YEAR 5 (2019) MONITORING REPORT
ABBEY LAMM
STREAM AND WETLAND MITIGATION SITE

ALAMANCE COUNTY, NORTH CAROLINA
FULL DELIVERY CONTRACT NO. 5790
DMS PROJECT NO. 96311
NCDWR PROJECT NO. 20140336
USACE ACTION ID NO. SAW-2014-01710

CAPE FEAR RIVER BASIN
CATALOGING UNIT 03030002

Data Collection – March-November 2019

PREPARED FOR:

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

January 2020

Mitigation Project Name	**Abbey Lamm Stream and Wetland**	**County**	**Alamance**	**USACE Action ID**	2014-01710
DMS ID	**96311**	**Date Project Instituted**	**2/21/2014**	**NCDWR Permit No**	2014-0336
River Basin	**Cape Fear**	**Date Prepared**	**6/14/2019**		
Cataloging Unit	**03030002**				

Credit Release Milestone	Stream Credits						Wetland Credits							
	Scheduled Releases (Stream)	Warm	Cool	Cold	Anticipated Release Year (Stream)	Actual Release Date (Stream)	Scheduled Releases (Forested)	Riparian Riverine	Riparian Non-riverine	Non-riparian	Scheduled Releases (Coastal)	Coastal	Anticipated Release Year (Wetland)	Actual Release Year (Wetland)
Potential Credits (Mitigation Plan)		4,731.600						1.000						
Potential Credits (As-Built Survey)		4,731.600						1.000						
1 (Site Establishment)	**N/A**				N/A	N/A	**N/A**				**N/A**		N/A	
2 (Year 0 / As-Built)	**30%**	1,419.480			2015	7/16/2015	**30%**	0.300			**30%**		2015	7/16/2015
3 (Year 1 Monitoring)	**10%**	473.160			2016	4/25/2016	**10%**	0.100			**10%**		2016	4/25/2016
4 (Year 2 Monitoring)	**10%**	473.160			2017	8/8/2017	**10%**	0.100			**15%**		2017	8/8/2017
5 (Year 3 Monitoring)	**10%**	473.160			2018	4/25/2018	**15%**	0.150			**20%**		2018	4/25/2018
6 (Year 4 Monitoring)	**5%**	236.580			2019	4/26/2019	**5%**	0.050			**10%**		2019	4/26/2019
7 (Year 5 Monitoring)	**10%**				2020		**15%**				**15%**		2020	
8 (Year 6 Monitoring)	**5%**				2021		**5%**				**N/A**		2021	
9 (Year 7 Monitoring)	**10%**				2022		**10%**				**N/A**		2022	
Stream Bankfull Standard	**10%**	473.160			2017	8/8/2017	**N/A**				**N/A**			
Total Credits Released to Date		**3,548.700**						**0.700**						

NOTES:

1/16/2019: During the review of the Year 3 monitoring report, DMS discovered that the schedule of credit release was incorrect from what was in the final mitigation plan. The credit release schedule has been adjusted for the unreleased credits after 4/25/2018.

Contingencies (if any):

Signature of Wilmington District Official Approving Credit Release

27 Sept 2019

Date

1 - For DMS, no credits are released during the first milestone

2 - For DMS projects, the second credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the NCIRT by posting it to the DMS (NCEEP) Portal, provided the following criteria have been met:

1) Approval of the final Mitigation Plan
2) Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property
3) Completion of all physical and biological improvements to the mitigation site pursuant to the mitigation plan
4) Reciept of necessary DA permit authorization or written DA approval for porjects where DA permit issuance is not required

3 - A 10% reserve of credits is to be held back until the bankfull event performance standard has been met

Information from DMS Debit Ledger dated 03/02/2016

DEBITS (released credits only)

		Ratios	1	1.5	2.5	5	1	3	2	5	1	3	2	5	1	3	2	5
			Stream Restoration	Stream Enhancment I	Stream Enhancement II	Stream Preservation	Riparian Restoration	Riparian Creation	Riparian Enhancement	Riparian Preservation	Nonriparian Restoration	Nonriparian Creation	Nonriparian Enhancement	Nonriparian Preservation	Coastal Marsh Restoration	Coastal Marsh Creation	Coastal Marsh Enhancement	Coastal Marsh Preservation
As-Built Amounts (feet and acres)			**4,400.000**		**829.000**		**1.000**											
As-Built Amounts (mitigation credits)			**4,400.000**		**331.600**		**1.000**											
Percentage Released			**75%**		**75%**		**70%**											
Released Amounts (feet / acres)			**3,300.000**		**621.750**		**0.700**											
Released Amounts (credits)			**3,300.000**		**248.700**		**0.700**											
NCDWR Permit	**USACE Action ID**	**Project Name**																
2013-0517	2013-00557	NCDOT TIP R-2413A/B - NC 68 Connector, Guilford County	1,320.000		248.700													
2013-0517	2013-00557	NCDOT TIP R-2413A/B - NC 68 Connector, Guilford County	440.000		82.900													
2013-0918	2005-21386	NCDOT TIP U-2525B/C - Greensboro Eastern Loop, Guilford County	880.000		165.800		0.327											
	2016-00402	SR 2022 - Bridge 108 - Division 7, Guilford County					0.173											
2013-0918	2005-21386	NCDOT TIP U-2525B/C - Greensboro Eastern Loop, Guilford County	430.000		82.900													
2013-0918	2005-21386	NCDOT TIP U-2525B/C - Greensboro Eastern Loop, Guilford County					0.150											
2013-0223	2001-21125	NCDOT TIP U-2524C/D - Greensboro Outer Loop	10.000															
2013-0918	2005-21386	NCDOT TIP U-2525B/C - Greensboro Eastern Loop, Guilford County	220.000		41.450		0.050											
Remaining Amounts (feet / acres)			**0.000**		**0.000**		**0.000**											
Remaining Amounts (credits)			**0.000**		**0.000**		**0.000**											

Information from DMS Debit Ledger dated 03/02/2016

Restoration Systems, LLC
1101 Haynes St. Suite 211
Raleigh, North Carolina
Ph: (919) 755-9490
Fx: (919) 755-9492

January 14, 2020

Jeremiah Dow
NC DEQ Division of Mitigation Services
217 West Jones St.
Raleigh, NC 27699-1652

Subject: Draft Monitoring Year 5 Annual Monitoring Report
Abbey Lamm Stream and Wetland Mitigation Site (DMS #96311)
Cape Fear River Basin 03030002, Alamance County
Contract No. 005790

Mr. Dow,

Below is the response from Restoration Systems to all comments received on the Draft Abbey Lamm Yr. 5 (2019) monitoring report. DMS comments are in black, and our responses are in blue. Please do not hesitate to reach out if you would like to discuss.

Sincerely,

Raymond Holz
Restoration Systems

Comments Received & Responses

1. Title Page
   a. Please add the following:
      i. DMS Project Number: 96311
      ii. NCDWR Project Number: 20140336
      iii. USACE Action ID Number: SAW-2014-01710

      These items were added to the title page(s).

2. Section 2.3
   a. Wetland Hydrology Gauge Table – Please shade the text red for gauge 6.
      Text for gauge 6 was shaded red.

   b. The footnote below the Hydrology Gauge Table that states "# These gauges did not meet success criteria due to a data shuttle failure that resulted in the loss of data…" Please be more specific about what data was lost.
      The statement was revised to read: "These gauges did not meet success criteria due to a data shuttle failure that resulted in the loss of data from March 20 to May 3. Based on rainfall and hydrology data that was not lost, these gauges would have likely met success criteria had the loss of data not occurred."

3. Section 2.4
   a. 3rd Paragraph – Please change NCDWQ to NCDWR.
      This change was made.

4. Table 1
    a. Change the column labeled "Restoration Linear Footage/Acreage" to indicate that these are As-built quantities.
    The column title was changed to "As-built Restoration Linear Footage/Acreage"

    b. Add a column for mitigation plan linear footage/acreage.
    A column was added titled "Mitigation Plan Linear Footage/Acreage."

    c. Currently, the "Mitigation Credits" column is calculated from As-built numbers. Please update this column with mitigation plan credits.
    The mitigation credits column was updated to match the mitigation plan credits. And the footnote that read, "NOTE: This table was revised after realizing that changes in stream footages due to minor changes in construction were not accounted for in the as-built document," was deleted.

5. Appendix B
    a. Figure 2 – Please update the CCPV to differentiate between Restoration and Enhancement reaches.
    Figure 2 was updated to differentiate between stream restoration and enhancement reaches.

6. Appendix D
    a. On riffle cross sections, please show the current Low Top of Bank (LTOB) line and the adjusted bankfull line based on MY0 cross sectional area. Additionally, please describe how BHR was calculated. For example, cross sections 8 and 12 appear to have aggraded since MY0, but the BHR is listed at 1.1 and 1.3 respectively. Based on the graph, one would expect to see a BHR of <1.
    MY0 LTOB lines were added to the cross-section graphs. The discrepancy in the BHR is due to the DMS BHR guidance changing during year 3 of the project. Rather than back calculating the first 3 data sets, DMS instructed us to fix the cross-sectional area starting in MY3 (not MY0). Therefore, the baseline data for the area best fit method of BHR calculations is actually MY3 rather than MY0.

    b. On cross section 9 (and elsewhere) there is a footnote that reads "Elevated BHR results from shallow channel depth." Please explain in more detail what is meant by this.
    The footnote was changed to the following in order to clarify: "No problems have been noted in this reach. Minor alterations in shallow channels may result in large discrepancies including elevated BHR."

7. Appendix E
    a. Table 14 – See comment 2. Please shade the gauge that did not meet red, and elaborate on the footnote regarding data loss.
    Gauge 6 was shaded red, and the footnote was revised as above to include "…from March 20 to May 3."

    b. Please include the Groundwater Gauge graphs.
    Groundwater gauge graphs have been included.

8. Digital data and drawings
    a. (Related to Comment 6 above) DMS cannot currently replicate reported BHR's with the given data. Please ensure that bank height ratios (BHR) are calculated using the methods specified in the Industry Technical Work group memorandum. Please specify the Bankfull and LTOB elevations used for the BHR calculations in the excel sheets and further clarify how calculations were done in the footnote for morphology and hydrologic monitoring tables.
    The BHR is calculated using the method specified in the Industry Technical Work Group memorandum (using a fixed cross-sectional area). However, this method was originally applied during MY3 of the project, so the MY3 cross-sectional area became the fixed area, rather than MY0. The bankfull and low bank height elevations used in the BHR calculations are listed in the table, and a footnote explains the 2 methods for BHR calculations used during the life of the project.

    b. CVS entry tool is missing many plant vigor numbers. Please include these and resubmit. Also, please enter in the observation/sampling dates for MY5 plots.
    We did not find any missing vigor data in the CVS database. The plants with "Missing" entered into the vigor column were unable to be located during MY5 monitoring. The plot observation/sampling dates were entered into the CVS database.

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NCDWR PROJECT NO. 20140336
USACE ACTION ID NO. SAW-2014-01710

CAPE FEAR RIVER BASIN
CATALOGING UNIT 03030002

Data Collection – March-November 2019

PREPARED BY:

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AND

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January 2020

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1.0 PROJECT SUMMARY

The Abbey Lamm Stream and Wetland Mitigation Site (Site) encompasses approximately 17.3 acres located approximately 2.0 miles east of Snow Camp in southern Alamance County within 14-digit Cataloging Unit and Targeted Local Watershed 03030002050050 of the Cape Fear River Basin (Figure 1, Appendix B and Table 4, Appendix A). Prior to Site construction, the Site consisted of agricultural land used for livestock grazing and hay production. Streams had been cleared of vegetation, dredged of cobble substrate, trampled by livestock, eroded vertically and laterally, and received extensive sediment and nutrient inputs from livestock. In addition, streamside wetlands had been drained by channel incision, soils were compacted, cleared of forest vegetation, and altered by existing land uses. Completed project activities, reporting history, completion dates, project contacts, and project attributes are summarized in Tables 1-4 (Appendix A).

Positive aspects supporting mitigation activities at the Site included the following.

- Streams have a Best Usage Classification of WS-V, NSW (Nutrient Sensitive Waters)
- Located in a Targeted Local Watershed (TLW)
- According to the *Cape Fear River Basin Restoration Priorities 2009,* benthic ratings in the TLW vary from "Fair" to "Good-Fair" indicating a need for improvement of aquatic conditions in the watershed (NCDMS 2009)
- A Significant Natural Heritage Area is located immediately east of the Site

The Site is not included in a Local Watershed Plan; however, this project meets overall goals of the Local Watershed Plans including 1) reduce sediment loading, 2) reduce nutrient loading, 3) manage stormwater runoff, 4) reduce toxic inputs, 5) provide and improve instream habitat, 6) provide and improve terrestrial habitat, 7) improve stream stability, and 8) improve hydrologic function. The following table summarizes the project goals/objectives and proposed functional uplift based on Site restoration activities and observations of two reference areas located in the vicinity of the Site.

Project Goals and Objectives

Project Goal/Objective	How Goal/Objective will be Accomplished
Improve Hydrology	
Restore Floodplain Access	Building a new channel at the historic floodplain elevation to restore overbank flows
Restore Wooded Riparian Buffer	Planting a woody riparian buffer
Improve Microtopography	Scarifying soils to reduce compaction and hoof shear due to cattle
Restore Stream Stability	Building a new channel, planting a woody riparian buffer, and removing cattle
Increase Sediment Transport	
Improve Stream Geomorphology	
Increase Surface Storage and Retention	Building a new channel at the historic floodplain elevation restoring overbank flows, removing cattle, scarifying compacted soils, and planting woody vegetation
Restore Appropriate Inundation/Duration	
Increase Subsurface Storage and Retention	Raising the stream bed elevation

Project Goals and Objectives (continued)

Project Goal/Objective	How Goal/Objective will be Accomplished
Improve Water Quality	
Increase Upland Pollutant Filtration	Planting a native, woody riparian buffer and installing 8 marsh treatment areas
Increase Thermoregulation	Planting a native, woody riparian buffer
Reduce Stressors and Sources of Pollution	Removing cattle and installing 8 marsh treatment areas
Increase Removal and Retention of Pathogens, Particulates (Sediments), Dissolved Materials (Nutrients), and Toxins from the Water Column	Raising the stream bed elevation, restoring overbank flows, planting with woody vegetation, removing cattle, increasing surface storage and retention, restoring appropriate inundation/duration, and installing 8 marsh treatment areas
Increase Energy Dissipation of Overbank/Overland Flows/Stormwater Runoff	Raising the stream bed elevation, restoring overbank flows, planting with woody vegetation, and installing 8 marsh treatment areas
Restore Habitat	
Restore In-stream Habitat	Building a stable channel with a cobble/gravel bed and planting a woody riparian buffer
Restore Stream-side Habitat	Planting a woody riparian buffer
Improve Vegetation Composition and Structure	

Project construction occurred between January and April 2015. Planting was completed in April 2015. Site activities include the restoration of perennial and intermittent stream channels, enhancement (level II) of perennial and intermittent stream channels, and restoration of riparian wetlands. A total of **4734.6 Stream Mitigation Units (SMUs) and 1.0 Riparian Wetland Mitigation Units (WMUs)** are being offered as depicted in the following tables. These tables were revised after realizing that changes in stream footages due to minor changes in construction were not accounted for in the as-built document.

Stream Mitigation Type	Perennial Stream Counting Towards Mitigation Credits (linear feet)	Intermittent Stream Counting Towards Mitigation Credits (linear feet)	Ratio	Stream Mitigation Units
Restoration	2625	1775	1:1	4400
Enhancement (Level II)	409	425	2.5:1	333.6
Totals	**3034**	**2200**		**4734.6**

Wetland Mitigation Type	Acreage	Ratio	Riparian Wetland Mitigation Units
Riparian Restoration	1.0	1:1	1.0
Riparian Enhancement*	0.4	--	--
Totals	**1.4**		**1.0**

*Wetland enhancement acreage is not included in mitigation credit calculations as per RFP 16-005568 requirements.

Stream Success Criteria

Monitoring and success criteria for stream restoration should relate to project goals and objectives. From a mitigation perspective, several of the goals and objectives are assumed to be functionally elevated by restoration activities without direct measurement. Other goals and objectives will be considered successful upon achieving vegetation success criteria. The following summarizes stream success criteria related to goals and objectives.

Project Goal/Objective	Stream Success Criteria
Improve Hydrology	
Restore Floodplain Access	Two overbank events will be documented, in separate years, during the monitoring period.
Restore Wooded Riparian Buffer	Attaining Vegetation Success Criteria.
Improve Microtopography	Removal of cattle and scarification of soils during construction.
Restore Stream Stability	Cross-sections, monitored annually, will be compared to as-built measurements to determine channel stability and maintenance of channel geomorphology.
Improve Stream Geomorphology	
Increase Surface Storage and Retention	Removal of cattle, installation of 8 marsh treatment areas, scarification of soils during construction, documentation of two overbank events in separate monitoring years, and attaining Wetland and Vegetation Success Criteria.
Restore Appropriate Inundation/Duration	
Increase Subsurface Storage and Retention	Two overbank events will be documented, in separate years, during the monitoring period and attaining Wetland Success Criteria.
Increase Sediment Transport	Pebble counts documenting coarsening of bed material from pre-existing conditions.
Improve Water Quality	
Increase Upland Pollutant Filtration	Installation of 8 marsh treatment areas and attaining Wetland and Vegetation Success Criteria
Increase Thermoregulation	Attaining Vegetation Success Criteria
Reduce Stressors and Sources of Pollution	Removal of cattle and installation of 8 marsh treatment areas
Increase Removal and Retention of Pathogens, Particulates (Sediments), Dissolved Materials (Nutrients), and Toxins from the Water Column	Removal of cattle, installation of 8 marsh treatment areas, documentation of two overbank events in separate monitoring years, and attaining Vegetation Success Criteria
Increase Energy Dissipation of Overbank/Overland Flows/Stormwater Runoff	Installation of 8 marsh treatment areas, documentation of two overbank events in separate monitoring years, and attaining Vegetation Success Criteria
Restore Habitat	
Restore In-stream Habitat	Reincorporating natural substrate removed from existing Site streams and stockpiled onsite into proposed stream beds, pebble counts documenting coarsening of bed material from pre-existing conditions, and attaining Vegetation Success Criteria (Section 8.3.1)
Restore Stream-side Habitat	Attaining Vegetation Success Criteria
Improve Vegetation Composition and Structure	Attaining Vegetation Success Criteria

Intermittent channels (UT 1 and UT 3) were questioned by IRT members with respect to jurisdictional status. Success criteria in these reaches require surface water flow within the stream channels during years with normal climactic conditions for at least 30 consecutive days. Furthermore, IRT members require these systems to have a discernible ordinary high water mark, which will be evaluated and considered towards project success. Iron-oxidizing bacteria and hydric soils within these reaches will be documented by photograph throughout the monitoring period, and will be considered signs of intermittent channels by IRT members.

Vegetation Success Criteria

An average density of 320 planted stems per acre must be surviving in the first three monitoring years. Subsequently, 290 planted stems per acre must be surviving in year 4, 260 planted stems per acre in year 5, and 210 planted stems per acre in year 7. In addition, planted vegetation must average 10 feet in height in each plot at year 7 since this Site is located in the Piedmont. Volunteer stems may be considered on a case-by-case basis in determining overall vegetation success; however, volunteer stems should be counted separately from planted stems.

Wetland Success Criteria

Monitoring and success criteria for wetland restoration should relate to project goals and objectives. From a mitigation perspective, several of the goals and objectives are assumed to be functionally elevated by restoration activities without direct measurement. Other goals and objectives will be considered successful upon achieving vegetation success criteria. The following summarizes wetland success criteria related to goals and objectives.

Project Goal/Objective	Wetland Success Criteria
Improve Hydrology	
Restore Wooded Riparian Buffer	Attaining Vegetation Success Criteria.
Improve Microtopography	Removal of cattle and scarification of soils during construction.
Increase Surface Storage and Retention	Removal of cattle, scarification of soils during construction, documentation of two overbank events in separate monitoring years, attaining Vegetation Success Criteria, and documentation of an elevated groundwater table (within 12 inches of the soil surface) for greater than 10 percent of the growing season during average climatic conditions.
Restore Appropriate Inundation/Duration	
Increase Subsurface Storage and Retention	
Improve Water Quality	
Increase Upland Pollutant Filtration	Installation of 8 marsh treatment areas and attaining Wetland and Vegetation Success Criteria.
Reduce Stressors and Sources of Pollution	Removal of cattle and installation of 8 marsh treatment areas.
Increase Removal and Retention of Pathogens, Particulates (Sediments), Dissolved Materials (Nutrients), and Toxins from the Water Column	Removal of cattle, installation of 8 marsh treatment areas, documentation of two overbank events in separate monitoring years, and attaining Vegetation Success Criteria.
Increase Energy Dissipation of Overbank/Overland Flows/Stormwater Runoff	Installation of 8 marsh treatment areas, documentation of two overbank events in separate monitoring years, and attaining Vegetation Success Criteria.
Restore Habitat	
Restore Stream-side Habitat	Attaining Vegetation Success Criteria.
Improve Vegetation Composition and Structure	

According to the *Soil Survey of Alamance County*, the growing season for Alamance County is from April 17 – October 22 (USDA 1960). However, the start date for the growing season is not typical for the Piedmont region; therefore, for purposes of this project, gauge hydrologic success will be determined using data from February 1 - October 22 to more accurately represent the period of biological activity. Based on growing season information outlined in the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region (Environmental Laboratory 2012), this will be confirmed annually by soil temperatures exceeding 41 degrees Fahrenheit at 12 inches depth and/or bud burst.

Target hydrological characteristics include saturation or inundation for 10 percent of the monitored period (February 1-October 22), during average climatic conditions. During years with atypical climatic conditions, groundwater gauges in reference wetlands may dictate threshold hydrology success criteria (75 percent of reference). These areas are expected to support hydrophytic vegetation. If wetland parameters are marginal as indicated by vegetation and/or hydrology monitoring, a jurisdictional determination will be performed. The jurisdictional determination will not supersede monitoring data, or overturn a failure in meeting success criteria; however, this information may be used by the IRT, at the discretion of the IRT, to make a final determination on Site wetland re-establishment success.

Summary of Monitoring Period/Hydrology Success Criteria by Year

Year	Soil Temperatures/Date Bud Burst Documented	Monitoring Period Used for Determining Success	10 Percent of Monitoring Period
2015 (Year 1)	--	April 8*-October 22 (198 days)	20 days
2016 (Year 2)	Bud burst and soil temperatures documented on March 30, 2016	March 30-October 22 (207 days)	21 days
2017 (Year 3)	Bud burst and soil temperatures documented on February 28, 2017	February 28-October 22 (237 days)	24 days
2018 (Year 4)	Bud burst and soil temperatures documented on March 6, 2018	March 6-October 22 (231 days)	23 days
2019 (Year 5)	March 1, 2019**	March 1-October 22 (235 days)	24 days

* Gauges were installed on April 8 during year 1 (2015), so this date was used as the start of the growing season.
** Based on data collected from a soil temperature data logger located on the Site.

Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in tables and figures within this report's appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report (formerly Mitigation Plan) and in the Mitigation Plan (formerly the Restoration Plan) documents available on the NC Division of Mitigation Services (NCDMS) website. All raw data supporting the tables and figures in the appendices are available from NCDMS upon request.

2.0 METHODOLOGY

Monitoring requirements and success criteria outlined in the latest guidance by NCDMS dated November 7, 2011 (*Monitoring Requirements and Reporting Standards for Stream and/or Wetland Mitigation*) will be followed and are briefly outlined below. Monitoring data collected at the Site should include reference

photos, plant survival analysis, channel stability analysis, and biological data, if specifically required by permit conditions.

Wetland hydrology is proposed to be monitored for a period of seven years (years 1-7). Riparian vegetation and stream morphology is proposed to be monitored for a period of seven years with measurements completed in years 1-3, year 5, and year 7. If monitoring demonstrates the Site is successful by year 5 and no concerns have been identified, Restoration Systems may propose to terminate monitoring at the Site and forego monitoring requirements for years 6 and 7. Early closure will only be provided through written approval from the USACE in consultation with the Interagency Review Team. Monitoring will be conducted by Axiom Environmental, Inc. Annual monitoring reports of the data collected will be submitted to the NCDMS by Restoration Systems no later than December 31 of each monitoring year data is collected.

2.1 Streams

Annual monitoring will include development of channel cross-sections and substrate on riffles and pools. Data to be presented in graphic and tabular format will include 1) cross-sectional area, 2) bankfull width, 3) average depth, 4) maximum depth, and 5) width-to-depth ratio. Post construction, permanently-monumented cross-sections were installed throughout the Site, at approximately 50 foot intervals. Sixty monitoring cross-sections will be measured annually. Cross-section locations are depicted on Figure 2 (Appendix B); data is included in Appendix D. Longitudinal profiles will not be measured routinely unless monitoring demonstrates channel bank or bed instability, in which case, longitudinal profiles may be required by the USACE along reaches of concern to track changes and demonstrate stability.

Visual assessment of in-stream structures will be conducted to determine if failure has occurred. Failure of a structure may be indicated by collapse of the structure, undermining of the structure, abandonment of the channel around the structure, and/or stream flow beneath the structure. In addition, visual assessments of the entire channel will be conducted in each of the seven years of monitoring as outlined in NCDMS *Monitoring Requirements and Reporting Standards for Stream and/or Wetland Mitigation*. Areas of concern will be depicted on a plan view figure identifying the location of concern along with a written assessment and photograph of the area. Morphology data can be found in Tables 8A-E and 9A-L (Appendix D).

Intermittent stream reaches, including UT 1 and UT 3, will receive priority 1 stream restoration to restore adjacent wetlands and elevate stream function. Priority 1 stream restoration along intermittent stream reaches was discussed by IRT members with regard to adequate base flow once stream restoration is complete. Therefore, stream flow gauges were installed in the upper and lower reaches of UT 1 and UT 3 to catalog flow for 30 consecutive days. Channel formation was evident in both UT 1 and UT 3 in years 1-5 (2015-2019) (Tables 10a-10b, Appendix E). The approximate location of stream flow gauges are depicted on Figure 2 (Appendix B); gauge data is included in Appendix E.

2.2 Vegetation

After planting was completed in April 2015, an initial evaluation was performed to verify planting methods and to determine initial species composition and density. Supplemental planting and additional Site modifications will be implemented, if necessary.

During quantitative vegetation sampling, 14 sample plots (10-meter by 10-meter) were installed within the Site as per guidelines established in *CVS-EEP Protocol for Recording Vegetation*, *Version 4.2* (Lee et al. 2008). In each sample plot, vegetation parameters to be monitored include species composition and species density. Visual observations of the percent cover of shrub and herbaceous species will also be documented by photograph.

Year 5 (2019) stem count measurements, taken in September 2019, indicate an average of 309 planted stems per acre (excluding livestakes) across the Site. Ten of fourteen individual vegetation plots met success criteria based on planted stems alone; however, when including naturally recruited stems of green ash

(*Fraxinus pennsylvanica*), black walnut (*Juglans nigra*), and river birch (*Betula nigra*), plots 7 and 13 are well above success criteria.

Heavy herbaceous competition in the first year (2015) growing season had affected planted stems; therefore, on March 10, 2016 open areas in the upper 2/3 of the Site were treated with a pre-emergent and grass specific herbicide (Appendix G). The treatment was successful in knocking back herbaceous growth; however, by the end of the growing season the amount of new herbaceous growth was similar to the density observed in prior to treatment efforts. RS does not plan to continue this form of treatment.

Working with Carolina Silvics, RS planted 1250 1-gallon pots during the week of December 20th, 2016, which included the following species: *Betula nigra, Fraxinus pennsylvanica, Platanus occidentalis, Quercus falcata, Quercus nigra, Quercus palustris, Quercus phellos,* and *Quercus rubra*. A remedial planting plan figure detailing location of planting and density, in addition to photographs, are provided in Appendix C. Of note, no remedial planting was performed within forested areas, i.e. vegetation plot 12. This is an enhancement area within an existing hardwood forest. Given planted species surviving within vegetation plot 12 and surrounding density of the existing forest, RS did not feel it was necessary to replant this area.

During year 5 (2019), it was observed that Japanese stiltgrass (*Microstegium vimineum*) densities were elevated within the old pond bed and were affecting planted stem survival. In June 2019, RS treated the microstegium with herbicide. Thus far, the treatment appears to have been successful in reducing the density of Japanese stiltgrass. The herbicide application form is in Appendix G.

2.3 Wetland Hydrology

Six groundwater monitoring gauges were installed to take measurements after hydrological modifications were performed at the Site. Groundwater gauges were installed in larger wetland sections along UT 1, UT 2, and the main stem channel. Gauges were installed at various elevations within the floodplain to accurately determine hydrology of wetland re-establishment areas. Approximate locations of wetland groundwater monitoring gauges are depicted on Figure 2 (Appendix D). Hydrological sampling will continue throughout the growing season at intervals necessary to satisfy jurisdictional hydrology success criteria (USEPA 1990). In addition, an on-site rain gauge will document rainfall data for comparison of groundwater conditions with extended drought conditions and floodplain crest gauges will confirm overbank flooding events.

Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)							
Gauge	***Year 1 (2015) February 1 Growing Season Start***	***Year 2 (2016) March 30 Growing Season Start***	***Year 3 (2017) February 28 Growing Season Start***	***Year 4 (2018) March 6 Growing Season Start***	***Year 5 (2019) March 1 Growing Season Start***	***Year 6 (2020)***	***Year 7 (2021)***
1	No*/10 days (3.8 percent)	Yes/75 days (36 percent)	No/12 days (5.1 percent)	Yes/68 days (29 percent)	Yes/28 days (11.9 percent)		
1B+	--	--	--	Yes/60 days (26 percent)	Yes/60 days (26 percent)		
2	Yes/35 days (13.3 percent)	Yes/122 days (59 percent)	Yes/82 days (35 percent)	Yes/30 days (13 percent)	No/19 days# (8.1 percent)		
3	No*/14 days (5.3 percent)	Yes/48 days (23 percent)	Yes/135 days (57 percent)	Yes/66 days (29 percent)	Yes/89 days (38 percent)		
4	No*/14 days (5.3 percent)	Yes/100 days (48 percent)	Yes/78 days (33 percent)	Yes/28 days (12 percent)	No/18 days# (7.7 percent)		

5	Yes/32 days (12.1 percent)	Yes/75 days (36 percent)	Yes/48 days (20 percent)	Yes/60 days (26 percent)	No/19 days# (8.1 percent)		
6	No*/9 days (3.4 percent)	No/7 days (3.4 percent)	No/5 days (2.1 percent)	Yes/25 days (11 percent)	No/19 days (8.1 percent)		
6B+	--	--	--	Yes/28 days (12 percent)	No/17 days# (7.2 percent)		
7**	--	Yes/116 days (56 percent)	Yes/153 days (65 percent)	Yes/103 days (45 percent)	Yes/103 days (44 percent)		
8**	--	Yes/206 days (100 percent)	Yes/211 days (89 percent)	Yes/231 days (100 percent)	Yes/124 days (53 percent)		
9**	--	Yes/54 days (26 percent)	No^/12 days (5.1 percent)	Yes/132 days (57 percent)	Yes/122 days (52 percent)		

* Due to Site construction activities, groundwater gauges were not installed until April 8, 2015. It is expected that all gauges would meet success criteria at the beginning of the growing season.

** These gauges were installed on March 8, 2016 to show wetland establishment within the old pond bed.

^ This gauge malfunctioned through the majority of the growing season due to continuous inundation. It is expected that this gauge would have met success criteria had it functioned properly.

+ These gauges were installed during Year 4 (2018) in close proximity with two gauges that had not met success criteria in previous monitoring years in order to verify the groundwater data at these locations.

These gauges did not meet success criteria due to a data shuttle failure that resulted in the loss of data from March 20 to May 3. Based on rainfall and hydrology data that was not lost, these gauges would have likely met success criteria had the loss of data not occurred.

2.4 Biotic Community Change

Changes in the biotic community are anticipated from a shift in habitat opportunities as tributaries are restored. In-stream, biological monitoring is proposed to track the changes during the monitoring period. The benthic macroinvertebrate community will be sampled using NCDWR protocols found in the *Standard Operating Procedures for Benthic Macroinvertebrates* (NCDWQ 2006) and *Benthic Macroinvertebrate Protocols for Compensatory Stream Restoration Projects* (NCDWQ 2001). Biological sampling of benthic macroinvertebrates will be used to compare preconstruction baseline data with postconstruction restored conditions.

Two benthic macroinvertebrate monitoring locations will be established within restoration reaches. Postrestoration collections will occur in the approximate location of the prerestoration sampling. Benthic macroinvertebrate samples will be collected from individual reaches using the Qual-4 collection method. Sampling techniques of the Qual-4 collection method consist of kick nets, sweep nets, leaf packs, and visual searches. Preproject biological sampling occurred on June 26, 2014; postproject monitoring will occur in June of monitoring years 2-5.

Identification of collected organisms will be performed by personnel with North Carolina Division of Water Resources (NCDWR) or by a NCDWR certified laboratory. Other data collected will include D50 values/NCDWR habitat assessment forms. Biological sampling for year 5 (2019) occurred on June 13, 2019. The samples were sent to Pennington and Associates, a NCDWQ certified laboratory, for identification and analysis. The results and Habitat Assessment Dataforms are included in Appendix F.

3.0 REFERENCES

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APPENDIX A

PROJECT BACKGROUND DATA AND MAPS

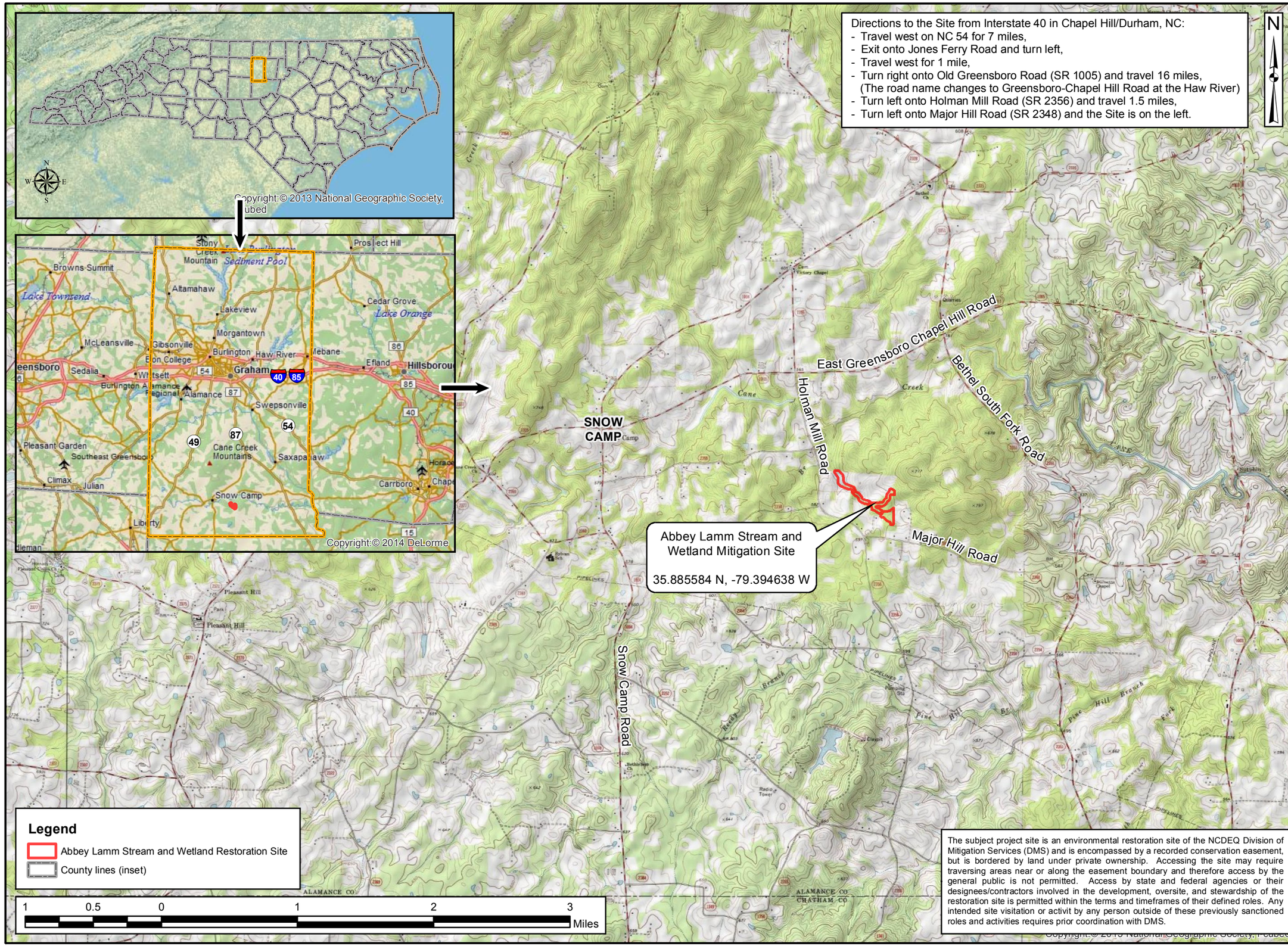
Figure 1. Vicinity Map

Table 1. Project Components and Mitigation Credits

Table 2. Project Activity and Reporting History

Table 3. Project Contacts Table

Table 4. Project Baseline Information and Attributes



Axiom Environmental, Inc.

Prepared for:

RESTORATION SYSTEMS | LLC

Project:

ABBEY LAMM STREAM AND WETLAND MITIGATION SITE

Alamance County, NC

Title:

Site Location

Notes:

Background Imagery sources (provided by ESRI Data and Maps):
1. Physical Map of the United States (2009) created by the U.S. Park Service (upper inset).
2. Delorme World Basemap digital mapping (2010, lower inset).
3. Snow Camp, NC (1978), Crutchfield Crossroads, NC (1974), Saxapahaw, NC (1977), and Silk Hope, NC (1974) 7.5-minute topographic quadrangles provided by the U.S. Geological Survey.

Drawn by:	KRJ
Date:	NOV 2015
Scale:	1:42000
Project No.:	14-005

FIGURE

1

Table 1. Project Components and Mitigation Credits

Mitigation Credits			
Stream	**Stream**	**Riparian Wetland**	**Nonriparian Wetland**
Restoration	**Enhancement**	**Restoration**	**Restoration**
4400	**331**	**1.0**	**--**

Projects Components								
Station Range	**Existing Linear Footage/ Acreage**	**Priority Approach**	**Restoration/ Restoration Equivalent**	**As-built Restoration Linear Footage/ Acreage**	**Mitigation Plan Restoration Linear Footage/ Acreage**	**Mitigation Ratio**	**Mitigation Credits (from Mit Plan)**	**Comment**
UT 1 Station 00+21 to 05+62	531	PI	Restoration	546	541	1:1	546	
UT 1a Station 00+00 to 01+54	154	PI	Restoration	154-9=145	154-8=146	1:1	145	9 lf of UT1a located outside of easement is not credit generating
UT 2 Station 00+22 to 04+75	502	PI	Restoration	453	455	1:1	453	
UT 3a Station 00+00 to 00+93	93		EII	93	93	2.5:1	37.2	
UT 3b Station 00+00 to 01+42	143		EII	142	143	2.5:1	56.8	
UT 3c Station 00+00 to 01+90	190		EII	190	190	2.5:1	76	
UT 3 Station 00+93 to 11+77	1021	PI	Restoration	1084	1084	1:1	1084	
Mainstem Channel Station 04+75 to 16+29	1098	PI	Restoration	1154-61-63= 1030	1154-61-63= 1030	1:1	1030	61 lf and 63 lf of Mainstem located outside of easement at two crossings are not credit generating
Mainstem Channel Station 16+29 to 20+57	428		EII	428-19=409	428-25=403	2.5:1	163.6	19 lf of Mainstem located outside of easement are not credit generating
Mainstem Channel Station 20+57 to 32+57	NA	PI	Restoration	1201-57=1142	1199-55=1144	1:1	1143	57 lf of Mainstem located outside of easement are not credit generating

Component Summation			
Restoration Level	**Stream (linear footage)**	**Riparian Wetland (acreage)**	**Nonriparian Wetland (acreage)**
Restoration	4400*	1.0	--
Enhancement (Level 1)	--	--	--
Enhancement (Level II)	829**	--	--
Enhancement	--	0.4***	--
Totals	**5229**	**--**	**--**
Mitigation Units	**4731 SMUs**	**1.0 Riparian WMUs**	**0.00 Nonriparian WMUs**

*An additional 190 linear feet of stream restoration is proposed outside of the easement and is therefore not included in this total or in mitigation credit calculations.
**An additional 19 linear feet of stream enhancement (level II) is proposed outside of the easement and is therefore not included in this total or in mitigation credit calculations.
***Wetland enhancement acreage is not included in mitigation credit calculations as per RFP 16-005568 requirements.

Table 2. Project Activity and Reporting History

Activity or Deliverable	Stream Monitoring Complete	Vegetation Monitoring Complete	Data Collection Complete	Completion or Delivery
Technical Proposal (RFP No. 16-005568)	--	--	--	October 2013
EEP Contract No. 5790	--	--	--	February 2014
Mitigation Plan	--	--	--	September 2014
Construction Plans	--	--	--	September 2014
Construction Earthwork	--	--	--	April 3, 2015
Planting	--	--	--	April 7, 2015
As-Built Documentation	April 14, 2015	April 9, 2015	May 2015	July 2015
Year 1 Monitoring	October 20, 2015	September 23, 2015	October 2015	November 2015
Fescue Treatment	--	--	--	March, 2016
Year 2 Monitoring	April 7, 2016	July 6, 2016	October 2016	December 2016
Remedial Planting	--	--	--	December 8, 2016
Year 3 Monitoring	March 27, 2017	July 19, 2017	October 2017	November 2017
Year 4 Monitoring	April 15, 2018	--	October 2018	October 2018
Year 5 Monitoring	March 4, 2019	September 25, 2019	November, 2019	January 2020

Table 3. Project Contacts Table

Full Delivery Provider Restoration Systems 1101 Haynes Street, Suite 211 Raleigh, North Carolina 27604 Worth Creech 919-755-9490	**Construction Contractor** Land Mechanic Designs 780 Landmark Road Willow Spring, NC 27592 Lloyd Glover 919-639-6132
Designer Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis 919-215-1693	**Planting Contractor** Carolina Silvics, Inc. 908 Indian Trail Road Edenton, NC 27932 Mary-Margaret McKinney 252-482-8491
Construction Plans and Sediment and Erosion Control Plans Sungate Design Group, PA 915 Jones Franklin Road Raleigh, NC 27606 Joshua G. Dalton, PE 919-859-2243	**As-built Surveyor** K2 Design Group 5688 US Highway 70 East Goldsboro, NC 27534 John Rudolph 919-751-0075
	Baseline & Monitoring Data Collection Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis 919-215-1693

Table 4. Project Attribute Table

Project Information				
Project Name	Abbey Lamm Restoration Site			
Project County	Alamance County, North Carolina			
Project Area (acres)	17.3			
Project Coordinates (latitude & latitude)	35.885584ºN, 79.394638ºW			
Project Watershed Summary Information				
Physiographic Province	Piedmont			
Project River Basin	Cape Fear			
USGS HUC for Project (14-digit)	03030002050050			
NCDWR Sub-basin for Project	03-06-04			
Project Drainage Area (acres)	257			
Percentage of Project Drainage Area that is Impervious	<2%			
Reach Summary Information				
Parameters	**Main**	**UT 1**	**UT 2**	**UT 3**
Length of reach (linear feet)	3258	695	455	1510
Valley Classification	alluvial			
Drainage Area (acres)	257	49	56	32
NCDWR Stream ID Score	--	29	35.25	28
NCDWR Water Quality Classification	WS-V, NSW			
Existing Morphological Description (Rosgen 1996)	Eg5/Fc5	E/G 5	C/G 5	Eg5
Existing Evolutionary Stage (Simon and Hupp 1986)	III/IV	II/III	IV/III	III
Underlying Mapped Soils	Efland silt loam, Goldston slaty silt loam, Herndon silt loam, Moderately gullied land, Orange silt loam			
Drainage Class	Well-drained, well-drained, well-drained, poorly to well-drained, moderately well-drained			
Hydric Soil Status	Nonhydric			
Slope	0.0179	0.0256-0.0362		
FEMA Classification	NA			
Native Vegetation Community	Piedmont Alluvial Forest/Dry-Mesic Oak-Hickory Forest			
Watershed Land Use/Land Cover (Site)	40% forest, 58% agricultural land, <2% low density residential/impervious surface			
Watershed Land Use/Land Cover (Cedarock Reference Channel)	65% forest, 30% agricultural land, <5% low density residential/impervious surface			
Percent Composition of Exotic Invasive Vegetation	<5%			

APPENDIX B

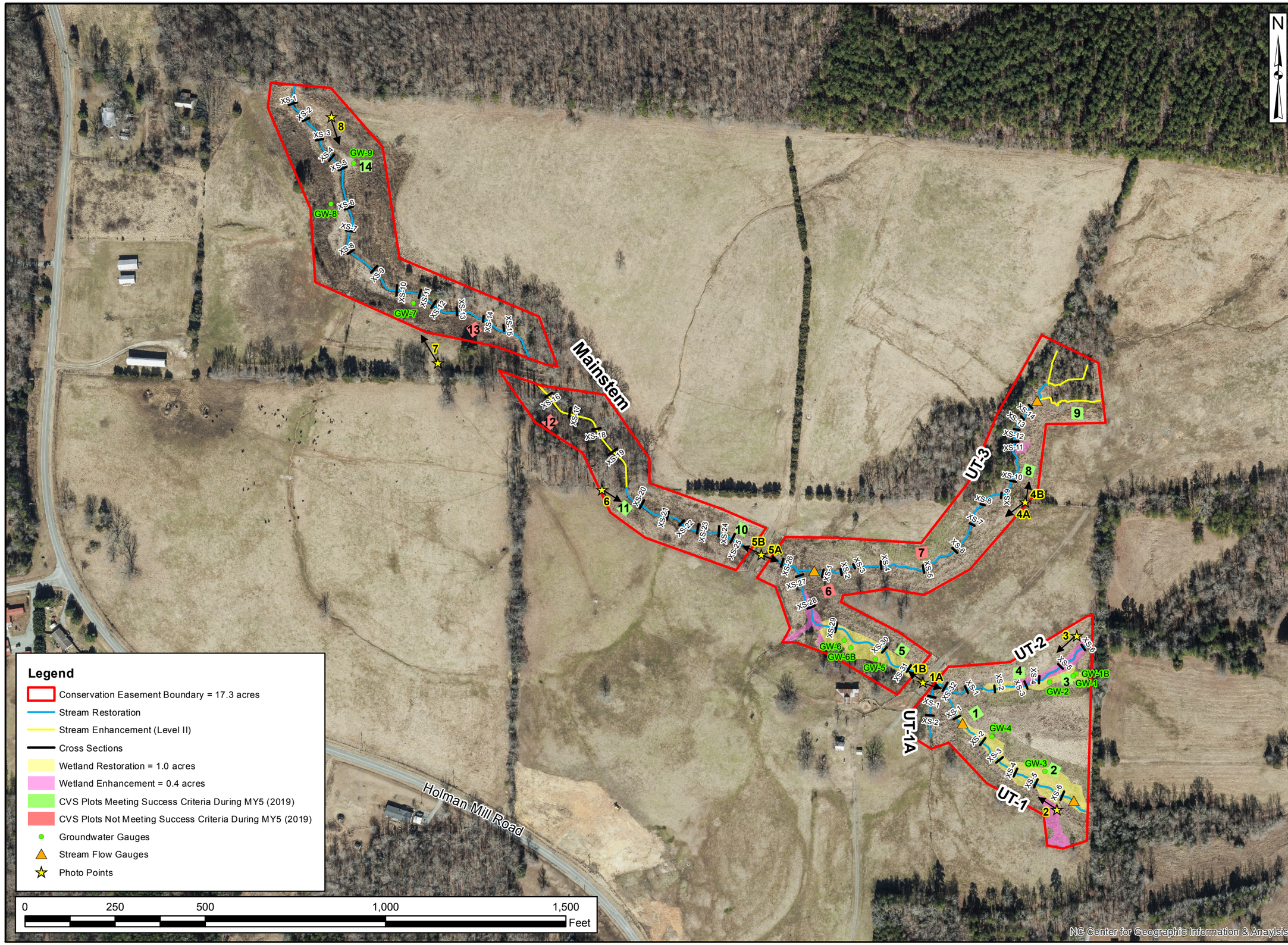
VISUAL ASSESSMENT DATA

Figure 2. Current Conditions Plan View (CCPV)

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

Table 6. Vegetation Condition Assessment

Stream Station Photographs



Axiom Environmental, Inc.

