

Lochill Farm Stream Mitigation Project Year 3 (2021) 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

MY3 Data Collection Period: September 2021



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: December 2021



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December 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 MY3 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 received December 2, 2021 in reference to the Lochill Farm Stream Mitigation Project - DRAFT MY3 Report. We have revised the document in response to the review comments as outlined below.

DMS MY3 Draft Report Comments:

1. Table 1.2. Update table to show the assets out three significant digits to match debit ledger (4,113.200 and 176,511.500).

Response: Table 1.2 was updated as requested.

2. Section 1.4 please make note in the narrative that the replanted stems matched the Mitigation Plan vegetation species.

Response: Section 1.4 has been revised as requested.

3. Table 7 is showing that there are some sweetgum and loblolly planted in AB, MY1, and MY2 years. It appears that there are several volunteers now added into the report at MY3 (per IRT guidance). Check to ensure these were entered correctly and revise if needed.

Response: Upon review of Table 7 it appears Baker failed to move the numbers associated with previous years' summary results to account for the addition of new rows in the table for volunteer species. Baker absolutely did not plant sweetgum nor loblolly pine at as-built! Table 7 has been revised so that the new summary data columns for previous monitoring years now match those previously presented in past monitoring reports. Baker regrets the error.

4. Looking through Mitigation Plan documentation, it appears that the 3 groundwater gages were installed post-Mitigation Plan review during an email conversation with Mac Haupt of DWR. Please include this email chain for IRT review to consider removal of those gages moving forward as it appears to show that DWR was amenable to that possibility (I'm attaching that email chain in this response).

Response: Baker has included this email in Appendix A and has added a brief discussion referencing it in the report text in Section 1.5.

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

Sincerely,



Scott King, LSS, PWS
Project Manager

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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 included 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 3 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. Only very minor fluctuations in geometry were observed from last year (as shown in Figure 4 and Table 9 in Appendix D), 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 3 monitoring, the planted acreage was successfully meeting all performance categories. The average density of total planted stems, based on data collected from the five permanent and one random monitoring plots for the Year 3 monitoring conducted in September 2021, was 560 planted stems per acre (Table 7 in Appendix C). Thus, the Year 3 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 Vegetation Problem Area (VPA) was identified during the previous Year 2 monitoring effort; an area approximately 0.31 acres in size along the outer portion of the Reach R3 buffer in which stem mortality was observed. This area still appeared to meet the minimum density requirement but was nevertheless less dense than other project buffer areas. As such, it was supplementally replanted in February of 2021 with 20, 1-gal plants consisting of approximately equal numbers of tulip poplar (*Liriodendron tulipifera*), sugarberry (*Celtis laevigata*), box elder (*Acer negundo*), and willow oak (*Quercus phellos*). Each of these species was among the originally planted species listed in the Mitigation Plan. Upon closer evaluation at the time of planting, the subject area was found to be only 0.28 acres in size. A subsequent assessment of the plants in October 2021 revealed that the planted stems appeared to be healthy and growing. Numerous stems were quickly and easily identified in the field, and they had leaves and/or bud scars to indicate seasonal growth and all-around good vigor.

During Year 3 monitoring, four separate post-construction bankfull events were documented (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, 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 four months below the 30% probable average. It was considerably wetter in the fall and winter of 2020-2021 but was a very dry spring and fall of 2021. A total of 43.4 inches of rainfall was observed for the site, a deficit of 3.8 inches below 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 3 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. This survey system collects point data with an accuracy of less than one tenth of a foot. 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). At the time of installation and in previous monitoring reports, Michael Baker has stated that if it became clear that the restored stream is not having any detrimental impact to the wetlands, we would request to the IRT that the wells be removed. An email chain included in Appendix A shows the discussion with Mac Haupt of DWR regarding this potential request and his agreement. The wells were originally proposed after the IRT post contract site visit and only requested by DWR as per their 401 permitting requirements. Currently, all three years of monitoring reveal that each groundwater well has had hydroperiods averaging between 24-33% of the growing season (Table 11), with the lowest recorded seasonal hydroperiod of 23.9% and the highest of 48.3%. The areas appear very wet in the field, even wetter than they were at pre-construction. Thus, Michael Baker would respectfully request that these wells be removed during MY4 as it seems abundantly clear that the stream restoration has not negatively affected the wetlands.

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.

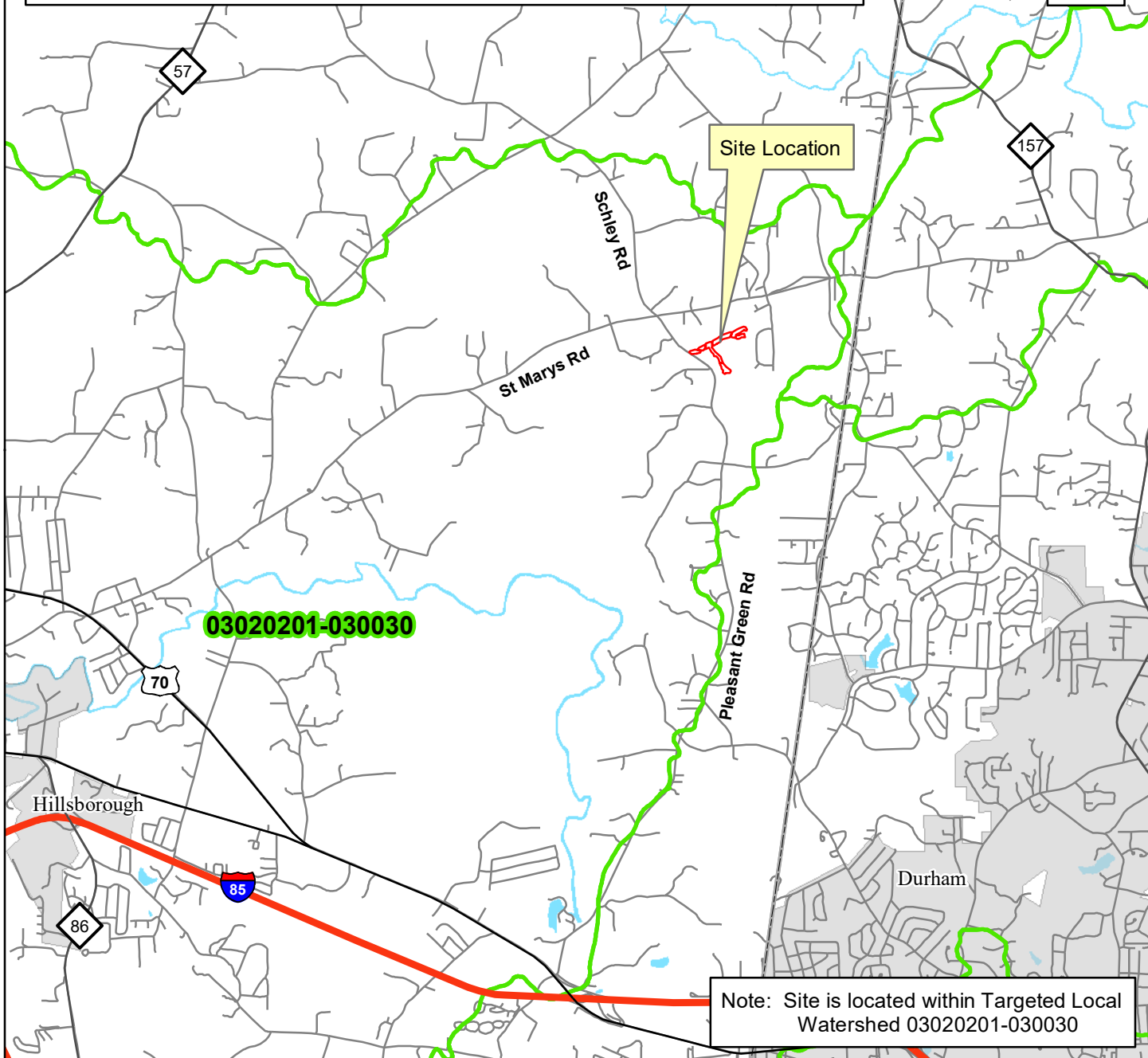
North Carolina Division of Mitigation Services. 2016. Neuse River Basin Restoration Priorities: Neuse-01 Catalog Unit *Update*. NC Department of Environmental Quality. Raleigh, NC.

- 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.

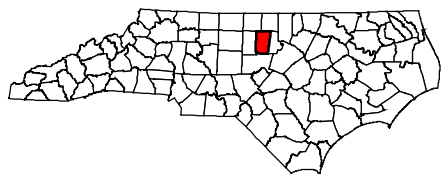
APPENDIX A

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.



Note: Site is located within Targeted Local Watershed 03020201-030030



Orange County

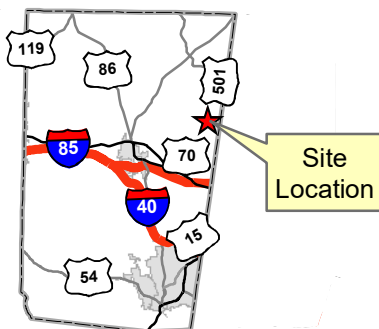
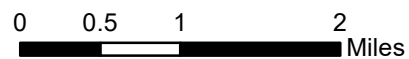


Figure 1
Project Vicinity Map
Lochill Farm Site

Michael Baker
INTERNATIONAL



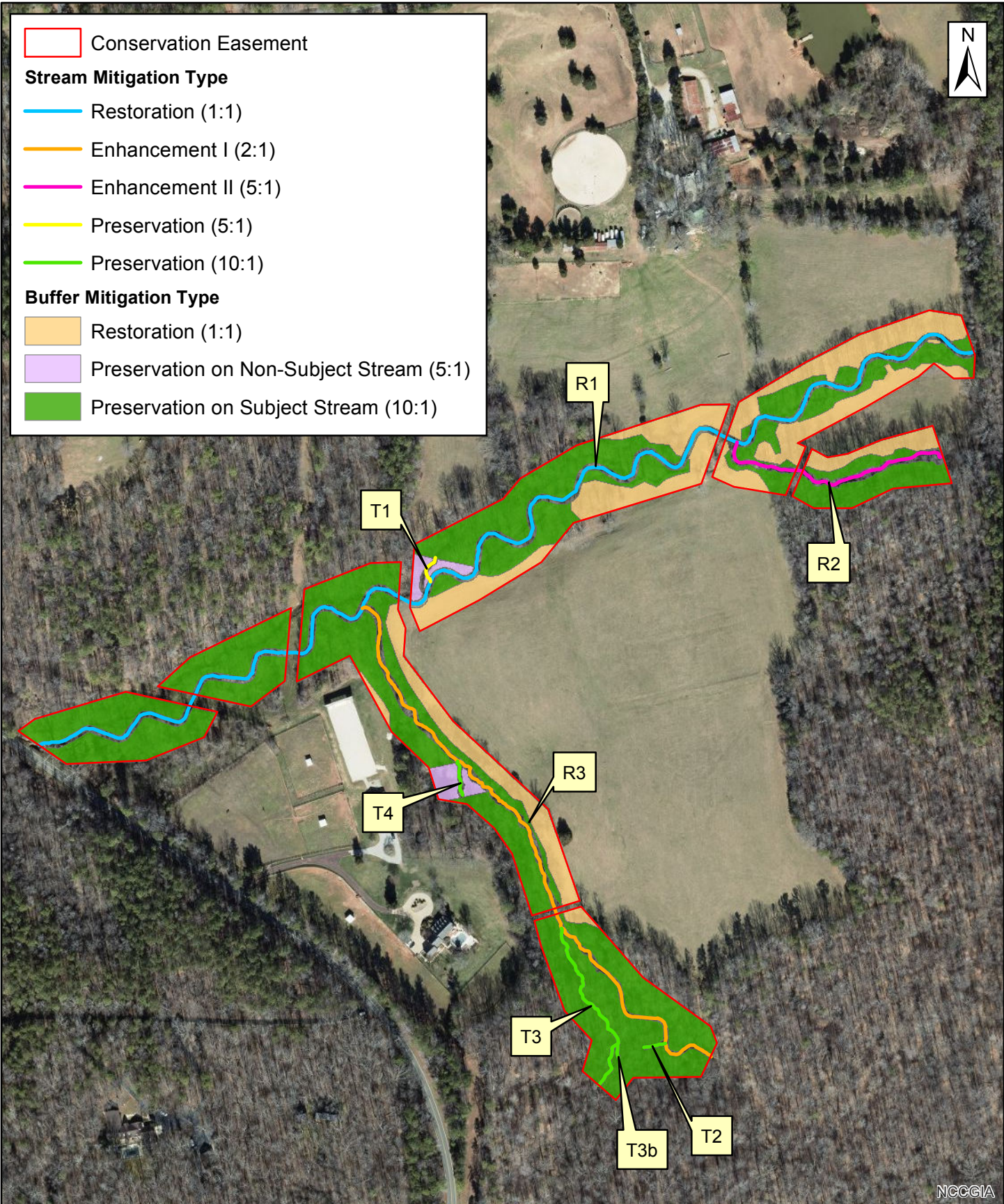


Table 1. Project Components and Mitigation Credits
Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083

