

# Lochill Farm Stream Mitigation Project Year 2 (2020) Monitoring Report Final

DMS Project ID No. 97083, DEQ Contract No. 6828  
USACE Action ID No. SAW-2016-00881, DWR# 16-0370  
Orange County, North Carolina, Neuse River Basin: 03020201-030030  
MY2 Data Collection Period: October 2020



Submitted to/Prepared for:

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

**Michael Baker**

**I N T E R N A T I O N A L**

Submission Date: January 2021

 *This document was printed using 30% recycled paper.*

<b>Mitigation Project Name</b>	<b>Lochill Farm Stream Mitigation Project</b>	<b>USACE Action ID</b>	<b>2016-00881</b>
<b>DMS ID</b>	<b>97083</b>	<b>DWR Permit</b>	<b>2016-0370</b>
<b>River Basin</b>	<b>Neuse</b>	<b>Date Project Instituted</b>	<b>3/22/2016</b>
<b>Cataloging Unit</b>	<b>03020201</b>	<b>Date Prepared</b>	<b>4/20/2020</b>
<b>County</b>	<b>Orange</b>	<b>Stream/Wet. Service Area</b>	<b>Neuse 03020201</b>

  
**Signature & Date of Official Approving Credit Release**

1 - For NCDMS, no credits are released during the first milestone  
2 - For NCDMS projects, the second credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the IRT by posting it to the DMS portal, provided the following have been met:

- 1) Approved of Final Mitigation Plan
  - 2) Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property.
  - 3) Completion of all physical and biological improvements to the mitigation site pursuant to the mitigation plan.
  - 4) Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.
- 3 - A 10% reserve of credits is to be held back until the bankfull event performance standard has been met.

Credit Release Milestone	Warm Stream Credits						
	Scheduled Releases %	Proposed Releases %	Proposed Released #	Not Approved # Releases	Approved Credits	Anticipated Release Year	Actual Release Date
<b>1 - Site Establishment</b>	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>2 - Year 0 / As-Built</b>	30.00%	30.00%	1,233.960	0.000	1,233.960	2019	5/28/2019
<b>3 - Year 1 Monitoring</b>	10.00%	10.00%	411.320	0.000	411.320	2020	4/20/2020
<b>4 - Year 2 Monitoring</b>	10.00%					2021	
<b>5 - Year 3 Monitoring</b>	10.00%					2022	
<b>6 - Year 4 Monitoring</b>	5.00%					2023	
<b>7 - Year 5 Monitoring</b>	10.00%					2024	
<b>8 - Year 6 Monitoring</b>	5.00%					2025	
<b>9 - Year 7 Monitoring</b>	10.00%					2026	
<b>Stream Bankfull Standard</b>	10.00%						
			<b>Totals</b>	0.000	1,645.280		

<b>Total Gross Credits</b>	4,113.200
<b>Total Unrealized Credits to Date</b>	0.000
<b>Total Released Credits to Date</b>	1,645.280
<b>Total Percentage Released</b>	40.00%
<b>Remaining Unreleased Credits</b>	2,467.920

#### Notes

#### Contingencies (if any)

#### Project Quantities

Mitigation Type	Restoration Type	Physical Quantity
Warm Stream	Restoration	3,105.000
Warm Stream	Enhancement I	1,602.000
Warm Stream	Enhancement II	600.000
Warm Stream	Preservation	768.000

Mitigation Project Name      Lochill Farm Stream Mitigation Project  
 DMS ID                              97083  
 River Basin                        Neuse  
 Cataloging Unit                03020201  
 County                                Orange

USACE Action ID                2016-00881  
 DWR Permit                        2016-0370  
 Date Project Instituted        3/22/2016  
 Date Prepared                    4/20/2020  
 Stream/Wet. Service Area      Neuse 03020201

							Stream Restoration Credits	Stream Restoration Equivalent Credits
<b>Debits</b>								
<b>Beginning Balance (mitigation credits)</b>							<b>4,026.000</b>	<b>87.200</b>
<b>Released Credits</b>							<b>0.000</b>	<b>0.000</b>
<b>Unrealized Credits</b>							<b>0.000</b>	<b>0.000</b>
Owning Program	Req. Id	TIP #	Project Name	USACE Permit #	DWR Permit #	DCM Permit #		
NCDOT Stream & Wetland ILF Program	REQ-008290	R-2721A	R-2721A - NC 540 - West of NC 55 to East of SR 1389	2009-02240	2018-1249		1,207.800	
NCDOT Stream & Wetland ILF Program	REQ-008187	I-5111 / I-4739	I-5111 / I-4739 - I-40 Widening (Wake & Johnston Counties)	2009-00556	2019-0593			26.160
<b>Total Credits Debited</b>							<b>1,207.800</b>	<b>26.160</b>
<b>Remaining Available balance (mitigation credits)</b>							<b>402.600</b>	<b>8.720</b>
<b>Remaining balance (unreleased credits)</b>							<b>2,415.600</b>	<b>52.320</b>

January 6, 2021

Lindsay Crocker, Project Manager  
NCDEQ, Division of Mitigation Services  
1652 Mail Service Center  
Raleigh, NC 27699-1652

**Subject:** Response to DMS Comments for DRAFT MY2 Report  
Lochill Farm Stream Mitigation Project, Orange County  
DMS Project # 97083, DEQ Contract #6828, Neuse-01 River Basin

Ms. Crocker:

Please find enclosed our responses to the NC Division of Mitigation Services (DMS) review comments dated December 17, 2020 in reference to the Lochill Farm Stream Mitigation Project - DRAFT MY2 Report. We have revised the draft document in response to the review comments as outlined below.

DMS MY2 Draft Report Comments:

1. Table 2. The re-planting took place between MY1 and MY2 growing seasons. Please update table in chronological order.

**Response: Table 2 has been revised as requested.**

Digital Review-

- Please provide photo point images as individual JPEGs.  
**Response: Photo-Point images provided as individual JPEGs as requested.**
- The table 7 export from the CVS tool contains divide by zero errors. Please ensure that the data support the creation of table 7 and resubmit.  
**Response: The error has been corrected and the data is confirmed as supporting table 7. The revised CVS tool has been provided with the digital e-submission.**
- Please provide the data that supports the groundwater gauge figures.  
**Response: The data for the groundwater gauges has been provided as requested.**
- If available, please submit Mitigation Plan design shapefiles.  
**Response: The shapefiles used for the figures from the project's mitigation plan design have been included in the digital e-submission.**

Please do not hesitate to contact me should you have any questions regarding our response submittal.

Sincerely,



Scott King, LSS, PWS  
Project Manager

Enclosures

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## 1.0 PROJECT SUMMARY

### 1.1 Project Description

Michael Baker Engineering, Inc. (Michael Baker) restored approximately 3,245 linear feet of existing jurisdictional stream, enhanced 2,227 linear feet of stream, and preserved 733 linear feet of unnamed tributaries to Buckwater Creek. Michael Baker also re-established approximately 3.9-acres of forested riparian buffer associated with this stream system and preserved an additional 11.9-acres. The project is located in the Neuse River Basin, within the Hydrologic Unit Code (HUC) 03020201-030030 (the Middle Eno River), which is identified as a Targeted Local Watershed (TLW) in DMS's 2010 Neuse River Basin Restoration Priority (RBRP) Plan and its March 2016 Update.

The Lochill Farm Stream Mitigation project is located on an active horse farm in Orange County, North Carolina, 6.2 miles northeast of the Town of Hillsborough (Figure 1). Historic agriculture uses on the project site include horse, cattle, and sheep animal operations as well as tobacco and small grain row-cropping and timber harvesting. These activities had negatively impacted both water quality and streambank stability along the project streams and their tributaries (Table 4). The project is being conducted as part of the DMS Full Delivery In-Lieu Fee Program and is anticipated to generate at close-out a total of 4,113 stream mitigation credits and 176,511 buffer mitigation credits (Table 1) and is protected by a 15.8-acre permanent conservation easement.

### 1.2 Goals and Objectives

The goals of this project are identified below:

- Reconnect stream reaches to their floodplains
- Stabilize steep and/or eroding stream banks
- Improve in-stream habitat
- Reestablish forested riparian buffers
- Permanently protect the project

To accomplish these goals, the following objectives were identified:

- To restore appropriate bankfull dimensions, remove spoil berms, and/or raise channel beds, by utilizing either a Priority I Restoration approach (R1) or an Enhancement Level I approach (R3).
- To construct streams of appropriate dimensions, pattern, and profile in restored reaches, slope stream banks and provide bankfull benches on enhanced streams, and utilize bio-engineering to provide long-term stability.
- Construct an appropriate channel morphology for all streams, increasing the number and depths of pools, with structures including cross vanes, geo-lifts, brush-toe, log vanes/weirs, boulder sills, root wads, and/or J-hooks. Also repair stream disconnects in the channels caused by clogged pipe culverts.
- Establish riparian buffers at a 50-foot minimum width along all stream reaches, planted with native tree and shrub species.
- Establish a permanent conservation easement restricting land use in perpetuity. This will prevent site disturbance and allow the project to mature and stabilize.

### 1.3 Project Success Criteria

The success criteria and performance standards for the project will follow the North Carolina Interagency Review Team (NCIRT) guidance document *Wilmington District Stream and Wetland Compensatory Mitigation Update* dated October 24, 2016 and as described in Section 7 of the approved Mitigation Plan. All specific monitoring activities will follow those outlined in detail in Section 8 of the approved Mitigation Plan and will be conducted for a period of seven years unless otherwise noted. Annual monitoring reports will follow the DMS document *Annual Monitoring Report Format, Data Requirements, and Content Guidance* from June 2017. The performance standards for the riparian buffer assets will be held in accordance with 15A NCAC 02B.0295(n)(2)(B) and 15A NCAC 02B.0295(n)(4), and annual monitoring reports will be submitted at the end of each of the first five monitoring years.

### 1.4 Monitoring Results and Project Performance

The Year 2 monitoring survey data of the twelve permanent cross-sections indicates that these stream sections are geomorphically stable and are within the lateral/vertical stability and in-stream structure performance categories. Certain cross-sections (as shown in Figure 4 and Table 9 in Appendix D) have shown only very minor fluctuations in their geometry from last year, but these fluctuations do not represent a trend towards instability based off visual field evaluations. All reaches are stable and performing as designed, and are rated at 100 percent for all the parameters evaluated (Table 5 in Appendix B). There were no Stream Problem Areas (SPAs) identified.

During Year 2 monitoring, the planted acreage performance categories were functioning well overall. The average density of total planted stems, based on data collected from the five permanent and one random monitoring plots for the Year 2 monitoring conducted in September 2020, was 573 stems per acre (Table 7 in Appendix C). Thus, the Year 2 vegetation data demonstrate that the Site meets the minimum success interim criteria of 320 trees per acre by the end of Year 3. Furthermore, the vegetation on the project is also meeting the performance criteria for all Riparian Buffer assets, as per 15A NCAC 02B.0295(n)(2)(B), with greater than 260 stems/acre, and with a minimum of four native hardwood tree and/or shrub tree species, where no one species is greater than 50 percent of stems. However, one VPA was identified during the Year 2 monitoring effort; an area approximately 0.31 acres in size along the R3 buffer in which high stem mortality was observed (as shown in the CCPV). It appears the area still meets the minimum density requirement but is nevertheless noticeably less dense than other project buffer areas. As such, it will be supplementally replanted in the winter of 2020-2021 to boost stem numbers.

Previously, during the Year 1 monitoring effort, three Vegetation Problem Areas (VPAs) had been identified. The first VPA consisted of areas of low stem density. A supplemental replanting effort along R1 of bareroot trees was conducted on 1/9/20 and consisted of sugarberry (*Celtis laevigata*), box elder (*Acer negundo*), swamp chestnut oak (*Quercus michauxii*), overcup oak (*Quercus lyrata*), and river birch (*Betula nigra*) species. They were planted in roughly equal numbers (~100 stems each) at a density of ~350 stems/acres. The area planted was larger than indicated in the original VPA reported last year as an inspection conducted closer to the time of replanting revealed the need for more stems in other portions the floodplain. The second VPA consisted of seven small areas along the floodplain of R1 where thin herbaceous growth was observed. These areas were raked and reseeded on 3/12/20 with a low rate of fertilizer applied (~0.25 lbs N/1,000 ft<sup>2</sup>), and then reseeded again on 7/10/20 and 9/31/20. Additionally, a total of ten 3-gal potted switchgrass (*Panicum virgatum*) plants were placed in these areas on 2/27/20. Herbaceous growth established very well in all of these previously thin locations during Year 2 monitoring as shown in the Maintenance and Repair photographs in Appendix B. They will be closely observed during Year 3 monitoring to ensure they continue to remain well vegetated. Finally, the third VPA consisted of four small areas of privet (*Ligustrum sinense*) resprouts totaling about 0.02 acres. These areas were treated on 7/10/20. The project will continue to be monitored and treated for any invasive species.

Additionally, on 2/27/20, ten 1-gal buttonbush (*Cephalanthus occidentalis*), two 1-gal winterberry (*Ilex verticillata*), and ten 1-gal overcup oaks (*Quercus lyrata*) were planted scattered throughout the wetland areas on the project, while four 1-gal American beautyberry (*Callicarpa americana*) and two 1-gal sweetshrub (*Calycanthus floridus*) plants were placed along the bridge crossing on R1. These plants were added to provide more diversity and color on the project and not because these areas had low stem densities.

During the previous Year 1 monitoring effort, a pipe crossing in the upper portion of Reach R3 was repaired. The sidewalls of the crossing were livestaked on 1/27/20 to help establish vegetation for additional stability. Inspections over the course of Year 2 monitoring observed that the livestakes are growing and establishing well and the crossing as a whole is stable (see the Maintenance and Repair Photographs in Appendix B).

During Year 2 monitoring, four separate post-construction bankfull events were observed (see Table 10 and Figure 5 in Appendix E and the Overbank Event Photographs in Appendix B). They were documented primarily through the use of an automated crest gauge, but also through manual cork crest gauge readings, stream camera photographs, and post-flood event site inspection photographs.

As the observed monthly rainfall data for the project presented in Figure 7 in Appendix E demonstrates, the past 12 months have seen wide variability as compared to historic average precipitation, with four months exceeding the 70% probable average and two months below the 30% probable average. A total of 51.7 inches of rainfall was observed for the project, an excess of 4.5 inches above the Orange County historic average of 47.2 inches.

Summary information/data related to the Site and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report Appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report and in the Mitigation Plan available on the DMS website. Any raw data supporting the tables and figures in the Appendices is available from DMS upon request.

This report documents the successful completion of the Year 2 monitoring activities for the post-construction monitoring period.

## **1.5 Technical and Methodological Descriptions**

Stream survey data was collected to a minimum of Class C Vertical and Class A Horizontal Accuracy using a Leica TS06 Total Station and was georeferenced to the NAD83 State Plane Coordinate System, FIPS3200 in US Survey Feet, which was derived from the As-built Survey. The survey data from the permanent project cross-sections were collected and classified using the Rosgen Stream Classification System to confirm design stream type (Rosgen 1994 and 1996).

The six vegetation-monitoring quadrants (plots) were installed across the site in accordance with the CVS-DMS Protocol for Recording Vegetation, Version 4.1 (Lee 2007) and the data collected from each was input into the CVS-DMS Data Entry Tool v. 2.3.1 (CVS 2012).

Three automated groundwater monitoring wells were installed in the floodplain along Reach R1 following USACE protocols (USACE 2005). The gauges themselves are all In-Situ brand Rugged Troll 100 data loggers. These were installed at the behest of DWR to provide supplemental information about the stream restoration's effect on the existing adjacent jurisdictional wetlands (Figure 6). If during monitoring it becomes clear that the restored stream is not having any detrimental impact to the wetlands, Michael Baker may request to the IRT that the wells be removed.

The specific locations of monitoring features, such as vegetation plots, permanent cross-sections, reference photograph stations, and crest gauges, are shown on the CCPV map found in Appendix B.



