PHASE II
MONITORING YEAR 0
ANNUAL REPORT

May, 2024

MILLSTONE CREEK MITIGATION SITE
Randolph County, NC
Cape Fear River Basin
HUC 03030003

DMS Project No. # 204
NCDEQ Contract No. 6741
USACE Action ID No. 2018-01788
DWR Project No. 16-1200
Data Collection Dates: February 2024 – April 2024

PREPARED FOR:

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

EXECUTIVE SUMMARY

NC State University (NCSU) developed the design and mitigation plan and administered the construction for Phase II of a design-bid-build for the Millstone Creek Mitigation Site (Site) for the North Carolina Department of Environmental Quality Division of Mitigation Services (DMS). Phase II of the project restored a total of 617 linear feet perennial streams in Randolph County, NC. The Site will generate 3,151.91 stream credits with an additional 31.62 potential stream credits pending validation of proposed water quality improvements. The work was completed in two phases in order to accommodate a paired watershed study to evaluate the effectiveness of Regenerative Stormwater Conveyance for removing nutrients and sediment in both storm flow and baseflow. The Site is located approximately 3 miles southeast of the Town of Ramseur off Highway 22 in the Cape Fear River Basin 8-Digit Hydrologic Unit Code (HUC) 03030003 in the Piedmont region. The Site is located on a family farm with cattle pasture that is sprayed with waste from a hog operation. The Site is located in the Cape Fear River Basin HUC 03030003020030 and NC Division of Water Resources (DWR) Subbasin 03-06-09. The project involves the restoration and enhancement of Millstone Creek and two unnamed tributaries to Millstone Creek. The downstream drainage area of the Site is 8.3 square miles. The 18.80-acre Site is protected with a permanent conservation easement.

The project goals established in the Mitigation Plan (NCSU 2020) were completed with careful consideration of the stream morphology, stability, macroinvertebrate and water quality data collected at the site. The project goals include:

- Enhance processing of nutrients from onsite sources.
- Improve stream channel stability.
- Improve instream habitat.
- Restore native riparian vegetation.
- Permanently protect site resources from local disturbance including livestock

Phase II of construction was completed in February 2024, as-built surveys were completed in February-March 2024, and planting was completed in February 2024. Monitoring Year 0 (MY0) assessments and site visits were completed between February - April 2024. Monitoring stations were installed as proposed in the Mitigation Plan with minor modifications in location. The stream reaches restored during Phase II are stable and functioning as designed. Hydrologic data will be collected and reported during MY1.

MILLSTONE CREEK MITIGATION SITE

Phase II Monitoring Year 0 Annual Report

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

Section 1: PROJECT OVERVIEW

The Millstone Mitigation Site (Site) is located in Randolph County, approximately 3 miles southeast of the Town of Ramseur off Highway 22. The Site is on a livestock farm in the Piedmont region. The Site is within Hydrologic Unit Code (HUC) 03030003020030, Subbasin 03-06-09. The watershed area for the Site is 8.3 square miles and contains primarily agricultural and wooded land. The project was completed in two phases. Grading and site work for Phase I were completed in September of 2021 and Phase II was completed in February of 2024.

1.1 Project Quantities and Credits

The Site is located on two parcels and a conservation easement was recorded on 18.80 acres. Mitigation work proposed within the Site included restoration and enhancement I of 3,576 linear feet of perennial stream channels and hydrologic enhancement to an existing 1.323 acre jurisdictional wetland. Phase I resulted in the restoration and enhancement of 2,951 linear feet of channel. Phase II provided an additional 617 linear feet of perennial stream. The total project is expected to provide 3,151.91 stream credits plus an additional 31.62 potential credits (2%) for WQ uplift by closeout. (Note: The mitigation plan indicates an additional 26.22 for the WQ uplift credit. The discrepancy is due to a math error.) Table 1 below provides additional detail regarding the restoration types, quantities, credit ratios and total credits.

Table 1: Project Quantities and Credits

Project Segment	Phase	Mitigation Plan Footage	As-Built Footage	Mitigation Category	Restoration Level	Mitigation Ratio (X:1)	Credits	WQ Monitoring (4%)	WQ Reduction Std. Achieved (2%)*	Comments
NT R1	I	326	326	Warm	R	1:1	326.00	13.04	6.52	Step-pool system with Regenerative Stormwater Conveyance
NT R2	I	103	103	Warm	R	1:1	103.00	4.12	2.06	Bank grading, in-stream structures, WQ treatment on NT R1
UTA R1	II	523	516	Warm	R	1:1	523.00	20.92	10.46	Step-pool system with Regenerative Stormwater Conveyance
UTA R2	II	100	101	Warm	R	1:1	100.00	4.00	2.00	Bank grading, in-stream structures, invasive removal
UTB	I	529	523	Warm	R	1:1	529.00	21.16	10.58	Bank grading, in-stream structures, WQ treatment on NT R1
MC R1	I	1462	1462	Warm	E1	1.5:1	974.67	0.00	0.00	Bank grading, in-stream structures, bank treatments, planting
MC R2	I	533	537	Warm	R	1:1	533.00	0.00	0.00	Priority 2 approach. Appropriate bankfull channel dimensions, minor floodplain grading, in-stream structures, bank treatments, planting
Totals		3576	3568				3088.67	63.24	31.62**	
Wetland 1		E	N/A		Enhancement	1.323 AC	2:1		0.662	Hydrological enhancement through filling ditch; no planting per IRT guidance

*The 2% Reduction is not available until data collection is complete and analyzed.

**Note the water quality credit differs from the 26.22 reported in the mitigation plan due to a math error.

Table 1 Continued

Restoration Level	Stream		
	Warm	**Cool**	**Cold**
Restoration	2,208.86		
Enhancement I	974.67		
Total Stream Credit	3,183.53		

1.2 Project Goals and Objectives

The project is intended to provide numerous ecological benefits. Table 2 below describes expected outcomes to water quality and ecological processes and provides project goals and objectives.

Table 2: Goals, Performance Criteria, and Functional Improvements

Goal	Objective/ Treatment	Likely Functional Uplift	Performance Criteria	Measurement	Cumulative Monitoring Results
Enhance processing of nutrients from onsite sources.	Construct stream and wetland systems designed to process nitrogen and phosphorus.	Reduction in sediment and nutrient inputs and treatment. Improved water quality and aquatic habitat.	*20% decrease in TN concentrations on NT and UT A. 8% wetland hydrology standard applied	Supplemental water quality monitoring of discharge and TN concentrations downstream of NT R2 and UTA R2. Two groundwater gauges installed in wetland to document enhanced wetland hydrology.	To be reported in M1, M2 & MY3.
Improve stream channel stability.	Grade streambanks, Construct stream channels with appropriate bankfull channel dimensions, planform geometry and profile such that channel maintenance and adjustments are representative of other natural systems.	Decrease sediment inputs from channel and bank erosion. Efficiently transport sediment loads and stream flow.	Stable channels with BHR less than 1.2.	Monitoring & visual assessment of 8 cross sections.	No deviations from design. 8 cross sections have been installed and baseline survey completed
Improve instream habitat.	Install habitat features and structures, add LWD, increase bedform diversity, improve in-stream water quality.	Increase in available habitat for macroinvertebrates and fish leading to an increase in biodiversity.	There is no required performance standard for this metric.	Visual assessment and macroinvertebrate surveys conducted via Supplemental Monitoring.	Reported in MY3, MY5 & MY7.

Table 2 Continued

Goal	Objective/ Treatment	Likely Functional Uplift	Performance Criteria	Measurement	Cumulative Monitoring Results
Restore native riparian vegetation.	Plant native tree, understory and grass species in riparian zones, streambank and wetland areas.	Reduce sediment inputs from bank erosion. Increase nutrient processing, uptake and storage within the floodplain. Create riparian habitats. Add a source of LWD and organic material to stream.	In planted open areas, the survival rate of 320 stems per acre at MY3, 260 planted stems per acre at MY5, and 210 stems per acre at MY7. Trees in each plot must average 7 feet in height by MY5 and 10 feet by MY7.	10 permanent and 4 mobile 100-square meter vegetation plots placed on 2% of the planted area of the Site and monitored annually. Shaded areas will be visually assessed.	10 permanent veg plots have been installed and surveyed. 4 mobile veg transects were also surveyed.
Permanently protect site resources from local disturbance including livestock	A conservation easement has been secured and recorded for the Site. A livestock exclusion fence and watering system has been installed with NC DMS funding.	Protection of the Site from encroachment into the conservation easement and direct impact to streams. Supports all functions including Hydrology (reach-scale), Hydraulic, Geomorphology, Physicochemical, and Biology.	Prevent easement encroachment.	Visually inspect the perimeter of the Site to ensure no easement encroachment is occurring.	No easement encroachments.

*This metric is assigned to 2% supplemental water quality credits only. Not meeting this metric will result in these credits not being realized; no credit loss will be assessed.

1.3 Project Attributes

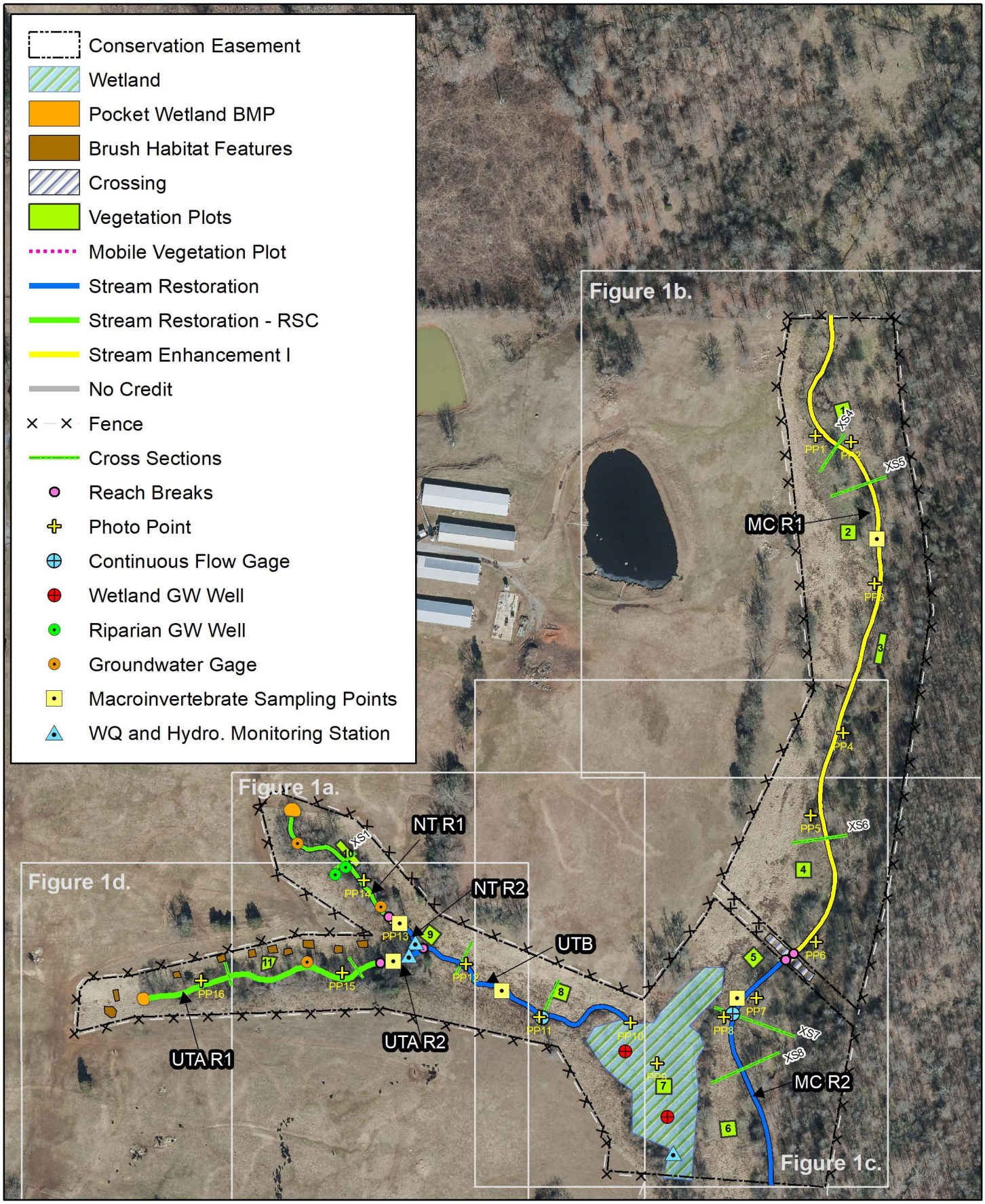
The Site includes all reaches of an unnamed tributary of Millstone Creek located on the Cox Family Farm and 2,015 (existing) feet of Millstone Creek. The entire project easement is contained on two farm properties owned by 1) Joe Dean Cox and Billie White Cox, and 2) Victor Craig Staley, Anthony Todd Stout and Co-Trustees of the Magalene Staley Family Trust. The tributary reaches and their watershed are contained within the Cox property. The property is used for cattle grazing and the application of spray waste from a confined hog operation. Prior to construction, land adjacent to the Site and within the established conservation easement have been heavily impacted by cattle grazing and the application of swine waste. Table 3 below and Table 8 in Appendix C present additional information on pre-restoration conditions.

Table 3: Project Attributes

PROJECT INFORMATION			
Project Name	Millstone Creek Mitigation Site	County	Randolph County
Project Area (acres)	18.80	Project Coordinates	N35°41'48.06" W79°37'26.24"
PROJECT WATERSHED SUMMARY INFORMATION			
Physiographic Province	Piedmont	River Basin	Cape Fear
USGS HUC 8-digit	03030003	USGS HUC 14-digit	03040101070010
DWR Sub-basin	03-06-09	Land Use Classification	48% pasture, 35% forested, 5% shrub, 7% grassland, 4% developed
Project Drainage Area (sq. mi)	8.3	Percentage of Impervious Area	<1%

RESTORATION TRIBUTARY SUMMARY INFORMATION				
Parameters	**Millstone**	**NT**	**UTA**	**UTB**
Pre-project length (feet)	1,995	429	623	529
Post-project (feet)	1,999	429	617	523
Valley confinement	Unconfined	Confined	Confined	Confined
Drainage area (acres)	5312	25	26	56
Perennial, Intermittent, Ephemeral	Perennial	Perennial	Perennial	Perennial
DWR Water Quality Classification	C			
Dominant Stream Classification (existing)	E5 / C5	G5 / F5	F5	G5 / E5
Dominant Stream Classification (proposed)	C5	B5	B5	E5
Dominant Evolutionary class (Simon) if applicable	Stage IV	Stage III	Stage III	Stage III

REGULATORY CONSIDERATIONS			
Parameters	**Applicable?**	**Resolved?**	**Supporting Documentation**
Water of the United States - Section 404	Yes	Yes	USACE Nationwide Permit No. 27 and DWQ 401 Water Quality Certification No. 16-1200
Water of the United States - Section 401	Yes	Yes	
Endangered Species Act	Yes	Yes	Categorical Exclusion in Mitigation Plan (NCSU, 2020)
Historic Preservation Act	Yes	Yes	
Coastal Zone Management Act (CZMA or CAMA)	N/A	N/A	N/A
Essential Fisheries Habitat	N/A	N/A	N/A



NORTH

0 140 280 560 Feet

Figure 1. Current Condition Plan View Key
Millstone Creek Mitigation Site
Cape Fear Basin 03030003
Monitoring Year 0 - 2021

Randolph County

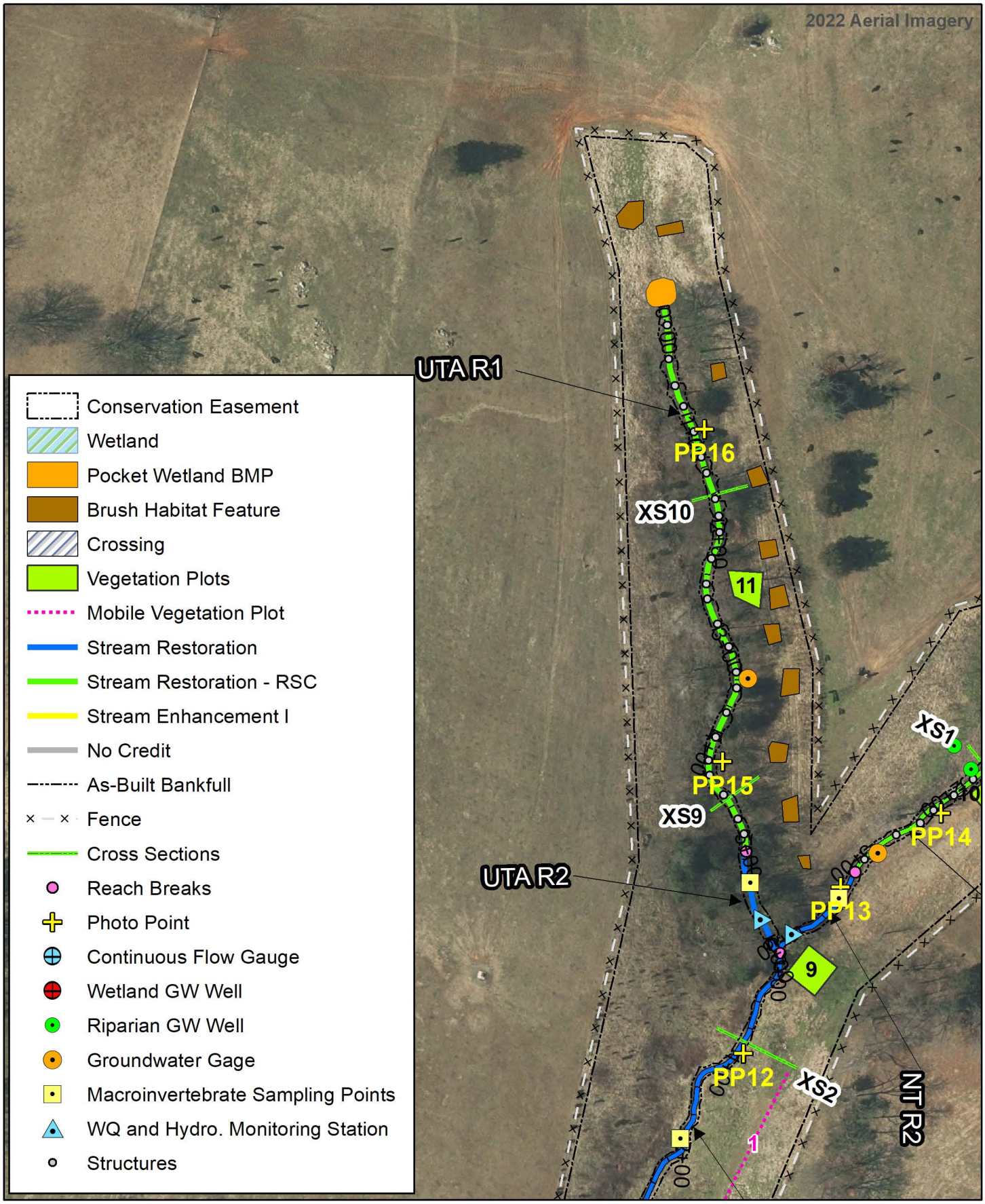


Figure 1d. Current Condition Plan View
Millstone Creek Mitigation Site
Cape Fear Basin 03030003
Monitoring Year 0 - 2024

Randolph County

Section 2: As-Built Condition (Baseline)

The Phase II Site construction and as-built surveys were both completed in February of 2024. The survey included developing an as-built topographic surface; as well as surveying the as-built channel centerlines, top of banks, structures, and cross-sections. Vegetation monitoring was conducted in March of 2024 immediately following the vegetation installation.

The As-Built Plans show that streams were constructed as designed with only minor deviations. The difference between the design alignment length and the surveyed stream lengths are negligible as noted in the project quantities and credits table. Several areas of existing healthy native vegetation were preserved beyond the right bank of the UTA. These areas were not planted, however, the quantities of planted trees and stems specified in the mitigation plan and construction documents were installed within the conversation easement for the Site.

2.1 As-Built/Record Drawings

A sealed half-size set of record drawings are in Appendix E which includes the post-construction survey, alignments, structures, and monitoring features. These include redlines for any significant field adjustments made during construction that differ from the design plans. Where needed, adjustments were made during construction based on field evaluations and are listed below.

2.1.1 UTA Reach 1 (NTR1)

- Station 0+90 to 1+55 - The channel is shifted to the north by 2-4’ due to the presence of a bedrock outcropping.

2.1.2 UTA Reach 2 (NTR2)

- No deviations from design were noted.

Section 3: Monitoring Year 0 Data Assessment

Monitoring and site visits were conducted following construction in order to assess the condition of the project for the MY0 period of Phase I. The vegetation and stream success criteria for the Site follow the approved success criteria presented in the Mitigation Plan (NCSU, 2020). Performance criteria for vegetation, stream, and hydrologic assessment are located in Section 1.2 Table 3: Goals, Performance Criteria, and Functional Improvements.

3.1 Vegetative Assessment

The MY0 vegetative survey was completed in March 2024. One permanent plot and one mobile transect were assessed. Vegetation monitoring resulted in a stem density of 648 planted stems per acre for the permanent plot. Refer to Appendix A for Vegetation Plot Photographs and the Vegetation Condition Assessment Table and Appendix B for Vegetation Plot Data.

3.2 Vegetation Areas of Concern

There are no vegetation cover concerns identified during MYO with the exception of some bare soil and a lack of grass cover on the graded slopes adjacent to the UTA beyond the left bank due to heavy rainfall that washed away some straw. However, it is anticipated that this area will recover; DMS will observe this area to ensure stability.

3.3 Stream Assessment

Morphological surveys for MY0 were conducted during February, March and April of 2024. The entire reach of the UTA was stable and functioning as designed. Bank height ratios are all equal to 1. Substrate measurements were not collected as per approval by the USACE. This change was made due to the lack of native gravel and cobble in the streambed. The UTA channel bed is quarry boulder steps and sand/mulch media. Refer to Appendix A for the Visual Stream Morphology Stability Assessment Table and Stream Photographs. Refer to Appendix C for Stream Geomorphology Data.

3.4 Stream Areas of Concern

No stream areas of concern were identified during MY0.

3.5 Hydrology Assessment

Hydrologic data will be collected and reported during MY1.

3.6 Wetland Assessment

Wetland enhancement was implemented during Phase I. Wetland water level monitoring will begin in 2024 and will continue for a period of seven years. No performance standard was established for the wetlands.

3.7 Adaptive Management Plan

No adaptive management plans are needed at this time.

3.8 Monitoring Year 0 Summary

Overall, the Site looks good, is performing as intended, and is on track to meet success criteria. The vegetation plot is also on track to exceed the MY3 interim requirement of 320 planted stems per acre, and all streams within the Site are stable and meeting project goals.

Summary information and data related to the performance of various project and monitoring elements can be found in the tables and figures in the report appendices. All raw data supporting the tables and figures in the appendices are available from DMS upon request.

Section 4: METHODOLOGY

Geomorphic data was collected following the standards outlined in The Stream Channel Reference Site: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in Stream Restoration: A Natural Channel Design Handbook (Doll et al., 2003). All as-built field data was recorded from existing construction control using a Spectra Precision Focus 35 total station or with a Spectra Precision SP85 RTK/VRS sub-centimeter GPS unit operating on the NCGS VRS system. Field data was collected using TDS software platforms and was processed and drafted using Carlson Civil Suite 2020. Groundwater wells with water level loggers were installed in the streambed of UTA R1 and UTB R2. Monitoring was initiated on all installed equipment. Hydrologic monitoring instrument installation and monitoring methods are in accordance with the United States Army Corps of Engineers standards (USACE, 2003). Three continuous flow and water quality sampling stations for supplemental monitoring are established at the downstream end of NT R2 and UTA R2 and downstream of the wetland using a staff gage, integrated flowmeter, trapezoidal flume and an automated ISCO sampler. Stage discharge relationships were developed for all three flumes from field measurements of velocity using a Doppler-based probe. In addition, wells with pressure transducers were installed and monitoring initiated in the riparian areas of NT R1 and UTA R1 to record groundwater levels and measure water quality for the supplemental water quality monitoring. Vegetation monitoring protocols followed the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008). Large woody debris counts were conducted in accordance with protocols outlined by the U.S. Forest Service (USFS) General Technical Report Monitoring Wilderness Stream Ecosystems (Davis et al., 2001).

Section 5: REFERENCES

Davis, J.C., G.W. Minshall, C.T. Robinson, and P. Landres, 2001. Large Woody Debris. In Monitoring Wilderness Stream Ecosystems. General Technical Report RMRS-GTR-70, pp. 73 - 77. US Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado.

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

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

Lee, Michael T., Peet, Robert K., Steven D., Wentworth, Thomas R. 2006. CVS-EEP Protocol for Recording Vegetation Version 4.0. http://www.nceep.net/business/monitoring/veg/datasheets.htm.

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

NC State University (NCSU). 2020. Millstone Creek Mitigation Site, Randolph County, North Carolina, Final Mitigation Plan, DMS, Raleigh, NC.

