Monitoring Report- Year 3
FINAL VERSION
Pen Dell Mitigation Project
Calendar Year of Data Collection: 2020

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: September-October 2020
Submission Date: December 11, 2020

Prepared for:

Environmental Quality

North Carolina Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

Prepared by:

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

Mitigation Project Name	**Pen Dell Mitigation Project**	**USACE Action ID**	**2016-00885**
DMS ID	**97079**	**DWR Permit**	**2016-0403 v2**
River Basin	**Neuse**	**Date Project Instituted**	**3/18/2016**
Cataloging Unit	**03020201**	**Date Prepared**	**4/21/2020**
County	**Johnston**	**Stream/Wet. Service Area**	**Neuse 03020201**

Signature & Date of Official Approving Credit Release

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

2 - For NCDMS projects, the initial credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the IRT by posting it to the DMS portal, provided the following have been met:

1) Approved of 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) Receipt of necessary DA permit authorization or written DA approval for projects 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.

Credit Release Milestone	**Warm Stream Credits**						
Project Credits	**Scheduled Releases %**	**Proposed Releases %**	**Proposed Released #**	**Not Approved # Releases**	**Approved Credits**	**Anticipated Release Year**	**Actual Release Date**
1 - Site Establishment	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 - Year 0 / As-Built	30.00%	30.00%	909.120	0.000	909.120	2019	3/21/2019
3 - Year 1 Monitoring	10.00%	10.00%	303.040	0.000	303.040	2019	8/19/2019
4 - Year 2 Monitoring	10.00%	10.00%	303.040	0.000	303.040	2020	4/21/2020
5 - Year 3 Monitoring	10.00%					2021	
6 - Year 4 Monitoring	5.00%					2022	
7 - Year 5 Monitoring	10.00%					2023	
8 - Year 6 Monitoring	5.00%					2024	
9 - Year 7 Monitoring	10.00%					2025	
Stream Bankfull Standard	10.00%						
			Totals	0.000	1,515.200		

Total Gross Credits	3,030.400
Total Unrealized Credits to Date	0.000
Total Released Credits to Date	1,515.200
Total Percentage Released	50.00%
Remaining Unreleased Credits	1,515.200

Notes

Contingencies (if any)

Project Quantities

Mitigation Type	**Restoration Type**	**Physical Quantity**
Warm Stream	Restoration	1,744.000
Warm Stream	Enhancement I	1,143.000
Warm Stream	Enhancement II	1,017.000
Warm Stream	Preservation	1,176.000

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County	**Johnston**	**Stream/Wet. Service Area**	**Neuse 03020201**

Debits

							Stream Restoration Credits	**Stream Restoration Equivalent Credits**
Beginning Balance (mitigation credits)							**2,912.800**	**117.600**
Released Credit							**0.000**	**0.000**
Unrealized Credits							**0.000**	**0.000**
Owning Program	**Req. Id**	**TIP #**	**Project Name**	**USACE Permit #**	**DWR Permit #**	**DCM Permit #**		
NCDOT Stream & Wetland ILF Program	REQ-008290	R-2721A	R-2721A - NC 540 - West of NC 55 to East of SR 1389	2009-02240	2018-1249		1,165.120	
NCDOT Stream & Wetland ILF Program	REQ-008187	I-5111 / I-4739	I-5111 / I-4739 - I-40 Widening (Wake & Johnston Counties)	2009-00556	2019-0593			47.040
Total Credits Debited							**1,165.120**	**47.040**
Remaining Available balance (Released credits)							**291.280**	**11.760**
Remaining balance (Unreleased credits)							**1,456.400**	**58.800**

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

December 11, 2020

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 9 Draft Monitoring Report Year 3 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 3 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 3 were developed by addressing NCDEQ DMS's review comments.

Under this cover, we are providing the Final Monitoring Report Year 3, and the required digital data for each (the .pdf copies of the entire updated reports and the updated digital data) via electronic delivery. We are providing our written responses to NCDEQ DMS's review comments on the Draft Monitoring Report Year 3 below. Each of the DMS review comments is copied below in **bold** text, followed by the appropriate response from WLS in regular text:

1. **The project states that all metrics met success, but one of the cross-sections and vegetation plots do not. Revise to remove statement or add explanation for metrics not meeting. See comments from Lake Wendell report.** WLS Response: WLS has updated section 5 of the report to clarify the metrics which are not meeting success criteria. Section 5.2 (Stream Horizontal & Vertical Stability) and section 5.5 (Vegetation) were updated with additional language and a explanation of the one cross section and one vegetation plot that do not meet success criteria.

2. **DMS Comment: Update rain report for October and November if possible.** WLS Response: WLS updated Figure 5 with the October and November rain total.

3. **DMS Comment: Confirm that the stream photos taken 3/2020 are still relevant for all streams in MY3.** WLS Response: All stream photos taken in March 2020 are still relevant for all locations in MY3. Photos were taken during the spring visual survey visit prior to the growing season.

Digital Deliverables:

1. **DMS Comment: Please include the visual assessment photos as JPEGS rather than a single PDF.** WLS Response: JPEGS of all photos are now included in the e-data.

2. **DMS Comment: Assign unique ID's to the photo station spatial features and resubmit these features, ensuring that these ID's match the photo station ID's provided in the Monitoring Report.** WLS Response: The GIS shapefile containing the photo stations has been updated to include the unique ID in the attribute table. The unique ID is also shown in appendix B on each photo.

Please contact me if you have any questions or comments.

Sincerely,

Water & Land Solutions, LLC

Catherine Manner
Water & Land Solutions, LLC
7721 Six Forks Road, Suite 130
Raleigh, NC 27615
Office Phone: (919) 614-5111
Mobile Phone: (571) 643-3165
Email: catherine@waterlandsolutions.com

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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 (see buffer summary table below). WLS staff visited the site several times throughout 2020. Monitoring Year 3 (MY3) data collection activities occurred between September and October 2020 (Table 2). This report presents the data for MY3. The Project meets the MY3 success criteria for stream hydrology, streambed material condition and stability, and stream flow. For stream horizontal and vertical stability, one cross section is not meeting requirements. One vegetation plot is not meeting success requirements for vegetation. Based on these results, the Project is expected to meet the Monitoring Year 4 (MY4) success criteria in 2021.

Buffer Project Areas and Assets

RIPARIAN BUFFER (15A NCAC 02B.0295)

Location	Jurisdictional Streams	Restoration Type	Reach ID/ Component	Buffer Width (ft)	Creditable Area (sf)*	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits (BMU)	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		0.000	0.000
				30-100	286,888		100%	1.00000	286888		0.000	0.000
				101-200			33%	3.00000	0		0.000	0.000
		Enhancement		20-29		2	75%	2.66667	0		0.000	0.000
				30-100	124,088		100%	2.00000	62044		0.000	0.000
				101-200			33%	6.00000	0		0.000	0.000
				SUBTOTALS	410976				348932		0.000	0.000

			ELIGIBLE PRESERVATION AREA		136992					
Location	Jurisdictional Streams	Restoration Type	Reach ID/ Component	Buffer Width (ft)	Creditable Area (sf)*	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits (BMU)	
Rural	Subject	Preservation		20-29		10	75%	13.33333	0	
				30-100	222827		100%	10.00000	22283	
				101-200			33%	30.00000	0	
	Nonsubject			20-29		5	75%	6.66667	0	
				30-100			100%	5.00000	0	
				101-200			33%	15.00000	0	
Urban	Subject or Nonsubject			20-29		3	75%	4.00000	0	
				30-100			100%	3.00000	0	
				101-200			33%	9.00000	0	
				SUBTOTALS	222827				22283	
				TOTALS	633803				371215	

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 gauge	Maintain average BHRs at 1.2 and ERs at 2.2 or greater and document out of bank and/or geomorphically significant flow events.	Provide temporary water storage and reduce erosive forces (shear stress) in channel during larger flow events.
Geomorphology (Level 3)	Improve Bedform Diversity	Pool to Pool spacing, riffle-pool sequence, pool max depth ratio, Longitudinal Profile	Increase riffle/pool percentage and pool-to-pool spacing ratios compared to reference reach conditions.	Provide a more natural stream morphology, energy dissipation and aquatic habitat/refugia.
	Increase Vertical and Lateral Stability	BEHI / NBS, Cross-sections and Longitudinal Profile Surveys, visual assessment	Decrease streambank erosion rates comparable to reference condition cross-section, pattern and vertical profile values.	Reduce sedimentation, excessive aggradation, and embeddedness to allow for interstitial flow habitat.
	Establish Riparian Buffer Vegetation	CVS Level I & II Protocol Tree Veg Plots (Strata Composition and Density), visual assessment	Minimum of 320 stems per acre must be present at year three; a minimum of 260 stems per acre must be present at year five; and a minimum of 210 stems per acre must be present at year seven.	Increase woody and herbaceous vegetation will provide channel stability and reduce streambank erosion, runoff rates and exotic species vegetation.
Physicochemical (Level 4)	Improve Water Quality	N/A	N/A	Removal of excess nutrients, FC bacteria, and organic pollutants will increase the hyporheic exchange and dissolved oxygen (DO) levels.
Biology (Level 5)	Improve Benthic Macroinvertebrate Communities and Aquatic Health	DWR Small Stream/ Qual v4 sampling, IBI (MY3, MY5, MY7)	N/A	Increase leaf litter and organic matter critical to provide in-stream cover/shade, wood recruitment, and carbon sourcing.

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

4.1 Streams

4.1.1 Stream Hydrology

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

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

4.1.2 Stream Profiles, Vertical Stability, and Floodplain Access

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

4.1.3 Stream Horizontal Stability

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

4.1.4 Streambed Material Condition and Stability

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

4.1.5 Jurisdictional Stream Flow

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

4.2 Vegetation

Vegetative restoration success for the project during the intermediate monitoring years will be based on the survival of at least 320, three-year-old planted trees per acre at the end of Year 3 of the monitoring period and at least 260, five-year-old, planted trees per acre at the end of Year 5 of the monitoring period. The final vegetative restoration success criteria will be achieving a density of not less than 210, seven-year-old planted stems per acre in Year 7 of monitoring. Planted vegetation (for projects in coastal plain and piedmont counties) must average seven feet in height at Year 5 of monitoring and 10 feet in height at Year 7 of monitoring. Volunteer 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 3 Assessment and Results

Annual monitoring was conducted during MY3 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). MY3 monitoring results are provided in the appendices. The Project meets the MY3 success criteria for stream hydrology and jurisdictional stream flow. For stream horizontal and vertical stability, all the cross sections except XS-8 meet criteria. All vegetation plots except plot 7 meet the required success criteria (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 gauge 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. At least two bankfull events occurred during MY3 (see table below). This event was documented using the described crest gauge and photography (Appendix E Table 8). The documented occurrence of these flow events and three events during prior to MY3 satisfies the requirement of the occurrence of four bankfull events (overbank flows) in at least two separate years.

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

5.2 Stream Horizontal & Vertical Stability

Visual assessment and monitoring of eight permanent cross sections were utilized for assessment of MY3 horizontal and vertical stream stability. The visual assessments for each stream reach concluded that the MY3 stream channel pattern and longitudinal profiles, instream structure locations, still closely match the profile design parameters and MY0/baseline conditions. The MY3 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. One riffle cross section, XS-8 located at station 51+79, experienced a 20% change in bank height ratio over MY1 due to minor sediment deposition on the banks and floodplain. Based on visual assessment and survey data this stream reach is stable from MY2 and is performing as designed. WLS will observe this area closely in MY4 for any further change.

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 MY3.

5.4 Jurisdictional Stream Flow Documentation

Jurisdictional stream flow documentation and monitoring of restored intermittent reaches is achieved using a flow gauge (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 gauge 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 MY3 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 stems per acre which does not meet the year 3 minimum of 320 stems per acre. Plot 7 contains seven stems total, one stem below the requirement to meet success criteria. Loss in stem density from MY1 to MY3 is due to a dense herbaceous layer. The surviving trees in this area appear to have grown above the herbaceous vegetation. During MY4, Plot 7 will be monitored closely.

The MY3 vegetation monitoring was also conducted utilizing visual assessment throughout the easement. The results of the visual assessment did not indicate any additional significant negative changes to the existing vegetation community.

5.6 Wetlands

Wetland mitigation credits are not contracted or proposed for this project and no performance standards for wetland hydrology success were proposed in the Mitigation Plan. One groundwater monitoring well was installed during the baseline monitoring along Reach R4 (wetland gauge 2). Two additional groundwater monitoring wells, including an additional one along Reach R4 (wetland gauge 1) and an additional one along Reach R5 (wetland gauge 3) (reference), were installed after the first year of monitoring in March of 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 gauges can be found in Appendix E. Wetland gauges 1 and 2 are exhibiting a 10.6% and 17.6% max hydroperiod for the MY3 growing season. This is less than the 52.4% max hydroperiod documented in the reference wetland.