Prepared for:

RS RESTORATION SYSTEMS | LLC

Project:

ABBEY LAMM STREAM AND WETLAND MITIGATION SITE

Alamance County, NC

Title:

Current Conditions Plan View

Notes:

Background Imagery source: 2018 aerial photogarphy provided by the NC OneMap program (online, provided by the NC Geographic Information Coordination Council)

Drawn by:	KRJ
Date:	NOV 2019
Scale:	1:3000
Project No.:	14-005

FIGURE

2

Table 5A **Visual Stream Morphology Stability Assessment**
Reach ID **Lamm Mainstem**
Assessed Length **2781**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	56	56			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	55	55			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	55	55			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	55	55			100%			
		2. Thalweg centering at downstream of meander (Glide)	55	55			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	14	14			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	14	14			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	14	14			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	14	14			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	14	14			100%			

Table 5B **Visual Stream Morphology Stability Assessment**
Reach ID **Lamm UT1-A**
Assessed Length **154**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	6	6			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	5	5			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	5	5			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	5	5			100%			
		2. Thalweg centering at downstream of meander (Glide)	5	5			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	4	4			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	4	4			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	4	4			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	4	4			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	4	4			100%			

Table 5C **Visual Stream Morphology Stability Assessment**
Reach ID **Lamm UT1**
Assessed Length **541**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	25	25			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	24	24			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	24	24			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	24	24			100%			
		2. Thalweg centering at downstream of meander (Glide)	24	24			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	10	10			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	10	10			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	10	10			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	10	10			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	10	10			100%			

Table 5D **Visual Stream Morphology Stability Assessment**
Reach ID **Lamm UT2**
Assessed Length **455**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	23	23			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	22	22			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	22	22			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	22	22			100%			
		2. Thalweg centering at downstream of meander (Glide)	22	22			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	12	12			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	12	12			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	12	12			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	12	12			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	12	12			100%			

Table 5E **Visual Stream Morphology Stability Assessment**
Reach ID **UT3**
Assessed Length **1084**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	38	38			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	37	37			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	37	37			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	37	37			100%			
		2. Thalweg centering at downstream of meander (Glide)	37	37			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	23	23			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	23	23			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	23	23			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	23	23			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	23	23			100%			

Table 6 — Vegetation Condition Assessment

Abbey Lamm

Planted Acreage[1] 16.4

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	None	0.1 acres	none	0	0.00	0.0%
2. Low Stem Density Areas	None	0.1 acres	none	0	0.00	0.0%
2B. Low Planted Stem Density Areas	None	0.1 acres	none	0	0.00	0.0%
			Total	0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	None	0.25 acres	none	0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2] 17.3

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern[4]	None	1000 SF	none	0	0.00	0.0%
5. Easement Encroachment Areas[3]	None	none	none	0	0.00	0.0%

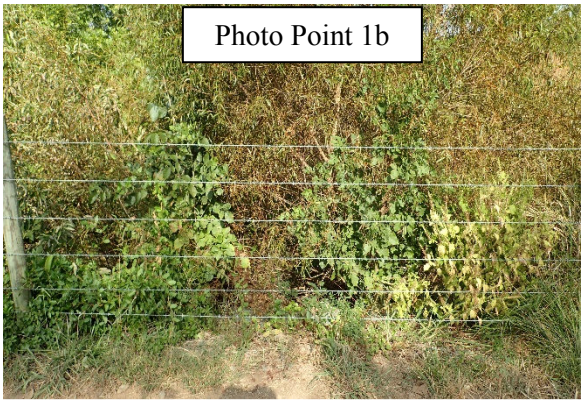
1 = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

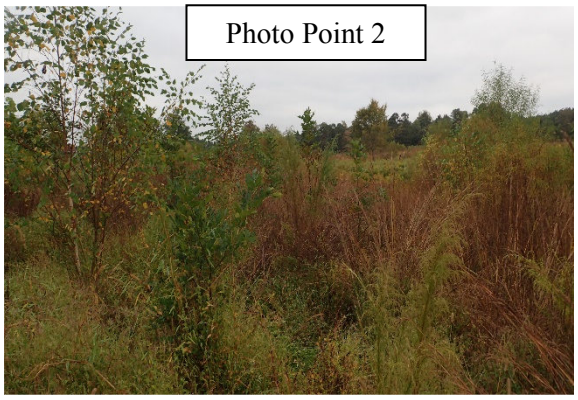
2 = The acreage within the easement boundaries.

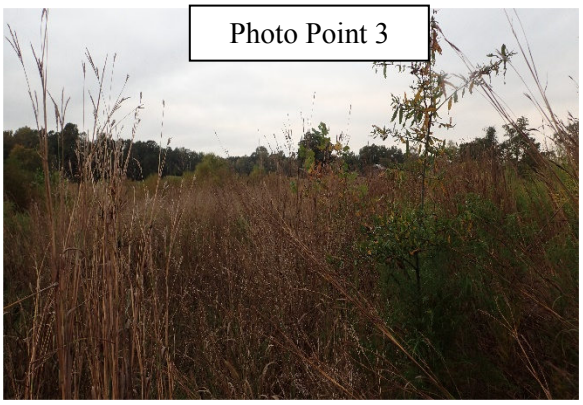
3 = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by DMS such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likley trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly ealry in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolzing invasives polygons, particulalry for situations where the conditon for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.

Abbey Lamm
Year 5 Fixed Station Photographs
Taken October 2019

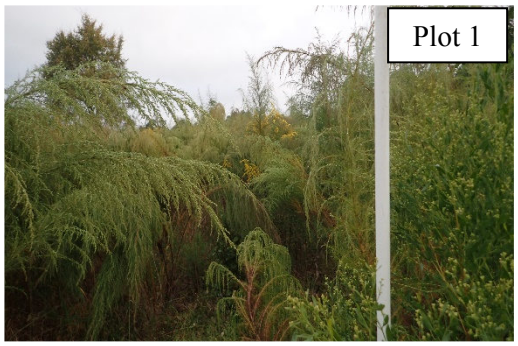


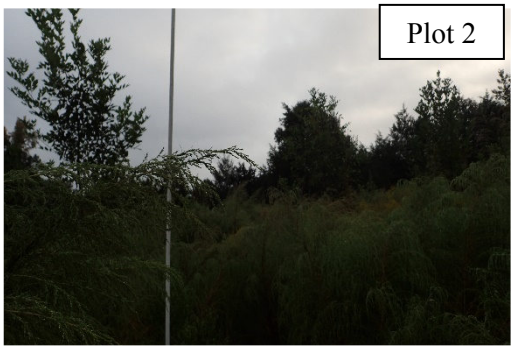


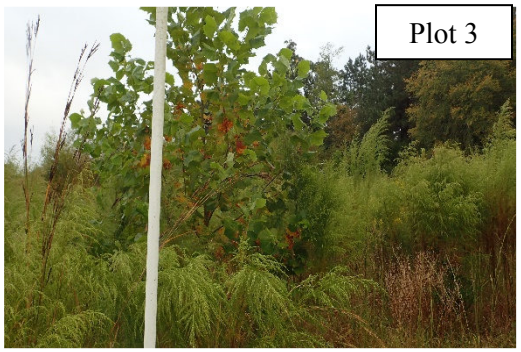


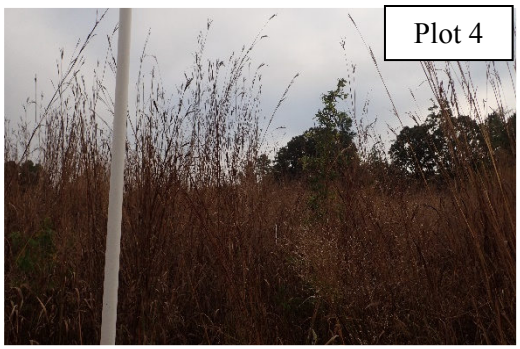
Abbey Lamm
Year 5 Fixed Station Photographs (continued)
Taken September 2019

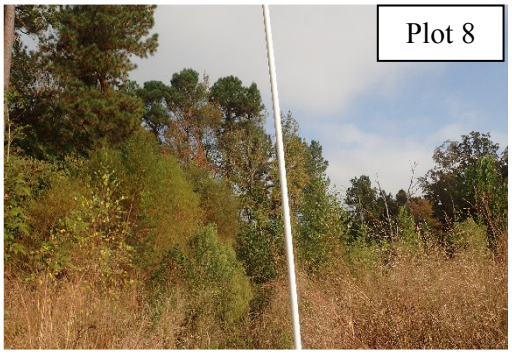
Abbey Lamm
Year 5 Vegetation Monitoring Photographs
Taken September 2019



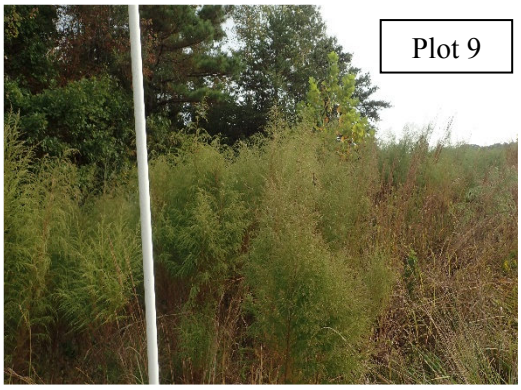


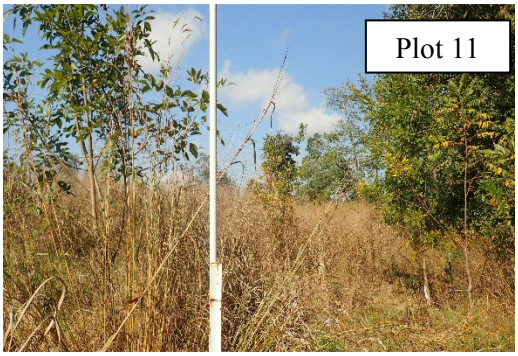






Abbey Lamm
Year 5 Vegetation Monitoring Photographs
Taken September 2019
(continued)





APPENDIX C

VEGETATION PLOT DATA

Table 7. Vegetation Plot Criteria Attainment

Table 8. CVS Vegetation Plot Metadata

Table 9. Total and Planted Stems by Plot and Species

Table 7. Vegetation Plot Criteria Attainment Based on Planted Stems

Vegetation Plot ID	Vegetation Survival Threshold Met?	MY 5 (2019) Planted Stems	MY 5 (2019) All Stems	Tract Mean
1	Yes	283	445	71.4%
2	Yes	526	768	
3	Yes	445	607	
4	Yes	323	526	
5	Yes	283	849	
6	No	202	202	
7	No	202	930	
8	Yes	566	1214	
9	Yes	323	1093	
10	Yes	283	323	
11	Yes	283	485	
12	No	80	80	
13	No	242	323	
14	Yes	283	323	
	Totals =	**309**	**583**	

Table 8. CVS Vegetation Plot Metadata

Report Prepared By	Corri Faquin
Date Prepared	9/26/2019 15:02
database name	RS-Lamm-2017-A-v2.3.1.mdb
database location	S:\Business\Projects\14\14-005 Abby Lamm Detailed\2019 Year 5 Monitoring\CVS
computer name	PHILLIP-LT
file size	56627200
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	14.005
project Name	Lamm
River Basin	Cape Fear
Sampled Plots	14

Table 9. Planted and Total Stems
Project Code 14.005. Project Name: Lamm

			Current Plot Data (MY5 2019)																													
			14.005-AXE-0001			14.005-AXE-0002			14.005-AXE-0003			14.005-AXE-0004			14.005-AXE-0005			14.005-AXE-0006			14.005-AXE-0007			14.005-AXE-0008			14.005-AXE-0009			14.005-AXE-0010		
Scientific Name	**Common Name**	**Species Type**	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree																														
Baccharis halimifolia	eastern baccharis	Shrub			1						1															3						
Betula nigra	river birch	Tree	2	2	2				1	1	1	1	1	1				1	1	1				2	2	2	1	1	1			
Carpinus caroliniana	American hornbeam	Tree													1	1	1															
Carya	hickory	Tree						2																								
Celtis	hackberry	Tree																														
Celtis laevigata	sugarberry	Tree																														
Cephalanthus occidentalis	common buttonbush	Shrub																														
Cornus amomum	silky dogwood	Shrub				1	1	1	3	3	3				1	1	1							6	6	6				1	1	1
Diospyros	diospyros	Tree																														
Diospyros virginiana	common persimmon	Tree						1			1	1	1	3				1	1	1										1	1	1
Fraxinus pennsylvanica	green ash	Tree			1	6	6	6	6	6	8			3	2	2	13						18	6	6	8			2	4	4	4
Juglans	walnut	Tree													1	1	1															
Juglans nigra	black walnut	Tree															1															1
Liquidambar	sweetgum	Tree																														
Liquidambar styraciflua	sweetgum	Tree			2			3																		7			9			
Liriodendron tulipifera	tuliptree	Tree				4	4	4									2										1	1	1			
Nyssa	tupelo	Tree	3	3	3	2	2	2																								
Nyssa aquatica	water tupelo	Tree																														
Nyssa sylvatica	blackgum	Tree													1	1	1															
Pinus taeda	loblolly pine	Tree																								1			3			
Platanus occidentalis	American sycamore	Tree							1	1	1	2	2	2				1	1	1	2	2	2				1	1	1			
Quercus	oak	Tree																														
Quercus alba	white oak	Tree										1	1	1	1	1	1				1	1	1				1	1	1	1	1	1
Quercus nigra	water oak	Tree										2	2	2				1	1	1							2	2	2			
Quercus pagoda	cherrybark oak	Tree																														
Quercus phellos	willow oak	Tree	2	2	2							1	1	1							2	2	2				2	2	2			
Quercus rubra	northern red oak	Tree																1	1	1												
Ulmus americana	American elm	Tree																											5			
Ulmus rubra	slippery elm	Tree																								3						
Unknown		Shrub or Tree																														
		Stem count	7	7	11	13	13	19	11	11	15	8	8	13	7	7	21	5	5	5	5	5	23	14	14	30	8	8	27	7	7	8
		size (ares)	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		
		Species count	3	3	6	4	4	7	4	4	6	6	6	7	6	6	8	5	5	5	3	3	4	3	3	7	6	6	10	4	4	5
		Stems per ACRE	283.3	283.3	445.2	526.1	526.1	768.9	445.2	445.2	607	323.7	323.7	526.1	283.3	283.3	849.8	202.3	202.3	202.3	202.3	202.3	930.8	566.6	566.6	1214	323.7	323.7	1093	283.3	283.3	323.7

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

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

Table 9. Planted and Total Stems (continued)
Project Code 14.005. Project Name: Lamm

			Current Plot Data (MY5 2019)												Annual Means														
			14.005-AXE-0011			14.005-AXE-0012			14.005-AXE-0013			14.005-AXE-0014			MY5 (2019)			MY3 (2017)			MY2 (2016)			MY1 (2015)			MY0 (2015)		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Acer rubrum	red maple	Tree												1			1			1									
Baccharis halimifolia	eastern baccharis	Shrub															5												
Betula nigra	river birch	Tree									1	1	1	1	9	9	10	10	10	10	6	6	6	9	9	9	14	14	14
Carpinus caroliniana	American hornbeam	Tree													1	1	1	2	2	2	1	1	1				5	5	5
Carya	hickory	Tree															2						3			1			
Celtis	hackberry	Tree																		1									
Celtis laevigata	sugarberry	Tree																						1	1	1	7	7	7
Cephalanthus occidentalis	common buttonbush	Shrub																						5	5	5	7	7	7
Cornus amomum	silky dogwood	Shrub	3	3	3				2	2	2				17	17	17	19	19	19	25	25	25	26	26	26	28	28	28
Diospyros	diospyros	Tree																						2	2	2			
Diospyros virginiana	common persimmon	Tree	1	1	2										4	4	9	3	3	5	7	7	7	14	14	14	20	20	20
Fraxinus pennsylvanica	green ash	Tree	3	3	3										27	27	66	26	26	62	27	27	41	21	21	21	24	24	24
Juglans	walnut	Tree													1	1	1	1	1	3									
Juglans nigra	black walnut	Tree			1						1						4			2			1			1			
Liquidambar	sweetgum	Tree																		4									
Liquidambar styraciflua	sweetgum	Tree															21						5						
Liriodendron tulipifera	tuliptree	Tree				1	1	1	3	3	3				9	9	11	10	10	10	12	12	12	27	27	27	44	44	44
Nyssa	tupelo	Tree													5	5	5	8	8	8	10	10	10	13	13	13	9	9	9
Nyssa aquatica	water tupelo	Tree																									1	1	1
Nyssa sylvatica	blackgum	Tree													1	1	1	2	2	2									
Pinus taeda	loblolly pine	Tree															4			8			1						
Platanus occidentalis	American sycamore	Tree										1	1	1	8	8	8	11	11	11	2	2	2	2	2	2	1	1	1
Quercus	oak	Tree																			2	2	2	11	11	11	27	27	27
Quercus alba	white oak	Tree				1	1	1	1	1	1				7	7	7	9	9	9	8	8	8	10	10	10	3	3	3
Quercus nigra	water oak	Tree										1	1	1	6	6	6	5	5	5									
Quercus pagoda	cherrybark oak	Tree										1	1	1	1	1	1												
Quercus phellos	willow oak	Tree										3	3	3	10	10	10	7	7	7	1	1	1						
Quercus rubra	northern red oak	Tree													1	1	1	6	6	6	1	1	1	4	4	4	6	6	6
Ulmus americana	American elm	Tree															5			3									
Ulmus rubra	slippery elm	Tree			3												6												
Unknown		Shrub or Tree																						3	3	3	9	9	9
		Stem count	7	7	12	2	2	2	6	6	8	7	7	8	107	107	202	119	119	178	102	102	126	148	148	150	205	205	205
		size (ares)	1			1			1			1			14			14			14			14			14		
		size (ACRES)	0.02			0.02			0.02			0.02			0.35			0.35			0.35			0.35			0.35		
		Species count	3	3	5	2	2	2	3	3	5	5	5	6	15	15	23	14	14	20	12	12	16	14	14	16	15	15	15
		Stems per ACRE	283.3	283.3	485.6	80.94	80.94	80.94	242.8	242.8	323.7	283.3	283.3	323.7	309.3	309.3	583.9	344	344	514.5	294.8	294.8	364.2	427.8	427.8	433.6	592.6	592.6	592.6

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 SURVEY DATA

Tables 10a-e. Baseline Stream Data Summary

Tables 11a-l. Morphology and Hydraulic Summary Data

Cross-section Plots

Substrate Plots

Table 10A. Baseline Morphology and Hydraulic Summary
Lamm UT 1

Parameter	USGS Gage Data			Pre-Existing Condition			Project Reference Cedarock Park			Project Reference Causey Farm			Design			As-built		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
BF Width (ft)	USGS gage data is unavailable for this project			4	12	6.5	8	12.1	8.1	10.7	11.3	11	6.5	7.5	7	6	9.1	8.6
Floodprone Width (ft)				6	27	17	15	25	18	122	140	131	30	90	50			50
BF Cross Sectional Area (ft2)						3.5			8			14.7			3.5	3.6	6.7	4.0
BF Mean Depth (ft)				0.3	0.9	0.6	0.8	1	0.8	1.3	1.4	1.4	0.46	0.55	0.5	0.5	0.7	0.6
BF Max Depth (ft)				0.7	1.3	1	1.1	1.4	1.4	1.9	2	2	0.6	0.8	0.7	0.7	1.2	0.9
Width/Depth Ratio				4.4	40	13.8	8	15.1	10.1	8	9	9	12	16	14	10	19	13
Entrenchment Ratio				1	6.8	2.9	1.9	2.2	2.1	11	13	12	4.3	12.9	7.1	6	8	5.8
Bank Height Ratio				1.3	2.6	1.7	1	1.8	1			1.4	1	1.3	1			1
Wetted Perimeter(ft)						===			===			===			===	6.3	9.6	8.9
Hydraulic radius (ft)						===			===			===			===	0.4	0.7	0.6
Pattern																		
Channel Beltwidth (ft)				No pattern of riffles and pools due to straightening activties			20	38	22.8	17	36	29.8	21	42	28	21	42	28
Radius of Curvature (ft)							11	27	16.5	9	113	30.6	14	70	21	14	70	21
Meander Wavelength (ft)							44	116	68.4	10	91	62.9	42	84	60	42	84	60
Meander Width ratio							2.4	4.7	2.8	1.5	3.5	2.7	3	6	4	3	6	4
Profile																		
Riffle length (ft)				No pattern of riffles and pools due to straightening activties					===			===			===	5	44	15
Riffle slope (ft/ft)							1.00%	5.76%	3.16%	0.20%	1.20%	0.98%	3.71%	7.73%	4.94%	1.10%	9.83%	2.98%
Pool length (ft)									===			===			===	5	12	8
Pool spacing (ft)							25	69	37.2	2	7.4	4	21	56	28	21	56	28
Substrate																		
d50 (mm)						===			===			===			===			===
d84 (mm)						===			===			===			===			===
Additional Reach Parameters																		
Valley Length (ft)						===			===			===			===			466
Channel Length (ft)						===			===			===			===			559
Sinuosity						1.02			1.2			1.46			1.2			1.2
Water Surface Slope (ft/ft)						2.84%			2.58%			0.53%			2.56% - 3.62%			2.56%
BF slope (ft/ft)						===			===			===			===			===
Rosgen Classification						E/G 5			E 4/5			E 4/5			E/C 3/4			E/C 3/4

Table 10B. Baseline Morphology and Hydraulic Summary
Lamm UT 2

Parameter	USGS Gage Data			Pre-Existing Condition			Project Reference Cedarock Park			Project Reference Causey Farm			Design			As-built^		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
BF Width (ft)	USGS gage data is unavailable for this project			7.1	15.6	9.7	8	12.1	8.1	10.7	11.3	11	6.5	7.5	7	5.9	9.7	7.6
Floodprone Width (ft)				15	40	27	15	25	18	122	140	131	30	90	50			50
BF Cross Sectional Area (ft2)						3.8			8			14.7			3.5	2.3	5.5	3.2
BF Mean Depth (ft)				0.2	0.5	0.4	0.8	1	0.8	1.3	1.4	1.4	0.46	0.55	0.5	0.4	0.6	0.4
BF Max Depth (ft)				0.5	1.3	0.8	1.1	1.4	1.4	1.9	2	2	0.6	0.8	0.7	0.5	1	0.7
Width/Depth Ratio				14.2	78	28.8	8	15.1	10.1	8	9	9	12	16	14	15	21	17
Entrenchment Ratio				1	5.6	3	1.9	2.2	2.1	11	13	12	4.3	12.9	7.1	5	9	6.6
Bank Height Ratio				1	3	1.6	1	1.8	1			1.4	1	1.3	1			1
Wetted Perimeter(ft)						===			===			===			===	6.1	10.1	7.7
Hydraulic radius (ft)						===			===			===			===	0.3	0.5	0.4
Pattern																		
Channel Beltwidth (ft)				No pattern of riffles and pools due to straightening activties			20	38	22.8	17	36	29.8	21	42	28	21	42	28
Radius of Curvature (ft)							11	27	16.5	9	113	30.6	14	70	21	14	70	21
Meander Wavelength (ft)							44	116	68.4	10	91	62.9	42	84	60	42	84	60
Meander Width ratio							2.4	4.7	2.8	1.5	3.5	2.7	3	6	4	3	8	4
Profile																		
Riffle length (ft)				No pattern of riffles and pools due to straightening activties					===			===			===	5	26	12
Riffle slope (ft/ft)							1.00%	5.76%	3.16%	0.20%	1.20%	0.98%	3.71%	7.73%	4.94%	0.84%	4.64%	2.94%
Pool length (ft)									===			===			===	4	14	8
Pool spacing (ft)							25	69	37.2	2	7.4	4	21	56	28	21	56	28
Substrate																		
d50 (mm)						===			===			===			===			===
d84 (mm)						===			===			===			===			===
Additional Reach Parameters																		
Valley Length (ft)						===			===			===			===			387
Channel Length (ft)						===			===			===			===			464
Sinuosity						1.03			1.2			1.46			1.2			1.2
Water Surface Slope (ft/ft)						3.07% - 4.31%			2.58%			0.53%			2.56% - 3.62%			3.01%
BF slope (ft/ft)						===			===			===			===			===
Rosgen Classification						C/G 5			E 4/5			E 4/5			E/C 3/4			E/C 3/4

^Measured as-built numbers do not include D-type reach.

Table 10C. Baseline Morphology and Hydraulic Summary
Lamm UT 3

Parameter	USGS Gage Data			Pre-Existing Condition			Project Reference Cedarock Park			Project Reference Causey Farm			Design			As-built		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
BF Width (ft)	USGS gage data is unavailable for this project			3.4	12.3	7.2	8	12.1	8.1	10.7	11.3	11	6.5	7.5	7	6.3	8.6	7.3
Floodprone Width (ft)				18	40	26	15	25	18	122	140	131	30	90	50			250
BF Cross Sectional Area (ft2)						2.6			8			14.7			3.5	2	3.1	2.5
BF Mean Depth (ft)				0.2	0.8	0.4	0.8	1	0.8	1.3	1.4	1.4	0.46	0.55	0.5	0.3	0.5	0.3
BF Max Depth (ft)				0.5	1.3	0.8	1.1	1.4	1.4	1.9	2	2	0.6	0.8	0.7	0.4	0.8	0.6
Width/Depth Ratio				4.3	61.5	24	8	15.1	10.1	8	9	9	12	16	14	15	27	23
Entrenchment Ratio				2.4	7	4.1	1.9	2.2	2.1	11	13	12	4.3	12.9	7.1	6	8	6.8
Bank Height Ratio				1	2	1.4	1	1.8	1			1.4	1	1.3	1			1
Wetted Perimeter(ft)						===			===			===			===	6.4	8.8	7.4
Hydraulic radius (ft)						===			===			===			===	0.3	0.4	0.3
Pattern																		
Channel Beltwidth (ft)				No pattern of riffles and pools due to straightening activties			20	38	22.8	17	36	29.8	21	42	28	21	42	28
Radius of Curvature (ft)							11	27	16.5	9	113	30.6	14	70	21	14	70	21
Meander Wavelength (ft)							44	116	68.4	10	91	62.9	42	84	60	42	84	60
Meander Width ratio							2.4	4.7	2.8	1.5	3.5	2.7	3	6	4	3	8	4
Profile																		
Riffle length (ft)				No pattern of riffles and pools due to straightening activties					===			===			===	6	66	21
Riffle slope (ft/ft)							1.00%	5.76%	3.16%	0.20%	1.20%	0.98%	3.71%	7.73%	4.94%	0.82%	6.50%	3.13%
Pool length (ft)									===			===			===	4	14	7
Pool spacing (ft)							25	69	37.2	2	7.4	4	21	56	28	21	56	28
Substrate																		
d50 (mm)						===			===			===			===			===
d84 (mm)						===			===			===			===			===
Additional Reach Parameters																		
Valley Length (ft)						===			===			===			===			846
Channel Length (ft)						===			===			===			===			1015
Sinuosity						1.05			1.2			1.46			1.2			1.2
Water Surface Slope (ft/ft)						3.34%			2.58%			0.53%			2.56% - 3.62%			3.19%
BF slope (ft/ft)						===			===			===			===			===
Rosgen Classification						Fc 5/6			Eg 5			E 4/5			E/C 3/4			C 3/4

Table 10D. Baseline Morphology and Hydraulic Summary
Lamm Main Upstream

Parameter	USGS Gage Data			Pre-Existing Condition			Project Reference Cedarock Park			Project Reference Causey Farm			Design			As-built		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
BF Width (ft)	USGS gage data is unavailable for this project			11.7	26.5	18.5	8	12.1	8.1	10.7	11.3	11	11.2	12.9	12.1	12.3	13.3	12.7
Floodprone Width (ft)				29	75	56	15	25	18	122	140	131	20	90	40			250
BF Cross Sectional Area (ft2)						10.4			8			14.7			10.4	8.8	12.5	10.4
BF Mean Depth (ft)				0.4	0.9	0.6	0.8	1	0.8	1.3	1.4	1.4	0.8	0.9	0.9	0.7	1	0.85
BF Max Depth (ft)				1.1	1.7	1.3	1.1	1.4	1.4	1.9	2	2	1.1	1.4	1.3	1	12.6	1.3
Width/Depth Ratio				11.7	66.3	31.5	8	15.1	10.1	8	9	9	12	16	14	13	17	15
Entrenchment Ratio				1.9	24	6.2	1.9	2.2	2.1	11	13	12	1.7	7.4	3.3	7	7	7.05
Bank Height Ratio				1	1.9	1.2	1	1.8	1			1.4	1	1.3	1			1
Wetted Perimeter(ft)						===			===			===			===	13	13.9	13.2
Hydraulic radius (ft)						===			===			===			===	0.7	0.9	0.8
Pattern																		
Channel Beltwidth (ft)				No pattern of riffles and pools due to straightening activties			20	38	22.8	17	36	29.8	36	73	48	36	73	48
Radius of Curvature (ft)							11	27	16.5	9	113	30.6	24	121	36	24	121	36
Meander Wavelength (ft)							44	116	68.4	10	91	62.9	73	145	103	73	145	103
Meander Width ratio							2.4	4.7	2.8	1.5	3.5	2.7	3	6	4	3	6	4
Profile																		
Riffle length (ft)				No pattern of riffles and pools due to straightening activties					===			===			===	9	66	26
Riffle slope (ft/ft)							1.00%	5.76%	3.16%	0.20%	1.20%	0.98%	2.15%	4.48%	2.86%	0.00%	3.87%	1.86%
Pool length (ft)									===			===			===	5	34	12
Pool spacing (ft)							25	69	37.2	2	7.4	4	36	97	48	36	97	48
Substrate																		
d50 (mm)						===			===			===			===			===
d84 (mm)						===			===			===			===			===
Additional Reach Parameters																		
Valley Length (ft)						===			===			===			===			949
Channel Length (ft)						===			===			===			===			1139
Sinuosity						1.05			1.2			1.46			1.2			1.2
Water Surface Slope (ft/ft)						1.76%			2.58%			0.53%			1.79%			1.57%
BF slope (ft/ft)						===			===			===			===			===
Rosgen Classification						Eg5/Fc			E 4/5			E 4/5			E/C 3/4			E/C 3/4

Table 10E. Baseline Morphology and Hydraulic Summary
Lamm Main Downstream

Parameter	USGS Gage Data			Pre-Existing Condition			Project Reference Cedarock Park			Project Reference Causey Farm			Design			As-built		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
BF Width (ft)	USGS gage data is unavailable for this project			8.7	17	13	8	12.1	8.1	10.7	11.3	11	11.2	12.9	12.1	12.8	13.4	13.0
Floodprone Width (ft)				17	24	22	15	25	18	122	140	131	20	90	40			250
BF Cross Sectional Area (ft2)						10.4			8			14.7			10.4	9.7	11.8	11.3
BF Mean Depth (ft)				0.6	1.2	0.9	0.8	1	0.8	1.3	1.4	1.4	0.8	0.9	0.9	0.8	0.9	0.8
BF Max Depth (ft)				0.9	1.9	1.4	1.1	1.4	1.4	1.9	2	2	1.1	1.4	1.3	1.1	1.3	1.3
Width/Depth Ratio				7.3	28.3	17.4	8	15.1	10.1	8	9	9	12	16	14	15	17	16
Entrenchment Ratio				1.2	2.6	1.8	1.9	2.2	2.1	11	13	12	1.7	7.4	3.3	7	7	6.9
Bank Height Ratio				1.3	2.7	2	1	1.8	1			1.4	1	1.3	1			1
Wetted Perimeter(ft)						===			===			===			===	13.2	14.1	13.6
Hydraulic radius (ft)						===			===			===			===	0.7	0.9	0.8
Pattern																		
Channel Beltwidth (ft)				No pattern of riffles and pools due to straightening activties			20	38	22.8	17	36	29.8	36	73	48	36	73	48
Radius of Curvature (ft)							11	27	16.5	9	113	30.6	24	121	36	24	121	36
Meander Wavelength (ft)							44	116	68.4	10	91	62.9	73	145	103	73	145	103
Meander Width ratio							2.4	4.7	2.8	1.5	3.5	2.7	3	6	4	3	6	4
Profile																		
Riffle length (ft)				No pattern of riffles and pools due to straightening activties					===			===			===	15	142	59
Riffle slope (ft/ft)							1.00%	5.76%	3.16%	0.20%	1.20%	0.98%	2.15%	4.48%	2.86%	0.71%	3.22%	1.93%
Pool length (ft)									===			===			===	7	40	18
Pool spacing (ft)							25	69	37.2	2	7.4	4	36	97	48	36	97	48
Substrate																		
d50 (mm)						===			===			===			===			===
d84 (mm)						===			===			===			===			===
Additional Reach Parameters																		
Valley Length (ft)						===			===			===			===			961
Channel Length (ft)						===			===			===			===			1153
Sinuosity						NA			1.2			1.46			1.2			1.2
Water Surface Slope (ft/ft)						NA			2.58%			0.53%			1.79%			1.72%
BF slope (ft/ft)						===			===			===			===			===
Rosgen Classification						Eg5/Fc			E 4/5			E 4/5			E/C 3/4			E/C 3/4

Table 11A. Morphology and Hydraulic Monitoring Summary
Lamm UT-Main (Downstream) - Stream and Wetland Restoration Site

Parameter	XS 1 Pool (Main Down)						XS 2 Riffle (Main Down)						XS 3 Riffle (Main Down)						XS 4 Riffle (Main Down)						XS 5 Pool (Main Down)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	13	12.2	12.5	11.8	10		12.8	14.4	12.6	13.2	13.9		13.1	*	12.9	14.3	12.8		13	12.7	12.1	12.6	12.6		14.1	14.8	15.7	17.2	17.3	
Floodprone Width (ft)	----	----	----	----	----		90	90	90	90	90		90	*	90	90	90		90	90	90	90	90		----	----	----	----	----	
BF Cross Sectional Area (ft2)	11.2	12.2	9.7	9.4	9.4		9.7	11.1	12.6	9.5	9.5		11.8	*	9.1	8.1	8.1		11.3	10.5	10.3	9.4	9.4		11.8	6.6	7.7	7.6	7.6	
BF Mean Depth (ft)	0.9	1.0	0.8	0.8	0.9		0.8	0.8	1.0	0.7	0.7		0.9	*	0.7	0.6	0.6		0.9	0.8	0.9	0.7	0.7		0.8	0.4	0.5	0.4	0.4	
BF Max Depth (ft)	1.7	1.5	1.6	1.4	1.6		1.1	1.1	1.2	1.2	1.1		1.3	*	1.3	1.2	1.3		1.3	1.4	1.4	1.2	1.1		1.7	0.8	0.8	0.8	0.7	
Width/Depth Ratio	----	----	----	----	----		16.9	18.7	12.6	18.3	20.3		14.5	*	18.3	25.2	20.2		15.0	15.4	14.2	16.9	16.9		----	----	----	----	----	
Entrenchment Ratio	----	----	----	----	----		7.0	6.3	7.1	6.8	6.5		6.9	*	7.0	6.3	7.0		6.9	7.1	7.4	7.1	7.1		----	----	----	----	----	
Low Bank Height (ft)	1.7	1.7	1.7	1.7	1.6		1.1	1.1	1.1	1.1	1.1		1.3	*	1.3	1.3	1.3		1.3	1.3	1.3	1.3	1.1		1.7	1.7	1.7	1.7	0.6	
Bank Height Ratio**	----	----	----	----	----		1	1	1.091	1.091	1		1	*	1	<1	1		1	1.077	1.077	<1	1		----	----	----	----	----	
Wetted Perimeter (ft)	13.6	12.7	13.2	12.3	10.7		13.2	14.7	13	13.6	14.3		13.7	*	13.4	14.7	13.2		13.6	13.2	12.8	13	13		15	15.1	15.9	17.3	17.4	
Hydraulic Radius (ft)	0.8	0.8	0.7	0.8	0.9		0.7	0.8	1.0	0.7	0.7		0.9	*	0.7	0.6	0.6		0.8	0.8	0.8	0.7	0.7		0.8	0.4	0.5	0.4	0.4	

Parameter	XS 6 Riffle (Main Down)						XS 7 Riffle (Main Down)						XS 8 Riffle (Main Down)						XS 9 Riffle (Main Down)						XS 10 Riffle (Main Down)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	13.4	13.3	13	12.7	13.3		12.8	11.2	12.2	11.9	12.7		13.6	13.5	14	14.7	14.5		12.3	14	12.5	12.1	12.3		16.1	17.2	17.3	16.9	16.6	
Floodprone Width (ft)	90	90	90	90	90		90	90	90	90	90		90	90	90	90	90		90	90	90	90	90		90	90	90	90	90	
BF Cross Sectional Area (ft2)	11.3	11	13.4	12.1	12.1		8.7	8.9	9.1	8.8	8.8		11.6	8.2	7.6	6.8	6.8		9.8	9.8	8.9	7.3	7.3		12.4	11.8	12.1	10.1	10.1	
BF Mean Depth (ft)	0.8	0.8	1.0	1.0	0.9		0.7	0.8	0.7	0.7	0.7		0.9	0.6	0.5	0.5	0.5		0.8	0.7	0.7	0.6	0.6		0.8	0.7	0.7	0.6	0.6	
BF Max Depth (ft)	1.3	1.6	1.8	1.7	2		1.2	1.2	1.3	1.2	1.2		1.5	0.9	0.8	0.8	0.7		1.2	1.3	1.2	1.3	1		1.3	1.1	1.2	1.2	1	
Width/Depth Ratio	15.9	16.1	12.6	13.3	14.6		18.8	14.1	16.4	16.1	18.3		15.9	22.2	25.8	31.8	30.9		15.4	20.0	17.6	20.1	20.7		20.9	25.1	24.7	28.3	27.3	
Entrenchment Ratio	6.7	6.8	6.9	7.1	6.8		7.0	8.0	7.4	7.6	7.1		6.6	6.7	6.4	6.1	6.2		7.3	6.4	7.2	7.4	7.3		5.6	5.2	5.2	5.3	5.4	
Low Bank Height (ft)	1.3	1.3	1.3	1.3	1.4		1.2	1.2	1.2	1.2	1.2		1.5	1.5	1.5	1.5	0.8		1.2	1.2	1.2	1.2	1.1		1.3	1.3	1.3	1.3	0.8	
Bank Height Ratio	1	1.231	1.385	1.308	<1		1	1	1.083	1	1		1	<1	<1	<1	1.143		1	1.083	1	1.083	1.1		1	<1	<1	<1	<1	
Wetted Perimeter (ft)	14.1	13.9	13.9	13.4	14.1		13.2	11.6	12.8	12.4	13		14.3	13.8	14.4	14.9	14.7		12.9	14.5	12.8	15.2	12.5		16.6	17.5	17.6	17.2	16.8	
Hydraulic Radius (ft)	0.8	0.8	1.0	0.9	0.9		0.7	0.8	0.7	0.7	0.7		0.8	0.6	0.5	0.5	0.5		0.8	0.7	0.7	0.5	0.6		0.7	0.7	0.7	0.6	0.6	

* Note: Cross Section 3 was not measured in MY1 due to yellow jacket nest at cross section.

**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Table 11B. Morphology and Hydraulic Monitoring Summary
Lamm UT-Main (Downstream) - Stream and Wetland Restoration Site

Parameter	MY-00 (2015)			MY-01 (2015)			MY-02 (2016)			MY-03 (2017)			MY-05 (2019)			MY-07 (2021)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern																		
Channel Beltwidth (ft)	36	73	48															
Radius of Curvature (ft)	24	121	36															
Meander Wavelength (ft)	73	145	103															
Meander Width Ratio	3	6	4															
Profile																		
Riffle Length (ft)	15	142	59															
Riffle Slope (ft/ft)	0.71%	3.22%	1.93%															
Pool Length (ft)	7	40	18															
Pool Spacing (ft)	36	97	48															
Additonal Reach Parameters																		
Valley Length (ft)	961			961			961			961			961					
Channel Length (ft)	1,153			1,153			1,153			1,153			1,153					
Sinuosity	1.2																	
Water Surface Slope (ft/ft)	0.0172																	
BF Slope (ft/ft)	------			------			------			------			------					
D50	16.2			13.6			42.1			40.8			30.6					
D84	60			67			97			99			98					
Rosgen Classification	C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4					

Table 11C. Morphology and Hydraulic Monitoring Summary
Lamm UT-Main (Downstream) - Stream and Wetland Restoration Site

Parameter	XS 11 Pool (Main Down)						XS 12 Riffle (Main Down)						XS 13 Riffle (Main Down)						XS 14 Riffle (Main Down)						XS 15 Pool (Main Down)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	13.4	10.5	10.7	11	13.6		11.9	11.5	11.8	12.5	12.7		15.4	16	17	15.8	16.4		13	13.3	12.9	13	13.1		16.1	13.8	12.6	12.6	12.3	
Floodprone Width (ft)	----	----	----	----	----		90	90	90	90	90		90	90	90	90	90		90	90	90	90	90		----	----	----	----	----	
BF Cross Sectional Area (ft2)	9.8	11.3	11.2	11.6	11.6		7.2	5.1	5.2	5.5	5.5		8.6	9.2	8.4	7.2	7.2		12.9	15.6	16	14.2	14.2		12.7	10.4	10.1	9.1	9.1	
BF Mean Depth (ft)	0.7	1.1	1.0	1.1	0.9		0.6	0.4	0.4	0.4	0.4		0.6	0.6	0.5	0.5	0.4		1.0	1.2	1.2	1.1	1.1		0.8	0.8	0.8	0.7	0.7	
BF Max Depth (ft)	1.4	1.6	1.6	1.6	1.6		1	1	0.8	0.6	0.7		0.9	1.5	1.1	1.3	1		1.4	2.2	1.9	1.9	1.8		1.8	1.6	1.5	1.4	1.2	
Width/Depth Ratio	----	----	----	----	----		19.7	25.9	26.8	28.4	29.3		27.6	27.8	34.4	34.7	37.4		13.1	11.3	10.4	11.9	12.1		----	----	----	----	----	
Entrenchment Ratio	----	----	----	----	----		7.6	7.8	7.6	7.2	7.1		5.8	5.6	5.3	5.7	5.5		6.9	6.8	7.0	6.9	6.9		----	----	----	----	----	
Low Bank Height (ft)	1.4	1.4	1.4	1.4	1.4		1	1	1	1	0.9		0.9	0.9	0.9	0.9	0.9		1.4	1.4	1.4	1.4	2.1		1.8	1.8	1.8	1.8	1.2	
Bank Height Ratio**	----	----	----	----	----		1	1	<1	<1	1.286		1	1.667	1.222	1.444	<1		1	1.571	1.357	1.357	1.167		----	----	----	----	----	
Wetted Perimeter (ft)	13.9	11.3	11.5	11.9	14.3		12.2	11.7	11.7	12.9	12.8		15.6	16.6	17.5	16.5	16.6		13.6	14.5	14.4	14.3	14.2		16.7	14.4	13.4	13.4	12.9	
Hydraulic Radius (ft)	0.7	1	1.0	1.0	0.8		0.6	0.4	0.4	0.4	0.4		0.6	0.6	0.5	0.4	0.4		1	1.1	1.1	1.0	1.0		0.8	0.7	0.8	0.7	0.7	

Parameter	XS 16 Riffle (Main Down)*						XS 17 Riffle (Main Down)*						XS 18 Riffle (Main Down)*						XS 19 Pool (Main Down)*					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	16.2	16.0	16.2	16.0	16.6		14.3	14	13.9	14.4	14.8		13.2	13.1	13.3	13.5	13.6		12	12.1	11.8	11.7	12.6	
Floodprone Width (ft)	20.0	20.0	20.0	20.0	20.0		19	19	19	19	19		31	31	31	31	31		----	----	----	----	----	
BF Cross Sectional Area (ft2)	10.1	9.6	9.8	8.6	8.6		11.2	12.6	11.5	13.2	13.2		10.1	11.6	11.9	11.8	11.8		13.1	14.6	14.6	13.4	13.4	
BF Mean Depth (ft)	0.6	0.6	0.6	0.5	0.5		0.8	0.9	0.8	0.9	0.9		0.8	0.9	0.9	0.9	0.9		1.1	1.2	1.2	1.1	1.1	
BF Max Depth (ft)	0.8	0.9	1.0	0.9	0.8		1.3	1.4	1.1	1.2	1.4		1.2	1.4	1.5	1.4	1.3		1.4	1.9	1.7	1.5	1.5	
Width/Depth Ratio	26.0	26.7	26.8	29.8	32.0		18.3	15.6	16.8	15.7	16.6		17.3	14.8	14.9	15.4	15.7		----	----	----	----	----	
Entrenchment Ratio	1.2	1.3	1.2	1.3	1.2		1.3	1.4	1.4	1.3	1.3		2.3	2.4	2.3	2.3	2.3		----	----	----	----	----	
Low Bank Height (ft)	1.9	0.8	0.8	0.8	1.9		1.3	1.3	1.3	1.3	2.3		1.2	1.2	1.2	1.2	2.2		1.4	1.4	1.4	1.4	1.6	
Bank Height Ratio	2.375	1.125	1.25	1.125	2.375		1	1.077	<1	<1	1.643		1	1.167	1.25	1.167	1.692		----	----	----	----	----	
Wetted Perimeter (ft)	16.4	16.2	16.5	16.2	16.7		15.3	14.9	14.9	15.7	16.1		14	14.1	14.7	14.8	14.3		12.9	13	12.8	12.6	13.2	
Hydraulic Radius (ft)	0.6	0.6	0.6	0.5	0.5		0.7	0.8	0.8	0.8	0.8		0.7	0.8	0.8	0.8	0.8		1	1.1	1.1	1.1	1.0	

* Enhancement (Level II) Reach

**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Table 11D. Morphology and Hydraulic Monitoring Summary
Lamm UT-Main (Downstream) - Stream and Wetland Restoration Site

Parameter	MY-00 (2015)			MY-01 (2015)			MY-02 (2016)			MY-03 (2017)			MY-05 (2019)			MY-07 (2021)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern																		
Channel Beltwidth (ft)	36	73	48															
Radius of Curvature (ft)	24	121	36															
Meander Wavelength (ft)	73	145	103															
Meander Width Ratio	3	6	4															
Profile																		
Riffle Length (ft)	15	142	59															
Riffle Slope (ft/ft)	0.71%	3.22%	1.93%															
Pool Length (ft)	7	40	18															
Pool Spacing (ft)	36	97	48															
Additonal Reach Parameters																		
Valley Length (ft)	961			961			961			961			961					
Channel Length (ft)	1,153			1,153			1,153			1,153			1,153					
Sinuosity	1.2																	
Water Surface Slope (ft/ft)	0.0172																	
BF Slope (ft/ft)	------			------			------			------			------					
D50	16.2			13.6			42.1			40.8			30.6					
D84	60			67			97			99			98					
Rosgen Classification	C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4					

Table 11E. Morphology and Hydraulic Monitoring Summary
Lamm Main (Upstream) - Stream and Wetland Restoration Site

Parameter	XS 20 Pool (Main Up)						XS 21 Riffle (Main Up)						XS 22 Riffle (Main Up)						XS 23 Riffle (Main Up)						XS 24 Pool (Main Up)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	7.1	8.1	11.8	11.7	10.6		13.3	13	12	13	12.6		12.6	13.4	13	13.3	11.8		12.3	13.3	11.9	12.8	12.7		12.8	13.1	12.1	12.9	14.7	
Floodprone Width (ft)	----	----	----	----	----		90	90	90	90	90		90	90	90	90	90		90	90	90	90	90		----	----	----	----	----	
BF Cross Sectional Area (ft2)	6.7	4.9	5.6	5.6	5.6		12.5	10	9.9	9.1	9.1		12.5	11.3	11.2	11.5	11.5		8.8	9.5	9.1	8.8	8.8		13.1	12.9	13.1	12.9	12.9	
BF Mean Depth (ft)	0.9	0.6	0.5	0.5	0.5		0.9	0.8	0.8	0.7	0.7		1.0	0.8	0.9	0.9	1.0		0.7	0.7	0.8	0.7	0.7		1.0	1.0	1.1	1.0	0.9	
BF Max Depth (ft)	1.3	1	1	1	1		1.4	1.5	1.6	1.6	1.3		1.4	1.9	1.9	2.2	2.2		1	1.3	1.5	1.4	1.4		1.8	1.6	1.7	1.6	1.6	
Width/Depth Ratio	----	----	----	----	----		14.2	16.9	14.5	18.6	17.4		12.7	15.9	15.1	15.4	12.1		17.2	18.6	15.6	18.6	18.3		----	----	----	----	----	
Entrenchment Ratio	----	----	----	----	----		6.8	6.9	7.5	6.9	7.1		7.1	6.7	6.9	6.8	7.6		7.3	6.8	7.6	7.0	7.1		----	----	----	----	----	
Low Bank Height (ft)	1.3	1.3	1.3	1.3	1.2		1.4	1.4	1.4	1.4	1.3		1.4	1.4	1.4	1.4	2.5		1	1	1	1	1.6		1.8	1.8	1.8	1.8	1.6	
Bank Height Ratio	----	----	----	----	----		1	1.071	1.143	1.143	1		1	1.357	1.357	1.571	1.136		1	1.3	1.5	1.4	1.143		----	----	----	----	----	
Wetted Perimeter (ft)	8.4	8.6	12.2	12.2	10.9		13.9	13.4	12.4	13.7	13		13.3	14.4	13.9	14.7	13.3		13	13.9	12.6	13.3	13.1		13.6	13.9	12.9	13.7	15.3	
Hydraulic Radius (ft)	0.8	0.6	0.5	0.5	0.5		0.9	0.7	0.8	0.7	0.7		0.9	0.8	0.8	0.8	0.9		0.7	0.7	0.7	0.7	0.7		1	0.9	1.0	0.9	0.8	

Parameter	XS 25 Riffle (Main Up)						XS 26 Pool (Main Up)						XS 27 Riffle (Main Up)						XS 28 Pool (Main Up)						XS 29 Riffle (Main Up)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	13.0	15.4	15.2	15.2	14.4		13.3	13.4	13.9	13.5	13.6		12.0	12.8	12.3	12.4	13.5		11.4	11.0	10.3	10.4	13.1		12.8	12.7	12.5	12.3	13.7	
Floodprone Width (ft)	90.0	90.0	90.0	90.0	90.0		----	----	----	----	----		90.0	90.0	90.0	90.0	90.0		----	----	----	----	----		90.0	90.0	90.0	90.0	90.0	
BF Cross Sectional Area (ft2)	11.3	11.4	10.8	10.6	10.6		12.1	11.8	11.6	10.8	10.8		9.5	9.7	10.8	9.8	9.8		8.4	8.9	7.6	8.3	8.3		12.1	12.1	12.0	11.6	11.6	
BF Mean Depth (ft)	0.9	0.7	0.7	0.7	0.7		0.9	0.9	0.8	0.8	0.8		0.8	0.8	0.9	0.8	0.7		0.7	0.8	0.7	0.8	0.6		0.9	1.0	1.0	0.9	0.8	
BF Max Depth (ft)	1.4	1.2	1.3	1.3	1.3		1.8	1.6	1.7	1.6	1.5		1.2	1.2	1.4	1.2	1.2		1.3	1.5	1.4	1.4	1.3		1.4	1.5	1.4	1.4	1.3	
Width/Depth Ratio	15.0	20.8	21.4	21.8	19.6		----	----	----	----	----		15.2	16.9	14.0	15.7	18.6		----	----	----	----	----		13.5	13.3	13.0	13.0	16.2	
Entrenchment Ratio	6.9	5.8	5.9	5.9	6.3		----	----	----	----	----		7.5	7.0	7.3	7.3	6.7		----	----	----	----	----		7.0	7.1	7.2	7.3	6.6	
Low Bank Height (ft)	1.4	1.4	1.4	1.4	1.2		1.8	1.8	1.8	1.8	1.5		1.2	1.2	1.2	1.2	1.3		1.3	1.3	1.3	1.3	1.4		1.4	1.4	1.4	1.4	1.2	
Bank Height Ratio**	1	<1	<1	<1	<1		1	<1	<1	<1	1		1	1	1.167	1	1.083		----	----	----	----	----		1	1.071	1	1	<1	
Wetted Perimeter (ft)	13.5	15.8	15.7	15.6	14.7		14.0	14.0	14.4	14.0	14.0		12.4	13.1	12.8	12.8	13.7		11.8	11.7	10.9	11.0	13.7		13.5	13.4	13.3	12.9	14.2	
Hydraulic Radius (ft)	0.8	0.7	0.7	0.7	0.7		0.9	0.8	0.8	0.8	0.8		0.8	0.7	0.8	0.8	0.7		0.7	0.8	0.7	0.8	0.6		0.9	0.9	0.9	0.9	0.8	

