Upper Silver Creek Restoration
Project Year 4 Monitoring Report

Burke County, North Carolina

NCDMS Project ID Number – 94645

Catawba River Basin: 03050101-050050

SAW ID: 2010-02157, DWR # 13-0595

Project Info:	Monitoring Year: 4 of 5 Year of Data Collection: 2018 Year of Completed Construction: 2015 Submission Date: December 2018
Submitted To:	NCDEQ – Division of Mitigation Services 5 Ravenscroft Drive, Suite 102 Asheville, NC 28801 NCDEQ Contract ID No. 003270

Upper Silver Creek Restoration Project
Year 4 Monitoring Report

Burke County, North Carolina

NCDMS Project ID Number – 94645

Report Prepared and Submitted by Michael Baker Engineering, Inc.
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January 2, 2019

NC Division of Mitigation Services (NCDMS)
Attn: Mr. Matthew Reid, Western Project Manager
5 Ravenscroft Drive, Suite 102
Asheville, NC 28801

Subject: Response to DMS comments on the Year 4 Monitoring Report Review for the Upper Silver Creek Stream and Wetland Restoration Project; Catawba River Basin - CU# 03050101; Burke County, North Carolina; NCEEP Project # 94645; Contract No. 003270

Dear Mr. Reid,

Please find enclosed the final Upper Silver Creek Year 4 Monitoring Report. I have addressed the comments that you submitted on the draft report. My responses to your comments are the following:

Table 2

- Please add two lines under Year 4 monitoring. One for "Vegetation Monitoring" and another for "Stream Monitoring". Include the dates that data was collected for both additional lines. The IRT has requested this information be provided.

  The additional lines and information has been added. This modification was not requested for any of our other reports, so we are unclear as to how broadly we should apply this request.

Cross-sections and Table 11

- Please confirm that the MY4 (2018) BHRs have been calculated based on the attached DMS technical guidance. The Abkf reported in Table 11 does not show the same area being used as the asbuilt data. Please add note on table indicating that beginning in MY4, the bankfull elevation and channel cross section dimensions are calculated using a fixed Abkf as described in the Standard Measurement of the BHR Monitoring Parameter provided by NCIRT and NCDMS (9/2018). Please update table and cross-section graphs as necessary with revised measurements.

  The BHRs have been calculated based on our best understanding of the new methodology and additional input from the Raleigh NCDMS staff (Greg Melia and Jeff Schaffer). The A_{bkf} that is reported in Table 11 is the A_{bkf} for MY4 based on the MY0 bankfull elevation used in each report. The BH Ratio reported on each cross-section and in Table 11 is based on the A_{bkf} reported in the MY0 report and requested in the new guidance. This involves adjusting an elevation transect line until the MY0 cross-sectional area is indicated under that line (call this elevation ABKF). The BH Ratio is the ratio of the depth from the low bank of that monitoring year (call this TOB elevation) to that years thalweg and the depth from the ABKF to that years thalweg, BH ratio = (TOB-TW)/(ABKF/TW), where TOB and TW are for the monitoring year

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and ABKF is based on the MY0 A_{bkf}. All cross-sections and data shown in the tables are based on this methodology and updates have been made as requested.

Profile UT2 and UT3

- The UT2 profile and sections of UT3 indicate significant aggradation. As Baker is aware, the USACE will be looking at defined bed/bank and often denies credit for channels that have become filled with sediment. I am aware of the large upstream sediment sources from past mining activities on UT2. Please add a short discussion in section 2.2.1 regarding this issue. Does Baker have any corrective action or adaptive management planned for these reaches?

  We have added more information to the discussion of aggradation in section 2.2.1. We do indicate that we will monitor the areas of aggradation indicated by the cross-sections and general project channels, to be sure that sandy material that has moved into the project reach due to the unusually high flows of this year, is moving through the system. We will specifically evaluate UT2 and areas of UT3 to evaluate ways that we can enhance sediment transport or directly remove accumulated sediment as needed. In some locations this likely will involve removal of vegetation (cattails) or woody debris that is causing aggradation.

General

- Please include responses to comments in front of final report.

  Our comments will be added to the final report.

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

Sincerely,

Micky Clemmons

Micky Clemmons,
Project Manager
Michael Baker Engineering, Inc.

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APPENDICES

1.0 EXECUTIVE SUMMARY

Michael Baker Engineering, Inc. (Baker) restored or enhanced 5,186 linear feet (LF) of perennial stream channel along Silver Creek and three unnamed tributaries (UT1, UT2, and UT3); and additionally restored, enhanced or created approximately 9.14 acres of wetlands that had been previously disturbed in Burke County, NC, (Appendix A). The Upper Silver Creek Stream and Wetland Restoration Project (Site) is located southeast of Morganton, NC, approximately 11 miles southeast of the intersection of Highway 64 and I-40 and to the north of the intersection of Highway 64 and Goldmine Road. The Site is located in the NC Division of Water Resources (NCDWR) sub-basin 03-08-31 and the NCDEQ Division of Mitigation Services (NCDMS) Targeted Local Watershed (TLW) 03050101-050050 of the Catawba River Basin. The project involved the restoration and enhancement of a Piedmont/Mountain Mixed Bottomland Hardwood Forest system (Schafale and Weakley 1990) from impairments within the project area due to past agricultural conversion, cattle grazing, gold mining and draining of floodplain wetlands by ditching activities.

The project goals directly addressed stressors identified in the Catawba River Basin Restoration Priority (RBRP) Plan such as degraded riparian conditions, channel modification, and excess sediment and nutrient inputs. The primary restoration goals, as outlined in the approved mitigation plan, are described below:

- Create geomorphically stable stream channels within the Upper Silver Creek project area including headwater tributaries in the Catawba River basin;
- Restore, enhance, and expand wetland functions across the Site;
- Improve and restore hydrologic connections between streams and degraded riparian wetland areas and overall ecosystem functionality;
- Improve water quality within the Upper Silver Creek project area through reduction of bank erosion, improved nutrient and sediment removal, and stabilization of streambanks; and
- Improve aquatic and terrestrial habitat.

To accomplish these goals, the following actions are recommended:

- Restore the existing incised, eroding, and channelized stream by creating a stable channel that has access to its floodplain;
- Improve water quality by establishing buffers for nutrient removal from runoff and by stabilizing stream banks to reduce bank erosion;
- Improve in-stream habitat by providing a more diverse bedform with riffles and pools, creating deeper pools, developing areas that increase oxygenation, providing woody debris for habitat, and reducing bank erosion; and
- Improve terrestrial habitat by planting riparian areas with native vegetation and protecting these areas with a permanent conservation easement. The riparian area will increase storm water runoff filtering capacity, improve bank stability, provide shading to decrease water temperature and improve habitat.

During 2018 there were at least four high flow events that inundated the floodplain, depositing woody debris and other flotsam in wrack lines well away from the top of bank. These events were documented on 4/2/2018, 5/8/2018, 10/3/2018, and 10/18/2018 and do not appear to have negatively impacted constructed banks or structures.

Year 4 (MY4) monitoring indicated that the planted acreage was functioning well with no bank, bench or floodplain areas having bare areas of a significant size. Invasive Chinese privet and multiflora rose were treated in MY3. No significant growth of these invasives was noted in 2018 and no invasive treatments were conducted in MY4. The invasive vegetation within this area will continue to be treated with herbicide to control new growth. Fourteen (14) vegetation plots have been established at this site for monitoring. The average density of total planted stems following the MY4 growing season is 702 stems per acre with an additional average of 43 volunteer stems per acre. Based on the average density of 702 planted stems per acre, the Site is on track to meet the established success criteria.

Stream geomorphological stability and performance during MY4 was assessed by surveying sixteen cross-sections, a profile of each channel, evaluating the bed particle size with five riffle pebble counts and by replicating channel location photographs. Channel cross-sections and profiles were similar to what was observed in the past with no major instability identified and the general morphology is responding as designed and meeting project goals. Some of the cross-sections indicated slight aggradation in areas, but none of these areas indicated a significant or systemic problem.

Stream pebble data indicated that the shift to smaller particles on all project reaches that was noted in MY3 had stabilized and the sediment is currently coarser overall and similar to what was seen in previous years. Pebble counts on UT2 and UT3 in MY3 indicated that fine sediment had accumulated in the channels. The pebble counts on these two reaches in MY4 indicate that this fine sediment has moved through the stream channel and substrate size has increased significantly. This suggests that this aggradation was temporary and not an ongoing trend for these tributaries. Overall, MY4 data indicate a properly functioning system, as there were no mid-channel bars or other sediment transport issues.

Wetland monitoring during MY4 demonstrated that all thirteen groundwater monitoring wells located on the Site met the wetland success criteria as stated in the Site Mitigation Plan. The gauges demonstrated consecutive hydroperiods of 12 percent or greater, ranging from 16.3 to 100 percent of the growing season. It was noted during 2018 monitoring that several of the rebar posts that were installed at each well to indicate the ground elevation were protruding from the soil up to 0.1 feet in some cases. This could have been due to either the soil settling around the post or upward swelling in freeze/thaw cycles since construction. The elevation of these rebar posts was adjusted to better reflect the actual ground level, and the calculation in the wetland data sheets was updated accordingly. In addition, it was noted that USAW4 and USAW6 were installed in fill material that did not reflect the wetland conditions of the surrounding area. These two wells were relocated slightly (<10 feet) to more accurately gauge water levels in the surrounding restored wetland areas. The onsite rain gauge that was installed at the Site in 2017 is functioning and providing accurate rainfall data that is shown in the well data sheets.

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, wetland 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, monitoring wells, flow gauges, and the crest gauge, are shown on the CCPV sheets found in Appendix A.

The Year 4 monitoring data and site photographs were collected in October 2018.

2.1 Vegetation Assessment

To determine if vegetation success criteria are achieved, vegetation monitoring quadrants (veg plots) were installed and monitored across the Site 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 14 plots established randomly within the planted riparian buffer and wetland area, per CVS Monitoring Level 2. No veg plots were established within the undisturbed wooded areas along the right bank of Silver Creek. The size of individual quadrants is 100 square meters for woody (tree) species and 1 square meter for herbaceous vegetation. Herbaceous quadrants were established in one corner of the larger woody plots and are monitored by comparing photographs taken year to year.

Year 4 monitoring found that all vegetation was in good condition. All vegetation monitoring quadrants indicated that most planted trees were growing and in good condition. The average density of planted stems following the Year 4 growing season was 702 stems per acre. There was also an average of 43 volunteer stems per acre, composed of six different tree species. The total average density of both planted and volunteer stems was 746 stems per acre. With an average density of 702 planted stems per acre, the Site is on track to meet the final success criteria of 260 stems per acre by the end of Year 5.

The areas of invasive Chinese privet (*Ligustrum sinense*) and multiflora rose (*Rosa multiflora*) vegetation that were treated in MY3 did not exhibit significant regrowth during MY4. These areas will be monitored, and any regrowth will be treated in MY5.

No other areas of concern regarding vegetation were observed along Silver Creek or the tributaries. Year 4 vegetation assessment information is provided in Appendix C.

2.2 Stream Assessment

The Upper Silver Creek Site approach was restoration of a stable morphology that allows for the transport of water and sediment through the Site and allows stream flows larger than bankfull flows to spread onto the floodplain. Stream monitoring efforts focus on visual observations, a crest gauge to document bankfull flooding events, surveying established stream cross-sections and channel profiles to assess channel stability and pebble counts to assess if proper sediment transport is taking place.

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

2.2.1 Morphologic Parameters and Channel Stability

Cross-sections were classified using the Rosgen Stream Classification System (Rosgen 1994) and all cross-sections were evaluated to determine if they meet design expectations. Cross-sections were also compared to the baseline cross-section plots to evaluate change between construction and the MY4 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 MY4 was assessed by surveying sixteen (16) cross-sections (7 on Silver Creek, 2 on UT1, 2 on UT2 and 5 on UT3) and a profile of these channels as described above. The bed particle size was evaluated with five riffle pebble counts (2 on Silver Creek and 1 on each of the tributaries) and by observation and replicating channel location photographs. Cross-sections of all the channels were very similar to past years, although a few indicated slight aggradation since construction (XS6 pool, XS9 pool, XS11 pool, XS12, XS14 pool, and XS15 pool). All but one of the cross-sections indicated as having aggraded material is a pool where aggradation is expected. The material that is accumulating in each location is sand that is moving through the system from upstream and likely does not indicate a long-term concern. Sandy material has been present in each reach since construction but moves through the system over time. This year has brought the highest rainfall on record in many areas of Western North Carolina and almost constant high flows have moved this sandy material into the project streams. We believe that this material will continue to move through the system and will not cause long-term problems; however, we will continue to monitor the areas of aggradation and will take corrective action if needed. In late winter and early spring of 2019, channels will be inspected and where natural sediment transport processes are being interrupted by vegetation or woody debris, these obstructions will be removed. Sediment may also be removed where possible if needed. In general, all four reaches are maintaining bedform diversity and transporting sediment as intended. There was also little change from past profile surveys and profiles of each channel do not indicate any instability issues.

The Visual Morphological Stability Assessment indicates that the Site is stable and no new channel problem areas (CPAs) were identified in MY4. The two instances of piping that were noted in the MY3 report are still piping in MY4 but are still serving their intended function of redirecting the thalweg away from the outer bank of the stream. These structures are called out in the CCPV as CPA-1 and CPA-2. The one instance of bank erosion that was noted in MY3 (CPA-3) is still eroding and will be monitored in MY5 for any further degradation or stabilization. The locations, descriptions, and photos of these areas are included in the Stream Problem Areas Table in Appendix D and in the MY4 data electronic file. These sites will be monitored in the coming year and repaired if necessary. Overall, channel morphology is responding as designed and meeting project goals.

Pebble count data for MY4 indicates that the shift to smaller particles on Silver Creek mainstem has stabilized at sizes similar to what was seen in previous years. In MY3, pebble counts on UT2 and UT3 indicated that fine sediment had accumulated in the channels. In MY4, there was still fine sediment present in the channels, but it did not dominate as much of the channel as it did in MY3. Pebble counts from UT2 and UT3 indicate that, while there is still sand and fine sediment present in the channel, the substrate coarsened overall in MY4. This is likely a natural process for these channels, both of which have sources of sandy material upstream of the project area. Both channels are transporting this fine material effectively over time as intended. These reaches will continue to be monitored to determine if this trend continues over time. Overall, the pebble data indicate a properly functioning system, as there were no mid-channel bars or other sediment transport issues.

Two beaver dams were removed from the site during MY3. These dams were not rebuilt during MY4 and there were no beaver dams found on the site in 2018.

2.2.2 Hydrology

Two crest gauges were installed on the floodplain at this site, at the bankfull elevation. One is located along the left top of bank on Silver Creek, at approximately Station 19+00, and the second is on the left top of bank of UT3, at approximately Station 9+50. The crest gauge on Silver Creek recorded four bankfull events of 1.19 feet (documented on 4/2/2018), 1.08 feet (documented on 5/8/2018), 0.88 feet (documented on 10/3/2018), and 1.64 feet (documented on 10/18/2018). The highest rainfall events recorded by the on-site rain gauge that likely resulted in these bankfull flows

occurred on 2/11/2018 (2.07 inches), 4/15/2018 (3.3 inches), 9/16/2018 (5.39 inches), and 10/11/2018 (3.24 inches). The site has now recorded six total bankfull events since construction and has met the success criteria. Physical indicators of bankfull flows, such as wrack lines and debris on the bank, were also observed throughout the reach but it is difficult to determine which bankfull event was responsible. Crest gauge readings are presented in Appendix D.

2.2.3 Photographic Documentation

Reference transects were photographed at each permanent cross-section. The survey tape was centered in the photograph of the bank. Photographs were also taken at specific photo points established along each channel during baseline reporting. 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 and do not indicate any stability issues at the site and no failing structures with the exception of minor piping at two structures as previously noted.

2.3 Wetland Assessment

Thirteen automated groundwater-monitoring stations were installed in the wetland restoration area to document the hydrologic conditions during the monitoring period. The installations followed USACE protocols (USACE 1997). Groundwater data collected during Year 4 monitoring are located in Appendix E.

To meet the hydrologic success criteria, the monitoring gauge data must show that, for each normal rainfall year within the monitoring period, the Site has been inundated or saturated for a certain hydroperiod. Criteria have been met when the wetland is saturated within 12 inches of the soil surface for 12 percent of the growing season when rainfall amounts approximate normal conditions. Alternatively, when dry conditions prevail, fourteen (14) or more consecutive days during the growing season when antecedent precipitation has been drier than normal for a minimum frequency of 5 years in 10 to 50 percent of the monitoring period becomes the success criteria (USACE, 1987 and 2005).

Visual monitoring of wetland areas will be conducted annually. Photographs will be used to visually document system performance and identify areas of low stem density, invasive species vegetation, beaver activity, or other areas of concern. Reference stations will be photographed each year for a minimum of five years following construction. Photographs will be taken from a height of approximately five to six feet. Permanent well markers were established and used to ensure that the same locations (and view directions) on the Site are documented in each monitoring period.

Wetland monitoring during MY4 demonstrated that all thirteen groundwater monitoring wells located on the Site met the wetland success criteria as stated in the Site Mitigation Plan. This is an improvement since MY3, in which 4 wells did not meet the success criteria. All gauges demonstrated consecutive hydroperiods of 12 percent or greater, ranging from 16.3 to 100 percent of the growing season. Two wells, USAW4 and USAW6, were relocated slightly (<10 feet) because it was determined that they had originally been installed in fill material after construction. This material drained much faster than the surrounding soil, which has a consistent hydric layer around 0.8 feet, and resulted in inaccurate pressure gauge readings that were not representative of the surrounding restored wetland. The rain data for the region (Figure 9) shows that rainfall was above the monthly average for much of the year, especially during the early part of the growing season. Baker will continue to monitor the groundwater hydrology of the Site during Monitoring Year 5.

An on-site recording rain gauge was installed at the site in August 2017. Data from this gauge will be used to measure local precipitation in the future to eliminate reliance on the nearby CRONOS stations. These stations often show a high level of variance across a small geographic area, which makes it difficult to determine the actual amount of rain the site receives. Having direct access to this data will allow accurate precipitation data to be collected and presented in future monitoring years.

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.

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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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____. 1997. Corps of Engineers Wetlands Research Program. Technical Note VN-rs-4.1. Environmental Laboratory. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

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

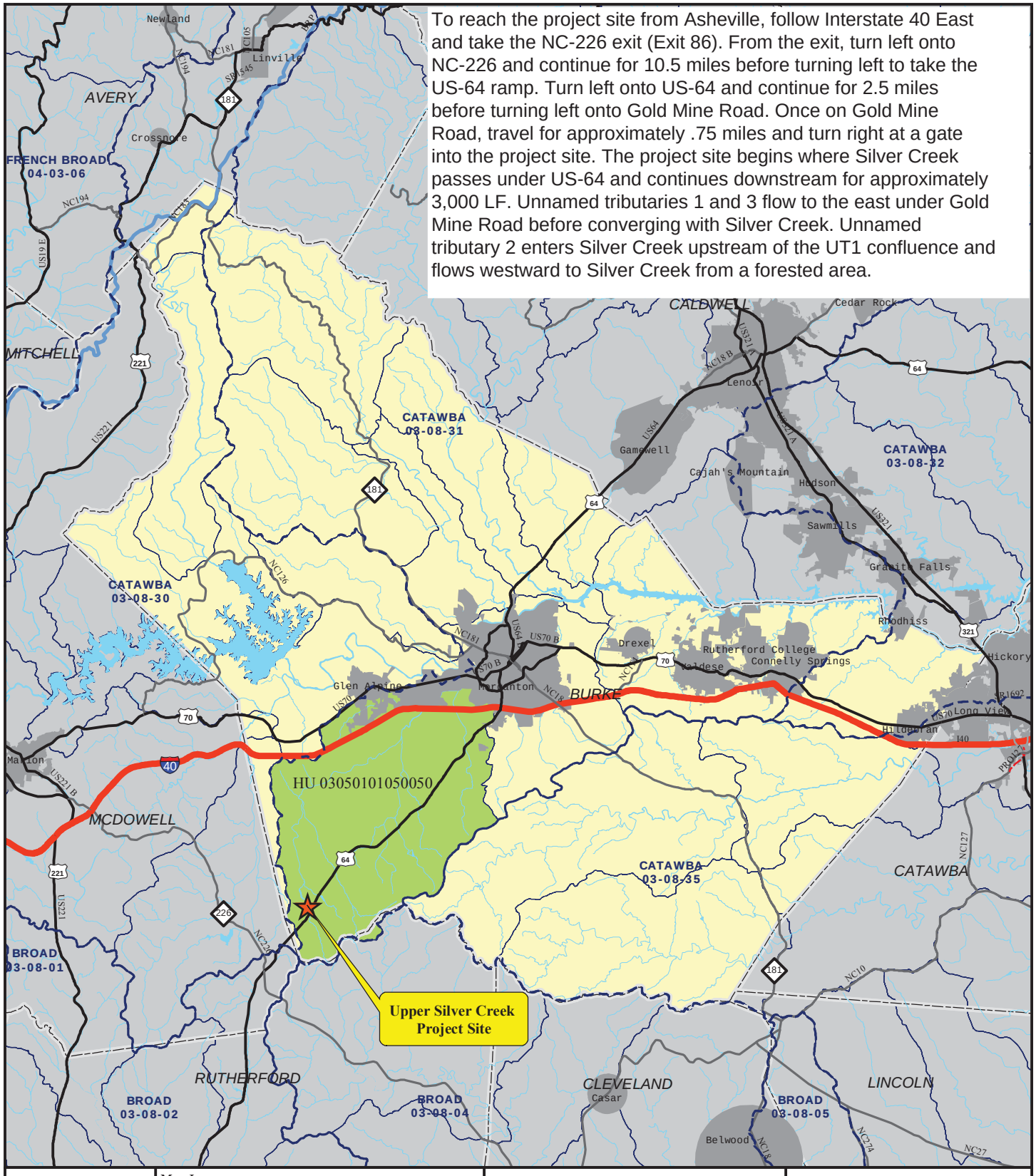
____. 2005. "Technical Standard for Water-Table Monitoring of Potential Wetland Sites," WRAP Technical Notes Collection (ERDC TN-WRAP-05-2), U.S. Army Engineer Research and Development Center. Vicksburg, MS.

Appendix A

General Figures and Plan Views

Includes:

Figure 1. Project Vicinity Map and Directions
Figure 2. Current Condition Plan View (CCPV) – Overview Map
Figure 2A. CCPV North half of Project
Figure 2B. CCPV South half of Project



Division of Mitigation Services

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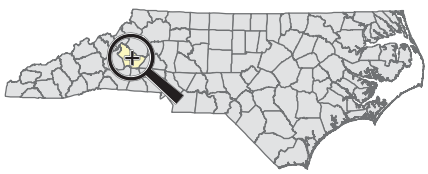

Burke County, NC

LEGEND:

- NCDWQ Sub-basin
- Counties
- USGS Hydrologic Unit
- Project Hydrologic Unit
- Burke County

0 1 2 4 Miles

Figure 1. Project Vicinity Map

Upper Silver Creek
NCDMWS Project #94645
Monitoring Year 4 Report
Burke County, NC

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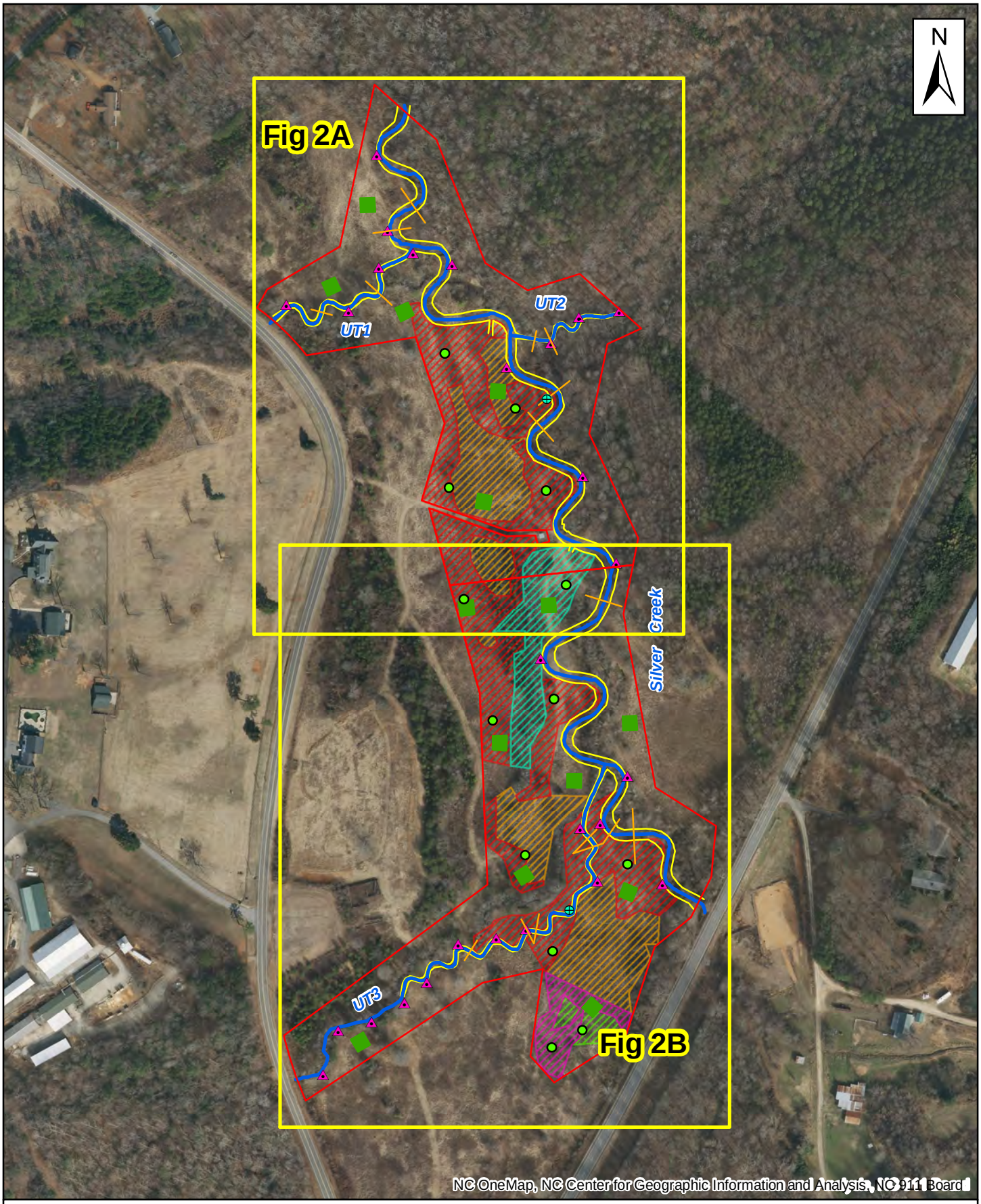

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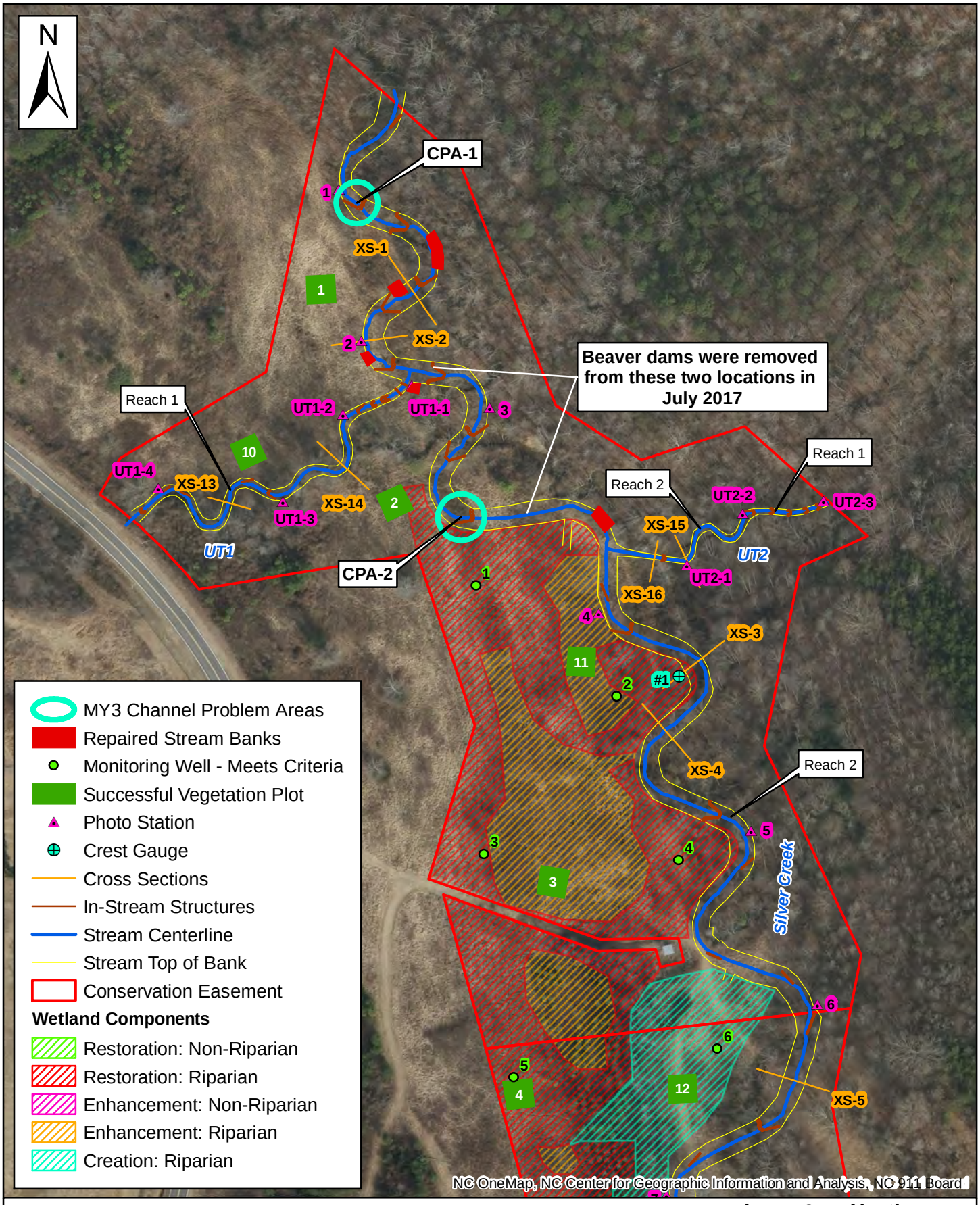
0 300 600 Feet

1 inch = 300 feet

DMS Project # 94645

Figure 2 - Overview
Current Conditions Plan View
Monitoring Year 4
Upper Silver Creek Site



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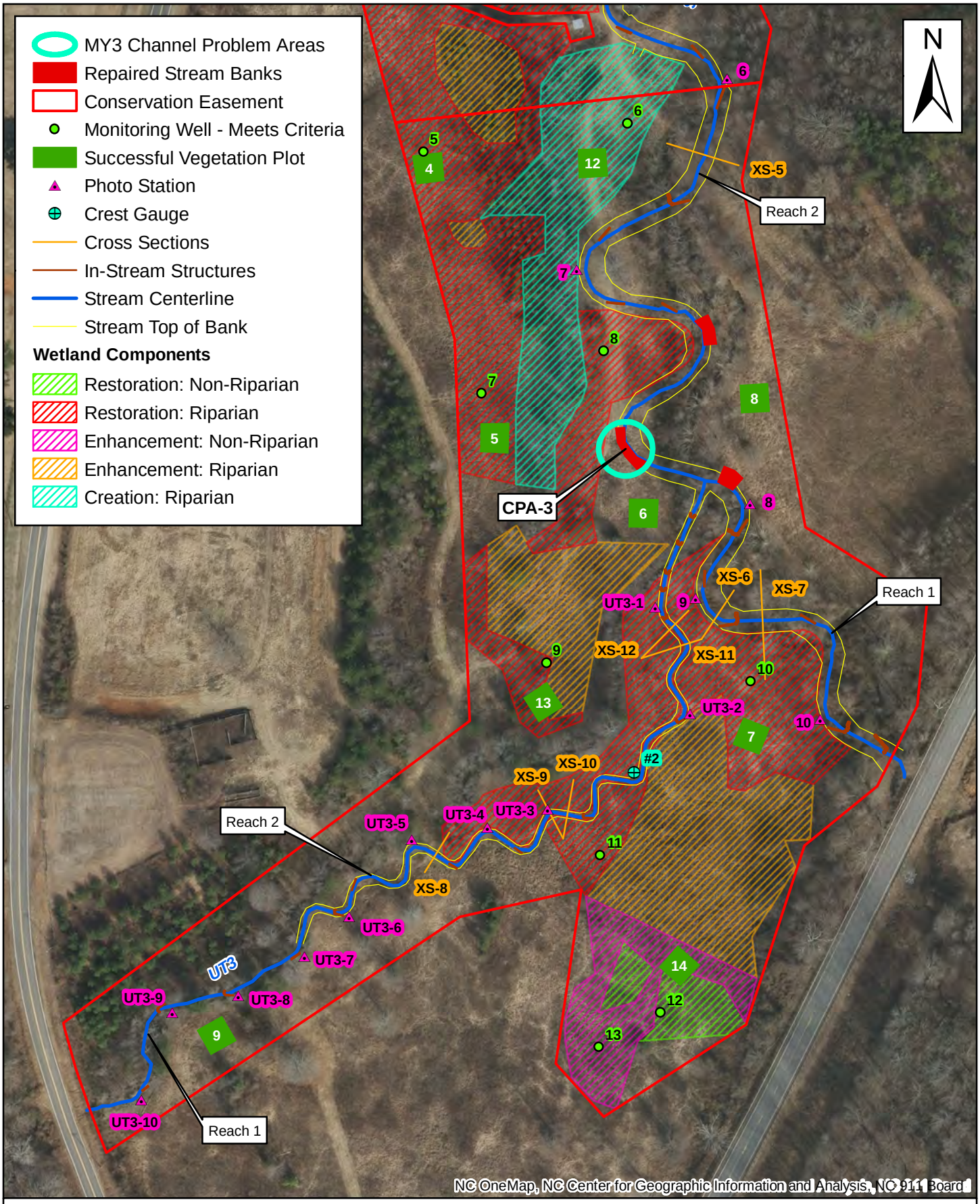
0 150 300 Feet

1 inch = 150 feet

DMS Project # 94645

Figure 2A - North
Current Conditions Plan View
Monitoring Year 4
Upper Silver Creek Site



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0 150 300 Feet

1 inch = 150 feet

DMS Project # 94645

Figure 2B - South
Current Conditions Plan View
Monitoring Year 4
Upper Silver Creek Site

Appendix B

General Project Tables

Includes:

Table 1. Project Components and Mitigation Credits

Figure 3. U. Silver Cr. 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

Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Mitigation Credits											
	Stream		Riparian Wetland			Non-riparian Wetland			Buffer	Nitrogen Nutrient Offset	Phosphorus Nutrient Offset
Type	R	EII	R	E	C	R	E	C			
Totals	4,843 SMU	137 SMU	4.67 WMU	1.43 WMU	0.33 WMU	0.21 WMU	0.21 WMU				

Project Components						
Project Component or Reach ID	Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration/ Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio
STREAMS						
Silver Creek		2643 LF				
Reach 1	0+32 to 8+70		Restoration - PII	838 SMU	838 LF	1:1
Reach 2	8+70 to 30+48		Restoration - PI	2,178 SMU	2178 LF	1:1
UT1		478 LF				
Reach 1	0+07 to 5+02		Restoration - PI	495 SMU	495 LF	1:1
UT2		187 LF				
Reach 1	0+00 to 1+03		Restoration - PI	103 SMU	103 LF	1:1
Reach 2	1+03 to 3+10		Restoration - PI	207 SMU	207 LF	1:1
UT3		1,162 LF				
Reach 1	0+00 to 3+43		Enhancement I	137 SMU	343 LF	2.5:1
Reach 2	3+43 to 13+65		Restoration - PI	1,022 SMU	1,022 LF	1:1
WETLANDS	See plan sheets					
JDW1a (NR)		0.42 AC	Enhancement	0.21 WMU	0.42 AC	2:1
JDW1b (Ri)		1.01 AC	Enhancement	0.51 WMU	1.01 AC	2:1
JDW2 (Ri)		0.51 AC	Enhancement	0.25 WMU	0.51 AC	2:1
JDW3 (Ri)		0.03 AC	Enhancement	0.02 WMU	0.03 AC	2:1
JDW4 (Ri)		0.24 AC	Enhancement	0.12 WMU	0.24 AC	2:1
JDW5 (Ri)		0.81 AC	Enhancement	0.40 WMU	0.81 AC	2:1
JDW6 (Ri)		0.25 AC	Enhancement	0.13 WMU	0.25 AC	2:1
R1A (NR)		0	Restoration	0.06 WMU	0.06 AC	1:1
R1B (NR)		0	Restoration	0.15 WMU	0.15 AC	1:1
R2 (Ri)		0	Restoration	1.22 WMU	1.22 AC	1:1
R3 (Ri)		0	Restoration	0.18 WMU	0.18 AC	1:1
R4 (Ri)		0	Restoration	0.44 WMU	0.44 AC	1:1
R5 (Ri)		0	Restoration	1.29 WMU	1.29 AC	1:1
R6 (Ri)		0	Restoration	1.54 WMU	1.54 AC	1:1
C1 (Ri)		0	Creation	0.33 WMU	0.99 AC	3:1

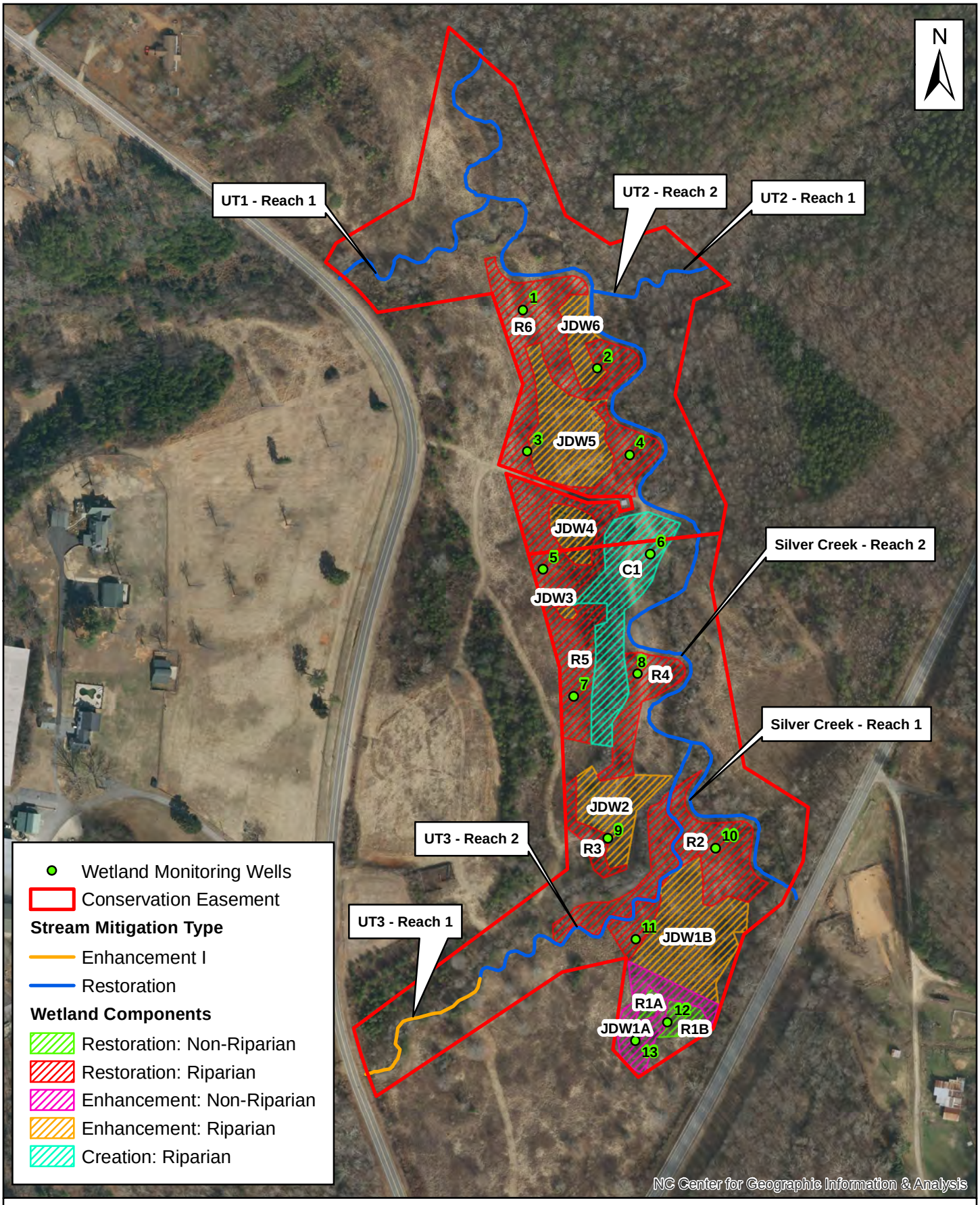
Component Summation

Restoration Level	Stream (LF)	Riparian Wetland (AC)		Non-riparian Wetland (AC)	Buffer (SF)	Upland (AC)
		Riverine	Non-Riverine			
Restoration	4,843	4.67		0.21		
Enhancement I		2.85		0.42		
Enhancement II	343					
Creation		0.99				
Preservation						
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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0 250 500 Feet

