Logan Creek Stream Restoration Project
Year 1 Monitoring Report

Jackson County, North Carolina

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

Savannah River Basin: 03060101-010020

Project Info:	Monitoring Year: 1 of 5 Year of Data Collection: November 2015 Year of Completed Construction: May 2015 Submission Date: May 2016
Submitted To:	NCDEQ – Division of Mitigation Services 5 Ravenscroft Drive, Suite 102 Asheville, NC 28801 NCDEQ Contract ID No. D06046-A

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

To accomplish these goals, we recommend the following actions:

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

During Monitoring Year 1 (MY1), our sampling indicated that the planted acreage was functioning well with most banks, benches and flood plain areas having a developing herbaceous community and good growth of planted trees. The access areas used during construction were particularly difficult to stabilize but after hydro-seeding they are now well vegetated. One other area with minimal vegetative cover is labeled VPA-1 on the CCPV map (Appendix A). This area has been replanted and appears to be improving but we will continue to monitor it. We have had discussions with the landowner concerning a mowing encroachment (EA-1) by maintenance staff and their encroachment by installing the outlet of a drainpipe within the easement (EA-2). These encroachment issues have been addressed and resolved; however, we continue to monitor the site for similar issues.

There have been three channel problem areas noted during the year. CPA-1 is a small area of stream bank instability near station 2+80, CPA-2 is another small area of bank instability caused by overbank flow from the encroaching drainage pipe and lastly CPA-3 is a small hole that developed above a toewood installation. All of these areas are less than five feet by five feet in area and will either be repaired (CPA-3) or monitored to determine if repair is needed.

As noted in the Baseline report, we installed eight (8) vegetation monitoring plots at this site, with seven (7) being installed along the restoration reach and one (1) being installed along the enhancement reach. The enhancement reach had minimal disturbance of the existing vegetation during construction. The location of these vegetation monitoring plots can be seen on Figures 2A-C. The average density of total planted stems following the MY1 growing season is 769 stems per acre (n=8). Only one volunteer stem was observed in a plot. With an average planted density of 769 stems per acre, the Site is on track to meet the minimum interim success criteria of 320 stems per acre by the end of MY3, and the final success criteria of 260 stems per acre by the end of MY5.

Stream geomorphological stability and performance during MY1 was assessed by surveying twelve (12) cross-sections (8 on Logan Creek, 2 on UT3, and 2 on UT6) and a profile of each channel, evaluating the bed particle size with 3 riffle pebble counts and by observation and replicating channel location photographs. An additional pool cross-section was added on UT3 during MY1 surveying so that we have both a riffle and pool cross-section on this tributary. Cross-sections and profiles of all the channels indicated that there was very little change in the channel during MY1. The Visual Morphological Stability Assessment indicates that the Site is stable and performing at 100 percent for all parameters. All structures were functioning as designed during MY1. Channel morphology is responding as designed and meeting project goals. There were no bankfull events recorded on the crest gauge during MY1 and there was no physical indications of over-bank flooding. Pebble count data indicate a shift to larger particle sizes at all of the riffles sampled.

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.

The MY1 monitoring data were collected between December 2015 and March 2016. Site surveys for channel cross-sections and photos, profiles and pebble counts were conducted in December and the first week in January. Vegetation monitoring plots and site photo points were monitored in March.

2.1 Vegetation Assessment

In order to determine if success criteria are achieved, vegetation monitoring quadrants (veg plots) were installed and are monitored in accordance with the CVS-NCDMS Protocol for Recording Vegetation, Version 4.1 (CVS 2007 and Lee, Peet, Roberts and Wentworth 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 II of Logan Creek and UT5. There is a small area of disturbance within the enhancement reach and Veg Plot 1 is located in that area where bare root trees were planted. The sizes of individual quadrants are 100 square meters for woody (tree) 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 year one monitoring. We found that all vegetation was in good condition. All plots indicated that trees were growing and in good to excellent condition and herbaceous vegetation, while not thick, was becoming established and growing well. The average density of planted trees following the Year 1 growing season is 769 stems per acre. There was only one volunteer stem found in one plot at this time, which bumps total stems up to 774 stems per acre. With an average planted stem density of 769 stems per acre, the Site is on track to meet the minimum interim success criteria of 320 stems per acre by the end of Year 3, and the final success criteria of 260 stems per acre by the end of Year 5.

There were few invasive species observed at this site during Year 1. Observation during monitoring activities indicated that there were only a few scattered individual small plants of the invasive species, Multiflora rose. Larger individual plants of this species were treated during construction and killed but some seeding appears to have occurred from these or other nearby plants. We will continue to monitor for additional plants growing from the existing seed bank and will treat these as needed. No other areas of concern regarding the existing vegetation was observed along Logan Creek or any of the tributaries. Year 1 vegetation assessment information is provided in Appendix C.

2.2 Stream Assessment

The approach for the Logan Creek Site includes 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. This survey system collects point data with an accuracy of less than one tenth of a foot.

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 the baseline cross-section plots to evaluate change between as-built and the MY1 survey. Morphological survey data is presented in Appendix D.

A longitudinal profile was surveyed for the entire length of each channel to document changes from the as-built baseline conditions during the first year of monitoring. The survey was tied to a permanent benchmark and measurements included thalweg, water surface, and top of low bank. Each of these measurements was taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth.

Stream geomorphological stability and performance during MY1 was assessed by surveying twelve (12) cross-sections (8 on Logan Creek, 2 on UT3, and 2 on UT6) and a profile of each channel, evaluating the bed particle size with 3 riffle pebble counts and by observation and replicating channel location photographs. An additional pool cross-section was added on UT3 during MY1 surveying so that we have both a riffle and pool cross-section on this tributary. Cross-sections of all the channels indicated that there was very little change in the cross-sections during MY1. A couple of the pool

cross-sections deepened slightly and there were other slight changes in pool cross-sectional morphology; however, these slight changes are not unusual during the first year as the channel changes to adjust with the sediment supply and discharge. No observed changes indicate any instability. The Visual Morphological Stability Assessment indicates that the Site is stable and performing at 100 percent for all parameters on reaches. All structures were functioning as designed during MY1. Channel morphology is responding as designed and meeting project goals.

Pebble count data indicate a shift to larger particle sizes at all of the riffles sampled. The channel had an average D50 of 19.3mm during baseline sampling but this has now changed to an average of 38.3mm. This represents a change from coarse gravel to very coarse gravel and likely represents and improvement in trout spawning habitat within the stream. This data also indicates that sand particles are being transported through the project reach. This is particularly important in the enhancement reach, as the bed of this reach had been inundated with sand, which greatly reduced aquatic habitat. During MY1 more gravel was observed immediately downstream of log structures within the enhancement reach. These were installed specifically to move this sand and create better habitat. This indicates a properly functioning system, as there were no mid-channel bars or other sediment transport issues.

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. No bankfull flow events were recorded on the crest gauge during the MY1 data collection period, which primarily extended from April 1, 2015 to November 30, 2015. There was also not evidence of greater than bankfull flows based on visual evidence such as wrack lines or sediment deposition. 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 MY1 monitoring. Photographs from these points will be 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. The only remaining area of minimal vegetative cover is the stockpile area at the north end of the project labeled VPA-1 on the CCPV map (Appendix A). We have replanted this area several times and in September the area was tilled, reseeded and mulched. We will continue to monitor this small area through the second year. Invasive vegetation is not a problem at this site. There are some individual Multiflora rose plants growing at scattered locations on the site. We sprayed this vegetation during 2015 and had good success controlling it. We expect some regrowth from the existing seed bank but will continue to monitor and use herbicides as needed. An additional issue affecting Site vegetation is mowing encroachment. There was one area along the easement line (EA-1) where the landowner encroached into the easement while attempting to mow the field outside of the easement line. These areas were pointed out to the landowner and we discussed the need to avoid encroaching into the easement. The easement line in these areas has been marked with additional posts to guide the maintenance staff during mowing. Additionally, during the year the landowner installed a drainage pipe that ran from a newly constructed building into the easement, emptying onto a large rip-rap pad

(EA-2). We contacted the landowner and DMS to inform them of this easement violation and to request that the pipe outlet be removed from the easement and all impacts to the easement be repaired. The pipe was removed before the end of the year, the affected area regraded, seeded, and erosion control matting installed. While this pipe outlet was installed, excessive stormflow was directed onto the floodplain and caused a small area of instability on the right bank where this flow entered the channel (CPA-2). High flows caused a small area of erosion on the left stream bank at station 2+80 (CPA-1). There apparently was an area of softer soil material incorporated in the bank and eroded during high flows. This happened early in the summer and has been stable in the intervening time. Both CPA-1 and CPA-2 are small and are not continuing to destabilize. We do not plan to repair them at this time but will monitor their condition and take corrective action if needed. The only other area that was considered a Channel Problem Area was a small hole that developed on the floodplain (CPA-3) above some woody debris that was installed in the bank. Standing water on the floodplain drains into the ground in this area and caused this subsidence. We will be filling this hole during 2016. A nature trail exists along the stream beginning at the lower end of Reach 1 and continuing upstream to the trout pond. This trail falls within the easement in many locations but also passes out of the easement in others. This was a pre-existing nature trail and the right to maintain it is allowed in the conservation easement. All issues discussed above reference the CCPV mapping and the Stream Problem Area table included in 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.

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

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.

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____. 2005. "Technical Standard for Water-Table Monitoring of Potential Wetland Sites," WRAP Technical Notes Collection (ERDC TN-WRAP-05-2), U.S. Army Engineer Research and Development Center. Vicksburg, MS.

____. 2003. Stream Mitigation Guidelines, April 2003, U.S. Army Corps of Engineers. Wilmington District.

Appendix A

General Figures and Plan Views

Includes:

Figure 1. Project Vicinity Map and Directions
Figure 2. Current Condition Plan View (CCPV) – Overview Map, Monitoring Year 1
Figure 2A. CCPV North Area of Project
Figure 2B. CCPV Mid Area of Project
Figure 2C. CCPV South Area of Project

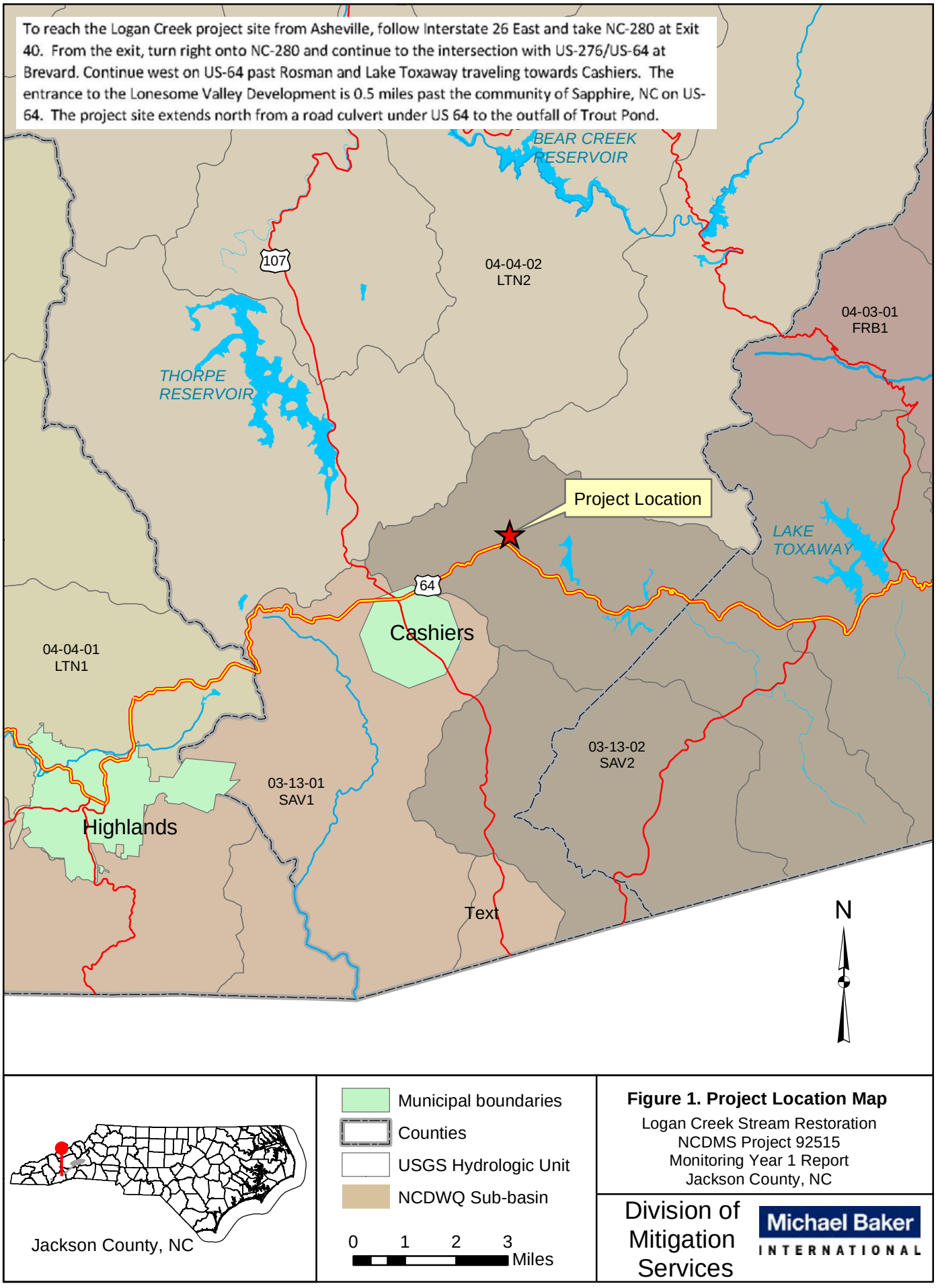
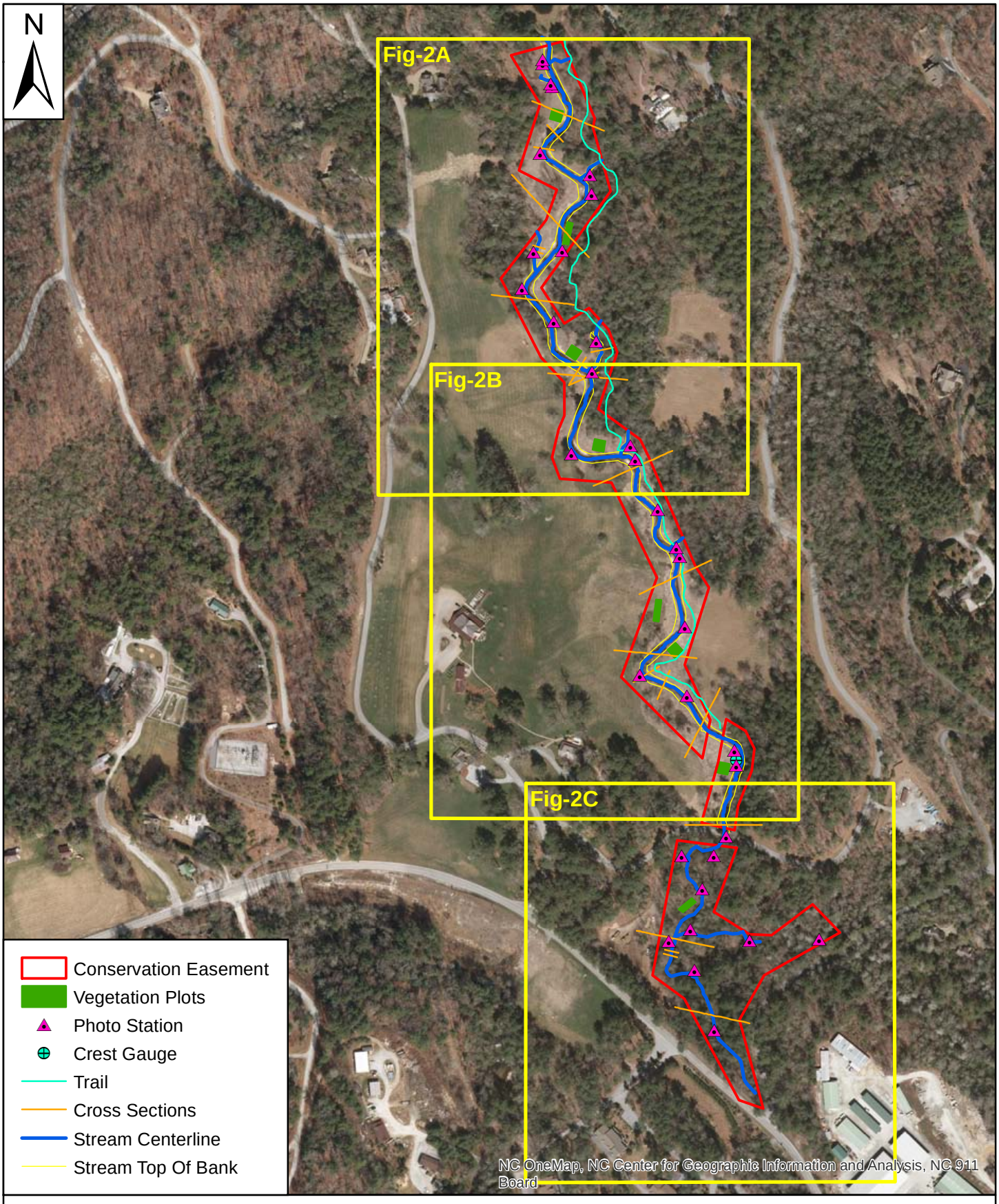


Figure 1. Project Location Map

Logan Creek Stream Restoration
NCDMS Project 92515
Monitoring Year 1 Report
Jackson County, NC

