



MONITORING YEAR 5 ANNUAL REPORT

Final

LITTLE TROUBLESOME CREEK MITIGATION SITE

Rockingham County, NC
NCDEQ Contract 003267
DMS Project Number 94640

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EXECUTIVE SUMMARY

Wildlands Engineering Inc. (Wildlands) completed a full-delivery project for the North Carolina Division of Mitigation Services (DMS) to restore a total of 4,968 linear feet (LF) of stream and restore, enhance, and create 17.2 acres (ac) of wetlands in Rockingham County, North Carolina. The project streams consist of Little Troublesome Creek, Irvin Creek and one unnamed tributary (UT1) to Little Troublesome Creek. The largest of these streams, Little Troublesome Creek, ultimately drains to the Haw River. At the downstream limits of the project, the drainage area is 3,245 acres (5.1 square miles).

The Little Troublesome Creek Stream Mitigation Site, hereafter referred to as the Stream Site, is located in Rockingham County on the southeastern side of Reidsville along Irvin and Little Troublesome Creeks. The wetland area, hereafter referred to as the Wetland Site, is located approximately four miles southeast of the Stream Site and is also adjacent to Little Troublesome Creek. The Stream Site is located south of Turner Road, east of the intersection of Turner Road and Way Street in the City of Reidsville, North Carolina (Figure 1). The Wetland Site is located approximately 3,000 feet southwest of the intersection of NC Highway 150 and Mizpah Church Road, south of the City of Reidsville (Figure 1). The Stream and Wetland Sites are located in the Inner Piedmont Belt of the Piedmont Physiographic Province (USGS, 1998). The Sites are located within the North Carolina Division of Water Resources (NCDWR) subbasin 03-06-01 of the Cape Fear River Basin, United States Geological Survey (USGS) Hydrologic Unit 03030002010030. Approximately 28% of the land in the project watershed has been developed and approximately 17% of the land surface is impervious. Land uses within the watershed include: forested land (55%), developed (28%), and cultivated land (17%). The Stream Site is a tract owned by Wildlands Little Troublesome Creek Holdings, LLC and the Wetland Site is owned by Jerry Apple.

Prior to construction activities, the most significant watershed stressors identified during the technical assessment were stream bank erosion and instability. Other stressors included declining aquatic habitat, loss of forest, degraded riparian buffers, loss of wetlands, lack of urban stormwater detention, and water quality problems related to increased sediment and nutrient loadings. As a result of the aforementioned stressors, the Stream Site and Wetland Site had poor water quality due to sediment pollution and poor habitat due to lack of riparian and wetland vegetation. In particular, the Stream Site lacked stable streambank vegetation despite being surrounded by mature vegetation. The Stream Site also lacked in-stream bed diversity and exhibited unstable geomorphic conditions. The primary objectives of the project were to stabilize highly eroding stream banks, reconnect streams to their historic floodplain, improve wetland hydrology and function, reduce nutrient levels, sediment input, and water temperature, increase dissolved oxygen concentrations, create appropriate in-stream and terrestrial habitat, and decrease channel velocities. These objectives were achieved by restoring 4,968 LF of perennial stream channel, and restoring, enhancing, and creating 17.2 acres of riparian wetland. The Stream Site and Wetland Site riparian areas were also planted to stabilize streambanks, improve habitat, and protect water quality. Figure 2 and Table 1 in Appendix 1 present design applications for the Sites.

The following project goals were established to address the effects listed above from watershed and project site stressors:

- Stabilize stream dimensions;
- Stabilize stream pattern and profile;
- Establish proper substrate distribution throughout the streams;
- Establish wetland hydrology for restored wetlands; and
- Restore native vegetation throughout wetlands and buffer zones.



The following secondary project goals (unmeasured) were established in the project Mitigation Plan (Wildlands, 2011) to address the effects from watershed and project site stressors:

- Decrease nutrient and urban runoff pollutant levels;
- Decrease sediment input;
- Decrease water temperature and increase dissolved oxygen levels;
- Create appropriate in-stream habitat;
- Create appropriate terrestrial habitat; and
- Decrease channel velocities.

Stream and wetland restoration, enhancement, and creation construction efforts were completed in May 2012. A conservation easement is in place on 33.0 ac (acres) of the Stream Site and 19.0 ac of the Wetland Site to protect them in perpetuity.

Monitoring Year 5 (MY-5) monitoring and site visits were completed during April-November, 2016 to assess the conditions of the Sites. Overall, the Sites have met the required hydrologic, vegetation, and stream success criteria for MY-5. The Sites overall average stem density of 571 stems/ acre is greater than the 260 stem/ acre density required at MY-5. Except for a few isolated bank erosion areas, the restored and enhanced streams are stable and functioning as designed and the Stream Site has met the Monitoring Year 5 (MY-5) hydrology success criteria. All groundwater gages met the MY-5 success criteria on the Wetland Site.



LITTLE TROUBLESOME CREEK MITIGATION SITE
Monitoring Year 5 Annual Report

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Section 1: PROJECT OVERVIEW

The Little Troublesome Creek Mitigation Site, hereafter referred to as the Sites, is located in Rockingham County within the Cape Fear River Basin (USGS Hydrologic Unit 03030002) near the town of Reidsville, North Carolina. The Little Troublesome Creek Stream Mitigation Site, hereafter referred to as the Stream Site, is located in Rockingham County on the southeastern side of Reidsville along Irvin and Little Troublesome Creeks. The wetland area, hereafter referred to as the Wetland Site, is located approximately four miles southeast of the Stream Site and is also adjacent to Little Troublesome Creek. The Stream Site is located south of Turner Road, east of the intersection of Turner Road and Way Street in the City of Reidsville, North Carolina (Figure 1). The Wetland Site is located approximately 3,000 feet southwest of the intersection of NC Highway 150 and Mizpah Church Road, south of the City of Reidsville (Figure 1). The Sites are located in the Inner Piedmont Belt of the Piedmont Physiographic Province (USGS, 1998). The project watersheds consists of forested, developed, and cultivated lands. The drainage area for the Stream Site is 3,245 acres at the lower end of Little Troublesome Creek.

The project stream reaches consist of Little Troublesome Creek, Irvin Creek, and one unnamed tributary (UT1) to Little Troublesome Creek (stream restoration approach). Mitigation work within the Sites included restoring 4,968 linear feet (LF) of perennial and intermittent stream channel and restoring, enhancing, and creating 17.2 acres (ac) of riparian wetland. The Stream and Wetland Sites were also planted with native vegetation to improve habitat and protect water quality. Conservation easements have been recorded on the Sites and are in place along the stream and wetland riparian corridors to protect them in perpetuity; 33.0 ac (Deed Book 1411, Page Number 2458) owned by Wildlands Little Troublesome Creek Holdings, LLC and 19.0 ac (Deed Book 1412, Page Number 1685) owned by Jerry Apple. Directions and maps of the Sites are provided in Figure 1 and project components are illustrated for the Sites in Figures 2a and 2b.

The final Mitigation Plan was submitted and accepted by the North Carolina Division on Mitigation Services (DMS) in June of 2011. Construction activities were completed by Fluvial Solutions in May of 2012. Planting and seeding activities were completed by Bruton Natural Systems, Inc. in May 2012. Baseline monitoring (MY-0) was conducted between April and May 2012. MY-5 monitoring and site visits were completed during April-November, 2016 to assess the condition of the Sites. Close-out of the Stream and Wetland Sites are proposed for 2017. Appendix 1 provides more detailed project activity, history, contact information, and watershed/site background information for this project.

1.1 Project Goals and Objectives

Prior to construction activities, the most significant watershed stressors identified during the technical assessment were stream bank erosion and instability. Other stressors included declining aquatic habitat, loss of forest, degraded riparian buffers, loss of wetlands, lack of urban stormwater detention, and water quality problems related to increased sediment and nutrient loadings. As a result of the aforementioned stressors, the Stream Site and Wetland Site had poor water quality due to sediment pollution and poor habitat due to lack of riparian and wetland vegetation. In particular, the Stream Site lacked stable streambank vegetation despite being surrounded by mature vegetation. The Stream Site also lacked in-stream bed diversity and exhibited unstable geomorphic conditions. Table 4 in Appendix 1 and Tables 10a, and 10b in Appendix 4 present the pre-restoration conditions in detail.

The Sites were designed to meet the over-arching goals as described in the Mitigation Plan (Wildlands, 2011) to address the effects from watershed and project site stressors. The project is intended to provide

numerous ecological benefits within the Cape Fear River Basin. While many of these benefits are limited to the Sites project area, others, such as pollutant removal and improved aquatic and terrestrial habitat, have more far-reaching effects. The following project specific primary goals established in the Mitigation Plan include:

- Stabilize stream dimensions;
- Stabilize stream pattern and profile;
- Establish proper substrate distribution throughout the streams;
- Establish wetland hydrology for restored wetlands; and
- Restore native vegetation throughout wetlands and buffer zones.

Secondary project goals (unmeasured) established in the Mitigation Plan were to address the effects from watershed and project site stressors include:

- Decrease nutrient and urban runoff pollutant levels;
- Decrease sediment input;
- Decrease water temperature and increase dissolved oxygen levels;
- Create appropriate in-stream habitat;
- Create appropriate terrestrial habitat; and
- Decrease channel velocities.

The primary and secondary project goals were addressed through the following project objectives:

- Riffle cross sections of the restoration and enhancement reaches were constructed to remain stable and will show little change in bankfull area, maximum depth ratio, and width-to-depth ratio over time.
- The project was constructed so that the bedform features of the restoration reaches will remain stable overtime. This includes riffles that will remain steeper and shallower than the pools, and pools that are deep with flat water surface slopes. The relative percentage of riffles and pools will not change significantly over time. Banks were constructed so that bank height ratios will remain very near to 1.0 for nearly all of the restoration reaches.
- Stream substrate will remain coarse in the riffles and finer in the pools.
- A free groundwater surface will be present within 12 inches of the ground surface in the restored wetland areas for 7 percent of the growing season measured on consecutive days under typical precipitation conditions.
- Native vegetation appropriate for the wetland and riparian buffer zones were planted throughout both the Wetland and Stream Sites. The planted trees will become well established and survival success criteria will be met.
- Off-site nutrient input will be absorbed on-site by filtering flood flows through restored floodplain areas and wetlands, where flood flows can disperse through native vegetation and be captured in vernal pools. Increased surface water residency time will provide contact treatment time and groundwater recharge potential.
- Sediment input from eroding stream banks was reduced by installing bioengineering and in-stream structures while creating a stable channel form using geomorphic design principles. Sediment from off-site sources will be captured by deposition on restored floodplain areas where native vegetation will slow overland flow velocities.
- Restored riffle/pool sequences where distinct points of re-aeration can occur will allow for oxygen levels to be maintained in the perennial reaches. Creation of deep pool zones will lower water temperature, helping to maintain dissolved oxygen concentrations.



Establishment and maintenance of riparian buffers will create long-term shading of the channel flow to minimize thermal heating.

- A channel form that includes riffle/pool sequences and gravel and cobble zones creating habitat for macroinvertebrates and fish. Large woody debris, rock structures, root wads, and native stream bank vegetation were introduced to substantially increase habitat value.
- Adjacent buffer areas were restored by removing invasive vegetation and planting native vegetation. These areas will be allowed to receive more regular and inundating flows. Riparian wetland areas were restored and enhanced to provide wetland habitat.
- By allowing for more overbank flooding and by increasing channel roughness, local channel velocities can be reduced. This will allow for less bank shear stress, formation of refuge zones during large storm events and zonal sorting of depositional material.

The design streams and wetlands were restored to the appropriate type based on the surrounding landscape, climate, and natural vegetation communities but also with strong consideration to existing watershed conditions and trajectory. The mitigation project was developed to restore a high quality of riparian function to the streams, wetlands, and riparian corridors.

1.2 Monitoring Year 5 Data Assessment

Annual monitoring and quarterly site visits were conducted during Monitoring Year 5 (MY-5) to assess the condition of the project. The stream and wetland mitigation success criteria for the Sites follow the approved success criteria presented in the Mitigation Plan (Wildlands, 2011).

1.2.1 Vegetative Assessment

A total of 35 (13 at the Stream Site; 22 at the Wetland Site) vegetation plots were established within the project easement areas using standard 10 meter by 10 meter vegetation monitoring plots. UT1 was constructed within a narrow cleared corridor to minimize disturbance to the surrounding mature vegetation. Due to the narrow planted corridor along UT1, vegetation plots were not established. Instead, a visual assessment of the planted corridor is used to evaluate vegetation growth success. The final vegetative success criteria is the survival of 260 planted stems per acre in the riparian corridor at the end of MY-5. The MY-5 vegetative survey was completed in June 2016.

The 2016 annual vegetation monitoring resulted in an average stem density of 635 stems per acre for the Stream Site, which is greater than the final requirement of 260 stems/acre and approximately 33% less than the baseline (MY-0) density recorded (953 stems/acre). There was an average of 16 stems per plot in MY-5 compared to 24 stems per plot in MY-0 for the Stream Site. All 13 plots at the Stream Site meet the MY-5 success criteria of 260 planted stems per acre.

At the Wetland Site, three of the plots did not meet the final success criteria and averaged 189 stems per acre; however with the inclusion of volunteer species the three plots average 499 stems per acre which is well above the final requirement of 260 stems/acre. These three plots are located on one of the wettest parts of the Wetland Site. In the past, Wildlands has observed higher planted tree mortality in areas with frequently standing water, compared to the drier parts of projects. There was an average of 12 stems per plot in MY-5 as compared to 17 stems per plot during MY-0 for the Wetland Site. Although three wetland vegetation plots are not meeting for planted stems, the volunteer stems consist of desirable hardwood species from the planting plan. With the inclusion of volunteer species, all 22 plots at the Wetland Site meet the MY-5 success criteria.

Refer to Appendix 2 for vegetation plot photographs, the vegetation condition assessment table, and the Current Condition Plan View Map, and Appendix 3 for vegetation data tables.



1.2.2 Vegetation Areas of Concern

Vegetative areas of concern noted during the annual visual assessments included isolated areas of non-native invasive species at the Stream Site. An invasive species management and control plan was initially initiated in MY3 and has continued annually during the monitoring period. Invasive species management has included foliar herbicidal applications.

Maintenance Plan

Visual assessments will be performed in 2017 prior to project close-out to determine if any additional maintenance is necessary to control invasive species within the Site.

1.2.3 Stream Assessment

Morphological surveys for the MY-5 were conducted in April 2016. With the exception of a few isolated areas of bank scour, all streams within the Stream Site are stable with little to no erosion and have met the success criteria for MY-5. Refer to Appendix 2 for the visual assessment table, the Integrated Current Condition Plan View Map, and reference photographs. Refer to Appendix 4 for the morphological data and plots.

In general, cross sections show little to no change in the bankfull area, maximum depth ratio, or width-to-depth ratio. Cross Sections on UT1 show a decrease in cross-sectional area and bankfull width. This is due to sediment deposition from Little Troublesome Creek during bankfull events. This is normal and is not a sign of instability. Surveyed riffle cross sections fell within the parameters defined for channels of the appropriate Rosgen stream type. Several pool cross sections on the Stream Site have shown an accumulation of sediment on the point bars resulting in a slight narrowing of the pool cross sections. Since point bars are depositional features, this is fully expected. As discussed in the Mitigation Plan, narrowing of the channel over time is expected for restored alluvial streams and is an indication of stability. The surveyed longitudinal profile data for the stream restoration reaches illustrates that the bedform features are maintaining lateral and vertical stability. The riffles are remaining steeper and shallower than the pools, while the pools are remaining deeper than riffles and maintaining flat water surface slopes. The longitudinal profiles show that the bank height ratios remain near 1.0 for all of the restoration reaches. UT1 longitudinal profile data is showing deposition throughout the stream. This sediment deposition appears to be from bankfull events on Little Troublesome Creek. This is normal and expected on small streams that flow into large channels and is not affecting channel stability.

In-stream structures such as root wads, used to enhance channel habitat and stability on the outside bank of meander bends are providing stability and habitat as designed. During MY-5 a few isolated areas of bank scour were documented on Little Troublesome Creek and Irvin Creek. These areas will be repaired during the winter of 2016/ 2017 as described below in section 1.2.4.

During MY-4 bank scour was documented in part of the meander bend at STA 207+50-208+80 on Little Troublesome Creek. Undercutting of the rootwads resulted in an area of bank scour within this meander bend. This was repaired at the beginning of MY-5 by lowering the rootwads and adding brush toe to fill in any voids. Geolifts were installed with brush whips and live stakes to stabilize the stream bank. Since the repair work, this section of Little Troublesome Creek appears stable and will continue to be monitored for any signs of instability.

No changes were observed that indicated a change in the radius of curvature or channel belt width; therefore, pattern data is not included in the MY-5 report.

1.2.4 Stream Areas of Concern

The Stream Site had a significant flow event during Hurricane Mathew, resulting in a few isolated areas of bank scour on Little Troublesome Creek and Irvin Creek. Wildlands is currently working with a contractor to repair these areas prior to project close-out. This repair will include installing brush toe and soil lifts with live willow whips. Most of the repair work will be done by hand and will include planting live stakes on the stream banks. Heavy equipment will only be used when necessary to avoid causing any damage to the Site. The only area that will require heavy equipment is one bend on Little Troublesome Creek. Refer to Appendix 2, Current Condition Plan View Maps for the location of bank scour on these streams.

1.2.5 Hydrology Assessment

At the end of the five year monitoring period, two or more bankfull events must have occurred in separate years within the restoration reaches. Bankfull events were recorded on Irvin Creek, Little Troublesome Creek, and UT1 by crest gage or onsite observations (wrack lines) during all five monitoring years, with multiple events occurring during some of these years. The Stream Site has therefor met the hydrologic success criteria. Please refer to Appendix 5 for hydrologic data. Trail cameras were established on Little Troublesome and Irvin Creeks to capture hourly pictures during MY-5. Appendix 5 shows a few of the pictures collected with the trail camera during bankfull events.

1.2.6 Wetland Assessment

Eight groundwater monitoring gages are established in the wetland restoration, enhancement, and creation zones. The gages were installed at appropriate locations so that the data collected will provide an indication of groundwater levels throughout the Wetland Site. A barotroll logger and a rain gage were also installed onsite. To provide data for the determination of the growing season for the wetland areas, two soil temperature probes were installed to collect growing season data. These probes are used to better define the beginning of the growing season using the threshold soil temperature of 41 degrees or higher measured at a depth of 12 inches (USACE, 2010). During MY-1, MY-2, and MY-3 NRCS WETS Data was used to determine the growing season for the Wetland Site. After discussions with the United States Army Corps of Engineers (USACE), it was agreed to use on-site soil temperature data to determine the beginning of the growing season and use NRCS WETS data to determine the end of the growing season. During MY-5, the beginning of the growing season was extended by 15 days based on data from the soil temperature probes. All monitoring gages were downloaded on a quarterly basis and maintained on an as needed basis. The success criteria for wetland hydrology is to have a free groundwater surface within 12 inches of the ground surface for 7 percent of the growing season, which is measured on consecutive days under typical precipitation conditions. All groundwater gages met the annual wetland hydrology success criteria for MY-5. Refer to Appendix 2 for the groundwater gage locations and Appendix 5 for groundwater hydrology data and plots.

1.2.7 Maintenance Plan

Wildlands is currently working with a contractor to repair the isolated area of bank erosion as described in section 1.2.4 above.

1.3 Monitoring Year 5 Summary

With the exception of pool deposition on UT1 and a few isolated areas of bank scour, all streams within the Stream Site are stable and functioning as designed. Repair work is being coordinated on Little Troublesome Creek and will be implemented this winter. The overall, average stem density for the Sites

meets the MY-5 success criteria; however, three individual vegetation plots did not meet the MY-5 success criteria as noted in the Integrated Current Condition Plan View Map. These three vegetation plots do meet the MY-5 success criteria when volunteer trees were included in the totals. While the stream hydrology success criteria was met during the initial two years of monitoring, additional bankfull events were documented in MY-5. All groundwater gages met the MY-5 success criteria. Summary information and data related to the performance of various project and monitoring elements can be found in the tables and figures in the report appendices.



Section 2: METHODOLOGY

Geomorphic data was collected following the standards outlined in *The Stream Channel Reference Site: An Illustrated Guide to Field Techniques* (Harrelson et al., 1994) and in the *Stream Restoration: A Natural Channel Design Handbook* (Doll et al., 2003). Cross section data was collected using a total station and was georeferenced. All data collected for the Integrated Current Condition Mapping was recorded using a Trimble handheld GPS with sub-meter accuracy and processed using Pathfinder and ArcView. Crest gages were installed in surveyed riffle cross sections and monitored quarterly. Hydrology attainment installation and monitoring methods are in accordance with the USACE (USACE, 2003) standards. Vegetation monitoring protocols followed the Carolina Vegetation Survey-NCDMS Level 2 Protocol (Lee et al., 2008). Reporting follows the NCDMS Monitoring Report Template and Guidance Version 1.2.1 (NCDMS, 2009). Narrative background and supporting information formerly found in these reports can be found in the Mitigation Plan documents available on DMS's website. All raw data supporting the tables and figures in the appendices are available from DMS upon request.

Section 3: REFERENCES

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APPENDIX 1. General Tables and Figures

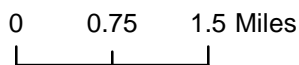
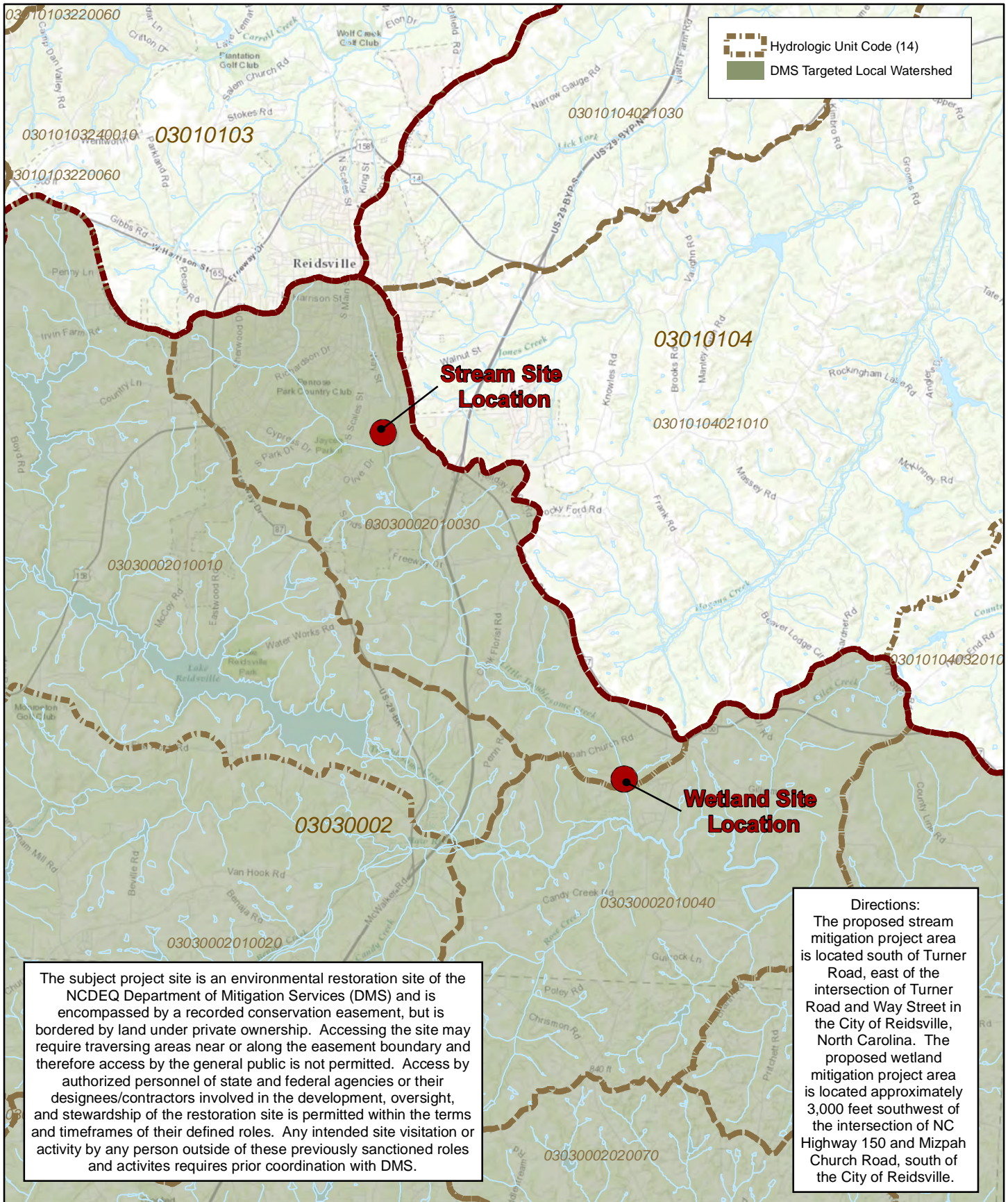
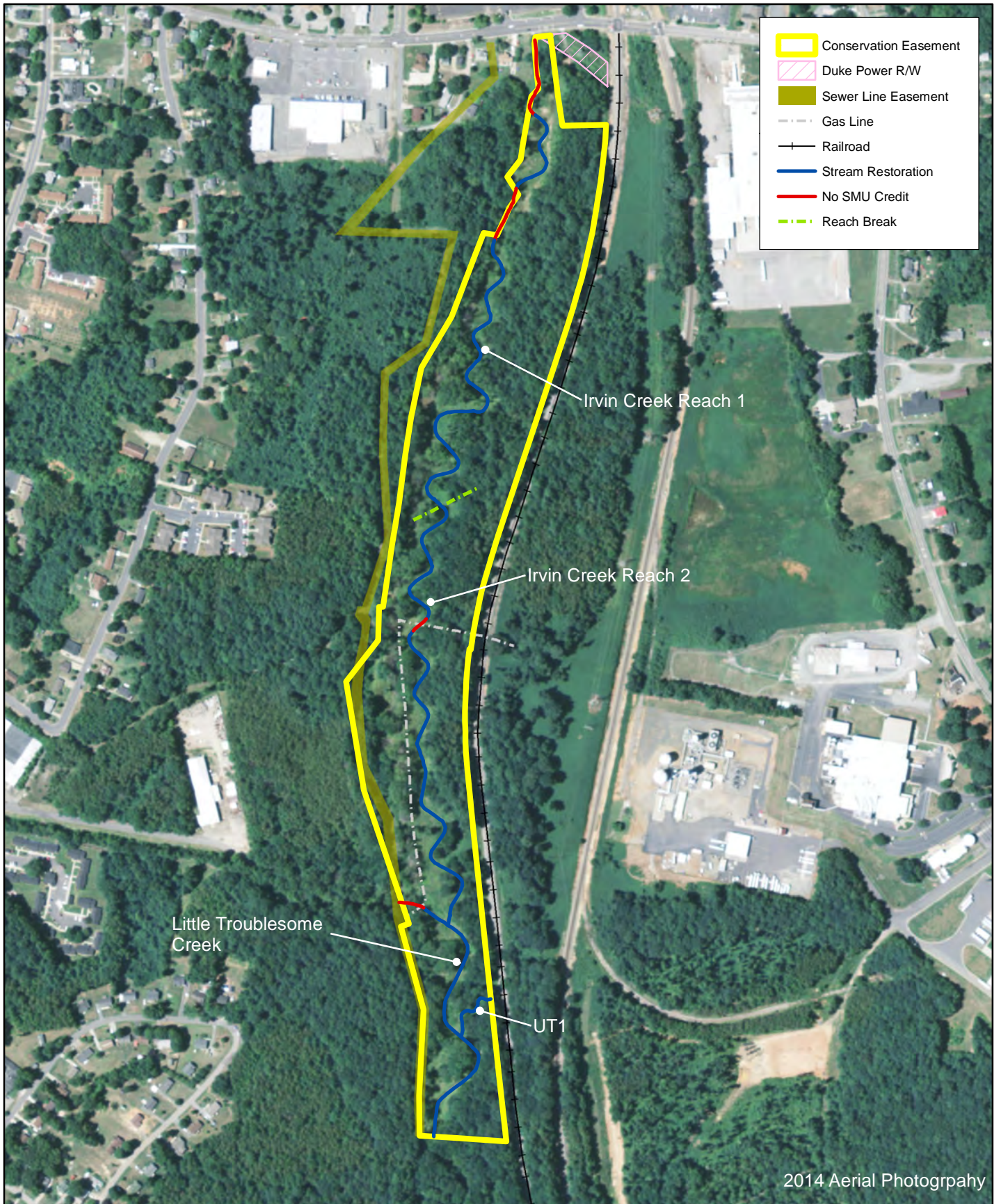


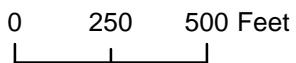
Figure 1 Project Vicinity Map
 Little Troublesome Creek Mitigation Site
 DMS Project Number 94640
 Monitoring Year 5 -2016
 Rockingham County, NC

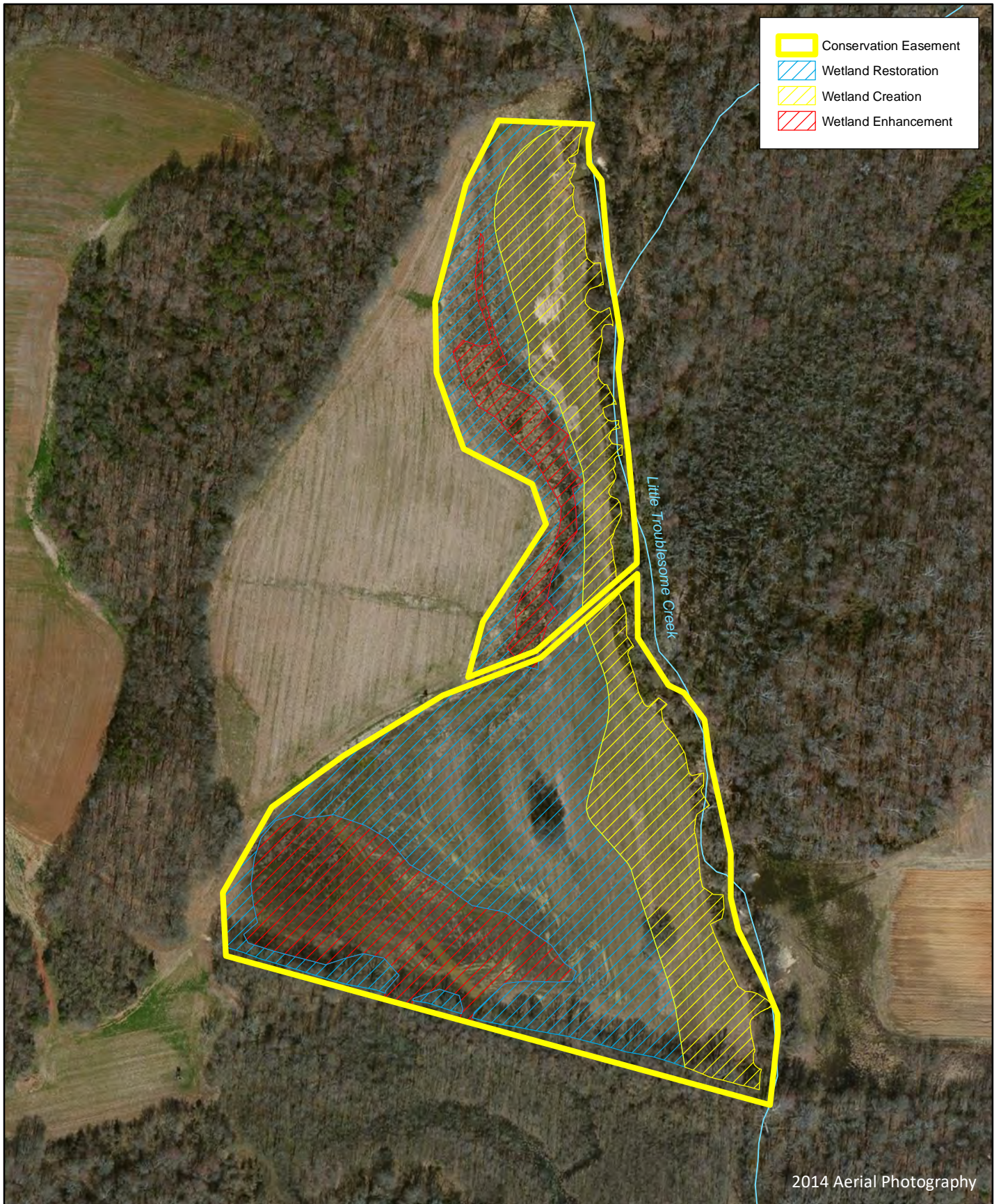


- Conservation Easement
- Duke Power R/W
- Sewer Line Easement
- Gas Line
- Railroad
- Stream Restoration
- No SMU Credit
- Reach Break

2014 Aerial Photography

Figure 2a Project Component/Asset Map
 Little Troublesome Creek Mitigation Site
 Stream Site
 DMS Project Number 94640
 Monitoring Year 5 - 2016
 Rockingham County, NC





	Conservation Easement
	Wetland Restoration
	Wetland Creation
	Wetland Enhancement

Figure 2b Project Component/Asset Map
 Little Troublesome Creek Mitigation Site
 Wetland Site
 DMS Project Number 94640
 Monitoring Year 5 - 2016
 Rockingham County, NC



0 125 250 Feet



Table 1. Project Components and Mitigation Credits
 Little Troublesome Creek Mitigation Site (DMS Project No. 94640)
 Monitoring Year 5 - 2016

Mitigation Credits									
	Stream [^]		Riparian Wetland		Non-Riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	4,968	N/A	10.2	2.8	N/A	N/A	N/A	N/A	N/A
Project Components									
Reach ID	As-Built Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration or Restoration Equivalent	Restoration Footage/ Acreage	Mitigation Ratio	Credits [^] (SMU/ WMU)		
Irvin Creek - Reach 1	103+00 to 106+69 108+80 to 123+05	1,640	Priority 1	Restoration	1,793	1:1	1,793		
Irvin Creek - Reach 2	123+05 to 128+52 129+19 to 142+38	1,505	Priority 1	Restoration	1,866	1:1	1,866		
Little Troublesome Creek	200+97 to 211+73	1,080	Priority 1	Restoration	1,076	1:1	1,076		
UT1	400+00 to 402+33	184	Priority 1/2	Restoration	233	1:1	233		
Wetlands									
RW1	N/A	N/A	Restoration	Restoration	8.605	1:1	8.6		
RW1	N/A	N/A	Creation	Restoration	4.862	3:1	1.6		
RW1	N/A	3.7	Enhancement	Restoration Equivalent	3.649	1.3:1**	2.8		
Component Summation									
Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (square feet)	Upland (acres)			
		Riverine	Non-Riverine						
Restoration	4,968	8.6	-	-	-	-			
Enhancement	-	3.7	-	-	-	-			
Enhancement I	-	-	-	-	-	-			
Enhancement II	-	-	-	-	-	-			
Creation	-	4.9	-	-	-	-			
Preservation	-	-	-	-	-	-			
High Quality Preservation	-	-	-	-	-	-			

[^]There is potential to gain more Stream Mitigation Units if the NC IRT Draft Regulatory Guidance for the Calculation of Stream and Buffer Mitigation Credit (March 11, 2009) is used for calculating Stream Mitigation Units.

