



# **MONITORING YEAR 5 ANNUAL REPORT**

**Final**

## **MARTIN DAIRY MITIGATION SITE**

Orange County, NC

NCDEQ Contract No. 006831

DMS Project No. 97087

USACE Action ID No. 2016-00874

NCDWR Project No. 2016-0366

Data Collection Period: January – October 2022

Draft Submission Date: November 1, 2022

Final Submission Date: December 29, 2022

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### **PREPARED FOR:**



**NC Department of Environmental Quality**

**Division of Mitigation Services**

1652 Mail Service Center

Raleigh, NC 27699-1652



December 29, 2022

Jeremiah Dow  
N.C. Division of Mitigation Services  
1652 Mail Service Center  
Raleigh, NC 27699-1652

RE: DMS Comments on the MY5 Report  
Martin Dairy, Project ID #97087, DMS Contract 6831

Dear Mr. Dow,

We have reviewed the comments on the Monitoring Year 5 Report for the above referenced project dated December 22, 2022 and have revised the report based on these comments. The revised documents are submitted with this letter. Below are responses to each of your comments. For your convenience, the comments are reprinted with our response in italics.

### **Report**

1. In the buffer report, please add a sentence where appropriate stating that the project is being proposed for 2023 closeout.

*A statement was added in the buffer report indicating the project is being proposed for 2023 closeout.*

### **Digital Files**

2. Please verify that BHR is being calculated using static MY0 Bankfull area, the table submitted indicated variation in bankfull area.

*The static MY0 bankfull area was implemented midway through this project. Wildlands did not go back and update the previous monitoring years after the static MY0 bankfull area was implemented. MY3 and MY5 are the only years that use the static MY0 bankfull area.*

3. Please submit bankfull events data if available.

*The bankfull events have been added to the support files.*

4. Please submit vegetation database.

*The vegetation database has been added to the support files.*



If you have any questions, please contact me by phone (919) 851-9986, or by email (jlorch@wildlandseng.com).

Sincerely,

A handwritten signature in black ink, appearing to read "Jason Lorch".

**Jason Lorch**, *Monitoring Coordinator*

**PREPARED BY:**

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312 West Millbrook Road, Suite 225  
Raleigh, NC 27609

**Jason Lorch**  
jlorch@wildlandseng.com  
Phone: 919.851.9986

**MARTIN DAIRY MITIGATION SITE**  
Monitoring Year 5 Annual Report

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## Section 1: PROJECT OVERVIEW

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The Martin Dairy Mitigation Site (Site) is located in central Orange County, approximately eight miles northeast of Hillsborough, NC and eight miles south of Caldwell, NC off of Schley Road (Figure 1). The Site is located in the Neuse River Basin and within the Falls Lake Water Supply Watershed, which has been designated a Nutrient Sensitive Water. The project streams drain to the Eno River and eventually to the Falls Lake Reservoir. The Site is within Hydrologic Unit Code 03020201030030, which is a Targeted Local Watershed (Figure 1) as identified in the 2010 Neuse River Basin Restoration Priorities (RBRP) (Breeding, 2010). The Site is in the Carolina Slate Belt of the Piedmont Physiographic Province (USGS, 1998). The project watershed consists primarily of agricultural and wooded land and the drainage area for project site is 526 acres (0.82 square miles).

The project streams consist of Martin Dairy Creek and one unnamed tributary (UT1). Mitigation work within the Site included restoration of 2,135 linear feet of perennial stream channels. The riparian areas were planted with native vegetation to improve habitat and protect water quality. The final Mitigation Plan (Wildlands, 2017) was submitted to and accepted by DMS in March 2017. Construction activities were completed by Land Mechanic Designs, Inc. in July 2017. Planting and seeding activities were completed by Bruton Natural Systems, Inc. in December 2017. Baseline monitoring (MY0) was conducted between August 2017 and January 2018. Annual monitoring will occur for seven years with the close-out anticipated to occur in 2025 given the success criteria are met. Appendix 1 provides additional details on project activity, history, contact information, and watershed/background information for the Site.

The Site is located on two tracts under the ownership of Ted H. Martin (PIN 9896-83-0483 & 9896-83-9111). A conservation easement was recorded on 11.155 acres (Deed Book 6218, Pages 270 - 289). The project is expected to provide 2,135 stream credits by closeout.

A project vicinity map and directions are provided in Figure 1 and project components/assets are illustrated in Figure 2.

### 1.1 Project Goals and Objectives

Prior to construction activities, the primary degradation at the Site was the clearing of vegetation and channelization of Martin Dairy Creek and UT1. Channelization, as indicated by dredge spoil in the floodplain, involved straightening and deepening of the stream. Historic livestock grazing and hay cultivation on the Site further contributed to degradation of the riparian corridor and stream channel. Table 4 in Appendix 1 and Tables 10a and 10b in Appendix 4 present the pre-restoration conditions in detail.

The project is intended to provide numerous ecological benefits within the Neuse River Basin. While benefits such as habitat improvement and geomorphic stability are limited to the project site, reduced nutrient and sediment loading have farther reaching effects. The table below, describes expected outcomes to water quality and ecological processes are provided with project goals and objectives. The project goals and objectives were developed as part of the Mitigation Plan considering the goals and objectives listed in the Neuse River RBRP plan and strive to maximize ecological and water quality uplift within the watershed.

The following project goals and related objectives established in the Mitigation Plan (Wildlands, 2017) include:

Goal	Objective	Expected Outcomes
Reconnect channels with floodplains and riparian wetlands to allow a natural flooding regime.	Reconstruct stream channels with designed bankfull dimensions and depth based on reference reach data. Remove existing dredge spoil to reconnect channel with adjacent wetlands.	Raise water table and hydrate riparian wetlands. Allow more frequent flood flows to disperse on the floodplain. Support geomorphology and higher level functions.
Improve the stability of stream channels.	Construct stream channels that will maintain stable cross-sections, patterns, and profiles over time.	Reduce sediment inputs from bank erosion. Reduce shear stress on channel boundary. Support all stream functions above hydrology.
Restore and enhance native floodplain and streambank vegetation.	Plant native tree and understory species in riparian zones and plant native shrub and herbaceous species on streambanks.	Reduce sediment inputs from bank erosion and runoff. Increase nutrient cycling and storage in floodplain. Provide riparian habitat. Add a source of LWD and organic material to the streams. Support all stream functions.
Improve instream habitat.	Install habitat features such as constructed riffles, lunger logs, and brush toes into restored streams. Add woody materials to channel beds. Construct pools of varying depth.	Increase and diversify available habitats for macroinvertebrates, fish, and amphibians leading to colonization and increase in biodiversity over time. Add complexity including LWD to the streams.
Permanently protect the Site from harmful uses.	Establish a conservation easement on the Site.	Protect the Site from encroachment on the riparian corridor and direct impact to streams and wetlands. Support all stream functions.

**1.2 Monitoring Year 5 Data Assessment**

Annual monitoring and site visits were conducted during MY5 to assess the condition of the project. The vegetation and stream success criteria for the Site follow the approved success criteria presented in the Mitigation Plan.

**1.2.1 Vegetative Assessment**

Planted woody vegetation is being monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008). A total of eight standard 10-meter by 10-meter vegetation plots were established during the baseline monitoring within the project easement area.

The final vegetative success criteria are the survival of 210 planted stems per acre at the end of MY7. The interim measure of vegetative success is the survival of at least 320 planted stems per acre at the end of MY3 and at least 260 stems per acre at the end of MY5. Planted vegetation must average 10 feet in height at the end of MY7.

The MY5 vegetative survey was completed in September 2022. The 2022 vegetation monitoring resulted in an average stem density of 334 planted stems per acre, which is above the interim requirement of 260 stems per acre required at MY5 and 44% less than the baseline density recorded January 2018 (597 stems per acre). There is an average of 8 stems per plot in MY5 compared to 14 stems per plot in MY0. Vegetation plots 6 and 8 did not meet the interim success requirement of 260 planted stems per acre, however, vegetation plot 6 is on track to meet the final success criteria of 210 planted stems per acre with 243 planted stems per acre. Vegetation plot 8 is not on track to meet the final success criteria with only 202 planted stems per acre. Despite the mortality of planted stems in these plots, the number of desirable volunteer species remains high. When accounting for volunteers each of these plots exceed the final success criteria with the number of stems per acre totaling 850 and 1,214 respectively. Volunteer species include persimmon (*Diospyros virginiana*), sycamore (*Platanus occidentalis*), and green ash (*Fraxinus pennsylvanica*). Along with a successional canopy developing, the herbaceous vegetation is dense and providing appropriate streambank stabilization and wildlife habitat.

Refer to Appendix 2 for vegetation plot photographs and the vegetation condition assessment table and Appendix 3 for vegetation data tables.

### **1.2.2 Vegetation Areas of Concern**

To further ensure vegetative success, invasive removal of sporadic populations of Japanese honeysuckle (*Lonicera japonica*), multiflora rose (*Rosa multiflora*), and Callery pear (*Pyrus calleryana*) was completed across the Site in April 2022 and will continue to be treated as needed throughout winter 2022.

Due to excessive deer browsing, Wildlands experimented with capsaicin tablets as a deterrent around the base of each tree on the northeast side of the Site (Figure 3) in April 2022. Based off visual observations the results were mixed and ultimately found to not be an effective treatment on a large scale. Another effort to combat deer browsing was to add soil amendments at the base of each tree in an effort to get the top of the tree above deer browsing level. This was completed along east side of the Site in May 2022 (Figure 3).

### **1.2.3 Stream Assessment**

Morphological surveys for MY5 were conducted in April 2022. All streams within the Site are stable and functioning as designed. In general, cross-sections at the Site show little to no change in the bankfull area, maximum depth ratio, or width-to-depth ratio. Pebble count data is no longer required per the September 29, 2021 Technical Work Group Meeting and is not included in this report. The IRT reserves the right to request pebble count data/particle distributions if deemed necessary during the monitoring period. Longitudinal profile surveys are not required on the project unless visual inspection indicates reach wide vertical instability. Refer to Appendix 2 for the visual stability assessment table, CCPV map, and stream photographs. Refer to Appendix 4 for the morphological data and plots.

### **1.2.4 Stream Areas of Concern**

No stream areas of concern were identified during MY5.

### **1.2.5 Hydrology Assessment**

At the end of the seven-year monitoring period, two or more bankfull events must have occurred in separate years within the restoration reaches. Also, two geomorphically significant events must be documented during the monitoring period. Bankfull events and multiple geomorphically significant events were recorded on all restoration reaches during MY1, MY2, MY3, MY4, and MY5 resulting in attainment of the stream hydrology success criteria. Since bankfull has been documented and proven on



all the restoration reaches Wildlands is requesting removal of all crest gauges for future monitoring years. Refer to Appendix 5 for hydrologic data.

#### **1.2.6 Maintenance Plan**

Additional invasive removal of sporadic populations of Japanese honeysuckle (*Lonicera japonica*) is scheduled for winter 2022. Additional soil amendments are scheduled to be added throughout the Site in spring 2023 to continue to combat deer browsing.

### **1.3 Monitoring Year 5 Summary**

Six of the eight vegetation plots have met the MY5 interim requirement of 260 planted stems per acre and are on track to meet the final success criteria of 210 stems per acre. When counting volunteer species, all vegetation plots exceed the interim success criteria for MY5. Despite the mortality of planted stems in vegetation plots 6 and 8 the total number of stems per acre and species diversity in each of the plots remains high. In April 2022, an invasive vegetation treatment occurred across the Site to treat sporadic populations of invasive species. The Site will continue to receive follow up invasive treatment in winter 2022. Additionally, in April 2022, Wildlands experimented with capsaicin tablets as a deer deterrent along the northeast side of the project. In May 2022, soil amendments were added across the east side of the project to further combat deer browse and ensure tree height success. All streams within the Site are stable and functioning as designed. Bankfull and geomorphically significant events on more than two separate years have been documented on all stream reaches, resulting in fulfillment of the stream hydrology success criteria. Wildlands is requesting the removal of all crest gauges for future monitoring years. Overall, the Site is meeting its goals of preventing excess nutrients and sediment from entering the Falls Lake Water Supply Watershed and Neuse River tributaries and is on track to meet final success criteria.