Division of Mitigation Services

Michael Baker INTERNATIONAL

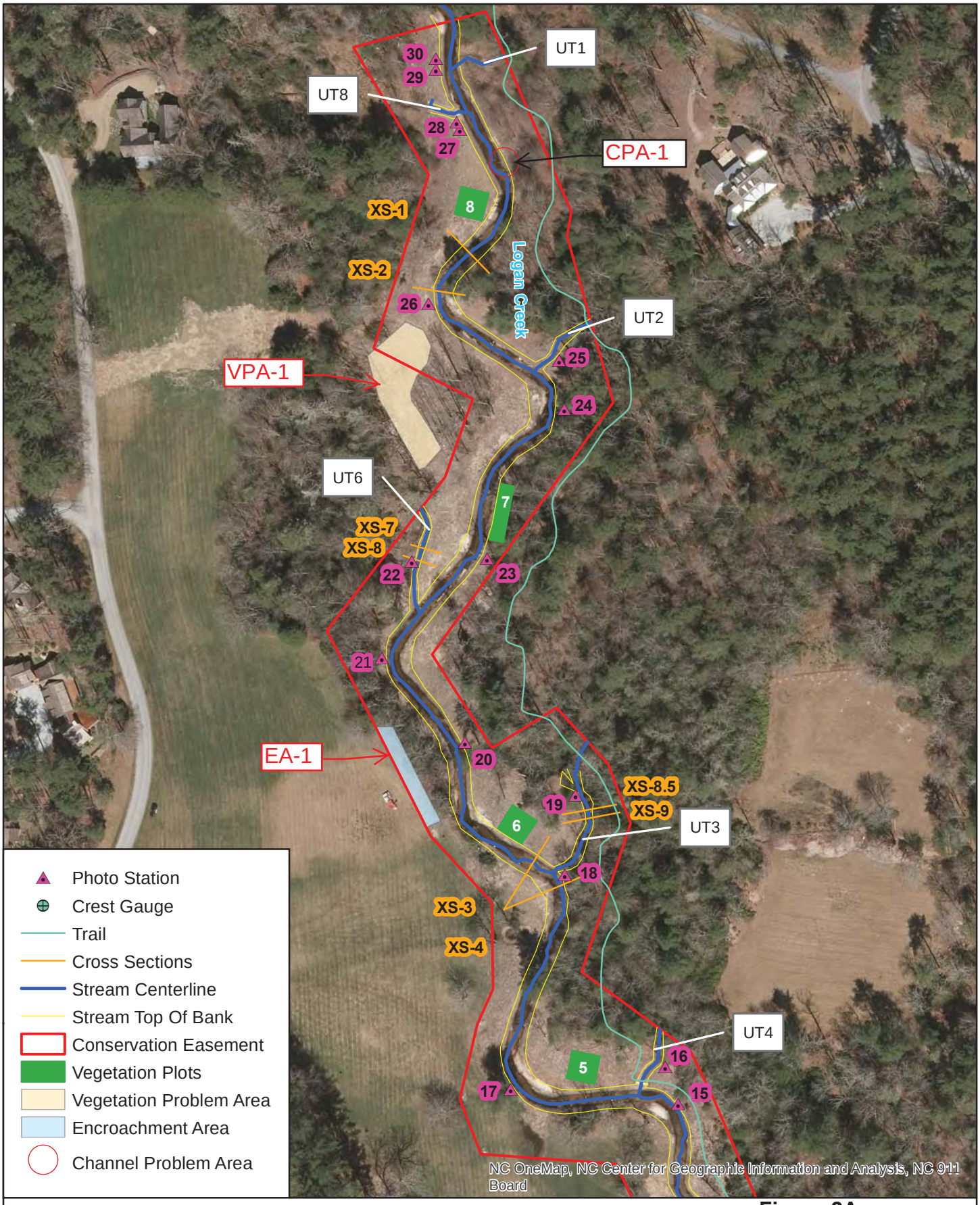


Michael Baker INTERNATIONAL

0 400 800 Feet

DMS Project # 92515

Figure 2
Current Conditions Plan View
Monitoring Year 1
Logan Creek Site

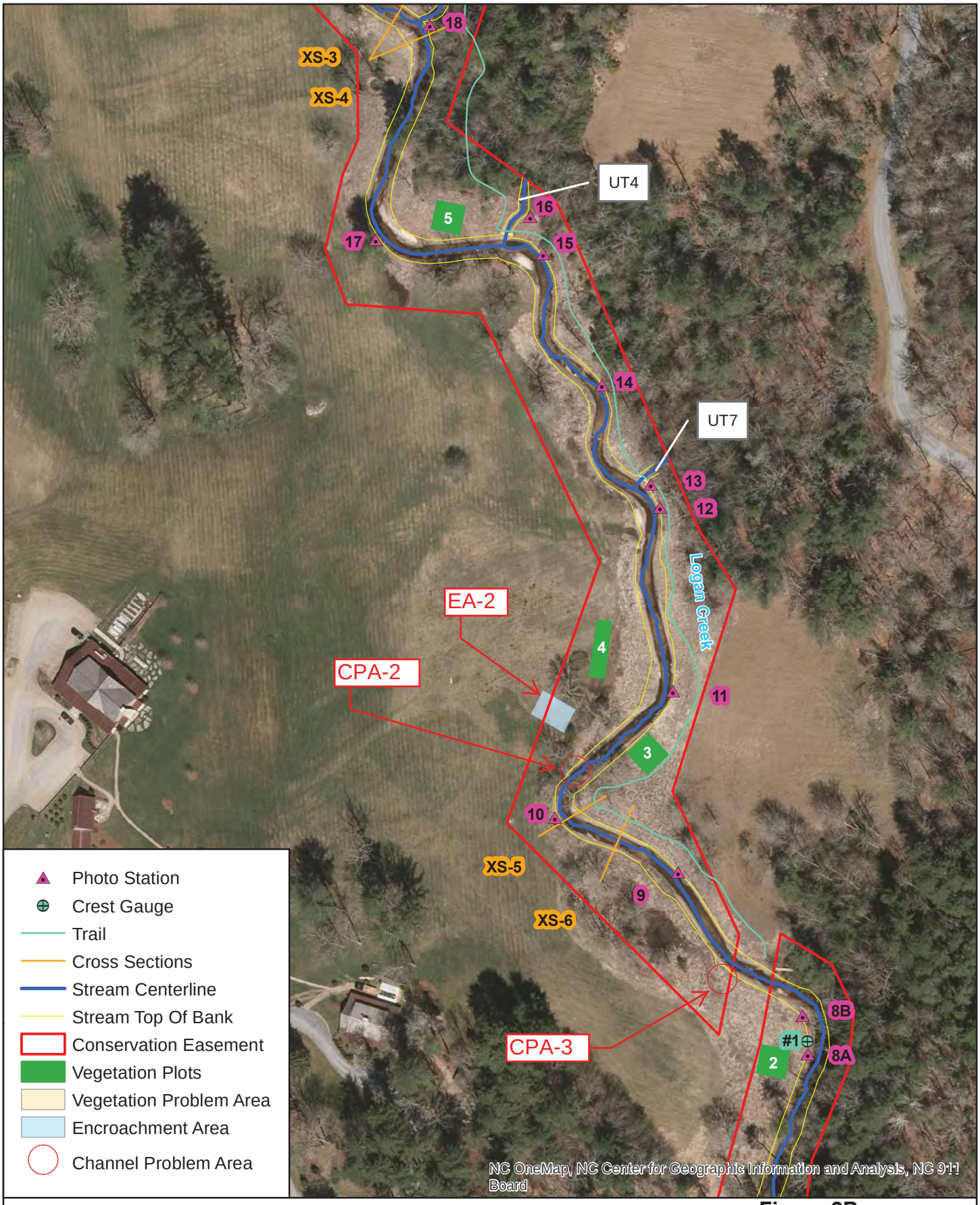


Michael Baker INTERNATIONAL

0 150 300 Feet

DMS Project # 92515

Figure 2A
Current Conditions Plan View
Monitoring Year 1
Logan Creek Site

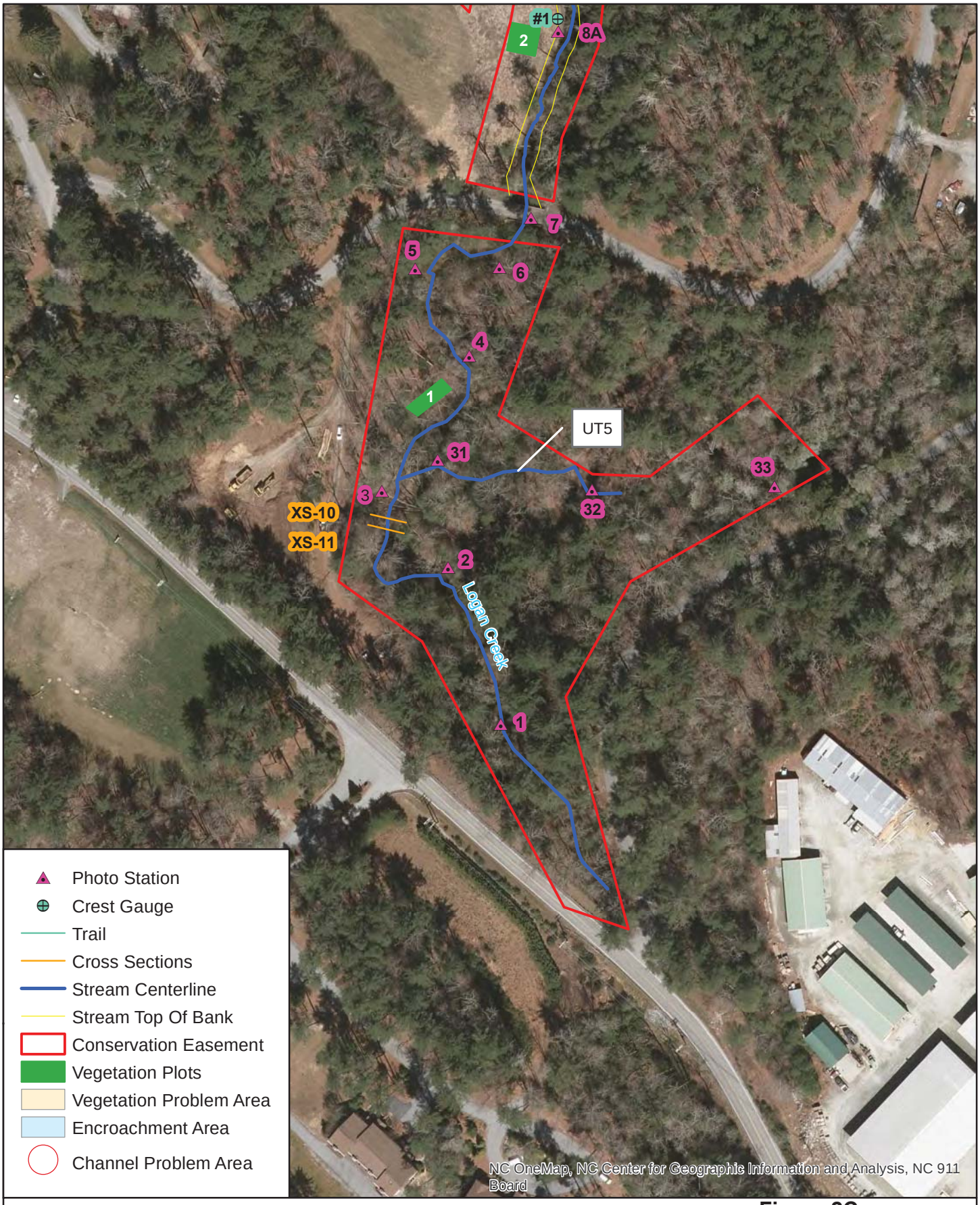


Michael Baker INTERNATIONAL

0 150 300 Feet

DMS Project # 92515

Figure 2B
Current Conditions Plan View
Monitoring Year 1
Logan Creek Site



Michael Baker INTERNATIONAL

0 150 300 Feet

DMS Project # 92515

Figure 2C
Current Conditions Plan View
Monitoring Year 1
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	3,444 SMU	692 SMU	136 SMU	57 SMU					

Project Components

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

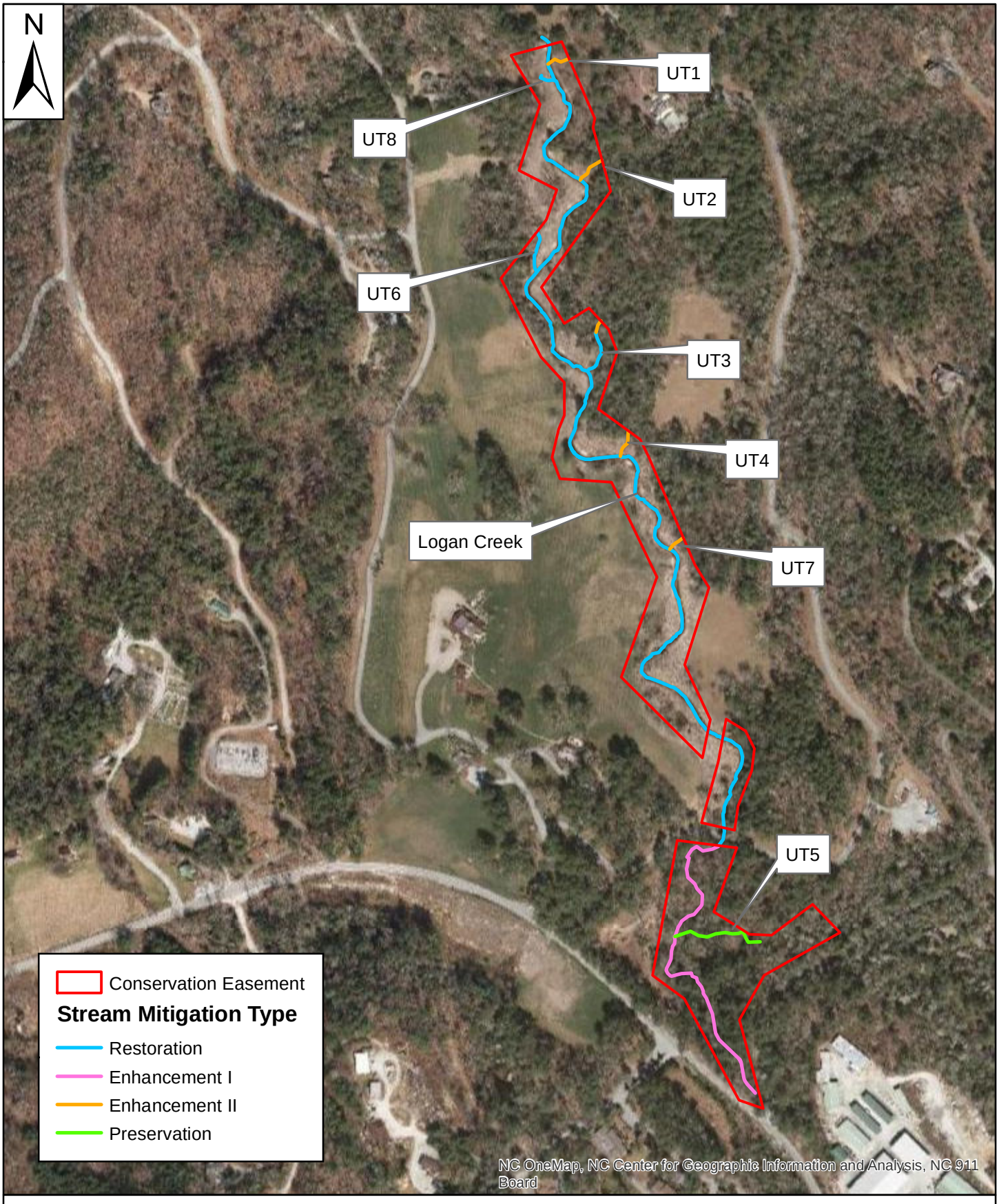
Component Summation

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

BMP Elements

Element		Location	Purpose/Function	Notes

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



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0 200 400 600 800 1,000 Feet

DMS Project # 92515

Figure 3
Stream Asset Map
Monitoring Year 1
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	N/A	Nov-15
Year 1 Monitoring	N/A	N/A	Apr-16
Year 2 Monitoring	Dec-16	N/A	N/A
Year 3 Monitoring	Dec-17	N/A	N/A
Year 4 Monitoring	Dec-18	N/A	N/A
Year 5 Monitoring	Dec-19	N/A	N/A

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

** Construction of the majority of the site was completed by November 1, 2014 after a 2 week extension of the trout moratorium. The Enhancement Reach was done after April 15, 2015 (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: Phillip Todd, Tel. 919-582-3575
Planting Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seeding Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seed Mix Sources	Green Resources (seed), Tel. 336-855-6363
Nursery Stock Suppliers	ArborGen Inc. (trees), 843-528-3204 Dykes and Son (trees), 931-668-8833
Monitoring Performers	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201 Asheville, NC 28806 Contact:
Stream 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**	
Length of Reach (LF)	3,134	1,038	
Valley Classification (Rosgen)	VIII	VIII	
Drainage Area (AC)	1,557	1,714	
NCDWR Stream Identification Score	52.5	52.5	
NCDWR Water Quality Classification	C; TR: +HQW	C; TR: +HQW	
Morphological Description (Rosgen stream type)	C-E	C-E	
Evolutionary Trend	C→E	C→E	
Underlying Mapped Soils	NkA	SaC	
Drainage Class	Poorly drained to very poorly drained soils	Very deep, well drained, mod permeable soils	
Soil Hydric Status	Non-Hydric	Non-Hydric	
Average Channel Slope (ft/ft)	0.004	0.007	
FEMA Classification	Zone AE	Zone AE	
Native Vegetation Community	Mixed Forested/Rhododendron and grassland	Mixed Forested/Rhododendron and grassland	
Percent Composition of Exotic/Invasive Vegetation[2]	<1%	<1%	

Parameters	**UT3**		**UT5**		**6 other small UTs in R1**
	R1	**R2**	**R1**	**R2**	
Length of Reach (LF)	40	138	40	138	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)

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	LOMR in process	
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

(per acre)

Plot #	Stream/ Wetland Stems[1]	Volunteers[2]	Total[3]	Success Criteria Met?
1	1012	40	1052	Yes
2	445	0	445	Yes
3	809	0	809	Yes
4	688	0	688	Yes
5	850	0	850	Yes
6	850	0	850	Yes
7	971	0	971	Yes
8	526	0	526	Yes
Project Avg	**769**	**5**	**774**	**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. Excludes live stakes, exotics and vines.

Exceeds requirements by 10%

Table 6. Vegetation Metadata Logan Creek Stream and Restoration Project - Project #92515	
Report Prepared By	Micky Clemmons
Date Prepared	4/7/2016 10:31
database name	92515_Logan_cvs-eep-entrytool-v2.3.1.mdb
database location	L:\projects\109243 - Logan Creek\Monitoring\YR1 monitoring\2.0 - Monitoring Data\App C - Vegetation Data\Veg
computer name	ASHELMCLEMMONS
file size	60628992
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 5,110 linear feet (LF) of stream along Logan Creek.
River Basin	Savannah
length(ft)	5,110
stream-to-edge width (ft)	at least 30 feet
area (sq m)	28481.19
Required Plots (calculated)	8
Sampled Plots	8

Table 7. Stem Count Arranged by Plot
Project: Logan Creek, DMS Project #92515.

