Monitoring Report- Year 2
FINAL VERSION
Pen Dell Mitigation Project
Calendar Year of Data Collection: 2019

NCDEQ DMS Project Identification # 97079
NCDEQ DMS Contract # 6824
Neuse River Basin (Cataloging Unit 03020201)
USACE Action ID Number: SAW-2016-00885
NCDEQ DWR Project # 2016-0403
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	**Pen Dell Mitigation Project**	**County**	**Johnston**	**USACE Action ID**	**2016-00885**
DMS ID	**97079**	**Date Project Instituted**	**3/18/2016**	**NCDWR Permit No**	**2016-0403**
River Basin	**Neuse**	**Date Prepared**	**8/19/2019**		
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)		**3,066.000**												
Potential Credits (As-Built Survey)		**3,030.400**												
1 (Site Establishment)	**N/A**				N/A	N/A	**N/A**				**N/A**		N/A	N/A
2 (Year 0 / As-Built)	**30%**	909.120			2019	3/21/2019	**30%**				**30%**		N/A	
3 (Year 1 Monitoring)	**10%**	303.040			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		**1,212.160**												

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

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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)		**1,744.000**	**1,143.000**	**1,017.000**	**1,176.000**												
As-Built Amounts (mitigation credits)		**1,744.000**	**762.000**	**406.800**	**117.600**												
Percentage Released		**40%**	**40%**	**40%**	**40%**												
Released Amounts (feet / acres)		**697.600**	**457.200**	**406.800**	**470.400**												
Released Amounts (credits)		**697.600**	**304.800**	**162.720**	**47.040**												
NCDWR Permit	USACE Action ID	Project Name															
Remaining Amounts (feet / acres)		**697.600**	**457.200**	**406.800**	**470.400**												
Remaining Amounts (credits)		**697.600**	**304.800**	**162.720**	**47.040**												

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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 Pen Dell Mitigation Project, NCDEQ DMS Full-Delivery Project ID #97079, Contract #006824, 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 Pen Dell 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. **Table 2 (asset table) does not match MY1. Please update to match.** WLS Response: Table 2 was updated to match MY1

2. **The MY2 vegetation results are written to show success for stream buffer, not DWR riparian buffer (260 @ MY5). Using 260, all plots are achieving success. Update wording and update table 6 to reflect success (color coding).** WLS Response: Wording and table was updated to reflect the buffer requirements.

3. **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.

4. **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.

5. **As discussed in the field, if the isolated area of low stem density is limited to the vegetation plot area only (#7), it may not be prudent to plant such a small area.** WLS Response: Due to the small size of the low stem density area it will not be re-planted, but instead monitored closely.

6. **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. **See comments 2, 3, 4, and 5 above and update accordingly.** WLS Response: WLS has updated the report per DWR's request.

2. **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. **3.1.2, last sentence states that permanent fencing "will be installed." Was this completed and can you update report to reflect current condition?** WLS Response: WLS will update the report to reflect that the permanent fencing has been installed along reach R2.

4. **Check the % change BHR as there is some inconsistency.** WLS Response: WLS cross checked spreadsheets with report to eliminate inconsistencies.

5. **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.** WLS Response: WLS has updated the scales across all Pen Dell cross sections to be consistent on the x and y axis.

6. **Page 6, Stream Hydrology. There must be two bankfull events in two separate years in order to achieve the bankfull standard credit release. Because MY2 only had one bankfull event, it doesn't count toward one of the years that showed 2 separate bankfull events. Please update the report and associated wording.** WLS Response: WLS has updated the text to reflect that only one bankfull event occurred.

7. **Table 8- please clarify that measurement is height above bankfull.** WLS Response: WLS clarified the height measurements in Table 8.

Electronic Deliverables:

1. **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. **Check BHR calcs for XS 1-2,3,8.** WLS Response: WLS has checked BHR calcs for all cross sections.

3. **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 language to the 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.

4. **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.

5. **Include precipitation data in the Hydrology files.** WLS Response: WLS has added precipitation data to the appropriate hydrology files.

6. **Ensure certain that overbank table is cumulative.** WLS Response: Cumulative data was added to the overbank table.

7. **Do not see the utility that impacts R4 in CCPV. This reach should be segmented in CCPV and spatial (GIS file).** WLS Response: A 30ft utility offset was added to the CCPV and the stream was updated accordingly.

8. **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.

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LIST OF APPENDICES

1 Project Summary

Water and Land Solutions, LLC (WLS) completed the construction and planting of the Pen Dell Mitigation Project (Project) full-delivery project for the North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) in April 2018. The Project is located in Johnston County, NC between the Community of Archer Lodge and the Town of Wendell at 35.73125˚, -78.35281˚. The Project site is located in the NCDEQ Sub-basin 03-04-06, in the Lower Buffalo Creek Priority Sub-watershed 030202011504.

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 5,064 linear feet of existing streams and 633,803 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 MY2. The Project meets the MY2 success criteria for stream hydrology, stream horizontal and vertical stability, streambed material 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 catchment area is 156 acres and has an impervious cover of approximately one percent. The dominant surrounding land uses are agriculture and mixed forest. Prior to construction, livestock had access to R3 and R4, and the riparian buffers were less than 50 feet wide on all reaches except R5.

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	Improve and/or remove existing stream crossings 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 <1.2 and increase ERs at 2.2 or greater.
Geomorphology (Level 3)	Improve Bedform Diversity	Increase riffle/pool percentage and pool-to-pool spacing ratios.
	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

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 15.95 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. 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. Permanent cattle exclusion fencing was provided around all restored reaches and riparian buffers, particularly along R3 and R4. 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 is 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 Enhancement Level II

Work along the R1 involved Enhancement Level II practices to improve the current channel condition and aquatic function. This area has been historically disturbed through agricultural practices and the channel

exhibits limited morphology. Prior to construction, the existing channel experienced minimal bank erosion and channel incision throughout most of its length. WLS planted native woody species vegetation and restored the riparian buffer in excess of 50 feet within the conservation easement. Additionally, a 20-foot long culverted pipe crossing and the associated embankment was removed, and a water quality treatment feature was installed outside of the conservation easement to reduce direct sediment and nutrient inputs.

3.1.2 R2 Enhancement Level I

Work along R2 involved Enhancement Level I activities by slightly raising the bed elevation and excavating floodplain benches. In-stream structures were installed to dissipate flow energies and protect streambanks. In-stream structures included constructed riffles for grade control and aquatic habitat, and log weirs/jams for encouraging step-pool formation, bank stability, and bedform diversity. Bioengineering techniques such as geolifts and live stakes were also to protect streambanks and promote woody vegetation growth along the streambanks. A water quality treatment feature was installed outside the permanent conservation easement along the pond periphery to provide habitat diversity and capture fine sediment and nutrients coming from the active agricultural field areas across Wendell Road. Riparian buffers in excess of 50 feet were restored and protected along R2. Additionally, permanent fencing was installed to permanently exclude livestock and reduce sediment and nutrient inputs.

3.1.3 R3 Enhancement Level I

Enhancement activities along R3 involved a Priority Level II restoration approach by slightly raising the bed elevation along the upper section and providing an active floodplain area within the valley. In-stream structures, such as log vanes, log steps, and log jam riffles were used to dissipate flow energy, protect streambanks, and eliminate potential for future incision. Channel banks were graded to stable side slopes and bioengineering techniques such as geolifts and live stakes were also be used to protect streambanks and promote woody vegetation growth. Healthy mature trees or significant native vegetation were protected and incorporated into the design and riparian buffers of at least 50 feet wide were established along the entire reach. Additionally, permanent fencing was installed along with alternative watering systems to exclude livestock and reduce direct sediment and nutrient inputs. The existing perched pipe culverts were removed, and a new culverted stream crossing was installed at a lower elevation to help improve flood flows and aquatic passage.

3.1.4 R4 Restoration

Work along R4 involved relocating the existing degraded channel towards the center of the valley and implementing a Priority Level I Restoration approach by raising the bed elevation and reconnecting the stream with its abandoned floodplain. This approach promotes more frequent over bank flooding in areas with hydric soils, thereby creating favorable conditions for wetland enhancement. The reach was restored as a Rosgen ‘C5’ stream type using appropriate riffle-pool morphology with a conservative meander planform geometry that accommodates the natural valley slope and width. This approach allowed restoration of a stable channel form with appropriate bedform diversity, as well as improved biological functions through increased aquatic and terrestrial habitats. In-stream structures were incorporated to control grade, dissipate flow energies, protect streambanks, and eliminate the potential for channel incision. In-stream structures included constructed wood 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. Riparian buffers greater than 50 feet were restored and protected along the entire

length of R4. Mature trees and significant native vegetation were protected and incorporated into the design. Additionally, shallow floodplain depressions were created to provide habitat diversity, temporary sediment storage and improved treatment of overland flows.

3.1.5 R5 Preservation

Preservation was implemented along this reach since the existing stream and wetland system is mostly stable with a mature riparian buffer due to minimal historic impacts. The preservation area is protected in perpetuity through a permanent conservation easement. This approach will extend the wildlife corridor from the project boundary throughout the entire riparian valley, while providing a hydrologic connection and critical habitat linkage within the catchment area.

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. The following Proposed Monitoring Plan Summary from the approved final mitigation plan summarizes the measurement methods and performance standards. Specific success criteria components and evaluation methods follow.

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)	Well device (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	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.

Functional Category (Level)	Project Goal / Parameter	Measurement Method	Performance Standard	Potential Functional Uplift
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 stems are only counted toward success if they are at least 18" tall, on the approved planting list, and surviving for at least 2 years. 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 and to document the site conditions. All the 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. All vegetation plots meet interim success criteria except vegetation plot 7 (see Figure 1).

5.1 Stream Hydrology

Monitoring to document the occurrence of the two required bankfull events (overbank flows) and the two required 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 middle of Reach R3 (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 bankfull event occured during MY1. At least one bankfull event occurred during MY2. This event was documented using the described crest gage and photography (Appendix E Table 8).

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, instream structure locations, still closely match the profile design parameters and MY0/baseline conditions. The MY2 plan form geometry or pattern still appears to fall within acceptable ranges of the design parameters for all restored reaches. Only minor channel adjustments in riffle slopes, pool depths and pattern were observed and therefore did not present a stability concern or indicate a need for remedial action.

5.3 Streambed Material Condition and Stability

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

5.4 Jurisdictional Stream Flow Documentation

Jurisdictional stream flow documentation and monitoring of restored intermittent reaches is achieved using a flow gage (pressure transducer) within the thalweg of the channel towards the middle portion of enhanced Reach R1 (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 flow 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.

Plot 7 had an average stem density of 283.3 stems per acre which does not meet the year 3 minimum of 320 stems per acre. Loss in stem density from MY1 to MY2 is due to a dense herbaceous layer. During MY3, Plot 7 will be monitored closely, and maintenance will be noted in future reports.

The MY2 vegetation monitoring was also conducted utilizing visual assessment throughout the easement. One area of concern adjacent to Plot 7 was found to be under the 0.1-acre threshold for low stem density. The area of concern will not be re-planted because of its small size and will be monitored closely in MY3. No other areas of concern were identified.

5.6 Wetlands

Wetland mitigation credits are not contracted or proposed for this project. One groundwater monitoring well was installed during the baseline monitoring along Reach R4 (wetland gage 2). Two additional groundwater monitoring wells, including an additional one along Reach R4 (wetland gage 1) and an additional one along Reach R5 (wetland gage 3) (preservation), were installed after the first year of monitoring, March 2019. All groundwater monitoring wells are pressure transducers. The wells were installed to document groundwater levels within restoration area and for reference and comparison to the preservation areas, at the request of the NCIRT (DWR). Data for the gages can be found in Appendix E. No performance standards for wetland hydrology success was proposed in the Mitigation Plan and therefore wetland mitigation monitoring is not included for this project.

6 References

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Appendices

Appendix A – Background Tables and Figures

Table 1. Mitigation Assets and Components
Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)

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	--	1017	10+00 -20+17	1017	1017	EII	EII	2.5	407	Constucted Riffle Above Road Crossing, Planted Buffer, Permanent Conservation Easement
R2	--	546	20+77 - 26+25	526	546	EI	EI	1.5	351	Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R3	--	617	30+93 - 37+00	617	601	EI	EI	1.5	411	Channel Enhancement, Floodplain Grading, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R4	--	1846	37+00 - 54+87	1779**	1724	R	R	1	1744	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R5	--	1176	56+26 - 68+02	1176	1176	P	P	10	118	Invasive Control, 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	1779**			
Enhancement				
Enhancement I	1143			
Enhancement II	1017			
Creation				
Preservation	1176			
High Quality Pres				

Overall Assets Summary

Asset Category	Overall Credits*
Stream	**3,031**
RP Wetland	
NR Wetland	

* Mitigation Credits are from approved Mitigation Plan, as verified by the as-built survey.
**Credits on R4 reduced by 35' for powerline ROW realized at As-Built

Table 2. Project Activity and Reporting History
Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)

Elapsed Time Since grading complete: 1 yrs 7 months
Elapsed Time Since planting complete: 1 yrs 7 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	9/29/2017
Section 404 General (Regional and Nationwide) Permit Verfication	N/A	1/12/2018
Begin Construction	N/A	1/29/2018
Mitigation Site Earthwork Completed	N/A	4/1/2018
Mitigation Site Planting Completed	N/A	4/6/2018
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	10/18/2019	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

Table 3. Project Contacts Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)	
Mitigation Provider Primary Project POC	Water & Land Solutions, LLC 7721 Six Forks Road, Suite 130, Raleigh, NC 27615 Catherine Manner Phone: 571-643-3165
Construction Contractor Primary Project POC	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520 Bill Wright Phone: 919-590-5193
Survey Contractor (Existing Condition Surveys) Primary Project POC	WithersRavenel 115 MacKenan Drive, Cary, NC 27511 Marshall Wight, PLS Phone: 919-469-3340
Survey Contractor (Conservation Easement, Construction and As-Builts Surveys) Primary Project POC	True Line Surveying, PC 205 West Main Street, Clayton, NC 27520 Curk T. Lane, PLS 919-359-0427
Planting Contractor Primary Project POC	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520 Bill Wright Phone: 919-590-5193
Seeding Contractor Primary Project POC	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520 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	Pen Dell Mitigation Project
County	Johnston
Project Area (acres)	16.1
Project Coordinates (latitude and longitude)	35.7303778 N, -78.3557472 W
Planted Acreage (Acres of Woody Stems Planted)	8.74
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)	156 acres, 0.24 sq mi
Project Drainage Area Percentage of Impervious Area	<1%
CGIA Land Use Classification	2.01.03, 2.99.05, 413, 4.98 (39% crops/hay, 31% pasture, 24% mixed forest, 2% open water/pond)

