Point 19 – Station 00+60 (October 23, 2019) upstream from left bank to vernal pool.

Intentionally left blank.

Photo 40. Logan Creek Photo Point 20 – Station 10+60 (October 23, 2019) downstream view from left bank.

Photo 41. Logan Creek Photo Point 20 – Station 10+60 (October 23, 2019) upstream view from left bank.

Photo 42. Logan Creek Photo Point 21 – Station 9+40 (October 23, 2019) upstream view from right bank.

Photo 43. Logan Creek Photo Point 21 – Station 9+40 (October 23, 2019) downstream view from right bank.

Photo 44. UT6 Photo Point 22 – Station 0+75 (October 23, 2019) upstream view from right bank.

Photo 45. UT6 Photo Point 22 – Station 0+75 (October 23, 2019) downstream view from right bank.

Photo 46. Logan Creek Photo Point 23 – Station 7+70 (October 23, 2019) downstream view from left bank.

Photo 47. Logan Creek Photo Point 23 – Station 7+70 (October 23, 2019) upstream view from left bank.

Photo 48. Logan Creek, Photo Point 24 – Station 5+70 (October 23, 2019) downstream view from left bank.

Photo 49. Logan Creek, Photo Point 24 – Station 5+70 (October 23, 2019) upstream view from left bank.

Photo 50. UT2, Photo Point 25 – Station 0+65 (October 23, 2019) upstream view from left bank.

Photo 51. UT2, Photo Point 25 – Station 0+65 (October 23, 2019) downstream view from left bank.

Photo 52. Logan Creek, Photo Point 26 – Station 3+80 (October 23, 2019) upstream view from right bank.

Photo 53. Logan Creek, Photo Point 26 – Station 3+80 (October 23, 2019) downstream view from right bank.

Photo 54. Logan Creek, Photo Point 27 – Station 1+12 (October 23, 2019) upstream view from right bank.

Photo 55. Logan Creek, Photo Point 27 – Station 1+12 (October 23, 2019) downstream view from right bank.

Photo 56. UT8, Photo Point 28 – Station 1+10 (October 23, 2019) upstream view from right bank and confluence.

Photo 57. UT1, Photo Point 29 – Station 0+50 (October 23, 2019) view upstream and confluence.

Photo 58. Logan Creek, Photo Point 30 – Station 0+50 (October 23, 2019) upstream view from right bank.

Photo 59. Logan Creek, Photo Point 30 – Station 0+50 (October 23, 2019) downstream view from right bank.

Photo 60. UT5 - Preservation, Photo Point 31 – Station 1+80 (October 23, 2019) downstream view from mid-channel to confluence.

Photo 61. UT5 - Preservation, Photo Point 31 – Station 1+80 (October 23, 2019) upstream view from mid-channel to confluence.

Photo 62. UT5 - Preservation, Photo Point 32 – (October 23, 2019) downstream view from right bank.

Photo 63. UT5 - Preservation, Photo Point 32 – (October 23, 2019) upstream view from right bank.

Table 8. Visual Morphological Stability Assessment
Logan Creek Stream Restoration Project: DMS Project ID No. 92515

Logan Creek, Reach 1 (3,184 LF), Restoration Reach						
Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	18	18	0	100	
	2. Armor stable (e.g. no displacement)?	18	18	0	100	
	3. Facet grades appears stable?	18	18	0	100	
	4. Minimal evidence of embedding/fining?	18	18	0	100	
	5. Length appropriate?	18	18	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	35	35	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	35	35	0	100	
	3. Length appropriate?	35	35	0	100	**100%**
C. Thalweg	1. Upstream of pool (structure) centering? (%)	100	100	0	100	
	2. Downstream of pool (structure) centering? (%)	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	17	19	2	89	
	2. Of those eroding, # w/concomitant point bar formation?	19	19	0	100	
	3. Apparent Rc within spec?	19	19	0	100	
	4. Sufficient floodplain access and relief?	19	19	0	100	**97%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	3,184	3,184	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	3,184	3,184	0	100	**100%**
F. Vanes, Rock/Log Drop Structures*	1. Free of back or arm scour?	24	24	0	100	
	2. Height appropriate?	24	24	0	100	
	3. Angle and geometry appear appropriate?	24	24	0	100	
	4. Free of piping or other structural failures?	24	24	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	24	24	0	100	
	2. Footing stable?	24	24	0	100	**100%**

Logan Creek, Reach 2 (1,038 LF), Enhancement Reach						
Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	10	10	0	100	
	2. Armor stable (e.g. no displacement)?	10	10	0	100	
	3. Facet grades appears stable?	10	10	0	100	
	4. Minimal evidence of embedding/fining?	10	10	0	100	
	5. Length appropriate?	10	10	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	13	13	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	13	13	0	100	
	3. Length appropriate?	13	13	0	100	**100%**
C. Thalweg	1. Upstream of pool (structure) centering? (%)	100	100	0	100	
	2. Downstream of pool (structure) centering? (%)	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	5	5	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	5	5	0	100	
	3. Apparent Rc within spec?	5	5	0	100	
	4. Sufficient floodplain access and relief?	5	5	0	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	1,038	1,038	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	1,038	1,038	0	100	**100%**
F. Vanes, Rock/Log Drop Structures*	1. Free of back or arm scour?	11	11	0	100	
	2. Height appropriate?	11	11	0	100	
	3. Angle and geometry appear appropriate?	11	11	0	100	
	4. Free of piping or other structural failures?	11	11	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	0	0	0		
	2. Footing stable?	0	0	0		

* Note: Most structures in Reach 2 were designed to have water go under them during low water, in order to move sand through the reach.

Table 8. Visual Morphological Stability Assessment - Continued
Logan Creek Stream Restoration Project: DMS Project ID No. 92515

UT3 (178 LF)						
Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	3	3	0	100	
	2. Armor stable (e.g. no displacement)?	3	3	0	100	
	3. Facet grades appears stable?	3	3	0	100	
	4. Minimal evidence of embedding/fining?	3	3	0	100	
	5. Length appropriate?	3	3	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	3	3	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	3	3	0	100	
	3. Length appropriate?	3	3	0	100	**100%**
C. Thalweg[1]	1. Upstream of pool (structure) centering? (%)	100	100	0	100	
	2. Downstream of pool (structure) centering? (%)	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	0	0			
	2. Of those eroding, # w/concomitant point bar formation?	0	0			
	3. Apparent Rc within spec?	0	0			
	4. Sufficient floodplain access and relief?	0	0			
E. Bed General	1. General channel bed aggradation areas (bar formation)	178	178	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	178	178	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	4	4	0	100	
	2. Height appropriate?	4	4	0	100	
	3. Angle and geometry appear appropriate?	4	4	0	100	
	4. Free of piping or other structural failures?	4	4	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	0	0			
	2. Footing stable?	0	0			

UT6, (127 LF)						
Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	3	3	0	100	
	2. Armor stable (e.g. no displacement)?	3	3	0	100	
	3. Facet grades appears stable?	3	3	0	100	
	4. Minimal evidence of embedding/fining?	3	3	0	100	
	5. Length appropriate?	3	3	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	2	2	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	2	2	0	100	
	3. Length appropriate?	2	2	0	100	**100%**
C. Thalweg	1. Upstream of pool (structure) centering? (%)	100	100	0	100	
	2. Downstream of pool (structure) centering? (%)	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	N/A	N/A	N/A	100	
	2. Of those eroding, # w/concomitant point bar formation?	N/A	N/A	N/A	100	
	3. Apparent Rc within spec?	N/A	N/A	N/A	100	
	4. Sufficient floodplain access and relief?	N/A	N/A	N/A	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	127	127	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	127	127	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	2	2	0	100	
	2. Height appropriate?	2	2	0	100	
	3. Angle and geometry appear appropriate?	2	2	0	100	
	4. Free of piping or other structural failures?	2	2	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**N/A**

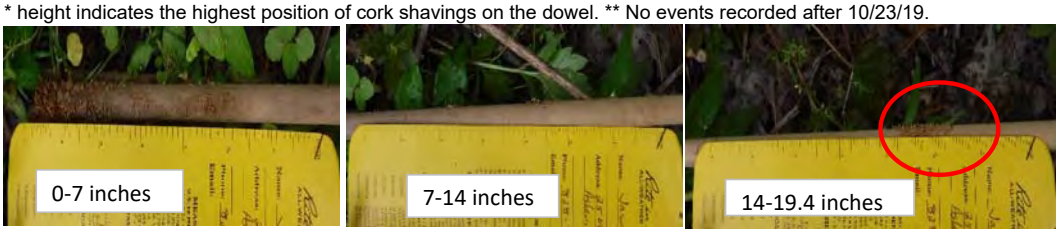
Table 8. Visual Morphological Stability Assessment - Continued
Logan Creek Stream Restoration Project: DMS Project ID No. 92515

UT8, (45 LF)						
Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	1	1	0	100	
	2. Armor stable (e.g. no displacement)?	1	1	0	100	
	3. Facet grades appears stable?	1	1	0	100	
	4. Minimal evidence of embedding/fining?	1	1	0	100	
	5. Length appropriate?	1	1	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	0	0	0		
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	0	0	0		
	3. Length appropriate?	0	0	0		
C. Thalweg	1. Upstream of pool (structure) centering? (%)	100	100	0	100	
	2. Downstream of pool (structure) centering? (%)	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	N/A	N/A	N/A	100	
	2. Of those eroding, # w/concomitant point bar formation?	N/A	N/A	N/A	100	
	3. Apparent Rc within spec?	N/A	N/A	N/A	100	
	4. Sufficient floodplain access and relief?	N/A	N/A	N/A	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	45	45	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	45	45	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	1	1	0	100	
	2. Height appropriate?	1	1	0	100	
	3. Angle and geometry appear appropriate?	1	1	0	100	
	4. Free of piping or other structural failures?	1	1	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**N/A**

Table 9. Verification of Bankfull or Greater than Bankfull Events
Logan Creek Stream Restoration Project: DMS Project ID No. 92515

Year	Date of Data Collection	Date of Event	Method of Data Collection	Gauge Watermark Height (inches)*
				Logan Creek Station 30+00
MY1	None	No events	N\A	0
MY2	3/18/2016	2 events: 1 in Dec-15 and 1 in Jan-16.	Crest Gauge	25.75
	8/17/2016	undetermined	Crest Gauge	1.56
MY3	10/26/2017	Between 7/26/2017 and 10/26/2017	Crest Gauge, Photographs	26.04
	10/26/2017	10/23/2017	Crest Gauge, Photographs	17.4
MY4	3/16/2018	Between 10/26/2017 and 3/16/2018	Crest Gauge	12.84
	6/12/2018**	Between 3/16/2018 and 6/12/2018	Crest Gauge, Photographs	11.88
MY5	5/7/2019	Between 6/12/18 and 5/7/19	Crest Gauge	19.4
	8/8/2019	Between 5/7/19 and 8/8/19	Crest Gauge	5.2
	10/23/2019	Between 8/8/19 and 10/23/19	Crest Gauge	1.5

* height indicates the highest position of cork shavings on the dowel. ** No events recorded after 10/23/19.



Crest Gauge reading taken on 5/7/2019 shows a distinct high flow event at 19.4 inches. Reading was taken with three consecutive measurements.

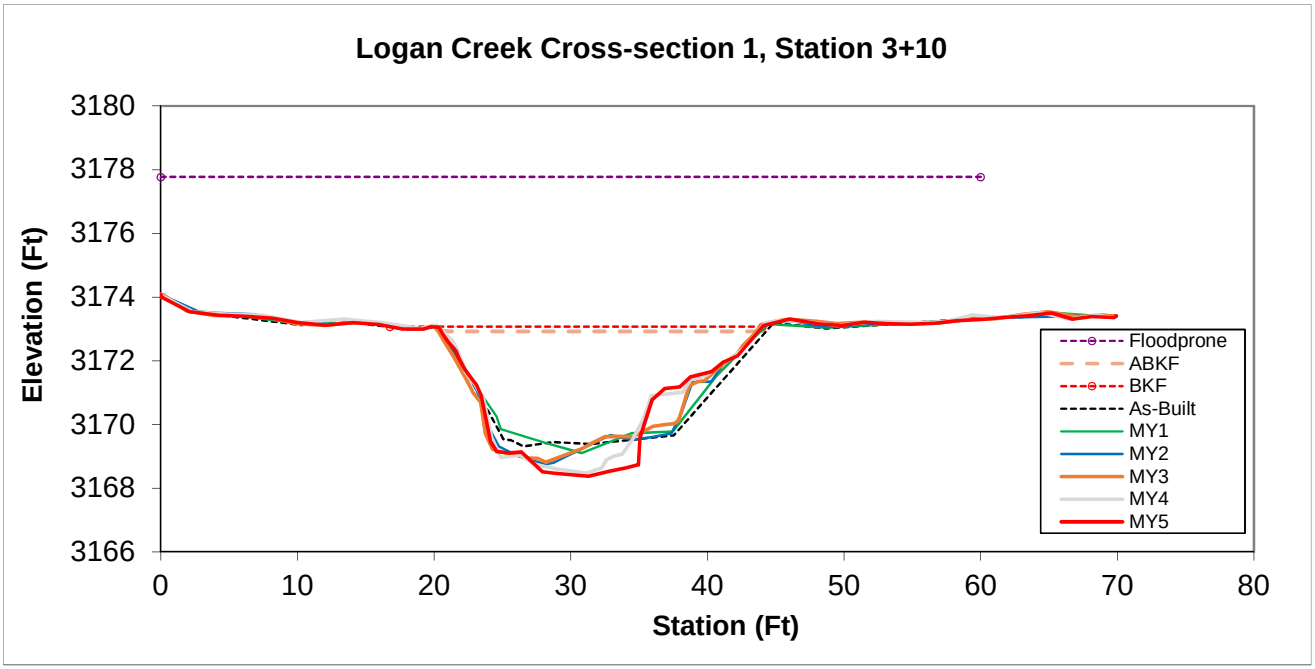
Crest gauge reading takenon 8/8/19 shows a distinct high flow event at 5.2 inches.

Crest gauge reading taken on 10/23/19 shows a high flow event at 1.5 inches.

Figure 6. Cross-Sections with Annual Overlays

Permanent Cross-Section 1
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	E	66.72	27.27	2.45	4.70	11.13	1.03	2.56	3173.07	3173.07	4.70



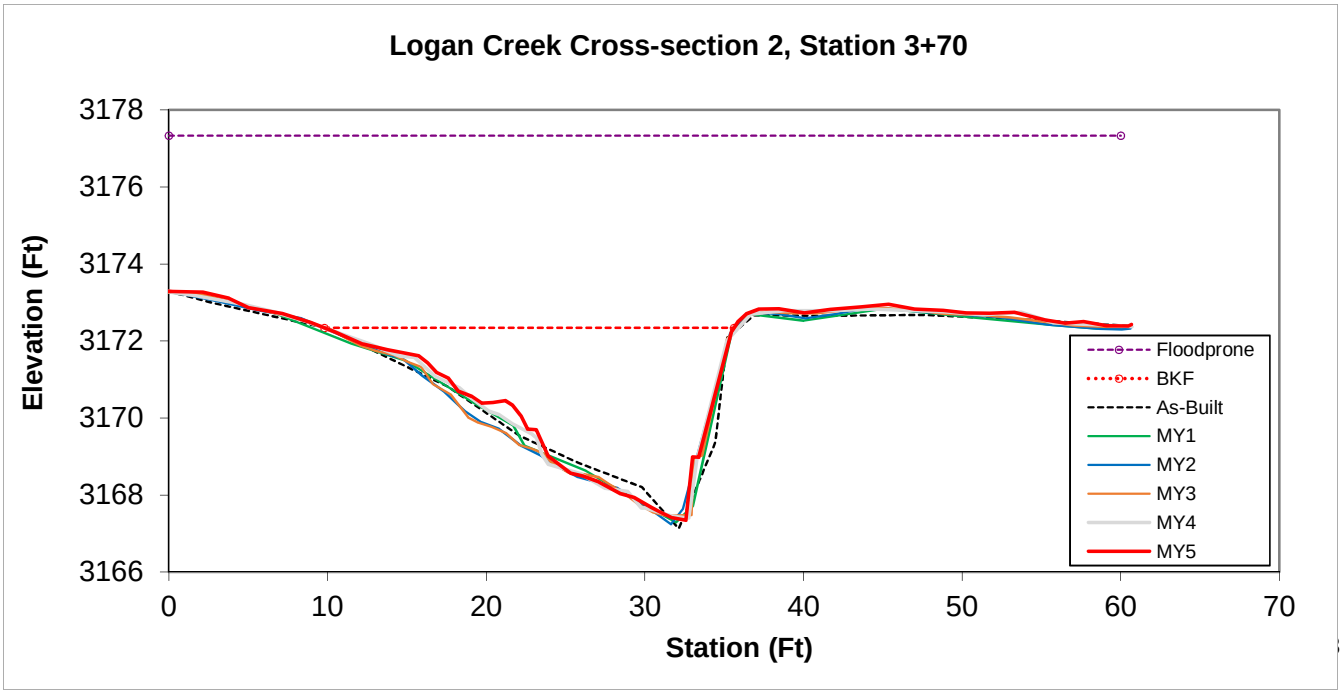
Looking at the Left Bank

Looking at the Right Bank

Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-Section 2
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	61.17	25.81	2.37	4.99	10.89		2.35	3172.34	3172.83	5.42



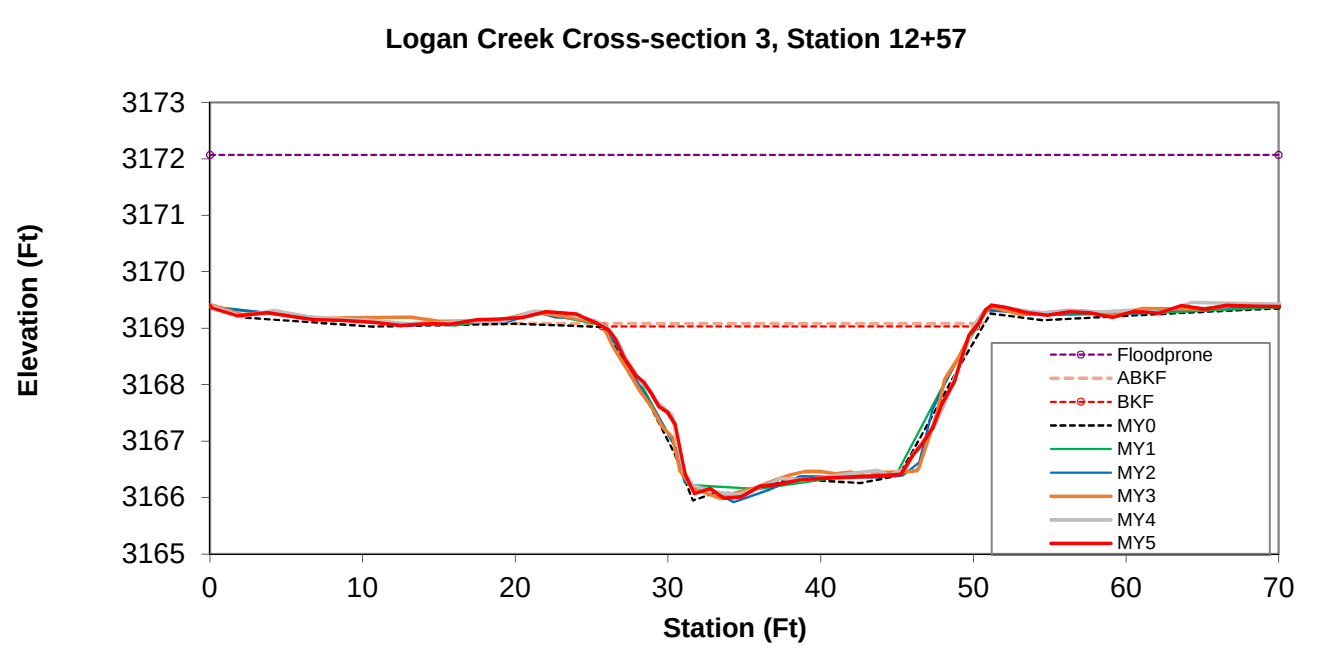
Looking at the Left Bank

Looking at the Right Bank

Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-Section 3
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	E	51.95	24.47	2.12	3.04	11.54	1.06	4.06	3169.03	3169.25	3.26



