MY0 FINAL MONITORING REPORT
Buffalo Creek Tributaries Mitigation Project
Johnston County
Neuse River Basin
CU 03020201

DMS Project # 100042
DMS Contract # 7422
DMS RFP # 16-007279
USACE Action ID Number: SAW-2018-00425
DWR Project # 2018-0199 V2
Calendar Year of Data Collection: 2021

Prepared for:

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

Environmental Quality

Memorandum

To: Lindsay Crocker, DMS

From: Catherine Manner

Date: 7/16/2021

Re: As-Built Baseline Report and Drawings for Buffalo Creek Tributaries Mitigation Site (#100042)

Lindsay,

Please find attached for review the Final MY0/As-Built Baseline Report for the Buffalo Creek Tributaries Mitigation Site.

Please let us know if you need anything else.

Thank you,

Catherine Manner

Catherine Manner

WATER & LAND SOLUTIONS
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July 16, 2021

NC Department of Environmental Quality
Division of Mitigation Services
Attn: Lindsay Crocker, Project Manager
217 W. Jones Street, Suite 3000
Raleigh, NC 27609

RE: WLS Responses to NCDEQ DMS Review Comments for Task 6 Submittal, Draft Baseline Monitoring Report for the Buffalo Creek Tributaries Mitigation Project, DMS Full-Delivery Project ID #100042, Contract #7422, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Ms. Crocker:

Water & Land Solutions, LLC (WLS) is pleased to present the Final Baseline Monitoring Report (including record drawings) for the Buffalo Creek Tributaries Mitigation Project to the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS). Per the DMS review comments, WLS has updated the Final As-Built Baseline Monitoring Report and associated deliverables accordingly. We are providing the electronic deliverables via cloud link. The electronic deliverables are organized under the following folder structure as required under the digital submission requirements:

1. Report PDF
2. Support Files
    1_ Tables
    2_CCPV
    3_Veg
    4_Geomorph
    5_Hydro
    6_Photos

We are providing our written responses to DMS' review comments on the Draft As-Built Baseline Report below. Each of the DMS review comments is copied below in **bold** text, followed by the appropriate response from WLS in regular text:

General:

- **Page 1, indicates 5,029 linear feet of construction. Clarify that this is the design, not as-built footage.** Response: The total design length of stream from the mitigation plan is 5,029 linear feet. The report and corresponding tables have been updated.

- **Deliverable Table is showing construction completed 4/22 and planting completed before that as 3/3. Review and correct or explain (add asterisk). These dates should be completion dates.** Response: Construction was completed on 4/22 and planting was completed on 4/26. The

date 3/3 was the initial planting date for the southern half of the project. The completion date of planting was revised in the corresponding table and report.

- **Table 1. Update typo error for R3 (upper) credit to show 56.500 (instead of 565.000).** Response: The error was updated to reflect the correct number of credits.

- **It was discussed in the field that there are some easement corners and posts that abut new subdivision yards and may be at risk for mowing encroachment. It is advisable that WLS works with those landowners to install some larger tress along those lines and consider alternative, more aesthetically pleasing markers at this early point in the project.** Response: Coordination and communication with landowners where easement abuts yards will be completed to prevent encroachment. These areas will be addressed prior to the submittal of the MY1 report, and any actions taken will be documented in MY1.

- **Work with DEQ Stewardship to ensure that the use of subdivision corners for parcels abutting easement corners in lieu of easement caps shown on the plat.** Response: DEQ Stewardship approved use of subdivision corners for parcels abutting easement corners in lieu of caps.

- **It was observed in the field that there are some areas of overland flow into the easement from the High School BMP Pond around R3 (lower). In the future, WLS will need to monitor this area to ensure that this does not de-stabilize the area and/or provide destabilizing sediment input to the system.** Response: The overland flow area around R3 (lower) will be monitored closely and any remedial action will be documented in future reports.

- **The stream geomorphology tables show that the bankfull discharge from pre to design to post remained constant. Explain how this occurred or correct calculations.** Response: The discharge numbers in the table are correct for pre, design, and MY0 for all reaches. The bankfull discharge estimate is held constant throughout and what varies is the cross-sectional area and velocity. As cross-sectional area increases, the velocity decreases and vice versus. The bankfull discharge is chosen and held at a constant and the designed cross-sectional area is based on that number. For 'C' stream types, the design channels acceptable velocity ranges are between 3-5 ft/s and for 'B' stream types it is between 4-6 ft/s.

- **The Mitigation Plan indicates that microbenthic invertebrate monitoring will occur to show pre-and post-response. Please provide this data and show monitoring on location on the CCPV in the baseline report.** Response: Data from the invertebrate monitoring occurred pre-construction and is now included in App F. Data is not tied to a performance standard and repeat sampling will occur in MY3. The location of sampling is shown on the CCPV.

- **Describe if there was any temporary or permanent cover planted in the vegetation section of the baseline report.** Response: Temporary and permanent seeding occurred during construction and followed the mitigation plan. The report has been updated to include the temporary/permanent seeding.

- **Provide elevation of wetland gauges in a table format or on drawings if possible/available.** Response: The elevation of wetland gauges was not surveyed during as-built.

- **Include any pictures and/or drone videos to assist IRT in visualizing.** Response: Photos and drone footage is included in the Photos folder of the E-Data.

Electronic Comments

- **Segment the stream features so that zero credit segments are not included as part of creditable segments (e.g. MS-R1, MS-R2). Please ensure that each record in the attribute table corresponds with a record in the asset table, and verify that feature lengths match the reported as-built lengths in the asset table.** Response: Zero credit segments have been removed from creditable segments. Records in the attribute table correspond to the asset table.

- **The ASB_WETLANDS shapefile only includes the Re-Establishment wetlands. Please include the Enhancement wetlands and ensure their areas match the as-built acreage reported in the asset table.** Response: The enhancement wetlands have been included in the e-data.

- **Please include spatial features characterizing the Pre-Existing Channel displayed in Figs. 1B & C.** Response: These were included with the initial submittal as the Pre-Existing Channel.shp.

Please contact me if you have any questions or comments.

Sincerely,

Water & Land Solutions, LLC

Catherine Manner
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LIST OF APPENDICES

1 Project Summary

1.1 Project Location and Description

The Buffalo Creek Tributaries Mitigation Project ("Project") is a North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) full-delivery stream and wetland mitigation project contracted with Water & Land Solutions, LLC (WLS) in response to RFP 16-007279. The Project will provide stream and wetland mitigation credits in the Neuse River Basin (Cataloging Unit 03020201). The project site is in Johnston County, North Carolina, between the Town of Wendell and the Community of Archer Lodge. The Project is in the Lower Buffalo Creek Priority Sub-watershed 030202011504, study area for the Neuse 01 Regional Watershed Plan Phase II, Final Report (RWP), and in the Targeted Local Watershed 03020201180050, of the Neuse River Basin.

The Project involved the restoration, enhancement, and preservation of eight stream reaches (MS-R1, MS-R2, R3 (upper), R3 (lower), R4, R5 (upper), R5 (lower), and R6) with designed totals of approximately 5,029 linear feet of streams. The Project also includes riparian wetland restoration (re-establishment) and enhancement of approximately 3.495 acres. The Project provides significant ecological improvements and functional uplift through stream and wetland restoration and will decrease nutrient, and sediment loads within the watershed. See Section 2 for a detailed benefits summary and Table 1 for a summary of project assets. Figure 1 illustrates the project mitigation components.

Prior to construction, many of the existing streams were incised and degraded due to excess bank erosion and increased stormwater flows. Wetland hydrology was drained across the floodplain and areas mapped with hydric soils. The existing vegetation within the riparian corridor consists of mixed hardwood forest with some disturbed pine forest. Adjacent land use consists of agriculture, silviculture and residential development.

1.2 Project Quantities and Credits

The Project mitigation components include a combination of Stream Restoration, Enhancement and Preservation activities, as well as Riparian Wetland Re-establishment and Enhancement, as summarized in the tables belo

Table 1. Buffalo Creek Tributaries Mitigation Project (DMS# 100042) Project Mitigation Quantities and Credits

Project Segment	Original Mitigation Plan Ft/Ac	As-Built Ft/Ac	Original Mitigation Category	Original Restoration Level	Original Mitigation Ratio (X:1)	Credits	Comments
Stream							
MS-R1	1543	1538	Warm	R	1.00000	1,543.000	Full channel restoration, planted buffer, permanent conservaiton easement
MS-R2	1351	1337	Warm	R	1.00000	1,351.000	Full channel restoration, planted buffer, permanent conservaiton easement
R3 (upper)	565	577	Warm	P	10.00000	56.500	Preservation of existing channel, permanent conservation easement
R3 (lower)	116	99	Warm	R	1.00000	116.000	Full channel restoration, planted buffer, permanent conservaiton easement
R4	459	499	Warm	EI	1.50000	306.000	Supplemental buffer planting, bank stabilization, permanent conservation easement
R5 (upper)	585	600	Warm	EI	1.50000	390.000	Supplemental buffer planting, bank stabilization, permanent conservation easement
R5 (lower)	158	171	Warm	R	1.00000	158.000	Full channel restoration, planted buffer, permanent conservaiton easement
R6	252	232	Warm	EI	1.50000	168.000	Supplemental buffer planting, bank stabilization, permanent conservation easement
Wetland							
W1	2.013	2.044	R	REE	1.00000	2.013	Planted buffer, hydrologic improvements, permanent conservation easement
W2	0.932	0.990	R	REE	1.00000	0.932	Planted buffer, hydrologic improvements, permanent conservation easement
W3	0.475	0.484	R	REE	1.00000	0.475	Planted buffer, hydrologic improvements, permanent conservation easement
WB	0.039	0.032	R	E	2.00000	0.020	Planted buffer, hydrologic improvements, permanent conservation easement
WC	0.004	0.004	R	E	2.00000	0.002	Planted buffer, hydrologic improvements, permanent conservation easement
WD	0.032	0.038	R	E	2.00000	0.016	Planted buffer, hydrologic improvements, permanent conservation easement

Project Credits

Restoration Level	Stream			Riparian Wetland	Non-Rip Wetland	Coastal Marsh
	Warm	Cool	Cold			
Restoration	3,168.000					
Re-establishment				3.420		
Rehabilitation						
Enhancement				0.038		
Enhancement I	864.000					
Enhancement II						
Creation						
Preservation	56.500					
Totals	**4,088.500**			**3.458**		

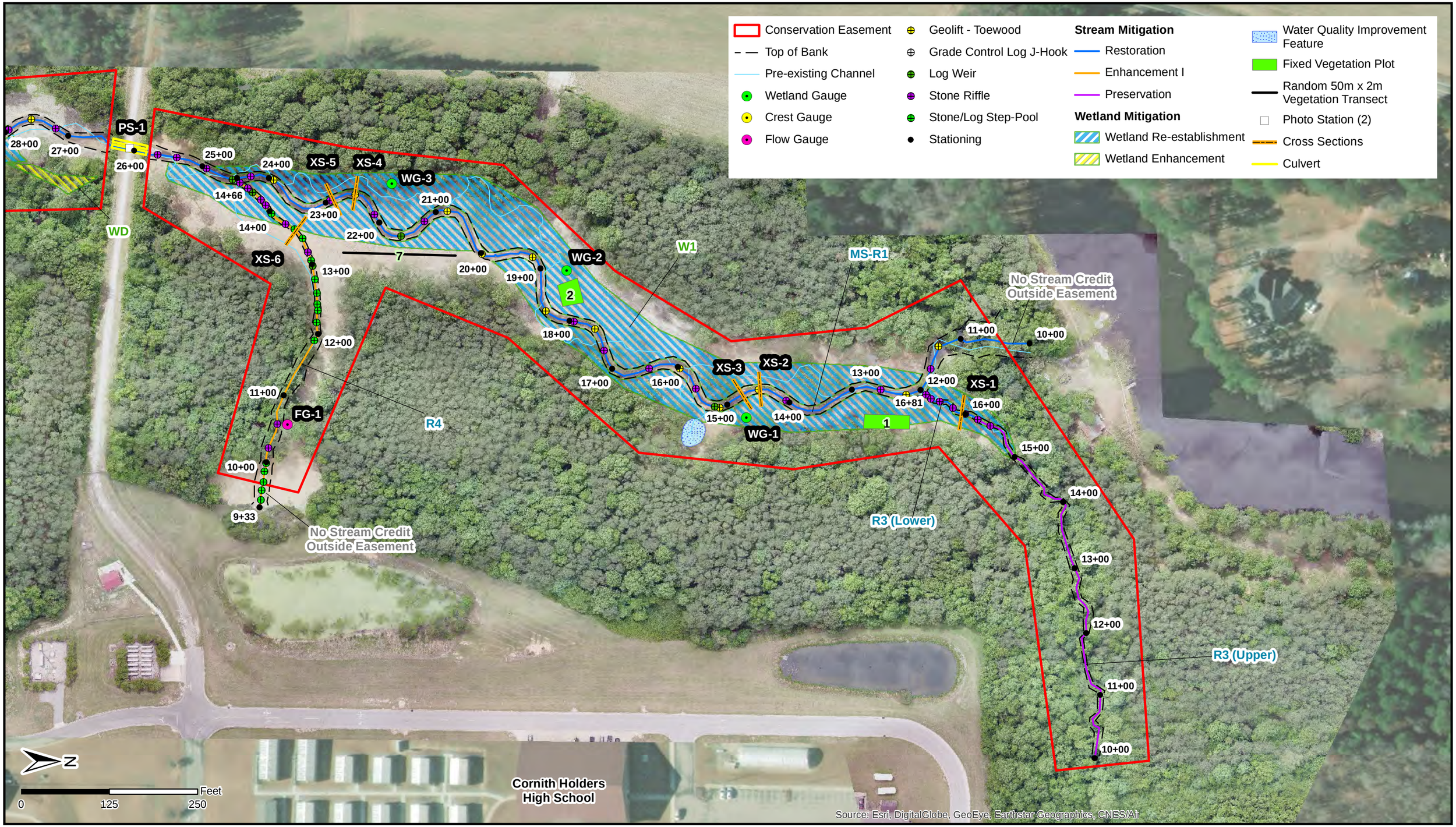
Total Stream Credit	**4,088.500**
Total Wetland Credit	**3.458**

Wetland Mitigation Category			Restoration Level	
CM	Coastal Marsh		HQP	High Quality Preservation
R	Riparian		P	Preservation
NR	Non-Riparian		E	Wetland Enhancement - Veg and Hydro
			EII	Stream Enhancement II
			EI	Stream Enhancement I
			C	Wetland Creation
			RH	Wetland Rehabilitation - Veg and Hydro
			REE	Wetland Re-establishment Veg and Hydro
			R	Restoration

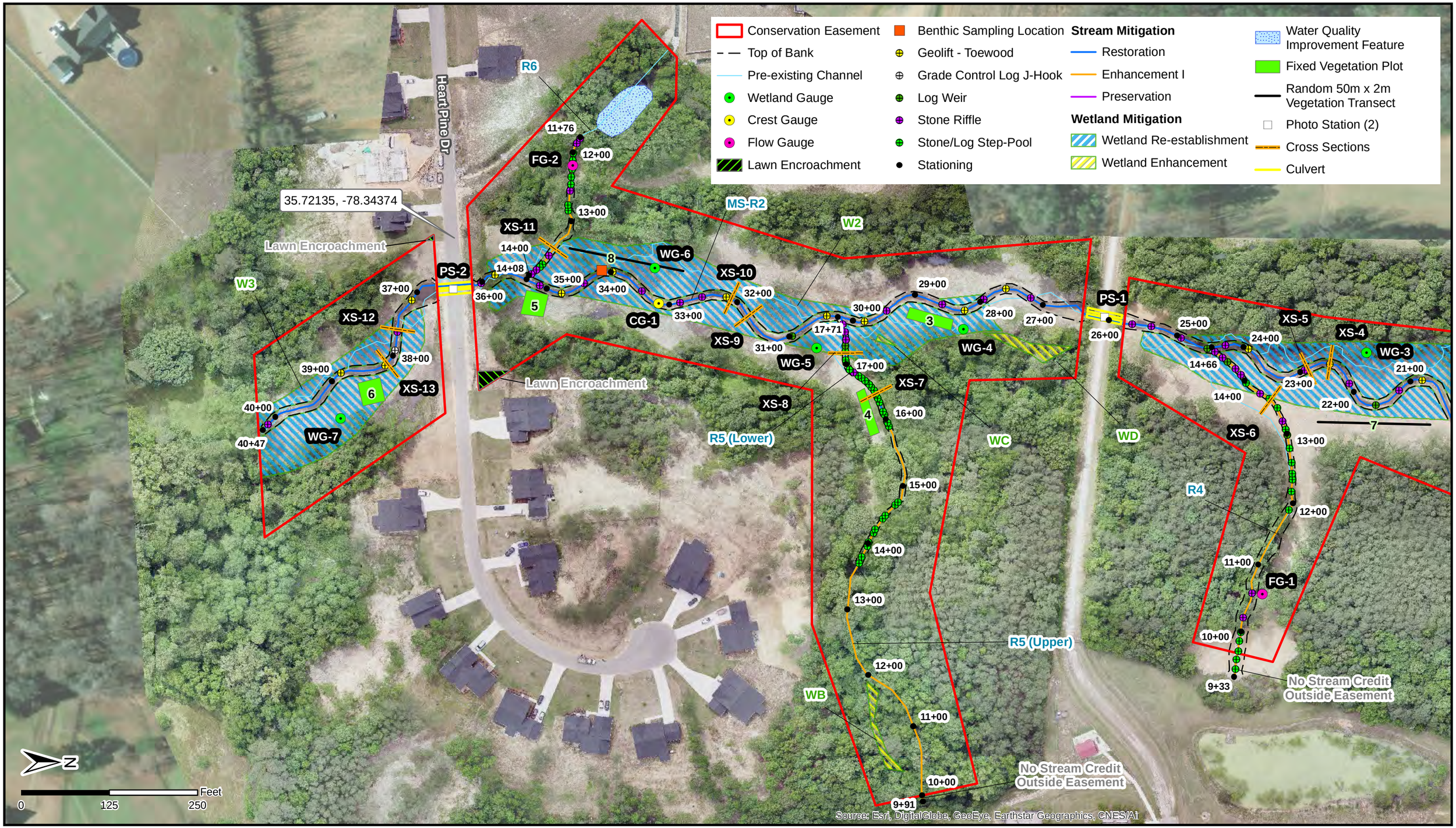
1.3 Current Condition Plan View

The following pages present the Current condition Plan View (CCPV).

WATER & LAND™ SOLUTIONS	NC Mitigation Services ENVIRONMENTAL QUALITY	**Buffalo Creek Tributaries Mitigation Project** **Johnston County, North Carolina**	USACE Action ID Number: SAW-2018-00425 June 2021 MY0	USACE Current Conditions Plan View Monitoring Year 0 NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 1a



WATER & LAND™ SOLUTIONS	NC Mitigation Services ENVIRONMENTAL QUALITY	**Buffalo Creek Tributaries Mitigation Project** **Johnston County, North Carolina**	USACE Action ID Number: SAW-2018-00425 June 2021 MY0	USACE Current Conditions Plan View Monitoring Year 0 NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 1b



WATER & LAND™ SOLUTIONS	Mitigation Services ENVIRONMENTAL QUALITY	**Buffalo Creek Tributaries Mitigation Project** **Johnston County, North Carolina**	USACE Action ID Number: SAW-2018-00425 June 2021 MY0	USACE Current Conditions Plan View Monitoring Year 0 NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 1 c

2 Goals, Performance Criteria, and Functional Improvements

2.1 Project Goals and Objectives

The Project will meet the goals and objectives described in the Buffalo Creek Tributaries Final Approved Mitigation Plan and will address general restoration goals and opportunities outlined in the DMS Neuse River Basin Watershed Restoration Priorities (RBRP). More specifically, three out of the four functional goals and objectives outlined in the Wake-Johnston Collaborative Local Watershed Plan (LWP) as well as the Neuse 01 RWP will be met by:

- Reducing sediment and nutrient inputs to the Buffalo Creek Watershed.
- Restoring, preserving, and protecting wetlands, streams, riparian buffers and aquatic habitat.

