Monitoring Report – MY2
FINAL VERSION
Lake Wendell Mitigation Project
Calendar Year of Data Collection: 2019

NCDEQ DMS Project Identification # 97081
NCDEQ DMS Contract # 6826
Neuse River Basin (Cataloging Unit 03020201)
USACE Action ID Number: SAW-2016-00876
NCDEQ DWR Project # 2016-0385
Johnston County, NC
Contracted Under RFP # 16-006477
Data Collection Period: June-October 2019, Submission Date: December 2019

Prepared for:

Environmental Quality

North Carolina Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
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Prepared by:

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Mitigation Project Name	**Lake Wendell**	**County**	**Johnston**	**USACE Action ID**	**2016-00876**
DMS ID	**97081**	**Date Project Instituted**	**3/18/2016**	**NCDWR Permit No**	**2016-0385**
River Basin	**Neuse**	**Date Prepared**	**8/22/2019**		
Cataloging Unit	**03020201**				

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 Date (Wetland)
Potential Credits (Mitigation Plan)		**3,392.100**												
Potential Credits (As-Built Survey)		**3,392.100**												
1 (Site Establishment)	**N/A**				N/A	N/A	**N/A**				**N/A**		N/A	N/A
2 (Year 0 / As-Built)	**30%**	1,017.630			2019	3/26/2019	**30%**				**30%**		N/A	
3 (Year 1 Monitoring)	**10%**	339.210			2019	8/19/2019	**10%**				**10%**		N/A	
4 (Year 2 Monitoring)	**10%**				2020		**10%**				**15%**		N/A	
5 (Year 3 Monitoring)	**10%**				2021		**15%**				**20%**		N/A	
6 (Year 4 Monitoring)	**5%**				2022		**5%**				**10%**		N/A	
7 (Year 5 Monitoring)	**10%**				2023		**15%**				**15%**		N/A	
8 (Year 6 Monitoring)	**5%**				2024		**5%**				**N/A**		N/A	
9 (Year 7 Monitoring)	**10%**				2025		**10%**				**N/A**		N/A	
Stream Bankfull Standard	**10%**						**N/A**				**N/A**			
Total Credits Released to Date		**1,356.840**												

NOTES:

CONTINGENCIES:

Signature of Wilmington District Official Approving Credit Release

27 Sept 2019

Date

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

2 - For NCDMS projects, the initial credit release milestone occurs when the as-built report (baseline monitoring report) has been approved by the NCIRT and posted it to the NCDMS 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

Mitigation Project Name	**Lake Wendell**		**County**	**Johnston**	**USACE Action ID**	**2016-00876**
DMS ID	**97081**		**Date Project Instituted**	**3/18/2016**	**NCDWR Permit No**	**2016-0385**
River Basin	**Neuse**		**Date Prepared**	**8/22/2019**		
Cataloging Unit	**03020201**					

DEBITS (released credits only)

			Ratios	1	1.5	2.5	10	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)				**3,219.000**		**255.000**	**711.000**												
As-Built Amounts (mitigation credits)				**3,219.000**		**102.000**	**71.100**												
Percentage Released				**40%**		**40%**	**40%**												
Released Amounts (feet / acres)				**1,287.600**		**102.000**	**284.400**												
Released Amounts (credits)				**1,287.600**		**40.800**	**28.440**												
NCDWR Permit	USACE Action ID	Project Name																	
Remaining Amounts (feet / acres)				**1,287.600**		**102.000**	**284.400**												
Remaining Amounts (credits)				**1,287.600**		**40.800**	**28.440**												

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December 31, 2019

NC Department of Environmental Quality
Division of Mitigation Services
Attn: Lindsay Crocker
217 West Jones Street, Suite 3000-A
Raleigh, NC 27603

RE: WLS Responses to NCDEQ DMS Review Comments for Task 8 Draft Monitoring Report Year 2 for the Lake Wendell Mitigation Project, NCDEQ DMS Full-Delivery Project ID #97081, Contract #6826, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Ms. Crocker:
Water & Land Solutions, LLC (WLS) is pleased to present the Final Monitoring Report Year 2 for the Lake Wendell Mitigation Project to the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS). The Final Monitoring Report Year 2 were developed by addressing NCDEQ DMS's review comments.

Under this cover, we are providing one hard copy of the Final Monitoring Report Year 2, and the required digital data for each (the .pdf copies of the entire updated reports and the updated digital data) via CDs. We are providing our written responses to NCDEQ DMS's review comments on the Draft Monitoring Report Year 2 below. Each of the DMS review comments is copied below in **bold** text, followed by the appropriate response from WLS in regular text:

Riparian Buffer MY2:

1. **DMS Comment: Table 2 (asset table) does not match MY1. Please update to match.** WLS Response: Table 2 was updated to match MY1.

2. **DMS Comment: The high number of red maple volunteers portrayed in the vegetation plots was discussed in the field. DMS suggested setting a realistic threshold height for volunteers to best represent the site conditions. A 3' threshold was discussed, and DMS has later learned that 12-18" may be the regulatory direction. Because guidance is not specific, WLS may elect to keep vegetation table as-is but seek clarification for future monitoring.** WLS Response: WLS changed the threshold for counting volunteers stems to a minimum of 18". The text and corresponding tables were updated to reflect this new threshold.

3. **DMS Comment: The report indicates that red maple will be selectively thinned. As discussed in the field, it may be impractical to thin these seedlings because they are very small.** WLS Response: After the threshold was changed per the comment above, the veg plots no longer have excessive stem counts for red maple and therefore will not be selectively thinned. Natural recruitment will be monitored closely to ensure that stem counts for red maple do not exceed 20% per plot.

4. **DMS Comment: 5.1 Vegetation. The final paragraph describes an area of low stem density that is 0.02 acres (800 sf) as an area of concern. If this area will be replanted, just make a note in the following monitoring report along with the number and species. This is also true of the kudzu area (note number and species of tree).** WLS Response: WLS has removed the low stem density area from this report and will continue to monitor the areas in MY3. If kudzu control allows for replanting to occur, WLS will document the number of trees and species in MY3.

5. **DMS Comment: Vegetation success: although your mitigation plan states tree species must be planted for success, please note that DWR rule states that volunteer hardwood trees and shrubs can be used to meet success.** WLS Response: Volunteer species will not be counted towards success in this report. In future reports they will be counted toward success if they are surviving for at least two years and were species in the approved planting plan.

Stream Report MY2:

1. **DMS Comment: See comments 2, 3, and 4 above and update accordingly.** WLS Response: WLS has updated the report per DMS's request.

2. **DMS Comment: The Mitigation Plan states that success is based on planted species, but the 2016 IRT guidance does allow volunteers to be counted toward success, if they were on the planted list. It may be prudent for WLS to note and / or present information that way if applicable.** WLS Response: See response from #5 above. The total number of planted and recruited stems is available in Table 7.

3. **DMS Comment: Check the % change BHR for all XS, especially 3, 5, and 8 (these should not be negative).** WLS Response: WLS has updated all BHR's to remove negative percentages.

4. **DMS Comment: Note the x and y axis on your stream cross sections varies in scale significantly. It may benefit your project to present all cross sections on a standard scale for comparison purposes for future reports.** WLS Response: WLS has updated the scales across all Lake Wendell cross sections to be consistent on the x and y axis.

5. **DMS Comment: Table 8- please clarify that measurement is height above bankfull. Please also provide all bankfull events (include MY1) for documentation of bankfull credit release.** WLS Response: All bankfull events for the project were included in Table 8 and clarification on the measurements was added per DMS's request.

6. **DMS Comment: As discussed in the field, DMS recommends monitoring the upper portion of R5 closely. If there is sediment or vegetation removal, it is suggested it not occur after dormant season in MY2. This should be reported in the summary if it is conducted.** WLS Response: WLS will continue to monitor R5 closely and will communicate with DMS and the NCIRT regarding any necessary maintenance to the stream channel.

Digital Deliverables:

1. **DMS Comment: Morphology - Please submit the spreadsheets that include the cumulative overlays of the XS as shown in the report (all years). Include the particle distribution summary parameters in the morph summary tables.** WLS Response: WLS added the XS spreadsheets including the cumulative overlays to the e-data submittal package. D50 particle distribution was added to the morphology summary table and represents the average across the site for all riffles and pools.

2. **DMS Comment: Calculation of XSA and Max depth are to completed using TOB in keeping with methods specified in the Industry Technical Work group memorandum. For clarity make sure the reader is aware that these methods are being employed. For example, please include a footnote to the effect: "*Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height*."** WLS Response: WLS added footnote to all XS spreadsheets. Note: WLS uses MY1 in place of as-built (MY0) due to issues of the as-built survey which were identified in MY1.

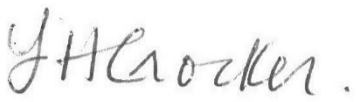
3. **DMS Comment: Hydrology Data –make note of the gauge type (e.g. transducer, RDS etc.) used in the excel data file. Please also label any probe or benchmark elevations, the raw and corrected readings of**

the water elevations and any offsets applied. DMS needs to be able to clearly identify these key elevations before incorporating these into the DMS database permitting independent calculation/verification. The DMS Excel template is an example of what is needed for reference and is required for use as part of RFPS within the last several years (available here: https://ncdenr.s3.amazonaws.com/s3fs-public/Mitigation%20Services/Document%20Management%20Library/Guidance%20and%20Template%20Documents/7_Mon_Baseline_and_Annual_Rep_Tables%20-%20Jun%202017.xlsx). WLS Response: WLS has updated the appropriate spreadsheet in the excel data file in accordance with the template.

4. **DMS Comment: Include precipitation data in the Hydrology files.** WLS Response: WLS has added precipitation data to the appropriate hydrology file.

5. **DMS Comment: Conservation Easement Shapefile- We need to determine if there is an issue with the Conservation easement file and the metes and bounds provided by the surveyor. DMS will review.** WLS Response: WLS confirmed metes and bounds provided by the surveyor are correct.

Thank you for your work.



Lindsay Crocker
DMS

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1 Project Summary

Water and Land Solutions, LLC (WLS) completed the construction and planting of the Lake Wendell Mitigation Project (Project) full-delivery project for the North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) in March 2018. The Project is located in Johnston County, North Carolina between the Community of Archer Lodge and the Town of Wendell at 35.73739˚, -78.3538°. The Project site is located in the NCDEQ Sub-basin 03-04-06, in the Upper Buffalo Creek Sub-watershed 030202011502.

The Project involved the restoration, enhancement, preservation and permanent protection of five stream reaches (R1, R2, R3, R4, and R5) and their riparian buffers, totaling 4,269 linear feet of streams and 490,477 square feet of riparian buffers. Monitoring Year 2 (MY2) monitoring activities occurred June through October of 2019 (Table 2). This report presents the data for MY2. The Project meets the MY2 success criteria for stream hydrology, stream horizontal and vertical stability, streambed condition and stability, stream flow, and vegetation. Based on these results, the Project is expected to meet the Monitoring Year 3 (MY3) success criteria in 2020.

2 Project Background

2.1 Project Location, Setting, and Existing Conditions

The Project site is located in the Upper Buffalo Creek Sub-watershed 030202011502 study area of the Neuse 01 Regional Watershed Plan, in the Wake-Johnston Collaborative Local Watershed Plan, and in Targeted Local Watershed 03020201180050.

The project includes five stream reaches (R1, R2, R3, R4, and R5) which consisted of restoration, enhancement, preservation and permanent protection of 4,269 linear feet of streams and 490,477 square feet of riparian buffers. The catchment area is 102 acres and has an impervious cover less than one percent. The dominant surrounding land uses are agriculture and mixed forest. Prior to construction, livestock had access to all Project streams, except R4, and the riparian buffers were less than 50 feet wide.

2.2 Mitigation Project Goals and Objectives

WLS established project mitigation goals and objectives based on the resource condition and functional capacity of the watershed to improve and protect diverse aquatic resources comparable to stable headwater stream systems within the Piedmont Physiographic Province. The proposed mitigation types and design approaches described in the final approved mitigation plan considered the general restoration and resource protection goals and strategies outlined in the 2010 Neuse River Basin Restoration Priority Plan (RBRP). The functional goals and objectives were further defined in the 2013 Wake-Johnston Collaborative Local Watershed Plan and 2015 Neuse 01 Regional Watershed Plan and include:

- Reducing sediment and nutrient inputs to the upper Buffalo Creek Watershed,
- Restoring, preserving and protecting wetlands, streams, riparian buffers and aquatic habitat,
- Implementing agricultural BMPs and stream restoration in rural catchments together as “project clusters”.

The following site-specific goals were developed to address the primary concerns outlined in the LWP and RWP and include:

Functional Category (Level)	Functional Goal / Parameter	Functional Design Objective
Hydrology (Level 1)	Improve Base Flow	Remove man-made pond dam and restore a more natural flow regime and aquatic passage.
Hydraulics (Level 2)	Reconnect Floodplain / Increase Floodprone Area Widths	Lower BHRs from >2.0 to 1.0-1.2 and maintain ERs at 2.2 or greater.
Geomorphology (Level 3)	Improve Bedform Diversity	Increase riffle/pool percentage to 70/30 and pool-to-pool spacing ratio 4-7X bankfull width.
	Increase Lateral Stability	Reduce BEHI/NBS streambank erosion rates comparable to downstream reference condition and stable cross-section values.
	Establish Riparian Buffer Vegetation	Plant native species vegetation a minimum 50' wide from the top of the streambanks with a composition/density comparable to downstream reference condition.
Physicochemical (Level 4)	Improve Water Quality	Remove cattle from riparian corridor and reduce fecal coliform bacteria levels.
Biology (Level 5)	Improve Macroinvertebrate Community and Aquatic Species Health	Incorporate native woody debris into channel and change DWR bioclassification rating from 'Poor' to a minimum 'Fair' by Monitoring Year 7.

To accomplish these site-specific goals, the following objectives will be measured and included with the performance standards to document overall project success:

- Provide a floodplain connection to incised stream with BHRs that range from 1.0 – 1.2 and ERs greater than 2.2 by removing a man-made pond, thereby promoting more natural flood flows,
- Improve bedform diversity by increasing scour pool spacing/depth variability every 4X-7X bankfull channel widths,
- Increase benthic macroinvertebrate habitat value by changing the DWR bioclassification rating from 'Poor' to 'Fair' after monitoring year 7,
- Reduce sediment loading from accelerated streambank erosion rates by decreasing BEHI/NBS values to 'Low' and constructing Radius of Curvature Ratios (Rc) to 2X-3X bankfull channel widths,
- Improve pre-restoration water quality parameters by increasing dissolved oxygen concentrations (DO), such that it meets a functioning level after monitoring year 7,
- Increase native species riparian buffer vegetation density/composition along streambank and floodplain areas that meet requirements of a minimum 50-foot-wide and 210 stems/acre after monitoring year 7,
- Improve aquatic habitat and fish movement through pond dam removal and the addition of in-stream cover and native woody debris by increasing the existing biotic index to a higher functioning level,
- Prevent cattle from accessing the conservation easement boundary by installing permanent fencing and reducing fecal coliform bacteria from the pre-restoration levels.

2.3 Project History, Contacts, and Timeframe

The chronology of the project history and activity is presented in Table 2. Relevant project contact information is presented in Table 3. Relevant project background information is presented in Table 4.

3 Project Mitigation Components

Refer to Figure 1 and Table 1 for the project components/asset information. A recorded conservation easement consisting of 11.97 acres protects and preserves all stream reaches, existing wetland areas, and riparian buffers in perpetuity.

3.1 Stream Mitigation Types and Approaches

Stream restoration practices involved raising the existing streambed and reconnecting the stream to the relic floodplain and constructing a channel through a drained farm pond (Reach R3). Some portions of the existing degraded channels that were abandoned within the restoration areas were filled to decrease surface and subsurface drainage and raise the local water table. The project also included restoring, enhancing and protecting riparian buffers and riparian wetlands within the conservation easement. The permanent fencing system consisting of woven wire fencing was installed to NRCS technical standards in the pasture areas along and outside of the northern conservation easement boundaries of Reaches R1, R2, and R3. The vegetative components of this project included stream bank, floodplain, and transitional upland zones planting. The Site was planted with native species riparian buffer vegetation and now protected through a permanent conservation easement. Table 1 and Figure 1 (Appendix A) provide a summary of the project components.

3.1.1 R1 Restoration

Due to the past manipulation and degraded nature of R1, a combination of Priority Level I/II Restoration approaches were implemented along entire reach. A buried concrete pipe system was removed and the stream channel was daylighted for approximately 200 feet to restore a more natural flow path and hydrologic function. Downstream of a culvert crossing installation, a new meandering channel was constructed, and remnant spoil piles were removed from the floodplain. In-stream structures, including log vanes, log and rock riffles, log steps and log weirs, were installed to provide control grade as well as dissipate flow energy, protect streambanks, and eliminate potential for future incision.

3.1.2 R2 Restoration

Restoration work along R2 involved a Priority Level I Restoration approach by raising the bed elevation and reconnecting the stream with its abandoned floodplain. This approach promoted the restoration of a stable channel form with appropriate bedform diversity, as well as improved biological functions through increased aquatic and terrestrial habitats. Proposed in-stream structures included constructed wood and stone riffles for grade control and habitat, log j-hook vanes, and log weirs/jams for encouraging step-pool formation energy dissipation, bank stability, and bedform diversity. A few mature trees were protected during construction and incorporated into the design. Bioengineering techniques such as vegetated geolifts, brush layers, and live stakes were used to protect streambanks and establish woody vegetation growth.

3.1.3 R3 Restoration

R3 restoration activities began immediately downstream from R2. In this area, a man-made farm pond was drained to reconnect the new stream channel with its geomorphic floodplain. Channel and floodplain excavation in this reach segment included the removal of shallow legacy sediments (approx. 12” depth) to accommodate a new bankfull channel and in-stream structures, as well as a more natural step-pool morphology using grade control structures in the steeper transitional areas. Shallow floodplain depressions and vernal pools were created in the floodplain to provide habitat diversity, nutrient cycling,

and improved treatment of overland flows. The existing drain-pipe under the dam was removed and a new culverted pipe crossing was installed at a lower elevation to allow for aquatic passage while blending with the natural valley topography.

3.1.4 R4 Preservation and Enhancement

R4 began immediately downstream from the new culverted crossing at R3. Preservation was proposed along much of this reach since the existing stream and wetland system is mostly stable with a mature riparian buffer due to minimal historic impacts. This approach will extend the wildlife corridor from the boundary of Lake Wendell throughout the entire riparian valley, while providing a hydrologic connection and critical habitat linkage within the catchment area. Enhancement Level II work was conducted along a short portion of this reach to address the bank erosion and lateral instability that occurred during Hurricane Matthew (October 10, 2016). Construction activities consisted of mechanized removal of the downed trees and resetting the remaining live root balls along the streambank, and re-grading the stream bank back to a stable dimension, installing erosion control matting, and supplemental riparian buffer planting and live stakes.

3.1.5 R5 Restoration and Enhancement

A Priority Level I/II Restoration approach was for the upstream portion of the reach to improve stream functions and water quality. The existing concrete pipe system was completely removed to allow for the complete daylighting and raising of the stream bed elevation to reconnect the stream with its active floodplain. The reach was restored using appropriate riffle-pool and step-pool morphology with limited meander geometry. In-stream structures, including log weirs and woody and stone riffles will be used to control grade, as well as dissipate flow energy, protect streambanks, and eliminate potential for future incision. Restored streambanks will be graded to stable side slopes and the floodplain will be reconnected to further promote stability and hydrological function. Work along the downstream portion of R5 involved Enhancement Level II practices to improve the current channel condition and aquatic function.