Parameter	XS 30 Pool (Main Up)						XS 31 Riffle (Main Up)						XS 32 Riffle (Main Up)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	12.3	12.6	11.7	12.4	15.3		11.6	11.4	11.6	11.7	12.2		12.7	13.2	13.9	14.1	13.8	
Floodprone Width (ft)	----	----	----	----	----		90	90	90	90	90		25	25	25	25	25	
BF Cross Sectional Area (ft2)	11.5	11	10	11.1	11.1		8.6	8.3	8.1	8.6	8.6		9	8.7	8.8	8.2	8.2	
BF Mean Depth (ft)	0.9	0.9	0.9	0.9	0.7		0.7	0.7	0.7	0.7	0.7		0.7	0.7	0.6	0.6	0.6	
BF Max Depth (ft)	1.7	1.8	1.7	1.8	1.7		1	1.2	1.2	1.2	1.2		1	0.9	1	0.8	0.8	
Width/Depth Ratio	----	----	----	----	----		15.6	15.7	16.6	15.9	17.3		17.9	20.0	22.0	24.2	23.2	
Entrenchment Ratio	----	----	----	----	----		7.8	7.9	7.8	7.7	7.4		2.0	1.9	1.8	1.8	1.8	
Low Bank Height (ft)	1.7	1.7	1.7	1.7	1.6		1	1	1	1	1.4		1	1	1	1	1	
Bank Height Ratio	----	----	----	----	----		1	1.2	1.2	1.2	1.167		1	<1	1	<1	1.25	
Wetted Perimeter (ft)	12.9	13.2	12.5	13	15.8		12	11.9	12.3	12.1	12.5		13	13.6	14.2	14.3	14	
Hydraulic Radius (ft)	0.9	0.8	0.8	0.9	0.7		0.7	0.7	0.7	0.7	0.7		0.7	0.6	0.6	0.6	0.6	

**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Table 11F. Morphology and Hydraulic Monitoring Summary
Lamm Main (Upstream) - Stream and Wetland Restoration Site

Parameter	MY-00 (2015)			MY-01 (2015)			MY-02 (2016)			MY-03 (2017)			MY-05 (2019)			MY-07 (2021)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern																		
Channel Beltwidth (ft)	36	73	48															
Radius of Curvature (ft)	24	121	36															
Meander Wavelength (ft)	73	145	103															
Meander Width Ratio	3	6	4															
Profile																		
Riffle Length (ft)	10	66	26															
Riffle Slope (ft/ft)	0.00%	3.87%	1.86%															
Pool Length (ft)	5	34	12															
Pool Spacing (ft)	36	97	48															
Additonal Reach Parameters																		
Valley Length (ft)	949			949			949			949			949					
Channel Length (ft)	1,139			1,139			1,139			1,139			1,139					
Sinuosity	1.2																	
Water Surface Slope (ft/ft)	0.0157																	
BF Slope (ft/ft)	------			------			------			------			------					
D50	16.2			13.6			42.1			40.8			30.6					
D84	60			67			97			99			98					
Rosgen Classification	C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4					

Table 11G. Morphology and Hydraulic Monitoring Summary
Lamm UT-1 - Stream and Wetland Restoration Site

Parameter	XS 1 Pool (UT 1)						XS 2 Riffle (UT 1)						XS 3 Riffle (UT 1)						XS 4 Pool* (UT 1)						XS 5 Riffle (UT 1)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	8.1	8.2	8	8.3	8.4		8	7.9	8	8.2	7.8		9.1	8.7	8.8	8.4	8.5		6	7.9	7	8.8	7.8		8.7	8.4	9	7.9	9.2	
Floodprone Width (ft)	----	----	----	----	----		50	50	50	50	50		50	50	50	50	50		----	----	----	----	----		50	50	50	50	50	
BF Cross Sectional Area (ft2)	6.4	5.4	5.4	4.5	4.5		5	4.5	4.3	4.6	4.6		6.7	6.5	6.5	6.4	6.4		3.6	3.6	3.5	4.1	4.1		4	4	3.7	3.5	3.5	
BF Mean Depth (ft)	0.8	0.7	0.7	0.5	0.5		0.6	0.6	0.5	0.6	0.6		0.7	0.7	0.7	0.8	0.8		0.6	0.5	0.5	0.5	0.5		0.5	0.5	0.4	0.4	0.4	
BF Max Depth (ft)	1.3	1.2	1.1	1.1	1		1	0.9	1	1	1		1.2	1.3	1.6	2	1.3		0.9	0.9	0.9	0.9	1		0.9	0.9	0.9	0.8	0.7	
Width/Depth Ratio	----	----	----	----	----		12.8	13.9	14.9	14.6	13.2		12.4	11.6	11.9	11.0	11.3		----	----	----	----	----		18.9	17.6	21.9	17.8	24.2	
Entrenchment Ratio	----	----	----	----	----		6.3	6.3	6.3	6.1	6.4		5.5	5.7	5.7	6.0	5.9		----	----	----	----	----		5.7	6.0	5.6	6.3	5.4	
Low Bank Height (ft)	1.3	1.3	1.3	1.3	1.3		1	1	1	1	1.4		1.2	1.2	1.2	1.2	1.3		0.9	0.9	0.9	0.9	0.9		0.9	0.9	0.9	0.9	1.1	
Bank Height Ratio**	----	----	----	----	----		1	<1	1	1	1.4		1	1.083	1.333	1.667	1		----	----	----	----	----		1	1	1	<1	1.571	
Wetted Perimeter (ft)	8.6	8.7	8.4	8.8	8.8		8.4	8.3	8.4	8.5	8.2		9.6	9.4	10.2	10.2	9.1		6.3	8.3	7.6	9.1	8.1		9	8.7	9.4	8.1	9.3	
Hydraulic Radius (ft)	0.7	0.6	0.6	0.5	0.5		0.6	0.5	0.5	0.5	0.6		0.7	0.7	0.6	0.6	0.7		0.6	0.4	0.5	0.5	0.5		0.4	0.5	0.4	0.4	0.4	

Parameter	XS 6 Riffle (UT 1)						XS 1 Riffle (UT 1-a)						XS 2 Riffle (UT 1-a)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	8.6	8.9	8.3	8.3	8.7		7.4	8	6.8	7.7	6.2		7.8	8.4	8	7.9	7.9	
Floodprone Width (ft)	17	18	17	17	17		50	50	50	14	14		50	50	50	50	50	
BF Cross Sectional Area (ft2)	4	3.8	4.2	3.9	3.9		2.5	2.7	1.9	2.1	2.1		3.4	3.7	3	3.5	3.5	
BF Mean Depth (ft)	0.5	0.4	0.5	0.5	0.4		0.3	0.3	0.3	0.3	0.3		0.4	0.4	0.4	0.4	0.4	
BF Max Depth (ft)	0.7	0.8	0.9	0.9	0.8		0.5	0.7	0.7	0.6	0.7		0.6	0.8	0.6	0.8	0.7	
Width/Depth Ratio	18.5	20.8	16.4	17.7	19.4		21.3	23.7	24.3	28.2	18.3		17.6	19.1	21.3	17.8	17.8	
Entrenchment Ratio	2.0	2.0	2.0	2.0	2.0		6.8	6.3	7.4	1.8	2.3		6.4	6.0	6.3	6.3	6.3	
Low Bank Height (ft)	0.7	0.7	0.7	0.7	1		0.5	0.5	0.5	0.5	0.8		0.6	0.6	0.6	0.6	0.8	
Bank Height Ratio**	1	1.143	1.286	1.286	1.25		1	1.4	1.4	1.2	1.143		1	1.333	1	1.333	1.143	
Wetted Perimeter (ft)	8.9	9.2	8.9	9	8.8		7.5	8.2	7.2	7.9	6.3		8	8.6	8.1	8.1	8.1	
Hydraulic Radius (ft)	0.4	0.4	0.5	0.4	0.4		0.3	0.3	0.3	0.3	0.3		0.4	0.4	0.4	0.4	0.4	

*XS-4 (UT-1) was determined to be a pool. It was mislabeled as a riffle during previous monitoring years.

**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Table 11H. Morphology and Hydraulic Monitoring Summary
Lamm UT-1 - Stream and Wetland Restoration Site

Parameter	MY-00 (2015)			MY-01 (2015)			MY-02 (2016)			MY-03 (2017)			MY-05 (2019)			MY-07 (2021)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern																		
Channel Beltwidth (ft)	21	42	28															
Radius of Curvature (ft)	14	70	21															
Meander Wavelength (ft)	42	84	60															
Meander Width Ratio	3	6	4															
Profile																		
Riffle Length (ft)	5	44	15															
Riffle Slope (ft/ft)	1.10%	9.83%	2.98%															
Pool Length (ft)	5	12	8															
Pool Spacing (ft)	21	56	28															
Additonal Reach Parameters																		
Valley Length (ft)	466			466			466			466			466					
Channel Length (ft)	559			559			559			559			559					
Sinuosity	1.2																	
Water Surface Slope (ft/ft)	0.0256																	
BF Slope (ft/ft)	------			------			------			------			------					
D50	15.2			13.4			11			13.3			7.5					
D84	67			58			73			77			46					
Rosgen Classification	C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4					

Table 11I. Morphology and Hydraulic Monitoring Summary
Lamm UT-2 - Stream and Wetland Restoration Site

Parameter	XS 1 Riffle (UT 2)						XS 2 Riffle (UT 2)						XS 3 Pool (UT 2)						XS 4 Riffle (UT 2)						XS 5 Riffle (UT 2)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	7.4	7.8	7.3	7.7	6.7		7.6	6.5	6.5	7.0	6.8		7.5	7.3	7.2	7.5	7.0		7.6	8.6	8.1	8.8	9.4		9.7	7.8	7.9	7.3	7.7	
Floodprone Width (ft)	50.0	50.0	50.0	50.0	50.0		50.0	50.0	50.0	50.0	50.0		----	----	----	----	----		50.0	50.0	50.0	50.0	50.0		50.0	50.0	50.0	50.0	50.0	
BF Cross Sectional Area (ft2)	3.2	3.8	3.4	3.1	3.1		2.7	2.6	2.0	2.9	2.9		7.2	6.3	5.9	6.1	6.1		3.6	3.4	3.4	3.4	3.4		5.5	5.6	5.6	5.6	5.6	
BF Mean Depth (ft)	0.4	0.5	0.5	0.4	0.5		0.4	0.4	0.3	0.4	0.4		1.0	0.9	0.8	0.8	0.9		0.5	0.4	0.4	0.4	0.4		0.6	0.7	0.7	0.8	0.7	
BF Max Depth (ft)	0.7	0.9	0.8	0.8	0.8		0.5	0.7	0.6	0.6	0.6		1.4	1.3	1.3	1.3	1.4		0.7	0.8	0.7	0.7	0.8		1.0	1.4	1.5	1.3	1.2	
Width/Depth Ratio	17.1	16.0	15.7	19.1	14.5		21.4	16.3	21.1	16.9	15.9		----	----	----	----	----		16.0	21.8	19.3	22.8	26.0		17.1	10.9	11.1	9.5	10.6	
Entrenchment Ratio	6.8	6.4	6.8	6.5	7.5		6.6	7.7	7.7	7.1	7.4		----	----	----	----	----		6.6	5.8	6.2	5.7	5.3		5.2	6.4	6.3	6.8	6.5	
Low Bank Height (ft)	0.7	0.7	0.7	0.7	0.9		0.5	0.5	0.5	0.5	0.8		1.4	1.4	1.4	1.4	1.2		0.7	0.7	0.7	0.7	0.8		1	1	1	1	1.4	
Bank Height Ratio**	1	1.286	1.143	1.143	1.125		1	1.4	1.2	1.2	1.333		----	----	----	----	----		1	1.143	1	1	1		1	1.4	1.5	1.3	1.167	
Wetted Perimeter (ft)	7.6	8.1	7.6	7.9	6.9		7.7	6.9	7.3	7.2	7.0		8.3	8.1	8.0	8.3	7.7		7.9	8.9	8.4	9.0	9.6		10.1	8.4	9.5	8.2	8.3	
Hydraulic Radius (ft)	0.4	0.5	0.4	0.4	0.4		0.3	0.4	0.3	0.4	0.4		0.9	0.8	0.7	0.7	0.8		0.4	0.4	0.4	0.4	0.4		0.5	0.7	0.6	0.7	0.7	

Parameter	XS 6 Riffle (UT 2)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	5.9	5.9	6.3	5.3	5.5	
Floodprone Width (ft)	50	50	50	50	50	
BF Cross Sectional Area (ft2)	2.3	2.7	2.2	2	2	
BF Mean Depth (ft)	0.4	0.5	0.3	0.4	0.4	
BF Max Depth (ft)	0.6	0.8	0.6	0.7	0.6	
Width/Depth Ratio	15.1	12.9	18.0	14.0	15.1	
Entrenchment Ratio	8.5	8.5	7.9	9.4	9.1	
Low Bank Height (ft)	0.6	0.6	0.6	0.6	0.6	
Bank Height Ratio**	1	1.333	1	1.167	1	
Wetted Perimeter (ft)	6.1	6.3	6.7	5.5	5.6	
Hydraulic Radius (ft)	0.4	0.4	0.3	0.4	0.4	

**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Table 11J. Morphology and Hydraulic Monitoring Summary
Lamm UT-2 - Stream and Wetland Restoration Site

Parameter	MY-00 (2015)			MY-01 (2015)			MY-02 (2016)			MY-03 (2017)			MY-05 (2019)			MY-07 (2021)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern																		
Channel Beltwidth (ft)	21	42	28															
Radius of Curvature (ft)	14	70	21															
Meander Wavelength (ft)	42	84	60															
Meander Width Ratio	3	6	4															
Profile																		
Riffle Length (ft)	5	26	12															
Riffle Slope (ft/ft)	0.84%	4.64%	2.94%															
Pool Length (ft)	4	14	8															
Pool Spacing (ft)	21	56	28															
Additonal Reach Parameters																		
Valley Length (ft)	387			387			387			387			387					
Channel Length (ft)	464			464			464			464			464					
Sinuosity	1.2																	
Water Surface Slope (ft/ft)	0.0301																	
BF Slope (ft/ft)	------			------			------			------			------					
D50	16.3			16			45.6			43.9			37.9					
D84	110			93			109			103			104					
Rosgen Classification	C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4					

Table 11K. Morphology and Hydraulic Monitoring Summary
Lamm UT-3 - Stream and Wetland Restoration Site

Parameter	XS 1 Riffle (UT 3)						XS 2 Pool (UT 3)						XS 3 Riffle (UT 3)						XS 4 Pool (UT 3)						XS 5 Riffle (UT 3)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	7.3	7.1	7.2	7.2	6.5		9.7	11.6	10.7	10.2	12.4		7.6	7.6	7.1	6.5	6.6		10.4	11.2	10.8	11.1	10.8		6.9	6.0	6.0	5.8	5.8	
Floodprone Width (ft)	50.0	50.0	50.0	50.0	50.0		----	----	----	----	----		50.0	50.0	50.0	50.0	50.0		----	----	----	----	----		50.0	50.0	50.0	50.0	50.0	
BF Cross Sectional Area (ft2)	2.4	2.4	2.6	2.6	2.6		5.9	5.6	5.5	4.8	4.8		2.5	2.9	2.6	2.0	2.0		7.5	7.1	6.6	6.2	6.2		3.1	4.2	4.1	4.0	4.0	
BF Mean Depth (ft)	0.3	0.3	0.4	0.4	0.4		0.6	0.5	0.5	0.5	0.4		0.3	0.4	0.4	0.3	0.3		0.7	0.6	0.6	0.6	0.6		0.4	0.7	0.7	0.7	0.7	
BF Max Depth (ft)	0.5	0.7	0.7	0.5	0.8		1.0	1.0	1.1	0.9	0.9		0.5	0.8	0.7	0.6	0.6		1.2	1.3	1.4	1.4	1.4		0.8	1.2	1.2	1.1	1.1	
Width/Depth Ratio	22.2	21.0	19.9	19.9	16.3		----	----	----	----	----		23.1	19.9	19.4	21.1	21.8		----	----	----	----	----		15.4	8.6	8.8	8.4	8.4	
Entrenchment Ratio	6.8	7.0	6.9	6.9	7.7		----	----	----	----	----		6.6	6.6	7.0	7.7	7.6		----	----	----	----	----		7.2	8.3	8.3	8.6	8.6	
Low Bank Height (ft)	0.5	0.5	0.5	0.5	0.8		1	1	1	1	0.9		0.5	0.5	0.5	0.5	0.5		1.2	1.2	1.2	1.2	1.4		0.8	0.8	0.8	0.8	1	
Bank Height Ratio**	1	1.4	1.4	1	1		----	----	----	----	----		1	1.6	1.4	1.2	<1		----	----	----	----	----		1	1.5	1.5	1.375	<1	
Wetted Perimeter (ft)	7.4	7.3	7.4	7.5	6.7		10.0	11.9	11.2	10.5	12.7		7.7	7.8	7.6	7.4	6.9		10.8	12.1	11.6	11.8	11.5		7.1	6.9	7.6	6.8	6.3	
Hydraulic Radius (ft)	0.3	0.3	0.4	0.3	0.4		0.6	0.5	0.5	0.5	0.4		0.3	0.4	0.3	0.3	0.3		0.7	0.6	0.6	0.5	0.5		0.4	0.6	0.5	0.6	0.6	

Parameter	XS 6 Riffle (UT 3)						XS 7 Pool (UT 3)						XS 8 Riffle (UT 3)						XS 9 Riffle (UT 3)						XS 10 Pool (UT 3)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	6.9	6.8	6.3	6.6	7.0		6.8	6.7	7.0	6.9	7.6		6.3	6.0	5.9	7.0	6.3		7.9	7.3	7.0	4.1	4.9		7.8	8.4	6.8	5.7	5.4	
Floodprone Width (ft)	50.0	50.0	50.0	50.0	50.0		----	----	----	----	----		50.0	50.0	50.0	50.0	50.0		50.0	50.0	50.0	50.0	10.0		----	----	----	----	----	
BF Cross Sectional Area (ft2)	2.8	3.0	2.6	2.3	2.3		7.1	8.7	8.9	9.9	9.9		2.0	2.3	2.3	2.5	2.5		2.5	2.6	3.1	1.8	1.8		5.0	3.7	3.3	3.4	3.4	
BF Mean Depth (ft)	0.4	0.4	0.4	0.3	0.3		1.0	1.3	1.3	1.4	1.3		0.3	0.4	0.4	0.4	0.4		0.3	0.4	0.4	0.4	0.4		0.6	0.4	0.5	0.6	0.6	
BF Max Depth (ft)	0.6	0.8	0.7	0.5	0.5		1.7	2.1	2.4	2.3	2.2		0.4	0.6	0.7	0.6	0.6		0.5	0.7	0.9	0.8	0.5		1.0	0.9	0.9	1.0	0.9	
Width/Depth Ratio	17.0	15.4	15.3	18.9	21.3		----	----	----	----	----		19.8	15.7	15.1	19.6	15.9		25.0	20.5	15.8	9.3	13.3		----	----	----	----	----	
Entrenchment Ratio	7.2	7.4	7.9	7.6	7.1		----	----	----	----	----		7.9	8.3	8.5	7.1	7.9		6.3	6.8	7.1	12.2	2.0		----	----	----	----	----	
Low Bank Height (ft)	0.6	0.6	0.6	0.6	0.4		1.7	1.7	1.7	1.7	2.3		0.4	0.4	0.4	0.4	0.7		0.5	0.5	0.5	0.5	0.6		1	1	1	1	0.9	
Bank Height Ratio**	1	1.333	1.167	<1	<1		----	----	----	----	----		1	1.5	1.75	1.5	1.167		1	1.4	1.8	1.6	1.2		----	----	----	----	----	
Wetted Perimeter (ft)	7.2	7.1	6.7	6.8	7.2		7.8	8.4	9.4	8.8	9.2		6.4	6.2	6.5	7.4	6.4		8.1	7.5	7.6	4.4	5.1		8.3	8.7	7.2	6.2	5.9	
Hydraulic Radius (ft)	0.4	0.4	0.4	0.3	0.3		0.9	1.0	0.9	1.1	1.1		0.3	0.4	0.4	0.3	0.4		0.3	0.3	0.4	0.4	0.4		0.6	0.4	0.5	0.5	0.6	

Parameter	XS 11 Riffle (UT 3)						XS 12 Riffle (UT 3)						XS 13 Pool (UT 3)						XS 14 Riffle (UT 3)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY5**	**MY7**
BF Width (ft)	6.3	7.2	7.0	4.6	5.2		7.9	6.6	6.7	4.2	6.6		7.0	5.5	5.4	5.1	4.9		8.6	8.7	8.0	8.3	10.1	
Floodprone Width (ft)	50.0	50.0	50.0	50.0	50.0		50.0	50.0	50.0	50.0	50.0		----	----	----	----	----		50.0	50.0	50.0	50.0	50.0	
BF Cross Sectional Area (ft2)	2.5	3.8	3.7	2.3	2.3		2.6	3.0	2.9	2.7	2.7		4.1	3.4	2.9	2.6	2.6		2.8	3.4	3.4	3.0	3.0	
BF Mean Depth (ft)	0.4	0.5	0.5	0.5	0.4		0.3	0.5	0.4	0.6	0.4		0.6	0.6	0.5	0.5	0.5		0.3	0.4	0.4	0.4	0.3	
BF Max Depth (ft)	0.6	1.2	1.1	0.9	0.7		0.6	0.9	1.1	1.2	0.9		1.2	0.9	0.8	0.8	0.8		0.7	0.9	0.9	0.8	0.9	
Width/Depth Ratio	15.9	13.6	13.2	9.2	11.8		24.0	14.5	15.5	6.5	16.1		----	----	----	----	----		26.4	22.3	18.8	23.0	34.0	
Entrenchment Ratio	7.9	6.9	7.1	10.9	9.6		6.3	7.6	7.5	11.9	7.6		----	----	----	----	----		5.8	5.7	6.3	6.0	5.0	
Low Bank Height (ft)	0.6	0.6	0.6	0.6	0.9		0.6	0.6	0.6	0.6	0.7		1.2	1.2	1.2	1.2	1.1		0.7	0.7	0.7	0.7	0.7	
Bank Height Ratio**	1	2	1.833	1.5	1.286		1	1.5	1.833	2	<1		----	----	----	----	----		1	1.286	1.286	1.143	<1	
Wetted Perimeter (ft)	6.5	7.7	7.7	5.2	5.6		8.1	6.9	7.6	5.1	6.9		8.2	5.9	5.8	5.7	5.3		8.8	9.3	8.3	8.5	10.6	
Hydraulic Radius (ft)	0.4	0.5	0.5	0.4	0.4		0.3	0.4	0.4	0.5	0.4		0.5	0.6	0.5	0.5	0.5		0.3	0.4	0.4	0.4	0.3	

**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Table 11L. Morphology and Hydraulic Monitoring Summary
Lamm UT-3 - Stream and Wetland Restoration Site

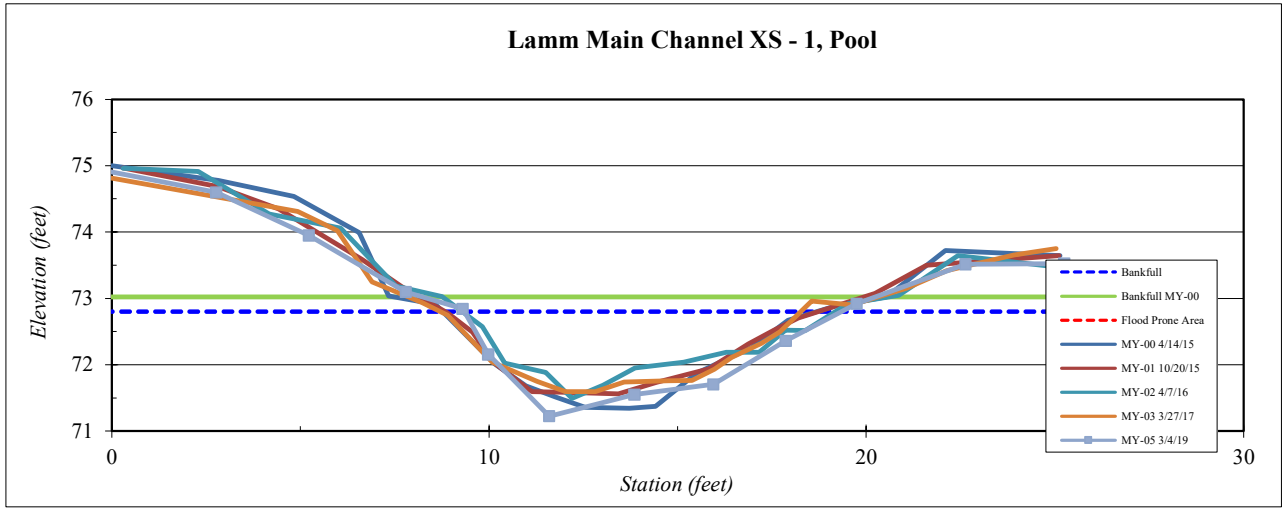
Parameter	MY-00 (2015)			MY-01 (2015)			MY-02 (2016)			MY-03 (2017)			MY-05 (2019)			MY-07 (2021)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern																		
Channel Beltwidth (ft)	21	42	28															
Radius of Curvature (ft)	14	70	21															
Meander Wavelength (ft)	42	84	60															
Meander Width Ratio	3	6	4															
Profile																		
Riffle Length (ft)	6	66	21															
Riffle Slope (ft/ft)	0.82%	6.50%	3.13%															
Pool Length (ft)	4	14	8															
Pool Spacing (ft)	21	56	28															
Additonal Reach Parameters																		
Valley Length (ft)	846			846			846			846			846					
Channel Length (ft)	1,015			1,015			1,015			1,015			1,015					
Sinuosity	1.2																	
Water Surface Slope (ft/ft)	0.0319																	
BF Slope (ft/ft)	------			------			------			------								
D50	8.7			17.4			6.9			12.2			12.8					
D84	87			95			29			54			60					
Rosgen Classification	C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4					

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 1, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.2	74.9
2.8	74.6
5.2	73.9
7.8	73.1
9.3	72.8
10.0	72.2
11.6	71.2
13.9	71.5
15.9	71.7
17.9	72.4
19.7	72.9
22.6	73.5
25.2	73.5

SUMMARY DATA	
Bankfull Elevation:	72.8
Bankfull Cross-Sectional Area:	9.4
Bankfull Width:	10.0
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.6
Mean Depth at Bankfull:	0.9
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0

Stream Type	C/E



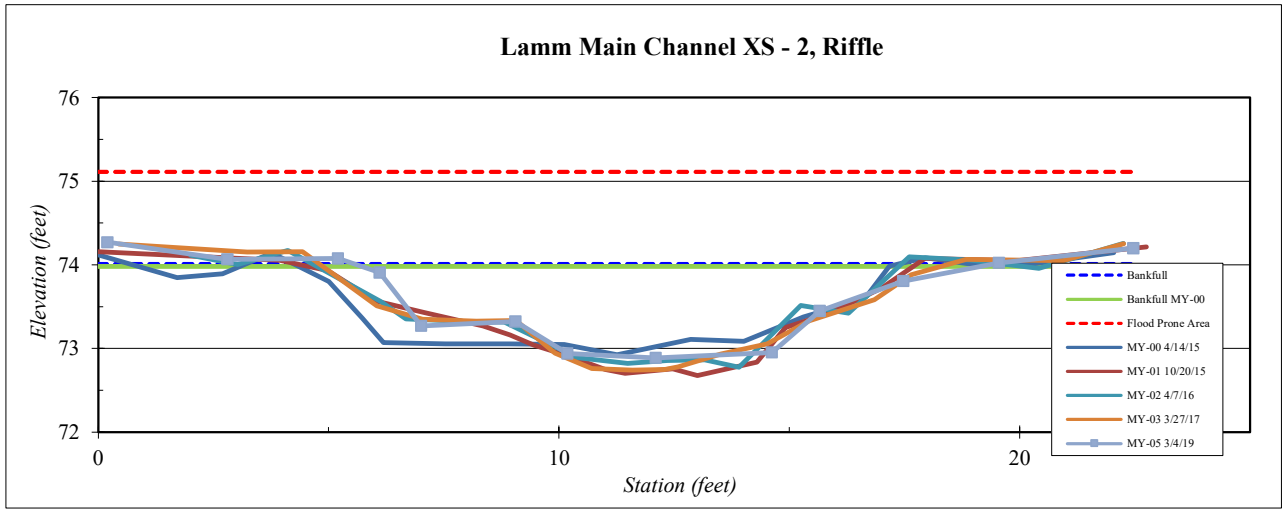
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 2, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.2	74.27
2.8	74.06
5.2	74.08
6.1	73.91
7.0	73.27
9.1	73.32
10.2	72.94
12.1	72.89
14.6	72.95
15.7	73.45
17.5	73.81
19.6	74.02
22.5	74.20

SUMMARY DATA	
Bankfull Elevation:	74.0
Bankfull Cross-Sectional Area:	9.5
Bankfull Width:	13.9
Flood Prone Area Elevation:	75.1
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.1
Mean Depth at Bankfull:	0.7
W / D Ratio:	20.3
Entrenchment Ratio:	6.5
Bank Height Ratio:	1.0

Stream Type	C/E



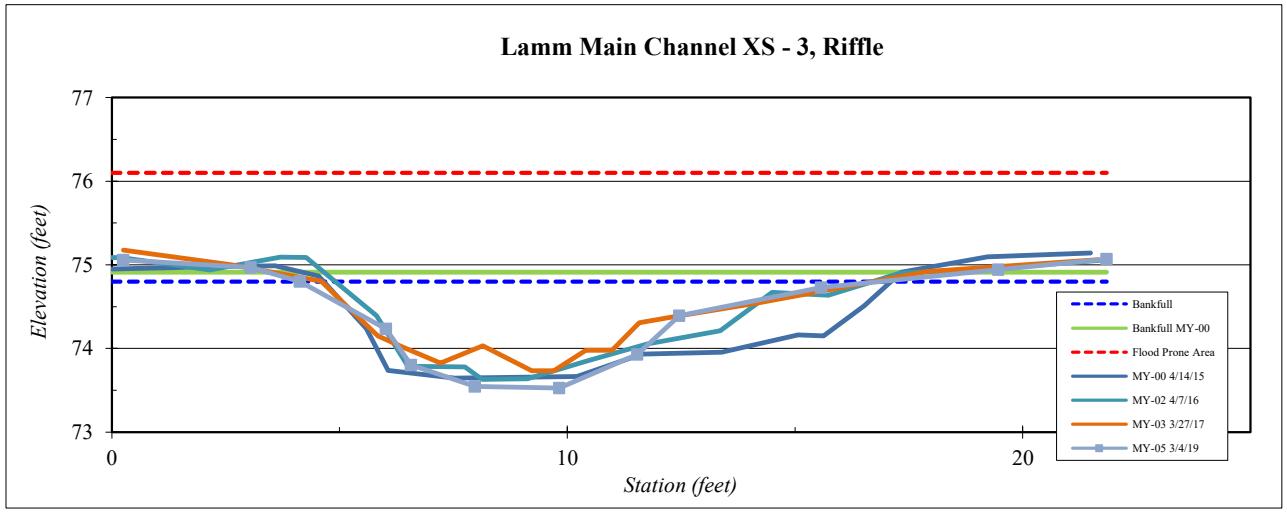
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 3, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.3	75.06
3.1	74.97
4.1	74.80
6.0	74.23
6.6	73.80
8.0	73.54
9.8	73.53
11.5	73.93
12.5	74.39
15.6	74.73
19.5	74.94
21.8	75.07

SUMMARY DATA	
Bankfull Elevation:	74.8
Bankfull Cross-Sectional Area:	8.1
Bankfull Width:	12.8
Flood Prone Area Elevation:	76.1
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.6
W / D Ratio:	20.2
Entrenchment Ratio:	7.0
Bank Height Ratio:	1.0

Stream Type	C/E



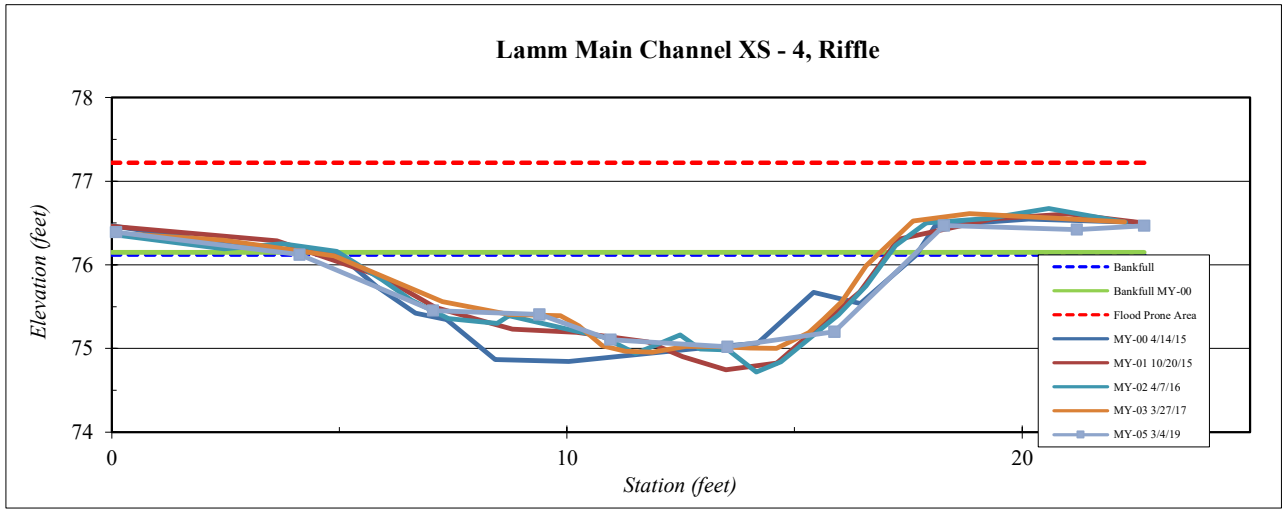
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.
Cross section not monitored during year 1 (2015) due to hornets nest at cross section location.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 4, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.1	76.39
4.1	76.12
7.1	75.45
9.4	75.41
11.0	75.11
13.5	75.02
15.9	75.20
18.3	76.47
21.2	76.42
22.7	76.47

SUMMARY DATA	
Bankfull Elevation:	76.1
Bankfull Cross-Sectional Area:	9.4
Bankfull Width:	13.3
Flood Prone Area Elevation:	77.2
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.1
Mean Depth at Bankfull:	0.7
W / D Ratio:	18.8
Entrenchment Ratio:	6.8
Bank Height Ratio:	1.0

Stream Type	C/E



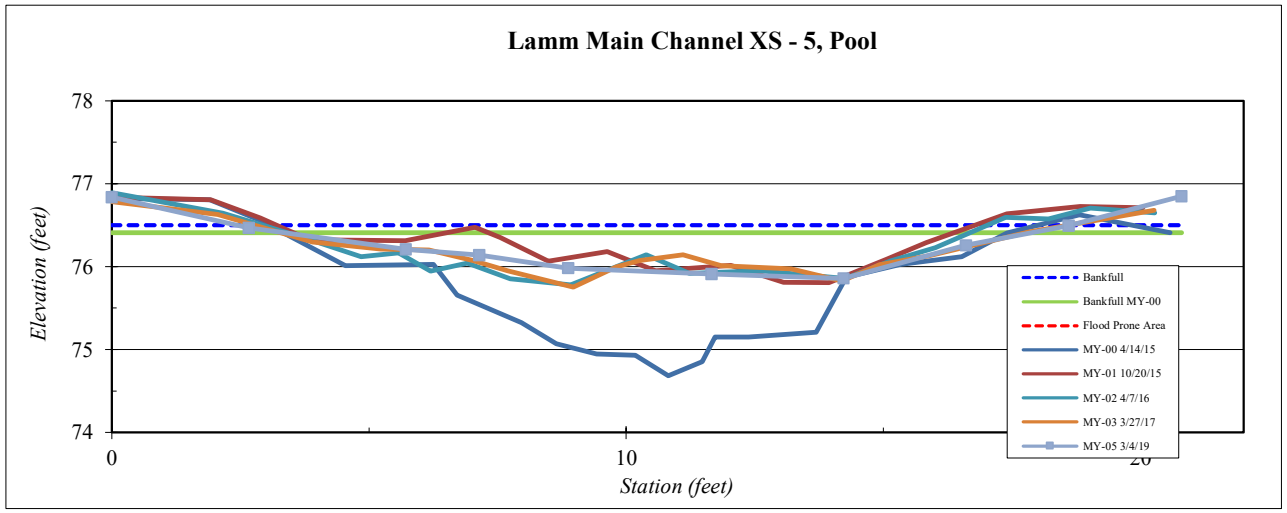
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 5, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	76.8
2.7	76.5
5.7	76.2
7.1	76.1
8.9	76.0
11.7	75.9
14.2	75.9
16.6	76.3
18.6	76.5
20.8	76.8

SUMMARY DATA	
Bankfull Elevation:	76.5
Bankfull Cross-Sectional Area:	7.6
Bankfull Width:	17.3
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	0.7
Mean Depth at Bankfull:	0.4
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	<1

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

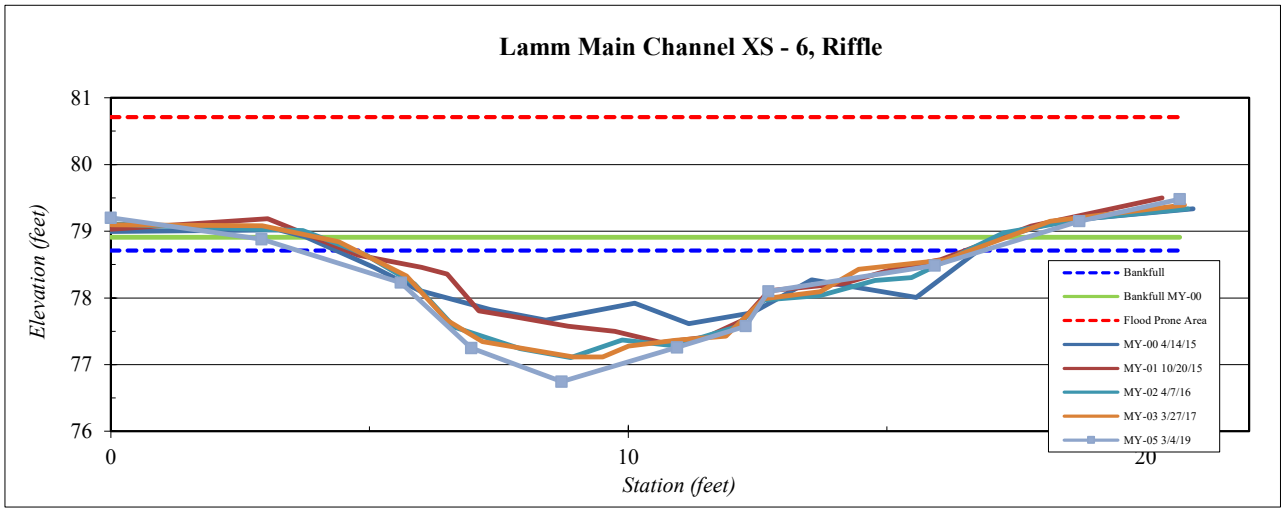
Sediment deposition in pool appears natural and is not expected to lead to instability.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 6, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	79.20
2.9	78.88
5.6	78.23
7.0	77.25
8.7	76.75
10.9	77.26
12.3	77.58
12.7	78.10
15.9	78.49
18.7	79.15
20.7	79.48

SUMMARY DATA	
Bankfull Elevation:	78.7
Bankfull Cross-Sectional Area:	12.1
Bankfull Width:	13.3
Flood Prone Area Elevation:	80.7
Flood Prone Width:	90.0
Max Depth at Bankfull:	2.0
Mean Depth at Bankfull:	0.9
W / D Ratio:	14.6
Entrenchment Ratio:	6.8
Bank Height Ratio:	<1

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

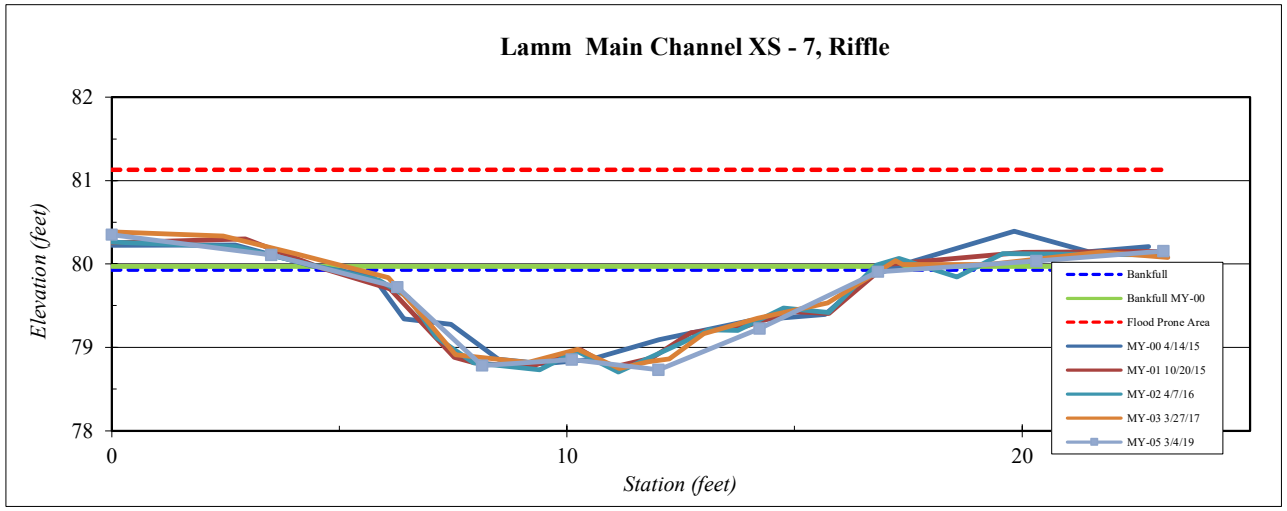
Channel constructed in lake bed, with stabilization occurring in years 1 through 5 monitoring. No problems visible in this reach.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 7, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	80.35
3.5	80.11
6.3	79.72
8.1	78.78
10.1	78.85
12.0	78.73
14.2	79.23
16.8	79.91
20.3	80.04
23.1	80.16

SUMMARY DATA	
Bankfull Elevation:	79.9
Bankfull Cross-Sectional Area:	8.8
Bankfull Width:	12.7
Flood Prone Area Elevation:	81.1
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.2
Mean Depth at Bankfull:	0.7
W / D Ratio:	18.3
Entrenchment Ratio:	7.1
Bank Height Ratio:	1.0

Stream Type	C/E



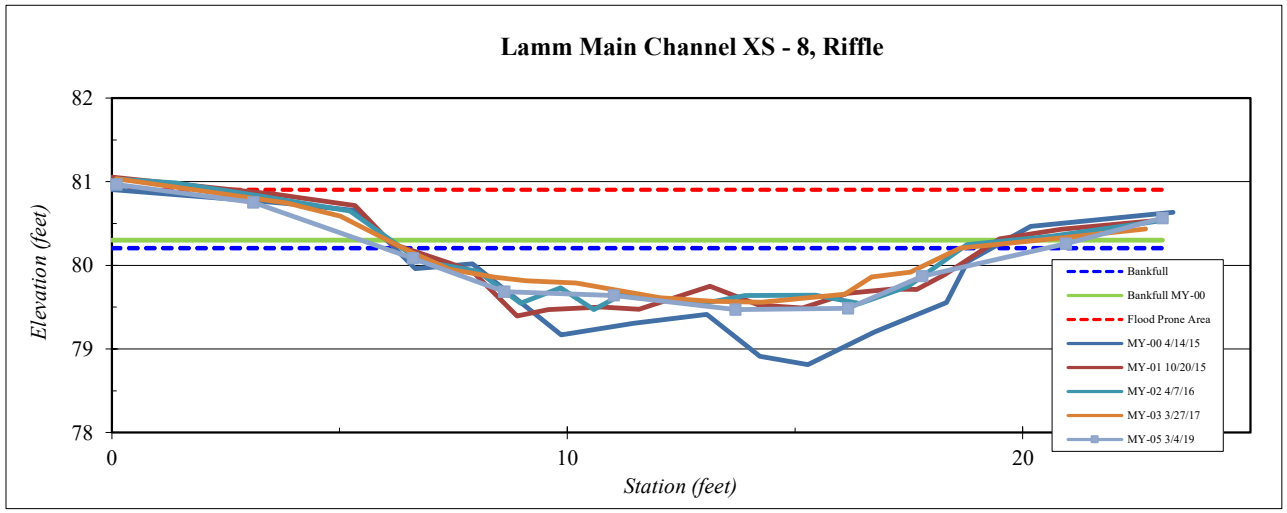
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 8, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.1	80.97
3.1	80.75
6.6	80.08
8.6	79.68
11.0	79.64
13.7	79.47
16.2	79.49
17.8	79.87
21.0	80.26
23.1	80.57

SUMMARY DATA	
Bankfull Elevation:	80.2
Bankfull Cross-Sectional Area:	6.8
Bankfull Width:	14.5
Flood Prone Area Elevation:	80.9
Flood Prone Width:	90.0
Max Depth at Bankfull:	0.7
Mean Depth at Bankfull:	0.5
W / D Ratio:	30.9
Entrenchment Ratio:	6.2
Bank Height Ratio:	1.1

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Sediment transport appears to be natural and has stabilized during years 1 to 5 monitoring.