Implementing stream restoration in rural catchments together as “project clusters”.

To accomplish these project-specific goals, the following objectives will be measured to document overall project success:

- Restore stream and floodplain interaction and geomorphically stable conditions by reconnecting historic flow paths and promoting more natural flood processes;
- Improve and protect water quality by reducing streambank erosion, nutrient and sediment inputs;
- Restore and protect riparian buffer functions and habitat connectivity in perpetuity by recording a permanent conservation easement; and
- Incorporate water quality improvement features to reduce nonpoint source inputs to receiving waters.

Table 2: Summary: Goals, Performance, and Results					
Goal	**Objective/Treatment**	**Likely Functional Uplift**	**Performance Criteria**	**Measurement**	**Cumulative Monitoring Results**
Improve Stream Base Flow Duration	Improve and/or remove existing stream crossings and restore a more natural flow regime and aquatic passage.	Create a more natural and higher functioning headwater flow regime and provide aquatic passage; re-establish appropriate wetland hydroperiods and provide hydrologic storage	Maintain seasonal flow on intermittent stream for a minimum of 30 consecutive days during normal annual rainfall	2 Flow gauges (R4 and R6).	Data in MY1
Reconnect channels with floodplains and riparian wetlands to allow a natural flooding regime.	Design BHRs to not exceed 1.2 and increase ERs no less than 2.2 for Rosgen 'C' and 'E' stream types and 1.4 for 'B' stream types.	Provide temporary water storage and reduce erosive forces (shear stress) in channel during larger flow events.	Minimum of four bankfull events in separate years. Wetland hydrology for 8% of growing season.	1 Crest gauge/pressure transducer (MS-R2), 7 Wetland groundwater gauges (W1,W2, and W3).	Data in MY1
Improve stabilty of stream channels	Construct stream channels that will maintain stable cross- sections, patterns, and profiles over time.	Reduction in sediment inputs from bank erosion, reduction of shear stress, and improved overall hydraulic function.	Bank height ratios remain below 1.2 over the monitoring period. Visual assessments showing progression towards stability.	13 Cross section surveys	all cross sections BHR<1.2.
Establish Riparian Buffer Vegetation	Plant native species vegetation a minimum 50' wide from the top of the streambanks with a composition/density comparable to downstream reference condition.	Increase woody and herbaceous vegetation will provide channel stability and reduce streambank erosion, runoff rates and exotic species vegetation.	Within planted portions of the site, a minimum of 320 stems per acre must be present at year three; a minimum of 260 stems per acre must be present at year five with average height of seven feet; and a minimum of 210 stems per acre at year seven with an average height of ten feet.	Tree data for 6 permanent veg Plots and 2 Random veg transects (species & height), visual assessment	8/8 met requirements - 2021

2.2 Project Success Criteria

The success criteria for the Project will follow the approved performance standards and monitoring protocols from the final approved mitigation plan; which was developed in compliance with the USACE October 2016 Guidance, USACE Stream Mitigation Guidelines (April 2003 and October 2005), and 2008 Compensatory Mitigation Final Rule. Cross-section and vegetation plot data will be collected in Years 0, 1, 2, 3, 5, and 7. Stream hydrology data and visual monitoring will be reported annually. Specific success criteria components and evaluation methods are described below.

2.2.1 Streams

***Stream Hydrology*:** Four separate bankfull or over bank events must be documented within the seven-year monitoring period and the stream hydrology monitoring will continue until four bankfull events have been documented in separate years. Stream hydrology monitoring will be accomplished with pressure transducers installed in pools and correlating sensor depth to top of bank elevation (see appendix D for installation diagrams). Recorded water depth above the top of bank elevation will document a bankfull event. The devices will record water depth hourly and will be inspected quarterly.

The stage recorders include an automatic pressure transducer (HOBO Water Level (13 ft) Logger) set in PVC piping in the channel. The elevation of the bed and top of bank at each stage recorder location will

be recorded to be able to document presence of water in the channel and out of bank events. Visual observations (i.e. wrack or debris lines) and traditional cork crest gauges will also be used to document out of bank events.

Stream Profiles, Vertical Stability, and Floodplain Access: Stream profiles, as a measure of vertical stability and floodplain access will be evaluated by looking at Bank Height Ratios (BHR). In addition, observed bedforms should be consistent with those observed for channels of the design stream type(s). The BHR shall not exceed 1.2 along the restored Project stream reaches. This standard only applies to restored reaches of the channel where BHRs were corrected through design and construction. Vertical stability will be evaluated with visual assessment, cross-sections and, if directed by the IRT, longitudinal profile.

Stream Horizontal Stability: Cross-sections will be used to evaluate horizontal stream stability on restored streams. There should be little change expected in as-built restoration cross-sections. If measurable changes do occur, they should be evaluated to determine if the changes represent a movement toward a more unstable condition (e.g., downcutting, erosion) or a movement towards increased stability (e.g., settling, vegetation establishment, deposition along the streambanks, decrease in width/depth ratio). Cross-sections shall be classified using the Rosgen Stream Classification method and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

Stream cross-section monitoring will be conducted using a Topcon RL-H5 Laser Level. Three-dimensional coordinates associated with cross-section data will be collected in the field (NAD83 State Plane feet FIPS 3200). Morphological data will be collected at 13 cross-sections. Survey data will be imported into Microsoft Excel® and the DMS Shiny App for data processing and analysis.

Reference photo transects will be taken at each permanent cross-section. Lateral photos should not indicate excessive erosion or continuing degradation of the streambanks. Photographs will be taken of both streambanks at each cross-section. A survey tape stretched between the permanent cross-section monuments/pins will be centered in each of the streambank photographs. The water elevation will be shown in the lower edge of the frame, and as much of the streambank as possible will be included in each photo. Photographers will attempt to consistently maintain the same area in each photo over time.

Streambed Material Condition and Stability: Streambed material should not significantly change over time and any significant changes (e.g., aggradation, degradation, embeddedness) will be noted after streambank vegetation becomes established and a minimum of two bankfull flows or greater have been documented. If significant changes are observed within stable riffles and pools, additional sediment transport analyses may be required.

Jurisdictional Stream Flow: Monitoring of stream flow will be conducted to demonstrate that the restored stream systems classified as intermittent exhibit surface flow for a minimum of 30 consecutive days throughout some portion of the year during a year with normal rainfall conditions. Stream flow monitoring will be accomplished with pressure transducers installed in pools and correlating sensor depth to the downstream top of riffle elevation (see appendix D for installation diagrams). If the pool water depth is at or above the top of riffle elevation, then the channel will be assumed to have surface flow. The devices will record water elevation twice per day and will be inspected quarterly to document surface hydrology and provide a basis for evaluating flow response to rainfall events.

2.2.2 Wetlands

Wetland Hydrology: The performance standard for wetland hydrology will be 12% percent based on the suggested wetland saturation thresholds for soils taxonomic subgroups. The proposed success criteria for wetland hydrology will be when the soils are saturated within 12 inches of the soil surface for 12% (27 days) of the 227-day growing season (March 21st through November 3rd) based on WETS data table for Johnston County, NC. The saturated conditions should occur during a period when antecedent precipitation has been normal or drier than normal for a minimum frequency of 5 years in 10 (USACE, 2005 and 2010b). Precipitation data will be obtained from an on-site rain gauge and the Clayton (CLAY) Research Weather Station, approximately 9 miles southeast of the Project site. If a normal year of precipitation does not occur during the first seven years of monitoring, WLS will continue to monitor the Project hydrology until the Project site has been saturated for the appropriate hydroperiod. If rainfall amounts for any given year during the monitoring period are abnormally low, reference wetland hydrology data will be compared to determine if there is a correlation with the weather conditions and site variability.

Wetland hydrology will be monitored to document success in wetland restoration and enhancement areas where hydrology was affected. This will be accomplished with automatic pressure transducer gauges (located in groundwater wells) that record daily (twice per day) groundwater levels. The pressure transducer gauges are HOBO Water Level (13ft) Loggers made by Onset. Seven gauges will be installed within the wetland crediting areas. One automatic pressure transducer will be installed above ground for use as a barometric reference. One rain gauge will be installed at the adjacent Odell's House Mitigation Project site (0.3 miles southeast of the project) to document rainfall at the project. Gauges are downloaded quarterly and wetland hydroperiods are calculated during the growing season. Gauge installation will follow current regulatory guidance. Visual observations of primary and secondary wetland hydrology indicators will also be recorded during quarterly site visits.

2.2.3 Vegetation

Vegetation monitoring will occur in the fall each required monitoring year, prior to leaf drop. Plots will be monitored in years 1, 2, 3, 5, and 7. Vegetative success for the Project during the intermediate monitoring years will be based the survival of at least 320, three-year-old planted trees per acre at the end of Year 3 of the monitoring period; and at least 260, five-year-old, planted trees per acre that must average seven feet in height at the end of Year 5 of the monitoring period. The final vegetative restoration success criteria will be achieving a density of no less than 210, seven-year-old planted stems per acre that must average ten feet in height in Year 7 of monitoring.

Vegetation success is being monitored at a total of six permanent vegetation plots (10m x 10m or 20m x 5m) and two random vegetation transects (50m x 2m). Vegetation plot monitoring follows the CVS-EEP Level 2 Protocol for Recording Vegetation, version 4.2 (Lee et al. 2008) and includes analysis of species composition and density of planted species. Data will be processed using the DMS ShinyApp. For each plot, the origin will be marked with a PVC pole and the other three corners marked with rebar. Tree species and height will be recorded for each planted stem and photos of each plot are to be taken from the origin each monitoring year.

2.2.4 Visual Assessment

WLS will conduct visual assessments in support of mitigation performance monitoring. Visual assessments of all stream reaches will be conducted twice per monitoring year with at least five months in between each site visit for each of the seven years of monitoring. Photographs will be used to visually document system performance and any areas of concern related to streambank and bed stability, condition of in-stream structures, channel migration, active headcuts, live stake mortality, invasive plant species or animal browsing, easement boundary encroachments, and general streambed conditions. Permanent photo points will be at the cross-sections and culvert crossings.

3 Project Attributes

3.1 Design Approach

3.1.1 Stream

The Project stream design approach included a combination of Stream Restoration, Enhancement Level I, and Preservation activities. A Priority Level I restoration approach was incorporated with the design of both a single-thread meandering channel along the main stem (MS-R1 and MS-R2) and step-pool channels (R3, R4, R5 and R6). All non-vegetated or disturbed areas within the conservation easement were planted with native species vegetation and any areas of invasive species were removed and/or treated.

Restoration: MS-R1, MS-R2, R3 (lower), R5 (lower)

- **MS-R1 –** MS-R1 was restored as a Rosgen 'C4' stream type using appropriate riffle-pool morphology with conservative meander planform geometry that accommodates the valley slope and width. Work involved a Priority Level I restoration to raise the bed elevation and reconnect the stream with its geomorphic floodplain to promote a more frequent over bank flooding regime.

- **MS-R2 –** MS-R2 was restored as a Rosgen 'C4' stream type using appropriate riffle-pool morphology with conservative meander planform geometry that accommodates the valley slope and width. Work involved a Priority Level I restoration to raise the bed elevation and reconnect the stream with its geomorphic floodplain to promote a more frequent over bank flooding regime.

- **R3 (lower) –** R3 (lower) was restored as a Rosgen 'B4' stream type using appropriate step-pool morphology with a minimal meander planform geometry in the lower portion that accommodates the valley slope and width. Work along R3 (lower) involved a Priority Level I Restoration by raising the bed elevation and reconnecting the stream with its geomorphic floodplain. Most of the channel was restored in its current location with minor adjustments to channel planform to tie into MS-R1.

- **R5 (lower)** – R5 (lower) was restored as a Rosgen 'B4' stream type using appropriate step-pool morphology with a minimal meander planform geometry. Work along R5 (lower) involved a Priority Level I Restoration by raising the bed elevation and reconnecting the stream with its geomorphic floodplain. The majority of the channel was restored in its current location with minor adjustments to channel planform to tie into MS-R2.

Enhancement Level I: R4, R5 (upper), and R6

- **R4 –** R4 begins below a stormwater outfall pipe within the upper catchment. WLS modified the BMP outlet by replacing an abandoned outfall pipe with a step-pool outlet channel to reroute base flow back into the natural stream valley. The lower portion of the reach was regraded across the floodplain to tie into MS-R1. In-stream structures, such as log weirs and stone riffles were used to dissipate flow energy, protect streambanks, and eliminate potential for future incision.

- **R5 (upper) –** R5 (upper) Enhancement Level I activities involved raising the bed elevation in the middle portion and removing any spoil/levees, thus providing better access to the geomorphic floodplain. In-stream structures, such as log weirs and stone riffles were used to dissipate flow energy, protect streambanks, and eliminate potential for future incision. Eroding channel banks were graded to stable side slopes, live staked and bare roots were also used to promote woody vegetation growth along the stream, riparian buffer and existing wetland area 'WB'.

- **R6 –** Enhancement Level I activities along R6 involved stabilizing an existing pond outlet and enhancing the stream with appropriate step-pool morphology. Work along the lower portion of R6 involved raising the bed elevation, installing in-stream structures and removing remnant spoil to provide better floodplain access. The majority of the channel remained in its pre-construction location with minor adjustments to channel planform before the confluence with MS-R2.

Preservation: R3 (upper)

- **R3 (upper)** - The upper section of R3 is classified as a Rosgen 'C5b' stream type. Preservation was proposed along this reach since the existing headwater stream is mostly stable with a mature riparian buffer due to minimal historic impacts. Riparian buffers in excess of 50 feet will be protected in perpetuity through a permanent conservation easement.

3.1.2 Wetland

Riparian Wetland Re-establishment: W1, W2, and W3

Areas of hydric soils documented on the floodplains of MS-R1 and MS-R2 were restored as a result of implementing a Priority Level I stream restoration, limited soil manipulation and removal (less than 1-foot depth) and planting native species vegetation. Both groundwater hydrology and overbank flood frequency will be restored.

Riparian Wetland Enhancement: WB, WC, and WD

Existing jurisdictional wetland areas were planted with native wet tolerant species and adjacent stream restoration will improve groundwater hydrology and overbank flood frequency.

3.2 Project Attributes

See Table 3 below for Project attributes.

Table 3. Project Attribute Table	
Project Name	Buffalo Creek Tributaries Mitigation Project
County	Johnston
Project Area (acres)	17.1
Project Coordinates (latitude and longitude decimal degrees)	35.72275, -78.34285
Project Watershed Summary Information	
Physiographic Province	Piedmont
River Basin	Neuse
USGS Hydrologic Unit 8-digit	3020201
DWR Sub-basin	03-04-06
Project Drainage Area (acres)	543 acres
Project Drainage Area Percentage of Impervious Area	13%
Land Use Classification	2.01.03, 2.01.01, 3.02 (20% cultivated crops, 9% grass/herbaceous, 48% mixed forest)

Reach Summary Information						
Parameters	**MS-R1**	**MS-R2**	**R3 (upper and lower)**	**R4**	**R5 (upper and lower)**	**R6**
Pre-project length (feet)	1,803	1,475	701	469	766	208
Post-project (feet)	1,538	1,337	676	499	771	232
Valley confinement (Confined, moderately confined, unconfined)	moderately confined	moderately confined	unconfined	unconfined	unconfined	unconfined
Drainage area (acres)	442	543	24	30	19	25
Perennial, Intermittent, Ephemeral	Perennial	Perennial	Int/Perennial[1]	Ephemeral[2]	Perennial	Intermittent
NCDWR Water Quality Classification	C, NSW	C, NSW	C, NSW	C, NSW	C, NSW	C, NSW
Dominant Stream Classification (existing)	G4c	G4c/Incised E4	C5b (upper), G5 (lower)	G5c/C5	Incised E5 (upper), G5c (lower)	B5a
Dominant Stream Classification (proposed)	C4	C4	B4	B4	B4	B4
Dominant Evolutionary class (Simon) if applicable	III/IV	III	III	IV/V	I/III	I

Wetland Summary Information						
Parameters	**W1**	**W2**	**W3**	**WB**	**WC**	**WD**
Pre-project (acres)	N/A	N/A	N/A	0.039	0.004	0.032
Post-project (acres)	2.044	0.990	0.484	0.032	0.004	0.038
Wetland Type (non-riparian, riparian)	Riparian	Riparian	Riparian	Riparian	Riparian	Riparian
Mapped Soil Series	Wt: Wedhadkee loam	Wt: Wedhadkee loam	Wt: Wedhadkee loam	Ly: Lynchburg sandy loam	Wt: Wedhadkee loam	Wt: Wedhadkee loam
Soil Hydric Status	Hydric A	Hydric A	Hydric A	N/A	Hydric A	Hydric A

Regulatory Considerations			
Parameters	**Applicable?**	**Resolved?**	**Supporting Docs?**
Water of the United States - Section 404	Yes	Yes	404 Permit
Water of the United States - Section 401	Yes	Yes	401 Permit
Endangered Species Act	Yes	Yes	Categorical Exclusion
Historic Preservation Act	Yes	Yes	Categorical Exclusion
Coastal Zone Management Act (CZMA or CAMA)	No	N/A	N/A
Essential Fisheries Habitat	No	N/A	N/A

Note 1: Indicates that the lower section of the reach was classified as perennial and upper stream reach was classified as intermittent.
Note 2: Reach R4 is shown as a blue line stream on the USGS topographic map. The historic flow path has been piped from an existing stormwater BMP towards Reach R5 and diverted away from its natural stream valley.

4 Monitoring Year 0 Assessment and Results

4.1 As-built Survey

An as-built survey conducted under the responsible charge of a North Carolina Professional Land Surveyor (Marshall Wight, PLS with WithersRavenel), was utilized to document the as-built or baseline condition of the Project post-construction. The Project construction and planting were completed in April 2021 and as-built survey was completed in May 2021. Planting on the lower half of the project started in March 2021. Baseline monitoring activities occurred in April and May 2021.

4.2 As-Built Plans/ Record Drawings

The results of the as-built survey establish and document post-construction or baseline conditions and will be used for comparing annual post-construction monitoring data. The as-built plans or record drawings were developed utilizing the final construction plans as the "background", and then overlaying the as-built survey information on the plan and profile sheets. Any significant adjustments or deviations made to the final construction plans during construction are shown as redline mark-ups or callouts on the as-built survey plan sheets. The as-built plans/record drawings were submitted separately.

4.3 As-Built/ Baseline Assessment

No deviations of significance were documented between the final construction plans and the as-built condition that may affect channel performance or changes in vegetation species planted. Along MS-R2, the channel was realigned from approximate design station 29+50 to 32+75 to protect a large hardwood tree (~10 DBH) and prevent root damage within the dripline. As a result of this realignment, lower R5 confluence was extended to tie into MS-R2. Similarly, lower R4 was realigned from approximate station 12+17 to 14+59 due to poor/wet soil conditions and to more closely follow the graded floodplain and valley contours. The in-stream structure installation followed the proposed design in these locations. Log riffles were replaced with stone riffles along R5 to minimize disturbance to exiting vegetation. Lastly, three log riffles were removed along lower R6 and three stone riffles were installed further upstream to increase bed stability and minimize disturbance to existing vegetation. No major issues or mitigating factors were observed immediately after construction which require consideration or remedial action.

4.4 Morphological Assessment

Morphological data for the as-built profile was collected in April and May 2021. Refer to Appendices A and C for summary data tables, morphological plots, and stream photographs.

