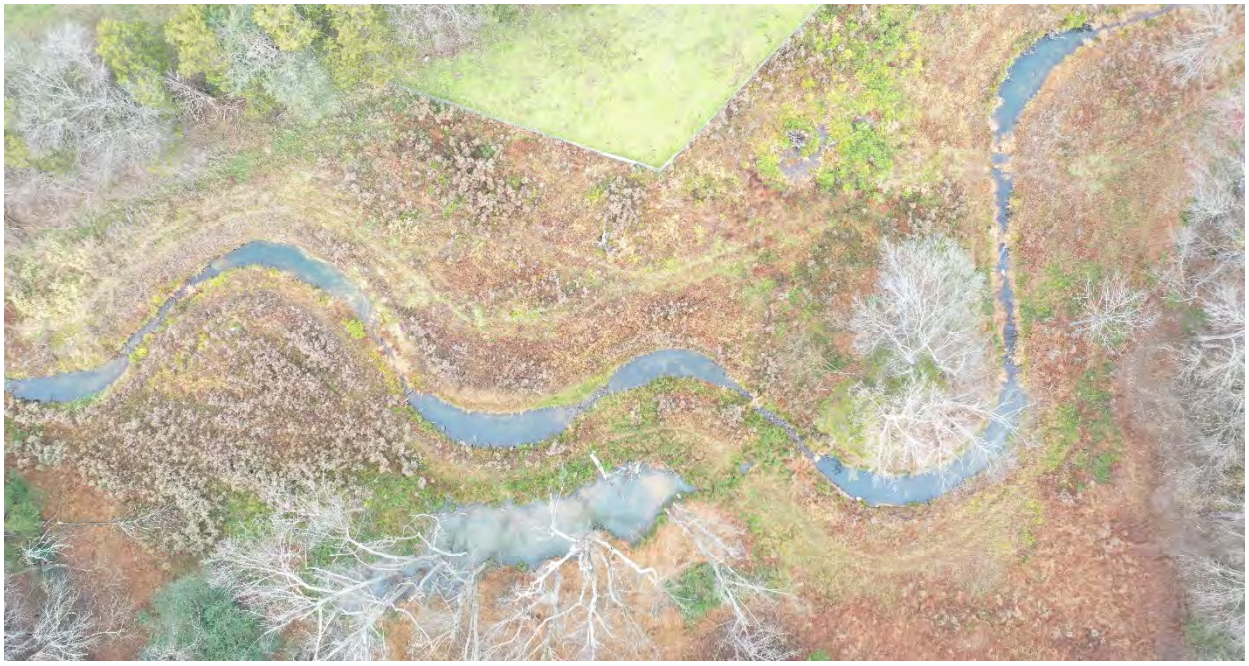


MONITORING YEAR 1 ANNUAL REPORT

FINAL

BUCKWATER MITIGATION SITE

Orange County, NC
NCDEQ Contract No. 006829
DMS Project Number 97084
USACE Action ID Number 2016-00873
NCDWR Project Number 2016-0406

Data Collection Period: October-December 2019
Draft Submission Date: December 31, 2019
Final Submission Date: February 6, 2020

PREPARED FOR:

NC Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

February 6, 2020

Jeremiah Dow
N.C. Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

RE: Task 7 MY1 Monitoring Report - Buckwater Mitigation Site, DMS ID# 97084
Neuse River Basin – CU# 03020201
Orange County, North Carolina
Contract No. 006829

Dear Mr. Dow,

We have reviewed the comments on the Monitoring Year 1 Report for the above referenced project dated February 3, 2020 and have revised the report based on these comments. The revised documents are submitted with this letter. Below are responses to each of your comments. For your convenience, the comments are reprinted with our response in italics.

1. Appendix 2

   a. Table 6: Please verify the areas of poor herbaceous growth identified in Section 1.2.7 do not exceed any mapping thresholds.

      The individual areas of poor herbaceous growth identified in Section 1.2.7 do not exceed the mapping threshold of 0.1 acres.

2. Appendix 3

   a. Please consider rounding some of the cross section BHRs listed as <1 to 1.0. For example, cross section 3's BHR is listed as <1 with an actual BHR of 0.995. A 1.0 BHR more accurately describes conditions.

      Bank height ratios were evaluated on all cross sections and cross sections 3, 4, and 6 were rounded from <1 to 1.0.

   b. Please discuss Reachwide Pebble Count Plots for T3 R2 and T7 R3, as both reaches are strongly trending toward finer material (for example T7 R3 MY0 D50 was 51.8 mm and the MY1 D50 is 0.6 mm).

      Pebble counts for T3 R2 and T7 R3 are discussed in section 1.2.4 of the annual monitoring report.

3. Buffer Monitoring Report

a. Table 7: See comment 1 above regarding mapping thresholds.

Please see response to comment 1 above.

If you have any questions, please contact me by phone (919) 851-9986, or by email (jlorch@wildlandseng.com).

Sincerely,

Jason Lorch, *Monitoring Coordinator*

PREPARED BY:

312 West Millbrook Road, Suite 225
Raleigh, NC 27609

Jason Lorch
jlorch@wildlandseng.com
Phone: 919.851.9986

EXECUTIVE SUMMARY

Wildlands Engineering, Inc. (Wildlands) implemented a full delivery project at the Buckwater Mitigation Site (Site) for the North Carolina Department of Environmental Quality Division of Mitigation Services (DMS) to restore and enhance a total of 16,276 linear feet (LF) of perennial and intermittent streams in Orange County, NC. The Site is expected to generate 12,621.936 stream mitigation units (SMUs) when calculated along stream centerlines. The Site is located approximately 4.5 miles northeast of Hillsborough, NC (Figure 1) in the Neuse River Basin 8-Digit Hydrologic Unit Code (HUC) 03020201 and within a DMS targeted watershed for the Neuse River Basin Hydrologic Unit Code (HUC) 03020201030030 and NC Division of Water Resources (DWR) Subbasin 03-04-01. The site contains Buckwater Creek and 14 unnamed tributaries. Buckwater Creek, T1, T2, T3, T4, T5, T6, T6A, T7, and T9 are perennial streams, while T4A, T4B, T6B, T7A and T8 are intermittent streams. The Site streams drain to the Eno River, which flows to Falls Lake, and are classified as water supply waters (WS-IV) and nutrient sensitive waters (NSW). The 51.84-acre Site is protected with a permanent conservation easement.

The Site is located within a Targeted Local Watershed (TLW) as discussed in the 2010 Neuse River Basin Restoration Priorities (RBRP) (Breeding, 2010), which highlights the importance of riparian buffers for stream restoration projects. Since the 1990s, cattle have activity grazed on three of the Site properties. Anything that is not grazed or in forest, including large residential lots, is used for cultivating hay.

The project goals established in the Mitigation Plan (Wildlands, 2017) were developed considering the goals and objectives listed in the Neuse River RBRP plan. The project goals include:

- Reconnect channels with floodplains and riparian wetlands to allow a natural flooding regime;
- Improve the stability of stream channels;
- Exclude cattle from project streams;
- Restore and enhance native floodplain and streambank vegetation;
- Improve instream habitat; and
- Permanently protect the Site from harmful land uses.

The project will contribute to achieving the goals for the watershed listed in the Neuse River RBRP and provide ecological benefits within the Neuse River Basin. While benefits such as habitat improvement and geomorphic stability are limited to the Site, reduced nutrient and sediment loading have farther reaching effects. In addition, planned projects in the same watershed and basin as this Site will realize cumulative benefits.

Site construction and planting were completed in April 2019. As-built surveys were conducted between January 2019 and April 2019. Monitoring Year 1 (MY1) assessments and site visits were completed in December 2019 to assess the conditions of the project. Overall, the Site has met the required vegetation and stream success criteria for MY1. The overall average stem density for the Site is 547 planted stems per acre and is therefore on track to meet the MY3 interim requirement of 320 planted stems per acre.

Invasive vegetation treatment was conducted in October 2019. Stream repairs were conducted in August 2019. Cross-sections 26 and 28, both pool cross-sections on T5, deviated from design due to point bar deposition, but no remedial action is required at this time. Bankfull and geomorphically significant events were recorded on Buckwater Creek Reach 6, T1 Reach 2, T2, T4, T5 (downstream of St. Mary's Rd), and T7 Reach 3 during the 2019 annual monitoring period. Additionally, the flow gages on T4A, T4B, T6 and T7A recorded baseflow for more than 30 consecutive days during MY1. One exception

was on T8, where equipment malfunctioned, prohibiting data from being collected. Several areas with poor herbaceous cover have been noted and addressed. These areas will continue to be monitored throughout MY2.

BUCKWATER MITIGATION SITE
Monitoring Year 1 Annual Report

TABLE OF CONTENTS

APPENDICES

Section 1: PROJECT OVERVIEW

The Buckwater Mitigation Site (Site) is located in central Orange County, approximately 4.5 miles northeast of Hillsborough, NC off of Walnut Hill Drive (Figure 1). The Site is located within the Falls Lake Water Supply Watershed, which is within the Neuse River Basin. Both the Neuse River and Falls Lake have been designated as Nutrient Sensitive Waters. The Site streams drain to the Eno River and are within Hydrologic Unit Code (HUC) 03020201030030, which is a Targeted Local Watershed (TLW) (Figure 1) as identified in the 2010 Neuse River Basin Restoration Priorities (RBRP) (Breeding, 2010). The Site is in in the Carolina Slate Belt of the Piedmont Physiographic Province (USGS, 1998). The project watershed consists primarily of agricultural and wooded land. The drainage area for the Site is 2,259 acres (3.53 square miles).

The project streams consist of Buckwater Creek and fourteen unnamed tributaries. Mitigation work within the Site included restoration, enhancement I, and enhancement II of 16,276 linear feet (LF) of intermittent and perennial stream channels. The riparian areas were planted with native vegetation to improve habitat and protect water quality. The final Mitigation Plan (Wildlands, 2017) was submitted to and accepted by the DMS in December 2017. Construction activities were completed by Ecotone, Inc. in April 2019. Planting and seeding activities were completed by Bruton Natural Systems, Inc. in April 2019. Baseline monitoring (MY0) was conducted between January and April 2019. Annual monitoring will occur for seven years with the close-out anticipated to commence in 2026 provided the success criteria are met. Appendix 1 provides additional details on project activity, history, contact information, and watershed background information for the Site.

The Site is located on 10 parcels under 9 different landowners. A conservation easement was recorded on 51.84 acres. The project is expected to provide 12,621.936 SMUs at closeout. A project vicinity map and directions are provided in Figure 1, and project components/assets are illustrated in Figure 2.

1.1 Project Goals and Objectives

Prior to construction activities, the primary causes of Site degradation were channel straightening and livestock grazing/agriculture, both of which originated prior to 1938. Agricultural activity remained high through the 1990s with several thousand beef cattle and three hog houses. Currently, approximately 130 cows graze on three properties and land that is not forested is used for cultivating hay. Several ponds along Buckwater Creek, T3, and T5 were built between 1938 and 1955. According to 1955 aerial photography, the top 1,000 feet of Buckwater Creek on the Site were straightened. Landowners tried to maintain lower Buckwater Creek below Walnut Hill Drive as a straightened channel with little success and gave up completely by the 1990s. Table 4 in Appendix 1 and Tables 10a through 10c in Appendix 4 present the pre-restoration conditions data.

The project is intended to provide numerous ecological benefits. While benefits such as habitat improvement and geomorphic stability are limited to the project site, reduced nutrient and sediment loading have farther reaching effects. The table below describes expected outcomes to water quality and ecological processes and provides project goals and objectives. The project goals and objectives were developed as part of the mitigation plan considering the goals and objectives listed in the Neuse River RBRP plan and strive to maximize ecological and water quality uplift within the watershed.

Goal	Objective	Expected Outcomes
Reconnect channels with floodplains and riparian wetlands to allow a natural flooding regime.	Reconstruct stream channels for bankfull dimensions and depth relative to the existing floodplain.	Raise water table and hydrate riparian wetlands. Allow more frequent flood flows to disperse on the floodplain. Support geomorphology and higher level functions.
Improve the stability of stream channels.	Construct stream channels that will maintain stable cross-sections, patterns, and profiles over time.	Significantly reduce sediment inputs from bank erosion. Reduce shear stress on channel boundary. Support all stream functions above hydrology.
Exclude cattle from project streams.	Install fencing around conservation easements adjacent to cattle pastures.	Reduce and control sediment inputs; reduce and manage nutrient inputs; reduce and manage fecal coliform inputs. Contribute to protection of or improvement to a Water Supply Waterbody. Support Falls Lake recovery plan.
Improve instream habitat.	Install habitat features such as constructed riffles, cover/lunker logs, and brush toes into restored/enhanced streams. Add woody materials to channel beds. Construct pools of varying depth.	Increase and diversify available habitats for macroinvertebrates, fish, and amphibians leading to colonization and increase in biodiversity over time. Add complexity including LWD to streams.
Restore and enhance native floodplain and streambank vegetation.	Plant native tree and understory species in riparian zone and plant appropriate species on streambank.	Reduce sediment inputs from bank erosion and runoff. Increase nutrient cycling and storage in floodplain. Provide riparian habitat. Add a source of LWD and organic material to stream. Support all stream functions.
Permanently protect the project site from harmful uses.	Establish conservation easements on the Site.	Protect Site from encroachment on the riparian corridor and direct impact to streams and wetlands. Support all stream functions.

1.2 Monitoring Year 1 Data Assessment

Annual monitoring and site visits were conducted during MY1 to assess the condition of the project. The vegetation and stream success criteria for the Site follow the approved success criteria presented in the Mitigation Plan.

1.2.1 Vegetative Assessment

Planted woody vegetation is being monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008). During the baseline monitoring a total of 19 10-meter by 10-meter vegetation plots were established.

The final vegetation success criteria at the end of MY7 are the survival of 210 planted stems per acre averaging 10 feet in height. Interim success criteria are the survival of 320 planted stems per acre at the end of MY3 and 260 planted stems per acre with an average stem height of 7 feet at the end of MY5.

The MY1 vegetative survey was completed in October 2019. The 2019 vegetation monitoring resulted in an average stem density of 547 planted stems per acre, which is well above the interim requirement of 320 stems per acre required at MY3 and approximately 9% less than the baseline density recorded (601

planted stems per acre). There is an average of 13 stems per plot as compared to 15 stems per plot in MY0. All 19 vegetation plots individually met the interim success criteria and are on track to meet the final success criteria required for MY7. Refer to Appendix 2 for vegetation plot photographs and the vegetation condition assessment table and Appendix 3 for vegetation data tables.

1.2.2 Vegetation Areas of Concern

Before construction, the Site had areas with abundant Chinese privet (*Ligustrum sinense*) and a few other invasive species. A significant amount of Chinese privet was removed during construction but in areas where mechanical removal was not possible, hand removal was necessary. Extensive invasive vegetation removal took place in October 2019. While invasive species have been greatly reduced, Wildlands recognizes re-sprouting is common and will monitor the Site closely in subsequent monitoring years.

1.2.3 Stream Assessment

Morphological surveys for MY1 were conducted in October 2019. All streams within the Site are stable and functioning as designed. 34 out of 36 cross-sections at the Site show little to no change in the bankfull area and width-to-depth ratio, and bank height ratios less than 1.2. Cross-sections 26 and 28, on T5, show deviations from as-built due to sediment deposition on the point bar. These point bars are forming on the inside bend of the pools as expected in a natural system. Substrate measurements indicate the maintenance of coarser materials in the riffle reaches and finer particles in the pools. Longitudinal profile surveys are not required on the project unless visual inspection indicates reach wide vertical instability. Refer to Appendix 2 for the visual stability assessment table, Current Condition Plan View (CCPV) map, and stream photographs. Refer to Appendix 4 for the morphological data and plots.

1.2.4 Stream Areas of Concern

Storm damage shortly after construction was repaired in August 2019 on Buckwater Reach 4, and along T3 Reach 2. Left bank grading repairs and sod mats were added on Buckwater Reach 4 between stations 109+05 and 109+60. Right bank grading with the placement of sod mats was completed on Buckwater Reach 4 between stations 141+10 and 141+50. On T4 Reach 2, between stations 314+10 and 315+10, several failing log sills were replaced, and sod mats were added to any disturbed stream banks.

During an IRT site walk on November 21, 2019, bank erosion was identified on Buckwater Creek Reach 7, which is an Enhancement II section. Bank repairs will be conducted during MY2 and are shown on Figure 3b (CCPV Map, Appendix 2).

Two of the 36 cross-sections (pool cross-sections, XS 26 and XS 28, on T5) show excessive sedimentation on the point bar. Most stream channels were dry due to drought conditions during time of survey. Due to lack of streamflow, sediment was not transported through the channels and collected in some pools. Sediment deposition on the point bar of a pool is ideal; this sediment is expected to be transported downstream during future storm events. No remedial action will be taken at this time.

Pebble counts along T3 Reach 2 and T7 Reach 3 show an increase in fine sediment. The fine sediment presumably came from the adjacent floodplain after construction, before vegetation was well established. Surveyed cross-sections for these reaches appear stable and show minor variability from as-built cross-sections. This sediment is expected to move downstream during storm events and is not a concern at this time. Sediment in T3 Reach 2 and T7 Reach 3 will be monitored in subsequent monitoring years and remedial will be taken if necessary.

1.2.5 Hydrology Assessment

By the end of MY7, two or more bankfull events must have occurred in separate years within the restoration reaches. Also, two geomorphically significant events must be documented during the monitoring period. Bankfull events were recorded on Buckwater Creek, T1, T4, and T5 (downstream of St. Mary's road). Multiple geomorphically significant events were recorded on all reaches except T5 (upstream of St. Mary's road) during MY1.

In addition, the presence of baseflow must be documented on restored intermittent reaches (T4A, T4B, T6, T7A, and T8) for a minimum of 30 days during a normal precipitation year. In-stream flow gages equipped with pressure transducers were installed to monitor continuity of baseflow. Partial data was collected on all reaches due to construction ending in April 2019. T4A, T4B, T6 and T7A maintained baseflow as expected for intermittent streams. The flow gage on T8 malfunctioned several times and no data was recorded until November 21, 2019. Per the IRT site walk on November 21, 2019 a new flow gage was installed on T7 Reach 2 and the flow gage on T6 Reach 2 has been moved to a riffle. Refer to Appendix 5 for hydrologic data.

1.2.6 Wetland Assessment

Three groundwater gages were installed and monitored within the existing wetlands zones. All gages were installed at locations requested by NCDWR and were downloaded and maintained quarterly. The purpose of these gages is to assess potential effects to wetland hydrology from the construction of restored stream channel through these areas. The results of this monitoring are not tied to a success criterion. The measured hydroperiod ranged from 4.9% to 21.8% of the growing season consecutively. Results from Groundwater Gage 1 and 3 indicate areas along Buckwater Reach 4 and T1 Reach 2 are maintaining wetland conditions. However, Groundwater Gage 2 on Buckwater Reach 4 suggests slow recharge of the groundwater table after stream construction. Refer to Appendix 5 for wetland data.

1.2.7 Adaptive Management Plan

During MY1 along T5 and T6, Wildlands observed poor herbaceous vegetation growth. Biochar, humic acid, rye grain, and native riparian seed have been applied and herbaceous growth will be monitored closely during MY2.

1.3 Monitoring Year 1 Summary

All vegetation plots are on track to meet the MY3 interim requirement of 320 planted stems per acre. Invasive vegetation treatment was completed in October 2019 and the Site will continue to be monitored for invasive vegetation. In August 2019, erosion that occurred shortly after construction was repaired. All streams within the Site are stable and functioning as designed. Cross-sections 26 and 28, both pools on T5, deviated from as-built dimension due to deposition on point bars but will be monitored during MY2. Bankfull or geomorphically significant events were documented on all stream reaches except for T5 (upstream of St. Mary's road) during MY1. Greater than 30 days of consecutive flow were recorded on T4A, T4B, and T7A. Data were not collected during the monitoring period on T8 due to a flow gage malfunction. Wildlands will continue to nurture areas of poor herbaceous vegetation growth.

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. Narrative background and supporting information formerly found in these reports can be found in the Mitigation Plan (Wildlands, 2017) available on DMS's website. All raw data supporting the tables and figures in the appendices are available from DMS upon request.

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 Stream Restoration: A Natural Channel Design Handbook (Doll et al., 2003). All Integrated Current Condition Mapping was recorded using a Trimble handheld GPS with sub-meter accuracy and processed using Pathfinder and ArcGIS. Crest gages and pressure transducers were installed in riffle cross-sections and monitored throughout the year. Hydrologic monitoring instrument installation and monitoring methods are in accordance with the United States Army Corps of Engineers standards (USACE, 2003). Vegetation monitoring protocols followed the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008).

Section 3: REFERENCES

Breeding, R. 2010. Neuse River Basin Restoration Priorities 2010. NCEEP, NC

Doll, B.A., Grabow, G.L., Hall, K.A., Halley, J., Harman, W.A., Jennings, G.D., and Wise, D.E. 2003. Stream Restoration A Natural Channel Design Handbook.

Harrelson, C.C., Rawlins, C.L., Potyondy, J.P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique.* Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Lee, M.T., Peet, R.K., S.D., Wentworth, T.R. 2008. CVS-EEP Protocol for Recording Vegetation Version 4.2. Retrieved from http://cvs.bio.unc.edu/protocol/cvs-eep-protocol-v4.2-lev1-5.pdf.

Rosgen, D. L. 1994. A classification of natural rivers. *Catena* 22:169-199.

Rosgen, D.L. 1996. Applied River Morphology. Pagosa Springs, CO: Wildland Hydrology Books.

Rosgen, D.L. 1997. A Geomorphological Approach to Restoration of Incised Rivers. Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision. Center For Computational Hydroscience and Bioengineering, Oxford Campus, University of Mississippi, Pages 12-22.

United States Army Corps of Engineers. 2003. Stream Mitigation Guidelines. USACE, NCDENR-DWQ, USEPA, NCWRC.

United States Geological Survey. 1998. North Carolina Geology. http://www.geology.enr.state.nc.us/usgs/carolina.htm

Wildlands Engineering, Inc. 2019. Buckwater Mitigation Site Baseline Monitoring Document and As-Built Baseline Report. DMS, Raleigh, NC.

Wildlands Engineering, Inc. 2017. Buckwater Mitigation Project Mitigation Plan. DMS, Raleigh, NC.

APPENDIX 1. General Figures and Tables

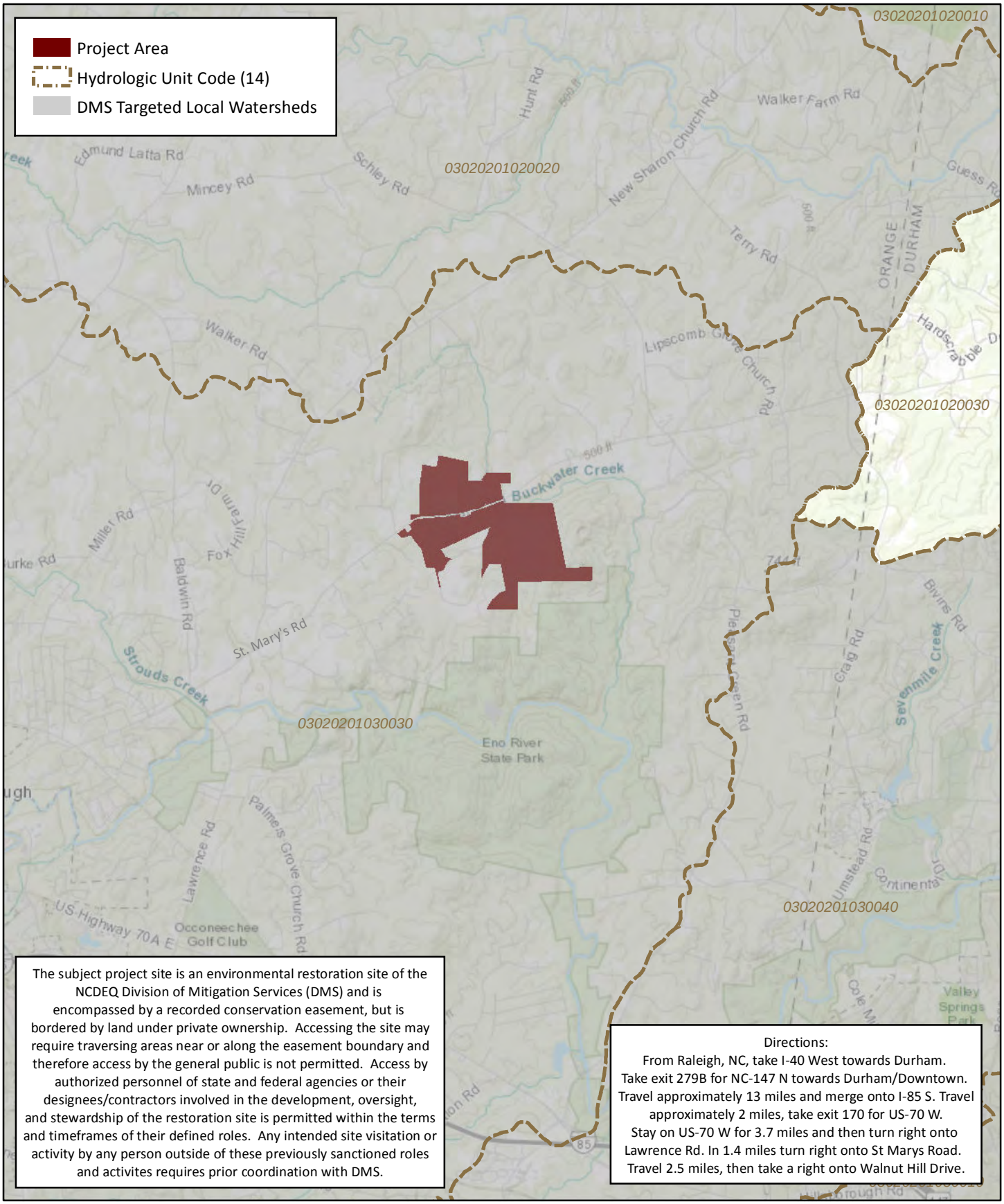


Figure 1. Project Vicinity Map
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Orange County, NC

WILDLANDS ENGINEERING

0 400 800 Feet

N

Figure 2. Project Component / Asset Map
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Orange County, NC

Table 1. Mitigation Assets and Components
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

PROJECT COMPONENTS								
Reach ID	**Existing Footage**	**Mitigation Plan Footage**	**Mitigation Category**	**Restoration Level**	**Priority Level**	**Mitigation Ratio (X:1)**	**As-Built Footage**	**Comments**
STREAMS								
Buckwater Reach 1	445	445	Warm	EII	N/A	2.5	433	Grade Control Structures, Bank Repair, Conservation Easement
Buckwater Reach 2	160	160	Warm	EI	P3	1.5	162	Grade Control Structures, Bank Repair, Planted Buffer
Buckwater Reach 3	232	232	Warm	EI	P1.5*	1.5	232	Grade Control Structures, Bank Repair, Planted Buffer
Buckwater Reach 4	2,282	2,067	Warm	R	P1	1.0	2,071	Full Channel Restoration, Planted Buffer, Invasive Control
		30				0.0	29	Utility Crossing
		206	Warm	R	P1	1.0	209	Full Channel Restoration, Planted Buffer
		72				0.0	70	Road Crossing
		194	Warm	R	P1	1.0	198	Full Channel Restoration, Planted Buffer
Buckwater Reach 5	435	486	Warm	R	P1.5*	1.0	485	Full Channel Restoration, Planted Buffer, Invasive Control
Buckwater Reach 6	884	379	Warm	R	P1.5*	1.0	363	Full Channel Restoration, Planted Buffer, Invasive Control
		118				0.0	30	Utility Crossing
Buckwater Reach 7	941	43				0.0	132	Utility Crossing
		891	Warm	EII	N/A	2.5	885	Grade Control Structures, Bank Repair, Enhancement Work Was Completed Beyond The Limits Of The Conservation Easement
Buckwater Reach 8	178	188	Warm	EII	N/A	2.5	185	Bank Repair, Conservation Easement
T1 Reach 1	501	366	Warm	EI	P1.5*	1.5	375	Grade Control Structures, Planted Buffer
		119				0.0	0	Road Crossing
T1 Reach 2	572	123				0.0	244	Utility Crossing
		485	Warm	R	P1	1.0	477	Full Channel Restoration, Planted Buffer
		25				0.0	43	Utility Crossing
T2	548	587	Warm	R	P1	1.0	592	Full Channel Restoration, Planted Buffer
T3 Reach 1	1,303	1,101	Warm	EII	N/A	2.5	1,107	Livestock Exclusion, Grade Control Strucres, Planted Buffer
		30				0.0	29	Road Crossing
		166	Warm	EII	N/A	2.5	167	Livestock Exclusion, Grade Control Structures, Planted Buffer
T3 Reach 2	877	658	Warm	R	P1	1.0	665	Full Channel Restoration, Planted Buffer, Livestock Exclusion
		63					93	Road Crossing
		193	Warm	R	P1	1.0	197	Full Channel Restoration, Planted Buffer, Livestock Exclusion
T4	1,081	961	Warm	R	P1	1.0	956	Full Channel Restoration, Planted Buffer
T4A Reach 1	312	311	Warm	R	P1	1.0	327	Farm Pond Drained, Full Channel Restoration, Planted Buffer
T4A Reach 2	259	175	Warm	EII	N/A	2.5	155	Livestock Exclusion, Grade Control Structures, Conservation Easement
		72				0.0	75	Road Crossing
T4A Reach 3	145	201	Warm	R	P1	1.0	208	Full Channel Restoration, Planted Buffer
		64				0.0	66	Road Crossing
T4B Reach 1	419	345	Warm	R	P1	1.0	346	Full Channel Restoration, Livestock Exclusion
T5	1,291	548	Warm	R	P1	1.0	554	Full Channel Restoration, Planted Buffer, Invasive Control
		167				0.0	0	Road Crossing
		711	Warm	R	P1	1.0	722	Full Channel Restoration, Planted Buffer, Farm Pond Drained
T6 Reach 1	697	695	Warm	EII	N/A	2.5	697	Invasive Control, Bank Repair, Conservation Easement
T6 Reach 2	492	458	Warm	EII	N/A	2.5	458	Invasive Control, Bank Repair, Conservation Easement
		30				0.0	30	Road Crossing
T6 Reach 3	704	620	Warm	EI	P1 & P1.5*	1.5	623	Grade Control Structures, Planted Buffer, Invasive Control
T6A	324	311	Warm	EII	N/A	2.5	313	Grade Control Structures, Bank Repair, Conservation Easement
T6B	136	136	Warm	EII	N/A	2.5	136	Grade Control Structures, Bank Repair, Conservation Easement
T7 Reach 1	317	322	Warm	EI	P1.5*	1.5	320	Grade Control Structures, Planted Buffer
T7 Reach 2	323	363	Warm	R	P1	1.0	367	Full Channel Restoration, Planted Buffer
T7 Reach 3	368	356	Warm	R	P2	1.0	357	Full Channel Restoration, Planted Buffer
T7A	227	242	Warm	EI	P1	1.5	240	Grade Control Structures, Planted Buffer
T8	620	631	Warm	EI	P1	1.5	621	Grade Control Structures, Planted Buffer
T9	73	73	Warm	EII	N/A	2.5	73	Grade Control Structures, Conservation Easement

*Priority 1.5 refers to a combination of Priority 1 and Priority 2 where the existing channel was raised and the floodplain was graded.

PROJECT CREDITS							
Restoration Level	**Stream**			**Riparian Wetland**		**Non-Riparian Wetland**	**Coastal Marsh**
	Warm	**Cool**	**Cold**	**Riverine**	**Non-Riverine**		
Restoration	9,051.000						
Enhancement I	1,715.336						
Enhancement II	1,855.600						
Preservation							
Re-Establishment							
Rehabilitation							
Enhancement							
Creation							
Totals	**12,621.936**						

Table 2. Project Activity and Reporting History
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Activity or Report		Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan		December 2017	December 2017
Final Design - Construction Plans		April 2018	April 2018
Construction		April 2018-April 2019	April 2019
Temporary S&E mix applied to entire project area [1]		April 2018-April 2019	April 2019
Permanent seed mix applied to reach/segments [1]		April 2018-April 2019	April 2019
Bare root and live stake plantings for reach/segments		April 2019	April 2019
Baseline Monitoring Document (Year 0)	Stream Survey	April 2019	July 2019
	Vegetation Survey	April 2019	
In-stream Repairs			August 2019
Invasive Treatment			October 2019
Year 1 Monitoring	Stream Survey	October 2019	December 2019
	Vegetation Survey	October 2019	
Year 2 Monitoring	Stream Survey	2020	December 2020
	Vegetation Survey	2020	
Year 3 Monitoring	Stream Survey	2021	December 2021
	Vegetation Survey	2021	
Year 4 Monitoring	Stream Survey	2022	December 2022
	Vegetation Survey	2022	
Year 5 Monitoring	Stream Survey	2023	December 2023
	Vegetation Survey	2023	
Year 6 Monitoring	Stream Survey	2024	December 2024
	Vegetation Survey	2024	
Year 7 Monitoring	Stream Survey	2025	December 2025
	Vegetation Survey	2025	

[1]Seed and mulch is added as each section of construction is completed.

Table 3. Project Contact Table
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

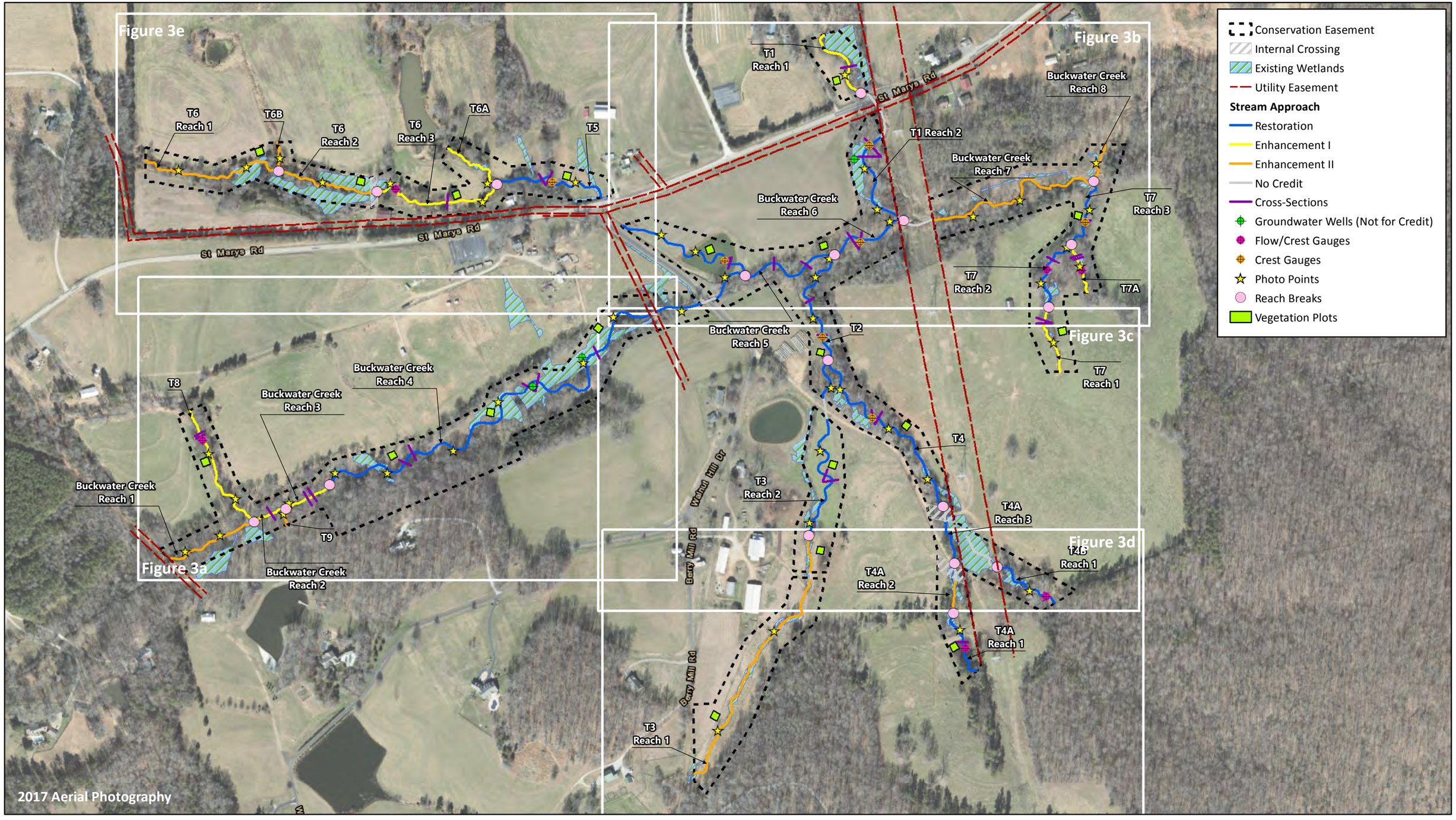
Designer Nicole Macaluso, PE	**Wildlands Engineering, Inc.** 312 West Millbrook Road, Suite 225 Raleigh, NC 27609 919.851.9986
Construction Contractor	**Ecotone, Inc** 2120 High Point Rd Forest Hill, MD 21050
Planting Contractor	**Bruton Natural Systems, Inc** P.O. Box 1197 Fremont, NC 27830
Seeding Contractor	**Ecotone, Inc** 2120 High Point Rd Forest Hill, MD 21050
Seed Mix Sources	**Green Resource, LLC**
Nursery Stock Suppliers **Bare Roots**	**Dykes and Sons Nursery and Greenhouse**
Live Stakes	**Bruton Natural Systems, Inc**
Monitoring Performers	**Wildlands Engineering, Inc.**
Monitoring, POC	Jason Lorch 919.851.9986

Table 4. Project Information and Attributes
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

PROJECT INFORMATION							
Project Name	Buckwater Mitigation Site						
County	Orange County						
Project Coordinates (latitude and longitude)	36° 6' 23.49" N, 79° 1' 29.11" W						
Project Area (acres)	51.84						
Planted Acerage (acres of woody stems planted)	21.80						
PROJECT WATERSHED SUMMARY INFORMATION							
Physiographic Province	Carolina Slate Belt of the Piedmont Physiographic Province						
River Basin	Neuse River						
USGS Hydrologic Unit 8-digit	03020201						
USGS Hydrologic Unit 14-digit	03020201030030						
DWR Sub-basin	03-04-01						
Project Drainiage Area (acres)	2,259						
Project Drainage Area Percentage of Impervious Area	3.9%						
CGIA Land Use Classification	63.9% forested, 32.1% cultivated, 3.9% impervious						
Reaches	**Buckwater**	**T1**	**T2 & T3**	**T4, T4A, & T4B**	**T5 & T6**	**T7 & T7A**	**T8**
Length of Reach (linear feet) - Post-Restoration	5,223	852	2,728	1,992	3,054	1,284	621
Drainage Area (acres)	2,259	1,216	218	77	109	28	21
NCDWR Stream Identification Score	42	37.5	42	40.5	60	30	30.5
NCDWR Water Quality Classification	WS-IV						
Morphological Desription (stream type)	Perennial	Perennial	Perennial	Intermittent	Intermittent	Intermittent	Intermittent
Evolutionary Trend (Simon's Model) - Pre-Restoration	V - Aggradation and Widening		IV- Degradation and Widening				
Underlying Mapped Soils	Appling-Helena, Chewacla loam, Herndon Tarrus Series						
Drainage Class	-			-			
Soil Hydric Status	-			-			
Slope	-			-			
FEMA Classification	Zone AE		Buckwater Floodplain Fringe			N/A	
Native Vegetation Community	Piedmont Bottomland Forest						
Percent Composition Exotic Invasive Vegetation - Post-Restoration	0%						

REGULATORY CONSIDERATIONS			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States - Section 404	Yes	Yes	USACE Nationwide Permit No. 27 and DWQ 401 Water Quality Certification No. 4134.
Waters of the United States - Section 401	Yes	Yes	
Division of Land Quality (Dam Safety)	N/A	N/A	N/A
Endangered Species Act	Yes	Yes	Buckwater Mitigation Plan; Wildlands determined "no effect" on Orange County listed endangered species. The USFWS responded on May 5, 2016 stating that "the proposed action is not likely to adversely affect any federally-listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for listing under the Act."
Historic Preservation Act	Yes	Yes	Correspondence from SHPO on May 6, 2016 stated the project would "have no effect on the archaeological potential of the Saint Mary's Road Rural Historic District" and the project "will not adversely affect" the Saint Mary's Road Rural Historic District nor the adjacent Holden-Roberts Farm (OR0673).
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A
FEMA Floodplain Compliance	Yes	Yes	A CLOMR was approved prior to the start of construction, as well as local floodplain development permit. A LOMR has been submitted to the State Floodplain Mapping Program and is awaiting approval.
Essential Fisheries Habitat	N/A	N/A	N/A