* Stream and wetland credits were modified during Monitoring Year 4 based on examination of as-built surveys. Stream credits were also calculated using the 2003 Stream Mitigation Guidelines instead of using the NC IRT Draft Regulatory Guidance for the Calculation of Stream and Buffer Mitigation Credit (March 11, 2009).

**The higher enhancement ratio was agreed to with Todd Tugwell, with the USACE, during a March 9, 2011 meeting for several reasons. The higher ratio is warranted because of the low quality of the existing wetland enhancement zone. Previously the enhancement zone, like the restoration and creation zones, was used for farming. The hydrology of the site has been altered by a drainage ditch and a berm along Little Troublesome Creek. There is no vegetation on the site except for some areas of grasses and cultivated crops. Enhancement activities performed on the site will include improving the hydrology of the enhancement zone (as well as the creation and restoration zones) and restoring the native vegetation. Therefore the functional uplift of the enhancement portion of the project will be nearly the same as that of the restoration zone and, thus, a high ratio for enhancement is appropriate.

Table 2. Project Activity and Reporting History

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Activity or Report	Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan	June 2011	June 2011
Final Design - Construction Plans	August 2011	August 2011
Construction	April 2012	May 2012
Temporary S&E mix applied to entire project area ¹	April 2012	May 2012
Permanent seed mix applied to reach/segments	April 2012	May 2012
Bare root plantings for reach/segments	April 2012	May 2012
Baseline Monitoring Document (Year 0 Monitoring - baseline)	May 2012	June 2012
Year 1 Monitoring	October 2012	December 2012
Year 2 Monitoring	October 2013	December 2013
Year 3 Monitoring	November 2014	December 2014
Year 4 Monitoring	November 2015	December 2015
Year 5 Monitoring	November 2016	December 2016

¹Seed and mulch is added as each section of construction is completed.**Table 3. Project Contacts Table**

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Designer Jeff Keaton, PE	Wildlands Engineering, Inc. 312 West Millbrook Road, Suite 225 Raleigh, NC 27609 919.851.9986
Construction Contractor Peter Jelenevsky	Fluvial Solutions PO Box 28749 Raleigh, NC 28749
Planting Contractor - Stream Site & Wetland Site Charlie Bruton	Bruton Natural Systems, Inc. PO Box 1197 Freemont, NC 27830 919.242.6555
Seeding Contractor - Stream and Wetland Site Peter Jelenevsky	Fluvial Solutions PO Box 28749 Raleigh, NC 28749
Seed Mix Sources	Mellow Marsh Farm
Nursery Stock Suppliers	Arborgen Dykes and Son Nursery NC Forestry Service, Claridge Nursery
Monitoring Performers Stream, Vegetation, and Wetland Monitoring POC	Wildlands Engineering, Inc. Jason Lorch 919.851.9986, ext. 107

Table 4. Project Baseline Information and Attributes

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Project Information					
Project Name	Little Troublesome Creek Mitigation Site				
County	Rockingham				
Project Area (acres)	Stream Site: 33 acres, Wetland Site: 19 acres				
Project Coordinates (latitude and longitude)	36° 20' 96"N, 79° 39' 31"W				
Project Watershed Summary Information					
Physiographic Province	Inner Piedmont Belt of the Piedmont				
River Basin	Cape Fear				
USGS Hydrologic Unit 8-digit	03030002				
USGS Hydrologic Unit 14-digit	03030002010030				
DWQ Sub-basin	03-06-01				
Project Drainage Area (acres)	3,245				
Project Drainage Area Percentage of Impervious Area	17%				
CGIA Land Use Classification	55% Forest Land, 17% Cultivated Land, 28% Developed				
Reach Summary Information					
Parameters	Irvin Creek Reach 1	Irvin Creek Reach 2	Little Troublesome Creek	UT1	RW1
Length of reach (linear feet) - Post-Restoration	2,095	1,932	1,171	233	N/A
Drainage area (acres)	525	584	3,245	62	N/A
NCDWQ stream identification score	44.5	44.5	45.5	26.5	N/A
NCDWQ Water Quality Classification	C	C	C; NSW	C	C; NSW
Morphological Description (stream type)	Perennial	Perennial	Perennial	Intermittent	N/A
Evolutionary trend (Simon's Model) - Pre-Restoration	Stage IV	Stage IV	Stage IV	Stage IV	N/A
Underlying mapped soils	CsA	CsA	CsA	CsA	CsA / HcA
Drainage class	Somewhat Poorly-Drained	Somewhat Poorly-Drained	Somewhat Poorly-Drained	Somewhat Poorly-Drained	Somewhat Poorly-Drained / Poorly Drained
Soil Hydric status	No	No	No	No	No / Yes
Slope	0-2%	0-2%	0-2%	0-2%	0-2%
FEMA classification	Zone AE				
Native vegetation community	Bottom-land forest				
Percent composition of exotic invasive vegetation - Post-Restoration	0%				
Regulatory Considerations					
Regulation	Applicable?	Resolved?	Supporting Documentation		
Waters of the United States - Section 404	X	X	Little Troublesome Creek Mitigation Plan; USACE Nationwide Permit No.27 and DWQ 401 Water Quality Certification No. 3689		
Waters of the United States - Section 401	X	X			
Division of Land Quality (Dam Safety)	N/A	N/A	N/A		
Endangered Species Act	X	X	Little Troublesome Creek Mitigation Plan; studies found "no effect" (letter from USFWS)		
Historic Preservation Act	X	X	Little Troublesome Creek Mitigation Plan; No historic resources were found to be impacted (letter from SHPO)		
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A		
FEMA Floodplain Compliance	X	X	Approved CLOMR		
Essential Fisheries Habitat	N/A	N/A	N/A		

*LF provided includes portions of the stream that will be monitored and has been reconstructed, but for which mitigation credit will not be claimed. Please refer to Table 1 for the credit summary lengths.

APPENDIX 2. Visual Assessment Data

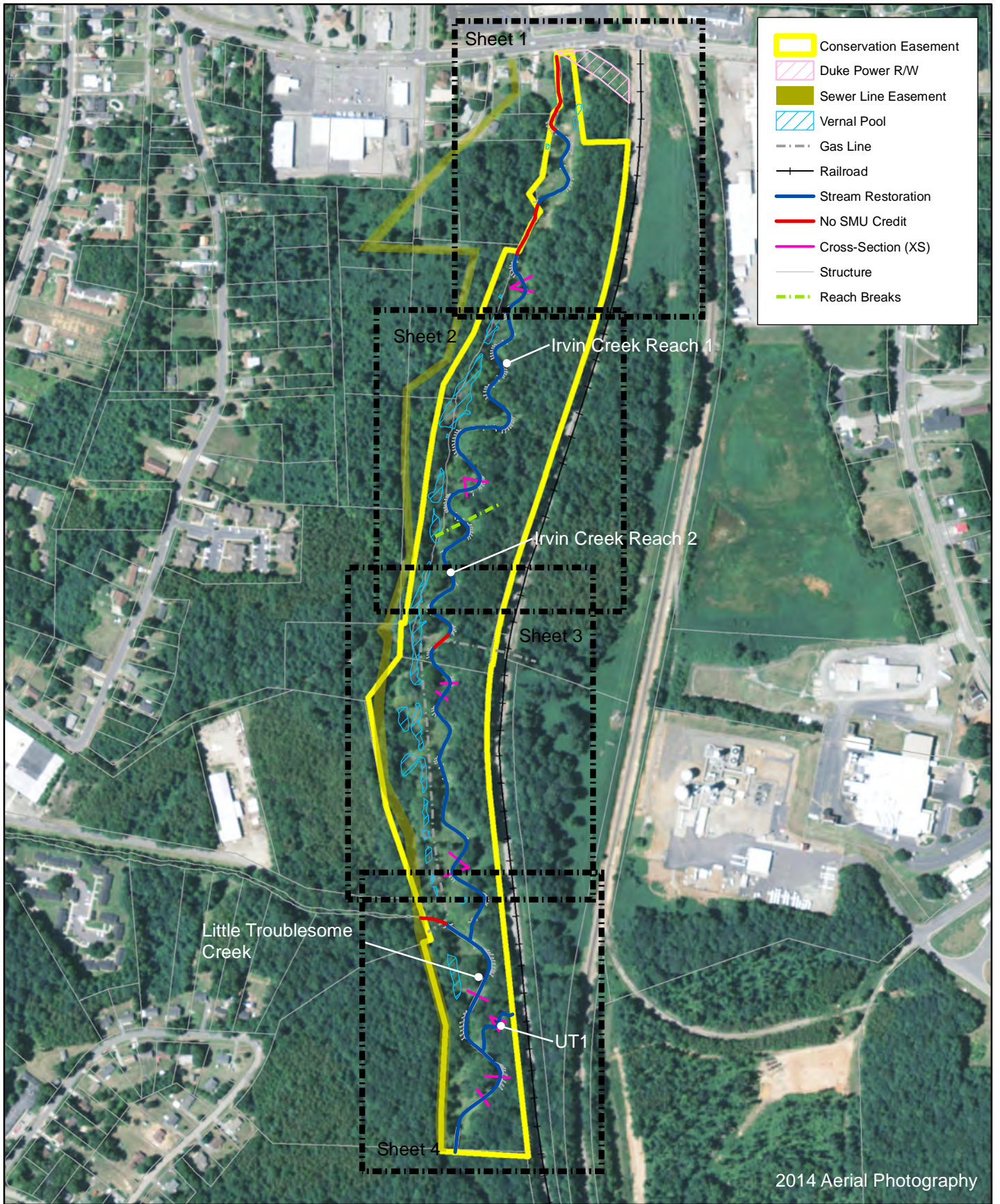


Figure 3.0 Integrated Current Condition Plan View
(Key)

Little Troublesome Creek Mitigation Site
Stream Site
DMS Project Number 94640
Monitoring Year 5 - 2016

Rockingham County, NC



0 250 500 Feet



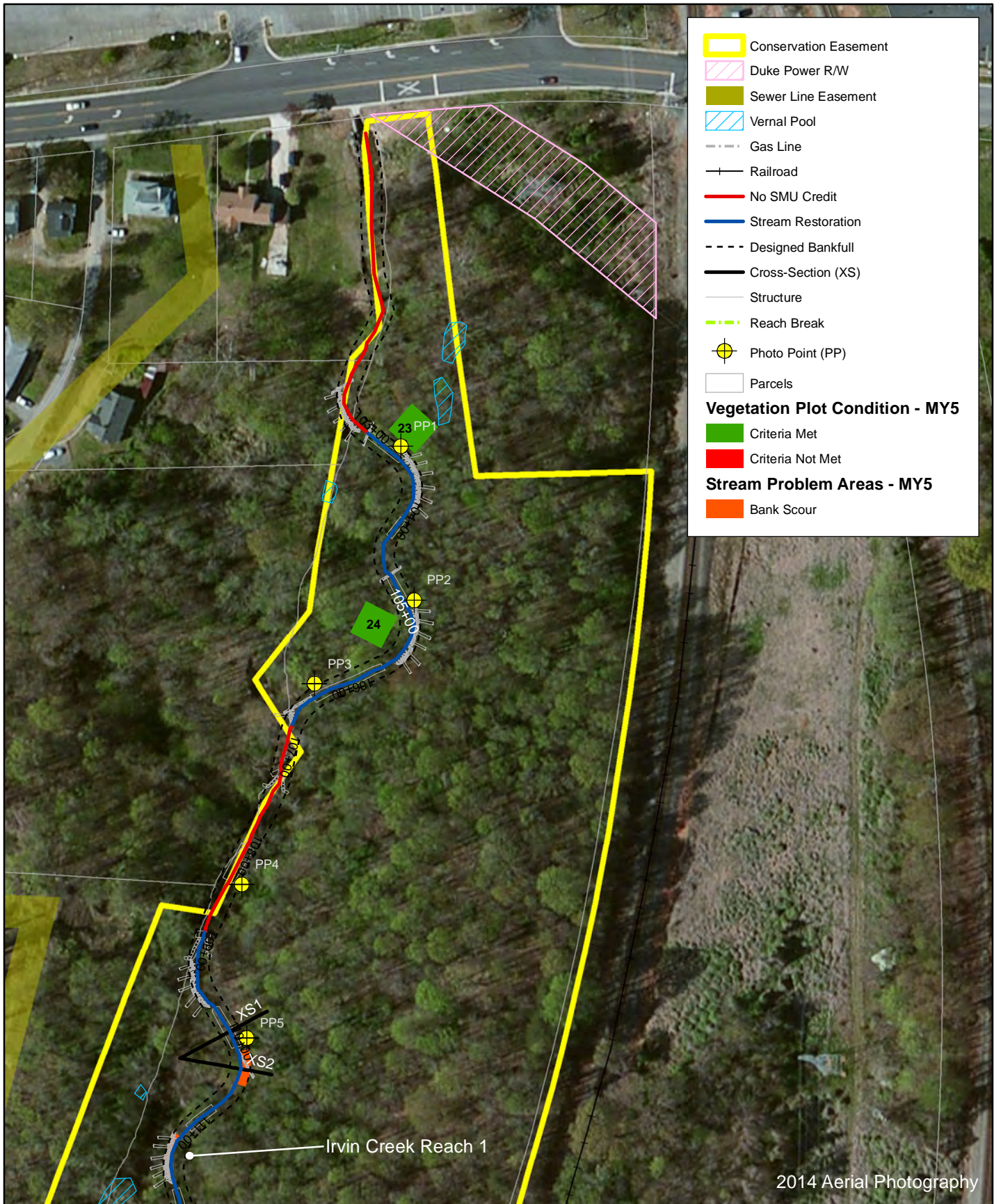
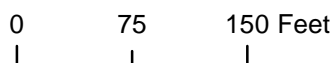


Figure 3.1 Integrated Current Condition Plan View
(Sheet 1 of 4)

Little Troublesome Creek Mitigation Site
Stream Site
DMS Project Number 94640
Monitoring Year 5 - 2016

Rockingham County, NC



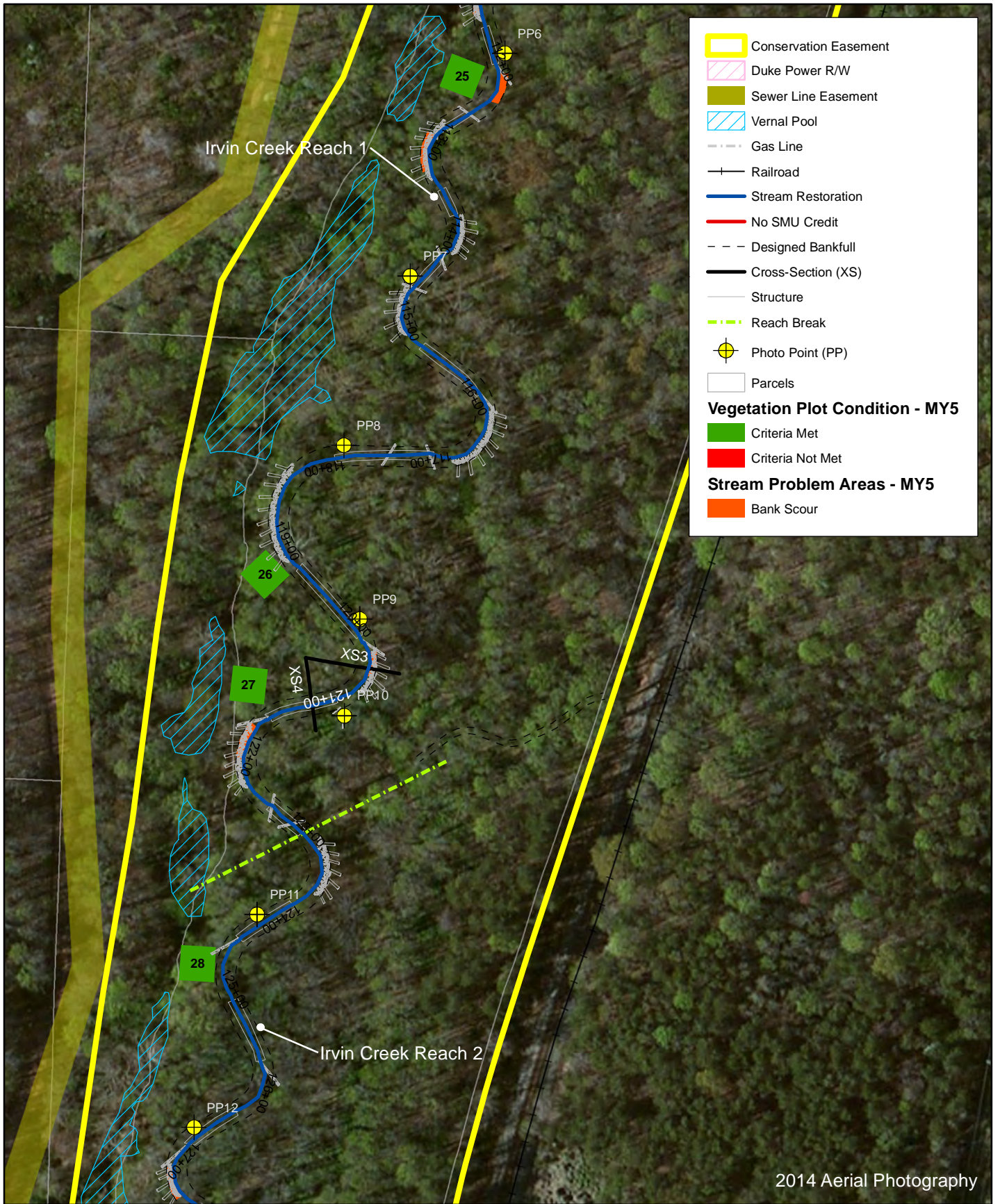
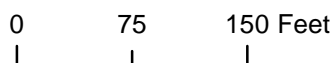


Figure 3.2 Integrated Current Condition Plan View
(Sheet 2 of 4)

Little Troublesome Creek Mitigation Site
Stream Site
DMS Project Number 94640
Monitoring Year 5 - 2016

Rockingham County, NC



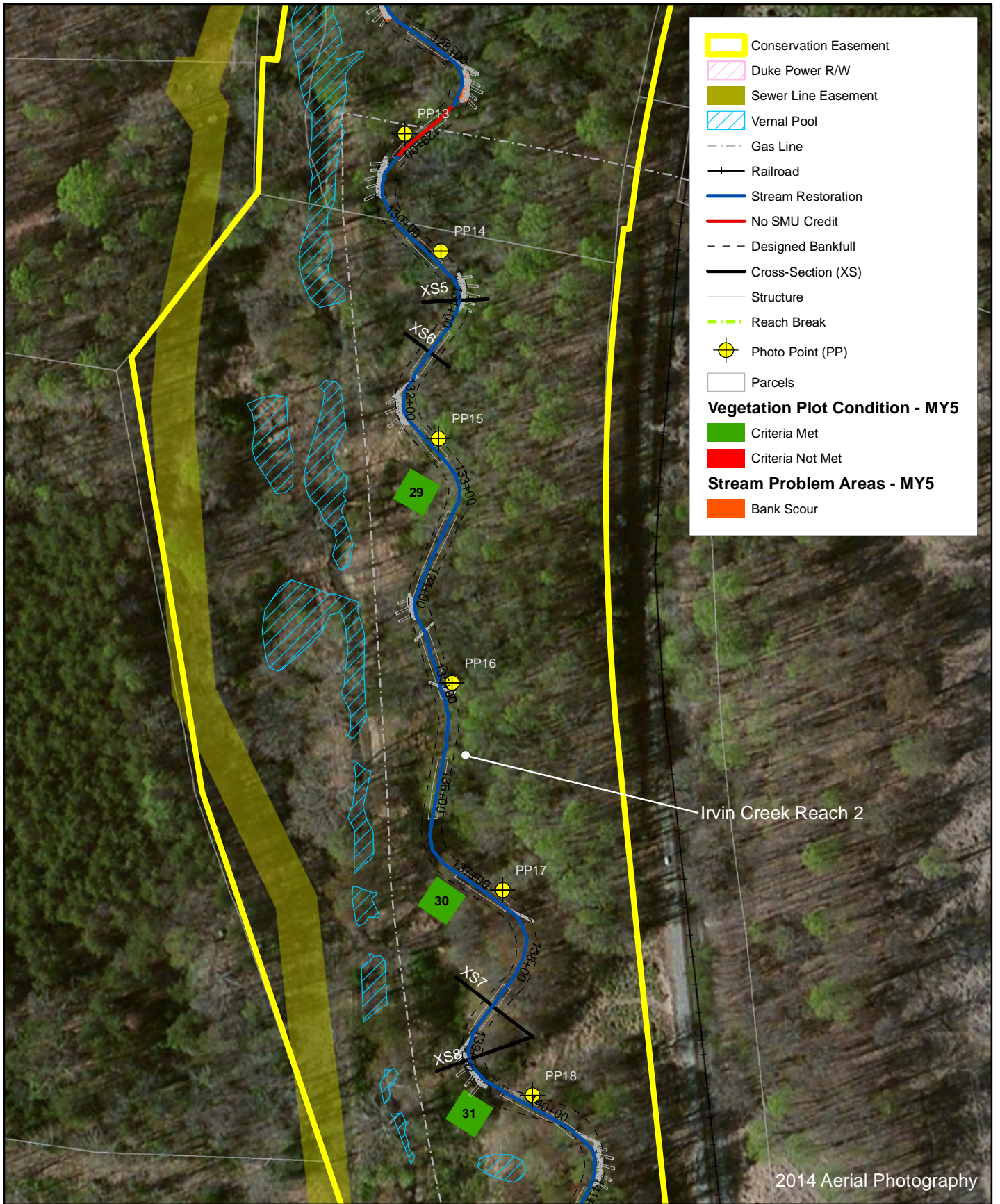
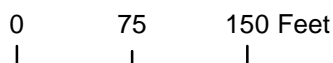


Figure 3.3 Integrated Current Condition Plan View
(Sheet 3 of 4)

Little Troublesome Creek Mitigation Site
Stream Site
DMS Project Number 94640
Monitoring Year 5 - 2016

Rockingham County, NC



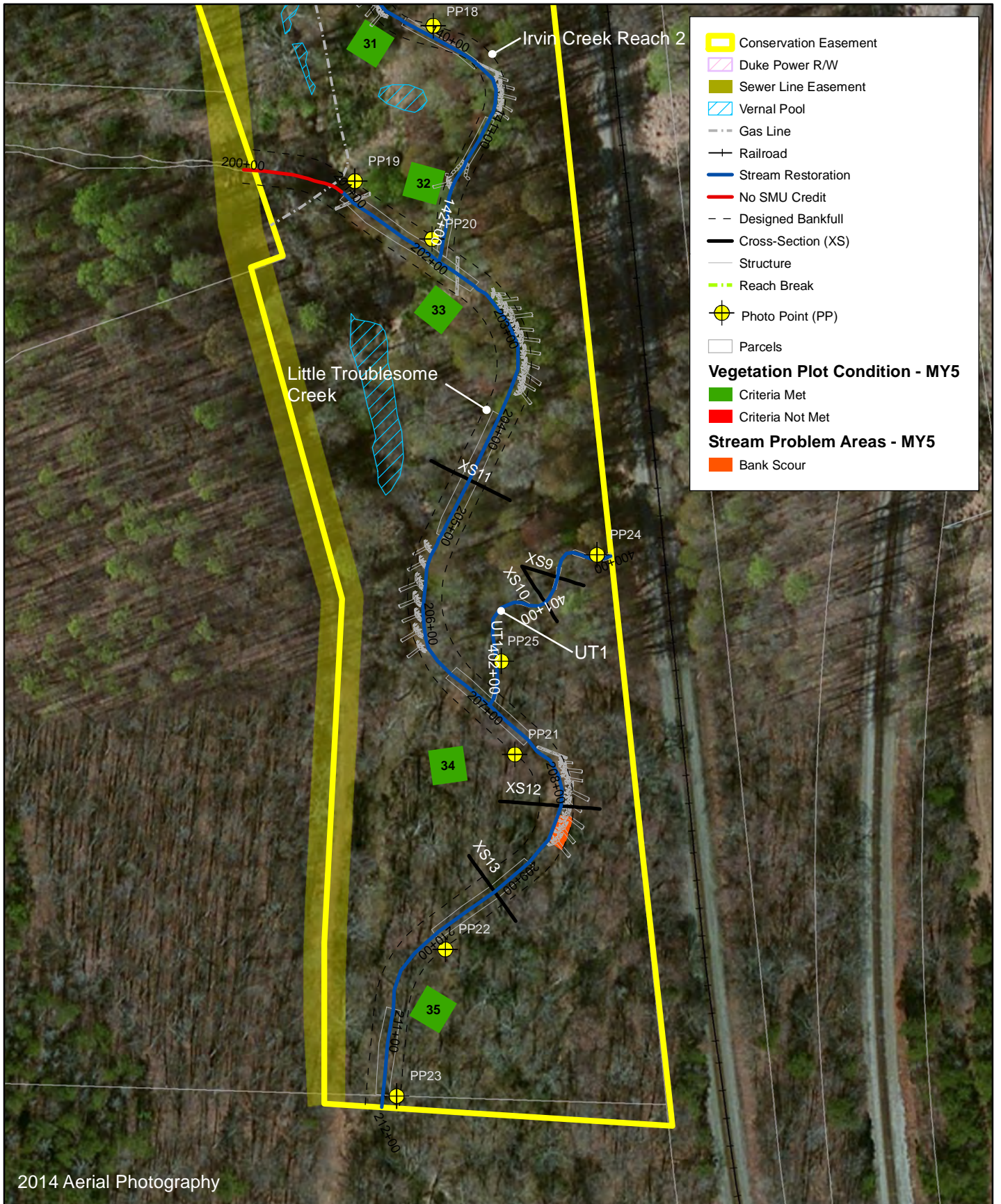


Figure 3.4 Integrated Current Condition Plan View
(Sheet 4 of 4)

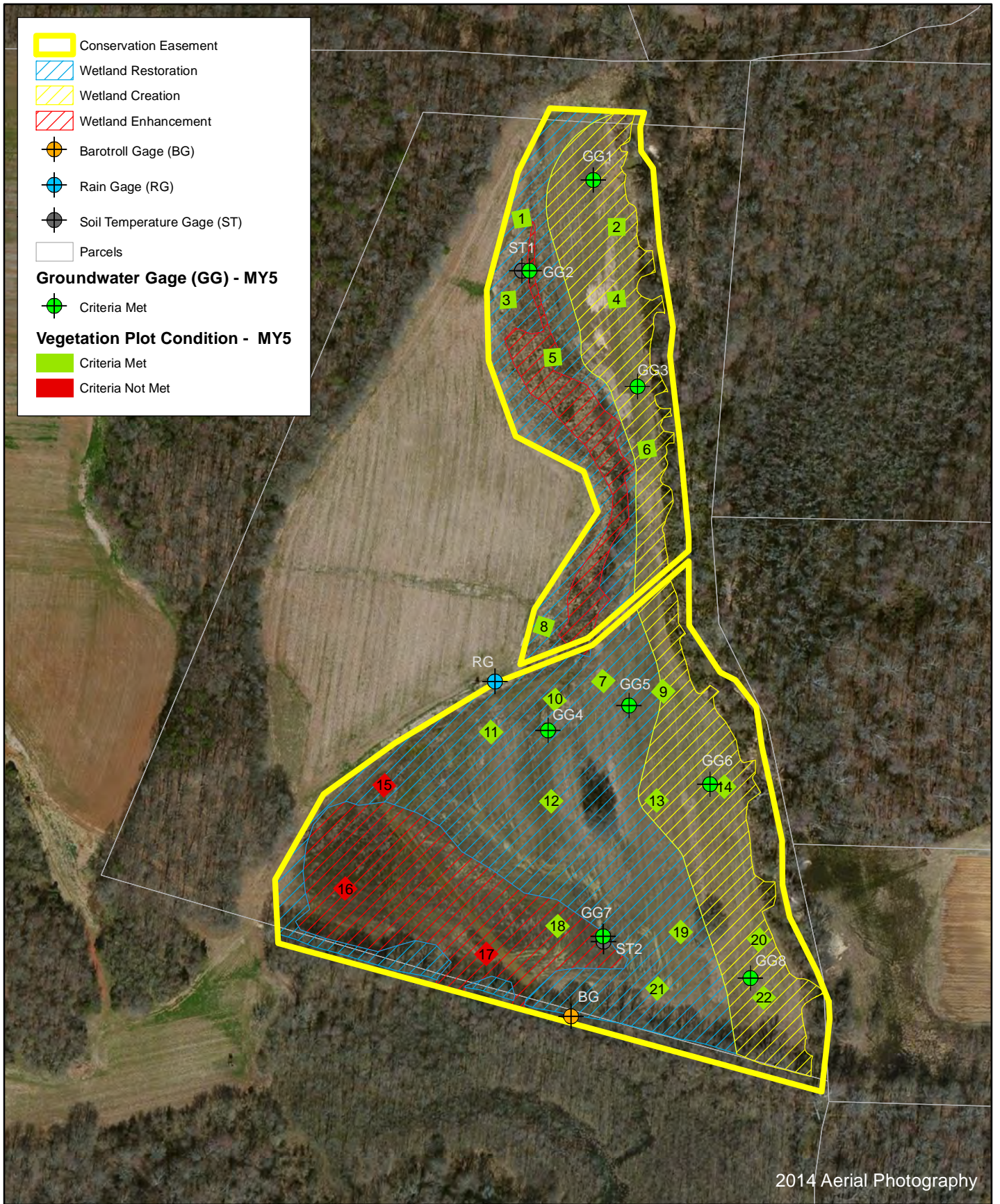
Little Troublesome Creek Mitigation Site
Stream Site
DMS Project Number 94640
Monitoring Year 5 - 2016

Rockingham County, NC



0 75 150 Feet





0 125 250 Feet



Figure 3.5 Integrated Current Condition Plan View
 Little Troublesome Creek Mitigation Site
 Wetland Site
 DMS Project Number 94640
 Monitoring Year 5 - 2016

Rockingham County, NC

Table 5a. Visual Stream Morphology Stability Assessment Table

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Irvin Creek Reach 1 (1,793 LF)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	16	16		100%				
	3. Meander Pool Condition	Depth Sufficient	16	16		100%				
		Length Appropriate	16	16		100%				
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	16	16		100%				
		Thalweg centering at downstream of meander bend (Glide)	16	16		100%				
					Totals		90%	0	0	100%
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			6	188	90%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, caving, or collapse			0	0	100%	0	0	100%
					Totals		90%	0	0	100%
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	36	36			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	24	24			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms	24	24			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%	31	31			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow	12	12			100%			

Table 5b. Visual Stream Morphology Stability Assessment Table

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Irvin Creek Reach 2 (1,866 LF)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	16	16		100%				
	3. Meander Pool Condition	Depth Sufficient	15	15		100%				
		Length Appropriate	15	15		100%				
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	15	15		100%				
		Thalweg centering at downstream of meander bend (Glide)	15	15	100%					
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			2	56	97%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, caving, or collapse			0	0	100%	0	0	100%
Totals					2	56	97%	0	0	100%
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	35	35			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	19	19			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	9	9			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	19	19			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	19	19			100%			

Table 5c. Visual Stream Morphology Stability Assessment Table

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

UT1 (233 LF)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation	
1. Bed	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%				
		Degradation			0	0	100%				
	2. Riffle Condition	Texture/Substrate	6	6		100%					
	3. Meander Pool Condition	Depth Sufficient	4	4		100%					
		Length Appropriate	4	4		100%					
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	4	4		100%					
		Thalweg centering at downstream of meander bend (Glide)	4	4		100%					
					Totals	0	0	100%	0	0	100%
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%	
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%	
	3. Mass Wasting	Bank slumping, caving, or collapse			0	0	100%	0	0	100%	
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	6	6		100%					
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	6	6		100%					
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0		100%					
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	0	0		100%					
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth	≥ 1.6 Rootwads/logs providing some cover at baseflow.	0		0	100%				
							100%				

Table 5d. Visual Stream Morphology Stability Assessment Table

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Little Troublesome Creek (1,076 LF)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	5	5		100%				
	3. Meander Pool Condition	Depth Sufficient	4	4		100%				
		Length Appropriate	4	4		100%				
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	4	4		100%				
		Thalweg centering at downstream of meander bend (Glide)	4	4		100%				
Totals										
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			1	27	97%	1	27	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, caving, or collapse			0	0	100%	0	0	100%
Totals										
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	9	9			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	6	6			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	1	1			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	4	4			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	4	4			100%			

