FINAL
MONITORING REPORT
2021 (Year 3)

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: January 2021 – October 2021
Submission: January 2022

Prepared for:

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF MITIGATION SERVICES
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Response to Monitoring Year 3 (2021) DMS Comments

Major Hill Mitigation Site (DMS #100015)
Cape Fear River Basin 03030002, Alamance County
Contract No. 100015

Comments Received (Black Text) & Responses (Blue Text)

Stream/Wetland Section:

1. Page 7 2.2 Vegetation, please notate on the supplemental planting list which of the trees were in the Mitigation Planting Plan and make note if the other species met the target community.
   Response: Footnotes were created linking the species included in the mitigation plan, the species that match the target community, and the species that were selected based solely on plant availability.

2. Revise table 1 to show final credit number out to 3 significant digits to match credit ledger (3,057.600 SMU and 0.760 WMU)
   Response: The overall assets in Table 1 were revised to match the credit ledger.

3. You may omit substrate data in future monitoring years.
   Response: Understood.

4. Report states that the growing season is 3/1-10/22 but the graphs show a growing season end date of 11/9. Please clarify and revise as needed. Growing season should match mitigation plan, and require vegetative indicators including bud burst and leaf drop.
   Response: The wetland hydrology data was revised to reflect the approved mitigation plan growing season methodology.

5. There was no discussion of any planned fescue treatment. Please indicate if there will be any additional fescue treatment or plans to re-plant in the future based on two vegetation plots not meeting final requirements.
   Response: The following was added to the Monitoring Summary and Section 2.3 Vegetation Monitoring of the Stream and Wetland Monitoring Report, and to Section 4.4 of the Riparian Buffer Monitoring Report; "*Restoration Systems continues to monitor fescue onsite and is planning an additional treatment in April of 2022. Based on permanent and random vegetation monitoring plots and visual observations, planted stems are establishing within areas where fescue was a concern. At this time, no additional planting is proposed.*"

Riparian Buffer Section:

1. Riparian buffer section is missing Appendix H. Remove or update.
   Response: Appendix H was removed from the Report. Herbicide Application Forms are available upon request.

Digital Comments:

1. The soil temperature data needs to be included in the report, represented with a time series, and must be corroborated with vegetative indicators as determined in the Mitigation Plan.
   Response: A soil temperature graph is included in Appendix E. This data is in the gauge data workbook in the digital submittal.

2. Please include a figure displaying the 30th and 70th percentiles of monthly precipitation compared to observed monthly precipitation.
   Response: This figure is included in Appendix E. The excel data is included in the digital submittal.

Major Hill Year 3, 2021 Monitoring Summary

General Notes

- No encroachment was identified in Year 3
- No evidence of nuisance animal activity (i.e., beaver, heavy deer browsing, etc.) was observed.

Streams

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

Wetlands

- Five of six groundwater gauges met success for the Year 3 (2021) monitoring period. Gauge 2 did not meet success, however it was successful for 8.9% of the growing season. Wetland hydrology data is in Appendix E.

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	Yes/74 days 31.4 percent				
2	No/19 days* 8.1 percent	No/19 days 8.0 percent	No/21 days 8.9 percent				
3	Yes/25 days 10.6 percent	Yes/235 days 100 percent	Yes/226 days 95.8 percent				
4	Yes/34 days 14.5 percent	Yes/72 days 30.5 percent	Yes/60 days 25.4 percent				
5	Yes/119 days 50.6 percent	Yes/135 days 57.4 percent	Yes/53 days 22.5 percent				
6	Yes/77 days 32.8 percent	Yes/44 days 18.7 percent	Yes/80 days 33.9 percent				

Vegetation Summary

Measurements of the 8 permanent vegetation plots resulted in an average of 364 planted stems/acre excluding livestakes. All plots met success criteria except permanent plots 1, 4, and 5; however, when including naturally recruited stems of green ash (*Fraxinus pennsylvanica*) and red oak (*Quercus rubra*), plot 1 met success criteria. Additionally, all three temporary vegetation transects met success criteria resulting in a sitewide average of 397 stems/acre, including natural recruits. Year 3 (2021) vegetation data is included in Tables 8-10 (Appendix C).

MY 3 (2021) Monitoring Activity and Reporting History

Activity or Deliverable	Data Collection Complete	Completion or Delivery
MY 3 (2021) Vegetation Data Collection	October 2021	--
MY 3 (2021) Stream Data Collection	March 2021	--
MY 3 (2021) Monitoring Report	October 2021	January 2022

Site Maintenance Report (2021)

Invasive Species Work	Maintenance work
8/05/2021 Tree of Heaven, Johnson Grass, Privet, Sweetgum, Princess Tree 11-12-2021 Fescue treatment	None

2022 Planned Vegetation Maintenance

Restoration Systems continues to monitor fescue onsite and is planning an additional treatment in April of 2022. Based on permanent and random vegetation monitoring plots and visual observations, planted stems are establishing within areas where fescue was a concern. At this time, no additional planting is proposed.

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APPENDICES

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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	X	X	X		X		X
Wetlands	X	X	X	X	X	X	X
Vegetation	X	X	X		X		X
Macroinvertebrates			X		X		X
Water Quality	X	X	X	X	X	X	X
Visual Assessment	X	X	X	X	X	X	X
Report Submittal	X	X	X	X	X	X	X

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 Monitoring Summary (continued)

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 3 (2021) monitoring. Stream morphology and water quality data is available in Appendix D, and benthic macroinvertebrate data is in Appendix F.

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
2021 (Year 3)	March 1, 2021^	March 1- October 22 (236 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.

^An onsite soil temperature data logger installed 12 inches below the ground surface read 49.14°F on March 1, and the soil temperature remained well-above 41°F thereafter. Additionally, bud bursts were documented on March 1.

Five of the six groundwater gauges met success criteria for the year 3 (2021) monitoring period. Gauge 2 was inundated/saturated for 21 days, or 8.9 percent of the growing season. Year 3 (2021) groundwater gauge data and graphs are located in Appendix E.

2.3 Vegetation Monitoring

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 after planting was complete to determine that those areas met required stem densities.

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**

* Included in mitigation plan planting list

[%] Not included in mitigation plan planting list but meets target community

[@] Species selected based on lack of availability of mitigation plan planting list and target community species

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 H (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 364 planted stems/acre excluding livestakes. All plots met success criteria except permanent plots 1, 4, and 5; however, when including naturally recruited stems of green ash (*Fraxinus pennsylvanica*) and red oak (*Quercus rubra*), plot 1 met success criteria. Additionally, all three temporary vegetation transects met success criteria resulting in a sitewide average of 397 stems/acre, including natural recruits. Year 3 (2021) vegetation data is included in Tables 8-10 (Appendix C).

2022 Planned Vegetation Maintenance

Restoration Systems continues to monitor fescue onsite and is planning an additional treatment in April of 2022. Based on permanent and random vegetation monitoring plots and visual observations, planted stems are establishing within areas where fescue was a concern. At this time, no additional planting is proposed.

3.0 REFERENCES

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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	**3057.600**
Riparian Riverine Wetland	**0.760**

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
MY 3 (2021) Vegetation Data Collection	October 2021	--
MY 3 (2021) Stream Data Collection	March 2021	--
MY 3 (2021) Monitoring Report	October 2021	January 2022

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	**Construction Contractor** Land Mechanic Designs 780 Landmark Road Willow Spring, NC 27592 Lloyd Glover 919-639-6132
Designer Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis 919-215-1693	**Planting Contractor** Carolina Silvics, Inc. 908 Indian Trail Road Edenton, NC 27932 Mary-Margaret McKinney 252-482-8491
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	**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

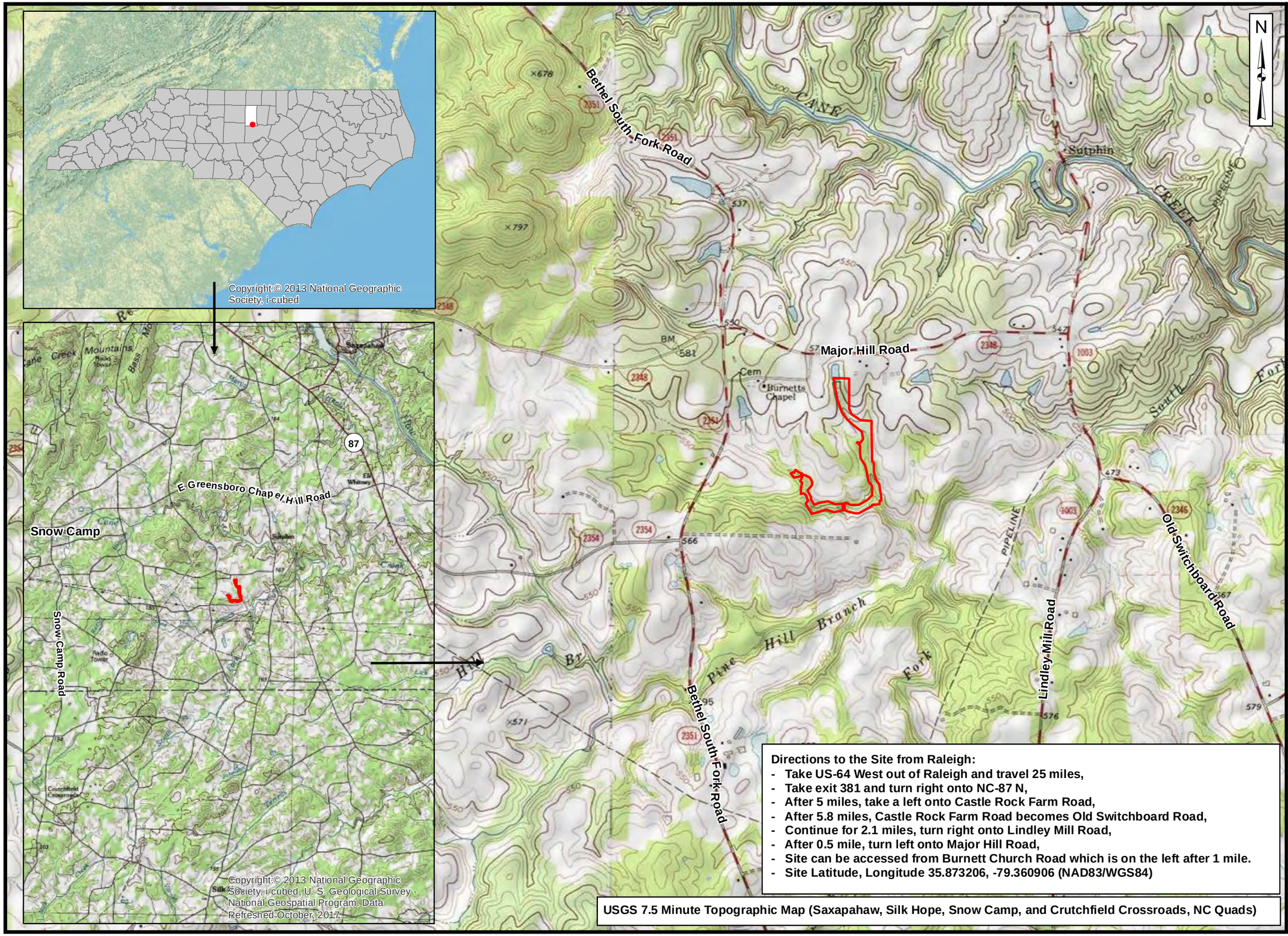
Project Information			
Project Name	Major Hill Restoration Site		
Project County	Alamance County, North Carolina		
Project Area (acres)	16.7		
Project Coordinates (latitude & latitude)	35.873206, -79.360906		
Planted Area (acres)	8.11		
Project Watershed Summary Information			
Physiographic Province	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 3 (2021)
- Groundwater Gauge Not Meeting Success Criteria During Year 3 (2021)
- Stream Gauges
- Rain Gauge/Soil Probe
- Marsh Treatment Areas
- Plot Origins
- CVS Plots Meeting Success Criteria During Year 3 (2021)
- CVS Plots Not Meeting Success Criteria During Year 3 (2021)
- Vegetation Transects Meeting Success Criteria During Year 3 (2021)
- 2020 Supplemental Planting Area
- Structures
- Cross-sections
- Newly-Installed Fencing
- Previously Existing Fencing that Remains Post-Construction
- Fencing Removed During Construction

N

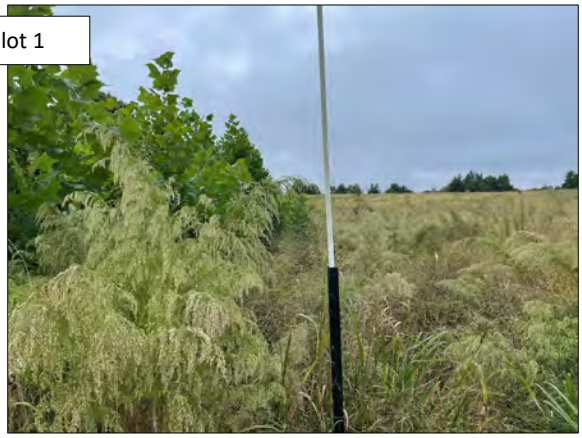
XS-10R
XS-9P
XS-8R
XS-7P
XS-6P
XS-5R
XS-4R
XS-3P
XS-2R
XS-1R
UT-1
UT-2
UT-3
4/4a
Seed, fertilizer, and lime application area.
Seed, fertilizer, and lime application area.

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: Nov 2021 Project: 17-009 FIGURE 2

Major Hill
MY-03 (2021) Vegetation Monitoring Photographs
Taken October 2021

Plot 1



Plot 2

Plot 3

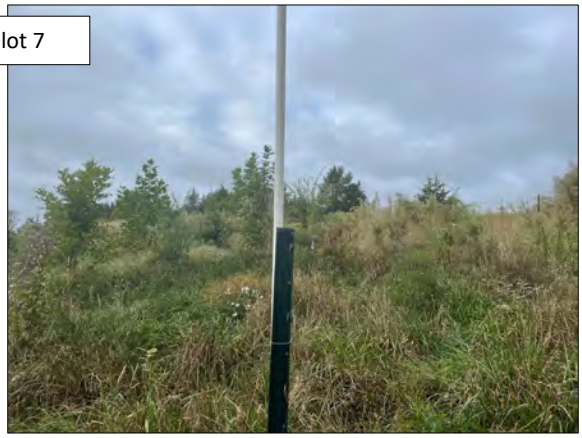
Plot 4

Plot 5

Plot 6

Major Hill
MY-03 (2021) Vegetation Monitoring Photographs
Taken October 2021

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 dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.

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 (MY3 2021)																							Annual Means											
		Species	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			MY3 (2021)			MY2 (2020)			MY1 (2019)			MY0 (2019)		
Scientific Name	Common Name	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	PnoLS	P-all	T
Acer rubrum	red maple	Tree																																3			
Asimina triloba	pawpaw	Tree										1	1	1							1	1	1				2	2	2	2	2	2	3	3	3	7	7	7
Betula nigra	river birch	Tree										1	1	1							1	1	1	1	1	1	3	3	3	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				1	1	1	11	11	11	10	10	10	14	14	14	5	5	5
Cercis canadensis	eastern redbud	Tree							2	2	2													2	2	2	4	4	4	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	3	1	1	1				1	1	1				4	4	4	8	8	10	9	9	10	9	9	9	5	5	5
Fraxinus	ash	Tree																						1	1	1	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	5	5	5
Fraxinus pennsylvanica	green ash	Tree	2	2	4							1	1	1	1	1	1				1	1	1			1	5	5	8	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	1	1	1	5	5	5
Nyssa sylvatica	blackgum	Tree				1	1	1	1	1	1																2	2	2	2	2	2	4	4	4	10	10	10
Platanus occidentalis	American sycamore	Tree				1	1	1							1	1	1	2	2	3							4	4	5	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										1	1	1	4	4	4	3	3	3	3	3	3	1	1	1	12	12	12	12	12	12	20	20	20	10	10	10
Quercus phellos	willow oak	Tree				2	2	2	2	2	2						1	1	1	1	5	5	5	3	3	3	13	13	14	12	12	12	16	16	16	18	18	18
Quercus rubra	northern red oak	Tree			1																								1									
Unknown		Shrub or Tree																																		6	6	6
		Stem count	5	5	8	8	8	8	10	10	12	5	5	5	6	6	7	12	12	13	11	11	11	15	15	16	72	72	80	75	75	79	103	103	109	129	129	129
		size (ares)	1			1			1			1			1			1			1			1			8			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			0.20		
		Species count	4	4	5	5	5	5	5	5	5	5	5	5	3	3	4	6	6	6	5	5	5	8	8	9	14	14	15	14	14	14	15	15	17	16	16	16
		Stems per ACRE	202.3	202.3	323.7	323.7	323.7	323.7	404.7	404.7	485.6	202.3	202.3	202.3	242.8	242.8	283.3	485.6	485.6	526.1	445.2	445.2	445.2	607	607	647.5	364.2	364.2	404.7	379.4	379.4	399.6	521	521	551.4	652.5556	652.5556	652.5556

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 (176°)	T-2 (325°)	T-3 (2°)
Betula nigra			1
Carpinus caroliniana		1	
Cercis canadensis		1	
Cornus amomum		2	
Diospyros virginiana	2	1	5
Fraxinus pennsylvanica	5	2	2
Morus rubra	1		
Platanus occidentalis	2		
Quercus nigra			1
Quercus pagoda		1	
Quercus rubra	1		
Total Stems	**11**	**8**	**9**
Total Stems/Acre	**445**	**324**	**364**