DMS Project # 94645

Figure 3
U. Silver Cr. Project Asset Map
Upper Silver Creek Site

Table 2. Project Activity and Reporting History
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Mitigation Plan Prepared	Jan-13	N/A	Jan-13
Mitigation Plan Amended	Sep-13	N/A	Sep-13
Mitigation Plan Approved	Oct-13	N/A	Oct-13
Final Design – (at least 90% complete)	N/A	N/A	May-14
Construction Begins	N/A	N/A	May-14
Temporary S&E mix applied to entire project area	N/A	N/A	Dec-14
Permanent seed mix applied to entire project area	N/A	N/A	Dec-14
Planting of live stakes	Winter 2015	N/A	Feb-15
Planting of bare root trees	N/A	N/A	Feb-15
End of Construction	N/A	N/A	Dec-14
Survey of As-built conditions (Year 0 Monitoring-baseline)	N/A	Mar-15	Jul-15
Repair of 3 piping structures	N/A	N/A	Aug-15
Mitigation Plan Addendum	N/A	N/A	Dec-15
Year 1 Monitoring	Dec-15	Dec-15	Apr-16
Repair of channel problem areas resulting from flooding	N/A	N/A	Mar-16
Year 2 Monitoring	Dec-16	Nov-16	Dec-16
Invasive vegetation treatment	N/A	N/A	Jun-17
Beaver dam removal	N/A	N/A	Jul-17
Year 3 Monitoring	Dec-17	Oct-17	Dec-17
Year 4 Monitoring	Dec-18	Nov-18	Dec-18
Vegetation Monitoring		Oct-18	
Stream Monitoring		Nov-18	
Year 5 Monitoring	Dec-19	N/A	N/A
Vegetation Monitoring			
Stream Monitoring			

Table 3. Project Contacts	
Upper Silver Creek Restoration Project: DMS Project ID No. 94645	
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	Mellow Marsh Farm (trees), 919-742-1200 ArborGen Inc. (trees), 843-528-3204 Dykes and Son (trees), 931-668-8833
Monitoring Performers	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201 Asheville, NC 28806
	Contact:
Stream Monitoring Point of Contact	Micky Clemmons, Tel. 828-412-6100
Vegetation Monitoring Point of Contact	Micky Clemmons, Tel. 828-412-6100
Wetland Monitoring Point of Contact	Micky Clemmons, Tel. 828-412-6100

Table 4. Project Attributes			
Upper Silver Creek Restoration Project: DMS Project ID No. 94645			
Project Information			
Project Name	Upper Silver Creek Mitigation Project		
County	Burke		
Project Area (acres)	22.0		
Project Coordinates (latitude and longitude)	35.6078 N, -81.81742 W		
Watershed Summary Information			
Physiographic Province	Blue Ridge (borders Piedmont)		
River Basin	Catawba		
USGS Hydrologic Unit 8-digit and 14-digit	03050101 / 03050101050050		
DWR Sub-basin	03-08-31		
Project Drainage Area (AC)	Mainstem 2.7 - 3.3, UT1 0.28, UT2 0.05, UT3 0.17		
Project Drainage Area Percentage of Impervious Area	<2%		
USGA Land Use Classification	Deciduous Forest (64%)	Woody Wetlands (1%)	
	Evergreen Forest (3%)	Developed, Open Space (5%)	
	Shrub/Scrub (5%)	Pasture/Hay (14%)	
	Grassland/Herbaceous (6%)		
NCDMS Land Use Classification for Silver Creek Watershed	Forest (59%)		
	Agriculture (23%)		
	Impervious Cover (2.9%)		
Stream Reach Summary Information			
Parameters	**Mainstem - Reach 1**	**Mainstem - Reach 2**	
Length of Reach (LF)	838	2,178	
Valley Classification (Rosgen)	VIII	VIII	
Drainage Area (AC)	1,746	2,147	
NCDWR Stream Identification Score	49.5	49.5	
NCDWR Water Quality Classification	C	C	
Morphological Description (Rosgen stream type)	E	E	
	Incised channel, little connection to floodplain	Incised channel, little connection to floodplain	
Evolutionary Trend	E→G, E→C/F	E→G, E→C/F	
Underlying Mapped Soils	AaA, FnA, UnB	AaA, FnA, UnB	
Drainage Class	Somewhat poorly to well drained	Somewhat poorly to well drained	
Soil Hydric Status	Site-specific	Site-specific	
Average Channel Slope (ft/ft)	0.004	0.004	
FEMA Classification	Zone AE	Zone AE	
Native Vegetation Community	Piedmont/Mtn. Mixed Bottomland Hardwoods	Piedmont/Mtn. Mixed Bottomland Hardwoods	
Percent Composition of Exotic/Invasive Vegetation	10%	5%	
Parameters	**UT1 - Reach 1**	**UT2 - Reach 1**	**UT2 - Reach 2**
Length of Reach (LF)	495	103	207
Valley Classification (Rosgen)	III	III	III
Drainage Area (AC)	177	32	32
NCDWR Stream Identification Score	47.5	45	45
NCDWR Water Quality Classification	C	C	C
Morphological Description (Rosgen stream type)	Gc	channelized B	channelized B
	Incised channel, little connection to floodplain	channelized/ditched channel	channelized/ditched channel
Evolutionary Trend	Gc→F	B→F→C	B→F→C
Underlying Mapped Soils	AaA, FnA	UnB	UnB, FnA
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)	0.016	0.037	0.037
FEMA Classification	N/A	N/A	N/A
Native Vegetation Community	Piedmont Dry-Mesic Oak and Hardwoods to Mixed Bottomland Hardwoods	Piedmont/Mtn. Mixed Bottomland Hardwoods	Piedmont/Mtn. Mixed Bottomland Hardwoods
Percent Composition of Exotic/Invasive Vegetation	5%	2%	2%

Parameters	UT3 - Reach 1	UT3 - Reach 2
Length of Reach (LF)	342	1,006
Valley Classification (Rosgen)	III	III
Drainage Area (AC)	123	123
NCDWR Stream Identification Score	49.75	49.75
NCDWR Water Quality Classification	C	C
Morphological Description (Rosgen stream type)	B/E	E
	Aggrading at upper end then stable to incising at lower end	Incised channel, little connection to floodplain
Evolutionary Trend	B/E→G	E→G
Underlying Mapped Soils	AaA	AaA, FnA
Drainage Class	Somewhat poorly to well drained	Somewhat poorly to well drained
Soil Hydric Status	Site-specific	Site-specific
Average Channel Slope (ft/ft)	0.015	0.015
FEMA Classification	N/A	N/A
Native Vegetation Community	Piedmont Dry-Mesic Oak and Hardwoods	Piedmont/Mtn. Mixed Bottomland Hardwoods
Percent Composition of Exotic/Invasive Vegetation	2%	2%

Wetland Summary Information

Parameters	JDW1	JDW2	JDW3	JDW4	JDW5	JDW6
Size of Wetland (AC)	1.43	0.51	0.03	0.24	0.81	0.3
Wetland Type	Riparian	Riparian	Riparian	Riparian	Riparian	Riparian
Mapped Soil Series	FnA	FnA	FnA	FnA	FnA	FnA
Drainage Class	Somewhat poorly to well drained	Somewhat poorly to well drained	Somewhat poorly to well drained	Somewhat poorly to well drained	Somewhat poorly to well drained	Somewhat poorly to well drained
Soil Hydric Status	Site-specific	Site-specific	Site-specific	Site-specific	Site-specific	Site-specific
Source of Hydrology	Hillslope seepage; Baseflow; Overbank Flooding	Hillslope seepage; Baseflow; Overbank Flooding	Hillslope seepage; Baseflow; Overbank Flooding	Hillslope seepage; Baseflow; Overbank Flooding	Hillslope seepage; Baseflow; Overbank Flooding	Hillslope seepage; Baseflow; Overbank Flooding
Hydrologic Impairment	Partially	Yes	No	Partially	Partially	Partially
Native Vegetation Community	Piedmont/Mountain Mixed Bottomland Hardwood Forest. Successional Deciduous Forest Land was once also present near Wetlands 2 & 5.					
Percent Composition of Exotic/Invasive Vegetation	~30%	~55%	~10%	~40%	~55%	~35%

Regulatory Considerations

Regulation	Applicable	Resolved	Supporting Documentation
Waters of the United States – Section 404	Yes	Yes	Categorical Exclusion
Waters of the United States – Section 401	Yes	Yes	Categorical Exclusion
Endangered Species Act	Yes	Yes	Categorical Exclusion
Historic Preservation Act	Yes	Yes	Categorical Exclusion
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	Yes	Yes	Categorical Exclusion
Essential Fisheries Habitat	No	N/A	N/A

Notes:
1. See Figure 2.3 of Mitigation Plan for key to soil series symbols.
2. All wetlands had been disturbed to some degree at the time the project was initiated. As a result, only remnants of native vegetative communities exist in the wetland areas.
3. Fescue is considered as invasive vegetation; it and other field grasses were the dominant nonnative wetland vegetation observed.
4. USGS Land Use Data (2001) used rather than CGIA Land Use Classification data which is more outdated (1996).
5. Source: Upper Catawba River Basin Restoration Priorities (NCEEP 2009) (https://deq.nc.gov/about/divisions/mitigation-services/dms-planning/watershed-planning-documents/catawba-river-basin)

Appendix C

Vegetation Assessment Data

Includes:

Table 5. Vegetation Plot Mitigation Success Summary

Table 6. Vegetation Metadata

Table 7. Stem Count Arranged by Plot

Figure 4. Vegetation Monitoring Plot Photos

Table 5. Vegetation Plot Mitigation Success Summary
(per acre)

Plot #	Stream/ Wetland Stems[1]	Volunteers[2]	Total[3]	Success Criteria Met?
1	1214	0	1214	Yes
2	1133	0	1133	Yes
3	364	121	486	Yes
4	688	0	688	Yes
5	809	0	809	Yes
6	647	40	688	Yes
7	567	0	567	Yes
8	567	324	890	Yes
9	364	40	405	Yes
10	809	0	809	Yes
11	728	0	728	Yes
12	728	0	728	Yes
13	647	81	728	Yes
14	567	0	567	Yes
Project Avg	**702**	**43**	**746**	

Stem Class	**characteristics**
[1]Stream/ Wetland Stems	Native planted woody stems. Includes shrubs, does NOT include live stakes. No vines
[2]Volunteers	Native woody stems. Not planted. No vines.
[3]Total	Planted + volunteer native woody stems. Includes live stakes. Excl. exotics. Excl. vines.

Exceeds requirements by 10%

Table 6. Vegetation Metadata Upper Silver Creek Stream and Wetland Restoration - Project 94645	
Report Prepared By	Russell Myers
Date Prepared	10/24/2018 13:33
database name	MY4_94645_UpperSilver_cvs-eep-entrytool-v2.3.1.mdb
database location	L:\projects\120598-Upr-Silver-FD\Monitoring\YR4 Monitoring\2.0 Monitoring Data\App C - Vegetation Data
computer name	ASHELRMYERS1
file size	64524288
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	94645
project Name	Upper Silver Creek
Description	Full Delivery stream and wetland restoration site
River Basin	Broad
length(ft)	5,169'
stream-to-edge width (ft)	Minimum of 30 ft
area (sq m)	62,321 sq. m.
Required Plots (calculated)	14
Sampled Plots	14

Table 7. Stem Count Arranged By Plot
Project: Upper Silver Creek, DMS Project #94645

			Current Plot Data (MY4 2018)																												
			94645-01-0001			94645-01-0002			94645-01-0003			94645-01-0004			94645-01-0005			94645-01-0006			94645-01-0007			94645-01-0008			94645-01-0009			94645-01-0010		
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	P	V	T	P	V	T
Acer rubrum	red maple	Tree	1		1	6		6		1	1	2		2										3		3						
Alnus serrulata	hazel alder	Shrub																														
Betula nigra	river birch	Tree							2		2							1		1	2		2							1		1
Carpinus caroliniana	American hornbeam	Tree	1		1	3		3				2		2							1		1				1		1	1		1
Cornus amomum	silky dogwood	Shrub							1		1	1		1	6		6	4		4	2		2									
Corylus cornuta	beaked hazelnut	Shrub Tree																1		1												
Diospyros virginiana	common persimmon	Tree	1		1							1		1										1	1	2						
Fraxinus pennsylvanica	green ash	Tree							2		2				8		8	1		1	1		1									
Liquidambar styraciflua	sweetgum	Tree																														
Liriodendron tulipifera	tuliptree	Tree				1		1				1		1										2	3	5		1	1	2		2
Platanus occidentalis	American sycamore	Tree	9		9	4		4	1	2	3	5		5	4		4	3	1	4	5		5	4	4	8	2		2	5		5
Quercus	oak	Tree																														
Quercus lyrata	overcup oak	Tree																														
Quercus michauxii	swamp chestnut oak	Tree	1		1	6		6				2		2	2		2	3		3	3		3	2		2				1		1
Quercus nigra	water oak	Tree							3		3																					
Quercus pagoda	cherrybark oak	Tree																														
Quercus phellos	willow oak	Tree	2		2	4		4				3		3				3		3							5		5	10		10
Unknown		Shrub or Tree																														
Vaccinium corymbosum	highbush blueberry	Shrub				1		1																								
Viburnum dentatum	southern arrowwood	Shrub	15		15	3		3																2		2	1		1			
		Stem count	30	0	30	28	0	28	9	3	12	17	0	17	20	0	20	16	1	17	14	0	14	14	8	22	9	1	10	20	0	20
		size (ares)	1			1			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			0.02			0.02		
		Species count	7	0	7	8	0	8	5	2	6	8	0	8	4	0	4	7	1	7	6	0	6	6	3	6	4	1	5	6	0	6
		Stems per ACRE	1214	0	1214	1133	0	1133	364	121	486	688	0	688	809	0	809	647	40	688	567	0	567	567	324	890	364	40	405	809	0	809

Table 7. Stem Count Arranged By Plot, Continued
Project: Upper Silver Creek, DMS Project #94645

			Current Plot Data (MY4 2018)												Annual Means																	
			94645-01-0011			94645-01-0012			94645-01-0013			94645-01-0014			MY4 (2018)			MY3 (2017)			MY2 (2016)			MY1 (2015)			MY0 (2015)*					
Scientific Name	Common Name	Species Type	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T
Acer rubrum	red maple	Tree				1		1							13	1	14	12	1	13	13	1	14	14		14	12		12			
Alnus serrulata	hazel alder	Shrub	1		1	1		1							2		2	2		2		1	1	1		1	1		1			
Betula nigra	river birch	Tree	3		3	6		6	3		3	1		1	19		19	20		20	19		19	21		21	8		8			
Carpinus caroliniana	American hornbeam	Tree				1		1							10		10	10	1	11	11	1	12	11		11	9		9			
Cornus amomum	silky dogwood	Shrub	11		11	3		3	2	2	4				30	2	32	30		30	32	5	37	32		32	16		16			
Corylus cornuta	beaked hazelnut	Shrub Tree													1		1	1		1	1		1	1		1	1		1			
Diospyros virginiana	common persimmon	Tree													3	1	4	3		3	3		3	3		3	3		3			
Fraxinus pennsylvanica	green ash	Tree				2		2				4		4	18		18	18		18	18	1	19	19		19	12		12			
Liquidambar styraciflua	sweetgum	Tree																	3	3		1	1									
Liriodendron tulipifera	tuliptree	Tree													6	4	10	6	7	13	7	1	8	11		11	10		10			
Platanus occidentalis	American sycamore	Tree	1		1	2		2	3		3	2		2	50	7	57	53	9	62	54	5	59	60		60	48		48			
Quercus	oak	Tree																			1		1	2		2						
Quercus lyrata	overcup oak	Tree				1		1							1		1	1		1	1		1	1		1						
Quercus michauxii	swamp chestnut oak	Tree	1		1				8		8	4		4	33		33	34	1	35	32		32	33		33	20		20			
Quercus nigra	water oak	Tree													3		3	3		3	3		3	4		4	4		4			
Quercus pagoda	cherrybark oak	Tree										1		1	1		1	1		1												
Quercus phellos	willow oak	Tree	1		1	1		1				2		2	31		31	32		32	32		32	32		32	17		17			
Unknown		Shrub or Tree																2		2	7		7	10		10	6		6			
Vaccinium corymbosum	highbush blueberry	Shrub													1		1	1		1	1		1	1		1	1		1			
Viburnum dentatum	southern arrowwood	Shrub													21		21	20		20	21		21	21		21	21		21			
		Stem count	18	0	18	18	0	18	16	2	18	14	0	14	243	15	258	249	22	271	256	16	272	277	0	277	189	0	189			
		size (ares)	1			1			1			1			14			14			14			14			9					
		size (ACRES)	0.02			0.02			0.02			0.02			0.35			0.35			0.35			0.35			0.22					
		Species count	6	0	6	9	0	9	4	1	4	6	0	6	17	5	17	18	6	19	17	8	19	18	0	18	16	0	16			
		Stems per ACRE	728	0	728	728	0	728	647	81	728	567	0	567	702	43	746	720	64	783	740	46	786	801	0	801	850	0	850			

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

*MY0 included 9 vegetation plots. However, upon review, it was discovered that we needed to have 14 plots to meet guidelines. Five additional plots were added in the Fall of 2015 and the MY1 and later means include these additional plots

Figure 4. Upper Silver Creek - Vegetation Plot Photos, DMS Project #94645

Photo 1. Vegetation Plot 1 – Tree photo
(October 18, 2018).

Photo 2. Vegetation Plot 1 – Herbaceous photo
(October 18, 2018).

Photo 3. Vegetation Plot 2 – Tree photo
(October 18, 2018).

Photo 4. Vegetation Plot 2 – Herbaceous photo
(October 18, 2018).

Photo 5. Vegetation Plot 3 – Tree photo
(October 18, 2018).

Photo 6. Vegetation Plot 3 – Herbaceous photo
(October 18, 2018).

Photo 7. Vegetation Plot 4 – Tree photo
(October 18, 2018).

Photo 8. Vegetation Plot 4 – Herbaceous photo
(October 18, 2018).

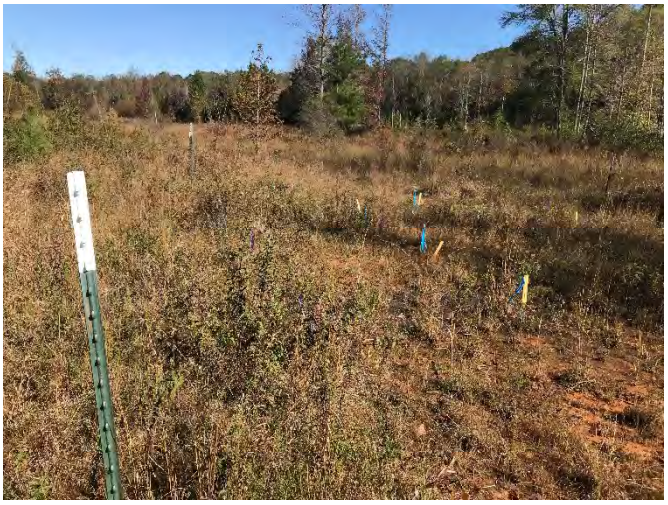


Photo 9. Vegetation Plot 5 – Tree photo
(October 18, 2018).

Photo Point 10, Vegetation Plot 5 – Herbaceous photo
(October 18, 2018).

Photo 11. Vegetation Plot 6 – Tree photo
(October 18, 2018).

Photo 12. Vegetation Plot 6 – Herbaceous photo
(October 18, 2018).

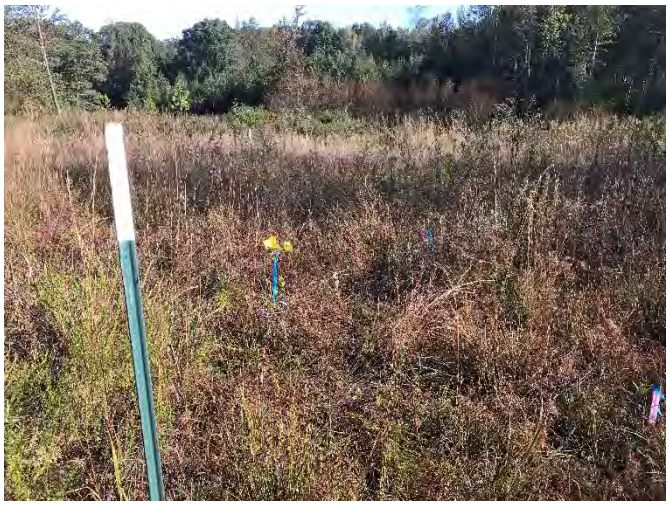


Photo 13. Vegetation Plot 7 – Tree photo (October 18, 2018).

Photo 14. Vegetation Plot 7 – Herbaceous photo (October 18, 2018).

Photo 15. Vegetation Plot 8 – Tree photo (October 18, 2018).

Photo 16. Vegetation Plot 8 – Herbaceous photo (October 18, 2018).

Photo 17. Vegetation Plot 9 – Tree photo (October 18, 2018).

Photo 18. Vegetation Plot 9 – Herbaceous photo (October 18, 2018).

Photo 19. Vegetation Plot 10 – Tree photo (October 18, 2018).

Photo 20. Vegetation Plot 10 – Herbaceous photo (October 18, 2018).

Photo 21. Vegetation Plot 11 – Tree photo (October 18, 2018).

Photo 22. Vegetation Plot 11 – Herbaceous photo (October 18, 2018).

Photo 23. Vegetation Plot 12 – Tree photo (October 18, 2018).

Photo 24. Vegetation Plot 12 – Herbaceous photo (October 18, 2018).

Photo 25. Vegetation Plot 13 – Tree photo (October 18, 2018).

Photo 26. Vegetation Plot 13 – Herbaceous photo (October 18, 2018).

Photo 27. Vegetation Plot 14 – Tree photo (October 18, 2018).

Photo 28. Vegetation Plot 14 – Herbaceous photo (October 18, 2018).

Appendix D

Stream Assessment Data

Includes:

Figure 5. Stream Photos by Channel and Station

Table 8. Visual Morphological Stability Assessment

Table 9. Verification of Bankfull or Greater than Bankfull Events

Figure 6. Cross-Sections with Annual Overlays

Figure 7. Longitudinal Profiles with Annual Overlays

Figure 8. Pebble Count Plots with Annual Overlays

Table 10. Monitoring Year 4 Stream Summary

Table 11. Morphology and Hydraulic Monitoring Summary

Figure 5. Upper Silver Creek Stream Photos by Channel and Station – MY4 (2018)

Photo 1. Mainstem Photo Point 1 – Station 29+26
(November 18, 2018) downstream view from left bank.

Photo 2. Mainstem Photo Point 1 – Station 29+26
(November 18, 2018) upstream view from left bank.

Photo 3. Mainstem Photo Point 2 – Station 26+44
(November 18, 2018) downstream view from left bank.

Photo 4. Mainstem Photo Point 2 – Station 26+44
(November 18, 2018) upstream from left bank.

Photo 5. Mainstem Photo Point 3 – Station 24+70
(November 18, 2018) upstream from right bank.

Photo 6. Mainstem Photo Point 3 – Station 24+70
(November 18, 2018) downstream from right bank.

Photo 7. Mainstem Photo Point 4 (PP4) – Station 20+30 (November 18, 2018) downstream from left bank.

Photo 8. Mainstem Photo Point 4 (PP4) – Station 20+30 (November 18, 2018) upstream from left bank.

Photo 9. Mainstem Photo Point 5 – Station 16+03 (November 18, 2018) upstream from right bank.

Photo 10, Mainstem Photo Point 5 – Station 16+03 (November 18, 2018) downstream from right bank.

Photo 11. Mainstem Photo Point 6 – Station 13+03 (November 18, 2018) upstream from right bank.

Photo 12. Mainstem Photo Point 6 – Station 13+03 (November 18, 2018) downstream from right bank.

Photo 13. Mainstem Photo Point 7 – Station 10+11 (November 18, 2018) downstream from left bank.

Photo 14. Mainstem Photo Point 7 – Station 10+11 (November 18, 2018) upstream from left bank.

Photo 15. Mainstem Photo Point 8 – Station 5+06 (November 18, 2018) upstream from right bank.

Photo 16. Mainstem Photo Point 8 – Station 5+06 (November 18, 2018) downstream from right bank.

Photo 17. Mainstem Photo Point 9 – Station 3+87 (November 18, 2018) downstream from left bank.

Photo 18. Mainstem Photo Point 9 – Station 3+87 (November 18, 2018) upstream from left bank.

Photo 19. Mainstem Photo Point 10 – Stat. 1+22
(November 18, 2018) downstream from left bank.

Photo 20. Mainstem Photo Point 10 – Stat. 1+22
(November 18, 2018) upstream from left bank.

Unnamed Tributary 1 - Monitoring Year 4 (2018)

Photo 21. UT1 Photo Point 1 – Station 4+82
(November 18, 2018) upstream from left bank.

Intentionally Left Blank

Photo 22. UT1 Photo Point 2 – Station 4+07
(November 18, 2018) downstream from left bank.

Photo 23. UT1 Photo Point 2 – Station 4+07
(November 18, 2018) upstream from left bank.

Photo 24. UT1 Photo Point 3 – Station 2+55
(November 18, 2018) upstream from right bank.

Photo 25. UT1 Photo Point 3 – Station 2+55
(November 18, 2018) downstream from right bank.

Photo 26. UT1 Photo Point 4 – Station 0+55
(November 18, 2018) downstream from left bank.

Photo 27. UT1 Photo Point 4 – Station 0+55
(November 18, 2018) upstream from left bank.

Unnamed Tributary 2 – Monitoring Year 3 (2017)

Photo 28. UT2 Photo Point 1 – Station 2+15
(November 18, 2018) downstream from left bank.

Photo 29. UT2 Photo Point 1 – Station 2+15
(November 18, 2018) upstream from left bank.

Photo 30. UT2 Photo Point 2 – Station 0+96
(November 18, 2018) upstream from right bank.

Photo 31. UT2 Photo Point 2 – Station 0+96
(November 18, 2018) downstream from right bank.

Photo 32. UT2 Photo Point 3 – Station 0+02
(November 18, 2018) downstream from right bank.

Photo 33. UT2 Photo Point 3 – Station 0+02
(November 18, 2018) upstream from right bank.

Unnamed Tributary 3 – Monitoring Year 4 (2018)

Photo 34. UT3 Photo Point 1 – Station 12+10
(October 18, 2018) downstream from left bank.

Photo 35. UT3 Photo Point 1 – Station 12+10
(October 18, 2018) upstream from left bank.

Photo 36. UT3 Photo Point 2 – Station 10+66
(October 18, 2018) upstream from right bank.

Photo 37. UT3 Photo Point 2 – Station 10+66
(October 18, 2018) downstream from right bank.

Photo 38. UT3 Photo Point 3 – Station 8+10
(October 18, 2018) downstream from left bank.

Photo 39. UT3 Photo Point 3 – Station 8+10
(October 18, 2018) upstream from left bank.

Photo 40. UT3 Photo Point 4 – Station 7+05
(October 18, 2018) downstream from left bank.

Photo 41. UT3 Photo Point 4 – Station 7+05
(October 18, 2018) upstream from left bank.

Photo 42. UT3 Photo Point 5 – Station 5+95
(October 18, 2018) downstream from left bank.

Photo 43. UT3 Photo Point 5 – Station 5+95
(October 18, 2018) upstream from left bank.

Photo 44. UT3 Photo Point 6 – Station 4+55
(October 18, 2018) upstream from right bank.

Photo 45. UT3 Photo Point 6 – Station 4+55
(October 18, 2018) downstream from right bank.

Photo 46. UT3 Photo Point 7 – Station 3+60
(October 18, 2018) upstream to structure.

Photo 47. UT3 Photo Point 8 – Station 2+70
(October 18, 2018) upstream to structure.

Photo 48. UT3 Photo Point 9 – Station 1+90 (October 18, 2018) upstream to structure.

Photo 49. UT3 Photo Point 10 – Station 0+60 (October 18, 2018) downstream to structure.

Table 8. Visual Morphological Stability Assessment
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Silver Creek, Reach 1 (838 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?	4	4	0	100	
	2. Armor stable (e.g. no displacement)?	4	4	0	100	
	3. Facet grades appears stable?	4	4	0	100	
	4. Minimal evidence of embedding/fining?	4	4	0	100	
	5. Length appropriate?	4	4	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	4	4	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	4	4	0	100	
	3. Length appropriate?	4	4	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?	3	4	0	75	
	2. Of those eroding, # w/concomitant point bar formation?	4	4	0	100	
	3. Apparent Rc within spec?	4	4	0	100	
	4. Sufficient floodplain access and relief?	4	4	0	100	**94%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	838	838	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	838	838	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	6	6	0	100	
	2. Height appropriate?	6	6	0	100	
	3. Angle and geometry appear appropriate?	6	6	0	100	
	4. Free of piping or other structural failures?	6	6	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	4	4	0	100	
	2. Footing stable?	4	4	0	100	**100%**

Silver Creek, Reach 2 (2,178 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?	17	17	0	100	
	2. Armor stable (e.g. no displacement)?	17	17	0	100	
	3. Facet grades appears stable?	17	17	0	100	
	4. Minimal evidence of embedding/fining?	17	17	0	100	
	5. Length appropriate?	17	17	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	16	16	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	16	16	0	100	
	3. Length appropriate?	16	16	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?	16	16	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	16	16	0	100	
	3. Apparent Rc within spec?	16	16	0	100	
	4. Sufficient floodplain access and relief?	16	16	0	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	2,178	2,178	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	2,178	2,178	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	21	21	0	100	
	2. Height appropriate?	21	21	0	100	
	3. Angle and geometry appear appropriate?	21	21	0	100	
	4. Free of piping or other structural failures?	19	21	2	90	**98%**
G. Wads/ Boulders	1. Free of scour?	14	14	0	100	
	2. Footing stable?	14	14	0	100	**100%**

Table 8. Visual Morphological Stability Assessment - Continued
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

UT1 (502 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?	7	7	0	100	
	2. Armor stable (e.g. no displacement)?	7	7	0	100	
	3. Facet grades appears stable?	7	7	0	100	
	4. Minimal evidence of embedding/fining?	7	7	0	100	
	5. Length appropriate?	7	7	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	10	10	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	10	10	0	100	
	3. Length appropriate?	10	10	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?	7	7	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	7	7	0	100	
	3. Apparent Rc within spec?	7	7	0	100	
	4. Sufficient floodplain access and relief?	7	7	0	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	502	502	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	502	502	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?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**100%**

UT2, Reach 1 (103 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?	4	4	0	100	
	2. Armor stable (e.g. no displacement)?	4	4	0	100	
	3. Facet grades appears stable?	4	4	0	100	
	4. Minimal evidence of embedding/fining?	4	4	0	100	
	5. Length appropriate?	4	4	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	5	5	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	5	5	0	100	
	3. Length appropriate?	5	5	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)	103	103	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	103	103	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	5	5	0	100	
	2. Height appropriate?	5	5	0	100	
	3. Angle and geometry appear appropriate?	5	5	0	100	
	4. Free of piping or other structural failures?	5	5	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**N/A**

Table 8. Visual Morphological Stability Assessment - Continued
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

UT2, Reach 2 (207 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?	4	4	0	100	
	2. Armor stable (e.g. no displacement)?	4	4	0	100	
	3. Facet grades appears stable?	4	4	0	100	
	4. Minimal evidence of embedding/fining?	4	4	0	100	
	5. Length appropriate?	4	4	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. 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?	3	3	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	3	3	0	100	
	3. Apparent Rc within spec?	3	3	0	100	
	4. Sufficient floodplain access and relief?	3	3	0	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	207	207	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	207	207	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 8. Visual Morphological Stability Assessment - Continued
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

UT3 Reach 1 (343 LF) (Enhancement II 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?	N/A	N/A	N/A	N/A	
	2. Armor stable (e.g. no displacement)?	N/A	N/A	N/A	N/A	
	3. Facet grades appears stable?	N/A	N/A	N/A	N/A	
	4. Minimal evidence of embedding/fining?	N/A	N/A	N/A	N/A	
	5. Length appropriate?	N/A	N/A	N/A	N/A	**N/A**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	N/A	N/A	N/A	N/A	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	N/A	N/A	N/A	N/A	
	3. Length appropriate?	N/A	N/A	N/A	N/A	**N/A**
C. Thalweg	1. Upstream of pool (structure) centering? (%)	N/A	N/A	N/A	N/A	
	2. Downstream of pool (structure) centering? (%)	N/A	N/A	N/A	N/A	**N/A**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	N/A	N/A	N/A	N/A	
	2. Of those eroding, # w/concomitant point bar formation?	N/A	N/A	N/A	N/A	
	3. Apparent Rc within spec?	N/A	N/A	N/A	N/A	
	4. Sufficient floodplain access and relief?	N/A	N/A	N/A	N/A	**N/A**
E. Bed General	1. General channel bed aggradation areas (bar formation)	343	343	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	343	343	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	3	3	0	100	
	2. Height appropriate?	3	3	0	100	
	3. Angle and geometry appear appropriate?	3	3	0	100	
	4. Free of piping or other structural failures?	3	3	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**N/A**

Table 8. Visual Morphological Stability Assessment - Continued
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

UT3 Reach 2 (1,022 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?	22	22	0	100	
	2. Armor stable (e.g. no displacement)?	22	22	0	100	
	3. Facet grades appears stable?	22	22	0	100	
	4. Minimal evidence of embedding/fining?	22	22	0	100	
	5. Length appropriate?	22	22	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	21	21	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	21	21	0	100	
	3. Length appropriate?	21	21	0	100	**100%**
C. Thalweg	1. Upstream of pool (structure) centering?	100	100	0	100	
	2. Downstream of pool (structure) centering?	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	17	17	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	17	17	0	100	
	3. Apparent Rc within spec?	17	17	0	100	
	4. Sufficient floodplain access and relief?	17	17	0	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	1,022	1,022	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	1,022	1,022	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	15	15	0	100	
	2. Height appropriate?	15	15	0	100	
	3. Angle and geometry appear appropriate?	15	15	0	100	
	4. Free of piping or other structural failures?	15	15	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	4	4	0	100	
	2. Footing stable?	4	4	0	100	**100%**

Table 9. Verification of Bankfull or Greater than Bankfull Events
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Date of Data Collection	Approximate Date of Event	Method of Data Collection	Gauge Watermark Height (inches)[1]	
			Silver Creek Station 19+00	UT3 Station 8+10
MY2				
2/29/2016	Unknown	Crest gauge	15.0	5.0
MY3				
5/2/2017	Unknown	Crest Gauge	5.4	3.0
MY4				
4/2/2018	2/11/2018	Crest Gauge	14.28	0 [2]
5/8/2018	4/15/2018	Crest Gauge	12.96	0 [2]
10/3/2018	9/16/2018	Crest Gauge	10.56	0 [2]
10/18/2018	10/11/2018	Crest Gauge	19.68	0 [2]

[1] Height indicates the highest position of cork shavings on the dowel and the height above bankfull, as 0" on the dowel is set at bankfull

[2] Crest gauge along UT3 was impacted by an ant hill and did not record a bankful event. The crest gauge was cleaned out repeatedly and refilled with cork in 2018 but the ant hill was rebuilt from cork from the crest gauge, so the events documented on 5/8/2018, 10/3/2018, and 10/18/2018 were not recorded. The crest gauge was cleaned out again in November 2018 after the ants left for the winter. They will be treated and eradicated if they return in spring.

