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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, North Carolina between the Community of Archer Lodge and the Town of Wendell at 35˚ 43' 52.51'' North and 78˚ 21' 10.12'' West. The Project site is located in the NCDEQ Sub-basin 03-04-06, in the Lower Buffalo Creek Priority Sub-watershed 030202011504 study area for the Neuse 01 Regional Watershed Plan (RWP), and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin.

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 approximately 5,064 linear feet of existing streams, approximately 633,803 square feet of riparian buffers. The Project construction and planting were completed in April 2018 and as-built survey was completed in June 2018. Planting and baseline monitoring activities occurred between April and May 2018 (Table 2). This report documents the completion of the construction activities and presents as-built baseline monitoring data (MY0) for the post-construction monitoring period. Only minor adjustments were made to the final design during construction and the MY0 longitudinal profiles and cross-section dimensions illustrate that the proposed design parameters and are within a normal range of variability for these natural stream systems. The Project is expected to meet the Year 1 Monitoring Year success criteria.

2 Project Background

2.1 Project Location, Setting, and Existing Conditions

The Pen Dell Mitigation Project (Project) site is located in the Upper Buffalo Creek Sub-watershed 030202011502 study area for the Neuse 01 Regional Watershed Plan (RWP), in the Wake-Johnston Collaborative Local Watershed Plan, and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin. The Project site is situated in the lower piedmont where potential for future development associated with the I-540 corridor and rapidly growing Johnston County area is imminent, as described in the Regional Watershed Plan (RWP) for the Upper Neuse River Basin within Hydrologic Unit (HU) 03020201.

The RWP identified and prioritized potential mitigation strategies to offset aquatic resource impacts from development and provided mitigation project implementation recommendations to improve ecological uplift within the Neuse 01 Sub-basin, which included traditional stream and wetland mitigation, buffer restoration, nutrient offsets, non-traditional mitigation projects such as stormwater and agricultural BMPs, and rare, threatened, or endangered (RTE) species habitat preservation or enhancement.

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 approximately 5,064 linear feet of streams and approximately 633,803 square feet of riparian buffers permanently protected by a conservation easement (15.95 acres). The catchment area is 156 acres and has an impervious cover of approximately one percent. The dominant land uses are agriculture and mixed forest. Prior to Project 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 (LWP) and 2015 Neuse 01 Regional Watershed Plan (RWP) and include:

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

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

- Restore stream and floodplain interaction and geomorphically stable conditions by reconnecting historic flow paths and promoting more natural flood processes,
- Improve and protect water quality by reducing streambank erosion, nutrient and sediment inputs,
- 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 function-based objectives will be measured and included with the performance standards to document overall project success as described in the table below:

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

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2.3 Project History, Contacts, and Timeframe

The chronology of the project history and activity is presented in Table 2. Relevant project contact information is presented in Table 3. Relevant project background information is presented in Table 4. The final mitigation plan and PCN were submitted to DMS September 29, 2017 for submission to 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.

Refer to Figure 1 and 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 Project Mitigation Components

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 (Appendix C) and now protected through a permanent conservation easement. Table 1 and Figure 1 (Appendix A) provide a summary of the project components.

3.1.1 R1 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 has 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 all of R2. Additionally, permanent fencing will be 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 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 flow 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 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 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.

3.2 Wetlands Mitigation Types and Approaches

Wetland mitigation credits are not contracted or proposed for this project.

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 (7) 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	Within planted portions of the site, a minimum of 320 stems per acre must be present at year three; a minimum of 260 stems per acre must be present at year five; and a minimum of 210 stems per acre must be present at year seven.	Increase woody and herbaceous vegetation will provide channel stability and reduce streambank erosion, runoff rates and exotic species vegetation.
Physicochemical (Level 4)	Improve Water Quality	N/A	N/A	Removal of excess nutrients, FC bacteria, and organic pollutants will increase the hyporheic exchange

				and dissolved oxygen (DO) levels.
Biology (Level 5)	Improve Benthic Macroinvertebrate Communities and Aquatic Health	DWR Small Stream/ Qual v4 sampling, IBI	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). Vertical stability and floodplain access will both be evaluated by looking at Entrenchment Ratios (ER). The ER shall be no less than 2.2 (>1.5 for "B" stream types) along the restored project stream reaches. This standard only applies to restored reaches of the channel where ERs were corrected through design and construction.

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.

4.1.5 Jurisdictional Stream Flow

The restored stream systems must be classified as at least intermittent, and therefore must exhibit base flow for some portion of the year 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 (7) feet in height at Year 5 of monitoring and ten (10) feet in height at Year 7 of monitoring. For all of the monitoring years (Year 1 through Year 7), the number of Red maple (*Acer rubrum*) stems cannot exceed 20% of the total stems in any of the vegetation monitoring plots.

4.3 Wetlands

Wetland mitigation credits are not contracted or proposed for this project. Wetland mitigation performance standards are therefore not included in this section.

5 Monitoring Plan

The monitoring plan is described in the approved mitigation plan and is intended to document the site improvements based on restoration potential, catchment health, ecological stressors and overall constraints. The measurement methods described below provide a connection between project goals and objectives, performance standards, and monitoring requirements to evaluate functional improvement.

5.1 Monitoring Schedule and Reporting

A period of at least six months will separate the as-built baseline measurements and the first-year monitoring measurements. The baseline monitoring document and as-built monitoring report will include all information required by the current DMS templates (June 2017) and applicable guidance referenced in the approved mitigation plan, including planimetric (plan view) and elevation (profile view) information, photographs, sampling plot locations, a description of initial vegetation species composition by community type, and location of monitoring stations. The report will include a list of the vegetation species planted, along with the associated planting densities. WLS will conduct mitigation performance monitoring based on these methods and will submit annual monitoring reports to DMS by December 1st of each monitoring year during which required monitoring is conducted. The annual monitoring reports will organize and present the information resulting from the methods described in detail below.

5.2 Visual Assessment Monitoring

WLS will conduct visual assessments in support of mitigation performance monitoring. Visual assessments of all stream reaches will be conducted twice per monitoring year with at least five months in between each site visit for each of the seven years of monitoring. Photographs will be used to visually document system performance and any areas of concern related to streambank and bed stability, condition of in-

stream structures, channel migration, active headcuts, live stake mortality, impacts from invasive plant species or animal browsing, easement boundary encroachments, cattle exclusion fence damage, and the general condition of pools and riffles. The monitoring activities will be summarized in DMS's *Visual Stream Morphology Stability Assessment Table* and the *Vegetation Conditions Assessment Table*, which are used to document and quantify the visual assessment throughout the monitoring period.

A series of photographs over time will be also be compared to evaluate channel aggradation (bar formations) or degradation, streambank erosion, successful maturation of riparian vegetation, and effectiveness of sedimentation and erosion control measures. More specifically, the longitudinal profile photos should indicate the absence of developing bars within the channel or excessive increase in channel depth, while lateral photos should not indicate excessive erosion or continuing degradation of the banks. The photographs will be taken from a height of approximately five feet to ensure that similar locations (and view directions) at the site are documented in each monitoring period and will be shown on the current conditions plan view map (CCPV). The results of the visual monitoring assessments will be used to support the development of the annual monitoring document that provides the visual assessment metrics.

5.3 Stream Assessment Monitoring

Based on the stream design approaches, different stream monitoring methods are proposed for the various project reaches. Hydrologic monitoring will be conducted for all project stream reaches. For reaches that involve a combination of traditional Restoration (Rosgen Priority Level I and II) and Enhancement Level I (bed/bank stabilization) approaches, geomorphic monitoring methods that follow those recommended by the *USACE Stream Mitigation Guidelines,* issued in April 2003 and October 2005, and NCEEP's *Stream and Wetland Mitigation Monitoring Guidelines,* which are described below, will be employed to evaluate the effectiveness of the restoration practices. Visual monitoring will also be conducted along these reaches as described herein. For project reaches involving Enhancement Level II and Preservation approaches, monitoring efforts will focus primarily on visual inspections, photo documentation, and vegetation assessments, each as described herein. The monitoring of these project reaches will utilize the methods described under visual monitoring. Each of the proposed stream monitoring methods are described in detail below.

5.3.1 Stream Hydrologic Monitoring

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, will be documented using a crest gage and photography. The crest gage has been installed on the floodplain of the restored channel towards the middle portion of Reach R4 (Figure 1). The crest gage will record the watermark associated with the highest flood stage between monitoring site visits. The gage will be checked each time WLS staff conduct a site visit to determine if a bankfull and/or geomorphically significant flow event has occurred since the previous gage check. Corresponding photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits. This monitoring will help establish that the restoration objectives of restoring floodplain functions and promoting more natural flood processes are being met.

5.3.2 Stream Geomorphic Monitoring

5.3.2.1 Stream Horizontal Pattern

A planimetric survey has been conducted for the entire length of restored channel to document as-built baseline conditions (MY0). The survey was tied to a permanent benchmark and measurements include

thalweg, bankfull, and top of banks. The plan view measurements such as sinuosity, radius of curvature, meander width ratio were taken on newly constructed meanders during baseline documentation (MY0) only. The described visual monitoring will also document any changes or excessive lateral movement in the plan view of the restored channel. The results of the planimetric survey should show that the restored horizontal geometry is consistent with intended design stream type. These measurements will demonstrate that the restored stream channel pattern provides more stable planform and associated features than the old channel, which provide improved aquatic habitat and geomorphic function, as per the restoration objectives.

5.3.2.2 Stream Longitudinal Profile

A longitudinal profile has been surveyed for the entire length of restored channel to document as-built baseline conditions for the first year of monitoring only. The survey was tied to a permanent benchmark and measurements include thalweg, water surface, bankfull, and top of low bank. Measurements were taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. The longitudinal profile shows that the bedform features installed are consistent with intended design stream type. The longitudinal profiles will not be taken during subsequent monitoring years unless vertical channel instability has been documented or remedial actions/repairs are deemed necessary. These measurements will demonstrate that the restored stream profile provides more bedform diversity than the old channel with multiple facet features (such as scour pools and riffles) that provide improved aquatic habitat, as per the restoration objectives. BHRs will be measured along each of the restored reaches using the results of the longitudinal profile to demonstrate that the BHRs shall not exceed 1.2 along the restored project reaches.

5.3.2.3 Stream Horizontal Dimension

Permanent cross-sections have been installed and surveyed at an approximate rate of one cross-section per twenty (20) bankfull widths or an average distance interval (not to exceed 500 LF) of restored stream, for a total of five (5) cross-sections located at riffles, and three (3) located at pools. Each cross-section has been monumented on both streambanks to establish the exact transect used and to facilitate repetition each year and easy comparison of year-to-year data. The cross-section surveys will occur in years zero (as-built), one, two, three, five, and seven, and must include measurements of Bank Height Ratio (BHR) and Entrenchment Ratio (ER). The monitoring survey will include points measured at all breaks in slope, including top of streambanks, bankfull, inner berm, edge of water, and thalweg, if the features are present.

There should be minimal change in as-built cross-sections. Stable cross-sections will establish that the restoration goal of creating geomorphically stable stream conditions has been met. If changes do take place, they will be documented in the survey data and evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the streambanks, or decrease in width-to-depth ratio). Using the Rosgen Stream Classification System, all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

Reference photo transects will be taken at each permanent cross-section. Photos should not indicate excessive erosion or continuing degradation of the streambanks. Photographs will be taken of both streambanks at each cross-section. A survey tape stretched between the permanent cross-section monuments/pins will be centered in each of the streambank photographs. The water elevation will be shown in the lower edge of the frame, and as much of the streambank as possible will be included in each photo. Photographers should attempt to consistently maintain the same area in each photo over time.

5.3.2.4 Streambed Material

Representative streambed material samples will be collected in locations where riffles are installed as part of the project. The dominant substrate is coarse sand and the post-construction riffle substrate samples will be compared to the existing riffle substrate data collected during the design phase. Any significant changes (e.g., aggradation, degradation, embeddedness) will be noted after streambank vegetation becomes established and a minimum of two bankfull flows or greater have been documented. If significant changes (i.e. excess deposition) are observed within stable riffles and pools, additional sediment transport analyses and calculations may be required.

5.3.3 Stream Flow Duration Monitoring

5.3.3.1 Jurisdictional Stream Flow Documentation

Monitoring of stream flow will be conducted to demonstrate that the restored stream systems classified as intermittent exhibit surface flow for a minimum of 30 consecutive days throughout some portion of the year during a year with normal rainfall conditions. To determine if rainfall amounts are normal for the given year, precipitation amounts using tallied data obtained from the Johnston County weather station weather station (COOP 317994), approximately twenty miles south of the site. Data from the weather station can be obtained from the CRONOS Database located on the State Climate Office of North Carolina's website. If a normal year of precipitation does not occur during the first seven years of monitoring, monitoring of flow conditions on the site will continue until it documents that the intermittent streams have been flowing during the appropriate times of the year.

The proposed monitoring of the restored intermittent reach will include the installation of a monitoring gage (flow gage) within the thalweg (bottom) of the channel towards the middle portion of the reach. A total of 1 monitoring flow gage (continuous-read pressure transducers) has been installed towards the middle portion of enhanced intermittent Reach R1 (Figure 1). The gage device will be inspected on a quarterly/semi-annual basis to document surface hydrology and provide a basis for evaluating flow response to rainfall events and surface runoff during various water tables levels throughout the monitoring period (KCI, DMS, 2010).

5.4 Vegetation

Successful restoration of the vegetation at the project site is dependent upon successful hydrologic restoration, active establishment and survival of the planted preferred canopy vegetation species, and volunteer regeneration of the native plant community. To determine if these criteria are successfully achieved, vegetation-monitoring quadrants or plots have been installed and will be monitored across the restoration site in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2017).

The vegetation monitoring plots are approximately 2% of the planted portion of the site with a total of seven (7) plots established randomly within the planted riparian buffer areas. The sampling may employ quasi-random plot locations which may vary upon approval from DMS, DWR and IRT. Any random plots should comprise more than 50% of the total required plots and the location (GPS coordinates and orientation) will identified in the monitoring reports. No monitoring quadrants were established within undisturbed wooded areas, such as those along Reach R5, however visual observations will be documented in the annual monitoring reports to describe any changes to the existing vegetation community. The size and location of individual quadrants is 100 square meters (10m X 10m) for woody

tree species. The vegetation plot corners have been marked and surveyed with a GPS unit. See Figure 1 in Appendix B for the vegetation monitoring plot locations.