Project Component (reach ID, etc.)	Wetland Position and HydroType	Existing Footage or Acreage	Stationing	As-Built Restored Footage, or SF ¹	As-Built Centerline Footage, or SF ²	Mitigation Plan Designed Footage	Restoration Level	Approach Priority Level	Mitigation Ratio (X:1)	Mitigation Plan Credits ³
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	4,113.200
RP Wetland	-
NR Wetland	-
Buffer	176,511.500

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

Elapsed Time Since grading complete: 3 years and 0 months
Elapsed Time Since planting complete: 2 years and 10 months
Number of Reporting Years¹: 3

Activity or Deliverable	Data Collection Complete	Completion or Delivery
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	Jan-21
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	Oct-21	Dec-21
Supplemental 1-gal plantings on lower R3	Planted in February 2021	
Year 4 Monitoring (anticipated)	Oct-22	Dec-22
Year 5 Monitoring (anticipated)	Oct-23	Dec-23
Year 6 Monitoring (anticipated)	Oct-24	Dec-24
Year 7 Monitoring (anticipated)	Oct-25	Dec-25

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

Table 3. Project Contacts

Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083

Designer	8000 Regency Parkway, Suite 600
Michael Baker Engineering, Inc.	Cary, NC 27518 Contact: Scott King, Tel. 919-219-6339
Construction Contractor	5616 Coble Church Rd
KBS Earthworks	Julian, NC 27283 Contact: Chris Sizemore, Telephone: 336-362-0289
Survey Contractor	88 Central Avenue
Kee Mapping and Surveying	Asheville, NC 28801 Contact: Brad Kee, Tel. 828-575-9021
Planting Contractor	5616 Coble Church Rd
KBS Earthworks	Julian, NC 27283 Contact: Chris Sizemore, Telephone: 336-362-0289
Seeding Contractor	5616 Coble Church Rd
KBS Earthworks	Julian, NC 27283 Contact: Chris Sizemore, Telephone: 336-362-0289
Seed Mix Sources	
Green Resources	Telephone: 336-855-6363
Nursery Stock Suppliers	
Mellow Marsh Farm	Telephone: 919-742-1200
ArborGen	Telephone: 843-528-3204
Monitoring Performers	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518
Stream Monitoring POC	Scott King, Tel. 919-219-6339
Vegetation Monitoring POC	Scott King, Tel. 919-219-6339

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			
Project Watershed Summary Information					
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			
Existing Reach Summary Information					
Parameters		Reach R1	Reach R2	Reach R3	Reach T1
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
Existing Reach Summary Information					
Parameters		Reach T2	Reach T3	Reach T3b	Reach T4
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
Regulatory Considerations					
Parameters		Applicable?	Resolved?	Supporting Docs?	
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	

Email exchange between Baker and DWR regarding the additional groundwater wells for wetland assessment:

From: [Haupt, Mac](#)
To: [Byers, Jake](#); [Crocker, Lindsay](#)
Cc: [King, Scott](#); [Baumgartner, Tim](#); andrea.w.hughes@usace.army.mil
Subject: RE: [External] RE: EXTERNAL: FW: Lochill gauge locations
Date: Thursday, March 8, 2018 12:54

Jake,

I am ok with the below email.

I know your concern regarding the gauges, however, the agencies do believe they are important to assess the effect of the channel construction on the wetlands.

I have completed the 401 review and you will be receiving an email shortly.

Thanks,
Mac

From: Byers, Jake [mailto:JByers@mbakerintl.com]
Sent: Thursday, March 08, 2018 12:13 PM
To: Haupt, Mac <mac.haupt@ncdenr.gov>; Crocker, Lindsay <Lindsay.Crocker@ncdenr.gov>
Cc: King, Scott <Scott.King@mbakerintl.com>; Baumgartner, Tim <tim.baumgartner@ncdenr.gov>
Subject: [External] RE: EXTERNAL: FW: Lochill gauge locations

CAUTION: External email. Do not click links or open attachments unless verified. Send all suspicious email as an attachment to [Report Spam](#).

Mac,

As we discussed over the last couple weeks, Michael Baker will install 3 of the 4 ground water monitoring wells in the approximate locations shown on the marked up plan sheets sent on 3/1/18. We will install these wells during monitoring device installation after construction. The locations will be documented and shown in the as-built report. The data collected from these gauges will not be used to determine success or failure of the contracted stream and riparian buffer mitigation credits. Data collected during the monitoring period will be included as supplemental information in the annual monitoring reports. If during monitoring, it becomes clear that the restored streams are not having any detrimental impacts to adjacent jurisdictional (PJD) wetlands, Michael Baker may request to DWR that these efforts be stopped and wells removed.

Please let me know if you have any further questions.

Thanks,

-Jake

Jacob "Jake" Byers, PE | Ecosystem Services Manager | Michael Baker Engineering, Inc.

797 Haywood Road, Suite 201 | Asheville, NC 28806 | [O] 828-412-6101 | [M] 919-259-4814
jbyers@mbakerintl.com | www.mbakertnl.com



From: Haupt, Mac [<mailto:mac.haupt@ncdenr.gov>]
Sent: Thursday, March 01, 2018 3:44 PM
To: Crocker, Lindsay <Lindsay.Crocker@ncdenr.gov>
Cc: Byers, Jake <JByers@mbakerintl.com>
Subject: EXTERNAL: FW: Lochill gauge locations

Lindsay,

Just sent this to Jake. Wanted you to be aware (that I wanted some gauges at Lochill to document channel's affect on adjacent wetlands).

Mac

From: Haupt, Mac
Sent: Thursday, March 01, 2018 3:41 PM
To: Byers, Jake <JByers@mbakerintl.com>
Cc: 'Hughes, Andrea W CIV USARMY CESAW (US)' <Andrea.W.Hughes@usace.army.mil>
Subject: Lochill gauge locations

Jake,

There are four gauges at the locations specified.

Call me tomorrow if you want to discuss.

Thanks,

Mac

From: Mac Haupt [<mailto:mac4492@icloud.com>]
Sent: Thursday, March 01, 2018 3:36 PM
To: Haupt, Mac <mac.haupt@ncdenr.gov>
Subject: [External] Document - Mar 1, 2018

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APPENDIX B

Visual Assessment Data

Conservation Easement

Cross-Section

Groundwater Well

Crest Gauge

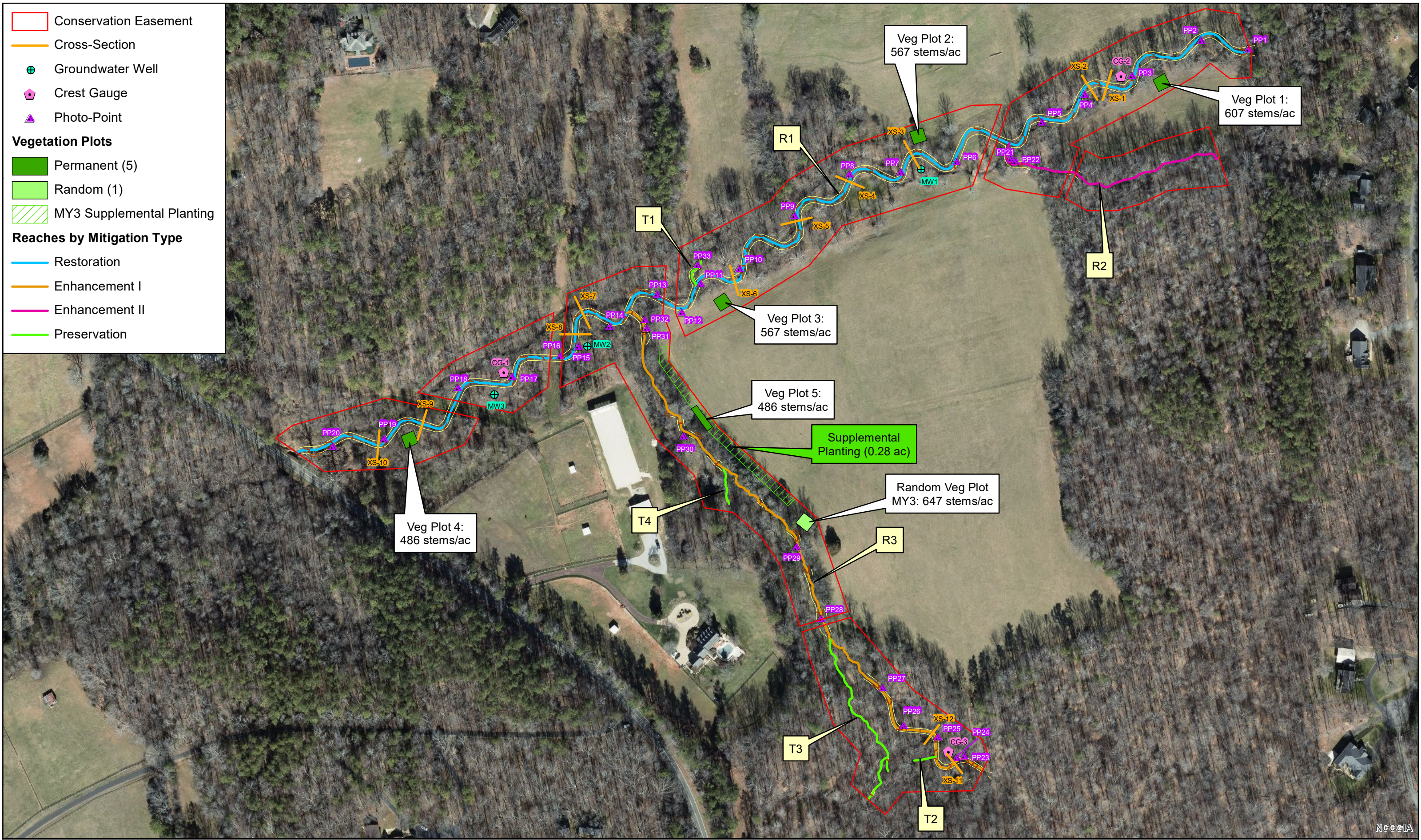
Photo-Point

Vegetation Plots

- Permanent (5)
- Random (1)
- MY3 Supplemental Planting

Reaches by Mitigation Type

- Restoration
- Enhancement I
- Enhancement II
- Preservation



NCCEIA



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%
	3. Meander Pool Condition	1. Depth - Sufficient (Max Pool Depth/Mean Bkf Depth ≥ 1.5)	34	34			100%
		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%	
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%
	Totals					0	0
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 does not exceed 15%	38	38			100%
	4. Habitat	Pool forming structures maintaining - Max Pool Depth/Mean Bankfull Depth ratio ≥ 1.5. Rootwads/logs providing some cover at low flow	36	36			100%