APPENDIX 2. Visual Assessment Data



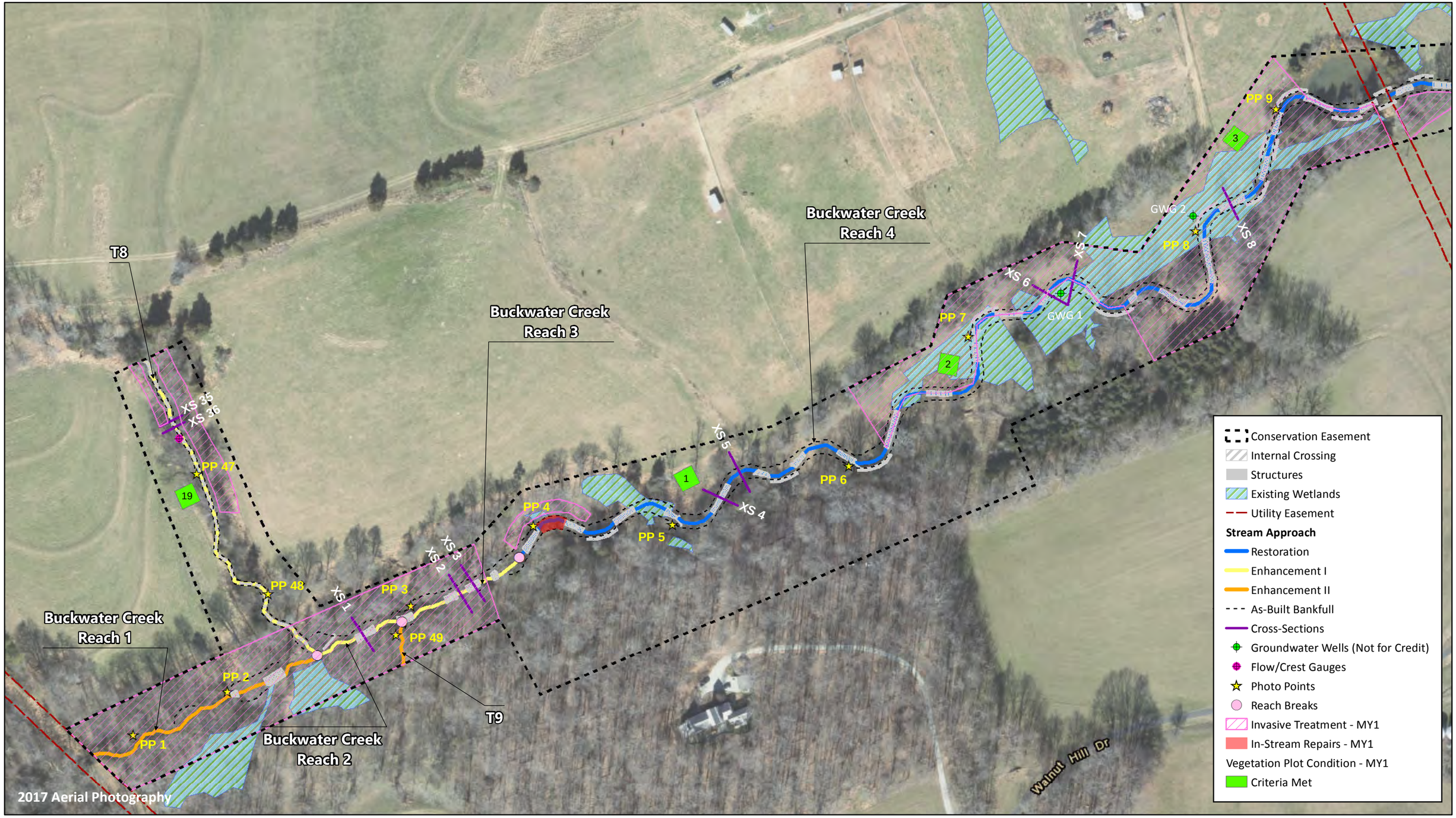
WILDLANDS ENGINEERING

0 400 800 Feet

N

Figure 3. Integrated Current Condition Plan View Key
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Orange County, NC



WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 3a. Integrated Current Condition Plan View
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Orange County, NC

Conservation Easement
Internal Crossing
Structures
Existing Wetlands
Utility Easement

Stream Approach

Restoration
Enhancement I
Enhancement II
As-Built Bankfull
Cross-Sections
Groundwater Wells (Not for Credit)
Flow/Crest Gauges
Crest Gauges
Barotroll
Photo Points
Reach Breaks
Invasive Treatment - MY1
In-Stream Reapirs - MY1
Stream Areas of Concern - MY1

Vegetation Plot Condition - MY1

Criteria Met

T1
Reach 1
XS 13
PP 17
5
St Marys Rd
4506
Stagg Rd
4414
4398
XS 14
XS 15
GW3
PP 18
T1
Reach 2
Buckwater Creek
Reach 8
PP 16
Buckwater Creek
Reach 7
PP 15
PP 45
PP 14
PP 19
PP 13
T5
Buckwater Creek
Reach 6
Buckwater Creek
Reach 5
PP 40
638
Walnut Hill Dr
PP 41
16
XS 27
XS 28
XS 9
XS 10
XS 11
XS 12
4
PP 12
PP 11
PP 26
XS 19
T2
PP 10
PP 9
PP 25
T7
Reach 3
18
XS 32
T7
Reach 2
PP 44
XS 31
XS 34
XS 33
PP 46
T7A
PP 43
XS 30
XS 29
2017 Aerial Photography

WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 3b. Integrated Current Condition Plan View
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Orange County, NC

Conservation Easement
Internal Crossing
Structures
Existing Wetlands
Utility Easement

Stream Approach

Restoration
Enhancement I
Enhancement II
As-Built Bankfull
Cross-Sections
Flow/Crest Gauges
Crest Gauges
Photo Points
Reach Breaks
Invasive Treatment - MY1
In-Stream Repairs - MY1

Vegetation Plot Condition - MY1

Criteria Met

PP 10
Reach 5
PP 25
XS 18
T2
10
T4
PP 24
PP 30
XS 22
XS 21
T3
Reach 2
PP 29
11
PP 23
8
XS 17
XS 16
PP 28
PP 22
7
T4A
Reach 3
T4A
Reach 2
T4B
Reach 1
XS 23
PP 31
XS 30
XS 29
17
T7
Reach 1
PP 42
Walnut Hill Dr
301
599
Berry Mill Rd

2017 Aerial Photography

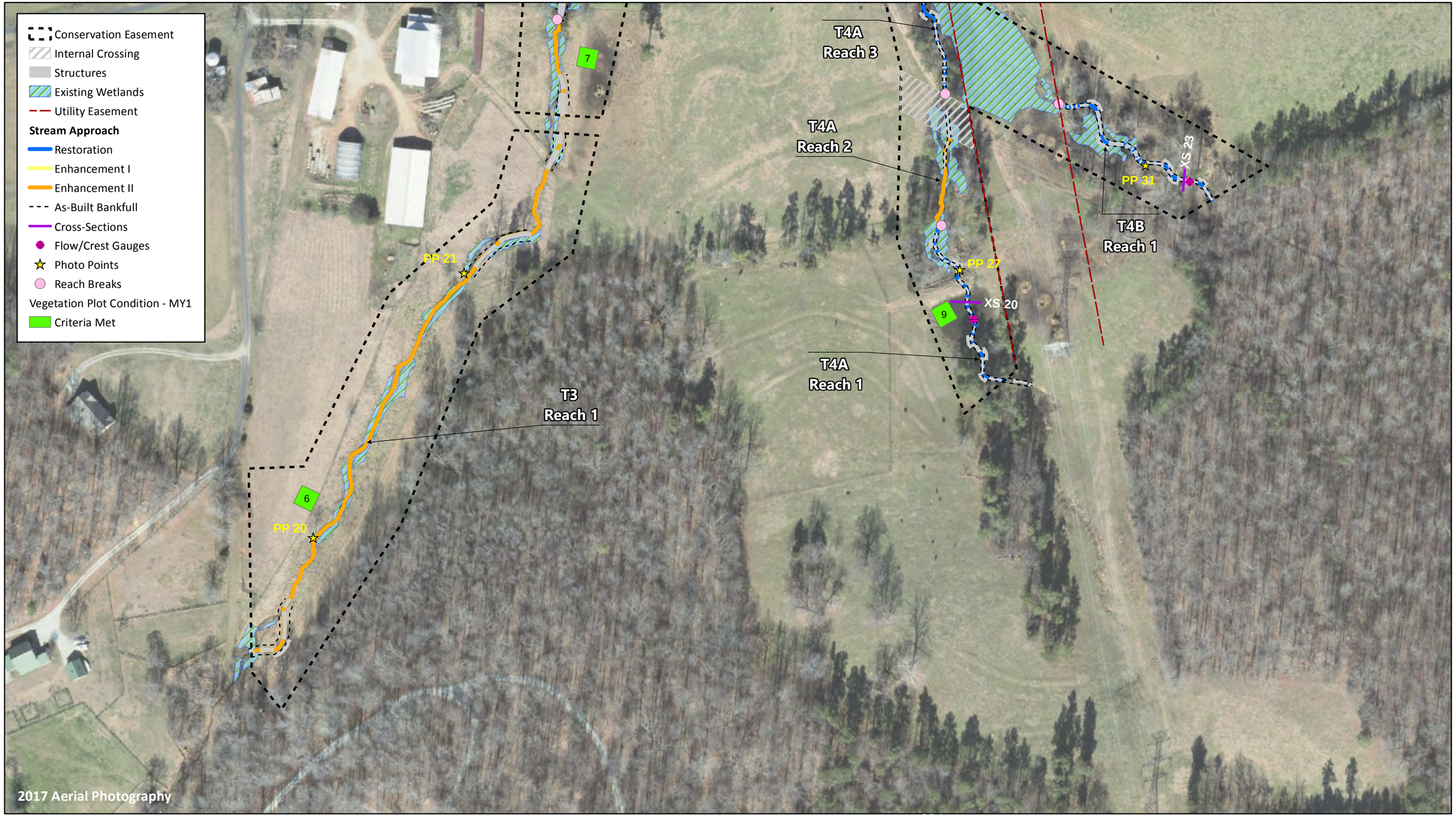
WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 3c. Integrated Current Condition Plan View
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Orange County, NC



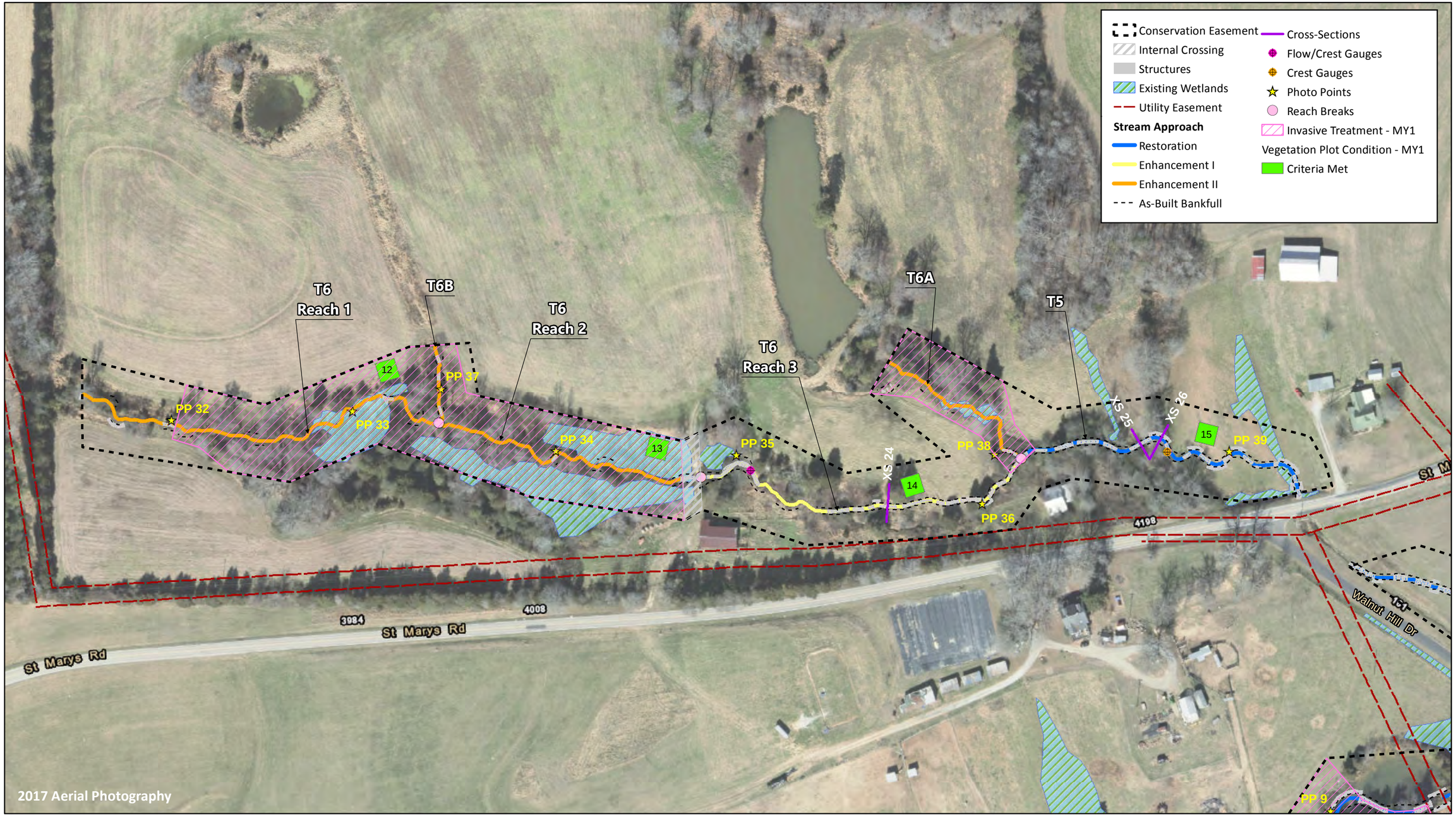
WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 3d. Integrated Current Condition Plan View
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Orange County, NC



WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 3e. Integrated Current Condition Plan View
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Orange County, NC

Table 5a. Visual Stream Morphology Stability Assessment Table
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

Buckwater Reach 2/3

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	6	6			100%			
		Length Appropriate	6	6			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	6	6			100%			
		Thalweg centering at downstream of meander bend (Glide)	6	6			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, caving, or collapse.			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	1	1			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	1	1			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%.	0	0			N/A			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	0	0			N/A			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5b. Visual Stream Morphology Stability Assessment Table
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

Buckwater Reach 4

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	27	27			100%			
	3. Meander Pool Condition	Depth Sufficient	25	25			100%			
		Length Appropriate	25	25			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	27	27			100%			
		Thalweg centering at downstream of meander bend (Glide)	25	25			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	4	4			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	4	4			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	4	4			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	11	11			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	11	11			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5c. Visual Stream Morphology Stability Assessment Table
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

Buckwater Reach 5/6

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	8	8			100%			
	3. Meander Pool Condition	Depth Sufficient	8	8			100%			
		Length Appropriate	8	8			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	8	8			100%			
		Thalweg centering at downstream of meander bend (Glide)	8	8			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	1	1			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	1	1			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%.	8	8			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	8	8			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5d. Visual Stream Morphology Stability Assessment Table
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

T1

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	15	15			100%			
	3. Meander Pool Condition	Depth Sufficient	14	14			100%			
		Length Appropriate	14	14			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	15	15			100%			
		Thalweg centering at downstream of meander bend (Glide)	14	14			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	0	0			N/A			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	0			N/A			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			N/A			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	7	7			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	7	7			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5e. Visual Stream Morphology Stability Assessment Table
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

T2/T3

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	25	25			100%			
	3. Meander Pool Condition	Depth Sufficient	23	23			100%			
		Length Appropriate	23	23			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	25	25			100%			
		Thalweg centering at downstream of meander bend (Glide)	23	23			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	0	0			N/A			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	0			N/A			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			N/A			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	17	17			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	17	17			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5f. Visual Stream Morphology Stability Assessment Table
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

T4/T4A

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	41	41			100%			
	3. Meander Pool Condition	Depth Sufficient	37	37			100%			
		Length Appropriate	37	37			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	41	41			100%			
		Thalweg centering at downstream of meander bend (Glide)	37	37			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	3	3			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	3	3			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	3	3			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	23	23			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	23	23			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5g. Visual Stream Morphology Stability Assessment Table
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

T4B

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	9	9			100%			
	3. Meander Pool Condition	Depth Sufficient	9	9			100%			
		Length Appropriate	9	9			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	9	9			100%			
		Thalweg centering at downstream of meander bend (Glide)	9	9			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	2	2			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	2	2			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	2	2			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	5	5			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	5	5			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5h. Visual Stream Morphology Stability Assessment Table
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

T5/T6

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	40	40			100%			
	3. Meander Pool Condition	Depth Sufficient	37	37			100%			
		Length Appropriate	37	37			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	40	40			100%			
		Thalweg centering at downstream of meander bend (Glide)	37	37			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	0	0			N/A			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	0			N/A			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			N/A			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	13	13			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	13	13			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5i Visual Stream Morphology Stability Assessment Table
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

T7

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	40	40			100%			
	3. Meander Pool Condition	Depth Sufficient	35	35			100%			
		Length Appropriate	35	35			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	40	40			100%			
		Thalweg centering at downstream of meander bend (Glide)	35	35			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	5	5			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	5	5			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	5	5			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	20	20			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	20	20			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5j. Visual Stream Morphology Stability Assessment Table
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

T7A

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	10	10			100%			
	3. Meander Pool Condition	Depth Sufficient	9	9			100%			
		Length Appropriate	9	9			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	10	10			100%			
		Thalweg centering at downstream of meander bend (Glide)	9	9			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	0	0			N/A			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	0			N/A			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			N/A			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	2	2			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	2	2			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5k. Visual Stream Morphology Stability Assessment Table
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

T8

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	25	25			100%			
	3. Meander Pool Condition	Depth Sufficient	24	24			100%			
		Length Appropriate	24	24			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	25	25			100%			
		Thalweg centering at downstream of meander bend (Glide)	24	24			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	0	0			N/A			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	0			N/A			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			N/A			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	6	6			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	6	6			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 6. Vegetation Condition Assessment Table

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Planted Acreage **21.80**

Vegetation Category	Definitions	Mapping Threshold (Ac)	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material	0.1	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%
		Total	**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 Ac	0	0	0%
		Cumulative Total	**0**	**0.0**	**0%**

Easement Acreage **51.84**

Vegetation Category	Definitions	Mapping Threshold (SF)	Number of Polygons	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern	Areas of points (if too small to render as polygons at map scale).	1,000	0	0	0%
Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale).	none	0	0	0%

STREAM PHOTOGRAPHS

PHOTO POINT 1 Buckwater R1 – upstream *(10/9/2019)*

PHOTO POINT 1 Buckwater R1 – downstream *(10/9/2019)*

PHOTO POINT 2 Buckwater R1 – upstream *(10/9/2019)*

PHOTO POINT 2 Buckwater R1 – downstream *(10/9/2019)*

PHOTO POINT 3 Buckwater R3 – upstream *(10/9/2019)*

PHOTO POINT 3 Buckwater R3 – downstream *(10/9/2019)*

PHOTO POINT 4 Buckwater R4 – upstream *(10/9/2019)*

PHOTO POINT 4 Buckwater R4 – downstream *(10/9/2019)*

PHOTO POINT 5 Buckwater R4 – upstream *(10/9/2019)*

PHOTO POINT 5 Buckwater R4 – downstream *(10/9/2019)*

PHOTO POINT 6 Buckwater R4 – upstream *(10/9/2019)*

PHOTO POINT 6 Buckwater R4 – downstream *(10/9/2019)*

	
PHOTO POINT 7 Buckwater R4 – upstream *(10/9/2019)*	**PHOTO POINT 7 Buckwater R4 – downstream *(10/9/2019)***
	
PHOTO POINT 8 Buckwater R4 – upstream *(10/9/2019)*	**PHOTO POINT 8 Buckwater R4 – downstream *(10/9/2019)***
	
PHOTO POINT 9 Buckwater R4 – upstream *(10/9/2019)*	**PHOTO POINT 9 Buckwater R4 – downstream *(10/9/2019)***

PHOTO POINT 10 Buckwater R4 – upstream *(10/9/2019)*

PHOTO POINT 10 Buckwater R4 – downstream *(10/9/2019)*

PHOTO POINT 11 Buckwater R4 – upstream *(10/9/2019)*

PHOTO POINT 11 Buckwater R4 – downstream *(10/9/2019)*

PHOTO POINT 12 Buckwater R5 – upstream *(10/9/2019)*

PHOTO POINT 12 Buckwater R5 – downstream *(10/9/2019)*

PHOTO POINT 13 Buckwater R6 – upstream *(10/9/2019)*

PHOTO POINT 13 Buckwater R6 – downstream *(10/9/2019)*

PHOTO POINT 14 Buckwater R7 – upstream *(10/9/2019)*

PHOTO POINT 14 Buckwater R7 – downstream *(10/9/2019)*

PHOTO POINT 15 Buckwater R7 – upstream *(10/9/2019)*

PHOTO POINT 15 Buckwater R7 – downstream *(10/9/2019)*

	
PHOTO POINT 16 Buckwater R8 – upstream *(10/9/2019)*	**PHOTO POINT 16 Buckwater R8 – downstream *(10/9/2019)***
	
PHOTO POINT 17 T1 Reach 1 – upstream *(10/9/2019)*	**PHOTO POINT 17 T1 Reach 1 – downstream *(10/9/2019)***
	
PHOTO POINT 18 T1 Reach 2 – upstream *(10/9/2019)*	**PHOTO POINT 18 T1 Reach 2 – downstream *(10/9/2019)***

PHOTO POINT 19 T1 Reach 2 – upstream *(10/9/2019)*

PHOTO POINT 19 T1 Reach 2 – downstream *(10/9/2019)*

PHOTO POINT 20 T3 Reach 1 – upstream *(10/9/2019)*

PHOTO POINT 20 T3 Reach 1 – downstream *(10/9/2019)*

PHOTO POINT 21 T3 Reach 1 – upstream *(10/9/2019)*

PHOTO POINT 21 T3 Reach 1 – downstream *(10/9/2019)*

PHOTO POINT 22 T3 Reach 2 – upstream *(10/9/2019)*

PHOTO POINT 22 T3 Reach 2 – downstream *(10/9/2019)*

PHOTO POINT 23 T3 Reach 2 – upstream *(10/9/2019)*

PHOTO POINT 23 T3 Reach 2 – downstream *(10/9/2019)*

PHOTO POINT 24 T3 – upstream *(10/9/2019)*

PHOTO POINT 24 T3 – downstream *(10/9/2019)*

	
PHOTO POINT 25 T2 – upstream *(10/9/2019)*	**PHOTO POINT 25 T2 – downstream *(10/9/2019)***
	
PHOTO POINT 26 T2 – upstream *(10/9/2019)*	**PHOTO POINT 26 T2 – downstream *(10/9/2019)***
	
PHOTO POINT 27 T4A Reach 1 – upstream *(10/9/2019)*	**PHOTO POINT 27 T4A Reach 1 – downstream *(10/9/2019)***

	
PHOTO POINT 28 T4 – upstream *(10/9/2019)*	**PHOTO POINT 28 T4 – downstream *(10/9/2019)***
	
PHOTO POINT 29 T4 – upstream *(10/9/2019)*	**PHOTO POINT 29 T4 – downstream *(10/9/2019)***
	
PHOTO POINT 30 T4 – upstream *(10/9/2019)*	**PHOTO POINT 30 T4 – downstream *(10/9/2019)***

	
PHOTO POINT 31 T4B Reach 1 – upstream *(10/9/2019)*	**PHOTO POINT 31 T4B Reach 1 – downstream *(10/9/2019)***
	
PHOTO POINT 32 T6 Reach 1 – upstream *(10/9/2019)*	**PHOTO POINT 32 T6 Reach 1 – downstream *(10/9/2019)***
	
PHOTO POINT 33 T6 Reach 1 – upstream *(10/9/2019)*	**PHOTO POINT 33 T6 Reach 1 – downstream *(10/9/2019)***

PHOTO POINT 34 T6 Reach 2 – upstream *(10/9/2019)*

PHOTO POINT 34 T6 Reach 2 – downstream *(10/9/2019)*

PHOTO POINT 35 T6 Reach 3 – upstream *(10/9/2019)*

PHOTO POINT 35 T6 Reach 3 – downstream *(10/9/2019)*

PHOTO POINT 36 T6 Reach 3 – upstream *(10/9/2019)*

PHOTO POINT 36 T6 Reach 3 – downstream *(10/9/2019)*

	
PHOTO POINT 37 T6B – upstream *(10/9/2019)*	**PHOTO POINT 37 T6B – downstream *(10/9/2019)***
	
PHOTO POINT 38 T6A – upstream *(10/9/2019)*	**PHOTO POINT 38 T6A – downstream *(10/9/2019)***
	
PHOTO POINT 39 T5 – upstream *(10/9/2019)*	**PHOTO POINT 39 T5 – downstream *(10/9/2019)***

PHOTO POINT 40 T5 – upstream *(10/9/2019)*

PHOTO POINT 40 T5 – downstream *(10/9/2019)*

PHOTO POINT 41 T5 – upstream *(10/9/2019)*

PHOTO POINT 41 T5 – downstream *(10/9/2019)*

PHOTO POINT 42 T7 Reach 1 – upstream *(10/9/2019)*

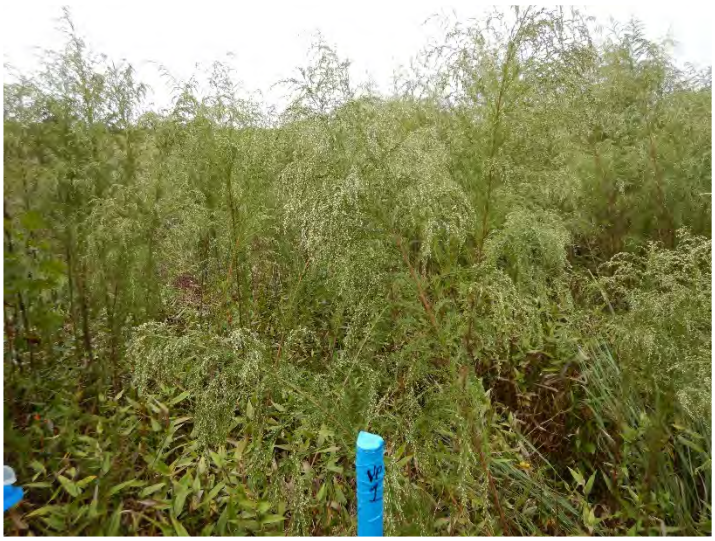
PHOTO POINT 42 T7 Reach 1 – downstream *(10/9/2019)*

	
PHOTO POINT 43 T7 Reach 2 – upstream *(10/9/2019)*	**PHOTO POINT 43 T7 Reach 2 – downstream *(10/9/2019)***
	
PHOTO POINT 44 T7 Reach 2 – upstream *(10/9/2019)*	**PHOTO POINT 44 T7 Reach 2 – downstream *(10/9/2019)***
	
PHOTO POINT 45 T7 Reach 3 – upstream *(10/9/2019)*	**PHOTO POINT 45 T7 Reach 3 – downstream *(10/9/2019)***

	
PHOTO POINT 46 T7A– upstream *(10/9/2019)*	**PHOTO POINT 46 T7A– downstream *(10/9/2019)***
	
PHOTO POINT 47 T8 – upstream *(10/9/2019)*	**PHOTO POINT 47 T8 – downstream *(10/9/2019)***
	
PHOTO POINT 48 T8 – upstream *(10/9/2019)*	**PHOTO POINT 48 T8 – downstream *(10/9/2019)***

	
PHOTO POINT 49 T9 – upstream *(10/9/2019)*	**PHOTO POINT 49 T9 – downstream *(10/9/2019)***

VEGETATION PLOT PHOTOGRAPHS

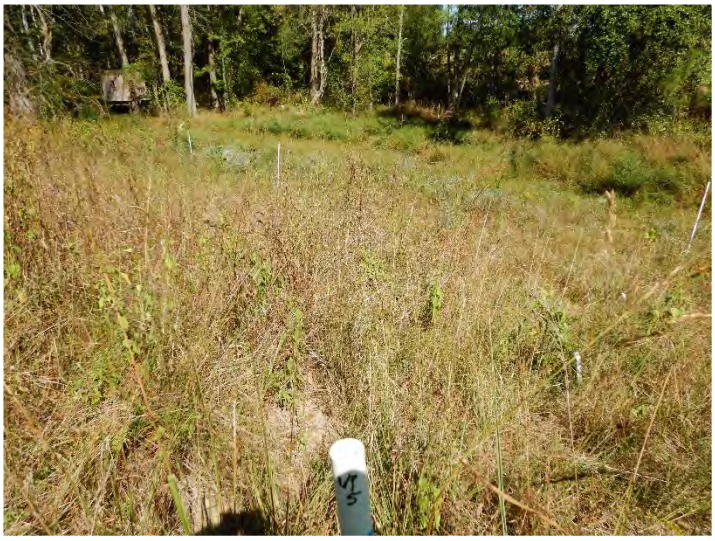


VEG PLOT 1 *(10/09/2019)*

VEG PLOT 2 *(10/09/2019)*

VEG PLOT 3 *(10/09/2019)*

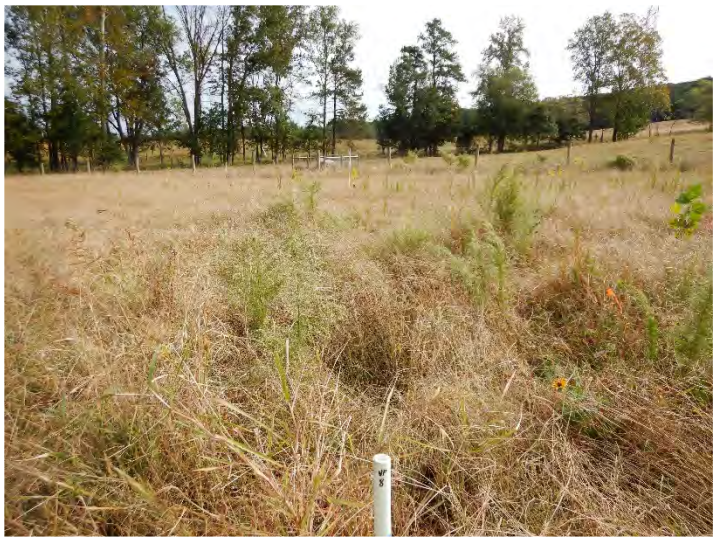
VEG PLOT 4 *(10/09/2019)*



VEG PLOT 5 *(10/09/2019)*

VEG PLOT 6 *(10/09/2019)*

VEG PLOT 7 *(10/09/2019)*



VEG PLOT 8 *(10/09/2019)*

VEG PLOT 9 *(10/09/2019)*

VEG PLOT 10 *(10/09/2019)*

VEG PLOT 11 *(10/09/2019)*

VEG PLOT 12 *(10/09/2019)*

VEG PLOT 13 *(10/09/2019)*

VEG PLOT 14 *(10/09/2019)*

VEG PLOT 15 *(10/09/2019)*

VEG PLOT 16 *(10/09/2019)*

VEG PLOT 17 *(10/09/2019)*

VEG PLOT 18 *(10/09/2019)*

VEG PLOT 19 *(10/09/2019)*

APPENDIX 3. Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment Table

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Plot	Success Criteria Met	Tract Mean
1	Yes	100%
2	Yes	
3	Yes	
4	Yes	
5	Yes	
6	Yes	
7	Yes	
8	Yes	
9	Yes	
10	Yes	
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	Yes	
19	Yes	

Table 8. CVS Vegetation Tables - Metadata
Buckwater Mitigation Project
DMS Project No. 97084
Monitoring Year 1 - 2019

Report Prepared By	Jason Lorch
Date Prepared	10/11/2019 12:44
Database Name	Buckwater- cvs-v2.5.0- MY1.mdb
Database Location	F:\Projects\005-02157 Buckwater\Monitoring\Monitoring Year 1\Vegetation Assessment
Computer Name	CARLYNN-PC
File Size	77271040
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Project Planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Project 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	97084
Project Name	Buckwater Mitigation Site
Description	Buffer Restoration Project
Sampled Plots	19

Table 9. Planted and Total Stem Counts

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

			Current Plot Data (MY1 2019)																	
			VP 1			VP 2			VP 3			VP 4			VP 5			VP 6		
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**
Aesculus pavia	Yellow Buckeye	Shrub Tree																		
Betula nigra	River Birch	Tree	1	1	1	2	2	2	3	3	4	2	2	2	3	3	3			
Fraxinus pennsylvanica	Green Ash	Tree	3	3	3	2	2	2	2	2	2	4	4	4	1	1	1	2	2	2
Juglans nigra	Black Walnut	Tree															1			
Liquidambar styraciflua	Sweet Gum	Tree			2															
Liriodendron tulipifera	Tulip Poplar	Tree	2	2	2	1	1	1	1	1	1				2	2	2			
Platanus occidentalis	Sycamore	Tree	1	1	1	5	5	5	4	4	4	2	2	2	4	4	4	4	4	4
Quercus alba	White Oak	Tree	2	2	2	1	1	1							1	1	1	1	1	1
Quercus lyrata	Overcup Oak	Tree										3	3	3	2	2	2	2	2	2
Quercus michauxii	Swamp Chestnut Oak	Tree	3	3	3				1	1	1									
Quercus phellos	Willow Oak	Tree	3	3	3				3	3	3	3	3	3				3	3	3
Quercus shumardii	Shumard Oak	Shrub Tree				3	3	3	1	1	1									
Viburnum dentatum	Arrow-wood	Shrub Tree																1	1	1
		Stem count	15	15	17	14	14	14	15	15	16	14	14	14	13	13	14	13	13	13
		size (ares)	1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	7	7	8	6	6	6	7	7	7	5	5	5	6	6	7	6	6	6
		Stems per ACRE	607	607	688	567	567	567	607	607	647	567	567	567	526	526	567	526	526	526

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

PnLS: 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

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

			Current Plot Data (MY1 2019)																	
			VP 7			VP 8			VP 9			VP 10			VP 11			VP 12		
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**
Aesculus pavia	Yellow Buckeye	Shrub Tree	2	2	2				1	1	1				1	1	1	2	2	2
Betula nigra	River Birch	Tree	1	1	1	1	1	1	1	1	1							2	2	2
Fraxinus pennsylvanica	Green Ash	Tree	1	1	1	1	1	1				4	4	4	1	1	1			
Juglans nigra	Black Walnut	Tree																		
Liquidambar styraciflua	Sweet Gum	Tree																		
Liriodendron tulipifera	Tulip Poplar	Tree				2	2	2	2	2	2							4	4	4
Platanus occidentalis	Sycamore	Tree	2	2	2	4	4	4	4	4	4	1	1	1	1	1	1	3	3	3
Quercus alba	White Oak	Tree	2	2	2															
Quercus lyrata	Overcup Oak	Tree	1	1	1	1	1	1	3	3	3	6	6	6	3	3	3			
Quercus michauxii	Swamp Chestnut Oak	Tree										1	1	1				3	3	3
Quercus phellos	Willow Oak	Tree	3	3	3	1	1	1							3	3	3	1	1	1
Quercus shumardii	Shumard Oak	Shrub Tree	1	1	1	1	1	1												
Viburnum dentatum	Arrow-wood	Shrub Tree													4	4	4			
		Stem count	13	13	13	11	11	11	11	11	11	12	12	12	13	13	13	15	15	15
		size (ares)		1			1			1			1			1			1	
		size (ACRES)		0.02			0.02			0.02			0.02			0.02			0.02	
		Species count	8	8	8	7	7	7	5	5	5	4	4	4	6	6	6	6	6	6
		Stems per ACRE	526	526	526	445	445	445	445	445	445	486	486	486	526	526	526	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

PnLS: 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

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

			Current Plot Data (MY1 2019)																				
			VP 13			VP 14			VP 15			VP 16			VP 17			VP 18			VP 19		
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**	**PnoLS**	**P-all**	**T**
Aesculus pavia	Yellow Buckeye	Shrub Tree							1	1	1				1	1	1	1	1	1			
Betula nigra	River Birch	Tree	4	4	4	4	4	4	3	3	3	1	1	1	2	2	2	3	3	3	1	1	1
Fraxinus pennsylvanica	Green Ash	Tree	3	3	3	3	3	3	2	2	2	1	1	1	1	1	1	1	1	1	2	2	2
Juglans nigra	Black Walnut	Tree																					
Liquidambar styraciflua	Sweet Gum	Tree			1																		
Liriodendron tulipifera	Tulip Poplar	Tree				3	3	3				2	2	2				1	1	1	2	2	2
Platanus occidentalis	Sycamore	Tree	4	4	4	2	2	2	4	4	4	3	3	3	3	3	3	2	2	2	3	3	3
Quercus alba	White Oak	Tree										2	2	2	1	1	1						
Quercus lyrata	Overcup Oak	Tree													2	2	2	2	2	2			
Quercus michauxii	Swamp Chestnut Oak	Tree	1	1	1	1	1	1	1	1	1										2	2	2
Quercus phellos	Willow Oak	Tree	2	2	2	1	1	1	1	1	1	4	4	4	1	1	1				4	4	4
Quercus shumardii	Shumard Oak	Shrub Tree							1	1	1							1	1	1			
Viburnum dentatum	Arrow-wood	Shrub Tree				1	1	1	2	2	2	1	1	1	2	2	2	2	2	2			
		Stem count	14	14	15	15	15	15	15	15	15	14	14	14	13	13	13	13	13	13	14	14	14
		size (ares)	1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	5	5	6	7	7	7	8	8	8	7	7	7	8	8	8	8	8	8	6	6	6
		Stems per ACRE	567	567	607	607	607	607	607	607	607	567	567	567	526	526	526	526	526	526	567	567	567

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

PnLS: 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

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

			Annual Means					
			MY1 (2019)			MY0 (2019)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T
Aesculus pavia	Yellow Buckeye	Shrub Tree	9	9	9	10	10	10
Betula nigra	River Birch	Tree	34	34	35	41	41	41
Fraxinus pennsylvanica	Green Ash	Tree	34	34	34	34	34	34
Juglans nigra	Black Walnut	Tree			1			
Liquidambar styraciflua	Sweet Gum	Tree			3			
Liriodendron tulipifera	Tulip Poplar	Tree	22	22	22	32	32	32
Platanus occidentalis	Sycamore	Tree	56	56	56	62	62	62
Quercus alba	White Oak	Tree	10	10	10	11	11	11
Quercus lyrata	Overcup Oak	Tree	25	25	25	22	22	22
Quercus michauxii	Swamp Chestnut Oak	Tree	13	13	13	13	13	13
Quercus phellos	Willow Oak	Tree	33	33	33	33	33	33
Quercus shumardii	Shumard Oak	Shrub Tree	8	8	8	9	9	9
Viburnum dentatum	Arrow-wood	Shrub Tree	13	13	13	15	15	15
		Stem count	257	257	262	282	282	282
		size (ares)		19			19	
		size (ACRES)		0.47			0.47	
		Species count	11	11	13	11	11	11
		Stems per ACRE	547	547	558	601	601	601

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

PnLS: 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
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Buckwater R4 & R5/6

		PRE-RESTORATION CONDITION			REFERENCE REACH DATA						DESIGN				AS-BUILT/BASELINE			
Parameter	Gage	Buckwater Creek Reach 4		Buckwater Creek Reach 5/6	Franklin Creek		Spencer Creek 2		Foust Creek		Buckwater Creek Reach 4		Buckwater Creek Reach 5/6		Buckwater Creek Reach 4		Buckwater Creek Reach 5/6	
					Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																		
Bankfull Width (ft)	N/A	13		15.0	18.2		10.7	11.2	18.5	19.4	17.6		19.0		13.8	17.2	20.5	21.5
Floodprone Width (ft)		17	44	20	---		60	114	49	63	38	87	40	91	150	200	200	
Bankfull Mean Depth		1.5	1.8	1.8	1.2		1.6	1.8	1.3	1.4	1.3		1.6		0.9	1.3	1.5	
Bankfull Max Depth		2.1	2.2	2.3	---		2.1	2.6	1.8	2.1	1.2	1.5	1.2	1.5	1.7	2.2	2.5	2.6
Bankfull Cross Sectional Area (ft^2)		20.0	24.0	28	21.7		17.8	19.7	23.9	24.1	22.5		29.7		12.5	21.9	30.6	33.6
Width/Depth Ratio		7.3	8.6	8.3	15.2		5.8	7.1	13.9	14.2	14.0		12.0		13.5	15.3	13.8	13.9
Entrenchment Ratio		1.3	3.3	1.3	3.6		5.5	10.2	2.6	3.4	2.5	5.0	2.2	5.0	8.7	14.5	9.3	9.8
Bank Height Ratio		1.6	1.7	2.0	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
D50 (mm)		16.0		18.0	---		---		---		---		---		30.0	37.0	25.6	44.0
Profile																		
Riffle Length (ft)	N/A	---		---	---		---		---		---		---		13	60	25	65
Riffle Slope (ft/ft)		---		---	---		0.013		0.015	0.035	0.009	0.022	0.005	0.015	0.001	0.025	0.003	0.016
Pool Length (ft)		---		---	---		---		---		---		---		46	82	54	94
Pool Max Depth (ft)		2.9	3.1	---	---		3.3		2.5	2.9	2.6	3.8	3.1	4.7	2.6	4.9	3.6	5.2
Pool Spacing (ft)		---		---	---		71		49	91	69	139	40	138	51	130	83	143
Pool Volume (ft^3)																		
Pattern																		
Channel Beltwidth (ft)	N/A	24	64	---	---		38	41	N/A		53	150	57	162	53	150	57	162
Radius of Curvature (ft)		19	48	---	---		11	15	N/A		35	53	38	57	35	53	38	57
Rc:Bankfull Width (ft/ft)		1.4	3.7	---	---		1.3	1.4	N/A		2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Meander Length (ft)		45	250	---	---		46	48	N/A		88	246	95	266	88	246	95	266
Meander Width Ratio		1.8	4.9	---	---		3.4	3.6	N/A		3.0	8.5	3.0	8.5	3.0	8.5	3.0	8.5
Substrate, Bed and Transport Parameters																		
Ri%/Ru%/P%/G%/S%	N/A																	
SC%/Sa%/G%/C%/B%/Be%																		
d16/d35/d50/d84/d95/d100		0.33/1.3/4.4/47/85/256		.34/39/7.8/33/71/>2048	8.8/25/68.7/>2048/>2048/>2048		<0.063/3/8.8/42/90/-		---		---		---		0.1/11/33.8/90/154.7/256		0.1/2.68/11.8/81.3/214.7/>2048	
Reach Shear Stress (Competency) lb/ft^2		0.87		0.53							0.57		0.69		0.97		0.54	
Max part size (mm) mobilized at bankfull																		
Stream Power (Capacity) W/m^2																		
Additional Reach Parameters																		
Drainage Area (SM)	N/A	1.00		1.60	2.15		0.96		1.37		1.00		1.60		1.00		1.60	
Watershed Impervious Cover Estimate (%)		3.9%		3.9%	---		---		---		3.9%		3.9%		3.9%		3.9%	
Rosgen Classification		E4/G4c		G4c	B4		E4		C4		C4		E4		C4		E4	
Bankfull Velocity (fps)		3.7		4	5.4		4.9	5.4	2.9	3.7	3.6		3.1	3.7	4.3		3.6	
Bankfull Discharge (cfs)		80		110	120		97		88		78		91	100	53		109	
Q-NFF regression																		
Q-USGS extrapolation																		
Q-Mannings																		
Valley Length (ft)		---		---	---		---		---		---		---		1,928		813	
Channel Thalweg Length (ft)		2,282		1,272	---		---		---		2,467		865		2,538		979	
Sinuosity		1.14		1.41	1.18		2.30		1.10		1.30		1.40		1.30		1.40	
Water Surface Slope ($ft/ft)^2$		0.007		0.007	0.023		0.005		0.009		0.007		0.004	0.007	0.007		0.006	
Bankfull Slope (ft/ft)		---		---	---		0.005		---		---		---		0.007		0.006	