Table 6. Vegetation Condition Assessment Table

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Planted Acreage 33.7

Vegetation Category	Definitions	Mapping Threshold (acres)	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material.	0.1	0	0.0	0.0%
Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1	0	0.0	0.0%
Total			0	0.0	0.0%
Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	0	0.0	0.0%
Cumulative Total			0	0.0	0.0%

Easement Acreage 52

Vegetation Category	Definitions	Mapping Threshold (SF)	Number of Polygons	Combined Acreage	% of Planted Acreage
Invasive Areas of Concern	Areas of points (if too small to render as polygons at map scale).	1000	0	0.0	0.0%
Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale).	none	0	0.0	0.0%

**Stream Photographs
Monitoring Year 5**



Photo Point 1 – looking upstream (4/10/2016)



Photo Point 1 – looking downstream (4/10/2016)



Photo Point 2 – looking upstream (4/10/2016)



Photo Point 2 – looking downstream (4/10/2016)



Photo Point 3 – looking upstream (4/10/2016)



Photo Point 3 – looking downstream (4/10/2016)





Photo Point 4 – looking upstream (4/10/2016)



Photo Point 4 – looking downstream (4/10/2016)



Photo Point 5 – looking upstream (4/10/2016)



Photo Point 5 – looking downstream (4/10/2016)



Photo Point 6 – looking upstream (4/10/2016)



Photo Point 6 – looking downstream (4/10/2016)





Photo Point 7 – looking upstream (4/10/2016)



Photo Point 7 – looking downstream (4/10/2016)



Photo Point 8 – looking upstream (4/10/2016)



Photo Point 8 – looking downstream (4/10/2016)



Photo Point 9 – looking upstream (4/10/2016)



Photo Point 9 – looking downstream (4/10/2016)





Photo Point 10 – looking upstream (4/10/2016)



Photo Point 10 – looking downstream (4/10/2016)



Photo Point 11 – looking upstream (4/10/2016)



Photo Point 11 – looking downstream (4/10/2016)



Photo Point 12 – looking upstream (4/10/2016)



Photo Point 12 – looking downstream (4/10/2016)





Photo Point 13 – looking upstream (4/10/2016)



Photo Point 13 – looking downstream (4/10/2016)



Photo Point 14 – looking upstream (4/10/2016)



Photo Point 14 – looking downstream (4/10/2016)



Photo Point 15 – looking upstream (4/10/2016)



Photo Point 15 – looking downstream (4/10/2016)





Photo Point 16 – looking upstream (4/10/2016)



Photo Point 16 – looking downstream (4/10/2016)



Photo Point 17 – looking upstream (4/10/2016)



Photo Point 17 – looking downstream (4/10/2016)



Photo Point 18 – looking upstream (4/10/2016)



Photo Point 18 – looking downstream (4/10/2016)





Photo Point 19 – looking upstream (4/10/2016)



Photo Point 19 – looking downstream (4/10/2016)



Photo Point 20 – looking upstream - Irvin (4/10/2016)



Photo Point 20 – looking upstream – LTC (4/10/2016)



Photo Point 20 – looking downstream - LTC (4/10/2016)





Photo Point 21 – looking upstream (4/10/2016)



Photo Point 21 – looking downstream (4/10/2016)



Photo Point 22 – looking upstream (4/10/2016)



Photo Point 22 – looking downstream (4/10/2016)



Photo Point 23 – looking upstream (4/10/2016)



Photo Point 23 – looking downstream (4/10/2016)





Photo Point 24 – looking upstream (4/10/2016)



Photo Point 24 – looking downstream (4/10/2016)



Photo Point 25 – looking upstream (4/10/2016)



Photo Point 25 – looking downstream (4/10/2016)



**Vegetation Photographs
Wetland Site
Monitoring Year 5**



Vegetation Plot 1 (6/21/2016)



Vegetation Plot 2 (6/21/2016)



Vegetation Plot 3 (6/21/2016)



Vegetation Plot 4 (6/21/2016)



Vegetation Plot 5 (6/21/2016)



Vegetation Plot 6 (6/21/2016)





Vegetation Plot 7 (6/21/2016)



Vegetation Plot 8 (6/21/2016)



Vegetation Plot 9 (6/21/2016)



Vegetation Plot 10 (6/21/2016)



Vegetation Plot 11 (6/21/2016)



Vegetation Plot 12 (6/21/2016)





Vegetation Plot 13 (6/21/2016)



Vegetation Plot 14 (6/21/2016)



Vegetation Plot 15 (6/21/2016)



Vegetation Plot 16 (6/21/2016)



Vegetation Plot 17 (6/21/2016)



Vegetation Plot 18 (6/21/2016)





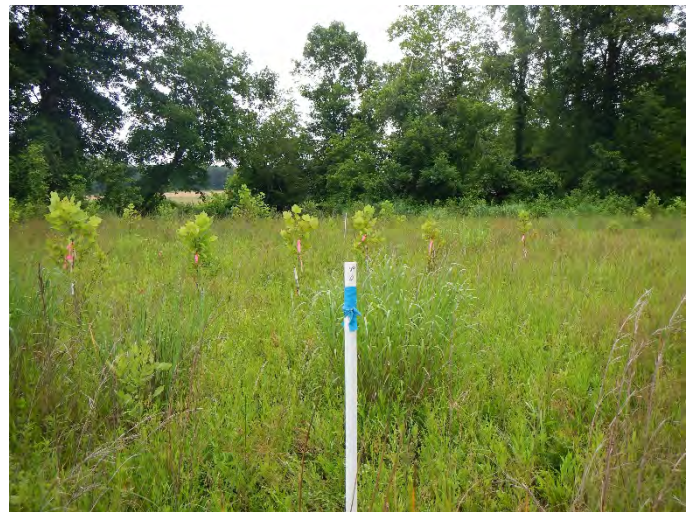
Vegetation Plot 19 (6/21/2016)



Vegetation Plot 20 (6/21/2016)



Vegetation Plot 21 (6/21/2016)



Vegetation Plot 22 (6/21/2016)



**Vegetation Photographs
Stream Site
Monitoring Year 5**



Vegetation Plot 23 (6/20/2016)



Vegetation Plot 24 (6/20/2016)



Vegetation Plot 25 (6/20/2016)



Vegetation Plot 26 (6/20/2016)



Vegetation Plot 27 (6/20/2016)



Vegetation Plot 28 (6/20/2016)





Vegetation Plot 29 (6/20/2016)



Vegetation Plot 30 (6/20/2016)



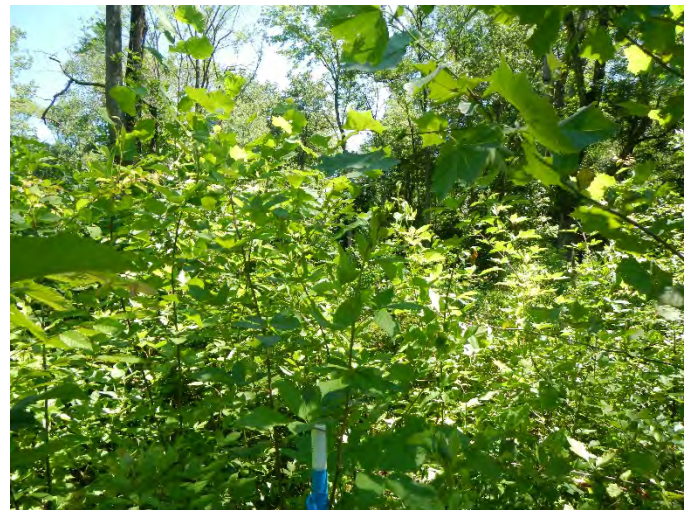
Vegetation Plot 31 (6/20/2016)



Vegetation Plot 32 (6/20/2016)



Vegetation Plot 33 (6/19/2016)



Vegetation Plot 34 (6/19/2016)





Vegetation Plot 35 (6/19/2016)



APPENDIX 3. Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Plot	MY5 Success Criteria Met (Y/N)	Tract Mean
1	Y	91%
2	Y	
3	Y	
4	Y	
5	Y	
6	Y	
7	Y	
8	Y	
9	Y	
10	Y	
11	Y	
12	Y	
13	Y	
14	Y	
15	N	
16	N	
17	N	
18	Y	
19	Y	
20	Y	
21	Y	
22	Y	
23	Y	
24	Y	
25	Y	
26	Y	
27	Y	
28	Y	
29	Y	
30	Y	
31	Y	
32	Y	
33	Y	
34	Y	
35	Y	

Table 8a. CVS Vegetation Table - Metadata

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Wetland Site

Report Prepared By	Kenton Beal
Date Prepared	8/18/2016 8:10
database name	LTC - Wetland Site MY5 cvs-eep-entrytool-v2.3.1.mdb
database location	F:\Projects\005-12700 Little Troublesome Creek\Monitoring\Monitoring Year 5\Vegetation Assessment
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	94640
project Name	Little Troublesome Creek-Cotton Rd Site
Description	Wetland Mitigation Site
Required Plots (calculated)	16
Sampled Plots	22

Table 8b. CVS Vegetation Table - Metadata

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Stream Site

Report Prepared By	Kenton Beal
Date Prepared	8/18/2016 8:04
database name	LTC - Stream Site MY5 cvs-eep-entrytool-v2.3.1.mdb
database location	F:\Projects\005-12700 Little Troublesome Creek\Monitoring\Monitoring Year 5\Vegetation Assessment
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	94640
project Name	Little Troublesome Mitigation Site
Description	Stream Mitigation Site
Required Plots (calculated)	13
Sampled Plots	13

Table 9. Planted and Total Stem Counts

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)
 Monitoring Year 5 - 2016

Stream Site			Current Plot Data (MY5 2016)														
			94640-WEI-0001			94640-WEI-0002			94640-WEI-0003			94640-WEI-0004			94640-WEI-0005		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree															
Betula nigra	river birch	Tree	4	4	4	7	7	7	4	4	4	4	4	4	1	1	1
Carpinus caroliniana	American hornbeam	Tree				4	4	4							1	1	1
Cornus amomum	silky dogwood	Shrub				2	2	2									
Fraxinus pennsylvanica	green ash	Tree	1	1	1	2	2	2	12	12	12	6	6	6	5	5	5
Liquidambar styraciflua	sweetgum	Tree															
Liriodendron tulipifera	tuliptree	Tree	1	1	1	2	2	2									
Platanus occidentalis	American sycamore	Tree	5	5	5	2	2	2	2	2	2	3	3	3	11	11	11
Quercus phellos	willow oak	Tree				3	3	3									
Quercus rubra	northern red oak	Tree				2	2	2									
Salix sericea	silky willow	Shrub															
Unknown		Shrub or Tree															
Stem count			11	11	11	24	24	24	18	18	18	13	13	13	18	18	18
size (ares)			1			1			1			1			1		
size (ACRES)			0.02			0.02			0.02			0.02			0.02		
Species count			4	4	4	8	8	8	3	3	3	3	3	3	4	4	4
Stems per ACRE			445.2	445.2	445.2	971.2	971.2	971.2	728.4	728.4	728.4	526.1	526.1	526.1	728.4	728.4	728.4

Stream Site			Current Plot Data (MY5 2016)											
			94640-WEI-0006			94640-WEI-0007			94640-WEI-0008			94640-WEI-0009		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree												
Betula nigra	river birch	Tree	1	1	1				5	5	5	9	9	9
Carpinus caroliniana	American hornbeam	Tree				3	3	3	1	1	1			
Cornus amomum	silky dogwood	Shrub												
Fraxinus pennsylvanica	green ash	Tree	1	1	1	5	5	5	1	1	1	6	6	6
Liquidambar styraciflua	sweetgum	Tree												
Liriodendron tulipifera	tuliptree	Tree							2	2	2	2	2	2
Platanus occidentalis	American sycamore	Tree	10	10	10	10	10	10	2	2	2	2	2	2
Quercus phellos	willow oak	Tree												
Quercus rubra	northern red oak	Tree												
Salix sericea	silky willow	Shrub												
Unknown		Shrub or Tree												
Stem count			12	12	12	18	18	18	11	11	11	19	19	19
size (ares)			1			1			1			1		
size (ACRES)			0.02			0.02			0.02			0.02		
Species count			3	3	3	3	3	3	5	5	5	4	4	4
Stems per ACRE			485.6	485.6	485.6	728.4	728.4	728.4	445.2	445.2	445.2	768.9	768.9	768.9

Stream Site			Current Plot Data (MY5 2016)											
			94640-WEI-0010			94640-WEI-0011			94640-WEI-0012			94640-WEI-0013		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree												
Betula nigra	river birch	Tree	4	4	4	2	2	2	4	4	4	3	3	3
Carpinus caroliniana	American hornbeam	Tree				6	6	6	7	7	7	1	1	1
Cornus amomum	silky dogwood	Shrub										1	1	1
Fraxinus pennsylvanica	green ash	Tree	1	1	1				1	1	1			
Liquidambar styraciflua	sweetgum	Tree												
Liriodendron tulipifera	tuliptree	Tree							5	5	5			
Platanus occidentalis	American sycamore	Tree	8	8	8	1	1	1				3	3	3
Quercus phellos	willow oak	Tree				1	1	1	5	5	5	4	4	4
Quercus rubra	northern red oak	Tree										3	3	3
Salix sericea	silky willow	Shrub												
Unknown		Shrub or Tree												
Stem count			13	13	13	10	10	10	22	22	22	15	15	15
size (ares)			1			1			1			1		
size (ACRES)			0.02			0.02			0.02			0.02		
Species count			3	3	3	4	4	4	5	5	5	6	6	6
Stems per ACRE			526.1	526.1	526.1	404.7	404.7	404.7	890.3	890.3	890.3	607	607	607

Color for Density

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%
- Volunteer species included in total

PnoLS: Number of Planted stems excluding live stakes
 P-all: Number of planted stems including live stakes
 T: Total Stems

Table 9. Planted and Total Stem Counts

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Stream Site			Annual Means																	
			MY5 (2016)			MY4 (2015)			MY3 (2014)			MY2 (2013)			MY1 (2012)			MY0 (2012)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree						18												
Betula nigra	river birch	Tree	48	48	48	53	53	64	36	36	36	33	33	33	36	36	36	36	36	36
Carpinus caroliniana	American hornbeam	Tree	23	23	23	24	24	24	39	39	39	44	44	44	50	50	50	56	56	56
Cornus amomum	silky dogwood	Shrub	3	3	3	3	3	3	4	4	4	5	5	5	6	6	6	8	8	8
Fraxinus pennsylvanica	green ash	Tree	41	41	41	49	49	51	52	52	52	55	55	55	63	63	63	67	67	67
Liquidambar styraciflua	sweetgum	Tree						82												
Liriodendron tulipifera	tuliptree	Tree	12	12	12	17	17	22	19	19	19	21	21	21	31	31	31	37	37	37
Platanus occidentalis	American sycamore	Tree	59	59	59	64	64	85	64	64	64	65	65	65	67	67	67	68	68	68
Quercus phellos	willow oak	Tree	13	13	13	15	15	17	16	16	16	17	17	17	20	20	20	22	22	22
Quercus rubra	northern red oak	Tree	5	5	5	5	5	5	5	5	5	11	11	11	13	13	13	11	11	11
Salix sericea	silky willow	Shrub						7												
Unknown		Shrub or Tree																1	1	1
Stem count			204	204	204	230	230	378	235	235	235	251	251	251	286	286	286	306	306	306
size (ares)			13			13			13			13			13					
size (ACRES)			0.32			0.32			0.32			0.32			0.32					
Species count			8	8	8	8	8	11	8	8	8	8	8	8	8	8	8	9	9	9
Stems per ACRE			635	635	635	716	716	1177	731.5	731.5	731.5	781.4	781.4	781.4	890.3	890.3	890.3	952.6	952.6	952.6

Color for Density

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%
- Volunteer species included in total

PnoLS: Number of Planted stems excluding live stakes
 P-all: Number of planted stems including live stakes
 T: Total Stems

Table 9. Planted and Total Stem Counts
 Little Troublesome Creek Mitigation Site (DMS Project No. 94640)
 Monitoring Year 5 - 2016

Wetland Site			Current Plot Data (MYS 2016)																	
Scientific Name	Common Name	Species Type	94640-WEI-0001			94640-WEI-0002			94640-WEI-0003			94640-WEI-0004			94640-WEI-0005			94640-WEI-0006		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree						5												
Alnus serrulata	hazel alder	Shrub	2	2	2						2	2	2							
Betula nigra	river birch	Tree	3	3	3	2	2	8	6	6	6	3	3	3				4	4	7
Cephalanthus occidentalis	common buttonbush	Shrub									10									
Cornus amomum	silky dogwood	Shrub									4	4	4					3	3	3
Fraxinus americana	white ash	Tree																		
Fraxinus pennsylvanica	green ash	Tree		2	3	3	23	7	7	7	3	3	13	12	12	12	2	2	4	
Liquidambar styraciflua	sweetgum	Tree		12																
Liriodendron tulipifera	tuliptree	Tree		12																
Nyssa sylvatica	blackgum	Tree						1	1	1	1	1	1	5	5	5				
Platanus occidentalis	American sycamore	Tree	7	7	7	2	2	6	5	5	5			3	3	3	1	1	3	
Quercus michauxii	swamp chestnut oak	Tree	1	1	1	2	2	2				1	1	1	1	1	1			
Quercus phellos	willow oak	Tree	1	1	1				1	1	1	4	4	4				1	1	1
Quercus rubra	northern red oak	Tree																		
Salix nigra	black willow	Tree										2							2	
Sambucus canadensis	common elderberry	Shrub																		
Unknown		Shrub or Tree																		
Stem count			14	14	40	9	9	44	20	20	30	18	18	30	21	21	21	11	11	20
size (ares)			1			1			1			1			1			1		
size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.02		
Species count			5	5	8	4	4	5	5	5	6	7	7	8	4	4	4	5	5	6
Stems per ACRE			566.6	566.6	1619	364.2	364.2	1781	809.4	809.4	1214	728.4	728.4	1214	849.8	849.8	849.8	445.2	445.2	809.4

Wetland Site			Current Plot Data (MYS 2016)																	
Scientific Name	Common Name	Species Type	94640-WEI-0007			94640-WEI-0008			94640-WEI-0009			94640-WEI-0010			94640-WEI-0011			94640-WEI-0012		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree			2			5			2			2			5			4
Alnus serrulata	hazel alder	Shrub				1	1	1												
Betula nigra	river birch	Tree	3	3	3	2	2	2	6	6	7	2	2	2	3	3	3	1	1	1
Cephalanthus occidentalis	common buttonbush	Shrub			2														1	
Cornus amomum	silky dogwood	Shrub				2	2	2				2	2	2				2	2	2
Fraxinus americana	white ash	Tree																		
Fraxinus pennsylvanica	green ash	Tree	9	9	29			5	4	4	29	2	2	7	5	5	7	1	1	11
Liquidambar styraciflua	sweetgum	Tree						6									1			
Liriodendron tulipifera	tuliptree	Tree																		
Nyssa sylvatica	blackgum	Tree				3	3	3	1	1	1							2	2	2
Platanus occidentalis	American sycamore	Tree	3	3	4	5	5	5			1	4	4	4	3	3	3	1	1	2
Quercus michauxii	swamp chestnut oak	Tree										2	2	2				5	5	5
Quercus phellos	willow oak	Tree	1	1	1				5	5	5									
Quercus rubra	northern red oak	Tree																		
Salix nigra	black willow	Tree																		
Sambucus canadensis	common elderberry	Shrub																		
Unknown		Shrub or Tree																		
Stem count			16	16	41	13	13	29	16	16	45	12	12	19	11	11	19	12	12	28
size (ares)			1			1			1			1			1			1		
size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.02		
Species count			4	4	6	5	5	8	4	4	6	5	5	6	3	3	5	6	6	8
Stems per ACRE			647.5	647.5	1659	526.1	526.1	1174	647.5	647.5	1821	485.6	485.6	768.9	445.2	445.2	768.9	485.6	485.6	1133

Color for Density
 Exceeds requirements by 10%
 Exceeds requirements, but by less than 10%
 Fails to meet requirements, by less than 10%
 Fails to meet requirements by more than 10%
 Volunteer species included in total

PnoLS: Number of Planted stems excluding live stakes
 P-all: Number of planted stems including live stakes
 T: Total Stems

Table 9. Planted and Total Stem Counts
 Little Troublesome Creek Mitigation Site (DMS Project No. 94640)
 Monitoring Year 5 - 2016

Wetland Site			Current Plot Data (MYS 2016)																				
Scientific Name	Common Name	Species Type	94640-WEI-0013			94640-WEI-0014			94640-WEI-0015			94640-WEI-0016			94640-WEI-0017			94640-WEI-0018					
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T			
Acer rubrum	red maple	Tree																	1			8	
Alnus serrulata	hazel alder	Shrub				2	2	2							1	1	1						
Betula nigra	river birch	Tree	2	2	2	3	3	3	2	2	2	2	2	2						1	1	1	
Cephalanthus occidentalis	common buttonbush	Shrub									5								1			4	
Cornus amomum	silky dogwood	Shrub				1	1	1				2	2	2									
Fraxinus americana	white ash	Tree																					
Fraxinus pennsylvanica	green ash	Tree	7	7	27	1	1	21	2	2	3	1	1	1	2	2	4	4	4	4	4	6	
Liquidambar styraciflua	sweetgum	Tree			2			1															
Liriodendron tulipifera	tuliptree	Tree																					
Nyssa sylvatica	blackgum	Tree																					
Platanus occidentalis	American sycamore	Tree				6	6	8	1	1	2	1	1	1							5	5	5
Quercus michauxii	swamp chestnut oak	Tree	1	1	1																		
Quercus phellos	willow oak	Tree	4	4	4	2	2	2															
Quercus rubra	northern red oak	Tree																					
Salix nigra	black willow	Tree																					
Sambucus canadensis	common elderberry	Shrub																					
Unknown		Shrub or Tree																					
Stem count			14	14	36	15	15	38	5	5	12	6	6	18	3	3	7	10	10	24			
size (ares)			1			1			1			1			1			1					
size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.02					
Species count			4	4	5	6	6	7	3	3	4	4	4	5	2	2	4	3	3	5			
Stems per ACRE			566.6	566.6	1457	607	607	1538	202.3	202.3	485.6	242.8	242.8	728.4	121.4	121.4	283.3	404.7	404.7	971.2			

Wetland Site			Current Plot Data (MYS 2016)											
Scientific Name	Common Name	Species Type	94640-WEI-0019			94640-WEI-0020			94640-WEI-0021			94640-WEI-0022		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree			10						12			
Alnus serrulata	hazel alder	Shrub						4	4	4	2	2	2	
Betula nigra	river birch	Tree				2	2	2						
Cephalanthus occidentalis	common buttonbush	Shrub			3					7				
Cornus amomum	silky dogwood	Shrub	1	1	1						1	1	1	
Fraxinus americana	white ash	Tree												
Fraxinus pennsylvanica	green ash	Tree	2	2	14	5	5	25	2	2	22	2	2	12
Liquidambar styraciflua	sweetgum	Tree			1						3			
Liriodendron tulipifera	tuliptree	Tree												
Nyssa sylvatica	blackgum	Tree	1	1	1				2	2	2	1	1	1
Platanus occidentalis	American sycamore	Tree	1	1	4	1	1	1	5	5	11	8	8	10
Quercus michauxii	swamp chestnut oak	Tree							1	1	1	1	1	1
Quercus phellos	willow oak	Tree	5	5	5	1	1	1	1	1	1			
Quercus rubra	northern red oak	Tree												
Salix nigra	black willow	Tree												
Sambucus canadensis	common elderberry	Shrub												
Unknown		Shrub or Tree												
Stem count			10	10	39	9	9	30	15	15	63	15	15	27
size (ares)			1			1			1			1		
size (ACRES)			0.02			0.02			0.02			0.02		
Species count			5	5	8	4	4	5	6	6	9	6	6	6
Stems per ACRE			404.7	404.7	1578	364.2	364.2	1214	607	607	2550	607	607	1093

Color for Density
 Exceeds requirements by 10%
 Exceeds requirements, but by less than 10%
 Fails to meet requirements, by less than 10%
 Fails to meet requirements by more than 10%
 Volunteer species included in total

PnoLS: Number of Planted stems excluding live stakes
 P-all: Number of planted stems including live stakes
 T: Total Stems

Table 9. Planted and Total Stem Counts
 Little Troublesome Creek Mitigation Site (DMS Project No. 94640)
 Monitoring Year 5 - 2016

Wetland Site			Annual Means																	
			MY5 (2016)			MY4 (2015)			MY3 (2014)			MY2 (2013)			MY1 (2012)			MY0 (2012)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree			56			45			33									
Alnus serrulata	hazel alder	Shrub	14	14	14	17	17	17	17	17	17	20	20	20	31	31	31	62	62	62
Betula nigra	river birch	Tree	47	47	57	46	46	61	41	41	42	43	43	43	55	55	55	75	75	75
Cephalanthus occidentalis	common buttonbush	Shrub			45			50			73									
Cornus amomum	silky dogwood	Shrub	18	18	19	21	21	26	20	20	20	20	20	20	30	30	30	38	38	38
Fraxinus americana	white ash	Tree													1	1	1			
Fraxinus pennsylvanica	green ash	Tree	76	76	284	74	74	197	70	70	170	64	64	64	68	68	68	71	71	71
Liquidambar styraciflua	sweetgum	Tree			26			35			20									
Liriodendron tulipifera	tuliptree	Tree			12						2									
Nyssa sylvatica	blackgum	Tree	17	17	17	21	21	21	21	21	21	25	25	25	27	27	27	17	17	17
Platanus occidentalis	American sycamore	Tree	62	62	85	62	62	80	60	60	86	67	67	67	75	75	75	82	82	82
Quercus michauxii	swamp chestnut oak	Tree	15	15	15	16	16	16	16	16	16	20	20	20	24	24	24	18	18	18
Quercus phellos	willow oak	Tree	26	26	26	26	26	26	26	26	27	30	30	30	35	35	35	11	11	11
Quercus rubra	northern red oak	Tree									1									
Salix nigra	black willow	Tree			4															
Sambucus canadensis	common elderberry	Shrub									25									
Unknown		Shrub or Tree																7	7	7
Stem count			275	275	660	283	283	574	271	271	553	289	289	289	346	346	346	381	381	381
size (ares)			22			22			22			22			22			22		
size (ACRES)			0.54			0.54			0.54			0.54			0.54			0.54		
Species count			8	8	13	8	8	11	8	8	14	8	8	8	9	9	9	9	9	9
Stems per ACRE			505.9	505.9	1214	520.6	520.6	1056	498.5	498.5	1017	531.6	531.6	531.6	636.5	636.5	636.5	700.8	700.8	700.8

Color for Density

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%
- Volunteer species included in total

PnoLS: Number of Planted stems excluding live stakes
 P-all: Number of planted stems including live stakes
 T: Total Stems

APPENDIX 4. Morphological Summary Data and Plots

Table 10a. Baseline Stream Data Summary

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Irvin Creek Reaches 1 and 2

Parameter	Gage	Pre-Restoration Condition				Reference Reach Data								Design ¹				As-Built/Baseline			
		Irvin Creek Reach 1		Irvin Creek Reach 2		Collins Creek		UT to Belews Creed		UT to Rocky Creek		Spencer Creek		Irvin Creek Reach 1		Irvin Creek Reach 2		Irvin Creek Reach 1		Irvin Creek Reach 2	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																					
Bankfull Width (ft)	N/A	17.7		15.2	17.2	11.9	20.1	14.4	12.2	8.7	19.0	19.0	18.6	19.7	18.1	20.9					
Floodprone Width (ft)		21.0		18.0	21.0	60		200	72	229	80+	200+	200+	200+	200+	200+	200+				
Bankfull Mean Depth		1.5		1.9	2.0	1.6	2.7	2.0	1.3	1.2	1.6	1.6	1.6	1.7	1.6	1.6	1.6				
Bankfull Max Depth		1.8		2.4	2.6	3.3	4.2	2.7	1.8	1.9	2.2	2.2	2.4	2.6	2.4	2.4	2.4				
Bankfull Cross-sectional Area (ft ²)		27.3		30.6	32.8	32.9		27.4	16.3	10.6	29.7	29.7	29.3	33.7	29.0	32.7					
Width/Depth Ratio		11.5		8.0	8.6	4.4	12.1	7.6	9.1	7.3	12.0	12.0	11.5	11.8	11.3	13.3					
Entrenchment Ratio		1.2		1.2	1.2	2.0	3.0	34.7	6.0	26.3	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+					
Bank Height Ratio		1.9	3.3	2.3	2.5	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0				
d50 (mm)		32.8		24.2													22.6			18.6	
Profile																					
Riffle Length (ft)	N/A					-	-	-	-	-	-	-	-	-	-	-	18	92	17	73	
Riffle Slope (ft/ft)		0.0010	0.0250	0.0019	0.0170	0.0030	0.0080	-	0.0606	0.0892	0.0100	0.0670	0.0060	0.0080	0.0070	0.0147	0.0039	0.0215	0.0021	0.0280	
Pool Length (ft)																		32	141	46	85
Pool Max Depth (ft)		2.1	3.7	2.3	3.3	2.4	4.6	2.2	2.5	2.8	4.0	2.9	4.0	3.7	4.2	3.6	4.0				
Pool Spacing (ft) [^]		39	60	27	76	32	80	75	26	81	13	47	76	133	77	135	57	236	91	142	
Pool Volume (ft ³)																					
Pattern																					
Channel Beltwidth (ft)	N/A	39	81	46	94	-	31	32	-	24	52	57	152	58	154	52	151	49	86		
Radius of Curvature (ft)		57	114	100	251	-	16	27	-	5	22	38	57	38	58	38	59	38	62		
Rc:Bankfull Width (ft/ft)		3.2	6.4	6.6	14.6	-	2.2	4.1	-	1.5	2.8	1.8	3.1	1.8	3.1	2.0	3.1	2.0	3.2		
Meander Wave Length (ft)		86	175	175	348	-	71	101	-	54	196	152	228	154	231	150	235	166	229		
Meander Width Ratio		2.2	4.6	3.0	5.5	-	2.15	2.22	-	2.8	6.0	3.0	8.0	3.0	8.0	2.7	7.9	2.6	4.5		
Substrate, Bed and Transport Parameters																					
Ri%/Ru%/P%/G%/S%	N/A																				
SC%/Sa%/G%/C%/B%/Be%																					
d16/d35/d50/d84/d95/d100		0.1/0.6/15/56/98/>2048		0.1/0.3/5/25/31/45		N/A	N/A	N/A	N/A								SC/SC/23/49/64/128		SC/SC/19/49/79/180		
Reach Shear Stress (Competency) lb/ft ²		0.88		0.42									0.38	0.43	0.38	0.41		0.40			
Max part size (mm) mobilized at bankfull																					
Stream Power (Capacity) W/m ²																					
Additional Reach Parameters																					
Drainage Area (SM)	N/A	0.67	0.82	0.82	0.91	1.68	3.40	1.10	0.50	0.82	0.91	0.82	0.91	0.82	0.91						
Watershed Impervious Cover Estimate (%)		17		17		-	-	-	-	17	17	17	17	17	17	17					
Rosgen Classification		G4c		G4c		E4	E5	E4b	E4/C4	C4	C4	C	C	C	C						
Bankfull Velocity (fps)		3.3		3.0	3.3					3.0	3.3	2.7	3.1	3.1	3.4						
Bankfull Discharge (cfs)		90		100		115	150	125	85	N/A	90	100	90	100							
Q-NFF regression		110		126																	
Q-USGS extrapolation		-		-																	
Q-Mannings		122		99	102																
Valley Length (ft)		1,491		1,505																	
Channel Thalweg Length (ft)		1,640		1,505							2,057*	1,919*	2,095*	1,932*							
Sinuosity (ft)		1.1		1.0		-	1.2	1.1	1.1	1.3	1.2	1.3	1.2	1.3	1.2						
Water Surface Slope (ft/ft)		-		-		0.0030	0.0070	0.0235	0.0132	-	-	N/A ¹	N/A ¹	N/A ¹	N/A ¹						
Bankfull Slope (ft/ft)	0.0107		0.0043		-	-	-	-	0.0045	0.0049	0.0045	0.0049	0.0045	0.0047							

(-): Data was not provided

¹Design parameters were expanded during the final design phase.

*LF provided includes portions of the stream that will be monitored and has been reconstructed, but for which mitigation credit will not be claimed. Please refer to Table 1 in Appendix 1 for the credit summary lengths.

[^]Pool to pool spacing calculations were measured using the most downstream pool in the meander for the as-built compared to the design pool to pool spacing, which included pools and plunge pools in the min and max values.

