

FINAL
MONITORING REPORT
YEAR 5 (2022)
MUD LICK CREEK MITIGATION SITE

Chatham County, North Carolina

NCDMS Project No. 93482

Contract No. 7683

USACE Action ID No. SAW-2014-00736 & DWR Project No 2014-1127

SCO No. 1209857-01

Data Collection: April-September 2022

Submission: January 2023



PREPARED FOR:

N.C. DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF MITIGATION SERVICES
1601 MAIL SERVICE CENTER
RALEIGH, NORTH CAROLINA 27699-1601

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PREPARED BY:

AXIOM ENVIRONMENTAL, INC.
218 SNOW AVENUE
RALEIGH, NORTH CAROLINA 27603

PROJECT SUMMARY

The North Carolina Division of Mitigation Services (NCDMS) has established the Mud Lick Creek Mitigation Site (Site) located within the Cape Fear River Basin Cataloging Unit (CU) 03030003 in the Upper Rocky River local watershed planning (LWP) area and 14-digit HUC 03030003070010. The Site was identified as a priority mitigation project in the *Detailed Assessment and Targeting of Management Report* (Tetra Tech 2005). The main stressors to aquatic resources identified during the watershed assessments described in the LWP documents include the following.

- Nutrient (nitrogen and phosphorous) loading from farming;
- Sediment loading from overland runoff, disturbed surfaces, and streambank erosion;
- Cattle access to streams increasing bank erosion and fecal coliform contamination; and
- Insufficient bank vegetation.

The project will contribute to meeting management recommendations to offset these stressors as described above for the LWP area by accomplishing the following primary goals.

- Control and reduce nutrient sources from the Site;
- Reduce sediment loads from disturbed areas on the Site and from eroding stream banks;
- Increased aeration of flows within the project extent promoting increases in dissolved oxygen concentrations;
- Reduce sources of fecal coliform pollution;
- Improve instream habitat;
- Reduce thermal loadings;
- Reconnect channels with floodplains and raise local water table; and
- Restore riparian habitat.

These goals will be accomplished through the following objectives:

- Restore riparian vegetation on the Site and thereby reduce sediment loads to streams from stream banks and existing pastures, increase on-Site retention of sediment and nutrients, create riparian habitat, and provide shade for streams to reduce thermal loadings;
- Stabilize eroding streambanks to reduce sediment inputs;
- Install fencing around the perimeter of the conservation easement to eliminate livestock access to streams, thereby reducing sediment, nutrient, and fecal coliform inputs;
- Plant restored and stabilized streambanks with native species to improve stability and habitat;
- Install instream structures to improve stability, create habitat, and help aerate stream flows;
- Raise streambeds to reconnect restored channels to floodplains and raise local water tables; and
- Restore streams and vegetation so the Site looks natural and aesthetically pleasing.

Stream Success Criteria: The stream restoration performance criteria for the Site will follow approved performance criteria presented in the 2015 *Mud Lick Creek Mitigation Site Final Mitigation Plan* as described below.

Stream Dimension: Riffle cross-sections on the restoration reaches and enhancement II reaches, where banks were re-graded (three reaches of Mud Lick Creek), should be stable and should show little change in bankfull area, maximum depth, and width-to-depth ratio. Bank-height-ratios shall not exceed 1.2 and entrenchment ratios shall be at least 2.2 for restored channels to be considered stable. All riffle cross-sections should fall within the parameters defined for channels of the appropriate stream type. If any changes do occur, these changes will be evaluated to assess whether the stream channel is showing signs of instability. Indicators of instability include a vertically incising thalweg or eroding channel banks. Changes in the channel that indicate a movement toward stability or enhanced habitat include a decrease in

the width-to-depth ratio in meandering channels or an increase in pool depth. Remedial action would not be taken if channel changes indicate a movement toward stability.

Stream Pattern and Profile: The as-built survey will include a longitudinal profile for the baseline monitoring report. Longitudinal profile surveys will not be conducted during the seven-year monitoring period unless other indicators during the annual monitoring indicate a trend toward vertical and lateral instability.

Substrate: Substrate materials in the restoration reaches should indicate a progression towards or the maintenance of coarser materials in the riffle features and smaller particles in the pool features.

Hydraulics: Two bankfull flow events, in separate monitoring years, must be documented on the restoration reaches and enhancement II reaches where banks were re-graded (three reaches of Mud Lick Creek) within the seven-year monitoring period.

Vegetation Success Criteria: The final vegetative success criteria will be the survival of 210 planted stems per acre in the riparian corridor along restored and enhanced reaches at the end of the required monitoring period (year seven). The interim measure of vegetative success for the Site will be the survival of at least 320 planted stems per acre at the end of the third monitoring year and at least 260 stems per acre at the end of the fifth year of monitoring. If this performance standard is met by year five and stem density is trending towards success (i.e., no less than 260 stems/acre), monitoring of vegetation on the Site may be terminated with written approval by the USACE in consultation with the NC Interagency Review Team. The extent of invasive species coverage will also be monitored and controlled as necessary throughout the required monitoring period (seven years).

Photo Documentation: Photographs should illustrate the Site's vegetation and morphological stability on an annual basis. Cross-section photos should demonstrate no excessive erosion or degradation of the banks. Longitudinal photos should indicate the absence of persistent bars within the channel or vertical incision. Grade control structures should remain stable. Deposition of sediment on the bank side of vane arms is preferable. Maintenance of scour pools on the channel side of vane arms is expected.

Visual Assessments: Visual assessments should support performance standards as described above.

As per Sections 7.2 and 12.4 of the Mitigation Plan, physio-chemical and biological parameters were included as part of specialized monitoring, depending on the data that could be obtained during the baseline period. Monitoring of these parameters was for investigative purposes only and not tied to mitigation success or credit. The sample size and variability of the pre-construction physio-chemical data was inadequate for the purposes of post-construction comparison and therefore, these will not be monitored moving forward. However, fish and macrobenthos will be monitored at the stations indicated in the asset and monitoring features map (Figure 2, Appendix B).

Site Background: The Site is located in northwestern Chatham County, north of Siler City and northwest of Silk Hope (Figure 1, Appendix B). The Site is located within United States Geological Survey (USGS) Hydrologic Unit and Targeted Local Watershed 03030003070010 (North Carolina Division of Water Resources Subbasin 03-06-12) of the Cape Fear River Basin. Prior to construction, the Site was used for agricultural livestock production. The proposed project will improve water quality as well as provide numerous ecological benefits within the Cape Fear River Basin. The project will help meet management recommendations of the *Upper Rocky River Local Watershed Plan* by restoring a vegetated riparian buffer zone, stabilizing eroding stream banks, and removing livestock from streams and riparian zones. These activities will result in reduced nutrient, sediment, and fecal coliform inputs; improved aquatic and riparian habitat, and other ecological benefits.

Mitigation Components: Project mitigation efforts will generate 2832 Stream Mitigation Units (SMUs) as the result of the following (Table 1, Appendix A & Figure 2, Appendix B).

- Restoration of 1215 linear feet of Site streams
- Enhancement (Level II) of 2426 linear feet of Site streams

Site design was completed in June 2015. Site construction occurred May 24–August 25, 2017 (final walkthrough) and the Site was planted in February 2018. Completed project activities, reporting history, completion dates, project contacts, and project attributes are summarized in Tables 1-4 (Appendix A). The assets and credits in the report and shown in Table 1 are based upon approved as-built numbers as approved by the IRT on 11/1/2018.

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1.0 METHODS

Monitoring of restoration efforts will be performed for seven years, or until success criteria are fulfilled. Monitoring is proposed for the stream channel and vegetation. In general, the restoration success criteria, and required remediation actions, are based on the *Stream Mitigation Guidelines* (USACE et al. 2003). Monitoring features are summarized in the following table and described below; monitoring features are depicted on Figure 2 (Appendix B).

Monitoring Summary

Parameter	Monitoring Feature	Quantity	Frequency
Streams			
Dimension	Cross-sections	7 riffles & 3 pools	annually
Substrate	Pebble counts	3 riffles	annually
Hydrology	Crest gauges	3	annually
Vegetation	Vegetation Plots	12	annually
	Warranty Plots	10	MY1
Visual assessments		Entire Site	biannually
Exotic & nuisance species		Entire Site	annually
Project boundary		Entire Site	annually
Reference photographs		22	annually
Supplemental Monitoring			
Biological	Macrobenthos	5 sites (Preconstruction only) 3 sites (MY3, MY5, & MY7)	
	Fish	3 sites (Preconstruction only) 2 sites (MY4 & MY7)	

Streams

The restored stream reaches are proposed to be monitored for geometric activity as follows.

- 7 permanent riffle cross-sections
- 3 permanent pool cross-sections
- 3 riffle pebble count samples for substrate analysis
- 3 stream crest gauges

The data will be presented in graphic and tabular format. Data to be presented will include 1) cross-sectional area, 2) bankfull width, 3) average depth, 4) maximum depth, and 5) width-to-depth ratio. Substrate analysis will be evaluated through pebble counts at three riffle cross-sections and data presented as a D50 for stream classification and tracking purposes. The stream will subsequently be classified according to stream geometry and substrate (Rosgen 1996). Significant changes in channel morphology including bank-height-ratios and entrenchment ratios will be tracked and reported by comparing data to asbuilt measurements in addition to each successive monitoring year. Annual photographs will include 22 fixed station photographs (12 vegetation plots and 10 cross-sections) (Appendix B). The Site contains three stream crest gauges to assist with documentation of bankfull events. One bankfull event was documented during monitoring year 5 (2022), making a total of six bankfull events have been documented over the monitoring period to date (Table 12, Appendix E).

Year 5 cross-section data indicate little change from as-built conditions and that the stream is functioning as designed, overall. Pool cross-sections (like cross-section 8) are typically not monitored for bank-height-

ratio because they are naturally sediment storage and transport areas within a stream. This is apparent in review of the varying D_{\max} and LBH values exhibited by cross-section 8 throughout the monitoring period. Bank erosion has not been noted within or adjacent to cross-section 8, and overall, the reach appears stable. Cross-sections 1 and 2 have been characterized by increased bank height ratio for the past several monitoring years. These cross-sections are located within an Enhancement (Level II) reach of stream that has scoured in previous years; however, the scour appears to have been minimized and the channel has reformed natural top-of-bank indicators within the dimensional parameters of the channel. Cross-sections 1 and 2 have both remained relatively consistent and stable for the past 3 monitoring years. All site cross-sections are meeting success criteria during year 5 (2022).

Two stream areas of concern were observed during monitoring year 5 (2022); both were documented during previous monitoring years. Stream Area of Concern #1 is located along Mud Lick Creek R2 where approximately 50 feet of the right bank and 20 feet of the left bank have eroded to the point of bank sloughing. This area remains relatively unchanged from year 1 (2018); the establishment of dense herbaceous vegetation and lack of high discharge events have allowed this area to continue to stabilize. Stream Area of Concern #2 consists of scour and sloughing along an outer bend along Mud Lick Creek R3, immediately downstream from cross-section 1. Material that had sloughed from the bank remains stable and herbaceous vegetation is vigorous. Both stream areas of concern are located within enhancement II stream reaches; all stream reaches generating restoration credit are stable throughout and functioning as designed. Stream areas of concern are depicted on Figure 2 in Appendix B.

Vegetation

Restoration monitoring procedures for vegetation health will monitor plant survival and species diversity. After planting of the area was completed, 12 permanent vegetation plots were installed and monitored at the Site; annual results are in Appendix C. Annual measurements of vegetation will consist of the following.

- 10 plant warranty inspection plots (only MY1)
- 12 CVS vegetation plots

A photographic record of plant growth should be included in each annual monitoring report; baseline photographs are included in Appendix B. During the first year, vegetation will receive a cursory, visual evaluation on a periodic basis to ascertain the degree of overtopping of planted elements by nuisance species. Subsequently, quantitative sampling of vegetation will be performed as outlined in the *CVS-EEP Protocol for Recording Vegetation, Version 4.2* (Lee et al. 2008) in late fall/early winter of the first monitoring year and annually toward the end of the growing for the remainder of the monitoring period until vegetation success criteria are achieved.

Year 5 (2022) stem count measurements for twelve permanent CVS plots indicate the planted stem density across the Site is 290 planted stems per acre. Nine of the twelve individual CVS plots met success criteria based on planted stems alone; however, when including naturally recruited stems of American elm (*Ulmus americana*), eastern redbud (*Cercis canadensis*), green ash (*Fraxinus pennsylvanica*), and American sycamore (*Platanus occidentalis*) the stem densities of plots 6 and 11 are above success criteria (Table 8, Appendix C). Plot 1 was two stems shy of success. Plot 1 experienced mortality of two stems between MY3 and 4 and another between MY4 and 5; there are no natural recruits in this plot. Plot 11 is dominated by dense herbaceous vegetation and extremely high numbers of sweetgum (*Liquidambar styraciflua*), increasing competition with planted stems. Areas within the site remaining below success criteria are primarily due to herbaceous competition with dense fescue (*festuca* spp.). There are several isolated areas of dense sweetgum along North Branch R2 that are out-competing more desirable tree species. During

vegetation data collection an abundance of deer browse was documented in all permanent CVS plots. Additionally, several populations of dense Chinese privet (*Ligustrum sinense*) and tree of heaven (*Ailanthus altissima*) were observed scattered throughout the Site. Although invasive treatments have been ongoing, these areas are relatively unchanged from previous years. Invasive populations are depicted on Figure 2 (Appendix B).

Due to decreasing Site stem density and continued observation of deer browse and competition with herbaceous species, DMS has implemented an adaptive management that includes supplementally planting 1- and 3-gallon containerized trees across 2.04 acres of the Site. Low stem density areas are depicted on Figure 2 (Appendix B), and the adaptive management plan is detailed in Appendix G.

Project Boundaries & Visual Assessments

Locations of any fence damage, vegetation damage, boundary encroachments, etc. will be documented and included on mapping.

Visual assessments will be performed along all streams on a bi-annual basis during the seven-year monitoring period. Problem areas will be noted such as channel instability (i.e. lateral and/or vertical instability, in-stream structure failure/instability and/or piping, headcuts), vegetated buffer health (i.e. low stem density, vegetation mortality, invasive species or encroachment), beaver activity, or livestock access. Areas of concern will be mapped and photographed accompanied by a written description in the annual report. Problem areas will be re-evaluated during each subsequent visual assessment.

During year 3 (2020) monitoring, onsite beaver activity was observed including a significant dam along North Branch R3, a dam along Mud Lick Creek R2, and several smaller dams throughout the Site. In response, on November 4, 2020, USDA trapped beaver and removed six dams. A small beaver dam was observed during year 5 (2022) along North Branch R2, the stream was dry at the time of assessment, it was unclear if there were active beaver populations still within the site. Beaver activity will continue to be monitored and USDA will be notified on an as needed basis.

Supplementary Monitoring

Supplemental monitoring will include biological monitoring in the Spring as follows.

- 3 benthos sampling sites (MY3, MY5, & MY7)
- 2 fish sampling sites (MY4 & MY7)

Additional parameters are being monitored for analytical purposes and are not tied to mitigation success and associated credit releases. The primary criteria for indication of improvement for the benthos and fish will be an increase of at least one bioclassification between the pre-con assessment and the post-con monitoring. Richness and EPT metrics will be analyzed as well. Based on values tabulated on Habitat Assessment Field Data Sheets, benthic macroinvertebrate habitat appears to be improving at the Site. Overall values for the data sheets have improved by 10 to 54 points since preconstruction. In addition, each independent variable on the data sheets has shown improvement over the monitoring period, except for channel modification. Biotic index (tolerance of a stream benthic community) has not shown significant improvement with station MLC-2 shifting from a Fairly Poor to Very Poor designation, station MLC-3 shifting from Poor to Very Poor, and station NBR-5 remaining within the Poor range. A summary of benthic results including Habitat Field Data Assessment Sheet scores and Biotic Index values from laboratory analysis results (preconstruction to MY5) is presented below. Full MY5 benthic sampling results and Habitat Field Data Assessment Sheets are located in Appendix F.

Site	MLC-2			MLC-3			NBR-5		
Habitat Assessment Field Data Sheet Data	Precon (2015)	MY3 (2020)	MY 5 (2022)	Precon (2015)	MY3 (2020)	MY5 (2022)	Precon (2015)	MY3 (2020)	MY5 (2022)
Channel Modification	5	3	4	5	3	3	4	5	5
Instream Habitat	11	14	11	11	11	11	9	18	15
Bottom Substrate	3	8	4	3	11	8	1	11	6
Pool Variety	4	10	6	6	10	6	0	10	6
Riffle Habitats	7	14	7	7	10	7	0	16	16
Bank Stability and Veg	8	4	10	13	6	11	10	14	12
Light Penetration	7	7	10	7	7	7	2	2	10
Riparian Veg Zone Width	2	10	10	1	10	10	12	10	10
Total Score	47	70	62	53	68	63	26	86	81
Biotic Index	6.01	8.05	8.25	6.64	6.68	7.70	6.90	5.90	7.70

2.0 REFERENCES

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

North Carolina Division of Mitigation Services (NCDMS) 2015. Mud Lick Creek Mitigation Site Final Mitigation Plan.

Rosgen D. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, Colorado.

Tetra Tech, 2005. Upper Rocky River Local Watershed Plan Preliminary Findings Report. Prepared for the North Carolina Ecosystem Enhancement Program.

United States Army Corps of Engineers (USACE), United States Environmental Protection Agency (USEPA), North Carolina Wildlife Resources Commission (NCWRC), Natural Resources Conservation Service (NRCS), and North Carolina Division of Water Quality (NCDWQ). 2003. Stream Mitigation Guidelines. State of North Carolina.