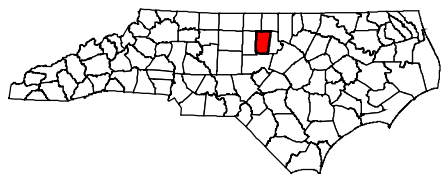
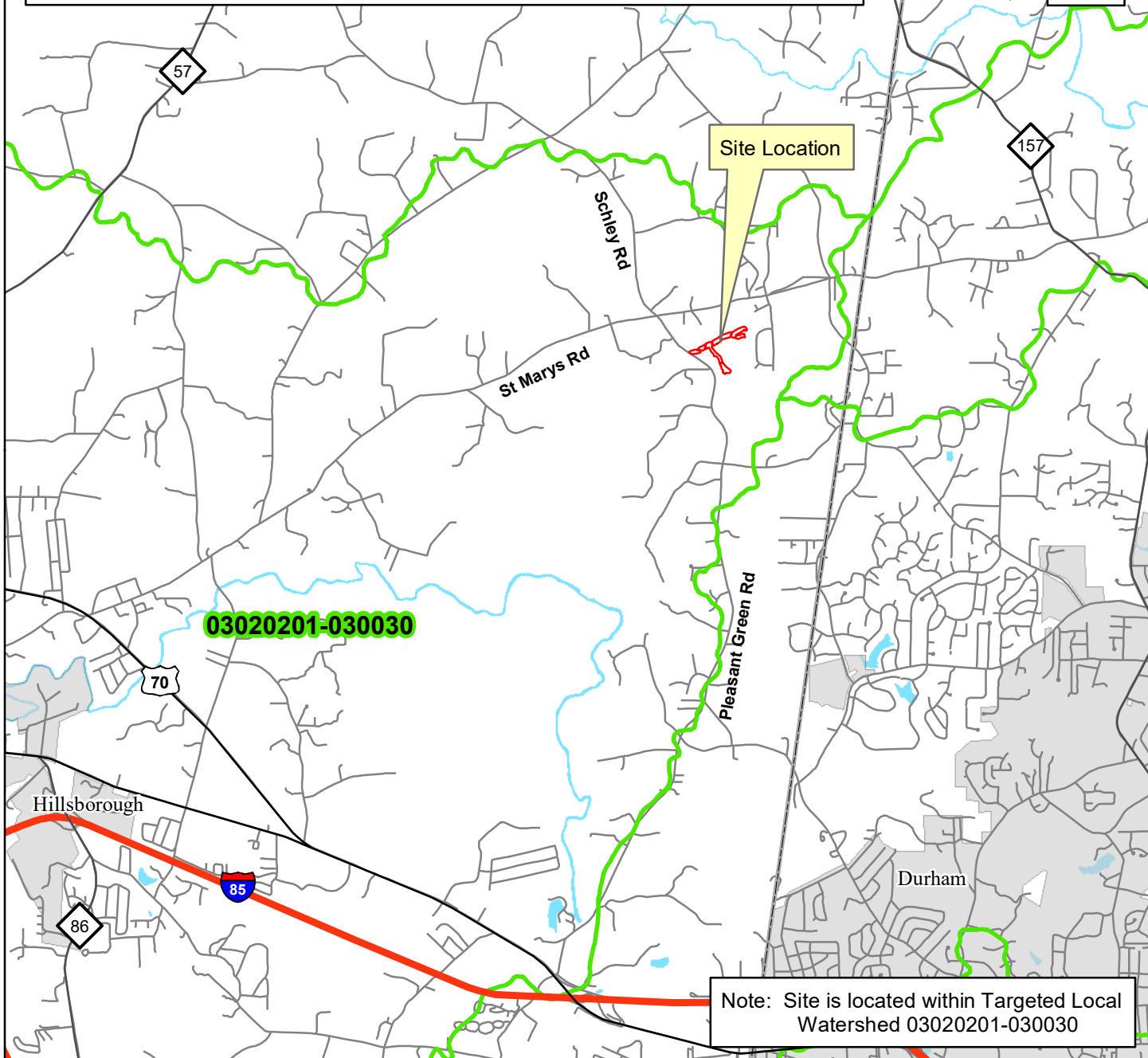
## 1.6 References

- Carolina Vegetation Survey (CVS) and NC Division of Mitigation Services (DMS). CVS-DMS Data Entry Tool v. 2.3.1. University of North Carolina, Raleigh, NC. 2012.
- Lee, M., Peet R., Roberts, S., Wentworth, T. 2007. CVS-DMS Protocol for Recording Vegetation, Version 4.1.
- North Carolina Division of Mitigation Services. 2010. Neuse River Basin Restoration Priorities. NC Department of Environmental Quality. Raleigh, NC.
- North Carolina Division of Mitigation Services. 2016. Neuse River Basin Restoration Priorities: Neuse-01 Catalog Unit *Update*. NC Department of Environmental Quality. Raleigh, NC.
- North Carolina Division of Mitigation Services. 2017. *Annual Monitoring Report Format, Data Requirements, and Content Guidance June 2017*. NC Department of Environmental Quality. Raleigh, NC.
- North Carolina Interagency Review Team (NCIRT). 2016. Guidance document “*Wilmington District Stream and Wetland Compensatory Mitigation Update*”. October 24, 2016
- Rosgen, D.L. 1994. A Classification of Natural Rivers. *Catena* 22:169-199.
- Rosgen, D.L. 1996. Applied River Morphology. Wildlands Hydrology. Pagosa Springs, CO.
- United States Army Corps of Engineers (USACE). 2005. “Technical Standard for Water-Table Monitoring of Potential Wetland Sites,” WRAP Technical Notes Collection (ERDC TN-WRAP-05-2), U.S. Army Engineer Research and Development Center. Vicksburg, MS.

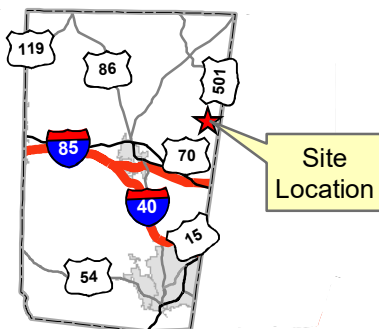
# **APPENDIX A**

## Background Tables and Figures

Directions to site: From I-85 South through Durham, take exit 170 for US-70 W and go 0.3 miles, then turn right at the stoplight onto Pleasant Green Rd and go 5.8 miles, then turn right at the stop sign onto St. Mary's Rd, then go 0.4 miles and turn right into the Lochill Farm driveway at 6120 St. Mary's Rd and park by the stables.

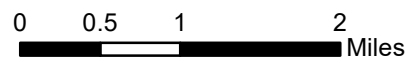


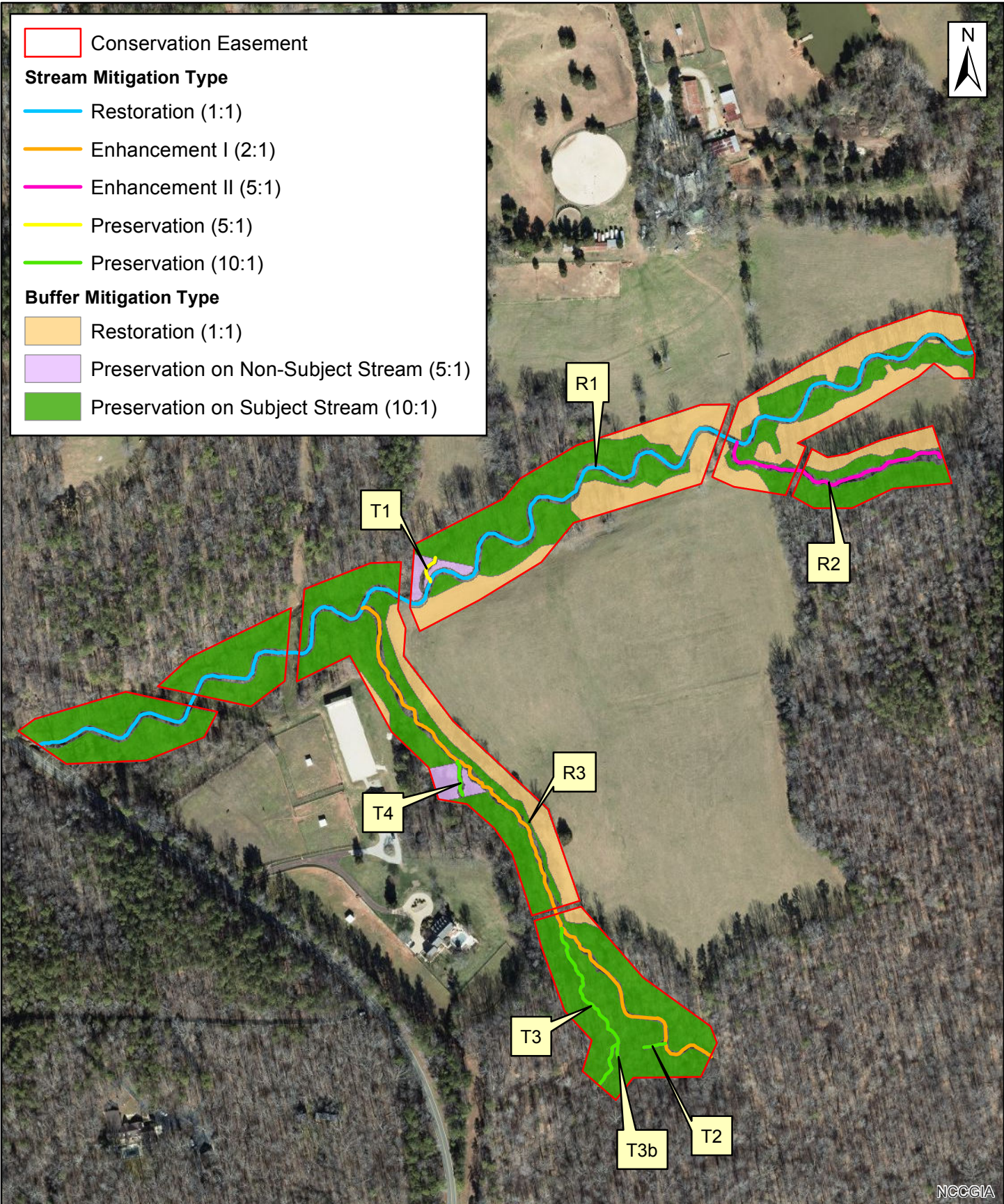
Orange County



**Figure 1**  
**Project Vicinity Map**  
**Lochill Farm Site**

**Michael Baker**  
INTERNATIONAL





**Table 1. Project Components and Mitigation Credits**  
**Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083**

Project Component (reach ID, etc.)	Wetland Position and HydroType	Existing Footage or Acreage	Stationing	As-Built Restored Footage, or SF <sup>1</sup>	As-Built Centerline Footage, or SF <sup>2</sup>	Mitigation Plan Designed Footage	Restoration Level	Approach Priority Level	Mitigation Ratio (X:1)	Mitigation Plan Credits <sup>3</sup>
Reach R1		2,925	10+00 -42+45	3,245	3,105	3,105	R	PI	1	3,105
Reach R2		590	10+00 -16+05	605	588	600	E	LII	5	120
Reach R3		1,697	10+00 -26+22	1,622	1,602	1,602	E	LI	2	801
Reach T1		96	10+00 -10+73	73	73	104	P	-	5	21
Reach T2		49	10+00 -10+54	54	54	59	P	-	10	6
Reach T3		482	10+00 -14+82	482	482	482	P	-	10	48
Reach T3b		34	10+00 -10+34	34	34	34	P	-	10	3
Reach T4		89	10+00 -10+90	90	89	89	P	-	10	9
Wetland Group 1										
Buffer Group 1 (BG1)				169,553	169,553		R		1	169,553
Buffer Group 2 (BG2)				13,067	13,067		P		5	2,613
Buffer Group 3 (BG3)				424,955	43,451		P		10	4,345

- 1 All stream stationing and restored footage numbers reported here, discussed in the report text, and shown in the as-built plan sheets use *thalweg* survey values.
- 2 The stream footage reported here uses the as-built stream *centerline* survey values and have all easement breaks removed from their totals. Buffer group values reported here are the creditable areas as allowed for each group as described in detail in the mitigation plan.
- 3 Credits reported here are taken directly from the approved mitigation plan Table 11.1

**Table 1.1**  
**As-Built Centerline Length and Area Summations by Mitigation Category**

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)	Credited Buffer (square feet)
		Riverine	Non-Riverine		
Restoration	3,105				169,553
Enhancement					
Enhancement I	1,602				
Enhancement II	588				
Creation					
Preservation	732				56,518
High Quality Pres					

**Table 1.2**  
**Overall Assets Summary**

Asset Category	Overall Credits
Stream	<b>4,113</b>
RP Wetland	-
NR Wetland	-
Buffer	<b>176,511</b>

**Table 2. Project Activity and Reporting History**  
**Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083**

**Elapsed Time Since grading complete:** 2 years and 0 months  
**Elapsed Time Since planting complete:** 1 year and 10 months  
**Number of Reporting Years<sup>1</sup>:** 2

<b>Activity or Deliverable</b>	<b>Data Collection Complete</b>	<b>Completion or Delivery</b>
404 permit date	N/A	Mar-18
Mitigation Plan	N/A	Jan-18
Final Design – Construction Plans	N/A	Nov-17
Construction Grading Completed	N/A	Nov-18
As-Built Survey	Dec-18	Dec-18
Livestake and Bareroot Planting Completed	N/A	Jan-19
As-Built Baseline Monitoring Report (MY0)	Feb-19	Apr-19
Year 1 Monitoring	Oct-19	Jan-20
Year 2 Monitoring	Oct-20	Nov-20
Supplemental bare root planting on R1 and R3	Planted in January 2020	
Riparian seed mixes placed in thin areas on R1 to establish herbaceous vegetation	Seeded in March, July, and September 2020	
Scattered privet treated along R1 and R3	Treated July 2020	
Year 3 Monitoring (anticipated)	Oct-21	Dec-21
Year 4 Monitoring (anticipated)	Oct-22	Dec-22
Year 5 Monitoring (anticipated)	Oct-23	Dec-23
Year 6 Monitoring (anticipoated)	Oct-24	Dec-24
Year 7 Monitoring (anticipated)	Oct-25	Dec-25

<sup>1</sup> = The number of monitoring reports excluding the as-built/baseline report

**Table 3. Project Contacts****Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083**

<b>Designer</b>	8000 Regency Parkway, Suite 600
<b>Michael Baker Engineering, Inc.</b>	Cary, NC 27518 Contact: Scott King, Tel. 919-481-5731
<b>Construction Contractor</b>	5616 Coble Church Rd
<b>KBS Earthworks</b>	Julian, NC 27283 Contact: Chris Sizemore, Telephone: 336-362-0289
<b>Survey Contractor</b>	88 Central Avenue
<b>Kee Mapping and Surveying</b>	Asheville, NC 28801 Contact: Brad Kee, Tel. 828-575-9021
<b>Planting Contractor</b>	5616 Coble Church Rd
<b>KBS Earthworks</b>	Julian, NC 27283 Contact: Chris Sizemore, Telephone: 336-362-0289
<b>Seeding Contractor</b>	5616 Coble Church Rd
<b>KBS Earthworks</b>	Julian, NC 27283 Contact: Chris Sizemore, Telephone: 336-362-0289
<b>Seed Mix Sources</b>	
<b>Green Resources</b>	Telephone: 336-855-6363
<b>Nursery Stock Suppliers</b>	
<b>Mellow Marsh Farm ArborGen</b>	Telephone: 919-742-1200 Telephone: 843-528-3204
<b>Monitoring Performers</b>	
<b>Michael Baker Engineering, Inc.</b>	8000 Regency Parkway, Suite 600 Cary, NC 27518
Stream Monitoring POC	Scott King, Tel. 919-481-5731
Vegetation Monitoring POC	Scott King, Tel. 919-481-5731