4 Performance Standards

The applied success criteria for the Project will follow necessary performance standards and monitoring protocols presented in final approved mitigation plan. Annual monitoring and semi-annual site visits will be conducted to assess the condition of the project throughout the monitoring period. Monitoring activities will be conducted for a period of seven years with the final duration dependent upon performance trends toward achieving project goals and objectives. Specific success criteria components and evaluation methods are described in the table below.

Functional Category (Level)	Project Goal / Parameter	Measurement Method	Performance Standard	Potential Functional Uplift
Hydrology (Level 1)	Improve Base Flow Duration and Overbank Flows (i.e. channel forming discharge)	Pressure transducer, regional curve, regression equations, catchment assessment	Maintain seasonal flow for a minimum of 30 consecutive days during normal annual rainfall.	Create a more natural and higher functioning headwater flow regime and provide aquatic passage.
Hydraulics (Level 2)	Reconnect Floodplain / Increase Floodprone Area Widths	Bank Height Ratio, Entrenchment Ratio, crest gage	Maintain average BHRs at 1.2 and ERs at 2.2 or greater and document out of bank and/or geomorphically significant flow events.	Provide temporary water storage and reduce erosive forces (shear stress) in channel during larger flow events.
Geomorphology (Level 3)	Improve Bedform Diversity	Pool to Pool spacing, riffle-pool sequence, pool max depth ratio, Longitudinal Profile	Increase riffle/pool percentage and pool-to-pool spacing ratios compared to reference reach conditions.	Provide a more natural stream morphology, energy dissipation and aquatic habitat/refugia.
	Increase Vertical and Lateral Stability	BEHI / NBS, Cross-sections and Longitudinal Profile Surveys, visual assessment	Decrease streambank erosion rates comparable to reference condition cross-section, pattern and vertical profile values.	Reduce sedimentation, excessive aggradation, and embeddedness to allow for interstitial flow habitat.
	Establish Riparian Buffer Vegetation	CVS Level I & II Protocol Tree Veg Plots (Strata Composition and Density), visual assessment	Within planted portions of the site, a minimum of 320 stems per acre must be present at year three; a minimum of 260 stems per acre must be present at year five; and a minimum of 210 stems per acre must be present at year seven.	Increase woody and herbaceous vegetation will provide channel stability and reduce streambank erosion, runoff rates and exotic species vegetation.
Physicochemical (Level 4)	Improve Water Quality	N/A	N/A	Removal of excess nutrients, FC bacteria, and organic pollutants will increase the hyporheic exchange and dissolved oxygen (DO) levels.
Biology (Level 5)	Improve Benthic Macroinvertebrate Communities and Aquatic Health	DWR Small Stream/ Qual v4 sampling, IBI (MY3, MY5, MY7)	N/A	Increase leaf litter and organic matter critical to provide in-stream cover/shade, wood recruitment, and carbon sourcing.

Note: Level 4 and 5 project parameters and monitoring activities will not be tied to performance standards nor required to demonstrate success for credit release.

4.1 Streams

4.1.1 Stream Hydrology

Two separate bankfull events must be documented within the seven-year monitoring period. These two bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years. In addition to the two bankfull flow events, two geomorphically significant flow events (Q_{gs}=0.66Q_2) must also be documented during the monitoring

period. There are no temporal requirements regarding the distribution of the geomorphically significant flows.

4.1.2 Stream Profiles, Vertical Stability, and Floodplain Access

Stream profiles, as a measure of vertical stability will be evaluated by looking at Bank Height Ratios (BHR). The BHR shall not exceed 1.2 along the restored project reaches. This standard only applies to the restored project reaches where BHRs were corrected through design and construction. In addition, observed bedforms should be consistent with those observed for channels of the design stream type(s).

4.1.3 Stream Horizontal Stability

Cross-sections will be used to evaluate horizontal stream stability. There should be little change expected in as-built restoration cross-sections. If measurable changes do occur, they should be evaluated to determine if the changes represent a movement toward a more unstable condition (e.g., downcutting, erosion) or a movement towards increased stability (e.g., settling, vegetation establishment, deposition along the streambanks, decrease in width/depth ratio). Cross-sections shall be classified using the Rosgen Stream Classification method and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

4.1.4 Streambed Material Condition and Stability

After construction, there should be minimal change in the particle size distribution of the streambed materials, over time, given the current watershed conditions and future sediment supply regime. Since the streams are predominantly sand-bed systems with minimal fine/coarse gravel, some coarsening is anticipated after restoration activities, however significant changes in particle size distribution are not expected. Streambed material condition is supplementary and is not part of success criteria.

4.1.5 Jurisdictional Stream Flow

The restored stream systems must be classified as at least intermittent, and therefore must exhibit base flow with at least 30 days of continuous flow during a year with normal rainfall conditions as described in the approved mitigation plan.

4.2 Vegetation

Vegetative restoration success for the project during the intermediate monitoring years will be based on the survival of at least 320, three-year-old trees per acre at the end of Year 3 of the monitoring period and at least 260, five-year-old, trees per acre at the end of Year 5 of the monitoring period. The final vegetative restoration success criteria will be achieving a density of not less than 210, seven-year-old stems per acre in Year 7 of monitoring. Planted vegetation (for projects in coastal plain and piedmont counties) must average seven feet in height at Year 5 of monitoring and 10 feet in height at Year 7 of monitoring. Volunteer species will be counted toward success if they are surviving for at least two years and if they are species found on the approved planting list. For all of the monitoring years (Year 1 through Year 7), the number of Red maple (*Acer rubrum*) stems cannot exceed 20 percent of the total stems in any of the vegetation monitoring plots.

5 Monitoring Year 2 Assessment and Results

Annual monitoring was conducted during MY2 in accordance with the monitoring plan as described in the approved mitigation plan to document the site conditions. All monitoring device locations are depicted on the CCPV (Figure 1). MY2 monitoring results are provided in the appendices. The Project meets the

MY2 success criteria for stream hydrology, stream horizontal and vertical stability, jurisdictional stream flow, and vegetation.

5.1 Stream Hydrology

Monitoring to document the occurrence of the bankfull events (overbank flows) and geomorphically significant flow events (Q_{gs}=0.66Q_2) within the monitoring period, along with floodplain access by flood flows, is being conducted using a crest gage installed near the downstream end of Reach R2 (Figure 1), to record the watermark associated with the highest flood stage between monitoring site visits. Photographs are also being used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits. At least two bankfull events occurred during MY2. These events were documented using the described crest gage and photography (Table 8). The documented occurrence of these two flow events and two events during MY1 satisfies the requirement of the occurrence of two bankfull events (overbank flows) in separate years.

5.2 Stream Horizontal & Vertical Stability

Visual assessment was utilized for assessment of MY2 horizontal and vertical stream stability. The visual assessments for each stream reach concluded that the MY2 stream channel pattern and longitudinal profiles, in-stream structure location/function, still closely match the profile design parameters and MY0/baseline conditions (Appendix D). The MY2 plan form geometry and dimensions fall within acceptable ranges of the design parameters for all restored reaches. Minor channel adjustments in riffle slopes, pool depths and pattern were observed based on natural sediment migration and stream bank vegetation establishment but did not present a stability concern or indicate a need for remedial action. Minor piping was noted at one of the instream structures, which is typical for smaller stream systems and is expected to resolve naturally as minor adjustments occur in the streambed at this location and is not a threat to overall channel stability.

5.3 Streambed Material Condition and Stability

A representative sediment sample was collected in R3 at a constructed riffle to assess streambed material condition and stability. The dominant substrate for the project was verified as coarse sand (Figure 2). The post-construction riffle substrate sampling indicated no significant change in streambed material condition or stability during MY2.

5.4 Jurisdictional Stream Flow Documentation

Jurisdictional stream flow documentation and monitoring of restored intermittent reaches is achieved by the installation of a flow gage (continuous-read pressure transducer) within the thalweg of the channel towards the middle portion of the Reach R5 (Figure 1). Additionally, to determine if rainfall amounts are normal for the given year, precipitation data was obtained from CLAY Central Crops Research Station in Johnston County, approximately nine miles southwest of the site. The monitoring gage documented that the stream exhibited surface flow for a minimum of 30 consecutive days throughout some portion of the year during a year with normal rainfall conditions (See Figure 4).

5.5 Vegetation

Vegetation monitoring for MY2 was conducted utilizing the seven vegetation monitoring Plots, with monitoring conducted in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2017). See Figure 1 in Appendix B for the

vegetation monitoring plot locations. Summary data and photographs of each Plot can be found in Appendix 3.

The MY2 vegetation monitoring was also conducted utilizing visual assessment throughout the easement. The results of the visual assessment did not indicate any negative changes to the existing vegetation community. One area of concern was observed along R1 buffer as shown on the CCPV. This area was utilized as a temporary staging area during construction and contains invasive vegetation (kudzu) along the right buffer. The area was treated twice during the 2019 year, once in August and once in September. Following the first treatment the percent cover of kudzu was reduced by 80 percent. This area will continue to be treated during MY3 monitoring and documented in the subsequent annual report. If needed, supplemental planting in the kudzu treatment area will be documented in the MY3 report.

5.6 Wetlands

Wetland mitigation credits are not contracted or proposed for this project. One groundwater monitoring well (pressure transducer) was installed during the baseline monitoring within an existing wetland area along Reach R4. The well was installed as a reference to document groundwater levels within the preservation area (Figure 4). No performance standards for wetland hydrology success was proposed in the Mitigation Plan and therefore wetland mitigation monitoring is not included for this project.

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Appendices

Appendix A – Background Tables and Figures

Table 1. Mitigation Assets and Components
Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)

Project Component (reach ID, etc.)[1]	Wetland Position and HydroType[2]	Existing Footage or Acreage	Stationing	Mitigation Plan Footage or Acreage	As-Built Footage or Acreage	Restoration Level	Approach Priority Level	Mitigation Ratio (X:1)	Mitigation Credits*	Notes/Comments
R1		839	10+00 -18+39	806	839	R	PI/PII	1	806	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement
R2		995	18+39 - 28+00	995	992	R	PI	1	995	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R3		1208	28+00 - 40+77	1208	1268	R	PI	1	1208	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R4		711	40+77 - 49+11	711	702	P	-	10	71	Livestock Exclusion, Invasive Control, Permanent Conservation Easement.
R4 (middle)		111	46+26 - 47+37	111	111	EII	EII	2.5	44	Bank Stabilization, Floodplain Debris Clearing, Invasive Control, Permanent Conservation Easement.
R5 (upper)		210	10+00 - 12+10	210	210	R	PI/PII	1	210	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R5 (lower)		144	12+10 - 13+58	144	147	EII	EII	2.5	58	Enhancement, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.

Length and Area Summations by Mitigation Category

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)
		Riverine	Non-Riverine	
Restoration	3219			
Enhancement				
Enhancement I				
Enhancement II	255			
Creation				
Preservation	711			
High Quality Pres				

Overall Assets Summary

Asset Category	Overall Credits*
Stream	**3,392**
RP Wetland	
NR Wetland	

* Mitigation Credits are from the final approved mitigation plan, as verified by the as-built survey

Table 2. Project Activity and Reporting History
Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)

Elapsed Time Since grading complete: **1 yrs 8 months**
Elapsed Time Since planting complete: **1 yrs 8 months**
Number of reporting Years[0]: **2**

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Project Contract Execution	N/A	3/18/2016
Final Mitigation Plan Submittal	N/A	8/25/2017
Section 404 General (Regional and Nationwide) Permit Verfication	N/A	10/5/2017
Begin Construction	N/A	11/13/2017
Mitigation Site Earthwork Completed	N/A	3/13/2018
Mitigation Site Planting Completed	N/A	3/30/2018
Installation of Monitoring Devices Completed	N/A	4/19/2018
Installation of Survey Monumentation and Boundary Marking	N/A	6/7/2018
As-built/Baseline (Year 0) Monitoring Report Submittal	6/23/2018	12/3/2018
Year 1 Monitoring Report Submittal	11/24/2018	12/4/2019
Year 2 MonitoringReport Submittal	10/29/2019	12/31/2019
Year 3 Monitoring Report Submittal	N/A	N/A
Year 4 Monitoring Report Submittal	N/A	N/A
Year 5 Monitoring Report Submittal	N/A	N/A
Year 6 Monitoring Report Submittal	N/A	N/A
Year 7 Monitoring Report Submittal	N/A	N/A

Bolded items are examples of those items that are not standard, but may come up and should be included
Non-bolded items represent events that are standard components over the course of a typical project, but the one listed may not be all inclusive.
The above are obviously **not** the extent of potential relevant project activities, but are just provided as example as part of this exhibit.

Table 3. Project Contacts Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)	
Mitigation Provider	Water & Land Solutions, LLC 7721 Six Forks Road, Suite 130 Raleigh, NC 27615
Primary Project POC	Catherine Manner Phone: 571-643-3165
Construction Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Survey Contractor (Existing Condition Surveys)	WithersRavenel 115 MacKenan Drive, Cary, NC 27511
Primary Project POC	Marshall Wight, PLS Phone: 919-469-3340
Survey Contractor (Conservation Easement, Construction and As-Builts Surveys)	True Line Surveying, PC 205 West Main Street, Clayton, NC 27520
Primary Project POC	Curk T. Lane, PLS 919-359-0427
Planting Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Seeding Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Seed Mix Sources	Green Resource 5204 Highgreen Ct., Colfax, NC 27235 Rodney Montgomery Phone: 336-215-3458
Nursery Stock Suppliers	Foggy Mountain Nursery (Live Stakes) 797 Helton Creek Rd, Lansing, NC 28643 Glenn Sullivan Phone: 336-977-2958 Dykes & Son Nursery (Bare Root Stock) 825 Maude Etter Rd, Mcminnville, Tn 37110 Jeff Dykes Phone: 931-668-8833
Monitoring Performers	Water & Land Solutions, LLC 7721 Six Forks Road, Suite 130 Raleigh, NC 27615
Stream Monitoring POC	Emily Dunnigan Phone: 269-908-6306
Vegetation Monitoring POC	Emily Dunnigan Phone: 269-908-6306

Table 4. Project Information and Attributes					
Project Name	Lake Wendell Mitigation Project				
County	Johnston				
Project Area (acres)	11.97				
Project Coordinates (latitude and longitude)	35.7373910 N, -78.3538050 W				
Planted Acreage (Acres of Woody Stems Planted)	8.9				
Project Watershed Summary Information					
Physiographic Province	Piedmont				
River Basin	Neuse				
USGS Hydrologic Unit 8-digit	03020201				
DWR Sub-basin	30406				
Project Drainage Area (Acres and Square Miles)	102 acres, 0.16 sq mi				
Project Drainage Area Percentage of Impervious Area	<1%				
CGIA Land Use Classification	2.01.03, 413, 4.99 (61% pasture, 31% mixed forest, 1% open water)				
Reach Summary Information					
Parameters	**Reach 1**	**Reach 2**	**Reach 3**	**Reach 4**	**Reach 5**
Length of reach (linear feet)	850	952	1121	955	354
Valley confinement (Confined, moderately confined, unconfined)	unconfined	unconfined	unconfined	unconfined	unconfined
Drainage area (Acres and Square Miles)	33 acres, 0.05 sq mi	64 acres, 0.1 sq mi	83 acres, 0.13 sq mi	102 acres, 0.16 sq mi	10 acres, 0.02 sq mi
Perennial, Intermittent, Ephemeral	Perennial	Perennial	Perennial	Perennial	Intermittent
NCDWR Water Quality Classification	C; NSW	C; NSW	C;NSW	C; NSW	C; NSW
Stream Classification (existing)	G5c	E5/F5	N/A pond	E5	G5
Stream Classification (proposed)	C5b	C5	C5	E5	C5b
Evolutionary trend (Simon)	II	II (upper), III/IV (lower	N/A pond	I	II (lower), III (upper)
FEMA classification	N/A	N/A	N/A	Zone AE	N/A
Wetland Summary Information					
Parameters	**Wetland 1**	**Wetland 2**	**Wetland 3**		
Size of Wetland (acres)	N/A	N/A	N/A		
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)					
Mapped Soil Series					
Drainage class					
Soil Hydric Status					
Source of Hydrology					
Restoration or enhancement method (hydrologic, vegetative etc.)					
Regulatory Considerations					
Parameters	**Applicable?**	**Resolved?**	**Supporting Docs?**		
Water of the United States - Section 404	Yes	Yes	Categorical Exclusion		
Water of the United States - Section 401	Yes	Yes	Categorical Exclusion		
Endangered Species Act	No	Yes	Categorical Exclusion		
Historic Preservation Act	No	N/A	Categorical Exclusion		
Coastal Zone Management Act (CZMA or CAMA)	No	N/A	Categorical Exclusion		
FEMA Floodplain Compliance	Yes	Yes	Categorical Exclusion		
Essential Fisheries Habitat	No	N/A	Categorical Exclusion		

Appendix B – Visual Assessment Data

Legend

- Conservation Easement
- Fence Line
- Crest Gage
- Flow Gage
- Wetland Gage
- Stream Reference Site Location
- Cross Section Pins
- Cross Sections
- Photo Points
- CVS Plot Origin

CVS Plots

- Success Criteria Met
- Water Quality Features
- Top of Streambank
- Culvert Pipes
- Pre-Construction Wetlands (1.16 acres)
- Stream Structural Issue
- Kudzu Area (0.13 acres)

Stream Mitigation Type

- Restoration
- Enhancement II
- Preservation

Access point:
35.73764°
78.34884°

Wendell Rd

R1 R2 R3 R4 R5

Culvert
Culvert
Minor Piping around Log Vane
Wetland Reference Gage
Crest Gage
Flow Gage

930/526 404/404 526/404 688/526 728/526 485/404 556/323

XS-1 XS-2 XS-3 XS-4 XS-5 XS-6 XS-7 XS-8 XS-115

Feet
0 230 460

N

Aerial: Google Earth Winter 2019

WATER & LAND™ SOLUTIONS

Lake Wendell Mitigation Project
Johnston County, North Carolina

NCDMS Contract No. 6826
NCDMS Project No. 97081
December 2019
MY2

Current Conditions
Plan View
Monitoring Year 2

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
1

Table 5. **Visual Stream Morphology Stability Assessment**
Project **Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)**
Reach ID **R1, R2, R3, R4, R5**
Assessed Length **4221**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion					100%	0	0	100%
*	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.					100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse					100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	68	68			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	41	41			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	24	25			96%			
	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)	16	16			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	16	16			100%			

Table 5a.	Vegetation Condition Assessment					
Project	Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)					
Planted Acreage[1]	8.9					
Vegetation Category	**Definitions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Planted Acreage**
1. Bare Areas	Very limited cover of both woody and herbaceous material.	1 acre	Solid light blue	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres	Pattern and Color	0	0.00	0.0%
			Total	0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	Pattern and Color	0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2]	12					
Vegetation Category	**Definitions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Easement Acreage**
4. Invasive Areas of Concern[4]	Areas or points (if too small to render as polygons at map scale).	1000 SF	orange hatched	1	0.13	1.1%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none	yellow hatched	0	0.00	0.0%

R1, facing upstream, Sta 11+50, June 11, 2018 (MY-00)

R1, facing upstream, Sta 11+50, October 14, 2019 (MY-02)

R1, facing downstream, Sta 11+50, June 11, 2018 (MY-00)

R1, facing downstream, Sta 11+50, October 14, 2019 (MY-02)

R1, facing upstream, Sta 13+50, April 27, 2018 (MY-00)

R1, facing upstream, Sta 13+50, October 14, 2019 (MY-02)