Table 10. Planted Vegetation Totals – Major Hill Restoration Site

Plot #	Success Criteria Met?	MY 3 (2021) Planted Stems/Ac	MY 3 (2021) All Stems/Ac
1	No	202	324
2	Yes	324	324
3	Yes	405	486
4	No	202	202
5	No	243	283
6	Yes	486	526
7	Yes	445	445
8	Yes	607	647
T-1	Yes	--	445
T-2	Yes	--	324
T-3	Yes	--	364
Average Planted Stems/Acre	**Yes**	**364**	**397**

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 Plot

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	12.7				8.6	7.4	7.8	7.7				13.0	12.5	13.1	12.6				10.3	10.4	12.8	10.8			
Floodprone Width (ft) (approx)	40.0	40.0	40.0	40.0				22.0	22.0	22.0	22.0				NA	NA	NA	NA				40.0	40.0	40.0	40.0			
BF Mean Depth (ft)	0.6	0.7	0.6	0.6				0.4	0.5	0.4	0.4				0.6	0.7	0.6	0.7				0.6	0.6	0.5	0.5			
BF Max Depth (ft)	1.2	1.2	1.2	1.2				0.7	0.7	0.7	0.7				1.7	1.6	1.6	1.7				0.9	1.1	1.1	1.1			
Low Bank Height	1.2	1.3	1.2	1.3				0.7	0.8	0.7	0.7				1.7	1.7	1.7	1.3				0.9	1.1	1.1	1.1			
BF Cross Sectional Area (ft^2)	7.5	7.5	7.5	7.5				3.5	3.5	3.5	3.5				8.4	8.4	8.4	8.4				5.8	5.8	5.8	5.8			
Width/Depth Ratio	18.6	16.7	21.2	21.6				21.1	15.6	17.4	17.1				NA	NA	NA	NA				18.3	18.6	28.2	19.9			
Entrenchment Ratio	3.4	3.6	3.2	3.1				2.6	3.0	2.8	2.9				NA	NA	NA	NA				3.9	3.8	3.1	3.7			
Bank Height Ratio*	1.0	1.1	1.0	1.1				1.0	1.1	1.0	1.0				1.0	1.1	1.1	<1				1.0	1.0	1.0	1.0			
d50 (mm)	25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7			

*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	7.7		10.8	12.7														
Floodprone Width (ft)	22		40	40		3	22		40	40		3	22		40	40		3	22		40	40														
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	0.4		0.5	0.6														
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	0.7		1.1	1.2														
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	3.5		5.8	7.5														
Width/Depth Ratio	18.0		18.0	21.0		3	15.6		16.7	18.6		3	17.4		21.2	28.2		3	19.3		20.1	21.5														
Entrenchment Ratio	2.6		3.4	3.9		3	3.0		3.6	3.8		3	2.8		3.1	3.2		3	2.9		3.1	3.7														
Bank Height Ratio	1.0		1.0	1.0		3	1.0		1.1	1.1		3	1.0		1.0	1.0		3	1.0		1.0	1.0														
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	12.7				8.9	9.9	10.0	10.5				7.4	9.5	6.9	7.2				6.0	5.7	6.5	6.5			
Floodprone Width (ft) (approx)	40.0	40.0	40.0	40.0				NA	NA	NA	NA				NA	NA	NA	NA				23.0	23.0	23.0	23.0			
BF Mean Depth (ft)	0.6	0.6	0.6	0.6				1.0	0.9	0.9	0.9				1.6	1.2	1.7	1.6				0.5	0.5	0.5	0.5			
BF Max Depth (ft)	1.1	1.2	1.1	1.2				2.0	2.1	2.0	2.2				2.5	2.4	2.0	2.4				0.8	0.9	0.9	0.9			
Low Bank Height	1.1	1.2	1.1	1.1				2.0	2.2	2.2	2.4				2.5	2.5	2.2	2.6				0.8	0.9	1.0	0.8			
BF Cross Sectional Area (ft^2)	7.1	7.1	7.1	7.1				9.1	9.1	9.1	9.1				11.7	11.7	11.7	11.7				3.0	3.0	3.0	3.0			
Width/Depth Ratio	19.6	19.6	21.3	22.8				NA	NA	NA	NA				NA	NA	NA	NA				12.0	10.8	14.1	14.0			
Entrenchment Ratio	3.4	3.4	3.3	3.1				NA	NA	NA	NA				NA	NA	NA	NA				3.8	4.0	3.5	3.5			
Bank Height Ratio*	1.0	1.0	1.0	<1				1.0	1.0	1.1	1.1				1.0	1.0	1.1	1.1				1.0	1.0	1.1	<1			
d50 (mm)	25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7			

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	11.8				10.9	11.2	13.3	9.4			
Floodprone Width (ft) (approx)	NA	NA	NA	NA				40.0	40.0	40.0	40.0			
BF Mean Depth (ft)	0.7	0.5	0.6	0.4				0.3	0.3	0.3	0.4			
BF Max Depth (ft)	1.3	1.2	1.3	1.2				0.7	0.6	0.6	0.6			
Low Bank Height	1.3	1.3	1.3	1.3				0.7	0.6	0.6	0.5			
BF Cross Sectional Area (ft^2)	4.9	4.9	4.9	4.9				3.5	3.5	3.5	3.5			
Width/Depth Ratio	NA	NA	NA	NA				33.9	35.8	50.5	25.0			
Entrenchment Ratio	NA	NA	NA	NA				3.7	3.6	3.0	4.3			
Bank Height Ratio*	1.0	1.1	1.0	1.1				1.0	1.0	1.0	<1			
d50 (mm)	25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7			

*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	6.5		9.4	12.7		3												
Floodprone Width (ft)	23		40	40		3	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	0.4		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	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	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	14.1		22.7	25.2		3												
Entrenchment Ratio	3.4		3.7	3.8		3	3.4		3.6	4.0		3	3.0		3.3	3.5		3	3.1		3.5	4.3		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	0.8		1.1	1.3		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

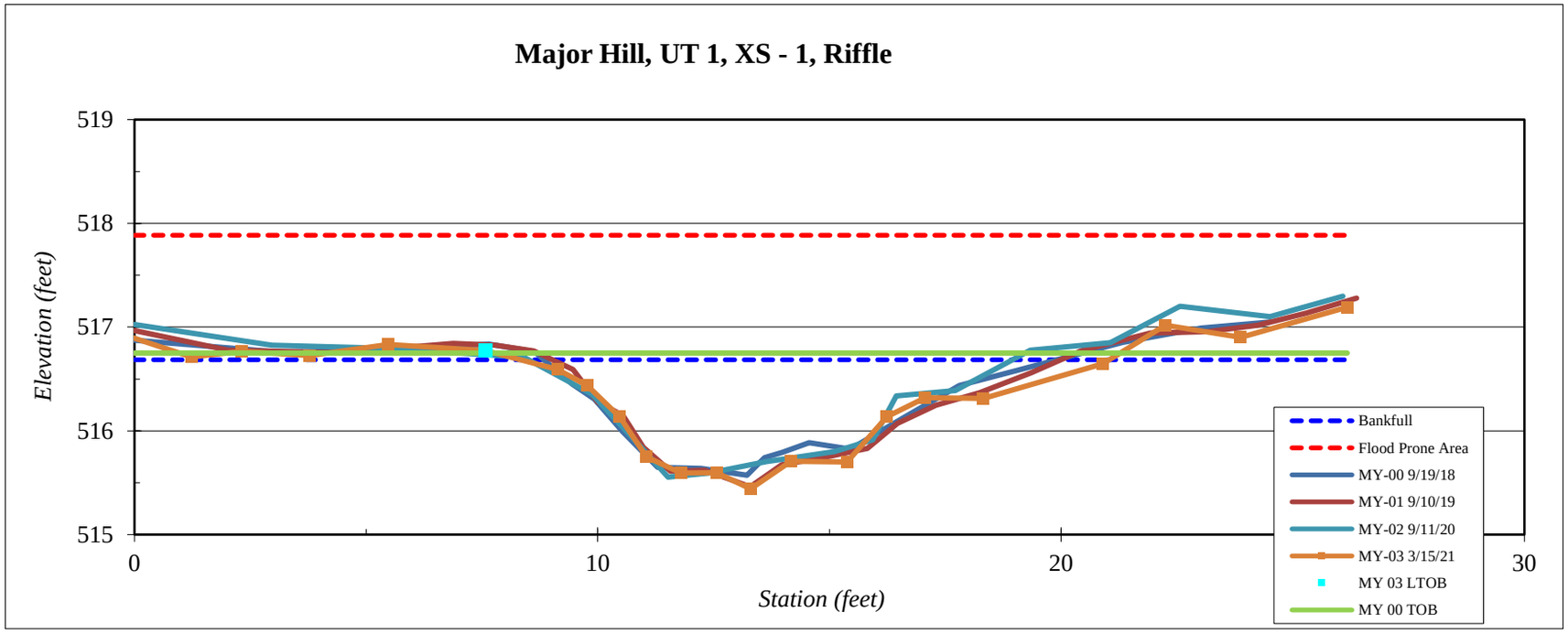
	Preconstruction				Year 1 (2019)		Year 2 (2020)		Year 3 (2021)	
	Upstream		Downstream		Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Parameter	**7/28/17**	**8/14/17**	**7/28/17**	**8/14/17**	**11/20/19**	**11/20/19**	**10/28/20**	**10/28/20**	**5/19/21**	**5/19/21**
TDS (ppm)	110.1	147	62.6	86.8	394	179	164.0	122.3	94.7	113.6
TDS (mg/l)	109.1	149	64.6	83.5	397	179	168.3	131.3	98.2	120.1
Conductivity (µS/cm)	159.2	215	92.1	128.3	557	252	242.1	186.9	135.4	162.3
Temperature (°C)	25.4	22.6	24.6	22.1	8	6.9	19.6	19.7	22.9	15.5
DO (mg/l)	-	1.93	-	3.06	-	-	5.36	7.64	5.68	7.16
DO (ppm)	-	1.06	-	2.53	-	-	5.42	7.72	5.71	7.25
pH	6.61	6.37	6.65	6.22	7	6.58	6.96	6.94	7.22	7.09

Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 1, Riffle
Feature	Riffle
Date:	3/15/2021
Field Crew:	Adams, Lawson

Station	Elevation
-0.2	516.92
1.2	516.71
2.3	516.77
3.8	516.72
5.5	516.83
7.6	516.77
9.1	516.59
9.8	516.44
10.5	516.13
11.1	515.75
11.8	515.59
12.6	515.60
13.3	515.44
14.2	515.71
15.4	515.70
16.2	516.14
17.1	516.32
18.3	516.31
20.9	516.65
22.2	517.02
23.9	516.90
26.2	517.2

SUMMARY DATA	
Bankfull Elevation:	516.7
LTOB Elevation:	516.8
Bankfull Cross-Sectional Area:	7.5
Bankfull Width:	12.7
Flood Prone Area Elevation:	517.9
Flood Prone Width:	40.0
Max Depth at Bankfull:	1.2
Low Bank Height:	1.3
Mean Depth at Bankfull:	0.6
W / D Ratio:	21.6
Entrenchment Ratio:	3.1
Bank Height Ratio:	1.1

Stream Type	C/E

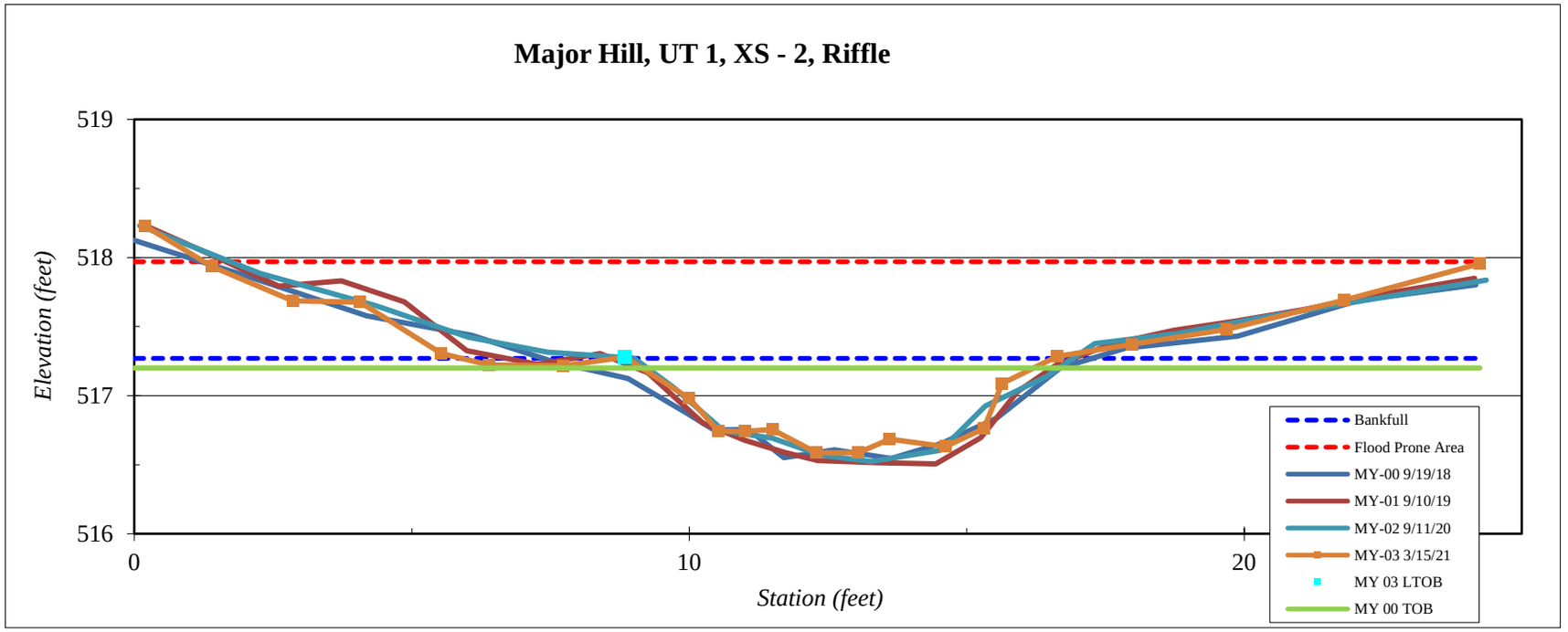


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 2, Riffle
Feature	Riffle
Date:	3/15/2021
Field Crew:	Adams, Lawson

Station	Elevation
0.2	518.23
1.4	517.93
2.9	517.69
4.1	517.68
5.5	517.30
6.4	517.22
7.7	517.22
8.8	517.28
10.0	516.98
10.5	516.74
11.0	516.74
11.5	516.75
12.3	516.59
13.1	516.59
13.6	516.68
14.6	516.63
15.3	516.76
15.6	517.09
16.6	517.28
18.0	517.37
19.7	517.48
21.8	517.7
24.2	518.0

SUMMARY DATA	
Bankfull Elevation:	517.3
LTOB Elevation:	517.3
Bankfull Cross-Sectional Area:	3.5
Bankfull Width:	7.7
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:	17.1
Entrenchment Ratio:	2.9
Bank Height Ratio:	1.0

Stream Type	C/E

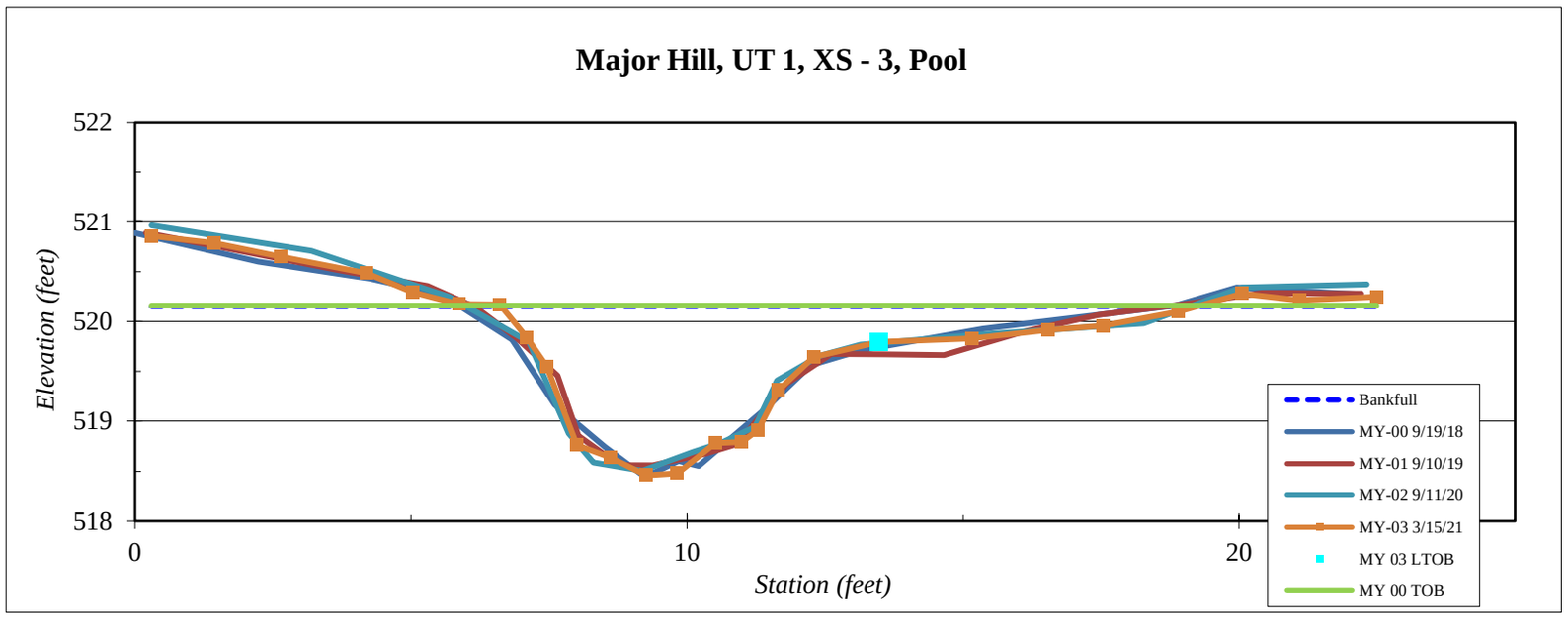


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 3, Pool
Feature	Pool
Date:	3/15/2021
Field Crew:	Adams, Lawson