Vegetation monitoring will occur in the fall each required monitoring year, prior to the loss of leaves. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings. Data will be collected at each individual quadrant and will include specific data for monitored stems on diameter, height, species, date planted, and grid location, as well as a collective determination of the survival density within that quadrant. Relative values will be calculated and importance values will be determined. Individual planted seedlings were marked at planting or monitoring baseline setup so that those stems can be found and identified consistently each successive monitoring year. Volunteer species will be noted and their inclusion in quadrant data will be evaluated with DMS on a case-by-case basis. The presence of invasive species vegetation within the monitoring quadrants will also be noted, as will any wildlife effects.

At the end of the first full growing season (from baseline/year 0) or after 180 days between March 1st and November 30th, species composition, stem density, and survival will be evaluated. For each subsequent year, vegetation plots shall be monitored for seven years in years 1, 2, 3, 5 and 7, and visual monitoring in years 4 and 6, or until the final success criteria are achieved.

WLS will provide required remedial action on a case-by-case basis, such as replanting more wet/drought tolerant species vegetation, conducting beaver and beaver dam management/removal, and removing undesirable/invasive species vegetation, and will continue to monitor vegetation performance until the corrective actions demonstrate that the site is trending towards or meeting the standard requirement. Existing mature woody vegetation will be visually monitored during annual site visits to document any mortality, due to construction activities or changes to the water table, that negatively impact existing forest cover or favorable buffer vegetation.

5.5 Wetlands

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

6 As-Built (Baseline) Condition

6.1 As-built (Baseline) Survey

An as-built survey, conducted under the responsible charge of a North Carolina Professional Land Surveyor (PLS), was utilized to document the as-built or baseline condition of the Project post-construction. The Project construction and planting were completed in April 2018 and as-built survey was completed in June 2018. Planting and baseline monitoring activities occurred between April and May 2018. The as-built survey included locating the constructed stream channels, in-stream structures, monitoring device locations, a longitudinal profile survey, and cross-section surveys. For comparison purposes, the site

reaches were divided into the same reaches that were established for the project assessment and design (R1, R2, R3, R4, and R5).

6.2 As-Built (Baseline) Plans/ Record Drawings

The results of the as-built survey are used to establish and document post-construction or baseline conditions and will be used for comparing post-construction monitoring data each monitoring year. The as-built survey plan set includes these same plan sheets (cover, legend/construction sequence/general notes, typical sections, details, plans and profile, and revegetation plan) as the final construction plans. The as-built survey plan set was developed utilizing the final construction plan set as the "background", and then overlaying the as-built survey information on the plan and profile sheets. Any significant adjustments or deviations made to the final construction plans during construction are shown as redline mark-ups or callouts on the as-built survey plan sheets, as appropriate, to serve as record drawings. The as-built survey plan set is located in Appendix E.

6.3 As-Built/Baseline Assessment

No deviations of significance were documented between the final construction plans and the as-built condition that may affect channel performance or changes in vegetation species planted. Additionally, no major issues or mitigating factors were observed immediately after construction which require consideration or remedial action.

6.3.1 Morphological Assessment

Morphological data for the as-built profile was collected between May and June 2018. Refer to Appendix B for summary data tables, morphological plots, and stream photographs.

6.3.1.1 Stream Horizontal Pattern & Longitudinal Profile

The MY0 stream channel pattern and longitudinal profiles closely match the profile design parameters. On the design profiles, riffles were depicted as straight lines with consistent slopes. Various locations the riffle profiles shown on the as-built survey illustrate multiple slope breaks due to the installation of log and rock structures and woody debris within the streambed. The constructed riffle slopes and pool depths vary slightly from design parameters due to field adjustments and fine sediment migration during construction. The MY0 plan form geometry or pattern fell within acceptable ranges of the design parameters for all restored reaches. These minor channel adjustments in riffle slopes, pool depths and pattern do not present a stability concern or indicate a need for remedial action and will be assessed visually during the annual assessments.

6.3.1.2 Stream Horizontal Dimension

The MY0 channel dimensions generally match the design parameters and are within acceptable a stable range of tolerance. It is expected that over time that some pools may accumulate fine sediment and organic matter, however, this is not an indicator of channel instability. Maximum riffle depths are expected to fluctuate slightly throughout the monitoring period as the channels adjust to restored flow regime.

6.3.1.3 Vegetation

The MY0 average planted density is 763 stems per acre, which exceeds the interim measure of vegetative success of at least 320 planted stems per acre at the end of the third monitoring year. Summary data and photographs of each plot can be found in Appendix 3.

6.3.1.4 Wetlands

Groundwater gage data will be included in the annual monitoring report to document existing wetland hydrology.

6.3.1.5 Bankfull Events

Bankfull events that occurred after construction will be documented in the MY1 report.

7 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)

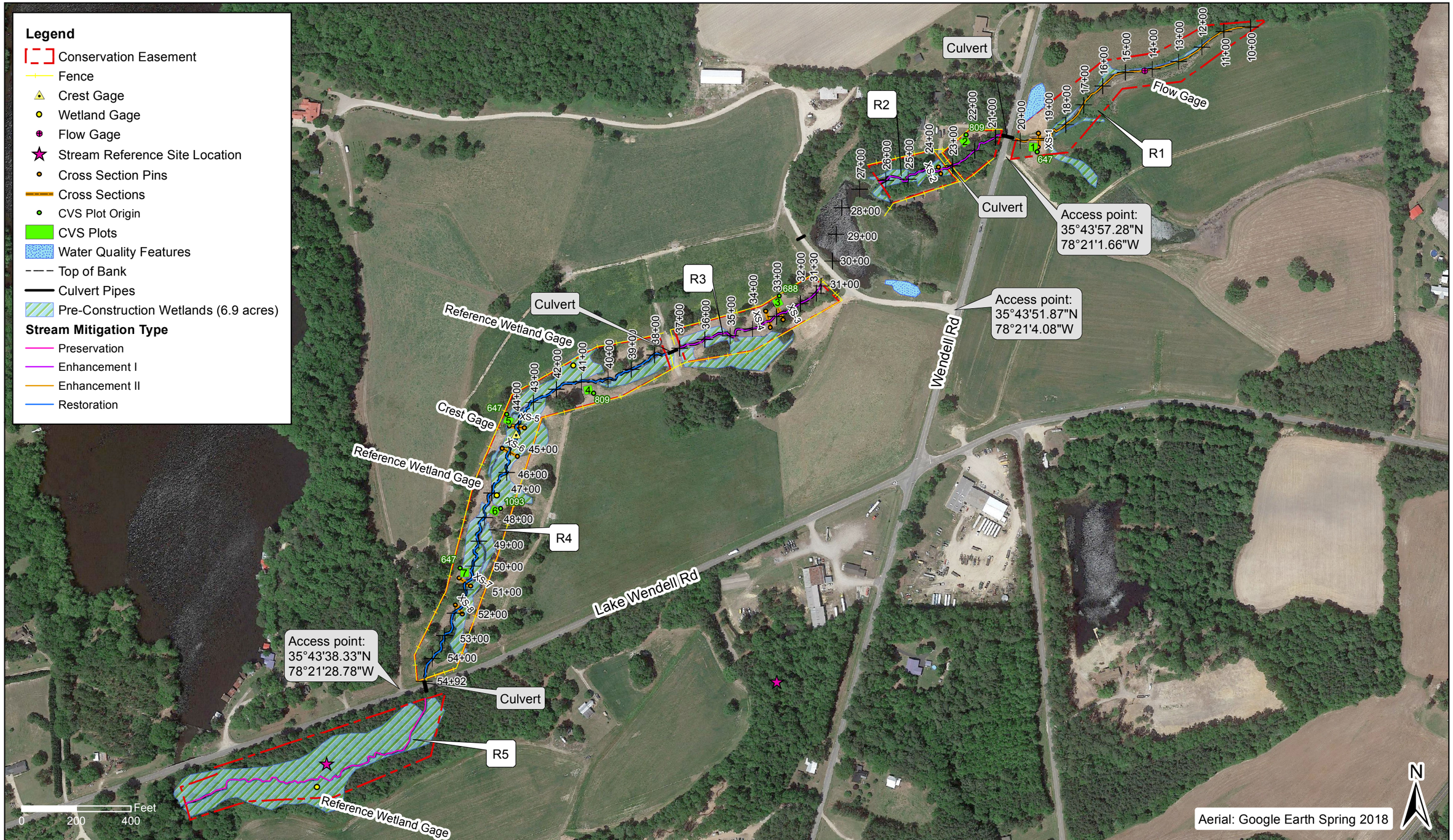
Elapsed Time Since grading complete: 0 yrs 8 months
Elapsed Time Since planting complete: 0 yrs 8 months
Number of reporting Years[0]: 0

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	11/23/2018	12/3/2018
Year 1 Monitoring Report Submittal	N/A	N/A
Year 2 MonitoringReport Submittal	N/A	N/A
Year 3 Monitoring Report Submittal	N/A	N/A
Year 4 Monitoring Report Submittal	N/A	N/A
Year 5 Monitoring Report Submittal	N/A	N/A
Year 6 Monitoring Report Submittal	N/A	N/A
Year 7 Monitoring Report Submittal	N/A	N/A

Table 3. Project Contacts Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)	
Mitigation Provider	Water & Land Solutions, LLC 11030 Raven Ridge Road, Suite 200, Raleigh, NC 27614
Primary Project POC	William Scott Hunt, III, PE Phone: 919-270-4646
Construction Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Survey Contractor (Existing Condition Surveys)	WithersRavenel 115 MacKenan Drive, Cary, NC 27511
Primary Project POC	Marshall Wight, PLS Phone: 919-469-3340
Survey Contractor (Conservation Easement, Construction and As-Builts Surveys)	True Line Surveying, PC 205 West Main Street, Clayton, NC 27520
Primary Project POC	Curk T. Lane, PLS 919-359-0427
Planting Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Seeding Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Seed Mix Sources	Green Resource 5204 Highgreen Ct., Colfax, NC 27235 Rodney Montgomery Phone: 336-215-3458
Nursery Stock Suppliers	Foggy Mountain Nursery (Live Stakes) 797 Helton Creek Rd, Lansing, NC 28643 Glenn Sullivan Phone: 336-977-2958 Dykes & Son Nursery (Bare Root Stock) 825 Maude Etter Rd, Mcminnville, Tn 37110 Jeff Dykes Phone: 931-668-8833
Monitoring Performers	Water & Land Solutions, LLC 11030 Raven Ridge Road, Suite 200, Raleigh, NC 27614
Stream Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646
Vegetation Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646
Wetland Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646

Table 4. Project Information and Attributes					
Project Name	Pen Dell Mitigation Project				
County	Johnston				
Project Area (acres)	16.0				
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
April 2018
MY0

Current Conditions
Plan View

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
1

Table 5. **Visual Stream Morphology Stability Assessment**
Project **Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)**
Reach ID **R1, R2, R3, R4, R5**
Assessed Length **5126**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
*	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	37	37			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	32	32			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	13	13			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	9	9			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	35	37			95%			

*** Please make Note that the calculation for bank footage uses the total bank footage in the reach not the linear footage of channel.**

Therefore the denominator is 2 times the channel length in the calculation.

For the above example this would be 430 divided by 5000 feet of bank = 91%

Formulas exist in the cells above

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

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

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

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

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

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

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

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

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

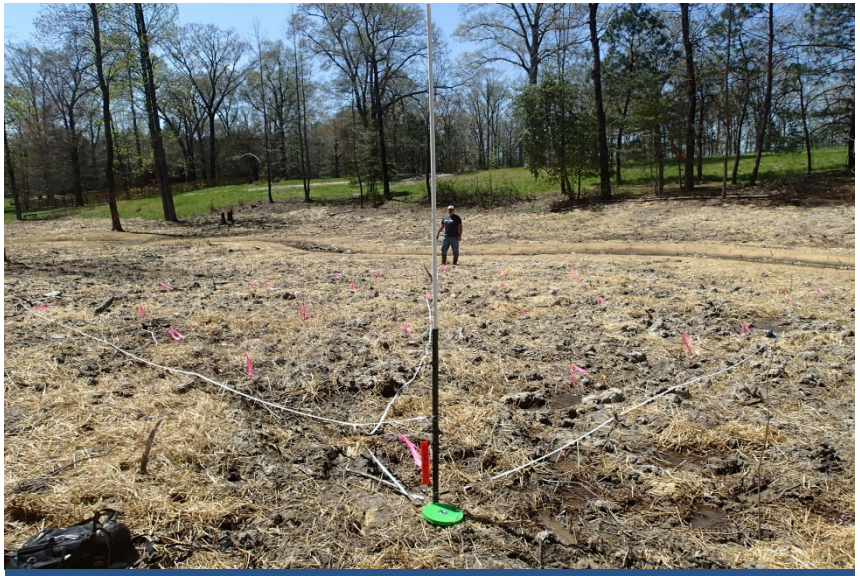
Veg Plot 1 April 12, 2018 (MY-00)

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

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

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

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



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

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

Appendix C – Vegetation Plot Data

Table 6. Baseline Vegetation

Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)

			Current Plot Data (MY0-2018)																					Annual Means		
			002-01-0001			002-01-0002			002-01-0003			002-01-0004			002-01-0005			002-01-0006			002-01-0007			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**
Acer rubrum	Red Maple	Tree													2	2	2	1	1	1				3	3	3
Alnus serrulata	Tag Alder, Smooth Alder, Hazel Alder	Shrub Tree							1	1	1							1	1	1	1	1	1	3	3	3
Betula nigra	River Birch, Red Birch	Tree	3	3	3				1	1	1	4	4	4	2	2	2	4	4	4				14	14	14
Carpinus caroliniana	Ironwood	Shrub Tree							3	3	3				2	2	2	4	4	4	1	1	1	10	10	10
Cornus amomum	Silky Dogwood	Shrub Tree	1	1	1				2	2	2				1	1	1	1	1	1	1	1	1	6	6	6
Diospyros virginiana	American Persimmon, Possumwood	Tree										1	1	1				1	1	1				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
Ilex verticillata	Winterberry	Shrub Tree				3	3	3																3	3	3
Lindera benzoin	Northern Spicebush	Shrub Tree	1	1	1	6	6	6	2	2	2										4	4	4	13	13	13
Liriodendron tulipifera	Tulip Tree	Tree	4	4	4	2	2	2				4	4	4				2	2	2	1	1	1	13	13	13
Magnolia virginiana	Sweetbay Magnolia	Shrub Tree	2	2	2	5	5	5	2	2	2	2	2	2				1	1	1	2	2	2	14	14	14
Platanus occidentalis	Sycamore, Plane-tree	Tree							2	2	2	2	2	2	5	5	5	4	4	4	1	1	1	14	14	14
Quercus michauxii	Basket Oak, Swamp Chestnut Oak	Tree							2	2	2	2	2	2	1	1	1	3	3	3	1	1	1	9	9	9
Quercus nigra	Water Oak, Paddle Oak	Tree	3	3	3	2	2	2	1	1	1	2	2	2							1	1	1	9	9	9
Quercus phellos	Willow Oak	Tree	1	1	1	2	2	2				1	1	1	1	1	1	3	3	3				8	8	8
Viburnum nudum	Southern Wild Raisin, Possumhaw	Shrub Tree																			1	1	1	1	1	1
		Stem count	16	16	16	20	20	20	17	17	17	20	20	20	16	16	16	27	27	27	16	16	16	132	132	132
		size (ares)	1			1			1			1			1			1			1			7		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.17		
		Species count	8	8	8	6	6	6	10	10	10	9	9	9	8	8	8	12	12	12	11	11	11	16	16	16
		Stems per ACRE	647	647	647	809	809	809	688	688	688	809	809	809	647	647	647	1093	1093	1093	647	647	647	763	763	763