APPENDIX A - Visual Assessment Data

Table 4. Visual Stream Morphology Stability Assessment Table

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Phase II Monitoring Year 0 – 2024

Un-Named Tributary A Reach 1 (UTA-R1)

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	516
					Assessed Bank Length	1032
Bank	Surface Scour/Bare Bank	Bank lacking vegetative cover resulting 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%
					0	100%
Structure	Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	24	24		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	24	24		100%

Un-Named Tributary A Reach 2 (UTA-R2)

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	101
					Assessed Bank Length	202
Bank	Surface Scour/Bare Bank	Bank lacking vegetative cover resulting 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%
					0	100%
Structure	Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	5	5		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	5	5		100%

Table 5. Visual Stream Morphology Stability Assessment Table

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Phase II Monitoring Year 0 –2024

Planted Acreage	2.2 (Phase II only)			
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.	0.10 acres	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%

Stream Photographs

	
PHOTO POINT 15 UTA-R1 – downstream (4-2-2024)	PHOTO POINT 16 UTA-R1 –downstream (9-2-2021)

Vegetation Plot Photographs

	
VEGETATION PLOT 11 (3-5-2024)	MOBILE TRANSECTION 5 (3-5-2024)

APPENDIX B – Vegetation Plot Data

Table 6. Vegetation Plot Data

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Phase II Monitoring Year 0 - 2024

Planted Acreage	2.2
Date of Initial Plant	2024-02-06
Date of Current Survey	2024-03-07
Plot size (ACRES)	0.0247

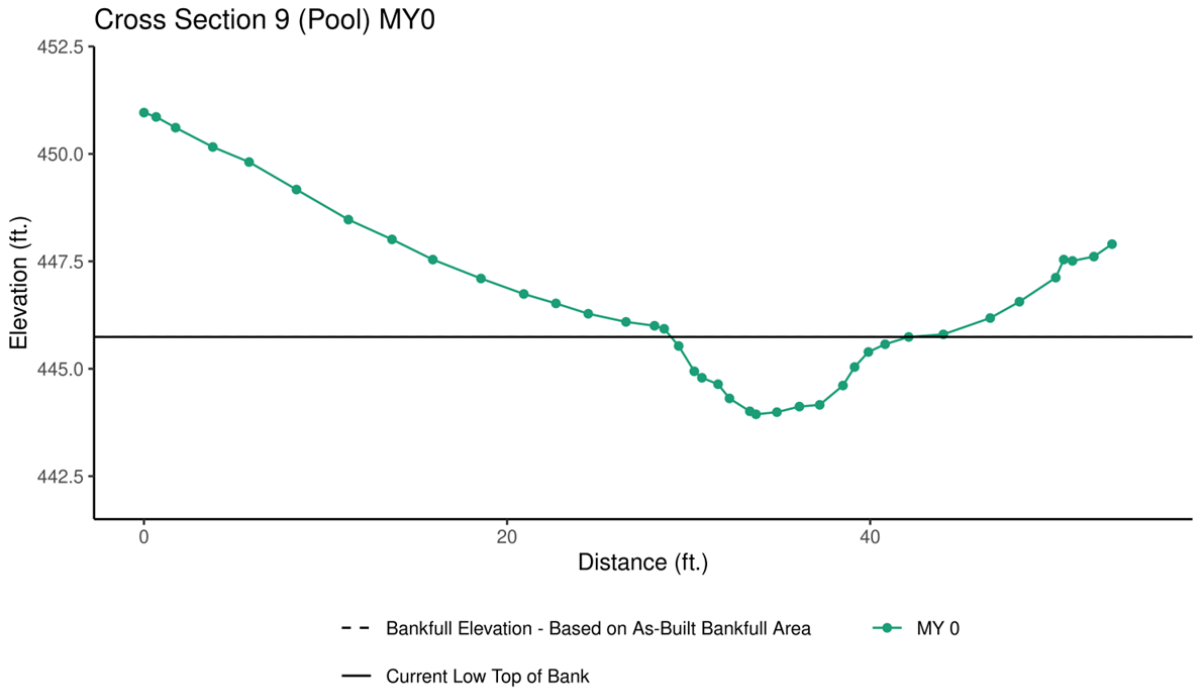
	Scientific Name	Common Name	Tree/ Shrub	Indicator Status	Veg Plot 11 F	
					Planted	Total
Species Included in Approved Mitigation Plan	Cercis canadensis	eastern redbud	Tree	FACU	1	1
	Diospyros virginiana	common persimmon	Tree	FAC	2	2
	Fagus grandifolia	American beech	Tree	FACU		
	Prunus serotina	black cherry	Tree	FACU	3	3
	Quercus alba	white oak	Tree	FACU		
	Quercus lyrata	overcup oak	Tree	OBL	5	5
	Quercus phellos	willow oak	Tree	FAC		
	Quercus rubra	northern red oak	Tree	FACU		
	Quercus sp.				5	5
Sum	Performance Standard				16	16
Mitigation Plan Performance Standard				Current Year Stem Count		16
				Stems/Acre		648
				Species Count		5
				Dominant Species Composition (%)		31
				Average Plot Height (ft.)		11
				% Invasives		0
Post Mitigation Plan Performance Standard				Current Year Stem Count		16
				Stems/Acre		648
				Species Count		5
				Dominant Species Composition (%)		31
				Average Plot Height (ft.)		11
				% Invasives		0

Table 7. Vegetation Performance Standards Summary Table

	Veg Plot 11 F				Veg Plot 5 R							
	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	648	11	5	0	567	1	7	0				

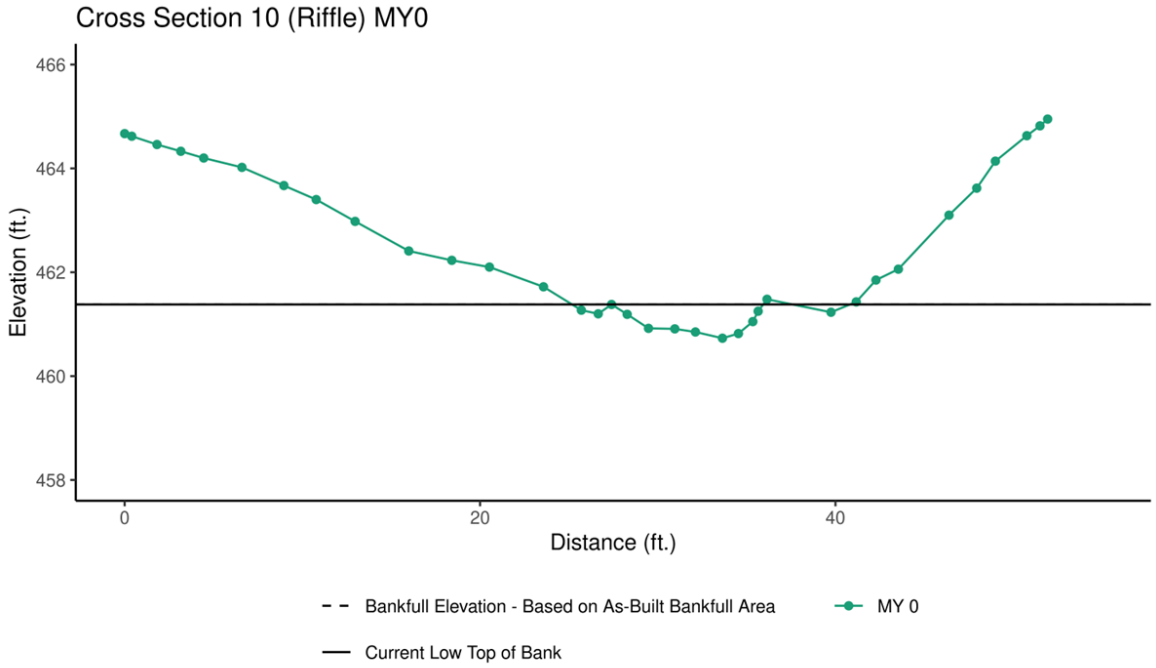
APPENDIX C. Stream Geomorphology Data

Cross-Section Plots



UTA-R1 – Cross Section 9 (Pool)	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	445.74					
Bank Height Ratio - Based on As-Built Bankfull Area	1.00					
Thalweg Elevation	443.94					
LTOB Elevation	445.74					
LTOB Max Depth	1.80					
LTOB Cross Sectional Area	13.92					

April 2, 2024 Downstream

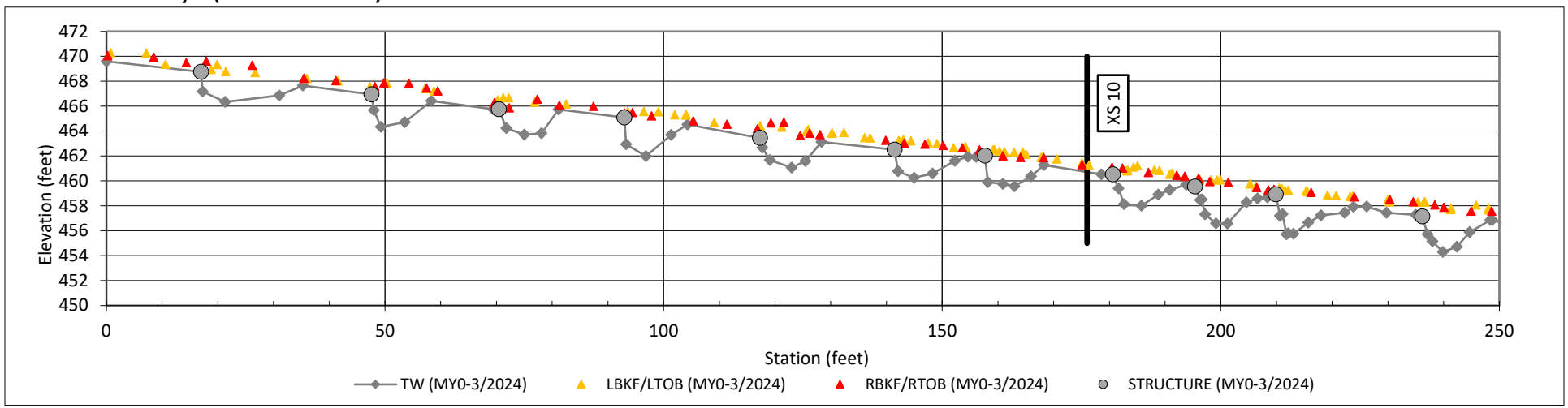


UTA-R1 – Cross Section 2 (Riffle)	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	461.38					
Bank Height Ratio - Based on As-Built Bankfull Area	1.00					
Thalweg Elevation	460.73					
LTOB Elevation	461.38					
LTOB Max Depth	0.65					
LTOB Cross Sectional Area	3.63					

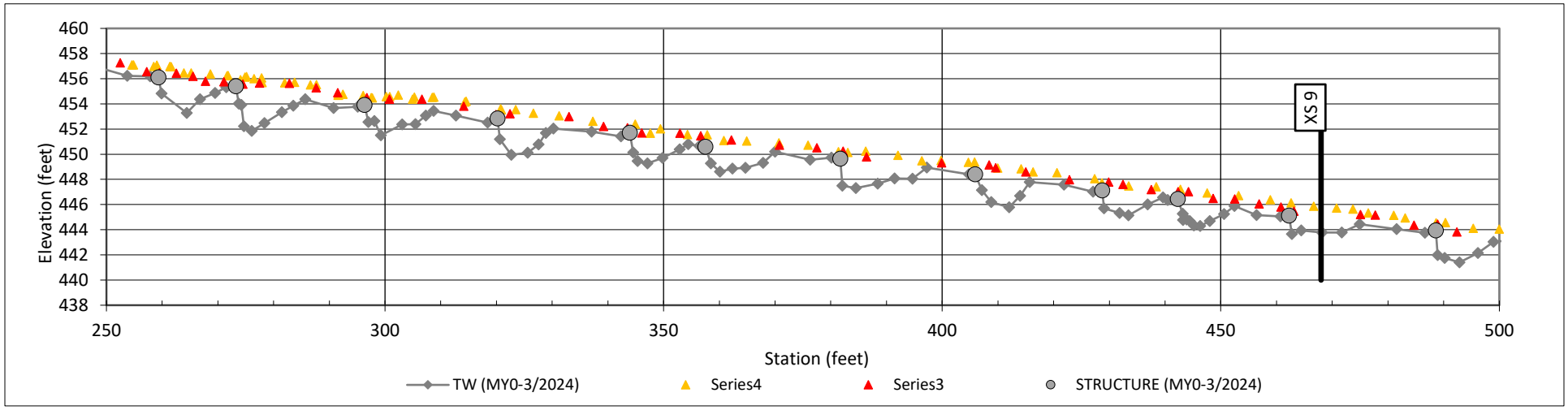
April 4, 2024 Downstream

Longitudinal Profile Plots
Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Phase II Monitoring Year 0 – 2024

Un-Named Tributary A (STA 0+00 to 2+50)



Un-Named Tributary A (STA 2+50 to 5+00)



Longitudinal Profile Plots
Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Phase II Monitoring Year 0 – 2024

Un-Named Tributary A (STA 5+00 to 6+17)

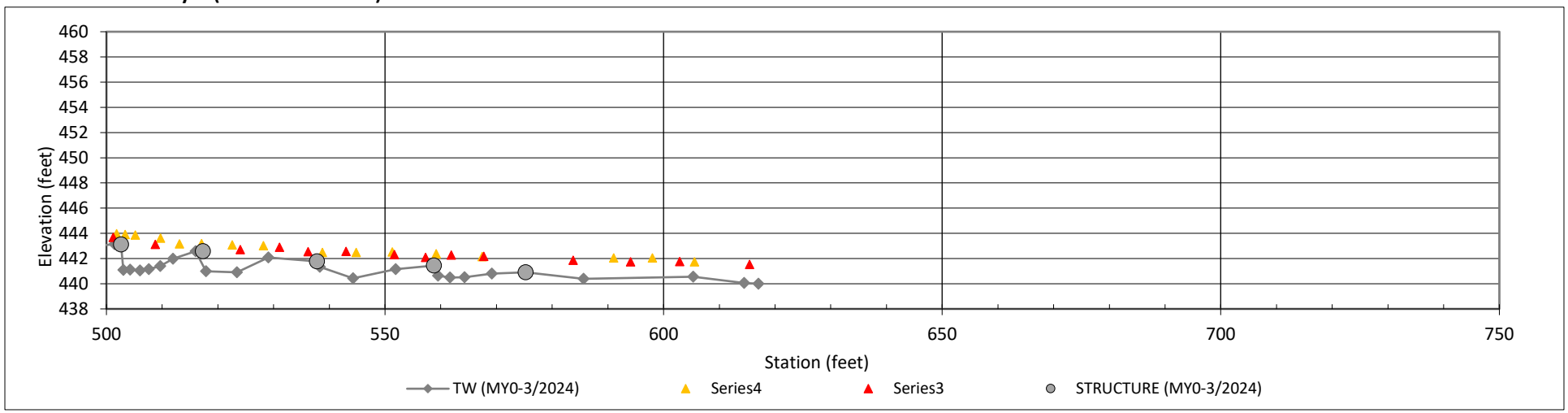


Table 8: Baseline Stream Data Summary

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Phase II Monitoring Year 0 – 2024

Parameter	Pre-Existing Condition					Design		Monitoring Baseline (MY0)		
UTA (Reach I)										*** As-Built Condition**
Parameter	**Pre-Existing Condition (applicable)**					**Design**		**Monitoring Baseline (MY0)**		
	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	7.2	10.1	11.3	11.9	3	8		8.8		1
Floodprone Width (ft)	13.6	16.5	17.9	18	3	20		23		1
Bankfull Mean Depth (ft)	0.3	0.6	0.7	0.8	3	0.4		0.40		1
Bankfull Max Depth (ft)	1.2	1.2	1.2	1.2	3	0.5		0.65		1
Bankfull Cross Sectional Area (ft^2)	2	6.6	8	9.9	3	3.3		3.6		1
Width/Depth Ratio	14.3	18.7	15.8	26	3	18.3		21.0		1
Entrenchment Ratio	1.2	1.7	1.5	2.5	3	2.5		2.6		1
Bank Height Ratio					3	**1**		1		**1**
Max part size (mm) mobilized at bankfull	117-203					96-176		96-176		
Rosgen Classification	F5					C5		C5		
Bankfull Discharge (cfs)	34.7					20.0		1.0		
Sinuosity (ft)	1.04					1.04		1.04		
Water Surface Slope (Channel) (ft/ft)	0.0405					0.052		0.052		
Other										
UTA Reach 2 (UTA2)										*** As-Built Condition**
Parameter	**Pre-Existing Condition (applicable)**					**Design**		**Monitoring Baseline (MY0)**		
	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)		14.5			1	8		11.4		1
Floodprone Width (ft)		16.0			1	20		24		1
Bankfull Mean Depth (ft)		1			1	1		0.6		1
Bankfull Max Depth (ft)		1.3			1	1.3		1.00		1
Bankfull Cross Sectional Area (ft^2)		14.6			1	8		6.6		1
Width/Depth Ratio		14.3			1	8		19.9		1
Entrenchment Ratio		1.1			1	2.5		2.1		1
Bank Height Ratio		1			1			1		**1**
Max part size (mm) mobilized at bankfull	118-204					148-239		58-123		
Rosgen Classification	F5					E5		B5		
Bankfull Discharge (cfs)	82.1					38.0		24.2		
Sinuosity (ft)	1.02					1.02		1.02		
Water Surface Slope (Channel) (ft/ft)	0.027					0.022		0.023		
Other										

Table 9: Cross-Section Morphology Monitoring Summary

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Phase II Monitoring Year 0 – 2024

	UTA													
	Cross Section 9 (Pool - Reach 1)							Cross Section 10 (Riffle - Reach 1)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	445.74							461.38						
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00							1.00						
Thalweg Elevation	443.94							460.73						
LTOB[2] Elevation	445.74							461.38						
LTOB[2] Max Depth (ft)	1.80							0.65						
LTOB[2] Cross Sectional Area (ft^2)	13.92							3.63						

[1]Bank Height Ratio (BHR) takes the As-built bankfull area as the basis for adjusting each subsequent year's bankfull elevation.
[2]LTOB Area and Max depth - These are based on the LTOB elevation for each year's 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 recorded and tracked above as LTOB max depth.

APPENDIX D. Project Timeline and Contact Information

Table 10: Project Activity and Reporting History

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Phase II Monitoring Year 0 – 2024

Activity or Deliverable		Data Collection Complete	Task Completion or Deliverable Submission
Project Instituted		NA	May 22, 2006
Mitigation Plan Approved		May 1, 2020	July 16, 2020
Construction (Grading) Completed		December, 2023	June, 2024
Planting Completed		February, 2024	June, 2024
As-built Survey Completed		February, 2024	June 2024
MY-0 Baseline Report	Stream Survey	April, 2024	June, 2024
	Vegetation Survey		
MY1 Monitoring	Stream Survey		
	Vegetation Survey		
MY2 Monitoring	Stream Survey		
	Vegetation Survey		
MY3 Monitoring	Stream Survey		
	Vegetation Survey		
MY4 Monitoring			
MY5 Monitoring	Stream Survey		
	Vegetation Survey		
MY6 Monitoring			

Table 11: Project Contact Table

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Phase II Monitoring Year 0 – 2024

Project Name/Number	
Provider	NC Division of Mitigation Services
Mitigation Provider POC	Melonie Allen, NC Division of Mitigation Services
Designer	Barbara A. Doll & Jonathan Page, Biological & Agricultural Engineering Dept., NC State University, Box 7625, Raleigh NC 27695
Primary project design POC	Barbara A. Doll, 919-515-5287
Construction Contractor	Wildlands Construction, 1042 Reavico Farms Rd, Yadkinville NC 27055

PHASE I
MONITORING YEAR 0
ANNUAL REPORT

June, 2022

MILLSTONE CREEK MITIGATION SITE
Randolph County, NC
Cape Fear River Basin
HUC 03030003

DMS Project No. # 204
NCDEQ Contract No. 6741
USACE Action ID No. 2018-01788
DWR Project No. 16-1200
Data Collection Dates: August 2021 – January 2022

PREPARED FOR:

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

EXECUTIVE SUMMARY

NC State University (NCSU) developed the design and mitigation plan and administered the construction for Phase I of a design-bid-build for the Millstone Creek Mitigation Site (Site) for the North Carolina Department of Environmental Quality Division of Mitigation Services (DMS). Phase I of the project restored a total of 1,489 linear feet and enhanced 1,462 feet of perennial streams in Randolph County, NC. The Site will generate 3,151.91 stream credits with an additional 31.62 potential stream credits pending validation of proposed water quality improvements. The work was completed in two phases in order to accommodate a paired watershed study to evaluate the effectiveness of Regenerative Stormwater Conveyance for removing nutrients and sediment in both storm flow and baseflow. The Site is located approximately 3 miles southeast of the Town of Ramseur off Highway 22 in the Cape Fear River Basin 8-Digit Hydrologic Unit Code (HUC) 03030003 in the Piedmont region. The Site is located on a family farm with cattle pasture that is sprayed with waste from a hog operation. The Site is located in the Cape Fear River Basin HUC 03030003020030 and NC Division of Water Resources (DWR) Subbasin 03-06-09. The project involves the restoration and enhancement of Millstone Creek and two unnamed tributaries to Millstone Creek. The downstream drainage area of the Site is 8.3 square miles. The 18.80 acre Site is protected with a permanent conservation easement.

The project goals established in the Mitigation Plan (NCSU 2020) were completed with careful consideration of the stream morphology, stability, macroinvertebrate and water quality data collected at the site. The project goals include:

- Enhance processing of nutrients from onsite sources.
- Improve stream channel stability.
- Improve instream habitat.
- Restore native riparian vegetation.
- Permanently protect site resources from local disturbance including livestock

Phase I of construction was completed in September of 2021, as-built surveys were completed in August - September 2021, and planting was completed in December 2021. Monitoring Year 0 (MY0) assessments and site visits were completed between September 2021 and January 2022. Monitoring stations were installed as proposed in the Mitigation Plan with minor modifications in location. All streams restored during Phase I are stable and functioning as designed. Hydrologic data will be collected and reported during MY1.

MILLSTONE CREEK MITIGATION SITE

Monitoring Year 0 Annual Report

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

Section 1: PROJECT OVERVIEW

The Millstone Mitigation Site (Site) is located in Randolph County, approximately 3 miles southeast of the Town of Ramseur off Highway 22. The Site is on a livestock farm in the Piedmont region. The Site is within Hydrologic Unit Code (HUC) 03030003020030, Subbasin 03-06-09. The watershed area for the Site is 8.3 square miles and contains primarily agricultural and wooded land. The project is being implemented in two phases. Grading and site work for Phase I were completed in September of 2021. Phase II is slated to go to construction before the end of 2022. Phase II results will be provided later as an addendum to this report.

1.1 Project Quantities and Credits

The Site is located on two parcels and a conservation easement was recorded on 18.80 acres. Mitigation work proposed within the Site included restoration and enhancement I of 3,576 linear feet of perennial stream channels and hydrologic enhancement to an existing 1.323 acre jurisdictional wetland. Phase I has completed the restoration and enhancement of 2,951 linear feet of channel. When complete Phase II is expected to provide restoration of an additional 623 linear feet of perennial stream. The project is also expected to provide 3,151.91 stream credits plus an additional 31.62 potential credits (2%) for WQ uplift by closeout, including the future work to be completed for Phase II. (Note: The mitigation plan indicates an additional 26.22 for the WQ uplift credit. The discrepancy is due to a math error.) Table 1 below provides additional detail regarding the restoration types, quantities, credit ratios and total credits.

Table 1: Project Quantities and Credits

Project Segment	Mitigation Plan Footage	As-Built Footage Phase I	Mitigation Category	Restoration Level	Mitigation Ratio (X:1)	Credits	WQ Monitoring (4%) *	WQ Reduction Std. Achieved (2%) **	Comments
NT R1	326	326	Warm	R	1:1	326.00	13.04	6.52	Step-pool system with Regenerative Stormwater Conveyance
NT R2	103	103	Warm	R	1:1	103.00	4.12	2.06	Bank grading, in-stream structures, WQ treatment on NT R1
UTA R1	523	Phase II	Warm	R	1:1	523.00	20.92	10.46	Step-pool system with Regenerative Stormwater Conveyance
UTA R2	100	Phase II	Warm	R	1:1	100.00	4.00	2.00	Bank grading, in-stream structures, invasive removal
UTB	529	523	Warm	R	1:1	529.00	21.16	10.58	Bank grading, in-stream structures, WQ treatment on NT R1
MC R1	1462	1462	Warm	E1	1.5:1	974.67	0.00	0.00	Bank grading, in-stream structures, bank treatments, planting
MC R2	533	537	Warm	R	1:1	533.00	0.00	0.00	Priority 2 approach. Appropriate bankfull channel dimensions, minor floodplain grading, in-stream structures, bank treatments, planting
Totals	3576	2951			Phase I	2465.67	38.32	31.62***	
					Phase II	3088.67	63.24		
Phase I: Standard + WQ Sampling					2465.67+38.32 =			2503.99	
Phase II: Standard + WQ Sampling + Reduction Achieved					3088.67+63.24+31.62=			3183.53	
Wetland 1	E	N/A		Enhancement	1.323 AC	2:1		0.662	Hydrological enhancement through filling ditch; no planting per IRT guidance

*The 4% is available upon installation of monitoring equipment.