Photo 1. Silver Creek mainstem crest gauge staff showing cork deposition in red circle at 1.19' above the bottom of the staff, which is at the bankfull elevation (4/2/2018)

Photo 2. Silver Creek mainstem crest gauge staff showing cork deposition in red circle at 1.19' above the bottom of the staff, which is at the bankfull elevation (4/2/2018)

Photo 3. Silver Creek mainstem crest gauge staff showing cork deposition in red circle at 1.08' above the bottom of the staff, which is at the bankfull elevation (5/8/2018)

Photo 4. Silver Creek mainstem crest gauge staff showing cork deposition in red circle at 1.08' above the bottom of the staff, which is at the bankfull elevation (5/8/2018)

Photo 5. Silver Creek mainstem crest gauge staff showing cork deposition in red circle at 0.88' above the bottom of the staff, which is at the bankfull elevation (10/3/2018)

Photo 6. Silver Creek mainstem crest gauge staff showing cork deposition in red circle at 0.88' above the bottom of the staff, which is at the bankfull elevation (10/3/2018)

Photo 7. Silver Creek mainstem crest gauge staff showing cork deposition in red circle at 1.64' above the bottom of the staff, which is at the bankfull elevation (10/18/2018)

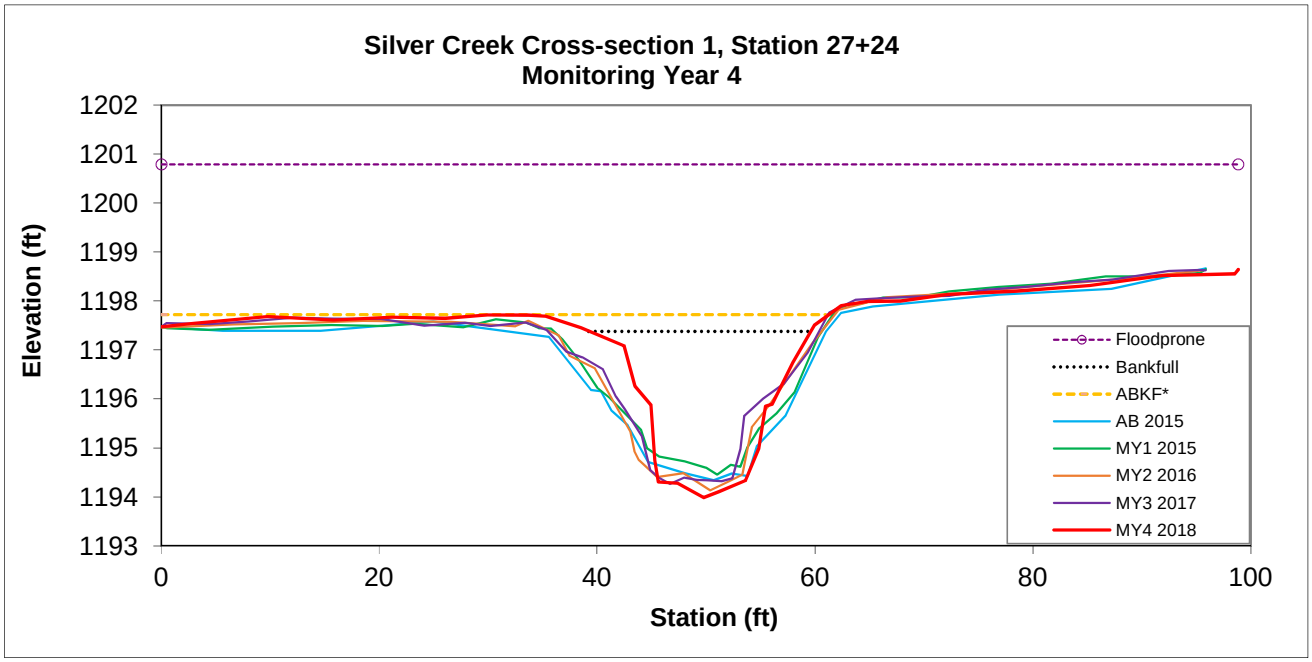
Photo 8. Silver Creek mainstem crest gauge staff showing cork deposition in red circle at 1.64' above the bottom of the staff, which is at the bankfull elevation (10/18/2018)

Figure 6. Cross-sections with Annual Overlays

Permanent Cross-section 1
(MY4 Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	C	38.27	20.28	1.89	3.39	10.73	1.00	4.87	1197.38	1197.73	3.74



Looking at the Left Bank

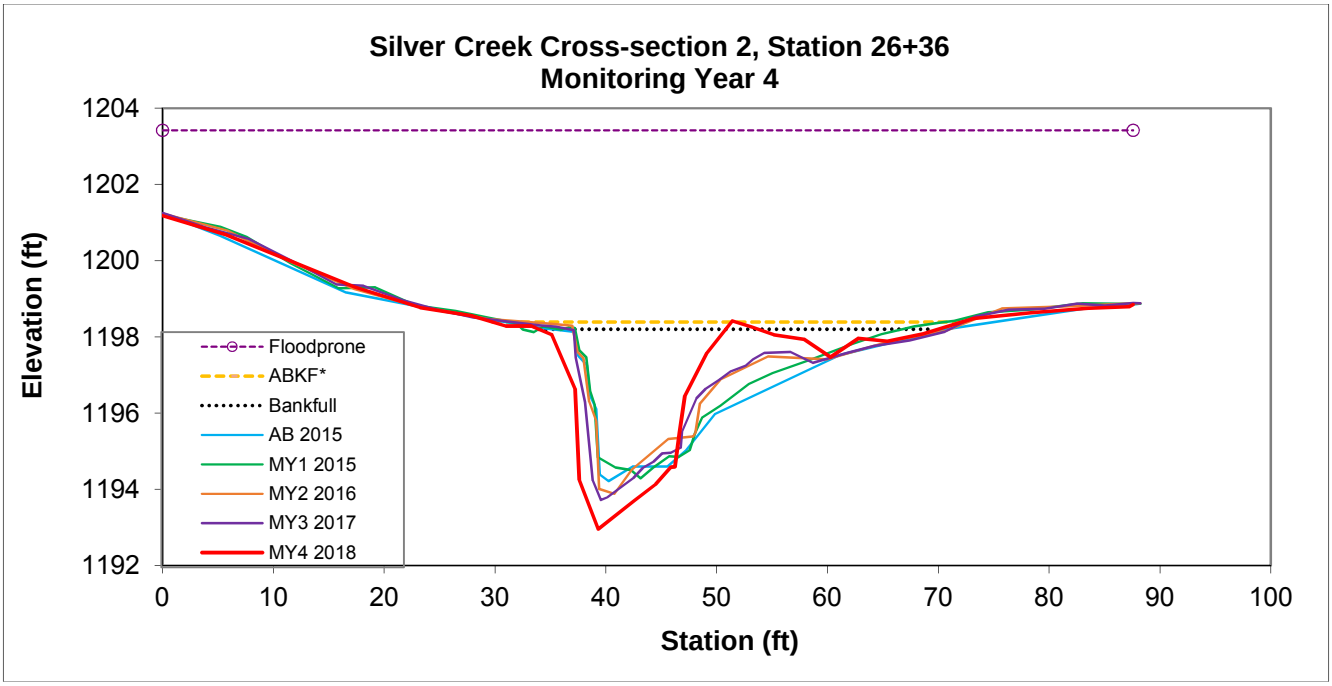
Looking at the Right Bank

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

Permanent Cross-section 2
(MY4 Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	51.28	33.02	1.55	5.24	21.30	0.98	2.67	1198.20	1198.28	5.32



Looking at the Left Bank

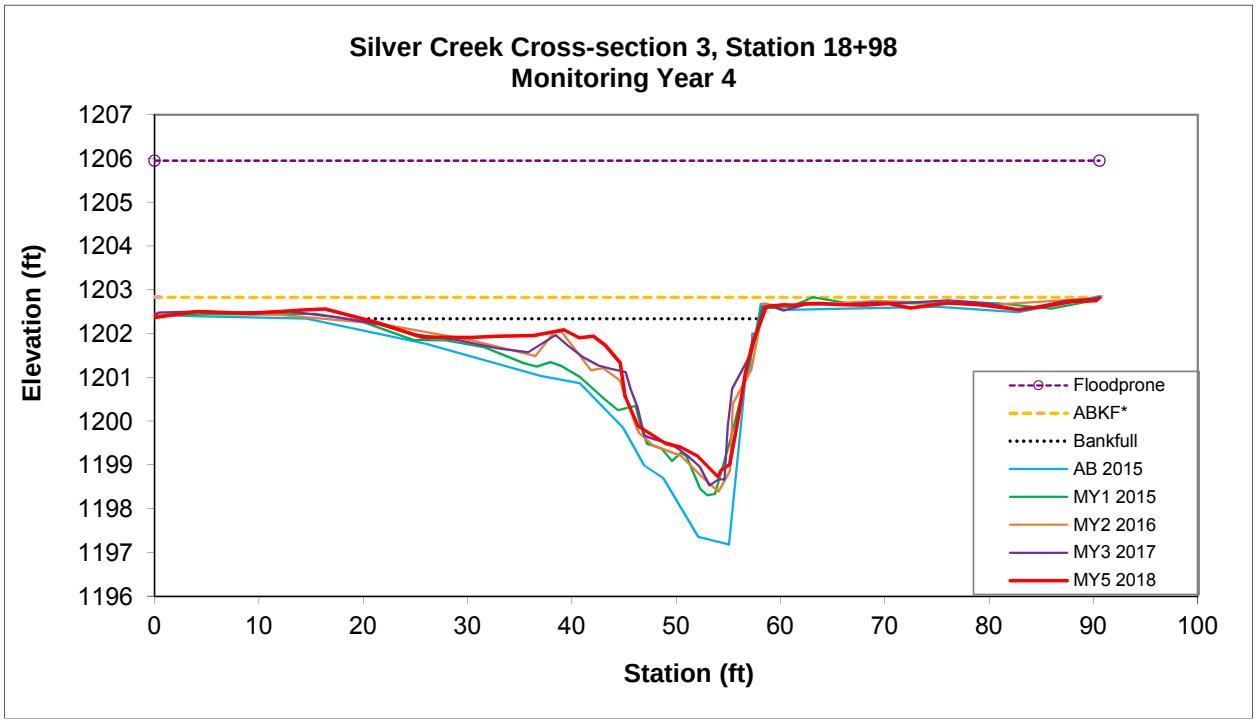
Looking at the Right Bank

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

Permanent Cross-section 3
(MY Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	43.51	38.31	1.14	3.61	33.61	0.93	2.36	1202.34	1202.56	3.83



Looking at the Left Bank

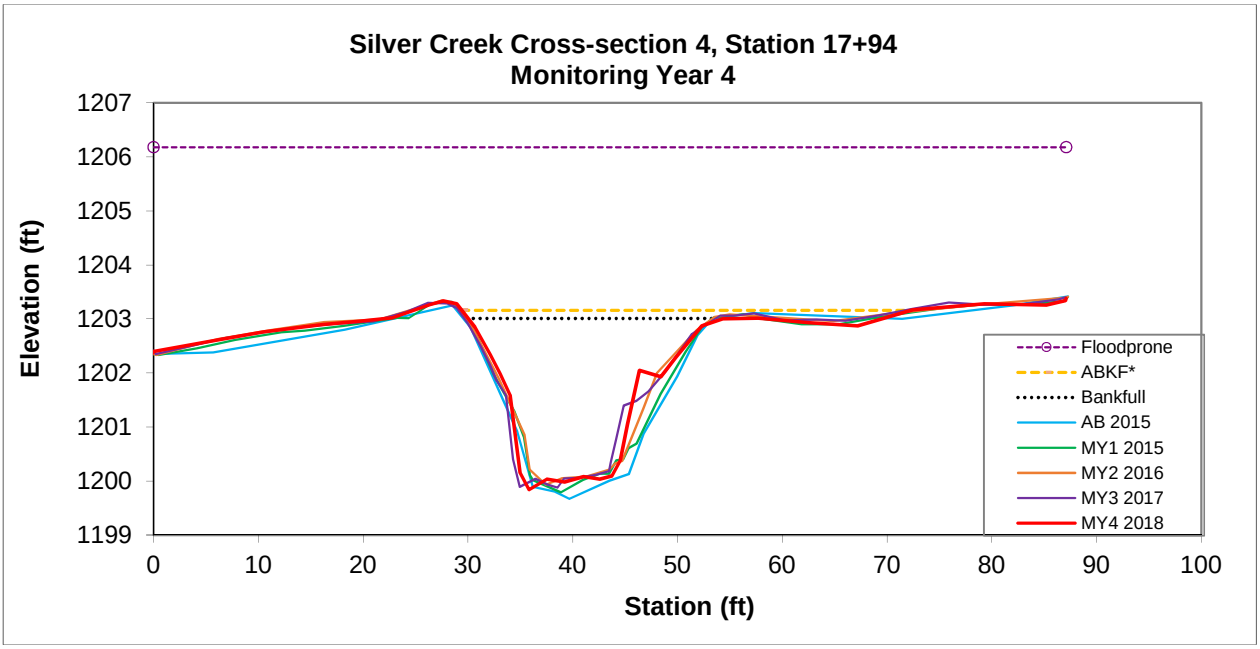
Looking at the Right Bank

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

Permanent Cross-section 4
(MY4 Data - collected Oct0ber, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	C	41.81	37.72	1.11	3.17	33.98	0.95	2.31	1203.01	1203.0	3.16



Looking at the Left Bank

Looking at the Right Bank

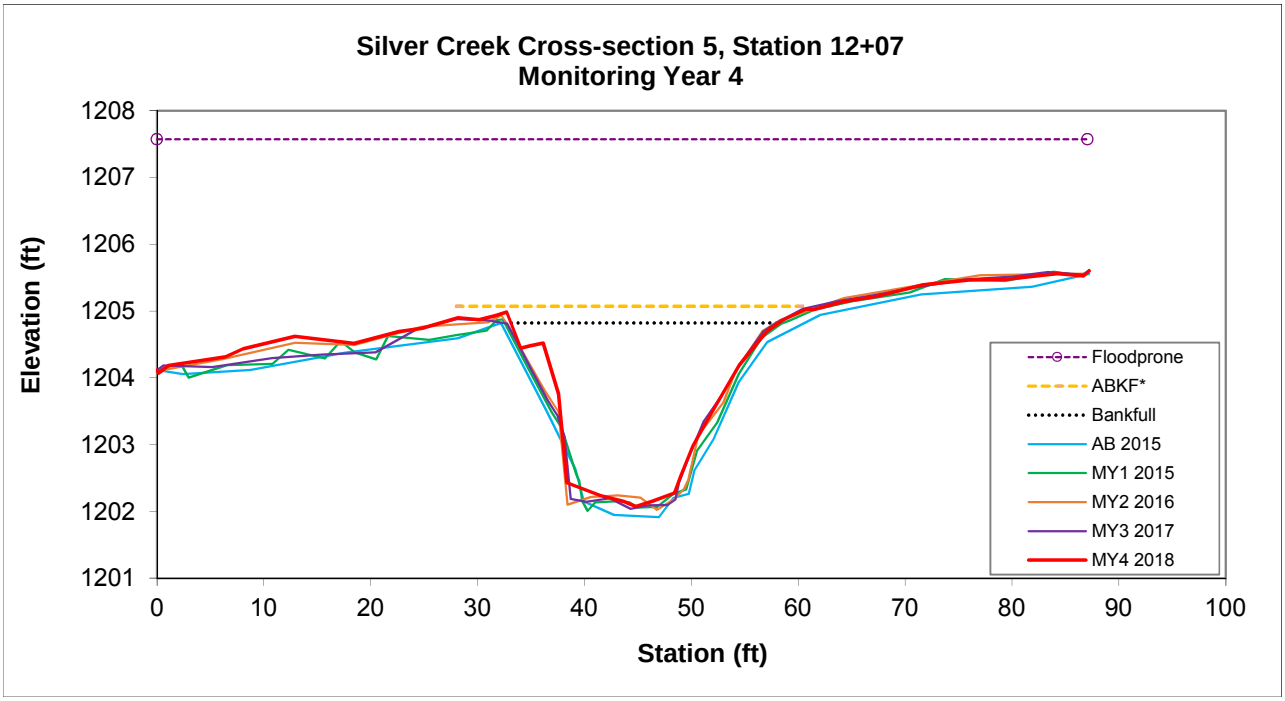
Note: *ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 5

(MY4 Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	C	39.5	25.0	1.58	2.75	15.8	0.97	3.77	1204.82	1204.99	2.92



Looking at the Left Bank

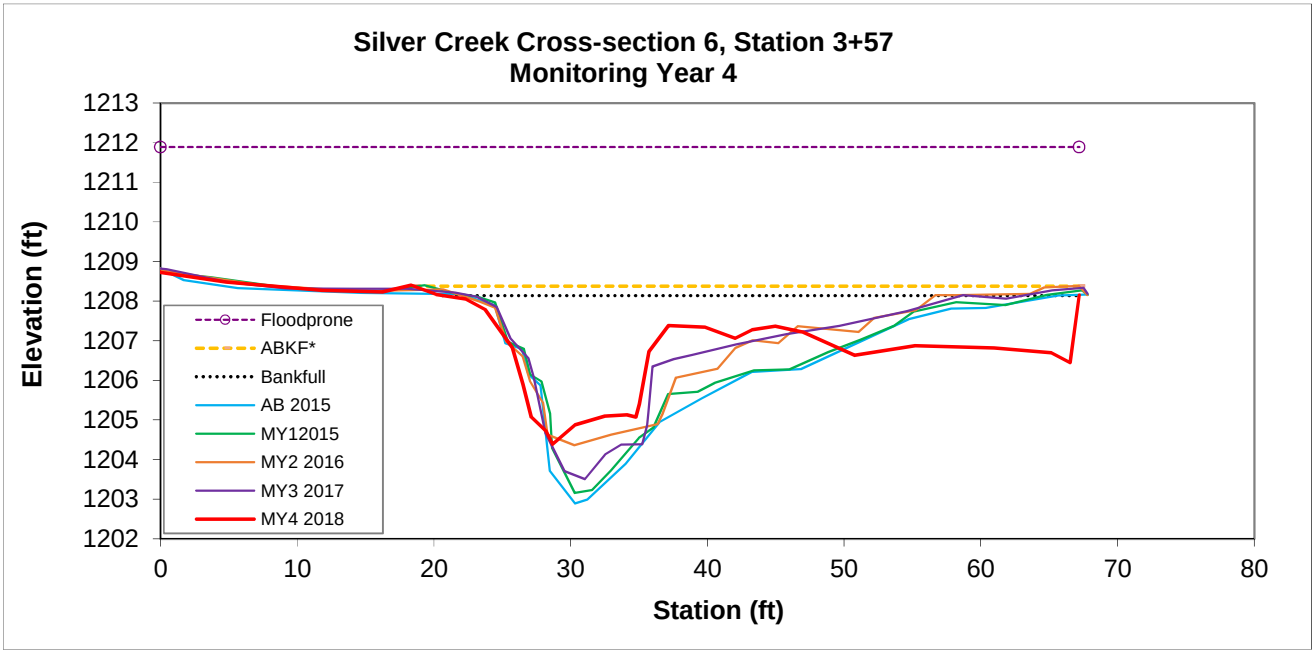
Looking at the Right Bank

Note: *ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.
** Previously reported years had the transect orientation backwards. We are correcting this with this report.

Permanent Cross-section 6
(MY4 Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	68.54	44.93	1.53	3.75	29.37	0.94	1.51	1208.14	1208.16	3.77



Looking at the Left Bank

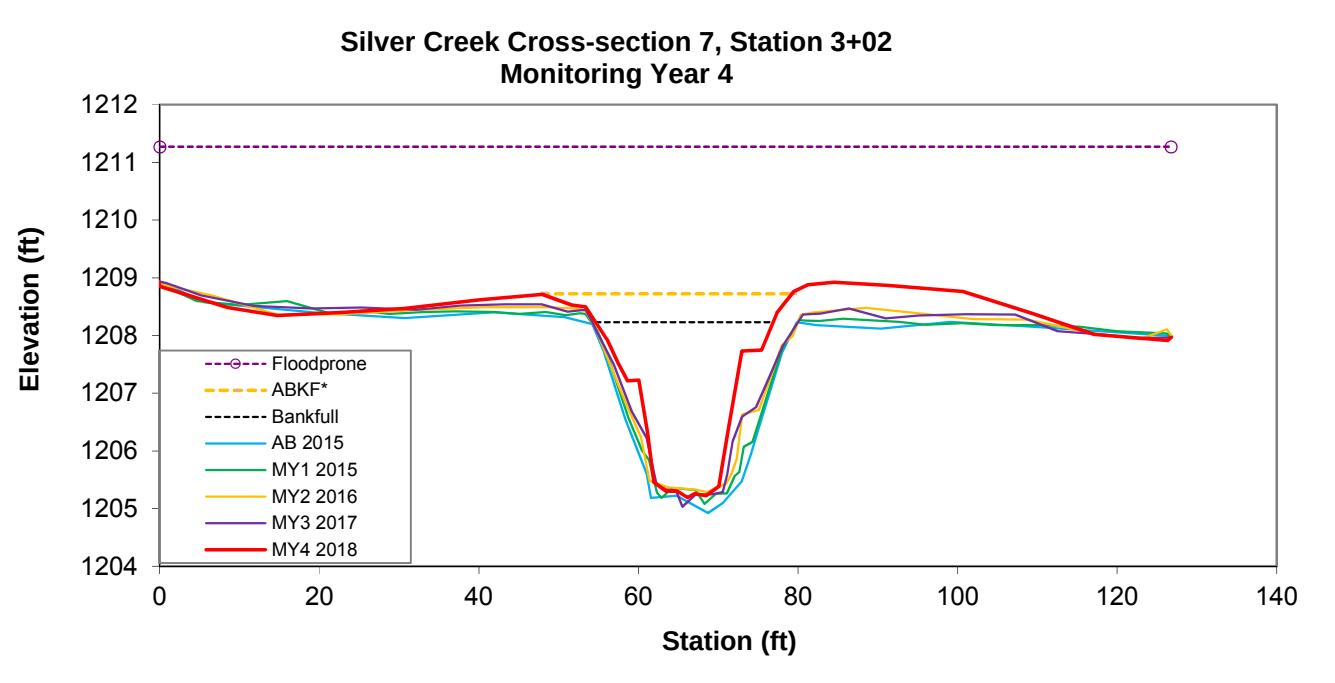
Looking at the Right Bank

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

Permanent Cross-section 7
(MY4 Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	C	37.16	22.23	1.67	3.04	13.31	1.00	5.71	1208.23	1208.71	3.52



Looking at the Left Bank

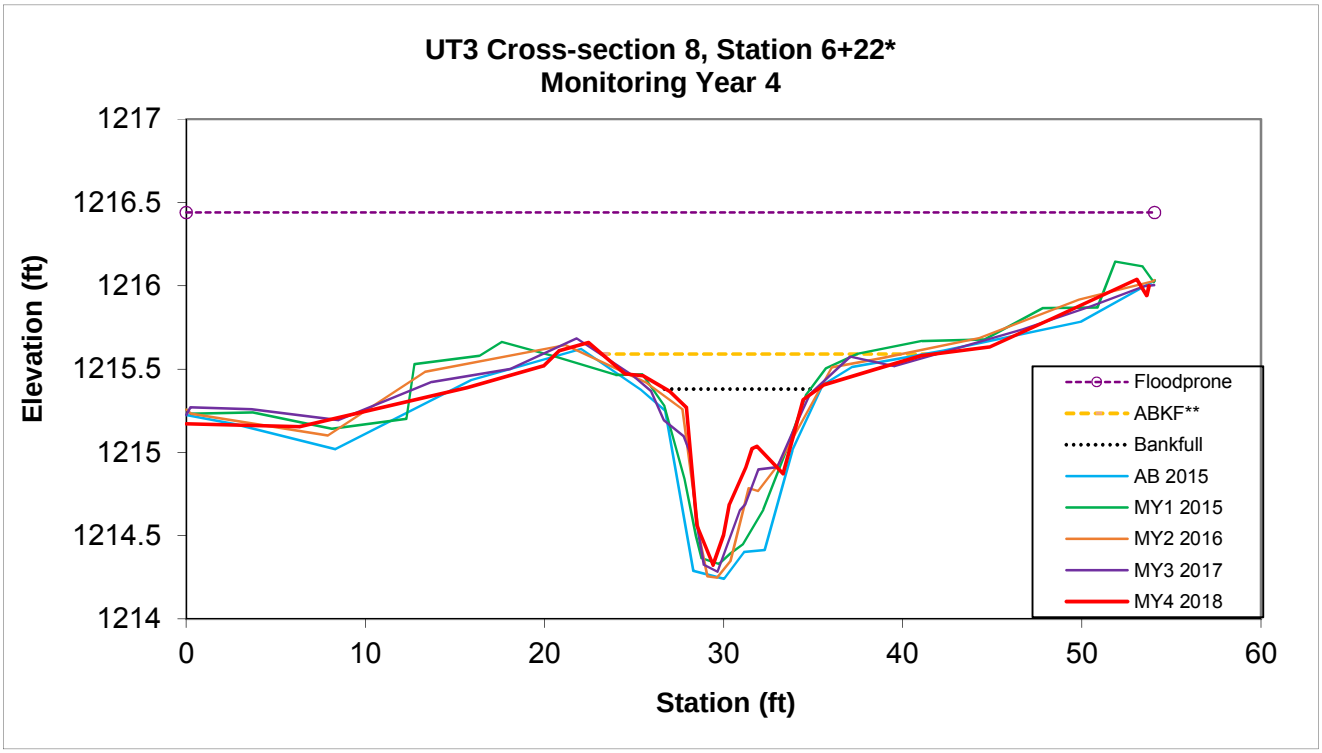
Looking at the Right Bank

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

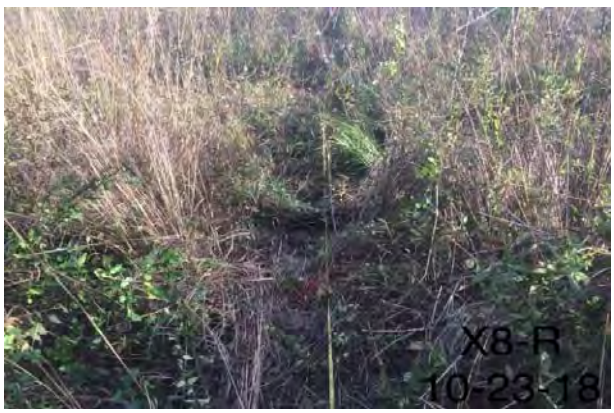
Permanent Cross-section 8
(MY4 Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	C	3.74	8.50	0.44	1.06	19.32	0.86	6.32	1215.38	1215.41	1.09



Looking at the Left Bank



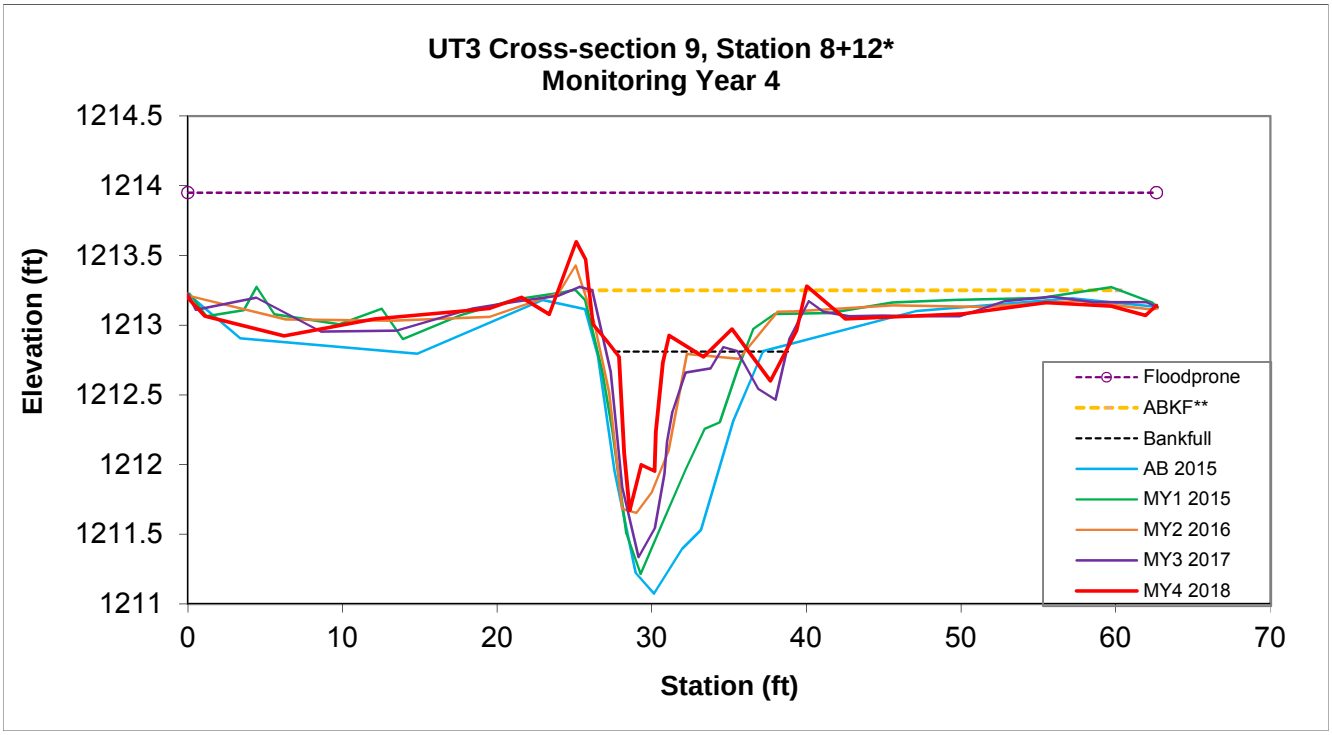
Looking at the Right Bank

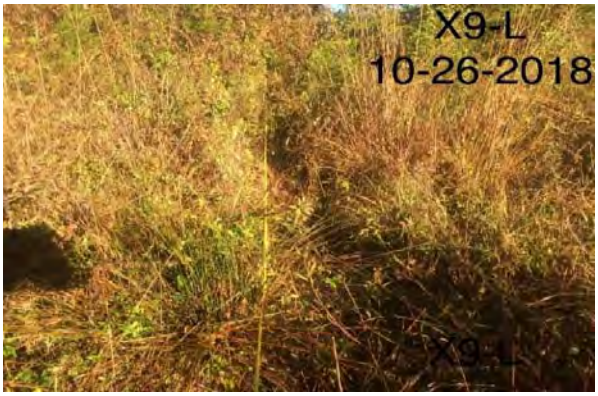
* Note: Stationing for Cross-section 8 has been changed to 6+22; this was the surveyed location last year and this year and is changed from what is shown in the As-built survey and the MY1 report.
** Note: ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 9
(MY4 Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	2.40	6.54	0.37	1.14	17.68	1.02	9.59	1212.81	1213.28	1.61





Looking at the Left Bank

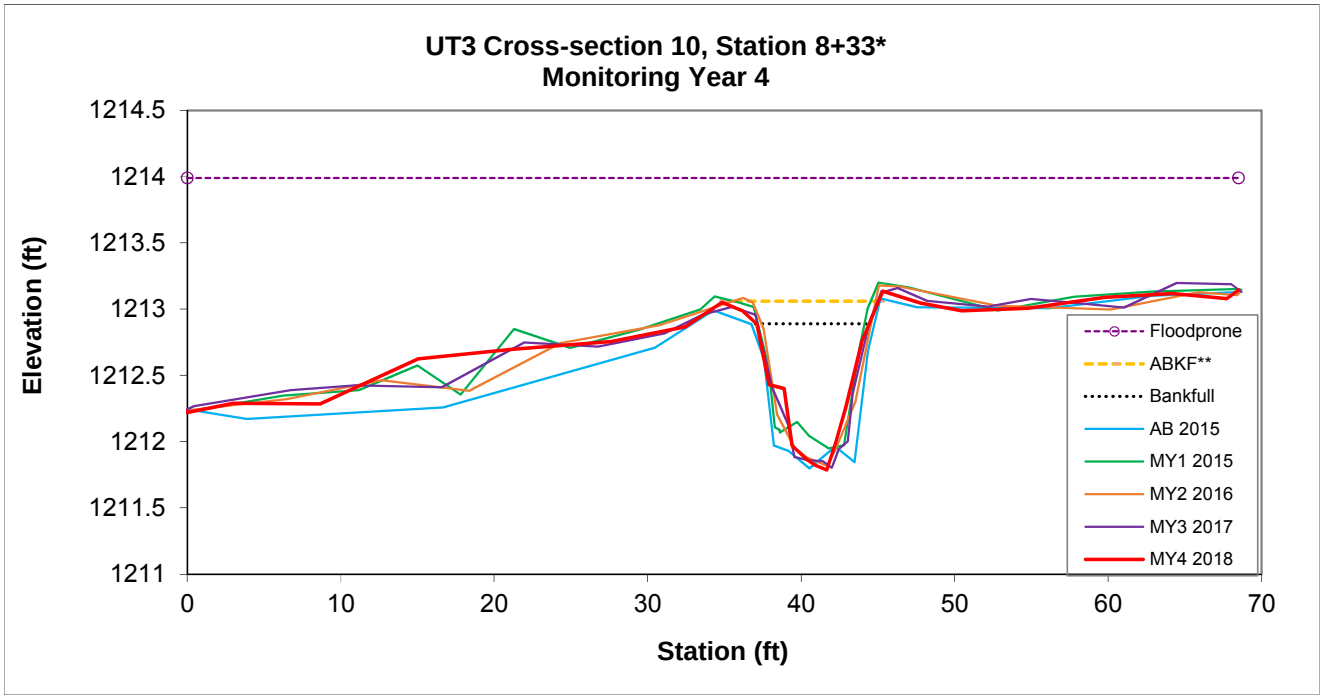
Looking at the Right Bank

Note: *Stationing for Cross-section 9 is being changed to 8+12 which is the surveyed location for the last two years and changes from what was indicated in the As-built survey and the MY1 report.
Note: **ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 10
(MY4 Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	E	4.85	7.34	0.66	1.1	11.12	0.99	9.35	1212.89	1213.05	1.262



Looking at the Left Bank

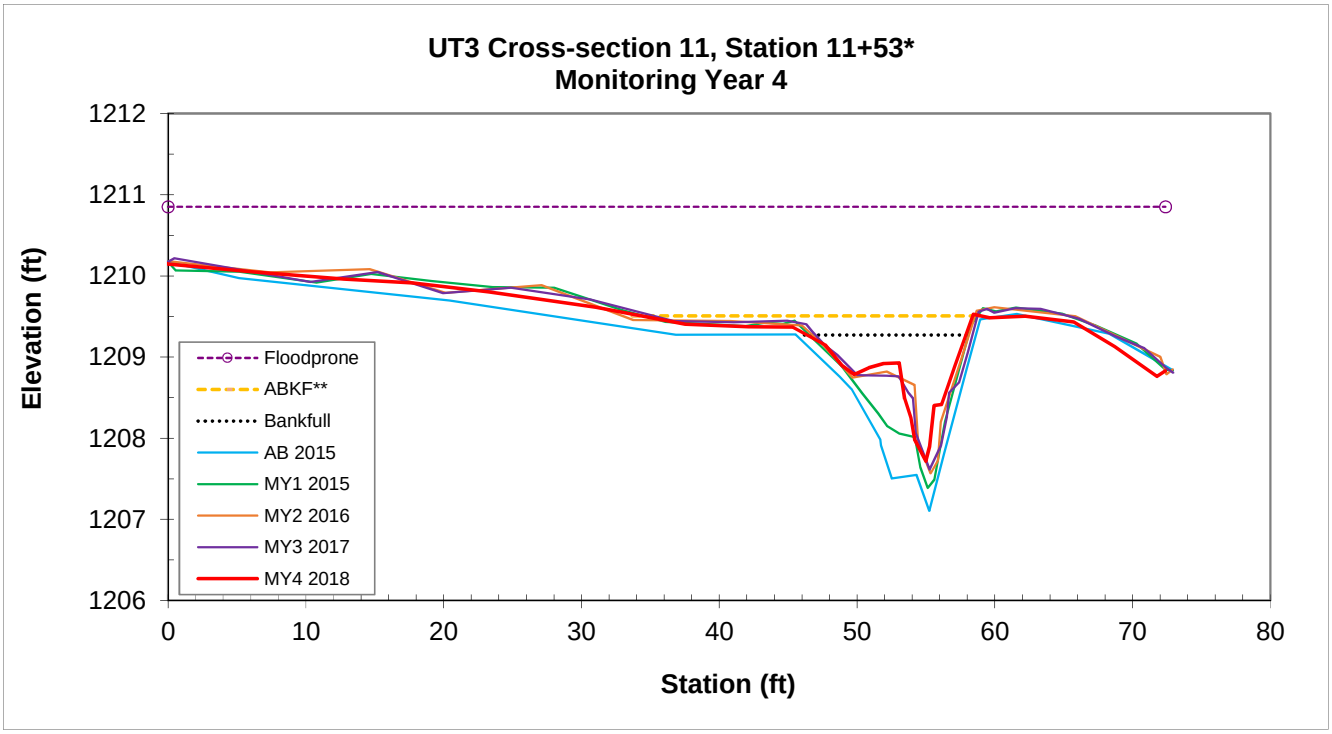
Looking at the Right Bank

Note: *Stationing for Cross-section 10 is being changed to 8+33 which is the surveyed location for the last two years and changes from what was indicated in the As-built survey and the MY1 report.
Note: **ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 11
(MY4 Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	6.12	11.51	0.53	1.56	21.72	0.92	6.34	1209.27	1209.37	1.65



Looking at the Left Bank

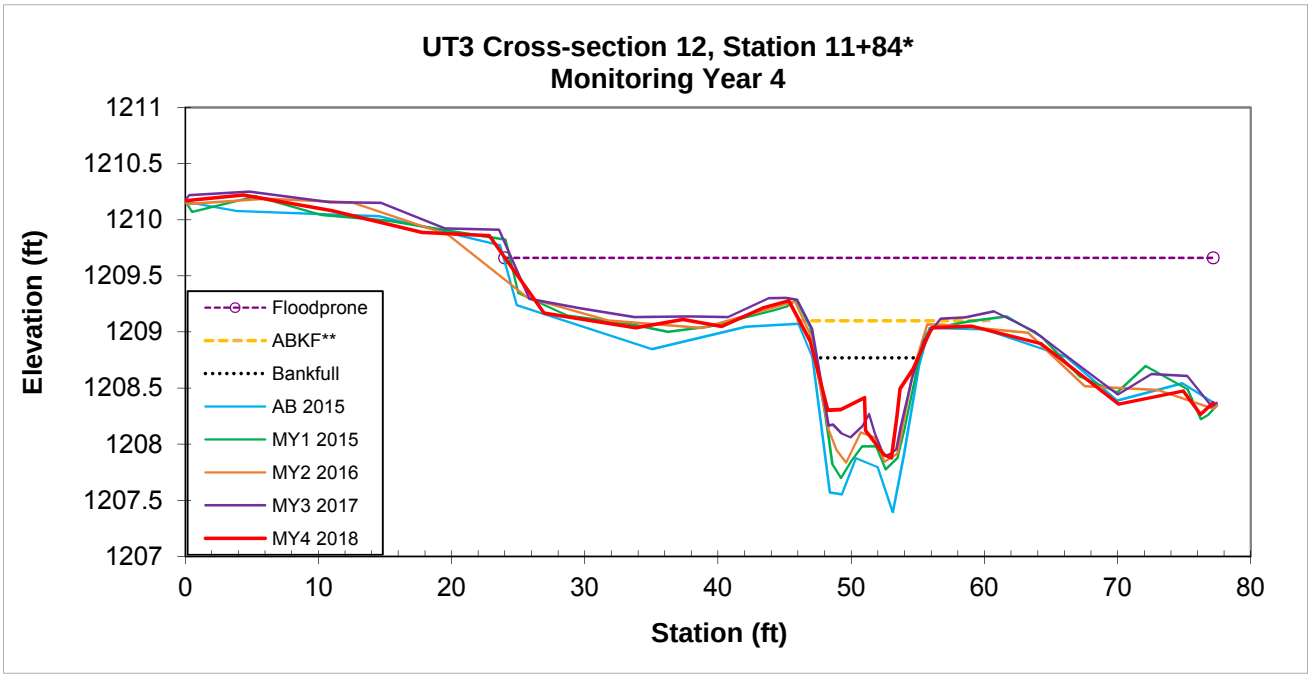
Looking at the Right Bank

Note: *Stationing for Cross-section 11 is being changed to 11+53 which is the surveyed location for the last two years and changes from what was indicated in the As-built survey and the MY1 report.
Note: **ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 12
(MY4 Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	C	3.59	7.79	0.46	0.89	16.93	0.95	6.83	1208.77	1209.04	1.16



Looking at the Left Bank

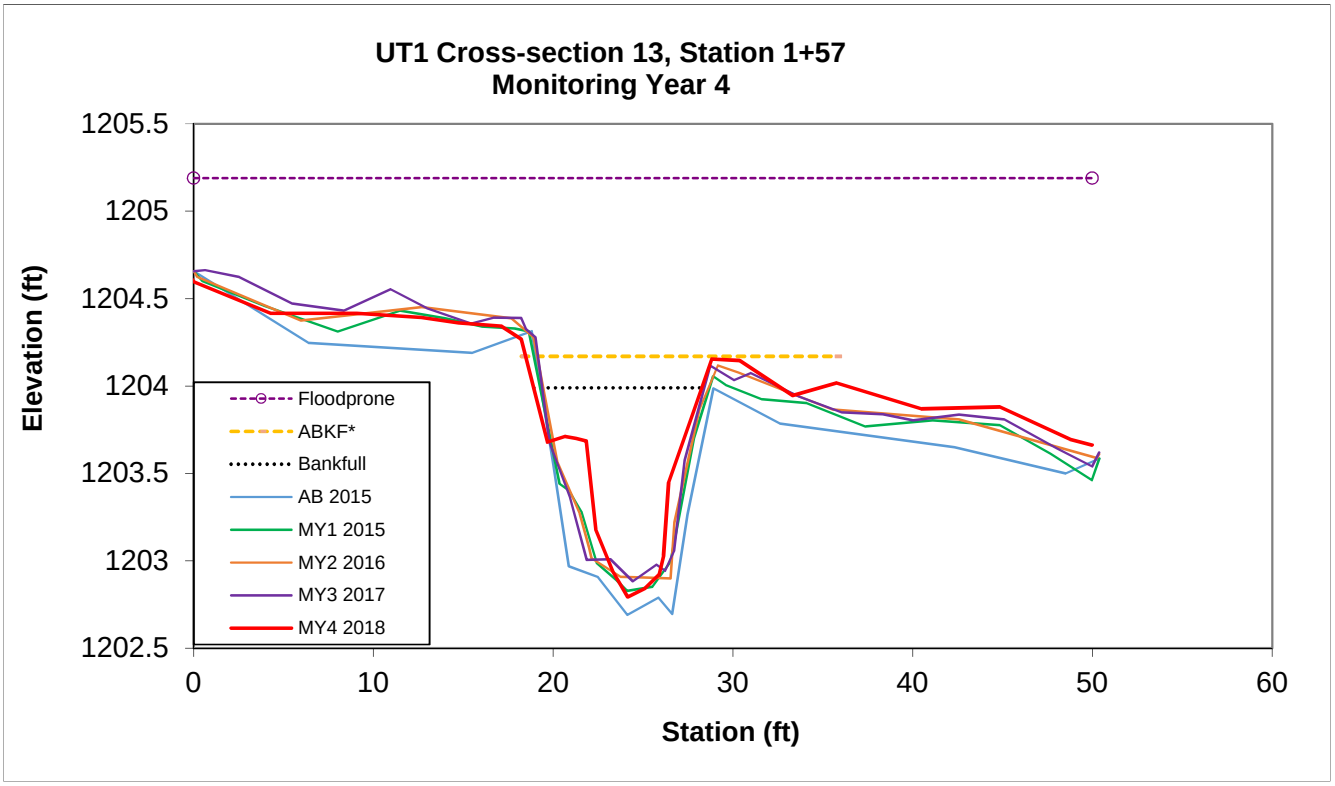
Looking at the Right Bank

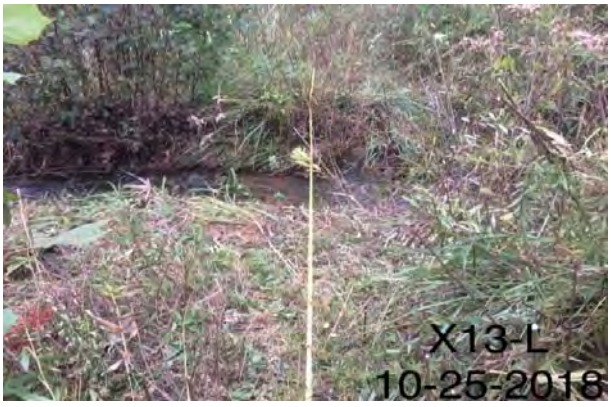
Note: *Stationing for Cross-section 11 is being changed to 11+53 which is the surveyed location for the last two years and changes from what was indicated in the As-built survey and the MY1 report.
Note: **ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 13
(MY4 Data - collected October, 2018)