			Current Plot Data (MY1 2015)																						
			92515-01-0001			92515-01-0002			92515-01-0003			92515-01-0004			92515-01-0005			92515-01-0006			92515-01-0007			92515-01-0008		
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	P	V	T
Alnus serrulata	hazel alder	Shrub				3		3	6		6	2		2	7		7	3		3	6		6	5		5
Betula nigra	river birch	Tree							1		1	4		4	3		3	1		1				2		2
Diospyros virginiana	common persimmon	Tree				2		2	1		1	2		2	4		4	4		4	6		6	1		1
Fraxinus pennsylvanica	green ash	Tree				1		1	4		4	4		4	2		2	8		8	3		3	2		2
Hamamelis virginiana	American witchhazel	Tree	11		11																					
Leucothoe fontanesiana	highland doghobble	Shrub				1		1							1		1				1		1			
Lindera benzoin	northern spicebush	Shrub	2		2																					
Liriodendron tulipifera	tuliptree	Tree				1		1	1		1	2		2				1		1	4		4	2		2
Nyssa sylvatica	blackgum	Tree	1		1	1		1	3		3				1		1				2		2	1		1
Quercus alba	white oak	Tree				2		2				2		2	2		2									
Quercus rubra	northern red oak	Tree							4		4	1		1	1		1	4		4	2		2			
Sambucus canadensis	Common Elderberry	Shrub		1	1																					
Unknown		Shrub or Tree																								
Viburnum dentatum	southern arrowwood	Shrub	11		11																					
		Stem count	25		26	11		11	20		20	17		17	21		21	21		21	24		24	13		13
		size (ares)	1			1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	4		5	7		7	7		7	7		7	8		8	6		6	7		7	6		6
		Stems per ACRE	1012		1052	445		445	809		809	688		688	850		850	850		850	971		971	526		526

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 #92515.

			Annual Means																	
			MY0 (2015)			MY1 (2015)			MY2 (2016)			MY3 (2017)			MY4 (2018)			MY5 (2019)		
Scientific Name	Common Name	Species Type	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T
Alnus serrulata	hazel alder	Shrub	33		33	32		32												
Betula nigra	river birch	Tree	13		13	11		11												
Diospyros virginiana	common persimmon	Tree	24		24	20		20												
Fraxinus pennsylvanica	green ash	Tree	24		24	24		24												
Hamamelis virginiana	American witchhazel	Tree				11		11												
Leucothoe fontanesiana	highland doghobble	Shrub	4		4	3		3												
Lindera benzoin	northern spicebush	Shrub				2		2												
Liriodendron tulipifera	tuliptree	Tree	17		17	11		11												
Nyssa sylvatica	blackgum	Tree	20		20	9		9												
Quercus alba	white oak	Tree	6		6	6		6												
Quercus rubra	northern red oak	Tree	13		13	12		12												
Sambucus canadensis	Common Elderberry	Shrub					1	1												
Unknown		Shrub or Tree	7		7															
Viburnum dentatum	southern arrowwood	Shrub	9		9	11		11												
		Stem count	170	0	170	152	1	153	0		0	0		0	0		0	0		0
		size (ares)	8			8			9			9			9			9		
		size (ACRES)	0.20			0.20			0.22			0.22			0.22			0.22		
		Species count	11	0	11	12	1	13	0		0	0		0	0		0	0		0
		Stems per ACRE	860	0	860	769	5	774	0		0	0		0	0		0	0		0

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%

Figure 4. Logan Creek Stream Restoration Project
Monitoring Year 1 Vegetation Plot Photos, DMS Project #92515

Photo 1. Vegetation Plot 1 – Tree photo (taken March 18, 2016).

Photo 2. Vegetation Plot 1 – Herbaceous photo (taken March 18, 2016).

Photo 3. Vegetation Plot 2 – Tree photo (taken March 18, 2016).

Photo 4. Vegetation Plot 2 – Herbaceous photo (taken March 18, 2016).

Photo 5. Vegetation Plot 3 – Tree photo (taken March 18, 2016).

Photo 6. Vegetation Plot 3 – Herbaceous photo (taken March 18, 2016).

Figure 4 continued. Logan Creek Stream Restoration Project Vegetation Plot Photos.

Photo 7. Vegetation Plot 4 – Tree photo (taken March 18, 2016).

Photo 8. Vegetation Plot 4 – Herbaceous photo (taken March 18, 2016).

Photo 9. Vegetation Plot 5 – Tree photo (taken March 18, 2016).

Photo Point 10, Vegetation Plot 5 – Herbaceous photo (taken March 18, 2016).

Photo 11. Vegetation Plot 6 – Tree photo (taken March 18, 2016).

Photo 12. Vegetation Plot 6 – Herbaceous photo (taken March 18, 2016).

Figure 4 continued. Logan Creek Stream Restoration Project Vegetation Plot Photos.

Photo 13. Vegetation Plot 7 – Tree photo (taken March 18, 2016).

Photo 14. Vegetation Plot 7 – Herbaceous photo (taken March 18, 2016).

Photo 15. Vegetation Plot 8 – Tree photo (taken March 18, 2016).

Photo 16. Vegetation Plot 8 – Herbaceous photo (taken March 18, 2016).

Table 8. Vegetative Problem Areas			
Feature Category	Station #/Range	Probable Cause	Photo #
Bare Bank	None		
Bare Bench	None		
Bare Flood Plain	Near Station 4+00, most of the area is outside of the easement.	This area was the soil stockpile area during construction. It has been seeded multiple times. Good coverage of trees but lacking in herbaceous vegetation. Had begun to grow some going into fall.	1 and 2
Invasive /Exotic Populations	None		

Photo 1. VPA 1 - Area near station 4+00 showing bare area of former construction entrance and soil stockpile area. Notice multiple trees.

Photo 2. Same area as in Photo 1 but from a different perspective.

Table 9. Vegetation Condition Assessment at Logan Creek

Planted Acreage[1]	7.49					
Vegetation Category	**Definitions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Planted Acreage**
1. Bare Areas	Limited cover of herbaceous vegetation within this area, much of which is outside of the easement area. Good stand of bare root trees. Area is discussed and shown on CCPV and Table 7.5.	0.1 acres	Pattern and Color	1	0.08	1.1%
2. Low Stem Density Areas	None	0.1 acres	Pattern and Color	0	0.00	0.0%
			Total	1	0.08	1.1%
3. Areas of Poor Growth Rates or Vigor	None	0.25 acres	Pattern and Color	0	0.00	0.0%
			Cumulative Total	1	0.08	1.1%
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]	Two areas shown on CCPV and in Table 12. These areas include on that is a mowing encroachment and the second is an easement violation where the landowner installed the outfall of a drain pipe. This last area has been removed and repaired.	none	Pattern and Color	2	0.07	1.0%

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, particulalry 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
Logan Creek Stream Restoration Project
Photo Points - Monitoring Year 1
(Stationing is the approximate location)

Photo 1. Logan Creek Photo Point 1 – Station 40+45 (March 2016) upstream view from right bank.

Photo 2. Logan Creek Photo Point 1 – Station 40+45 (March 2016) downstream view from right bank.

Photo 3. Logan Creek Photo Point 2 – Station 38+60 (March 2016) downstream view from left bank.

Photo 4. Logan Creek Photo Point 2 – Station 38+60 (March 2016) upstream view from left bank.

Photo 5. Logan Creek Photo Point 3 – Station 36+75 (March 2016) upstream view from right bank.

Photo 6. Logan Creek Photo Point 3 – Station 36+75 (March 2016) downstream view from right bank.

Photo 7. Logan Creek Photo Point 4 – Station 34+80 (March 2016) downstream from left bank.

Photo 8. Logan Creek Photo Point 4 – Station 34+80 (March 2016) upstream from left bank.

Photo 9. Logan Creek Photo Point 5 – Station 33+60 (March 2016) upstream from right bank.

Photo 10. Logan Creek Photo Point 5 – Station 33+60 (March 2016) downstream from right bank.

Photo 11. Logan Creek Photo Point 6 – Station 32+70 (March 2016) downstream view from left bank.

Photo 12. Logan Creek Photo Point 6 – Station 32+70 (March 2016) upstream view from left bank.

Photo 13. Logan Creek Photo Point 7 – Station 32+15 (March 2016) downstream view from bridge.

Photo 14. Logan Creek Photo Point 7 – Station 32+00 (March 2016) upstream view from bridge.

Photo 15. Logan Creek Photo Point 8a – Station 29+75 (March 2016) downstream view from right bank.

Photo 16. Logan Creek Photo Point 8b – Station 29+25 (March 2016) upstream view from right bank.

Photo 17. Logan Creek Photo Point 9 – Station 26+75 (March 2016) downstream view from left bank.

Photo 18. Logan Creek Photo Point 9 – Station 26+75 (March 2016) upstream view from left bank.

Photo 19. Logan Creek Photo Point 10 – Station 25+25 (March 2016) upstream view from right bank.

Photo 20. Logan Creek Photo Point 10 – Station 25+25 (March 2016) downstream view from right bank.

Photo 21. Logan Creek Photo Point 11 – Station 23+20 (March 2016) downstream view from left bank.

Photo 22. Logan Creek Photo Point 11 – Station 23+20 (March 2016) upstream view from left bank.

Photo 23. Logan Creek Photo Point 12 – Station 21+20 (March 2016) downstream view from left bank.

Photo 24. Logan Creek Photo Point 12 – Station 21+20 (March 2016) upstream view from left bank.

Photo 25. UT7 Photo Point 13 – (March 2016) upstream view from left bank.

Photo 26. UT7 Photo Point 13 – (March 2016) downstream view from left bank.

Photo 27. Logan Creek Photo Point 14 – Station 19+45 (March 2016) downstream view from left bank.

Photo 28. Logan Creek Photo Point 14 – Station 19+45 (March 2016) upstream view from left bank.

Photo 29. Logan Creek Photo Point 15 – Station 17+45 (March 2016) downstream view from left bank.

Photo 30. Logan Creek Photo Point 15 – Station 17+45 (March 2016) upstream view from left bank.

Photo 31. UT4 Photo Point 16 – Station 0+40 (March 2016) downstream view from left bank.

Photo 32. UT4 Photo Point 16 – Station 0+40 (March 2016) upstream view from left bank.

Photo 32. Logan Creek Photo Point 17 – Station 15+50 (March 2016) upstream view from right bank.

Photo 33. Logan Creek Photo Point 17 – Station 15+50 (March 2016) downstream view from right bank.

Photo 34. Logan Creek Photo Point 18 – Station 12+90 (March 2016) downstream view from left bank.

Photo 35. Logan Creek Photo Point 18 – Station 12+90 (March 2016) upstream view from left bank.

Photo 36. UT3 Photo Point 19 – Station 00+60 (March 2016) upstream from left bank.

Photo 37. UT3 Photo Point 19 – Station 00+60 (March 2016) downstream from left bank.

Photo 38. UT3 Photo Point 19 – Station 00+60 (March 2016) upstream from left bank to vernal pool.

Photo 39. Intentionally left blank.

Photo 40. Logan Creek Photo Point 20 – Station 10+60 (March 2016) downstream view from left bank.

Photo 41. Logan Creek Photo Point 20 – Station 10+60 (March 2016) upstream view from left bank.

Photo 42. Logan Creek Photo Point 21 – Station 9+40 (March 2016) upstream view from right bank.

Photo 43. Logan Creek Photo Point 21 – Station 9+40 (March 2016) downstream view from right bank.

Photo 44. UT6 Photo Point 22 – Station 0+75 (March 2016) upstream view from right bank.

Photo 45. UT6 Photo Point 22 – Station 0+75 (March 2016) downstream view from right bank.

Photo 46. Logan Creek Photo Point 23 – Station 7+70 (March 2016) downstream view from left bank.

Photo 47. Logan Creek Photo Point 23 – Station 7+70 (March 2016) upstream view from left bank.

Photo 48. Logan Creek, Photo Point 24 – Station 5+70 (March 2016) downstream view from left bank.

Photo 49. Logan Creek, Photo Point 24 – Station 5+70 (March 2016) upstream view from left bank.

Photo 50. UT2, Photo Point 25 – Station 0+65 (March 2016) upstream view from left bank.

Photo 51. UT2, Photo Point 25 – Station 0+65 (March 2016) downstream view from left bank.

Photo 52. Logan Creek, Photo Point 26 – Station 3+80 (March 2016) upstream view from right bank.

Photo 53. Logan Creek, Photo Point 26 – Station 3+80 (March 2016) downstream view from right bank.

Photo 54. Logan Creek, Photo Point 27 – Station 1+12 (March 2016) upstream view from right bank.

Photo 55. Logan Creek, Photo Point 27 – Station 1+12 (March 2016) downstream view from right bank.

Photo 56. UT8, Photo Point 28 – Station 1+10 (March 2016) upstream view from right bank and confluence.

Photo 57. UT1, Photo Point 29 – Station 0+50 (March 2016) view upstream and confluence.

Photo 58. Logan Creek, Photo Point 30 – Station 0+50 (March 2016) upstream view from right bank.

Photo 59. Logan Creek, Photo Point 30 – Station 0+50 (March 2016) downstream view from right bank.

Photo 60. UT5 - Preservation, Photo Point 31 – Station 1+80 (March 2016) downstream view from mid-channel to confluence.

Photo 61. UT5 - Preservation, Photo Point 31 – Station 1+80 (March 2016) upstream view from mid-channel to confluence.

Photo 62. UT5 - Preservation, Photo Point 32 – (March 2016) downstream view from right bank.

Photo 63. UT5 - Preservation, Photo Point 32 – (March 2016) upstream view from right bank.

Photo 64. UT5 - Preservation, Photo Point 33 – (March 2016) downstream view from right bank.

Photo 65. UT5 - Preservation, Photo Point 33 – (March 2016) downstream view from right bank.

Photo 64. UT5 - Preservation, Photo Point 33 – (March 2016) upstream view from right bank.

Table 10. 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?	19	19	0	100	
	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	**100%**
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		

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			

Table 10. Visual Morphological Stability Assessment - Continued
Logan Creek Stream Restoration Project: DMS Project ID No. 92515

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**

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

Date of Data Collection	Date of Event	Method of Data Collection	Gauge Watermark Height (inches)*
			Logan Creek Station 30+00
Dec-15	N/A	N/A	0

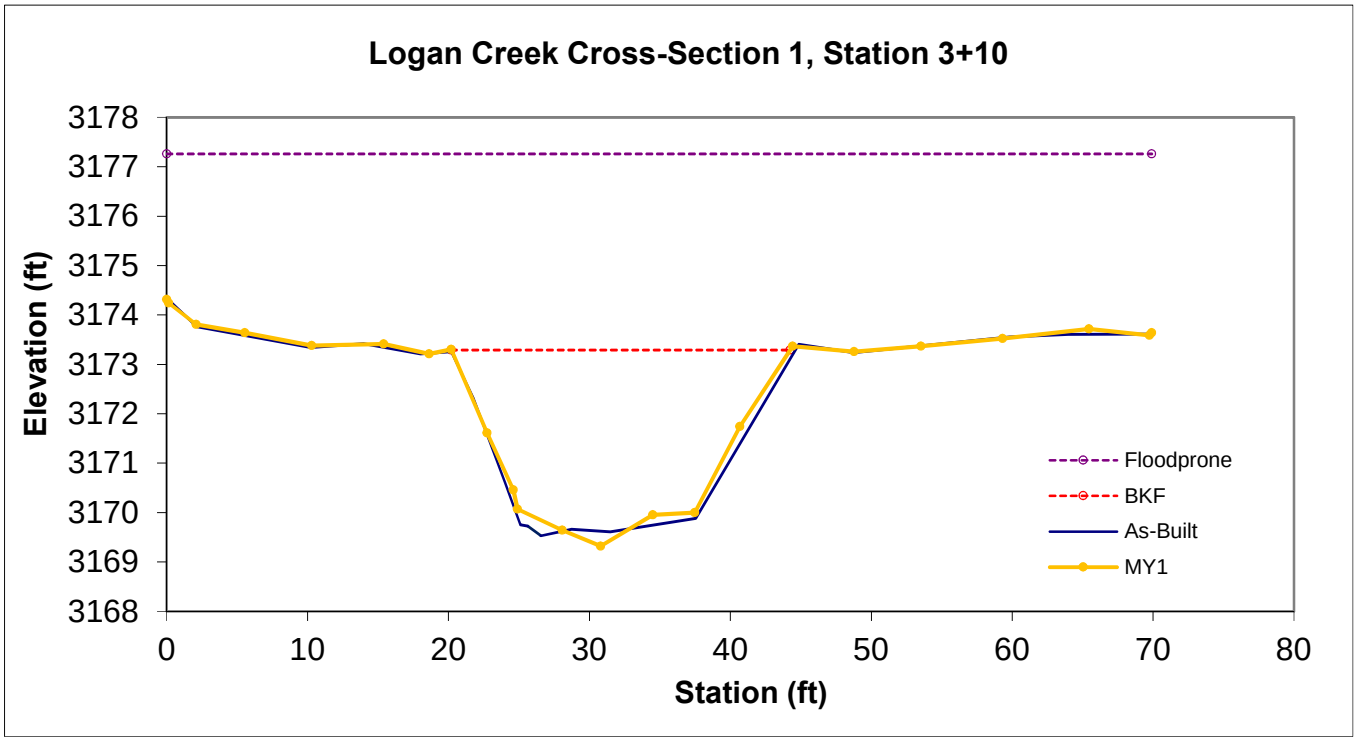
* height indicates the highest position of cork shavings on the dowel.

Figure 6. Cross-Sections with Annual Overlays.

Permanent Cross-Section 1

MY1 Data - collected December, 2015.