Summary information and data related to the performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the Mitigation Plan available on DMS's website. All raw data supporting the tables and figures in the appendices are available from DMS upon request.

## Section 2: REFERENCES

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- Breeding, R. 2010. Neuse River Basin Restoration Priorities 2010. NCEEP, NC
- Doll, B.A., Grabow, G.L., Hall, K.A., Halley, J., Harman, W.A., Jennings, G.D., and Wise, D.E. 2003. Stream Restoration A Natural Channel Design Handbook.
- Harrelson, C.C., Rawlins, C.L., Potyondy, J.P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.
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- United States Army Corps of Engineers. 2003. Stream Mitigation Guidelines. USACE, NCDENR-DWQ, USEPA, NCWRC.
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- Wildlands Engineering, Inc. 2018. Martin Dairy Mitigation Site Baseline Monitoring Document and As-Built Baseline Report. DMS, Raleigh, NC.
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## **APPENDIX 1. General Figures and Tables**

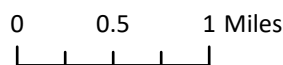
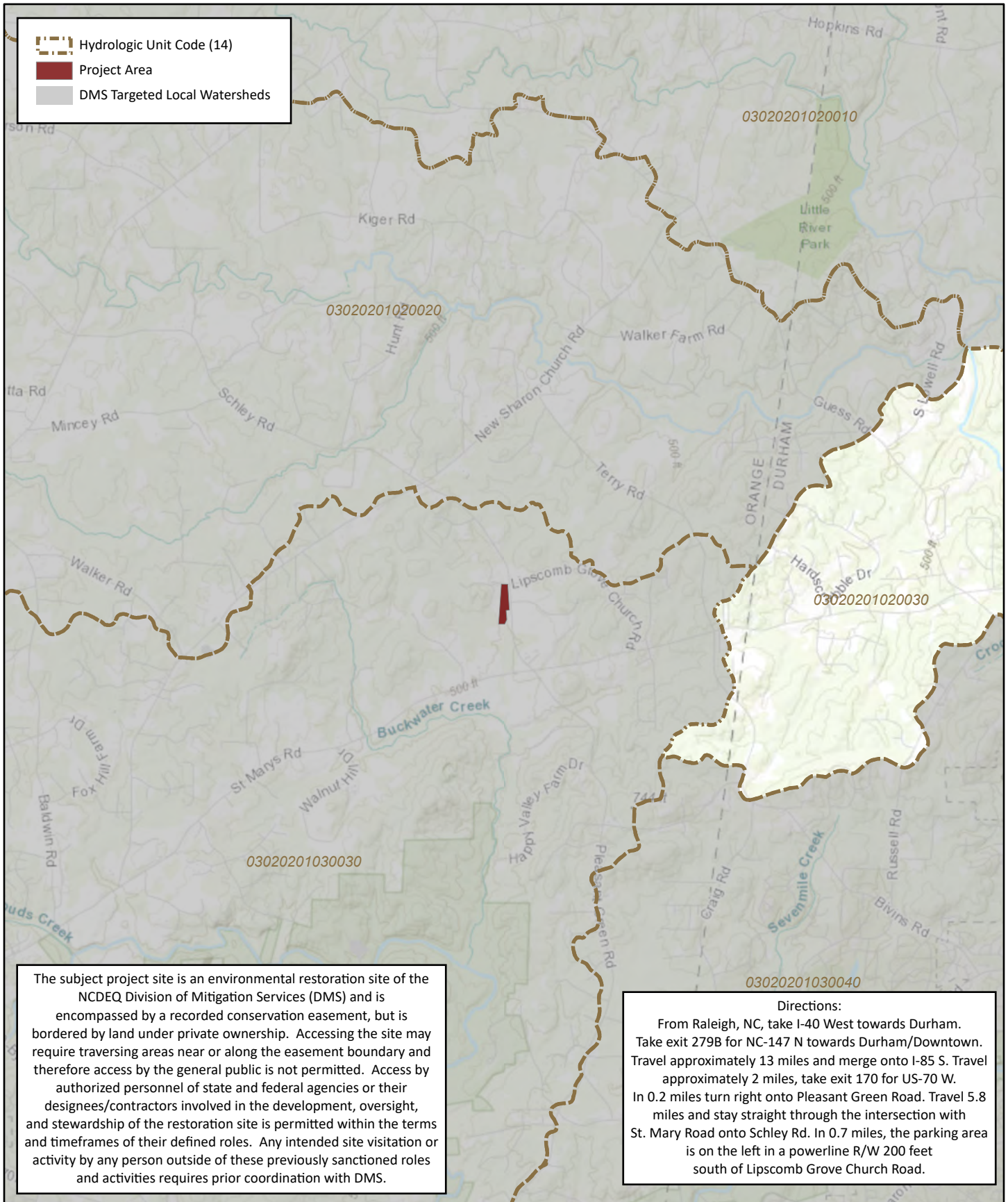


Figure 1. Project Vicinity Map  
 Martin Dairy Mitigation Site  
 DMS Project No. 97087  
 Monitoring Year 5 - 2022  
 Orange County, NC

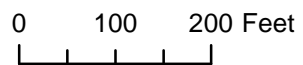
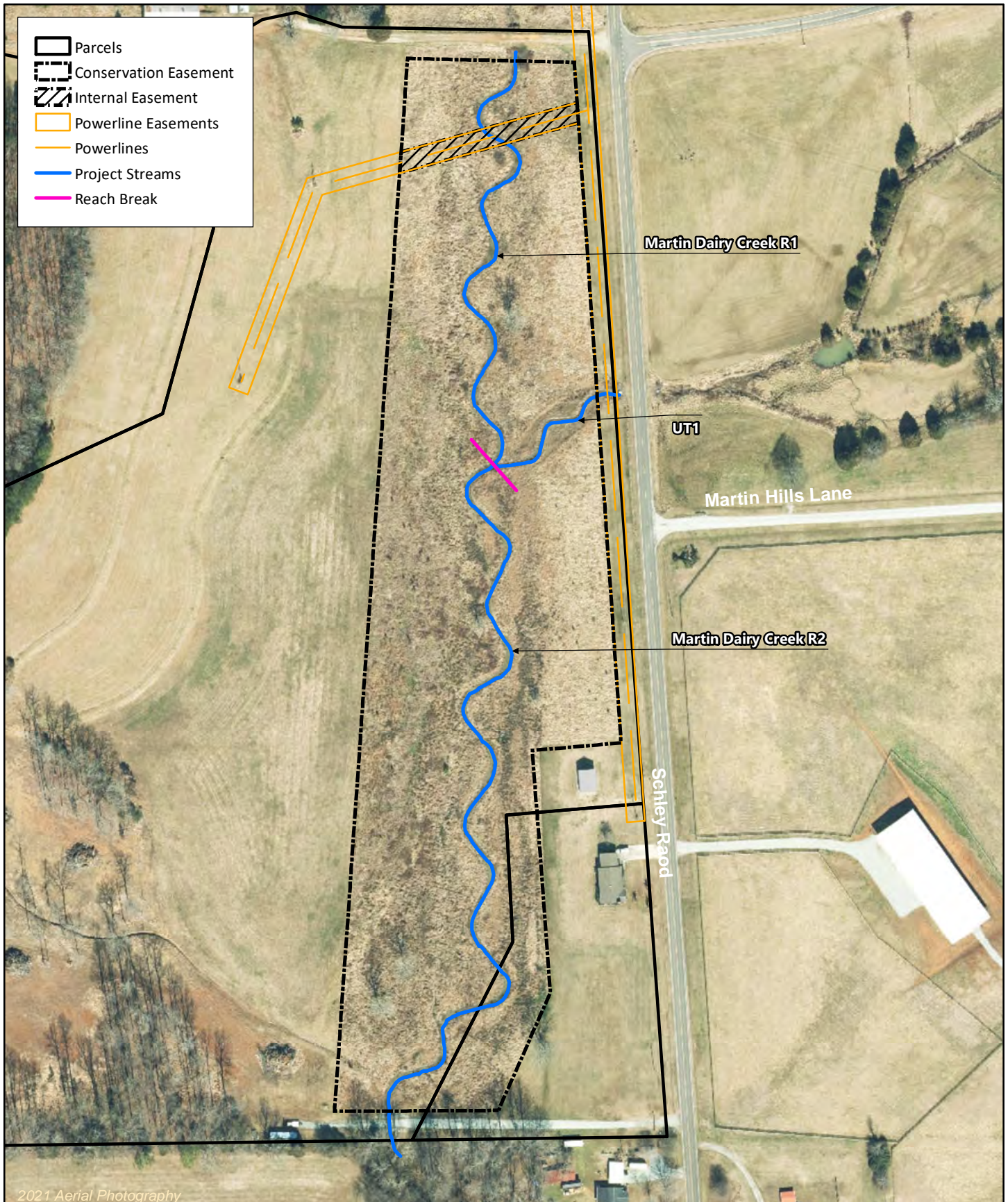


Figure 2. Project Component/Asset Map  
 Martin Dairy Mitigation Site  
 DMS Project No. 97087  
 Monitoring Year 5 - 2022  
 Orange County, NC

**Table 1. Project Components and Mitigation Credits**

Martin Dairy Mitigation Site  
 DMS Project No. 97087  
 Monitoring Year 5 - 2022

MITIGATION CREDITS									
	Stream		Riparian Wetland		Non-Riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	2,135	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PROJECT COMPONENTS									
Reach ID	Centerline Stationing	Existing Footage	Approach	Restoration or Restoration Equivalent	Restoration Footage (LF)*	As-Built Thalweg Footage (LF)	Mitigation Ratio	Credits (SMU / WMU)	
STREAMS									
Martin Dairy R1	100+13 - 101+38, 101+78 - 107+61	503	P1	Restoration	708	721	1	708	
Martin Dairy R2	107+61 - 119+71	1,173	P1	Restoration	1,210	1,258	1	1,210	
UT1	200+33 - 202+50	138	PII	Restoration	217	214	1	217	
COMPONENT SUMMATION									
Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (acres)	Upland (acres)			
		Riverine	Non-Riverine						
Restoration	2,135	-	-	-	-	-			
Enhancement		-	-	-	-	-			
Enhancement I	-								
Enhancement II	-								
Creation		-	-	-					
Preservation	-	-	-	-		-			
High Quality Preservation	-	-	-	-		-			

N/A: not applicable

\*Linear footage calculated along stream centerline.

**Table 2. Project Activity and Reporting History**

Martin Dairy Mitigation Site

DMS Project No. 97087

**Monitoring Year 5 - 2022**

Activity or Report		Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan		March 2017	March 2017
Final Design - Construction Plans		March 2017	March 2017
Construction		June 2017 - July 2017	July 2017
Temporary S&E mix applied to entire project area <sup>1</sup>		June 2017 - July 2017	July 2017
Permanent seed mix applied to reach/segments <sup>1</sup>		June 2017 - July 2017	July 2017
Bare root and live stake plantings for reach/segments		December 2017	December 2017
Baseline Monitoring Document (Year 0)	Stream Survey	August 2017	January 2018
	Vegetation Survey	January 2018	
Year 1 Monitoring	Stream Survey	June 2018	December 2018
	Vegetation Survey	September 2018	
Year 2 Monitoring	Stream Survey	May 2019	December 2019
	Vegetation Survey	September 2019	
Year 3 Monitoring	Supplemental Planting	January 2020	December 2020
	Stream Survey	March 2020	
	Vegetation Survey	September 2020	
Year 4 Monitoring			December 2021
Year 5 Monitoring	Invasive Removal	April 2022	December 2022
	Vegetation Height Management	April-May 2022	
	Stream Survey	April 2022	
	Vegetation Survey	September 2022	
Year 6 Monitoring			December 2023
Year 7 Monitoring	Stream Survey	2024	December 2024
	Vegetation Survey	2024	

<sup>1</sup>Seed and mulch is added as each section of construction is completed.