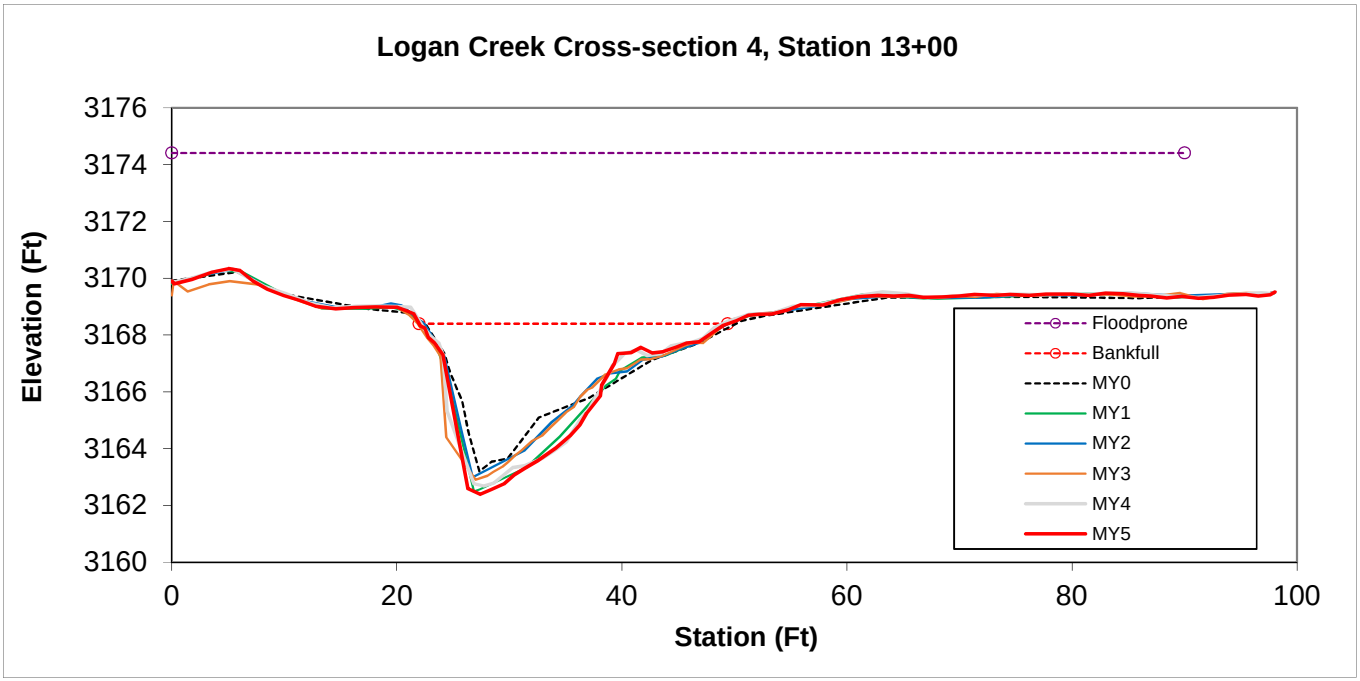
Looking at the Left Bank

Looking at the Right Bank

Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-Section 4
(MY5Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	E	74.43	27.41	2.72	6.01	10.08		3.58	3168.40	3168.98	6.59



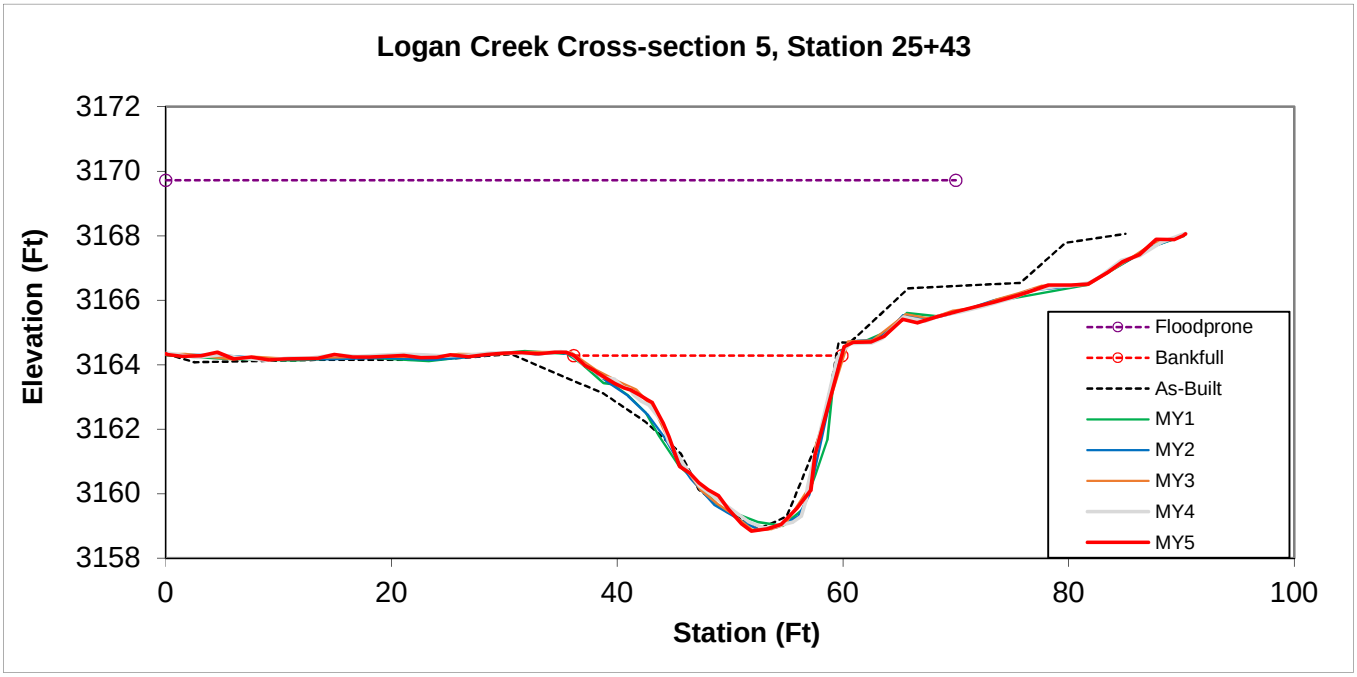
Looking at the Left Bank

Looking at the Right Bank

Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-Section 5
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	70.73	23.75	2.98	5.44	7.97		3.80	3164.28	3164.38	5.54



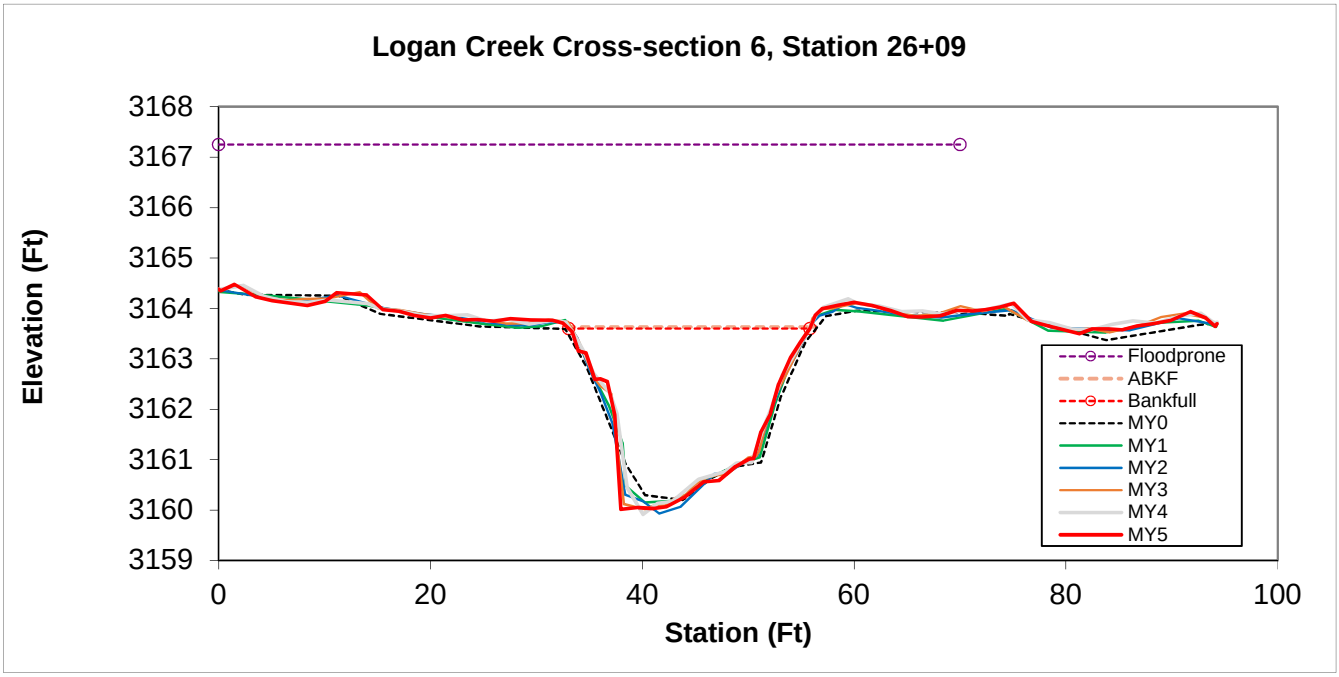
Looking at the Left Bank

Looking at the Right Bank

Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-Section 6
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	E	50.96	22.77	2.24	3.59	10.17	1.01	4.14	3163.6	3163.71	3.658



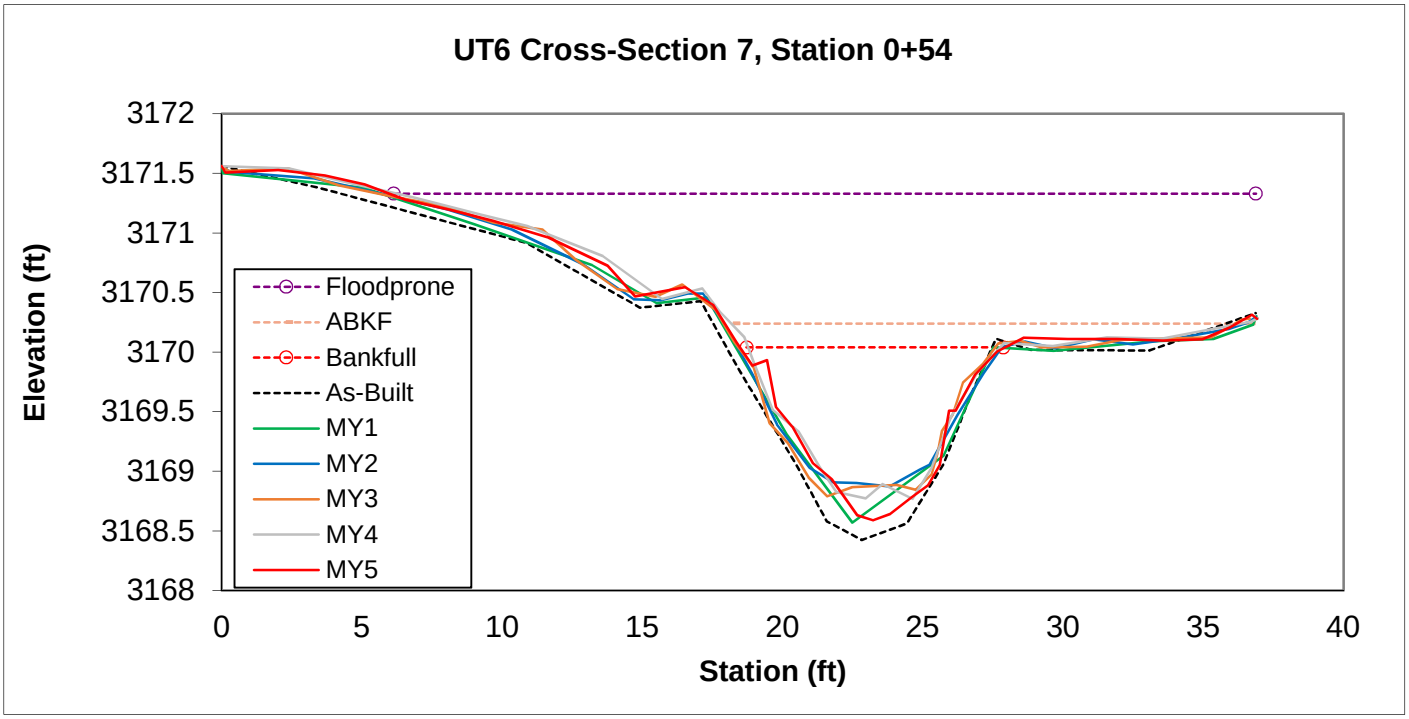
Looking at the Left Bank

Looking at the Right Bank

Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 7
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	7.57	9.45	0.8	1.45	11.81		3.56	3170.04	3170.12	1.53



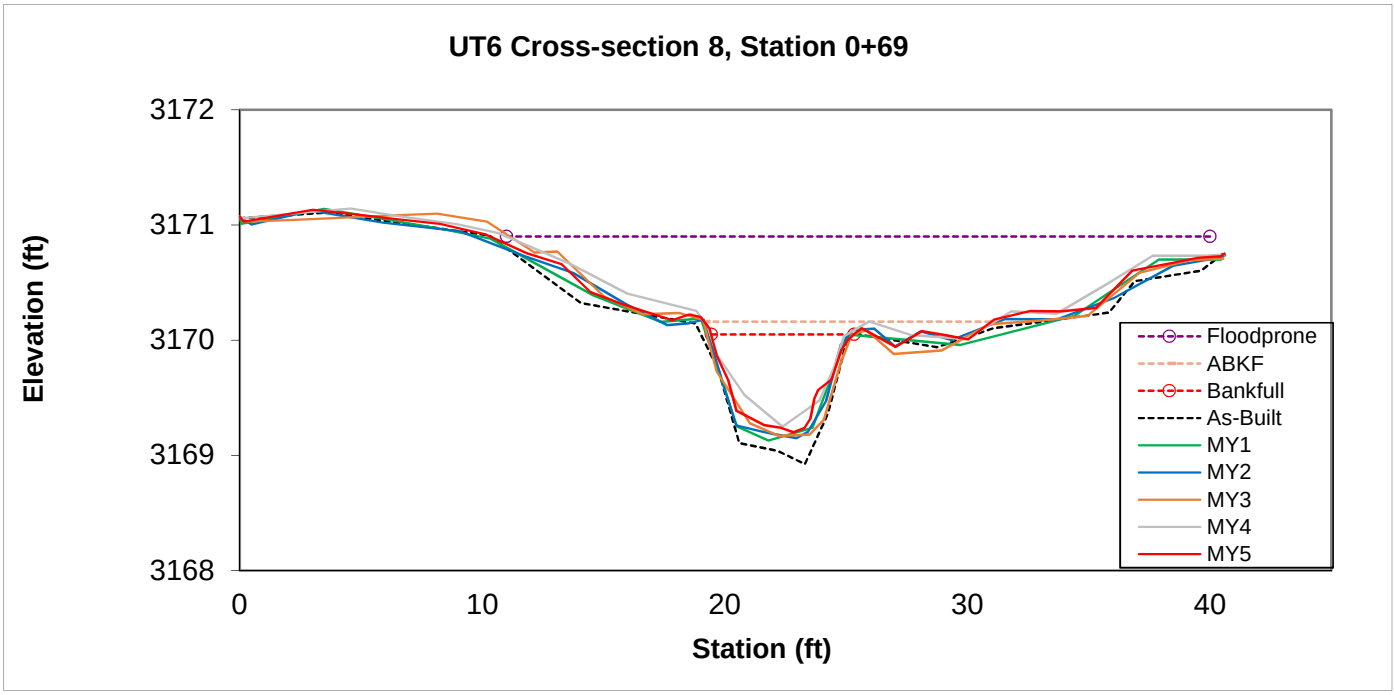
Looking at the Left Bank

Looking at the Right Bank

Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 8
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	E	3.28	5.89	0.56	0.85	10.52	0.94	5.14	3170.05	3170.10	0.90



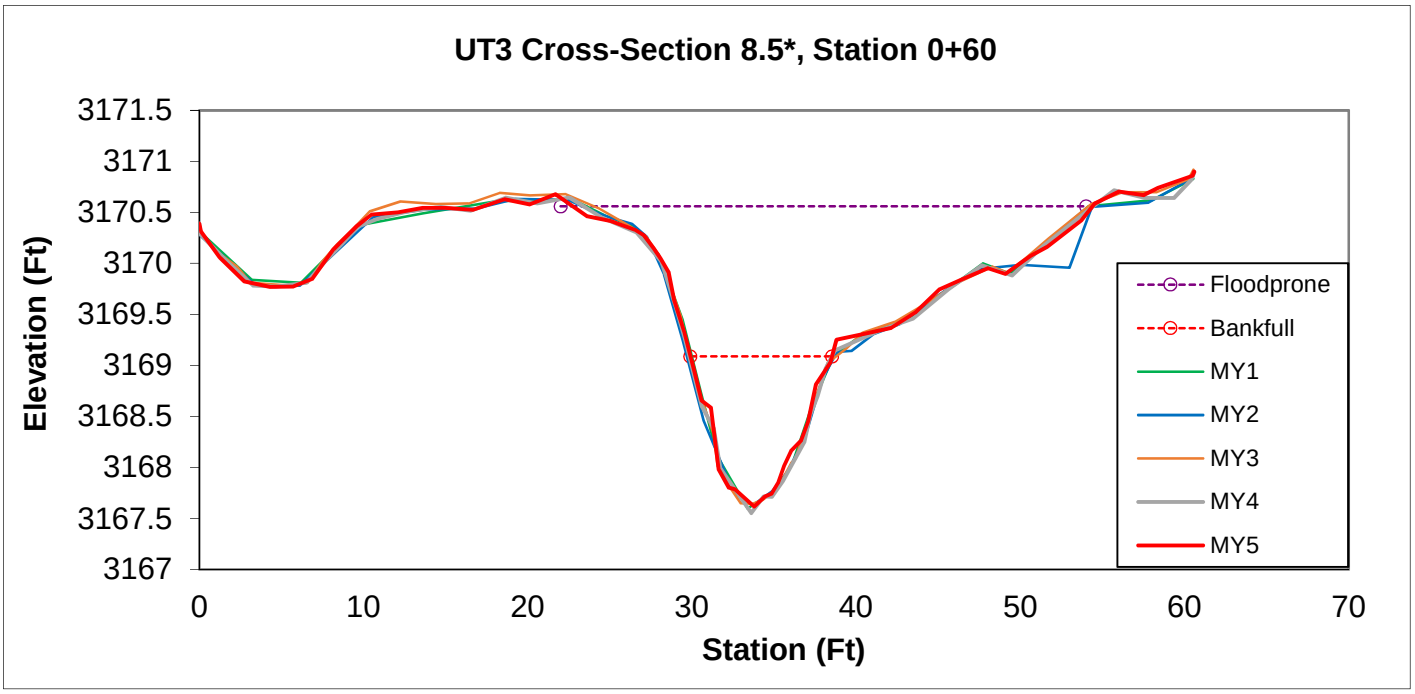
Looking at the Left Bank

Looking at the Right Bank

Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 8.5
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	7.69	8.63	0.89	1.47	9.7		5.68	3169.09	3170.27	2.65