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	62.4	24.04	2.6	3.97	9.26	1	2.9	3173.29	3173.08



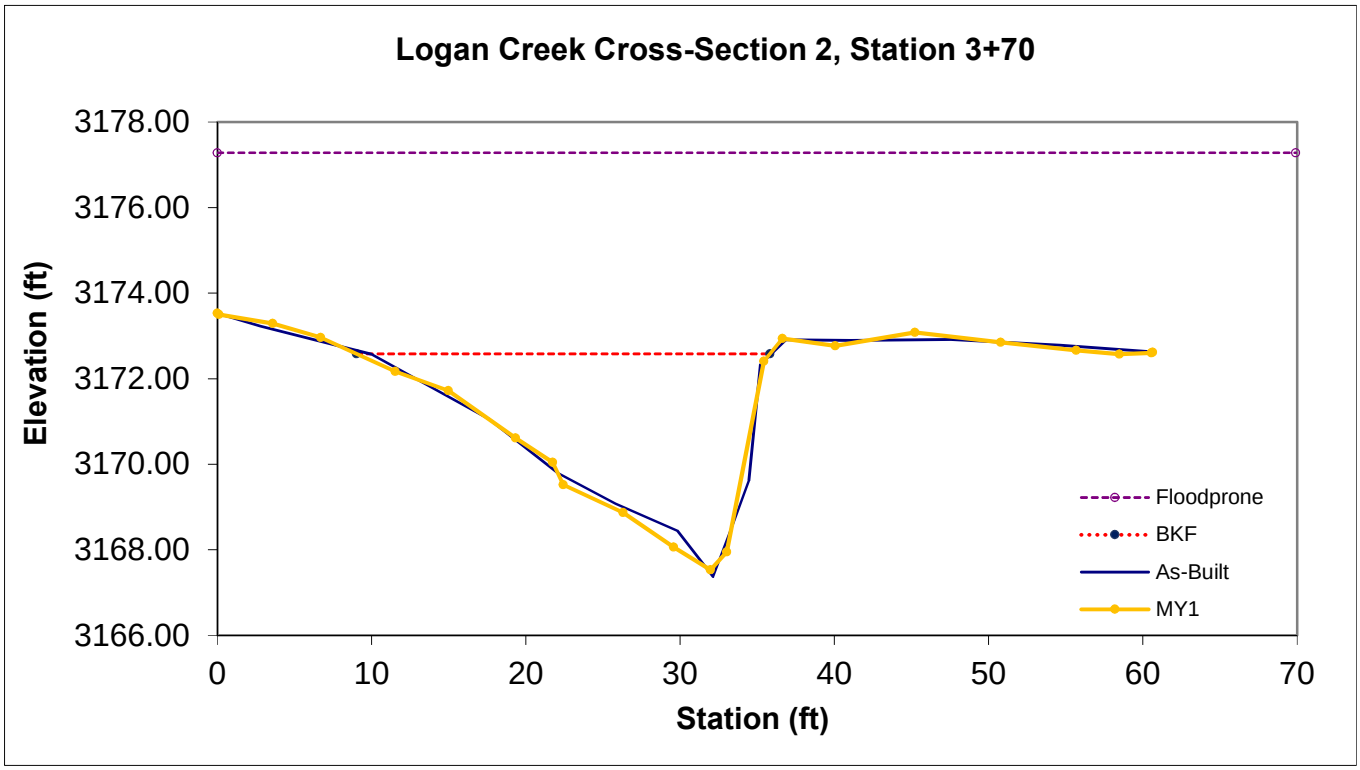
Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-Section 2

MY1 Data - collected December, 2015.

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		65.2	26.81	2.43	5.05	11.02	1.1	2.3	3172.34	3172.7



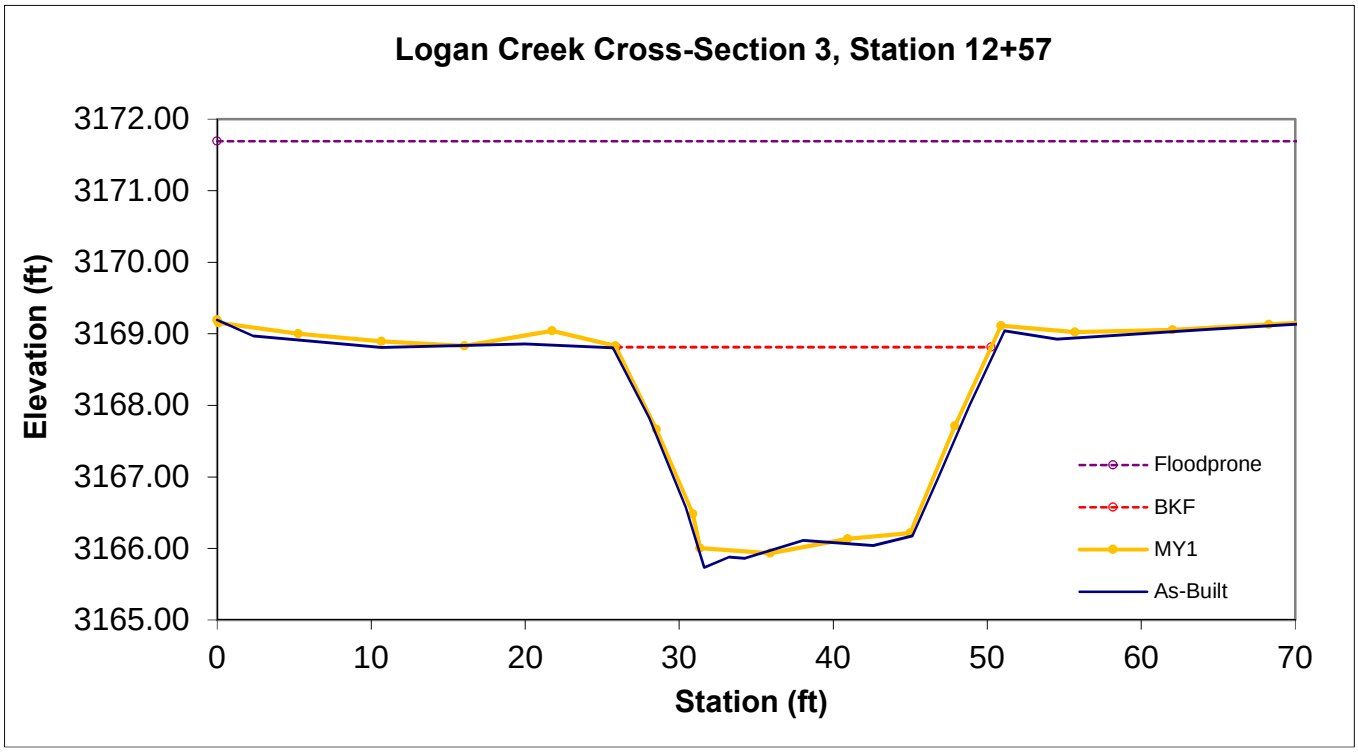
Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-Section 3

MY1 Data - collected January, 2016.

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	51.2	24.34	2.1	2.88	11.58	1.1	4.1	3169.03	3169.26

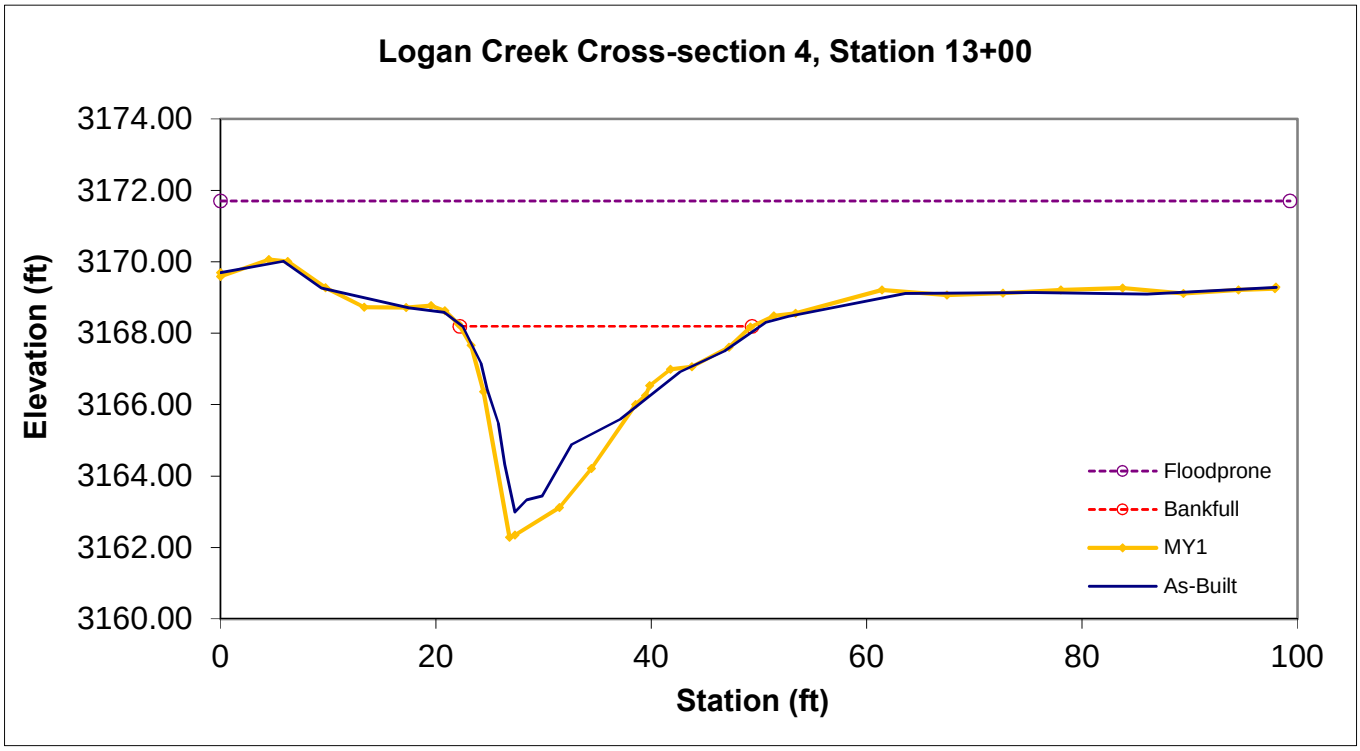


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-Section 4
MY1 Data - collected January, 2016.

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		73.8	27.12	2.72	5.91	9.97	1.1	3.6	3168.19	3168.77

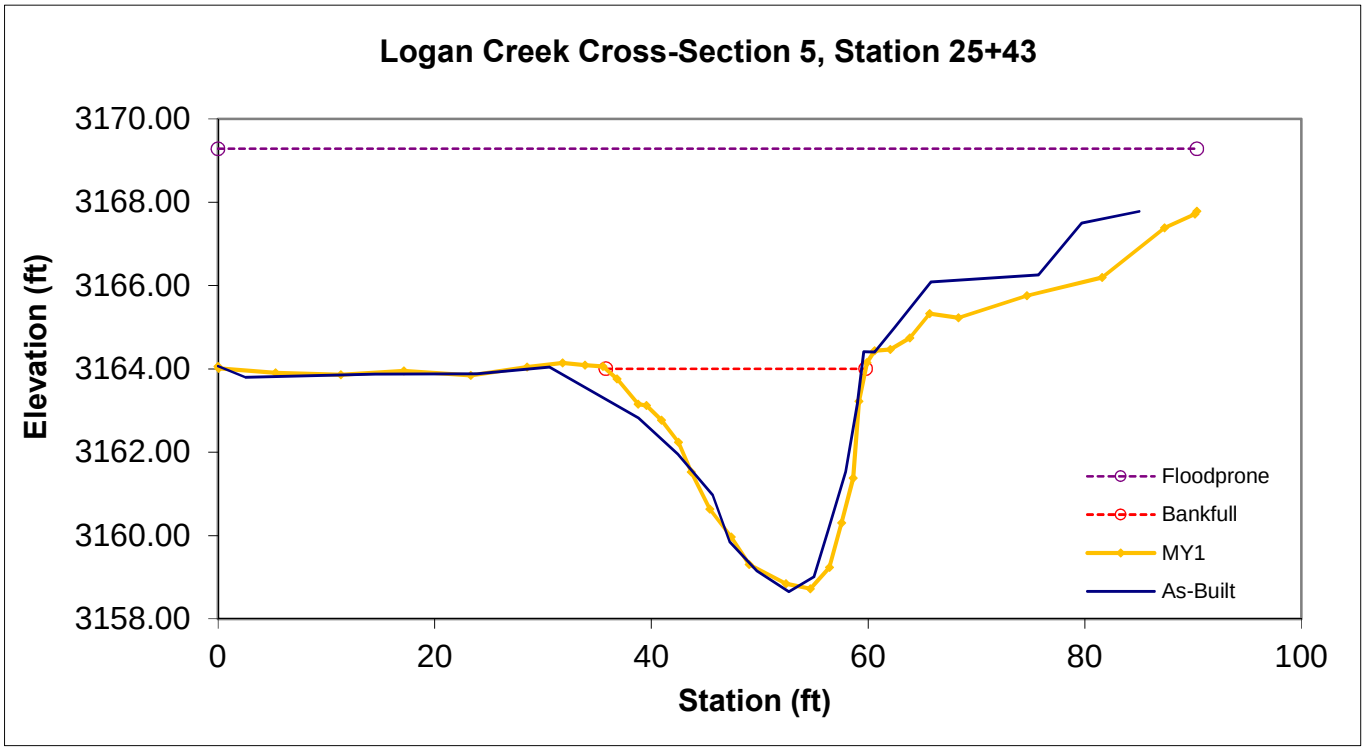


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-Section 5
MY1 Data - collected January, 2016.

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		74.3	24.01	3.1	5.28	7.76	1	3.8	3164	3164.34

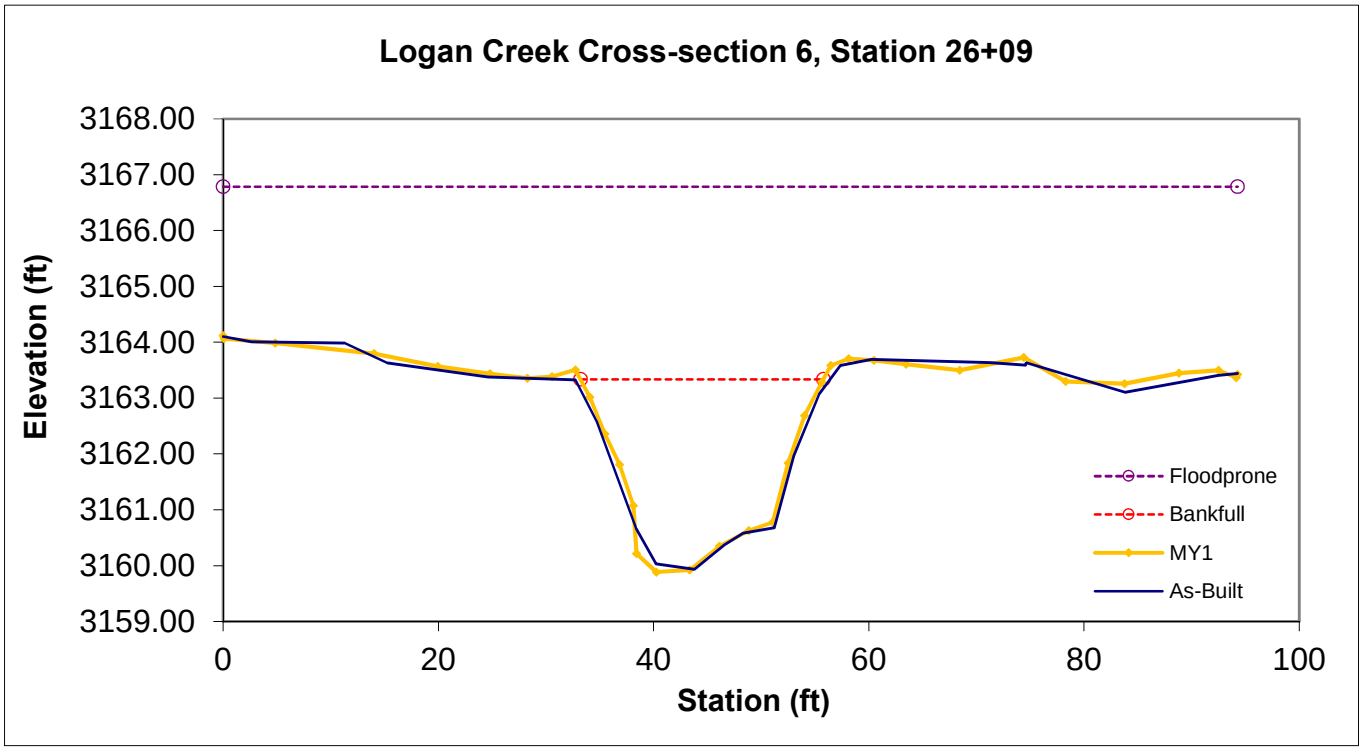


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-Section 6
MY1 Data - collected January, 2016.

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	50.2	22.57	2.23	3.45	10.14	1	4.2	3163.6	3163.77

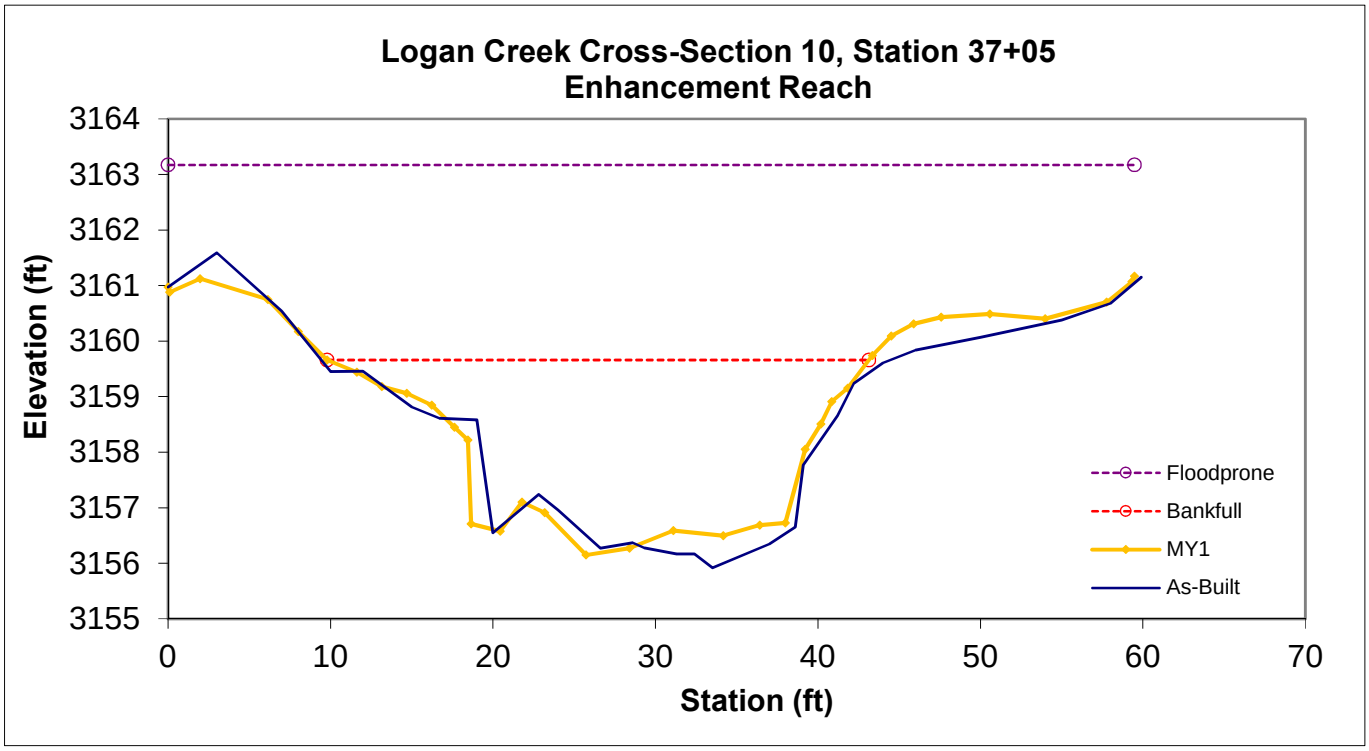


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-Section 10
MY1 Data - collected January, 2016.