R1, facing downstream, Sta 13+50, April 27, 2018 (MY-00)

R1, facing downstream, Sta 13+50, October 14, 2019 (MY-02)

R1, facing downstream, Sta 17+50, April 27, 2018 (MY-00)

R1, facing downstream, Sta 17+50, October 14, 2019 (MY-02)

R1, facing upstream, Sta 17+50, April 27, 2018 (MY-00)

R1, facing upstream, Sta 17+50, October 14, 2019 (MY-02)

R2, facing downstream, Sta 18+50, April 30, 2018 (MY-00)

R2, facing downstream, Sta 18+50, October 14, 2019 (MY-02)

R2, facing upstream, Sta 26+00, April 27, 2018 (MY-00)

R2, facing upstream, Sta 26+00, October 14, 2019 (MY-02)

R2, facing downstream, Sta 27+50, April 27, 2018 (MY-00)

R2, facing downstream, Sta 28+00, October 14, 2019 (MY-02)

R2, facing upstream, Sta 28+25, April 27, 2018 (MY-00)

R2, facing upstream, Sta 28+00, October 14, 2019 (MY-02)

R3, facing downstream, Sta 32+00, April 27, 2018 (MY-00)

R3, facing downstream, Sta 28+00, October 14, 2019 (MY-02)

R3, facing downstream, Sta 37+75, April 27, 2018 (MY-00)

R2, facing downstream, Sta 37+75, October 14, 2019 (MY-02)

R3, facing upstream, Sta 39+50, March 20, 2018 (MY-00)

R3, facing upstream, Sta 39+50, October 14, 2019 (MY-02)

R4, facing downstream, Sta 40+00, March 20, 2018 (MY-00)

R4, facing downstream, Sta 40+00, October 14, 2019 (MY-02)

R4, facing downstream, Sta 44+00, August 21, 2015 (MY-00)

R4, facing downstream, Sta 44+00, October 14, 2019 (MY-02)

R5, facing downstream, Sta 10+00, April 27, 2018 (MY-00)

R5, facing downstream, Sta 10+00, October 14, 2019 (MY-02)

R5, facing upstream, old flow gage, Sta 13+50, Apr 27, 2018 (MY-00)

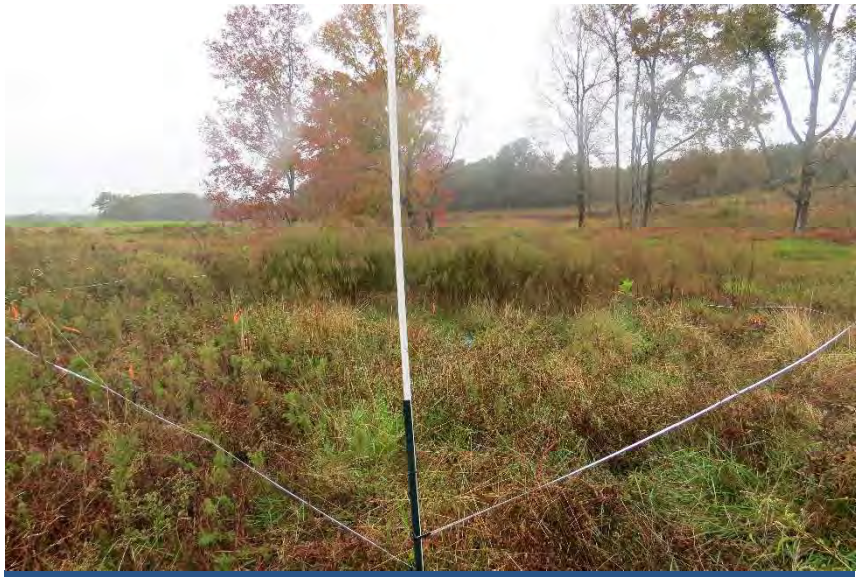
R5, facing upstream, Sta 13+50, October 14, 2019 (MY-02)

Veg Plot 1, November 5, 2018 (MY-01)

Veg Plot 1, October 15, 2019 (MY-02)

Veg Plot 2, April 27, 2018 (MY-00)

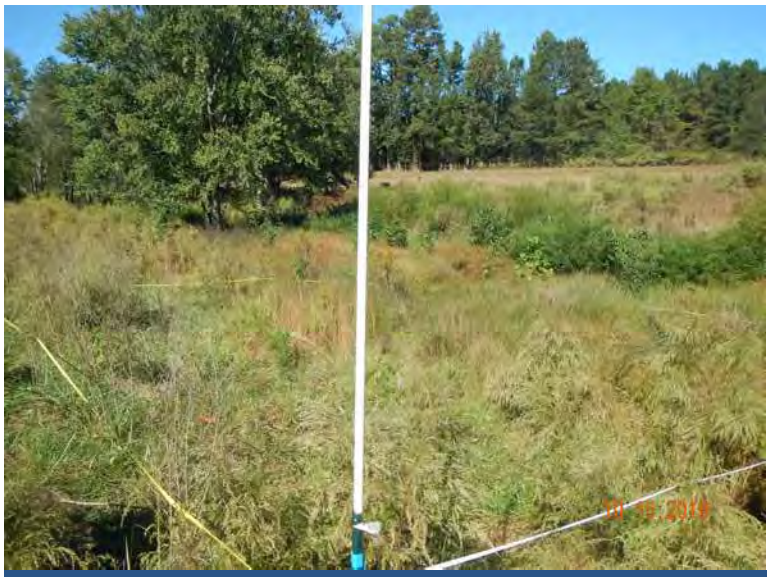
Veg Plot 2, October 15, 2019 (MY-02)



Veg Plot 3, November 5, 2018 (MY-01)

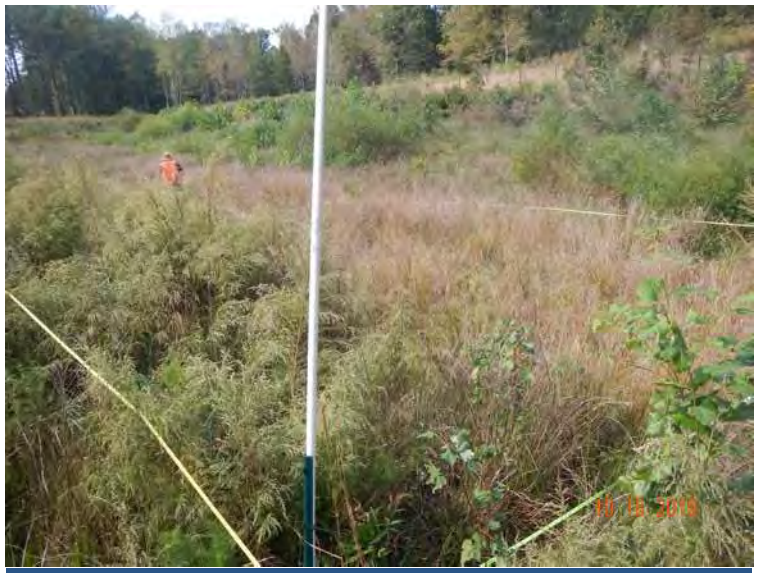
Veg Plot 3, October 15, 2019 (MY-02)

Veg Plot 4, April 13, 2018 (MY-00)



Veg Plot 4, October 15, 2019 (MY-02)

Veg Plot 5, April 13, 2018 (MY-00)



Veg Plot 5, October 15, 2019 (MY-02)

Veg Plot 6, April 13, 2018 (MY-00)

Veg Plot 6, October 15, 2019 (MY-02)

Veg Plot 7 April 13, 2018 (MY-00)

Veg Plot 7 October 15, 2019 (MY-02)

Appendix C – Vegetation Plot Data

EEP Project Code 1. Project Name: Lake Wendell

Table 6

			Current Plot Data (MY2 2019)																				Annual Means								
			001-01-0001			001-01-0002			001-01-0003			001-01-0004			001-01-0005			001-01-0006			001-01-0007			MY2 (2019)			MY1 (2018)			MY0 (2018)		
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 negundo		Tree						1																	1						
Acer rubrum		Tree			2			1			2	2	2	3			2	2	2	4	2	2	2	6	6	16	6	6	62	7	7	7
Alnus serrulata	Tag Alder, Smooth Ald	Shrub Tree							1	1	1							1	1	1	1	1	1	3	3	3	2	2	2	3	3	3
Betula nigra	River Birch, Red Birch	Tree	1	1	1	4	4	4	3	3	3	2	2	2				1	1	1				11	11	11	9	9	9	12	12	12
Carpinus caroliniana		Shrub Tree	1	1	1										2	2	2							3	3	3	4	4	4	5	5	5
Cornus amomum	Silky Dogwood	Shrub Tree	1	1	1	1	1	1																2	2	2	2	2	2	3	3	3
Diospyros virginiana	American Persimmon,	Tree										2	2	2										2	2	2	2	2	2	2	2	2
Fraxinus pennsylvanica	Green Ash, Red Ash	Tree	1	1	1	1	1	1	1	1	1				1	1	1							4	4	4	4	4	4	4	4	4
Ilex verticillata	Winterberry	Shrub Tree																												1	1	1
Lindera benzoin	Northern Spicebush	Shrub Tree																												8	8	8
Liquidambar styraciflua	Sweet Gum, Red Gum	Tree			20						15						5									40			9			
Liriodendron tulipifera		Tree	1	1	1				2	2	2				2	2	2	1	1	1	2	2	2	8	8	8	13	13	13	27	27	27
Magnolia virginiana		Shrub Tree				1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	1	1	1	7	7	7	8	8	8	8	8	8
Platanus occidentalis	Sycamore, Plane-tree	Tree	1	1	1	1	1	1	1	1	1				4	4	4	1	1	1	3	3	3	11	11	11	12	12	12	18	18	18
Prunus serotina		Shrub Tree												2												2						
Quercus michauxii	Basket Oak, Swamp Ch	Tree	1	1	1							4	4	4	1	1	1	1	1	1				7	7	7	7	7	7	7	7	7
Quercus nigra	Water Oak, Paddle Oak	Tree	1	1	1	2	2	2				1	1	1										4	4	4	4	4	4	9	9	9
Quercus phellos	Willow Oak	Tree							4	4	4				2	2	2	2	2	2	1	1	1	9	9	9	10	10	10	11	11	11
Rosa palustris	Swamp Rose	Shrub Vine																											1			
Salix nigra	Black Willow	Tree																											1			
		Stem count	8	8	30	10	10	12	13	13	30	13	13	16	13	13	20	10	10	12	10	10	10	77	77	130	83	83	150	125	125	125
		size (ares)	1			1			1			1			1			1			1			7			7			7		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.17			0.17			0.17		
		Species count	8	8	10	6	6	8	7	7	9	6	6	7	7	7	9	8	8	8	6	6	6	13	13	16	13	13	16	15	15	15
		Stems per ACRE	323.7	323.7	1214	404.7	404.7	485.6	526.1	526.1	1214	526.1	526.1	647.5	526.1	526.1	809.4	404.7	404.7	485.6	404.7	404.7	404.7	445.2	445.2	751.6	479.8	479.8	867.2	722.7	722.7	722.7

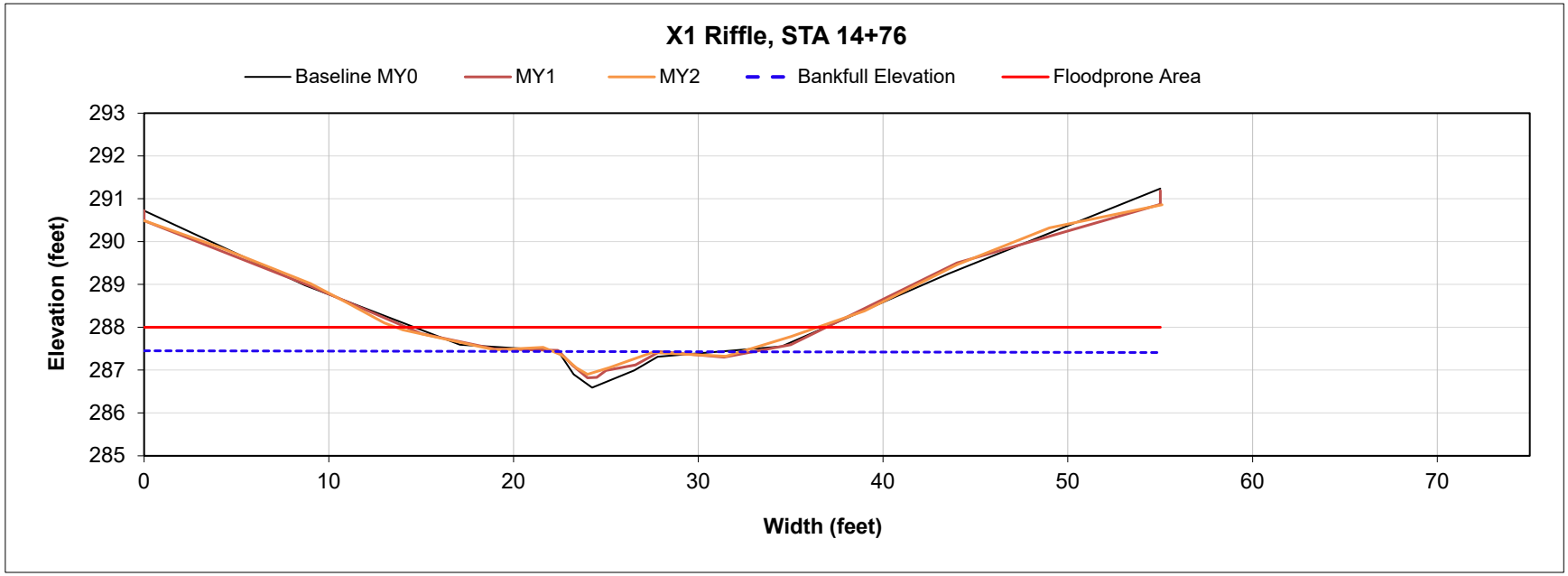
Volunteers were only counted if they were at least 18" tall.

Appendix D – Stream Measurement and Geomorphology Data

Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R1
Cross Section ID	X1
Field Crew	K. Obermiller, E. Dunnigan

Dimension Data Summary: MY2 2019	
Bankfull Elevation (ft)	287.5
Low Bank Height Elevation (ft)	287.4
Bankfull Max Depth (ft)	0.6
Low Bank Height (ft)	0.5
Bank Height Ratio	<1.0
Bankfull X-section Area (ft²)	2.0
% Change Bank Height Ratio	10.0%

Looking Downstream



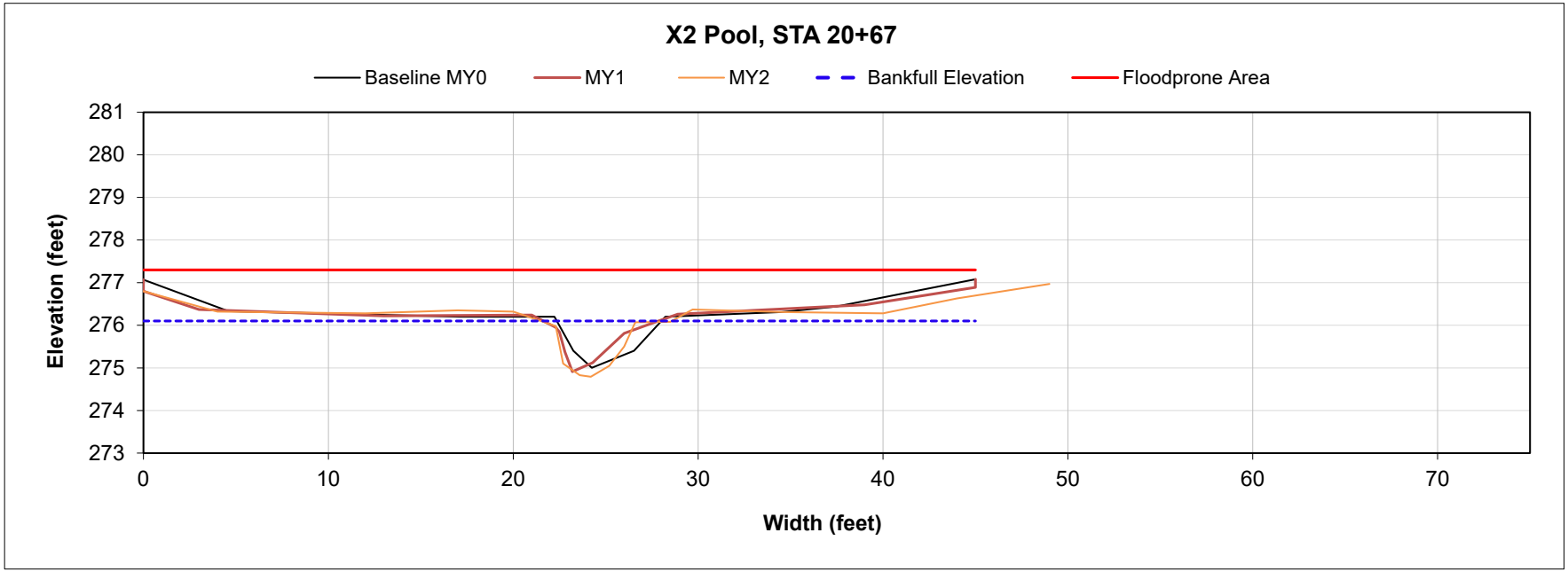
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height.*

*** MY1 used in place of as-built (MY0) due to issues with the as-built survey standards identified during MY1.*

Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R2
Cross Section ID	X2
Field Crew	K. Obermiller, E. Dunnigan

Dimension Data Summary: MY2 2019	
Bankfull Elevation (ft)	276.1
Low Bank Height Elevation (ft)	276.1
Bankfull Max Depth (ft)	1.3
Low Bank Height (ft)	1.3
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	4.1
% Change Bank Height Ratio	0.0%

Looking Downstream



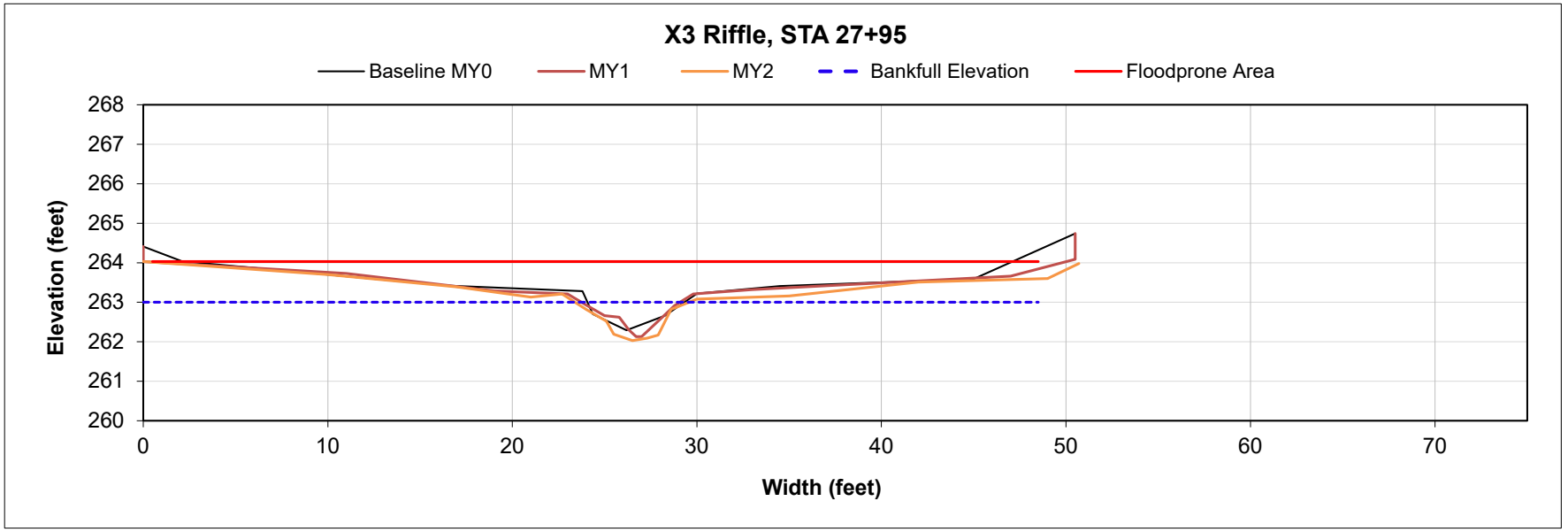
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height.*