(---): Data was not provided
N/A: Not Applicable

Table 10b. Baseline Stream Data Summary
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

T2 & T3

		PRE-RESTORATION CONDITION				REFERENCE REACH DATA						DESIGN				AS-BUILT/BASELINE			
Parameter	**Gage**	**T2**		**T3**		**UT to Wells**		**Spencer Creek 3**		**UT to Varnals Creek**		**T2**		**T3**		**T2**		**T3**	
		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)		8.8	11	7.5	13	6.2	8.6	6.3	9.3	9.3	10.5	10.6		9.6		9.1		14.4	
Floodprone Width (ft)		14	49	22	26	16	22	14	125	60	100	23	53	21	48	100		300	
Bankfull Mean Depth		0.9	1.4	0.6	0.8	0.6	1	0.8	1	1.1	1.2	0.8		0.8		0.7		1.1	
Bankfull Max Depth		1.2	1.8	1.1	1.3	0.9	1.4	1	1.2	1.5	1.7	1.2	1.3	0.9	1.1	1.2		2.0	
Bankfull Cross Sectional Area (ft^2)		8.3	15	6.2	7.5	3.9	6.3	6.6	8.7	10.3	12.3	8.9		7.3		6.4		15.3	
Width/Depth Ratio		7.9	9.4	9.2	23	6.1	12.6	7.9	9.3	8.1	9.3	13.0		13.0		13.2		13.6	
Entrenchment Ratio		1.3	>5.6	1.7	>3.4	1.9	4.1	1.7	4.3	5.7	10.0	2.2	5.0	2.2	5.0	10.9		20.8	
Bank Height Ratio		1.4	2.0	1.2	1.7	1.0	1.8	1.0		1.0		1.0		1.0		1.0		1.0	
D50 (mm)	N/A	21		45		---		---		---		---		---		48.9		45.0	
Profile																			
Riffle Length (ft)		---		---		---		---		---		---		---		16	61	8	56
Riffle Slope (ft/ft)		---		---		0.017	0.078	0.018	0.034	0.024	0.057	0.019	0.071	0.015	0.038	0.006	0.073	0.004	0.036
Pool Length (ft)		---		---		---		---		---		---		---		12.0	55.0	13.0	65.0
Pool Max Depth (ft)		1.5		1.8		1.6	1.9	1.2	1.8	2.5	2.6	1.7	2.6	1.5	2.3	1.6	3.8	1.7	3.0
Pool Spacing (ft)		---		---		17	63	9	46	8	82	23	93	33	93	27	71	30	81
Pool Volume (ft^3)	N/A																		
Pattern																			
Channel Beltwidth (ft)		---		---		10	35	10	50	15	45	27	90	24	82	27	90	24	82
Radius of Curvature (ft)		---		---		2.3	32	12	85	8	47	21	32	19	29	21	32	19	29
Rc:Bankfull Width (ft/ft)		---		---		0.3	4.0	1.9	9.1	0.6	3.2	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Meander Length (ft)		---		---		35	70	55.0	142.0	16.0	47.0	80	159	72	144	80	159	72	144
Meander Width Ratio	N/A	---		---		4.4	8.8	8.7	15.3	1.1	3.2	2.5	8.5	2.5	8.5	2.5	8.5	2.5	8.5
Substrate, Bed and Transport Parameters																			
Ri%/Ru%/P%/G%/S%																			
SC%/Sa%/G%/C%/B%/Be%																			
d16/d35/d50/d84/d95/d100		.45/4.4/9.7/71.1/183/>208		0.43/11.3/20.9/55.7/110/180		0.1/0.6/4.5/53/96/x		1.87/8.85/11/65/128/x		---		---		---		0.25/16/32.7/80.3/227.6/1024		0.28/10.32/21.5/103.6/193.1/512	
Reach Shear Stress (Competency) lb/ft^2		1.18		1.00		---		---		---		0.8		0.6		0.8		1.1	
Max part size (mm) mobilized at bankfull																			
Stream Power (Capacity) W/m^2	N/A																		
Additional Reach Parameters																			
Drainage Area (SM)		0.34		0.22		0.13		0.37		0.41		0.34		0.22		0.34		0.22	
Watershed Impervious Cover Estimate (%)		0.2%		2.0%		---		---		---		0.2%		2.0%		0.2%		2.0%	
Rosgen Classification		E4/G4c		E4/Incised B4c		C4		E4		B4/E4b		B4/C4		C4		B4/C4		C4	
Bankfull Velocity (fps)		3.1	4.3	3.5	4.2	3.8	5.3	5.0	5.6	4.4	5.2	4.0		3.6		3.1		4.3	
Bankfull Discharge (cfs)		36		26		15		35		54		36		26		20		66	
Q-NFF regression																			
Q-USGS extrapolation																			
Q-Mannings																			
Valley Length (ft)		---		---		---		---		---		---		---		508		729	
Channel Thalweg Length (ft)		543		918		---		---		---		587		851		591		903	
Sinuosity		1.2		1.2		1.4		1.0	1.3	1.2		1.2		1.3		1.2		1.2	
Water Surface Slope ($ft/ft)^2$		0.015		0.018		0.019		0.019	0.022	0.17		0.012	0.02	0.010	0.023	0.017		0.016	
Bankfull Slope (ft/ft)	N/A	---		---		---		---		---		---		---		0.017		0.016	

(---): Data was not provided
N/A: Not Applicable

Table 10c. Baseline Stream Data Summary
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

T4 & T5

		PRE-RESTORATION CONDITION				REFERENCE REACH DATA						DESIGN				AS-BUILT/BASELINE			
Parameter	Gage	T4		T5		UT to Wells		Spencer Creek 3		UT to Varnals Creek		T4		T5		T4		T5	
						Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																			
Bankfull Width (ft)	N/A	7.2		6.1	8.9	6.2	8.6	6.3	9.3	9.3	10.5	7.6		9.7		6.7		6.1	8.6
Floodprone Width (ft)		9		10	22	16	22	14	125	60	100	11	17	20	46	150		100	200
Bankfull Mean Depth		0.6		0.6		0.6	1	0.8	1	1.1	1.2	0.6		0.7		0.5		0.8	1.0
Bankfull Max Depth		0.8		0.9	1.4	0.9	1.4	1	1.2	1.5	1.7	0.7	0.9	0.8	1.0	1.0		1.1	1.5
Bankfull Cross Sectional Area (ft^2)		4.8	5.1	6.2	6.3	3.9	6.3	6.6	8.7	10.3	12.3	4.3		6.7		3.6		8.1	8.5
Width/Depth Ratio		11		9.7	13	6.1	12.6	7.9	9.3	8.1	9.3	13.0		14.0		12.3		4.5	8.7
Entrenchment Ratio		1.3		1.6	2.3	1.9	4.1	1.7	4.3	5.7	10.0	1.4	2.2	2.2	5.0	22.3		11.7	33.0
Bank Height Ratio		1.6		2.1	4.1	1.0	1.8	1.0		1.0		1.0		1.0		1.0		1.0	
D50 (mm)		54.0		8.5		---		---		---		---		---		90		37.2	50.3
Profile																			
Riffle Length (ft)	N/A	---		---		---		---		---		---		---		20	55	13	40
Riffle Slope (ft/ft)		---		---		0.017	0.078	0.018	0.034	0.024	0.057	0.026	0.103	0.014	0.043	0.001	0.046	0.015	0.023
Pool Length (ft)		---		---		---		---		---		---		---		9.0	38.0	36.0	71.0
Pool Max Depth (ft)		1.9		---		1.6	1.9	1.2	1.8	2.5	2.6	1.1	1.8	1.4	2.1	1.4	2.7	1.5	3.1
Pool Spacing (ft)		---		---		17	63	9	46	8	82	17	67	20	61	23	66	16	51
Pool Volume (ft^3)																			
Pattern																			
Channel Beltwidth (ft)	N/A	---		---		10	35	10	50	15	45	---		29	82	---		29	82
Radius of Curvature (ft)		---		---		2.3	32	12	85	8	47	---		18	28	---		18	28
Rc:Bankfull Width (ft/ft)		---		---		0.3	4.0	1.9	9.1	0.6	3.2	---		2.0	3.0	---		2.0	3.0
Meander Length (ft)		---		---		35	70	55	142	16	47	---		49	136	---		49	136
Meander Width Ratio		---		---		4.4	8.8	8.7	15.3	1.1	3.2	---		3.0	8.5	---		3.0	8.5
Substrate, Bed and Transport Parameters																			
Ri%/Ru%/P%/G%/S%	N/A																		
SC%/Sa%/G%/C%/B%/Be%																			
d16/d35/d50/d84/d95/d100		.05/8.0/32.0/93.6/157/256		0.16/0.42/4.2/66.8/107/>2048		0.1/0.6/4.5/53/96/x		1.87/8.85/11/65/128/x		---		---		---		0.16/0.55/5.6/107.3/155.5/256		0.16/5.60/17.3/80.3/120.1/180	
Reach Shear Stress (Competency) lb/ft^2		1.09		0.24		---		---		---		0.8		0.4		1.0		0.58	
Max part size (mm) mobilized at bankfull																			
Stream Power (Capacity) W/m^2																			
Additional Reach Parameters																			
Drainage Area (SM)	N/A	0.12		0.17		0.13		0.37		0.41		0.12		0.17		0.12		0.17	
Watershed Impervious Cover Estimate (%)		0.0%		1.0%		---		---		---		0.0%		1.0%		0.0%		1.0%	
Rosgen Classification		G4		Incised E4/C4		C4		E4		B4/E4b		B4/C4		B4/C4		B4		C4	
Bankfull Velocity (fps)		3.3	3.6	3	3.4	3.8	5.3	5.0	5.6	4.4	5.2	3.9		3.3		3.4		2.6	
Bankfull Discharge (cfs)		17		21		15		35		54		18		22		70		12	
Q-NFF regression																			
Q-USGS extrapolation																			
Q-Mannings																			
Valley Length (ft)		---		---		---		---		---		---		---		878		992	
Channel Thalweg Length (ft)		1,081		1,291		---		---		---		961		1,259		982		1,295	
Sinuosity		1.1		1.1		1.4		1.0	1.3	1.2		1.2		1.3		1.1		1.3	
Water Surface Slope ($ft/ft)^2$		0.027		0.015		0.020		0.019	0.022	0.17		0.024		0.013		0.024		0.014	
Bankfull Slope (ft/ft)		---		---		---		---		---		---		---		0.024		0.014	

(---): Data was not provided
N/A: Not Applicable

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

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 1 - 2019

	Buckwater Creek Reach 2						Buckwater Creek Reach 3											
	Cross-Section 1 (Riffle)						Cross-Section 2 (Pool)						Cross-Section 3 (Riffle)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	509.51	509.51					508.12	508.03					509.71	509.65				
Low Bank Elevation (ft)	509.51	509.51					508.12	508.03					509.71	509.65				
Bankfull Width (ft)	20.7	20.3					19.6	19.0					23.7	22.8				
Floodprone Width (ft)	200	200					N/A	N/A					150	150				
Bankfull Mean Depth (ft)	1.5	1.5					2.5	2.4					2.3	2.4				
Bankfull Max Depth (ft)	2.2	2.1					3.4	3.4					3.5	3.7				
Bankfull Cross-Sectional Area (ft^2)	31.9	31.2					49.1	45.3					55.3	54.9				
Bankfull Width/Depth Ratio	13.5	13.2					7.9	7.9					10.1	9.5				
Entrenchment Ratio[1]	9.6	9.8					N/A	N/A					6.3	6.6				
Bankfull Bank Height Ratio[2]	1.0	<1.0					N/A	N/A					1.0	1.0				
	Buckwater Creek Reach 4																	
	Cross-Section 4 (Riffle)						Cross-Section 5 (Pool)						Cross-Section 6 (Riffle)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	505.91	505.93					506.10	506.05					500.92	501.01				
Low Bank Elevation (ft)	505.91	505.93					506.10	506.06					500.92	501.01				
Bankfull Width (ft)	17.2	17.7					24.8	24.1					16.5	14.8				
Floodprone Width (ft)	150	150					N/A	N/A					200	200				
Bankfull Mean Depth (ft)	1.3	1.2					2.0	2.0					1.1	1.2				
Bankfull Max Depth (ft)	2.2	2.1					3.4	3.3					2.2	2.1				
Bankfull Cross-Sectional Area (ft^2)	21.9	21.7					50.4	47.8					17.8	17.6				
Bankfull Width/Depth Ratio	13.5	14.5					12.2	12.2					15.3	12.4				
Entrenchment Ratio[1]	8.7	8.5					N/A	N/A					12.1	13.5				
Bankfull Bank Height Ratio[2]	1.0	1.0					N/A	N/A					1.0	1.0				
	Buckwater Creek Reach 4												Buckwater Creek Reach 5					
	Cross-Section 7 (Pool)						Cross-Section 8 (Riffle)						Cross-Section 9 (Pool)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	500.69	500.88					496.69	496.55					488.72	488.74				
Low Bank Elevation (ft)	500.69	500.88					496.69	496.55					488.72	488.74				
Bankfull Width (ft)	22.9	25.0					13.8	12.2					16.4	15.9				
Floodprone Width (ft)	N/A	N/A					200	200					N/A	N/A				
Bankfull Mean Depth (ft)	1.7	1.6					0.9	0.8					1.3	1.3				
Bankfull Max Depth (ft)	3.7	3.9					1.7	1.5					2.0	2.0				
Bankfull Cross-Sectional Area (ft^2)	38.8	39.8					12.5	9.8					21.7	21.2				
Bankfull Width/Depth Ratio	13.6	15.7					15.3	15.1					12.4	11.9				
Entrenchment Ratio[1]	N/A	N/A					14.5	16.4					N/A	N/A				
Bankfull Bank Height Ratio[2]	N/A	N/A					1.0	<1.0					N/A	N/A				
	Buckwater Creek Reach 5						Buckwater Creek Reach 6											
	Cross-Section 10 (Riffle)						Cross-Section 11 (Pool)						Cross-Section 12 (Riffle)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	488.49	488.43					486.68	486.46					487.04	487.06				
Low Bank Elevation (ft)	488.49	488.43					486.68	486.46					487.04	487.06				
Bankfull Width (ft)	21.5	20.5					23.6	22.3					20.5	20.5				
Floodprone Width (ft)	200	200					N/A	N/A					200	200				
Bankfull Mean Depth (ft)	1.5	1.5					2.2	2.1					1.5	1.4				
Bankfull Max Depth (ft)	2.5	2.3					3.9	3.9					2.6	2.4				
Bankfull Cross-Sectional Area (ft^2)	33.3	30.0					52.4	46.0					30.6	29.1				
Bankfull Width/Depth Ratio	13.9	14.0					10.6	10.8					13.8	14.5				
Entrenchment Ratio[1]	9.3	9.8					N/A	N/A					9.8	9.7				
Bankfull Bank Height Ratio[2]	1.0	<1.0					N/A	N/A					1.0	<1.0				

[1]Entrenchment Ratio is the flood prone width divided by the bankfull width.

[2]Bank Height Ratio is the bank height divided by the max depth of the bankfull channel.

*Mophological survey and analysis not required for MY4 and MY6

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

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 1- 2019

	T1 Reach 1						T1 Reach 2											
	Cross-Section 13 (Riffle)						Cross-Section 14 (Riffle)						Cross-Section 15 (Pool)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	488.81	488.82					487.70	487.70					487.21	487.66				
Low Bank Elevation (ft)	488.81	488.82					487.70	487.70					487.21	487.66				
Bankfull Width (ft)	22.0	21.6					20.8	20.5					27.0	33.5				
Floodprone Width (ft)	150	150					200	200					N/A	N/A				
Bankfull Mean Depth (ft)	1.4	1.3					1.6	1.5					1.6	1.7				
Bankfull Max Depth (ft)	2.4	2.2					2.5	2.1					3.2	3.6				
Bankfull Cross-Sectional Area (ft^2)	31.5	28.3					20.8	30.9					42.2	55.5				
Bankfull Width/Depth Ratio	15.4	16.5					13.2	13.6					17.3	20.3				
Entrenchment Ratio[1]	6.8	6.9					9.6	9.8					N/A	N/A				
Bankfull Bank Height Ratio[2]	1.0	<1.0					1.0	<1.0					N/A	N/A				
	T3 Reach 2												T2					
	Cross-Section 16 (Pool)						Cross-Section 17 (Riffle)						Cross-Section 18 (Riffle)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	505.82	505.97					505.31	505.32					494.17	494.19				
Low Bank Elevation (ft)	505.82	505.97					505.31	505.32					494.17	494.19				
Bankfull Width (ft)	12.7	12.9					14.4	14.1					9.1	9.0				
Floodprone Width (ft)	N/A	N/A					300	300					100	100				
Bankfull Mean Depth (ft)	1.4	1.5					1.1	1.1					0.7	0.7				
Bankfull Max Depth (ft)	2.5	2.8					2.0	2.0					1.2	1.3				
Bankfull Cross-Sectional Area (ft^2)	17.6	19.5					15.3	15.7					6.4	6.2				
Bankfull Width/Depth Ratio	9.1	8.5					13.6	12.6					13.2	12.9				
Entrenchment Ratio[1]	N/A	N/A					20.8	21.3					10.9	11.2				
Bankfull Bank Height Ratio[2]	N/A	N/A					1.0	1.0					1.0	<1.0				
	T2						T4A Reach 1						T4					
	Cross-Section 19 (Pool)						Cross-Section 20 (Riffle)						Cross-Section 21 (Pool)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	491.10	491.21					539.53	539.56					502.51	502.53				
Low Bank Elevation (ft)	491.10	491.21					539.53	539.56					502.51	502.53				
Bankfull Width (ft)	13.9	14.3					3.3	2.6					7.4	6.7				
Floodprone Width (ft)	N/A	N/A					20	20					N/A	N/A				
Bankfull Mean Depth (ft)	1.0	0.9					0.4	0.4					0.9	0.8				
Bankfull Max Depth (ft)	1.9	2.0					0.7	0.7					1.6	1.3				
Bankfull Cross-Sectional Area (ft^2)	13.6	13.4					1.3	1.0					6.7	5.3				
Bankfull Width/Depth Ratio	14.3	15.2					8.4	6.7					9.3	8.5				
Entrenchment Ratio[1]	N/A	N/A					6.0	7.7					N/A	N/A				
Bankfull Bank Height Ratio[2]	N/A	N/A					1.0	<1.0					N/A	N/A				
	T4						T4B Reach 1						T6 Reach 3					
	Cross-Section 22 (Riffle)						Cross-Section 23 (Riffle)						Cross-Section 24 (Riffle)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	502.09	502.12					540.79	540.75					517.07	517.02				
Low Bank Elevation (ft)	502.09	502.12					540.79	540.75					517.07	517.02				
Bankfull Width (ft)	6.7	6.4					4.3	4.2					8.8	8.1				
Floodprone Width (ft)	150	150					25	25					100	100				
Bankfull Mean Depth (ft)	0.5	0.4					0.5	0.5					0.8	0.9				
Bankfull Max Depth (ft)	1.0	0.7					0.8	0.6					1.3	1.6				
Bankfull Cross-Sectional Area (ft^2)	3.6	2.8					2.1	2.0					7.1	7.4				
Bankfull Width/Depth Ratio	12.3	14.3					8.4	9.0					10.8	9.0				
Entrenchment Ratio[1]	22.3	23.6					5.9	6.0					11.4	12.3				
Bankfull Bank Height Ratio[2]	1.0	<1.0					1.0	<1.0					1.0	1.0				

[1]Entrenchment Ratio is the flood prone width divided by the bankfull width.

[2]Bank Height Ratio is the bank height divided by the max depth of the bankfull channel.

*Mophological survey and analysis not required for MY4 and MY6

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

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 1 - 2019

	T5																	
	Cross Section 25 (Riffle)						Cross Section 26 (Pool)						Cross Section 27 (Riffle)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	504.92	504.93					504.17	504.15					491.22	491.29				
Low Bank Elevation (ft)	504.92	504.93					504.17	504.15					491.22	491.29				
Bankfull Width (ft)	8.6	8.0					8.7	8.4					6.1	6.6				
Floodprone Width (ft)	100	100					N/A	N/A					200	200				
Bankfull Mean Depth (ft)	1.0	1.0					1.0	0.5					0.8	0.6				
Bankfull Max Depth (ft)	1.5	1.5					1.8	1.0					1.1	1.0				
Bankfull Cross-Sectional Area (ft^2)	8.5	7.8					8.5	3.8					8.1	3.9				
Bankfull Width/Depth Ratio	8.7	8.1					9.0	18.3					4.5	11.2				
Entrenchment Ratio[1]	11.7	12.6					N/A	N/A					33.0	30.1				
Bankfull Bank Height Ratio[2]	1.0	1.0					N/A	N/A					1.0	<1.0				
	T5						T7 Reach 1											
	Cross Section 28 (Pool)						Cross Section 29 (Riffle)						Cross Section 30 (Pool)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	490.75	490.78					506.31	506.29					505.68	505.88				
Low Bank Elevation (ft)	490.75	490.78					506.31	506.29					505.68	505.88				
Bankfull Width (ft)	9.3	9.7					10.0	9.7					8.6	9.9				
Floodprone Width (ft)	N/A	N/A					100	100					N/A	N/A				
Bankfull Mean Depth (ft)	1.6	1.3					0.7	0.7					0.9	0.9				
Bankfull Max Depth (ft)	2.5	2.4					1.0	1.5					1.5	1.7				
Bankfull Cross-Sectional Area (ft^2)	15.2	12.3					7.4	7.0					7.5	8.9				
Bankfull Width/Depth Ratio	5.7	7.7					13.5	13.5					9.8	11.0				
Entrenchment Ratio[1]	N/A	N/A					10.0	10.3					N/A	N/A				
Bankfull Bank Height Ratio[2]	N/A	N/A					1.0	<1.0					N/A	N/A				
	T7 Reach 2						T7 Reach 3						T7A					
	Cross Section 31 (Riffle)						Cross Section 32 (Riffle)						Cross Section 33 (Riffle)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	493.84	493.84					485.52	485.60					490.11	490.07				
Low Bank Elevation (ft)	493.84	493.84					485.52	485.60					490.11	490.07				
Bankfull Width (ft)	8.2	7.8					9.5	10.2					5.8	5.7				
Floodprone Width (ft)	100	100					25	25					50	50				
Bankfull Mean Depth (ft)	0.6	0.5					0.5	0.5					0.6	0.5				
Bankfull Max Depth (ft)	0.9	1.0					0.9	0.9					1.0	1.0				
Bankfull Cross-Sectional Area (ft^2)	4.6	4.0					5.2	5.3					3.3	3.1				
Bankfull Width/Depth Ratio	14.8	15.0					17.6	19.6					10.2	10.5				
Entrenchment Ratio[1]	12.2	12.9					2.6	2.5					8.6	8.8				
Bankfull Bank Height Ratio[2]	1.0	<1.0					1.0	1.0					1.0	<1.0				
	T7A						T8											
	Cross Section 34 (Pool)						Cross Section 35 (Riffle)						Cross Section 36 (Pool)					
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
Bankfull Elevation (ft)	489.85	489.92					529.20	529.22					528.62	528.78				
Low Bank Elevation (ft)	489.85	489.92					529.20	529.22					528.62	528.78				
Bankfull Width (ft)	10.5	11.6					5.1	5.1					6.1	6.4				
Floodprone Width (ft)	N/A	N/A					100	100					N/A	N/A				
Bankfull Mean Depth (ft)	0.9	0.7					0.5	0.4					1.1	0.9				
Bankfull Max Depth (ft)	2.0	1.5					0.7	0.8					1.7	1.4				
Bankfull Cross-Sectional Area (ft^2)	9.4	8.5					2.6	2.2					6.7	6.0				
Bankfull Width/Depth Ratio	11.6	15.9					9.8	11.4					5.5	6.7				
Entrenchment Ratio[1]	N/A	N/A					19.8	19.8					N/A	N/A				
Bankfull Bank Height Ratio[2]	N/A	N/A					1.0	<1.0					N/A	N/A				

[1]Entrenchment Ratio is the flood prone width divided by the bankfull width.

[2]Bank Height Ratio is the bank height divided by the max depth of the bankfull channel.

*Mophological survey and analysis not required for MY4 and MY6

Table 12a. Monitoring Data - Stream Reach Data Summary

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 1 - 2019

Buckwater Reach 4

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY5		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle												
Bankfull Width (ft)	13.8	17.2	12.2	17.7								
Floodprone Width (ft)	150	200	150	200								
Bankfull Mean Depth	0.9	1.3	0.8	1.2								
Bankfull Max Depth	1.7	2.2	1.5	2.1								
Bankfull Cross-Sectional Area (ft^2)	12.5	21.9	9.8	21.7								
Width/Depth Ratio	13.5	15.3	12.4	15.1								
Entrenchment Ratio	8.7	14.5	8.5	16.4								
Bank Height Ratio	1.0		<1.0	1.0								
Profile												
Riffle Length (ft)	13	60										
Riffle Slope (ft/ft)	0.0010	0.0250										
Pool Length (ft)	46	82										
Pool Max Depth (ft)	2.6	4.9										
Pool Spacing (ft)	51	83										
Pool Volume (ft^3)												
Pattern												
Channel Beltwidth (ft)	53	150										
Radius of Curvature (ft)	35	53										
Rc:Bankfull Width (ft/ft)	2.0	3.0										
Meander Wave Length (ft)	88	246										
Meander Width Ratio	3.0	8.5										
Additional Reach Parameters												
Rosgen Classification	C4											
Channel Thalweg Length (ft)	2,538											
Sinuosity (ft)	1.30											
Water Surface Slope (ft/ft)	0.0071											
Bankfull Slope (ft/ft)	0.007											
Ri%/Ru%/P%/G%/S%												
SC%/Sa%/G%/C%/B%/Be%												
d16/d35/d50/d84/d95/d100	0.1/11/33.8/90/154.7/256		SC/6.69/27.6/90/157.1/256									
% of Reach with Eroding Banks	1%		0%									

*Mophological survey and analysis not required for MY4 and MY6.

Table 12b. Monitoring Data - Stream Reach Data Summary

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 1 - 2019

Buckwater Reach 5/6

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY5		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle												
Bankfull Width (ft)	20.5	21.5	20.5									
Floodprone Width (ft)	200		200									
Bankfull Mean Depth	1.5		1.4	1.5								
Bankfull Max Depth	2.5	2.6	2.3	2.4								
Bankfull Cross-Sectional Area (ft^2)	30.6	33.6	29.1	30.0								
Width/Depth Ratio	13.8	13.9	14.0	14.5								
Entrenchment Ratio	9.3	9.8	9.7	9.8								
Bank Height Ratio	1.0		<1.0									
Profile												
Riffle Length (ft)	25	65										
Riffle Slope (ft/ft)	0.0034	0.0158										
Pool Length (ft)	54	94										
Pool Max Depth (ft)	3.6	5.2										
Pool Spacing (ft)	83	143										
Pool Volume (ft^3)												
Pattern												
Channel Beltwidth (ft)	57	162										
Radius of Curvature (ft)	38	57										
Rc:Bankfull Width (ft/ft)	2.0	3.0										
Meander Wave Length (ft)	95	266										
Meander Width Ratio	3.0	8.5										
Additional Reach Parameters												
Rosgen Classification	E4											
Channel Thalweg Length (ft)	979											
Sinuosity (ft)	1.40											
Water Surface Slope (ft/ft)	0.0060											
Bankfull Slope (ft/ft)	0.00582											
Ri%/Ru%/P%/G%/S%												
SC%/Sa%/G%/C%/B%/Be%												
d16/d35/d50/d84/d95/d100	0.1/2.68/11.8/81.3/ 214.7/>2048		.38/11/29/78.1/ 128 /512									
% of Reach with Eroding Banks	0%		0%									

*Mophological survey and analysis not required for MY4 and MY6.

Table 12c. Monitoring Data - Stream Reach Data Summary

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 1 - 2019

T2

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY5		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle												
Bankfull Width (ft)	9.1		9.0									
Floodprone Width (ft)	100		100									
Bankfull Mean Depth	0.7		0.7									
Bankfull Max Depth	1.2		1.3									
Bankfull Cross-Sectional Area (ft^2)	6.4		6.2									
Width/Depth Ratio	13.2		12.9									
Entrenchment Ratio	10.9		11.2									
Bank Height Ratio	1.0		<1.0									
Profile												
Riffle Length (ft)	16	61										
Riffle Slope (ft/ft)	0.006	0.073										
Pool Length (ft)	12.0	55.0										
Pool Max Depth (ft)	1.6	3.8										
Pool Spacing (ft)	27	71										
Pool Volume (ft^3)												
Pattern												
Channel Beltwidth (ft)	27	90										
Radius of Curvature (ft)	21	32										
Rc:Bankfull Width (ft/ft)	2.0	3.0										
Meander Wave Length (ft)	80	159										
Meander Width Ratio	2.5	8.5										
Additional Reach Parameters												
Rosgen Classification	B4/C4											
Channel Thalweg Length (ft)	591											
Sinuosity (ft)	1.2											
Water Surface Slope (ft/ft)	0.0170											
Bankfull Slope (ft/ft)	0.0170											
Ri%/Ru%/P%/G%/S%												
SC%/Sa%/G%/C%/B%/Be%												
d16/d35/d50/d84/d95/d100	0.25/16/32.7/80.3/ 227.6/1024		SC/0.35/24.4/80.3/ 123.1/256									
% of Reach with Eroding Banks	0%		0%									

*Mophological survey and analysis not required for MY4 and MY6.

Table 12d. Monitoring Data - Stream Reach Data Summary

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 1 - 2019

T3 Reach 2

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY5		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle												
Bankfull Width (ft)	14.4		14.1									
Floodprone Width (ft)	300		300									
Bankfull Mean Depth	1.1		1.1									
Bankfull Max Depth	2.0		2.0									
Bankfull Cross-Sectional Area (ft^2)	15.3		15.7									
Width/Depth Ratio	13.6		12.6									
Entrenchment Ratio	20.8		21.3									
Bank Height Ratio	1.0		1.0									
Profile												
Riffle Length (ft)	8	56										
Riffle Slope (ft/ft)	0.004	0.036										
Pool Length (ft)	13.0	65.0										
Pool Max Depth (ft)	1.7	3.0										
Pool Spacing (ft)	30	81										
Pool Volume (ft^3)												
Pattern												
Channel Beltwidth (ft)	24	82										
Radius of Curvature (ft)	19	29										
Rc:Bankfull Width (ft/ft)	2.0	3.0										
Meander Wave Length (ft)	72	144										
Meander Width Ratio	2.5	8.5										
Additional Reach Parameters												
Rosgen Classification	C4											
Channel Thalweg Length (ft)	903											
Sinuosity (ft)	1.2											
Water Surface Slope (ft/ft)	0.0159											
Bankfull Slope (ft/ft)	0.0155											
Ri%/Ru%/P%/G%/S%												
SC%/Sa%/G%/C%/B%/Be%												
d16/d35/d50/d84/d95/d100	0.28/10.32/21.5/ 103.6/193.1/512		SC/SC/1.7/64/128/180									
% of Reach with Eroding Banks	11%		0%									

*Mophological survey and analysis not required for MY4 and MY6.

Table 12e. Monitoring Data - Stream Reach Data Summary

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 1 - 2019

T4

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY5		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle												
Bankfull Width (ft)	6.7		6.4									
Floodprone Width (ft)	150		150									
Bankfull Mean Depth	0.5		0.4									
Bankfull Max Depth	1.0		0.7									
Bankfull Cross-Sectional Area (ft^2)	3.6		2.8									
Width/Depth Ratio	12.3		14.3									
Entrenchment Ratio	22.3		23.6									
Bank Height Ratio	1.0		<1.0									
Profile												
Riffle Length (ft)	20	55										
Riffle Slope (ft/ft)	0.001	0.046										
Pool Length (ft)	9.0	38.0										
Pool Max Depth (ft)	1.4	2.7										
Pool Spacing (ft)	23	66										
Pool Volume (ft^3)												
Pattern												
Channel Beltwidth (ft)	---											
Radius of Curvature (ft)	---											
Rc:Bankfull Width (ft/ft)	---											
Meander Wave Length (ft)	---											
Meander Width Ratio	---											
Additional Reach Parameters												
Rosgen Classification	B4											
Channel Thalweg Length (ft)	982											
Sinuosity (ft)	1.1											
Water Surface Slope (ft/ft)	0.0239											
Bankfull Slope (ft/ft)	0.0244											
Ri%/Ru%/P%/G%/S%												
SC%/Sa%/G%/C%/B%/Be%												
d16/d35/d50/d84/d95/d100	0.16/0.55/5.6/107.3/ 155.5/256		SC/.19/1/71.7/115.7/ 362									
% of Reach with Eroding Banks	0%		0%									

*Mophological survey and analysis not required for MY4 and MY6.

Table 12f. Monitoring Data - Stream Reach Data Summary

Buckwater Mitigation Site

DMS Project No. 97084

Monitoring Year 1 - 2019

T5

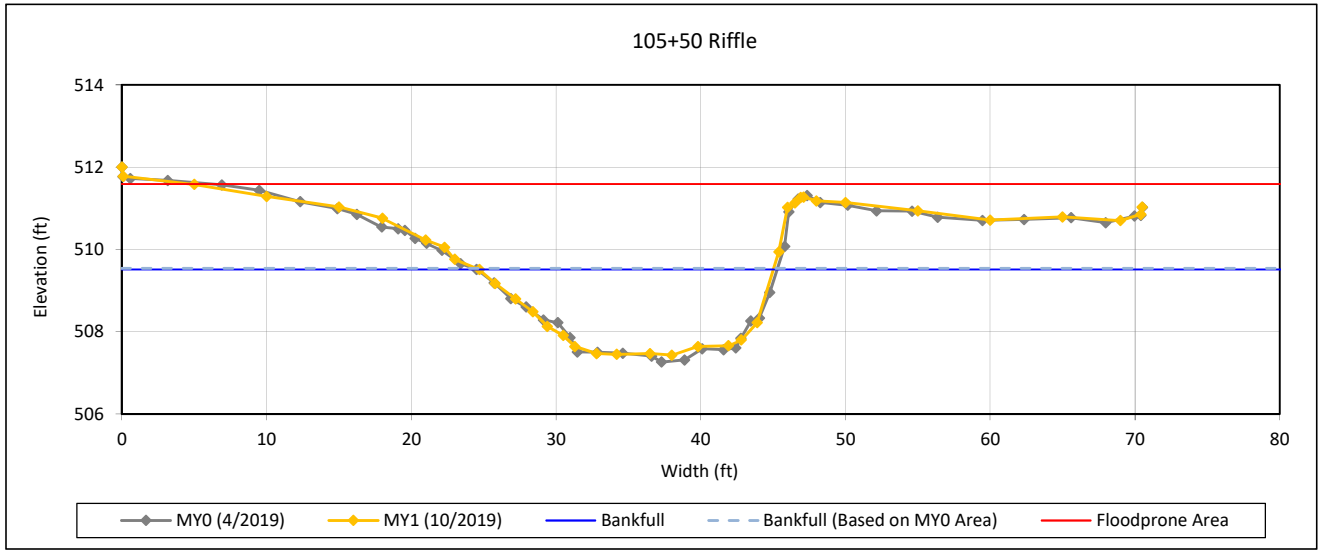
Parameter	As-Built/Baseline		MY1		MY2		MY3		MY5		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle												
Bankfull Width (ft)	6.1	8.6	6.6	8.0								
Floodprone Width (ft)	100	200	100	200								
Bankfull Mean Depth	0.8	1.0	0.6	1.0								
Bankfull Max Depth	1.1	1.5	1.0	1.5								
Bankfull Cross-Sectional Area (ft^2)	8.1	8.5	3.9	7.8								
Width/Depth Ratio	4.5	8.7	8.1	11.2								
Entrenchment Ratio	11.7	33.0	12.6	30.1								
Bank Height Ratio	1.0		<1.0	1.0								
Profile												
Riffle Length (ft)	13	40										
Riffle Slope (ft/ft)	0.015	0.023										
Pool Length (ft)	36.0	71.0										
Pool Max Depth (ft)	1.5	3.1										
Pool Spacing (ft)	16	51										
Pool Volume (ft^3)												
Pattern												
Channel Beltwidth (ft)	29	82										
Radius of Curvature (ft)	18	28										
Rc:Bankfull Width (ft/ft)	2.0	3.0										
Meander Wave Length (ft)	49	136										
Meander Width Ratio	3.0	8.5										
Additional Reach Parameters												
Rosgen Classification	C4											
Channel Thalweg Length (ft)	1,295											
Sinuosity (ft)	1.3											
Water Surface Slope (ft/ft)	0.0138											
Bankfull Slope (ft/ft)	0.0136											
Ri%/Ru%/P%/G%/S%												
SC%/Sa%/G%/C%/B%/Be%												
d16/d35/d50/d84/d95/d100	0.16/5.60/17.3/80.3/ 120.1/180		0.84/8.37/20.1/90/ 180 />2048									
% of Reach with Eroding Banks	0%		0%									

*Mophological survey and analysis not required for MY4 and MY6.