Based on fixed baseline bankfull

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	C	5.87	11.49	0.51	1.2	22.53	0.99	4.38	1203.99	1204.16	1.37





Looking at the Left Bank

Looking at the Right Bank

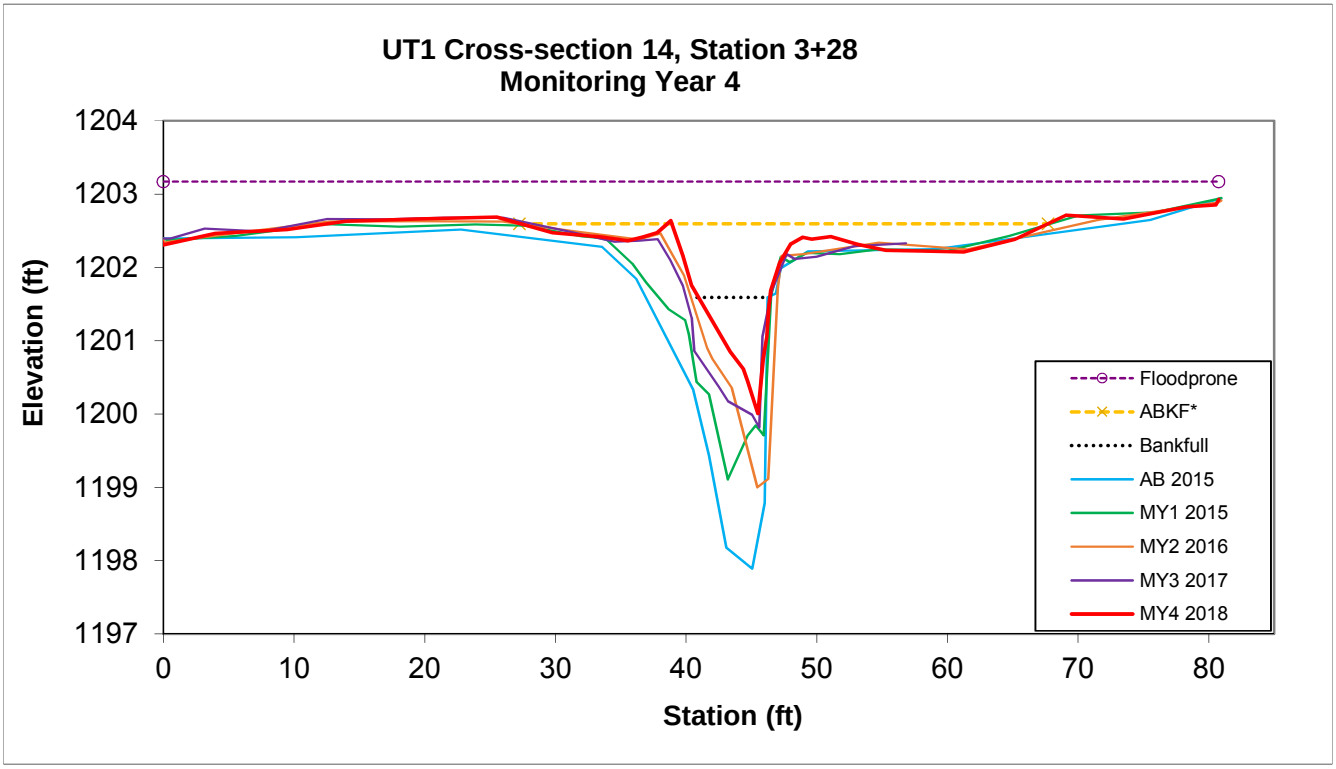
Note: *ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 14

(MY4 Data - collected October, 2018)

Based on fixed baseline bankfull

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	3.91	5.46	0.72	1.58	7.58	0.92	14.83	1201.59	1202.41	2.40



Looking at the Left Bank

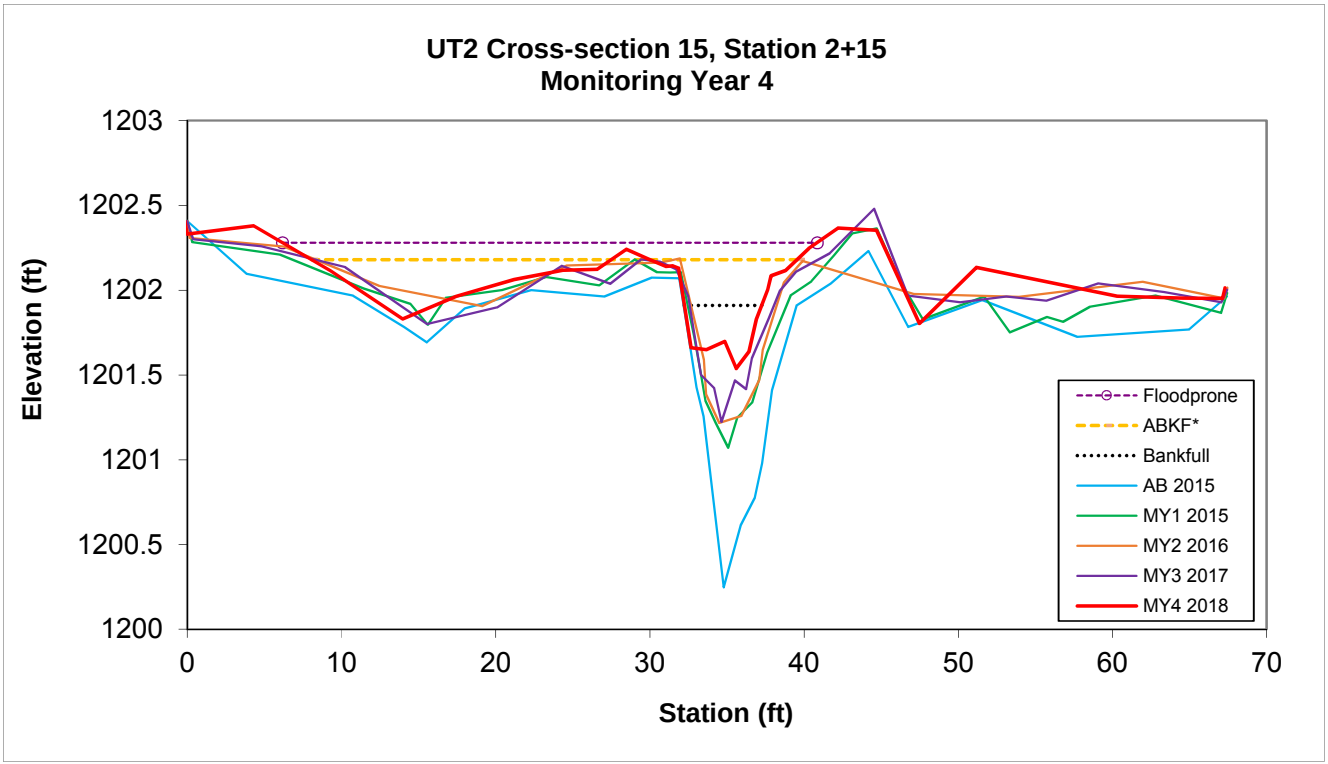
Looking at the Right Bank

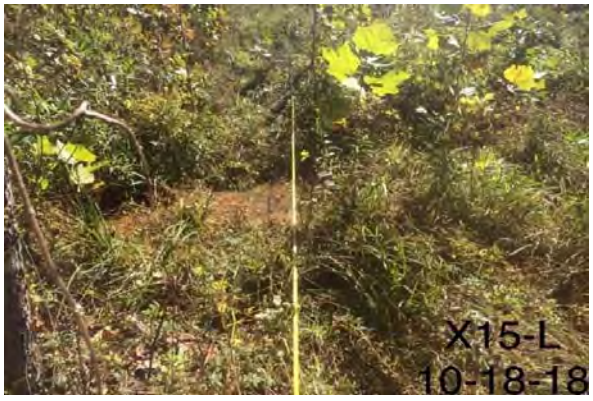
Note: *ABKF stands for as-built bankfull which represents the bankfull line held at the as-built cross sectional area.

Permanent Cross-section 15
(MY4 Data - collected October, 2018)

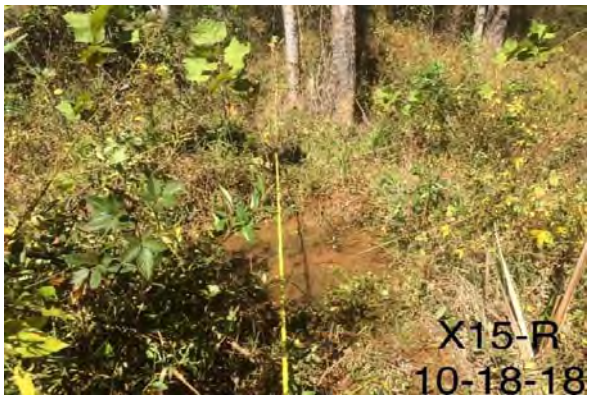
Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Pool	-	1.17	5.01	0.23	0.37	21.78	0.92	11.39	1201.91	1202.14	0.60





Looking at the Left Bank



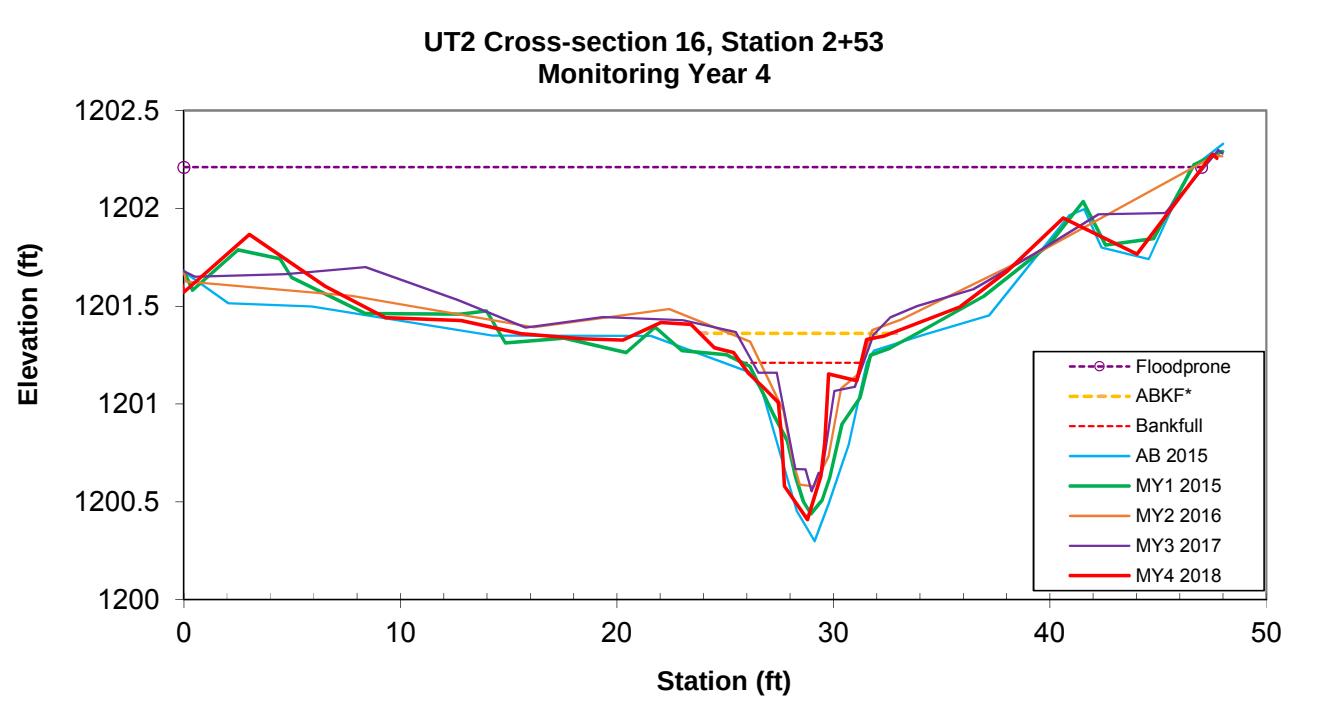
Looking at the Right Bank

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

Permanent Cross-section 16
(MY4 Data - collected October, 2018)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev	Low TOB Depth
Riffle	C	1.72	5.55	0.31	0.80	17.90	0.97	8.29	1201.21	1201.33	0.92

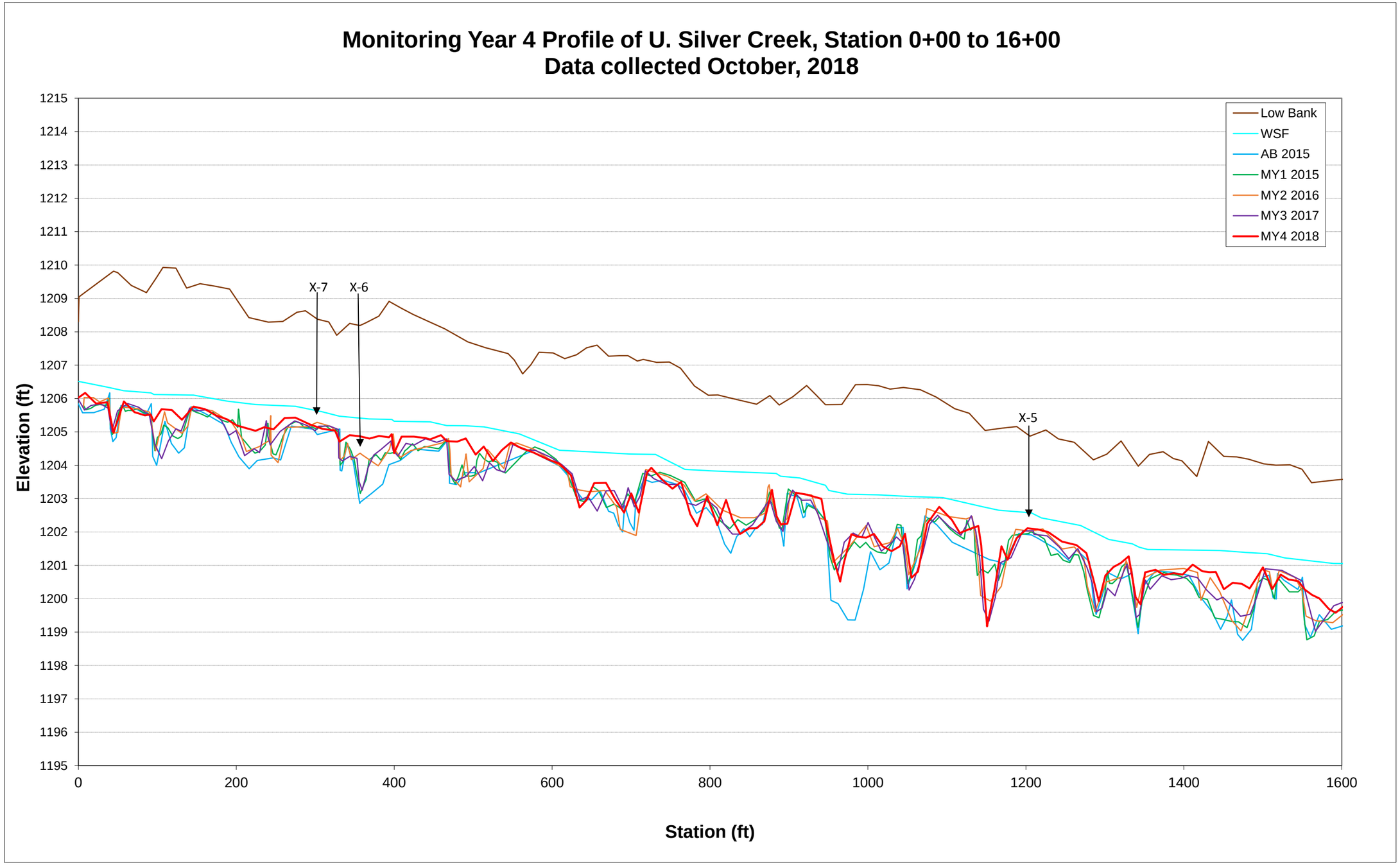


Looking at the Left Bank

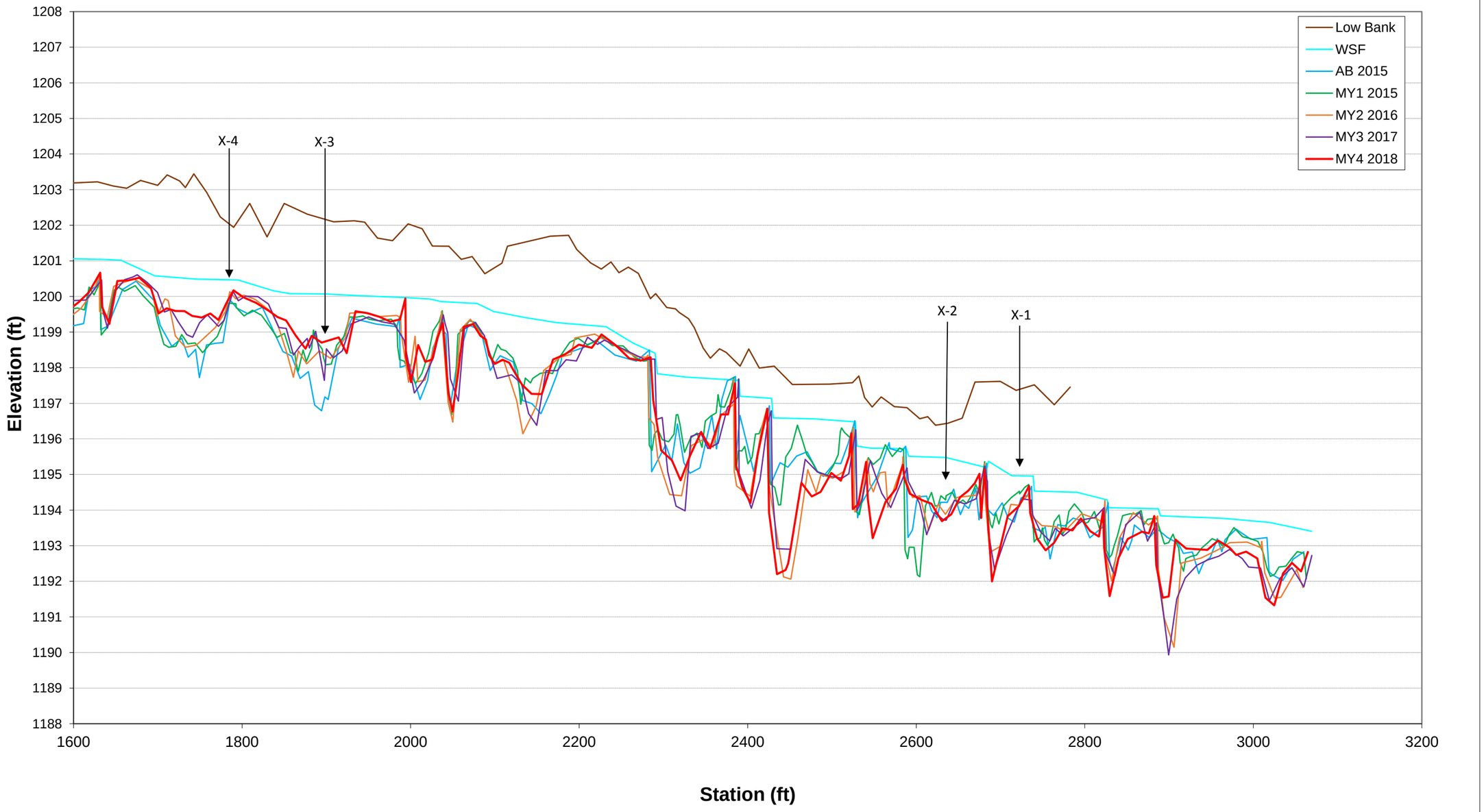
Looking at the Right Bank

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

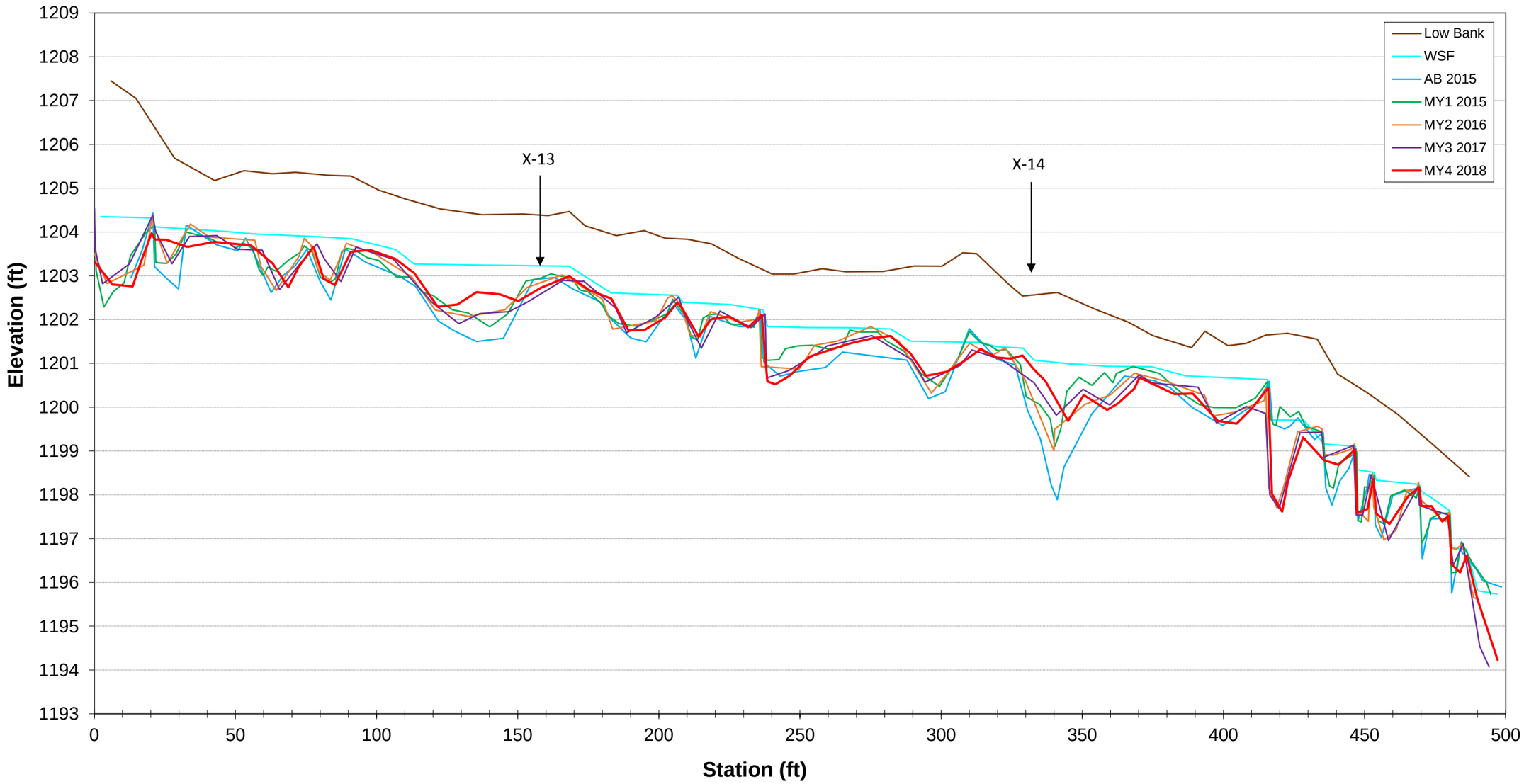
Figure 7. Longitudinal Profiles with Annual Overlay



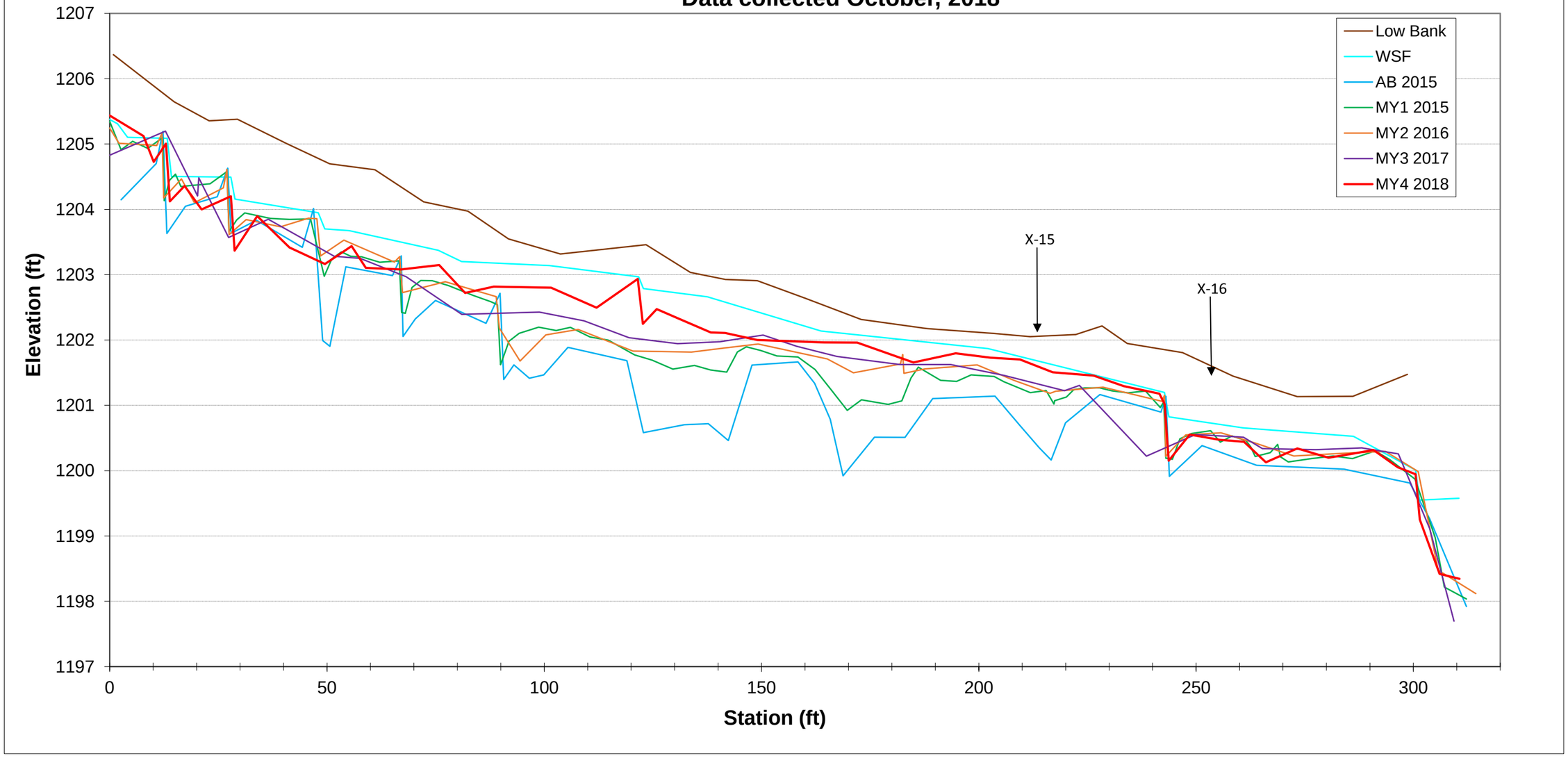
Monitoring Year 4 Profile of U. Silver Creek, Station 16+00 to 32+00
Data collected October, 2018



Monitoring Year 4, Profile of UT1, Station 0+00 to 5+00
Data collected October, 2018



Monitoring Year 4 Profile of UT2, Station 0+00 to 3+20
Data collected October, 2018



Monitoring Year 4, Profile of UT3, Station 0+00 to 14+00
Data collected October 2018

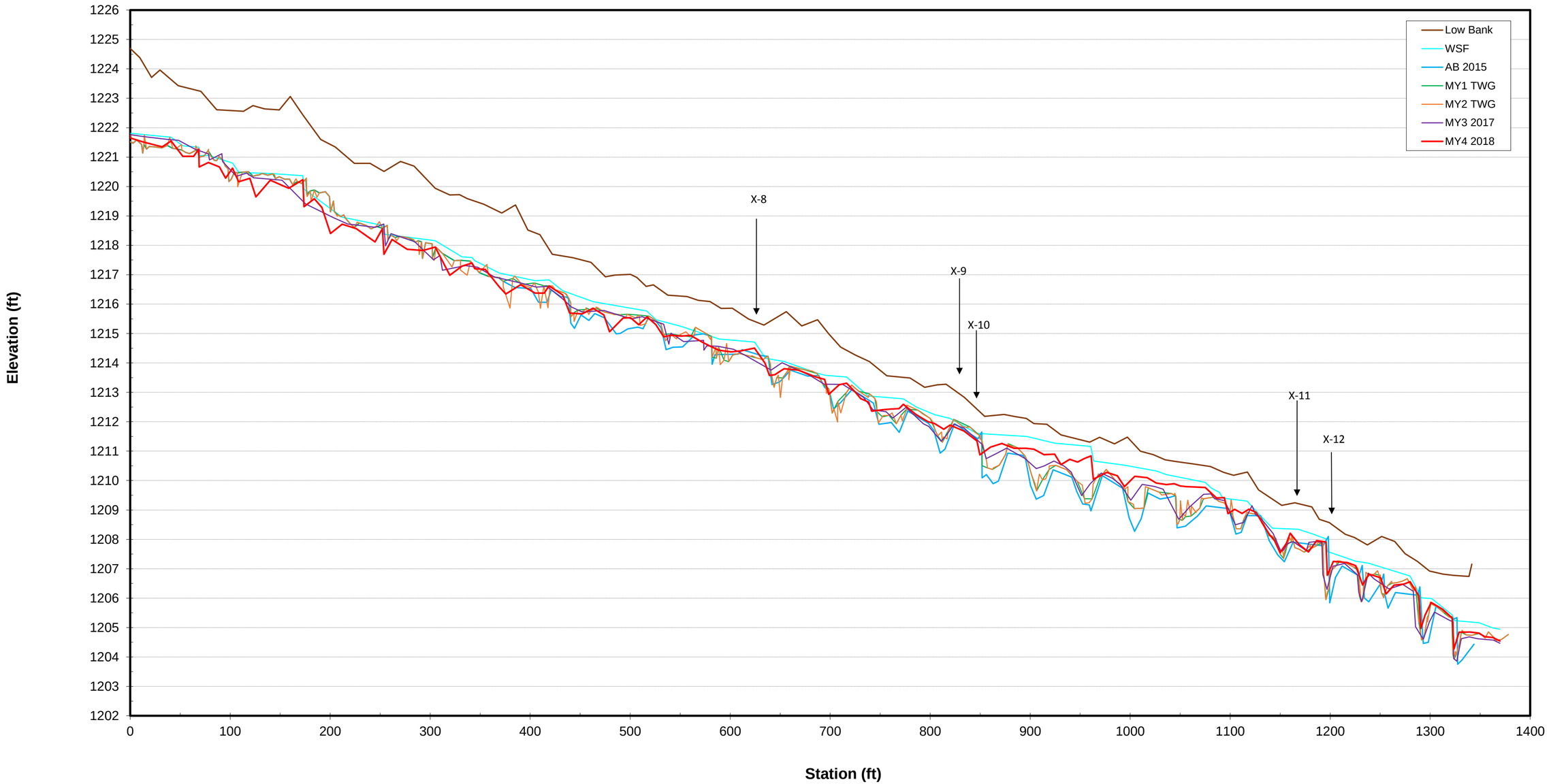


Figure 8. Pebble Count Plots with Annual Overlays

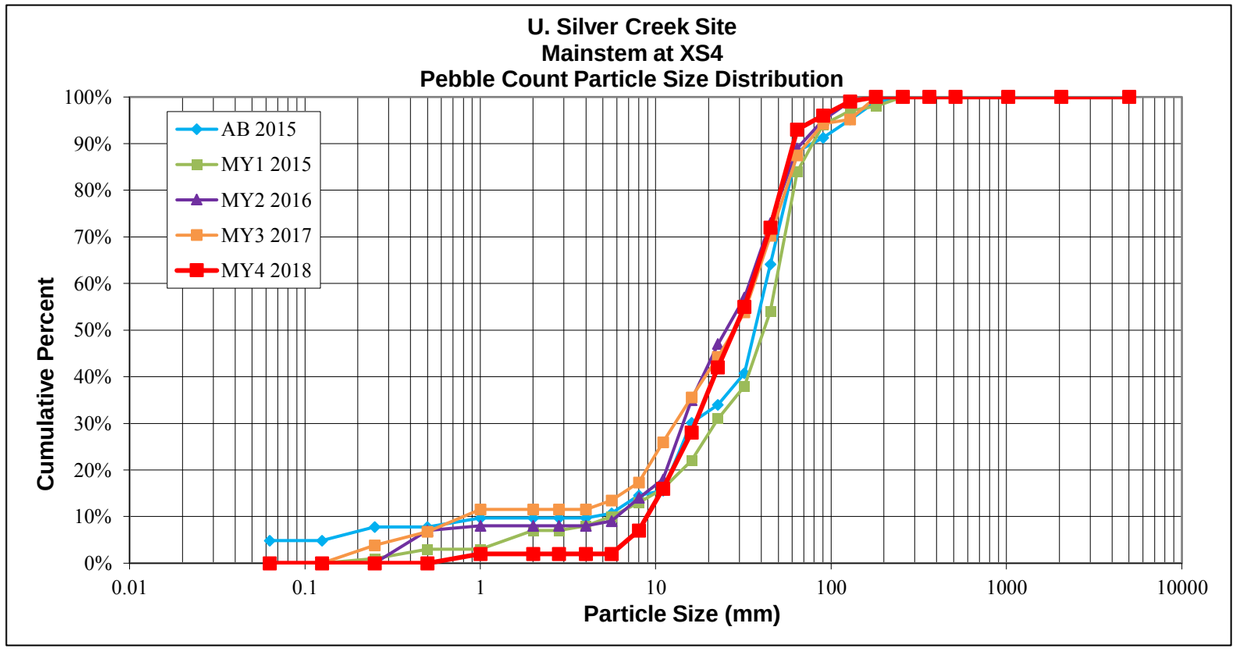
Cross-Section Pebble Count; Monitoring Year 4
U. Silver Creek Mitigation Project, DMS# 94645

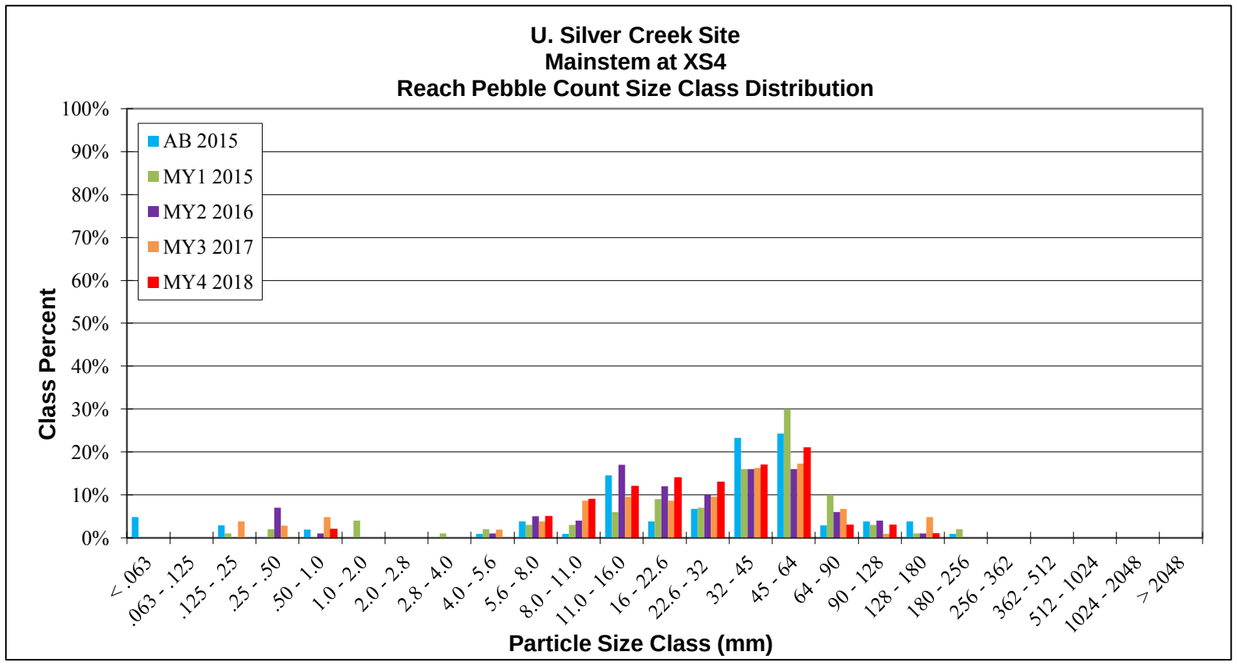
SITE OR PROJECT:	U. Silver Cr
REACH/LOCATION:	Riffle at XS4
FEATURE:	Riffle
DATE:	19-Oct-18

			MY4 2018			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			0%	0.50
	Coarse	.50 - 1.0	2	2%	2%	1.0
	Very Coarse	1.0 - 2.0			2%	2.0
Gravel	Very Fine	2.0 - 2.8			2%	2.8
	Very Fine	2.8 - 4.0			2%	4.0
	Fine	4.0 - 5.6			2%	5.6
	Fine	5.6 - 8.0	5	5%	7%	8.0
	Medium	8.0 - 11.0	9	9%	16%	11.0
	Medium	11.0 - 16.0	12	12%	28%	16.0
	Coarse	16 - 22.6	14	14%	42%	22.6
	Coarse	22.6 - 32	13	13%	55%	32
	Very Coarse	32 - 45	17	17%	72%	45
	Very Coarse	45 - 64	21	21%	93%	64
Cobble	Small	64 - 90	3	3%	96%	90
	Small	90 - 128	3	3%	99%	128
	Large	128 - 180	1	1%	100%	180
	Large	180 - 256			100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			100	100%		

Largest particle= 128

Summary Data			
Channel materials			
D16 =	11.0	D84 =	55.0
D35 =	19.0	D95 =	80.3
D50 =	28.0	D100 =	128 - 180