4.4.1 Stream Horizontal Pattern & Longitudinal Profile

The MY0 stream horizontal pattern and longitudinal profiles closely match the design parameters. The MY0 plan form geometry or pattern fell within acceptable ranges of the design parameters for all restored reaches. These minor channel adjustments in riffle slopes, pool depths and pattern do not present a stability concern or indicate a need for remedial action and will be assessed visually during the annual assessments.

4.4.2 Stream Horizontal Dimension

The MY0 channel dimensions generally match the design parameters and are within acceptable and stable ranges of tolerance. It is expected over time that some pools may accumulate fine sediment and organic matter, however, this is not an indicator of channel instability. Maximum riffle depths are also expected

to fluctuate slightly throughout the monitoring period as the channels adjust to new flow regime and catchment conditions.

4.5 Stream Hydrology

4.5.1 Stream Flow

Two pressure transducers (flow gauges) were installed in April 2021 on reaches R4 and R6 to document baseflow conditions. The flow gauge locations are within the upper one-third of the project reaches as shown on the CCPV and the data will be included in the Monitoring Year 1 Report. See Appendix D for the pressure transducer installation diagrams.

4.5.2 Bankfull Events

One crest gauge was installed in March 2021 to document bankfull events. WLS installed a conventional cork crest gauge, along with a pressure transducer to validate flood status MS-R2. Stream hydrology data will be included in the Monitoring Year 1 Report in this section and in the appendices. Recorder locations are shown on the CCPV.

4.5.3 Wetlands

Seven groundwater wells were installed in March and April 2021 to monitor wetland hydrology. Groundwater well locations are shown on the CCPV and the data will be included subsequent monitoring reports. Elevations of groundwater wells are in Appendix E.

4.5.4 Vegetation

Monitoring of the six permanent vegetation plots and two random transects was completed during April 2021. Vegetation data and photos can be found in Appendix B. The MY0 average planted density is 673 stems per acre, which exceeds the interim measure of vegetative success of at least 320 planted stems per acre at the end of the third monitoring year. Each vegetation plot is also meeting the interim measure requirements and has 607 - 769 stems per acre. Volunteer species were not noted at baseline monitoring but are expected to establish in upcoming years.

Temporary and permanent seeding was conducted during and after construction activities, following the approved mitigation plan. Visual assessment of vegetation outside of the monitoring plots indicates that the herbaceous vegetation is becoming well established throughout the project.

Two encroachments were noted near the southern most culvert crossing on MS-R2. Both are recently sodded/planted grassy areas near the boundaries of recent housing development. To prevent further encroachment, the homeowners will be contacted, and the easement line will be more clearly marked and planted. Actions taken will be detailed in the MY1 report.

No areas of significant invasive plant species were observed post-construction. The site will be monitored closely, and any invasive plant species will be treated as needed. Any treatments will be documented and included in subsequent monitoring reports.

Appendix A:
Visual Assessment Data

Visual Stream Morphology Stability Assessment Table
Vegetation Condition Assessment Table
Photos: Cross-Section Photos
Photos: Stream Photo Points (Culvert Crossings)

Visual Stream Stability Assessment						
Reach	MS-R1, MS-R2, R3 (upper), R3 (lower), R4, R5 (upper), R5 (lower), R6					
Assessed Stream Length	5,053					
Assessed Bank Length	9,200					
Major Channel Category		**Metric**	**Number Stable, Performing as Intended**	**Total Number in As-built**	**Amount of Unstable Footage**	**% Stable, Performing as Intended**
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
				Totals	0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	131	131		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	28	28		100%

Visual Vegetation Assessment				
Planted acreage	**6.3**			
Vegetation Category	**Definitions**	**Mapping Threshold**	**Combined Acreage**	**% of Planted Acreage**
Bare Areas	Very limited cover of both woody and herbaceous material.	0.10 acres	0.00	0.0%
Low Stem Density Areas	Woody stem densities clearly below target levels based on current MY stem count criteria.	0.10acres	0.00	0.0%
		Total	0.00	0.0%
Areas of Poor Growth Rates	Planted areas where average height is not meeting current MY Performance Standard.	0.10 acres	0.00	0.0%
		Cumulative Total	0.00	0.0%
Easement Acreage	**17.1**			
Vegetation Category	**Definitions**	**Mapping Threshold**	**Combined Acreage**	**% of Easement Acreage**
Invasive Areas of Concern	Invasives may occur outside of planted areas and within the easement and will therefore be calculated against the total easement acreage. Include species with the potential to directly outcompete native, young, woody stems in the short-term or community structure for existing communities. Species included in summation above should be identified in report summary.	0.10 acres	0.00	0.0%
Easement Encroachment Areas	Encroachment may be point, line, or polygon. Encroachment to be mapped consists of any violation of restrictions specified in the conservation easement. Common encroachments are mowing, cattle access, vehicular access. Encroachment has no threshold value as will need to be addressed regardless of impact area.	none	0.01	

R3 Lower, XS-1, Upstream (MY-00)

R3 Lower, XS-1, Left Bank (MY-00)

R3 Lower, XS-1, Downstream (MY-00)

R3 Lower, XS-1, Right Bank (MY-00)

MS-R1, XS-2, Upstream (MY-00)

MS-R1, XS-2, Left Bank (MY-00)

MS-R1, XS-2, Downstream (MY-00)

MS-R1, XS-2, Right Bank (MY-00)

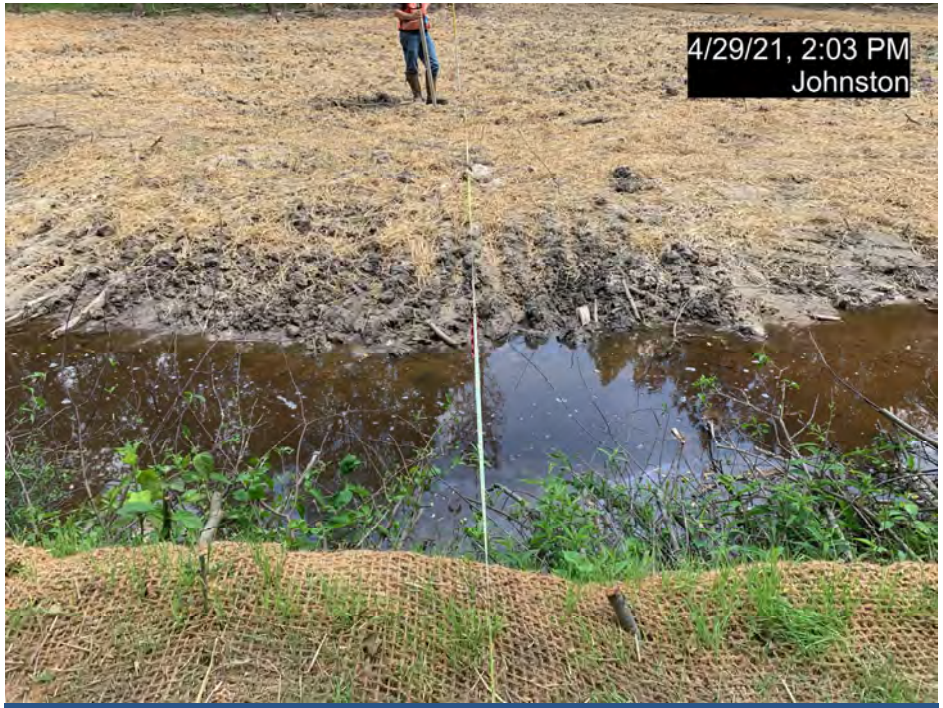
MS-R1, XS-3, Upstream (MY-00)

MS-R1, XS-3, Left Bank (MY-00)

MS-R1, XS-3, Downstream (MY-00)

MS-R1, XS-3, Right Bank (MY-00)

MS-R1, XS-4, Upstream (MY-00)



MS-R1, XS-4, Left Bank (MY-00)

MS-R1, XS-4, Downstream (MY-00)

MS-R1, XS-4, Right Bank (MY-00)

MS-R1, XS-5, Upstream (MY-00)

MS-R1, XS-5, Left Bank (MY-00)

MS-R1, XS-5, Downstream (MY-00)

MS-R1, XS-5, Right Bank (MY-00)

R4, XS-6, Upstream (MY-00)

R4, XS-6, Left Bank (MY-00)

R4, XS-6, Downstream (MY-00)

R4, XS-6, Right Bank (MY-00)

R5 Lower, XS-7, Upstream (MY-00)

R5 Lower, XS-7, Left Bank (MY-00)

R5 Lower, XS-7, Downstream (MY-00)

R5 Lower, XS-7, Right Bank (MY-00)

R5 Lower, XS-8, Upstream (MY-00)

R5 Lower, XS-8, Left Bank (MY-00)

R5 Lower, XS-8, Downstream (MY-00)

R5 Lower, XS-8, Right Bank (MY-00)

MS-R2, XS-9, Upstream (MY-00)

MS-R2, XS-9, Left Bank (MY-00)

MS-R2, XS-9, Downstream (MY-00)

MS-R2, XS-9, Right Bank (MY-00)

MS-R2, XS-10, Upstream (MY-00)

MS-R2, XS-10, Left Bank (MY-00)

MS-R2, XS-10, Downstream (MY-00)

MS-R2, XS-10, Right Bank (MY-00)

R6, XS-11, Upstream (MY-00)

R6, XS-11, Left Bank (MY-00)

R6, XS-11, Downstream (MY-00)

R6, XS-11, Right Bank (MY-00)

MS-R2, XS-12, Upstream (MY-00)

MS-R2, XS-12, Left Bank (MY-00)

MS-R2, XS-12, Downstream (MY-00)

MS-R2, XS-12, Right Bank (MY-00)

MS-R2, XS-13, Upstream (MY-00)

MS-R2, XS-13, Left Bank (MY-00)

MS-R2, XS-13, Downstream (MY-00)

MS-R2, XS-13, Right Bank (MY-00)

PS-1 – MS-R1 Culvert Crossing, Upstream (MY-00)

PS-1 – MS-R1 Culvert Crossing, Downstream (MY-00)

PS-2 – MS-R2 Culvert Crossing, Upstream (MY-00)

PS-2 – MS-R2 Culvert Crossing, Downstream (MY-00)

Appendix B:
Vegetation Plot Data

Redline Plant List
Vegetation Performance Standards Summary Table
Vegetation Plot Counts and Densities Table
Photos: Vegetation Plot Photos
Vegetation Plot Maps

Buffalo Creek Mitigation Project Final Planting List				
Species	**Common Name**	**Stems**	**% Planted**	**Mitigation Plan %**
Fraxinus pennsylvanica	Green Ash	132	3.00%	3%
Betula nigra	River birch	440	10.00%	10%
Tilia americana	Basswood	440	10.00%	10%
Quercus alba	White oak	440	10.00%	10%
Platanus occidentalis	American sycamore	440	10.00%	10%
Nyssa sylvatica	Black gum	440	10.00%	10%
Liriodendron tulipifera	Tulip Poplar	440	10.00%	10%
Quercus rubra	Northern red oak	440	10.00%	10%
Diospyros virginiana	Persimmon	176	4.00%	4%
Carpinus caroliniana	Ironwood	176	4.00%	4%
Hamemelis virginiana	Witch hazel	176	4.00%	4%
Asimina triloba	Pawpaw	176	4.00%	4%
Lindera benzoin	Spicebush	176	4.00%	4%
Alnus serulatta	Tag Alder	132	3.00%	3%
Corylus americana	Hazelnut	176	4.00%	4%
Total		**4,400**	**100%**	

* There were no changes of the Final Plant list from the Mitigation Plan

Vegetation Performance Standards Summary Table												
	Veg Plot 1 F				Veg Plot 2 F				Veg Plot 3 F			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3												
Monitoring Year 2												
Monitoring Year 1												
Monitoring Year 0	688		8	0	607		11	0	688		8	0
	Veg Plot 4 F				Veg Plot 5 F				Veg Plot 6 F			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3												
Monitoring Year 2												
Monitoring Year 1												
Monitoring Year 0	607		9	0	648		13	0	769		9	0
	Veg Plot Group 1 R				Veg Plot Group 2 R							
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives				
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3												
Monitoring Year 2												
Monitoring Year 1												
Monitoring Year 0	648		12	0	729		11	0				

*Each monitoring year represents a different plot for the random vegetation plot "groups". Random plots are denoted with an R, and fixed plots with an F.

Buffalo Creek Stem Counts and Densities	
Planted Acreage	6.34
Date of Initial Plant	2021-03-03
Date(s) of Supplemental Plant(s)	#N/A
Date(s) Mowing	#N/A
Date of Current Survey	2021-03-25
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/ Shrub	Indicator Status	Veg Plot 1 F		Veg Plot 2 F		Veg Plot 3 F		Veg Plot 4 F		Veg Plot 5 F		Veg Plot 6 F		Veg Plot 7 R	Veg Plot 8 R
					Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Total	Total
Species Included in Approved Mitigation Plan	Alnus serrulata	hazel alder	Tree	FACW	3	3							1	1				
	Asimina triloba	pawpaw	Tree	FAC	1	1			1	1	2	2	2	2	2	2	3	1
	Betula nigra	river birch	Tree	FACW			2	2	1	1	1	1	1	1	1	1	1	2
	Carpinus caroliniana	American hornbeam	Tree	FAC	1	1	1	1			1	1	1	1	3	3	1	1
	Corylus americana	American hazelnut	Shrub	FACU	1	1	2	2	1	1			1	1			1	1
	Diospyros virginiana	common persimmon	Tree	FAC	3	3	1	1							1	1	1	
	Fraxinus pennsylvanica	green ash	Tree	FACW			1	1			3	3			1	1	1	
	Hamamelis virginiana	American witchhazel	Tree	FACU			1	1	3	3	1	1	1	1			1	1
	Lindera benzoin	northern spicebush	Tree	FACW			1	1			1	1	1	1				1
	Liriodendron tulipifera	tuliptree	Tree	FACU					1	1	2	2	1	1	3	3	1	3
	Nyssa sylvatica	blackgum	Tree	FAC	1	1	1	1					1	1			1	3
	Platanus occidentalis	American sycamore	Tree	FACW					8	8	2	2	2	2	2	2	2	2
	Quercus alba	white oak	Tree	FACU	4	4	2	2	1	1	2	2	2	2	1	1	2	2
	Quercus rubra	northern red oak	Tree	FACU	3	3	2	2	1	1			1	1	5	5		1
	Tilia americana	American basswood	Tree	FACU			1	1					1	1			1	
Sum	Performance Standard				17	17	15	15	17	17	15	15	16	16	19	19	16	18
Mitigation Plan Performance Standard	Current Year Stem Count					17		15		17		15		16		19	16	18
	Stems/Acre					688		607		688		607		648		769	648	729
	Species Count					8		11		8		9		13		9	12	11
	Dominant Species Composition (%)					24		13		47		20		12		26	19	17
	Average Plot Height					2		1		2		2		2		2	2	2
	% Invasives					0		0		0		0		0		0	0	0
Post Mitigation Plan Performance Standard	Current Year Stem Count					17		15		17		15		16		19	16	18
	Stems/Acre					688		607		688		607		648		769	648	729
	Species Count					8		11		8		9		13		9	12	11
	Dominant Species Composition (%)					24		13		47		20		12		26	19	17
	Average Plot Height					2		1		2		2		2		2	2	2
	% Invasives					0		0		0		0		0		0	0	0

1). Bolded species are proposed for the current monitoring year, italicized species are not approved, and a regular font indicates that the species has been approved.
2). The "Species Included in Approved Mitigation Plan" section contains only those species that were included in the original approved mitigation plan. The "Post Mitigation Plan Species" section includes species that are being proposed through a mitigation plan addendum for the current monitoring year (bolded) , species that have been approved in prior monitoring years through a mitigation plan addendum (regular font), and species that are not approved (italicized).
3). The "Mitigation Plan Performance Standard" section is derived only from stems included in the original mitigation plan, whereas the "Post Mitigation Plan Performance Standard" includes data from mitigation plan approved, post mitigation plan approved, and proposed stems.

Fixed Veg Plot 1 (MY-00)

Fixed Veg Plot 3 (MY-00)

Fixed Veg Plot 2 (MY-00)

Fixed Veg Plot 4 (MY-00)

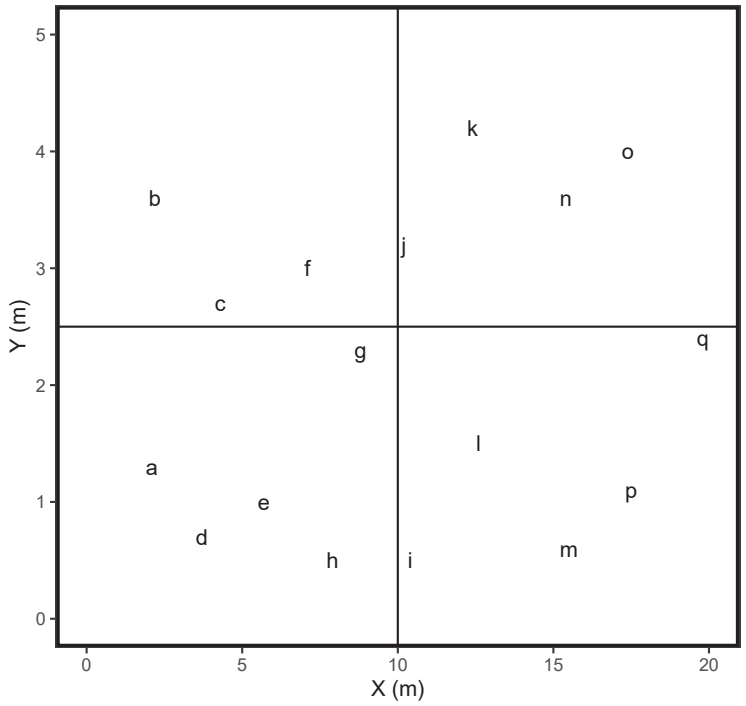
Fixed Veg Plot 5 (MY-00)

Random Veg Plot 7, Facing North (MY-00)

Fixed Veg Plot 6 (MY-00)

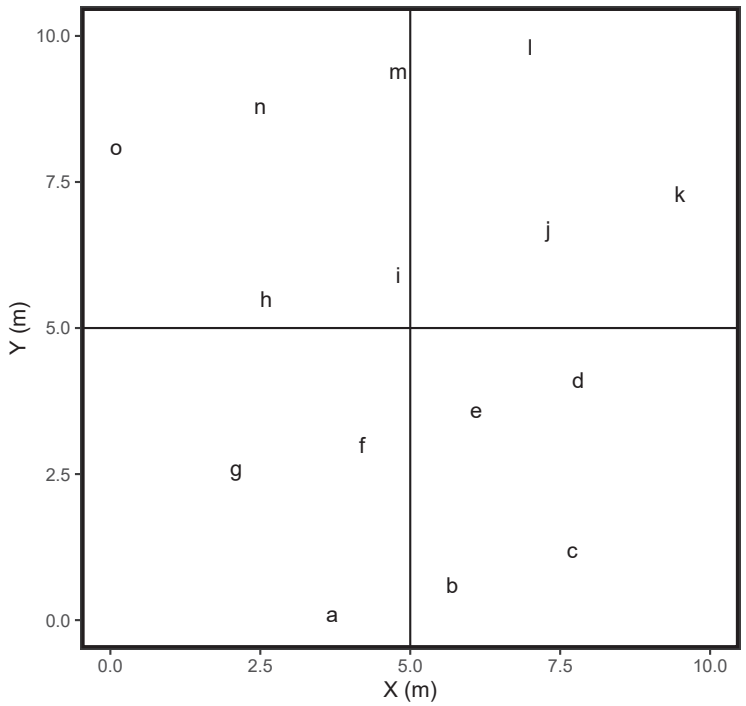
Random Veg Plot 8, Facing North (MY-00)