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: **2 yrs 6 months**
Elapsed Time Since planting complete: **2 yrs 6 months**
Number of reporting Years[0]: **3**

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 Monitoring Report Submittal	10/18/2019	12/31/2019
Year 3 Monitoring Report Submittal	10/14/2020	12/11/2020
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

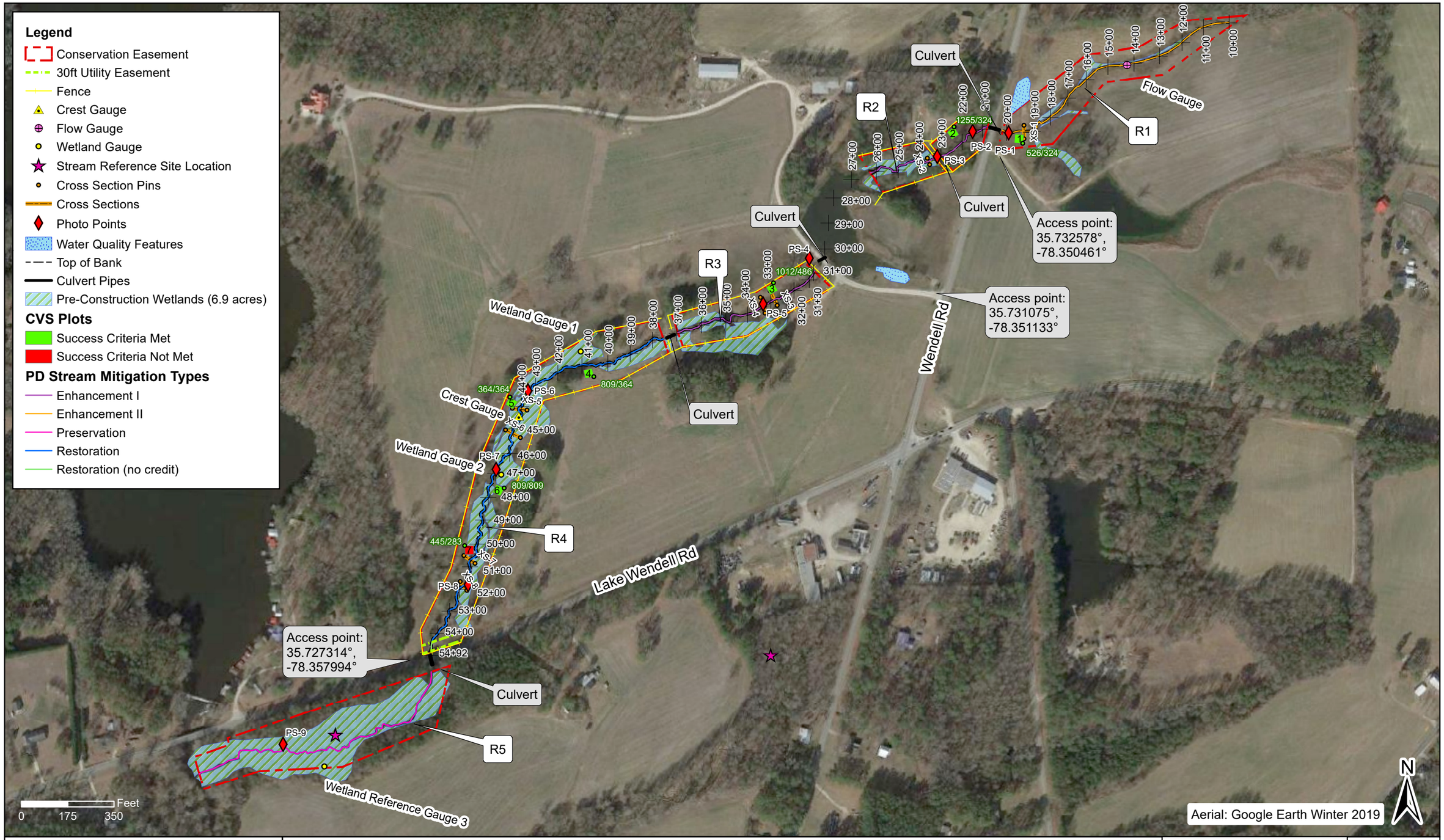
Wetland Summary Information

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
October 2020
MY3

Current Conditions
Plan View
Monitoring Year 3

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 Bankfu 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%

PS-1, R1, facing upstream, Sta 20+00, March 29, 2018 (MY-00)

PS-1, R1, facing upstream, Sta 20+00, March 10, 2020 (MY-03)

PS-2, R2, facing downstream, Sta 21+50, April 27, 2018 (MY-00)

PS-2, R2, facing downstream, Sta 21+50, March 10, 2020 (MY-03)

PS-3, R2, facing upstream at crossing, Sta 23+00, April 27, 2018 (MY-00)

PS-3, R2, facing upstream at crossing, Sta 23+00, March 10, 2020 (MY-03)

PS-4, R3, facing downstream, Sta 31+00, April 27, 2018 (MY-00)

PS-4, R3, facing downstream, Sta 31+00, March 10, 2020 (MY-03)

PS-5, R3, facing upstream, Sta 34+00, April 27, 2018 (MY-00)

PS-5, R3, facing downstream, Sta 34+00, March 10, 2020 (MY-03)

PS-6, R4, facing upstream, Sta 43+50, April 27, 2018 (MY-00)

PS-6, R4, facing upstream, Sta 43+50, March 10, 2020 (MY-03)

PS-7, R4, facing upstream, Sta 47+00, April 27, 2018 (MY-00)

PS-7, R4, facing upstream, Sta 47+00, March 10, 2020 (MY-03)

PS-8, R4, facing upstream, Sta 52+00, April 27, 2018 (MY-00)

PS-8, R4, facing upstream, Sta 52+00, March 10, 2020 (MY-03)

PS-9, R5, facing upstream, near Sta 62+00, Sept 1, 2015, 2018 (MY-00)

PS-9, R5, facing upstream, Sta 62+00, March 10, 2020 (MY-03)

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

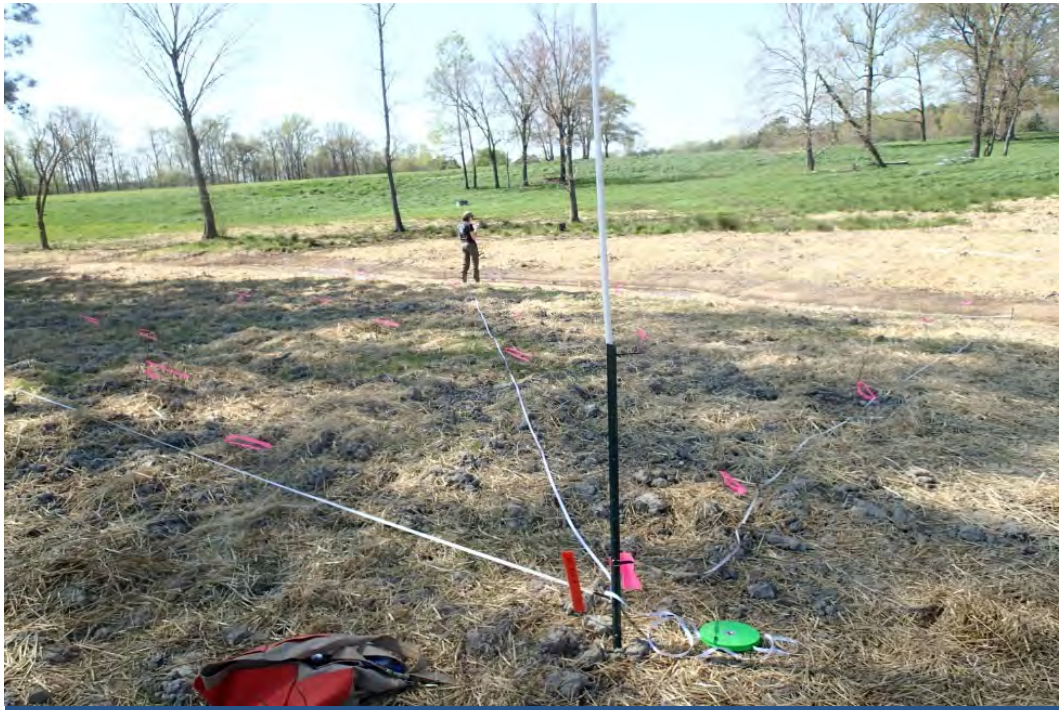
Veg Plot 1, October 13, 2020 (MY-03)

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

Veg Plot 2, October 13, 2020 (MY-03)

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

Veg Plot 3, October 13, 2020 (MY-03)

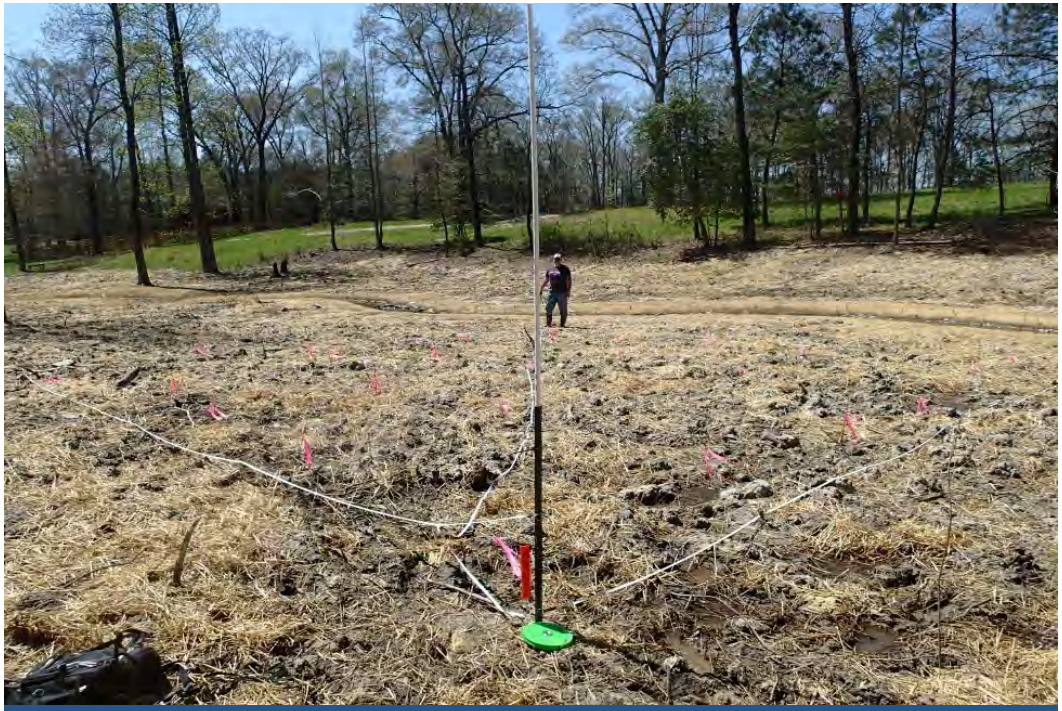


Veg Plot 4, April 12, 2018 (MY-00)

Veg Plot 4, October 13, 2020 (MY-03)

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

Veg Plot 5, October 13, 2020 (MY-03)



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

Veg Plot 6, October 13, 2020 (MY-03)

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

Veg Plot 7, October 13, 2020 (MY-03)

Appendix C – Vegetation Plot Data

Table 6: CVS - Pen-Del Mitigation Project

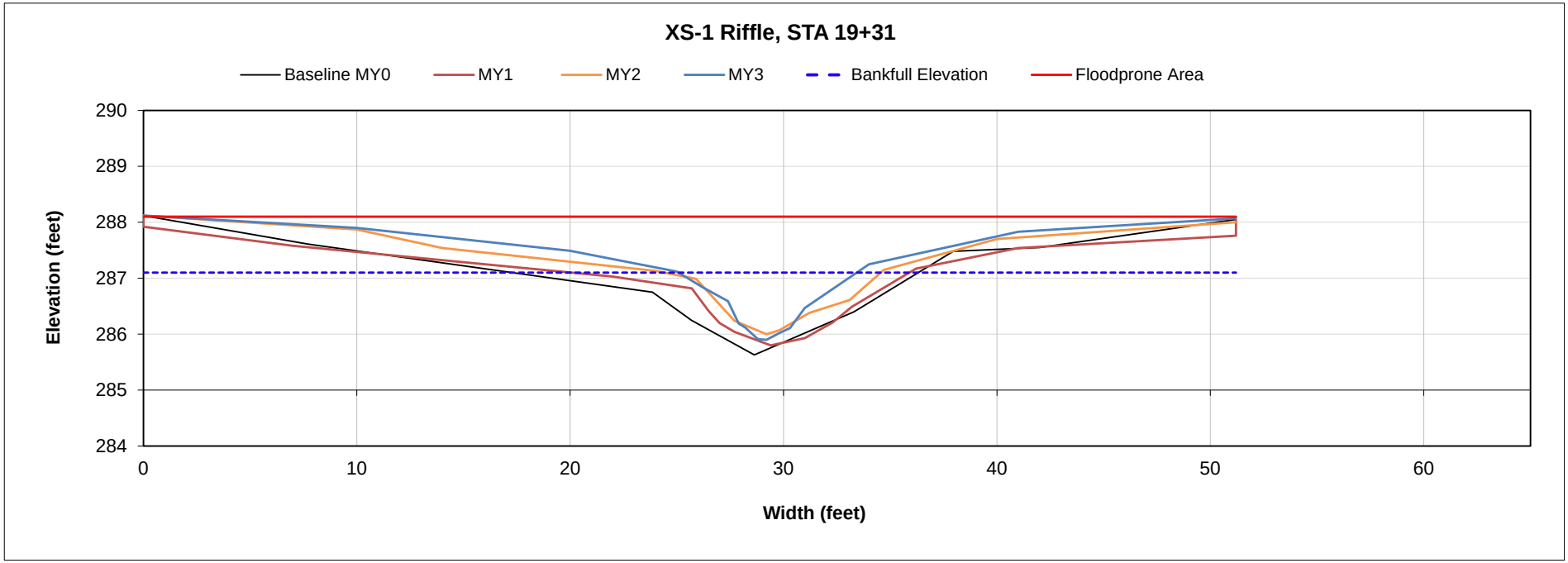
			Current Plot Data (MY3 2020)																					Annual Means											
			002-01-0001			002-01-0002			002-01-0003			002-01-0004			002-01-0005			002-01-0006			002-01-0007			MY3 (2020)			MY2 (2019)			MY1 (2018)			MY0 (2018)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	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	PnoLS	P-all	T
Acer rubrum		Tree						10			8	1	1	6	1	1	1	1	1	1			4	3	3	30	3	3	14	4	4	122	3	3	3
Alnus serrulata	Tag Alder, Smooth Ald	Shrub Tree	1	1	1				1	1	1							1	1	1				3	3	3	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	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	5	5	5	9	9	10	10	10	10
Carya	Hickory	Tree																													1			
Cornus amomum	Silky Dogwood	Shrub Tree							2	2	2										1	1	1	3	3	3	4	4	4	6	6	6	6	6	6
Diospyros virginiana	American Persimmon,	Tree										1	1	1										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	10	10	10
Ilex verticillata	Winterberry	Shrub Tree				3	3	3																3	3	3	3	3	3	3	3	3	3	3	3
Lindera benzoin	Northern Spicebush	Shrub Tree				1	1	1																1	1	1	2	2	2	3	3	3	13	13	13
Liquidambar styraciflua	Sweet Gum, Red Gum	Tree			3			5			4			2												14			5			3			
Liriodendron tulipifera		Tree	1	1	1	1	1	5																2	2	6	2	2	2	5	5	5	13	13	13
Magnolia virginiana		Shrub Tree				1	1	1	1	1	1	2	2	2				1	1	1	2	2	2	7	7	7	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	11	11	11	14	14	14	14	14	14
Populus deltoides		Tree																													1			
Quercus michauxii	Basket Oak, Swamp Ch	Tree	2	2	2				3	3	3	2	2	2				3	3	3				10	10	10	9	9	9	11	11	11	9	9	9
Quercus nigra	Water Oak, Paddle Oa	Tree	1	1	1						1	2	2	2				1	1	1				4	4	5	4	4	4	3	3	3	9	9	9
Quercus phellos	Willow Oak	Tree				2	2	2				1	1	1				1	1	1	1	1	1	5	5	5	6	6	6	8	8	8	8	8	8
Rhus copallinum		Shrub Tree																													3			
Rosa palustris	Swamp Rose	Shrub Vine																											4			39			
Salix nigra	Black Willow	Tree																											1			7			
Salix sericea	Silky Willow	Shrub Tree			2																					2									
Sambucus canadensis	Common Elderberry	Shrub Tree																											5			3			
Ulmus alata	Winged Elm	Tree						4																		4									
Ulmus rubra	Slippery Elm, Red Elm	Tree																											2			3			
Viburnum nudum	Southern Wild Raisin,	Shrub Tree																															1	1	1
		Stem count	8	8	13	8	8	31	12	12	25	13	13	20	9	9	9	20	20	20	7	7	11	77	77	129	78	78	106	100	100	279	132	132	132
		size (ares)	1			1			1			1			1			1			1			7			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			0.17		
		Species count	6	6	8	5	5	8	8	8	11	8	8	9	5	5	5	10	10	10	5	5	6	15	15	18	15	15	20	15	15	23	16	16	16
		Stems per ACRE	323.7	323.7	526.1	323.7	323.7	1255	485.6	485.6	1012	526.1	526.1	809.4	364.2	364.2	364.2	809.4	809.4	809.4	283.3	283.3	445.2	445.2	445.2	745.8	450.9	450.9	612.8	578.1	578.1	1613	763.1	763.1	763.1