Appendix A.
Background Tables

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

Table 1. Mud Lick Creek (ID-93482) - Mitigation Assets and Components**

Project Component (reach ID, etc.)	Wetland Position and HydroType	Existing Footage	Stationing	Mitigation Plan Footage	As-Built Footage *	Restoration Level	Approach Priority Level	Mitigation Ratio (X:1)	Mitigation Credits	Notes/Comments
North Branch R1		318	100+10 - 103+28	327	318	EII	-	1.5	212.000	Planting, fencing
North Branch R2		522	103+28 - 108+66	520	538	R	PI	1	538.000	
North Branch R3		351	108+66 - 111+51	303	265	R	P2	1	265.000	20 LF of restoration was removed from North Branch Reach 2 in order to account for an easement break
East Branch R1		165	200+05 - 201+69	168	164	EII	-	1.5	109.333	Planting, fencing
East Branch R2		315	201+69 - 205+81	409	412	R	P2	1	412.000	
Mud Lick Creek R1		525	300+72 - 306+23	623	551	EII	-	1.5	367.333	Planting, fencing, bank repairs
Mud Lick Creek R2		718	306+23 - 313+14	693	660	EII	-	1.5	440.000	Planting, fencing, bank repairs; 31 LF of enhancement II was removed from Mud Lick Creek Reach 2 in order to account for an easement break
Mud Lick Creek R3		733	313+14 - 320+47	748	733	EII	-	1.5	488.667	Planting, fencing, bank repairs

*Reach start and end stationing may differ slightly from the mitigation plan due to removal of stream lengths that are outside the conservation easement. The upstream ends of Mud Lick Creek, North Branch, and East Branch experienced footage reductions of 72', 10', and 5' respectively, while the downstream end of Mud Lick Creek experienced a footage reduction of 17'.

**The assets and credits in the report and shown in Table 1 are based upon approved as-built numbers as approved by the IRT on 11/1/2018

Length and Area Summations by Mitigation Category

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)
		Riverine	Non-Riverine	
Restoration	1215			
Enhancement				
Enhancement I				
Enhancement II	2426			
Creation				
Preservation				
High Quality Pres				

Overall Assets Summary

Asset Category	Overall Credits
Stream	2,832.333

**Table 2. Project Activity and Reporting History
Mud Lick Creek (ID-93482)**

Elapsed Time Since Grading Complete: 5 years 3 months

Elapsed Time Since Planting Complete: 4 years 10 months

Number of Reporting Years: 5

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Project Institution	--	February 13, 2013
Mitigation Plan	--	December 2015
404 Permit Date	--	March 25, 2016
Final Design – Construction Plans	--	June 2015
Construction	--	August 25, 2017
Bare Root; Containerized; and B&B Plantings for the Entire Project Site	February 2018	February 2018
Baseline Monitoring Document (Year 0 Monitoring Baseline)	July 2018	September 2018
Monitoring Year 1 (2018) Document	December 2018	December 2018
Monitoring Year 2 (2019) Document	September 2019	January 2020
Monitoring Year 3 (2020) Document	September/October 2020	January 2021
Monitoring Year 4 (2021) Document	October 2021	December 2021
Monitoring Year 5 (2022) Document	September 2022	January 2023

Table 3. Project Contact Table

Mud Lick Creek (ID-93482)

Designer	Wildlands Engineering, Inc. (License No. F-0831) 312 West Millbrook Rd, Suite 225 Raleigh, NC 27609 Angela N. Allen, PE (919) 851-9986
Construction Plans and Sediment and Erosion Control Plans	Wildlands Engineering, Inc. (License No. F-0831) 312 West Millbrook Rd, Suite 225 Raleigh, NC 27609 Angela N. Allen, PE (919) 851-9986
Construction Contractor	North State Environmental, Inc. 2889 Lowery Street Winston Salem, NC 27101 Michael Anderson (336) 725-2010
Planting Contractor	North State Environmental, Inc. 2889 Lowery Street Winston Salem, NC 27101 Stephen Joyce (336) 725-2010
As-built Surveyors	Allied Associates, PA 4720 Kester Mill Road Winston Salem, NC 27103 David Alley (336) 765-2377
Baseline Data Collection	Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis (919) 215-1693

Table 4. Project Baseline Information and Attributes**Mud Lick Creek (ID-93482)**

Project Information						
Project name	Mud Lick Creek Mitigation Site					
Project county	Chatham County, North Carolina					
Project area (Acres)	11.2					
Project coordinates (lat/long)	35.8128°N, 79.4350°W					
Planted Acres	9.6					
Project Watershed Summary Information						
Physiographic region	Carolina Slate Belt of the Piedmont Physiographic Province					
Project river basin	Cape Fear River Basin					
USGS hydrologic unit (8 digit/14-digit)	03030003/03030003070010					
NCDWR Sub-basin	03-06-12					
Project drainage area (mi ²)	3.64					
% Drainage area impervious	< 1%					
CGIA land use classification	Developed, Forested/Scrubland, Agriculture/Managed Herb., Open Water					
Reach Summary Information						
Parameters	Mud Lick Creek – R1	Mud Lick Creek – R2	Mud Lick Creek – R3	North Branch – R1	North Branch – R2	East Branch
Restored length (linear feet)	551	660	733	856	265	576
Valley confinement	Slightly confined - unconfined					
Drainage area (acres/mi ²)	1747/2.73	2170/3.39	2330/3.64	236.8/0.37	416/0.65	172.8/0.27
Perennial (P), Intermittent (I)	P	P	P	P	P	P
NCDWR water quality classification	WS-III, CA					
Stream Classification (existing)	E4	C4	E4	E4	B4c	B4c
Stream Classification (proposed)	E4	C4	E4	C4	C4	C4
Evolutionary trend (Simon & Hupp)	IV/V	IV/V	IV/V	IV	IV	IV
FEMA classification	AE	AE	AE	AE	AE	AE
Regulatory Considerations						
Regulation	Applicable?	Resolved?		Supporting Documentation		
Waters of the US – Section 404	Yes	Yes		SAW-2014-00736		
Waters of the US – Section 401	Yes	Yes		SAW-2014-00736		
Endangered Species Act	Yes	Yes		No Effect – CE Document		
Historic Preservation Act	No	NA		CE Document		
Coastal Zone Management Act (CZMA/CAMA)	No	NA		NA		
FEMA Floodplain Compliance	Yes	Yes		Chatham County Floodplain Development Permit #14-001		
Essential Fisheries Habitat	No	NA		NA		

Appendix B
Visual Assessment Data

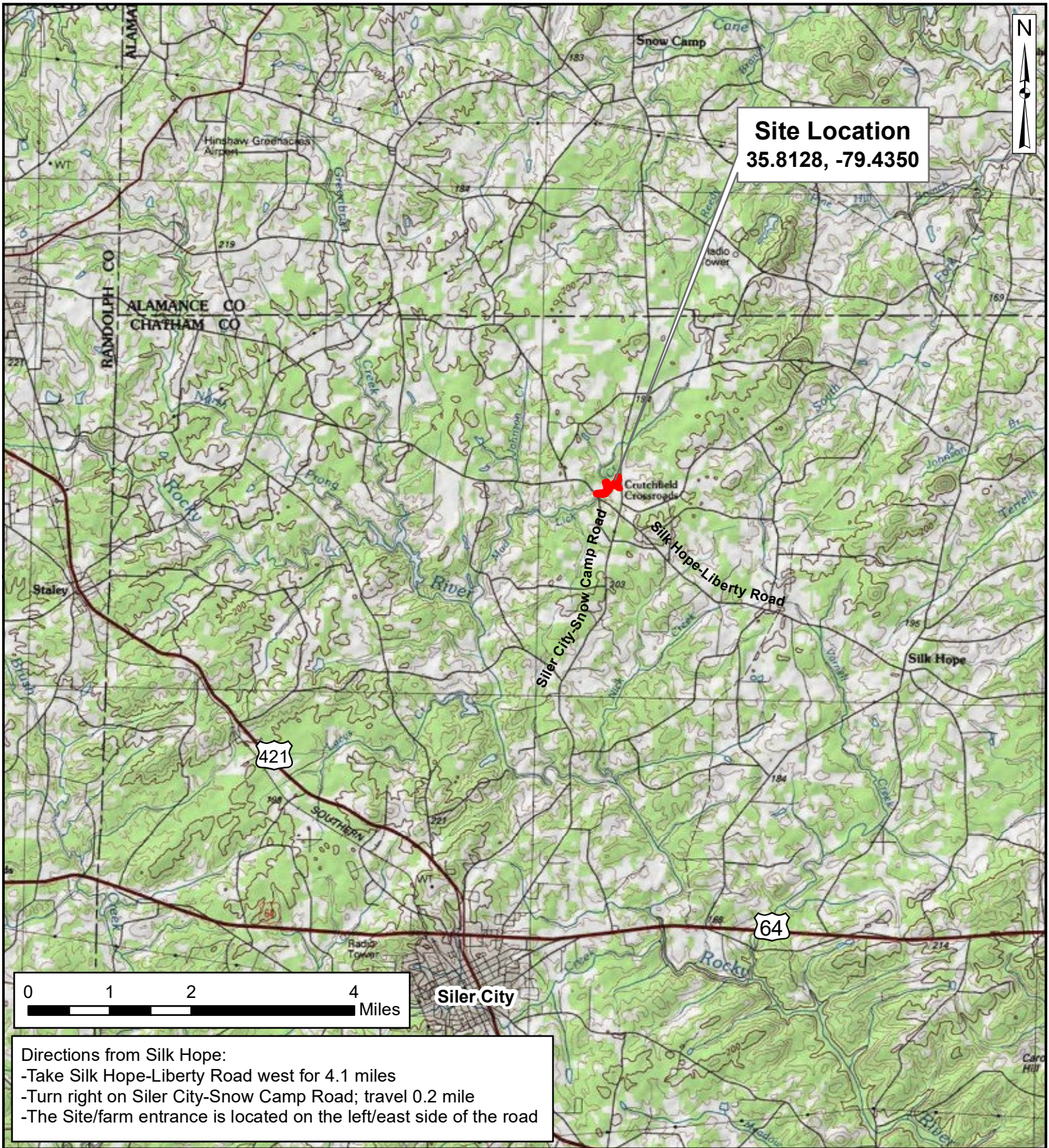
Figure 1. Site Location

Figure 2. Current Conditions Plan View

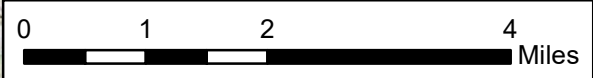
Tables 5A-5C. Visual Stream Morphology Stability Assessment

Table 6. Vegetation Condition Assessment

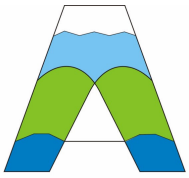
Vegetation Plot Photographs



Site Location
35.8128, -79.4350



Directions from Silk Hope:
 -Take Silk Hope-Liberty Road west for 4.1 miles
 -Turn right on Siler City-Snow Camp Road; travel 0.2 mile
 -The Site/farm entrance is located on the left/east side of the road



Axiom Environmental
 218 Snow Avenue
 Raleigh, NC 27603
 (919) 215-1693

Axiom Environmental, Inc.

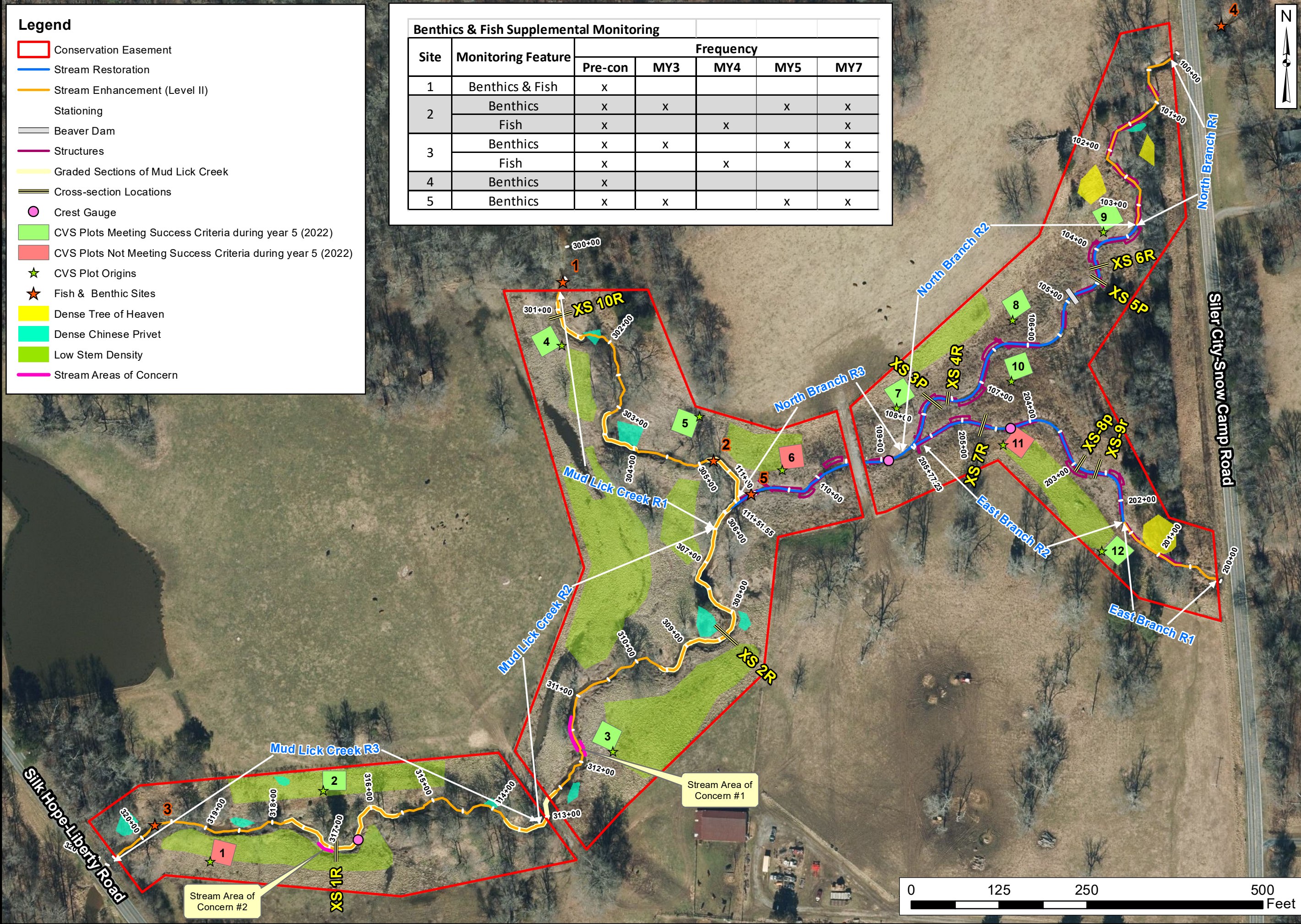
SITE LOCATION
MUD LICK CREEK MITIGATION SITE
DMS PROJECT NUMBER 93482
Chatham County, North Carolina

Dwn. by:	CLF	FIGURE 1
Date:	July 2018	
Project:	12-004.22	

Legend

- Conservation Easement
- Stream Restoration
- Stream Enhancement (Level II)
- Stationing
- Beaver Dam
- Structures
- Graded Sections of Mud Lick Creek
- Cross-section Locations
- Crest Gauge
- CVS Plots Meeting Success Criteria during year 5 (2022)
- CVS Plots Not Meeting Success Criteria during year 5 (2022)
- ★ CVS Plot Origins
- ★ Fish & Benthic Sites
- Dense Tree of Heaven
- Dense Chinese Privet
- Low Stem Density
- Stream Areas of Concern

Benthics & Fish Supplemental Monitoring						
Site	Monitoring Feature	Frequency				
		Pre-con	MY3	MY4	MY5	MY7
1	Benthics & Fish	X				
2	Benthics	X	X		X	X
	Fish	X		X		X
3	Benthics	X	X		X	X
	Fish	X		X		X
4	Benthics	X				
5	Benthics	X	X		X	X



Prepared for:
 North Carolina
 Department of
 Environmental
 Quality
 Division of
 Mitigation Services

Project:
**MUD LICK
 CREEK
 MITIGATION
 SITE**
 DMS Project
 Number 93482
 Chatham County, NC

Title:
**CURRENT
 CONDITIONS
 PLAN
 VIEW**

Drawn by:
 PHP, CLF
 Date:
 Nov 2022
 Scale:
 1:1,500
 Project No.:
 12-004.22

FIGURE
2

Table 5A
 Reach ID
 Assessed Length

Visual Stream Morphology Stability Assessment
 North Branch R-2
 538

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
Totals					0	0	100%	0	0	100%
2. Engineered Structures	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 <u>not</u> exceed 15%. (See guidance for this table in EEP monitoring guidance document)	8	8			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio \geq 1.6 Rootwads/logs providing some cover at base-flow.	8	8			100%			

Table 5B
 Reach ID
 Assessed Length

Visual Stream Morphology Stability Assessment
 North Branch R-3
 265

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
Totals					0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	3	3			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	3	3			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	3	3			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>not</u> exceed 15%. (See guidance for this table in EEP monitoring guidance document)	3	3			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	3	3			100%			

Table 5C
 Reach ID
 Assessed Length

Visual Stream Morphology Stability Assessment
 East Branch R-2
 412

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
Totals					0	0	100%	0	0	100%
2. Engineered Structures	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 <u>not</u> exceed 15%. (See guidance for this table in EEP monitoring guidance document)	5	5			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	5	5			100%			