**Table 3. Project Contact Table**

Martin Dairy Mitigation Site

DMS Project No. 97087

**Monitoring Year 5 - 2022**

<b>Designer</b> Angela Allen, PE	<b>Wildlands Engineering, Inc.</b> 312 West Millbrook Road, Suite 225 Raleigh, NC 27609 919.851.9986
<b>Construction Contractor</b>	<b>Land Mechanic Designs, Inc.</b> 126 Circle G Lane Willow Spring, NC 27592
<b>Planting Contractor</b>	<b>Bruton Natural Systems, Inc</b> P.O. Box 1197 Fremont, NC 27830
<b>Seeding Contractor</b>	<b>Land Mechanic Designs, Inc.</b> 126 Circle G Lane Willow Spring, NC 27592
<b>Seed Mix Sources</b>	<b>Green Resource, LLC</b>
<b>Nursery Stock Suppliers</b> <b>Bare Roots</b>	<b>Dykes and Sons Nursery and Greenhouse</b>
<b>Live Stakes</b>	<b>Bruton Natural Systems, Inc</b>
<b>Monitoring Performers</b>	<b>Wildlands Engineering, Inc.</b>
Monitoring, POC	Jason Lorch 919.851.9986

**Table 4. Project Information and Attributes**

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

PROJECT INFORMATION			
Project Name	Martin Dairy Mitigation Site		
County	Orange County		
Project Area (acres)	11.155		
Planted Area (acres)	10.139		
Project Coordinates (latitude and longitude)	36° 7' 25.76" N, 79° 0' 14.26" W		
PROJECT WATERSHED SUMMARY INFORMATION			
Physiographic Province	Carolina Slate Belt of the Piedmont Physiographic Province		
River Basin	Neuse River		
USGS Hydrologic Unit 8-digit	03020201		
USGS Hydrologic Unit 14-digit	03020201030030		
DWR Sub-basin	03-04-01		
Project Drainage Area (acres)	526		
Project Drainage Area Percentage of Impervious Area	0.4%		
CGIA Land Use Classification	59.0% forested, 40.6% cultivated, 0.4% impervious		
REACH SUMMARY INFORMATION			
Parameters	Martin Dairy	UT1	
Length of Reach (linear feet) - Post-Restoration	1,918	217	
Drainage Area (acres)	526	141	
NCDWR Stream Identification Score	36.75	30.75	
NCDWR Water Quality Classification	WS-IV		
Morphological Description (stream type)	Perennial		
Evolutionary Trend (Simon's Model) - Pre-Restoration	IV: Degradation and Widening		
Underlying Mapped Soils	Chewacla loam, Herndon silt loam, Tatum silt loam		
Drainage Class	-	-	
Soil Hydric Status	-	-	
Slope	-	-	
FEMA Classification	N/A		
Native Vegetation Community	Piedmont Bottomland Forest		
Percent Composition Exotic Invasive Vegetation - Post-Restoration	0%		
REGULATORY CONSIDERATIONS			
Regulation	Applicable?	Resolved?	Supporting Documentation
Waters of the United States - Section 404	Yes	Yes	USACE Nationwide Permit No. 27 and DWQ 401 Water Quality Certification No. 4087.
Waters of the United States - Section 401	Yes	Yes	
Division of Land Quality (Dam Safety)	N/A	N/A	N/A
Endangered Species Act	Yes	Yes	Martin Dairy Mitigation Plan; Wildlands determined "no effect" on Orange County listed endangered species. The USFWS responded on June 3, 2016 and concurred with NCRWC stating that "the proposed action is not likely to adversely affect any federally-listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for listing under the Act."
Historic Preservation Act	Yes	Yes	Correspondence from SHPO on June 3, 2016 indicating they were not aware of any historic resources that would be affected by the project.
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A
FEMA Floodplain Compliance	N/A	N/A	N/A
Essential Fisheries Habitat	N/A	N/A	N/A



## **APPENDIX 2. Visual Assessment Data**

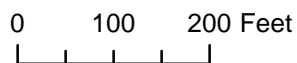
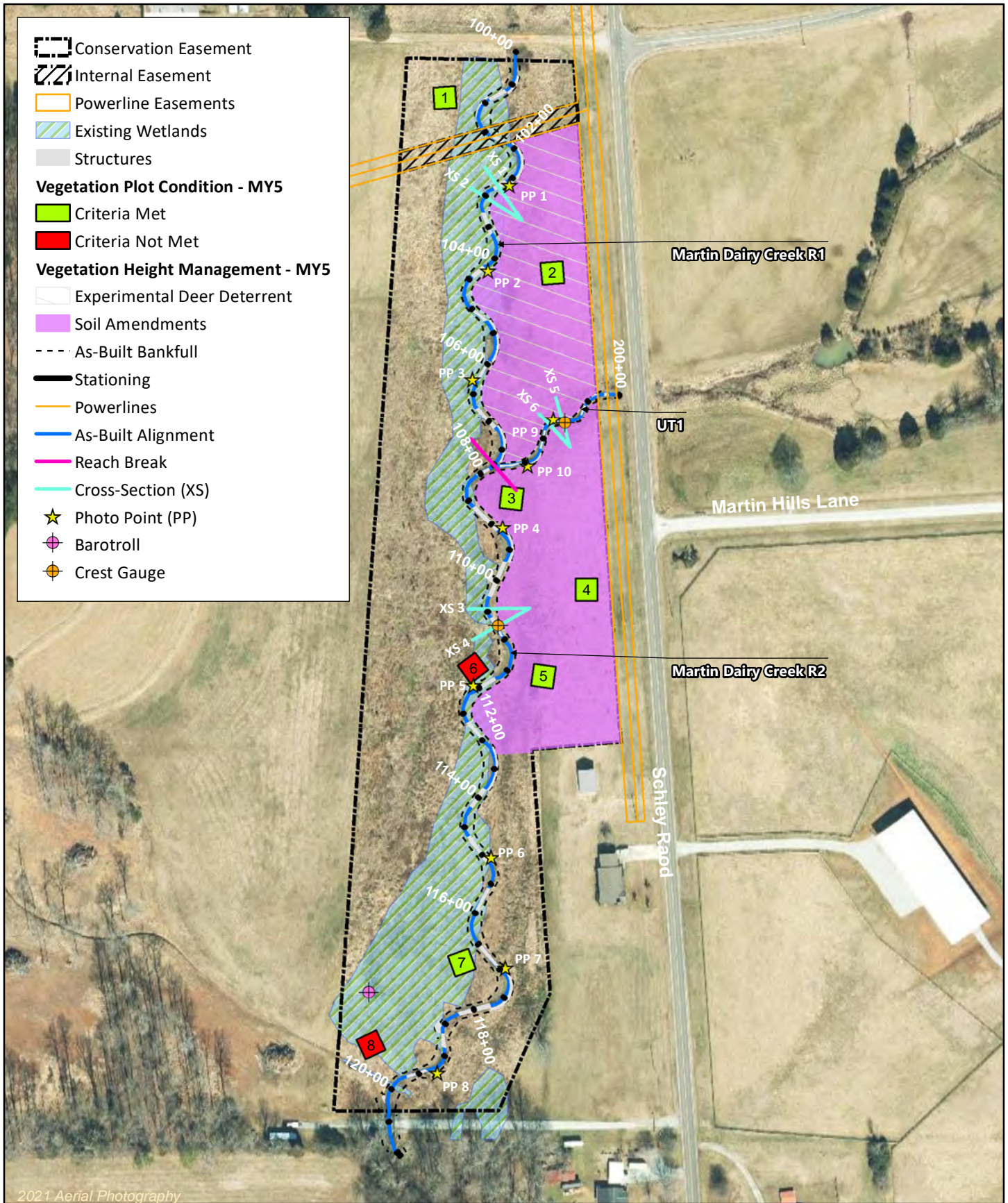


Figure 3. Intergrated Current Condition Plan View  
 Martin Dairy Mitigation Site  
 DMS Project No. 97087  
 Monitoring Year 5 - 2022  
 Orange County, NC

**Table 5a. Visual Stream Morphology Stability Assessment Table**

Martin Dairy Mitigation Project

DMS Project No. 97087

Monitoring Year 5 - 2022

**Martin Dairy Reach 1**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run Units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	8	8		100%				
	3. Meander Pool Condition	Depth Sufficient	9	9		100%				
		Length Appropriate	9	9		100%				
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	8	8		100%				
		Thalweg centering at downstream of meander bend (Glide)	9	9		100%				
<b>Totals</b>					0	0	100%	n/a	n/a	n/a
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse.			0	0	100%	n/a	n/a	n/a
<b>Totals</b>					0	0	100%	n/a	n/a	n/a
3. Engineered Structures <sup>1</sup>	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	5	5			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	5	5			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	5	5			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	5	5			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	6	6			100%			

<sup>1</sup>Excludes constructed riffles since they are evaluated in section 1.

**Table 5b. Visual Stream Morphology Stability Assessment Table**

Martin Dairy Mitigation Project

DMS Project No. 97087

Monitoring Year 5 - 2022

**Martin Dairy Reach 2**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run Units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	13	13		100%				
	3. Meander Pool Condition	Depth Sufficient	13	13		100%				
		Length Appropriate	13	13		100%				
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	13	13		100%				
		Thalweg centering at downstream of meander bend (Glide)	13	13		100%				
<b>Totals</b>										
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
<b>Totals</b>										
3. Engineered Structures <sup>1</sup>	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	8	8			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	8	8			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	8	8			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	4	4			100%			

<sup>1</sup>Excludes constructed riffles since they are evaluated in section 1.

**Table 5c. Visual Stream Morphology Stability Assessment Table**

Martin Dairy Mitigation Project

DMS Project No. 97087

Monitoring Year 5 - 2022

UT1

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run Units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	4	4		100%				
	3. Meander Pool Condition	Depth Sufficient	4	4		100%				
		Length Appropriate	4	4		100%				
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	4	4		100%				
		Thalweg centering at downstream of meander bend (Glide)	4	4		100%				
<b>Totals</b>					0	0	100%	n/a	n/a	n/a
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
<b>Totals</b>					0	0	100%	n/a	n/a	n/a
3. Engineered Structures <sup>1</sup>	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 sills or arms.	1	1			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	1	1			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	2	2			100%			

<sup>1</sup>Excludes constructed riffles since they are evaluated in section 1.

**Table 6. Vegetation Condition Assessment Table**

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

**Planted Acreage 10.139**

Vegetation Category	Definitions	Mapping Threshold (Ac)	Number of Polygons	Combined Acreage	% of Planted Acreage
<b>Bare Areas</b>	Very limited cover of both woody and herbaceous material	0	0	0	0%
<b>Low Stem Density Areas</b>	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0	0	0	0%
<b>Total</b>			<b>0</b>	<b>0</b>	<b>0%</b>
<b>Areas of Poor Growth Rates or Vigor</b>	Areas with woody stems of a size class that are obviously small given the monitoring year.	0	0	0	0%
<b>Cumulative Total</b>			<b>0</b>	<b>0</b>	<b>0%</b>

**Easement Acreage 11.155**

Vegetation Category	Definitions	Mapping Threshold (SF)	Number of Polygons	Combined Acreage	% of Easement Acreage
<b>Invasive Areas of Concern</b>	Areas of points (if too small to render as polygons at map scale).	1,000	0	0	0%
<b>Easement Encroachment Areas</b>	Areas of points (if too small to render as polygons at map scale).	none	0	0	0%