*** MY1 used in place of as-built (MY0) due to issues with the as-built survey standards identified during MY1.*

Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R2
Cross Section ID	X3
Field Crew	K. Obermiller, E. Dunnigan

Dimension Data Summary: MY2 2019	
Bankfull Elevation (ft)	263.0
Low Bank Height Elevation (ft)	263.1
Bankfull Max Depth (ft)	1.0
Low Bank Height (ft)	1.1
Bank Height Ratio	1.1
Bankfull X-section Area (ft²)	4.1
% Change Bank Height Ratio	10.0%

Looking Downstream



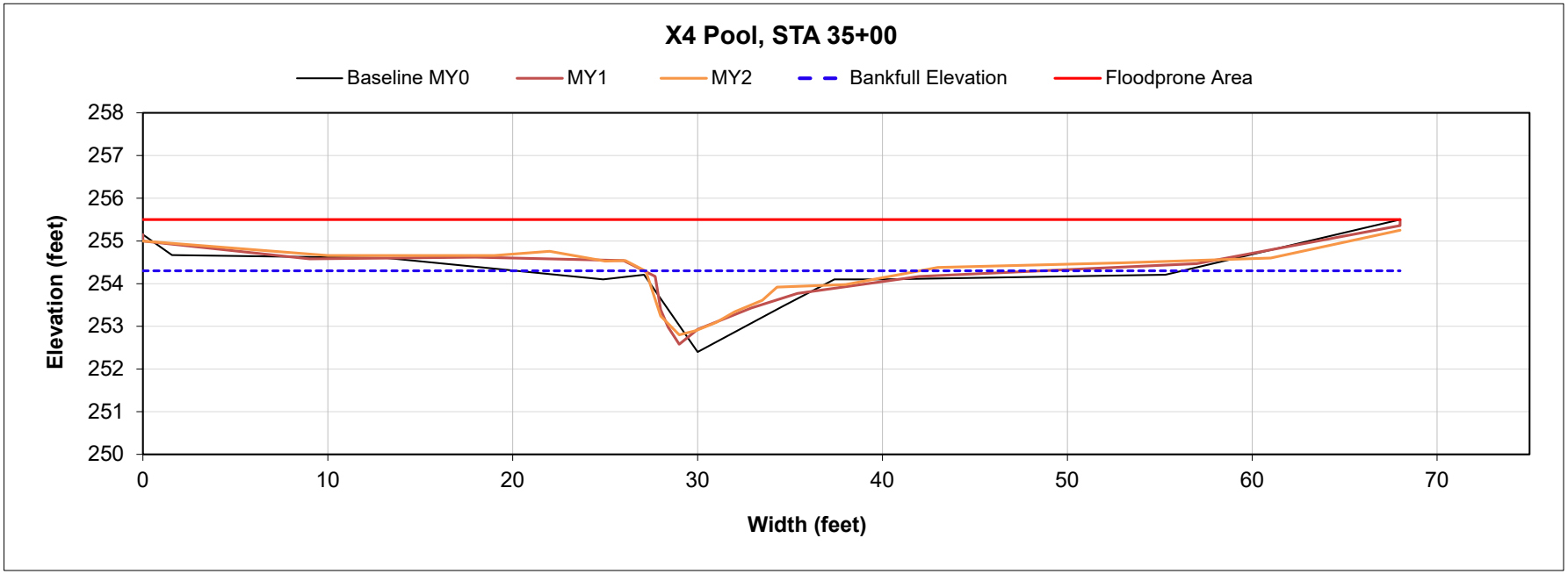
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height.*

*** MY1 used in place of as-built (MY0) due to issues with the as-built survey standards identified during MY1.*

Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R3
Cross Section ID	X4
Field Crew	K. Obermiller, E. Dunnigan

Dimension Data Summary: MY2 2019	
Bankfull Elevation (ft)	254.3
Low Bank Height Elevation (ft)	254.4
Bankfull Max Depth (ft)	1.5
Low Bank Height (ft)	1.6
Bank Height Ratio	1.1
Bankfull X-section Area (ft²)	8.5
% Change Bank Height Ratio	10.0%

Looking Downstream

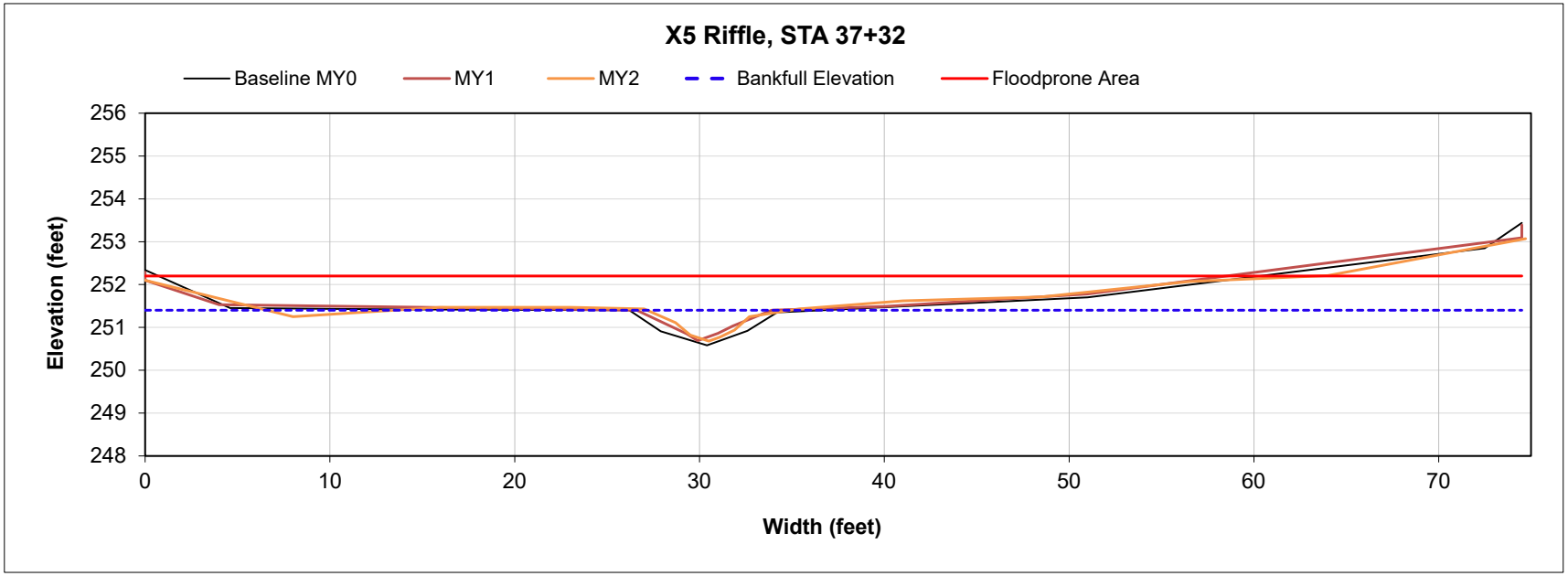


** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height.*
*** MY1 used in place of as-built (MY0) due to issues with the as-built survey standards identified during MY1.*

Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R3
Cross Section ID	X5
Field Crew	K. Obermiller, E. Dunnigan

Dimension Data Summary: MY2 2019	
Bankfull Elevation (ft)	251.4
Low Bank Height Elevation (ft)	251.4
Bankfull Max Depth (ft)	0.8
Low Bank Height (ft)	0.8
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	2.8
% Change Bank Height Ratio	0.0%

Looking Downstream



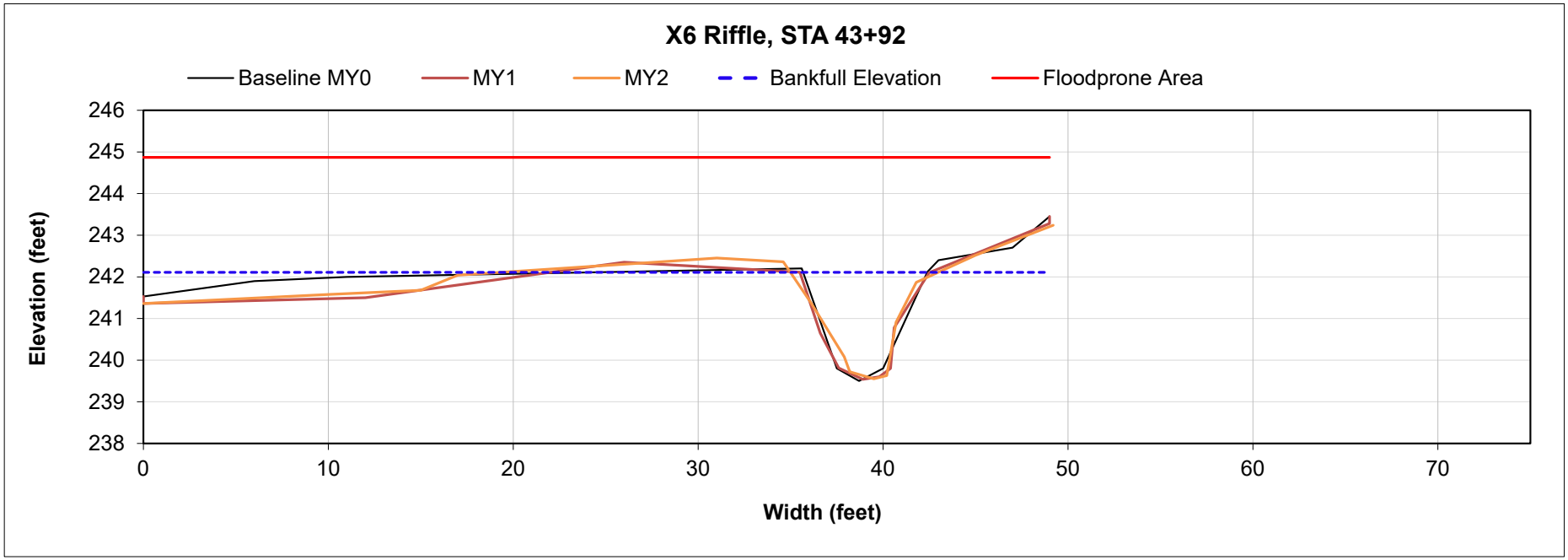
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height.*

*** MY1 used in place of as-built (MY0) due to issues with the as-built survey standards identified during MY1.*

Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R4 (Preservation)
Cross Section ID	X6
Field Crew	K. Obermiller, E. Dunnigan

Dimension Data Summary: MY2 2019	
Bankfull Elevation (ft)	242.2
Low Bank Height Elevation (ft)	242.9
Bankfull Max Depth (ft)	2.7
Low Bank Height (ft)	3.4
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	11.2
% Change Bank Height Ratio	0.0%

Looking Downstream



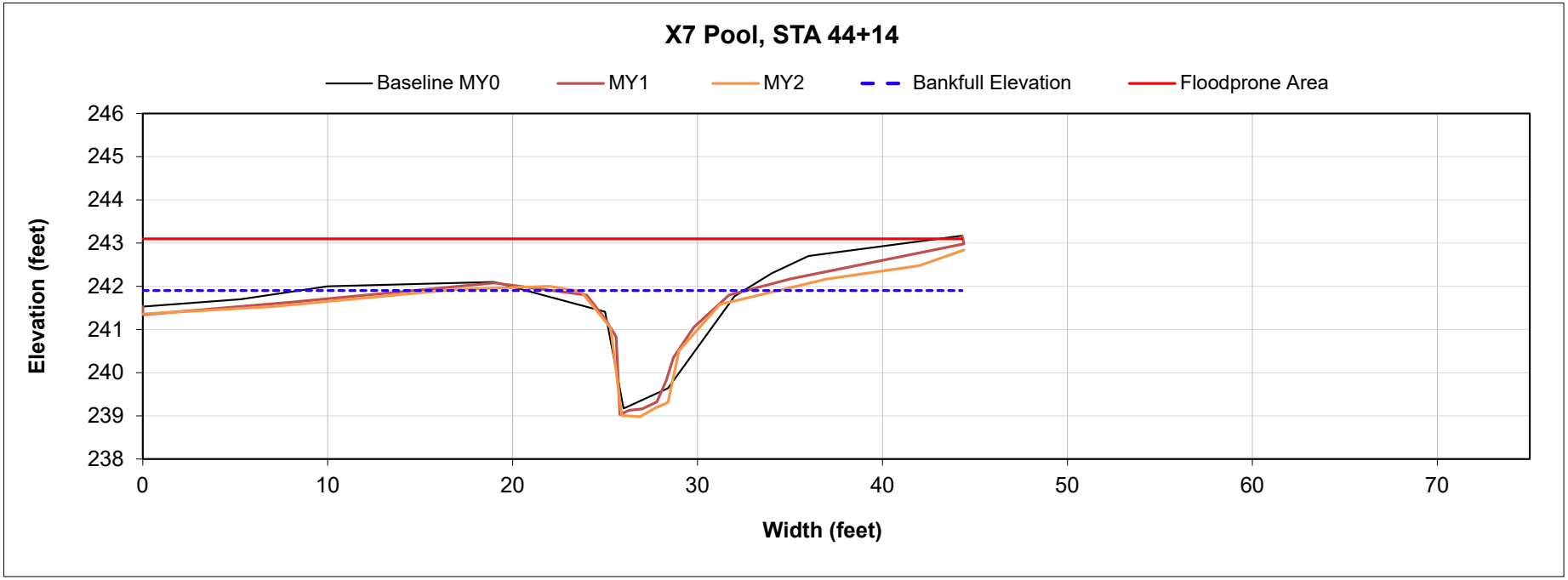
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height.*

*** MY1 used in place of as-built (MY0) due to issues with the as-built survey standards identified during MY1.*

Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R4 (Preservation)
Cross Section ID	X7
Field Crew	K. Obermiller, E. Dunnigan

Dimension Data Summary: MY2 2019	
Bankfull Elevation (ft)	241.9
Low Bank Height Elevation (ft)	241.9
Bankfull Max Depth (ft)	2.9
Low Bank Height (ft)	2.9
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	12.3
% Change Bank Height Ratio	0.0%

Looking Downstream



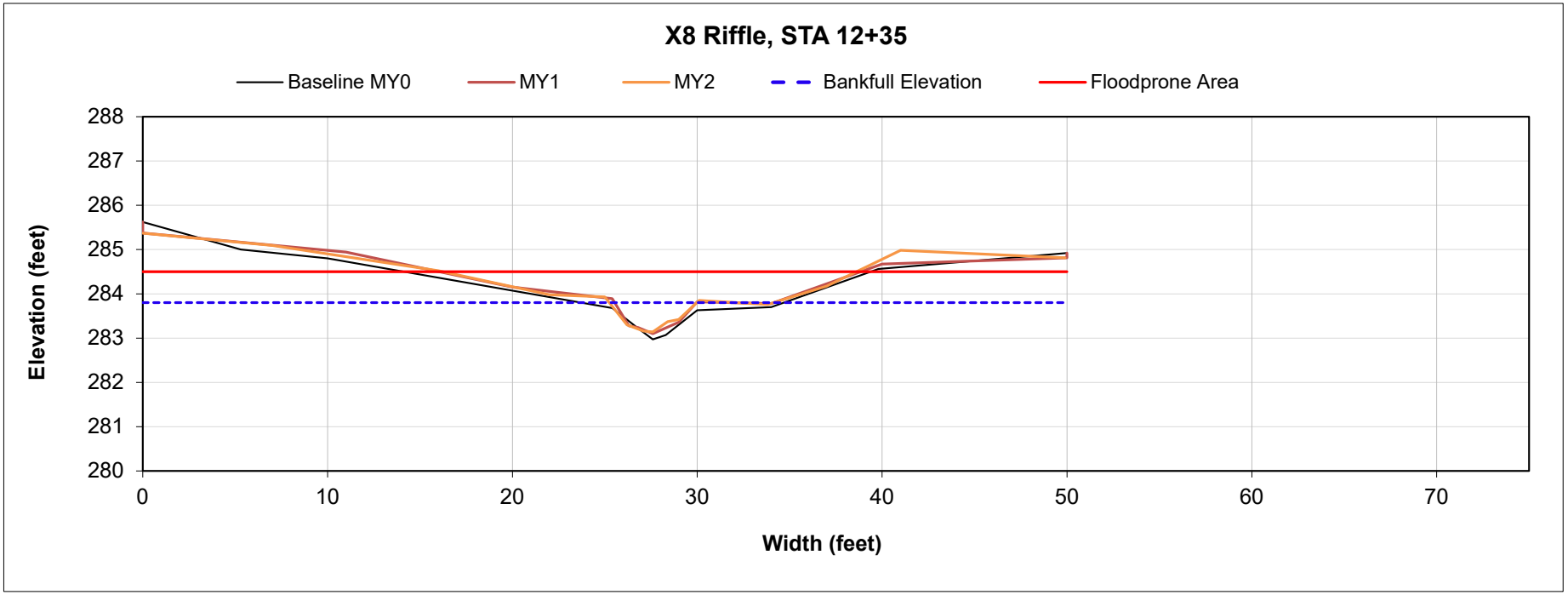
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height.*

*** MY1 used in place of as-built (MY0) due to issues with the as-built survey standards identified during MY1.*

Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R5
Cross Section ID	X8
Field Crew	K. Obermiller, E. Dunnigan

Dimension Data Summary: MY2 2019	
Bankfull Elevation (ft)	283.9
Low Bank Height Elevation (ft)	283.9
Bankfull Max Depth (ft)	0.7
Low Bank Height (ft)	0.7
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	2.1
% Change Bank Height Ratio	0.0%

Looking Downstream



** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height.*
*** MY1 used in place of as-built (MY0) due to issues with the as-built survey standards identified during MY1.*

Lake Wendell
Pebble Count

Date Collected: 9/21/2018 10/18/2019

MATERIAL	PARTICLE	SIZE (mm)	MY 1 Total #	MY2 Total #	MY3	MY4	MY5	MY6	MY7
SILT/CLAY	Silt / Clay	< .063	6	10					
SAND	Very Fine	.063 - .125	12	4					
	Fine	.125 - .25	9	3					
	Medium	.25 - .50	13	5					
	Coarse	.50 - 1.0	18	4					
	Very Coarse	1.0 - 2.0	17	12					
GRAVEL	Very Fine	2.0 - 2.8	11	1					
	Very Fine	2.8 - 4.0		1					
	Fine	4.0 - 5.6	4	2					
	Fine	5.6 - 8.0	4	4					
	Medium	8.0 - 11.0	2	5					
	Medium	11.0 - 16.0	1	11					
	Coarse	16 - 22.6	1	6					
	Coarse	22.6 - 32	1	8					
	Very Coarse	32 - 45		10					
	Very Coarse	45 - 64	1	5					
COBBLE	Small	64 - 90		5					
	Small	90 - 128		3					
	Large	128 - 180		1					
	Large	180 - 256							
BOULDER	Small	256 - 362							
	Small	362 - 512							
	Medium	512 - 1024							
	Large-Very Large	1024 - 2048							
BEDROCK	Bedrock	> 2048							
		Total	100	100					