**The 2% Reduction is not available until after Phase II has been completed and data has been collected and analyzed.

***Note the water quality credit differs from the 26.22 reported in the mitigation plan due to a math error.

Table 1 Continued

Restoration Level	Stream		
	Warm	**Cool**	**Cold**
Restoration Completed (Phase I)	1,529.32		
Restoration Proposed (Phase 2)	679.54		
Restoration Total	2,208.86		
Enhancement I (Phase I Completed)	974.67		
Total Stream Credit	3,183.53		

1.2 Project Goals and Objectives

The project is intended to provide numerous ecological benefits. Table 2 below describes expected outcomes to water quality and ecological processes and provides project goals and objectives.

Table 2: Goals, Performance Criteria, and Functional Improvements

Goal	Objective/ Treatment	Likely Functional Uplift	Performance Criteria	Measurement	Cumulative Monitoring Results
Enhance processing of nutrients from onsite sources.	Construct stream and wetland systems designed to process nitrogen and phosphorus.	Reduction in sediment and nutrient inputs and treatment. Improved water quality and aquatic habitat.	*20% decrease in TN concentrations on NT and UT A. 8% wetland hydrology standard applied	Supplemental water quality monitoring of discharge and TN concentrations downstream of NT R2 and UTA R2. Two groundwater gauges installed in wetland to document enhanced wetland hydrology.	To be reported in M1, M2 & MY3.
Improve stream channel stability.	Grade streambanks, Construct stream channels with appropriate bankfull channel dimensions, planform geometry and profile such that channel maintenance and adjustments are representative of other natural systems.	Decrease sediment inputs from channel and bank erosion. Efficiently transport sediment loads and stream flow.	Stable channels with BHR less than 1.2.	Monitoring & visual assessment of 8 cross sections.	No deviations from design. 8 cross sections have been installed and baseline survey completed
Improve instream habitat.	Install habitat features and structures, add LWD, increase bedform diversity, improve in-stream water quality.	Increase in available habitat for macroinvertebrates and fish leading to an increase in biodiversity.	There is no required performance standard for this metric.	Visual assessment and macroinvertebrate surveys conducted via Supplemental Monitoring.	Reported in MY3, MY5 & MY7.

Table 2 Continued

Goal	Objective/ Treatment	Likely Functional Uplift	Performance Criteria	Measurement	Cumulative Monitoring Results
Restore native riparian vegetation.	Plant native tree, understory and grass species in riparian zones, streambank and wetland areas.	Reduce sediment inputs from bank erosion. Increase nutrient processing, uptake and storage within the floodplain. Create riparian habitats. Add a source of LWD and organic material to stream.	In planted open areas, the survival rate of 320 stems per acre at MY3, 260 planted stems per acre at MY5, and 210 stems per acre at MY7. Trees in each plot must average 7 feet in height by MY5 and 10 feet by MY7.	10 permanent and 4 mobile 100-square meter vegetation plots placed on 2% of the planted area of the Site and monitored annually. Shaded areas will be visually assessed.	10 permanent veg plots have been installed and surveyed. 4 mobile veg transects were also surveyed.
Permanently protect site resources from local disturbance including livestock	A conservation easement has been secured and recorded for the Site. A livestock exclusion fence and watering system has been installed with NC DMS funding.	Protection of the Site from encroachment into the conservation easement and direct impact to streams. Supports all functions including Hydrology (reach-scale), Hydraulic, Geomorphology, Physicochemical, and Biology.	Prevent easement encroachment.	Visually inspect the perimeter of the Site to ensure no easement encroachment is occurring.	No easement encroachments.

*This metric is assigned to 2% supplemental water quality credits only. Not meeting this metric will result in these credits not being realized; no credit loss will be assessed.

1.3 Project Attributes

The Site includes all reaches of an unnamed tributary of Millstone Creek located on the Cox Family Farm and 2,015 (existing) feet of Millstone Creek. The entire project easement is contained on two farm properties owned by 1) Joe Dean Cox and Billie White Cox, and 2) Victor Craig Staley, Anthony Todd Stout and Co-Trustees of the Magalene Staley Family Trust. The tributary reaches and their watershed are contained within the Cox property. The property is used for cattle grazing and application of spray waste from a confined hog operation. Prior to construction, land adjacent to the Site and within the established conservation easement have been heavily impacted by cattle grazing and the application of swine waste. Table 3 below and Table 8 in Appendix C present additional information on pre-restoration conditions.

Table 3: Project Attributes

PROJECT INFORMATION			
Project Name	Millstone Creek Mitigation Site	County	Randolph County
Project Area (acres)	18.80	Project Coordinates	N35°41'48.06" W79°37'26.24"
PROJECT WATERSHED SUMMARY INFORMATION			
Physiographic Province	Piedmont	River Basin	Cape Fear
USGS HUC 8-digit	03030003	USGS HUC 14-digit	03040101070010
DWR Sub-basin	03-06-09	Land Use Classification	48% pasture, 35% forested, 5% shrub, 7% grassland, 4% developed
Project Drainage Area (sq. mi)	8.3	Percentage of Impervious Area	<1%

RESTORATION TRIBUTARY SUMMARY INFORMATION				
Parameters	**Millstone**	**NT**	**UTA**	**UTB**
Pre-project length (feet)	1,995	429	623	529
Post-project (feet)	1,999	429	Phase II	523
Valley confinement	Unconfined	Confined	Confined	Confined
Drainage area (acres)	5312	25	26	56
Perennial, Intermittent, Ephemeral	Perennial	Perennial	Perennial	Perennial
DWR Water Quality Classification	C			
Dominant Stream Classification (existing)	E5 / C5	G5 / F5	F5	G5 / E5
Dominant Stream Classification (proposed)	C5	B5	B5	E5
Dominant Evolutionary class (Simon) if applicable	Stage IV	Stage III	Stage III	Stage III

REGULATORY CONSIDERATIONS			
Parameters	**Applicable?**	**Resolved?**	**Supporting Documentation**
Water of the United States - Section 404	Yes	Yes	USACE Nationwide Permit No. 27 and DWQ 401 Water Quality Certification No. 16-1200
Water of the United States - Section 401	Yes	Yes	
Endangered Species Act	Yes	Yes	Categorical Exclusion in Mitigation Plan (NCSU, 2020)
Historic Preservation Act	Yes	Yes	
Coastal Zone Management Act (CZMA or CAMA)	N/A	N/A	N/A
Essential Fisheries Habitat	N/A	N/A	N/A

Section 2: As-Built Condition (Baseline)

The Phase I Site construction and as-built surveys were completed in September of 2021, respectively. The survey included developing an as-built topographic surface; as well as, surveying the as-built channel centerlines, top of banks, structures, and cross-sections. Vegetation monitoring was conducted in January of 2022 because the planting of the Site was not completed until December of 2021.

The As-Built Plans show that streams were constructed as designed with only minor deviations. The difference between the design alignment length and the surveyed stream lengths are negligible as noted in the project quantities and credits table. The existing fence along the southern boundary of the easement was removed and replaced with new fencing to better secure the site from cattle access. In addition, several areas of existing healthy native vegetation were preserved. This vegetation became established following the installation of the conservation easement fencing and associated cattle exclusion in 2015. These areas were not planted, however, the quantities of planted trees and stems specified in the mitigation plan and construction documents were installed within the conversation easement for the Site.

2.1 As-Built/Record Drawings

A sealed half-size set of record drawings are in Appendix E which includes the post-construction survey, alignments, structures, and monitoring features. These include redlines for any significant field adjustments made during construction that differ from the design plans. Where needed, adjustments were made during construction based on field evaluations and are listed below.

2.1.1 Millstone Reach 1 (MCR1)

- Station 3+75 to 4+80 - The toe of slope was moved to match the bottom front edge of the Brush Toe;
- Entire Reach - All pool depths a 2 feet below (rather than 4 feet) the thalweg for the upstream point of curvature due to the presence of running sand; and
- Station 3+00 to 4+25 - The floodplain above the right bank is approximately 1 foot higher than the pre-construction existing condition. The difference could be the result of sediment deposition from overbank flooding that has occurred since the existing condition survey was collected.

2.1.2 Millstone Reach 2 (MCR2)

- Entire Reach - All pool depths a 2 feet below (rather than 4 feet) the thalweg for the upstream point of curvature due to the presence of running sand;
- Station 15+00 and 18+00 - Floodplain grading on the left bank was reduced to minimize removal of excess material being stockpiled outside of the easement area;
- Station 18+50 to 20+20 - Floodplain grading reduced to better transition flow at the end of the bankfull bench into the existing channel; and
- Station 12+00 - The floodplain above the right bank is approximately 1 foot higher than the pre-construction existing condition. The difference could be the result of sediment deposition from overbank flooding that has occurred since the existing condition survey was collected.

2.1.3 North Tributary Reach 1 (NTR1)

- Station 0+20 to 0+80 - The channel is shifted slightly to the east and the bankfull bench was eliminated on the right bank in order to avoid grading of the steep bank on the west side of the

channel. The floodplain bench was extended on the left bank to compensate for the loss of floodplain bench width on the right bank.

- Stations 0+95, 1+20, 1+43 and 2+50 - Boulder Step Structures are two feet south of their design location.
- Entire Reach - Boulders installed are larger than the specifications, and
- Stations 2+50 to 3+25 - The media extends 0.5 feet deeper than designed to compensate for 11.5 cubic yards of media not installed under the larger boulders.

2.1.4 North Tributary Reach 2 (NTR2)

- No deviations from design were noted.

2.1.5 Unnamed Tributary of Millstone Creek Reach A (UTA)

- This reach will be constructed as part of Phase II

2.1.6 Unnamed Tributary of Millstone Creek Reach B (UTB)

- Station 0+00 to 0+20 - Grading of the channel banks was eliminated because the existing banks were stable and the stream was not incised at this location.
- Station 3+75 to 5+00 - Channel grading was shifted 5 to 8 feet to the north to reduce grading into the steep slope.

2.1.7 Wetland

- A rock and log step structure was added to the outlet channel of the existing wetland to ensure that the transition between the graded areas and tie in on existing ditch off easement was stable and to protect the wetland from a future head cut that could migrate upstream from the ditch below.

Section 3: Monitoring Year 0 Data Assessment

Monitoring and site visits were conducted following construction in order to assess the condition of the project for the MY0 period of Phase I. The vegetation and stream success criteria for the Site follow the approved success criteria presented in the Mitigation Plan (NCSU, 2020). Performance criteria for vegetation, stream, and hydrologic assessment are located in Section 1.2 Table 3: Goals, Performance Criteria, and Functional Improvements.

3.1 Vegetative Assessment

The MY0 vegetative survey was completed in January 2022. Ten permanent plots and four mobile transects were assessed. Vegetation monitoring resulted in a stem density range of 486 to 769 planted stems per acre for 8 of the 10 permanent plots, which is well above the interim requirement of 320 stems per acre required at MY3. However, two of the permanent vegetation plots, plot 3 and 7, did not meet the criteria. Plot 7 is located in an existing jurisdictional wetland where no plants were installed per IRT instructions, so performance criteria are not relevant to this plot. Plot 7 is therefore intended to document natural recruitment. Vegetation Plot 3, is located on the boundary between the Millstone Creek Reach 1 enhancement work and the existing wooded area. Streambanks were graded in this section of the project and minimal disturbance occurred in this location. However, it does not appear that any woody plants were installed in this particular location. We propose that this vegetation plot be moved due to the current shaded location not being optimal for planting. The remaining vegetation plots met the interim success criteria and are on track to meet the final success criteria required for MY7. Refer to Appendix A for Vegetation Plot Photographs and the Vegetation Condition Assessment Table and Appendix B for Vegetation Plot Data.

3.2 Vegetation Areas of Concern

There are no vegetation cover concerns identified during the MYO monitoring with the exception of a lack of grass cover on the floodplain for MCR2 beyond the right bank due to heavy storms that have dumped substantial fine sediment onto the floodplain. However, it is anticipated that this area will recover; DMS is observing this area for a period of one year.

3.3 Stream Assessment

Morphological surveys for MY0 were conducted in August and September of 2021. All streams within the Site are stable and functioning as designed. Bank height ratios are all equal to 1. Substrate measurements were not collected as per approval by the US ACE. This change was made due to the lack of native gravel and cobble in the streambed. Millstone Creek substrate is primarily sand, the NT RSC channel bed is quarry boulder steps and sand/mulch media and the UTB channel bed is predominantly logs and quarry rock riffles. Large Woody Debris counts were collected and compared to the pre-existing condition. Refer to Appendix A for the Visual Stream Morphology Stability Assessment Table and Stream Photographs. Refer to Appendix C for Stream Geomorphology Data.

3.4 Stream Areas of Concern

No stream areas of concern were identified during MY0.

3.5 Hydrology Assessment

Hydrologic data will be collected and reported during MY1.

3.6 Wetland Assessment

Wetland water levels will be monitored for seven years. No performance standard or reverification of the wetland extent are required.

3.7 Adaptive Management Plan

No adaptive management plans are needed at this time.

3.8 Monitoring Year 0 Summary

Overall, the Site looks good, is performing as intended, and is on track to meet success criteria. All vegetation plots are on track to exceed the MY3 interim requirement of 320 planted stems per acre, and all streams within the Site are stable and meeting project goals.

Summary information and data related to the performance of various project and monitoring elements can be found in the tables and figures in the report appendices. All raw data supporting the tables and figures in the appendices are available from DMS upon request.

Section 4: METHODOLOGY

Geomorphic data was collected following the standards outlined in The Stream Channel Reference Site: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in Stream Restoration: A Natural Channel Design Handbook (Doll et al., 2003). All as-built field data was recorded from existing construction control using a Spectra Precision Focus 35 total station or with a Spectra Precision SP85 RTK/VRS sub-centimeter GPS unit operating on the NCGS VRS system. Field data was collected using TDS software platforms and was processed and drafted using Carlson Civil Suite 2020. Groundwater wells with water level loggers were installed in the streambed of NT R1 and NT R2 and a gauge with a pressure transducer was installed in both UTB and MC R2. Two sensor groundwater gauges were installed in the wetland. Monitoring was initiated on all installed equipment. Hydrologic monitoring instrument installation and monitoring methods are in accordance with the United States Army Corps of Engineers standards (USACE, 2003). Three continuous flow and water quality sampling stations for supplemental monitoring are established at the downstream end of NT R2 and UTA R2 and downstream of the wetland using a staff gage, integrated flowmeter, trapezoidal flume and an automated ISCO sampler. Stage discharge relationships were developed for all three flumes from field measurements of velocity using a Doppler-based probe. In addition, wells with pressure transducers were installed and monitoring initiated in the riparian areas of NT R1 and UTA R1 to record groundwater levels and measure water quality for the supplemental water quality monitoring. Vegetation monitoring protocols followed the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008). Large woody debris counts were conducted in accordance with protocols outlined by the U.S. Forest Service (USFS) General Technical Report Monitoring Wilderness Stream Ecosystems (Davis et al., 2001).

Section 5: REFERENCES

Davis, J.C., G.W. Minshall, C.T. Robinson, and P. Landres, 2001. Large Woody Debris. In Monitoring Wilderness Stream Ecosystems. General Technical Report RMRS-GTR-70, pp. 73 - 77. US Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado.

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

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

Lee, Michael T., Peet, Robert K., Steven D., Wentworth, Thomas R. 2006. CVS-EEP Protocol for Recording Vegetation Version 4.0. http://www.nceep.net/business/monitoring/veg/datasheets.htm.

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

NC State University (NCSU). 2020. Millstone Creek Mitigation Site, Randolph County, North Carolina, Final Mitigation Plan, DMS, Raleigh, NC.

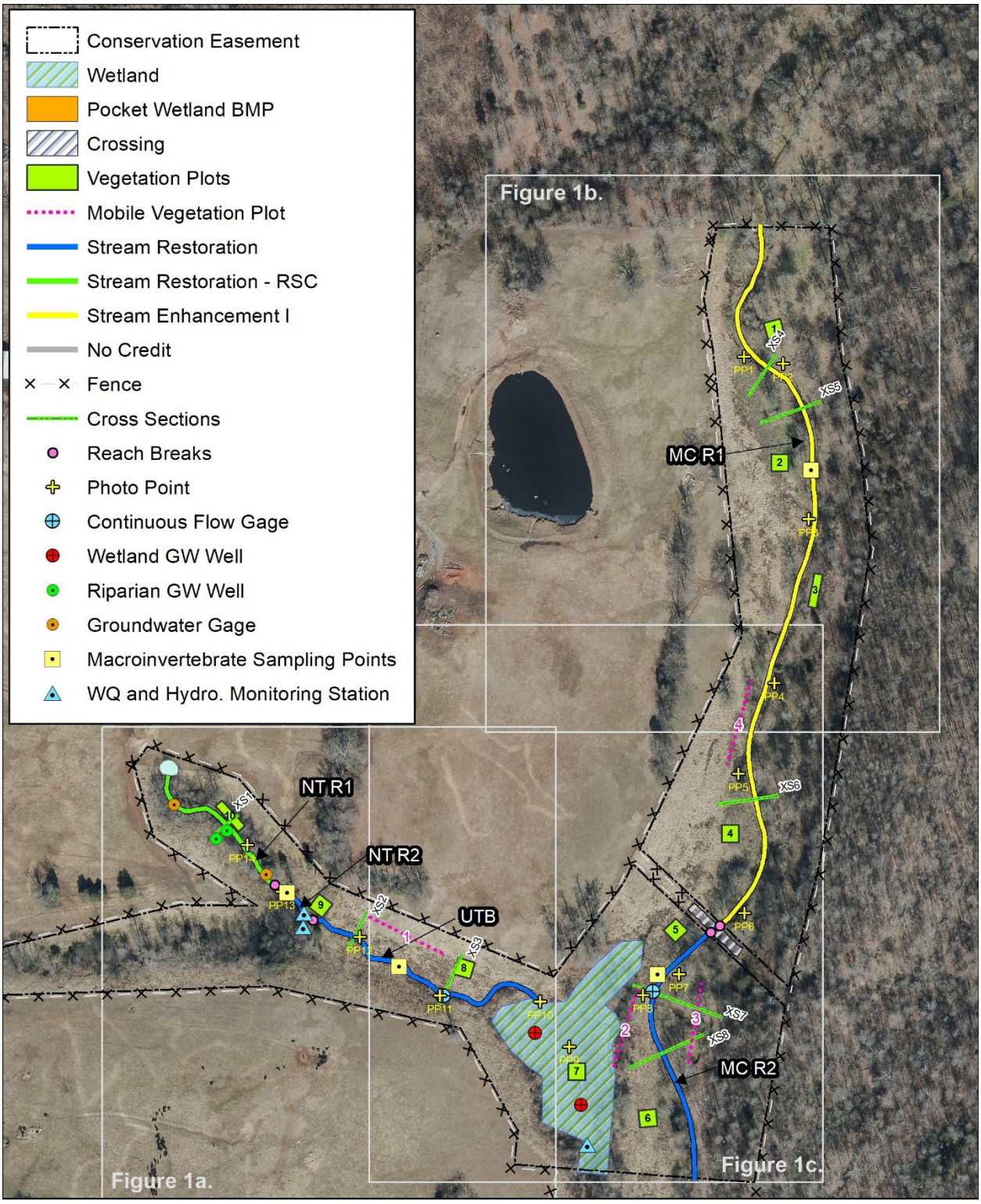


Figure 1. Current Condition Plan View Key
Millstone Creek Mitigation Site
Cape Fear Basin 03030003
Monitoring Year 0 - 2021

Randolph County

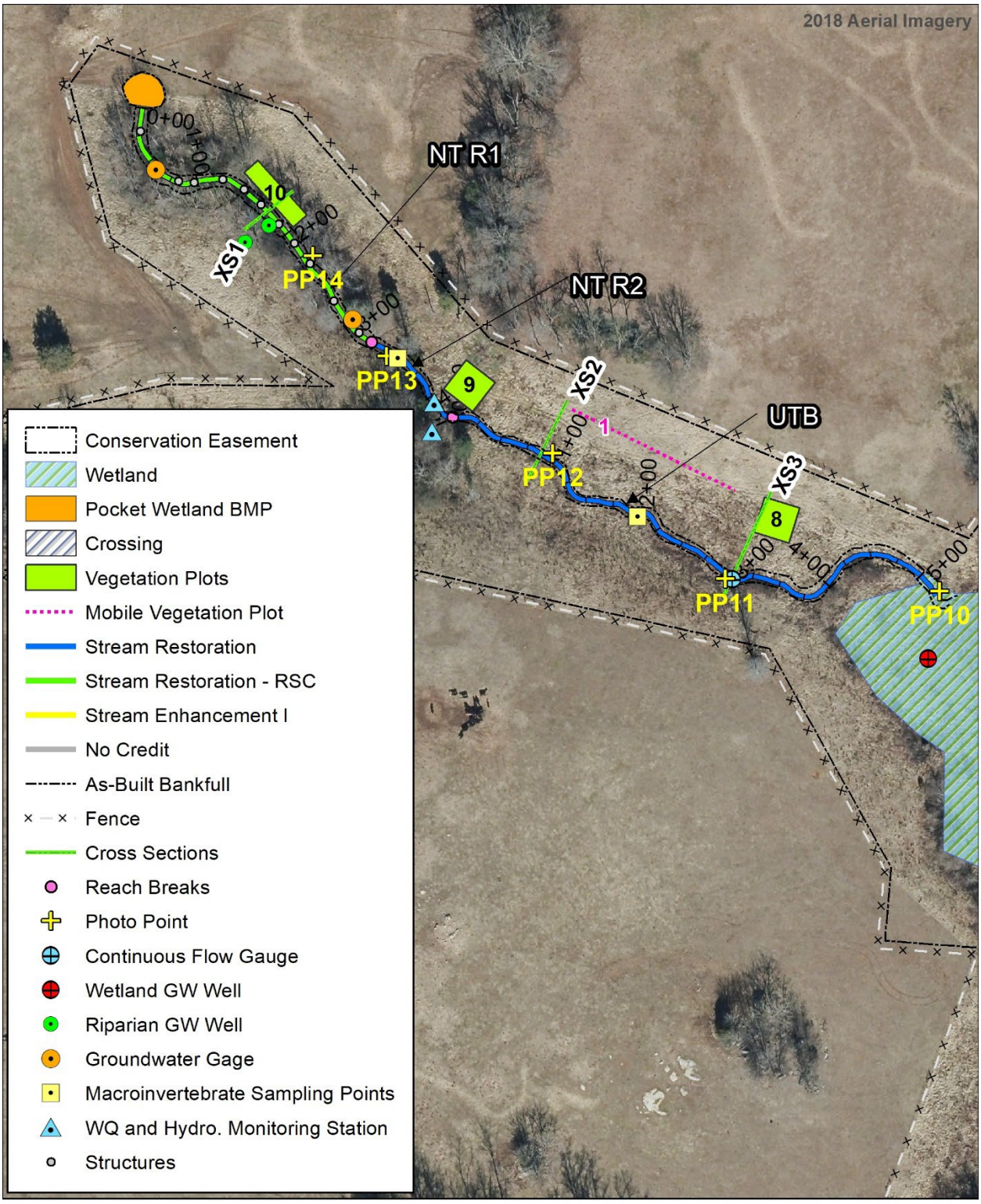
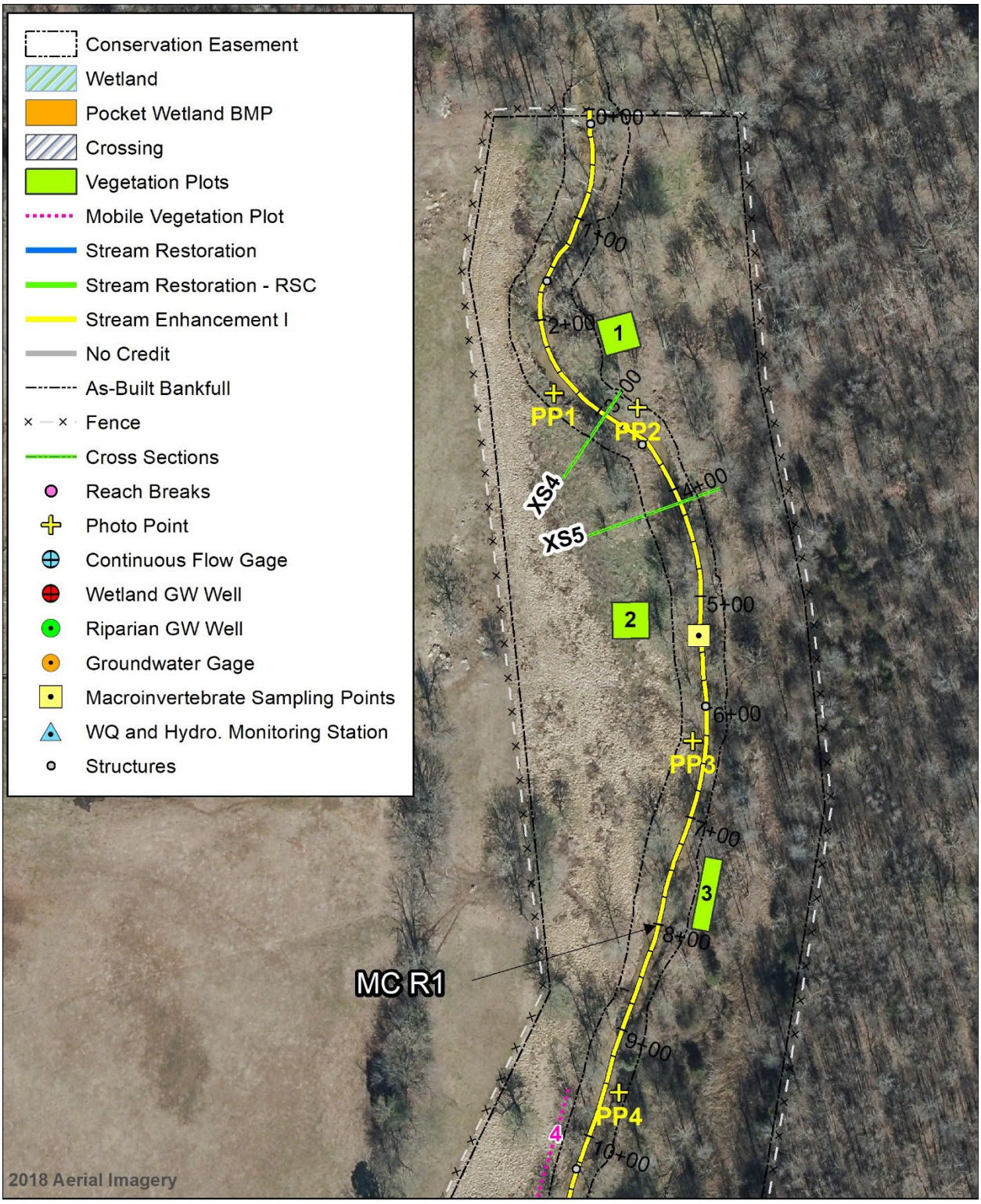