Appendix D – Stream Measurement and Geomorphology Data

Project Name	Pen Dell Mitigation Project
Project ID	97079
Reach ID	R2
Cross Section ID	XS-1
Field Crew	E. Dunnigan, K. Obermiller

Dimension Data Summary: MY3 2020	
Bankfull Elevation (ft)	287.2
Low Bank Height Elevation (ft)	287.1
Bankfull Max Depth (ft)	1.3
Low Bank Height (ft)	1.2
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	5.3
% Change Bank Height Ratio	0.0%

Looking Downstream



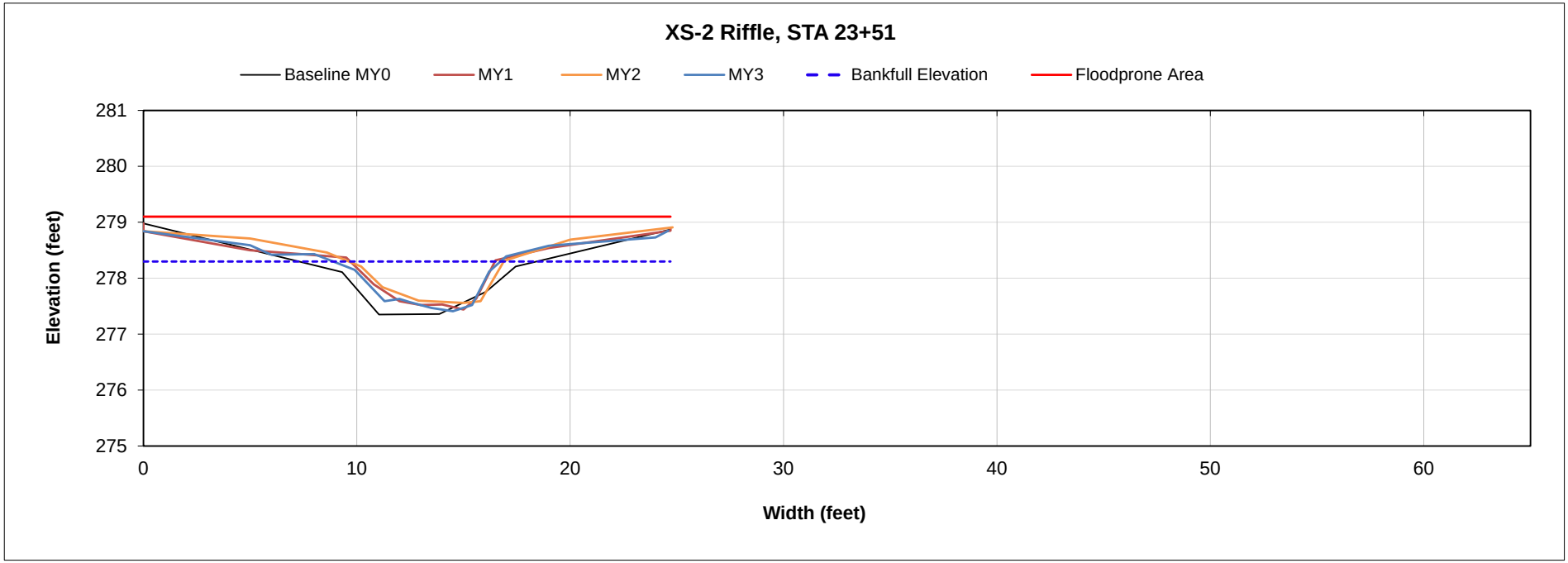
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull 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	R2
Cross Section ID	XS-2
Field Crew	E. Dunnigan, K. Obermiller

Dimension Data Summary: MY3 2020	
Bankfull Elevation (ft)	278.3
Low Bank Height Elevation (ft)	278.4
Bankfull Max Depth (ft)	0.9
Low Bank Height (ft)	1.0
Bank Height Ratio	1.1
Bankfull X-section Area (ft²)	4.1
% Change Bank Height Ratio	10.0%

Looking Downstream



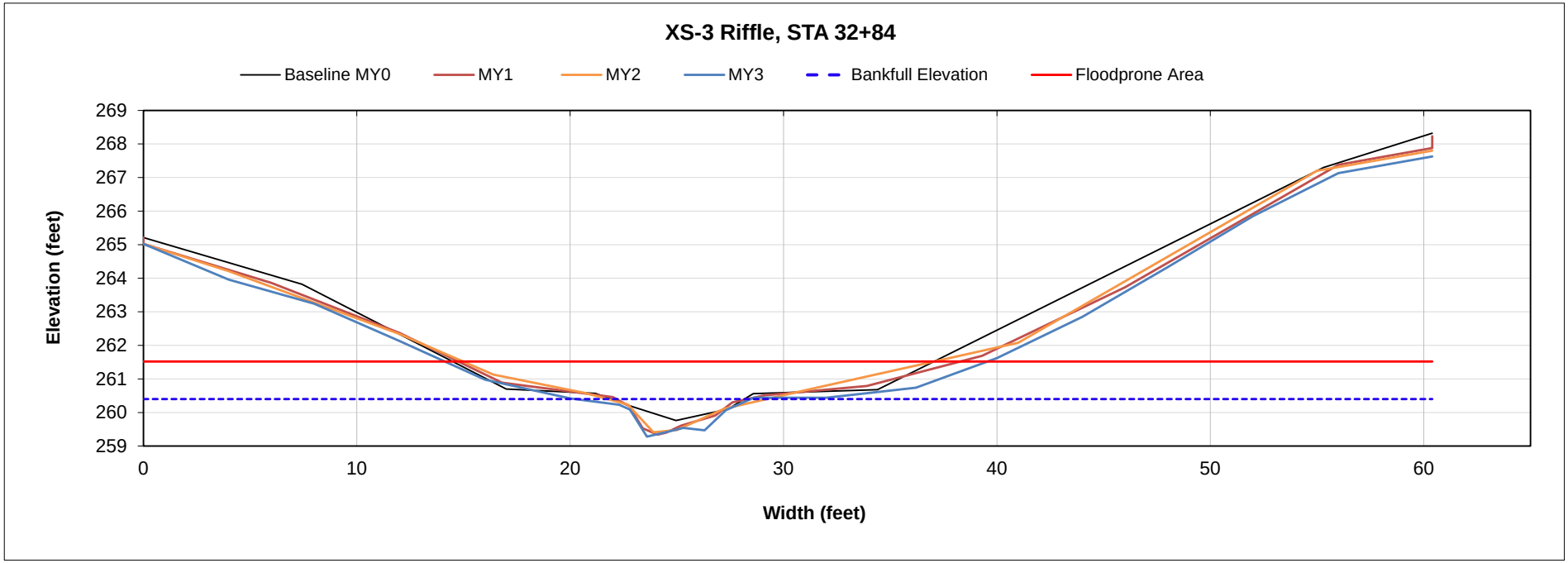
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull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

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

Project Name	Pen Dell Mitigation Project
Project ID	97079
Reach ID	R3
Cross Section ID	XS-3
Field Crew	E. Dunnigan, N. Childs

Dimension Data Summary: MY3 2020	
Bankfull Elevation (ft)	260.4
Low Bank Height Elevation (ft)	260.4
Bankfull Max Depth (ft)	1.1
Low Bank Height (ft)	1.2
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	4.3
% Change Bank Height Ratio	0.0%

Looking Downstream



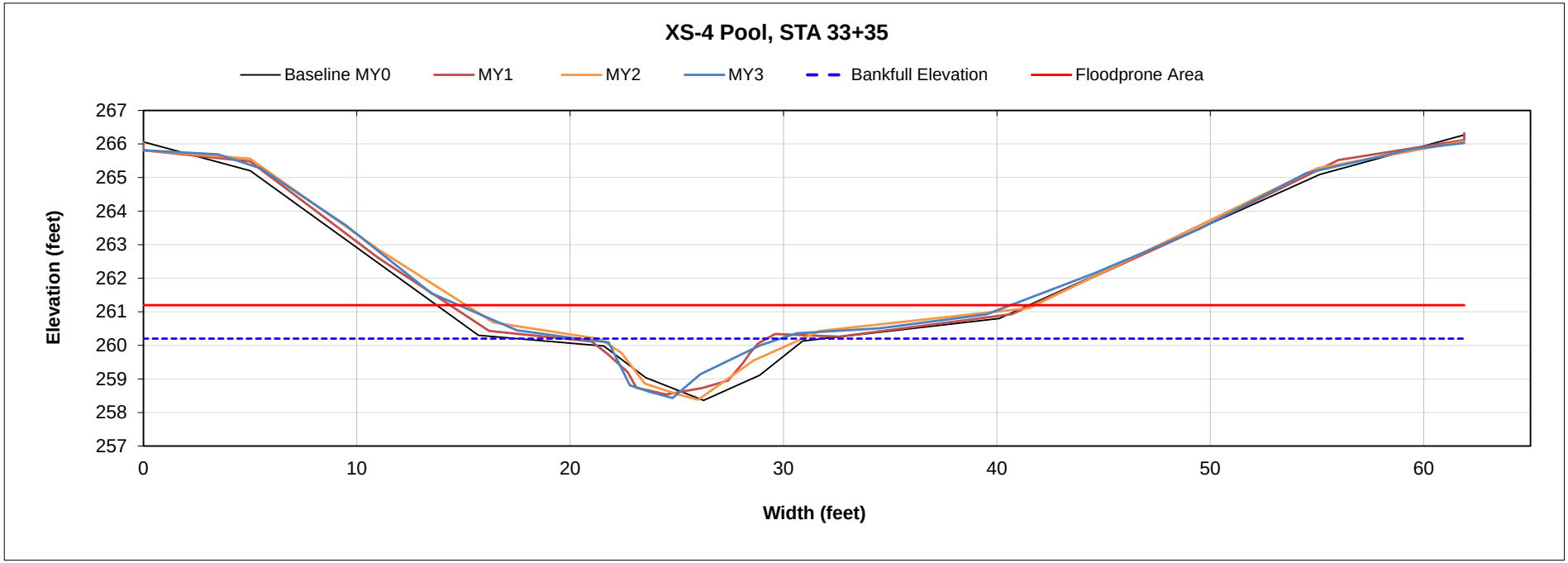
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull 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	XS-4
Field Crew	E. Dunnigan, N. Childs

Dimension Data Summary: MY3 2020	
Bankfull Elevation (ft)	260.2
Low Bank Height Elevation (ft)	260.1
Bankfull Max Depth (ft)	1.8
Low Bank Height (ft)	1.7
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	7.8
% Change Bank Height Ratio	0.0%