Cumulative	D16	0.11	0.2					
	D35	0.38	1.7					
	D50	0.73	12					
	D65	1.3	22					
	D84	3.5	41					
	D95	9.4	83					

MY2

Riffle			Pool	
Channel materials			Channel materials	
D16 =	0.64		D16 =	0.062
D35 =	10		D35 =	0.55
D50 =	21		D50 =	1.4
D84 =	57		D84 =	19
D95 =	97		D95 =	26

Weighted pebble count by bed features Lake Wendell Mitigation Project MY2

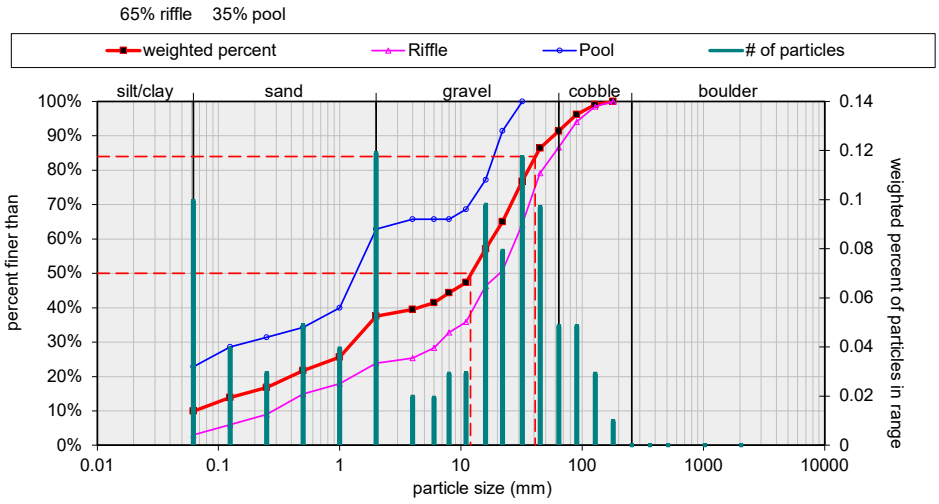


Table 7a. Baseline Stream Data Summary Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)								
Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R1								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	5.0	7.0	4.5	8.3	5.9	5.9	6.0	
Floodprone Width (ft)	6.1	18.7	10.0	20.0	14.0	30.0	25.3	
Bankfull Mean Depth (ft)	0.5	0.7	0.8	1.6	0.5	0.5	0.5	
Bankfull Max Depth (ft)	0.8	1.5	0.9	1.3	0.6	0.6	0.7	
Bankfull Cross Sectional Area (ft^2)	2.5	2.8	3.0	5.0	2.7	2.7	2.7	
Width/Depth Ratio	5.3	17.7	6.2	14.2	13.0	13.0	12.3	
Entrenchment Ratio	1.2	9.9	7.1	8.4	2.4	5.1	4.2	
Bank Height Ratio	1.1	2.3	0.9	1.1	1.0	1.0	1.0	
Profile								
Riffle Length (ft)	6.2	38.2	9.5	22.7	10.0	30.0	11.3	31.2
Riffle Slope (ft/ft)	0.016	0.037	0.009	0.015	0.020	0.035	0.017	0.036
Pool Length (ft)	4.1	7.9	6.1	8.7	7.0	10.0	5.5	12.5
Pool Max Depth (ft)	1.1	2.3	1.8	2.4	1.1	1.6	1.2	1.7
Pool Spacing (ft)	26.4	83.9	14.4	22.3	11.8	35.5	7.7	33.3
Pattern								
Channel Beltwidth (ft)	11.0	32.0	23.4	29.0	30.0	45.0	25.0	51.0
Radius of Curvature (ft)	8.0	50.0	11.2	17.5	15.0	25.0	11.0	36.0
Rc:Bankfull Width (ft/ft)	1.6	10.0	1.6	2.5	2.0	3.0	2.1	4.2
Meander Wavelength (ft)	20.0	100.0	43.4	65.1	30.0	44.8	23.0	56.0
Meander Width Ratio	2.2	6.4	3.9	4.5	5.1	7.6	4.1	7.4
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	---		---		0.67		---	
Max part size (mm) mobilized at bankfull	---		---		2.00		---	
Stream Power ($W/m^{2)}$	---		---		42.00		---	
Additional Reach Parameters								
Rosgen Classification	G5c		E5/C5		B5c		B5c	
Bankfull Velocity (fps)	3.7		4.5		4.0		4.0	
Bankfull Discharge (cfs)	10.0		---		10.0		10.0	
Sinuosity	1.05		1.1 - 1.3		1.10		1.10	
Water Surface Slope (Channel) (ft/ft)	0.025		0.020		0.025		0.026	
Bankfull Slope (ft/ft)	0.027		0.020		0.025		0.027	

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R2								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	5.9	9.5	4.5	8.3	6.8	6.8	6.1	
Floodprone Width (ft)	13.7	14.1	10.0	20.0	15.0	30.0	46.0	
Bankfull Mean Depth (ft)	0.6	0.7	0.8	1.6	0.5	0.5	0.6	
Bankfull Max Depth (ft)	0.9	1.0	0.9	1.3	0.7	0.7	0.9	
Bankfull Cross Sectional Area (ft^2)	4.2	5.9	3.0	5.0	3.6	3.6	3.5	
Width/Depth Ratio	8.2	15.2	6.2	14.2	13.0	13.0	10.8	
Entrenchment Ratio	1.4	2.2	7.1	8.4	2.2	4.4	7.5	
Bank Height Ratio	1.8	1.9	0.9	1.1	1.0	1.0	1.0	
Profile								
Riffle Length (ft)	5.9	27.7	9.5	22.7	10.0	30.0	9.9	33.3
Riffle Slope (ft/ft)	0.015	0.029	0.009	0.015	0.015	0.020	0.016	0.033
Pool Length (ft)	3.9	7.8	6.1	8.7	7.9	9.8	5.4	13.6
Pool Max Depth (ft)	2.0	3.8	1.8	2.4	1.1	1.6	1.2	1.9
Pool Spacing (ft)	17.0	51.0	14.4	22.3	22.0	48.0	13.0	37.1
Pattern								
Channel Beltwidth (ft)	13.0	37.0	23.4	29.0	30.0	45.0	25.0	47.0
Radius of Curvature (ft)	7.0	29.0	11.2	17.5	15.0	25.0	9.8	30.3
Rc:Bankfull Width (ft/ft)	1.2	4.9	1.6	2.5	2.0	3.0	2.5	4.2
Meander Wavelength (ft)	42.0	121.0	43.4	65.1	30.0	44.8	29.0	17.0
Meander Width Ratio	2.3	6.3	3.9	4.5	5.1	7.6	4.4	7.9
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.51		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		29.10		-	
Additional Reach Parameters								
Rosgen Classification	E5/F5		E5/C5		C5		C5	
Bankfull Velocity (fps)	4.1		4.5		4.7		4.0	
Bankfull Discharge (cfs)	16.9		-		16.9		16.9	
Sinuosity	1.14		1.1 - 1.3		1.17		1.15	
Water Surface Slope (Channel) (ft/ft)	0.016		0.020		0.018		0.019	
Bankfull Slope (ft/ft)	0.017		0.020		0.017		0.019	

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R3	**(Pond)**							
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	9.5	-	4.5	8.3	7.8	7.8	7.9	
Floodprone Width (ft)	13.7	-	10.0	35.0	17.0	35.0	59.0	
Bankfull Mean Depth (ft)	0.6	-	0.8	1.6	0.6	0.6	0.5	
Bankfull Max Depth (ft)	0.9	-	0.9	1.3	0.7	0.8	0.8	
Bankfull Cross Sectional Area (ft^2)	5.9	-	3.0	5.0	4.4	4.4	3.7	
Width/Depth Ratio	15.2	-	6.2	14.2	14.0	14.0	16.8	
Entrenchment Ratio	1.4	-	7.1	8.4	2.2	4.5	7.4	
Bank Height Ratio	1.8	-	0.9	1.1	1.0	1.0	1.0	
Profile								
Riffle Length (ft)	-	-	9.5	22.7	12.0	33.0	10.0	30.0
Riffle Slope (ft/ft)	-	-	0.009	0.015	0.015	0.022	0.020	0.035
Pool Length (ft)	-	-	6.1	8.7	8.0	10.5	7.0	10.0
Pool Max Depth (ft)	-	-	1.8	2.4	1.4	2.0	1.1	1.6
Pool Spacing (ft)	-	-	14.4	22.3	25.0	55.0	11.8	35.5
Pattern								
Channel Beltwidth (ft)	-	-	23.4	29.0	25.0	45.0	30.0	46.0
Radius of Curvature (ft)	-	-	11.2	17.5	16.0	23.0	15.0	27.0
Rc:Bankfull Width (ft/ft)	-	-	1.6	2.5	2.0	3.0	2.5	4.2
Meander Wavelength (ft)	-	-	43.4	65.1	30.0	44.8	21.0	49.0
Meander Width Ratio	-	-	3.9	4.5	3.3	5.7	5.1	7.6
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.52		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		29.80		-	
Additional Reach Parameters								
Rosgen Classification	N/A (Pond)		E5/C5		C5		C5	
Bankfull Velocity (fps)	2.7		4.5		4.4		4.0	
Bankfull Discharge (cfs)	16.9		-		16.9		16.9	
Sinuosity	-		1.1 - 1.3		1.18		1.17	
Water Surface Slope (Channel) (ft/ft)	0.016		0.020		0.017		0.015	
Bankfull Slope (ft/ft)	-		0.020		0.018		0.016	

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R4								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	6.2	-	4.5	8.3	6.2	8.5	6.2	
Floodprone Width (ft)	44.1	-	10.0	35.0	17.0	35.0	17.0	
Bankfull Mean Depth (ft)	1.0	-	0.8	1.6	0.7	0.9	0.7	
Bankfull Max Depth (ft)	1.8	-	0.9	1.3	0.8	0.9	0.8	
Bankfull Cross Sectional Area (ft^2)	6.2	-	3.0	5.0	6.2	6.2	6.2	
Width/Depth Ratio	6.3	-	6.2	14.2	12.0	12.0	12.0	
Entrenchment Ratio	7.1	-	7.1	8.4	1.8	5.3	1.8	
Bank Height Ratio	1.0	-	0.9	1.1	1.0	1.1	1.0	
Profile								
Riffle Length (ft)	9.5	21.9	9.5	22.7	12.0	33.0	9.5	21.9
Riffle Slope (ft/ft)	0.013	0.022	0.009	0.015	0.013	0.022	0.013	0.022
Pool Length (ft)	6.1	8.5	6.1	8.7	8.0	10.5	6.1	8.5
Pool Max Depth (ft)	2.0	2.2	1.8	2.4	1.4	2.0	2.0	2.2
Pool Spacing (ft)	18.0	44.0	14.4	22.3	25.0	55.0	18.0	44.0
Pattern								
Channel Beltwidth (ft)	29.0	53.0	23.4	29.0	25.0	45.0	29.0	53.0
Radius of Curvature (ft)	12.0	20.0	11.2	17.5	16.0	23.0	12.0	20.0
Rc:Bankfull Width (ft/ft)	1.9	3.2	1.6	2.5	2.0	3.0	1.9	3.2
Meander Wavelength (ft)	52.0	77.0	43.4	65.1	30.0	44.8	52.0	77.0
Meander Width Ratio	4.7	8.5	3.9	4.5	3.3	5.7	4.7	8.5
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.49		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		29.00		-	
Additional Reach Parameters								
Rosgen Classification	E5		E5/C5		E5		E5	
Bankfull Velocity (fps)	3.2		4.0		3.2		3.2	
Bankfull Discharge (cfs)	23.7		-		23.7		23.7	
Sinuosity	1.25		1.1 - 1.3		1.25		1.25	
Water Surface Slope (Channel) (ft/ft)	0.014		0.020		0.014		0.014	
Bankfull Slope (ft/ft)	0.015		0.020		0.015		0.015	

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R5								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	2.3	-	4.5	8.3	4.4	4.4	4.3	
Floodprone Width (ft)	3.3	-	10.0	35.0	15.0	30.0	24.0	
Bankfull Mean Depth (ft)	0.6	-	0.8	1.6	0.4	0.4	0.4	
Bankfull Max Depth (ft)	0.8	-	0.9	1.3	0.5	0.5	0.7	
Bankfull Cross Sectional Area (ft^2)	1.4	-	3.0	5.0	1.5	1.5	1.6	
Width/Depth Ratio	3.5	-	10.3	14.2	13.0	13.0	12.1	
Entrenchment Ratio	1.5	-	2.0	5.0	3.4	6.8	5.5	
Bank Height Ratio	3.3	-	0.9	1.1	1.0	1.0	1.0	
Profile								
Riffle Length (ft)	15.7	37.1	5.1	13.9	13.0	31.0	10.3	37.0
Riffle Slope (ft/ft)	0.019	0.027	0.017	0.026	0.015	0.027	0.017	0.027
Pool Length (ft)	3.1	11.0	4.5	7.0	6.8	9.4	4.7	8.5
Pool Max Depth (ft)	2.1	2.3	1.1	1.7	1.1	1.6	1.1	1.5
Pool Spacing (ft)	11.0	36.0	10.0	30.0	22.0	44.0	8.7	33.3
Pattern								
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-
Radius of Curvature (ft)	-	-	-	-	-	-	-	-
Rc:Bankfull Width (ft/ft)	-	-	-	-	-	-	-	-
Meander Wavelength (ft)	-	-	-	-	-	-	-	-
Meander Width Ratio	-	-	-	-	-	-	-	-
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.48		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		24.30		-	
Additional Reach Parameters								
Rosgen Classification	G5		B5		B5		B5	
Bankfull Velocity (fps)	4.7		4.0		4.5		4.5	
Bankfull Discharge (cfs)	4.5		-		4.5		4.5	
Sinuosity	1.03		1.1 - 1.2		1.25		1.06	
Water Surface Slope (Channel) (ft/ft)	0.026		0.025		0.027		0.025	
Bankfull Slope (ft/ft)	0.025		0.025		0.027		0.024	

Table 7b. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)

	Cross Section 1 (Riffle)							Cross Section 2 (Pool)							Cross Section 3 (Riffle)						
Parameters	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	5.8	5.5	10.4					6.1	7.9	7.0					6.6	6.8	6.4				
Floodprone Width (ft)	23.1	23.0	21.7					45.0	45.0	49.0					46.0	45.0	50.0				
Bankfull Mean Depth (ft)	0.4	0.4	0.2					0.8	0.6	0.6					0.5	0.5	0.5				
Bankfull Max Depth (ft)	0.7	0.6	0.6					1.2	1.3	1.3					1.1	1.1	1.0				
Bankfull Cross Sectional Area (ft^2)	2.3	2.0	2.0					4.6	4.1	4.1					3.5	3.5	3.5				
Bankfull Width/Depth Ratio	14.6	13.2	55.2					8.0	14.2	12.0					12.7	13.0	11.9				
Bankfull Entrenchment Ratio	4.3	4.2	2.1					7.5	5.7	7.0					7.5	6.8	7.8				
Bankfull Bank Height Ratio	1.0	1.0	0.9					1.0	1.0	1.0					1.0	1.0	1.1				
d50 (mm)	N/a	0.8	21.0					N/a	0.6	1.4					N/a	0.8	21.0				
	Cross Section 4 (Pool)							**Cross Section 5 (Riffle)**							**Cross Section 6 (Riffle)**						
Parameters	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	14.2	14.3	14.2					7.9	7.3	8.4					6.7	7.0	8.6				
Floodprone Width (ft)	68.0	68.0	68.0					59.0	59.0	49.0					49.0	49.0	49.0				
Bankfull Mean Depth (ft)	0.6	0.6	1.6					0.5	0.5	0.3					1.6	1.6	1.3				
Bankfull Max Depth (ft)	1.6	1.6	1.5					0.8	0.8	0.8					2.5	2.6	2.7				
Bankfull Cross Sectional Area (ft^2)	8.5	8.5	8.5					3.7	2.7	2.7					10.8	11.2	11.2				
Bankfull Width/Depth Ratio	23.8	24.4	23.8					16.8	15.1	25.2					4.2	4.4	6.7				
Bankfull Entrenchment Ratio	4.8	4.8	4.8					7.4	8.0	5.8					7.3	7.0	5.7				
Bankfull Bank Height Ratio	1.0	1.0	1.1					1.0	<1	1.0					1.0	1.0	1.0				
d50 (mm)	N/a	0.6	1.4					N/a	0.8	21.0					N/a	0.8	21.0				
	Cross Section 7 (Pool)							**Cross Section 8 (Riffle)**													
Parameters	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	13.1	12.7	10.7					4.3	4.6	4.9											
Floodprone Width (ft)	44.0	44.0	44.0					24.0	20.0	23.0											
Bankfull Mean Depth (ft)	1.2	1.3	1.2					0.4	0.5	0.4											
Bankfull Max Depth (ft)	2.9	2.8	2.9					0.7	0.6	0.7											
Bankfull Cross Sectional Area (ft^2)	15.4	12.3	12.3					1.6	2.1	2.1											
Bankfull Width/Depth Ratio	10.9	9.6	9.3					12.1	10.1	11.3											
Bankfull Entrenchment Ratio	3.4	3.5	4.1					5.5	4.3	4.7											
Bankfull Bank Height Ratio	1.0	1.0	1.0					1.0	1.2	1.0											
d50 (mm)	N/a	0.64	1.35					N/a	0.8	21											

	Table 7c. Monitoring Data - Stream Reach Summary Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)											
Parameter	**Baseline**		**MY1**		**MY2**		**MY3**		**MY4**		**MY5**	
Reach ID: R1												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	11.3	31.2										
Riffle Slope (ft/ft)	0.017	0.036										
Pool Length (ft)	5.5	12.5										
Pool Max depth (ft)	1.2	1.7										
Pool Spacing (ft)	7.7	33.3										
Pattern												
Channel Beltwidth (ft)	25	51										
Radius of Curvature (ft)	11	36										
Rc:Bankfull width (ft/ft)	2.1	4.2										
Meander Wavelength (ft)	23	56										
Meander Width Ratio	4.1	7.4										
Additional Reach Parameters												
Rosgen Classification	G5c											
Sinuosity (ft)	1.05											
Water Surface Slope (Channel) (ft/ft)	0.026											
BF slope (ft/ft)	0.0265											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Pattern and Profile data will not typically be collected unless visual data, dimensional data or profile data indicate significant deviations from baseline conditions

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R2												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	9.9	33.3										
Riffle Slope (ft/ft)	0.016	0.033										
Pool Length (ft)	5.4	13.6										
Pool Max depth (ft)	1.2	1.9										
Pool Spacing (ft)	13	37.1										
Pattern												
Channel Beltwidth (ft)	25	47										
Radius of Curvature (ft)	9.8	30.3										
Rc:Bankfull width (ft/ft)	2.5	4.2										
Meander Wavelength (ft)	29	17										
Meander Width Ratio	4.4	7.9										
Additional Reach Parameters												
Rosgen Classification	C5											
Sinuosity (ft)	1.15											
Water Surface Slope (Channel) (ft/ft)	0.019											
BF slope (ft/ft)	0.019											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Pattern and Profile data will not typically be collected unless visual data, dimensional data or profile data indicate significant deviations from baseline conditions