Table 10b. Baseline Stream Data Summary
 Little Troublesome Creek Mitigation Site (DMS Project No. 94640)
 Monitoring Year 5 - 2016

Little Troublesome Creek and UT1

Parameter	Gage	Pre-Restoration Condition ¹				Reference Reach Data		Design ¹				As-Built/Baseline														
		UT1		Little Troublesome Creek		Min	Max	UT1 ²		Little Troublesome Creek		UT1 ²		Little Troublesome Creek												
		Min	Max	Min	Max			Min	Max	Min	Max	Min	Max	Min	Max											
Dimension and Substrate - Riffle																										
Bankfull Width (ft)	N/A	5.2		28.7		refer to table 5a	7.8		32.3		10.9		32.6		41.0											
Floodprone Width (ft)		8.0		93.0			100+		285+		36.7		200+													
Bankfull Mean Depth		1.2		2.6			0.6		2.7		0.5		2.2		2.7											
Bankfull Max Depth		1.9		3.3			0.9		3.8		1.0		4.1		4.17											
Bankfull Cross-sectional Area (ft ²)		6.4		73.6			5.0		86.6		5.1		77.4		87.1											
Width/Depth Ratio		4.3		11.2			12.0		12.0		23.0		12.2		15.47											
Entrenchment Ratio		1.5		3.2			2.2+		2.2+		2.2+		2.2+													
Bank Height Ratio		1.2	2.5	1.6	2.8		1.0		1.0		1.0		1.0													
d50 (mm)		0.8		9.7							0.4		20.7													
Profile																										
Riffle Length (ft)	N/A					refer to table 5a	-		-		11		26		79	142										
Riffle Slope (ft/ft) ¹		0.0072		0.0500			0.0185		0.0369		0.0066		0.0088		0.0231		0.0600		0.0063		0.0126					
Pool Length (ft)							-		-		18		48		88		159									
Pool Max Depth (ft)		2.2		3.3			3.2		5.3		1.2		5.9													
Pool Spacing (ft) ⁴		29		42			46		127		24		43		129		226		35		59		206		267	
Pool Volume (ft ³)																										
Pattern																										
Channel Beltwidth (ft)	N/A	-		119		refer to table 5a	27		62		113		258		27		62		113		258					
Radius of Curvature (ft)		-		103			313		16		23		65		97		16		23		65		97			
Rc:Bankfull Width (ft/ft)		-		3.6			10.9		2.0		3.0		2.0		3.0		2.0		3.0		2.0		3.0			
Meander Wave Length (ft)		-		179			315		62		94		258		388		62		94		258		388			
Meander Width Ratio		-		4.1					3.5		8.0		3.5		8.0		3.5		8.0		3.5		8.0			
Substrate, Bed and Transport Parameters																										
Ri%/Ru%/P%/G%/S%	N/A					refer to table 5a																				
SC%/Sa%/G%/C%/B%/Be%																										
d16/d35/d50/d84/d95/d100		SC/SC/SC/4/13/>2048		0.2/0.5/1/22/30/>2048									SC/SC/0.4/44/64/128		SC/C/21/62/110/180											
Reach Shear Stress (Competency) lb/ft ²		0.96		0.41					N/A ³		N/A ³		0.34		0.38		0.53									
Max part size (mm) mobilized at bankfull																										
Stream Power (Capacity) W/m ²																										
Additional Reach Parameters																										
Drainage Area (SM)	N/A	0.10		4.95		5.07		0.10		5.07		0.10		5.07												
Watershed Impervious Cover Estimate (%)		17		17		17		17		17		17		17												
Rosgen Classification		G5		C5		C5		C5		C5		C5		C5		C4										
Bankfull Velocity (fps)		4.4		5.0		2.7		4.3		2.7		4.2		4.8												
Bankfull Discharge (cfs)		14		370		14		370		14		370														
Q-NFF regression		-		422																						
Q-USGS extrapolation		-		-																						
Q-Mannings		-		237																						
Valley Length (ft)		184		982																						
Channel Thalweg Length (ft)		184		1,080				240		1,158*		233		1,171*												
Sinuosity (ft)		1.0		1.1				1.3		1.3		1.2		1.3												
Water Surface Slope (ft/ft)		-		-				-		-		N/A ¹		N/A ¹												
Bankfull Slope (ft/ft)		0.0183		0.0033				0.0123		0.0044		0.0126		0.0038												

(-): Data was not provided

¹Design parameters were expanded during the final design phase.

²Restoration approach was adjusted from a priority 1 to a priority 2 during the final design phase.

³The critical shear stress analysis was not performed on the sand bed channels.

*LF provided includes portions of the stream that will be monitored and has been reconstructed, but for which mitigation credit will not be claimed. Please refer to Table 1 in Appendix 1 for the credit summary lengths.

⁴Pool to pool spacing calculations were measured using the most downstream pool in the meander for the as-built compared to the design pool to pool spacing, which included pools and plunge pools in the min and max values.

Table 11 Morphology and Hydraulic Summary (Dimensional Parameters - Cross Section)

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Irvin Creek Reaches 1 and 2, Little Troublesome Creek, & UT1

Irvin Creek Reach 1																								
Cross Section 1 (Riffle)							Cross Section 2 (Pool)						Cross Section 3 (Pool)						Cross Section 4 (Riffle)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
<i>based on fixed bankfull elevation</i>	722.4						722.1						718.7						718.1					
Bankfull Width (ft)	18.6	17.7	17.5	17.5	17.5	15.2	19.9	18.0	18.3	16.5	14.7	14.6	31.1	31.1	34.5	31.0	28.9	29.3	19.7	20.2	25.5	20.5	19.3	19.2
Floodprone Width (ft)	200+	200+	200+	200+	200+	200+	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	200+	200+	200+	200+	200+	200+
Bankfull Mean Depth (ft)	1.6	1.5	1.5	1.4	1.3	1.5	1.9	2.2	2.4	2.7	2.9	3.3	1.9	1.9	1.6	1.7	1.6	1.7	1.7	1.7	1.3	1.4	1.4	1.4
Bankfull Max Depth (ft)	2.4	2.5	2.4	2.4	2.4	2.4	3.7	4.0	3.9	4.0	4.2	4.7	4.2	4.2	4.5	4.4	4.3	4.5	2.6	2.7	2.6	2.5	2.6	2.6
Bankfull Cross Sectional Area (ft ²)	29.3	27.2	26.0	24.5	22.4	22.2	36.8	38.6	43.1	44.0	42.7	48.2	57.6	57.6	56.5	51.2	46.4	48.5	33.7	34.4	33.0	28.8	27.3	27.5
Bankfull Width/Depth Ratio	11.8	11.6	11.8	12.6	13.6	10.4	10.7	8.4	7.8	6.2	5.0	4.4	16.8	16.8	21.1	18.8	18.0	17.8	11.5	11.9	19.8	14.6	13.6	13.4
Bankfull Entrenchment Ratio	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+
Bankfull Bank Height Ratio	1.0	1.0	1.0	1.1	1.1	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1
Irvin Creek Reach 2																								
Cross Section 5 (Pool)							Cross Section 6 (Riffle)						Cross Section 7 (Riffle)						Cross Section 8 (Pool)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
<i>based on fixed bankfull elevation</i>	713.7						713.9						710.5						710.2					
Bankfull Width (ft)	35.3	35.6	36.9	34.2	32.9	32.9	18.1	18.6	18.0	18.2	17.9	18.6	20.9	20.9	32.3	19.5	18.8	18.5	29.2	32.0	35.7	26.6	27.8	24.4
Floodprone Width (ft)	N/A	N/A	N/A	N/A	N/A	N/A	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	N/A	N/A	N/A	N/A	N/A	N/A
Bankfull Mean Depth (ft)	1.4	1.3	1.3	1.2	1.2	1.1	1.6	1.5	1.7	1.5	1.5	1.4	1.6	1.4	1.1	1.4	1.4	1.3	1.7	1.6	1.5	1.7	1.6	1.7
Bankfull Max Depth (ft)	4.0	4.1	4.2	4.1	4.0	4.1	2.4	2.5	2.6	2.4	2.4	2.4	2.4	2.4	2.7	2.4	2.4	2.3	3.6	3.6	3.9	3.7	3.8	3.8
Bankfull Cross Sectional Area (ft ²)	47.9	46.0	49.2	42.3	40.6	35.9	29.0	27.8	30.7	27.8	27.1	26.7	32.7	28.7	35.1	27.3	26.6	23.8	50.1	50.0	54.8	45.5	45.5	42.3
Bankfull Width/Depth Ratio	26.0	27.5	27.6	27.6	26.7	30.1	11.3	12.4	10.6	11.9	11.8	12.9	13.3	15.2	29.7	13.9	13.3	14.3	17.0	20.5	23.3	15.5	16.9	14.0
Bankfull Entrenchment Ratio	N/A	N/A	N/A	N/A	N/A	N/A	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	N/A	N/A	N/A	N/A	N/A	N/A
Bankfull Bank Height Ratio	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.1
UT1												Little Troublesome Creek												
Cross Section 9 (Riffle)							Cross Section 10 (Pool)						Cross Section 11 (Riffle)						Cross Section 12 (Pool)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
<i>based on fixed bankfull elevation</i>	707.5						707.2						708.9						707.5					
Bankfull Width (ft)	10.9	8.0	8.3	6.9	5.8	5.3	9.3	9.6	8.9	7.9	6.0	2.7	32.6	33.0	31.9	32.1	32.6	31.6	41.0	42.2	42.1	40.4	39.2	29.1
Floodprone Width (ft)	36.7	35.7	34.3	33.9	34.0	32.4	N/A	N/A	N/A	N/A	N/A	N/A	200+	200+	200+	200+	200+	200+	N/A	N/A	N/A	N/A	N/A	N/A
Bankfull Mean Depth (ft)	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.6	0.5	0.4	0.4	0.8	2.7	2.6	2.6	2.6	2.5	2.5	3.1	3.1	3.2	3.5	3.0	3.7
Bankfull Max Depth (ft)	1.0	1.0	1.0	0.9	0.9	0.9	1.2	1.2	1.1	1.2	1.1	1.0	4.1	4.0	3.9	3.9	4.0	3.9	5.9	6.5	7.4	8.3	6.6	6.4
Bankfull Cross Sectional Area (ft ²)	5.1	4.1	3.7	3.3	2.8	2.4	6.4	5.6	4.0	3.1	2.7	2.1	87.1	84.6	82.8	82.4	80.7	80.0	125.3	128.8	133.4	139.8	116.4	108.7
Bankfull Width/Depth Ratio	23.0	15.5	18.5	14.2	12.2	11.7	13.5	16.6	19.7	19.9	13.5	3.5	12.2	12.9	12.3	12.5	13.2	12.5	13.4	13.8	13.3	11.7	13.2	7.8
Bankfull Entrenchment Ratio	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	N/A	N/A	N/A	N/A	N/A	N/A	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	N/A	N/A	N/A	N/A	N/A	N/A
Bankfull Bank Height Ratio	1.0	1.0	1.0	1.1	1.2	1.2	1.0	1.0	1.0	1.0	1.0	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1
Little Troublesome Creek																								
Cross Section 13 (Riffle)																								
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5																		
<i>based on fixed bankfull elevation</i>	707.3																							
Bankfull Width (ft)	34.6	35.7	33.7	31.8	31.4	31.2																		
Floodprone Width (ft)	200+	200+	200+	200+	200+	200+																		
Bankfull Mean Depth (ft)	2.2	2.1	2.2	2.3	2.3	2.2																		
Bankfull Max Depth (ft)	4.2	3.9	3.9	3.9	4.0	4.3																		
Bankfull Cross Sectional Area (ft ²)	77.4	74.8	74.4	73.6	70.7	69.9																		
Bankfull Width/Depth Ratio	15.5	17.1	15.3	13.8	13.9	13.9																		
Bankfull Entrenchment Ratio	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+																		
Bankfull Bank Height Ratio	1.0	1.0	1.0	1.0	1.0	1.0																		

Table 12a. Monitoring Data - Stream Reach Data Summary

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Irvin Creek Reach 1

Parameter	As-Built/Baseline		MY1			MY2			MY3			MY4			MY5		
	Min	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Dimension and Substrate - Riffle																	
Bankfull Width (ft)	18.6	19.7	17.7	19.0	20.2	17.5	21.5	25.5	17.5	19.0	20.5	17.5	18.4	19.3	15.2	17.2	19.2
Floodprone Width (ft)	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+
Bankfull Mean Depth	1.6	1.7	1.5	1.6	1.7	1.3	1.4	1.5	1.4	1.4	1.4	1.3	1.4	1.4	1.4	1.5	1.5
Bankfull Max Depth	2.4	2.6	2.5	2.6	2.7	2.4	2.5	2.6	2.4	2.5	2.5	2.4	2.5	2.6	2.4	2.5	2.6
Bankfull Cross Sectional Area (ft ²)	29.3	33.7	27.2	30.8	34.4	26.0	29.5	33.0	24.5	26.7	28.8	22.4	24.9	27.3	22.2	24.9	27.5
Width/Depth Ratio	11.5	11.8	11.6	11.7	11.9	11.8	15.8	19.8	12.6	13.6	14.6	13.6	13.6	13.6	10.4	11.9	13.4
Entrenchment Ratio	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.1	1.2	1.2
D50 (mm)			35.0	-	44.2	23.7	-	41.1	13.1	-	29.3	16.9	-	19.2	10.3	-	15.5
Profile																	
Riffle Length (ft)	18	92	11	41	79	33	47	98	26	47	87	26	45	89	25	42	75
Riffle Slope (ft/ft)	0.0039	0.0215	0.0008	0.0075	0.0174	0.0038	0.0060	0.0117	0.0023	0.0102	0.0142	0.0020	0.0071	0.0181	0.0050	0.0077	0.0205
Pool Length (ft)	32	141	33	63	153	42	64	141	45	65	146	39	60	139	43	62	142
Pool Max Depth (ft)	3.7	4.2	4.0	4.2	4.3	3.9	4.2	4.5	4.0	4.2	4.4	4.2	4.3	4.3	4.5	4.6	4.7
Pool Spacing (ft)	57	236	63	105	227	86	120	203	81	115	278	78	108	216	86	96	217
Pool Volume (ft ³)																	
Pattern																	
Channel Beltwidth (ft)	52	151															
Radius of Curvature (ft)	38	59															
Rc:Bankfull Width (ft/ft)	2.0	3.1															
Meander Wave Length (ft)	150	235															
Meander Width Ratio	2.7	7.9															
Additional Reach Parameters																	
Rosgen Classification	C		C			C			C			C			C		
Channel Thalweg Length (ft)	2,095		2,095			2,095			2,095			2,095			2,095		
Sinuosity (ft)	1.3		1.3			1.3			1.3			1.3			1.3		
Water Surface Slope (ft/ft)	N/A		0.0044			0.0039			0.0038			0.0037			0.0039		
Bankfull Slope (ft/ft)	0.0045		0.0048			0.0043			0.0043			0.0041			0.0042		
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	SC/SC/23/49/64/128		0.2/0.7/10/38/58/362			0.1/0.5/2/47/80/128			0.2/0.7/2.0/26.9/43.1/256			0.3/1.0/5.6/28.5/58.6/180			0.4/0.9/2.8/27.6/53.7/90		
% of Reach with Eroding Banks			0%			0%			0%			0%			0%		

(-): Data was not provided

Table 12b. Monitoring Data - Stream Reach Data Summary

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Irvin Creek Reach 2

Parameter	As-Built/Baseline		MY1			MY2			MY3			MY4			MY5		
	Min	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Dimension and Substrate - Riffle																	
Bankfull Width (ft)	18.1	20.9	18.6	19.8	20.9	18.0	25.1	32.3	18.2	18.9	19.5	17.9	18.4	18.8	18.5	18.6	18.6
Floodprone Width (ft)	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+
Bankfull Mean Depth	1.6	1.6	1.4	1.5	1.5	1.1	1.4	1.7	1.4	1.5	1.5	1.4	1.5	1.5	1.3	1.4	1.4
Bankfull Max Depth	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.4	2.4
Bankfull Cross Sectional Area (ft ²)	29.0	32.7	27.8	28.3	28.7	30.7	32.9	35.1	27.3	27.6	27.8	26.6	26.9	27.1	23.8	25.3	26.7
Width/Depth Ratio	11.3	13.3	12.4	13.8	15.2	10.6	20.1	29.7	11.9	12.9	13.9	11.8	12.6	13.3	12.9	13.6	14.3
Entrenchment Ratio	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1
D50 (mm)			18.6	-	39.8	20.7	-	42.7	11.3	-	14.8	14	-	18.4	13.3	-	16.9
Profile																	
Riffle Length (ft)	17	73	21	59	72	29	59	72	35	59	79	30	59	79	35	57	80
Riffle Slope (ft/ft)	0.0021	0.0280	0.0026	0.0087	0.0149	0.0016	0.0078	0.0169	0.0040	0.0081	0.0151	0.0041	0.0085	0.0137	0.0043	0.0078	0.0136
Pool Length (ft)	46	85	52	64	89	42	66	109	52	64	87	44	58	83	49	64	94
Pool Max Depth (ft)	3.6	4.0	3.6	3.9	4.1	3.9	4.1	4.2	3.7	3.9	4.1	3.8	3.9	4.0	3.8	3.9	4.0
Pool Spacing (ft)	91	142	89	123	139	88	126	140	87	124	162	88	122	156	69	123	146
Pool Volume (ft ³)																	
Pattern																	
Channel Beltwidth (ft)	49	86															
Radius of Curvature (ft)	38	62															
Rc:Bankfull Width (ft/ft)	2	3															
Meander Wave Length (ft)	166	229															
Meander Width Ratio	3	5															
Additional Reach Parameters																	
Rosgen Classification	C		C			C			C			C			C		
Channel Thalweg Length (ft)	1,932		1,932			1,932			1,932			1,932			1,932		
Sinuosity (ft)	1.2		1.2			1.2			1.2			1.2			1.2		
Water Surface Slope (ft/ft)	N/A		0.0045			0.0048			0.0047			0.0046			0.0046		
Bankfull Slope (ft/ft)	0.0047		0.0049			0.0046			0.0050			0.0047			0.0045		
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	SC/SC/19/48/79/180		0.1/0.4/6/66/104/512			5/13/21/51/80/256			0.1/1.1/3.6/64/113.8/362			0.1/1.3/5.0/84.6/128/362			0.1/0.4/1.2/69.7/115/180		
% of Reach with Eroding Banks			0%			0%			0%			0%			0%		

(-): Data was not provided

Table 12c. Monitoring Data - Stream Reach Data Summary

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

UT1

Parameter	As-Built/Baseline		MY1			MY2			MY3			MY4			MY5		
	Min	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Dimension and Substrate - Riffle																	
Bankfull Width (ft)	10.9		8.0			8.3			6.9			5.8			5.3		
Floodprone Width (ft)	36.7		35.7			34.3			33.9			34.0			32.4		
Bankfull Mean Depth	0.5		0.5			0.5			0.5			0.5			0.5		
Bankfull Max Depth	1.0		1.0			1.0			0.9			0.9			0.9		
Bankfull Cross Sectional Area (ft ²)	5.1		4.1			3.7			3.3			2.8			2.4		
Width/Depth Ratio	23.0		15.5			18.5			14.2			12.2			11.7		
Entrenchment Ratio	2.2+		2.2+			2.2+			2.2+			2.2+			2.2+		
Bank Height Ratio	1.0		1.0			1.0			1.1			1.0			1.2		
D50 (mm)			13.3			42.4			36.7			36.7			50.2		
Profile																	
Riffle Length (ft)	11	26	14	20	31	9	17	28	21	25	27	9	33	36	5	12	69
Riffle Slope (ft/ft)	0.0231	0.0600	0.0089	0.0217	0.0448	0.0225	0.0274	0.0446	0.0070	0.0173	0.0235	0.0119	0.0172	0.0423	0.0084	0.0177	0.0209
Pool Length (ft)	18	48	15	23	36	20	28	43	17	27	31	17	25	26	8	18	34
Pool Max Depth (ft)	1.2		1.2			1.1			1.2			1.1			1.0		
Pool Spacing (ft)	35	59	43	52	62	47	58	60	36	-	67	36	44	52	16	24	58
Pool Volume (ft ³)																	
Pattern																	
Channel Beltwidth (ft)	27	62															
Radius of Curvature (ft)	16	23															
Rc:Bankfull Width (ft/ft)	2.0	3.0															
Meander Wave Length (ft)	62	94															
Meander Width Ratio	3.5	8.0															
Additional Reach Parameters																	
Rosgen Classification	C5		C5			C5			C5			C5			C5		
Channel Thalweg Length (ft)	233		233			233			233			233			233		
Sinuosity (ft)	1.2		1.2			1.2			1.2			1.2			1.2		
Water Surface Slope (ft/ft)	N/A		0.0120			0.0136			0.0093			0.0106			0.0123		
Bankfull Slope (ft/ft)	0.0126		0.0121			0.0108			0.0113			0.0108			0.0103		
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	SC/SC/0.4/44/64/128		SC/0.1/0.5/501/90/128			SC/0.4/0.9/43/76/180			SC/0.3/0.4/50.6/90/180			SC/1.2/1.8/34.3/57.6/90			0.2/0.6/4.2/86.2/180/256		
% of Reach with Eroding Banks			0%			0%			0%			0%			0%		

(-): Data was not provided

Table 12d. Monitoring Data - Stream Reach Data Summary

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Little Troublesome Creek

Parameter	As-Built/Baseline		MY1			MY2			MY3			MY4			MY5		
	Min	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Dimension and Substrate - Riffle																	
Bankfull Width (ft)	32.6	48.8	33.0	34.4	35.7	31.9	32.8	33.7	31.8	32.0	32.1	31.4	32.0	32.6	31.2	31.4	31.6
Floodprone Width (ft)	200+		200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+	200+
Bankfull Mean Depth	1.6	2.7	2.1	2.4	2.6	2.2	2.4	2.6	2.3	2.5	2.6	2.3	2.4	2.5	2.5	2.4	2.5
Bankfull Max Depth	4.1	4.2	3.9	4.0	4.0	3.9	3.9	3.9	3.9	3.9	3.9	4.0	4.0	4.0	3.9	4.1	4.3
Bankfull Cross Sectional Area (ft ²)	79.6	87.1	74.8	79.7	84.6	74.4	78.6	82.8	73.6	78.0	82.4	70.7	75.7	80.7	69.9	75.0	80.0
Width/Depth Ratio	12.2	30	12.9	15.0	17.1	12.3	13.8	15.3	12.5	13.2	13.8	13.2	13.6	13.9	12.5	13.2	13.9
Entrenchment Ratio	2.2+		0.0	-	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+
Bank Height Ratio	1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
d50 (mm)			32.7	-	39.7	41.8	-	47.3	34.5	-	35.0	40.2	-	44.2	40.2	-	44.3
Profile																	
Riffle Length (ft)	79	142	74	107	147	77	100	141	71	112	146	71	102	135	63	92	122
Riffle Slope (ft/ft)	0.0063	0.0126	0.0061	0.0071	0.0178	0.0056	0.0080	0.0127	0.0056	0.0080	0.0139	0.0045	0.0095	0.0153	0.0055	0.0085	0.0106
Pool Length (ft)	88	159	88	121	168	83	127	162	89	121	155	85	113	164	85	121	164
Pool Max Depth (ft)	5.9		6.5			7.4			8.3			6.6			6.4		
Pool Spacing (ft)	206	267	194	219	297	208	242	289	218	223	316	249	258	265	220	230	270
Pool Volume (ft ³)																	
Pattern																	
Channel Beltwidth (ft)	113	258															
Radius of Curvature (ft)	65	97															
Rc:Bankfull Width (ft/ft)	2.0	3.0															
Meander Wave Length (ft)	258	388															
Meander Width Ratio	3.5	8.0															
Additional Reach Parameters																	
Rosgen Classification	C4		C4			C4			C4			C4			C4		
Channel Thalweg Length (ft)	1,171		1,171			1,171			1,171			1,171			1,171		
Sinuosity (ft)	1.3		1.3			1.3			1.3			1.3			1.3		
Water Surface Slope (ft/ft)	N/A		0.0039			0.0038			0.0034			0.0038			0.0039		
Bankfull Slope (ft/ft)	0.0038		0.0039			0.0037			0.0030			0.0034			0.0034		
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	SC/SC/21/62/110/180		SC/0.3/8/74/165/512			0.1/0.3/0.7/60/130/362			0.3/1.2/73.4/196.6/362			SC/0.5/5.6/90.0/157.1/362			0.2/0.6/1.8/93.2/147/362		
% of Reach with Eroding Banks			0%			0%			4%			0%			3%		

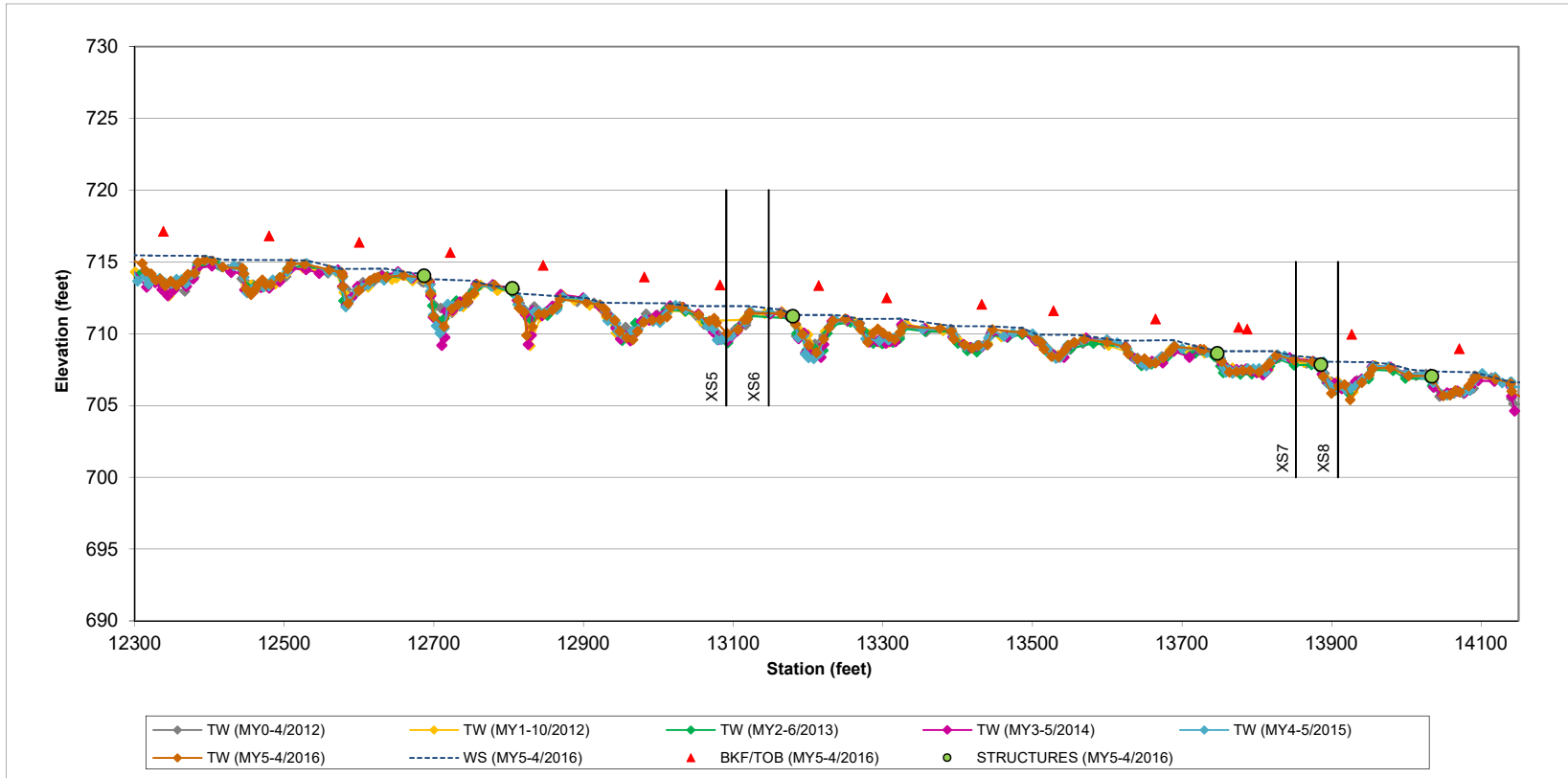
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Longitudinal Profile Plots

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Irvin Creek Reach 2

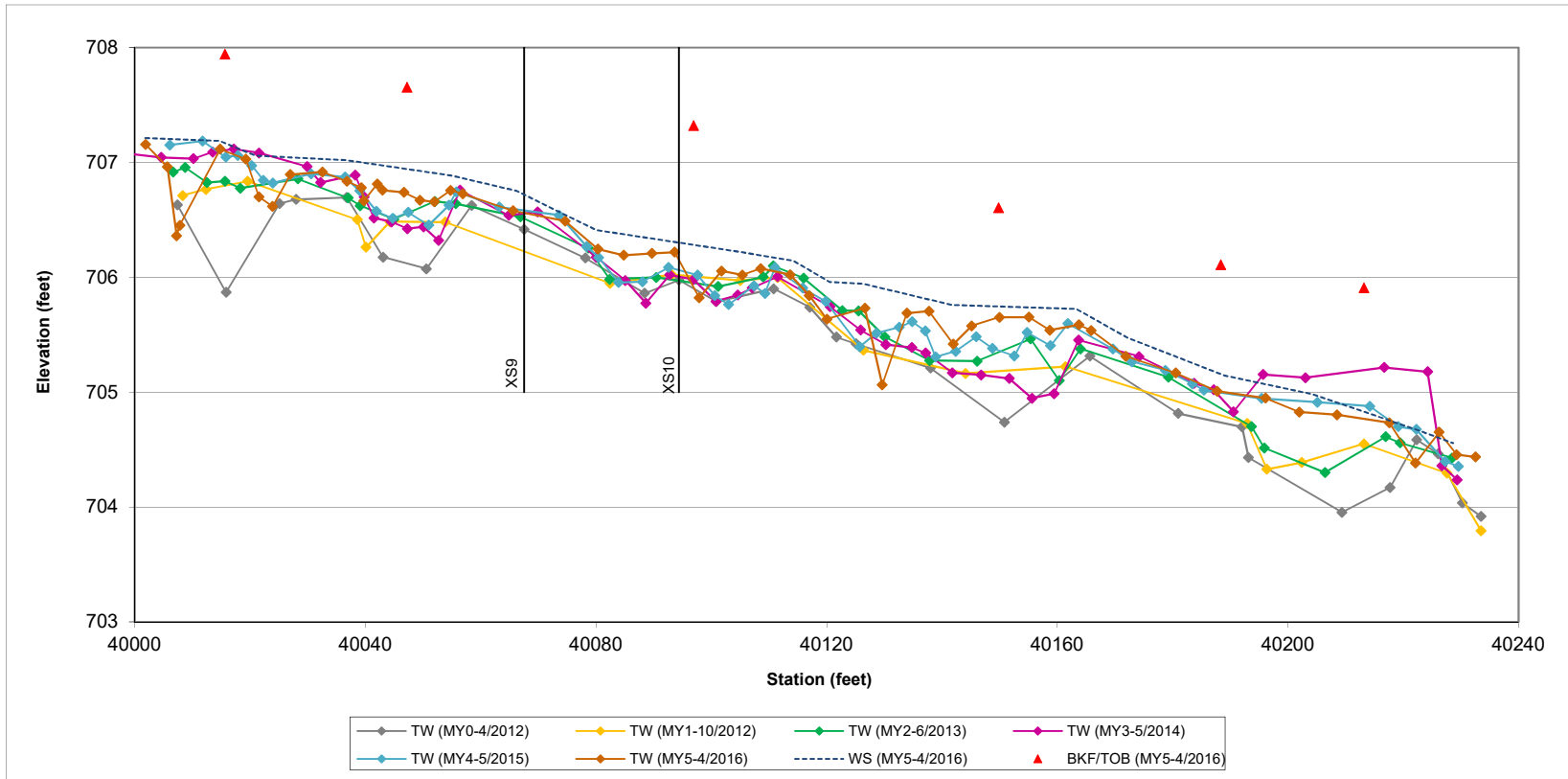


Longitudinal Profile Plots

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

UT1

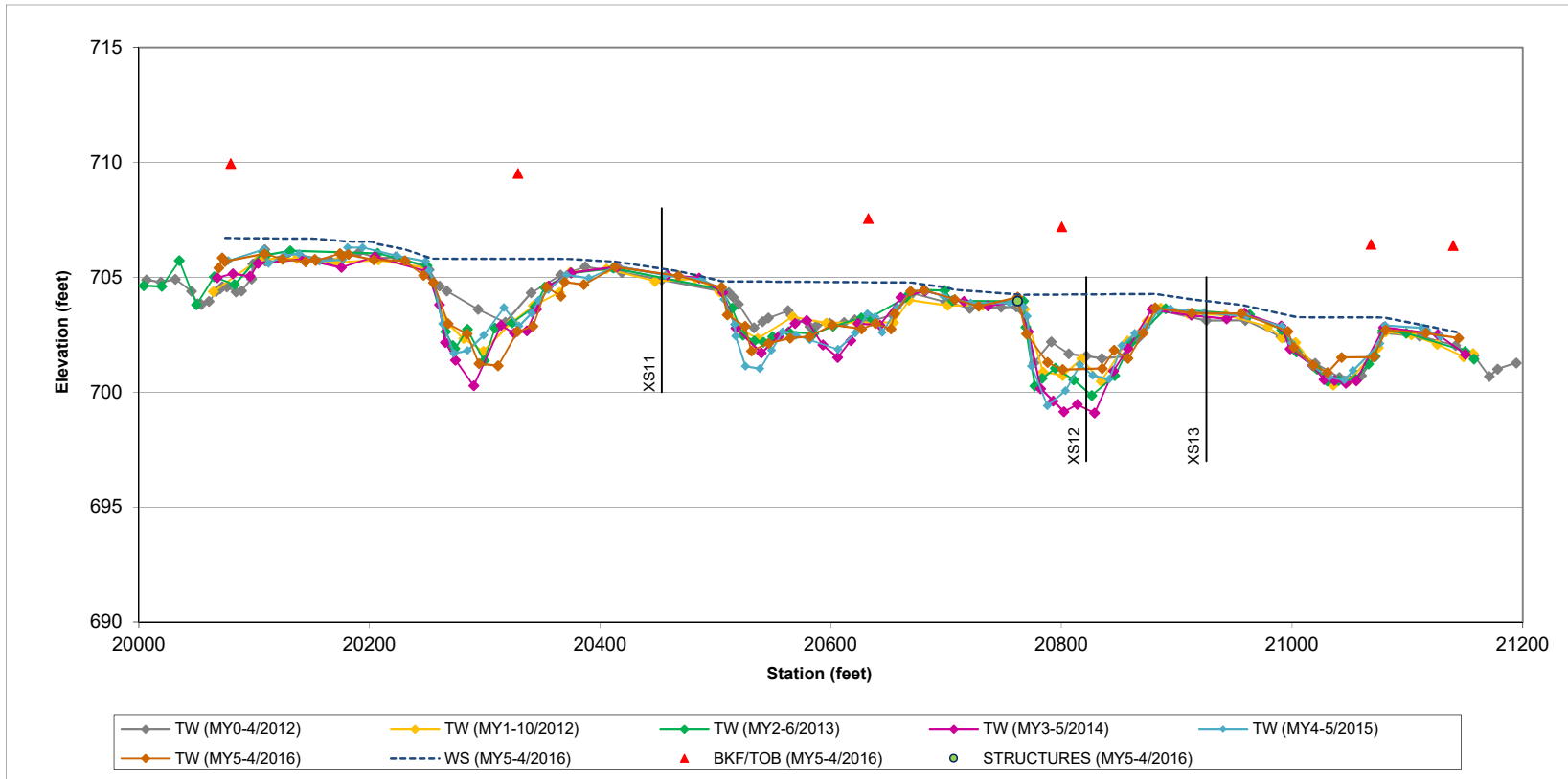


Longitudinal Profile Plots

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Little Troublesome Creek



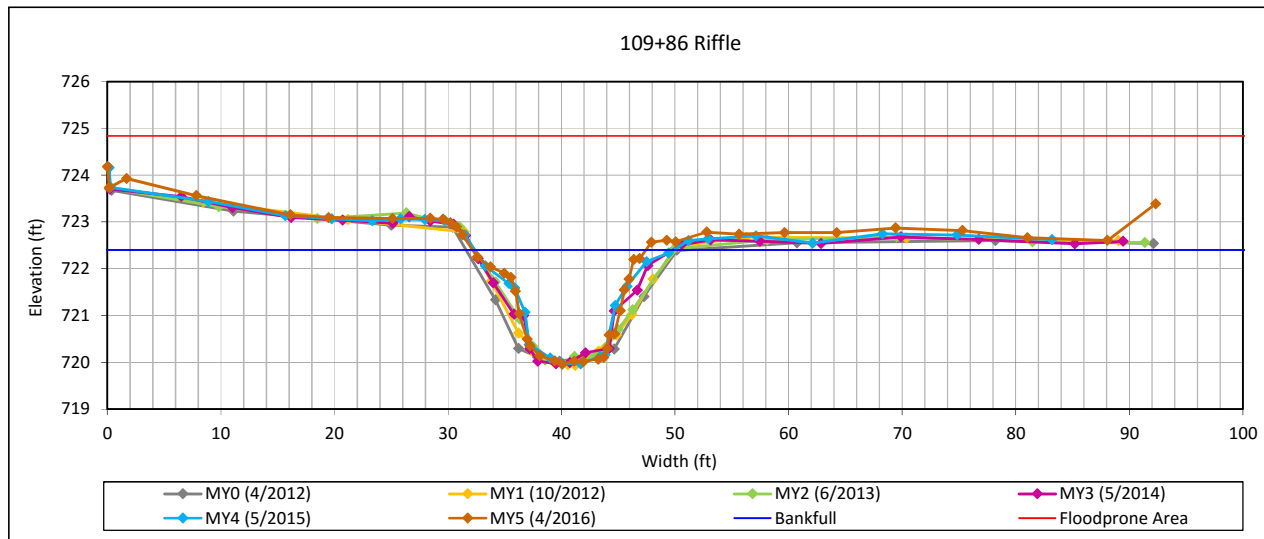
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 1 - Irvin Creek Reach 1