Plot 1



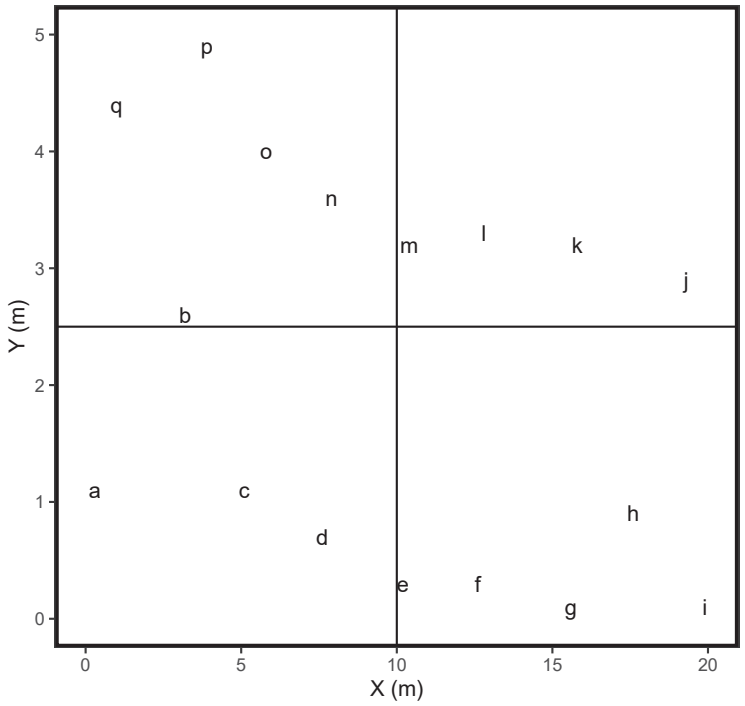
Plot ID	Scientific Name	Common Name	Mapped Stem Label
1	Quercus rubra	northern red oak	a
1	Quercus rubra	northern red oak	b
1	Quercus alba	white oak	c
1	Quercus alba	white oak	d
1	Quercus alba	white oak	e
1	Asimina triloba	pawpaw	f
1	Nyssa sylvatica	blackgum	g
1	Quercus alba	white oak	h
1	Carpinus caroliniana	American hornbeam	i
1	Corylus americana	American hazelnut	j
1	Alnus serrulata	hazel alder	k
1	Quercus rubra	northern red oak	l
1	Diospyros virginiana	common persimmon	m
1	Diospyros virginiana	common persimmon	n
1	Diospyros virginiana	common persimmon	o
1	Alnus serrulata	hazel alder	p
1	Alnus serrulata	hazel alder	q

Plot 2



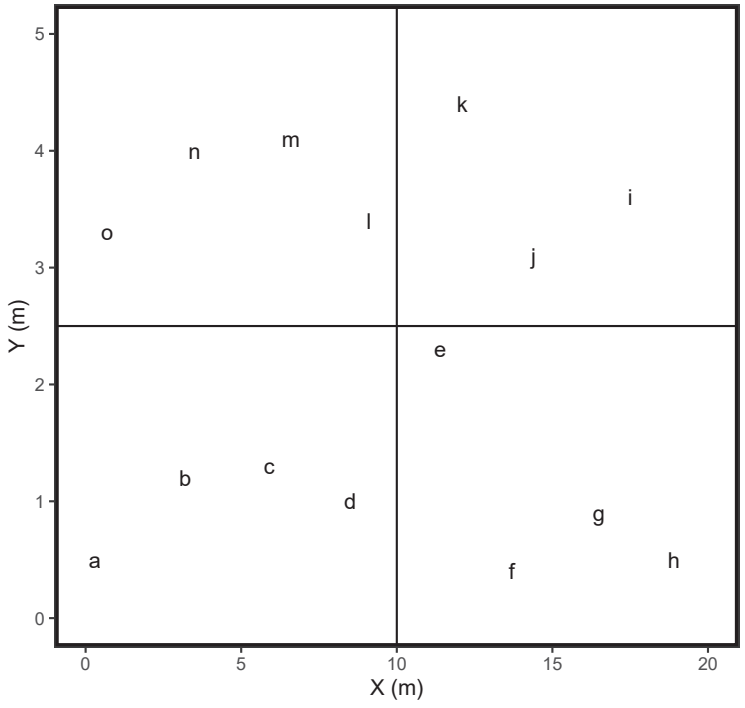
Plot ID	Scientific Name	Common Name	Mapped Stem Label
2	Corylus americana	American hazelnut	a
2	Corylus americana	American hazelnut	b
2	Betula nigra	river birch	c
2	Lindera benzoin	northern spicebush	d
2	Hamamelis virginiana	American witchhazel	e
2	Diospyros virginiana	common persimmon	f
2	Nyssa sylvatica	blackgum	g
2	Tilia americana	American basswood	h
2	Quercus alba	white oak	i
2	Fraxinus pennsylvanica	green ash	j
2	Quercus rubra	northern red oak	k
2	Quercus rubra	northern red oak	l
2	Quercus alba	white oak	m
2	Betula nigra	river birch	n
2	Carpinus caroliniana	American hornbeam	o

Plot 3



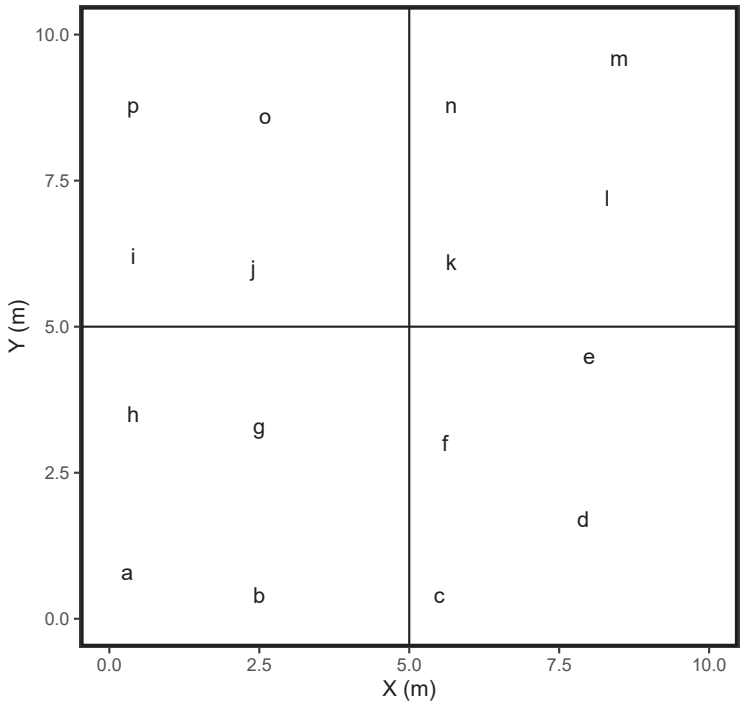
Plot ID	Scientific Name	Common Name	Mapped Stem Label
3	Platanus occidentalis	American sycamore	a
3	Quercus rubra	northern red oak	b
3	Corylus americana	American hazelnut	c
3	Liriodendron tulipifera	tuliptree	d
3	Platanus occidentalis	American sycamore	e
3	Platanus occidentalis	American sycamore	f
3	Platanus occidentalis	American sycamore	g
3	Hamamelis virginiana	American witchhazel	h
3	Quercus alba	white oak	i
3	Betula nigra	river birch	j
3	Platanus occidentalis	American sycamore	k
3	Asimina triloba	pawpaw	l
3	Platanus occidentalis	American sycamore	m
3	Hamamelis virginiana	American witchhazel	n
3	Platanus occidentalis	American sycamore	o
3	Hamamelis virginiana	American witchhazel	p
3	Platanus occidentalis	American sycamore	q

Plot 4



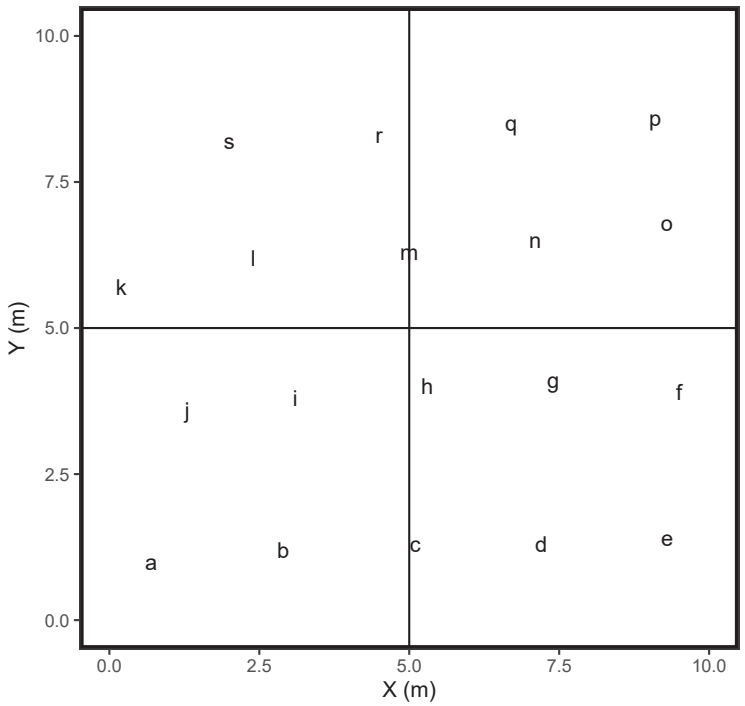
Plot ID	Scientific Name	Common Name	Mapped Stem Label
4	Carpinus caroliniana	American hornbeam	a
4	Asimina triloba	pawpaw	b
4	Fraxinus pennsylvanica	green ash	c
4	Fraxinus pennsylvanica	green ash	d
4	Platanus occidentalis	American sycamore	e
4	Liriodendron tulipifera	tuliptree	f
4	Hamamelis virginiana	American witchhazel	g
4	Platanus occidentalis	American sycamore	h
4	Quercus alba	white oak	i
4	Betula nigra	river birch	j
4	Lindera benzoin	northern spicebush	k
4	Quercus alba	white oak	l
4	Liriodendron tulipifera	tuliptree	m
4	Asimina triloba	pawpaw	n
4	Fraxinus pennsylvanica	green ash	o

Plot 5



Plot ID	Scientific Name	Common Name	Mapped Stem Label
5	Betula nigra	river birch	a
5	Platanus occidentalis	American sycamore	b
5	Asimina triloba	pawpaw	c
5	Alnus serrulata	hazel alder	d
5	Carpinus caroliniana	American hornbeam	e
5	Quercus rubra	northern red oak	f
5	Nyssa sylvatica	blackgum	g
5	Hamamelis virginiana	American witchhazel	h
5	Corylus americana	American hazelnut	i
5	Tilia americana	American basswood	j
5	Asimina triloba	pawpaw	k
5	Platanus occidentalis	American sycamore	l
5	Liriodendron tulipifera	tuliptree	m
5	Quercus alba	white oak	n
5	Quercus alba	white oak	o
5	Lindera benzoin	northern spicebush	p

Plot 6

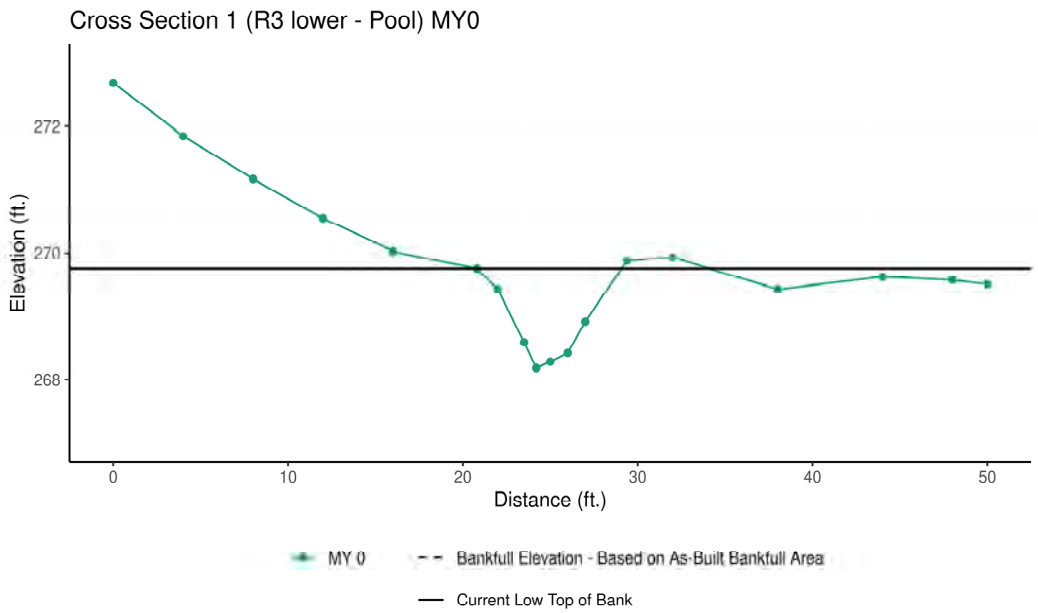


Plot ID	Scientific Name	Common Name	Mapped Stem Label
6	Diospyros virginiana	common persimmon	a
6	Fraxinus pennsylvanica	green ash	b
6	Asimina triloba	pawpaw	c
6	Asimina triloba	pawpaw	d
6	Quercus rubra	northern red oak	e
6	Carpinus caroliniana	American hornbeam	f
6	Betula nigra	river birch	g
6	Platanus occidentalis	American sycamore	h
6	Quercus rubra	northern red oak	i
6	Liriodendron tulipifera	tuliptree	j
6	Carpinus caroliniana	American hornbeam	k
6	Liriodendron tulipifera	tuliptree	l
6	Quercus rubra	northern red oak	m
6	Quercus alba	white oak	n
6	Quercus rubra	northern red oak	o
6	Carpinus caroliniana	American hornbeam	p
6	Liriodendron tulipifera	tuliptree	q
6	Quercus rubra	northern red oak	r
6	Platanus occidentalis	American sycamore	s

Appendix C:

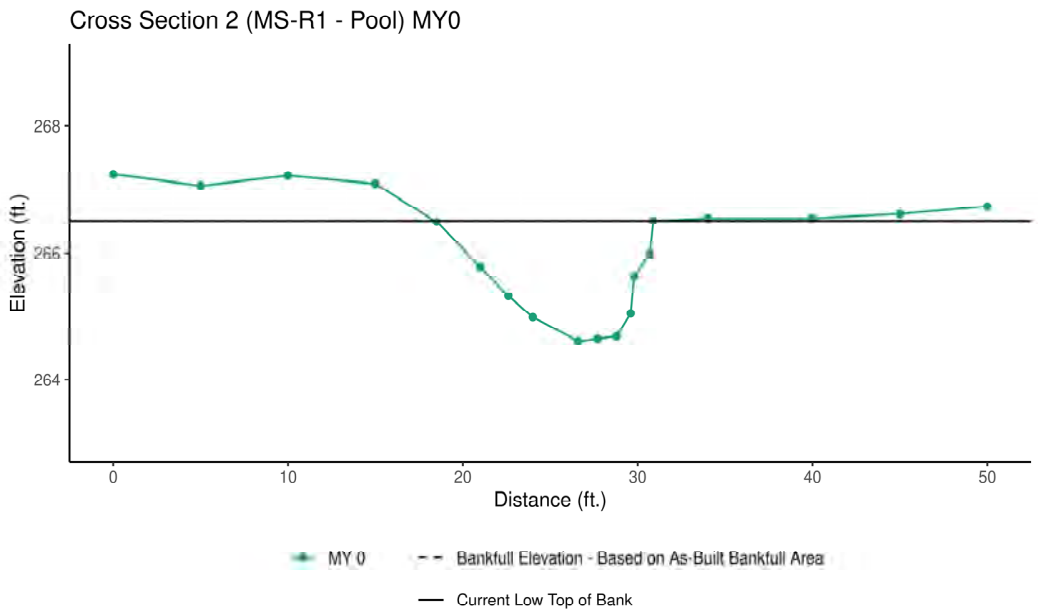
Stream Geomorphology Data

Cross-Section Charts with Annual Overlays
Baseline Longitudinal Profile
Baseline Stream Data Summary Tables
Cross-Section Morphology Data



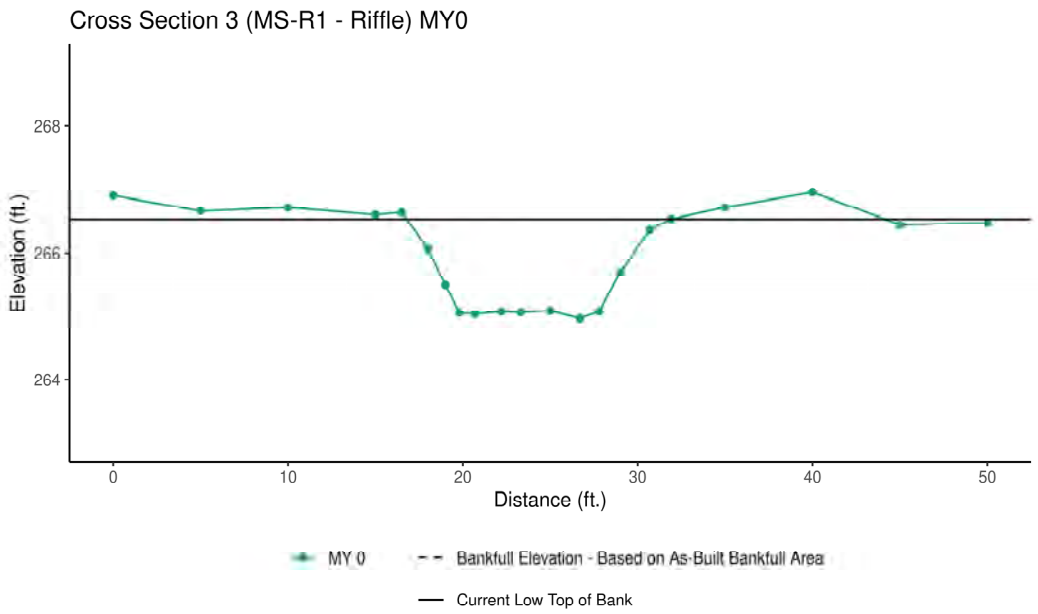
Distance	Elevation	Features
0	272.6858	TLP
4	271.8458	
8	271.1658	
12	270.5458	
16	270.0258	
20.8	269.7558	TLB, BKF
22	269.4258	
23.5	268.5858	
24.2	268.1758	THW
25	268.2758	
26	268.4158	
27	268.9158	
29.4	269.8858	TRB
32	269.9358	
38	269.4258	
44	269.6258	
48	269.5758	
50	269.5058	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	269.76							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	268.18							
LTOB Elevation	269.76							
LTOB Max Depth	1.58							
LTOB Cross Sectional Area	6.88							