Reach Summary Information

Parameters	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5
Length of reach (linear feet)	1017	546	617	1846	1176
Valley confinement (Confined, moderately confined, unconfined)	unconfined	mod. confined	unconfined	unconfined	unconfined
Drainage area (Acres and Square Miles)	63 acres, 0.1 sq mi	73 acres, 0.11 sq mi	105 acres, 0.16 sq mi	134 acres, 0.21 sq mi	156 acres, 0.24 sq mi
Perennial, Intermittent, Ephemeral	Intermittent	Perennial/Intermittent	Perennial	Perennial	Perennial
NCDWR Water Quality Classification	C; NSW	C; NSW	C;NSW	C; NSW	C; NSW
Stream Classification (existing)	G5c	E5(incised)	E5(incised)	E5(incised), F5	E5
Stream Classification (proposed)	C5b	C5	C5	C5	E5
Evolutionary trend (Simon)	I	II	III/IV	III/IV	I
FEMA classification	N/A	N/A	N/A	N/A	Zone AE

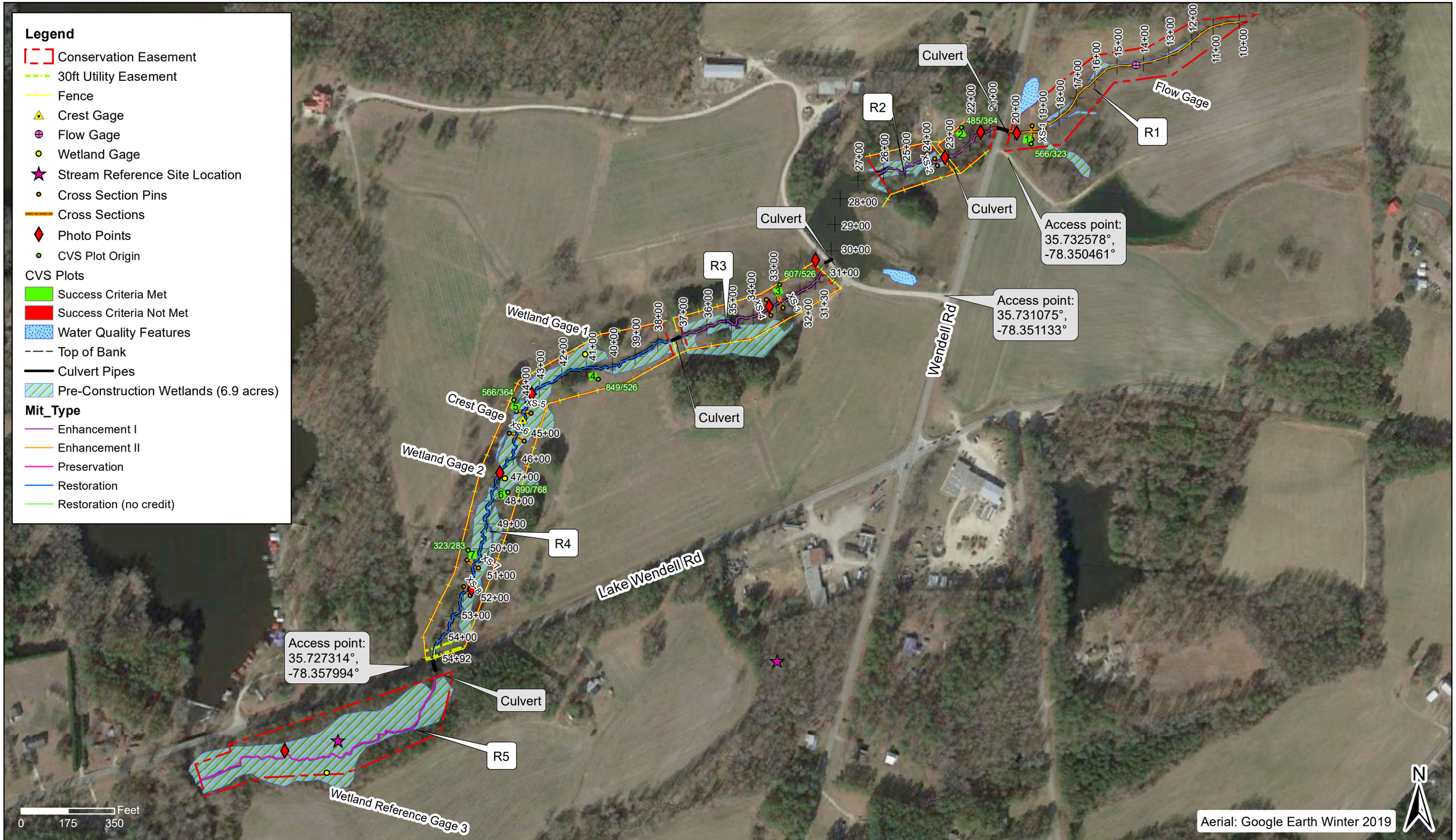
Wetland Summary Information

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



WATER & LAND™ SOLUTIONS	**Pen Dell Mitigation Project** **Johnston County, North Carolina**	NCDMS Contract No. 6824 NCDMS Project No. 97079 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 **Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)**
Reach ID **R1, R2, R3, R4, R5**
Assessed Length **5126**

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.	37	37			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	32	32			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	13	13			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)	9	9			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	37	37			100%			

Table 5a.	Vegetation Condition Assessment					
Project	Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)					
Planted Acreage[1]	10.1					
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	Pattern and Color	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]	15.95					
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	Pattern and Color	0	0.00	0.0%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none	Pattern and Color	0	0.00	0.0%

R1, facing upstream, Sta 20+00, March 29, 2018 (MY-00)

R1, facing upstream, Sta 20+00, October 17, 2019 (MY-02)

R2, facing downstream, Sta 21+50, April 27, 2018 (MY-00)

R2, facing downstream, Sta 21+50, October 17, 2019 (MY-02)

R2, facing upstream at crossing, Sta 23+00, April 27, 2018 (MY-00)

R2, facing upstream at crossing, Sta 23+00, October 17, 2019 (MY-02)

R3, facing downstream, Sta 31+00, April 27, 2018 (MY-00)

R3, facing downstream, Sta 31+00, October 17, 2019 (MY-02)

R3, facing upstream, Sta 33+00, April 27, 2018 (MY-00)

R3, facing downstream, Sta 33+00, October 17, 2019 (MY-02)

R4, facing upstream, Sta 43+50, April 27, 2018 (MY-00)

R4, facing upstream, Sta 43+50, October (MY-02)

R4, facing upstream, Sta 44+50, April 27, 2018 (MY-00)

R4, facing upstream, Sta 44+50, October 17, 2019 (MY-02)

R4, facing upstream, Sta 52+00, April 27, 2018 (MY-00)

R4, facing upstream, Sta 52+00, October 17, 2019 (MY-02)

R5, facing downstream near Sta 62+00, Sept 1, 2015, 2018 (MY-00)

R5, facing downstream near Sta 62+00, October 17, 2019 (MY-02)

Veg Plot 1, April 12, 2018 (MY-00)

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

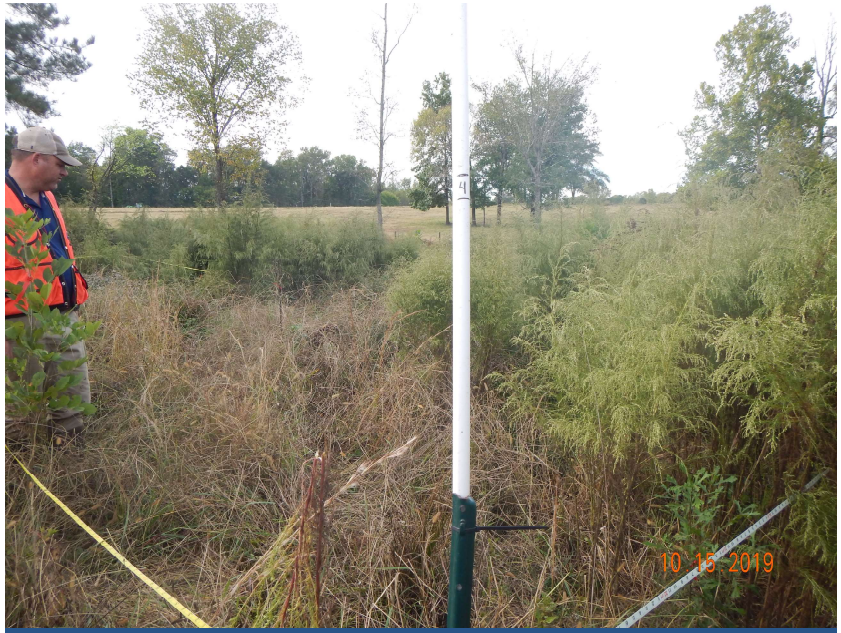
Veg Plot 2, April 12, 2018 (MY-00)

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

Veg Plot 3, April 12, 2018 (MY-00)

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

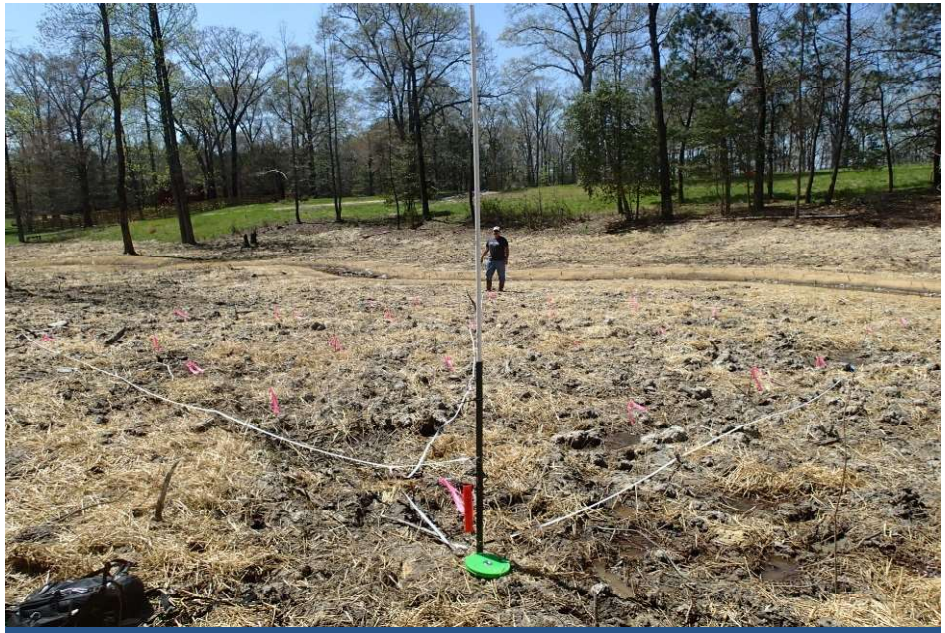
Veg Plot 4, April 12, 2018 (MY-00)



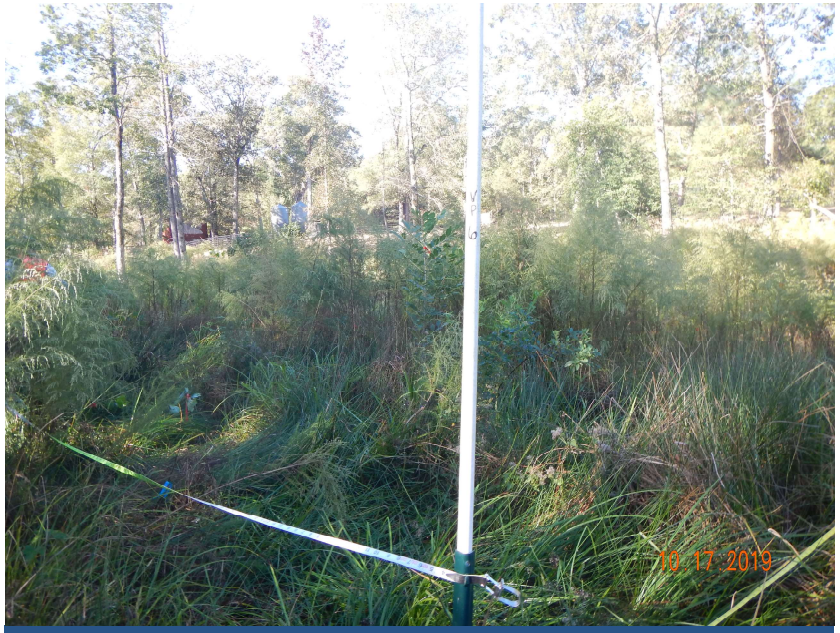
Veg Plot 4, October 15 2019 (MY-02)

Veg Plot 5, April 12, 2018 (MY-00)

Veg Plot 5, October 17, 2019 (MY-02)



Veg Plot 6, April 12, 2018 (MY-00)



Veg Plot 6, October 17, 2019 (MY-02)

Veg Plot 7, April 12, 2018 (MY-00)

Veg Plot 7, October 17, 2019 (MY-02)

Appendix C – Vegetation Plot Data

EEP Project Code 2. Project Name: Pen-Del

Table 7

			Current Plot Data (MY2 2019)																						Annual Means								
			002-01-0001			002-01-0002			002-01-0003			002-01-0004			002-01-0005			002-01-0006			002-01-0007			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 rubrum		Tree						2			2	1	1	4	1	1	2	1	1	3			1	3	3	14	4	4	122	3	3	3
Alnus serrulata	Tag Alder, Smooth Alde	Shrub Tree	1	1	1				1	1	1							1	1	1				3	3	3	3	3	3	3	3	3
Betula nigra	River Birch, Red Birch	Tree	2	2	2				1	1	1	2	2	2	1	1	1	3	3	3				9	9	9	11	11	11	14	14	14
Carpinus caroliniana		Shrub Tree							1	1	1				1	1	1	3	3	3				5	5	5	9	9	10	10	10	10
Carya	Hickory	Tree																											1			
Cornus amomum	Silky Dogwood	Shrub Tree							3	3	3										1	1	1	4	4	4	6	6	6	6	6	6
Diospyros virginiana	American Persimmon,	Tree										1	1	1										1	1	1	2	2	2	2	2	2
Fraxinus pennsylvanica	Green Ash, Red Ash	Tree	1	1	1				1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	10	10	10	10	10	10	10	10	10
Ilex verticillata	Winterberry	Shrub Tree				3	3	3																3	3	3	3	3	3	3	3	3
Lindera benzoin	Northern Spicebush	Shrub Tree				2	2	2																2	2	2	3	3	3	13	13	13
Liquidambar styraciflua	Sweet Gum, Red Gum	Tree						1						2			2									5			3			
Liriodendron tulipifera		Tree	1	1	1	1	1	1																2	2	2	5	5	5	13	13	13
Magnolia virginiana		Shrub Tree				1	1	1	1	1	1	2	2	2							2	2	2	6	6	6	8	8	8	14	14	14
Platanus occidentalis	Sycamore, Plane-tree	Tree							2	2	2				4	4	4	4	4	4	1	1	1	11	11	11	14	14	14	14	14	14
Populus deltoides		Tree																											1			
Quercus michauxii	Basket Oak, Swamp Ch	Tree	1	1	1				3	3	3	2	2	2				3	3	3				9	9	9	11	11	11	9	9	9
Quercus nigra	Water Oak, Paddle Oak	Tree	1	1	1							2	2	2				1	1	1				4	4	4	3	3	3	9	9	9
Quercus phellos	Willow Oak	Tree	1	1	1	2	2	2				1	1	1				1	1	1	1	1	1	6	6	6	8	8	8	8	8	8
Rhus copallinum		Shrub Tree																											3			
Rosa palustris	Swamp Rose	Shrub Vine												2			2									4			39			
Salix nigra	Black Willow	Tree			1																					1			7			
Sambucus canadensis	Common Elderberry	Shrub Tree			5																					5			3			
Ulmus rubra	Slippery Elm, Red Elm	Tree												1						1						2			3			
Viburnum nudum	Southern Wild Raisin, F	Shrub Tree																												1	1	1
		Stem count	8	8	14	9	9	12	13	13	15	13	13	21	9	9	14	19	19	22	7	7	8	78	78	106	100	100	279	132	132	132
		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	7	7	9	5	5	7	8	8	9	8	8	11	5	5	7	9	9	10	5	5	6	15	15	20	15	15	23	16	16	16
		Stems per ACRE	323.7	323.7	566.6	364.2	364.2	485.6	526.1	526.1	607	526.1	526.1	849.8	364.2	364.2	566.6	768.9	768.9	890.3	283.3	283.3	323.7	450.9	450.9	612.8	578.1	578.1	1613	763.1	763.1	763.1