## **STREAM PHOTOGRAPHS**



**PHOTO POINT 1 Martin Dairy R1 – upstream (4/6/2022)**



**PHOTO POINT 1 Martin Dairy R1 – downstream (4/6/2022)**



**PHOTO POINT 2 Martin Dairy R1 – upstream (4/6/2022)**



**PHOTO POINT 2 Martin Dairy R1 – downstream (4/6/2022)**



**PHOTO POINT 3 Martin Dairy R1 – upstream (4/6/2022)**



**PHOTO POINT 3 Martin Dairy R1 – downstream (4/6/2022)**





**PHOTO POINT 4 Martin Dairy R2 – upstream (4/6/2022)**



**PHOTO POINT 4 Martin Dairy R2 – downstream (4/6/2022)**



**PHOTO POINT 5 Martin Dairy R2 – upstream (4/6/2022)**



**PHOTO POINT 5 Martin Dairy R2 – downstream (4/6/2022)**



**PHOTO POINT 6 Martin Dairy R2 – upstream (4/6/2022)**



**PHOTO POINT 6 Martin Dairy R2 – downstream (4/6/2022)**



**PHOTO POINT 7 Martin Dairy R2 – upstream (4/6/2022)**



**PHOTO POINT 7 Martin Dairy R2 – downstream (4/6/2022)**



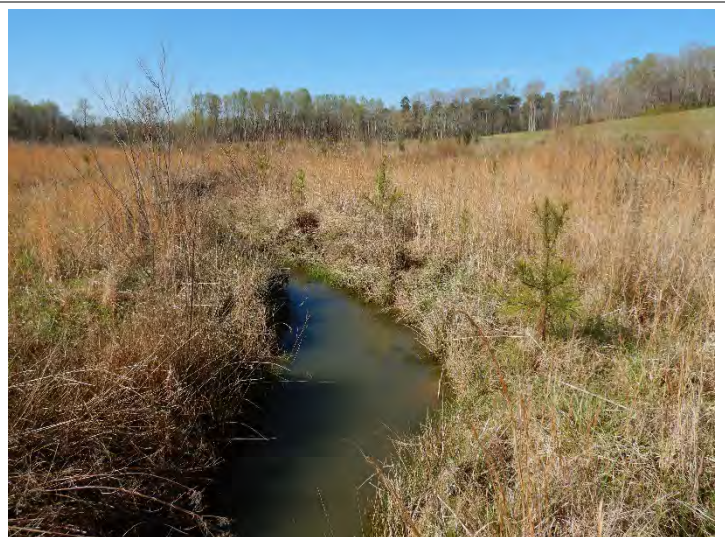
**PHOTO POINT 8 Martin Dairy R2 – upstream (4/6/2022)**



**PHOTO POINT 8 Martin Dairy R2 – downstream (4/6/2022)**



**PHOTO POINT 9 UT1 – upstream (4/6/2022)**



**PHOTO POINT 9 UT1 – downstream (4/6/2022)**



**PHOTO POINT 10 UT1 – upstream (4/6/2022)**



**PHOTO POINT 10 UT1 – downstream (4/6/2022)**

**VEGETATION PLOT PHOTOGRAPHS**



**VEG PLOT 1 (09/13/2022)**



**VEG PLOT 2 (09/13/2022)**



**VEG PLOT 3 (09/13/2022)**



**VEG PLOT 4 (09/13/2022)**



**VEG PLOT 5 (09/13/2022)**



**VEG PLOT 6 (09/13/2022)**



**VEG PLOT 7** (09/13/2022)



**VEG PLOT 8** (09/13/2022)

### **APPENDIX 3. Vegetation Plot Data**

**Table 7. Vegetation Plot Criteria Attainment Table**

Martin Dairy Mitigation Site

DMS Project No. 97087

**Monitoring Year 5 - 2022**

Plot	Met Success Criteria	Tract Mean
1	Yes	75%
2	Yes	
3	Yes	
4	Yes	
5	Yes	
6	No*	
7	Yes	
8	No*	

\*Vegetation Plots 6 and 8 do not meet the MY5 success criteria of 260 planted stems per acre. However, when including desirable volunteers, both Vegetation Plots 6 and 8 do meet the MY5 success criteria for 260 planted stems per acre.



**Table 8. CVS Vegetation Tables - Metadata**

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

<b>Report Prepared By</b>	Jason Lorch
<b>Date Prepared</b>	9/13/2022 13:15
<b>Database Name</b>	Martin Dairy- cvs-v2.5.0.- MY5.mdb
<b>Database Location</b>	X:\Shared\Projects\W02158_Martin_Dairy\Monitoring\Monitoring Year 5 - 2022\Vegetation Assessment
<b>Computer Name</b>	SAVANNAH2021
<b>File Size</b>	51679232
<b>DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----</b>	
<b>Metadata</b>	Description of database file, the report worksheets, and a summary of project(s) and project data.
<b>Project Planted</b>	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
<b>Project Total Stems</b>	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
<b>Plots</b>	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
<b>Vigor</b>	Frequency distribution of vigor classes for stems for all plots.
<b>Vigor by Spp</b>	Frequency distribution of vigor classes listed by species.
<b>Damage</b>	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
<b>Damage by Spp</b>	Damage values tallied by type for each species.
<b>Damage by Plot</b>	Damage values tallied by type for each plot.
<b>Planted Stems by Plot and Spp</b>	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
<b>ALL Stems by Plot and spp</b>	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
<b>PROJECT SUMMARY-----</b>	
<b>Project Code</b>	97087
<b>Project Name</b>	Martin Dairy
<b>Description</b>	Stream Restoration Project
<b>Sampled Plots</b>	8

**Table 9. Planted and Total Stem Counts**

Martin Dairy Mitigation Site  
 DMS Project No. 97087  
 Monitoring Year 5 - 2022

Scientific Name	Common Name	Species Type	Current Plot Data (MYS 2022)											
			VP 1			VP 2			VP 3			VP 4		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
<i>Baccharis angustifolia</i>	False-willow	Shrub Tree									1			
<i>Baccharis halimifolia</i>	Silverling	Shrub Tree												
<i>Betula nigra</i>	River Birch	Tree	1	1	1	2	2	3	3	3	3	1	1	1
<i>Carya</i>	Hickory	Tree												
<i>Cephalanthus occidentalis</i>	Buttonbush	Shrub Tree												
<i>Cercis canadensis</i>	Eastern Redbud	Shrub Tree												
<i>Cornus amomum</i>	Silky Dogwood	Shrub Tree												
<i>Cornus florida</i>	Flowering Dogwood	Shrub Tree												
<i>Diospyros virginiana</i>	American Persimmon	Tree												
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	2	2	2	3	3	3	2	2	3	3	3	4
<i>Juglans nigra</i>	Black Walnut	Tree												
<i>Ligustrum sinense</i>	Chinese Privet	Exotic												
<i>Liquidambar styraciflua</i>	Sweet Gum	Tree			4			5			8			4
<i>Liriodendron tulipifera</i>	Tulip Poplar	Tree	2	2	2									
<i>Nyssa sylvatica</i>	Black Gum	Tree												
<i>Pinus taeda</i>	Loblolly Pine	Tree			2									
<i>Platanus occidentalis</i>	Sycamore	Tree	2	2	2	2	2	2	2	2	3	2	2	2
<i>Prunus serotina</i>	Black Cherry	Shrub Tree												
<i>Pyrus calleryana</i>	Bradford Pear	Exotic												
<i>Quercus palustris</i>	Pin Oak	Tree										2	2	2
<i>Quercus phellos</i>	Willow Oak	Tree	2	2	2	4	4	4	4	4	4	2	2	2
<i>Quercus rubra</i>	Southern Red Oak	Tree												
<i>Salix nigra</i>	Black Willow	Tree												
<i>Ulmus</i>	Elm	Tree												
<i>Ulmus alata</i>	Winged Elm	Tree												
<i>Ulmus americana</i>	American Elm	Tree												
<i>Ulmus rubra</i>	Slippery Elm	Tree												
<b>Stem count</b>			9	9	15	11	11	17	11	11	22	10	10	15
<b>size (ares)</b>			1			1			1			1		
<b>size (ACRES)</b>			0.02			0.02			0.02			0.02		
<b>Species count</b>			5	5	7	4	4	5	4	4	6	5	5	6
<b>Stems per ACRE</b>			364	364	607	445	445	688	445	445	890	405	405	607

**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%
- Volunteers

PnoLS: Number of Planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total Stems

**Table 9. Planted and Total Stem Counts**

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

Scientific Name	Common Name	Species Type	Current Plot Data (MYS 2022)											
			VP 5			VP 6			VP 7			VP 8		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
<i>Baccharis angustifolia</i>	False-willow	Shrub Tree												
<i>Baccharis halimifolia</i>	Silverling	Shrub Tree												
<i>Betula nigra</i>	River Birch	Tree	2	2	2	1	1	1	1	1	1	1	1	1
<i>Carya</i>	Hickory	Tree												
<i>Cephalanthus occidentalis</i>	Buttonbush	Shrub Tree												
<i>Cercis canadensis</i>	Eastern Redbud	Shrub Tree												
<i>Cornus amomum</i>	Silky Dogwood	Shrub Tree												
<i>Cornus florida</i>	Flowering Dogwood	Shrub Tree												
<i>Diospyros virginiana</i>	American Persimmon	Tree						12			2			5
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	1	1	1	1	1	4	1	1	3	2	2	5
<i>Juglans nigra</i>	Black Walnut	Tree												
<i>Ligustrum sinense</i>	Chinese Privet	Exotic												
<i>Liquidambar styraciflua</i>	Sweet Gum	Tree												
<i>Liriodendron tulipifera</i>	Tulip Poplar	Tree												
<i>Nyssa sylvatica</i>	Black Gum	Tree												
<i>Pinus taeda</i>	Loblolly Pine	Tree												
<i>Platanus occidentalis</i>	Sycamore	Tree	4	4	4	4	4	4	4	4	4	2	2	19
<i>Prunus serotina</i>	Black Cherry	Shrub Tree	1	1	1									
<i>Pyrus calleryana</i>	Bradford Pear	Exotic												
<i>Quercus palustris</i>	Pin Oak	Tree												
<i>Quercus phellos</i>	Willow Oak	Tree							1	1	1			
<i>Quercus rubra</i>	Southern Red Oak	Tree												
<i>Salix nigra</i>	Black Willow	Tree			2									
<i>Ulmus</i>	Elm	Tree												
<i>Ulmus alata</i>	Winged Elm	Tree												
<i>Ulmus americana</i>	American Elm	Tree												
<i>Ulmus rubra</i>	Slippery Elm	Tree												
<b>Stem count</b>			8	8	10	6	6	21	7	7	11	5	5	30
<b>size (ares)</b>			1			1			1			1		
<b>size (ACRES)</b>			0.02			0.02			0.02			0.02		
<b>Species count</b>			4	4	5	3	3	4	4	4	5	3	3	4
<b>Stems per ACRE</b>			324	324	405	243	243	850	283	283	445	202	202	1,214

**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%
- Volunteers

PnoLS: Number of Planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total Stems

**Table 9. Planted and Total Stem Counts**

Martin Dairy Mitigation Site  
 DMS Project No. 97087  
 Monitoring Year 5 - 2022

Scientific Name	Common Name	Species Type	Annual Means																	
			MY5 (2022)			MY4 (2021)			MY3 (2020)			MY2 (2019)			MY1 (2018)			MY0 (2018)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
<i>Baccharis angustifolia</i>	False-willow	Shrub Tree			1															
<i>Baccharis halimifolia</i>	Silverling	Shrub Tree						3												
<i>Betula nigra</i>	River Birch	Tree	11	11	12	13	13	14	12	12	18	14	14	14	16	16	16	17	17	17
<i>Carya</i>	Hickory	Tree									1									
<i>Cephalanthus occidentalis</i>	Buttonbush	Shrub Tree											12				8			
<i>Cercis canadensis</i>	Eastern Redbud	Shrub Tree												1	1	1	3	3	3	
<i>Cornus amomum</i>	Silky Dogwood	Shrub Tree						5												
<i>Cornus florida</i>	Flowering Dogwood	Shrub Tree									4				2	2	2	2	2	
<i>Diospyros virginiana</i>	American Persimmon	Tree			19															
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	15	15	25	14	14	71	15	15	83	15	15	45	17	17	29	18	18	18
<i>Juglans nigra</i>	Black Walnut	Tree						1												
<i>Ligustrum sinense</i>	Chinese Privet	Exotic						1			1									
<i>Liquidambar styraciflua</i>	Sweet Gum	Tree			21			26			9			9			2			
<i>Liriodendron tulipifera</i>	Tulip Poplar	Tree	2	2	2	4	4	4	4	4	4	5	5	7	7	7	7	19	19	19
<i>Nyssa sylvatica</i>	Black Gum	Tree						18			24									
<i>Pinus taeda</i>	Loblolly Pine	Tree			2			4												
<i>Platanus occidentalis</i>	Sycamore	Tree	22	22	40	22	22	36	22	22	29	22	22	27	24	24	25	25	25	25
<i>Prunus serotina</i>	Black Cherry	Shrub Tree	1	1	1															
<i>Pyrus calleryana</i>	Bradford Pear	Exotic						3			2			3						
<i>Quercus palustris</i>	Pin Oak	Tree	2	2	2	2	2	2	3	3	3	12	12	12	16	16	16	20	20	20
<i>Quercus phellos</i>	Willow Oak	Tree	13	13	13	19	19	19	15	15	15	12	12	12	14	14	14	14	14	14
<i>Quercus rubra</i>	Southern Red Oak	Tree									1									
<i>Salix nigra</i>	Black Willow	Tree			2			2			2									
<i>Ulmus</i>	Elm	Tree											2			1				
<i>Ulmus alata</i>	Winged Elm	Tree						1												
<i>Ulmus americana</i>	American Elm	Tree						1												
<i>Ulmus rubra</i>	Slippery Elm	Tree						7			6									
<b>Stem count</b>			66	66	140	74	74	218	71	71	202	80	80	143	97	97	121	118	118	118
<b>size (ares)</b>			8			8			8			8			8			8		
<b>size (ACRES)</b>			0.20			0.20			0.20			0.20			0.20			0.20		
<b>Species count</b>			7	7	12	6	6	18	6	6	15	6	6	10	8	8	11	8	8	8
<b>Stems per ACRE</b>			334	334	708	374	374	1,103	359	359	1,022	405	405	723	491	491	612	597	597	597

