MONITORING REPORT
2020 (Year 2)

MAJOR HILL STREAM AND WETLAND MITIGATION SITE

Alamance County, North Carolina

DMS Project ID No. 100015
Full Delivery Contract No. 7193
USACE Action ID No. SAW-2017-01472
DWR No. 17-0921
RFP No. 16-006990

Cape Fear River Basin
Cataloging Unit 03030002

Data Collection: July 2020 – October 2020
Submission: January 2021

Prepared for:

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF MITIGATION SERVICES
1652 MAIL SERVICE CENTER
RALEIGH, NORTH CAROLINA 27699-1652

Mitigation Project Name	**Major Hill Stream & Wetland Mitigation Site**	**USACE Action ID**	**2017-01472**
DMS ID	**100015**	**DWR Permit**	**2017-0921**
River Basin	**Cape Fear**	**Date Project Instituted**	**5/22/2017**
Cataloging Unit	**03030002**	**Date Prepared**	**4/20/2020**
County	**Alamance**	**Stream/Wet. Service Area**	**Cape Fear 03030002**

Todd J Tugwell 9/21/2020

Signature & Date of Official Approving Credit Release

1 - For NCDMS, no credits are released during the first milestone

2 - For NCDMS projects, the second credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the IRT by posting it to the DMS portal, provided the following have been met:

1) Approved of Final Mitigation Plan

2) Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property.

3) Completion of all physical and biological improvements to the mitigation site pursuant to the mitigation plan.

4) Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.

3 - A 10% reserve of credits is to be held back until the bankfull event performance standard has been met.

Credit Release Milestone	**Warm Stream Credits**						
Project Credits	**Scheduled Releases %**	**Proposed Releases %**	**Proposed Released #**	**Not Approved # Releases**	**Approved Credits**	**Anticipated Release Year**	**Actual Release Date**
1 - Site Establishment	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 - Year 0 / As-Built	30.00%	30.00%	917.280	0.000	917.280	2019	5/17/2019
3 - Year 1 Monitoring	10.00%	10.00%	305.760	0.000	305.760	2020	4/20/2020
4 - Year 2 Monitoring	10.00%					2021	
5 - Year 3 Monitoring	10.00%					2022	
6 - Year 4 Monitoring	5.00%					2023	
7 - Year 5 Monitoring	10.00%					2024	
8 - Year 6 Monitoring	5.00%					2025	
9 - Year 7 Monitoring	10.00%					2026	
Stream Bankfull Standard	10.00%						
			Totals	0.000	1,223.040		

Total Gross Credits	3,057.600
Total Unrealized Credits to Date	0.000
Total Released Credits to Date	1,223.040
Total Percentage Released	40.00%
Remaining Unreleased Credits	1,834.560

Credit Release Milestone	**Riparian Credits**						
Project Credits	**Scheduled Releases %**	**Proposed Releases %**	**Proposed Released #**	**Not Approved # Releases**	**Approved Credits**	**Anticipated Release Year**	**Actual Release Date**
1 - Site Establishment	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 - Year 0 / As-Built	30.00%	30.00%	0.228	0.000	0.228	2019	5/17/2019
3 - Year 1 Monitoring	10.00%	10.00%	0.076	0.000	0.076	2020	4/20/2020
4 - Year 2 Monitoring	10.00%					2021	
5 - Year 3 Monitoring	15.00%					2022	
6 - Year 4 Monitoring	5.00%					2023	
7 - Year 5 Monitoring	15.00%					2024	
8 - Year 6 Monitoring	5.00%					2025	
9 - Year 7 Monitoring	10.00%					2026	
Stream Bankfull Standard	N/A	N/A	N/A	N/A	N/A	N/A	N/A
			Totals	0.000	0.304		

Total Gross Credits	0.760
Total Unrealized Credits to Date	0.000
Total Released Credits to Date	0.304
Total Percentage Released	40.00%
Remaining Unreleased Credits	0.456

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County	**Alamance**	**Stream/Wet. Service Area**	**Cape Fear 03030002**

Notes

Contingencies (if any)

Project Quantities

Mitigation Type	Restoration Type	Physical Quantity
Warm Stream	Restoration	1,738.000
Warm Stream	Enhancement II	3,299.000
Riparian	Restoration	0.540
Riparian	Enhancement	0.440

Debits

							Stream Restoration Credits	Riparian Restoration	Riparian Restoration Equivalent Credits
Beginning Balance (mitigation credits)							**3,057.600**	**0.540**	**0.220**
Released Credits							**1,223.040**	**0.216**	**0.088**
Unrealized Credits							**0.000**	**0.000**	**0.000**
Owning Program	**Req. Id**	**TIP #**	**Project Name**	**USACE Permit #**	**DWR Permit #**	**DCM Permit #**			
Statewide Stream & Wetland ILF Program	REQ-006404		Brickhaven and Sanford Mines	2014-02254	2015-0041		521.400		
Statewide Stream & Wetland ILF Program	REQ-006404		Brickhaven and Sanford Mines	2014-02254	2015-0041		395.880		
Statewide Stream & Wetland ILF Program	REQ-004030	I-2402A I-2402B I-2402D	DOT - I-85 Greensboro Bypass	1995-02886	1998-0349			0.162	
Statewide Stream & Wetland ILF Program	REQ-004030	I-2402A I-2402B I-2402D	DOT - I-85 Greensboro Bypass	1995-02886	1998-0349				0.066
Total Credits Debited							**917.280**	**0.162**	**0.066**
Remaining Available balance (Released credits)							**305.760**	**0.054**	**0.022**
Remaining balance (Unreleased credits)							**1,834.560**	**0.324**	**0.132**

NCDMS comment responses:

1. Describe what date the supplemental planting occurred in the monitoring report text and in Table 2. There were no low vigor areas called out in the MY1, although VP 1 and 4 did not meet in MY1. Explain why those vegetation plots were not replanted in the 2020 low-vigor replant that occurred adjacent to them and if and how RS plans to do any additional replanting.
   Vegetation plots 1 and 4 were not replanted based on Y1 veg success data (including random transects adjacent to the plots). The transect data was collected in the fall of 2019. Based on field assessment in winter of 2020, we felt that although the random transect showed high density of trees, visually (not Y1 plot data) we felt a light planting of additional stems was warranted to help with long term success of these areas. We planted 370 stems of 8 varieties over 1.20 acres (~300 stems/acre) in the Supplemental Planting Areas shown on the 2020 CCPV. We plan on doing another random transect in these areas to include in the Y3 report. No supplemental planting will occur in 2021.

Riparian Buffer Section

1. Section 4.3, Table 5, Table 6, and Figure A state that 2 vegetation plots did not meet success. Riparian buffer success is based on 260 stems/acre planted AND volunteer at MY5. Please revise these report items to reflect this.
   The riparian buffer section was revised to indicate that all vegetation plots are meeting the success criteria of 260 stems/acre.

2. Add discussion of replanted area to Riparian Buffer report and to Figure A.
   A discussion of the replanted area was added to section 4.3 of the Riparian Buffer report, and the polygons were added to Figure A.

Digital Review-

1. Please submit buffer asset features that are organized by distance (e.g. 0-100, 101-200) and restoration approach. The current features in DMS's possession are not segmented by restoration approach. Please also ensure that these features have areas that match areas reported in Table 2.
   The riparian buffer asset feature (RiparianBufferAssetsREV.shp) has been included with the final digital submittal. The feature areas match the areas reported in Table 2.

Major Hill Year 2, 2020 Monitoring Summary

General Notes

- No encroachment was identified in Year 2
- No evidence of nuisance animal activity (i.e., beaver, heavy deer browsing, etc.) was observed.

Streams

- Stream monitoring show that all stream channels and structures are stable.

Wetlands

- Five of six groundwater gauges met success for the Year 2 (2020) monitoring period. Wetland hydrology data is in Appendix E. Gauge 2 did not meet success, however it was successful for 8% of the growing season.

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)	Year 5 (2023)	Year 6 (2024)	Year 7 (2025)
1	No/14 days* 6.0 percent	Yes/136 Days 57.9 percent					
2	No/19 days* 8.1 percent	No/19 days 8.0 percent					
3	Yes/25 days 10.6 percent	Yes/235 days 100 percent					
4	Yes/34 days 14.5 percent	Yes/72 days 30.5 percent					
5	Yes/119 days 50.6 percent	Yes/135 days 57.4 percent					
6	Yes/77 days 32.8 percent	Yes/44 days 18.7 percent					

Vegetation Summary

Measurements of the 8 permanent vegetation plots resulted in an average of 379 planted stems/acre excluding livestakes. Three additional transects were measured after replanting an area of low density identified in Year 1. Measurements of all 11 permanent and random vegetation plots resulted in an average of 467 stems/acre, including natural recruits. Additionally, all plots met success criteria except permanent Plot 1 and Plot 4. Year 2 (2020) vegetation data is included in Tables 8-10 (Appendix C).

Site Permitting/Monitoring Activity and Reporting History

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Technical Proposal Issue Date (RFP No. 16-006990)	September 16, 2016	September 16, 2016
Institution Date (NCDMS Contract No. 7193)	--	May 22, 2017
Mitigation Plan	--	February 2018
404 Permit Date	--	June 28, 2018
Construction Plans	--	July 2018
Site Construction	--	July 25-September 6, 2018
Planting	--	December 2018-January 2019
Asbuilt Stream Data Collection	September 19, 2018	--
Asbuilt Vegetation Data Collection	January 8, 2019	--
Asbuilt Baseline Monitoring Report	--	March 2019
MY1 (2019) Vegetation Data Collection	September 9, 2019	--
MY1 (2019) Stream Data Collection	September 10, 2019	--
MY1 (2019) Monitoring Report	October 2019	November 2019
Supplemental Planting	--	January 31, 2020
MY 2 (2020) Vegetation Data Collection	October 2020	--
MY 2 (2020) Stream Data Collection	July/October 2020	--
MY 2 (2020) Monitoring Report	October 2020	January 2021

Site Maintenance Report (2020)

Invasive Species Work	Maintenance work
5-6-2020 Microstegium	None
6-3-2020 Princess Tree, Tree-of-Heaven, Privet, Rose	
10/13/2020 Tree of Heaven, Multiflora Rose, Privet, Princess Tree, and Veg within UT-1	

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TABLE OF CONTENTS

1.0 PROJECT SUMMARY 1
1.1 Project Goals & Objectives 1
1.2 Project Background 3
1.3 Project Components and Structure 3
1.4 Success Criteria 3
1.4.1 Stream Success Criteria 4
1.4.2 Wetland Success Criteria 4
1.4.3 Vegetation Success Criteria 4
2.0 METHODS 5
2.1 Stream Monitoring 5
2.2 Wetland Monitoring 6
2.3 Vegetation 6
3.0 REFERENCES 8

APPENDICES

Appendix A. Background Tables
Table 1. Project Components and Mitigation Units
Table 2. Project Activity and Reporting History
Table 3. Project Contacts Table
Table 4. Project Attributes

Appendix B. Visual Assessment Data
Figure 1. Project Location
Figure 2. Current Conditions Plan View
Tables 5A-5C. Visual Stream Morphology Stability Assessment
Table 6. Vegetation Condition Assessment
Vegetation Plot Photographs

Appendix C. Vegetation Data
Table 7. Planted Bare Root Woody Vegetation
Table 8. Total Stems by Plot and Species
Table 9. Temporary Vegetation Plot Data
Table 10. Planted Vegetation Totals

Appendix D. Stream Geomorphology Data
Tables 11A-11B. Baseline Stream Data Summary
Tables 12A-12D. Monitoring Data (Dimensional Morphology Summary & Stream Reach Data Summary)
Table 13. Water Quality Data
Cross-Section Plots
Substrate Plots

Appendix E. Hydrology Data
Table 14A. UT1 Upstream Channel Evidence
Table 14B. UT1 Downstream Channel Evidence
Stream Gauge Graphs
Table 15. Verification of Bankfull Events
Table 16. Groundwater Hydrology Data
Groundwater Gauge Graphs

Appendix F. Riparian Buffer MY2 (2020) Monitoring Report

Appendix G. Miscellaneous
Herbicide Application Forms
Remedial planting plan

1.0 PROJECT SUMMARY

Restoration Systems, LLC has established the North Carolina Division of Mitigation Services (NCDMS) Major Hill Stream and Wetland Restoration Site (Site).

1.1 Project Goals & Objectives

Project goals are based on the *Cape Fear River Basin Restoration Priorities* (RBRP) report (NCEEP 2009) and on-site data collection of channel morphology and function observed during field investigations. The Site is located within Targeted Local Watershed (TLW) 03030002050050. The RBRP report documents benthic ratings vary between "Fair" and "Good-Fair" possibly due to cattle, dairy, and poultry operations. The project is not located in a Regional or Local Watershed Planning Area; however, RBRP goals are addressed by project activities as follows with Site specific information following the RBRP goals in parenthesis.

1. Reduce and control sediment inputs (reduction of 10.0 tons/year after mitigation is complete);
2. Reduce and manage nutrient inputs (livestock removal from streams, elimination of fertilizer application, and marsh treatment areas may result in a direct reduction of 852.4 pounds of nitrogen and 70.6 pounds of phosphorus per year);
3. Protect and augment designated natural heritage areas.

Site specific mitigation goals and objectives were developed through the use of North Carolina Stream Assessment Method (NC SAM) and North Carolina Wetland Assessment Method (NC WAM) analyses of existing and reference stream systems at the Site (NC SFAT 2015 and NC WFAT 2010) (see Table 1).

Stream/Wetland Targeted Functions, Goals, and Objectives

Targeted Functions	Goals	Objectives	Compatibility of Success Criteria
(1) HYDROLOGY			
(2) Flood Flow (Floodplain Access) (3) Streamside Area Attenuation (4) Wooded Riparian Buffer (4) Microtopography	• Attenuate flood flow across the Site. • Minimize downstream flooding to the maximum extent possible. • Connect streams to functioning wetland systems.	• Construct new channel at historic floodplain elevation to restore overbank flows and restore jurisdictional wetlands • Plant woody riparian buffer • Remove livestock • Deep rip floodplain soils to reduce compaction and increase soil surface roughness • Protect riparian buffers with a perpetual conservation easement	• BHR not to exceed 1.2 • Document four overbank events in separate monitoring years • Livestock excluded from the easement • Attain Wetland Hydrology Success Criteria • Attain Vegetation Success Criteria • Conservation Easement recorded
(3) Stream Stability (4) Channel Stability (4) Sediment Transport	• Increase stream stability within the Site so that channels are neither aggrading nor degrading.	• Construct channels with proper pattern, dimension, and longitudinal profile • Remove livestock • Construct stable channels with cobble/gravel substrate • Plant woody riparian buffer	• Cross-section measurements indicate a stable channel with cobble/gravel substrate • Visual documentation of stable channels and structures • BHR not to exceed 1.2 • ER of 1.4 or greater • < 10% change in BHR and ER in any given year • Livestock excluded from the easement • Attain Vegetation Success Criteria
(1) WATER QUALITY			
(2) Streamside Area Vegetation (3) Upland Pollutant Filtration (3) Thermoregulation (2) Indicators of Stressors	• Remove direct nutrient and pollutant inputs from the Site and reduce contributions to downstream waters.	• Remove livestock and reduce agricultural land/inputs • Install marsh treatment areas • Plant woody riparian buffer • Restore/enhance jurisdictional wetlands adjacent to Site streams	• Livestock excluded from the easement • Attain Wetland Hydrology Success Criteria • Attain Vegetation Success Criteria
(1) HABITAT			
(2) In-stream Habitat (3) Substrate (3) Stream Stability (3) In-Stream Habitat (2) Stream-side Habitat (3) Stream-side Habitat (3) Thermoregulation Wetland Landscape Patch Structure Wetland Vegetation Composition	• Improve instream and stream-side habitat.	• Construct stable channels with cobble/gravel substrate • Plant woody riparian buffer to provide organic matter and shade • Construct new channel at historic floodplain elevation to restore overbank flows and plant woody riparian buffer • Protect riparian buffers with a perpetual conservation easement • Restore/enhance jurisdictional wetlands adjacent to Site streams	• Cross-section measurement indicate a stable channel with cobble/gravel substrate • Visual documentation of stable channels and in-stream structures. • Attain Wetland Hydrology Success Criteria • Attain Vegetation Success Criteria • Conservation Easement recorded

1.2 Project Background

The Major Hill Stream and Wetland Mitigation Site (hereafter referred to as the "Site") encompasses 16.7 acres along warm water, unnamed tributaries to Pine Hill Branch. The Site is located approximately 3.5 miles southeast of Snow Camp and 6 miles north of Silk Hope in southern Alamance County near the Chatham County line (Figure 1, Appendix B).

Prior to construction, Site land use consisted of disturbed forest and agricultural land used for livestock grazing and hay production. Livestock had unrestricted access to Site streams, which had been relocated to the floodplain edge, ditched, impounded, trampled by livestock, eroded vertically and laterally, and received extensive sediment and nutrient inputs from stream banks and adjacent pastures. Approximately 60 percent of the stream channel had been degraded contributing to sediment export from the Site resulting from mechanical processes such as livestock hoof shear. In addition, streamside wetlands were cleared and drained by channel downcutting and land uses. Preconstruction Site conditions resulted in degraded water quality, a loss of aquatic habitat, reduced nutrient and sediment retention, and unstable channel characteristics (loss of horizontal flow vectors that maintain pools and an increase in erosive forces to channel bed and banks). Site restoration activities restored riffle-pool morphology aiding in energy dissipation, increased aquatic habitat, stabilized channel banks, and will greatly reduce sediment loss from channel banks.

1.3 Project Components and Structure

Site restoration activities generated 3058 Stream Mitigation Units (SMUs) and 0.76 Wetland Mitigation Units (WMUs) as the result of the following:

- 1738 linear feet of Priority I stream restoration
- 3299 linear feet of stream enhancement (Level II)
- 0.54 acre of riparian wetland restoration
- 0.44 acre of riparian wetland enhancement

Additional activities that occurred at the Site included the following.

- Installation of a marsh treatment area to treat drainage prior to entering UT1.
- Fencing the entire conservation easement by leaving some pre-existing fencing, removing fencing, and installing additional fencing.
- Planting 8.11 acres of the Site with 8600 stems (planted species and densities by zone are included in Table 5 [Appendix C]).
- Removing a small, abandoned farm pond by 1) notching the dam to dewater; 2) removal of the dam to the elevation of the adjacent floodplain; 3) excavating sediment that was unsuitable for channel bank construction; 4) backfilling areas of sediment removed with soil suitable for channel construction (as necessary); 5) excavation of the design channel, 6) stabilization of the channel with coir matting, seed, and mulch; and 7) installation of structures.

Site design was completed in February 2018. Construction started on July 25, 2018 and ended within a final walkthrough on September 6, 2018. The Site was planted in December 2018-January 2019. Completed project activities, reporting history, completion dates, project contacts, and background information are summarized in Tables 1-4 (Appendix A).

1.4 Success Criteria

Project success criteria have been established per the October 24, 2016 NC Interagency Review Team *Wilmington District Stream and Wetland Compensatory Mitigation Update*.

1.4.1 Stream Success Criteria

From a mitigation perspective, several of the goals and objectives are assumed to be functionally elevated by restoration activities without direct measurement. Other goals and objectives will be considered successful upon achieving vegetation success criteria. The following summarizes stream success criteria.

- All streams must maintain an Ordinary High-Water Mark (OHWM), per RGL 05-05.
- Continuous surface flow must be documented each year for at least 30 consecutive days.
- Bank height ratio (BHR) cannot exceed 1.2 at any measured cross-section.
- Entrenchment ratio (ER) must be no less than 1.4 at any measured riffle cross-section.
- BHR and ER at any measure riffle cross-section should not change by more than 10% from baseline condition during any given monitoring period.
- The stream project shall remain stable and all other performance standards shall be met through four separate bankfull events, occurring in separate years, during the monitoring years 1-7.

1.4.2 Wetland Success Criteria

The following summarizes wetland success criteria.

- Saturation or inundation within the upper 12 inches of the soil surface for, at a minimum, 10 percent of the growing season, during average climatic conditions

According to the *Soil Survey of Alamance County*, the growing season for Alamance County is from April 17 – October 22 (USDA 1960). However, the start date for the growing season is not typical for the Piedmont region; therefore, for purposes of this project gauge hydrologic success will be determined using data from March 1 - October 22 to more accurately represent the period of biological activity. Based on growing season information outlined in the *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region* (USACE 2010), this will be confirmed annually by soil temperatures exceeding 41 degrees Fahrenheit at 12 inches depth and/or bud burst.

Target hydrological characteristics include saturation or inundation for 10 percent of the monitored period (March 1-October 22), during average climatic conditions. During years with atypical climatic conditions, groundwater gauges in reference wetlands may be used for comparison to the Site; however, reference gauge data will not be tied to success criteria. These areas are expected to support hydrophytic vegetation. If wetland parameters are marginal as indicated by vegetation and/or hydrology monitoring, a jurisdictional determination will be performed. The jurisdictional determination will not supersede monitoring data, or overturn a failure in meeting success criteria; however, this information may be used by the IRT, at the discretion of the IRT, to make a final determination on Site wetland re-establishment success.