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%
	3. Meander Pool Condition	1. Depth - Sufficient (Max Pool Depth/Mean Bkf Depth ≥ 1.5)	1	1			100%
		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%	
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%
	Totals					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 does not exceed 15%	1	1			100%
	4. Habitat	Pool forming structures maintaining - Max Pool Depth/Mean Bankfull Depth ratio ≥ 1.5. Rootwads/logs providing some cover at low flow	1	1			100%

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 ≥ 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%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting is expected			0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapsing			0	0	100%
	Totals					0	0
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	19	19			100%
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	19	19			100%
	2a. Piping	Structures lacking any substantial flow underneath or around sills or arms	19	19			100%
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	19	19			100%
	4. Habitat	Pool forming structures maintaining - Max Pool Depth/Mean Bankfull Depth ratio ≥ 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

Planted Acreage: 9.8						
Vegetation Category	Defintions	Mapping Threshold (acres)	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
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	N/A	0	0.00	0.0%
Total				0	0.00	0.0%
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%
Cumulative Total				0	0.00	0.0%
Easement Acreage: 15.8						
Vegetation Category	Defintions	Mapping Threshold	CCPV Depiction	Number of Points	Combined Acreage	% of Planted Acreage
4. Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale)	1000 ft ²	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: MY3 Stream Station Photo-Points (taken 3/11/21)



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: MY3 Stream Station Photo-Points (taken 3/11/21)



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: MY3 Stream Station Photo-Points (taken 3/11/21)



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: MY3 Stream Station Photo-Points (taken 3/11/21)



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: MY3 Stream Station Photo-Points (taken 3/11/21)



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: MY3 Stream Station Photo-Points (taken 3/11/21)



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: MY3 Vegetation Plot Photographs (taken 9/4/2021)



Vegetation Plot 1



Vegetation Plot 2



Vegetation Plot 3



Vegetation Plot 4



Vegetation Plot 5



Random Vegetation Plot MY3

Lochill Farm: MY3 Overbank Event Photographs



Manual crest gauge reading of 0.57 ft on upper R1 (photo from 6/24/21, storm on 4/9/21)



Closeup of wrack line on R1 showing evidence of overbank flow



Manual crest gauge reading of N/A on R3 (photo from 6/24/21)



Location of wrack line on R1 for evidence of overbank flow



Debris jams around base of crest gauge on upper R1 (photo from 3/11/21)



Debris jam/wrack line on right floodplain of R1 next to manual crest gauge (photo from 3/11/21)

Lochill Farm: MY3 Overbank Event Photographs



Manual crest gauge reading of 1.01 ft on upper R1 (photo from 3/11/21, storm on 2/16/21)



Close-up of manual crest gauge reading of 1.01 ft on upper R1 (photo from 3/11/21, storm on 2/16/21)



Debris jammed up against crest gauge base (pushed back for photo) on upper R3 (photo from 3/11/21)



Manual crest gauge reading of 0.56 ft on upper R3 (photo from 3/11/21, storm on 2/16/21)



Manual crest gauge reading of 1.17 ft on upper R1 (photo from 10/20/21, storm from 7/19/21)



Close-up of manual crest gauge reading of 1.17 ft on upper R1 (photo from 10/20/21, storm from 7/19/21)

Lochill Farm: MY3 Additional Monitoring Photographs



Bridge on R1 at Station ~18+20 (3/11/21)



Stable crossing over bridge on R1 at Station ~18+20 (6/21/21)



Pipe crossing on R3 at Station ~16+30 (3/11/21)



Stable pipe crossing on R3 at Station ~16+30 (3/11/21)



Pipes at crossing at top of R3 at Station 10+00 (3/11/21)



Crossing over pipes at top of R3 at Station 10+00 (path shown by arrow, 3/11/21)

Lochill Farm: MY3 Additional Monitoring Photographs



Flow on Reach R2 at confluence with R1 (3/10/21)



Flow on Reach R2 at confluence with R1 (6/24/21)



Previously thin/sparse herbaceous area of R1 floodplain (as noted in MY1) revegetating well (photo 6/24/21)



Previously thin/sparse herbaceous area of R1 floodplain (as noted in MY1) revegetating well (photo 6/24/21)



Area of supplemental planting in February 2021 establishing well (photo from 10/20/21)



Floodplain vegetation from very bottom of site looking upstream from Pleasant Green Rd (10/20/21)

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 (MY3, 2021)																		Annual Means												
			Veg Plot 1			Veg Plot 2			Veg Plot 3			Veg Plot 4			Veg Plot 5			MY3 Random Plot ¹			MY3 (2021)			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	V	T	P			
<i>Acer negundo</i>	Boxelder	Tree							3	4	7	1		1	1		1	2	2	4	7	6	13	4		4	4		4	5			
<i>Alnus serrulata</i>	Tag Alder	Shrub Tree				1	2	3				1		1	1		1				3	2	5	6		6	6		6	6			
<i>Asimina triloba</i>	Pawpaw	Shrub Tree																												1			
<i>Betula nigra</i>	River Birch	Tree	2		2	4		4	1		1	2		2	2		2				11		11	15		15	17		17	18			
<i>Carpinus caroliniana</i>	Ironwood	Shrub Tree	3		3	1		1	1		1	1		1	1		1				6		6	10		10	10		10	10			
<i>Celtis laevigata</i>	Sugarberry	Shrub Tree				2		2			2		2	1		1	1		1	6		6	5		5	9		9	7				
<i>Cercis canadensis</i>	Redbud	Shrub Tree	1		1	1		1											2		2	2	1	3									
<i>Diospyros virginiana</i>	Persimmon	Tree																						2	2								
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	3		3			5	5								2	2		5	5	10	5	1	6	5		5	5				
<i>Ilex verticillata</i>	Winterberry	Shrub Tree							1		1									1		1	2		2	3		3	3				
<i>Juglans nigra</i>	Black Walnut	Tree												2	2	1		1	1	2	3		1	1									
<i>Lindera benzoin</i>	Northern Spicebush	Shrub Tree							2		2									2		2	2		2	3		3	3				
<i>Liquidambar styraciflua</i>	Sweet Gum	Tree		5	5		10	10		5	5					5	5	8	8		33	33		1	1								
<i>Liriodendron tulipifera</i>	Tulip tree	Tree	5		5	1		1				1		1				4	4		11		11	7		7	12		12	10			
<i>Nyssa sylvatica</i>	Black Gum	Tree										1		1				1	1	1	2		2	1		1	1		1	1			
<i>Pinus taeda</i>	Loblolly Pine	Tree		4	4						4					3	3		3	3		10	14										
<i>Platanus occidentalis</i>	Sycamore	Tree	1		1	4	10	14	4	10	14	2	10	12	5	7	12	4	10	14	20	47	67	20	8	28	24		24	19			
<i>Quercus lyrata</i>	Overcup Oak	Tree										1		1						1		1											
<i>Quercus michauxii</i>	Swamp Chestnut Oak	Tree																					1		1	1		1	1				
<i>Quercus pagoda</i>	Cherrybark Oak	Tree		1	1															1	1		1	1		1	1						
<i>Quercus phellos</i>	Willow Oak	Tree															1	1	1	1	1	1	1		1	3		3	7				
<i>Salix nigra</i>	Black Willow	Tree										5	5							5	5												
<i>Ulmus americana</i>	American Elm	Tree																						3	3								
<i>Viburnum dentatum</i>	Arrow-wood	Shrub Tree													2		2				2		2	2		2	5		5	5			
<i>Viburnum nudum</i>	Poosumhaw	Shrub Tree							2	2	2									2	2	2	2		2	2		2	2				
	Stem count		15	10	25	14	27	41	14	21	37	12	15	27	12	17	29	16	23	39	83	113	198	85	18	103	105		105	103			
	size (ares)		1			1			1			1			1			1			6			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			0.148
	Species count		6	3	9	7	4	9	7	4	9	9	2	10	6	4	9	8	4	10	17	10	21	16	8	21	15		15	16			
	Stems per ACRE		607	405	1012	567	1093	1659	567	850	1497	486	607	1093	486	688	1174	647	931	1578	560	762	1335	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

¹ Plot MY3 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 3 Data - September 2021)

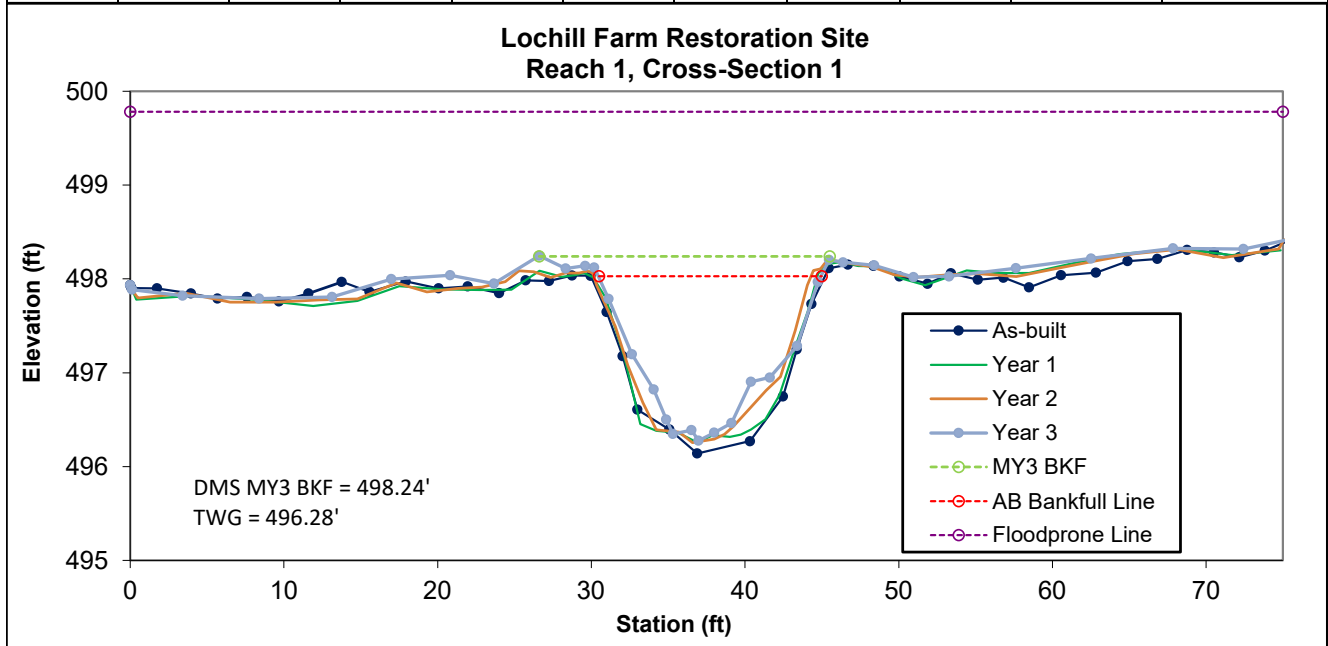


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	AB BKF Elev	LTOB Elev
Riffle	C	15.7	14.5	1.1	1.8	13.3	0.9	5.2	498.03	498.123