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 1 - Buckwater Creek Reach 2



Bankfull Dimensions	
31.2	x-section area (ft.sq.)
20.3	width (ft)
1.5	mean depth (ft)
2.1	max depth (ft)
21.3	wetted perimeter (ft)
1.5	hydraulic radius (ft)
13.2	width-depth ratio
200.0	W flood prone area (ft)
9.8	entrenchment ratio
< 1.0	low bank height ratio

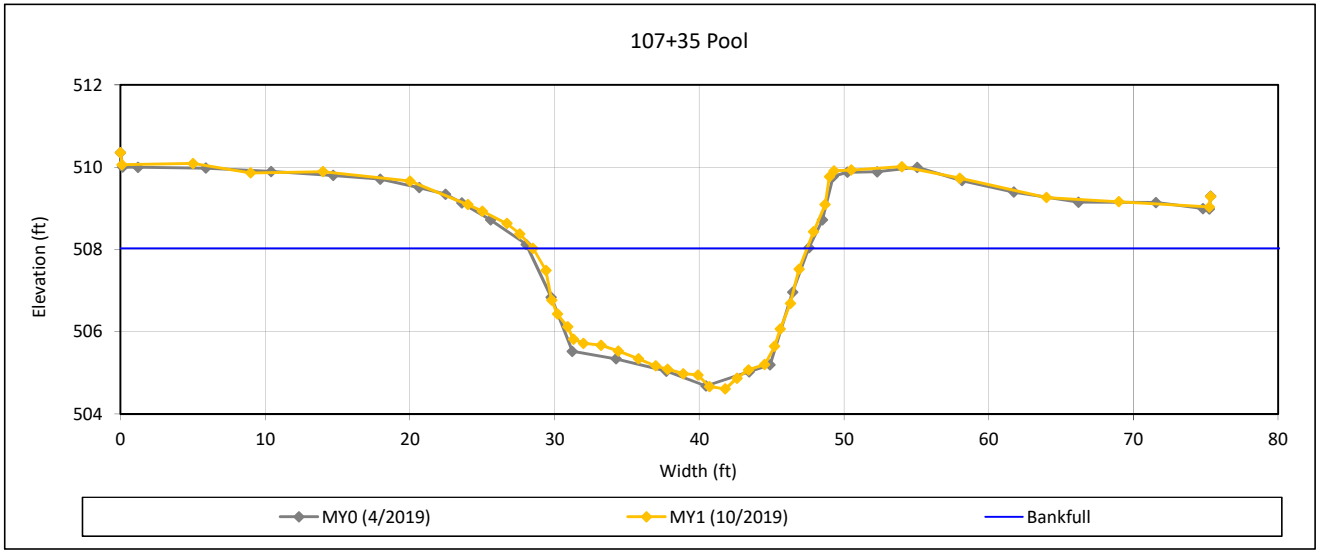
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 2 - Buckwater Creek Reach 3



Bankfull Dimensions	
45.3	x-section area (ft.sq.)
19.0	width (ft)
2.4	mean depth (ft)
3.4	max depth (ft)
21.2	wetted perimeter (ft)
2.1	hydraulic radius (ft)
7.9	width-depth ratio

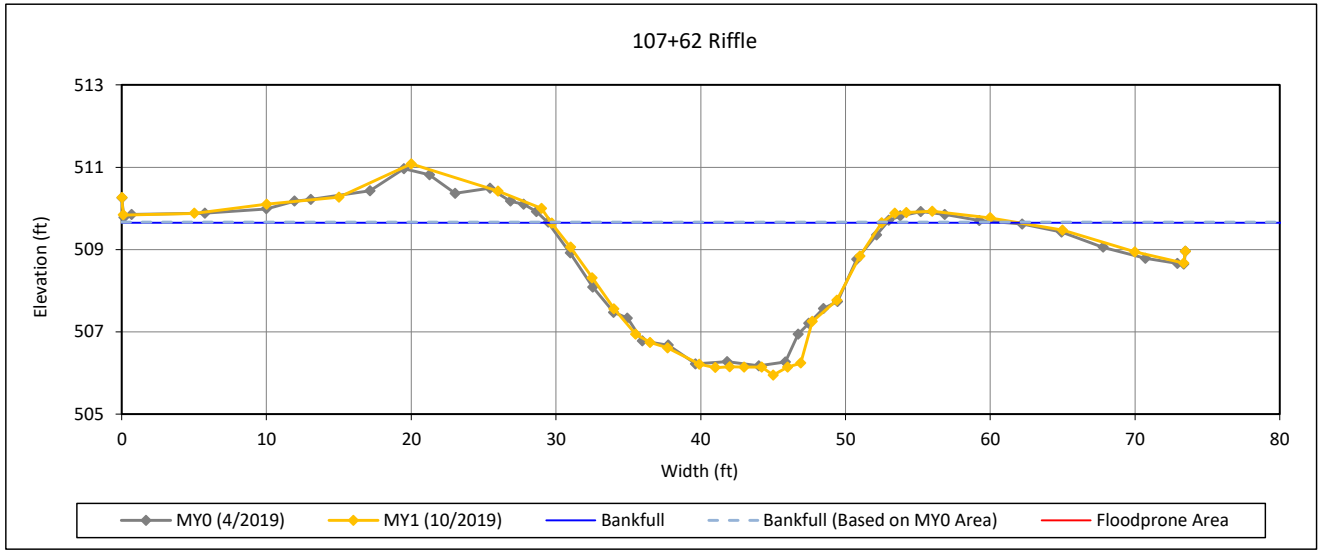
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 3 - Buckwater Creek Reach 3



Bankfull Dimensions	
54.9	x-section area (ft.sq.)
22.8	width (ft)
2.4	mean depth (ft)
3.7	max depth (ft)
24.6	wetted perimeter (ft)
2.2	hydraulic radius (ft)
9.5	width-depth ratio
150.0	W flood prone area (ft)
6.6	entrenchment ratio
1.0	low bank height ratio

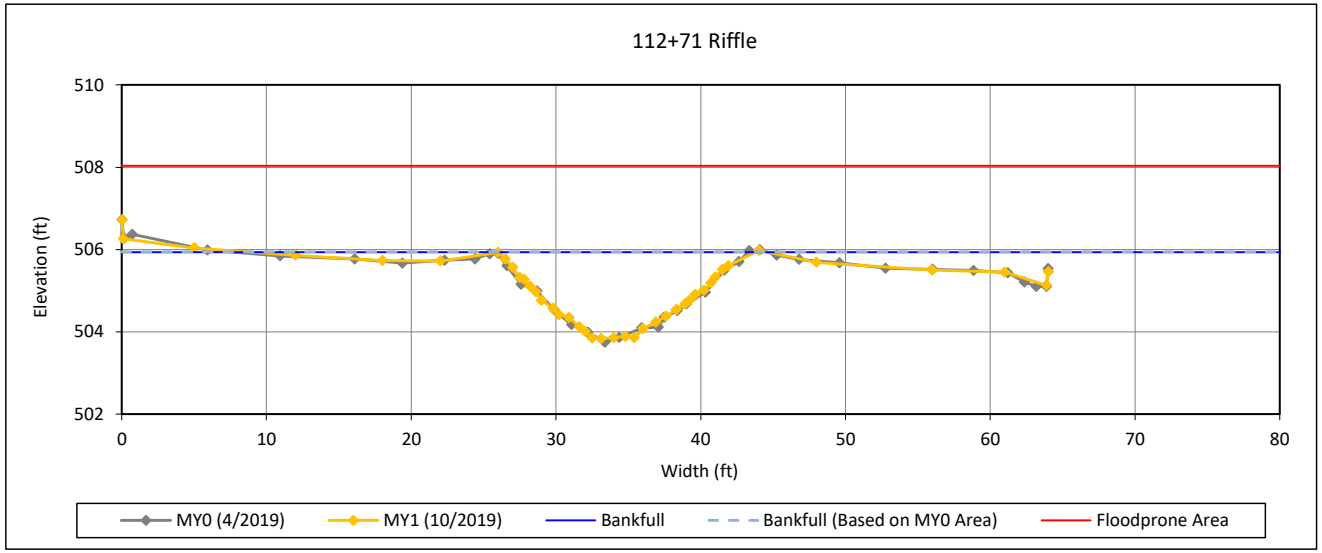
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 4 - Buckwater Creek Reach 4



Bankfull Dimensions	
21.7	x-section area (ft.sq.)
17.7	width (ft)
1.2	mean depth (ft)
2.1	max depth (ft)
18.4	wetted perimeter (ft)
1.2	hydraulic radius (ft)
14.5	width-depth ratio
150.0	W flood prone area (ft)
8.5	entrenchment ratio
1.0	low bank height ratio

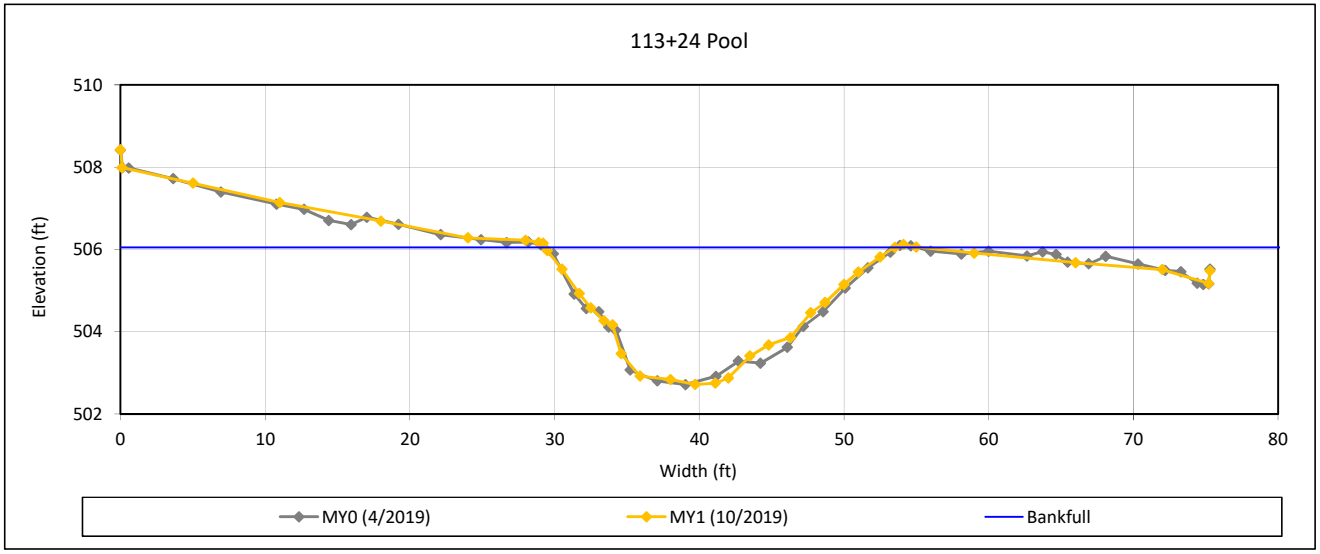
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 5 - Buckwater Creek Reach 4



Bankfull Dimensions	
47.8	x-section area (ft.sq.)
24.1	width (ft)
2.0	mean depth (ft)
3.3	max depth (ft)
25.4	wetted perimeter (ft)
1.9	hydraulic radius (ft)
12.2	width-depth ratio

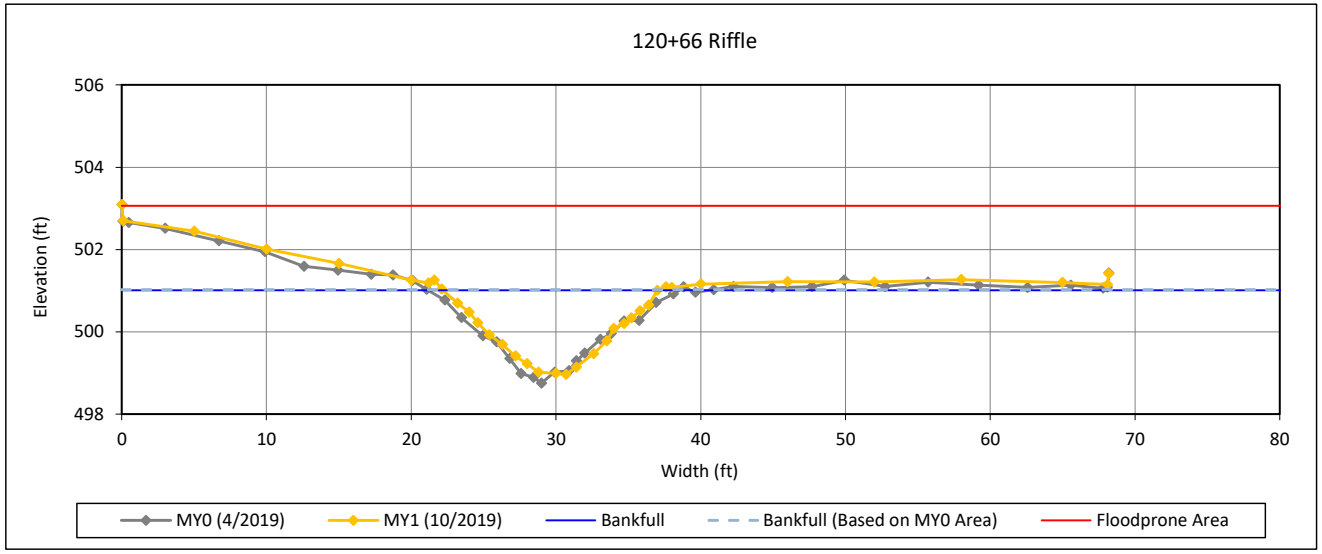
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 6 - Buckwater Creek Reach 4



Bankfull Dimensions	
17.6	x-section area (ft.sq.)
14.8	width (ft)
1.2	mean depth (ft)
2.1	max depth (ft)
15.5	wetted perimeter (ft)
1.1	hydraulic radius (ft)
12.4	width-depth ratio
200.0	W flood prone area (ft)
13.5	entrenchment ratio
1.0	low bank height ratio

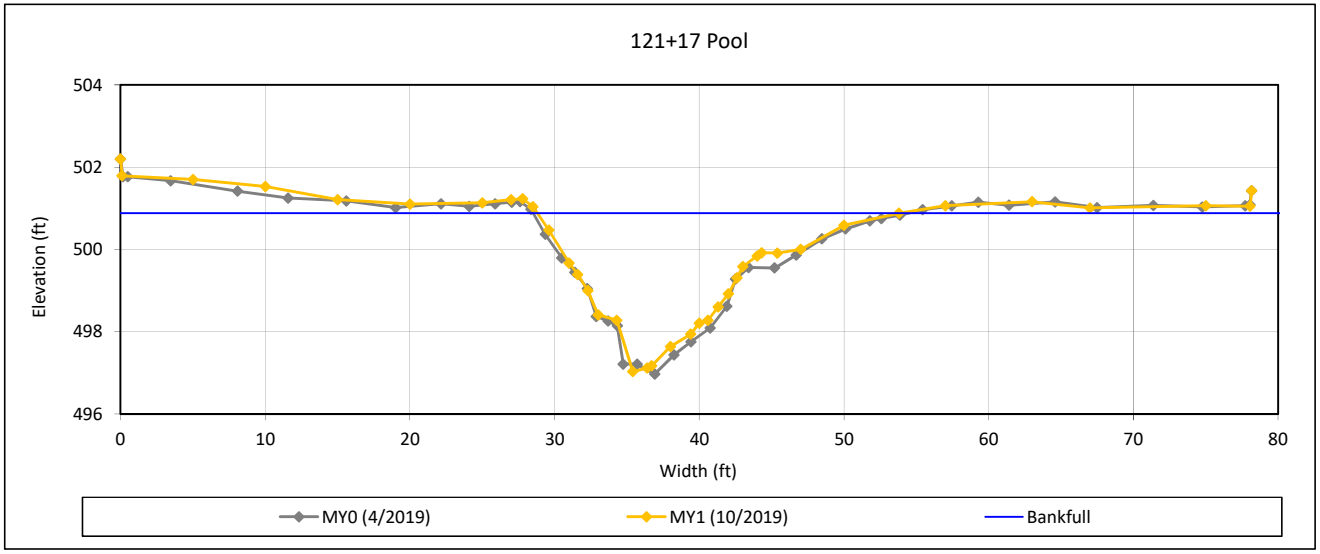
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 7 - Buckwater Creek Reach 4



Bankfull Dimensions	
39.8	x-section area (ft.sq.)
25.0	width (ft)
1.6	mean depth (ft)
3.9	max depth (ft)
26.9	wetted perimeter (ft)
1.5	hydraulic radius (ft)
15.7	width-depth ratio

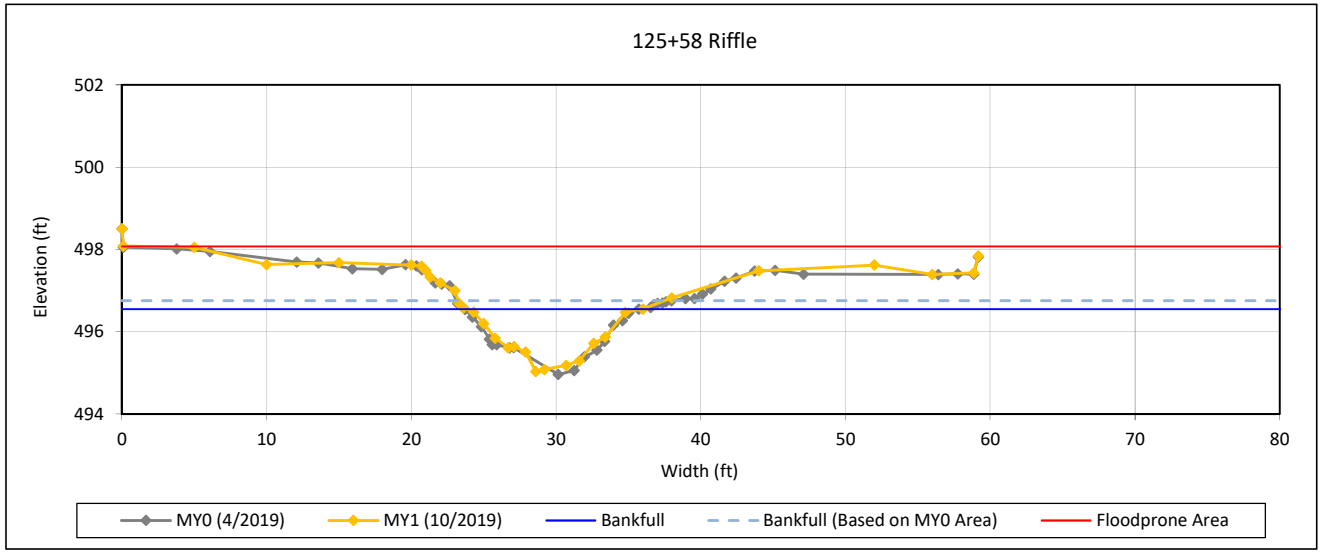
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 8 - Buckwater Creek Reach 4



Bankfull Dimensions	
9.8	x-section area (ft.sq.)
12.2	width (ft)
0.8	mean depth (ft)
1.5	max depth (ft)
12.8	wetted perimeter (ft)
0.8	hydraulic radius (ft)
15.1	width-depth ratio
200.0	W flood prone area (ft)
16.4	entrenchment ratio
< 1.0	low bank height ratio

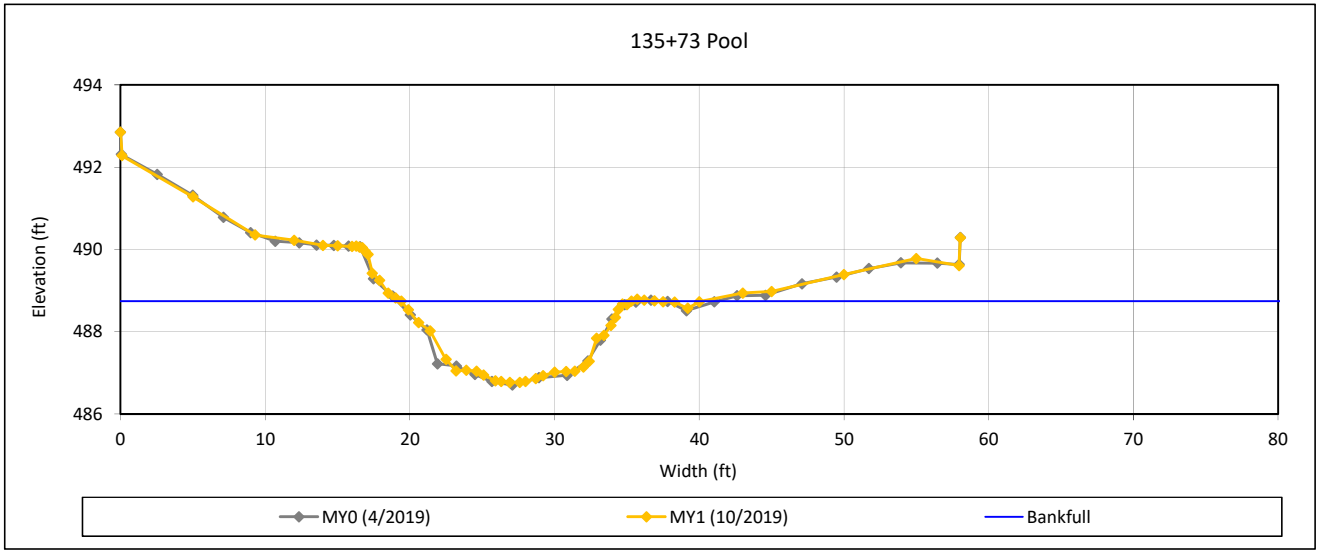
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 9 - Buckwater Creek Reach 5



Bankfull Dimensions	
21.2	x-section area (ft.sq.)
15.9	width (ft)
1.3	mean depth (ft)
2.0	max depth (ft)
16.8	wetted perimeter (ft)
1.3	hydraulic radius (ft)
11.9	width-depth ratio

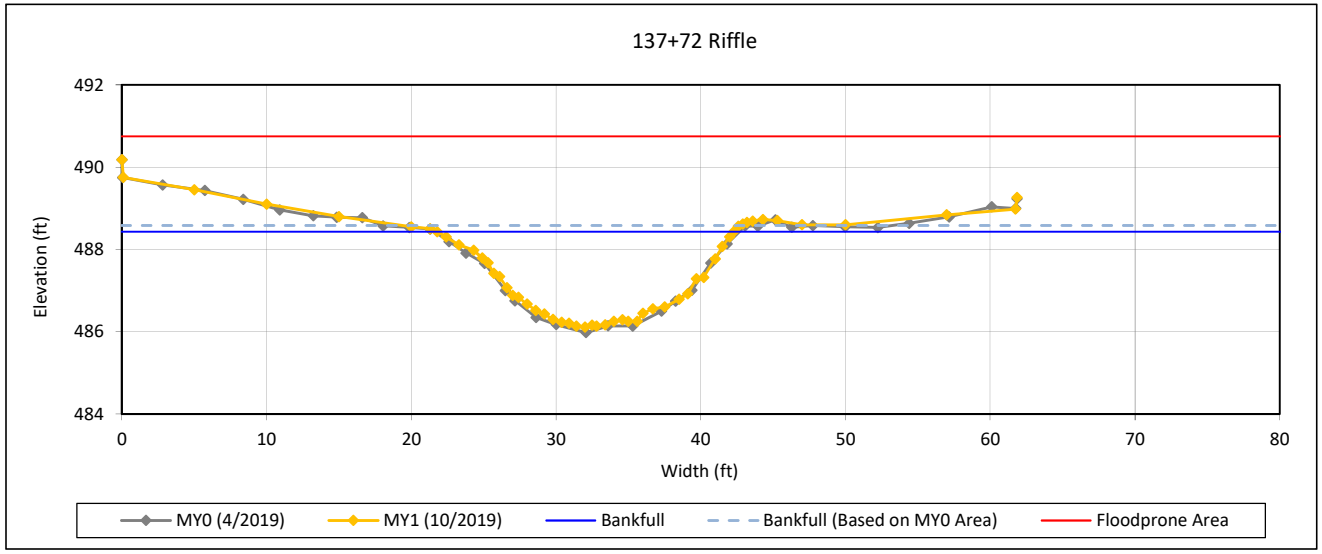
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 10 - Buckwater Creek Reach 5



Bankfull Dimensions	
30.0	x-section area (ft.sq.)
20.5	width (ft)
1.5	mean depth (ft)
2.3	max depth (ft)
21.3	wetted perimeter (ft)
1.4	hydraulic radius (ft)
14.0	width-depth ratio
200.0	W flood prone area (ft)
9.8	entrenchment ratio
< 1.0	low bank height ratio

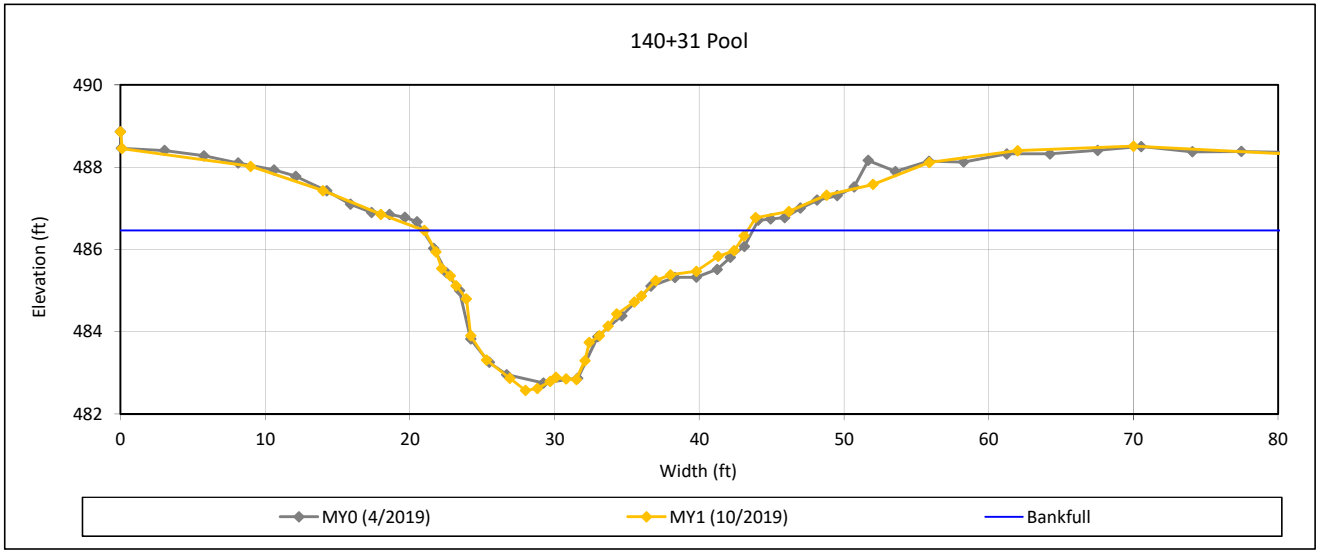
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 11 - Buckwater Creek Reach 6



Bankfull Dimensions	
46.0	x-section area (ft.sq.)
22.3	width (ft)
2.1	mean depth (ft)
3.9	max depth (ft)
24.6	wetted perimeter (ft)
1.9	hydraulic radius (ft)
10.8	width-depth ratio

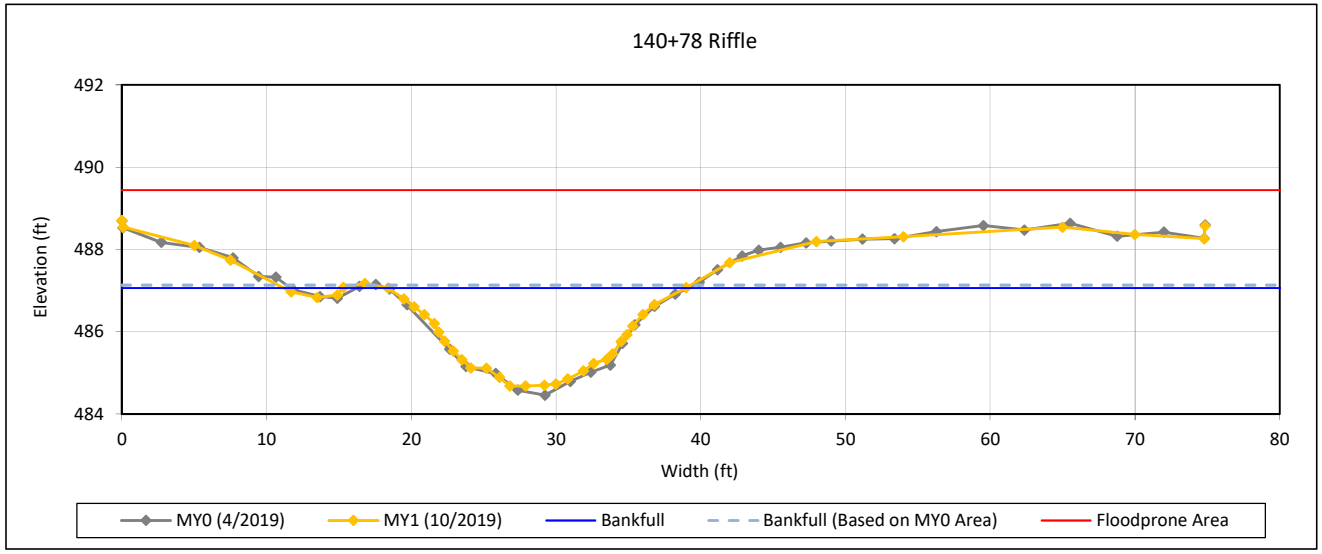
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 12 - Buckwater Creek Reach 6



Bankfull Dimensions	
29.1	x-section area (ft.sq.)
20.5	width (ft)
1.4	mean depth (ft)
2.4	max depth (ft)
21.3	wetted perimeter (ft)
1.4	hydraulic radius (ft)
14.5	width-depth ratio
200.0	W flood prone area (ft)
9.7	entrenchment ratio
< 1.0	low bank height ratio

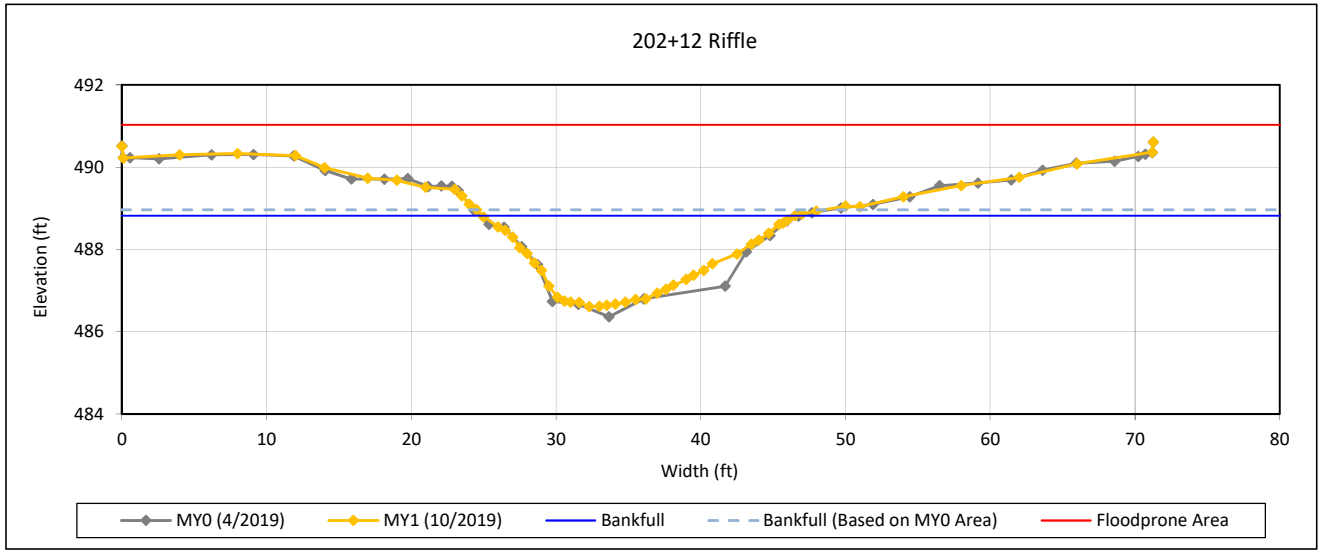
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 13 - T1 Reach 1



Bankfull Dimensions	
28.3	x-section area (ft.sq.)
21.6	width (ft)
1.3	mean depth (ft)
2.2	max depth (ft)
22.2	wetted perimeter (ft)
1.3	hydraulic radius (ft)
16.5	width-depth ratio
150.0	W flood prone area (ft)
6.9	entrenchment ratio
< 1.0	low bank height ratio

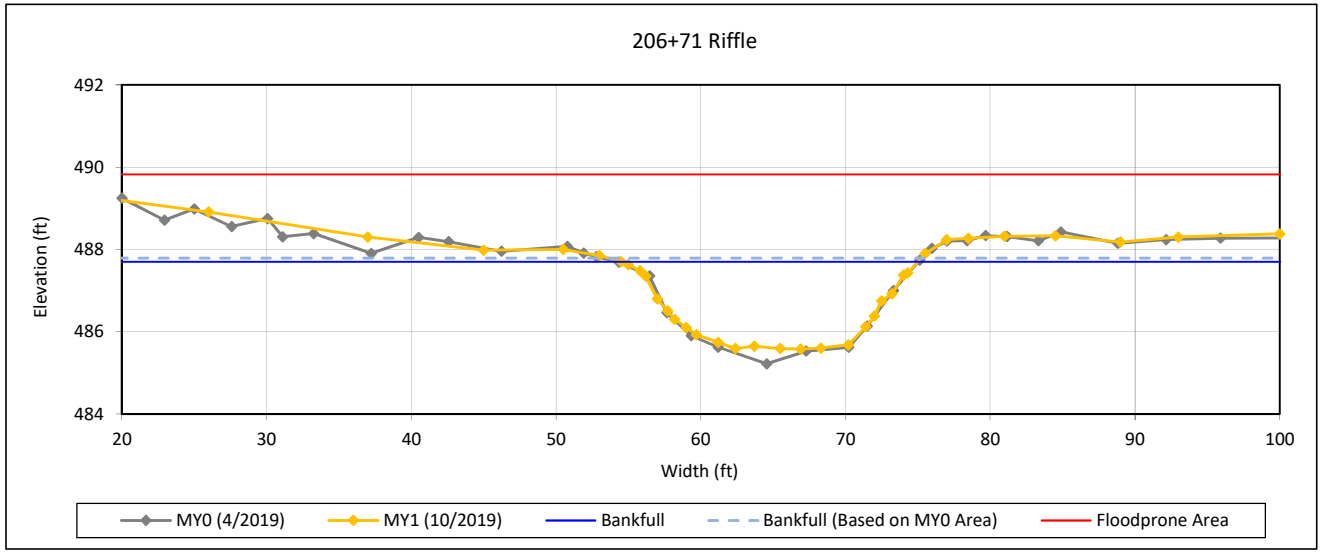
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 14 - T1 Reach 2



Bankfull Dimensions	
30.9	x-section area (ft.sq.)
20.5	width (ft)
1.5	mean depth (ft)
2.1	max depth (ft)
21.3	wetted perimeter (ft)
1.4	hydraulic radius (ft)
13.6	width-depth ratio
200.0	W flood prone area (ft)
9.8	entrenchment ratio
< 1.0	low bank height ratio

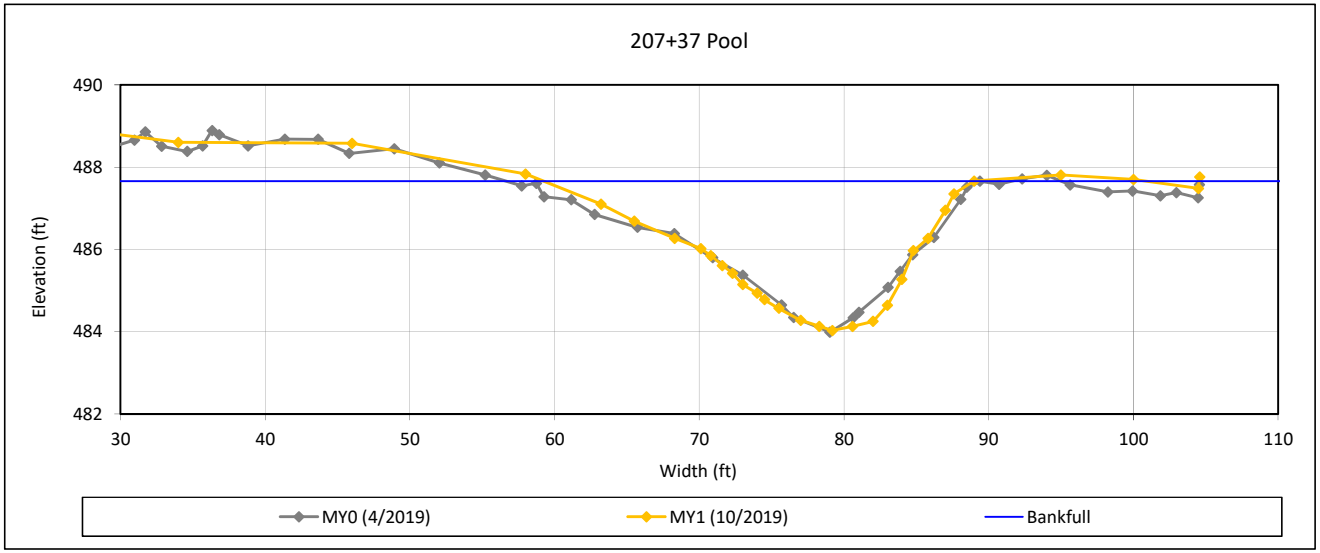
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 15 - T1 Reach 2



Bankfull Dimensions	
55.5	x-section area (ft.sq.)
33.5	width (ft)
1.7	mean depth (ft)
3.6	max depth (ft)
34.9	wetted perimeter (ft)
1.6	hydraulic radius (ft)
20.3	width-depth ratio

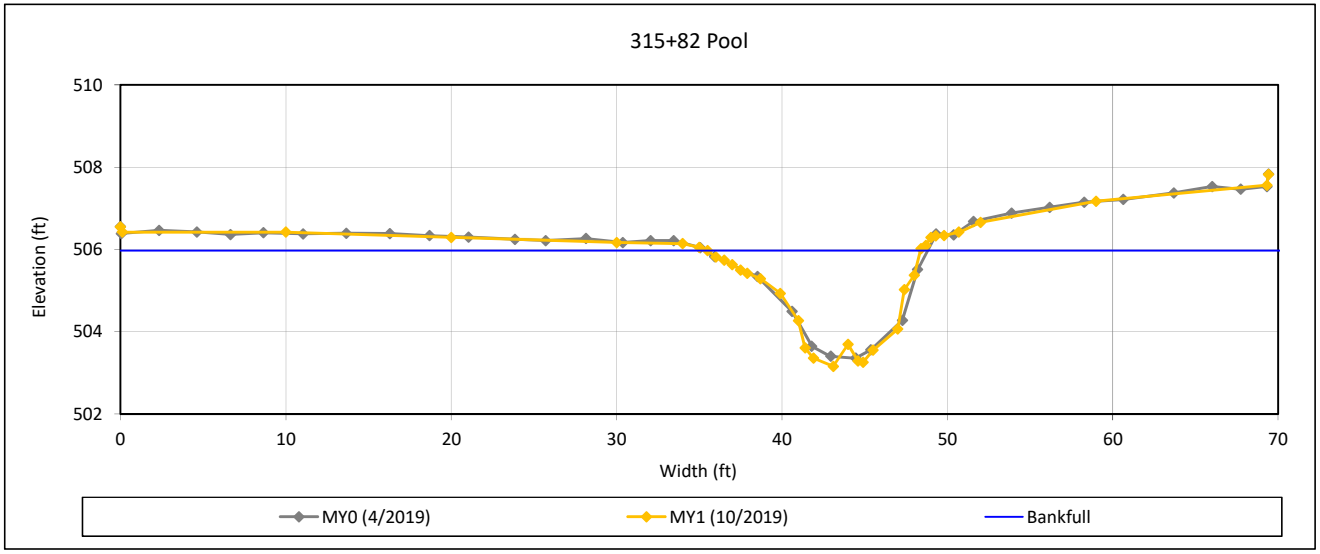
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 16 - T3 Reach 2



Bankfull Dimensions	
19.5	x-section area (ft.sq.)
12.9	width (ft)
1.5	mean depth (ft)
2.8	max depth (ft)
15.1	wetted perimeter (ft)
1.3	hydraulic radius (ft)
8.5	width-depth ratio

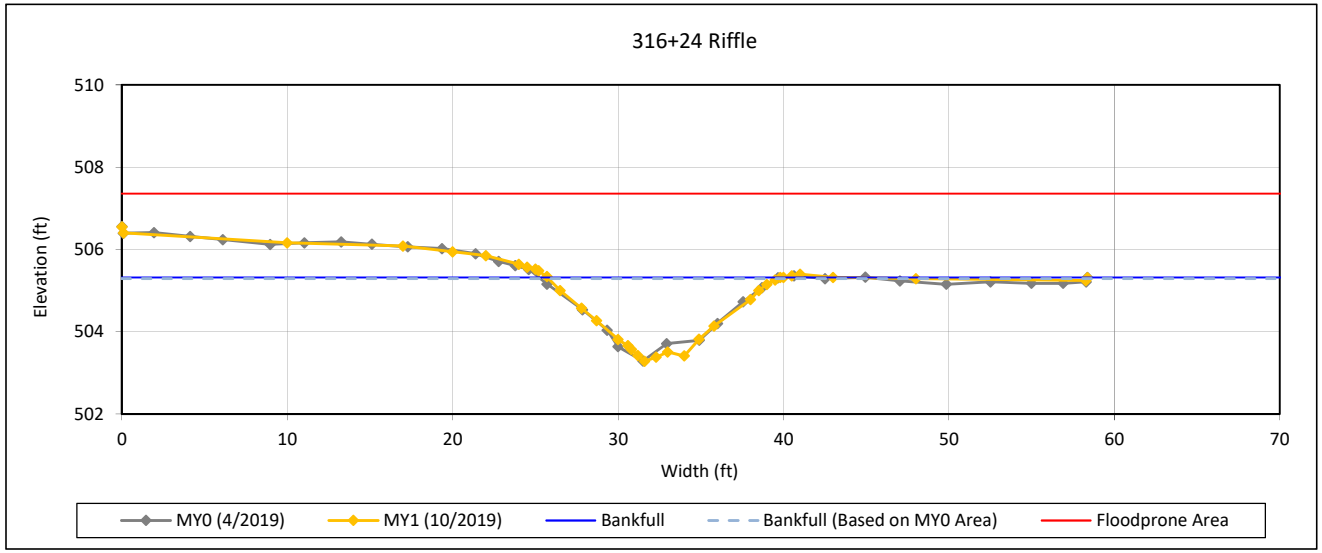
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 17 - T3 Reach 2



Bankfull Dimensions	
15.7	x-section area (ft.sq.)
14.1	width (ft)
1.1	mean depth (ft)
2.0	max depth (ft)
14.7	wetted perimeter (ft)
1.1	hydraulic radius (ft)
12.6	width-depth ratio
300.0	W flood prone area (ft)
21.3	entrenchment ratio
1.0	low bank height ratio

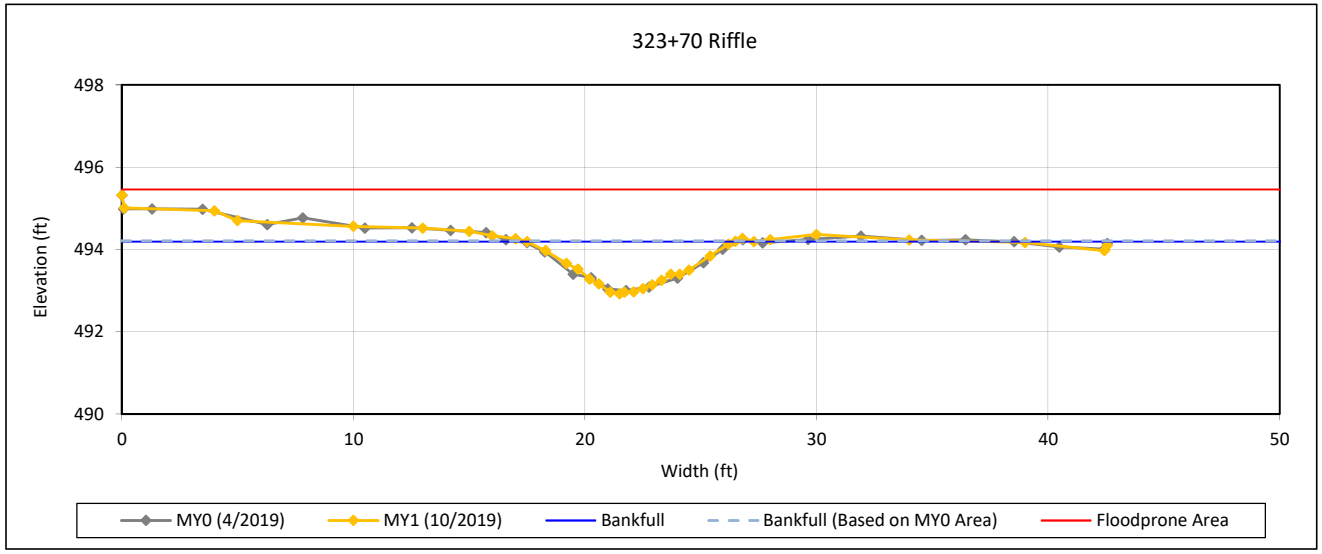
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 18 - T2



Bankfull Dimensions	
6.2	x-section area (ft.sq.)
9.0	width (ft)
0.7	mean depth (ft)
1.3	max depth (ft)
9.4	wetted perimeter (ft)
0.7	hydraulic radius (ft)
12.9	width-depth ratio
100.0	W flood prone area (ft)
11.2	entrenchment ratio
< 1.0	low bank height ratio