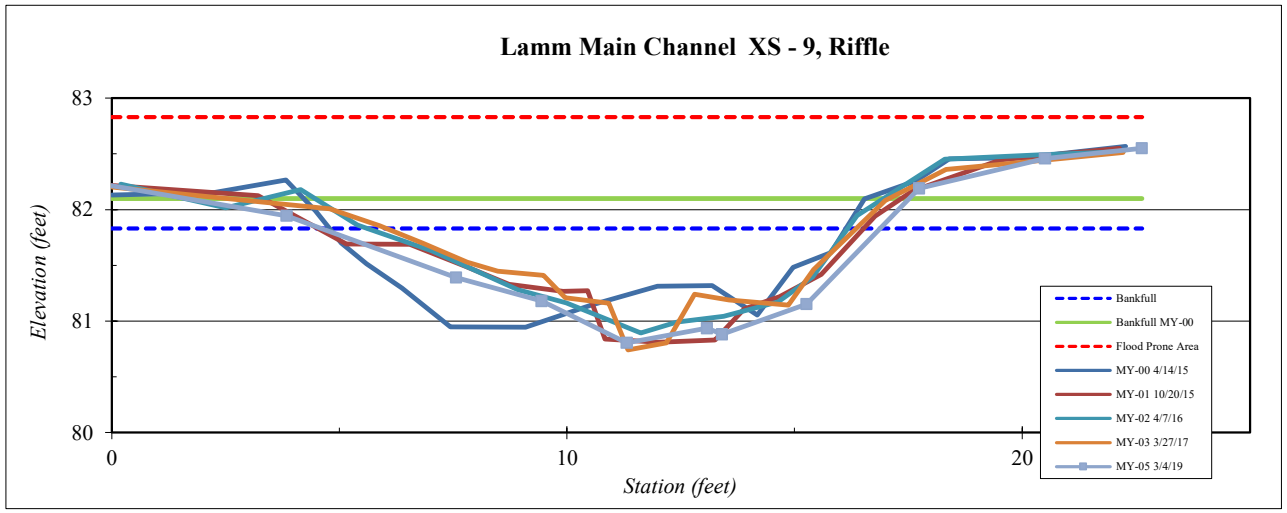
No problems appear to be occurring in this reach.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 9, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.2	82.23
3.8	81.95
7.6	81.39
9.4	81.18
11.3	80.80
13.1	80.94
13.4	80.88
15.3	81.15
17.7	82.19
20.5	82.46
22.6	82.55

SUMMARY DATA	
Bankfull Elevation:	81.8
Bankfull Cross-Sectional Area:	7.3
Bankfull Width:	12.3
Flood Prone Area Elevation:	82.8
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.0
Mean Depth at Bankfull:	0.6
W / D Ratio:	20.7
Entrenchment Ratio:	7.3
Bank Height Ratio:	1.1

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

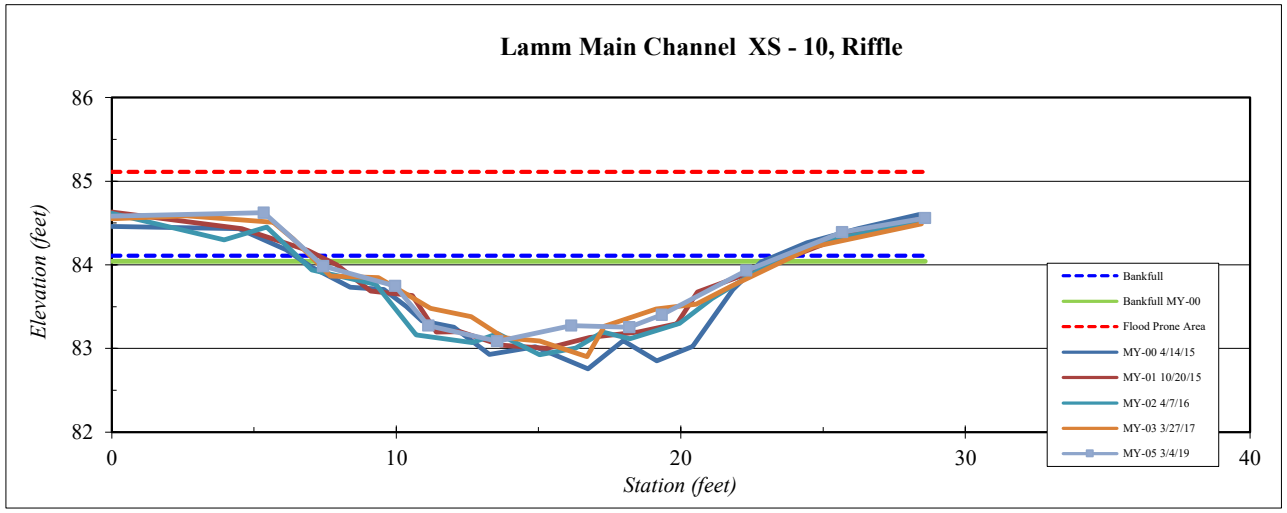
No problems have been noted in this reach. Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 10, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.1	84.58
5.3	84.62
7.4	83.98
10.0	83.75
11.1	83.27
13.5	83.09
16.1	83.27
18.2	83.25
19.3	83.40
22.3	83.93
25.7	84.39
28.6	84.56

SUMMARY DATA	
Bankfull Elevation:	84.1
Bankfull Cross-Sectional Area:	10.1
Bankfull Width:	16.6
Flood Prone Area Elevation:	85.1
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.0
Mean Depth at Bankfull:	0.6
W / D Ratio:	27.3
Entrenchment Ratio:	5.4
Bank Height Ratio:	<1

Stream Type	C/E



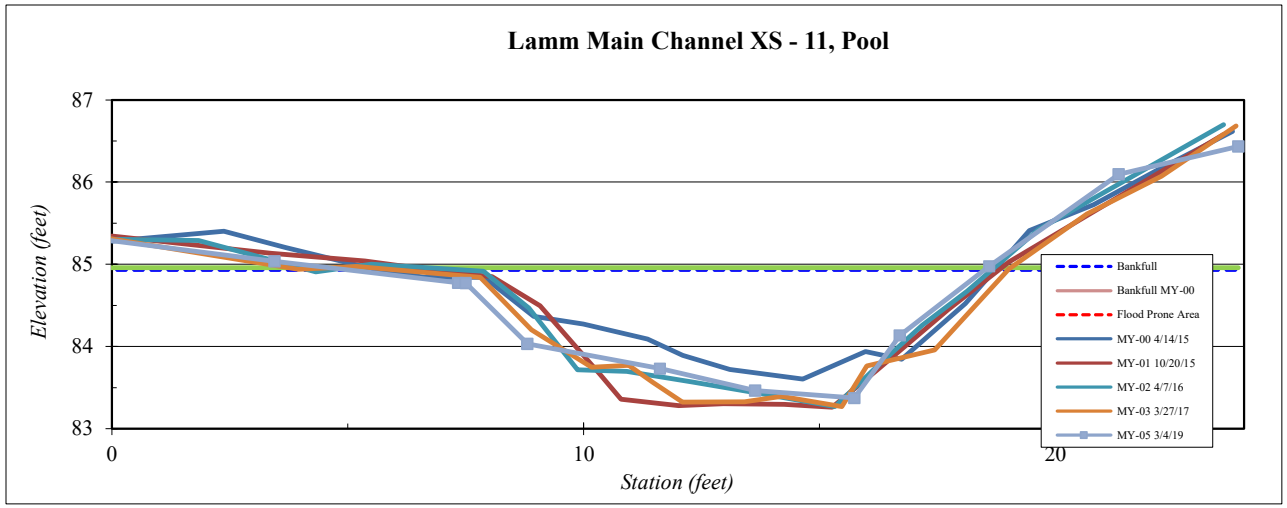
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 11, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.3	85.3
3.4	85.0
7.3	84.8
7.5	84.8
8.8	84.0
11.6	83.7
13.6	83.5
15.7	83.4
16.7	84.1
18.6	85.0
21.3	86.1
23.9	86.4

SUMMARY DATA	
Bankfull Elevation:	84.9
Bankfull Cross-Sectional Area:	11.6
Bankfull Width:	13.6
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.6
Mean Depth at Bankfull:	0.9
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	<1

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

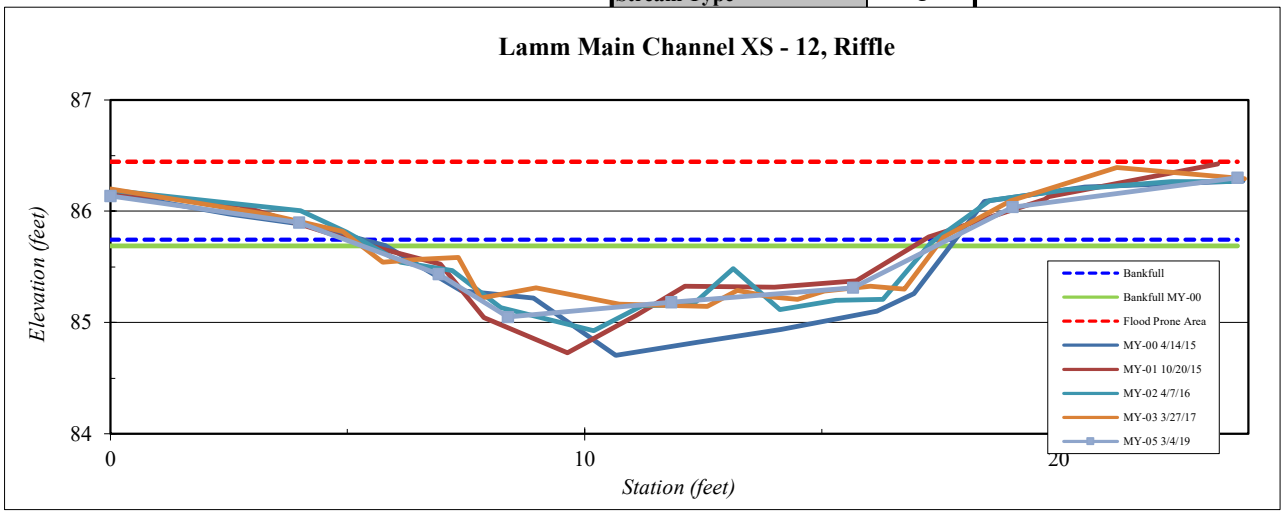
Some downcutting occurred just after asbuilt but has stabilized during years 1 through 5.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 12, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	86.14
4.0	85.90
6.9	85.44
8.4	85.05
11.8	85.18
15.7	85.31
19.0	86.04
23.8	86.30

SUMMARY DATA	
Bankfull Elevation:	85.7
Bankfull Cross-Sectional Area:	5.5
Bankfull Width:	12.7
Flood Prone Area Elevation:	86.4
Flood Prone Width:	90.0
Max Depth at Bankfull:	0.7
Mean Depth at Bankfull:	0.4
W / D Ratio:	29.3
Entrenchment Ratio:	7.1
Bank Height Ratio:	1.3

Stream Type	C



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Elevated BHR does not indicate instability along this reach.

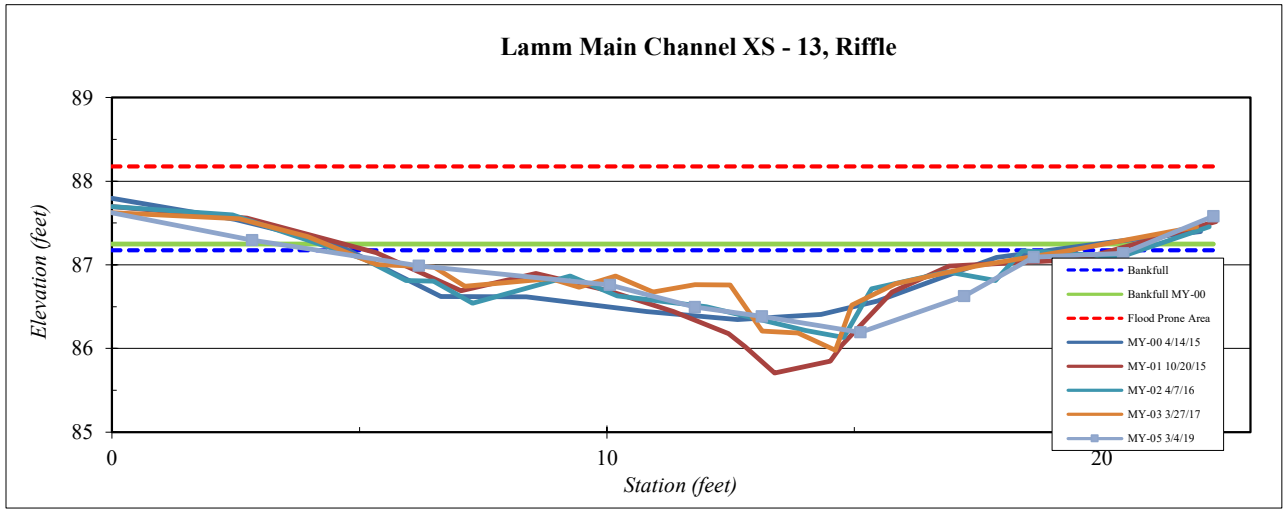
Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 13, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.8	87.72
2.8	87.30
6.2	86.99
10.1	86.76
11.8	86.49
13.1	86.38
15.1	86.19
17.2	86.62
18.6	87.09
20.4	87.13
22.3	87.58

SUMMARY DATA	
Bankfull Elevation:	87.2
Bankfull Cross-Sectional Area:	7.2
Bankfull Width:	16.4
Flood Prone Area Elevation:	88.2
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.0
Mean Depth at Bankfull:	0.4
W / D Ratio:	37.4
Entrenchment Ratio:	5.5
Bank Height Ratio:	<1

Stream Type	C



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

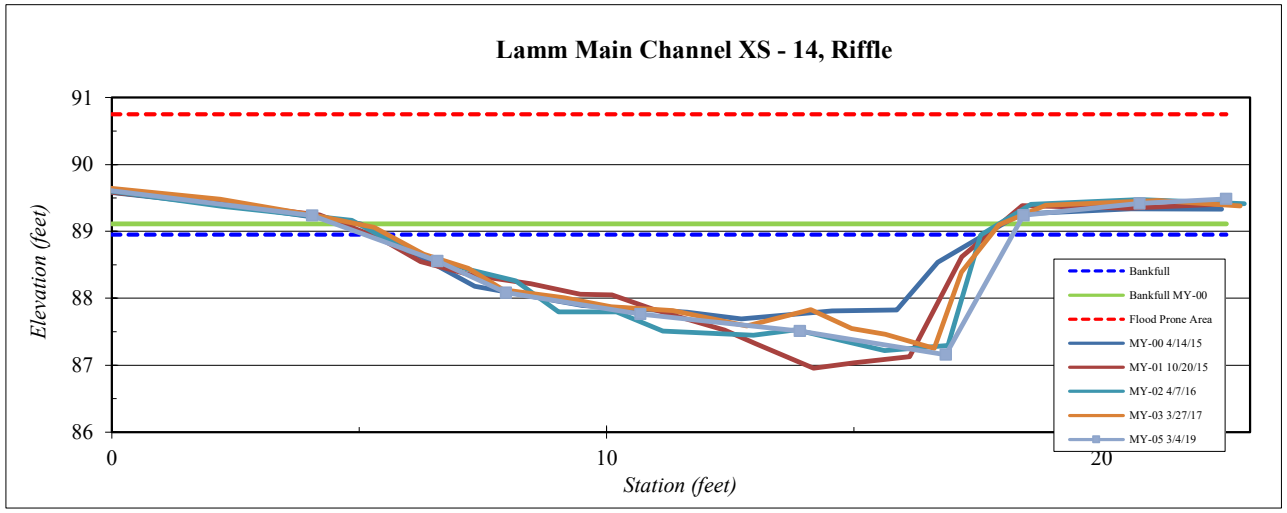
Channel constructed in lake bed. Unconsolidated materials are forming a new channel within the constructed channel.
Depth decreased during MY-01-03 and is stabilizing.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 14, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.6	89.66
4.1	89.24
6.6	88.56
8.0	88.08
10.7	87.76
13.9	87.51
16.9	87.16
18.4	89.24
20.8	89.42
22.5	89.49

SUMMARY DATA	
Bankfull Elevation:	89.0
Bankfull Cross-Sectional Area:	14.2
Bankfull Width:	13.1
Flood Prone Area Elevation:	90.8
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.8
Mean Depth at Bankfull:	1.1
W / D Ratio:	12.1
Entrenchment Ratio:	6.9
Bank Height Ratio:	1.2

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

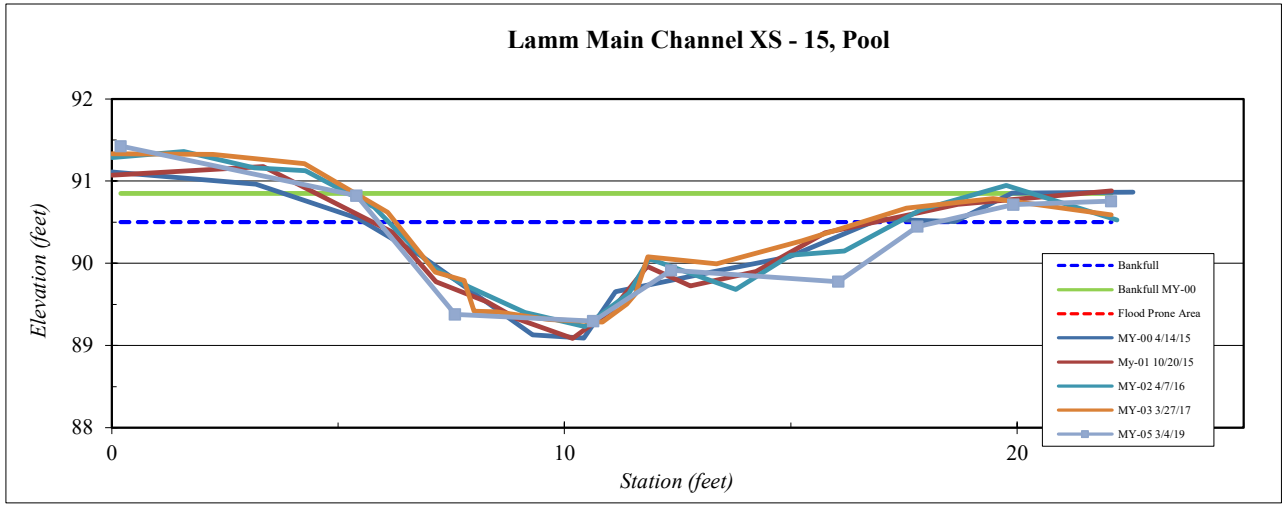
Channel constructed in lake bed. Unconsolidated materials are forming a new channel within the constructed channel.
Depth is decreasing since MY-01 and is stabilizing in MY-02-05.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 15, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.2	91.4
5.4	90.8
7.6	89.4
10.6	89.3
12.4	89.9
16.0	89.8
17.8	90.4
19.9	90.7
22.1	90.8

SUMMARY DATA	
Bankfull Elevation:	90.5
Bankfull Cross-Sectional Area:	9.1
Bankfull Width:	12.3
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.2
Mean Depth at Bankfull:	0.7
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0

Stream Type	C/E



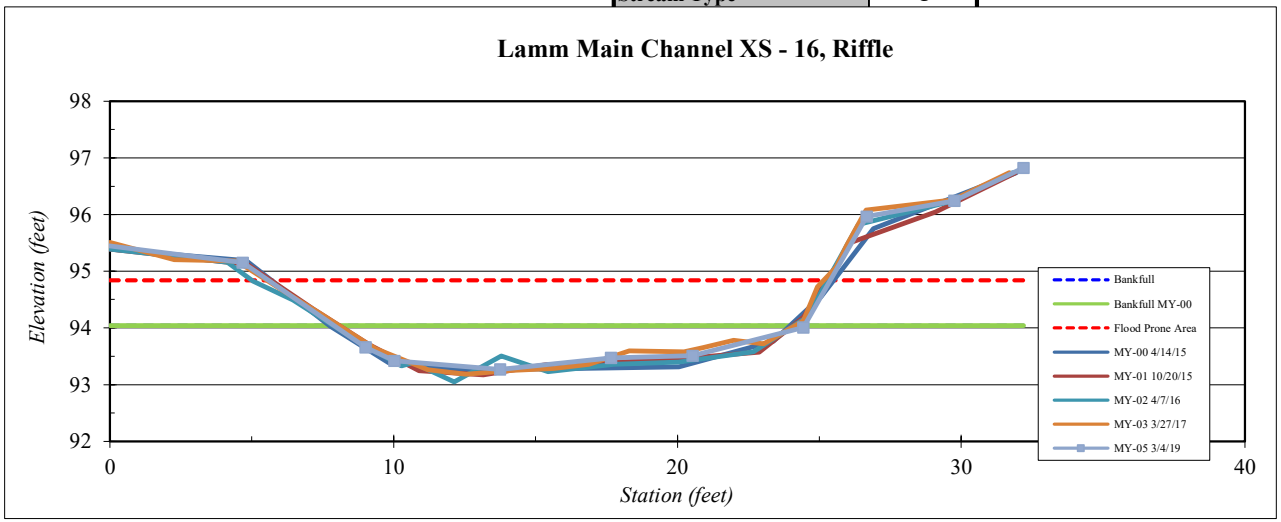
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 16, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.1	95.45
4.7	95.15
9.0	93.66
10.0	93.42
13.7	93.27
17.7	93.47
20.5	93.51
24.4	94.01
26.7	95.97
29.8	96.24
32.2	96.82

SUMMARY DATA	
Bankfull Elevation:	94.0
Bankfull Cross-Sectional Area:	8.6
Bankfull Width:	16.6
Flood Prone Area Elevation:	94.8
Flood Prone Width:	20.0
Max Depth at Bankfull:	0.8
Mean Depth at Bankfull:	0.5
W / D Ratio:	32.0
Entrenchment Ratio:	1.2
Bank Height Ratio:	2.38

Stream Type	C



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

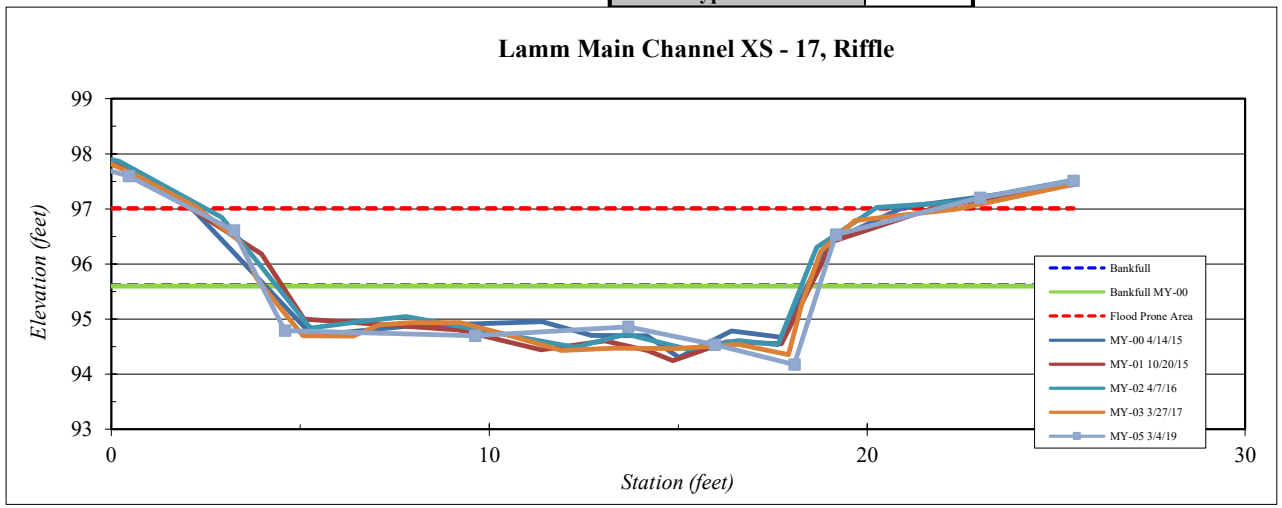
Enhancement Level II Reach. BHR varies through this reach; however, the reach is stable.
Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 17, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-3.3	98.33
0.5	97.59
3.2	96.61
4.6	94.79
9.6	94.69
13.7	94.86
16.0	94.53
18.1	94.18
19.2	96.53
23.0	97.20
25.5	97.51

SUMMARY DATA	
Bankfull Elevation:	95.6
Bankfull Cross-Sectional Area:	13.2
Bankfull Width:	14.8
Flood Prone Area Elevation:	97.0
Flood Prone Width:	19.0
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	0.9
W / D Ratio:	16.6
Entrenchment Ratio:	1.3
Bank Height Ratio:	1.6

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

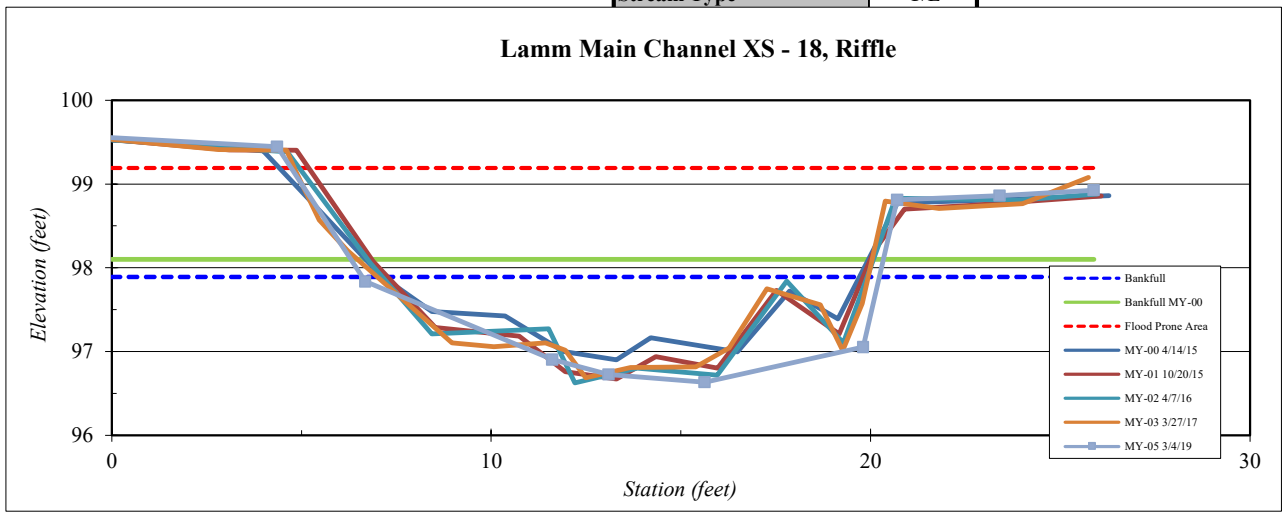
Enhancement Level II Reach. BHR varies through this reach; however, the reach is stable.
Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 18, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.1	99.56
4.4	99.45
6.7	97.83
11.6	96.90
13.1	96.73
15.6	96.63
19.8	97.05
20.7	98.81
23.4	98.86
25.9	98.93

SUMMARY DATA	
Bankfull Elevation:	97.9
Bankfull Cross-Sectional Area:	11.8
Bankfull Width:	13.6
Flood Prone Area Elevation:	99.2
Flood Prone Width:	31.0
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.9
W / D Ratio:	15.7
Entrenchment Ratio:	2.3
Bank Height Ratio:	1.7

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

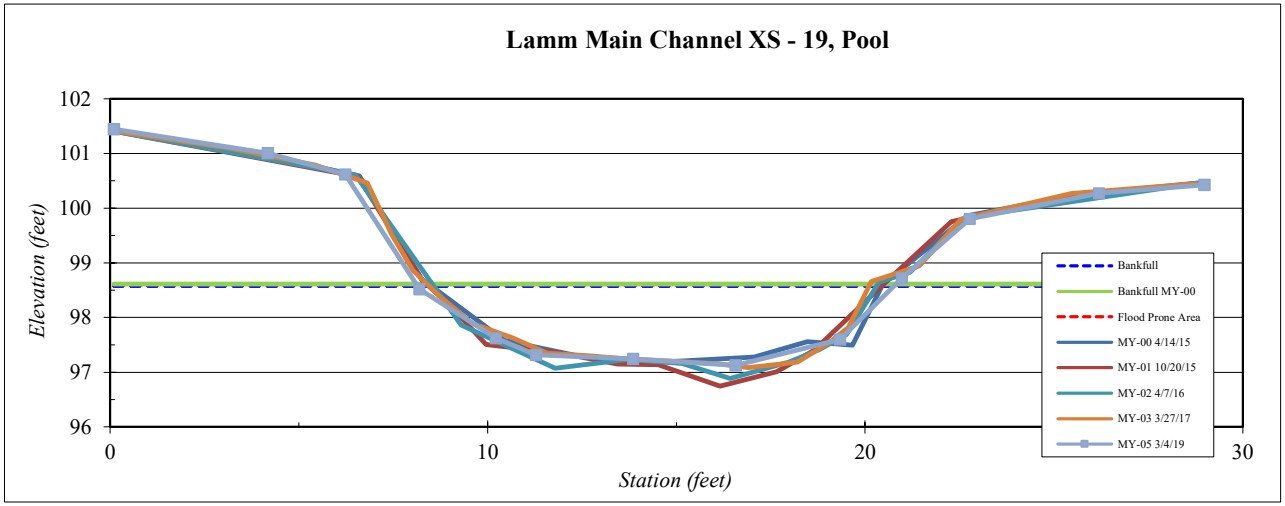
Enhancement Level II Reach. BHR varies through this reach; however, the reach is stable.
Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 19, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.1	101.4
4.2	101.0
6.2	100.6
8.2	98.5
10.2	97.6
11.3	97.3
13.9	97.2
16.6	97.1
19.3	97.6
21.0	98.7
22.8	99.8
26.2	100.3
29.0	100.4

SUMMARY DATA	
Bankfull Elevation:	98.6
Bankfull Cross-Sectional Area:	13.4
Bankfull Width:	12.6
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.5
Mean Depth at Bankfull:	1.1
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.1

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Enhancement Level II Reach. No problems have been noted in this reach.

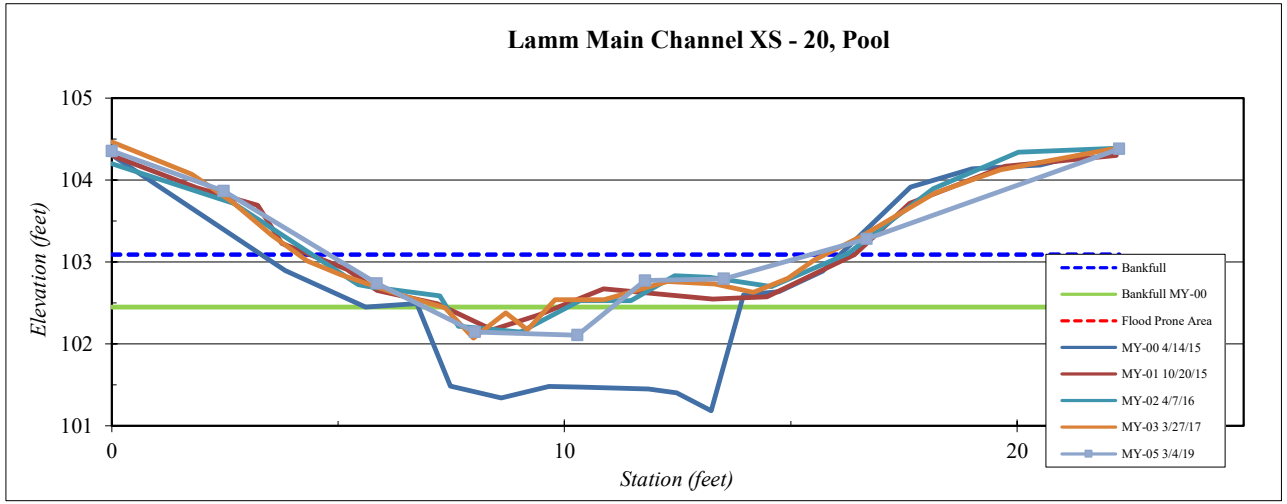
Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 20, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	104.4
2.5	103.9
5.9	102.7
8.0	102.1
10.3	102.1
11.8	102.8
13.5	102.8
16.7	103.3
22.3	104.4

SUMMARY DATA	
Bankfull Elevation:	103.1
Bankfull Cross-Sectional Area:	5.6
Bankfull Width:	10.6
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.0
Mean Depth at Bankfull:	0.5
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.2

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

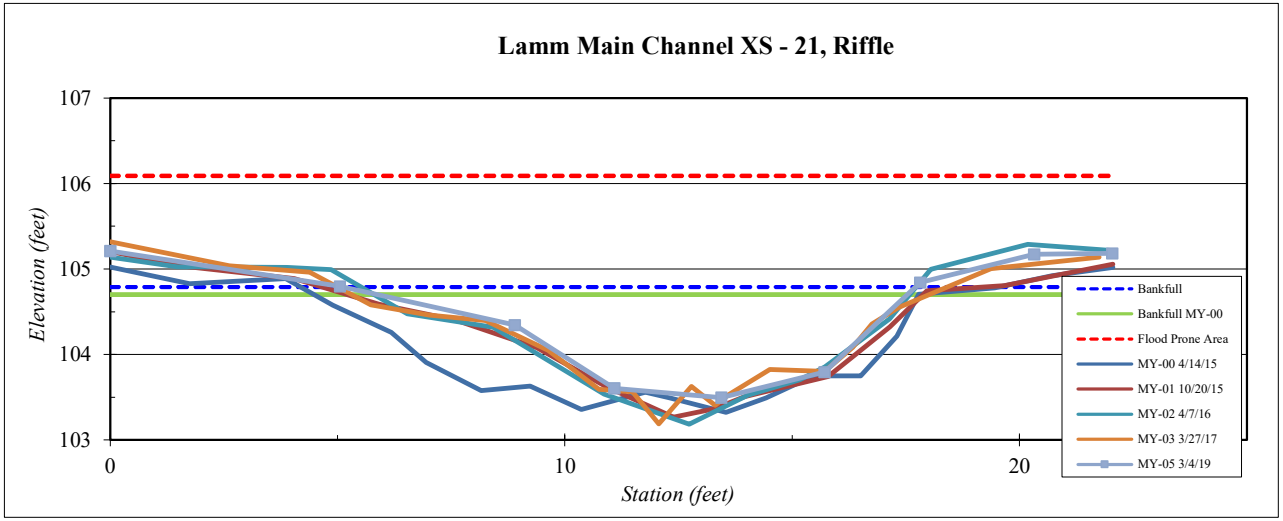
Sediment has aggraded behind a bedrock sill. Sediment has been stable MY-01 through MY-05.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 21, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	105.21
5.0	104.80
8.9	104.34
11.1	103.60
13.4	103.50
15.7	103.79
17.8	104.84
20.3	105.17
22.0	105.18

SUMMARY DATA	
Bankfull Elevation:	104.8
Bankfull Cross-Sectional Area:	9.1
Bankfull Width:	12.6
Flood Prone Area Elevation:	106.1
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.7
W / D Ratio:	17.4
Entrenchment Ratio:	7.1
Bank Height Ratio:	1.00

Stream Type	C/E



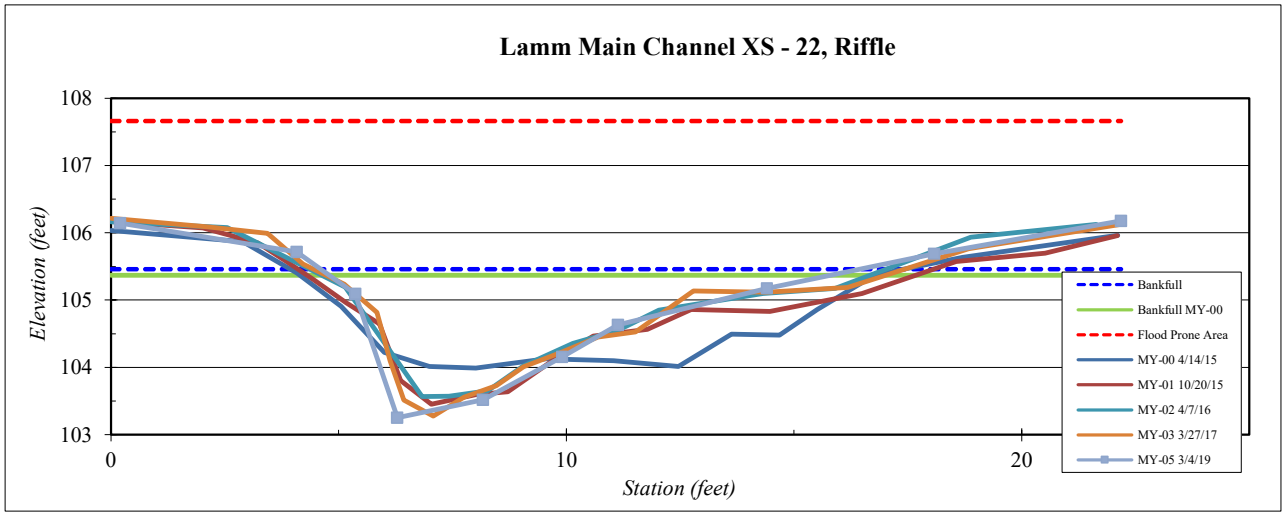
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 22, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.2	106.14
4.1	105.72
5.4	105.09
6.3	103.25
8.2	103.52
9.9	104.16
11.1	104.63
14.4	105.18
18.1	105.69
22.2	106.18

SUMMARY DATA	
Bankfull Elevation:	105.5
Bankfull Cross-Sectional Area:	11.5
Bankfull Width:	11.8
Flood Prone Area Elevation:	107.7
Flood Prone Width:	90.0
Max Depth at Bankfull:	2.2
Mean Depth at Bankfull:	1.0
W / D Ratio:	12.1
Entrenchment Ratio:	7.6
Bank Height Ratio:	1.1

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

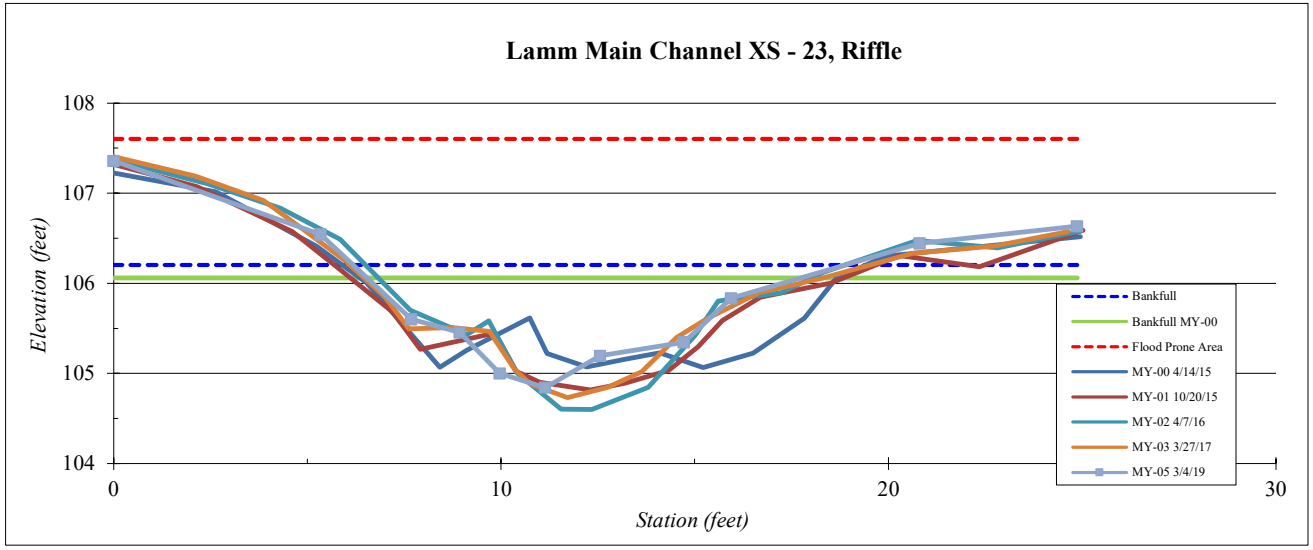
Overall channel area has decreased. Sediment mobilization has resulted in minor downcutting, which has stabilized over the past 5 years. No problems are visible in this reach.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 23, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	107.36
5.3	106.54
7.7	105.60
8.9	105.45
10.0	105.00
11.1	104.84
12.6	105.20
14.7	105.35
15.9	105.83
20.8	106.44
24.9	106.63

SUMMARY DATA	
Bankfull Elevation:	106.2
Bankfull Cross-Sectional Area:	8.8
Bankfull Width:	12.7
Flood Prone Area Elevation:	107.6
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	0.7
W / D Ratio:	18.3
Entrenchment Ratio:	7.1
Bank Height Ratio:	1.1

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

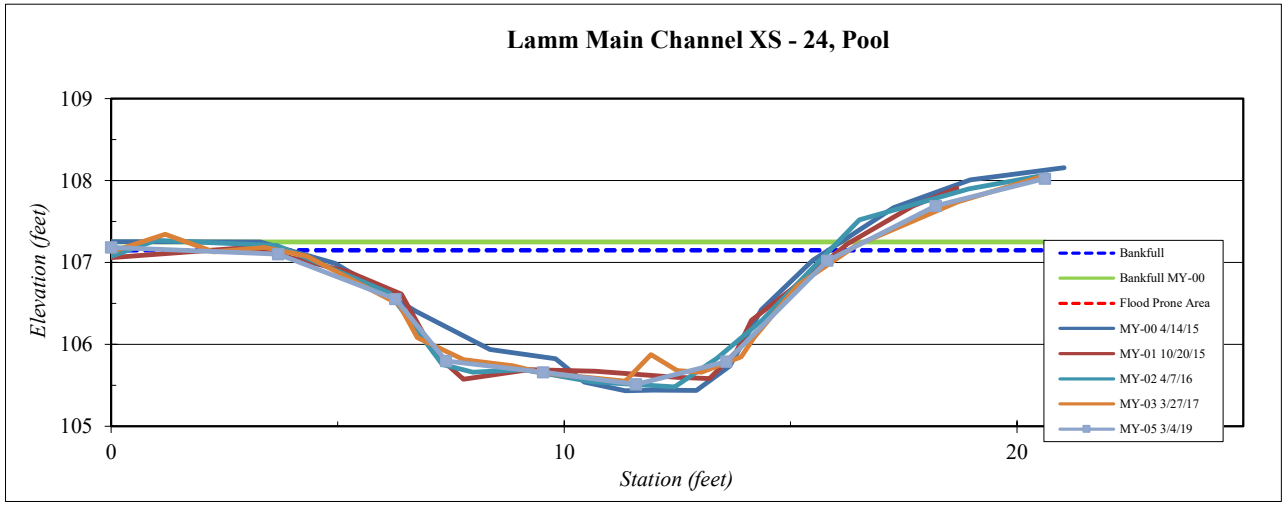
Overall channel area has remained constant. Sediment mobilization has resulted in minor downcutting, which has stabilized over the past 5 years. No problems are visible in this reach.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 24, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	107.2
3.7	107.1
6.3	106.6
7.4	105.8
9.5	105.7
11.6	105.5
13.6	105.8
15.8	107.0
18.2	107.7
20.6	108.0

SUMMARY DATA	
Bankfull Elevation:	107.2
Bankfull Cross-Sectional Area:	12.9
Bankfull Width:	14.7
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.6
Mean Depth at Bankfull:	0.9
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0

Stream Type	C/E



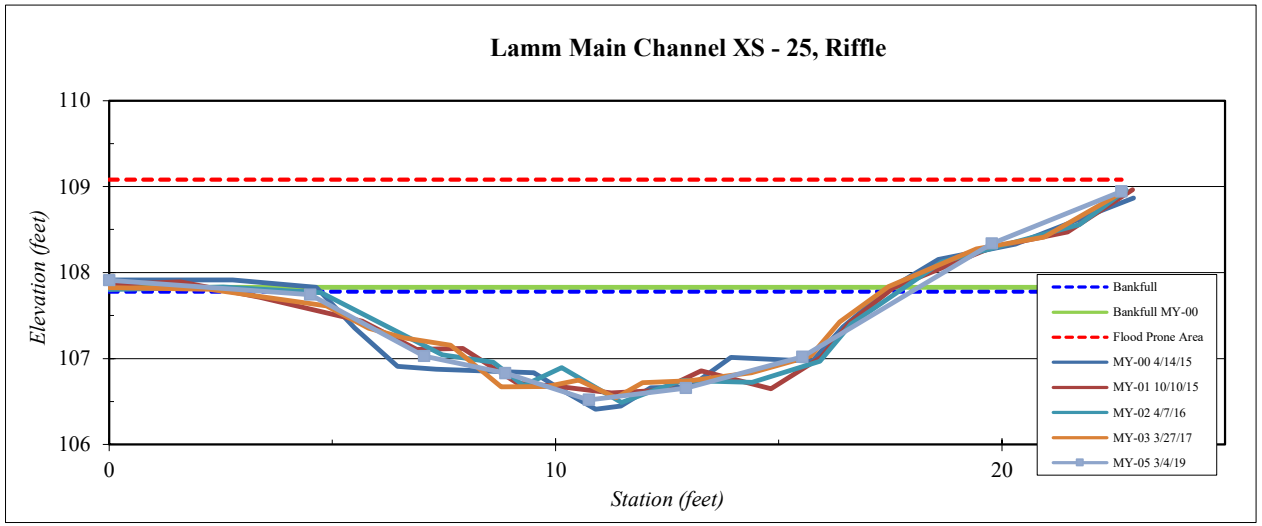
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 25, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	107.91
4.5	107.74
7.1	107.03
8.9	106.83
10.8	106.52
12.9	106.66
15.5	107.02
19.8	108.34
22.7	108.94

SUMMARY DATA	
Bankfull Elevation:	107.8
Bankfull Cross-Sectional Area:	10.6
Bankfull Width:	14.4
Flood Prone Area Elevation:	109.1
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.7
W / D Ratio:	19.6
Entrenchment Ratio:	6.3
Bank Height Ratio:	<1

Stream Type	C/E



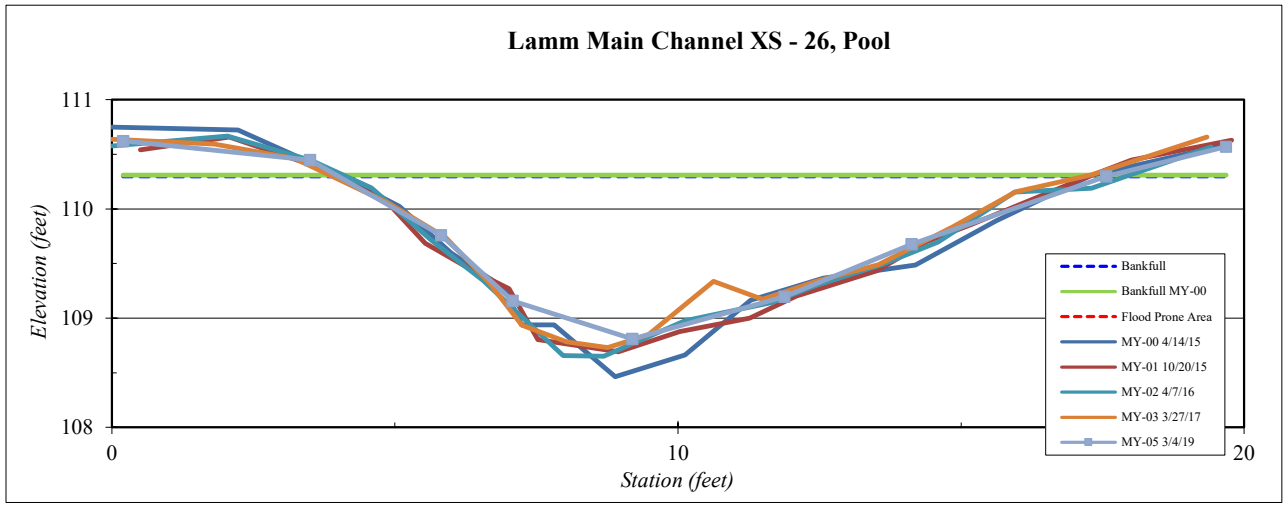
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 26, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.2	110.6
3.5	110.4
5.8	109.8
7.1	109.2
9.2	108.8
11.9	109.2
14.1	109.7
17.6	110.3
19.7	110.6

SUMMARY DATA	
Bankfull Elevation:	110.3
Bankfull Cross-Sectional Area:	10.8
Bankfull Width:	13.6
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.5
Mean Depth at Bankfull:	0.8
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0

Stream Type	C/E



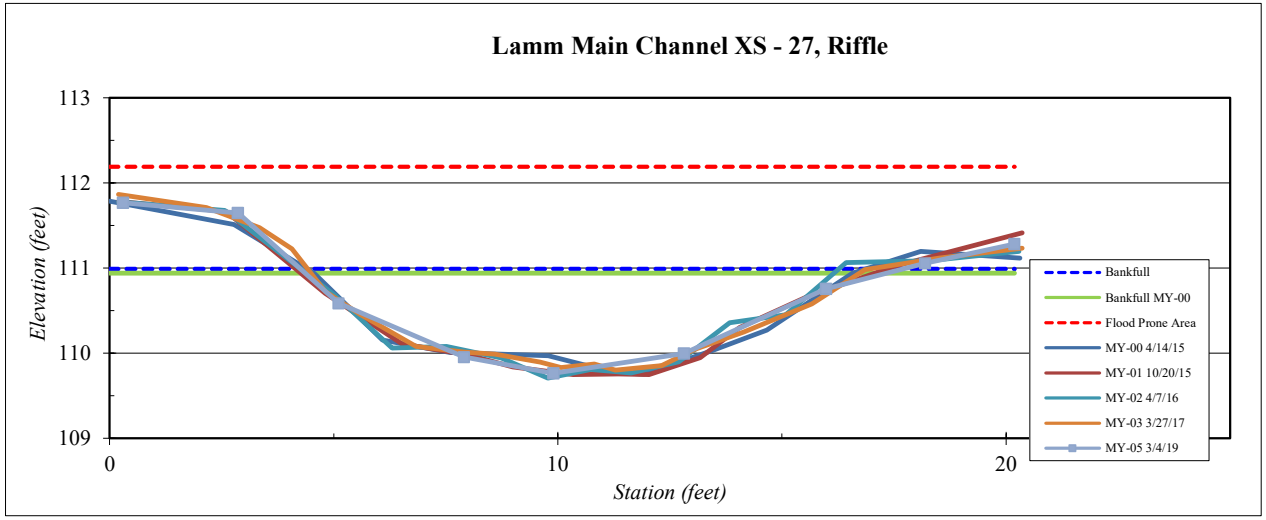
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 27, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.3	111.77
2.9	111.65
5.1	110.59
7.9	109.95
9.9	109.77
12.8	110.00
16.0	110.76
18.2	111.06
20.2	111.29

SUMMARY DATA	
Bankfull Elevation:	111.0
Bankfull Cross-Sectional Area:	9.8
Bankfull Width:	13.5
Flood Prone Area Elevation:	112.2
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.2
Mean Depth at Bankfull:	0.7
W / D Ratio:	18.6
Entrenchment Ratio:	6.7
Bank Height Ratio:	1.1

Stream Type	C/E



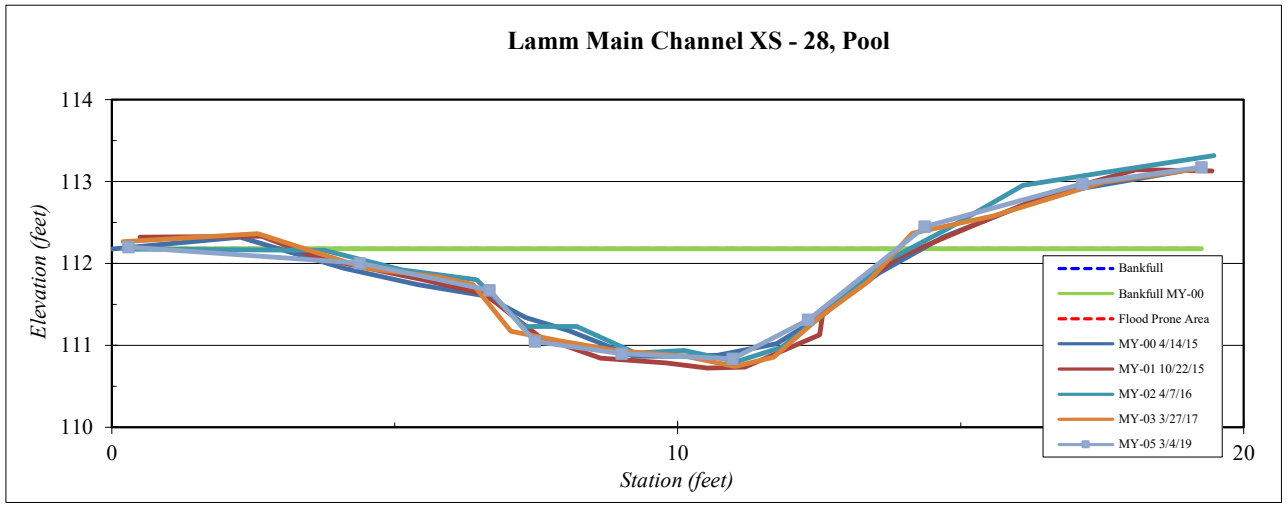
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 28, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.3	112.2
4.4	112.0
6.7	111.7
7.5	111.0
9.0	110.9
11.0	110.8
12.3	111.3
14.4	112.4
17.2	113.0
19.3	113.2