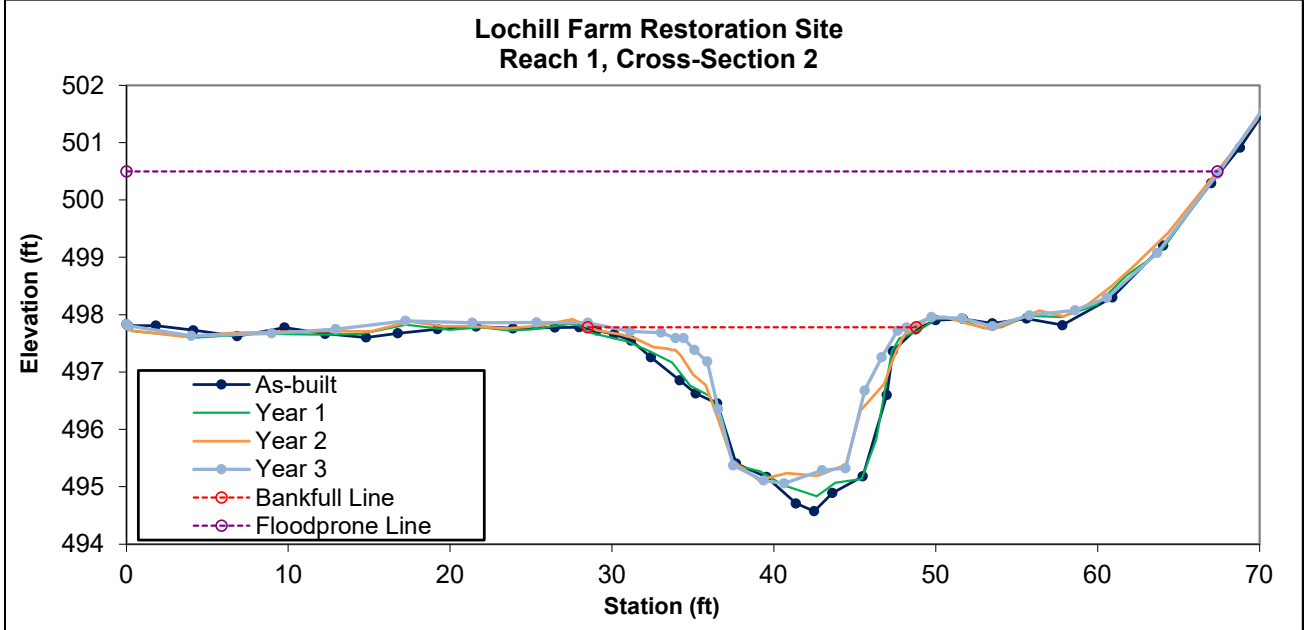


Note: Per DMS/IRT request, the bank height ratio has been calculated using the bankfull elevation as determined from the as-built bankfull area. All other values were calculated using the original as-built bankfull elevation, as was done for previous monitoring reports.

Permanent Cross-section 2
(Year 3 Data - September 2021)



Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	AB BKF Elev	LTOB Elev
Pool	--	24.6	18.4	1.3	2.7	13.7	--	--	497.78	497.593



Permanent Cross-section 3
(Year 3 Data - September 2021)

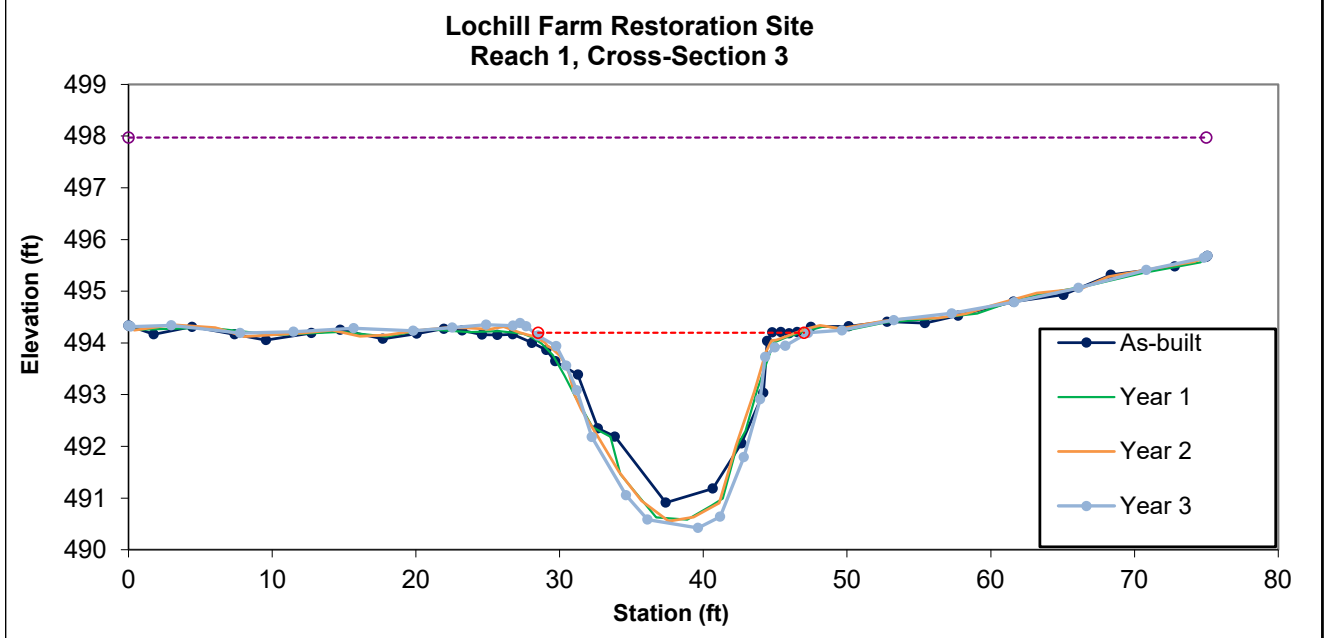


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	AB BKF Elev	LTOB Elev
Pool	--	40.6	19.3	2.1	3.8	9.2	--	--	494.2	493.915



Permanent Cross-section 4
(Year 3 Data - September 2021)

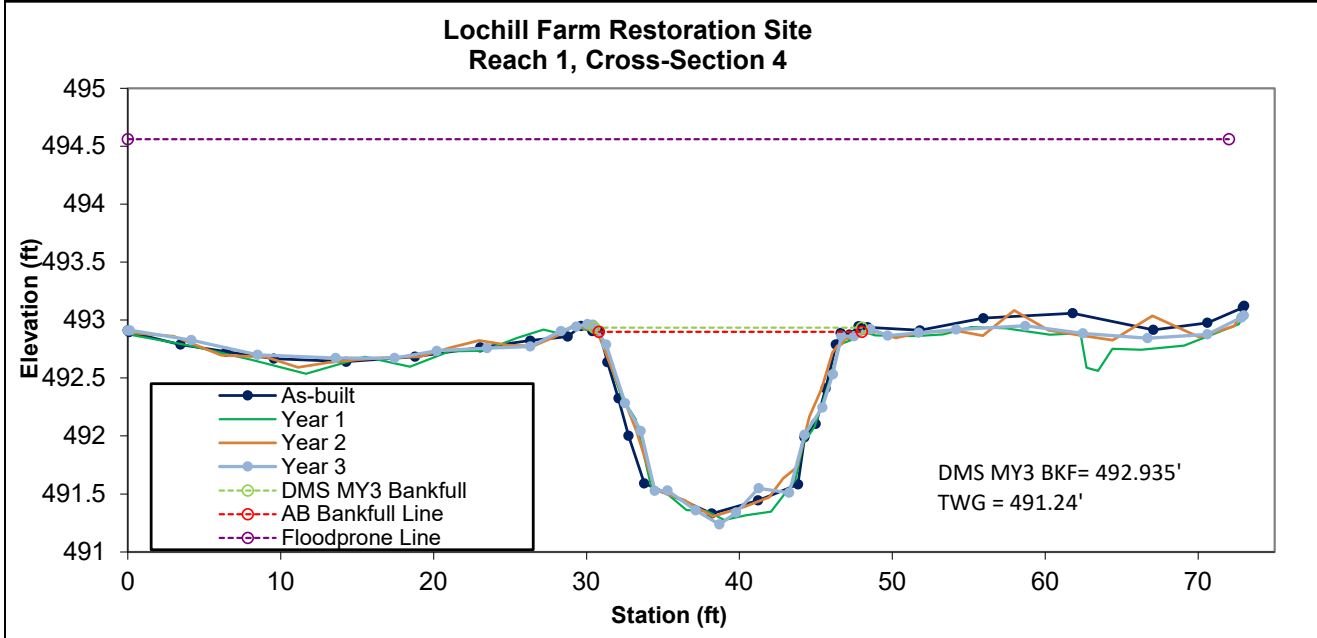


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	AB BKF Elev	LTOB Elev
Riffle	C	17.7	15.9	1.1	1.7	14.4	1.0	4.6	492.9	492.864



Note: Per DMS/IRT request, the bank height ratio 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 5
(Year 3 Data - September 2021)

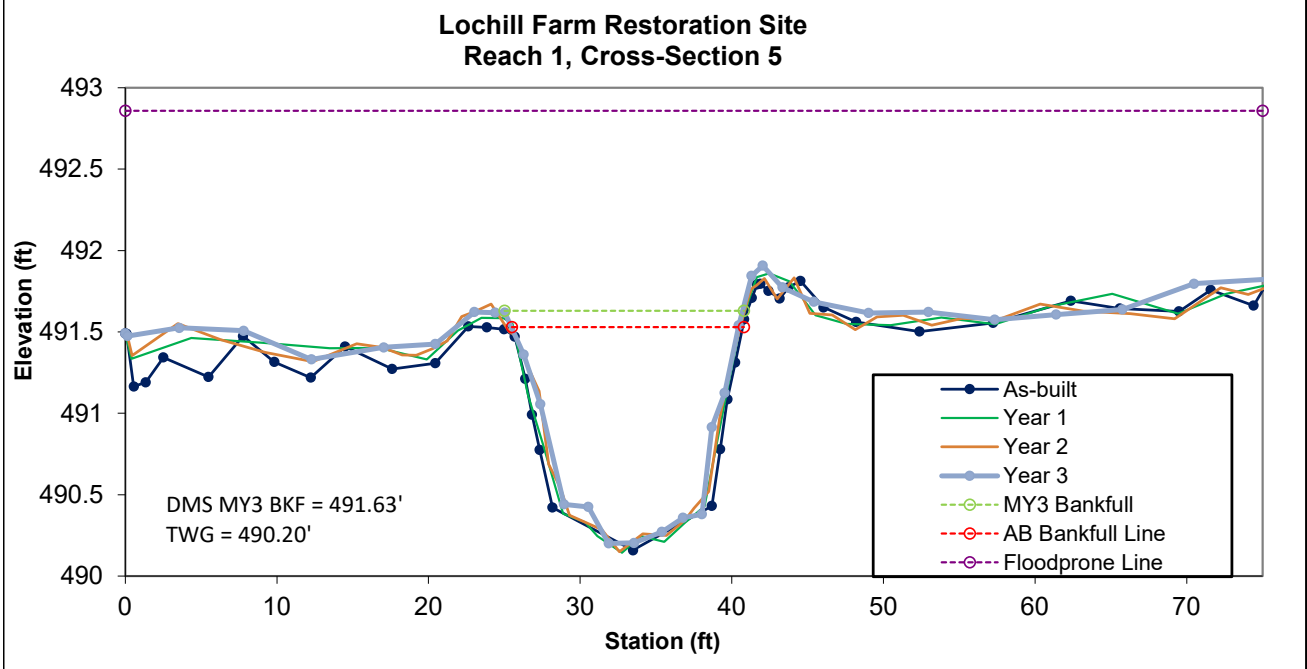


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	AB BKF Elev	LTOB Elev
Riffle	C	14	15	0.9	1.3	16.1	1.0	5.0	491.53	491.618



Note: Per DMS/IRT request, the bank height ratio 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 3 Data - September 2021)