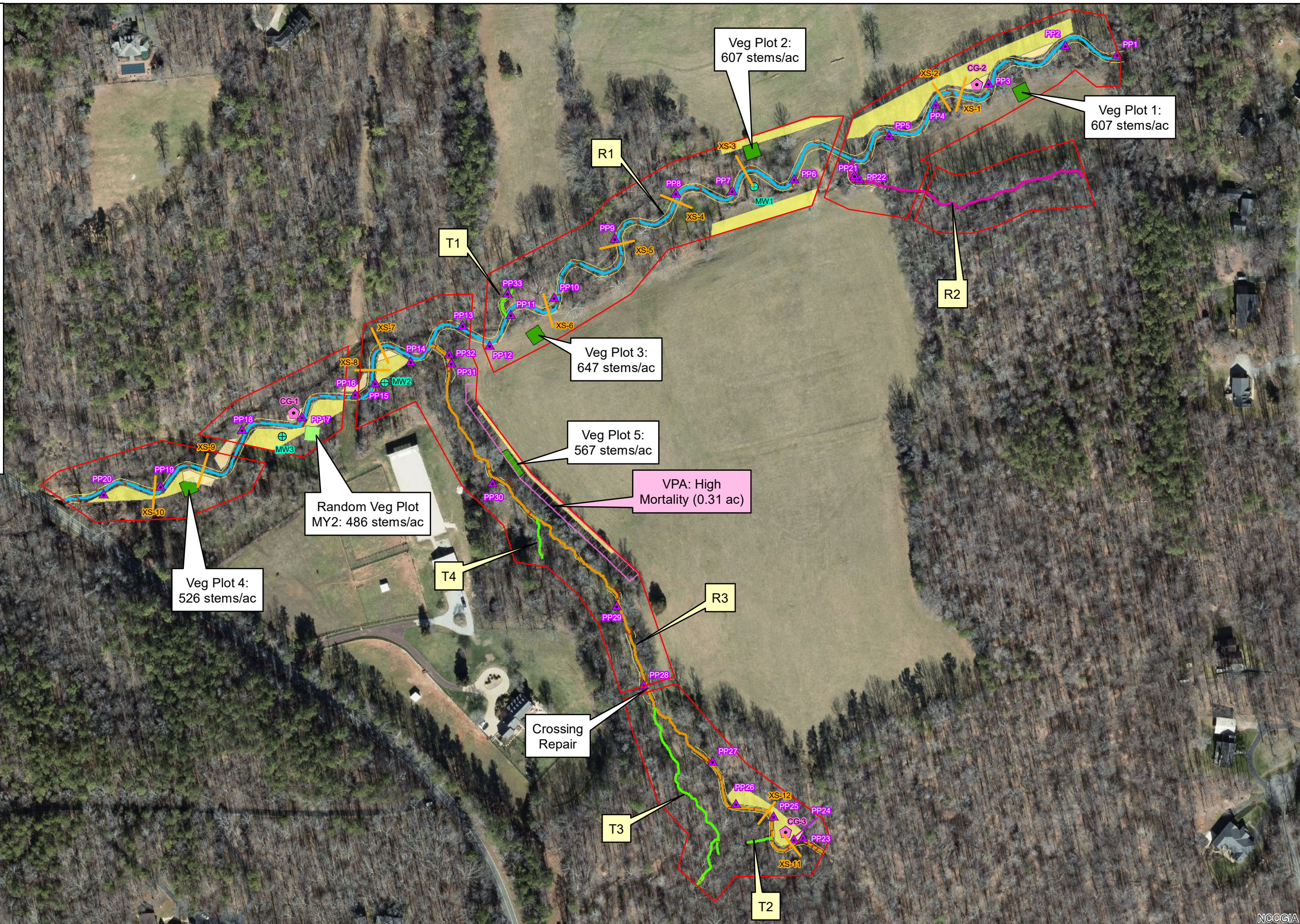
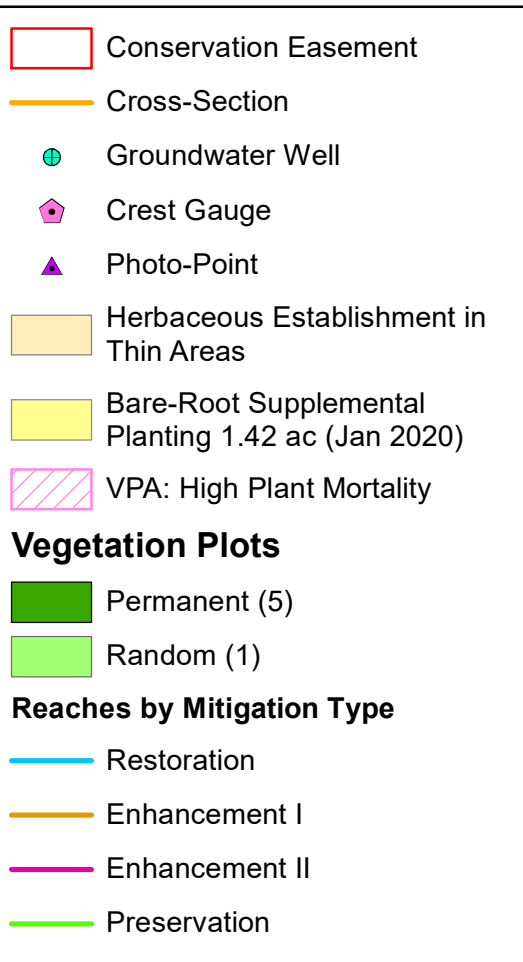
**Table 4. Project Attributes**  
**Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083**

Project Name		Lochill Farm Stream Mitigation Project			
County		Orange County			
Project Area (acres)		15.8			
Project Coordinates (latitude and longitude)		36.113419 N, -78.991165 W			
Planted Acreage (Acres of Woody Stems Planted)		8.1			
<b>Project Watershed Summary Information</b>					
Physiographic Province		Piedmont			
River Basin		Neuse			
USGS Hydrologic Unit 8-digit	3020201	USGS Hydrologic Unit 14-digit	3020201-030030		
DWR Sub-basin		03-04-01			
Project Drainage Area (Acres and Square Miles)		1,020 acres/1.59 square miles (at downstream end of R1)			
Project Drainage Area Percentage of Impervious Area		<1% impervious area			
CGIA Land Use Classification		80.6% forested, 12.7% agriculture, 6.5% developed, 0.2% open water			
<b>Existing Reach Summary Information</b>					
<b>Parameters</b>		<b>Reach R1</b>	<b>Reach R2</b>	<b>Reach R3</b>	<b>Reach T1</b>
Length of reach (linear feet)		2,925	590	1,697	96
Valley confinement (Confined, moderately confined, unconfined)		Unconfined	Unconfined	Unconfined	Unconfined
Drainage area (Acres)		1,020	12	190	0.8
Perennial, Intermittent, Ephemeral		Perennial	Intermittent	Perennial	Intermittent
NCDWR Water Quality Classification		WS-IV, NSW	WS-IV, NSW	WS-IV, NSW	WS-IV, NSW
Stream Classification (existing)		E4 (incised)	B5	E4b to B4	E5
Stream Classification (proposed)		C4	B5	C4b	E5
Evolutionary trend (Simon)		IV - Degradation and Widening	I - Stable System	IV - Degradation and Widening	I - Stable System
FEMA classification		Zone X	Zone X	Zone X	Zone X
<b>Existing Reach Summary Information</b>					
<b>Parameters</b>		<b>Reach T2</b>	<b>Reach T3</b>	<b>Reach T3b</b>	<b>Reach T4</b>
Length of reach (linear feet)		49	482	34	89
Valley confinement (Confined, moderately confined, unconfined)		Unconfined	Unconfined	Unconfined	Unconfined
Drainage area (Acres and Square Miles)		0.7	37	36	2.9
Perennial, Intermittent, Ephemeral		Intermittent	Perennial	Perennial	Perennial
NCDWR Water Quality Classification		WS-IV, NSW	WS-IV, NSW	WS-IV, NSW	WS-IV, NSW
Stream Classification (existing)		E5	E5	E5	E5
Stream Classification (proposed)		E5	R5	E5	E5
Evolutionary trend (Simon)		I - Stable System	I - Stable System	I - Stable System	I - Stable System
FEMA classification		Zone X	Zone X	Zone X	Zone X
<b>Regulatory Considerations</b>					
<b>Parameters</b>		<b>Applicable?</b>	<b>Resolved?</b>	<b>Supporting Docs?</b>	
Water of the United States - Section 404		Yes	Yes	PCN / NWP 27 / JD	
Water of the United States - Section 401		Yes	Yes	PCN / NWP 27 / JD	
Endangered Species Act		Yes	Yes	Categorical Exclusion	
Historic Preservation Act		Yes	Yes	Categorical Exclusion	
Coastal Zone Management Act (CZMA or CAMA)		No	N/A	N/A	
FEMA Floodplain Compliance		No	N/A	N/A	
Essential Fisheries Habitat		No	N/A	N/A	



# **APPENDIX B**

## Visual Assessment Data



**Table 5. Visual Stream Morphology Stability Assessment**  
**Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083**

Reach ID: Reach R1									
Assessed Length (LF):		3,245							
Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number per As built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended		
1. Bed	1. Vertical Stability	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	32	32			100%		
		1. Depth - Sufficient (Max Pool Depth/Mean Bkf Depth $\geq$ 1.5)	34	34			100%		
	3. Meander Pool Condition	2. Length - Sufficient (>30% of centerline distance between tail of upstream riffle and head of downstream riffle)	34	34			100%		
		4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	32	32			100%	
	2. Thalweg centering at downstream of meander bend (Glide)		34	34			100%		
						<b>Totals</b>	0	0	100%
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover due to active scour and erosion			0	0	100%		
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting is expected			0	0	100%		
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%		
						<b>Totals</b>	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	38	38			100%		
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	38	38			100%		
		2a. Piping	Structures lacking any substantial flow underneath or around sills or arms	38	38			100%	
	3. Bank Position	Bank erosion within the structures extent of influence <b>does not</b> exceed 15%	38	38			100%		
	4. Habitat	Pool forming structures maintaining - Max Pool Depth/Mean Bankfull Depth ratio $\geq$ 1.5. Rootwads/logs providing some cover at low flow	36	36			100%		
							<b>Totals</b>	0	0

Reach ID: Reach R2								
Assessed Length (LF):		605						
Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number per As built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	
1. Bed	1. Vertical Stability	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%	
		1. Depth - Sufficient (Max Pool Depth/Mean Bkf Depth $\geq$ 1.5)	1	1			100%	
	3. Meander Pool Condition	2. Length - Sufficient (>30% of centerline distance between tail of upstream riffle and head of downstream riffle)	1	1			100%	
		4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	1	1			100%
2. Thalweg centering at downstream of meander bend (Glide)	1		1			100%		
					<b>Totals</b>	0	0	100%
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover due to active scour and erosion			0	0	100%	
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting is expected			0	0	100%	
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	
						<b>Totals</b>	0	0
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	1	1			100%	
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	1	1			100%	
		2a. Piping	Structures lacking any substantial flow underneath or around sills or arms	1	1			100%
	3. Bank Position	Bank erosion within the structures extent of influence <b>does not</b> exceed 15%	1	1			100%	
	4. Habitat	Pool forming structures maintaining - Max Pool Depth/Mean Bankfull Depth ratio $\geq$ 1.5. Rootwads/logs providing some cover at low flow	1	1			100%	
							<b>Totals</b>	0

**Table 5. Visual Stream Morphology Stability Assessment**  
**Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083**

Reach ID: Reach R3							
Assessed Length (LF):		1,622					
Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number per As built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended
1. Bed	1. Vertical Stability	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	8	8			100%
		1. Depth - Sufficient (Max Pool Depth/Mean Bkf Depth $\geq$ 1.5)	10	10			100%
	3. Meander Pool Condition	2. Length - Sufficient (>30% of centerline distance between tail of upstream riffle and head of downstream riffle)	10	10			100%
		4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	8	8		
	2. Thalweg centering at downstream of meander bend (Glide)		10	10			100%
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover due to active scour and erosion			0	0	100%
		Banks undercut/overhanging to the extent that mass wasting is expected			0	0	100%
	2. Undercut	Banks slumping, caving or collapse			0	0	100%
					0	0	100%
<b>Totals</b>					0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	19	19			100%
		Grade control structures exhibiting maintenance of grade across the sill	19	19			100%
	2. Grade Control	Structures lacking any substantial flow underneath or around sills or arms	19	19			100%
		Bank erosion within the structures extent of influence <b>does not</b> exceed 15%	19	19			100%
	3. Bank Position	Pool forming structures maintaining - Max Pool Depth/Mean Bankfull Depth ratio $\geq$ 1.5. Rootwads/logs providing some cover at low flow	17	17			100%

**Table 6. Vegetation Conditions Assessment**  
**Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083**

<b>Planted Acreage: 9.8</b>						
<b>Vegetation Category</b>	<b>Defintions</b>	<b>Mapping Threshold (acres)</b>	<b>CCPV Depiction</b>	<b>Number of Polygons</b>	<b>Combined Acreage</b>	<b>% of Planted Acreage</b>
1. Bare Areas	Very limited cover both woody and herbaceous material.	0.1	N/A	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1	pink hatched polygon	1	0.31	3.2%
				<b>Total</b>	<b>1</b>	<b>3.2%</b>
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems or a size class that are obviously small given the monitoring year.	0.25	N/A	0	0.00	0.0%
				<b>Cumulative Total</b>	<b>1</b>	<b>3.2%</b>
<b>Easement Acreage: 15.8</b>						
<b>Vegetation Category</b>	<b>Defintions</b>	<b>Mapping Threshold</b>	<b>CCPV Depiction</b>	<b>Number of Points</b>	<b>Combined Acreage</b>	<b>% of Planted Acreage</b>
4. Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale)	1000 ft <sup>2</sup>	N/A	0	0.00	0.0%
5. Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale)	none	N/A	0	0.00	0.0%

**Lochill Farm: MY2 Stream Station Photo-Points (taken 10/20/20)**



PP-1: Reach 1, view downstream, Station 10+00



PP-2: Reach 1, view downstream, Station 11+50



PP-3: Reach 1, view downstream, Station 13+75



PP-4: Reach 1, view downstream, Station 15+25



PP-5: Reach 1, view downstream, Station 16+50



PP-6: Reach 1, view upstream, Station 19+50

**Lochill Farm: MY2 Stream Station Photo-Points (taken 10/20/20)**



PP-7: Reach 1, view downstream, Station 21+50



PP-8: Reach 1, view downstream, Station 23+00



PP-9: Reach 1, view downstream, Station 25+00



PP-10: Reach 1, view upstream, Station 27+50



PP-11: Reach 1, view downstream, Station 29+00



PP-12: Reach 1, view downstream, Station 30+00

**Lochill Farm: MY2 Stream Station Photo-Points (taken 10/20/20)**



PP-13: Reach 1, view downstream, Station 30+50



PP-14: Reach 1, view downstream, Station 32+00



PP-15: Reach 1, view downstream, Station 33+50



PP-16: Reach 1, view downstream, Station 34+25



PP-17: Reach 1, view downstream, Station 35+75



PP-18: Reach 1, view downstream, Station 37+25



**Lochill Farm: MY2 Stream Station Photo-Points (taken 10/20/20)**



PP-19: Reach 1, view downstream, Station 39+75



PP-20: Reach 1, view downstream, Station 41+00



PP-21: Reach 2, view upstream, Station 15+50



PP-22: Reach 2, view downstream, Station 15+75



PP-23: Reach 3, view upstream, Station 10+50



PP-24: Reach 3, view downstream, Station 10+75

**Lochill Farm: MY2 Stream Station Photo-Points (taken 10/20/20)**



PP-25: Reach R3, view upstream, Station 11+75



PP-26: Reach 3, view downstream, Station 12+75



PP-27: Reach 3, view downstream, Station 14+00



PP-28: Reach 3, view downstream, Station 16+25



PP-29: Reach 3, view downstream, Station 18+25



PP-30: Reach 3, view downstream, Station 22+50

**Lochill Farm: MY2 Stream Station Photo-Points (taken 10/20/20)**



PP-31: Reach 3, view upstream, Station 25+50



PP-32: Reach 3, view downstream, Station 25+75



PP-33: Reach T1, view downstream, Station 10+00

Lochill Farm: MY2 Vegetation Plot Photographs (taken 10/1/2020)



Vegetation Plot 1



Vegetation Plot 2



Vegetation Plot 3



Vegetation Plot 4



Vegetation Plot 5



Random Vegetation Plot MY2

Lochill Farm: MY2 Overbank Event Photographs



Manual crest gauge reading of 0.41 ft on upper R1 (photo from 2/27/20, storm on 2/27/20)



Stream camera on upper R1 from 2/6/20 at 16:00 (3 hours before flood event peak)



Manual crest gauge reading of 0.23 ft on upper R1 (photo from 5/8/20, storm on 3/25/20)



Close-up of manual crest gauge reading of 0.23 ft on upper R1 floodplain (photo 5/8/20 for storm on 3/25/20)



Stream camera on upper R1 from 3/25/20 at 08:00 (4 hours after flood event peak)



Manual crest gauge reading of 0.69 ft on upper R1 (photo from 7/10/20, storm on 5/20/20)

Lochill Farm: MY2 Overbank Event Photographs



Close-up of manual crest gauge reading of 0.69 ft on upper R1 (photo from 7/10/20, storm on 5/20/20)