Station	Elevation
0.3	520.9
1.4	520.8
2.6	520.7
4.2	520.5
5.0	520.3
5.9	520.2
6.6	520.2
7.1	519.8
7.5	519.6
8.0	518.8
8.6	518.6
9.3	518.5
9.8	518.5
10.5	518.8
11.0	518.8
11.3	518.9
11.7	519.3
12.3	519.6
13.5	519.8
15.2	519.8
16.5	519.9
17.5	520.0
18.9	520.1
20.0	520.3
21.1	520.2
22.5	520.2

SUMMARY DATA	
Bankfull Elevation:	520.2
LTOB Elevation:	519.8
Bankfull Cross-Sectional Area:	8.4
Bankfull Width:	12.6
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.7
Low Bank Height:	1.3
Mean Depth at Bankfull:	0.7
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	0.8

Stream Type	C/E

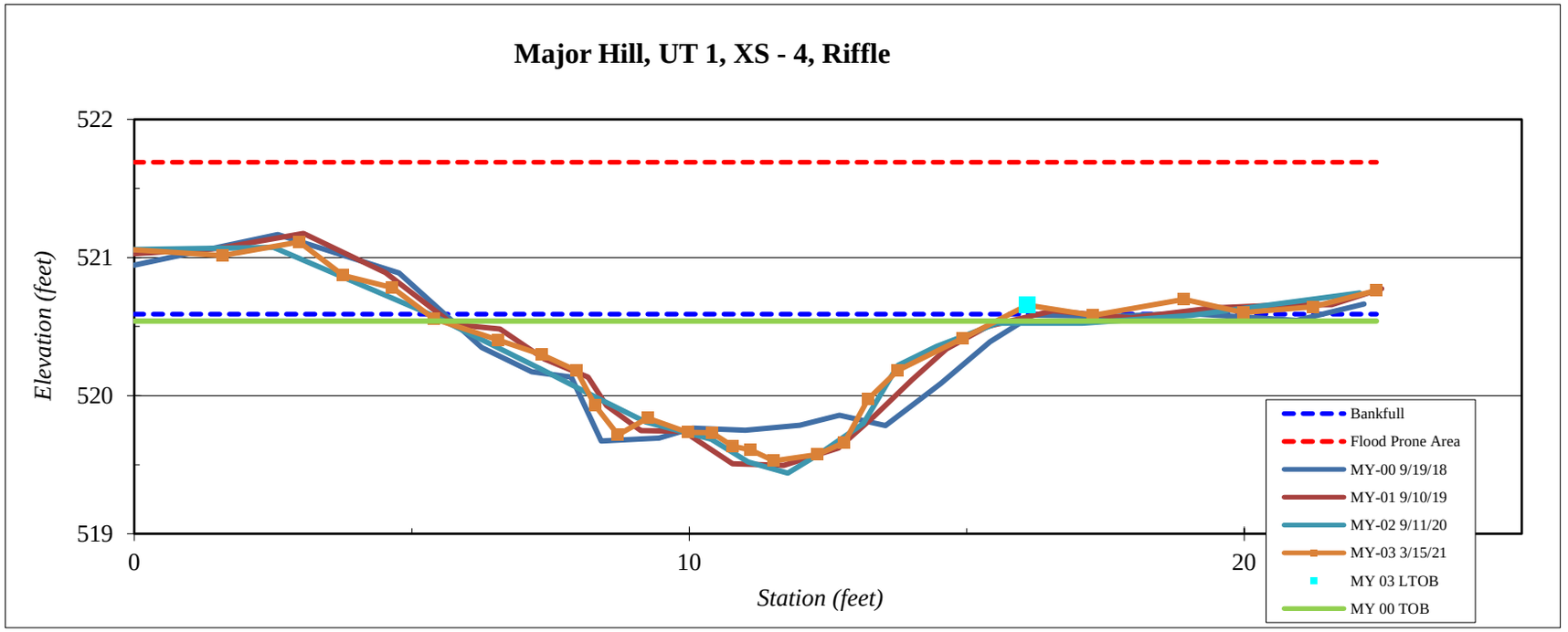


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 4, Riffle
Feature	Riffle
Date:	3/15/2021
Field Crew:	Adams, Lawson

Station	Elevation
-0.1	521.06
1.6	521.01
3.0	521.11
3.8	520.87
4.6	520.78
5.4	520.56
6.6	520.40
7.3	520.30
8.0	520.18
8.3	519.93
8.7	519.72
9.2	519.84
10.0	519.73
10.4	519.73
10.8	519.63
11.1	519.61
11.5	519.53
12.3	519.57
12.8	519.66
13.2	519.97
13.8	520.18
14.9	520.4
16.1	520.7
17.3	520.6
18.9	520.7
20.0	520.6
21.2	520.6
22.4	520.8

SUMMARY DATA	
Bankfull Elevation:	520.6
LTOB Elevation:	520.7
Bankfull Cross-Sectional Area:	5.8
Bankfull Width:	10.8
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:	19.9
Entrenchment Ratio:	3.7
Bank Height Ratio:	1.0

Stream Type	C/E

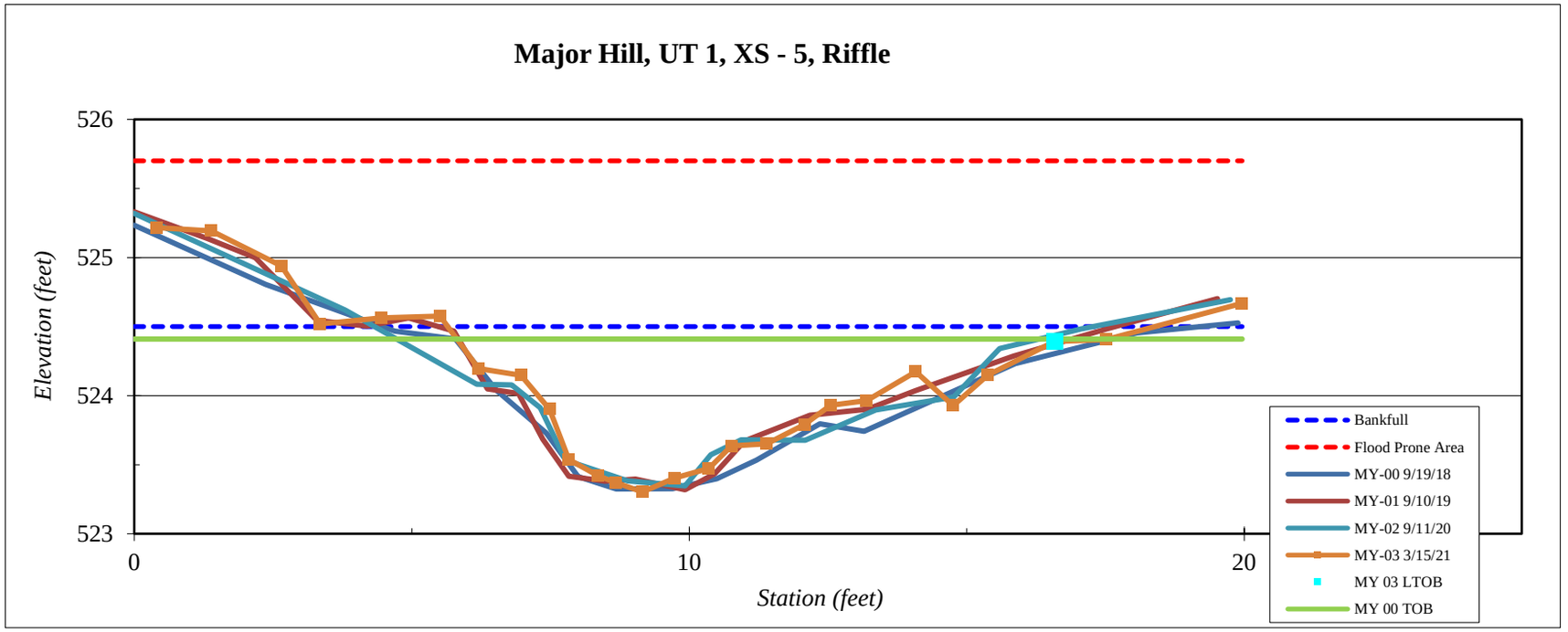


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 5, Riffle
Feature	Riffle
Date:	3/15/2021
Field Crew:	Adams, Lawson

Station	Elevation
0.4	525.22
1.4	525.19
2.7	524.94
3.4	524.52
4.4	524.56
5.5	524.58
6.2	524.20
7.0	524.15
7.5	523.90
7.8	523.54
8.4	523.42
8.7	523.37
9.2	523.30
9.7	523.40
10.4	523.47
10.8	523.64
11.4	523.65
12.1	523.79
12.5	523.93
13.2	523.97
14.1	524.17
14.8	523.9
15.4	524.1
16.6	524.4
17.5	524.4
20.0	524.7

SUMMARY DATA	
Bankfull Elevation:	524.5
LTOB Elevation:	524.4
Bankfull Cross-Sectional Area:	7.1
Bankfull Width:	12.7
Flood Prone Area Elevation:	525.7
Flood Prone Width:	40.0
Max Depth at Bankfull:	1.2
Low Bank Height:	1.1
Mean Depth at Bankfull:	0.6
W / D Ratio:	22.8
Entrenchment Ratio:	3.1
Bank Height Ratio:	0.9

Stream Type	C/E

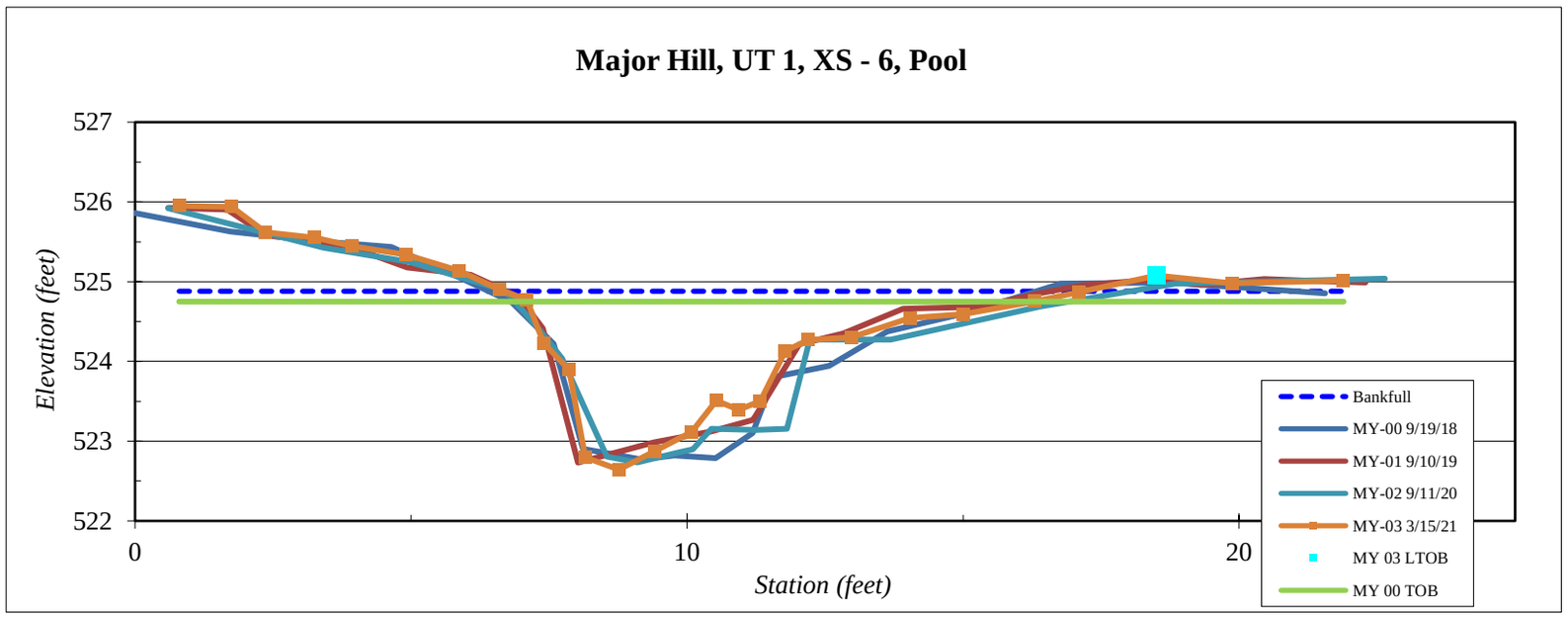


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 6, Pool
Feature	Pool
Date:	3/15/2021
Field Crew:	Adams, Lawson

Station	Elevation
0.8	526.0
1.8	525.9
2.4	525.6
3.3	525.6
3.9	525.4
4.9	525.3
5.9	525.1
6.6	524.9
7.1	524.8
7.4	524.2
7.9	523.9
8.2	522.8
8.8	522.6
9.4	522.9
10.1	523.1
10.5	523.5
10.9	523.4
11.3	523.5
11.8	524.1
12.2	524.3
13.0	524.3
14.0	524.5
15.0	524.6
16.3	524.8
17.1	524.9
18.5	525.1
19.9	525.0
21.9	525.0

SUMMARY DATA	
Bankfull Elevation:	524.9
LTOB Elevation:	525.1
Bankfull Cross-Sectional Area:	9.1
Bankfull Width:	10.5
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	2.2
Low Bank Height:	2.4
Mean Depth at Bankfull:	0.9
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.1

Stream Type	C/E

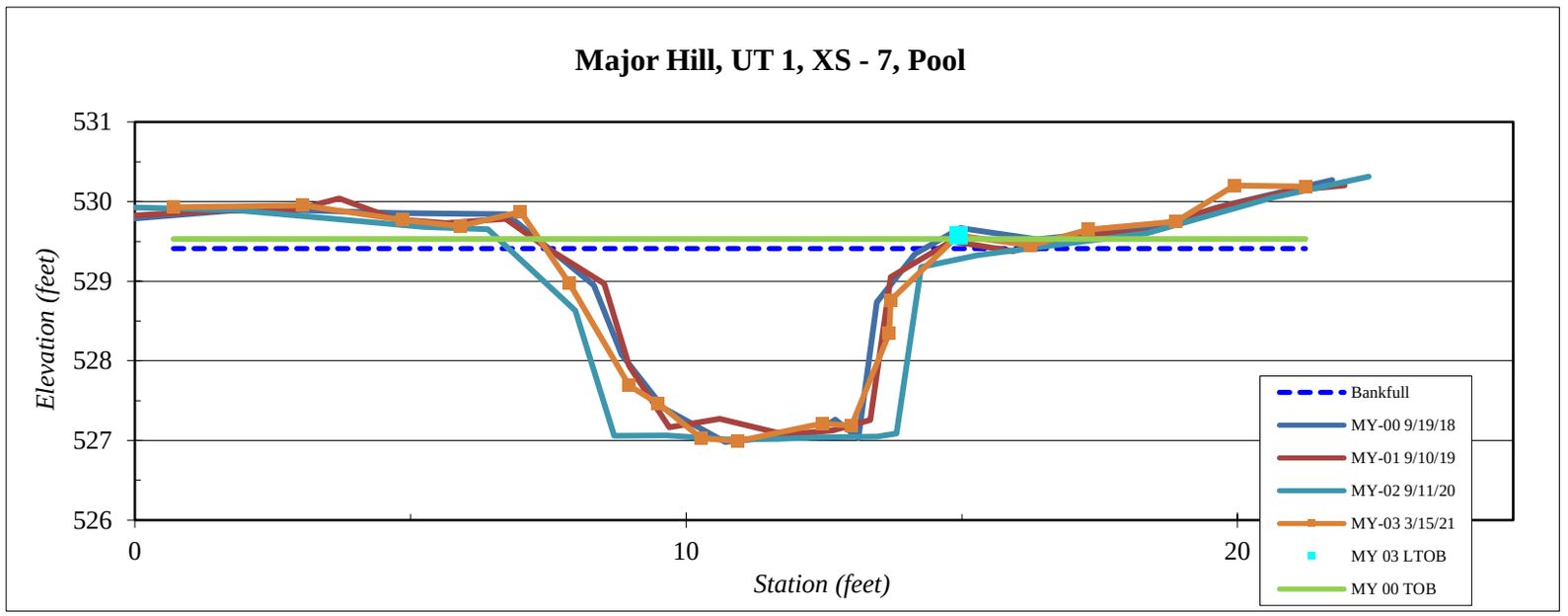


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 7, Pool
Feature	Pool
Date:	3/15/2021
Field Crew:	Adams, Lawson

Station	Elevation
0.7	529.9
3.0	530.0
4.9	529.8
5.9	529.7
7.0	529.9
7.9	529.0
9.0	527.7
9.5	527.5
10.3	527.0
10.9	527.0
12.5	527.2
13.0	527.2
13.7	528.3
13.7	528.8
14.9	529.6
16.2	529.5
17.3	529.6
18.9	529.8
19.9	530.2
21.2	530.2

SUMMARY DATA	
Bankfull Elevation:	529.4
LTOB Elevation:	529.6
Bankfull Cross-Sectional Area:	11.7
Bankfull Width:	7.2
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	2.4
Low Bank Height:	2.6
Mean Depth at Bankfull:	1.6
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.1