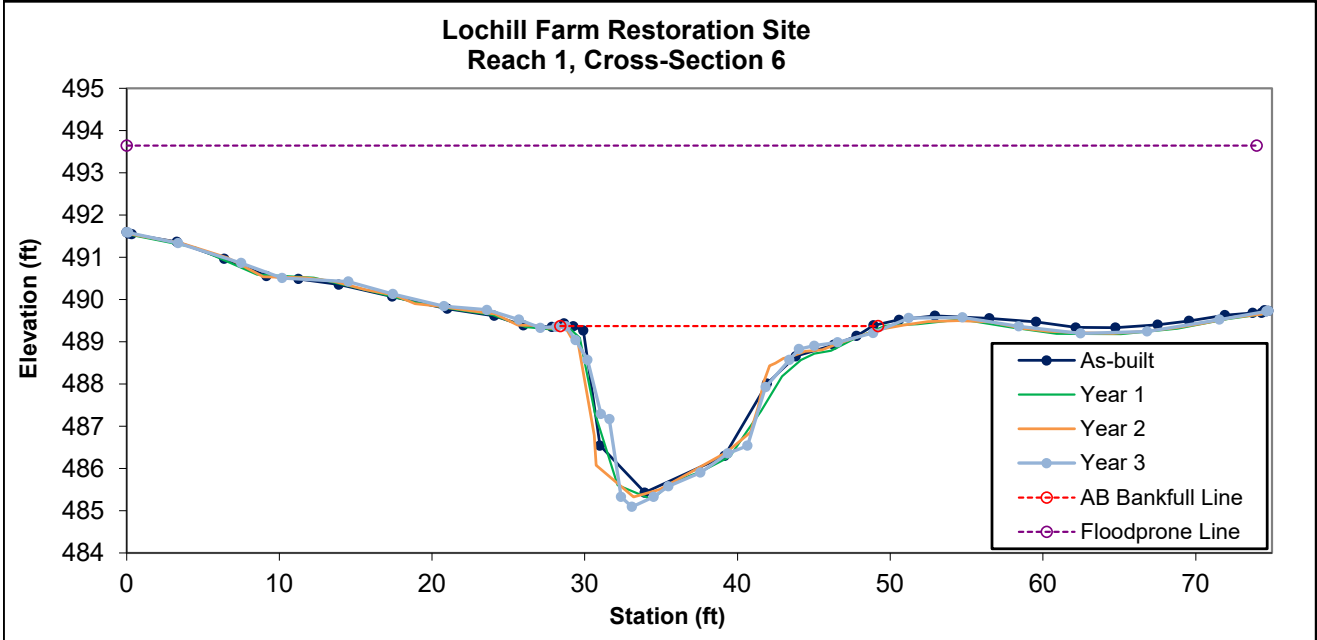


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	AB BKF Elev	LTOB Elev
Pool	--	41.8	21.8	1.9	4.3	11.4	--	--	489.37	488.826



Permanent Cross-section 7
(Year 3 Data - September 2021)

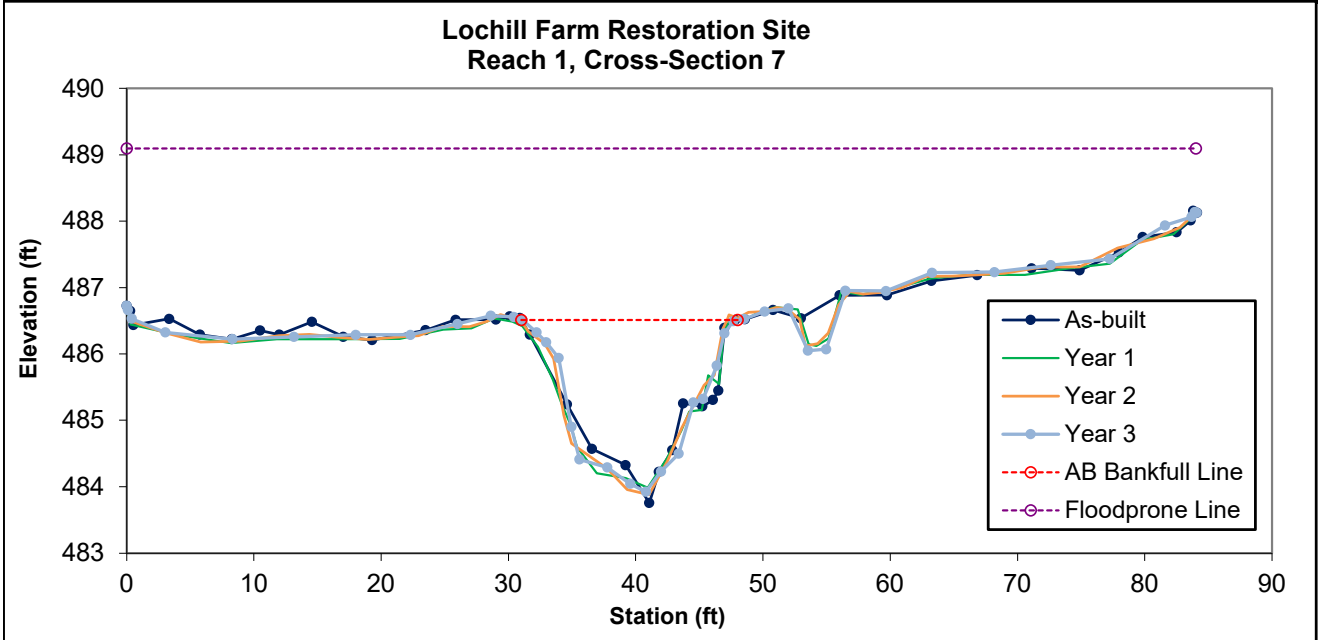


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	AB BKF Elev	LTOB Elev
Pool	--	25.1	17.0	1.5	2.6	11.5	--	--	486.51	486.495



Permanent Cross-section 8
(Year 3 Data - September 2021)

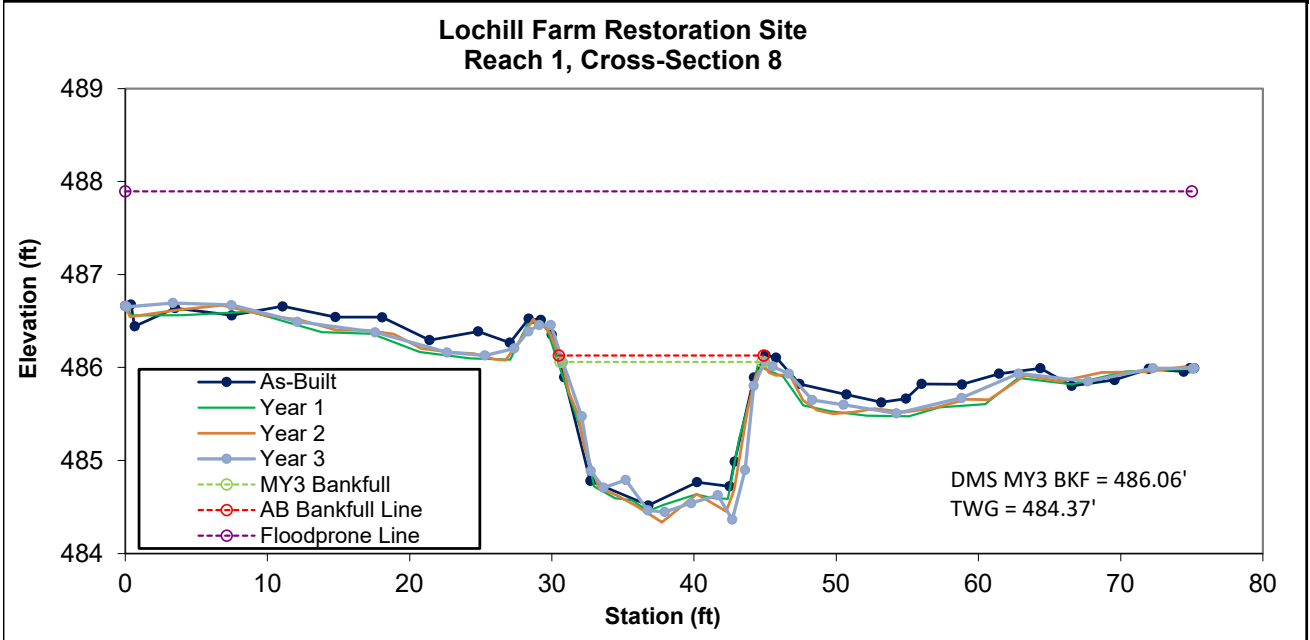


Looking at the Left Bank



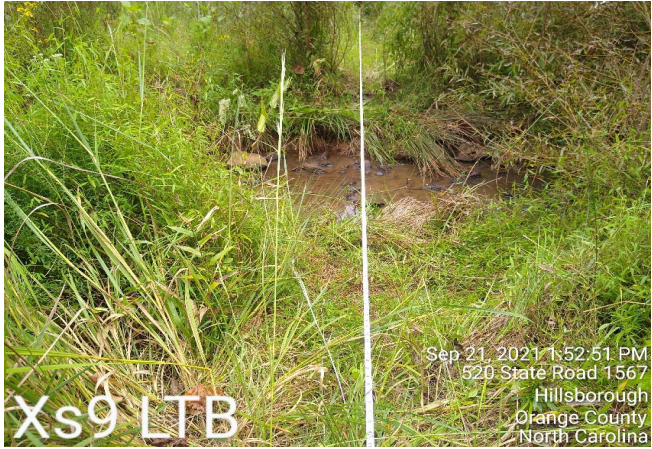
Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	AB BKF Elev	LTOB Elev
Riffle	C	18.3	14.4	1.3	1.8	11.2	1.0	5.2	486.13	486.063



Note: Per DMS/IRT request, the bank height ratio 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 3 Data - September 2021)

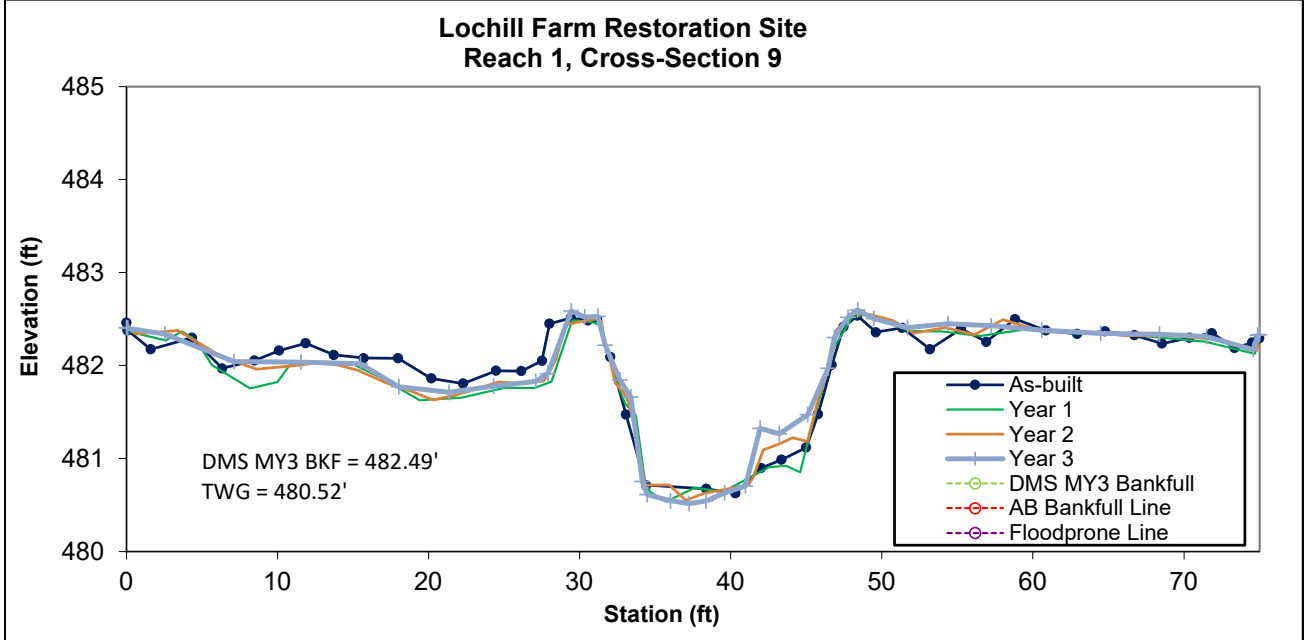


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	AB BKF Elev	LTOB Elev
Riffle	C	21.3	16.4	1.3	2.0	12.6	1.0	4.6	482.49	482.52



Note: Per DMS/IRT request, the bank height ratio 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 3 Data - September 2021)