SUMMARY DATA	
Bankfull Elevation:	112.2
Bankfull Cross-Sectional Area:	8.3
Bankfull Width:	13.1
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.6
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.1

Stream Type	C/E



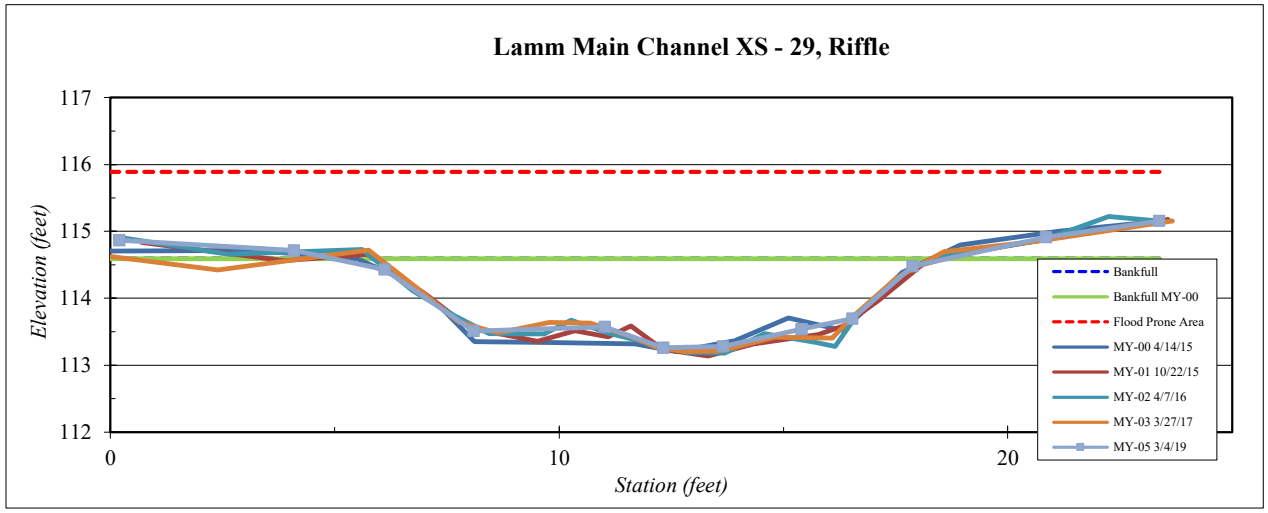
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 29, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.2	114.87
4.1	114.71
6.1	114.43
8.1	113.51
11.0	113.57
12.3	113.26
13.7	113.28
15.4	113.54
16.5	113.70
17.9	114.48
20.9	114.91
23.4	115.15

SUMMARY DATA	
Bankfull Elevation:	114.6
Bankfull Cross-Sectional Area:	11.6
Bankfull Width:	13.7
Flood Prone Area Elevation:	115.9
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.8
W / D Ratio:	16.2
Entrenchment Ratio:	6.6
Bank Height Ratio:	<1

Stream Type	C/E



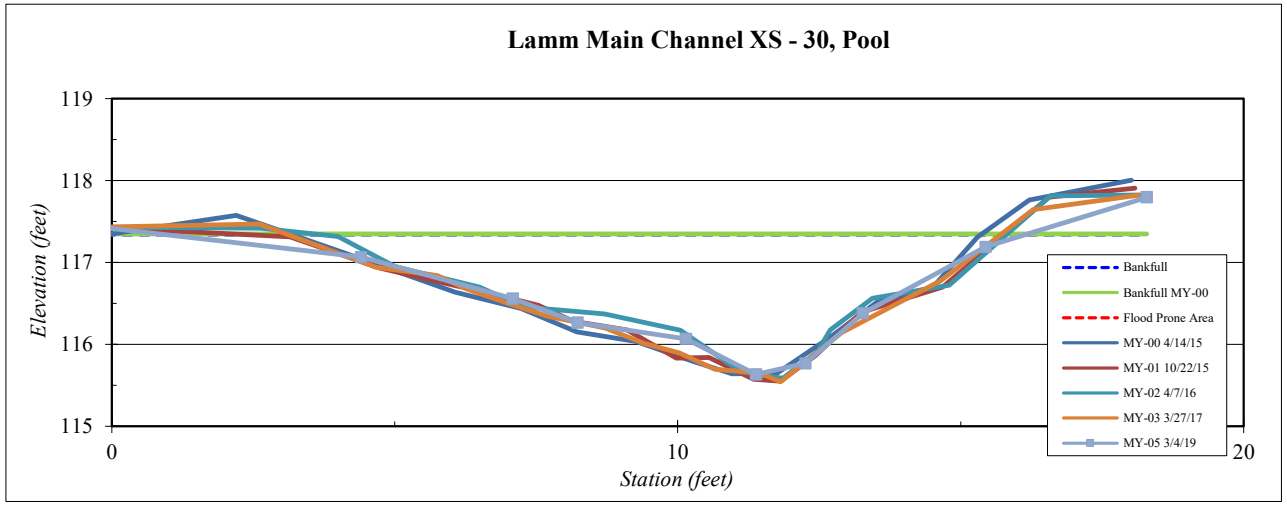
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 30, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.1	117.4
4.4	117.1
7.1	116.6
8.2	116.3
10.1	116.1
11.4	115.6
12.3	115.8
13.3	116.4
15.4	117.2
18.3	117.8

SUMMARY DATA	
Bankfull Elevation:	117.3
Bankfull Cross-Sectional Area:	11.1
Bankfull Width:	15.3
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.7
Mean Depth at Bankfull:	0.7
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	<1

Stream Type	C/E



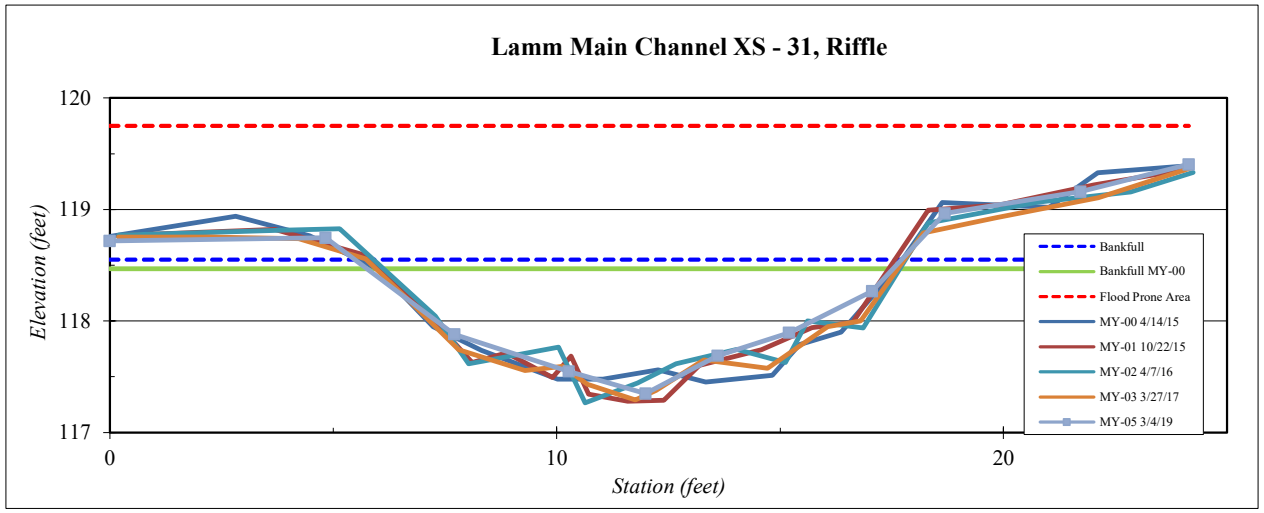
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 30, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	118.72
4.8	118.75
7.7	117.88
10.3	117.55
12.0	117.35
13.6	117.69
15.2	117.89
17.1	118.27
18.7	118.96
21.7	119.16
24.1	119.40

SUMMARY DATA	
Bankfull Elevation:	118.6
Bankfull Cross-Sectional Area:	8.6
Bankfull Width:	12.2
Flood Prone Area Elevation:	119.8
Flood Prone Width:	90.0
Max Depth at Bankfull:	1.2
Mean Depth at Bankfull:	0.7
W / D Ratio:	17.3
Entrenchment Ratio:	7.4
Bank Height Ratio:	1.2

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

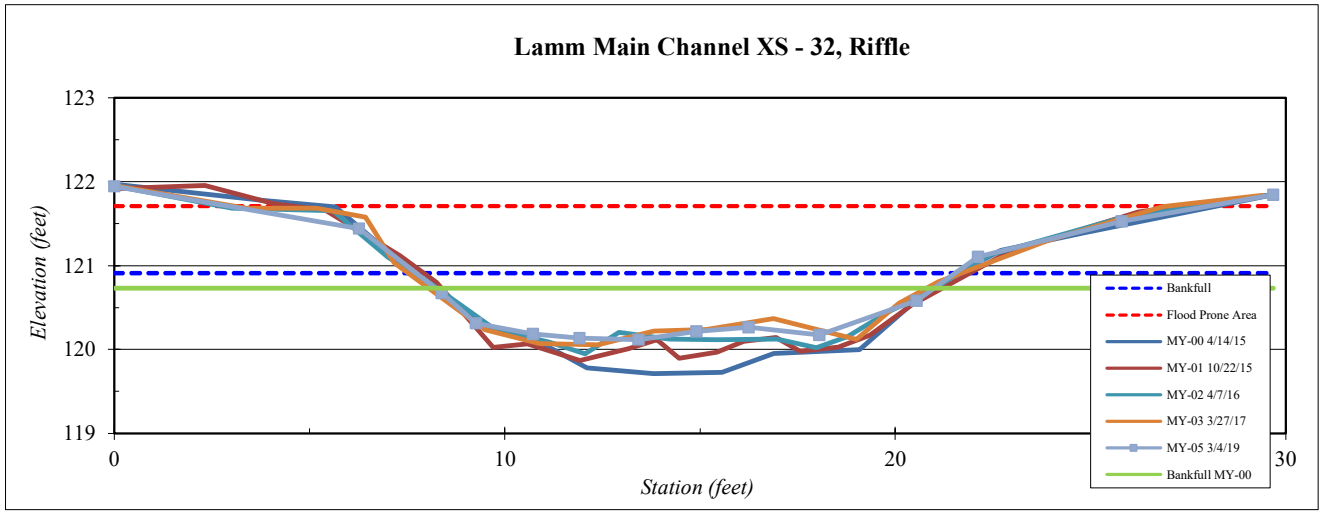
No problems have been noted in this reach. Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	Main Channel XS - 32, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	121.94
6.3	121.44
8.4	120.67
9.3	120.31
10.7	120.18
11.9	120.14
13.4	120.12
14.9	120.21
16.3	120.26
18.1	120.17
20.5	120.58
22.1	121.10
25.8	121.53
29.7	121.84

SUMMARY DATA	
Bankfull Elevation:	120.9
Bankfull Cross-Sectional Area:	8.2
Bankfull Width:	13.8
Flood Prone Area Elevation:	121.7
Flood Prone Width:	25.0
Max Depth at Bankfull:	0.8
Mean Depth at Bankfull:	0.6
W / D Ratio:	23.2
Entrenchment Ratio:	1.8
Bank Height Ratio:	1.3

Stream Type	C/E



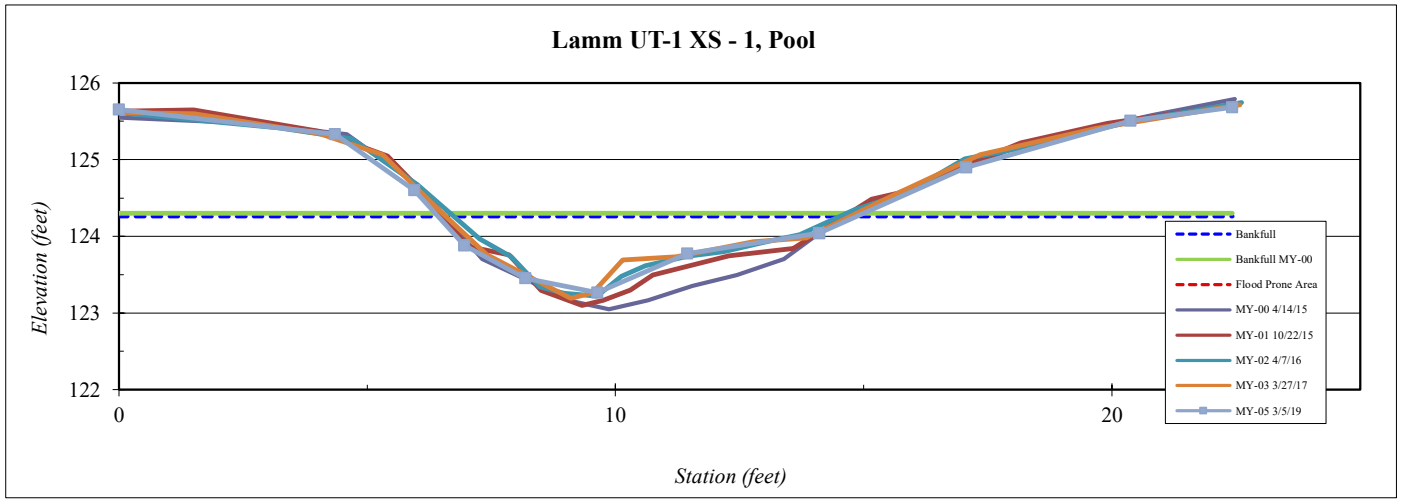
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 1 XS - 1, Pool
Feature	Pool
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	125.7
4.3	125.3
5.9	124.6
7.0	123.9
8.2	123.5
9.6	123.3
11.4	123.8
14.1	124.0
17.1	124.9
20.4	125.5
22.4	125.7

SUMMARY DATA	
Bankfull Elevation:	124.3
Bankfull Cross-Sectional Area:	4.5
Bankfull Width:	8.4
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.0
Mean Depth at Bankfull:	0.5
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.3

Stream Type	C/E



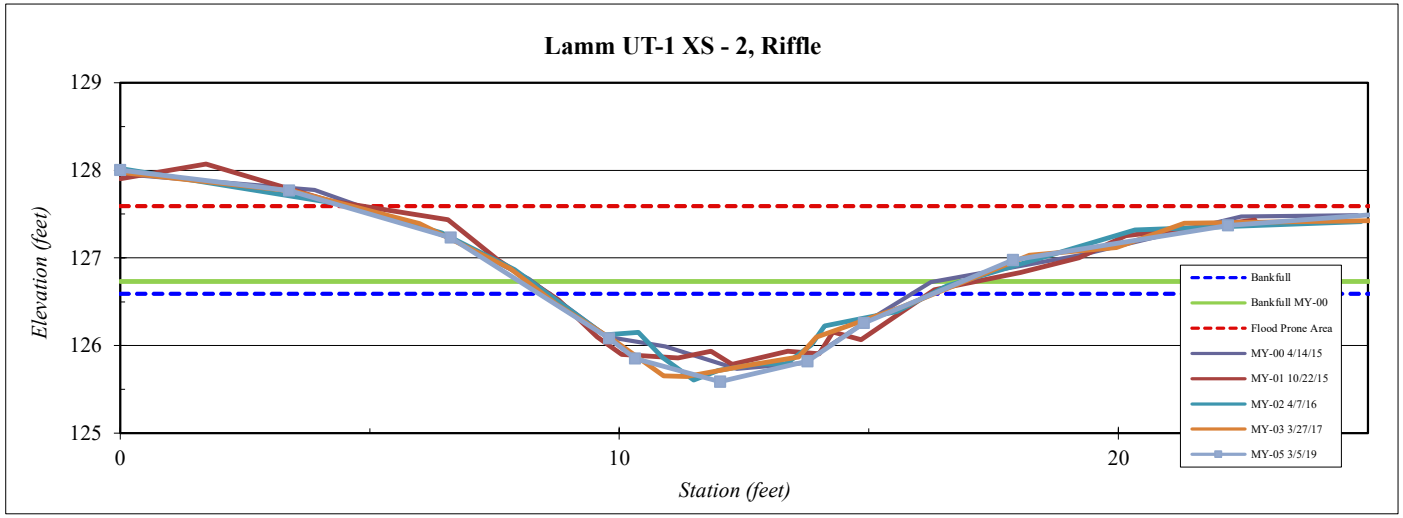
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 1 XS - 2, Riffle
Feature	Riffle
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	128.00
3.4	127.77
6.6	127.23
9.8	126.08
10.3	125.85
12.0	125.59
13.8	125.82
14.9	126.26
17.9	126.97
22.2	127.37
25.0	127.49

SUMMARY DATA	
Bankfull Elevation:	126.6
Bankfull Cross-Sectional Area:	4.6
Bankfull Width:	7.9
Flood Prone Area Elevation:	127.6
Flood Prone Width:	50.0
Max Depth at Bankfull:	1.0
Mean Depth at Bankfull:	0.6
W / D Ratio:	13.6
Entrenchment Ratio:	6.3
Bank Height Ratio:	1.4

Stream Type	C/E



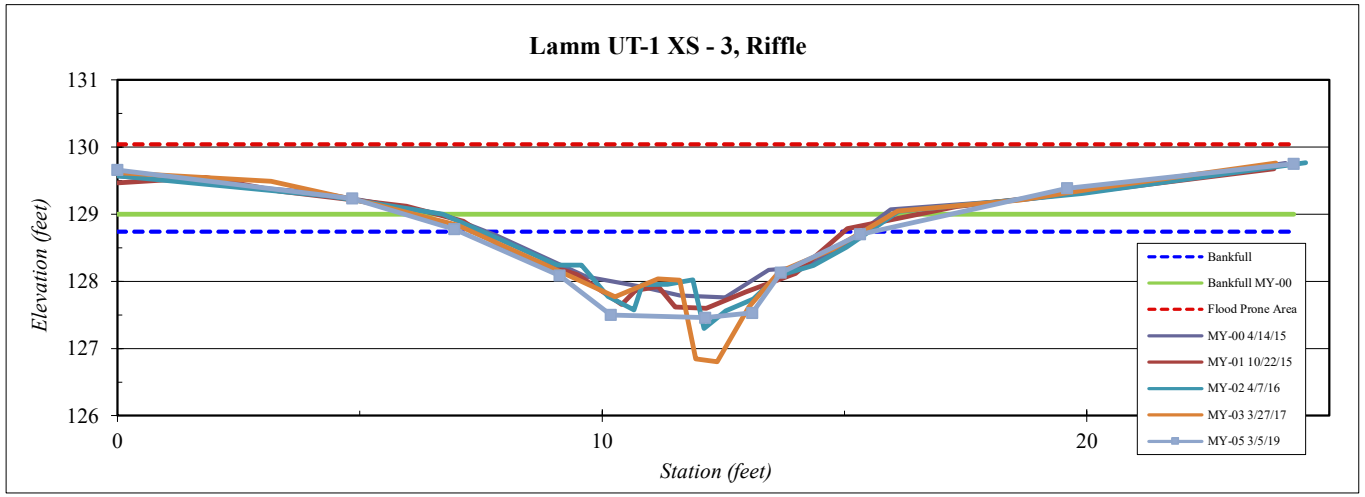
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 1 XS - 3, Riffle
Feature	Riffle
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	129.66
4.8	129.23
7.0	128.78
9.1	128.09
10.2	127.50
12.1	127.46
13.1	127.53
13.7	128.13
15.3	128.70
19.6	129.39
24.3	129.75

SUMMARY DATA	
Bankfull Elevation:	128.7
Bankfull Cross-Sectional Area:	6.4
Bankfull Width:	8.5
Flood Prone Area Elevation:	130.0
Flood Prone Width:	50.0
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.8
W / D Ratio:	11.3
Entrenchment Ratio:	5.9
Bank Height Ratio:	1.0

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

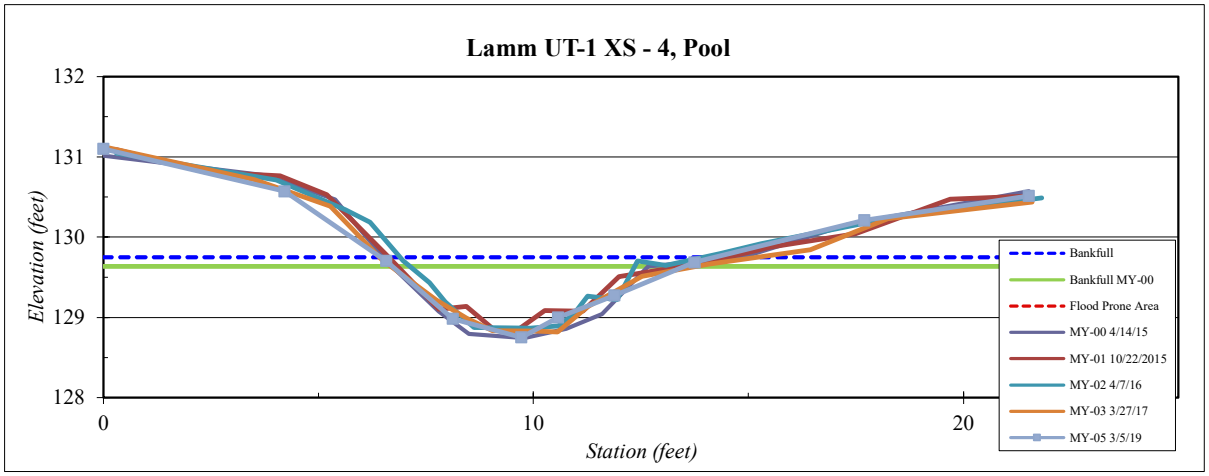
Elevated BHR results from shallow channel depth. UT 1 appears stable throughout.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 1 XS - 4, Pool
Feature	Pool
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	131.10
4.2	130.57
6.6	129.70
8.1	128.98
9.7	128.75
10.6	129.00
11.9	129.27
13.7	129.69
17.7	130.21
21.5	130.51

SUMMARY DATA	
Bankfull Elevation:	129.8
Bankfull Cross-Sectional Area:	4.1
Bankfull Width:	7.8
Flood Prone Area Elevation:	N/A
Flood Prone Width:	N/A
Max Depth at Bankfull:	1.0
Mean Depth at Bankfull:	0.5
W / D Ratio:	N/A
Entrenchment Ratio:	N/A
Bank Height Ratio:	<1

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

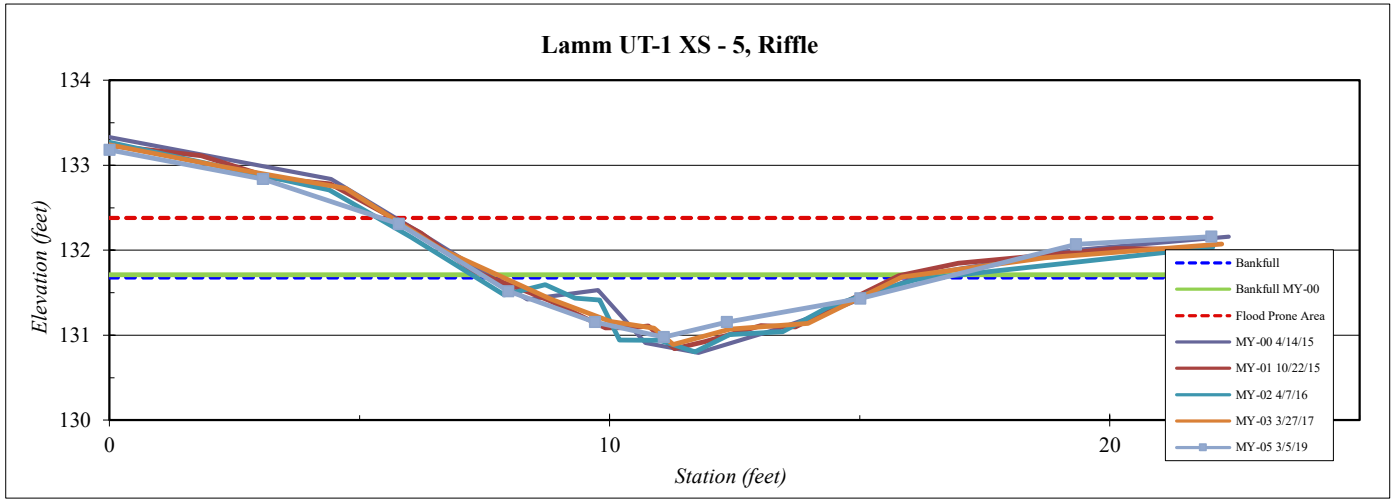
XS-4 was determined to be a pool during MY-05. It was labeled a pool during MY-0 but was mislabeled as a riffle during MY-01 through MY-03.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 1 XS - 5, Riffle
Feature	Riffle
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	133.18
3.1	132.84
5.8	132.31
8.0	131.52
9.7	131.16
11.1	130.98
12.3	131.16
15.0	131.43
19.3	132.07
22.0	132.16

SUMMARY DATA	
Bankfull Elevation:	131.7
Bankfull Cross-Sectional Area:	3.5
Bankfull Width:	9.2
Flood Prone Area Elevation:	132.4
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.7
Mean Depth at Bankfull:	0.4
W / D Ratio:	24.2
Entrenchment Ratio:	5.4
Bank Height Ratio:	1.6

Stream Type	C/E



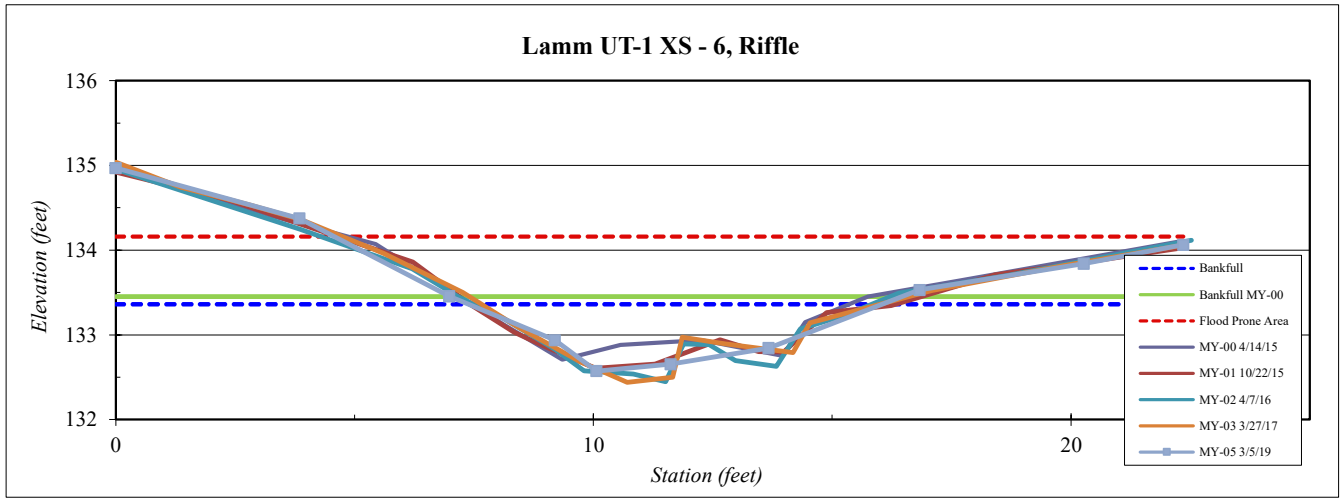
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 1 XS - 6, Riffle
Feature	Riffle
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	134.97
3.8	134.37
7.0	133.46
9.2	132.93
10.1	132.57
11.6	132.65
13.7	132.84
16.8	133.53
20.3	133.84
22.3	134.06

SUMMARY DATA	
Bankfull Elevation:	133.4
Bankfull Cross-Sectional Area:	3.9
Bankfull Width:	8.7
Flood Prone Area Elevation:	134.2
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.8
Mean Depth at Bankfull:	0.4
W / D Ratio:	19.4
Entrenchment Ratio:	5.7
Bank Height Ratio:	1.25

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

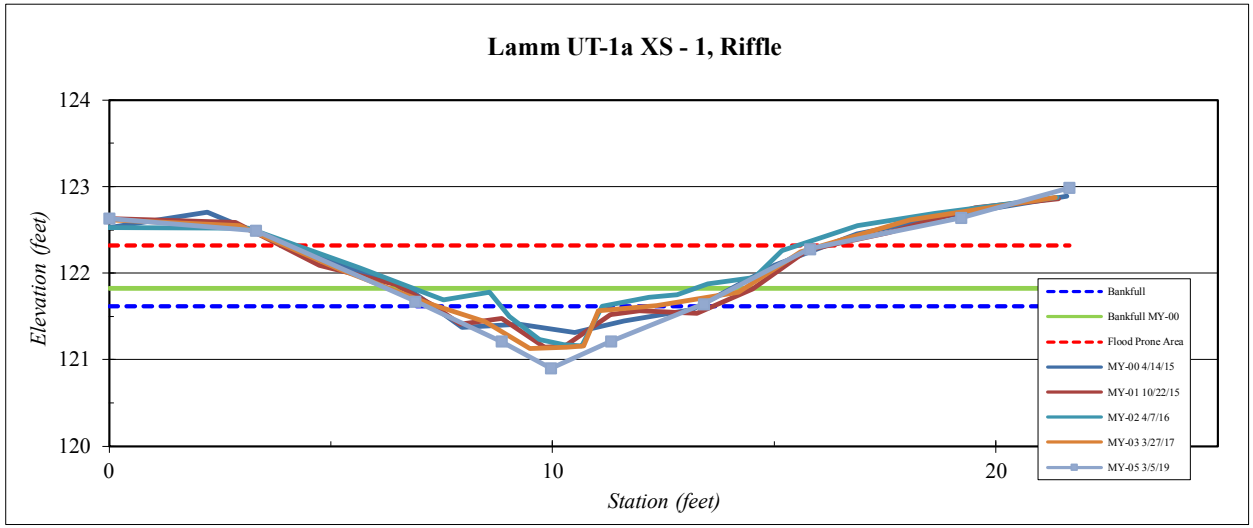
Overall channel area has remained constant. Sediment mobilization has resulted in minor downcutting, which has stabilized over the past 5 years. No problems are visible in this reach.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 1a XS - 1, Riffle
Feature	Riffle
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	122.63
3.3	122.49
6.9	121.67
8.8	121.21
10.0	120.90
11.3	121.21
13.4	121.64
15.8	122.28
19.2	122.64
21.6	122.99

SUMMARY DATA	
Bankfull Elevation:	121.6
Bankfull Cross-Sectional Area:	2.1
Bankfull Width:	6.2
Flood Prone Area Elevation:	122.3
Flood Prone Width:	14.0
Max Depth at Bankfull:	0.7
Mean Depth at Bankfull:	0.3
W / D Ratio:	18.3
Entrenchment Ratio:	2.3
Bank Height Ratio:	1.1

Stream Type	C



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

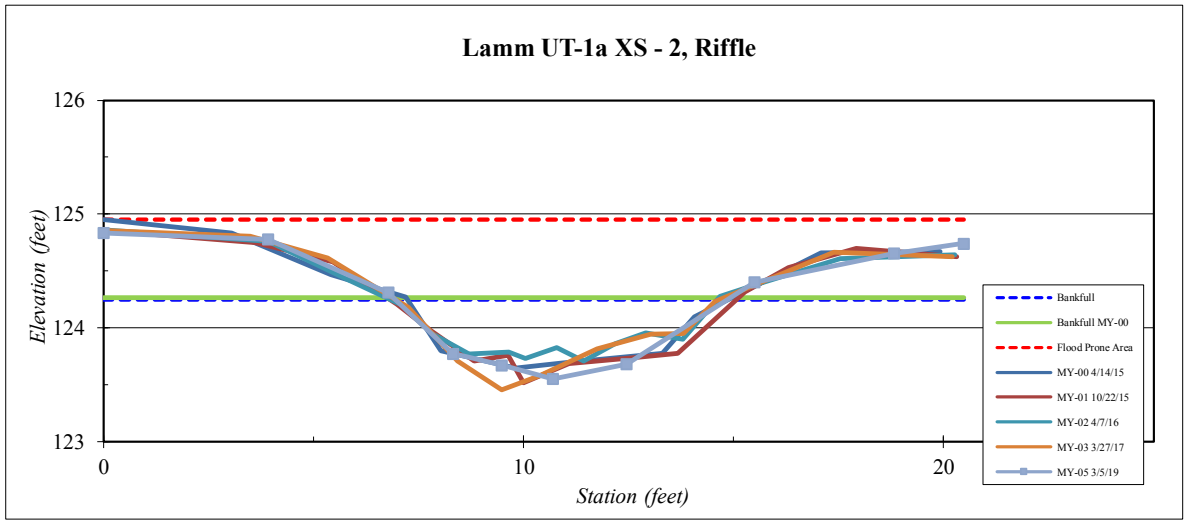
No problems have been noted in this reach. Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 1a XS - 2, Riffle
Feature	Riffle
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	124.84
3.9	124.78
6.8	124.31
8.3	123.77
9.5	123.67
10.7	123.55
12.5	123.68
15.5	124.40
18.8	124.65
20.5	124.74

SUMMARY DATA	
Bankfull Elevation:	124.3
Bankfull Cross-Sectional Area:	3.5
Bankfull Width:	7.9
Flood Prone Area Elevation:	125.0
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.7
Mean Depth at Bankfull:	0.4
W / D Ratio:	17.8
Entrenchment Ratio:	6.3
Bank Height Ratio:	1.14

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

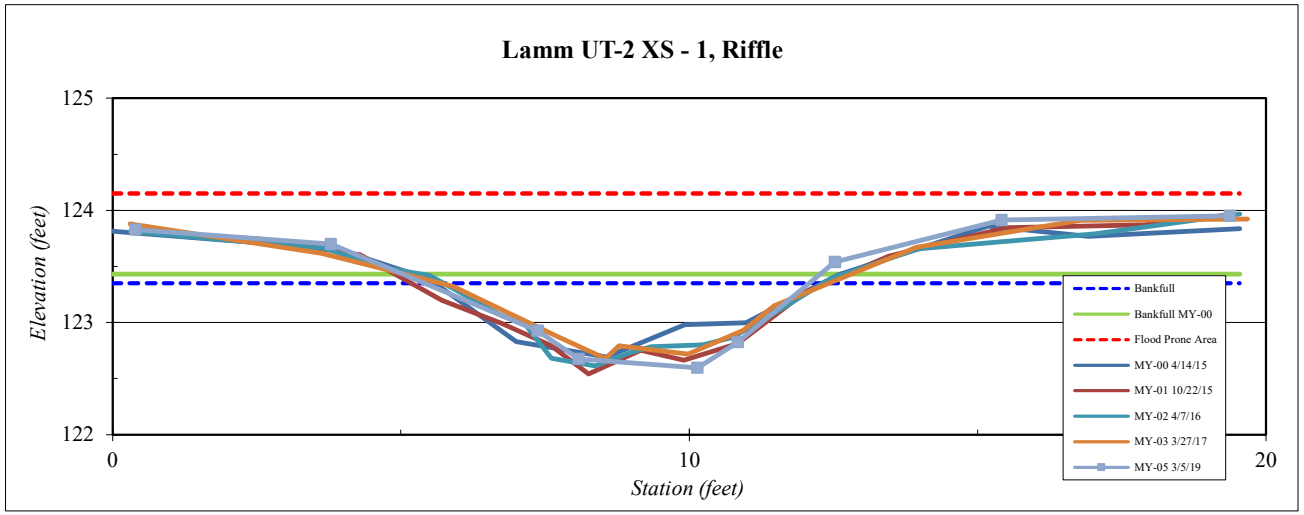
No problems have been noted in this reach. Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 2 XS - 1, Riffle
Feature	Riffle
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.4	123.83
3.8	123.70
7.4	122.93
8.1	122.68
10.1	122.60
10.8	122.82
12.5	123.54
15.4	123.91
19.4	123.95

SUMMARY DATA	
Bankfull Elevation:	123.4
Bankfull Cross-Sectional Area:	3.1
Bankfull Width:	6.7
Flood Prone Area Elevation:	124.2
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.8
Mean Depth at Bankfull:	0.5
W / D Ratio:	14.5
Entrenchment Ratio:	7.5
Bank Height Ratio:	1.1

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

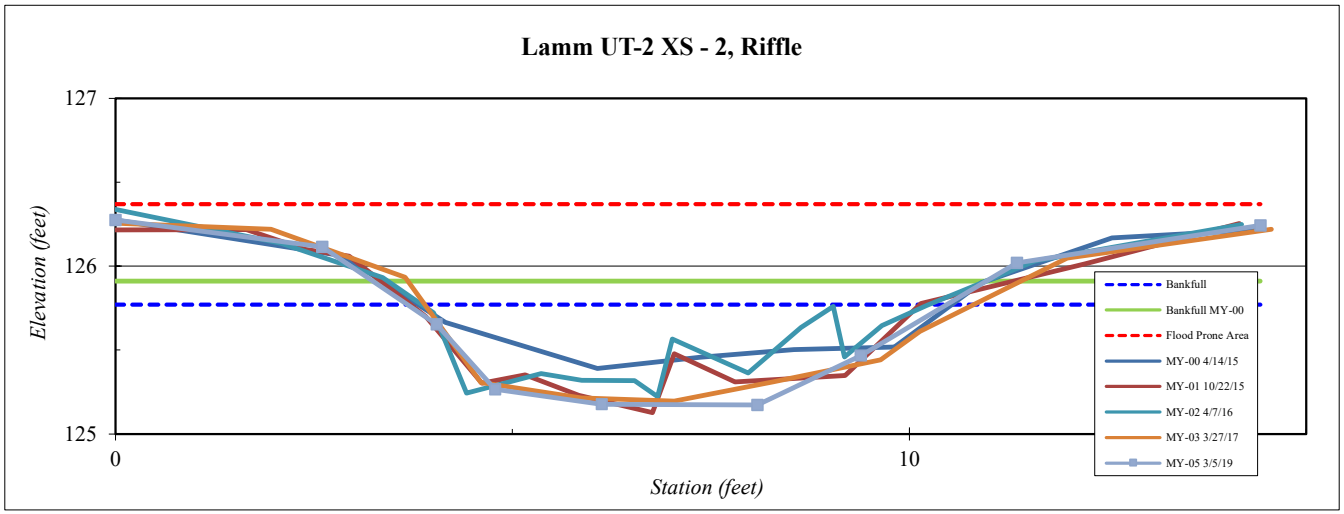
No problems have been noted in this reach. Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 2 XS - 2, Riffle
Feature	Riffle
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	126.27
2.6	126.11
4.0	125.65
4.8	125.27
6.1	125.18
8.1	125.17
9.4	125.47
11.4	126.02
14.4	126.24

SUMMARY DATA	
Bankfull Elevation:	125.8
Bankfull Cross-Sectional Area:	2.9
Bankfull Width:	6.8
Flood Prone Area Elevation:	126.4
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.6
Mean Depth at Bankfull:	0.4
W / D Ratio:	15.9
Entrenchment Ratio:	7.4
Bank Height Ratio:	1.3

Stream Type	C



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

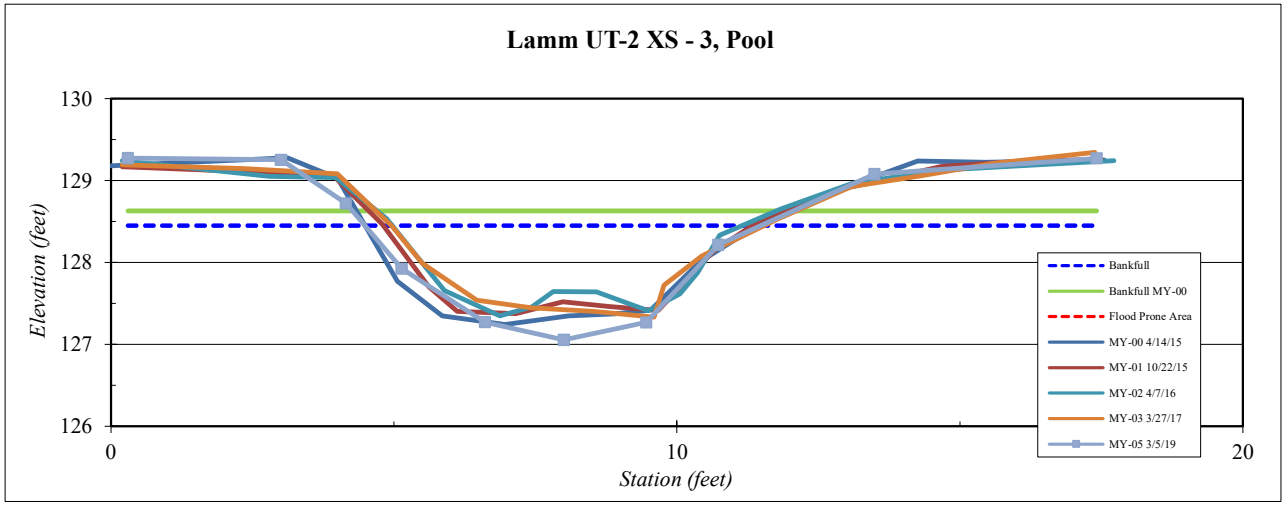
No problems have been noted in this reach. Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 2 XS - 3, Pool
Feature	Pool
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.3	129.3
3.0	129.3
4.1	128.7
5.1	127.9
6.6	127.3
8.0	127.1
9.5	127.3
10.7	128.2
13.5	129.1
17.4	129.3

SUMMARY DATA	
Bankfull Elevation:	128.5
Bankfull Cross-Sectional Area:	6.1
Bankfull Width:	7.0
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	0.9
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	<1

Stream Type	C/E



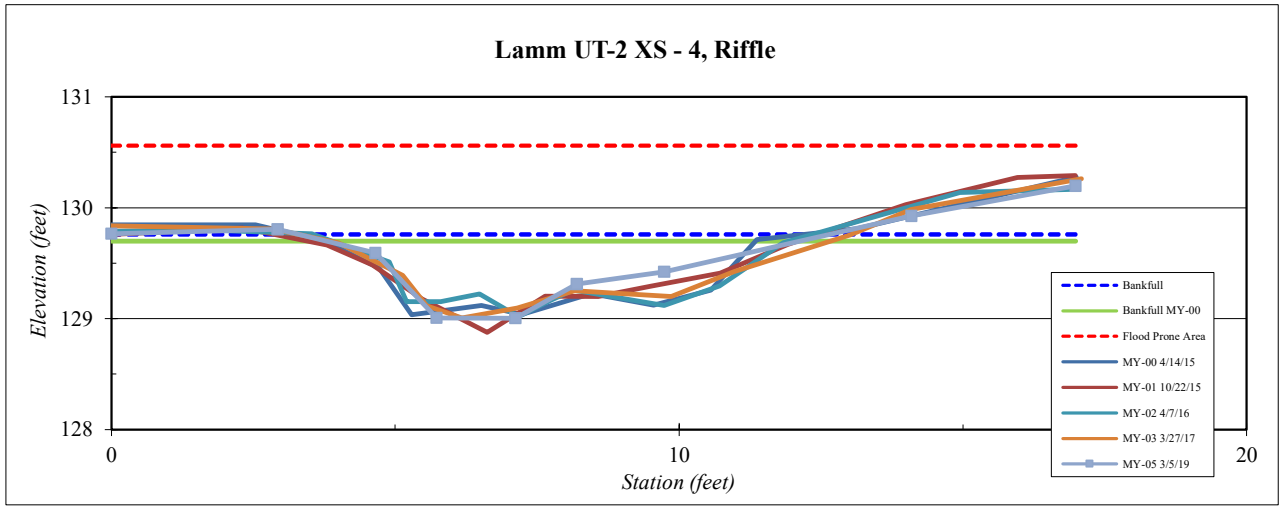
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 2 XS - 4, Riffle
Feature	Riffle
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	129.77
2.9	129.81
4.7	129.59
5.7	129.01
7.1	129.00
8.2	129.31
9.7	129.42
14.1	129.93
17.0	130.20

SUMMARY DATA	
Bankfull Elevation:	129.8
Bankfull Cross-Sectional Area:	3.4
Bankfull Width:	9.4
Flood Prone Area Elevation:	130.6
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.8
Mean Depth at Bankfull:	0.4
W / D Ratio:	26.0
Entrenchment Ratio:	5.3
Bank Height Ratio:	1.0

Stream Type	C/E



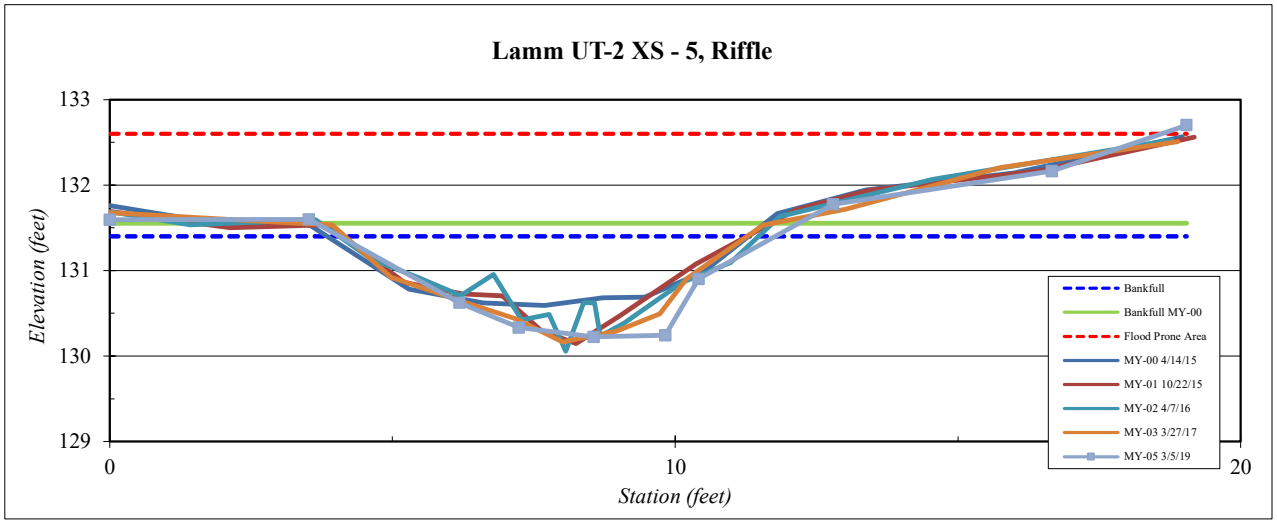
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 2 XS - 5, Riffle
Feature	Riffle
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	131.59
3.5	131.60
6.2	130.62
7.2	130.33
8.6	130.22
9.8	130.24
10.4	130.90
12.8	131.78
16.7	132.16
19.0	132.70

SUMMARY DATA	
Bankfull Elevation:	131.4
Bankfull Cross-Sectional Area:	5.6
Bankfull Width:	7.7
Flood Prone Area Elevation:	132.6
Flood Prone Width:	50.0
Max Depth at Bankfull:	1.2
Mean Depth at Bankfull:	0.7
W / D Ratio:	10.6
Entrenchment Ratio:	6.5
Bank Height Ratio:	1.2

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

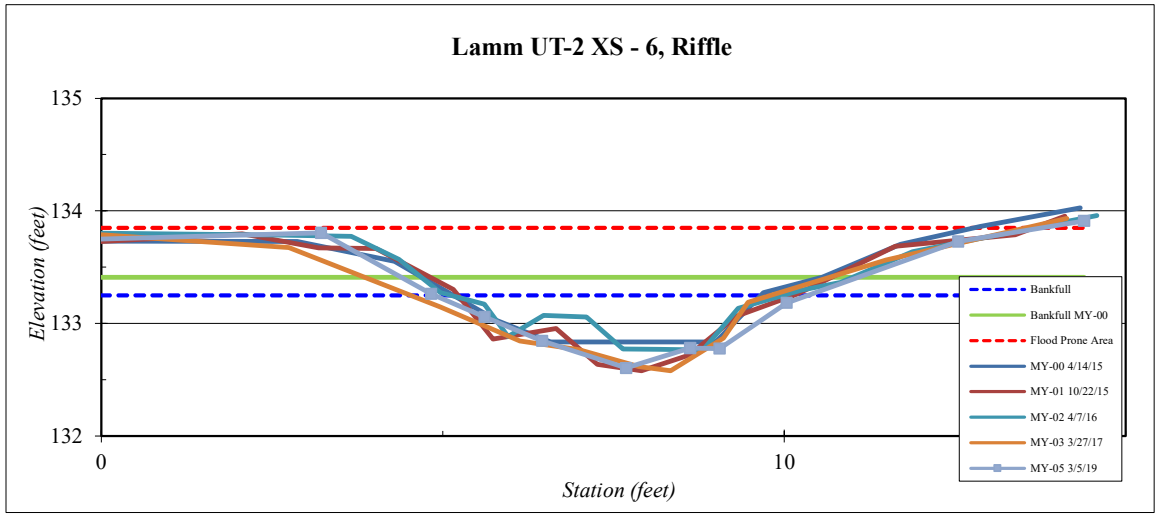
Overall channel area has remained constant. Sediment mobilization has resulted in minor downcutting, which has stabilized over the past 5 years. No problems are visible in this reach.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 2 XS - 6, Riffle
Feature	Riffle
Date:	3/5/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.1	133.75
3.2	133.81
4.8	133.26
5.6	133.06
6.5	132.85
7.7	132.60
8.6	132.78
9.1	132.78
10.0	133.18
12.5	133.73
14.4	133.91