Table 6
Planted Acreage

Vegetation Condition Assessment
9.6

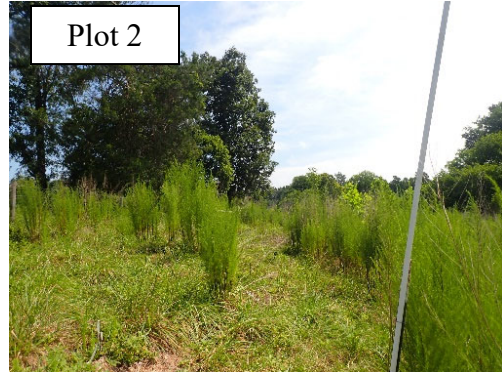
Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	None	0.1 acres	None	0	0.00	0.0%
2. Low Stem Density Areas	Areas of low stem density due to herbaceous competition and deer browse	0.1 acres	green polygons	9	2.04	21.3%
Total				9	2.04	21.3%
3. Areas of Poor Growth Rates or Vigor	None	0.25 acres	None	0	0.00	0.0%
Cumulative Total				9	2.04	21.3%

Easement Acreage

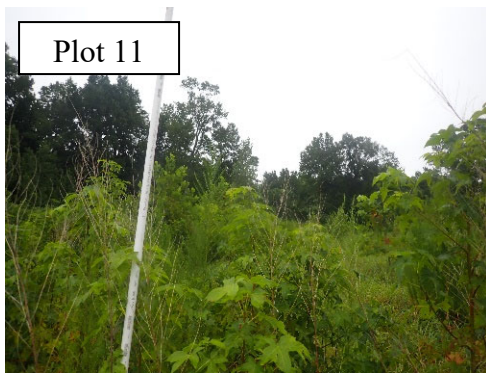
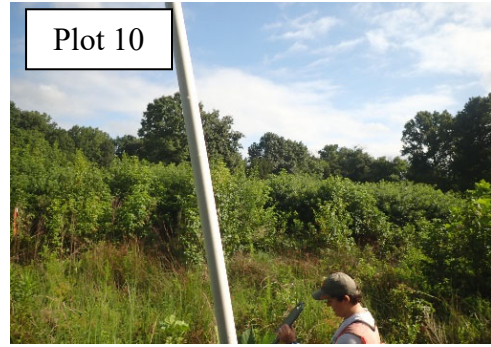
11.2

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern	Several small areas of dense Chinese privet and dense tree of heaven. Treatment is ongoing.	200 SF	blue and yellow polygons	13	0.20	1.8%
5. Easement Encroachment Areas	None	none	None	0	0.00	0.0%

**Mud Lick Creek Stream Restoration Site
MY-05 Vegetation Monitoring Photographs
Taken August 2022**



**Mud Lick Creek Stream Restoration Site
MY-05 Vegetation Monitoring Photographs
Taken August 2022**



Appendix C.
Vegetation Plot Data

Table 7. Planted Woody Vegetation
Table 8. Total and Planted Stems by Plot and Species

**Table 7. Planted Woody Vegetation
Mud Lick Creek Restoration Project (#93482)**

Species	Quantity
Green Ash (<i>Fraxinus pennsylvanica</i>)	300
Sycamore (<i>Platanus occidentalis</i>)	400
Eastern Redbud (<i>Cercis canadensis</i>)	400
Cottonwood (<i>Populus deltoides</i>)	300
River birch (<i>Betula nigra</i>)	300
Hackberry (<i>Celtis occidentalis</i>)	300
Black Gum (<i>Nyssa sylvatica</i>)	300
American Elm (<i>Ulmus americana</i>)	300
Eastern Hophornbeam (<i>Ostrya virginica</i>)	300
Elderberry (<i>Sambucus spp.</i>)	300
Black Locust (<i>Robinia psuedoaccia</i>)	300
Silky Dogwood (<i>Cornus ammomum</i>)	300
Witch Hazel (<i>Hamamelis virginica</i>)	550
Buttonbush (<i>Cephalanthus occidentalis</i>)	300
Persimmon (<i>Diospyros virginiana</i>)	300
Ironwood (<i>Carpinus caroliniana</i>)	400
Swamp Tupelo (<i>Nyssa biflora</i>)	100
Swamp Chestnut oak (<i>Quercus michauxii</i>)	100
Water oak (<i>Quercus nigra</i>)	100
Tulip Poplar (<i>Liridendron tulipifera</i>)	300
TOTAL	5950

Table 8. Total and Planted Stems by Plot and Species
DMS Project Code 93482. Project Name: Mud Lick Creek

			Current Plot Data (MY5 2022)																													
Scientific Name	Common Name	Species Type	93482-01-0001			93482-01-0002			93482-01-0003			93482-01-0004			93482-01-0005			93482-01-0006			93482-01-0007			93482-01-0008			93482-01-0009					
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T			
Acer negundo	boxelder	Tree																														
Acer rubrum	red maple	Tree																														
Alnus	alder	Shrub																														
Baccharis halimifolia	eastern baccharis	Shrub																														
Betula nigra	river birch	Tree										1	1	1	1	1	1	1	1	1						3	3	3	1	1	1	
Carpinus caroliniana	American hornbeam	Tree																		1	1	1					1	1	1	4	4	4
Carya	hickory	Tree																														
Celtis laevigata	sugarberry	Tree	2	2	2																											
Celtis occidentalis	common hackberry	Tree																														
Cephalanthus occidentalis	common buttonbush	Shrub																		1	1	1					1	1	1			
Cercis canadensis	eastern redbud	Tree											1	1	1																	
Cornus amomum	silky dogwood	Shrub										1	1	1													1	1	1	1	1	1
Corylus americana	American hazelnut	Shrub											1	1	1																	
Diospyros virginiana	common persimmon	Tree											1	1	1														1	1	1	
Fraxinus pennsylvanica	green ash	Tree	1	1	1	1	1	1				1	1	1	8	8	8															
Juglans nigra	black walnut	Tree																														
Liquidambar styraciflua	sweetgum	Tree																													30	
Liriodendron tulipifera	tuliptree	Tree																													2	
Nyssa	tupelo	Tree																														
Nyssa biflora	swamp tupelo	Tree										1	1	1	1	1	1															
Ostrya virginiana	hophornbeam	Tree																														
Platanus occidentalis	American sycamore	Tree	2	2	2																											
Populus deltoides	eastern cottonwood	Tree																														
Quercus	oak	Tree																														
Quercus lyrata	overcup oak	Tree																														
Quercus michauxii	swamp chestnut oak	Tree																														
Quercus nigra	water oak	Tree																														
Rhus copallinum	flameleaf sumac	shrub																														
Robinia pseudoacacia	black locust	Tree																														
Ulmus americana	American elm	Tree																														
Ulmus rubra	slippery elm	Tree																														
Unknown		Shrub or Tree																														
Viburnum dentatum	southern arrowwood	Shrub																														
	Stem count		5	5	5	7	7	8	7	7	7	8	8	8	9	9	9	4	4	9	7	7	7	9	9	15	9	9	40			
	size (ares)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
	size (ACRES)		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02			
	Species count		3	3	3	5	5	6	3	3	3	6	6	6	2	2	2	4	4	8	3	3	3	5	5	6	6	6	7			
	Stems per ACRE		202.3	202.3	202.3	283.3	283.3	323.7	283.3	283.3	283.3	323.7	323.7	323.7	364.2	364.2	364.2	161.9	161.9	364.2	283.3	283.3	283.3	364.2	364.2	607	364.2	364.2	1619			

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

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

Table 8. Total and Planted Stems by Plot and Species (continued)
DMS Project Code 93482. Project Name: Mud Lick Creek

Scientific Name	Common Name	Species Type	Current Plot Data (MY5 2022)									Annual Means																		
			93482-01-0010			93482-01-0011			93482-01-0012			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	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	
Acer negundo	boxelder	Tree													1						8			4	1	1	3	1	1	10
Acer rubrum	red maple	Tree																			3						2			10
Alnus	alder	Shrub																												3
Baccharis halimifolia	eastern baccharis	Shrub																						2						
Betula nigra	river birch	Tree									7	7	7	8	8	8	8	8	8	8	8	8	8	6	6	6	4	4	4	
Carpinus caroliniana	American hornbeam	Tree				1	1	1	2	2	2	9	9	9	10	10	10	10	10	10	11	11	11	12	12	12	15	15	15	
Carya	hickory	Tree																											1	
Celtis laevigata	sugarberry	Tree									2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Celtis occidentalis	common hackberry	Tree	2	2	2	1	1	1				3	3	3	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
Cephalanthus occidentalis	common buttonbush	Shrub									2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4
Cercis canadensis	eastern redbud	Tree									1	1	3	2	2	2	2	2	2	3	3	3	8	8	8	6	6	6	6	6
Cornus amomum	silky dogwood	Shrub							2	2	2	7	7	8	7	7	7	7	7	7	9	9	9	9	9	9	8	8	8	8
Corylus americana	American hazelnut	Shrub									1	1	1	1	1	1														
Diospyros virginiana	common persimmon	Tree	2	2	2	1	1	1	1	1	2	6	6	7	6	6	6	7	7	8	5	5	5	4	4	4	5	5	5	5
Fraxinus pennsylvanica	green ash	Tree			4				1	1	1	12	12	17	12	12	12	11	11	12	11	11	11	14	14	15	12	12	13	
Juglans nigra	black walnut	Tree									2		2			3			3			4			1				5	
Liquidambar styraciflua	sweetgum	Tree						120			3		153			278			124			98			19				10	
Liriodendron tulipifera	tuliptree	Tree									2	2	9	2	2	3	4	4	8	4	4	7								
Nyssa	tupelo	Tree	1	1	1						1	1	1				1	1	1	2	2	2								
Nyssa biflora	swamp tupelo	Tree				1	1	1			3	3	3	4	4	4	5	5	5	5	5	5	6	6	6	6	6	6	6	6
Ostrya virginiana	hophornbeam	Tree									2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1
Platanus occidentalis	American sycamore	Tree	1	1	4			2			13	13	18	13	13	36	11	11	13	12	12	14	7	7	7	7	7	7	7	7
Populus deltoides	eastern cottonwood	Tree																		3	3	3	4	4	4	3	3	3	3	3
Quercus	oak	Tree													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Quercus lyrata	overcup oak	Tree				1	1	1			1	1	1																	
Quercus michauxii	swamp chestnut oak	Tree	1	1	1	1	1	1	1	1	1	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	7	7	7
Quercus nigra	water oak	Tree	1	1	1						2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3
Rhus copallinum	flameleaf sumac	shrub						1																						
Robinia pseudoacacia	black locust	Tree																	1	1	1	1	1	1	1	1	1	1	1	1
Ulmus americana	American elm	Tree									4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Ulmus rubra	slippery elm	Tree									2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Unknown		Shrub or Tree																	1	1	1	2	2	2	3	3	3	3	3	3
Viburnum dentatum	southern arrowwood	Shrub																	2	2	2									
Stem count			8	8	15	6	6	129	7	7	13	86	86	265	89	89	398	96	96	242	102	102	215	97	97	123	90	90	129	
size (ares)			1			1			1			12			12			12			12			12			12			
size (ACRES)			0.02			0.02			0.02			0.30			0.30			0.30			0.30			0.30			0.30			
Species count			6	6	7	6	6	9	5	5	7	20	20	24	19	19	23	22	22	26	22	22	26	19	19	22	18	18	23	
Stems per ACRE			323.7	323.7	607	242.8	242.8	5220	283.3	283.3	526.1	290	290	893.7	300.1	300.1	1342	323.7	323.7	816.1	344	344	725.1	327.1	327.1	414.8	303.5	303.5	435	

Color for Density

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%

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

Appendix D.
Stream Geomorphology Data

Tables 10a-10c. Baseline Stream Data Summary
Tables 11a-11f. Monitoring Data-Dimensional Data Summary
Cross-section Plots

Table 10a. Baseline Stream Data Summary (Mud Lick Creek)
Mud Lick Creek Mitigation Project - NCDMS Project Number 93482

Parameter	Gauge	Regional Curve			Pre-Existing Condition (Mud Lick Creek)					Reference Reach(es) Data					Design (Mud Lick Creek)			Monitoring Baseline (Mud Lick Creek)					
		LL	UL	Eq.	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Max	Med	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle Only																							
BF Width (ft)					18.2		22.0	24.6		5.3		10.8	12.3					18.3		19.8	21		3
Floodprone Width (ft)					250.0		306.0	378.0		14		60	125					100		100	100		3
BF Mean Depth (ft)					1.9		2.1	2.3		0.8		1.0	1.8					1.6		2.0	2.7		3
BF Max Depth (ft)					3.0		4.0	4.2		1.0		1.5	2.6					3.6		3.7	3.8		3
BF Cross Sectional Area (ft ²)					41.3		46.3	47.5		5.4		10.6	19.7					33.0		40.4	49.8		3
Width/Depth Ratio					8.0		10.5	12.8		5.2		8.6	14.4					6.8		9.9	13.1		3
Entrenchment Ratio					12.4		13.7	17.2		1.7		4.3	>10.2					4.8		5.1	5.5		3
Bank Height Ratio					1.1		1.2	1.2		1.0		1.0	1.1					1.0		1.0	1.3		3
Profile																							
Riffle length (ft)																							
Riffle slope (ft/ft)										0.0040		0.0188	0.0704										
Pool length (ft)																							
Pool Max depth (ft)					3.7		4.4	5.2		1.2		1.8	3.3										
Pool spacing (ft)										9.0		46.0	73.0										
Pattern																							
Channel Beltwidth (ft)					26.1		52.9	69.9		10		41	102										
Radius of Curvature (ft)					9.9		24.8	58.8		11		21	85										
Rc:Bankfull width (ft/ft)					0.5		1.1	2.39		1.3		2	9.1										
Meander Wavelength (ft)					59.9		159.6	244.4		-		-	-										
Meander Width ratio					1.4		2.2	3.8		1.6		4.4	8.9										
Transport parameters																							
Reach Shear Stress (competency) lbs/ft ²																							
Max part size (mm) mobilized at bankfull																							
Stream Power (transport capacity) W/m ²																							
Additional Reach Parameters																							
Rosgen Classification					E/C4					E/C4					E/C-type								
Bankfull Velocity (fps)					3.0 - 3.4					2.2 - 5.6													
Bankfull Discharge (cfs)					123.9 - 157.42					20 -97													
Valley Length (ft)																							
Channel Thalweg Length (ft)																							
Sinuosity					1.20 - 1.37					1.0 - 2.3													
Water Surface Slope (ft/ft)																							
BF slope (ft/ft)																							
Bankfull Floodplain Area (acres)																							
% of Reach with Eroding Banks																							
Channel Stability or Habitat Metric																							
Biological or Other																							

Table 10b. Baseline Stream Data Summary (North Branch)
Mud Lick Creek Mitigation Project - NCDMS Project Number 93482

Parameter	Gauge	Regional Curve			Pre-Existing Condition (North Branch)					Reference Reach(es) Data					Design (North Branch)			Monitoring Baseline (North Branch)				
		LL	UL	Eq.	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Max	Med	Min	Mean	Med	Max	SD
Dimension and Substrate - Riffle Only																						
BF Width (ft)					8.3			10.4		5.3		10.8	12.3		13.8	14.0		14.6		16.2	17.7	2
Floodprone Width (ft)					33.3			80.0		14		60	125		30	70		100		100	100	2
BF Mean Depth (ft)					0.7			1.5		0.8		1.0	1.8		1.0	1.2		0.8		0.9	1.0	2
BF Max Depth (ft)					1.5			2.3		1.0		1.5	2.6		1.3	2.0		1.8		1.8	1.8	2
BF Cross Sectional Area (ft ²)					7.7			12.7		5.4		10.6	19.7		14.4	16.3		14.2		14.4	14.5	2
Width/Depth Ratio					5.4			14.0		5.2		8.6	14.4		12.0	13.0		14.6		18.4	22.1	2
Entrenchment Ratio					1.9			10.1		1.7		4.3	>10.2		2.2	5.0		5.6		6.2	6.8	2
Bank Height Ratio					1.7			2.0		1.0		1.0	1.1		1.0	1.0		1.0		1.0	1.0	2
Profile																						
Riffle length (ft)																						
Riffle slope (ft/ft)										0.0040		0.0188	0.0704		0.0060	0.0340						
Pool length (ft)																						
Pool Max depth (ft)					2.1			2.7		1.2		1.8	3.3		1.3	4.7						
Pool spacing (ft)										9.0		46.0	73.0		19.0	92.0						
Pattern																						
Channel Beltwidth (ft)					11		26	38.5		10		41	102		41	125						
Radius of Curvature (ft)					6.1		17	37		11		21	85		25	42						
Rc:Bankfull width (ft/ft)					0.73		1.6	4.46		1.3		2	9.1		1.8	3						
Meander Wavelength (ft)					37.9		64.1	100.6		-		-	-		41	168						
Meander Width ratio					1.1		2.8	4.6		1.6		4.4	8.9		3	15						
Transport parameters																						
Reach Shear Stress (competency) lbs/ft ²																						
Max part size (mm) mobilized at bankfull																						
Stream Power (transport capacity) W/m ²																						
Additional Reach Parameters																						
Rosgen Classification					E5/B5c					E/C4					C4			C-type				
Bankfull Velocity (fps)					3.3 - 3.5					2.2 - 5.6					2.4 - 4.3							
Bankfull Discharge (cfs)					25.41 - 44.45					20 -97					34.6 - 70.1							
Valley Length (ft)																						
Channel Thalweg Length (ft)																						
Sinuosity					1.22 - 1.32					1.0 - 2.3					1.2 - 1.3							
Water Surface Slope (ft/ft)																						
BF slope (ft/ft)																						
Bankfull Floodplain Area (acres)																						
% of Reach with Eroding Banks																						
Channel Stability or Habitat Metric																						
Biological or Other																						