Looking at the Left Bank

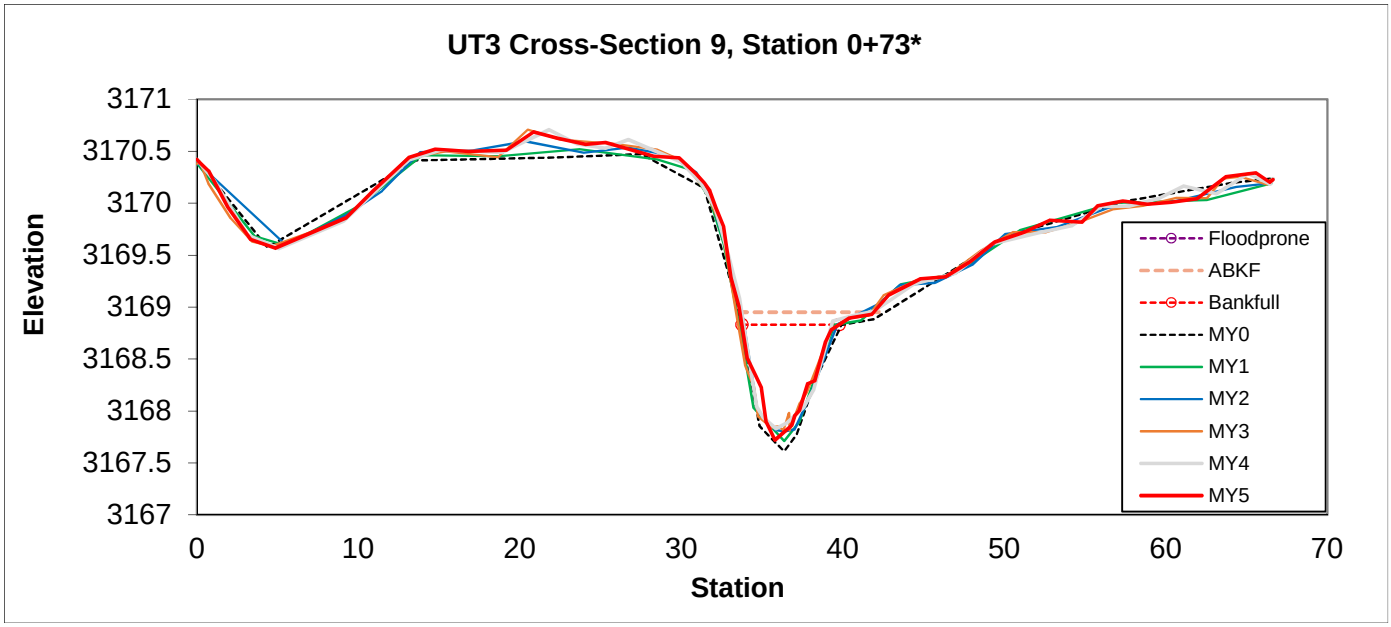
Looking at the Right Bank

* This Pool cross-section was not taken for the baseline but was added during MY1 survey and will be continued each year going forward.

Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 9
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	E	3.63	6.02	0.6	1.11	10.03	0.8626	5.18	3168.83	3168.78	1.06



Looking at the Left Bank

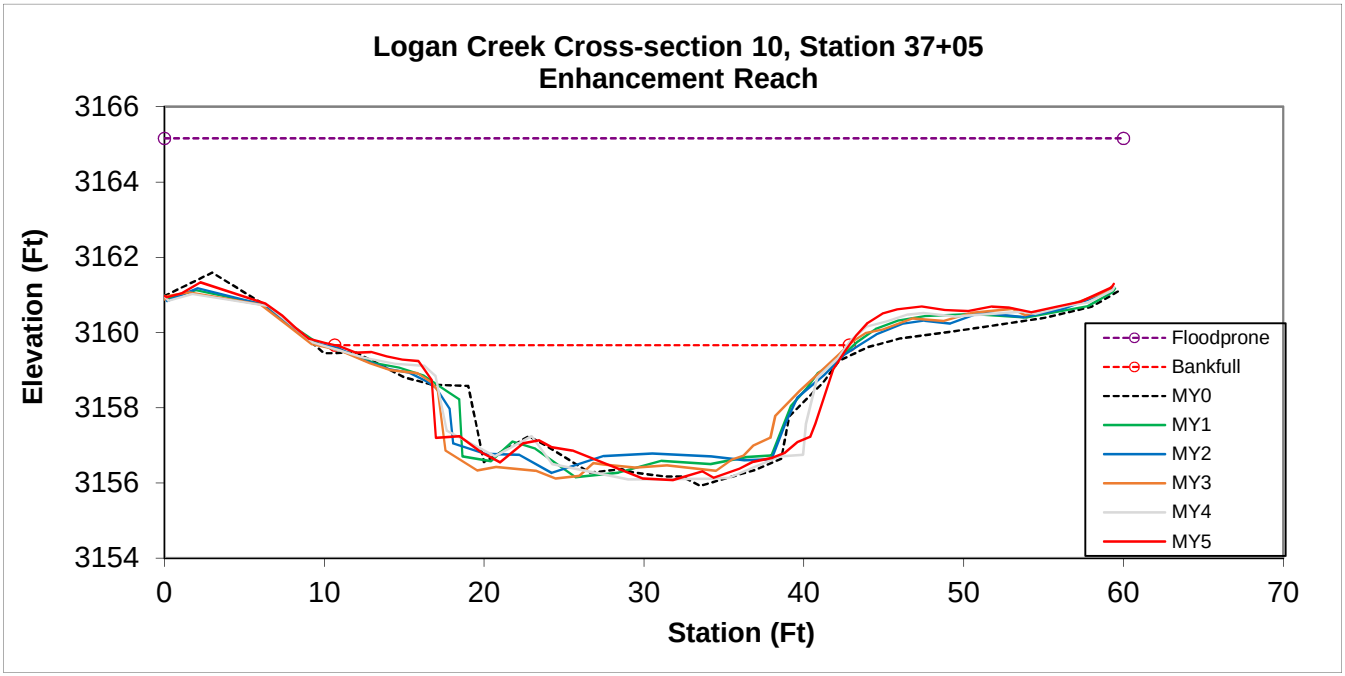
Looking at the Right Bank

* The stationing shown on this cross section plot has been changed to correct an error shown in the MY0 plots.

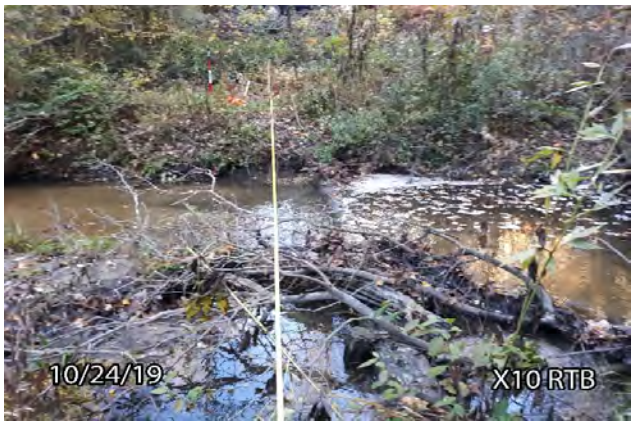
Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 10
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	75.71	32.18	2.35	3.59	13.69		1.85	3159.66	3160.614	4.54



Looking at the Left Bank

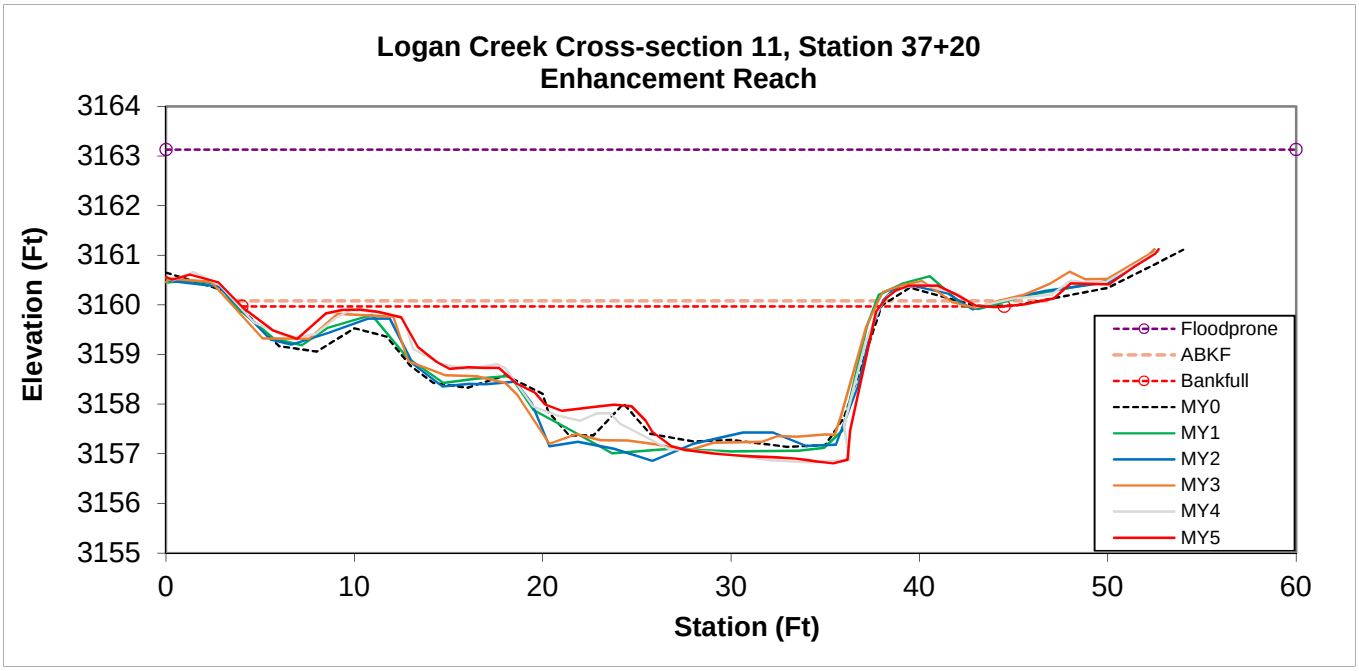


Looking at the Right Bank

Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 11
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	B	56.53	34.98	1.62	3.16	21.59	1.13	1.51	3159.97	3160.39	3.58



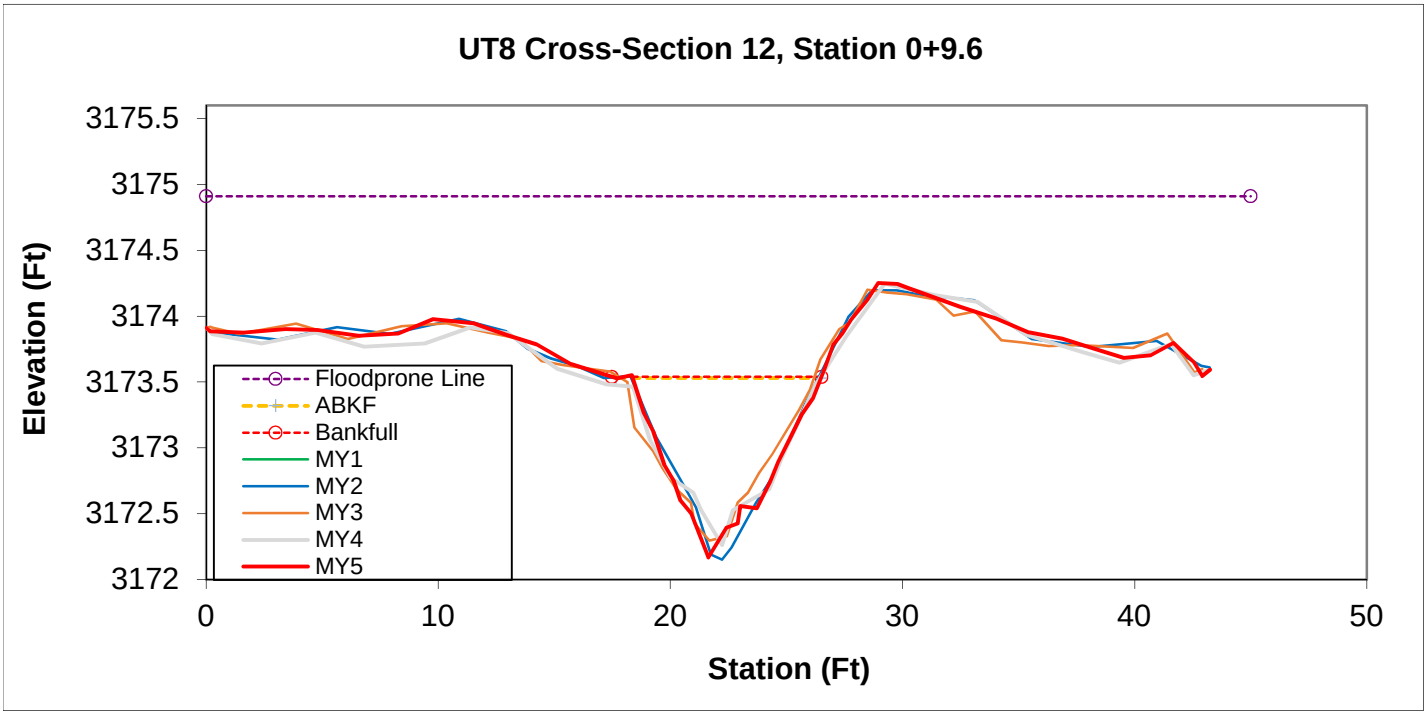
Looking at the Left Bank

Looking at the Right Bank

Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 12
(MY5 Data - collected October, 2019)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	E	6.09	8.69	0.7	1.37	12.41	1.0169	4.97	3173.54	3173.55	1.38

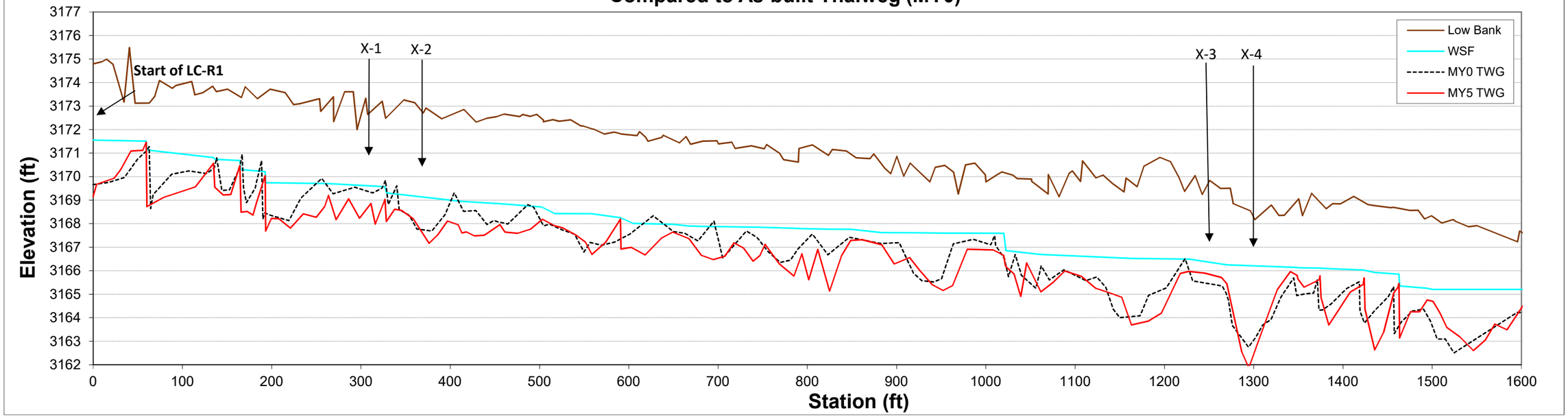


Looking at the Left Bank

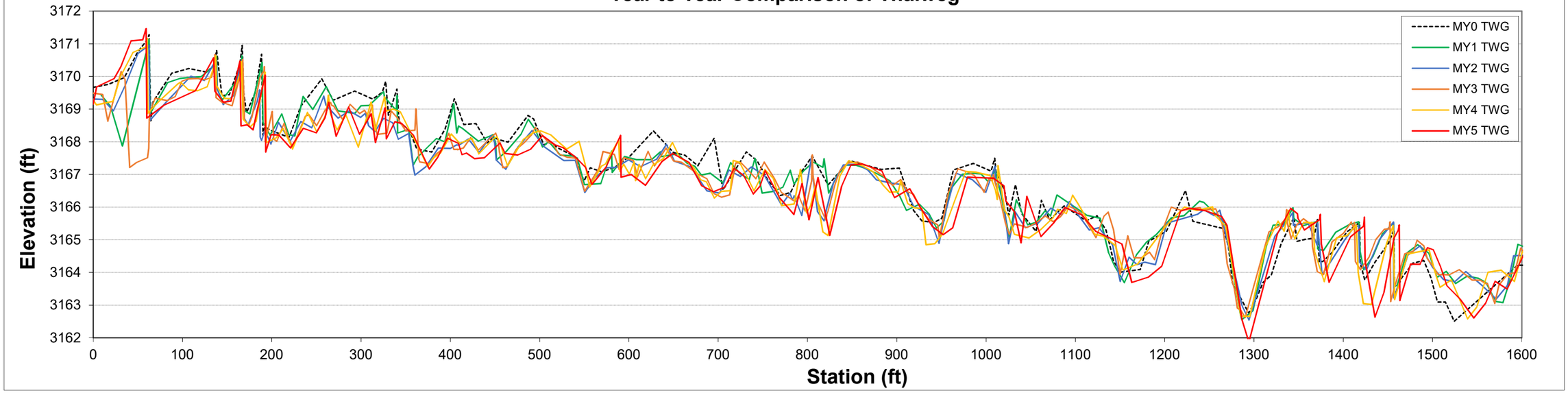
Looking at the Right Bank

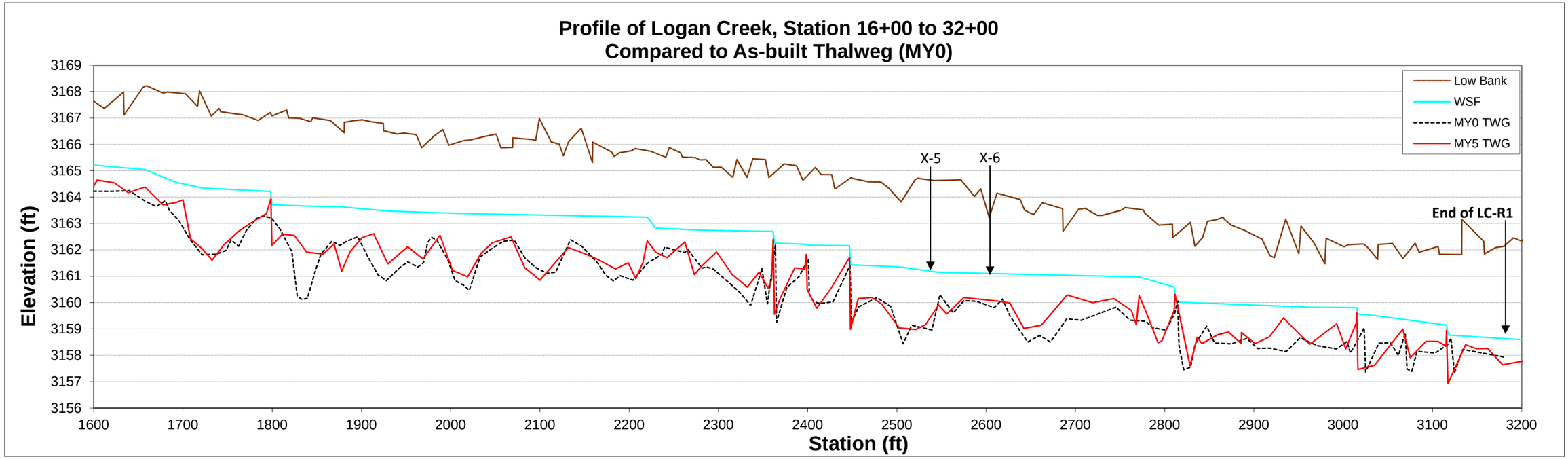
*This Riffle cross-section was not taken during AB or MY1 surveys but was added in MY2 and will be continued each year going forward.
Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