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		71.2	33.35	2.13	3.51	15.62	1.1	1.8	3159.66	3160.09

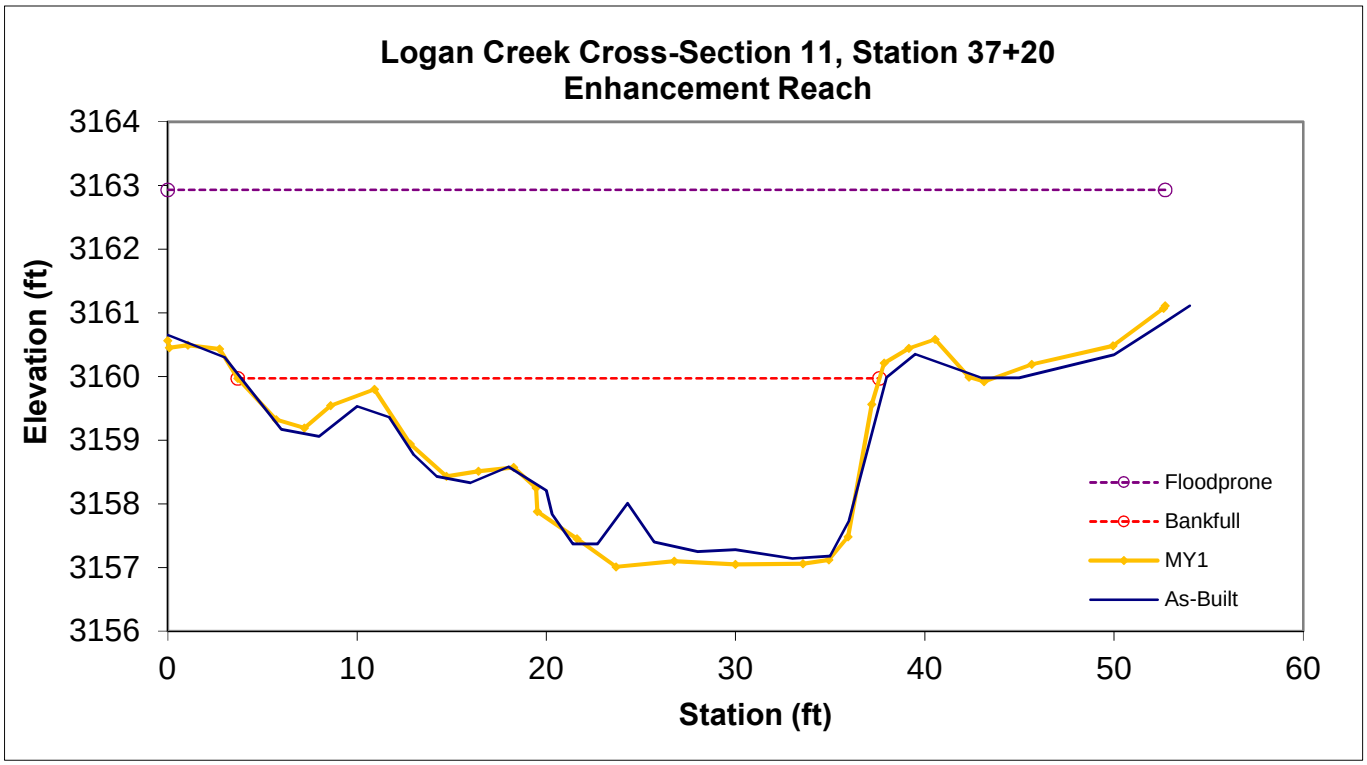


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-Section 11
MY1 Data - collected January, 2016.

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	61.8	33.92	1.82	2.96	18.62	1.2	1.6	3159.97	3160.43

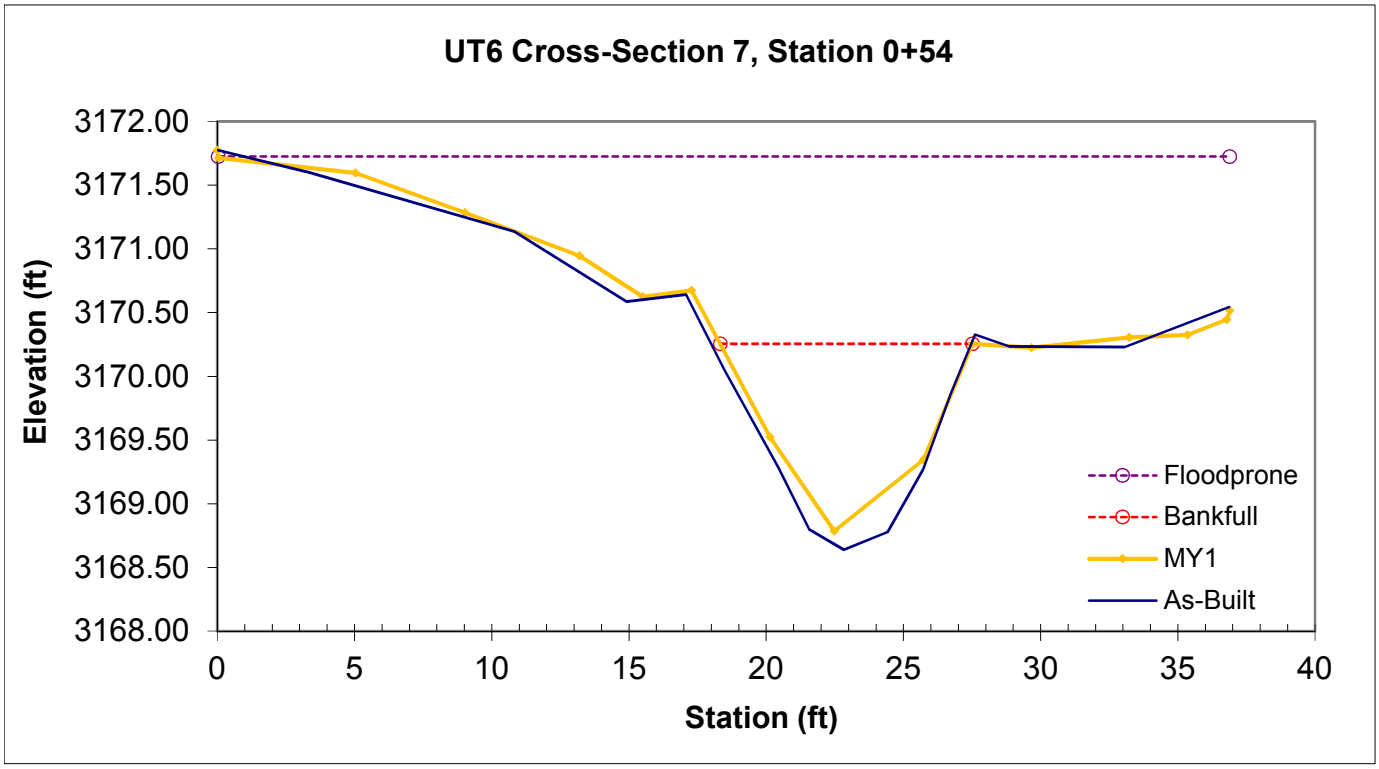


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 7
(MY1 Data - collected December, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		7.9	9.18	0.86	1.47	10.65	1	4	3170.04	3170.09

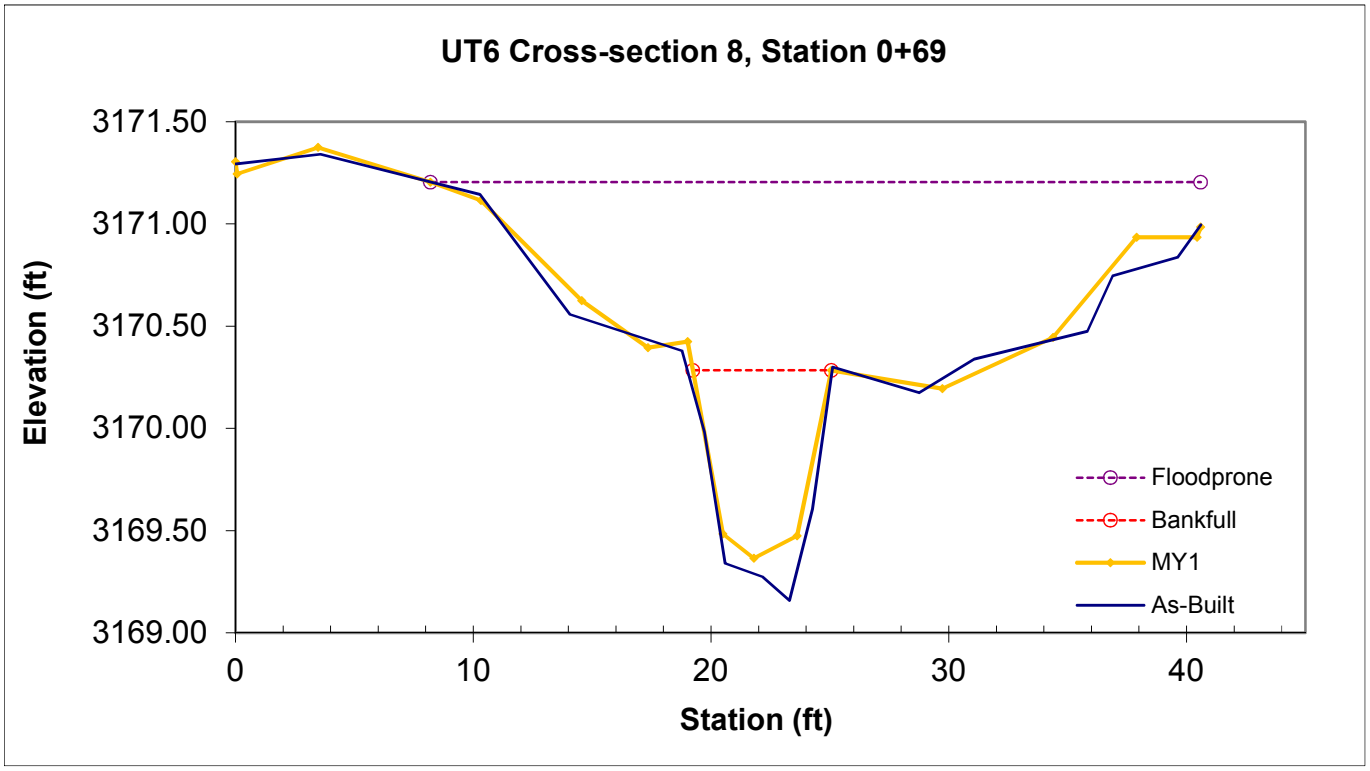


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 8
(MY1 Data - collected December, 2015)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	3.8	5.82	0.65	0.92	8.97	1	5.6	3170.05	3170.05

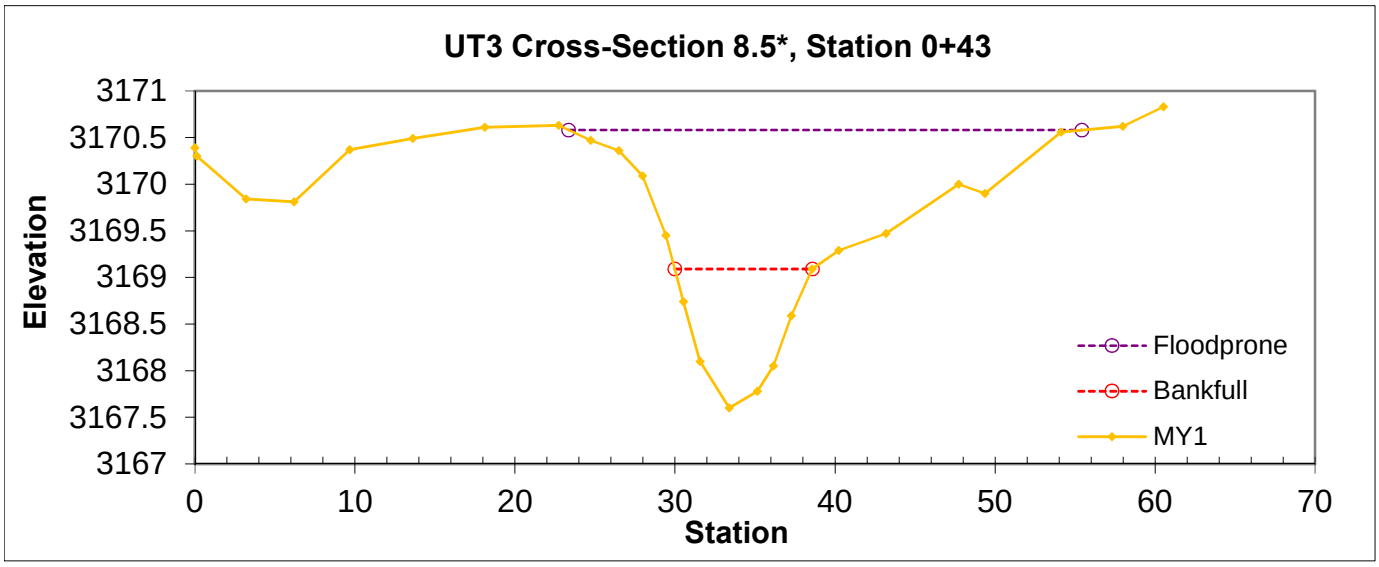


Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 8.5
(MY1 Data - collected January, 2016)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		7.9	8.59	0.92	1.49	9.36	1.1	3.7	3169.09	3169.29



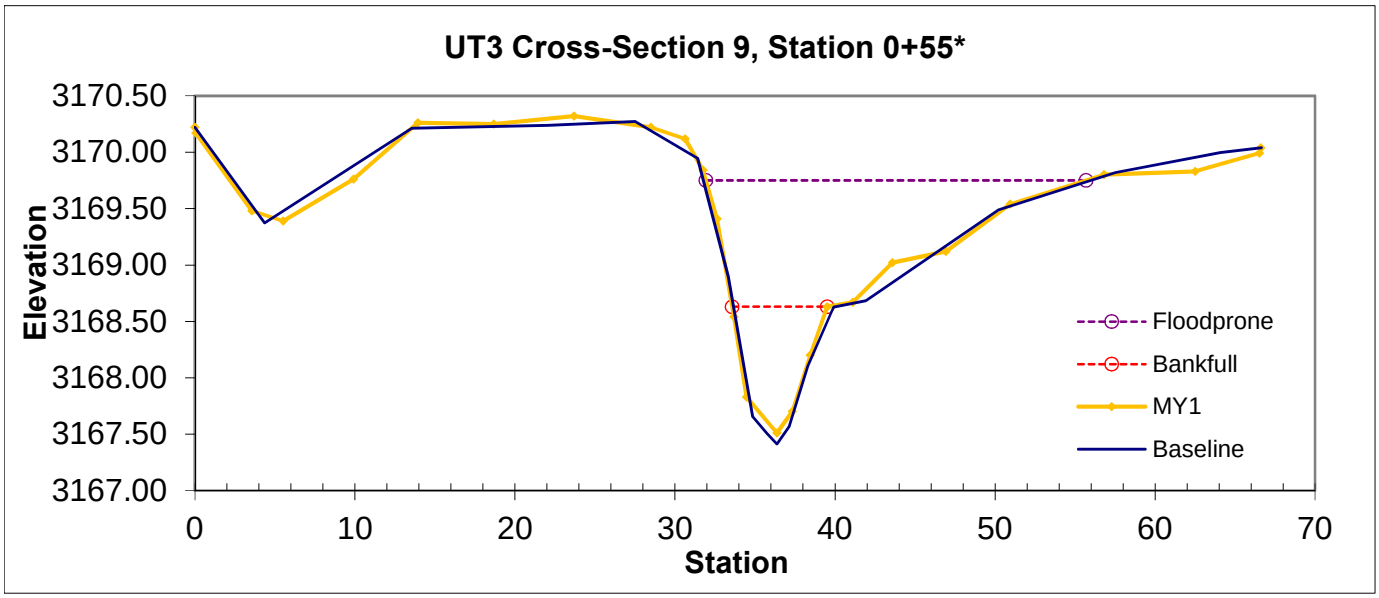
Looking at the Left Bank

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.