Looking Downstream



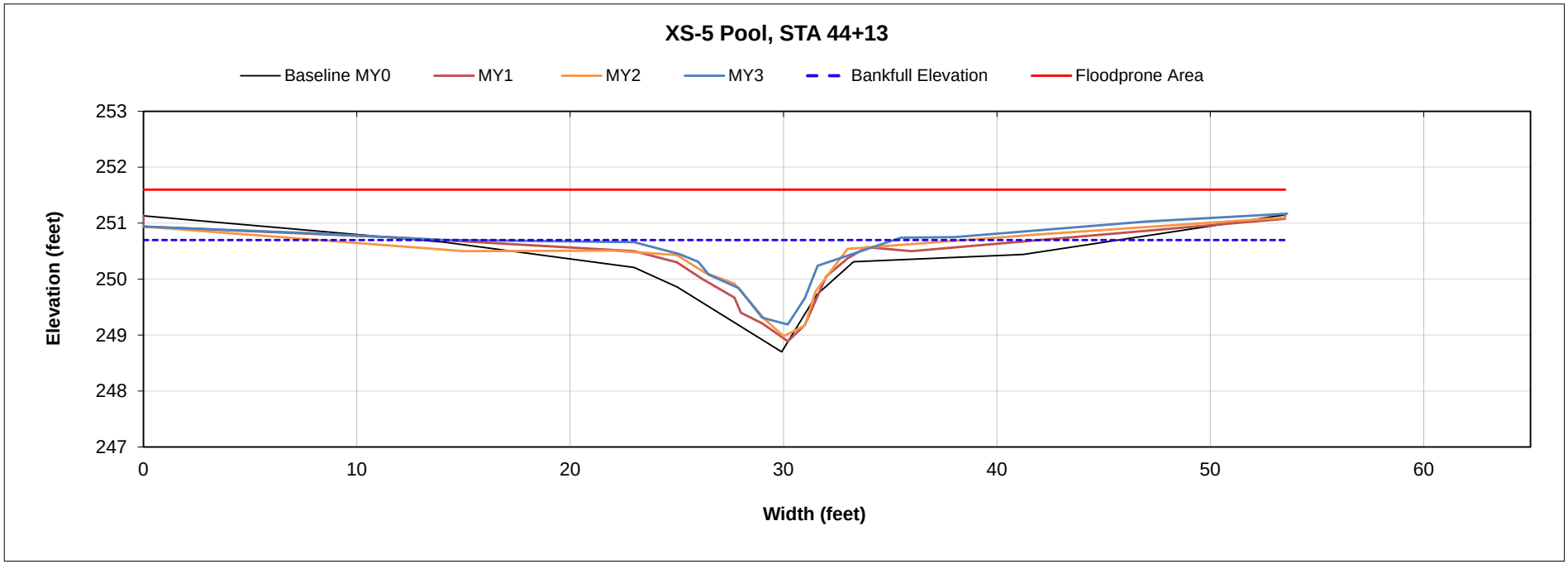
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull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

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

Project Name	Pen Dell Mitigation Project
Project ID	97079
Reach ID	R4
Cross Section ID	XS-5
Field Crew	E. Dunnigan, K. Obermiller

Dimension Data Summary: MY3 2020	
Bankfull Elevation (ft)	250.7
Low Bank Height Elevation (ft)	250.7
Bankfull Max Depth (ft)	1.5
Low Bank Height (ft)	1.5
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	6.9
% Change Bank Height Ratio	0.0%

Looking Downstream



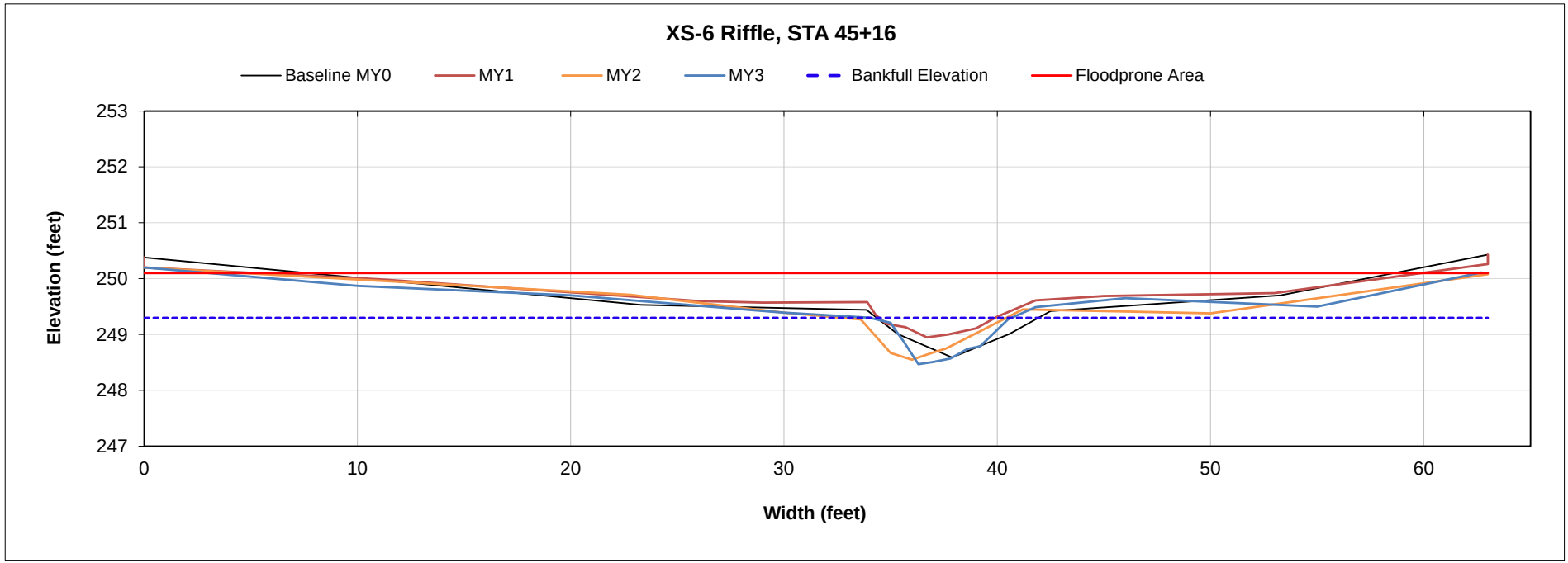
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull 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	XS-6
Field Crew	E. Dunnigan, K. Obermiller

Dimension Data Summary: MY3 2020	
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	0.0%

Looking Downstream



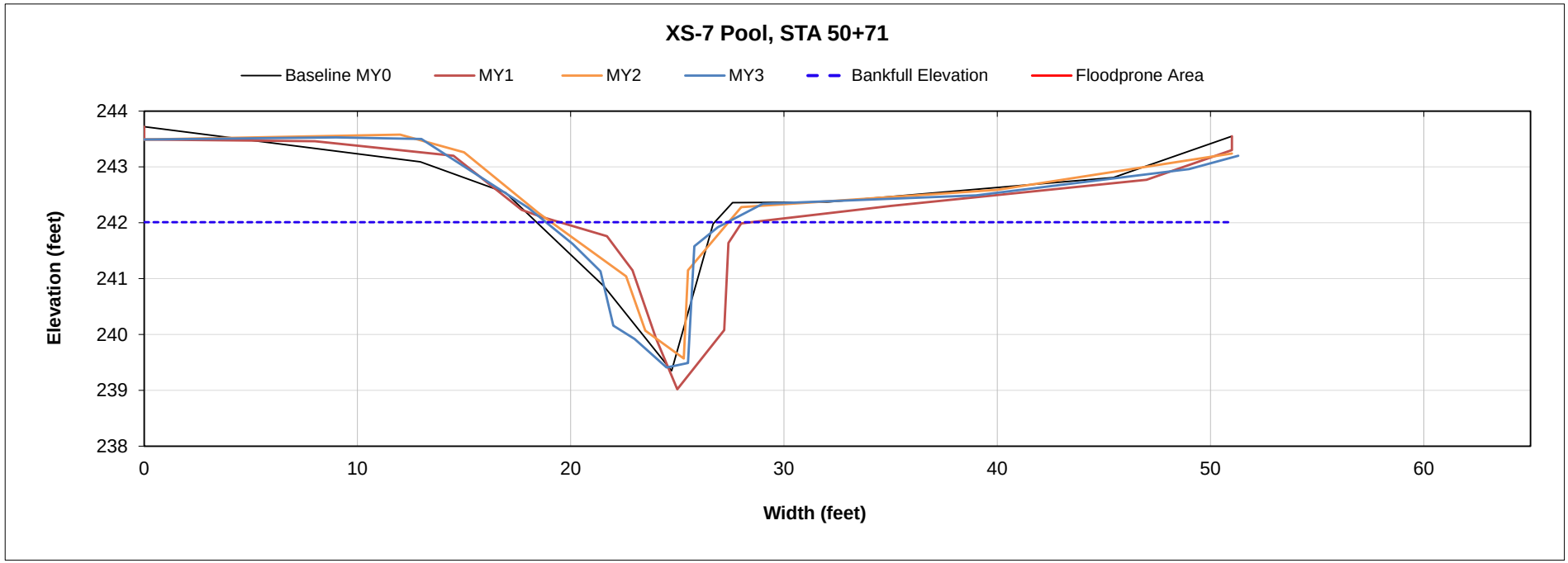
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull 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	XS-7
Field Crew	E. Dunnigan, K. Obermiller

Dimension Data Summary: MY3 2020	
Bankfull Elevation (ft)	242.0
Low Bank Height Elevation (ft)	241.9
Bankfull Max Depth (ft)	2.6
Low Bank Height (ft)	2.5
Bank Height Ratio	1.0
Bankfull X-section Area (ft²)	10.7
% Change Bank Height Ratio	0.0%

Looking Downstream



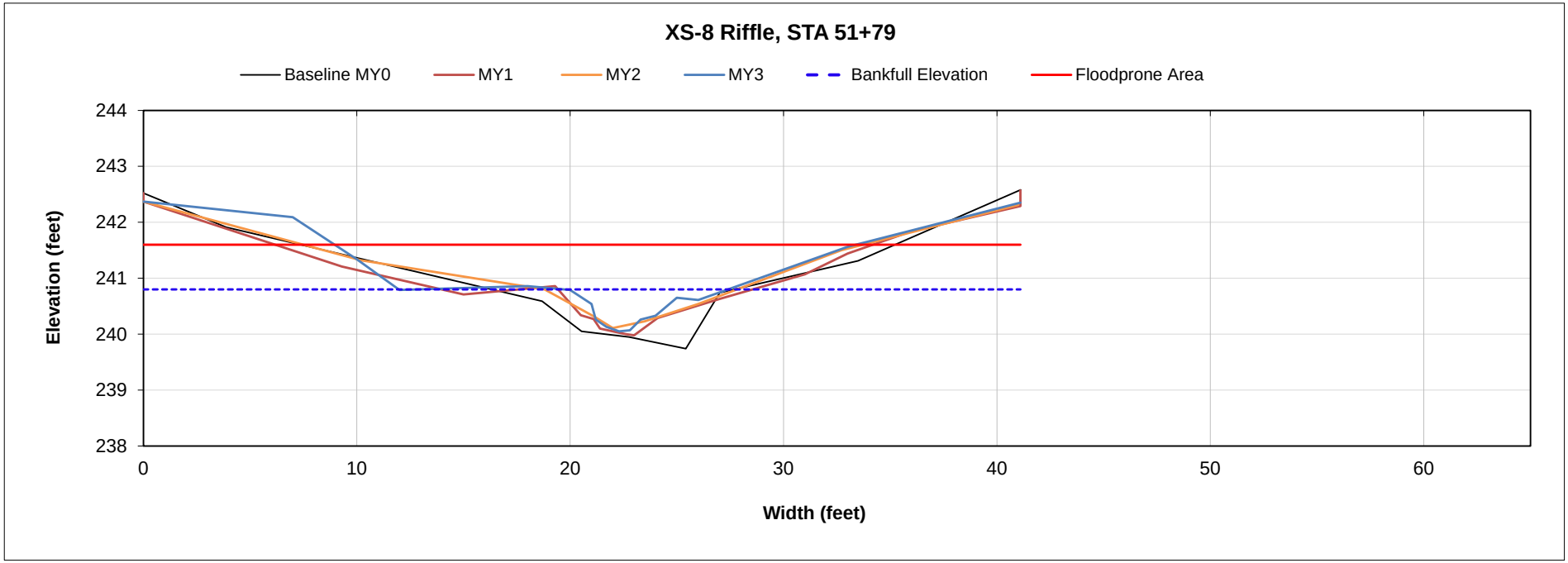
** Bank Height Ratio is calculated based on MY1 cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioner sin NC (9/2018). The remainder of the bankfull 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	XS-8
Field Crew	E. Dunnigan, K. Obermiller

Dimension Data Summary: MY3 2020	
Bankfull Elevation (ft)	240.8
Low Bank Height Elevation (ft)	240.7
Bankfull Max Depth (ft)	0.8
Low Bank Height (ft)	0.6
Bank Height Ratio	< 1.0
Bankfull X-section Area (ft²)	2.9
% Change Bank Height Ratio	20.0%

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 9/30/2020

MATERIAL	PARTICLE	SIZE (mm)	MY 1 Total #	MY2 Total #	MY3 Total #	MY4 Total #	MY5 Total #	MY6 Total #	MY7 Total #
SILT/CLAY	Silt / Clay	< .063	7	11	18				
	Very Fine	.063 - .125	5	3	6				
	Fine	.125 - .25	11	10	17				
S A N	Medium	.25 - .50	12	10					
	Coarse	.50 - 1.0	13	15	26				
	Very Coarse	1.0 - 2.0	22	4	2				
	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	2				
GRAVEL	Medium	8.0 - 11.0	1	5	6				
	Medium	11.0 - 16.0	2	9	11				
	Coarse	16 - 22.6	2	9	9				
	Coarse	22.6 - 32		5					
	Very Coarse	32 - 45	3	4	2				
	Very Coarse	45 - 64		1	1				
	Small	64 - 90		1					
	Small	90 - 128							
COBBLE	Large	128 - 180							
	Large	180 - 256							
	Small	256 - 362							
	Small	362 - 512							
BOULDER	Medium	512 - 1024							
	arge-Very Larg	1024 - 2048							
BEDROCK	Bedrock	> 2048	100	100	100				
		Total							

Cumulative	D16	0.16	0.14	0.062				
	D35	0.5	0.52	0.2				
	D50	1.1	1.2	0.64				
	D65	1.7	7.7	0.95				
	D84	4	18	14				
	D95	22	35	20				

MY3

Riffle			Pool	
Channel materials			Channel materials	
D16 =	0.062		D16 =	0.14
D35 =	0.24		D35 =	0.19
D50 =	0.91		D50 =	0.24
D65 =	11		D65 =	0.62
D84 =	17		D84 =	0.85
D95 =	22		D95 =	1.2