1.4.3 Vegetation Success Criteria

The following summarizes vegetation success criteria.

- Within planted portions of the site, a minimum of 320 stems per acre must be present at year 3; and a minimum of 210 stems per acre must be present at year 7.
- Trees must average 7 feet in height at year 5, and 10 feet in height at year 7.
- Planted and volunteer stems are counted, provided they are included in the approved planting list for the site; natural recruits not on the planting list may be considered by the IRT on a case-by-case basis.
- Any single species can only account for 50% of the required stems within any vegetation plot.

2.0 METHODS

Monitoring requirements and success criteria outlined in this plan follow the October 24, 2016 NC Interagency Review Team *Wilmington District Stream and Wetland Compensatory Mitigation Update*. Monitoring will be conducted by Axiom Environmental, Inc. Annual monitoring reports of the data collected will be submitted to the NCDMS by Restoration Systems no later than December 31 of each monitoring year data is collected. The monitoring schedule is summarized in the following table.

Monitoring Schedule

Resource	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Streams							
Wetlands							
Vegetation							
Macroinvertebrates							
Water Quality							
Visual Assessment							
Report Submittal							

2.1 Stream Monitoring

Annual monitoring will include development of channel cross-sections and substrate on riffles and pools (Figure 2, Appendix B). Data presented in graphic and tabular format include 1) cross-sectional area, 2) bankfull width, 3) average depth, 4) maximum depth, and 5) width-to-depth ratio. Longitudinal profiles were monitored for as-built; however, profiles will not be measured routinely unless monitoring demonstrates channel bank or bed instability, in which case, longitudinal profiles may be required by the USACE along reaches of concern to track changes and demonstrate stability.

Stream Monitoring Summary

Parameter	Method	Schedule/Frequency	Number/Extent
Stream Profile	Full longitudinal survey	As-built (unless otherwise required)	All restored stream channels
Stream Dimension	Cross-sections	Years 1, 2, 3, 5, and 7	10 cross-sections
Channel Stability	Visual Assessments	Yearly	All restored stream channels
	Bank Pins	Yearly	Only if instability is documented during monitoring
	Additional Cross-sections	Yearly	Only if instability is documented during monitoring
Stream Hydrology	Continuous monitoring water level gauges and/or trail camera	Continuous recording through monitoring period	Two gauges on UT1 (upstream and downstream) and one trail camera on UT1 (downstream)
Water Quality	Water samples	Yearly	Two locations
Macroinvertebrates	Qual 4 sampling	Years 3, 5, and 7	Two locations

All streams are functioning as designed, and no stream areas of concern were observed during year 2 (2020) monitoring. Stream morphology and water quality data is available in Appendix D.

2.2 Wetland Monitoring

Six groundwater monitoring gauges were installed within the drained pond area and the remaining wetland restoration areas to take measurements after hydrological modifications were performed at the Site (Figure 2, Appendix B). Hydrological sampling will continue throughout the entire year at intervals necessary to satisfy jurisdictional hydrology success criteria. In addition, an on-site rain gauge will document rainfall data for comparison of groundwater conditions with extended drought conditions and a trail camera was installed to confirm overbank flooding events. Growing season soil temperatures will also be documented using a continuously logging soil temperature probe, this data will be provided with wetland hydrology data.

Wetland Monitoring Summary

Parameter	Method	Schedule/Frequency	Number/Extent	Data Collected
Wetland Restoration	Groundwater gauges	As-built, Years 1, 2, 3, 4, 5, 6, and 7	6 gauges spread throughout restored wetlands	Soil temperature at the beginning of each monitoring period, groundwater and rain data for each monitoring period

Summary of Monitoring Period/Hydrology Success Criteria by Year

Year	Soil Temperatures/Date Bud Burst Documented	Monitoring Period Used for Determining Success	10 Percent of Monitoring Period
2019 (Year 1)	March 1, 2019*	March 1-October 22 (235 days)	24 Days
2020 (Year 2)	March 1, 2020**	March 1-October 22 (235 Days)	24 Days

*An onsite soil temperature data logger installed 12 inches below the ground surface read 47.90°F on March 1, and the soil temperature remained well above 41°F thereafter.

**An onsite soil temperature data logger installed 12 inches below the ground surface read 48.13°F on March 1, and the soil temperature was well-above 41°F the weeks prior and thereafter. Additionally, bud bursts were documented on March 2.

Five of the six groundwater gauges met success criteria for the year 2 (2020) monitoring period. Year 2 (2020) groundwater gauge data and graphs are located in Appendix E. Gauge 2 was inundated/saturated for 19 days, or 8.0 percent of the growing season.

2.3 Vegetation

Planting occurred in December 2018-January 2019 within 8.11 acres of the Site and included 8600 stems (planted species and densities by zone are included in Table 7 [Appendix C]). After planting was completed, an initial evaluation was performed to verify planting methods and to determine initial species composition and density.

In early January 2020, a winter-time visual assessment of the site was performed, and it was determined that although Year 1 (2019) vegetation data, including random transects, showed a high density of trees, a light supplemental planting would help ensure the long-term success in several areas. On January 31, 2020, three areas that visually exhibited low stem density and/or poor vigor were supplementally planted (Figure 2, Appendix B). During the supplemental planting effort approximately 370 stems were planted across 1.20 acres (approximately 300 stems per acre). As the planting was designated for visual purposes and was

not an effort to increase stem density data, no stems were planted within permanent vegetation plots. The following table lists species included in the supplemental planting list. Preparation included the application of 100 lbs of lime, 50 lbs of fertilizer, and 3 lbs of seed to stabilize bare areas. In addition, three random vegetation transects were measured including Transect 1 (near Plot 6), Transect 2 (near Plot 4), and Transect 3 (near Plot 1). After the veg data was complete it was concluded that those areas met required stem densities (Table 9, Appendix C).

2020 Supplemental Planting Species List

Species	Number of Stems
Tag Alder (*Alnus serrulata*)	20
Chinkapin (*Castanea pumila*)	20
Hackberry (*Celtis occidentalis*)	50
Hawthorn (*Crataegus marshallii*)	20
Crab Apple (*Malus angustifolia*)	50
Red Mulberry (*Morus rubra*)	100
Sycamore (*Platanus occidentalis*)	50
Shumard Oak (*Quercus shumardii*)	50
Total	**370**

An assessment was made during the early Fall 2018 to treat fescue within the Dry-Mesic Oak Hickory Forest planting zones to reduce competition with planted stems. Treatment was conducted December 2018 and will continue as needed. Treatments of invasive plant species continued during 2019 throughout the Site. Japanese Stiltgrass and Tree-of-Heaven were high priority during the 2019 invasive treatment season. Restoration Systems will continue to treat and monitor the site for invasive species throughout the monitoring period. See Appendix G (Herbicide Application Forms) for a detailed account of site-wide treatments.

Vegetation Monitoring Summary

Parameter	Method	Schedule/Frequency	Number/Extent	Data Collected
Vegetation establishment and vigor	Permanent vegetation plots 0.0247 acre (100 square meters) in size	As-built, Years 1, 2, 3, 5, and 7	8 plots spread across the Site	Species, height, location, planted vs. volunteer, and age
	Random vegetation plots, 0.0247 acre (100 square meters) in size	As-built, Years 1, 2, 3, 5, and 7	2 plots randomly selected each year	Species and height

During quantitative vegetation sampling, 8 sample plots (10-meter by 10-meter) were installed within the Site as per guidelines established in *CVS-EEP Protocol for Recording Vegetation*, *Version 4.2* (Lee et al. 2008). Measurement also included three random sample plots (50-meter by 2-meter). Measurements of the 8 permanent vegetation plots resulted in an average of 379 planted stems/acre excluding livestakes. Measurements of all 11 permanent and random vegetation plots resulted in an average of 467 stems/acre, including natural recruits. Additionally, all plots met success criteria except permanent Plot 1 and Plot 4. Year 2 (2020) vegetation data is included in Tables 8-10 (Appendix C).

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Appendix A
Background Tables

Table 1. Project Components and Mitigation Units
Table 2. Project Activity and Reporting History
Table 3. Project Contacts Table
Table 4. Project Attributes Table

Table 1. Project Components and Mitigation Credits - Major Hill Restoration Site

Reach ID	Stream Stationing/ Wetland Type	Existing Footage/ Acreage	Mitigation Plan Footage/ Acreage	Constructed Footage/ Acreage	Restoration Level	Restoration or Restoration Equivalent	Mitigation Ratio	Mitigation Credits	Comment
UT 1	00+00 to 16+99	1829	1699	1699	Restoration	1699	1:1	1699	
UT 1	16+99 to 27+96	1097	1060	1097	EII	1097	2.5:1	439	
UT 2	00+00 to 01+68	168	168	168	EII	168	2.5:1	67	
UT 2	01+68 to 02+07	39	43	39	Restoration	39	1:1	39	
UT 3	00+00 to 22+98	2298	2197	2298*	EII	2298-80-144-40=2034	2.5:1	814	80 lf and 40 lf of UT3 are not credit generating due to crossings and drainage easement. 144 lf are not credit generating due to lack of control of south bank and drainage easement.
Wetlands	Riparian Riverine	--	0.54	0.54	Restoration	0.54	1:1	0.54	Wetland Restoration
Wetlands	Riparian Riverine	0.52	0.44	0.44	Enhancement	0.44	2:1	0.22	Wetland Enhancement

Table 1 continued. Project Components and Mitigation Credits - Major Hill Restoration Site

Length & Area Summations by Mitigation Category		
Restoration Level	**Stream (linear footage)**	**Riparian Wetland (acreage)**
Restoration	1738	0.54
Enhancement (Level II)	3299*	--
Enhancement	--	0.44**

* An additional 264 linear feet of stream enhancement (level II) is proposed outside of the easement (at road crossings), or the sponsor controls only one bank of the stream, and is therefore not included in this total or in mitigation credit calculations.
**Approximately 0.08 acre of existing, degraded wetland will not be enhanced as the result of the design channel crossing the wetland area.

Overall Assets Summary	
Asset Category	**Overall Credits**
Stream	**3058**
Riparian Riverine Wetland	**0.76**

Table 2. Project Activity and Reporting History - Major Hill Restoration Site

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Technical Proposal Issue Date (RFP No. 16-006990)	September 16, 2016	September 16, 2016
Institution Date (NCDMS Contract No. 7193)	--	May 22, 2017
Mitigation Plan	--	February 2018
404 Permit Date	--	June 28, 2018
Construction Plans	--	July 2018
Site Construction	--	July 25-September 6, 2018
Planting	--	December 2018-January 2019
Asbuilt Stream Data Collection	September 19, 2018	--
Asbuilt Vegetation Data Collection	January 8, 2019	--
Asbuilt Baseline Monitoring Report	--	March 2019
MY1 (2019) Vegetation Data Collection	September 9, 2019	--
MY1 (2019) Stream Data Collection	September 10, 2019	--
MY1 (2019) Monitoring Report	October 2019	November 2019
Supplemental Planting	--	January 31, 2020
MY 2 (2020) Vegetation Data Collection	October 2020	--
MY 2 (2020) Stream Data Collection	July/October 2020	--
MY 2 (2020) Monitoring Report	October 2020	November 2020

Table 3. Project Contacts Table - Major Hill Restoration Site

Full Delivery Provider
Restoration Systems
1101 Haynes Street, Suite 211
Raleigh, North Carolina 27604
Worth Creech 919-755-9490

Designer
Axiom Environmental, Inc.
218 Snow Avenue
Raleigh, NC 27603
Grant Lewis 919-215-1693

Construction Plans and Sediment and Erosion Control Plans
Sungate Design Group, PA
915 Jones Franklin Road
Raleigh, NC 27606
Joshua G. Dalton, PE 919-859-2243

Construction Contractor
Land Mechanic Designs
780 Landmark Road
Willow Spring, NC 27592
Lloyd Glover 919-639-6132

Planting Contractor
Carolina Silvics, Inc.
908 Indian Trail Road
Edenton, NC 27932
Mary-Margaret McKinney 252-482-8491

As-built Surveyor
K2 Design Group
5688 US Highway 70 East
Goldsboro, NC 27534
John Rudolph 919-751-0075

Baseline & Monitoring Data Collection
Axiom Environmental, Inc.
218 Snow Avenue
Raleigh, NC 27603
Grant Lewis 919-215-1693

Table 4. Project Attribute Table - Major Hill Restoration Site

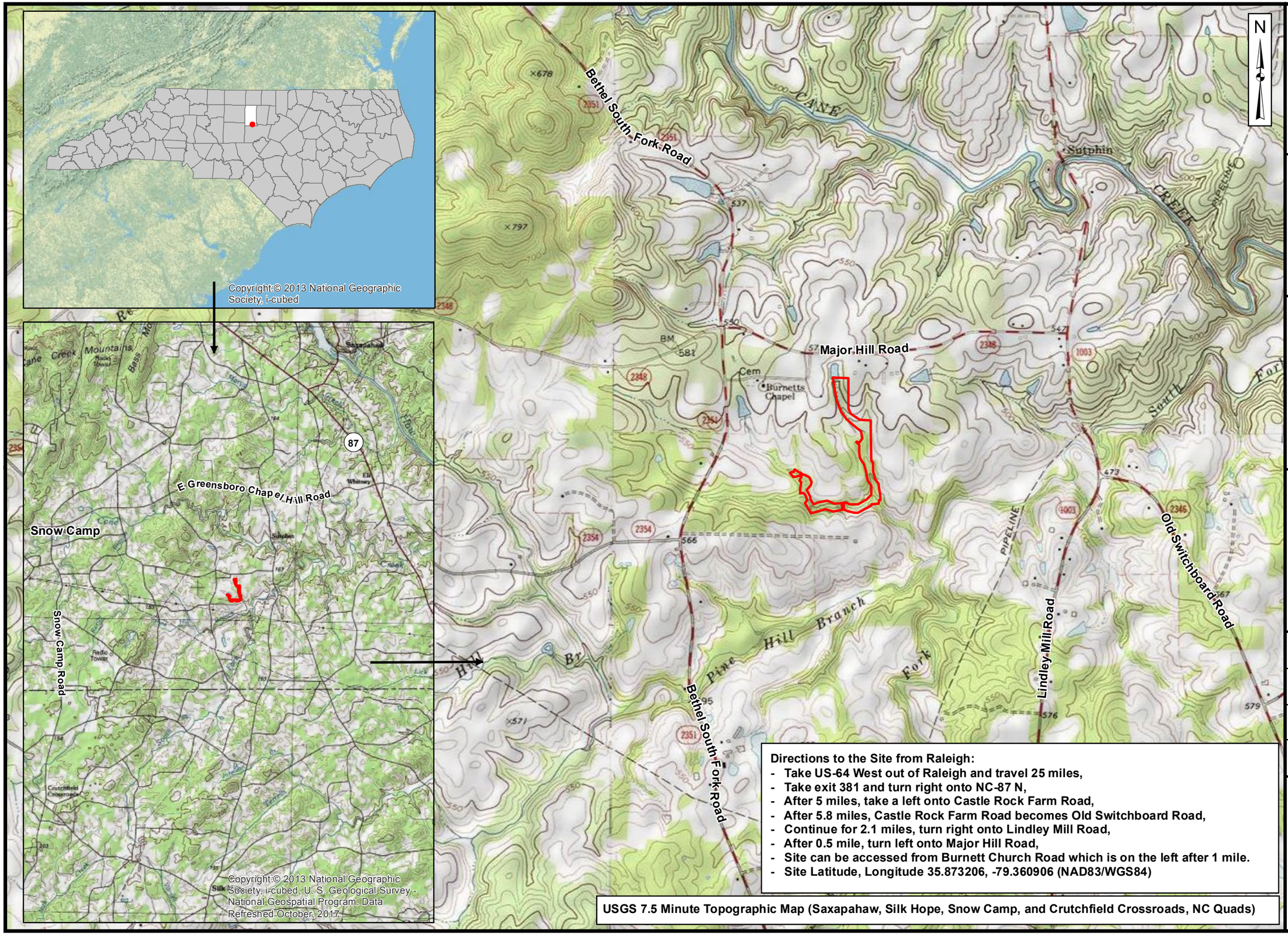
Project Information			
Project Name	Major Hill Restoration Site		
Project County	Alamance County, North Carolina		
Project Area (acres)	16.7		
Project Coordinates (latitude & latitude)	35.873206, -79.360906		
Planted Area (acres)	8.11		
Project Watershed Summary Information			
Physiographic Province	Piedmont		
Project River Basin	Cape Fear		
USGS HUC for Project (14-digit)	03030002050050		
NCDWR Sub-basin for Project	03-06-04		
Project Drainage Area (acres)	17 to 445		
Percentage of Project Drainage Area that is Impervious	<2%		
CGIA Land Use Classification	Managed Herbaceous Cover & Mixed Upland Hardwoods		
Reach Summary Information			
Parameters	**UT 1**	**UT 2**	**UT 3**
Length of reach (linear feet)	2796	207	2298
Valley Classification & Confinement	Alluvial, moderately confined to confined		
Drainage Area (acres)	71.7	17.2	444.7
NCDWR Stream ID Score	20.25 – 33.5	--	--
Perennial, Intermittent, Ephemeral	Intermittent/Perennial	Intermittent	Perennial
NCDWR Water Quality Classification	WS-V, NSW		
Existing Morphological Description (Rosgen 1996)	Cg5	C4/5	C3
Proposed Stream Classification (Rosgen 1996)	C/E 4	C4/5	C3
Existing Evolutionary Stage (Simon and Hupp 1986)	III/IV	III	I
Underlying Mapped Soils	Efland silt loam, Georgeville silt loam, Herndon silt loam, Orange silt loam, Worsham sandy loam, Local Alluvial Land		
Drainage Class	Well-drained, well-drained, well-drained, poorly drained, well-drained, poorly drained, respectively		
Hydric Soil Status	Nonhydric, nonhydric, nonhydric, nonhydric, hydric, hydric, respectively		
Slope	0.0241	0.0256	0.0130
FEMA Classification	NA		
Native Vegetation Community	Piedmont Alluvial Forest/Dry-Mesic Oak-Hickory Forest		
Watershed Land Use/Land Cover (Site)	45% forest, 35% agricultural land, 20% low density residential/impervious surface		
Watershed Land Use/Land Cover (Cedarock Reference Channel)	65% forest, 30% agricultural land, <5% low density residential/impervious surface		
Percent Composition of Exotic Invasive Vegetation	<5%		

Table 4. Project Attribute Table - Major Hill Restoration Site (Continued)

Wetland Summary Information	
Parameters	**Wetlands**
Wetland acreage	0.54 acre drained or impounded & 0.44 acre degraded
Wetland Type	Riparian riverine
Mapped Soil Series	Worsham and Local Alluvial Land
Drainage Class	Poorly drained
Hydric Soil Status	Hydric
Source of Hydrology	Groundwater, stream overbank
Hydrologic Impairment	Incised streams, compacted soils, livestock
Native Vegetation Community	Piedmont/Low Mountain Alluvial Forest
% Composition of Exotic Invasive Vegetation	<5%
Restoration Method	Hydrologic, vegetative
Enhancement Method	Vegetative

Appendix B
Visual Assessment Data

Figure 1. Project Location
Figure 2. Current Conditions Plan View
Vegetation Plot Photographs
Tables 5A-5C. Visual Stream Morphology Stability Assessment
Table 6. Vegetation Condition Assessment



Axiom Environmental, Inc.

Prepared for:

RESTORATION SYSTEMS | LLC

Project:

MAJOR HILL STREAM AND WETLAND MITIGATION SITE

Alamance County, NC

Title:

PROJECT LOCATION

Drawn by: KRJ

Date: NOV 2017

Scale: 1:20,000

Project No.: 17-009

FIGURE

1

Legend

- Easement
- Stream Restoration
- Stream Enhancement (Level II)
- Wetland Restoration
- Wetland Enhancement
- Trail Camera
- Benthic/Water Quality Stations
- Groundwater Gauge Meeting Success Criteria During Year 2 (2020)
- Groundwater Gauge Not Meeting Success Criteria During Year 2 (2020)
- Stream Gauges
- Rain Gauge/Soil Probe
- Marsh Treatment Areas
- Plot Origins
- CVS Plots Meeting Success Criteria During Year 2 (2020)
- CVS Plots Not Meeting Success Criteria During Year 2 (2020)
- Vegetation Transects Meeting Success Criteria During Year (2020)
- 2020 Supplemental Planting Area
- Structures
- Cross-sections
- Newly-Installed Fencing
- Previously Existing Fencing that Remains Post-Construction
- Fencing Removed During Construction

N

XS-10R
XS-9P
XS-8R
XS-7P
XS-6P
XS-5R
XS-4R
XS-3P
XS-2R
XS-1R
UT-1
UT-2
UT-3
T-1
T-2
T-3
Seed, fertilizer, and lime application area.
Seed, fertilizer, and lime application area.