SUMMARY DATA	
Bankfull Elevation:	133.3
Bankfull Cross-Sectional Area:	2.0
Bankfull Width:	5.5
Flood Prone Area Elevation:	133.9
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.6
Mean Depth at Bankfull:	0.4
W / D Ratio:	15.1
Entrenchment Ratio:	9.1
Bank Height Ratio:	1.0

Stream Type	C/E



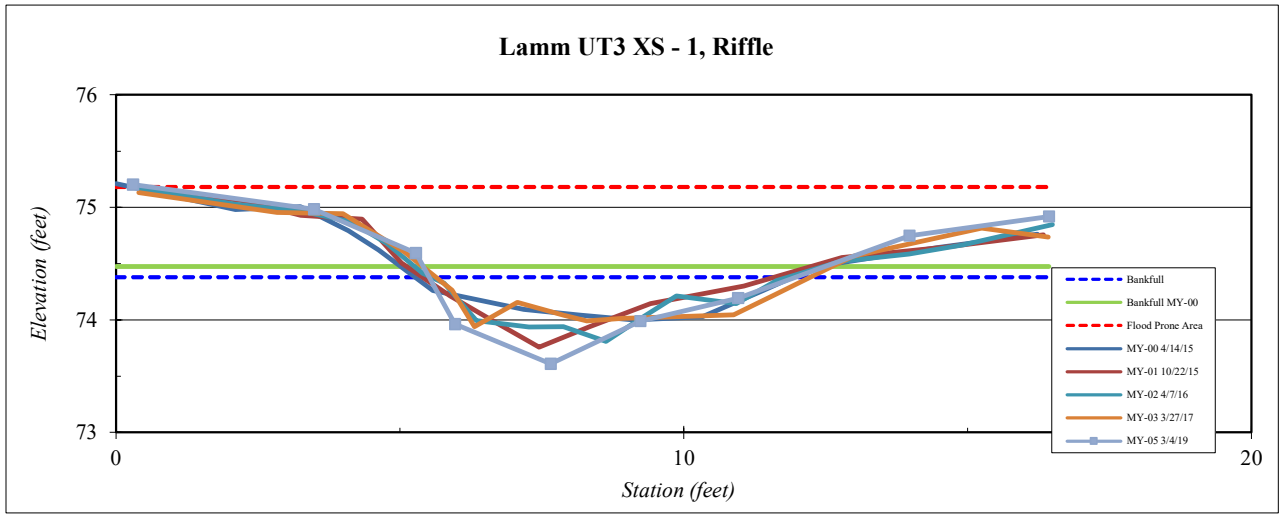
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 1, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.3	75.20
3.5	74.98
5.3	74.59
6.0	73.96
7.7	73.61
9.2	73.99
11.0	74.19
14.0	74.75
16.4	74.92

SUMMARY DATA	
Bankfull Elevation:	74.4
Bankfull Cross-Sectional Area:	2.6
Bankfull Width:	6.5
Flood Prone Area Elevation:	75.2
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.8
Mean Depth at Bankfull:	0.4
W / D Ratio:	16.3
Entrenchment Ratio:	7.7
Bank Height Ratio:	1.0

Stream Type	C



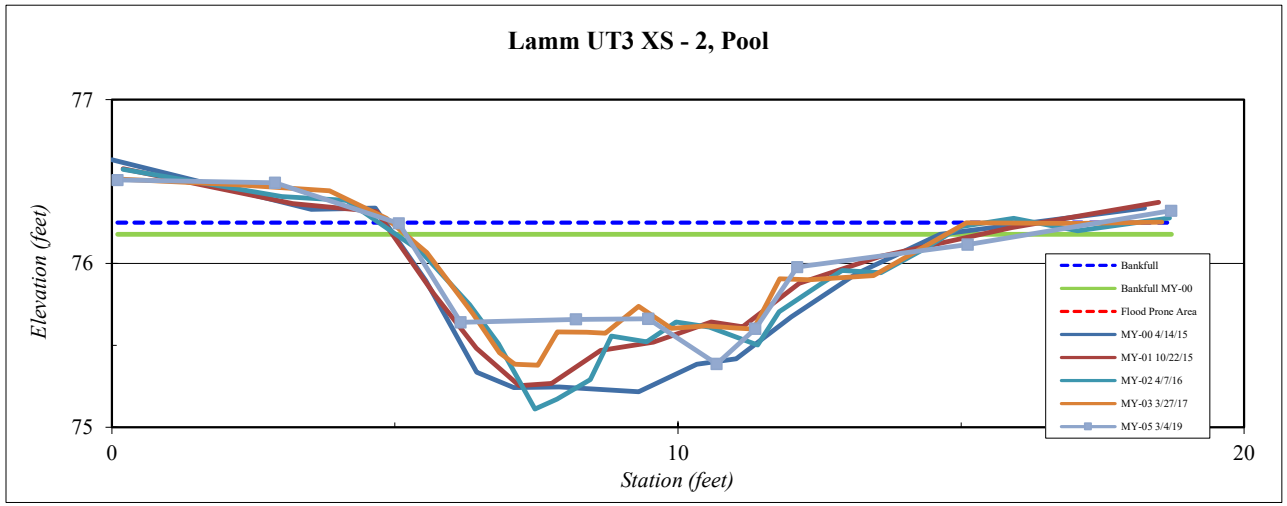
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 2, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.1	76.5
2.9	76.5
5.1	76.2
6.2	75.6
8.2	75.7
9.5	75.7
10.7	75.4
11.4	75.6
12.1	76.0
15.1	76.1
18.7	76.3

SUMMARY DATA	
Bankfull Elevation:	76.3
Bankfull Cross-Sectional Area:	4.8
Bankfull Width:	12.4
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	0.9
Mean Depth at Bankfull:	0.4
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0

Stream Type	C/E



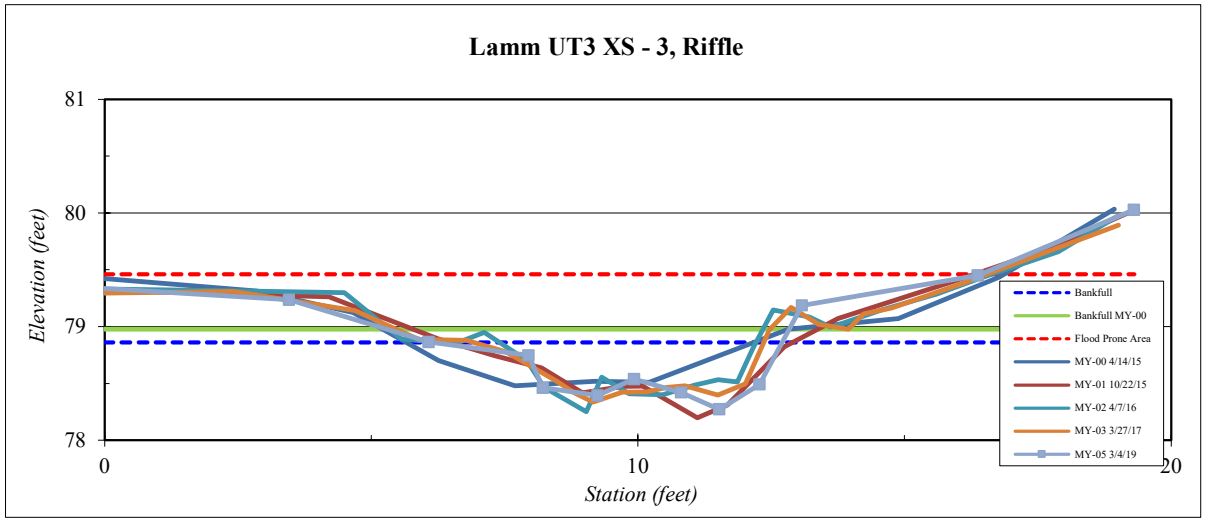
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 3, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.3	79.34
3.5	79.24
6.1	78.86
8.0	78.74
8.2	78.46
9.2	78.39
9.9	78.54
10.8	78.42
11.5	78.27
12.3	78.49
13.1	79.19
16.4	79.45
19.3	80.03

SUMMARY DATA	
Bankfull Elevation:	78.9
Bankfull Cross-Sectional Area:	2.0
Bankfull Width:	6.6
Flood Prone Area Elevation:	79.5
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.6
Mean Depth at Bankfull:	0.3
W / D Ratio:	21.8
Entrenchment Ratio:	7.6
Bank Height Ratio:	<1

Stream Type	C



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

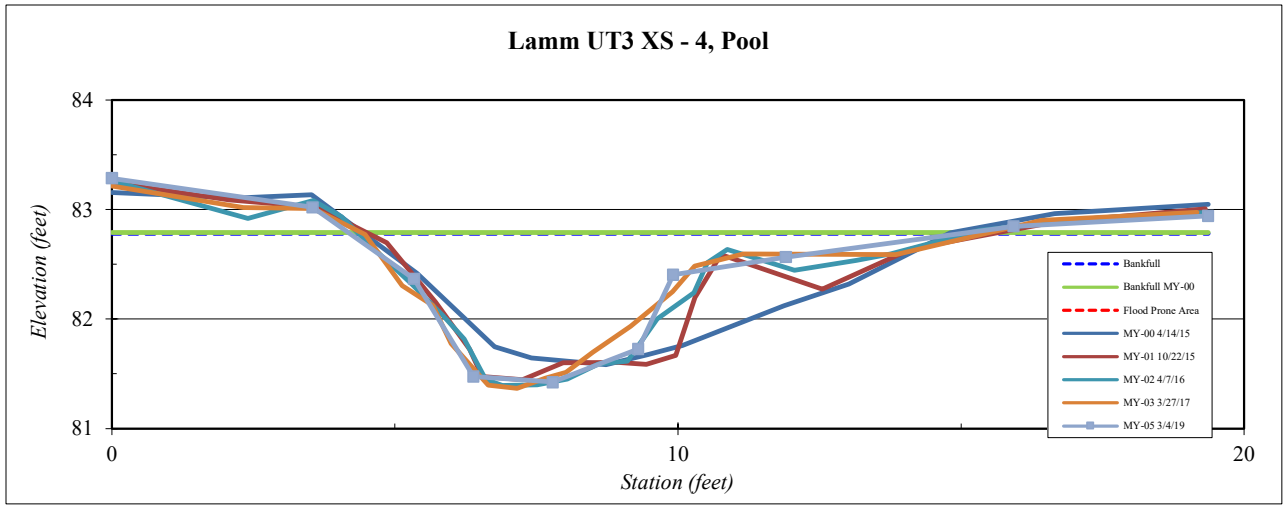
UT 3 has slight resorting of fill material in the channel; however, area has primarily remained constant and no significant erosion is apparent.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 4, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	83.3
3.5	83.0
5.3	82.4
6.4	81.5
7.8	81.4
9.3	81.7
9.9	82.4
11.9	82.6
15.9	82.8
19.4	82.9

SUMMARY DATA	
Bankfull Elevation:	82.8
Bankfull Cross-Sectional Area:	6.2
Bankfull Width:	10.8
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	0.6
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0

Stream Type	C/E



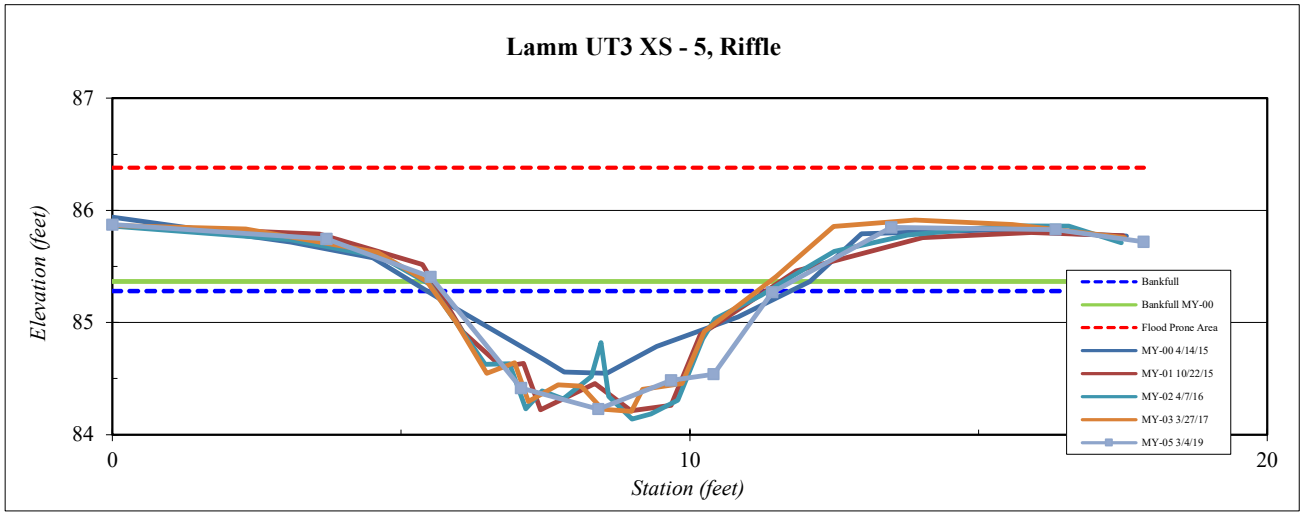
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 5, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	85.87
3.7	85.74
5.5	85.41
7.1	84.42
8.4	84.23
9.7	84.48
10.4	84.54
11.4	85.27
13.5	85.85
16.3	85.83
17.9	85.72

SUMMARY DATA	
Bankfull Elevation:	85.3
Bankfull Cross-Sectional Area:	4.0
Bankfull Width:	5.8
Flood Prone Area Elevation:	86.4
Flood Prone Width:	50.0
Max Depth at Bankfull:	1.1
Mean Depth at Bankfull:	0.7
W / D Ratio:	8.4
Entrenchment Ratio:	8.6
Bank Height Ratio:	<1

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

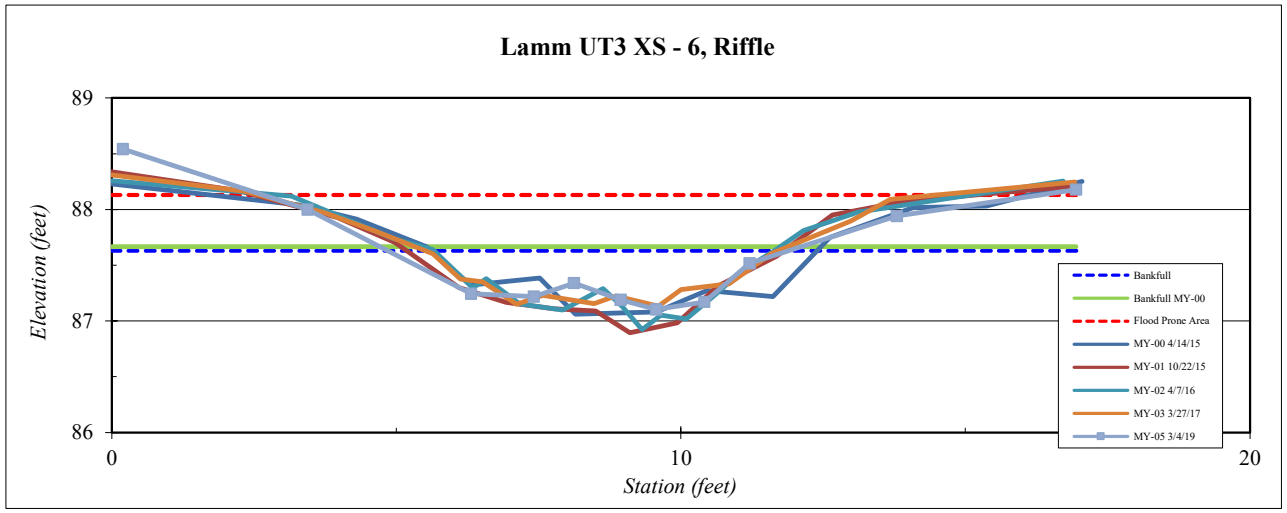
Sediment mobilization has resulted in minor downcutting, which has stabilized over the past 5 years. No problems are visible in this reach.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 6, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.2	88.54
3.4	88.00
6.3	87.25
7.4	87.22
8.1	87.34
8.9	87.19
9.6	87.10
10.4	87.17
11.2	87.52
13.8	87.94
16.9	88.18

SUMMARY DATA	
Bankfull Elevation:	87.6
Bankfull Cross-Sectional Area:	2.3
Bankfull Width:	7.0
Flood Prone Area Elevation:	88.1
Flood Prone Width:	14.0
Max Depth at Bankfull:	0.5
Mean Depth at Bankfull:	0.3
W / D Ratio:	21.3
Entrenchment Ratio:	2.0
Bank Height Ratio:	<1

Stream Type	C/E



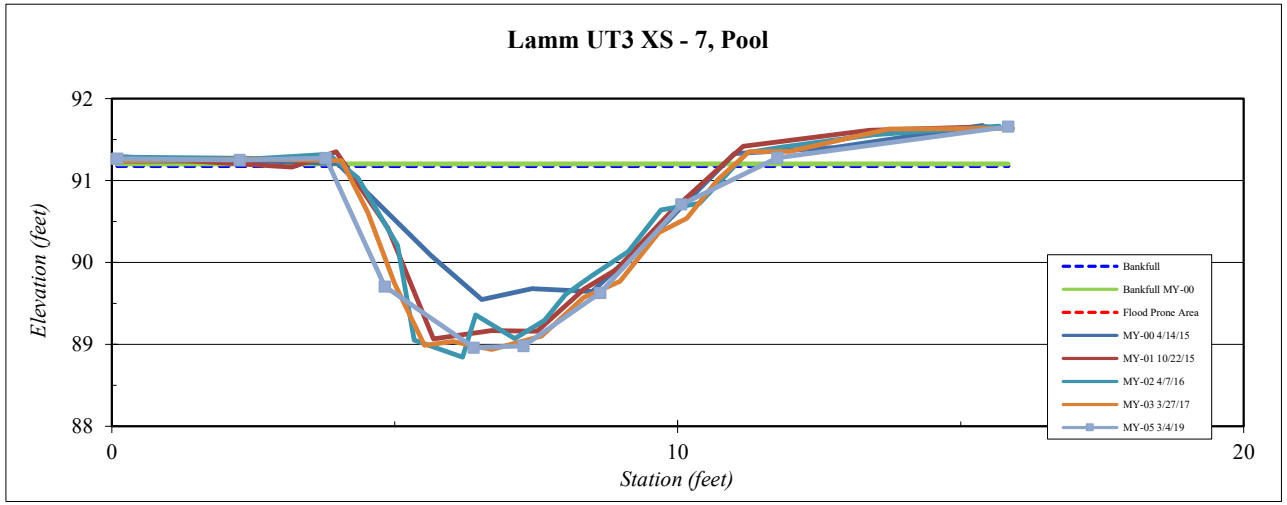
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 7, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.1	91.3
2.3	91.2
3.8	91.3
4.8	89.7
6.4	89.0
7.3	89.0
8.6	89.6
10.1	90.7
11.8	91.3
15.8	91.7

SUMMARY DATA	
Bankfull Elevation:	91.2
Bankfull Cross-Sectional Area:	9.9
Bankfull Width:	7.6
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	2.2
Mean Depth at Bankfull:	1.3
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0

Stream Type	C/E



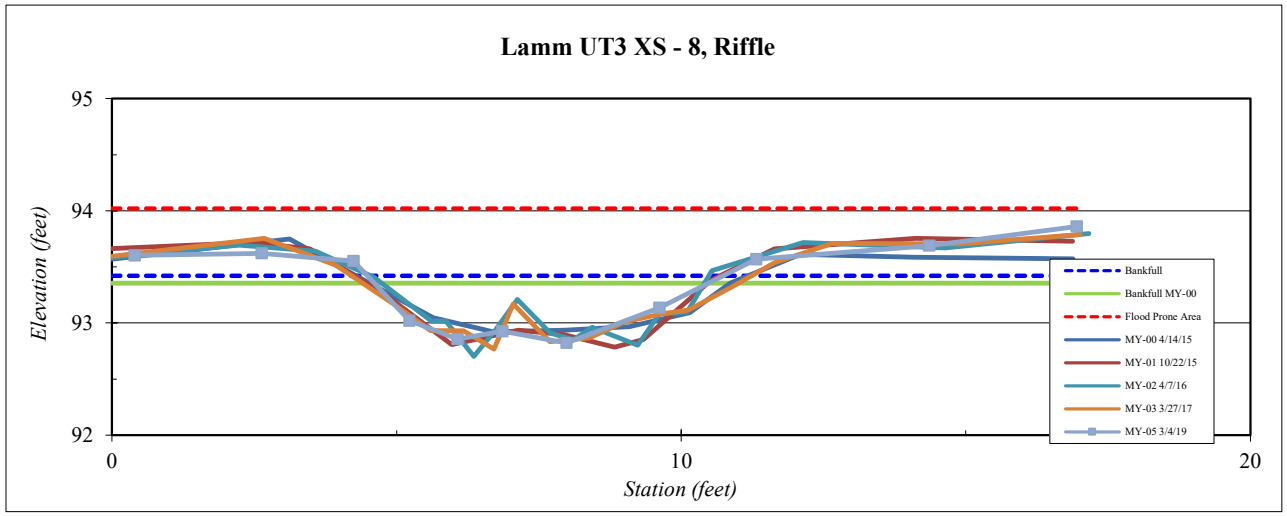
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 8, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.4	93.60
2.6	93.62
4.2	93.55
5.2	93.02
6.1	92.86
6.9	92.93
8.0	92.82
9.6	93.13
11.3	93.57
14.4	93.69
17.0	93.86

SUMMARY DATA	
Bankfull Elevation:	93.4
Bankfull Cross-Sectional Area:	2.5
Bankfull Width:	6.3
Flood Prone Area Elevation:	94.0
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.6
Mean Depth at Bankfull:	0.4
W / D Ratio:	15.9
Entrenchment Ratio:	7.9
Bank Height Ratio:	1.2

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

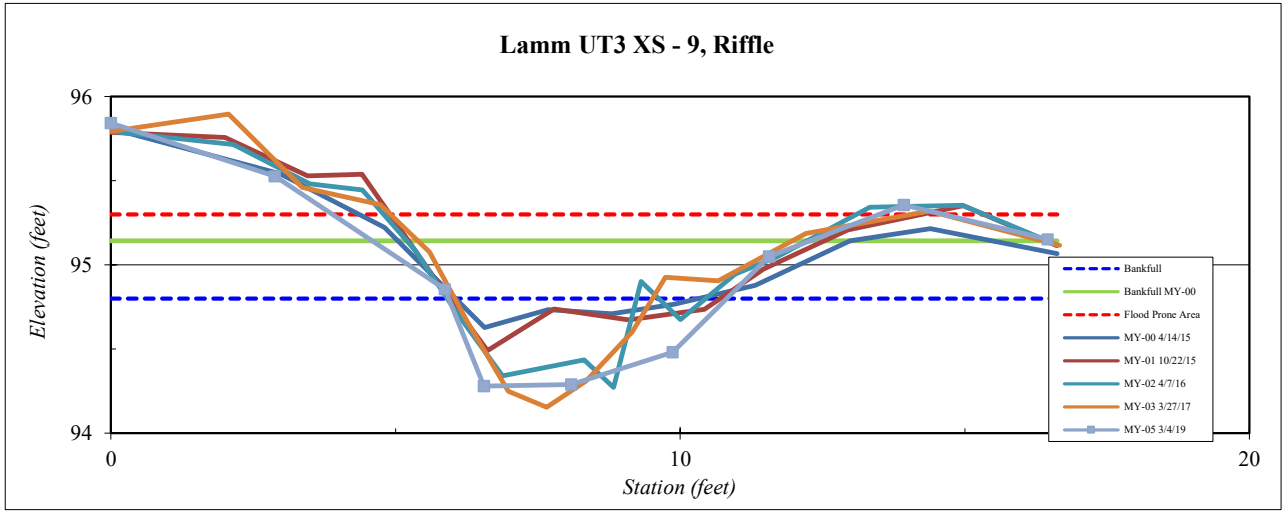
No problems have been noted in this reach. Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 9, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	95.84
2.9	95.53
5.9	94.86
6.6	94.28
8.1	94.29
9.9	94.48
11.6	95.05
13.9	95.36
16.5	95.15

SUMMARY DATA	
Bankfull Elevation:	94.8
Bankfull Cross-Sectional Area:	1.8
Bankfull Width:	4.9
Flood Prone Area Elevation:	95.3
Flood Prone Width:	10.0
Max Depth at Bankfull:	0.5
Mean Depth at Bankfull:	0.4
W / D Ratio:	13.3
Entrenchment Ratio:	2.0
Bank Height Ratio:	1.2

Stream Type	C



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

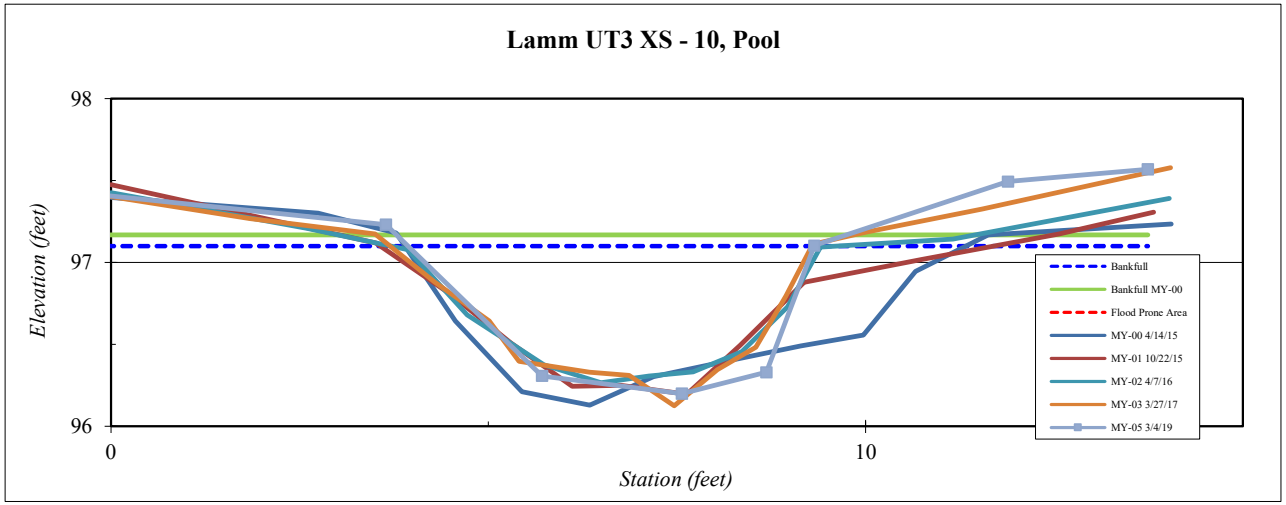
Sediment mobilization has resulted in minor downcutting, which has stabilized over the past 4 years. No problems are visible in this reach.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 10, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.3	97.4
3.6	97.2
5.7	96.3
7.6	96.2
8.7	96.3
9.3	97.1
11.9	97.5
13.7	97.6

SUMMARY DATA	
Bankfull Elevation:	97.1
Bankfull Cross-Sectional Area:	3.4
Bankfull Width:	5.4
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	0.9
Mean Depth at Bankfull:	0.6
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.0

Stream Type	C/E



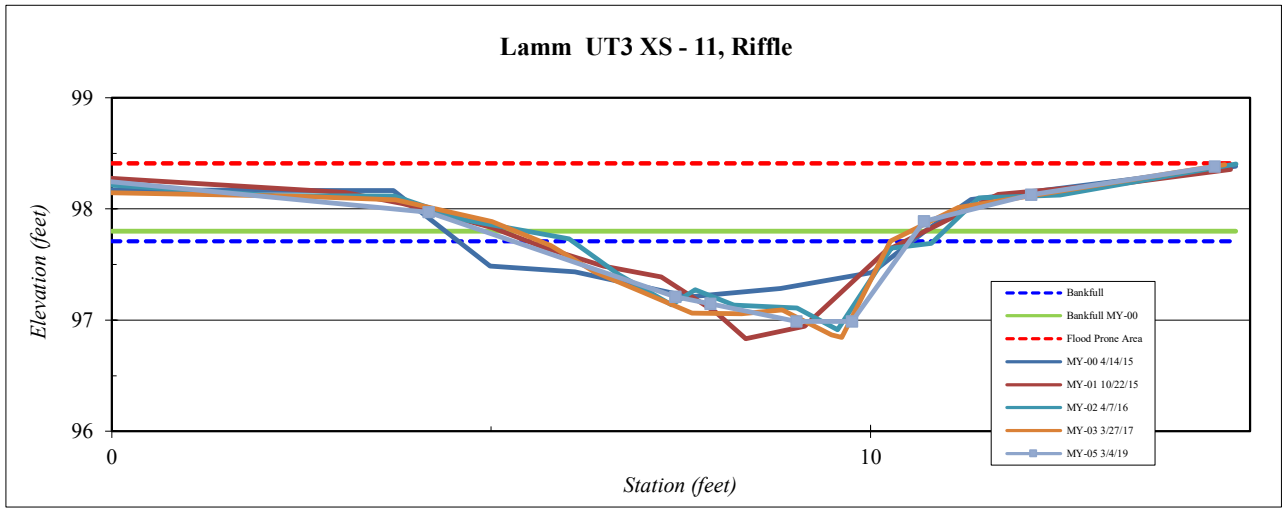
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 11, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.2	98.26
4.2	97.97
7.4	97.21
7.9	97.15
9.0	96.99
9.8	96.99
10.7	97.89
12.1	98.13
14.5	98.38

SUMMARY DATA	
Bankfull Elevation:	97.7
Bankfull Cross-Sectional Area:	2.3
Bankfull Width:	5.2
Flood Prone Area Elevation:	98.4
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.7
Mean Depth at Bankfull:	0.4
W / D Ratio:	11.8
Entrenchment Ratio:	9.6
Bank Height Ratio:	1.3

Stream Type	C/E



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

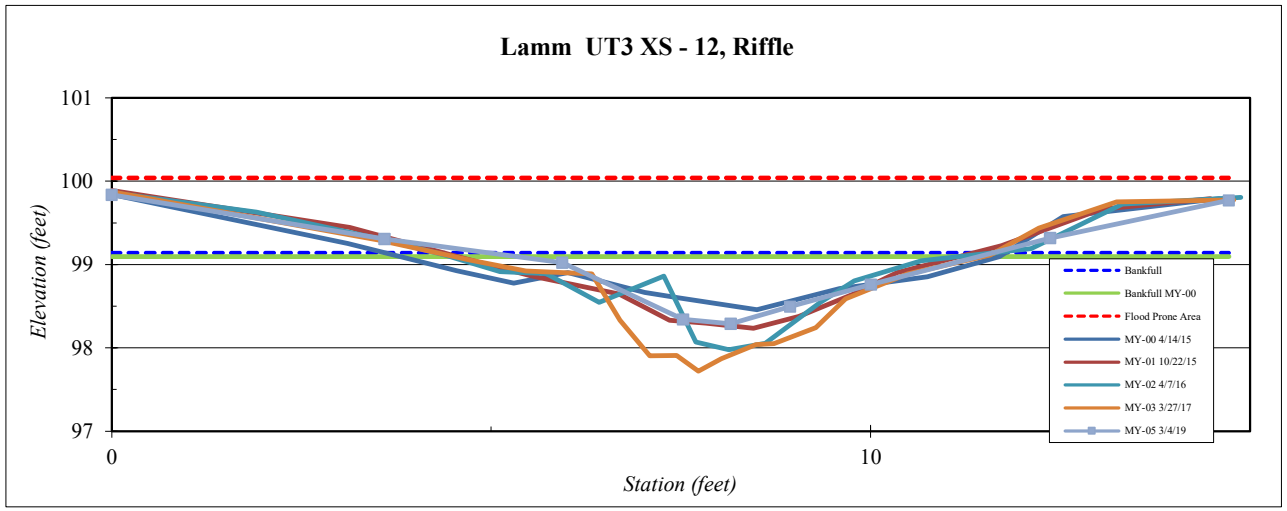
No problems have been noted in this reach. Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 12, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.0	99.84
3.6	99.31
5.9	99.02
7.5	98.34
8.2	98.29
8.9	98.49
10.0	98.76
12.4	99.32
14.7	99.77

SUMMARY DATA	
Bankfull Elevation:	99.1
Bankfull Cross-Sectional Area:	2.7
Bankfull Width:	6.6
Flood Prone Area Elevation:	100.0
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.9
Mean Depth at Bankfull:	0.4
W / D Ratio:	16.1
Entrenchment Ratio:	7.6
Bank Height Ratio:	<1

Stream Type	C



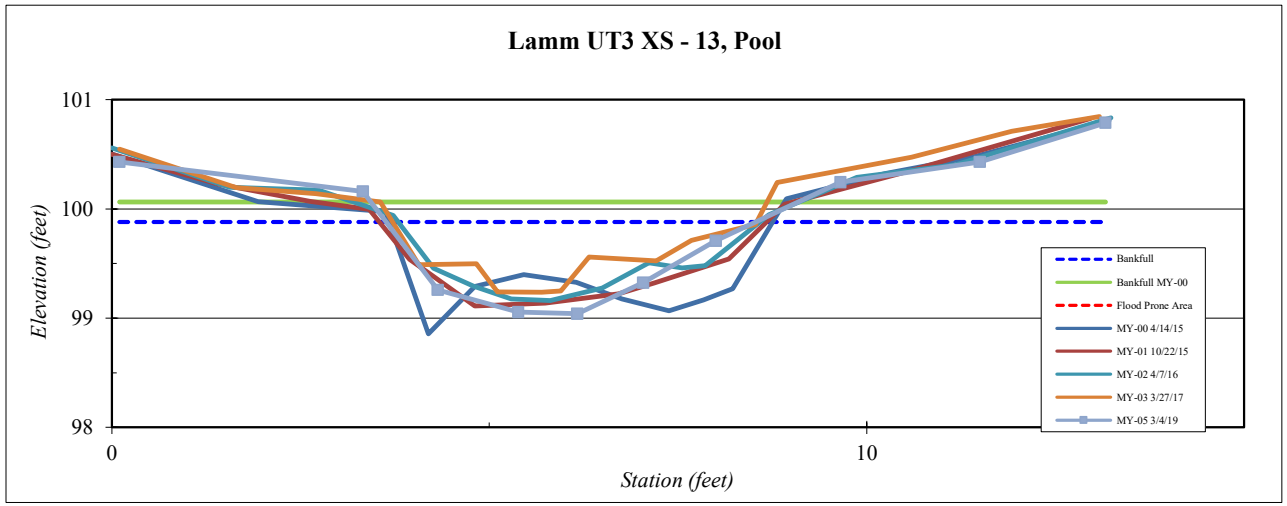
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 13, Pool
Feature	Pool
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
0.1	100.4
3.3	100.2
4.3	99.3
5.4	99.1
6.2	99.0
7.0	99.3
8.0	99.7
9.7	100.2
11.5	100.4
13.2	100.8

SUMMARY DATA	
Bankfull Elevation:	99.9
Bankfull Cross-Sectional Area:	2.6
Bankfull Width:	4.9
Flood Prone Area Elevation:	NA
Flood Prone Width:	NA
Max Depth at Bankfull:	0.8
Mean Depth at Bankfull:	0.5
W / D Ratio:	NA
Entrenchment Ratio:	NA
Bank Height Ratio:	1.4

Stream Type	C/E



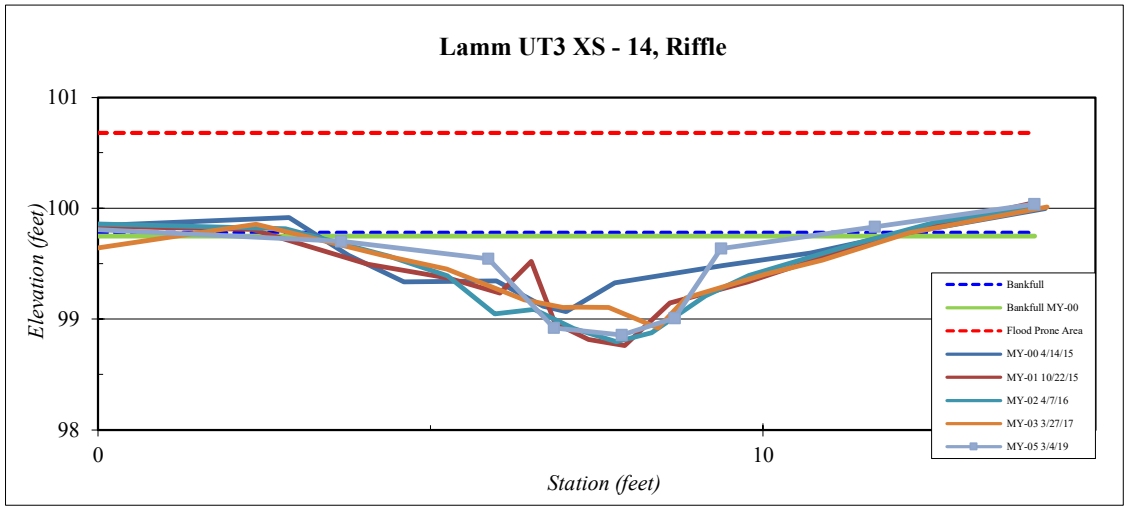
**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

Site	Abbey Lamm
Watershed:	Cape Fear, 0303002
XS ID	UT 3 XS - 14, Riffle
Feature	Riffle
Date:	3/4/2019
Field Crew:	Perkinson, Radecki

Station	Elevation
-0.1	99.81
3.7	99.70
5.9	99.55
6.9	98.92
7.9	98.86
8.7	99.01
9.4	99.64
11.7	99.83
14.1	100.04

SUMMARY DATA	
Bankfull Elevation:	99.8
Bankfull Cross-Sectional Area:	3.0
Bankfull Width:	10.1
Flood Prone Area Elevation:	100.7
Flood Prone Width:	50.0
Max Depth at Bankfull:	0.9
Mean Depth at Bankfull:	0.3
W / D Ratio:	34.0
Entrenchment Ratio:	5.0
Bank Height Ratio:	<1

Stream Type	C



**MY0-3 BHR were calculated using DMS method of "Dmax year x /Dmax year 0". MY5-7 were calculated using DMS method of area best fit.

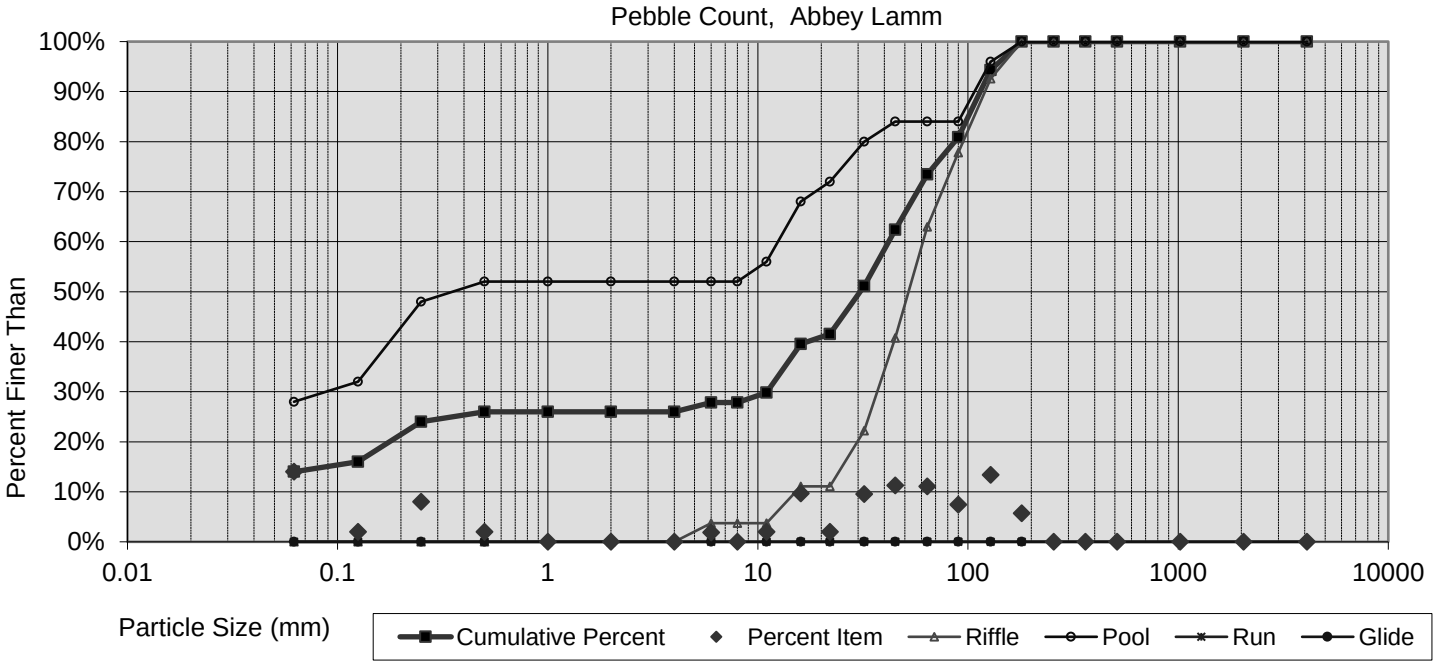
No problems have been noted in this reach. Minor alterations in shallow channels may result in large discrepancies including elevated BHR.

Pebble Count,

Abbey Lamm

Cape Fear

Note: **Mainstem - Reach-wide**



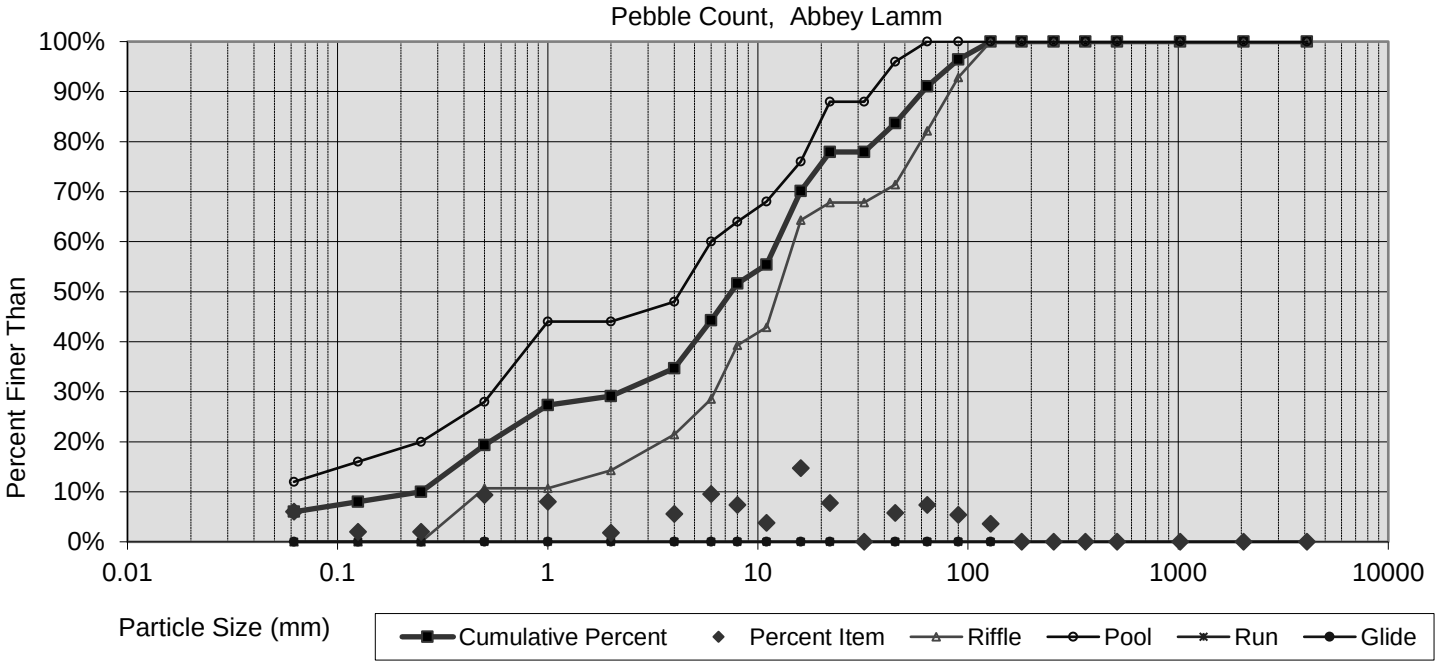
Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.125	13.42	30.6	98	133	14%	12%	47%	27%	0%	0%

Pebble Count,

Abbey Lamm

Cape Fear

Note: **UT-1 - Reach-wide**



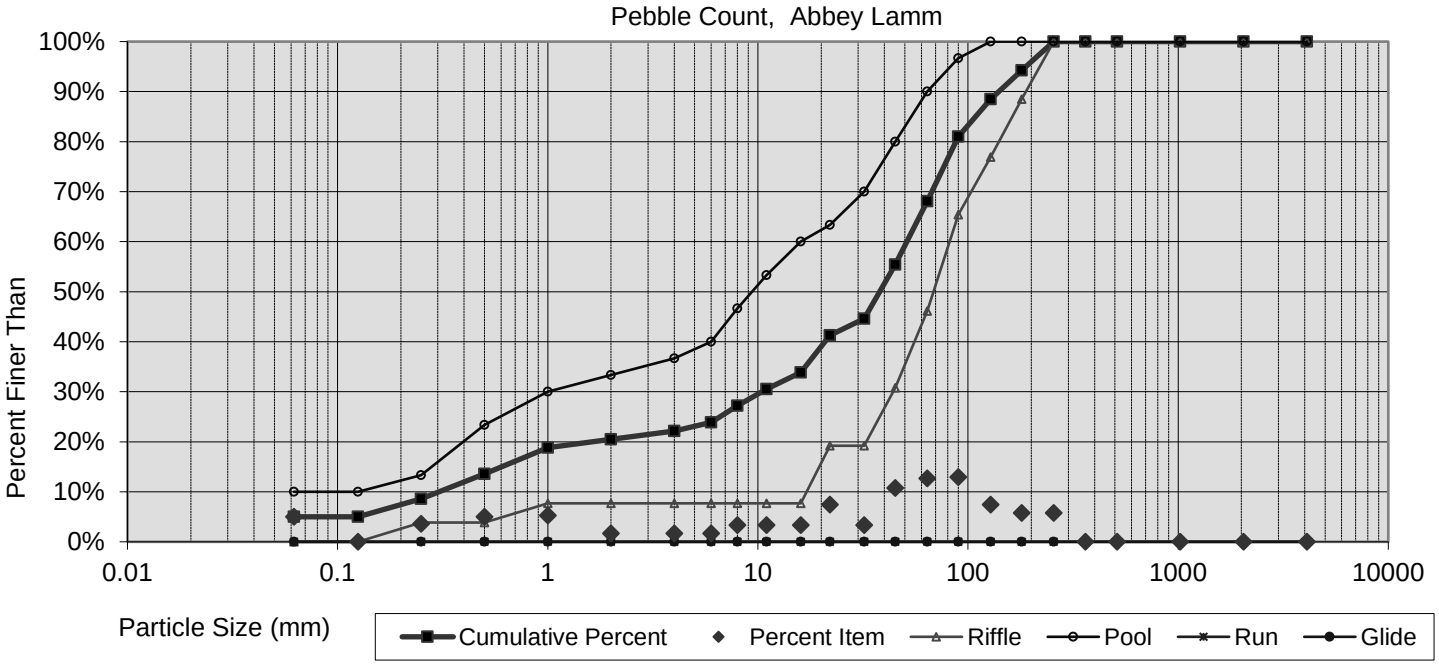
Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.390	4.05	7.5	46	82	6%	23%	62%	9%	0%	0%

Pebble Count,

Abbey Lamm

Cape Fear

Note: **UT-2 - Reach-wide**



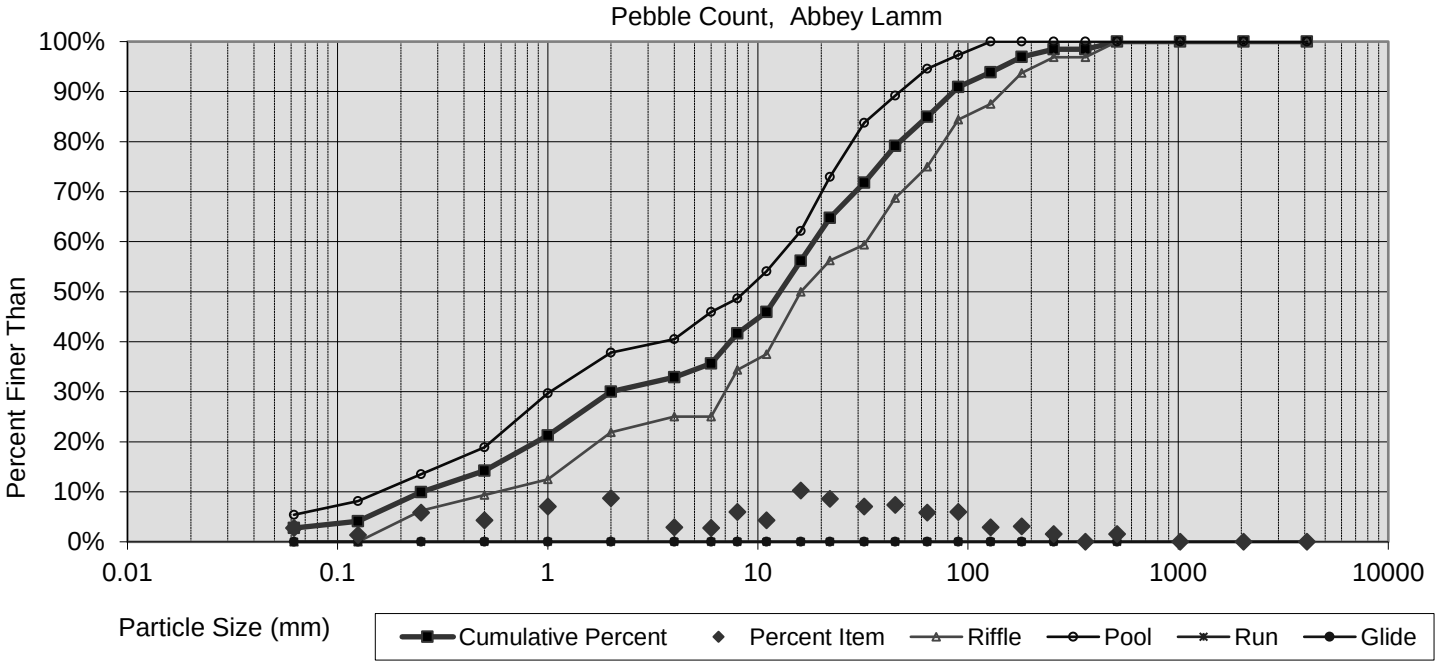
Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.687	16.81	37.9	104	189	5%	16%	48%	32%	0%	0%