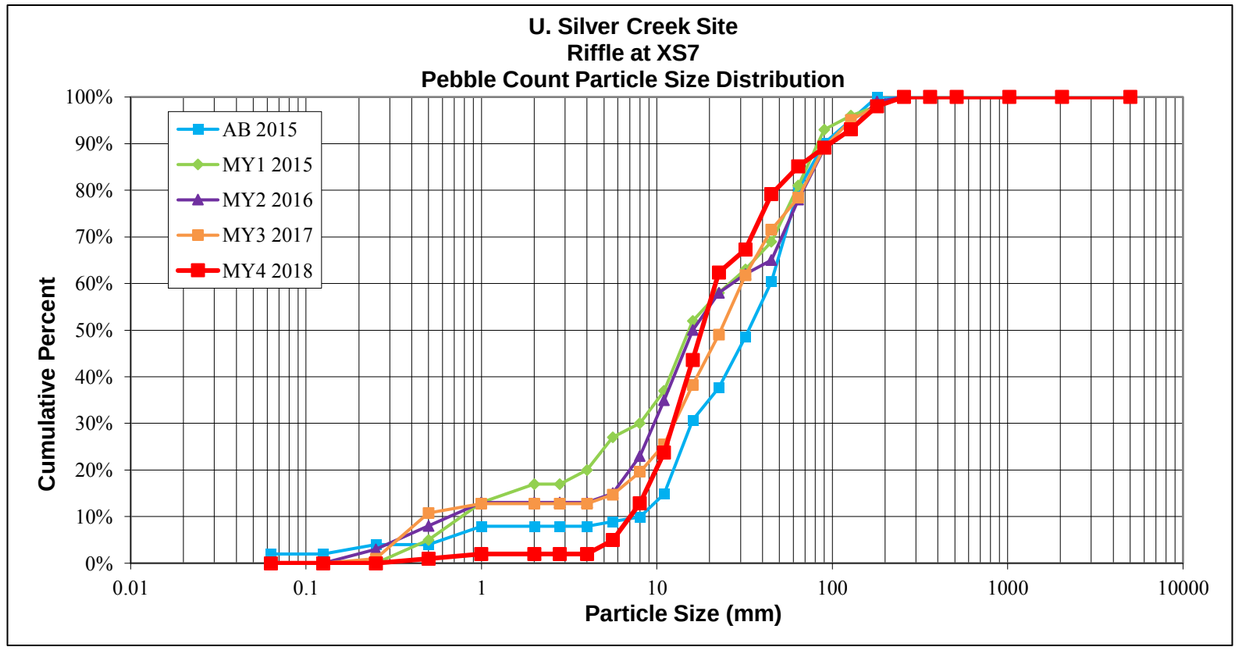
Cross-Section Pebble Count; Monitoring Year 4
U. Silver Creek Mitigation Project, DMS# 94645

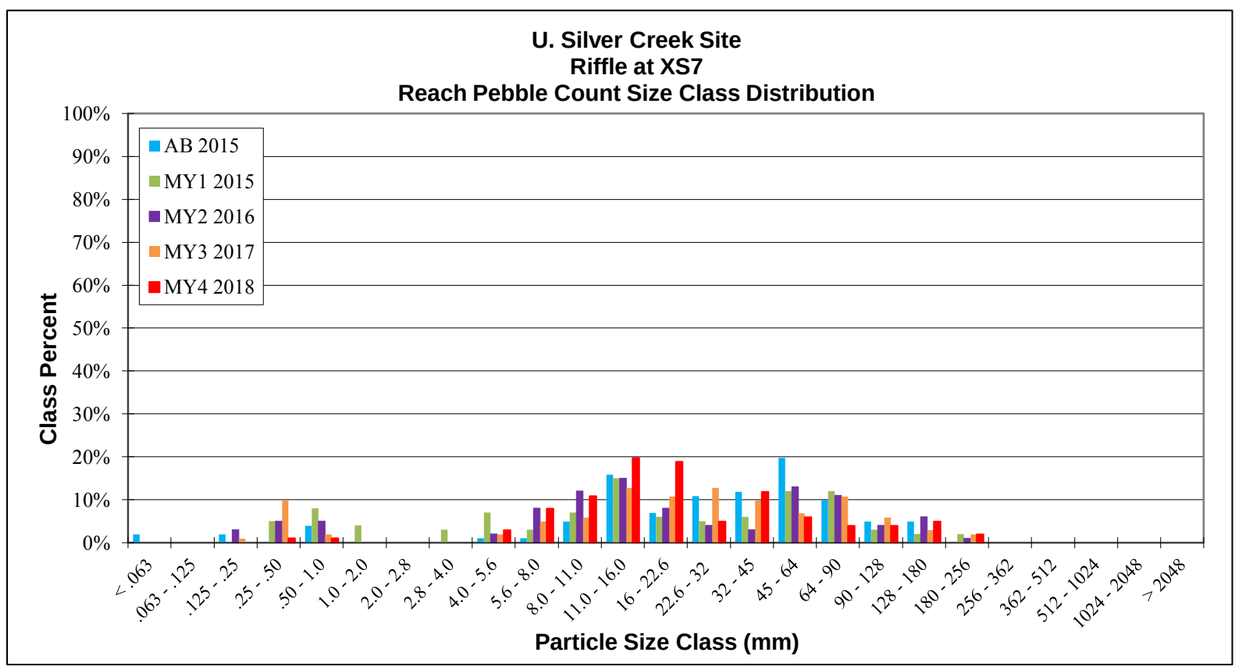
SITE OR PROJECT:	U. Silver Cr
REACH/LOCATION:	Riffle at XS7
FEATURE:	Riffle
DATE:	18-Oct-18

			MY4 2018			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%	2%	1.0
	Very Coarse	1.0 - 2.0			2%	2.0
Gravel	Very Fine	2.0 - 2.8			2%	2.8
	Very Fine	2.8 - 4.0			2%	4.0
	Fine	4.0 - 5.6	3	3%	5%	5.6
	Fine	5.6 - 8.0	8	8%	13%	8.0
	Medium	8.0 - 11.0	11	11%	24%	11.0
	Medium	11.0 - 16.0	20	20%	44%	16.0
	Coarse	16 - 22.6	19	19%	62%	22.6
	Coarse	22.6 - 32	5	5%	67%	32
	Very Coarse	32 - 45	12	12%	79%	45
	Very Coarse	45 - 64	6	6%	85%	64
Cobble	Small	64 - 90	4	4%	89%	90
	Small	90 - 128	4	4%	93%	128
	Large	128 - 180	5	5%	98%	180
	Large	180 - 256	2	2%	100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			101	100%		

Largest particle= 180

Summary Data			
Channel materials			
D16 =	8.8	D84 =	59.8
D35 =	13.6	D95 =	146.2
D50 =	18.0	D100 =	180 - 256





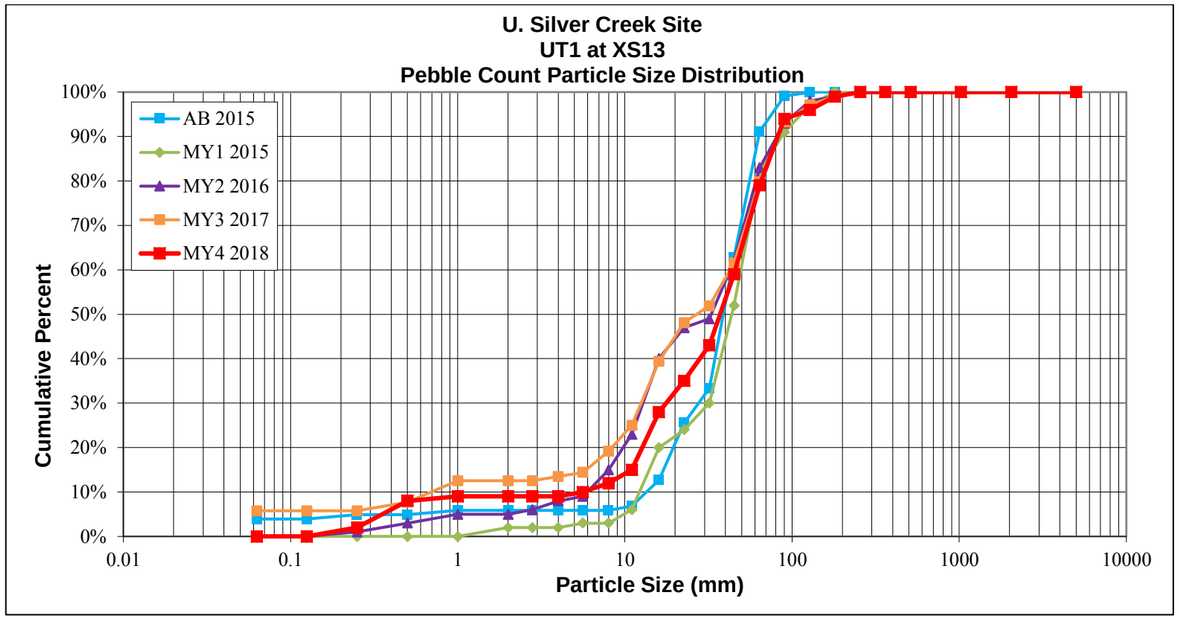
Cross-Section Pebble Count; Monitoring Year 4
U. Silver Creek Mitigation Project, DMS# 94645

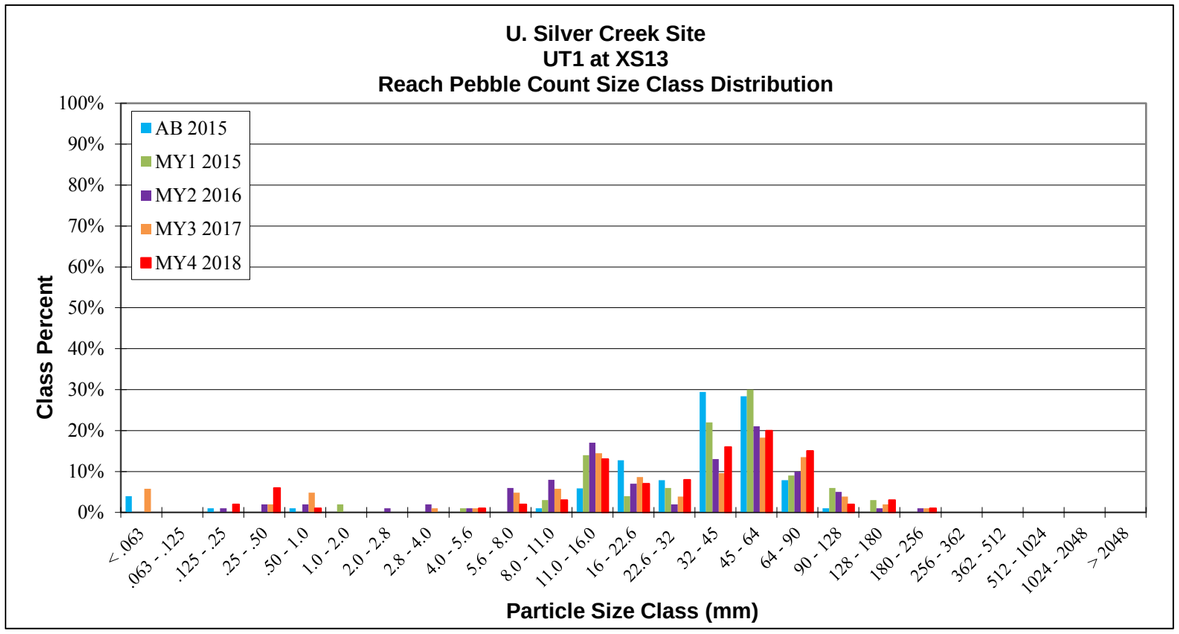
SITE OR PROJECT:	U. Silver Cr
REACH/LOCATION:	UT1 XS13
FEATURE:	Riffle
DATE:	19-Oct-18

			MY4 2018			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	2	2%	2%	0.25
	Medium	.25 - .50	6	6%	8%	0.50
	Coarse	.50 - 1.0	1	1%	9%	1.0
	Very Coarse	1.0 - 2.0			9%	2.0
Gravel	Very Fine	2.0 - 2.8			9%	2.8
	Very Fine	2.8 - 4.0			9%	4.0
	Fine	4.0 - 5.6	1	1%	10%	5.6
	Fine	5.6 - 8.0	2	2%	12%	8.0
	Medium	8.0 - 11.0	3	3%	15%	11.0
	Medium	11.0 - 16.0	13	13%	28%	16.0
	Coarse	16 - 22.6	7	7%	35%	22.6
	Coarse	22.6 - 32	8	8%	43%	32
	Very Coarse	32 - 45	16	16%	59%	45
	Very Coarse	45 - 64	20	20%	79%	64
Cobble	Small	64 - 90	15	15%	94%	90
	Small	90 - 128	2	2%	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			100	100%		

Largest particle= 180

Summary Data			
Channel materials			
D16 =	11.3	D84 =	71.7
D35 =	22.6	D95 =	107.3
D50 =	37.1	D100 =	180 - 256





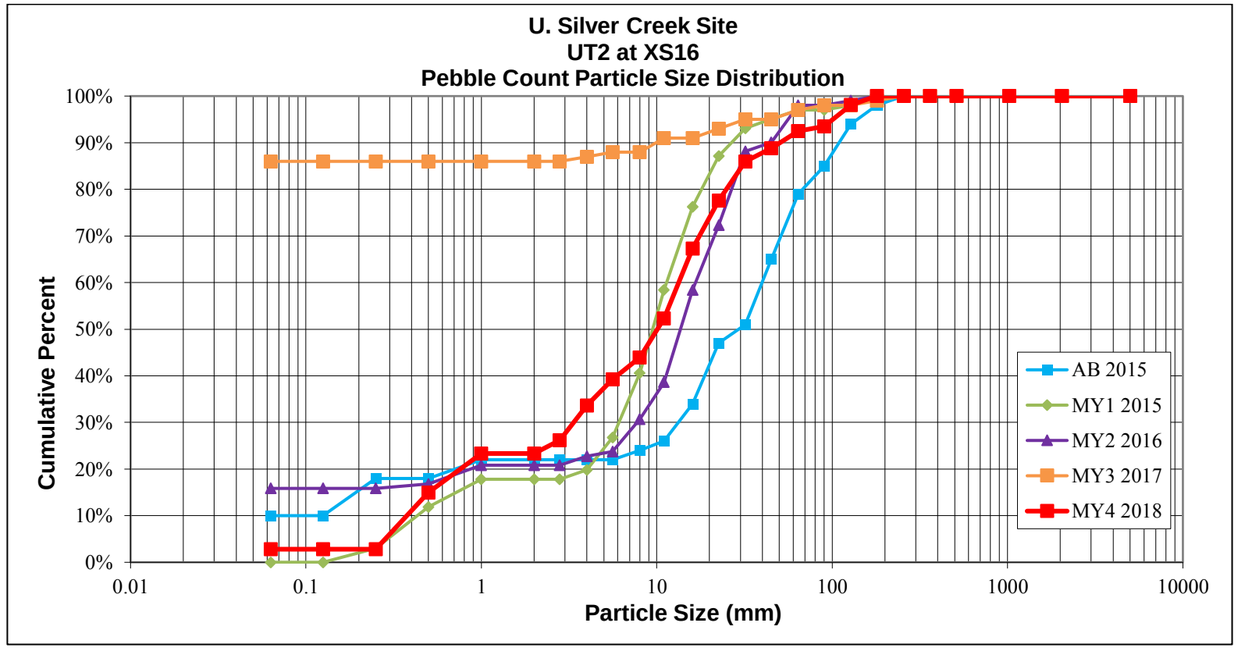
Cross-Section Pebble Count; Monitoring Year 4
U. Silver Creek Mitigation Project, DMS# 94645

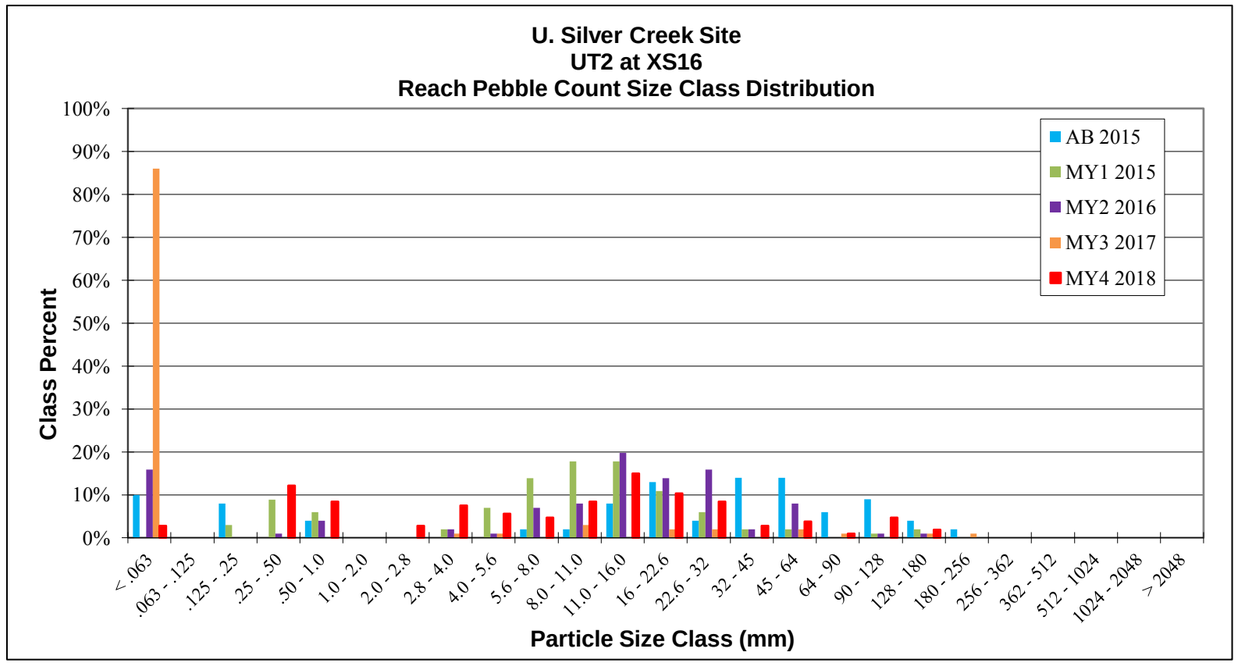
SITE OR PROJECT:	U. Silver Cr
REACH/LOCATION:	UT2 XS16
FEATURE:	Riffle
DATE:	19-Oct-18

			MY4 2018			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063	3	3%	3%	0.063
Sand	Very Fine	.063 - .125			3%	0.125
	Fine	.125 - .25			3%	0.25
	Medium	.25 - .50	13	12%	15%	0.50
	Coarse	.50 - 1.0	9	8%	23%	1.0
	Very Coarse	1.0 - 2.0			23%	2.0
Gravel	Very Fine	2.0 - 2.8	3	3%	26%	2.8
	Very Fine	2.8 - 4.0	8	7%	34%	4.0
	Fine	4.0 - 5.6	6	6%	39%	5.6
	Fine	5.6 - 8.0	5	5%	44%	8.0
	Medium	8.0 - 11.0	9	8%	52%	11.0
	Medium	11.0 - 16.0	16	15%	67%	16.0
	Coarse	16 - 22.6	11	10%	78%	22.6
	Coarse	22.6 - 32	9	8%	86%	32
	Very Coarse	32 - 45	3	3%	89%	45
	Very Coarse	45 - 64	4	4%	93%	64
Cobble	Small	64 - 90	1	1%	93%	90
	Small	90 - 128	5	5%	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			107	100%		

Largest particle= 128

Summary Data			
Channel materials			
D16 =	0.5	D84 =	29.5
D35 =	4.3	D95 =	101.1
D50 =	10.1	D100 =	128 - 180





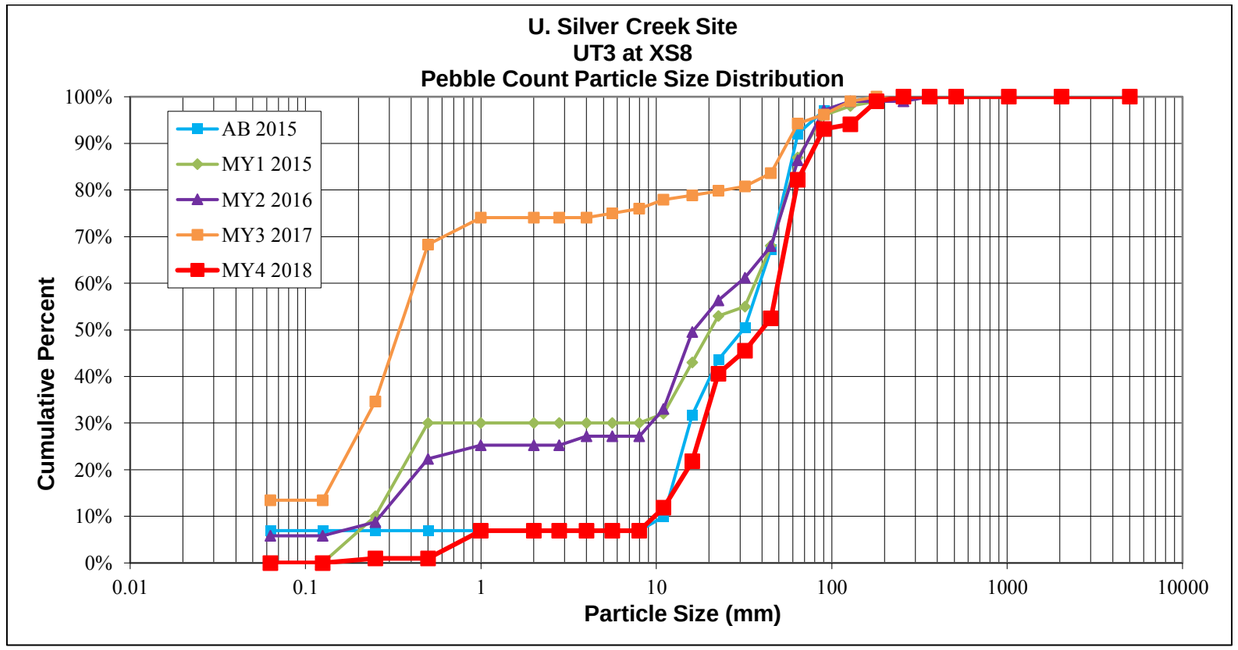
Cross-Section Pebble Count; Monitoring Year 4
U. Silver Creek Mitigation Project, DMS# 94645

SITE OR PROJECT:	U. Silver Cr
REACH/LOCATION:	UT3 XS8
FEATURE:	Riffle
DATE:	19-Oct-18

			MY4 2018			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125			0%	0.125
	Fine	.125 - .25	1	1%	1%	0.25
	Medium	.25 - .50			1%	0.50
	Coarse	.50 - 1.0	6	6%	7%	1.0
	Very Coarse	1.0 - 2.0			7%	2.0
Gravel	Very Fine	2.0 - 2.8			7%	2.8
	Very Fine	2.8 - 4.0			7%	4.0
	Fine	4.0 - 5.6			7%	5.6
	Fine	5.6 - 8.0			7%	8.0
	Medium	8.0 - 11.0	5	5%	12%	11.0
	Medium	11.0 - 16.0	10	10%	22%	16.0
	Coarse	16 - 22.6	19	19%	41%	22.6
	Coarse	22.6 - 32	5	5%	46%	32
	Very Coarse	32 - 45	7	7%	52%	45
	Very Coarse	45 - 64	30	30%	82%	64
Cobble	Small	64 - 90	11	11%	93%	90
	Small	90 - 128	1	1%	94%	128
	Large	128 - 180	5	5%	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			101	100%		

Largest particle= 180

Summary Data			
Channel materials			
D16 =	12.86	D84 =	67.76
D35 =	20.39	D95 =	136.57
D50 =	39.84	D100 =	180 - 256



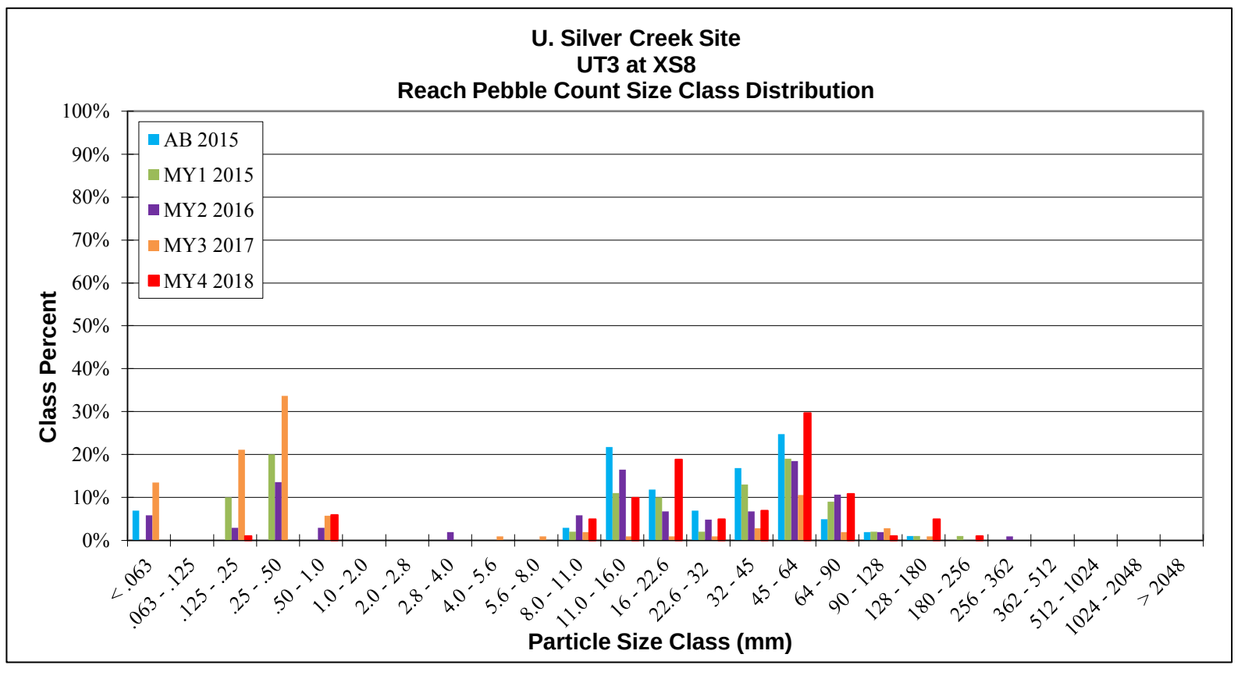


Table 10. Monitoring Year 4 Stream Summary

Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Silver Creek Mainstem

Parameter	USGS Gauge	Regional Curve Interval [1,2]			Pre-Existing Condition[1]						Reference Reach Data: Morgan Creek						Design					
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
BF Width (ft)	-	29.0	19.0	-	18.5	-	-	21.2	-	7	33.2	-	-	33.5	-	-	-	26.0	-	-	-	-
Floodprone Width (ft)	-	-	-	-	397.0	-	-	453.0	-	7	77.5	-	-	86.8	-	-	397	-	-	453.0	-	-
BF Mean Depth (ft)	-	1.6	2.1	-	2.3		-	2.9	-	7	2.3	-	-	2.4	-	-	-	2.2	-	-	-	-
BF Max Depth (ft)	-	-	-	-	3.3	-	-	3.9	-	7	2.8	-	-	2.9	-	-	-	3.0	-	-	-	-
BF Cross-sectional Area (ft²)	-	46.0	45.0	-	46.3	-	-	55.2	-	7	75.1	-	-	79.8	-	-	-	56.0	-	-	-	-
Width/Depth Ratio	-	-	-	-	7.4	-	-	8.8	-	7	14.1	-	-	14.7	-	-	-	12	-	-	-	-
Entrenchment Ratio	-	-	-	-	19.6	-	-	24.0	-	7	2.3	-	-	2.6	-	-	15.3	-	-	17.4	-	-
Bank Height Ratio	-	-	-	-	1.1	-	-	1.5	-	7	1.0	-	-	1.0	-	-	1.0	-	-	1.1	-	-
d50 (mm)	-	-	-	-	-	17.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pattern																						
Channel Beltwidth (ft)	-	-	-	-	45	-	-	106	-	-	-	-	-	-	-	-	104	-	-	208	-	-
Radius of Curvature (ft)	-	-	-	-	16.0	-	-	62.0	-	-	-	-	-	-	-	-	47.0	-	-	73.0	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	1.0	-	-	3.1	-	-	-	-	-	-	-	-	1.8	-	-	2.8	-	-
Meander Wavelength (ft)	-	-	-	-	59	-	-	139	-	-	-	-	-	-	-	-	182	-	-	312	-	-
Meander Width Ratio	-	-	-	-	2.3	-	-	5.4	-	-	-	-	-	-	-	-	7.0	-	-	12.0	-	-
Profile																						
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Riffle Slope (ft/ft)	-	-	-	-	0.001	-	-	0.108	-	-	0.014	-	-	0.024	-	-	0.005	-	-	0.008	-	-
Pool Length (ft)	-	-	-	-	15	-	-	135	-	-	-	-	-	-	-	-	78	-	-	137	-	-
Pool Spacing (ft)	-	-	-	-	40	-	-	162	-	-	46	-	-	277	-	-	104	-	-	182	-	-
Pool Max Depth (ft)	-	-	-	-	4.0	-	-	4.1	-	-	4.1	-	-	4.1	-	-	5.5	-	-	7.7	-	-
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																						
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	1.0 / 8.4 / 17 / 43 / 57						- / 1.2 / 3.0 / 77 / 800						-					
Reach Shear Stress (competency) lb/f²	-	-	-	-	0.035	-	-	1.13	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m²	-	-	-	-	34	-	-	40	-	-	-	-	-	-	-	-	29	-	-	35	-	-
Additional Reach Parameters																						
Drainage Area (SM)	-		3.0		2.73	-	-	3.35	-	-	-	8.4	-	-	-	-	2.73	-	-	3.35	-	-
Impervious cover estimate (%)	-	-	-	-	-	<5%	-	-	-	-	-	-	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	E	-	-	-	-	-	C4	-	-	-	-	-	C	-	-	-	-
BF Velocity (fps)	-	-	-	-	2.8	-	-	4.9	-	7	-	7	-	-	-	-	-	4.20	-	-	-	-
BF Discharge (cfs)	-	232.0	196.0	213.2	180	-	-	240	-	-	-	524	-	-	-	-	-	230.0	-	-	-	-
Valley Length	-	-	-	-	-	1947	-	-	-	-	-	-	-	-	-	-	-	1947.0	-	-	-	-
Channel length (ft)[2]	-	-	-	-	-	3179	-	-	-	-	-	-	-	-	-	-	-	3068	-	-	-	-
Sinuosity	-	-	-	-	-	1.63	-	-	-	-	-	-	-	-	-	-	-	1.58	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	0.004	-	-	-	-	-	0.007	-	-	-	-	0.003	-	-	0.004	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.003	-	-	0.008	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	2.1	-	-	-	-	-	-	-	-	-	-	-	5.2	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Parameter	As-built						MY1						MY2						MY3						MY4					
Dimension and Substrate - Riffle	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)	23.8	27.0	27.5	29.1	2.04	4	23.5	25.0	25.2	26.1	1.05	4	23.5	24.9	25.1	25.8	0.84	4	24.0	24.9	25.0	25.8	0.62	4	20.3	26.3	23.5	37.7	6.83	4
Floodprone Width (ft)	-	>300	-	-	-	-	-	>300	-	-	-	-	-	>300	-	-	-	-	-	>300	-	-	-	-	-	>300	-	-	-	-
BF Mean Depth (ft)	1.7	1.9	1.9	2.1	0.18	4	1.7	1.8	1.8	2.0	0.11	4	1.7	1.8	1.8	1.8	0.06	4	1.7	1.7	1.7	1.8	0.06	4	1.1	1.6	1.6	1.9	0.28	4
BF Max Depth (ft)	2.9	3.1	3.2	3.3	0.18	4	2.8	3.0	3.0	3.2	0.17	4	2.8	3.0	3.0	3.2	0.16	4	2.8	3.1	3.1	3.2	0.17	4	2.8	3.1	3.1	3.4	0.23	4
BF Cross-sectional Area (ft²)	46.9	49.7	48.6	54.5	2.92	4	43.4	45.4	43.8	50.6	3.02	4	41.1	44.0	43.7	47.6	2.51	4	41.6	42.9	41.9	46.2	1.93	4	36.5	39.0	38.9	41.8	1.94	4
Width/Depth Ratio	11.8	14.8	15.1	17.3	2.44	4	12.4	13.8	13.6	15.7	1.20	4	13.5	14.1	13.9	15.0	0.59	4	13.7	14.5	14.6	15.1	0.52	4	10.7	18.5	14.5	34.0	9.15	4
Entrenchment Ratio	3.1	3.7	3.5	4.8	0.66	4	3.3	4.0	3.8	4.9	0.59	4	3.5	4.0	3.8	4.9	0.54	4	3.5	4.0	3.7	4.9	0.57	4	2.3	4.1	4.2	5.8	1.32	4
Bank Height Ratio	1.0	1.0	1.0	1.1	0.04	4	1.00	1.00	1.00	1.00	0.00	4	1.00	1.00	1.00	1.00	0.43	4	1.01	1.03	1.03	1.06	0.02	4	0.95	0.98	0.99	1.00	0.02	4
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pattern																														
Channel Beltwidth (ft)	99.0	133.3	137.7	157.9	19.24	13	99.0	133.3	137.7	157.9	19.24	13	99.0	133.3	137.7	157.9	19.24	13	99.0	133.3	137.7	157.9	19.24	13	99.0	133.3	137.7	157.9	19.24	13
Radius of Curvature (ft)	52.6	57.2	55.0	67.9	5.03	8	52.6	57.2	55.0	67.9	5.03	8	52.6	57.2	55.0	67.9	5.03	8	52.6	57.2	55.0	67.9	5.03	8	52.6	57.2	55.0	67.9	5.03	8
Rc:Bankfull width (ft/ft)	1.95	2.12	2.04	2.51	0.19	8	1.95	2.12	2.04	2.51	0.19	8	1.95	2.12	2.04	2.51	0.19	8	1.95	2.12	2.04	2.51	0.19	8	1.95	2.12	2.04	2.51	0.19	8
Meander Wavelength (ft)	172.0	225.4	201.7	310.0	49.34	8	172.0	225.4	201.7	310.0	49.3	8	172.0	225.4	201.7	310.0	49.34	8	172.0	225.4	201.7	310.0	49.3	8	172.0	225.4	201.7	310.0	49.34	8
Meander Width Ratio	6.4	8.3	7.5	11.5	1.83	8	6.4	8.3	7.5	11.5	1.8	8	6.4	8.3	7.5	11.5	1.83	8	6.4	8.3	7.5	11.5	1.8	8	6.4	8.3	7.5	11.5	1.83	8
Profile																														
Riffle Length (ft)	36.7	50.3	44.7	89.4	15.10	10.0	12.1	50.0	47.6	83.8	17.0	16	27.3	56.3	57.2	86.5	16.72	15	22.7	53.3	51.1	79.5	15.7	15	32.4	54.8	49.9	85.3	16.60	15
Riffle Slope (ft/ft)	0.001	0.008	0.007	0.015	0.004	10.0	0.000	0.008	0.006	0.023	0.007	16	0.001	0.006	0.005	0.013	0.004	15	0.000	0.007	0.008	0.013	0.005	15	0.000	0.008	0.009	0.014	0.004	15
Pool Length (ft)	50.4	97.1	94.0	136.6	20.40	16.0	42.7	80.3	87.7	116.8	22.6	14	16.7	80.0	83.7	126.0	26.74	19	11.9	81.5	84.2	160.7	34.4	19	21.0	80.3	82.2	149.1	31.40	19
Pool Spacing (ft)	113.7	145.8	140.1	210.4	29.60	15	42.8	115.2	120.5	191.4	36.6	19	48.1	113.6	116.6	202.2	42.03	20	50.5	118.9	111.9	193.5	39.1	20	50.2	113.8	117.1	184.7	34.10	20
Pool Max Depth (ft)	4.0	4.8	5.2	5.3	0.58	3	3.9	4.3	4.0	5.0	0.48	3	3.8	4.0	4.0	4.3	0.23	3	1.1	2.0	1.7	4.2	0.86	20	0.8	1.8	1.7	3.5	0.76	20
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																														
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	mean 11.2 / 21.8 / 35.0 / 66.6 /126.9					2	mean 6.4 / 18.8 / 28.3 / 66.9 /107.5					2	mean 7.7 / 13.5 / 20.6 / 67.2 /116.7					2	mean 6.7 / 15.1 / 25.5 / 68.0 / 123					2	mean 9.9 / 16.3 / 23 / 57.4 / 113.25					2
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)	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-
Impervious cover estimate (%)	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-
BF Velocity (fps)	-	4.27	-	-	-	-	-	4.21	-	-	-	-	-	4.21	-	-	-	-	-	4.21	-	-	-	-	-	4.21	-	-	-	-
BF Discharge (cfs)	-	212.2	-	-	-	-	-	229.3	-	-	-	-	-	229.3	-	-	-	-	-	229.3	-	-	-	-	-	229.3	-	-	-	-
Valley Length	-	1947.0	-	-	-	-	-	1947.0	-	-	-	-	-	1947.0	-	-	-	-	-	1947.0	-	-	-	-	-	1947.0	-	-	-	-
Channel length (ft)[2]	-	3016	-	-	-	-	-	3016	-	-	-	-	-	3016	-	-	-	-	-	3016	-	-	-	-	-	3016	-	-	-	-
Sinuosity	-	1.55	-	-	-	-	-	1.55	-	-	-	-	-	1.55	-	-	-	-	-	1.55	-	-	-	-	-	1.55	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	0.004	-	-	-	-	-	0.004	-	-	-	-	-	0.004	-	-	-	-	-	0.004	-	-	-	-	-	0.004	-	-	-	-
BF slope (ft/ft)	-	0.004	-	-	-	-	-	0.004	-	-	-	-	-	0.004	-	-	-	-	-	0.004	-	-	-	-	-	0.004	-	-	-	-
Bankfull Floodplain Area (acres)	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1 . Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.
2. 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.