Figure 1a. Current Condition Plan View
Millstone Creek Mitigation Site
Cape Fear Basin 03030003
Monitoring Year 0 - 2021

Randolph County

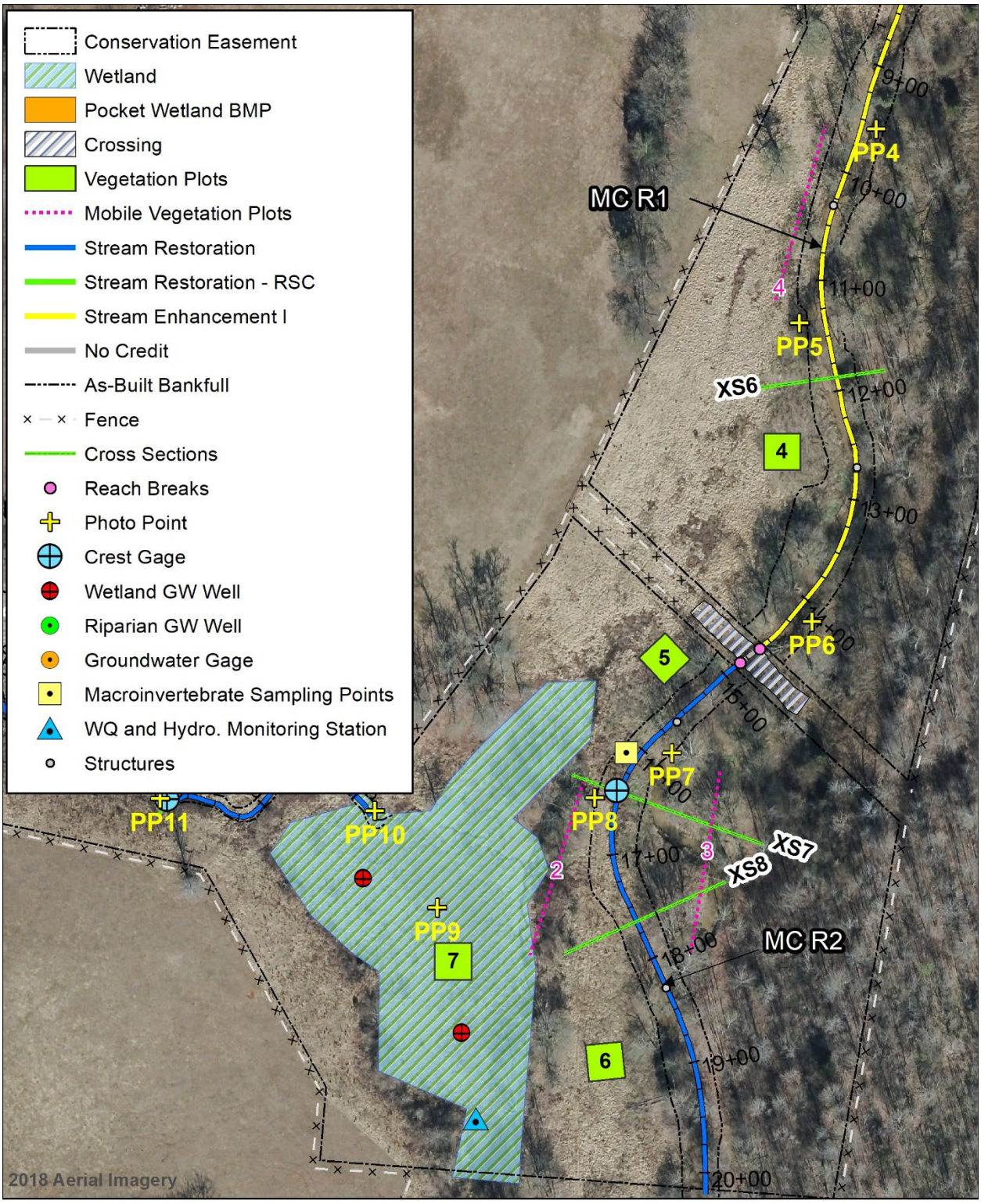


NORTH

0 50 100 200 Feet

Figure 1b. Current Condition Plan View
Millstone Creek Mitigation Site
Cape Fear Basin 03030003
Monitoring Year 0 - 2021

Randolph County



NORTH

0 50 100 200 Feet

Figure 1c. Current Condition Plan View
Millstone Creek Mitigation Site
Cape Fear Basin 03030003
Monitoring Year 0 - 2021

Randolph County

APPENDIX A - Visual Assessment Data

Table 4. Visual Stream Morphology Stability Assessment Table

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

North Tributary Reach 1 (NTR1)

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	326
					Assessed Bank Length	652
Bank	Surface Scour/Bare Bank	Bank lacking vegetative cover resulting 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%
					0	100%
Structure	Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	14	14		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	14	14		100%

North Tributary Reach 2 (NTR2)

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	103
					Assessed Bank Length	206
Bank	Surface Scour/Bare Bank	Bank lacking vegetative cover resulting 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%
					0	100%
Structure	Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	4	4		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	4	4		100%

Table 4. Visual Stream Morphology Stability Assessment Table

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

Un-Named Tributary B (UTB)

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	529
					Assessed Bank Length	1058
Bank	Surface Scour/Bare Bank	Bank lacking vegetative cover resulting 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%
					0	100%
Structure	Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	16	16		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	16	16		100%

Millstone Creek Reach 1 (MCR1)

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	1462
					Assessed Bank Length	2924
Bank	Surface Scour/Bare Bank	Bank lacking vegetative cover resulting 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.			10	99.7%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
					10	99.7%
Structure	Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	32	32		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	32	32		100%

Table 4. Visual Stream Morphology Stability Assessment Table

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

Millstone Creek Reach 2 (MCR2)

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	533
					Assessed Bank Length	1066
Bank	Surface Scour/Bare Bank	Bank lacking vegetative cover resulting 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%
					0	100%
Structure	Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	10	10		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	10	10		100%

Table 5. Visual Stream Morphology Stability Assessment Table

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 –

Planted Acreage	**11.5 (Phase I only)**			
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.	0.10 acres	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	**17.96**			
Vegetation Category	**Definitions**	**Mapping Threshold**	**Combined Acreage**	**% of Easement Acreage**
Invasive Areas of Concern	Invasive plants 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, and vehicular access. Encroachment has no threshold value as will need to be addressed regardless of impact area.	none	0 Encroachments Noted/ 0 acres	

Stream Photos

	
PHOTO POINT 1 MCR1 – upstream (9-2-2021)	PHOTO POINT 2 MCR1 –downstream (9-2-2021)
	
PHOTO POINT 3 MCR1 – upstream (9-2-2021)	PHOTO POINT 4 MCR1 – upstream (9-2-2021)
	
PHOTO POINT 5 MCR1 – upstream (9-2-2021)	PHOTO POINT 6 MCR1/MCR2 – downstream (9-2-2021)

	
PHOTO POINT 7 MCR2 – upstream (9-2-2021)	PHOTO POINT 8 MCR2 –downstream (9-2-2021)
	
PHOTO POINT 8 MCR2 – upstream (9-2-2021)	PHOTO POINT 9 WETLAND – upstream/NW (9-2-2021)
	
PHOTO POINT 9 WETLAND – downstream/SE (9-2-2021)	PHOTO POINT 10 UTB- upstream (9-2-2021)

	
PHOTO POINT 11 UTB – downstream (9-2-2021)	PHOTO POINT 12 MCR1 –downstream (9-2-2021)
	
PHOTO POINT 13 NTR2 – upstream (9-2-2021)	PHOTO POINT 14 NTR1 – upstream (9-2-2021)

Vegetation Plot Photographs

	
VEGETATION PLOT 1 (1-5-2022)	VEGETATION PLOT 2 (1-5-2022)
	
VEGETATION PLOT 3 (1-5-2022)	VEGETATION PLOT 4 (1-5-2022)
	
VEGETATION PLOT 5 (1-5-2022)	VEGETATION PLOT 6 (1-5-2022)

	
VEGETATION PLOT 7 (1-5-2022)	VEGETATION PLOT 8 (1-5-2022)
	
VEGETATION PLOT 9 (1-5-2022)	VEGETATION PLOT 10 (1-5-2022)

	
MOBILE TRANSECTION 1 (1-11-2022)	MOBILE TRANSECTION 2 (1-11-2022)
	
MOBILE TRANSECTION 3 (1-11-2022)	MOBILE TRANSECTION 4 (1-11-2022)

APPENDIX B – Vegetation Plot Data

Table 6. Vegetation Plot Data

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 - 2021

Planted Acreage	11.6
Date of Initial Plant	2021-12-01
Date of Current Survey	2022-01-05
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	
					Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total
Species Included in Approved Mitigation Plan	Alnus serrulata	hazel alder	Tree	OBL							1	1	2	2
	Betula nigra	river birch	Tree	FACW	3	3					2	2	3	3
	Cercis canadensis	eastern redbud	Tree	FACU	4	4	1	1						
	Juglans nigra	black walnut	Tree	FACU			2	2						
	Liridendron tulipifera				1	1								
	Liriodendron tulipifera	tuliptree	Tree	FACU	3	3	2	2			6	6	3	3
	Nyssa sylvatica	blackgum	Tree	FAC	1	1	1	1			3	3	2	2
	Other						1	1						
	Other												1	1
	Platanus occidentalis	American sycamore	Tree	FACW	2	2					1	1	2	2
	Quercus alba	white oak	Tree	FACU										
	Quercus phellos	willow oak	Tree	FAC			4	4			3	3		
	Quercus prinoides	dwarf chinquapin oak	Shrub	UPL	1	1								
	Quercus sp.										1	1	2	2
	Viburnum nudum	possumhaw	Shrub	OBL	2	2	4	4						
Sum	**Performance Standard**				17	17	15	15			17	17	15	15
Mitigation Plan Performance Standard	Current Year Stem Count					17		15		0		17		15
	Stems/Acre					688		607		0		688		607
	Species Count					8		7		0		7		7
	Dominant Species Composition (%)					24		27		0		35		20
	Average Plot Height (ft.)					217		215				231		230
	% Invasives					0		0		0		0		0
Post Mitigation Plan Performance Standard	Current Year Stem Count					17		15		0		17		15
	Stems/Acre					688		607		0		688		607
	Species Count					8		7		0		7		7
	Dominant Species Composition (%)					24		27		0		35		20
	Average Plot Height (ft.)					217		215				231		230
	% Invasives					0		0		0		0		0

Table 6. Vegetation Plot Data

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 - 2021

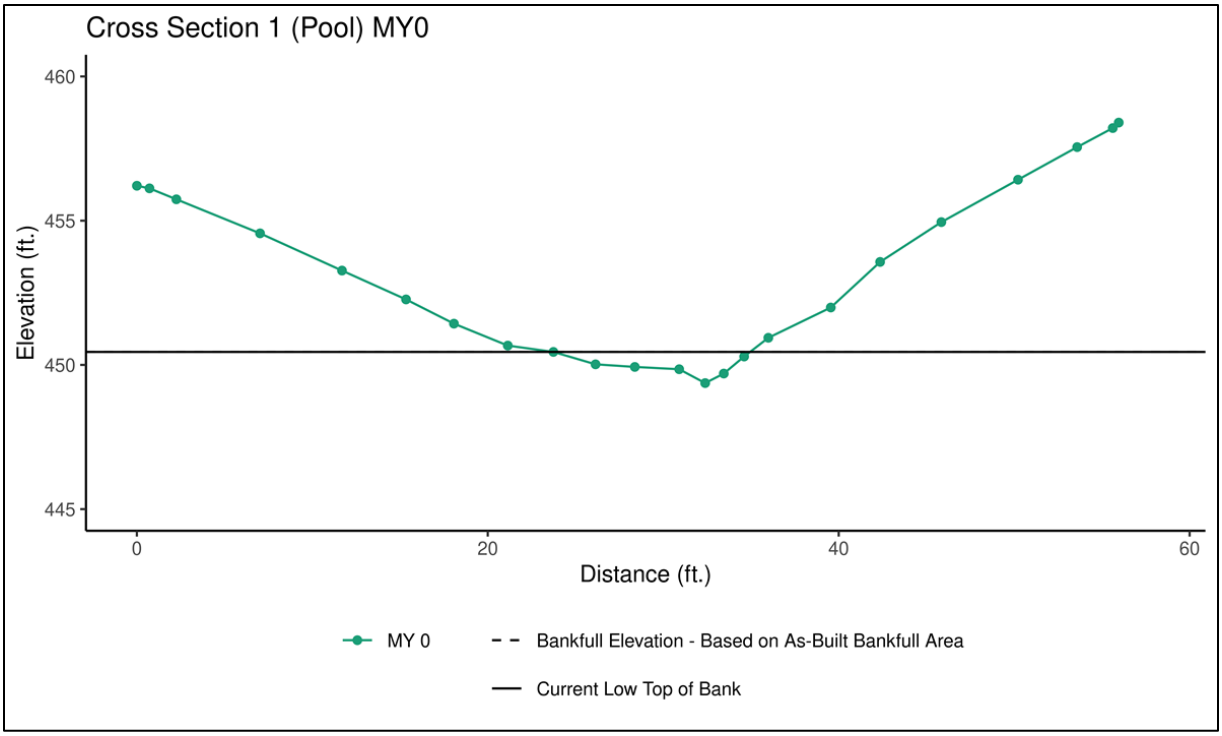
Planted Acreage	11.6
Date of Initial Plant	2021-12-01
Date of Current Survey	2022-01-05
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/ Shrub	Indicator Status	Veg Plot 6 F		Veg Plot 7 F		Veg Plot 8 F		Veg Plot 9 F		Veg Plot 10 F	
					Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total
Species Included in Approved Mitigation Plan	Alnus serrulata	hazel alder	Tree	OBL	4	4			1	1	1	1	1	1
	Betula nigra	river birch	Tree	FACW					1	1				
	Cercis canadensis	eastern redbud	Tree	FACU					2	2				
	Diospyros virginiana	common persimmon	Tree	FAC							1	1		
	Ilex glabra	inkberry	Shrub	FAC									2	2
	Juglans nigra	black walnut	Tree	FACU							2	2	1	1
	Liriodendron tulipifera	tuliptree	Tree	FACU	7	7			2	2				
	Nyssa sylvatica	blackgum	Tree	FAC	1	1								
	Other												2	2
	Other				1	1					3	3		
	Platanus occidentalis	American sycamore	Tree	FACW	2	2			5	5				
	Quercus alba	white oak	Tree	FACU					2	2	1	1		
	Quercus phellos	willow oak	Tree	FAC					1	1	1	1		
	Quercus sp.				2	2			3	3	4	4	6	6
	Sambucus canadensis	Amer. black elderberry	Tree		1	1								
	Viburnum nudum	possumhaw	Shrub	OBL	1	1								
Sum	Performance Standard							19	19			17	17	13
Mitigation Plan Performance Standard	Current Year Stem Count					19		0		17		13		12
	Stems/Acre					769		0		688		526		486
	Species Count					8		0		8		7		5
	Dominant Species Composition (%)					37		0		29		31		50
	Average Plot Height (ft.)					220				235		217		190
	% Invasives					0		0		0		0		0
Post Mitigation Plan Performance Standard	Current Year Stem Count					19		0		17		13		12
	Stems/Acre					769		0		688		526		486
	Species Count					8		0		8		7		5
	Dominant Species Composition (%)					37		0		29		31		50
	Average Plot Height (ft.)					217		215				231		230
	% Invasives					0		0		0		0		0

Table 7. 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		7	0	0		0	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	688		7	0	607		7	0	769		8	0
	Veg Plot 7 F				Veg Plot 8 F				Veg Plot 9 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	0		0	0	688		8	0	526		7	0
	Veg Plot 10 F											
	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	486		5	0								

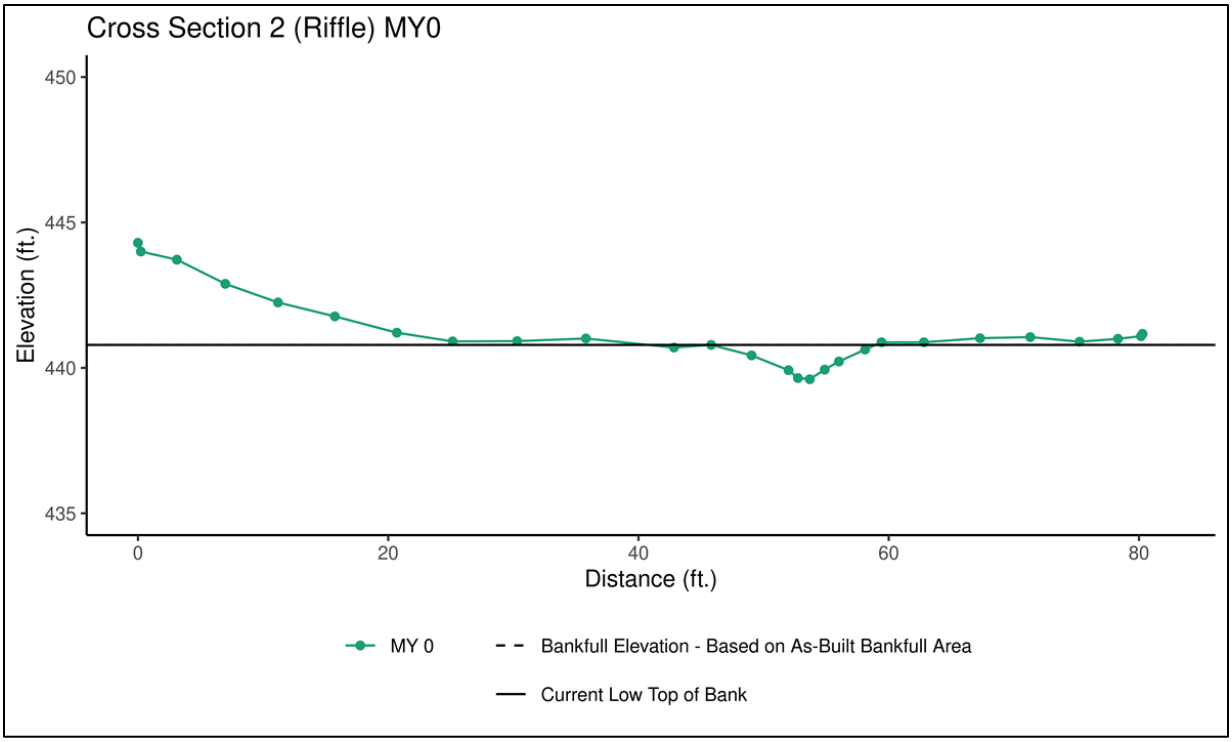
APPENDIX C. Stream Geomorphology Data

Cross-Section Plots



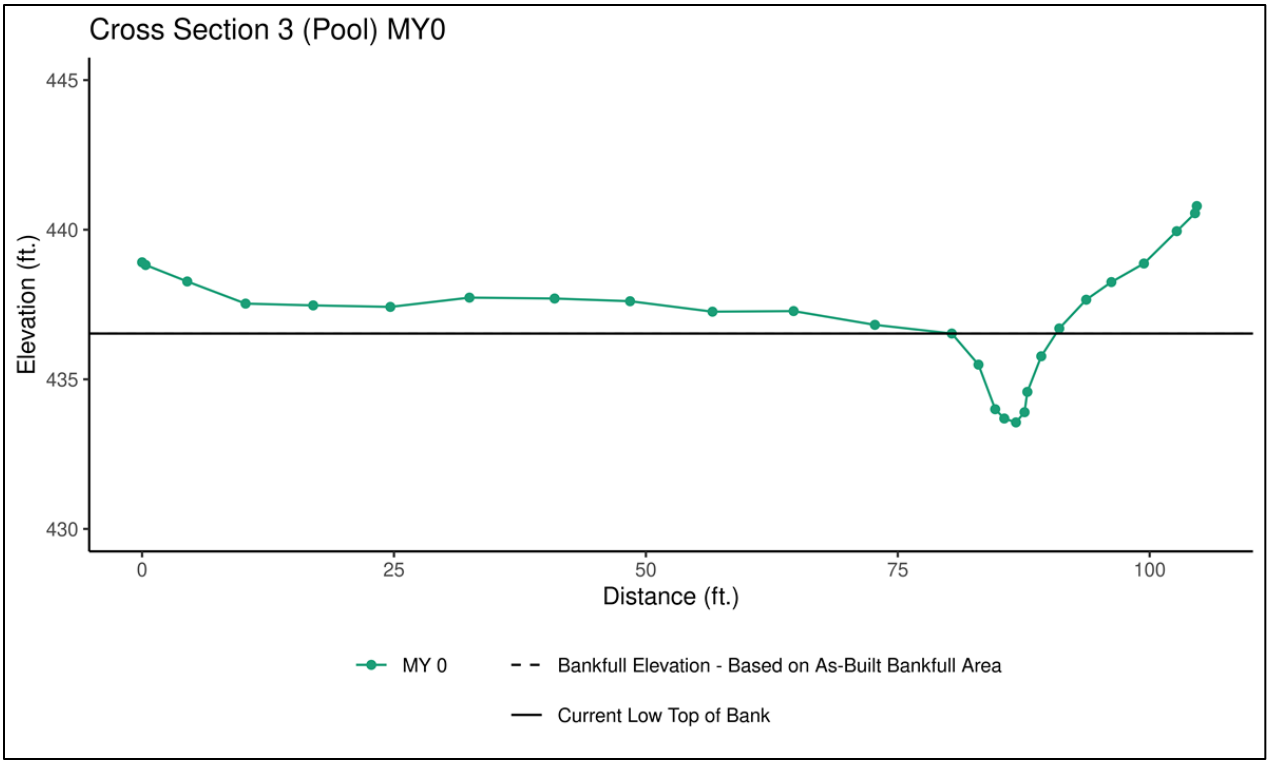
NTR1 – Cross Section 1 (Pool)	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	450.45					
Bank Height Ratio - Based on As-Built Bankfull Area	1.00					
Thalweg Elevation	449.37					
LTOB Elevation	450.45					
LTOB Max Depth	1.08					
LTOB Cross Sectional Area	5.76					

April 8, 2022 Downstream



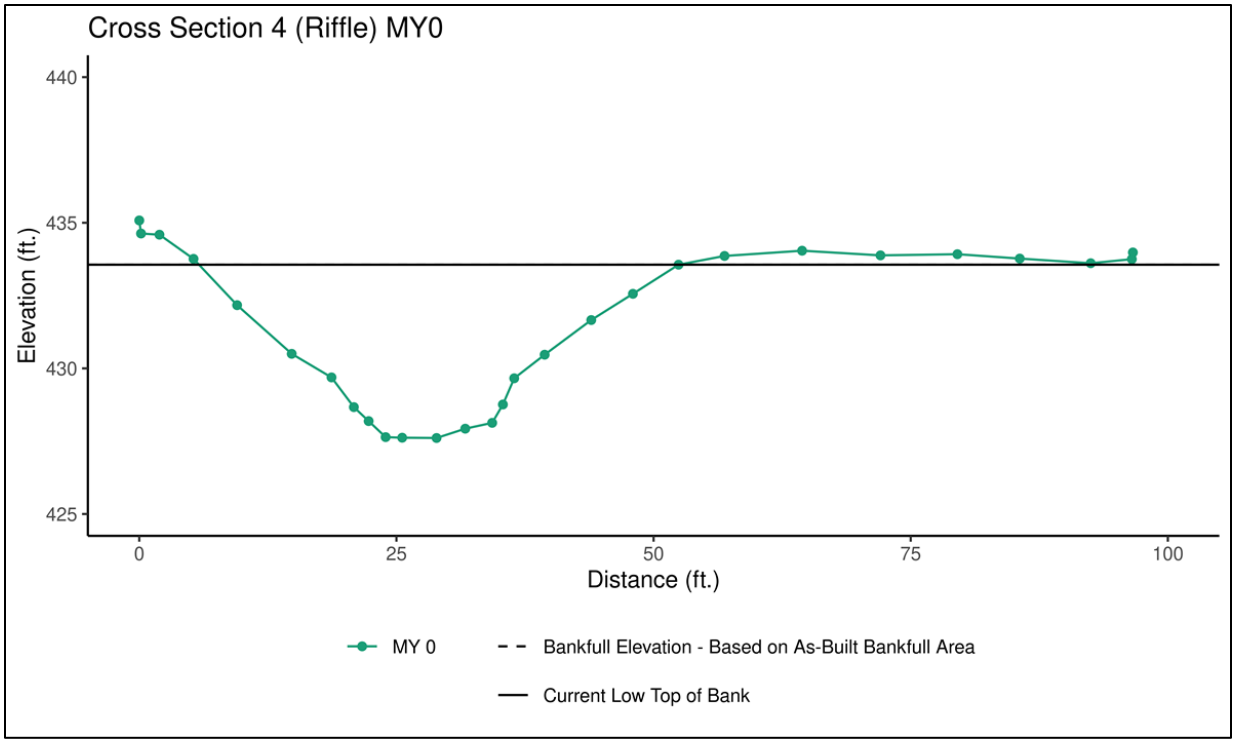
UTB – Cross Section 2 (Riffle)	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	440.79					
Bank Height Ratio - Based on As-Built Bankfull Area	1.00					
Thalweg Elevation	439.61					
LTOB Elevation	440.79					
LTOB Max Depth	1.18					
LTOB Cross Sectional Area	7.10					