Pebble Count,

Abbey Lamm

Cape Fear

Note: **UT-3 - Reach-wide**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.595	5.45	12.8	60	145	3%	26%	53%	13%	1%	4%

APPENDIX E

HYDROLOGY DATA

Tables 12A-B. UT1 and UT3 Channel Evidence

Stream Gauge Graphs

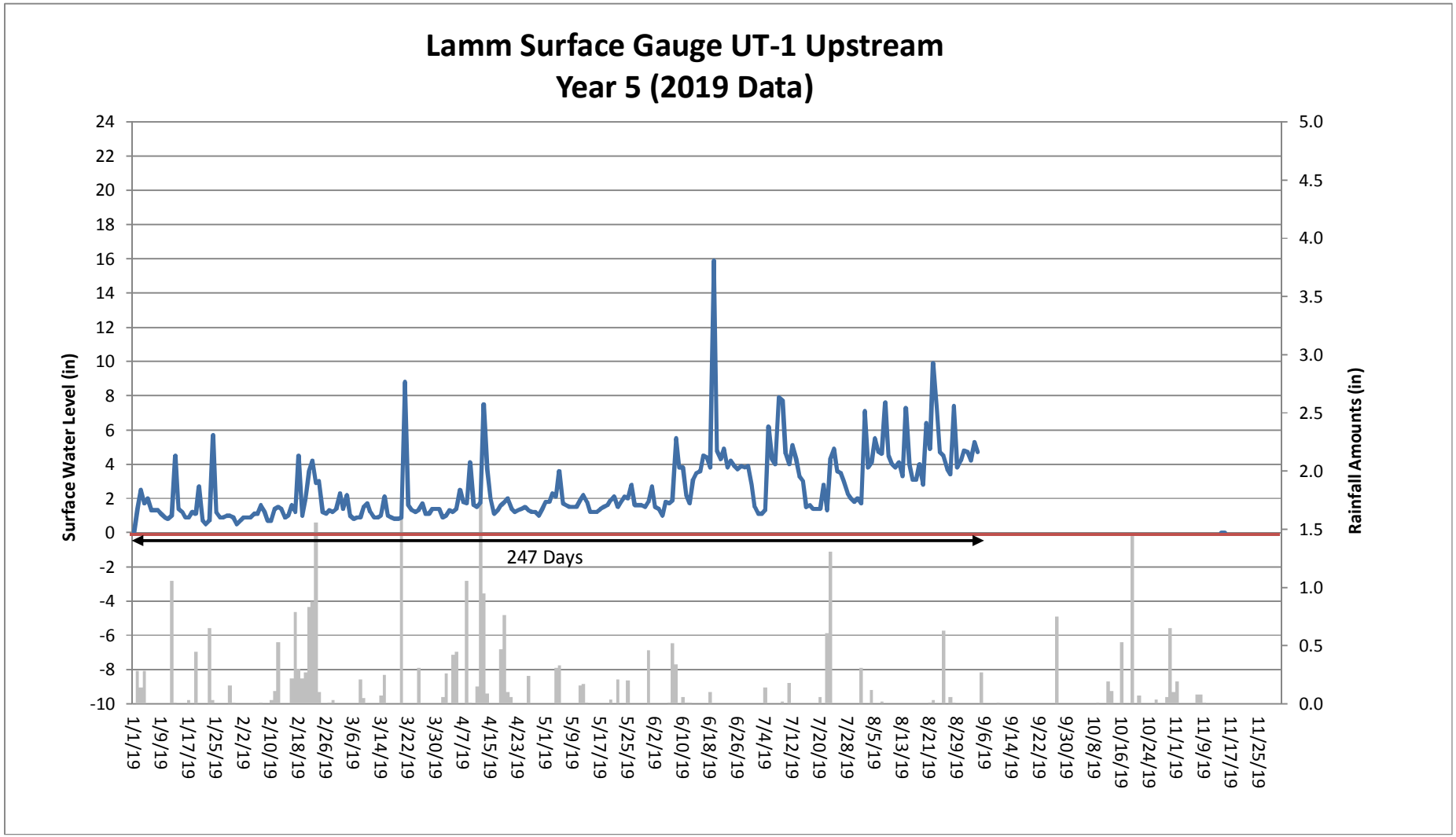
Table 13. Verification of Bankfull Events

Table 14. Groundwater Hydrology Data

Groundwater Gauge Graphs

Table 12A. UT1 Channel Evidence

UT3 Channel Evidence	Year 1 (2015)	Year 2 (2016)	Year 3 (2017)	Year 4 (2018)	Year 5 (2019)	Reference Photo
Max consecutive days channel flow	64	101	118	119	247	UT-1 channel formation at the stream gauge
Presence of litter and debris (wracking)	Yes	Yes	Yes	Yes	Yes	
Leaf litter disturbed or washed away	Yes	Yes	Yes	Yes	Yes	
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes	Yes	Yes	Yes	Yes	
Sediment deposition and/or scour indicating sediment transport	Yes	Yes	Yes	Yes	Yes	
Water staining due to continual presence of water	Yes	Yes	Yes	Yes	Yes	
Formation of channel bed and banks	Yes	Yes	Yes	Yes	Yes	
Sediment sorting within the primary path of flow	Yes	Yes	Yes	Yes	Yes	
Sediment shelving or a natural line impressed on the banks	Yes	Yes	Yes	Yes	Yes	
Change in plant community (absence or destruction of terrestrial vegetation and/or transition to species adapted for flow or inundation for a long duration, including hydrophytes)	Yes	Yes	Yes	Yes	Yes	
Development of channel pattern (meander bends and/or channel braiding) at natural topographic breaks, woody debris piles, or plant root systems	Yes	Yes	Yes	Yes	Yes	
Exposure of woody plant roots within the primary path of flow	No	No	No	No	No	
Other:						


Lamm Surface Gauge UT-1 Upstream
Year 5 (2019 Data)
Surface Water Level (in)
Rainfall Amounts (in)
247 Days
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/19
1/9/19
1/17/19
1/25/19
2/2/19
2/10/19
2/18/19
2/26/19
3/6/19
3/14/19
3/22/19
3/30/19
4/7/19
4/15/19
4/23/19
5/1/19
5/9/19
5/17/19
5/25/19
6/2/19
6/10/19
6/18/19
6/26/19
7/4/19
7/12/19
7/20/19
7/28/19
8/5/19
8/13/19
8/21/19
8/29/19
9/6/19
9/14/19
9/22/19
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11/9/19
11/17/19
11/25/19

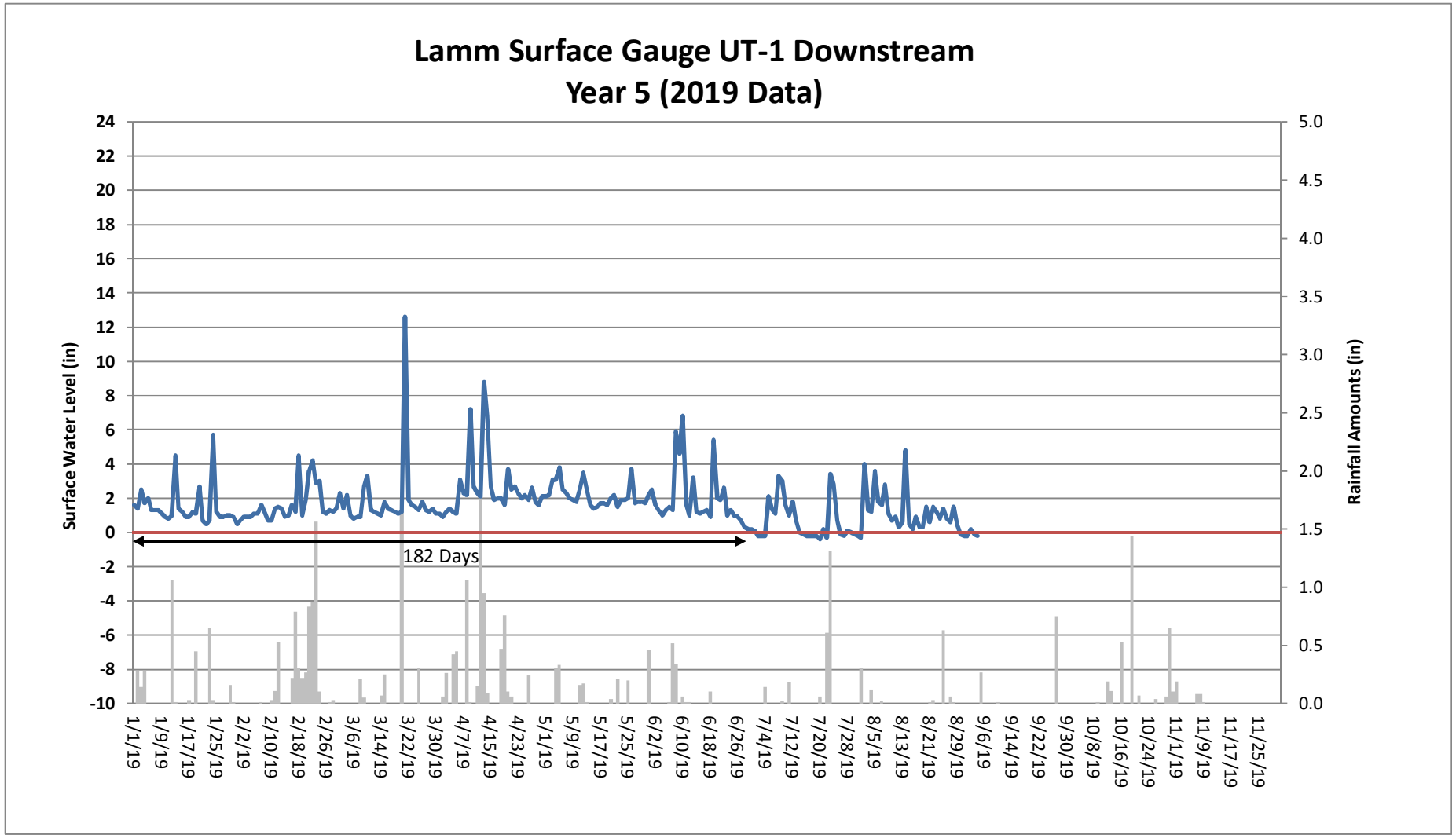
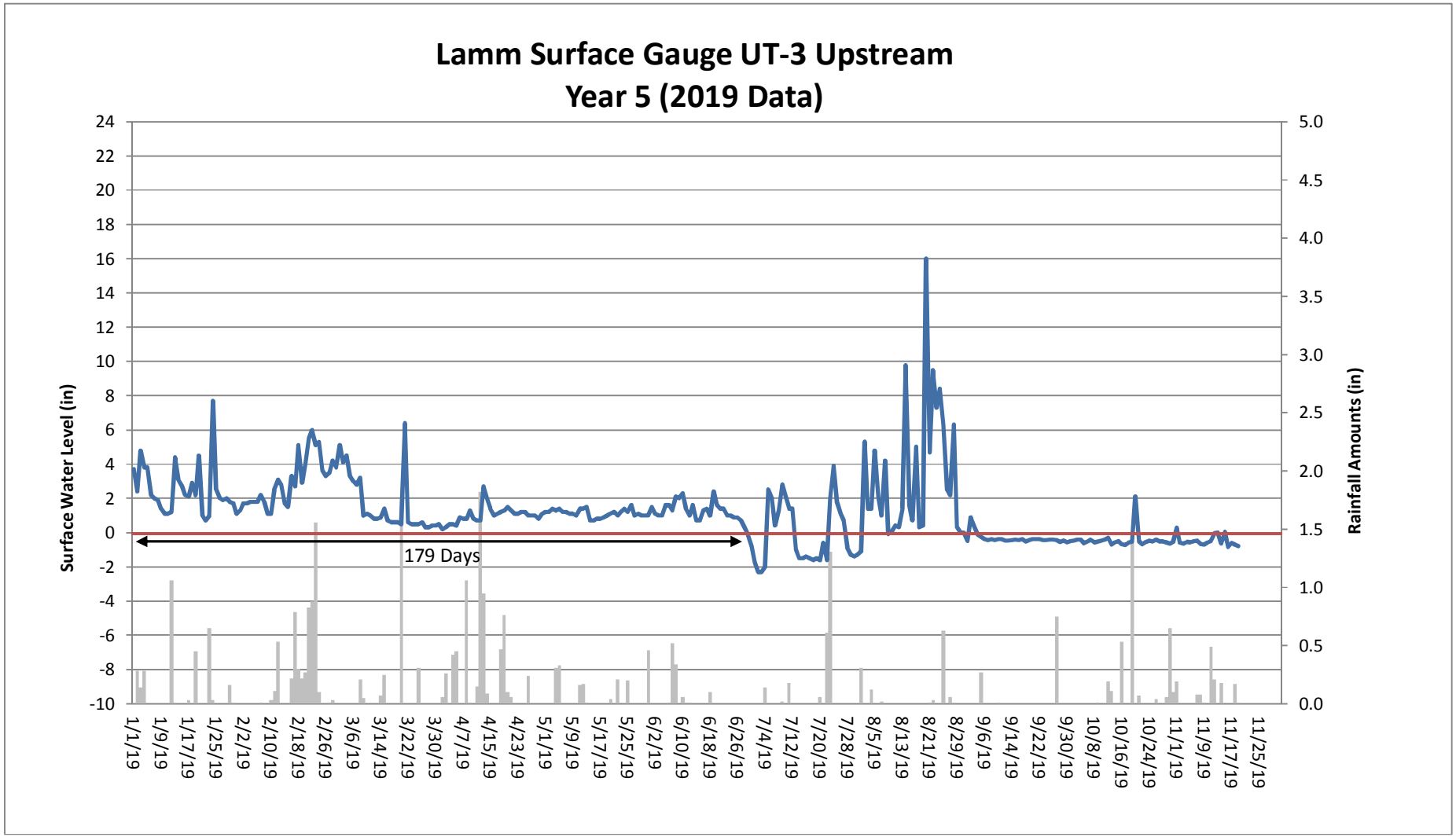

Lamm Surface Gauge UT-1 Downstream
Year 5 (2019 Data)
Surface Water Level (in)
Rainfall Amounts (in)
182 Days
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/19
1/9/19
1/17/19
1/25/19
2/2/19
2/10/19
2/18/19
2/26/19
3/6/19
3/14/19
3/22/19
3/30/19
4/7/19
4/15/19
4/23/19
5/1/19
5/9/19
5/17/19
5/25/19
6/2/19
6/10/19
6/18/19
6/26/19
7/4/19
7/12/19
7/20/19
7/28/19
8/5/19
8/13/19
8/21/19
8/29/19
9/6/19
9/14/19
9/22/19
9/30/19
10/8/19
10/16/19
10/24/19
11/1/19
11/9/19
11/17/19
11/25/19

Table 12B. UT3 Channel Evidence

UT3 Channel Evidence	Year 1 (2015)	Year 2 (2016)	Year 3 (2017)	Year 4 (2018)	Year 5 (2019)	Reference Photo
Max consecutive days channel flow	51	100	160	104	90	UT-3 channel formation at the stream gauge
Presence of litter and debris (wracking)	Yes	Yes	Yes	Yes	Yes	
Leaf litter disturbed or washed away	Yes	Yes	Yes	Yes	Yes	
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes	Yes	Yes	Yes	Yes	
Sediment deposition and/or scour indicating sediment transport	Yes	Yes	Yes	Yes	Yes	
Water staining due to continual presence of water	Yes	Yes	Yes	Yes	Yes	
Formation of channel bed and banks	Yes	Yes	Yes	Yes	Yes	
Sediment sorting within the primary path of flow	Yes	Yes	Yes	Yes	Yes	
Sediment shelving or a natural line impressed on the banks	Yes	Yes	Yes	Yes	Yes	
Change in plant community (absence or destruction of terrestrial vegetation and/or transition to species adapted for flow or inundation for a long duration, including hydrophytes)	Yes	Yes	Yes	Yes	Yes	
Development of channel pattern (meander bends and/or channel braiding) at natural topographic breaks, woody debris piles, or plant root systems	Yes	Yes	Yes	Yes	Yes	
Exposure of woody plant roots within the primary path of flow	No	No	No	No	No	
Other:						


Lamm Surface Gauge UT-3 Upstream
Year 5 (2019 Data)
Surface Water Level (in)
Rainfall Amounts (in)
179 Days
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/19
1/9/19
1/17/19
1/25/19
2/2/19
2/10/19
2/18/19
2/26/19
3/6/19
3/14/19
3/22/19
3/30/19
4/7/19
4/15/19
4/23/19
5/1/19
5/9/19
5/17/19
5/25/19
6/2/19
6/10/19
6/18/19
6/26/19
7/4/19
7/12/19
7/20/19
7/28/19
8/5/19
8/13/19
8/21/19
8/29/19
9/6/19
9/14/19
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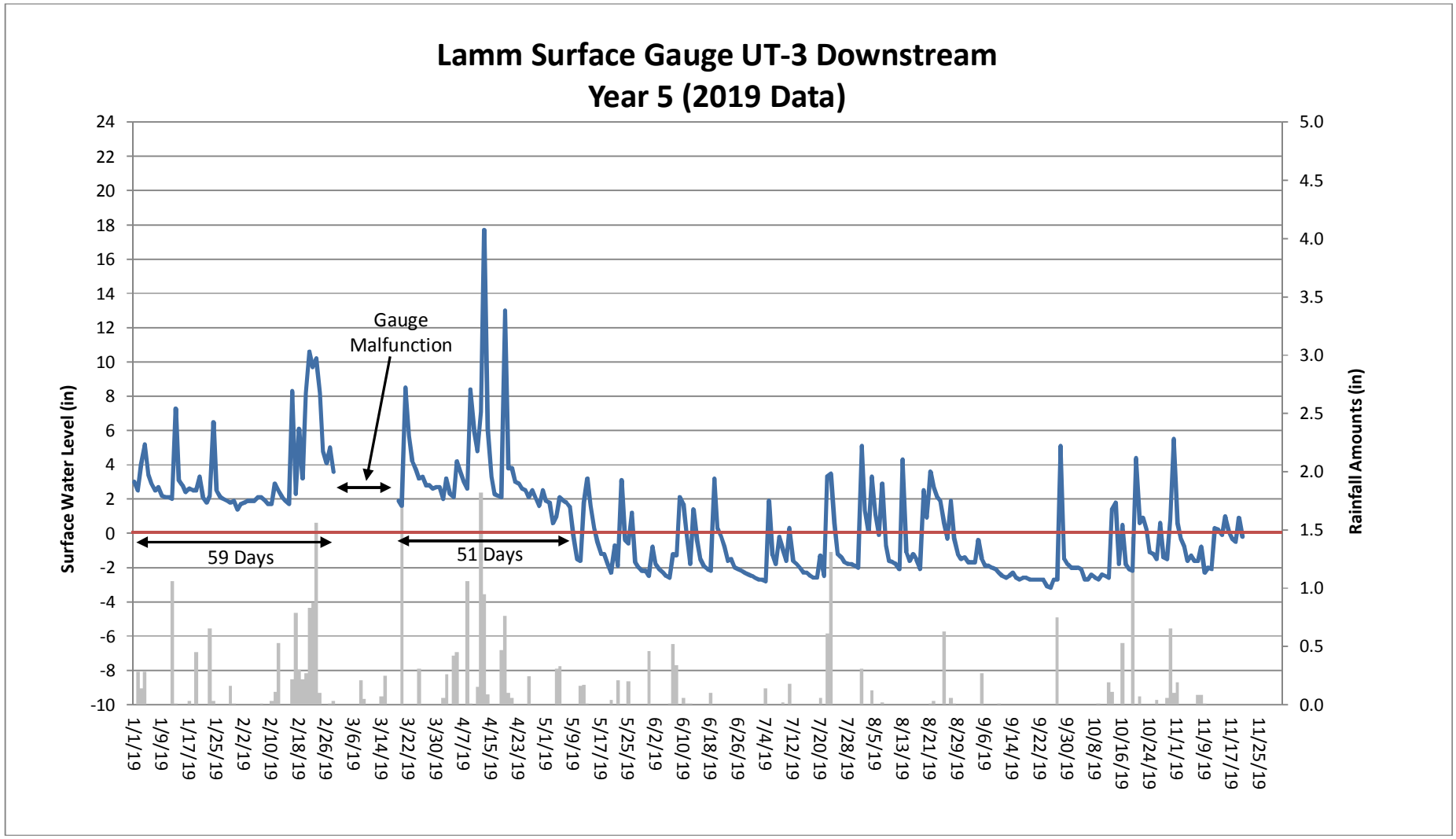
11/17/19
11/25/19


Lamm Surface Gauge UT-3 Downstream
Year 5 (2019 Data)
Surface Water Level (in)
Rainfall Amounts (in)
Gauge
Malfunction
59 Days
51 Days
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
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0.5
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4/15/19
4/23/19
5/1/19
5/9/19
5/17/19
5/25/19
6/2/19
6/10/19
6/18/19
6/26/19
7/4/19
7/12/19
7/20/19
7/28/19
8/5/19
8/13/19
8/21/19
8/29/19
9/6/19
9/14/19
9/22/19
9/30/19
10/8/19
10/16/19
10/24/19
11/1/19
11/9/19
11/17/19
11/25/19

Table 13. Verification of Bankfull Events

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
May 27, 2015	April 30, 2015	1.66 inches of rain documented in one day at an onsite rain gauge.	--
June 28, 2015	June 19, 2015	Wrack, sediment, and laid-back vegetation observed in the floodplain after 2.28 inches of rain was recorded in one day at an onsite rain gauge.	1-3
October 10, 2016	October 8, 2016	A trail camera installed on the right bank of UT3 documented a bankfull flow after 3.41 inches of rain was recorded in one day at an onsite rain gauge.	4
April 28, 2017	April 24, 2017	Wrack and laid-back vegetation observed in the floodplain after 3.41 inches of rain was recorded over two days at an onsite rain gauge.	5
July 19, 2017	June 19, 2017	2.24 inches of rain documented in one day at an onsite rain gauge.	--
June 11, 2018	April 24, 2018	Wrack observed in the floodplain after 2.66 inches of rain documented* between April 23-24, 2018 at an onsite rain gauge.	6
October 23, 2018	August 21, 2018	Stream gauge data indicates a bankfull event occurred after 2.60 inches of rain documented* between August 20-21, 2018 at an onsite rain gauge.	--
October 23, 2018	September 17, 2018	Stream gauge data indicates a bankfull event occurred after 5.33 inches of rain was recorded between September 15 and 17, 2018 at an onsite rain gauge.	--
October 23, 2018	October 11, 2018	Wrack and laid-back vegetation observed in the floodplain after 2.47 inches of rain was recorded on October 11, 2018 at an onsite rain gauge.	7-8
March 8, 2019	February 23, 2019	Stream gauge data indicates a bankfull event occurred after 3.27 inches of rain was recorded between February 22 and 23, 2019 at an onsite rain gauge.	--
May 4, 2019	March 20, 2019	Stream gauge data indicates a bankfull event occurred after 1.75 inches of rain was recorded on March 20, 2019 at an onsite rain gauge.	--
May 4, 2019	April 13, 2019	Stream gauge data indicates a bankfull event occurred after 2.77 inches of rain was recorded between April 12 and 13, 2019 at an onsite rain gauge.	--
September 4, 2019	July 23, 2019	Stream gauge data indicates a bankfull event occurred after 1.92 inches of rain was recorded between July 22 and 23, 2019 at an onsite rain gauge.	--

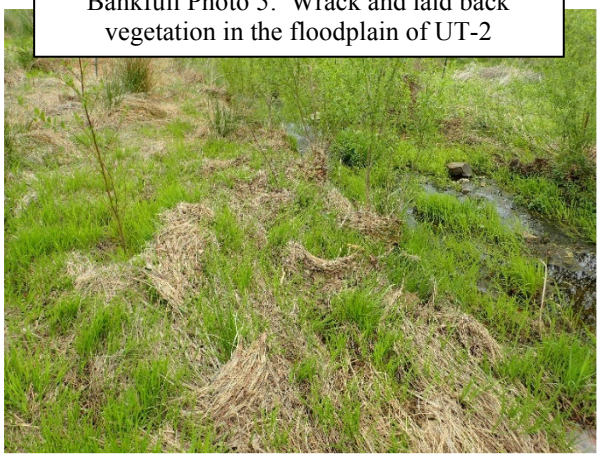
Bankfull Photo 1: Wrack and sediment in the floodplain of the mainstem

Bankfull Photo 2: Wrack in the floodplain of the mainstem

Bankfull Photo 3: Wrack and laid back vegetation in the floodplain of UT-3

Bankfull Photo 4: Trail Cam photo of UT-3 during rain event October 08, 2016

Bankfull Photo 5: Wrack and laid back vegetation in the floodplain of UT-2



Bankfull Photo 6: Wrack in streamside vegetation along the mainstem

Bankfull Photo 7: Large wrack and laid back vegetation in the floodplain just upstream of a piped crossing on the mainstem

Bankfull Photo 8: Wrack and laid back vegetation in the floodplain of the mainstem

Table 14. Groundwater Hydrology Data

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2015) February 1 Growing Season Start	Year 2 (2016) March 30 Growing Season Start	Year 3 (2017) February 28 Growing Season Start	Year 4 (2018) March 6 Growing Season Start	Year 5 (2019) March 1 Growing Season Start	Year 6 (2020)	Year 7 (2021)
1	No*/10 days (3.8 percent)	Yes/75 days (36 percent)	No/12 days (5.1 percent)	Yes/68 days (29 percent)	Yes/28 days (11.9 percent)		
1B+	--	--	--	Yes/60 days (26 percent)	Yes/60 days (26 percent)		
2	Yes/35 days (13.3 percent)	Yes/122 days (59 percent)	Yes/82 days (35 percent)	Yes/30 days (13 percent)	No/19 days# (8.1 percent)		
3	No*/14 days (5.3 percent)	Yes/48 days (23 percent)	Yes/135 days (57 percent)	Yes/66 days (29 percent)	Yes/89 days (38 percent)		
4	No*/14 days (5.3 percent)	Yes/100 days (48 percent)	Yes/78 days (33 percent)	Yes/28 days (12 percent)	No/18 days# (7.7 percent)		
5	Yes/32 days (12.1 percent)	Yes/75 days (36 percent)	Yes/48 days (20 percent)	Yes/60 days (26 percent)	No/19 days# (8.1 percent)		
6	No*/9 days (3.4 percent)	No/7 days (3.4 percent)	No/5 days (2.1 percent)	Yes/25 days (11 percent)	No/19 days (8.1 percent)		
6B+	--	--	--	Yes/28 days (12 percent)	No/17 days# (7.2 percent)		
7**	--	Yes/116 days (56 percent)	Yes/153 days (65 percent)	Yes/103 days (45 percent)	Yes/103 days (44 percent)		
8**	--	Yes/206 days (100 percent)	Yes/211 days (89 percent)	Yes/231 days (100 percent)	Yes/124 days (53 percent)		
9**	--	Yes/54 days (26 percent)	No^/12 days (5.1 percent)	Yes/132 days (57 percent)	Yes/122 days (52 percent)		

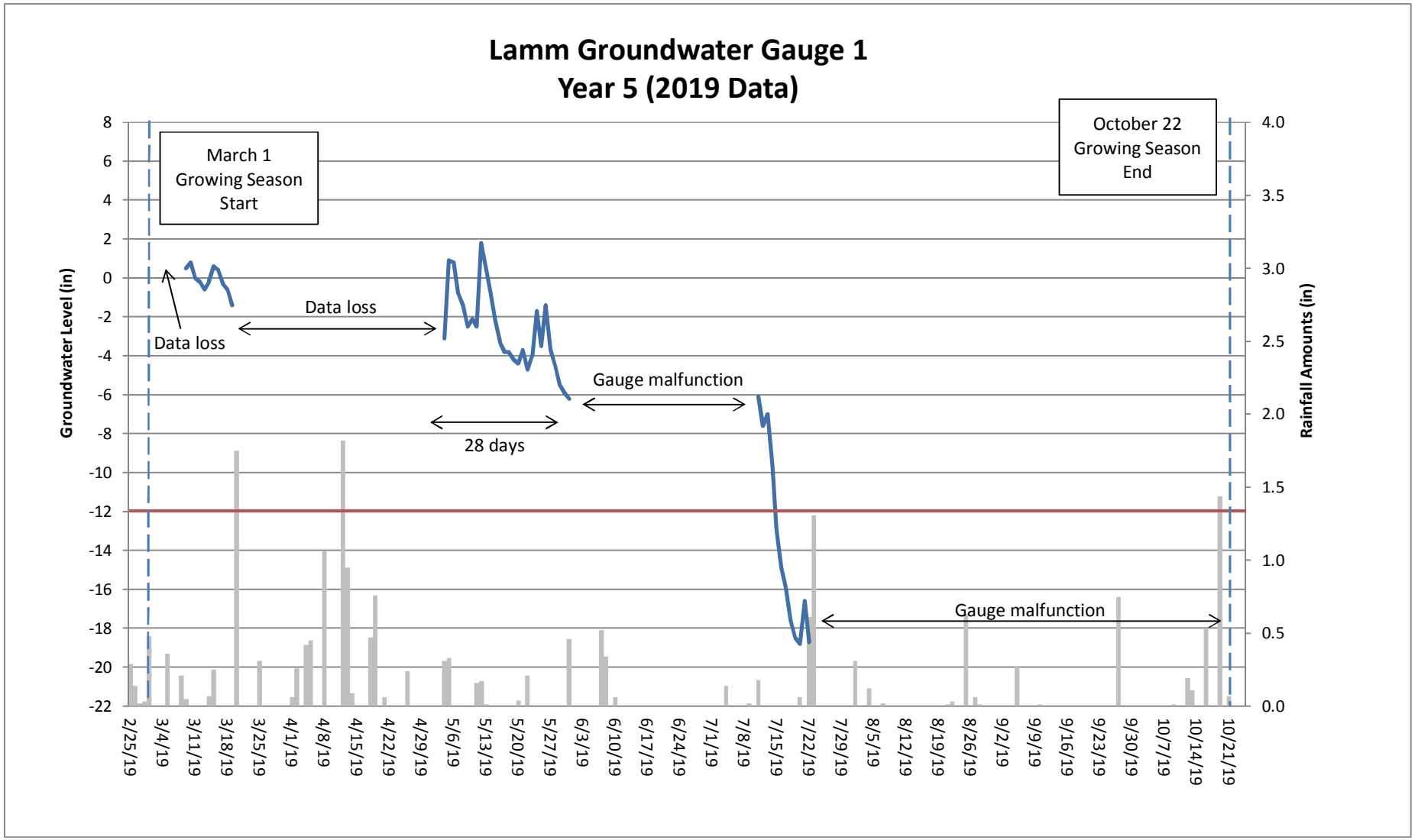
* Due to Site construction activities, groundwater gauges were not installed until April 8, 2015. It is expected that all gauges would meet success criteria at the beginning of the growing season.

** These gauges were installed on March 8, 2016 to show wetland establishment within the old pond bed.

^ This gauge malfunctioned through the majority of the growing season due to continuous inundation. It is expected that this gauge would have met success criteria had it functioned properly.

+ These gauges were installed during Year 4 (2018) in close proximity with two gauges that had not met success criteria in previous monitoring years in order to verify the groundwater data at these locations.

These gauges did not meet success criteria due to a data shuttle failure that resulted in the loss of data from March 20 to May 3. Based on rainfall and hydrology data that was not lost, these gauges would have likely met success criteria had the loss of data not occurred.


Lamm Groundwater Gauge 1
Year 5 (2019 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
Data loss
Data loss
Gauge malfunction
28 days
Gauge malfunction
Groundwater Level (in)
Rainfall Amounts (in)
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2/25/19
3/4/19
3/11/19
3/18/19
3/25/19
4/1/19
4/8/19
4/15/19
4/22/19
4/29/19
5/6/19
5/13/19
5/20/19
5/27/19
6/3/19
6/10/19
6/17/19
6/24/19
7/1/19
7/8/19
7/15/19
7/22/19
7/29/19
8/5/19
8/12/19
8/19/19
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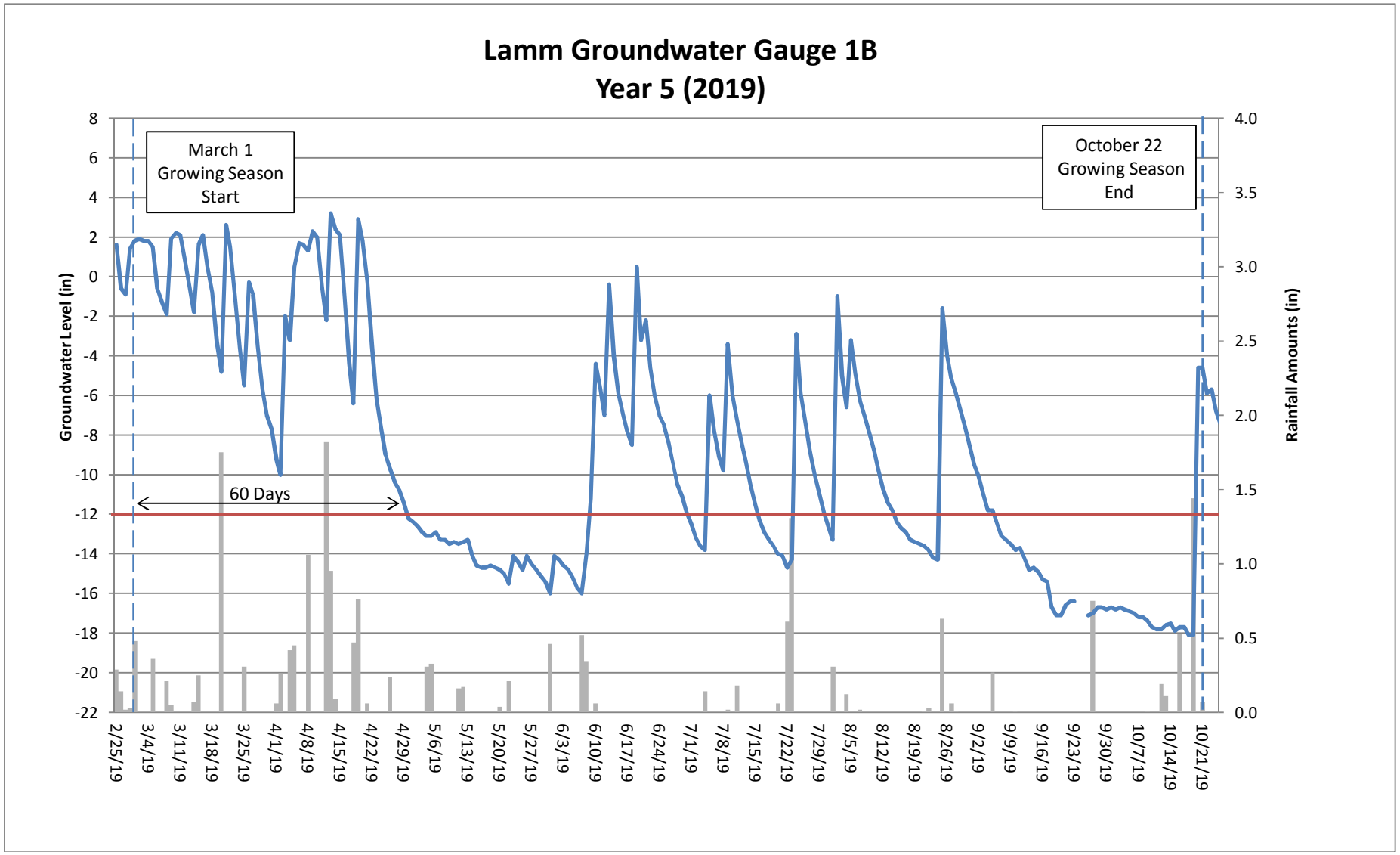
10/14/19
10/21/19


Lamm Groundwater Gauge 1B
Year 5 (2019)
March 1
Growing Season
Start
October 22
Growing Season
End
60 Days
Groundwater Level (in)
Rainfall Amounts (in)
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2/25/19
3/4/19
3/11/19
3/18/19
3/25/19
4/1/19
4/8/19
4/15/19
4/22/19
4/29/19
5/6/19
5/13/19
5/20/19
5/27/19
6/3/19
6/10/19
6/17/19
6/24/19
7/1/19
7/8/19
7/15/19
7/22/19
7/29/19
8/5/19
8/12/19
8/19/19
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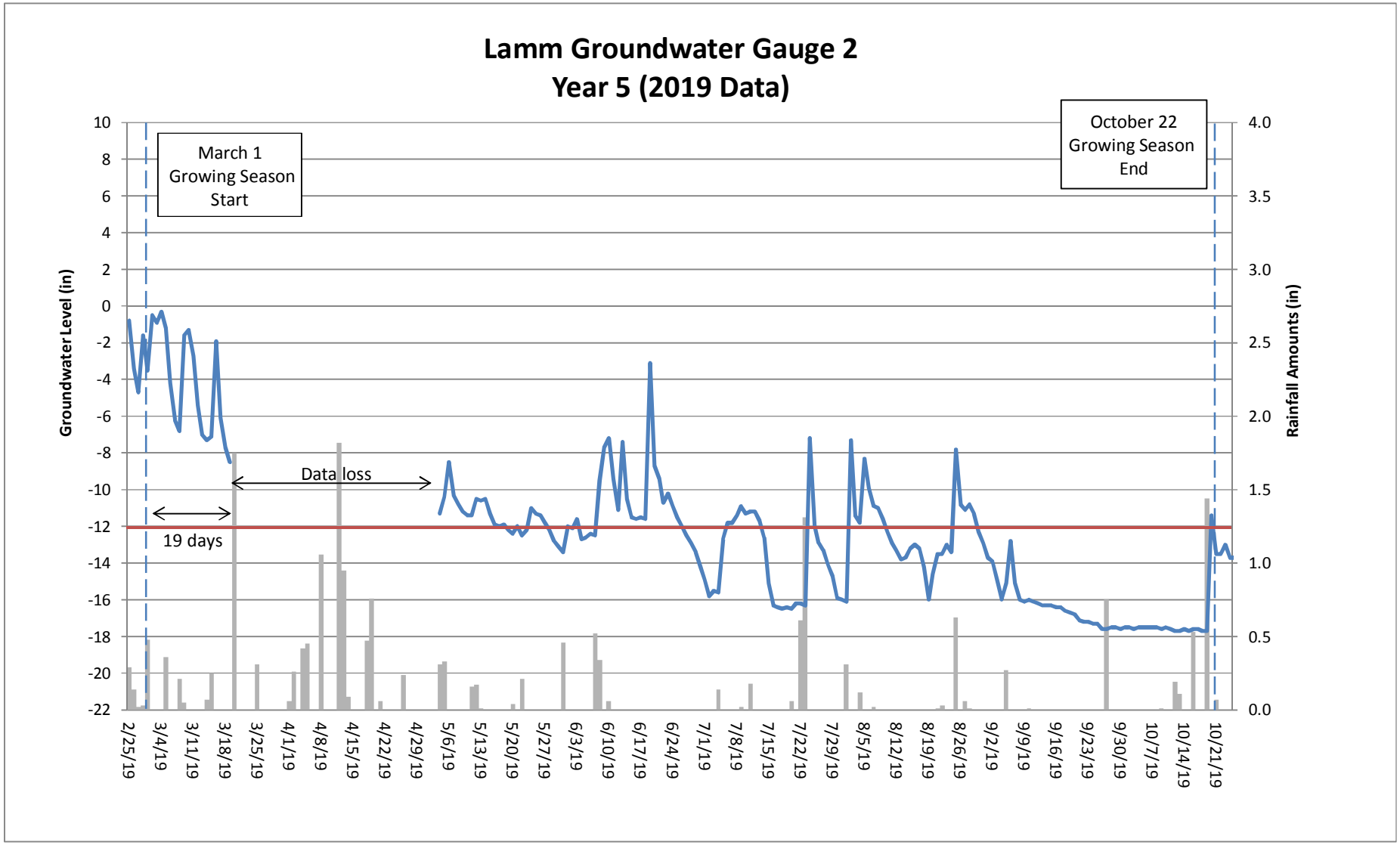
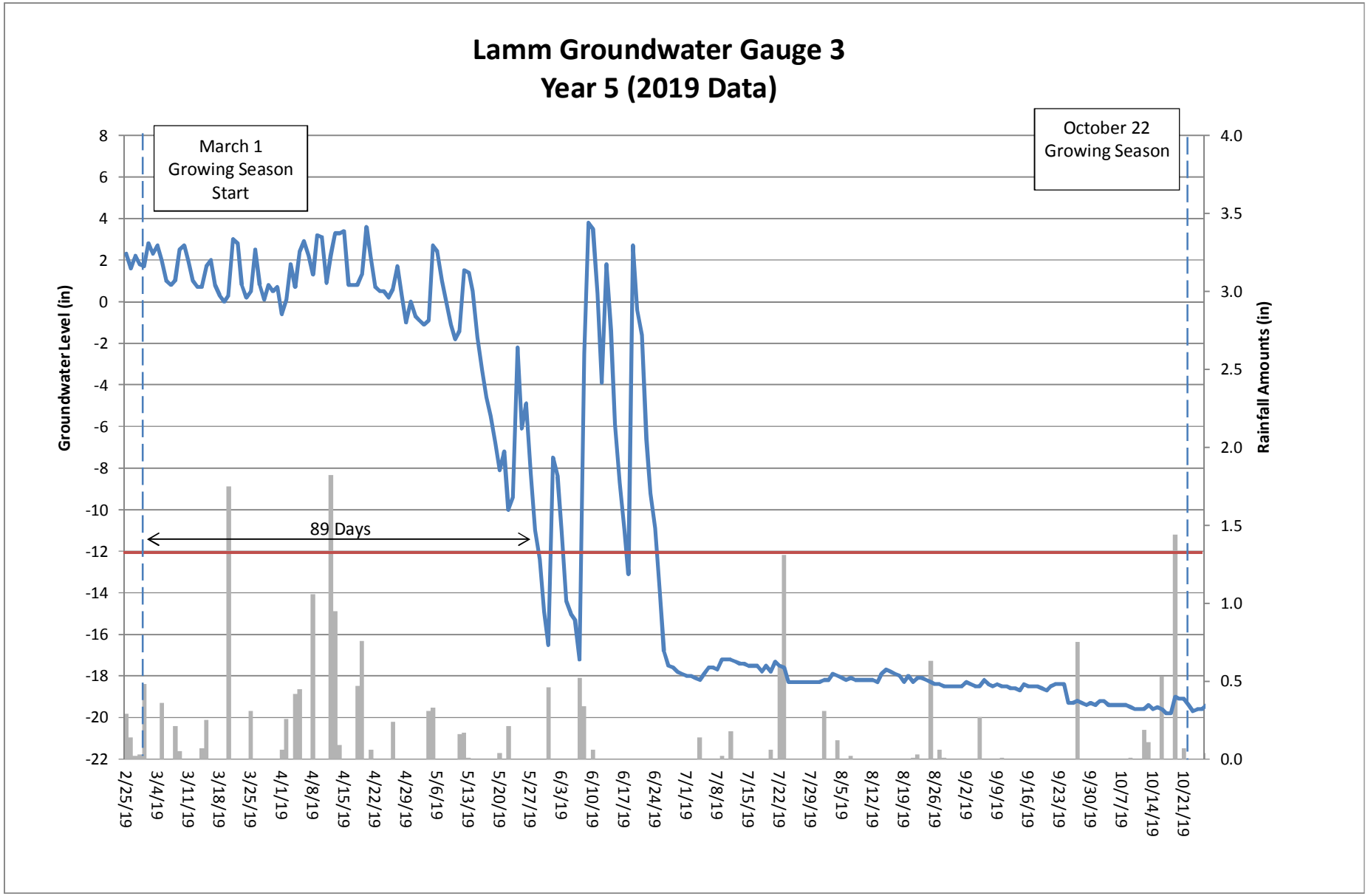
10/7/19
10/14/19
10/21/19


Lamm Groundwater Gauge 2
Year 5 (2019 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
Data loss
19 days
Groundwater Level (in)
Rainfall Amounts (in)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2/25/19
3/4/19
3/11/19
3/18/19
3/25/19
4/1/19
4/8/19
4/15/19
4/22/19
4/29/19
5/6/19
5/13/19
5/20/19
5/27/19
6/3/19
6/10/19
6/17/19
6/24/19
7/1/19
7/8/19
7/15/19
7/22/19
7/29/19
8/5/19
8/12/19
8/19/19
8/26/19
9/2/19
9/9/19
9/16/19
9/23/19
9/30/19
10/7/19
10/14/19
10/21/19


Lamm Groundwater Gauge 3
Year 5 (2019 Data)
March 1
Growing Season
Start
October 22
Growing Season
89 Days
Groundwater Level (in)
Rainfall Amounts (in)
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2/25/19
3/4/19
3/11/19
3/18/19
3/25/19
4/1/19
4/8/19
4/15/19
4/22/19
4/29/19
5/6/19
5/13/19
5/20/19
5/27/19
6/3/19
6/10/19
6/17/19
6/24/19
7/1/19
7/8/19
7/15/19
7/22/19
7/29/19
8/5/19
8/12/19
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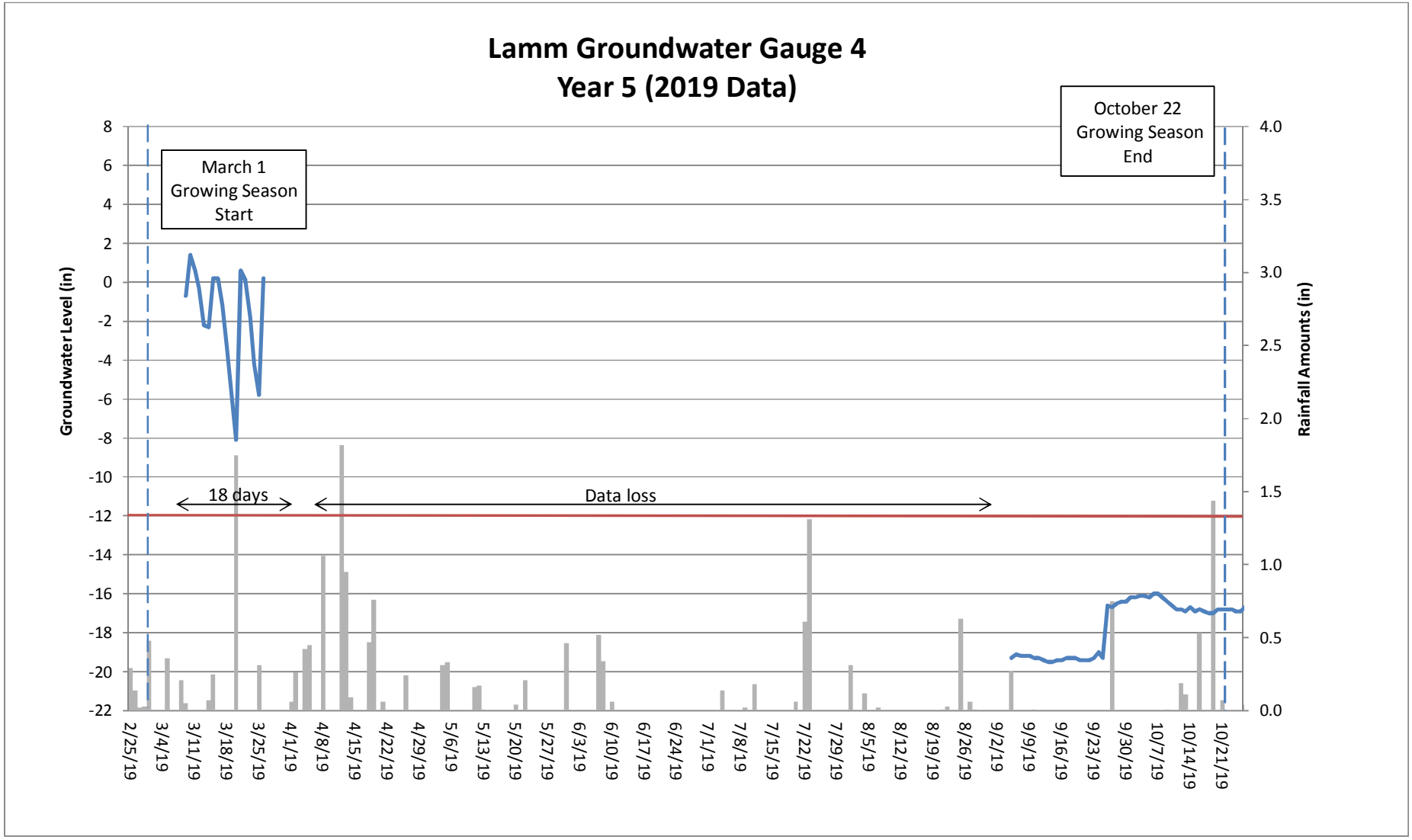
10/7/19
10/14/19
10/21/19