0 70 140 280 420 560 Feet

Axiom Environmental
218 Snow Ave
Raleigh, NC 27607
(919) 215-1693

CURRENT CONDITIONS PLAN VIEW
Major Hill Stream and Wetland Mitigation
Alamance County, North Carolina

Dwn. By:	KRJ
Date:	Jan 2021
Project:	17-009
FIGURE	2

Major Hill
MY-02 (2020) Vegetation Monitoring Photographs
Taken October 2020

Plot 1

Plot 2

Plot 3

Plot 4

Plot 5

Plot 6

Major Hill
MY-02 (2020) Vegetation Monitoring Photographs
Taken October 2020

Plot 7

Plot 8

Table 5A **Visual Stream Morphology Stability Assessment**
Reach ID **Major Hill UT-1**
Assessed Length **1699**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	71	71			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	70	70			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	70	70			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	70	70			100%			
		2. Thalweg centering at downstream of meander (Glide)	70	70			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	26	26			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	26	26			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	26	26			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	26	26			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	26	26			100%			

Table 5B **Visual Stream Morphology Stability Assessment**
Reach ID **Major Hill UT-2**
Assessed Length **39**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	2	2			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	2	2			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	2	2			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	2	2			100%			
		2. Thalweg centering at downstream of meander (Glide)	2	2			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	0	0			NA			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	0			NA			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			NA			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	0	0			NA			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	0	0			NA			

Table 6 Vegetation Condition Assessment

Major Hill

Planted Acreage[1] **8.1**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	None	0.1 acres	none	0	0.00	0.0%
2. Low Stem Density Areas	None	0.1 acres	none	0	0.00	0.0%
2B. Low Planted Stem Density Areas	None	0.1 acres	none	0	0.00	0.0%
			Total	0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	None	0.25 acres	none	0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2] **16.7**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern[4]	None	1000 SF	none	0	0.00	0.0%
5. Easement Encroachment Areas[3]	None	none	none	0	0.00	0.0%

1 = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

2 = The acreage within the easement boundaries.

3 = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by DMS such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likley trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly ealry in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolzing invasives polygons, particulalry for situations where the conditon for an area is somewhere between isolated specimens and

Appendix C
Vegetation Data

Table 7. Planted Bare Root Woody Vegetation
Table 8. Total Stems by Plot and Species
Table 9. Temporary Vegetation Plot Data
Table 10. Planted Vegetation Totals

Table 7. Planted Bare Root Woody Vegetation – Major Hill Restoration Site

Species	Piedmont/Low Mountain Alluvial Forest	Dry-Mesic Oak/Hickory Forest	Marsh Treatment Wetland	Streamside Assemblage	Total
Acres	**1.1**	**5.5**	**0.01**	**1.5**	**8.11**
Alnus serrulata			5	20	25
Asimina triloba				200	200
Betula nigra	100			200	300
Carpinus caroliniana		600			600
Cephalanthus occidentalis			5	20	25
Cercis canadensis		500			500
Cornus amomum	95		5	800	900
Diospyros virginiana		450			450
Fraxinus americana		100			100
Fraxinus pennsylvanica	150			750	900
Liriodendron tulipifera	75				75
Nyssa sylvatia		600			600
Platanus occidentalis	120			780	900
Quercus nigra	110	790		500	1,400
Quercus phellos	100	700		400	1,200
*Salix nigra**				400*	400
Sambucus canadensis			11	14	25
TOTALS	750	3,740	26	4,084	**8,600**
Stems/Acre	682	680	2600	2722	**1060**

*Live stakes of *Salix nigra* were planted; all other planted species were planted as bare root plants.

Table 8. Total Stems by Plot and Species
Project Code 17.009. Project Name: Major Hill

			Current Plot Data (MY2 2020)																						Annual Means								
			17.009-01-0001			17.009-01-0002			17.009-01-0003			17.009-01-0004			17.009-01-0005			17.009-01-0006			17.009-01-0007			17.009-01-0008			MY2 (2020)			MY1 (2019)*			MY0 (2019)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree																													3			
Asimina triloba	pawpaw	Tree										1	1	1							1	1	1				2	2	2	3	3	3	7	7	7
Betula nigra	river birch	Tree										1	1	1	1	1	1							2	2	2	4	4	4	6	6	6	9	9	9
Carpinus caroliniana	American hornbeam	Tree	1	1	1	3	3	3	4	4	4							2	2	2							10	10	10	14	14	14	5	5	5
Cercis canadensis	eastern redbud	Tree							2	2	2													3	3	3	5	5	5	8	8	8	14	14	14
Cornus amomum	silky dogwood	Shrub																												2	2	2	1	1	1
Diospyros virginiana	common persimmon	Tree			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				4	4	4	9	9	10	9	9	9	5	5	5
Fraxinus	ash	Tree																						1	1	1	1	1	1	1	1	1	1	1	1
Fraxinus americana	white ash	Tree																3	3	3				2	2	2	5	5	5	5	5	5	5	5	5
Fraxinus pennsylvanica	green ash	Tree	2	2	4							1	1	2	1	1	1				1	1	1				5	5	8	4	4	4	3	3	3
Liquidambar styraciflua	sweetgum	Tree																													2			
Liriodendron tulipifera	tuliptree	Tree	1	1	1																						1	1	1	1	1	1	5	5	5
Nyssa sylvatica	blackgum	Tree				1	1	1	1	1	1																2	2	2	4	4	4	10	10	10
Platanus occidentalis	American sycamore	Tree				1	1	1							1	1	1	2	2	2	1	1	1				5	5	5	7	7	8	7	7	7
Quercus	oak	Tree	1	1	1																1	1	1				2	2	2	3	3	3	23	23	23
Quercus nigra	water oak	Tree										2	2	2	4	4	4	2	2	2	3	3	3	1	1	1	12	12	12	20	20	20	10	10	10
Quercus phellos	willow oak	Tree				2	2	2	1	1	1							2	2	2	4	4	4	3	3	3	12	12	12	16	16	16	18	18	18
Unknown		Shrub or Tree																															6	6	6
		Stem count	5	5	8	8	8	8	9	9	9	6	6	7	8	8	8	12	12	12	11	11	11	16	16	16	75	75	79	103	103	109	129	129	129
		size (ares)	1			1			1			1			1			1			1			1			8			8			8		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.20			0.20			0.20		
		Species count	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	7	7	7	14	14	14	15	15	17	16	16	16
		Stems per ACRE	202.3	202.3	323.7	323.7	323.7	323.7	364.2	364.2	364.2	242.8	242.8	283.3	323.7	323.7	323.7	485.6	485.6	485.6	445.2	445.2	445.2	647.5	647.5	647.5	379.4	379.4	399.6	521	521	551.4	652.6	652.6	652.6

*The increases in stem counts of species such as *Carpinus caroliniana* , *Diospyros virginiana* , and *Quercus nigra* are due to mis-identification during MY0 (dormant season) monitoring and/or refinement in identification during MY1 monitoring.

Color for Density
Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%

PnoLS = Planted excluding livestakes
P-all = Planting including livestakes
T = All planted and natural recruits including livestakes
T includes natural recruits

Table 9. Temporary Vegetation Plot Data – Major Hill Restoration Site

Species	50m x 2m Temporary Plot (Bearing)		
	T-1 (356º)	T-2 (321º)	T-3 (341º)
Carpinus caroliniana	3		1
Cercis canadensis			1
Cornus amomum		1	
Diospyros virginiana		2	1
Fraxninus pennsylvanica	5	3	11
Lirodendron tulipifera			3
Platanus occidentalis		1	
Quercus phellos	4		2
Quercus rubra	2	2	6
Total Stems	**14**	**9**	**25**
Total Stems/Acre	**567**	**364**	**1012**

Table 10. Planted Vegetation Totals – Major Hill Restoration Site

Plot #	Success Criteria Met?	MY 2 (2020) Planted Stems/Ac	MY 2 (2020) All Stems/Ac
1	No	202	323
2	Yes	323	323
3	Yes	364	364
4	No	242	283
5	Yes	323	323
6	Yes	485	485
7	Yes	445	445
8	Yes	647	647
T-1	Yes	--	567
T-2	Yes	--	364
T-3	Yes	--	1012
Average Planted Stems/Acre	**Yes**	**379**	**467**

Appendix D
Stream Geomorphology Data

Tables 11A-11B. Baseline Stream Data Summary
Tables 12A-12D. Monitoring Data (Dimensional Morphology Summary & Stream Reach Data Summary)
Table 13. Water Quality Data
Cross-Section Plots
Substrate Plots

Table 11a. Baseline Stream Data Summary (UT 1 Upstream
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Gauge	Regional Curve			Pre-Existing Condition (UT 1 Upstream)					Reference Reach(es) Data					Design (UT 1 Upstream)			Monitoring Baseline (UT 1 Upstream)					
Dimension and Substrate - Riffle Only		**LL**	**UL**	**Eq.**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Max**	**Med**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**
BF Width (ft)					3.8		5.6	6.4		8.0		9.6	12.1		5.6	6.4	6.0	6.0		10.9	11.8		3
Floodprone Width (ft)					11.0		27.0	48.0		15		75	140		20	60	40	23		40	40		3
BF Mean Depth (ft)					0.3		0.5	0.7		0.8		1.1	1.4		0.4	0.5	0.4	0.3		0.5	0.6		3
BF Max Depth (ft)					0.7		0.9	1.3		1.1		1.7	2.0		0.5	0.7	0.6	0.7		0.8	1.1		3
BF Cross Sectional Area (ft^2)					2.6		2.6	2.6		8.0		11.4	14.7		2.6	2.6	2.6	3.0		3.5	7.1		3
Width/Depth Ratio					5.4		13.4	27.0		8.0		9.6	15.1		12.0	16.0	14.0	12.0		19.6	33.9		3
Entrenchment Ratio					1.4		5.8	12.6		1.9		7.1	13.0		3.6	9.3	6.6	3.4		3.7	3.8		3
Bank Height Ratio					1.0		1.4	1.7		1.0		1.2	1.8		1.0	1.3	1.2	1.0		1.0	1.3		3
Profile																							
Riffle length (ft)																		5		16	47		3
Riffle slope (ft/ft)										0.0100		0.0207	0.0576		0.0268	0.0401	0.0357	0.0000		0.0252	0.0539		3
Pool length (ft)																		4.0		13.0	28.0		3
Pool Max depth (ft)										1.5		2.3	2.7		0.6	0.9	0.8	1.3		2.0	2.5		3
Pool spacing (ft)										22.0		40.8	81.0		18.0	48.0	24.0	18.0		24.0	48.0		3
Pattern																							
Channel Beltwidth (ft)										17		26.3	38		18	36	24	18		24	36		
Radius of Curvature (ft)										9		23.6	113		12	60	18	12		18	60		
Rc:Bankfull width (ft/ft)										0.8		2.4	10.3		2	10	3	2		3	10		
Meander Wavelength (ft)										10		65.7	116		36	72	51	36		51	72		
Meander Width ratio										1.5		2.7	4.7		3	6	4	3		4	6		
Transport parameters																							
Reach Shear Stress (competency) lbs/ft^2																							
Max part size (mm) mobilized at bankfull																							
Stream Power (transport capacity) W/m^2																							
Additional Reach Parameters																							
Rosgen Classification					Cg 5					Eb 5					E/C 4			E/C-type					
Bankfull Velocity (fps)																							
Bankfull Discharge (cfs)					9.5					28.8 - 60.6					9.5			9.5					
Valley Length (ft)																							
Channel Thalweg Length (ft)																							
Sinuosity					1.07					1.2 - 1.46					1.08			1.08					
Water Surface Slope (ft/ft)					0.0225					0.0053 - 0.0258					0.0223			0.0195					
BF slope (ft/ft)																							
Bankfull Floodplain Area (acres)																							
% of Reach with Eroding Banks																							
Channel Stability or Habitat Metric																							
Biological or Other																							

Table 11b. Baseline Stream Data Summary (UT 1 Downstream
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Gauge	Regional Curve			Pre-Existing Condition (UT 1 Downstream)					Reference Reach(es) Data					Design (UT 1 Downstream)			Monitoring Baseline (UT 1 Downstream)					
Dimension and Substrate - Riffle Only		**LL**	**UL**	**Eq.**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Max**	**Med**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**
BF Width (ft)					4.9		6.7	8.7		8.0		9.6	12.1		6.8	7.8	7.3	8.6		10.3	11.8		3
Floodprone Width (ft)					9.0		14.0	21.0		15		75	140		25	75	50	22		40	40		3
BF Mean Depth (ft)					0.4		0.6	0.8		0.8		1.1	1.4		0.4	0.8	0.6	0.4		0.6	0.6		3
BF Max Depth (ft)					0.7		0.9	1.2		1.1		1.7	2.0		0.6	0.8	0.7	0.7		0.9	1.2		3
BF Cross Sectional Area (ft^2)					3.8		3.8	3.8		8.0		11.4	14.7		3.8	3.8	3.8	3.5		5.8	7.5		3
Width/Depth Ratio					6.1		13.1	21.8		8.0		9.6	15.1		12.0	16.0	14.0	18.0		18.0	21.0		3
Entrenchment Ratio					1.4		2.2	4.3		1.9		7.1	13.0		3.7	9.6	6.9	2.6		3.4	3.9		3
Bank Height Ratio					1.6		2.2	2.8		1.0		1.2	1.8		1.0	1.3	1.2	1.0		1.0	1.0		3
Profile																							
Riffle length (ft)																		5		16	47		1
Riffle slope (ft/ft)										0.0100		0.0207	0.0576		0.0000	0.0297	0.0264	0.0000		0.0252	0.0539		1
Pool length (ft)																		4.0		13.0	28.0		1
Pool Max depth (ft)										1.5		2.3	2.7		0.7	1.1	1.0	1.7		1.7	1.7		1
Pool spacing (ft)										22.0		40.8	81.0		21.9	58.4	29.2	18.0		24.0	48.0		1
Pattern																							
Channel Beltwidth (ft)										17		26.3	38		21.9	43.8	29.2	22		29	44		
Radius of Curvature (ft)										9		23.6	113		14.6	72.9	21.9	14		22	73		
Rc:Bankfull width (ft/ft)										0.8		2.4	10.3		2	10	3	2		3	10		
Meander Wavelength (ft)										10		65.7	116		43.8	87.5	62	44		62	88		
Meander Width ratio										1.5		2.7	4.7		3	6	4	3		4	6		
Transport parameters																							
Reach Shear Stress (competency) lbs/ft^2																							
Max part size (mm) mobilized at bankfull																							
Stream Power (transport capacity) W/m^2																							
Additional Reach Parameters																							
Rosgen Classification					Cg 5					Eb 5					E/C 4			E/C-type					
Bankfull Velocity (fps)																							
Bankfull Discharge (cfs)					14.2					28.8 - 60.6					14.2			14.2					
Valley Length (ft)																							
Channel Thalweg Length (ft)																							
Sinuosity					1.26					1.2 - 1.46					1.12			1.12					
Water Surface Slope (ft/ft)					0.0147					0.0053 - 0.0258					0.0165			0.0195					
BF slope (ft/ft)																							
Bankfull Floodplain Area (acres)																							
% of Reach with Eroding Banks																							
Channel Stability or Habitat Metric																							
Biological or Other																							

Table 12a. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Cross Section 1 (UT 1 Downstream) Riffle							Cross Section 2 (UT 1 Downstream) Riffle							Cross Section 3 (UT 1 Downstream) Pool							Cross Section 4 (UT 1 Downstream) Riffle						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	11.8	11.2	12.6					8.6	7.4	7.8					13.0	12.5	13.1					10.3	10.4	12.8				
Floodprone Width (ft) (approx)	40.0	40.0	40.0					22.0	22.0	22.0					NA	NA	NA					40.0	40.0	40.0				
BF Mean Depth (ft)	0.6	0.7	0.6					0.4	0.5	0.4					0.6	0.7	0.6					0.6	0.6	0.5				
BF Max Depth (ft)	1.2	1.2	1.2					0.7	0.7	0.7					1.7	1.6	1.6					0.9	1.1	1.1				
Low Bank Height	1.2	1.3	1.2					0.7	0.8	0.7					1.7	1.7	1.7					0.9	1.1	1.1				
BF Cross Sectional Area (ft^2)	7.5	7.5	7.5					3.5	3.5	3.5					8.4	8.4	8.4					5.8	5.8	5.8				
Width/Depth Ratio	18.6	16.7	21.2					21.1	15.6	17.4					NA	NA	NA					18.3	18.6	28.2				
Entrenchment Ratio	3.4	3.6	3.2					2.6	3.0	2.8					NA	NA	NA					3.9	3.8	3.1				
Bank Height Ratio*	1.0	1.1	1.0					1.0	1.1	1.0					1.0	1.1	1.1					1.0	1.0	1.0				
d50 (mm)	25.4	33.0	4.9					25.4	33.0	4.9					25.4	33.0	4.9					25.4	33.0	4.9				

*Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioners in NC (9/2018).

Table 12b. Monitoring Data - Stream Reach Data Summary
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Baseline (UT 1 Downstream)						MY-1 (UT 1 Downstream)						MY-2 (UT 1 Downstream)						MY-3 (UT 1 Downstream)						MY-5 (UT 1 Downstream)						MY-7 (UT 1 Downstream)					
Dimension and Substrate - Riffle Only	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	8.6		10.3	11.8		3	7.4		10.4	11.2		3	7.8		12.6	12.8		3																	
Floodprone Width (ft)	22		40	40		3	22		40	40		3	22		40	40		3																	
BF Mean Depth (ft)	0.4		0.6	0.6		3	0.5		0.6	0.7		3	0.4		0.5	0.6		3																	
BF Max Depth (ft)	0.7		0.9	1.2		3	0.7		1.1	1.2		3	0.7		1.1	1.2		3																	
BF Cross Sectional Area (ft^2)	3.5		5.8	7.5		3	3.5		5.8	7.5		3	3.5		5.8	7.5		3																	
Width/Depth Ratio	18.0		18.0	21.0		3	15.6		16.7	18.6		3	17.4		21.2	28.2		3																	
Entrenchment Ratio	2.6		3.4	3.9		3	3.0		3.6	3.8		3	2.8		3.1	3.2		3																	
Bank Height Ratio	1.0		1.0	1.0		3	1.0		1.1	1.1		3	1.0		1.0	1.0		3																	
Profile																																				
Riffle length (ft)	5		16	47		1																														
Riffle slope (ft/ft)	0.0000		0.0252	0.0539		1																														
Pool length (ft)	4.0		13.0	28.0		1																														
Pool Max depth (ft)	1.7		1.7	1.7		1																														
Pool spacing (ft)	18.0		24.0	48.0		1																														
Pattern																																				
Channel Beltwidth (ft)	22		29	44																																
Radius of Curvature (ft)	14		22	73																																
Rc:Bankfull width (ft/ft)	2		3	10																																
Meander Wavelength (ft)	44		62	88																																
Meander Width ratio	3		4	6																																

Profile surveys during the stream monitoring period are not required, unless evidence of bed and/or bank instability is observed and the data is requested by the IRT.

Additional Reach Parameters																																				
Rosgen Classification	E/C type																																			
Channel Thalweg Length (ft)																																				
Sinuosity	1.12																																			
Water Surface Slope (Channel) (ft/ft)	0.0195																																			
BF slope (ft/ft)																																				
Ri%/RU%P%G%/S%																																				
SC%/SA%/G%/C%/B%BE%																																				
d16/d35/d50/d84/d95																																				
% of Reach with Eroding Banks																																				
Channel Stability or Habitat Metric																																				
Biological or Other																																				

Table 12c. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Cross Section 5 (UT 1 Upstream)							Cross Section 6 (UT 1 Upstream)							Cross Section 7 (UT 1 Upstream)							Cross Section 8 (UT 1 Upstream)						
	Riffle							Pool							Pool							Riffle						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	11.8	11.8	12.3					8.9	9.9	10.0					7.4	9.5	6.9					6.0	5.7	6.5				
Floodprone Width (ft) (approx)	40.0	40.0	40.0					NA	NA	NA					NA	NA	NA					23.0	23.0	23.0				
BF Mean Depth (ft)	0.6	0.6	0.6					1.0	0.9	0.9					1.6	1.2	1.7					0.5	0.5	0.5				
BF Max Depth (ft)	1.1	1.2	1.1					2.0	2.1	2.0					2.5	2.4	2.0					0.8	0.9	0.9				
Low Bank Height	1.1	1.2	1.1					2.0	2.2	2.2					2.5	2.5	2.2					0.8	0.9	1.0				
BF Cross Sectional Area (ft^2)	7.1	7.1	7.1					9.1	9.1	9.1					11.7	11.7	11.7					3.0	3.0	3.0				
Width/Depth Ratio	19.6	19.6	21.3					NA	NA	NA					NA	NA	NA					12.0	10.8	14.1				
Entrenchment Ratio	3.4	3.4	3.3					NA	NA	NA					NA	NA	NA					3.8	4.0	3.5				
Bank Height Ratio*	1.0	1.0	1.0					1.0	1.0	1.1					1.0	1.0	1.1					1.0	1.0	1.1				
d50 (mm)	25.4	33.0	4.9					25.4	33.0	4.9					25.4	33.0	4.9					25.4	33.0	4.9				

Parameter	Cross Section 9 (UT 1 Upstream)							Cross Section 10 (UT 1 Upstream)						
	Pool							Riffle						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	7.0	9.4	8.0					10.9	11.2	13.3				
Floodprone Width (ft) (approx)	NA	NA	NA					40.0	40.0	40.0				
BF Mean Depth (ft)	0.7	0.5	0.6					0.3	0.3	0.3				
BF Max Depth (ft)	1.3	1.2	1.3					0.7	0.6	0.6				
Low Bank Height	1.3	1.3	1.3					0.7	0.6	0.6				
BF Cross Sectional Area (ft^2)	4.9	4.9	4.9					3.5	3.5	3.5				
Width/Depth Ratio	NA	NA	NA					33.9	35.8	50.5				
Entrenchment Ratio	NA	NA	NA					3.7	3.6	3.0				
Bank Height Ratio*	1.0	1.1	1.0					1.0	1.0	1.0				
d50 (mm)	25.4	33.0	4.9					25.4	33.0	4.9				

*Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioners in NC (9/2018).