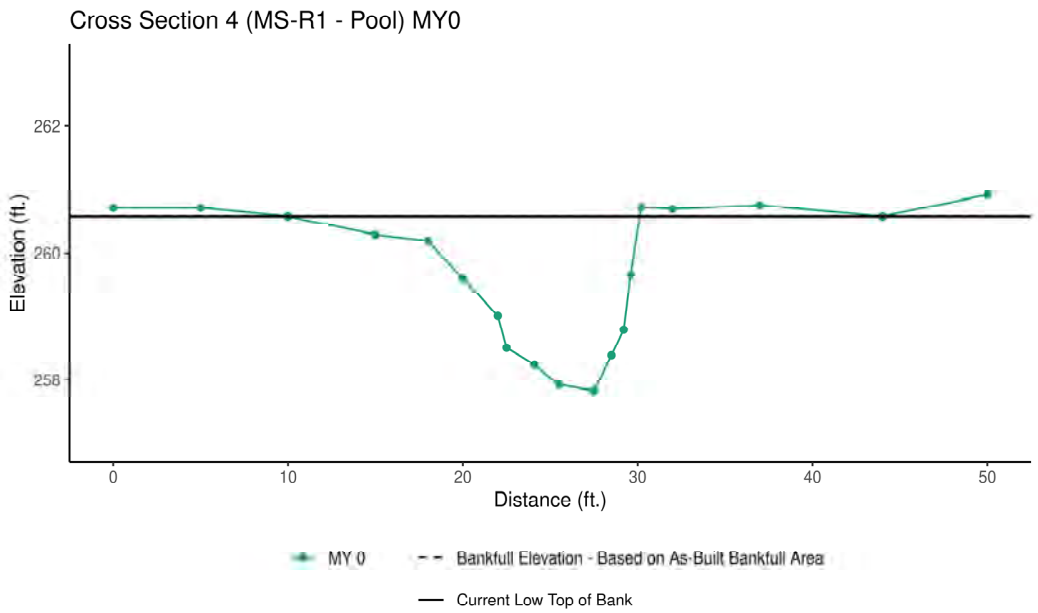
Distance	Elevation	Features
0	267.239	TLP
5	267.069	
10	267.219	
15	267.099	
18.5	266.489	LTB
21	265.779	
22.6	265.319	LEW
24	264.989	
26.6	264.609	THW
27.7	264.649	
28.8	264.689	
29.6	265.049	REW
29.8	265.629	
30.7	265.989	
30.9	266.509	TRB, BKF
34	266.549	
40	266.549	
45	266.619	
50	266.739	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	266.51							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	264.61							
LTOB Elevation	266.51							
LTOB Max Depth	1.9							
LTOB Cross Sectional Area	15.14							



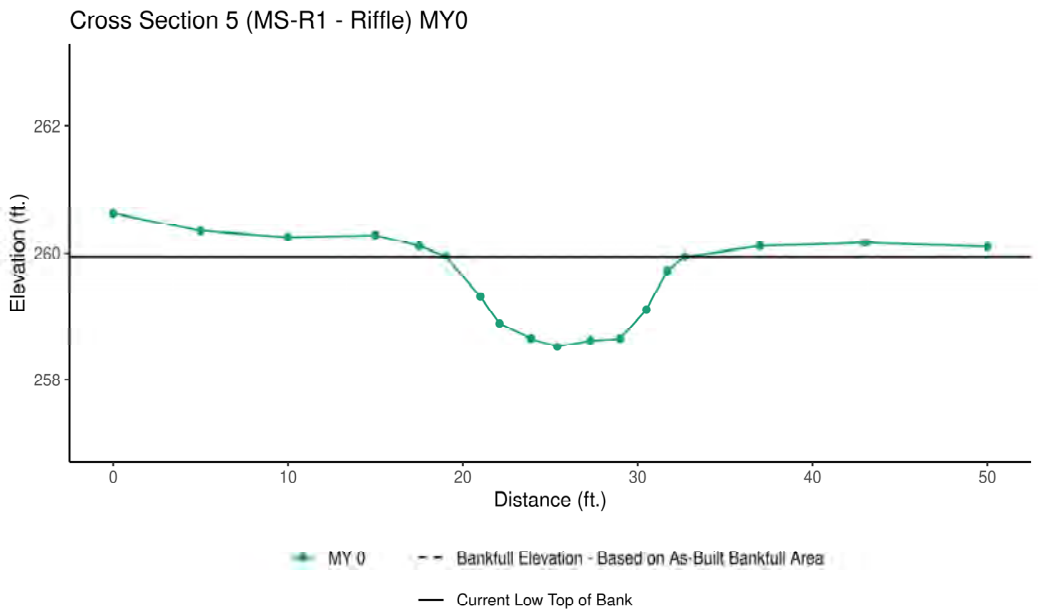
Distance	Elevation	Features
0	266.915	TLP
5	266.665	
10	266.725	
15	266.605	
16.5	266.645	TLB
18	266.065	
19	265.495	
19.8	265.065	LEW
20.7	265.045	
22.2	265.085	
23.3	265.075	THW
25	265.095	
26.7	264.975	
27.8	265.085	REW
29	265.695	
30.7	266.365	
31.9	266.535	TRB, BKF
35	266.725	
40	266.965	
45	266.445	
50	266.475	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	266.54							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	265.08							
LTOB Elevation	266.54							
LTOB Max Depth	1.46							
LTOB Cross Sectional Area	15.47							



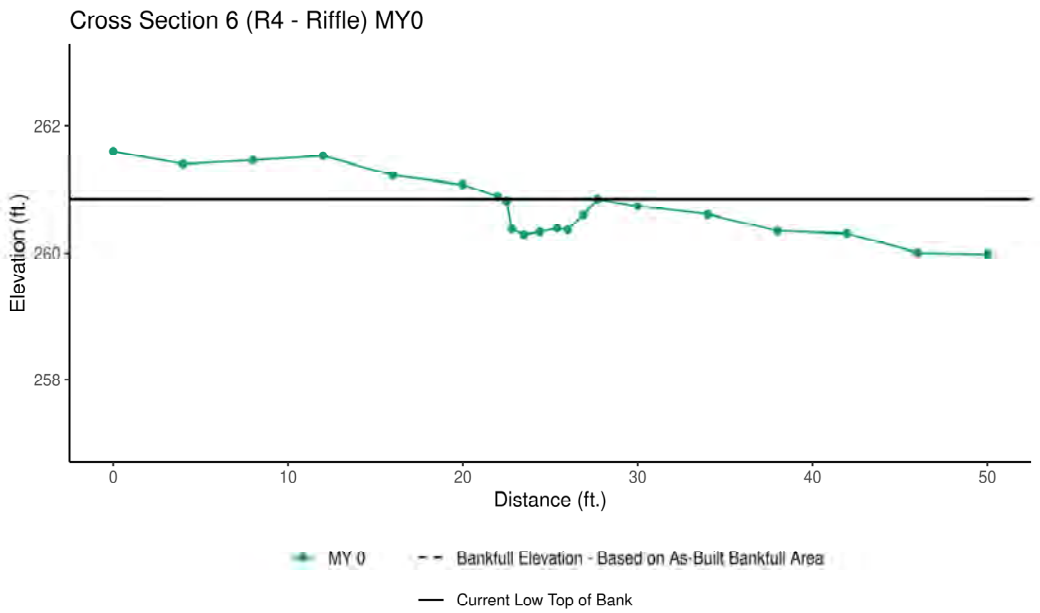
Distance	Elevation	Features
0	260.718	TLP
5	260.718	
10	260.578	TLB, BKF
15	260.288	
18	260.188	
20	259.598	
22	259.008	
22.5	258.498	LEW
24.1	258.228	
25.5	257.928	
27.5	257.828	THW
28.5	258.378	
29.2	258.788	REW
29.6	259.658	
30.2	260.728	TRB
32	260.698	
37	260.758	
44	260.578	
50	260.928	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	260.58							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	257.83							
LTOB Elevation	260.58							
LTOB Max Depth	2.75							
LTOB Cross Sectional Area	23.68							



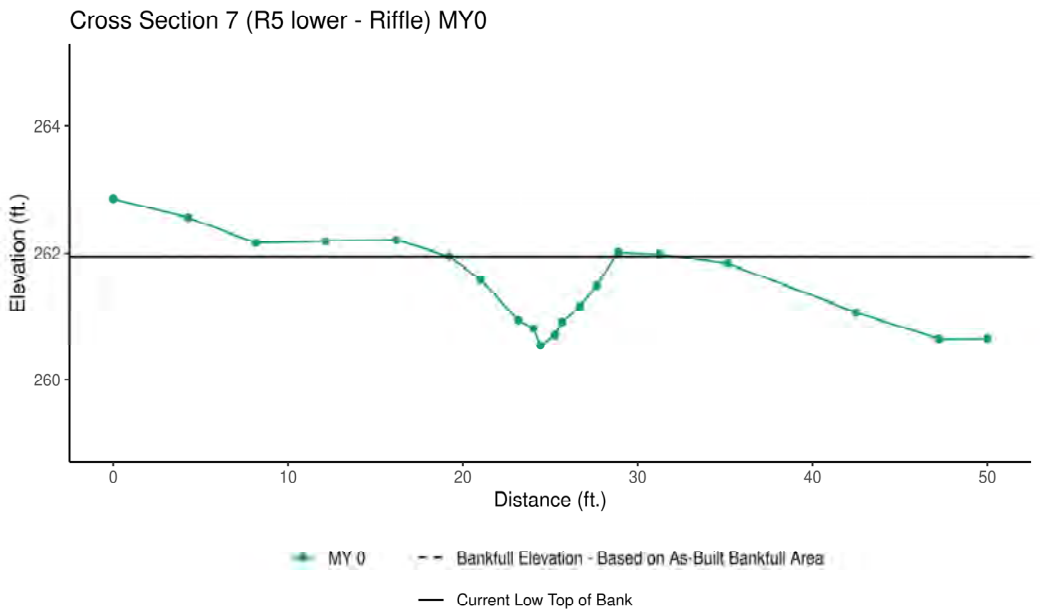
Distance	Elevation	Features
0	260.627	TLP
5	260.347	
10	260.247	
15	260.277	
17.5	260.107	
19	259.957	TLB
21	259.307	
22.1	258.887	LEW
23.9	258.647	
25.4	258.517	THW
27.3	258.617	REW
29	258.647	
30.5	259.107	
31.7	259.717	
32.7	259.947	TRB, BKF
37	260.107	
43	260.157	
50	260.097	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	259.95							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	258.52							
LTOB Elevation	259.95							
LTOB Max Depth	1.43							
LTOB Cross Sectional Area	12.96							



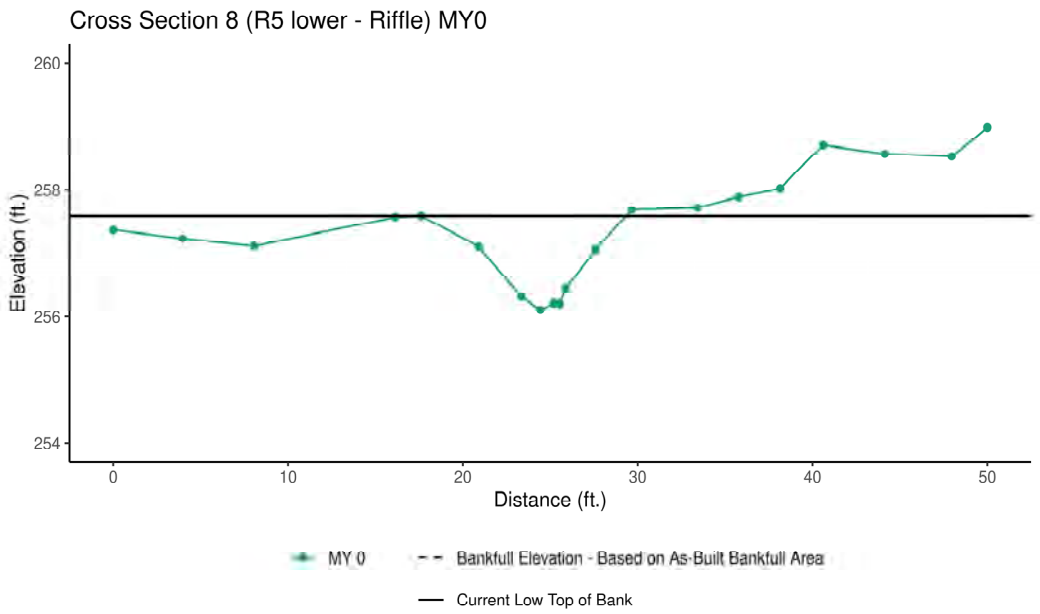
Distance	Elevation	Features
0	261.605	TLP
4	261.405	
8	261.465	
12	261.535	
16	261.225	
20	261.085	
22	260.895	TLB
22.5	260.825	
22.8	260.375	
23.5	260.285	
24.4	260.335	THW
25.4	260.385	
26	260.365	
26.9	260.605	
27.7	260.855	TRB, BKF
30	260.745	
34	260.615	
38	260.345	
42	260.305	
46	260.005	
50	259.985	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	260.86							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	260.34							
LTOB Elevation	260.86							
LTOB Max Depth	0.52							
LTOB Cross Sectional Area	2.10							



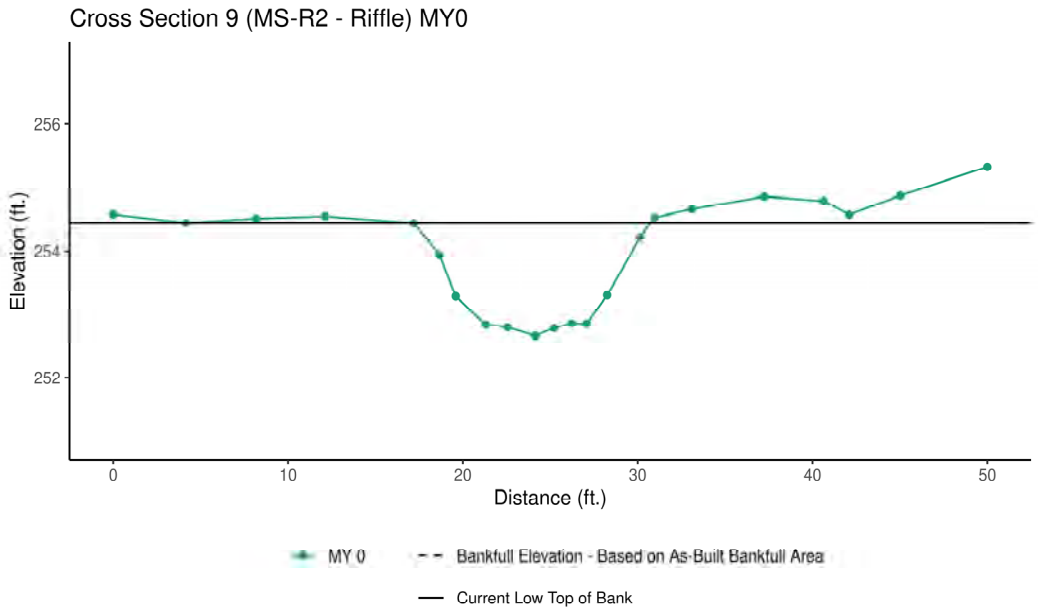
Distance	Elevation	Features
0	262.861	TLP
4.29153877	262.559	
8.13661066	262.156	
12.155325	262.183	
16.2040094	262.202	
19.2151351	261.95	TLB, BKF
21.0285011	261.572	
23.1769196	260.942	LEW
24.0346089	260.813	
24.4363263	260.537	THW
25.2756042	260.709	
25.6875562	260.913	REW
26.6842696	261.156	
27.6593441	261.486	
28.8831093	262.014	TRB
31.2480915	261.985	
35.1307878	261.835	
42.4778166	261.067	
47.2457422	260.645	
50	260.65	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	261.95							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	260.54							
LTOB Elevation	261.95							
LTOB Max Depth	1.413							
LTOB Cross Sectional Area	6.62							



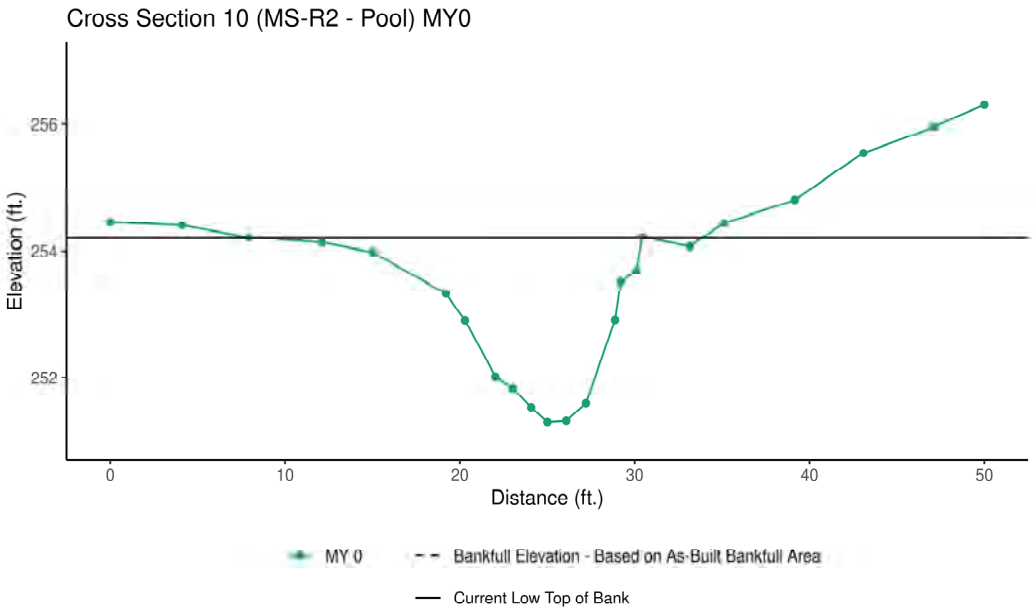
Distance	Elevation	Features
0	257.362	TLP
3.96904334	257.223	
8.06162887	257.106	
16.1082859	257.565	
17.6152051	257.586	TLB, BKF
20.9150235	257.097	
23.3536575	256.308	LEW
24.4341095	256.107	THW
25.1959934	256.207	
25.5451463	256.202	
25.8891145	256.439	REW
27.5861522	257.053	
29.667025	257.688	TRB
33.3984039	257.717	
35.7601197	257.89	
38.1529983	258.021	
40.6094298	258.708	
44.1344083	258.565	
47.9582985	258.525	
50	258.976	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	257.59							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	256.11							
LTOB Elevation	257.59							
LTOB Max Depth	1.479							
LTOB Cross Sectional Area	8.35							



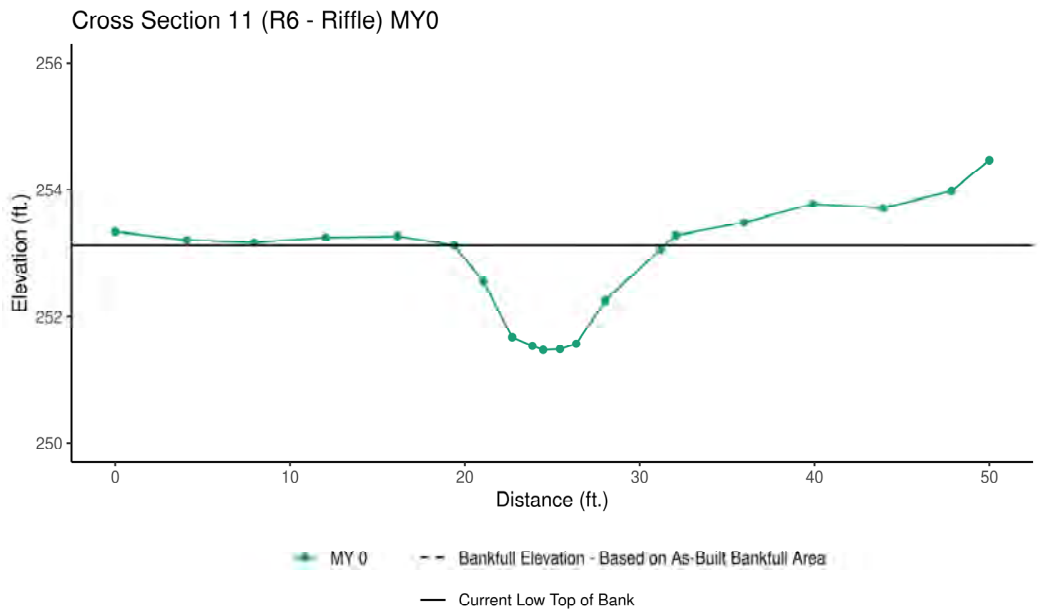
Distance	Elevation	Features
0	254.58	TLP
4.17429575	254.443	
8.15994473	254.513	
12.126084	254.55	
17.1879714	254.438	TLB, BKF
18.6638767	253.942	
19.591683	253.28	LEW
21.3178804	252.842	
22.5509993	252.801	
24.1406265	252.662	THW
25.2093326	252.787	
26.2245229	252.862	
27.0755113	252.858	
28.2526602	253.297	REW
30.1390965	254.217	
30.9691165	254.53	TRB
33.0877724	254.662	
37.2234589	254.865	
40.6448202	254.794	
42.094684	254.574	
45.027072	254.884	
50	255.322	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	254.44							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	252.66							
LTOB Elevation	254.44							
LTOB Max Depth	1.776							
LTOB Cross Sectional Area	15.98							