Lamm Groundwater Gauge 4
Year 5 (2019 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
18 days
Data loss
Groundwater Level (in)
Rainfall Amounts (in)
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2/25/19
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6/3/19
6/10/19
6/17/19
6/24/19
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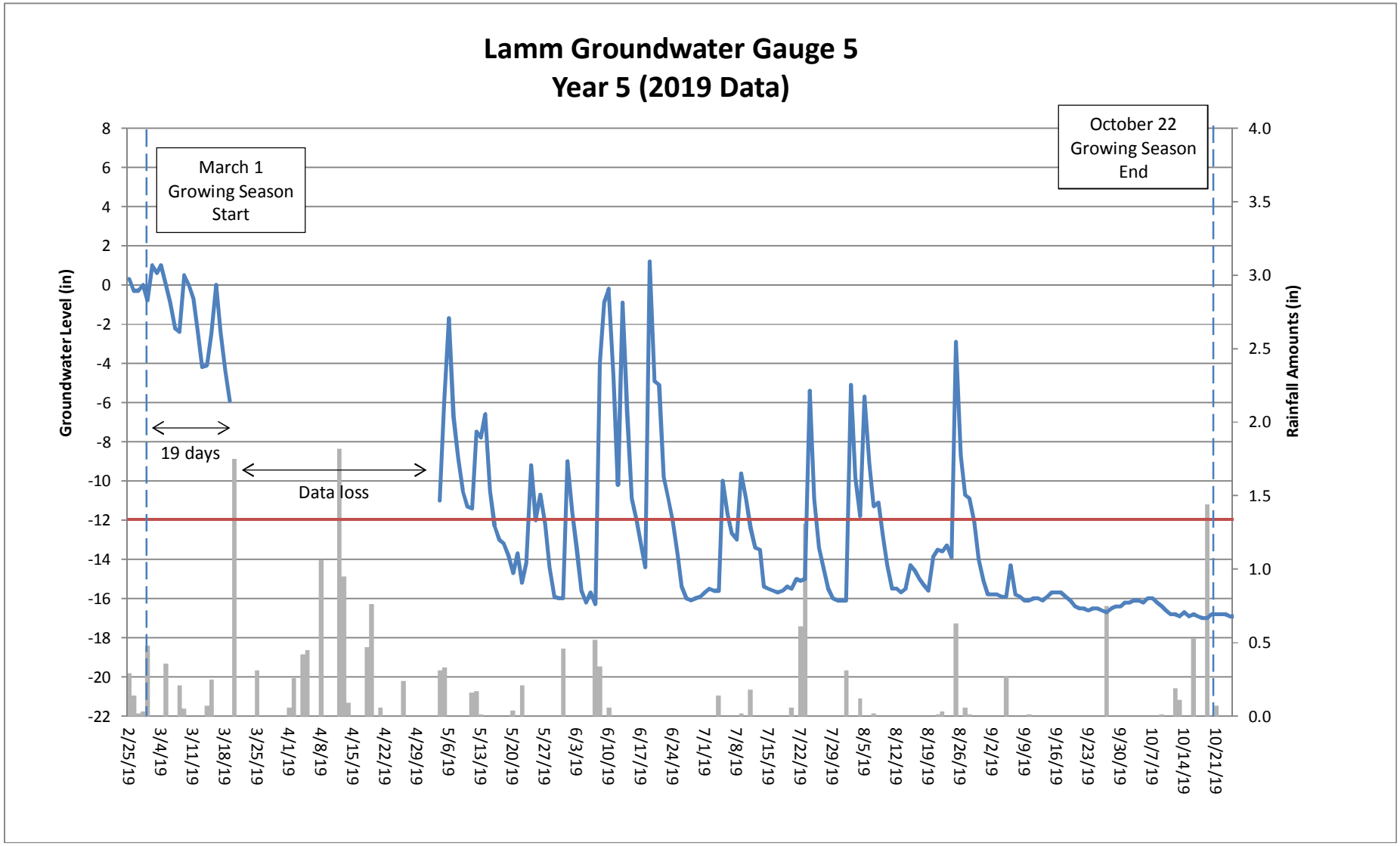
10/14/19
10/21/19


Lamm Groundwater Gauge 5
Year 5 (2019 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
19 days
Data loss
Groundwater Level (in)
Rainfall Amounts (in)
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2/25/19
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6/3/19
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6/17/19
6/24/19
7/1/19
7/8/19
7/15/19
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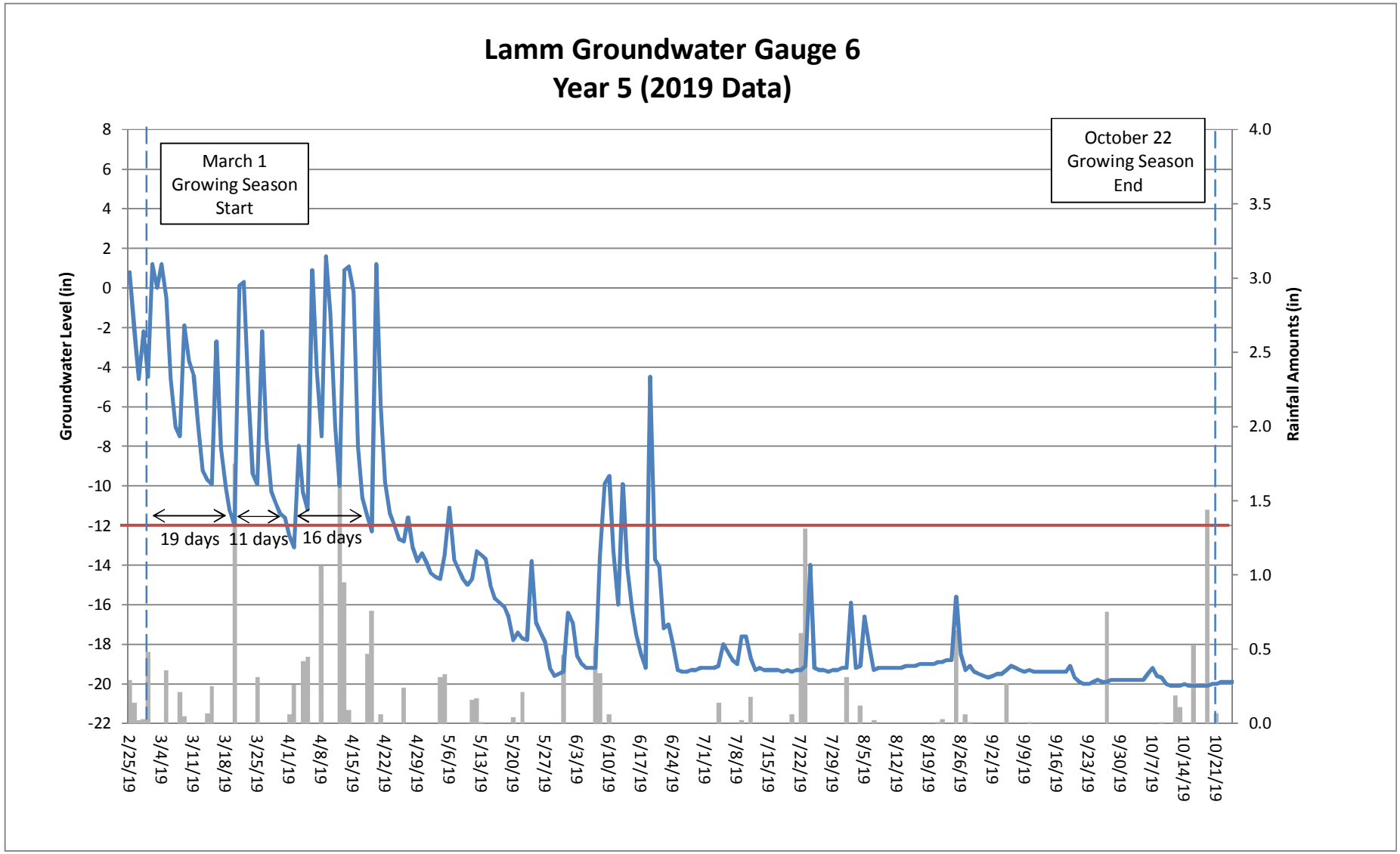
10/21/19


Lamm Groundwater Gauge 6
Year 5 (2019 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
19 days
11 days
16 days
Groundwater Level (in)
Rainfall Amounts (in)
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
4.0
3.5
3.0
2.5
2.0
1.5
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0.5
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6/10/19
6/17/19
6/24/19
7/1/19
7/8/19
7/15/19
7/22/19
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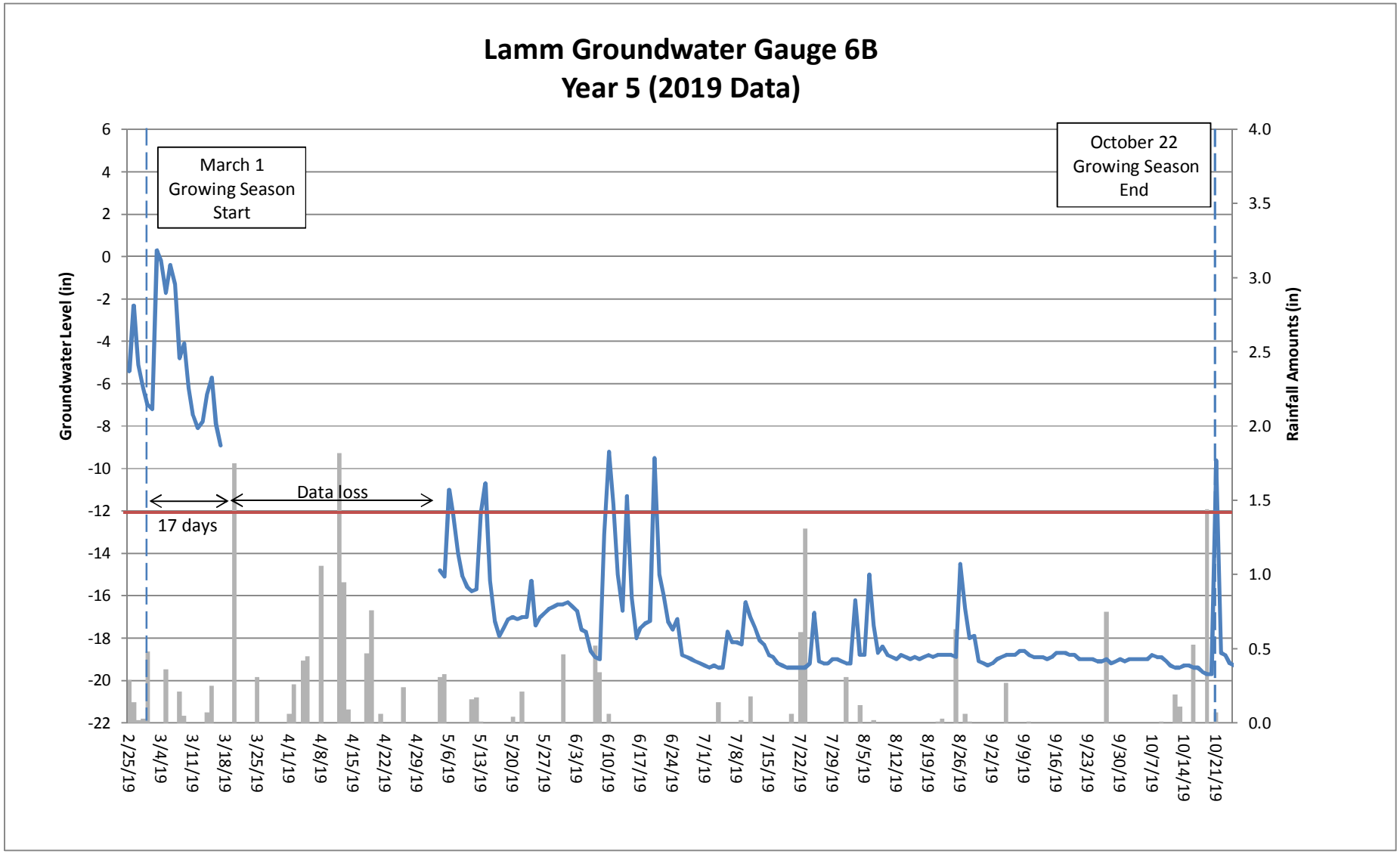
10/21/19


Lamm Groundwater Gauge 6B
Year 5 (2019 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
Data loss
17 days
Groundwater Level (in)
Rainfall Amounts (in)
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
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4/29/19
5/6/19
5/13/19
5/20/19
5/27/19
6/3/19
6/10/19
6/17/19
6/24/19
7/1/19
7/8/19
7/15/19
7/22/19
7/29/19
8/5/19
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8/19/19
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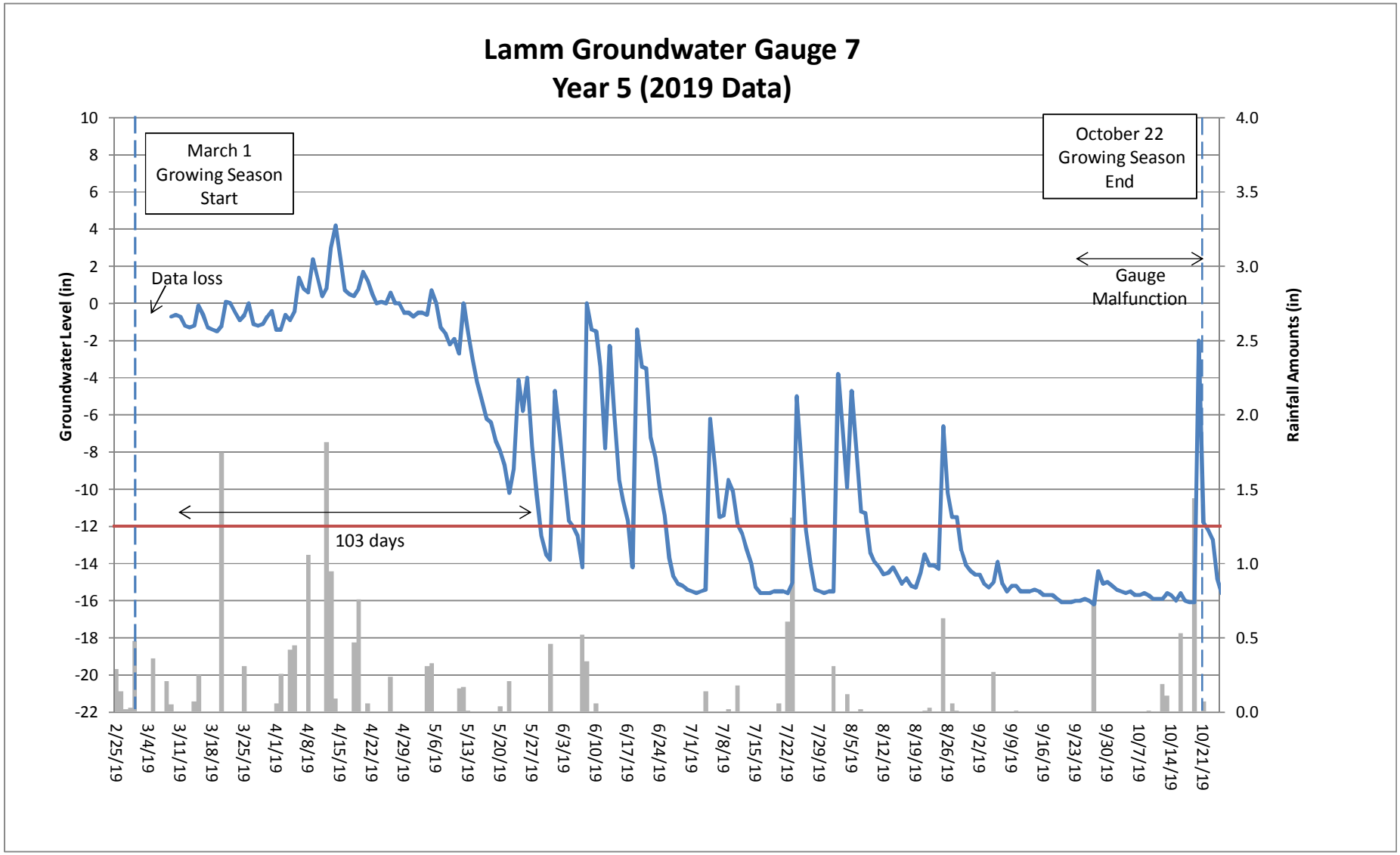
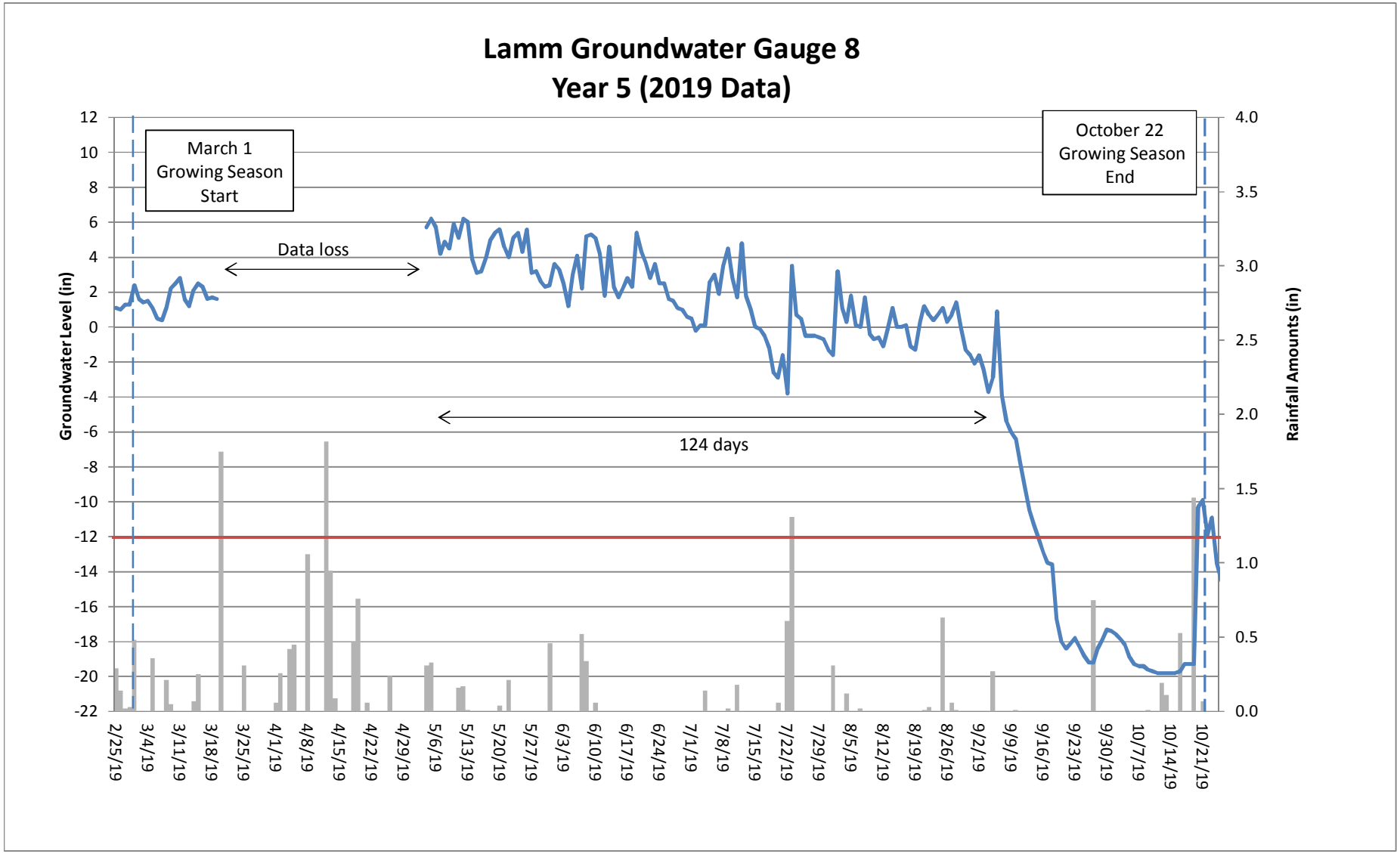
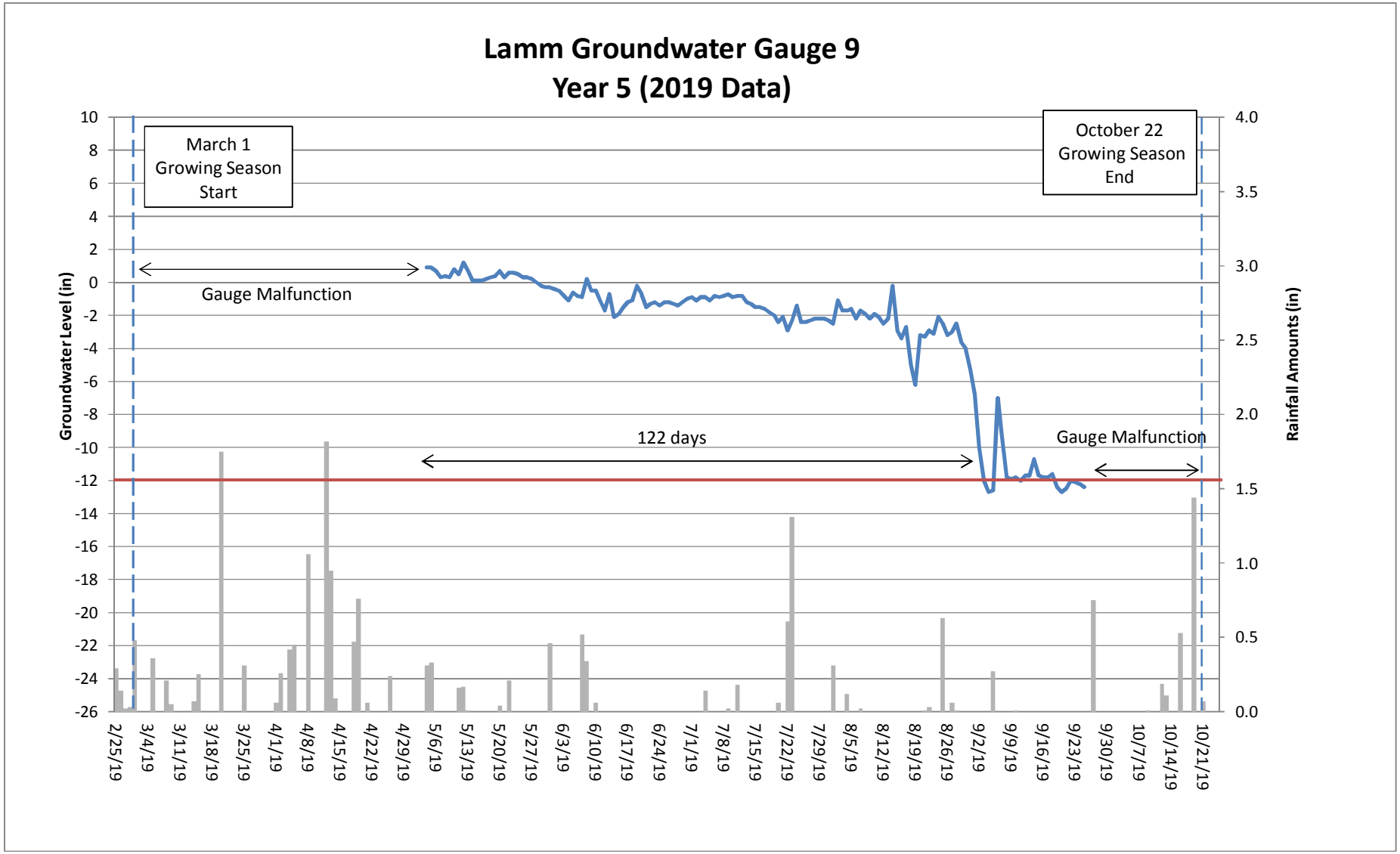
10/14/19
10/21/19


Lamm Groundwater Gauge 7
Year 5 (2019 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
Data loss
Gauge
Malfunction
103 days
Groundwater Level (in)
Rainfall Amounts (in)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2/25/19
3/4/19
3/11/19
3/18/19
3/25/19
4/1/19
4/8/19
4/15/19
4/22/19
4/29/19
5/6/19
5/13/19
5/20/19
5/27/19
6/3/19
6/10/19
6/17/19
6/24/19
7/1/19
7/8/19
7/15/19
7/22/19
7/29/19
8/5/19
8/12/19
8/19/19
8/26/19
9/2/19
9/9/19
9/16/19
9/23/19
9/30/19
10/7/19
10/14/19
10/21/19


Lamm Groundwater Gauge 8
Year 5 (2019 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
Data loss
124 days
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2/25/19
3/4/19
3/11/19
3/18/19
3/25/19
4/1/19
4/8/19
4/15/19
4/22/19
4/29/19
5/6/19
5/13/19
5/20/19
5/27/19
6/3/19
6/10/19
6/17/19
6/24/19
7/1/19
7/8/19
7/15/19
7/22/19
7/29/19
8/5/19
8/12/19
8/19/19
8/26/19
9/2/19
9/9/19
9/16/19
9/23/19
9/30/19
10/7/19
10/14/19
10/21/19


Lamm Groundwater Gauge 9
Year 5 (2019 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
Gauge Malfunction
122 days
Gauge Malfunction
Groundwater Level (in)
Rainfall Amounts (in)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2/25/19
3/4/19
3/11/19
3/18/19
3/25/19
4/1/19
4/8/19
4/15/19
4/22/19
4/29/19
5/6/19
5/13/19
5/20/19
5/27/19
6/3/19
6/10/19
6/17/19
6/24/19
7/1/19
7/8/19
7/15/19
7/22/19
7/29/19
8/5/19
8/12/19
8/19/19
8/26/19
9/2/19
9/9/19
9/16/19
9/23/19
9/30/19
10/7/19
10/14/19
10/21/19

APPENDIX F

BENTHIC DATA

Results

Habitat Assessment Data Sheets

PAI ID NO			52711	52712	52713
STATION			UT-1	UT-2	MAIN
DATE			6/13/2019	6/13/2019	6/13/2019
SPECIES	T.V.	F.F.G.			
PLATYHELMINTHES					
Turbellaria		**P**			
Planariidae		**O**			
Girardia (Dugesia) tigrina	**7.1**	**P**		7	3
MOLLUSCA					
Bivalvia					
Veneroida					
Sphaeriidae		**FC**			
Pisidium sp.	**6.6**	**FC**	3		
Gastropoda					
Basommatophora					
Physidae					
Physella sp.	**8.7**	**CG**		3	
ANNELIDA					
Clitellata					
Oligochaeta		**CG**			
Tubificida					
Lumbriculida					
Lumbriculidae		**CG**			
Lumbriculus sp.		**CG**		1	
ARTHROPODA					
Crustacea					
Isopoda					
Asellidae		**SH**			
Caecidotea sp.	**8.4**	**CG**	2	1	
Amphipoda		**CG**			
Crangonyctidae					
Crangonyx sp.	**7.2**	**CG**		7	1
Decapoda					
Cambaridae			1	1	
Insecta					
Ephemeroptera					
Caenidae		**CG**			
Caenis sp.	**6.8**	**CG**			2
Heptageniidae		**SC**			
Stenonema femoratum	**6.9**	**SC**			4
Leptophlebiidae		**CG**			
Habrophlebiodes sp.				4	
SPECIES	T.V.	F.F.G.			

PAI ID NO			52711	52712	52713
STATION			UT-1	UT-2	MAIN
DATE			6/13/2019	6/13/2019	6/13/2019
SPECIES	T.V.	F.F.G.			
Odonata					
Aeshnidae		P			
Aeshna sp.		P	1		1
Coenagrionidae		P		1	
Corduliidae				2	
Somatochlora sp.	8.9	P	2		
Hemiptera					
Gerridae		P		1	
Megaloptera					
Corydalidae		P			
Chauliodes sp.		P	1		
Sialidae		P			
Sialis sp.	7	P	2	1	
Trichoptera					
Hydropsychidae		FC			
Cheumatopsyche sp.	6.6	FC			20
Diplectrona modesta	2.3	FC	4		
Hydropsyche depravata gp.	7.9	FC		2	1
Leptoceridae		CG			
Nectopsyche sp.		SH		1	
Philopotamidae		FC			
Chimarra aterrima	3.3	FC			1
Coleoptera					
Hydrophilidae		P			
Tropisternus sp.	9.3	P			1
Diptera					
Chironomidae					
Ablabesmyia mallochi	7.4	P		1	1
Conchapelopia sp.	8.4	P			1
Parametriocnemus sp.	3.9	CG			1
Paratendipes albimanus/duplicatus	5.6		2	1	
Polypedilum aviceps	3.6	SH		3	4
Procladius sp.	8.8	P	1		
Rheotanytarsus exiguus gp.	6.5	FC	1		1
Tanytarsus sp.	6.6	FC		1	
Xylotopus par	6.1	SH	1		
Zavrelimyia sp.	8.6	P	1		
TOTAL NO. OF ORGANISMS			**22**	**38**	**42**
TOTAL NO. OF TAXA			**13**	**17**	**14**
EPT TAXA			**1**	**3**	**5**
BIOTIC INDEX ASSIGNED VALUES			**6.19**	**6.82**	**6.41**

Lamm Main

3/06 Revision 6

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Unit, DWQ **TOTAL SCORE** 89

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 Lamm Main **Location/road:** Major Hill **(Road Name** Major Hill **)County** Alamance

Date 190613 **CC#** 03030002 **Basin** Cape Fear **Subbasin** 03-06-04

Observer(s) P.P. A.S. Type of Study: ☐ Fish ☐Benthos ☐ Basinwide ☐Special Study (Describe) _____

Latitude 35.845875 Longitude -79.395705 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 30 %Active Pasture _____% Active Crops
_____%Fallow Fields _____% Commercial _____%Industrial 50 %Other - Describe: mitigation site / Buffer

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

Width: (meters) Stream 2 Channel (at top of bank) 1 **Stream Depth:** (m) Avg .2 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: 60 ° 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** stream/wetland mitigation site YR-4

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: Rainfall above average prior to sampling

Lamm-Maier

I. Channel Modification

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

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

Remarks restoration reach Subtotal 5

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

A **Rocks** R **Macrophytes** C **Sticks and leafpacks** R **Snags and logs** R **Undercut banks or root mats**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

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

☐ No woody vegetation in riparian zone Remarks Subtotal 16

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

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

Remarks Subtotal 12

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

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

Subtotal 43

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

Remarks

Page Total 43

Lumm-Main

V. Riffle Habitats

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

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

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

Subtotal 16

VI. Bank Stability and Vegetation

FACE UPSTREAM

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

Total 14

Remarks _____

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

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

Remarks _____ Subtotal 8

VIII. Riparian Vegetative Zone Width

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

FACE UPSTREAM

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

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

Remarks _____ Total 8

Page Total 46

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

TOTAL SCORE 89

Lamm UT-1

3/06 Revision 6

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

92

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

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 Lamm UT-1 Location/road: Major Hill (Road Name Major Hill) County Alamance

Date 190613 **CC#** 03030002 Basin Cape Fear Subbasin 03-06-04

Observer(s) P.P. A.S. Type of Study: ☐ Fish ☒ Benthos ☐ Basinwide ☐ Special Study (Describe) _____

Latitude 35.884168 Longitude -79.392811 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 30 %Active Pasture _____% Active Crops
_____%Fallow Fields _____% Commercial _____%Industrial 50 %Other - Describe: stream and gutter restoration

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

Width: (meters) Stream 1 Channel (at top of bank) .8 **Stream Depth:** (m) Avg .1 Max .4
☐ 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: 60 ° 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** wetland & stream restoration site

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: Rainfall above average

Lamm UT-1

I. Channel Modification

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

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

Remarks _____ Subtotal 5

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

A **Rocks** C **Macrophytes** C **Sticks and leafpacks** R **Snags and logs** C **Undercut banks or root mats**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

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

☐ No woody vegetation in riparian zone Remarks _____ Subtotal 19

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

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

Remarks _____ Subtotal 12

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

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

Subtotal 8

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

Remarks _____

Page Total 44

Lamm_UT1

V. Riffle Habitats

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

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

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

Subtotal 16

VI. Bank Stability and Vegetation

FACE UPSTREAM

	Left Bank Score	Rt. Bank Score
A. Banks stable		
1. little evidence of erosion or bank failure(except outside of bends), little potential for erosion..	7	7
B. Erosion areas present		
1. diverse **trees**, shrubs, grass; plants healthy with good root systems.....	6	6
2. few trees or small trees and **shrubs**; vegetation appears generally healthy.....	5	5
3. sparse **mixed** vegetation; plant types and conditions suggest poorer soil binding.....	3	3
4. mostly **grasses**, few if any trees and shrubs, high erosion and failure potential at high flow..	2	2
5. little or no bank vegetation, mass erosion and bank failure evident.....	0	0
		Total 14

Remarks_____

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

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

Remarks_____ Subtotal 10

VIII. Riparian Vegetative Zone Width

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

FACE UPSTREAM

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

	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. width > 18 meters.....	5	5
2. width 12-18 meters.....	4	4
3. width 6-12 meters.....	3	3
4. width < 6 meters.....	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. width > 18 meters.....	4	4
b. width 12-18 meters.....	3	3
c. width 6-12 meters.....	2	2
d. width < 6 meters.....	1	1
2. breaks common		
a. width > 18 meters.....	3	3
b. width 12-18 meters.....	2	2
c. width 6-12 meters.....	1	1
d. width < 6 meters.....	0	0
		Total 8

Remarks_____

Page Total 48

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

TOTAL SCORE 92

3/06 Revision 6

Lamm UT-2

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Unit, DWQ **TOTAL SCORE** 79

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 Lamm UT-2 Location/road: Mayor Hill (Road Name Mayor Hill) County Alamance

Date 190613 **CC#** 03030002 Basin Cape Fear Subbasin 03-06-04

Observer(s) P.L. A.S. Type of Study: ☐ Fish ☒ Benthos ☐ Basinwide ☐ Special Study (Describe) _____

Latitude 35.9847260 Longitude 79.392217 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: 30 %Forest _____ %Residential 70 %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 .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) 1

Bank Angle: 125 ° 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** stream migration site

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 Clear **Photos:** ☐ N ☐ Y ☐ Digital ☐ 35mm

Remarks: rainfall has been above average prior to benthic collection

I. Channel Modification Score

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

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

Remarks_____ Subtotal 5

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

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

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

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

☐ No woody vegetation in riparian zone Remarks_____ Subtotal 14

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 12

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

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..... 6
   b. pools about the same size..... 4

B. Pools absent..... 0

Subtotal 10

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

Remarks_____

Page Total 40

V. Riffle Habitats

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

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

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

Subtotal 16

VI. Bank Stability and Vegetation

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

Total 14

Remarks _____

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

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

Remarks _____ Subtotal 10

VIII. Riparian Vegetative Zone Width

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

FACE UPSTREAM

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

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

Remarks _____ Total 8

Page Total 48

☐ Disclaimer-form filled out, but score doesn't match subjective opinion-atypical stream. **TOTAL SCORE** 79

APPENDIX G

MISCELLANEOUS

Figure-March 2016 Fescue Treatment

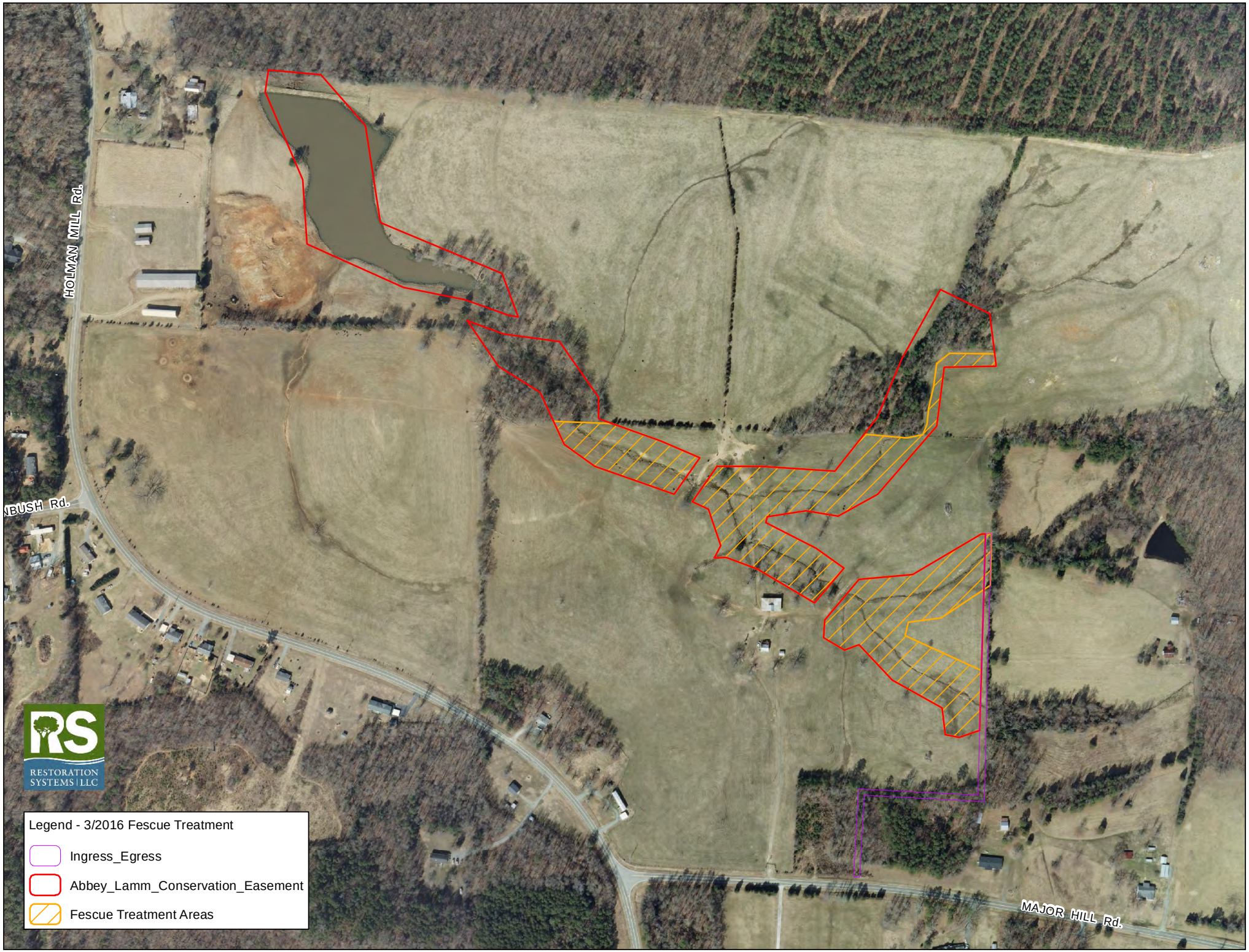
2016 Herbicide Application Forms

Supplemental Photographs

Remedial Planting Plan Figure

2016 Replant Photos

Herbicide Application Forms


HOLMAN MILL Rd.
NBUSH Rd.
MAJOR HILL Rd.
RESTORATION SYSTEMS | LLC
Legend - 3/2016 Fescue Treatment
Ingress_Egress
Abbey_Lamm_Conservation_Easement
Fescue Treatment Areas

Carolina Silvics, Inc. Pesticide Application Log

CarSilv - 0163

Client	Restoration Systems		
Project SIte	Abbey Lamm		
Date	03-11-2016		
Start Time	8:00	End Time	15:30
Only PAL for Site for This Day?	Yes	If NO, this is PAL # of ##	
Sky Cover	Partly Cloudy	Temp (F)	70
Wind Direction	E	Wind Speed	Calm
Applicators	William A Skinner (NC 026-32003/VA 129456)		
Application Method	Foliar Spray (ATV - Broadcast)		
Herbicide	Oust® XP (sulfometuron methyl)		
Herbicide Rate (%)		Total Concentrate	30oz
Surfactant or Adjuvant (1)			
Surfactant/Adjudivant 1 Rate (%)			
Other	Grounded (deposition agent)		
Other Rate/Amt	8oz/ac		
Diluent	Water		
Total Solution	125 gallon		
Species Controlled	fescue		
Area Description			
Additional Comments	Oust® application rate was 3oz/ac		

Abbey Lamm Stream & Wetland Mitigation Site: Year 2 (2016) Photos

Photo 1: Downstream end of the Main Stem looking upstream into the old pond bed **Photo Date: 10-19-2016**

Abbey Lamm Stream & Wetland Mitigation Site: Year 2 (2016) Photos

Photo 2: Downstream end of the Main Stem looking upstream into the old pond bed **Photo Date: 10-19-2016**

Abbey Lamm Stream & Wetland Mitigation Site: Year 2 (2016) Photos

Photo 3: Downstream end of the Main Stem looking upstream into the old pond bed **Photo Date: 10-19-2016**

Abbey Lamm Stream & Wetland Mitigation Site: Year 2 (2016) Photos

Photo 4: Upstream end of the old pond looking downstream **Photo Date: 10-19-2016**

Abbey Lamm Stream & Wetland Mitigation Site: Year 2 (2016) Photos

Photo 5: middle crossing looking upstream at the Main Stem and UT-3 on the left **Photo Date: 10-19-2016**

Abbey Lamm Stream & Wetland Mitigation Site: Year 2 (2016) Photos

Photo 6: middle crossing looking upstream at the Main Stem and UT-3 on the left **Photo Date: 10-19-2016**

Abbey Lamm Stream & Wetland Mitigation Site: Year 2 (2016) Photos

Photo 7: UT 1 & UT-2

Photo Date: 10-19-2016

Abbey Lamm Stream & Wetland Mitigation Site: Year 2 (2016) Photos

Photo 8: UT 3 (XC 5, 6, 7) **Photo Date: 10-19-2016**

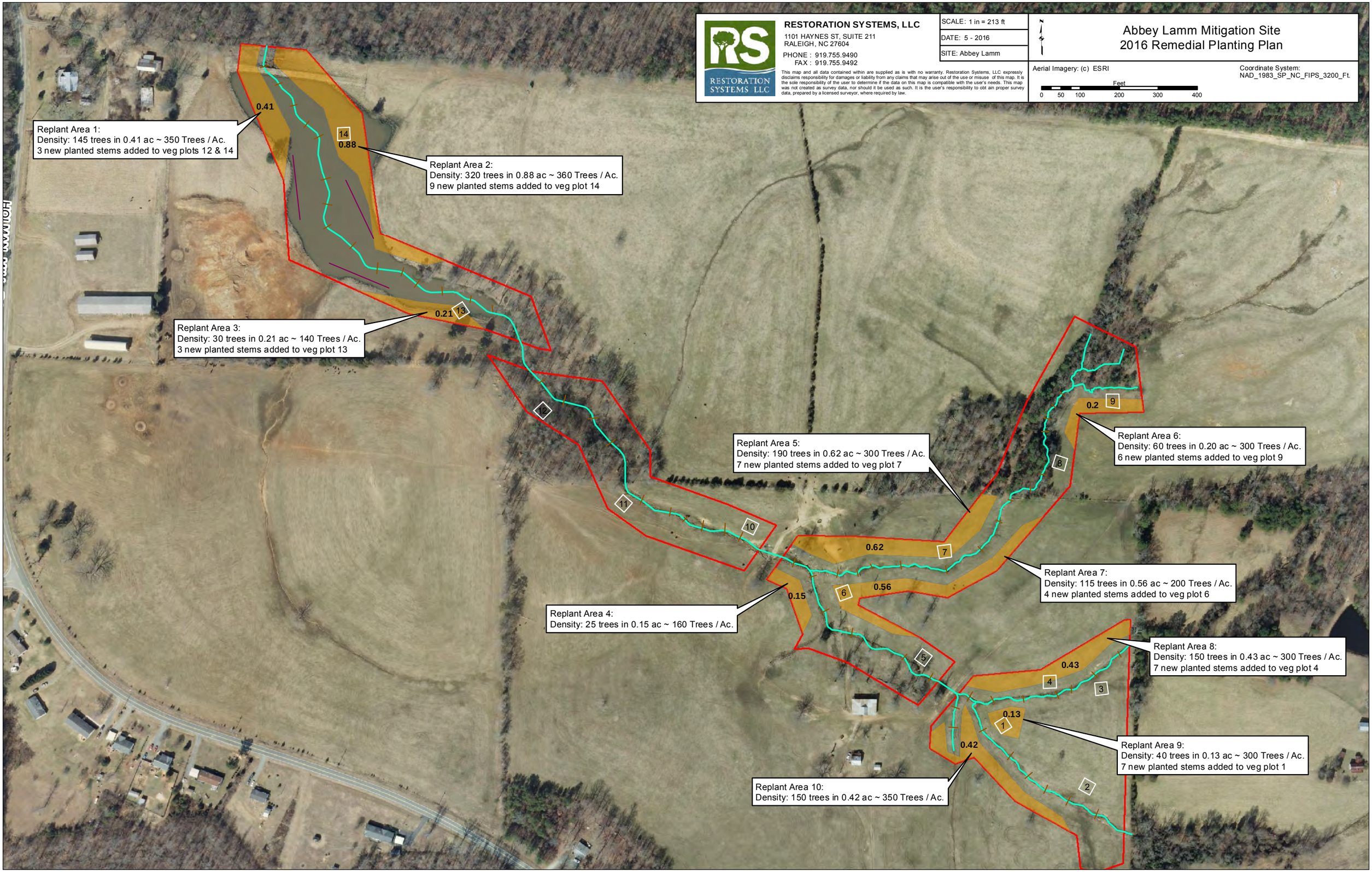
Abbey Lamm Stream & Wetland Mitigation Site: Year 2 (2016) Photos

Photo 9: UT 3 (XC 6, 7, 8)

Photo Date: 10-19-2016

Abbey Lamm Stream & Wetland Mitigation Site: Year 2 (2016) Photos

Photo 10: UT-1, 2, 3, & Main Stem **Photo Date: 10-19-2016**


RESTORATION SYSTEMS, LLC
1101 HAYNES ST, SUITE 211
RALEIGH, NC 27604
PHONE : 919.755.9490
FAX : 919.755.9492
This map and all data contained within are supplied as is with no warranty. Restoration Systems, LLC expressly disclaims responsibility for damages or liability from any claims that may arise out of the use or misuse of this map. It is the sole responsibility of the user to determine if the data on this map is compatible with the user's needs. This map was not created as survey data, nor should it be used as such. It is the user's responsibility to obt ain proper survey data, prepared by a licensed surveyor, where required by law.
SCALE: 1 in = 213 ft
DATE: 5 - 2016
SITE: Abbey Lamm
Abbey Lamm Mitigation Site
2016 Remedial Planting Plan
Aerial Imagery: (c) ESRI
Coordinate System:
NAD_1983_SP_NC_FIPS_3200_Ft.
Feet
0 50 100 200 300 400
Replant Area 1:
Density: 145 trees in 0.41 ac ~ 350 Trees / Ac.
3 new planted stems added to veg plots 12 & 14
0.41
14
0.88
Replant Area 2:
Density: 320 trees in 0.88 ac ~ 360 Trees / Ac.
9 new planted stems added to veg plot 14
0.21
13
Replant Area 3:
Density: 30 trees in 0.21 ac ~ 140 Trees / Ac.
3 new planted stems added to veg plot 13
12
11
10
Replant Area 4:
Density: 25 trees in 0.15 ac ~ 160 Trees / Ac.
0.15
Replant Area 5:
Density: 190 trees in 0.62 ac ~ 300 Trees / Ac.
7 new planted stems added to veg plot 7
0.62
7
0.56
6
5
0.2
9
8
Replant Area 6:
Density: 60 trees in 0.20 ac ~ 300 Trees / Ac.
6 new planted stems added to veg plot 9
Replant Area 7:
Density: 115 trees in 0.56 ac ~ 200 Trees / Ac.
4 new planted stems added to veg plot 6
0.43
4
3
Replant Area 8:
Density: 150 trees in 0.43 ac ~ 300 Trees / Ac.
7 new planted stems added to veg plot 4
0.13
1
0.42
2
Replant Area 9:
Density: 40 trees in 0.13 ac ~ 300 Trees / Ac.
7 new planted stems added to veg plot 1
Replant Area 10:
Density: 150 trees in 0.42 ac ~ 350 Trees / Ac.

ABBEY LAMM
STREAM AND WETLAND MITIGATION SITE
ALAMANCE COUNTY, NORTH CAROLINA
FULL DELIVERY CONTRACT NO. 5790

Photographs taken January 13th, 2017

Photo 1: Looking S. along Replant Area -1 **Photo Date: 1-13-2017**

Photo 2: Looking N. in Replant Area 2, just N. of veg. plot 14 **Photo Date: 1-13-2017**

Photo 3: Looking W. in Replant Area 3, near veg. plot 13 **Photo Date: 1-13-2017**

Photo 4: Looking NE. in Replant Area 5, near veg. plot 7 **Photo Date: 1-13-2017**

Photo 5: Looking N. in Replant Area 6. **Photo Date: 1-13-2017**

Photo 6: Looking N. in Replant Area 6, towards veg. plot 9. **Photo Date: 1-13-2017**

Photo 7: Looking SW. in Replant Area 8. **Photo Date: 1-13-2017**

Photo 8: Looking NW. in Replant Area 10. **Photo Date: 1-13-2017**

Photo 9: Surviving bear roots outside of replant area **Photo Date: 1-13-2017**

Photo 10: Surviving bear root outside of replant area **Photo Date: 1-13-2017**

Carolina Silvics, Inc. Pesticide Application Log

Carolina Silvics, Inc.

Unique ID

CarSilv - 0713

Client

Restoration Systems

Project SIte

Abbey Lamm

Date

Tuesday, June 18, 2019

Start Time

9:00

End Time

13:00

Only PAL for Site for This Day?

Yes

Sky Cover

Clear

Temp (F)

85

Wind Direction

ENE

Wind Speed

1-5 mph

Applicators

Joshua G Merritt (NC 026-33717)

Create your own automated PDFs with JotForm PDF Editor

JotForm

Grainger Coughtrey (NC 026-34612)

Application Method

Foliar Spray (Backpack)

Herbicide

Roundup® Custom (glyphosate)

Herbicide Rate (%)

.25

Total Concentrate

3.2 fl oz

Surfactant or Adjuvant (1)

Agri-Dex®

Surfactant/Adjudivant 1 Rate (%)

.75

Diluent

Water

Total Solution

10 gallons

Species Controlled

Microstegium

Area Description

Treated microstegium within the old pond.
Microstegium densities were high within this area.

Create your own automated PDFs with JotForm PDF Editor

JotForm