Bankfull Dimensions

22.2	x-section area (ft.sq.)
15.2	width (ft)
1.5	mean depth (ft)
2.4	max depth (ft)
16.8	wetted parameter (ft)
1.3	hydraulic radius (ft)
10.4	width-depth ratio
200.0	W flood prone area (ft)
13.1	entrenchment ratio
1.2	low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

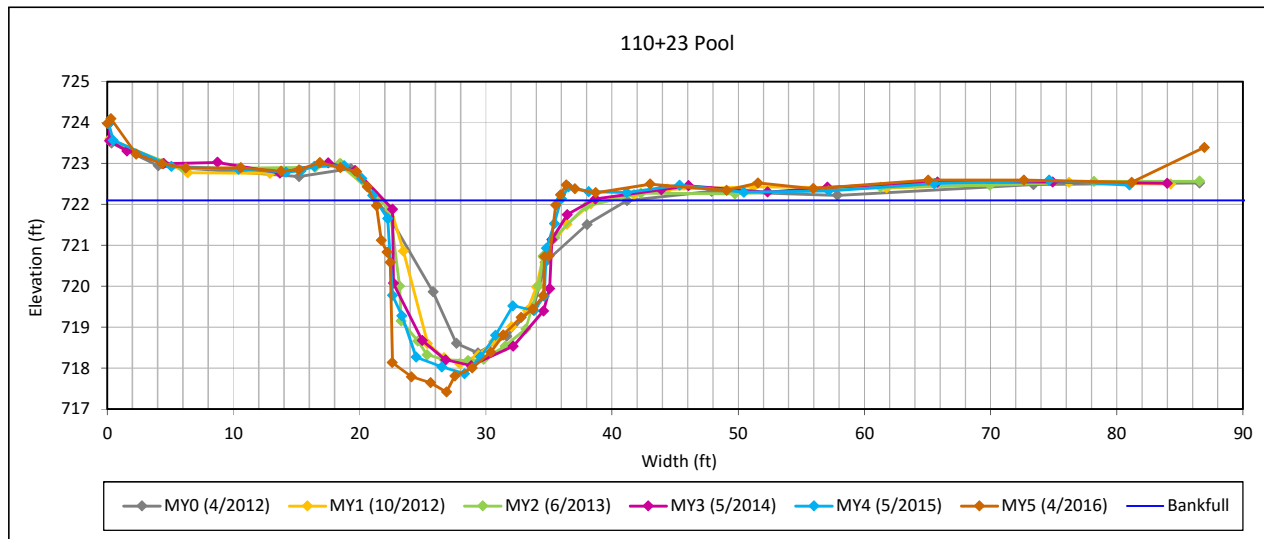
Cross Section Plots

Maney Farm Mitigation Project

DMS Project No.96314

Monitoring Year 5

Cross Section 2 - Irvin Creek Reach 1



Bankfull Dimensions

48.2	x-section area (ft.sq.)
14.6	width (ft)
3.3	mean depth (ft)
4.7	max depth (ft)
19.9	wetted perimeter (ft)
2.4	hydraulic radius (ft)
4.4	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
1.0	low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

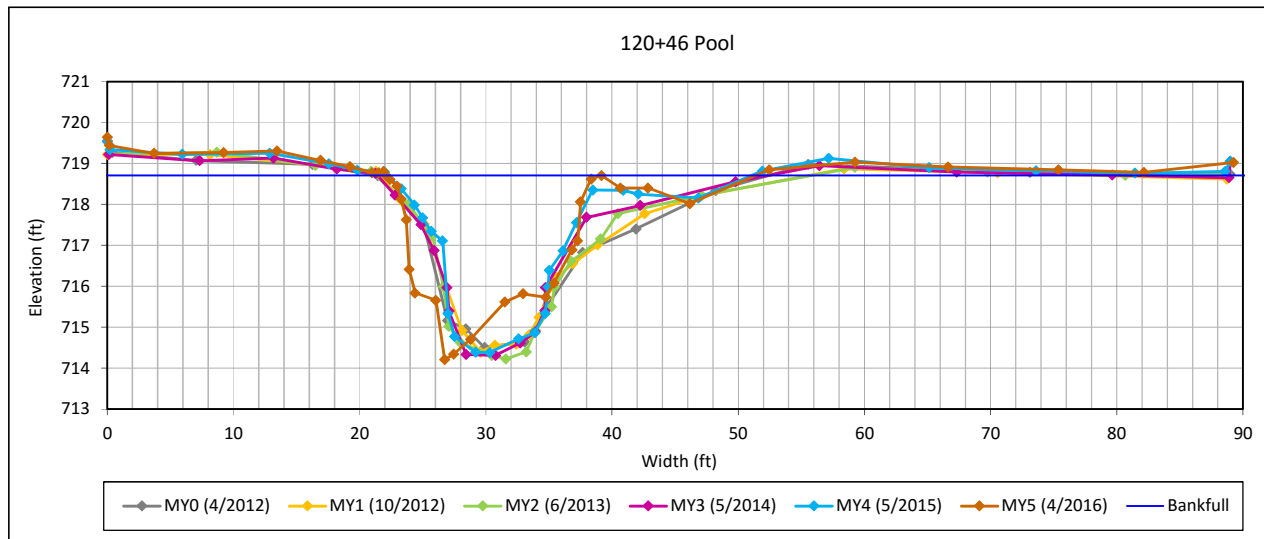
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 3 - Irvin Creek Reach 1



Bankfull Dimensions

48.5	x-section area (ft.sq.)
29.3	width (ft)
1.7	mean depth (ft)
4.5	max depth (ft)
33.5	wetted perimeter (ft)
1.4	hydraulic radius (ft)
17.8	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
1.0	low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

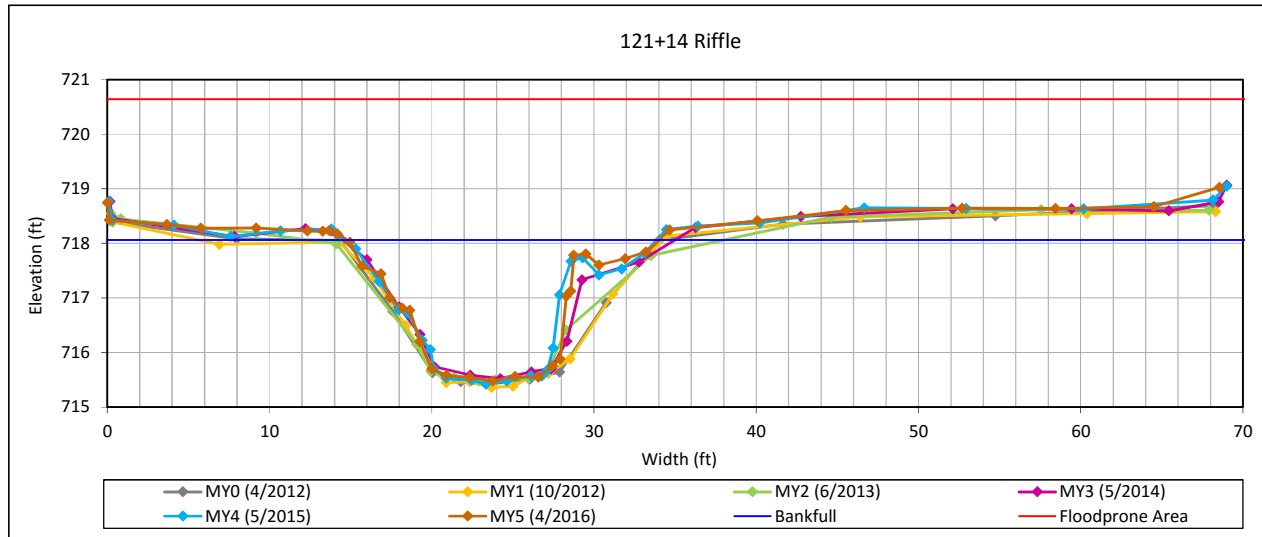
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 4 - Irvin Creek Reach 1



Bankfull Dimensions

27.5	x-section area (ft.sq.)
19.2	width (ft)
1.4	mean depth (ft)
2.6	max depth (ft)
21.4	wetted perimeter (ft)
1.3	hydraulic radius (ft)
13.4	width-depth ratio
200.0	W flood prone area (ft)
10.4	entrenchment ratio
1.1	low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

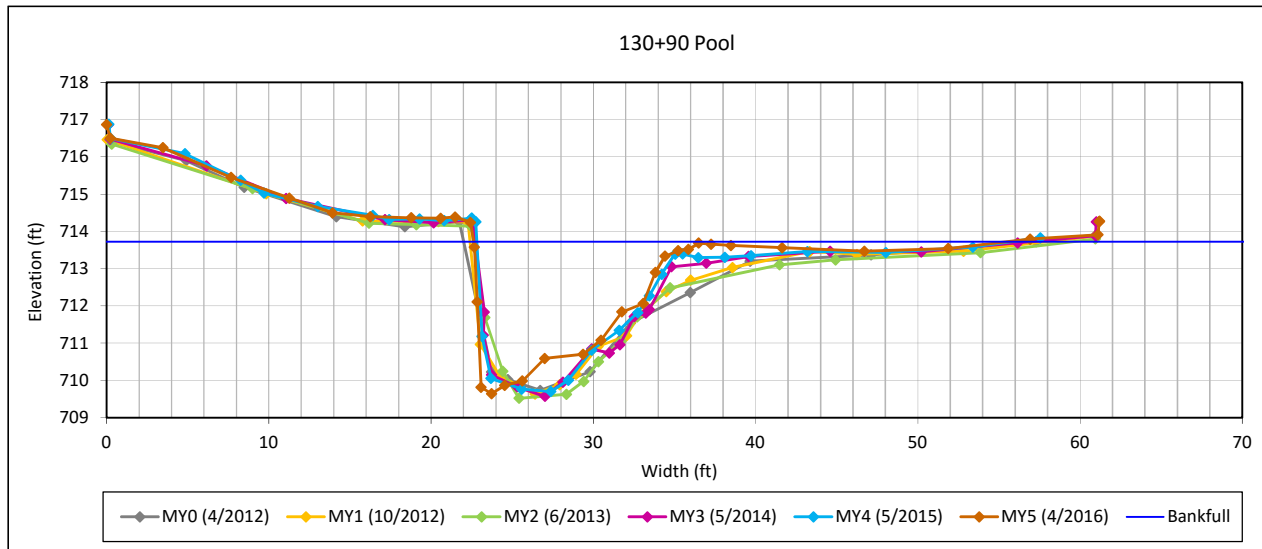
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 5 - Irvin Creek Reach 2



Bankfull Dimensions

35.9	x-section area (ft.sq.)
32.9	width (ft)
1.1	mean depth (ft)
4.1	max depth (ft)
37.4	wetted perimeter (ft)
1.0	hydraulic radius (ft)
30.1	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
1.0	low bank height ratio

Survey Date:

Field Crew: Wildlands Engineering



View Downstream

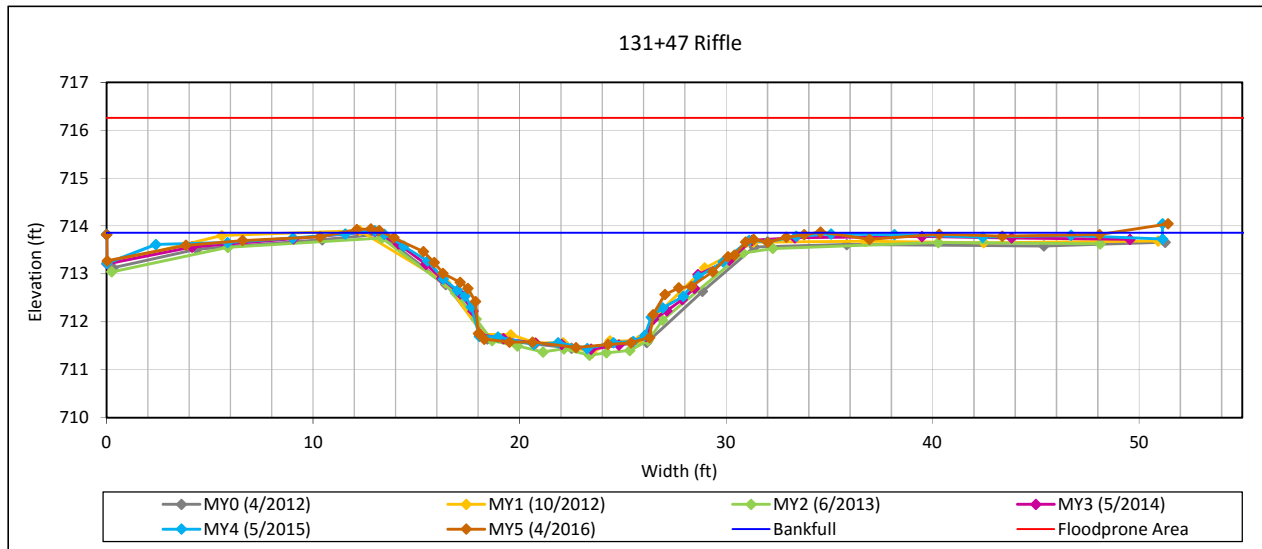
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 6 - Irvin Creek Reach 2



Bankfull Dimensions

26.7	x-section area (ft.sq.)
18.6	width (ft)
1.4	mean depth (ft)
2.4	max depth (ft)
20.1	wetted perimeter (ft)
1.3	hydraulic radius (ft)
12.9	width-depth ratio
200.0	W flood prone area (ft)
10.8	entrenchment ratio
1.0	low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

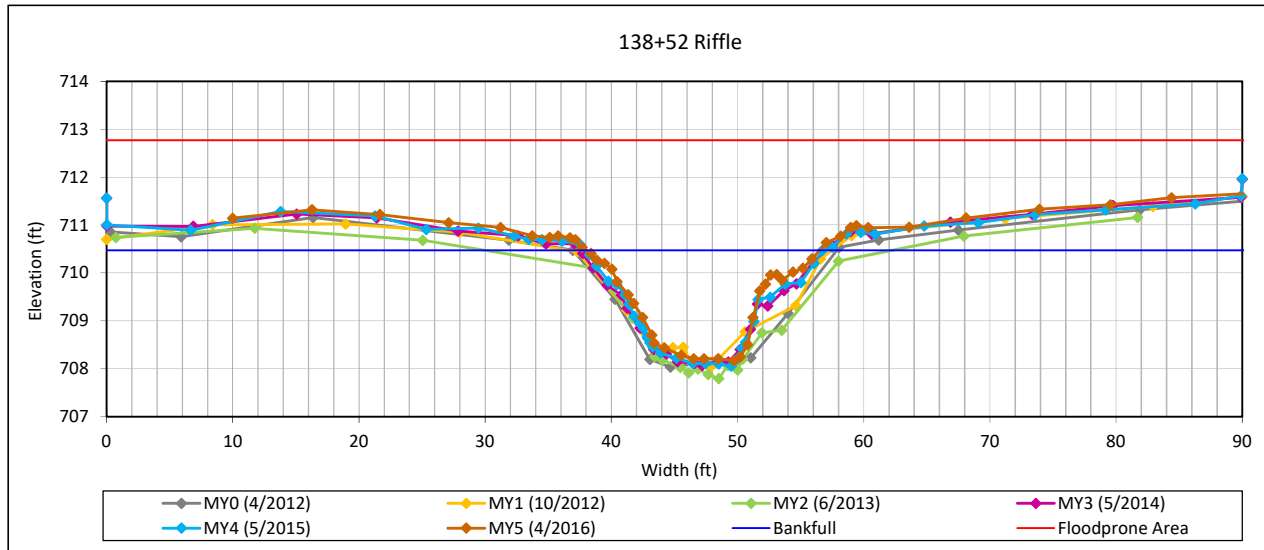
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 7 - Irvin Creek Reach 2



Bankfull Dimensions

23.8	x-section area (ft.sq.)
18.5	width (ft)
1.3	mean depth (ft)
2.3	max depth (ft)
19.6	wetted perimeter (ft)
1.2	hydraulic radius (ft)
14.3	width-depth ratio
200.0	W flood prone area (ft)
10.8	entrenchment ratio
1.1	low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

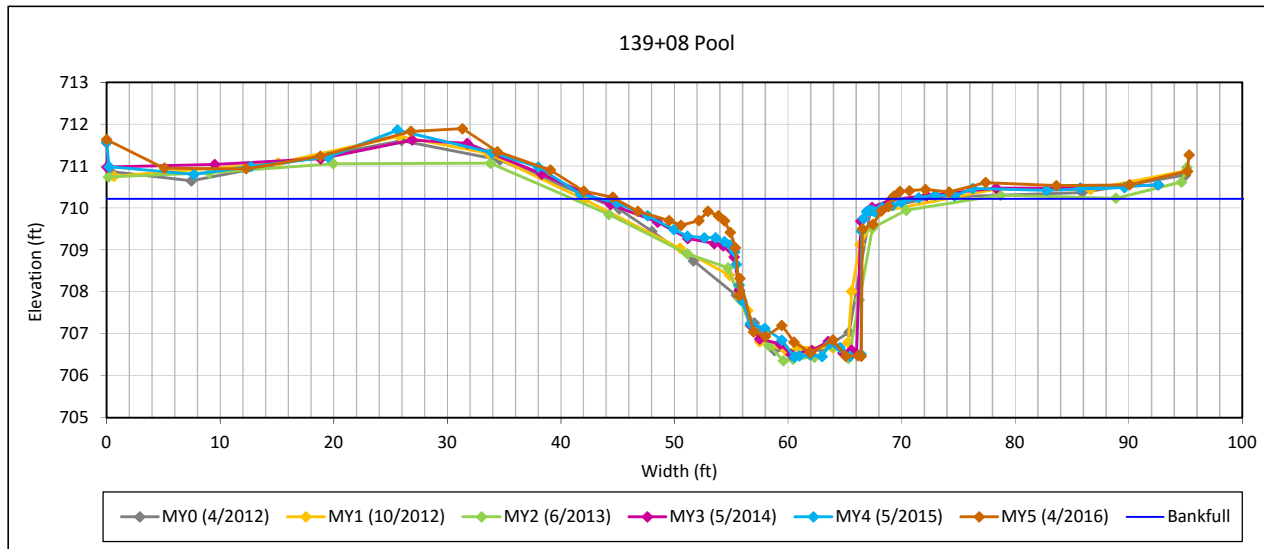
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 8 - Irvin Creek Reach 2



Bankfull Dimensions

42.3	x-section area (ft.sq.)
24.4	width (ft)
1.7	mean depth (ft)
3.8	max depth (ft)
29.7	wetted perimeter (ft)
1.4	hydraulic radius (ft)
14.0	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
1.1	low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

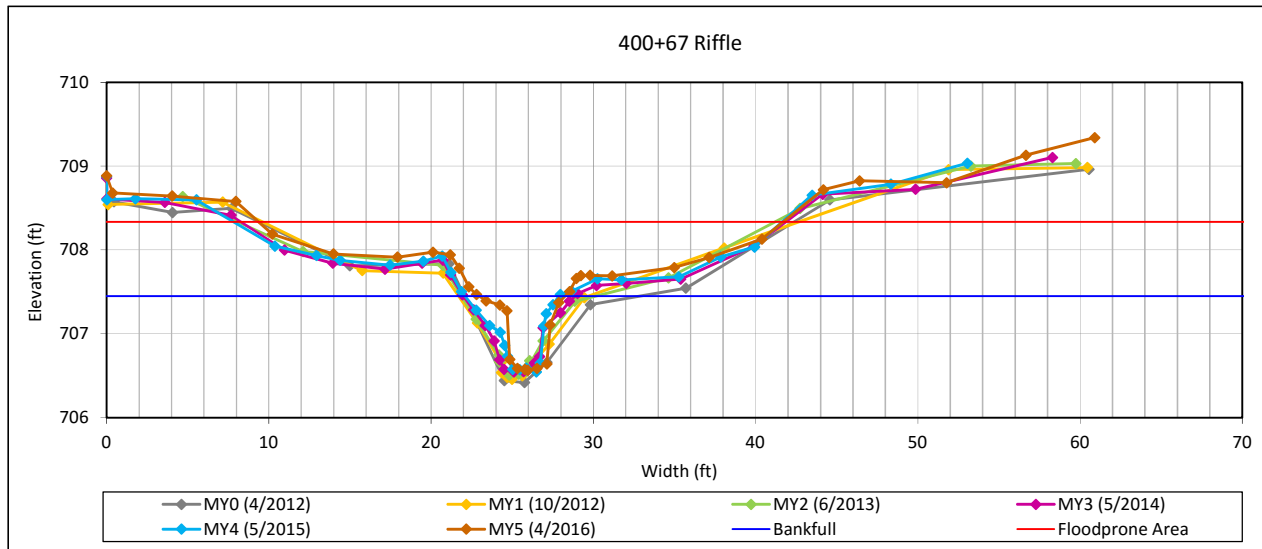
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 9 - UT1



Bankfull Dimensions

2.4	x-section area (ft.sq.)
5.3	width (ft)
0.5	mean depth (ft)
0.9	max depth (ft)
6.2	wetted perimeter (ft)
0.4	hydraulic radius (ft)
11.7	width-depth ratio
32.4	W flood prone area (ft)
6.1	entrenchment ratio
1.2	low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

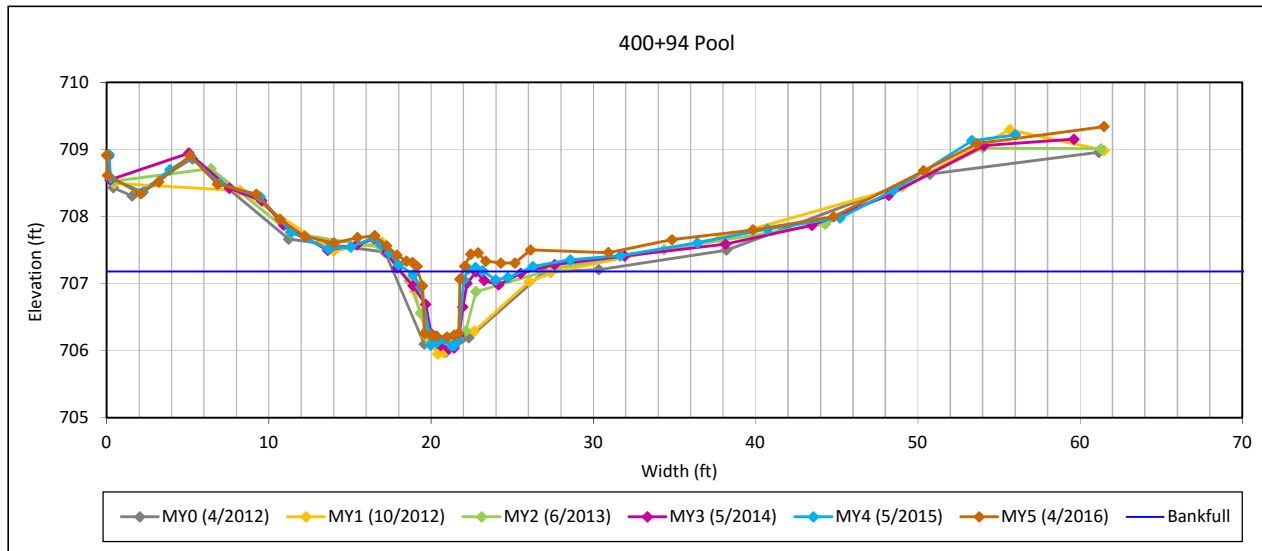
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 10 - UT1



Bankfull Dimensions

- 2.1 x-section area (ft.sq.)
- 2.7 width (ft)
- 0.8 mean depth (ft)
- 1.0 max depth (ft)
- 4.2 wetted perimeter (ft)
- 0.5 hydraulic radius (ft)
- 3.5 width-depth ratio
- W flood prone area (ft)
- entrenchment ratio
- 1.2 low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

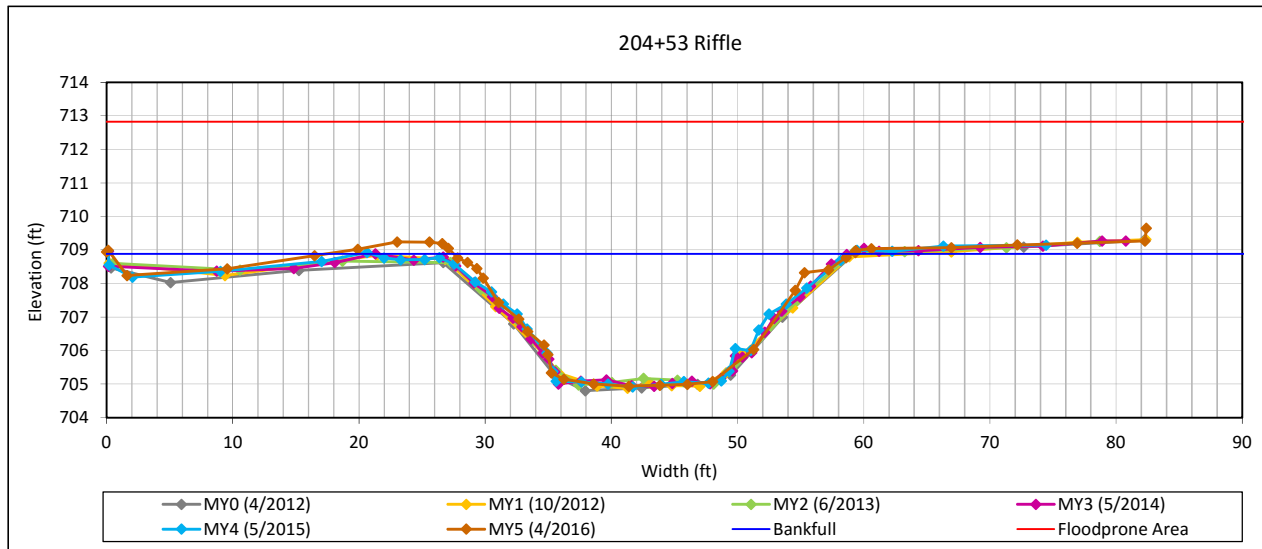
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 11 - Little Troublesome Creek



Bankfull Dimensions

80.0	x-section area (ft.sq.)
31.6	width (ft)
2.5	mean depth (ft)
3.9	max depth (ft)
33.5	wetted perimeter (ft)
2.4	hydraulic radius (ft)
12.5	width-depth ratio
200.0	W flood prone area (ft)
6.3	entrenchment ratio
1.0	low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

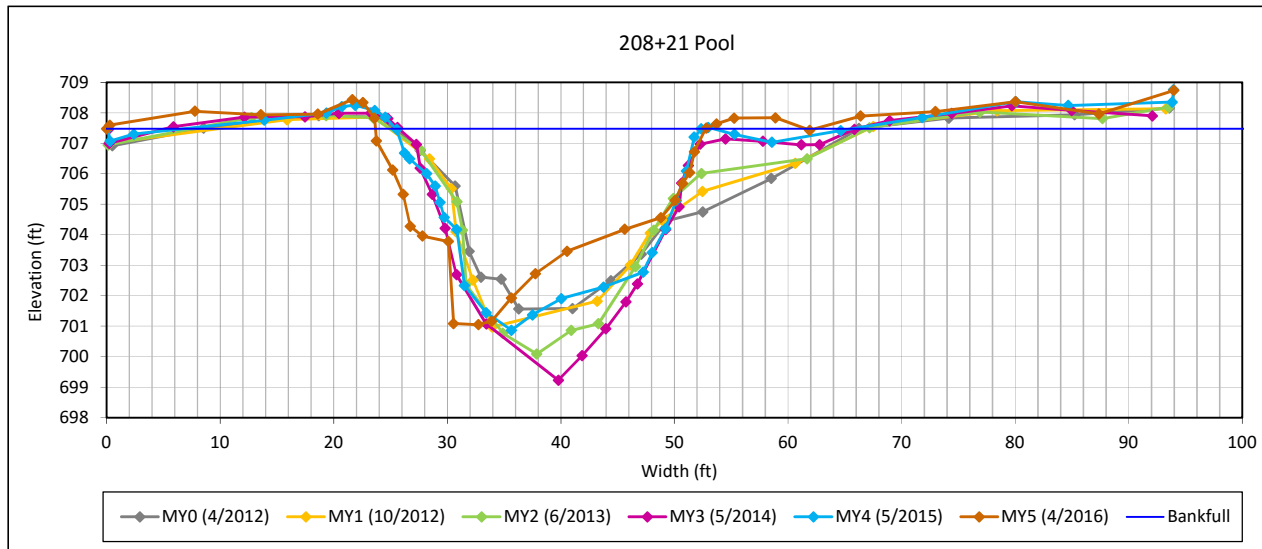
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 12 - Little Troublesome Creek



Bankfull Dimensions

108.7	x-section area (ft.sq.)
29.1	width (ft)
3.7	mean depth (ft)
6.4	max depth (ft)
34.5	wetted perimeter (ft)
3.2	hydraulic radius (ft)
7.8	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
1.1	low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

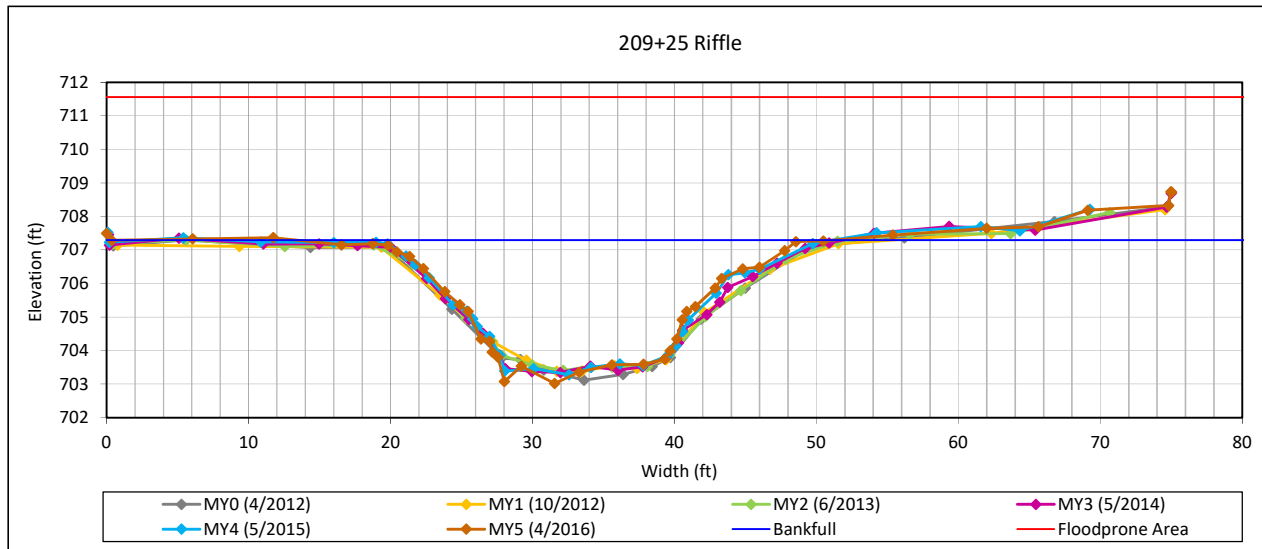
Cross Section Plots

Little Troublesome Creek Mitigation Site

DMS Project No.94640

Monitoring Year 5

Cross Section 13 - Little Troublesome Creek



Bankfull Dimensions

69.9	x-section area (ft.sq.)
31.2	width (ft)
2.2	mean depth (ft)
4.3	max depth (ft)
33.6	wetted perimeter (ft)
2.1	hydraulic radius (ft)
13.9	width-depth ratio
200.0	W flood prone area (ft)
6.4	entrenchment ratio
1.0	low bank height ratio

