Monitoring Report – MY6
FINAL VERSION
Lake Wendell Mitigation Project
Calendar Year of Data Collection: 2023

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 V2
Johnston County, NC
Contracted Under RFP # 16-006477
Data Collection Period: March & October 2023
Submission Date: December 29, 2023

Prepared for:

North Carolina Department of Environmental Quality
Division of Mitigation Services
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December 29th, 2023

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

RE: WLS Responses to NCDEQ DMS Review Comments for Task 12 Draft Monitoring Report Year 6 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. Dunnigan:
Water & Land Solutions, LLC (WLS) is pleased to present the Final Monitoring Report Year 6 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 6 was developed by addressing NCDEQ DMS's review comments.

Under this cover, we are providing the Final Monitoring Report Year 6, and the required digital data for each (the .pdf copies of the entire updated reports and the updated digital data) via electronic delivery. We are providing our written responses to NCDEQ DMS's review comments on the Draft Monitoring Report Year 6 below. Each of the DMS review comments is copied below in **bold** text, followed by the appropriate response from WLS in regular text:

1. **Pg. 1, Section 1: Please update the buffer credit table to say no credits are convertible to nutrient offset.** WLS Response: The buffer credit table has been updated accordingly.

2. **Pg. 9, Section 5.4: Was any further encroachment of VPA3 noted during MY6? Did you get any response from the landowner after contact regarding VPA3?** WLS Response: No further encroachment of VPA3 was noted in MY6. The WLS project manager spoke to the landowner via phone after the attorney letter was received, and the letter was acknowledged.

3. **Pg. 9, Section 5.4: Please indicate that the proposed planted trees will only be species included in the approved mitigation plan or be approved by the IRT prior to planting.** WLS Response: Verbiage has been added in Section 5.4 to ensure that the proposed planted trees will only be species included in the approved mitigation plan or approved by the IRT prior to planting.

4. **Appendix D, Figure 4: Please update with rainfall through November if possible.** WLS Response: Rainfall through November 2023 has been updated in the Appendix D Rainfall Table.

5. **Reminder to update the bond through MY6 prior to invoicing.** WLS Response: WLS will update the bond prior to invoicing.

Electronic Deliverables:

1. **The random vegetation plot submitted in year 6 overlaps the random veg plot submitted in year 5. This may be resurvey based on DWR request, if so, please disregard the comment.** WLS Response: This was a resurvey request based on the DWR Buffer Closeout Site Meeting on July 19, 2023.

2. **There are three stream problem areas, one encroachment area, and two vegetation problem areas identified in the visual assessment tables and on the CCPV. Please submit these visual assessment digital files.** WLS Response: All relevant shapefiles have been added to the E-data folder.

Please contact me if you have any questions or comments.

Sincerely,

Water & Land Solutions, LLC

Alyssa Davis

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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 (see Table 2 below). WLS staff visited the site several times throughout 2023. Additional visits were made by DMS and Katie Merritt for Buffer Close-Out on July 19, 2023. Comments on the MY6 Buffer Close-out visit can be found in Appendix E. Monitoring Year 6 (MY6) data collection occurred in March and October of 2023 (see Appendix A, Table 2). This report presents the data for MY6. The Project meets the MY6 success criteria for stream hydrology, streambed condition and stability, and stream flow. Based on these results, the Project is expected to meet the Monitoring Year 7 (MY7) final success criteria in 2024.

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	Restoration	20-29			1	75%	1.33333	-		-	-
				0-100	342,525	342,525		100%	1.00000	342,525.000	No	-	-
				101-200				33%	3.03030	-		-	-
		Enhancement	Enh & Cattle Ex.	20-29			2	75%	2.66667	-		-	-
				0-100	44,852	44,852		100%	2.00000	22,426.000	No	-	-
				101-200				33%	6.06061	-		-	-
				SUBTOTALS		387,377				364,951.000		-	-
			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	Preservation	20-29			10	75%	13.33333	-			
				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 fi÷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.

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 (LWP) and 2015 Neuse 01 Regional Watershed Plan (RWP) 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.
Physiochemical (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 Appendix A, Table 2. Relevant project contact information is presented in Appendix A, Table 3. Relevant project background information is presented in Appendix A, Table 4.

3 Project Mitigation Components

Refer to Appendix B, Figure 1 and Appendix A, 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 zone planting. The Site was planted with native species riparian buffer vegetation and is now protected through a permanent conservation easement. Table 1 (Appendix A) and Figure 1 (Appendix B) 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 the 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 drainpipe 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, 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 the 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 gauge	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.
Physiochemical (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 (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 within riffles 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

Pebble counts or streambed material samples will not be collected per the DMS Pebble Count Data Requirements memo sent on October 19, 2021. The IRT reserves the right to request pebble count data/particle distributions if deemed necessary during the monitoring period.

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 years 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 planted trees per acre at the end of Year 3 of the monitoring period and at least 260, five-year-old planted 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 no less than 210, seven-year-old planted 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 at least 12" tall, 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 6 Assessment and Results

Annual monitoring was conducted during MY6 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). MY6 results are provided in the appendices. The Project meets the MY6 success criteria for stream hydrology and jurisdictional stream flow. Visual surveys indicate that the stream horizontal and vertical stability are meeting requirements.

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 gauge 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. One recorded bankfull event occurred during MY6. This event was documented using photography (Table 8). Documented flow events in MY1 and MY2 satisfied the requirement of the occurrence of two bankfull events in separate years. See the table below for a summary of bankfull events documented in all monitoring years.

Monitoring Year	Documented Bankfull Events	Requirement Met
1	2	No
2	2	Yes
3	2	Yes
4	1	Yes
5	1	Yes
6	1	Yes

5.2 Stream Horizontal & Vertical Stability

Visual assessment was utilized for assessment of MY6 horizontal and vertical stream stability. The visual assessments for each stream reach concluded that the MY6 stream channel pattern and longitudinal profiles and in-stream structures location/function still closely match the profile design parameters and MY0/baseline conditions (Appendix C). Cross-section surveys were not required for MY6 per the mitigation plan. They will be completed in MY7.

Minor piping was noted in MY3 at two in-stream structures near approximate stations 26+00 (SPA1) and 26+50 (SPA2). An additional log structure was found to have minor piping near station 24+00 (SPA4). Hand repair work was conducted during MY5 at SPA2 and SPA4. Crushed stone was added behind the log structures to prevent water from piping underneath. Livestakes were also added near the structures to prevent bank erosion. The hand work did not remediate the issues as piping has continued in MY6. While these three structures are not functioning as designed, there is not a systemic problem upstream or downstream. Monitoring of these areas will continue in MY7.

5.3 Jurisdictional Stream Flow Documentation

Jurisdictional stream flow documentation and monitoring of restored intermittent reaches is achieved by the installation of a flow gauge (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 gauge documented the stream exhibited surface flow for 193 consecutive days from January 1st to July 12th, 2023 (see Figure 3a).

5.4 Vegetation

Vegetation plot surveys were not required during MY6 per the mitigation plan, surveys will continue in MY7. The MY6 vegetation monitoring was conducted utilizing visual assessment throughout the easement. The results of the visual assessment did not indicate any negative changes to the existing vegetation community. An area of encroachment approximately 0.009 acres was found along R5 in MY5, see Figure 1 (VPA3). This area had been mowed by the adjacent homeowner and was vegetated with dog fennel and other pasture weeds. Management of this area in MY5 included additional t-posts and a physical barrier (horse tape) to delineate the easement boundary and discourage further mowing. The landowner was contacted via mail by our attorney, and receipt was acknowledged via a phone call with the WLS project manager. During MY6, additional large, containerized trees were planted in this area (See table below for planted species).