Color for Density

Exceeds requirements by 10%

Exceeds requirements, but by less than 10%

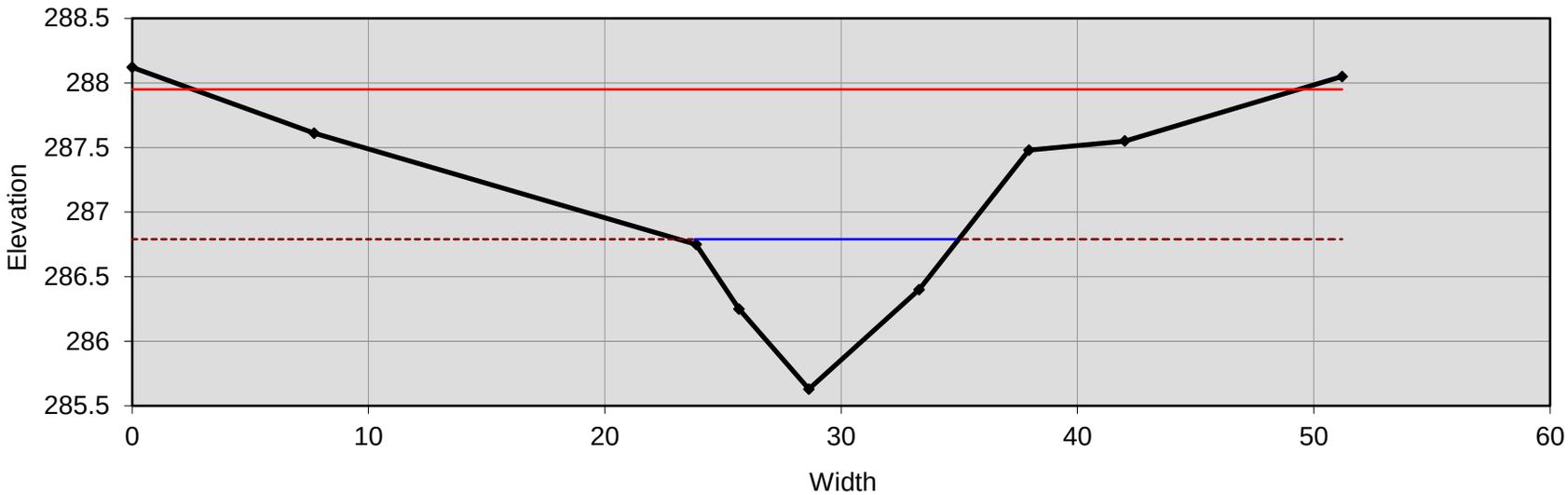
Fails to meet requirements, by less than 10%

Fails to meet requirements by more than 10%

Appendix D – Stream Measurement and Geomorphology Data

Cross Section X-1

19 + 31 Pen Dell Mitigation Project - As-Built (MY0), Riffle

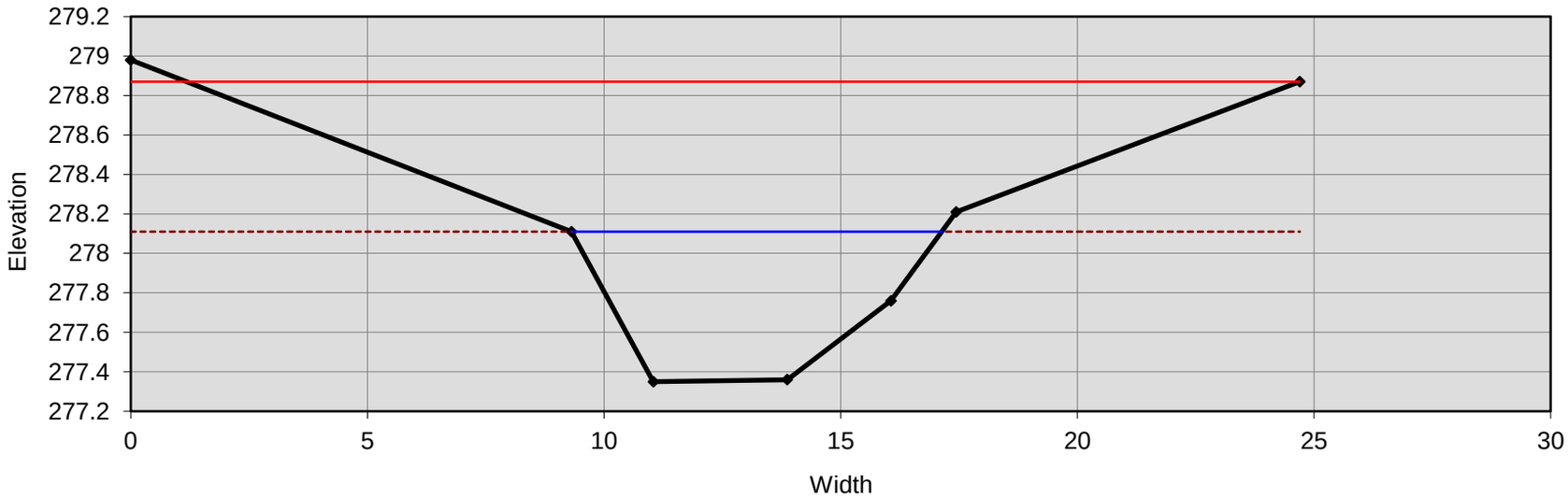


Bankfull Dimensions		Flood Dimensions		Materials	
7.0	x-section area (ft.sq.)	49.0	W flood prone area (ft)	---	D50 (mm)
11.1	width (ft)	4.4	entrenchment ratio	---	D84 (mm)
0.6	mean depth (ft)	1.2	low bank height (ft)	0	threshold grain size (mm):
1.2	max depth (ft)	1.0	low bank height ratio		
11.4	wetted parimeter (ft)				
0.6	hyd radi (ft)				
17.7	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.5	velocity (ft/s)	0.033	Manning's roughness	0.019	channel slope (%)
3.1	discharge rate (cfs)	0.15	D'Arcy-Weisbach fric.	0.01	shear stress (lb/sq.ft.)
0.10	Froude number	---	resistance factor u/u*	0.06	shear velocity (ft/s)
		---	relative roughness	0.0034	unit strm power (lb/ft/s)

Cross Section X-2

23 + 51 Pen Dell Mitigation Project - As-Built (MY0), Riffle

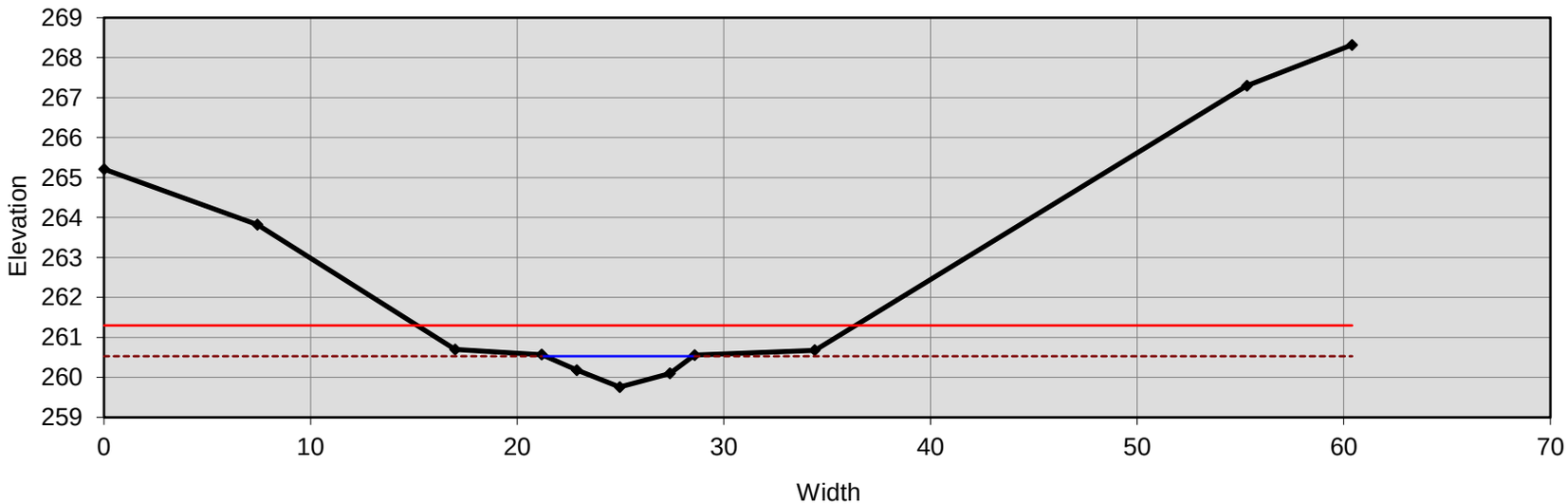


Bankfull Dimensions		Flood Dimensions		Materials	
4.2	x-section area (ft.sq.)	23.0	W flood prone area (ft)	---	D50 (mm)
7.8	width (ft)	2.9	entrenchment ratio	---	D84 (mm)
0.5	mean depth (ft)	0.8	low bank height (ft)	0	threshold grain size (mm):
0.8	max depth (ft)	1.0	low bank height ratio		
8.1	wetted parimeter (ft)				
0.5	hyd radi (ft)				
14.6	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.4	velocity (ft/s)	0.035	Manning's roughness	0.021	channel slope (%)
1.7	discharge rate (cfs)	0.18	D'Arcy-Weisbach fric.	0.01	shear stress (lb/sq.ft.)
0.10	Froude number	---	resistance factor u/u*	0.06	shear velocity (ft/s)
		---	relative roughness	0.0028	unit strm power (lb/ft/s)

Cross Section X-3

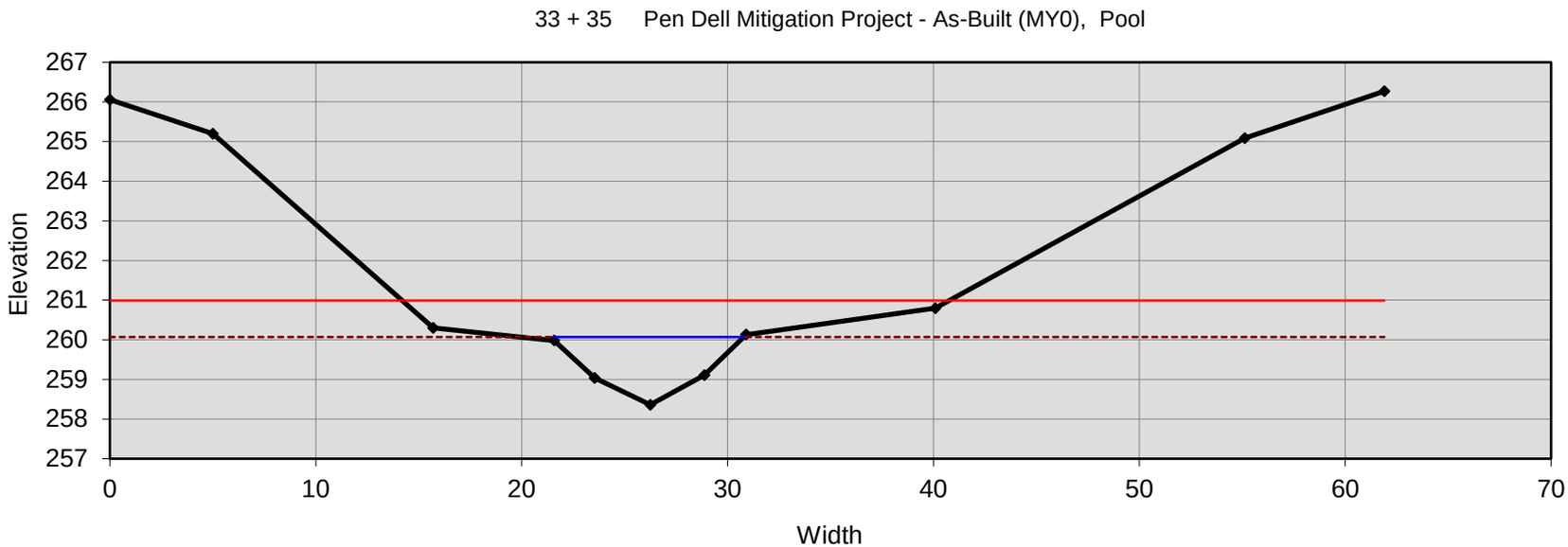
32 + 84 Pen Dell Mitigation Project - As-Built (MY0), Riffle



Bankfull Dimensions		Flood Dimensions		Materials	
3.1	x-section area (ft.sq.)	19.8	W flood prone area (ft)	---	D50 (mm)
7.1	width (ft)	2.8	entrenchment ratio	---	D84 (mm)
0.4	mean depth (ft)	0.8	low bank height (ft)	0	threshold grain size (mm):
0.8	max depth (ft)	1.0	low bank height ratio		
7.3	wetted parimeter (ft)				
0.4	hyd radi (ft)				
16.3	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.3	velocity (ft/s)	0.033	Manning's roughness	0.014	channel slope (%)
0.9	discharge rate (cfs)	0.17	D'Arcy-Weisbach fric.	0.00	shear stress (lb/sq.ft.)
0.08	Froude number	---	resistance factor u/u*	0.04	shear velocity (ft/s)
		---	relative roughness	0.0012	unit strm power (lb/ft/s)