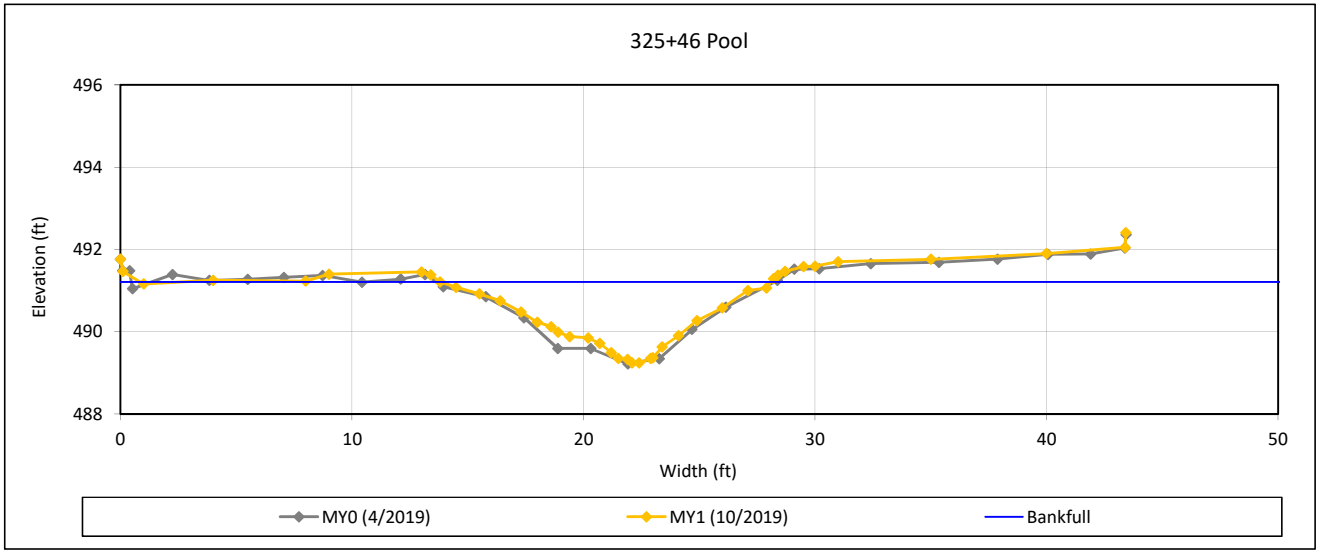
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 19 - T2



Bankfull Dimensions	
13.4	x-section area (ft.sq.)
14.3	width (ft)
0.9	mean depth (ft)
2.0	max depth (ft)
15.0	wetted perimeter (ft)
0.9	hydraulic radius (ft)
15.2	width-depth ratio

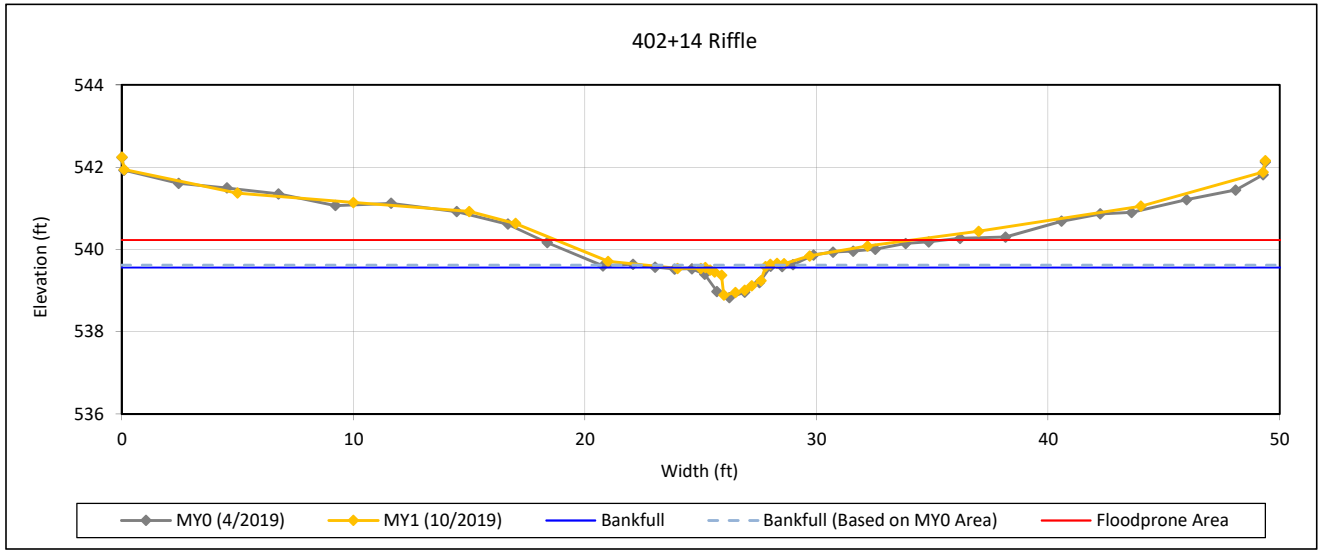
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 20 - T4A Reach 1



Bankfull Dimensions	
1.0	x-section area (ft.sq.)
2.6	width (ft)
0.4	mean depth (ft)
0.7	max depth (ft)
3.2	wetted perimeter (ft)
0.3	hydraulic radius (ft)
6.7	width-depth ratio
20.0	W flood prone area (ft)
7.7	entrenchment ratio
< 1.0	low bank height ratio

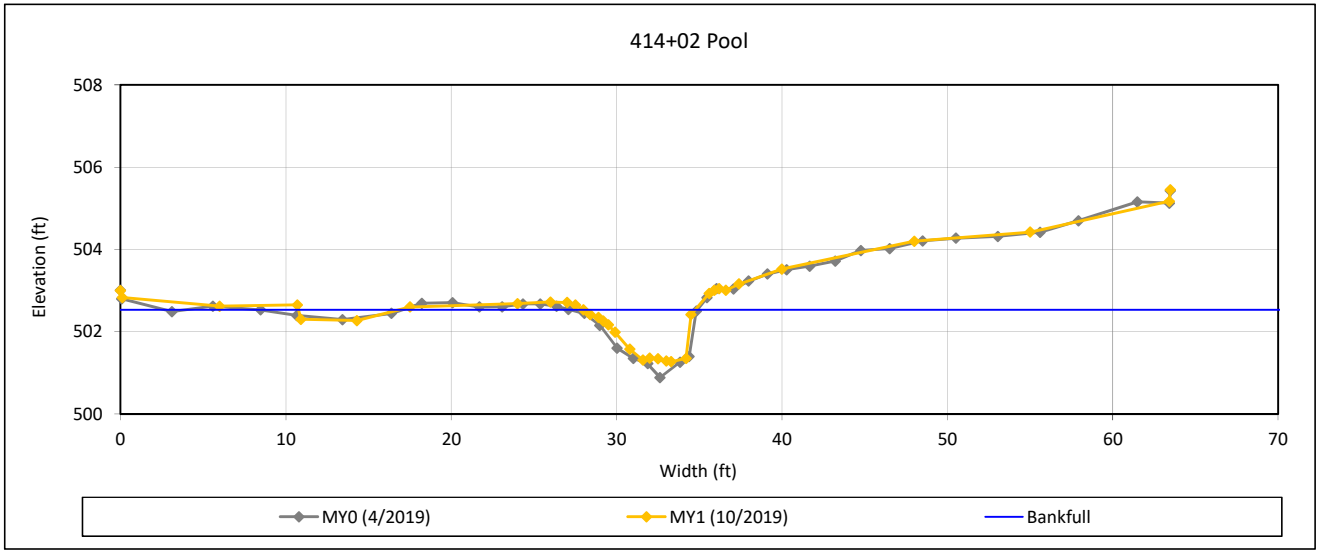
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 21 - T4



Bankfull Dimensions	
5.3	x-section area (ft.sq.)
6.7	width (ft)
0.8	mean depth (ft)
1.3	max depth (ft)
7.8	wetted perimeter (ft)
0.7	hydraulic radius (ft)
8.5	width-depth ratio

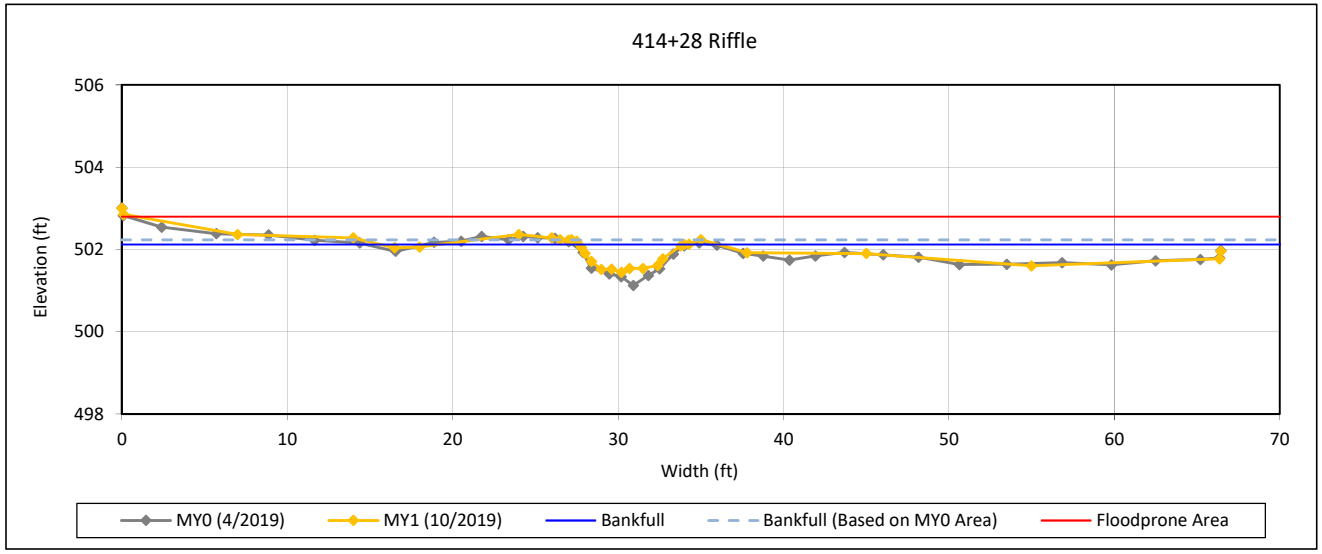
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 22 - T4



Bankfull Dimensions	
2.8	x-section area (ft.sq.)
6.4	width (ft)
0.4	mean depth (ft)
0.7	max depth (ft)
6.6	wetted perimeter (ft)
0.4	hydraulic radius (ft)
14.3	width-depth ratio
150.0	W flood prone area (ft)
23.6	entrenchment ratio
< 1.0	low bank height ratio

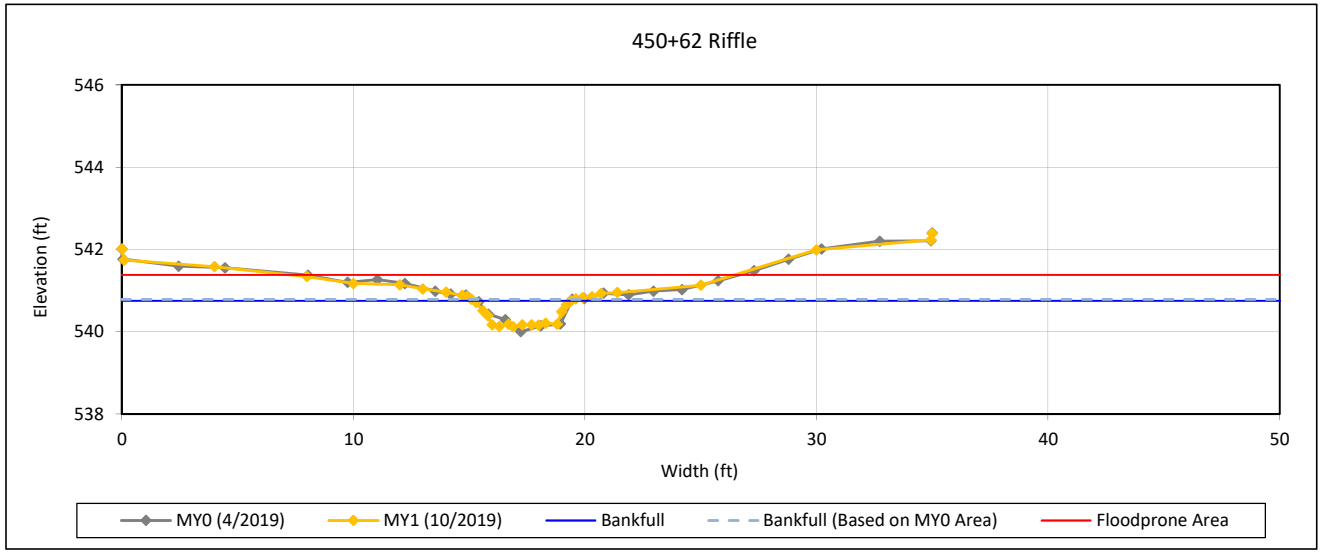
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 23 - T4B Reach 1



Bankfull Dimensions	
2.0	x-section area (ft.sq.)
4.2	width (ft)
0.5	mean depth (ft)
0.6	max depth (ft)
4.7	wetted perimeter (ft)
0.4	hydraulic radius (ft)
9.0	width-depth ratio
25.0	W flood prone area (ft)
6.0	entrenchment ratio
< 1.0	low bank height ratio

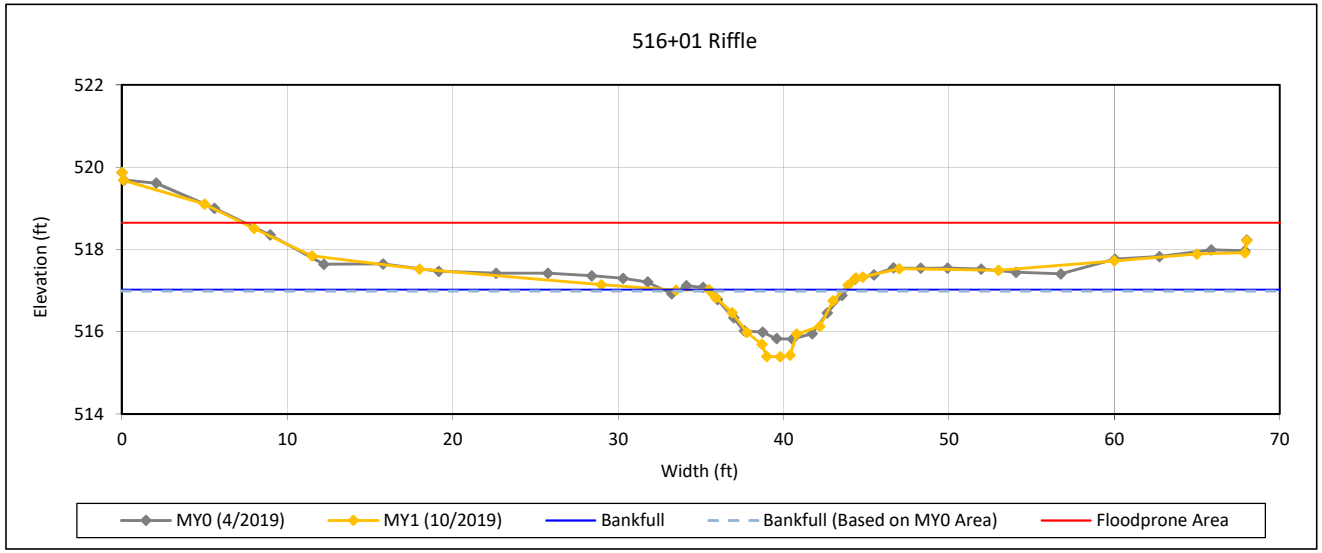
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 24 - T6 Reach 3



Bankfull Dimensions	
7.4	x-section area (ft.sq.)
8.1	width (ft)
0.9	mean depth (ft)
1.6	max depth (ft)
9.1	wetted perimeter (ft)
0.8	hydraulic radius (ft)
9.0	width-depth ratio
100.0	W flood prone area (ft)
12.3	entrenchment ratio
1.0	low bank height ratio

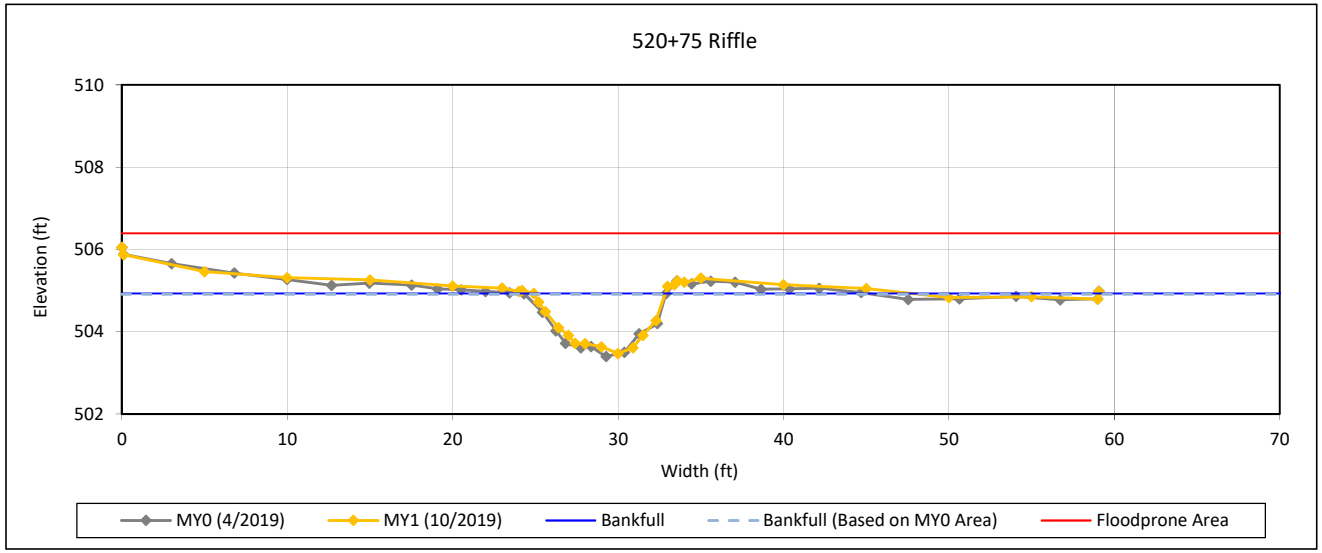
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 25 - T5



Bankfull Dimensions	
7.8	x-section area (ft.sq.)
8.0	width (ft)
1.0	mean depth (ft)
1.5	max depth (ft)
8.7	wetted perimeter (ft)
0.9	hydraulic radius (ft)
8.1	width-depth ratio
100.0	W flood prone area (ft)
12.6	entrenchment ratio
1.0	low bank height ratio

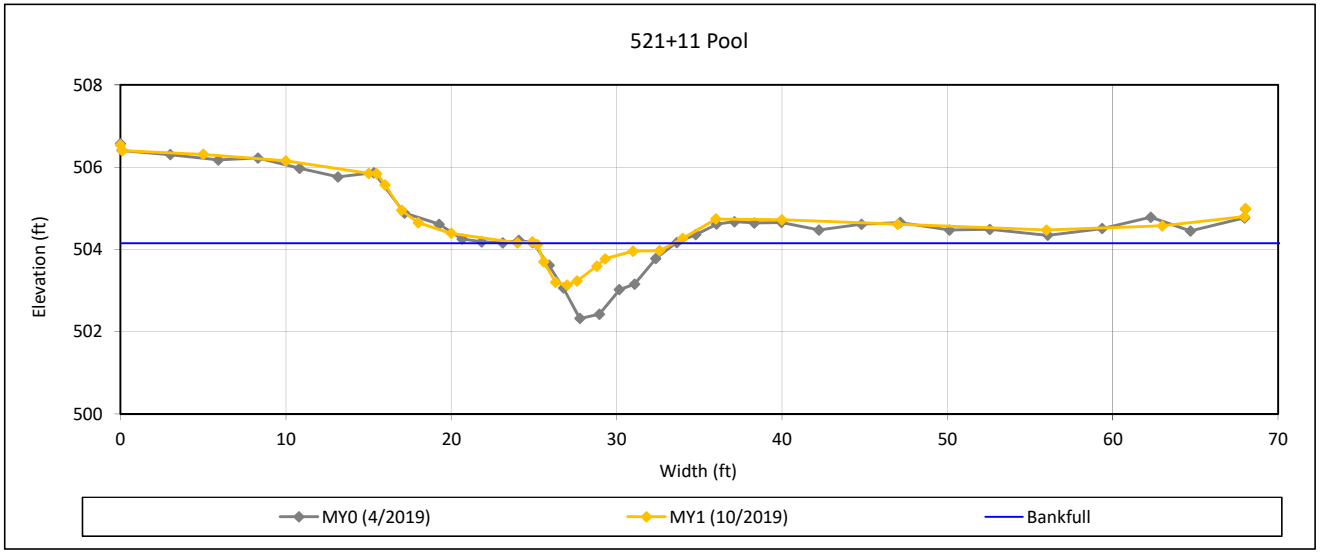
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 26 - T5



Bankfull Dimensions	
3.8	x-section area (ft.sq.)
8.4	width (ft)
0.5	mean depth (ft)
1.0	max depth (ft)
8.9	wetted perimeter (ft)
0.4	hydraulic radius (ft)
18.3	width-depth ratio

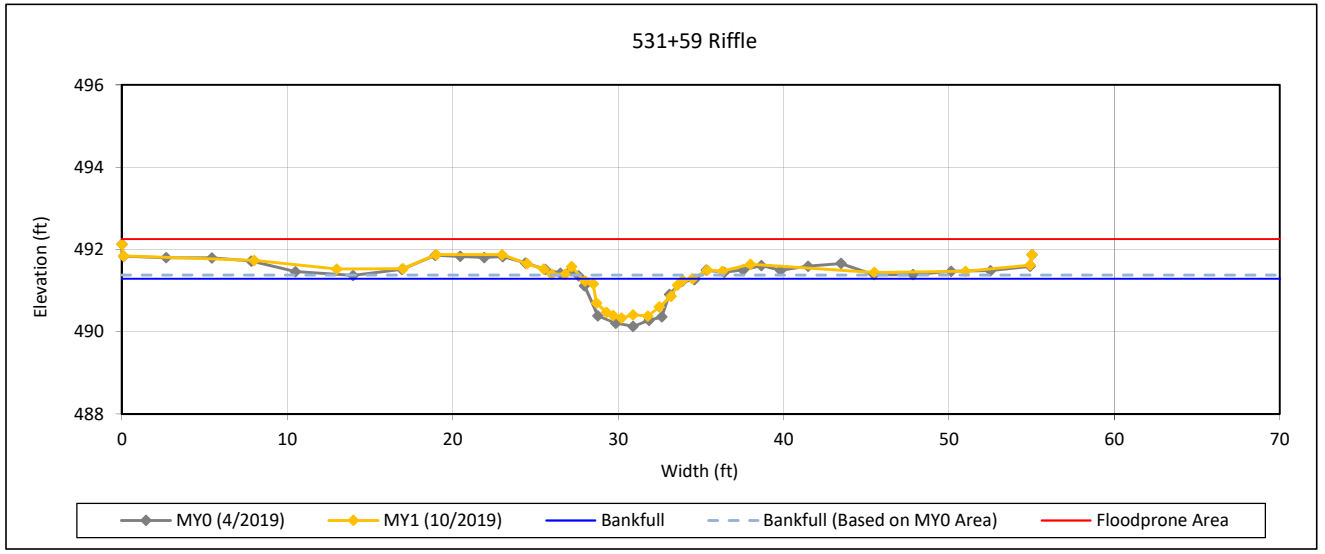
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 27 - T5



Bankfull Dimensions	
3.9	x-section area (ft.sq.)
6.6	width (ft)
0.6	mean depth (ft)
1.0	max depth (ft)
7.2	wetted perimeter (ft)
0.5	hydraulic radius (ft)
11.2	width-depth ratio
200.0	W flood prone area (ft)
30.1	entrenchment ratio
< 1.0	low bank height ratio

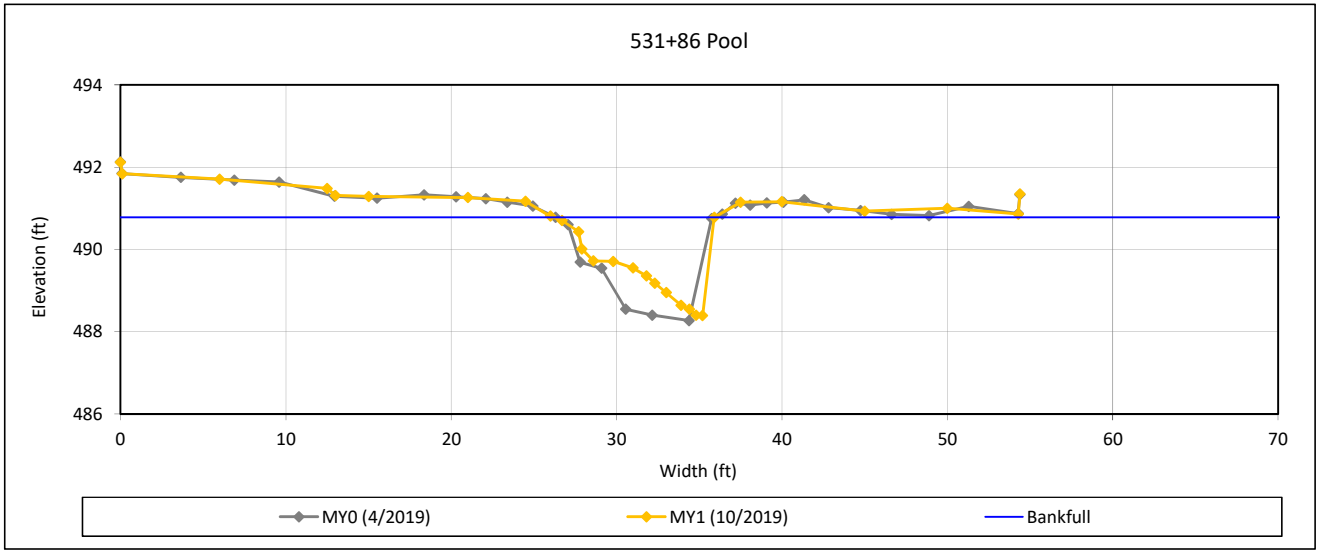
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 28 - T5



Bankfull Dimensions	
12.3	x-section area (ft.sq.)
9.7	width (ft)
1.3	mean depth (ft)
2.4	max depth (ft)
12.1	wetted perimeter (ft)
1.0	hydraulic radius (ft)
7.7	width-depth ratio

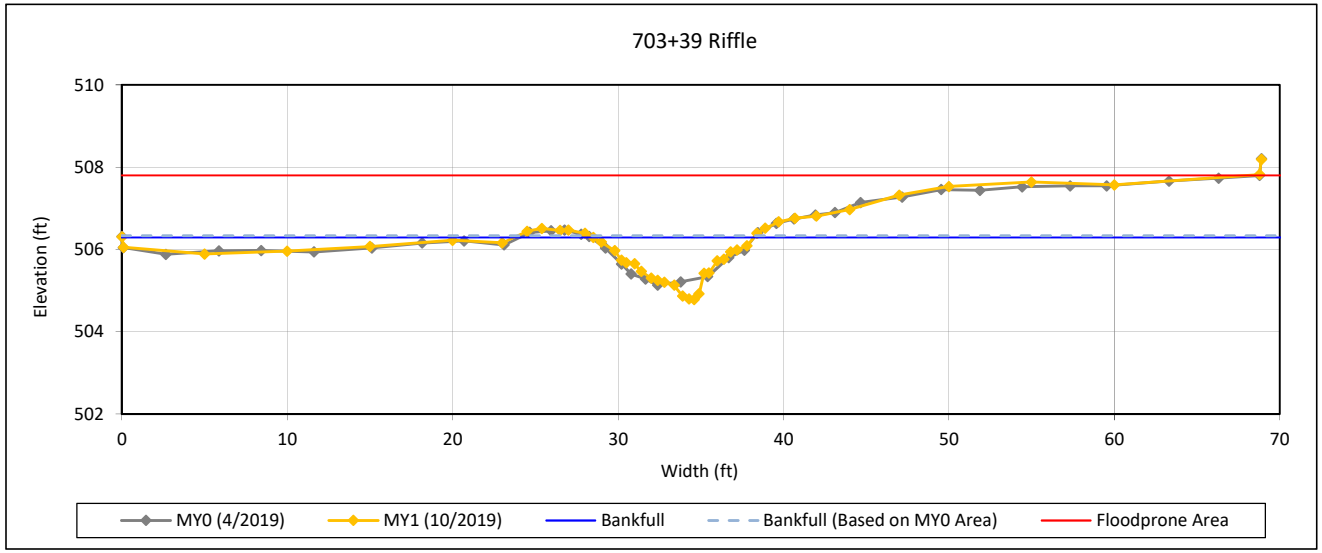
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 29 - T7 Reach 1



Bankfull Dimensions	
7.0	x-section area (ft.sq.)
9.7	width (ft)
0.7	mean depth (ft)
1.5	max depth (ft)
10.4	wetted perimeter (ft)
0.7	hydraulic radius (ft)
13.5	width-depth ratio
100.0	W flood prone area (ft)
10.3	entrenchment ratio
< 1.0	low bank height ratio

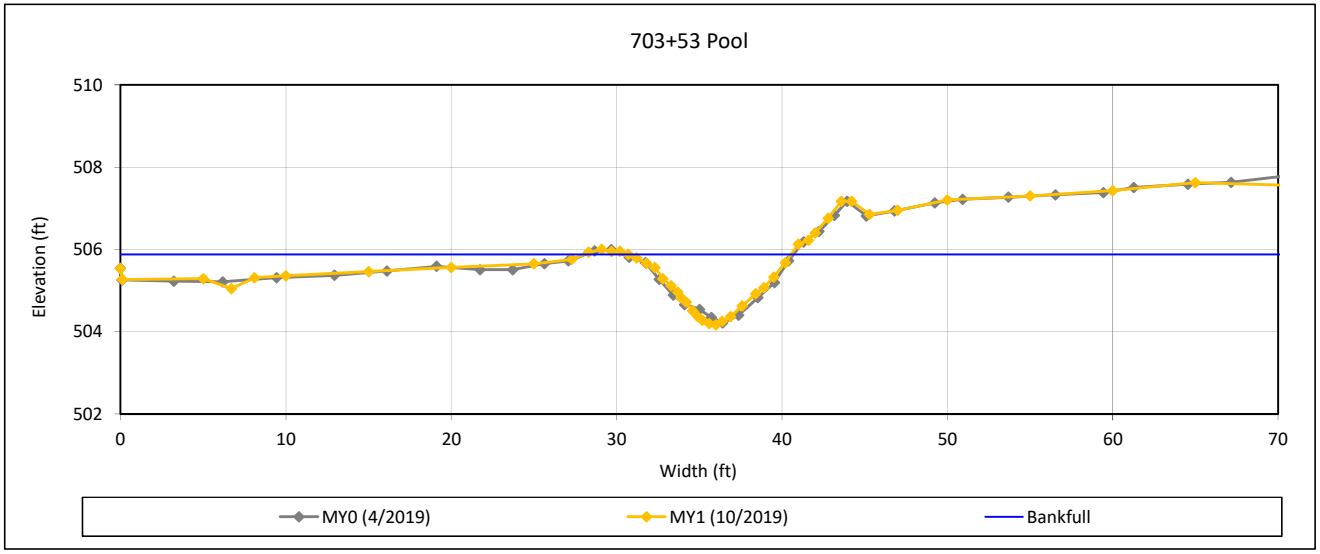
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 30 - T7 Reach 1



Bankfull Dimensions	
8.9	x-section area (ft.sq.)
9.9	width (ft)
0.9	mean depth (ft)
1.7	max depth (ft)
10.5	wetted perimeter (ft)
0.8	hydraulic radius (ft)
11.0	width-depth ratio

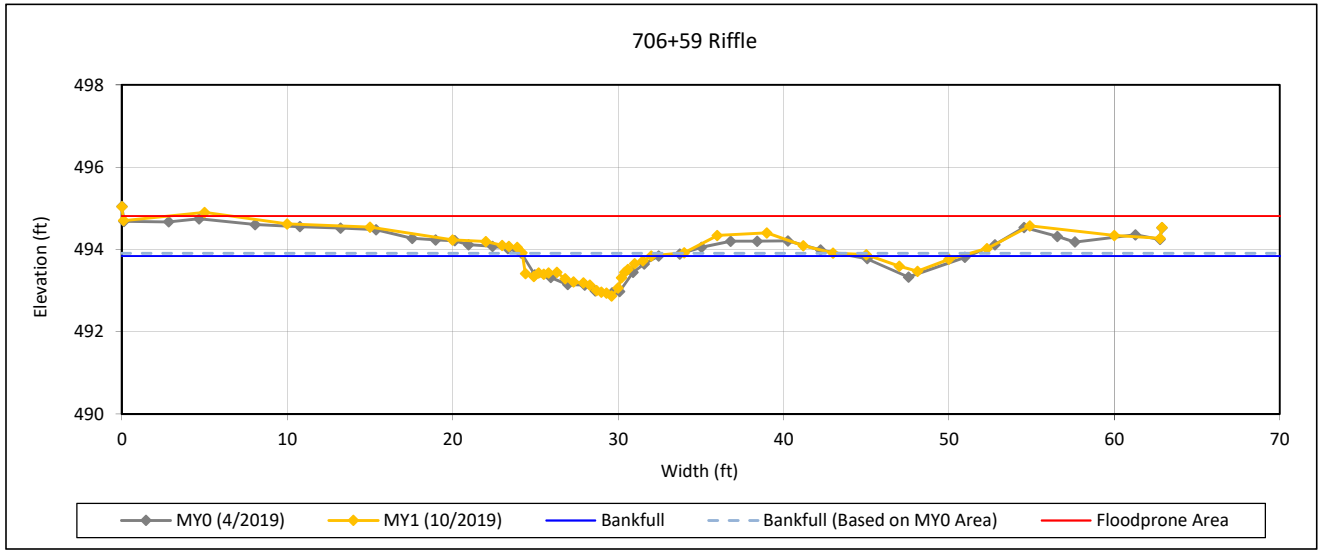
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 31 - T7 Reach 2



Bankfull Dimensions	
4.0	x-section area (ft.sq.)
7.8	width (ft)
0.5	mean depth (ft)
1.0	max depth (ft)
8.4	wetted perimeter (ft)
0.5	hydraulic radius (ft)
15.0	width-depth ratio
100.0	W flood prone area (ft)
12.9	entrenchment ratio
< 1.0	low bank height ratio

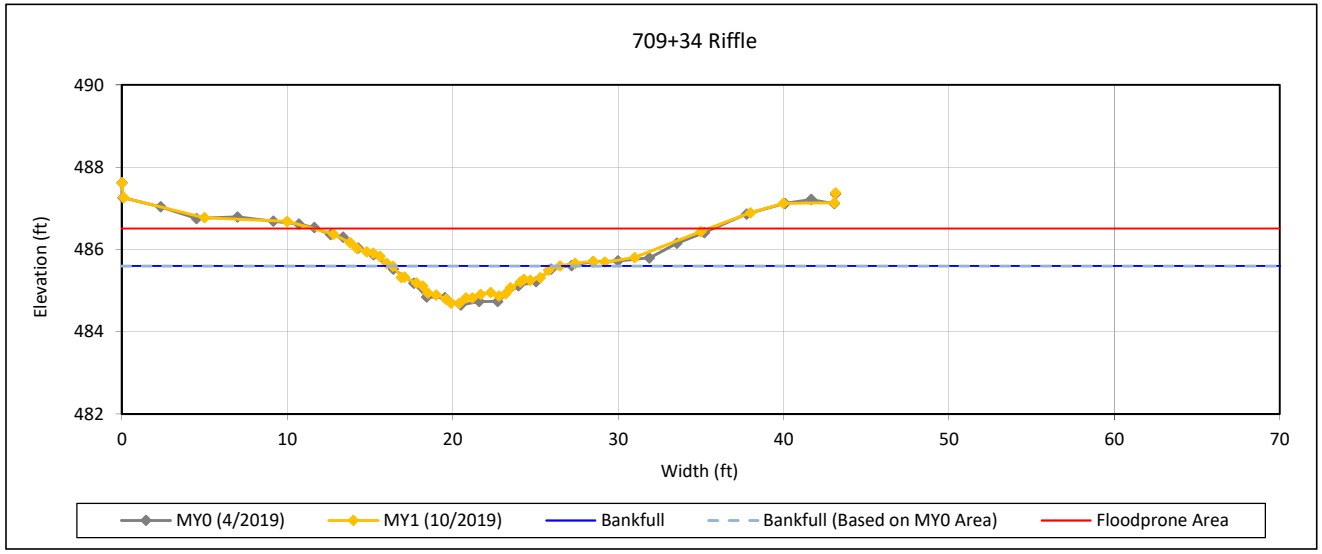
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 32 - T7 Reach 3



Bankfull Dimensions	
5.3	x-section area (ft.sq.)
10.2	width (ft)
0.5	mean depth (ft)
0.9	max depth (ft)
10.5	wetted perimeter (ft)
0.5	hydraulic radius (ft)
19.6	width-depth ratio
25.0	W flood prone area (ft)
2.5	entrenchment ratio
1.0	low bank height ratio

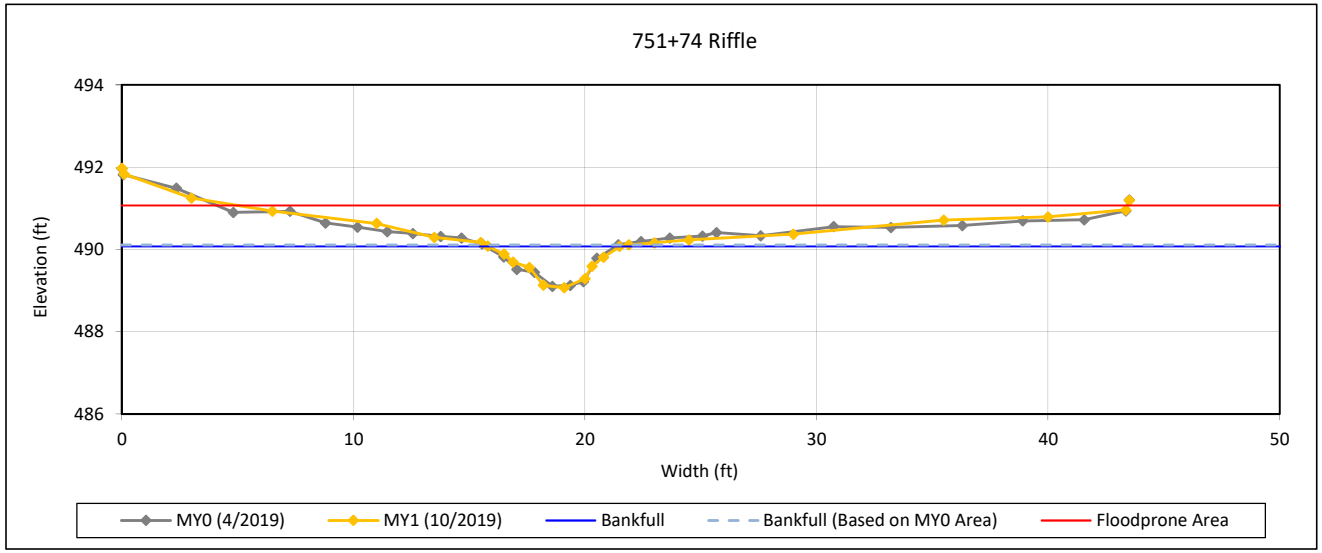
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 33 - T7A



Bankfull Dimensions	
3.1	x-section area (ft.sq.)
5.7	width (ft)
0.5	mean depth (ft)
1.0	max depth (ft)
6.1	wetted perimeter (ft)
0.5	hydraulic radius (ft)
10.5	width-depth ratio
50.0	W flood prone area (ft)
8.8	entrenchment ratio
< 1.0	low bank height ratio

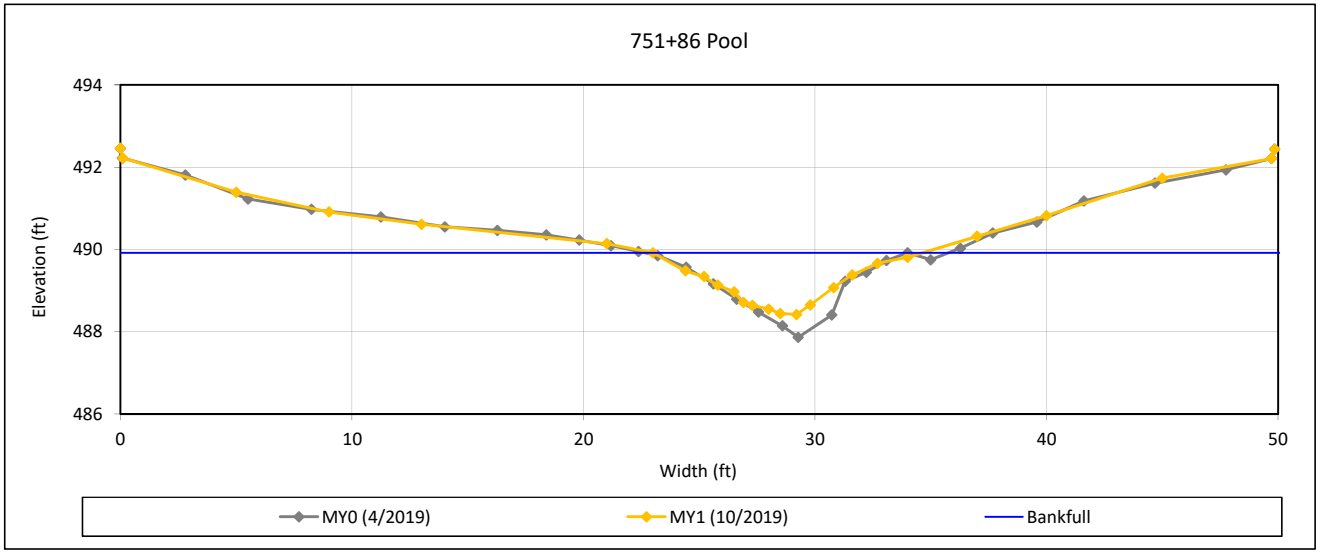
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 34 - T7A



Bankfull Dimensions	
8.5	x-section area (ft.sq.)
11.6	width (ft)
0.7	mean depth (ft)
1.5	max depth (ft)
12.1	wetted perimeter (ft)
0.7	hydraulic radius (ft)
15.9	width-depth ratio