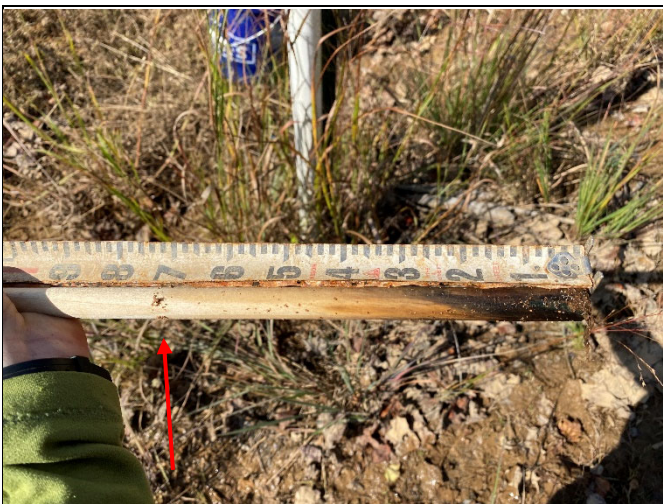
Stream camera on upper R1 from 5/20/20 at 16:00 (9 hours before flood event peak)



Stream camera on upper R1 from 5/21/20 at 08:00 (7 hours after flood event peak)



Manual crest gauge reading of 0.16 ft on upper R3 (photo from 7/10/20, storm on 5/20/20)



Manual crest gauge reading of 0.71 ft on upper R1 (photo from 10/14/20, storm [Hurricane Delta] on 10/11/20)



Close-up of manual crest gauge reading of 0.71 ft on upper R1 (photo from 10/14/20, storm [Hurricane Delta] on 10/11/20)

Lochill Farm: MY2 Overbank Event Photographs



Debris lines along banks of upper R1 (10/14/20)



Debris along bank of middle R1 (10/14/20)



Debris along banks of upper R1 (10/14/20)

Lochill Farm: MY2 Maintenance and Repair Photographs



Repaired pipe crossing on R3 (upstream side) at Station 16+20 in Sept. 2019



Repaired pipe crossing on R3 (downstream side) at Station 16+50 in Sept. 2019



Repaired pipe crossing on R3 (upstream side) at Station 16+20 in October 2020



Repaired pipe crossing on R3 (downstream side) at Station 16+50 in October 2020



Upper R1 floodplain with establishing herbaceous vegetation (5/8/20)



Upper R1 floodplain with establishing herbaceous vegetation (10/13/20)



Lochill Farm: MY2 Maintenance and Repair Photographs



Upper R1 floodplain with establishing herbaceous vegetation (5/8/20)



Upper R1 floodplain with establishing herbaceous vegetation (10/13/20)



Lower R1 floodplain with establishing herbaceous vegetation (5/8/20)



Lower R1 floodplain with establishing herbaceous vegetation (5/8/20)



Lower R1 floodplain with establishing herbaceous vegetation (5/8/20)



Lower R1 floodplain with establishing herbaceous vegetation (10/13/20)

Lochill Farm: MY2 Maintenance and Repair Photographs



Lower R1 floodplain with establishing herbaceous vegetation (10/13/20)



Lower R1 floodplain with establishing herbaceous vegetation (10/13/20)



Facing upstream from very bottom of R1 on Pleasant Green Rd. (5/8/20)



Facing upstream from very bottom of R1 on Pleasant Green Rd. (10/13/20)

Lochill Farm: MY2 Additional Monitoring Photographs



Bridge on R1 at Station ~18+20 (10/13/20)



Crossing over bridge on R1 at Station ~18+20 (10/13/20)



Pipe at crossing on R3 at Station ~16+30 (10/13/20)



Crossing over pipe on R3 at Station ~16+30 (10/13/20)



Pipes at crossing at top of R3 at Station 10+00 (10/13/20)



Crossing over pipes at top of R3 at Station 10+00 (path shown by arrow, 10/13/20)

Lochill Farm: MY2 Additional Monitoring Photographs



Flow on Reach R2 at confluence with R1 (1/9/20)



Flow on Reach R2 at confluence with R1 (2/27/20)



Flow on Reach R2 at confluence with R1 (5/8/20)



Flow on Reach R2 at confluence with R1 (10/13/20)

# **APPENDIX C**

## Vegetation Plot Data

Table 7. Planted Stem Counts by Plot and Species  
Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083

Scientific Name	Common Name	Species Type	Current Plot Data (MY2 2020)															Annual Means										
			Veg Plot 1			Veg Plot 2			Veg Plot 3			Veg Plot 4			Veg Plot 5			MY2 Random Plot <sup>1</sup>			MY2 (2020)			MY1 (2019)			MY0/AB (2019)	
			P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	
<i>Acer negundo</i>	Boxelder	Tree							1		1	1		1		2		2				4		4	4		4	5
<i>Alnus serrulata</i>	Tag Alder	Shrub Tree				1		1	3		3	1		1	1		1		1			6		6	6		6	6
<i>Asimina triloba</i>	Paw-Paw	Shrub Tree																									1	
<i>Betula nigra</i>	River Birch	Tree	2		2	5		5	1		1	3		3	2		2	2		2	15		15	17		17	18	
<i>Carpinus caroliniana</i>	Ironwood	Shrub Tree	4		4	1		1	1		1			1		1		1	3		3	10		10	10		10	10
<i>Celtis laevigata</i>	Sugarberry	Shrub Tree				1		1	1		1	2		2	1		1				5		5	9		9	7	
<i>Cercis canadensis</i>	Redbud	Shrub Tree	1	1	2	1		1												2	1	3						
<i>Diospyros virginiana</i>	Persimmon	Tree						1	1		1	1									2	2						
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	3		3			1	1								2		2	5	1	6	5		5		5	5
<i>Ilex verticillata</i>	Winterberry	Shrub Tree								1		1		1						2		2	3		3		3	3
<i>Juglans nigra</i>	Black Walnut	Tree															1	1			1	1						
<i>Lindera benzoin</i>	Northern Spicebush	Shrub Tree								2		2								2		2	3		3		3	3
<i>Liquidambar styraciflua</i>	Sweet Gum	Tree						1	1												1	1						
<i>Liriodendron tulipifera</i>	Tulip Tree	Tree	4		4	1		1				1		1			1		1	7		7	12		12		10	10
<i>Nyssa sylvatica</i>	Black Gum	Tree										1		1						1	1	1		1		1		1
<i>Platanus occidentalis</i>	Sycamore	Tree	1		1	5		1	6	3	2	5	3	5	8	5		5	3		3	20	8	28	24	24	19	19
<i>Quercus michauxii</i>	Swamp Chestnut Oak	Tree															1		1	1		1	1		1		1	1
<i>Quercus pagoda</i>	Cherrybark Oak	Tree		1	1																1	1						
<i>Quercus phellos</i>	Willow Oak	Tree								1		1								1		1	3		3		7	7
<i>Ulmus americana</i>	American Elm	Tree											2	2				1	1			3	3					
<i>Viburnum dentatum</i>	Arrow-wood	Shrub Tree														2		2			2	2	5		5		5	5
<i>Viburnum nudum</i>	Possumhaw	Shrub Tree								2		2								2		2	2		2		2	2
		Stem count	15	2	17	15	4	19	16	3	19	13	7	20	14	0	14	12	2	14	85	18	103	105		105	103	
		size (ares)		1			1			1			1			1			1		6		6				6	6
		size (ACRES)		0.025			0.025			0.025			0.025			0.025			0.025		0.148		0.148				0.148	0.148
		Species count	6	2	7	7	4	10	10	2	11	8	2	9	7	0	7	6	2	8	16	8	21	15		15	16	
		Stems per ACRE	607	81	688	607	162	769	647	121	769	526	283	809	567	0	567	486	81	567	573	121	695	708		708	695	

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%

P = Planted Stem  
V = Volunteer  
T = Total

<sup>1</sup> Plot MY2 is a randomly located vegetation plot that will move locations each monitoring year.

# **APPENDIX D**

## Stream Geomorphology Data

**Figure 4. Cross-Sections with Annual Overlay**

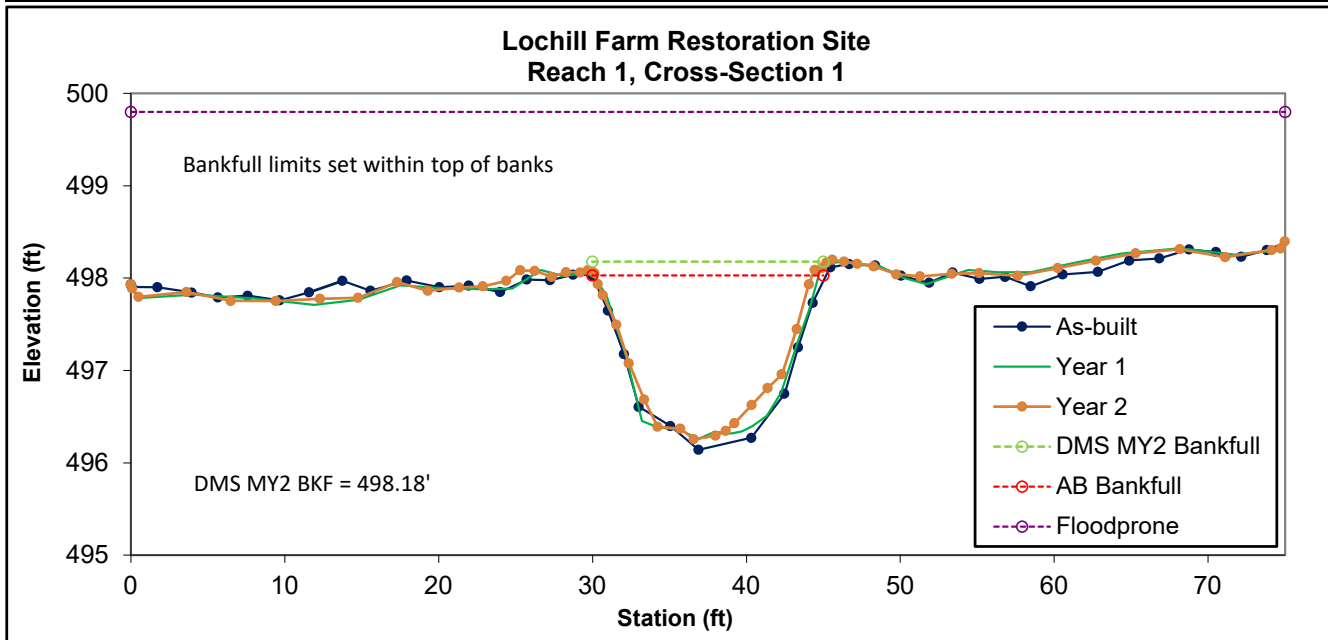
**Permanent Cross-section 1**  
(Year 2 Data - September 2020)



Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	11.0	9.7	1.1	1.8	8.5	0.9	7.8	498.03	498.06



Note: Per DMS/IRT request, the bank height ratio for MY2 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the original as-built bankfull elevation, as was done for previous monitoring reports.



## Permanent Cross-section 2

(Year 2 Data - September 2020)

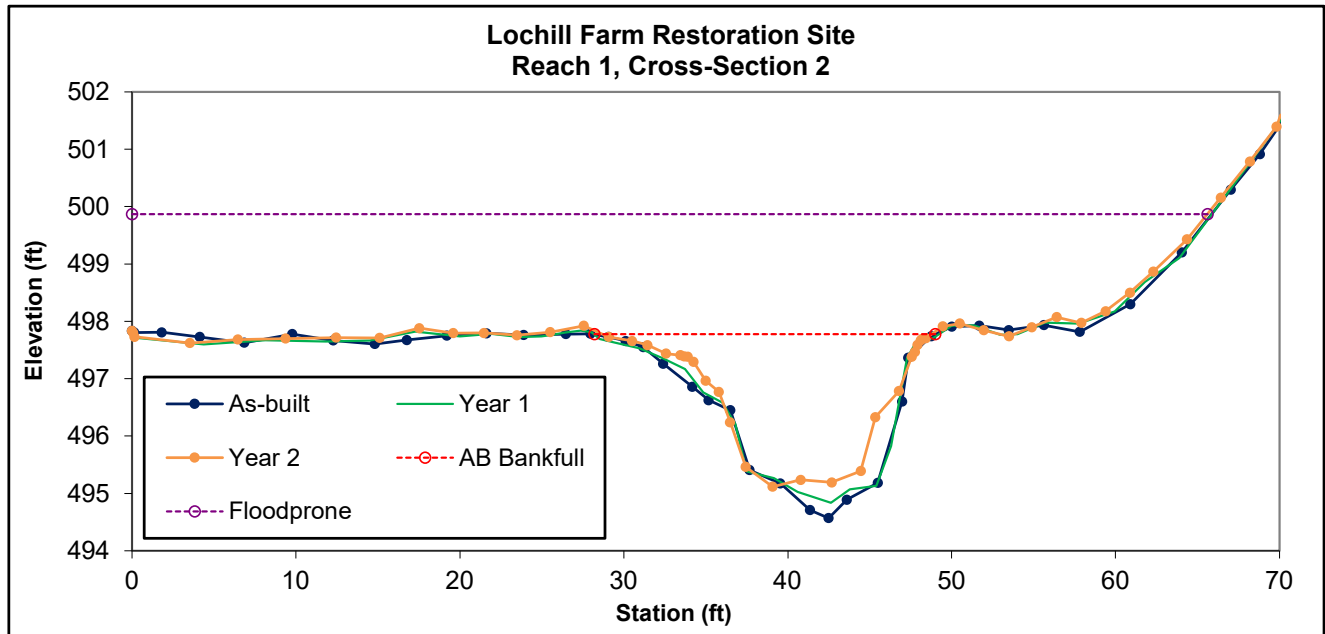


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	27.2	21.1	1.3	2.7	16.3	-	-	497.78	497.81



### Permanent Cross-section 3

(Year 2 Data - September 2020)

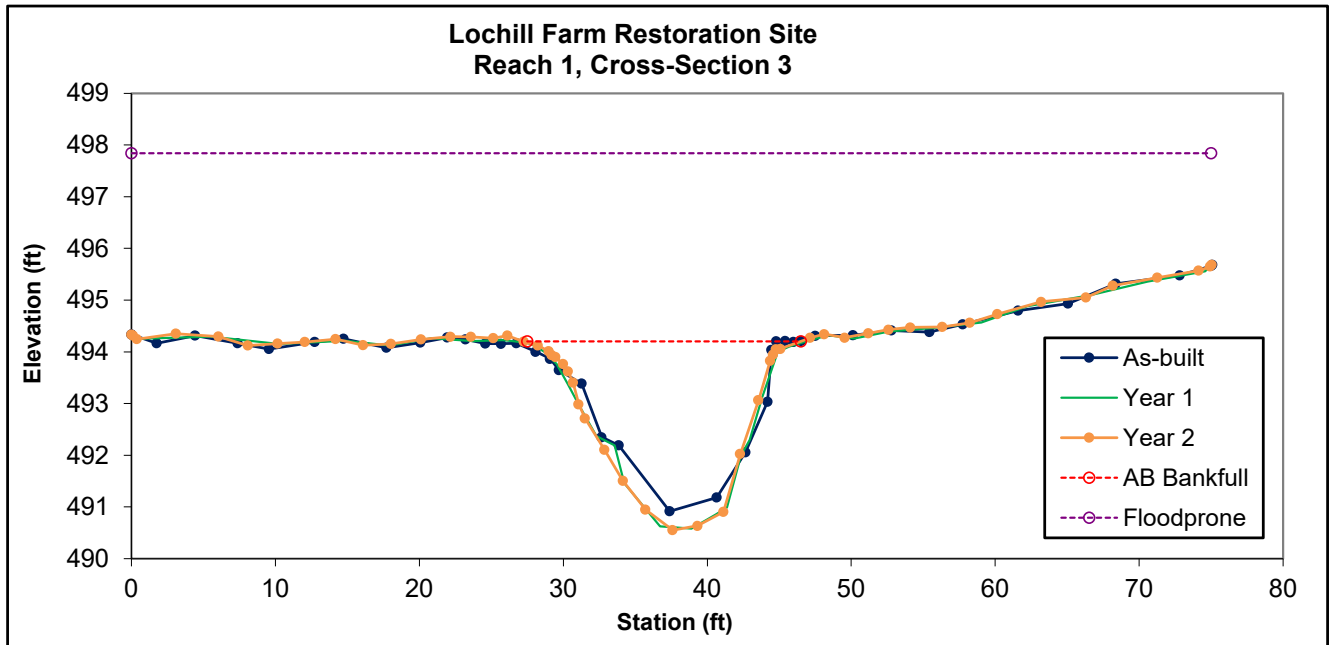


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	37.2	23.5	1.6	3.6	14.8	-	-	494.20	494.12