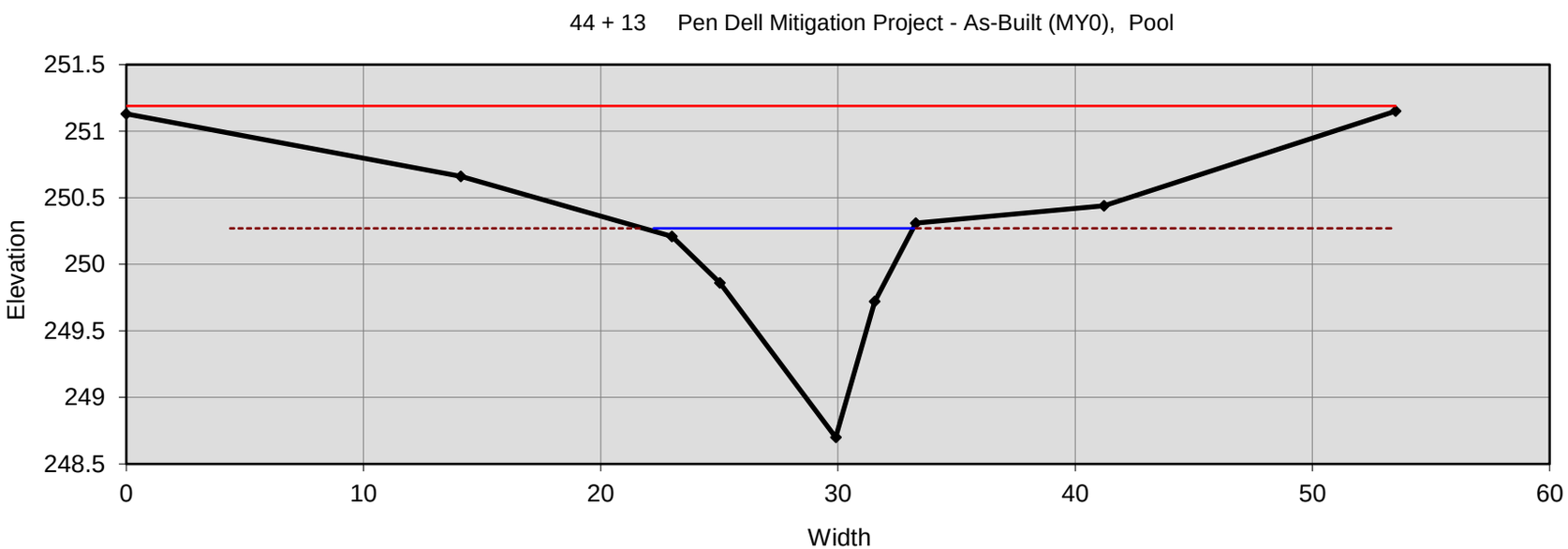
Cross Section X-4



Bankfull Dimensions		Flood Dimensions		Materials	
9.2	x-section area (ft.sq.)	29.6	W flood prone area (ft)	---	D50 (mm)
9.2	width (ft)	3.2	entrenchment ratio	---	D84 (mm)
1.0	mean depth (ft)	1.7	low bank height (ft)	0	threshold grain size (mm):
1.7	max depth (ft)	1.0	low bank height ratio		
9.8	wetted parimeter (ft)				
0.9	hyd radi (ft)				
9.2	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.5	velocity (ft/s)	0.035	Manning's roughness	0.014	channel slope (%)
4.5	discharge rate (cfs)	0.15	D'Arcy-Weisbach fric.	0.01	shear stress (lb/sq.ft.)
0.09	Froude number	---	resistance factor u/u*	0.07	shear velocity (ft/s)
		---	relative roughness	0.0042	unit strm power (lb/ft/s)

Cross Section X-5

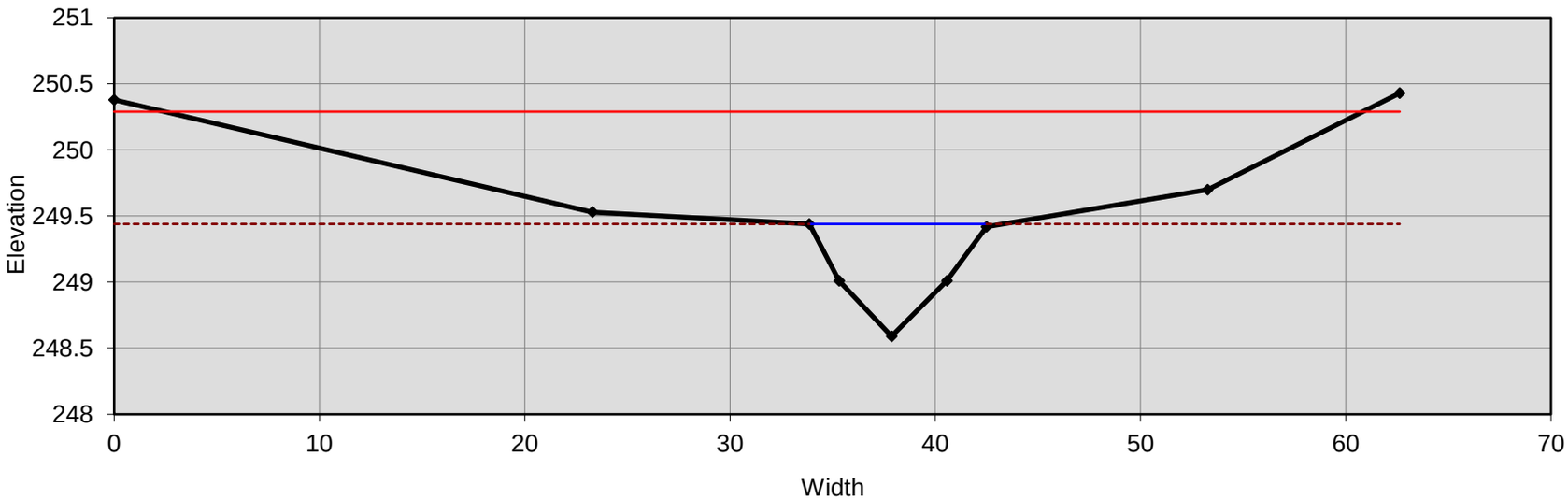


Bankfull Dimensions		Flood Dimensions		Materials	
7.5	x-section area (ft.sq.)	53.0	W flood prone area (ft)	---	D50 (mm)
10.2	width (ft)	5.2	entrenchment ratio	---	D84 (mm)
0.7	mean depth (ft)	1.6	low bank height (ft)	0	threshold grain size (mm):
1.6	max depth (ft)	1.0	low bank height ratio		
10.7	wetted parimeter (ft)				
0.7	hyd radi (ft)				
13.8	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.4	velocity (ft/s)	0.035	Manning's roughness	0.012	channel slope (%)
2.8	discharge rate (cfs)	0.16	D'Arcy-Weisbach fric.	0.01	shear stress (lb/sq.ft.)
0.08	Froude number	---	resistance factor u/u*	0.05	shear velocity (ft/s)
		---	relative roughness	0.002	unit strm power (lb/ft/s)

Cross Section X-6

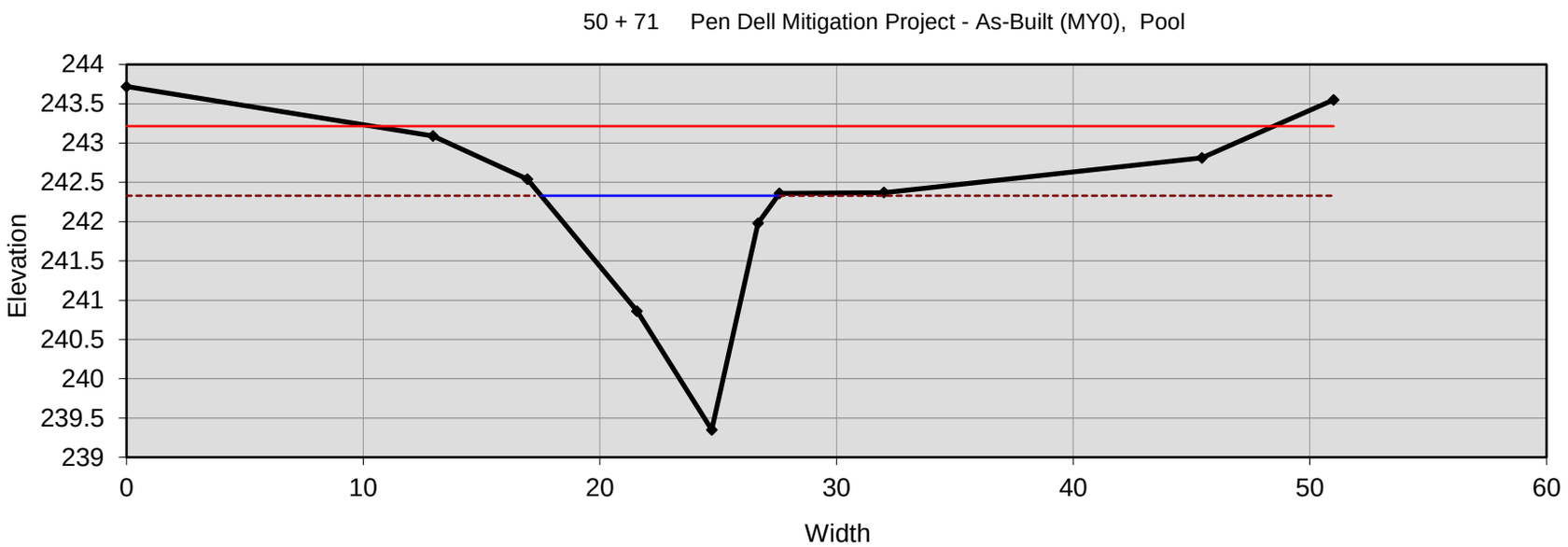
45 + 16 Pen Dell Mitigation Project - As-Built (MY0), Riffle



Bankfull Dimensions		Flood Dimensions		Materials	
4.1	x-section area (ft.sq.)	56.0	W flood prone area (ft)	---	D50 (mm)
8.6	width (ft)	6.5	entrenchment ratio	---	D84 (mm)
0.5	mean depth (ft)	0.9	low bank height (ft)	0	threshold grain size (mm):
0.9	max depth (ft)	1.0	low bank height ratio		
8.8	wetted parimeter (ft)				
0.5	hyd radi (ft)				
18.1	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.3	velocity (ft/s)	0.035	Manning's roughness	0.016	channel slope (%)
1.3	discharge rate (cfs)	0.18	D'Arcy-Weisbach fric.	0.00	shear stress (lb/sq.ft.)
0.08	Froude number	---	resistance factor u/u*	0.05	shear velocity (ft/s)
		---	relative roughness	0.0015	unit strm power (lb/ft/s)

Cross Section X-7



Bankfull Dimensions	
13.4	x-section area (ft.sq.)
10.0	width (ft)
1.3	mean depth (ft)
3.0	max depth (ft)
12.0	wetted parimeter (ft)
1.1	hyd radi (ft)
7.5	width-depth ratio

Flood Dimensions	
38.0	W flood prone area (ft)
3.8	entrenchment ratio
3.0	low bank height (ft)
1.0	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
1	threshold grain size (mm):

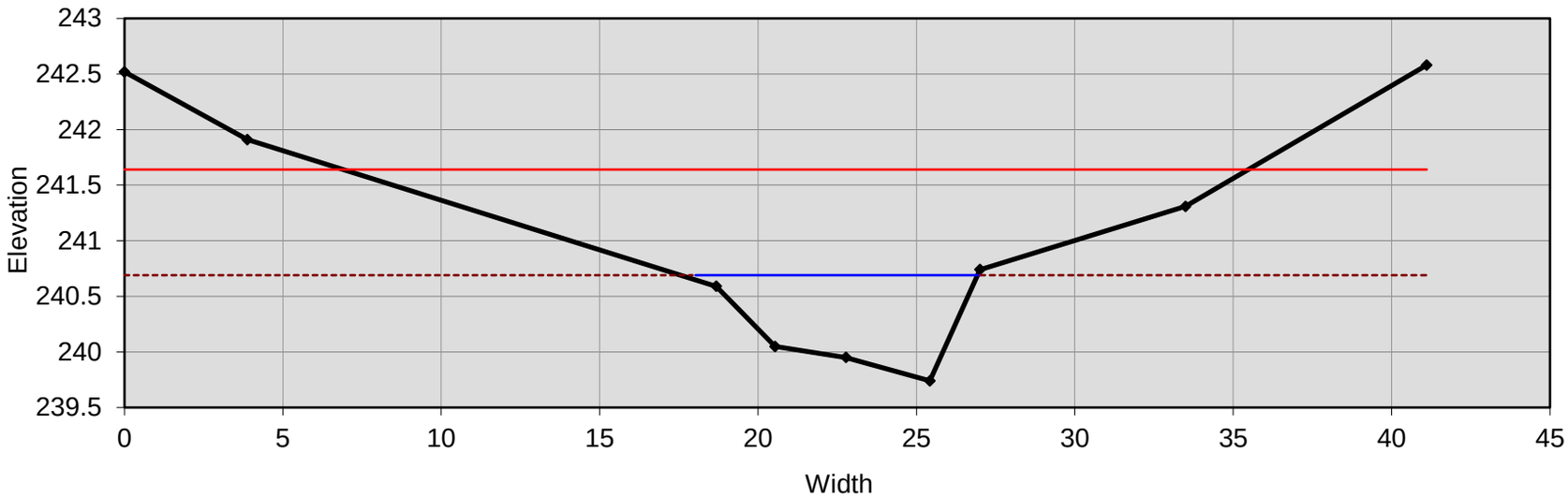
Bankfull Flow	
0.6	velocity (ft/s)
8.0	discharge rate (cfs)
0.10	Froude number

Flow Resistance	
0.035	Manning's roughness
0.14	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.017	channel slope (%)
0.01	shear stress (lb/sq.ft.)
0.08	shear velocity (ft/s)
0.0085	unit strm power (lb/ft/s)