Survey Date: 4/2016

Field Crew: Wildlands Engineering



View Downstream

Reachwide and Cross Section Substrate Plots

Little Troublesome Creek Mitigation Site

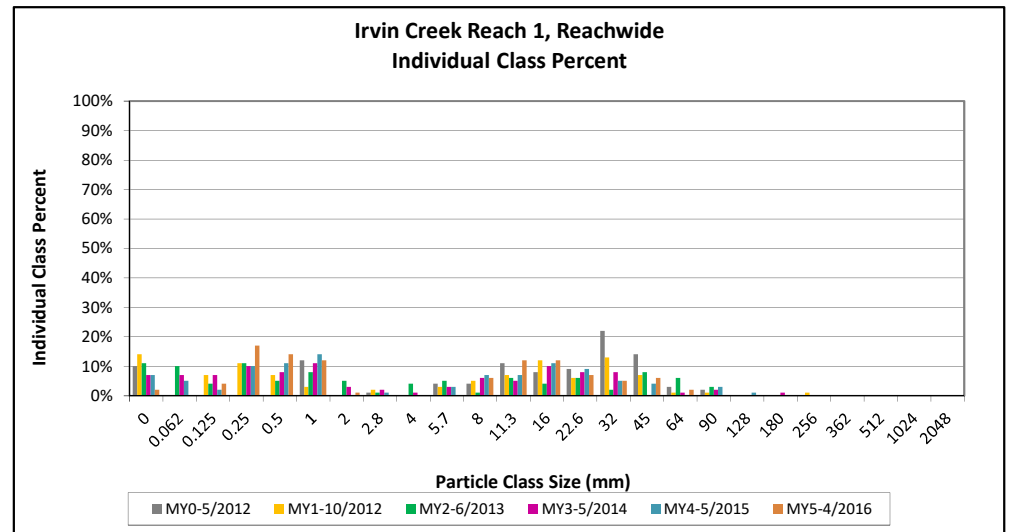
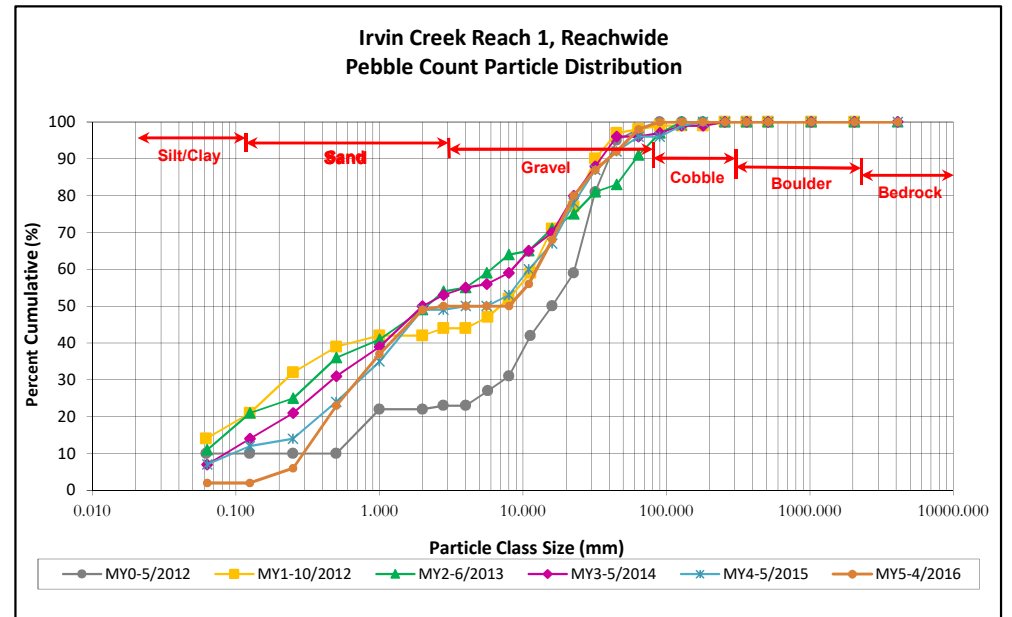
DMS Project No. 94640

Monitoring Year 5 - 2016

Irvin Creek Reach 1, Reachwide

Particle Class		Diameter (mm)		Particle Count			Irvin Creek Reach 1 Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
<i>SILT/CLAY</i>	Silt/Clay	0.000	0.062		2	2	2	2
<i>SAND</i>	Very fine	0.062	0.125					2
	Fine	0.125	0.250		4	4	4	6
	Medium	0.250	0.500	1	16	17	17	23
	Coarse	0.5	1.0	1	13	14	14	37
	Very Coarse	1.0	2.0	1	11	12	12	49
<i>GRAVEL</i>	Very Fine	2.0	2.8	1		1	1	50
	Very Fine	2.8	4.0					50
	Fine	4.0	5.7					50
	Fine	5.7	8.0					50
	Medium	8.0	11.3	4	2	6	6	56
	Medium	11.3	16.0	11	1	12	12	68
	Coarse	16.0	22.6	11	1	12	12	80
	Coarse	22.6	32	7		7	7	87
	Very Coarse	32	45	5		5	5	92
	Very Coarse	45	64	6		6	6	98
<i>COBBLE</i>	Small	64	90	2		2	2	100
	Small	90	128					100
	Large	128	180					100
	Large	180	256					100
<i>BOULDER</i>	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
<i>BEDROCK</i>	Bedrock	2048	>2048					100
Total				50	50	100	100	100

Reachwide Channel materials (mm)	
D ₁₆ =	0.38
D ₃₅ =	0.91
D ₅₀ =	2.8
D ₈₄ =	27.6
D ₉₅ =	53.7
D ₁₀₀ =	90.0



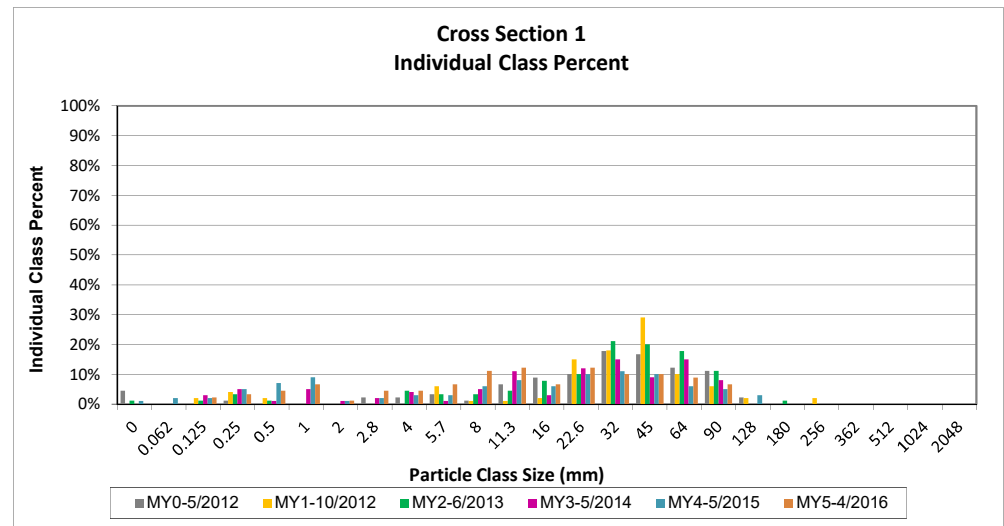
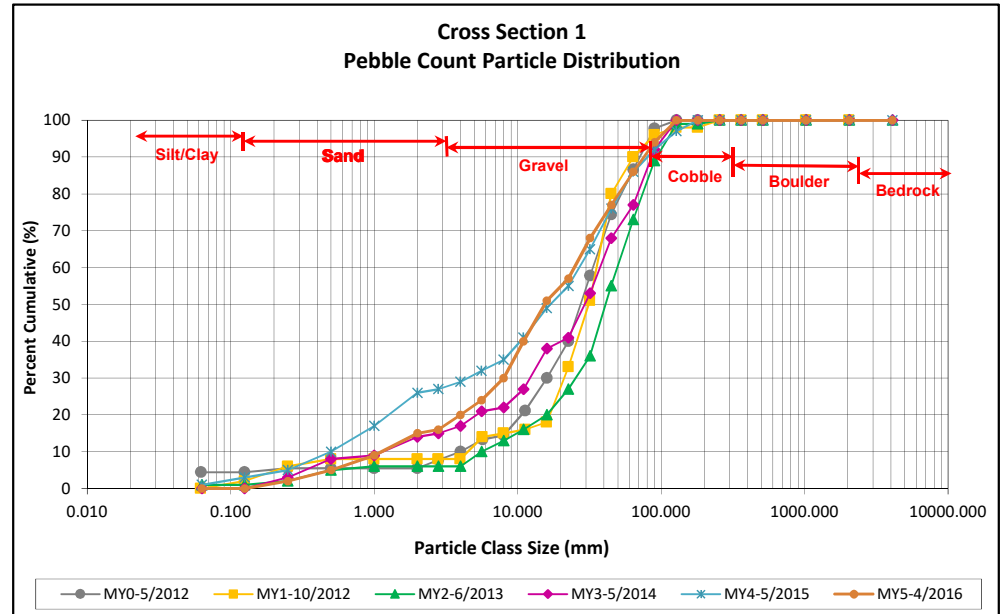
Reachwide and Cross Section Substrate Plots

Little Troublesome Creek Mitigation Site
 DMS Project No. 94640
 Monitoring Year 5 - 2016

Irvin Creek Reach 1, Cross Section 1

Particle Class		Diameter (mm)		Particle Count	Cross Section 1 Summary	
		min	max		Total	Class Percentage
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250	2	2	2
	Medium	0.250	0.500	3	3	5
	Coarse	0.5	1.0	4	4	9
	Very Coarse	1.0	2.0	6	6	15
GRAVEL	Very Fine	2.0	2.8	1	1	16
	Very Fine	2.8	4.0	4	4	20
	Fine	4.0	5.7	4	4	24
	Fine	5.7	8.0	6	6	30
	Medium	8.0	11.3	10	10	40
	Medium	11.3	16.0	11	11	51
	Coarse	16.0	22.6	6	6	57
	Coarse	22.6	32	11	11	68
	Very Coarse	32	45	9	9	77
Very Coarse	45	64	9	9	86	
COBBLE	Small	64	90	8	8	94
	Small	90	128	6	6	100
	Large	128	180			100
	Large	180	256			100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
Total				100	100	100

Cross Section 1	
Channel materials (mm)	
D ₁₆ =	2.8
D ₃₅ =	9.4
D ₅₀ =	15.5
D ₈₄ =	59.2
D ₉₅ =	95.4
D ₁₀₀ =	128.0



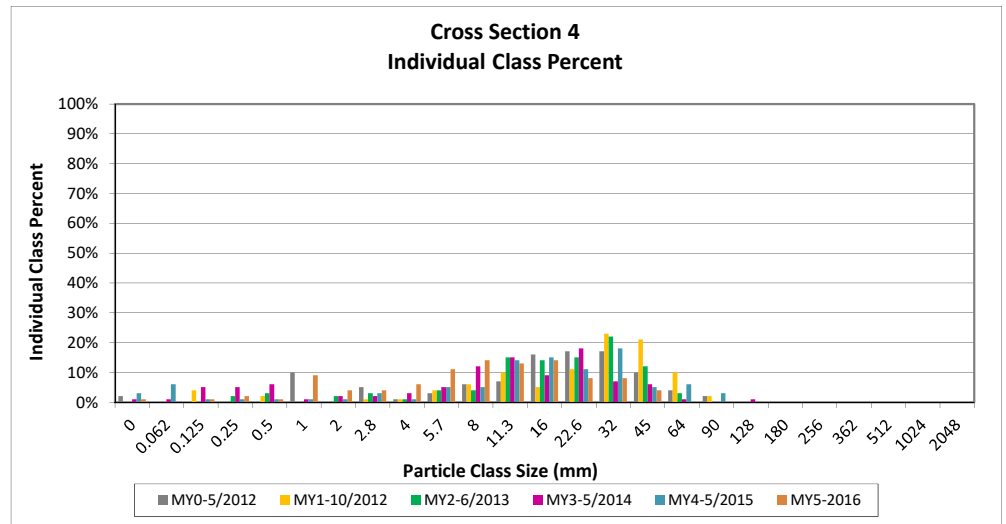
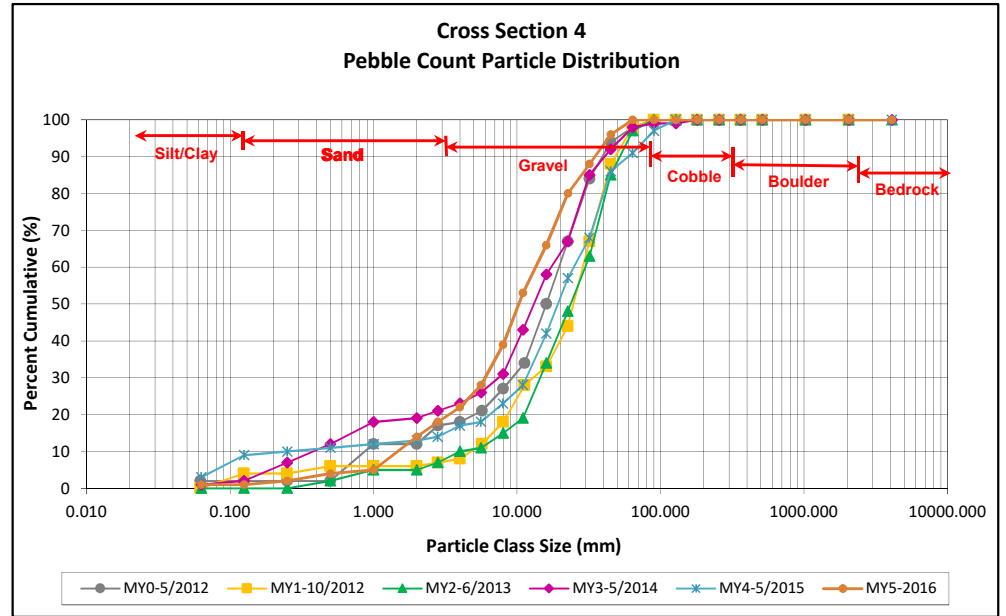
Reachwide and Cross Section Substrate Plots

Little Troublesome Creek Mitigation Site
 DMS Project No. 94640
 Monitoring Year 5 - 2016

Irvin Creek Reach 1, Cross Section 4

Particle Class		Diameter (mm)		Particle Count	Cross Section 4 Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	1	1	1
SAND	Very fine	0.062	0.125			1
	Fine	0.125	0.250	1	1	2
	Medium	0.250	0.500	2	2	4
	Coarse	0.5	1.0	1	1	5
	Very Coarse	1.0	2.0	9	9	14
GRAVEL	Very Fine	2.0	2.8	4	4	18
	Very Fine	2.8	4.0	4	4	22
	Fine	4.0	5.7	6	6	28
	Fine	5.7	8.0	11	11	39
	Medium	8.0	11.3	14	14	53
	Medium	11.3	16.0	13	13	66
	Coarse	16.0	22.6	14	14	80
	Coarse	22.6	32	8	8	88
	Very Coarse	32	45	8	8	96
	Very Coarse	45	64	4	4	100
COBBLE	Small	64	90			100
	Small	90	128			100
	Large	128	180			100
	Large	180	256			100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
Total				100	100	100

Cross Section 4 Channel materials (mm)	
D ₁₆ =	2.4
D ₃₅ =	7.0
D ₅₀ =	10.3
D ₈₄ =	26.9
D ₉₅ =	43.1
D ₁₀₀ =	64.0



Reachwide and Cross Section Substrate Plots

Little Troublesome Creek Mitigation Site

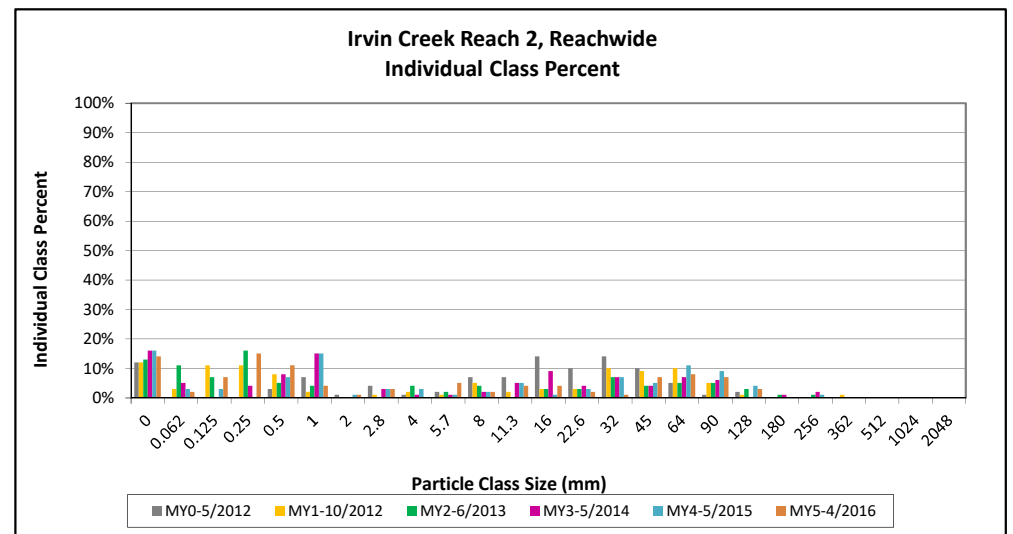
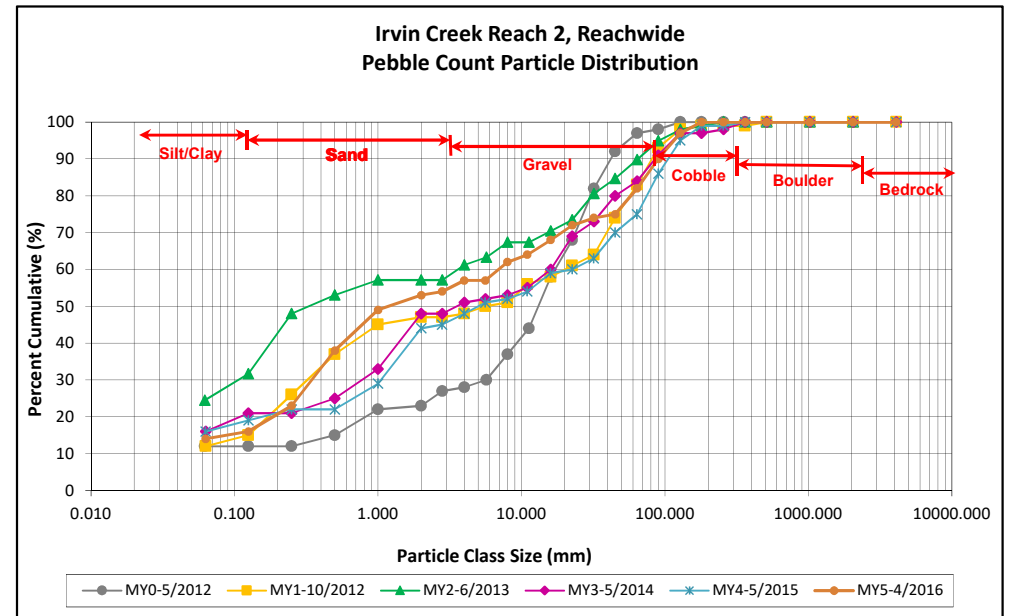
DMS Project No. 94640

Monitoring Year 5 - 2016

Irvin Creek Reach 2, Reachwide

Particle Class		Diameter (mm)		Particle Count			Irvin Creek Reach 2 Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		14	14	14	14
SAND	Very fine	0.062	0.125		2	2	2	16
	Fine	0.125	0.250		7	7	7	23
	Medium	0.250	0.500	1	14	15	15	38
	Coarse	0.5	1.0	2	9	11	11	49
	Very Coarse	1.0	2.0	3	1	4	4	53
GRAVEL	Very Fine	2.0	2.8		1	1	1	54
	Very Fine	2.8	4.0	1	2	3	3	57
	Fine	4.0	5.7					57
	Fine	5.7	8.0	5		5	5	62
	Medium	8.0	11.3	2		2	2	64
	Medium	11.3	16.0	4		4	4	68
	Coarse	16.0	22.6	4		4	4	72
	Coarse	22.6	32	2		2	2	74
	Very Coarse	32	45	1		1	1	75
	Very Coarse	45	64	7		7	7	82
COBBLE	Small	64	90	8		8	8	90
	Small	90	128	7		7	7	97
	Large	128	180	3		3	3	100
	Large	180	256					100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
Total				50	50	100	100	100

Reachwide Channel materials (mm)	
D ₁₆ =	0.1
D ₃₅ =	0.4
D ₅₀ =	1.2
D ₈₄ =	69.7
D ₉₅ =	115.7
D ₁₀₀ =	180.0



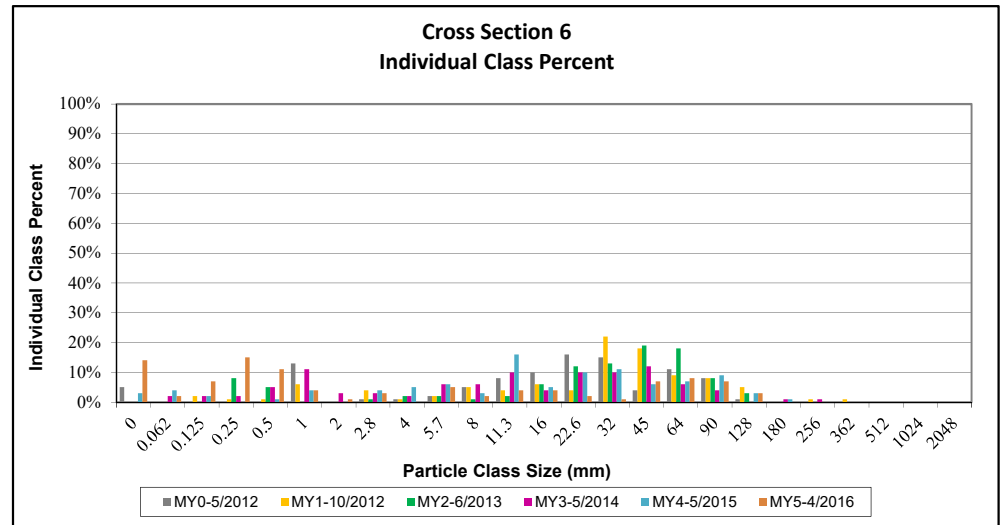
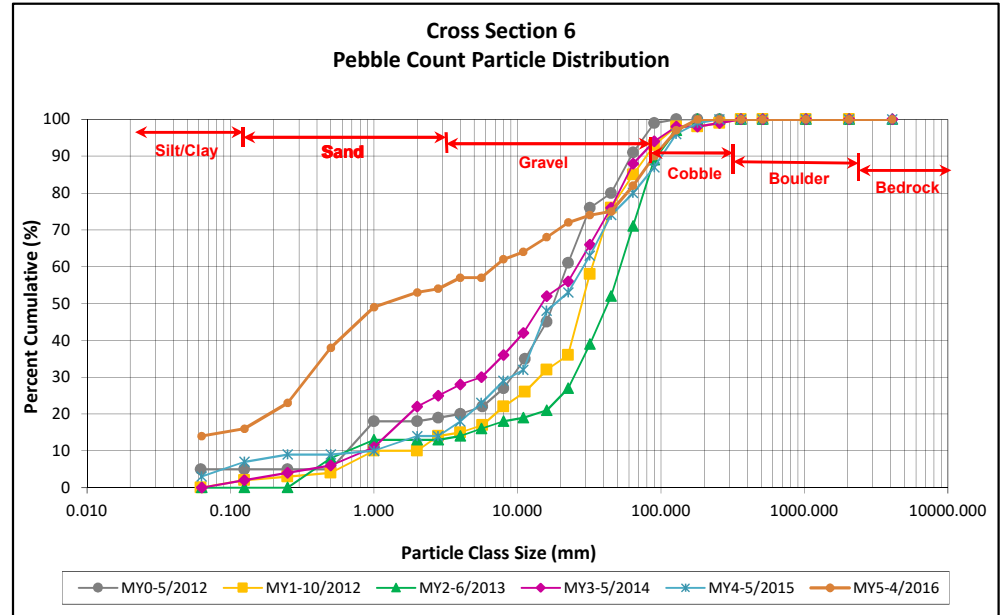
Reachwide and Cross Section Substrate Plots

Little Troublesome Creek Mitigation Site
 DMS Project No. 94640
 Monitoring Year 5 - 2016

Irvin Creek Reach 2, Cross Section 6 (Riffle)

Particle Class		Diameter (mm)		Particle Count	Cross Section 6 Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	1	1	1
SAND	Very fine	0.062	0.125			1
	Fine	0.125	0.250			1
	Medium	0.250	0.500			1
	Coarse	0.5	1.0			1
	Very Coarse	1.0	2.0			1
GRAVEL	Very Fine	2.0	2.8	6	6	7
	Very Fine	2.8	4.0	4	4	11
	Fine	4.0	5.7	3	3	14
	Fine	5.7	8.0	7	7	21
	Medium	8.0	11.3	10	10	31
	Medium	11.3	16.0	17	17	48
	Coarse	16.0	22.6	13	13	61
	Coarse	22.6	32	13	13	74
	Very Coarse	32	45	5	5	79
	Very Coarse	45	64	8	8	87
COBBLE	Small	64	90	9	9	96
	Small	90	128	2	2	98
	Large	128	180	2	2	100
	Large	180	256			100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
Total				100	100	100

Cross Section 6 Channel materials (mm)	
D ₁₆ =	6.2
D ₃₅ =	12.0
D ₅₀ =	16.9
D ₈₄ =	56.1
D ₉₅ =	86.7
D ₁₀₀ =	180.0



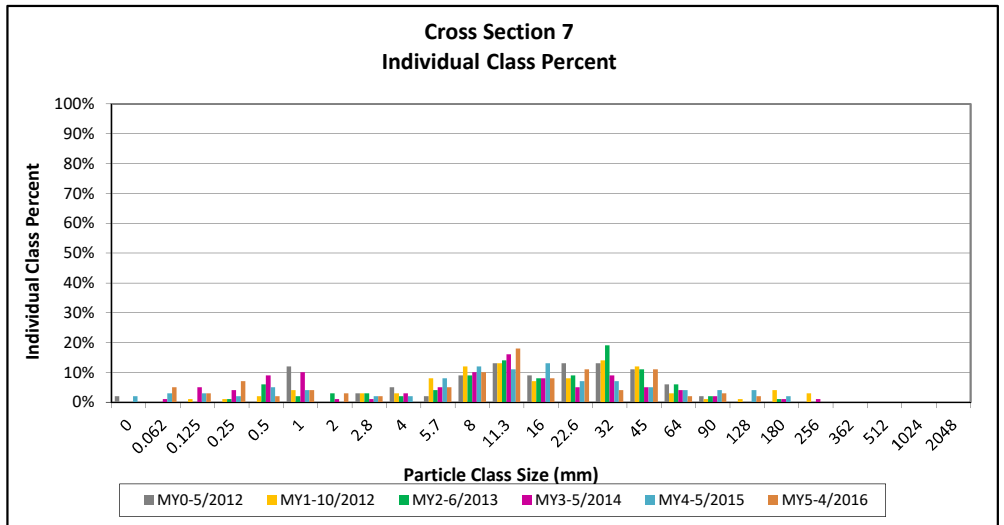
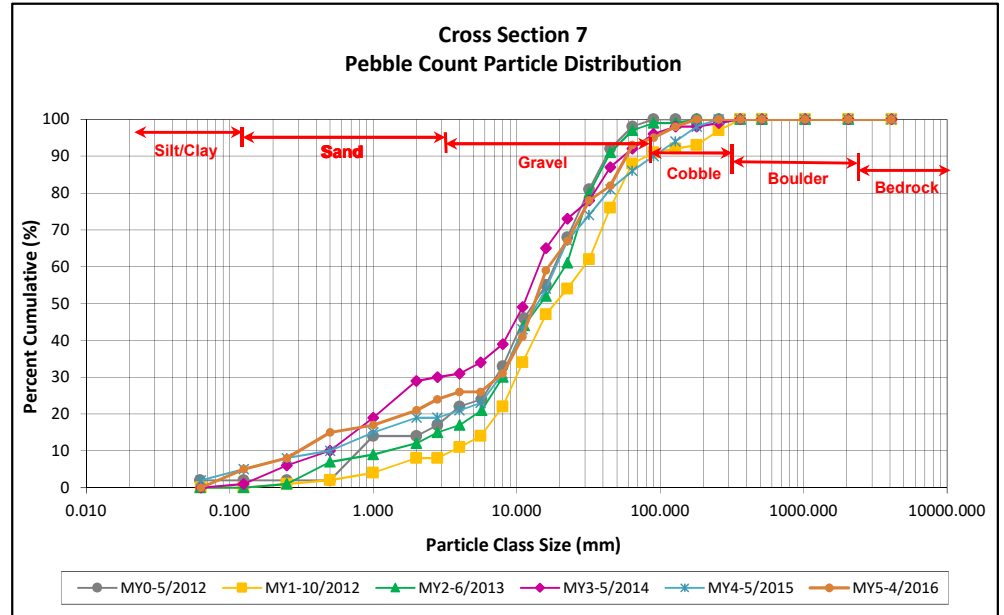
Reachwide and Cross Section Substrate Plots

Little Troublesome Creek Mitigation Site
 DMS Project No. 94640
 Monitoring Year 5 - 2016

Irvin Creek Reach 2, Cross Section 7 (Riffle)

Particle Class		Diameter (mm)		Particle Count Total	Cross Section 7 Summary	
		min	max		Class Percentage	Percent Cumulative
<i>SILT/CLAY</i>	Silt/Clay	0.000	0.062			0
<i>SAND</i>	Very fine	0.062	0.125	5	5	5
	Fine	0.125	0.250	3	3	8
	Medium	0.250	0.500	7	7	15
	Coarse	0.5	1.0	2	2	17
	Very Coarse	1.0	2.0	4	4	21
<i>GRAVEL</i>	Very Fine	2.0	2.8	3	3	24
	Very Fine	2.8	4.0	2	2	26
	Fine	4.0	5.7			26
	Fine	5.7	8.0	5	5	31
	Medium	8.0	11.3	10	10	41
	Medium	11.3	16.0	18	18	59
	Coarse	16.0	22.6	8	8	67
	Coarse	22.6	32	11	11	78
	Very Coarse	32	45	4	4	82
	Very Coarse	45	64	11	11	93
<i>COBBLE</i>	Small	64	90	2	2	95
	Small	90	128	3	3	98
	Large	128	180	2	2	100
	Large	180	256			100
<i>BOULDER</i>	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
<i>BEDROCK</i>	Bedrock	2048	>2048			100
Total				100	100	100

Cross Section 7 Channel materials (mm)	
D ₁₆ =	0.7
D ₃₅ =	9.1
D ₅₀ =	13.3
D ₈₄ =	48.0
D ₉₅ =	90.0
D ₁₀₀ =	180.0