Stream Type	C/E

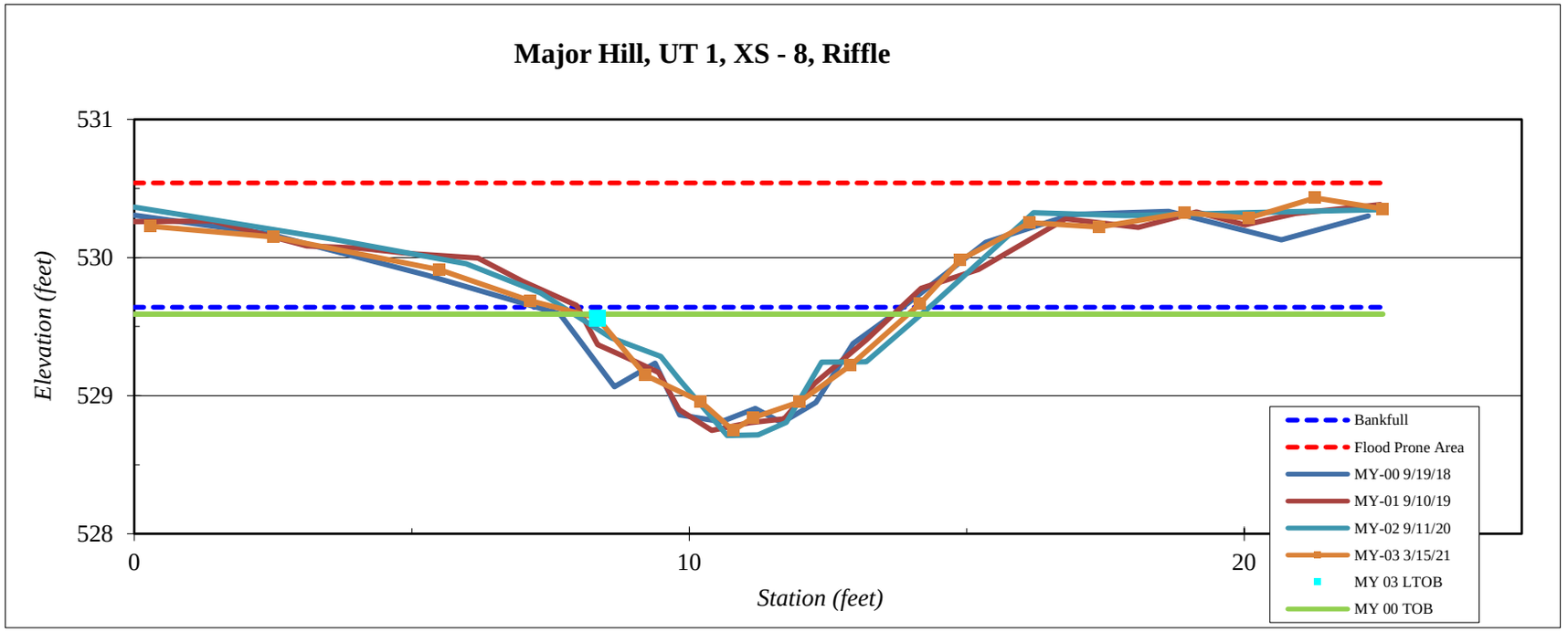


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 8, Riffle
Feature	Riffle
Date:	3/15/2021
Field Crew:	Adams, Lawson

Station	Elevation
0.3	530.23
2.5	530.15
5.5	529.91
7.1	529.69
8.3	529.56
9.2	529.15
10.2	528.96
10.8	528.75
11.2	528.84
12.0	528.95
12.9	529.22
14.2	529.67
14.9	529.98
16.1	530.25
17.4	530.22
18.9	530.33
20.1	530.29
21.3	530.43
22.5	530.35

SUMMARY DATA	
Bankfull Elevation:	529.6
LTOB Elevation:	529.6
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:	0.8
Mean Depth at Bankfull:	0.5
W / D Ratio:	14.0
Entrenchment Ratio:	3.5
Bank Height Ratio:	0.9

Stream Type	C/E

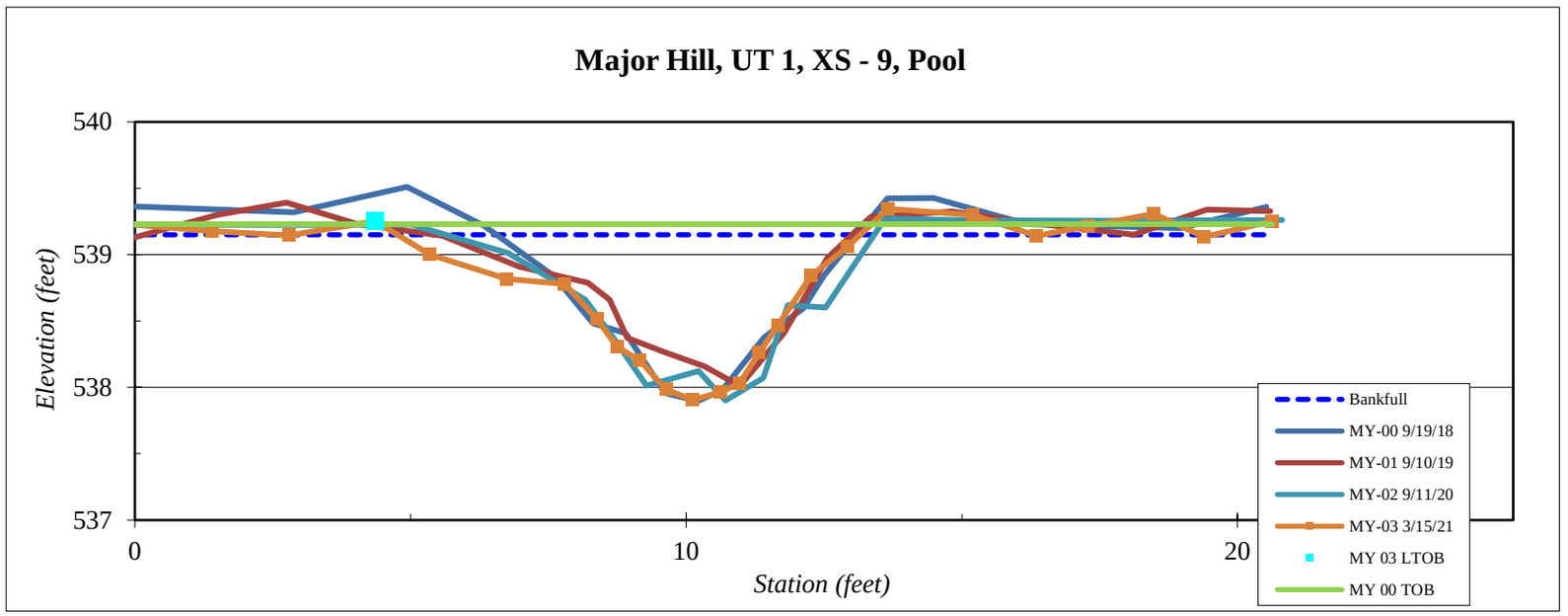


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 9, Pool
Feature	Pool
Date:	3/15/2021
Field Crew:	Adams, Lawson

Station	Elevation
-0.2	539.2
1.4	539.2
2.8	539.1
4.4	539.3
5.4	539.0
6.8	538.8
7.8	538.8
8.4	538.5
8.8	538.3
9.2	538.2
9.6	538.0
10.1	537.9
10.6	538.0
11.0	538.0
11.3	538.3
11.7	538.5
12.3	538.8
12.9	539.1
13.7	539.3
15.2	539.3
16.4	539.1
17.3	539.2
18.5	539.3
19.4	539.1
20.6	539.3

SUMMARY DATA	
Bankfull Elevation:	539.2
LTOB Elevation:	539.3
Bankfull Cross-Sectional Area:	4.9
Bankfull Width:	9.1
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.2
Low Bank Height:	1.3
Mean Depth at Bankfull:	0.5
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.1

Stream Type	C/E

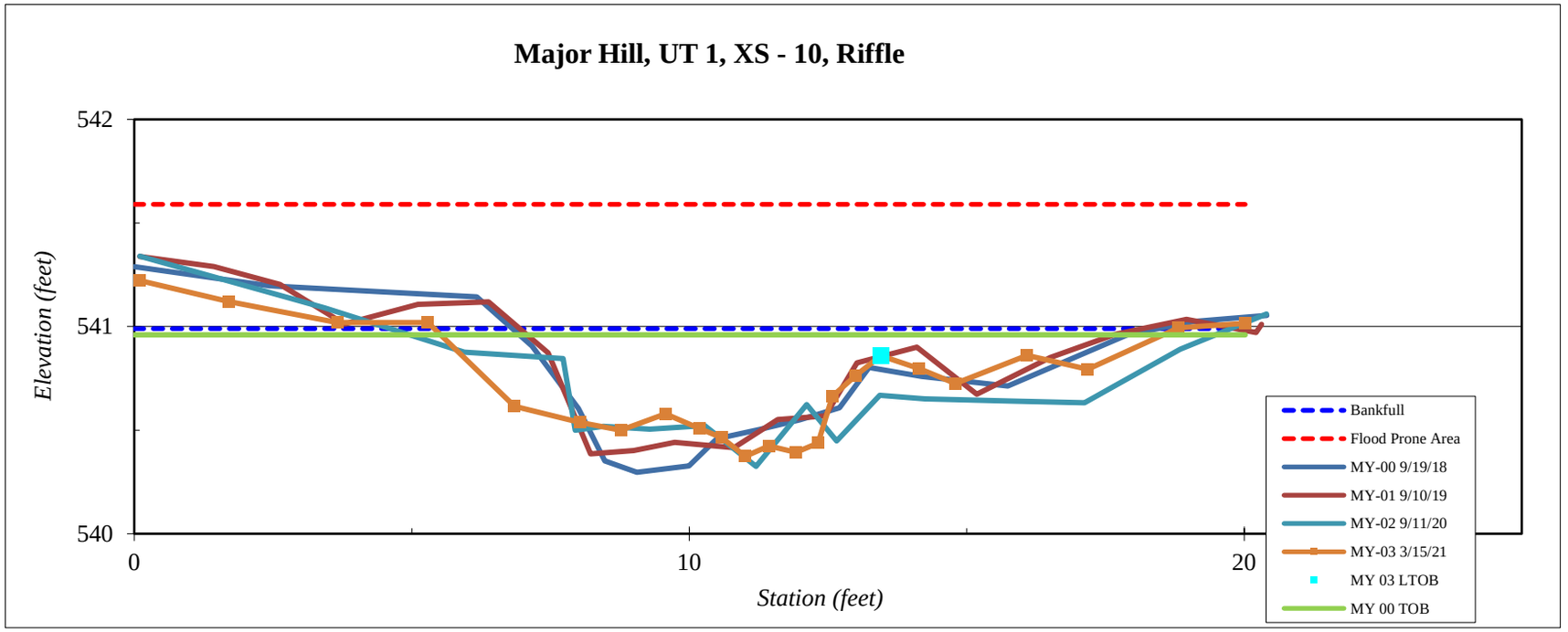


Site	Major Hill
Watershed:	Cape Fear, 0303002
XS ID	UT 1, XS - 10, Riffle
Feature	Riffle
Date:	3/15/2021
Field Crew:	Adams, Lawson

Station	Elevation
0.1	541.22
1.7	541.12
3.7	541.02
5.3	541.02
6.9	540.62
8.0	540.54
8.8	540.50
9.6	540.58
10.2	540.51
10.6	540.46
11.0	540.37
11.4	540.42
11.9	540.39
12.3	540.44
12.6	540.66
13.0	540.76
13.5	540.86
14.1	540.80
14.8	540.73
16.1	540.86
17.2	540.79
18.8	541.0
20.0	541.0

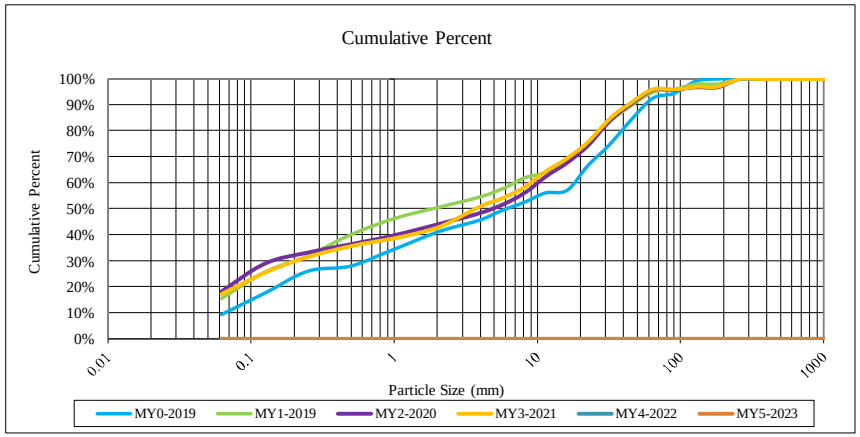
SUMMARY DATA	
Bankfull Elevation:	541.0
LTOB Elevation:	540.9
Bankfull Cross-Sectional Area:	3.5
Bankfull Width:	9.4
Flood Prone Area Elevation:	541.6
Flood Prone Width:	40.0
Max Depth at Bankfull:	0.6
Low Bank Height:	0.5
Mean Depth at Bankfull:	0.4
W / D Ratio:	0.3
Entrenchment Ratio:	4.3
Bank Height Ratio:	0.8

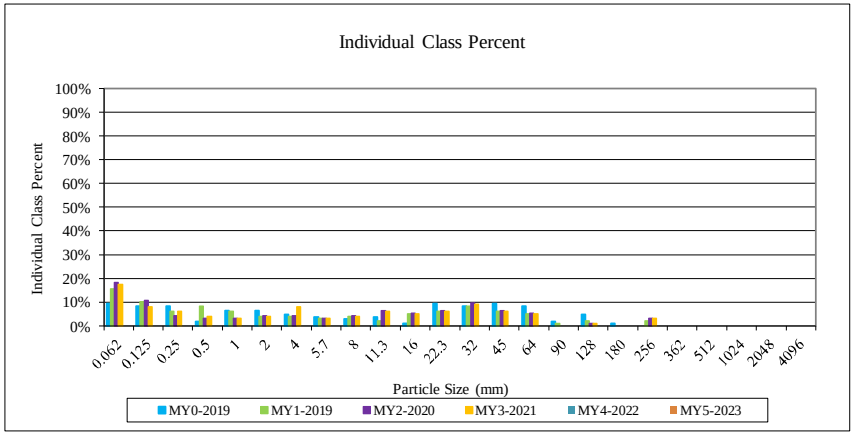
Stream Type	C/E



Project Name: Major Hill					
UT1 Reachwide					
All Features					
			2021		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	17	17%	36%
Sand	very fine sand	0.125	8	8%	44%
	fine sand	0.250	6	6%	48%
	medium sand	0.50	4	4%	48%
	coarse sand	1.00	3	3%	56%
	very coarse sand	2.0	4	4%	60%
Gravel	very fine gravel	4.0	8	8%	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	9%	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			98	100%	100%

Summary Data	
D50	3.7
D84	31
D95	60





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
Soil Temperature Graph
Figure E1. 30-70 Percentile Graph for Rainfall
Groundwater Gauge Graphs

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

UT1 Upstream Channel Evidence	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)
Max consecutive days channel flow	99	158	136
Presence of litter and debris (wracking)	Yes	Yes	Yes
Leaf litter disturbed or washed away	Yes	Yes	Yes
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes	Yes	Yes
Sediment deposition and/or scour indicating sediment transport	Yes	Yes	Yes
Water staining due to continual presence of water	Yes	Yes	Yes
Formation of channel bed and banks	Yes	Yes	Yes
Sediment sorting within the primary path of flow	Yes	Yes	Yes
Sediment shelving or a natural line impressed on the banks	Yes	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	Yes
Development of channel pattern (meander bends and/or channel braiding) at natural topographic breaks, woody debris piles, or plant root systems	Yes	Yes	Yes
Exposure of woody plant roots within the primary path of flow	No	Yes	Yes
Other:			

UT1 Upstream Channel Evidence

Major Hill Stream Flow Gauge UT1 Upstream
Year 3 (2021 Data)