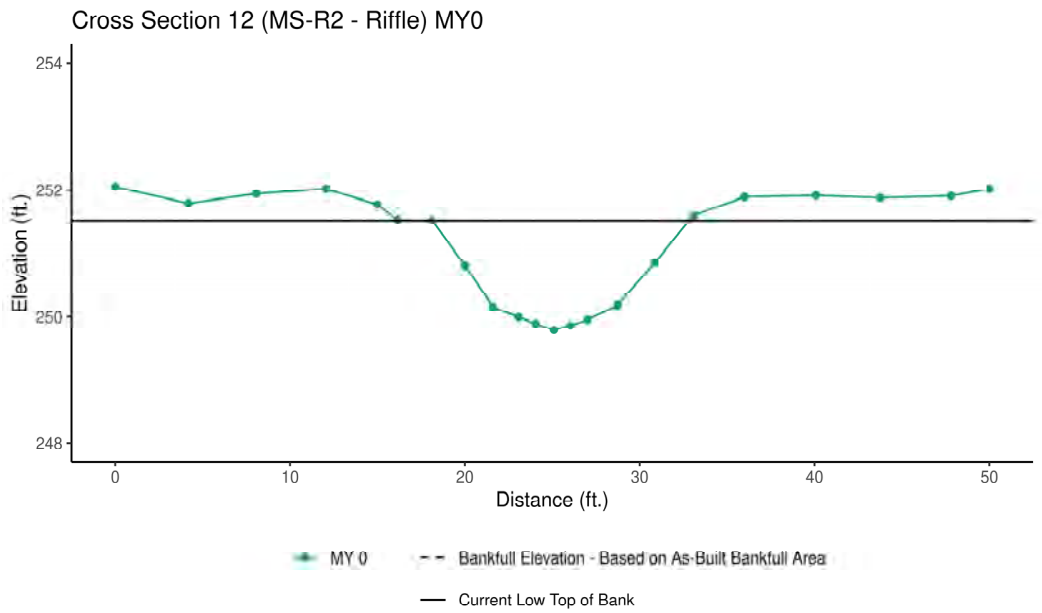
Distance	Elevation	Features
0	254.455	TLP
4.09334338	254.406	
7.95182155	254.212	TLB, BKF
12.1106106	254.132	
15.0386239	253.98	
19.2007982	253.325	
20.289034	252.906	LEW
22.0291437	252.014	
23.0310421	251.83	
24.0792854	251.523	
25.0053388	251.289	THW
26.0875891	251.31	
27.2109596	251.591	
28.8779685	252.912	REW
29.2014582	253.515	
30.098502	253.687	
30.4211246	254.218	TRB
33.1423322	254.072	
35.1123414	254.437	
39.1518392	254.81	
43.0858957	255.544	
47.1274395	255.961	
50	256.302	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	254.21							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	251.29							
LTOB Elevation	254.21							
LTOB Max Depth	2.923							
LTOB Cross Sectional Area	25.22							



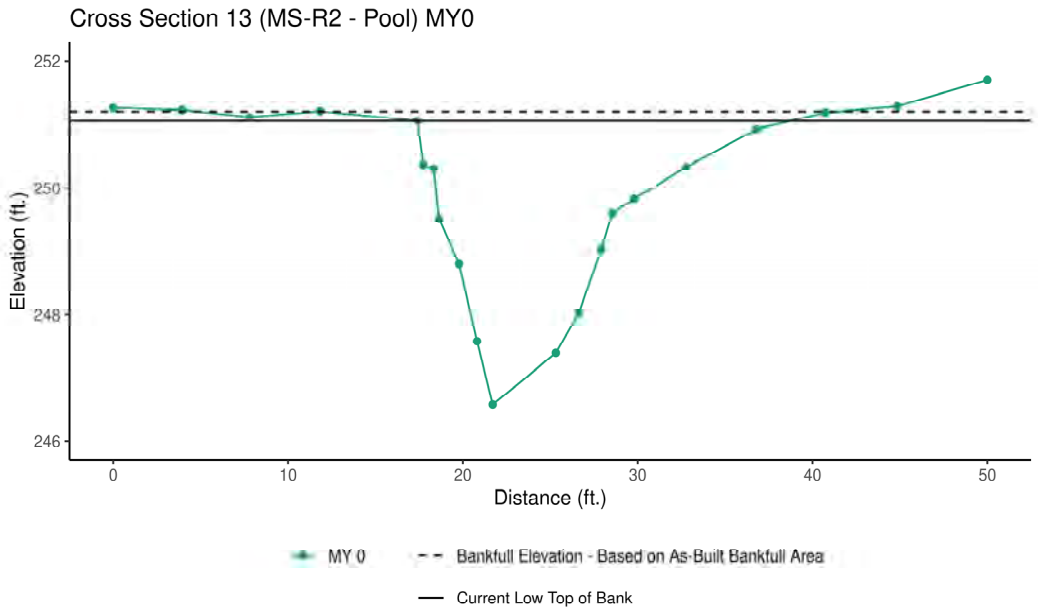
Distance	Elevation	Features
0	253.334	TLP
4.08197611	253.198	
7.96135328	253.158	
12.0295857	253.24	
16.1486042	253.261	
19.4126493	253.114	TLB, BKF
21.0621057	252.552	
22.7074694	251.666	LEW
23.8626661	251.528	
24.4786479	251.463	THW
25.4414381	251.476	
26.3680034	251.561	REW
28.033879	252.252	
31.1953324	253.062	
32.0759926	253.274	TRB
35.9603049	253.482	
39.9212964	253.779	
43.9225064	253.713	
47.8438382	253.985	
50	254.456	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	253.11							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	251.46							
LTOB Elevation	253.11							
LTOB Max Depth	1.651							
LTOB Cross Sectional Area	11.39							



Distance	Elevation	Features
0	252.051	TLP
4.18465542	251.791	
8.07118095	251.945	
12.0441937	252.019	
15.0044666	251.772	
16.1421045	251.522	
18.1086422	251.514	TLB, BKF
20.0084893	250.804	
21.6057972	250.149	LEW
23.0715723	249.996	
24.0562604	249.883	
25.0945931	249.785	THW
26.0373699	249.859	
27.0166756	249.951	
28.7324578	250.179	REW
30.8660824	250.849	
33.0908138	251.592	TRB
35.9940361	251.894	
40.0830887	251.916	
43.7727606	251.879	
47.8003477	251.91	
50	252.02	TRP

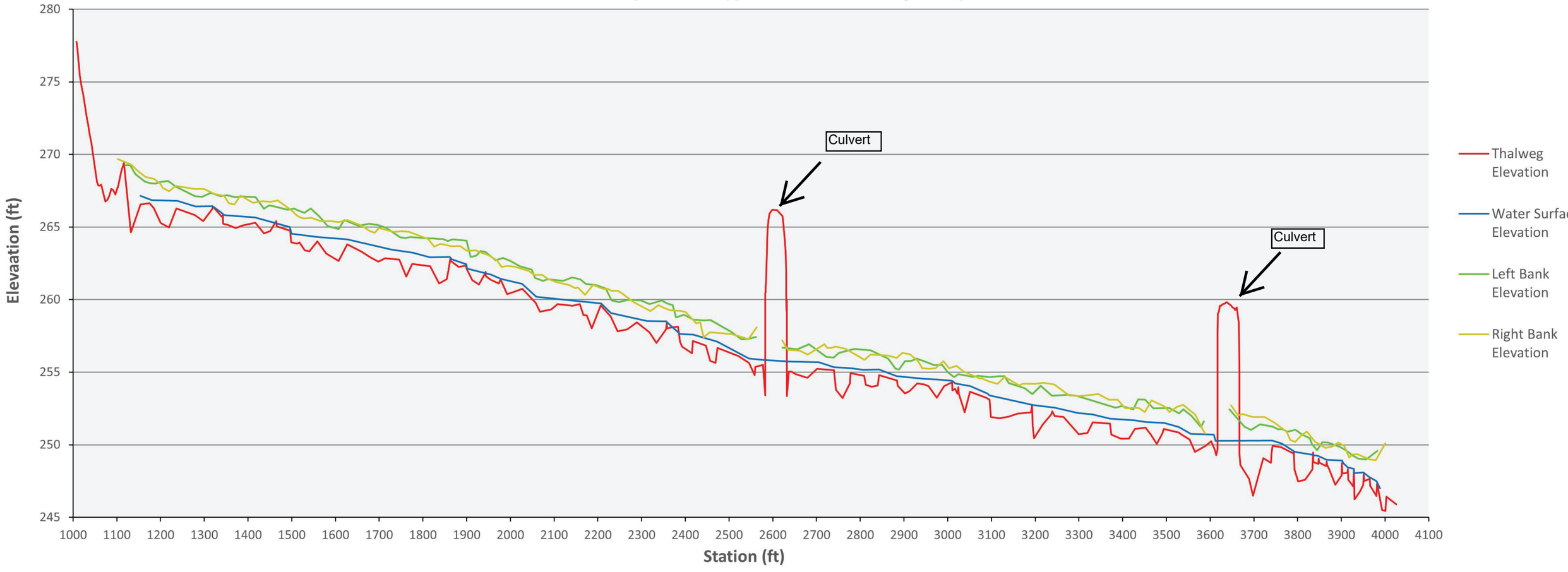
	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	251.51							
Bank Height Ratio - Based on As-Built Bankfull Area	1.00							
Thalweg Elevation	249.79							
LTOB Elevation	251.51							
LTOB Max Depth	1.729							
LTOB Cross Sectional Area	16.19							

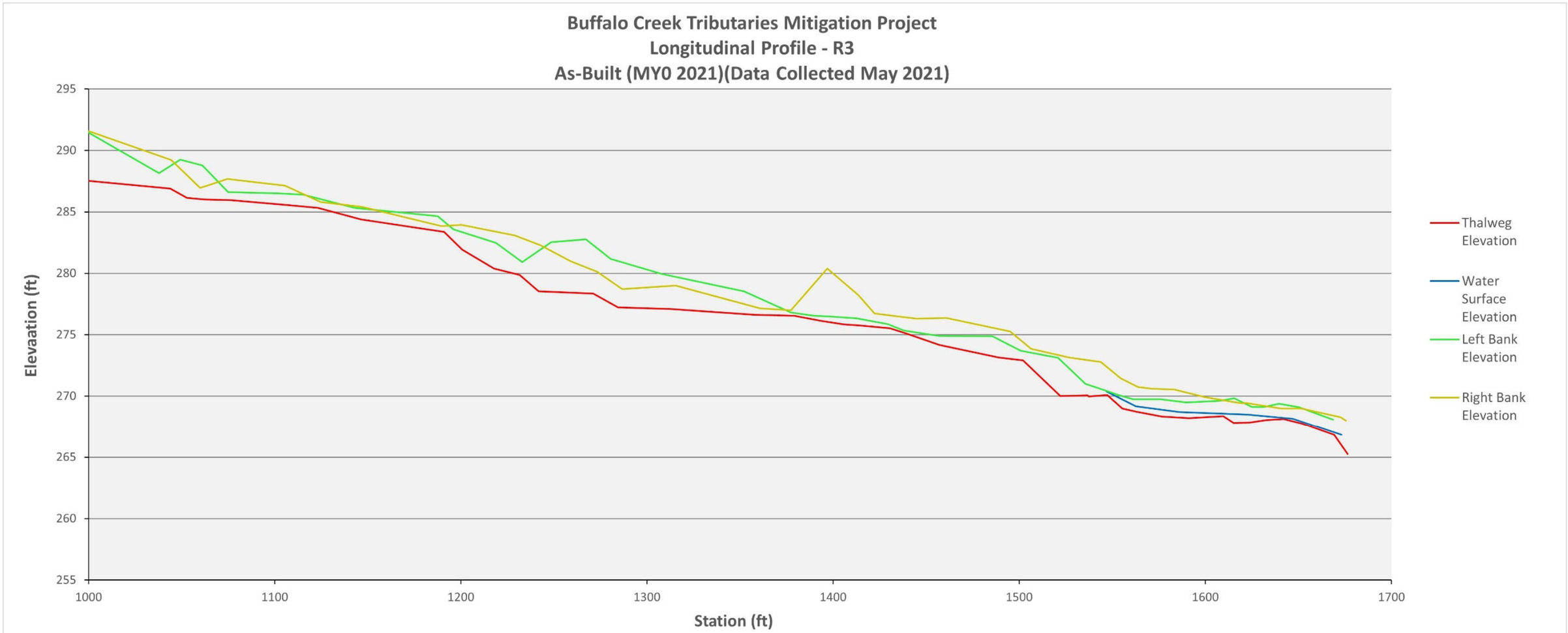


Distance	Elevation	Features
0	251.258	TLP
3.938218	251.224	
7.80778125	251.112	
11.831754	251.205	
17.4038017	251.051	TLB
17.7413312	250.357	
18.3319201	250.295	LEW
18.6379307	249.505	
19.7791131	248.801	
20.809455	247.571	THW
21.7059884	246.571	
25.3179224	247.384	
26.631151	248.02	
27.9201431	249.027	
28.549506	249.595	REW
29.8074607	249.831	
32.7719437	250.322	
36.7940144	250.924	
40.7058469	251.179	TRB, BKF
44.8508027	251.28	
50	251.704	TRP

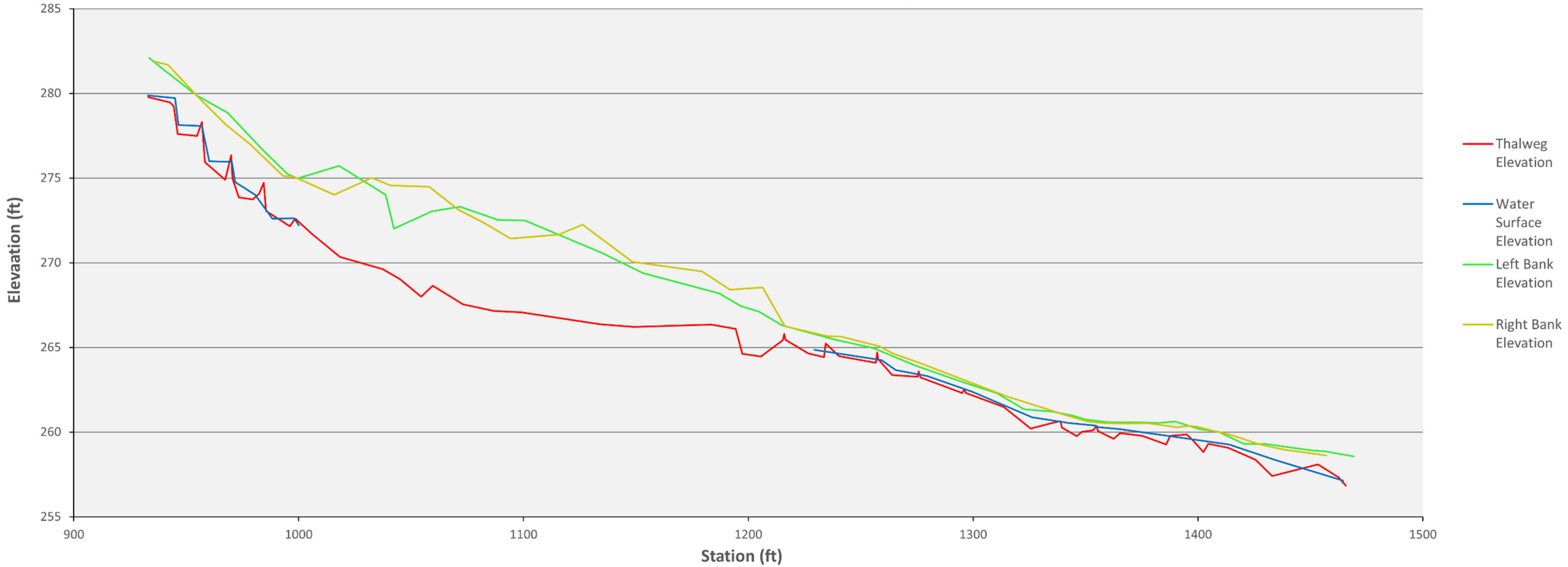
	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	251.18							
Bank Height Ratio - Based on As-Built Bankfull Area	0.96							
Thalweg Elevation	247.57							
LTOB Elevation	251.05							
LTOB Max Depth	3.48							
LTOB Cross Sectional Area	35.74							

Buffalo Creek Tributaries Mitigation Project
Longitudinal Profile - MS-R1, MS-R2
As-Built (MY0 2021)(Data Collected May 2021)

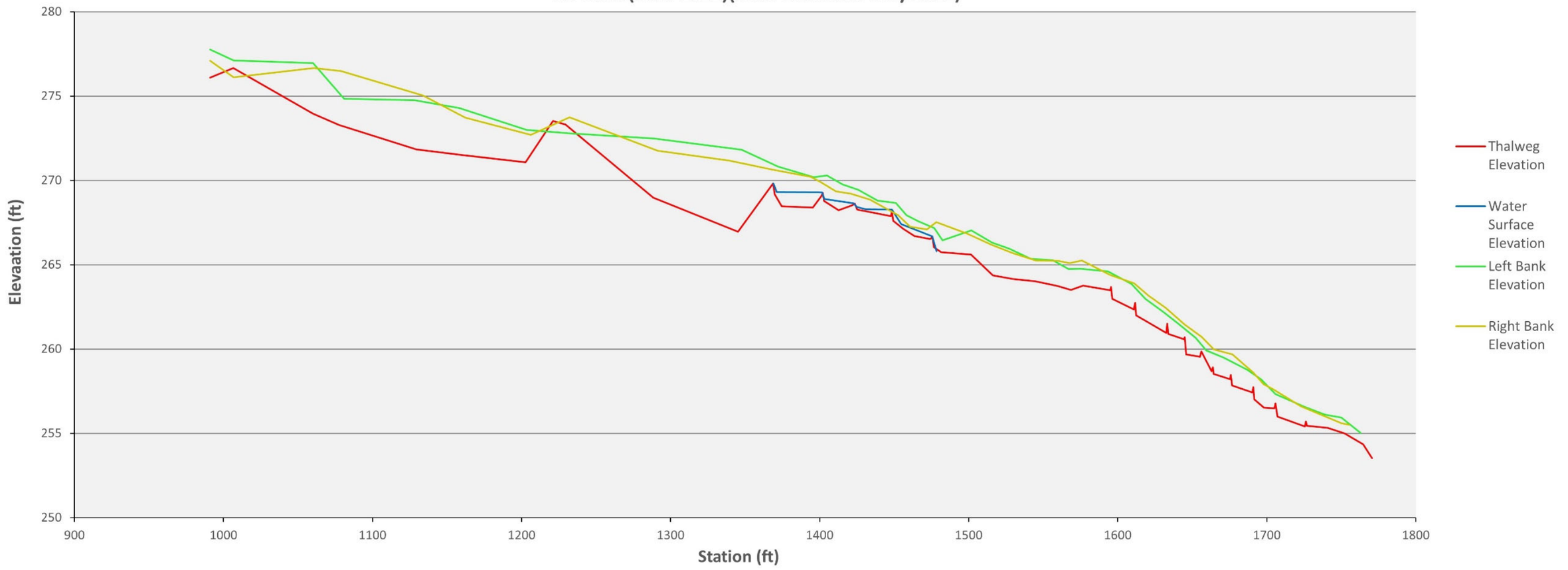



Buffalo Creek Tributaries Mitigation Project
Longitudinal Profile - R3
As-Built (MY0 2021)(Data Collected May 2021)
Elevation (ft)
295
290
285
280
275
270
265
260
255
1000
1100
1200
1300
1400
1500
1600
1700
Station (ft)
Thalweg Elevation
Water Surface Elevation
Left Bank Elevation
Right Bank Elevation