Weighted pebble count by bed features Pen Dell Mitigation Project

65% riffle 35% pool

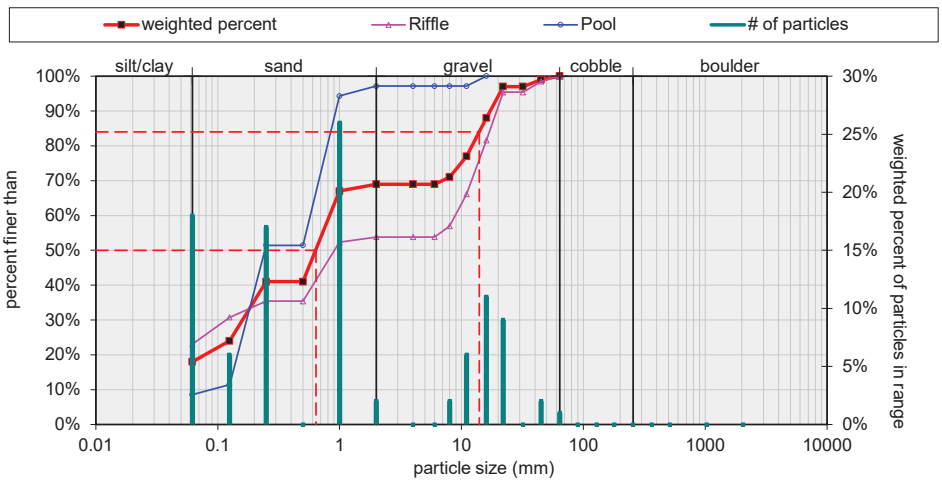


Table 7a. Baseline Stream Data Summary
Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)

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	Condition		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	-	7.8	9.5
Floodprone Width (ft)	13.7	-	10.0	20.0	15.0	30.0	13.0	13.7
Bankfull Mean Depth (ft)	0.9	-	0.8	1.6	0.5	-	0.5	0.9
Bankfull Max Depth (ft)	0.9	-	0.9	1.3	0.7	-	0.8	0.9
Bankfull Cross Sectional Area (ft^2)	5.9	-	3.0	5.0	3.6	-	4.2	5.9
Width/Depth Ratio	15.2	-	6.2	14.2	13.0	-	14.6	15.2
Entrenchment Ratio	1.4	-	7.1	8.4	2.2	4.4	1.4	2.9
Bank Height Ratio	1.9	-	0.9	1.1	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	-	7.1	-
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	-	0.4	-
Bankfull Max Depth (ft)	1.6	-	0.9	1.3	0.7	-	0.8	-
Bankfull Cross Sectional Area (ft^2)	5.0	-	3.0	5.0	4.4	-	3.1	-
Width/Depth Ratio	11.0	-	6.2	14.2	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	Condition		Reach Data		Design		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		8.3	8.6
Floodprone Width (ft)	35.0	-	10.0	35.0	17.0	45.0	25.0	56.0
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	1.1
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		13.1	18.1
Entrenchment Ratio	6.1	-	7.1	8.4	2.2	5.8	3.0	6.5
Bank Height Ratio	1.5	-	0.9	1.1	1.0		1.0	1.1
Profile								
Riffle Length (ft)	9.5	21.9	9.5	22.7	12.0	33.0	9.5	21.9
Riffle Slope (ft/ft)	0.013	0.022	0.009	0.015	0.013	0.022	0.013	0.022
Pool Length (ft)	6.1	8.5	6.1	8.7	8.0	10.5	6.1	8.5
Pool Max Depth (ft)	2.0	2.2	1.8	2.4	1.4	2.0	2.0	2.2
Pool Spacing (ft)	18.0	44.0	14.4	22.3	25.0	55.0	18.0	44.0
Pattern								
Channel Beltwidth (ft)	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)

	Cross Section 1 (Riffle)							Cross Section 2 (Riffle)						
Parameters	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	11.1	10.5	9.3	8.6				7.8	7.0	7.5	7.6			
Floodprone Width (ft)	49.0	49.2	51.5	51.5				23.0	25.0	24.0	24.0			
Bankfull Mean Depth (ft)	0.6	0.5	0.6	0.6				0.5	0.6	0.5	0.5			
Bankfull Max Depth (ft)	1.2	1.0	1.1	1.3				0.8	0.9	0.8	0.9			
Bankfull Cross Sectional Area (ft^2)	7.0	5.3	5.3	5.3				4.2	4.1	4.1	4.1			
Bankfull Width/Depth Ratio	17.7	20.7	16.4	13.9				14.6	11.4	14.0	13.9			
Bankfull Entrenchment Ratio	4.4	4.7	5.5	6.0				2.9	3.6	3.2	3.2			
Bankfull Bank Height Ratio	1.0	1.0	0.9	1.0				1.0	1.0	1.0	1.1			
d50 (mm)	N/a	1.5	5.1	0.9				N/a	1.5	5.1	0.9			
	Cross Section 3 (Riffle)							**Cross Section 4 (Pool)**						
Parameters	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	7.1	7.1	8.9	8.2				9.2	8.6	8.6	9.1			
Floodprone Width (ft)	19.8	24.0	19.8	25.4				29.6	30.0	29.6	26.1			
Bankfull Mean Depth (ft)	0.4	0.5	0.5	0.5				1.0	0.9	0.9	0.9			
Bankfull Max Depth (ft)	0.8	1.1	1.1	1.1				1.7	1.6	1.7	1.8			
Bankfull Cross Sectional Area (ft^2)	3.1	4.3	4.3	4.3				9.2	7.8	7.8	7.8			
Bankfull Width/Depth Ratio	16.3	13.6	18.1	15.8				9.2	9.1	9.6	10.6			
Bankfull Entrenchment Ratio	2.8	3.4	2.2	3.1				3.2	3.5	3.4	2.9			
Bankfull Bank Height Ratio	1.0	1.0	1.0	1.0				1.0	1.0	1.1	1.0			
d50 (mm)	N/a	1.5	5.1	0.9				N/a	0.4	0.7	0.2			
	Cross Section 5 (Pool)							**Cross Section 6 (Riffle)**						
Parameters	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	10.0	10.9	19.7	12.0				8.6	7.9	7.7	6.7			
Floodprone Width (ft)	53.0	53.5	53.0	53.0				63.0	63.0	61.0	60.6			
Bankfull Mean Depth (ft)	0.7	0.6	0.3	0.6				0.5	0.5	0.4	0.4			
Bankfull Max Depth (ft)	1.5	1.6	1.6	1.5				0.9	0.7	0.8	0.8			
Bankfull Cross Sectional Area (ft^2)	6.9	6.9	6.9	6.9				4.1	3.0	3.0	3.0			
Bankfull Width/Depth Ratio	14.4	17.3	56.3	20.9				18.1	21.0	20.0	14.8			
Bankfull Entrenchment Ratio	5.2	4.9	2.7	4.4				6.5	8.0	7.9	9.1			
Bankfull Bank Height Ratio	1.0	1.0	1.0	1.0				1.0	<1	1.0	1.0			
d50 (mm)	N/a	0.4	0.7	0.2				N/a	1.5	5.1	0.9			
	Cross Section 7 (Pool)							**Cross Section 8 (Riffle)**						
Parameters	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				8.1	7.7	8.5	9.1			
Floodprone Width (ft)	38.0	51.0	32.0	34.7				27.0	25.0	25.0	25.0			
Bankfull Mean Depth (ft)	1.3	1.3	1.1	1.3				0.5	0.5	0.3	0.3			
Bankfull Max Depth (ft)	3.0	3.2	2.7	2.6				0.8	0.9	0.7	0.8			
Bankfull Cross Sectional Area (ft^2)	13.4	10.7	10.7	10.7				4.4	2.9	2.9	2.9			
Bankfull Width/Depth Ratio	7.5	8.2	9.2	6.1				15.0	14.2	24.8	28.4			
Bankfull Entrenchment Ratio	3.8	5.0	3.2	4.3				3.3	4.0	2.9	2.7			
Bankfull Bank Height Ratio	1.0	<1	1.0	1.0				1.0	1.0	1.1	< 1.0			
d50 (mm)	N/a	0.4	0.7	0.2				N/a	1.5	5.1	0.9			

	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 (EII)												
	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 (EI)												
	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	(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												

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

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R3 (EI)												
	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												

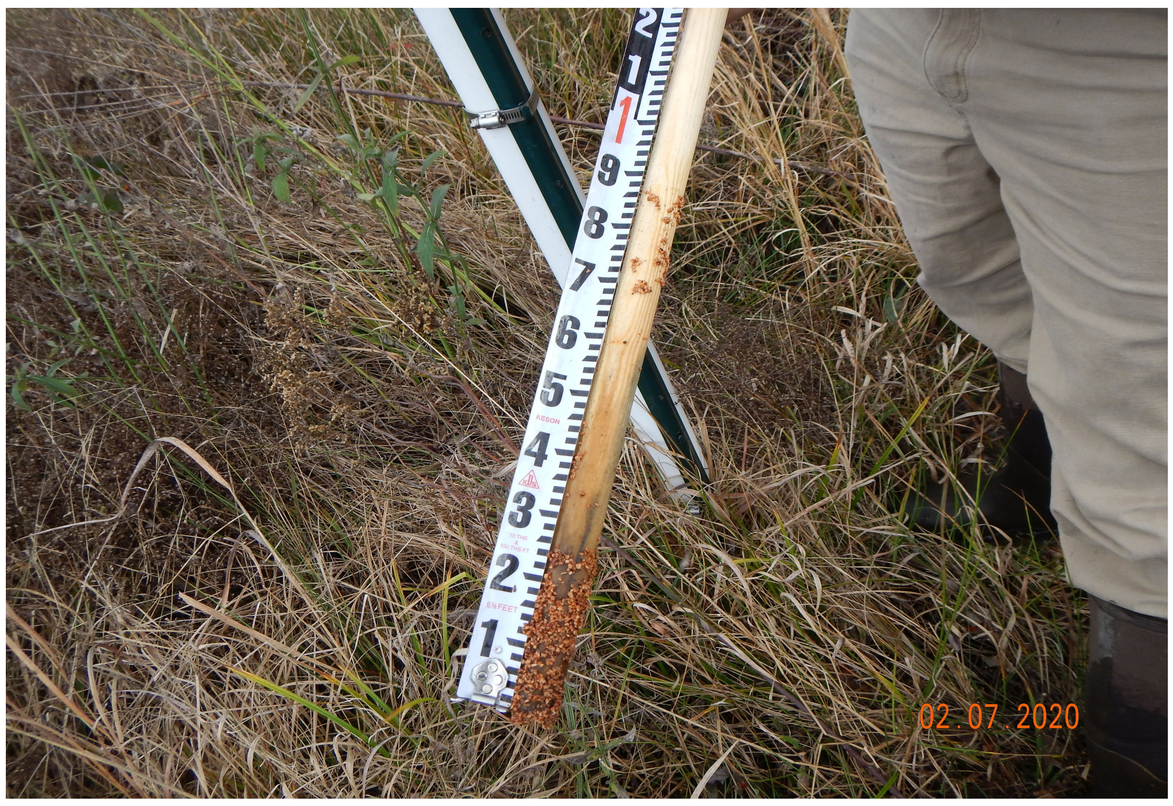
Pattern and Profile data will not typically be collected unless visual data, dimensional data or profile data indicate significant deviations from baseline conditions

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R4												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	9.5	21.9										
Riffle Slope (ft/ft)	0.013	0.022										
Pool Length (ft)	6.1	8.5										
Pool Max depth (ft)	2	2.2										
Pool Spacing (ft)	18	44										
Pattern												
Channel Beltwidth (ft)	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												

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

Appendix E – Hydrologic Data

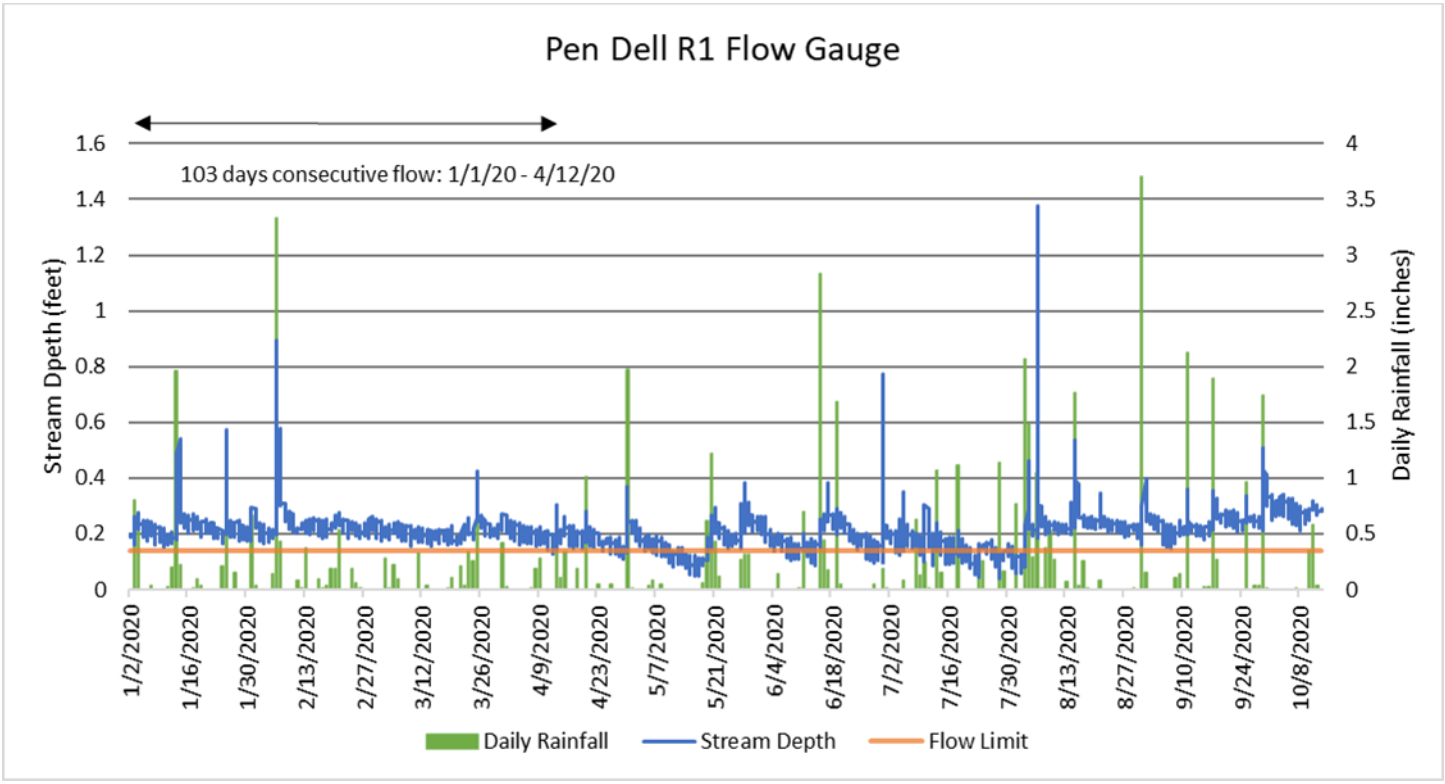
Table 8. Verification of Flow Events						
Date of Data Collection	**Date of Occurrence**	**Method**	**Greater than Bankfull (Bkf) or Qgs (Q2*0.66 = 36.64 CFS) Stage?**	**Photo/ Notes**	**Measurement above bankfull**	**Requirement Met**
9/17/2018	9/16-9/17/2018	Observed indicators of stage (wrack lines) after sotrm event	Bkf	Photos	NA	No
11/21/2018	9/16-9/17/2018	Crest Gauge	Bkf	Photos		No
7/26/2019	7/24/2019	Crest Gauge	Bkf	Photos	.11 ft	No
2/7/2020	Unknown	Crest Gauge	Bkf & Qgs	Photos	.85 ft	Yes
10/13/2020	Unknown	Crest Gauge	Bkf	Photos	.13 ft	Yes