April 8, 2022 Downstream



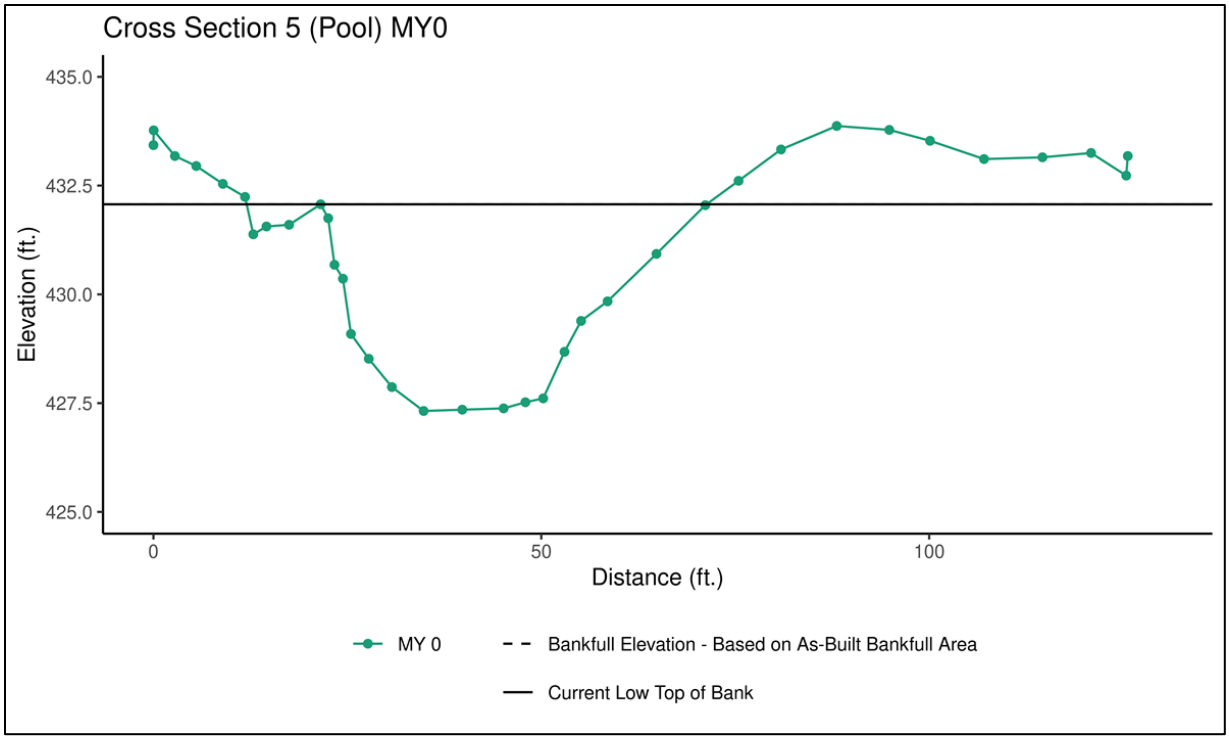
UTB – Cross Section 3 (Pool)	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	436.53					
Bank Height Ratio - Based on As-Built Bankfull Area	1.00					
Thalweg Elevation	433.56					
LTOB Elevation	436.53					
LTOB Max Depth	2.97					
LTOB Cross Sectional Area	15.57					

April 8, 2022 Downstream



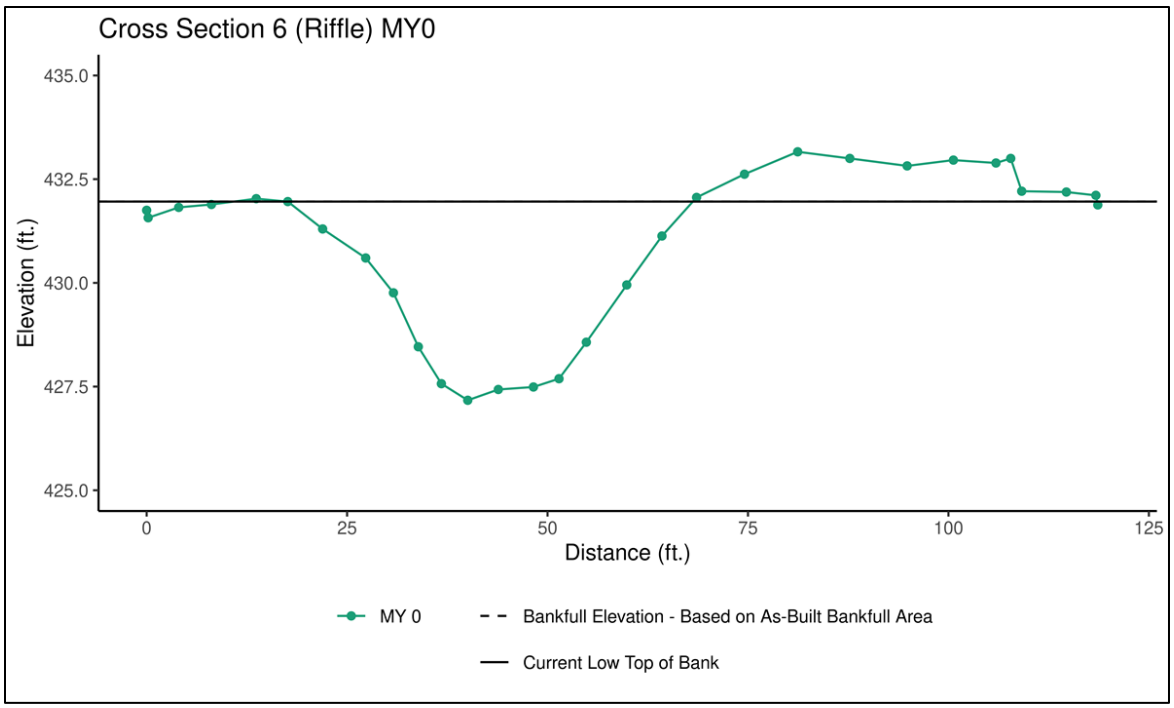
MCR1 – Cross Section 4 (Riffle)	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	433.56					
Bank Height Ratio - Based on As-Built Bankfull Area	1.00					
Thalweg Elevation	427.61					
LTOB Elevation	433.56					
LTOB Max Depth	5.95					
LTOB Cross Sectional Area	153.88					

April 8, 2022 Downstream



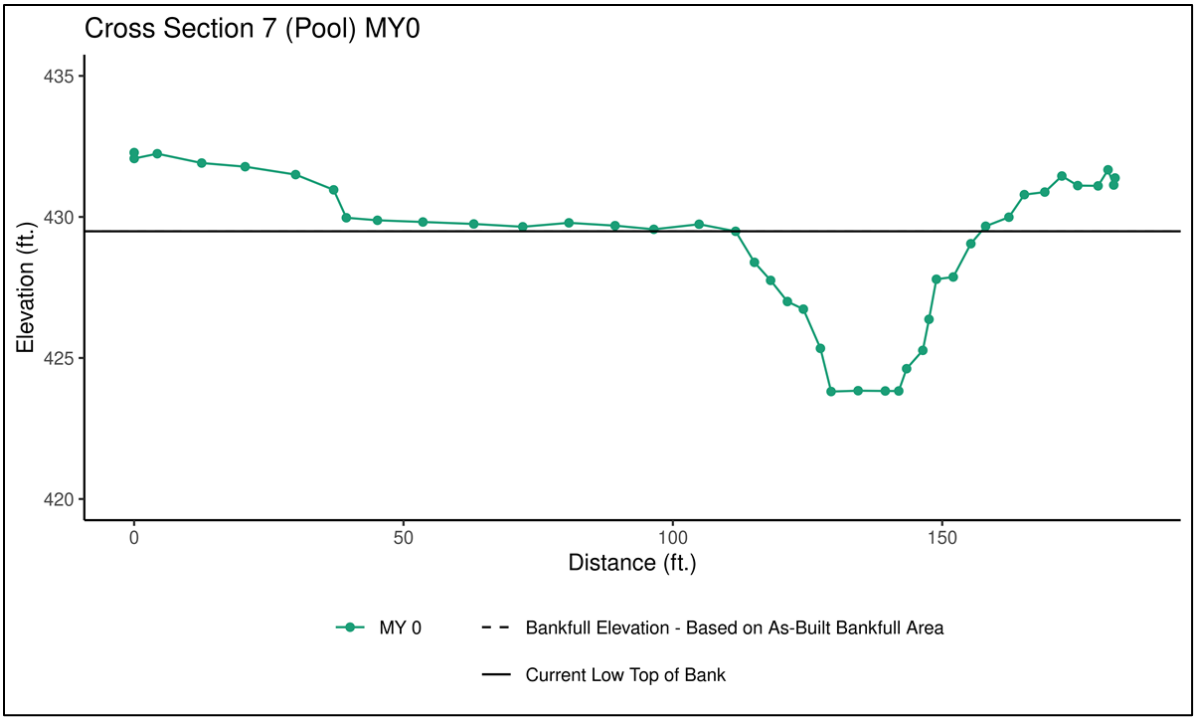
MCR1 – Cross Section 5 (Pool)	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	432.07					
Bank Height Ratio - Based on As-Built Bankfull Area	1.00					
Thalweg Elevation	427.32					
LTOB Elevation	432.07					
LTOB Max Depth	4.75					
LTOB Cross Sectional Area	154.17					

April 8, 2022 Downstream



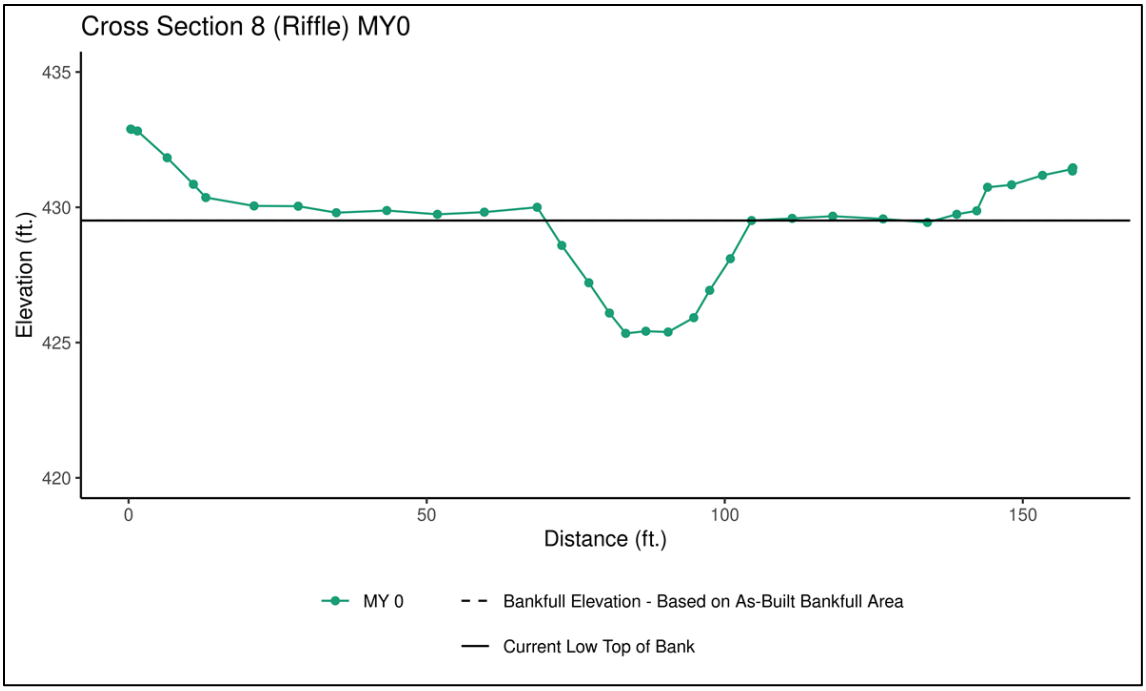
MCR1 – Cross Section 6 (Riffle)	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	431.96					
Bank Height Ratio - Based on As-Built Bankfull Area	1.00					
Thalweg Elevation	427.43					
LTOB Elevation	431.96					
LTOB Max Depth	4.53					
LTOB Cross Sectional Area	133.02					

April 8, 2022 Downstream



MCR2 – Cross Section 7 (Pool)	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	429.49					
Bank Height Ratio - Based on As-Built Bankfull Area	1.00					
Thalweg Elevation	423.83					
LTOB Elevation	429.49					
LTOB Max Depth	5.66					
LTOB Cross Sectional Area	146.27					

April 8, 2022 Downstream

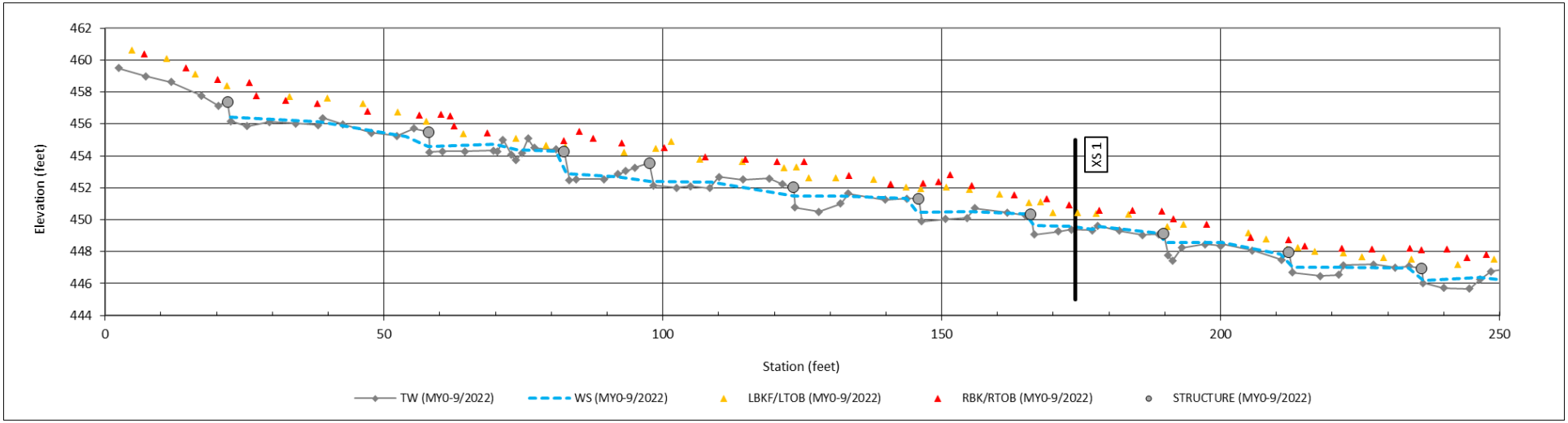


MCR2 – Cross Section 8 (Riffle)	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	429.51					
Bank Height Ratio - Based on As-Built Bankfull Area	1.00					
Thalweg Elevation	425.42					
LTOB Elevation	429.51					
LTOB Max Depth	4.09					
LTOB Cross Sectional Area	89.89					

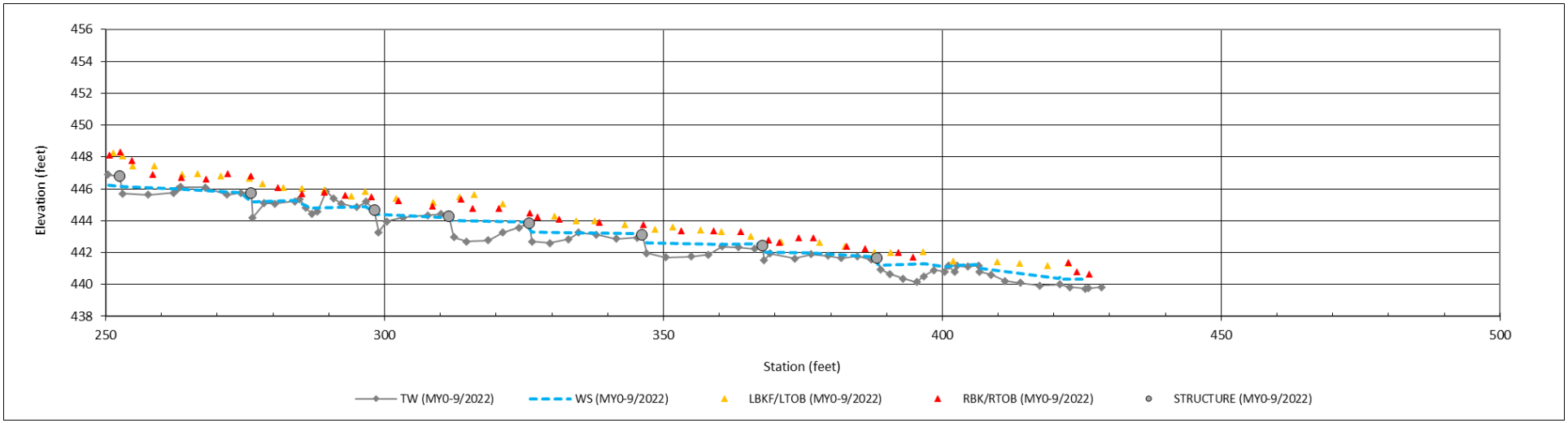
April 8, 2022 Downstream

Longitudinal Profile Plots
Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

North Tributary Reach 1 (STA 0+00 to 2+50)

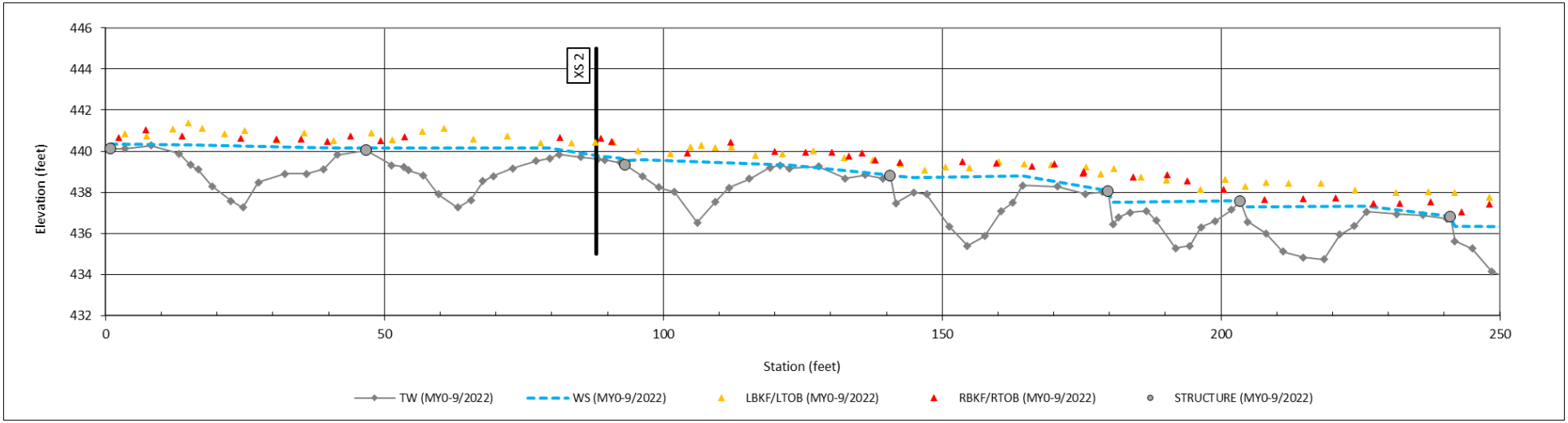


North Tributary Reach 1 & Reach 2 (STA 2+50 to 4+29)

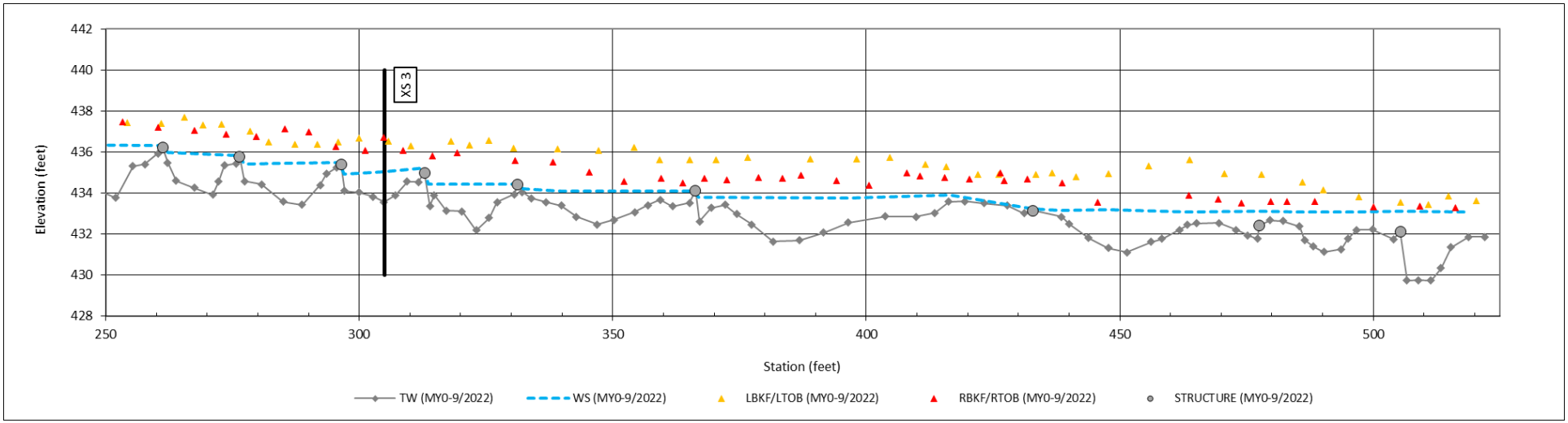


Longitudinal Profile Plots
Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

Un-Named Tributary B (STA 0+00 to 2+50)

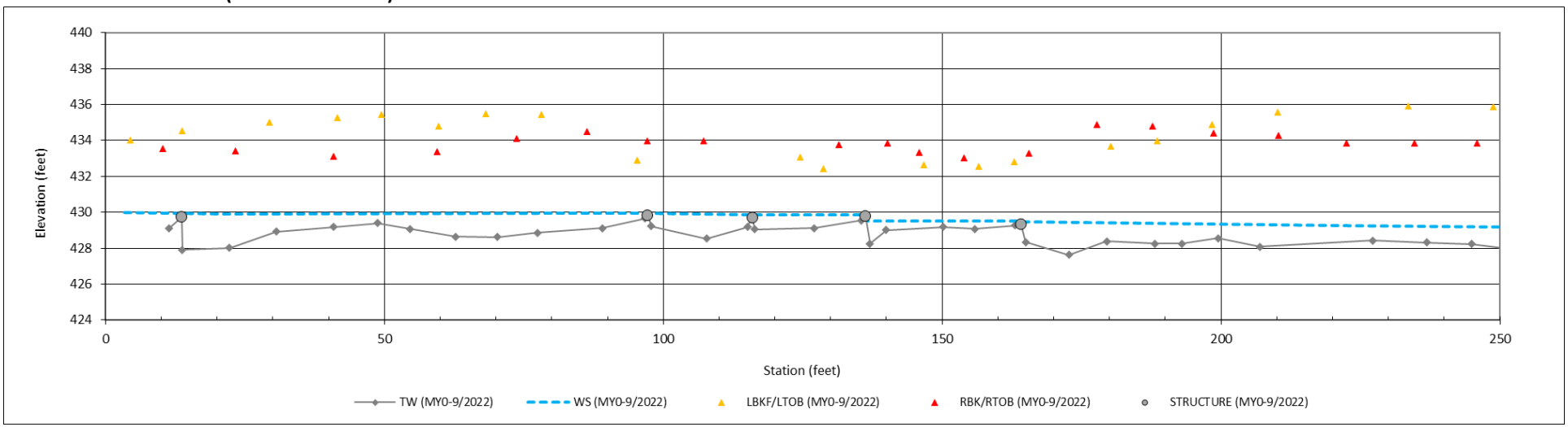


Un-Named Tributary B (STA 2+50 to 5+23)