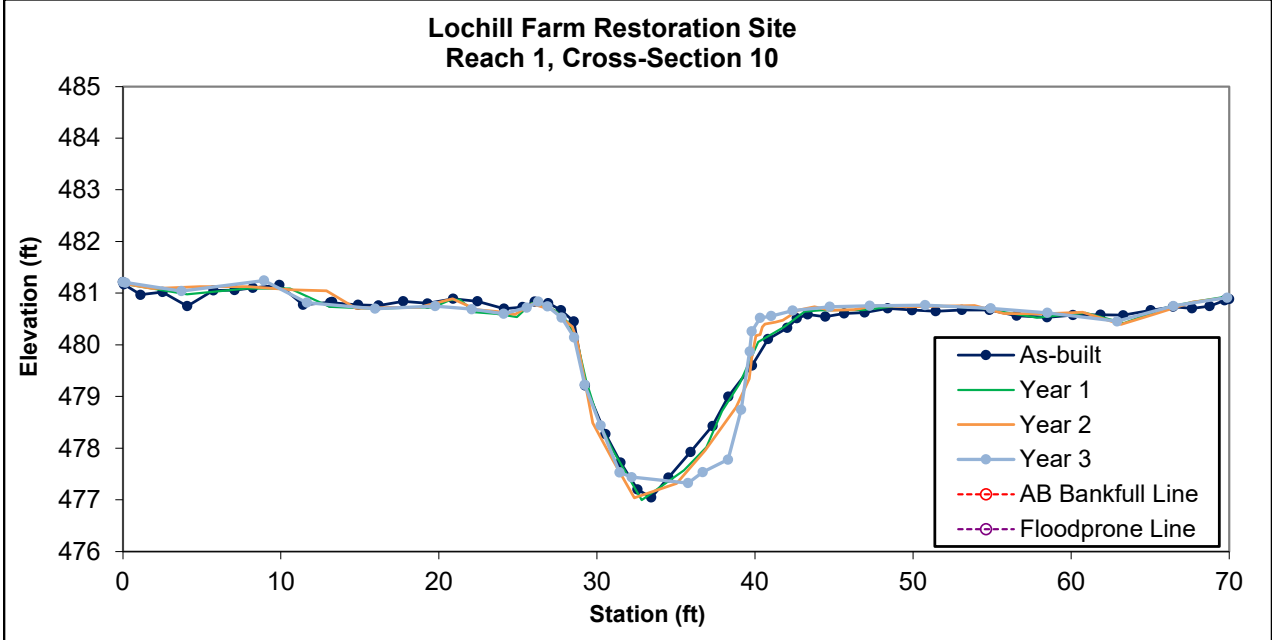


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	AB BKF Elev	LTOB Elev
Pool	--	29.0	12.5	2.3	3.2	5.4	--	--	480.51	480.519



Permanent Cross-section 11
(Year 3 Data - September 2021)

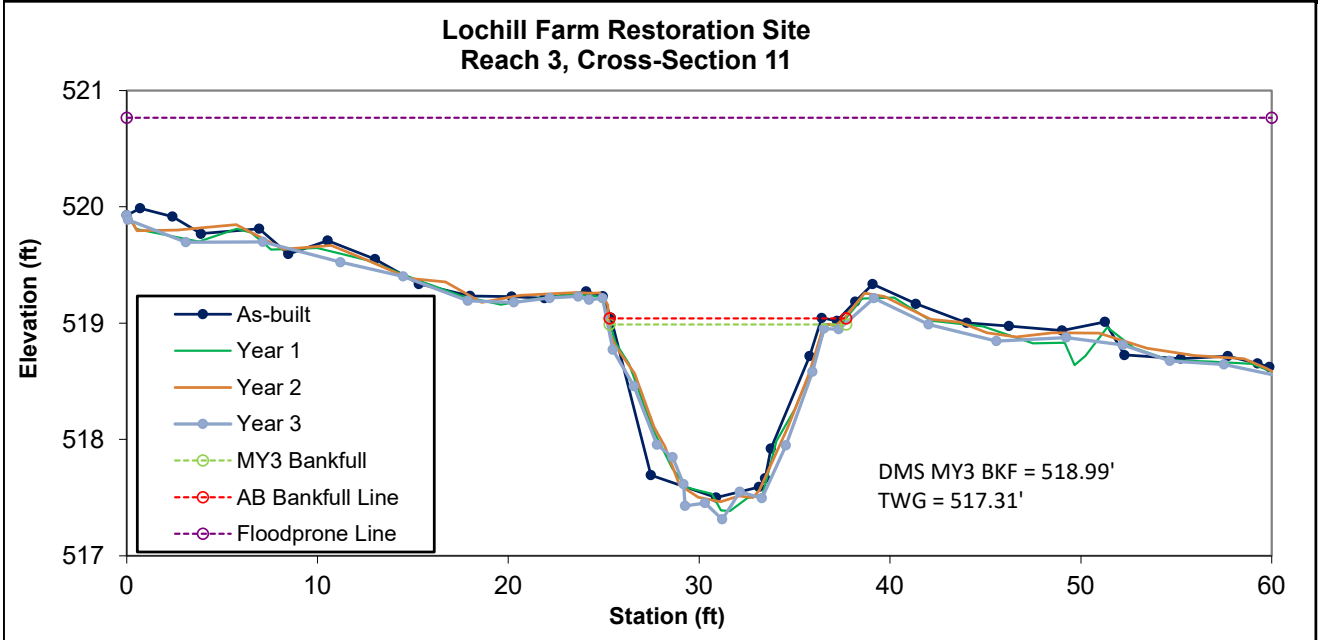


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	AB BKF Elev	LTOB Elev
Riffle	C	12.7	12.8	1.0	1.7	12.9	1.0	4.7	519.04	518.953



Note: Per DMS/IRT request, the bank height ratio 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 3 Data - September 2021)



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	AB BKF Elev	LTOB Elev
Pool	--	18.6	20.9	0.9	2.0	23.4	--	--	516.12	515.86

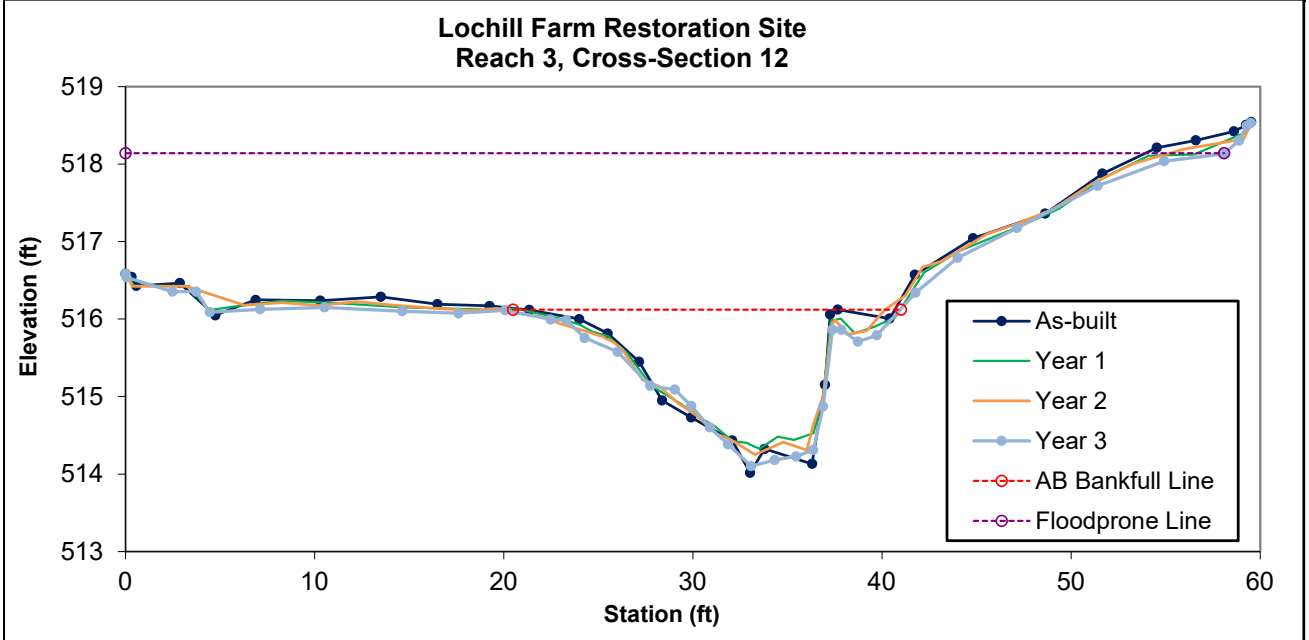


Table 8. Baseline Stream Data Summary
Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083

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	
Dimension and Substrate - Riffle																	
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 (ft ²)	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	
Pattern																	
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	
Profile																	
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	
Substrate and Transport Parameters																	
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			
Additional Reach Parameters																	
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	
Dimension and Substrate - Riffle																	
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 (ft ²)	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	----	----	
Pattern																	
*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	
Profile																	
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	----	----	
Substrate and Transport Parameters																	
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			
Additional Reach Parameters																	
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.