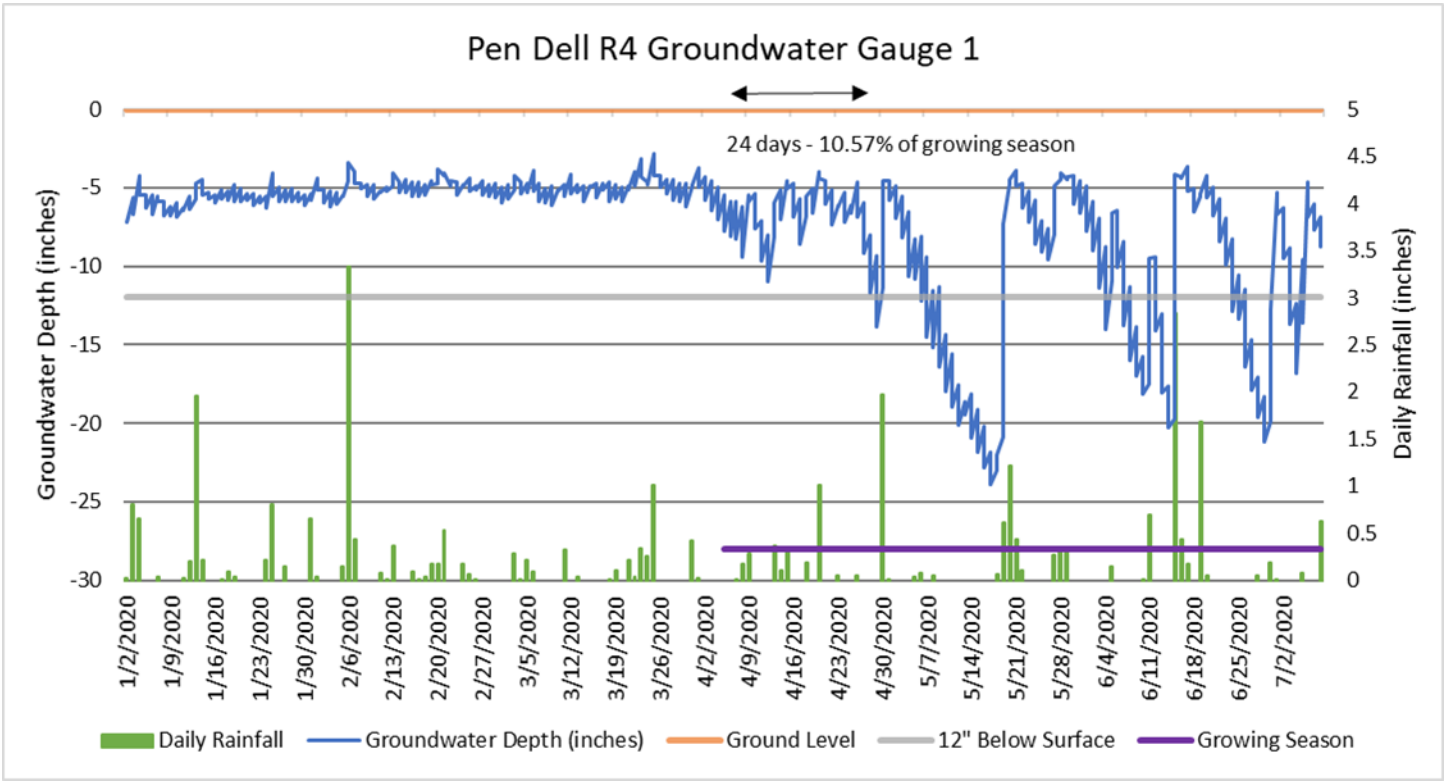
2/7/2020

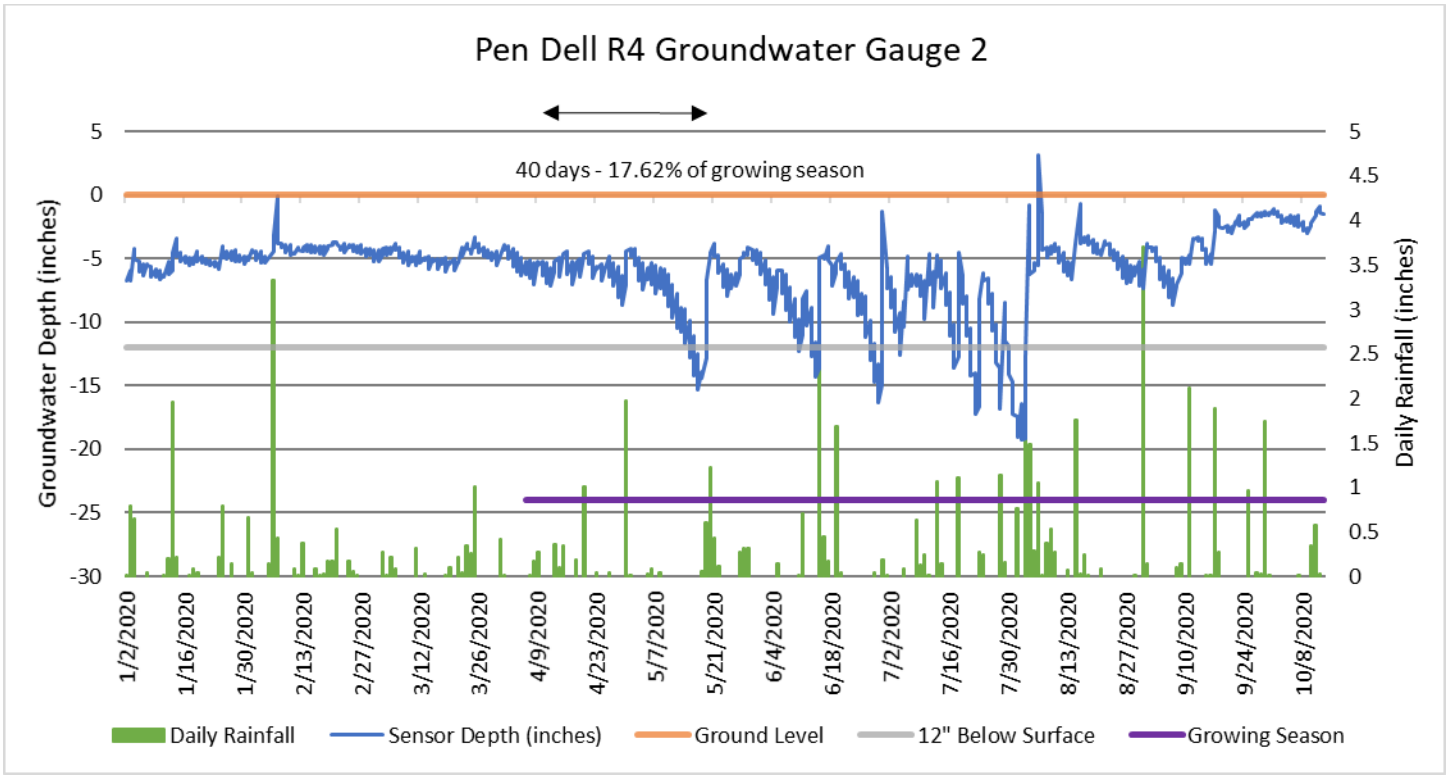
10/13/2020

Figure 4:



*Longest consecutive days of flow: 103 days, January 1, 2020 - April 12, 2020.




Pen Dell R4 Groundwater Gauge 2
40 days - 17.62% of growing season
Groundwater Depth (inches)
Daily Rainfall (inches)
5
0
-5
-10
-15
-20
-25
-30
4.5
4
3.5
3
2.5
2
1.5
1
0.5
1/2/2020
1/16/2020
1/30/2020
2/13/2020
2/27/2020
3/12/2020
3/26/2020
4/9/2020
4/23/2020
5/7/2020
5/21/2020
6/4/2020
6/18/2020
7/2/2020
7/16/2020
7/30/2020
8/13/2020
8/27/2020
9/10/2020
9/24/2020
10/8/2020
Daily Rainfall
Sensor Depth (inches)
Ground Level
12" Below Surface
Growing Season

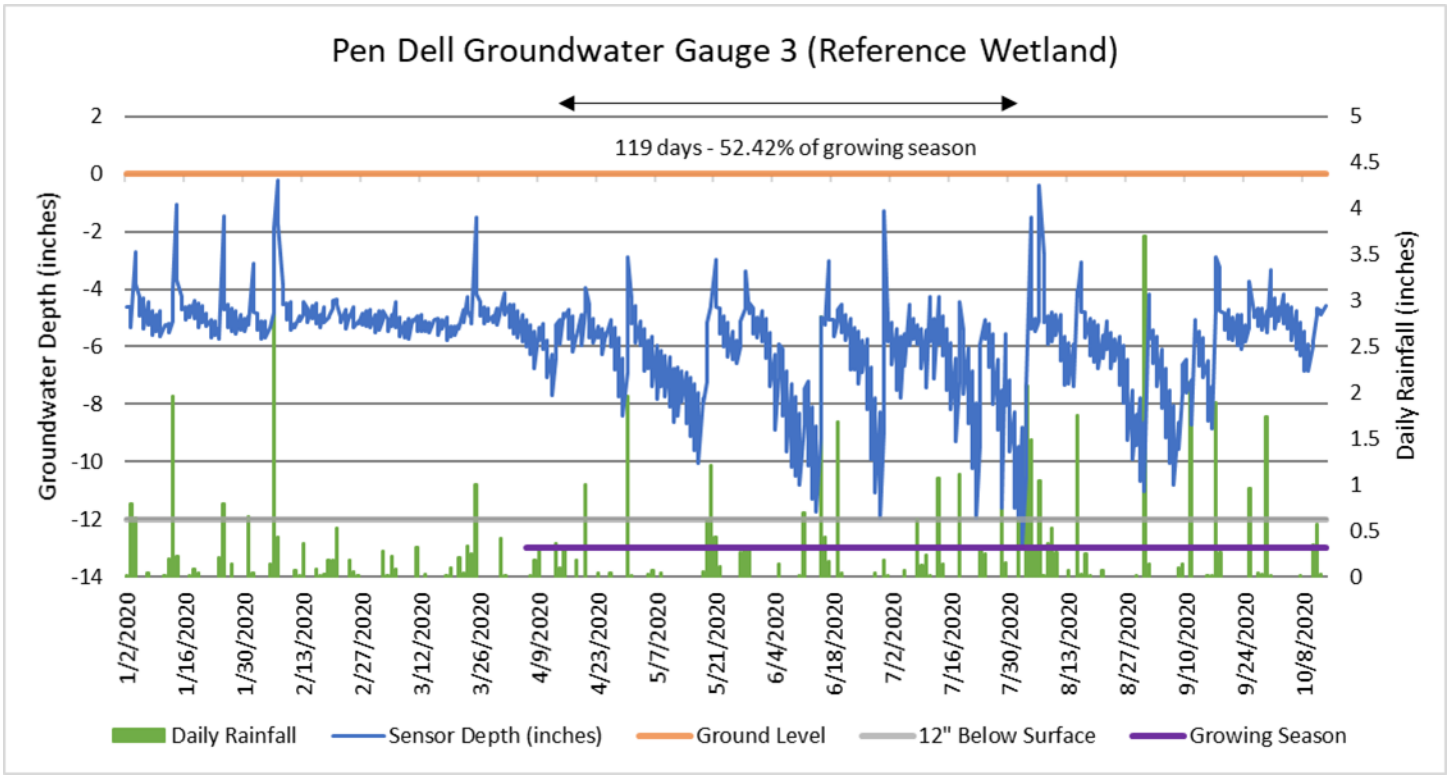

Pen Dell Groundwater Gauge 3 (Reference Wetland)
119 days - 52.42% of growing season
Groundwater Depth (inches)
Daily Rainfall (inches)
2
0
-2
-4
-6
-8
-10
-12
-14
4.5
4
3.5
3
2.5
2
1.5
1
0.5
1/2/2020
1/16/2020
1/30/2020
2/13/2020
2/27/2020
3/12/2020
3/26/2020
4/9/2020
4/23/2020
5/7/2020
5/21/2020
6/4/2020
6/18/2020
7/2/2020
7/16/2020
7/30/2020
8/13/2020
8/27/2020
9/10/2020
9/24/2020
10/8/2020
Daily Rainfall
Sensor Depth (inches)
Ground Level
12" Below Surface
Growing Season