Permanent Cross-section 9
(MY1 Data - collected January, 2016)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	4.1	5.93	0.7	1.12	8.48	1	4	3168.83	3168.83

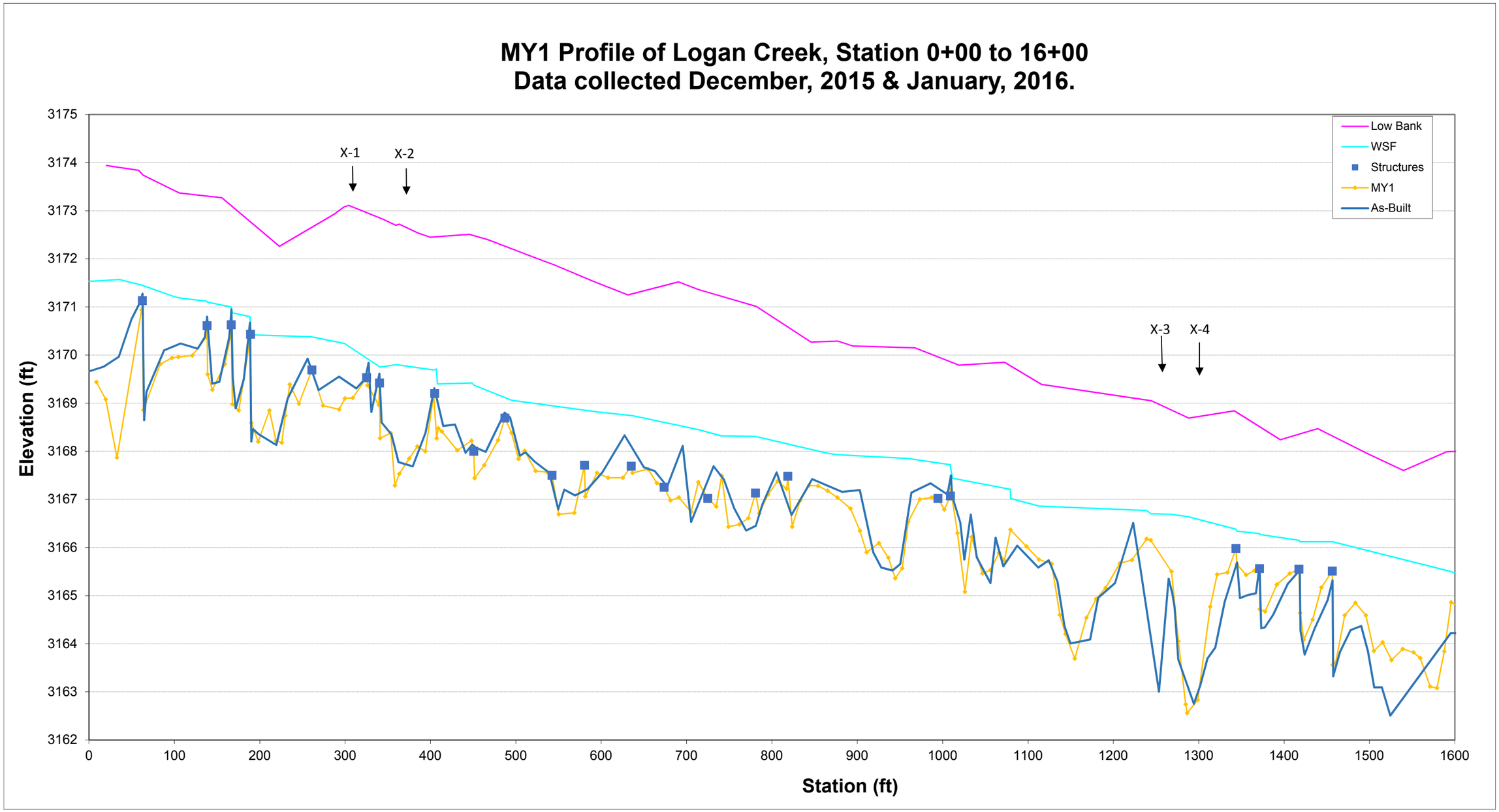


Looking at the Left Bank

Looking at the Right Bank

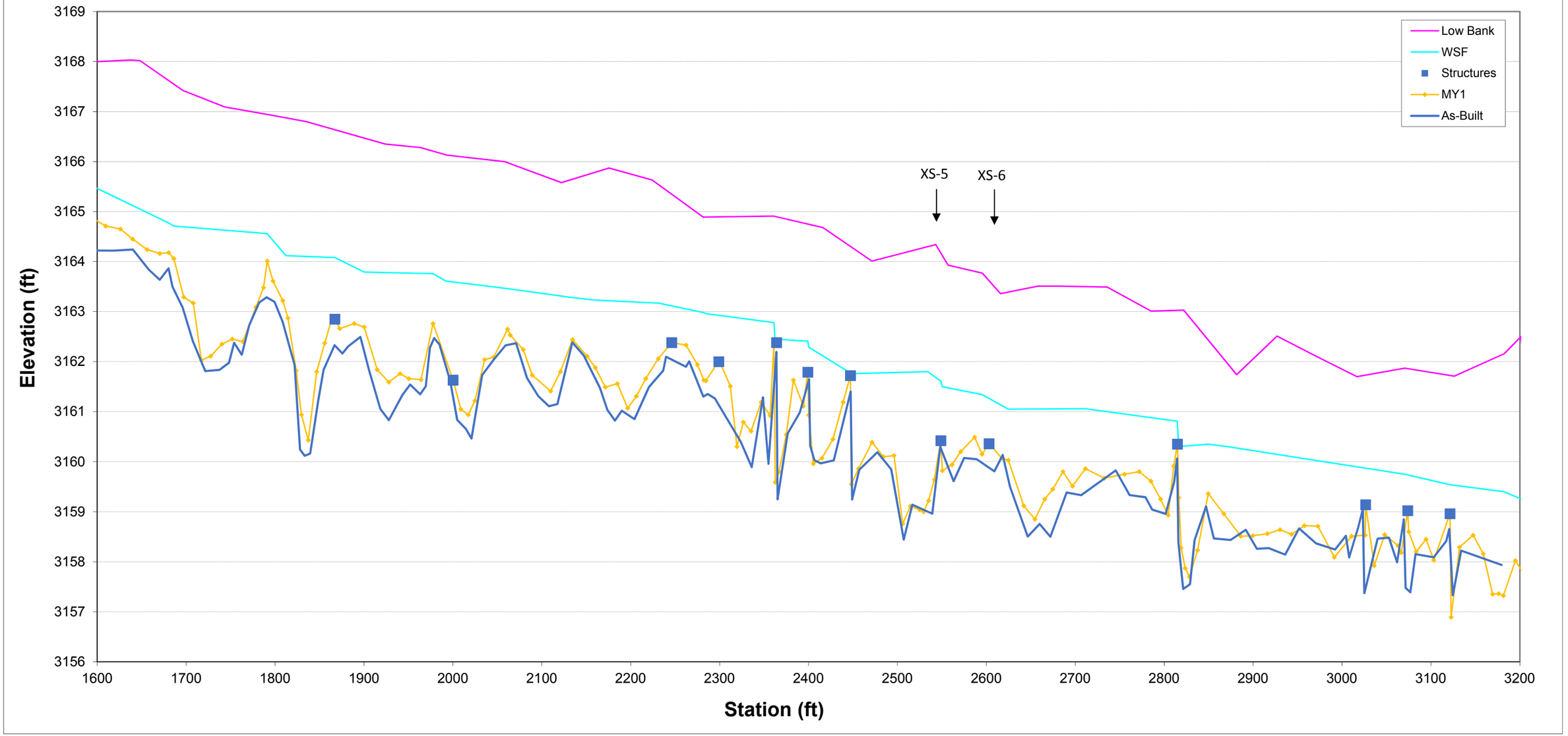
* Stationing is modified with this report because stationing reported in the baseline report was incorrect as was the photo location due to the photo being taken after the fact.

Figure 7. Longitudinal profiles with annual overlays.

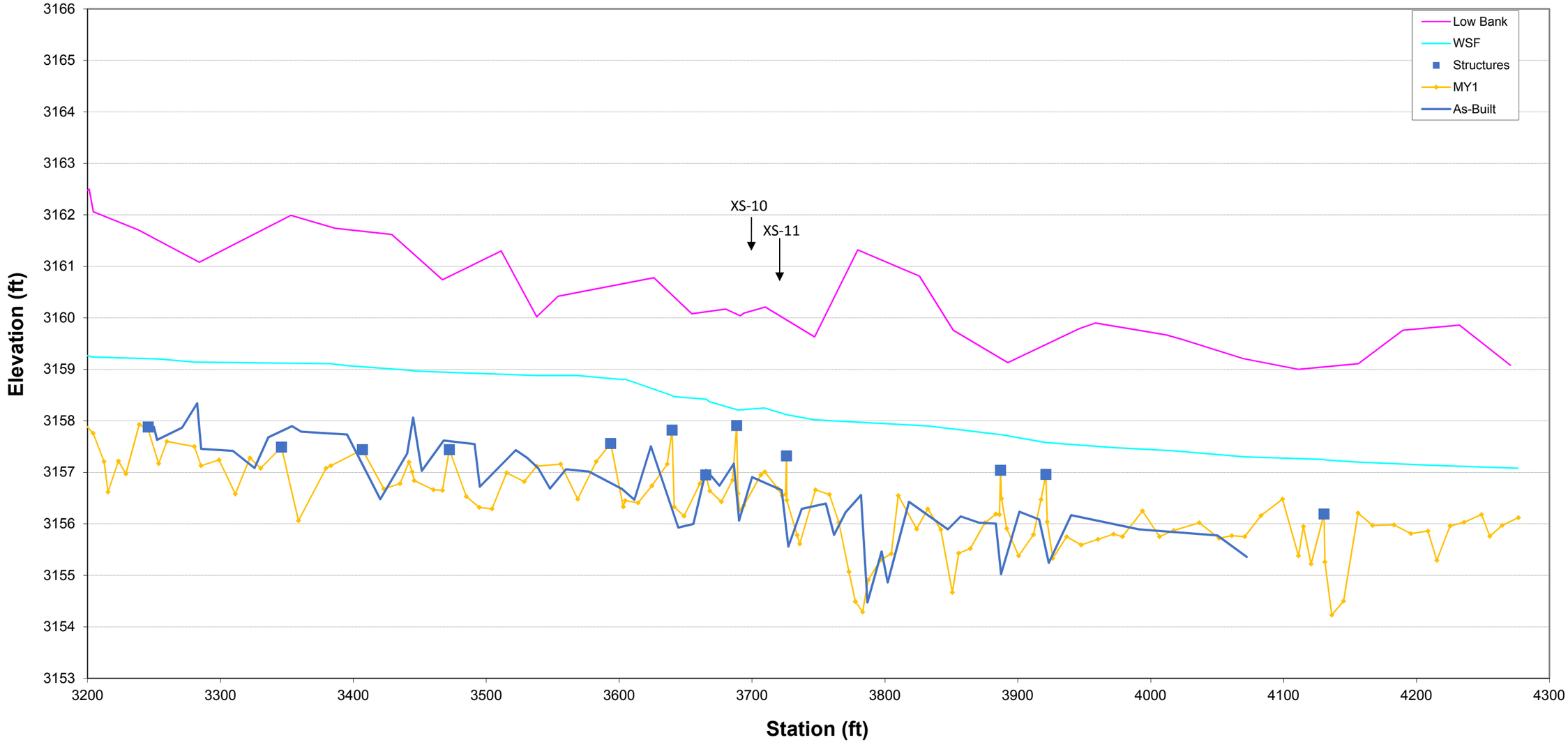


* Some structures shown are random woody debris saved from the old channel and installed in the new channel.

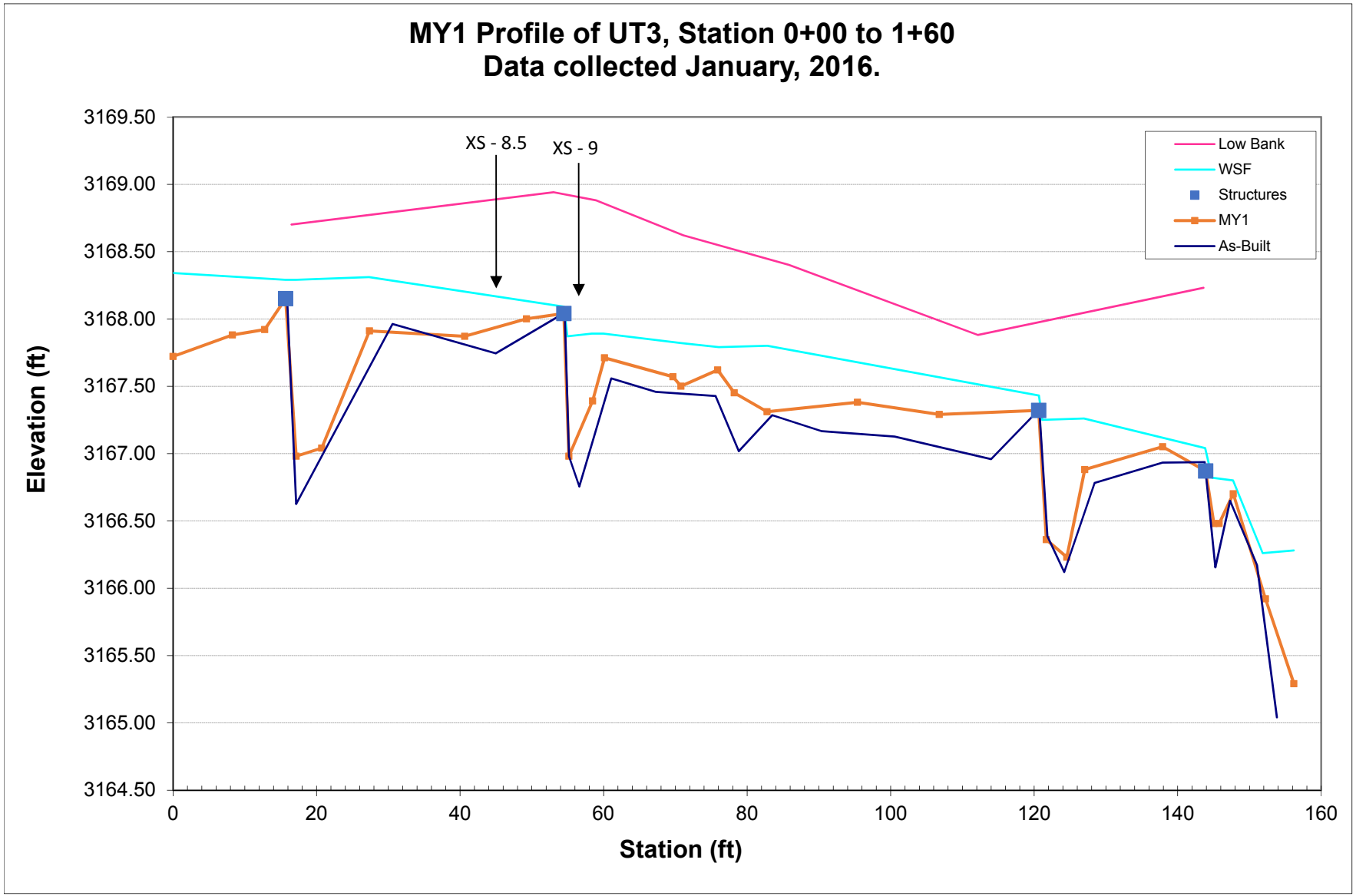
MY1 Profile of Logan Creek, Station 16+00 to 32+00
Data collected December, 2015 & January, 2016.



MY1 Profile of Logan Creek, Station 32+00 to 43+00
Data collected January, 2016 - Enhancement Reach

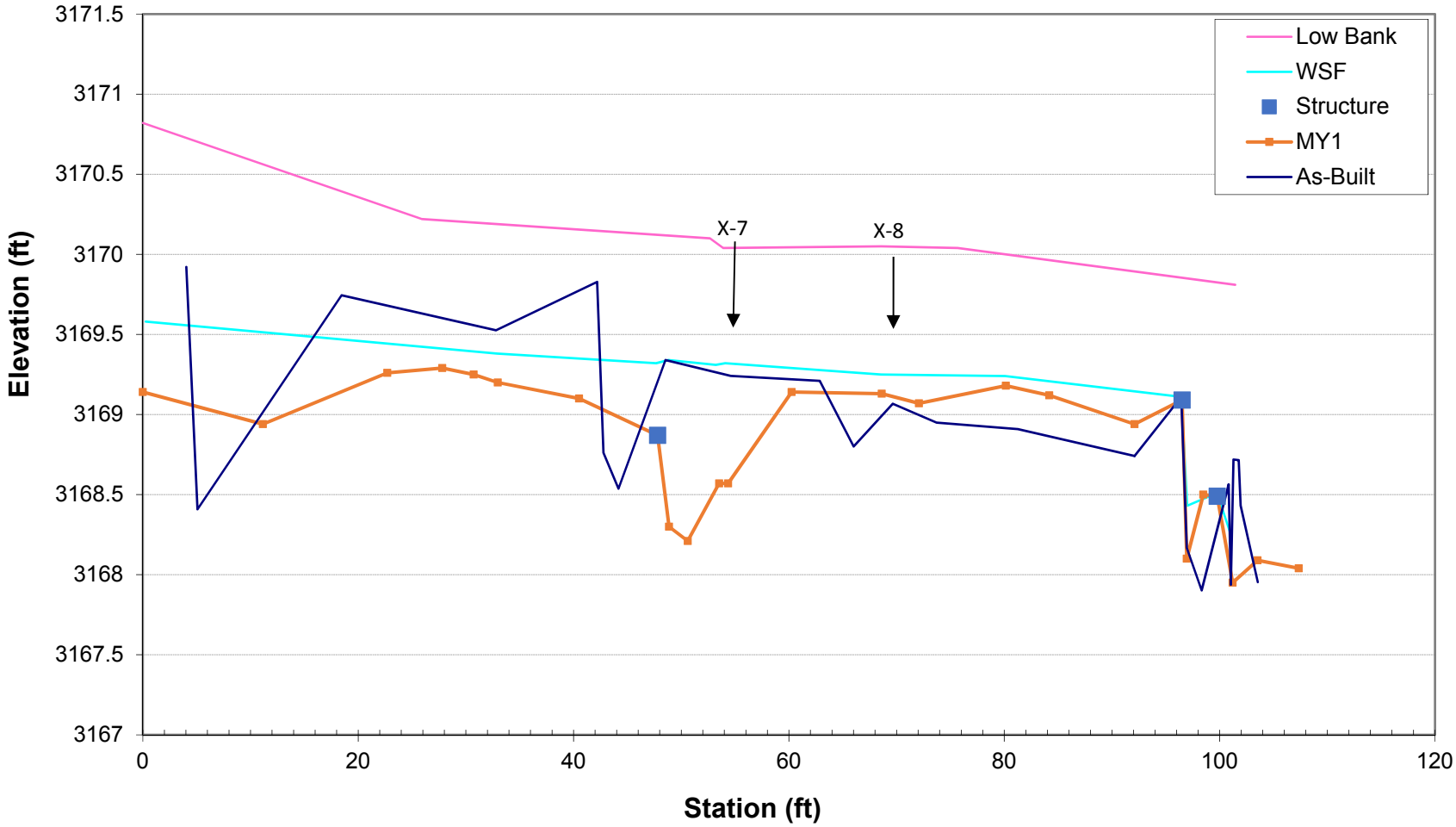


* Some structures shown are random woody debris saved from the old channel and installed in the new channel.



* Zero station is at the 0+00 of the MY1 survey and the baseline 0+00 was adjusted to 0+15.7.

MY1 Profile of UT6, Station 0+00 to 1+20
Data collected December, 2015



* Zero station is at the 0+00 of the MY1 survey and the baseline 0+00 was adjusted to 0+15.7.

Figure 8. Pebble count plots with annual overlays.