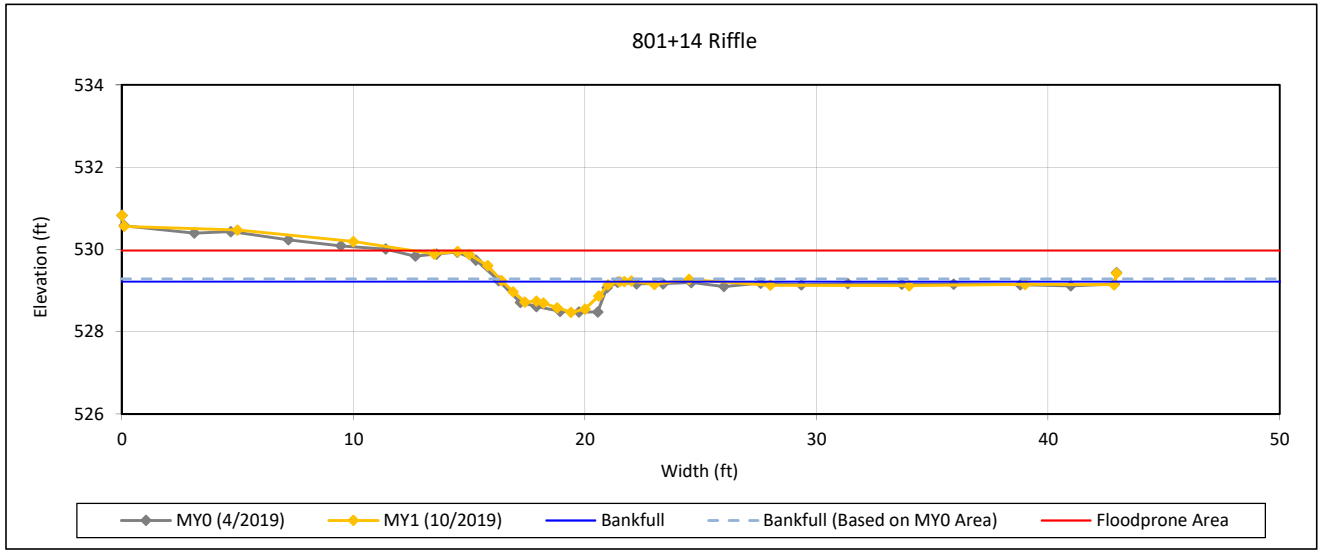
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 35 - T8



Bankfull Dimensions	
2.2	x-section area (ft.sq.)
5.1	width (ft)
0.4	mean depth (ft)
0.8	max depth (ft)
5.4	wetted perimeter (ft)
0.4	hydraulic radius (ft)
11.4	width-depth ratio
100.0	W flood prone area (ft)
19.8	entrenchment ratio
< 1.0	low bank height ratio

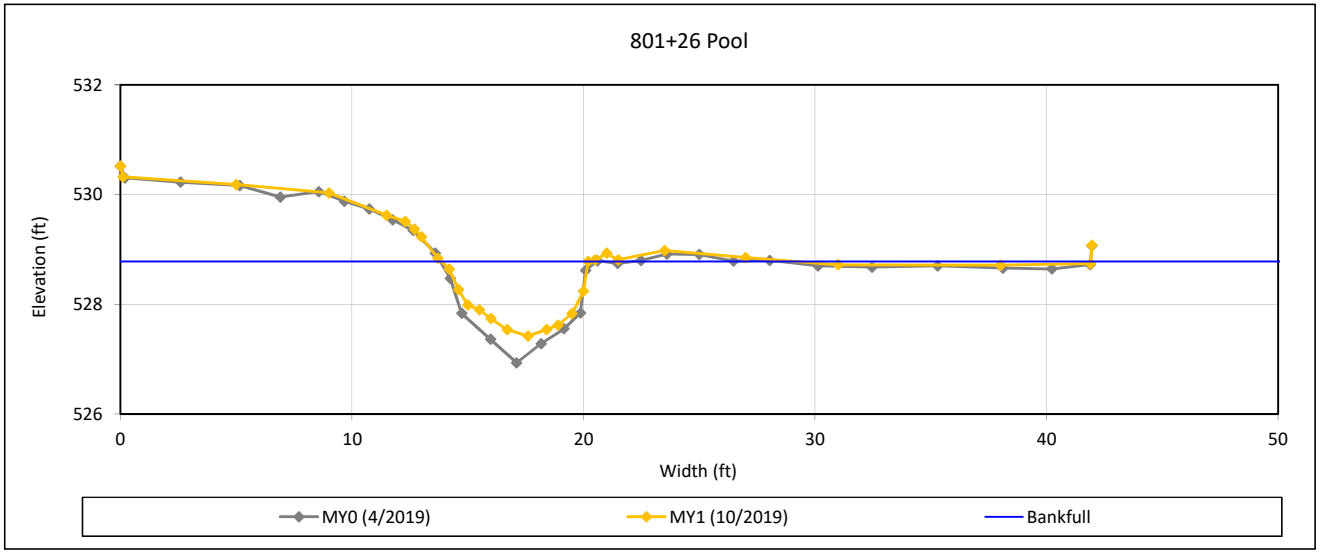
Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Cross-Section 36 - T8



Bankfull Dimensions	
6.0	x-section area (ft.sq.)
6.4	width (ft)
0.9	mean depth (ft)
1.4	max depth (ft)
7.3	wetted perimeter (ft)
0.8	hydraulic radius (ft)
6.7	width-depth ratio

Survey Date: 10/2019
Field Crew: Wildlands Engineering

View Downstream

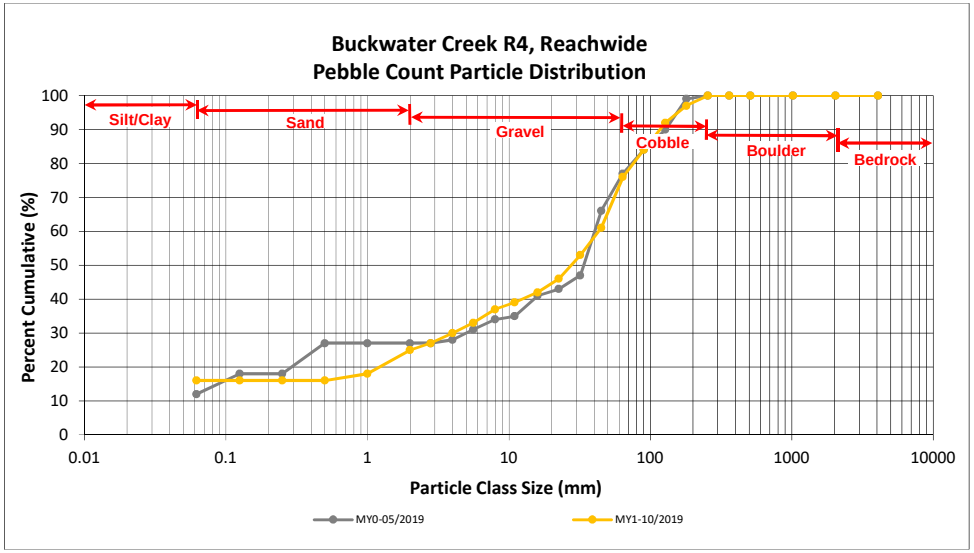
Reachwide Pebble Count Plots

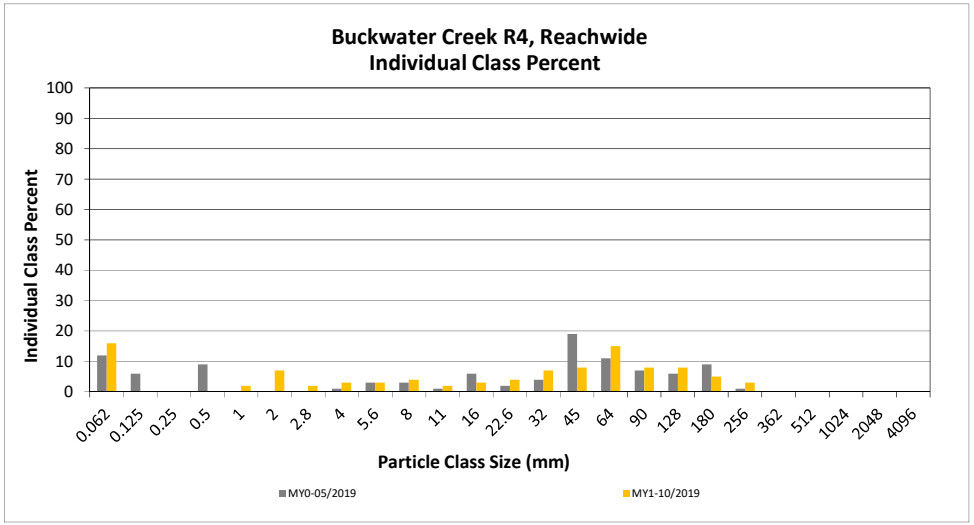
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Buckwater Creek R4, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	5	11	16	16	16
SAND	Very fine	0.062	0.125					16
	Fine	0.125	0.250					16
	Medium	0.25	0.50					16
	Coarse	0.5	1.0	1	1	2	2	18
	Very Coarse	1.0	2.0	3	4	7	7	25
GRAVEL	Very Fine	2.0	2.8		2	2	2	27
	Very Fine	2.8	4.0		3	3	3	30
	Fine	4.0	5.6	1	2	3	3	33
	Fine	5.6	8.0		4	4	4	37
	Medium	8.0	11.0		2	2	2	39
	Medium	11.0	16.0	2	1	3	3	42
	Coarse	16.0	22.6	2	2	4	4	46
	Coarse	22.6	32	4	3	7	7	53
	Very Coarse	32	45	5	3	8	8	61
	Very Coarse	45	64	9	6	15	15	76
COBBLE	Small	64	90	6	2	8	8	84
	Small	90	128	7	1	8	8	92
	Large	128	180	3	2	5	5	97
	Large	180	256	2	1	3	3	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} =	Silt/Clay
D_{35} =	6.69
D_{50} =	27.6
D_{84} =	90.0
D_{95} =	157.1
D_{100} =	256.0





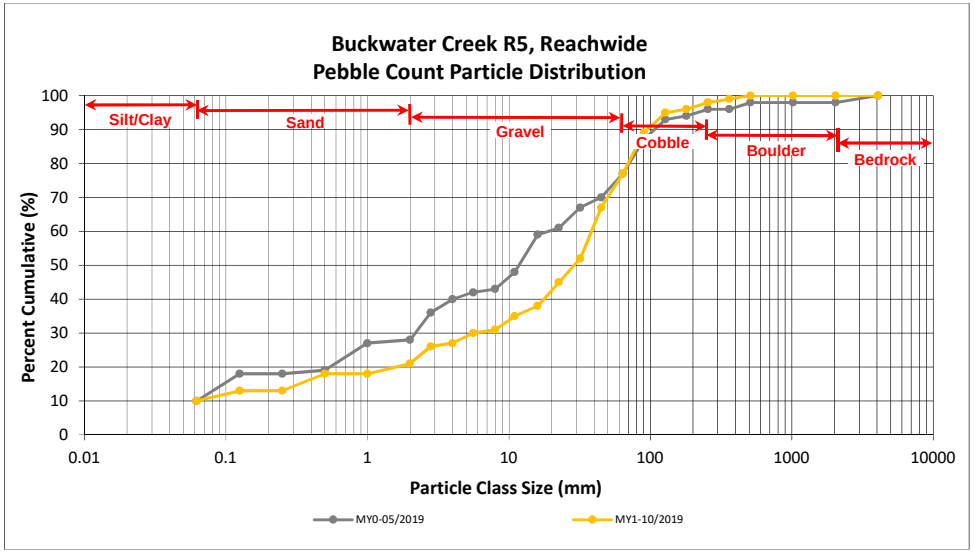
Reachwide Pebble Count Plots

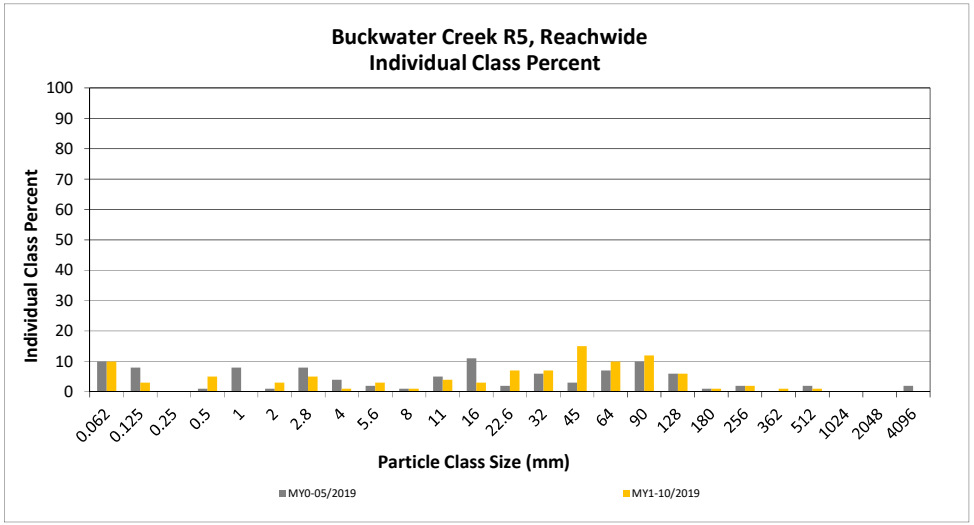
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Buckwater Creek R5, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		10	10	10	10
SAND	Very fine	0.062	0.125		3	3	3	13
	Fine	0.125	0.250					13
	Medium	0.25	0.50	5		5	5	18
	Coarse	0.5	1.0					18
	Very Coarse	1.0	2.0		3	3	3	21
GRAVEL	Very Fine	2.0	2.8		5	5	5	26
	Very Fine	2.8	4.0		1	1	1	27
	Fine	4.0	5.6		3	3	3	30
	Fine	5.6	8.0	1		1	1	31
	Medium	8.0	11.0	1	3	4	4	35
	Medium	11.0	16.0		3	3	3	38
	Coarse	16.0	22.6	2	5	7	7	45
	Coarse	22.6	32	6	1	7	7	52
	Very Coarse	32	45	7	8	15	15	67
	Very Coarse	45	64	7	3	10	10	77
COBBLE	Small	64	90	10	2	12	12	89
	Small	90	128	6		6	6	95
	Large	128	180	1		1	1	96
	Large	180	256	2		2	2	98
BOULDER	Small	256	362	1		1	1	99
	Small	362	512	1		1	1	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} =	0.38
D_{35} =	11.00
D_{50} =	29.0
D_{84} =	78.1
D_{95} =	128.0
D_{100} =	512.0





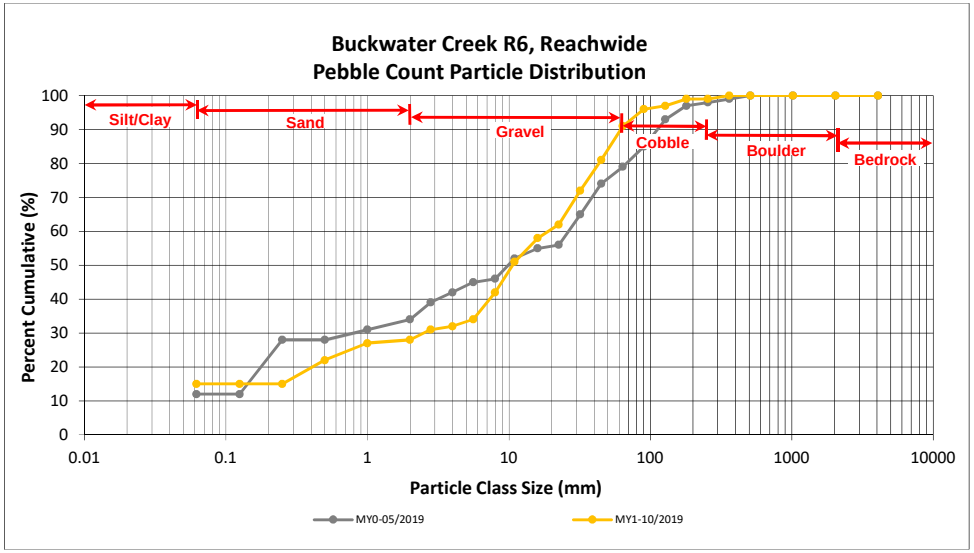
Reachwide Pebble Count Plots

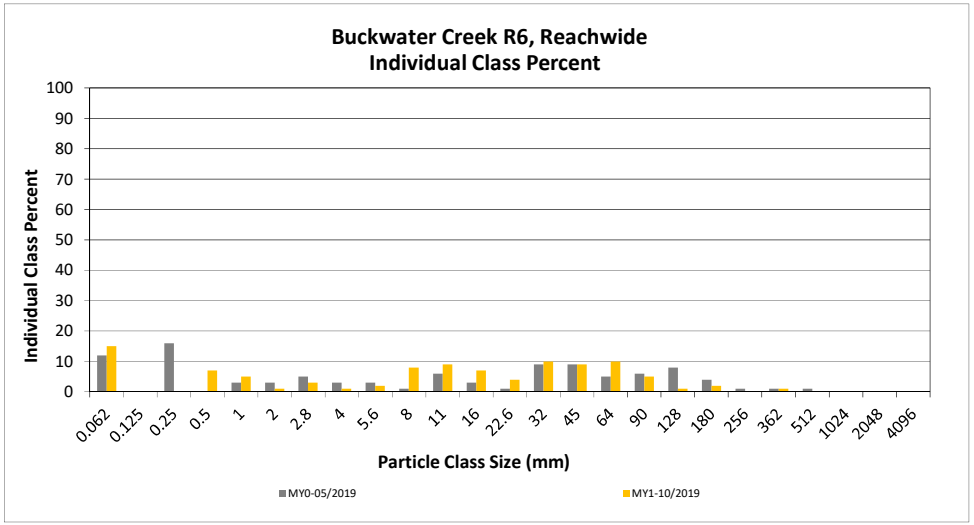
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Buckwater Creek R6, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	2	13	15	15	15
SAND	Very fine	0.062	0.125					15
	Fine	0.125	0.250					15
	Medium	0.25	0.50	3	4	7	7	22
	Coarse	0.5	1.0		5	5	5	27
	Very Coarse	1.0	2.0		1	1	1	28
GRAVEL	Very Fine	2.0	2.8		3	3	3	31
	Very Fine	2.8	4.0		1	1	1	32
	Fine	4.0	5.6		2	2	2	34
	Fine	5.6	8.0		8	8	8	42
	Medium	8.0	11.0	3	6	9	9	51
	Medium	11.0	16.0	7		7	7	58
	Coarse	16.0	22.6	3	1	4	4	62
	Coarse	22.6	32	8	2	10	10	72
	Very Coarse	32	45	6	3	9	9	81
	Very Coarse	45	64	10		10	10	91
COBBLE	Small	64	90	4	1	5	5	96
	Small	90	128	1		1	1	97
	Large	128	180	2		2	2	99
	Large	180	256					99
BOULDER	Small	256	362	1		1	1	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} =	0.28
D_{35} =	5.86
D_{50} =	10.6
D_{84} =	50.0
D_{95} =	84.1
D_{100} =	362.0





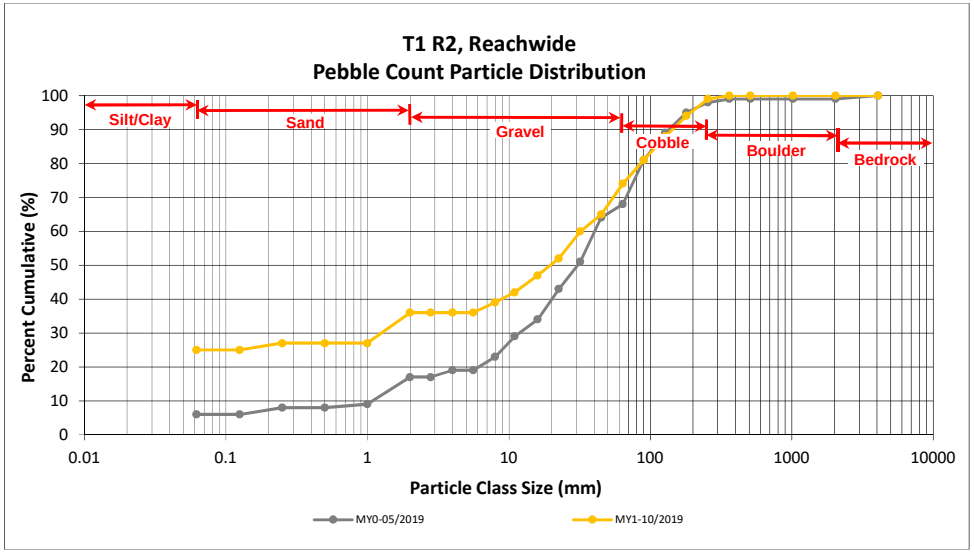
Reachwide Pebble Count Plots

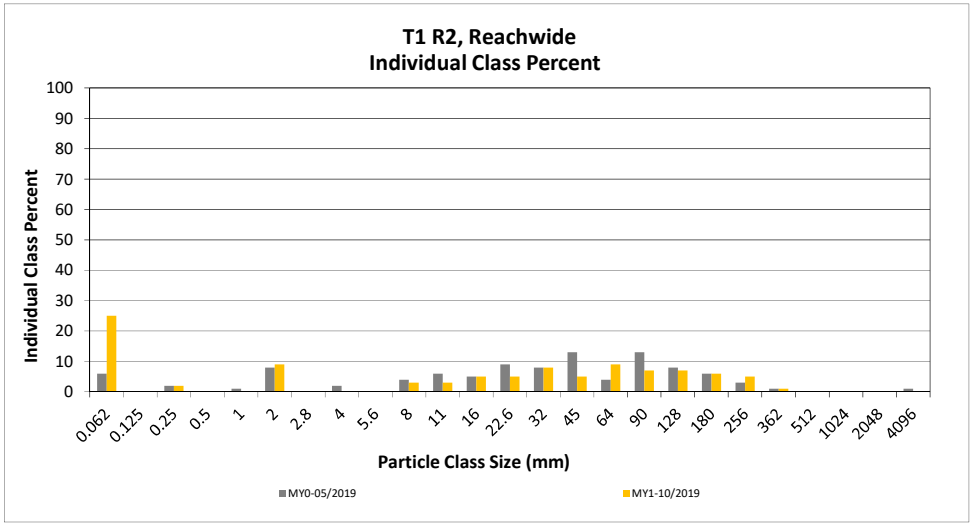
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

T1 R2, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	5	20	25	25	25
SAND	Very fine	0.062	0.125					25
	Fine	0.125	0.250		2	2	2	27
	Medium	0.25	0.50					27
	Coarse	0.5	1.0					27
	Very Coarse	1.0	2.0	5	4	9	9	36
GRAVEL	Very Fine	2.0	2.8					36
	Very Fine	2.8	4.0					36
	Fine	4.0	5.6					36
	Fine	5.6	8.0	2	1	3	3	39
	Medium	8.0	11.0	2	1	3	3	42
	Medium	11.0	16.0	4	1	5	5	47
	Coarse	16.0	22.6	3	2	5	5	52
	Coarse	22.6	32	4	4	8	8	60
	Very Coarse	32	45	3	2	5	5	65
	Very Coarse	45	64	4	5	9	9	74
COBBLE	Small	64	90	6	1	7	7	81
	Small	90	128	6	1	7	7	88
	Large	128	180	4	2	6	6	94
	Large	180	256	1	4	5	5	99
BOULDER	Small	256	362	1		1	1	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} =	Silt/Clay
D_{35} =	1.85
D_{50} =	19.7
D_{84} =	104.7
D_{95} =	193.1
D_{100} =	362.0





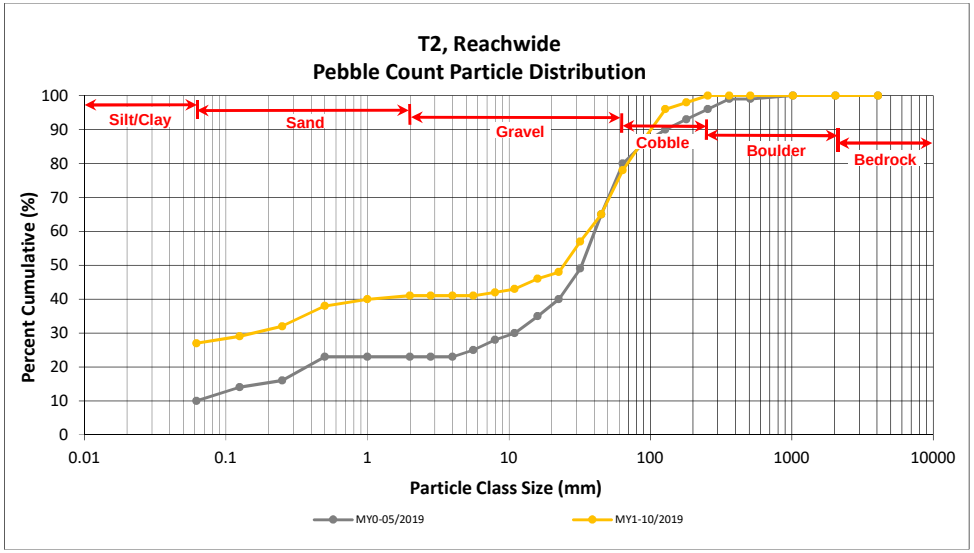
Reachwide Pebble Count Plots

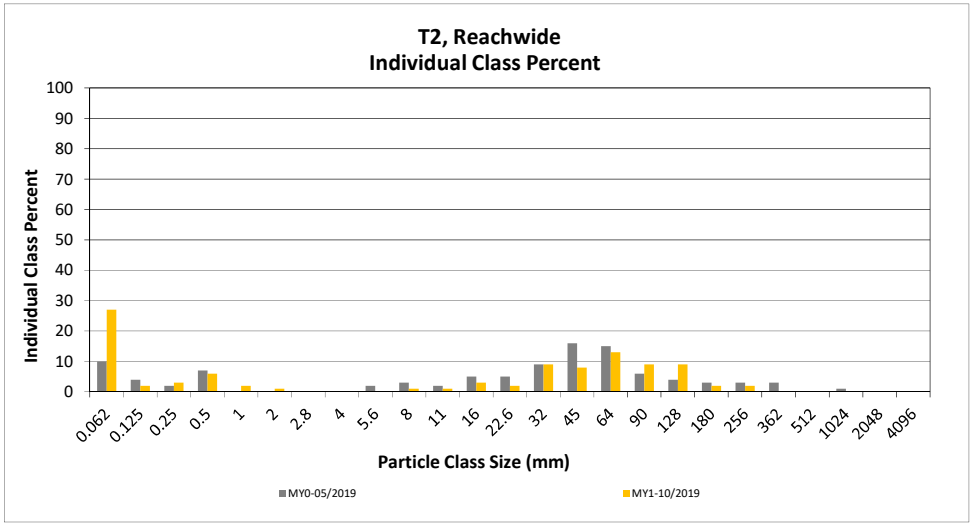
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

T2, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	4	23	27	27	27
SAND	Very fine	0.062	0.125		2	2	2	29
	Fine	0.125	0.250		3	3	3	32
	Medium	0.25	0.50		6	6	6	38
	Coarse	0.5	1.0	1	1	2	2	40
	Very Coarse	1.0	2.0	1		1	1	41
GRAVEL	Very Fine	2.0	2.8					41
	Very Fine	2.8	4.0					41
	Fine	4.0	5.6					41
	Fine	5.6	8.0		1	1	1	42
	Medium	8.0	11.0	1		1	1	43
	Medium	11.0	16.0	1	2	3	3	46
	Coarse	16.0	22.6	1	1	2	2	48
	Coarse	22.6	32	6	3	9	9	57
	Very Coarse	32	45	8		8	8	65
	Very Coarse	45	64	8	5	13	13	78
COBBLE	Small	64	90	8	1	9	9	87
	Small	90	128	7	2	9	9	96
	Large	128	180	2		2	2	98
	Large	180	256	2		2	2	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} =	Silt/Clay
D_{35} =	0.35
D_{50} =	24.4
D_{84} =	80.3
D_{95} =	123.1
D_{100} =	256.0





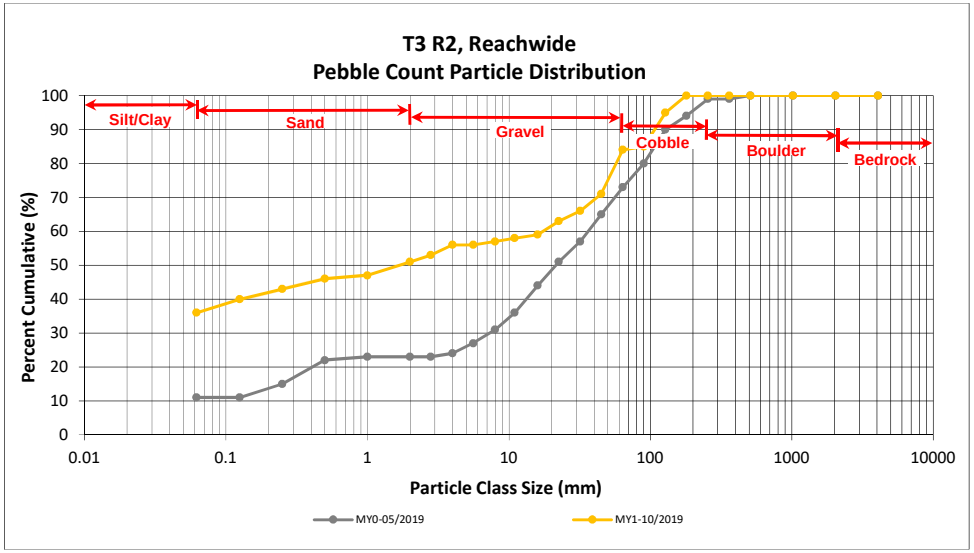
Reachwide Pebble Count Plots

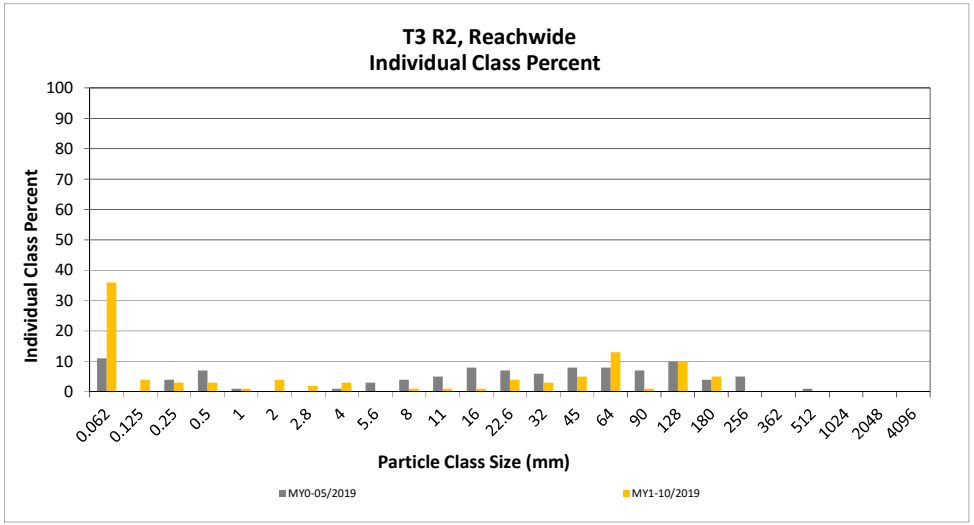
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

T3 R2, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	11	25	36	36	36
SAND	Very fine	0.062	0.125	1	3	4	4	40
	Fine	0.125	0.250		3	3	3	43
	Medium	0.25	0.50	1	2	3	3	46
	Coarse	0.5	1.0	1		1	1	47
	Very Coarse	1.0	2.0	2	2	4	4	51
GRAVEL	Very Fine	2.0	2.8		2	2	2	53
	Very Fine	2.8	4.0		3	3	3	56
	Fine	4.0	5.6					56
	Fine	5.6	8.0	1		1	1	57
	Medium	8.0	11.0	1		1	1	58
	Medium	11.0	16.0	1		1	1	59
	Coarse	16.0	22.6	2	2	4	4	63
	Coarse	22.6	32	1	2	3	3	66
	Very Coarse	32	45	4	1	5	5	71
	Very Coarse	45	64	11	2	13	13	84
COBBLE	Small	64	90	1		1	1	85
	Small	90	128	9	1	10	10	95
	Large	128	180	3	2	5	5	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} =	Silt/Clay
D_{35} =	Silt/Clay
D_{50} =	1.7
D_{84} =	64.0
D_{95} =	128.0
D_{100} =	180.0





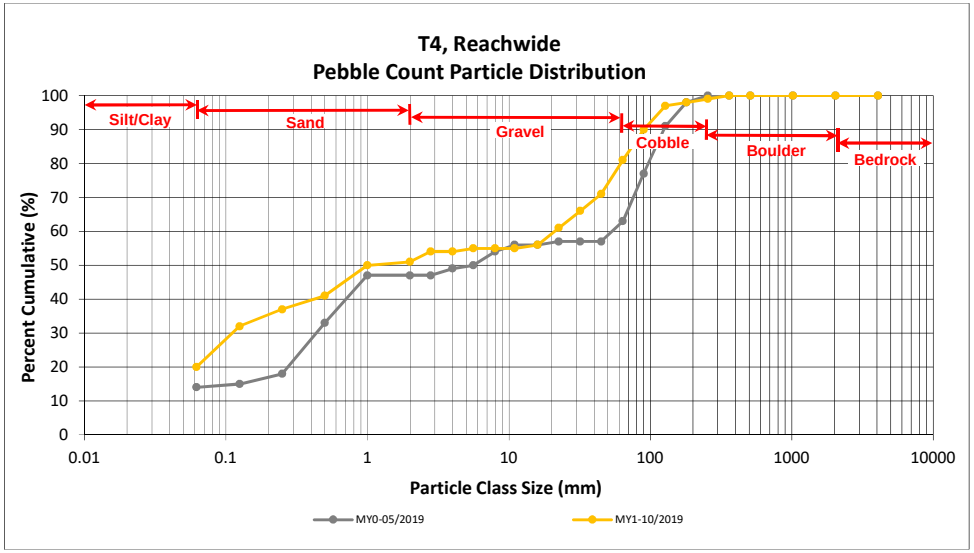
Reachwide Pebble Count Plots

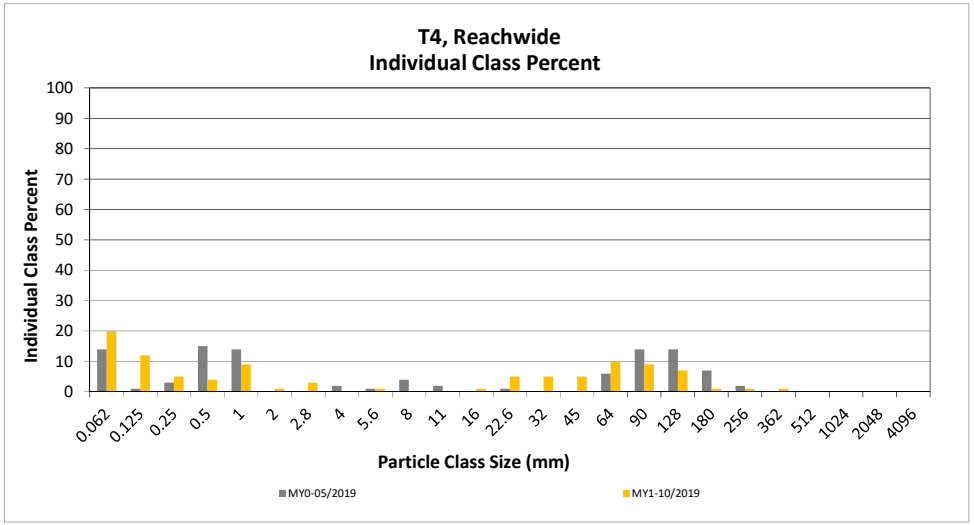
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

T4, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	3	17	20	20	20
SAND	Very fine	0.062	0.125		12	12	12	32
	Fine	0.125	0.250	5		5	5	37
	Medium	0.25	0.50	1	3	4	4	41
	Coarse	0.5	1.0		9	9	9	50
	Very Coarse	1.0	2.0		1	1	1	51
GRAVEL	Very Fine	2.0	2.8		3	3	3	54
	Very Fine	2.8	4.0					54
	Fine	4.0	5.6		1	1	1	55
	Fine	5.6	8.0					55
	Medium	8.0	11.0					55
	Medium	11.0	16.0	1		1	1	56
	Coarse	16.0	22.6	2	3	5	5	61
	Coarse	22.6	32	5		5	5	66
	Very Coarse	32	45	4	1	5	5	71
	Very Coarse	45	64	10		10	10	81
COBBLE	Small	64	90	9		9	9	90
	Small	90	128	7		7	7	97
	Large	128	180	1		1	1	98
	Large	180	256	1		1	1	99
BOULDER	Small	256	362	1		1	1	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} =	Silt/Clay
D_{35} =	0.19
D_{50} =	1.0
D_{84} =	71.7
D_{95} =	115.7
D_{100} =	362.0





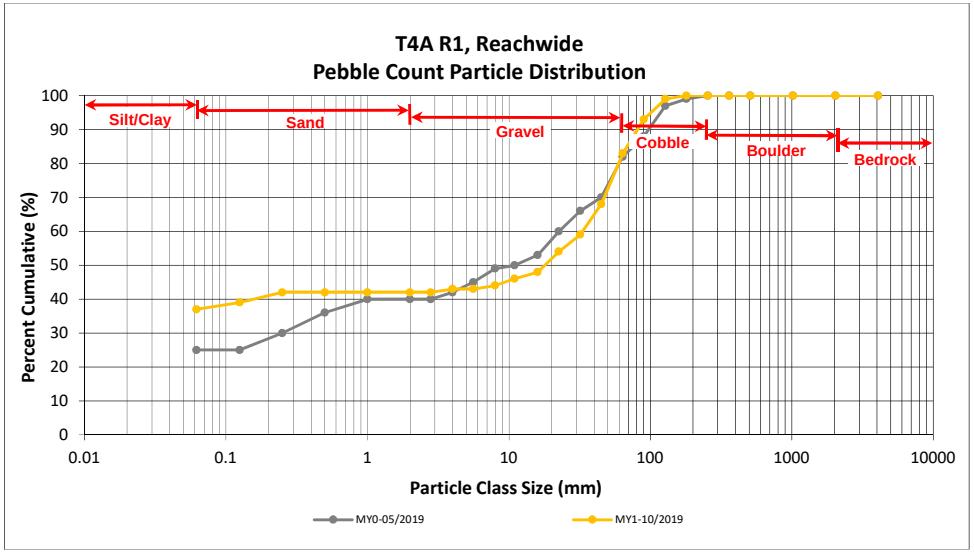
Reachwide Pebble Count Plots

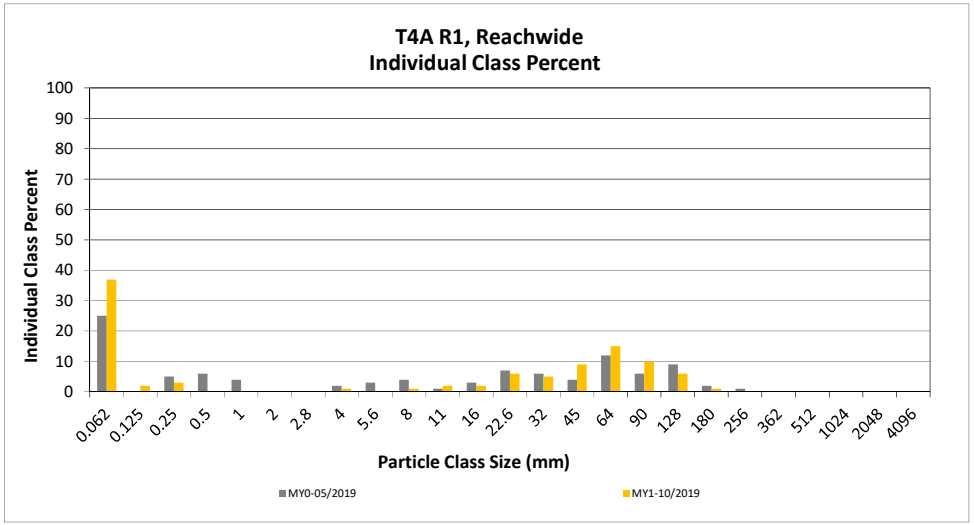
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

T4A R1, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	3	34	37	37	37
SAND	Very fine	0.062	0.125		2	2	2	39
	Fine	0.125	0.250		3	3	3	42
	Medium	0.25	0.50					42
	Coarse	0.5	1.0					42
	Very Coarse	1.0	2.0					42
GRAVEL	Very Fine	2.0	2.8					42
	Very Fine	2.8	4.0		1	1	1	43
	Fine	4.0	5.6					43
	Fine	5.6	8.0	1		1	1	44
	Medium	8.0	11.0	1	1	2	2	46
	Medium	11.0	16.0	1	1	2	2	48
	Coarse	16.0	22.6	5	1	6	6	54
	Coarse	22.6	32	5		5	5	59
	Very Coarse	32	45	8	1	9	9	68
	Very Coarse	45	64	12	3	15	15	83
COBBLE	Small	64	90	8	2	10	10	93
	Small	90	128	5	1	6	6	99
	Large	128	180	1		1	1	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} =	Silt/Clay
D_{35} =	Silt/Clay
D_{50} =	18.0
D_{84} =	66.2
D_{95} =	101.2
D_{100} =	180.0