A previous area of concern (VPA1) located along R1 buffer as shown on the CCPV (noted first in MY1) 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 2023 year in June and August (see table below for treatments). Following these treatments, the percent cover of kudzu was reduced to approximately one percent. The entirety of VPA1 was planted with trees from the approved list in the mitigation plan on February 1st, 2021 (see table below for plant list). Due to a low stem count observed during the Buffer Close Out meeting on July 19, 2023, there was a request for a random transect in VPA1 during MY6 (see Appendix E for Buffer Close out correspondence). A random vegetation plot in VPA1 was surveyed on October 10th, 2023 (see table below for results). The transect did not meet stem requirements and will require a supplemental planting of 20 containerized trees in the dormant season prior to MY7. All proposed planted trees will be species included in the approved mitigation plan or approved by the IRT prior to planting. This area will continue to be treated for Kudzu during MY7 and documented in future reports.

Kudzu Treatment Table

Monitoring Year	Invasive Treatment	Date Treatment Conducted
2	Kudzu foliar spray and cut	August 15, 2019
	Kudzu foliar spray	September 24, 2019
3	Kudzu crown removal	March 18, 2020
	Kudzu foliar spray	October 7, 2020
4	Kudzu foliar spray	July 1, 2021
5	Kudzu spray and cut	September 8, 2022
6	Kudzu foliar spray	June 14, 2023
	Kudzu foliar spray	August 8, 2023

Random Veg Plot (VPA1) Results

Species	Number of Stems	Heights
Loblolly Pine	5	5.9, 6.3, 5.1, 3.5, 3.8
Sweetgum	5	6.8, 3.5, 4.4, 4.7, 4.9
Northern Red Oak	1	3.6

Planted Species VPA3

Species	Number of Stems	Potted Size
Betula nigra (River Birch)	2	15 gallon
Magnolia virginiana (Sweetbay Magnolia)	1	15 gallon
Platanus occidentalis (American Sycamore)	2	15 gallon

5.5 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 3). No performance standards for wetland hydrology success were proposed in the Mitigation Plan, and therefore wetland mitigation monitoring is not included for this project. The wetland gauge recorded a maximum consecutive hydroperiod of 60 days or 32.16% of the growing season. The wetland gauge data is in Appendix D.

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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	**3,392.100**
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: 5 yrs 8 months
Elapsed Time Since planting complete: 5 yrs 8 months
Number of reporting Years[0]: 6

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	11/15/2019
Encroachment Documented (VPA 2)	10/1/2020	N/A
Year 3 Monitoring Report Submittal	10/15/2020	12/11/2020
Encroachment/Kudzu Area Planting (VPA1 & 2)	N/A	2/1/2021
Year 4 Monitoring Report Submittal	9/14/2021	10/20/2021
In-Stream Structure Repairs (SPA 2 & 4)	N/A	6/14/2022
Encroachment Documented (VPA3)	6/14/2022	N/A
Year 5 Monitoring Report Submittal	9/13/2022	11/30/2022
Replant Encroachment (VPA3) (~0.009 acres)	N/A	4/2023
Invasive Treatment	N/A	6/14/2023
Buffer Close Out	N/A	7/19/2023
Invasive Treatment	N/A	8/8/2023
Year 6 Monitoring Report Submittal	10/10/2023	12/29/2023
Year 7 Monitoring Report Submittal	N/A	N/A

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	Leah Farr Phone: 919-971-4575
Vegetation Monitoring POC	Leah Farr Phone: 919-971-4575

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

Figure 1: Current Condition Plan View (CCPV)
Table 5: Visual Stream Morphology Stability Assessment
Table 5a: Vegetation Condition Assessment
Stream Station Photographs
Stream Problem Area Photographs
Vegetation Problem Area Photographs

Legend

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

CVS Vegetation Plots

- Success Criteria Met
- Random Transect VPA1
- Water Quality Features
- Top of Streambank
- Culvert Pipes
- Pre-Construction Wetlands (1.16 acres)
- Stream Structural Issues
- Kudzu Area (0.13 acres)
- Encroachment (0.009 acres)

Stream Mitigation Type

- Restoration
- Enhancement II
- Preservation

Access point: 35.73764° 78.34884°

VPA1 - Kudzu

VPA3 - Encroachment

SPA1

SPA2

SPA4

R1

R2

R3

R4

R5

Culvert

Culvert

Crest Gauge

Flow Gauge

Wetland Reference Gauge

405/405

486/486

567/486

607/567

486/486

485/364

405/324

PS-1

PS-2

PS-3

PS-4

PS-5

PS-6

PS-7

PS-8

PS-9

PS-10

PS-11

PS-12

PS-13

XS-1

XS-2

XS-3

XS-4

XS-5

XS-6

XS-7

XS-8

Wendell Road

N

0 220 440 Feet

Aerial: Google Earth March 2021

WATER & LAND™ SOLUTIONS	NC Mitigation Services ENVIRONMENTAL QUALITY	**Lake Wendell Mitigation Project** **Johnston County, North Carolina**	NCDMS Contract No. 6826 NCDMS Project No. 97081 October 2023 MY6	Current Conditions Plan View Monitoring Year 6 NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 1

Table 5a	Visual Stream Morphology Stability Assessment
Project	Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)
Reach ID	R1
Assessed Length	839

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	17	17			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	5	5			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	6	6			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	3	3			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	3	3			100%			

Table 5b	Visual Stream Morphology Stability Assessment									
Project	Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)									
Reach ID	R2									
Assessed Length	992									
Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	8	8			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	4	4			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	1	4			25%			
	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)	7	7			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	7	7			100%			

Table 5c	Visual Stream Morphology Stability Assessment									
Project	Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)									
Reach ID	R3									
Assessed Length	1,268									
Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	27	27			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	3	3			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	4	4			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	12	12			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	12	12			100%			

Table 5d	Visual Stream Morphology Stability Assessment
Project	Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)
Reach ID	R4
Assessed Length	813

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

Table 5e	Visual Stream Morphology Stability Assessment
Project	Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)
Reach ID	R5
Assessed Length	357

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	5	5			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	3	3			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	3	3			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	0	0			N/A			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	0	0			N/A			

Table 5f 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.	0.01 acres	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	1	0.009	0.1%

PS-1, R1, facing upstream, Sta 11+50, June 11, 2018 (MY-00)

PS-1, R1, facing upstream, Sta 11+50, March 2, 2023 (MY-06)

PS-1, R1, facing downstream, Sta 11+50, June 11, 2018 (MY-00)

PS-1, R1, facing downstream, Sta 11+50, March 2, 2023 (MY-06)

PS-2, R1, facing upstream, Sta 13+50, April 27, 2018 (MY-00)

PS-2, R1, facing upstream, Sta 13+50, March 2, 2023 (MY-06)

PS-2, R1, facing downstream, Sta 13+50, April 27, 2018 (MY-00)

PS-2, R1, facing downstream, Sta 13+50, March 2, 2023 (MY-06)

PS-3, R1, facing downstream, Sta 17+50, April 27, 2018 (MY-00)

PS-3, R1, facing downstream, Sta 17+50, March 2, 2023 (MY-06)

PS-3, R1, facing upstream, Sta 17+50, April 27, 2018 (MY-00)

PS-3, R1, facing upstream, Sta 17+50, March 2, 2023 (MY-06)

PS-4, R2, facing downstream, Sta 18+50, April 30, 2018 (MY-00)

PS-4, R2, facing downstream, Sta 18+50, March 2, 2023 (MY-06)