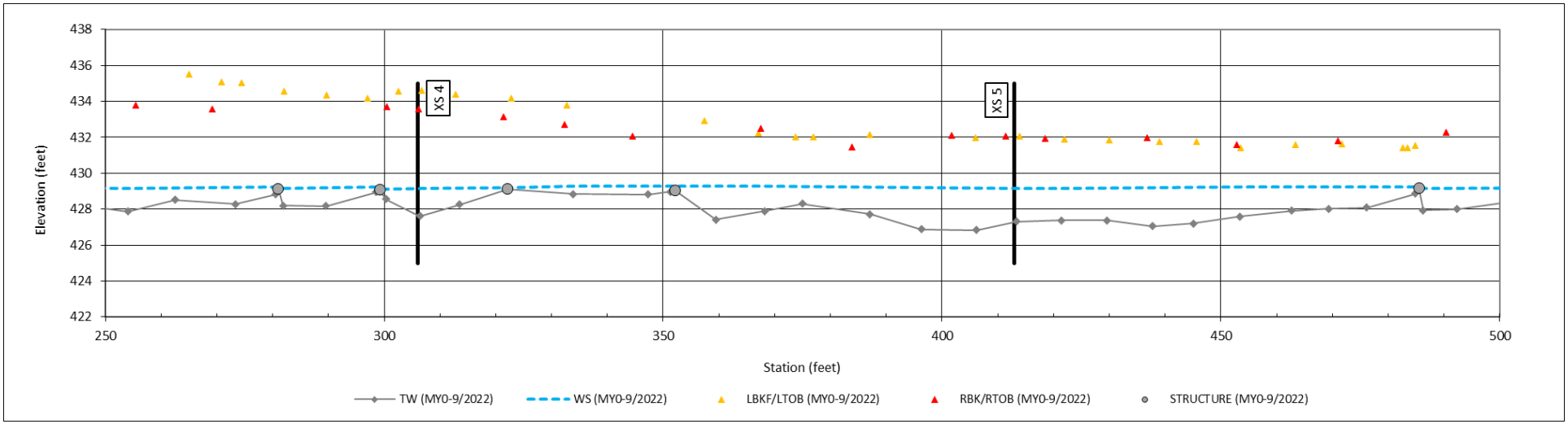


Longitudinal Profile Plots
Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

Millstone Creek Reach 1 (STA 0+00 to 2+50)

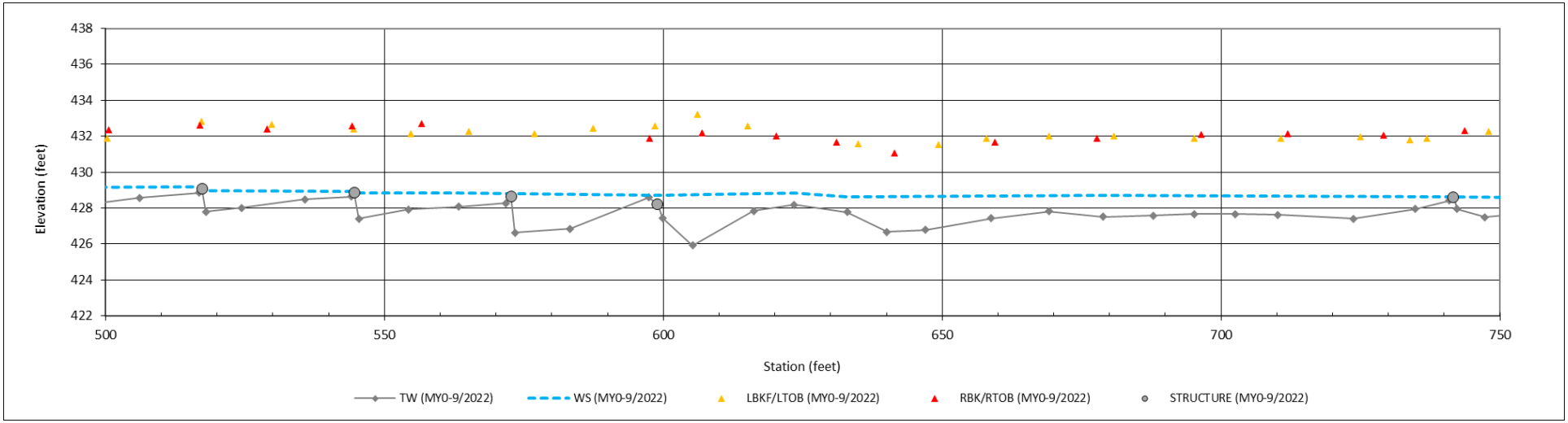


Millstone Creek Reach 1 (STA 2+50 to 5+00)

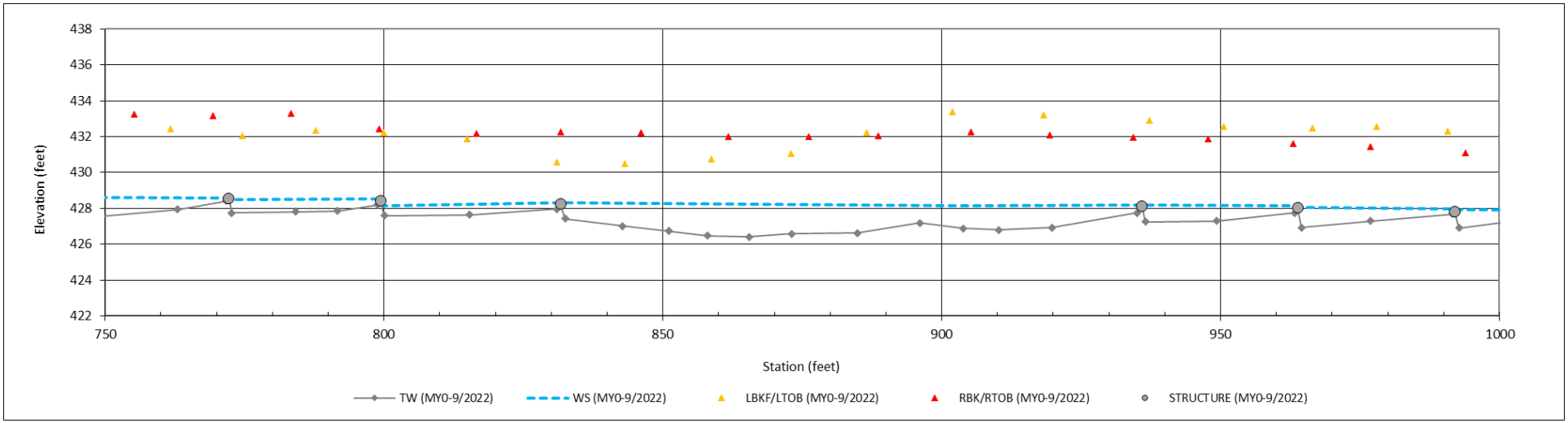


Longitudinal Profile Plots
Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

Millstone Creek Reach 1 (STA 5+00 to 7+50)

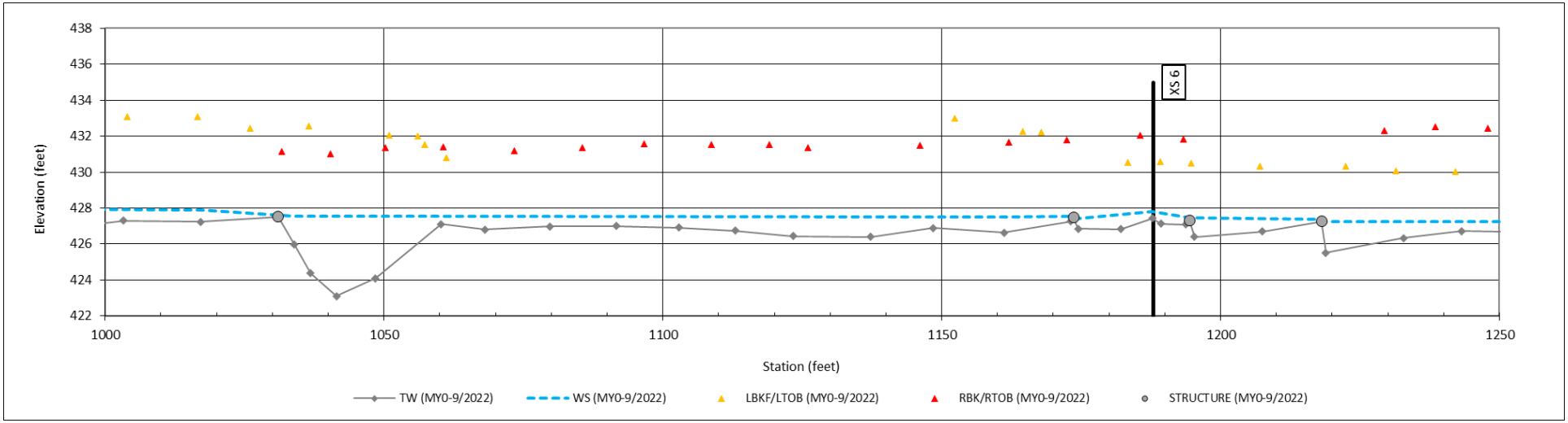


Millstone Creek Reach 1 (STA 7+50 to 10+00)

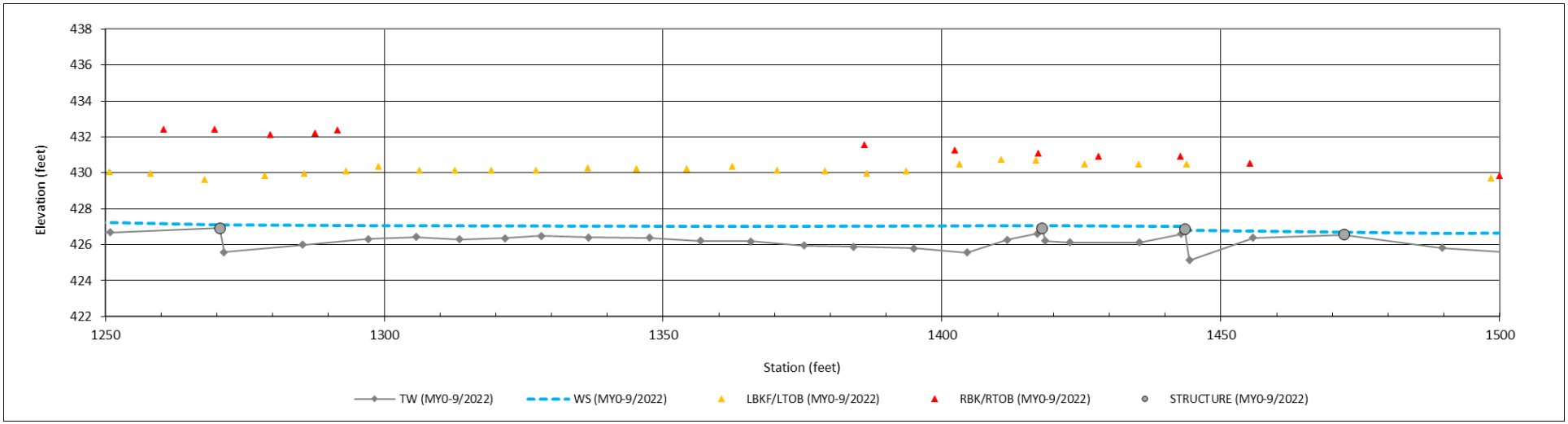


Longitudinal Profile Plots
Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

Millstone Creek Reach 1 (STA 10+00 to 12+50)

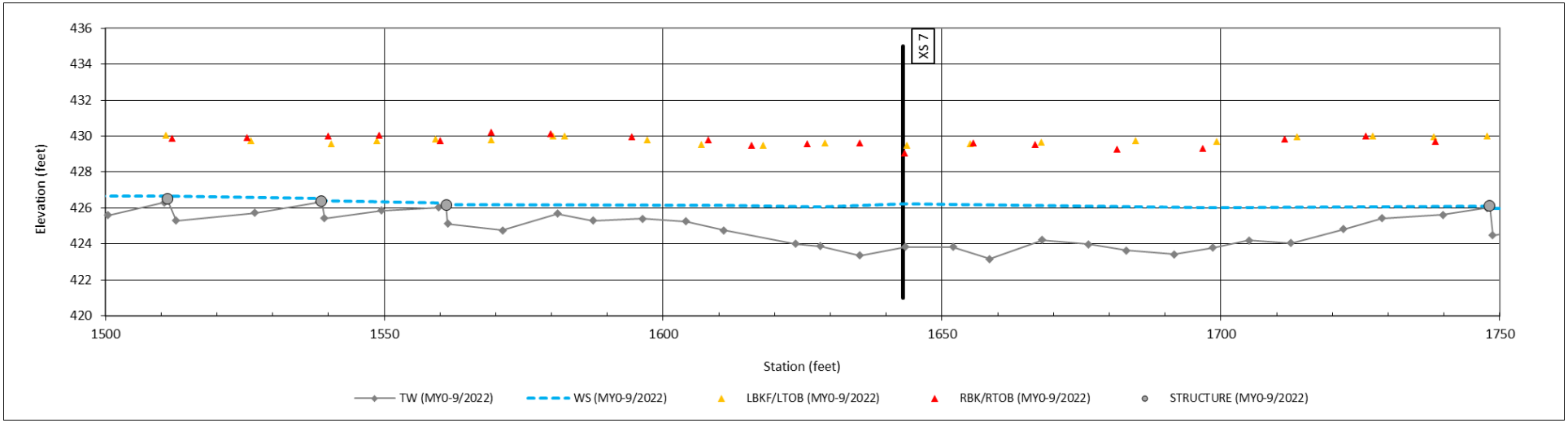


Millstone Creek Reach 1 & Reach 2 (STA 12+50 to 15+00)



Longitudinal Profile Plots
Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

Millstone Creek Reach 2 (STA 15+00 to 17+50)



Millstone Creek Reach 2 (STA 17+50 to 20+20)

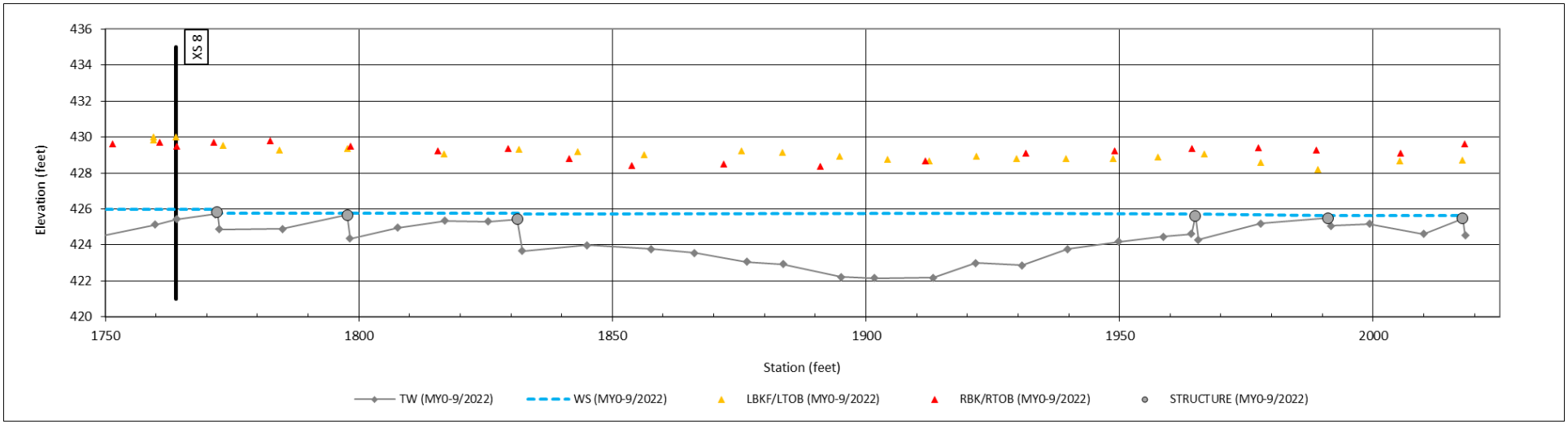


Table 8: Baseline Stream Data Summary

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

Parameter	Pre-Existing Condition					Design		Monitoring Baseline (MY0)		
North Tributary Reach 1 (NTR1)									*** As-Built Condition**	
	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	5.8	5.85	5.85	5.9	2	8		8.2		1
Floodprone Width (ft)	8.3	8.5	8.5	8.7	2	14.3		16.5		1
Bankfull Mean Depth (ft)	0.4	0.5	0.5	0.6	2	0.4		0.41		1
Bankfull Max Depth (ft)	0.6	0.75	0.75	0.9	2	0.5		0.65		1
Bankfull Cross Sectional Area (ft^2)	2.3	3	3	3.7	2	3.5		3.4		1
Width/Depth Ratio	9.4	11.95	11.95	14.5	2	18.3		19.8		1
Entrenchment Ratio	1.4	1.45	1.45	1.5	2	1.8		2.0		1
Bank Height Ratio	**3**	3.1	3.1	**3.2**	2	**1**		1		**1**
Max part size (mm) mobilized at bankfull	48-108					93-172		86-164		
Rosgen Classification	G5/F5					B5		B5		
Bankfull Discharge (cfs)	9.7					15.4		14.3		
Sinuosity (ft)	1.03					1.1		1.1		
Water Surface Slope (Channel) (ft/ft)	0.023					0.048		0.047		
Other										
North Tributary Reach 2 (NTR2)									*** As-Built Condition**	
	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)		4.9			1	4.9		9.7		1
Floodprone Width (ft)		9.8			1	8.3		21		1
Bankfull Mean Depth (ft)		0.5			1	0.5		0.5		1
Bankfull Max Depth (ft)		0.6			1	0.6		1.7		1
Bankfull Cross Sectional Area (ft^2)		2.3			1	2.3		4.6		1
Width/Depth Ratio		10.2			1	10.2		20.5		1
Entrenchment Ratio		2.0			1	1.7		2.2		1
Bank Height Ratio		1			1	1		1		**1**
Max part size (mm) mobilized at bankfull	70-141					70-141		60-127		
Rosgen Classification	B5					B5		B5		
Bankfull Discharge (cfs)	8.8					8.8		14.0		
Sinuosity (ft)	1.05					1.05		1.05		
Water Surface Slope (Channel) (ft/ft)	0.037					0.037		0.029		
Other										
UTB										
	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	4.4	4.8	4.4	5.6	3	10	15	13.1		1
Floodprone Width (ft)	6.16	34.7	10.1	88	3	65.0		65		1
Bankfull Mean Depth (ft)	0.5	0.6	0.7	0.7	3	0.7	0.9	0.5		1
Bankfull Max Depth (ft)	0.9	0.9	0.9	0.9	3	0.9	1.5	1.2		1
Bankfull Cross Sectional Area (ft^2)	2.1	2.9	3.0	3.7	3	7.0	13.0	7.10		1
Width/Depth Ratio	6.6	8.1	8.4	9.3	3	14.3	21.4	24.3		1
Entrenchment Ratio	1.4	7.7	1.8	20.0	3	6.5	4.3	4.9		1
Bank Height Ratio	**1**	1.65	1.65	**2.3**	3	1		1		**1**
Max part size (mm) mobilized at bankfull	33-82					52-114		29-76		
Rosgen Classification	G5/E5					C5		C5		
Bankfull Discharge (cfs)	8.1					26.0		19.6		
Sinuosity (ft)	1.08					1.08		1.12		
Water Surface Slope (Channel) (ft/ft)	0.0144					0.0140		0.0140		
Other										

* Baseline morphology data for NTR1 and NTR2 are based on the general topographic survey of the as-built condition. The data is not based on a permanent cross section as there are no permanent riffle cross sections located in either of these two reaches.

Table 8: Baseline Stream Data Summary

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

Parameter	Pre-Existing Condition					Design		Monitoring Baseline (MY0)		
Millstone Creek Reach 1 (MCR1)										
	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)	28.9	37.8	37.8	46.6	3	28.9	46.6	67.5	46.6	2
Floodprone Width (ft)	217	274	274	331	3	217	331	65.0	65.0	2
Bankfull Mean Depth (ft)	2.6	2.65	2.65	2.7	3	2.6	3.3	2.0	3.3	2
Bankfull Max Depth (ft)	3.3	3.7	3.7	4.1	3	3.4	4.8	4.8	5.9	2
Bankfull Cross Sectional Area (ft^2)	75.3	99.5	99.5	123.6	3	75.3	123.6	136.0	153.9	2
Width/Depth Ratio	11.1	14.4	14.4	17.6	3	11.1	17.6	33.5	14.1	2
Entrenchment Ratio	7.1	7.3	7.3	7.5	3	7.1	7.5	1.0	1.4	2
Bank Height Ratio	**1.0**	1.1	1.1	**1.1**	3	**1.0**	**1.1**	1	1	2
Max part size (mm) mobilized at bankfull	167-260					67-85		19-57		
Rosgen Classification	G5/E5					C5		C5		
Bankfull Discharge (cfs)	9.7					243-295		363		
Sinuosity (ft)	1.08					1.06		1.1		
Water Surface Slope (Channel) (ft/ft)	0.0144					0.002		0.0022		
Other										
Millstone Creek Reach 2 (MCR2)										
	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)		30.9			1	36.0		34.5		1
Floodprone Width (ft)	219	226	226	232	1	217	331	225.0		1
Bankfull Mean Depth (ft)		3.4			1	2.6		2.7		1
Bankfull Max Depth (ft)		4.3			1	3.6		4.2		1
Bankfull Cross Sectional Area (ft^2)		105.8			1	85.0		94.3		1
Width/Depth Ratio		9.0			1	13.8		12.7		1
Entrenchment Ratio	7.1	7.3	7.3	7.5	1	6.0	9.2	6.5		1
Bank Height Ratio		1.2			1	**1.0**	**1.0**	1		1
Max part size (mm) mobilized at bankfull	27-73					24-72		21-60		
Rosgen Classification	E5					C5		C5		
Bankfull Discharge (cfs)	358.4					305.0		270		
Sinuosity (ft)	1.13					1.09		1.08		

Table 9: Cross-Section Morphology Monitoring Summary

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

	North Tributary Reach 1							UTB													
	Cross Section 1 (Pool - Reach 1)							Cross Section 2 (Riffle)							Cross Section 3 (Pool)						
	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	450.45							440.79							436.53						
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00							1.00							1.00						
Thalweg Elevation	449.37							439.61							433.56						
LTOB[2] Elevation	450.45							440.79							436.53						
LTOB[2] Max Depth (ft)	1.08							1.18							2.97						
LTOB[2] Cross Sectional Area (ft^2)	5.76							7.10							15.57						
	Millstone Creek																				
	Cross Section 4 (Riffle - Reach 1)							Cross Section 5 (Pool - Reach 1)							Cross Section 6 (Riffle - Reach 1)						
	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	433.56							432.07							431.96						
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00							1.00							1.00						
Thalweg Elevation	427.61							427.32							427.43						
LTOB[2] Elevation	433.56							432.07							431.96						
LTOB[2] Max Depth (ft)	5.95							4.75							4.53						
LTOB[2] Cross Sectional Area (ft^2)	153.88							154.17							133.02						
	Millstone Creek																				
	Cross Section 7 (Pool - Reach 2)							Cross Section 8 (Riffle - Reach 2)							Cross Section						
	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	429.49							429.51													
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00							1.00													
Thalweg Elevation	423.83							425.42													
LTOB[2] Elevation	429.49							429.51													
LTOB[2] Max Depth (ft)	5.66							4.09													
LTOB[2] Cross Sectional Area (ft^2)	146.27							89.89													

[1]Bank Height Ratio (BHR) takes the As-built bankfull area as the basis for adjusting each subsequent year's bankfull elevation

[2]LTOB Area and Max depth - These are based on the LTOB elevation for each year's 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 recorded and tracked above as LTOB max depth.