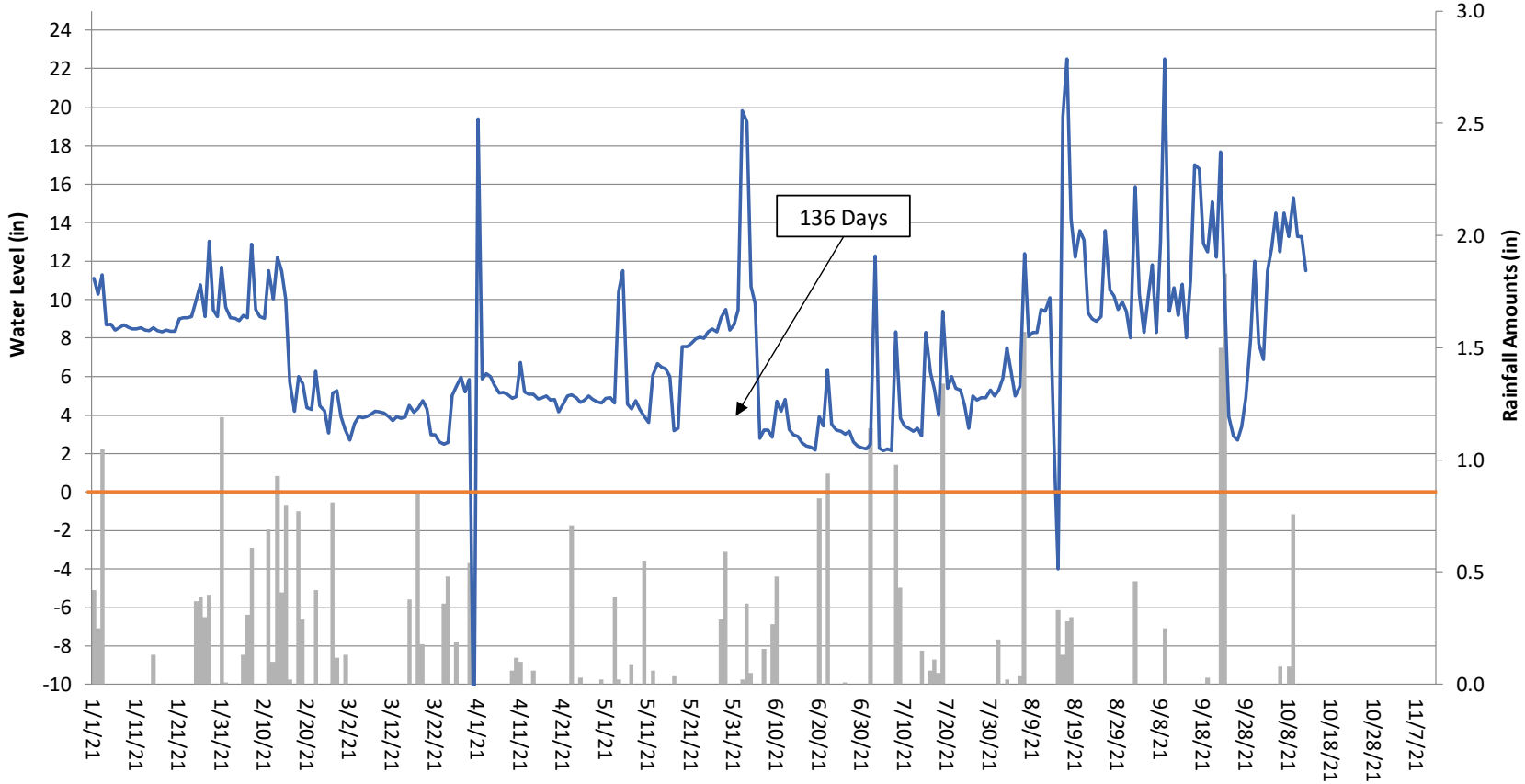


Table 14B. UT1 Downstream Channel Evidence – Major Hill Restoration Site

UT1 Downstream Channel Evidence	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)
Max consecutive days channel flow	52	236	285
Presence of litter and debris (wracking)	Yes	Yes	Yes
Leaf litter disturbed or washed away	Yes	Yes	Yes
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes	Yes	Yes
Sediment deposition and/or scour indicating sediment transport	Yes	Yes	Yes
Water staining due to continual presence of water	Yes	Yes	Yes
Formation of channel bed and banks	Yes	Yes	Yes
Sediment sorting within the primary path of flow	Yes	Yes	Yes
Sediment shelving or a natural line impressed on the banks	Yes	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	Yes
Development of channel pattern (meander bends and/or channel braiding) at natural topographic breaks, woody debris piles, or plant root systems	Yes	Yes	Yes
Exposure of woody plant roots within the primary path of flow	No	Yes	Yes
Other:		Bankfull event documented.	

UT1 Downstream Channel Evidence

Major Hill Stream Flow Gauge UT1 Downstream
Year 3 (2021 Data)

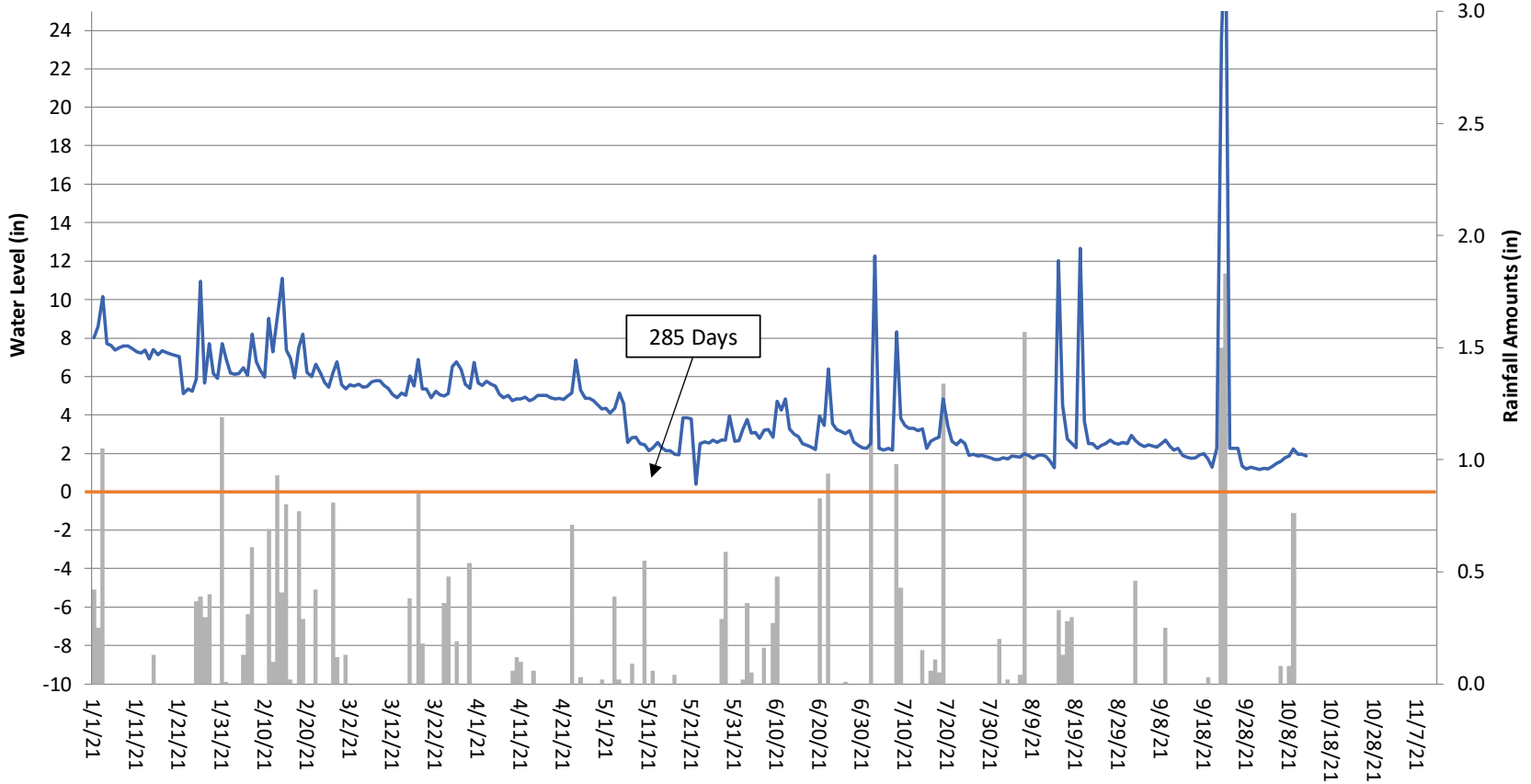


Table 15. Verification of Bankfull Events

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 of rain was recorded at an onsite rain gauge	3
January 31, 2021	January 31, 2021	A bankfull event was documented via trail camera after approximately 1.19 inches of rain was recorded at an onsite rain gauge	4
March 11, 2021	February 15, 2021	Wrack and laid-back vegetation were observed along the top of bank and floodplain of UT-1 indicating a bankfull event occurred after 2.93 inches of rain was documented between February 11 and 15, 2021.	5

Photo 1

Photo 2


Photo 3
29.23 inHg 64°F 04/13/2020 07:31AM MH DS


Photo 4
29.67 inHg -47155°F 01/31/2021 10:00AM MH DS

Photo 5

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	Yes/74 days 31.4 percent				
2	No/19 days* 8.1 percent	No/19 days 8.0 percent	No/21 days 8.9 percent				
3	Yes/25 days 10.6 percent	Yes/235 days 100 percent	Yes/226 days 95.8 percent				
4	Yes/34 days 14.5 percent	Yes/72 days 30.5 percent	Yes/60 days 25.4 percent				
5	Yes/119 days 50.6 percent	Yes/135 days 57.4 percent	Yes/53 days 22.5 percent				
6	Yes/77 days 32.8 percent	Yes/44 days 18.7 percent	Yes/80 days 33.9 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.

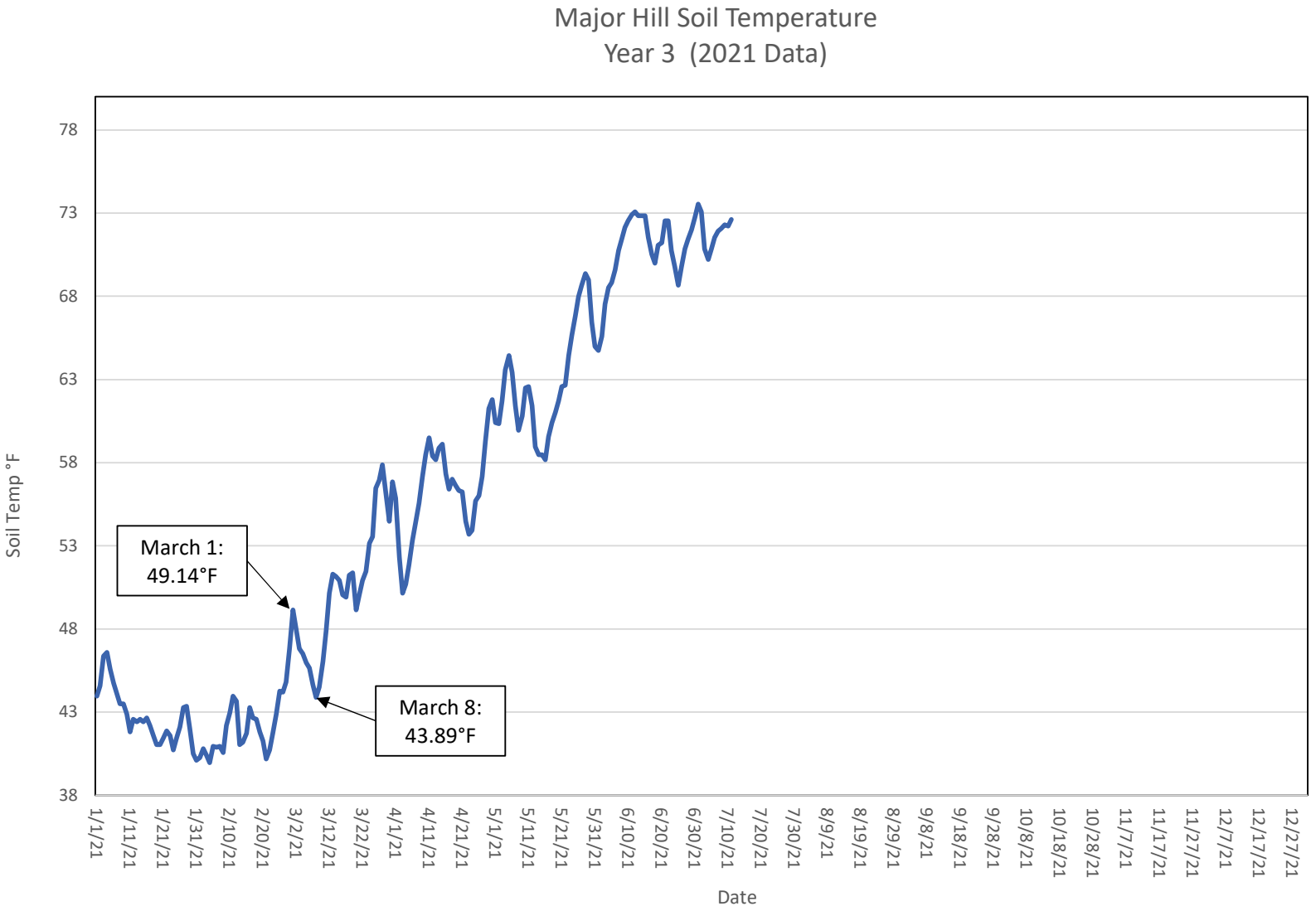
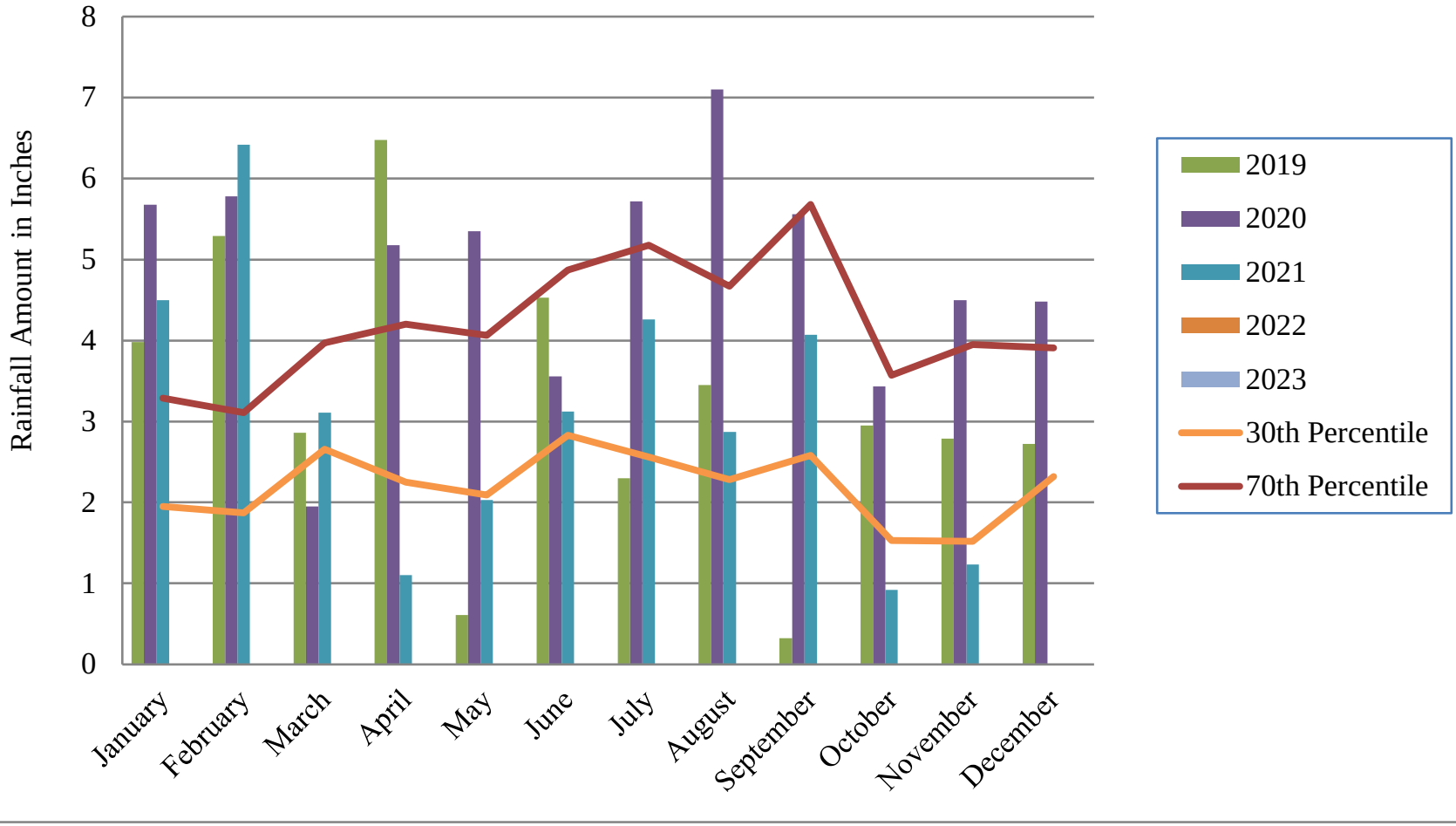
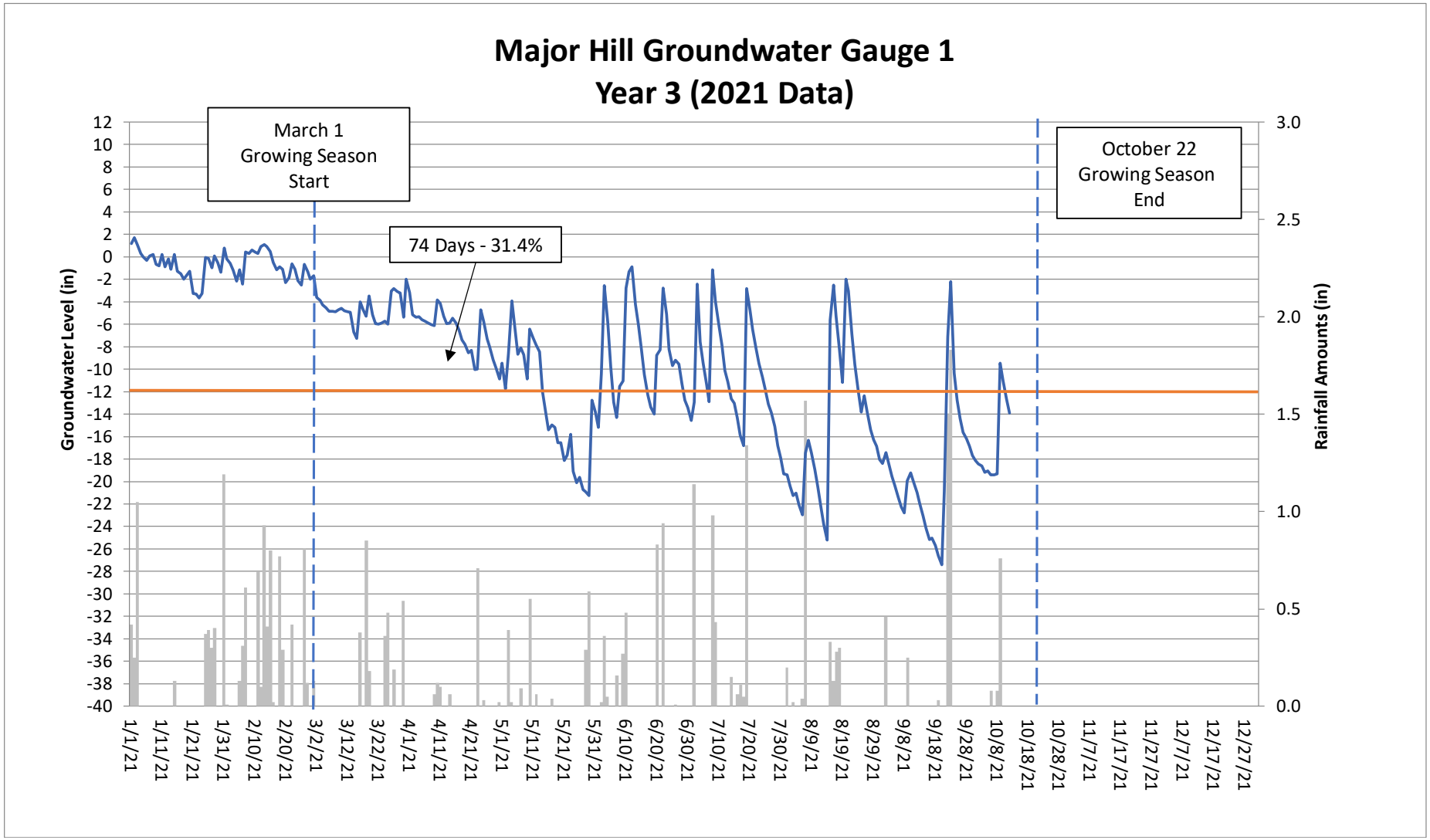