Table 12d. Monitoring Data - Stream Reach Data Summary
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Baseline (UT 1 Upstream)						MY-1 (UT 1 Upstream)						MY-2 (UT 1 Upstream)						MY-3 (UT 1 Upstream)						MY-5 (UT 1 Upstream)						MY-7 (UT 1 Upstream)					
Dimension and Substrate - Riffle Only	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**
BF Width (ft)	6.0		10.9	11.8		3	5.7		11.2	11.8		3	6.5		12.3	13.3		3																		
Floodprone Width (ft)	23		40	40		3	23		40	40		3	23		40	40		3																		
BF Mean Depth (ft)	0.3		0.5	0.6		3	0.3		0.5	0.6		3	0.3		0.5	0.6		3																		
BF Max Depth (ft)	0.7		0.8	1.1		3	0.6		0.9	1.2		3	0.6		0.9	1.1		3																		
BF Cross Sectional Area (ft^2)	3.0		3.5	7.1		3	3.0		3.5	7.1		3	3.0		3.5	7.1		3																		
Width/Depth Ratio	12.0		19.6	33.9		3	10.8		19.6	35.8		3	14.1		21.3	50.5		3																		
Entrenchment Ratio	3.4		3.7	3.8		3	3.4		3.6	4.0		3	3.0		3.3	3.5		3																		
Bank Height Ratio	1.0		1.0	1.3		3	1.0		1.0	1.0		3	1.0		1.0	1.1		3																		
Profile																																				
Riffle length (ft)	5		16	47		3																														
Riffle slope (ft/ft)	0.0000		0.0252	0.0539		3																														
Pool length (ft)	4.0		13.0	28.0		3																														
Pool Max depth (ft)	1.3		2.0	2.5		3																														
Pool spacing (ft)	18.0		24.0	48.0		3																														
Pattern																																				
Channel Beltwidth (ft)	18		24	36																																
Radius of Curvature (ft)	12		18	60																																
Rc:Bankfull width (ft/ft)	2		3	10																																
Meander Wavelength (ft)	36		51	72																																
Meander Width ratio	3		4	6																																

Profile surveys during the stream monitoring period are not required, unless evidence of bed and/or bank instability is observed and the data is requested by the IRT.

Additional Reach Parameters

Rosgen Classification	E/C type																																			
Channel Thalweg Length (ft)																																				
Sinuosity	1.08																																			
Water Surface Slope (Channel) (ft/ft)	0.0195																																			
BF slope (ft/ft)																																				
Ri%/RU%P%G%/S%																																				
SC%/SA%/G%/C%/B%BE%																																				
d16/d35/d50/d84/d95																																				
% of Reach with Eroding Banks																																				
Channel Stability or Habitat Metric																																				
Biological or Other																																				

Table 13. Major Hill Water Quality Data – Major Hill Restoration Site

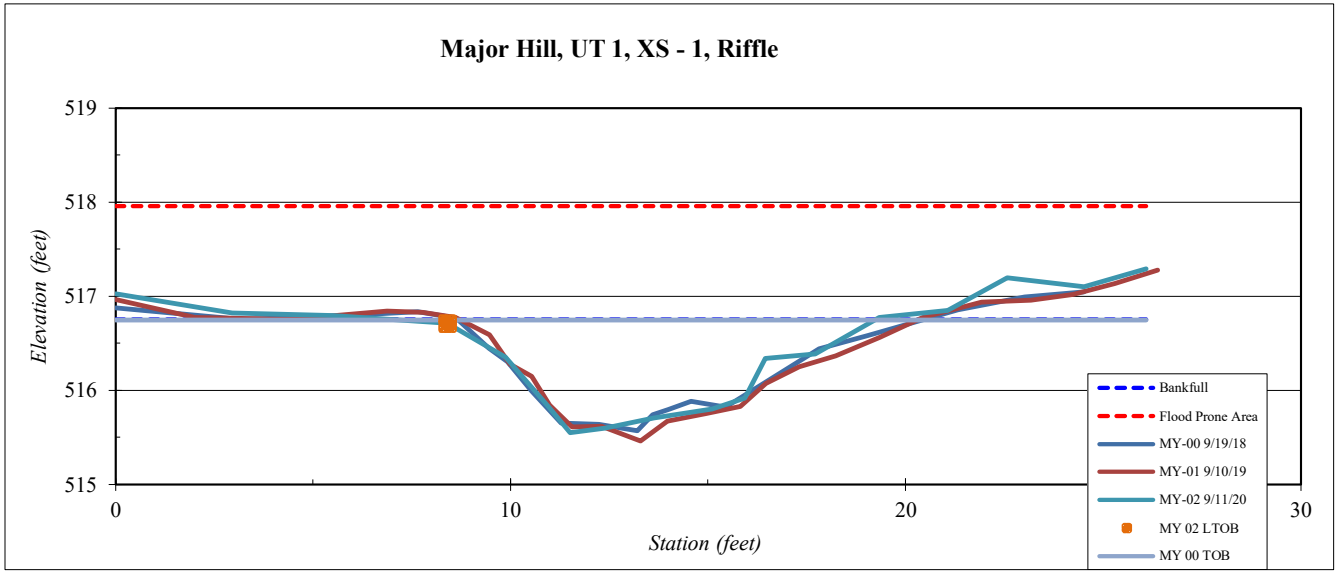
	Preconstruction				Year 1 (2019)		Year 2 (2020)	
	Upstream		Downstream		Upstream	Downstream	Upstream	Downstream
Parameter	**7/28/17**	**8/14/17**	**7/28/17**	**8/14/17**	**11/20/19**	**11/20/19**	**10/28/20**	**10/28/20**
TDS (ppm)	110.1	147	62.6	86.8	394	179	164.0	122.3
TDS (mg/l)	109.1	149	64.6	83.5	397	179	168.3	131.3
Conductivity (m/s)	159.2	215	92.1	128.3	557	252	242.1	186.9
Temperature (°C)	25.4	22.6	24.6	22.1	8	6.9	19.6	19.7
DO (mg/l)	-	1.93	-	3.06	-	-	5.36	7.64
DO (ppm)	-	1.06	-	2.53	-	-	5.42	7.72
pH	6.61	6.37	6.65	6.22	7	6.58	6.96	6.94

Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 1, Riffle
Feature	Riffle
Date:	9/11/2020
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	517.02
3.0	516.82
5.5	516.80
8.4	516.71
9.9	516.35
10.9	515.84
11.5	515.55
12.4	515.59
13.6	515.70
15.1	515.80
15.9	515.91
16.4	516.34
17.7	516.39
19.3	516.78
21.1	516.85
22.6	517.20
24.5	517.10
26.1	517.30

SUMMARY DATA	
Bankfull Elevation:	516.8
LTOB Elevation:	516.8
Bankfull Cross-Sectional Area:	7.5
Bankfull Width:	12.6
Flood Prone Area Elevation:	518.0
Flood Prone Width:	40.0
Max Depth at Bankfull:	1.2
Low Bank Height:	1.2
Mean Depth at Bankfull:	0.6
W / D Ratio:	21.2
Entrenchment Ratio:	3.2
Bank Height Ratio:	1.0

Stream Type	C/E

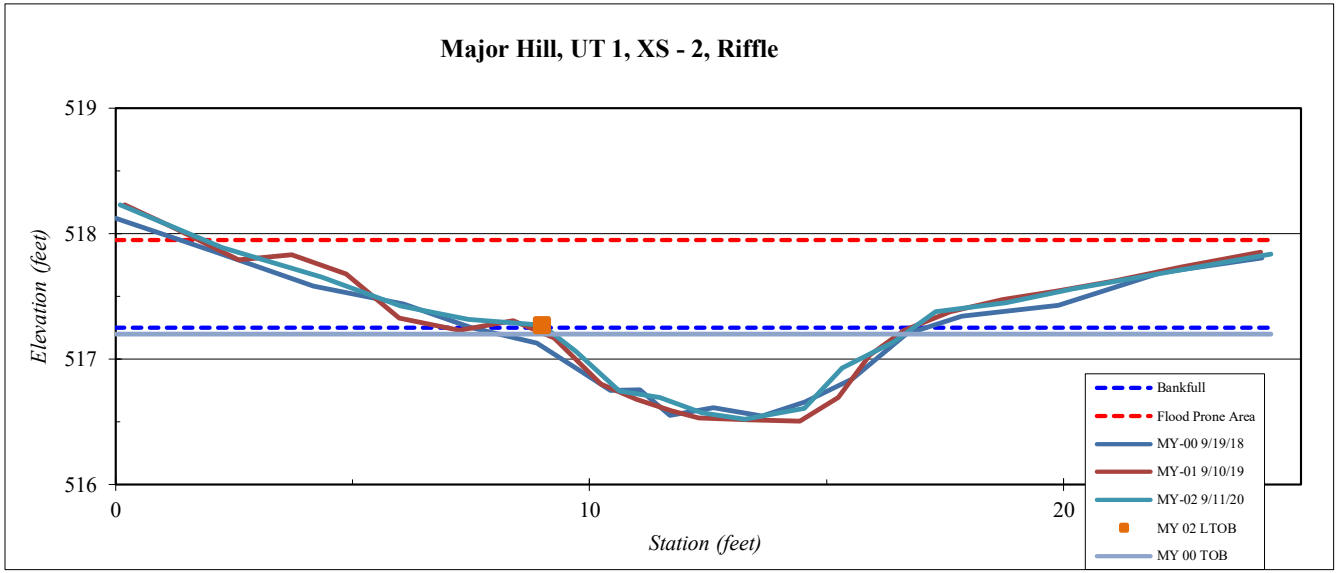


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 2, Riffle
Feature	Riffle
Date:	9/11/2020
Field Crew:	Perkinson, Radecki

Station	Elevation
0.1	518.23
2.3	517.88
4.4	517.65
6.0	517.42
7.4	517.31
9.0	517.27
9.7	517.06
10.6	516.74
11.5	516.69
12.4	516.57
13.3	516.52
14.5	516.61
15.3	516.93
16.4	517.14
17.3	517.38
18.8	517.45
20.2	517.56
24.4	517.84

SUMMARY DATA	
Bankfull Elevation:	517.3
LTOB Elevation:	517.3
Bankfull Cross-Sectional Area:	3.5
Bankfull Width:	7.8
Flood Prone Area Elevation:	518.0
Flood Prone Width:	22.0
Max Depth at Bankfull:	0.7
Low Bank Height:	0.7
Mean Depth at Bankfull:	0.4
W / D Ratio:	17.4
Entrenchment Ratio:	2.8
Bank Height Ratio:	1.0

Stream Type	C/E

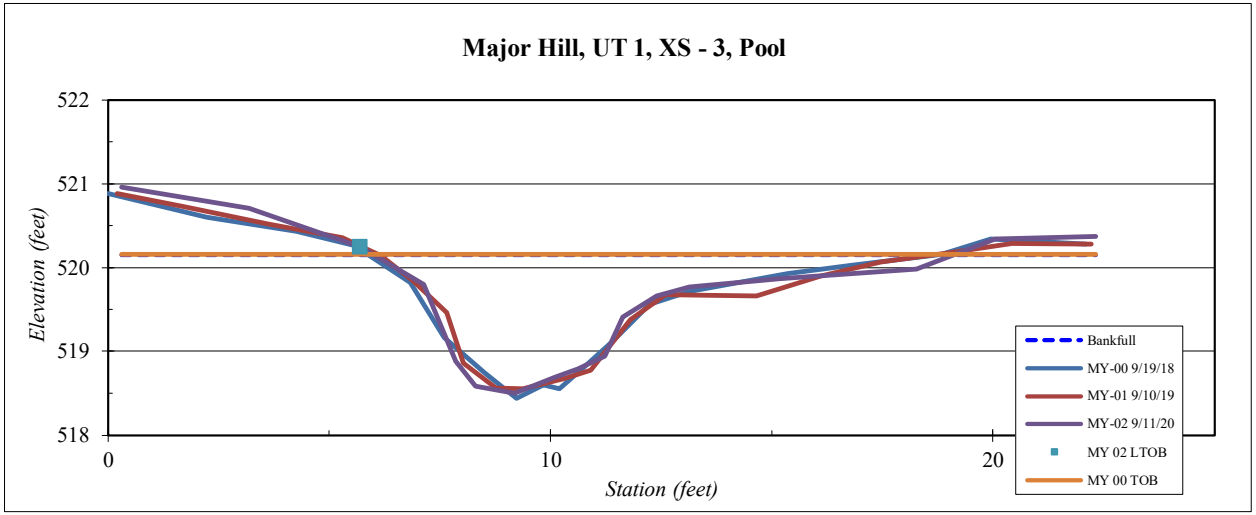


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 3, Pool
Feature	Pool
Date:	9/11/2020
Field Crew:	Perkinson, Radecki

Station	Elevation
0.3	521.0
3.2	520.7
5.7	520.2
7.1	519.8
7.9	518.9
8.3	518.6
9.2	518.5
10.1	518.7
10.6	518.8
11.2	518.9
11.6	519.4
12.4	519.7
13.1	519.8
15.2	519.9
18.3	520.0
20.1	520.3
22.3	520.4

SUMMARY DATA	
Bankfull Elevation:	520.2
LTOB Elevation:	520.3
Bankfull Cross-Sectional Area:	8.4
Bankfull Width:	13.1
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.6
Low Bank Height:	1.7
Mean Depth at Bankfull:	0.6
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.1

Stream Type	C/E

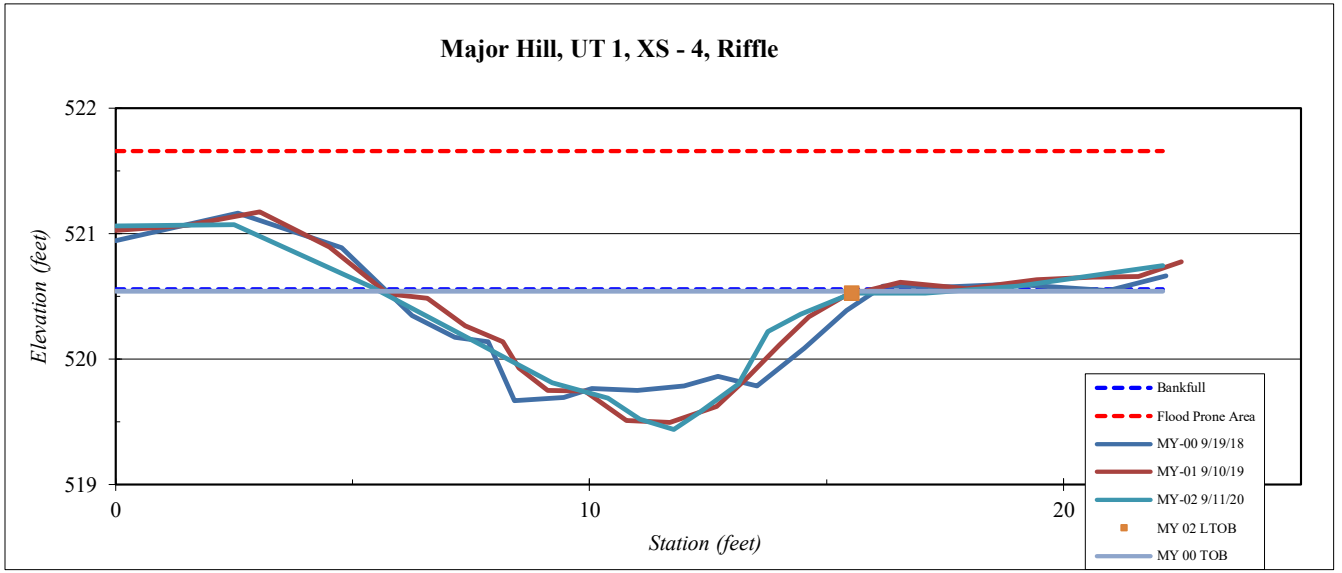


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 4, Riffle
Feature	Riffle
Date:	9/11/2020
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	521.06
2.5	521.07
5.4	520.57
7.3	520.20
8.3	519.99
9.2	519.81
10.4	519.69
11.1	519.52
11.8	519.44
12.3	519.58
13.1	519.80
13.8	520.22
14.5	520.36
15.5	520.52
17.1	520.52
19.0	520.58
22.1	520.74

SUMMARY DATA	
Bankfull Elevation:	520.6
LTOB Elevation:	520.5
Bankfull Cross-Sectional Area:	5.8
Bankfull Width:	12.8
Flood Prone Area Elevation:	521.7
Flood Prone Width:	40.0
Max Depth at Bankfull:	1.1
Low Bank Height:	1.1
Mean Depth at Bankfull:	0.5
W / D Ratio:	28.2
Entrenchment Ratio:	3.1
Bank Height Ratio:	1.0

Stream Type	C/E

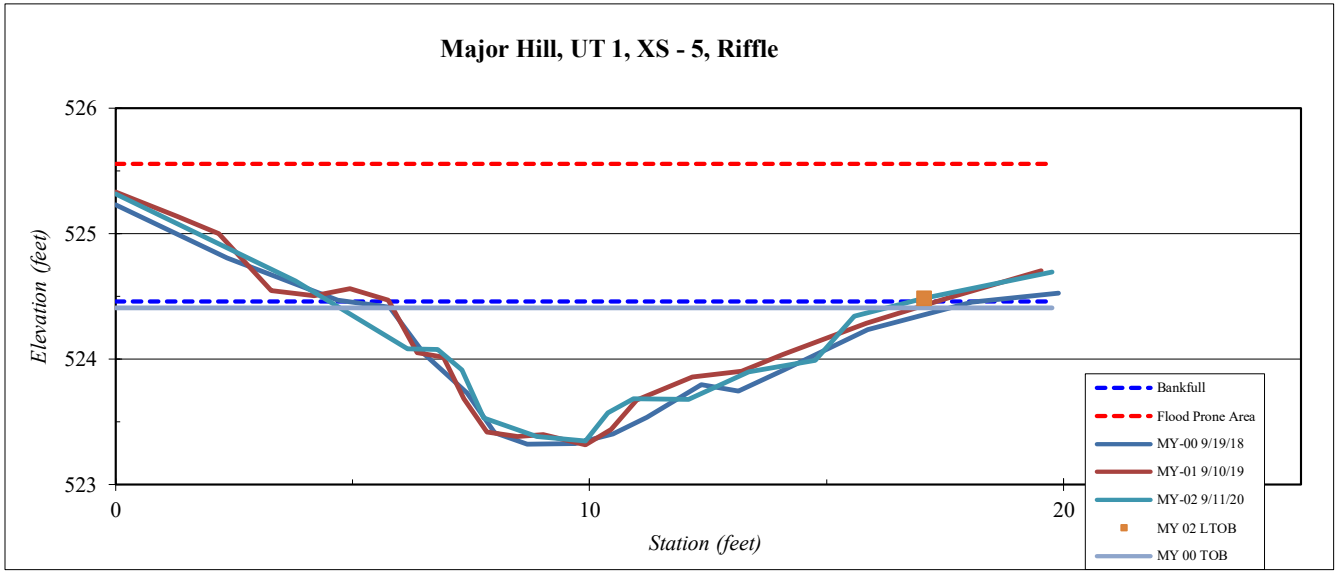


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 5, Riffle
Feature	Riffle
Date:	9/11/2020
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	525.32
3.8	524.62
6.2	524.08
6.8	524.08
7.3	523.91
7.8	523.53
8.9	523.38
9.9	523.35
10.4	523.57
10.9	523.68
12.1	523.68
13.4	523.90
14.8	523.99
15.6	524.34
17.1	524.48
19.7	524.69

SUMMARY DATA	
Bankfull Elevation:	524.5
LTOB Elevation:	524.5
Bankfull Cross-Sectional Area:	7.1
Bankfull Width:	12.3
Flood Prone Area Elevation:	525.6
Flood Prone Width:	40.0
Max Depth at Bankfull:	1.1
Low Bank Height:	1.1
Mean Depth at Bankfull:	0.6
W / D Ratio:	21.3
Entrenchment Ratio:	3.3
Bank Height Ratio:	1.0