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R3												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	10	30										
Riffle Slope (ft/ft)	0.02	0.035										
Pool Length (ft)	7	10										
Pool Max depth (ft)	1.1	1.6										
Pool Spacing (ft)	11.8	35.5										
Pattern												
Channel Beltwidth (ft)	30	46										
Radius of Curvature (ft)	15	27										
Rc:Bankfull width (ft/ft)	2.5	4.2										
Meander Wavelength (ft)	21	49										
Meander Width Ratio	5.1	7.6										
Additional Reach Parameters												
Rosgen Classification	C5											
Sinuosity (ft)	1.17											
Water Surface Slope (Channel) (ft/ft)	0.0153											
BF slope (ft/ft)	0.016											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Pattern and Profile data will not typically be collected unless visual data, dimensional data or profile data indicate significant deviations from baseline conditions

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R4												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	9.5	21.9										
Riffle Slope (ft/ft)	0.013	0.022										
Pool Length (ft)	6.1	8.5										
Pool Max depth (ft)	2	2.2										
Pool Spacing (ft)	18	44										
Pattern												
Channel Beltwidth (ft)	29	53										
Radius of Curvature (ft)	12	20										
Rc:Bankfull width (ft/ft)	1.9	3.2										
Meander Wavelength (ft)	52	77										
Meander Width Ratio	4.7	8.5										
Additional Reach Parameters												
Rosgen Classification	E5											
Sinuosity (ft)	1.25											
Water Surface Slope (Channel) (ft/ft)	0.014											
BF slope (ft/ft)	0.015											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

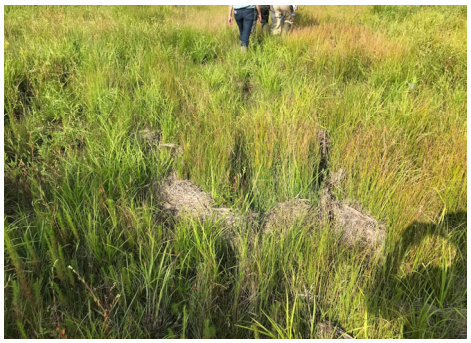
Pattern and Profile data will not typically be collected unless visual data, dimensional data or profile data indicate significant deviations from baseline conditions

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R5												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	10.3	37										
Riffle Slope (ft/ft)	0.017	0.027										
Pool Length (ft)	4.7	8.5										
Pool Max depth (ft)	1.1	1.5										
Pool Spacing (ft)	8.7	33.3										
Pattern												
Channel Beltwidth (ft)	-	-										
Radius of Curvature (ft)	-	-										
Rc:Bankfull width (ft/ft)	-	-										
Meander Wavelength (ft)	-	-										
Meander Width Ratio	-	-										
Additional Reach Parameters												
Rosgen Classification	B5											
Sinuosity (ft)	1.06											
Water Surface Slope (Channel) (ft/ft)	0.025											
BF slope (ft/ft)	0.024											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Pattern and Profile data will not typically be collected unless visual data, dimensional data or profile data indicate significant deviations from baseline conditions

Appendix E – Hydrologic Data

Table 8. Verification of Flow Events					
Date of Data Collection	**Date of Occurrence**	**Method**	**Greater than Bankfull (Bkf) or Qgs (Q2*0.66) Stage?**	**Photo/ Notes**	**Height above bankfull**
8/16/2018	8/3/2018	Crest Gauge	Bkf, 3" above FP elevation	Photos	
9/17/2018	9/16-9/17/2018	Oberserved visual indicators (wrack lines) of stage after storm	Bkf	Photos	
11/21/2018	9/16-9/17/2018	Crest Gauge	Bkf	Photos	
7/26/2019	7/24/2019	Crest Gauge	Bkf	Photos	3.25 in
8/20/2019	uknown	Crest Gauge	Bkf	Photos	4.5 in



8/16/2018

9/17/2018

9/17/2018

9/17/2018

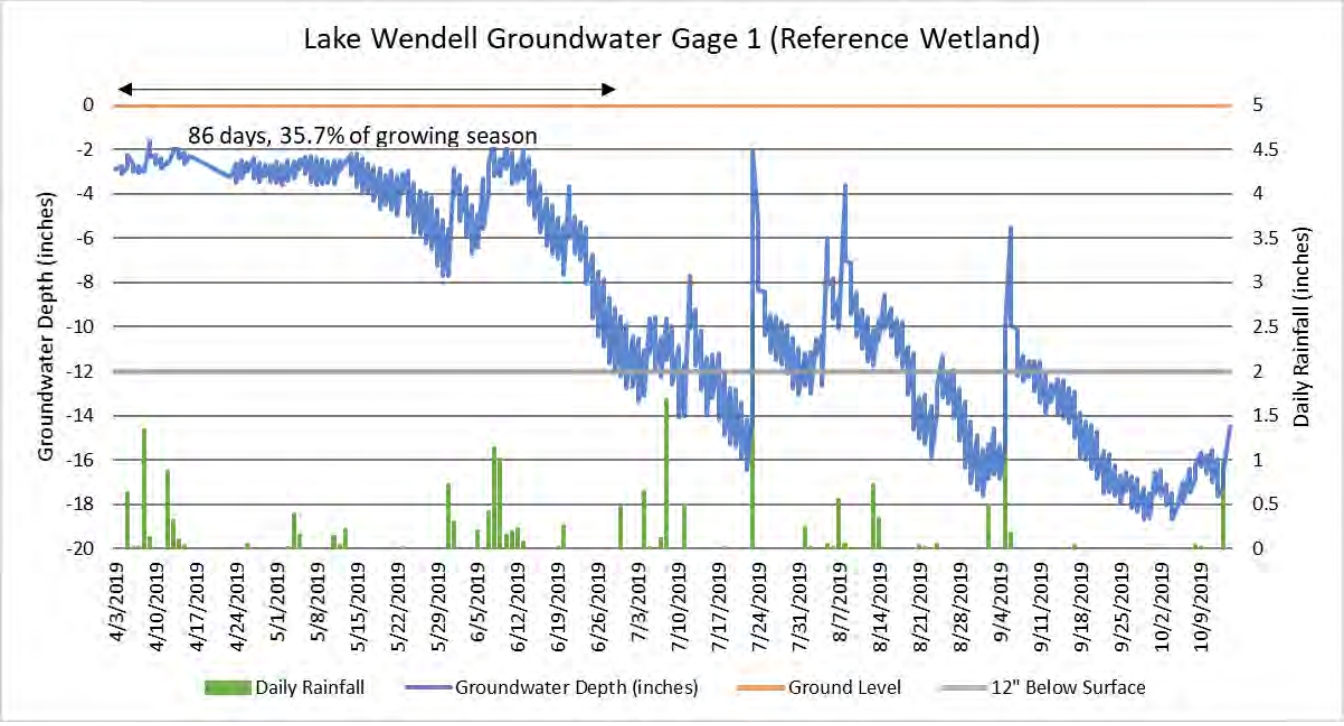
9/17/2018

11/21/2018

7/26/2019

8/20/2019

Figure 4: Hydrograph Data (Pressure transducer)



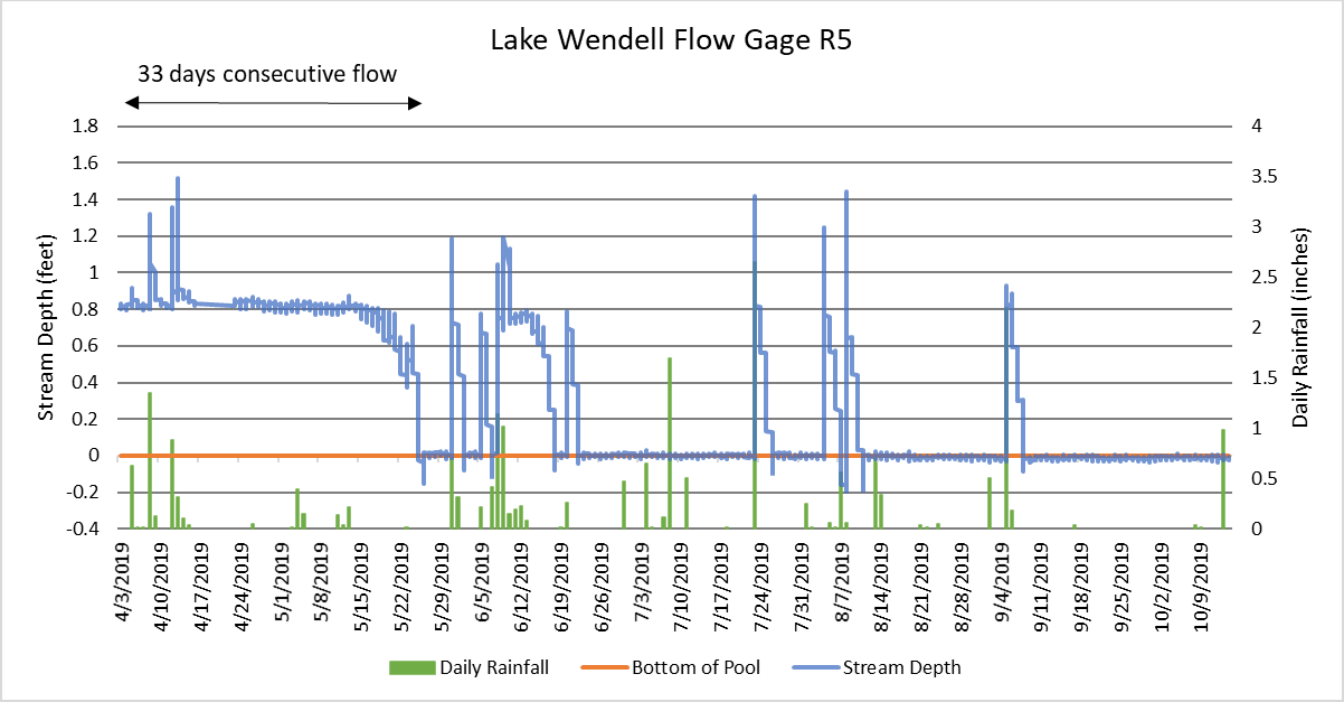


Figure 4: Groundwater Gauge Data
Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)
MY2 2019

Monitoring Gauge Name	Max Consecutive Hydroperiod: Saturation within 12 Inches of Soil Surface (Percent of Growing Season) WETS Station: 317994 - Smithfield Growing Season: 4/6-11/4 (227 days)							
	2018	2019	2020	2021	2022	2023	2024	Mean
Lake Wendell Reference Wetland	95.20%	53.52%						

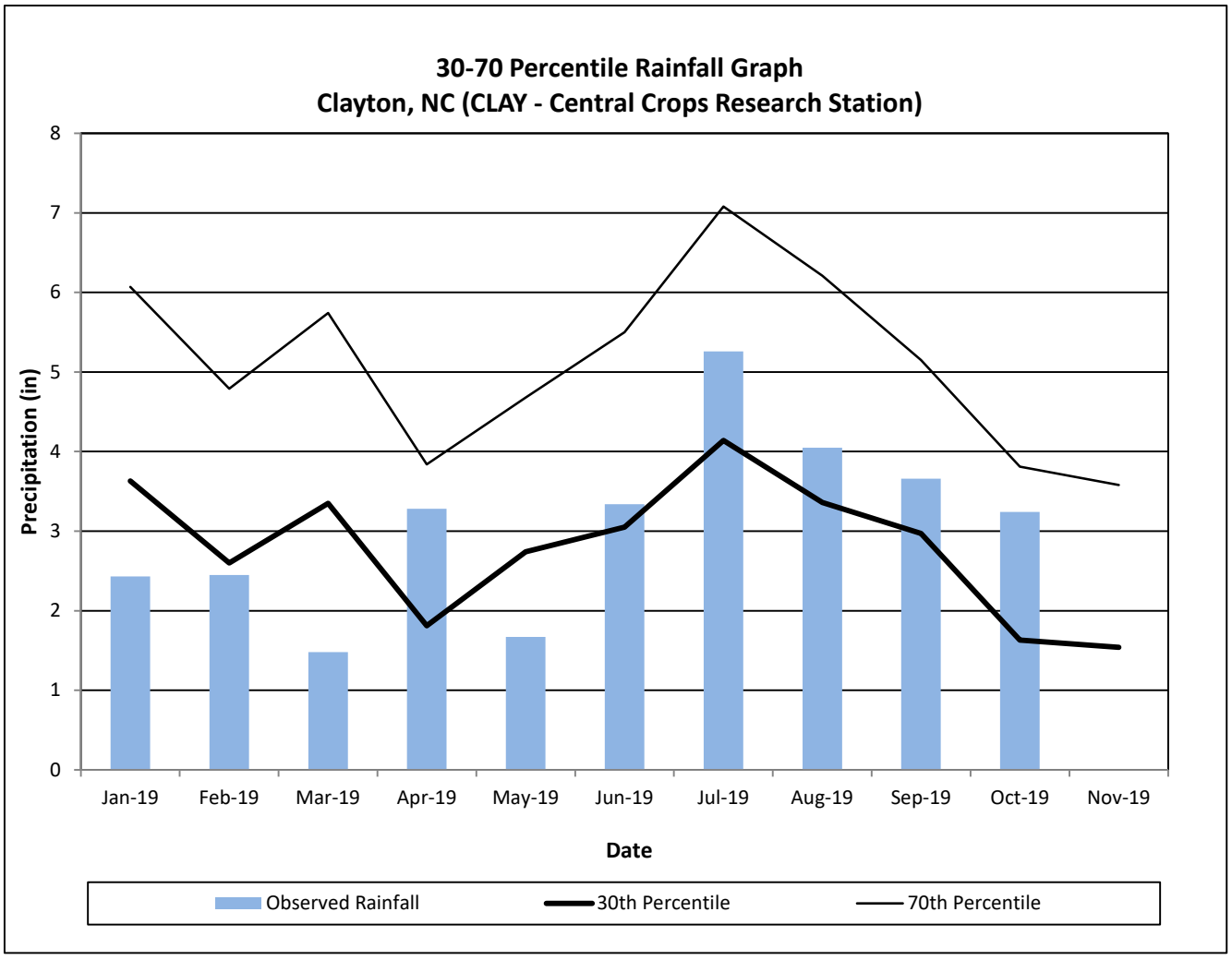
86 Consecutive Days Meeting Criteria of Saturation Within 12" of Surface During Growing Season (4/06/2019-6/30/2019)

Annual Precip Total	NA
WETS 30th Percentile	42.7
WETS 70th Percentile	51.8
Normal	Y

	Impoundment
	X% above or below success criteria
N/A	Not available - Gage pulled or yet to be installed by this phase
M	Malfunction, Data Overwritten or Unretrievable

*January-November

Figure 5: Monthly Rainfall Data
Lake Wendell Mitigation Project (NCDEQ DMS Project ID # 97081)
MY2 2019



*30th and 70th percentile rainfall data collected from weather station (COOP 317994) in Smithfield, NC.
**Incomplete Month

Month	30%	70%	Observed
Jan-19	3.63	6.07	2.43
Feb-19	2.60	4.79	2.45
Mar-19	3.35	5.74	1.48
Apr-19	1.81	3.84	3.28
May-19	2.74	4.68	1.67
Jun-19	3.05	5.50	3.34
Jul-19	4.14	7.08	5.26
Aug-19	3.36	6.21	4.05
Sep-19	2.97	5.15	3.66
Oct-19	1.63	3.81	3.24
Nov-19	1.54	3.58	**
Dec-19	**	**	**

Monitoring Report – Year 2
FINAL VERSION
Lake Wendell Mitigation Project (Riparian Buffer Mitigation)
Calendar Year of Data Collection: 2019

NCDEQ DMS Project Identification # 97081
NCDEQ DMS Contract # 6826
Neuse River Basin (Cataloging Unit 03020201)
USACE Action ID Number: SAW-2016-00876
NCDEQ DWR Project # 2016-0385
Johnston County, NC
Contracted Under RFP # 16-006477
Data Collection Period: June-October 2019, Submission Date: December 2019

Prepared for:

Environmental Quality

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1 Project Summary

Water and Land Solutions, LLC (WLS) completed the construction and planting of the Lake Wendell Mitigation Project (Project) full-delivery project for the North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) in March 2018. The Project is located in Johnston County, North Carolina between the Community of Archer Lodge and the Town of Wendell at 35.73739˚, -78.3538°. The Project site is located in the NCDEQ Sub-basin 03-04-06, in the Upper Buffalo Creek Sub-watershed 030202011502.

The Project involved the restoration, enhancement, preservation and permanent protection of five stream reaches (R1, R2, R3, R4, and R5) and their riparian buffers, totaling 4,269 linear feet of streams and 490,477 square feet of riparian buffers. Monitoring Year 2 (MY2) monitoring activities occurred between June and October 2019 (Table 2). This report presents the data for the second year of monitoring (MY2). The Project meets the MY2 success criteria for vegetation. Based on these results, the Project is expected to meet the Monitoring Year 3 (MY3) success criteria in 2020.

2 Project Background

2.1 Project Location, Setting, and Existing Conditions

The Project site is located in the Upper Buffalo Creek Sub-watershed 030202011502 study area of the Neuse 01 Regional Watershed Plan, in the Wake-Johnston Collaborative Local Watershed Plan, and in Targeted Local Watershed 03020201180050.

The catchment area is 102 acres and has an impervious cover less than one percent. The dominant surrounding land uses are agriculture and mixed forest. Prior to construction, livestock had access to all Project streams, except R4, and the riparian buffers were less than 50 feet wide.

2.2 Mitigation Project Goals and Objectives

The following riparian buffer mitigation site-specific goals were developed:

- Restore and protect riparian buffer functions and habitat connectivity in perpetuity by recording a permanent conservation easement,
- Implement agricultural BMPs to reduce nonpoint source inputs to receiving waters.

To accomplish these site-specific goals, the following objectives will be measured and included with the performance standards to document overall project success:

- Increase native species riparian buffer vegetation density/composition along streambank and floodplain areas that meet requirements of a minimum 50-foot-wide and 260 stems/acre after monitoring year 5.
- Prevent cattle from accessing the conservation easement boundary by installing permanent fencing and reducing fecal coliform bacteria from the pre-restoration levels.

2.3 Project History, Contacts, and Timeframe

The Project will provide riparian buffer mitigation credits in accordance with North Carolina Administrative Code (NCAC), "Consolidated Buffer Mitigation Rule", Rule 15A NCAC 02B .0295, effective November 1, 2015. Riparian buffer mitigation site viability was confirmed by DWRs April 28, 2016 letter entitled "Site Viability for Buffer Mitigation & Nutrient Offset – Lake Wendell Located Near 2869 Wendell Road, Wendell, NC, Johnston County". The referenced site viability letter included a determination by DWR that Project Reaches R1, R2, R3 and R4 were either intermittent or perennial. A separate request for Stream Origin/Buffer Applicability Determination for Potential Mitigation for Project Reach R5 was submitted to DWR on May 18, 2017, as required under the referenced site viability letter. On June 1, 2017 DWR performed the requested determination and Reach R5 was determined to be intermittent, as communicated in the DWR June 8, 2017 letter entitled "On-Site Stream Determination for Applicability to the Neuse Riparian Buffer Rules and Water Quality Standards (15A NCAC 02B.0233)", therefore confirming Reach R5's eligibility for riparian buffer mitigation. See Appendix D for DWR correspondence and approval letters.