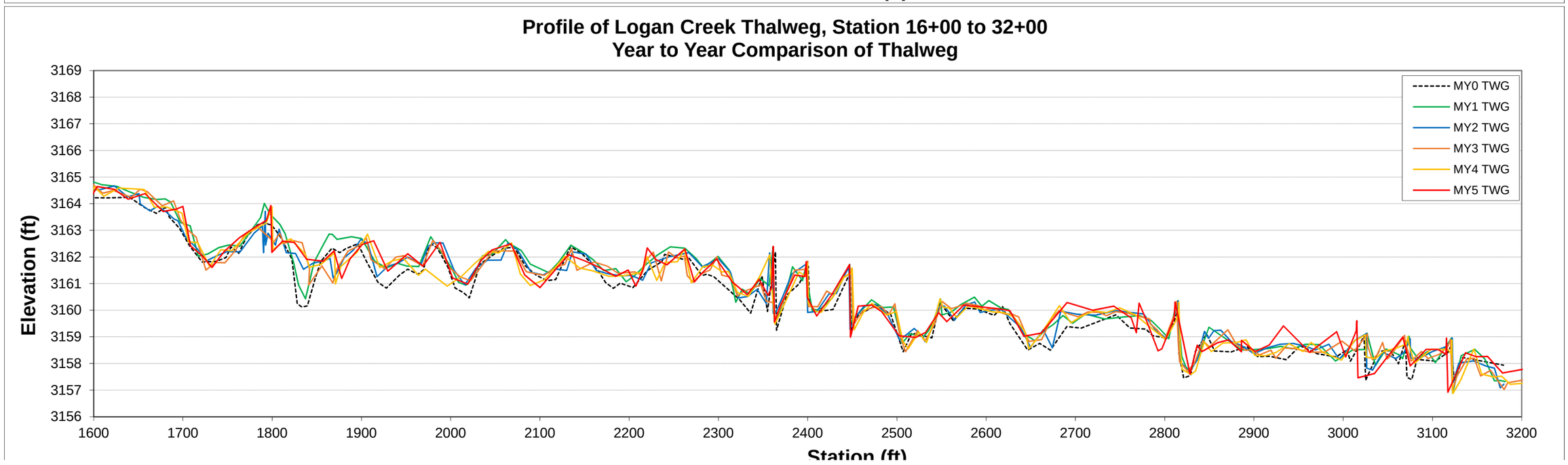
Profile of Logan Creek, Station 0+00 to 16+00, Compared to As-built Thalweg (MY0)



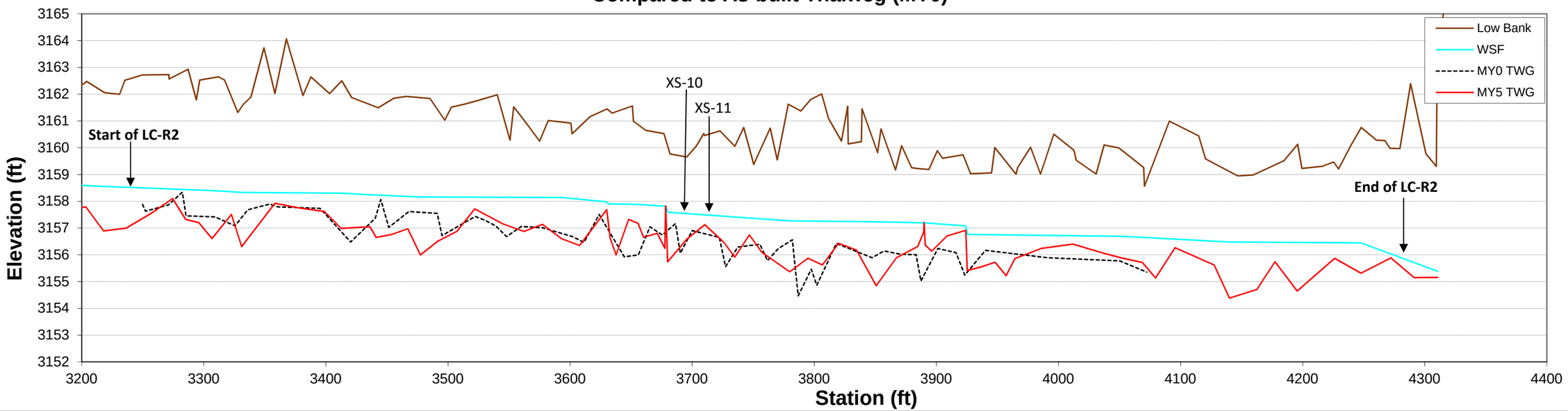
Profile of Logan Creek Thalweg, Station 0+00 to 16+00, Year to Year Comparison of Thalweg



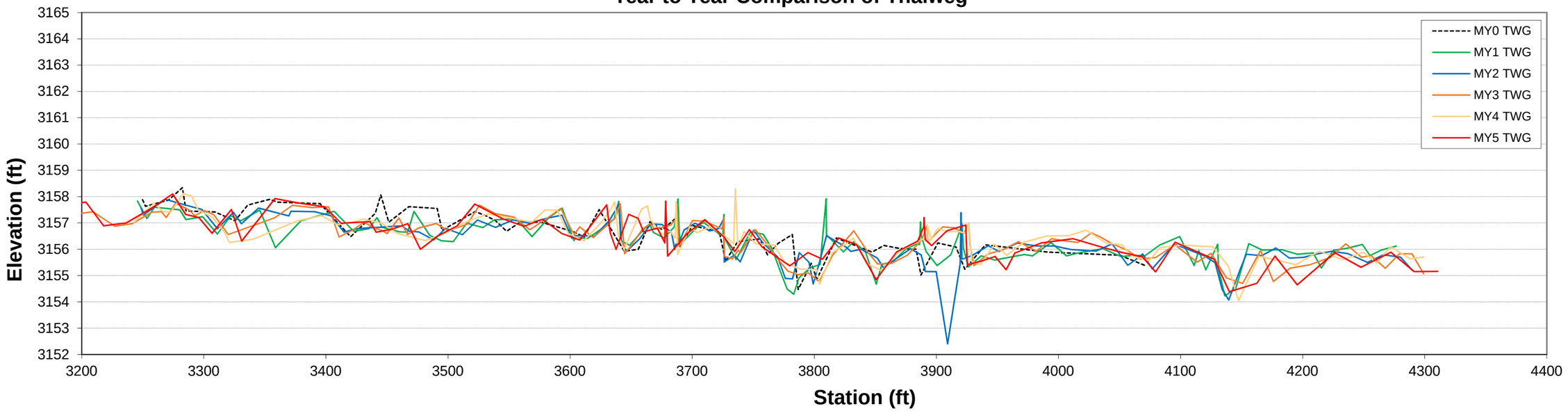

Profile of Logan Creek, Station 16+00 to 32+00
Compared to As-built Thalweg (MY0)
Elevation (ft)
Station (ft)
Low Bank
WSF
MY0 TWG
MY5 TWG
X-5
X-6
End of LC-R1
3169
3168
3167
3166
3165
3164
3163
3162
3161
3160
3159
3158
3157
3156
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
3100
3200

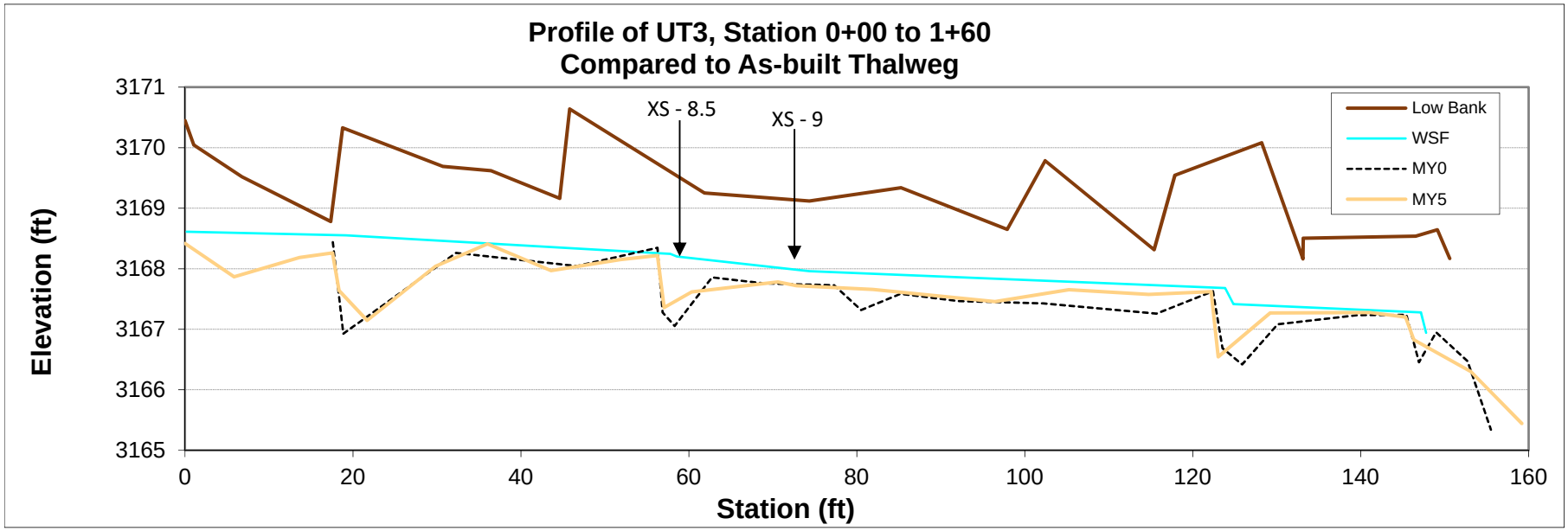

Profile of Logan Creek Thalweg, Station 16+00 to 32+00
Year to Year Comparison of Thalweg
Elevation (ft)
Station (ft)
MY0 TWG
MY1 TWG
MY2 TWG
MY3 TWG
MY4 TWG
MY5 TWG
3169
3168
3167
3166
3165
3164
3163
3162
3161
3160
3159
3158
3157
3156
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
3100
3200

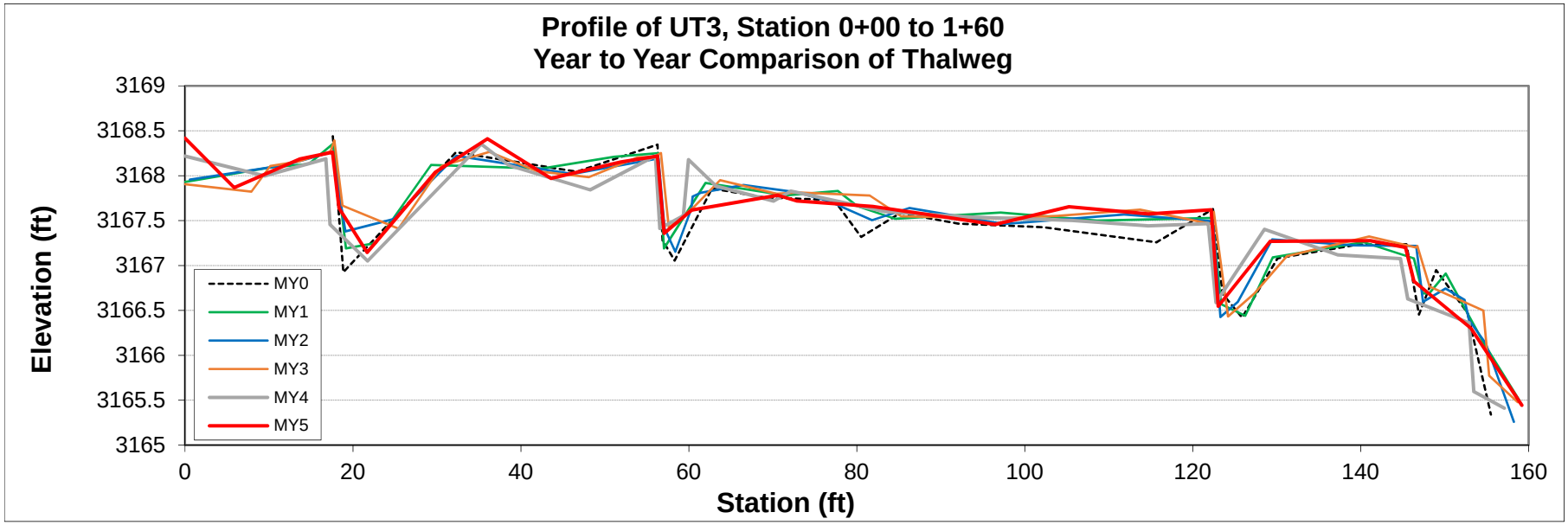
Profile of Logan Creek, Station 32+43 to 42+81
Compared to As-built Thalweg (MY0)

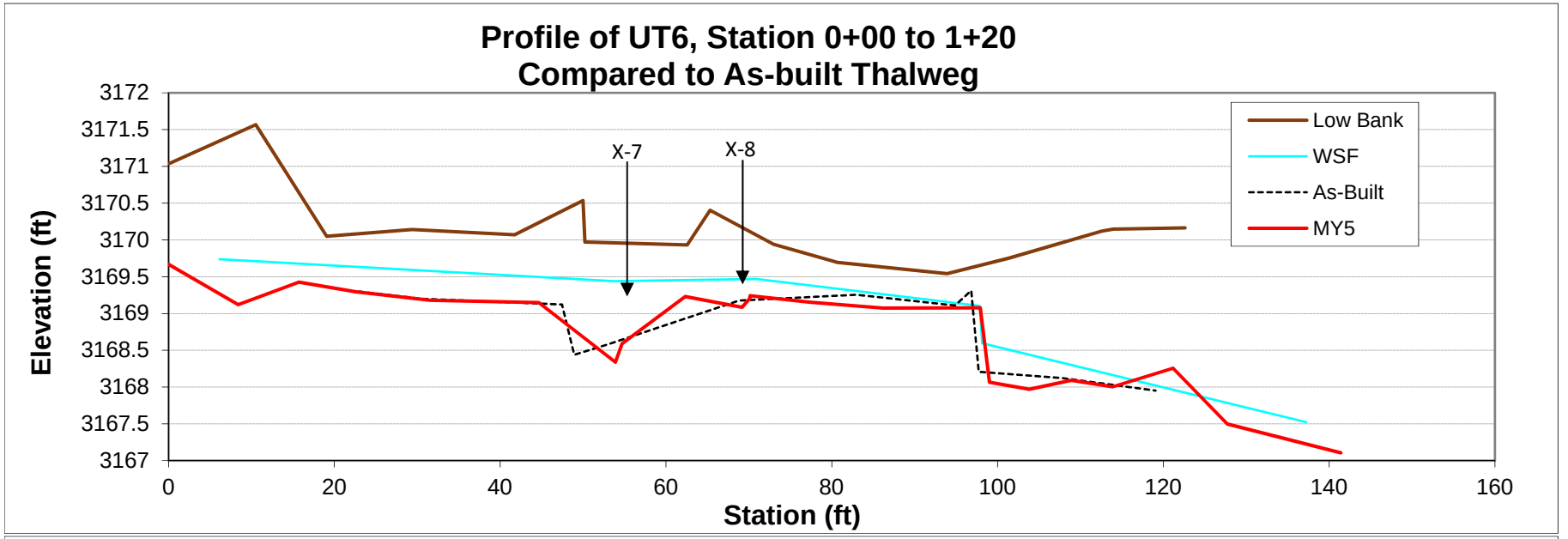


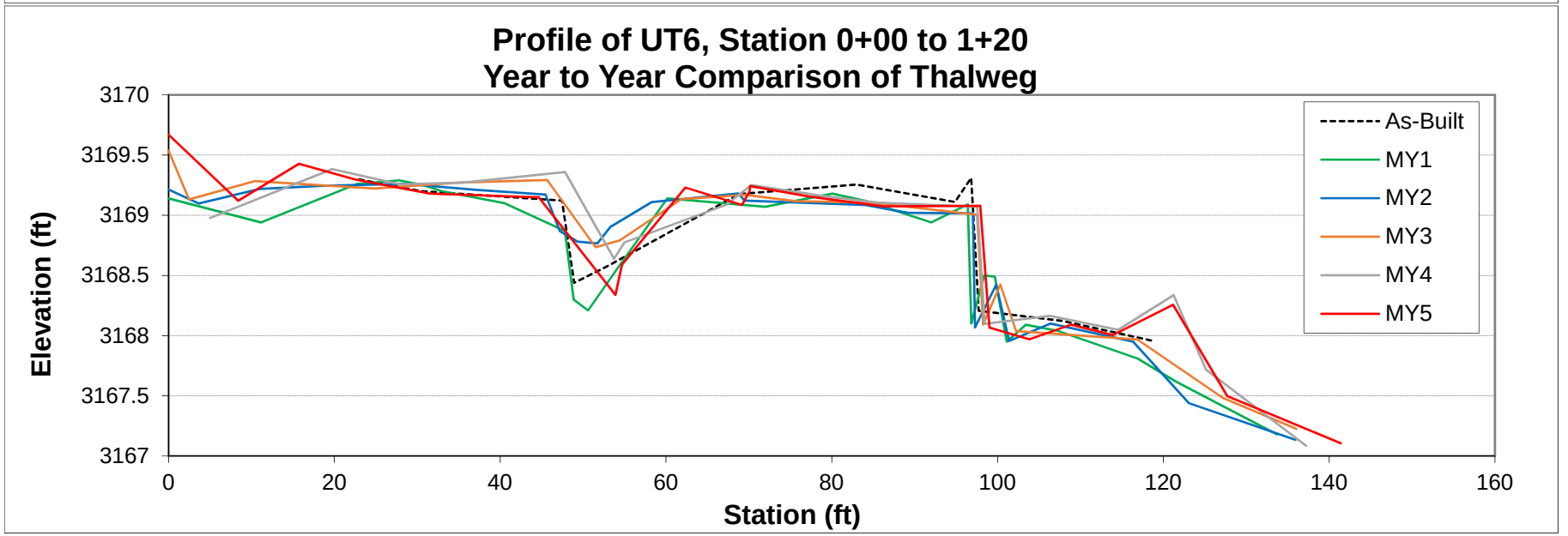
Profile of Logan Creek Thalweg, Station 32+43 to 42+81
Year to Year Comparison of Thalweg