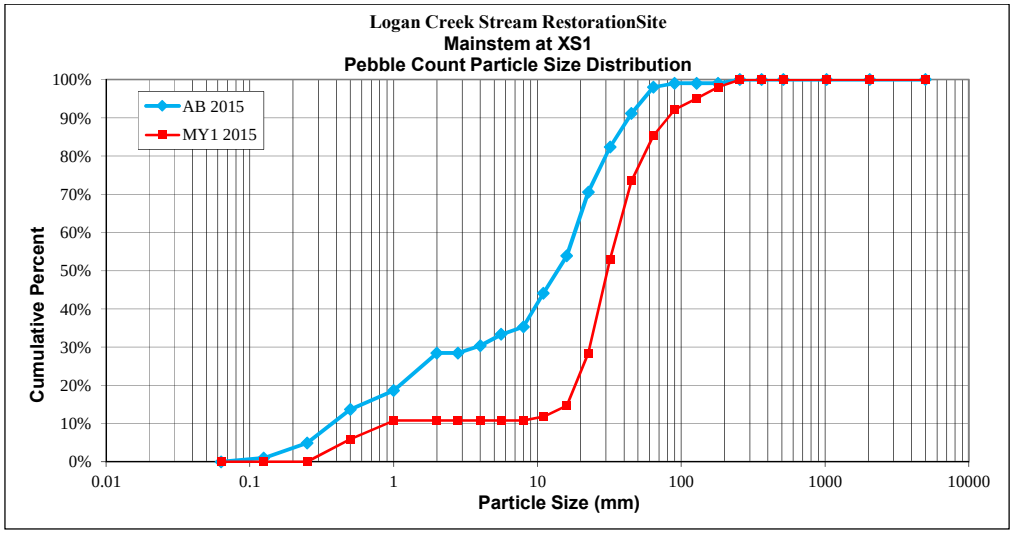
Cross-Section Pebble Count; Monitoring Year 1
Logan Creek Mitigation Project, DMS #92515

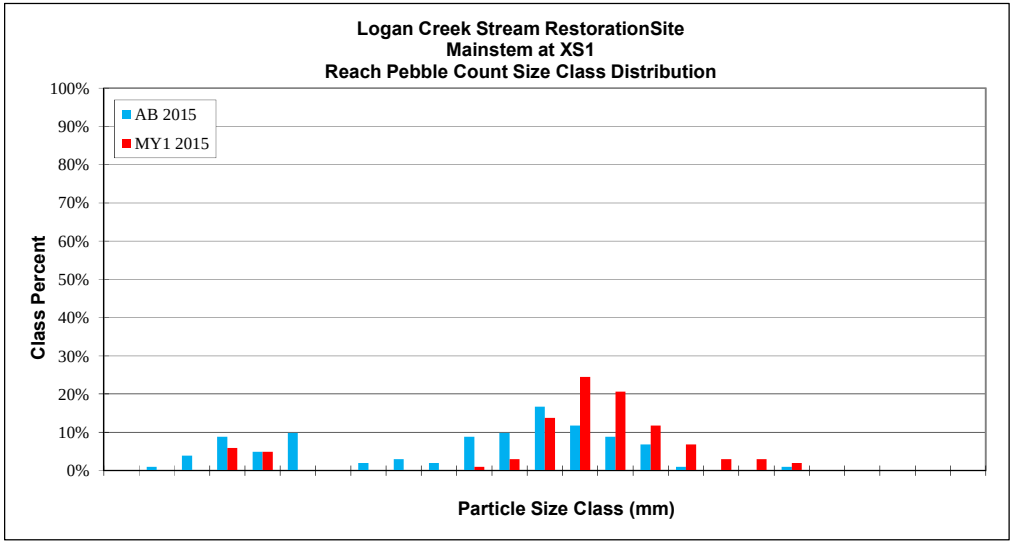
SITE OR PROJECT:	Logan Cr
REACH/LOCATION:	Riffle at XS1
FEATURE:	Riffle
DATE:	5-Jan-16

			MY1 2015			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125			0%	0.125
	Fine	.125 - .25			0%	0.25
	Medium	.25 - .50	6	6%	6%	0.50
	Coarse	.50 - 1.0	5	5%	11%	1.0
	Very Coarse	1.0 - 2.0			11%	2.0
Gravel	Very Fine	2.0 - 2.8			11%	2.8
	Very Fine	2.8 - 4.0			11%	4.0
	Fine	4.0 - 5.6			11%	5.6
	Fine	5.6 - 8.0			11%	8.0
	Medium	8.0 - 11.0	1	1%	12%	11.0
	Medium	11.0 - 16.0	3	3%	15%	16.0
	Coarse	16 - 22.6	14	14%	28%	22.6
	Coarse	22.6 - 32	25	25%	53%	32
	Very Coarse	32 - 45	21	21%	74%	45
	Very Coarse	45 - 64	12	12%	85%	64
Cobble	Small	64 - 90	7	7%	92%	90
	Small	90 - 128	3	3%	95%	128
	Large	128 - 180	3	3%	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			102	100%		

Largest particle= 190

Summary Data			
Channel materials			
D16 =	16.5	D84 =	61.6
D35 =	24.8	D95 =	126.5
D50 =	30.7	D100 =	180 - 256





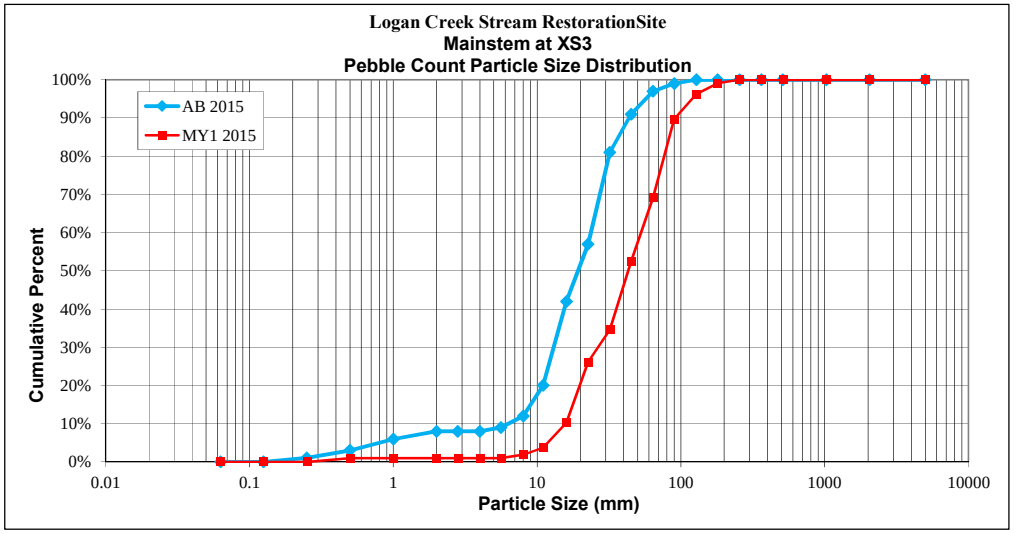
Cross-Section Pebble Count; Monitoring Year 1
Logan Creek Mitigation Project, DMS #92515

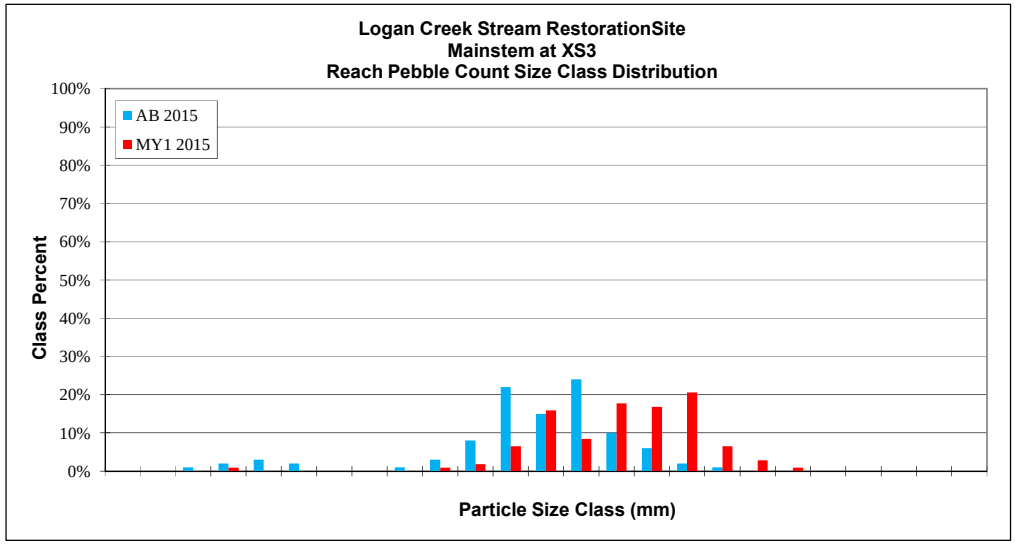
SITE OR PROJECT:	Logan Cr
REACH/LOCATION:	Riffle at XS3
FEATURE:	Riffle
DATE:	16-Dec-15

			MY1 2015			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125			0%	0.125
	Fine	.125 - .25			0%	0.25
	Medium	.25 - .50	1	1%	1%	0.50
	Coarse	.50 - 1.0			1%	1.0
	Very Coarse	1.0 - 2.0			1%	2.0
Gravel	Very Fine	2.0 - 2.8			1%	2.8
	Very Fine	2.8 - 4.0			1%	4.0
	Fine	4.0 - 5.6			1%	5.6
	Fine	5.6 - 8.0	1	1%	2%	8.0
	Medium	8.0 - 11.0	2	2%	4%	11.0
	Medium	11.0 - 16.0	7	7%	10%	16.0
	Coarse	16 - 22.6	17	16%	26%	22.6
	Coarse	22.6 - 32	9	8%	35%	32
	Very Coarse	32 - 45	19	18%	52%	45
	Very Coarse	45 - 64	18	17%	69%	64
Cobble	Small	64 - 90	22	21%	90%	90
	Small	90 - 128	7	7%	96%	128
	Large	128 - 180	3	3%	99%	180
	Large	180 - 256	1	1%	100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			107	100%		

Largest particle= 200

Summary Data			
Channel materials			
D16 =	18.1	D84 =	81.9
D35 =	32.3	D95 =	119.6
D50 =	43.0	D100 =	180 - 256





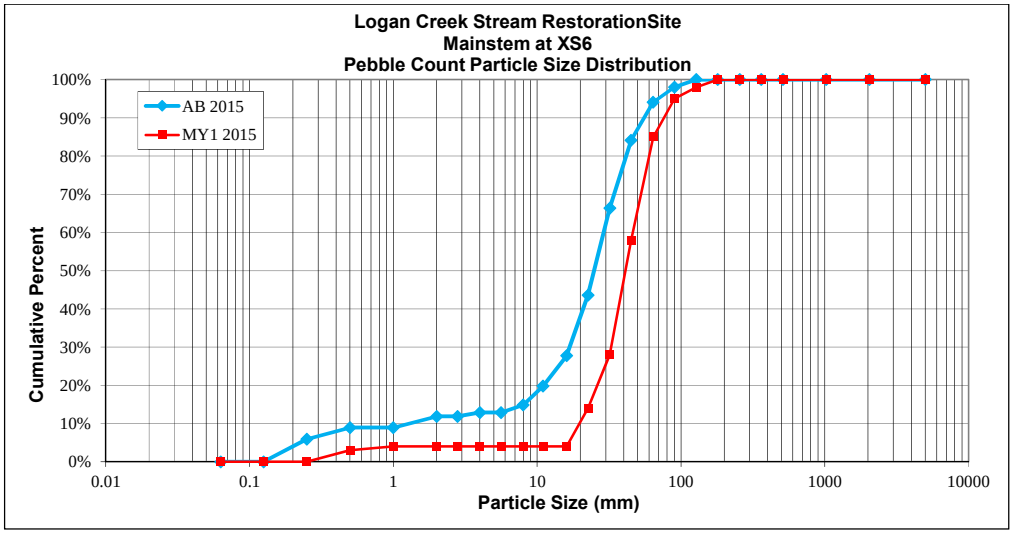
Cross-Section Pebble Count; Monitoring Year 1
Logan Creek Mitigation Project, DMS #92515

SITE OR PROJECT:	Logan Cr
REACH/LOCATION:	Riffle at XS6
FEATURE:	Riffle
DATE:	5-Jan-16

			MY1 2015			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125			0%	0.125
	Fine	.125 - .25			0%	0.25
	Medium	.25 - .50	3	3%	3%	0.50
	Coarse	.50 - 1.0	1	1%	4%	1.0
	Very Coarse	1.0 - 2.0			4%	2.0
Gravel	Very Fine	2.0 - 2.8			4%	2.8
	Very Fine	2.8 - 4.0			4%	4.0
	Fine	4.0 - 5.6			4%	5.6
	Fine	5.6 - 8.0			4%	8.0
	Medium	8.0 - 11.0			4%	11.0
	Medium	11.0 - 16.0			4%	16.0
	Coarse	16 - 22.6	10	10%	14%	22.6
	Coarse	22.6 - 32	14	14%	28%	32
	Very Coarse	32 - 45	30	30%	58%	45
	Very Coarse	45 - 64	27	27%	85%	64
Cobble	Small	64 - 90	10	10%	95%	90
	Small	90 - 128	3	3%	98%	128
	Large	128 - 180	2	2%	100%	180
	Large	180 - 256			100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			100	100%		

Largest particle= 128

Summary Data			
Channel materials			
D16 =	23.8	D84 =	63.2
D35 =	34.6	D95 =	90.0
D50 =	41.1	D100 =	128 - 180



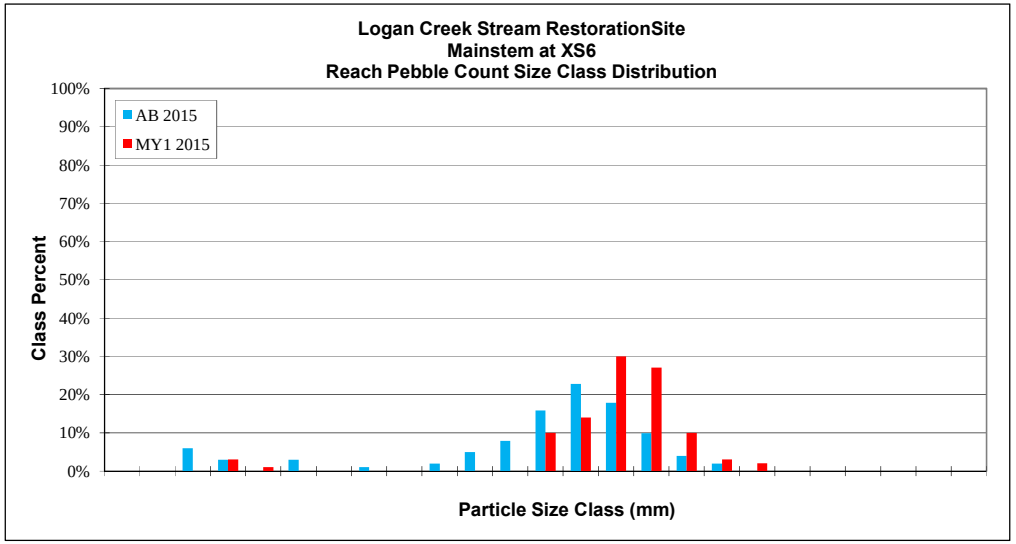


Table 12. Monitoring Year 1 Stream Summary
Logan Creek Restoration Project; DMS Project ID No. 94645

Logan Creek Mainstem

Parameter	USGS Gauge	Regional Curve Interval [1]			Pre-Existing Condition[1]						Reference Reach Data Right Prong Logan Creek						Design						As-built						MY1					
Dimension and Substrate - Riffle		NC Mtn. Regional Curve			Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	26.4	28.3	-	22.9	27.3	23.8	38.7	6.6	4	-	16.7	-	-	-	-	-	26.0	-	-	-	-	23.6	24.3	24.1	25.2	0.67	3	22.6	23.7	24.0	24.3	0.77	3
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	35.0	-	-	-	-	-	150.00	-	-	-	-	-	>150	-	-	-	3	-	>150	-	-	-	3
BF Mean Depth (ft)	-	1.4	1.5	-	1.50	2.2	2.4	2.60	0.4	4	-	1.06	-	-	-	-	-	2.3	-	-	-	-	2.1	2.3	2.2	2.6	0.22	3	2.1	2.3	2.2	2.6	0.21	3
BF Max Depth (ft)	-	-	-	-	3.4	3.6	3.5	3.8	0.2	4	-	1.54	-	-	-	-	-	4.0	-	-	-	-	3.1	3.4	3.4	3.7	0.24	3	2.9	3.4	3.5	4.0	0.45	3
BF Cross-sectional Area (ft^2)	-	37.5	42.7	-	55.8	58.0	58.4	59.5	1.36	4	-	17.7	-	-	-	-	-	58.5	-	-	-	-	51.7	56.0	53.2	63.0	5.01	3	50.2	54.6	51.2	62.4	5.53	3
Width/Depth Ratio	-	-	-	-	8.9	13.6	9.8	25.7	7.01	4	-	15.8	-	-	-	-	-	12	-	-	-	-	9.2	10.7	10.8	12.0	1.12	3	9.3	10.3	10.1	11.6	0.96	3
Entrenchment Ratio	-	-	-	-	3.4	11.3	12.0	17.8	5.83	4	-	2.0	-	-	-	-	-	5.8	-	-	-	-	2.9	3.6	3.9	4.0	0.50	3	2.9	3.7	4.0	4.1	0.54	3
Bank Height Ratio	-	-	-	-	1	1.2	1.1	1.5	0.2	4	-	1.2	-	-	-	-	-	1.0	-	-	-	-	1.0	1.00	1.00	1.0	0.00	3	1.0	1.0	1.0	1.1	0.05	3
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pattern																																		
Channel Beltwidth (ft)	-	-	-	-	194	216	217	252	18.13	7	-	80	-	-	-	-	65	-	-	140	-	-	130.0	193.2	190.0	258.0	41.45	6	130.0	193.2	190.0	258.0	41.5	6
Radius of Curvature (ft)	-	-	-	-	23	32	30	46	8.6	5	-	23	-	-	-	-	28	-	-	75	-	-	44.0	63.9	66.1	104.0	17.17	9	44.0	63.9	66.1	104.0	17.2	9
Rc:Bankfull width (ft/ft)	-	-	-	-	0.85	1.19	1.11	1.7	0.32	5	-	1.38	-	-	-	-	1.1	-	-	2.9	-	-	1.80	2.60	2.70	4.30	0.71	9	1.80	2.60	2.70	4.30	0.71	9
Meander Wavelength (ft)	-	-	-	-	120	177	197	239	46.75	5	-	150	-	-	-	-	118	-	-	236	-	-	145.0	236.7	244.5	321.0	48.10	12	145.0	236.7	244.5	321.0	48.1	12
Meander Width Ratio	-	-	-	-	4.44	6.56	7.3	8.85	1.73	5	-	4.8	-	-	-	-	2.5	-	-	5.4	-	-	6.0	9.7	10.1	13.2	1.98	12	6.0	9.7	10.1	13.2	2.0	12
Profile																																		
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25.65	68.1	65.34	149.75	31.6	16
Riffle Slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.019	-	-	-	-	0.003	-	-	0.007	-	-	-	-	-	-	-	-	0.0009	0.0079	0.0049	0.0218	0.0065	16
Pool Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31.03	66.38	64.5	112.21	25.4	19
Pool Spacing (ft)	-	-	-	-	-	-	-	-	-	-	-	75	-	-	-	-	94	-	-	165	-	-	-	-	-	-	-	-	86.6	148.6	143.45	292.6	51.9	20
Pool Max Depth (ft)	-	-	-	-	2.9	3.8	4.0	4.5	0.64	3	-	2.28	-	-	-	-	-	6.00	-	-	-	-	5.2	5.3	5.2	5.4	0.1	3	5.1	5.4	5.3	5.9	0.36	3
Pool Volume (ft^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																																		
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	0.8 / 5.8 / 12.4 / 35.4 / 169.6						-	-	-	-	-	-	-	-	-	-	-	-	mean 5.1 / 10.9 / 16.5 / 34.8 / 55.9						mean 17.3/ 28.6 / 36.9 / 71.8 / 123.1					
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 towads end of project						-	0.83	-	-	-	-	2.1 at upper end of project to 2.67 towads end of project						2.1 at upper end of project to 2.67 towads end of project						2.1 at upper end of project to 2.67 towads end of project					
Impervious cover estimate (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.67	-	-	-	-	-	2.67	-	-	-	-	-	2.67	-	-	-	-
Rosgen Classification	-	-	-	-	-	C4 to E4	-	-	-	-	-	C4	-	-	-	-	-	C4	-	-	-	-	-	C4	-	-	-	-	-	C4	-	-	-	-
BF Velocity (fps)	-	-	-	-	-	-	-	-	-	-	-	3.55	-	-	-	-	-	4.31	-	-	-	-	-	4.33	-	-	-	-	-	4.20	-	-	-	-
BF Discharge (cfs)	-	205.7	237.0		-	-	-	-	-	-	-	98	-	-	-	-	-	271.5	-	-	-	-	-	242.6	-	-	-	-	-	264.8	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)	-	-	-	-	-	4,700	-	-	-	-	-	-	-	-	-	-	-	4,101	-	-	-	-	-	4,172	-	-	-	-	-	4,172	-	-	-	-
Sinuosity	-	-	-	-	-	-	-	-	-	-	-	2.01	-	-	-	-	-	1.3	-	-	-	-	-	1.31	-	-	-	-	-	1.34	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.0079	-	-	-	-	-	0.0035	-	-	-	-	-	0.0039	-	-	-	-	-	0.0033	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.016	-	-	-	-	-	0.0047	-	-	-	-	-	0.0052	-	-	-	-	-	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.