**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%
- Volunteers

PnoLS: Number of Planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total Stems

## **APPENDIX 4. Morphological Summary Data and Plots**

Table 10a. Baseline Stream Data Summary  
 Martin Dairy Mitigation Site  
 DMS Project No. 97087  
 Monitoring Year 5 - 2022

Martin Dairy

Parameter	Gage	PRE-RESTORATION CONDITION				REFERENCE REACH DATA						DESIGN				AS-BUILT/BASELINE			
		Martin Dairy Reach 1		Martin Dairy Reach 2		Long Branch		Spencer Creek 2		Foust Creek		Martin Dairy Reach 1		Martin Dairy Reach 2		Martin Dairy Reach 1		Martin Dairy Reach 2	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
<b>Dimension and Substrate - Riffle</b>																			
Bankfull Width (ft)		8.6	14.0	14.8	18.6	10.7	11.2	18.5	19.4	15.0	16.2	14.8	12.8						
Floodprone Width (ft)		121	200	50	60	114	49	63	33	75	36	81	150	200					
Bankfull Mean Depth		1.2	1.2	1.3	2.1	1.6	1.8	1.3	1.4	1.1	1.2	0.9	1.1						
Bankfull Max Depth		2.1	2.4	1.9	2.9	2.1	2.6	1.8	2.1	1.3	1.7	1.4	1.8						
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	N/A	10.0	16.1	25.0	34.6	17.8	19.7	23.9	24.1	16.8	20.0	13.2	14.2						
Width/Depth Ratio		7.3	12.2	7.9	13.8	5.8	7.1	13.9	14.2	13.4	13.2	16.7	11.6						
Entrenchment Ratio		14.2	14.3	3	5.5	10.2	2.6	3.4	2.2-5	2.2-5	10.1	15.6							
Bank Height Ratio		1.5	1.4	1.2-1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0							
D50 (mm)		2.6	11.0	---	---	---	---	---	---	10.6	10.6	13.1	10.2						
<b>Profile</b>																			
Riffle Length (ft)		---	---	---	---	---	---	---	---	---	---	12.0	35.9	16.7	51.0				
Riffle Slope (ft/ft)		---	---	0.0130	0.0120	0.0130	0.0150	0.0350	0.0060	0.0180	0.0060	0.0190	0.0039	0.0193	0.0166	0.0266			
Pool Length (ft)	N/A	---	---	---	---	---	---	---	---	---	---	38.2	77.4	36.1	83.1				
Pool Max Depth (ft)		---	---	2.2	3.3	2.5	2.9	1.3	3.3	1.4	3.6	1.4	2.5	1.1	1.9				
Pool Spacing (ft)		16	91	22	108	50	105	71	49	91	60	105	65	113	41	101	55	111	
Pool Volume (ft <sup>3</sup> )		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
<b>Pattern</b>																			
Channel Beltwidth (ft)		15	20	17	28	60	38	41	N/A	36	75	39	81	36	75	39	81		
Radius of Curvature (ft)		11	32	7	46	16	87	11	15	N/A	27	75	29	81	27	75	29	81	
Rc:Bankfull Width (ft/ft)	N/A	1.3	3.7	0.5	3.3	1.1	4.7	1.3	1.4	N/A	1.8	5.0	1.8	5.0	1.8	5.0	1.8	5.0	
Meander Length (ft)		46	74	46	114	66.0	191	46.0	48.0	N/A	60	225	65	243	60	225	65	243	
Meander Width Ratio		1.7	2.3	1.2	2.0	3.2	4.1	3.4	3.6	N/A	2.4	5.0	2.4	5.0	2.4	5.0	2.4	5.0	
<b>Substrate, Bed and Transport Parameters</b>																			
Ri%/Ru%/P%/G%/S%		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
SC%/Sa%/G%/C%/B%/Be%		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
d16/d35/d50/d84/d95/d100	N/A	0.13/1.3/2.6/4.6/7.7/77/-/-	2.4/8.1/11/15/33/54/-/-	---	---	<0.063/3/8.8/42/90/-	---	---	SC/0.45/2.8/21.8/45.0/128.0	0.11/1.10/5.0/27.6									
Reach Shear Stress (Competency) lb/ft <sup>2</sup>		0.33	0.41	---	---	---	---	---	0.25	0.38	---	---	---	---	---	---	---		
Max part size (mm) mobilized at bankfull		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Stream Power (Capacity) W/m <sup>2</sup>		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
<b>Additional Reach Parameters</b>																			
Drainage Area (SM)		0.54	0.82	1.49	0.96	1.38	0.54	0.82	0.54	0.82	0.54	0.82							
Watershed Impervious Cover Estimate (%)		0.4%	0.4%	---	---	---	---	---	---	---	---	---							
Rosgen Classification		C4/E4	C4/E4	C4/E4	E4	C4	C4/E4	C4/E4	C4/E4	C4/E4	C4/E4	C4/E4							
Bankfull Velocity (fps)		5.0	3.8	3.6 - 4.0	4.9 - 5.4	2.9 - 3.7	2.8	3.2	2.2	3.3									
Bankfull Discharge (cfs)		---	---	101-124	97.0	88.0	47.0	63.0	41.0	56.0									
Q-NFF regression		---	---	---	---	---	---	---	---	---									
Q-USGS extrapolation	N/A	---	---	---	---	---	---	---	---	---									
Q-Mannings		---	---	---	---	---	---	---	---	---									
Valley Length (ft)		---	---	---	---	---	607	1,043	607	1,043									
Channel Thalweg Length (ft)		---	---	---	---	---	---	---	776	1,258									
Sinuosity		1.05	1.09	1.30	2.30	1.10	1.25	1.28	1.27	1.22									
Water Surface Slope (ft/ft) <sup>2</sup>		---	---	---	---	---	---	---	0.0046	0.0072									
Bankfull Slope (ft/ft)		0.009	0.007	0.004	0.005	0.009	---	---	0.005	0.007									

(---): Data was not provided

**Table 10b. Baseline Stream Data Summary**

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

**UT1**

Parameter	Gage	PRE-RESTORATION	REFERENCE REACH DATA						DESIGN		AS-BUILT/BASELINE			
		UT1	Agony Acres UT1-Reach 3		UT to Polecat Creek		UT to Varnals Creek		UT1		UT1			
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
<b>Dimension and Substrate - Riffle</b>														
Bankfull Width (ft)	N/A	5.7	9.1	10.4	5.3	10.9	9.3	10.5	9.4		9.2			
Floodprone Width (ft)		12.7	36		25	65	20	64	21	47	65			
Bankfull Mean Depth		1.0	1.0	1.2	1.0	1.1	1.1	1.2	0.7		0.7			
Bankfull Max Depth		1.4	1.8		1.4	1.7	1.5	1.7	0.8	1.3	1.4			
Bankfull Cross-Sectional Area (ft <sup>2</sup> )		5.7	10.7	11.3	5.4	12.4	10.3	12.3	6.7		6.3			
Width/Depth Ratio		5.7	7.3	10.1	5.2	9.6	8.1	9.3	13.2		13.3			
Entrenchment Ratio		2.2	3.9		3.2	8.3	1.9	6.1	2.2	5.0	7.1			
Bank Height Ratio		2.1	1.0		1.0	1.1	0.9	1.0	1.0	1.0	1.0			
D50 (mm)		5.1	---		---		---		---		7.4			
<b>Profile</b>														
Riffle Length (ft)	N/A	---	---		---		---		---		4	28		
Riffle Slope (ft/ft)		---	---		0.004	0.047	0.024	0.057	0.006	0.024	0.009	0.016		
Pool Length (ft)		---	---		---		---		---		4.2	34.9		
Pool Max Depth (ft)		2.0	2.5		1.8		2.5	2.6	0.8	2.2	0.4	1.3		
Pool Spacing (ft)		---	---		34	52	8	82	38	56	30	73		
Pool Volume (ft <sup>3</sup> )		---	---		---		---		---		---			
<b>Pattern</b>														
Channel Beltwidth (ft)	N/A	9	19	21	93	28	50	15	45	23	66	23	66	
Radius of Curvature (ft)		4	13	14	60	19	50	8	47	17	52	17	52	
Rc:Bankfull Width (ft/ft)		0.7	2.3	14.0	60.0	2.0	5.3	0.6	3.2	1.8	5.5	1.8	5.5	
Meander Length (ft)		35	47	121	171	--	--	--	--	56	155	56	155	
Meander Width Ratio		1.6	3.3	2.3	8.9	3.0	5.3	1.0	3.0	2.4	7.0	2.4	7.0	
<b>Substrate, Bed and Transport Parameters</b>														
Ri%/Ru%/P%/G%/S%	N/A													
SC%/Sa%/G%/C%/B%/Be%														
d16/d35/d50/d84/d95/d100		0.048/3/5.1/6.7/8.9/13/-/-	---		---		---		---		0.07/0.28/7.3/20.1/37.9/64.0			
Reach Shear Stress (Competency) lb/ft <sup>2</sup>		0.6	---		---		---		0.2		0.3			
Max part size (mm) mobilized at bankfull														
Stream Power (Capacity) W/m <sup>2</sup>														
<b>Additional Reach Parameters</b>														
Drainage Area (SM)	N/A	0.22	0.30		0.41		0.41		0.22		0.22			
Watershed Impervious Cover Estimate (%)		0.4%	---		---		---		0.4%		0.4%			
Rosgen Classification		C4/E4	E4		E4		E4		C4/E4		C4/E4			
Bankfull Velocity (fps)		4.7	2.2	2.4	2.2	3.5	4.4	5.2	3.6		2.5			
Bankfull Discharge (cfs)		---	25.0		20.3		54.0		24.0		21.0			
Q-NFF regression														
Q-USGS extrapolation														
Q-Mannings														
Valley Length (ft)		---	---		---		---		186		186			
Channel Thalweg Length (ft)		---	---		---		---		213		213			
Sinuosity		1.1	1.4		1.4		1.2		1.1		1.1			
Water Surface Slope (ft/ft) <sup>2</sup>		---	---		---		---		---		0.0072			
Bankfull Slope (ft/ft)		0.0160	0.0039	0.0280	0.0120		0.0170		---		0.0103			