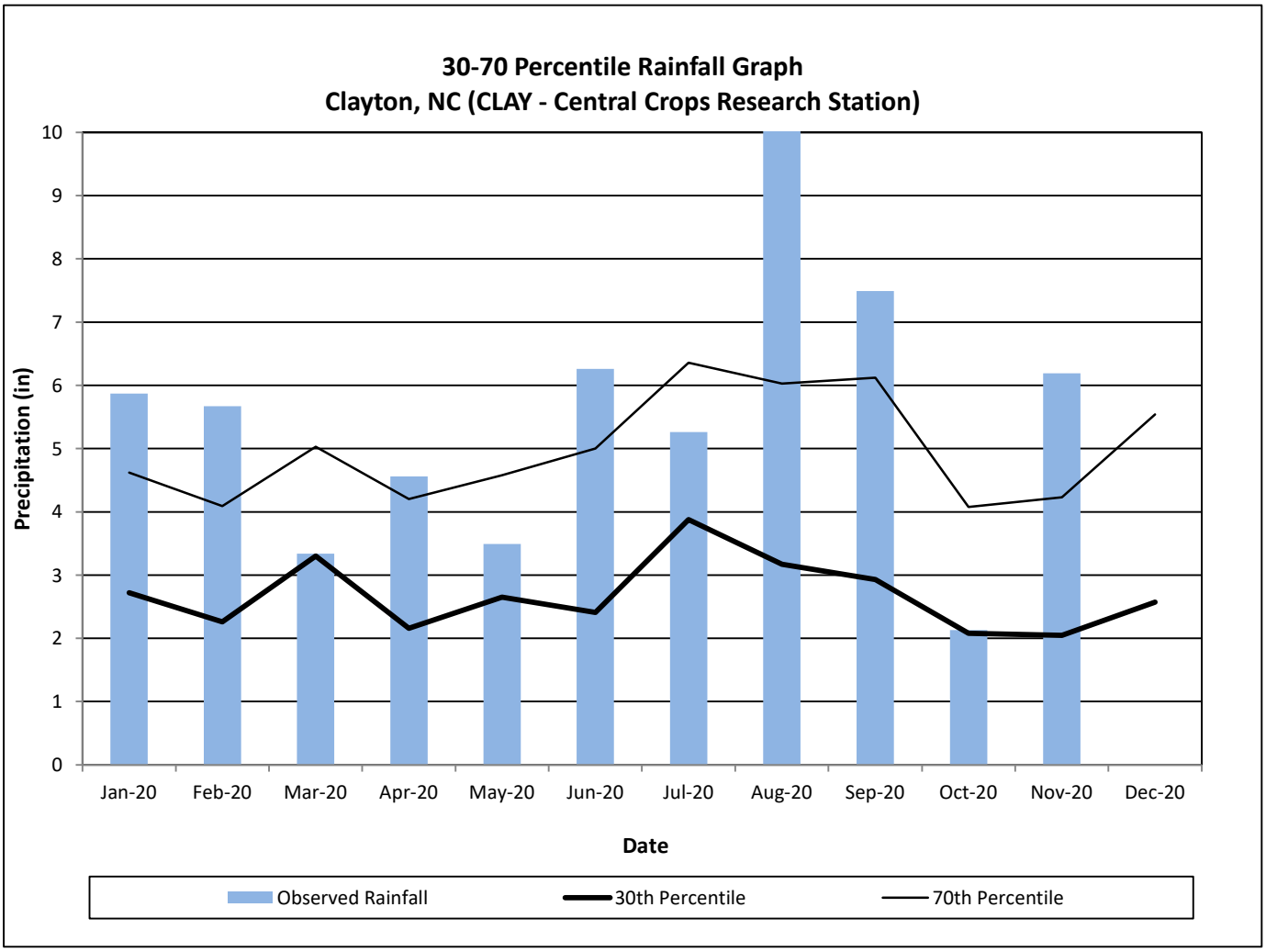
Figure 4

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 Gauge 1	M	16.74%	10.57%					
Pen Dell R4 Wetland Gauge 2	NA	19.38%	17.62%					
Pen Dell Reference Wetland	94.70%	19.82%	52.42%					

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)
MY3 2020



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

Month	30%	70%	Observed
Jan-20	2.72	4.62	5.87
Feb-20	2.26	4.09	5.67
Mar-20	3.30	5.03	3.34
Apr-20	2.16	4.20	4.56
May-20	2.65	4.58	3.49
Jun-20	2.41	5.00	6.26
Jul-20	3.88	6.36	5.26
Aug-20	3.17	6.03	12.75
Sep-20	2.93	6.12	7.49
Oct-20	2.08	4.08	2.13
Nov-20	2.05	4.23	6.19
Dec-20	2.57	5.54	**

Monitoring Report- Year 3
FINAL VERSION
Pen Dell Mitigation Project (Riparian Buffer Mitigation)
Calendar Year of Data Collection: 2020

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: September – October 2020
Submission Date: December 11, 2020

Prepared for:

Environmental Quality

North Carolina Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

Prepared by:

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

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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. WLS staff visited the site several times throughout Monitoring Year 3 (MY3) for monitoring activities. MY3 data collection occurred between September and October 2020 (Table 2). This report presents the data for the MY3. The Project meets the MY3 success criteria for vegetation. Based on these results, the Project is expected to meet the Monitoring Year 4 (MY4) success criteria in 2021.

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. Monitoring Year 3 occurred between September 2020 and October 2020.

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 MY3 vegetation assessment, no areas of concern was observed within the conservation easement boundary. Any areas identified during MY4 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 planted 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 12" tall. Volunteer species will only be included if surviving for at least two years and are included were included in the approved planting plan. In addition, diffuse flow of runoff shall be maintained in the riparian buffer areas.

5 Monitoring Year 3 Assessment and Results

Annual monitoring was conducted during MY3 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 MY3 monitoring data results are listed in the appendices. The Project meets the MY3 success criteria for vegetation.

5.1 Vegetation

Vegetation monitoring for MY3 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 vegetative success criteria of at least 260 planted stems per acre at the end of MY5 and the site is on trajectory to remain successful. Summary data and photographs of each plot can be found in Appendix 3.

6 References

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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.

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___. 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)	0
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	Dec-20
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	Subject or Nonsubject	Restoration		20-29			1	75%	1.33333	0.000		-	0.000
Rural or	Subject or Nonsubject	Restoration	Restoration	0-100	286,888	286,888	1	100%	1.00000	286,888.000	Yes	14,970.199	--
Rural or	Subject or Nonsubject	Restoration		101-200			1	33%	3.03030	0.000		-	0.000
Rural or	Subject or Nonsubject	Enhancement		20-29			2	75%	2.66667	0.000		-	0.000
Rural or	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	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*

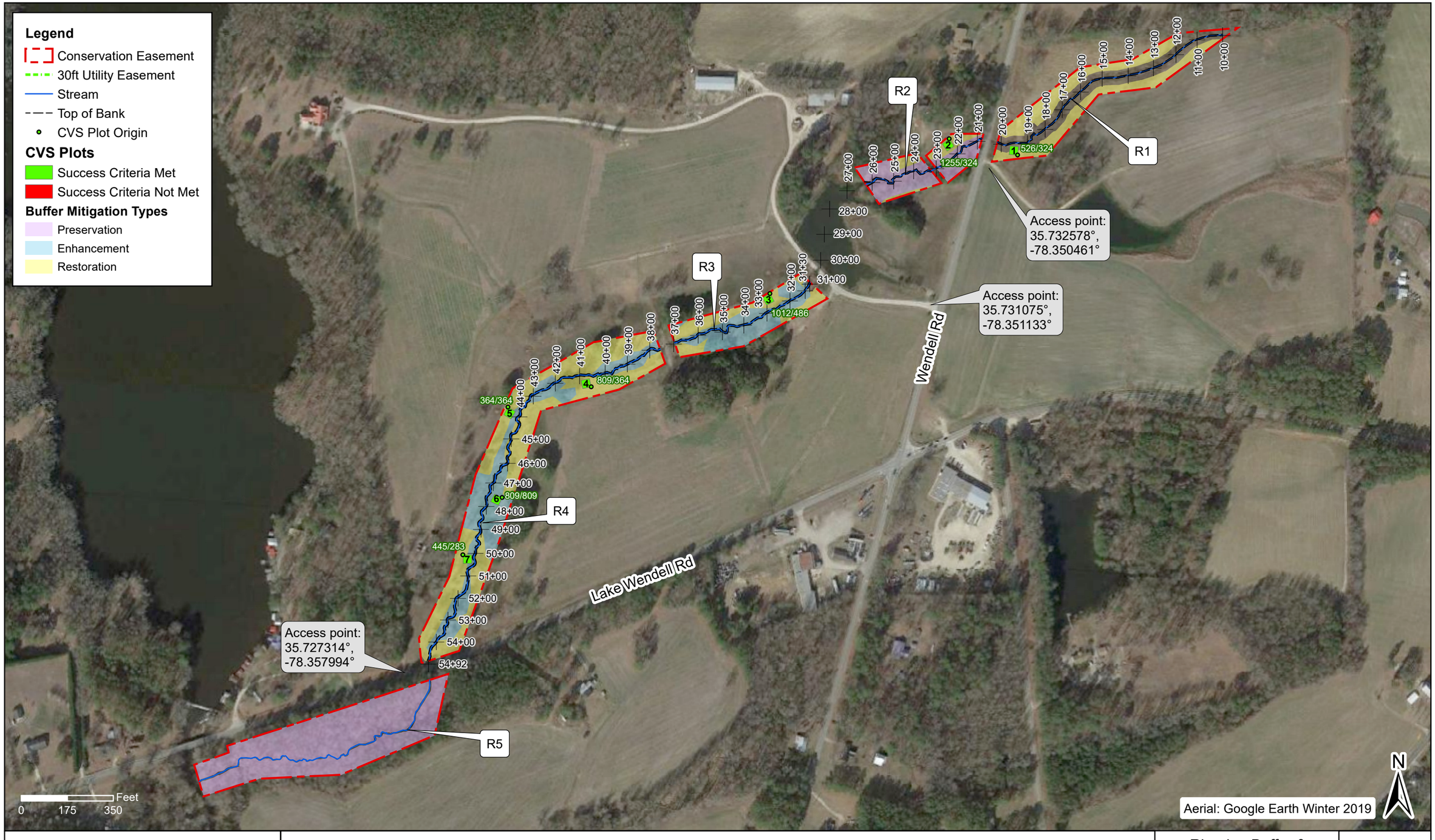
**When preservation areas exceed the total eligible preservation area, select the areas with the best credit ratios as the creditable areas.*

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.
6) Cut up asset feature layer by reach, and attribute feature name by adding column to asset table.
7) Add a field for buffer area and run the calculate geometry tool in the GIS attribute table (in square feet).
8) Add blocks of rows for each buffer component (by reach and restoration level) in excel table as necessary and as portrayed in GIS attribute table.
FILLIBLE CELLS, leave blank if N/A

Regulatory direction for Riparian Buffer in this table follows NCAC rule 15A NCAC 02B .0295, effective November 1, 2015.
Regulatory direction for Nutrient Offset in this table follows Nutrient Offsets Payments Rule 15A NCAC 02B. 0240, amended effective September 1, 2010 and
DWR – 1998. Methodology and Calculations for determining Nutrient Reductions associated with Riparian Buffer Establishment.
N.O. calculation based on effectiveness in 30 years, with 146.40 lb/ac P; and 2,273.02 lb/ac N. The N credit ratio used is 19.16325 sf per pound. The P credit ratio used is 297.54098 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



WATER & LAND™ SOLUTIONS

Pen Dell Mitigation Project
Johnston County, North Carolina

NCDMS Contract No. 6824
NCDMS Project No. 97079
December 2020
MY3

Riparian Buffer & Nutrient Offset Buffer Mitigation Plan View

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE **1**

Table 4.	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%

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

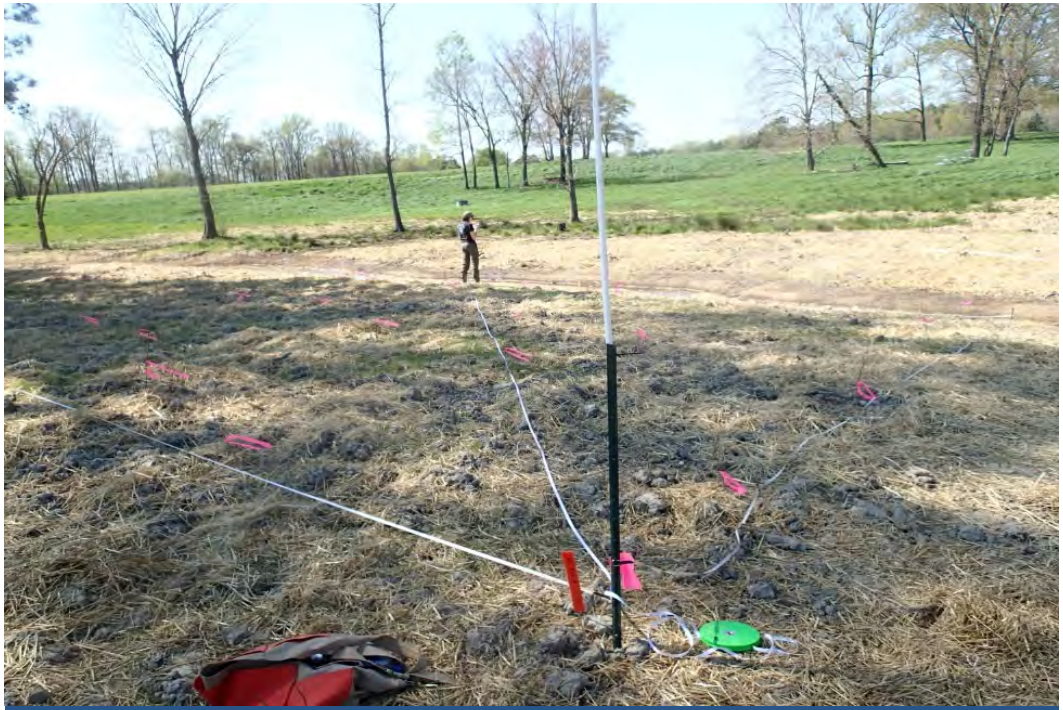
Veg Plot 1, October 13, 2020 (MY-03)

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

Veg Plot 2, October 13, 2020 (MY-03)

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

Veg Plot 3, October 13, 2020 (MY-03)