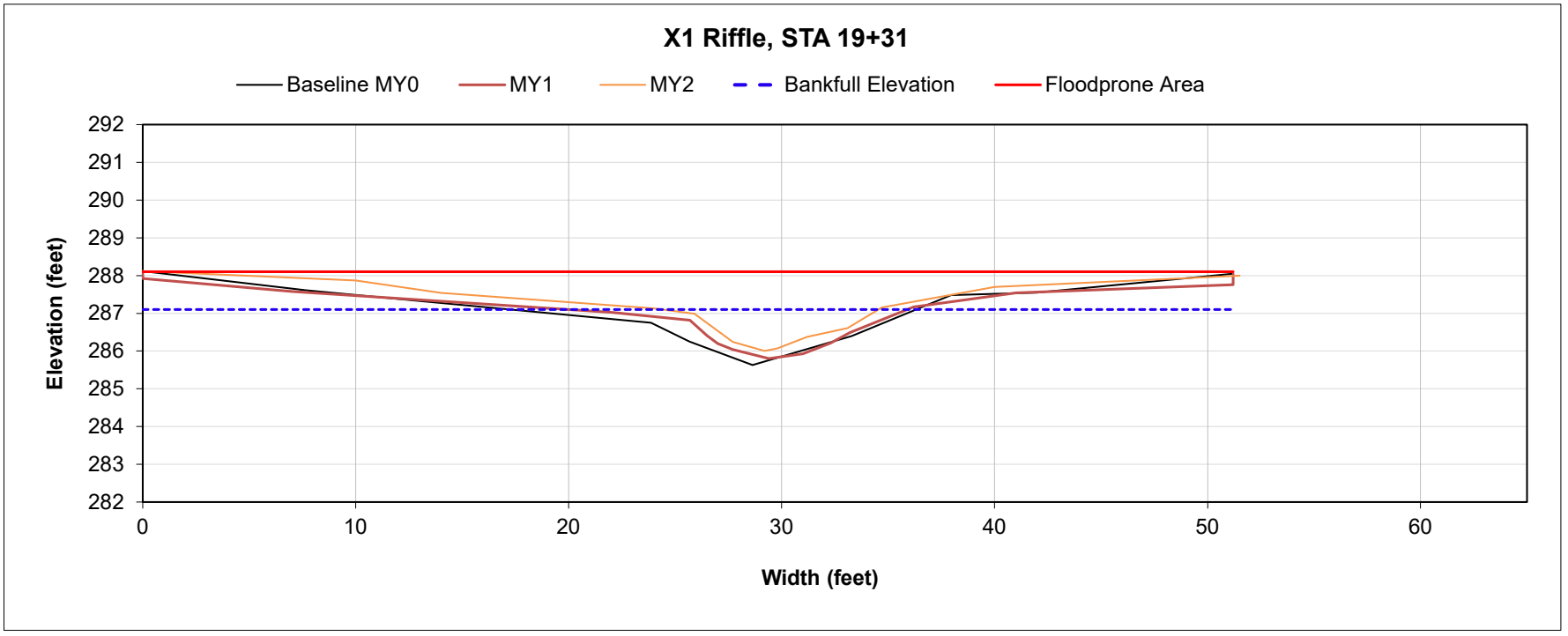
Volunteers were counted if they were at least 18" tall.

Appendix D – Stream Measurement and Geomorphology Data

Project Name	Pen Dell Mitigation Project
Project ID	97079
Reach ID	R1
Cross Section ID	X1
Field Crew	E. Dunnigan, K. Obermiller

DIMENSION DATA SUMMARY: MY2 2019	
Bankfull Elevation (ft)	287.1
Low Bank Height Elevation (ft)	287.0
Bankfull Max Depth (ft)	1.1
Low Bank Height (ft)	1.0
Bank Height Ratio	< 1.0
Bankfull X-section Area (ft²)	5.3
% Change Bank Height Ratio	10.0%

Looking Downstream

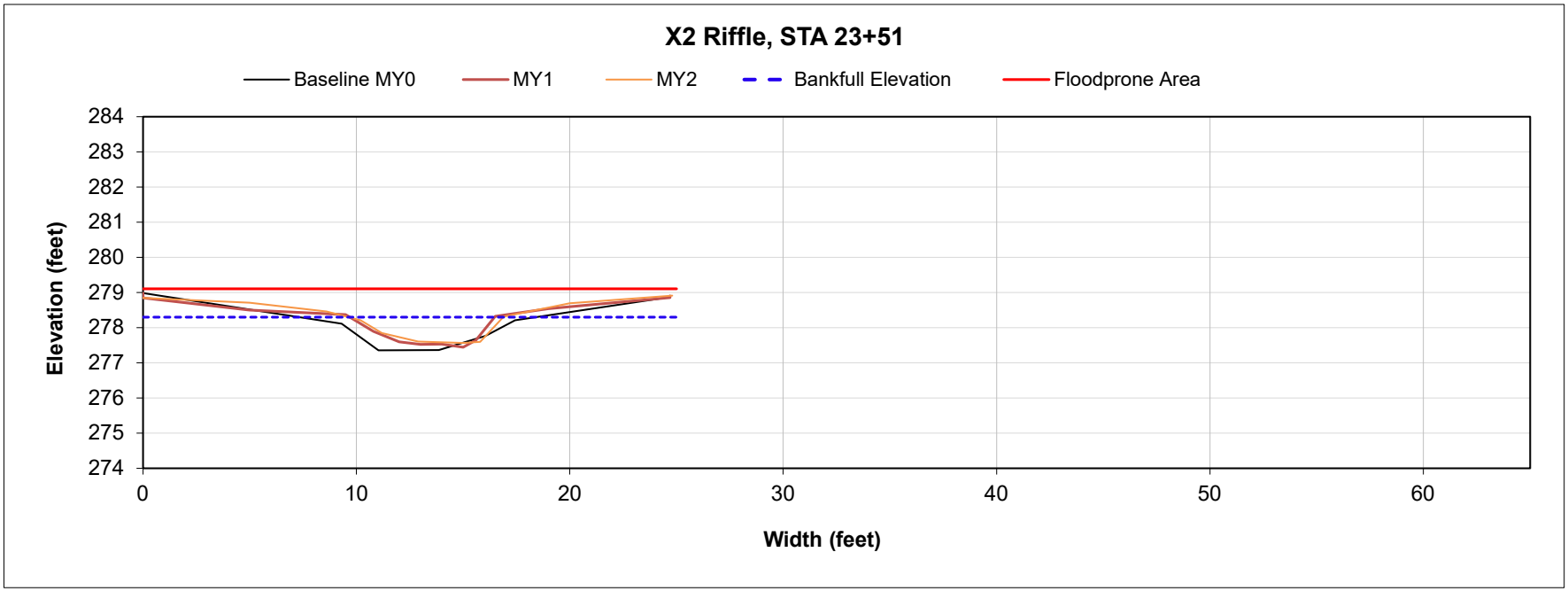


** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull 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	Pen Dell Mitigation Project
Project ID	97079
Reach ID	R2
Cross Section ID	X2
Field Crew	K. Obermiller, E. Dunnigan

DIMENSION DATA SUMMARY: MY2 2019	
Bankfull Elevation (ft)	278.3
Low Bank Height Elevation (ft)	278.3
Bankfull Max Depth (ft)	0.8
Low Bank Height (ft)	0.8
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	4.1
% Change Bank Height Ratio	0.0%

Looking Downstream

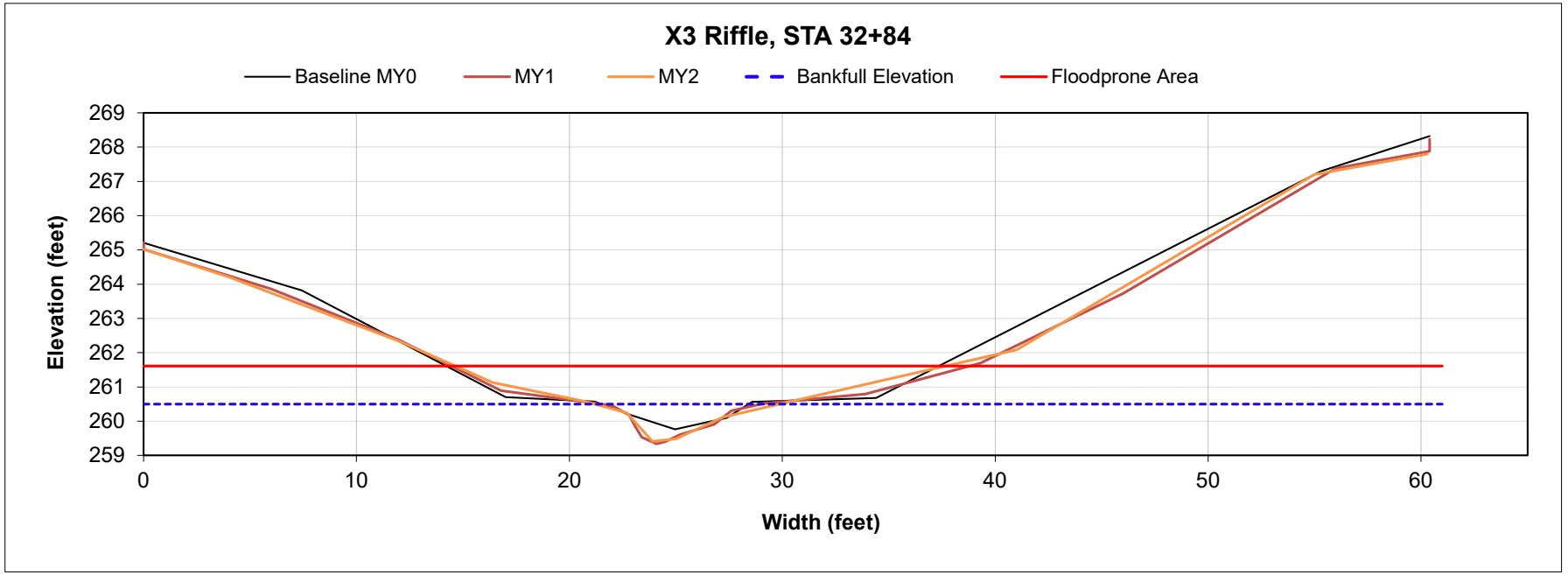


** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull 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	Pen Dell Mitigation Project
Project ID	97079
Reach ID	R3
Cross Section ID	X3
Field Crew	K. Obermiller, N. Childs, E. Dunnigan

DIMENSION DATA SUMMARY: MY2 2019	
Bankfull Elevation (ft)	260.5
Low Bank Height Elevation (ft)	260.5
Bankfull Max Depth (ft)	1.1
Low Bank Height (ft)	1.1
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	4.3
% Change Bank Height Ratio	0.0%

Looking Downstream



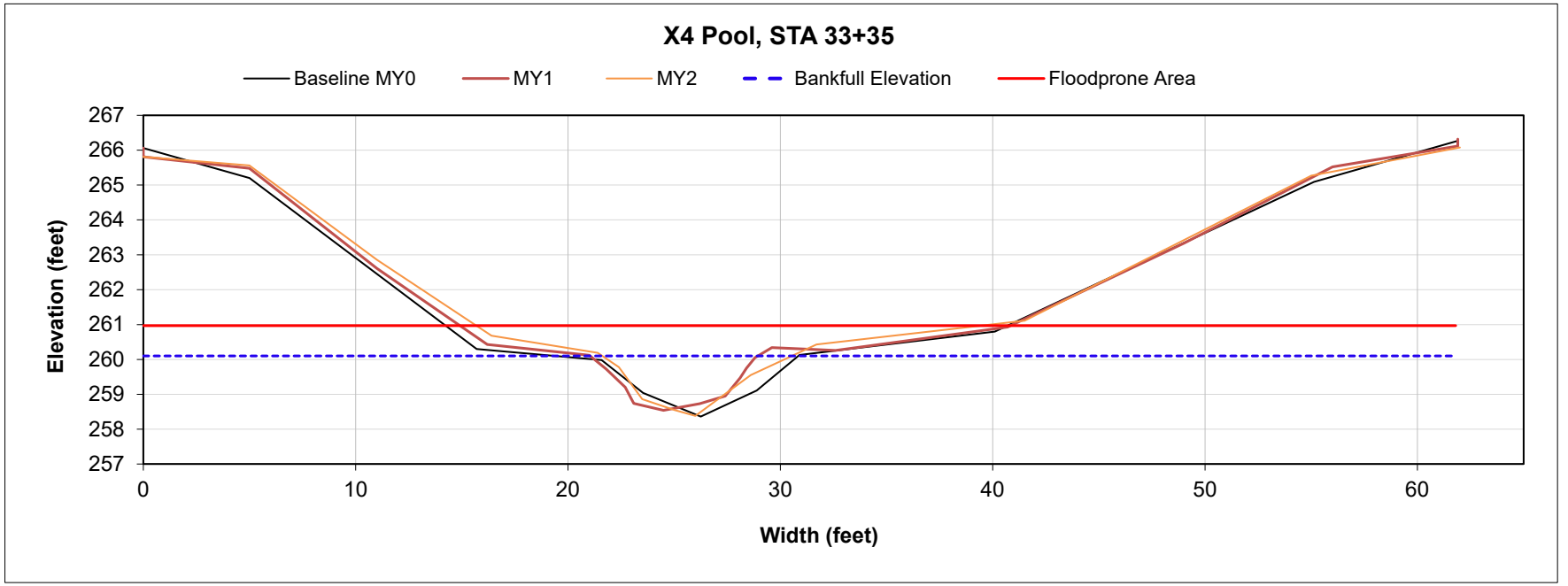
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull 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	Pen Dell Mitigation Project
Project ID	97079
Reach ID	R3
Cross Section ID	X4
Field Crew	K. Obermiller, E. Dunnigan