(---): Data was not provided

**Table 11. Morphology and Hydraulic Summary (Dimensional Parameters - Cross-Section)**

Martin Dairy Mitigation Site  
DMS Project No. 97087  
Monitoring Year 5 - 2022

Martin Dairy Reach 1												
	Cross-Section 1 (Riffle)						Cross-Section 2 (Pool)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY5	MY7	Base	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation (ft)	505.8	505.9	506.1	506.0	506.2		505.7	505.9	505.8	505.9	505.9	
Low Bank Elevation (ft)	505.8	506.1	506.1	506.0	506.2		505.7	505.8	505.8	505.9	505.9	
Bankfull Width (ft)	14.8	15.0	14.5	14.9	15.3		20.0	22.5	19.5	19.1	18.5	
Floodprone Width (ft)	150	150	150	150	150		N/A	N/A	N/A	N/A	N/A	
Bankfull Mean Depth (ft)	0.9	0.9	1.0	0.9	0.9		1.5	1.3	1.5	1.5	1.4	
Bankfull Max Depth (ft)	1.4	1.6	1.7	1.6	1.7		3.0	2.7	3.0	2.9	2.8	
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	13.2	13.2	13.8	14.0	14.3		29.4	29.4	28.6	28.1	25.2	
Bankfull Width/Depth Ratio	16.7	16.9	15.2	15.8	16.3		13.6	17.2	13.3	13.1	13.6	
Entrenchment Ratio <sup>1</sup>	10.1	10.0	10.4	10.1	9.8		N/A	N/A	N/A	N/A	N/A	
Bankfull Bank Height Ratio <sup>2</sup>	1.0	1.1	1.0	1.0	1.0		N/A	N/A	N/A	N/A	N/A	
Martin Dairy Reach 2												
	Cross-Section 3 (Pool)						Cross-Section 4 (Riffle)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY5	MY7	Base	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation (ft)	501.8	501.8	501.8	501.9	501.9		501.5	501.4	501.5	501.4	501.3	
Low Bank Elevation (ft)	501.8	501.8	501.8	501.9	501.9		501.5	501.4	501.5	501.4	501.3	
Bankfull Width (ft)	20.8	21.3	21.0	22.5	23.1		12.8	12.4	13.0	12.7	12.4	
Floodprone Width (ft)	N/A	N/A	N/A	N/A	N/A		200	200	200	200	200	
Bankfull Mean Depth (ft)	1.7	1.6	1.9	2.0	2.0		1.1	1.1	1.2	1.3	1.2	
Bankfull Max Depth (ft)	3.5	3.5	3.8	4.0	4.1		1.8	1.9	2.1	2.1	1.9	
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	34.9	34.9	39.2	44.9	46.4		14.2	14.2	15.7	15.9	14.5	
Bankfull Width/Depth Ratio	12.4	13.1	11.2	11.3	11.5		11.6	10.9	10.8	10.1	10.6	
Entrenchment Ratio <sup>1</sup>	N/A	N/A	N/A	N/A	N/A		15.6	16.1	15.3	15.8	16.1	
Bankfull Bank Height Ratio <sup>2</sup>	N/A	N/A	N/A	N/A	N/A		1.0	1.0	1.1	1.1	1.0	
UT1												
	Cross-Section 5 (Riffle)						Cross-Section 6 (Pool)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY5	MY7	Base	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation (ft)	504.0	503.9	503.9	503.9	503.9		504.1	504.1	504.1	504.0	504.0	
Low Bank Elevation (ft)	504.0	504.0	503.9	503.9	503.9		504.1	504.1	504.1	504.0	504.0	
Bankfull Width (ft)	9.2	9.5	9.7	10.1	9.7		11.5	11.9	12.3	11.3	11.3	
Floodprone Width (ft)	65	65	65	65	65		N/A	N/A	N/A	N/A	N/A	
Bankfull Mean Depth (ft)	0.7	0.7	0.6	0.6	0.5		1.0	1.0	1.0	1.0	1.0	
Bankfull Max Depth (ft)	1.4	1.4	1.4	1.3	1.3		2.0	2.2	2.2	2.1	2.1	
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	6.3	6.3	5.8	5.6	5.2		11.8	11.8	12.5	11.0	11.3	
Bankfull Width/Depth Ratio	13.3	14.3	16.1	18.4	18.0		11.3	12.1	12.1	11.7	11.4	
Entrenchment Ratio <sup>1</sup>	7.1	6.8	6.7	6.4	6.7		N/A	N/A	N/A	N/A	N/A	
Bankfull Bank Height Ratio <sup>2</sup>	1.0	1.1	<1.0	1.0	<1.0		N/A	N/A	N/A	N/A	N/A	

<sup>1</sup>Entrenchment Ratio is calculated using the method specified in the Industry Technical Workgroup Memorandum.

<sup>2</sup>Bank Height Ratio is calculated using the method specified in the Industry Technical Workgroup Memorandum.



**Table 12a. Monitoring Data - Stream Reach Data Summary**

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

**Martin Dairy Reach 1**

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY5		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
<b>Dimension and Substrate - Riffle</b>												
Bankfull Width (ft)	14.8		15.0		14.5		14.9		15.3			
Floodprone Width (ft)	150		150		150		150		150			
Bankfull Mean Depth	0.9		0.9		1.0		0.9		0.9			
Bankfull Max Depth	1.4		1.6		1.7		1.6		1.7			
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	13.2		13.2		13.8		14.0		14.3			
Width/Depth Ratio	16.7		16.9		15.2		15.8		16.3			
Entrenchment Ratio	10.1		10.0		10.4		10.1		9.8			
Bank Height Ratio	1.0		1.1		1.0		1.0		1.0			
D50 (mm)	13.1		20.6		32.0		42.5		*			
<b>Profile</b>												
Riffle Length (ft)	12.0	35.9										
Riffle Slope (ft/ft)	0.0039	0.0193										
Pool Length (ft)	38.2	77.4										
Pool Max Depth (ft)	1.4	2.5										
Pool Spacing (ft)	41	101										
Pool Volume (ft <sup>3</sup> )												
<b>Pattern</b>												
Channel Beltwidth (ft)	36	75										
Radius of Curvature (ft)	27	75										
Rc:Bankfull Width (ft/ft)	1.8	5.0										
Meander Wave Length (ft)	60	225										
Meander Width Ratio	2.4	5.0										
<b>Additional Reach Parameters</b>												
Rosgen Classification	C4/E4											
Channel Thalweg Length (ft)	776											
Sinuosity (ft)	1.27											
Water Surface Slope (ft/ft)	0.0046											
Bankfull Slope (ft/ft)	0.005											
Ri%/Ru%/P%/G%/S%												
SC%/Sa%/G%/C%/B%/Be%												
d16/d35/d50/d84/d95/d100	SC/0.45/2.8/21.8/ 45.0/128.0		SC/0.18/14.6/45.0 68.5/128.0		SC/1.0/6.8/37.9/69.7/ 180		0.30/2.57/17.1/78.1 165.3/512.0		*			
% of Reach with Eroding Banks	0%		0%		0%		0%		0%			

\*Pebble count data is no longer required per the September 29, 2021 IRT Technical Work Group Meeting.

**Table 12b. Monitoring Data - Stream Reach Data Summary**

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

**Martin Dairy Reach 2**

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY5		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
<b>Dimension and Substrate - Riffle</b>												
Bankfull Width (ft)	12.8		12.4		13.0		12.7		12.4			
Floodprone Width (ft)	200		200		200		200		200			
Bankfull Mean Depth	1.1		1.1		1.2		1.3		1.2			
Bankfull Max Depth	1.8		1.9		2.1		2.1		1.9			
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	14.2		14.2		15.7		15.9		14.5			
Width/Depth Ratio	11.6		10.9		10.8		10.1		10.6			
Entrenchment Ratio	15.6		16.1		15.3		15.8		16.1			
Bank Height Ratio	1.0		1.0		1.1		1.1		1.0			
D50 (mm)	10.2		38.7		40.8		45.9		*			
<b>Profile</b>												
Riffle Length (ft)	16.7	51.0										
Riffle Slope (ft/ft)	0.0166	0.0266										
Pool Length (ft)	36.1	83.1										
Pool Max Depth (ft)	1.1	1.9										
Pool Spacing (ft)	55	111										
Pool Volume (ft <sup>3</sup> )												
<b>Pattern</b>												
Channel Beltwidth (ft)	39	81										
Radius of Curvature (ft)	29	81										
Rc:Bankfull Width (ft/ft)	1.8	5.0										
Meander Wave Length (ft)	65	243										
Meander Width Ratio	2.4	5.0										
<b>Additional Reach Parameters</b>												
Rosgen Classification	C4/E4											
Channel Thalweg Length (ft)	1,258											
Sinuosity (ft)	1.22											
Water Surface Slope (ft/ft)	0.0072											
Bankfull Slope (ft/ft)	0.007											
Ri%/Ru%/P%/G%/S%												
SC%/Sa%/G%/C%/B%/Be%												
d16/d35/d50/d84/d95/d100	0.11/1.10/5.0/27.6/64.0/512.0		0.55/13.27/24.7/68.5/104.7/180.0		0.16/4.58/10.5/84.1/160.7/512.0		SC/3.55/19.7/85.7/180.0/362.0		*			
% of Reach with Eroding Banks	0%		0%		0%		0%		0%			

\*Pebble count data is no longer required per the September 29, 2021 IRT Technical Work Group Meeting.

**Table 12c. Monitoring Data - Stream Reach Data Summary**

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

**UT1**

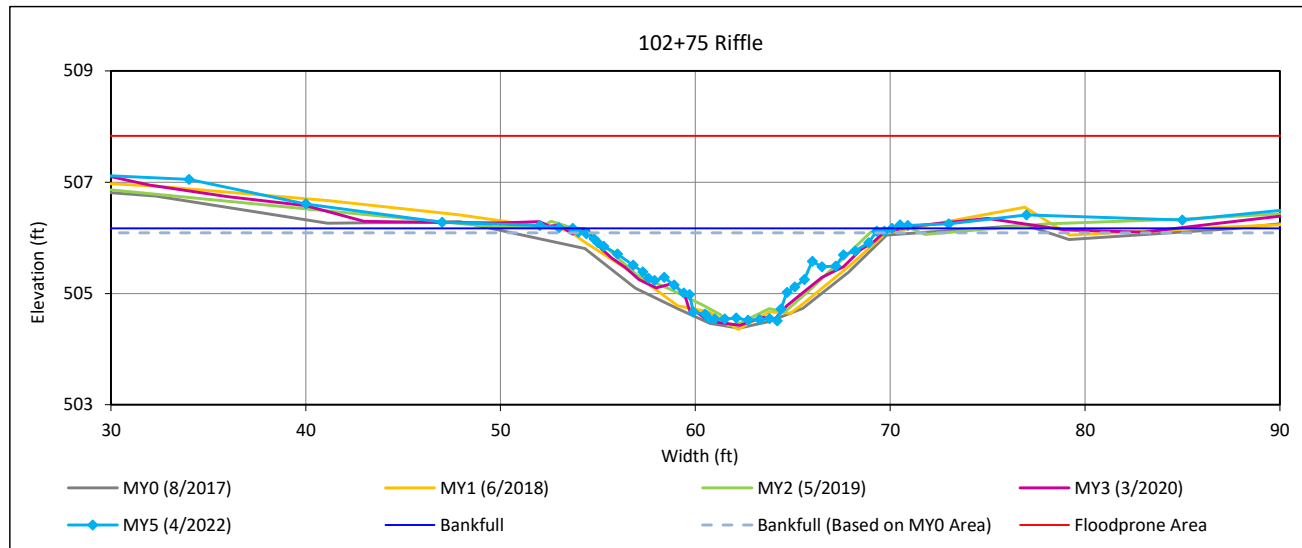
Parameter	As-Built/Baseline		MY1		MY2		MY3		MY5		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
<b>Dimension and Substrate - Riffle</b>												
Bankfull Width (ft)	9.2		9.5		9.7		10.1		9.7			
Floodprone Width (ft)	65		65		65		65		65			
Bankfull Mean Depth	0.7		0.7		0.6		0.6		0.5			
Bankfull Max Depth	1.4		1.4		1.4		1.3		1.3			
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	6.3		6.3		5.8		5.6		5.2			
Width/Depth Ratio	13.3		14.3		16.1		18.4		18.0			
Entrenchment Ratio	7.1		6.8		6.7		6.4		6.7			
Bank Height Ratio	1.0		1.1		<1.0		1.0		<1.0			
D50 (mm)	7.4		72.1		14.6		20.3		*			
<b>Profile</b>												
Riffle Length (ft)	4	28										
Riffle Slope (ft/ft)	0.009	0.016										
Pool Length (ft)	4.2	34.9										
Pool Max Depth (ft)	0.4	1.3										
Pool Spacing (ft)	30	73										
Pool Volume (ft <sup>3</sup> )												
<b>Pattern</b>												
Channel Beltwidth (ft)	23	66										
Radius of Curvature (ft)	17	52										
Rc:Bankfull Width (ft/ft)	1.8	5.5										
Meander Wave Length (ft)	56	155										
Meander Width Ratio	2.4	7.0										
<b>Additional Reach Parameters</b>												
Rosgen Classification	C4/E4											
Channel Thalweg Length (ft)	213											
Sinuosity (ft)	1.1											
Water Surface Slope (ft/ft)	0.0072											
Bankfull Slope (ft/ft)	0.0103											
Ri%/Ru%/P%/G%/S%												
SC%/Sa%/G%/C%/B%/Be%												
d16/d35/d50/d84/d95/d100	0.07/0.28/7.3/20.1/ 37.9/64.0		SC/9.38/21.5/75.9/ 128.0/256.0		SC/0.09/4.3/21.1/50.6/ 90.0		SC/0.79/6.1/33.9 64.0/256.0		*			
% of Reach with Eroding Banks	0%		0%		0%		0%		0%			

\*Pebble count data is no longer required per the September 29, 2021 IRT Technical Work Group Meeting.