**Permanent Cross-section 4**  
(Year 2 Data - September 2020)

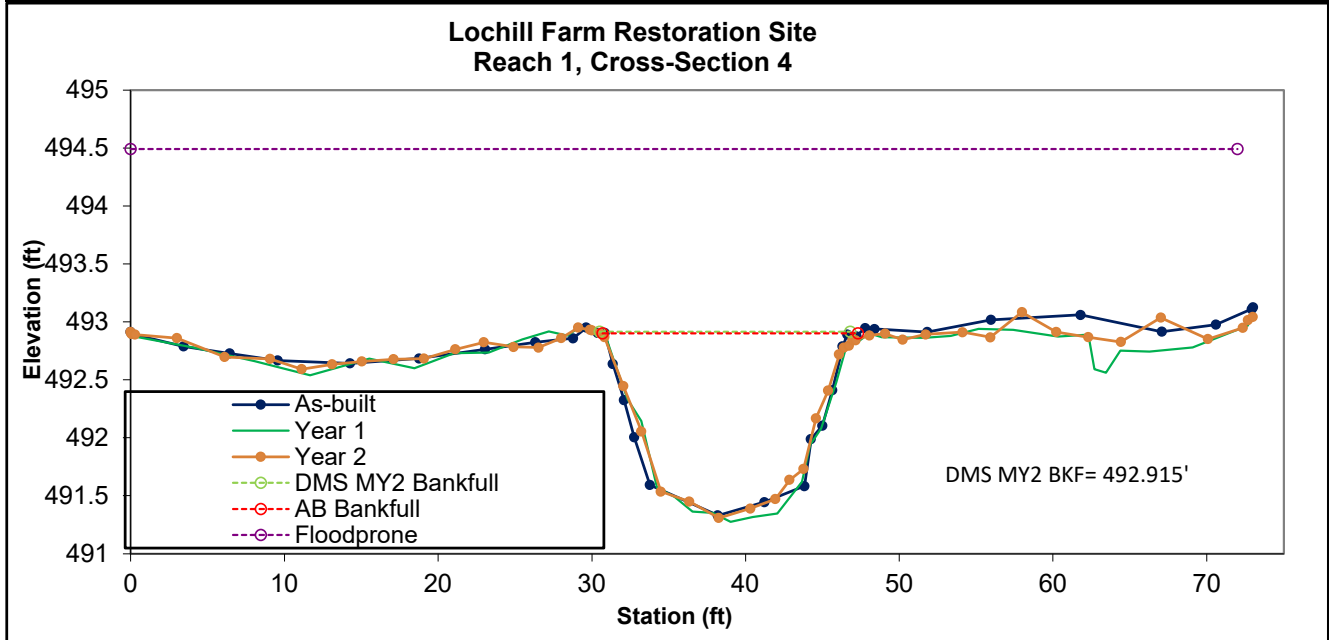


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	17.9	24.2	0.7	1.6	32.6	1.0	3.0	492.90	492.90



Note: Per DMS/IRT request, the bank height ratio for MY2 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the original as-built bankfull elevation, as was done for previous monitoring reports.”

monitoring reports.”

**Permanent Cross-section 5**  
(Year 2 Data - September 2020)

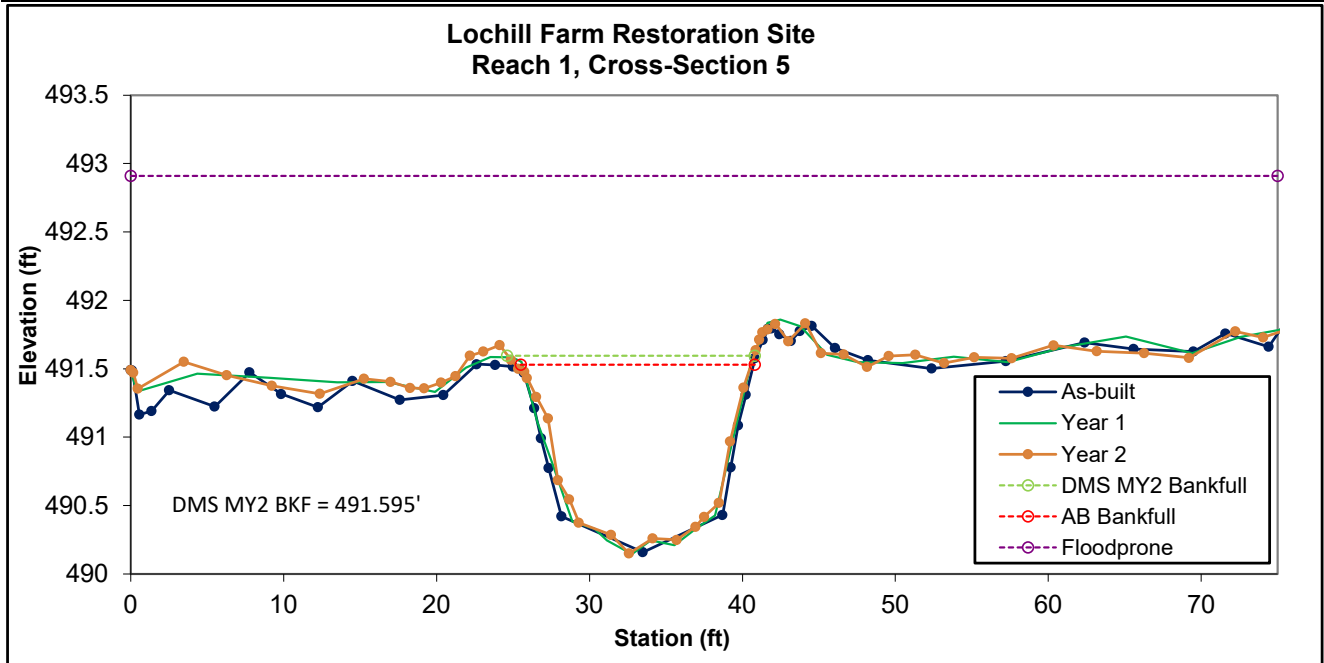


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	14.4	15.4	0.9	1.4	16.6	1.0	4.9	491.53	491.60



Note: Per DMS/IRT request, the bank height ratio for MY2 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the original as-built bankfull elevation, as was done for previous monitoring reports.

**Permanent Cross-section 6**  
(Year 2 Data - September 2020)

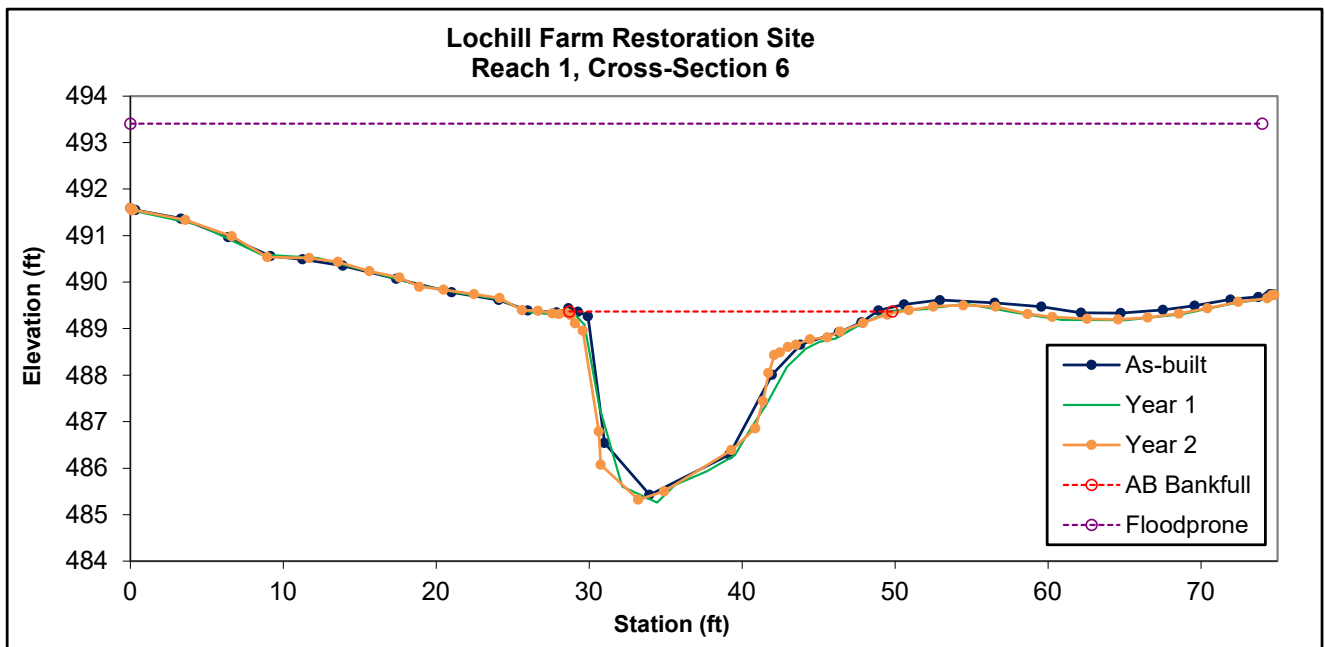


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	43.0	23.6	1.8	4.0	12.9	-	-	489.37	489.38



**Permanent Cross-section 7**  
(Year 2 Data - September 2020)

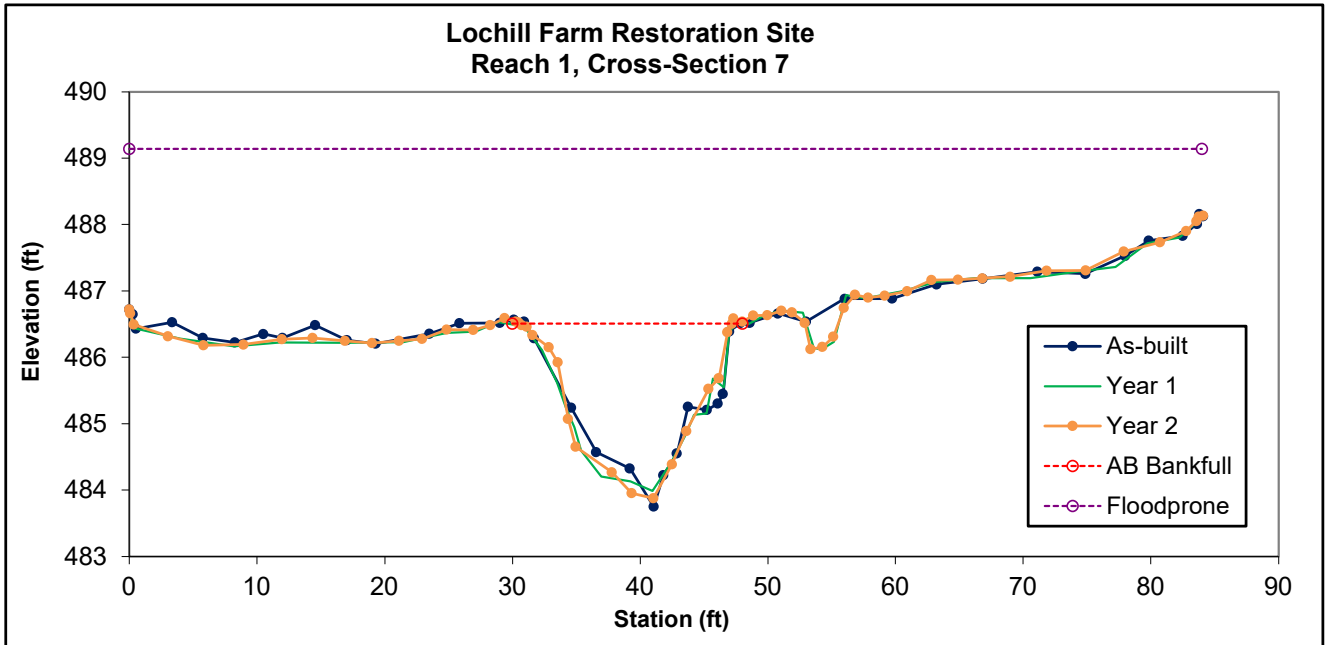


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	26.7	25.1	1.1	2.6	23.6	-	-	486.51	486.50



**Permanent Cross-section 8**  
(Year 2 Data - September 2020)

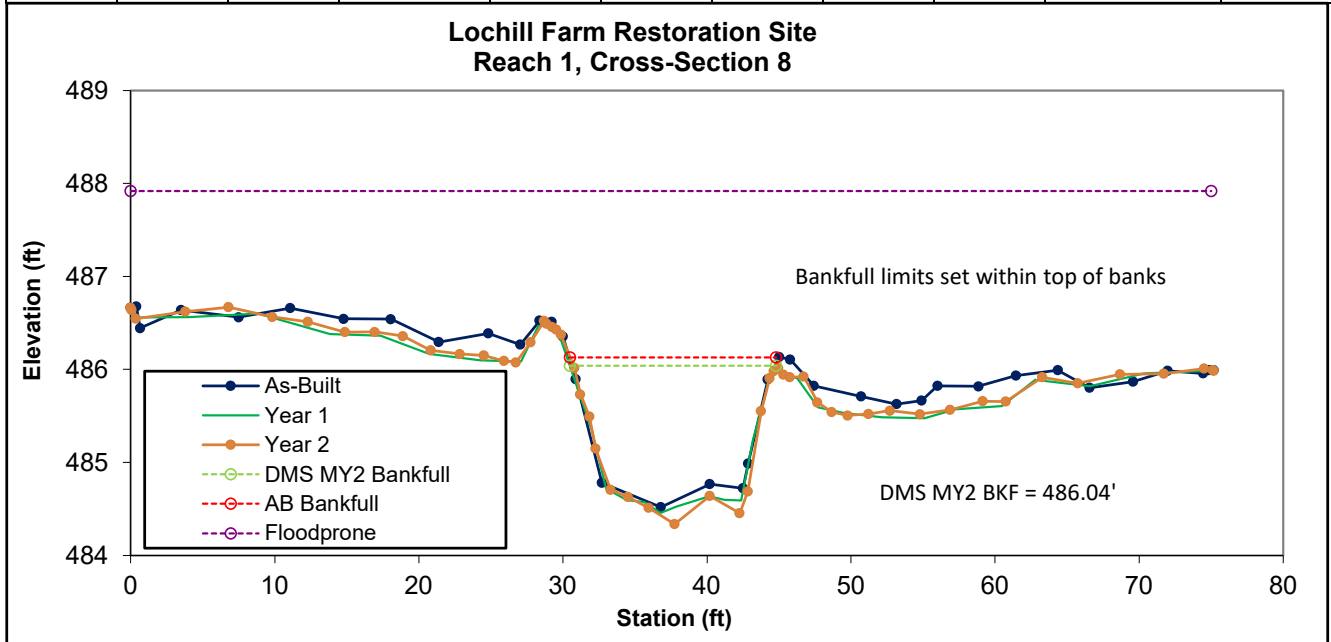


Looking at the Left Bank



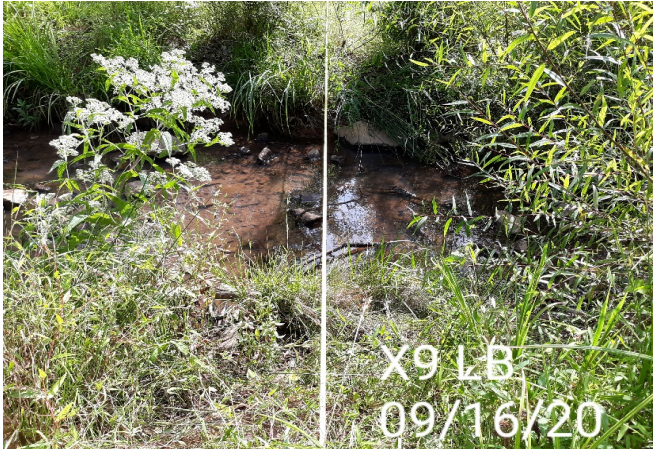
Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	18.5	14.4	1.3	1.8	11.2	1.0	5.2	486.13	486.10



Note: Per DMS/IRT request, the bank height ratio for MY2 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the original as-built bankfull elevation, as was done for previous monitoring reports.