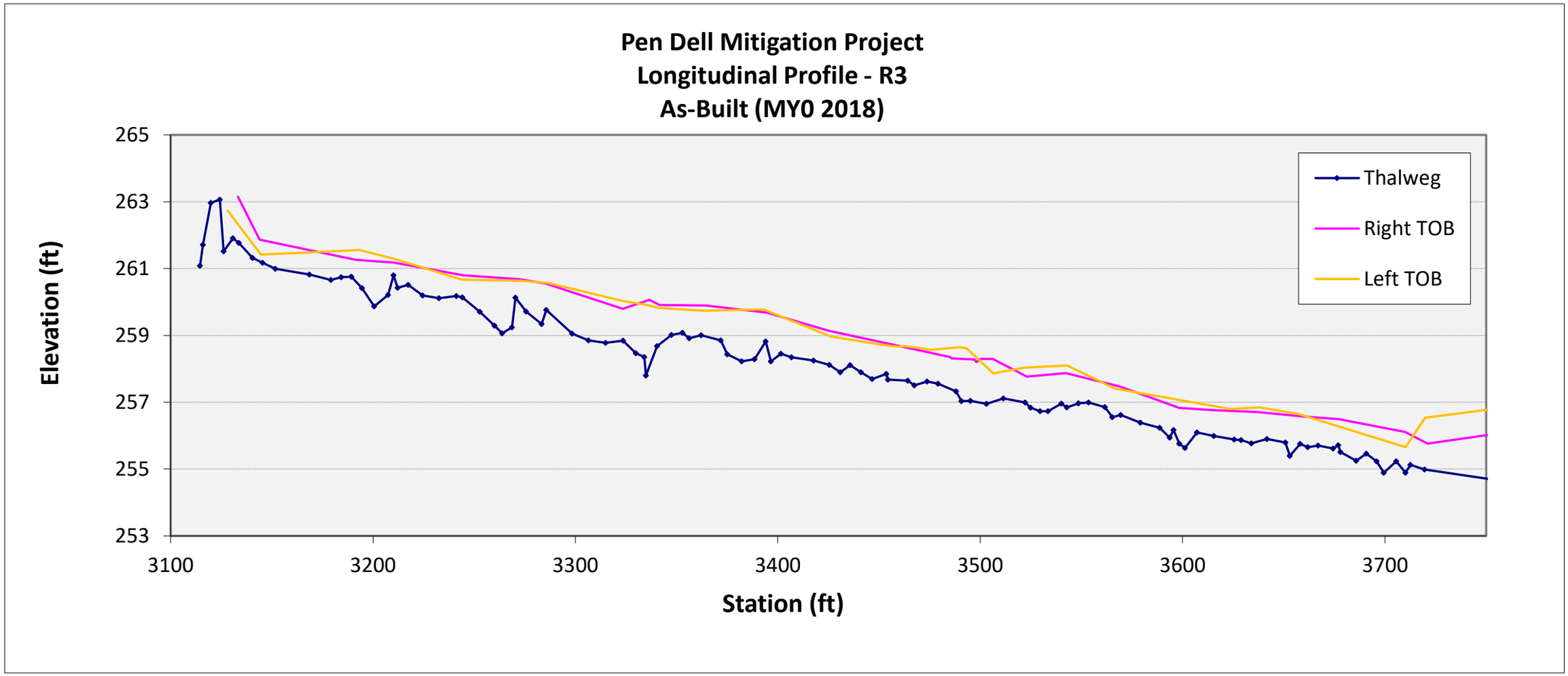
Cross Section X-8

51 + 79 Pen Dell Mitigation Project - As-Built (MY0), Riffle



Bankfull Dimensions		Flood Dimensions		Materials	
5.2	x-section area (ft.sq.)	25.0	W flood prone area (ft)	---	D50 (mm)
8.3	width (ft)	3.0	entrenchment ratio	---	D84 (mm)
0.6	mean depth (ft)	0.9	low bank height (ft)	0	threshold grain size (mm):
0.9	max depth (ft)	1.0	low bank height ratio		
8.6	wetted parimeter (ft)				
0.6	hyd radi (ft)				
13.1	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.4	velocity (ft/s)	0.035	Manning's roughness	0.018	channel slope (%)
2.1	discharge rate (cfs)	0.17	D'Arcy-Weisbach fric.	0.01	shear stress (lb/sq.ft.)
0.09	Froude number	---	resistance factor u/u*	0.06	shear velocity (ft/s)
		---	relative roughness	0.0029	unit strm power (lb/ft/s)


Pen Dell Mitigation Project
Longitudinal Profile - R3
As-Built (MY0 2018)
Elevation (ft)
265
263
261
259
257
255
253
3100
3200
3300
3400
3500
3600
3700
Station (ft)
Thalweg
Right TOB
Left TOB

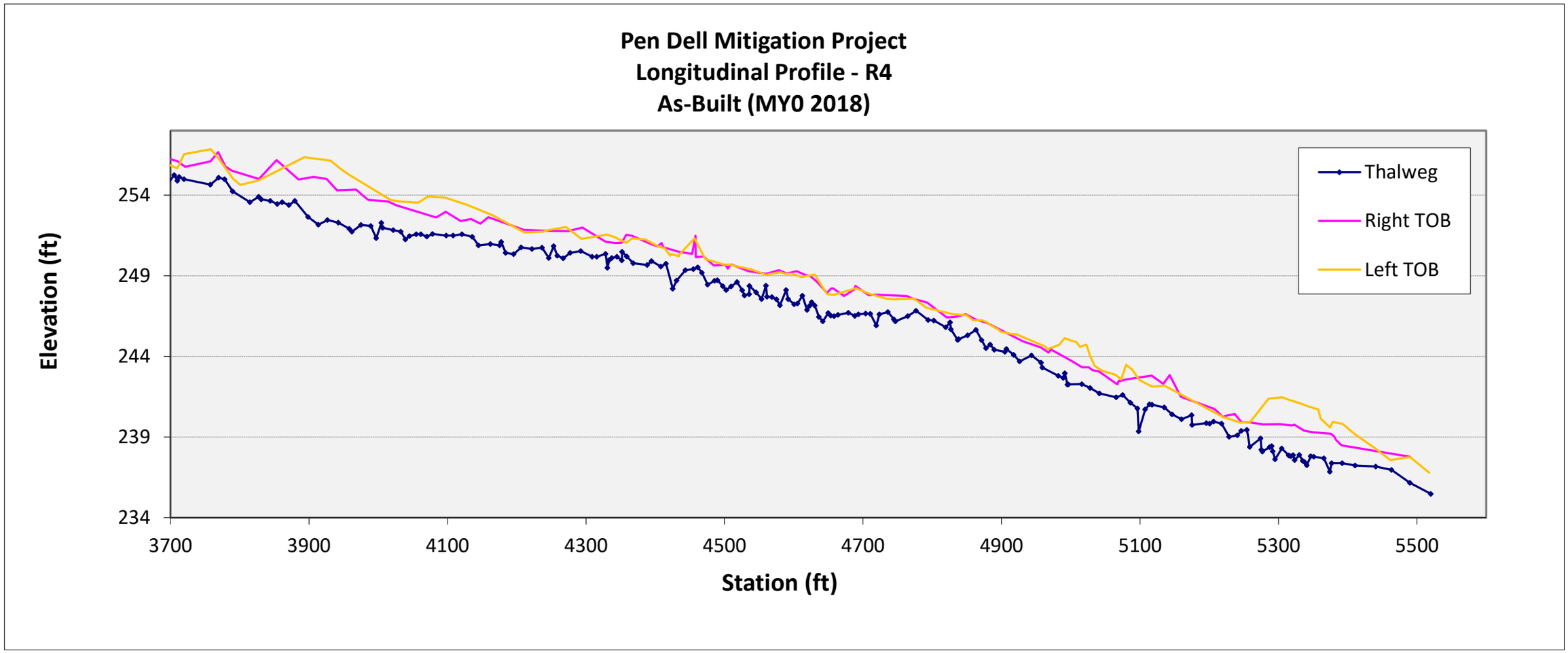

Pen Dell Mitigation Project
Longitudinal Profile - R4
As-Built (MY0 2018)
Elevation (ft)
254
249
244
239
234
3700
3900
4100
4300
4500
4700
4900
5100
5300
5500
Station (ft)
Thalweg
Right TOB
Left TOB

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

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

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

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R4								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	6.0	-	4.5	8.3	7.8		8.6	8.3
Floodprone Width (ft)	35.0	-	10.0	35.0	17.0	45.0	56.0	25.0
Bankfull Mean Depth (ft)	1.3	-	0.8	1.6	0.6		0.5	0.6
Bankfull Max Depth (ft)	1.8	-	0.9	1.3	0.8		0.9	0.9
Bankfull Cross Sectional Area (ft^2)	12.3	-	3.0	5.0	4.7		4.1	5.2
Width/Depth Ratio	4.4	-	6.2	14.2	13.0		18.1	13.1
Entrenchment Ratio	6.1	-	7.1	8.4	2.2	5.8	6.5	3.0
Bank Height Ratio	1.5	-	0.9	1.1	1.0		1.0	1.0
Profile								
Riffle Length (ft)	9.5	21.9	9.5	22.7	12.0	33.0	9.5	21.9
Riffle Slope (ft/ft)	0.013	0.022	0.009	0.015	0.013	0.022	0.013	0.022
Pool Length (ft)	6.1	8.5	6.1	8.7	8.0	10.5	6.1	8.5
Pool Max Depth (ft)	2.0	2.2	1.8	2.4	1.4	2.0	2.0	2.2
Pool Spacing (ft)	18.0	44.0	14.4	22.3	25.0	55.0	18.0	44.0
Pattern								
Channel Beltwidth (ft)	13.0	41.0	23.4	29.0	35.0	50.0	28.0	59.0
Radius of Curvature (ft)	7.9	28.9	11.2	17.5	16.0	25.0	12.0	23.0
Rc:Bankfull Width (ft/ft)	1.3	4.8	1.6	2.5	2.0	3.0	1.9	3.3
Meander Wavelength (ft)	36.0	101.0	43.4	65.1	55.0	80.0	52.0	77.0
Meander Width Ratio	2.2	6.8	3.9	4.5	4.5	6.4	4.7	8.5
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.49		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		32.00		-	
Additional Reach Parameters								
Rosgen Classification	E5/F5		E5/C5		C5		C5	
Bankfull Velocity (fps)	1.9		4.0		4.9		4.9	
Bankfull Discharge (cfs)	23.0		-		23.0		23.0	
Sinuosity	1.14		1.1 - 1.3		1.18		1.18	
Water Surface Slope (Channel) (ft/ft)	0.013		0.015		0.012		0.012	
Bankfull Slope (ft/ft)	0.012		0.015		0.012		0.013	

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

Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)

	Cross Section 1 (Riffle)							Cross Section 2 (Riffle)							Cross Section 3 (Riffle)							Cross Section 4 (Pool)							Cross Section 5 (Pool)						
Parameter	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	11.1							7.8							7.1							9.2							10.2						
Floodprone Width (ft)	49.0							23.0							19.8							29.6							53.0						
Bankfull Mean Depth (ft)	0.6							0.5							0.4							1.0							0.7						
Bankfull Max Depth (ft)	1.2							0.8							0.8							1.7							1.6						
Bankfull Cross Sectional Area (ft^2)	7.0							4.2							3.1							9.2							7.5						
Bankfull Width/Depth Ratio	17.7							14.6							16.3							9.2							13.8						
Bankfull Entrenchment Ratio	4.4							2.9							2.8							3.2							5.2						
Bankfull Bank Height Ratio	1.0							1.0							1.0							1.0							1.0						
d50 (mm)	N/a							N/a							N/a							N/a							N/a						
	Cross Section 6 (Riffle)							**Cross Section 7 (Pool)**							**Cross Section 8 (Riffle)**																						
Parameter	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	8.6							10.0							8.3																					
Floodprone Width (ft)	56.0							38.0							25.0																					
Bankfull Mean Depth (ft)	0.5							1.3							0.6																					
Bankfull Max Depth (ft)	0.9							3.0							0.9																					
Bankfull Cross Sectional Area (ft^2)	4.1							13.4							5.2																					
Bankfull Width/Depth Ratio	18.1							7.5							13.1																					
Bankfull Entrenchment Ratio	6.5							3.8							3.0																					
Bankfull Bank Height Ratio	1.0							1.0							1.0																					
d50 (mm)	N/a							N/a							N/a																					

	Table 7c. Monitoring Data - Stream Reach Summary Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)											
Parameter	**Baseline**		**MY1**		**MY2**		**MY3**		**MY4**		**MY5**	
Reach ID: R1												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	-	-										
Riffle Slope (ft/ft)	-	-										
Pool Length (ft)	-	-										
Pool Max depth (ft)	-	-										
Pool Spacing (ft)	-	-										
Pattern												
Channel Beltwidth (ft)	-	-										
Radius of Curvature (ft)	-	-										
Rc:Bankfull width (ft/ft)	-	-										
Meander Wavelength (ft)	-	-										
Meander Width Ratio	-	-										
Additional Reach Parameters												
Rosgen Classification	C5											
Sinuosity (ft)	1.03											
Water Surface Slope (Channel) (ft/ft)	0.017											
BF slope (ft/ft)	0.017											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

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

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R2												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	-	-										
Riffle Slope (ft/ft)	-	-										
Pool Length (ft)	-	-										
Pool Max depth (ft)	-	-										
Pool Spacing (ft)	-	-										
Pattern												
Channel Beltwidth (ft)	-	-										
Radius of Curvature (ft)	-	-										
Rc:Bankfull width (ft/ft)	-	-										
Meander Wavelength (ft)	-	-										
Meander Width Ratio	-	-										
Additional Reach Parameters												
Rosgen Classification	E5 incised (Pond)											
Sinuosity (ft)	1.07											
Water Surface Slope (Channel) (ft/ft)	0.016											
BF slope (ft/ft)	0.017											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R3												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	12	30										
Riffle Slope (ft/ft)	0.013	0.029										
Pool Length (ft)	7	9.8										
Pool Max depth (ft)	1.1	2										
Pool Spacing (ft)	13	48										
Pattern												
Channel Beltwidth (ft)	25	45										
Radius of Curvature (ft)	15	25										
Rc:Bankfull width (ft/ft)	1.5	3										
Meander Wavelength (ft)	30	44.8										
Meander Width Ratio	3.5	7.1										
Additional Reach Parameters												
Rosgen Classification	C5											
Sinuosity (ft)	1.12											
Water Surface Slope (Channel) (ft/ft)	0.015											
BF slope (ft/ft)	0.015											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R4												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	9.5	21.9										
Riffle Slope (ft/ft)	0.013	0.022										
Pool Length (ft)	6.1	8.5										
Pool Max depth (ft)	2	2.2										
Pool Spacing (ft)	18	44										
Pattern												
Channel Beltwidth (ft)	28	59										
Radius of Curvature (ft)	12	23										
Rc:Bankfull width (ft/ft)	1.9	3.3										
Meander Wavelength (ft)	52	77										
Meander Width Ratio	4.7	8.5										
Additional Reach Parameters												
Rosgen Classification	C5											
Sinuosity (ft)	1.18											
Water Surface Slope (Channel) (ft/ft)	0.012											
BF slope (ft/ft)	0.013											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Appendix E – As-Built Plans / Record Drawings

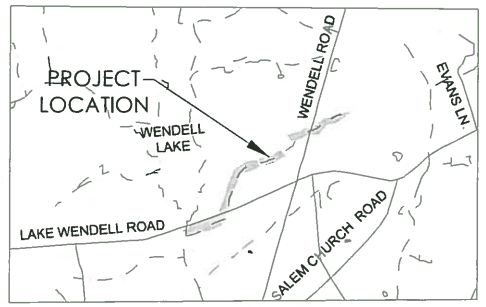
NC DEPARTMENT OF ENVIRONMENTAL QUALITY - DIVISION OF MITIGATION SERVICES

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NORTH CAROLINA

NCDEQ - DMS PROJECT ID # 97079
NCDEQ - DMS CONTRACT #6824 UNDER RFP 16-006477
NEUSE RIVER BASIN (CU 03020201)
USACE ACTION ID # SAW-2016-00885
TYPE OF WORK : AS-BUILT PLANS FOR STREAM AND RIPARIAN BUFFER MITIGATION

VICINITY MAP
N.T.S.