DIMENSION DATA SUMMARY: MY2 2019	
Bankfull Elevation (ft)	260.1
Low Bank Height Elevation (ft)	260.2
Bankfull Max Depth (ft)	1.7
Low Bank Height (ft)	1.8
Bank Height Ratio	1.1
Bankfull X-section Area (ft²)	7.8
% Change Bank Height Ratio	10.0%

Looking Downstream



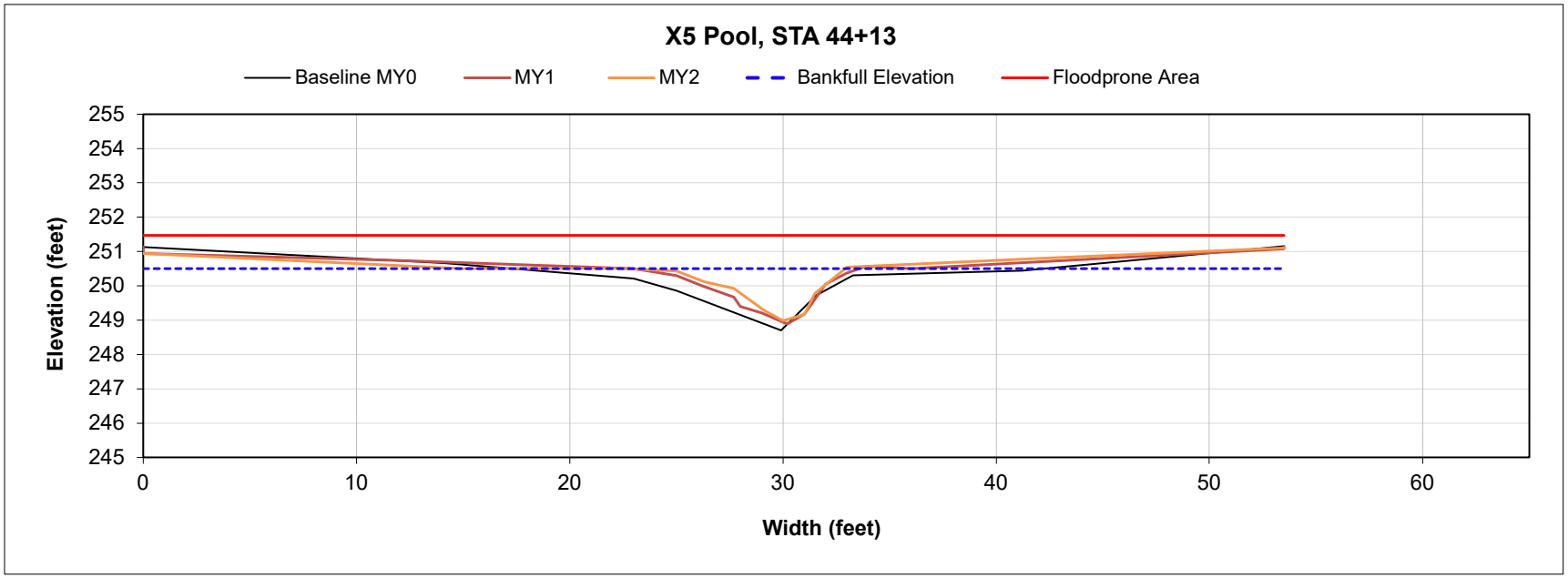
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull 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	Pen Dell Mitigation Project
Project ID	97079
Reach ID	R4
Cross Section ID	X5
Field Crew	K. Obermiller, N. Childs, E. Dunnigan

DIMENSION DATA SUMMARY: MY2 2019	
Bankfull Elevation (ft)	250.5
Low Bank Height Elevation (ft)	250.5
Bankfull Max Depth (ft)	1.6
Low Bank Height (ft)	1.6
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	6.9
% Change Bank Height Ratio	0.0%

Looking Downstream

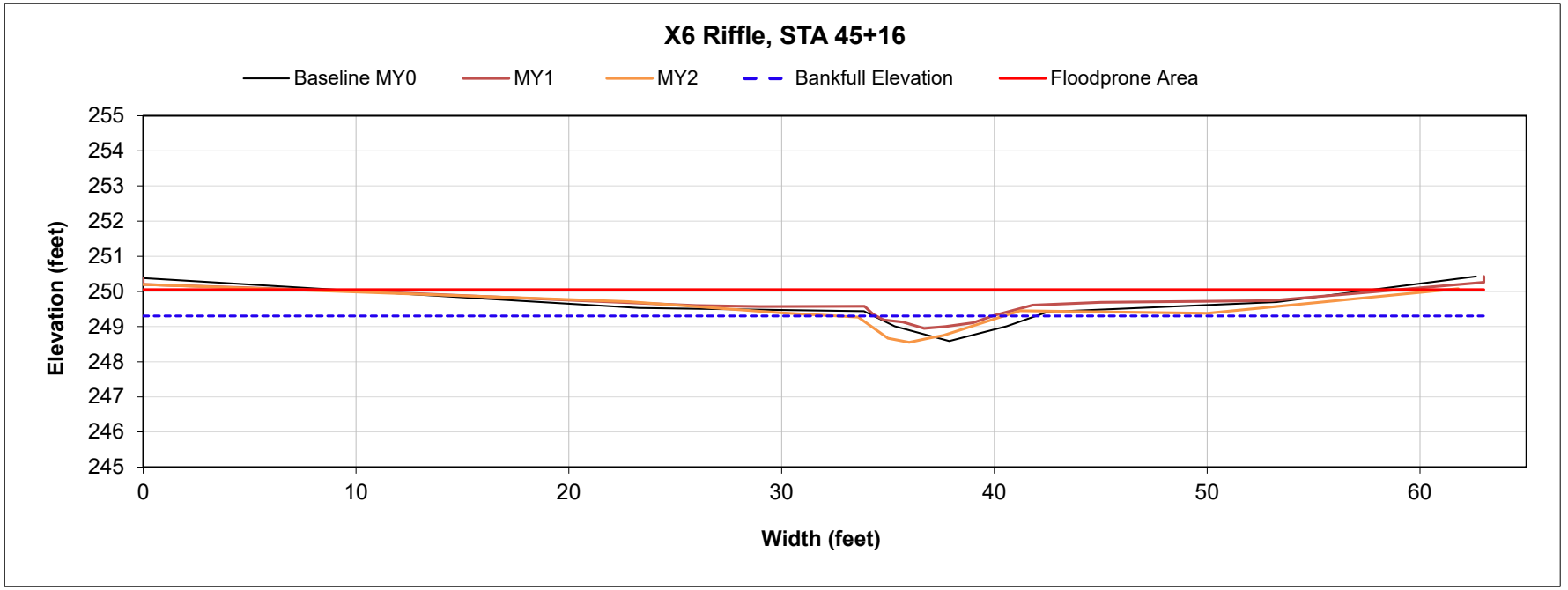


** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull 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	Pen Dell Mitigation Project
Project ID	97079
Reach ID	R4
Cross Section ID	X6
Field Crew	K. Obermiller, E. Dunnigan

DIMENSION DATA SUMMARY: MY2 2019	
Bankfull Elevation (ft)	249.3
Low Bank Height Elevation (ft)	249.3
Bankfull Max Depth (ft)	0.8
Low Bank Height (ft)	0.8
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	3.0
% Change Bank Height Ratio	10.0%

Looking Downstream

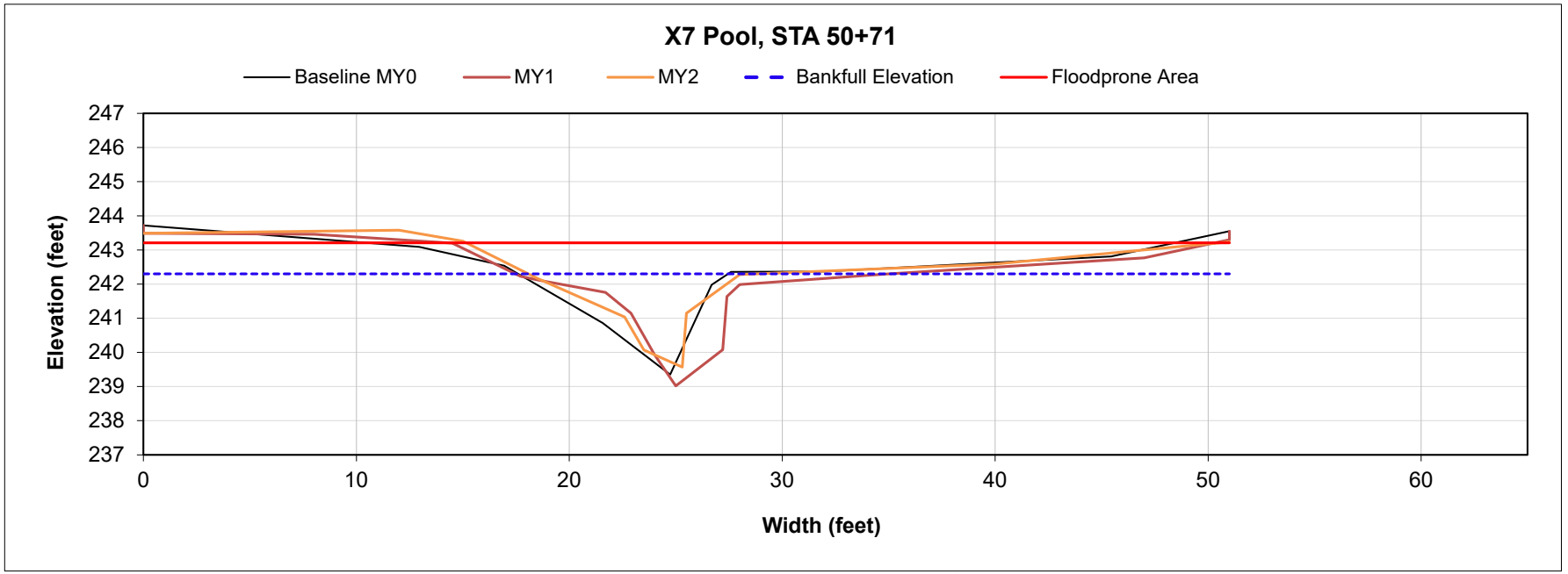


** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull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

Project Name	Pen Dell Mitigation Project
Project ID	97079
Reach ID	R4
Cross Section ID	X7
Field Crew	K. Obermiller, E. Dunnigan, N. Childs

DIMENSION DATA SUMMARY: MY2 2019	
Bankfull Elevation (ft)	242.3
Low Bank Height Elevation (ft)	242.3
Bankfull Max Depth (ft)	2.7
Low Bank Height (ft)	2.7
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	10.7
% Change Bank Height Ratio	10.0%

Looking Downstream



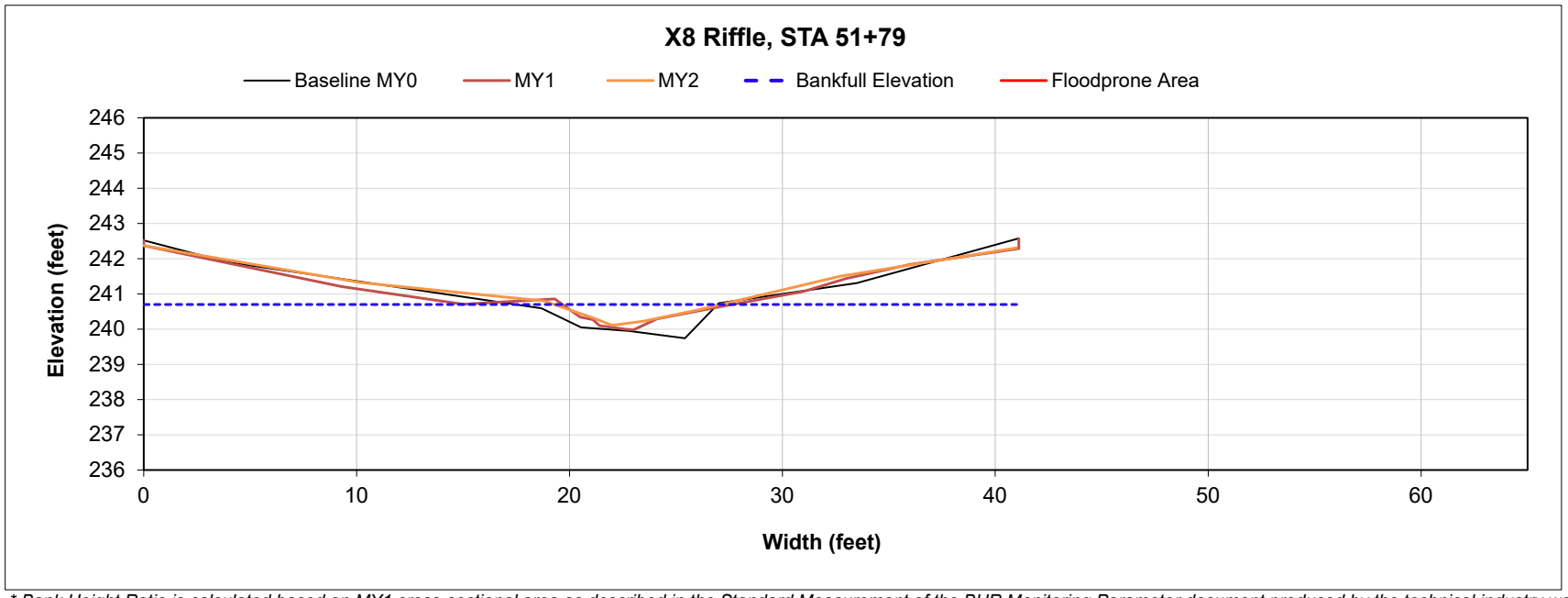
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull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

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

Project Name	Pen Dell Mitigation Project
Project ID	97079
Reach ID	R4
Cross Section ID	X8
Field Crew	K. Obermiller, N. Childs, E. Dunnigan

DIMENSION DATA SUMMARY: MY2 2019	
Bankfull Elevation (ft)	240.7
Low Bank Height Elevation (ft)	240.8
Bankfull Max Depth (ft)	0.7
Low Bank Height (ft)	0.8
Bank Height Ratio	1.1
Bankfull X-section Area (ft²)	2.9
% 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.*