**Permanent Cross-section 9**  
(Year 2 Data - September 2020)

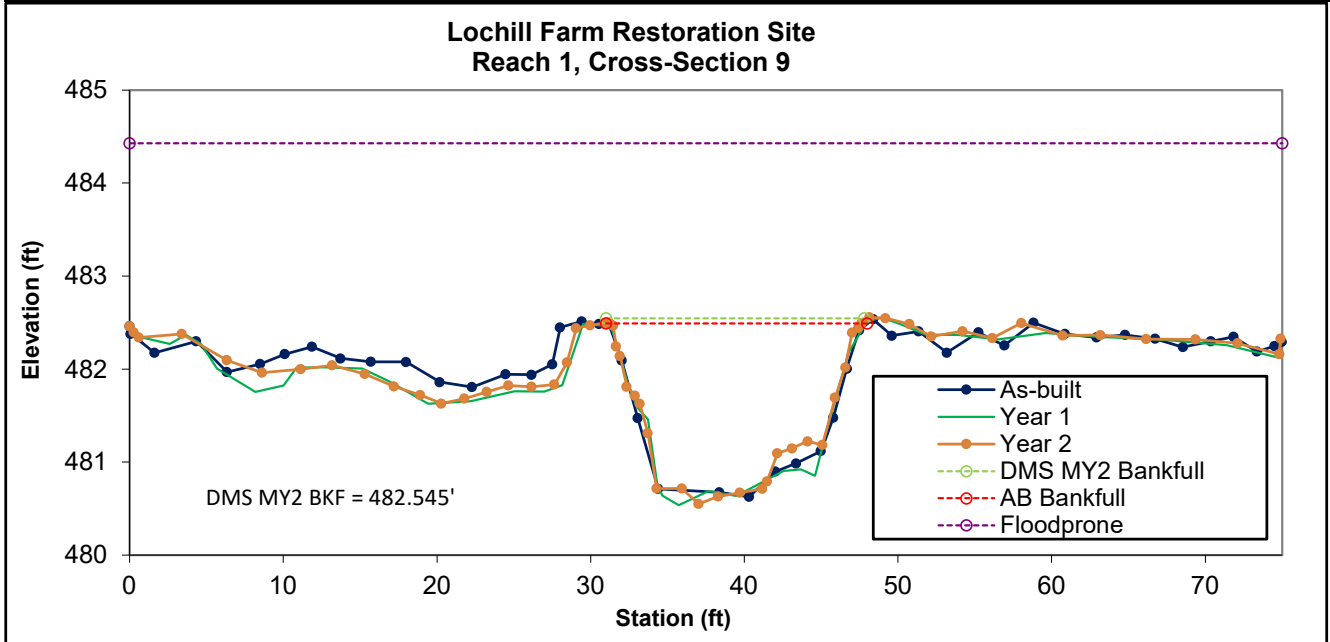


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	21.9	17.8	1.2	1.9	14.5	1.0	4.2	482.49	482.50



Note: Per DMS/IRT request, the bank height ratio for MY2 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the original as-built bankfull elevation, as was done for previous monitoring reports.



**Permanent Cross-section 10**  
(Year 2 Data - September 2020)

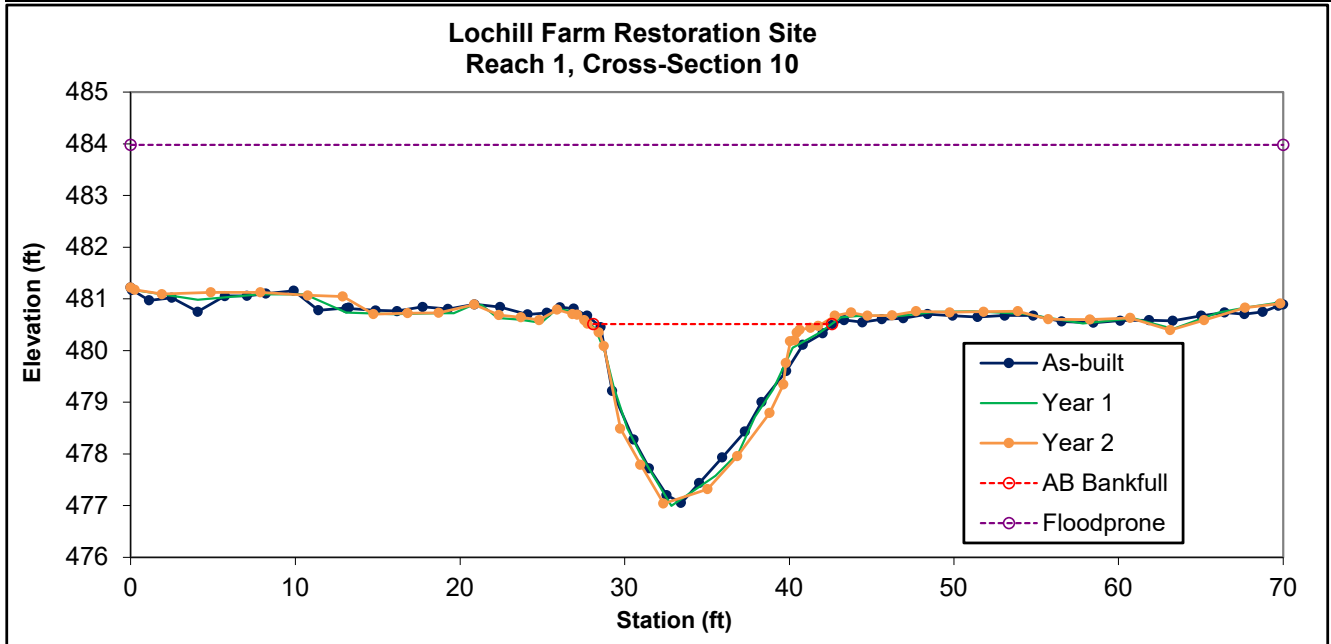


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	28.5	12.8	2.2	3.5	5.8	-	-	480.51	480.644



**Permanent Cross-section 11**  
(Year 2 Data - September 2020)

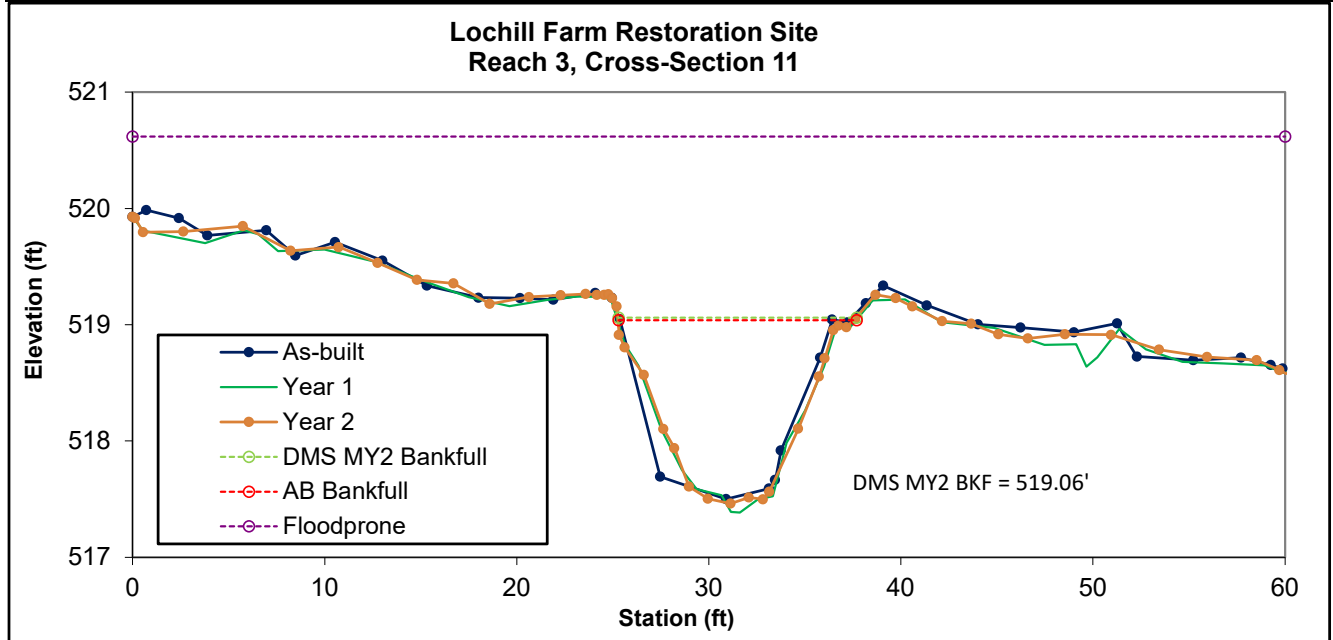


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	11.9	11.2	1.1	1.6	10.6	1.0	5.4	519.04	518.99



Note: Per DMS/IRT request, the bank height ratio for MY2 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the original as-built bankfull elevation, as was done for previous monitoring reports.

**Permanent Cross-section 12**  
(Year 2 Data - September 2020)



Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	16.7	18.4	0.9	1.9	20.2	-	-	516.12	515.98

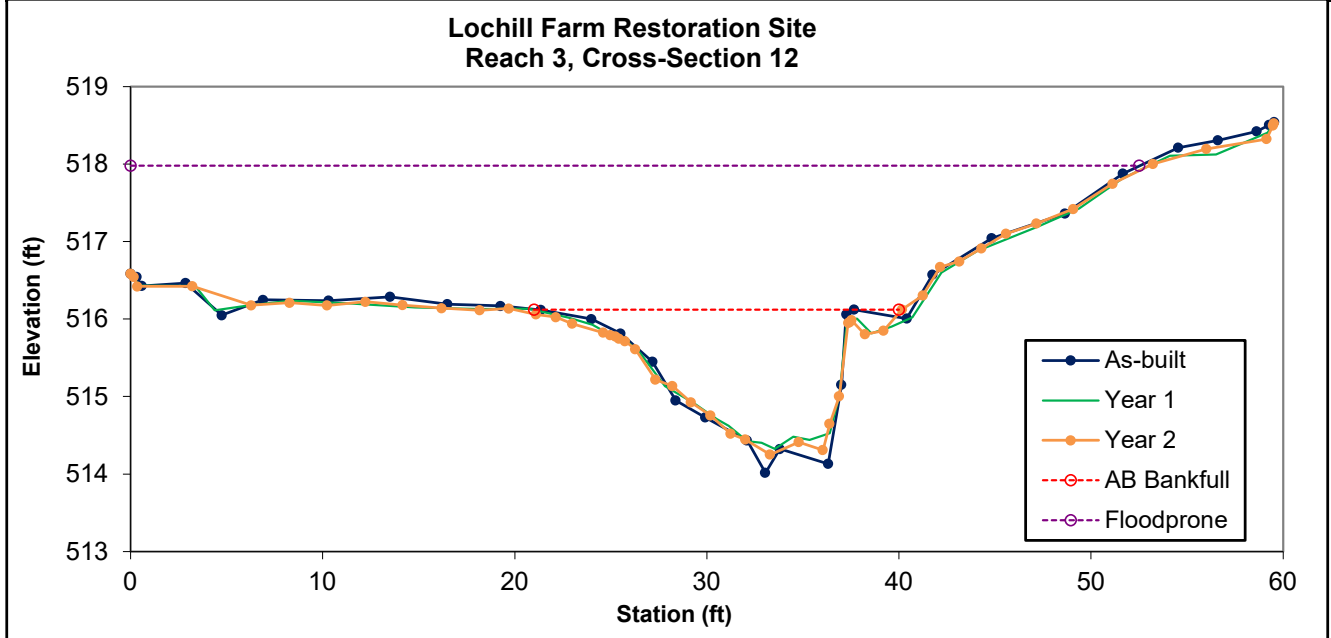


Table 8. Baseline Stream Data Summary																
Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083																
Reach 1																
Parameter	Pre-Existing Condition				Reference Reach(es) Data				Design				As-built			
					Composite											
	Min	Mean	Med	Max	Min	Mean	Med	Max	Min	Mean	Med	Max	Min	Mean	Med	Max
<b>Dimension and Substrate - Riffle</b>																
BF Width (ft)	10.1	12.4	----	14.6	8.7	16.8	14.7	33.2	----	15.7	----	----	14.6	16.0	16.6	16.9
Floodprone Width (ft)	13	56	----	99	26	79	52	229	65	83	----	100	73	75	75	76
BF Mean Depth (ft)	1.3	1.6	----	1.9	0.9	1.2	0.9	2.3	----	1.2	----	----	0.9	1.2	1.2	1.3
BF Max Depth (ft)	1.9	2.3	----	2.6	1.4	1.8	1.5	2.8	----	1.5	----	----	1.4	1.7	1.6	1.9
BF Cross-sectional Area (ft²)	15.3	19.4	----	23.5	10.6	23.3	13.6	75.1	----	19.0	----	----	15.5	18.6	18.3	22.7
Width/Depth Ratio	5.2	7.9	----	10.6	7.3	14.5	14.5	18.6	----	13.0	----	----	12.0	14.0	12.5	18.4
Entrenchment Ratio	1.5	5.0	----	8.5	2.0	6.6	2.9	26.3	4.1	5.3	----	6.4	4.4	4.7	4.5	5.2
Bank Height Ratio	1.7	2.2	----	2.6	1.0	1.0	1.0	1.0	----	1.0	----	----	1.0	1.0	1.0	1.0
d50 (mm)	17.7	21.7	----	25.6	----	----	----	----	----	----	----	----	36	54	59	64
<b>Pattern</b>																
Channel Beltwidth (ft)	25	47	----	68	14	31	28	52	56	91	----	125	55	71	73	83
Radius of Curvature (ft)	23	44	----	65	5	18	19	26	31	39	----	47	30	36	35	49
Rc/Bankfull width (ft/ft)	1.5	4.0	----	6.4	0.6	1.5	1.4	2.5	2.0	2.5	----	3.0	1.9	2.3	2.2	3.0
Meander Wavelength (ft)	52	87	----	121	32	87	74	196	112	152	----	192	124	155	152	199
Meander Width Ratio	1.7	4.2	----	6.7	1.1	2.7	2.4	6.0	3.6	5.8	----	8.0	3.4	4.4	4.6	5.2
<b>Profile</b>																
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	19	48	48	82
Riffle Slope (ft/ft)	----	0.0260	----	----	0.0100	0.0282	0.0190	0.0670	0.0062	0.0075	----	0.0101	0.0046	0.0070	0.0068	0.0120
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	21	35	33	62
Pool to Pool Spacing (ft)	49	130	----	211	13	92	64	277	64	87	----	110	49	98	102	140
Pool Max Depth (ft)	4.2	5.5	----	6.8	1.8	2.6	2.5	4.1	2.5	3.3	----	4.0	2.8	3.3	3.3	3.9
<b>Substrate and Transport Parameters</b>																
SC% / Sa% / G% / C% / Bo%		1% / 10% / 77% / 11% / 1%			----	----	----	----	----	----	----	----	0% / 1% / 61% / 38% / 1%			
d16 / d35 / d50 / d84 / d95		4 / 9 / 13 / 49 / 110			----	----	----	----	----	----	----	----	23 / 41 / 54 / 96 / 158			
<b>Additional Reach Parameters</b>																
Drainage Area (SM)	----	1.59	----	----	0.41	2.57	0.75	8.35	----	1.59	----	----	----	1.59	----	----
Impervious cover estimate (%)	----	0.27%	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Rosgen Classification	----	E4	----	----	----	C4	----	----	----	C4	----	----	----	C4	----	----
BF Velocity (fps)	3.2	3.8	----	4.3	3.5	4.3	----	5.0	----	3.9	----	----	----	----	----	----
BF Discharge (cfs)	----	75	----	----	----	----	----	----	----	75	----	----	----	----	----	----
Valley Length	----	2,559	----	----	----	----	----	----	----	2,559	----	----	----	2,559	----	----
Channel Length (ft)	----	2,936	----	----	----	----	----	----	----	3,252	----	----	----	3,245	----	----
Sinuosity	----	1.15	----	----	1.2	1.3	----	1.4	----	1.27	----	----	----	1.27	----	----
Water Surface Slope (Channel) (ft/ft)	----	0.0081	----	----	0.0070	0.0112	0.0132	0.0133	0.0052	0.0066	----	0.0153	----	0.0066	----	----