The final mitigation plan and PCN were submitted to DMS August 25, 2017 for submission to DWR and the NCIRT. The Section 404 General (Regional and Nationwide) Permit Verification was issued October 5, 2017. Project construction started on November 13, 2017 and mitigation site earthwork was completed on March 13, 2018, by RiverWorks Construction. Mitigation site planting was completed on March 30, 2018, by RiverWorks Construction. Trueline Surveying, PC completed the as-built survey in June 2018. WLS completed the installation of baseline monitoring devices on April 19, 2018 and the installation of survey monumentation and conservation easement boundary marking on June 7, 2018. MY1 was completed on November 24th, 2019 and submitted December 4th, 2019. Monitoring Year 2 data collection was completed from June until October 29th, 2019.

The project background and attribute summary are presented in Table 1. Refer to Figure 1 and Table 2 for the project areas and buffer asset information. Relevant project contact information is presented in Table 3.

3 Project Mitigation Components

3.1 Riparian Buffer Mitigation Types and Approaches

Riparian buffer mitigation included restoring, enhancing and preserving the riparian buffer functions and corridor habitat. The project included planting to re-establish a native species vegetation riparian buffer corridor, which extended a minimum of 50 feet from the top of the streambanks along each of the project reaches, as well as permanently protecting those buffers with a conservation easement. Many areas of the conservation easement had riparian buffer widths greater than 50 feet established along one or both streambanks to provide additional functional uplift. The only exception is at the upstream end of Reach R1, where the width of the proposed left riparian buffer varies between 20 feet and 29 feet from the left top of bank. This narrow area of proposed riparian buffer is due to the site constraint caused by an existing residential structure. For project reaches proposed for restoration and enhancement, the riparian buffers were restored through reforestation of the entire conservation easement with native species riparian buffer vegetation (Table 5). For project reach sections proposed for preservation, the existing riparian

buffers are permanently protected via the recorded conservation easement. Additionally, permanent fencing was installed along with alternative watering systems to exclude livestock from the restored riparian buffer and conservation easement areas. The permanent fencing system consisting of woven wire fencing was installed to NRCS technical standards in the pasture areas along and outside of the northern conservation easement boundaries of Reaches R1, R2, and R3. Figure 1 (Appendix A) provide a summary of the project components.

3.1.1 Tree and Shrub Planting Approaches

The riparian buffer planting zones for the project included the streambanks, floodplain, riparian wetland, and upland transitional areas. Plantings were conducted using native species bare-root trees and shrubs, live stakes, and seedlings that were generally planted at a total target density of 680 stems per acre. WLS implemented a riparian buffer planting strategy that includes a combination of overstory, or canopy, and understory species. The site planting strategy also included early successional, as well as climax species. The vegetation selections were mixed throughout the project planting areas so that the early successional species will give way to climax species as they mature over time.

3.1.2 Temporary and Permanent Seeding Approaches

Permanent seed mixtures of native species herbaceous vegetation and temporary herbaceous vegetation seed mixtures were applied to all disturbed areas of the project site. Temporary and permanent seeding were conducted simultaneously at all disturbed areas of the site during construction utilizing mechanical broadcast spreaders. The as-built re-vegetation plan lists the utilized species, mixtures, and application rates for permanent seeding.

3.1.3 Invasive Species Vegetation Treatment

During the project construction, invasive species exotic vegetation was either mechanically removed or chemically treated both to control its presence and reduce its spread within the conservation easement areas. During MY2 vegetation assessment, one area of concern was observed along R1 buffer as shown on the Figure 1. This area was utilized as a temporary staging area during construction and contains invasive species vegetation (kudzu) along the right buffer. This area was treated twice, using a 3 percent solution of Garlon 3A during MY2, on August 15th and September 24th, 2019. WILS will continue to monitor and treat the kudzu during MY3.

4 Performance Standards

The applied success criteria for the Project will follow necessary performance standards and monitoring protocols presented in final approved mitigation plan. Annual monitoring and semi-annual site visits will be conducted to assess the condition of the project throughout the monitoring period. Monitoring activities will be conducted for a period of five years. Specific success criteria components and evaluation methods are described below.

4.1 Vegetation

Measurements of the final vegetative restoration success for the project will be achieving a density of not less than 260, five-year-old stems per acre in Year 5 of monitoring. This final performance criteria shall include a minimum of four native hardwood tree species or four native hardwood tree and native

shrub species, where no one species is greater than 50 percent of the stems. Native hardwood tree and native shrub volunteer species will be included to meet the final performance criteria of 260 stems per acre. Volunteers species will only be counted toward success if they were included in the approved planting plan and if they are surviving for at least two years. In addition, diffuse flow of runoff shall be maintained in the riparian buffer areas.

5 Monitoring Year 2 Assessment and Results

Annual monitoring was conducted during MY2 in accordance with the monitoring plan as described in the approved mitigation plan and was intended to document the site improvements based on restoration potential, catchment health, ecological stressors and overall constraints. All the monitoring device locations are depicted on CCPV (Figure 1) and MY2 monitoring data results are listed in the appendices. The Project meets the MY2 success criteria for vegetation.

5.1 Vegetation

Vegetation monitoring for MY2 was conducted utilizing the seven vegetation monitoring plots, with monitoring conducted in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2017). See Figure 1 in Appendix B for the vegetation monitoring plot locations. The surviving planted stems include a minimum of four native hardwood tree species or four native hardwood tree and native shrub species, where no one species is greater than 50 percent of the stems. Summary data and photographs of each plot can be found in Appendix 3.

The MY2 vegetation monitoring was also conducted utilizing visual assessment along all the Project stream reaches. The overall results of the visual assessment did not indicate any negative changes to the existing vegetation community. Additionally, the visual monitoring confirmed that diffuse flow of runoff is being maintained in the riparian buffer areas.

6 References

Lee, M., Peet R., Roberts, S., Wentworth, T. CVS-NCEEP Protocol for Recording Vegetation, Version 4.1, 2007.

North Carolina Department of Environmental Quality, Division of Mitigation Services, Wildlands Engineering, Inc. 2015. Neuse 01 Regional Watershed Plan Phase II. Raleigh, NC.

North Carolina Department of Environmental Quality, Division of Mitigation Services, 2017. Annual Report Format, Data Requirements, and Content Guidance. Raleigh, NC.

Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina, third approximation. North Carolina Natural Heritage Program. NCDENR Division of Parks and Recreation. Raleigh, NC.

United States Army Corps of Engineers. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. Environmental Laboratory. US Army Engineer Waterways Experiment Station. Vicksburg, MS.

___. 1997. Corps of Engineers Wetlands Research Program. Technical Note VN-RS-4.1. Environmental Laboratory. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

___. 2003. Stream Mitigation Guidelines, April 2003, U.S. Army Corps of Engineers. Wilmington District.

Water and Land Solutions, LLC (2017). Lake Wendell Stream and Riparian Buffer Mitigation Plan. NCDMS, Raleigh, NC.

Appendices

Appendix A – Background Tables

Table 1. Buffer Project Attributes

Project Name	Lake Wendell Mitigation Project
Hydrologic Unit Code	03020201
River Basin	Neuse
Geographic Location (Lat, Long)	35.7373910 N, -78.3538050 W
Site Protection Instrument (DB, PG)	85, 148
Total Credits (BMU)	354,404.00
Types of Credits	Riparian Buffer
Mitigation Plan Date	Aug-18
Initial Planting Date	Mar-18
Baseline Report Date	Nov-18
MY1 Report Date	Dec-18
MY2 Report Date	Dec-19
MY3 Report Date	
MY4 Report Date	
MY5 Report Date	

Table 2. Buffer Project Areas and Assets: Lake Wendell

RIPARIAN BUFFER (15A NCAC 02B.0295)

Location	Jurisdictional Streams	Restoration Type	Reach ID/ Component	Buffer Width (ft)	Total Area (sf)	Creditable Area (sf)*	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits (BMU)	If Converted to Nutrient Offset: Convertible to Nutrient Offset (Yes or No)	If Converted to Nutrient Offset: Nutrient Offset: N (lbs)	If Converted to Nutrient Offset: Nutrient Offset: P (lbs)
Rural or Urban	Subject or Nonsubject	Restoration		20-29			1	75%	1.33333	-		-	-
			Restoration	0-100	342,525	342,525		100%	1.00000	342,525.000	Yes	17,873.412	N/A
				101-200				33%	3.03030	-		-	-
		Enhancement		20-29			2	75%	2.66667	-		-	-
			Enh & Cattle Ex.	0-100	44,852	44,852		100%	2.00000	22,426.000	No	-	-
				101-200				33%	6.06061	-		-	-
				SUBTOTALS		**387,377**				**364,951.000**		**17,873.412**	**-**
			ELIGIBLE PRESERVATION AREA			**129,126**							

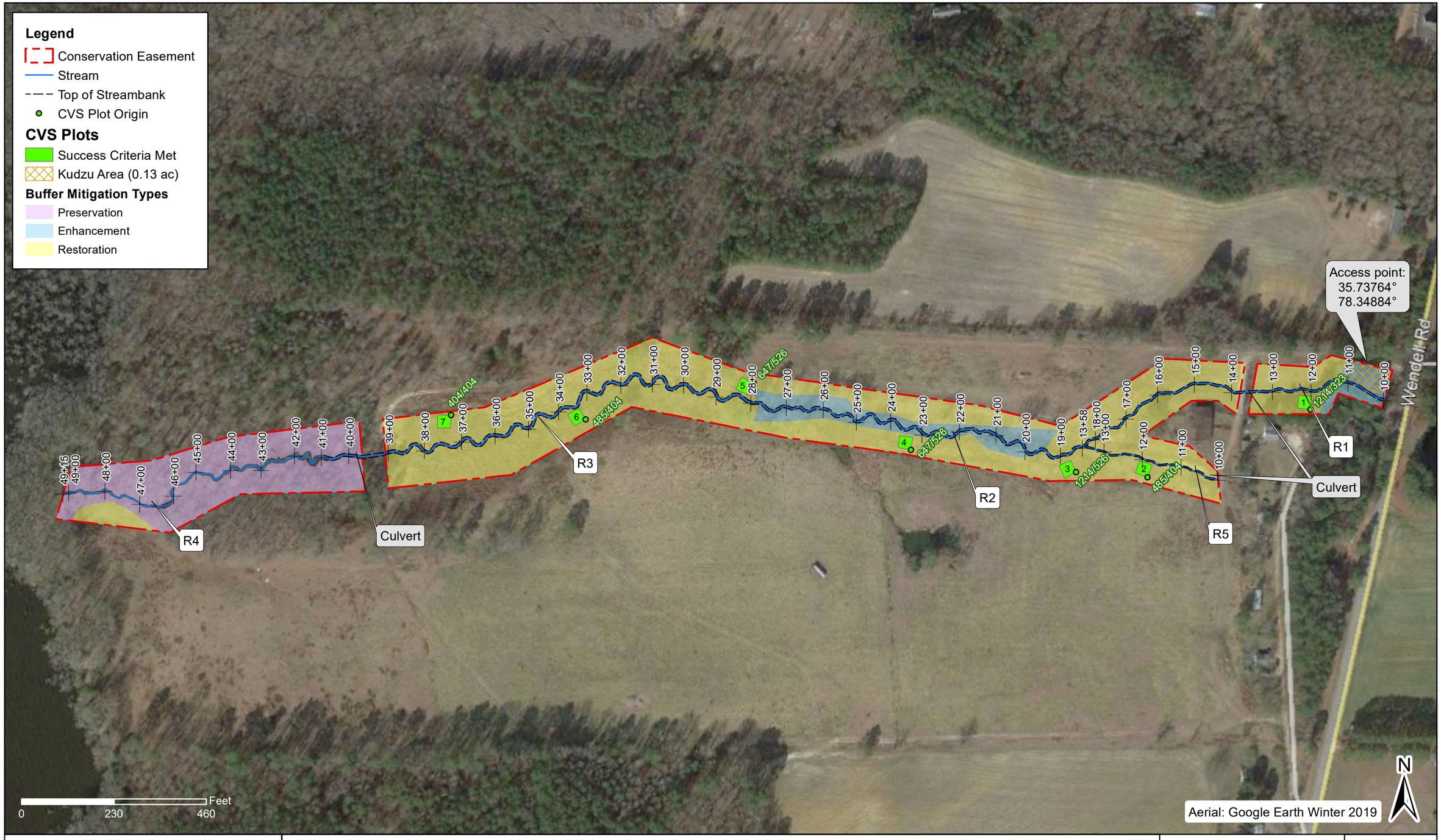
Location	Jurisdictional Streams	Restoration Type	Reach ID/ Component	Buffer Width (ft)		Creditable Area (sf)*	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits (BMU)
Rural	Subject	Preservation		20-29			10	75%	13.33333	-
			Preservation	0-100	104,103	104,103		100%	10.00000	10,410.300
				101-200				33%	30.30303	-
	Nonsubject			20-29			5	75%	6.66667	-
				0-100				100%	5.00000	-
				101-200				33%	15.15152	-
Urban	Subject or Nonsubject			20-29			3	75%	4.00000	-
				0-100				100%	3.00000	-
				101-200				33%	9.09091	-
				SUBTOTALS		**104,103**				**10,410.300**
				TOTALS		**491,480**				**375,361.300**

**Area eligible for preservation may be no more than 25% of total area, where total area is back-calculated with the equation R+E/0.75.*
**Buffers must be at minimum 20' wide for reiparian buffer credit, buffers must be 50' wide for nutrient offset credit.*
**When preservation areas exceed the total eligible preservation area, select the areas with the best credit ratios as the creditable areas.*

Regulatory direction for Riparian Buffer in this table follows NCAC rule 15A NCAC 02B .0295, effective November 1, 2015.
Regulatory direction for Nutrient Offset in this table follows Nutrient Offsets Payments Rule 15A NCAC 02B. 0240, amended effective September 1, 2010 and
DWR – 1998. Methodology and Calculations for determining Nutrient Reductions associated with Riparian Buffer Establishment.
N.O. calculation based on effectiveness in 30 years, with 146.40 lb/ac P; and 2,273.02 lb/ac N. The N credit ratio used is 19.16394 sf per pound. The P credit ratio used is 297.54097 sf per pound.

Table 3. Project Contacts Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)	
Mitigation Provider	Water & Land Solutions, LLC 7721 Six Forks Road, Suite 130 Raleigh, NC 27615
Primary Project POC	Catherine Manner Phone: 571-643-3165
Construction Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Survey Contractor (Existing Condition Surveys)	WithersRavenel 115 MacKenan Drive, Cary, NC 27511
Primary Project POC	Marshall Wight, PLS Phone: 919-469-3340
Survey Contractor (Conservation Easement, Construction and As-Builts Surveys)	True Line Surveying, PC 205 West Main Street, Clayton, NC 27520
Primary Project POC	Curk T. Lane, PLS 919-359-0427
Planting Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Seeding Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Seed Mix Sources	Green Resource 5204 Highgreen Ct., Colfax, NC 27235 Rodney Montgomery Phone: 336-215-3458
Nursery Stock Suppliers	Foggy Mountain Nursery (Live Stakes) 797 Helton Creek Rd, Lansing, NC 28643 Glenn Sullivan Phone: 336-977-2958 Dykes & Son Nursery (Bare Root Stock) 825 Maude Etter Rd, Mcminnville, Tn 37110 Jeff Dykes Phone: 931-668-8833
Monitoring Performers	Water & Land Solutions, LLC 7721 Six Forks Road, Suite 130 Raleigh, NC 27615
Stream Monitoring POC	Emily Dunnigan Phone: 269-908-6306
Vegetation Monitoring POC	Emily Dunnigan Phone: 269-908-6306

Appendix B – Visual Assessment Data



WATER & LAND™ SOLUTIONS

Lake Wendell Mitigation Project
Johnston County, North Carolina

NCDMS Contract No. 6826
NCDMS Project No. 97081
December 2019
MY2

Riparian Buffer
Mitigation Plan View

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
1

Table 4 Project Planted Acreage[1]	Vegetation Condition Assessment Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081) 8.9					
Vegetation Category	**Definitions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Planted Acreage**
1. Bare Areas	Very limited cover of both woody and herbaceous material.	1 acre	Solid light blue	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres	Pattern and Color	0	0.00	0.0%
			Total	0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	Pattern and Color	0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2] **12**

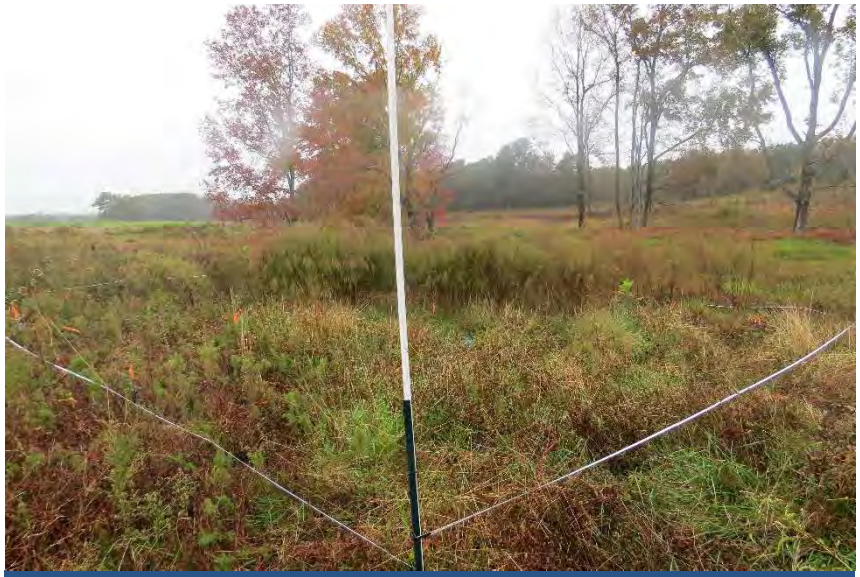
Vegetation Category	**Definitions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Easement Acreage**
4. Invasive Areas of Concern[4]	Areas or points (if too small to render as polygons at map scale).	1000 SF	orange hatched	1	0.13	1.1%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none	yellow hatched	0	0.00	0.0%

Veg Plot 1, November 5, 2018 (MY-01)

Veg Plot 1, October 15, 2019 (MY-02)

Veg Plot 2, April 27, 2018 (MY-00)

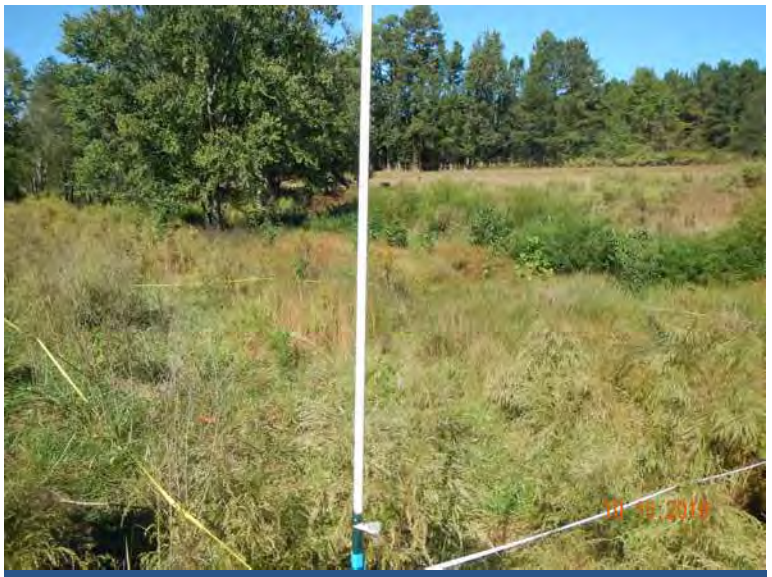
Veg Plot 2, October 15, 2019 (MY-02)



Veg Plot 3, November 5, 2018 (MY-01)