Table 11a. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)

Mud Lick Creek Mitigation Project - NCDMS Project Number 93482

Parameter	Cross Section 1 (Mud Lick Cr)							Cross Section 2 (Mud Lick Cr)							Cross Section 10 (Mud Lick Cr)						
	Riffle							Riffle							Riffle						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	18.3	18.8	18.6	19.1	18.0	17.4		21.0	22.0	14.9	15.9	14.6	15.0		19.8	19.6	18.9	18.4	18.1	18.2	
Floodprone Width (ft) (approx)	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0	100.0	100.0	
BF Mean Depth (ft)	2.7	2.6	2.7	2.6	2.8	2.9		1.6	1.5	2.2	2.1	2.3	2.2		2.0	2.1	2.1	2.2	2.2	2.2	
BF Max Depth (ft)	3.8	3.8	3.8	3.6	3.7	4.0		3.7	3.6	3.3	3.5	3.3	3.4		3.6	3.4	3.5	3.7	3.8	3.8	
Low Bank Height	5.0	5.1	5.0	3.7	3.9	3.9		3.7	3.6	3.9	4.0	3.7	3.5		3.6	3.4	3.7	3.8	4.0	4.1	
BF Cross Sectional Area (ft ²)	49.8	49.8	49.8	49.8	49.8	49.8		33.0	33.0	33.0	33.0	33.0	33.0		40.4	40.4	40.4	40.4	40.4	40.4	
Area at Low Bank (ft ²)	49.8	NA	75.8	75.8	52.5	48.0		33.0	NA	42.6	42.6	39.8	34.4		40.4	NA	43.2	43.2	45.9	45.3	
Width/Depth Ratio	6.7	7.1	6.9	7.3	6.5	6.1		13.4	14.7	6.7	7.7	6.5	6.8		9.7	9.5	8.8	8.4	8.1	8.2	
Entrenchment Ratio	5.5	5.3	NA**	NA**	NA**	NA**		4.8	4.5	NA**	NA**	NA**	NA**		5.1	5.1	NA**	NA**	NA**	NA**	
Bank Height Ratio*	1.3	1.3	1.3	1.0	1.04	1.0		1.0	1.0	1.2	1.1	1.13	1.0		1.0	1.0	1.1	1.0	1.08	1.07	
d50 (mm)	9.9	4.4	4.3	4.3	3.8	NA^		9.9	4.4	4.3	4.3	3.8	NA^		9.9	4.4	4.3	4.3	3.8	NA^	

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

** Based on the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioners in NC (9/2018), entrenchment ratio is no longer reported for success criteria.

^ Based on 2021 discussion with the NCIRT and NCDMS, it was determined that substrate data (d50) will no longer be reported.

Table 11b. Monitoring Data - Stream Reach Data Summary

Mud Lick Creek Mitigation Project - NCDMS Project Number 93482

Parameter	Baseline (Mud Lick Creek)						MY-1 (Mud Lick Creek)						MY-2 (Mud Lick Creek)						MY-3 (Mud Lick Creek)						MY-4 (Mud Lick Creek)						MY-5 (Mud Lick Creek)					
	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle Only																																				
BF Width (ft)	18.3		19.8	21		3	18.8		19.6	22		3	14.9		18.6	18.9		3	15.9		18.4	19.1		3	14.6		18.0	18.1		3	15.0		17.4	18.2		3
Floodprone Width (ft)	100		100	100		3	100		100.0	100		3	100		100	100		3	100		100	100		3	100		100	100		3	100		100	100		3
BF Mean Depth (ft)	1.6		2.0	2.7		3	1.5		2.1	2.7		3	2.1		2.2	2.7		3	2.1		2.2	2.6		3	2.2		2.3	2.8		3	2.2		2.2	2.9		3
BF Max Depth (ft)	3.6		3.7	3.8		3	3.4		3.6	3.8		3	3.3		3.5	3.8		3	3.5		3.6	3.7		3	3.3		3.7	3.8		3	3.4		3.8	4.0		3
BF Cross Sectional Area (ft ²)	33.0		40.4	49.8		3	33.0		40.4	49.8		3	33.0		40.4	49.8		3	33.0		40.4	49.8		3	33.0		40.4	49.8		3	33.0		40.4	49.8		3
Area at Low Bank (ft ²)	33.0		40.4	49.8		3	NA		NA	NA		NA	42.6		43.2	75.8		3	42.6		43.2	75.8		3	48.4		54.9	71.2		3	34.4		45.3	48.0		3
Width/Depth Ratio	6.8		9.9	13.1		3	7.0		9.3	14.7		3	6.8		6.9	9.0		3	7.3		7.6	8.4		3	6.4		6.5	8.1		3	6.1		6.8	8.2		3
Entrenchment Ratio	4.8		5.1	5.5		3	4.5		5.1	5.3		3	NA**		NA**	NA**		3	NA**		NA**	NA**		3	NA**		NA**	NA**		3	NA**		NA**	NA**		3
Bank Height Ratio	1.0		1.0	1.3		3	1.0		1.0	1.3		3	1.1		1.2	1.3		3	1.0		1.0	1.1		3	1.0		1.1	1.1		3	1.0		1.0	1.1		3
Riffle length (ft)																																				
Riffle slope (ft/ft)																																				
Pool length (ft)																																				
Pool Max depth (ft)																																				
Pool spacing (ft)																																				
Pattern																																				
Channel Beltwidth (ft)																																				
Radius of Curvature (ft)																																				
Rc:Bankfull width (ft/ft)																																				
Meander Wavelength (ft)																																				
Meander Width ratio																																				
Additional Reach Parameters																																				
Rosgen Classification	C-type						Ce-type						Ce-type						Ce-type						Ce-type											
Channel Thalweg Length (ft)																																				
Sinuosity																																				
Water Surface Slope (Channel) (ft/ft)																																				
BF slope (ft/ft)																																				
Ri%/RU%P%G%/S%																																				
SC%/SA%/G%/C%/B%BE%																																				
d16/d35/d50/d84/d95																																				
% of Reach with Eroding Banks																																				
Channel Stability or Habitat Metric																																				
Biological or Other																																				

Table 11c. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Mud Lick Creek Mitigation Project - NCDMS Project Number 93482

Parameter	Cross Section 3 (North Branch)							Cross Section 4 (North Branch)							Cross Section 5 (North Branch)							Cross Section 6 (North Branch)						
	Pool							Riffle							Pool							Riffle						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	14.2	13.7	13.3	13.2	12.0	12.7		17.7	22.7	20.7	22.1	19.8	16.9		14.2	14.6	15.1	14.2	12.4	11.6		14.6	15.1	14.8	19.4	17.2	14.6	
Floodprone Width (ft) (approx)	NA	NA	NA	NA	NA	NA		100.0	100.0	100.0	100.0	100.0	100.0		NA	NA	NA	NA	NA	NA		100.0	100.0	100.0	100.0	100.0	100.0	
BF Mean Depth (ft)	1.1	1.1	1.2	1.2	1.3	1.2		0.8	0.6	0.7	0.6	0.7	0.8		1.3	1.3	1.2	1.3	1.5	1.6		1.0	1.0	1.0	0.7	0.8	1.0	
BF Max Depth (ft)	2.2	2.1	2.2	2.3	2.4	2.4		1.8	1.9	1.8	1.8	2.1	1.9		2.6	2.6	2.7	2.8	2.7	2.9		1.8	1.8	1.8	1.9	2.0	2.1	
Low Bank Height	2.2	2.1	2.3	2.5	2.7	2.4		1.8	1.9	1.8	1.8	2.0	1.8		2.6	2.6	2.8	2.9	2.8	2.8		1.8	1.8	1.8	2.1	2.2	2.1	
BF Cross Sectional Area (ft ²)	15.5	15.5	15.5	15.5	15.5	15.5		14.2	14.2	14.2	14.2	14.2	14.2		18.6	18.6	18.6	18.6	18.6	18.6		14.5	14.5	14.5	14.5	14.5	14.5	
Area at Low Bank (ft ²)	15.5	NA	18.0	18.0	19.9	16.1		14.2	NA	14.2	14.2	13.8	12.3		18.6	NA	20.3	20.3	19.7	17.7		14.5	NA	15.0	15.0	16.9	14.2	
Width/Depth Ratio	NA	NA	NA	NA	NA	NA		22.1	36.3	30.2	34.4	27.6	20.1		NA	NA	NA	NA	NA	NA		14.7	15.7	15.1	26.0	20.4	14.8	
Entrenchment Ratio	NA	NA	NA	NA	NA	NA		5.6	4.4	NA**	NA**	NA**	NA**		NA	NA	NA	NA	NA	NA		6.8	6.6	NA**	NA**	NA**	NA**	
Bank Height Ratio*	NA	NA	NA	NA	NA	NA		1.0	1.0	1.0	1.0	1.0	0.94		NA	NA	NA	NA	NA	NA		1.0	1.0	1.0	1.11	1.06	1.0	
d50 (mm)	--	--	--	--	--	--		18.8	8.0	8.4	4.0	4.9	NA^		--	--	--	--	--	--		18.8	8.0	8.4	4.0	4.9	NA^	

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

** Based on the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioners in NC (9/2018), entrenchment ratio is no longer reported for success criteria.

^ Based on 2021 discussion with the NCIRT and NCDMS, it was determined that substrate data (d50) will no longer be reported.

Table 11d. Monitoring Data - Stream Reach Data Summary
Mud Lick Creek Mitigation Project - NCDMS Project Number 93482

Parameter	Baseline (North Branch)						MY-1 (North Branch)						MY-2 (North Branch)						MY-3 (North Branch)						MY-4 (North Branch)						MY-5 (North Branch)							
	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n		
Dimension and Substrate - Riffle Only																																						
BF Width (ft)	14.6		16.2	17.7		2	15.1		18.9	22.7		2	14.8		17.8	20.7		2	19.4		20.8	22.1		2	17.2		18.5	19.8		2	14.6		15.8	16.9		2		
Floodprone Width (ft)	100		100	100		2	100		100.0	100		2	100		100	100		2	100		100	100		2	100		100	100		2	100		100	100		2		
BF Mean Depth (ft)	0.8		0.9	1.0		2	0.6		0.8	1.0		2	0.7		0.9	1.0		2	0.6		0.8	1.0		2	0.7		0.8	0.8		2	0.8		0.9	1.0		2		
BF Max Depth (ft)	1.8		1.8	1.8		2	1.8		1.9	1.9		2	1.8		1.8	1.8		2	1.8		1.8	1.9		2	2.0		2.1	2.1		2	1.9		2.0	2.1		2		
BF Cross Sectional Area (ft ²)	14.2		14.4	14.5		2	14.2		14.4	14.5		2	14.2		14.4	14.5		2	14.2		14.4	14.5		2	14.2		14.4	14.5		2	14.2		14.4	14.5		2		
Area at Low Bank (ft ²)	14.2		14.4	14.5		2	NA		NA	NA		NA	14.2		14.6	15.0		2	14.2		14.6	15.0		2	11.6		11.6	13.8		2	12.3		13.3	14.2		2		
Width/Depth Ratio	14.6		18.4	22.1		2	15.1		26.5	37.8		2	14.8		17.8	20.7		2	19.4		28.1	36.8		2	20.4		24.0	27.7		2	14.8		26.5	20.1		2		
Entrenchment Ratio	5.6		6.2	6.8		2	4.4		5.5	6.6		2	NA**		NA**	NA**		2	NA**		NA**	NA**		2	NA**		NA**	NA**		2	NA**		NA**	NA**		2		
Bank Height Ratio	1.0		1.0	1.0		2	1.0		1.0	1.0		2	1.0		1.0	1.0		2	1.0		1.1	1.1		2	1.0		1.0	1.1		2	0.9		1.0	1.0		2		
Profile																																						
Riffle length (ft)																																						
Riffle slope (ft/ft)																																						
Pool length (ft)																																						
Pool Max depth (ft)																																						
Pool spacing (ft)																																						
Pattern																																						
Channel Beltwidth (ft)																																						
Radius of Curvature (ft)																																						
Rc:Bankfull width (ft/ft)																																						
Meander Wavelength (ft)																																						
Meander Width ratio																																						
Additional Reach Parameters																																						
Rosgen Classification	C-type						C-type						C-type						C-type						C-type													
Channel Thalweg Length (ft)																																						
Sinuosity																																						
Water Surface Slope (Channel) (ft/ft)																																						
BF slope (ft/ft)																																						
Ri%/RU%P%G%/S%																																						
SC%/SA%/G%/C%/B%BE%																																						
d16/d35/d50/d84/d95																																						
% of Reach with Eroding Banks																																						
Channel Stability or Habitat Metric																																						
Biological or Other																																						

Table 11e. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)

Mud Lick Creek Mitigation Project - NCDMS Project Number 93482

Parameter	Cross Section 7 (East Branch)							Cross Section 8 (East Branch)							Cross Section 9 (East Branch)						
	Riffle							Pool							Riffle						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	8.9	11.1	10.2	14.4	9.4	11.0		7.6	10.8	8.2	7.5	9.7	8.1		16.6	21.1	18.6	24.6	21.9	18.6	
Floodprone Width (ft) (approx)	100.0	100.0	100.0	100.0	100.0	100.0		NA	NA	NA	NA	NA	NA		100.0	100.0	100.0	100.0	100.0	100.0	
BF Mean Depth (ft)	0.8	0.6	0.7	0.5	0.7	0.6		1.4	1.0	1.3	1.4	1.1	1.3		0.6	0.5	0.6	0.4	0.5	0.6	
BF Max Depth (ft)	1.2	1.4	1.3	1.4	1.4	1.4		2.4	1.5	2.1	2.4	2.0	2.2		1.5	1.6	1.5	1.5	1.7	1.6	
Low Bank Height	1.2	1.4	1.4	1.4	1.6	1.5		2.4	1.5	2.2	2.4	1.6	2.7		1.5	1.6	1.5	1.5	1.7	1.6	
BF Cross Sectional Area (ft ²)	6.7	6.7	6.7	6.7	6.7	6.7		10.5	10.5	10.5	10.5	10.5	10.5		10.6	10.6	10.6	10.6	10.6	10.6	
Area at Low Bank (ft ²)	6.7	NA	7.5	7.5	8.4	7.5		10.5	NA	11.7	11.7	7.6	15.1		10.6	NA	10.7	10.7	10.2	10.3	
Width/Depth Ratio	11.8	18.4	15.5	30.9	13.2	18.0		NA	NA	NA	NA	NA	NA		26.0	42.0	32.6	57.1	45.2	32.8	
Entrenchment Ratio	11.2	9.0	NA**	NA**	NA**	NA**		NA	NA	NA	NA	NA	NA		6.0	4.7	NA**	NA**	NA**	NA**	
Bank Height Ratio*	1.0	1.0	1.1	1.0	1.12	1.05		NA	NA	NA	NA	NA	NA		1.0	1.0	1.0	1.0	1.0	1.0	
d50 (mm)	14.3	3.7	5.4	2.5	2.5	NA^		--	--	--	--	--	--		14.3	3.7	5.4	2.5	2.5	NA^	

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

** Based on the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioners in NC (9/2018), entrenchment ratio is no longer reported for success criteria.

^ Based on 2021 discussion with the NCIRT and NCDMS, it was determined that substrate data (d50) will no longer be reported.