Stream Type	C/E

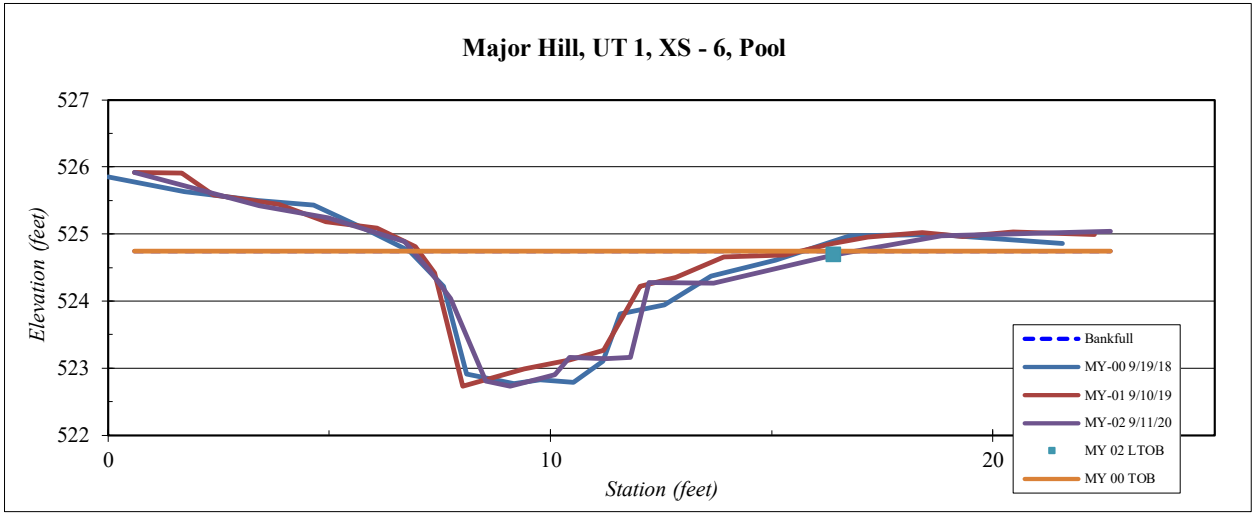


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 6, Pool
Feature	Pool
Date:	9/11/2020
Field Crew:	Perkinson, Radecki

Station	Elevation
0.6	525.9
3.4	525.4
5.0	525.2
6.7	524.9
7.3	524.5
7.7	524.0
8.5	522.8
9.1	522.7
9.8	522.9
10.1	522.9
10.4	523.2
11.2	523.1
11.8	523.2
12.2	524.3
13.7	524.3
16.4	524.7
18.8	525.0
22.6	525.0

SUMMARY DATA	
Bankfull Elevation:	524.8
LTOB Elevation:	524.9
Bankfull Cross-Sectional Area:	9.1
Bankfull Width:	10.0
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	2.0
Low Bank Height:	2.2
Mean Depth at Bankfull:	0.9
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.1

Stream Type	C/E

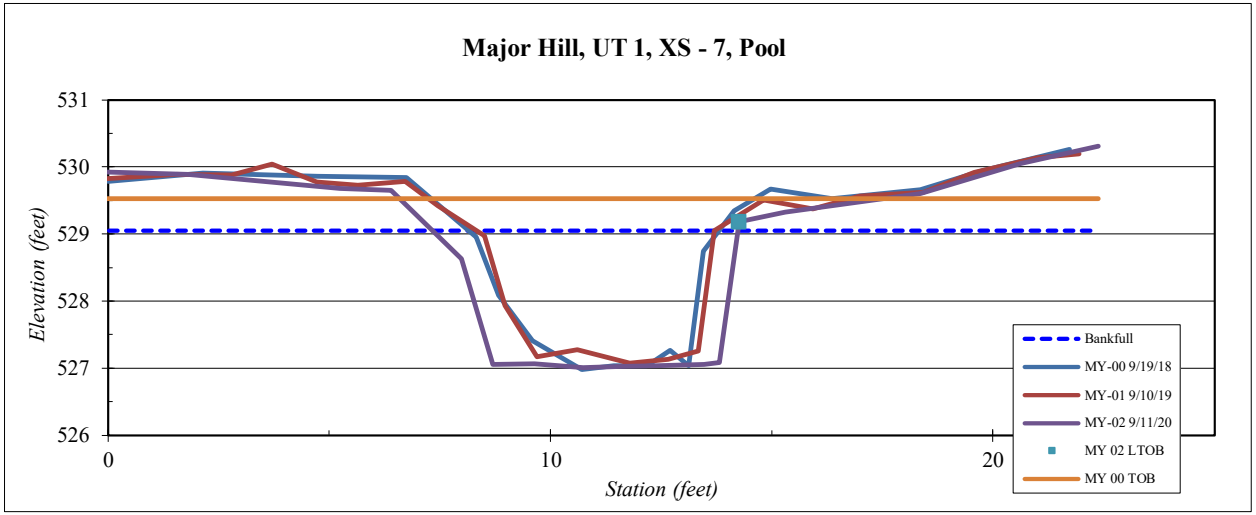


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 7, Pool
Feature	Pool
Date:	9/11/2020
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.8	529.9
1.8	529.9
5.2	529.7
6.4	529.7
8.0	528.6
8.7	527.1
9.6	527.1
10.7	527.0
11.7	527.0
12.4	527.0
13.5	527.1
13.8	527.1
14.3	529.2
15.3	529.3
18.4	529.6
20.6	530.1
22.4	530.3

SUMMARY DATA	
Bankfull Elevation:	529.1
LTOB Elevation:	529.2
Bankfull Cross-Sectional Area:	11.7
Bankfull Width:	6.9
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	2.0
Low Bank Height:	2.2
Mean Depth at Bankfull:	1.7
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.1

Stream Type	C/E

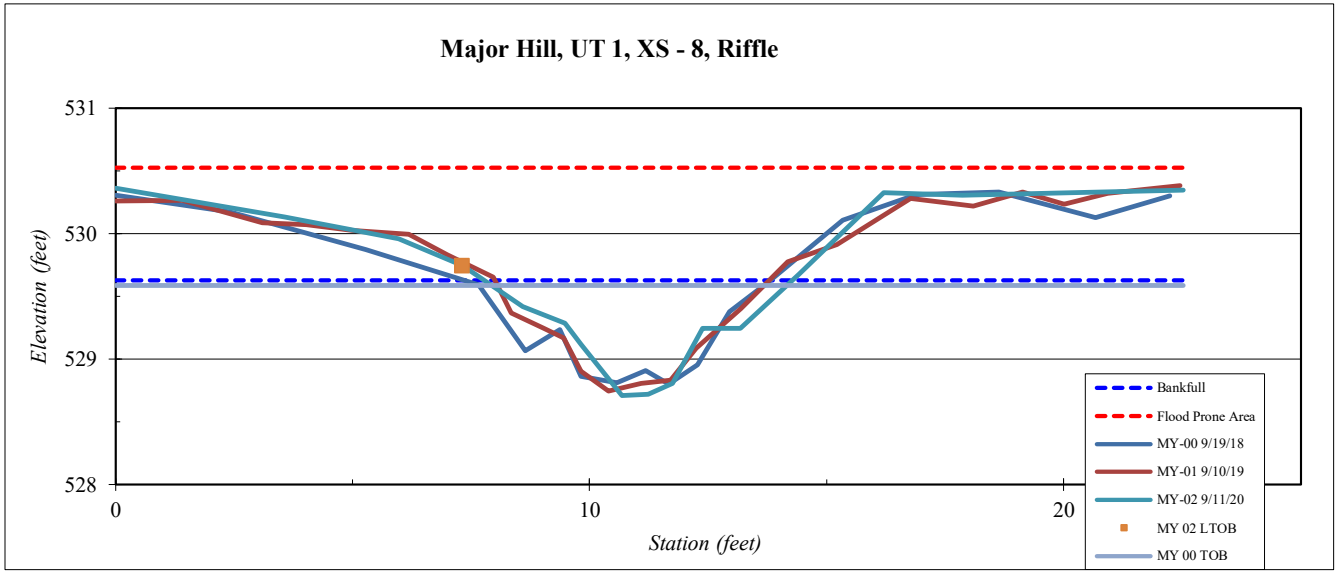


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 8, Riffle
Feature	Riffle
Date:	9/11/2020
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	530.37
3.6	530.13
6.0	529.96
7.3	529.74
8.6	529.42
9.5	529.28
9.8	529.12
10.7	528.71
11.2	528.72
11.7	528.81
12.4	529.24
13.2	529.24
14.4	529.67
16.2	530.33
17.9	530.30
22.5	530.35

SUMMARY DATA	
Bankfull Elevation:	529.6
LTOB Elevation:	529.7
Bankfull Cross-Sectional Area:	3.0
Bankfull Width:	6.5
Flood Prone Area Elevation:	530.5
Flood Prone Width:	23.0
Max Depth at Bankfull:	0.9
Low Bank Height:	1.0
Mean Depth at Bankfull:	0.5
W / D Ratio:	14.1
Entrenchment Ratio:	3.5
Bank Height Ratio:	1.1

Stream Type	C/E

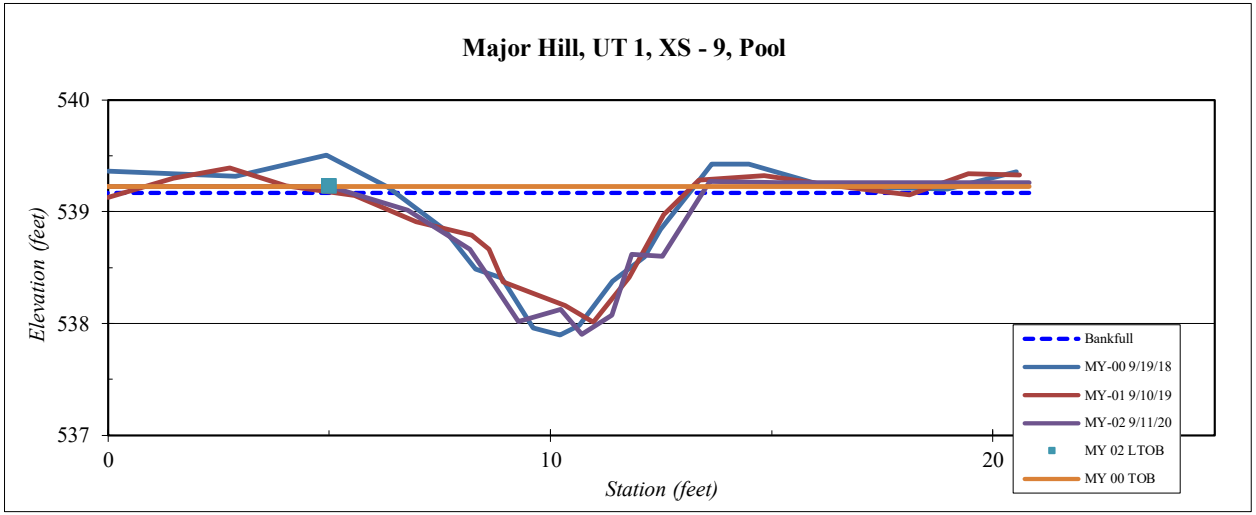


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 9, Pool
Feature	Pool
Date:	9/11/2020
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.2	539.2
2.9	539.2
5.0	539.2
6.8	539.0
8.2	538.7
8.7	538.4
9.3	538.0
10.2	538.1
10.7	537.9
11.4	538.1
11.8	538.6
12.5	538.6
13.6	539.3
15.2	539.3
17.8	539.3
20.8	539.3

SUMMARY DATA	
Bankfull Elevation:	539.2
LTOB Elevation:	539.2
Bankfull Cross-Sectional Area:	4.9
Bankfull Width:	8.0
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.3
Low Bank Height:	1.3
Mean Depth at Bankfull:	0.6
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0

Stream Type	C/E

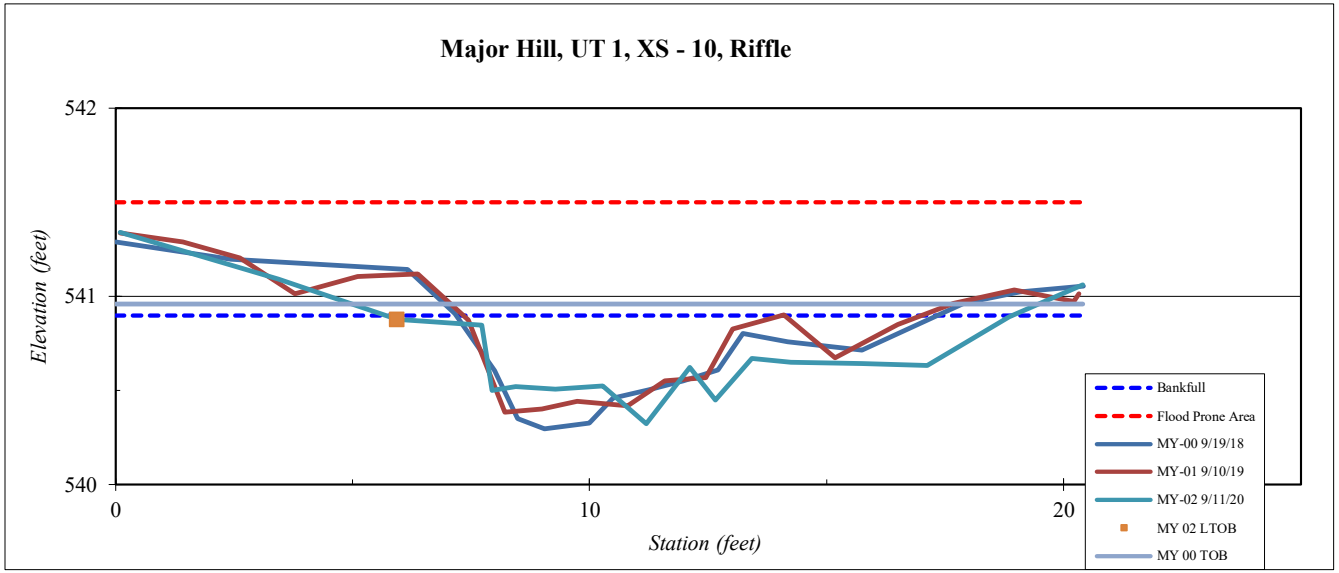


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 10, Riffle
Feature	Riffle
Date:	9/11/2020
Field Crew:	Perkinson, Radecki

Station	Elevation
0.1	541.34
3.4	541.09
5.9	540.88
7.7	540.85
7.9	540.50
8.5	540.52
9.3	540.50
10.3	540.52
11.2	540.33
12.1	540.62
12.7	540.45
13.4	540.67
14.2	540.65
15.7	540.64
17.1	540.63
18.8	540.89
20.4	541.06

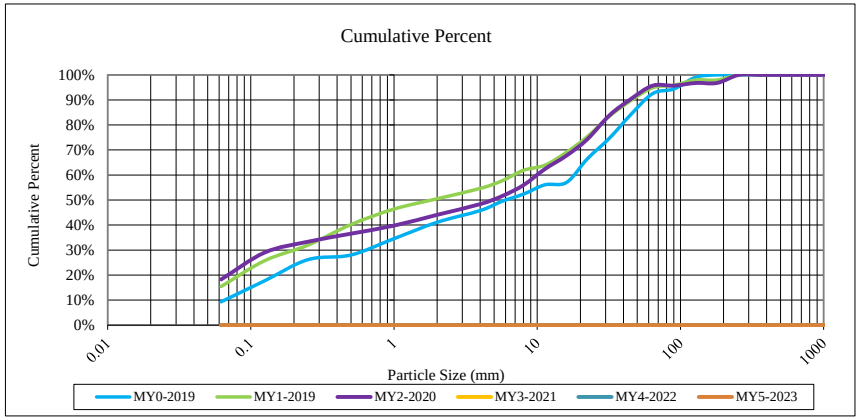
SUMMARY DATA	
Bankfull Elevation:	540.9
LTOB Elevation:	540.9
Bankfull Cross-Sectional Area:	3.5
Bankfull Width:	13.3
Flood Prone Area Elevation:	541.5
Flood Prone Width:	40.0
Max Depth at Bankfull:	0.6
Low Bank Height:	0.6
Mean Depth at Bankfull:	0.3
W / D Ratio:	50.5
Entrenchment Ratio:	3.0
Bank Height Ratio:	1.0

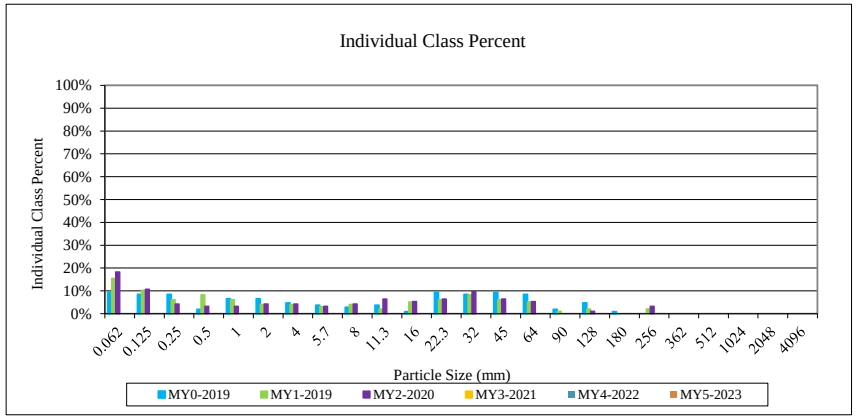
Stream Type	C/E



Project Name: Major Hill					
UT1 Reachwide					
All Features					
			2020		
Description	**Material**	**Size (mm)**	**Total #**	**Item %**	**Cum %**
Silt/Clay	silt/clay	0.062	17	18%	36%
Sand	very fine sand	0.125	10	11%	44%
	fine sand	0.250	4	4%	48%
	medium sand	0.50	3	3%	48%
	coarse sand	1.00	3	3%	56%
	very coarse sand	2.0	4	4%	60%
Gravel	very fine gravel	4.0	4	4%	68%
	fine gravel	5.7	3	3%	72%
	fine gravel	8.0	4	4%	84%
	medium gravel	11.3	6	6%	92%
	medium gravel	16.0	5	5%	92%
	course gravel	22.3	6	6%	96%
	course gravel	32.0	9	10%	96%
	very coarse gravel	45	6	6%	96%
	very coarse gravel	64	5	5%	100%
Cobble	small cobble	90	0	0%	100%
	medium cobble	128	1	1%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	3	3%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	4096	0	0%	100%
TOTAL % of whole count			93	100%	100%

Summary Data	
D50	4.9
D84	32
D95	61





Appendix E.
Hydrology Data

Table 14A. UT1 Upstream Channel Evidence
Table 14B. UT1 Downstream Channel Evidence
Stream Gauge Graphs
Table 15. Verification of Bankfull Events
Table 16. Groundwater Hydrology Data
Groundwater Gauge Graphs

Table 14A. UT1 Upstream Channel Evidence – Major Hill Restoration Site

UT1 Upstream Channel Evidence	Year 1 (2019)	Year 2 (2020)
Max consecutive days channel flow	99	158
Presence of litter and debris (wracking)	Yes	Yes
Leaf litter disturbed or washed away	Yes	Yes
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes	Yes
Sediment deposition and/or scour indicating sediment transport	Yes	Yes
Water staining due to continual presence of water	Yes	Yes
Formation of channel bed and banks	Yes	Yes
Sediment sorting within the primary path of flow	Yes	Yes
Sediment shelving or a natural line impressed on the banks	Yes	Yes
Change in plant community (absence or destruction of terrestrial vegetation and/or transition to species adapted for flow or inundation for a long duration, including hydrophytes)	Yes	Yes
Development of channel pattern (meander bends and/or channel braiding) at natural topographic breaks, woody debris piles, or plant root systems	Yes	Yes
Exposure of woody plant roots within the primary path of flow	No	Yes
Other:		