UT1

Parameter	USGS Gauge	Regional Curve Interval [1,2]			Pre-Existing Condition[1]						Reference Reach Data: UT3 upstream of Gold Mine Road						Design					
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
BF Width (ft)	-	11.9	6.9	-	6.1	-	-	9.3	-	4	6.3	-	-	7.9	-	-	-	9.5	-	-	-	-
Floodprone Width (ft)	-	-	-	-	10.9	-	-	60.5	-	4	15.0	-	-	19.0	-	-	10.9	-	-	60.5	-	-
BF Mean Depth (ft)	-	0.70	1.00	-	0.97	-	-	1.50	-	4	0.70	-	-	0.90	-	-	-	0.95	-	-	-	-
BF Max Depth (ft)	-	-	-	-	1.37	-	-	2.1	-	4	1.0	-	-	1.4	-	-	-	1.2	-	-	-	-
BF Cross-sectional Area (ft²)	-	9.1	9.0	-	9.0	-	-	9.1	-	4	5.5	-	-	6.5	-	-	-	9.0	-	-	-	-
Width/Depth Ratio	-	-	-	-	4.0	-	-	9.6	-	4	7.3	-	-	11.7	-	-	-	10	-	-	-	-
Entrenchment Ratio	-	-	-	-	1.2	-	-	10.0	-	4	1.9	-	-	3.0	-	-	1.1	-	-	6.4	-	-
Bank Height Ratio	-	-	-	-	1.5	-	-	3.0	-	4	1.0	-	-	1.0	-	-	1.0	-	-	1.0	-	-
d50 (mm)	-	-	-	-	-	18.0	-	-	-	-	-	3.0	-	-	-	-	-	-	-	-	-	-
Pattern																						
Channel Beltwidth (ft)	-	-	-	-	30.0	-	-	60.0	-	-	-	-	-	-	-	-	33.0	-	-	76.0	-	-
Radius of Curvature (ft)	-	-	-	-	9.0	-	-	21.0	-	-	-	-	-	-	-	-	17.0	-	-	27.0	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	1.2	-	-	2.7	-	-	-	-	-	-	-	-	1.8	-	-	2.8	-	-
Meander Wavelength (ft)	-	-	-	-	92.0	-	-	138.0	-	-	45.0	-	-	75.0	-	-	67.0	-	-	114.0	-	-
Meander Width Ratio	-	-	-	-	12.0	-	-	18.0	-	-	1.2	-	-	1.2	-	-	7.0	-	-	12.0	-	-
Profile																						
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Riffle Slope (ft/ft)	-	-	-	-	0.018	-	-	0.039	-	-	0.013	-	-	0.054	-	-	0.017	-	-	0.022	-	-
Pool Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pool Spacing (ft)	-	-	-	-	15.0	-	-	50.0	-	-	39.9	-	-	62.3	-	-	38.0	-	-	66.5	-	-
Pool Max Depth (ft)	-	-	-	-	2.0	-	-	2.4	-		1.8	-	-	1.8	-	-	1.9	-	-	3.3	-	-
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																						
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	4.0 / 12 / 18 / 49 / 85						-	-	-	-	-	-	-	-	-	-	-	-
Reach Shear Stress (competency) lb/f²	-	-	-	-	0.1	-	-	1.0	-	-	0.2	-	-	0.6	-	-	-	0.5 - 0.6	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m²	-	-	-	-	-	32.0	-	-	-	-	6.5	-	-	28.5	-	-	-	30	-	-	-	-
Additional Reach Parameters																						
Drainage Area (SM)	-		0.28			-	-	0.28	-	-	-	0.12	-	-	-	-	0.28	-	-	0.28	-	-
Impervious cover estimate (%)	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	E, Gc, Bc	-	-	-	-	-	E/Bc	-	-	-	-	-	E (high W/D	-	-	-	-
BF Velocity (fps)	-	-	-	-	3.4	-	-	4.6	-		2.1	-	3.4	-	-	-	-	3.7	-	-	-	-
BF Discharge (cfs)	-	38.0	36.0	-	31	-	-	41	-	-	-	18	-	-	-	-	-	33.5	-	-	-	-
Valley Length	-	-	-	-	-	371	-	-	-	-	-	-	-	-	-	-	-	367.0	-	-	-	-
Channel length (ft)[2]	-	-	-	-	-	524	-	-	-	-	-	134.5	-	-	-	-	-	373	-	-	-	-
Sinuosity	-	-	-	-	-	1.41		-	-	-	-	1.05	-	-	-	-	-	1.35	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	0.0160	-	-	-	-	-	0.0189	-	-	-	-	-	0.0150	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.011	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Parameter	As-built						MY1						MY2						MY3						MY4					
Dimension and Substrate - Riffle	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)	-	9.6	-	-	-	1	-	9.3	-	-	-	1	-	9.2	-	-	-	1	-	9.0	-	-	-	1	-	11.5	-	-	-	1
Floodprone Width (ft)	-	>150	-	-	-	1	-	>150	-	-	-	1	-	>150	-	-	-	1	-	>150	-	-	-	1	-	>150	-	-	-	1
BF Mean Depth (ft)	-	0.93	-	-	-	1	-	0.8	-	-	-	1	-	0.8	-	-	-	1	-	0.8	-	-	-	1	-	0.5	-	-	-	1
BF Max Depth (ft)	-	1.3	-	-	-	1	-	1.1	-	-	-	1	-	1.1	-	-	-	1	-	1.1	-	-	-	1	-	1.2	-	-	-	1
BF Cross-sectional Area (ft²)	-	8.9	-	-	-	1	-	7.0	-	-	-	1	-	7.0	-	-	-	1	-	7.0	-	-	-	1	-	5.9	-	-	-	1
Width/Depth Ratio	-	10.3	-	-	-	1	-	12.3	-	-	-	1	-	12.2	-	-	-	1	-	11.7	-	-	-	1	-	22.5	-	-	-	1
Entrenchment Ratio	-	5.3	-	-	-	1	-	5.2	-	-	-	1	-	5.5	-	-	-	1	-	5.6	-	-	-	1	-	4.4	-	-	-	1
Bank Height Ratio	-	1.00	-	-	-	1	-	1.00	-	-	-	1	-	1.10	-	-	-	1	-	1.10	-	-	-	1	-	0.99	-	-	-	1
d50 (mm)	-	38.8	-	-	-	-	-	43.6	-	-	-	-	-	32.9	-	-	-	1	-	26.9	-	-	-	1	-	37.1	-	-	-	1
Pattern																														
Channel Beltwidth (ft)	33.3	49.6	44.6	70.1	13.1	5	33.3	49.6	44.6	70.1	13.1	5	33.3	49.6	44.6	70.1	13.1	5	33.3	49.6	44.6	70.1	13.1	5	33.3	49.6	44.6	70.1	13.08	5
Radius of Curvature (ft)	21.4	23.0	22.6	25.6	1.63	5	21.4	23.0	22.6	25.6	1.6	5	21.4	23.0	22.6	25.6	1.6	5	21.4	23.0	22.6	25.6	1.6	5	21.4	23.0	22.6	25.6	1.63	5
Rc:Bankfull width (ft/ft)	2.2	2.4	2.4	2.7	0.17	5	2.2	2.4	2.4	2.7	0.17	5	2.2	2.4	2.4	2.7	0.17	5	2.2	2.4	2.4	2.7	0.17	5	2.2	2.4	2.4	2.7	0.17	5
Meander Wavelength (ft)	69.6	74.4	72.0	81.6	5.18	3	69.6	74.4	72.0	81.6	5.18	3	69.6	74.4	72.0	81.6	5.18	3	69.6	74.4	72.0	81.6	5.18	3	69.6	74.4	72.0	81.6	5.18	3
Meander Width Ratio	7.3	7.8	7.5	8.5	0.5	3	7.3	7.8	7.5	8.5	0.5	3	7.3	7.8	7.5	8.5	0.5	3	7.3	7.8	7.5	8.5	0.5	3	7.3	7.8	7.5	8.5	0.54	3
Profile																														
Riffle Length (ft)	16.1	20.2	19.9	24.9	4.1	4	9.9	18.5	18.1	30.5	6.3	7	9.9	19.2	21.3	30.8	7.2	8	9.8	21.4	21.4	30.9	7.0	8	6.7	14.3	14.0	22.5	4.46	8
Riffle Slope (ft/ft)	0.019	0.030	0.027	0.050	0.012	4	0.010	0.021	0.020	0.039	0.011	7	0.010	0.032	0.030	0.064	0.016	8	0.008	0.020	0.017	0.033	0.009	8	0.006	0.028	0.021	0.062	0.020	8
Pool Length (ft)	26.1	33.8	35.1	41.7	6.6	5	8.6	26.9	32.2	40.6	10.9	9	10.8	25.4	21.8	56.3	13.4	11	12.3	27.4	22.4	60.4	15.4	11	10.0	25.8	23.5	51.6	13.88	11
Pool Spacing (ft)	23.4	46.0	51.6	60.1	13.3	7	21.9	41.7	40.9	60.7	14.6	9	19.2	36.2	36.8	56.1	12.7	12	11.5	34.2	26.9	59.5	14.8	14	6.5	32.3	26.9	67.6	17.27	14
Pool Max Depth (ft)	-	1.4	-	-	-	1	-	2.5	-	-	-	1	-	2.6	-	-	-	1	-	1.2	-	-	-	1	0.5	1.1	1.0	2.1	0.40	9
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																														
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	17.5 / 32.6 / 38.8 / 58.6 / 75.6						14.4/ 34.6 / 43.6 / 69.0 / 113.8						8.3/ 14.3 / 32.9 / 66.2 / 103.6						6.3/ 14.3 / 26.9 / 71.2 / 105.5						11.3 / 22.6 / 37.1 / 71.7 / 107.3					
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)	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-
Impervious cover estimate (%)	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-
BF Velocity (fps)	-	3.81	-	-	-	-	-	3.48	-	-	-	-	-	3.48	-	-	-	-	-	3.48	-	-	-	-	-	3.48	-	-	-	-
BF Discharge (cfs)	-	33.9	-	-	-	-	-	24.4	-	-	-	-	-	24.4	-	-	-	-	-	24.4	-	-	-	-	-	24.4	-	-	-	-
Valley Length	-	367.0	-	-	-	-	-	367.0	-	-	-	-	-	367.0	-	-	-	-	-	367.0	-	-	-	-	-	367.0	-	-	-	-
Channel length (ft)[2]	-	495	-	-	-	-	-	495	-	-	-	-	-	495	-	-	-	-	-	495	-	-	-	-	-	495	-	-	-	-
Sinuosity	-	1.36		-	-	-	-	1.36		-	-	-	-	1.36		-	-	-	-	1.36	-	-	-	-	-	1.36	-	-	-	-
Water Surface Slope (Channel) (ft/ft)		0.0162	-		-	-		0.0162	-		-	-		0.0162	-		-	-		0.0162	-		-	-		0.0162	-		-	-
BF slope (ft/ft)		0.0161	-		-	-		0.0161	-		-	-		0.0161	-		-	-		0.0161	-		-	-		0.0161	-		-	-
Bankfull Floodplain Area (acres)	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1 . Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.
2. Harman, W.A., D.E Wise, M.A. Walker, R. Morris, MA Cantrell, M. Clemmons, G.D. Jennings, D.R. Clinton, J.M. Patterson. 2000. Bankfull Regional Curves for North Carolina Mountain Streams. In: AWRA Conference Proceedings, D.L. Kane, editor. American Water Resources Specialty Conference on Water Resources in Extreme Environments. Anchorage, Alaska.

Table 10. Monitoring Year 4 Stream Summary

Upper Silver Creek Restoration Project: DMS Project ID No. 94645

UT2

Parameter	USGS Gauge	Regional Curve Interval [1,2] NC Mtn.	NC Pied.	Rural	Pre-Existing Condition[1] Min	Mean	Med	Max	SD	n	Reference Reach Data: Morgan Creek Min	Mean	Med	Max	SD	n	Design Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																						
BF Width (ft)	-	6.0	3.1	-	3.1	-	-	3.4	-	2	6.3	-	-	7.9	-	-	-	6.0	-	-	-	-
Floodprone Width (ft)	-	-	-	-	5.1	-	-	6.4	-	2	15.0	-	-	19.0	-	-	60.0		-	120.0	-	-
BF Mean Depth (ft)	-	0.40	0.60	-	0.84	-	-	0.90	-	2	0.70	-	-	0.90	-	-	-	0.50	-	-	-	-
BF Max Depth (ft)	-	-	-	-	1.1	-	-	1.4	-	2	1.0	-	-	1.35	-	-	-	0.6	-	-	-	-
BF Cross-sectional Area (ft²)	-	2.6	2.6	-	2.8	-	-	2.9	-	2	5.5	-	-	6.5	-	-	-	3.0	-	-	-	-
Width/Depth Ratio	-	-	-	-	3.5	-	-	4.0	-	2	7.3	-	-	11.7	-	-	-	12.0	-	-	-	-
Entrenchment Ratio	-	-	-	-	1.6	-	-	1.9	-	2	1.9	-	-	3.0	-	-	10.0	-	-	20.0	-	-
Bank Height Ratio	-	-	-	-	2.2	-	-	2.4	-	2	-	-	-	-	-	-	-	1.1	-	-	-	-
d50 (mm)	-	-	-	-	-	18.0	-	-	-	-	-	3.0	-	-	-	-	-	-	-	-	-	-
Pattern																						
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22.0	-	-	30.0	-	-
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0	-	-	18.0	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0	-	-	3.0	-	-
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	-	45.0	-	-	75.0	-	-	42.0	-	-	72.0	-	-
Meander Width Ratio	-	-	-	-	-	-	-	-	-	-	1.2	-	-	1.2	-	-	7.0	-	-	12.0	-	-
Profile																						
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Riffle Slope (ft/ft)	-	-	-	-	0.014	-	-	0.057	-	-	0.013	-	-	0.054	-	-	0.014	-	-	0.033	-	-
Pool Length (ft)	-	-	-	-	5.2	-	-	12.7	-	-	-	-	-	-	-	-	17.4	-	-	26.0	-	-
Pool Spacing (ft)	-	-	-	-	9.5	-	-	51.0	-	-	39.9	-	-	62.3	-	-	9.0	-	-	30.0	-	-
Pool Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	1.8	-	-	-	-	-	1.4	-	-	-	-
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																						
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	5.6 / 13 / 18 / 43 / 60						-	-	-	-	-	-	-	-	-	-	-	-
Reach Shear Stress (competency) lb/f²	-	-	-	-	-	-	-	-	-	-	0.2	-	-	0.6	-	-	-	0.3	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m²	-	-	-	-	45.0	-	-	51.0	-	-	6.5	-	-	28.5	-	-	-	33.0	-	-	-	-
Additional Reach Parameters																						
Drainage Area (SM)	-		0.05		-	0.05	-	-	-	-	-	0.12	-	-	-	-	0.05	-	-	0.05	-	-
Impervious cover estimate (%)	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	G/B[3]	-	-	-	-	-	E/Bc	-	-	-	-	-	Cb, C	-	-	-	-
BF Velocity (fps)	-	-	-	-	3.2	-	-	3.9	-	-	2.1	-	3.4	-	-	-	-	3.50	-	-	-	-
BF Discharge (cfs)	-	-	9.5	-	9	-	-	11	-	-	-	18	-	-	-	-	-	10.0	-	-	-	-
Valley Length	-	-	-	-	-	194	-	-	-	-	-	-	-	-	-	-	-	248.0	-	-	-	-
Channel length (ft)[2]	-	-	-	-	-	209	-	-	-	-	-	134.5	-	-	-	-	-	333	-	-	-	-
Sinuosity	-	-	-	-	-	1.08	-	-	-	-	-	1.05	-	-	-	-	-	1.34	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	0.01	-	-	0.17	-	-	-	0.0197	-	-	-	-	0.0070	0.02		0.0310	-	-
BF slope (ft/ft)	-	-	-	-	-	0.024	-	-	-	-	-	-	-	-	-	-		0.02			-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Parameter	As-built Min	Mean	Med	Max	SD	n	MY1 Min	Mean	Med	Max	SD	n	MY2 Min	Mean	Med	Max	SD	n	MY3 Min	Mean	Med	Max	SD	n	MY4 Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																														
BF Width (ft)	-	6.6	-	-	-	1	-	5.8	-	-	-	1	-	4.7	-	-	-	1	-	5.5	-	-	-	1	-	5.55	-	-	-	1
Floodprone Width (ft)	-	>100	-	-	-	1	-	>100	-	-	-	1	-	>100	-	-	-	1	-	>100	-	-	-	1	-	>100	-	-	-	1
BF Mean Depth (ft)	-	0.41	-	-	-	1	-	0.4	-	-	-	1	-	0.3	-	-	-	1	-	0.4	-	-	-	1	-	0.31	-	-	-	1
BF Max Depth (ft)	-	0.9	-	-	-	1	-	0.8	-	-	-	1	-	0.6	-	-	-	1	-	0.7	-	-	-	1	-	0.80	-	-	-	1
BF Cross-sectional Area (ft²)	-	2.7	-	-	-	1	-	2.2	-	-	-	1	-	1.5	-	-	-	1	-	2.0	-	-	-	1	-	1.72	-	-	-	1
Width/Depth Ratio	-	16.0	-	-	-	1	-	15.7	-	-	-	1	-	14.5	-	-	-	1	-	14.8	-	-	-	1	-	17.90	-	-	-	1
Entrenchment Ratio	-	7.0	-	-	-	1	-	7.1	-	-	-	1	-	8.7	-	-	-	1	-	12.3	-	-	-	1	-	8.30	-	-	-	1
Bank Height Ratio	-	1.2	-	-	-	1	-	1.0	-	-	-	1	-	1.2	-	-	-	1	-	1.30	-	-	-	1	-	0.97	-	-	-	1
d50 (mm)	-	29.3	-	-	-	-	-	9.5	-	-	-	-	-	13.6	-	-	-	1	-	-	-	-	-	1	-	10.10	-	-	-	1
Pattern																														
Channel Beltwidth (ft)	30.4	32.6	32.2	35.3	2.02	3	30.4	32.6	32.2	35.3	2.02	3	30.4	32.6	32.2	35.3	2.02	3	30.4	32.6	32.2	35.3	2.02	3	30.40	32.63	32.20	35.30	2.02	3
Radius of Curvature (ft)	14.3	15.5	14.4	17.7	1.58	3	14.3	15.5	14.4	17.7	1.58	3	14.3	15.5	14.4	17.7	1.58	3	14.3	15.5	14.4	17.7	1.58	3	14.30	15.47	14.40	17.70	1.58	3
Rc:Bankfull width (ft/ft)	2.17	2.34	2.18	2.68	0.24	3	2.17	2.34	2.18	2.68	0.24	3	2.17	2.34	2.18	2.68	0.24	3	2.17	2.34	2.18	2.68	0.24	3	2.17	2.34	2.18	2.68	0.24	3
Meander Wavelength (ft)	52.1	54.9	54.9	57.6	2.8	2	52.1	54.9	54.9	57.6	2.8	2	52.1	54.9	54.9	57.6	2.8	2	52.1	54.9	54.9	57.6	2.8	2	52.10	54.85	54.85	57.60	2.75	2
Meander Width Ratio	7.9	8.3	8.3	8.7	0.4	2	7.9	8.3	8.3	8.7	0.4	2	7.9	8.3	8.3	8.7	0.4	2	7.9	8.3	8.3	8.7	0.4	2	7.89	8.31	8.31	8.73	0.42	2
Profile																														
Riffle Length (ft)	13.6	20.8	14.3	47.8	13.5	5	8.7	14.5	15.1	17.6	2.6	9	8.5	21.0	13.2	57.3	16.3	8	7.2	15.8	11.6	42.8	12.3	6	7.68	19.00	14.45	46.89	13.00	6
Riffle Slope (ft/ft)	0.0000	0.0131	0.0147	0.0214	0.0081	5	0.0000	0.0130	0.0129	0.0230	0.0072	9	0.0000	0.0132	0.0152	0.0235	0.0068	8	0.0013	0.0279	0.0120	0.1117	0.0381	6	0.00	0.01	0.01	0.02	0.01	6
Pool Length (ft)	7.5	17.3	15.6	28.8	8.0	8	2.9	11.9	9.5	25.7	8.1	9	4.5	11.0	11.0	20.5	5.5	8	7.2	22.5	23.0	38.7	8.5	8	5.20	15.40	12.42	42.85	11.70	8
Pool Spacing (ft)	14.8	28.8	25.2	47.9	11.5	8	14.8	32.9	22.8	73.4	18.9	7	11.7	25.6	26.0	50.7	10.9	9	7.7	34.4	29.5	72.6	18.9	9	7.60	28.44	25.29	58.73	14.92	9
Pool Max Depth (ft)	-	1.7	-	-	-	1	-	0.8	-	-	-	1	-	0.8	-	-	-	1	-	0.6	-	-	-	8	0.21	0.49	0.48	0.83	0.17	9
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																														
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	0.2 / 16.4 / 29.3 / 85.0 / 139.4						0.8 / 6.9 / 9.5 / 20.5 / 44.6						0.3 / 9.5 / 13.6 / 29.2 / 56.0						- / - / - / - / 45						.5 / 4.3 / 10.1 / 29.5 / 101.1					
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)	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-
Impervious cover estimate (%)	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-
BF Velocity (fps)	-	2.98	-	-	-	-	-	2.92	-	-	-	-	-	2.92	-	-	-	-	-	2.92	-	-	-	-	-	2.92	-	-	-	-
BF Discharge (cfs)	-	8.0	-	-	-	-	-	6.4	-	-	-	-	-	6.4	-	-	-	-	-	6.4	-	-	-	-	-	6.4	-	-	-	-
Valley Length	-	248.0	-	-	-	-	-	248.0	-	-	-	-	-	248.0	-	-	-	-	-	248.0	-	-	-	-	-	248.0	-	-	-	-
Channel length (ft)[2]	-	310	-	-	-	-	-	310	-	-	-	-	-	310	-	-	-	-	-	310	-	-	-	-	-	310	-	-	-	-
Sinuosity	-	1.2	-	-	-	-	-	1.2	-	-	-	-	-	1.2	-	-	-	-	-	1.2	-	-	-	-	-	1.2	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	0.0101	0.0198	-	0.0295	-	-	-	0.0241	-	-	-	-	-	0.0241	-	-	-	-	-	0.0241	-	-	-	-	-	0.0241	-	-	-	-
BF slope (ft/ft)	0.0077	0.0175	-	0.0272	-	-	-	0.0203	-	-	-	-	-	0.0203	-	-	-	-	-	0.0203	-	-	-	-	-	0.0203	-	-	-	-
Bankfull Floodplain Area (acres)	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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UT3

Parameter	USGS Gauge	Regional Curve Interval [1,2] NC Mtn.	NC Pied.	Rural	Pre-Existing Condition[1] Min	Mean	Med	Max	SD	n	Reference Reach Data: Morgan Creek Min	Mean	Med	Max	SD	n	Design Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																						
BF Width (ft)	-	9.8	5.5	-	3.7	-	-	5.3	-	2	0.1	-	-	0.1	-	-	-	8.0	-	-	-	-
Floodprone Width (ft)	-	-	-	-	7.7	-	-	48.0	-	-	15.0	-	-	19.0	-	-	-	-	-	-	-	-
BF Mean Depth (ft)	-	0.6	0.8	-	1.05	-	-	1.57	-	-	0.70	-	-	0.90	-	-	-	0.8	-	-	-	-
BF Max Depth (ft)	-	-	-	-	1.7	-	-	2.0	-	-	1.0	-	-	1.4	-	-	1.0	-	-	1.1	-	-
BF Cross-sectional Area (ft²)	-	6.4	6.3	-	5.56	-	-	5.93	-	-	5.5	-	-	6.5	-	-	-	6.0	-	-	-	-
Width/Depth Ratio	-	-	-	-	2.4	-	-	5	-	-	7.3	-	-	11.7	-	-	-	8.9	-	-	-	-
Entrenchment Ratio	-	-	-	-	2.1	-	-	9.1	-	-	1.9	-	-	3.0	-	-	-	-	-	-	-	-
Bank Height Ratio	-	-	-	-	1.0	-	-	2.4	-	-	-	-	-	-	-	-	1.0	-	-	1.0	-	-
d50 (mm)	-	-	-	-	-	16.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pattern																						
Channel Beltwidth (ft)	-	-	-	-	44.0	-	-	94.0	-	-	-	-	-	-	-	-	25.0	-	-	56.0	-	-
Radius of Curvature (ft)	-	-	-	-	11.0	-	-	30.0	-	-	-	-	-	-	-	-	13.0	-	-	21.0	-	-
Rc:Bankfull width (ft/ft)	-	-	-	-	2.5	-	-	6.7	-	-	-	-	-	-	-	-	1.8	-	-	3.0	-	-
Meander Wavelength (ft)	-	-	-	-	49.0	-	-	72.0	-	-	45.0	-	-	75.0	-	-	49.0	-	-	84.0	-	-
Meander Width Ratio	-	-	-	-	10.9	-	-	12.8	-	-	6.4	-	-	10.5	-	-	7.0	-	-	12.0	-	-
Profile																						
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Riffle Slope (ft/ft)	-	-	-	-	0.005	-	-	0.031	-	-	0.013	-	-	0.054	-	-	0.016	-	-	0.022	-	-
Pool Length (ft)	-	-	-	-	25.0	-	-	65.0	-	-	17.4	-	-	26	-	-	20.0	-	-	40.0	-	-
Pool Spacing (ft)	-	-	-	-	40.0	-	-	140.0	-	-	39.9	-	-	62.3	-	-	18.0	-	-	42.0	-	-
Pool Max Depth (ft)	-	-	-	-	1.8	-	-	1.8	-		1.8	-	-	1.8	-	-	1.6	-	-	2.8	-	-
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																						
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	1.0 / 8.4 / 17 / 43 / 57						- / 1.2 / 3.0 / 77 / 800						-					
Reach Shear Stress (competency) lb/f²	-	-	-	-	0.55	-	-	0.8	-	-	-	-	-	-	-	-	-	0.6	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m²	-	-	-	-	25.0	-	-	45.0	-	-	6.5	-	-	28.5	-	-	-	37.0	-	-	-	-
Additional Reach Parameters																						
Drainage Area (SM)	-		0.17		0.14	-	-	0.17	-	-	-	0.12	-	-	-	-	0.14	-	-	0.17	-	-
Impervious cover estimate (%)	-	-	-	-	-	<5%	-	-	-	-	-	-	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	E	-	-	-	-	-	E/Bc	-	-	-	-	-	E	-	-	-	-
BF Velocity (fps)	-	-	-	-	3.9	-	-	4.9	-	-	2.1	-	3.4	-	-	-	-	3.3	-	-	-	-
BF Discharge (cfs)	-	26.0	24.0	-	20	-	-	25	-	-	-	15	-	-	-	-	-	21.7	-	-	-	-
Valley Length	-	-	-	-	-	1002	-	-	-	-	-	-	-	-	-	-	-	1015	-	-	-	-
Channel length (ft)[2]	-	-	-	-	-	1210	-	-	-	-	-	135	-	-	-	-	-	1332	-	-	-	-
Sinuosity	-	-	-	-	-	1.21	-	-	-	-	-	1.05	-	-	-	-	-	1.31	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	0.015	-	-	-	-	-	0.020	-	-	-	-	-	0.013	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	0.012	-	-	-	-	-	-	-	-	-	-	-	0.013	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Parameter	As-built Min	Mean	Med	Max	SD	n	MY1 Min	Mean	Med	Max	SD	n	MY2 Min	Mean	Med	Max	SD	n	MY3 Min	Mean	Med	Max	SD	n	MY4 Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle																														
BF Width (ft)	8.1	8.8	8.2	10.1	0.91	3	7.0	7.9	7.8	8.8	0.76	3	7.2	8.1	7.8	9.2	0.85	3	7.3	8.1	7.6	9.3	0.87	3	7.3	7.9	7.8	8.5	0.48	3
Floodprone Width (ft)		>150	-	-	-	-	-	>150	-	-	-	-	-	>150	-	-	-	3	-	>150	-	-	-	3	-	>150	-	-	-	3
BF Mean Depth (ft)	0.7	0.8	0.8	0.9	0.10	3	0.6	0.7	0.7	0.7	0.05	3	0.5	0.7	0.7	0.7	0.11	3	0.5	0.6	0.6	0.7	0.09	3	0.4	0.5	0.5	0.7	0.10	3
BF Max Depth (ft)	1.1	1.2	1.1	1.4	0.13	3	0.9	1.0	1.1	1.1	0.06	3	1.1	1.1	1.1	1.1	0.03	3	0.9	1.0	1.1	1.1	0.11	3	0.9	1.0	1.1	1.1	0.09	3
BF Cross-sectional Area (ft²)	6.3	6.7	6.5	7.3	0.43	3	4.8	5.3	5.3	5.8	0.41	3	4.7	5.3	5.3	5.8	0.45	3	4.4	4.8	4.6	5.3	0.37	3	3.6	4.1	3.7	4.9	0.56	3
Width/Depth Ratio	9.1	11.6	10.3	15.5	2.75	3	10.2	11.8	10.6	14.5	1.97	3	9.7	12.8	10.6	18.05	3.75	3	10.13	13.9	13.1	18.56	3.49	3	11.12	15.79	16.93	19.32	3.44	3
Entrenchment Ratio	5.4	7.8	8.5	9.4	1.71	3	6.1	7.7	7.0	9.9	1.62	3	5.9	7.5	7.0	9.6	1.55	3	5.8	7.4	6.9	9.4	1.50	3	6.3	7.5	6.8	9.4	1.32	3
Bank Height Ratio	1.0	1.1	1.1	1.2	0.08	3	1.1	1.2	1.2	1.3	0.08	3	1.0	1.1	1.1	1.3	0.12	3	1.1	1.1	1.2	1.2	0.05	3	0.9	0.9	1.0	1.0	0.05	3
d50 (mm)	-	31.2	-	-	-	-	-	20.4	-	-	-	-	-	16.4	-	-	-	-	-	0.3	-	-	-	-	-	39.84	-	-	-	-
Pattern																														
Channel Beltwidth (ft)	36.4	47.0	48.4	57.7	7.21	7	36.4	47.0	48.4	57.7	7.21	7	36.4	47.0	48.4	57.7	7.21	7	36.4	47.0	48.4	57.7	7.21	7	36.4	47.0	48.4	57.7	7.21	7
Radius of Curvature (ft)	14.0	18.8	19.4	25.1	3.72	7	14.0	18.8	19.4	25.1	3.72	7	14.0	18.8	19.4	25.1	3.72	7	14.0	18.8	19.4	25.1	3.72	7	14.0	18.8	19.4	25.1	3.72	7
Rc:Bankfull width (ft/ft)	1.6	2.1	2.2	2.9	0.42	7	1.6	2.1	2.2	2.9	0.42	7	1.6	2.1	2.2	2.9	0.42	7	1.6	2.1	2.2	2.9	0.42	7	1.6	2.1	2.2	2.9	0.42	7
Meander Wavelength (ft)	63.5	74.9	71.7	94.2	10.30	7	63.5	74.9	71.7	94.2	10.30	7	63.5	74.9	71.7	94.2	10.30	7	63.5	74.9	71.7	94.2	10.30	7	63.5	74.9	71.7	94.2	10.30	7
Meander Width Ratio	7.2	8.5	8.1	10.7	1.17	7	7.2	8.5	8.1	10.7	1.17	7	7.2	8.5	8.1	10.7	1.17	7	7.2	8.5	8.1	10.7	1.17	7	7.2	8.5	8.1	10.7	1.17	7
Profile																														
Riffle Length (ft)	13.1	21.1	20.6	28.2	4.50	11	10.8	24.3	21.0	65.2	12.20	15	11.4	27.2	26.7	64.5	11.8	18	10.3	25.9	21.6	58.5	11.6	17	8.8	21.5	22.0	40.5	10.6	17
Riffle Slope (ft/ft)	0.004	0.016	0.017	0.025	0.01	11	0.007	0.022	0.019	0.038	0.010	15	0.007	0.021	0.017	0.070	0.014	18	0.000	0.016	0.013	0.051	0.014	17	0.005	0.020	0.018	0.055	0.015	17
Pool Length (ft)	18.4	26.4	25.8	33.5	5.00	11	15.0	25.6	26.1	39.9	7.30	17	13.5	22.8	23.5	34.4	6.23	17	7.6	28.5	28.8	60.5	13.90	17	7.4	22.1	19.4	44.5	9.09	17
Pool Spacing (ft)	36.3	49.0	47.7	60.7	7.30	15	32.7	52.2	48.6	95.3	13.60	17	22.6	50.0	48.5	94.5	14.98	17	33.6	50.3	48.1	86.2	13.20	17	18.8	48.0	39.9	117.5	23.76	17
Pool Max Depth (ft)	1.7	2.0	2.0	2.2	0.21	2	1.6	1.7	1.7	1.9	0.15	2.0	1.2	1.4	1.4	1.7	0.27	2	0.3	0.9	0.8	1.6	0.40	17	0.4	0.6	0.6	0.8	0.14	17
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																														
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	12.2 / 17.6 / 31.2 / 57.0 / 78.3						0.3 / 12.2 / 20.4 / 60.5 / 86.7						0.4 / 11.5 / 16.4 / 61.1 / 84.2						0.14 / .25 / .34 / 45.52 / 73.35						12.86 / 20.39 / 39.84 / 67.76 / 136.57					
Reach Shear Stress (competency) lb/f²	0.2	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																														
Drainage Area (SM)	0.14	-	-	0.17	-	-	0.14	-	-	0.17	-	-	0.14	-	-	0.17	-	-	0.14	-	-	0.17	-	-	0.14	-	-	0.17	-	-
Impervious cover estimate (%)	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	E	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-
BF Velocity (fps)	-	3.43	-	-	-	-	-	3.17	-	-	-	-	-	3.17	-	-	-	-	-	3.17	-	-	-	-	-	3.17	-	-	-	-
BF Discharge (cfs)	-	23	-	-	-	-	-	16.8	-	-	-	-	-	16.8	-	-	-	-	-	16.8	-	-	-	-	-	16.8	-	-	-	-
Valley Length	-	1015	-	-	-	-	-	1015	-	-	-	-	-	1015	-	-	-	-	-	1015	-	-	-	-	-	1015	-	-	-	-
Channel length (ft)[2]	-	1348	-	-	-	-	-	1348	-	-	-	-	-	1348	-	-	-	-	-	1348	-	-	-	-	-	1348	-	-	-	-
Sinuosity	-	1.33	-	-	-	-	-	1.33	-	-	-	-	-	1.33	-	-	-	-	-	1.33	-	-	-	-	-	1.33	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	0.013	-	-	-	-	-	0.0128	-	-	-	-	-	0.0128	-	-	-	-	-	0.0128	-	-	-	-	-	0.0128	-	-	-	-
BF slope (ft/ft)	-	0.013	-	-	-	-	-	0.013	-	-	-	-	-	0.013	-	-	-	-	-	0.013	-	-	-	-	-	0.013	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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2. 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 11. Morphology and Hydraulic Monitoring Summary

Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Silver Creek (3,016 LF)																										
	Cross-section X-1, Station 2724.3 (Riffle)							Cross-section X-2, Station 2636.7 (Pool)							Cross-section X-3, Station 1898.2 (Pool)							Cross-section X-4, Station 1793.8 (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)	29.06	24.58	24.91	24.91	20.28			35.67	29.50	34.01	34.54	33.02			43.45	39.50	42.01	39.84	38.31			23.81	23.50	23.52	24.00	37.72		
BF Mean Depth (ft)	1.69	1.76	1.81	1.68	1.89			1.63	1.76	1.46	1.51	1.55			1.72	1.45	1.19	1.17	1.14			2.01	1.89	1.75	1.75	1.11		
Width/Depth Ratio	17.16	13.90	13.77	14.83	10.73			21.82	16.76	23.30	22.87	21.30			25.20	27.30	35.15	34.05	33.61			11.82	12.44	13.46	13.71	33.98		
BF Cross-sectional Area (ft^2)	49.20	43.40	45.00	41.90	38.27			58.30	51.90	49.60	52.03	51.28			74.90	57.30	50.20	46.81	43.51			48.00	44.20	41.10	41.90	41.81		
BF Max Depth (ft)	3.04	2.92	3.24	3.11	3.39			3.98	3.92	4.32	4.48	5.24			5.16	4.00	3.95	3.81	3.61			3.34	3.22	3.08	3.13	3.17		
Width of Floodprone Area (ft)	>300	>300	>300	>300	>300			>300	>300	>300	>300	>300			>300	>300	>300	>300	>300			>300	>300	>300	>300	>300		
Entrenchment Ratio	3.30	3.90	3.80	3.85	4.87			2.50	3.00	2.60	2.55	2.67			2.10	2.30	2.20	2.27	2.36			3.70	3.70	3.70	3.63	2.31		
Bank Height Ratio	1.10	1.00	1.10	1.06	1.00			1.00	1.00	1.00	1.00	0.98			0.70	0.70	0.90	1.07	0.93			1.00	1.00	1.00	1.02	0.95		
Wetted Perimeter (ft)	32.44	28.10	28.53	28.27	22.63			38.93	33.02	36.93	37.56	37.84			46.89	42.40	44.39	42.18	40.68			27.83	27.28	27.02	27.50	39.65		
Hydraulic Radius (ft)	1.52	1.54	1.58	1.48	1.69			1.50	1.57	1.34	1.39	1.36			1.60	1.35	1.13	1.11	1.07			1.72	1.62	1.52	1.52	1.05		
Fixed baseline bankfull elevation	1197.40	1197.40	1197.40	1197.38	1197.38			1198.20	1198.20	1198.20	1198.20	1198.20			1202.34	1202.34	1202.34	1202.34	1202.34			1203.00	1203.00	1203.01	1203.01	1203.01		
Based on current/developing bankfull feature																												
BF Width (ft)	29.06	26.22	26.20	-	-			35.67	29.50	35.29	-	-			43.45	42.55	42.01	-	-			23.81	23.50	23.52	-	-		
BF Mean Depth (ft)	1.69	1.72	1.82	-	-			1.63	1.76	1.50	-	-			1.72	1.45	1.19	-	-			2.01	1.89	1.75	-	-		
Width/Depth Ratio	17.16	15.23	14.40	-	-			21.82	16.76	23.50	-	-			25.20	29.31	35.15	-	-			11.82	12.44	13.46	-	-		
BF Cross-sectional Area (ft^2)	49.20	45.10	47.60	-	-			58.30	51.90	53.09	-	-			74.90	61.80	50.20	-	-			48.00	44.20	41.10	-	-		
BF Max Depth (ft)	3.04	2.99	3.34	-	-			3.98	3.92	4.42	-	-			5.16	4.15	3.95	-	-			3.34	3.22	3.08	-	-		
Width of Floodprone Area (ft)	>300	>300	>300	-	-			>300	>300	>300	-	-			>300	>300	>300	-	-			>300	87.26	>300	-	-		
Entrenchment Ratio	3.30	3.70	>3.70	-	-			2.50	3.00	>2.50	-	-			2.10	2.10	2.20	-	-			3.70	3.70	3.70	-	-		
Bank Height Ratio	1.10	1.00	1.00	-	-			1.00	1.00	1.00	-	-			0.70	0.70	0.90	-	-			1.00	1.00	1.00	-	-		
Wetted Perimeter (ft)	32.44	29.66	29.84	-	-			38.93	33.02	38.29	-	-			46.89	45.45	44.39	-	-			27.83	27.28	27.02	-	-		
Hydraulic Radius (ft)	1.52	1.52	1.60	-	-			1.50	1.57	1.39	-	-			1.60	1.36	1.13	-	-			1.72	1.62	1.52	-	-		
Cross Sectional Area between end pins (ft^2)	-	-	-	-	-			-	-	-	-	-			-	-	-	-	-			-	-	-	-	-		
d50 (mm)	-	-	-	-	-			-	-	-	-	-			-	-	-	-	-			36.60	41.30	25.10	27.80	28.00		
* Corrected from baseline report.																												
	Cross-section X-5, Station 1206.9 (Riffle)							Cross-section X-6, Station 357.2 (Pool)							Cross-section 7, Station 302.5 (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)	28.43	26.08	25.21	25.01	25.02			43.48	41.92	34.57	35.96	44.93			26.61	25.90	25.80	25.75	22.23									
BF Mean Depth (ft)	1.65	1.66	1.68	1.66	1.58			1.84	1.75	1.69	1.59	1.53			2.05	1.95	1.84	1.80	1.67									
Width/Depth Ratio	17.25	15.69	15.04	15.07	15.84			23.59	23.92	20.50	22.62	29.37			12.98	13.26	14.00	14.31	13.31									
BF Cross-sectional Area (ft^2)	46.90	43.40	42.30	41.56	39.53			80.10	73.50	58.30	57.16	68.54			54.50	50.60	47.60	46.23	37.16									
BF Max Depth (ft)	2.91	2.81	2.80	2.77	2.75			5.25	4.98	3.78	4.63	3.75			3.30	3.15	2.95	3.20	3.04									
Width of Floodprone Area (ft)	>300	>300	>300	>300	>300			>300	>300	>300	>300	>300			>300	>300	>300	>300	>300									
Entrenchment Ratio	3.10	3.30	3.50	3.48	3.49			1.60	1.60	2.00	1.89	1.51			4.80	4.90	4.90	4.93	5.71									
Bank Height Ratio	1.00	1.00	1.00	1.01	0.97			1.00	0.90	1.00	1.01	0.94			1.00	1.00	1.00	1.04	1.00									
Wetted Perimeter (ft)	31.73	29.40	28.57	28.33	26.42			47.16	45.42	37.95	39.14	48.74			30.71	29.80	29.48	29.35	24.01									
Hydraulic Radius (ft)	1.48	1.48	1.48	1.47	1.50			1.70	1.70	1.54	1.46	1.41			1.77	1.70	1.61	1.58	1.55									
Fixed baseline bankfull elevation	1208.80	1208.80	1208.80	1208.82	1204.82			1208.14	1208.14	1208.14	1208.14	1208.14			1208.23	1208.23	1208.23	1208.23	1208.23									
Based on current/developing bankfull feature																												
BF Width (ft)	28.43	26.08	25.75	-	-			43.48	41.92	34.57	-	-			26.61	25.90	26.80	-	-									
BF Mean Depth (ft)	1.65	1.66	1.68	-	-			1.84	1.75	1.69	-	-			2.05	1.95	1.84	-	-									
Width/Depth Ratio	17.25	15.69	15.30	-	-			23.59	23.92	20.50	-	-			12.98	13.26	14.10	-	-									
BF Cross-sectional Area (ft^2)	46.90	43.40	43.29	-	-			80.10	73.50	58.30	-	-			54.50	50.60	50.98	-	-									
BF Max Depth (ft)	2.91	2.81	2.84	-	-			5.25	4.98	3.78	-	-			3.30	3.15	3.08	-	-									
Width of Floodprone Area (ft)	>300	>300	>300	-	-			>300	>300	>300	-	-			>300	>300	>300	-	-									
Entrenchment Ratio	3.10	3.30	>3.40	-	-			1.60	1.60	2.00	-	-			4.80	4.90	>4.70	-	-									
Bank Height Ratio	1.00	1.00	1.00	-	-			1.00	0.90	1.00	-	-			1.00	1.00	1.00	-	-									
Wetted Perimeter (ft)	31.73	29.40	29.11	-	-			47.16	45.42	37.95	-	-			30.71	29.80	30.48	-	-									
Hydraulic Radius (ft)*	1.48	1.48	1.49	-	-			1.70	1.70	1.54	-	-			1.77	1.70	1.67	-	-									
Cross Sectional Area between end pins (ft^2)	-	-	-	-	-			-	-	-	-	-			-	-	-	-	-									
d50 (mm)	-	-	-	-	-			-	-	-	-	-			33.40	15.20	16.00	23.20	18.00									