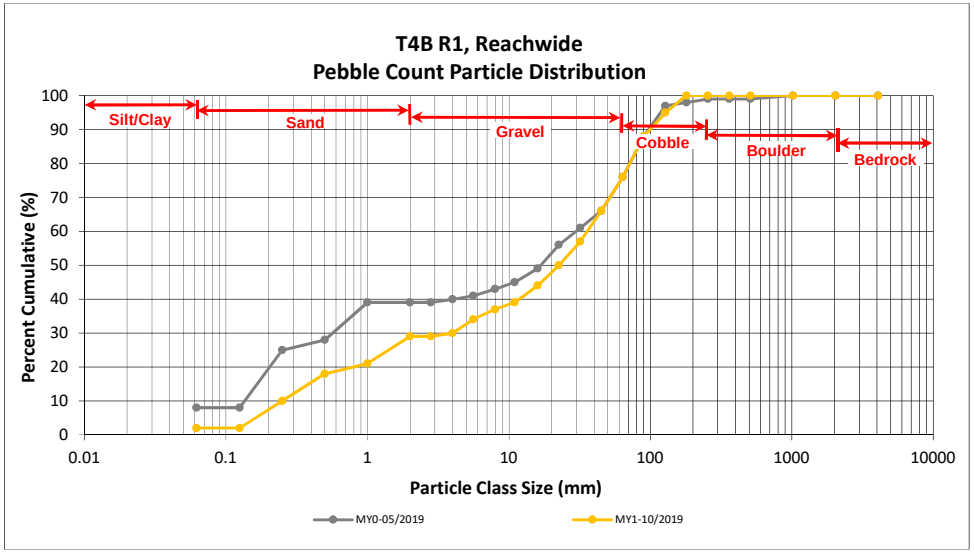
Reachwide Pebble Count Plots

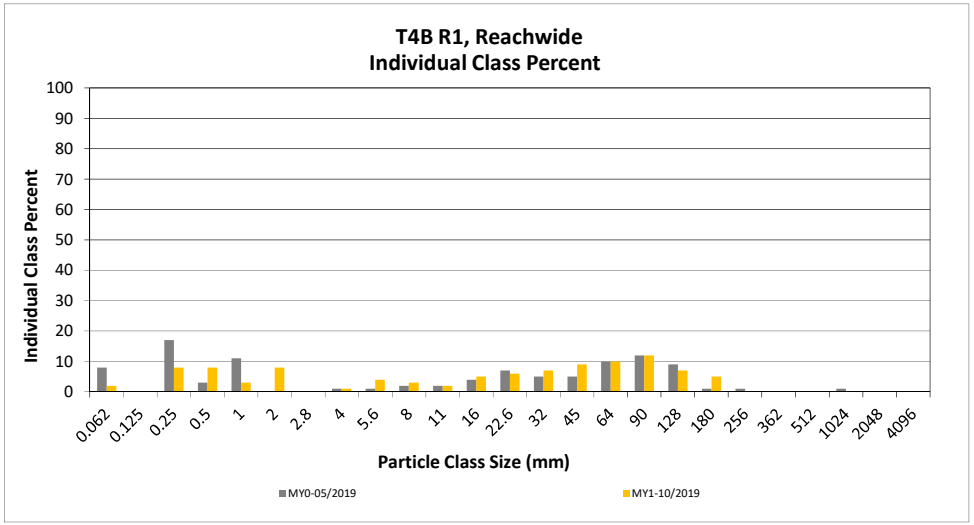
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

T4B R1, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	1	1	2	2	2
SAND	Very fine	0.062	0.125					2
	Fine	0.125	0.250	1	7	8	8	10
	Medium	0.25	0.50	1	7	8	8	18
	Coarse	0.5	1.0	2	1	3	3	21
	Very Coarse	1.0	2.0	2	6	8	8	29
GRAVEL	Very Fine	2.0	2.8					29
	Very Fine	2.8	4.0		1	1	1	30
	Fine	4.0	5.6		4	4	4	34
	Fine	5.6	8.0		3	3	3	37
	Medium	8.0	11.0	1	1	2	2	39
	Medium	11.0	16.0	2	3	5	5	44
	Coarse	16.0	22.6	4	2	6	6	50
	Coarse	22.6	32	6	1	7	7	57
	Very Coarse	32	45	4	5	9	9	66
	Very Coarse	45	64	8	2	10	10	76
COBBLE	Small	64	90	8	4	12	12	88
	Small	90	128	6	1	7	7	95
	Large	128	180	4	1	5	5	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} =	0.42
D_{35} =	6.31
D_{50} =	22.6
D_{84} =	80.3
D_{95} =	128.0
D_{100} =	180.0





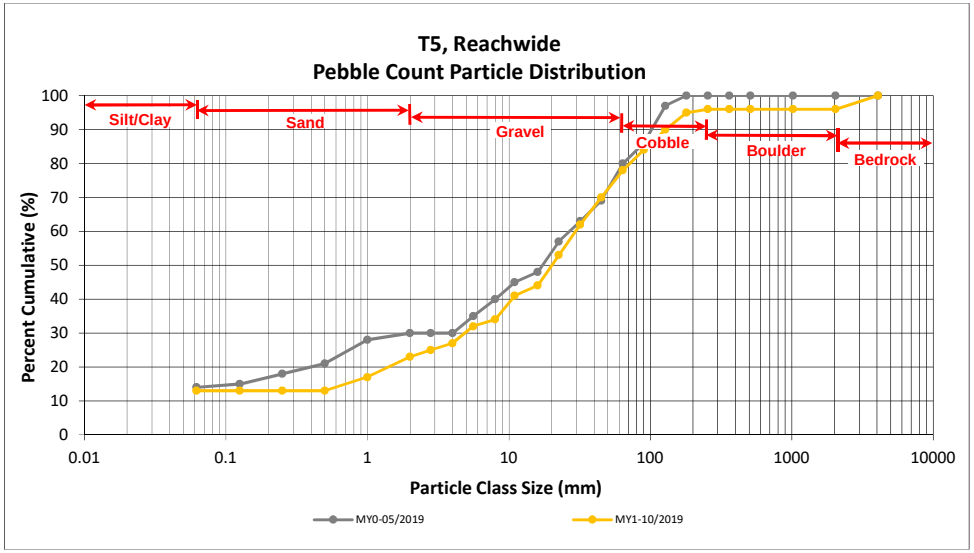
Reachwide Pebble Count Plots

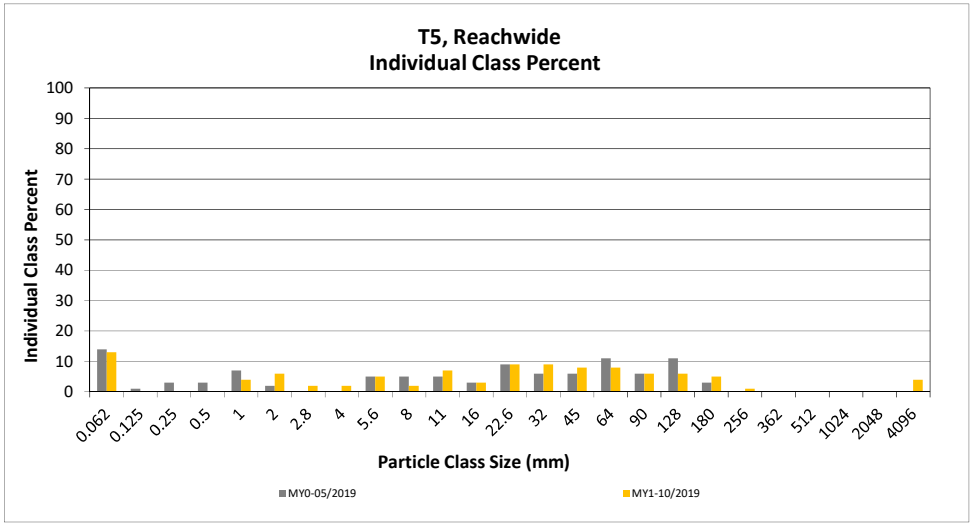
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

T5, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		13	13	13	13
SAND	Very fine	0.062	0.125					13
	Fine	0.125	0.250					13
	Medium	0.25	0.50					13
	Coarse	0.5	1.0	2	2	4	4	17
	Very Coarse	1.0	2.0	4	2	6	6	23
GRAVEL	Very Fine	2.0	2.8		2	2	2	25
	Very Fine	2.8	4.0	1	1	2	2	27
	Fine	4.0	5.6	3	2	5	5	32
	Fine	5.6	8.0	1	1	2	2	34
	Medium	8.0	11.0	2	5	7	7	41
	Medium	11.0	16.0	2	1	3	3	44
	Coarse	16.0	22.6	4	5	9	9	53
	Coarse	22.6	32	5	4	9	9	62
	Very Coarse	32	45	7	1	8	8	70
	Very Coarse	45	64	5	3	8	8	78
COBBLE	Small	64	90	4	2	6	6	84
	Small	90	128	4	2	6	6	90
	Large	128	180	5		5	5	95
	Large	180	256	1		1	1	96
BOULDER	Small	256	362					96
	Small	362	512					96
	Medium	512	1024					96
	Large/Very Large	1024	2048					96
BEDROCK	Bedrock	2048	>2048		4	4	4	100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.84
D_{35} =	8.37
D_{50} =	20.1
D_{84} =	90.0
D_{95} =	180.0
D_{100} =	>2048





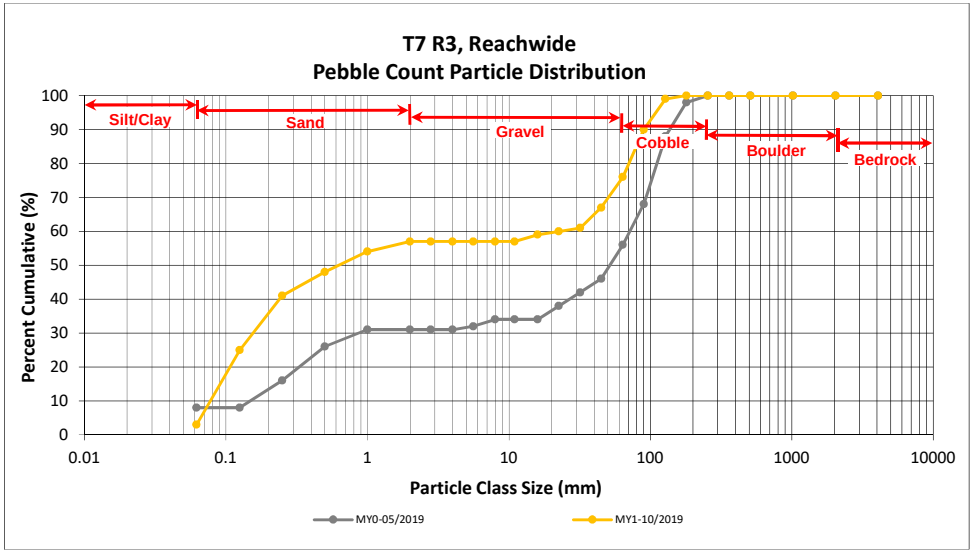
Reachwide Pebble Count Plots

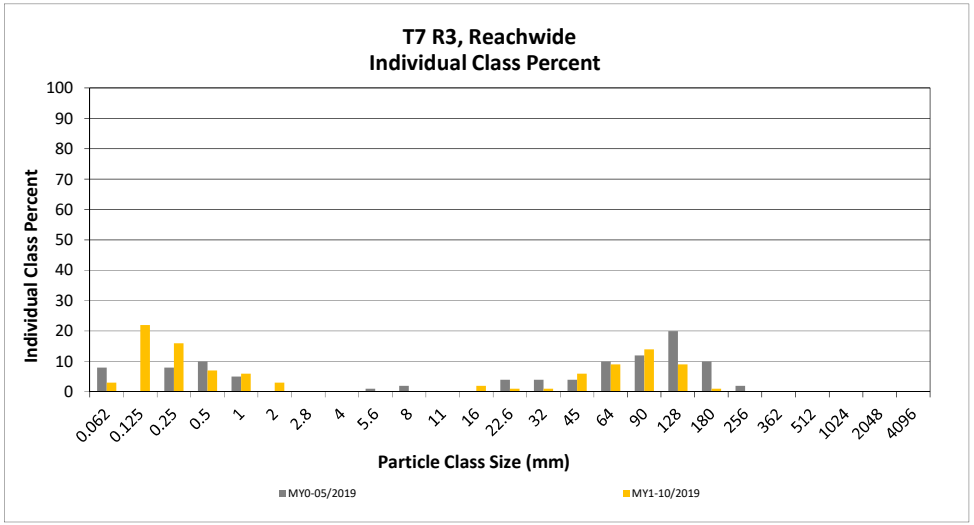
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

T7 R3, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		3	3	3	3
SAND	Very fine	0.062	0.125		22	22	22	25
	Fine	0.125	0.250		16	16	16	41
	Medium	0.25	0.50	7		7	7	48
	Coarse	0.5	1.0	3	3	6	6	54
	Very Coarse	1.0	2.0		3	3	3	57
GRAVEL	Very Fine	2.0	2.8					57
	Very Fine	2.8	4.0					57
	Fine	4.0	5.6					57
	Fine	5.6	8.0					57
	Medium	8.0	11.0					57
	Medium	11.0	16.0	2		2	2	59
	Coarse	16.0	22.6	1		1	1	60
	Coarse	22.6	32	1		1	1	61
	Very Coarse	32	45	6		6	6	67
	Very Coarse	45	64	7	2	9	9	76
COBBLE	Small	64	90	13	1	14	14	90
	Small	90	128	9		9	9	99
	Large	128	180	1		1	1	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} =	0.09
D_{35} =	0.19
D_{50} =	0.6
D_{84} =	77.8
D_{95} =	109.5
D_{100} =	180.0





APPENDIX 5. Hydrology Summary Data

Table 13. Verification of Bankfull Events

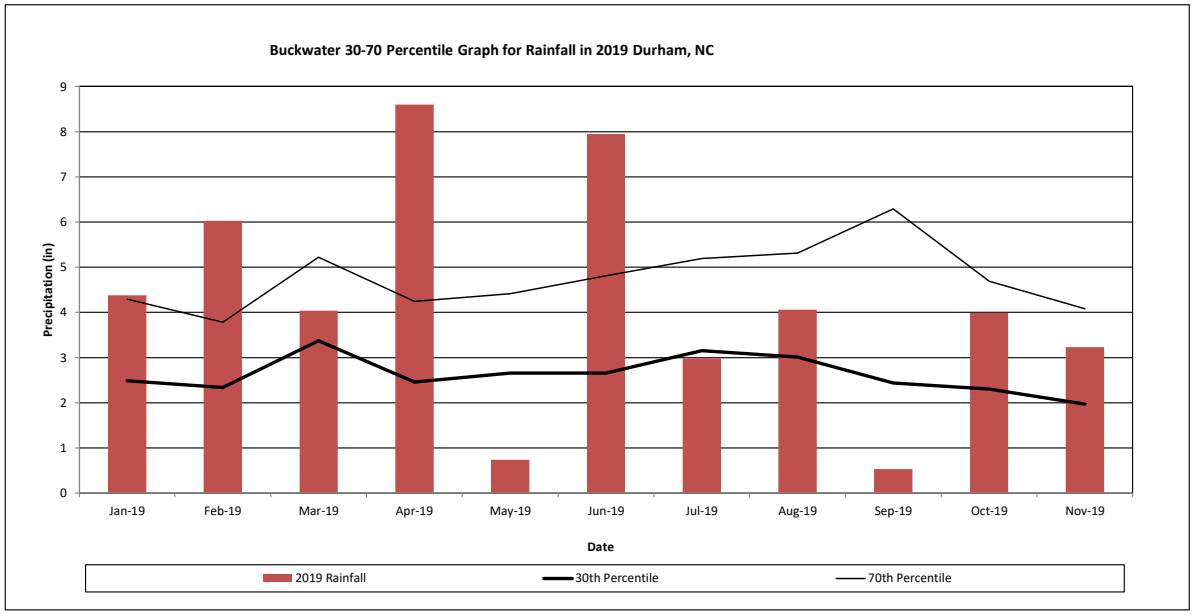
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

	MY1		
Reach	**Date of Data Collection**	**Date of Occurrence**	**Method**
Buckwater Creek Reach 6	8/6/2019	6/18/2019	Crest Gage/ Pressure Transducer
T1 Reach 2	5/29/2019	4/13/2019	
T2	8/6/2019	6/18/2019*	
T4	5/29/2019	4/14/2019*	
	8/6/2019	6/18/2019	
T5: *US of St. Mary's Rd*	N/A	N/A	
T5: *DS of St. Mary's Rd*	5/29/2019	4/13/2019	
	8/6/2019	6/18/2019	
T7 Reach 3	8/6/2019	6/18/2019*	

*Geomorphically significant events

Monthly Rainfall Data

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019



[1] 2019 monthly rainfall from USDA Station Durham 11 W

[2] 30th and 70th percentile rainfall data collected from weather station Chapel Hill 2 W, NC (USDA, 2019).

Table 14. Wetland Gage Summary

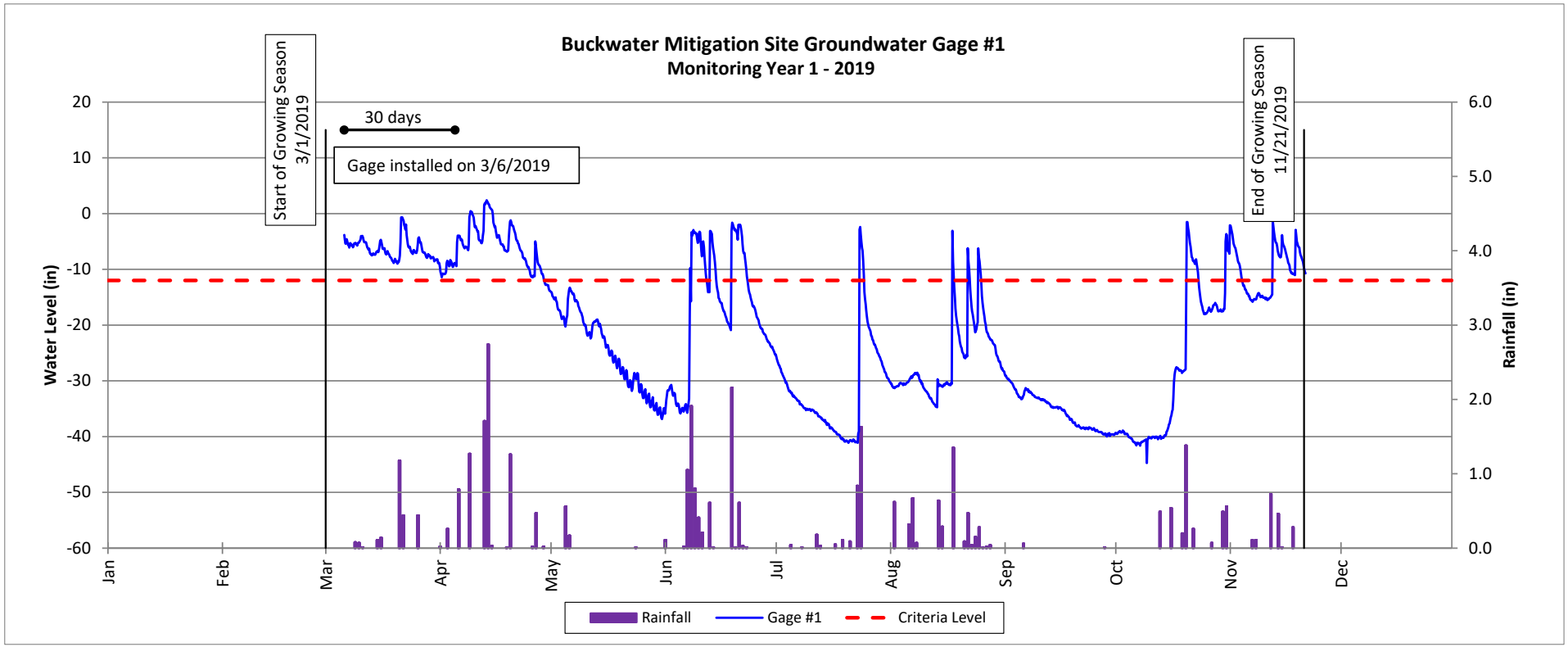
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Summary of Groundwater Gage Results for Monitoring Years 1 through 7							
Gage	Max Consecutive Days During Growing Season (Percentage)						
	MY1 (2019)	MY2 (2020)	MY3 (2021)	MY4 (2022)	MY5 (2023)	MY6 (2024)	MY7 (2025)
1	**55 Days (20.7%)**						
2	**13 Days (4.9%)**						
3	**58 Days (21.8%)**						

*Gage data is not tied to any success criteria.

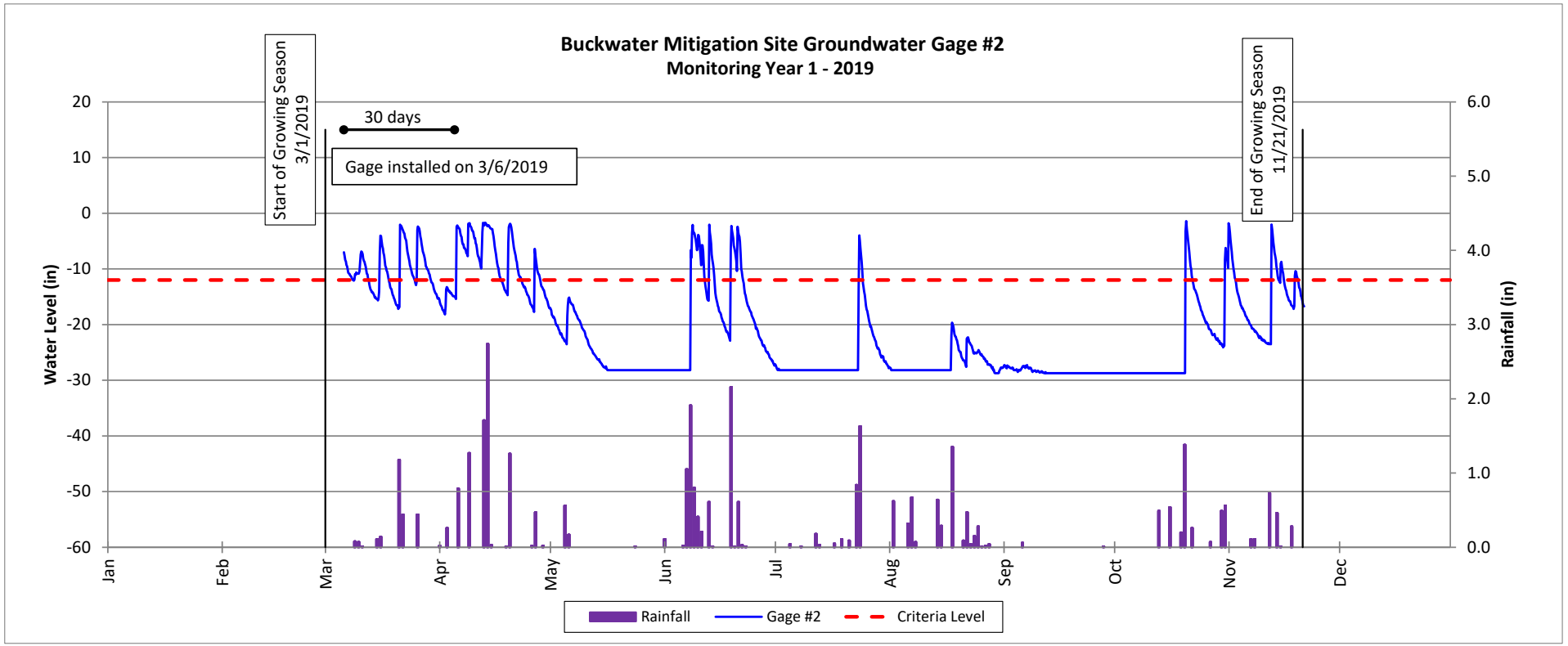
Groundwater Gage Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019



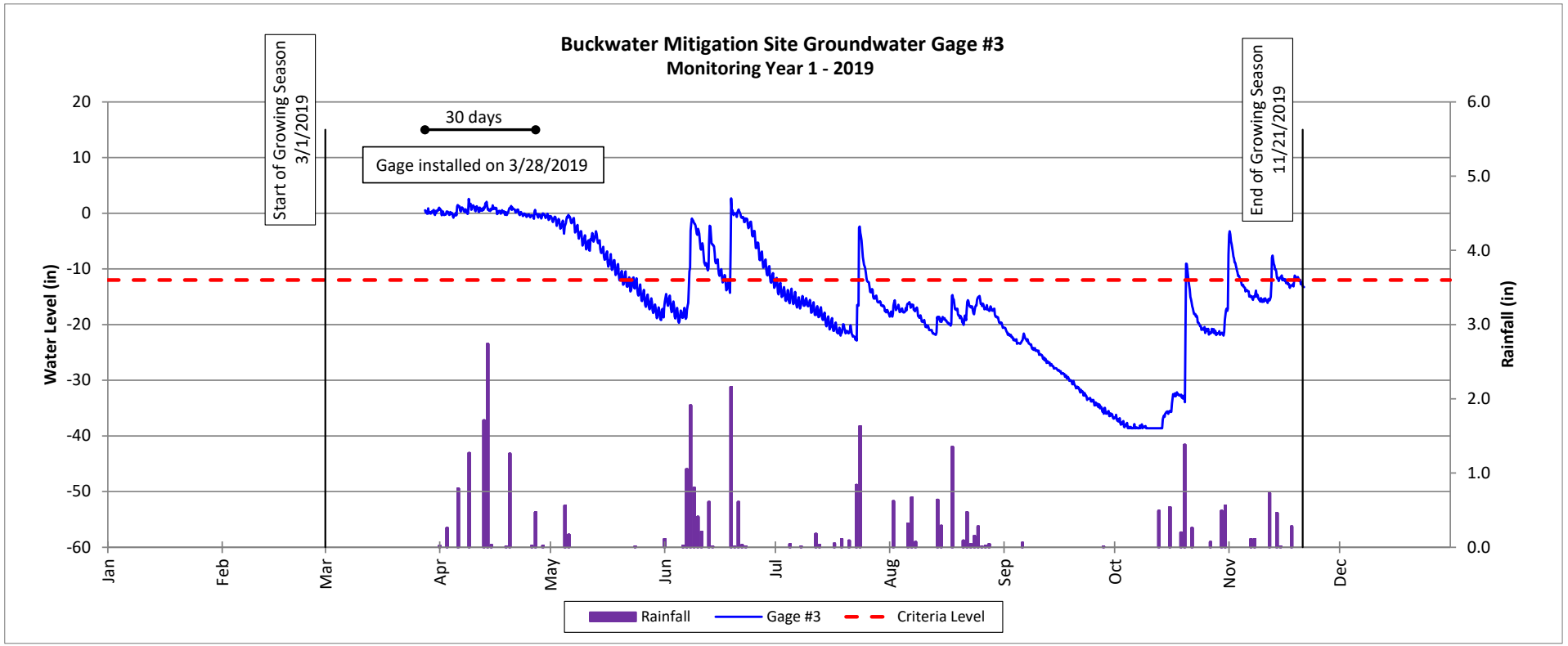
Groundwater Gage Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

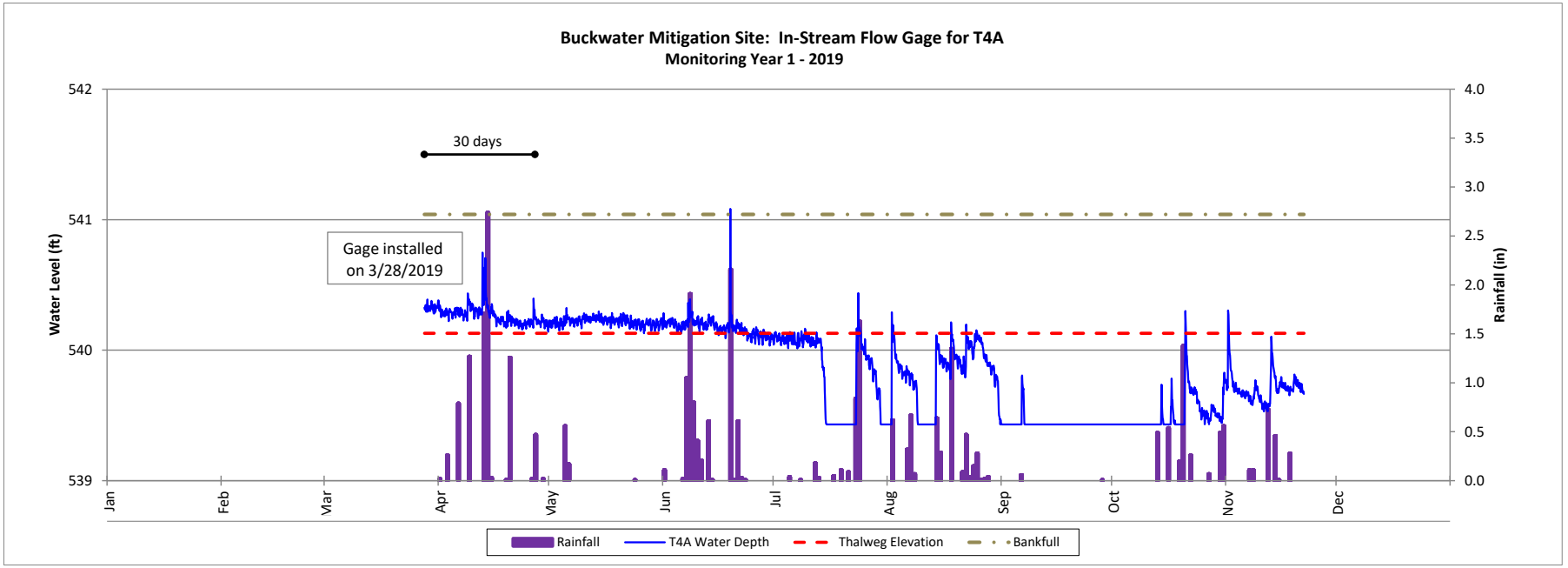


Groundwater Gage Plots

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

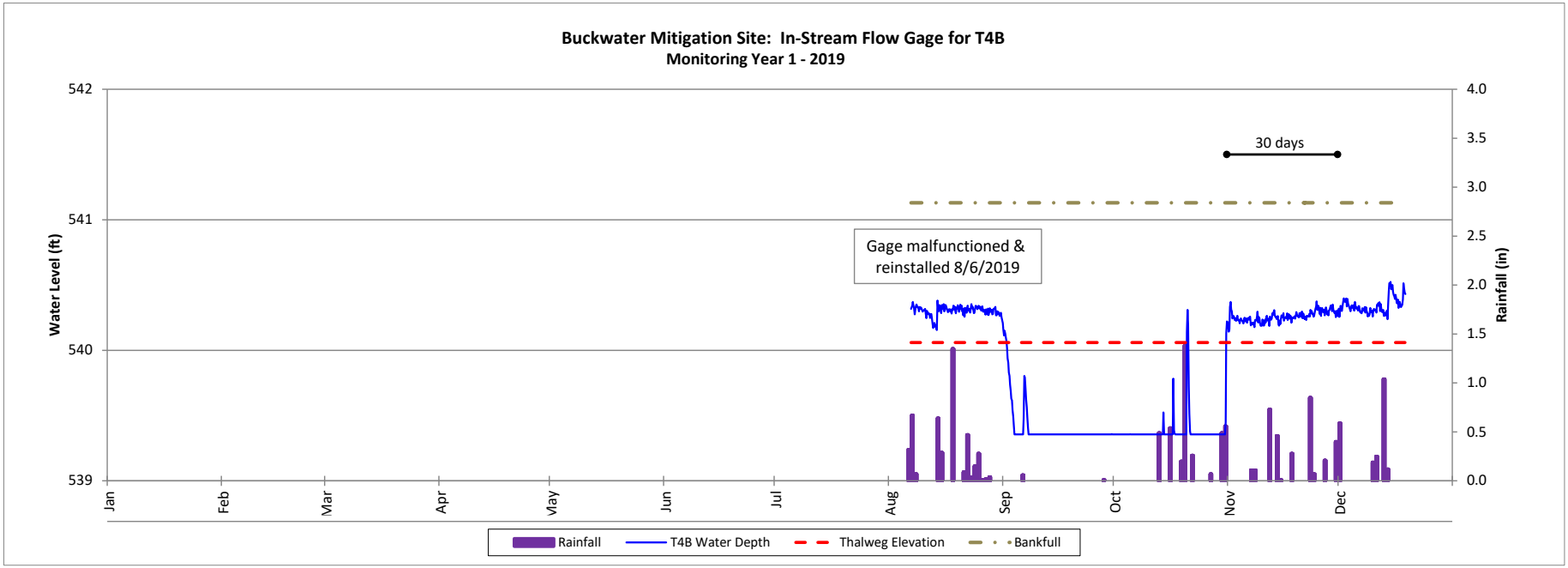


Recorded In-stream Flow Events
Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019



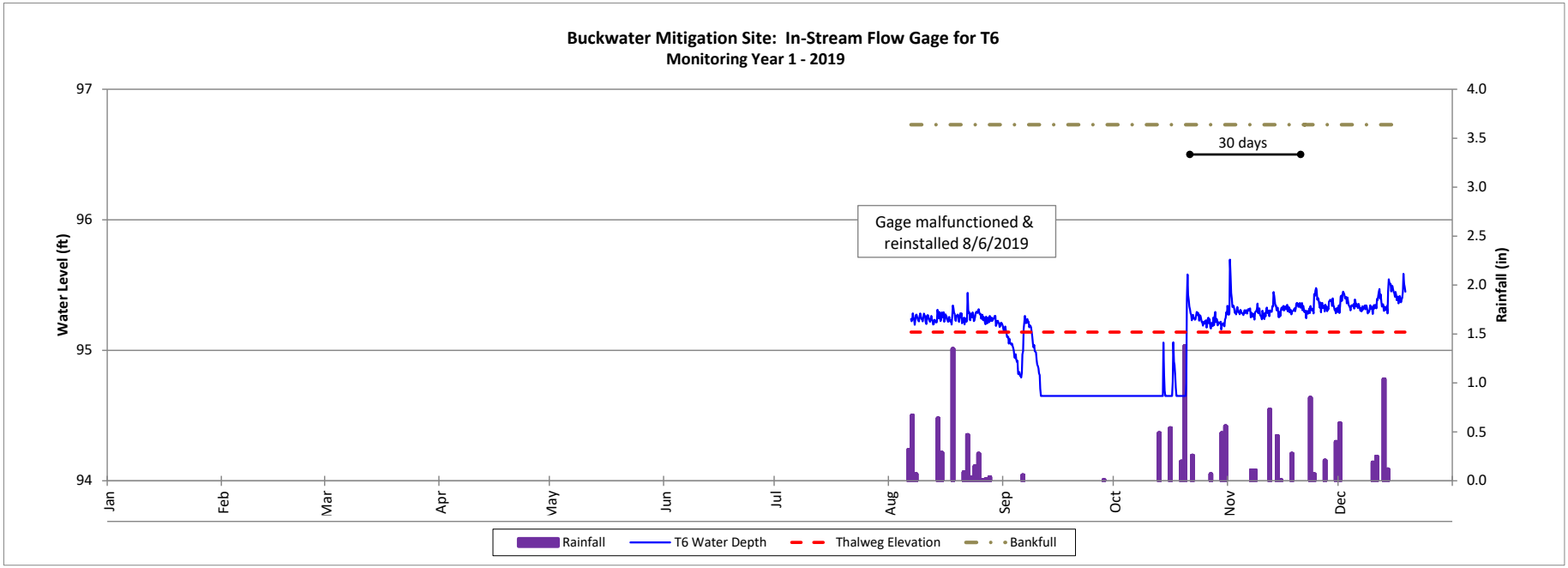
Recorded In-stream Flow Events

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019



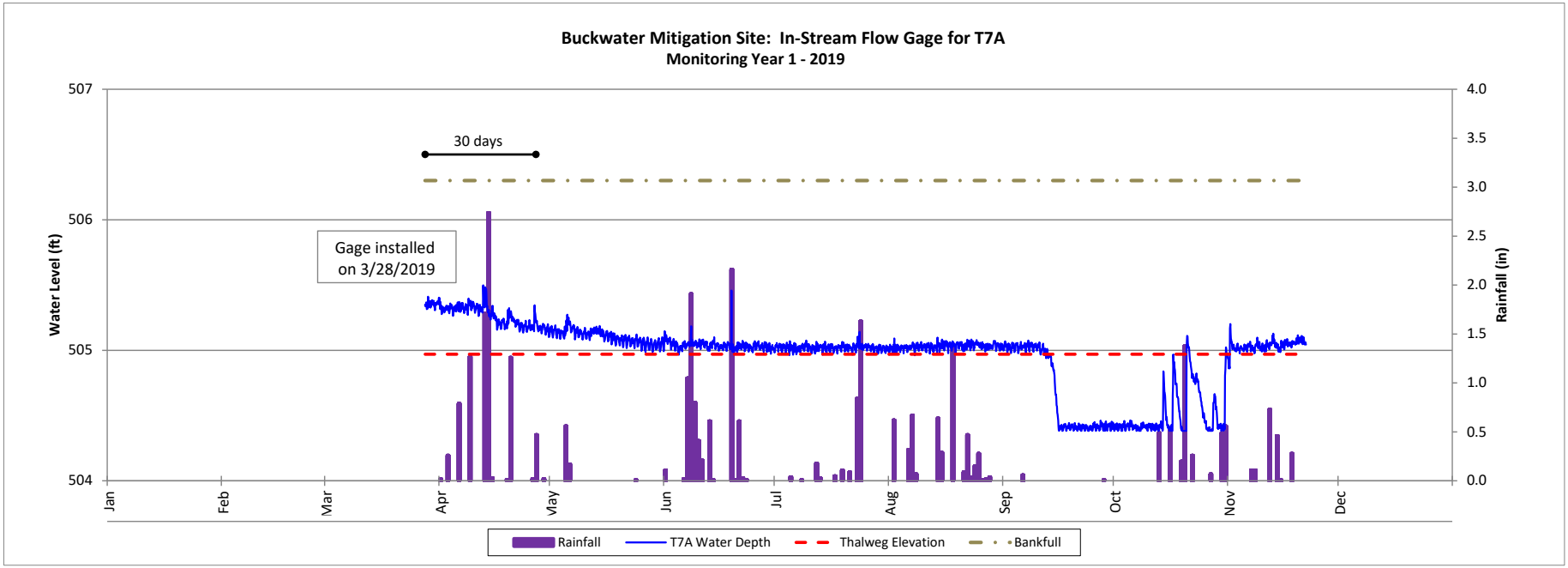
Recorded In-stream Flow Events

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019



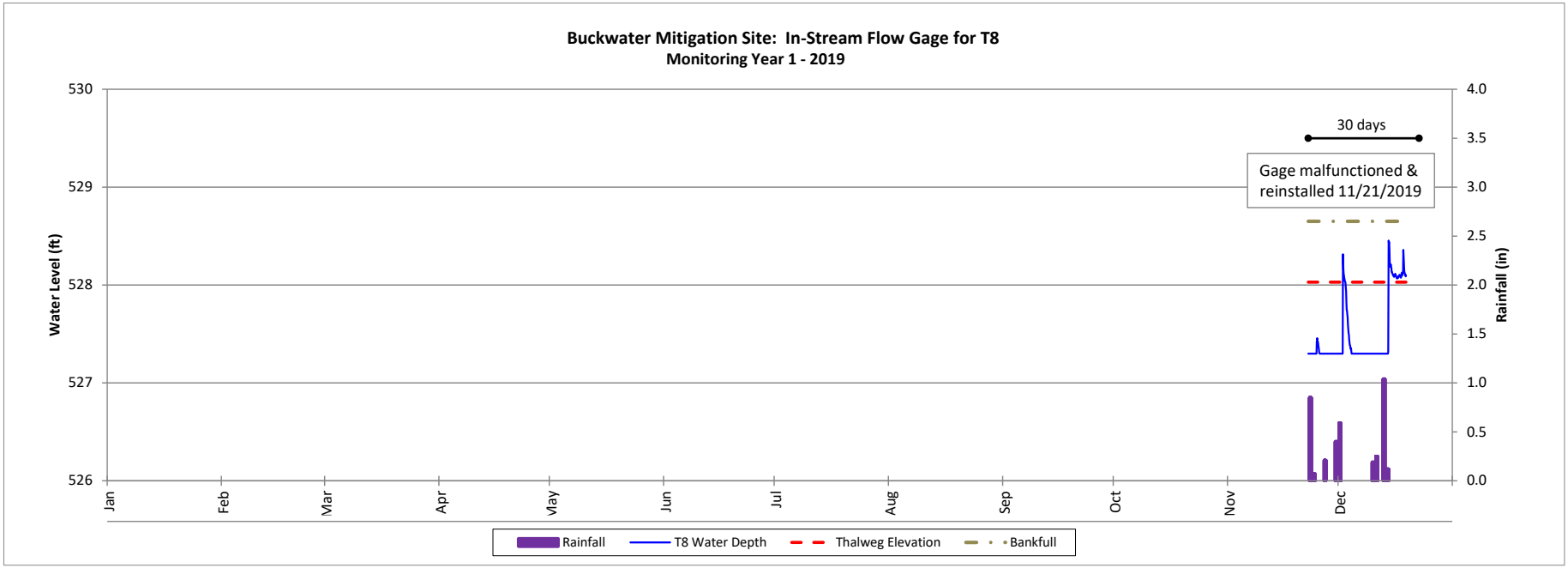
Recorded In-stream Flow Events

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019



Recorded In-stream Flow Events

Buckwater Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019



MONITORING YEAR 1 ANNUAL REPORT
FINAL

BUCKWATER BUFFER MITIGATION SITE
Orange County, NC
NCDEQ Contract No. 006829
DMS Project Number 97084
NCDWR Project Number 2016-0406 v2

Data Collection Period: October 2019
Draft Submission Date: December 31, 2019
Final Submission Date: February 6, 2020

PREPARED FOR:

NC Department of Environmental Quality
Division of Mitigation Services
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Phone: (919) 851-9986

BUCKWATER BUFFER MITIGATION SITE

Monitoring Year 1 Report

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APPENDICES

Section 1: PROJECT OVERVIEW

1.1 Project Summary

Wildlands Engineering, Inc. (Wildlands) implemented a full delivery project at the Buckwater Mitigation Site (Site) for the North Carolina Department of Environmental Quality Division of Mitigation Services (DMS) to restore a total of 16,276 linear feet (LF) of perennial and intermittent streams in Orange County, NC. The site included the restoration of Buckwater Creek and 14 unnamed tributaries. The project also restored, enhanced, and preserved a total of 36.03 acres (1,569,466.8 ft^2) of riparian buffer at the Site, which will provide Riparian Buffer Credits and Nutrient Offset Credits. The Site is located approximately 4.5 miles northeast of Hillsborough, NC (Figure 1) in the Neuse River Basin 8-Digit Hydrologic Unit Code (HUC) 03020201. The project is located within a DMS targeted watershed for the Neuse River Basin Hydrologic Unit Code (HUC) 03020201030030 and NC Division of Water Resources (DWR) Subbasin 03-04-01. The Site streams drain to the Eno River, which flows to Falls Lake, and are classified as water supply waters (WS-IV) and nutrient sensitive waters (NSW).