Pen Dell

Figure 3: 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	7	11					
SAND	Very Fine	.063 - .125	5	3					
	Fine	.125 - .25	11	10					
	Medium	.25 - .50	12	10					
	Coarse	.50 - 1.0	13	15					
	Very Coarse	1.0 - 2.0	22	4					
GRAVEL	Very Fine	2.0 - 2.8	14	2					
	Very Fine	2.8 - 4.0	6	2					
	Fine	4.0 - 5.6	1	2					
	Fine	5.6 - 8.0	1	7					
	Medium	8.0 - 11.0	1	5					
	Medium	11.0 - 16.0	2	9					
	Coarse	16 - 22.6	2	9					
	Coarse	22.6 - 32		5					
	Very Coarse	32 - 45	3	4					
	Very Coarse	45 - 64		1					
COBBLE	Small	64 - 90		1					
	Small	90 - 128							
	Large	128 - 180							
	Large	180 - 256							
BOULDER	Small	256 - 362							
	Small	362 - 512							
	Medium	512 - 1024							
	Large-Very Large	1024 - 2048							
BEDROCK	Bedrock	> 2048	100	100					
		Total							

Cumulative	D16	0.16	0.14					
	D35	0.5	0.52					
	D50	1.1	1.2					
	D65	1.7	7.7					
	D84	4	18					
	D95	22	35					

MY2

Riffle			Pool	
Channel materials			Channel materials	
D16 =	0.24		D16 =	0.062
D35 =	0.67		D35 =	0.21
D50 =	5.4		D50 =	0.67
D84 =	22		D84 =	7.7
D95 =	40		D95 =	20

Weighted pebble count by bed features Pen Dell Mitigation Project MY2

65% riffle 35% pool

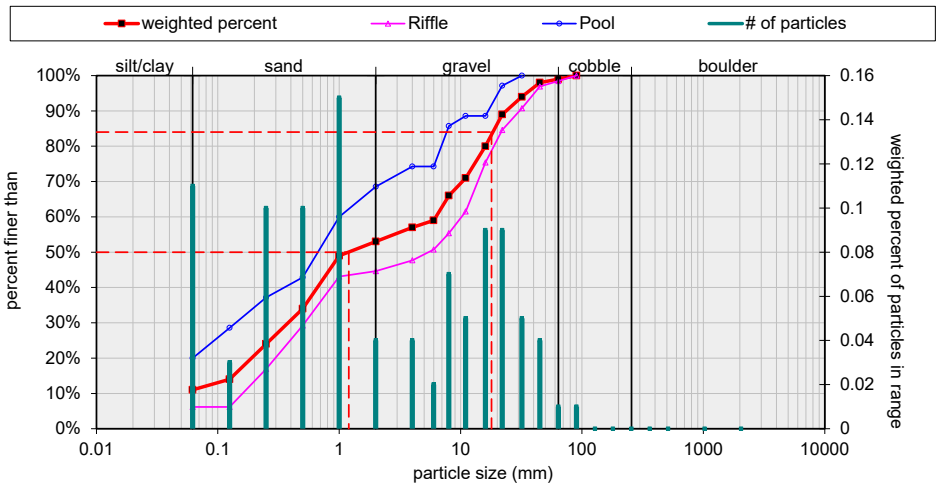


Table 7a. Baseline Stream Data Summary Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)								
Parameter	**Pre-Restoration Condition**		**Reference Reach Data**		**Design**		**As-Built/ Baseline**	
Reach ID: R1 (EII)								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	4.4	6.6	4.5	8.3	5.7		11.1	-
Floodprone Width (ft)	15.9	42.0	10.0	20.0	15.0	30.0	49.0	-
Bankfull Mean Depth (ft)	0.4	0.8	0.8	1.6	0.5		0.6	-
Bankfull Max Depth (ft)	0.5	0.9	0.9	1.3	0.6		1.2	-
Bankfull Cross Sectional Area (ft^2)	1.9	4.2	3.0	5.0	2.7		7.0	-
Width/Depth Ratio	8.2	15.2	6.2	14.2	12.0		17.7	-
Entrenchment Ratio	1.4	2.2	7.1	8.4	2.6	5.3	4.4	-
Bank Height Ratio	0.7	1.5	0.9	1.1	1.0		1.0	-
Profile								
Riffle Length (ft)	6.2	38.2	9.5	22.7	-	-	-	-
Riffle Slope (ft/ft)	0.016	0.037	0.009	0.015	-	-	-	-
Pool Length (ft)	4.1	7.9	6.1	8.7	-	-	-	-
Pool Max Depth (ft)	1.1	2.3	1.8	2.4	-	-	-	-
Pool Spacing (ft)	26.4	83.9	14.4	22.3	-	-	-	-
Pattern								
Channel Beltwidth (ft)	11.0	32.0	23.4	29.0	-	-	-	-
Radius of Curvature (ft)	8.0	50.0	11.2	17.5	-	-	-	-
Rc:Bankfull Width (ft/ft)	1.6	10.0	1.6	2.5	-	-	-	-
Meander Wavelength (ft)	20.0	100.0	43.4	65.1	-	-	-	-
Meander Width Ratio	2.2	6.4	3.9	4.5	-	-	-	-
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.50		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		36.90		-	
Additional Reach Parameters								
Rosgen Classification	G5c		E5/C5		C5		C5	
Bankfull Velocity (fps)	2.7		4.5		3.7		3.7	
Bankfull Discharge (cfs)	13.0		-		13.0		13.0	
Sinuosity	1.03		1.1 - 1.3		1.10		1.05	
Water Surface Slope (Channel) (ft/ft)	0.017		0.020		0.017		0.017	
Bankfull Slope (ft/ft)	0.017		0.020		0.017		0.017	

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R2 (EI)								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	9.5	-	4.5	8.3	6.8	6.8	7.8	9.5
Floodprone Width (ft)	13.7	-	10.0	20.0	15.0	30.0	23.0	13.7
Bankfull Mean Depth (ft)	0.9	-	0.8	1.6	0.5	0.5	0.5	0.9
Bankfull Max Depth (ft)	0.9	-	0.9	1.3	0.7	0.7	0.8	0.9
Bankfull Cross Sectional Area (ft^2)	5.9	-	3.0	5.0	3.6	3.6	4.2	5.9
Width/Depth Ratio	15.2	-	6.2	14.2	13.0	13.0	14.6	15.2
Entrenchment Ratio	1.4	-	7.1	8.4	2.2	4.4	2.9	1.4
Bank Height Ratio	1.9	-	0.9	1.1	1.0	1.0	1.0	1.9
Profile								
Riffle Length (ft)	5.9	27.7	9.5	22.7	-	-	-	-
Riffle Slope (ft/ft)	0.015	0.029	0.009	0.015	-	-	-	-
Pool Length (ft)	3.9	7.8	6.1	8.7	-	-	-	-
Pool Max Depth (ft)	2.0	3.8	1.8	2.4	-	-	-	-
Pool Spacing (ft)	17.0	51.0	14.4	22.3	-	-	-	-
Pattern								
Channel Beltwidth (ft)	13.0	37.0	23.4	29.0	-	-	-	-
Radius of Curvature (ft)	7.0	29.0	11.2	17.5	-	-	-	-
Rc:Bankfull Width (ft/ft)	1.2	4.9	1.6	2.5	-	-	-	-
Meander Wavelength (ft)	42.0	121.0	43.4	65.1	-	-	-	-
Meander Width Ratio	2.3	6.3	3.9	4.5	-	-	-	-
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.51		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		36.10		-	
Additional Reach Parameters								
Rosgen Classification	E5		E5/C5		E5/C5		E5/C5	
Bankfull Velocity (fps)	2.7		4.5		4.1		4.1	
Bankfull Discharge (cfs)	16.0		-		16.0		16.0	
Sinuosity	1.07		1.1 - 1.3		1.07		1.07	
Water Surface Slope (Channel) (ft/ft)	0.016		0.020		0.016		0.016	
Bankfull Slope (ft/ft)	0.017		0.020		0.017		0.017	

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R3								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	7.4	-	4.5	8.3	7.8	7.8	7.1	
Floodprone Width (ft)	10.4	39.4	10.0	35.0	17.0	35.0	19.8	
Bankfull Mean Depth (ft)	0.8	-	0.8	1.6	0.6	0.6	0.4	
Bankfull Max Depth (ft)	1.6	-	0.9	1.3	0.7	0.8	0.8	
Bankfull Cross Sectional Area (ft^2)	5.0	-	3.0	5.0	4.4	4.4	3.1	
Width/Depth Ratio	11.0	-	6.2	14.2	14.0	14.0	16.3	
Entrenchment Ratio	1.4	-	7.1	8.4	2.2	4.5	2.8	
Bank Height Ratio	1.2	2.0	0.9	1.1	1.0	1.0	1.0	
Profile								
Riffle Length (ft)	11.0	41.0	9.5	22.7	12.0	33.0	12.0	30.0
Riffle Slope (ft/ft)	0.012	0.012	0.009	0.015	0.015	0.022	0.013	0.029
Pool Length (ft)	3.5	7.9	6.1	8.7	8.0	10.5	7.0	9.8
Pool Max Depth (ft)	2.8	-	1.8	2.4	1.4	2.0	1.1	2.0
Pool Spacing (ft)	3.5	9.6	14.4	22.3	25.0	55.0	13.0	48.0
Pattern								
Channel Beltwidth (ft)	29.0	53.0	23.4	29.0	25.0	45.0	25.0	45.0
Radius of Curvature (ft)	9.0	40.0	11.2	17.5	16.0	23.0	15.0	25.0
Rc:Bankfull Width (ft/ft)	1.2	5.4	1.6	2.5	2.0	3.0	1.5	3.0
Meander Wavelength (ft)	52.0	77.0	43.4	65.1	30.0	44.8	30.0	44.8
Meander Width Ratio	3.9	7.2	3.9	4.5	3.3	5.7	3.5	7.1
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.52		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		30.40		-	
Additional Reach Parameters								
Rosgen Classification	E5 incised (Pond)		E5/C5		E5/C5		E5/C5	
Bankfull Velocity (fps)	2.7		4.5		4.4		4.4	
Bankfull Discharge (cfs)	19.0		-		19.0		19.0	
Sinuosity	1.05		1.1 - 1.3		1.12		1.12	
Water Surface Slope (Channel) (ft/ft)	0.012		0.015		0.015		0.015	
Bankfull Slope (ft/ft)	0.013		0.015		0.015		0.015	

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)	6.0	-	4.5	8.3	7.8		8.6	8.3
Floodprone Width (ft)	35.0	-	10.0	35.0	17.0	45.0	56.0	25.0
Bankfull Mean Depth (ft)	1.3	-	0.8	1.6	0.6		0.5	0.6
Bankfull Max Depth (ft)	1.8	-	0.9	1.3	0.8		0.9	0.9
Bankfull Cross Sectional Area (ft^2)	12.3	-	3.0	5.0	4.7		4.1	5.2
Width/Depth Ratio	4.4	-	6.2	14.2	13.0		18.1	13.1
Entrenchment Ratio	6.1	-	7.1	8.4	2.2	5.8	6.5	3.0
Bank Height Ratio	1.5	-	0.9	1.1	1.0		1.0	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)	13.0	41.0	23.4	29.0	35.0	50.0	28.0	59.0
Radius of Curvature (ft)	7.9	28.9	11.2	17.5	16.0	25.0	12.0	23.0
Rc:Bankfull Width (ft/ft)	1.3	4.8	1.6	2.5	2.0	3.0	1.9	3.3
Meander Wavelength (ft)	36.0	101.0	43.4	65.1	55.0	80.0	52.0	77.0
Meander Width Ratio	2.2	6.8	3.9	4.5	4.5	6.4	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 ($W/m^{2)}$	-		-		32.00		-	
Additional Reach Parameters								
Rosgen Classification	E5/F5		E5/C5		C5		C5	
Bankfull Velocity (fps)	1.9		4.0		4.9		4.9	
Bankfull Discharge (cfs)	23.0		-		23.0		23.0	
Sinuosity	1.14		1.1 - 1.3		1.18		1.18	
Water Surface Slope (Channel) (ft/ft)	0.013		0.015		0.012		0.012	
Bankfull Slope (ft/ft)	0.012		0.015		0.012		0.013	

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

0

	Cross Section 1 (Riffle)							Cross Section 2 (Riffle)							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)	11.1	10.5	9.3					7.8	7.0	7.5					7.1	7.1	8.9				
Floodprone Width (ft)	49.0	49.2	51.5					23.0	25.0	24.0					19.8	24.0	19.8				
Bankfull Mean Depth (ft)	0.6	0.5	0.6					0.5	0.6	0.5					0.4	0.5	0.5				
Bankfull Max Depth (ft)	1.2	1.0	1.1					0.8	0.9	0.8					0.8	1.1	1.1				
Bankfull Cross Sectional Area (ft^2)	7.0	5.3	5.3					4.2	4.1	4.1					3.1	4.3	4.3				
Bankfull Width/Depth Ratio	17.7	20.7	16.4					14.6	11.4	14.0					16.3	13.6	18.1				
Bankfull Entrenchment Ratio	4.4	4.7	5.5					2.9	3.6	3.2					2.8	3.4	2.2				
Bankfull Bank Height Ratio	1.0	1.0	0.9					1.0	1.0	1.0					1.0	1.0	1.0				
d50 (mm)	N/a	1.5	5.1					N/a	1.5	5.1					N/a	1.5	5.1				
	Cross Section 4 (Pool)							**Cross Section 5 (Pool)**							**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)	9.2	8.6	8.6					10.0	10.9	19.7					8.6	7.9	7.7				
Floodprone Width (ft)	29.6	30.0	29.6					53.0	53.5	53.0					63.0	63.0	61.0				
Bankfull Mean Depth (ft)	1.0	0.9	0.9					0.7	0.6	0.3					0.5	0.5	0.4				
Bankfull Max Depth (ft)	1.7	1.6	1.7					1.5	1.6	1.6					0.9	0.7	0.8				
Bankfull Cross Sectional Area (ft^2)	9.2	7.8	7.8					6.9	6.9	6.9					4.1	3.0	3.0				
Bankfull Width/Depth Ratio	9.2	9.1	9.6					14.4	17.3	56.3					18.1	21.0	20.0				
Bankfull Entrenchment Ratio	3.2	3.5	3.4					5.2	4.9	2.7					6.5	8.0	7.9				
Bankfull Bank Height Ratio	1.0	1.0	1.1					1.0	1.0	1.0					1.0	<1	1.0				
d50 (mm)	N/a	0.4	0.7					N/a	0.4	0.7					N/a	1.5	5.1				
	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)	10.0	10.3	9.9					8.1	7.7	8.5											
Floodprone Width (ft)	38.0	51.0	32.0					27.0	25.0	25.0											
Bankfull Mean Depth (ft)	1.3	1.3	1.1					0.5	0.5	0.3											
Bankfull Max Depth (ft)	3.0	3.2	2.7					0.8	0.9	0.7											
Bankfull Cross Sectional Area (ft^2)	13.4	10.7	10.7					4.4	2.9	2.9											
Bankfull Width/Depth Ratio	7.5	8.2	9.2					15.0	14.2	24.8											
Bankfull Entrenchment Ratio	3.8	5.0	3.2					3.3	4.0	2.9											
Bankfull Bank Height Ratio	1.0	<1	1.0					1.0	1.0	1.1											
d50 (mm)	N/a	0.4	0.7					N/a	1.5	5.1											