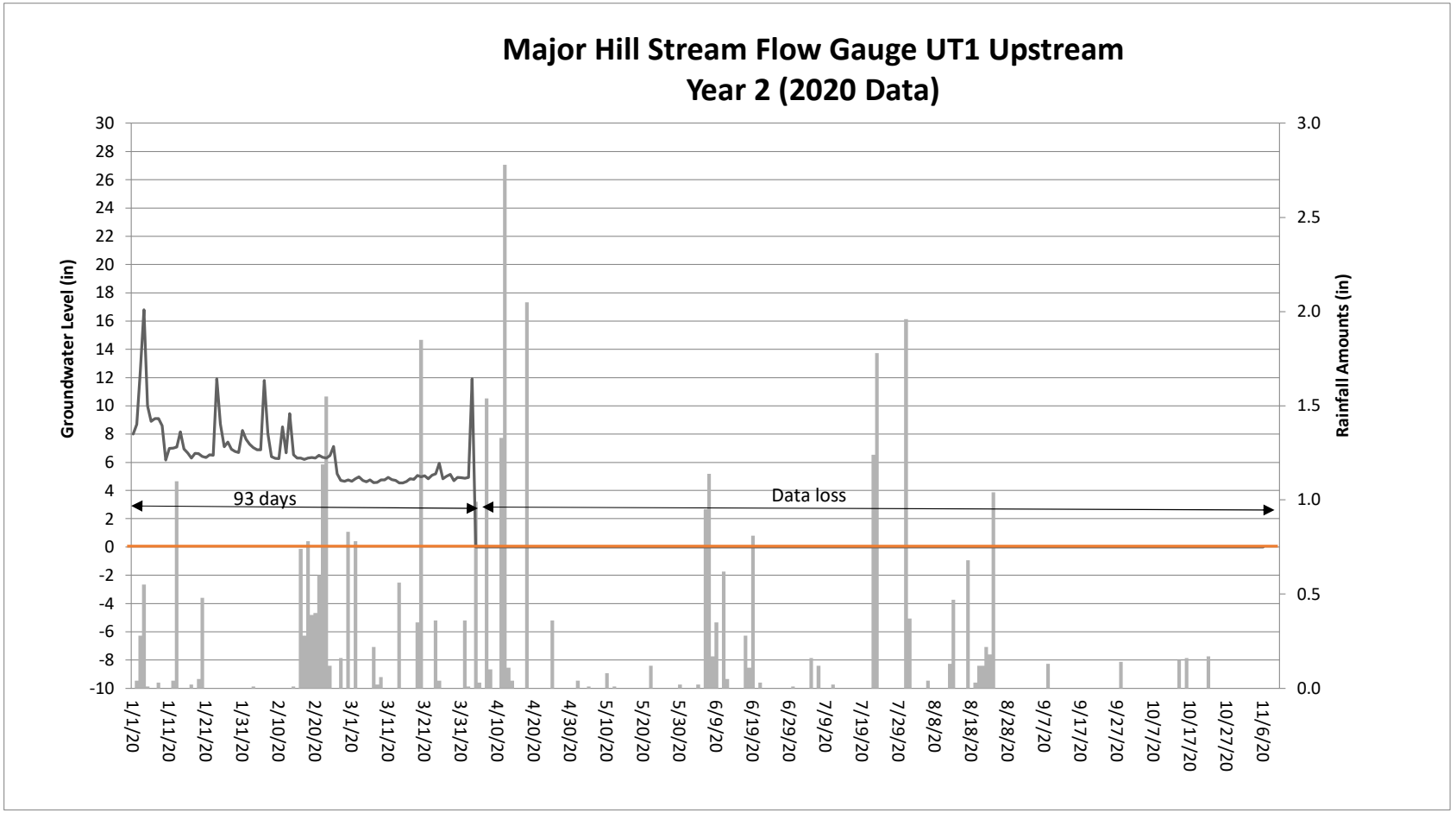

Major Hill Stream Flow Gauge UT1 Upstream
Year 2 (2020 Data)
Groundwater Level (in)
Rainfall Amounts (in)
93 days
Data loss
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/20
1/11/20
1/21/20
1/31/20
2/10/20
2/20/20
3/1/20
3/11/20
3/21/20
3/31/20
4/10/20
4/20/20
4/30/20
5/10/20
5/20/20
5/30/20
6/9/20
6/19/20
6/29/20
7/9/20
7/19/20
7/29/20
8/8/20
8/18/20
8/28/20
9/7/20
9/17/20
9/27/20
10/7/20
10/17/20
10/27/20
11/6/20

Table 14B. UT1 Downstream Channel Evidence – Major Hill Restoration Site

UT1 Downstream Channel Evidence	Year 1 (2019)	Year 2 (2020)
Max consecutive days channel flow	52	236
Presence of litter and debris (wracking)	Yes	Yes
Leaf litter disturbed or washed away	Yes	Yes
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes	Yes
Sediment deposition and/or scour indicating sediment transport	Yes	Yes
Water staining due to continual presence of water	Yes	Yes
Formation of channel bed and banks	Yes	Yes
Sediment sorting within the primary path of flow	Yes	Yes
Sediment shelving or a natural line impressed on the banks	Yes	Yes
Change in plant community (absence or destruction of terrestrial vegetation and/or transition to species adapted for flow or inundation for a long duration, including hydrophytes)	Yes	Yes
Development of channel pattern (meander bends and/or channel braiding) at natural topographic breaks, woody debris piles, or plant root systems	Yes	Yes
Exposure of woody plant roots within the primary path of flow	No	Yes
Other:		Bankfull event documented.

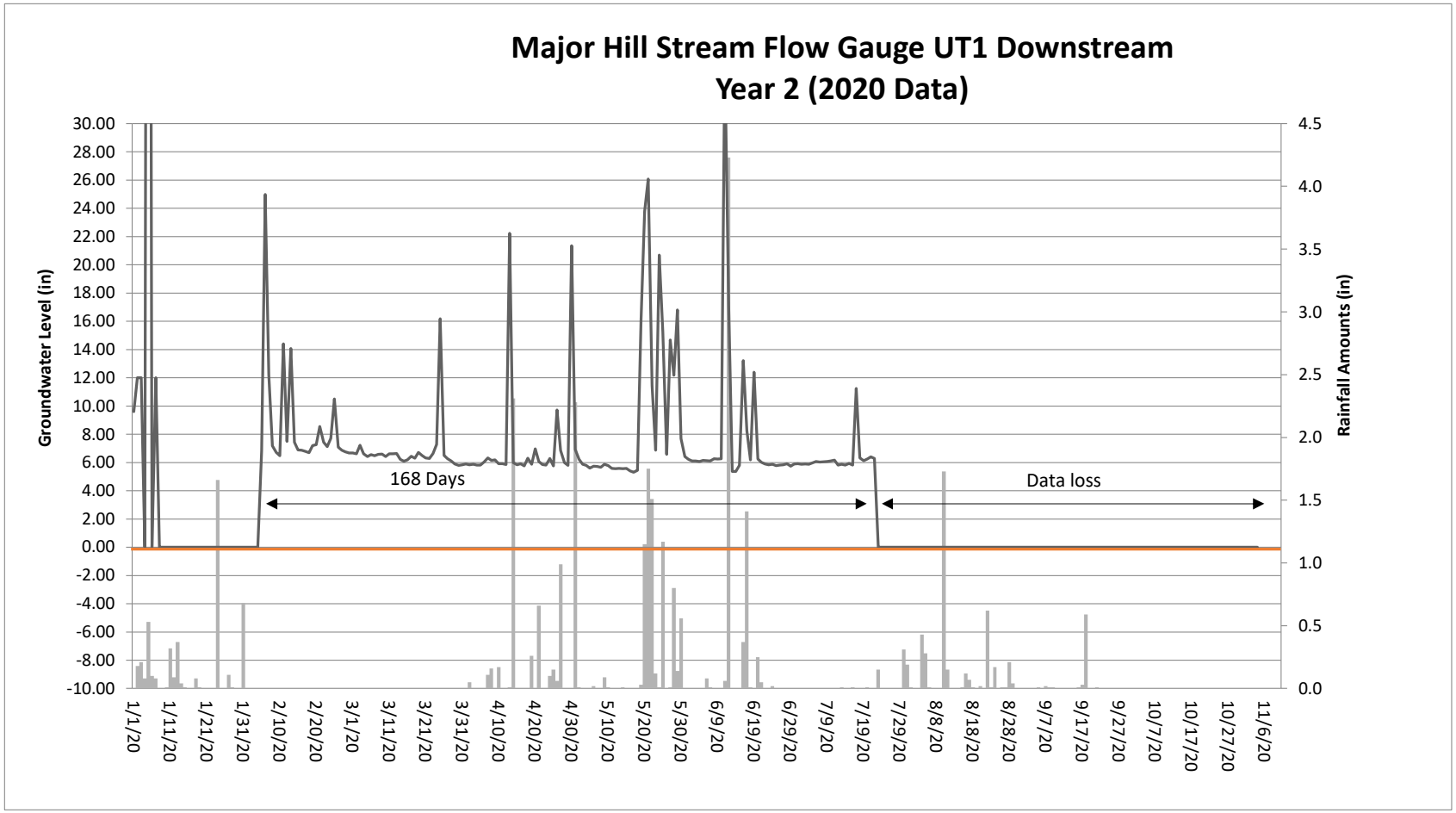

Major Hill Stream Flow Gauge UT1 Downstream
Year 2 (2020 Data)
Groundwater Level (in)
Rainfall Amounts (in)
30.00
28.00
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
168 Days
Data loss
1/1/20
1/11/20
1/21/20
1/31/20
2/10/20
2/20/20
3/1/20
3/11/20
3/21/20
3/31/20
4/10/20
4/20/20
4/30/20
5/10/20
5/20/20
5/30/20
6/9/20
6/19/20
6/29/20
7/9/20
7/19/20
7/29/20
8/8/20
8/18/20
8/28/20
9/7/20
9/17/20
9/27/20
10/7/20
10/17/20
10/27/20
11/6/20

Table 15. Verification of Bankfull Events

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
March 19, 2019	January 13, 2019	A trail camera captured the stream at bankfull after 1.10 inches of rain was documented on January 13, 2019 at an onsite rain gauge.	1
March 19, 2019	February 23, 2019	A trail camera captured the stream at bankfull after 2.74 inches of rain was documented between February 22-23, 2019 at an onsite rain gauge.	2
June 27, 2019	April 13, 2019	Stream gauge data indicates a bankfull event occurred after 4.11 inches of rain was documented between April 12-13, 2019 at an onsite rain gauge.	--
September 9, 2019	July 24, 2019	A bankfull event likely occurred after 3.02 inches of rain was documented between July 23-24, 2019 at an onsite rain gauge.	--
September 9, 2019	August 1, 2019	A bankfull event likely occurred after 1.96 inches of rain was documented on August 1, 2019 at an onsite rain gauge.	--
April 13, 2020	April 13, 2020	A bankfull event was documented via trail camera after approximately 2.31 inches was recorded at an onsite rain gauge	3

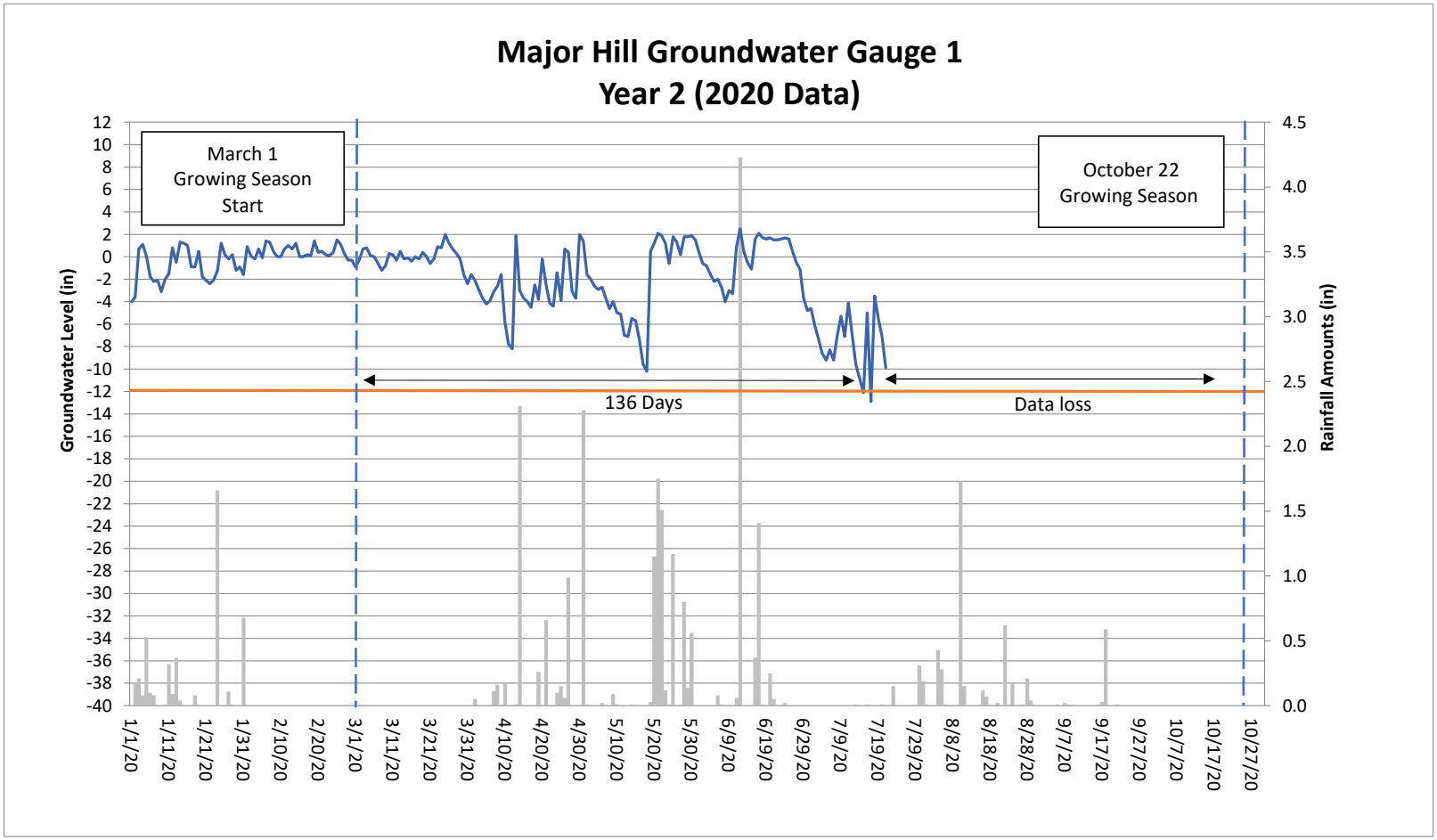
Photo 2

Photo 3

Table 16. Groundwater Hydrology Data – Major Hill Restoration Site

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)	Year 5 (2023)	Year 6 (2024)	Year 7 (2025)
1	No/14 days* 6.0 percent	Yes/136 Days 57.9 percent					
2	No/19 days* 8.1 percent	No/19 days 8.0 percent					
3	Yes/25 days 10.6 percent	Yes/235 days 100 percent					
4	Yes/34 days 14.5 percent	Yes/72 days 30.5 percent					
5	Yes/119 days 50.6 percent	Yes/135 days 57.4 percent					
6	Yes/77 days 32.8 percent	Yes/44 days 18.7 percent					

* These gauges did not meet success criteria due to a data shuttle failure that resulted in the loss of data. Based on rainfall and hydrology data that was not lost, all gauges would have likely met success criteria had the loss of data not occurred.


Major Hill Groundwater Gauge 1
Year 2 (2020 Data)
March 1
Growing Season
Start
October 22
Growing Season
136 Days
Data loss
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/20
1/11/20
1/21/20
1/31/20
2/10/20
2/20/20
3/1/20
3/11/20
3/21/20
3/31/20
4/10/20
4/20/20
4/30/20
5/10/20
5/20/20
5/30/20
6/9/20
6/19/20
6/29/20
7/9/20
7/19/20
7/29/20
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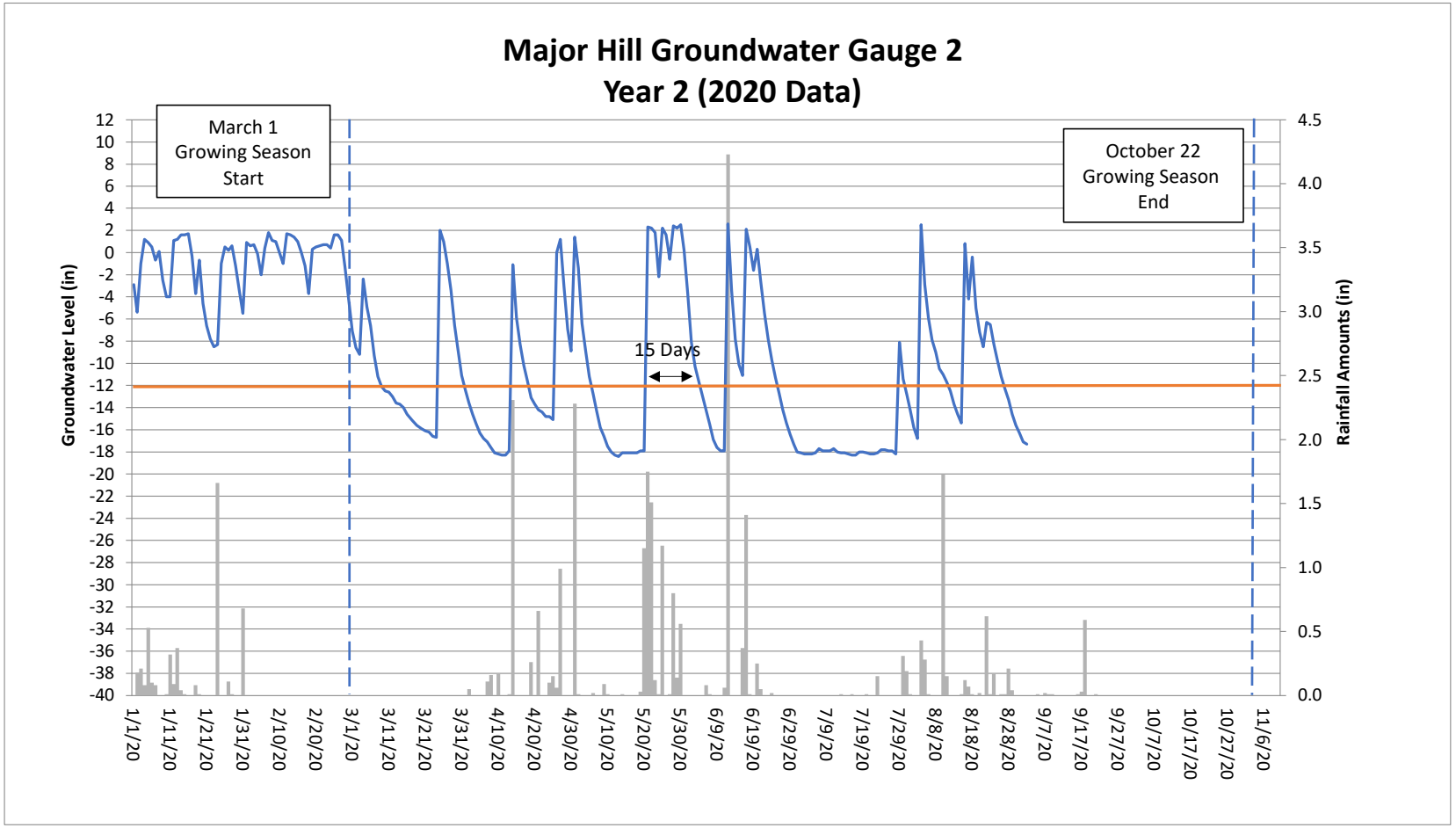
10/17/20
10/27/20


Major Hill Groundwater Gauge 2
Year 2 (2020 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
15 Days
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/20
1/11/20
1/21/20
1/31/20
2/10/20
2/20/20
3/1/20
3/11/20
3/21/20
3/31/20
4/10/20
4/20/20
4/30/20
5/10/20
5/20/20
5/30/20
6/9/20
6/19/20
6/29/20
7/9/20
7/19/20
7/29/20
8/8/20
8/18/20
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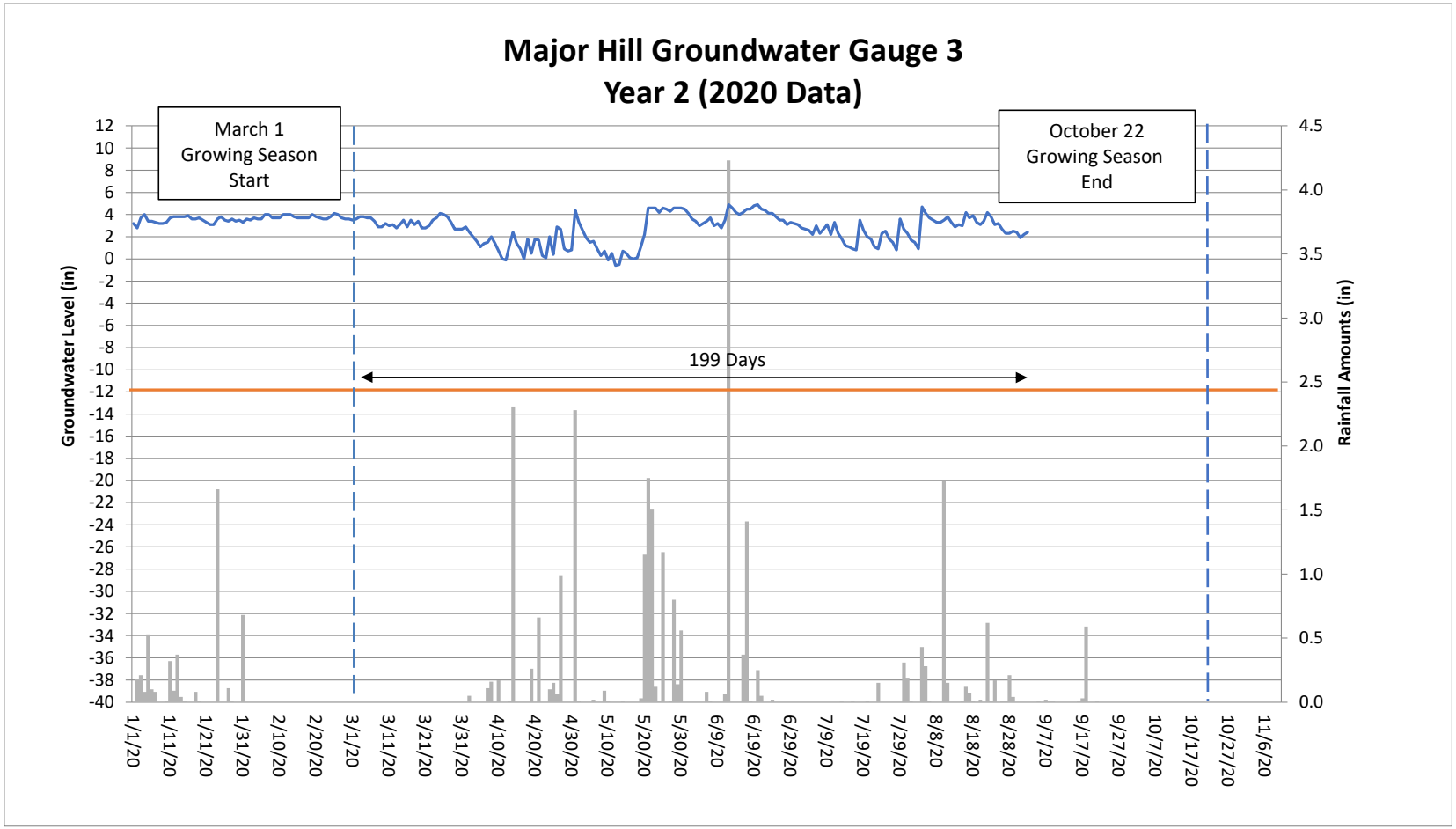
9/27/20
10/7/20
10/17/20
10/27/20
11/6/20