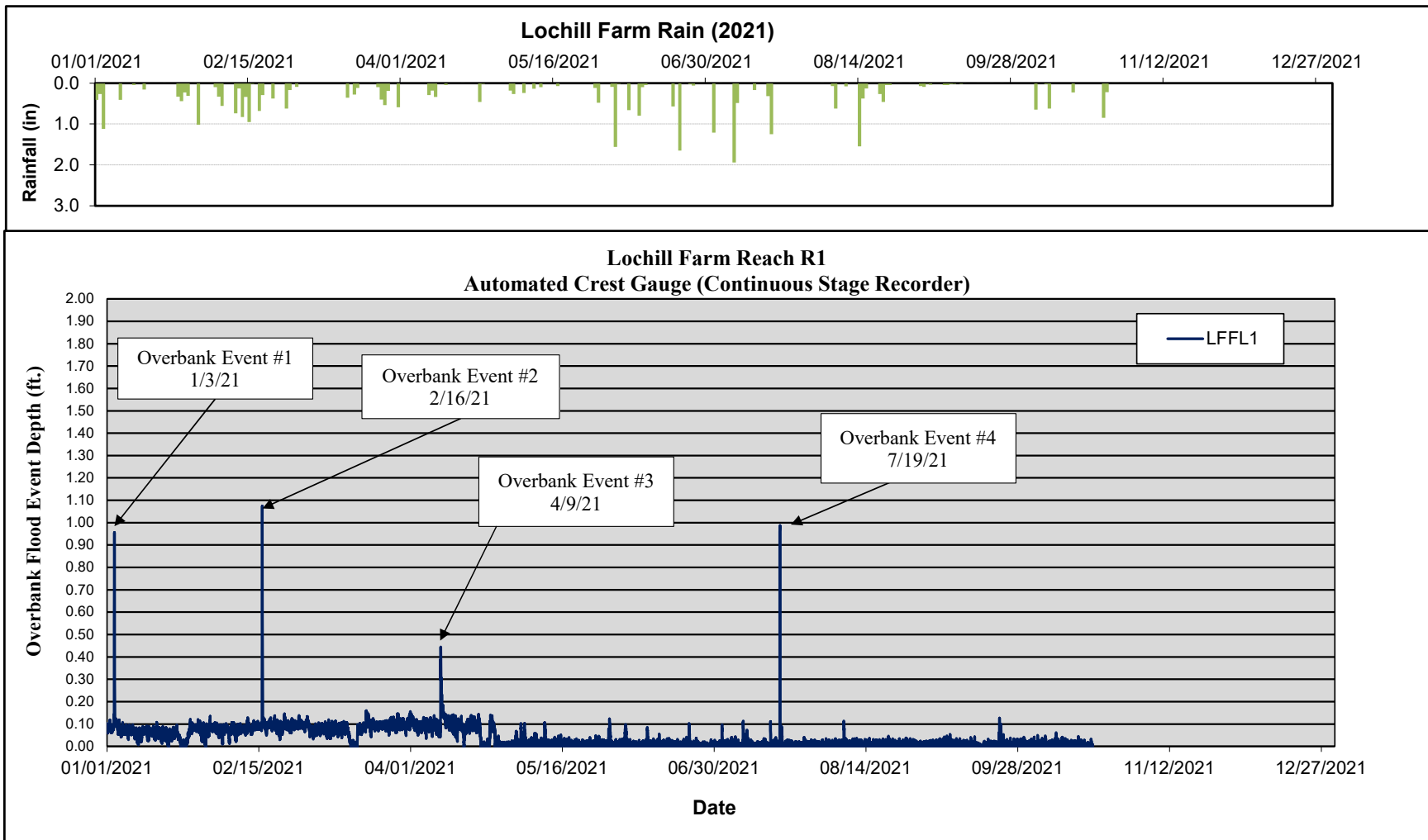
Table 9. Cross-Section Morphology Data Summary Lochill Farm Stream Mitigation Project - NCDMS Project No. 97083																													
Stream Reach		Reach 1																											
		Cross-section X-1 (Riffle)						Cross-section X-2 (Pool)						Cross-section X-3 (Pool)						Cross-section X-4 (Riffle)									
Dimension and substrate		Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Based on fixed baseline bankfull elevation																													
	BF Width (ft)	15.2	14.8	14.1	14.5				21.0	22.3	21.1	18.4				21.5	20.2	23.5	19.3				16.6	17.4	16.4	15.9			
	BF Mean Depth (ft)	1.3	1.3	1.2	1.1				1.5	1.4	1.3	1.3				1.6	1.9	1.6	2.1				1.1	1.1	1.1	1.1			
	Width/Depth Ratio	12.0	11.7	11.7	13.3				13.7	16.1	16.3	13.7				13.8	10.8	14.8	9.2				15.0	16.5	15.4	14.4			
	BF Cross-sectional Area (ft²)	19.4	18.5	17.1	15.7				32.3	31.3	27.2	24.6				33.6	37.7	37.2	40.6				18.3	18.5	17.5	17.7			
	BF Max Depth (ft)	1.9	1.8	1.8	1.8				3.2	2.9	2.7	2.7				3.3	3.6	3.6	3.8				1.6	1.6	1.6	1.7			
	Width of Floodprone Area (ft)	75	75	75	75				-	-	-	-				-	-	-	-				73	73	73	73			
	Entrenchment Ratio	4.9	5.1	5.3	5.2				-	-	-	-				-	-	-	-				4.4	4.2	4.5	4.6			
	Bank Height Ratio (MY3 will provide standard)*	1.0	1.0	0.9	0.9				-	-	-	-				-	-	-	-				1.0	1.0	1.0	1.0			
	Wetted Perimeter (ft)	15.9	15.5	14.8	15.1				22.8	24.1	22.5	20.2				23.5	22.2	25.5	21.7				17.2	18.0	16.9	16.5			
	Hydraulic Radius (ft)	1.2	1.2	1.2	1.0				1.4	1.3	1.2	1.2				1.4	1.7	1.5	1.9				1.1	1.0	1.0	1.1			
	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	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Based on fixed baseline bankfull elevation																													
	BF Width (ft)	16.9	15.0	15.4	15.0				19.6	20.8	23.6	21.8				16.8	18.0	16.5	17.0				14.6	14.9	14.4	14.4			
	BF Mean Depth (ft)	0.9	1.0	0.9	0.9				2.0	2.1	1.8	1.9				1.5	1.4	1.5	1.5				1.2	1.2	1.3	1.3			
	Width/Depth Ratio	18.4	14.9	16.6	16.1				9.6	9.9	12.9	11.4				11.4	12.5	10.7	11.5				12.3	12.3	11.2	11.2			
	BF Cross-sectional Area (ft²)	15.5	15.0	14.4	14.0				40.1	43.4	43.0	41.8				24.7	26.1	25.4	25.1				17.3	18.0	18.5	18.3			
	BF Max Depth (ft)	1.4	1.4	1.4	1.3				3.9	4.1	4.0	4.3				2.8	2.5	2.6	2.6				1.6	1.7	1.8	1.8			
	Width of Floodprone Area (ft)	76	76	76	76				-	-	-	-				-	-	-	-				75	75	75	75			
	Entrenchment Ratio	4.5	5.1	4.9	5.0				-	-	-	-				-	-	-	-				5.2	5.0	5.2	5.2			
	Bank Height Ratio (MY3 will provide standard)*	1.0	1.0	0.9	1.0				-	-	-	-				-	-	-	-				1.0	1.0	1.0	1.0			
	Wetted Perimeter (ft)	17.4	15.4	15.9	15.5				22.4	23.4	26.7	25.0				18.3	19.5	17.7	18.3				15.4	15.7	15.3	15.5			
	Hydraulic Radius (ft)	0.9	1.0	0.9	0.9				1.8	1.9	1.6	1.7				1.4	1.3	1.4	1.4				1.1	1.1	1.2	1.2			
	d50 (mm)	64	-	-	-				-	-	-	-				-	-	-	-				-	-	-	-			
Stream Reach		Reach 1												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	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Based on fixed baseline bankfull elevation																													
	BF Width (ft)	16.9	17.3	17.8	16.4				14.3	14.7	14.0	12.5				11.8	12.4	11.2	12.8				16.4	16.6	18.4	20.9			
	BF Mean Depth (ft)	1.3	1.3	1.2	1.3				1.9	1.9	2.0	2.3				1.0	1.0	1.1	1.0				1.0	1.0	0.9	0.9			
	Width/Depth Ratio	12.5	13.1	14.5	12.6				7.6	7.9	6.8	5.4				11.5	12.9	10.6	12.9				15.9	17.3	20.2	23.4			
	BF Cross-sectional Area (ft²)	22.7	22.8	21.9	21.3				26.8	27.3	28.6	29.0				12.1	12.0	11.9	12.7				16.9	16.0	16.7	18.6			
	BF Max Depth (ft)	1.9	2.0	1.9	2.0				3.5	3.5	3.5	3.2				1.5	1.7	1.6	1.7				2.1	1.8	1.9	2.0			
	Width of Floodprone Area (ft)	75	75	75	75				-	-	-	-				60	60	60	60				-	-	-	-			
	Entrenchment Ratio	4.4	4.3	4.2	4.6				-	-	-	-				5.1	4.8	5.4	4.7				-	-	-	-			
	Bank Height Ratio (MY3 will provide standard)*	1.0	1.0	1.0	1.0				-	-	-	-				1.0	1.0	0.9	1.0				-	-	-	-			
	Wetted Perimeter (ft)	17.7	18.3	18.8	17.4				16.3	16.6	16.4	15.2				12.5	13.1	11.8	13.6				18.0	21.4	19.4	22.0			
	Hydraulic Radius (ft)	1.3	1.2	1.2	1.2				1.6	1.6	1.7	1.9				1.0	0.9	1.0	0.9				0.9	0.8	0.9	0.8			
	d50 (mm)	59	-	-	-				-	-	-	-				55	-	-	-				-	-	-	-			

* Per DMS/IRT request, bank height ratio for has been calculated using a 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

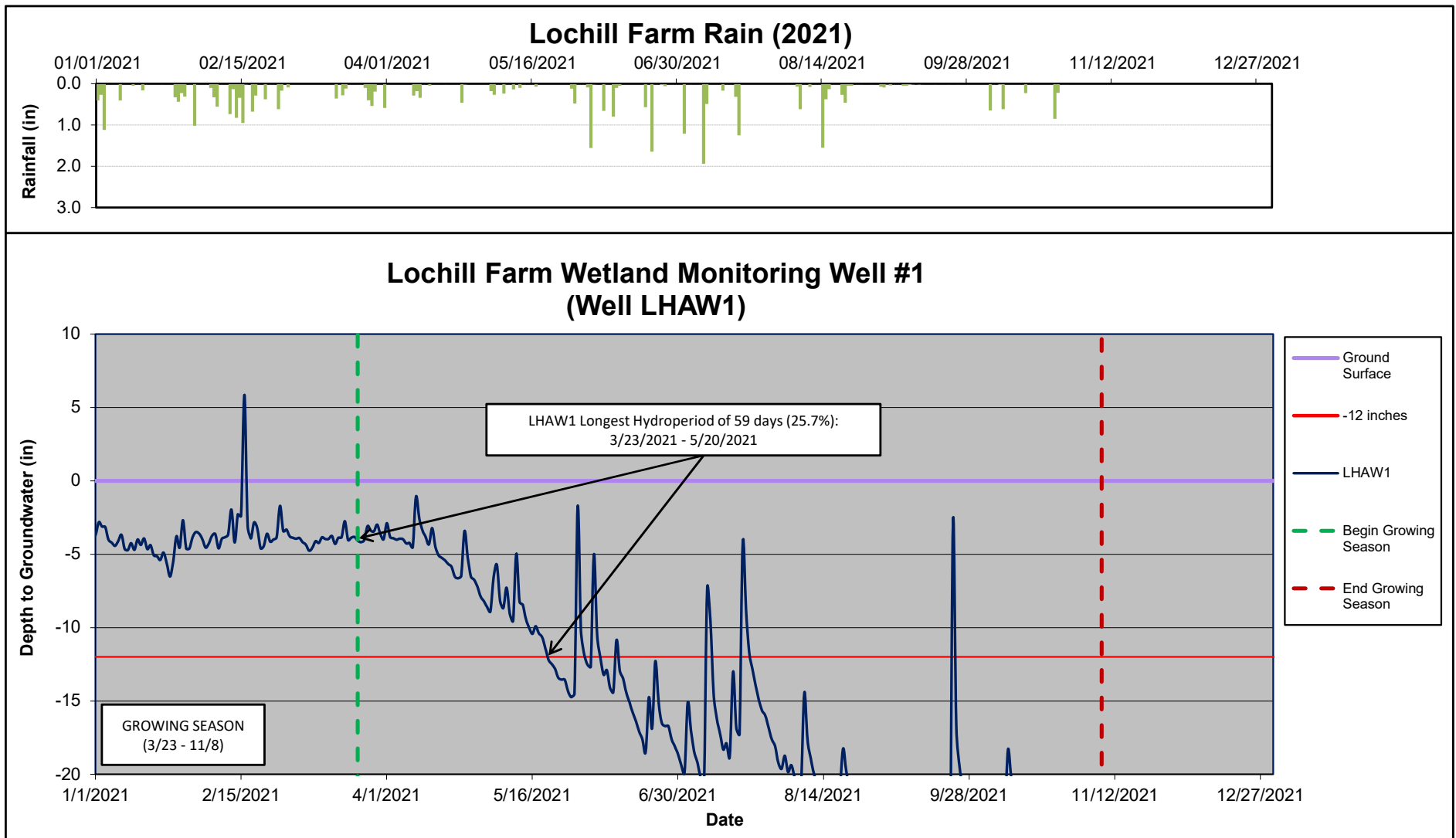
Figure 5. Automated Crest Gauge (Continuous Stage Recorder) Graph



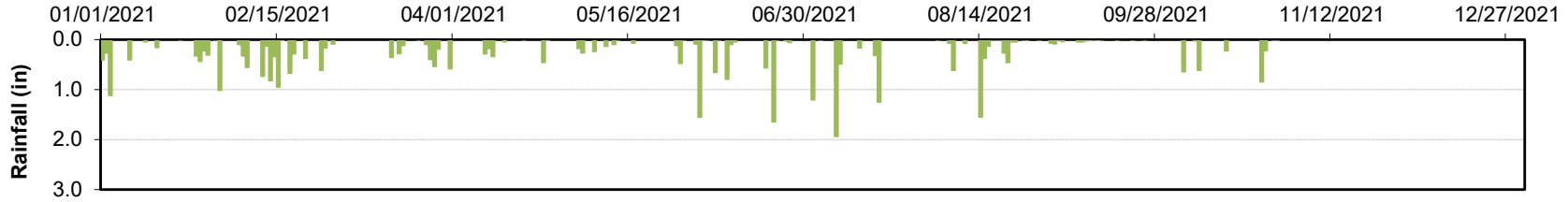
Note: Data presented here is from 1/1/21 thru 10/20/21

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.