Major Hill Soil Temperature
Year 3 (2021 Data)
Soil Temp °F
78
73
68
63
58
53
48
43
38
March 1:
49.14°F
March 8:
43.89°F
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
10/8/21
10/18/21
10/28/21
11/7/21
11/17/21
11/27/21
12/7/21
12/17/21
12/27/21
Date

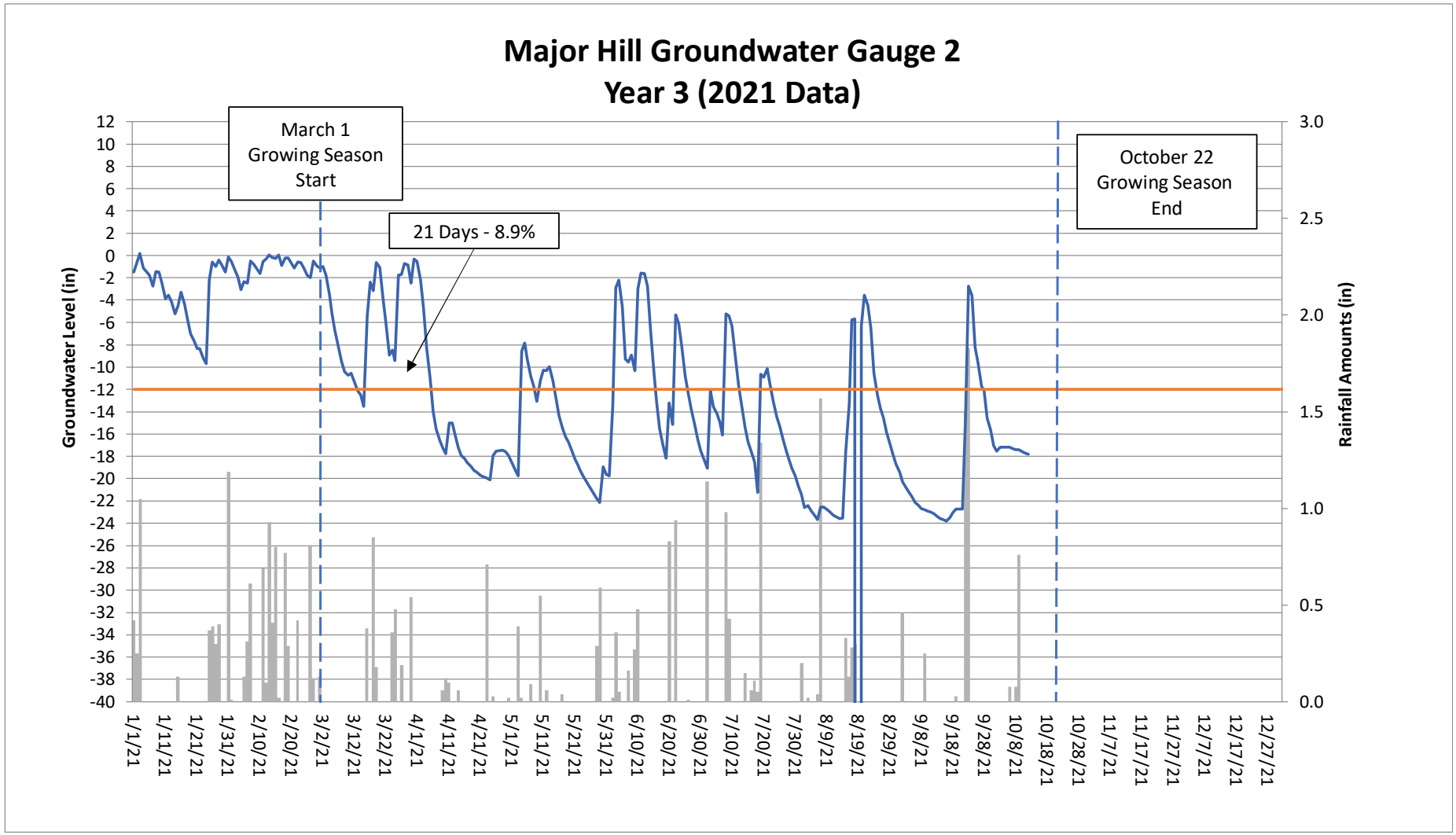
Figure E1: Major Hill
30-70 Percentile Graph for Rainfall

Current year data from onsite rain gauge

30-70th percentile data from WETS Station: Burlington Alamance Regional Airport, NC




Major Hill Groundwater Gauge 1
Year 3 (2021 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
74 Days - 31.4%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
10/8/21
10/18/21
10/28/21
11/7/21
11/17/21
11/27/21
12/7/21
12/17/21
12/27/21


Major Hill Groundwater Gauge 2
Year 3 (2021 Data)
March 1
Growing Season
Start
21 Days - 8.9%
October 22
Growing Season
End
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
10/8/21
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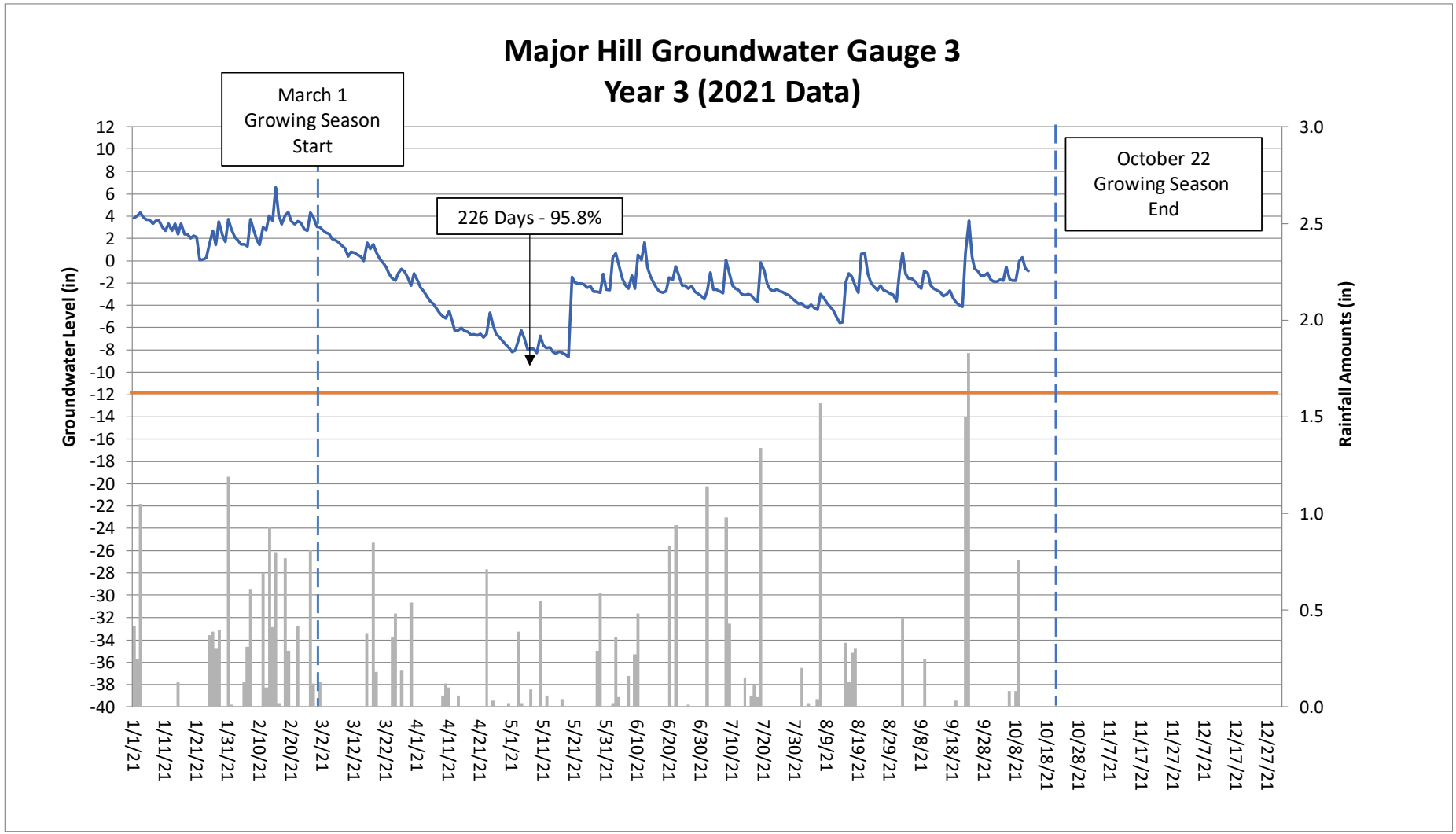
12/17/21
12/27/21


Major Hill Groundwater Gauge 3
Year 3 (2021 Data)
March 1
Growing Season
Start
226 Days - 95.8%
October 22
Growing Season
End
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
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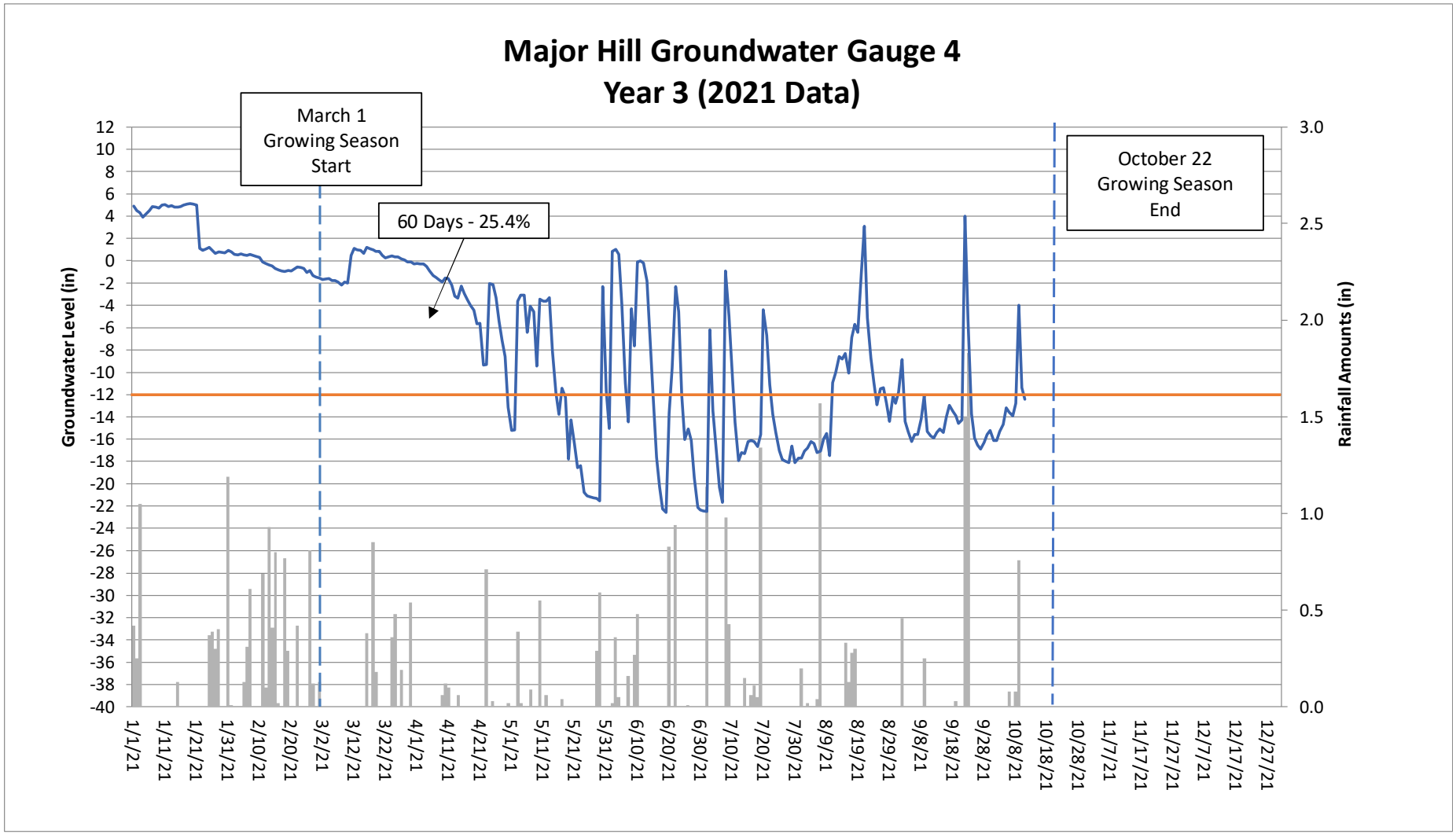
12/17/21
12/27/21