Table 10: Large Woody Debris Assessment Table

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

	Pre-Existing Condition							After Restoration							Difference
	Date: 5-6-16				Length Assessed (ft)		2040	Date: 11-2-21				Length Assessed (ft)		2020	
	Score							Score							
Pieces	**1**	**2**	**3**	**4**	**5**	**Count**	**Total Score**	**1**	**2**	**3**	**4**	**5**	**Count**	**Total Score**	
Length/Bankfull Width	20	9	3	3	3	38	74	2	11	27			40	105	
Diameter	10	9	7	6	6	38	103	2		1	36	1	40	154	
Location			4	17	17	38	165				6	34	40	194	
Type	1		16	13	8	38	141	1		9	26	4	40	152	
Structure	24	4	6		4	38	70	7	33				40	73	
Stability	1	3	7	3	24	38	160	1				39	40	196	
Orientation	13	6	8	4	7	38	100	2	7		10	21	40	161	
Total	69	31	51	46	69		**813**	**15**	**51**	**37**	**78**	**99**		**1035**	**222**
Average/Linear Foot							**0.4**							**0.5**	**0.1**
Average/300 Feet							**120**							**154**	**33**
Debris Dams															
Length	3		1			4	6	7	1				8	9	
Height	2		2			4	8		6	2			8	18	
Structure			3		1	4	14			2	4	2	8	32	
Location		1	1		2	4	15				6	2	8	34	
Stability	2		2			4	8					8	8	40	
Total	7	1	9	0	82		**51**	7	7	4	10	12		**133**	**82**
							0.03							**0.066**	**0.04**
							7.5							**19.8**	**12.3**
Grand Total							**864**							**1168**	**304**

APPENDIX D. Project Timeline and Contact Information

Table 11: Project Activity and Reporting History

Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

Activity or Deliverable		Data Collection Complete	Task Completion or Deliverable Submission
Project Instituted		NA	May 22, 2006
Mitigation Plan Approved		May 1, 2020	July 16, 2020
Construction (Grading) Completed		September, 2021	October, 2021
Planting Completed		December 2021	December 28, 2021
As-built Survey Completed		September, 2021	January, 2022
MY-0 Baseline Report	Stream Survey	April, 2022	April, 2022
	Vegetation Survey		
MY1 Monitoring	Stream Survey		
	Vegetation Survey		
MY2 Monitoring	Stream Survey		
	Vegetation Survey		
MY3 Monitoring	Stream Survey		
	Vegetation Survey		
MY4 Monitoring			
MY5 Monitoring	Stream Survey		
	Vegetation Survey		
MY6 Monitoring			

Table 12: Project Contact Table

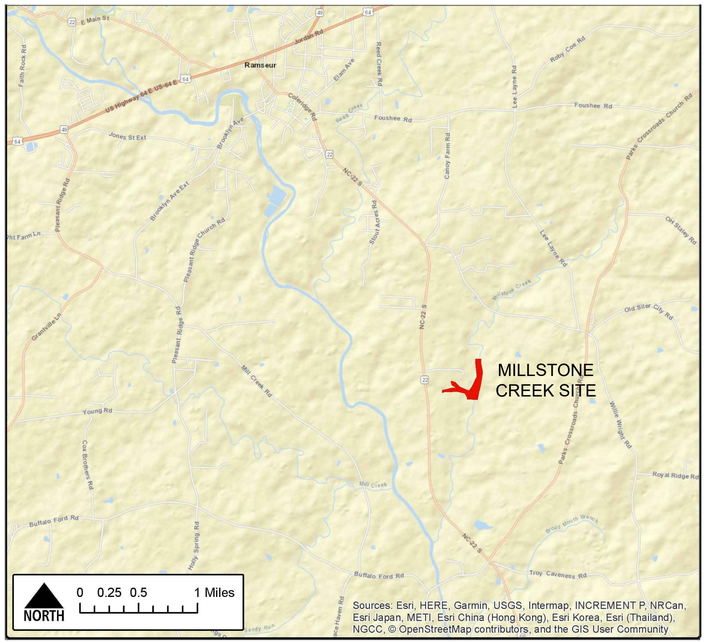
Millstone Creek Mitigation Site
DMS Project No. IMS# 204
Monitoring Year 0 – 2021

Project Name/Number	
Provider	NC Division of Mitigation Services
Mitigation Provider POC	Melonie Allen, NC Division of Mitigation Services
Designer	Barbara A. Doll & Jonathan Page, Biological & Agricultural Engineering Dept., NC State University, Box 7625, Raleigh NC 27695
Primary project design POC	Barbara A. Doll, 919-515-5287
Construction Contractor	Backwater Environmental, PO Box 1107, 515 S. Kennedy St., Eden, NC 27289

APPENDIX E. Record Drawings

NC DEPARTMENT OF ENVIRONMENTAL QUALITY - DIVISION OF MITIGATION SERVICES
MILLSTONE CREEK MITIGATION SITE - PHASE 1
RECORD DRAWINGS

RANDOLPH COUNTY, NORTH CAROLINA
SCO ID # 20-22021-01A; NCDMS IMS# 204; USACE AID: SAW-2019-01363
LAT: 35.696683 LONG: -79.623956



I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE SURVEY DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 2nd DAY OF FEBRUARY, 2022.

DAVID S. TURNER, P.L.S. #L-4551

NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER 02-02-22

I, DAVID S. TURNER, CERTIFY THAT THE AS-BUILT TOPOGRAPHIC SURVEY FOR THIS PROJECT WAS COMPLETED UNDER MY DIRECT AND RESPONSIBLE CHARGE AND TAKEN FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION; THAT THIS AS-BUILT TOPOGRAPHIC SURVEY WAS PERFORMED AT THE 95 PERCENT CONFIDENCE LEVEL TO MEET FEDERAL GEOGRAPHIC DATA COMMITTEE STANDARDS; THAT THIS SURVEY WAS PERFORMED TO MEET THE REQUIREMENTS FOR A TOPOGRAPHIC SURVEY TO THE HORIZONTAL ACCURACY OF CLASS A AND THE VERTICAL ACCURACY WHEN APPLICABLE TO CLASS C STANDARD, AND THAT THE ORIGINAL DATA WAS OBTAINED IN AUG-OCT 2021; THAT THE SURVEY WAS COMPLETED ON 8 OCTOBER 2021; AND ALL COORDINATES ARE BASED ON NAD83 (2011) AND ALL ELEVATIONS ARE BASED ON NAVD88. WITNESS MY ORIGINAL SIGNATURE, LICENSE NUMBER, AND SEAL THIS 2nd DAY OF FEBRUARY, 2022.

DAVID S. TURNER, P.L.S. #L-4551

NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER 02-02-22

AS-BUILT & RECORD DRAWINGS
JANUARY 28, 2022

PROJECT DIRECTORY

OWNER:	**NORTH CAROLINA DIVISION OF MITIGATION SERVICES**
	MELONIE ALLEN 217 WEST JONES STREET RALEIGH, NC 27603 919.707.8540 melonie.allen@ncdenr.gov
ENGINEER:	**NORTH CAROLINA STATE UNIVERSITY**
	BARBARA A. DOLL, PHD, PE CAMPUS BOX 7625 RALEIGH, NC 27695 919.515.5287 bdoll@ncsu.edu
	JONATHAN L. PAGE, PE CAMPUS BOX 7625 RALEIGH, NC 27695 919.515.8595 jlpage3@ncsu.edu
SURVEYOR:	**TURNER LAND SURVEYING**
	DAVID S. TURNER, PLS PO BOX 148 SWANNANOA, NC 26778 919.827.0745

SHEET INDEX

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY, NC
PHASE 1

TITLE 1.1

NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER 02-02-22
JANUARY 28, 2022

NC STATE

DRAWN: JLP, JAF
DESIGN: BAD, JLP
CHECK: BAD
APPROVED: BAD
PROJECT NAME: MILLSTONE CREEK MITIGATION SITE
SCALE: AS NOTED
DATE: JANUARY 28, 2022

SCO ID # 20-22021-01A
PHASE # 1

STANDARD LINES AND SYMBOLS

PRECONSTRUCTION FEATURES

- EXISTING TOB
- EXISTING CONSERVATION EASEMENT
- EXISTING PROPERTY LINE
- EXISTING EASEMENT FENCING
- EXISTING WETLANDS
- EXISTING BUILDING FOOTPRINT
- EXISTING GATE

DESIGN FEATURES

- DESIGN REGENERATIVE STORMWATER CONVEYANCE
- DESIGN ENHANCEMENT 1
- DESIGN RESTORATION
- DESIGN WETLAND ENHANCEMENT
- DESIGN CHANNEL CENTERLINE
- DESIGN BANKFULL
- DESIGN LOG SILL
- DESIGN BRUSH TOE WITH SOIL GEOLIFT
- DESIGN LOG VANE WITH BOULDER J-HOOK
- DESIGN REGENERATIVE STORMWATER CONVEYANCE CHANNEL
- DESIGN LOG RIFFLE
- DESIGN CONSTRUCTED RIFFLE

AS-BUILT FEATURES

- AS-BUILT THALWEG
- AS-BUILT TOP OF BANK
- AS-BUILT SURVEY LIMIT
- AS-BUILT FENCE
- AS-BUILT GATE
- AS-BUILT CONTOURS
- TREELINE
- TREE
- AS-BUILT LOG SILL
- AS-BUILT BRUSH TOE WITH SOIL GEOLIFT
- AS-BUILT LOG VANE WITH BOULDER J-HOOK
- AS-BUILT FLOOD GATE
- AS-BUILT LOG RIFFLE
- AS-BUILT CONSTRUCTED RIFFLE
- AS-BUILT RIPRAP/STONE
- MONITORING CROSS SECTION
- VEG PLOT
- PHOTO POINT
- MONITORING WELL/ GROUNDWATER GAUGE
- CONTROL POINT

CONTROL POINTS

POINT NO.	NORTHING(Y)	EASTING(X)	ELEV(Z)	DESCRIPTION
1	709432.11	1814267.16	469.769	TLS#1NL
2	709005.28	1814573.92	462.591	TLS#2NL
3	709098.44	1814902.49	443.691	TLS#3NL
4	708694.19	1815046.77	438.284	TLS#4NL
5	708593.88	1815321.16	431.151	TLS#5NL
6	709193.14	1815191.97	437.679	TLS#6NL
7	709060.41	1815494.85	442.400	TLS#7NL
9	709762.36	1815629.26	447.277	TLS#9NL
10	710108.00	1815387.34	439.149	TLS#10NL

NOTE: AS-BUILT SURVEY COMPLETED AUG-OCT 2021

NOTES:
1. DEVIATIONS FROM THE DESIGN WILL BE SHOWN IN RED

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY, NC
PHASE 1

2.1

PROJECT OVERVIEW

NORTH CAROLINA PROFESSIONAL SEAL 043864 ENGINEER DAVID A. DOLL

JANUARY 28, 2022

NC STATE

DRAWN:	JLP, JAF
DESIGN:	BAD, JLP
CHECK:	BAD
APPROVED:	BAD
PROJECT NAME:	MILLSTONE CREEK MITIGATION SITE
SCALE:	AS NOTED
DATE:	JANUARY 28, 2022

SCO ID # 20-22021-01A

PHASE # 1

COX, ROBERT G (COX, LISA G)
PIN: 8711308335
Deed Book-Page 001491-01287

COX, BILLIE W
PIN: 8711307018
Deed Book-Page 001888-02342

JOE DEAN TRAIL (APP.)

NC - 22

WASTE TREATMENT LAGOON

PASTURE

COX, JOE DEAN
PIN: 8710492424
Deed Book-Page 001228-01304

FOREST

COX, JOSEPH TALTON
(COX, BENJAMIN GRAHAM)
PIN: 8710396500
Deed Book-Page 00019F-00849

STATE OF NC
CONSERVATION EASEMENT
TRACT 1
Deed Book-Page 002141-01027

SHEET 4.1

SHEET 4.2

SHEET 4.3

SHEET 4.4

SHEET 4.5

NT R1

NT R2

UTB

MC R1

MC R2

WETLAND

PHASE 2 CONSTRUCTION TO BE COMPLETED AT LATER DATE

STATE OF NC
CONSERVATION EASEMENT
TRACT 2
Deed Book-Page 002141-01027

STATE OF NC
CONSERVATION EASEMENT
Deed Book-Page
002192-01144

PASTURE

STALEY, VICTOR CRAIG
(STOUT, ANTHONY TODD)
PIN: 8711514205
Deed Book-Page 002344-01227

CARMAC, KAROLYN C
PIN: 8710482381
Deed Book-Page 00096E-00700

FENCE FENCE FENCE

NOTES:
1. DEVIATIONS FROM THE DESIGN WILL BE SHOWN IN RED

0 100 200 Feet
SCALE: 1" = 100'

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY, NC
PHASE 1

PROJECT OVERVIEW

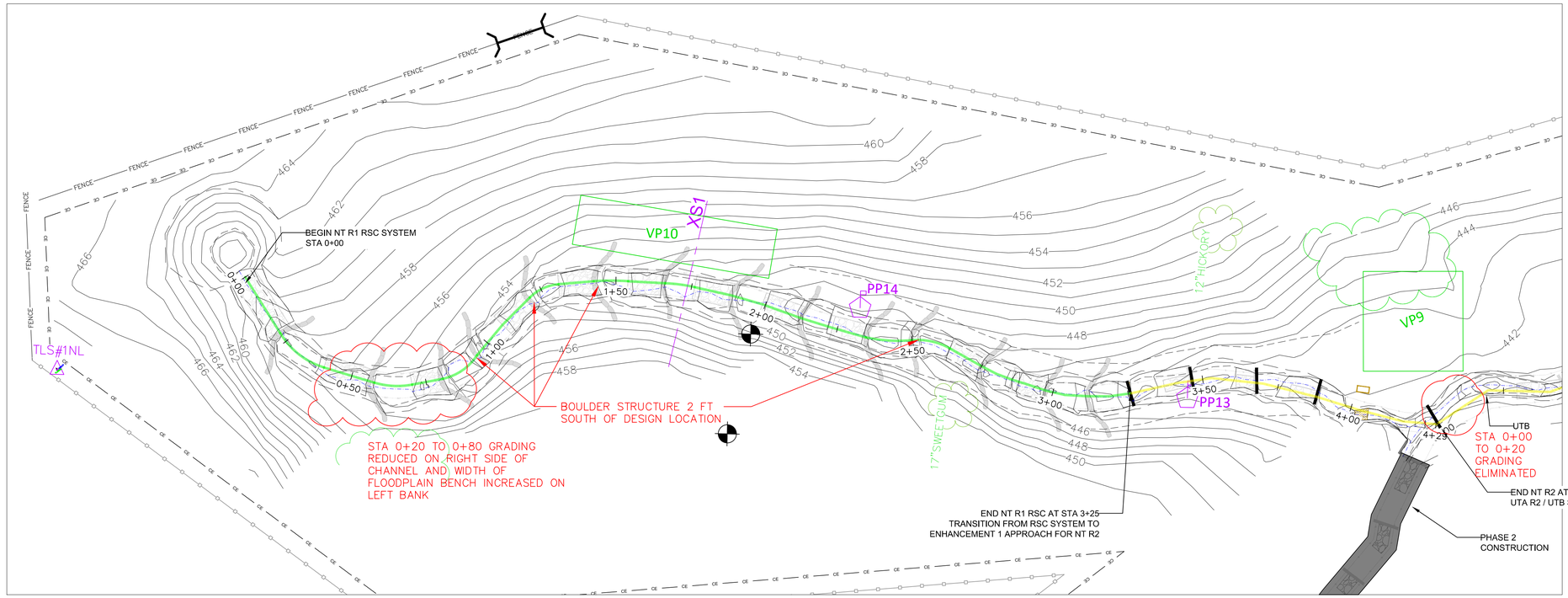
2.2

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 036963 PAUL A. DOLL REGISTERED
JANUARY 26, 2022

NC STATE

DRAWN:	JLP, JKF
DESIGN:	BAD, JLP
CHECK:	BAD
APPROVED:	BAD
PROJECT NAME:	MILLSTONE CREEK MITIGATION SITE
SCALE:	AS NOTED
DATE:	JANUARY 26, 2022

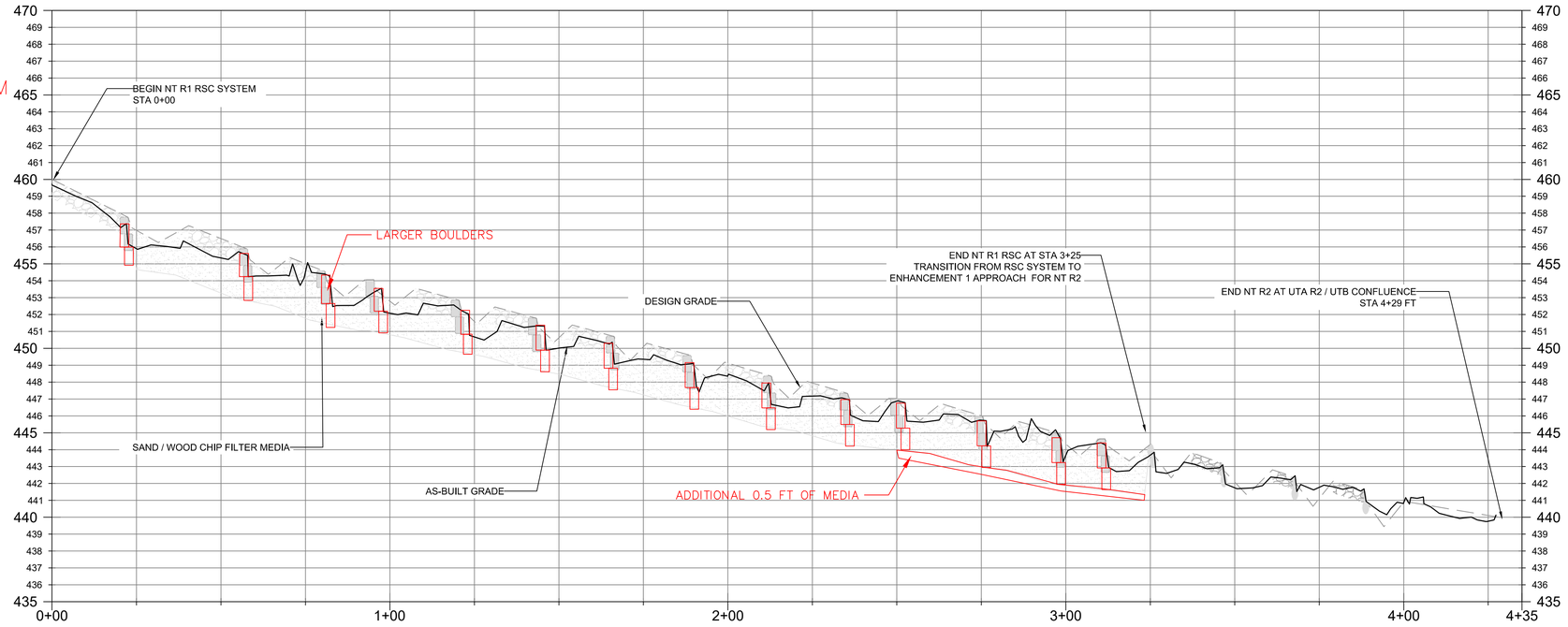
SCO ID # 20-22021-01A
PHASE # 1



SCALE: 1" = 20'

NOTES:

1. DEVIATIONS FROM THE DESIGN WILL BE SHOWN IN RED
2. BOULDERS ARE LARGER THAN SPECIFIED AND EXTEND TO THE BOTTOM OF THE MEDIA TRENCH. AN ADDITIONAL 0.5 FT OF MEDIA WAS ADDED FROM STA 2+50 TO STA 3+25 TO COMPENSATE FOR THE LOSS IN MEDIA VOLUME DUE TO THE LARGER BOULDERS



MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY, NC
PHASE 1

4.1

NT: PLAN - PROFILE

NORTH CAROLINA PROFESSIONAL SEAL 036564 ENGINEER DAVID B. HARBIN

JANUARY 28, 2022

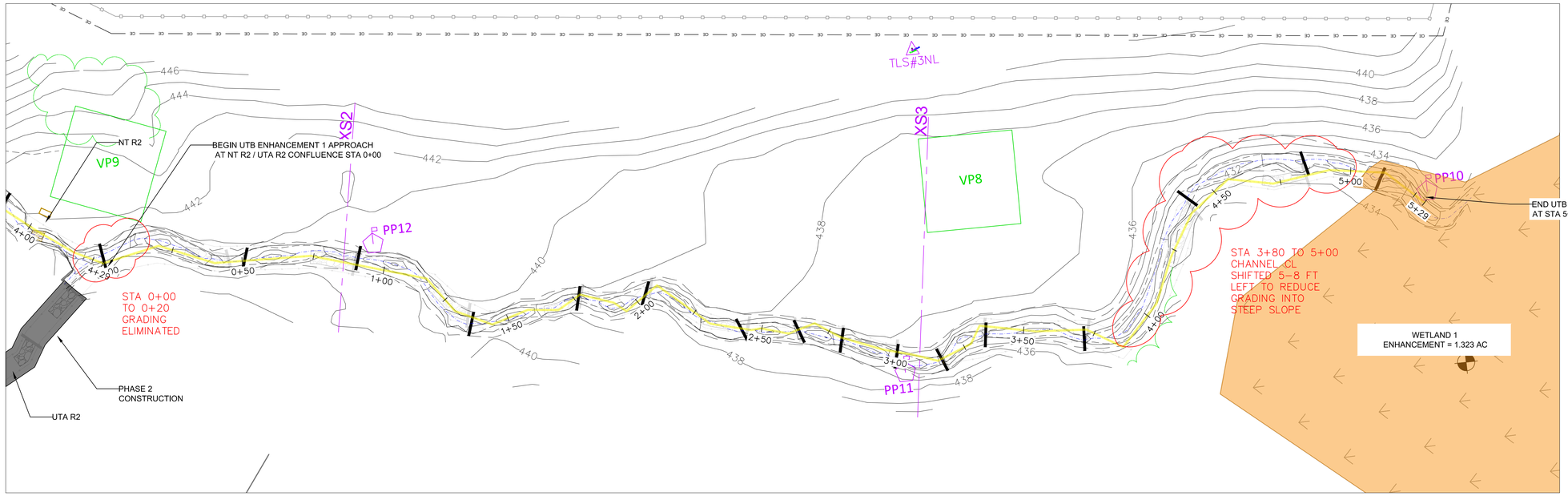
NC STATE

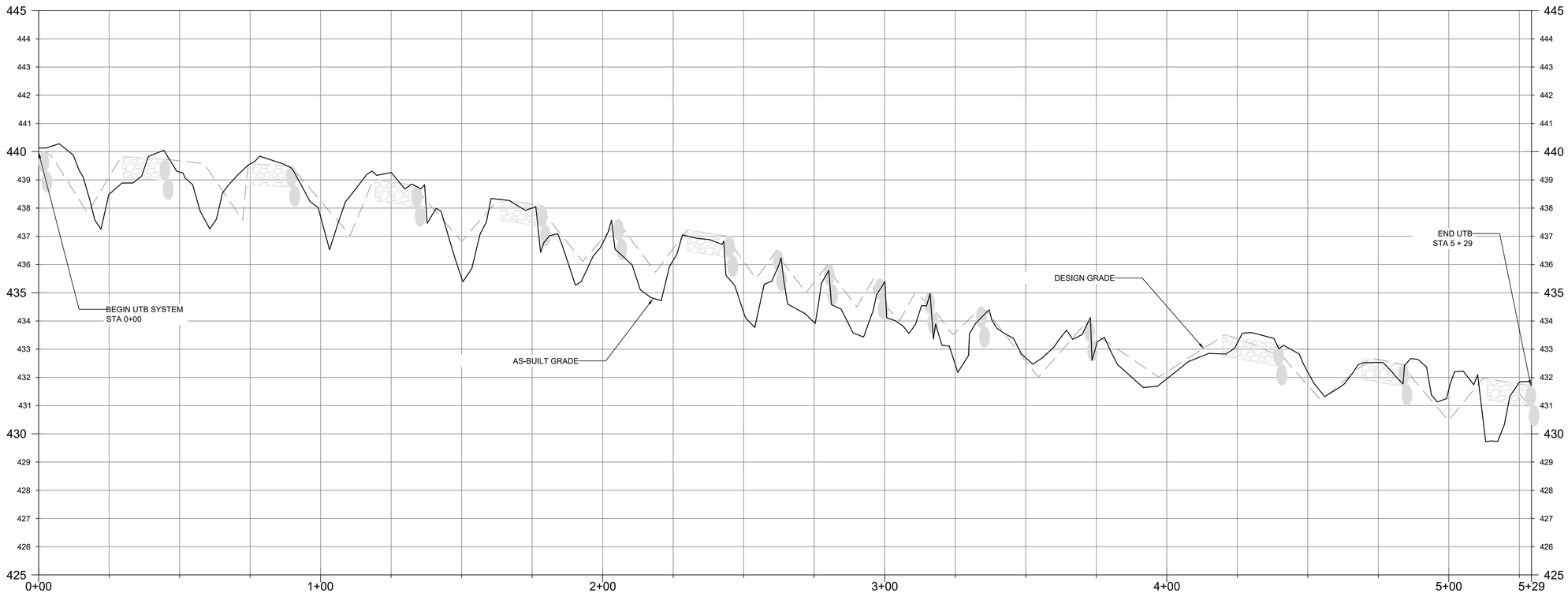
DRAWN:	JLP, JKF
DESIGN:	BAD, JLP
CHECK:	BAD
APPROVED:	BAD
PROJECT NAME:	MILLSTONE CREEK MITIGATION SITE
SCALE:	AS NOTED
DATE:	JANUARY 28, 2022