PS-5, R2, facing upstream, Sta 26+50, April 27, 2018 (MY-00)

PS-5, R2, facing upstream, Sta 26+50, March 2, 2023 (MY-06)

PS-6, R2, facing downstream, Sta 27+50, April 27, 2018 (MY-00)

PS-6, R2, facing downstream, Sta 27+50, March 2, 2023 (MY-06)

PS-7, R2, facing upstream, Sta 28+25, April 27, 2018 (MY-00)

PS-7, R2, facing upstream, Sta 28+25, March 2, 2023 (MY-06)

PS-8, R3, facing downstream, Sta 32+00, April 27, 2018 (MY-00)

PS-8, R3, facing downstream, Sta 32+00, March 2, 2023 (MY-06)

PS-9, R3, facing downstream, Sta 37+50, April 27, 2018 (MY-00)

PS-9, R2, facing downstream, Sta 37+50, March 2, 2023 (MY-06)

PS-10, R3, facing upstream, Sta 39+50, March 20, 2018 (MY-00)

PS-10, R3, facing upstream, Sta 39+50, March 2, 2023 (MY-06)

PS-10, R4, facing downstream, Sta 40+00, March 20, 2018 (MY-00)

PS-10, R4, facing downstream, Sta 40+00, March 2, 2023 (MY-06)

PS-11, R4, facing downstream, Sta 44+50, August 21, 2018 (MY-00)

PS-11, R4, facing downstream, Sta 44+50, March 2, 2023 (MY-06)

PS-12, R5, facing downstream, Sta 10+00, April 27, 2018 (MY-00)

PS-12, R5, facing downstream, Sta 10+00, March 2, 2023 (MY-06)

PS-13, R5, facing upstream, old crest gauge, Sta 13+50, Apr 27, 2018 (MY-00)

PS-13, R5, facing upstream, Sta 13+50, March 2, 2023 (MY-06)

SPA1, October 14, 2020 (MY-03)

SPA1, March 2, 2023 (MY-06)

SPA2, October 14, 2020 (MY-03)

SPA2 (after repair), June 14, 2022 (MY-05)

SPA2, March 2, 2023 (MY-06)

SPA4, March 30, 2022 (MY-05)

SPA4, March 30, 2022 (MY-05)

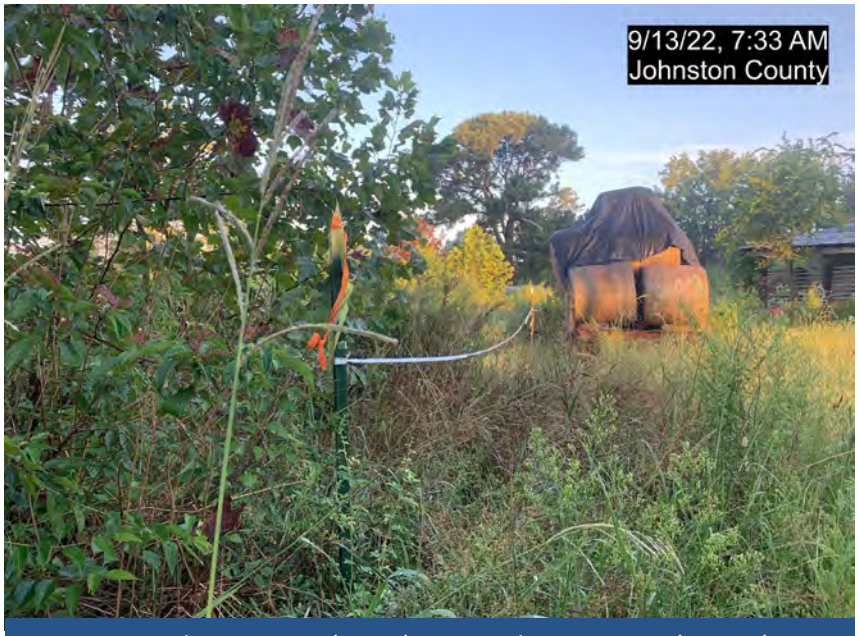
SPA4 (after repair), June 14, 2022 (MY-05)

SPA4, March 2, 2023 (MY-06)

Kudzu Problem Area (VPA1), October 22, 2020 (MY-03)

Kudzu Problem Area (VPA1), October 25, 2023 (MY-06)

Encroachment Area (VPA3), June 14, 2022 (MY-05)



Encroachment Area (VPA3), September 13, 2022 (MY-05)

Encroachment Area (VPA3), June 13, 2023 (MY-06)

Encroachment Area (VPA3), Replanted area, October 25, 2023 (MY-06)

Random Veg Transect in VPA1, Southwest, October 10, 2023 (MY-06)

Random Veg Transect in VPA1, Northeast, October 10, 2023 (MY-06)

Appendix C:

Stream Measurement and Geomorphology Data

Table 7a: Baseline Stream Data Summary
Table 7b: Cross-section Morphology Data
Table 7c: Stream Reach Morphology Data