	Table 7c. Monitoring Data - Stream Reach Summary Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)											
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)	-	-										
Riffle Slope (ft/ft)	-	-										
Pool Length (ft)	-	-										
Pool Max depth (ft)	-	-										
Pool Spacing (ft)	-	-										
Pattern												
Channel Beltwidth (ft)	-	-										
Radius of Curvature (ft)	-	-										
Rc:Bankfull width (ft/ft)	-	-										
Meander Wavelength (ft)	-	-										
Meander Width Ratio	-	-										
Additional Reach Parameters												
Rosgen Classification	C5											
Sinuosity (ft)	1.03											
Water Surface Slope (Channel) (ft/ft)	0.017											
BF slope (ft/ft)	0.017											
[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)	-	-										
Riffle Slope (ft/ft)	-	-										
Pool Length (ft)	-	-										
Pool Max depth (ft)	-	-										
Pool Spacing (ft)	-	-										
Pattern												
Channel Beltwidth (ft)	-	-										
Radius of Curvature (ft)	-	-										
Rc:Bankfull width (ft/ft)	-	-										
Meander Wavelength (ft)	-	-										
Meander Width Ratio	-	-										
Additional Reach Parameters												
Rosgen Classification	E5 incised (Pond)											
Sinuosity (ft)	1.07											
Water Surface Slope (Channel) (ft/ft)	0.016											
BF slope (ft/ft)	0.017											
[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												

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)	12	30										
Riffle Slope (ft/ft)	0.013	0.029										
Pool Length (ft)	7	9.8										
Pool Max depth (ft)	1.1	2										
Pool Spacing (ft)	13	48										
Pattern												
Channel Beltwidth (ft)	25	45										
Radius of Curvature (ft)	15	25										
Rc:Bankfull width (ft/ft)	1.5	3										
Meander Wavelength (ft)	30	44.8										
Meander Width Ratio	3.5	7.1										
Additional Reach Parameters												
Rosgen Classification	C5											
Sinuosity (ft)	1.12											
Water Surface Slope (Channel) (ft/ft)	0.015											
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												

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)	28	59										
Radius of Curvature (ft)	12	23										
Rc:Bankfull width (ft/ft)	1.9	3.3										
Meander Wavelength (ft)	52	77										
Meander Width Ratio	4.7	8.5										
Additional Reach Parameters												
Rosgen Classification	C5											
Sinuosity (ft)	1.18											
Water Surface Slope (Channel) (ft/ft)	0.012											
BF slope (ft/ft)	0.013											
[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												

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	Measurement above bankfull
9/17/2018	9/16-9/17/2018	Observed indicators of stage (wrack lines) after sotrm event	Bkf	Photos	
11/21/2018	9/16-9/17/2018	Crest Gage	Bkf	Photos	
7/26/2019	7/24/2019	Crest Gage	Bkf	Photos	1.1 inches

9/17/2018

9/17/2018

9/17/2018

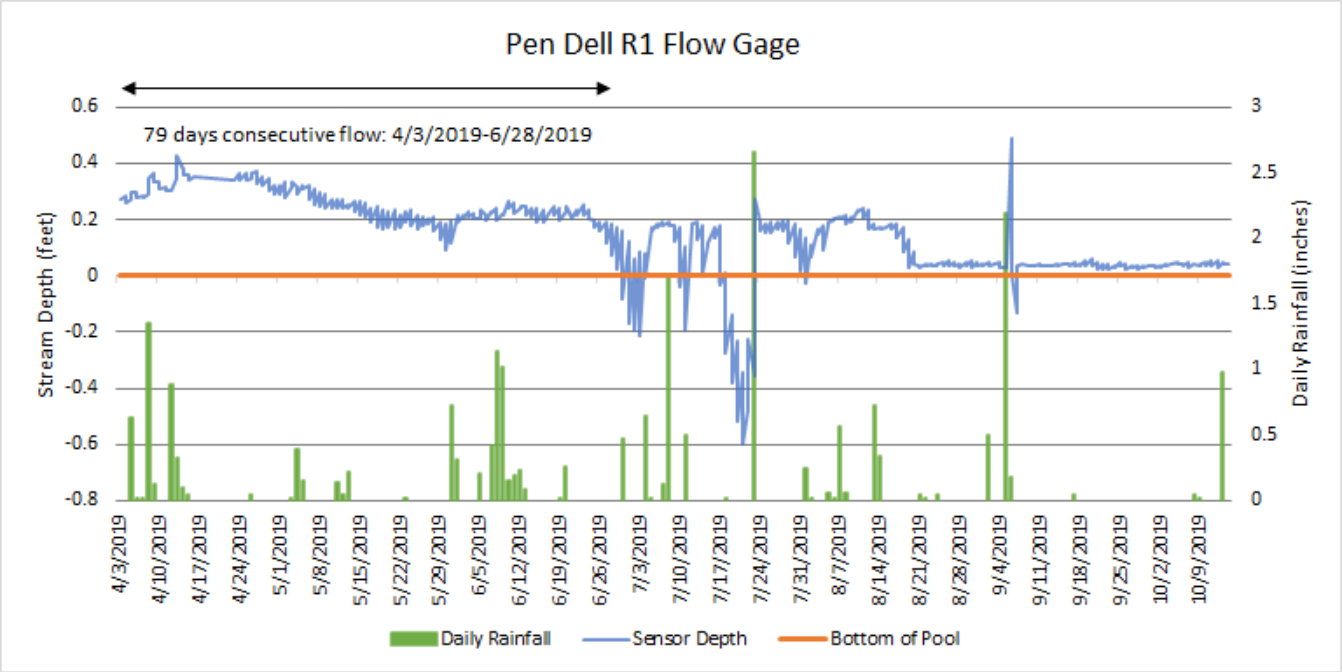
9/17/2018

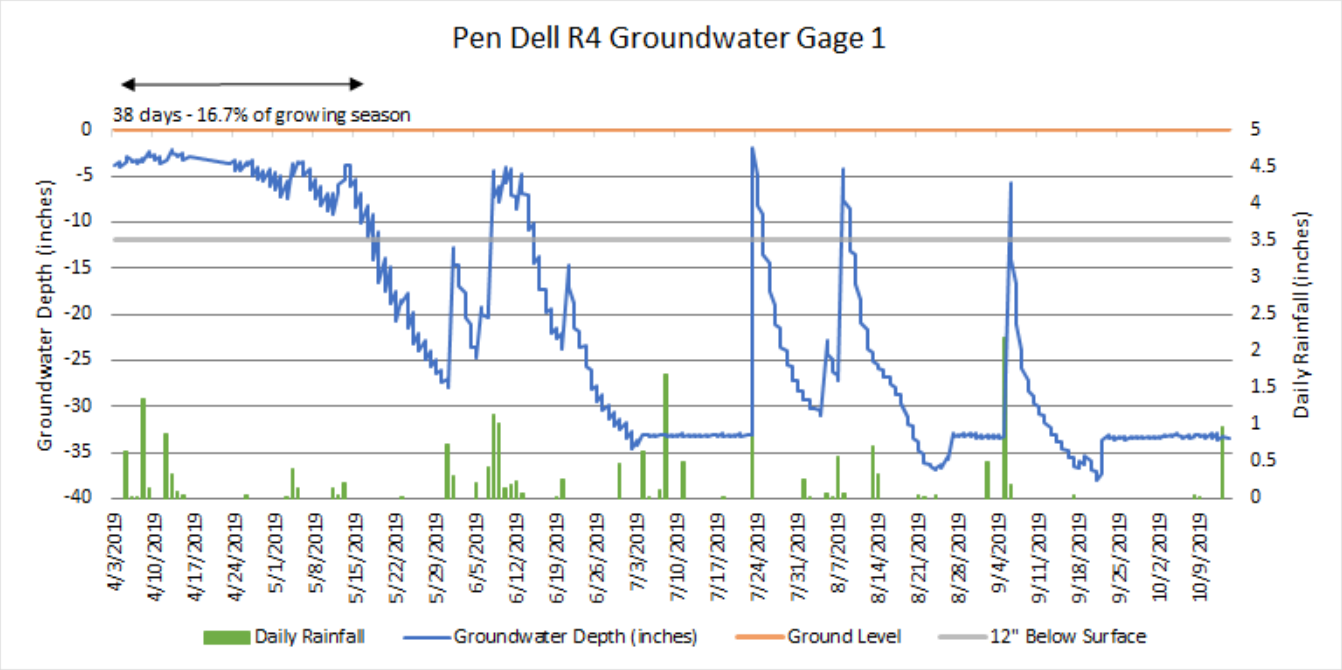
9/17/2018

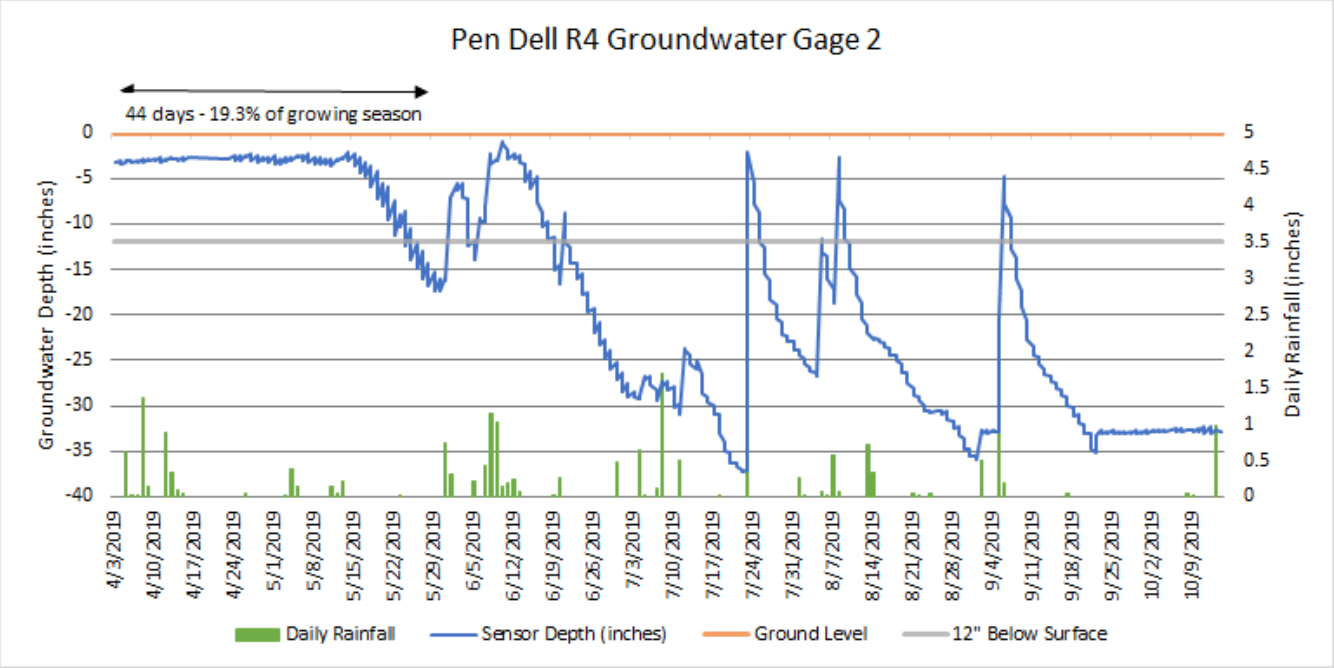
11/21/2018

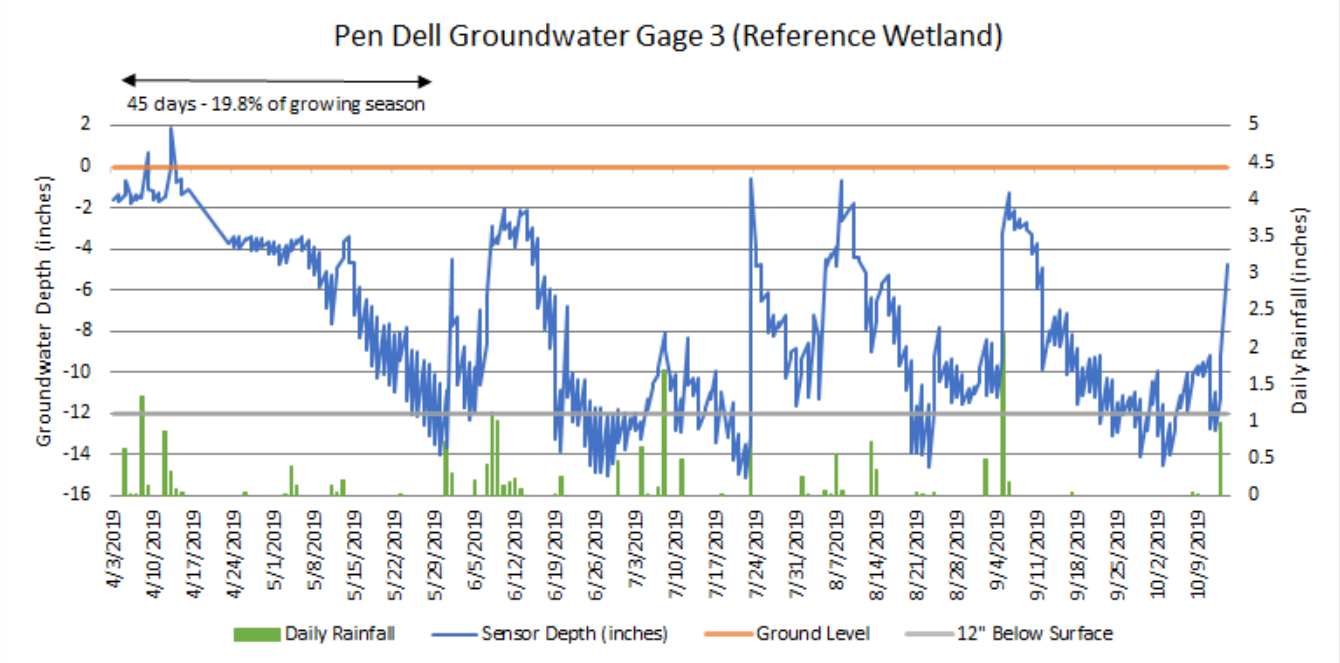
7/26/2019

Figure 4:


Pen Dell R1 Flow Gage
79 days consecutive flow: 4/3/2019-6/28/2019
Stream Depth (feet)
Daily Rainfall (inches)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
3
2.5
2
1.5
1
0.5
0
4/3/2019
4/10/2019
4/17/2019
4/24/2019
5/1/2019
5/8/2019
5/15/2019
5/22/2019
5/29/2019
6/5/2019
6/12/2019
6/19/2019
6/26/2019
7/3/2019
7/10/2019
7/17/2019
7/24/2019
7/31/2019
8/7/2019
8/14/2019
8/21/2019
8/28/2019
9/4/2019
9/11/2019
9/18/2019
9/25/2019
10/2/2019
10/9/2019
Daily Rainfall
Sensor Depth
Bottom of Pool