NCDEQ-DMS CONTRACT ADMINISTRATOR:
KRISTIE CORSON
1652 MAIL SERVICE CENTER
RALEIGH, NC 27699-1652
PH: 919-707-8935

SHEET INDEX

1	COVER SHEET
2	LEGEND/CONSTRUCTION SEQUENCE /GENERAL NOTES
3	TYPICAL SECTIONS
4-7	DETAILS
8-15	PLAN AND PROFILE
16-20	REVEGETATION PLAN

PROJECT SUMMARY

Project Reach Designation	Type of Mitigation	Stream Length (LF)	Mitigation Ratio (X:1)	Proposed Stream Mitigation Credits (SMCs)
R1	Stream Enhancement Level II	1,017	2.5	407
R2	Stream Enhancement Level I	546	1.5	351
R3	Stream Enhancement Level I	617	1.5	411
R4	Stream Restoration (PI)	1,779	1	1,779
R5	Stream Preservation	1,176	10	118
Total		**5,135**		**3,066**

Project Component	Type of Mitigation	Buffer Area (SF)	Mitigation Ratio (X:1)	Proposed Buffer Mitigation Credits (BMCs)
Buffer Group 1	Riparian Buffer Restoration	286,888	1	286,888
Buffer Group 2	Riparian Buffer Enhancement	124,088	2	62,044
Buffer Group 3	Riparian Buffer Preservation	222,827	10	22,283
Total		**633,803**		**371,215**

Note 1: No mitigation credits were calculated outside the conservation easement boundaries.

CERTIFICATE OF AS-BUILT SURVEY AND ACCURACY

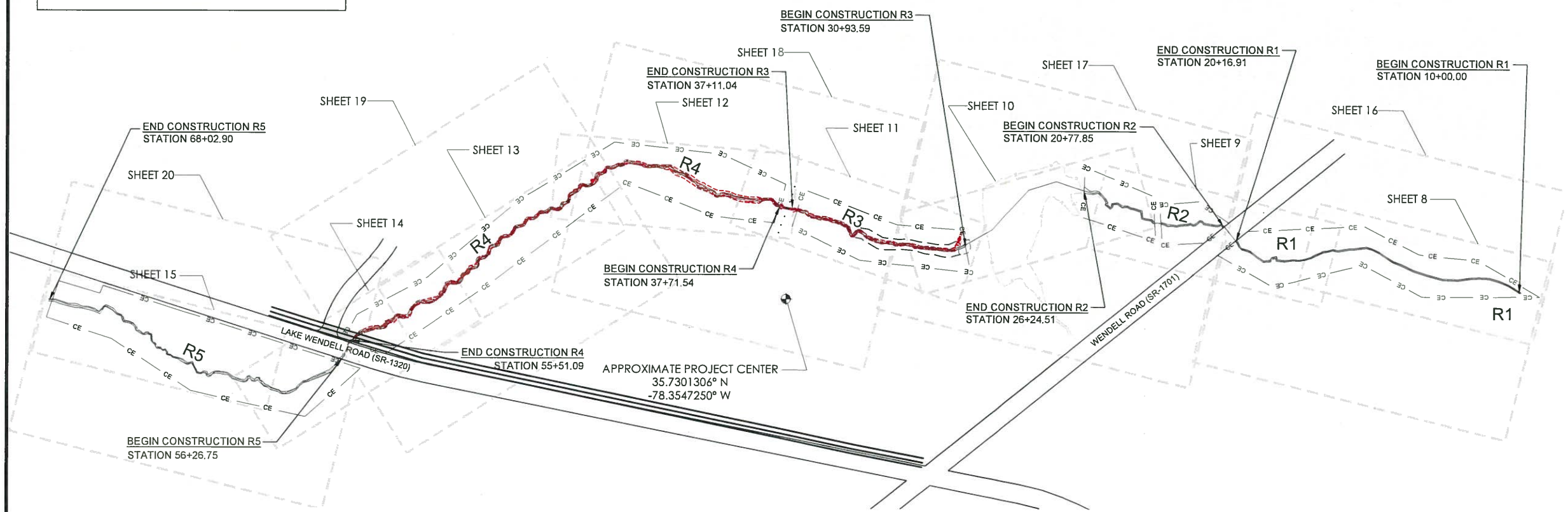
I, CURK T. LANE, CERTIFY THAT THE AS-BUILT GROUND TOPOGRAPHIC SURVEY INFORMATION DEPICTED ON THESE PLANS WAS PROVIDED FROM AN ACTUAL SURVEY MADE UNDER MY DIRECT SUPERVISION; THAT THESE AS-BUILT PLANS/RECORD DRAWINGS WERE PREPARED BY WLS ENGINEERING, PLLC, FOR WATER & LAND SOLUTIONS, LLC, AND WERE CREATED FROM THE AS-BUILT SURVEY DIGITAL FILES PROVIDED BY TRUE LINE SURVEYING, P.C.; THAT THE REFERENCED SURVEY WAS PERFORMED AT THE 95% CONFIDENCE LEVEL TO MEET THE FEDERAL GEOGRAPHIC DATA COMMITTEE STANDARDS; THAT THE REFERENCED SURVEY WAS PERFORMED TO MEET THE REQUIREMENTS FOR A TOPOGRAPHIC SURVEY TO THE ACCURACY OF CLASS A HORIZONTAL AND CLASS C VERTICAL, WHERE APPLICABLE; THAT THE CONTOURS SHOWN AS BROKEN LINES MAY NOT MEET THE STATED STANDARD AND ALL COORDINATES ARE BASED ON NAD 83 (NSRS 2011) AND ALL ELEVATIONS ARE BASED ON NAVD 88; THAT THE AS-BUILT GROUND TOPOGRAPHIC MAPPING MEETS THE SPECIFICATIONS FOR TOPOGRAPHIC SURVEYS AS STATED IN TITLE 21, CHAPTER 56, SECTION 1606; THAT THE AS-BUILT GROUND TOPOGRAPHIC MAPPING WAS NOT PREPARED IN ACCORDANCE WITH G.S. 47-30, AS AMENDED, AND DOES NOT REPRESENT AN OFFICIAL BOUNDARY SURVEY.

WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS THE 29th DAY OF NOVEMBER, 2018

OFFICIAL SEAL

NORTH CAROLINA PROFESSIONAL SEAL L-3990 LAND SURVEYOR CURK T. LANE

CURK T. LANE, PLS L-3990



WATER & LAND SOLUTIONS
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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III 03.01.19

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17
D	ISSUED FOR CONSTRUCTION	1-29-18
E	AS-BUILT	11-30-18

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO. :	97079
FILENAME :	01_PEN DELL_COVER.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 400'
VERT. SCALE :	N/A

NORTH

200 100 0 200 400
GRAPHIC SCALE

SHEET NAME

COVER SHEET

SHEET NUMBER

1

LEGEND

ROOTWAD

LOG VANE

LOG WEIR

LOG STEP-POOL

STONE AND LOG STEP-POOL

CONSTRUCTED STONE RIFFLE

CONSTRUCTED LOG RIFFLE

GRADE CONTROL LOG J-HOOK VANE

GEOLIFT W/ TOEWOOD

PROPOSED OUTLET CHANNEL

FP ——— FP — 100 YEAR FLOOD PLAIN

——— OHPL ——— EXISTING OVERHEAD ELECTRIC

TEMPORARY STREAM CROSSING

PERMANENT STREAM CROSSING

CE ——— CE — PROPOSED CONSERVATION EASEMENT BOUNDARY

EXISTING MAJOR CONTOUR

EXISTING MINOR CONTOUR

100 PROPOSED MAJOR CONTOUR

101 PROPOSED MINOR CONTOUR

LD ——— LD — LIMITS OF DISTURBANCE

C/F ——— C/F — CUT/FILL LIMITS

WLB ——— WLB — EXISTING WETLAND BOUNDARY

EXISTING WOODLINE

PROPOSED TOP OF STREAM BANK

EXISTING PROPERTY BOUNDARY

EXISTING FENCE

15+00 PROPOSED CENTERLINE (THALWEG)

X ——— X — PROPOSED FIELD FENCE

TP ——— TP — PROPOSED TREE PROTECTION FENCE

EXISTING FARM PATH

PROPOSED FARM PATH

EXISTING TREE

PROPOSED WATER QUALITY TREATMENT FEATURE

CHANNEL BLOCK

CHANNEL FILL

X PROPOSED GATE

EXISTING STRUCTURE

EXISTING WETLAND AREA

CONSTRUCTION SEQUENCE

THE ENGINEER WILL PROVIDE CONSTRUCTION OBSERVATION DURING THE CONSTRUCTION PHASE OF THIS PROJECT. THE GENERAL CONSTRUCTION SEQUENCE SHALL BE USED DURING IMPLEMENTATION OF THE PROPOSED PROJECT CONSTRUCTION. CONTRACTOR SHALL REFER TO THE APPROVED PERMITS FOR SPECIFIC CONSTRUCTION SEQUENCE ITEMS AND SHALL BE RESPONSIBLE FOR FOLLOWING THE APPROVED PLANS AND PERMIT CONDITIONS.

1. THE CONTRACTOR SHALL NOTIFY "NC 811" (1-800-632-4949) BEFORE ANY EXCAVATION BEGINS. ANY UTILITIES AND RESPECTIVE EASEMENTS SHOWN ON THE PLANS ARE CONSIDERED APPROXIMATE AND THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY DISCREPANCIES. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES AND ADJOINING EASEMENTS AND SHALL REPAIR OR REPLACE ANY DAMAGED UTILITIES AT HIS/HER OWN EXPENSE.
2. THE CONTRACTOR SHALL MOBILIZE EQUIPMENT, MATERIALS AND PREPARE STAGING AREA(S) AND STOCKPILE AREA(S) AND HAUL ROADS AS SHOWN ON THE PLANS.
3. CONSTRUCTION TRAFFIC SHALL BE RESTRICTED TO THE PROJECT AREA BOUNDARIES OR AS DENOTED "LIMITS OF DISTURBANCE" OR "HAUL ROADS" ON THE PLANS.
4. THE CONTRACTOR SHALL INSTALL APPROVED TEMPORARY SEDIMENTATION AND EROSION CONTROL MEASURES AT LOCATIONS INDICATED ON THE PLANS.
5. THE CONTRACTOR SHALL INSTALL TEMPORARY SILT FENCE AROUND ALL STAGING AREA(S). TEMPORARY SILT FENCING WILL ALSO BE PLACED AROUND THE TEMPORARY STOCKPILE AREAS AS MATERIAL IS STOCKPILED THROUGHOUT THE CONSTRUCTION PERIOD.
6. THE CONTRACTOR SHALL INSTALL ALL TEMPORARY AND PERMANENT STREAM CROSSINGS AS SHOWN ON THE PLANS IN ACCORDANCE WITH THE SEDIMENTATION AND EROSION CONTROL PERMIT. THE EXISTING CHANNEL AND DITCHES ON SITE WILL REMAIN OPEN DURING THE INITIAL STAGES OF CONSTRUCTION TO ALLOW FOR DRAINAGE AND TO MAINTAIN SITE ACCESSIBILITY.
7. THE CONTRACTOR SHALL CONSTRUCT ONLY THE PORTION OF THE PROPOSED CHANNEL THAT CAN BE COMPLETED AND STABILIZED WITHIN THE SAME DAY. THE CONTRACTOR SHALL APPLY TEMPORARY AND PERMANENT SEEDING, MATTING AND MULCHING TO ALL DISTURBED AREAS AT THE END OF EACH WORK DAY.
8. THE CONTRACTOR SHALL CLEAR AND GRUB AN AREA ADEQUATE TO CONSTRUCT THE STREAM CHANNEL AND GRADING OPERATIONS AFTER ALL SEDIMENTATION AND EROSION CONTROL PRACTICES HAVE BEEN INSTALLED AND APPROVED. IN GENERAL, THE CONTRACTOR SHALL WORK FROM UPSTREAM TO DOWNSTREAM AND IN-STREAM STRUCTURES AND CHANNEL FILL MATERIAL SHALL BE INSTALLED USING A PUMP-AROUND OR FLOW DIVERSION MEASURE AS SHOWN ON THE PLANS.
9. THE CONTRACTOR WILL BEGIN CONSTRUCTION BY EXCAVATING CHANNEL FILL MATERIAL IN AREAS ALONG THE EXISTING CHANNEL. THE CONTRACTOR MAY FILL DITCHES WHICH DO NOT CONTAIN ANY WATER DURING THE GRADING OPERATIONS. ALONG DITCHES WITH WATER OR STREAM REACHES, EXCAVATED MATERIAL SHOULD BE STOCKPILED IN DESIGNATED AREAS SHOWN ON THE PLANS. IN ANY AREAS WHERE EXCAVATION DEPTHS WILL EXCEED TEN INCHES, TOPSOIL SHALL BE SEPARATED, STOCKPILED AND PLACED BACK OVER THESE AREAS TO A DEPTH OF EIGHT INCHES TO ACHIEVE DESIGN GRADES AND CREATE A SOIL BASE FOR VEGETATION PLANTING ACCORDING TO THE DESIGN PLANS AND CONSTRUCTION SPECIFICATIONS.
10. CONTRACTOR SHALL BEGIN DESIGN CHANNEL CONSTRUCTION AT STATION 10+00 AND PROCEED IN A DOWNSTREAM DIRECTION. THE DESIGN CHANNEL SHOULD BE CONSTRUCTED OFFLINE AND/OR IN THE DRY WHENEVER POSSIBLE.
11. AFTER EXCAVATING THE CHANNEL TO DESIGN GRADES, INSTALL IN-STREAM STRUCTURES, GRASSING, MATTING, AND TEMPORARY VEGETATION IN THIS SECTION, AND READY THE CHANNEL TO ACCEPT FLOW PER APPROVAL BY THE ENGINEER.
12. FLOWING WATER MAY BE TURNED INTO THE CONSTRUCTED CHANNEL ONCE THE AREA IN AND AROUND THE NEW CHANNEL HAS BEEN STABILIZED. IMMEDIATELY BEGIN PLUGGING, FILLING, AND GRADING THE ABANDONED CHANNEL, AS INDICATED ON PLANS, MOVING IN A DOWNSTREAM DIRECTION TO ALLOW FOR DRAINAGE OF THE OLD CHANNELS. NO FLOWING WATER SHALL BE TURNED INTO ANY SECTION OF RESTORED CHANNEL PRIOR TO THE CHANNEL BEING COMPLETELY STABILIZED WITH ALL IN-STREAM STRUCTURES INSTALLED.
13. THE NEW CHANNEL SECTIONS AND FARM POND AREA SHALL REMAIN OPEN ON THE DOWNSTREAM END TO ALLOW FOR DRAINAGE DURING RAIN EVENTS.
14. ANY GRADING ACTIVITIES ADJACENT TO THE EXISTING OR LIVE STREAM CHANNEL SHALL BE COMPLETED PRIOR TO TURNING WATER INTO THE NEW STREAM CHANNEL SEGMENTS. GRADING ACTIVITIES SHALL NOT BE PERFORMED WITHIN 10 FEET OF THE NEW STREAM CHANNEL BANKS. THE CONTRACTOR SHALL NOT GRADE OR ROUGHEN ANY AREAS WHERE EXCAVATION ACTIVITIES HAVE NOT BEEN COMPLETED.
15. ONCE A STREAM WORK PHASE IS COMPLETE, APPLY TEMPORARY SEEDING TO ANY AREAS DISTURBED DURING CONSTRUCTION WITHIN HOURS AND ALL SLOPES STEEPER THAN 3:1 SHALL BE STABILIZED WITH GROUND COVER AS SOON AS PRACTICABLE WITHIN 7 CALENDAR DAYS. ALL OTHER DISTURBED AREAS AND SLOPES FLATTER THAN 3:1 SHALL BE STABILIZED WITHIN 14 CALENDAR DAYS FRO THE LAST LAND-DISTURBING ACTIVITY.
16. PERMANENT SEEDING SHALL BE PLACED ON ALL DISTURBED AREAS WITHIN 15 WORKING DAYS OR 90 CALENDAR DAYS (WHICHEVER IS SHORTER) FOLLOWING COMPLETION OF CONSTRUCTION. ALL DISTURBED AREAS SHOULD HAVE ESTABLISHED GROUND COVER PRIOR TO DEMOBILIZATION. REMOVE ANY TEMPORARY STREAM CROSSINGS AND TEMPORARY EROSION CONTROL MEASURES.
17. THE CONTRACTOR SHALL TREAT AREAS OF INVASIVE SPECIES VEGETATION THROUGHOUT THE PROJECT AREA ACCORDING TO THE DESIGN PLANS AND CONSTRUCTION SPECIFICATIONS PRIOR TO DEMOBILIZATION.
18. THE CONTRACTOR SHALL PLANT WOODY VEGETATION AND LIVE STAKES, ACCORDING TO PLANTING DETAILS AND SPECIFICATIONS. THE CONTRACTOR SHALL COMPLETE THE REFORESTATION PHASE OF THE PROJECT AND APPLY PERMANENT SEEDING AT THE APPROPRIATE TIME OF THE YEAR.
19. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OFF-SITE REMOVAL OF ALL TRASH, EXCESS BACKFILL, AND ANY OTHER INCIDENTAL MATERIALS PRIOR TO DEMOBILIZATION OF EQUIPMENT FROM THE SITE. THE DISPOSAL AND STOCKPILE LOCATIONS SELECTED MUST BE APPROVED TO THE ENGINEER AND ANY FEES SHALL BE PAID FOR BY THE CONTRACTOR.