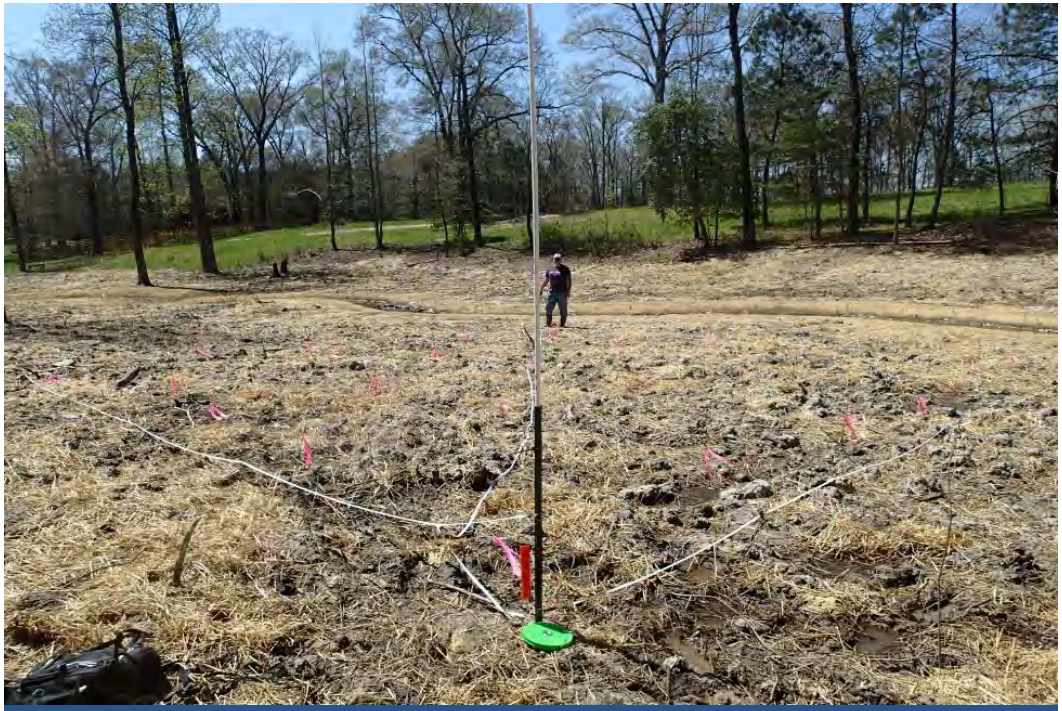


Veg Plot 4, April 12, 2018 (MY-00)

Veg Plot 4, October 13, 2020 (MY-03)

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

Veg Plot 5, October 13, 2020 (MY-03)



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

Veg Plot 6, October 13, 2020 (MY-03)

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

Veg Plot 7, October 13, 2020 (MY-03)

Appendix C – Vegetation Plot Data

Table 5: CVS - Pen-Del Mitigation Project

			Current Plot Data (MY3 2020)																					Annual Means											
			002-01-0001			002-01-0002			002-01-0003			002-01-0004			002-01-0005			002-01-0006			002-01-0007			MY3 (2020)			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	PnoLS	P-all	T
Acer rubrum		Tree						10			8	1	1	6	1	1	1	1	1	1			4	3	3	30	3	3	14	4	4	122	3	3	3
Alnus serrulata	Tag Alder, Smooth Ald	Shrub Tree	1	1	1				1	1	1							1	1	1				3	3	3	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	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	5	5	5	9	9	10	10	10	10
Carya	Hickory	Tree																													1			
Cornus amomum	Silky Dogwood	Shrub Tree							2	2	2										1	1	1	3	3	3	4	4	4	6	6	6	6	6	6
Diospyros virginiana	American Persimmon,	Tree										1	1	1										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	10	10	10
Ilex verticillata	Winterberry	Shrub Tree				3	3	3																3	3	3	3	3	3	3	3	3	3	3	3
Lindera benzoin	Northern Spicebush	Shrub Tree				1	1	1																1	1	1	2	2	2	3	3	3	13	13	13
Liquidambar styraciflua	Sweet Gum, Red Gum	Tree			3			5			4			2												14			5			3			
Liriodendron tulipifera		Tree	1	1	1	1	1	5																2	2	6	2	2	2	5	5	5	13	13	13
Magnolia virginiana		Shrub Tree				1	1	1	1	1	1	2	2	2				1	1	1	2	2	2	7	7	7	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	11	11	11	14	14	14	14	14	14
Populus deltoides		Tree																													1			
Quercus michauxii	Basket Oak, Swamp Ch	Tree	2	2	2				3	3	3	2	2	2				3	3	3				10	10	10	9	9	9	11	11	11	9	9	9
Quercus nigra	Water Oak, Paddle Oal	Tree	1	1	1						1	2	2	2				1	1	1				4	4	5	4	4	4	3	3	3	9	9	9
Quercus phellos	Willow Oak	Tree				2	2	2				1	1	1				1	1	1	1	1	1	5	5	5	6	6	6	8	8	8	8	8	8
Rhus copallinum		Shrub Tree																													3			
Rosa palustris	Swamp Rose	Shrub Vine																											4			39			
Salix nigra	Black Willow	Tree																											1			7			
Salix sericea	Silky Willow	Shrub Tree			2																					2									
Sambucus canadensis	Common Elderberry	Shrub Tree																											5			3			
Ulmus alata	Winged Elm	Tree						4																		4									
Ulmus rubra	Slippery Elm, Red Elm	Tree																											2			3			
Viburnum nudum	Southern Wild Raisin,	Shrub Tree																															1	1	1
		Stem count	8	8	13	8	8	31	12	12	25	13	13	20	9	9	9	20	20	20	7	7	11	77	77	129	78	78	106	100	100	279	132	132	132
		size (ares)	1			1			1			1			1			1			1			7			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			0.17		
		Species count	6	6	8	5	5	8	8	8	11	8	8	9	5	5	5	10	10	10	5	5	6	15	15	18	15	15	20	15	15	23	16	16	16
		Stems per ACRE	323.7	323.7	526.1	323.7	323.7	1255	485.6	485.6	1012	526.1	526.1	809.4	364.2	364.2	364.2	809.4	809.4	809.4	283.3	283.3	445.2	445.2	445.2	745.8	450.9	450.9	612.8	578.1	578.1	1613	763.1	763.1	763.1

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.

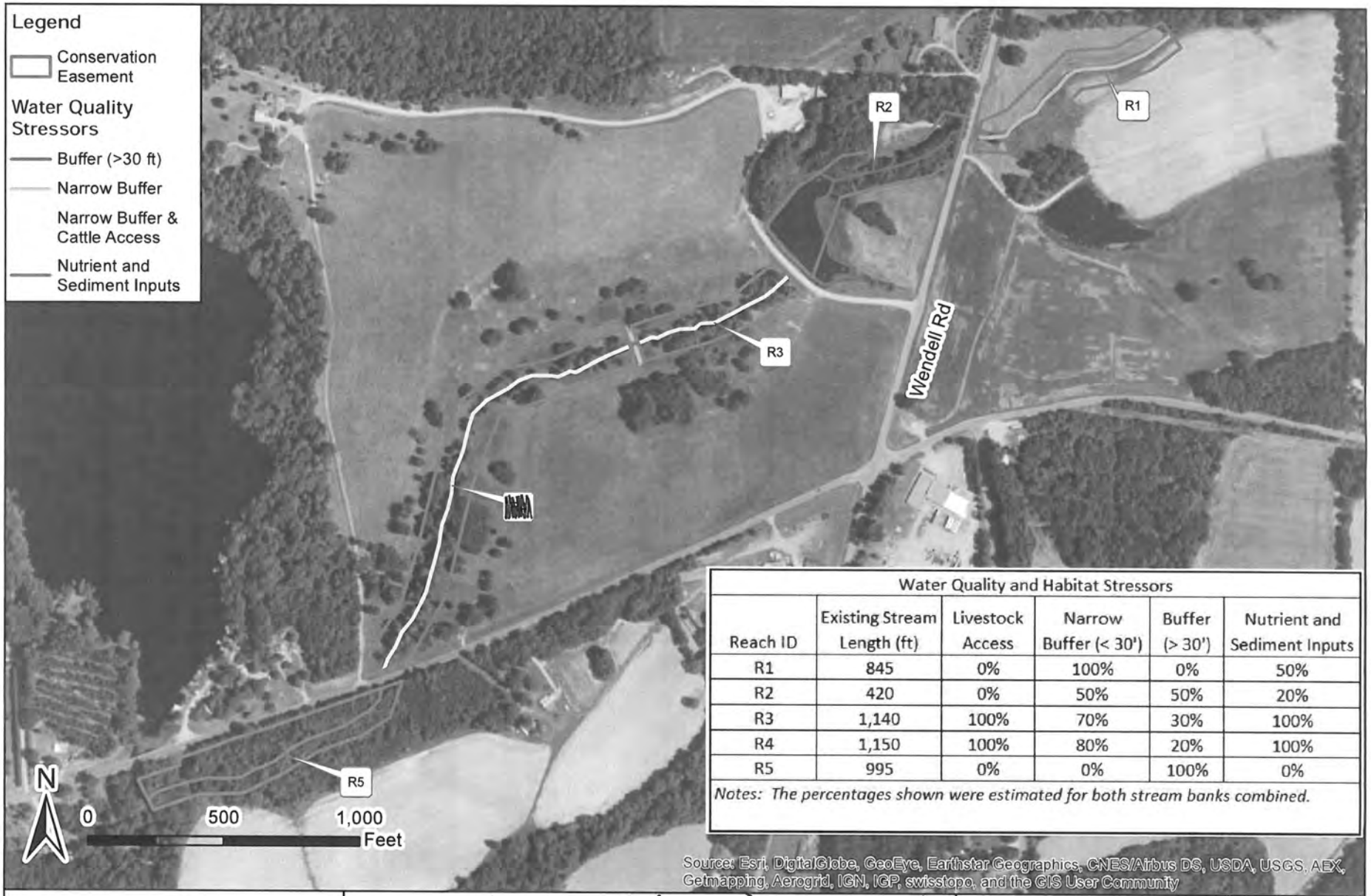
Sincerely,

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.

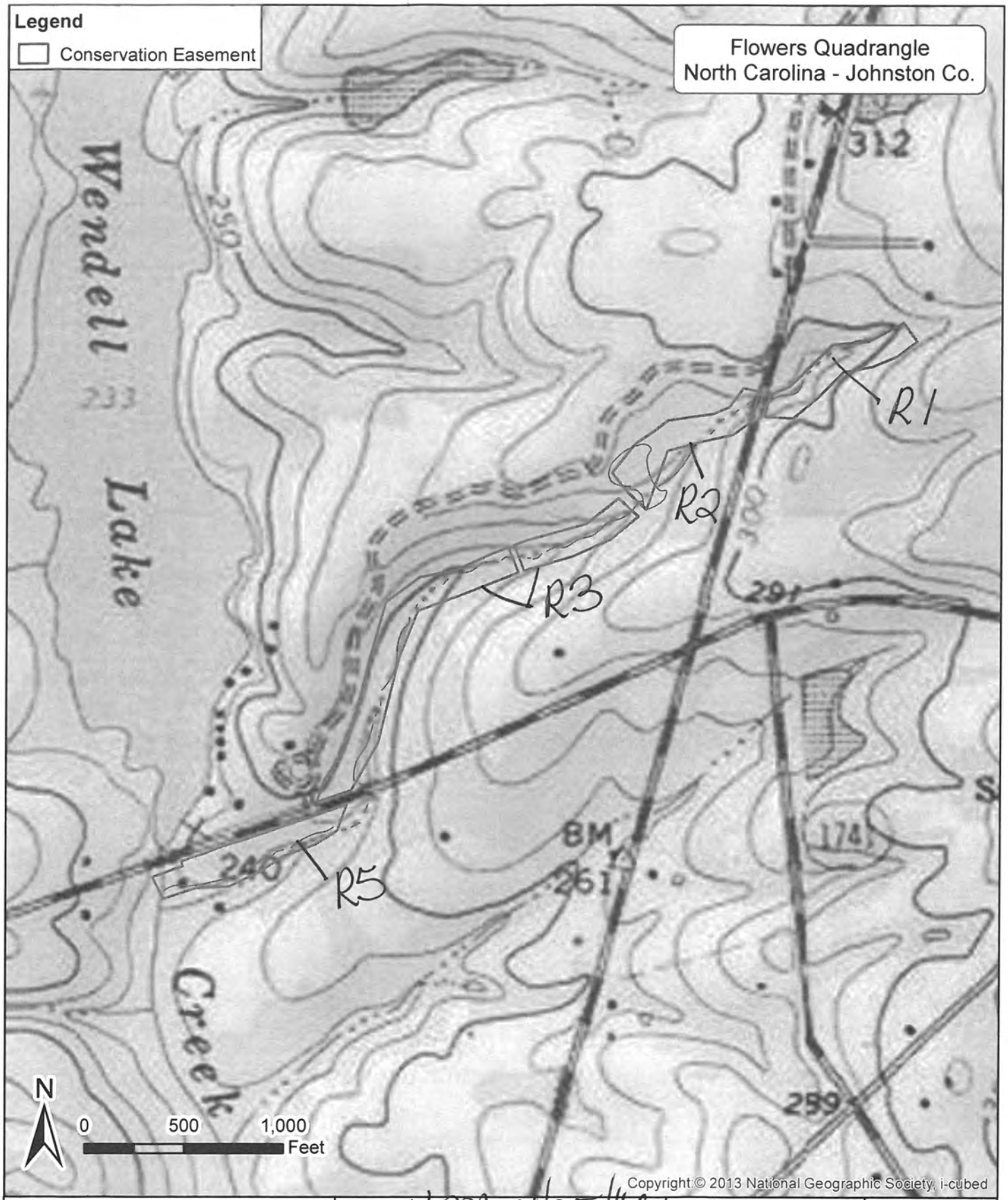
WATER & LAND SOLUTIONS™

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



WATER & LAND™ SOLUTIONS

Pen Dell
Mitigation Project
DWR#2016-0403

tym 4/25/14

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