Work at the Site was planned, designed, and constructed per Buckwater Mitigation Plan (2017) and the Consolidated Buffer Mitigation Rule 15A NCAC 02B .0295 (effective November 1, 2015). The purpose of the riparian buffer restoration is to provide riparian buffer credits to compensate for buffer impacts within the Hydrologic Unit Code 03020201 and the Falls Lake Watershed. The service area for the Riparian Buffer Credits is depicted in Figure 2. The mitigation credits generated from this site are listed in Tables 1a and 1b and shown in Figure 3.

1.2 Project Goals and Objectives

Prior to construction activities, the primary causes of Site degradation were channel straightening and livestock grazing/agriculture, both of which originated prior to 1938. Agricultural activity remained high through the 1990s with several thousand beef cattle and three hog houses. Currently, approximately 130 cows graze on three properties and land that is not forested is used for cultivating hay. Several ponds along Buckwater Creek, T3, and T5 were built between 1938 and 1955. According to 1955 aerial photography, the top 1,000 feet of Buckwater Creek on the Site were straightened. Landowners tried to maintain lower Buckwater Creek below Walnut Hill Drive as a straightened channel with little success and gave up completely by the 1990s.

The major goals of the buffer restoration project are to provide ecological and water quality enhancements to the Neuse River Basin within the Falls Lake Water Supply Watershed by creating a functional riparian corridor and restoring the riparian buffer. This project supports specific goals identified in the 2010 Neuse River Basin Restoration Priorities Plan (RBRP) for the Neuse River Targeted Local Watershed (TLW). This document highlights the importance of riparian buffers for stream restoration projects. Riparian buffers immobilize and retain nutrients and suspended sediment. The RBRP also supports the Falls Lake watershed plan. Specific enhancements to water quality and ecological processes are outlined below:

- Decrease nutrient levels - nutrient inputs will be decreased by filtering runoff from the agricultural fields through restored, native buffer zones. Nutrient inputs will also be absorbed on-site by native vegetation, further reducing nutrient inputs to waters of the Neuse River Basin.
- Decrease sediment input - sediment loading will be deposited on restored floodplain areas, thereby reducing sediment inputs to Falls Lake.
- Create higher quality terrestrial habitat - buffer areas will be restored by removing invasive vegetation and planting native vegetation. A variety of native vegetation will improve wildlife habitat.

- Permanently protect the Site from harmful uses - establish a conservation easement on the Site, which will protect aquatic habitat and reduce pollutant loading to a water supply.

The 51.84-acre Site is protected with a permanent conservation easement. Of the 51.84 acres, Neuse riparian buffer credits were generated by restoring 21.8 acres; preserving 8.66 acres; and enhancing 5.57 acres. 15.81 acres will not generate buffer mitigation credit. In general, riparian buffer restoration area widths on streams extend out to 200 feet from top of bank for Neuse River buffer credits. Figure 3 details the buffer credit generation.

1.3 Monitoring Year 1 Data Assessment

The final mitigation plan was submitted and accepted by DMS in December 2017. Construction activities by Ecotone, Inc. finished in April 2019. The planting was completed by Bruton Natural Systems, Inc. in April 2019. The baseline as-built survey was completed by Turner Land Surveying in July 2019. Refer to Appendix 1 for detailed project activity, history, contact information, and watershed/site background information.

Vegetative performance for buffer restoration areas will be in accordance with 15A NCAC 02B .0295(n)(2)(B), and (n)(4) (effective November 1, 2015). To meet success criteria, areas generating buffer mitigation credits shall include a minimum of four native hardwood tree species, where no one species is greater than 50 percent of stems, and shall have a survival of at least 260 planted stems per acre at the end of the required five-year monitoring period . For the monitoring to be finished and buffer credit to be awarded, DWR must provide written approval of successful revegetation of buffer restoration areas. MY1 monitoring was conducted to assess the condition of the vegetation in October 2019.

1.3.1 Vegetative Assessment

The quantity of monitoring vegetation plots was determined in accordance with the Carolina Vegetative Sampling Protocol (CVS Levels I & II) such that at least 2 percent of the Site is encompassed in monitoring plots. A total of 19 vegetation plots (10 meters by 10 meters) were established within the conservation easement boundaries and within five feet from the top of stream banks. The plot corners have been marked and are recoverable either through field identification or with the use of a GPS unit. Reference photographs are taken at the origin looking diagonally across the plot to the opposite corner on an annual basis. Trees will be annually marked with flagging tape. Species composition, vigor, height, density, and survival rates will be evaluated by plot on an annual basis. The extent of invasive species coverage will also be monitored and controlled as necessary.

The 2019 annual vegetation monitoring resulted in an average survivability of 547 planted stems per acre, which is greater than the final requirement of 260 stems per acre, but approximately 9% less than the baseline density recorded (601 planted stems per acre) in January 2019. The average number of stems per plot remained the same from MY0 to MY1 at 14 stems per plot. The site is on track to meet its final success criteria. Refer to Appendix 3 for vegetation plot criteria attainment data, CVS vegetation plot metadata, and vegetation summary tables and Appendix 2 for vegetation plot photographs, vegetation condition assessment table, and monitoring plan view.

1.3.2 Vegetation Areas of Concern

Before construction, the Site had several areas with abundant Chinese privet (*Ligustrum sinense*). A significant amount of Chinese privet was removed during construction but in areas where mechanical removal by the construction crew was not possible, hand treatment was necessary. Extensive invasive vegetation treatment took place in October 2019. Though the invasive vegetation has been treated, Wildlands recognizes re-sprouting is common and will monitor closely for reappearance.

During MY1 along T5 and T6, Wildlands observed poor herbaceous vegetation growth. Biochar, humic acid, rye grain, and native riparian seed have been applied and herbaceous growth will be monitored closely during MY2.

1.4 Monitoring Year 1 Summary

Overall, the Site has met the required vegetation success criteria for MY1, and no remedial actions are proposed. Summary information/data related to the performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information, formerly found in these reports, can be found in the Mitigation Plan (Wildlands, 2017) available on DMS's website. All raw data supporting the tables and figures in the appendices are available from DMS upon request.

Section 2: METHODOLOGY

Planted woody vegetation was monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2006). A total of 19 standard 10-meter by 10-meter vegetation plots were established within the Site conservation easement area.

Section 3: REFERENCES

Breeding, R. 2010. Neuse River Basin Restoration Priorities. North Carolina Ecosystem Enhancement Program.

Lee, Michael T. Peet, Robert K., Steven D. Wentworth, Thomas R. 2008. CVS-EEP Protocol for Recording Vegetation Version 4.2. http://cvs.bio.unc.edu/protocol/cvs-eep-protocol-v4.2-lev1-2.pdf

Natural Resources Conservation Service (NRCS). Web Soil Survey of Orange County. http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

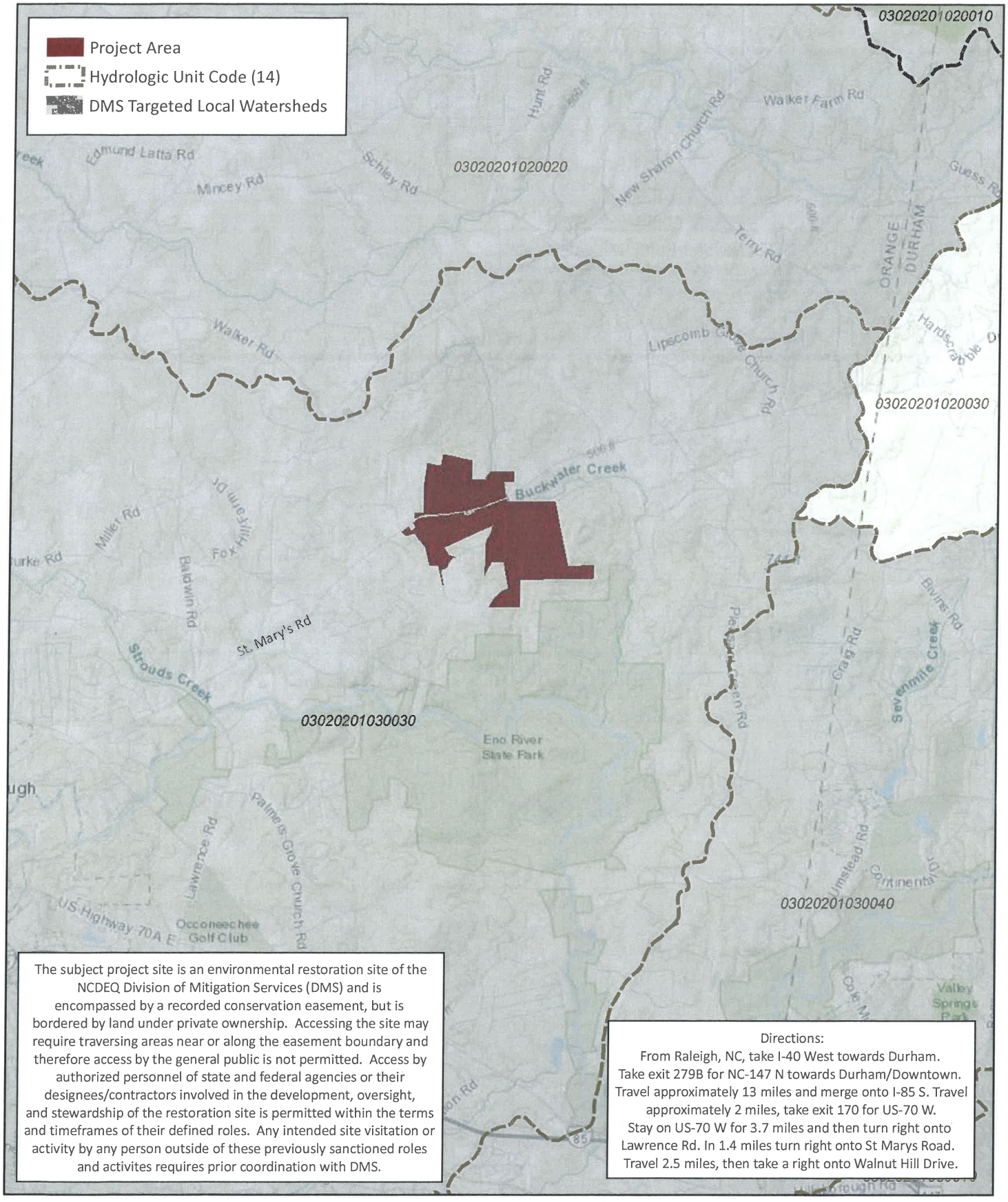
http://portal.ncdenr.org/c/document_library/get_file?uuid=864e82e8-725c-415e-8ed9-c72dfcb55012&groupId=60329

North Carolina Division of Environmental Quality, Division of Water Resources (NCDWR) 2011. Surface Water Classifications. http://deq.nc.gov/about/divisions/water-resources/planning/classification-standards/classifications

North Carolina Department of Environmental Quality, Division of Mitigation Services (NCDMS), 2017. Riparian Buffer and Nutrient Offset Buffer Baseline and Annual Monitoring Report Template version 2.0

Wildlands Engineering, Inc. (2017). Buckwater Mitigation Project Mitigation Plan. DMS, Raleigh, NC.

APPENDIX 1. General Figures and Tables



The subject project site is an environmental restoration site of the NCDEQ Division of Mitigation Services (DMS) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight, and stewardship of the restoration site is permitted within the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activites requires prior coordination with DMS.

Directions:
From Raleigh, NC, take I-40 West towards Durham. Take exit 279B for NC-147 N towards Durham/Downtown. Travel approximately 13 miles and merge onto I-85 S. Travel approximately 2 miles, take exit 170 for US-70 W. Stay on US-70 W for 3.7 miles and then turn right onto Lawrence Rd. In 1.4 miles turn right onto St Marys Road. Travel 2.5 miles, then take a right onto Walnut Hill Drive.

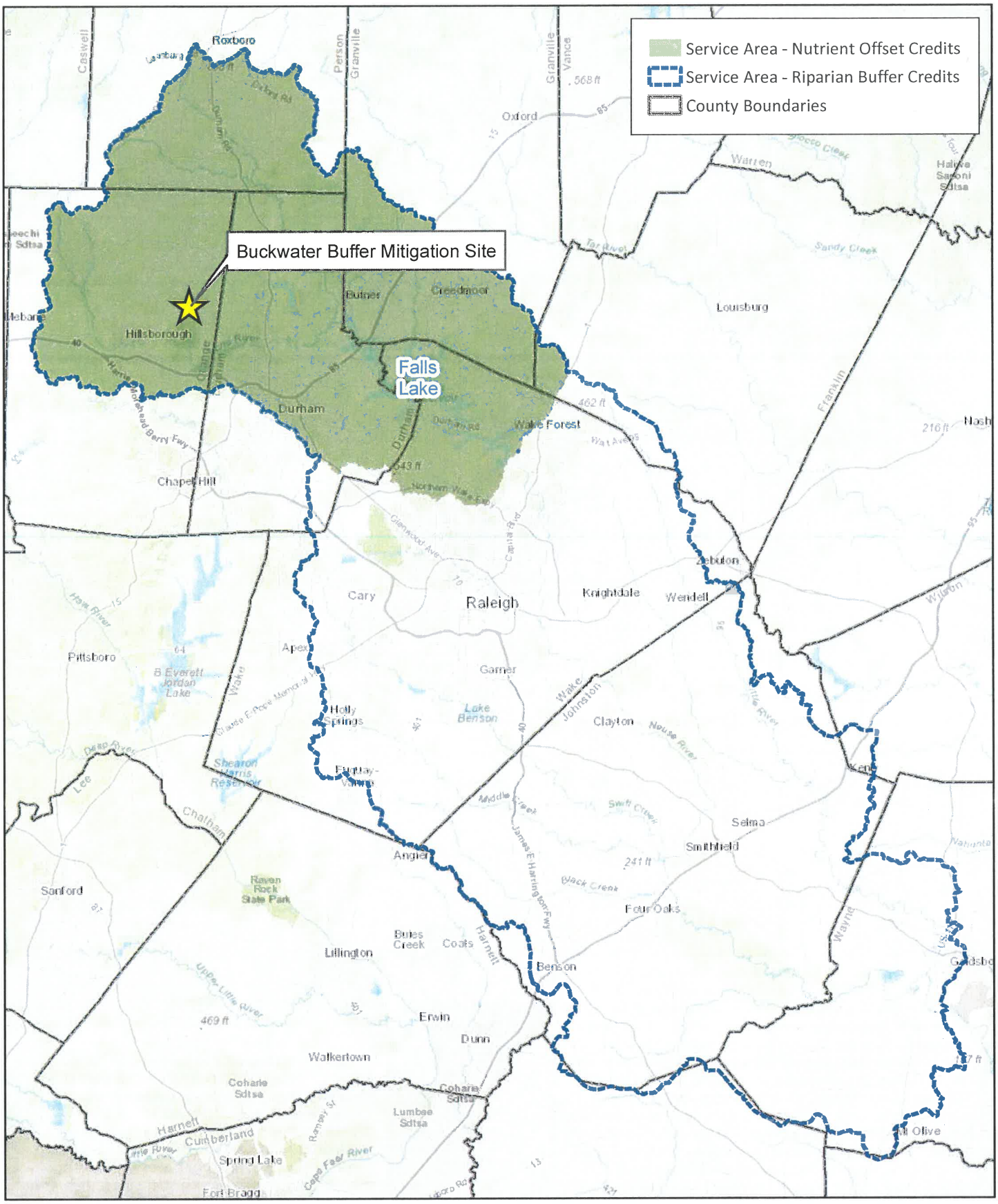
WILDLANDS ENGINEERING

0 0.5 1 Miles

N

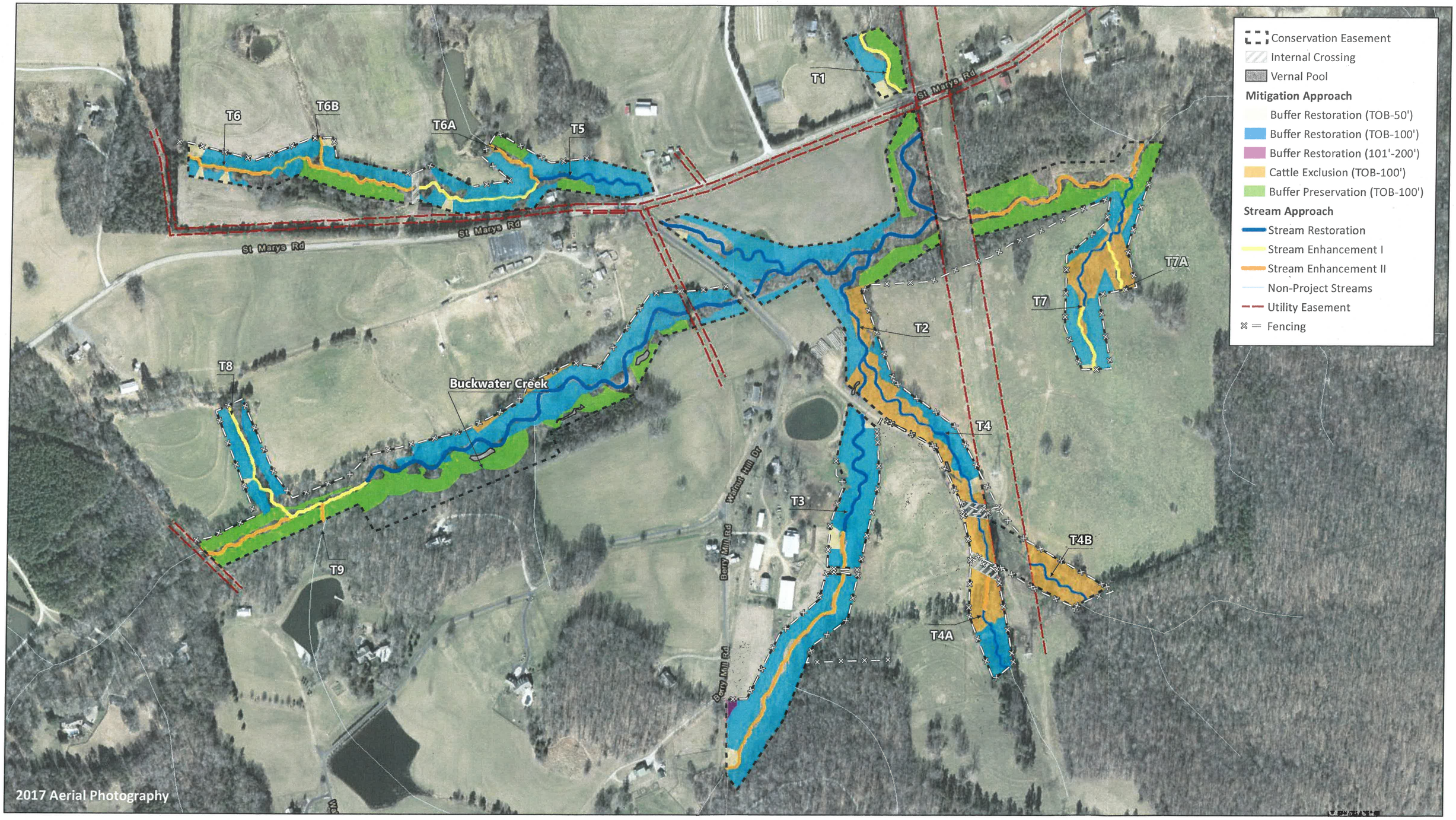
Figure 1. Project Vicinity Map
Buckwater Buffer Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Orange County, NC



WILDLANDS ENGINEERING

Figure 2. Service Area
Buckwater Buffer Mitigation Site
Monitoring Year 1 - 2019
Neuse River Basin (03020201)
Orange County, NC



WILDLANDS ENGINEERING

0 400 800 Feet

N

Figure 3. Project Component / Asset Map
Buckwater Buffer Mitigation Site
Monitoring Year 1 - 2019
Neuse River Basin (03020201)

Orange County, NC

Table 1a. Buffer Project Areas and Assets

Buckwater Buffer Mitigation Site

DMS Project No. 97084

Monitoring Year 1 - 2019

Location	Jurisdictional Streams	Method	Feature Name	Min-Max Buffer Width (ft)	Total Area (sf)*	Creditable Area (sf)	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits
Rural	Subject	Restoration	Buffer Area E	20-29	27,683	27,683	1	75%	1.33333	20,762.302
Rural	Subject	Restoration	Buffer Area A	0-100	919,068	919,068	1	100%	1.00000	919,068.000
Rural	Subject	Restoration	Buffer Area B	101-200	2,899	2,899	1	33%	3.03030	956.671
Rural	Subject	Cattle Exclusion	Buffer Area C	0-100	242,491	242,491	2	100%	2.00000	121,245.500
					SUBTOTALS	1,192,141				1,062,032.473
					ELIGIBLE PRESERVATION AREA	397,380				
Location	Jurisdictional Streams	Method	Feature Name	Min-Max Buffer Width (ft)	Total Area (sf)*	Creditable Area (sf)	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits
Rural	Subject	Preservation	Buffer Area D	0-100	377,426	377,426	10	100%	10.00000	37,742.600
					SUBTOTALS	377,426				37,742.600
					TOTALS	1,569,567				1,099,775.073

*Differences in total area compared to the total area listed in the Mitigation Plan are due to the increased accuracy of the surveyed tree lines and the installation of vernal pools during stream construction.

Table 1b. Nutrient Offset Project Areas and Assets Available Upon Conversion

Buckwater Buffer Mitigation Site

DMS Project No. 97084

Monitoring Year 1 - 2019

Riparian Width	Credit Type	Mitigation Type	Feature Name	Credit Ratio	Mitigation Area from Survey (ac)	Mitigation Area from Survey (sq ft)	Credited Acerage	Generated Credits per Acre	Generated Credits (lb)
101' - 200'	Nitrogen	Restoration (TOB'-100)	Buffer Area A	1:1	21.10	919,068	21.10	2,273.02	**47,958.196**
		Restoration (101'-200)	Buffer Area B	1:1	0.07	2,899	0.07		**151.274**
	Phosphorous	Restoration (TOB'-100)	Buffer Area A	1:1	21.10	919,608	21.10	146.40	**3,088.879**
		Restoration (101'-200)	Buffer Area B	1:1	0.07	2,899	0.07		**9.743**
								Total Nitrogen Credits	**48,109.470**
								Total Phosphorous Credits	**3,098.622**

Table 5. Adjacent Forested Areas Existing Tree and Shrub Species
Buckwater Buffer Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Common Name	Scientific Name	Wetland Indicator Status
American Beech	*Fagus grandifolia*	FACU
Black Walnut	*Juglans nigra*	FACU
Green Ash	*Fraxinus pennsylvanica*	FACW
Mockernut Hickory	*Carya tomentosa*	UPL
Red Maple	*Acer rubrum*	FAC
Red Cedar	*Juniperus virginiana*	FACU
Sweet Gum	*Liquidambar styraciflua*	FAC
Spice Bush	*Lindera benzoin*	FAC
Yellow Buckeye	*Aesculus flava*	FACU

Table 6. Planted Tree Species
Buckwater Buffer Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Common Name	Scientific Name	Number Planted	% of Total
Willow Oak	*Quercus phellos*	1,842	10%
Sycamore	*Platanus occidentalis*	3,686	20%
River Birch	*Betula nigra*	2,764	15%
Overcup Oak	*Quercus lyrata*	1,106	6%
Swamp Chestnut Oak	*Quercus michauxii*	738	4%
Tulip Poplar	*Liriodendron tulipifera*	2,764	15%
White Oak	*Quercus alba*	922	5%
Shumard Oak	*Quercus shumardii*	920	5%
Green Ash	*Fraxinus pennsylvanica*	3,132	17%
Possumhaw Viburnum	*Viburnum dentatum*	184	1%
Allegheny Serviceberry	*Amelanchier laevis*	184	1%
Red Buckeye	*Aesculus pavia*	184	1%

APPENDIX 2. Visual Assessment Data

Figure 4a

Figure 4b

T6

T6B

T6A

T5

T1

St Marys Rd

T7A

T7

T2

T8

Buckwater Creek

T4

Walnut Hill Dr

T3

Berry Mill Rd

T4B

T4A

T9

2017 Aerial Photography

- Conservation Easement
- Internal Crossing
- Vernal Pool
- Vegetation Plots

Mitigation Approach

- Buffer Restoration (TOB-50')
- Buffer Restoration (TOB-100')
- Buffer Restoration (101'-200')
- Cattle Exclusion (TOB-100')
- Buffer Preservation (TOB-100')

Stream Approach

- Stream Restoration
- Stream Enhancement I
- Stream Enhancement II
- Non-Project Streams
- Utility Easement
- Fencing

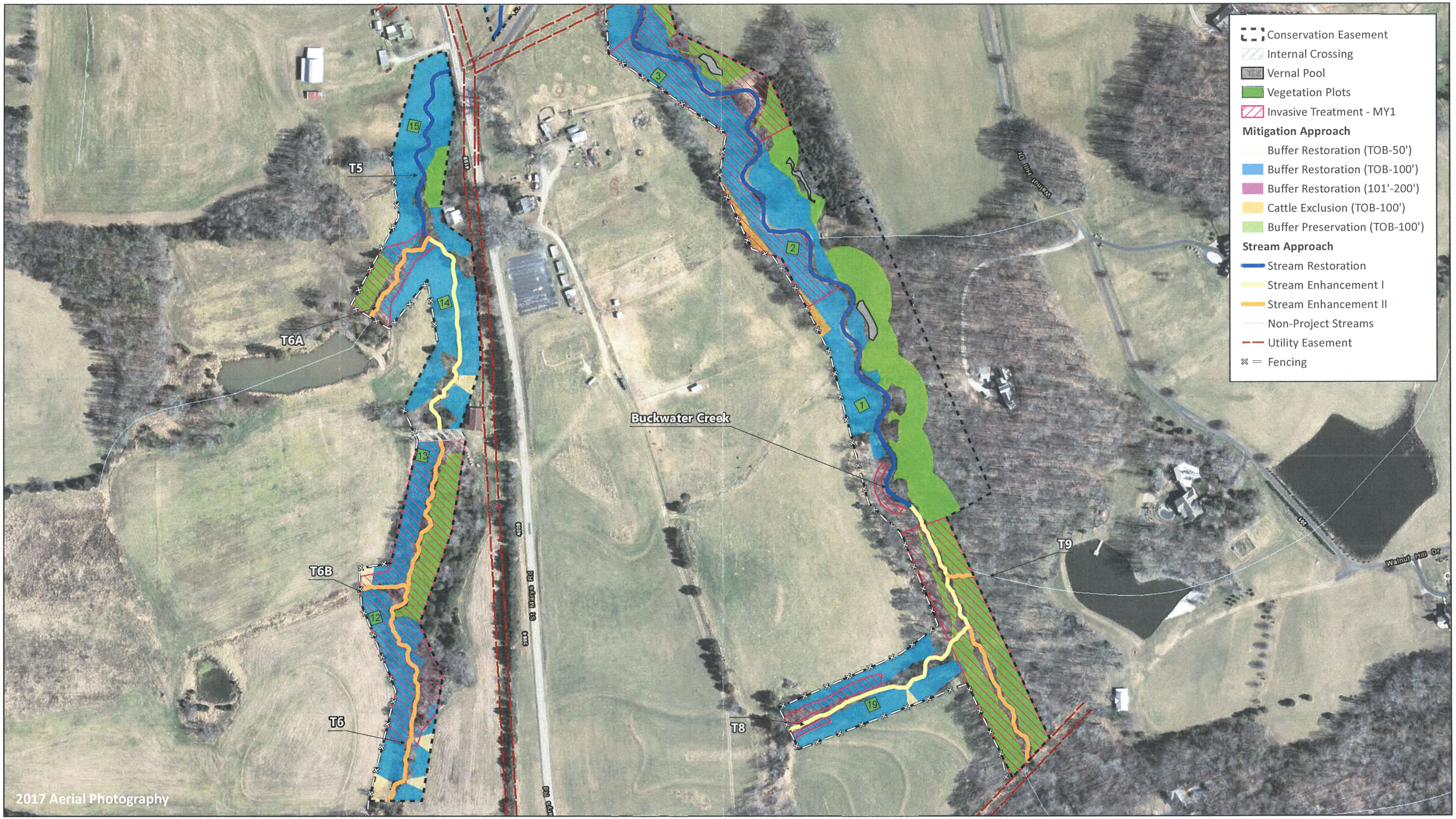
WILDLANDS ENGINEERING

0 400 800 Feet

N

Figure 4. Monitoring Plan View Key
Buckwater Buffer Mitigation Site
Monitoring Year 1 - 2019
Neuse River Basin (03020201)

Orange County, NC

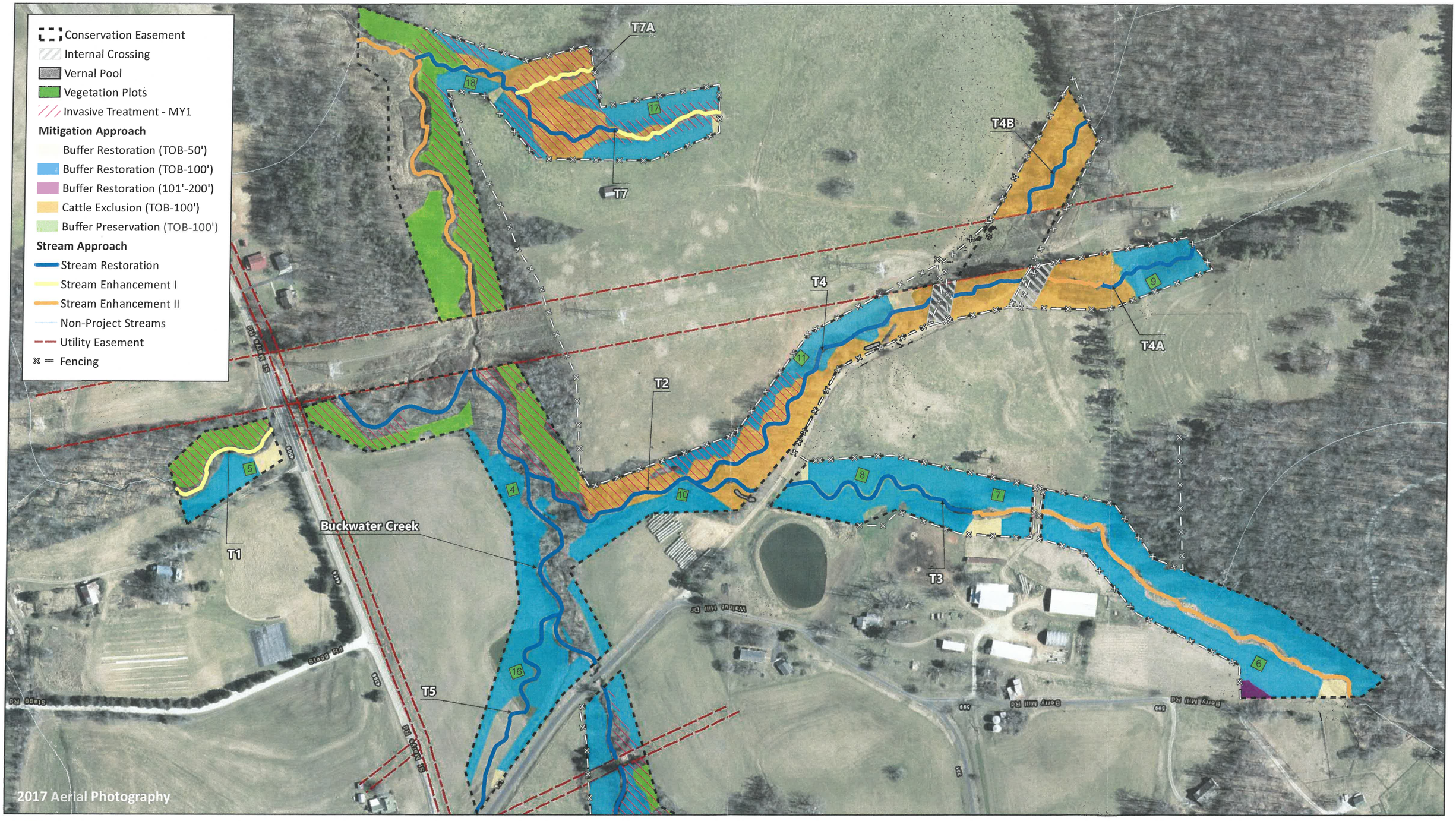


WILDLANDS ENGINEERING

0 250 500 Feet

Figure 4a. Monitoring Plan View
Buckwater Buffer Mitigation Site
Monitoring Year 1 - 2019
Neuse River Basin (03020201)

Orange County, NC



WILDLANDS ENGINEERING

0 250 500 Feet

Figure 4b. Monitoring Plan View
Buckwater Buffer Mitigation Site
Monitoring Year 1 - 2019
Neuse River Basin (03020201)

Orange County, NC

Table 7. Vegetation Condition Assessment Table
Buckwater Buffer Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Planted Acreage **21.80**

Vegetation Category	Definitions	Mapping Threshold (Ac)	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material	0.1	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%
		Total	**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 Ac	0	0	0%
		Cumulative Total	**0**	**0.0**	**0%**

Easement Acreage **51.84**

Vegetation Category	Definitions	Mapping Threshold (SF)	Number of Polygons	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern	Areas of points (if too small to render as polygons at map scale).	1,000	0	0	0%
Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale).	none	0	0	0%

VEGETATION PLOT PHOTOGRAPHS

VEG PLOT 1 *(10/09/2019)*

VEG PLOT 2 *(10/09/2019)*

VEG PLOT 3 *(10/09/2019)*

VEG PLOT 4 *(10/09/2019)*

VEG PLOT 5 *(10/09/2019)*

VEG PLOT 6 *(10/09/2019)*

VEG PLOT 7 *(10/09/2019)*

VEG PLOT 8 *(10/09/2019)*

VEG PLOT 9 *(10/09/2019)*

VEG PLOT 10 *(10/09/2019)*

VEG PLOT 11 *(10/09/2019)*

VEG PLOT 12 *(10/09/2019)*

VEG PLOT 13 *(10/09/2019)*

VEG PLOT 14 *(10/09/2019)*

VEG PLOT 15 *(10/09/2019)*

VEG PLOT 16 *(10/09/2019)*

VEG PLOT 17 *(10/09/2019)*

VEG PLOT 18 *(10/09/2019)*

VEG PLOT 19 *(10/09/2019)*

APPENDIX 3. Vegetation Plot Data

Table 8. Vegetation Plot Criteria Attainment Table
Buckwater Buffer Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Plot	Success Criteria Met (Y/N)	Tract Mean
1	Yes	100%
2	Yes	
3	Yes	
4	Yes	
5	Yes	
6	Yes	
7	Yes	
8	Yes	
9	Yes	
10	Yes	
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	Yes	
19	Yes	

Table 9. CVS Vegetation Tables - Metadata
Buckwater Buffer Mitigation Project
DMS Project No.97084
Monitoring Year 1 - 2019

Report Prepared By	Jason Lorch
Date Prepared	10/11/2019 12:44
Database Name	Buckwater- cvs-v2.5.0- MY1.mdb
Database Location	F:\Projects\005-02157 Buckwater\Monitoring\Monitoring Year 1\Vegetation Assessment
Computer Name	CARLYNN-PC
File Size	77271040
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Project Planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Project 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	97084
Project Name	Buckwater Mitigation Site
Description	Buffer Restoration Project
Sampled Plots	19

Table 10. Planted and Total Stem Counts
Buckwater Buffer Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

			Current Plot Data (MY1 2019)																				
			VP1			VP2			VP3			VP4			VP5			VP6			VP7		
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	PnoLS	P-all	T
Aesculus pavia	Red Buckeye	Shrub Tree																			2	2	2
Betula nigra	River Birch	Tree	1	1	1	2	2	2	3	3	4	2	2	2	3	3	3				1	1	1
Fraxinus pennsylvanica	Green Ash	Tree	3	3	3	2	2	2	2	2	2	4	4	4	1	1	1	2	2	2	1	1	1
Juglans nigra	Black Walnut	Tree															1						
Liquidambar styraciflua	Sweet Gum	Tree			2																		
Liriodendron tulipifera	Tulip Poplar	Tree	2	2	2	1	1	1	1	1	1				2	2	2						
Platanus occidentalis	Sycamore	Tree	1	1	1	5	5	5	4	4	4	2	2	2	4	4	4	4	4	4	2	2	2
Quercus alba	White Oak	Tree	2	2	2	1	1	1							1	1	1	1	1	1	2	2	2
Quercus lyrata	Overcup Oak	Tree										3	3	3	2	2	2	2	2	2	1	1	1
Quercus michauxii	Swamp Chestnut Oak	Tree	3	3	3				1	1	1												
Quercus phellos	Willow Oak	Tree	3	3	3				3	3	3	3	3	3				3	3	3	3	3	3
Quercus shumardii	Shumard Oak	Shrub Tree				3	3	3	1	1	1										1	1	1
Viburnum dentatum	Arrow-wood	Shrub Tree																1	1	1			
		Stem count	15	15	17	14	14	14	15	15	16	14	14	14	13	13	14	13	13	13	13	13	13
		size (ares)	1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	7	7	8	6	6	6	7	7	7	5	5	5	6	6	7	6	6	6	8	8	8
		Stems per ACRE	607	607	688	567	567	567	607	607	647	567	567	567	526	526	567	526	526	526	526	526	526

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

PnLS: Number of planted stems excluding live stakes
P-all: Number of planted stems including live stakes
T: Total stems

Table 10. Planted and Total Stem Counts
Buckwater Buffer Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

			Current Plot Data (MY1 2019)																				
			VP8			VP9			VP10			VP11			VP12			VP13			VP14		
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	PnoLS	P-all	T
Aesculus pavia	Red Buckeye	Shrub Tree				1	1	1				1	1	1	2	2	2						
Betula nigra	River Birch	Tree	1	1	1	1	1	1							2	2	2	4	4	4	4	4	4
Fraxinus pennsylvanica	Green Ash	Tree	1	1	1				4	4	4	1	1	1				3	3	3	3	3	3
Juglans nigra	Black Walnut	Tree																					
Liquidambar styraciflua	Sweet Gum	Tree																		1			
Liriodendron tulipifera	Tulip Poplar	Tree	2	2	2	2	2	2							4	4	4				3	3	3
Platanus occidentalis	Sycamore	Tree	4	4	4	4	4	4	1	1	1	1	1	1	3	3	3	4	4	4	2	2	2
Quercus alba	White Oak	Tree																					
Quercus lyrata	Overcup Oak	Tree	1	1	1	3	3	3	6	6	6	3	3	3									
Quercus michauxii	Swamp Chestnut Oak	Tree							1	1	1				3	3	3	1	1	1	1	1	1
Quercus phellos	Willow Oak	Tree	1	1	1							3	3	3	1	1	1	2	2	2	1	1	1
Quercus shumardii	Shumard Oak	Shrub Tree	1	1	1																		
Viburnum dentatum	Arrow-wood	Shrub Tree										4	4	4							1	1	1
		Stem count	11	11	11	11	11	11	12	12	12	13	13	13	15	15	15	14	14	15	15	15	15
		size (ares)	1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	7	7	7	5	5	5	4	4	4	6	6	6	6	6	6	5	5	6	7	7	7
		Stems per ACRE	445	445	445	445	445	445	486	486	486	526	526	526	607	607	607	567	567	607	607	607	607

Color for Density

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Volunteer Species included in total

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Table 10. Planted and Total Stem Counts
Buckwater Buffer Mitigation Site
DMS Project No. 97084
Monitoring Year 1 - 2019

Scientific Name	Common Name	Species Type	Current Plot Data (MY1 2019)															Annual Means					
			VP15			VP16			VP17			VP18			VP19			MY1 (2019)			MY0 (2019)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Aesculus pavia	Red Buckeye	Shrub Tree	1	1	1				1	1	1	1	1	1				9	9	9	10	10	10
Betula nigra	River Birch	Tree	3	3	3	1	1	1	2	2	2	3	3	3	1	1	1	34	34	35	41	41	41
Fraxinus pennsylvanica	Green Ash	Tree	2	2	2	1	1	1	1	1	1	1	1	1	2	2	2	34	34	34	34	34	34
Juglans nigra	Black Walnut	Tree																		1			
Liquidambar styraciflua	Sweet Gum	Tree																		3			
Liriodendron tulipifera	Tulip Poplar	Tree				2	2	2				1	1	1	2	2	2	22	22	22	32	32	32
Platanus occidentalis	Sycamore	Tree	4	4	4	3	3	3	3	3	3	2	2	2	3	3	3	56	56	56	62	62	62
Quercus alba	White Oak	Tree				2	2	2	1	1	1							10	10	10	11	11	11
Quercus lyrata	Overcup Oak	Tree							2	2	2	2	2	2				25	25	25	22	22	22
Quercus michauxii	Swamp Chestnut Oak	Tree	1	1	1										2	2	2	13	13	13	13	13	13
Quercus phellos	Willow Oak	Tree	1	1	1	4	4	4	1	1	1				4	4	4	33	33	33	33	33	33
Quercus shumardii	Shumard Oak	Shrub Tree	1	1	1							1	1	1				8	8	8	9	9	9
Viburnum dentatum	Arrow-wood	Shrub Tree	2	2	2	1	1	1	2	2	2	2	2	2				13	13	13	15	15	15
		Stem count	15	15	15	14	14	14	13	13	13	13	13	13	14	14	14	257	257	262	282	282	282
		size (ares)	1			1			1			1			1			19			19		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.47			0.47		
		Species count	8	8	8	7	7	7	8	8	8	8	8	8	6	6	6	11	11	13	11	11	11
		Stems per ACRE	607	607	607	567	567	567	526	526	526	526	526	526	567	567	567	547	547	558	601	601	601

Color for Density

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APPENDIX 4. Overview Photos