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

Table 11. Morphology and Hydraulic Monitoring Summary

Upper Silver Creek Restoration Project: DMS Project ID No. 94645

UT1 (495 LF)																											
	Cross-section X-13, Station 1+57 (Riffle)							Cross-section X-14, Station 3+28 (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)	9.59	9.28	9.20	9.02	11.49			9.32	8.59	6.59	6.43	5.46															
BF Mean Depth (ft)	0.93	0.75	0.76	0.77	0.51			1.98	1.27	1.36	1.09	0.72															
Width/Depth Ratio	10.33	12.32	12.15	11.71	22.53			4.71	6.75	4.84	5.90	7.58															
BF Cross-sectional Area (ft^2)	8.90	7.00	7.00	6.96	5.87			18.50	10.90	9.00	7.01	3.91															
BF Max Depth (ft)	1.30	1.13	1.09	1.11	1.20			3.70	2.48	2.59	1.76	1.58															
Width of Floodprone Area (ft)	>150	>150	>150	>150	>150			>150	>150	>150	>150	>150															
Entrenchment Ratio	5.30	5.40	5.50	5.59	4.38			8.70	9.40	12.30	12.59	14.83															
Bank Height Ratio	1.00	1.10	1.10	1.10	0.99			1.10	1.20	1.20	1.34	0.92															
Wetted Perimeter (ft)	11.45	10.78	10.72	10.56	12.13			13.28	11.13	9.31	8.61	6.69															
Hydraulic Radius (ft)	0.78	0.65	0.65	0.66	0.48			1.39	0.98	0.97	0.81	0.59															
Fixed baseline bankfull elevation	1203.99	1203.99	1203.99	1203.99	1203.99			1201.60	1201.60	1201.60	1201.59	1201.59															
Based on current/developing bankfull feature																											
BF Width (ft)	9.59	9.75	9.96	-	-			9.30	10.96	8.31	-	-															
BF Mean Depth (ft)	0.93	0.81	0.82	-	-			1.98	1.36	1.58	-	-															
Width/Depth Ratio	10.33	12.04	12.11	-	-			4.71	8.03	5.26	-	-															
BF Cross-sectional Area (ft^2)	8.90	7.90	8.20	-	-			18.50	15.00	13.10	-	-															
BF Max Depth (ft)	1.30	1.23	1.22	-	-			3.70	2.89	3.16	-	-															
Width of Floodprone Area (ft)	>150	>150	>150	-	-			>150	>150	>150	-	-															
Entrenchment Ratio	5.30	5.20	5.10	-	-			8.70	7.40	9.70	-	-															
Bank Height Ratio	1.00	1.00	1.00	-	-			1.10	1.00	1.00	-	-															
Wetted Perimeter (ft)	11.45	11.37	11.60	-	-			13.26	13.68	11.47	-	-															
Hydraulic Radius (ft)	0.78	0.69	0.71	-	-			1.40	1.10	1.14	-	-															
Cross Sectional Area between end pins (ft^2)	-	-	-	-	-			-	-	-	-	-															
d50 (mm)	38.80	43.60	32.90	26.90	37.10			-	-	-	-	-															

UT2 (310 LF)																											
	Cross-section X-15, Station 2+15 (Pool)							Cross-section X-16, Station 2+53 (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)	7.33	6.42	5.55	5.46	5.01			6.60	5.82	4.68	5.11	5.55															
BF Mean Depth (ft)	0.83	0.46	0.45	0.37	0.23			0.41	0.37	0.32	0.27	0.31															
Width/Depth Ratio	8.88	13.87	12.28	14.76	21.78			15.99	15.71	14.47	18.93	17.90															
BF Cross-sectional Area (ft^2)	6.10	3.00	2.50	2.02	1.17			2.70	2.20	1.50	1.37	1.72															
BF Max Depth (ft)	1.66	0.84	0.69	0.69	0.37			0.91	0.77	0.63	0.66	0.80															
Width of Floodprone Area (ft)	>100	>100	>100	>100	>100			>100	>100	>100	>100	>100															
Entrenchment Ratio	9.20	10.50	12.10	12.34	11.39			7.00	7.10	8.70	7.97	8.29															
Bank Height Ratio	1.10	1.20	1.40	1.30	0.92			1.20	1.00	1.20	1.23	0.97															
Wetted Perimeter (ft)	8.99	7.34	6.45	6.20	5.14			7.42	6.56	5.32	5.65	6.15															
Hydraulic Radius (ft)	0.68	0.41	0.39	0.33	0.23			0.36	0.34	0.28	0.24	0.28															
Fixed baseline bankfull elevation	1201.90	1201.90	1201.90	1201.91	1201.91			1201.21	1201.21	1201.21	1201.21	1201.21															
Based on current/developing bankfull feature																											
BF Width (ft)	7.33	8.35	6.43	-	-			6.60	5.82	5.46	-	-															
BF Mean Depth (ft)	0.83	0.46	0.52	-	-			0.41	0.37	0.38	-	-															
Width/Depth Ratio	8.88	13.87	12.33	-	-			15.99	15.71	14.50	-	-															
BF Cross-sectional Area (ft^2)	6.10	4.00	3.30	-	-			2.70	2.20	2.10	-	-															
BF Max Depth (ft)	1.66	0.98	0.83	-	-			0.91	0.77	0.74	-	-															
Width of Floodprone Area (ft)	>100	>100	>100	-	-			>100	>100	>100	-	-															
Entrenchment Ratio	9.20	8.10	10.50	-	-			7.00	7.10	8.10	-	-															
Bank Height Ratio	1.10	1.10	1.10	-	-			1.20	1.00	1.10	-	-															
Wetted Perimeter (ft)	8.99	9.27	7.47	-	-			7.42	6.56	6.22	-	-															
Hydraulic Radius (ft)	0.68	0.43	0.44	-	-			0.36	0.34	0.34	-	-															
Cross Sectional Area between end pins (ft^2)	-	-	-	-	-			-	-	-	-	-			-							-						
d50 (mm)	-	-	-	-	-			29.30	9.50	13.60	-	10.10			-							-						

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

Table 11. Morphology and Hydraulic Monitoring Summary

Upper Silver Creek Restoration Project: DMS Project ID No. 94645

UT3 (1,348 LF)																											
	Cross-section X-8, Station 6+22 (Riffle)							Cross-section X-9, Station 8+12 (Pool)							Cross-section X-10, Station 8+33 (Riffle)							Cross-section X-11, Station 11+53 (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)	10.05	8.81	9.22	9.28	8.50			10.73	9.50	9.36	10.57	6.54			8.1	6.95	7.19	7.29	7.34			13.03	11.53	11.35	11.35	11.51		
BF Mean Depth (ft)	0.65	0.61	0.51	0.50	0.44			1.02	0.82	0.46	0.50	0.37			0.8	0.68	0.74	0.72	0.66			1.01	0.85	0.61	0.63	0.53		
Width/Depth Ratio	15.46	14.53	18.05	18.56	19.32			10.53	11.64	20.37	21.14	17.68			10.3	10.16	9.70	10.13	11.12			12.80	13.65	18.73	18.02	21.72		
BF Cross-sectional Area (ft^2)	6.50	5.30	4.70	4.61	3.74			10.90	7.80	4.30	5.30	2.40			6.3	4.80	5.31	5.27	4.85			13.22	9.70	6.90	7.12	6.12		
BF Max Depth (ft)	1.13	1.05	1.13	1.10	1.06			1.74	1.59	1.16	1.47	1.14			1.1	0.94	1.08	1.09	1.10			2.17	1.88	1.70	1.65	1.56		
Width of Floodprone Area (ft)	>150	>150	>150	>150	>150			>150	>150	>150	>150	>150			>150	>150	>150	>150	>150			>150	>150	>150	>150	>150		
Entrenchment Ratio	5.40	6.10	5.90	5.83	6.32			5.80	6.60	6.70	5.93	9.59			8.5	9.90	9.60	9.42	9.35			5.60	6.30	6.40	6.43	6.34		
Bank Height Ratio	1.00	1.10	1.00	1.18	0.86			1.00	1.20	1.20	1.24	1.02			1.10	1.20	1.10	1.06	0.99			1.00	1.10	1.10	1.10	0.92		
Wetted Perimeter (ft)	11.35	10.03	10.24	10.28	9.09			12.77	11.14	10.28	11.57	7.73			9.6	8.31	8.67	8.73	7.85			15.05	13.23	12.57	12.61	12.48		
Hydraulic Radius (ft)	0.57	0.53	0.46	0.45	0.41			0.85	0.70	0.42	0.46	0.31			0.7	0.58	0.61	0.60	0.62			0.88	0.73	0.55	0.56	0.49		
Fixed baseline bankfull elevation	1215.38	1215.38	1215.38	1215.38	1215.38			1212.81	1212.81	1212.81	1212.81	1212.81			1212.89	1212.89	1212.89	1212.89	1212.89			1209.27	1209.27	1209.27	1209.27	1209.27		
Based on current/developing bankfull feature																											
BF Width (ft)	10.10	11.68	12.21	-	-			10.70	12.10	12.07	-	-			8.10	7.47	7.99	-	-			13.00	13.02	12.34	-	-		
BF Mean Depth (ft)	0.65	0.53	0.50	-	-			1.02	0.87	0.61	-	-			0.78	0.76	0.81	-	-			1.01	0.92	0.67	-	-		
Width/Depth Ratio	15.46	22.03	24.49	-	-			10.53	13.84	19.78	-	-			10.34	9.83	9.89	-	-			12.80	14.21	18.43	-	-		
BF Cross-sectional Area (ft^2)	6.50	6.20	6.10	-	-			10.90	10.60	7.40	-	-			6.30	5.70	6.40	-	-			13.22	11.90	8.30	-	-		
BF Max Depth (ft)	1.13	1.14	1.26	-	-			1.74	1.86	1.44	-	-			1.09	1.07	1.23	-	-			2.17	2.06	1.82	-	-		
Width of Floodprone Area (ft)	>150	>150	>150	-	-			>150	>150	>150	-	-			>150	>150	>150	-	-			>150	>150	>150	-	-		
Entrenchment Ratio	5.40	4.60	4.40	-	-			5.80	5.20	5.20	-	-			8.50	9.20	8.60	-	-			5.60	5.60	5.90	-	-		
Bank Height Ratio	1.00	1.00	1.00	-	-			1.00	1.00	1.00	-	-			1.10	1.10	1.00	-	-			1.00	1.00	1.00	-	-		
Wetted Perimeter (ft)	11.40	12.74	13.21	-	-			12.74	13.84	13.29	-	-			9.66	8.99	9.61	-	-			15.02	14.86	13.68	-	-		
Hydraulic Radius (ft)	0.57	0.49	0.46	-	-			0.86	0.77	0.56	-	-			0.65	0.63	0.67	-	-			0.88	0.80	0.61	-	-		
Cross Sectional Area between end pins (ft^2)	-	-	-	-	-			-	-	-	-	-			-	-	-	-	-			-	-	-	-	-		
d50 (mm)	31.20	20.40	16.40	0.34	39.84			-	-	-	-	-			-	-	-	-	-			-	-	-	-	-		

	Cross-section X-12, Station 11+84 (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)	8.17	7.80	7.69	7.62	7.79																						
BF Mean Depth (ft)	0.90	0.74	0.66	0.58	0.46																						
Width/Depth Ratio	9.12	10.57	11.72	13.14	16.93																						
BF Cross-sectional Area (ft^2)	7.30	5.80	5.00	4.40	3.59																						
BF Max Depth (ft)	1.38	1.07	0.93	0.87	0.89																						
Width of Floodprone Area (ft)	>150	>150	>150	>150	>150																						
Entrenchment Ratio	9.40	7.00	7.30	6.94	6.83																						
Bank Height Ratio	1.20	1.30	1.30	1.17	0.95																						
Wetted Perimeter (ft)	9.97	9.28	9.01	8.78	8.41																						
Hydraulic Radius (ft)	0.73	0.63	0.55	0.50	0.43																						
Fixed baseline bankfull elevation	1208.77	1208.77	1208.77	1208.77	1208.77																						
Based on current/developing bankfull feature																											
BF Width (ft)	8.20	9.13	9.15	-																							
BF Mean Depth (ft)	0.90	0.87	0.82	-																							
Width/Depth Ratio	9.12	10.45	11.11	-																							
BF Cross-sectional Area (ft^2)	7.30	8.00	7.50	-																							
BF Max Depth (ft)	1.38	1.34	1.23	-																							
Width of Floodprone Area (ft)	>150	>150	>150	-																							
Entrenchment Ratio	9.40	8.50	8.50	-																							
Bank Height Ratio	1.20	1.00	1.00	-																							
Wetted Perimeter (ft)	10.00	10.87	10.79	-																							
Hydraulic Radius (ft)	0.73	0.74	0.70	-																							
Cross Sectional Area between end pins (ft^2)	-	-	-	-																							
d50 (mm)	-	-	-	-																							

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

Appendix E

Wetland Assessment Data

Includes:

Figure 9. Observed Rainfall vs Historical Average

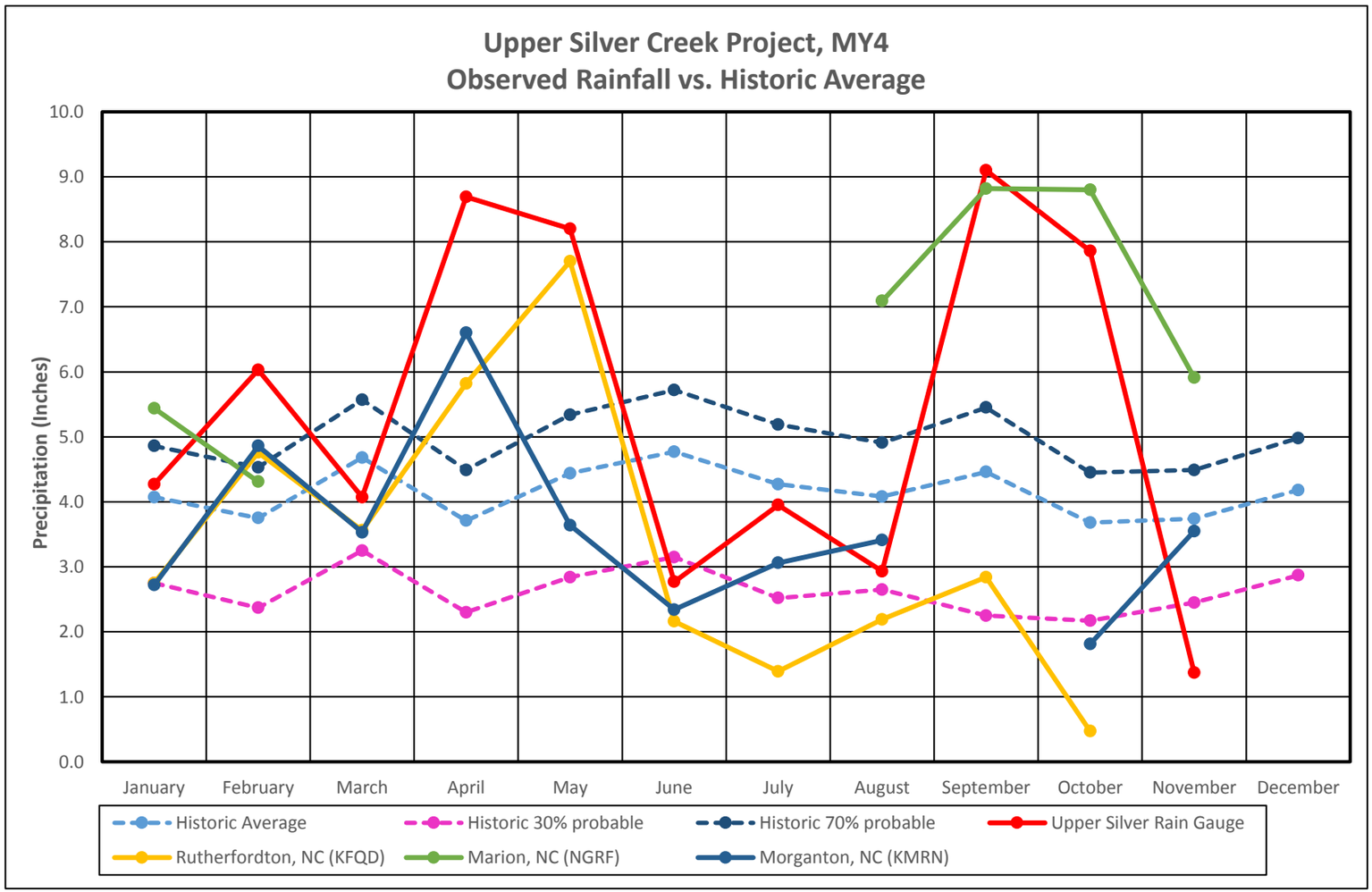
Figure 10. Wetland Gauge Graphs

Table 12. Wetland Gauge Attainment data

Table 12a. Wetland Restoration Area Well Success

Figure 11. Wetland Photo Log

Figure 9. Observed Rainfall vs. Historical Average



Note: Rainfall data from Marion (NGRF) and Morganton (KMRN) was incomplete for some months and only data that was available is presented.

Historic rainfall data from Burke County Soil Survey, NRCS, pg. 420
Rainfall data source for Upper Silver Rain Gauge: Onsite HOBO tipping bucket rain gauge with Pendant Data Logger
Rainfall data source for Rutherfordton, NC: http://climate.ncsu.edu/cronos?station=KFQD&temporal=hourly
Rainfall data source for Spindale, NC: http://climate.ncsu.edu/cronos?station=SPIN&temporal=hourly
Rainfall data source for Morganton, NC: http://climate.ncsu.edu/cronos?station=KMRN&temporal=hourly
Rainfall data source for historic averages: Morganton, NC WETS Table (1971-2016)

Figure 10. Wetland gauge graphs, showing depth to groundwater and rainfall during MY4.

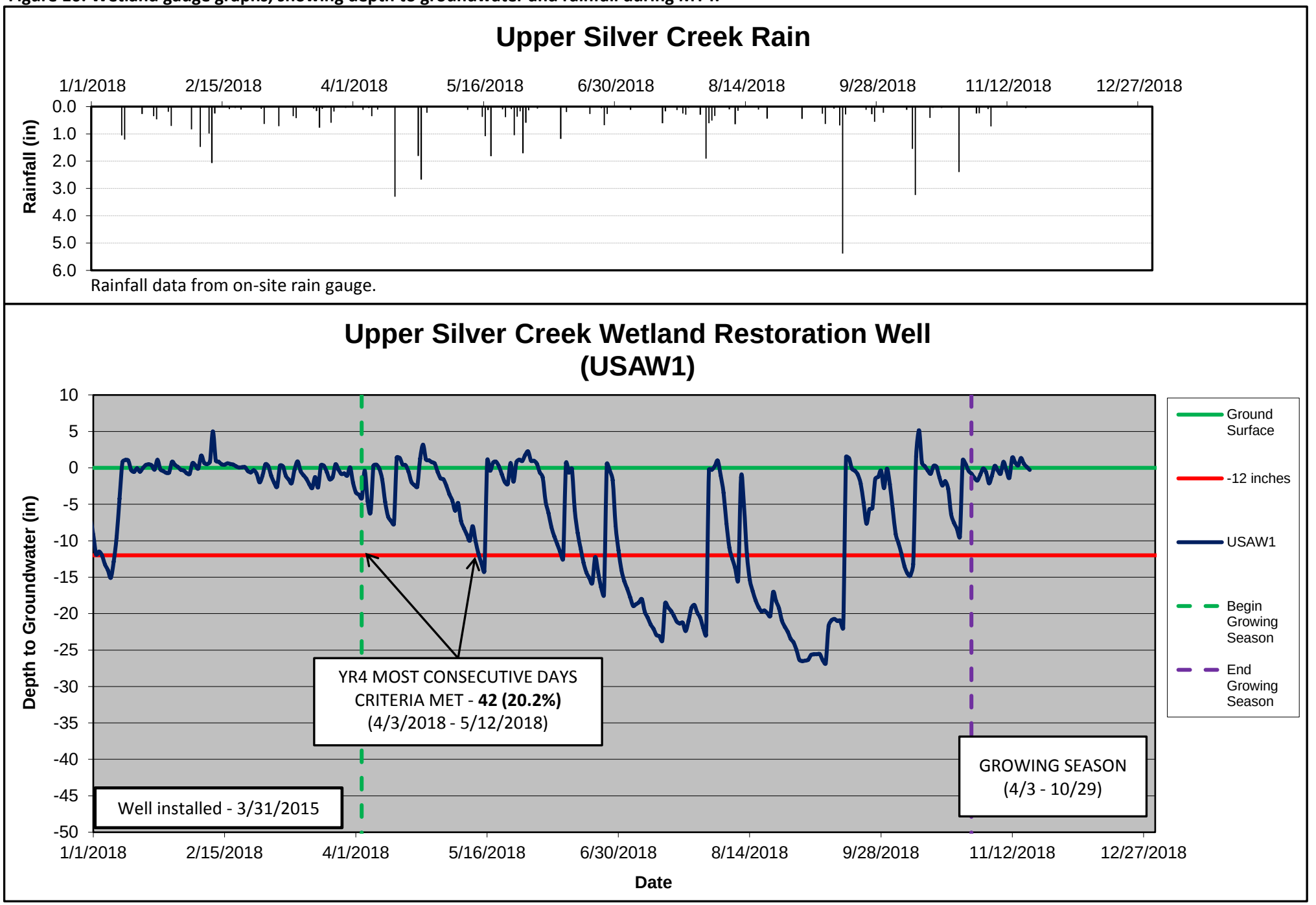


Figure 10. Wetland gauge graphs (continued)

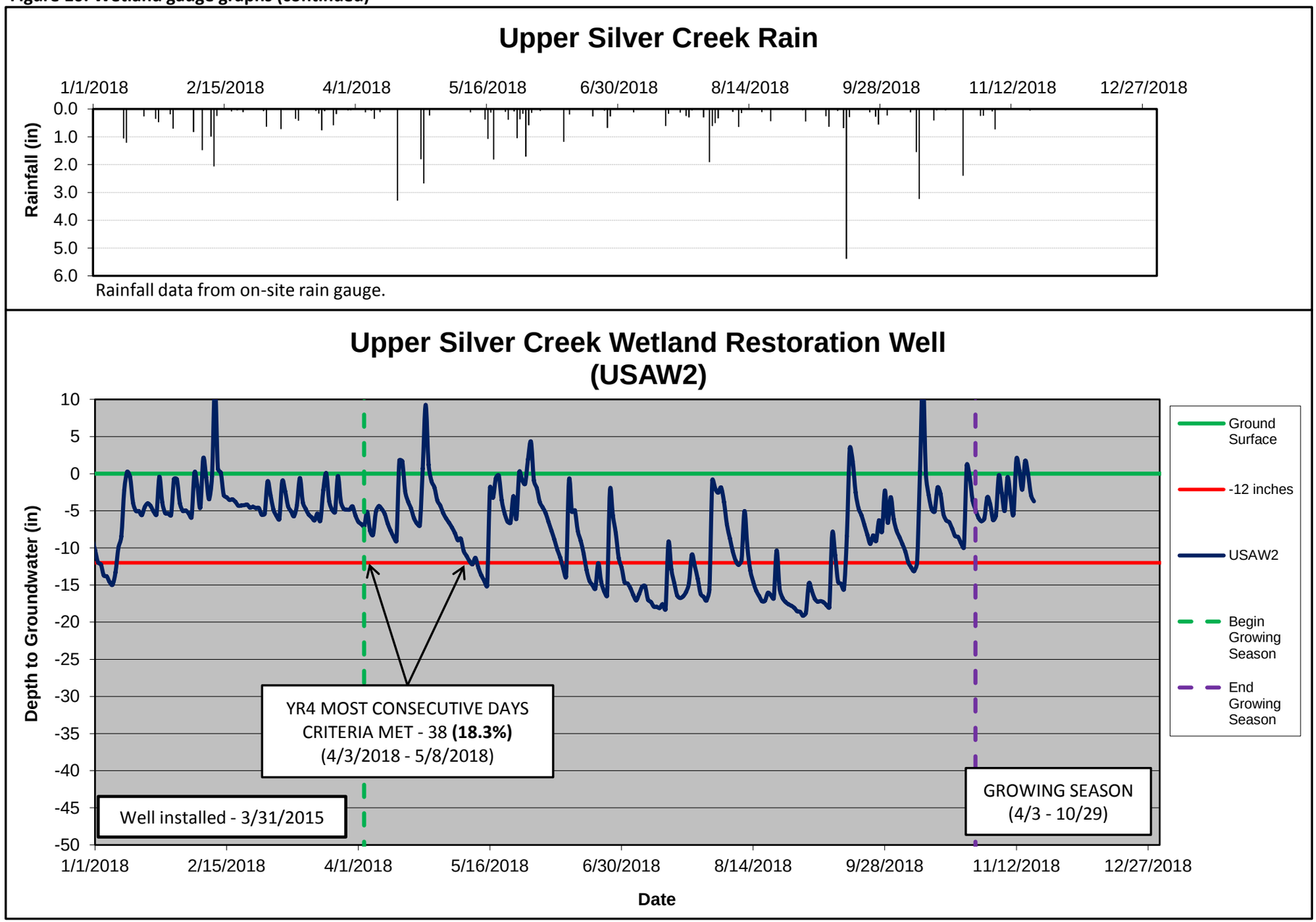


Figure 10. Wetland gauge graphs (continued)

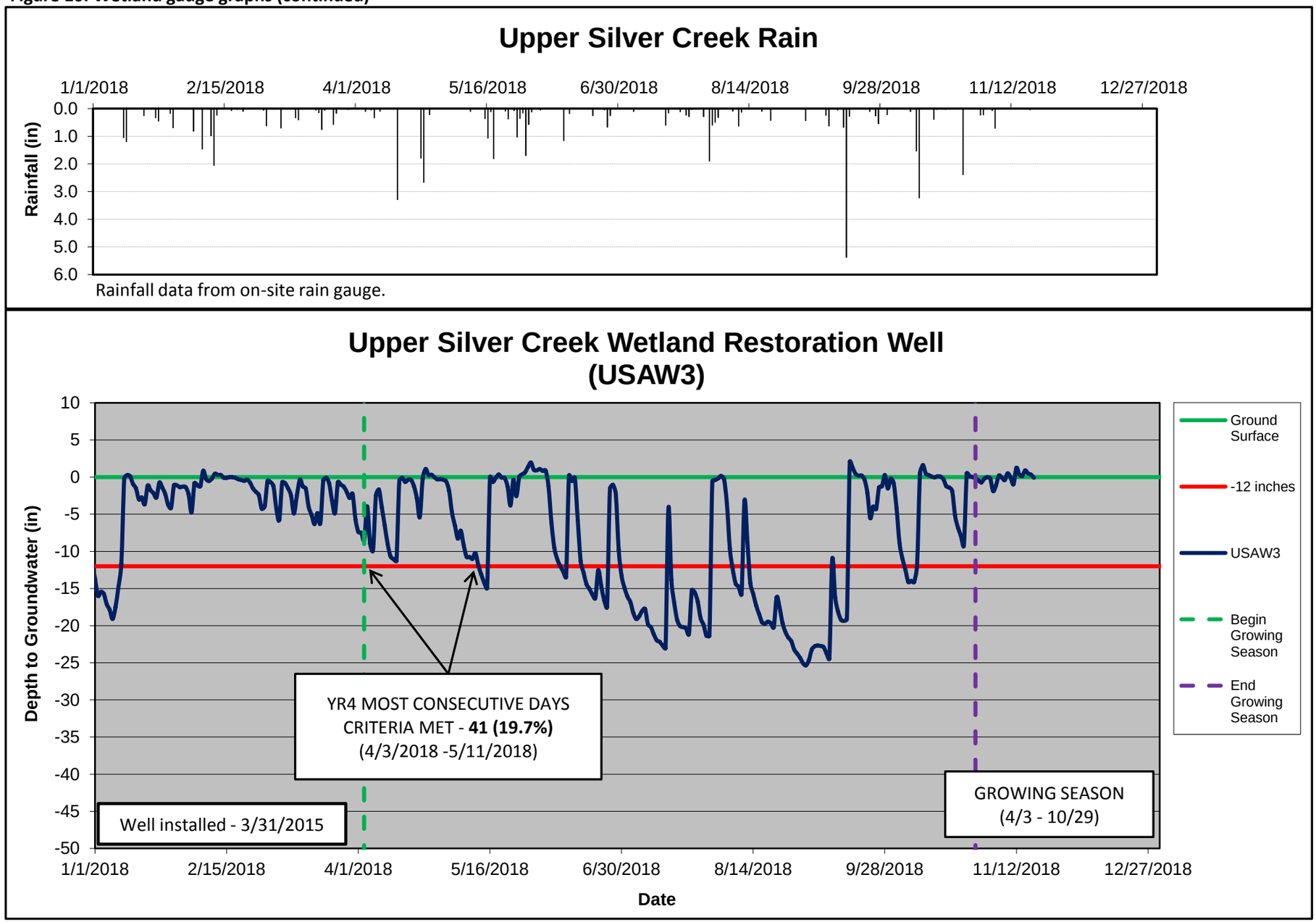


Figure 10. Wetland gauge graphs (continued)

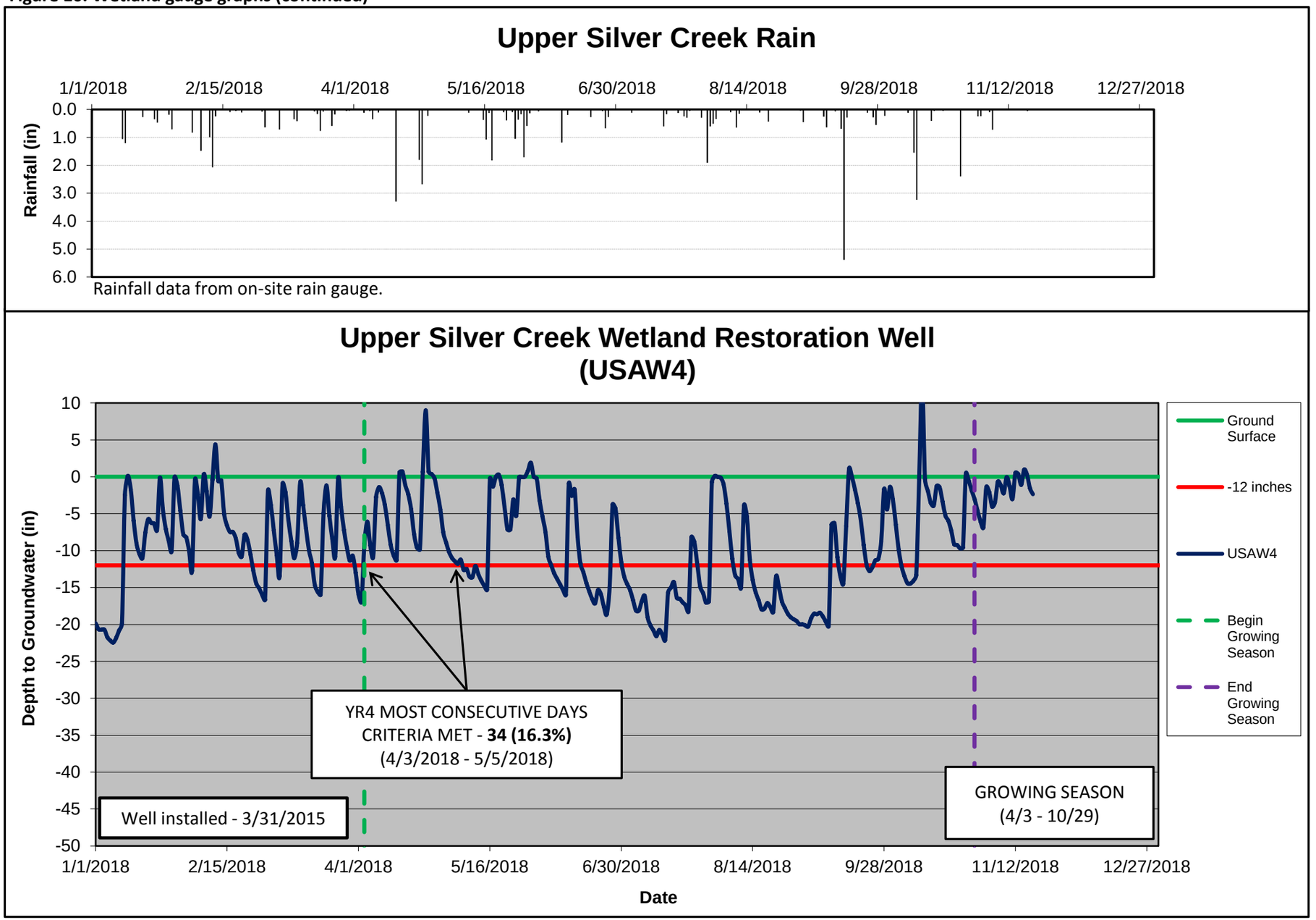


Figure 10. Wetland gauge graphs (continued)

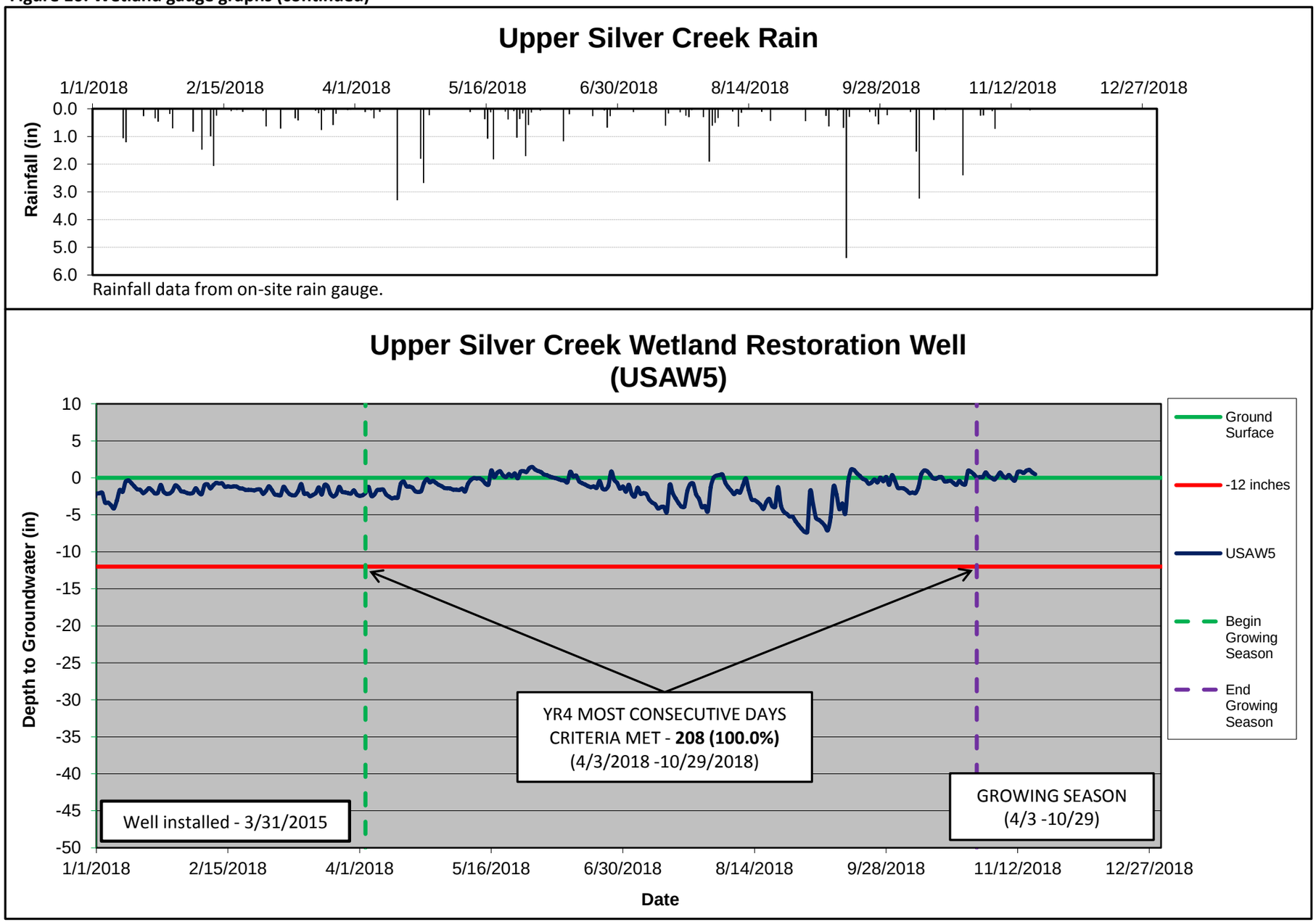
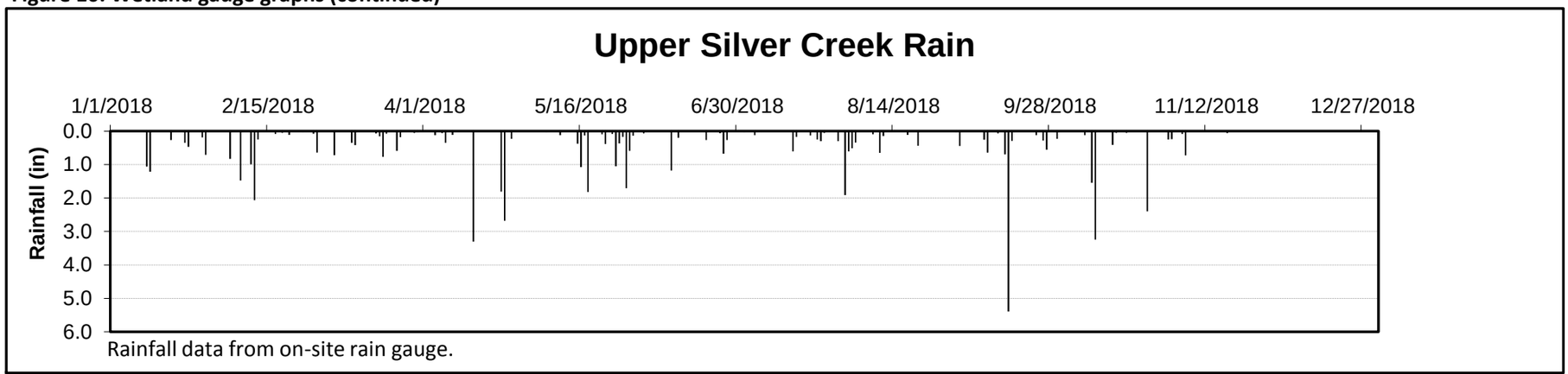


Figure 10. Wetland gauge graphs (continued)



Rainfall data from on-site rain gauge.