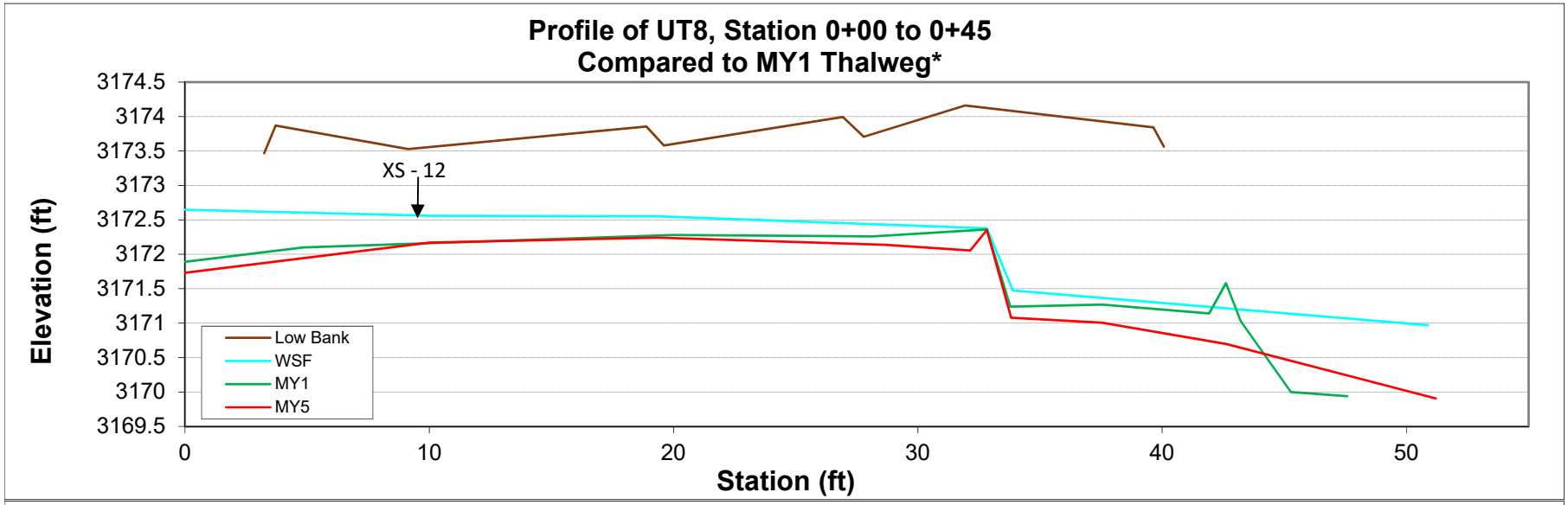


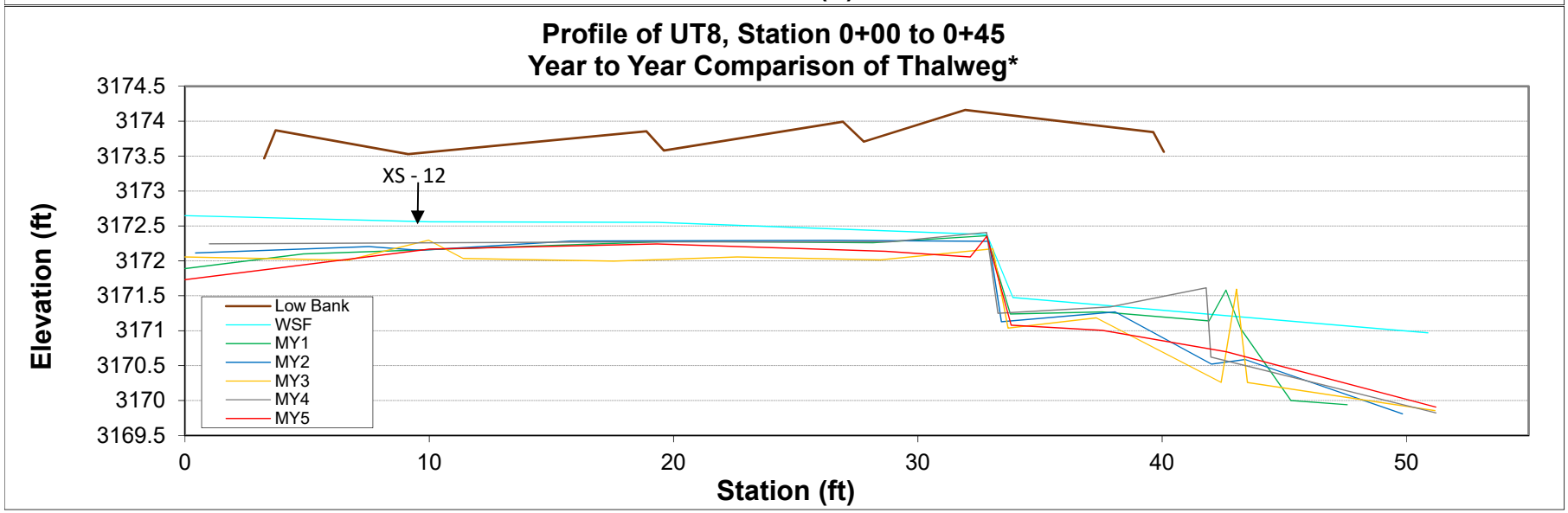

Profile of UT3, Station 0+00 to 1+60
Compared to As-built Thalweg
Elevation (ft)
Station (ft)
XS - 8.5
XS - 9
Low Bank
WSF
MY0
MY5
3171
3170
3169
3168
3167
3166
3165
0
20
40
60
80
100
120
140
160


Profile of UT3, Station 0+00 to 1+60
Year to Year Comparison of Thalweg
Elevation (ft)
Station (ft)
MY0
MY1
MY2
MY3
MY4
MY5
3169
3168.5
3168
3167.5
3167
3166.5
3166
3165.5
3165
0
20
40
60
80
100
120
140
160


Profile of UT6, Station 0+00 to 1+20
Compared to As-built Thalweg
Elevation (ft)
3172
3171.5
3171
3170.5
3170
3169.5
3169
3168.5
3168
3167.5
3167
X-7
X-8
Low Bank
WSF
As-Built
MY5
0
20
40
60
80
100
120
140
160
Station (ft)


Profile of UT6, Station 0+00 to 1+20
Year to Year Comparison of Thalweg
Elevation (ft)
3170
3169.5
3169
3168.5
3168
3167.5
3167
As-Built
MY1
MY2
MY3
MY4
MY5
0
20
40
60
80
100
120
140
160
Station (ft)





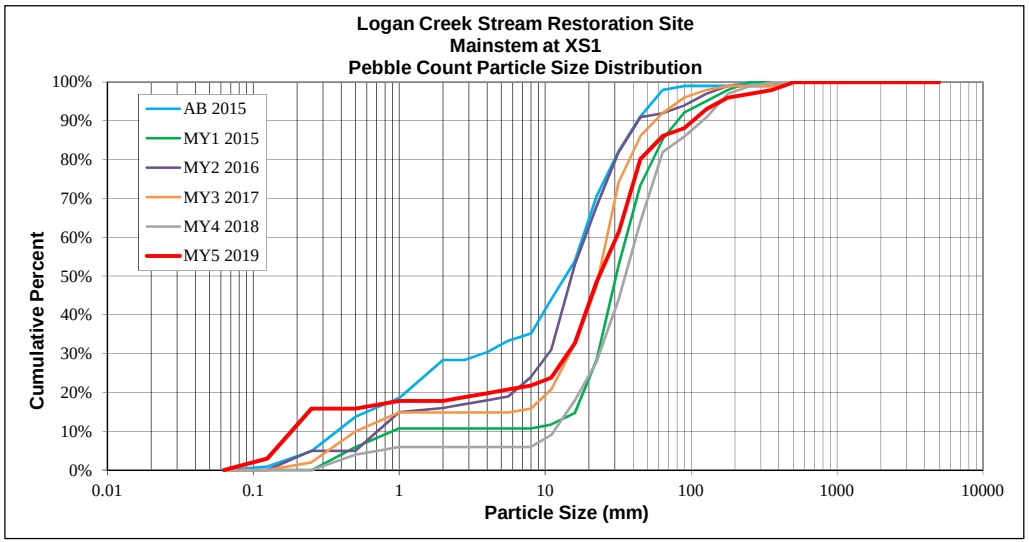
* Note: This profile was added in MY1 because restoration credit is being requested for this reach. However, the profile on this reach was not surveyed and included in the MY0 report.

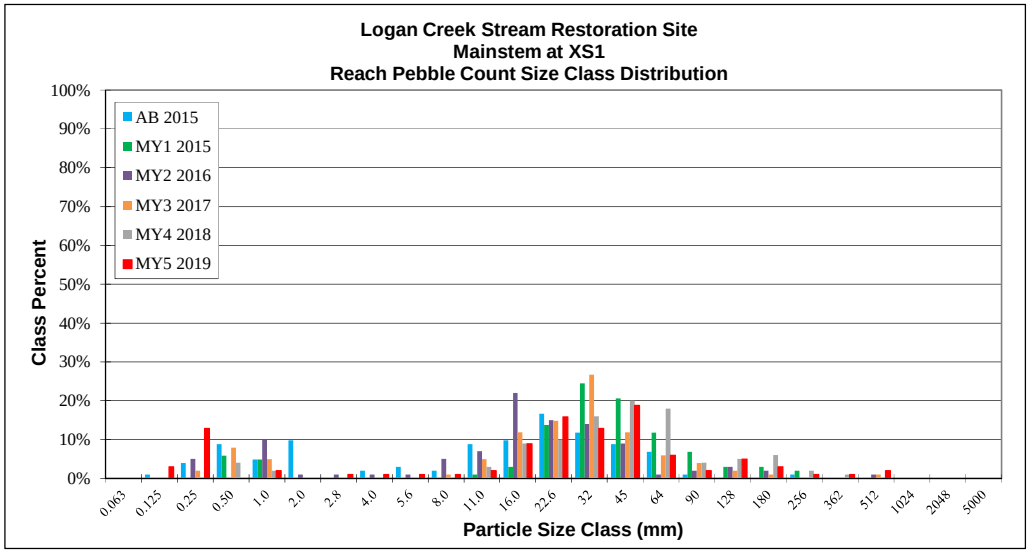
Cross-Section Pebble Count; Monitoring Year 5
Logan Creek Mitigation Project, DMS #92515

SITE OR PROJECT:	Logan Cr
REACH/LOCATION:	Riffle at XS1
FEATURE:	Riffle
DATE:	23-Oct-19

			MY5 2019			Distribution
MATERIAL	**PARTICLE**	**SIZE (mm)**	**Total**	**Class %**	**% Cum**	**Plot Size (mm)**
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125	3	3%	3%	0.125
	Fine	.125 - .25	13	13%	16%	0.25
	Medium	.25 - .50			16%	0.50
	Coarse	.50 - 1.0	2	2%	18%	1.0
	Very Coarse	1.0 - 2.0			18%	2.0
Gravel	Very Fine	2.0 - 2.8	1	1%	19%	2.8
	Very Fine	2.8 - 4.0	1	1%	20%	4.0
	Fine	4.0 - 5.6	1	1%	21%	5.6
	Fine	5.6 - 8.0	1	1%	22%	8.0
	Medium	8.0 - 11.0	2	2%	24%	11.0
	Medium	11.0 - 16.0	9	9%	33%	16.0
	Coarse	16 - 22.6	16	16%	49%	22.6
	Coarse	22.6 - 32	13	13%	61%	32
	Very Coarse	32 - 45	19	19%	80%	45
	Very Coarse	45 - 64	6	6%	86%	64
Cobble	Small	64 - 90	2	2%	88%	90
	Small	90 - 128	5	5%	93%	128
	Large	128 - 180	3	3%	96%	180
	Large	180 - 256	1	1%	97%	256
Boulder	Small	256 - 362	1	1%	98%	362
	Small	362 - 512	2	2%	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 =	0.5	D84 =	56.4
D35 =	16.8	D95 =	159.8
D50 =	23.5	D100 =	362 - 512



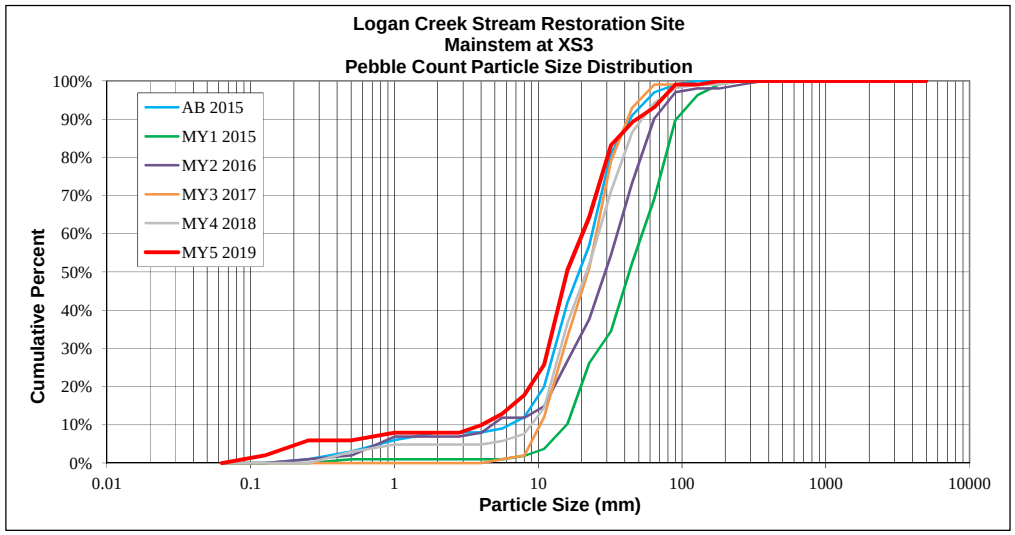


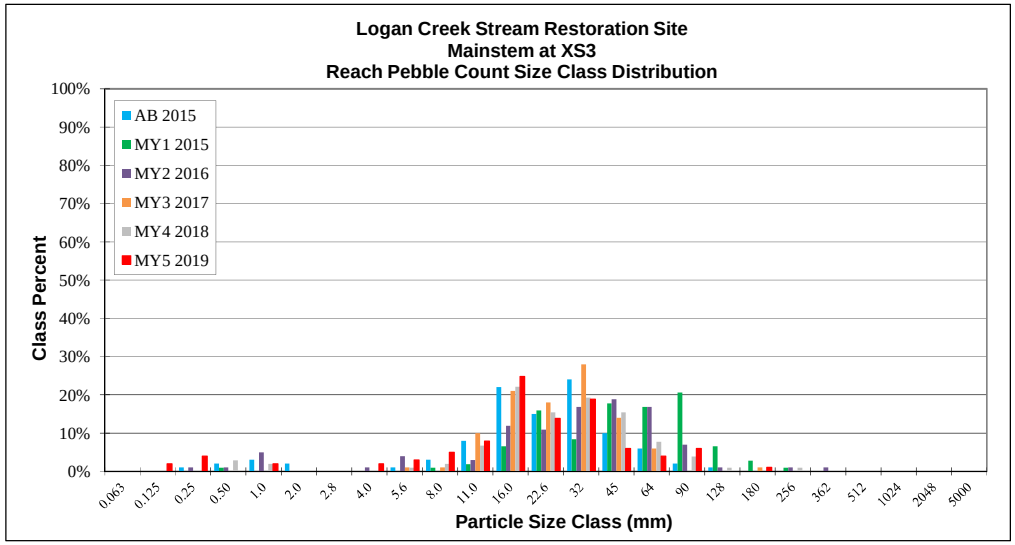
Cross-Section Pebble Count; Monitoring Year 5
Logan Creek Mitigation Project, DMS #92515

SITE OR PROJECT:	Logan Cr
REACH/LOCATION:	Riffle at XS3
FEATURE:	Riffle
DATE:	23-Oct-19

			MY5 2019			Distribution
MATERIAL	**PARTICLE**	**SIZE (mm)**	**Total**	**Class %**	**% Cum**	**Plot Size (mm)**
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125	2	2%	2%	0.125
	Fine	.125 - .25	4	4%	6%	0.25
	Medium	.25 - .50			6%	0.50
	Coarse	.50 - 1.0	2	2%	8%	1.0
	Very Coarse	1.0 - 2.0			8%	2.0
Gravel	Very Fine	2.0 - 2.8			8%	2.8
	Very Fine	2.8 - 4.0	2	2%	10%	4.0
	Fine	4.0 - 5.6	3	3%	13%	5.6
	Fine	5.6 - 8.0	5	5%	18%	8.0
	Medium	8.0 - 11.0	8	8%	26%	11.0
	Medium	11.0 - 16.0	25	25%	50%	16.0
	Coarse	16 - 22.6	14	14%	64%	22.6
	Coarse	22.6 - 32	19	19%	83%	32
	Very Coarse	32 - 45	6	6%	89%	45
	Very Coarse	45 - 64	4	4%	93%	64
Cobble	Small	64 - 90	6	6%	99%	90
	Small	90 - 128			99%	128
	Large	128 - 180	1	1%	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			101	100%		

Summary Data			
Channel materials			
D16 =	7.0	D84 =	33.6
D35 =	12.7	D95 =	71.5
D50 =	15.9	D100 =	128 - 180