Table 11f. Monitoring Data - Stream Reach Data Summary

Mud Lick Creek Mitigation Project - NCDMS Project Number 93482

Parameter	Baseline (East Branch)						MY-1 (East Branch)						MY-2 (East Branch)						MY-3 (East Branch)						MY-4 (East Branch)						MY-5 (East Branch)					
	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension and Substrate - Riffle Only																																				
BF Width (ft)	8.9		12.8	16.6		2	11.1		16.2	21.2		2	10.2		14.5	18.7		2	14.4		19.5	24.6		2	9.4		15.6	21.9		2	11.0		14.8	18.6		2
Floodprone Width (ft)	100		100	100		2	100		100	100		2	100		100	100		2	100		100	100		2	100		100	100		2	100		100	100		2
BF Mean Depth (ft)	0.6		0.7	0.8		2	0.5		0.6	0.6		2	0.6		0.7	0.7		2	0.4		0.5	0.5		2	0.5		0.6	0.7		2	0.6		0.6	0.6		2
BF Max Depth (ft)	1.2		1.4	1.5		2	1.4		1.5	1.6		2	1.3		1.4	1.5		2	1.4		1.5	1.5		2	1.4		1.6	1.7		2	1.4		1.5	1.6		2
BF Cross Sectional Area (ft ²)	6.7		8.7	10.6		2	6.7		8.7	10.6		2	6.7		8.7	10.6		2	6.7		8.7	10.6		2	6.7		8.7	10.6		2	6.7		8.7	10.6		2
Area at Low Bank (ft ²)	6.7		8.7	10.6		2	NA		NA	NA		2	7.5		9.1	10.7		2	7.5		9.1	10.7		2	8.4		8.6	8.8		2	7.5		8.9	10.3		2
Width/Depth Ratio	11.1		19.4	27.7		2	18.5		30.5	42.2		2	14.6		22.9	31.2		2	28.8		45.2	61.5		2	13.1		29.1	45.1		2	18.0		25.4	32.8		2
Entrenchment Ratio	6.0		8.6	11.2		2	4.7		6.9	9		2	NA**		NA**	NA**		2	NA**		NA**	NA**		2	NA**		NA**	NA**		2	NA**		NA**	NA**		2
Bank Height Ratio	1.0		1.0	1.0		2	1		1	1		2	1.0		1.0	1.1		2	1.0		1.0	1.0		2	1.0		1.0	1.1		2	1.0		1.0	1.1		2
Profile																																				
Riffle length (ft)																																				
Riffle slope (ft/ft)																																				
Pool length (ft)																																				
Pool Max depth (ft)																																				
Pool spacing (ft)																																				
Pattern																																				
Channel Beltwidth (ft)																																				
Radius of Curvature (ft)																																				
Rc:Bankfull width (ft/ft)																																				
Meander Wavelength (ft)																																				
Meander Width ratio																																				
Additional Reach Parameters																																				
Rosgen Classification	C-type						C-type						C-type						C-type						C-type											
Channel Thalweg Length (ft)																																				
Sinuosity																																				
Water Surface Slope (Channel) (ft/ft)																																				
BF slope (ft/ft)																																				
Ri%/RU%P%G%/S%																																				
SC%/SA%/G%/C%/B%BE%																																				
d16/d35/d50/d84/d95																																				
% of Reach with Eroding Banks																																				
Channel Stability or Habitat Metric																																				
Biological or Other																																				

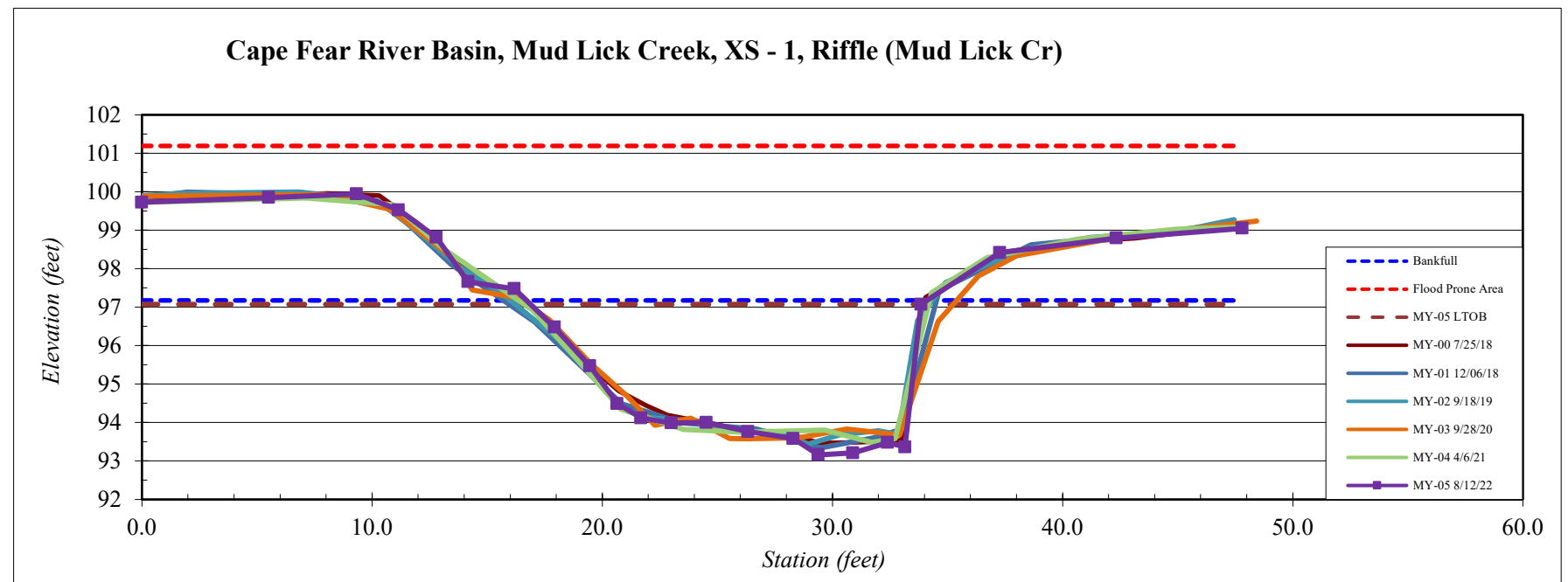
River Basin:	Cape Fear
Site Name	Mud Lick Creek
XS ID	XS - 1, Riffle (Mud Lick Cr)
Drainage Area (sq mi):	3.64
Date:	8/12/2022
Field Crew:	Adams, Fleming, Lance, D. Lewis



Stream Type	E
--------------------	---

Station	Elevation
0.00	99.73
5.51	99.85
9.32	99.95
11.15	99.53
12.80	98.81
14.17	97.66
16.19	97.48
17.92	96.48
19.47	95.47
20.65	94.49
21.69	94.12
23.00	93.99
24.52	94.00
26.33	93.77
28.30	93.58
29.39	93.16
30.90	93.21
32.40	93.48
33.15	93.37
33.86	97.07
37.28	98.42
42.34	98.79
47.81	99.05

SUMMARY DATA	
Bankfull Elevation:	97.2
Bankfull Cross-Sectional Area:	49.8
Area at Low Bank:	75.9
Bankfull Width:	17.4
Flood Prone Area Elevation:	101.2
Flood Prone Width:	100.0
Max Depth at Bankfull:	4.0
Low Bank Height:	3.9
Mean Depth at Bankfull:	2.9
W / D Ratio:	6.1
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0



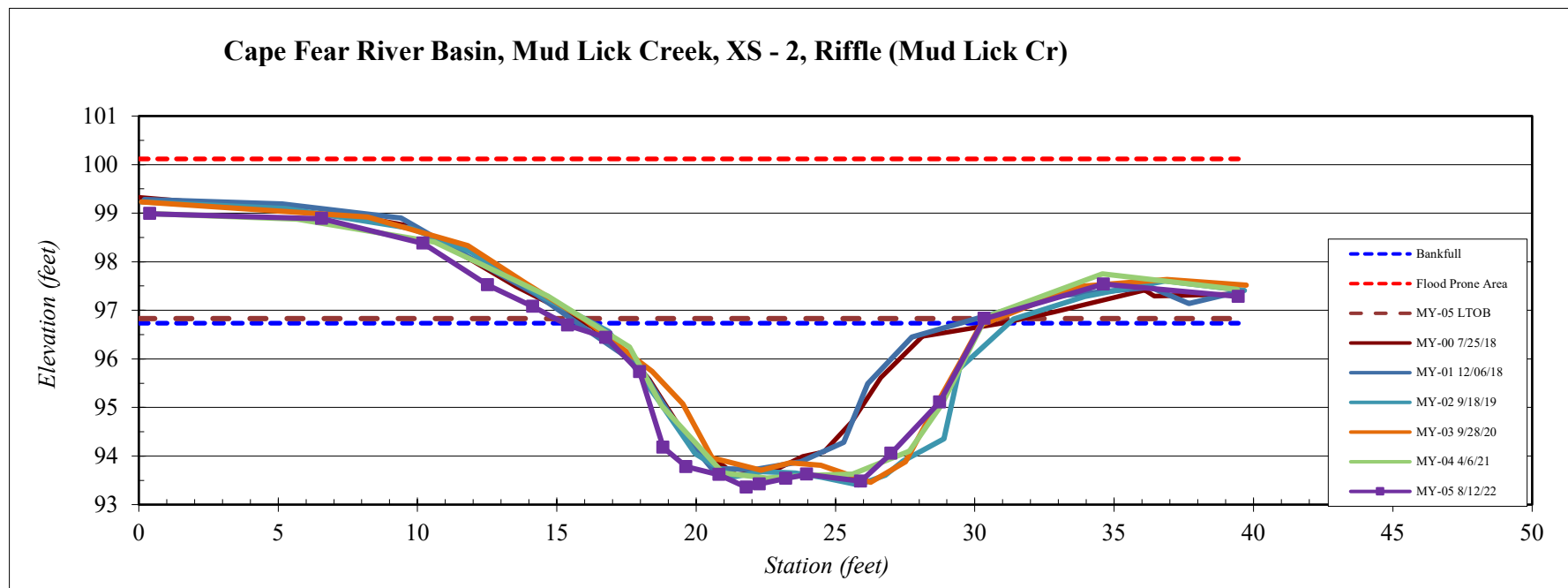
River Basin:	Cape Fear
Site Name	Mud Lick Creek
XS ID	XS - 2, Riffle (Mud Lick Cr)
Drainage Area (sq mi):	3.64
Date:	8/12/2022
Field Crew:	Adams, Fleming, Lance, D. Lewis



Stream Type	E
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Station	Elevation
0.40	98.99
6.57	98.89
10.20	98.38
12.52	97.52
14.15	97.08
15.40	96.69
16.76	96.44
17.98	95.73
18.82	94.17
19.64	93.78
20.83	93.61
21.81	93.35
22.27	93.42
23.23	93.54
23.97	93.62
25.92	93.48
26.99	94.05
28.74	95.11
30.35	96.83
34.62	97.54
39.46	97.28

SUMMARY DATA	
Bankfull Elevation:	96.7
Bankfull Cross-Sectional Area:	33.0
Area at Low Bank:	48.3
Bankfull Width:	15.0
Flood Prone Area Elevation:	100.1
Flood Prone Width:	100.0
Max Depth at Bankfull:	3.4
Low Bank Height:	3.5
Mean Depth at Bankfull:	2.2
W / D Ratio:	6.8
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0



Scouring on the right bank of this cross-section is apparent, however this is an EII reach and localized at this location.

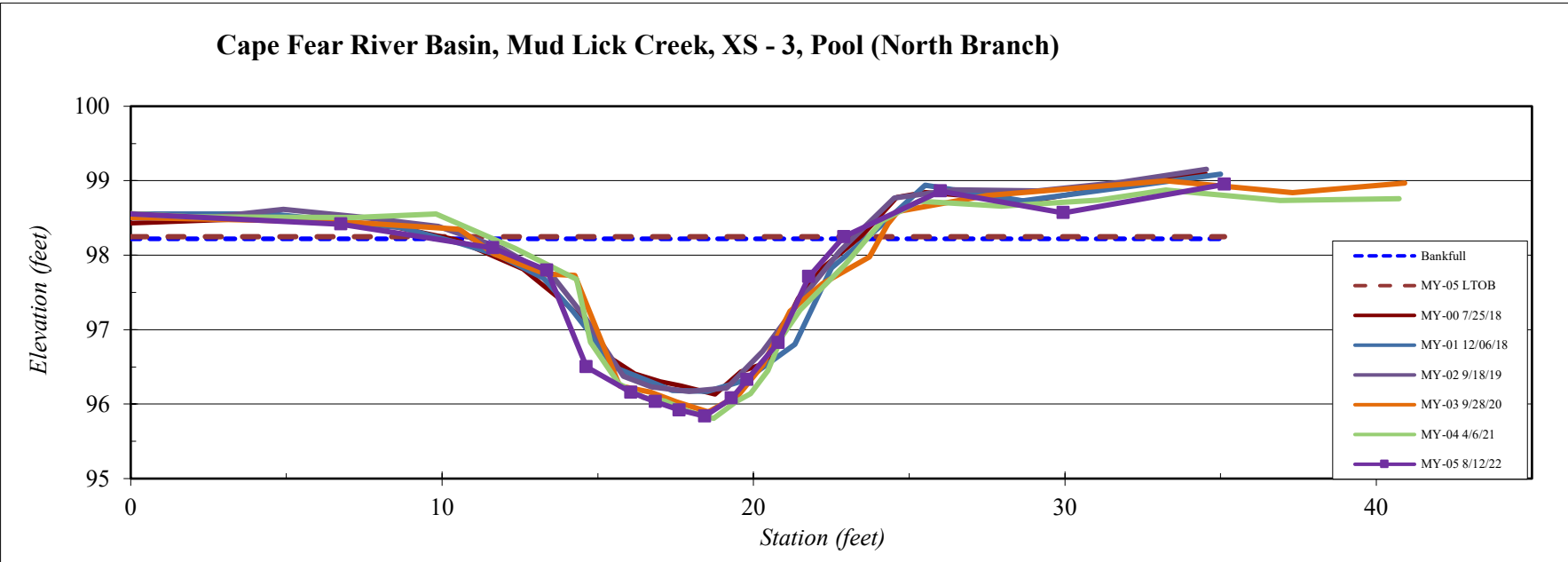
River Basin:	Cape Fear
Site Name	Mud Lick Creek
XS ID	XS - 3, Pool (North Branch)
Drainage Area (sq mi):	0.65
Date:	8/12/2022
Field Crew:	Adams, Fleming, Lance, D. Lewis



Station	Elevation
-0.20	98.56
6.75	98.42
11.64	98.10
13.37	97.80
14.64	96.50
16.07	96.16
16.85	96.03
17.62	95.92
18.44	95.84
19.30	96.08
19.80	96.33
20.80	96.83
21.78	97.71
22.91	98.25
26.01	98.86
29.95	98.57
35.13	98.95

SUMMARY DATA	
Bankfull Elevation:	98.2
Bankfull Cross-Sectional Area:	15.5
Area at Low Bank:	16.1
Bankfull Width:	12.7
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	2.4
Low Bank Height:	2.4
Mean Depth at Bankfull:	1.2
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	NA

Stream Type	E
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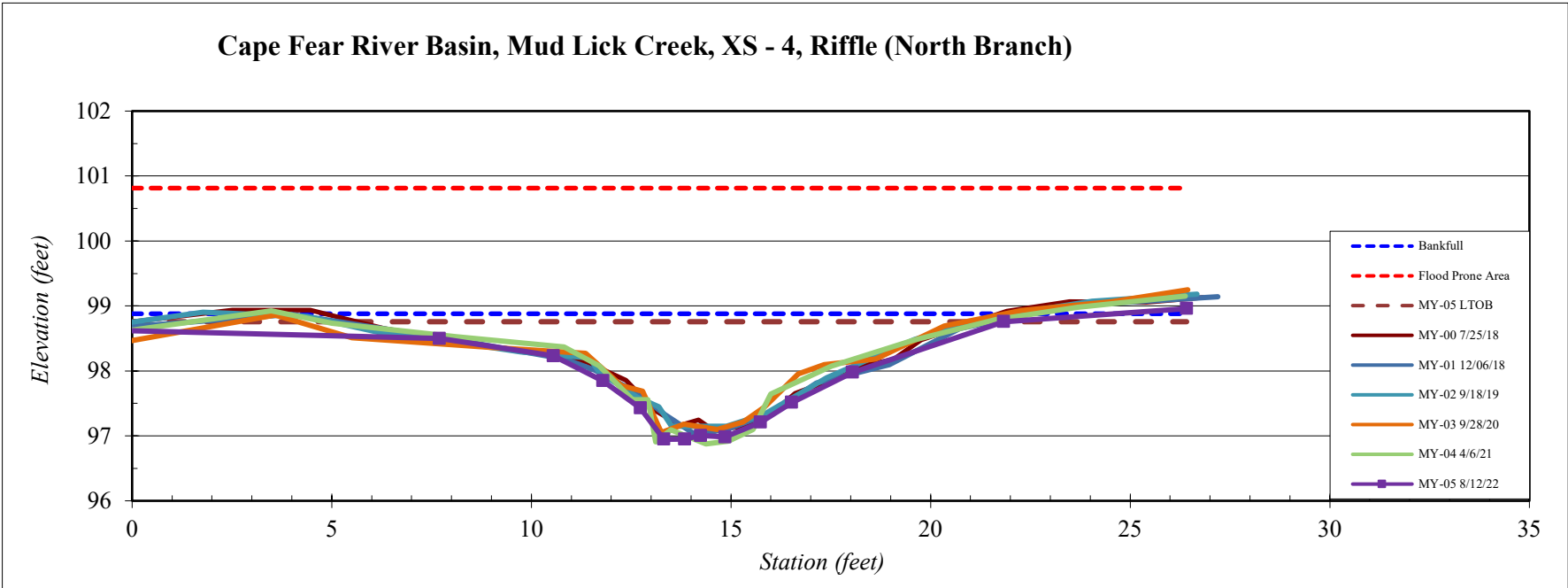
River Basin:	Cape Fear
Site Name	Mud Lick Creek
XS ID	XS - 4, Riffle (North Branch)
Drainage Area (sq mi):	0.65
Date:	8/12/2022
Field Crew:	Adams, Fleming, Lance, D. Lewis



Stream Type	C
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Station	Elevation
-0.10	98.62
7.70	98.50
10.55	98.23
11.80	97.85
12.73	97.43
13.32	96.95
13.84	96.95
14.25	97.00
14.86	96.98
15.74	97.21
16.53	97.51
18.05	97.98
21.83	98.76
26.41	98.96

SUMMARY DATA	
Bankfull Elevation:	98.9
Bankfull Cross-Sectional Area:	14.2
Area at Low Bank:	12.3
Bankfull Width:	16.9
Flood Prone Area Elevation:	100.8
Flood Prone Width:	100.0
Max Depth at Bankfull:	1.9
Low Bank Height:	1.8
Mean Depth at Bankfull:	0.8
W / D Ratio:	20.1
Entrenchment Ratio:	NA
Bank Height Ratio:	0.94