Reachwide and Cross Section Substrate Plots

Little Troublesome Creek Mitigation Site

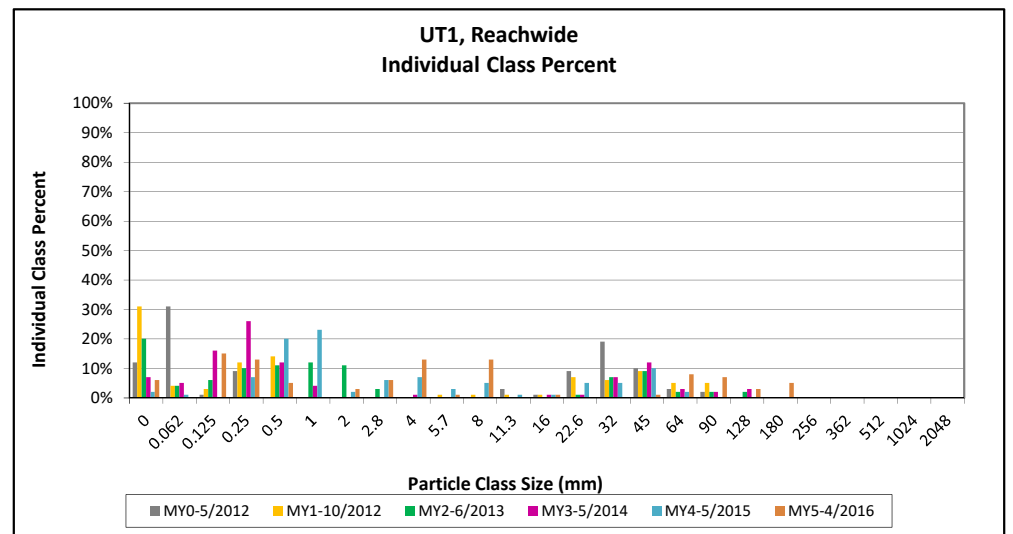
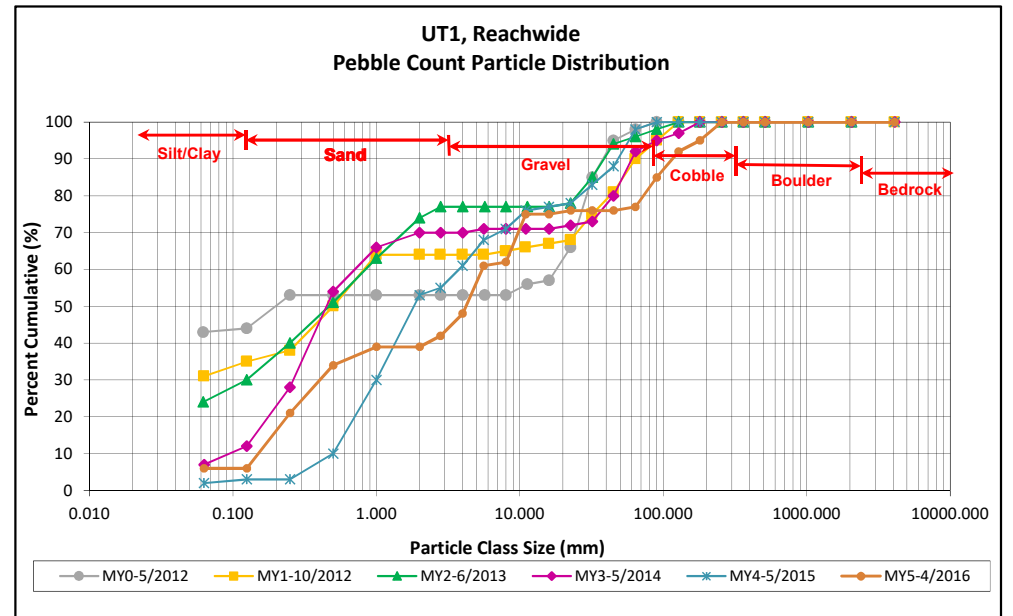
DMS Project No. 94640

Monitoring Year 5 - 2016

UT1, Reachwide

Particle Class		Diameter (mm)		Particle Count			UT1 Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
<i>SILT/CLAY</i>	Silt/Clay	0.000	0.062		6	6	6	6
<i>SAND</i>	Very fine	0.062	0.125					6
	Fine	0.125	0.250	4	11	15	15	21
	Medium	0.250	0.500	2	11	13	13	34
	Coarse	0.5	1.0	1	4	5	5	39
	Very Coarse	1.0	2.0					39
<i>GRAVEL</i>	Very Fine	2.0	2.8		3	3	3	42
	Very Fine	2.8	4.0	2	4	6	6	48
	Fine	4.0	5.7	4	9	13	13	61
	Fine	5.7	8.0		1	1	1	62
	Medium	8.0	11.3	4	9	13	13	75
	Medium	11.3	16.0					75
	Coarse	16.0	22.6		1	1	1	76
	Coarse	22.6	32					76
	Very Coarse	32	45					76
<i>COBBLE</i>	Small	64	90	8		8	8	85
	Small	90	128	7		7	7	92
	Large	128	180	3		3	3	95
	Large	180	256	5		5	5	100
<i>BOULDER</i>	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
<i>BEDROCK</i>	Bedrock	2048	>2048					100
Total				40	60	100	100	100

Reachwide Channel materials (mm)	
D ₁₆ =	0.2
D ₃₅ =	0.6
D ₅₀ =	4.2
D ₈₄ =	86.2
D ₉₅ =	180.0
D ₁₀₀ =	256.0



Reachwide and Cross Section Substrate Plots

Little Troublesome Creek Mitigation Site

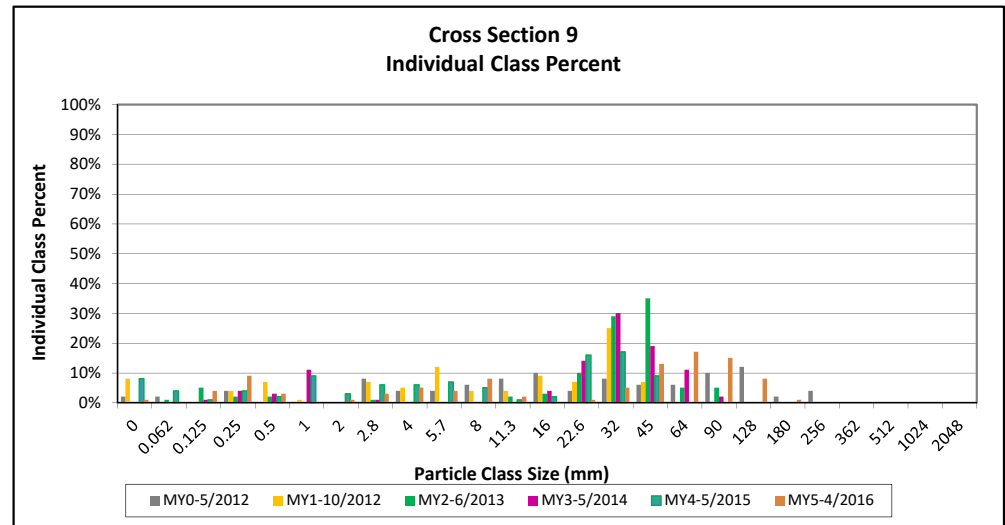
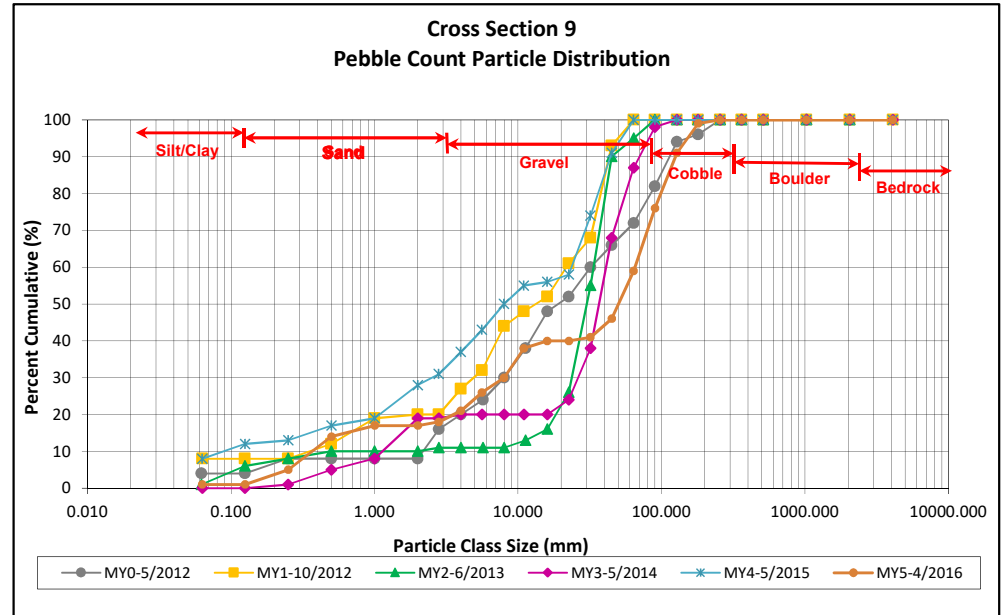
DMS Project No. 94640

Monitoring Year 5 - 2016

UT1, Cross Section 9

Particle Class		Diameter (mm)		Particle Count	Cross Section 9 Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	1	1	1
SAND	Very fine	0.062	0.125			1
	Fine	0.125	0.250	4	4	5
	Medium	0.250	0.500	9	9	14
	Coarse	0.5	1.0	3	3	17
	Very Coarse	1.0	2.0			17
GRAVEL	Very Fine	2.0	2.8	1	1	18
	Very Fine	2.8	4.0	3	3	21
	Fine	4.0	5.7	5	5	26
	Fine	5.7	8.0	4	4	30
	Medium	8.0	11.3	8	8	38
	Medium	11.3	16.0	2	2	40
	Coarse	16.0	22.6			40
	Coarse	22.6	32	1	1	41
	Very Coarse	32	45	5	5	46
	Very Coarse	45	64	13	13	59
COBBLE	Small	64	90	17	17	76
	Small	90	128	15	15	91
	Large	128	180	8	8	99
	Large	180	256	1	1	100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
Total				100	100	100

Cross Section 9 Channel materials (mm)	
D ₁₆ =	0.8
D ₃₅ =	9.8
D ₅₀ =	50.2
D ₈₄ =	108.6
D ₉₅ =	151.8
D ₁₀₀ =	256.0



Reachwide and Cross Section Substrate Plots

Little Troublesome Creek Mitigation Site

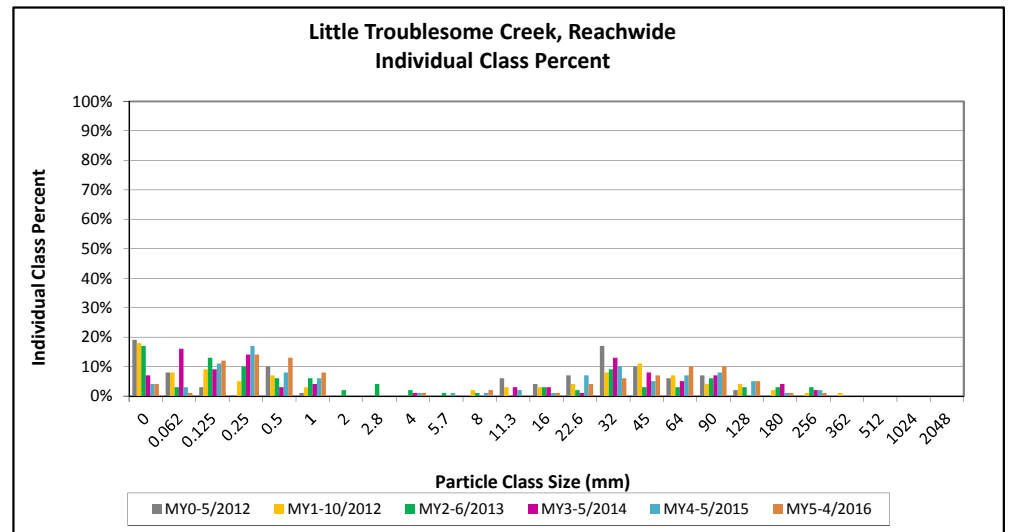
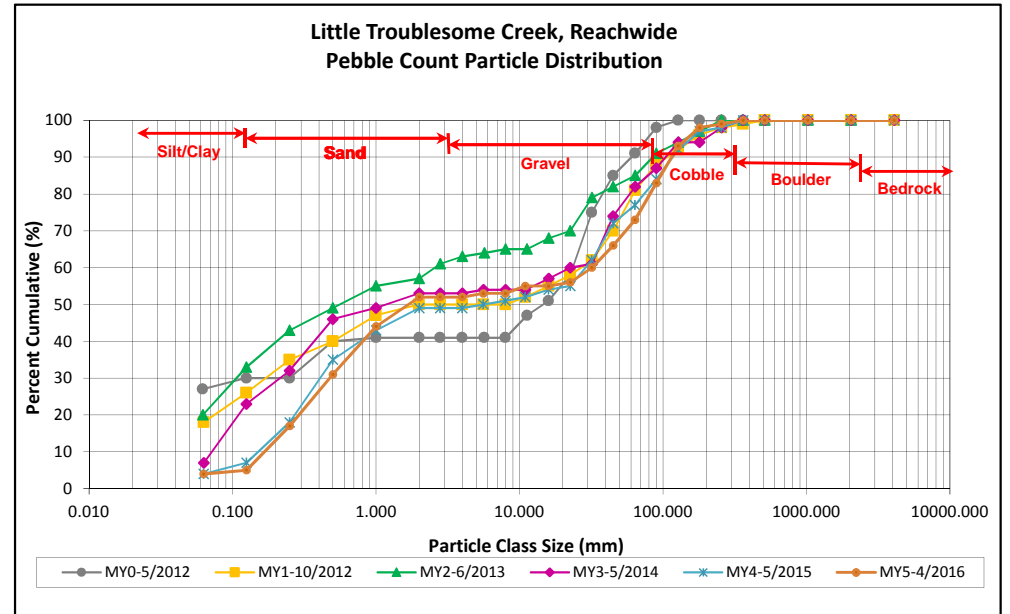
DMS Project No. 94640

Monitoring Year 5 - 2016

Little Troublesome Creek, Reachwide

Particle Class		Diameter (mm)		Particle Count			Little Troublesome Creek Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
<i>SILT/CLAY</i>	Silt/Clay	0.000	0.062		4	4	4	4
<i>SAND</i>	Very fine	0.062	0.125		1	1	1	5
	Fine	0.125	0.250		12	12	12	17
	Medium	0.250	0.500	2	12	14	14	31
	Coarse	0.5	1.0	1	12	13	13	44
	Very Coarse	1.0	2.0	2	5	7	7	51
<i>GRAVEL</i>	Very Fine	2.0	2.8					51
	Very Fine	2.8	4.0					51
	Fine	4.0	5.7		1	1	1	52
	Fine	5.7	8.0					52
	Medium	8.0	11.3	1	2	3	3	55
	Medium	11.3	16.0					55
	Coarse	16.0	22.6	1		1	1	56
	Coarse	22.6	32	3	1	4	4	60
	Very Coarse	32	45	6		6	6	66
	Very Coarse	45	64	7		7	7	73
<i>COBBLE</i>	Small	64	90	9	1	10	10	83
	Small	90	128	10		10	10	93
	Large	128	180	4	1	5	5	98
	Large	180	256	1		1	1	99
<i>BOULDER</i>	Small	256	362	1		1	1	100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
<i>BEDROCK</i>	Bedrock	2048	>2048					100
Total				48	52	100	100	100

Reachwide Channel materials (mm)	
D ₁₆ =	0.2
D ₃₅ =	0.6
D ₅₀ =	1.8
D ₈₄ =	93.2
D ₉₅ =	146.7
D ₁₀₀ =	362.0



Reachwide and Cross Section Substrate Plots

Little Troublesome Creek Mitigation Site

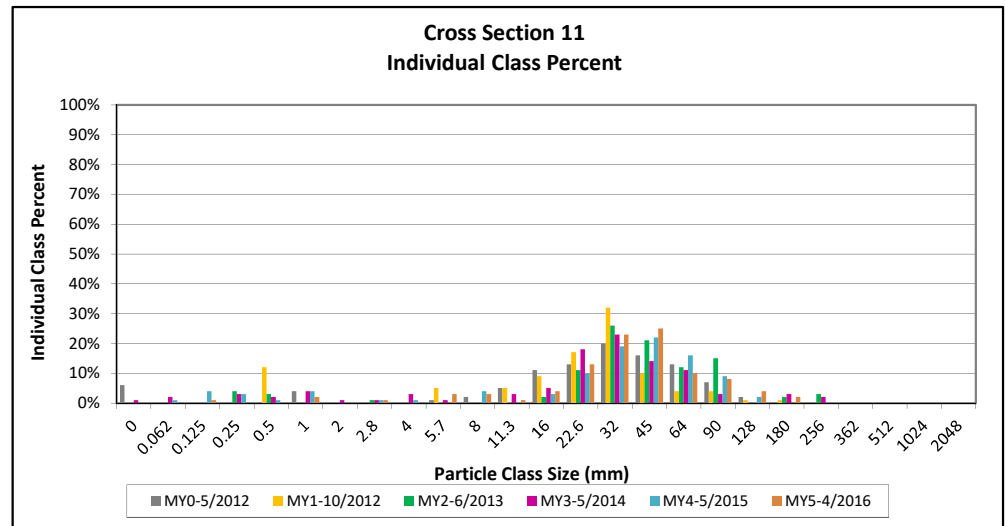
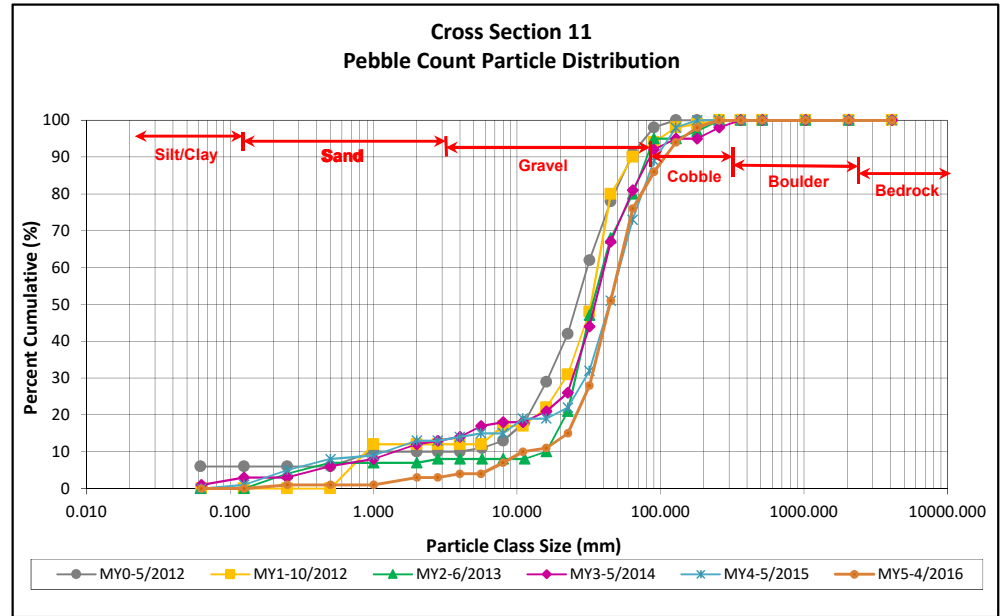
DMS Project No. 94640

Monitoring Year 5 - 2016

Little Troublesome Creek , Cross Section 11

Particle Class		Diameter (mm)		Particle Count	Cross Section 11 Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250	1	1	1
	Medium	0.250	0.500			1
	Coarse	0.5	1.0			1
	Very Coarse	1.0	2.0	2	2	3
GRAVEL	Very Fine	2.0	2.8			3
	Very Fine	2.8	4.0	1	1	4
	Fine	4.0	5.7			4
	Fine	5.7	8.0	3	3	7
	Medium	8.0	11.3	3	3	10
	Medium	11.3	16.0	1	1	11
	Coarse	16.0	22.6	4	4	15
	Coarse	22.6	32	13	13	28
	Very Coarse	32	45	23	23	51
	Very Coarse	45	64	25	25	76
COBBLE	Small	64	90	10	10	86
	Small	90	128	8	8	94
	Large	128	180	4	4	98
	Large	180	256	2	2	100
BEDROCK	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
Total				100	100	100

Cross Section 11	
Channel materials (mm)	
D ₁₆ =	23.2
D ₃₅ =	35.5
D ₅₀ =	44.3
D ₈₄ =	84.1
D ₉₅ =	139.4
D ₁₀₀ =	256.0



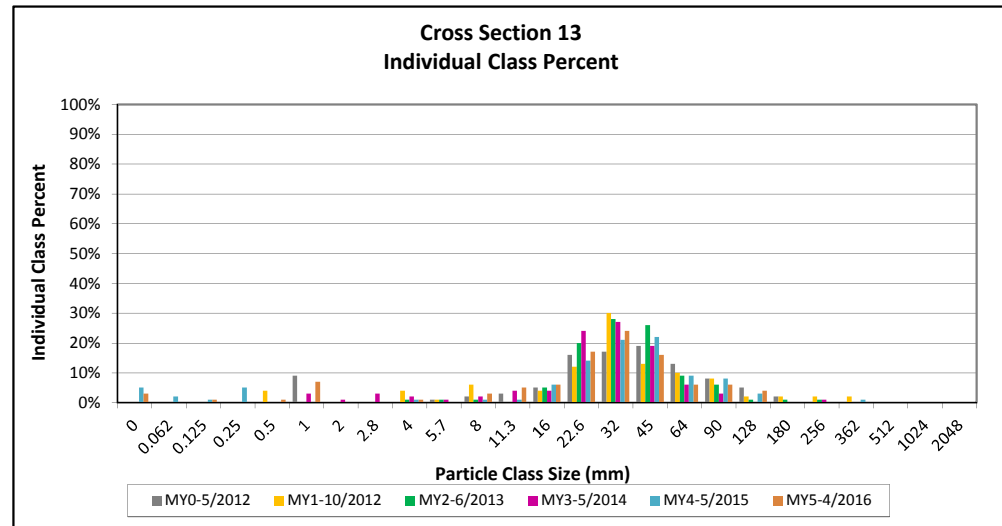
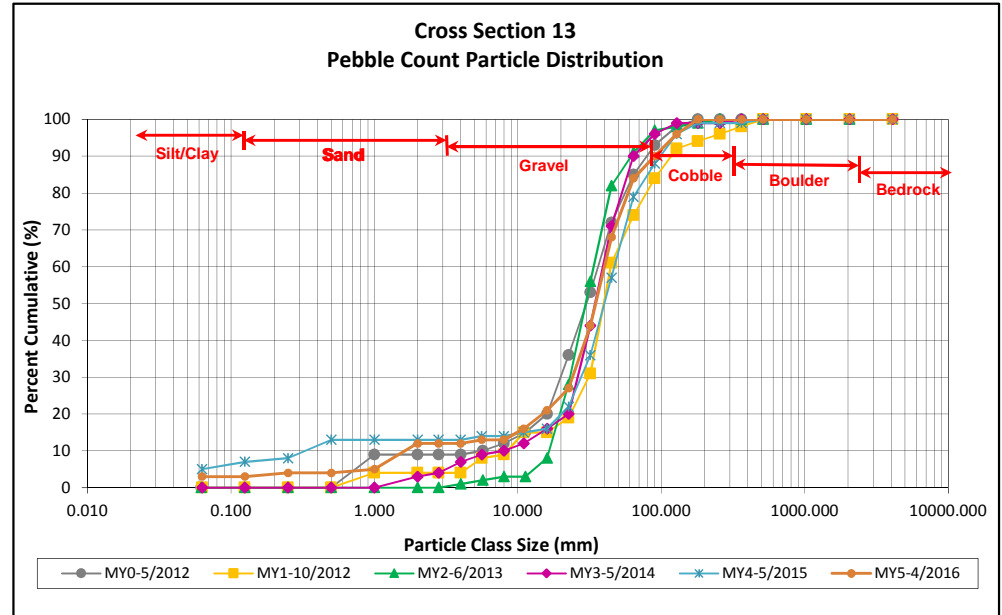
Reachwide and Cross Section Substrate Plots

Little Troublesome Creek Mitigation Site
 DMS Project No. 94640
 Monitoring Year 5 - 2016

Little Troublesome Creek , Cross Section 13

Particle Class		Diameter (mm)		Particle Count	Cross Section 13 Summary	
		min	max		Class Percentage	Percent Cumulative
<i>SILT/CLAY</i>	Silt/Clay	0.000	0.062	5	5	5
<i>SAND</i>	Very fine	0.062	0.125	2	2	7
	Fine	0.125	0.250	1	1	8
	Medium	0.250	0.500	5	5	13
	Coarse	0.5	1.0			13
	Very Coarse	1.0	2.0			13
<i>GRAVEL</i>	Very Fine	2.0	2.8			13
	Very Fine	2.8	4.0			13
	Fine	4.0	5.7	1	1	14
	Fine	5.7	8.0			14
	Medium	8.0	11.3	1	1	15
	Medium	11.3	16.0	1	1	16
	Coarse	16.0	22.6	6	6	22
	Coarse	22.6	32	14	14	36
	Very Coarse	32	45	21	21	57
Very Coarse	45	64	22	22	79	
<i>COBBLE</i>	Small	64	90	9	9	88
	Small	90	128	8	8	96
	Large	128	180	3	3	99
	Large	180	256			99
<i>BOULDER</i>	Small	256	362			99
	Small	362	512	1	1	100
	Medium	512	1024			100
<i>BEDROCK</i>	Large/Very Large	1024	2048			100
	Bedrock	2048	>2048			100
		Total		100	100	100

Cross Section 13 Channel materials (mm)	
D ₁₆ =	16.0
D ₃₅ =	31.2
D ₅₀ =	40.2
D ₈₄ =	77.3
D ₉₅ =	122.5
D ₁₀₀ =	512.0



APPENDIX 5. Hydrology Summary Data and Plots

Table 13. Verification of Bankfull Events

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Reach	Date of Data Collection	Date of Occurrence	Method
Irvin Creek	4/11/2016	2/24/2016	Crest Gage/ Trail
	8/30/2016	8/5/2016	Camera
Little Troublesome Creek	4/11/2016	2/24/2016	Crest Gage/ Trail
	8/30/2016	8/5/2016	Camera
UT1	4/11/2016	2/24/2016	Crest Gage/ Trail
	8/30/2016	8/5/2016	Camera

Table 14. Wetland Gage Attainment Summary

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Summary of Groundwater Gage Results for Years 1 through 7					
Gage	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)				
	Year 1 (2012)	Year 2 (2013)	Year 3 (2014)	Year 4 (2015)	Year 5 (2016)
1	No/5.5 Days (2.4%)	Yes/18.0 Days (8.0%)	Yes/17.0 Days (7.5%)	Yes/25.0 Days (10.3%)	Yes/30.0 Days (12.4%)
2	Yes/26.5 Days (11.7%)	Yes/61.5 Days (27.2%)	Yes/50.5 Days (22.3%)	Yes/59.0 Days (24.4%)	Yes/39.0 Days (16.2%)
3	Yes/87.5 Days (38.7%)	Yes/195.5 Days (86.5%)	Yes/98.5 Days (43.6%)	Yes/84.0 Days (34.7%)	Yes/183.0 Days (75.9%)
4	Yes/65.5 Days (29%)	Yes/165.5 Days (73.2%)	Yes/74.0 Days (32.7%)	Yes/62.0 Days (25.6%)	Yes/17.0 Days (7.1%)
5	Yes/60.5 Days (26.8%)	Yes/24.0 Days (10.6%)	Yes/45.5 Days (20.1%)	Yes/29.0 Days (12.0%)	Yes/36.0 Days (14.9%)
6	No/6.0 Days (2.7%)	Yes/17.5 Days (7.7%)	Yes/19.5 Days (8.6%)	Yes/24.0 Days (9.9%)	Yes/32.0 Days (13.3%)
7	Yes/83.0 Days (36.7%)	Yes/70.0 Days (31.0%)	Yes/60.0 Days (26.5%)	Yes/65.0 Days (26.9%)	Yes/44.0 Days (18.3%)
8	No/11.5 Days (5.1%)	Yes/31.5 Days (13.9%)	Yes/44.5 Days (19.7%)	Yes/26.0 Days (10.7%)	Yes/31.0 Days (12.9%)

**Bankfull Verification Photographs
Monitoring Year 5**



Bankfull Event 1 – Little Troublesome Creek (2/3/2016)



Bankfull Event 2 – Little Troublesome Creek (2/16/2016)



Bankfull Event 3 – Little Troublesome Creek (2/24/2016)



Bankfull Event 4 – Little Troublesome Creek (8/2/2016)



Bankfull Event 5 – Little Troublesome Creek (8/5/2016)

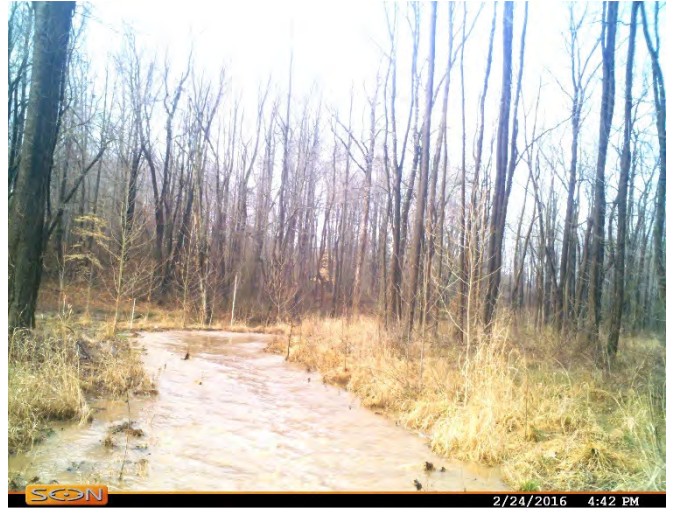


Bankfull Event 6 – Little Troublesome Creek (8/7/2016)





Bankfull Event 7 – Little Troublesome Creek (8/8/2016)



Bankfull Event 1 – Irvin Creek (2/24/2016)

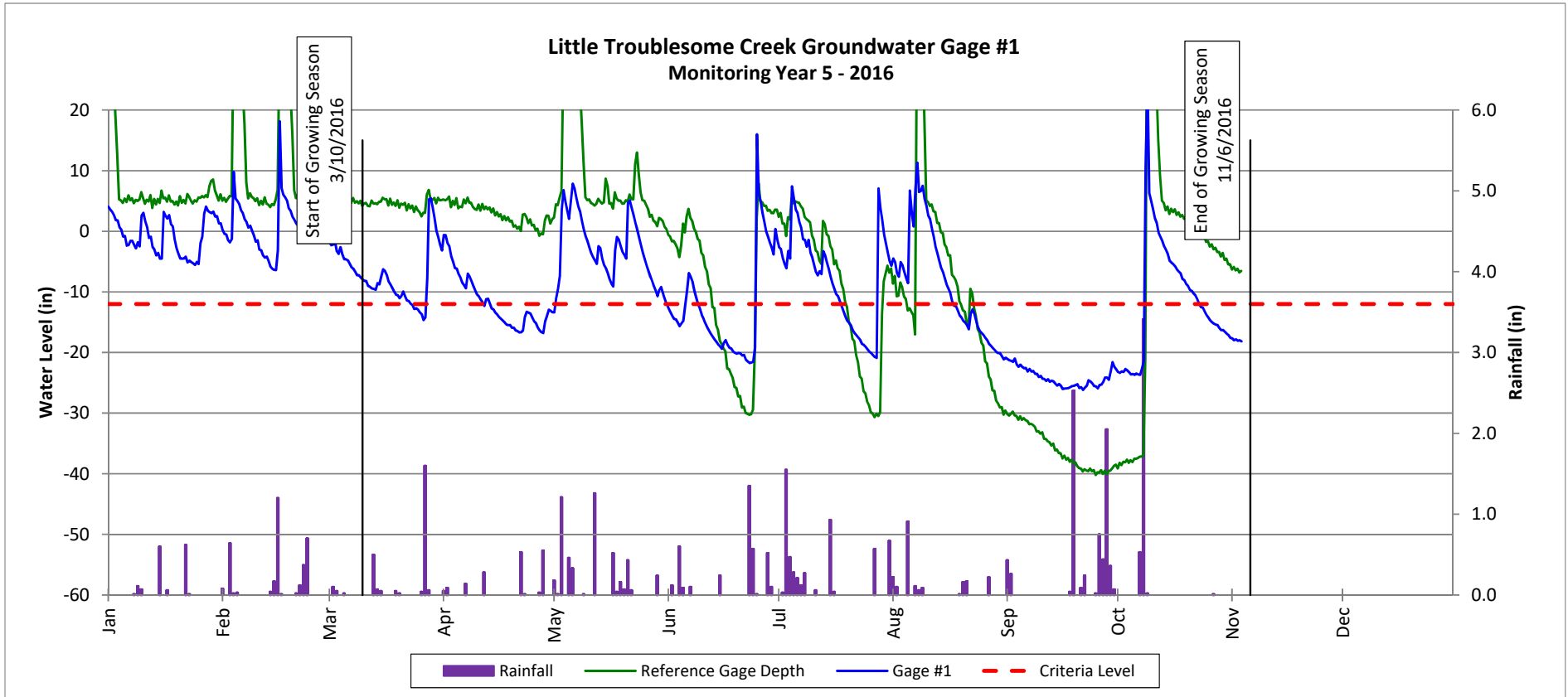


Groundwater Gage Plots

Little Troublesome Creek Wetland (DMS Project No. 94640)