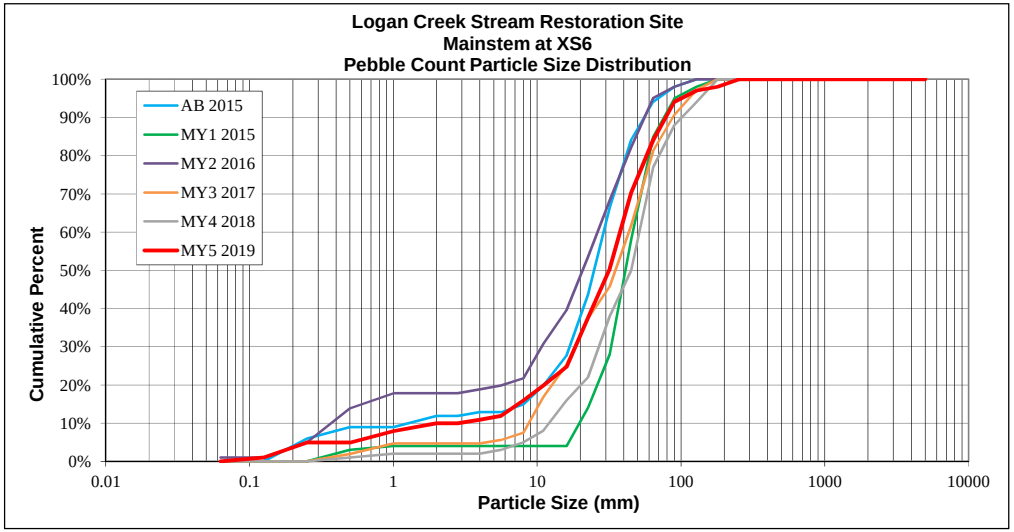


Cross-Section Pebble Count; Monitoring Year 5
Logan Creek Mitigation Project, DMS #92515

SITE OR PROJECT:	Logan Cr
REACH/LOCATION:	Riffle at XS6
FEATURE:	Riffle
DATE:	23-Oct-19

			MY5 2019			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			5%	0.50
	Coarse	.50 - 1.0	3	3%	8%	1.0
	Very Coarse	1.0 - 2.0	2	2%	10%	2.0
Gravel	Very Fine	2.0 - 2.8			10%	2.8
	Very Fine	2.8 - 4.0	1	1%	11%	4.0
	Fine	4.0 - 5.6	1	1%	12%	5.6
	Fine	5.6 - 8.0	4	4%	16%	8.0
	Medium	8.0 - 11.0	4	4%	20%	11.0
	Medium	11.0 - 16.0	5	5%	25%	16.0
	Coarse	16 - 22.6	13	13%	38%	22.6
	Coarse	22.6 - 32	13	13%	50%	32
	Very Coarse	32 - 45	20	20%	70%	45
	Very Coarse	45 - 64	14	14%	84%	64
Cobble	Small	64 - 90	10	10%	94%	90
	Small	90 - 128	3	3%	97%	128
	Large	128 - 180	1	1%	98%	180
	Large	180 - 256	2	2%	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 =	8.1	D84 =	63.7
D35 =	21.1	D95 =	100.6
D50 =	31.6	D100 =	180 - 256



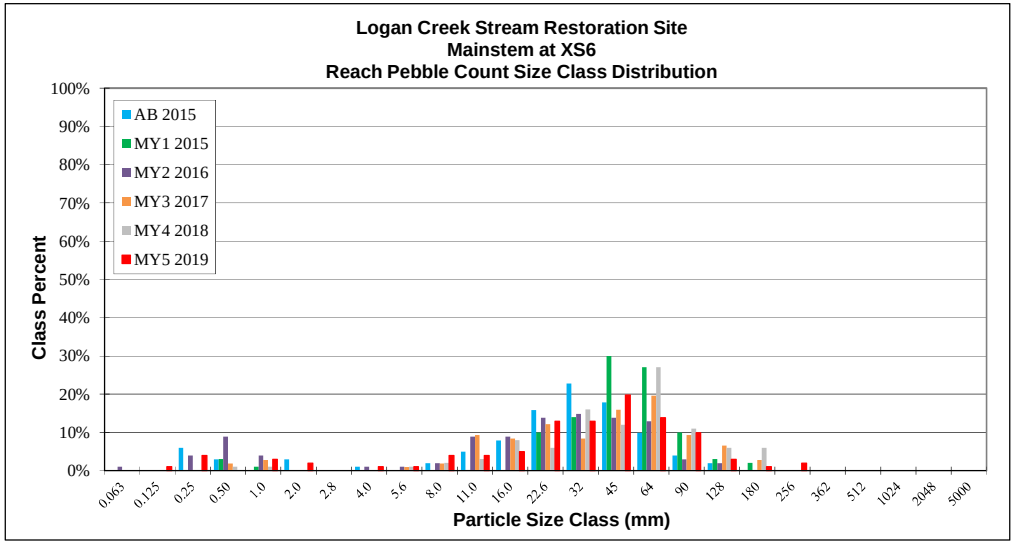


Table 10. Monitoring Year 5 Stream Summary
Logan Creek Restoration Project; DMS Project ID No. 94645

Logan Creek Mainstem

Parameter	USGS Gauge	Regional Curve Interval [1]			Pre-Existing Condition[1]						Reference Reach Data – Right Prong Logan Creek					
Dimension and Substrate - Riffle		NC Mtn. Regional Curve			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	-	-	-	-
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	35.0	-	-	-	-
BF Mean Depth (ft)	-	1.4	1.5	-	1.50	2.2	2.4	2.60	0.4	4	-	1.06	-	-	-	-
BF Max Depth (ft)	-	-	-	-	3.4	3.6	3.5	3.8	0.2	4	-	1.54	-	-	-	-
BF Cross-sectional Area (ft²)	-	37.5	42.7	-	55.8	58.0	58.4	59.5	1.36	4	-	17.7	-	-	-	-
Width/Depth Ratio	-	-	-	-	8.9	13.6	9.8	25.7	7.01	4	-	15.8	-	-	-	-
Entrenchment Ratio	-	-	-	-	3.4	11.3	12.0	17.8	5.83	4	-	2.0	-	-	-	-
Bank Height Ratio	-	-	-	-	1	1.2	1.1	1.5	0.2	4	-	1.2	-	-	-	-
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-
Pattern																
Channel Beltwidth (ft)	-	-	-	-	194	216	217	252	18.13	7	-	80	-	-	-	-
Radius of Curvature (ft)	-	-	-	-	23	32	30	46	8.6	5	-	23	-	-	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	0.85	1.19	1.11	1.7	0.32	5	-	1.38	-	-	-	-
Meander Wavelength (ft)	-	-	-	-	120	177	197	239	46.75	5	-	150	-	-	-	-
Meander Width Ratio	-	-	-	-	4.44	6.56	7.3	8.85	1.73	5	-	4.8	-	-	-	-
Profile																
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Riffle Slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.019	-	-	-	-
Pool Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pool Spacing (ft)	-	-	-	-	-	-	-	-	-	-	-	75	-	-	-	-
Pool Max Depth (ft)	-	-	-	-	2.9	3.8	4.0	4.5	0.64	3	-	2.28	-	-	-	-
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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						-	-	-	-	-	-
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)	-	2.1 to 2.67			2.1 at upper end of project to 2.67 towards end of project						-	0.83	-	-	-	-
Impervious cover estimate (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosgen Classification	-	-	-	-	-	C4 to E4	-	-	-	-	-	C4	-	-	-	-
BF Velocity (fps)	-	-	-	-	-	-	-	-	-	-	-	3.55	-	-	-	-
BF Discharge (cfs)	-	205.7	237.0		-	-	-	-	-	-	-	98	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)	-	-	-	-	-	4,700	-	-	-	-	-	-	-	-	-	-
Sinuosity	-	-	-	-	-	-	-	-	-	-	-	2.01	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.0079	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.016	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Parameter	Design						As-built					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	26.0	-	-	-	-	23.6	24.3	24.1	25.2	0.67	3
Floodprone Width (ft)	-	150.00	-	-	-	-	-	>150	-	-	-	3
BF Mean Depth (ft)	-	2.3	-	-	-	-	2.1	2.3	2.2	2.6	0.22	3
BF Max Depth (ft)	-	4.0	-	-	-	-	3.1	3.4	3.4	3.7	0.24	3
BF Cross-sectional Area (ft²)	-	58.5	-	-	-	-	51.7	56.0	53.2	63.0	5.01	3
Width/Depth Ratio	-	12	-	-	-	-	9.2	10.7	10.8	12.0	1.12	3
Entrenchment Ratio	-	5.8	-	-	-	-	2.9	3.6	3.9	4.0	0.50	3
Bank Height Ratio	-	1.0	-	-	-	-	1.0	1.00	1.00	1.0	0.00	3
d50 (mm)	-	12.4	-	-	-	-	12.4	12.4	12.4	12.4	0.00	1
Pattern												
Channel Beltwidth (ft)	65	-	-	140	-	-	130.0	193.2	190.0	258.0	41.45	6
Radius of Curvature (ft)	28	-	-	75	-	-	44.0	63.9	66.1	104.0	17.17	9
Rc:Bankfull width (ft/ft)	1.1	-	-	2.9	-	-	1.80	2.60	2.70	4.30	0.71	9
Meander Wavelength (ft)	118	-	-	236	-	-	145.0	236.7	244.5	321.0	48.10	12
Meander Width Ratio	2.5	-	-	5.4	-	-	6.0	9.7	10.1	13.2	1.98	12
Profile												
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-
Riffle Slope (ft/ft)	0.003	-	-	0.007	-	-	-	-	-	-	-	-
Pool Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-
Pool Spacing (ft)	94	-	-	165	-	-	-	-	-	-	-	-
Pool Max Depth (ft)	-	6.00	-	-	-	-	5.2	5.3	5.2	5.4	0.1	3
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	-	-	mean 5.1 / 10.9 / 16.5 / 34.8 / 55.9					
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)	2.1 at upper end of project to 2.67 towards end of project						2.1 at upper end of project to 2.67 towards end of project					
Impervious cover estimate (%)	-	2.67	-	-	-	-	-	2.67	-	-	-	-
Rosgen Classification	-	C4	-	-	-	-	-	C4	-	-	-	-
BF Velocity (fps)	-	4.31	-	-	-	-	-	4.33	-	-	-	-
BF Discharge (cfs)	-	271.5	-	-	-	-	-	242.6	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)	-	4,101	-	-	-	-	-	4,172	-	-	-	-
Sinuosity	-	1.3	-	-	-	-	-	1.31	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	0.0035	-	-	-	-	-	0.0039	-	-	-	-
BF slope (ft/ft)	-	0.0047	-	-	-	-	-	0.0052	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-

Parameter	MY1						MY2					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	22.6	23.7	24.0	24.3	0.77	3	22.5	26.2	24.3	33.9	4.50	4
Floodprone Width (ft)	-	>150	-	-	-	3	>54	>80	-	>100	-	4
BF Mean Depth (ft)	2.1	2.3	2.2	2.6	0.21	3	1.8	2.2	2.2	2.7	0.32	4
BF Max Depth (ft)	2.9	3.4	3.5	4.0	0.45	3	3.0	3.5	3.4	4.3	0.53	4
BF Cross-sectional Area (ft²)	50.2	54.6	51.2	62.4	5.53	3	51.4	57.7	57.3	64.8	5.74	4
Width/Depth Ratio	9.3	10.3	10.1	11.6	0.96	3	8.9	12.2	10.6	18.6	3.81	4
Entrenchment Ratio	2.9	3.7	4.0	4.1	0.54	3	1.6	3.2	3.5	4.2	1.06	4
Bank Height Ratio	1.0	1.0	1.0	1.1	0.05	3	1.0	1.1	1.0	1.2	0.09	4
d50 (mm)	30.7	38.3	41.1	43.0	5.41	3	15.2	21.7	20.7	29.2	5.8	3
Pattern												
Channel Beltwidth (ft)	130.0	193.2	190.0	258.0	41.5	6	130.0	193.2	190.0	258.0	41.5	6
Radius of Curvature (ft)	44.0	63.9	66.1	104.0	17.2	9	44.0	63.9	66.1	104.0	17.2	9
Rc:Bankfull width (ft/ft)	1.80	2.60	2.70	4.30	0.71	9	1.80	2.60	2.70	4.30	0.71	9
Meander Wavelength (ft)	145.0	236.7	244.5	321.0	48.1	12	145.0	236.7	244.5	321.0	48.1	12
Meander Width Ratio	6.0	9.7	10.1	13.2	2.0	12	6.0	9.7	10.1	13.2	2.0	12
Profile												
Riffle Length (ft)	25.7	68.1	65.3	149.8	31.6	16	18.6	90.5	93.5	162.3	47.4	9
Riffle Slope (ft/ft)	0.0009	0.0079	0.0049	0.0218	0.0065	16	0.0025	0.0076	0.0075	0.0162	0.0042	9
Pool Length (ft)	31.0	66.4	64.5	112.2	25.4	19	48.1	89.2	82.2	150.6	29.1	14
Pool Spacing (ft)	86.6	148.6	143.5	292.6	51.9	20	50	127.4	119.8	264	46.3	24
Pool Max Depth (ft)	5.1	5.4	5.3	5.9	0.36	3	5	5.3	5.4	5.4	0.15	3
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	mean 17.3/ 28.6 / 36.9 / 71.8 / 123.1						mean 6.7/ 16.3 / 22.2 / 45.4 / 91.4					
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)	2.1 at upper end of project to 2.67 towads end of project						2.1 at upper end of project to 2.67 towards end of project					
Impervious cover estimate (%)	-	2.67	-	-	-	-	-	2.67	-	-	-	-
Rosgen Classification	-	C4	-	-	-	-	-	C4	-	-	-	-
BF Velocity (fps)	-	4.20	-	-	-	-	-	4.20	-	-	-	-
BF Discharge (cfs)	-	264.8	-	-	-	-	-	264.8	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)	-	4,172	-	-	-	-	-	4,172	-	-	-	-
Sinuosity	-	1.34	-	-	-	-	-	1.34	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	0.0033	-	-	-	-	-	0.0033	-	-	-	-
BF slope (ft/ft)	-	0.0044	-	-	-	-	-	0.0044	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-

Parameter	MY3						MY4						MY5					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	22.4	26.2	24.1	34.1	4.62	4	22.6	26.7	25.1	34.2	4.46	4	22.6	27.3	25.9	35.0	4.7	4
Floodprone Width (ft)	>54	>80	-	>100	-	4	>54	>80	-	>100	-	4	>54	>80		>100		4
BF Mean Depth (ft)	1.7	2.2	2.2	2.7	0.34	4	1.7	2.1	2.2	2.5	0.28	4	1.6	2.1	2.2	2.5	0.30	4
BF Max Depth (ft)	2.9	3.5	3.3	4.3	0.53	4	3.0	3.6	3.4	4.6	0.64	4	3.0	3.6	3.4	4.7	0.66	4
BF Cross-sectional Area (ft²)	50.8	56.8	55.9	64.7	5.60	4	49.1	55.9	54.9	64.9	6.19	4	49.1	56.1	54.2	66.7	6.69	4
Width/Depth Ratio	8.9	12.4	10.6	19.6	4.24	4	10.3	13.0	10.9	20.0	4.04	4	10.3	13.6	11.3	21.6	4.61	4
Entrenchment Ratio	1.5	3.2	3.5	4.2	1.08	4	1.5	3.1	3.4	4.2	1.10	4	1.5	3.1	3.3	4.2	1.11	4
Bank Height Ratio	1.0	1.0	1.0	1.1	0.04	4	1.01	1.05	1.02	1.14	0.06	4	1.01	1.06	1.05	1.13	0.05	4
d50 (mm)	22.2	26.8	23.3	35.0	5.8	3	21.6	34.0	34.7	45.0	8.3	3	15.9	23.7	23.5	31.6	6.4	3
Pattern																		
Channel Beltwidth (ft)	130.0	193.2	190.0	258.0	41.5	6	130.0	193.2	190.0	258.0	41.5	6	130.0	193.2	190.0	258.0	41.5	6
Radius of Curvature (ft)	44.0	63.9	66.1	104.0	17.2	9	44.0	63.9	66.1	104.0	17.2	9	44.0	63.9	66.1	104.0	17.2	9
Rc:Bankfull width (ft/ft)	1.80	2.60	2.70	4.30	0.71	9	1.80	2.60	2.70	4.30	0.71	9	1.80	2.60	2.70	4.30	0.71	9
Meander Wavelength (ft)	145.0	236.7	244.5	321.0	48.1	12	145.0	236.7	244.5	321.0	48.1	12	145.0	236.7	244.5	321.0	48.1	12
Meander Width Ratio	6.0	9.7	10.1	13.2	2.0	12	6.0	9.7	10.1	13.2	2.0	12	6.0	9.7	10.1	13.2	2.0	12
Profile																		
Riffle Length (ft)	40.6	105.7	90.6	238.8	61.8	9	27.5	103.3	80.6	220.2	65.3	9	52.4	95.8	95.8	134.4	23.9	9
Riffle Slope (ft/ft)	0.0060	0.0046	0.0034	0.0118	0.0036	9	0.0031	0.0078	0.0064	0.0129	0.0033	9	0.0045	0.0077	0.0079	0.0111	0.0017	9
Pool Length (ft)	24.2	89.2	82.2	150.6	29.1	14	28.5	90.1	84.5	208.8	45.2	14	31.2	81.4	82.9	111.8	21.6	14
Pool Spacing (ft)	38	152.3	126.5	524	109.0	24	52.1	141.7	132.8	239.5	54.6	23	51.9	109.4	108.5	186.6	38.1	22
Pool Max Depth (ft)	3	3.3	3.3	3.9	0.40	4	2.0	2.5	2.5	3.0	0.4	4	3.6	5.0	5.2	6.0	0.9	4
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																		
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	mean 10.2 / 18.2 / 26.8 / 49.7 / 82.2						mean 14.0 / 24.0 / 34.0 / 66.0 / 121.6						mean 5.2 / 16.9 / 23.7 / 51.2 / 110.6					
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)	2.1 at upper end of project to 2.67 towards end of project						2.1 at upper end of project to 2.67 towards end of project						2.1 at upper end of project to 2.67 towards end of project					
Impervious cover estimate (%)	-	2.67	-	-	-	-	-	2.67	-	-	-	-	-	2.67	-	-	-	-
Rosgen Classification	-	C4	-	-	-	-	-	C4	-	-	-	-	-	C4	-	-	-	-
BF Velocity (fps)	-	4.20	-	-	-	-	-	4.20	-	-	-	-	-	4.20	-	-	-	-
BF Discharge (cfs)	-	264.8	-	-	-	-	-	264.8	-	-	-	-	-	264.8	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)	-	4,172	-	-	-	-	-	4,172	-	-	-	-	-	4,172	-	-	-	-
Sinuosity	-	1.34	-	-	-	-	-	1.34	-	-	-	-	-	1.34	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	0.0033	-	-	-	-	-	0.0033	-	-	-	-	-	0.0033	-	-	-	-
BF slope (ft/ft)	-	0.0044	-	-	-	-	-	0.0044	-	-	-	-	-	0.0044	-	-	-	-
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.