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	-	5.8	-
Floodprone Width (ft)	6.1	18.7	10.0	20.0	14.0	30.0	23.1	-
Bankfull Mean Depth (ft)	0.5	0.7	0.8	1.6	0.5	-	0.4	-
Bankfull Max Depth (ft)	0.8	1.5	0.9	1.3	0.6	-	0.7	-
Bankfull Cross Sectional Area (ft^2)	2.5	2.8	3.0	5.0	2.7	-	2.3	-
Width/Depth Ratio	5.3	17.7	6.2	14.2	13.0	-	14.6	-
Entrenchment Ratio	1.2	9.9	7.1	8.4	2.4	5.1	4.3	-
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	-	6.6	-
Floodprone Width (ft)	13.7	14.1	10.0	20.0	15.0	30.0	45.0	-
Bankfull Mean Depth (ft)	0.6	0.7	0.8	1.6	0.5	-	0.5	-
Bankfull Max Depth (ft)	0.9	1.0	0.9	1.3	0.7	-	1.1	-
Bankfull Cross Sectional Area (ft^2)	4.2	5.9	3.0	5.0	3.6	-	3.6	-
Width/Depth Ratio	8.2	15.2	6.2	14.2	13.0	13.0	12.8	-
Entrenchment Ratio	1.4	2.2	7.1	8.4	2.2	4.4	7.4	-
Bank Height Ratio	1.8	1.9	0.9	1.1	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	-	7.3	-
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	-	0.5	-
Bankfull Max Depth (ft)	0.9	-	0.9	1.3	0.7	-	0.8	-
Bankfull Cross Sectional Area (ft^2)	5.9	-	3.0	5.0	4.4	-	3.5	-
Width/Depth Ratio	15.2	-	6.2	14.2	14.0	-	15.1	-
Entrenchment Ratio	1.4	-	7.1	8.4	2.2	4.5	8.0	-
Bank Height Ratio	1.8	-	0.9	1.1	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	8.5
Floodprone Width (ft)	44.1	-	10.0	35.0	17.0	35.0	17.0	35.0
Bankfull Mean Depth (ft)	1.0	-	0.8	1.6	0.7	0.9	0.7	0.9
Bankfull Max Depth (ft)	1.8	-	0.9	1.3	0.8	0.9	0.8	0.9
Bankfull Cross Sectional Area (ft^2)	6.2	-	3.0	5.0	6.2	6.2	6.2	6.2
Width/Depth Ratio	6.3	-	6.2	14.2	12.0	12.0	12.0	12.0
Entrenchment Ratio	7.1	-	7.1	8.4	1.8	5.3	1.8	1.8
Bank Height Ratio	1.0	-	0.9	1.1	1.0	1.1	1.0	1.1
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	-	4.3	
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	
Bankfull Max Depth (ft)	0.8	-	0.9	1.3	0.5	-	0.7	
Bankfull Cross Sectional Area (ft^2)	1.4	-	3.0	5.0	1.5	-	1.6	
Width/Depth Ratio	3.5	-	10.3	14.2	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	
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	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Width (ft)	5.8	5.5	10.4	8.6	N/A	11.0	N/A		6.1	7.9	7.0	4.0	N/A	5.1	N/A		6.6	6.8	6.4	6.0	N/A	6.4	N/A	
Floodprone Width (ft)	23.1	23.0	21.7	21.6	N/A	22.7	N/A		45.0	45.0	49.0	49.0	N/A	48.8	N/A		46.0	45.0	50.0	46.2	N/A	44.7	N/A	
Bankfull Mean Depth (ft)	0.4	0.4	0.2	0.2	N/A	0.2	N/A		0.8	0.6	0.6	1.0	N/A	0.8	N/A		0.5	0.5	0.5	0.6	N/A	0.5	N/A	
Bankfull Max Depth (ft)	0.7	0.6	0.6	0.6	N/A	0.5	N/A		1.2	1.3	1.3	1.4	N/A	1.1	N/A		1.1	1.1	1.0	0.9	N/A	0.8	N/A	
Bankfull Cross Sectional Area (ft^2)	2.3	2.0	2.0	2.0	N/A	1.9	N/A		4.6	4.1	4.1	4.1	N/A	4.1	N/A		3.5	3.5	3.5	3.5	N/A	3.5	N/A	
Bankfull Width/Depth Ratio	14.6	13.2	55.2	38.0	N/A	61.9	N/A		8.0	14.2	12.0	3.9	N/A	6.3	N/A		12.7	13.0	11.9	10.1	N/A	11.8	N/A	
Bankfull Entrenchment Ratio	4.3	4.2	2.1	2.5	N/A	2.1	N/A		7.5	5.7	7.0	12.2	N/A	9.5	N/A		7.5	6.8	7.8	7.7	N/A	7.0	N/A	
Bankfull Bank Height Ratio	1.0	1.0	<1	<1	N/A	0.87	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A		1.0	1.0	1.1	1.1	N/A	1.00	N/A	
d50 (mm)	N/A	0.80	21.00	0.82	21.00	N/A	N/A		N/A	0.64	1.35	0.20	0.65	N/A	N/A		N/A	0.80	21.00	0.82	21.00	N/A	N/A	
	Cross Section 4 (Pool)								**Cross Section 5 (Riffle)**								**Cross Section 6 (Riffle)**							
Parameters	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Width (ft)	14.2	14.3	14.2	19.8	N/A	14.7	N/A		7.9	7.3	8.4	7.9	N/A	6.4	N/A		6.7	7.0	8.6	7.7	N/A	7.2	N/A	
Floodprone Width (ft)	68.0	68.0	68.0	68.0	N/A	68.0	N/A		59.0	59.0	49.0	59.1	N/A	61.3	N/A		49.0	49.0	49.0	49.0	N/A	49.0	N/A	
Bankfull Mean Depth (ft)	0.6	0.6	0.6	0.4	N/A	0.6	N/A		0.5	0.5	0.3	0.3	N/A	0.4	N/A		1.6	1.6	1.3	1.4	N/A	1.6	N/A	
Bankfull Max Depth (ft)	1.6	1.6	1.5	1.5	N/A	1.6	N/A		0.8	0.8	0.8	0.8	N/A	0.7	N/A		2.5	2.6	2.7	2.5	N/A	2.7	N/A	
Bankfull Cross Sectional Area (ft^2)	8.5	8.5	8.5	8.5	N/A	8.5	N/A		3.7	2.7	2.7	2.7	N/A	2.7	N/A		10.8	11.2	11.2	11.2	N/A	11.2	N/A	
Bankfull Width/Depth Ratio	23.8	24.4	23.8	46.5	N/A	25.3	N/A		16.8	15.1	25.2	23.1	N/A	14.9	N/A		4.2	4.4	6.7	5.3	N/A	4.6	N/A	
Bankfull Entrenchment Ratio	4.8	4.8	4.8	3.4	N/A	4.6	N/A		7.4	8.0	5.8	7.5	N/A	9.6	N/A		7.3	7.0	5.7	6.3	N/A	6.8	N/A	
Bankfull Bank Height Ratio	N/A	N/A	N/A	N/A	N/A	N/A	N/A		1.0	<1	1.0	1.0	N/A	1.08	N/A		1.0	1.0	1.0	1.0	N/A	1.06	N/A	
d50 (mm)	N/A	0.64	1.35	0.20	0.65	N/A	N/A		N/A	0.80	21.00	0.82	21.00	N/A	N/A		N/A	0.80	21.00	0.82	21.00	N/A	N/A	
	Cross Section 7 (Pool)								**Cross Section 8 (Riffle)**															
Parameters	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7								
Bankfull Width (ft)	13.1	12.7	10.7	8.0	N/A	6.9	N/A		4.3	4.6	4.9	8.6	N/A	5.0	N/A									
Floodprone Width (ft)	44.0	44.0	44.0	44.0	N/A	43.2	N/A		24.0	20.0	23.0	23.0	N/A	23.2	N/A									
Bankfull Mean Depth (ft)	1.2	1.3	1.2	1.5	N/A	1.8	N/A		0.4	0.5	0.4	0.2	N/A	0.4	N/A									
Bankfull Max Depth (ft)	2.9	2.8	2.9	3.0	N/A	3.1	N/A		0.7	0.6	0.7	0.6	N/A	0.7	N/A									
Bankfull Cross Sectional Area (ft^2)	15.4	12.3	12.3	12.3	N/A	12.3	N/A		1.6	2.1	2.1	2.1	N/A	2.1	N/A									
Bankfull Width/Depth Ratio	10.9	9.6	9.3	5.2	N/A	3.9	N/A		12.1	10.1	11.3	35.4	N/A	12.0	N/A									
Bankfull Entrenchment Ratio	3.4	3.5	4.1	5.5	N/A	6.2	N/A		5.5	4.3	4.7	2.7	N/A	4.7	N/A									
Bankfull Bank Height Ratio	N/A	N/A	N/A	N/A	N/A	N/A	N/A		1.0	1.2	1.0	<1	N/A	0.96	N/A									
d50 (mm)	N/A	0.64	1.35	0.20	0.65	N/A	N/A		N/A	0.80	21.00	0.82	21.00	N/A	N/A									