GENERAL NOTES

1. THE PROJECT SITE IS LOCATED IN JOHNSTON COUNTY, NORTH CAROLINA, APPROXIMATELY 3.1 MILES SOUTH OF THE TOWN OF WENDELL AS SHOWN ON THE COVER SHEET VICINITY MAP. TO ACCESS THE SITE FROM RALEIGH, TAKE I-440 E AND US-264 E/US-64 E TO MARKS CREEK. TAKE EXIT 427 FROM US-264 E/US-64 E (14.7 MI) AND CONTINUE ON WENDELL FALLS PARKWAY. TAKE EAGLE ROCK ROAD AND STOTTS MILL ROAD TO WENDELL ROAD. TAKE A RIGHT ONTO THE GRAVEL ENTRANCE AT 2499 WENDELL ROAD. FOLLOW THE FARM ROAD TO THE SITE BOUNDARY.
2. THE PROJECT SITE BOUNDARIES ARE SHOWN ON THE DESIGN PLANS AS THE PROPOSED CONSERVATION EASEMENT. THE CONTRACTOR SHALL PERFORM ALL RELATED WORK ACTIVITIES WITHIN THE PROJECT SITE BOUNDARIES AND/OR WITHIN THE LIMITS OF DISTURBANCE (LOD). THE PROJECT SITE SHALL BE ACCESSED THROUGH THE DESIGNATED ACCESS POINTS SHOWN ON THE PLANS. THE CONTRACTOR IS RESPONSIBLE FOR MAINTAINING PERMITTED ACCESS THROUGHOUT ALL CONSTRUCTION ACTIVITIES.
3. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS AND MEASURES TO PROTECT ALL PROPERTIES FROM DAMAGE. THE CONTRACTOR SHALL REPAIR ALL DAMAGE CAUSED BY HIS/HER OPERATIONS TO ALL PUBLIC AND PRIVATE PROPERTY AND LEAVE THE PROPERTY IN GOOD CONDITION AND/OR AT LEAST EQUIVALENT TO THE PRE-CONSTRUCTION CONDITIONS. UPON COMPLETION OF ALL CONSTRUCTION ACTIVITIES, THE AREA IS TO BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND PRIOR TO CONSTRUCTION.
4. THE TOPOGRAPHIC BASE MAP WAS DEVELOPED USING SURVEY DATA COLLECTED BY WITHERSRAVENEL, INC. (WR) IN THE FALL OF 2016. THE HORIZONTAL DATUM WAS TIED TO NAD83 NC STATE PLANE COORDINATE SYSTEM, US SURVEY FEET AND NAVD88 VERTICAL DATUM USING VRS NETWORK AND NCGS MONUMENT. IT IS POSSIBLE THAT EXISTING ELEVATIONS AND SITE CONDTIONS MAY HAVE CHANGED SINCE THE ORIGINAL SURVEY WAS COMPLETED DUE TO EROSION, AND/OR SEDIMENT ACCRETION. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONFIRM EXISTING GRADES AND ADJUST QUANTITIES, EARTHWORK, AND WORK EFFORTS AS NECESSARY.
5. THE CONTRACTOR SHALL VISIT THE CONSTRUCTION SITE AND THOROUGHLY FAMILIARIZE HIM/HERSELF WITH ALL EXISTING CONDITIONS. PRIOR TO BEGINNING CONSTRUCTION. THE CONTRACTOR SHALL VERIFY THE ACCURACY AND COMPLETENESS OF THE CONSTRUCTION SPECIFICATIONS AND DESIGN PLANS REGARDING THE NATURE AND EXTENT OF THE WORK DESCRIBED.
6. THE CONTRACTOR SHALL BRING ANY DISCREPANCIES BETWEEN THE CONSTRUCTION PLANS AND SPECIFICATIONS AND/OR FIELD CONDITIONS TO THE ATTENTION OF THE SPONSORS ENGINEER BEFORE CONSTRUCTION BEGINS.
7. THERE SHALL BE NO CLEARING OR REMOVAL OF ANY NATIVE SPECIES VEGETATION OR TREES OF SIGNIFICANCE, OTHER THAN THOSE INDICATED ON THE PLANS OR AS DIRECTED BY THE ENGINEER.
8. THE CONTRACTOR SHALL EXERCISE CARE DURING GRADING ACTIVITIES IN THE VICINITY OF NATIVE VEGETATION AND TREES OF SIGNIFICANCE AT THE CONSTRUCTION SITE. ALL GRADING IN THE VICINITY OF TREES NOT IDENTIFIED FOR REMOVAL SHALL BE MADE IN A MANNER THAT DOES NOT DISTURB THE ROOT SYSTEM WITHIN THE DRIP LINE OF THE TREE.
9. WORK ACTIVITIES ARE BEING PERFORMED AS AN ENVIRONMENTAL RESTORATION PLAN NEAR PRIVATE RESIDENCES. THE CONTRACTOR SHALL MAKE ALL REASONABLE EFFORTS TO REDUCE SEDIMENT LOSS, PROTECT PUBLIC SAFETY, AND MINIMIZE DISTURBANCE OF THE SITE WHILE PERFORMING THE CONSTRUCTION WORK. ALL AREAS SHALL BE KEPT NEAT, CLEAN, AND FREE OF ALL TRASH AND DEBRIS, AND ALL REASONABLE PRECAUTIONS SHALL BE TAKEN TO AVOID DAMAGE TO EXISTING ROADS, VEGETATION, TURF, STRUCTURES, AND PRIVATE PROPERTY.
10. PRIOR TO START OF WORK, THE CONTRACTOR SHALL SUBMIT THE SOURCE OF MATERIALS, INCLUDING AGGREGATES, EROSION CONTROL MATTING, WOOD AND NATIVE PLANTING MATERIAL TO THE ENGINEER FOR REVIEW AND APPROVAL. NO WORK SHALL BE PERFORMED UNTIL THE SOURCE OF MATERIAL IS APPROVED BY THE ENGINEER.
11. THE CONTRACTOR SHALL BE HELD SOLELY RESPONSIBLE FOR ANY NECESSARY COORDINATION BETWEEN THE VARIOUS COUNTY, STATE OR FEDERAL AGENCIES, UTILITY COMPANIES, HIS/HER SUB-CONTRACTORS, AND THE ENGINEER FOR THE DURATION OF THE PROJECT.
12. PRIOR TO START OF WORK, THE CONTRACTOR SHALL SUBMIT THEIR DETAILED PLANTING SCHEDULE TO THE ENGINEER FOR REVIEW. NO WORK SHALL BE PERFORMED UNTIL THIS SCHEDULE IS APPROVED BY THE ENGINEER. THE DETAILED PLANTING SCHEDULE SHALL CONFORM TO THE PLANTING REVEGETATION PLAN AND SHALL INCLUDE A SPECIES LIST AND TIMING SEQUENCE.
13. THE CONTRACTOR IS REQUIRED TO INSTALL IN-STREAM STRUCTURES AND CULVERT PIPES USING A BACKHOE/EXCAVATOR WITH A HYDRAULIC THUMB OF SUFFICIENT SIZE TO PLACE STRUCTURES INCLUDING LOGS, STONE, BOULDERS, ROOT WADS, AND TEMPORARY WOOD MAT STREAM CROSSINGS.

GRADING NOTES

1. NO GRADING ACTIVITIES SHALL OCCUR BEYOND THE PROJECT LIMITS OF DISTURBANCE (LOD) AS SHOWN ON THE DESIGN PLANS.
2. ONCE PROPOSED GRADES ARE ACHIEVED ALONG THE CONSTRUCTED STREAM CHANNEL, BANKFULL BENCHES AND FLOODPLAIN AREAS AS SHOWN ON THE PLANS, GRADED AREAS SHALL BE ROUGHENED USING TECHNIQUES DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS.
3. ALL SUITABLE SOIL MATERIAL REQUIRED TO FILL AND/OR PLUG EXISTING DITCHES AND/OR STREAM CHANNEL SHALL BE GENERATED ON-SITE AS DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS. ANY EXCESS SPOIL MATERIAL SHALL BE STOCKPILED IN DESIGNATED AREAS AND OR HAULED OFF-SITE AS APPROVED BY THE ENGINEER.

WATER & LAND SOLUTIONS
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(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17
D	ISSUED FOR CONSTRUCTION	1-29-18
E	AS-BUILT	11-30-18

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

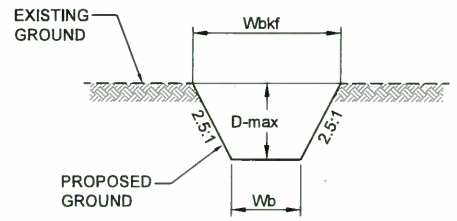
PROJECT NO. :	97079
FILENAME :	02_PEN DELL_GENERAL NOTES - SYMBOL_SHEET.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N/A

SHEET NAME

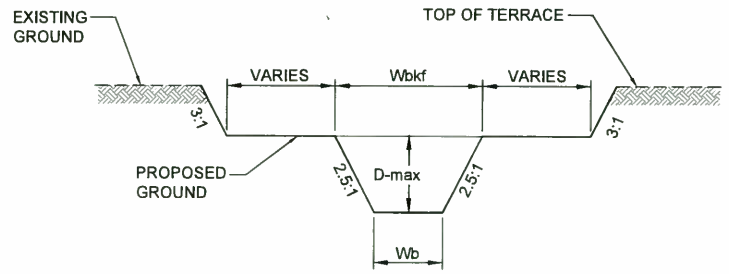
LEGEND/ CONSTRUCTION SEQUENCE/ GENERAL NOTES