Monitoring Year 5 - 2016

Wetland RW1

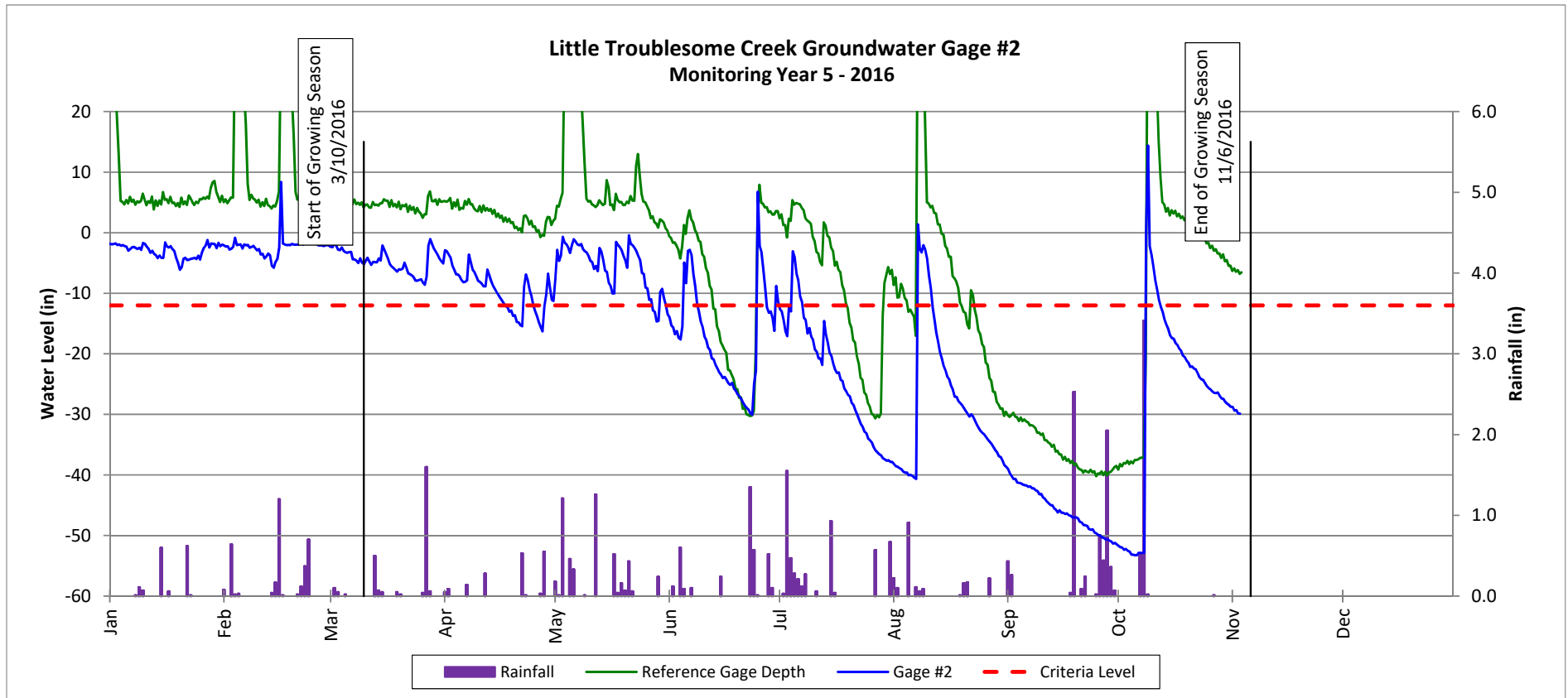


Groundwater Gage Plots

Little Troublesome Creek Wetland (DMS Project No. 94640)

Monitoring Year 5 - 2016

Wetland RW1

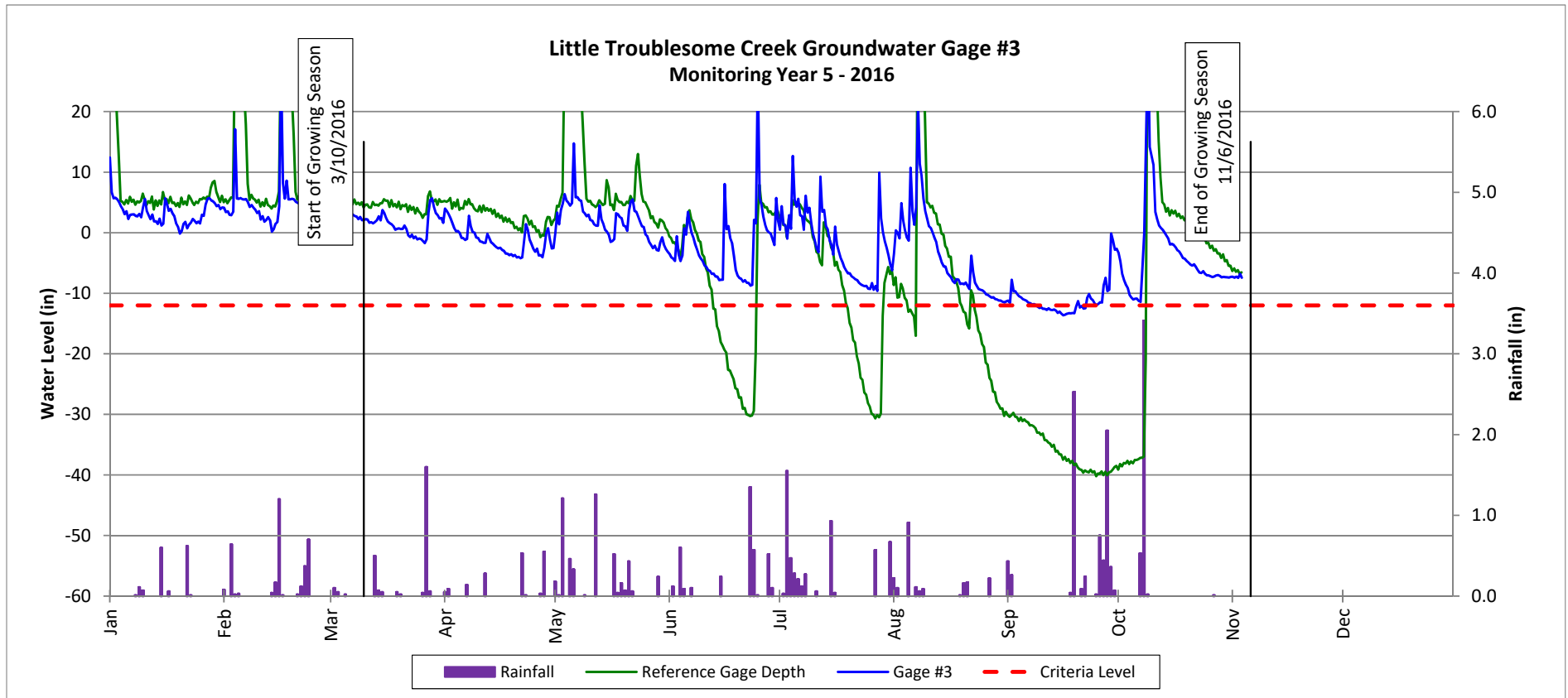


Groundwater Gage Plots

Little Troublesome Creek Wetland (DMS Project No. 94640)

Monitoring Year 5 - 2016

Wetland RW1

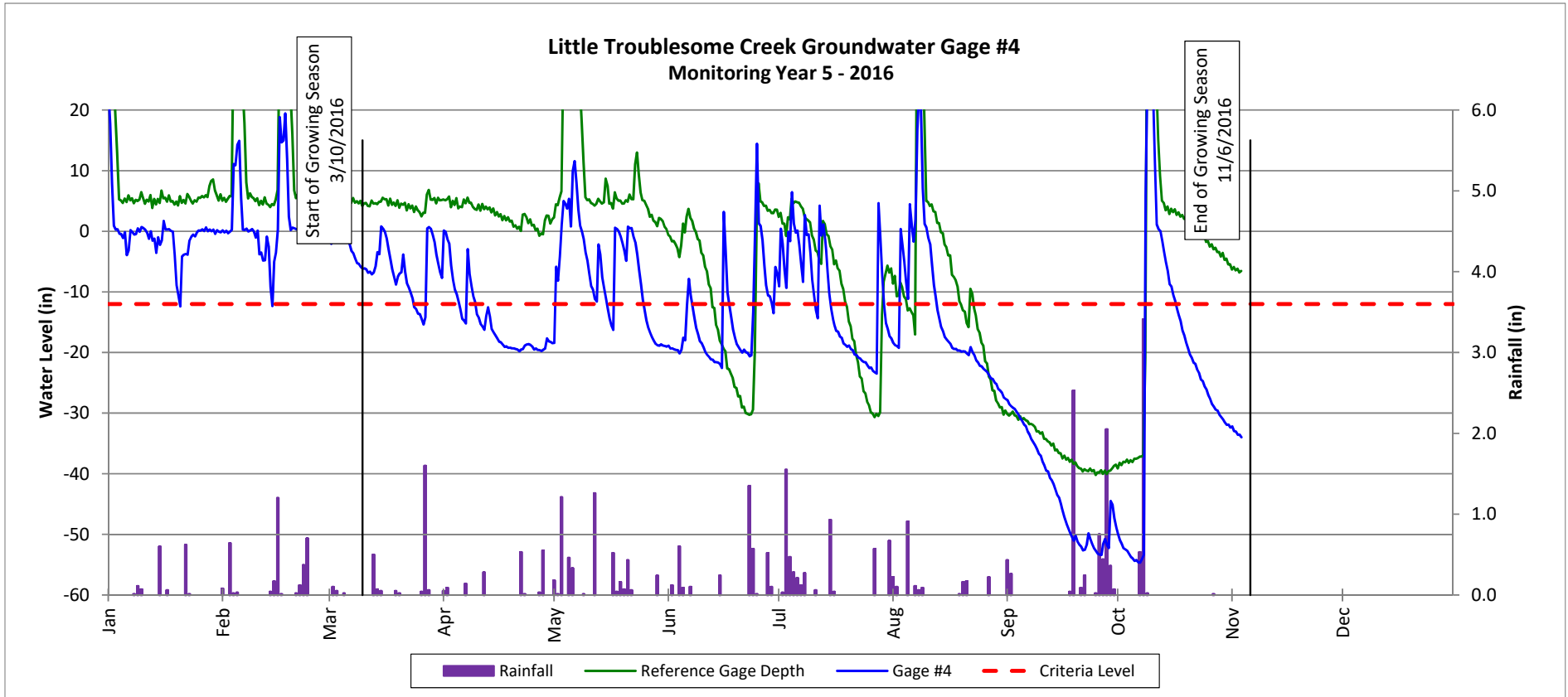


Groundwater Gage Plots

Little Troublesome Creek Wetland (DMS Project No. 94640)

Monitoring Year 5 - 2016

Wetland RW1

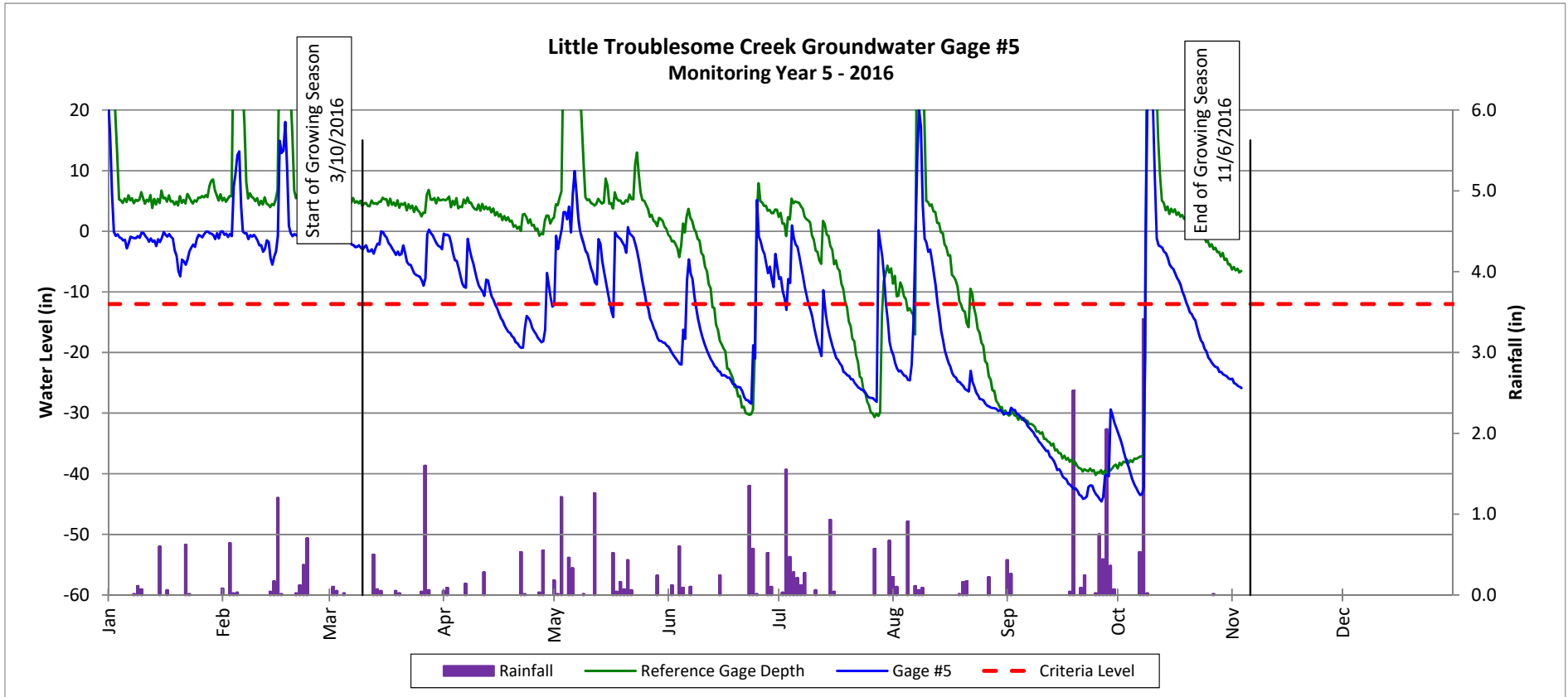


Groundwater Gage Plots

Little Troublesome Creek Wetland (DMS Project No. 94640)

Monitoring Year 5 - 2016

Wetland RW1

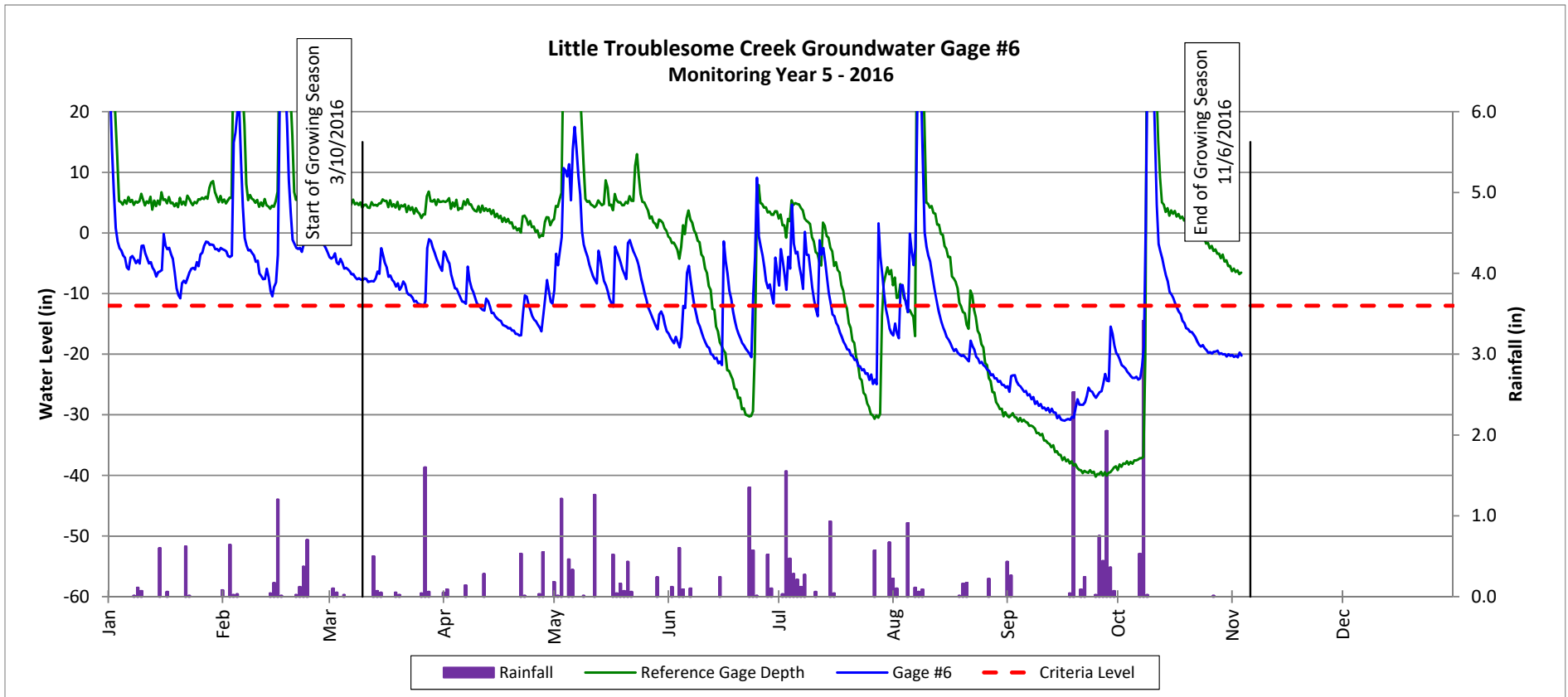


Groundwater Gage Plots

Little Troublesome Creek Wetland (DMS Project No. 94640)

Monitoring Year 5 - 2016

Wetland RW1

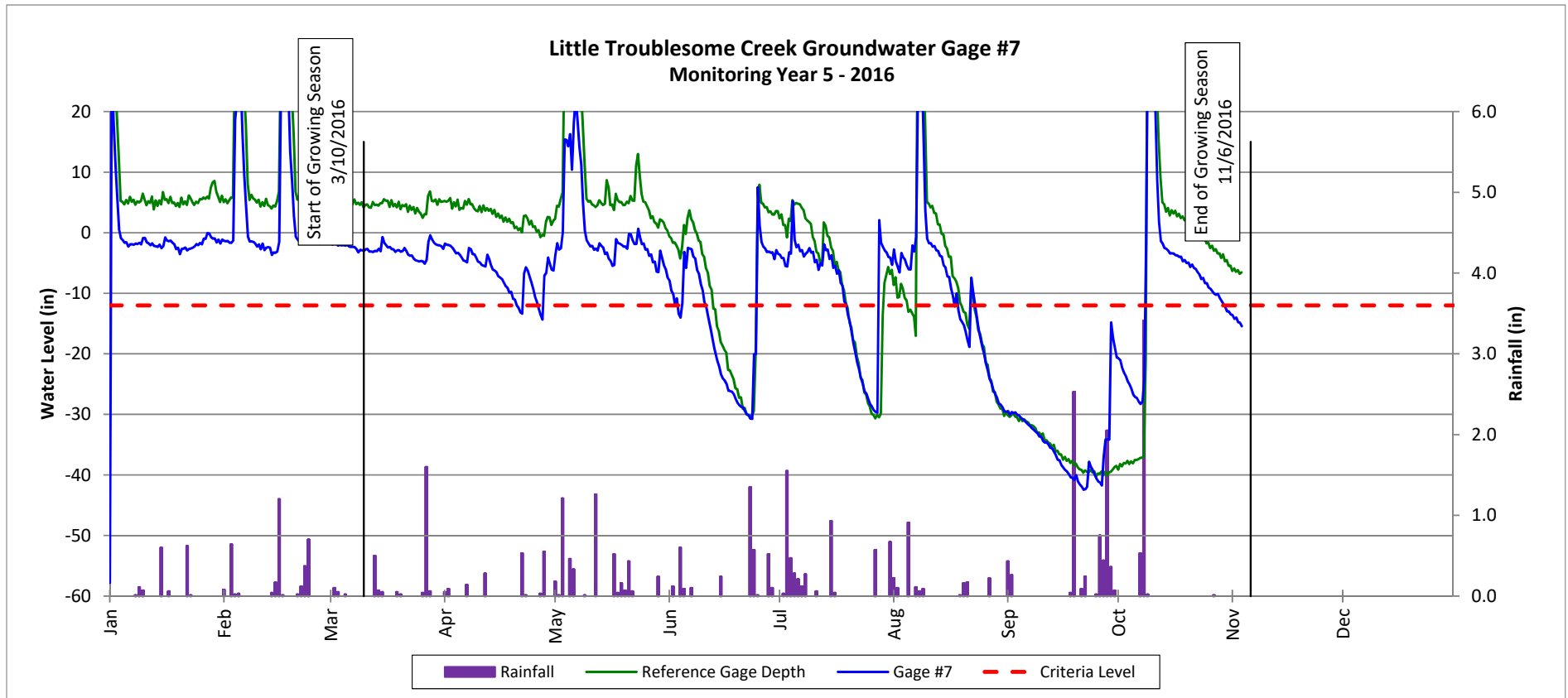


Groundwater Gage Plots

Little Troublesome Creek Wetland (DMS Project No. 94640)

Monitoring Year 5 - 2016

Wetland RW1

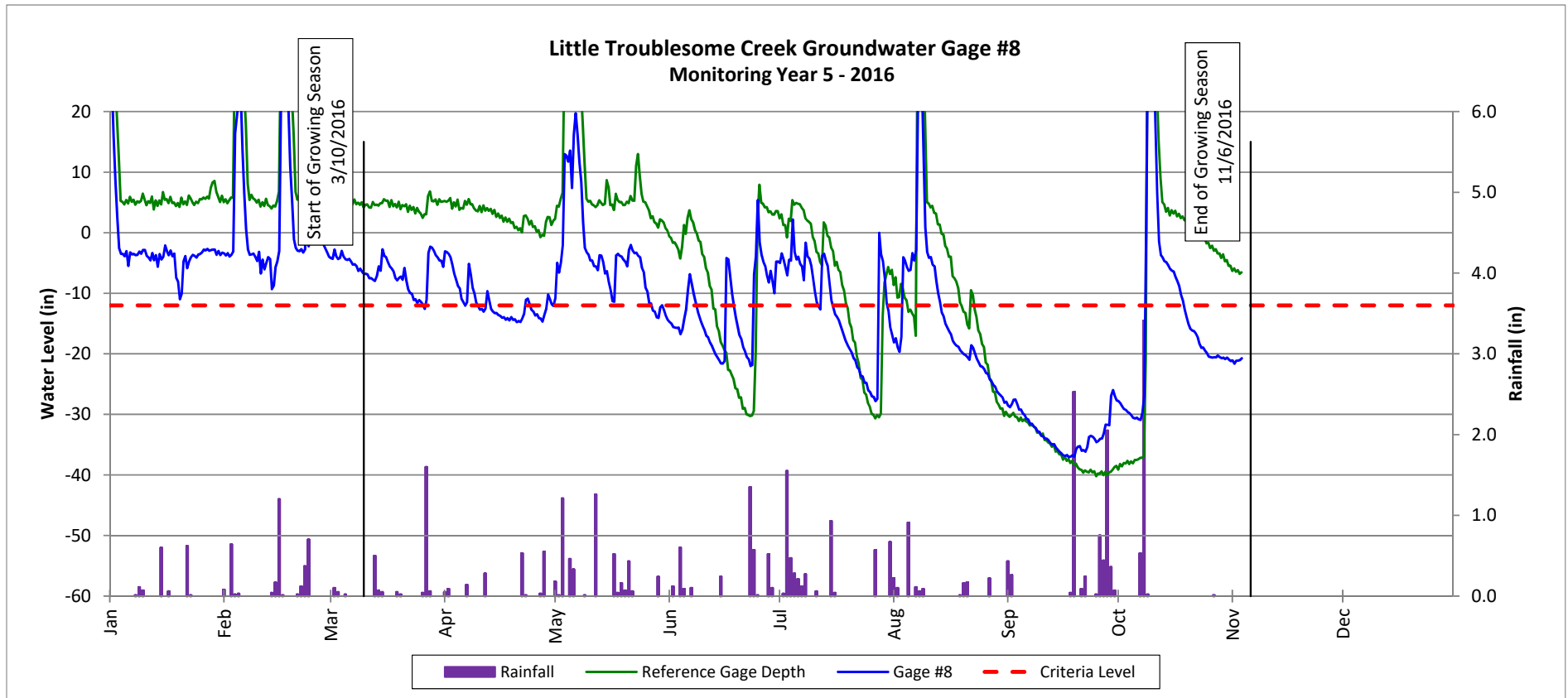


Groundwater Gage Plots

Little Troublesome Creek Wetland (DMS Project No. 94640)

Monitoring Year 5 - 2016

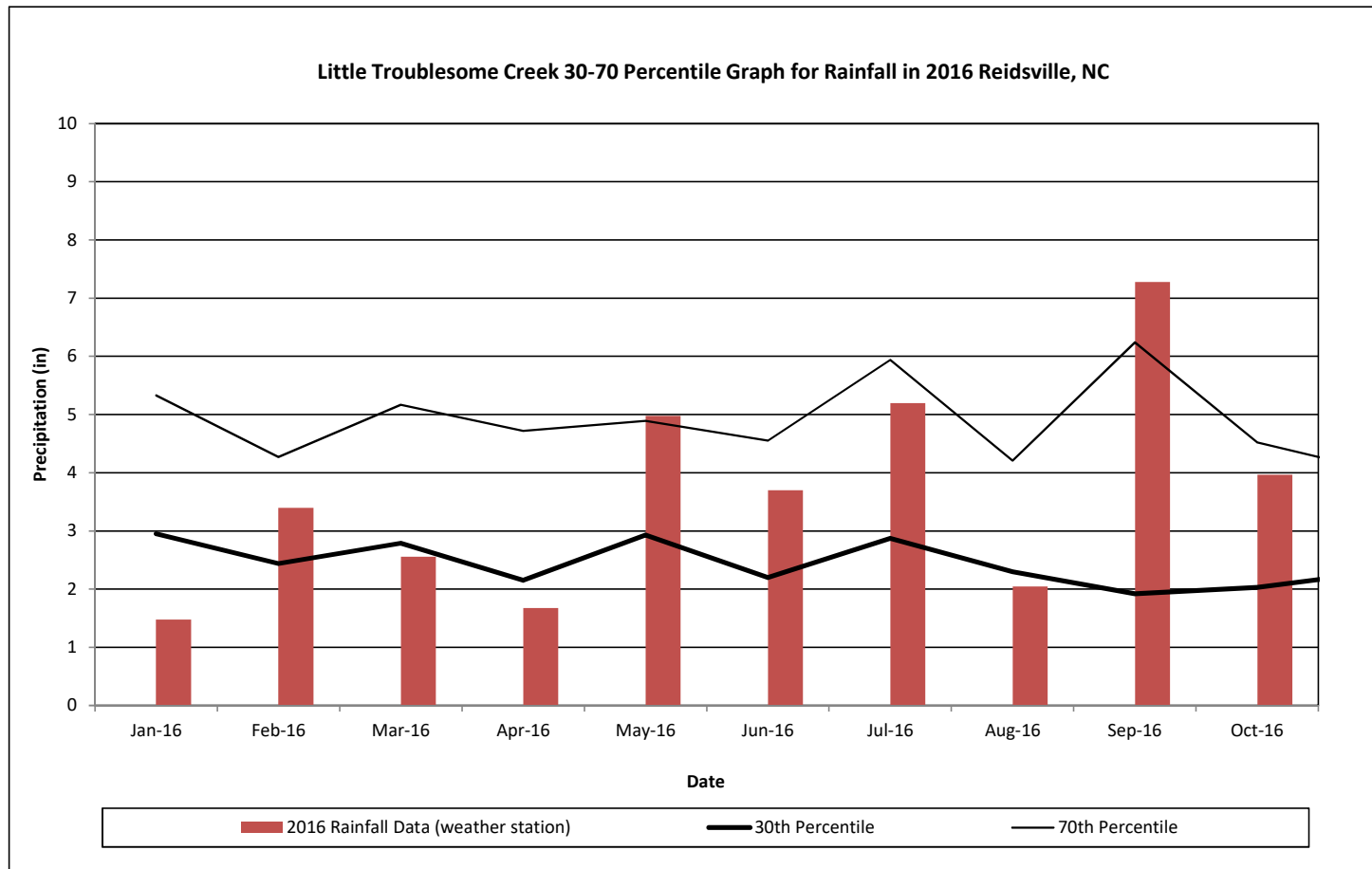
Wetland RW1



Monthly Rainfall Data

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 -2016



¹ 2016 monthly rainfall collected by Weather Underground Station KNCBROWN2 (Reidsville, NC).

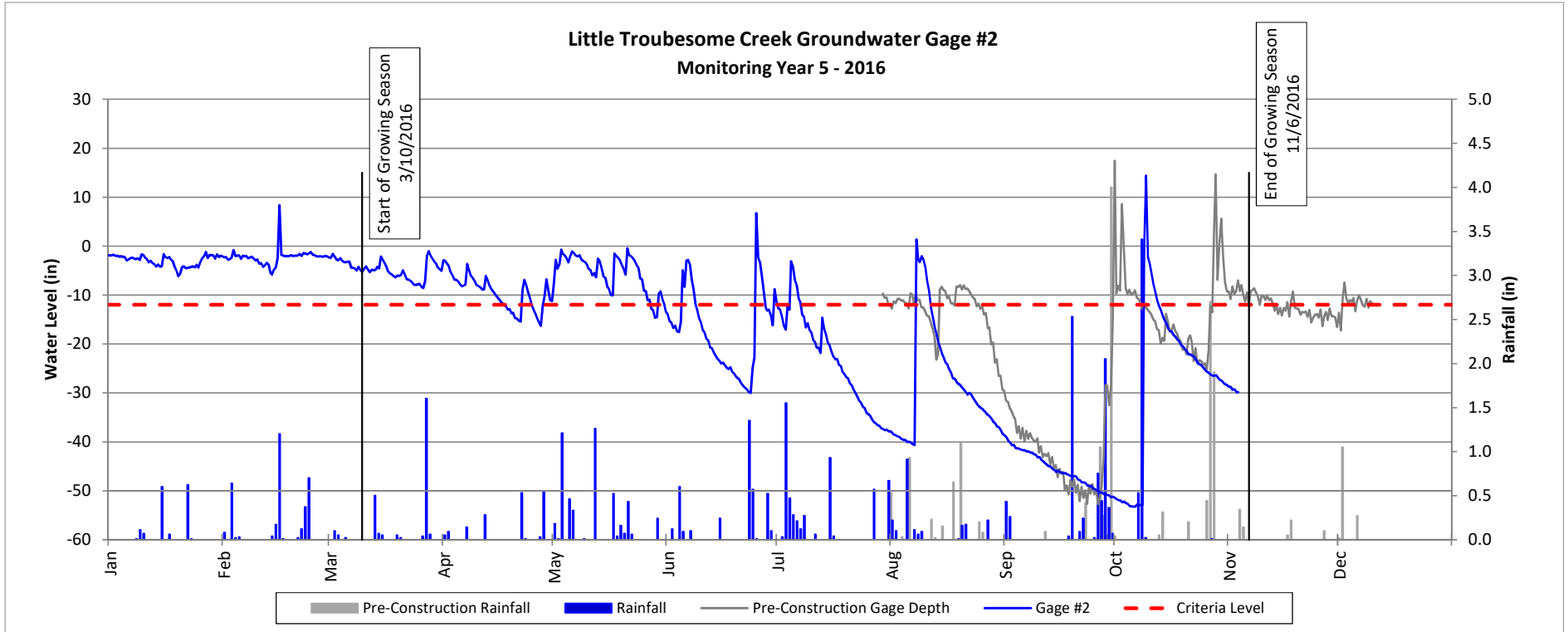
² 30th and 70th percentile rainfall data collected from weather station NC7202, in Reidsville, NC (USDA, 2002).

Pre and Post Construction Groundwater Gage Comparison Plots

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Wetland RW1

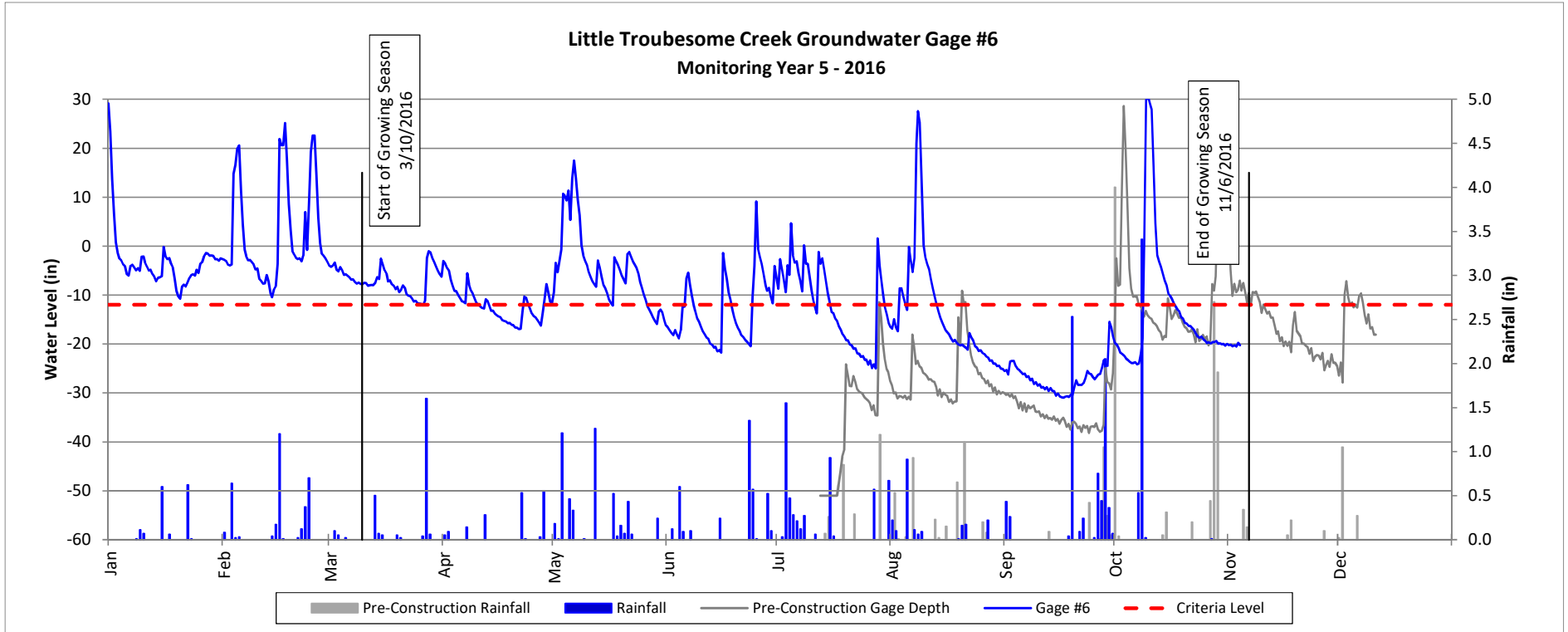


Pre and Post Construction Groundwater Gage Comparison Plots

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Wetland RW1



Pre and Post Construction Groundwater Gage Comparison Plots

Little Troublesome Creek Mitigation Site (DMS Project No. 94640)

Monitoring Year 5 - 2016

Wetland RW1