SCO ID # 20-22021-01A

PHASE # 1

NOTES:
1. DEVIATIONS FROM THE DESIGN WILL BE SHOWN IN RED





MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY, NC
PHASE 1

4.2

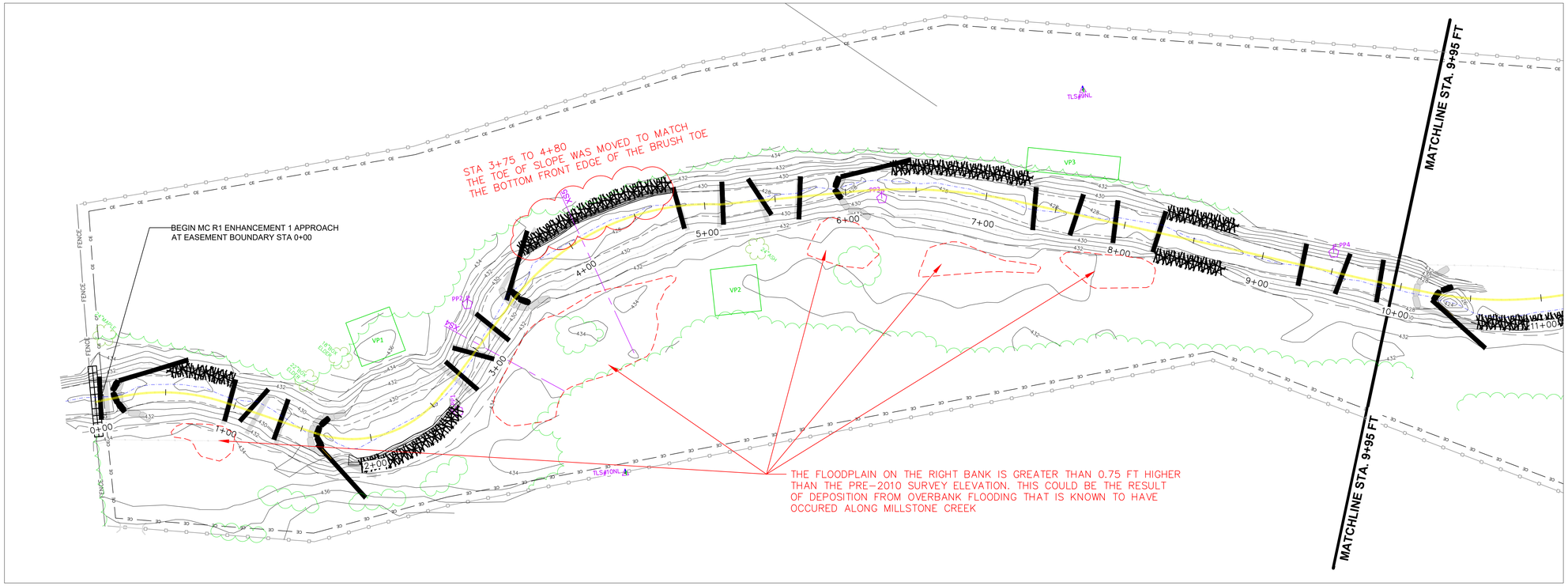
UTB: PLAN - PROFILE

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 036361 JOHN PAUL DOLL
JANUARY 28, 2022

NC STATE

DRAWN:	JLP, JAF
DESIGN:	BAD, JLP
CHECK:	BAD
APPROVED:	BAD
PROJECT NAME:	MILLSTONE CREEK MITIGATION SITE
SCALE:	AS NOTED
DATE:	JANUARY 28, 2022

SCO ID # 20-22021-01A
PHASE # 1

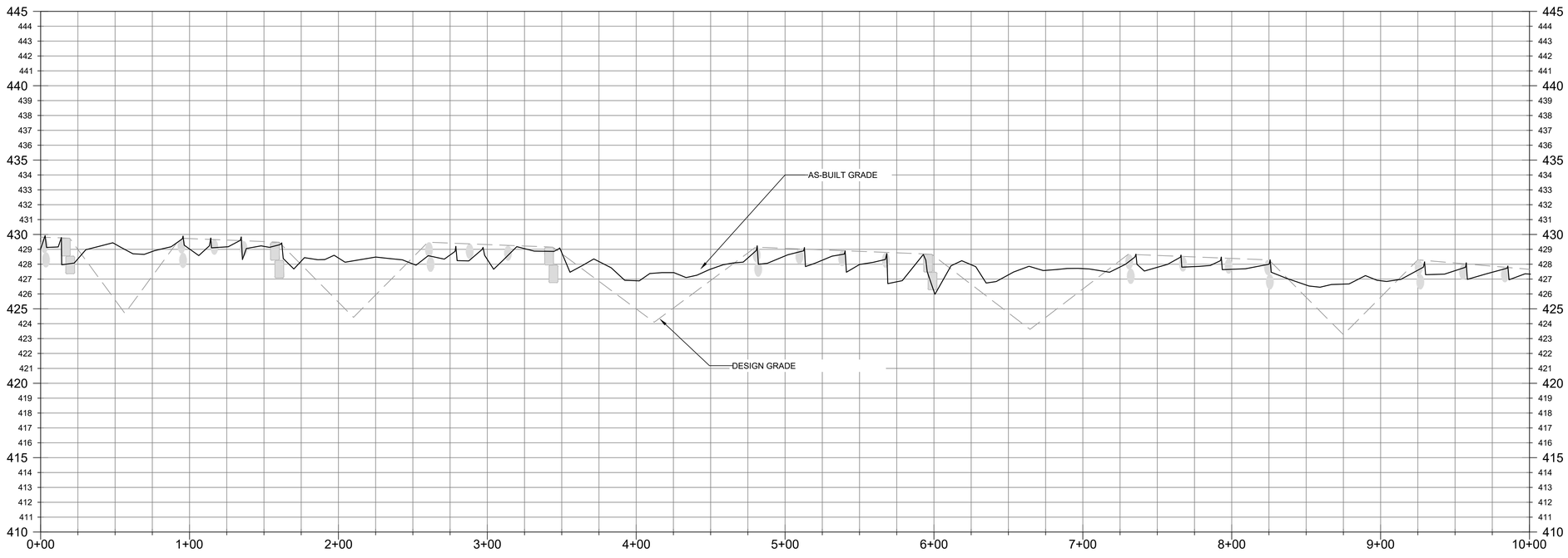


0 40 80 Feet

SCALE: 1" = 40'

NOTES:

1. DEVIATIONS FROM THE DESIGN WILL BE SHOWN IN RED
2. ALL J-HOOKS WERE LOCATED AND ORIENTED ACCORDING TO THE DESIGN DETAIL NOT THE PLAN VIEW LOCATION
3. ALL POOL DEPTHS WERE MODIFIED TO BE TWO (2) FT BELOW THE THALWEG FOR THE UPSTREAM PC DUE TO THE PRESENCE OF RUNNING SAND



MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY, NC
PHASE 1

4.3

MC: PLAN - PROFILE

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 036361 ANDREW PAUL DOLL

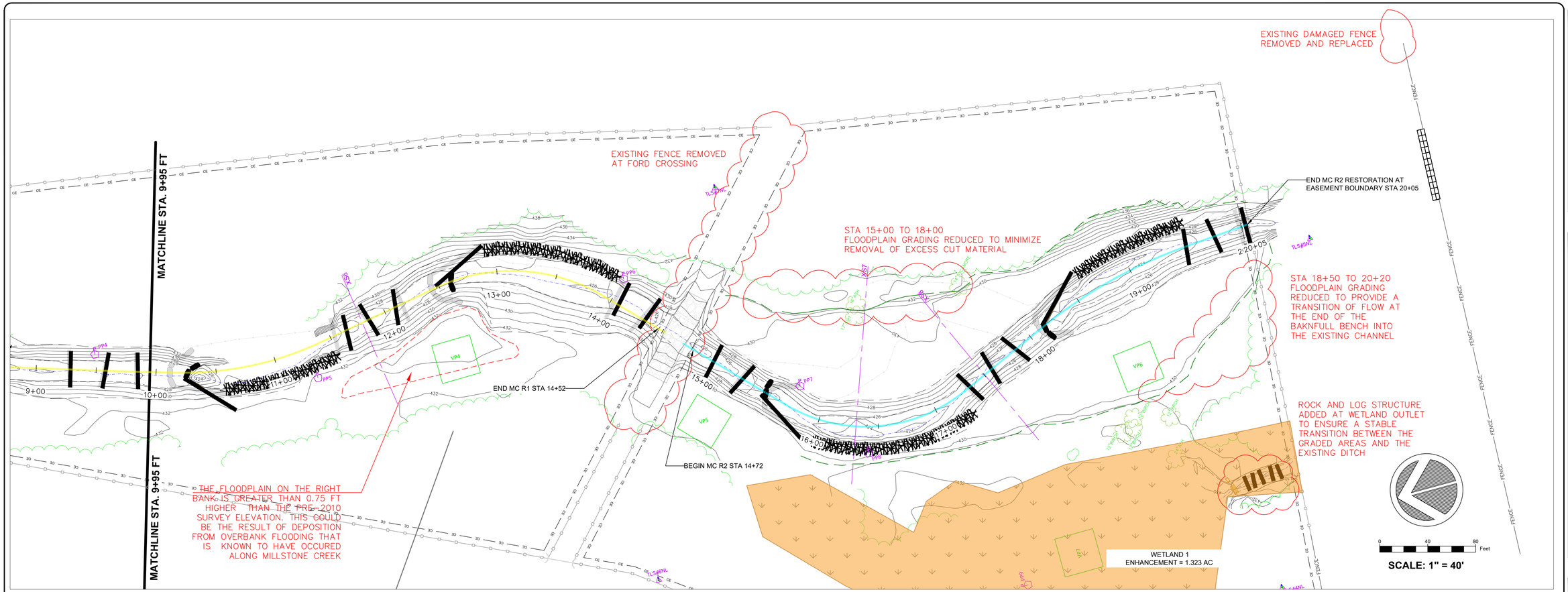
JANUARY 28, 2022

NC STATE

DRAWN:	JLP, JAF
DESIGN:	BAD, AJP
CHECK:	BAD
APPROVED:	BAD
PROJECT NAME:	MILLSTONE CREEK MITIGATION SITE
SCALE:	AS NOTED
DATE:	JANUARY 28, 2022

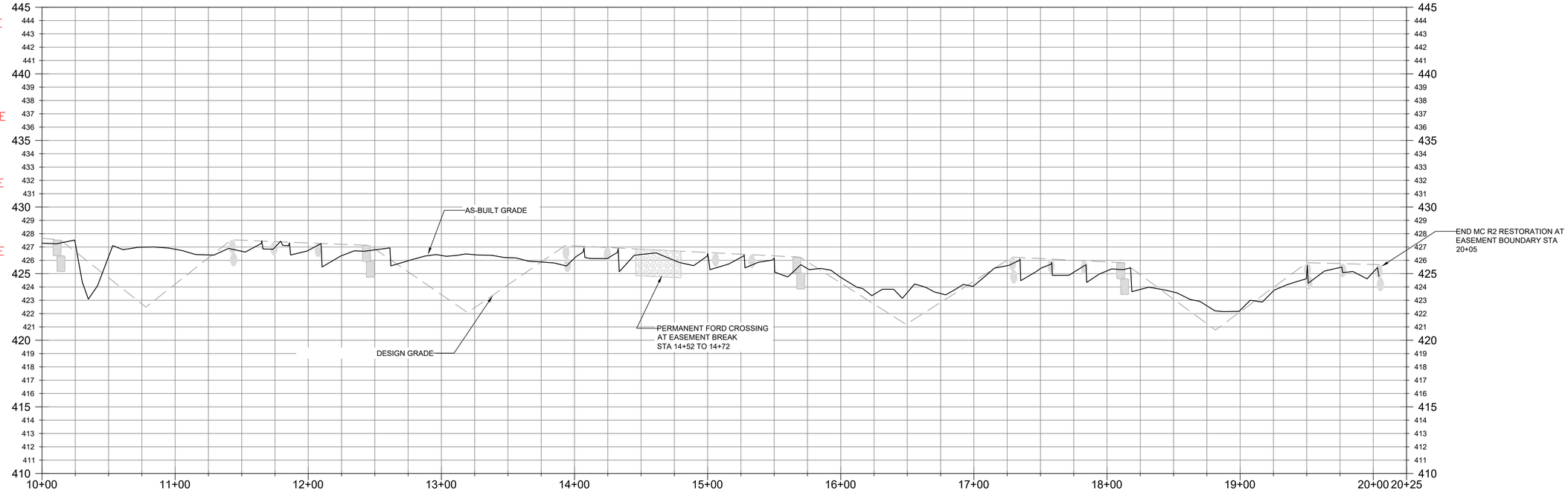
SCO ID # 20-22021-01A

PHASE # 1



NOTES:

1. DEVIATIONS FROM THE DESIGN WILL BE SHOWN IN RED
2. ALL J-HOOKS WERE LOCATED AND ORIENTED ACCORDING TO THE DESIGN DETAIL NOT THE PLAN VIEW LOCATION
3. ALL POOL DEPTHS WERE MODIFIED TO BE TWO (2) FT BELOW THE THALWEG FOR THE UPSTREAM PC DUE TO THE PRESENCE OF RUNNING SAND



MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY, NC
PHASE 1

4.4

MC: PLAN - PROFILE

JANUARY 28, 2022

NC STATE

PROJECT NAME:	MILLSTONE CREEK MITIGATION SITE
SCALE:	AS NOTED
DATE:	JANUARY 28, 2022
DRAWN:	JLP, JAF
DESIGN:	BAD, JLP
CHECK:	BAD
APPROVED:	BAD

SCO ID # 20-22021-01A

PHASE # 1

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY, NC
PHASE 1

WETLAND PLAN

4.5

ROCK AND LOG STRUCTURE ADDED AT WETLAND OUTLET TO ENSURE A STABLE TRANSITION BETWEEN THE GRADED AREAS AND THE EXISTING DITCH

WETLAND 1
ENHANCEMENT = 1.320 AC

MC R2

UTB

NOTES:
1. DEVIATIONS FROM THE DESIGN WILL BE SHOWN IN RED

0 20 40 Feet

SCALE: 1" = 20'

NORTH CAROLINA PROFESSIONAL SEAL 036824 ENGINEER PAUL A. DOLL

JANUARY 28, 2022

NC STATE

DRAWN:	JLP, JAF
DESIGN:	BAD, JLP
CHECK:	BAD
APPROVED:	BAD
PROJECT NAME:	MILLSTONE CREEK MITIGATION SITE
SCALE:	AS NOTED
DATE:	JANUARY 28, 2022

SCO ID # 20-22021-01A

PHASE # 1

Temporary Seeding Schedule and Rates		
Date	**Type**	**Application Rate (lbs/acre)**
Jan 1 – May 1	Rye Grain	120
	Ground Agricultural Limestone	2,000
	10-10-10 Fertilizer	750
	Straw Mulch	4,000
May 1 – Aug 15	German Millet	40
	Ground Agricultural Limestone	2,000
	10-10-10 Fertilizer	750
	Straw Mulch	4,000
Aug 15 – Dec 30	Rye Grain	120
	Ground Agricultural Limestone	2,000
	10-10-10 Fertilizer	750
	Straw Mulch	4,000

Permanent Seeding Rates		
Wetland Seed Mix – 20 lbs per acre		
Species	**Common Name**	**Percent**
Bidens aristosa	Showy tickseed	7
Carex vulpinoidea	Fox sedge	12
Dichanthelium clandestinum	Deertongue	8
Elymus virginicus	Virginia wildrye	20
Juncus effusus	Soft rush	4
Panicum dichotomiflorum	Smooth panicgrass	14
Panicum rigidulum	Redtop panicgrass	8
Panicum virgatum	Switchgrass	23
Polygonum pensylvanicum	Pennsylvania smartweed	2
Sparganium americanum	Eastern bur reed	2
		100
Streambank and Floodplain Seed Mix – 20 lbs per acre		
Species	**Common Name**	**Percent**
Agrostis perennans	Autumn bentgrass	15
Andropogon gerardii	Big bluestem	10
Coreopsis lanceolata	Lanceleaf coreopsis	10
Elymus virginicus	Virginia wildrye	20
Juncus effusus	Soft rush	5
Panicum virgatum	Switchgrass	15
Rudbeckia hirta	Blackeyed susan	10
Schizachyrium scoparium	Little bluestem	5
Sorghastrum nutans	Indian grass	5
Tripsacum dactyloides	Eastern gamagrass	5
		100
Upland Hardwood Forest – 20 lbs per acre		
Species	**Common Name**	**Percent**
Achillea millefolium	Common yarrow	10
Agrostis perennans	Autumn bentgrass	6
Asclepias tuberosa	Butterfly weed	1
Bidens aristosa	Showy tickseed sunflower	11
Chamaecrista fasciculata	Partridge pea	10
Coreopsis lanceolata	Lance-leaf coreopsis	10
Echinacea purpurea	Purple coneflower	4
Elymus virginicus	Virginia wildrye	6
Gaillardia pulchella	Indian blanket	8
Helianthus angustifolius	Swamp sunflower	2
Helianthus maximiliani	Maximilian's sunflower	2
Monarda punctata	Spotted beebalm	2
Rudbeckia hirta	Blackeyed susan	6
Schizachyrium scoparium	Little bluestem	4
Sorghastrum nutans	Indian grass	6
Symphyotrichum pilosum	Heath aster	1
Tridens flavus	Purpletop	4
Tripsacum dactyloides	Eastern gamagrass	6
Verbena hastata	Blue vervain	1
		100
Pasture Seed Mix – 60 lbs per acre		
Species	**Common Name**	**Percent**
Dactylis glomerata	Orchard Grass	50
Schedonorus phoenix	KY 31 Tall Fescue	50
		100

Vegetation Area	Streambank		Floodplain		Upland Hardwood Forest		Total
Area (acres)	2.1		4.9		4.6		11.6
Density	2,800		680		680		-
Species	# planted	% total	# planted	% total	# planted	% total	# planted
*Silky dogwood (*Cornus amomum*)	1,504	25					1,504
*Silky willow (*Salix sericea*)	1,504	25					1,504
*Elderberry (*Sambucus canadensis*)	1,504	25					1,504
Yellowroot (*Xanthorhiza simplicissima*)	602	10					602
**Buttonbush (*Cephalanthus occidentalis*)	902	15	170	5			1,072
Tag alder (*Alnus serrulata*)			170	5			170
River Birch (*Betula nigra*)			476	14			476
Ironwood (*Carpinus caroliniana*)			340	10			340
Water oak (Quercus nigra)			170	5			170
Inkberry (Ilex glabra)			340	10			340
Tulip poplar (Liriodendron tulipifera)			340	10			340
Sycamore (Plantanus occidentalis)			340	10			340
Black gum (Nyssa sylvatica)			170	5			170
Swamp Chestnut Oak (*Quercus michauxii*)			204	6			204
Possumhaw (*Viburnum nudum*)			204	6			204
Willow oak (Quercus phellos)			238	7	157	5	395
Black Walnut (*Juglans nigra*)			238	7	314	10	552
White oak (Quercus alba)					471	15	471
Black Cherry (*Prunus serotina*)					314	10	314
Red Bud (*Cercis canadensis*)					157	5	157
Persimmon (*Diospyros virginiana*)					157	5	157
Overcup Oak (*Quercus lyrata*)					314	10	314
Sassafras (*Sassafras albidum*)					157	5	157
Red Oak (*Quercus rubra*)					471	15	471
Chestnut Oak (*Quercus prinus*)					314	10	314
American Beech (*Fagus grandifolia*)					314	10	314
Total	**6,016**	**100**	**3,400**	**100**	**3,137**	**100**	**12,553**

*Provide as live stakes
**Provide as live stakes on streambanks and bareroot in floodplain zone

VEGETATION AREAS

STREAMBANK

FLOODPLAIN

UPLAND HARDWOOD FOREST

WETLAND

PASTURE

EXISTING VEGETATION PRESERVED

SCALE: 1" = 100'

NOTES:
1. DEVIATIONS FROM THE DESIGN WILL BE SHOWN IN RED

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY, NC
PHASE 1

VEGETATION PLAN

5.1

JANUARY 28, 2022

NC STATE

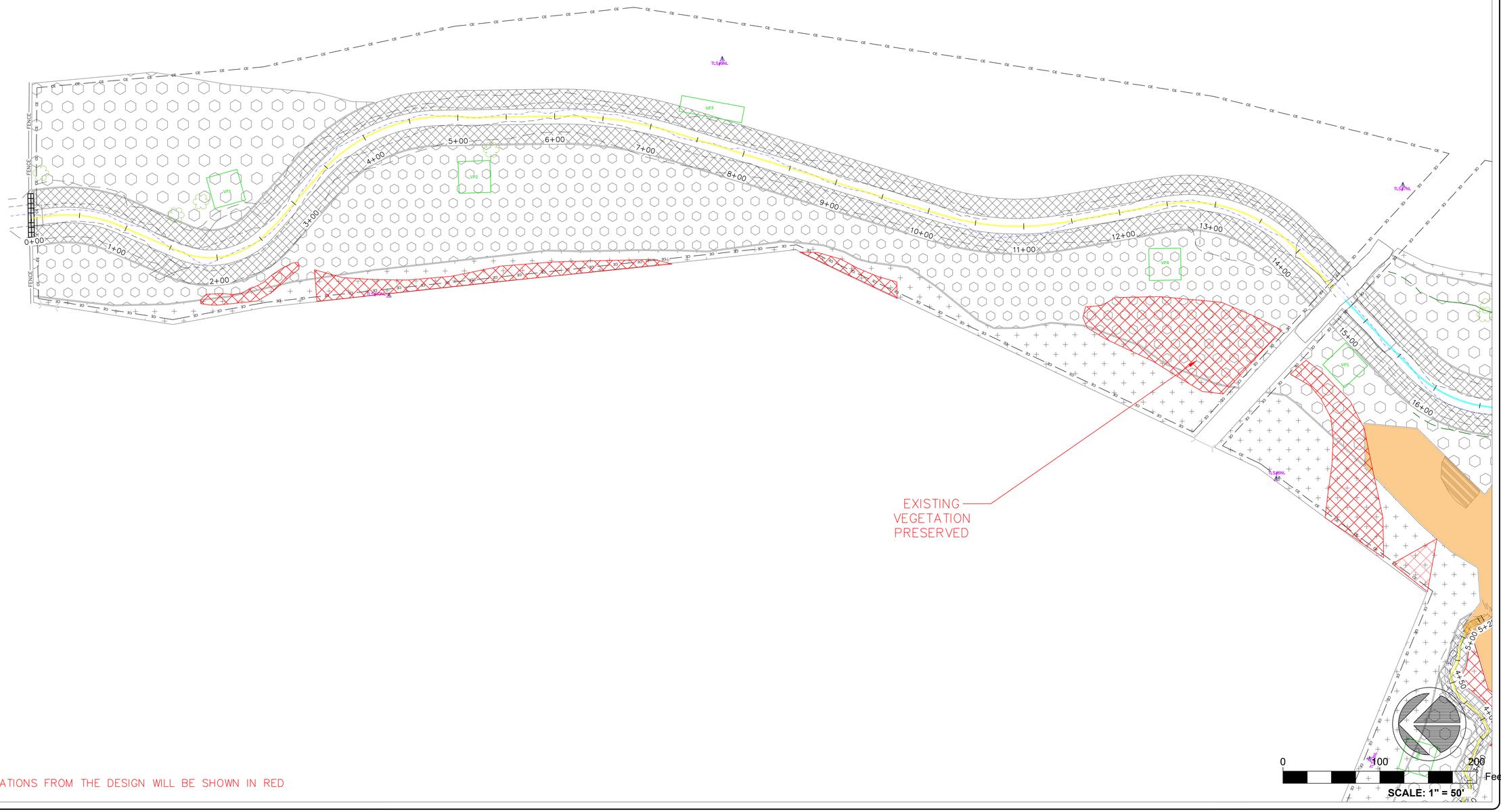
PROJECT NAME:	MILLSTONE CREEK MITIGATION SITE
SCALE:	AS NOTED
DATE:	JANUARY 28, 2022
DRAWN:	JLP, JNF
DESIGN:	BAD, JLP
CHECK:	BAD
APPROVED:	BAD

SCO ID # 20-22021-01A

PHASE # 1

VEGETATION AREAS

- STREAMBANK
- FLOODPLAIN
- UPLAND HARDWOOD FOREST
- WETLAND
- PASTURE
- EXISTING VEGETATION PRESERVED



NOTES:
1. DEVIATIONS FROM THE DESIGN WILL BE SHOWN IN RED

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY, NC
PHASE 1

5.2

VEGETATION PLAN

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 036887 BRANDON A. DULL REGISTERED

JANUARY 28, 2022

NC STATE

PROJECT NAME:	MILLSTONE CREEK MITIGATION SITE
SCALE:	AS NOTED
DATE:	JANUARY 28, 2022
DRAWN:	JLP, JKF
DESIGN:	BAD, JLP
CHECK:	BAD
APPROVED:	BAD

SCO ID # 20-22021-01A

PHASE # 1

VEGETATION AREAS

- STREAMBANK
- FLOODPLAIN
- UPLAND HARDWOOD FOREST
- WETLAND
- PASTURE
- EXISTING VEGETATION PRESERVED

EXISTING VEGETATION PRESERVED

PHASE 2 CONSTRUCTION AND PLANTING

EXISTING DAMAGED FENCE REMOVED AND REPLACED

NOTES:
1. DEVIATIONS FROM THE DESIGN WILL BE SHOWN IN RED

0 100 200 Feet

SCALE: 1" = 50'

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY, NC
PHASE 1

5.3

VEGETATION PLAN

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 036564 DAVID A. HARBERT

JANUARY 28, 2022

NC STATE

DRAWN:	JLP, JKF	PROJECT NAME: MILLSTONE CREEK MITIGATION SITE
DESIGN:	BAD, JLP	SCALE: AS NOTED
CHECK:	BAD	DATE: JANUARY 28, 2022
APPROVED:	BAD	

SCO ID # 20-22021-01A

PHASE # 1