**Table 8. Baseline Stream Data Summary**  
**Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083**

Reach 3																
Parameter	Pre-Existing Condition				Reference Reach(es) Data				Design				As-built			
	Min	Mean	Med	Max	Min	Mean	Med	Max	Min	Mean	Med	Max	Min	Mean	Med	Max
<b>Dimension and Substrate - Riffle</b>																
BF Width (ft)	6.2	8.6	----	11.0	----	----	----	----	----	11.0	----	----	----	11.8	----	----
Floodprone Width (ft)	14	37	----	60	----	----	----	----	24.0	42.0	----	60.0	----	60.3	----	----
BF Mean Depth (ft)	0.9	1.1	----	1.2	----	----	----	----	----	0.9	----	----	----	1.0	----	----
BF Max Depth (ft)	1.3	1.4	----	1.4	----	----	----	----	----	1.2	----	----	----	1.5	----	----
BF Cross-sectional Area (ft²)	7.5	9.1	----	10.6	----	----	----	----	----	10.3	----	----	----	12.1	----	----
Width/Depth Ratio	5.2	8.3	----	11.3	12	15	----	18	----	12.2	----	----	----	11.5	----	----
Entrenchment Ratio	2.3	3.9	----	5.4	----	----	----	----	2.2	3.9	----	5.5	----	5.1	----	----
Bank Height Ratio	1.6	1.7	----	1.7	----	1.0	----	----	----	1.0	----	----	----	1.0	----	----
d50 (mm)	----	23.0	----	----	----	----	----	----	----	----	----	----	----	55	----	----
<b>Pattern</b>																
*Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	54	57	----	60	55	57	56	61
*Radius of Curvature (ft)	----	----	----	----	----	----	----	----	27	30	----	33	26	30	31	33
*Rc/Bankfull width (ft/ft)	----	----	----	----	2.0	2.5	----	3.0	2.0	2.5	----	3.0	2.2	2.5	2.6	2.8
*Meander Wavelength (ft)	----	----	----	----	----	----	----	----	96	123	----	150	94	125	128	153
*Meander Width Ratio	----	----	----	----	3.5	6.8	----	10.0	4.9	5.2	----	5.5	4.7	4.9	4.7	5.2
<b>Profile</b>																
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	24	40	36	60
Riffle Slope (ft/ft)	----	0.0258	----	----	----	----	----	----	----	0.027	----	----	----	0.027	----	----
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	16	25	27	34
Pool to Pool Spacing (ft)	20	36	----	51	----	----	----	----	20	39	----	57	12	34	32	70
Pool Max Depth (ft)	1.4	1.7	----	2.0	----	----	----	----	----	2.5	----	----	----	2.1	----	----
<b>Substrate and Transport Parameters</b>																
SC% / Sa% / G% / C% / B%		1% / 11% / 68% / 20% / 0%			----	----	----	----	----	----	----	----		0% / 0% / 60% / 39% / 1%		
d16 / d35 / d50 / d84 / d95		5.9 / 13 / 23 / 79 / 141			----	----	----	----	----	----	----	----		31 / 43 / 55 / 113 / 170		
<b>Additional Reach Parameters</b>																
Drainage Area (SM)	----	0.30	----	----	----	----	----	----	----	0.30	----	----	----	0.30	----	----
Impervious cover estimate (%)	----	0.27%	----	----	----	----	----	----	----	----	----	----	----	----	----	----
*Rosgen Classification	----	B4 to E4b	----	----	----	C4b	----	----	----	C4b	----	----	----	C4b	----	----
BF Velocity (fps)	3.6	5.5	----	7.4	4.0	5.0	----	6.0	----	4.4	----	----	----	----	----	----
BF Discharge (cfs)	----	45	----	----	----	----	----	----	----	45	----	----	----	----	----	----
Valley Length	----	1,488	----	----	----	----	----	----	----	1,488	----	----	----	1,488	----	----
Channel Length (ft)	----	1,599	----	----	----	----	----	----	----	1,616	----	----	----	1,622	----	----
Sinuosity	----	1.07	----	----	1.1	1.2	----	1.3	----	1.09	----	----	----	1.09	----	----
Water Surface Slope (Channel) (ft/ft)	----	0.0220	----	----	----	----	----	----	----	0.0216	----	----	----	0.0213	----	----

\* These parameters apply only to the upper portion of Reach R3 where the channel was relocated with improved pattern, profile, and in-stream structures.

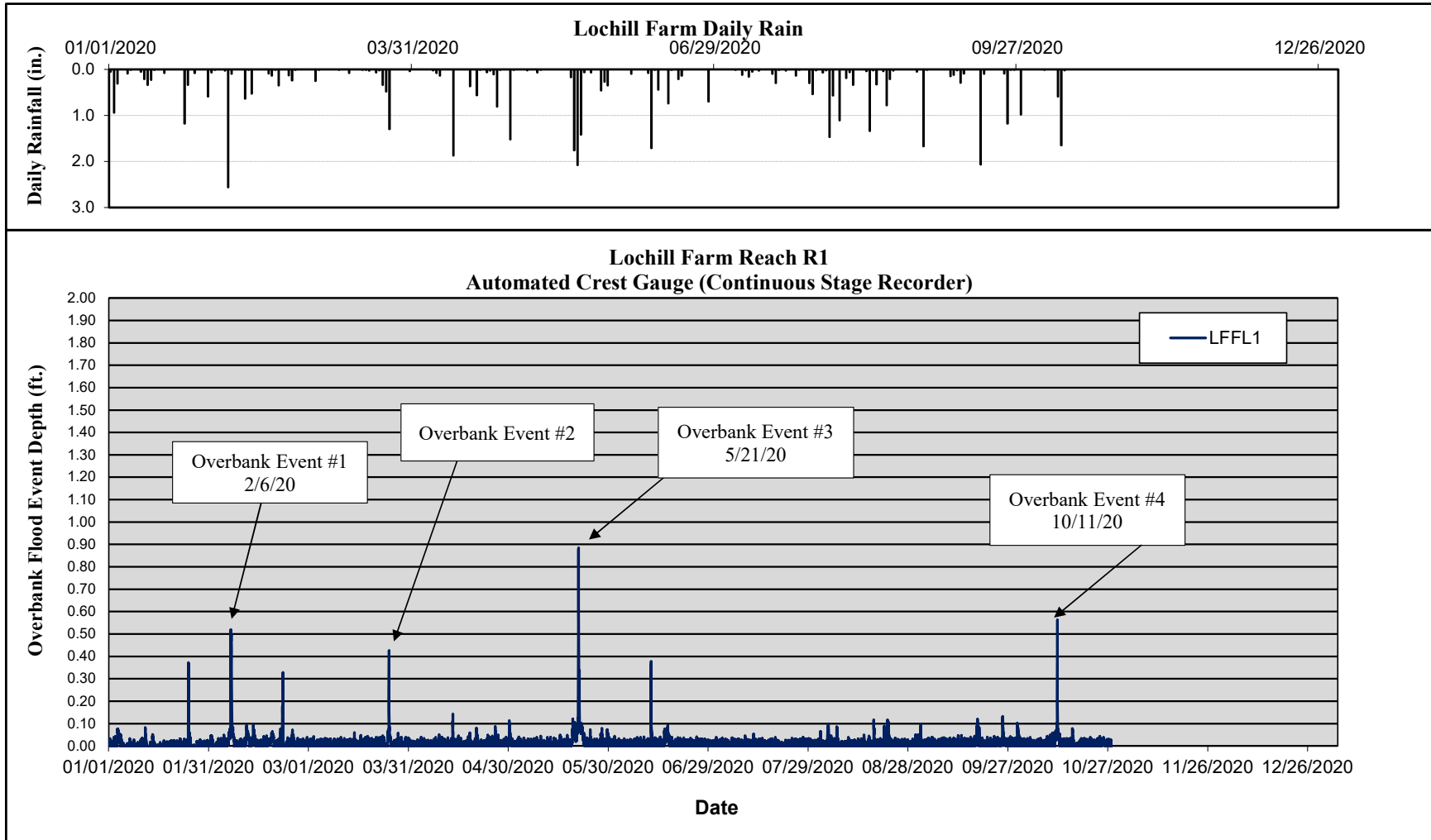
Table 9. Cross-Section Morphology Data Summary																													
Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083																													
Stream Reach		Reach 1																											
		Cross-section X-1 (Riffle)						Cross-section X-2 (Pool)						Cross-section X-3 (Pool)						Cross-section X-4 (Riffle)									
Dimension and substrate		Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
<b>Based on fixed baseline bankfull elevation</b>																													
	BF Width (ft)	15.2	14.8	14.1					21.0	22.3	21.1					21.5	20.2	23.5					16.6	17.4	16.4				
	BF Mean Depth (ft)	1.3	1.3	1.2					1.5	1.4	1.3					1.6	1.9	1.6					1.1	1.1	1.1				
	Width/Depth Ratio	12.0	11.7	11.7					13.7	16.1	16.3					13.8	10.8	14.8					15.0	16.5	15.4				
	BF Cross-sectional Area (ft²)	19.4	18.5	17.1					32.3	31.3	27.2					33.6	37.7	37.2					18.3	18.5	17.5				
	BF Max Depth (ft)	1.9	1.8	1.8					3.2	2.9	2.7					3.3	3.6	3.6					1.6	1.6	1.6				
	Width of Floodprone Area (ft)	75	75	75					-	-	-					-	-	-					73	73	73				
	Entrenchment Ratio	4.9	5.1	5.3					-	-	-					-	-	-					4.4	4.2	4.5				
	Bank Height Ratio (MY2 will provide standard)*	1.0	1.0	0.9					-	-	-					-	-	-					1.0	1.0	1.0				
	Wetted Perimeter (ft)	15.9	15.5	14.8					22.8	24.1	22.5					23.5	22.2	25.5					17.2	18.0	16.9				
	Hydraulic Radius (ft)	1.2	1.2	1.2					1.4	1.3	1.2					1.4	1.7	1.5					1.1	1.0	1.0				
	d50 (mm)	36	-	-					-	-	-					-	-	-					-	-	-				
Stream Reach		Reach 1																											
		Cross-section X-5 (Riffle)						Cross-section X-6 (Pool)						Cross-section X-7 (Pool)						Cross-section X-8 (Riffle)									
Dimension and substrate		Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
<b>Based on fixed baseline bankfull elevation</b>																													
	BF Width (ft)	16.9	15.0	15.4					19.6	20.8	23.6					16.8	18.0	16.5					14.6	14.9	14.4				
	BF Mean Depth (ft)	0.9	1.0	0.9					2.0	2.1	1.8					1.5	1.4	1.5					1.2	1.2	1.3				
	Width/Depth Ratio	18.4	14.9	16.6					9.6	9.9	12.9					11.4	12.5	10.7					12.3	12.3	11.2				
	BF Cross-sectional Area (ft²)	15.5	15.0	14.4					40.1	43.4	43.0					24.7	26.1	25.4					17.3	18.0	18.5				
	BF Max Depth (ft)	1.4	1.4	1.4					3.9	4.1	4.0					2.8	2.5	2.6					1.6	1.7	1.8				
	Width of Floodprone Area (ft)	76	76	76					-	-	-					-	-	-					75	75	75				
	Entrenchment Ratio	4.5	5.1	4.9					-	-	-					-	-	-					5.2	5.0	5.2				
	Bank Height Ratio (MY2 will provide standard)*	1.0	1.0	0.9					-	-	-					-	-	-					1.0	1.0	1.0				
	Wetted Perimeter (ft)	17.4	15.4	15.9					22.4	23.4	26.7					18.3	19.5	17.7					15.4	15.7	15.3				
	Hydraulic Radius (ft)	0.9	1.0	0.9					1.8	1.9	1.6					1.4	1.3	1.4					1.1	1.1	1.2				
	d50 (mm)	64	-	-					-	-	-					-	-	-					-	-	-				
Stream Reach		Reach 3																											
		Cross-section X-9 (Riffle)						Cross-section X-10 (Pool)						Cross-section X-11 (Riffle)						Cross-section X-12 (Pool)									
Dimension and substrate		Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
<b>Based on fixed baseline bankfull elevation</b>																													
	BF Width (ft)	16.9	17.3	17.8					14.3	14.7	14.0					11.8	12.4	11.2					16.4	16.6	18.4				
	BF Mean Depth (ft)	1.3	1.3	1.2					1.9	1.9	2.0					1.0	1.0	1.1					1.0	1.0	0.9				
	Width/Depth Ratio	12.5	13.1	14.5					7.6	7.9	6.8					11.5	12.9	10.6					15.9	17.3	20.2				
	BF Cross-sectional Area (ft²)	22.7	22.8	21.9					26.8	27.3	28.6					12.1	12.0	11.9					16.9	16.0	16.7				
	BF Max Depth (ft)	1.9	2.0	1.9					3.5	3.5	3.5					1.5	1.7	1.6					2.1	1.8	1.9				
	Width of Floodprone Area (ft)	75	75	75					-	-	-					60	60	60					-	-	-				
	Entrenchment Ratio	4.4	4.3	4.2					-	-	-					5.1	4.8	5.4					-	-	-				
	Bank Height Ratio (MY2 will provide standard)*	1.0	1.0	1.0					-	-	-					1.0	1.0	0.9					-	-	-				
	Wetted Perimeter (ft)	17.7	18.3	18.8					16.3	16.6	16.4					12.5	13.1	11.8					18.0	21.4	19.4				
	Hydraulic Radius (ft)	1.3	1.2	1.2					1.6	1.6	1.7					1.0	0.9	1.0					0.9	0.8	0.9				
	d50 (mm)	59	-	-					-	-	-					55	-	-					-	-	-				

\* Per DMS/IRT request, bank height ratio for MY2 has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the as-built bankfull elevation.

# **APPENDIX E**

## Hydrologic Data

**Figure 5. Automated Crest Gauge (Continuous Stage Recorder) Graph**

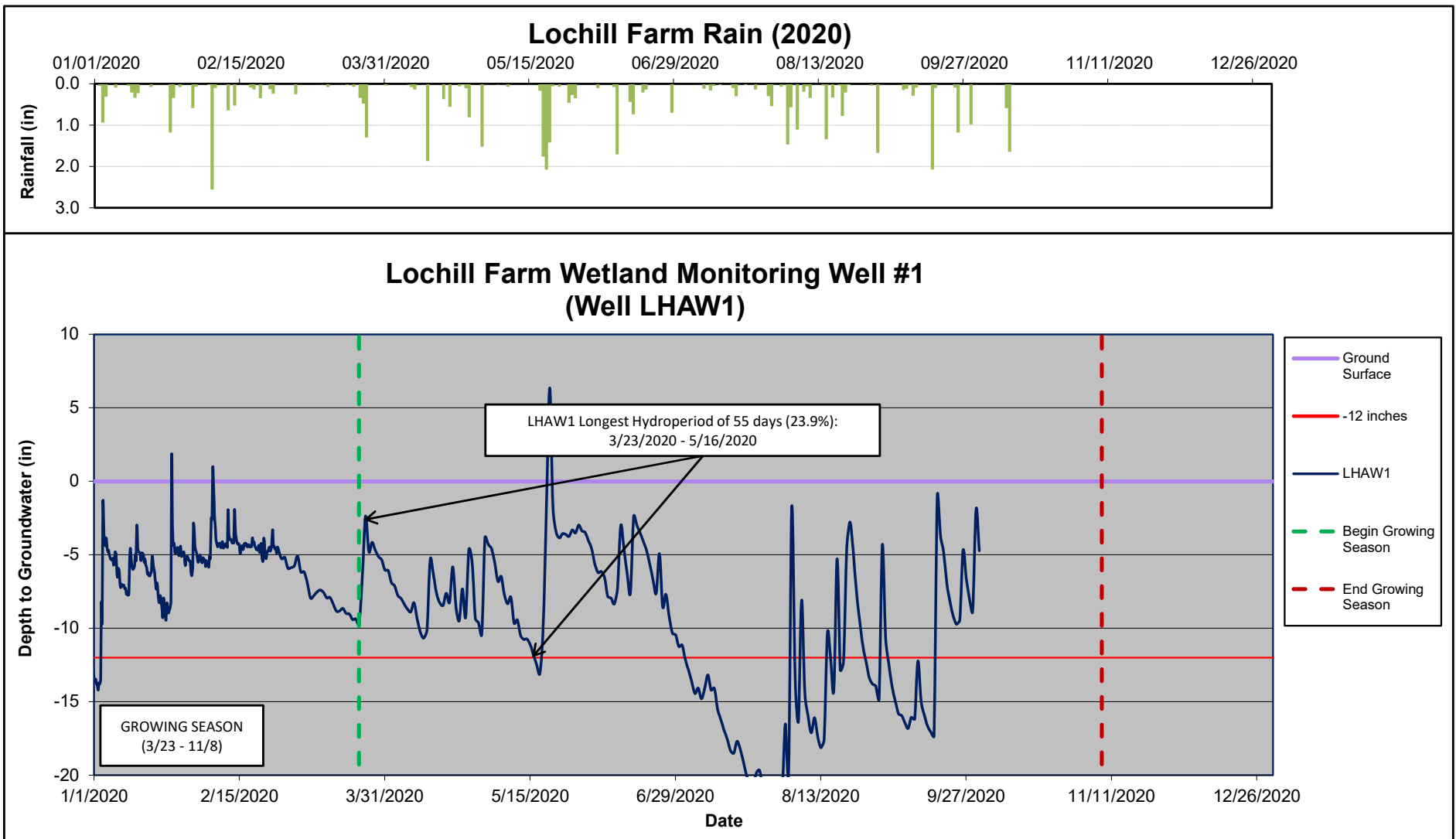


Note: Data presented here is from 1/1/20 thru 9/30/20

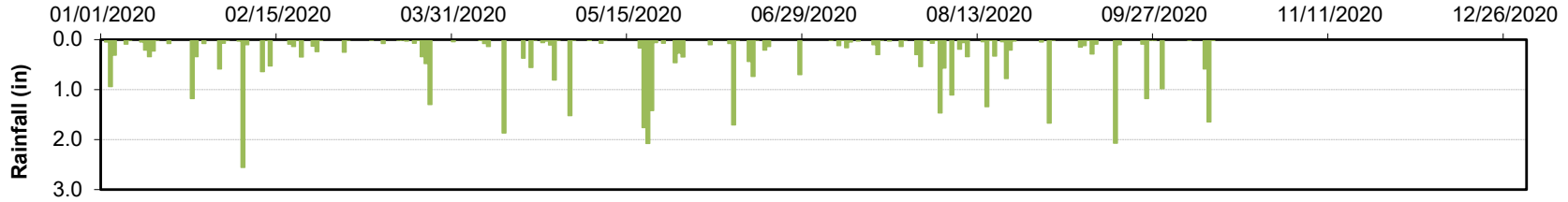
Only the four largest overbank events are called out here and in the report. However, several smaller overbank events also appear to have occurred as shown in the graph above.