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												

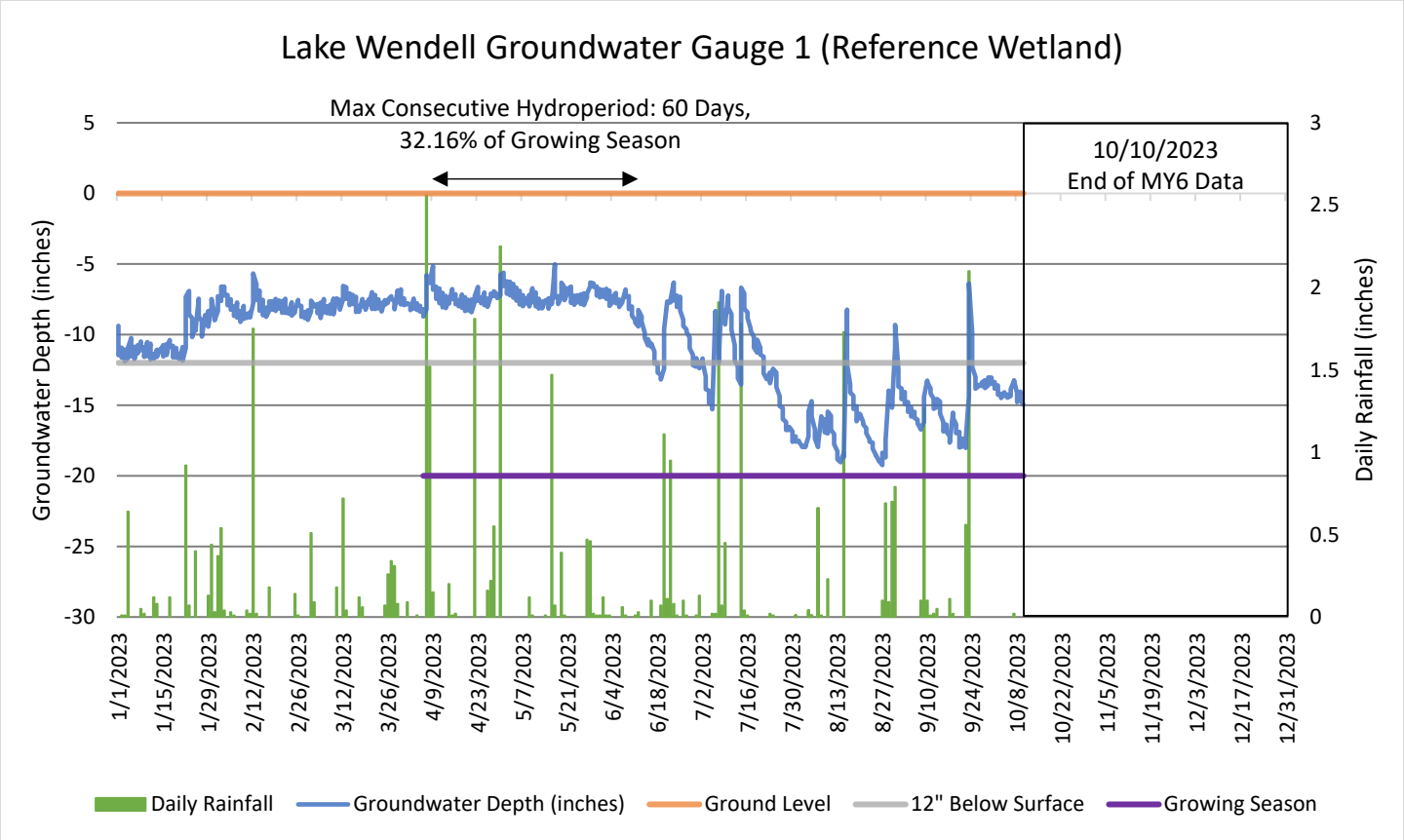
Pattern and Profile data will not typically be collected unless visual data, dimensional data or profile data indicate significant deviations from baseline conditions

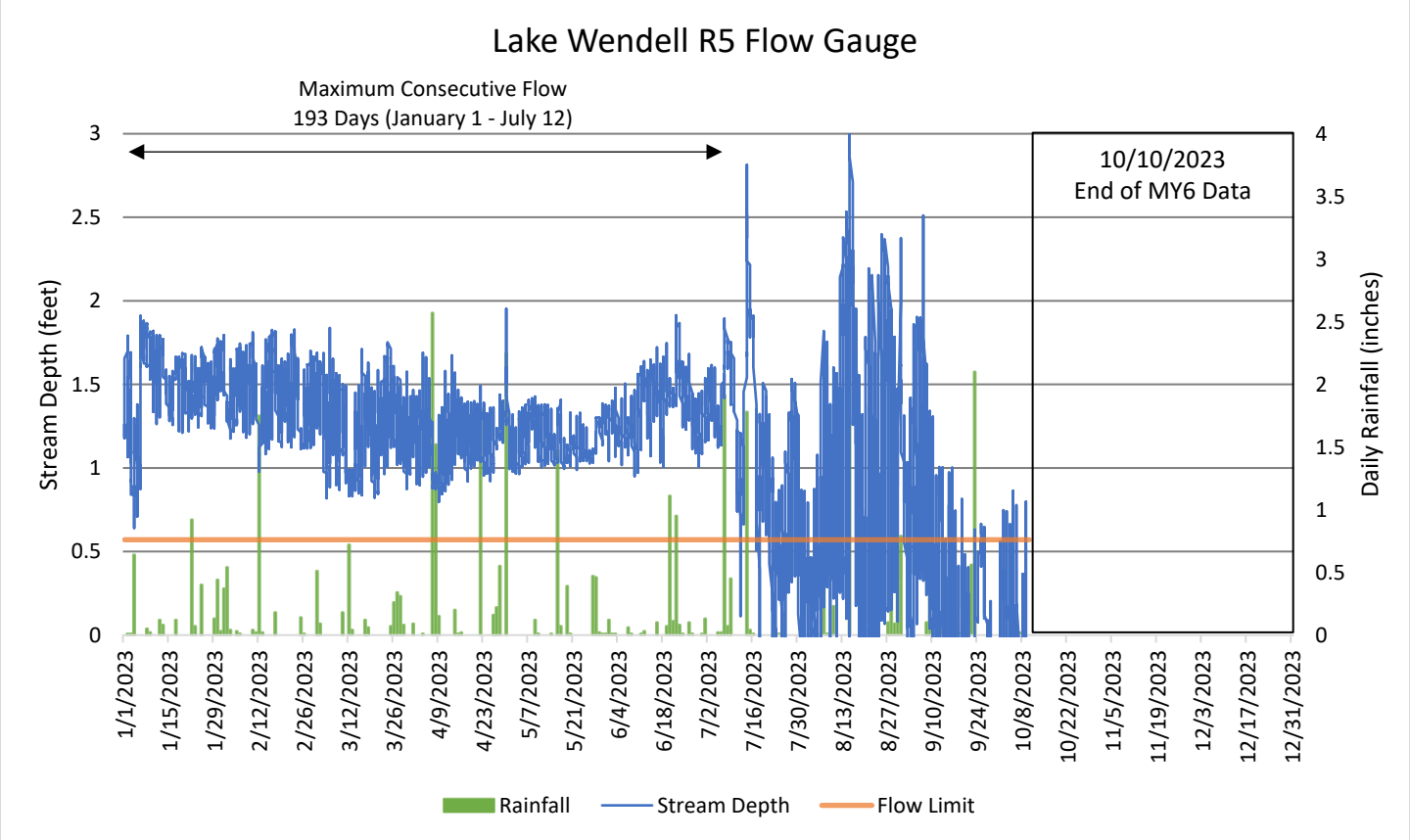
Appendix D: Hydrologic Data

Table 8: Verification of Flow Events
Figure 3a: Hydrograph Data
Figure 3b: Groundwater Gauge Data
Figure 4: Monthly Rainfall Data

Table 8. Verification of Flow Events						
Monitoring Year	Date of Data Collection	Date of Occurrence	Method	Greater than Bankfull (Bkf) or Qgs (Q2*0.66 = 21.73 CFS) Stage?	Photo/ Notes	Height above bankfull
MY1	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	
MY2	7/26/2019	7/24/2019	Crest Gauge	Bkf	Photos	.325 ft
	8/20/2019	uknown	Crest Gauge	Bkf & Qgs	Photos	.45 ft
MY3	2/7/2020	uknown	Crest Gauge	Bkf & Qgs	Photos	.6 ft
	9/30/2020	uknown	Crest Gauge	Bkf & Qgs	Photos	1.2 ft
MY4	1/13/2021	unknown	Crest Gauge	Bkf	Photos	0.5 ft
MY5	3/30/2022	unknown	Oberserved visual indicators (recent alluvial deposit and wrack lines) of stage after storm	Bkf	Photos	
MY6	10/25/2023	unknown	Observed indicators of bankfull stage (wrack lines) after storm event	Bkf	Photos	