**Cross-Section Plots**

Martin Dairy Mitigation Site  
 DMS Project No. 97087  
 Monitoring Year 5 - 2022

**Cross-Section 1 Martin Dairy Reach 1**



**Bankfull Dimensions**

14.3	x-section area (ft.sq.)
15.3	width (ft)
0.9	mean depth (ft)
1.7	max depth (ft)
16.1	wetted perimeter (ft)
0.9	hydraulic radius (ft)
16.3	width-depth ratio
150.0	W flood prone area (ft)
9.8	entrenchment ratio
1.0	low bank height ratio

Survey Date: 4/2022  
 Field Crew: Wildlands Engineering



View Downstream

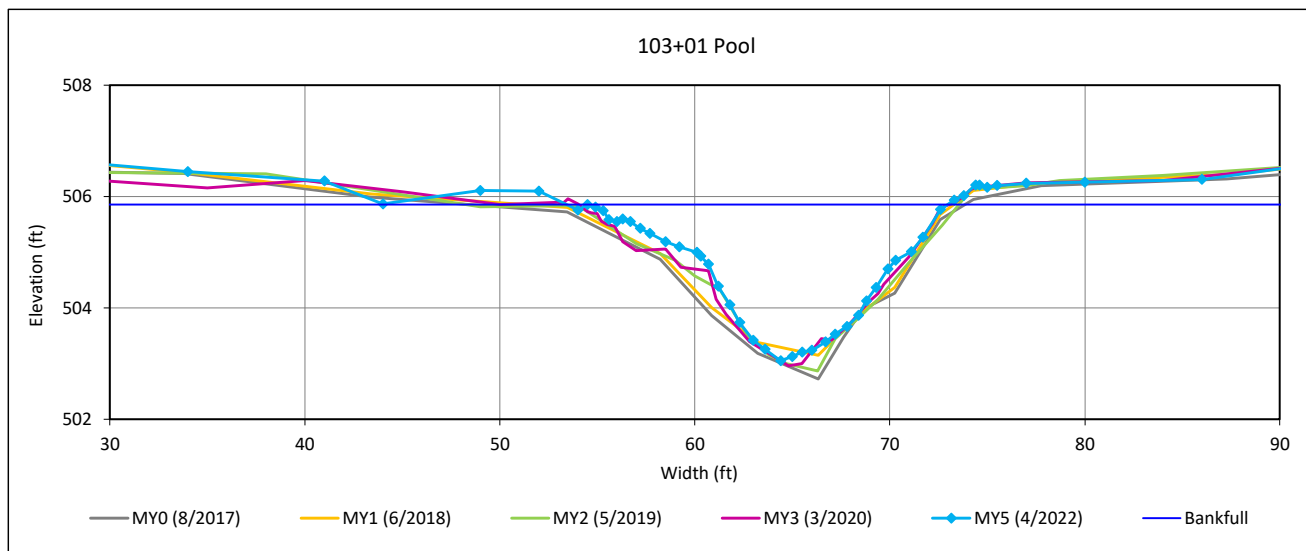
### Cross-Section Plots

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

#### Cross-Section 2 Martin Dairy Reach 1



#### Bankfull Dimensions

25.2	x-section area (ft.sq.)
18.5	width (ft)
1.4	mean depth (ft)
2.8	max depth (ft)
19.6	wetted perimeter (ft)
1.3	hydraulic radius (ft)
13.6	width-depth ratio

Survey Date: 4/2022

Field Crew: Wildlands Engineering



View Downstream

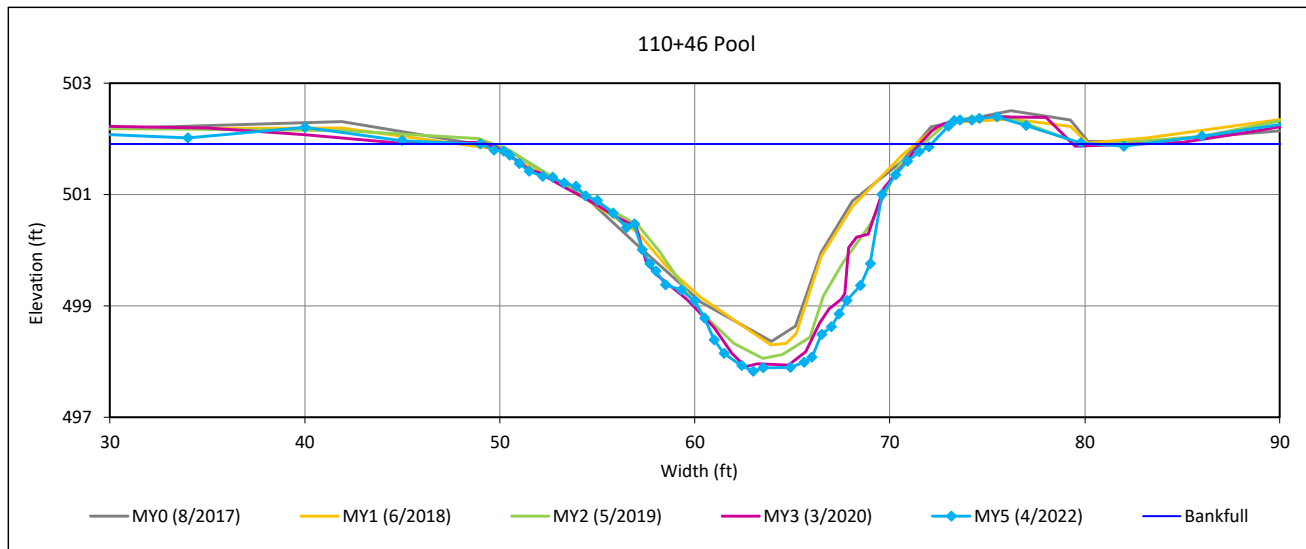
### Cross-Section Plots

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

#### Cross-Section 3 Martin Dairy Reach 2



#### Bankfull Dimensions

46.4	x-section area (ft.sq.)
23.1	width (ft)
2.0	mean depth (ft)
4.1	max depth (ft)
25.5	wetted perimeter (ft)
1.8	hydraulic radius (ft)
11.5	width-depth ratio

Survey Date: 4/2022

Field Crew: Wildlands Engineering

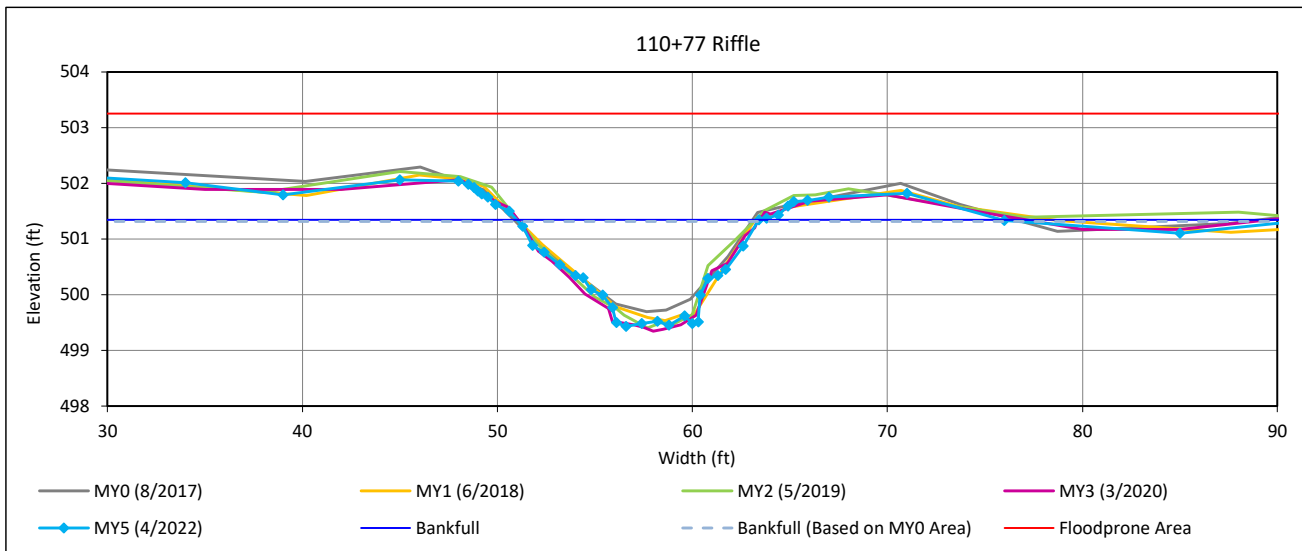


View Downstream

**Cross-Section Plots**

Martin Dairy Mitigation Site  
 DMS Project No. 97087  
 Monitoring Year 5 - 2022

**Cross-Section 4 Martin Dairy Reach 2**



**Bankfull Dimensions**

14.5	x-section area (ft.sq.)
12.4	width (ft)
1.2	mean depth (ft)
1.9	max depth (ft)
13.6	wetted perimeter (ft)
1.1	hydraulic radius (ft)
10.6	width-depth ratio
200.0	W flood prone area (ft)
16.1	entrenchment ratio
1.0	low bank height ratio

Survey Date: 4/2022  
 Field Crew: Wildlands Engineering



View Downstream

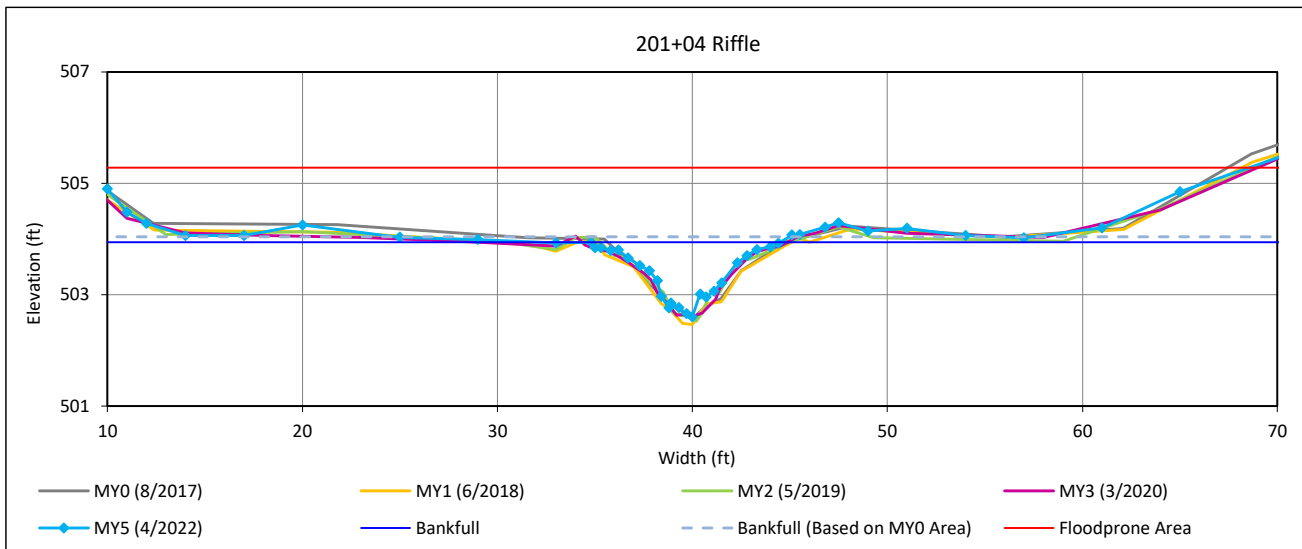
### Cross-Section Plots

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

#### Cross-Section 5 UT1



#### Bankfull Dimensions

5.2	x-section area (ft.sq.)
9.7	width (ft)
0.5	mean depth (ft)
1.3	max depth (ft)
10.4	wetted perimeter (ft)
0.5	hydraulic radius (ft)
18.0	width-depth ratio
65.0	W flood prone area (ft)
6.7	entrenchment ratio
< 1.0	low bank height ratio