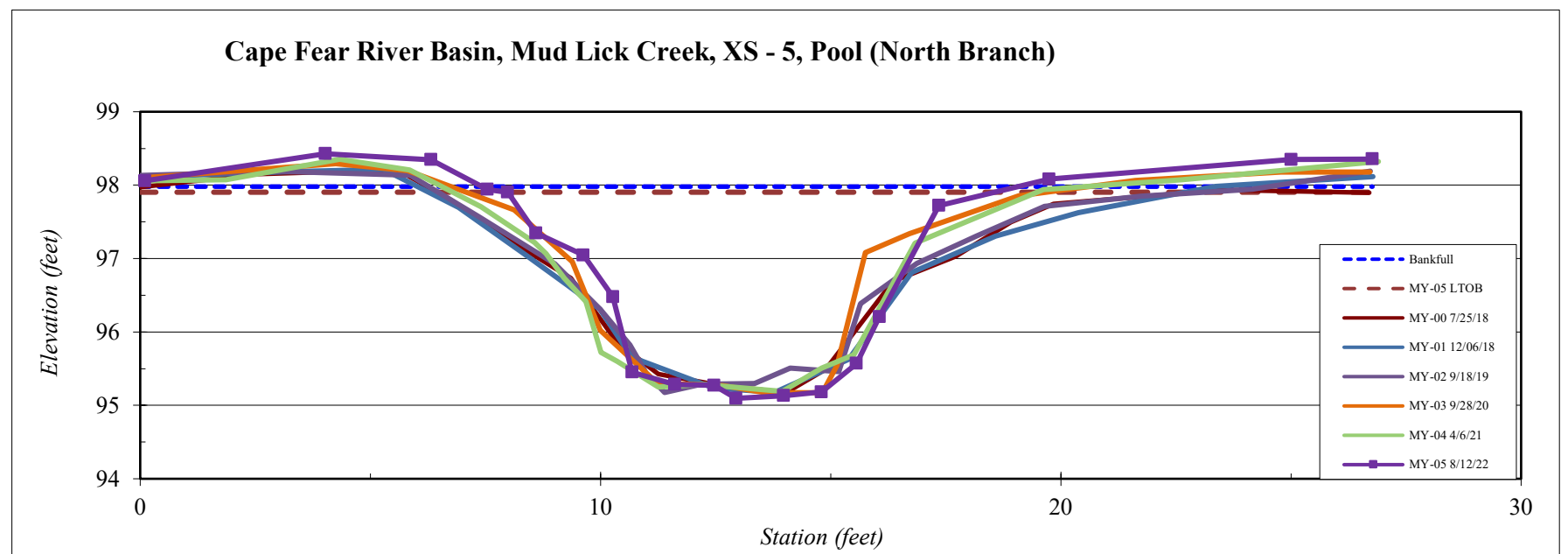
River Basin:	Cape Fear
Site Name	Mud Lick Creek
XS ID	XS - 5, Pool (North Branch)
Drainage Area (sq mi):	0.65
Date:	8/12/2022
Field Crew:	Adams, Fleming, Lance, D. Lewis



Station	Elevation
0.10	98.06
4.02	98.43
6.32	98.35
7.55	97.94
7.99	97.90
8.60	97.35
9.63	97.05
10.27	96.48
10.69	95.45
11.62	95.29
12.47	95.27
12.94	95.10
13.98	95.13
14.80	95.18
15.56	95.57
16.06	96.21
17.35	97.72
19.75	98.08
25.01	98.35
26.77	98.36

SUMMARY DATA	
Bankfull Elevation:	98.0
Bankfull Cross-Sectional Area:	18.6
Area at Low Bank:	17.7
Bankfull Width:	11.6
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	2.9
Low Bank Height:	2.8
Mean Depth at Bankfull:	1.6
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	NA

Stream Type	C
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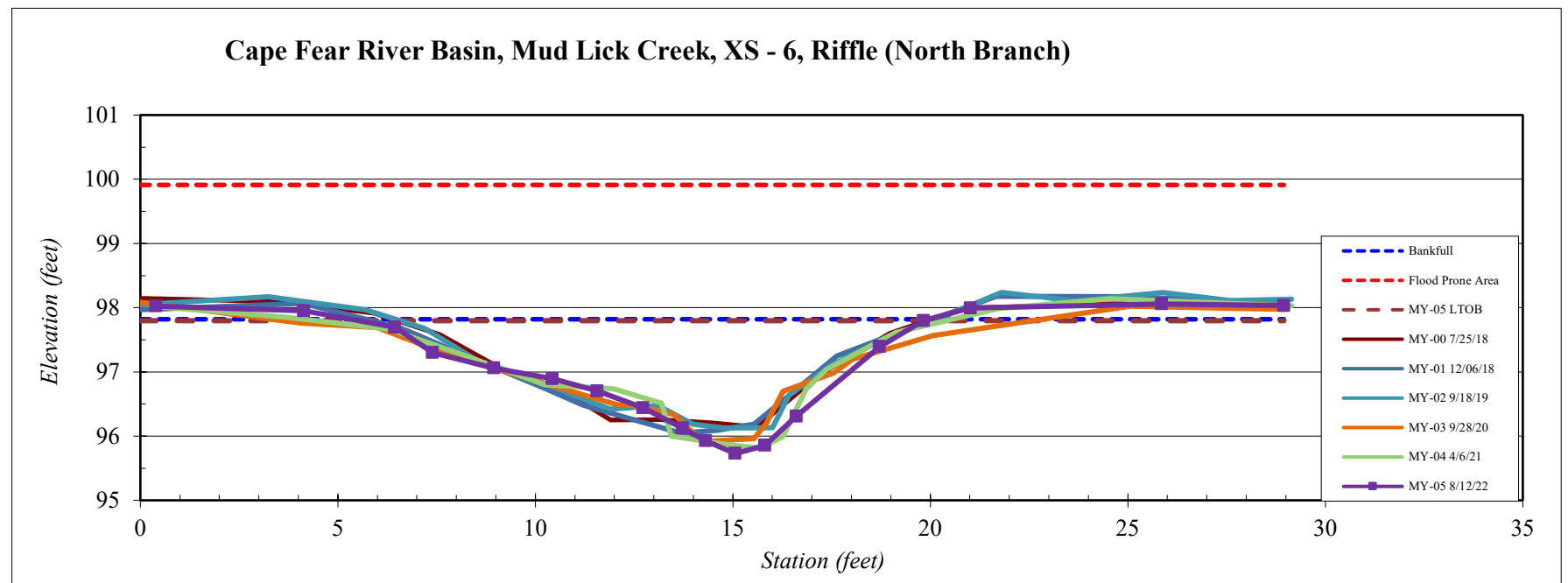
River Basin:	Cape Fear
Site Name	Mud Lick Creek
XS ID	XS - 6, Riffle (North Branch)
Drainage Area (sq mi):	0.65
Date:	8/12/2022
Field Crew:	Adams, Fleming, Lance, D. Lewis



Station	Elevation
0.40	98.02
4.14	97.95
6.44	97.69
7.40	97.30
8.95	97.06
10.44	96.89
11.57	96.70
12.73	96.44
13.73	96.12
14.32	95.92
15.06	95.73
15.81	95.85
16.61	96.31
18.72	97.39
19.83	97.80
21.02	97.99
25.86	98.06
28.95	98.03

SUMMARY DATA	
Bankfull Elevation:	97.8
Bankfull Cross-Sectional Area:	14.5
Area at Low Bank:	14.2
Bankfull Width:	14.6
Flood Prone Area Elevation:	99.9
Flood Prone Width:	100.0
Max Depth at Bankfull:	2.1
Low Bank Height:	2.1
Mean Depth at Bankfull:	1.0
W / D Ratio:	14.8
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0

Stream Type	C
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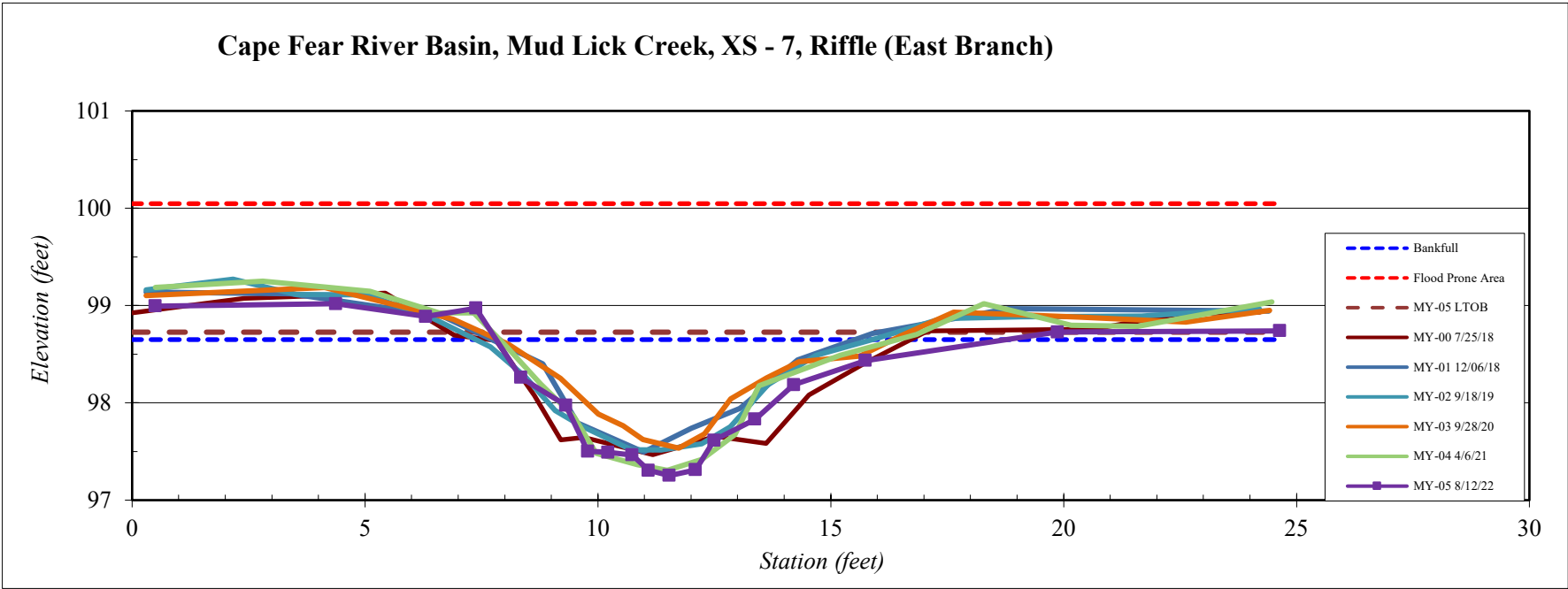
River Basin:	Cape Fear
Site Name	Mud Lick Creek
XS ID	XS - 7, Riffle (East Branch)
Drainage Area (sq mi):	0.27
Date:	8/12/2022
Field Crew:	Adams, Fleming, Lance, D. Lewis

Station	Elevation
0.50	98.99
4.37	99.02
6.31	98.89
7.38	98.97
8.35	98.26
9.31	97.98
9.79	97.50
10.22	97.49
10.74	97.46
11.09	97.31
11.54	97.25
12.10	97.31
12.50	97.62
13.37	97.83
14.21	98.19
15.75	98.43
19.87	98.73
24.64	98.74

SUMMARY DATA	
Bankfull Elevation:	98.7
Bankfull Cross-Sectional Area:	6.7
Area at Low Bank:	7.5
Bankfull Width:	11.0
Flood Prone Area Elevation:	100.0
Flood Prone Width:	100.0
Max Depth at Bankfull:	1.4
Low Bank Height:	1.5
Mean Depth at Bankfull:	0.6
W / D Ratio:	18.0
Entrenchment Ratio:	NA
Bank Height Ratio:	1.05



Stream Type	C
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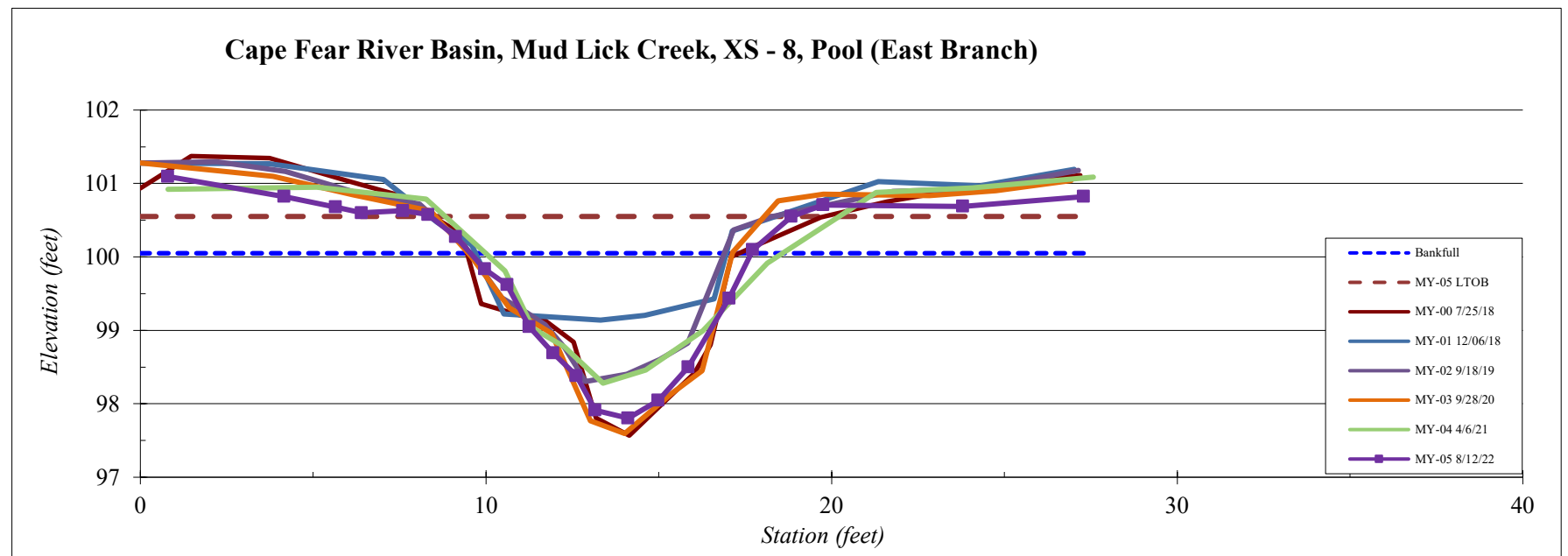
River Basin:	Cape Fear
Site Name	Mud Lick Creek
XS ID	XS - 8, Pool (East Branch)
Drainage Area (sq mi):	0.27
Date:	8/12/2022
Field Crew:	Adams, Fleming, Lance, D. Lewis

Station	Elevation
0.80	101.09
4.16	100.82
5.65	100.68
6.40	100.60
7.60	100.63
8.32	100.58
9.12	100.28
9.97	99.83
10.61	99.62
11.25	99.05
11.94	98.69
12.61	98.38
13.16	97.91
14.11	97.80
14.99	98.05
15.85	98.50
17.03	99.44
17.72	100.10
18.83	100.55
19.75	100.71
23.80	100.69
27.29	100.82

SUMMARY DATA	
Bankfull Elevation:	100.1
Bankfull Cross-Sectional Area:	10.5
Area at Low Bank:	15.1
Bankfull Width:	8.1
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	2.2
Low Bank Height:	2.7
Mean Depth at Bankfull:	1.3
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	NA



Stream Type	C
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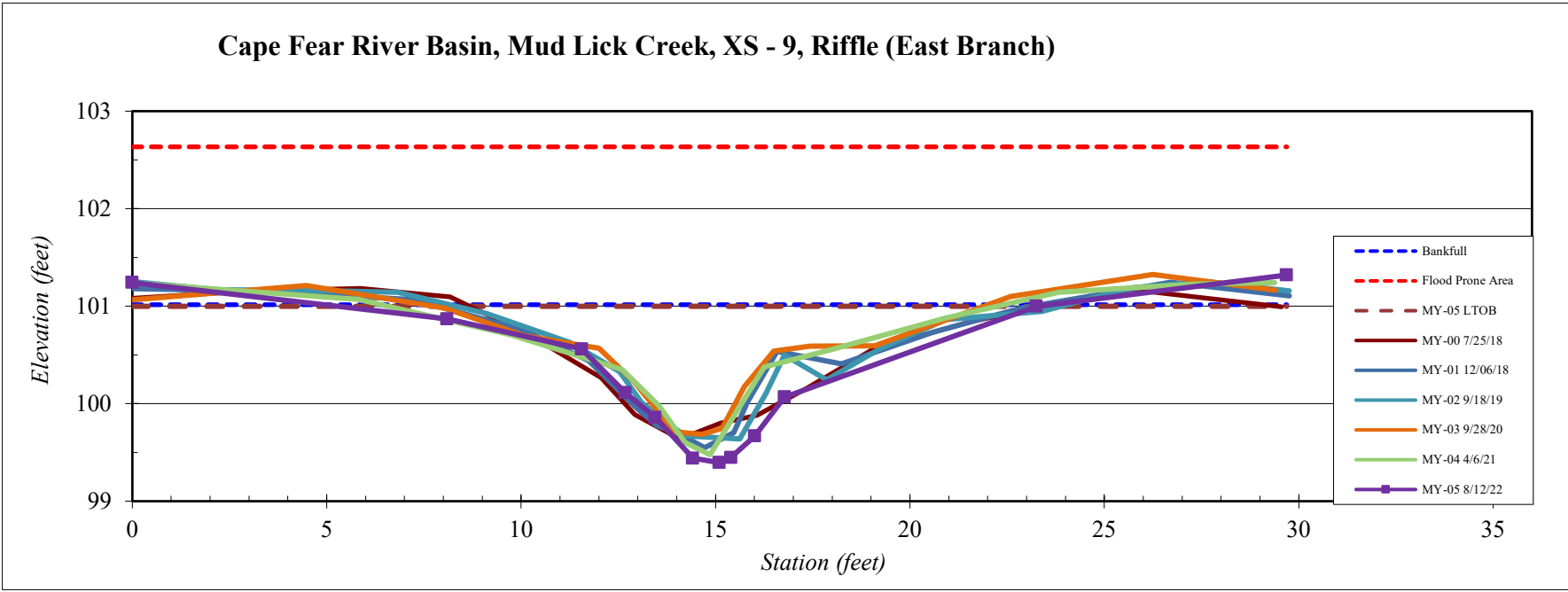
River Basin:	Cape Fear
Site Name	Mud Lick Creek
XS ID	XS - 9, Riffle (East Branch)
Drainage Area (sq mi):	0.27
Date:	8/12/2022
Field Crew:	Adams, Fleming, Lance, D. Lewis