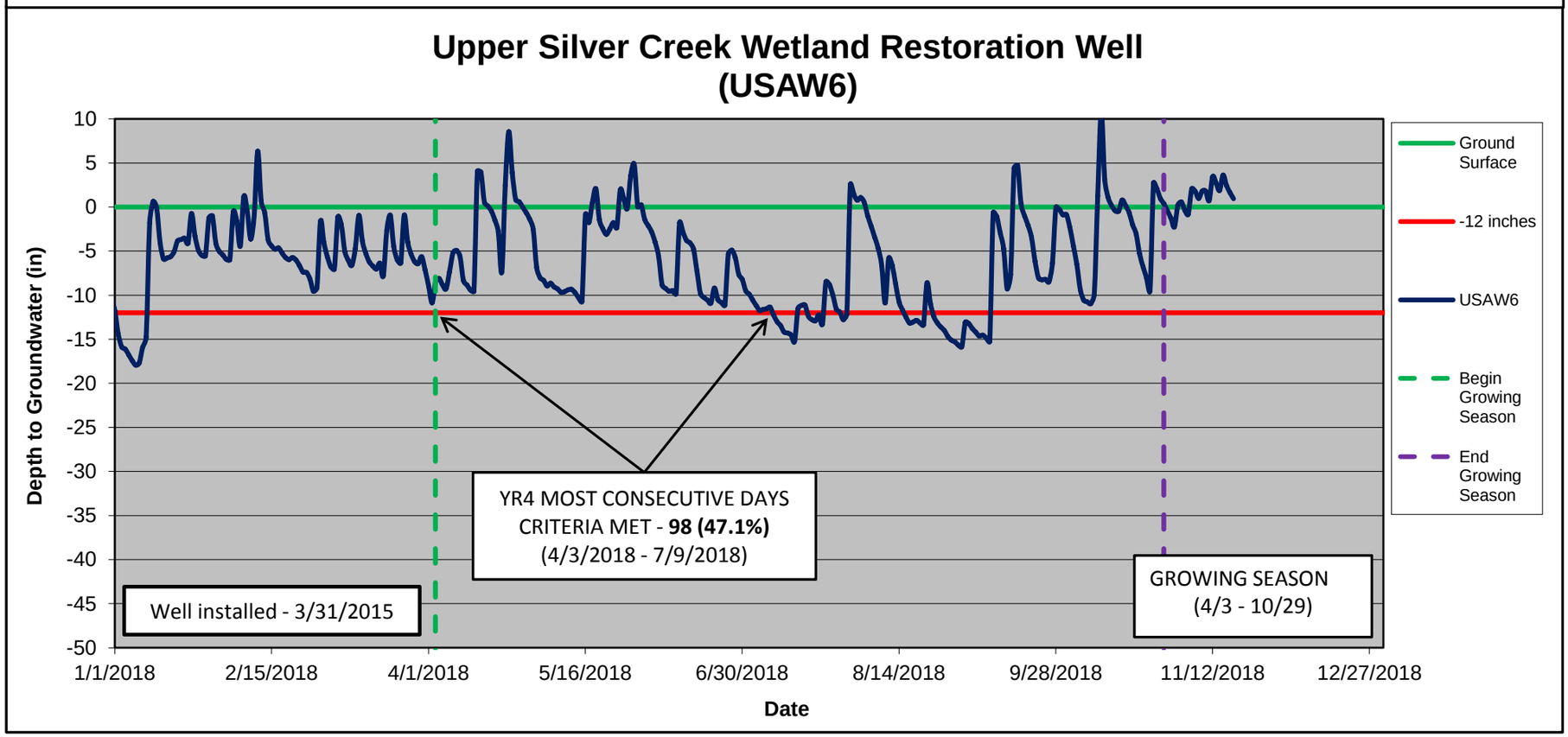


Figure 10. Wetland gauge graphs (continued)

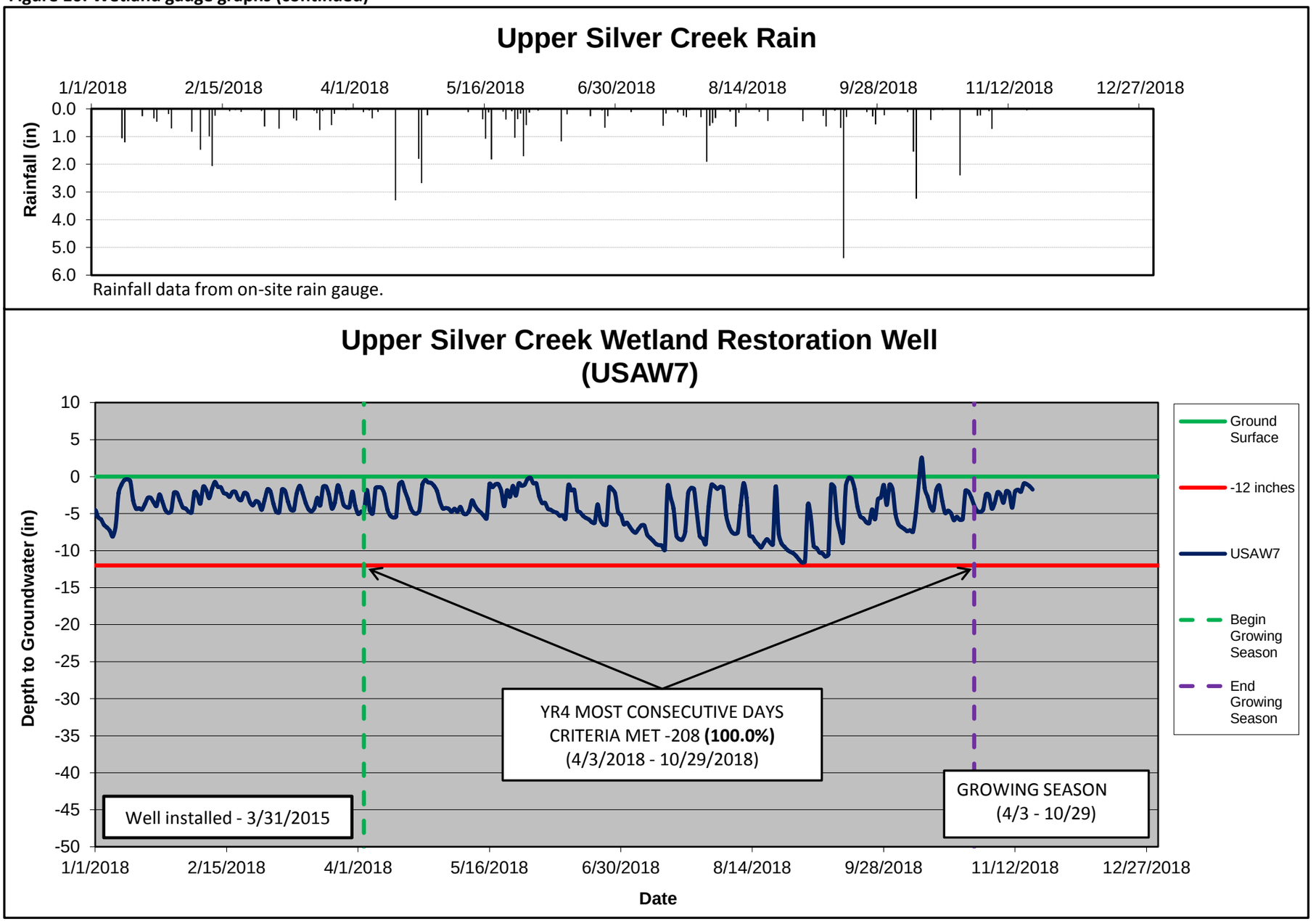


Figure 10. Wetland gauge graphs (continued)

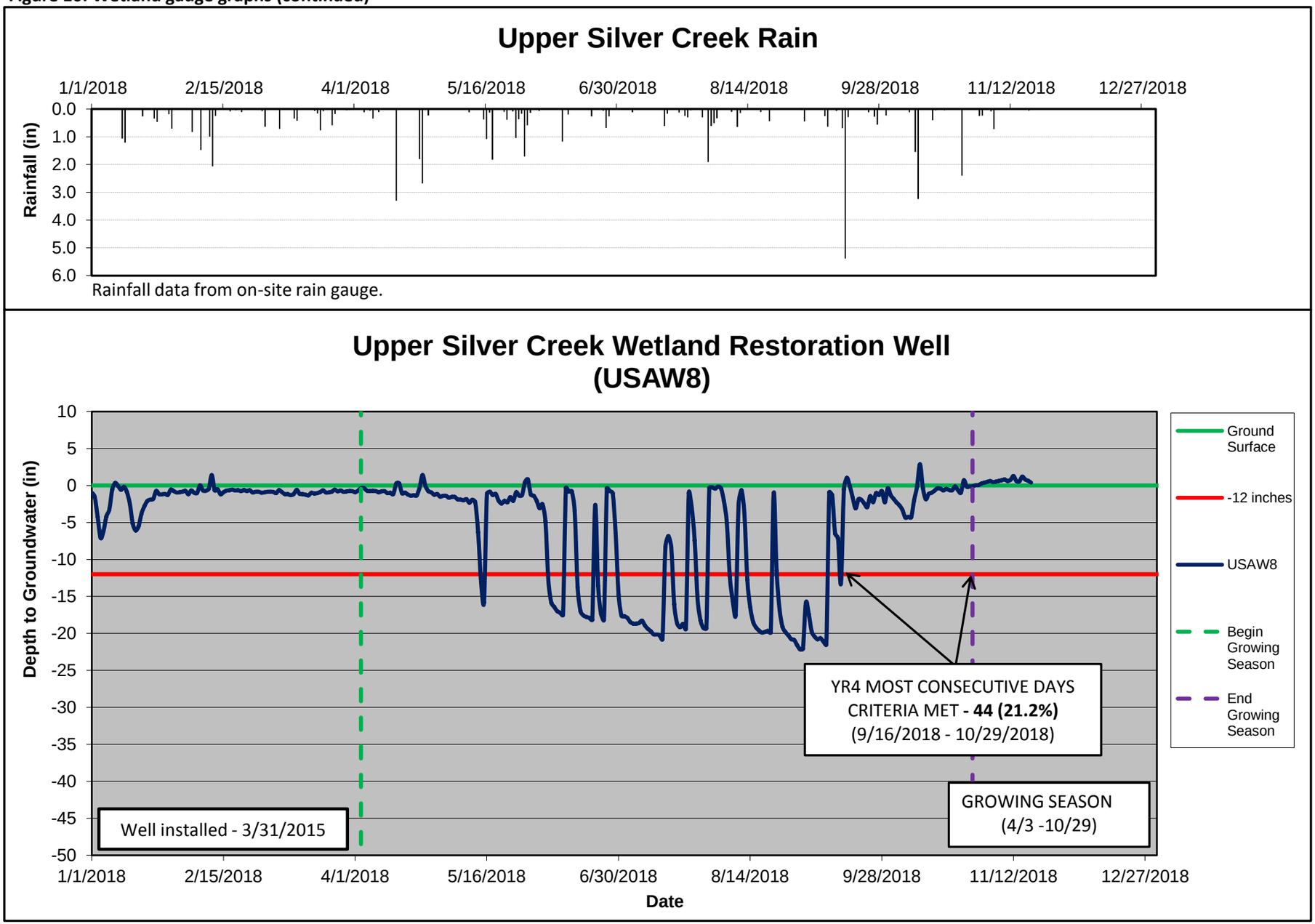


Figure 10. Wetland gauge graphs (continued)

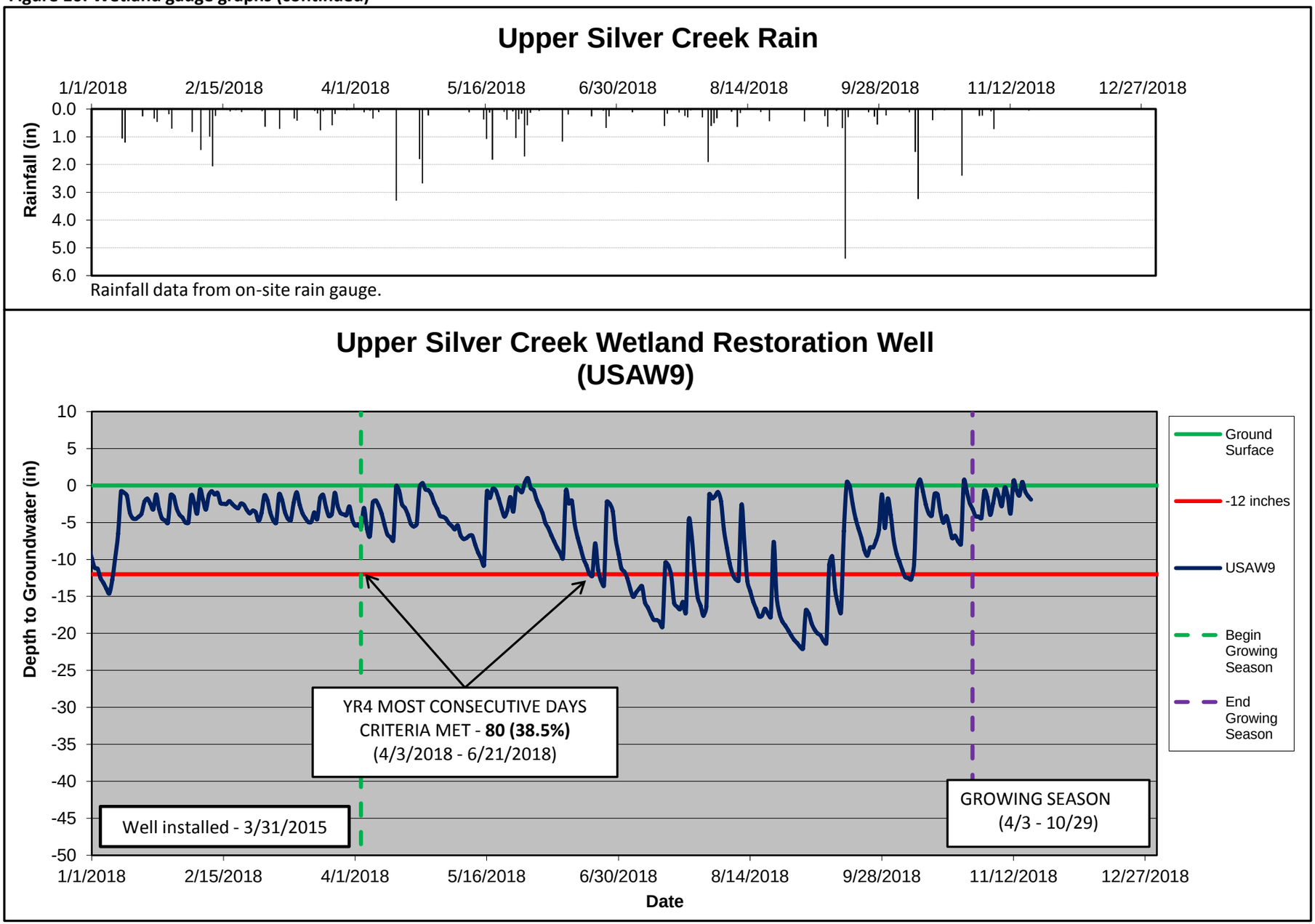


Figure 10. Wetland gauge graphs (continued)

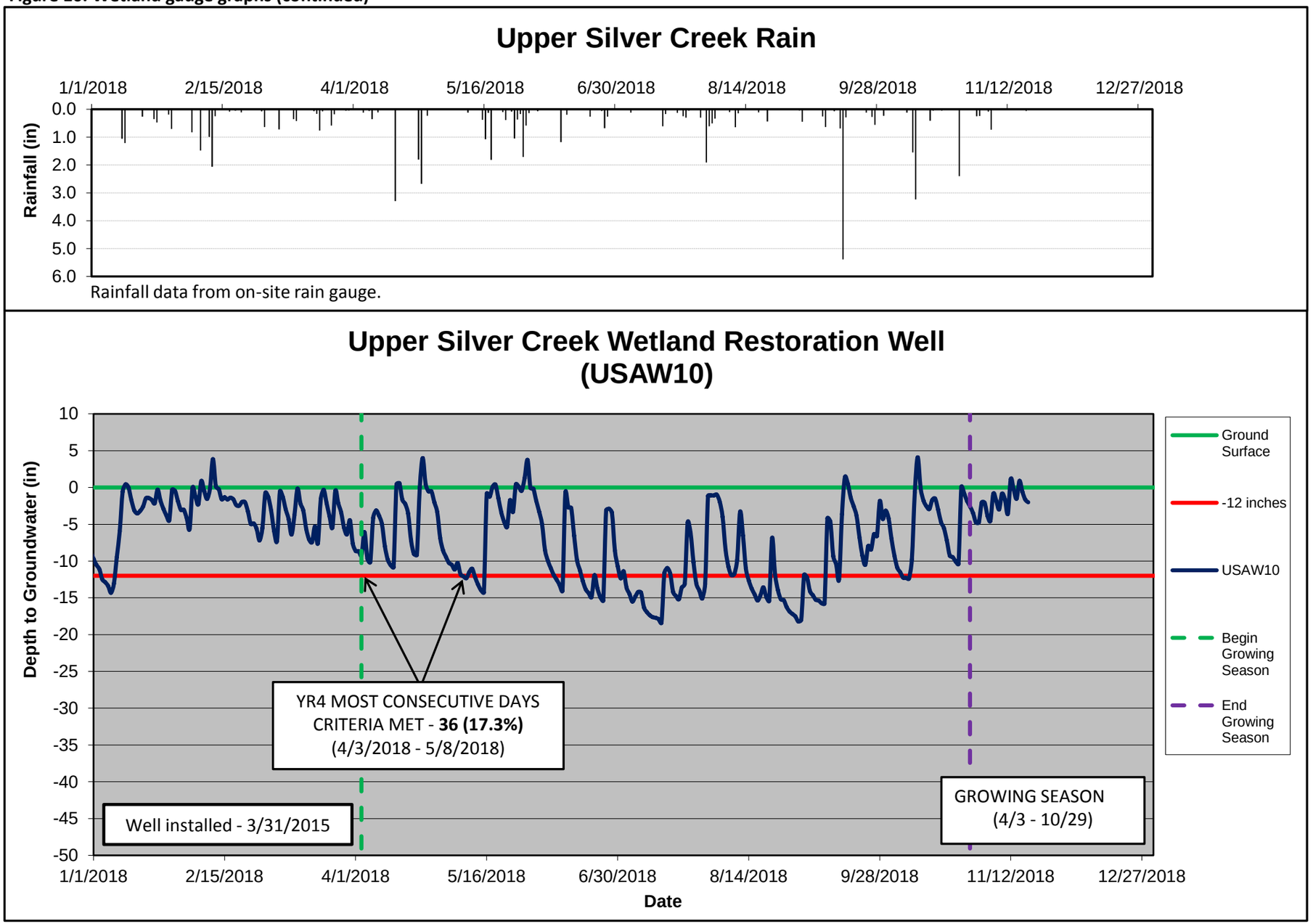


Figure 10. Wetland gauge graphs (continued)

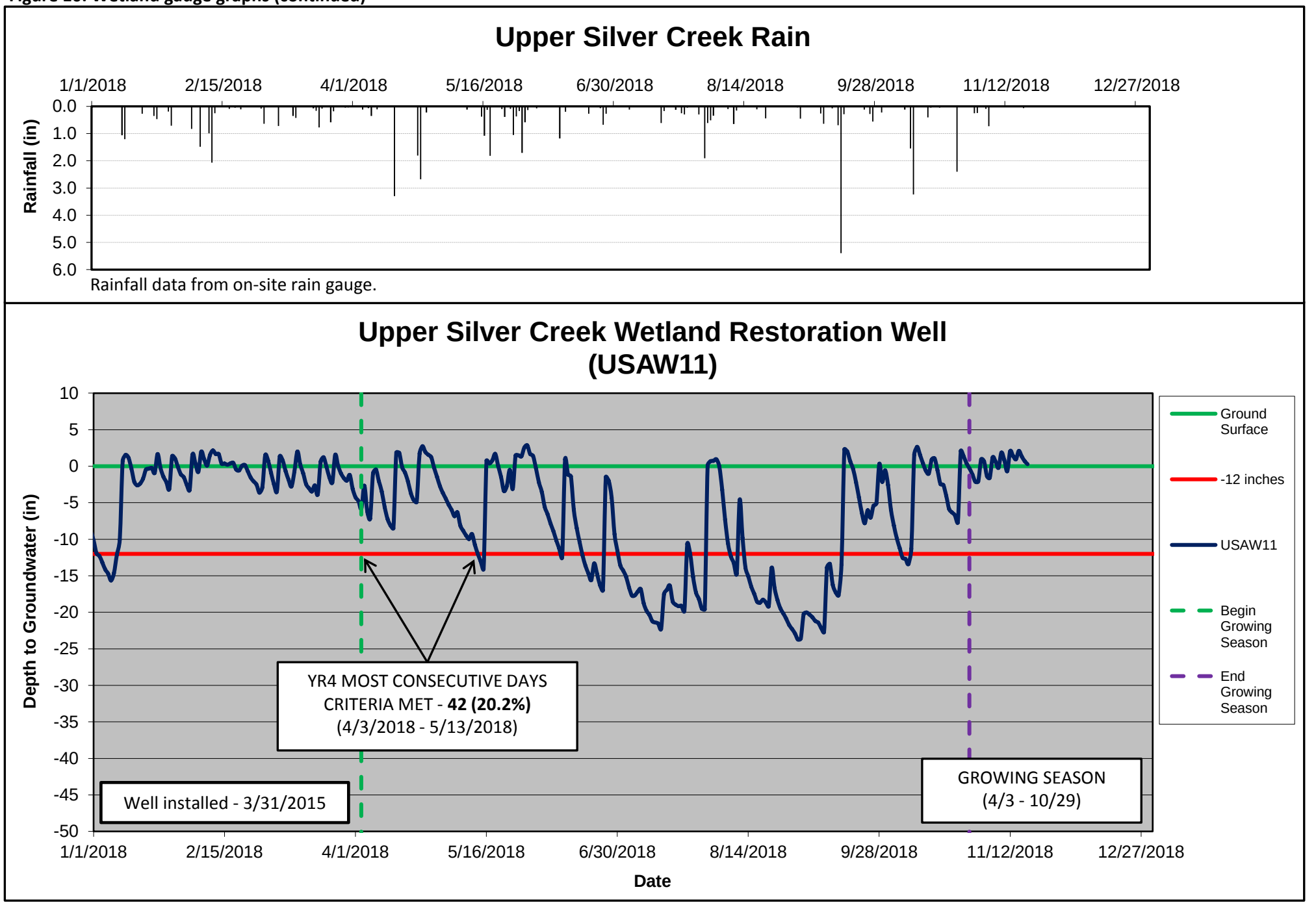


Figure 10. Wetland gauge graphs (continued)

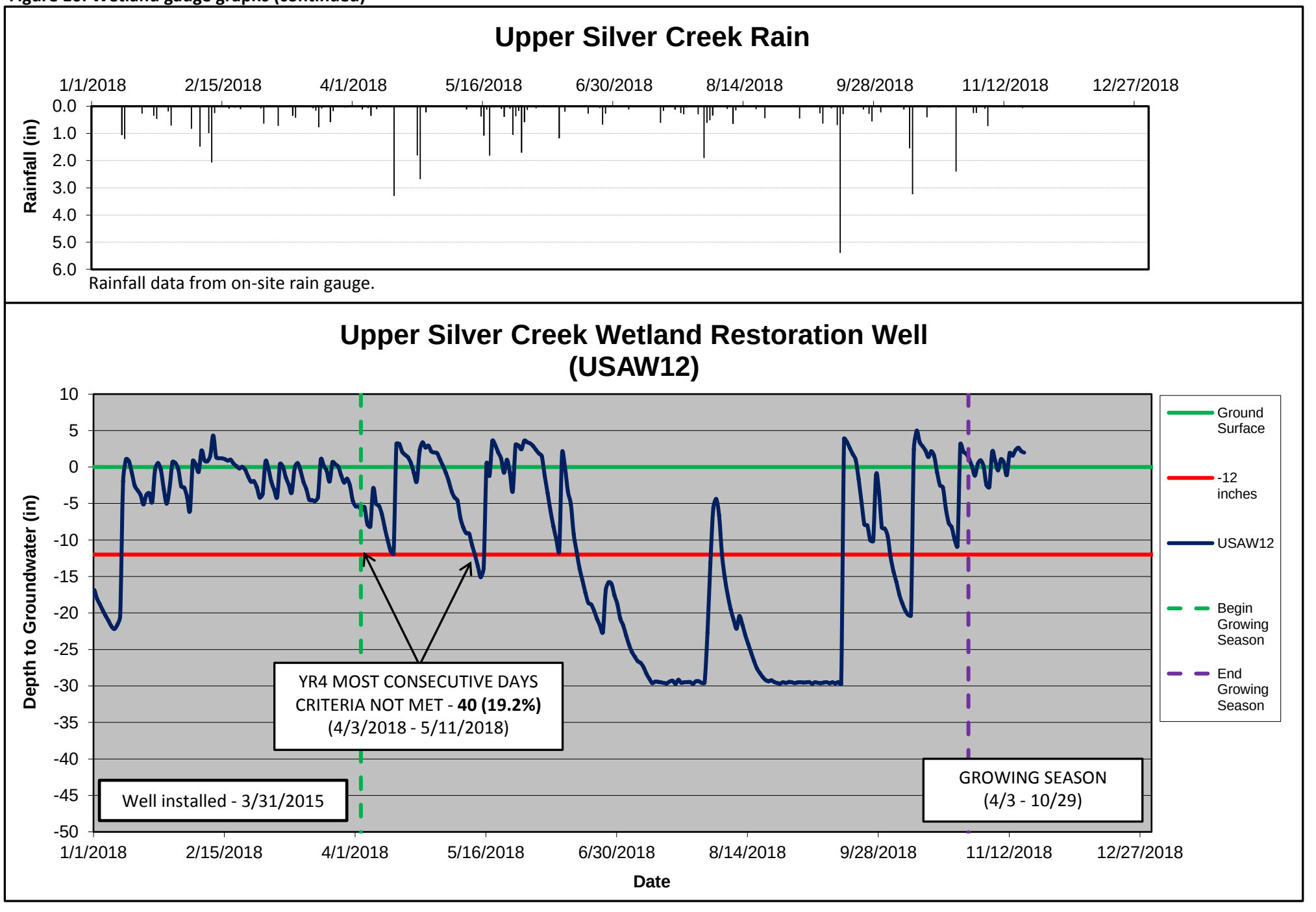


Figure 10. Wetland gauge graphs (continued)

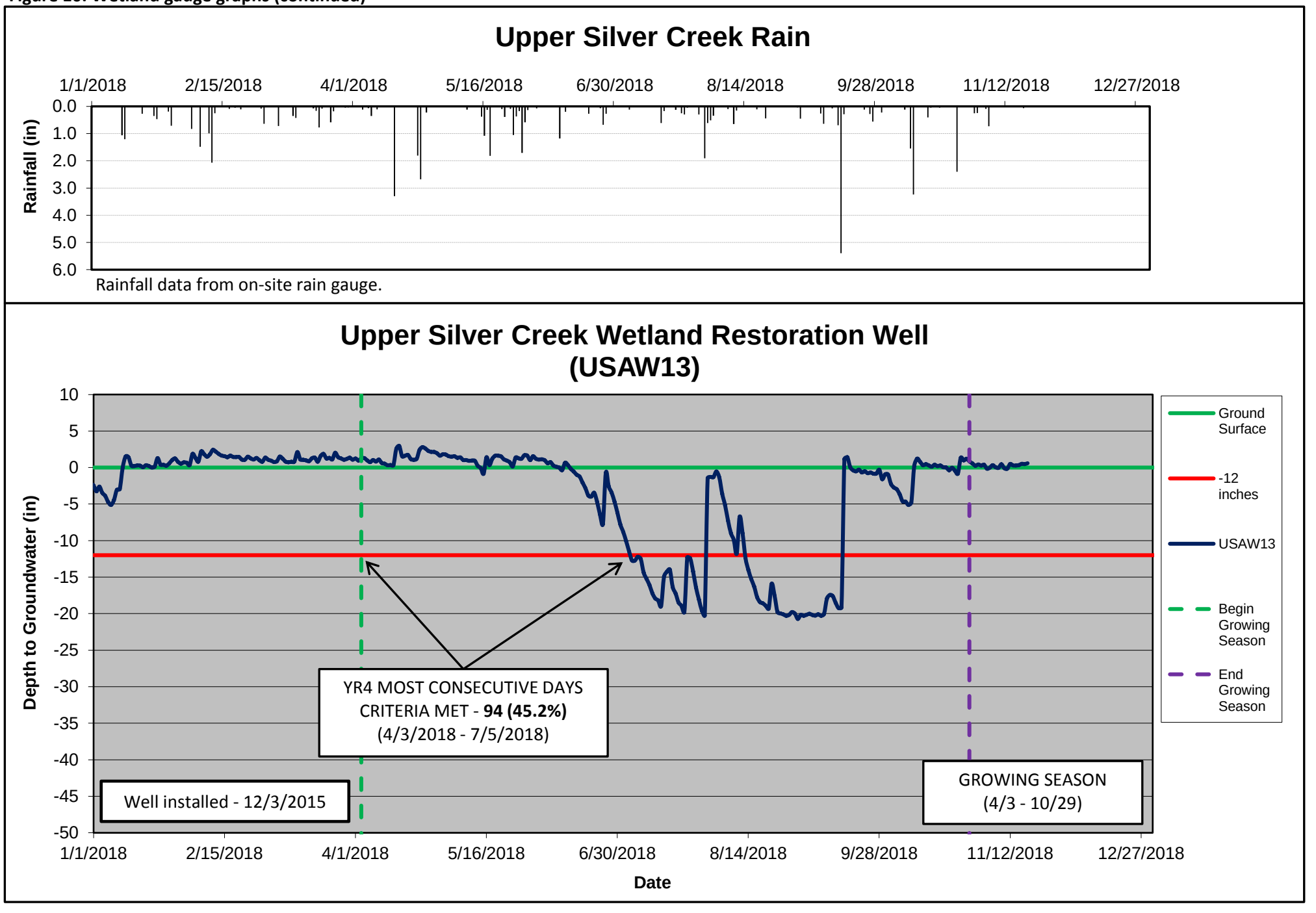


Table 12. Wetland gauge attainment data, summary of groundwater gauge results for MY 1 through 5 at the U. Silver Creek Project Site, DMS Project #94645.

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)				
	Monitoring Year 1 (2015)	Monitoring Year 2 (2016)	Monitoring Year 3 (2017)	Monitoring Year 4 (2018)	Monitoring Year 5 (2019)
USAW1	Yes/36.5 days (17.5 %)	No/9.5 days (4.6%)	Yes/44 days (21.2%)	Yes/42 days (20.2%)	
USAW2	No/21.8 days (10.5 %)	No/12.3 days (5.9%)	Yes/71 days (34.1%)	Yes/38 days (18.3%)	
USAW3	No/20.3 days (9.7 %)	No/7 days (3.4%)	No/21 days (10.1%)	Yes/41 days (19.7%)	
USAW4	No/5.5 days (2.6 %)	No/5 days (2.4%)	No/11 days (5.3%)	Yes/34 days (16.3%)	
USAW5	Yes/80.5 days (38.7 %)	Yes/77.5 days (37.3 %)	Yes/119 days (57.2%)	Yes/208 days (100.0%)	
USAW6	No/19.5 days (9.4 %)	No/7 days (3.4 %)	No/16 days (7.7 %)	Yes/98 days (47.1%)	
USAW7	Yes/74.5 days (35.8 %)	Yes/72.5 days (34.9 %)	Yes/110 days (52.9%)	Yes/208 days (100.0%)	
USAW8	No/2.5 days (1.2 %)	No/5.8 days (2.8 %)	Yes/46 days (22.1%)	Yes/44 days (21.2%)	
USAW9	Yes/35.5 days (17.1 %)	No/13.5 days (6.5 %)	Yes/44 days (21.2%)	Yes/80 days (38.5%)	
USAW10	No/19.8 days (9.5 %)	No/9.8 days (4.7 %)	Yes/44 days (21.2%)	Yes/36 days (17.3%)	
USAW11	No/18.5 days (8.9 %)	No/11.5 days (5.5 %)	Yes/44 days (21.2%)	Yes/42 days (20.2%)	
USAW12	No/17.5 days (8.4 %)	No/7.3 days (3.5 %)	No/20 days (9.6%)	Yes/40 days (19.2%)	
USAW13		Yes/55.5 days (26.7 %)	Yes/87 days (41.8%)	Yes/94 days (45.2%)	

Table 12a. Wetland Restoration Area Well Success

Upper Silver Creek Restoration Project: Project ID No. 94645

Well ID[5]	*Percentage of Consecutive Days <12 inches from Ground Surface[1]	Most Consecutive Days Meeting Criteria[2]	*Percentage of Cumulative Days <12 inches from Ground Surface[1]	Cumulative Days Meeting Criteria[3]	Number of Instances where Water Table is 12 inches from Ground Surface[4]
Cross-sectional Well Arrays					
USAW1	20.2	42.0	62.0	129.0	8
USAW2	18.3	38.0	63.9	133.0	13
USAW3	19.7	41.0	60.1	125.0	10
USAW4	16.3	34.0	56.7	118.0	11
USAW5	100.0	208.0	101.0	210.0	1
USAW6	47.1	98.0	83.2	173.0	6
USAW7	100.0	208.0	101.0	210.0	1
USAW8	21.2	44.0	66.3	138.0	12
USAW9	38.5	80.0	71.2	148.0	11
USAW10	17.3	36.0	68.8	143.0	15
USAW11	20.2	42.0	62.5	130.0	9
USAW12	19.2	40.0	52.9	110.0	5
USAW13	45.2	94.0	72.1	150.0	3

Notes:

[1]Indicates the percentage of most consecutive number of days within the monitored growing season with a water 12 inches or less from the soil surface.

[2]Indicates the most consecutive number of days within the monitored growing season with a water table 12 inches or less from the soil surface.

[3]Indicates the cumulative number of days within the monitored growing season with a water table 12 inches or less from the soil surface.

[4]Indicates the number of instances within the monitored growing season when the water table rose to 12 inches or less from the soil surface.

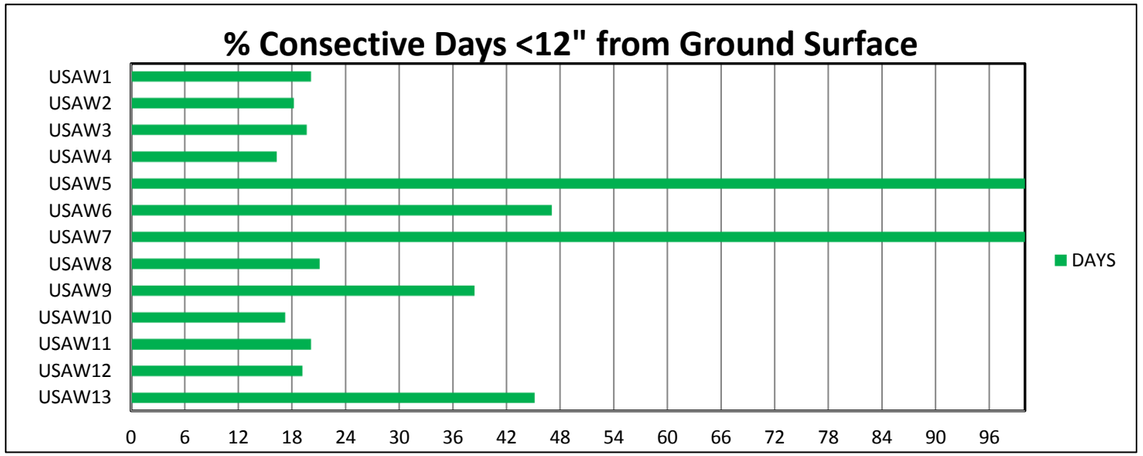
[5]USAW13 was installed in December of 2015.

Growing season for Burke County is from April 3 to October 29 and is 208 days long.

Growing season percentage for success is 12% of 208 days = 25 days; where water table is 12 inches or less from the ground surface

HIGHLIGHTED indicates wells that *did not* meet the success criteria for the most consecutive number of days within the monitored growing season with a water 12 inches or less from the soil surface. Following Year 3 of wetland monitoring, ten of thirteen wells did not exhibit a hyrdroperiod of 12% or greater during the growing season. These wells will be observed closely throughout monitoring Year 3.

12 In-Situ groundwater monitoring dataloggers (1-12) were installed on 3/17/2015. Installation of the dataloggers was completed following construction in spring 2015 when groundwater levels are normally closer to the ground surface. USAW13 was installed in December of 2015



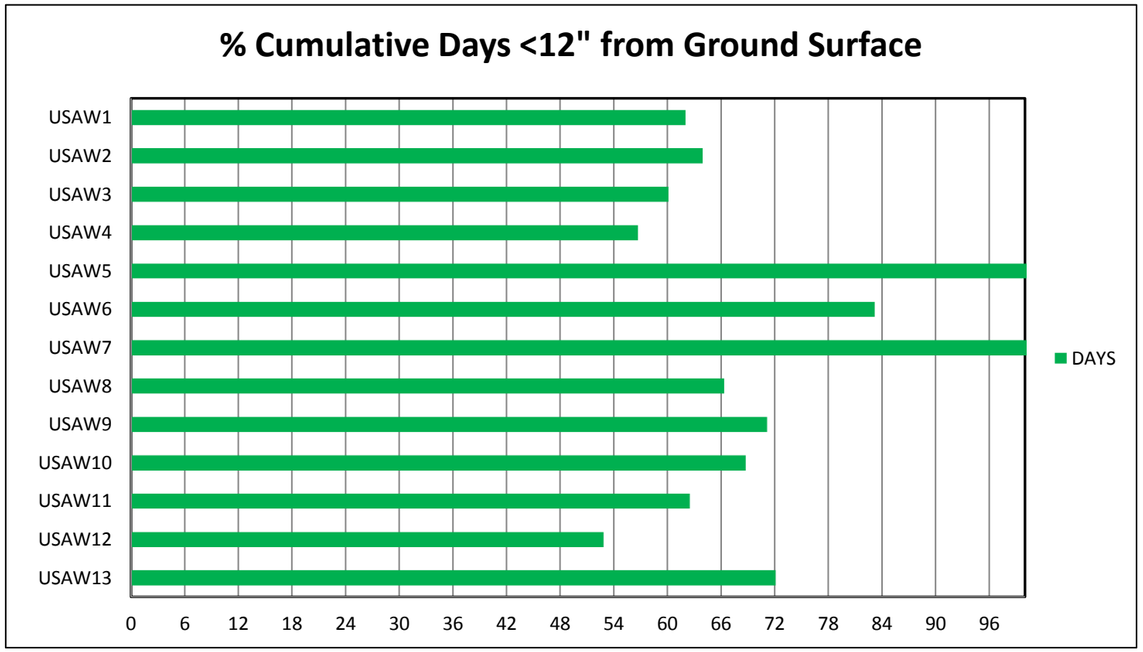


Figure 11. U. Silver Creek Wetland Photo Log, MY4 (2018)

Photo 1. Wetland Photo Point – W1, replicates photo 50 in Baseline Report (November 18, 2018).

Photo 2. Wetland Photo Point – W2, replicates photo 51 in Baseline Report (November 18, 2018).

Photo 3. Wetland Photo Point – W3 replicates photo 52 in Baseline Report (November 18, 2018).

Photo 4. Wetland Photo Point – W4, replicates photo 53 in Baseline Report (November 18, 2018).

Photo 5. Wetland Photo Point – W5, replicates photo 54 in Baseline Report (November 18, 2018).

Photo 6. Wetland Photo Point – W6, replicates photo 55 in Baseline Report (November 18, 2018).

Photo 7. Wetland Photo Point – W7, replicates photo 56 in Baseline Report (November 18, 2018).

Photo 8. Wetland Photo Point – W8, replicates photo 57 in Baseline Report (November 18, 2018).

Photo 9. Wetland Photo Point – W9, replicates photo 58 in Baseline Report (November 18, 2018).

Photo 10. Wetland Photo Point – W10, replicates photo 59 in Baseline Report (November 18, 2018).

Photo 11. Wetland Photo Point – W11, replicates photo 60 in Baseline Report (November 18, 2018).

Photo 12. Wetland Photo Point – W12, replicates photo 61 in Baseline Report (November 18, 2018).

Photo 13. Wetland Photo Point – W13 added between time of baseline and MY1 survey, (November 18, 2018)