Pen Dell R4 Groundwater Gage 1
38 days - 16.7% of growing season
Groundwater Depth (inches)
Daily Rainfall (inches)
0
-5
-10
-15
-20
-25
-30
-35
-40
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
4/3/2019
4/10/2019
4/17/2019
4/24/2019
5/1/2019
5/8/2019
5/15/2019
5/22/2019
5/29/2019
6/5/2019
6/12/2019
6/19/2019
6/26/2019
7/3/2019
7/10/2019
7/17/2019
7/24/2019
7/31/2019
8/7/2019
8/14/2019
8/21/2019
8/28/2019
9/4/2019
9/11/2019
9/18/2019
9/25/2019
10/2/2019
10/9/2019
Daily Rainfall
Groundwater Depth (inches)
Ground Level
12" Below Surface





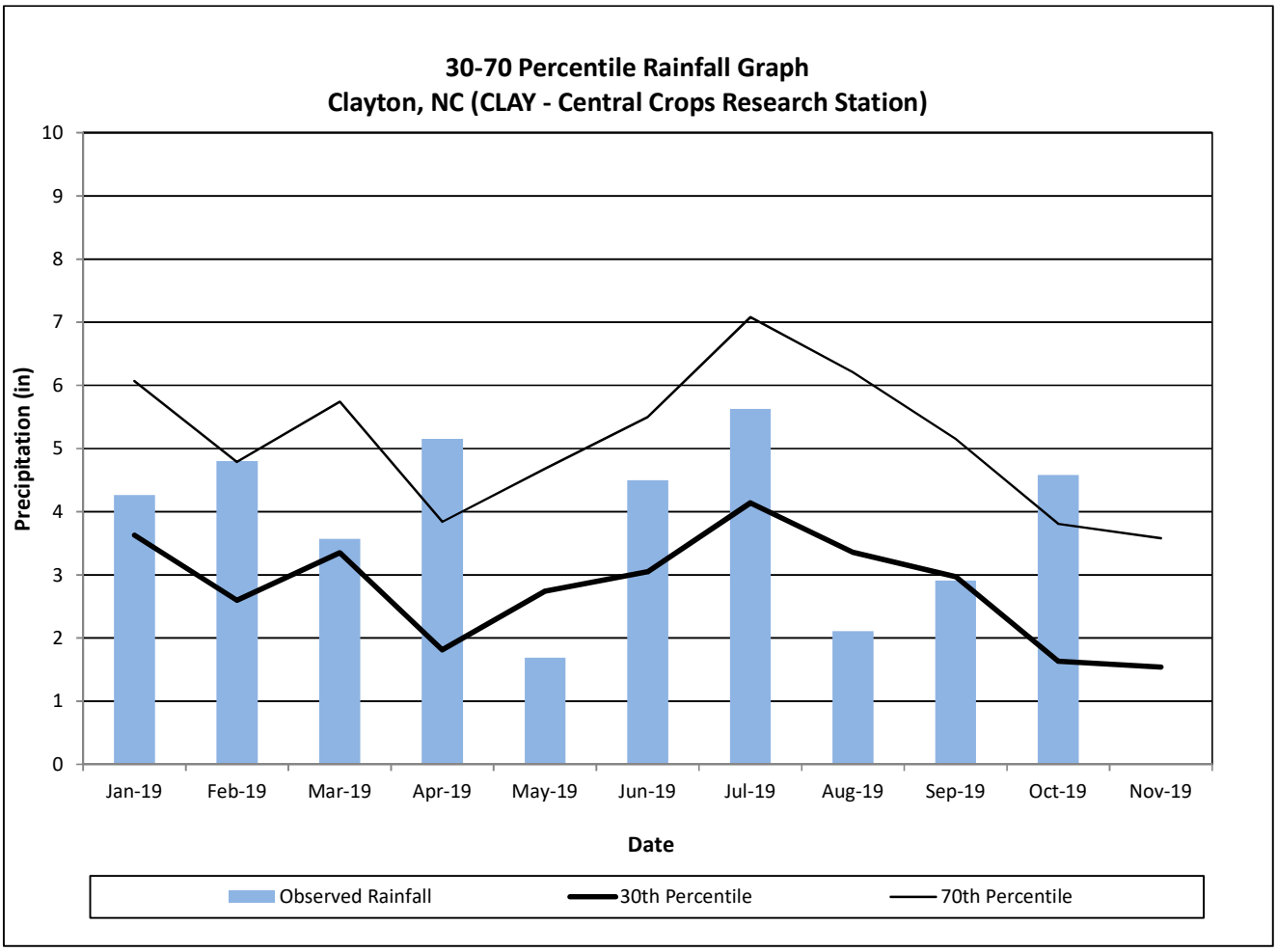
*Pressure Transducers were used for all groundwater gages.

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
Pen Dell R4 Wetland Gage 1	M	16.74%						
Pen Dell R4 Wetland Gage 2	NA	19.38%						
Pen Dell Reference Wetland	94.70%	19.82%						

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

Figure 5: Monthly Rainfall Data
Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)
MY2 2019

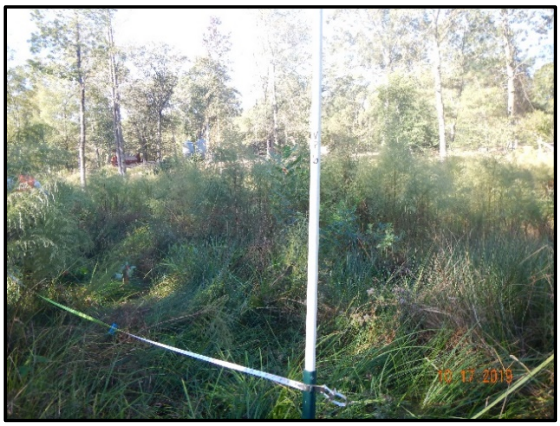


*30th and 70th percentile rainfall data collected from weather station (COOP 317994) in Smithfield, NC.
**Incomplete Month

Month	30%	70%	Observed
Jan-19	3.63	6.07	4.26
Feb-19	2.60	4.79	4.8
Mar-19	3.35	5.74	3.57
Apr-19	1.81	3.84	5.15
May-19	2.74	4.68	1.69
Jun-19	3.05	5.50	4.5
Jul-19	4.14	7.08	5.63
Aug-19	3.36	6.21	2.11
Sep-19	2.97	5.15	2.91
Oct-19	1.63	3.81	4.58
Nov-19	1.54	3.58	**
Dec-19	**	**	**

Monitoring Report- Year 2
FINAL VERSION
Pen Dell Mitigation Project (Riparian Buffer Mitigation)
Calendar Year of Data Collection: 2019

NCDEQ DMS Project Identification # 97079
NCDEQ DMS Contract # 6824
Neuse River Basin (Cataloging Unit 03020201)
USACE Action ID Number: SAW-2016-00885
NCDEQ DWR Project # 2016-0403
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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LIST OF APPENDICES

1 Project Summary

Water and Land Solutions, LLC (WLS) completed the construction and planting of the Pen Dell Mitigation Project (Project) full-delivery project for the North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) in April 2018. The Project is located in Johnston County, NC between the Community of Archer Lodge and the Town of Wendell at 35.73125°, -78.35281°. The Project site is located in the NCDEQ Sub-basin 03-04-06, in the Lower Buffalo Creek Priority Sub-watershed 030202011504.

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 5,064 linear feet of streams and 633,803 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 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 the Targeted Local Watershed 03020201180050.

The catchment area is 156 acres and has an impervious cover of approximately one percent. The dominant surrounding land uses are agriculture and mixed forest. Prior to construction, livestock had access to Reaches R3 and R4, and the riparian buffers were less than 50 feet wide on all reaches except R5.

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 – Pen Dell Located Near 2505 Wendell Rd, Wendell, NC, Johnston County". The referenced viability letter specified for Reach R1 that riparian buffer credits being only being allowed outside of 25 feet off the top of stream banks. The described site viability confirmation included a determination by DWR that Project Reaches R2, R3 (Includes Project Reach R4) and R5 were either intermittent or perennial. A request for Stream Origin/Buffer Applicability Determination for Project Reach R1, as required in the referenced viability letter, was submitted to DWR on June 10, 2016. On June 20, 2016 and June 21, 2016 DWR performed the requested determination and Reach R1 was determined to be intermittent, as communicated in the DWR June 22, 2016 letter entitled "Subject: Buffer Determination Letter, NBRO #16-180 Johnston County", therefore confirming Reach R1'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 September 29, 2017 for submission to DWR and the NCIRT. The Section 404 General (Regional and Nationwide) Permit Verification was issued January 12, 2018. Project construction started on January 29, 2018 and mitigation site earthwork was completed on April 1, 2018, and mitigation site planting was completed on April 6, 2018, both 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. Monitoring year 1 occurred between April and November 2018. Monitoring year 2 occurred in between November 2018 and October 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 R2, where the width of the proposed left riparian buffer varies between 20 feet and 29 feet from the right top of bank. This narrow area of proposed riparian buffer is due to the site constraint caused by an existing residential driveway. 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. For project reach sections proposed for preservation, the existing riparian buffers are permanently protected via the conservation easement. A significant area of the existing northern riparian buffer for Reach R2 was incorrectly described as "Native hardwood forest, closed canopy" in the referenced site viability letter, as this area of the buffer was a fescue lawn. WLS proposed this area for

riparian buffer restoration in the approved mitigation plan (Figure 11 Riparian Buffer Mitigation). Additionally, permanent fencing was installed along with alternative watering systems to exclude livestock from the restored riparian buffer and conservation easement areas. Table 1 and 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. The as-built planting boundaries are shown on the as-built vegetation plans in Appendix E and Figure 1. Proposed plantings were conducted using native species bare-root trees and shrubs, live stakes, and seedlings. Proposed plantings predominantly consisted of bare-root vegetation and 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, no areas of concern was observed within the conservation easement boundary. Any areas identified during MY3 monitoring will be treated and documented in the subsequent annual report.

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. Volunteer species are only counted if they are at least 18” tall. Volunteer species will only be

included if surviving for at least two years and were included in the approved planting plan. 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. All veg plots meet the interim measure of vegetative success of at least 260 planted stems per acre at the end of the fifth monitoring year. 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. One area of concern adjacent to Plot 7 was found to be under the 0.1-acre threshold for low stem density. This area will be monitored closely. No other areas of concern were identified.

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.

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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). Pen Dell Stream and Riparian Buffer Mitigation Plan. NCDMS, Raleigh, NC.

Appendices

Appendix A – Background Tables

Table 1. Buffer Project Attributes

Project Name	Pen Dell Mitigation Project
Hydrologic Unit Code	03020201
River Basin	Neuse
Geographic Location (Lat, Long)	35˚43’ 52.51’’ N 78˚21’ 10.12’’ W
Site Protection Instrument (DB, PG)	85, 148
Total Credits (BMU)	371,215
Types of Credits	Riparian Buffer
Mitigation Plan Date	Nov-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

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	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	0.000		-	0.000
Rural or Urban	Subject or Nonsubject	Restoration	Restoration	0-100	286,888	286,888	1	100%	1.00000	286,888.000	Yes	14,970.199	--
Rural or Urban	Subject or Nonsubject	Restoration		101-200			1	33%	3.03030	0.000		-	0.000
Rural or Urban	Subject or Nonsubject	Enhancement		20-29			2	75%	2.66667	0.000		-	0.000
Rural or Urban	Subject or Nonsubject	Enhancement	Cattle Exc. Enh	0-100	124,088	124,088	2	100%	2.00000	62,044.000	No	-	0.000
Rural or Urban	Subject or Nonsubject	Enhancement		101-200			2	33%	6.06061	0.000		-	0.000
					SUBTOTALS	**410,976**				**348,932.000**		**14,970.199**	**0.000**

ELIGIBLE PRESERVATION AREA					**136,992**	

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
Rural	Subject	Preservation		20-29			10	75%	13.33333	0.000
Rural	Subject	Preservation	Preservation	0-100	222,827	136,992	10	100%	10.00000	13,699.200
Rural	Subject	Preservation		101-200			10	33%	30.30303	0.000
Rural	Nonsubject	Preservation		20-29			5	75%	6.66667	0.000
Rural	Nonsubject	Preservation		0-100			5	100%	5.00000	0.000
Rural	Nonsubject	Preservation		101-200			5	33%	15.15152	0.000
Urban	Subject or Nonsubject	Preservation		20-29			3	75%	4.00000	0.000
Urban	Subject or Nonsubject	Preservation		0-100			3	100%	3.00000	0.000
Urban	Subject or Nonsubject	Preservation		101-200			3	33%	9.09091	0.000
					SUBTOTALS	**136,992**				**13,699.200**
					TOTALS	**547,968**				**362,631.200**

**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 riparian 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 DWR's 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 Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)	
Mitigation Provider Primary Project POC	Water & Land Solutions, LLC 7721 Six Forks Road, Suite 130, Raleigh, NC 27615 Catherine Manner Phone: 571-643-3165
Construction Contractor Primary Project POC	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520 Bill Wright Phone: 919-590-5193
Survey Contractor (Existing Condition Surveys) Primary Project POC	WithersRavenel 115 MacKenan Drive, Cary, NC 27511 Marshall Wight, PLS Phone: 919-469-3340
Survey Contractor (Conservation Easement, Construction and As-Builts Surveys) Primary Project POC	True Line Surveying, PC 205 West Main Street, Clayton, NC 27520 Curk T. Lane, PLS 919-359-0427
Planting Contractor Primary Project POC	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520 Bill Wright Phone: 919-590-5193
Seeding Contractor Primary Project POC	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520 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

Legend

- Conservation Easement
- 30ft Utility Easement
- Stream
- Top of Bank
- CVS Plot Origin

CVS Plots

- Success Criteria Met
- Success Criteria Not Met

Buffer Mitigation Types

- Preservation
- Enhancement
- Restoration

R1
R2
R3
R4
R5

Access point: 35.732578°, -78.350461°

Access point: 35.731075°, -78.351133°

Access point: 35.727314°, -78.357994°

Wendell Rd

Lake Wendell Rd

566/323
485/364
607/526
849/526
566/364
890/768
323/283

10+00 11+00 12+00 13+00 14+00 15+00 16+00 17+00 18+00 19+00 20+00 21+00 22+00 23+00 24+00 25+00 26+00 27+00 28+00 29+00 30+00 31+00 31+30 32+00 33+00 34+00 35+00 36+00 37+00 38+00 39+00 40+00 41+00 42+00 43+00 44+00 45+00 46+00 47+00 48+00 49+00 50+00 51+00 52+00 53+00 54+00 54+92

0 175 350 Feet

N

Aerial: Google Earth Winter 2019

WATER & LAND™ SOLUTIONS

Pen Dell Mitigation Project
Johnston County, North Carolina

NCDMS Contract No. 6824
NCDMS Project No. 97079
December 2019
MY2

Riparian Buffer & Nutrient Offset 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 Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079) 10.1					
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	Pattern and Color	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] **15.95**

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	Pattern and Color	0	0.00	0.0%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none	Pattern and Color	0	0.00	0.0%