Station	Elevation
0.00	101.24
8.09	100.87
11.56	100.56
12.69	100.11
13.45	99.86
14.42	99.44
15.10	99.40
15.40	99.45
16.01	99.67
16.77	100.07
23.25	101.00
29.69	101.32

SUMMARY DATA	
Bankfull Elevation:	101.0
Bankfull Cross-Sectional Area:	10.6
Area at Low Bank:	10.3
Bankfull Width:	18.6
Flood Prone Area Elevation:	102.6
Flood Prone Width:	100.0
Max Depth at Bankfull:	1.6
Low Bank Height:	1.6
Mean Depth at Bankfull:	0.6
W / D Ratio:	32.8
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0

Stream Type	C
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River Basin:	Cape Fear
Site Name	Mud Lick Creek
XS ID	XS - 10, Riffle (Mud Lick Cr)
Drainage Area (sq mi):	3.64
Date:	8/12/2022
Field Crew:	Adams, Fleming, Lance, D. Lewis

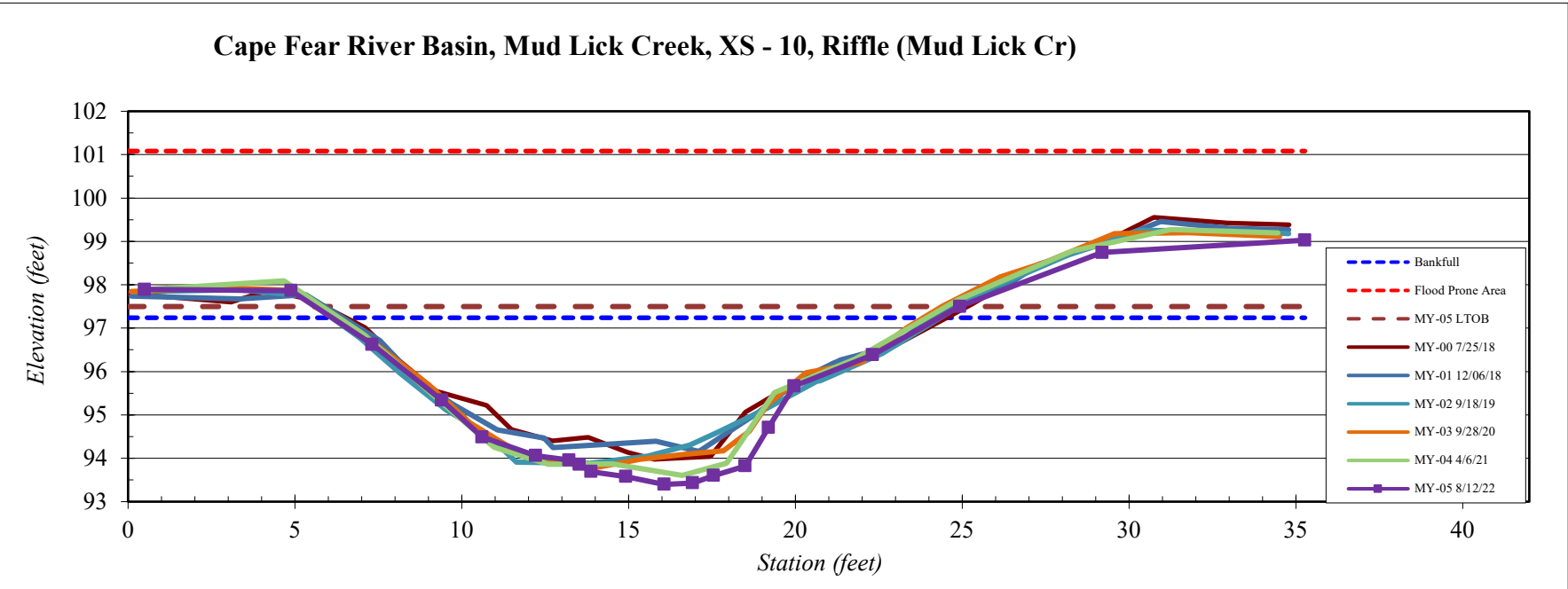


Station	Elevation
0.50	97.89
4.89	97.86
7.32	96.63
9.40	95.34
10.61	94.49
12.22	94.06
13.22	93.96
13.53	93.85
13.89	93.69
14.92	93.58
16.07	93.40
16.92	93.43
17.55	93.60
18.50	93.82
19.19	94.71
19.96	95.67
22.31	96.38
24.93	97.50
29.20	98.75
35.27	99.03

SUMMARY DATA	
Bankfull Elevation:	97.2
Bankfull Cross-Sectional Area:	40.4
Area at Low Bank:	45.3
Bankfull Width:	18.2
Flood Prone Area Elevation:	101.1
Flood Prone Width:	100.0
Max Depth at Bankfull:	3.8
Low Bank Height:	4.1
Mean Depth at Bankfull:	2.2
W / D Ratio:	8.2
Entrenchment Ratio:	NA
Bank Height Ratio:	1.07

Stream Type E

Cape Fear River Basin, Mud Lick Creek, XS - 10, Riffle (Mud Lick Cr)



Appendix E.
Hydrology Data

Table 12. Verification of Bankfull Events

**Table 12. Verification of Bankfull Events
Mud Lick Creek Restoration Site (DMS Project No. 93482)**

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
December 6, 2018	October 16-17, 2018	Observations throughout floodplain and crest gauge indicate a bankfull event after 4.61 inches of rain fell over 48 hours.	1, 2
May 8, 2019	February 24, 2019	Observation of wrack in floodplain along North Branch R2 and crest gauge data from all site crest gauges indicate a bankfull event after 2.27 inches of rain fell over 48 hours.	3
September 18, 2019	July 24, 2019	Observation of wrack on Mud Lick Creek R2 floodplain fences and crest gauge data from all site crest gauges indicate a bankfull event after 3.02 inches of rain fell over 48 hours.	4
May 29, 2020	February 7, 2020	Observations of wrack throughout site along all stream reaches, and crest gauge data from all site crest gauges indicate a bankfull event after approximately 3.59 inches of rain fell over 24-hour period.	5, 6, 7
November 16, 2020	November 12, 2020	Observations of wrack throughout site along all stream reaches, and crest gauge data from all site crest gauges indicate a bankfull event after approximately 4.60 inches of rain fell over 48-hour period.	8, 9
August 12, 2022	July 9, 2022	Observation of wrack in floodplain along North Branch R2 and crest gauge data from all site crest gauges indicate a bankfull event after 2.80 inches of rain fell over 48 hours.	10









Appendix F.
2022 Benthic Macroinvertebrate Sampling Data

Results
Habitat Forms

PAI ID NO			55806	55808	55807
STATION			MLCR2 2	MLCR3 3	NBR5 5
DATE			6/9/2022	6/9/2022	6/9/2022
SPECIES	Tolerance Value	Functional Feeding Group			
ANNELIDA					
Hirudinea		P			
Rhynchobdellida					
Glossiphoniidae		P			
<i>Batrachobdella phalera</i>		P			1
ARTHROPODA					
Crustacea					
Cladocera					
Chydoridae					
<i>Alona sp.</i>			2		
Amphipoda					
Hyalellidae		CG			
<i>Hyalella azteca</i>	7.2	CG		1	2
Insecta					
Ephemeroptera					
Baetidae		CG			
<i>Callibaetis sp.</i>	9.2	CG		1	
Odonata					
Aeshnidae		P			1
Coenagrionidae		P		3	
<i>Ischnura sp.</i>	9.5		1	1	1
Corduliidae					
<i>Somatochlora sp.</i>	8.9	P	3		4
Plecoptera					
Perlidae		P			
<i>Perlsta sp.</i>	2.9	P		4	
Hemiptera					
Corixidae		PI	2	1	
<i>Palmacorixa sp.</i>					2
Megaloptera					
Sialidae		P			
<i>Sialis sp.</i>	7	P	5	5	3
Coleoptera					
Dytiscidae		P			
<i>Neoporus sp.</i>	5				1
Hydrophilidae		P			
<i>Tropisternus sp.</i>	9.3	P		1	1
Diptera					
Ceratopogonidae		P		1	
Chironomidae					
Chronominae			1		
<i>Cryptochironomus sp.</i>	6.4	P		1	
<i>Einfeldia sp.</i>		CG	2		
<i>Kiefferulus dux</i>			1	2	
<i>Microtendipes pedellus gp.</i>	3.9	CG			1
<i>Polypedilum illinoense gp.</i>	8.7	SH			1
<i>Procladius sp.</i>	8.8	P	1	2	1
TOTAL NO. OF ORGANISMS			18	23	19
TOTAL NO. OF TAXA			9	12	12
EPT INDEX			0	2	0
BIOTIC INDEX ASSIGNED VALUES			8.25	6.68	7.70

11/13 Revision 8

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Branch, DWR

TOTAL SCORE 46

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

Stream Mad Creek Creek Location/road: Crockerfield Crossroads (Road Name _____) County Madison
Date 220609 CC# 03030003 Basin Carefree Subbasin 03-06-08

Observer(s) _____ Type of Study: Fish Benthos Basinwide Special Study (Describe) _____

Latitude 35.813326 Longitude 79.434204 Ecoregion: MT P Slate Belt Triassic Basin

Water Quality: Temperature _____ °C DO _____ mg/l Conductivity (corr.) _____ μS/cm pH _____

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

Visible Land Use: 20 %Forest _____ %Residential 80 %Active Pasture _____ % Active Crops _____ %Fallow Fields _____ % Commercial _____ %Industrial _____ %Other - Describe: _____

Watershed land use : Forest Agriculture Urban Animal operations upstream

Width: (meters) Stream 2 Channel (at top of bank) 5 Stream Depth: (m) Avg .5 Max 1
 Width variable Large river >25m wide

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

Bank Angle: 115 ° or NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)

- Channelized Ditch
- Deeply incised-steep, straight banks Both banks undercut at bend Channel filled in with sediment
- Recent overbank deposits Bar development Buried structures Exposed bedrock

Excessive periphyton growth Heavy filamentous algae growth Green tinge Sewage smell
 Manmade Stabilization: N Y: Rip-rap, cement, gabions Sediment/grade-control structure Berm/levee
Flow conditions : High Normal Low
Turbidity: Clear Slightly Turbid Turbid Tannic Milky Colored (from dyes)
Good potential for Wetlands Restoration Project?? YES NO Details _____

upstream 1-in restored, this reach EII

Channel Flow Status

Useful especially under abnormal or low flow conditions.

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

Weather Conditions: cool (cloudy) **Photos:** N Y Digital 35mm

Remarks: below normal rainfall past 90 days

I. Channel Modification

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

Evidence of dredging Evidence of desnagging=no large woody debris in stream Banks of uniform shape/height
 Remarks _____ Subtotal 4

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

 Rocks Macrophytes / Sticks and leafpacks — Snags and logs / Undercut banks or root mats

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

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

No woody vegetation in riparian zone

Remarks _____

Subtotal 11

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

A. substrate with good mix of gravel, cobble and boulders

	Score
1. embeddedness <20% (very little sand, usually only behind large boulders).....	15
2. embeddedness 20-40%.....	12
3. embeddedness 40-80%.....	8
4. embeddedness >80%.....	3

B. substrate gravel and cobble

1. embeddedness <20%.....	14
2. embeddedness 20-40%.....	11
3. embeddedness 40-80%	6
4. embeddedness >80%.....	2

C. substrate mostly gravel

1. embeddedness <50%.....	8
2. embeddedness >50%.....	4

D. substrate homogeneous

1. substrate nearly all bedrock.....	3
2. substrate nearly all sand	3
3. substrate nearly all detritus.....	2
4. substrate nearly all silt/ clay.....	1

Remarks _____

Subtotal 4

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

A. Pools present

	Score
1. Pools Frequent (>30% of 200m area surveyed)	
a. variety of pool sizes.....	10
b. pools about the same size (indicates pools filling in).....	8

2. Pools Infrequent (<30% of the 200m area surveyed)

- a. variety of pool sizes.....
- b. pools about the same size.....

6
4
0
Subtotal 6

B. Pools absent.....

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

Page Total _____

V. Riffle Habitats

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

- | | <u>Score</u> | <u>Score</u> |
|---|--------------|--------------|
| A. well defined riffle and run, riffle as wide as stream and extends 2X width of stream.... | 16 | 12 |
| B. riffle as wide as stream but riffle length is not 2X stream width | 14 | <u>7</u> |
| C. riffle not as wide as stream and riffle length is not 2X stream width | 10 | 3 |
| D. riffles absent | 0 | |

Subtotal 7

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

VI. Bank Stability and Vegetation

A. Erosion

- 1. No, or very little, erosion present 7
- 2. Erosion mostly at outside of meanders 6
- 3. Less than 50% of banks eroding..... 3
- 4. Massive erosion..... 0

Erosion Score 3

B. Bank Vegetation

- 1. Mostly mature trees (>12" DBH) present..... 7
- 2. Mostly small trees (<12" DBH) present, large trees rare 5
- 3. No trees on bank, can have some shrubs and grasses 3
- 4. Mostly grasses or mosses on bank..... 2
- 5. Little or no bank vegetation, bare soil everywhere..... 0

Vegetation Score 7

Subtotal 17

Remarks _____

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

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

Remarks _____ Subtotal _____

VIII. Riparian Vegetative Zone Width

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

		FACE UPSTREAM	
Dominant vegetation: <input checked="" type="checkbox"/> Trees <input checked="" type="checkbox"/> Shrubs <input checked="" type="checkbox"/> Grasses <input type="checkbox"/> Weeds/old field <input type="checkbox"/> Exotics (kudzu, etc)		Lft. Bank	Rt. Bank
		Score	Score
A. Riparian zone intact (no breaks)			
1. width > 18 meters.....		5	5
2. width 12-18 meters.....		4	4
3. width 6-12 meters.....		3	3
4. width < 6 meters.....		2	2
B. Riparian zone not intact (breaks)			
1. breaks rare			
a. width > 18 meters.....		4	4
b. width 12-18 meters.....		3	3
c. width 6-12 meters.....		2	2
d. width < 6 meters.....		1	1
2. breaks common			
a. width > 18 meters.....		3	3
b. width 12-18 meters.....		2	2
c. width 6-12 meters.....		1	1
d. width < 6 meters.....		0	0
Remarks _____		Subtotal	10

Page Total _____

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

TOTAL SCORE 46

MLCR3

11/13 Revision 8

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Branch, DWR

TOTAL SCORE 63 63

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

Stream Mud Lick Creek Location/road: Critchfield (Road Name Crossroads) County Chatham

Date 220609 CC# 03030003 Basin Cape Fear Subbasin 03-06-08

Observer(s) PHP Type of Study: Fish Benthos Basinwide Special Study (Describe) _____

Latitude 35.811892 Longitude 79.437375 Ecoregion: MT P Slate Belt Triassic Basin

Water Quality: Temperature _____ °C DO _____ mg/l Conductivity (corr.) _____ μS/cm pH _____

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

Visible Land Use: 20 %Forest _____ %Residential 80 %Active Pasture _____ % Active Crops _____ %Fallow Fields _____ % Commercial _____ %Industrial _____ %Other - Describe: _____

Watershed land use : Forest Agriculture Urban Animal operations upstream

Width: (meters) Stream 4 Channel (at top of bank) 2 Stream Depth: (m) Avg .1 Max .1
 Width variable Large river >25m wide

Bank Height (from deepest part of riffle to top of bank-first flat surface you stand on): (m) 1.5

Bank Angle: 95 ° or NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)

- Channelized Ditch
- Deeply incised-steep, straight banks Both banks undercut at bend Channel filled in with sediment
- Recent overbank deposits Bar development Buried structures Exposed bedrock

Excessive periphyton growth Heavy filamentous algae growth Green tinge Sewage smell
 Manmade Stabilization: N Y: Rip-rap, cement, gabions Sediment/grade-control structure Berm/levee
 Flow conditions : High Normal Low
 Turbidity: Clear Slightly Turbid Turbid Tannic Milky Colored (from dyes)
 Good potential for Wetlands Restoration Project?? YES NO Details upst-ean tributary
has been restored, trees reach untouched

Channel Flow Status

Useful especially under abnormal or low flow conditions.

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

Weather Conditions: _____ Photos: N Y Digital 35mm

Remarks: poor conditions, below normal reach all pool areas

I. Channel Modification

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

Evidence of dredging Evidence of desnagging=no large woody debris in stream Banks of uniform shape/height
 Remarks _____ Subtotal 3

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

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

2. Pools Infrequent (<30% of the 200m area surveyed)

- a. variety of pool sizes.....
- b. pools about the same size.....