Major Hill Groundwater Gauge 3
Year 2 (2020 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
199 Days
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/20
1/11/20
1/21/20
1/31/20
2/10/20
2/20/20
3/1/20
3/11/20
3/21/20
3/31/20
4/10/20
4/20/20
4/30/20
5/10/20
5/20/20
5/30/20
6/9/20
6/19/20
6/29/20
7/9/20
7/19/20
7/29/20
8/8/20
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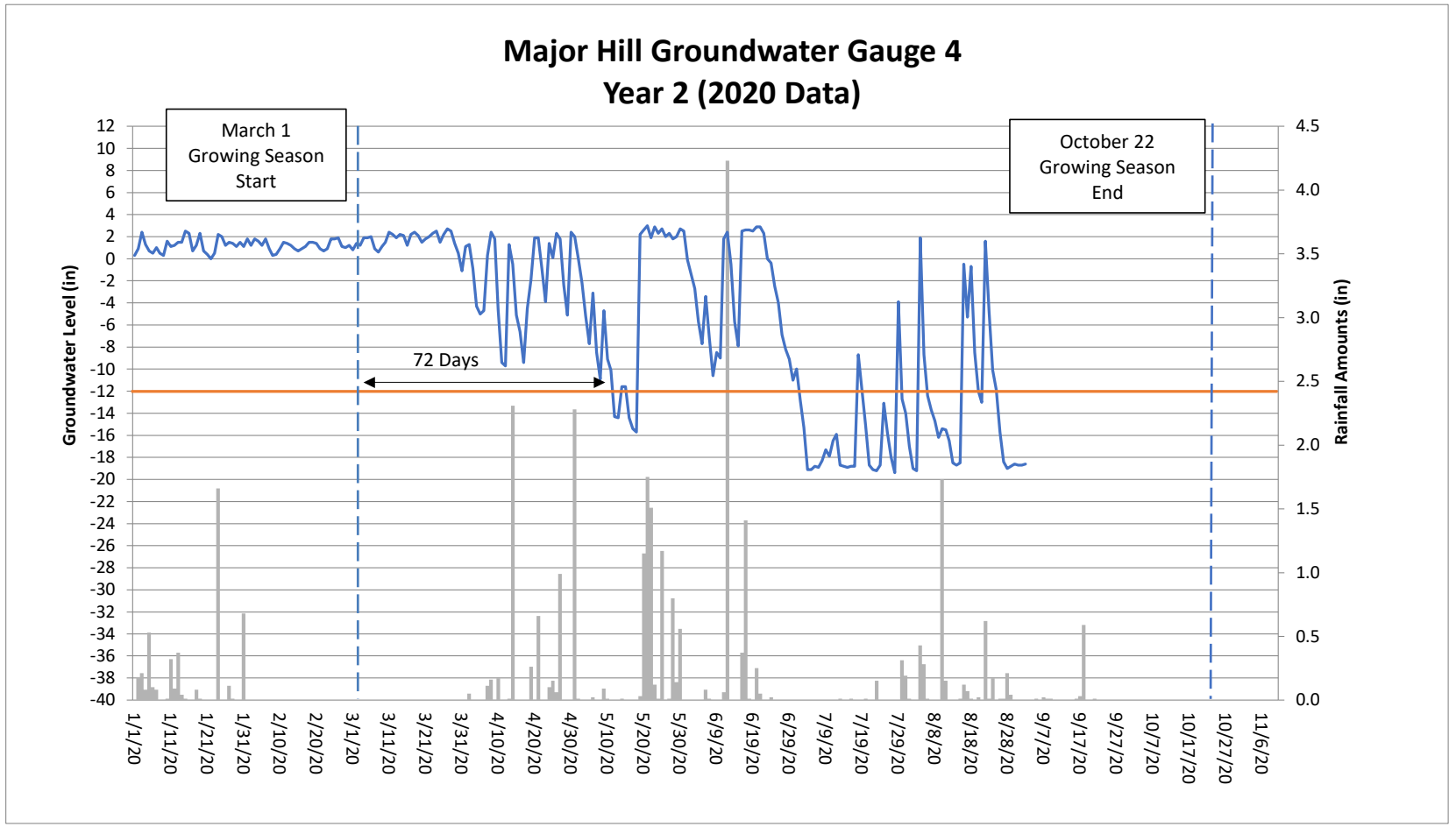
10/27/20
11/6/20


Major Hill Groundwater Gauge 4
Year 2 (2020 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
72 Days
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/20
1/11/20
1/21/20
1/31/20
2/10/20
2/20/20
3/1/20
3/11/20
3/21/20
3/31/20
4/10/20
4/20/20
4/30/20
5/10/20
5/20/20
5/30/20
6/9/20
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7/29/20
8/8/20
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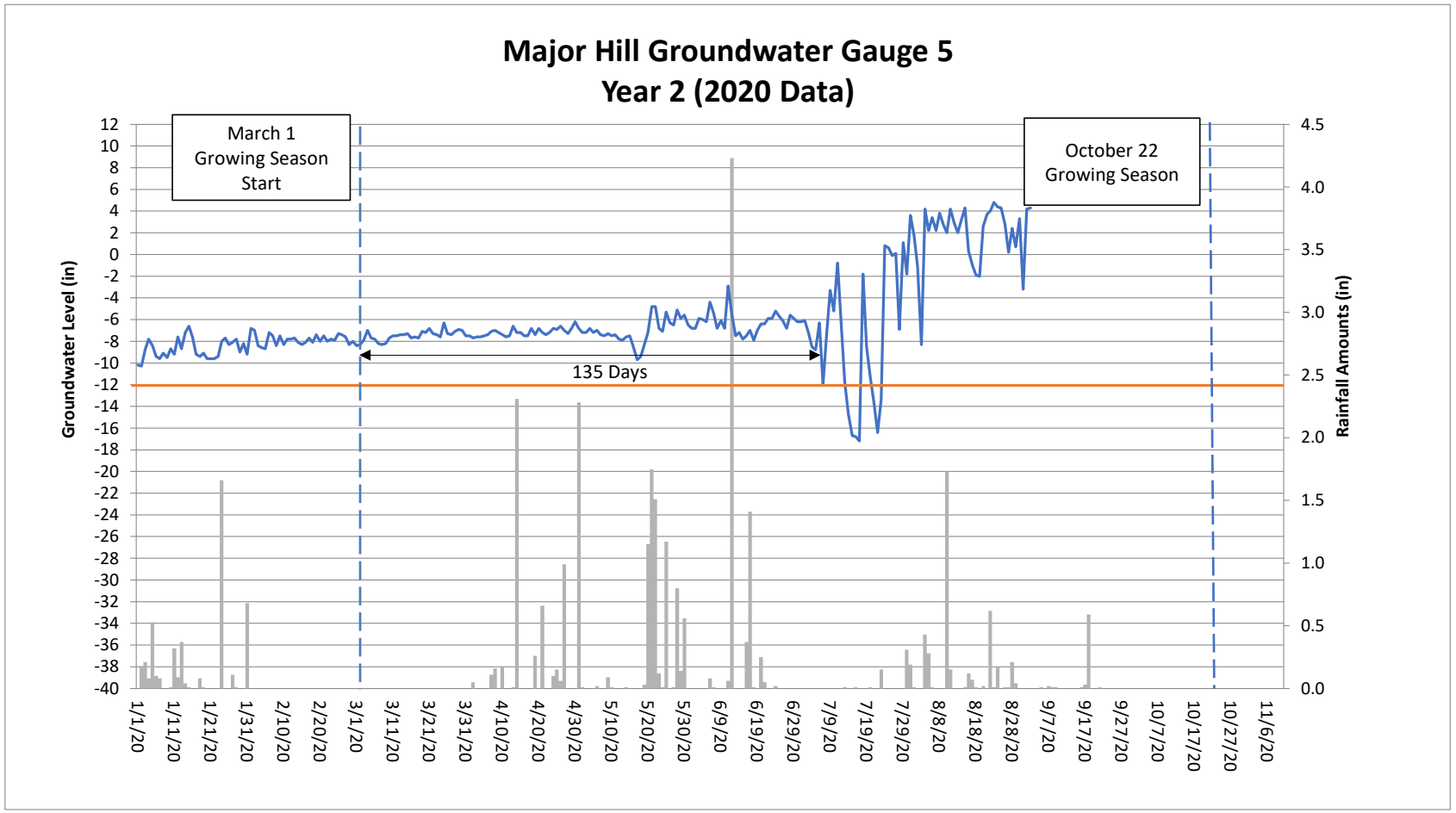
10/27/20
11/6/20


Major Hill Groundwater Gauge 5
Year 2 (2020 Data)
March 1
Growing Season
Start
October 22
Growing Season
135 Days
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/20
1/11/20
1/21/20
1/31/20
2/10/20
2/20/20
3/1/20
3/11/20
3/21/20
3/31/20
4/10/20
4/20/20
4/30/20
5/10/20
5/20/20
5/30/20
6/9/20
6/19/20
6/29/20
7/9/20
7/19/20
7/29/20
8/8/20
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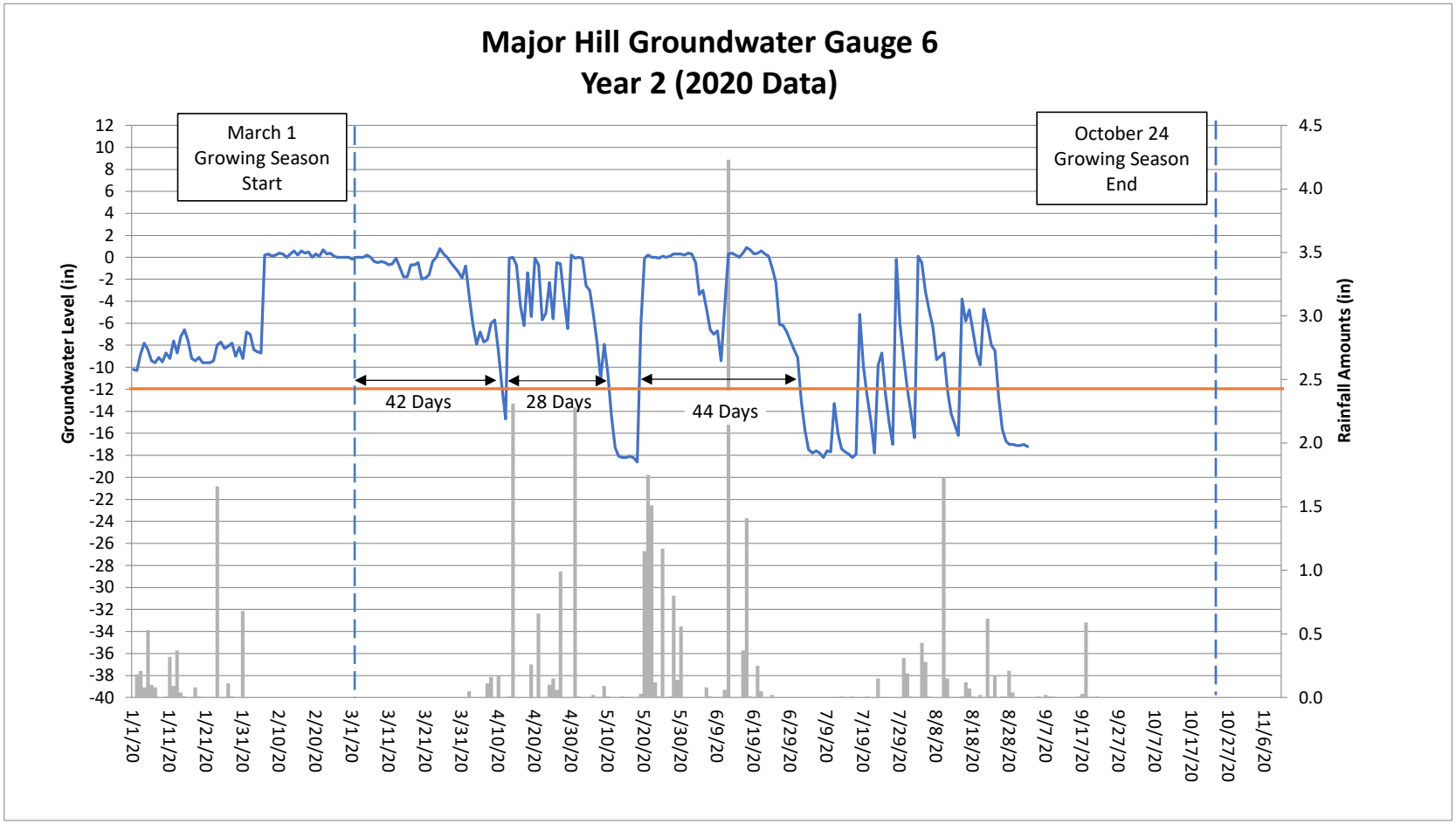
10/27/20
11/6/20


Major Hill Groundwater Gauge 6
Year 2 (2020 Data)
March 1
Growing Season
Start
October 24
Growing Season
End
42 Days
28 Days
44 Days
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/20
1/11/20
1/21/20
1/31/20
2/10/20
2/20/20
3/1/20
3/11/20
3/21/20
3/31/20
4/10/20
4/20/20
4/30/20
5/10/20
5/20/20
5/30/20
6/9/20
6/19/20
6/29/20
7/9/20
7/19/20
7/29/20
8/8/20
8/18/20
8/28/20
9/7/20
9/17/20
9/27/20
10/7/20
10/17/20
10/27/20
11/6/20

Appendix F.

Riparian Buffer Year 2 (2020) Monitoring Report

RIPARIAN BUFFER MY2 (2020) MONITORING REPORT
MAJOR HILL MITIGATION SITE
Alamance County, North Carolina

DMS Project ID No. 100015
Full Delivery Contract No. 7193
USACE Action ID No. SAW-2017-01472
DWR No. 17-0921
RFP No. 16-006990

Cape Fear River Basin – Haw River Arm
Cataloging Unit 03030002

Prepared for:

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF MITIGATION SERVICES
1652 MAIL SERVICE CENTER
RALEIGH, NORTH CAROLINA 27699-1652

January 2021

This project with conforms with the North Carolina consolidated buffer mitigation rule 15A NCAC 02B .0295, effective November 1, 2015 and the Jordan Lake Buffer Protection Rule (15A NCAC 02B .0267 & 15A NCAC 02B .0268)

Table of Contents

1.0 MITIGATION PROJECT SUMMARY 1
2.0 REGULATORY CONSIDERATIONS 2
3.0 RIPARIAN RESTORATION, ENHANCEMENT, & PRESERVATION PLAN 2
3.1 Riparian Area Restoration Activities 2
3.1.1 Site Preparation 2
3.1.2 Planting 4
3.2 Riparian Buffer Enhancement via Cattle Exclusion Activities 4
3.3 Riparian Buffer Preservation Activities 5
3.4 Marsh Treatment Area 5
4.0 ANNUAL MONITORING 5
4.1 Monitoring 5
4.2 Performance Standards 6
4.3 Results and Discussion 6
4.4 Maintenance and Management 7
5.0 REFERENCES 9

Tables

Table 1. Buffer Project Attributes 1
Table 2. Buffer Project Areas and Assets 3
Table 3. Planted Bare Root Woody Vegetation 4
Table 4. Riparian Buffer Monitoring 5
Table 5. Riparian Buffer Vegetation Totals 7
Table 6. Total Stems by Plot and Species 8

Attachments

Attachment 1
Figure A. Riparian Buffer Asset Map
Figure B. Riparian Buffer Planting Map

1.0 MITIGATION PROJECT SUMMARY

The Major Hill Stream and Wetland Mitigation Site (hereafter referred to as the "Site") encompasses 16.7 acres along warm water, unnamed tributaries to Pine Hill Branch. The Site is located approximately 3.5 miles southeast of Snow Camp and 6 miles north of Silk Hope in southern Alamance County near the Chatham County line. Project attributes are included in the following table.

Table 1. Buffer Project Attributes

Project Name	Major Hill
Hydrologic Unit Code	3030002050050
River Basin	Cape Fear
Geographic Location (Lat, Long)	35.873206, -79.360906
Site Protection Instrument (DB, PG)	(2789, 896), (2514, 756), (3143, 270), (3150, 920)
Total Credits (BMU)	402,837
Types of Credits	Riparian Buffer Restoration, Enhancement, & Preservation
Mitigation Plan Date	Apr-18
Initial Planting Date	Dec 2018-Jan 2019
Baseline Report Date	Mar-19
MY1 Report Date	Nov-19
MY2 Report Date	Jan-21
MY3 Report Date	
MY4 Report Date	
MY5 Report Date	

The Site drainage area is primarily composed of pasture, forest, agriculture land, and sparse residential property. Impervious surfaces account for less than five percent of the upstream land surface.

Prior to construction, Site land use consisted of pasture, hayfields, disturbed forest, and agricultural land used for livestock grazing and hay production. Livestock had unrestricted access to Site streams, and stream banks were eroded vertically and laterally and received extensive sediment and nutrient inputs. Riparian zones in the upper reaches of UT 1 were primarily composed of herbaceous vegetation that was sparse and disturbed due to livestock grazing, bush hogging, and regular land-management activities. The downstream reaches of UT 1 and all of UT 3 were primarily wooded with livestock disturbance to stream channels. UT 2 was the lone tributary not subject to continuous, unrestricted livestock access. Riparian areas immediately adjacent to UT 2 were forested with a fence to protect this area from livestock access.

The riparian areas were restored in concurrence with the Major Hill Stream and Wetland Mitigation Site (NC DMS Project ID 10015, SAW-2017-01472) and involved restoring riparian buffers adjacent to restored streams to help reduce non-point source contaminant discharges to downstream waters in the Haw River sub-watershed of Jordan Lake. All riparian areas were assessed by DWR (Katie Merritt and Sue Homewood) during an onsite visit February 20th, 2018 to determine viability for buffer mitigation.

The Site is protected with a permanent conservation easement. Riparian restoration, enhancement, and preservation area widths adjacent to restored streams extend out to a maximum of 200 feet from the top of

stream banks with a minimum width of 50 from the top of banks. Riparian buffer enhancement and preservation credits generated on this Site are allowed pursuant to 15A NCAC 02B .0295 (o). No riparian restoration areas that are less than 20 feet wide from Top of Banks are used to generate riparian buffer credit.

Riparian buffer mitigation credit was not generated in areas that are generating wetland mitigation credit.

2.0 REGULATORY CONSIDERATIONS

Credit determination for this Site follows the North Carolina consolidated buffer mitigation rule 15A NCAC 02B .0295, effective November 1, 2015 (see Table 2 on the following page and Figure A, Attachment 1).

3.0 RIPARIAN RESTORATION, ENHANCEMENT, & PRESERVATION PLAN

This Site was also proposed as a stream and wetland mitigation project; therefore, restoration of riparian areas was accomplished through the goals and methods outlined by the *Major Hill Stream and Wetland Mitigation Plan*. All applicable federal, state, and local documentation, permits, and/or authorizations were acquired as part of implementing the above-mentioned mitigation plan.