FIGURE 3a: Hydrograph Data

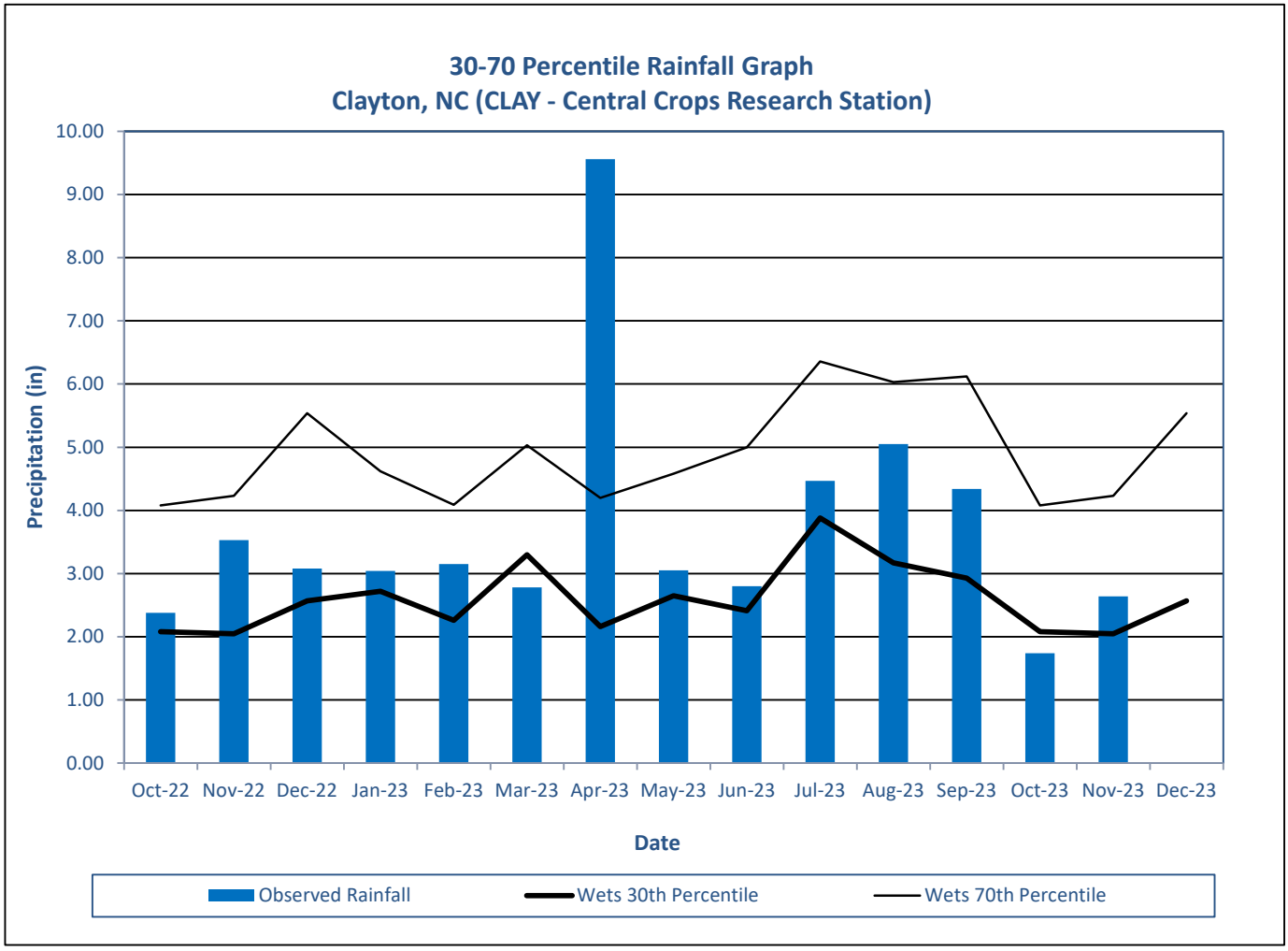




226 days of cumulative flow, 57 days of cumulative no flow

Figure 3b: Groundwater Gauge Data Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081) MY6 2023								
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%	32.16%	33.04%	26.43%	32.16%		**45.42%**

Figure 4: Monthly Rainfall Data
Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)
MY6 2023



*30th and 70th percentile rainfall data collected from weather station CLAY - Central Crops Research Station in Clayton, NC.
**Incomplete Month

Month	30%	70%	Observed
Oct-22	2.08	4.08	2.38
Nov-22	2.05	4.23	3.53
Dec-22	2.57	5.54	3.08
Jan-23	2.72	4.62	3.04
Feb-23	2.26	4.09	3.15
Mar-23	3.30	5.03	2.78
Apr-23	2.16	4.20	9.56
May-23	2.65	4.58	3.05
Jun-23	2.41	5.00	2.8
Jul-23	3.88	6.36	4.47
Aug-23	3.17	6.03	5.05
Sep-23	2.93	6.12	4.34
Oct-23	2.08	4.08	1.74
Nov-23	2.05	4.23	2.64
Dec-23	2.57	5.54	**

Appendix E: Correspondence

Buffer Close-Out Acceptance Letter – October 24, 2023
DMS Boundary Inspection Report Letter – May 25, 2023
WLS Response Letter – June 19, 2023
Attorney Landowner Encroachment Letter

ROY COOPER
Governor
ELIZABETH S. BISER
Secretary
RICHARD E. ROGERS, JR.
Director

NORTH CAROLINA
Environmental Quality

October 24, 2023

Division of Mitigation Services
Attn: Melonie Allen
(via electronic mail: melonie.allen@deq.nc.gov)

DWR Project # 2016-0385v2
Johnston County

Re: **Lake Wendell Mitigation Site**
DMS ID #97081 –CLOSEOUT ACCEPTANCE LETTER

Dear Ms. Allen,

On July 31, 2023, the Division of Water Resources (DWR) received a formal close-out packet from you on behalf of the Division of Mitigation Services (DMS) requesting approval to close-out the subject site for monitoring and maintenance of the riparian areas where riparian buffer credit and nutrient offset credit is generated. On July 19, 2023, Katie Merritt with DWR visited the subject site with staff from DMS (Jeremiah Dow, Emily Dunnigan) and to assess the vegetation and overall site conditions. The asset map and asset table, both initialed by Ms. Merritt on October 23, 2023, are attached. The credit asset table originally submitted with the close-out packet showed that buffer credits could be converted to nutrient offset credits. However, upon review, it was determined that DWR only approved riparian buffer credits for this project. Therefore, no nutrient offset credits are approved with this closeout acceptance.

Minor remediation work was deemed necessary by DWR during the site visit at the upmost reach of R1. Trees were not observed due to an abundance of kudzu and other herbaceous vegetation. Supplemental planting or a replant will be necessary if a transect in this area reveals low to absent stem density. This area and any supplemental planting performed by DMS will need be included in the monitoring reports to the InterAgency Review Team (IRT) for future monitoring years associated with the stream and/or wetland mitigation. The remedial action plan is attached to this letter.

This mitigation site is located in the Neuse River Basin *(not within the Falls Watershed)* and within the 8-digit HUC 03020201. Due to the location of this mitigation site, Riparian Buffer Credits can be provided for permitted impacts within the Neuse River Basin 8-digit HUC 03020201, excluding impacts in the Falls Watershed.