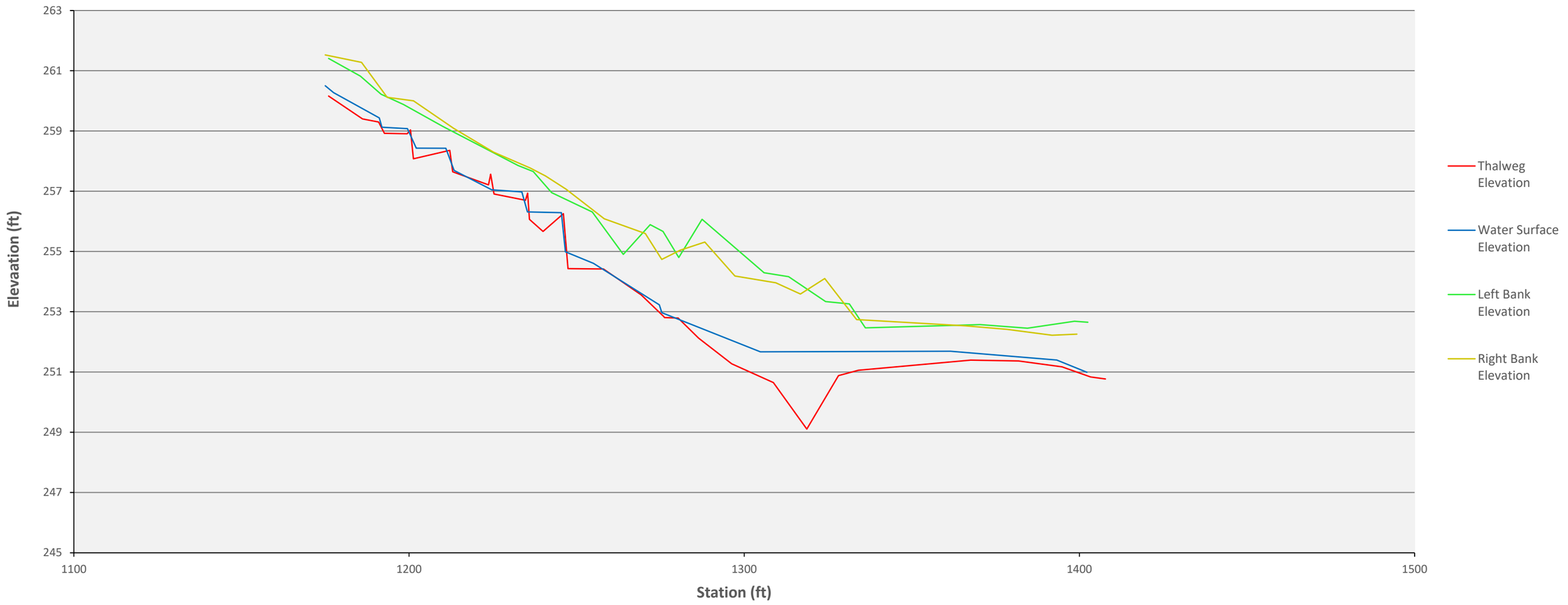
Buffalo Creek Tributaries Mitigation Project
Longitudinal Profile - R4
As-Built (MY0 2021)(Data Collected May 2021)



Buffalo Creek Tributaries Mitigation Project
Longitudinal Profile - R5
As-Built (MY0 2021)(Data Collected May 2021)



Buffalo Creek Tributaries Mitigation Project
Longitudinal Profile - R6
As-Built (MY0 2021)(Data Collected May 2021)



Baseline Stream Data Summary (Data Collected May 2021)
Buffalo Creek Tributaries Mitigation Project: MS-R1

Parameter	Pre-Existing Condition (applicable)					Design		Monitoring Baseline (MY0)		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)		10.6			1.0		14.0		15.1	2.0
Floodprone Width (ft)		12.5			1.0	65.0	80.0		80.0	2.0
Bankfull Mean Depth (ft)		1.6			1.0		1.2		1.1	2.0
Bankfull Max Depth (ft)		1.8			1.0		1.5		1.6	2.0
Bankfull Cross Sectional Area (ft^2)		17.2			1.0		16.5		16.2	2.0
Width/Depth Ratio		6.6			1.0		11.9		14.1	2.0
Entrenchment Ratio		1.2			1.0	4.6	5.7		3.3	2.0
Bank Height Ratio		2.6			1.0		1.0		1.0	2.0
Max part size (mm) mobilized at bankfull	84					79		87		
Rosgen Classification	G4c					C4		C4		
Bankfull Discharge (cfs)	70.0					70.0		70.0		
Sinuosity (ft)	1.36					1.22		1.19		
Water Surface Slope (Channel) (ft/ft)	0.0058					0.0065		0.0078		
Other										

Baseline Stream Data Summary
Buffalo Creek Tributaries Mitigation Project: R3 (lower)

Parameter	Pre-Existing Condition (applicable)					Design		Monitoring Baseline (MY0)		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)		7.1			1.0		5.5		8.3	1.0
Floodprone Width (ft)		22.0			1.0	20.0	25.0		43.0	1.0
Bankfull Mean Depth (ft)		0.5			1.0		0.4		0.8	1.0
Bankfull Max Depth (ft)		0.8			1.0		0.5		1.6	1.0
Bankfull Cross Sectional Area (ft^2)		3.7			1.0		2.1		6.9	1.0
Width/Depth Ratio		13.6			1.0		14.2		10.0	1.0
Entrenchment Ratio		3.1			1.0	3.6	4.6		5.2	1.0
Bank Height Ratio		1.0			1.0		1.0		1.0	1.0
Max part size (mm) mobilized at bankfull	156					125		168		
Rosgen Classification	G5					B4		B4		
Bankfull Discharge (cfs)	12.0					12.0		12.0		
Sinuosity (ft)	1.12					1.13		1.14		
Water Surface Slope (Channel) (ft/ft)	0.0362					0.0363		0.0289		
Other										

Baseline Stream Data Summary
Buffalo Creek Tributaries Mitigation Project: MS-R2

Parameter	Pre-Existing Condition (applicable)					Design		Monitoring Baseline (MY0)		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)		10.2			1.0		14.5		14.7	2.0
Floodprone Width (ft)		51.9			1.0	60.0	90.0		90.0	2.0
Bankfull Mean Depth (ft)		1.6			1.0		1.2		1.1	2.0
Bankfull Max Depth (ft)		2.3			1.0		1.6		1.7	2.0
Bankfull Cross Sectional Area (ft^2)		16.1			1.0		18.0		16.1	2.0
Width/Depth Ratio		6.4			1.0		11.7		13.4	2.0
Entrenchment Ratio		5.1			1.0	4.1	6.2		3.4	2.0
Bank Height Ratio		1.6			1.0		1.0		1.0	2.0
Max part size (mm) mobilized at bankfull	69					69		71		
Rosgen Classification	G4c/Incised E4					C4		C4		
Bankfull Discharge (cfs)	75.0					75.0		75.0		
Sinuosity (ft)	1.26					1.11		1.11		
Water Surface Slope (Channel) (ft/ft)	0.0045					0.0052		0.0059		
Other										

Baseline Stream Data Summary
Buffalo Creek Tributaries Mitigation Project: R4

Parameter	Pre-Existing Condition (applicable)					Design		Monitoring Baseline (MY0)		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)					0.0		5.5		5.4	1.0
Floodprone Width (ft)					0.0	10.0	15.0		35.0	1.0
Bankfull Mean Depth (ft)					0.0		0.4		0.4	1.0
Bankfull Max Depth (ft)					0.0		0.6		0.9	1.0
Bankfull Cross Sectional Area (ft^2)					0.0		2.3		2.2	1.0
Width/Depth Ratio					0.0		12.9		13.6	1.0
Entrenchment Ratio					0.0	1.8	2.7		9.2	1.0
Bank Height Ratio					0.0		1.0		1.0	1.0
Max part size (mm) mobilized at bankfull						138		120		
Rosgen Classification	G5c/C5					B4		B4		
Bankfull Discharge (cfs)	10.0					10.0		10.0		
Sinuosity (ft)	1.07					1.05		1.09		
Water Surface Slope (Channel) (ft/ft)	0.0371					0.038		0.034		
Other										

Baseline Stream Data Summary Buffalo Creek Tributaries Mitigation Project: R5										
Parameter	Pre-Existing Condition (applicable)					Design		Monitoring Baseline (MY0)		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)		2.8			1.0		5.0		9.5	2.0
Floodprone Width (ft)		26.2			1.0	10.0	25.0		25.0	2.0
Bankfull Mean Depth (ft)		0.8			1.0		0.3		0.7	2.0
Bankfull Max Depth (ft)		1.0			1.0		0.5		1.4	2.0
Bankfull Cross Sectional Area (ft^2)		2.1			1.0		1.7		6.6	2.0
Width/Depth Ratio		3.7			1.0		14.8		13.7	2.0
Entrenchment Ratio		9.3			1.0	2.0	5.0		5.3	2.0
Bank Height Ratio		1.8			1.0		1.0		1.0	2.0
Max part size (mm) mobilized at bankfull	134					96		195		
Rosgen Classification	E5b					B4		B4		
Bankfull Discharge (cfs)	7.0					7.0		7.0		
Sinuosity (ft)	1.14					1.10		1.07		
Water Surface Slope (Channel) (ft/ft)	0.0275					0.0287		0.0361		
Other										

Baseline Stream Data Summary Buffalo Creek Tributaries Mitigation Project: R6										
Parameter	Pre-Existing Condition (applicable)					Design		Monitoring Baseline (MY0)		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)		4.2			1.0		6.0		12.0	1.0
Floodprone Width (ft)		7.9			1.0	25.0	30.0		50.0	1.0
Bankfull Mean Depth (ft)		0.5			1.0		0.4		0.9	1.0
Bankfull Max Depth (ft)		0.8			1.0		0.6		1.7	1.0
Bankfull Cross Sectional Area (ft^2)		2.1			1.0		2.2		11.4	1.0
Width/Depth Ratio		8.2			1.0		16.4		12.6	1.0
Entrenchment Ratio		1.9			1.0	4.2	5.0		4.2	1.0
Bank Height Ratio		1.3			1.0		1.0		1.0	1.0
Max part size (mm) mobilized at bankfull	199					171		262		
Rosgen Classification	B5a					B4		B4		
Bankfull Discharge (cfs)	12.0					12.0		12.0		
Sinuosity (ft)	1.13					1.11		1.10		
Water Surface Slope (Channel) (ft/ft)	0.0566					0.0574		0.042		
Other										

Monitoring Data - Cross Section Morphology Monitoring Summary

Buffalo Creek Tributaries Mitigation Project, DMS Project #100042

	Cross-Section 1 (Riffle - R3 lower)							Cross-Section 2 (Pool - MS-R1)							Cross-Section 3 (Riffle - MS-R1)							Cross-Section 4 (Pool - MS-R1)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	269.76							266.51							266.54							260.58						
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00							1.00							1.00							1.00						
Thalweg Elevation	268.18							264.61							265.08							257.83						
LTOB[2] Elevation	269.76							266.51							266.54							260.58						
LTOB[2] Max Depth (ft)	1.58							1.90							1.46							2.75						
LTOB[2] Cross Sectional Area (ft^2)	6.88							15.14							15.47							23.68						

	Cross-Section 5 (Riffle - MS-R1)							Cross-Section 6 (Riffle - R4)							Cross-Section 7 (Riffle - R5 lower)							Cross-Section 8 (Riffle - R5 lower)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	259.95							260.86							261.95							257.59						
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00							1.00							1.00							1.00						
Thalweg Elevation	258.52							260.34							260.54							256.11						
LTOB[2] Elevation	259.95							260.86							261.95							257.59						
LTOB[2] Max Depth (ft)	1.43							0.52							1.41							1.48						
LTOB[2] Cross Sectional Area (ft^2)	12.96							2.10							6.62							8.35						

	Cross-Section 9 (Riffle - MS-R2)							Cross-Section 10 (Pool - MS-R2)							Cross-Section 11 (Riffle - R6)							Cross-Section 12 (Riffle - MS-R2)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	254.44							254.21							253.11							251.51						
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00							1.00							1.00							1.00						
Thalweg Elevation	252.66							251.29							251.46							249.79						
LTOB[2] Elevation	254.44							254.21							253.11							251.51						
LTOB[2] Max Depth (ft)	1.78							2.92							1.65							1.73						
LTOB[2] Cross Sectional Area (ft^2)	15.98							25.22							11.39							16.19						

	Cross-Section 13 (Pool - MS-R2)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	251.18						
Bank Height Ratio_Based on AB Bankfull[1] Area	0.96						
Thalweg Elevation	247.57						
LTOB[2] Elevation	251.05						
LTOB[2] Max Depth (ft)	3.48						
LTOB[2] Cross Sectional Area (ft^2)	35.74						

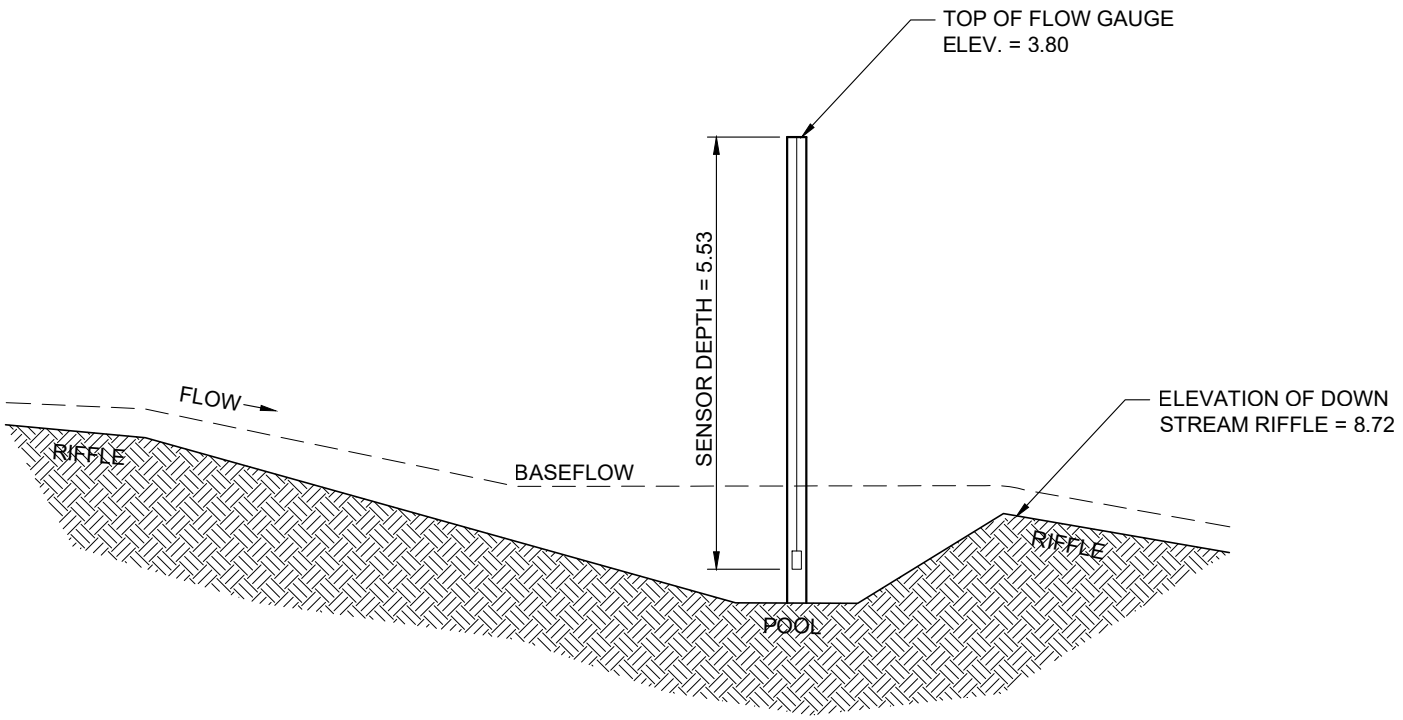
The above morphology parameters reflect the 2018 guidance that arose from the mitigation technical workgroup consisting of DMS, the IRT and industry mitigation providers/practitioners. The outcome resulted in the focus on three primary morphological parameters of interest for the purposes of tracking channel change moving forward. They are the bank height ratio using a constant As-built bankfull area and the cross sectional area and max depth based on each years low top of bank. These are calculated as follows:

1 - **Bank Height Ratio (BHR)** takes the As-built bankful area as the basis for adjusting each subsequent years bankfull elevation. For example if the As-built bankfull area was 10 ft2, then the MY1 bankfull elevation would be adjusted until the calculated bankfull area within the MY1 cross section survey = 10 ft2. The BHR would then be calculated with the difference between the low top of bank (LTOB) elevation for MY1 and the thalweg elevation for MY1 in the numerator with the difference between the MY1 bankfull elevation and the MY1 thalweg elevation in the denominator. This same process is then carried out in each successive year.

2 - **LTOB Area and Max depth -** These are based on the LTOB elevation for each years survey (The same elevation used for the LTOB in the BHR calculation). Area below the LTOB elevation will be used and tracked for each year as above. The difference between the LTOB elevation and the thalweg elevation (same as in the BHR calculation) will be recroded and tracked above as LTOB max depth.