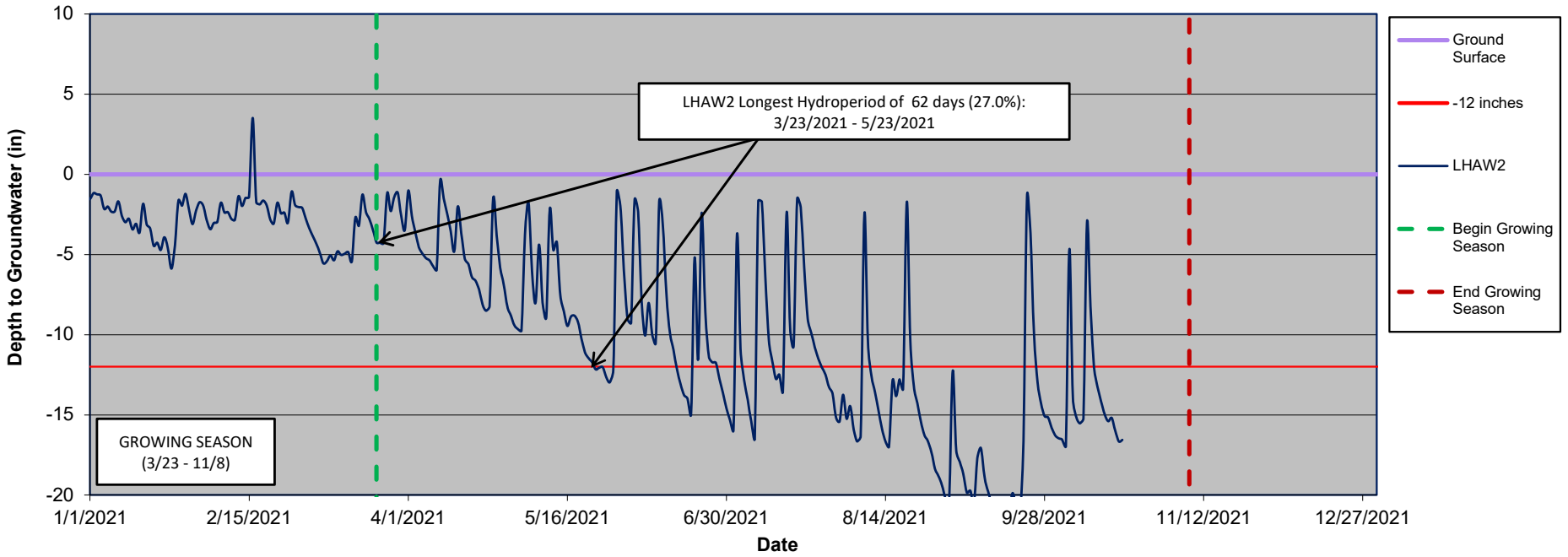
Figure 6. Wetland Monitoring Well Graphs



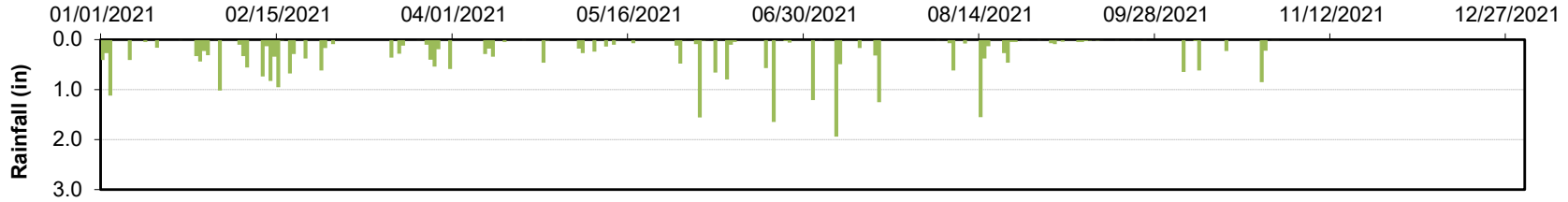
Lochill Farm Rain (2021)



Lochill Farm Wetland Monitoring Well #2 (Well LHAW2)



Lochill Farm Rain (2021)



Lochill Farm Wetland Monitoring Well #3 (Well LHAW3)

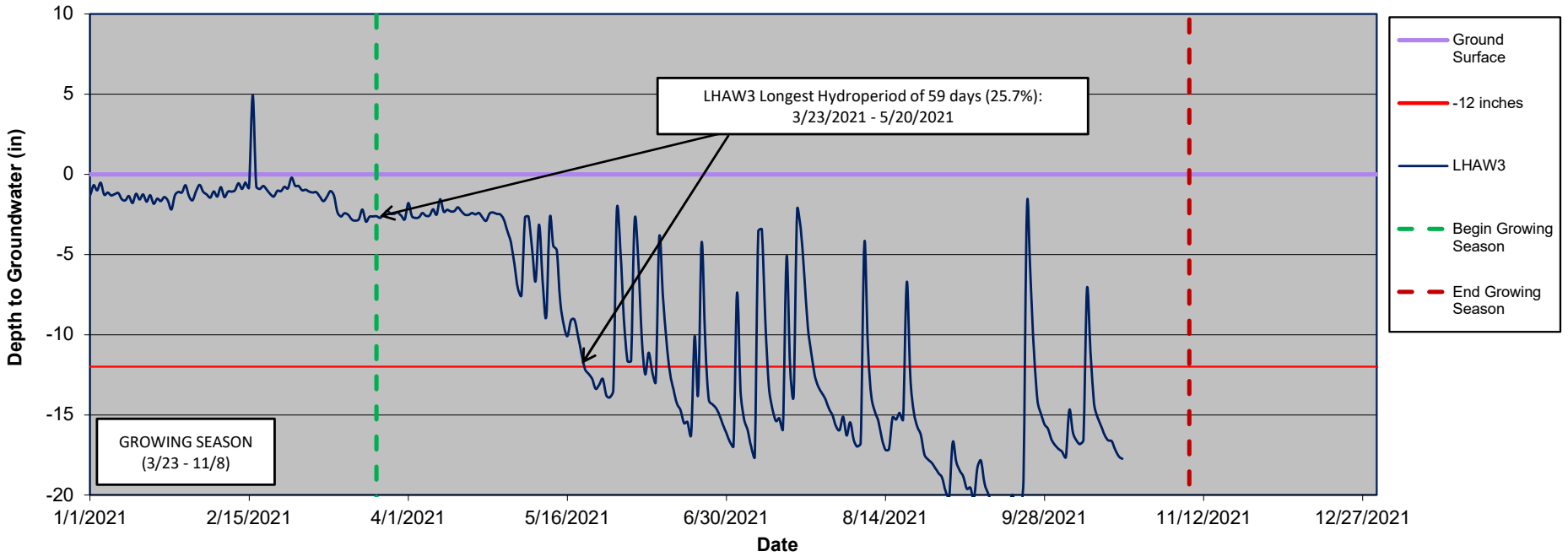
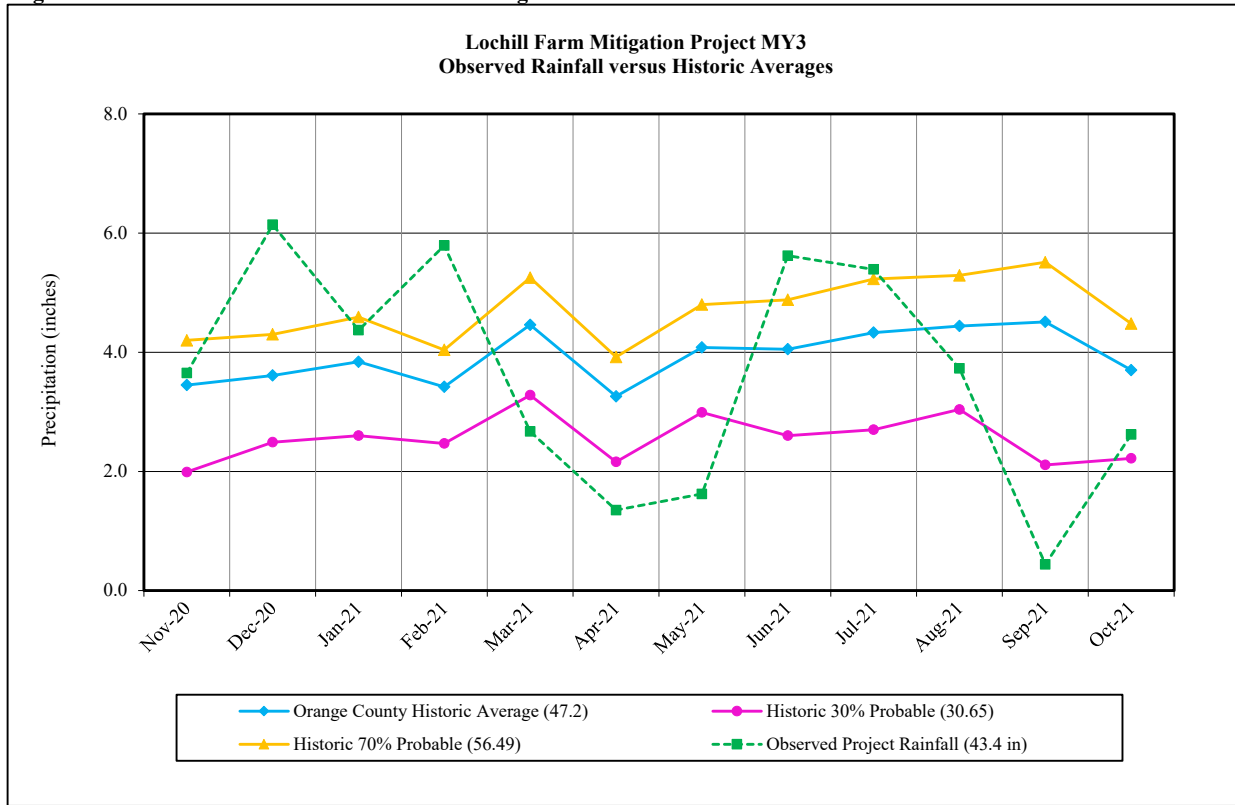


Figure 7. Observed Rainfall Versus Historic Averages



Note: Historic average annual rainfall for Orange County is 47.2", while the observed project rainfall recorded a total of 43.4" over the previous 12 months (from 11/1/2020 to 10/31/2021).

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
Year 1 Monitoring (2019)					
3/7/19	N/A ¹	0.42 ft	N/A ¹	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
Year 2 Monitoring (2020)					
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
Year 3 Monitoring (2021)					
-	-	0.95 ft	-	1/3/2021 (1.12" rain event)	Continuous Stage Recorder
3/11/21	1.01 ft	1.08 ft	0.56 ft	2/16/2021 (0.95" rain event)	Continuous Stage Recorder, Cork Crest Gauge, Photos
6/24/21	0.57 ft	0.44 ft	N/A	4/9/2021 (0.52" rain event, after previous rain events)	Continuous Stage Recorder, Cork Crest Gauge, Photos
10/20/21	1.17 ft	0.98 ft	N/A	7/19/2021 (1.25" rain event)	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).

¹ 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 ¹							Most Consecutive Days Meeting Criteria ²						
	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)
Wetland Monitoring Wells (Installed January 2019)														
SCAW1	25.7	23.9	25.7					59	55.0	59.0				
SCAW2	27.4	24.3	27.0					63	56.0	62.0				
SCAW3	26.1	48.3	25.7					60	111.0	59.0				

¹Indicates 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.

²Indicates 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 ³						
	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)
Wetland Monitoring Wells (Installed January 2019)														
SCAW1	33.5	54.3	30.9					77	125.0	71.0				
SCAW2	46.5	65.2	49.1					107	150.0	113.0				
SCAW3	41.3	67.0	40.0					95	154.0	92.0				

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