DWR has reviewed the close-out request and the following is approved:

Project Site Location	Mitigation Type	Credit Type	Convertible to Buffer?	*Convertible to Nutrient?
Neuse 03020201 (see notes above)	Riparian Preservation	Buffer	Yes 10,410.300 ft^2	No
Neuse 03020201 (see notes above)	Riparian Restoration	Buffer	Yes 342,525 ft^2	No
Neuse 03020201 (see notes above)	Riparian Cattle Exclusion Enhancement	Buffer	Yes 22,426 ft^2	No
Total Buffer Credit Potential ***(if not converting to nutrient offset)***			375,361.300 ft^2	
Total Nutrient Offset Credit Potential ***(if not converting to riparian buffer)***				No credits

**buffer credits used for buffer credit cannot be used for nutrient offset*
**nutrient offset credit used for nutrient offset credit cannot be used for buffer credit*

Please feel free to contact Ms. Merritt at (919) 500-0683 if you have any questions regarding this correspondence.

Sincerely,

DocuSigned by:
Stephanie Goss
755ABF0CD80B428...

Stephanie Goss, Supervisor
401 & Buffer Permitting Branch

ATTACHMENTS: Project Components Table, Project Component Map, Remedial Action Plan

cc: File Copy – (DWR)
USACE (IRT) – Kim Isenhour (kimberly.t.isenhour@usace.army.mil
DWR (IRT) – Maria Polizzi (maria.polizzi@deq.nc.gov)

Table 2. Buffer Project Areas and Assets: Lake Wendell

RIPARIAN BUFFER (15A NCAC 02B.0295)

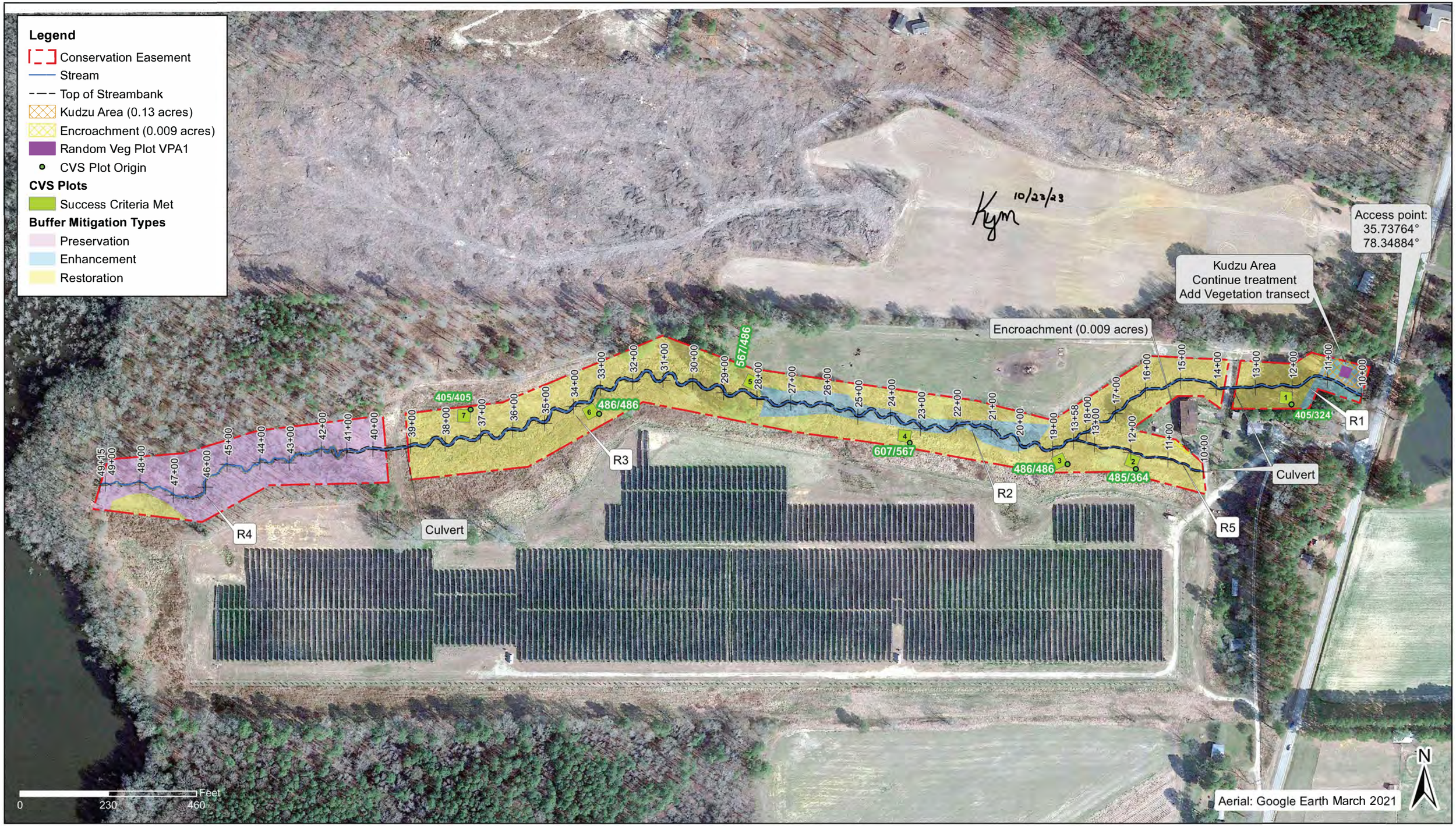
											If Converted to Nutrient Offset		
Location	**Jurisdictional Streams**	**Restoration Type**	**Reach ID/ Component**	**Buffer Width (ft)**	**Total Area (sf)**	**Creditable Area (sf)***	**Initial Credit Ratio (x:1)**	**% Full Credit**	**Final Credit Ratio (x:1)**	**Riparian Buffer Credits (BMU)**	**Convertible to Nutrient Offset (Yes or No)**	**Nutrient Offset: N (lbs)**	**Nutrient Offset: P (lbs)**
Rural or Urban	Subject or Nonsubject	Restoration		20-29				75%	1.33333	-		-	-
			Restoration	0-100	342,525	342,525	1	100%	1.00000	342,525.000	No	-	
				101-200				33%	3.03030	-		-	-
		Enhancement		20-29				75%	2.66667	-		-	-
			Enh & Cattle Ex.	0-100	44,852	44,852	2	100%	2.00000	22,426.000	No	-	-
				101-200				33%	6.06061	-		-	-
				SUBTOTALS		**387,377**				**364,951.000**		**-**	**-**
			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				75%	13.33333	-			
			Preservation	0-100	104,103	104,103	10	100%	10.00000	10,410.300			
				101-200				33%	30.30303	-			
	Nonsubject			20-29				75%	6.66667	-			
				0-100			5	100%	5.00000	-			
				101-200				33%	15.15152	-			
Urban	Subject or Nonsubject			20-29				75%	4.00000	-			
				0-100			3	100%	3.00000	-			
				101-200				33%	9.09091	-			
				SUBTOTALS		**104,103**				**10,410.300**			
				TOTALS		**491,480**				**375,361.300**			

Kym 10/23/23

**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.*



WATER & LAND™ SOLUTIONS	NC Mitigation Services ENVIRONMENTAL QUALITY	**Lake Wendell Mitigation Project** **Johnston County, North Carolina**	Kym 10/23/23	NCDMS Contract No. 6826 NCDMS Project No. 97081 July 2023	Riparian Buffer Mitigation Plan View NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE **X**

WATER & LAND SOLUTIONS
7721 SIX FORKS ROAD, SUITE 130, RALEIGH, NC 27615
(919) 614 - 5111 | waterlandsolutions.com

Meeting Minutes

Lake Wendell & Pen Dell

Subject: DWR Buffer Close Out Site Visit

Date Prepared: July 19, 2023

Meeting Date and Time: July 19, 2023 @ 9:30 am

Meeting Location: On Site at both Lake Wendell and Pen Dell

Attendees: DWR: Katie Merritt, Blake Hartshorn
NC DMS: Emily Dunnigan, Jeremiah Dow
WLS: Catherine Roland, Kyle Obermiller, Leah Farr

Recorded By: Leah Farr

Water & Land Solutions (WLS) is pleased to present these meeting minutes and discussion points from the Division of Water Resources (DWR) Buffer Close Out Site Meeting for Lake Wendell and Pen Dell. The project site is located within Neuse 03020201 in Johnston County, North Carolina. The meeting began at 9:30 am at Lake Wendell and then proceeded to Pen Dell. The project site review notes are presented below in the order of which they were visited.