Table 12 Monitoring Year 1 Stream Summary
Logan Creek Restoration Project; DMS Project ID No. 94645

UT3

Parameter	USGS Gauge	Regional Curve Interval [1]			Pre-Existing Condition [1]						Reference Reach Data Morgan Creek						Design						As-built						MY1					
Dimension and Substrate - Riffle		NC Mtn./NC Pied.	Rural		Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	5.3	4.1	-	-	-	-	-	-	-	-	16.7	-	-	-	-	-	6.0	-	-	-	-	6.1	6.2	6.2	6.3	0.06	2	-	5.9	-	-	-	1
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	35.0	-	-	-	-	-	-	-	-	-	-	-	>27	-	-	-	-	-	28.1	-	-	-	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
BF Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	1.54	-	-	-	-	-		-	-	-	-	1.1	1.2	1.2	1.2	0.0	2	-	1.1	-	-	-	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	-	4.1	-	-	-	1
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	15.8	-	-	-	-	-		-	-	-	-	8.1	8.4	8.4	8.7	0.3	2	-	8.5	-	-	-	1
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-	-	-	-	-	4.3	5.5	5.5	6.6	1.2	2	-	4.0	-	-	-	1
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	1.0	1.0	1.0	1.0	0.0	2	-	1.0	-	-	-	1
d50 (mm)	-	-	-	-	-		-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pattern																																		
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-	-	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	-	-	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Width Ratio	-	-	-	-	-	-	-	-	-	-	-	4.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profile																																		
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0	31.8	19.0	77.0	26.3	4	14.3	18.7	14.9	30.5	6.9	4	27.1	43.8	43.8	60.51	16.7	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	0.0000	0.0032	0.0032	0.0064	0.0032	2
Pool Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.0	-	-	0	4	6.5	11.6	7.9	21.4	5.7	5	5.68	11.56	11.70	17.29	4.70	3
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	21.23	42.9	38.02	69.37	20	3
Pool Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	2.28	-	-	-	-	-	1.2	-	-	-	-	1.7	-	-	-	-	1	-	1.5	-	-	-	-
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/f²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																													UT3 - UT6					
Drainage Area (SM)	-	0.025 to 0.08				0.025 to 0.08			-	-	-	0.83	-	-	-	-	-	-	-	-	-	-	-	0.025 to 0.08			-	-	-	0.025 to 0.08		-	-	-
Impervious cover estimate (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5%	-	-	-	-	-	<5%		-	-	-
Rosgen Classification	-	-	-	-	-	-	-	-	-	-	-	C4	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	C		-	-	-
BF Velocity (fps)	-	-	-	-	-	-	-	-	-	7	-	3.55	-	-	-	-	-	-	-	-	-	-	-	4.27	-	-	-	-	-	4.81		-	-	-
BF Discharge (cfs)	-	7.8	18.3		-	-	-	-	-	-	-	98	-	-	-	-	-	-	-	-	-	-	-	212.2	-	-	-	-	-	22.1		-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)*	-	-	-	-	-	75	-	-	-	-	-	-	-	-	-	-	-	311.0	-	-	-	-	-	350	-	-	-	-	-	153		-	-	-
Sinuosity	-	-	-	-	-	-	-	-	-	-	-	2.01	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	-	1.17		-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.0079	-	-	-	-	-	-	-	-	-	-	-	0.0043	-	-	-	-	-	0.0225		-	-	-
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. 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 12 Monitoring Year 1 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					
Dimension and Substrate - Riffle		NC Mtn./NC Pied.		Rural	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	5.3	4.1	-	-	-	-	-	-	-	-	16.7	-	-	-	-	-	6.0	-	-	-	-	6.1	6.2	6.2	6.3	0.06	2	-	5.8	-	-	-	1
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	35.0	-	-	-	-	-	-	-	-	-	-	-	>27	-	-	-	-	-	32.4	-	-	-	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
BF Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	1.54	-	-	-	-	-		-	-	-	-	1.1	1.2	1.2	1.2	0.0	2	-	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
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	15.8	-	-	-	-	-		-	-	-	-	8.1	8.4	8.4	8.7	0.3	2	-	9.0	-	-	-	1
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-	-	-	-	-	4.3	5.5	5.5	6.6	1.2	2	-	5.6	-	-	-	1
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	1.0	1.0	1.0	1.0	0.0	2	-	1.0	-	-	-	1
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Pattern																																		
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-	-	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	-	-	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Width Ratio	-	-	-	-	-	-	-	-	-	-	-	4.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profile																																		
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0	31.8	19.0	77.0	26.3	4	14.3	18.7	14.9	30.5	6.9	4	17.81	27.00	27.03	36.25	9.2	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
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	7.0	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	3.4	2
Pool Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	2.28	-	-	-	-	-	1.2	-	-	-	-	1.7	-	-	-	-	1	-	1.5	-	-	-	-
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/f^2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m^2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																													UT3 - UT6					
Drainage Area (SM)	-	0.025 to 0.08			0.025 to 0.08				-	-	-	0.83	-	-	-	-	-	-	-	-	-	-	-	0.025 to 0.08			-	-	-	0.025 to 0.08		-	-
Impervious cover estimate (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5%	-	-	-	-	-	<5%		-	-	-
Rosgen Classification	-	-	-	-	-	-	-	-	-	-	-	C4	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	C		-	-	-
BF Velocity (fps)	-	-	-	-	-	-	-	-	-	7	-	3.55	-	-	-	-	-	-	-	-	-	-	-	4.27	-	-	-	-	-	3.32		-	-	-
BF Discharge (cfs)	-	7.8	18.3		-	-	-	-	-	-	-	98	-	-	-	-	-	-	-	-	-	-	-	212.2	-	-	-	-	-	15.2		-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel length (ft)*	-	-	-	-	-	75	-	-	-	-	-	-	-	-	-	-	-	311.0	-	-	-	-	-	350	-	-	-	-	-	104		-	-	-
Sinuosity	-	-	-	-	-	-	-	-	-	-	-	2.01	-	-	-	-	-	-	-	-	-	-	-	1.5	-	-	-	-	-	1.04		-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	0.0079	-	-	-	-	-	-	-	-	-	-	-	0.0043	-	-	-	-	-	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	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 13. 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	-	-	-	-	-	25.9	26.8	-	-	-	-	-	25.2	24.3	-	-	-	-	-	27.6	27.1	-	-	-	-	-
BF Mean Depth (ft)	2.6	2.6	-	-	-	-	-	2.5	2.4	-	-	-	-	-	2.1	2.1	-	-	-	-	-	2.3	2.7	-	-	-	-	-
Width/Depth Ratio	9.2	9.3	-	-	-	-	-	10.5	11.0	-	-	-	-	-	12.0	11.6	-	-	-	-	-	12.1	10.0	-	-	-	-	-
BF Cross-sectional Area (ft²)	63.0	62.4	-	-	-	-	-	63.9	65.2	-	-	-	-	-	53.2	51.2	-	-	-	-	-	62.8	73.8	-	-	-	-	-
BF Max Depth (ft)	3.7	4.0	-	-	-	-	-	5.2	5.1	-	-	-	-	-	3.1	2.9	-	-	-	-	-	5.2	5.9	-	-	-	-	-
Width of Floodprone Area (ft)	>70	>70	-	-	-	-	-	>60	>60	-	-	-	-	-	>100	>100	-	-	-	-	-	>100	>100	-	-	-	-	-
Entrenchment Ratio	2.9	2.9	-	-	-	-	-	2.3	2.3	-	-	-	-	-	3.9	4.1	-	-	-	-	-	3.6	3.6	-	-	-	-	-
Bank Height Ratio	1.0	1.0	-	-	-	-	-	1.1	1.1	-	-	-	-	-	1.0	1.1	-	-	-	-	-	1.0	1.0	-	-	-	-	-
Wetted Perimeter (ft)	29.3	29.3	-	-	-	-	-	30.9	31.7	-	-	-	-	-	29.5	28.6	-	-	-	-	-	32.2	32.6	-	-	-	-	-
Hydraulic Radius (ft)	2.1	2.1	-	-	-	-	-	2.1	2.1	-	-	-	-	-	1.8	1.8	-	-	-	-	-	2.0	2.3	-	-	-	-	-
Based on current/developing bankfull feature																												
BF Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Mean Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Cross-sectional Area (ft²)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width of Floodprone Area (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wetted Perimeter (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cross Sectional Area between end pins (ft²)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d50 (mm)	13.8	30.7	-	-	-	-	-	-	-	-	-	-	-	-	19.2	43	-	-	-	-	-	-	-	-	-	-	-	-

	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	-	-	-	-	-	23.6	22.6	-	-	-	-	-	31.0	33.4	-	-	-	-	-	29.2	33.9	-	-	-	-	-
BF Mean Depth (ft)	3.0	3.1	-	-	-	-	-	2.2	2.2	-	-	-	-	-	2.1	2.1	-	-	-	-	-	2.1	1.8	-	-	-	-	-
Width/Depth Ratio	7.1	7.8	-	-	-	-	-	10.8	10.1	-	-	-	-	-	14.4	15.6	-	-	-	-	-	14.0	18.6	-	-	-	-	-
BF Cross-sectional Area (ft²)	63.9	74.3	-	-	-	-	-	51.7	50.2	-	-	-	-	-	66.6	71.2	-	-	-	-	-	60.7	61.8	-	-	-	-	-
BF Max Depth (ft)	5.4	5.3	-	-	-	-	-	3.4	3.5	-	-	-	-	-	3.5	3.5	-	-	-	-	-	2.9	3.0	-	-	-	-	-
Width of Floodprone Area (ft)	>80	>80	-	-	-	-	-	>95	>95	-	-	-	-	-	>60	>60	-	-	-	-	-	>54	>54	-	-	-	-	-
Entrenchment Ratio	4.4	4.4	-	-	-	-	-	4.0	4.0	-	-	-	-	-	4.2	1.8	-	-	-	-	-	4.5	1.6	-	-	-	-	-
Bank Height Ratio	1.0	1.0	-	-	-	-	-	1.0	1.0	-	-	-	-	-	1.0	1.1	-	-	-	-	-	1.1	1.2	-	-	-	-	-
Wetted Perimeter (ft)	27.3	30.2	-	-	-	-	-	28.0	27.0	-	-	-	-	-	35.2	37.6	-	-	-	-	-	33.4	37.6	-	-	-	-	-
Hydraulic Radius (ft)	2.3	2.5	-	-	-	-	-	1.8	1.9	-	-	-	-	-	1.9	1.9	-	-	-	-	-	1.8	1.6	-	-	-	-	-
Based on current/developing bankfull feature																												
BF Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Mean Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Cross-sectional Area (ft²)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width of Floodprone Area (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wetted Perimeter (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cross Sectional Area between end pins (ft²)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d50 (mm)	-	-	-	-	-	-	-	24.9	41.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 13. Morphology and Hydraulic Monitoring Summary
Logan Creek Restoration Project: DMS Project ID No. 92515

UT3 (178 LF)

	Cross-section X-8.5, Station 0+43 (Riffle)							Cross-section X-9, Station 0+55** (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	-	-	-	-	-	6.3	5.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Mean Depth (ft)	-	0.9	-	-	-	-	-	0.7	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width/Depth Ratio	-	9.4	-	-	-	-	-	8.7	8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Cross-sectional Area (ft²)	-	7.9	-	-	-	-	-	4.5	4.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Max Depth (ft)	-	1.5	-	-	-	-	-	1.2	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width of Floodprone Area (ft)	-	32.0	-	-	-	-	-	26.8	23.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entrenchment Ratio	-	3.7	-	-	-	-	-	4.3	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Height Ratio	-	1.1	-	-	-	-	-	1.0	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wetted Perimeter (ft)	-	10.4	-	-	-	-	-	7.7	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	-	0.8	-	-	-	-	-	0.6	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Based on current/developing bankfull feature																															
BF Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Mean Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Cross-sectional Area (ft²)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width of Floodprone Area (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wetted Perimeter (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cross Sectional Area between end pins (ft²)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*This cross-sections was not taken for baseline. ** 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	-	-	-	-	-	6.1	5.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Mean Depth (ft)	1.0	0.9	-	-	-	-	-	0.8	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width/Depth Ratio	9.5	10.7	-	-	-	-	-	8.1	9.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Cross-sectional Area (ft²)	10.1	7.9	-	-	-	-	-	4.6	3.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Max Depth (ft)	1.7	1.5	-	-	-	-	-	1.1	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width of Floodprone Area (ft)	> 50	> 50	-	-	-	-	-	> 50	> 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entrenchment Ratio	3.8	4.0	-	-	-	-	-	6.6	5.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Height Ratio	1.0	1.0	-	-	-	-	-	1.0	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wetted Perimeter (ft)	11.8	10.9	-	-	-	-	-	7.7	7.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	0.9	0.7	-	-	-	-	-	0.6	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Based on current/developing bankfull feature																															
BF Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Mean Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Cross-sectional Area (ft²)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width of Floodprone Area (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wetted Perimeter (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cross Sectional Area between end pins (ft²)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 14. Stream Problem Areas and Photos Logan Creek Stream Restoration Project, Number #92515			
Feature Issue	Station	Suspected Cause	Photo #
Aggradation/Bar Formation	None	None	None
Bank Scour	Station 2+80	High flows caused a soft place in the clay bank material to scour. (CPA-1 on CCPV)	1
	Station 24+90	Overland flow from pipe encroachment (see below) caused saturation of bank and bank erosion. (CPA-2 on CCPV)	2
	Station 28+00	A hole has developed over some embedded woody debris under a geolift. This developed from standing water on the floodplain and flooding. (CPA-3 on CCPV)	3
Engineered Structures	None	None	None
Encroachments	Station 11+50	Maintenance workers mowed beyond easement line into buffer. (EA-1 on CCPV)	4
	Station 24+00	Landowner installed a drainpipe from a new building upslope that crossed the easement line and diverted stormwater from the building site to the floodplain within the easement. This was repaired in November 2016. (EA-2 on CCPV)	5 to 9

Logan Creek Stream Restoration Project – Monitoring Year 1 Stream Problem Area Photos

Bank Scour

Photo 1. Bank Scour – Station 2+80, Small area of bank scour due to soft place in bank eroding on high flow.

Photo 2. Bank Scour – Station 24+90, Small hole on the floodplain developed from water standing over woody debris of geolift.

Photo 3. Bank Scour – Station 28+00, Small hole on the floodplain developed from water standing over woody debris of geolift.

Encroachments

Photo 4. Encroachment – Maintenance workers mowed beyond easement line into buffer.

Photo 5. Encroachment by landowner who installed a drainpipe to have its outfall within the easement.

Photo 6. Encroachment by pipe installation, showing opening with standing water and silt on vegetation.

Photo 7. Encroachment by pipe installation showing outlet and riprap apron.

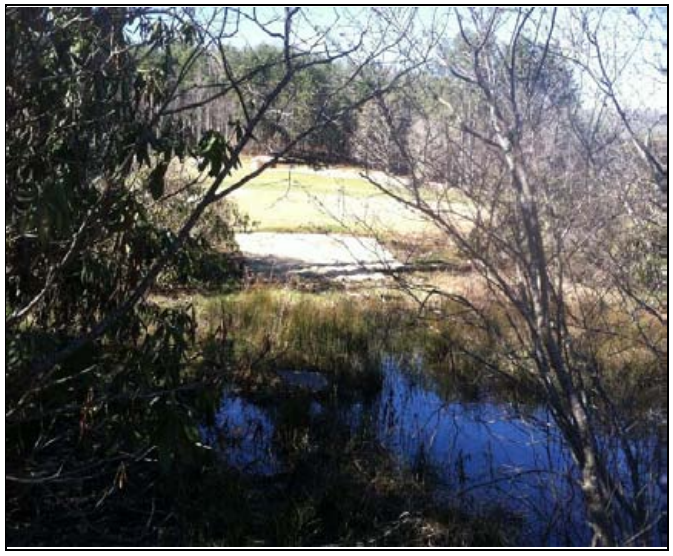

Photo 8. Perspective similar to that of Photo 6 showing the area after the pipe was removed.

Photo 9. View along the easement line after the pipe was removed. Perspective is similar to Photo 5 but from the opposite direction.