UT3

Parameter	USGS Gauge	Regional Curve Interval [1]			Pre-Existing Condition[1]						Reference Reach Data – Morgan Creek					
Dimension and Substrate - Riffle		NC Mtn./NC Pied. Rural			Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	5.3	4.1	-	-	-	-	-	-	-	-	16.7	-	-	-	-
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	35.0	-	-	-	-
BF Mean Depth (ft)	-	0.4	0.5	-	-	-	-	-	-	-	-	1.06	-	-	-	-
BF Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	1.54	-	-	-	-
BF Cross-sectional Area (ft²)	-	1.9	4.1	-	-	-	-	-	-	-	-	17.7	-	-	-	-
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	15.8	-	-	-	-
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	2.0	-	-	-	-
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	1.2	-	-	-	-
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)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Riffle Slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.019	-	-	-	-
Pool Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pool Spacing (ft)	-	-	-	-	-	-	-	-	-	-	-	75	-	-	-	-
Pool Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	2.28	-	-	-	-
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)	-	0.05				0.05			-	-	-	0.83	-	-	-	-
Impervious cover estimate (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosgen Classification	-	-	-	-	-	-	-	-	-	-	-	C4	-	-	-	-
BF Velocity (fps)	-	-	-	-	-	-	-	-	-	7	-	3.55	-	-	-	-
BF Discharge (cfs)	-	7.8	18.3		-	-	-	-	-	-	-	98	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)[2]	-	-	-	-	-	75	-	-	-	-	-	-	-	-	-	-
Sinuosity	-	-	-	-	-	-	-	-	-	-	-	2.01	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.0079	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.016	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Parameter	Design						As-built					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	6.0	-	-	-	-	6.1	6.2	6.2	6.3	0.06	2
Floodprone Width (ft)	-	-	-	-	-	-	-	>27	-	-	-	-
BF Mean Depth (ft)	-	0.7	-	-	-	-	0.70	0.70	0.70	0.80	0.02	2.00
BF Max Depth (ft)	-		-	-	-	-	1.1	1.2	1.2	1.2	0.0	2
BF Cross-sectional Area (ft²)	-	4.2	-	-	-	-	4.5	4.6	4.6	4.6	0.1	2
Width/Depth Ratio	-		-	-	-	-	8.1	8.4	8.4	8.7	0.3	2
Entrenchment Ratio	-	-	-	-	-	-	4.3	5.5	5.5	6.6	1.2	2
Bank Height Ratio	-	-	-	-	-	-	1.0	1.0	1.0	1.0	0.0	2
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-	-
Pattern												
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-	-	-	-	-
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	-	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	-	-	-
Meander Width Ratio	-	-	-	-	-	-	-	-	-	-	-	-
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)	0.0052	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)	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)	-	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)	-	-	-	-	-	-	-	0.05			-	-
Impervious cover estimate (%)	-	-	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	-	-	C	-	-	-	-
BF Velocity (fps)	-	-	-	-	-	-	-	4.27	-	-	-	-
BF Discharge (cfs)	-	-	-	-	-	-	-	212.2	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)[2]	-	311.0	-	-	-	-	-	350	-	-	-	-
Sinuosity	-	-	-	-	-	-	-	1.5	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	-	-	0.0043	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	0.004	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-

Parameter	MY1						MY2					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	5.9	-	-	-	1	-	5.8	-	-	-	1
Floodprone Width (ft)	-	28.1	-	-	-	1	-	22.6	-	-	-	1
BF Mean Depth (ft)	-	0.70	-	-	-	1	-	0.70	-	-	-	1
BF Max Depth (ft)	-	1.1	-	-	-	1	-	1.0	-	-	-	1
BF Cross-sectional Area (ft²)	-	4.1	-	-	-	1	-	4.0	-	-	-	1
Width/Depth Ratio	-	8.5	-	-	-	1	-	8.4	-	-	-	1
Entrenchment Ratio	-	4.0	-	-	-	1	-	3.9	-	-	-	1
Bank Height Ratio	-	1.0	-	-	-	1	-	1.0	-	-	-	1
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-	-
Pattern												
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-	-	-	-	-
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	-	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	-	-	-
Meander Width Ratio	-	-	-	-	-	-	-	-	-	-	-	-
Profile												
Riffle Length (ft)	27.1	43.8	43.8	60.5	16.7	2	24.1	42.8	39.3	64.9	16.8	3
Riffle Slope (ft/ft)	0.0000	0.0032	0.0032	0.0064	0.0032	2	0.0072	0.0092	0.0084	0.0121	0.0021	3
Pool Length (ft)	5.68	11.56	11.70	17.29	4.70	3	7.50	10.90	10.20	15.00	3.10	3
Pool Spacing (ft)	21.23	42.9	38.02	69.37	20	3	24.1	42.8	39.3	64.9	16.8	3
Pool Max Depth (ft)	-	1.5	-	-	-	-	-	1.5	-	-	-	-
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)	-	0.05		-	-	-	-	0.05		-	-	-
Impervious cover estimate (%)	-	<5%		-	-	-	-	<5%		-	-	-
Rosgen Classification	-	C		-	-	-	-	E		-	-	-
BF Velocity (fps)	-	4.81		-	-	-	-	4.81		-	-	-
BF Discharge (cfs)	-	22.1		-	-	-	-	22.1		-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)[2]	-	153		-	-	-	-	153		-	-	-
Sinuosity	-	1.17		-	-	-	-	1.17		-	-	-
Water Surface Slope (Channel) (ft/ft)	-	0.0225		-	-	-	-	0.0225		-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-

Parameter	MY3						MY4						MY5					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	6.2	-	-	-	1	-	5.5	-	-	-	1	-	6.0	-	-	-	1
Floodprone Width (ft)	-	22.6	-	-	-	1	-	22.6	-	-	-	1	-	23.4	-	-	-	1
BF Mean Depth (ft)	-	0.60	-	-	-	1	-	0.69	-	-	-	1	-	0.60	-	-	-	1
BF Max Depth (ft)	-	1.0	-	-	-	1	-	1.0	-	-	-	1	-	1.1	-	-	-	1
BF Cross-sectional Area (ft²)	-	3.8	-	-	-	1	-	3.8	-	-	-	1	-	3.6	-	-	-	1
Width/Depth Ratio	-	9.9	-	-	-	1	-	7.9	-	-	-	1	-	10.0	-	-	-	1
Entrenchment Ratio	-	4.9	-	-	-	1	-	5.3	-	-	-	1	-	5.2	-	-	-	1
Bank Height Ratio	-	1.1	-	-	-	1	-	0.96	-	-	-	1	-	0.90	-	-	-	1
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pattern																		
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Width Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profile																		
Riffle Length (ft)	15.3	31.5	20.3	58.7	19.4	3	20.7	35.6	24.4	61.8	18.6	3	16.2	29.3	20.1	51.6	15.8	3
Riffle Slope (ft/ft)	0.0049	0.0061	0.0065	0.0068	0.0008	3	0.0063	0.0202	0.0115	0.0427	0.0161	3	0.0029	0.0080	0.0075	0.0137	0.0044	3
Pool Length (ft)	6.99	9.42	8.58	12.68	2.40	3	3.94	9.72	6.70	18.53	6.30	3	6.97	13.16	14.23	18.27	4.68	3
Pool Spacing (ft)	32.2	44.4	34.6	66.5	15.6	3	34.3	45.1	34.8	66.2	14.9	3	35.5	45.9	36.3	65.8	14.1	3
Pool Max Depth (ft)	-	1.0	-	-	-	-	-	0.9	-	-	-	-		1.5				-
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)	-	0.05		-	-	-	-	0.05		-	-	-	-	0.05		-	-	-
Impervious cover estimate (%)	-	<5%		-	-	-	-	<5%		-	-	-	-	<5%		-	-	-
Rosgen Classification	-	E		-	-	-	-	E		-	-	-	-	E		-	-	-
BF Velocity (fps)	-	4.81		-	-	-	-	4.81		-	-	-	-	4.81		-	-	-
BF Discharge (cfs)	-	22.1		-	-	-	-	22.1		-	-	-	-	22.1		-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)[2]	-	153		-	-	-	-	153		-	-	-	-	153		-	-	-
Sinuosity	-	1.17		-	-	-	-	1.17		-	-	-	-	1.17		-	-	-
Water Surface Slope (Channel) (ft/ft)	-	0.0225		-	-	-	-	0.0225		-	-	-	-	0.0225		-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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 10. Monitoring Year 5 Stream Summary
Logan Creek Restoration Project; DMS Project ID No. 94645

UT6

Parameter	USGS Gauge	Regional Curve Interval [1]				Pre-Existing Condition [1]						Reference Reach Data (Morgan Creek)						Design						As-built						MY1						MY2						MY3						MY4						MY5					
		NC Mtn./NC Ped.			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	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																																																						
BF Width (ft)	-	5.3	4.1	-	-	-	-	-	-	-	-	-	16.7	-	-	-	-	-	6.0	-	-	-	-	-	6.1	6.2	6.2	6.3	0.06	2	-	5.8	-	-	-	1	-	6.0	-	-	-	1	-	5.64	-	-	-	1	-	5.89	-	-	-	1
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	35.0	-	-	-	-	-	-	-	-	-	-	-	>27	-	-	-	-	1	-	32.4	-	-	-	1	-	>35	-	-	-	1	-	>35	-	-	-	1	-	>35	-	-	-	1
BF Mean Depth (ft)	-	0.4	0.5	-	-	-	-	-	-	-	-	-	1.06	-	-	-	-	-	0.7	-	-	-	-	-	0.70	0.70	0.70	0.80	0.02	2.00	-	0.70	-	-	-	1	-	0.9	-	-	-	1	-	0.60	-	-	-	1	-	0.56	-	-	-	1
BF Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	1.54	-	-	-	-	-	-	-	-	-	-	-	1.1	1.2	1.2	1.2	0.0	2	-	0.9	-	-	-	1	-	0.9	-	-	-	1	-	0.8	-	-	-	1	-	0.9	-	-	-	1
BF Cross-sectional Area (ft^2)	-	1.9	4.1	-	-	-	-	-	-	-	-	-	17.7	-	-	-	-	-	4.2	-	-	-	-	-	4.5	4.6	4.6	4.6	0.1	2	-	3.8	-	-	-	1	-	3.7	-	-	-	1	-	3.8	-	-	-	1	-	3.3	-	-	-	1
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	-	15.8	-	-	-	-	-	-	-	-	-	-	-	8.1	8.4	8.4	8.7	0.3	2	-	9.1	-	-	-	1	-	9.5	-	-	-	1	-	10.5	-	-	-	1	-	11.3	-	-	-	1
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-	-	-	-	-	-	4.3	5.5	5.5	6.6	1.2	2	-	5.4	-	-	-	1	-	4.9	-	-	-	1	-	5.1	-	-	-	1	-	5.2	-	-	-	1
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	-	1.0	1.0	1.0	1.0	0.0	2	-	1.0	-	-	-	1	-	1.1	-	-	-	1	-	1.0	-	-	-	1	-	0.9	-	-	-	1
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	1
Pattern																																																					
Channel Belt width (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	17.8	27.0	27.0	36.3	9.2	2	27.5	31.0	31.0	34.5	3.5	2	35.2	35.4	35.4	35.6	0.2	2	27.2	27.7	27.7	28.1	0.4	2	28.7	32.2	32.2	35.6	3.4	2
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	0.0014	0.0052	0.0052	0.0090	0.0038	2	0.0029	0.0033	0.0033	0.0036	0.0004	2	0.0014	0.0021	0.0021	0.0028	0.0007	2	0.0069	0.0037	0.0037	0.0066	0.0029	2	0.0042	0.0066	0.0066	0.0090	0.0024	2
Pool Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.0	-	-	0	4	6.5	11.6	7.9	21.4	5.7	5	19.75	26.73	26.73	33.70	7.00	2	9.40	16.30	16.30	23.20	6.90	2	2.76	9.51	9.51	16.26	6.8	2	22.49	23.09	23.09	23.69	0.6	2	20.56	21.95	21.95	23.33	1.4	2
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	39.46	42.9	42.9	46.34	3.40	2	45.60	46.85	46.85	48.10	1.25	2	46.87	47.9	47.91	48.94	1.00	2	44.71	46.70	46.73	48.74	2.00	2	45.24	46.69	46.69	48.13	1.45	2
Pool Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	2.28	-	-	-	-	-	-	1.2	-	-	-	-	1.7	-	-	-	-	1	-	1.5	-	-	-	1	-	1.17	-	-	-	1	-	0.735	-	-	-	1	-	0.87	-	-	-	1	-	1.50	-	-	-	1
Pool Volume (ft^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																																																					
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reach Shear Stress (competency) lb/ft²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																																																					
Drainage Area (SM)	-		0.02				0.02					-	0.83	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	-	-	-	-	0.02	-	-	-	-	-	0.02	-	-	-	-	-	0.02	-	-	-	-	-	0.02	-	-	-	-
Impervious cover estimate (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	-	-	-	-	-	-	-	C4	-	-	-	-	-	-	-	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-
BF Velocity (fps)	-	-	-	-	-	-	-	-	-	7	-	-	3.55	-	-	-	-	-	-	-	-	-	-	-	-	4.27	-	-	-	-	-	3.32	-	-	-	-	-	3.32	-	-	-	-	-	3.32	-	-	-	-	-	3.32	-	-	-	-
BF Discharge (cfs)	-	7.8	18.3	-	-	-	-	-	-	-	-	-	98	-	-	-	-	-	-	-	-	-	-	-	-	212.2	-	-	-	-	-	15.2	-	-	-	-	-	15.2	-	-	-	-	-	15.2	-	-	-	-	-	15.2	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)	-	-	-	-	-	75	-	-	-	-	-	-	-	-	-	-	-	-	311.0	-	-	-	-	-	-	350	-	-	-	-	-	104	-	-	-	-	-	104	-	-	-	-	-	104	-	-	-	-	-	104	-	-	-	-
Sinuosity	-	-	-	-	-	-	-	-	-	-	-	-	2.01	-	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	-	1.04	-	-	-	-	-	1.04	-	-	-	-	-	1.04	-	-	-	-	-	1.04	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	0.0079	-	-	-	-	-	-	-	-	-	-	-	-	0.0043	-	-	-	-	-	0.0114	-	-	-	-	-	0.0114	-	-	-	-	-	0.0114	-	-	-	-	-	0.0114	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	0.016	-	-	-	-	-	-	-	-	-	-	-	-	0.004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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. Clinnsmons, G.D. Jennings, D.B. 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.

UT8

Parameter	USGS Gauge	Regional Curve Interval [1]				Pre-Existing Condition [1]						Reference Reach Data (Morgan Creek)						Design						As-built						MY1						MY2						MY3						MY4						MY5					
		NC Mtn./NC Ped.			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	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																																																					
BF Width (ft)	-	5.3	4.1	-	-	-	-	-	-	-	-	-	16.7	-	-	-	-	-	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	8.1	-	-	-	1	-	8.4	-	-	-	1	-	10.3	-	-	-	1	-	8.7	-	-	-	1
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	35.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	>50	-	-	-	1	-	>50	-	-	-	1	-	>50	-	-	-	1	-	>50	-	-	-	1
BF Mean Depth (ft)	-	0.4	0.5	-	-	-	-	-	-	-	-	-	1.06	-	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	0.70	-	-	-	1	-	0.70	-	-	-	1	-	0.6	-	-	-	1	-	0.7	-	-	-	1
BF Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1.4	-	-	-	1	-	1.2	-	-	-	1	-	1.3	-	-	-	1	-	1.4	-	-	-	1
BF Cross-sectional Area (ft^2)	-	1.9	4.1	-	-	-	-	-	-	-	-	-	17.7	-	-	-	-	-	4.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	6.0	-	-	-	1	-	5.8	-	-	-	1	-	5.9	-	-	-	1	-	6.1	-	-	-	1
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	-	15.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	11.0	-	-	-	1	-	12.2	-	-	-	1	-	17.7	-	-	-	1	-	12.4	-	-	-	1
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	5.3	-	-	-	1	-	5.1	-	-	-	1	-	4.2	-	-	-	1	-	5.0	-	-	-	1
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1.0	-	-	-	1	-	1.0	-	-	-	1	-	0.93	-	-	-	1	-	1.00	-	-	-	1
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pattern: reach is to short for this data.																																																					
Channel Belt width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	-	-	-	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Width Ratio	-	-	-	-	-	-	-	-	-	-	-	-	4.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profile: reach is to short for this data.																																																					
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0	31.8	19.0	77.0	26.3	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Riffle Slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	0.019	-	-	-	-	-	0.0052	0.0107	0.0106	0.017	0.0041	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pool Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.0	-	-	0	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pool Spacing (ft)	-	-	-	-	-	-	-	-	-	-	-	-	75	-	-	-	-	-	18.0	22.7	24.0	26.0	3.4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pool Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	2.28	-	-	-	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pool Volume (ft^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																																																					
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reach Shear Stress (competency) lb/ft²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																																																					
Drainage Area (SM)	-		0.02				0.02					-	0.83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	-	-	-	-	0.02	-	-	-	-	-	0.02	-	-	-	-	-	0.02	-	-	-	-
Impervious cover estimate (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	-	-	-	-	-	-	-	C4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-
BF Velocity (fps)	-	-	-	-	-	-	-	-	-	7	-	-	3.55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.32	-	-	-	-	-	3.32	-	-	-	-	-	3.32	-	-	-	-	-	3.32	-	-	-	-
BF Discharge (cfs)	-	7.8	18.3	-	-	-	-	-	-	-	-	-	98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.2	-	-	-	-	-	15.2	-	-	-	-	-	15.2	-	-	-	-	-	15.2	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	311.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	104	-	-	-	-	-	104	-	-	-	-	-	104	-	-	-	-	-	104	-	-	-	-
Sinuosity	-	-	-	-	-	-	-	-	-	-	-	-	2.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.04	-	-	-	-	-	1.04	-	-	-	-	-	1.04	-	-	-	-	-	1.04	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	0.0079	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0114	-	-	-	-	-	0.0114	-	-	-	-	-	0.0114	-	-	-	-	-	0.0114	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	0.016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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. Clinnsmons, G.D. Jennings, D.B. 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 11. 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	24.0	24.1	24.0	26.0	27.3	-	25.9	26.8	26.0	26.0	26.1	25.8	-	25.2	24.3	24.5	24.3	24.2	24.5	-	27.6	27.1	27.1	27.4	26.8	27.4	-
BF Mean Depth (ft)	2.6	2.6	2.7	2.7	2.5	2.5	-	2.5	2.4	2.5	2.6	2.4	2.4	-	2.1	2.1	2.2	2.2	2.1	2.1	-	2.3	2.7	2.4	2.6	2.7	2.7	-
Width/Depth Ratio	9.2	9.3	8.9	8.9	10.4	11.1	-	10.5	11.0	10.3	10.2	10.9	10.9	-	12.0	11.6	11.4	11.3	11.4	11.5	-	12.1	10.0	11.2	10.7	9.8	10.1	-
BF Cross-sectional Area (ft^2)	63.0	62.4	64.8	64.7	64.9	66.7	-	63.9	65.2	65.5	66.2	62.9	61.2	-	53.2	51.2	52.7	52.3	51.4	52.0	-	62.8	73.8	65.4	70.2	73.2	74.4	-
BF Max Depth (ft)	3.7	4.0	4.3	4.3	4.6	4.7	-	5.2	5.1	5.1	4.9	4.9	5.0	-	3.1	2.9	3.1	3.1	3.0	3.0	-	5.2	5.9	5.4	5.5	4.7	6.0	-
Width of Floodprone Area (ft)	>70	>70	>70	>70	>70	>70	-	>60	>60	>60	>60	>60	>60	-	>100	>100	>100	>100	>100	>100	-	>100	>100	>100	>100	>100	>100	-
Entrenchment Ratio	2.9	2.9	2.9	2.9	2.7	2.6	-	2.3	2.3	2.3	2.3	2.3	2.4	-	3.9	4.1	4.1	4.1	4.1	4.1	-	3.6	3.6	3.6	3.6	3.7	3.6	-
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0	1.0	-	1.1	1.1	1.0	1.1	1.1	1.1	-	1.0	1.1	1.0	1.0	1.0	1.1	-	1.0	1.0	1.1	1.0	1.3	1.1	-
Wetted Perimeter (ft)	29.3	29.3	29.5	29.4	31.0	31.0	-	30.9	31.7	31.0	31.1	31.0	30.6	-	29.5	28.6	28.8	28.6	28.4	28.7	-	32.2	32.6	31.9	32.5	32.3	32.9	-
Hydraulic Radius (ft)	2.1	2.1	2.2	2.2	2.1	2.1	-	2.1	2.1	2.1	2.1	2.0	2.0	-	1.8	1.8	1.8	1.8	1.8	1.8	-	2.0	2.3	2.0	2.2	2.3	2.3	-
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)	13.8	30.7	15.2	23.3	35.4	23.5	-	-	-	-	-	-	-	-	19.2	43	29.2	22.2	21.6	15.9	-	-	-	-	-	-	-	-