Survey Date: 4/2022

Field Crew: Wildlands Engineering



View Downstream



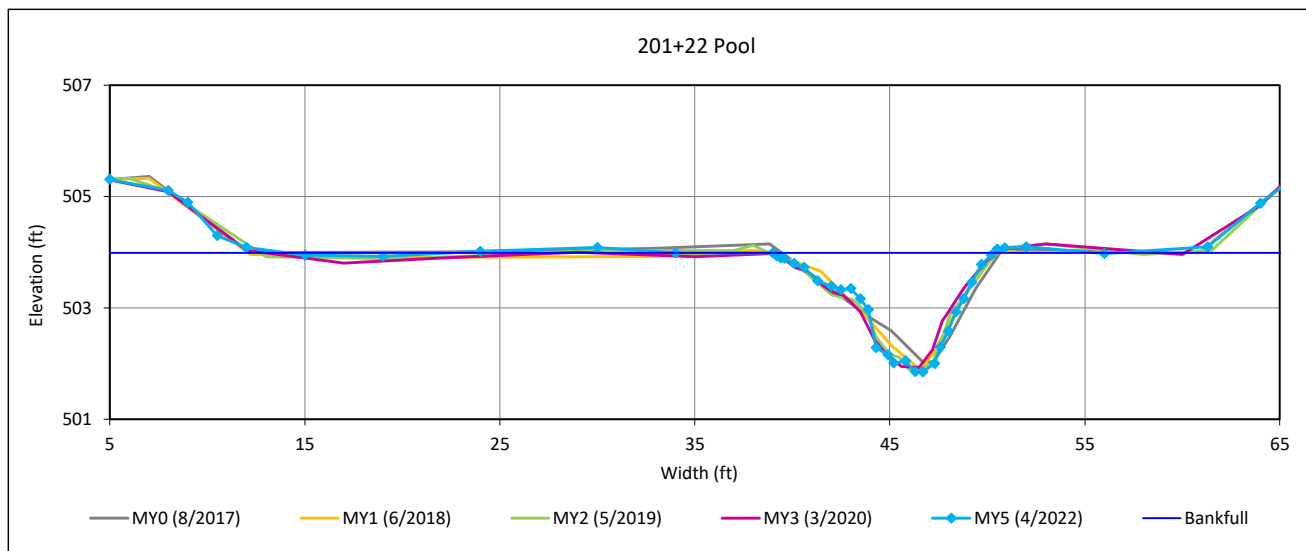
### Cross-Section Plots

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 5 - 2022

#### Cross-Section 6 UT1



#### Bankfull Dimensions

11.3	x-section area (ft.sq.)
11.3	width (ft)
1.0	mean depth (ft)
2.1	max depth (ft)
12.6	wetted perimeter (ft)
0.9	hydraulic radius (ft)
11.4	width-depth ratio

Survey Date: 4/2022

Field Crew: Wildlands Engineering



View Downstream

## **APPENDIX 5. Hydrology Summary Data**

**Table 13. Verification of Bankfull Events**

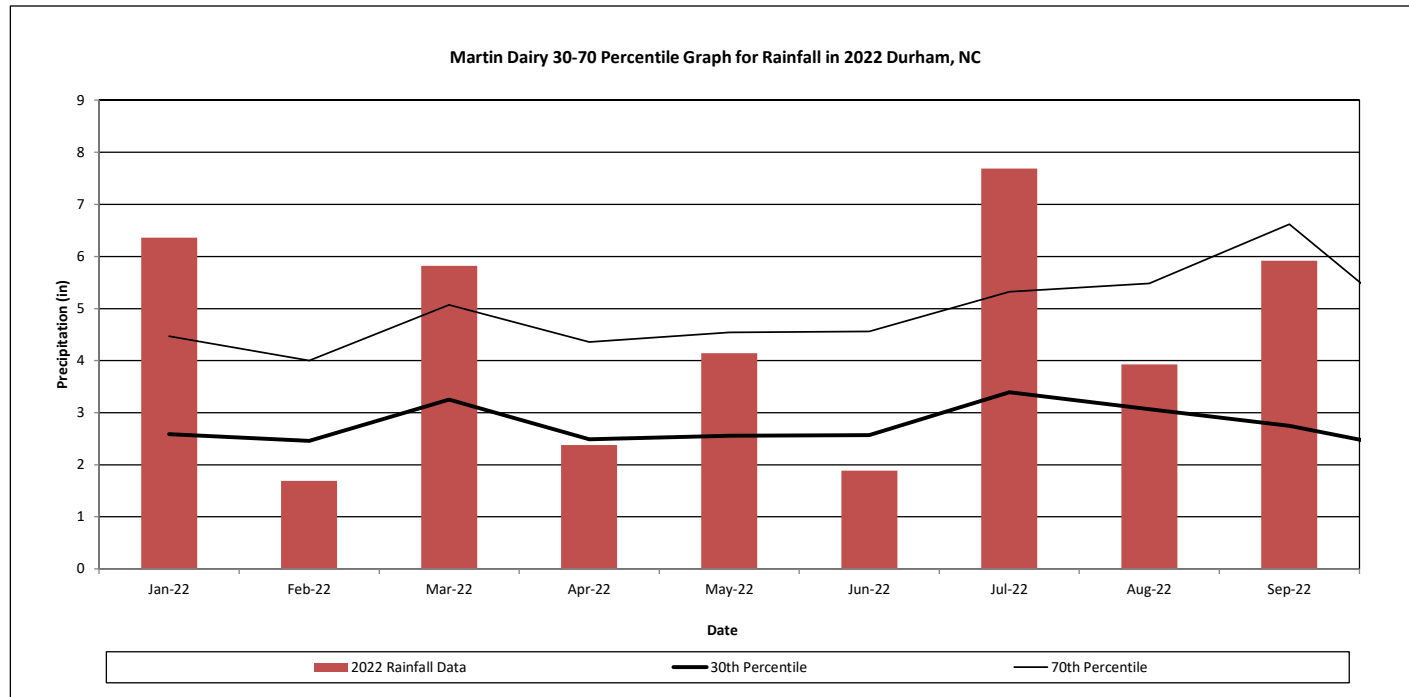
Martin Dairy Mitigation Site  
 DMS Project No. 97087  
 Monitoring Year 5 - 2022

Reach	MY1 Date of Occurrence	MY2 Date of Occurrence	MY3 Date of Occurrence	MY4 Date of Occurrence	MY5 Date of Occurrence	Method
Martin Dairy	4/15/2018	4/13/2019	1/24/2020	1/3/2021	5/24/2022	Crest Gage/ Pressure Transducer
	9/17/2018*	6/19/2019	2/6/2020	7/19/2021		
UT1	4/15/2018	3/24/2019	1/24/2020	1/3/2021	3/12/2022	
	9/17/2018*	4/13/2019	2/6/2020	4/10/2021	5/24/2022	
		6/19/2019	6/11/2020	7/19/2021	10/1/2022	

\*Hurricane Florence

**Monthly Rainfall Data**

Martin Dairy Mitigation Site  
 DMS Project No. 97087  
 Monitoring Year 5 - 2022



<sup>1</sup> 2022 monthly rainfall from USDA Station Durham 6.8 NNW.

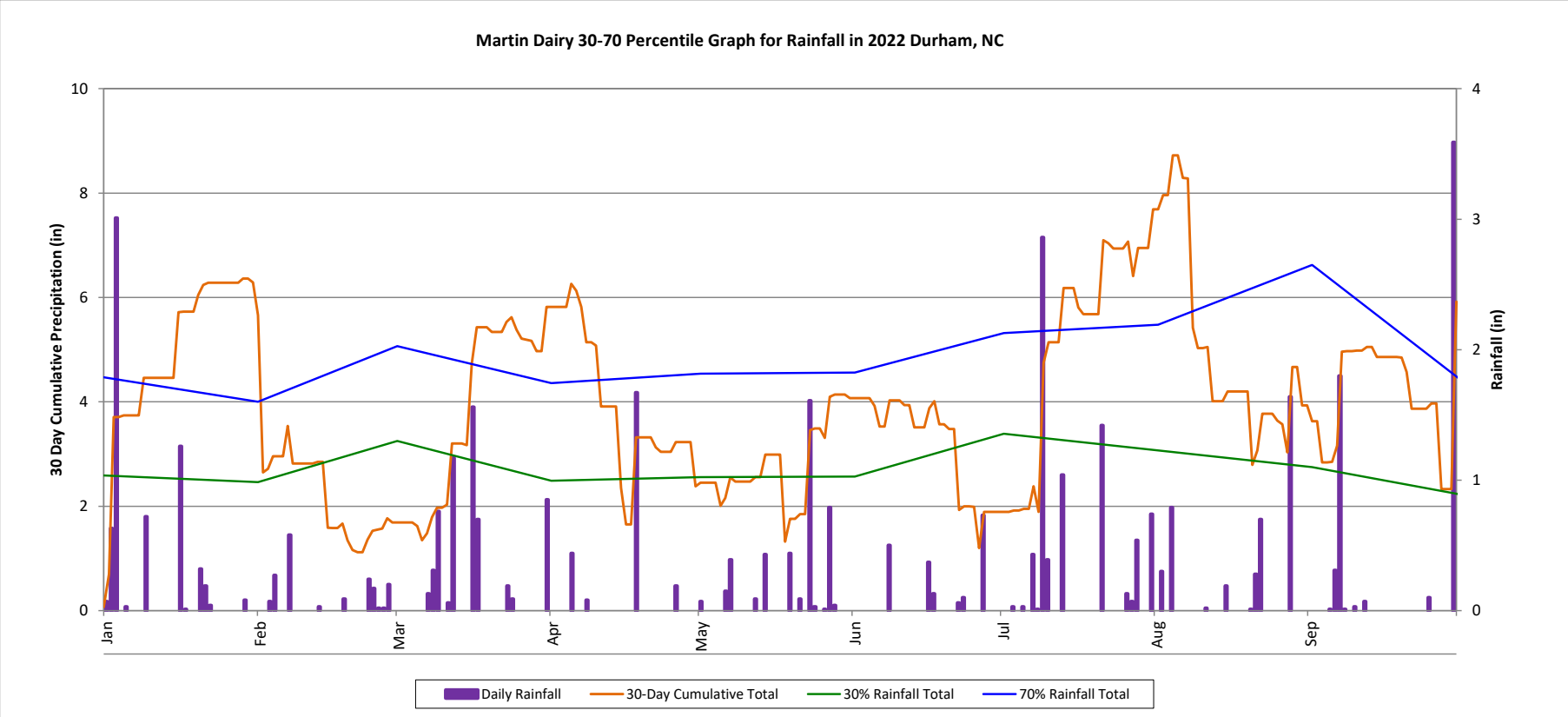
<sup>2</sup> 30th and 70th percentile rainfall data collected from weather station Chapel Hill 2 W, NC (USDA, 2022).

**30-Day Cumulative Total Rainfall Data**

Martin Dairy Mitigation Project

DMS Project No. 97087

Monitoring Year 5 - 2022



<sup>1</sup> 2022 monthly rainfall from USDA Station Durham 6.8 NNW.

<sup>2</sup> 30th and 70th percentile rainfall data collected from weather station Chapel Hill 2 W, NC (USDA, 2022).