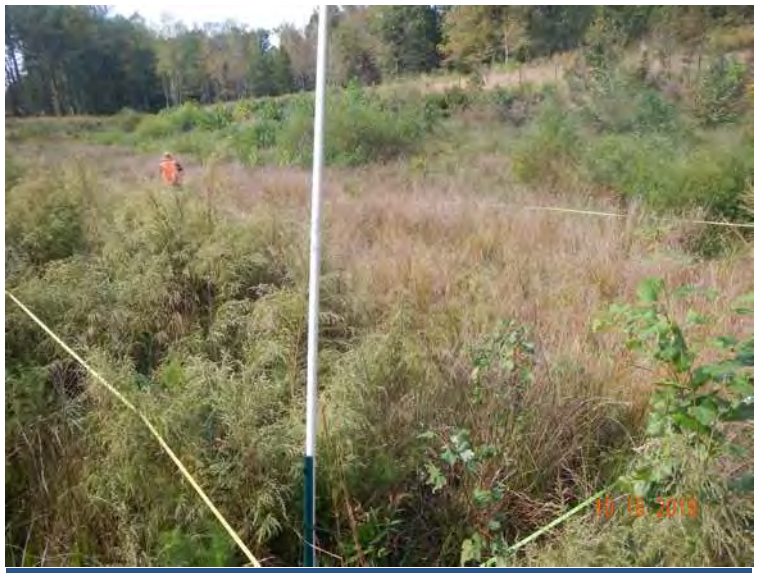
Veg Plot 3, October 15, 2019 (MY-02)

Veg Plot 4, April 13, 2018 (MY-00)



Veg Plot 4, October 15, 2019 (MY-02)

Veg Plot 5, April 13, 2018 (MY-00)



Veg Plot 5, October 15, 2019 (MY-02)

Veg Plot 6, April 13, 2018 (MY-00)

Veg Plot 6, October 15, 2019 (MY-02)

Veg Plot 7 April 13, 2018 (MY-00)

Veg Plot 7 October 15, 2019 (MY-02)

VPA1 Bare ground Area (photo east) 10/14/2019

VPA2 Bare ground Area (photo west) 10/14/2019

VPA3 Kudzu (photo west) 10/14/2019

Appendix C – Vegetation Plot Data

EEP Project Code 1. Project Name: Lake Wendell

Table 5

			Current Plot Data (MY2 2019)																				Annual Means								
			001-01-0001			001-01-0002			001-01-0003			001-01-0004			001-01-0005			001-01-0006			001-01-0007			MY2 (2019)			MY1 (2018)			MY0 (2018)		
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 negundo		Tree						1																	1						
Acer rubrum		Tree			2			1			2	2	2	3			2	2	2	4	2	2	2	6	6	16	6	6	62	7	7	7
Alnus serrulata	Tag Alder, Smooth Ald	Shrub Tree							1	1	1							1	1	1	1	1	1	3	3	3	2	2	2	3	3	3
Betula nigra	River Birch, Red Birch	Tree	1	1	1	4	4	4	3	3	3	2	2	2				1	1	1				11	11	11	9	9	9	12	12	12
Carpinus caroliniana		Shrub Tree	1	1	1										2	2	2							3	3	3	4	4	4	5	5	5
Cornus amomum	Silky Dogwood	Shrub Tree	1	1	1	1	1	1																2	2	2	2	2	2	3	3	3
Diospyros virginiana	American Persimmon,	Tree										2	2	2										2	2	2	2	2	2	2	2	2
Fraxinus pennsylvanica	Green Ash, Red Ash	Tree	1	1	1	1	1	1	1	1	1				1	1	1							4	4	4	4	4	4	4	4	4
Ilex verticillata	Winterberry	Shrub Tree																												1	1	1
Lindera benzoin	Northern Spicebush	Shrub Tree																												8	8	8
Liquidambar styraciflua	Sweet Gum, Red Gum	Tree			20						15						5									40			9			
Liriodendron tulipifera		Tree	1	1	1				2	2	2				2	2	2	1	1	1	2	2	2	8	8	8	13	13	13	27	27	27
Magnolia virginiana		Shrub Tree				1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	1	1	1	7	7	7	8	8	8	8	8	8
Platanus occidentalis	Sycamore, Plane-tree	Tree	1	1	1	1	1	1	1	1	1				4	4	4	1	1	1	3	3	3	11	11	11	12	12	12	18	18	18
Prunus serotina		Shrub Tree												2												2						
Quercus michauxii	Basket Oak, Swamp Ch	Tree	1	1	1							4	4	4	1	1	1	1	1	1				7	7	7	7	7	7	7	7	7
Quercus nigra	Water Oak, Paddle Oak	Tree	1	1	1	2	2	2				1	1	1										4	4	4	4	4	4	9	9	9
Quercus phellos	Willow Oak	Tree							4	4	4				2	2	2	2	2	2	1	1	1	9	9	9	10	10	10	11	11	11
Rosa palustris	Swamp Rose	Shrub Vine																											1			
Salix nigra	Black Willow	Tree																											1			
		Stem count	8	8	30	10	10	12	13	13	30	13	13	16	13	13	20	10	10	12	10	10	10	77	77	130	83	83	150	125	125	125
		size (ares)	1			1			1			1			1			1			1			7			7			7		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.17			0.17			0.17		
		Species count	8	8	10	6	6	8	7	7	9	6	6	7	7	7	9	8	8	8	6	6	6	13	13	16	13	13	16	15	15	15
		Stems per ACRE	323.7	323.7	1214	404.7	404.7	485.6	526.1	526.1	1214	526.1	526.1	647.5	526.1	526.1	809.4	404.7	404.7	485.6	404.7	404.7	404.7	445.2	445.2	751.6	479.8	479.8	867.2	722.7	722.7	722.7

Volunteers were only counted if they were at least 18" tall.

Appendix D – NC DWR Correspondence and Approvals

Water Resources
ENVIRONMENTAL QUALITY

PAT MCCRORY
Governor
DONALD R. VAN DER VAART
Secretary
S. JAY ZIMMERMAN
Director

April 28, 2016

DWR Project #: 2016-0385

Scott Hunt
Water & Land Solutions, LLC
11030 Raven Ridge Rd, Suite 119
Raleigh, NC 27614
(via electronic mail)

Re: Site Viability for Buffer Mitigation & Nutrient Offset – Lake Wendell
Located near 2869 Wendell Rd, Wendell, NC
Johnston County

Dear Mr. Hunt,

On April 8, 2016, Katie Merritt, with the Division of Water Resources (DWR), assisted you and others from Water & Land Solutions, LLC at the proposed Lake Wendell Mitigation Site (Site) in Wendell, NC. The Site is located in the Neuse River Basin within the 8-digit Hydrologic Unit Code 03020201. The Site is being proposed as part of a full-delivery stream restoration project for the Division of Mitigation Services (RFP #16-006477). The Interagency Review Team (IRT) was also present onsite. At your request, Ms. Merritt performed a site assessment of features onsite to determine suitability for buffer and nutrient offset mitigation. Features are more accurately shown in the attached maps signed by Ms. Merritt on April 20, 2016. If approved, mitigating this site could provide stream mitigation credits, riparian buffer credits and/or nutrient offset credits.

Ms. Merritt's evaluation of features from Top of Bank (TOB) out to 200' for buffer and nutrient offset mitigation pursuant to Rule 15A NCAC 02B .0295 (effective November 1, 2015) and Rule 15A NCAC 02B .0240 is provided in the table below:

Feature	Classification	[1]Subject to Buffer Rule	Adjacent Landuses	Buffer Credit Viable	[2]Nutrient Offset Viable at 2,273 lbs/acre	Mitigation Type/Comments
R1 (above pipe)	Modified Natural Stream	Yes	narrow buffer of Mixed native hardwood & pine forest	Yes[3]	No	Enhancement per 15A NCAC 02B .0295 (b)(4) in entire 50' from TOB
R1 (piped portion – fence line)	Piped stream	Yes[3]	managed lawn	Yes[3]	No	Restoration
R1 (below fence line – R5 confluence)	Modified natural stream	Yes	pasture actively grazed by cattle	Yes	Yes	Restoration

R2	Stream	Yes	Pasture actively grazed by cattle and narrow closed canopy of native hardwoods	Yes	Yes *(outside of forested area)*	Narrow closed canopy = Enhancement per 15A NCAC 02B .0295 (o)(6); Outside of forested areas = Restoration
R3	Ag Pond *(to be drained)*	Yes	Pasture actively grazed by cattle	Yes[3]	Yes	Restoration *(if pond is drained, a stream channel has to develop to be viable for any credit)*
R4	Stream	Yes	Native hardwood forest, closed canopy	Yes	No	Preservation per 15A NCAC 02B .0295 (o)(5)
R5	Undetermined conveyance	Not on maps	Pasture actively grazed by cattle	n/a	Yes	Need stream determination by DWR; if feature is a stream, feature is viable for buffer restoration per 15A NCAC 02B .0295 (o)(3)

[1]Subjectivity calls were determined using the 1:24,000 scale quadrangle topographic map prepared by USGS and the most recent printed version of the soil survey map prepared by the NRCS

[2]For nutrient offset viability to be determined, the landowner must provide proof in writing that the land is being used for agriculture or has been used for agriculture previously (prior to rule baseline). Dates, supported by photos or other written records, must be included to confirm that the uses of the open fields onsite are/were for hay crop cultivation/row crop/cattle.

[3]Feature has been piped or is a pond, but has potential for buffer mitigation if feature is restored into a stream.

Maps showing the project site and the features are provided and signed by Ms. Merritt on April 20, 2016. This letter should be provided in all future mitigation plans for this Site. In addition, all vegetative plantings, performance criteria and other mitigation requirements for riparian restoration, enhancement and preservation must follow the requirements in 15A NCAC 02B .0295 to be eligible for buffer and nutrient offset credits. Where buffer and nutrient offset credits are viable in the same area, only one credit type is allowed to be generated for credit, not both.

For any areas depicted as not being viable for nutrient offset credit, one could propose a different measure other than riparian restoration/enhancement, along with supporting calculations and sufficient detail to support estimates of load reduction, for review by the DWR to determine viability for nutrient offset according to 15A NCAC 02B .0240.

Please contact Katie Merritt at (919)-807-6371 if you have any questions regarding this correspondence.

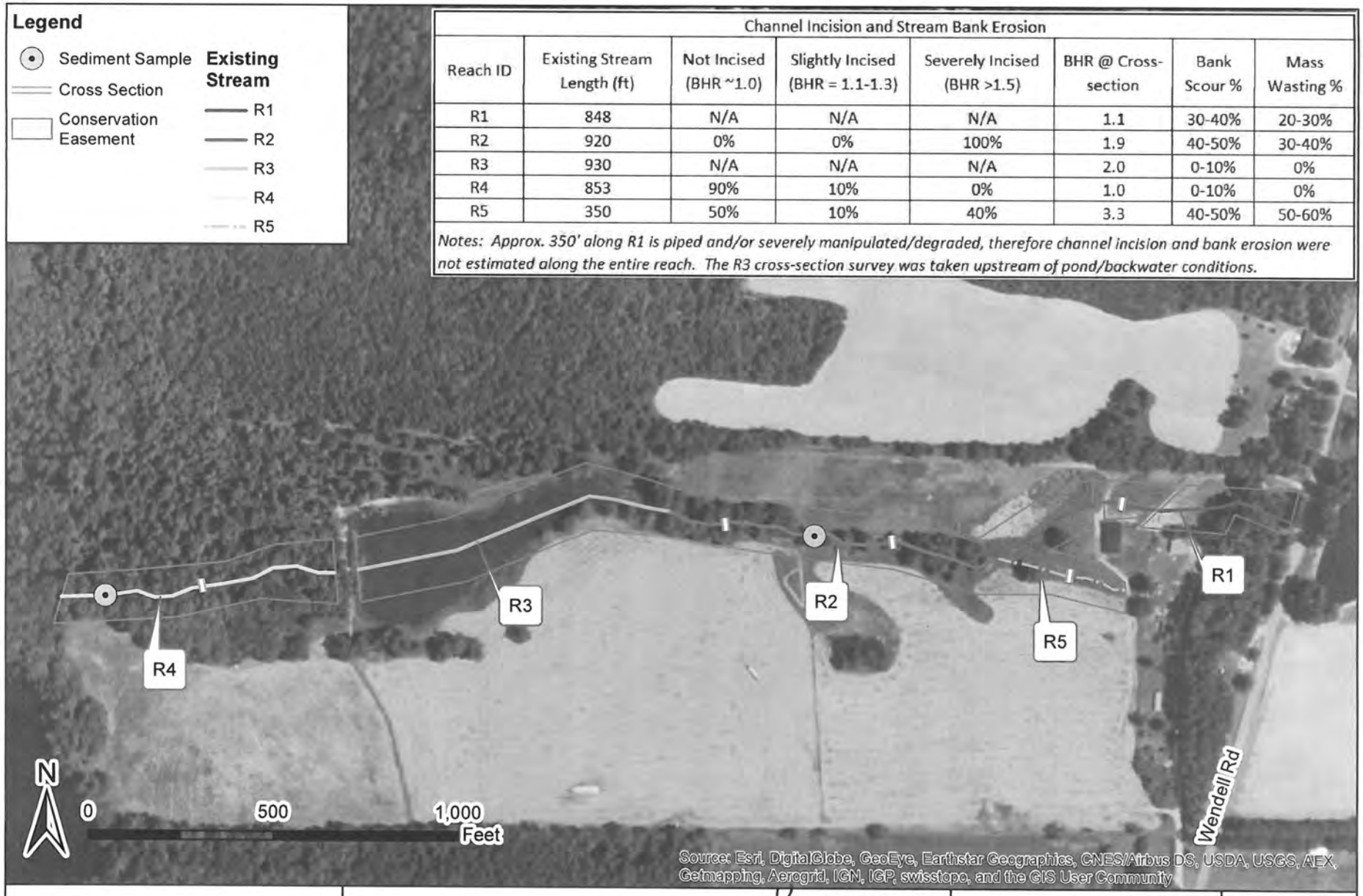
Sincerely,

Karen Higgins

Karen Higgins, Supervisor
401 and Buffer Permitting Branch

KAH/*km*
Attachments: Site Aerial Map, USGS Topographic Map, NRCS Soil Survey

cc:File Copy (Katie Merritt)
DMS – Jeff Schaffer (via electronic mail)



Channel Incision and Stream Bank Erosion							
Reach ID	Existing Stream Length (ft)	Not Incised (BHR ~1.0)	Slightly Incised (BHR = 1.1-1.3)	Severely Incised (BHR >1.5)	BHR @ Cross-section	Bank Scour %	Mass Wasting %
R1	848	N/A	N/A	N/A	1.1	30-40%	20-30%
R2	920	0%	0%	100%	1.9	40-50%	30-40%
R3	930	N/A	N/A	N/A	2.0	0-10%	0%
R4	853	90%	10%	0%	1.0	0-10%	0%
R5	350	50%	10%	40%	3.3	40-50%	50-60%

Notes: Approx. 350' along R1 is piped and/or severely manipulated/degraded, therefore channel incision and bank erosion were not estimated along the entire reach. The R3 cross-section survey was taken upstream of pond/backwater conditions.

WATER & LAND™ SOLUTIONS

Lake Wendell Mitigation Project

4/29/16

Channel Stabilty & Monitoring Features

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 8

Kpm 4/20/16 #2016-0385
Lake Wendell Site

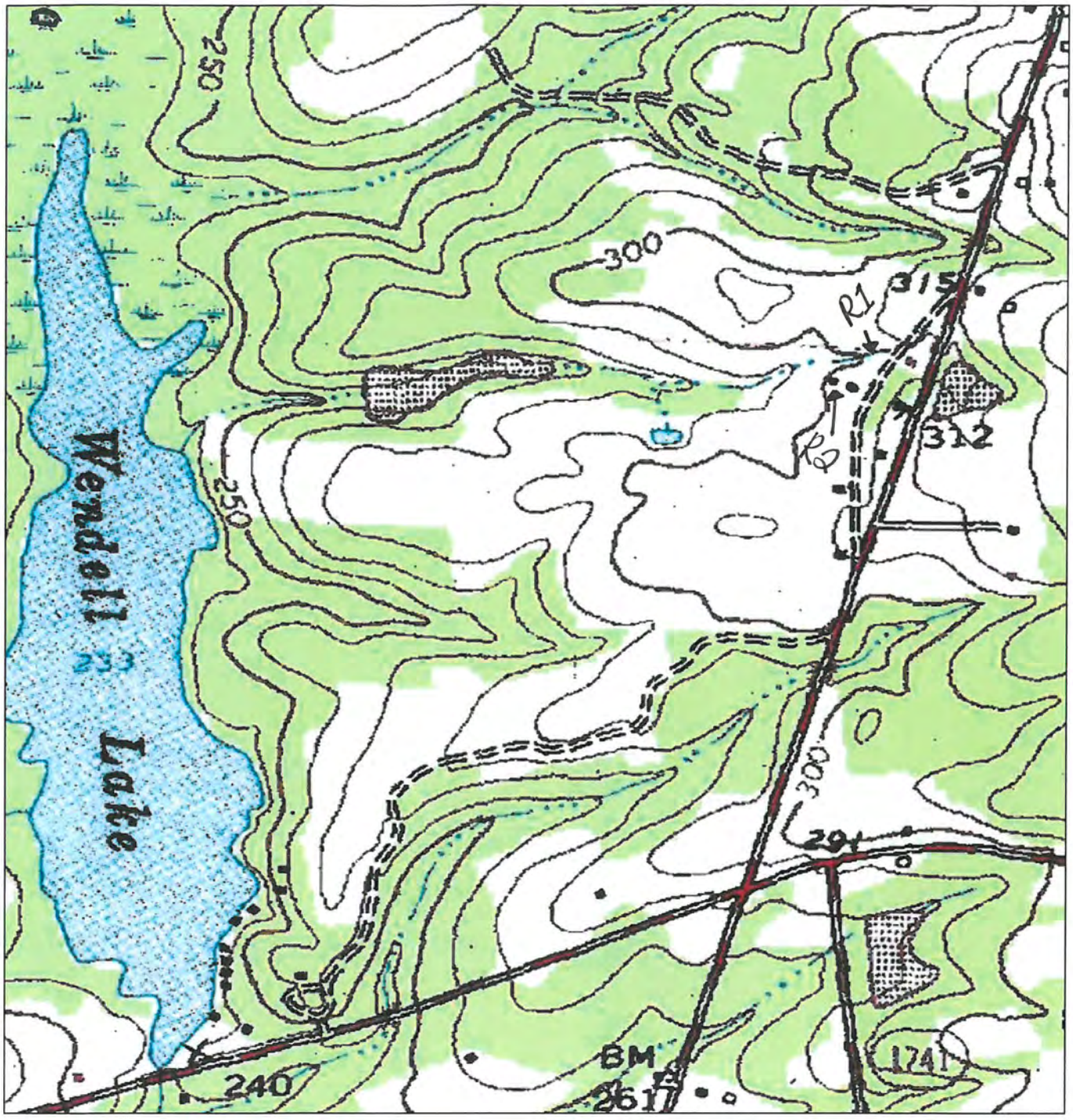
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 2
JOHNSTON COUNTY, NORTH CAROLINA

Scale 1:24000

JOHNSTON COUNTY, NORTH CAROLINA NO. 2

NC USGS Topo & Parcels Map



April 20, 2016

1:6,528

0 0.075 0.15 0.3 mi

0 0.1 0.2 0.4 km

Kym 4/20/16

2016-0385
Lake Wendell Site

Participating NC Counties, NCCGIA, NC OneMap, US EPA

bgeorgou