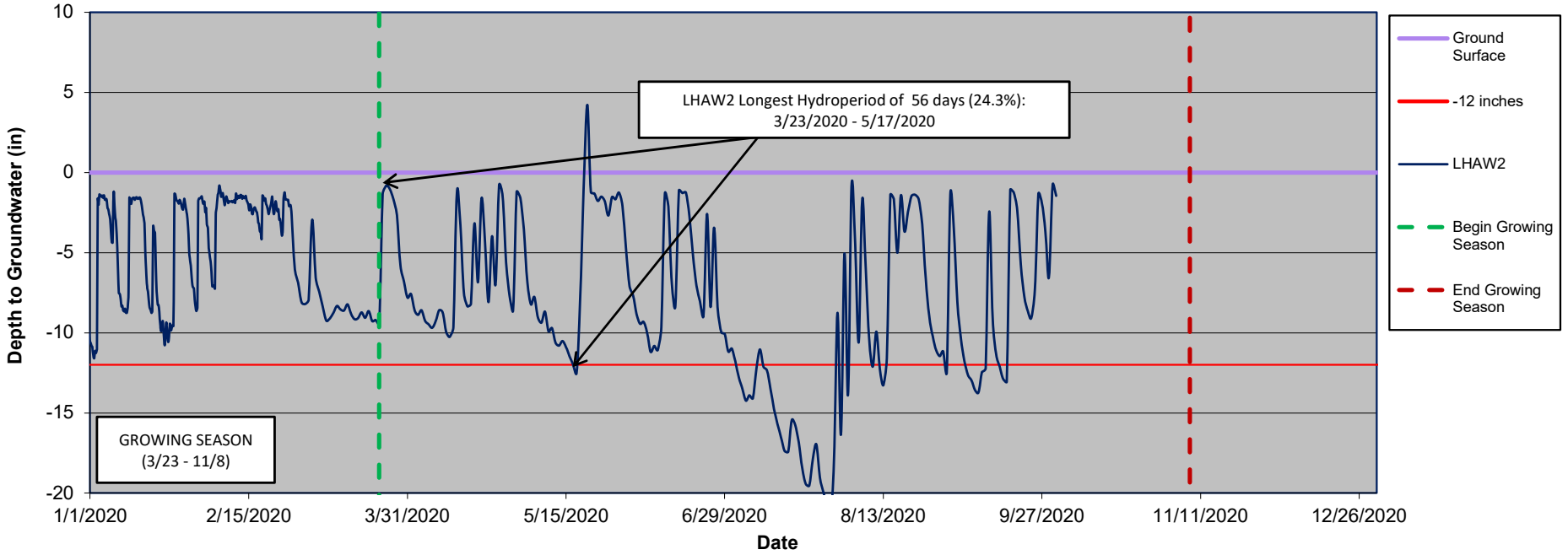
Figure 6. Wetland Monitoring Well Graphs



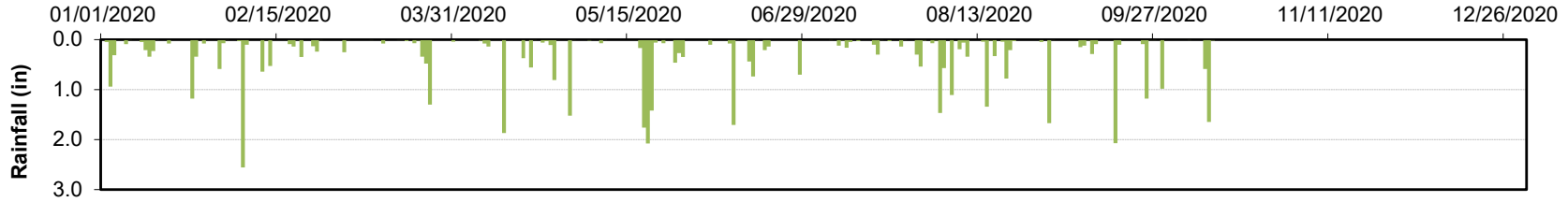
### Lochill Farm Rain (2020)



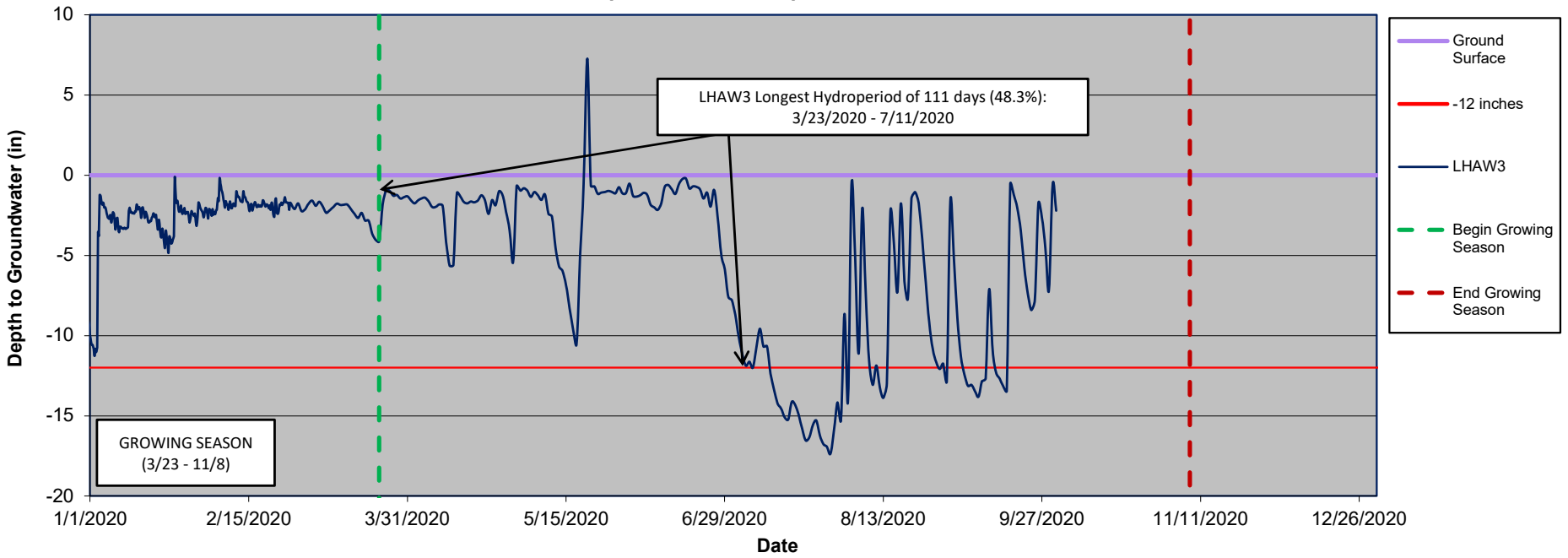
### Lochill Farm Wetland Monitoring Well #2 (Well LHAW2)



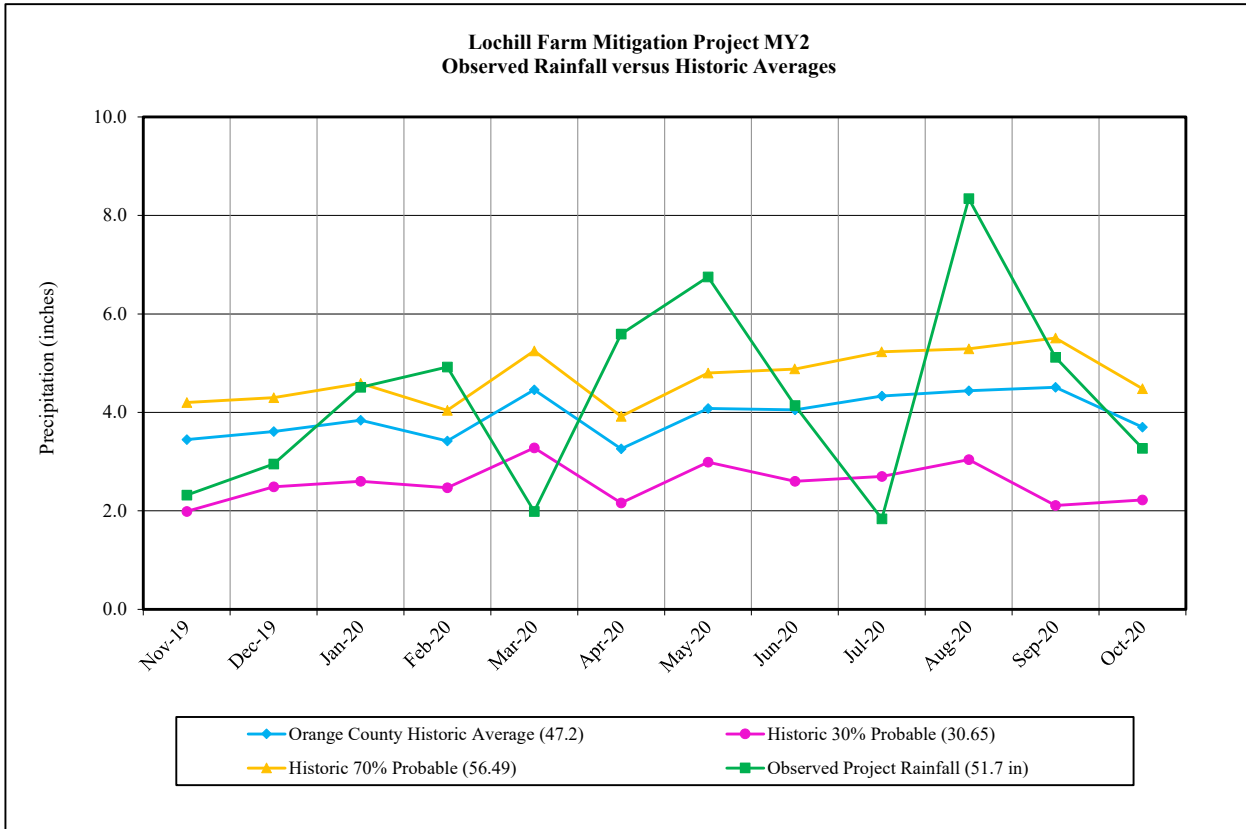
### Lochill Farm Rain (2020)



### Lochill Farm Wetland Monitoring Well #3 (Well LHAW3)



**Figure 7. Observed Rainfall Versus Historic Averages**



Note: Historic average annual rainfall for Orange County is 47.2", while the observed project rainfall recorded a total of 51.7" over the previous 12 months (from 11/1/2019 to 10/31/2020). Project rainfall was collected from the nearest NC-CRONOS station.

**Table 10. Verification of Bankfull Events**  
**Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083**

Date of Manual Gauge Collection	Reach R1 Manual Cork Crest Gauge	Reach R1 Automated Crest Gauge (Continuous Stage Recorder)	Reach R3 Manual Cork Crest Gauge	Date of Bankfull Event Occurrence	Method of Data Collection
<b>Year 1 Monitoring (2019)</b>					
3/7/19	N/A <sup>1</sup>	0.42 ft	N/A <sup>1</sup>	2/23/19 (1.3" rain event)	Continuous Stage Recorder, Photos
4/18/19	0.71 ft	0.96 ft	0.30 ft	4/13/19 (1.8" rain event)	Cork Crest Gauges, Continuous Stage Recorder, Photos
6/19/19	0.81 ft	0.90 ft	0.29 ft	6/18/19 (1.32" rain event)	Cork Crest Gauges, Continuous Stage Recorder, Photos
<b>Year 2 Monitoring (2020)</b>					
2/27/20	0.41 ft	0.52 ft	N/A	2/6/20 (2.56" rain event)	Continuous Stage Recorder, Cork Crest Gauge, Photos
5/8/20	0.23 ft	0.43 ft	N/A	3/25/20 (1.3" rain event, after 0.82" over the previous 24 hours)	Continuous Stage Recorder, Cork Crest Gauge, Photos
7/10/20	0.69 ft	0.87 ft	0.16 ft	5/20/20 (2.08" rain event, after 1.76" over the previous 24 hours)	Continuous Stage Recorder, Cork Crest Gauge, Photos
10/14/20	0.71 ft	0.57 ft	N/A	10/11/20 (1.65" rain event, after 0.59" over previous 24 hours, all related to Hurricane Delta)	Continuous Stage Recorder, Cork Crest Gauge, Photos

Note: Manual cork crest gauge readings were corroborated with associated spikes in the automated Continuous Stage Recorder (see graph in Appendix E) and/or with photographs (Appendix B).

<sup>1</sup> Wet cork in manual crest gauges were found to be frozen solid when checked on morning of 3/7/19

**Table 11. Wetland Hydrology Summary Data**  
**Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083**

Well ID	Percentage of Consecutive Days <12 inches from Ground Surface <sup>1</sup>							Most Consecutive Days Meeting Criteria <sup>2</sup>						
	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)	Year 5 (2023)	Year 6 (2024)	Year 7 (2025)	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)	Year 5 (2023)	Year 6 (2024)	Year 7 (2025)
<b>Wetland Monitoring Wells (Installed January 2019)</b>														
SCAW1	25.7	23.9						59	55.0					
SCAW2	27.4	24.3						63	56.0					
SCAW3	26.1	48.3						60	111.0					

<sup>1</sup>Indicates the percentage of the single greatest consecutive number of days within the monitored growing season with a water table 12 inches or less from the soil surface.

<sup>2</sup>Indicates the single greatest consecutive number of days within the monitored growing season with a water table 12 inches or less from the soil surface.

Growing season for Orange County is from March 23 to November 8 and is **230** days long. 12% of the growing season is **27.6** days.

Well ID	Percentage of Cumulative Days <12 inches from Ground Surface							Cumulative Days Meeting Criteria <sup>3</sup>						
	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)	Year 5 (2023)	Year 6 (2024)	Year 7 (2025)	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)	Year 5 (2023)	Year 6 (2024)	Year 7 (2025)
<b>Wetland Monitoring Wells (Installed January 2019)</b>														
SCAW1	33.5	54.3						77	125.0					
SCAW2	46.5	65.2						107	150.0					
SCAW3	41.3	67.0						95	154.0					

<sup>3</sup>Indicates the total number of days within the monitored growing season with a water table 12 inches or less from the soil surface.