	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)	21.3	24.0	23.9	23.8	23.6	23.8	-	23.6	22.6	22.5	22.4	22.6	22.8	-	31.0	33.4	33.4	33.3	33.0	32.2	-	29.2	33.9	33.9	34.1	34.2	35.0	-
BF Mean Depth (ft)	3.0	3.1	3.1	3.0	3.0	3.0	-	2.2	2.2	2.3	2.3	2.2	2.2	-	2.1	2.1	2.1	2.3	2.3	2.4	-	2.1	1.8	1.8	1.7	1.7	1.6	-
Width/Depth Ratio	7.1	7.8	7.8	8.0	7.9	8.0	-	10.8	10.1	9.9	9.9	10.3	10.2	-	14.4	15.6	15.9	14.8	14.1	13.7	-	14.0	18.6	18.6	19.6	20.0	21.6	-
BF Cross-sectional Area (ft^2)	63.9	74.3	73.3	71.0	70.6	70.7	-	51.7	50.2	51.4	50.8	49.1	51.0	-	66.6	71.2	70.3	74.7	77.1	75.7	-	60.7	61.8	61.8	59.4	58.3	56.5	-
BF Max Depth (ft)	5.4	5.3	5.4	5.4	5.4	5.4	-	3.4	3.5	3.7	3.6	3.7	3.6	-	3.5	3.5	3.4	3.5	3.6	3.6	-	2.9	3.0	3.0	2.9	3.1	3.2	-
Width of Floodprone Area (ft)	>80	>90	>90	>90	>90	>90	-	>95	>95	>95	>95	>95	>95	-	>60	>60	>60	>60	>60	>60	-	>54	>54	>54	>54	>54	>54	-
Entrenchment Ratio	4.4	4.4	3.8	3.8	3.8	3.8	-	4.0	4.0	4.2	4.2	4.2	4.1	-	4.2	1.8	1.8	1.8	1.8	1.9	-	4.5	1.6	1.6	1.5	1.5	1.5	-
Bank Height Ratio	1.0	1.0	1.0	1.0	1.1	1.0	-	1.0	1.0	1.0	1.0	1.0	1.0	-	1.0	1.1	1.0	1.0	1.3	1.3	-	1.1	1.2	1.2	1.1	1.1	1.1	-
Wetted Perimeter (ft)	27.3	30.2	30.0	29.8	29.6	29.7	-	28.0	27.0	27.1	26.9	26.9	27.3	-	35.2	37.6	37.6	37.8	37.7	36.9	-	33.4	37.6	37.6	37.6	37.6	38.2	-
Hydraulic Radius (ft)	2.3	2.5	2.4	2.4	2.4	2.4	-	1.8	1.9	1.9	1.9	1.8	1.9	-	1.9	1.9	1.9	2.0	2.0	2.1	-	1.8	1.6	1.6	1.6	1.6	1.5	-
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)	-	-	-	-	-	-	-	24.9	41.1	20.7	35.0	45.0	31.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Per DMS/IRT request, the bank height ratio for MY4 and MY5 has been calculated using the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

Table 11. Morphology and Hydraulic Monitoring Summary
Logan Creek Restoration Project: DMS Project ID No. 92515

UT3 (178 LF)

	Cross-section X-8.5, Station 0+60* (Pool)							Cross-section X-9, 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)	-	8.6	8.2	8.9	8.7	8.6	-	6.3	5.9	5.8	6.2	5.5	6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Mean Depth (ft)	-	0.9	0.9	0.9	0.9	0.9	-	0.7	0.7	0.7	0.6	0.7	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width/Depth Ratio	-	9.4	9.9	9.9	9.3	9.7	-	8.7	8.5	8.4	9.9	7.9	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Cross-sectional Area (ft^2)	-	7.9	8.2	8.1	8.1	7.7	-	4.5	4.1	4.0	3.8	3.8	3.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Max Depth (ft)	-	1.5	1.5	1.4	1.5	1.5	-	1.2	1.1	1.0	1.0	1.0	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width of Floodprone Area (ft)	-	32.0	30.9	30.9	32.4	31.7	-	26.8	23.8	22.6	22.6	22.6	23.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entrenchment Ratio	-	3.7	3.4	4.5	6.1	5.7	-	4.3	4.0	3.9	4.9	5.3	5.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Height Ratio	-	1.1	1.0	1.1	1.1	1.1	-	1.0	1.0	1.0	1.1	1.0	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wetted Perimeter (ft)	-	10.4	10.0	10.7	10.5	10.4	-	7.7	7.3	7.2	7.4	6.8	7.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	-	0.8	0.8	0.8	0.8	0.7	-	0.6	0.6	0.6	0.5	0.6	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*Stationing is corrected in this report.

UT6 (127 LF)

	Cross-section X-7, Station 0+54 (Pool)							Cross-section X-8, Station 0+69 (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)	9.8	9.2	9.4	9.7	9.1	9.7	-	6.1	5.8	5.8	6.0	5.6	5.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Mean Depth (ft)	1.0	0.9	0.8	0.8	0.8	0.8	-	0.8	0.7	0.6	0.6	0.5	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width/Depth Ratio	9.5	10.7	12.1	11.2	11.2	12.1	-	8.1	9.0	9.1	9.5	11.3	10.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Cross-sectional Area (ft^2)	10.1	7.9	7.4	7.4	7.3	7.8	-	4.6	3.8	3.7	3.8	2.8	3.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Max Depth (ft)	1.7	1.5	1.2	1.2	1.3	1.5	-	1.1	0.9	0.9	0.9	0.8	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width of Floodprone Area (ft)	> 50	> 50	> 50	> 50	>50	>50	-	> 35	> 35	> 35	> 35	>35	>35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entrenchment Ratio	3.8	4.0	3.1	3.3	3.4	3.8	-	6.6	5.6	5.4	4.9	5.2	5.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Height Ratio	1.0	1.0	1.0	1.1	0.9	0.9	-	1.0	1.0	1.0	1.1	1.0	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wetted Perimeter (ft)	11.8	10.9	11.0	11.3	10.7	11.3	-	7.7	7.1	7.1	7.3	6.6	7.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	0.9	0.7	0.7	0.7	0.7	0.7	-	0.6	0.5	0.5	0.5	0.4	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Per DMS/IRT request, the bank height ratio for MY4 and MY5 has been calculated using the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

Table 11. Morphology and Hydraulic Monitoring Summary
Logan Creek Restoration Project: DMS Project ID No. 92515

UT8 (45 LF)																														
	Cross-section X-12, Station 0+9.6 (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)	-	-	8.1	8.4	10.3	8.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
BF Mean Depth (ft)	-	-	0.7	0.7	0.6	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Width/Depth Ratio	-	-	11.0	12.2	17.7	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
BF Cross-sectional Area (ft^2)	-	-	6.0	5.8	5.9	6.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
BF Max Depth (ft)	-	-	1.4	1.2	1.3	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Width of Floodprone Area (ft)	-	-	> 50	> 50	>50	>50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Entrenchment Ratio	-	-	5.3	5.1	4.2	5.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Bank Height Ratio	-	-	1.0	1.0	0.9	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Wetted Perimeter (ft)	-	-	9.6	9.8	11.4	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Hydraulic Radius (ft)	-	-	0.6	0.6	0.5	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
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)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Note: Per DMS/IRT request, the bank height ratio for MY4 and MY5 has been calculated using the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.																														

Table 12. MY1 to MY5 Stream Problem Areas and Photos Logan Creek Stream Restoration Project, Number #92515				
Feature Issue	**Station**	**Suspected Cause**	**Status**	**Photo #**
Aggradation/Bar Formation	None	N/A	N/A	N/A
Bank Scour	2+10	**CPA 2-1**. Identified MY2. Flooding during December and January caused a small area of bank scour at this location. Bank was repaired in 2017 and has remained stable through 2019 (MY5).	Resolved	1, 2, 3, & 4
	4+60	**CPA 2-3**. Identified MY2. Flooding during December and January 2017 caused a small area of bank scour at this location. The bank was repaired in 2017 and the area has not worsened, is stabilizing and is supporting more vegetation in 2019.	Resolved	9,10,11 & 12
	11+70	**CPA 2-4**. Identified MY2. Flooding during December and January 2017 caused a small area of bank scour at this location. This bank has revegetated and stabilized. It was stable in the fall of 2019.	Resolved	13,14,15 & 16
	26+60	**CPA 2-5**. Identified MY2. Flooding during December and January 2017 caused a small area of bank scour at this location. This scour area has revegetated and stabilized. It was stable in the fall of 2019.	Resolved	17, 18, 19 & 20
	27+00	**CPA 2-6**. Identified MY2. Flooding during December and January 2017 caused a small area of bank scour at this location. Scour area was repaired in 2017 and has revegetated and stabilized in 2018 and remains stable in 2019.	Resolved	21, 22, 23, 24 & 25
	21+00	**CPA 3-2**. Identified MY3. Bank slump (approx. 6 ft.) along left bank of main stem. Has stabilized and is no longer eroding.	Resolved	29, 30 & 31
	11+50	**CPA 3-4**. Identified MY3. Bank slump (approx. 8 ft.) along right bank of main stem. The slump area has not worsened, is stabilizing and is supporting more vegetation in 2019.	Resolved	35, 36 & 37

Table 12. continued				
Engineered Structures	2+00	**CPA 2-2**. Identified MY2. Piping of log structure after the fabric sealing this structure tore during flooding of December and January. Structure was repaired in 2017 and was no longer piping in MY5.	Resolved	5, 6, 7 & 8
	23+75	**CPA 3-1**. Identified MY3. Piping of log structure has stabilized and is no longer piping in MY5.	Resolved	26, 27 & 28
	14+75	**CPA 3-3**. Identified MY3. Piping of log structure after the fabric sealing this structure tore. Structure has stabilized and is no longer piping in MY5.	Resolved	32, 33 & 34
	UT8 - 00+40	**CPA 3-5**. Identified MY3. Piping of log structure on UT-8 near the confluence of UT-8 and Logan Creek. Hand repairs made Feb-20. It is no longer piping.	Resolved	38 & 39
Encroachments	(approximately) 23+00 to 28+00	**EA-1**. Identified MY2. The nature trail (an allowance in the easement); was mowed wide. We discussed this with staff at Lonesome Valley and they reduced the width they are maintaining.	Resolved, working with Stewardship Program to document agreed to width.	40, 41
	Left bank near 28+50	**EA-2**. Identified MY5. There is a narrow trail down the adjacent slope from a private residence and across a foot bridge. We will work with Lonesome Valley to resolve.	On Going	42, 43
	Left bank near 23+00	**EA-3**. Identified MY5. There is a small triangular area being moved by an adjacent landowner. We will work with Lonesome Valley to resolve.	On Going	44, 45

Logan Creek Stream Restoration Project – Monitoring Years 1-5 CPA Photos

CPA 2-1

Photo 1. CPA 2-1, Station 2+10, small area of bank scour caused by flooding of December and January.

Photo 2. CPA 2-1, Station 2+10, same area as shown in photo 1, with vegetation stabilizing site. Bank was graded, matting was reinstalled, and live stakes were added during October 2017.

Photo 3. CPA 2-1, Scour area has stabilized and is no longer eroding after repairs were made in 2017.

Photo 4. CPA 2-1, Scour area is stable and supporting vegetation, late winter photo (3-2020).

CPA 2-2

Photo 5. CPA 2-2 – Station 2+00, Piping of log structure after the fabric sealing this structure tore during flooding of December and January.

Photo 6. CPA 2-2 – Station 2+00, Piping structure was repaired in May 2017. Fabric was replaced and substrate was replaced upstream of log structure.

Photo 7. CPA 2-2 – Log structure that was repaired in 2017 has remained stable and is no longer piping.

Photo 8. CPA 2-2 – Log structure has remained stable and not piping, late winter photo (3-2020) after multiple high water events.

CPA 2-3

Photo 9. CPA 2-3 – Station 4+60, small area of bank scour caused by flooding of December and January 2016.

Photo 10. CPA 2-3 – Station 4+60, bank scour area was regraded, matting was reinstalled, and herbaceous vegetation was transplanted in May 2017. Livestakes were installed in October 2017.

Photo 11. CPA 2-3 – Station 4+60, bank scour area has vegetated but not completely stable.

Photo 12. CPA 2-3 – Station 4+60, bank scour area maintaining vegetation but still some signs it is not completely stable.

CPA 2-4

Photo 13. CPA 2-4 – Station 11+70, small area of bank scour caused by flooding of December and January 2016.

Photo 14. CPA 2-4 – Station 11+70, scour area noted in MY2 has stabilized for the most part. Livestakes were planted in the scour area as well as the bank downstream of the problem area in October 2017.

Photo 15. CPA 2-4 – Station 11+70, Bank has vegetated and stabilized in 2018.

Photo 16. CPA 2-4 – Station 11+70, Bank maintained not completely stable but improving with growing vegetation in 2019

CAP 2-5

Photo 17. CPA 2-5 – Station 26+60, small area of bank scour caused by flooding of December and January 2016.

Photo 18. CPA 2-5 – Station 26+60, bank scour area was regraded, matting was reinstalled, and herbaceous vegetation was transplanted in May 2017. Livestakes were installed in October 2017.

Photo 19. CPA 2-5 – Station 26+60, Scour area has revegetated and stabilized.

Photo 20. CPA 2-5 – Station 26+60, Scour area stabilized with vegetation in 2019, late winter photo (3-2020).

CPA 2-6

Photo 21. CPA 2-6 – Station 27+00, small area of bank scour caused by flooding of December and January 2016.

Photo 22. CPA 2-6 – Station 27+00, bank scour area was regraded, matting was reinstalled, and herbaceous vegetation was transplanted in May 2017. Livestakes were installed in October 2017.

Photo 23. CPA 2-6 – Station 27+00, scour area has revegetated and stabilized in 2018.

Photo 24. CPA 2-6 – Station 27+00, scour area remained vegetated and stable in 2019.

Photo 25. CPA 2-6 – Station 27+00, scour area vegetated and stable, some bare bank late winter (3-2020).

CPA 3-1

Photo 26. CPA 3-1 – Station 23+75, piping of log structure after the fabric sealing this structure tore in 2017.

Photo 27. CPA 3-1 – Log structure has stabilized and is no longer piping.

Photo 28. CPA 3-1 – Log structure continues to be stable in late winter 2020.

CPA 3-2

Photo 29. CPA 3-2 – Station 21+00, small bank slump area (approx. 6 ft.) along left bank of main stem.

Photo 30. CPA 3-2 – Area has stabilized and is fully vegetated.

Photo 31. CPA 3-2 – Area has stabilized and is fully vegetated, in late winter 2020.

CPA 3-3

Photo 32. CPA 3-3 – Station 14+75, piping of log structure after the fabric sealing this structure tore in 2017.

Photo 33. CPA 3-3 – Station 14+75, piping log structure has stabilized and is no longer piping in 2018.

Photo 34. CPA 3-3 – Station 14+75, Log structure continues to be stable in late winter 2020.

CPA 3-4

Photo 35. CPA 3-4 – Station 11+50, small bank slump (approx. 8 ft.) along right bank of main stem.

Photo 36. CPA 3-4 – Station 11+50, slump area has not stabilized but has not worsened in 2018.

Photo 37. CPA 3-4 – Station 11+50, slump area left a gap in the bank but it is stable in late winter 2020.

CPA 3-5

Photo 38. CPA 3-5 – Station UT8 00+40, piping of log structure on UT-8 near the confluence of UT-8 and Logan Creek

Photo 39. CPA 3-5 – Station UT8 00+40, piping of log structure repaired, in late winter 2020.

Encroachments

Photo 40. EA 2-1 – Maintenance workers mowed the nature trail wider than had been agreed to earlier, near stationing 23+00 to 28+00.

Photo 41. EA 2-1 – Maintenance workers now maintaining the trail at 7’ width.

Photo 42. EA 2. Older foot bridge that was installed by Lonesome Valley and later abandoned, but not removed. Landowner now is using it to access the easement area.

Photo 43. EA 2. Appears that a landowner is maintaining a trail down the slope to the foot bridge.

Photo 35. EA 3. Landowner is mowing a small triangular area into the easement.

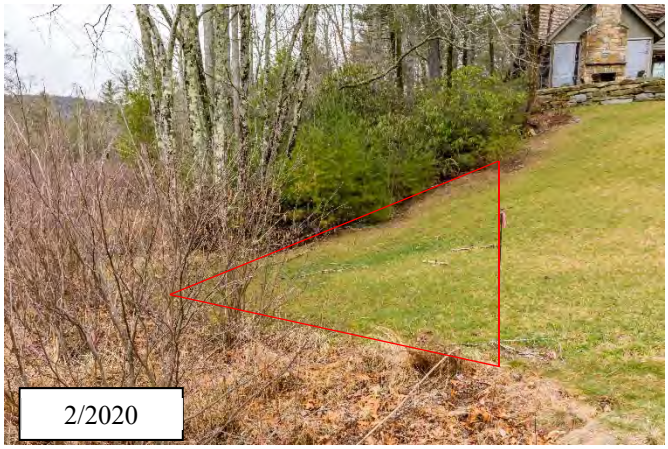


Photo 36. EA 3. Maintenance workers now maintaining the trail at 7’ width.