6
4

B. Pools absent.....

0
Subtotal 6

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

Page Total _____

V. Riffle Habitats

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

Riffles Frequent	Riffles Infrequent
<u>Score</u>	<u>Score</u>

- A. well defined riffle and run, riffle as wide as stream and extends 2X width of stream.... 16
- B. riffle as wide as stream but riffle length is not 2X stream width 14
- C. riffle not as wide as stream and riffle length is not 2X stream width 10
- D. riffles absent**..... 0

12
7
3

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

Subtotal 7

VI. Bank Stability and Vegetation

A. Erosion

- 1. No, or very little, erosion present 7
- 2. Erosion mostly at outside of meanders 6
- 3. Less than 50% of banks eroding..... 3
- 4. Massive erosion..... 0

Erosion Score 6

B. Bank Vegetation

- 1. Mostly mature trees (>12" DBH) present..... 7
- 2. Mostly small trees (<12" DBH) present, large trees rare 5
- 3. No trees on bank, can have some shrubs and grasses 3
- 4. Mostly grasses or mosses on bank..... 2
- 5. Little or no bank vegetation, bare soil everywhere..... 0

Vegetation Score 5

Remarks _____

Subtotal _____

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

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

Score
10
8
7
2
0

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

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

No woody vegetation in riparian zone Remarks _____ Subtotal 11

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

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

Remarks _____ Subtotal 8

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

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

Remarks _____ Subtotal _____

VIII. Riparian Vegetative Zone Width

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

		FACE UPSTREAM	
Dominant vegetation: <input checked="" type="checkbox"/> Trees <input checked="" type="checkbox"/> Shrubs <input checked="" type="checkbox"/> Grasses <input type="checkbox"/> Weeds/old field <input type="checkbox"/> Exotics (kudzu, etc)		Lft. Bank	Rt. Bank
		Score	Score
A. Riparian zone intact (no breaks)			
1. width > 18 meters.....		5	5
2. width 12-18 meters.....		4	4
3. width 6-12 meters.....		3	3
4. width < 6 meters.....		2	2
B. Riparian zone not intact (breaks)			
1. breaks rare			
a. width > 18 meters.....		4	4
b. width 12-18 meters.....		3	3
c. width 6-12 meters.....		2	2
d. width < 6 meters.....		1	1
2. breaks common			
a. width > 18 meters.....		3	3
b. width 12-18 meters.....		2	2
c. width 6-12 meters.....		1	1
d. width < 6 meters.....		0	0
Remarks _____		Subtotal <u>10</u>	

Page Total _____

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

TOTAL SCORE 63

MLC NBR23

11/13 Revision 8

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

TOTAL SCORE 81

Biological Assessment Branch, DWR

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

Stream Mudlick Creek location/road: Crockerfield (Road Name Crockerfield) County Chatham

Date 2/20/09 CC# 03030003 Basin Cape Fear Subbasin 03-06-08

Observer(s) _____ Type of Study: Fish Benthos Basinwide Special Study (Describe) _____

Latitude 35.41396 Longitude -79.434522 Ecoregion: MT P Slate Belt Triassic Basin

Water Quality: Temperature _____ °C DO _____ mg/l Conductivity (corr.) _____ μS/cm pH _____

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

Visible Land Use: 20% Forest _____% Residential 80% Active Pasture _____% Active Crops _____% Fallow Fields _____%
Commercial _____% Industrial _____% Other - Describe: _____

Watershed land use: Forest Agriculture Urban Animal operations upstream

Width: (meters) Stream 2 Channel (at top of bank) 1 Stream Depth: (m) Avg .1 Max .5
 Width variable Large river >25m wide

Bank Height (from deepest part of riffle to top of bank-first flat surface you stand on): (m) .5

Bank Angle: 120 ° or NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)

- Channelized Ditch
- Deeply incised-steep, straight banks Both banks undercut at bend Channel filled in with sediment
- Recent overbank deposits Bar development Buried structures Exposed bedrock

Excessive periphyton growth Heavy filamentous algae growth Green tinge Sewage smell
 Manmade Stabilization: N Y: Rip-rap, cement, gabions Sediment/grade-control structure Berm/levee
Flow conditions : High Normal Low
Turbidity: Clear Slightly Turbid Turbid Tannic Milky Colored (from dyes)
Good potential for Wetlands Restoration Project?? YES NO Details

Channel has been restored

Channel Flow Status

Useful especially under abnormal or low flow conditions.

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

Weather Conditions: cool - cloudy **Photos:** N Y Digital 35mm

Remarks: Very wetter conditions

I. Channel Modification

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

Evidence of dredging Evidence of desnagging=no large woody debris in stream Banks of uniform shape/height
Remarks restored channel Subtotal 4

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

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

2. Pools Infrequent (<30% of the 200m area surveyed)

- a. variety of pool sizes..... 6
- b. pools about the same size..... 4

B. Pools absent..... 0

Subtotal 8

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

Page Total _____

V. Riffle Habitats

Definition: Riffle is area of reactivation-can be debris dam, or narrow channel area. Riffles **Frequent** Riffles **Infrequent**

- | | <u>Score</u> | <u>Score</u> |
|---|--------------|--------------|
| A. well defined riffle and run, riffle as wide as stream and extends 2X width of stream.... | 16 | 12 |
| B. riffle as wide as stream but riffle length is not 2X stream width | 14 | 7 |
| C. riffle not as wide as stream and riffle length is not 2X stream width | 10 | 3 |
| D. riffles absent | 0 | |

Subtotal 16

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

VI. Bank Stability and Vegetation

A. Erosion

- 1. No, or very little, erosion present 7
- 2. Erosion mostly at outside of meanders..... 6
- 3. Less than 50% of banks eroding..... 3
- 4. Massive erosion..... 0

Erosion Score 7

B. Bank Vegetation

- 1. Mostly mature trees (>12" DBH) present..... 7
- 2. Mostly small trees (<12" DBH) present, large trees rare 5
- 3. No trees on bank, can have some shrubs and grasses 3
- 4. Mostly grasses or mosses on bank..... 2
- 5. Little or no bank vegetation, bare soil everywhere..... 0

Vegetation Score 5

Remarks _____ Subtotal _____

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

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

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

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

No woody vegetation in riparian zone

Remarks _____

Subtotal 15

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

A. substrate with good mix of gravel, cobble and boulders

	Score
1. embeddedness <20% (very little sand, usually only behind large boulders).....	15
2. embeddedness 20-40%.....	12
3. embeddedness 40-80%.....	8
4. embeddedness >80%.....	3

B. substrate gravel and cobble

1. embeddedness <20%.....	14
2. embeddedness 20-40%.....	11
3. embeddedness 40-80%.....	6
4. embeddedness >80%.....	2

C. substrate mostly gravel

1. embeddedness <50%.....	8
2. embeddedness >50%.....	4

D. substrate homogeneous

1. substrate nearly all bedrock.....	3
2. substrate nearly all sand.....	3
3. substrate nearly all detritus.....	2
4. substrate nearly all silt/ clay.....	1

Remarks _____

Subtotal 6

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

A. Pools present

I. Pools Frequent (>30% of 200m area surveyed)

	Score
a. variety of pool sizes.....	10
b. pools about the same size (indicates pools filling in).....	8

Remarks _____ Subtotal _____

VIII. Riparian Vegetative Zone Width

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

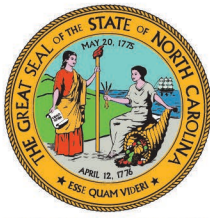
		FACE UPSTREAM	
Dominant vegetation: <input checked="" type="checkbox"/> Trees <input checked="" type="checkbox"/> Shrubs <input checked="" type="checkbox"/> Grasses <input type="checkbox"/> Weeds/old field <input type="checkbox"/> Exotics (kudzu, etc)		Lft. Bank	Rt. Bank
		Score	Score
A. Riparian zone intact (no breaks)			
1. width > 18 meters.....		5	5
2. width 12-18 meters.....		4	4
3. width 6-12 meters.....		3	3
4. width < 6 meters.....		2	2
B. Riparian zone not intact (breaks)			
1. breaks rare			
a. width > 18 meters.....		4	4
b. width 12-18 meters.....		3	3
c. width 6-12 meters.....		2	2
d. width < 6 meters.....		1	1
2. breaks common			
a. width > 18 meters.....		3	3
b. width 12-18 meters.....		2	2
c. width 6-12 meters.....		1	1
d. width < 6 meters.....		0	0
Remarks _____		Subtotal	10

Page Total _____

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

TOTAL SCORE 81

Appendix G.
2022 Adaptive Management Plan



NORTH CAROLINA
Environmental Quality

ROY COOPER
Governor

ELIZABETH S. BISER
Secretary

MARC RECKTENWALD
Director

MEMORANDUM

DATE: October 25, 2022

TO: IRT Members

FROM: DMS, Jeremiah Dow

RE: Mud Lick Creek Project
Request for IRT Approval of Adaptive Management Plan for Supplemental Planting

Mud Lick Creek is a design-bid-build stream project that was instituted on 2/13/2013. Wildlands Engineering, Inc. prepared the mitigation plan in 2015 and Axiom Environmental, Inc. was contracted to perform project monitoring. In 2021 DMS contracted Michael Baker Engineering, Inc. (Baker) to manage invasive and nuisance vegetation. Baker will also provide the supplemental planting services. The project is currently in monitoring year 5. In MY4, four veg plots – 1, 6, 10, & 11 – out of 12 plots did not meet success criteria

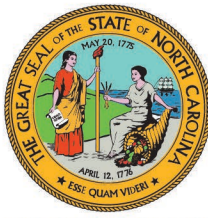
On 6/4/2021, the IRT and DMS conducted a credit release site visit where areas of low density and/or low vigor were identified. No additional management activities were prescribed at that time and the IRT recommended continued monitoring of problematic areas with an understanding that supplemental planting may be necessary. Baker was contracted to manage fescue in low vigor areas and thin sweet gum on the eastern side of the project to reduce competition with existing planted stems. On August 30, 2022 DMS personnel visited the site to assess the invasive and nuisance vegetation management efforts and low stem density/vigor areas. During that site visit it was determined that supplemental planting would be necessary, and targeted planting areas were mapped with GPS.

Due to competition with dense herbaceous vegetation and sweet gum, and evidence of widespread deer browse, it was decided that the site should be supplementally planted with 1 gallon and 3 gallon containerized trees. Proposed planting list is attached, and all listed species are from the approved Mitigation Plan.

2.04 acres are proposed for supplemental planting out of 9.6 total acres planted which accounts for 21% of the total planted area.



North Carolina Department of Environmental Quality | Division of Mitigation Services
217 West Jones Street | 1652 Mail Service Center | Raleigh, North Carolina 27699-1652
919.707.8976



NORTH CAROLINA
Environmental Quality

ROY COOPER
Governor

ELIZABETH S. BISER
Secretary

MARC RECKTENWALD
Director

Supplemental planting will include the following:

Size	Species	Quantity
1 Gall.	<i>Nyssa sylvatica</i> (Black Gum)	25
1 Gall.	<i>Ulmus americana</i> (American Elm)	25
3 Gall.	<i>Platanus occidentalis</i> (Sycamore)	50
3 Gall.	<i>Populus deltoides</i> (E. Cottonwood)	50
3 Gall.	<i>Betula nigra</i> (River Birch)	50
3 Gall.	<i>Sambucus canadensis</i> (Elderberry)	50
1 Gall.	<i>Cornus amomum</i> (Silky Dogwood)	50
1 Gall.	<i>Hamamelis virginiana</i> (Witch Hazel)	50
1 Gall.	<i>Diospyros virginiana</i> (Persimmon)	50
3 Gall.	<i>Quercus michauxii</i> (Swamp Chestnut Oak)	50
3 Gall.	<i>Liriodendron tulipifera</i> (Tulip Poplar)	50



North Carolina Department of Environmental Quality | Division of Mitigation Services
217 West Jones Street | 1652 Mail Service Center | Raleigh, North Carolina 27699-1652
919.707.8976

From: [Dow, Jeremiah J](#)
To: [Isenhour, Kimberly T CIV USARMY CESAW \(USA\)](#)
Cc: [Tugwell, Todd J CIV USARMY CESAW \(US\)](#); [Haywood, Casey M CIV USARMY CESAW \(USA\)](#); [Davis, Erin B](#); [Wilson, Travis W.](#); kathryn_matthews@fws.gov; [Allen, Melonie](#); [Bowers, Todd](#); [Crocker, Lindsay](#); [Crumbley, Tyler A CIV USARMY CESAW \(USA\)](#)
Subject: RE: [External] RE: Notice of IRT Adaptive Management Plan Review/ NCDMS Mud Lick Creek Mitigation Site/ Chatham County/ SAW-2014-00736
Date: Tuesday, November 29, 2022 3:54:00 PM
Attachments: [MudLickCreek_IRT_AdaptiveManagementRequestMemo_2022.pdf](#)

Please see response to comments in red below.

Thank you,
Jeremiah

From: Isenhour, Kimberly T CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Sent: Tuesday, November 22, 2022 1:27 PM
To: Dow, Jeremiah J <jeremiah.dow@ncdenr.gov>
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Subject: [External] RE: Notice of IRT Adaptive Management Plan Review/ NCDMS Mud Lick Creek Mitigation Site/ Chatham County/ SAW-2014-00736

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Good afternoon,

The 15-day comment review period for the NCDMS Mud Lick Creek Mitigation Site Adaptive Management Plan (SAW-2014-00736) closed on November 12, 2022. Per Section 332.8(o)(9) of the 2008 Mitigation Rule, this review followed the streamlined review process. NCDMS requested to supplementally plant 2.04 acres of 9.6 total acres or 21% of the planted area this winter at Mud Lick Creek. The MY4 report indicated 4 vegetation plots failed due to herbaceous competition and sweetgum. Additionally, during the 6/4/2021 credit release site visit, the IRT noted several areas of low stem densities and/or low vigor and many plots had evidence of deer browse. All comments received during the review process are below.

1. Erin Davis, DWR: DWR concurs with all of EPA's comments below. Additionally, we request green ash be removed from that supplemental planting list. Please either include an additional species or adjust quantities of other species listed. **Green Ash was removed from the supplemental planting list and replaced with Black Gum and American Elm. An updated version of the AMP memo is attached with the new planting list.**
2. Todd Bowers, EPA: The need and approach for supplemental planting with mitigation

plan approved species is well demonstrated. The only issue I have is coming up with a new monitoring scheme for the Mud Lick Creek site. I recommend an annual monitoring plan that contains a couple more veg plots in the larger of the supplementally planted areas to ensure the additional trees along with those established are progressing toward success; at least to the third year criteria before final closeout. If interim success is not met then additional monitoring (beyond MY7) and possibly another round of planting and additional monitoring may be needed.

- Proposed species are approved.
 - Recommend additional veg plots (2) to monitoring larger areas that received supplemental planting. **DMS will monitor random veg transects in the 2 larger supplemental planting areas (large area south of VP4 and the area near VP3).**
 - Monitor new areas/veg plots for 3 years to include MY5, 6, and 7. **The site is in MY5 now and will not be planted until the start of MY6 but transects or veg plots in the supplemental planting areas will be monitored in MY6 through project closeout.**
 - Full closeout if performance standards in new veg plots meet third year performance (>320 stems/acre) at MY7. **Understood.**
 - If trend is not towards success at MY7, extend monitoring period and do not close out until all areas/veg plots are meeting performance criteria. **Understood.**
3. Travis Wilson, WRC: WRC requests an additional year of vegetation monitoring. **Understood, please see response to USACE below.**
4. Kim Isenhour, USACE:
- a. Was the beaver dam removed, and did it affect the vegetation in plot 10? **DMS has managed beaver with APHIS throughout this project and will continue to do so if beaver are active. Currently the small dam is not affecting VP10. It is not clear that it is an active dam.**
 - b. What are the pink lines on the stream bank near veg plot 3? **That was included in error. It is the location of a stream problem area that was identified in MY1 and has been shown on the CCPV since as an area to closely monitor.**
 - c. Why is the area around plot 10 not being replanted? **This is the area with extremely dense Sweet Gum (102 stems in VP10 in MY4) that has since been thinned, but at the time it was nearly impossible to assess an accurate stem density for the area. The latest draft monitoring report for MY5 shows zero (0) Sweet Gum and sufficient planted stems (323/acre) to meet success criteria. The plot has 607 stems/ acre counting Green Ash and Sycamore volunteers.**
 - d. Are soil amendments needed? It's difficult to know the source of the low stem density without more information. **Soil amendments are not proposed. Herbaceous competition is the primary cause of low stem density.**
 - e. It would have been helpful to include the reach names on the map and a soils map. For future submittals, please follow the attached Adaptive Management Plan Guidance. **In the future we will closely follow the Adaptive Management Plan Guidance.**
 - f. When deer browse has been an issue on past projects, such as Vile Creek, alternative species were proposed that seemed to survive. Was this considered? **The initial**

planting list was very diverse, and although we didn't select species to address deer browse, there are at least 2 species on the current list that are deer resistant (River Birch & Tulip Poplar).

- g. The Corps concurs that an additional year of vegetation monitoring should occur in MY6, to include two additional plots. Prior to close-out, the Corps requests transect data in several of the replanted areas to assess overall vegetation success. In MY6, we will do veg monitoring in the 2 large areas as described above. In MY7 we propose to monitor 3 areas (areas near VP1, VP2, & VP11) in addition to the 2 veg transects to be monitored in MY6, for a total of 5 transects in MY7.

Please reach out with any questions.

Have a nice Thanksgiving,

Kim

Kim Isenhour

Mitigation Project Manager, Regulatory Division | U.S. Army Corps of Engineers | 919.946.5107