Lake Wendell:

- The group started by walking down the southern easement boundary. The group walked into the easement checking tree health and height in vegetation plots 2, 4, 6, and 7. The height and species in the vegetation plots were checked in accordance with the MY5 veg plot survey.
- DWR and DMS commented on the success of black willow live stakes along R2 and R3. Katie Merritt was pleased with the shading of the stream reaches.
- The group followed the northern portion of the easement to verify cattle exclusion fencing along the boundary.
- The group ended in the Kudzu Area (VPA1) on upper R1. DWR attempted to locate trees within VPA1 and requested an additional transect within VPA1 during MY6.
  If the transect does not meet requirements, WLS will complete supplemental planting of 10 containerized trees in the dormant growing season in winter 2023/2024.
  *The species amount will be depended on species availability will include:
  - *Plantanus occidentalais* – Sycamore
  - *Quercus Phellos* – Willow Oak
  - *Quercus nigra* – Water Oak
  - *Betula nigra* – River Birch
  - *Quercus michauxii* – Swamp Chestnut Oak

- Overall, the vegetation throughout the site was established and exceeded height criteria.

ROY COOPER
Governor
ELIZABETH S. BISER
Secretary
MARC RECKTENWALD
Director

NORTH CAROLINA
Environmental Quality

May 25, 2023

Emily Dunnigan
Eastern Project Manager
Division of Mitigation Services
Green Square Office
217 West Jones Street
Raleigh, NC 27603

Subject: Boundary Inspection Report – MY6 Site
Lake Wendell Mitigation Project, Johnston County, NC; DMS ID No. 97081

Emily,

The MY6 boundary inspection was conducted by DMS on May 23, 2023. The inspection was conducted in accordance with the DMS Property Checklist which included an office review and a site visit to document site conditions. The entire easement boundary was inspected during the site visit to validate easement integrity and identify any potential issues on the site. This report summarizes those inspection results. Site photos and locations are shown on the attached kmz map.

Office Review:

- The office review did indicate a few small areas of concern. There is a small trail listed on the plat that does not appear to be part of the project.
- Multiple residential and farm structures are located very close to the easement boundary.
- A dam footprint still exists within the easement area.

Field Inspection:

- The easement corners were adequately monumented with stamped aluminum caps.
- Corner and in-line markings were generally adequate with the few exceptions noted on the action items and documented in the attached kmz file.
- The small internal trail indicated on the plat is no longer used and is excluded from the project.

Action Items

1. Add CE signs to KMZ points #7 and #9
2. Remove drain pipe from within CE KMZ point #1
3. Remove debris from KMZ points #3, #4, #8 and #10.
4. Clear vegetation to make visible the witness post at KMZ point #12.
5. Remove old fence at KMZ #5,#6, #10 and #11

Let me know if you have any questions or need additional information.

Sincerely,
Jeffrey Horton
Project Specialist
NCDEQ-DMS

Cell: (919) 218-3480

cc: R:\EEP PROJECT LIBRARY FILES\PROJECT DELIVERABLES(REPORTS)\FD PROJECTS\Liberty Rock 787701 (#100135)\4_T2_Cons_Ease\DMS Easement Inspections\MY0

WATER & LAND SOLUTIONS
7721 SIX FORKS ROAD, SUITE 130, RALEIGH, NC 27615
(919) 614 - 5111 | waterlandsolutions.com

June 19th, 2023

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

RE: WLS Responses to NCDEQ DMS Review Comments for action items for Boundary Inspection Report Year 6 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. Dunnigan:
Water & Land Solutions, LLC (WLS) is pleased to respond to the Boundary Inspection Report Year 6 for the Lake Wendell Mitigation Project to the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS). The Boundary Inspection Report Year 6 was developed by addressing NCDEQ DMS's review comments.

We are providing our written responses to NCDEQ DMS's review comments on the Boundary Inspection Report Year 6 below. Each of the DMS review comments is copied below in **bold** text, followed by the appropriate response from WLS in regular text:

1. **Add CE signs to KMZ points #7 and #9**. WLS Response: Signs were added to both points.

2. **Remove drain pipe from within CE KMZ point #1.** WLS Response: The drainpipe was removed, capped, and buried outside of the conservation easement. The landowner was also contacted and reported to WLS that the drainpipe was no longer active or in use.

3. **Remove debris from KMZ points #3, #4, #8 and #10.** WLS Response: Debris was removed from easement around points 3, 4, 8, and 10. Additional horse tape and flagging was added at point 8 adjacent to the barn to better mark the easement.

4. **Clear vegetation to make visible the witness post at KMZ point #12.** WLS Response: Poison Ivy vegetation was blocking visibility of the sign. It was sprayed with herbicide to increase visibility.

5. **Remove old fence at KMZ #5, #6, #10 and #11: WLS Response:** Old fencing from all locations was removed from easement.

Please contact me if you have any questions or comments.

Sincerely,

Water & Land Solutions, LLC

Leah Farr
Water & Land Solutions, LLC
7721 Six Forks Road, Suite 130
Raleigh, NC 27615
Office Phone: (919) 614-5111
Mobile Phone: (919) 971-4575
Email: leah@waterlandsolutions.com

WATER & LAND SOLUTIONS
7721 SIX FORKS ROAD, SUITE 130, RALEIGH, NC 27615
(919) 614 - 5111 | waterlandsolutions.com

Dear Mrs. Durham,

On May 23, 2023, the Division of Mitigation Services completed an easement bounday inspection of the Lake Wendell Site. There were a few items that they asked us to address with you. There is a PVC pipe from the residence of 2869 Wendell Road protruding into the conservation easement. In December 2020, we exchanged emails about this pipe and Dennis confirmed that he re-routed the water coming from the pipe somewhere outside of the easement. The Division of Mitigation Services found the PVC pipe inside the easement and requested that since the pipe is not in use that we cap the pipe. The staff from WLS cut the pipe off at the easement edge, capped it and buried it with the loose dirt surrounding the pipe on June 14th, 2023.

During the boundary inspection it was also observed that a significant amount of trash from the residence of 2709 Wendell Road had been blown and tossed into the easement area adjacent to the house. Most of the trash was removed from the easement by WLS staff on June 13th, 2023. Please instruct the tenants not to throw trash into the conservation easement as it is a violation of the easement.

Thank you kindly,

Please contact me if you have any questions or comments.

Sincerely,

Water & Land Solutions, LLC

Leah Farr
Water & Land Solutions, LLC
7721 Six Forks Road, Suite 130
Raleigh, NC 27615
Mobile Phone: (919) 971-4575
Email: leah@waterlandsolutions.com