Major Hill Groundwater Gauge 4
Year 3 (2021 Data)
March 1
Growing Season
Start
60 Days - 25.4%
October 22
Growing Season
End
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
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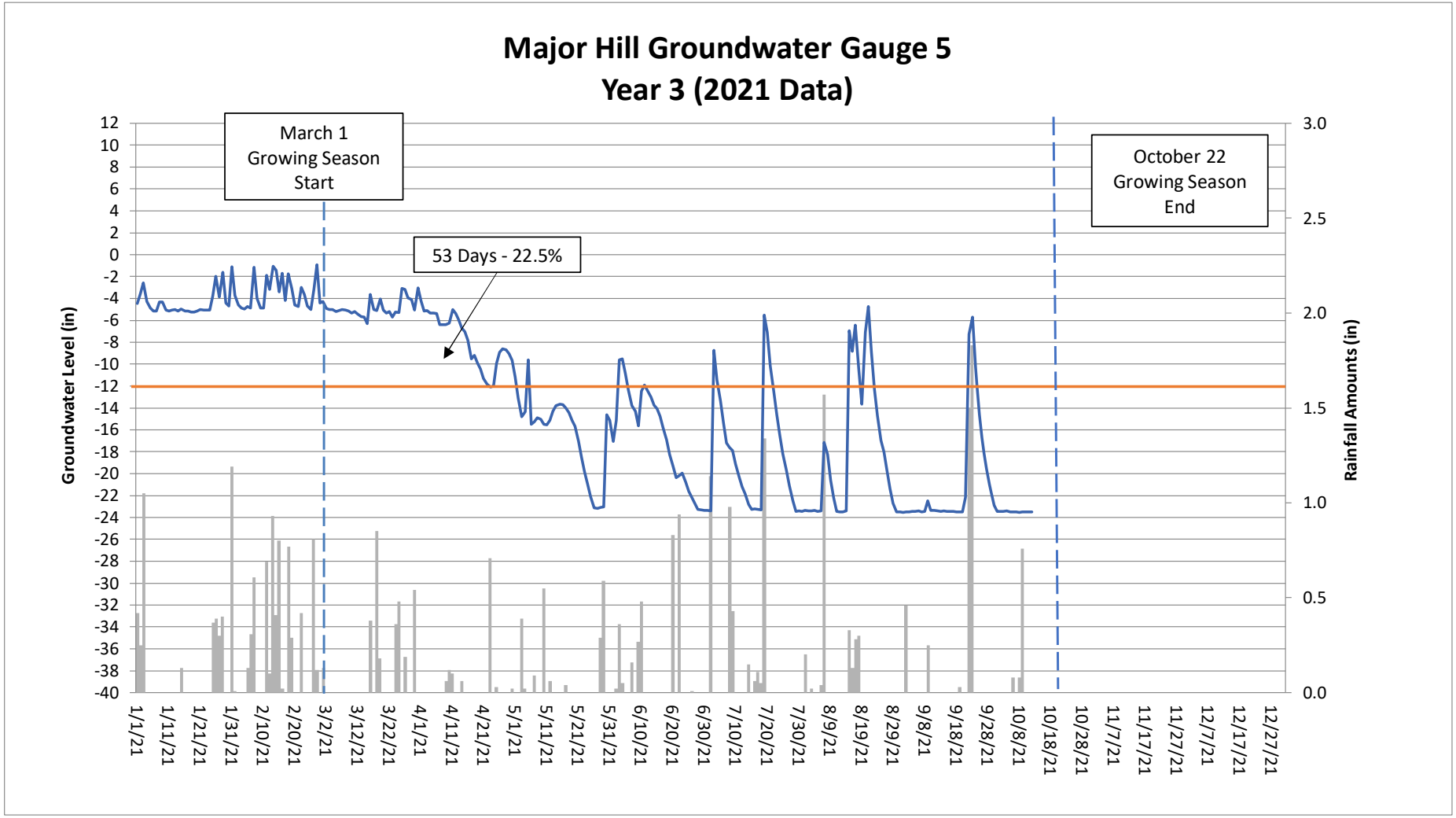
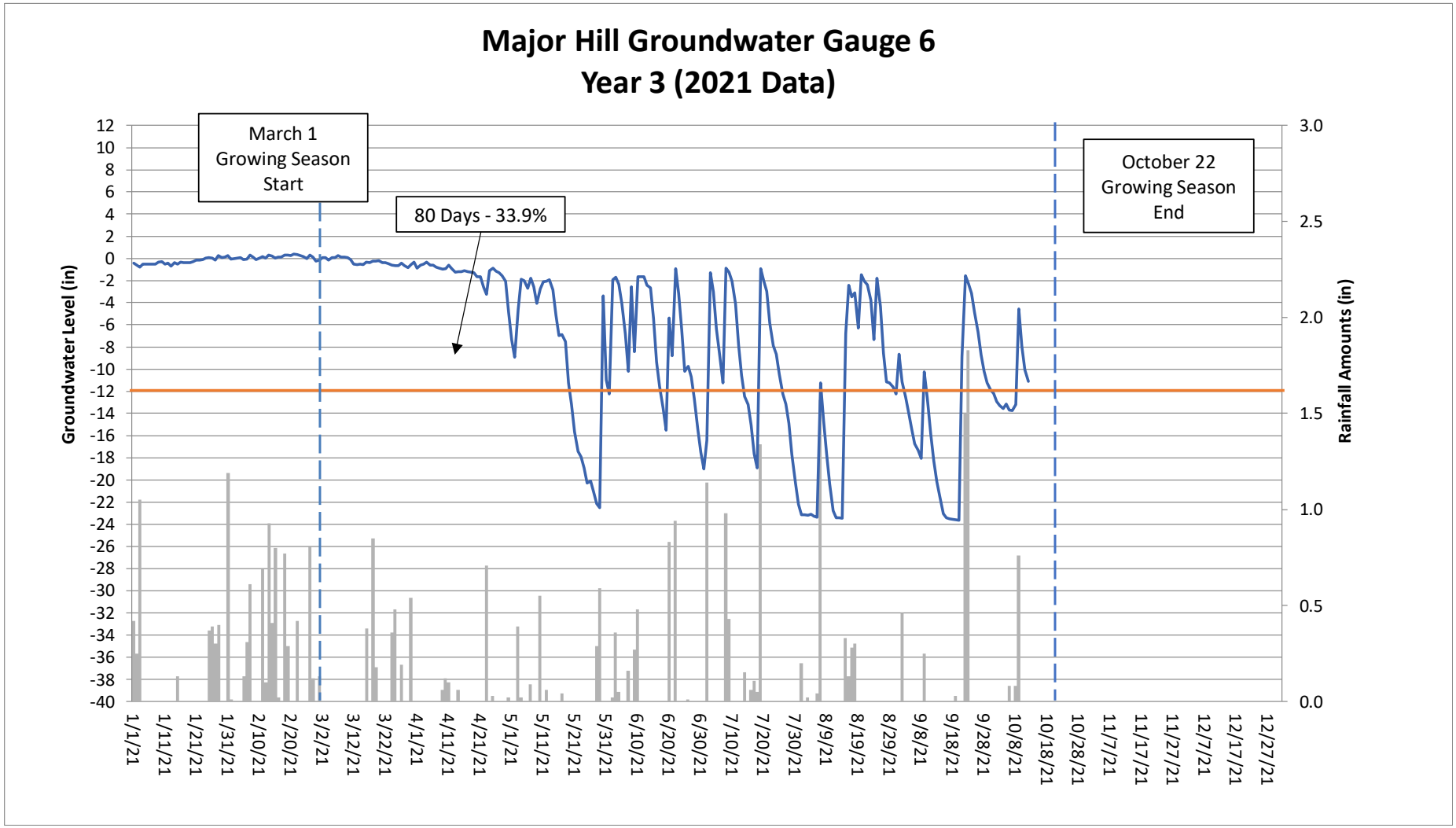
12/17/21
12/27/21


Major Hill Groundwater Gauge 5
Year 3 (2021 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
53 Days - 22.5%
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
10/8/21
10/18/21
10/28/21
11/7/21
11/17/21
11/27/21
12/7/21
12/17/21
12/27/21


Major Hill Groundwater Gauge 6
Year 3 (2021 Data)
March 1
Growing Season
Start
80 Days - 33.9%
October 22
Growing Season
End
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
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/21
1/11/21
1/21/21
1/31/21
2/10/21
2/20/21
3/2/21
3/12/21
3/22/21
4/1/21
4/11/21
4/21/21
5/1/21
5/11/21
5/21/21
5/31/21
6/10/21
6/20/21
6/30/21
7/10/21
7/20/21
7/30/21
8/9/21
8/19/21
8/29/21
9/8/21
9/18/21
9/28/21
10/8/21
10/18/21
10/28/21
11/7/21
11/17/21
11/27/21
12/7/21
12/17/21
12/27/21

Appendix F.
Benthic Data

Benthic Results
Habitat Datasheets

PAI ID NO			54832	54833
STATION			Major Hill Uptream	Major Hill Downstream
DATE			5/19/2021	5/19/2021
SPECIES	Tolerance Value	Functional Feeding Group		
PLATYHELMINTHES				
Turbellaria		P		
Tricladida		P		
Planariidae		O		
Phagocata sp.				1
MOLLUSCA				
Bivalvia				
Veneroida				
Sphaeriidae		FC		
Pisidium sp.	6.6	FC	2	
Gastropoda				
Basommatophora				
Lymnaeidae		SC		
Pseudosuccinea columella	7.7	CG		
Physidae				
Physella sp.	8.7	CG		
ANNELIDA				
Oligochaeta		CG		
Tubificida				
Naididae		CG		
Naidinae		CG	3	
Dero sp.	9.8	CG	1	
Tubificinae w.h.c.		CG	1	
Tubificinae w.o.h.c.		CG	5	
Lumbriculida				
Lumbriculidae		CG		
Lumbriculus sp.		CG		
Hirudinea		8		
Arhynchobdellida				
Erpobdellidae			3	
ARTHROPODA				
Crustacea				
Ostracoda				
Isopoda				
Asellidae		SH		
Caecidotea sp.	8.4	CG	1	11
Amphipoda		CG		
Crangonyctidae				
Crangonyx sp.	7.2	CG	17	3
Insecta				
Ephemeroptera				
Baetidae		CG		
Baetis intercalaris	5	CG		
Baetis pluto	3.4			
Baetis tricaudatus	1.5	CG		

STATION			Major Hill Uptream	Major Hill Downstream
DATE			5/19/2021	5/19/2021
SPECIES	Tolerance Value	Functional Feeding Group		
Callibaetis fluctuans	9.2	CG		
Callibaetis sp.	9.2	CG	2	
Diphetor hageni	1.1	CG		
Labiobaetis frondalis	4.6			
Labiobaetis propinquus	5.8			
Baetiscidae		CG		
Baetisca carolina	4.2			
Ephemerellidae		SC		
Dannella provonshai		SC		
Ephemerella invaria gp.	2.6	CG		
Heptageniidae		SC		
Epeorus dispar	1	CG		
Maccaffertium carlsoni	2.1	SC		
Maccaffertium modestum	5.7	SC		5
Maccaffertium sp.		SC		
Stenacron interpunctatum	6.4	SC		2
Isonychiidae		FC		
Isonychia sp.	3.6	FC		
Leptophlebiidae		CG		
Habrophlebiodes brunneipennis				
Habrophlebiodes sp.				
Odonata				
Aeshnidae		P	1	
Boyeria vinosa	5.8	P		
Calopterygidae		P		
Calopteryx sp.	7.5	P		
Coenagrionidae		P		
Argia sp.	8.3	P		
Ischnura sp.	9.5		1	
Cordulegastridae		P		
Cordulegaster maculata	5.7			
Gomphidae		P		
Lanthus sp.	1.6	P		
Ophiogomphus sp.	5.9	P		
Stylogomphus albistylus	5	P		
Libellulidae		P		
Libellula sp.	9.4	P		
Pachydiplax longipennis	9.6		1	
Plecoptera				
Leuctridae		SH		
Leuctra sp.	1.5	SH		
Paraleuctra sara				
Nemouridae		SH		
Amphinemura nigritta	3.8	SH		
Perlidae		P		
Acroneuria cf filicis		P		

STATION			Major Hill Uptream	Major Hill Downstream
DATE			5/19/2021	5/19/2021
SPECIES	Tolerance Value	Functional Feeding Group		
Eccoptura xanthenes	4.7	**P**		
Perlesta frisoni	2.9	**P**		
Perlesta sp.	2.9	**P**		26
Perlodidae		**P**		
Isoperla holochlora	0.7	**P**		
Remensus bilobatus	0.9	**-**		
Hemiptera				
Belostomatidae				
Belostoma sp.	9.5	**P**	7	
Corixidae		**PI**	9	2
Veliidae		**P**		
Microvelia sp.		**P**		
Megaloptera				
Sialidae		**P**		
Sialis sp.	7	**P**		1
Trichoptera				
Hydropsychidae		**FC**		
Cheumatopsyche sp.	6.6	**FC**		25
Diplectrona modesta	2.3	**FC**		
Hydropsyche depravata gp.	7.9	**FC**		
Philopotamidae		**FC**		
Chimarra sp.	3.3	**FC**		10
Dolophilodes distinctus	1	**FC**		
Coleoptera				
Dryopidae				
Helichus basalis	*0.5*	**SC**		
Helichus fastigiatus	*4.1*	**SC**		
Dytiscidae		**P**		
Laccophilus sp.	*9.8*	**P**		
Neoporus sp.	5		2	
Elmidae		**CG**		
Stenelmis sp.	*5.6*	**SC**		2
Haliplidae				
Peltodytes muticus	*8.4*	**SH**	2	
Hydrophilidae		**P**		
Helophorus lineatus				
Tropisternus sp.	*9.3*	**P**	3	
Psephenidae		**SC**		
Psephenus herricki	*2.3*	**SC**		
Staphylinidae		**P**		
Diptera				
Chironomidae				
Chironomus sp.	*9.3*	**CG**		
Conchapelopia sp.	8.4	**P**	1	4
Cricotopus sp.				
Cryptochironomus sp.	*6.4*	**P**		1

STATION			Major Hill Uptream	Major Hill Downstream
DATE			5/19/2021	5/19/2021
SPECIES	Tolerance Value	Functional Feeding Group		
Dicrotendipes neomodestus	*7.9*	**CG**		2
Microtendipes pedellus gp.	*3.9*	**CG**		6
Odontomesa fulva	*4.9*			
Paracladopelma undine	*4.5*		2	
Parametriocnemus sp.	*3.9*	**CG**		1
Paratendipes albimanus/duplicatus	*5.6*		2	2
Polypedilum aviceps	*3.6*	**SH**		5
Polypedilum illinoense gp.	*8.7*	**SH**		2
Procladius sp.	*8.8*	**P**		2
Psectrocladius dyari	*10*		15	
Rheotanytarsus exiguus gp.	*6.5*	**FC**		
Stictochironomus devinctus	*5.4*	**CG**		1
Tanytarsus sp.	*6.6*	**FC**		
Zavrelia sp.	*6.1*	**CG**		1
Culicidae		**FC**	1	
Anopheles sp.	*8.6*	**FC**	1	
Culex sp.		**FC**		
Dixidae		**CG**		
Dixa sp.	*2.5*	**CG**		
Dixella sp.	4.9	**CG**		2
Ephydridae		**PI**		
Psychodidae		**CG**		
Pericoma sp.		**CG**		
Sciomyzidae				
Sciaridae				
Tipulidae		**SH**		
Dicranota sp.	*0*	**P**		
Limnophila sp.		**P**		
Pseudolimnophila sp.	*6.2*	**P**		
Tipula sp.	*7.5*	**SH**		2
TOTAL NO. OF ORGANISMS			**133088**	**133124**
TOTAL NO. OF TAXA			**26**	**27**
EPT TAXA			**3**	**7**
BIOTIC INDEX ASSIGNED VALUES			**8.47**	**5.63**

MM UT 1 DS
MAJOR HILL DOWN

3/06 Revision 6

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Unit, DWQ **TOTAL SCORE** 95

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

Stream Major Hill UT 1 Down Location/road: _____ (Road Name _____) County Alamance

Date 2/05/19 CC# 03030002 Basin Cane Creek Subbasin 03-06-04

Observer(s) MA + AK Type of Study: ☐ Fish ☒ Benthos ☐ Basinwide ☐ Special Study (Describe) _____

Latitude 36.873213 Longitude -79.358804 Ecoregion: ☐ MT ☐ P ☐ Slate Belt ☐ Triassic Basin

Water Quality: Temperature 15.5 °C DO 5.68 mg/l Conductivity (corr.) 135 µS/cm pH 7.22

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

Visible Land Use: _____%Forest _____%Residential _____%Active Pasture _____% Active Crops
_____%Fallow Fields _____% Commercial _____%Industrial _____%Other - Describe: _____

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

Width: (meters) Stream 5.2 Channel (at top of bank) 8 **Stream Depth:** (m) Avg 5" Max 10"
☐ Width variable ☐ Large river >25m wide

Bank Height (from deepest part of riffle to top of bank-first flat surface you stand on): (m) 2-3

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

☐ Channelized Ditch
☐Deeply incised-steep, straight banks ☐Both banks undercut at bend ☐Channel filled in with sediment
☐ Recent overbank deposits ☐Bar development ☐Buried structures ☐Exposed bedrock
☐ Excessive periphyton growth ☐ Heavy filamentous algae growth ☐Green tinge ☐ Sewage smell
Manmade Stabilization: ☐N ☐Y: ☐Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐Berm/levee
Flow conditions : ☐High ☒Normal ☐Low
Turbidity: ☒Clear ☐ Slightly Turbid ☐Turbid ☐Tannic ☐Milky ☐Colored (from dyes)
Good potential for Wetlands Restoration Project?? ☐ **YES** ☐**NO Details** _____
Channel Flow Status
Useful especially under abnormal or low flow conditions.

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

Weather Conditions: Sunny, 75° **Photos:** ☐N ☐Y ☐ Digital ☐35mm

Remarks: _____

Heron WTP

I. Channel Modification

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

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

Remarks _____ Subtotal 5

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

✓ **Rocks** ____**Macrophytes** ✓ **Sticks and leafpacks** ____**Snags and logs** ____**Undercut banks or root mats**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

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

☐ No woody vegetation in riparian zone Remarks _____ Subtotal 18

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

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

Remarks _____ Subtotal 12

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

	Score
A. Pools present	
1. Pools Frequent (>30% of 200m area surveyed)	
a. variety of pool sizes	(10)
b. pools about the same size (indicates pools filling in)	8
2. Pools Infrequent (<30% of the 200m area surveyed)	
a. variety of pool sizes	6
b. pools about the same size	4
B. Pools absent	0

Subtotal 10

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

Remarks _____

Page Total 45

Mean 4 & 10

V. Riffle Habitats

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

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

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

Subtotal 16

VI. Bank Stability and Vegetation

FACE UPSTREAM	Left Bank Score	Rt. Bank Score
A. Banks stable		
1. little evidence of erosion or bank failure(except outside of bends), little potential for erosion..	7	7
B. Erosion areas present		
1. diverse **trees**, shrubs, grass; plants healthy with good root systems.....	6	6
2. few trees or small trees and **shrubs**; vegetation appears generally healthy.....	5	5
3. sparse **mixed** vegetation; plant types and conditions suggest poorer soil binding.....	3	3
4. mostly **grasses**, few if any trees and shrubs, high erosion and failure potential at high flow..	2	2
5. little or no bank vegetation, mass erosion and bank failure evident.....	0	0

Total 14

Remarks _____

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

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

Remarks _____ Subtotal 10

VIII. Riparian Vegetative Zone Width

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

FACE UPSTREAM

Dominant vegetation: ☐Trees ☐ Shrubs ☐Grasses ☐ Weeds/old field ☐Exotics (kudzu, etc)

	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. width > 18 meters.....	5	5
2. width 12-18 meters.....	4	4
3. width 6-12 meters.....	3	3
4. width < 6 meters.....	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. width > 18 meters.....	4	4
b. width 12-18 meters.....	3	3
c. width 6-12 meters.....	2	2
d. width < 6 meters.....	1	1
2. breaks common		
a. width > 18 meters.....	3	3
b. width 12-18 meters.....	2	2
c. width 6-12 meters.....	1	1
d. width < 6 meters.....	0	0

Remarks _____ Total 10

Page Total 50

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

TOTAL SCORE 95

MH UT1-up

3/06 Revision 6

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Unit, DWQ

TOTAL SCORE 88

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

Stream Major-Hill UT1 up Location/road: Major Hill (Road Name ______)County Alamance

Date 210519 CC# 03030002 Basin Cape Fear Subbasin 03-06-04

Observer(s) MA + AK Type of Study: ☐ Fish ☒ Benthos ☐ Basinwide ☐ Special Study (Describe) ______

Latitude 35.814390 Longitude -79.359219 Ecoregion: ☐ MT ☐ P ☐ Slate Belt ☐ Triassic Basin

Water Quality: Temperature 73.2°F °C DO 5.68 mg/l Conductivity (corr.) 135.4 µS/cm pH 7.22

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

Visible Land Use: 15 %Forest ______ %Residential ______ %Active Pasture ______ % Active Crops
______ %Fallow Fields ______ % Commercial ______ %Industrial ______ %Other - Describe: ______

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

Width: (meters) Stream 4-5 Channel (at top of bank) 5 **Stream Depth:** (m) Avg < 2'' Max 6''
☑ Width variable ☐ Large river >25m wide

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

Bank Angle: 45 ° or ☐ NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)

☐ Channelized Ditch
☐ Deeply incised-steep, straight banks ☐ Both banks undercut at bend ☐ Channel filled in with sediment
☐ Recent overbank deposits ☐ Bar development ☐ Buried structures ☐ Exposed bedrock
☐ Excessive periphyton growth ☐ Heavy filamentous algae growth ☐ Green tinge ☐ Sewage smell
Manmade Stabilization: ☐ N ☐ Y: ☐ Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐ Berm/levee
Flow conditions : ☐ High ☐ Normal ☑ Low
Turbidity: ☐ Clear ☑ Slightly Turbid ☐ Turbid ☐ Tannic ☐ Milky ☐ Colored (from dyes)
Good potential for Wetlands Restoration Project?? ☐ YES ☐ NO Details ______

Channel Flow Status

Useful especially under abnormal or low flow conditions.