Veg Plot 1, April 12, 2018 (MY-00)

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

Veg Plot 2, April 12, 2018 (MY-00)

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

Veg Plot 3, April 12, 2018 (MY-00)

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

Veg Plot 4, April 12, 2018 (MY-00)

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

Veg Plot 5, April 12, 2018 (MY-00)

Veg Plot 5, October 17, 2019 (MY-02)

Veg Plot 6, April 12, 2018 (MY-00)

Veg Plot 6, October 17, 2019 (MY-02)

Veg Plot 7, April 12, 2018 (MY-00)

Veg Plot 7, October 17, 2019 (MY-02)

Appendix C – Vegetation Plot Data

EEP Project Code 2. Project Name: Pen-Del

Table 5

			Current Plot Data (MY2 2019)																						Annual Means								
			002-01-0001			002-01-0002			002-01-0003			002-01-0004			002-01-0005			002-01-0006			002-01-0007			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 rubrum		Tree						2			2	1	1	4	1	1	2	1	1	3			1	3	3	14	4	4	122	3	3	3
Alnus serrulata	Tag Alder, Smooth Alde	Shrub Tree	1	1	1				1	1	1							1	1	1				3	3	3	3	3	3	3	3	3
Betula nigra	River Birch, Red Birch	Tree	2	2	2				1	1	1	2	2	2	1	1	1	3	3	3				9	9	9	11	11	11	14	14	14
Carpinus caroliniana		Shrub Tree							1	1	1				1	1	1	3	3	3				5	5	5	9	9	10	10	10	10
Carya	Hickory	Tree																											1			
Cornus amomum	Silky Dogwood	Shrub Tree							3	3	3										1	1	1	4	4	4	6	6	6	6	6	6
Diospyros virginiana	American Persimmon,	Tree										1	1	1										1	1	1	2	2	2	2	2	2
Fraxinus pennsylvanica	Green Ash, Red Ash	Tree	1	1	1				1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	10	10	10	10	10	10	10	10	10
Ilex verticillata	Winterberry	Shrub Tree				3	3	3																3	3	3	3	3	3	3	3	3
Lindera benzoin	Northern Spicebush	Shrub Tree				2	2	2																2	2	2	3	3	3	13	13	13
Liquidambar styraciflua	Sweet Gum, Red Gum	Tree						1						2			2									5			3			
Liriodendron tulipifera		Tree	1	1	1	1	1	1																2	2	2	5	5	5	13	13	13
Magnolia virginiana		Shrub Tree				1	1	1	1	1	1	2	2	2							2	2	2	6	6	6	8	8	8	14	14	14
Platanus occidentalis	Sycamore, Plane-tree	Tree							2	2	2				4	4	4	4	4	4	1	1	1	11	11	11	14	14	14	14	14	14
Populus deltoides		Tree																											1			
Quercus michauxii	Basket Oak, Swamp Ch	Tree	1	1	1				3	3	3	2	2	2				3	3	3				9	9	9	11	11	11	9	9	9
Quercus nigra	Water Oak, Paddle Oak	Tree	1	1	1							2	2	2				1	1	1				4	4	4	3	3	3	9	9	9
Quercus phellos	Willow Oak	Tree	1	1	1	2	2	2				1	1	1				1	1	1	1	1	1	6	6	6	8	8	8	8	8	8
Rhus copallinum		Shrub Tree																											3			
Rosa palustris	Swamp Rose	Shrub Vine												2			2									4			39			
Salix nigra	Black Willow	Tree			1																					1			7			
Sambucus canadensis	Common Elderberry	Shrub Tree			5																					5			3			
Ulmus rubra	Slippery Elm, Red Elm	Tree												1						1						2			3			
Viburnum nudum	Southern Wild Raisin, F	Shrub Tree																												1	1	1
		Stem count	8	8	14	9	9	12	13	13	15	13	13	21	9	9	14	19	19	22	7	7	8	78	78	106	100	100	279	132	132	132
		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	7	7	9	5	5	7	8	8	9	8	8	11	5	5	7	9	9	10	5	5	6	15	15	20	15	15	23	16	16	16
		Stems per ACRE	323.7	323.7	566.6	364.2	364.2	485.6	526.1	526.1	607	526.1	526.1	849.8	364.2	364.2	566.6	768.9	768.9	890.3	283.3	283.3	323.7	450.9	450.9	612.8	578.1	578.1	1613	763.1	763.1	763.1

Volunteers were 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 #: 2016-0403

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 – Pen Dell
Located near 2505 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 Pen Dell 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 25, 2016. If approved, mitigating this site could provide stream mitigation credits, riparian buffer credits and/or nutrient offset credits.

Ms. Merritt's evaluation of the 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 Land uses	Buffer Credit Viable	[2]Nutrient Offset Viable at 2,273 lbs/acre	Mitigation Type/Comments
R1 (wood line to road)	Undetermined conveyance	n/a	Active and pre-existing row crop; Land use along the conveyance consisted of a +/- 25' narrow forested fringe w/ canopy from 1999-2010	n/a	Yes	Restoration for nutrient offset outside of 25' on both sides of conveyance w/ plantings and easement starting at TOB back max 200'; Need stream determination by DWR if pursuing buffer credit; if feature is a stream, feature is viable for buffer restoration per 15A NCAC 02B .0295 (o)(3) outside of 25' on both sides of conveyance.

R2 (Wendell Rd to below pond)	stream	Yes	Native hardwood forest, closed canopy	Yes	No	Preservation per 15A NCAC 02B .0295 (o)(5)
R3 (dirt path crossing to Lake Wendell Rd	stream	Yes	All pasture actively grazed by cattle with mix of Native hardwood forest canopy	Yes	Yes	entire 50' from TOB and within all clusters of closed canopy hardwoods= Enhancement per 15A NCAC 02B .0295 (6); outside of forested areas *(pine tree clustered areas are not viable for credit)* =Restoration
R5	Stream	Yes	Native hardwood forest, closed canopy	Yes	No	Preservation per 15A NCAC 02B .0295 (o)(5)

[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.

Maps showing the project site and the features are provided and are signed by Ms. Merritt on April 25, 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/or 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.

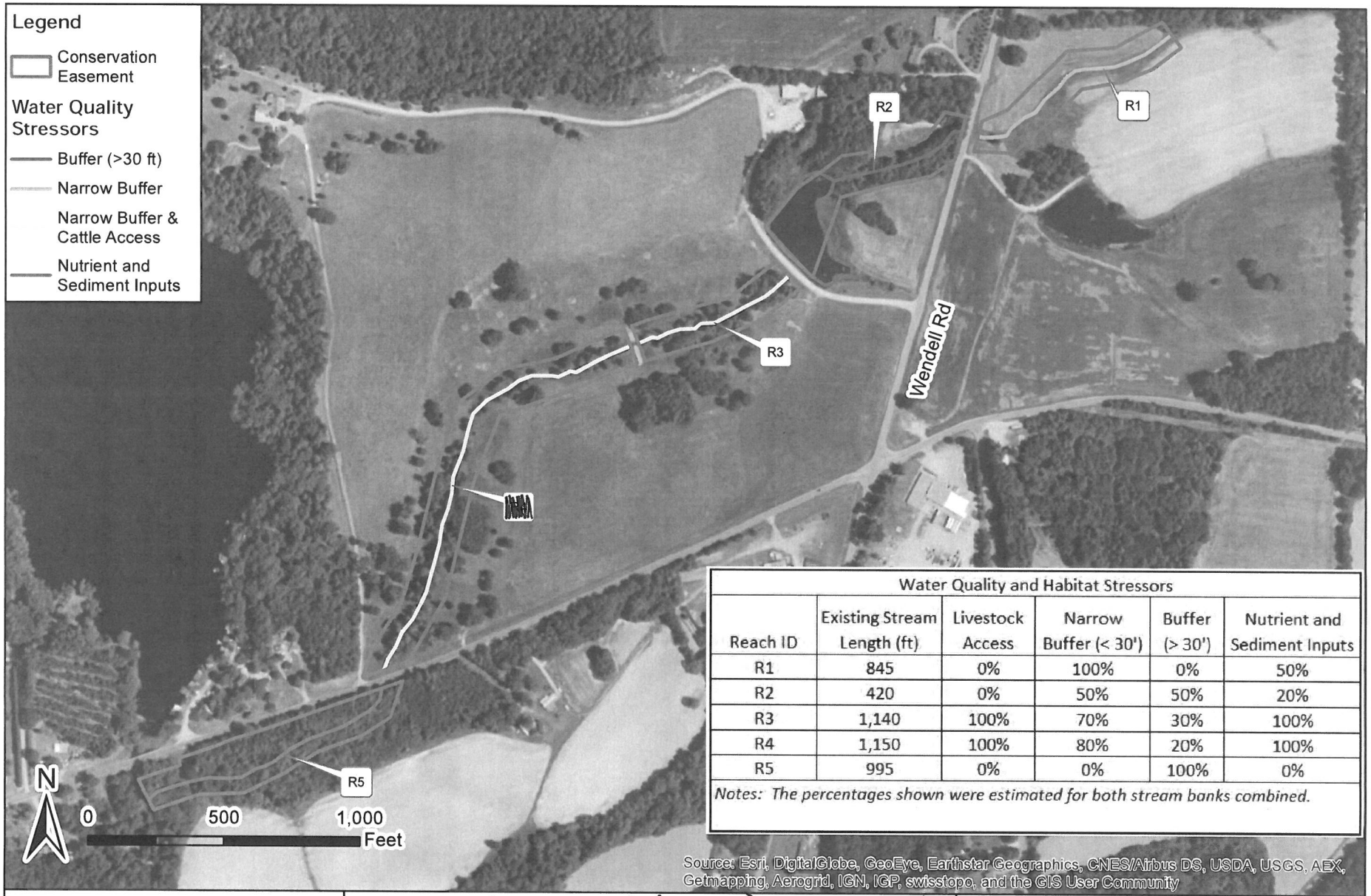
Sincerely,

Karen Higgins

Karen Higgins, Supervisor
401 and Buffer Permitting Branch

KAH/*km*
Attachments: Site Aerial Map, USGS Topographic Map, 1999 Aerial Photo, 2010 Aerial Photo

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



Water Quality and Habitat Stressors					
Reach ID	Existing Stream Length (ft)	Livestock Access	Narrow Buffer (< 30')	Buffer (> 30')	Nutrient and Sediment Inputs
R1	845	0%	100%	0%	50%
R2	420	0%	50%	50%	20%
R3	1,140	100%	70%	30%	100%
R4	1,150	100%	80%	20%	100%
R5	995	0%	0%	100%	0%

Notes: The percentages shown were estimated for both stream banks combined.

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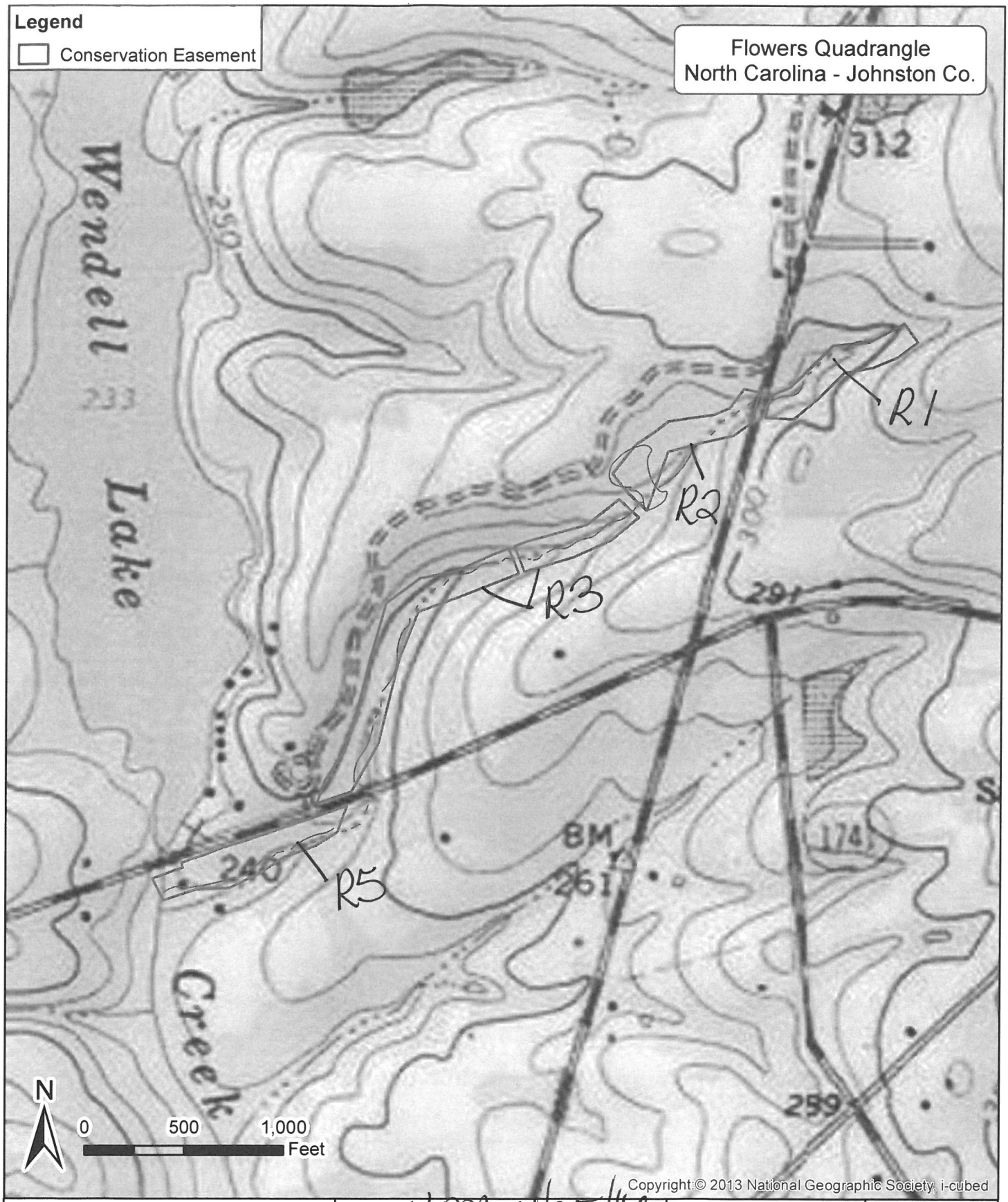
Site Aerial (Current) Kym 4/25/16

Pen Dell
Mitigation Project DWR # 2016-0403

Water Quality Stressors

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
9



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KJM 4/25/14

Pen Dell
Mitigation Project
DWR#2016-0403

USGS
Topographic
Map

NAD 1983 2011 State Plane

FIGURE
2

Google earth feet 600 meters 100

Aerial dated 12/2005
DWR# 2016-0403 (Pen Dell)
Kym 4/25/16

Google earth

feet 400
meters 100

Aerial dated 7/2010

DWR# 2014-0403 (Pen Dell)
Kym 4/25/14