Primary goals focused on 1) improving water quality, 2) enhancing flood attenuation and hydrology, 3) improving aquatic resources, and 4) restoring riparian habitat. Completed mitigation provides floodplain connectivity, floodplain resistance, stream stability, sediment transport, surface and subsurface storage and retention, in-stream habitat, riparian habitat and structure, thermal regulation, floodplain biogeochemical processing, and pollutant filtration as well as remove sources of pollutants. The riparian area will be restored through the revegetation of native plant communities.

3.1 Riparian Area Restoration Activities

3.1.1 Site Preparation

Soil grading occurred during stream restoration activities. Topsoils were stockpiled during construction activities and spread on the soil surface once critical subgrade was established. The replaced topsoil will serve as a viable growing medium for community restoration to provide nutrients and aid in the survival of planted species.

Farm Pond Removal

To complete the stream and wetland restoration activities and subsequent riparian buffer restoration, the removal of a small farm pond, ~0.58 acres occurred. Stream, wetland and riparian area restoration within the abandoned pond included 1) notching the dam to dewater; 2) removal of the dam to the elevation of the adjacent floodplain; 3) excavating sediment that is unsuitable for channel bank construction; 4) backfilling areas of sediment removed with soil suitable for channel construction (as necessary); 5) excavation of the design channel, 6) stabilization of the channel with coir matting, seed, and mulch; and 7) installation of structures.

Table 2. Buffer Project Areas and Assets

RIPARIAN BUFFER (15A NCAC 02B.0295)											If Converted to Nutrient Offset	
Location	**Jurisdictional Streams**	**Restoration Type**	**Reach ID/ Component**	**Buffer Width (ft)**	**Creditable Area (sf)***	**Initial Credit Ratio (x:1)**	**% Full Credit**	**Final Credit Ratio (x:1)**	**Riparian Buffer Credits (BMU)**	**Convertible to Nutrient Offset (Yes or No)**	**Nutrient Offset: N (lbs)**	**Nutrient Offset: P (lbs)**
Rural	Subject & Nonsubject	Restoration	1	0-100	213,290	1	100%	1.00000	213,290.000	Yes	11129.775	716.842
Rural	Subject & Nonsubject	Restoration	2	101-200	40,976	1	33%	3.03030	13,522.094	Yes	2138.186	137.715
Rural	Subject	Enhancement	3	0-100	341,433	2	100%	2.00000	170,716.500	No	0.000	0.000
				SUBTOTALS	**595,699**				**397,528.594**		**13,267.960**	**854.558**
			ELIGIBLE PRESERVATION AREA		**198,566**							
Location	**Jurisdictional Streams**	**Restoration Type**	**Reach ID/ Component**	**Buffer Width (ft)**	**Creditable Area (sf)***	**Initial Credit Ratio (x:1)**	**% Full Credit**	**Final Credit Ratio (x:1)**	**Riparian Buffer Credits (BMU)**			
Rural	Nonsubject	Preservation	4	0-100	25,614	5	100%	5.00000	5,122.800			
Rural	Nonsubject	Preservation	5	101-200	2,814	5	33%	15.15152	185.724			
				SUBTOTALS	**28,428**				**5,308.524**			
				TOTALS	**624,127**				**402,837.117**			

**Area eligible for preservation may be no more than 25% of total area, where total area is back-calculated with the equation R+E/0.75.*

**Buffers must be at minimum 20' wide for riparian buffer credit, buffers must be 50' wide for nutrient offset credit*

**When preservation areas exceed the total eligible preservation area, select the areas with the best credit ratios as the creditable areas.*

3.1.2 Planting

Bare-root seedlings within the Piedmont Alluvial and Dry-Mesic Oak-Hickory Forests will be planted at a density of approximately 680 stems per acre on 8-foot centers. Species in the stream-side assemblage and Marsh Wetland Treatment Areas were planted at a density of approximately 2720 stems per acre on 4-foot centers. The following table summarizes planted bare root stems within the Site.

Table 3. Planted Bare Root Woody Vegetation

Species	Piedmont/Low Mountain Alluvial Forest	Dry-Mesic Oak/Hickory Forest	Marsh Treatment Wetland	Streamside Assemblage	Total
Acres	**1.1**	**5.5**	**0.01**	**1.5**	**8.11**
Alnus serrulata			5	20	25
Asimina triloba				200	200
Betula nigra	100			200	300
Carpinus caroliniana		600			600
Cephalanthus occidentalis			5	20	25
Cercis canadensis		500			500
Cornus amomum	95		5	800	900
Diospyros virginiana		450			450
Fraxinus americana		100			100
Fraxinus pennsylvanica	150			750	900
Liriodendron tulipifera	75				75
Nyssa sylvatia		600			600
Platanus occidentalis	120			780	900
Quercus nigra	110	790		500	1,400
Quercus phellos	100	700		400	1,200
*Salix nigra**				400*	400
Sambucus canadensis			11	14	25
TOTALS	750	3,740	26	4,084	**8,600**
Stems/Acre	682	680	2600	2722	**1060**

*Live stakes of *Salix nigra* were planted; all other planted species were planted as bare root plants.

3.2 Riparian Buffer Enhancement via Cattle Exclusion Activities

Riparian buffer enhancement included permanently protecting existing riparian buffer from livestock via exclusionary fencing, cutting, clearing, filling, grading, and any similar activities that would affect the functionality of the riparian buffer. These areas are defined primarily as disturbed mixed hardwoods. Buffer credits sought in the enhancement area are allowed under 15A NCAC 02B .0295 (o)(6). The enhancement

area extends a maximum of 200 feet from the top of the bank with a minimum width of 20 from top of banks.

A small portion of UT-3 is generating riparian buffer enhancement credit from only one side of the stream. Prior to construction, cattle had access to the entire area; however, the only access point was from the pasture on the northern side of the stream, the Parcel owned by Mr. Lamm. Once fencing was installed to prevent cattle access from Mr. Lamm's parcel to the stream, cattle will no longer be able to access the south side of the stream. This action will result in compliance with 15A NCAC 02B .0295 (o)(6), which states that the permanent exclusion of grazing livestock must be done such that the livestock are fenced out of the stream and its adjacent buffer. The southern parcel, which is not apart of the conservation easement, is owned by the Caviness family and is a single-family home. Cattle will not be grazing within their parcel post construction.

3.3 Riparian Buffer Preservation Activities

Riparian buffer preservation includes permanently protecting existing riparian buffers from cutting, clearing, filling, grading, and any similar activities that would affect the functionality of the riparian buffer. Areas specified for Preservation at the Site, in accordance with 15A NCAC 02B .0295, are defined primarily as mixed hardwoods, with the number of high-value species above 200 per acre. They are areas where livestock were fenced out prior to construction with little or no historical livestock access.

3.4 Marsh Treatment Area

A marsh treatment area was constructed to intercept surface waters draining through agricultural areas before discharging into UT1. The marsh treatment area is excluded from credit calculations.

4.0 ANNUAL MONITORING

4.1 Monitoring

Eight vegetation monitoring plots (10-meter by 10-meter) were installed within the Site as per guidelines established in *CVS-EEP Protocol for Recording Vegetation*, *Version 4.2* (Lee et al. 2008); this covers 3.4% of the area generating riparian buffer restoration credit. Vegetation monitoring will occur annually in the fall (between September and November), prior to the loss of leaves for a period of five monitoring years following planting. Parameters to be monitored include species composition and species density. Visual observations of the percent cover of shrub and herbaceous species will also be documented by photograph. In addition, inspections for beaver and other potential nuisance species will occur throughout the course of the monitoring period.

The following table outlines riparian buffer monitoring for this project; monitoring parameter descriptions follow.

Table 4. Riparian Buffer Monitoring

Required	Parameter	Quantity	Frequency	Notes
Yes	Vegetation	Eight (8) plots located across all restored buffer zones.	Annual	Vegetation will be monitored for five years or until performance standards are met. Visual monitoring of the site will be done all five years. Analysis of vegetation will be recorded using level 2 CVS Monitoring protocol.
Yes	Project Boundary	NA	Annual	Locations of fence damage, vegetation damage, boundary encroachments, etc. will be mapped.

4.2 Performance Standards

Performance standards were established to verify that the vegetation component supports community elements necessary for forest development and the maintenance of diffuse flow through the riparian buffer in accordance with North Carolina Division of Water Resources Administrative Code 15A NCAC 02B.0295 (Mitigation Program Requirements for Protection and Maintenance of Riparian Buffers). Performance standards are dependent upon the density and growth of at least four native hardwood tree species where no one species is greater than 50% of the stems. After five years of monitoring, an average density of 260 woody stems per acre, including planted shrubs (silky dogwood and blueberry), must be surviving, and diffuse flow maintained. 15A NCAC 02b .0295 (2)(E) dictates that monitoring for planted stems would also include the health of planted stems. Level 2 CVS monitoring protocol requires the vigor, a determinant of health, of a monitored stem be recorded. If requested, RS will make available during the monitoring years, planted stem health, e.g. vigor.

4.3 Results and Discussion

In early January 2020, a winter-time visual assessment of the site was performed, and it was determined that although Year 1 (2019) vegetation data, including random transects, showed a high density of trees, a light supplemental planting would help ensure the long-term success in several areas. On January 31, 2020, three areas that visually exhibited low stem density and/or poor vigor were supplementally planted (Figure 2, Appendix B). During the supplemental planting effort approximately 370 stems were planted across 1.20 acres (approximately 300 stems per acre). As the planting was designated for visual purposes and was not an effort to increase stem density data, no stems were planted within permanent vegetation plots. The following table lists species included in the supplemental planting list. Preparation included the application of 100 lbs of lime, 50 lbs of fertilizer, and 3 lbs of seed to stabilize bare areas (see Figure A for planting areas).

Supplemental Planting Species List

Species	Number of Stems
Tag Alder (*Alnus serrulata*)	20
Chinkapin (*Castanea pumila*)	20
Hackberry (*Celtis occidentalis*)	50
Hawthorn (*Crataegus marshallii*)	20
Crab Apple (*Malus angustifolia*)	50
Red Mulberry (*Morus rubra*)	100
Sycamore (*Platanus occidentalis*)	50
Shumard Oak (*Quercus shumardii*)	50
Total	**370**

Based on the number of stems counted, average densities were measured at 467 hardwood tree stems per acre (excluding livestakes, shrubs, pines, and vines) at year 2 (2020). In addition, all plots, including 3 temporary transects within the supplemental planting areas, met success criteria. The following Table 5 summarizes riparian buffer success criteria and Table 6 summarizes all permanent vegetation plot data by species, plot, and year. Vegetation plot photographs are included in Appendix B of the *Major Hill Stream and Wetland Mitigation Site Year 2 (2020) Annual Monitoring Report*.

Table 5. Riparian Buffer Vegetation Totals

Plot #	Success Criteria Met?	MY 2 (2020) Planted Stems/Ac	MY 2 (2020) All Stems/Ac
1	Yes	202	323
2	Yes	323	323
3	Yes	364	364
4	Yes	242	283
5	Yes	323	323
6	Yes	485	485
7	Yes	445	445
8	Yes	647	647
T-1	Yes	--	567
T-2	Yes	--	364
T-3	Yes	--	1012
Average Planted Stems/Acre	**Yes**	**379**	**467**

4.4 Maintenance and Management

No maintenance or management activities are currently planned for the coming year, and no remedial action activities are necessary at this time.

Table 6. Total Stems by Plot and Species
Project Code 17.009. Project Name: Major Hill

			Current Plot Data (MY2 2020)																							Annual Means								
			17.009-01-0001			17.009-01-0002			17.009-01-0003			17.009-01-0004			17.009-01-0005			17.009-01-0006			17.009-01-0007			17.009-01-0008			MY2 (2020)			MY1 (2019)*			MY0 (2019)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree																													3			
Asimina triloba	pawpaw	Tree										1	1	1							1	1	1				2	2	2	3	3	3	7	7	7
Betula nigra	river birch	Tree										1	1	1	1	1	1							2	2	2	4	4	4	6	6	6	9	9	9
Carpinus caroliniana	American hornbeam	Tree	1	1	1	3	3	3	4	4	4							2	2	2							10	10	10	14	14	14	5	5	5
Cercis canadensis	eastern redbud	Tree							2	2	2													3	3	3	5	5	5	8	8	8	14	14	14
Cornus amomum	silky dogwood	Shrub																												2	2	2	1	1	1
Diospyros virginiana	common persimmon	Tree			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				4	4	4	9	9	10	9	9	9	5	5	5
Fraxinus	ash	Tree																						1	1	1	1	1	1	1	1	1	1	1	1
Fraxinus americana	white ash	Tree																3	3	3				2	2	2	5	5	5	5	5	5	5	5	5
Fraxinus pennsylvanica	green ash	Tree	2	2	4							1	1	2	1	1	1				1	1	1				5	5	8	4	4	4	3	3	3
Liquidambar styraciflua	sweetgum	Tree																													2			
Liriodendron tulipifera	tuliptree	Tree	1	1	1																						1	1	1	1	1	1	5	5	5
Nyssa sylvatica	blackgum	Tree				1	1	1	1	1	1																2	2	2	4	4	4	10	10	10
Platanus occidentalis	American sycamore	Tree				1	1	1							1	1	1	2	2	2	1	1	1				5	5	5	7	7	8	7	7	7
Quercus	oak	Tree	1	1	1																1	1	1				2	2	2	3	3	3	23	23	23
Quercus nigra	water oak	Tree										2	2	2	4	4	4	2	2	2	3	3	3	1	1	1	12	12	12	20	20	20	10	10	10
Quercus phellos	willow oak	Tree				2	2	2	1	1	1							2	2	2	4	4	4	3	3	3	12	12	12	16	16	16	18	18	18
Unknown		Shrub or Tree																															6	6	6
		Stem count	5	5	8	8	8	8	9	9	9	6	6	7	8	8	8	12	12	12	11	11	11	16	16	16	75	75	79	103	103	109	129	129	129
		size (ares)	1			1			1			1			1			1			1			1			8			8			8		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.20			0.20			0.20		
		Species count	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	7	7	7	14	14	14	15	15	17	16	16	16
		Stems per ACRE	202.3	202.3	323.7	323.7	323.7	323.7	364.2	364.2	364.2	242.8	242.8	283.3	323.7	323.7	323.7	485.6	485.6	485.6	445.2	445.2	445.2	647.5	647.5	647.5	379.4	379.4	399.6	521	521	551.4	652.6	652.6	652.6

*The increases in stem counts of species such as *Carpinus caroliniana* , *Diospyros virginiana* , and *Quercus nigra* are due to mis-identification during MY0 (dormant season) monitoring and/or refinement in identification during MY1 monitoring.

Color for Density
Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%

PnoLS = Planted excluding livestakes
P-all = Planting including livestakes
T = All planted and natural recruits including livestakes
T includes natural recruits

5.0 REFERENCES

Jordan Lake Water Supply Watershed Buffer Rules 15A NCAC 02B .0267, 15A NCAC 02B .0268, and 15A NCAC 02B .0295

Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2008. CVS-EEP Protocol for Recording Vegetation, Level 1-2 Plot Version 4.2. Ecosystem Enhancement Program, North Carolina Department of Environment and Natural Resources.

Schafale, M.P. and A.S. Weakley. 1990. *Classification of the Natural Communities of North Carolina: Third Approximation*. North Carolina Natural Heritage Program, Division of Parks and Recreation, N.C. Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.

ATTACHMENT 1

Figure A. Riparian Buffer Asset Map
Figure B. Riparian Buffer Planting Map

Legend

- Easement
- New Fencing Installed for Cattle Exclusion
- Existing Fencing Left in Place for Cattle Exclusion
- Fencing Removed/Reworked for Cattle Exclusion
- Stream Asbuilt TOB-TOB
- Marsh Treatment Area
- Plot Origins
- CVS Plots Meeting Success Criteria MY2
- Vegetation Transects Meeting Success Criteria MY2
- Supplemental Planting Area
- Wetland Restoration
- Wetland Enhancement

Riparian Buffer Mitigation Type

- TOB - 100 ft. Restoration (1:1) - 213,290 sq ft
- 101 ft. - 200 ft. Restoration (1:1 but 33% credit per Rule) - 40,976 sq ft
- TOB - 100 ft. Enhancement (2:1 Cattle Ex. per Rule) - 341,433 sq ft
- TOB - 100 ft. Preservation (Non-Subject Stream 5:1) - 25,614 sq ft
- 101 ft. - 200 ft. Preservation (Non-Subject Stream 5:1 and 33% Credit per Rule) - 2,814 sq ft
- Non Credit Generating (Less than 20 ft.)
- TOB to 50 feet
- 100 foot line
- 150 foot line
- 200 foot line

N

UT-1
UT-2
UT-3
T-1
T-2
T-3
1
2
3
4
5
6
7
8

No credit is being generated within the Marsh Treatment Area.

This area is located outside of the easement and is not generating credit.

0 70 140 280 420 560 Feet

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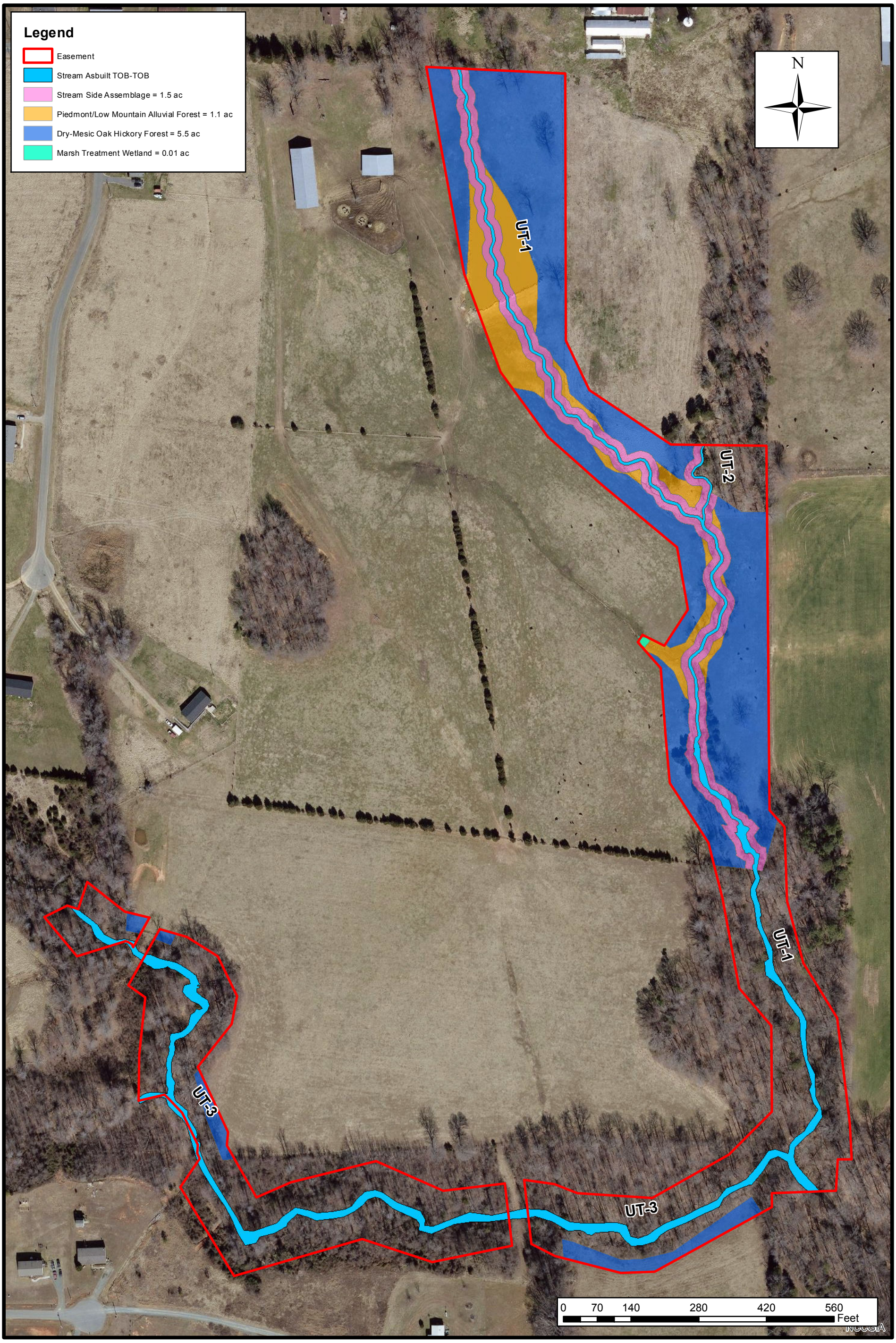
Axiom Environmental, Inc.

Riparian Buffer Asset Map
Major Hill Mitigation Site
Alamance County, North Carolina

Dwn. By:	CLF
Date:	Jan 2021
Project:	17-009

FIGURE
A



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Axiom Environmental, Inc.

Riparian Buffer Planting Map
Major Hill Mitigation Site
Alamance County, North Carolina

Dwn. By:	KRJ
Date:	Feb 2019
Project:	17-009

FIGURE
B