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

Weather Conditions: Sunny-75° **Photos:** ☐ N ☐ Y ☐ Digital ☐ 35mm

Remarks: three year old stream restoration

Heron UT1 4A

I. Channel Modification Score

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

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

Remarks Restored Channel Subtotal 5

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

✓ **Rocks** ___ **Macrophytes** ___ **Sticks and leafpacks** ___ **Snags and logs** ✓ **Undercut banks or root mats**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

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

☐ No woody vegetation in riparian zone Remarks Subtotal 18

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

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

Remarks Subtotal 8

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

	Score
A. Pools present	
1. Pools Frequent (>30% of 200m area surveyed)	
a. variety of pool sizes	(10)
b. pools about the same size (indicates pools filling in)	8
2. Pools Infrequent (<30% of the 200m area surveyed)	
a. variety of pool sizes	6
b. pools about the same size	4
B. Pools absent	0

Subtotal 10

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

Remarks

Page Total 41

Hou-4T14d

V. Riffle Habitats

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

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

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

Subtotal 16

VI. Bank Stability and Vegetation

FACE UPSTREAM

	Left Bank Score	Rt. Bank Score
A. Banks stable		
1. little evidence of erosion or bank failure(except outside of bends), little potential for erosion..	7 (circled)	7 (circled)
B. Erosion areas present		
1. diverse **trees**, shrubs, grass; plants healthy with good root systems....................................	6	6
2. few trees or small trees and **shrubs**; vegetation appears generally healthy..........................	5	5
3. sparse **mixed** vegetation; plant types and conditions suggest poorer soil binding................	3	3
4. mostly **grasses**, few if any trees and shrubs, high erosion and failure potential at high flow..	2	2
5. little or no bank vegetation, mass erosion and bank failure evident...	0	0

Total 14

Remarks ____

VII. Light Penetration

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

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

Remarks ____ Subtotal 7

VIII. Riparian Vegetative Zone Width

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

FACE UPSTREAM

Dominant vegetation: ☑ Trees ☑ Shrubs ☑ Grasses ☐ Weeds/old field ☐Exotics (kudzu, etc)

	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. width > 18 meters..	5 (circled)	5 (circled)
2. width 12-18 meters..	4	4
3. width 6-12 meters..	3	3
4. width < 6 meters..	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. width > 18 meters..	4	4
b. width 12-18 meters..	3	3
c. width 6-12 meters..	2	2
d. width < 6 meters..	1	1
2. breaks common		
a. width > 18 meters..	3	3
b. width 12-18 meters..	2	2
c. width 6-12 meters..	1	1
d. width < 6 meters..	0	0

Remarks ____ Total 10

Page Total 47

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

TOTAL SCORE 88

Appendix G.
Riparian Buffer Year 3 (2021) Monitoring Report

FINAL RIPARIAN BUFFER MY3 (2021) 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

November 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

Tables

Attachments

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	Jan-22
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)

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)	If Converted to Nutrient Offset: Nutrient Offset: N (lbs)	If Converted to Nutrient Offset: 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. 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 397 hardwood tree stems per acre (excluding livestakes, shrubs, pines, and vines) at year 3 (2021). In addition, all but three permanent plots met success criteria based on planted stems alone. Plots 1 and 5 meet success criteria when including naturally recruited stems of green ash (*Fraxinus pennsylvanica*), willow oak (*Quercus phellos*), and red oak (*Quercus rubra*). Additionally, three temporary vegetation transects also 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 3 (2021) Annual Monitoring Report*.

Table 5. Riparian Buffer Vegetation Totals

Plot #	Success Criteria Met?	MY 3 (2021) Planted Stems/Ac	MY 3 (2021) All Stems/Ac
1	Yes	202	324
2	Yes	324	324
3	Yes	405	486
4	No	202	202
5	Yes	243	283
6	Yes	486	526
7	Yes	445	445
8	Yes	607	647
T-1	Yes	--	445
T-2	Yes	--	324
T-3	Yes	--	364
Average Planted Stems/Acre	**Yes**	**364**	**397**

4.4 2022 Maintenance and Management

Restoration Systems continues to monitor fescue onsite and is planning an additional treatment in April of 2022. Based on permanent and random vegetation monitoring plots and visual observations, planted stems are establishing within areas where fescue was a concern. At this time, no additional planting is proposed.

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

			Current Plot Data (MY3 2021)																					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			MY3 (2021)			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	PnoLS	P-all	T
Acer rubrum	red maple	Tree																															3			
Asimina triloba	pawpaw	Tree										1	1	1							1	1	1				2	2	2	2	2	2	3	3	3	7	7	7
Betula nigra	river birch	Tree										1	1	1							1	1	1	1	1	1	3	3	3	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				1	1	1	11	11	11	10	10	10	14	14	14	5	5	5
Cercis canadensis	eastern redbud	Tree							2	2	2													2	2	2	4	4	4	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	3	1	1	1				1	1	1				4	4	4	8	8	10	9	9	10	9	9	9	5	5	5
Fraxinus	ash	Tree																						1	1	1	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	5	5	5
Fraxinus pennsylvanica	green ash	Tree	2	2	4							1	1	1	1	1	1				1	1	1			1	5	5	8	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	1	1	1	5	5	5
Nyssa sylvatica	blackgum	Tree				1	1	1	1	1	1																2	2	2	2	2	2	4	4	4	10	10	10
Platanus occidentalis	American sycamore	Tree				1	1	1							1	1	1	2	2	3							4	4	5	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										1	1	1	4	4	4	3	3	3	3	3	3	1	1	1	12	12	12	12	12	12	20	20	20	10	10	10
Quercus phellos	willow oak	Tree				2	2	2	2	2	2						1	1	1	1	5	5	5	3	3	3	13	13	14	12	12	12	16	16	16	18	18	18
Quercus rubra	northern red oak	Tree			1																								1									
Unknown		Shrub or Tree																																		6	6	6
		Stem count	5	5	8	8	8	8	10	10	12	5	5	5	6	6	7	12	12	13	11	11	11	15	15	16	72	72	80	75	75	79	103	103	109	129	129	129
		size (ares)	1			1			1			1			1			1			1			1			8			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			0.20		
		Species count	4	4	5	5	5	5	5	5	5	5	5	5	3	3	4	6	6	6	5	5	5	8	8	9	14	14	15	14	14	14	15	15	17	16	16	16
		Stems per ACRE	202.3	202.3	323.7	323.7	323.7	323.7	404.7	404.7	485.6	202.3	202.3	202.3	242.8	242.8	283.3	485.6	485.6	526.1	445.2	445.2	445.2	607	607	647.5	364.2	364.2	404.7	379.4	379.4	399.6	521	521	551.4	652.5556	652.5556	652.5556

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
Year 3 (2021) Planted Stem Height Data

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 MY3
- CVS Plots Not Meeting Success Criteria MY3
- Vegetation Transects Meeting Success Criteria MY3
- 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

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

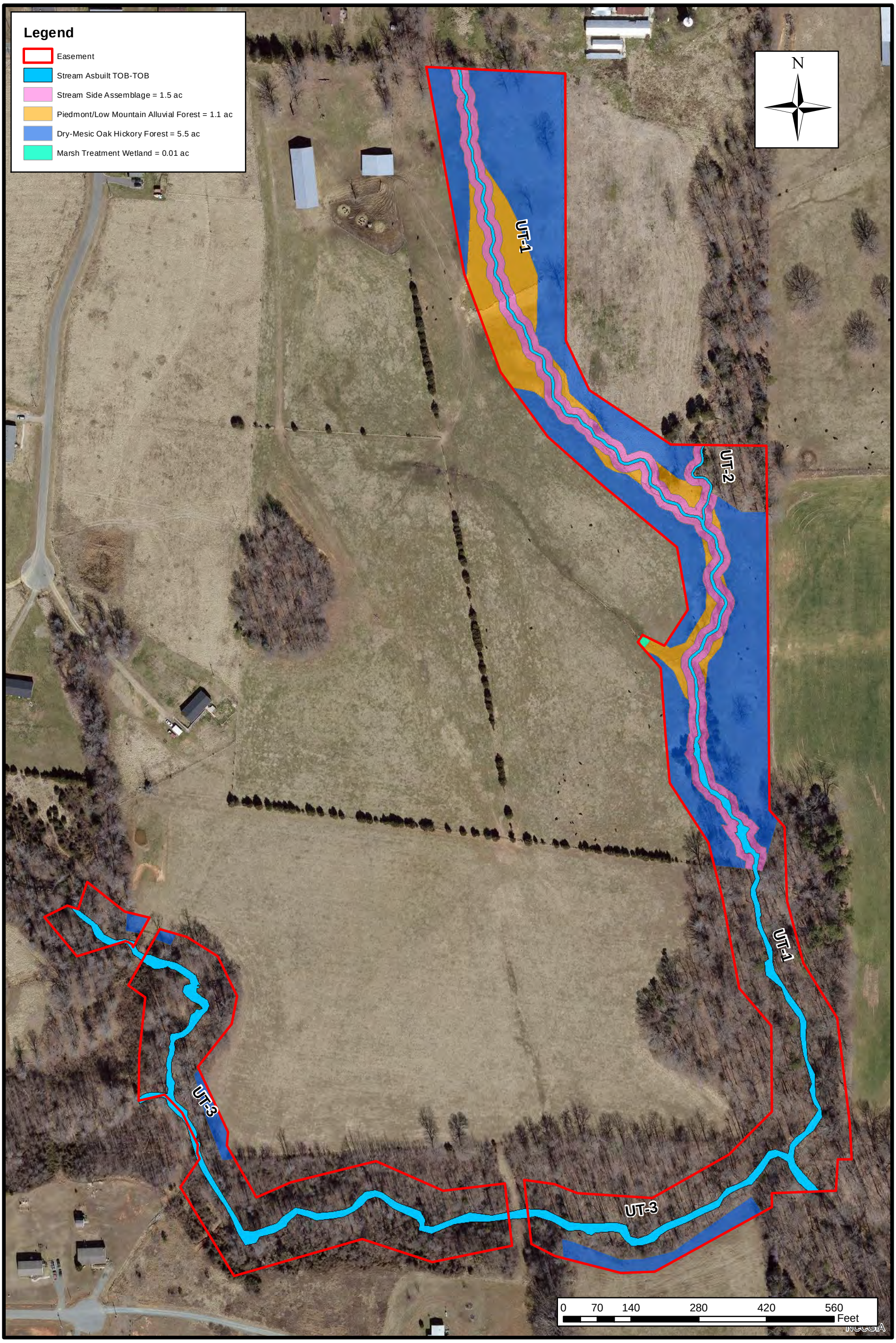
NCCGIA

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



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

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

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

FIGURE
B

Plot	Scientific Name	X	Y	Height (cm)	DBH (cm)	Vigor
1	Liriodendron tulipifera	7.3	1.3	105		4
1	Carpinus caroliniana	9.2	4.1	131		4
1	Quercus	6.6	4.7	63		4
1	Fraxinus pennsylvanica	1.6	3.8	73		4
1	Fraxinus pennsylvanica	6.7	9.7	90		4
2	Quercus phellos	2.9	0.5	190	1	4
2	Carpinus caroliniana	4.8	3.4	88		4
2	Carpinus caroliniana	7.1	6.5	31		2
2	Platanus occidentalis	10.0	7.1	100		3
2	Platanus occidentalis	4.5	10.0	0		Missing
2	Nyssa sylvatica	4.5	8.0	23		3
2	Quercus phellos	1.6	5.9	148	0.5	3
2	Diospyros virginiana	7.8	2.6	82		4
2	Carpinus caroliniana	7.5	4.6	64		4
3	Carpinus caroliniana	2.4	1.4	123		3
3	Quercus phellos	5.3	1.4	123		3
3	Carpinus caroliniana	8.1	1.3	52		2
3	Carpinus caroliniana	6.8	2.7	94		4
3	Quercus phellos	10.0	3.0	43		4
3	Quercus nigra	9.0	7.0	0		Missing
3	Carpinus caroliniana	7.2	8.4	0		Missing
3	Carpinus caroliniana	6.2	6.4	0		Missing
3	Carpinus caroliniana	6.3	5.3	37		4
3	Cercis canadensis	4.2	10.0	10		3
3	Cercis canadensis	1.3	10.0	30		4
3	Diospyros virginiana	1.3	8.1	200	0.8	4
3	Nyssa sylvatica	1.7	5.3	92		4
4	Fraxinus pennsylvanica	7.6	0.9	52		4
4	Quercus nigra	9.6	0.0	0		0
4	Quercus nigra	9.7	3.0	0		Missing
4	Betula nigra	7.6	3.3	50		4
4	Quercus nigra	9.8	7.1	0		Missing
4	Asimina triloba	8.3	8.2	24		1
4	Quercus nigra	6.2	8.0	18		3
4	Quercus nigra	4.8	6.3	0		Missing
4	Diospyros virginiana	2.4	7.2	100		4
4	Cercis canadensis	3.7	8.7	0		Missing
5	Quercus nigra	0.3	1.0	110		4
5	Platanus occidentalis	2.8	0.1	245	3	4
5	Fraxinus pennsylvanica	2.1	3.7	88		4
5	Diospyros virginiana	5.1	4.3	0		Missing
5	Quercus nigra	5.5	1.2	61		4
5	Nyssa sylvatica	8.4	3.4	0		Missing
5	Quercus nigra	7.5	8.0	43		2
5	Quercus nigra	5.0	7.2	0		0
5	Quercus nigra	0.2	6.5	124		4

Plot	Scientific Name	X	Y	Height (cm)	DBH (cm)	Vigor
5	Betula nigra	2.5	7.2	0		Missing
6	Quercus nigra	2.2	0.3	73		4
6	Carpinus caroliniana	3.0	2.7	52		4
6	Diospyros virginiana	0.9	3.4	111		4
6	Cercis canadensis	5.9	2.1	0		Missing
6	Quercus phellos	6.5	0.8	83		4
6	Carpinus caroliniana	8.4	2.4	95		4
6	Quercus nigra	9.8	3.9	92		4
6	Platanus occidentalis	7.6	4.8	200	0.8	4
6	Quercus nigra	5.5	4.7	0		Missing
6	Fraxinus americana	9.0	7.0	170	0.2	4
6	Fraxinus americana	6.8	7.2	190	0.3	4
6	Fraxinus americana	4.6	8.0	200	0.4	4
6	Quercus nigra	0.5	8.1	87		4
6	Platanus occidentalis	2.2	6.7	175	0.5	4
7	Platanus occidentalis	2.6	2.5	0		Missing
7	Cornus amomum	2.4	4.7	0		Missing
7	Quercus phellos	4.8	0.9	118		4
7	Quercus phellos	5.3	3.0	170	0.3	4
7	Betula nigra	5.7	4.9	95		4
7	Quercus nigra	7.6	3.5	38		4
7	Quercus phellos	8.8	1.2	118		4
7	Asimina triloba	8.5	6.1	272	2	4
7	Quercus phellos	6.3	7.1	160	0.2	4
7	Quercus nigra	8.8	8.5	200	1	4
7	Quercus nigra	1.2	6.9	74		4
7	Quercus phellos	1.7	5.1	84		4
7	Fraxinus pennsylvanica	3.6	8.2	290	3	4
8	Diospyros virginiana	3.3	1.1	0		Missing
8	Diospyros virginiana	4.3	1.5	85		4
8	Fraxinus	4.8	3.2	110		3
8	Quercus phellos	1.3	3.7	0		Missing
8	Diospyros virginiana	1.3	4.6	105		4
8	Cercis canadensis	7.3	0.4	50		4
8	Fraxinus americana	9.9	2.9	104		4
8	Betula nigra	7.3	2.8	65		2
8	Quercus nigra	5.1	5.0	112		4
8	Carpinus caroliniana	7.5	5.7	43		4
8	Cercis canadensis	9.8	6.0	44		2
8	Quercus phellos	7.4	6.2	144	0.2	4
8	Diospyros virginiana	7.2	7.6	150	0.2	4
8	Quercus phellos	8.4	8.7	95		4
8	Fraxinus americana	5.0	8.5	112		4
8	Cercis canadensis	1.5	7.4	0		0
8	Diospyros virginiana	3.0	7.1	110		4
8	Quercus phellos	1.7	9.2	82		4