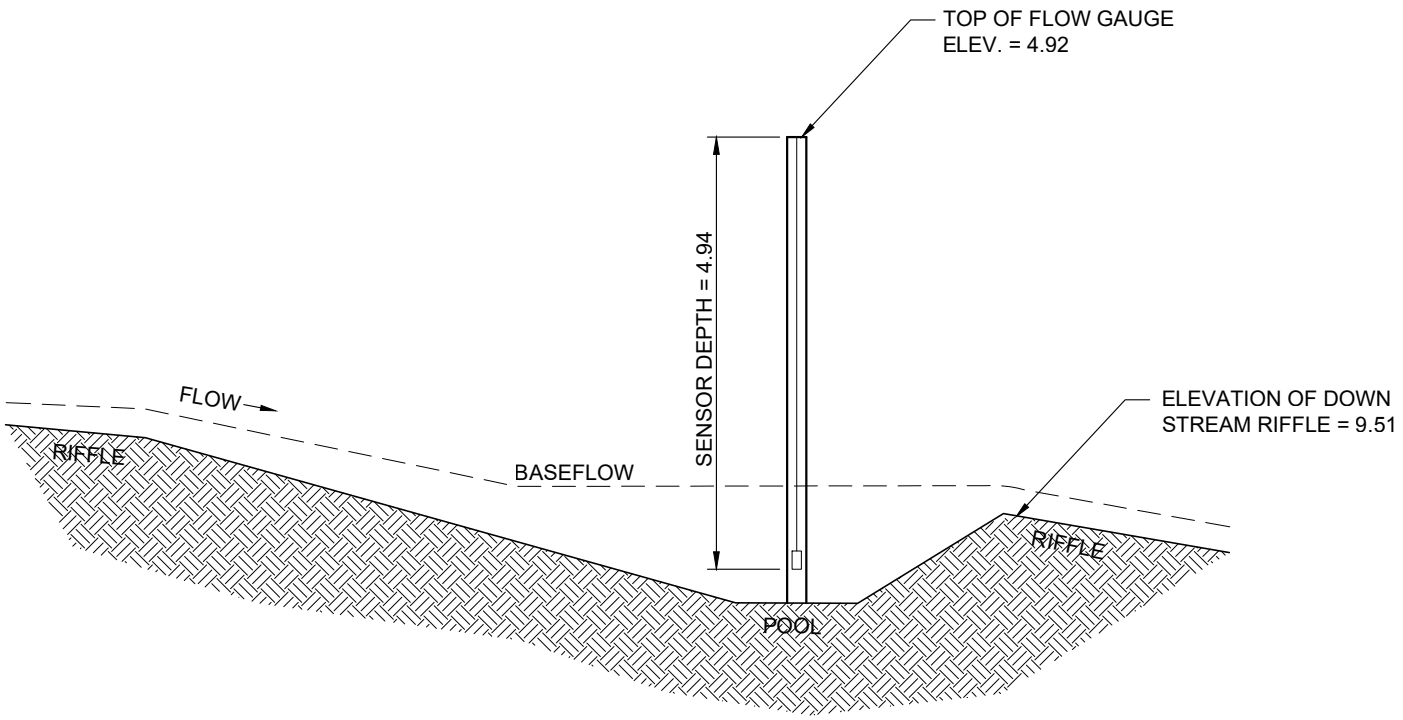
Appendix D:
Hydrologic Data

Flow Gauge Diagrams
Crest Gauge Diagram
Photos: Wetland Gauge and Surface Water Gauge Photos



FLOW GAUGE #1 - R4

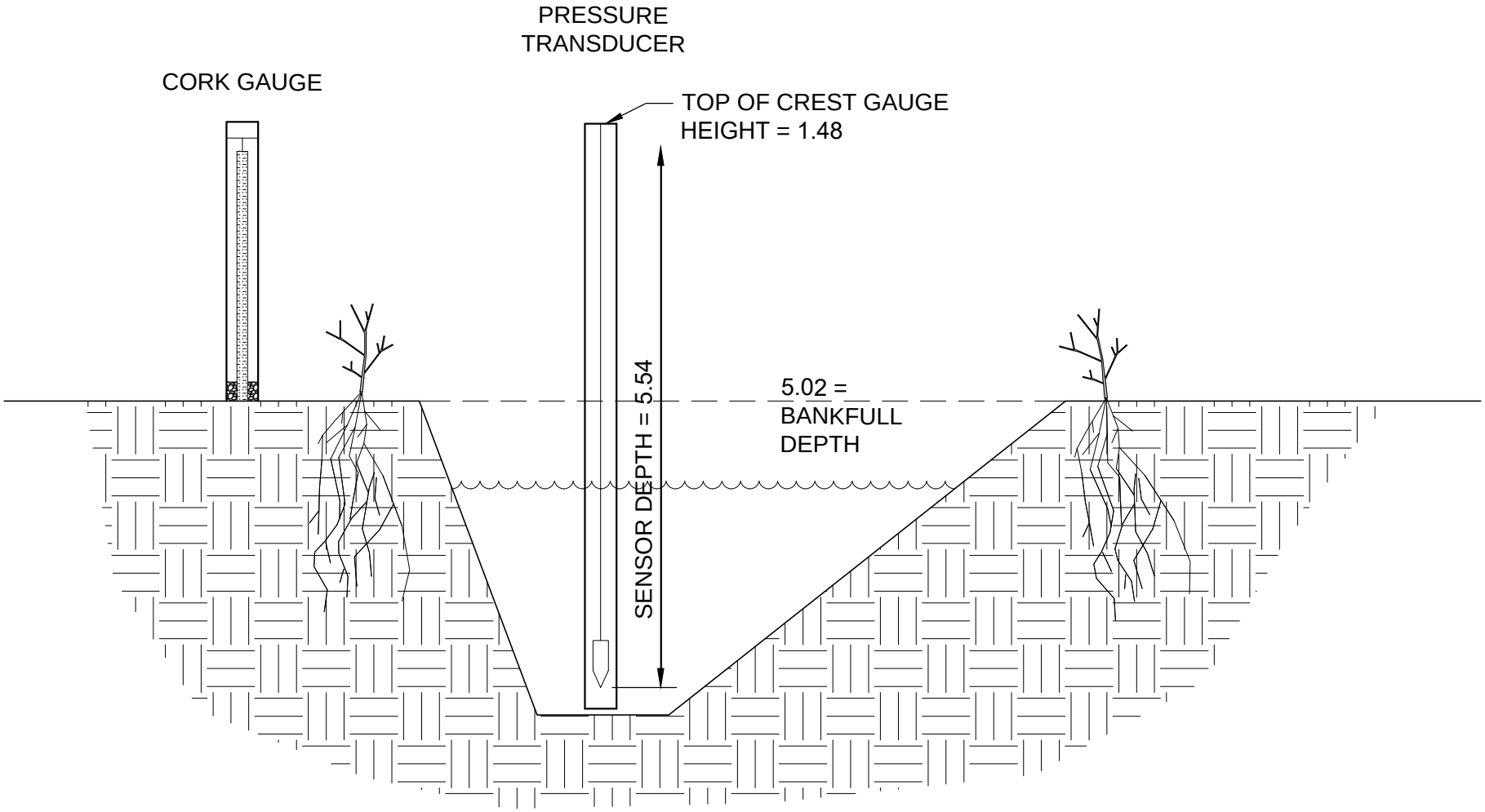
Flow Depth = Sensor Depth - (Top of Gague - Top of Riffle)
Flow Depth = 5.53 - (3.80 - 8.72)
Flow Depth = 0.61 feet



FLOW GAUGE #2 - R6

Flow Depth = Sensor Depth - (Top of Gauge - Top of Riffle)
Flow Depth = 4.94 - (4.92 - 9.51)
Flow Depth = 0.35 feet

CROSS SECTIONAL VIEW OF STREAM



Crest Gauge CG-1 (MS-R2)

Bankfull Event Depth (for transducer) = Sensor Depth - (Top of Gauge - Bankfull Depth)

Bankfull Event Depth = 5.54 - (1.48 - 5.02)

Bankfull Event Depth = 2.00

Flow Gauge (FG-1) – R4

Flow Gauge (FG-2) – R6

Crest Gauge (CG-1, Pressure Transducer) – MS-R2

Crest Gauge (CG-1, Cork) – MS-R2

Wetland Gauge (WG-1) – W1

Wetland Gauge (WG-2) – W1

Wetland Gauge (WG-3) – W1

Wetland Gauge (WG-4) – W2

Wetland Gauge (WG-5) – W2

Wetland Gauge (WG-6) – W2

Wetland Gauge (WG-7) – W3

Appendix E:
Project Timeline and Contact Info

Activity or Deliverable	Data Collection Complete	Task Completion or Deliverable Submission
Project Instituted	NA	1/2/2018
Mitigation Plan Approved	NA	6/29/2020
Construction (Grading) Completed	NA	4/22/2021
Planting Completed	NA	4/26/2021
As-built Survey Completed	NA	6/16/2021
MY-0 Baseline Report	05/04/21	6/17/2021
MY1+ Monitoring Reports		
Remediation Items (e.g. beaver removal, supplements, repairs etc.)		
Encroachment		

Buffalo Creek Tributaries Mitigaiton Project: DMS #100042	
Provider	7721 Six Forks Road, Suite 130
Water & Land Solutions, LLC	Raleigh, NC 27615
Mitigation Provider POC: Emily Dunnigan	(571) 643-3165
Designer	7721 Six Forks Road, Suite 130
Water & Land Solutions, LLC	Raleigh, NC 27615
Primary project design POC: Christopher Tomsic	(828) 493-3287
Construction Contractor	114 W. Main Street
Providence Construction Services, LLC	Clayton, NC 27520
Primary Construction POC: Mike Rouse	(919) 805-6324

Appendix F:
Other Data

Macrobenthos Sampling Data

Macrobenthic Sampling Data

MS-R2 - Buffalo Creek Mitigation Site			
Monitoring Year	MY0		
Biotic Index Score	6.83		
Water Quality Level	Fair		

View Upstream

View Downstream

Buffalo Creek Tributaries 6/5/2020	
Taxa / Biotic Index Value	
EPHEMEROPTERA	
Family Baetidae	
Baetis intercalaris (5.0)	
Family Heptageniidae	
Maccaffertium modestum (5.7)	R
TRICHOPTERA	
Family Hydropsychidae	
Cheumatopsyche spp (6.6)	A
Hydropsyche betteni (7.9)	A
Family Philopotamidae	
Chimarra spp (3.3)	R
MISC DIPTERA	
Family Ptychopteridae	
Bittacomorpha spp	
Family Tipulidae	
Tipula spp (7.5)	
COLEOPTERA	
Family Elmidae	
Macronychus glabratus (4.7)	R
ODONATA	
Family Aeshnidae	
Boyeria vinosa (5.6)	R
Family Calopterygidae	
Calopteryx spp (7.5)	C
Family Coenagrionidae	
Enallagma sp (8.5)	
Ischnura spp (9.5)	
Family Corduliidae	
Neurocordulia spp (5.3)	
Family Cordulegastridae	
Cordulegaster spp (5.7)	C
Family Gomphidae	
Progomphus (8.2)	
Family Libellulidae	
Eurythemis simplicicollis	
OLIGOCHAETA	
Family Naididae	
Pristina spp (7.7)	R
Spirosperma nicolskyi (6.0)	
Stylaria lacustris (8.4)	
MEGALOPTERA	
Family Corydalidae	
Nigronia serricornis (4.6)	C
CRUSTACEA	
Family Asellidae	
Caecidotea spp (8.4)	
Other Arthropods	
Daphnia	
Copepoda	
MOLLUSCA	
Family Ancylidae	
Laevapex spp (6.6)	
Family Lymnaeidae	
Pseudosuccinea columella (7.7)	
Total Taxa Richness	10
EPT Taxa Richness	4
EPT Abundance	22
Biotic Index	**6.83**

BENTHOS COLLECTION CARD

DATE 6/5/20 COLLECT TIME 10:18 AM COLLECTORS KD/ED CARD# 1

WATERBODY MS-R3 BUFFALO

STAT. LOC. 35.72344 -78.34350 RIVER BASIN NEUSE COUNTY JOHNSTON

Substrate:

Boulder (10")	0	%
Cobble (2.5"-10")	5	%
Gravel (0.1"-2.5")	75	%
Sand (1-0.1")	20	%
Silt/fine Particle	5	%
Other	0	%

River:

Mean depth	0.3'
Maximum depth	0.5'
Width	9.0'
Current	Strong
Recent Rain?	NO

Field Parameters:

Bank Erosion	N ___ Mod X Sev ___
Canopy	%100 Type Mature
Aufwuchs	N — Mod ___ Abund ___
Fodostemum	N — Mod ___ Abund ___
Tribs Present?	___

Photos (=) ___

Instream Habitat: (0,+,++)

Pools	+	Backwaters	6
Riffles	++	Detritus	+
Snags	+	Aquatic Weeds	0
Undercut Banks	++	Other	0
Root Mats	0		

Samples: (=)

Kicks	1
Sweeps	2
Leaf Packs	1
Rock/Log	—
Sand	—
Visuals	2
Other	—

Water Chemistry:

Temperature (°C)	___
Dissolved Oxygen (mg/L)	___
Conductivity (umhos/cm)	___
pH	___

YSI Malfunction

Field Observations RIFFLE

11/13 Revision 8

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Branch, DWR **TOTAL SCORE 88**

Directions for use: The observer is to survey a **minimum of 100 meters with 200 meters preferred** of stream, preferably in an **upstream** direction starting above the bridge pool and the road right-of-way. The segment which is assessed should represent average stream conditions. To perform a proper habitat evaluation the observer needs to get into the stream. To complete the form, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. A final habitat score is determined by adding the results from the different metrics.

MS-2

Stream UT BUFFALO CREEK Location/road: Salem Church (Road Name Rd) County JOHNSTON

Date 6-5-2020 **CC#** 1/1 **Basin** NEUSE **Subbasin** BUFFALO CREEK

Observer(s) KD/ED Type of Study: ☐ Fish ☒ Benthos ☐ Basinwide ☐ Special Study (Describe) _____

Latitude 35.72344 Longitude -78.34350 Ecoregion: ☐ MT ☒ P ☐ Slate Belt ☐ Triassic Basin

Water Quality: Temperature _____ °C DO _____ mg/l Conductivity (corr.) _____ µS/cm pH _____
NOT TAKEN

Physical Characterization: Visible land use refers to immediate area that you can see from sampling location - include what you estimate driving thru the watershed in watershed land use.

Visible Land Use: 75 %Forest 10 %Residential _____ %Active Pasture _____ % Active Crops _____ %Fallow Fields _____ %
Commercial 15 %Industrial _____ %Other - Describe: _____
(School)

Watershed land use : ☒ Forest ☐ Agriculture ☐ Urban ☐ Animal operations upstream

Width: (~~meters~~ ft) Stream 9.0' Channel (at top of bank) 15.0' **Stream Depth:** (ft) Avg 0.3' Max 0.5' in Riffle
☒ Width variable ☐ Large river >25m wide

Bank Height (from deepest part of riffle to top of bank-first flat surface you stand on): (ft) 4.5'

Bank Angle: 80 ° or ☐ NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)

☐ Channelized Ditch
☐ Deeply incised-steep, straight banks ☐ Both banks undercut at bend ☐ Channel filled in with sediment
☐ Recent overbank deposits ☐ Bar development ☐ Buried structures ☐ Exposed bedrock

☐ Excessive periphyton growth ☐ Heavy filamentous algae growth ☐Green tinge ☐ Sewage smell
Manmade Stabilization: ☒N ☐Y: ☐Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐Berm/levee
Flow conditions : ☐High ☒Normal ☐Low
Turbidity: ☒Clear ☐ Slightly Turbid ☐Turbid ☐Tannic ☐Milky ☐Colored (from dyes)
Good potential for Wetlands Restoration Project?? ☒ YES ☐NO Details Hydric soils in flood plain, Stream heavily incised

Channel Flow Status

Useful especially under abnormal or low flow conditions.

A. Water reaches base of both lower banks, minimal channel substrate exposed	☐
B. Water fills >75% of available channel, or <25% of channel substrate is exposed	☒
C. Water fills 25-75% of available channel, many logs/snags exposed	☐
D. Root mats out of water	☐
E. Very little water in channel, mostly present as standing pools	☐

Weather Conditions: Normal **Photos:** ☐N ☒Y ☐ Digital ☐35mm

Remarks:

I. Channel Modification

	Score
A. channel natural, frequent bends	(5)
B. channel natural, infrequent bends (channelization could be old)	4
C. some channelization present	3
D. more extensive channelization, >40% of stream disrupted	2
E. no bends, completely channelized or rip rapped or gabioned, etc	0

☐ Evidence of dredging ☐Evidence of desnagging=no large woody debris in stream ☐Banks of uniform shape/height
Remarks Subtotal 5

II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. If >70% of the reach is rocks, 1 type is present, circle the score of 17. Definition: leafpacks consist of older leaves that are packed together and have begun to decay (not piles of leaves in pool areas). Mark as Rare, Common, or Abundant.

A **Rocks** R **Macrophytes** C **Sticks and leafpacks** C **Snags and logs** C **Undercut banks or root mats**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>70% Score	40-70% Score	20-40% Score	<20% Score
4 or 5 types present	20	(16)	12	8
3 types present	19	15	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

☐ No woody vegetation in riparian zone Remarks many banks unstable Subtotal 16

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) Look at entire reach for substrate scoring, but only look at riffle for embeddedness, and use rocks from all parts of riffle-look for "mud line" or difficulty extracting rocks.

	Score
A. substrate with good mix of gravel, cobble and boulders	
1. embeddedness <20% (very little sand, usually only behind large boulders)	15
2. embeddedness 20-40%	12
3. embeddedness 40-80%	8
4. embeddedness >80%	3
B. substrate gravel and cobble	
1. embeddedness <20%	(14)
2. embeddedness 20-40%	11
3. embeddedness 40-80%	6
4. embeddedness >80%	2
C. substrate mostly gravel	
1. embeddedness <50%	8
2. embeddedness >50%	4
D. substrate homogeneous	
1. substrate nearly all bedrock	3
2. substrate nearly all sand	3
3. substrate nearly all detritus	2
4. substrate nearly all silt/ clay	1

Remarks good gravel riffles Subtotal 14

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams, or side eddies.

	Score
A. Pools present	
1. Pools Frequent (>30% of 200m area surveyed)	
a. variety of pool sizes	(10)
b. pools about the same size (indicates pools filling in)	8

2. Pools Infrequent (<30% of the 200m area surveyed)
   a. variety of pools 6
   b. pools about the same size 4

B. Pools absent 0

Subtotal 10

☐ Pool bottom boulder-cobble=hard ☐ Bottom sandy-sink as you walk ☐ Silt bottom ☐ Some pools over wader depth

Remarks _____

Page Total 45

V. Riffle Habitats

Definition: Riffle is area of reaeration-can be debris dam, or narrow channel area.

	Riffles **Frequent** Score	Riffles **Infrequent** Score
A. well defined riffle and run, riffle as wide as stream and extends 2X width of stream....	(16)	12
B. riffle as wide as stream but riffle length is not 2X stream width	14	7
C. riffle not as wide as stream and riffle length is not 2X stream width	10	3
D. riffles absent.	0	

Channel Slope: ☐Typical for area ☐Steep=fast flow ☐Low=like a coastal stream

Subtotal 16

VI. Bank Stability and Vegetation

A. Erosion
1. No, or very little, erosion present 7
2. Erosion mostly at outside of meanders 6
3. Less than 50% of banks eroding 3
4. Massive erosion ..... (0)

Erosion Score 0

B. Bank Vegetation
1. Mostly mature trees (>12" DBH) present ..... (7)
2. Mostly small trees (<12" DBH) present, large trees rare 5
3. No trees on bank, can have some shrubs and grasses 3
4. Mostly grasses or mosses on bank 2
5. Little or no bank vegetation, bare soil everywhere 0

Vegetation Score 7

Remarks _____

Subtotal 7

VII. Light Penetration Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead. Note shading from mountains, but not use to score this metric.

	Score
A. Stream with **good** canopy with some breaks for light penetration	(10)
B. Stream with **full canopy** - breaks for light penetration absent.....	8
C. Stream with **partial** canopy - sunlight and shading are essentially equal.....	7
D. Stream with **minimal** canopy - full sun in all but a few areas.....	2
E. **No canopy** and no shading.....	0

Remarks _____ Subtotal 10

VIII. Riparian Vegetative Zone Width

Definition: Riparian zone for this form is area of natural vegetation adjacent to stream (can go beyond floodplain). Definition: A break in the riparian zone is any place on the stream banks which allows sediment or pollutants to directly enter the stream, such as paths down to stream, storm drains, uprooted trees, otter slides, etc.

FACE UPSTREAM	Lft. Bank Score	Rt. Bank Score
Dominant vegetation: ☒ Trees ☐ Shrubs ☐ Grasses ☐ Weeds/old field ☐ Exotics (kudzu, etc)		
A. Riparian zone **intact** (no breaks)		
1. width > 18 meters	(5)	(5)
2. width 12-18 meters	4	4
3. width 6-12 meters	3	3
4. width < 6 meters	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. width > 18 meters	4	4
b. width 12-18 meters	3	3
c. width 6-12 meters	2	2
d. width < 6 meters	1	1
2. breaks common		
a. width > 18 meters	3	3
b. width 12-18 meters	2	2
c. width 6-12 meters	1	1
d. width < 6 meters	0	0

Remarks _____ Subtotal 10

Page Total 43

☐ Disclaimer-form filled out, but score doesn't match subjective opinion-atypical stream. **TOTAL SCORE** 88