SHEET NUMBER

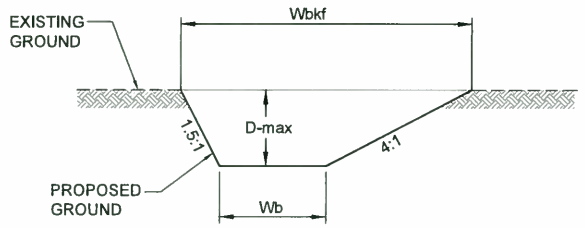
2



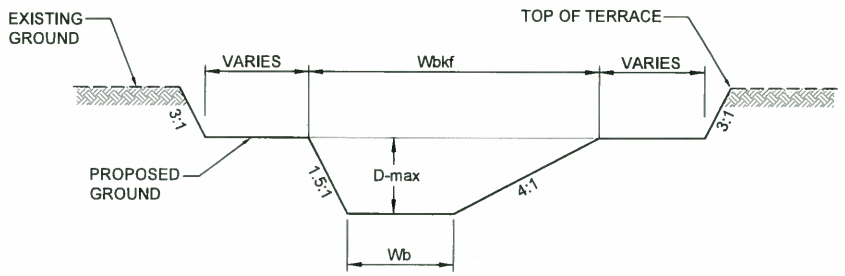
RIFFLE
N.T.S



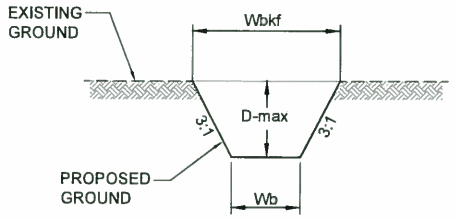
RIFFLE WITH BANKFULL BENCH
N.T.S



POOL
N.T.S



POOL WITH BANKFULL BENCH
N.T.S



OUTLET CHANNEL
N.T.S

Reach Name	R1		R2		R3		R4		R5		
Feature	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Outlet Channel
Width of Bankfull, Wbkf (ft)	5.7	7.1	6.8	8.3	7.4	9.4	7.8	10.1	7.5	10.7	3.0 (Min.)
Average Depth, Dbkf (ft)	0.5	0.7	0.6	0.7	0.6	0.8	0.6	0.9	0.8	1.0	N/A
Maximum Depth, D-Max (ft)	0.7	1.1	0.7	1.1	0.8	1.2	0.8	1.5	1.0	1.5	0.5
Width to Depth Ratio, bkf W/D	12.0	10.5	12.0	11.9	13.0	12.1	13.0	11.4	10.0	11.0	N/A
Bankfull Area, Abkf (sq ft)	2.7	4.8	3.9	5.8	4.2	7.3	4.7	9.0	5.7	10.4	N/A
Bottom Width, Wb (ft)	2.3	1.6	3.9	2.3	3.5	2.8	3.8	1.9	3.4	3.2	N/A

WATER & LAND SOLUTIONS
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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
01.01.19

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17
D	ISSUED FOR CONSTRUCTION	1-29-18
E	AS-BUILT	11-30-18

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

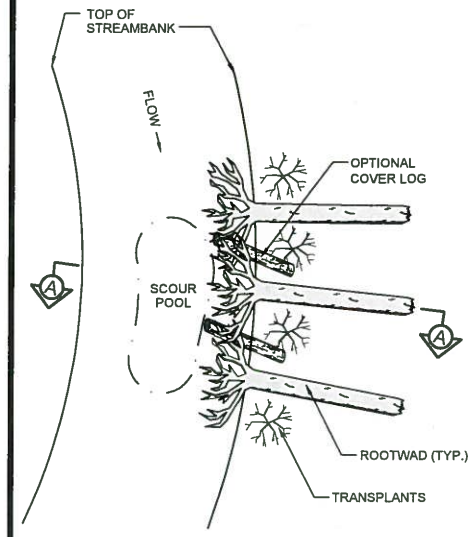
PROJECT NO. :	97079
FILENAME :	03_PEN DELL_TYPICAL_SECTIONS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

SHEET NAME

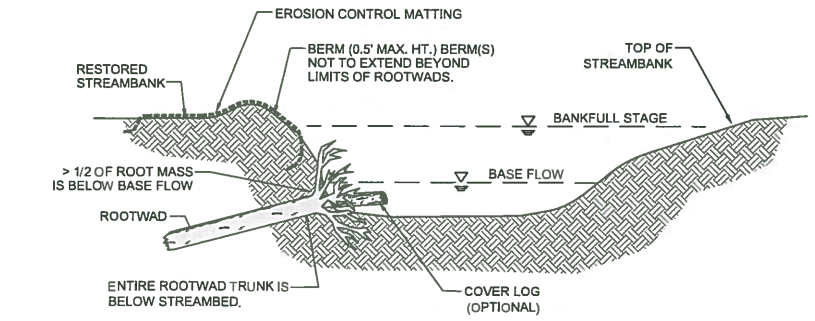
TYPICAL SECTIONS

SHEET NUMBER

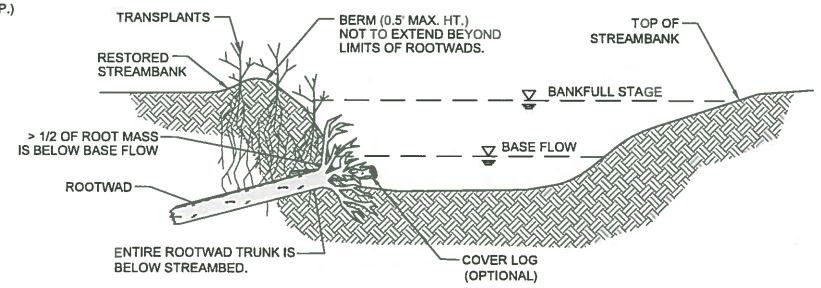
3



PLAN VIEW



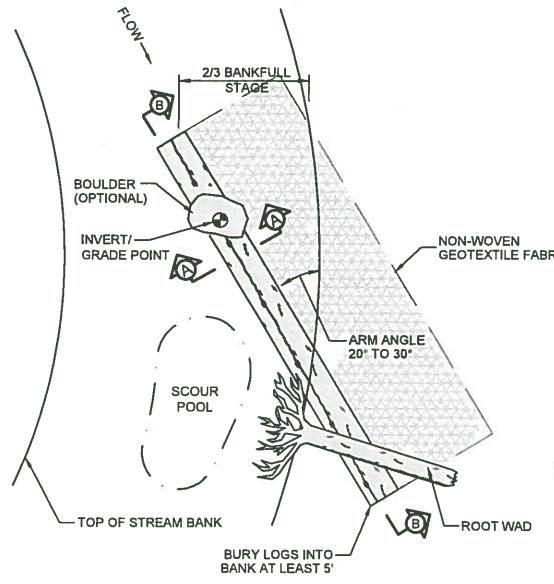
SECTION A-A
ROOTWADS WITHOUT TRANSPLANTS



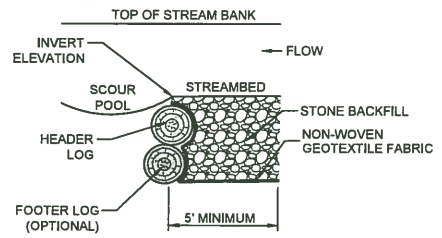
SECTION A-A
ROOTWADS WITH TRANSPLANTS

NOTES:
1. THE TRENCHING METHOD REQUIRES THAT A TRENCH BE EXCAVATED FOR THE LOG PORTION OF THE ROOTWAD. A COVER LOG SHOULD BE INSTALLED UNDERNEATH THE ROOTWAD IN A TRENCH EXCAVATED PERPENDICULAR TO THE BANK AND BELOW THE RESTORED STREAMBED. ONE-THIRD OF THE ROOTWAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS.

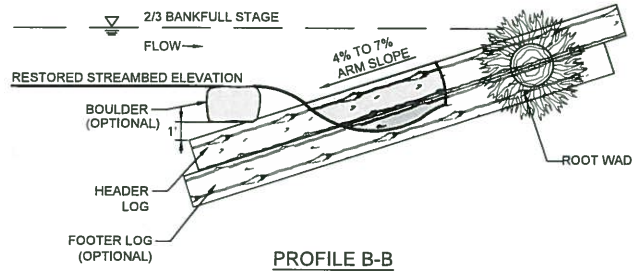
ROOTWADS
NOT TO SCALE



PLAN VIEW



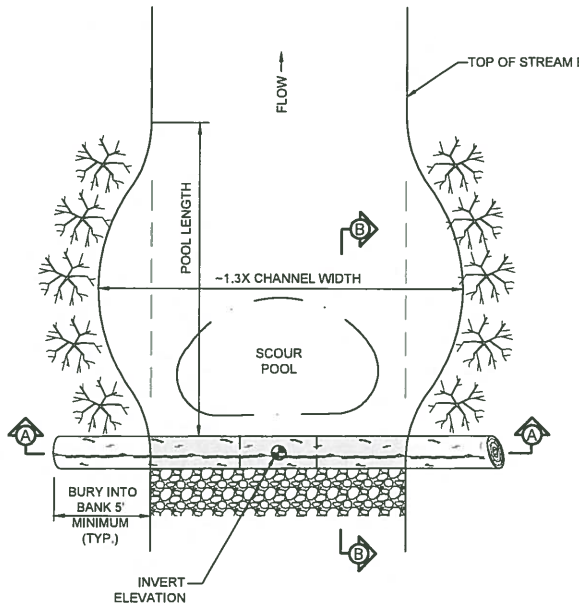
SECTION A-A



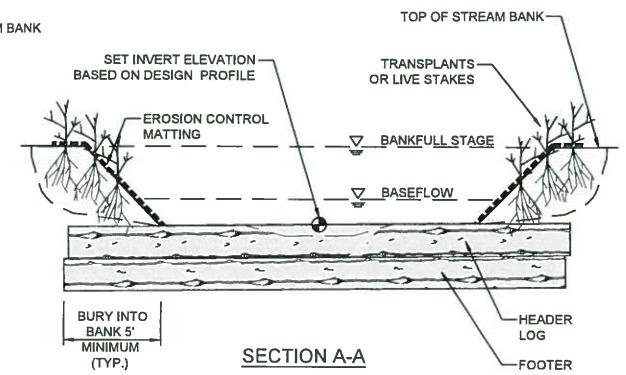
PROFILE B-B

NOTES:
1. LOGS SHOULD BE AT LEAST 10" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOGS.
3. ROOTWADS SHOULD BE PLACED BENEATH THE HEADER LOG AND PLACED SO THAT IT LOCKS THE HEADER LOG INTO THE BANK. SEE ROOTWAD DETAIL.
4. BOULDERS OF SUFFICIENT SIZE CAN PLACED ON TOP OF HEADER LOG FOR ANCHORING, PER DIRECTION OF ENGINEER.
5. LOGS SHOULD BE BURIED INTO THE STREAM BED AND BANKS AT LEAST 5 FEET.
6. GEOTEXTILE FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.
7. TRANSPLANTS CAN BE USED INSTEAD OF ROOTWADS, PER DIRECTION OF ENGINEER.

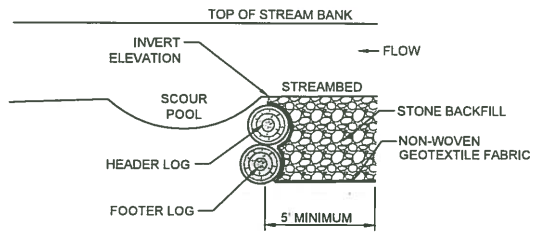
LOG VANE
NOT TO SCALE



PLAN VIEW



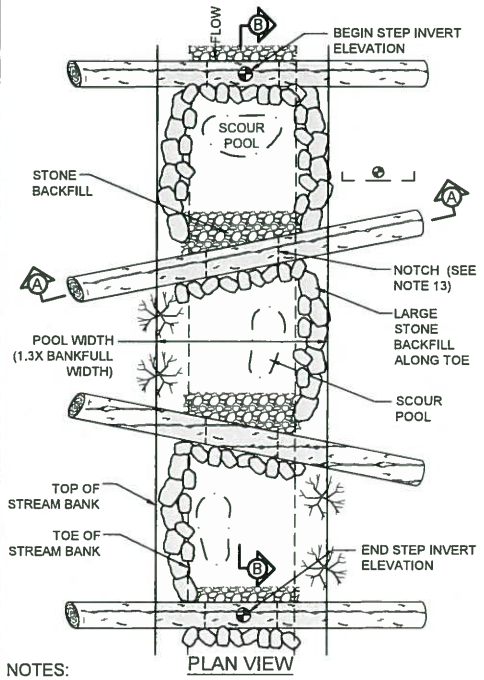
SECTION A-A



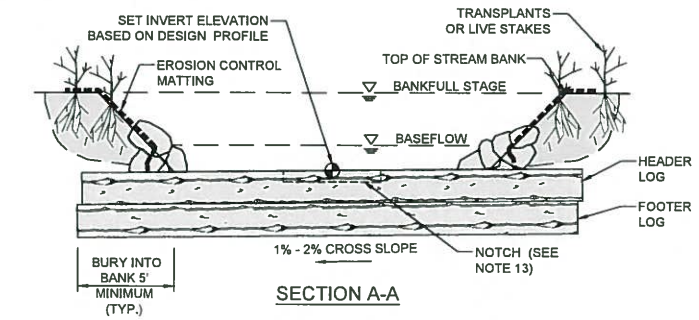
PROFILE B-B

NOTES:
1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT HARDWOOD AND RECENTLY HARVESTED.
2. LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG, AT THE DIRECTION OF THE ENGINEER.
3. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
4. CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL BE USED TO CENTER FLOW AND NOT EXCEED 3 INCHES IN DEPTH.
5. USE GEOTEXTILE FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
6. INSTALL VEGETATION TRANSPLANTS FROM TOE OF STREAM BANK TO TOP OF STREAM BANK.
7. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

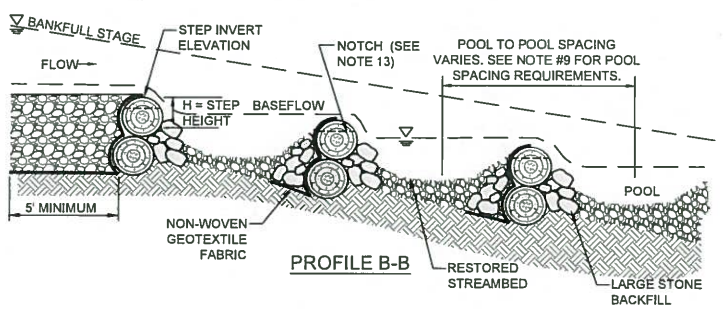
LOG WEIR
NOT TO SCALE



PLAN VIEW



SECTION A-A



PROFILE B-B

NOTES:
1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT HARDWOOD AND RECENTLY HARVESTED.
2. SOIL SHALL BE WELL COMPACTED AROUND PORTION OF FOOTER LOGS WITH BUCKET OF TRACK HOE.
3. INSTALL GEOTEXTILE FILTER FABRIC UNDERNEATH LOGS.
4. UNDERCUT POOL BED ELEVATION 8 INCHES TO ALLOW FOR LAYER OF STONE. INSTALL LARGE STONE BACKFILL ALONG SIDE SLOPES.
5. INSTALL EROSION CONTROL MATTING ALONG COMPLETED BANKS SUCH THAT THE EROSION CONTROL MATTING AT THE TOE OF THE BANK EXTENDS DOWN TO THE UNDERCUT ELEVATION.
6. INSTALL LARGE STONE BACKFILL ALONG SIDE SLOPES.
7. FINAL CHANNEL BED SHAPE SHOULD BE ROUNDED, COMPACTED, AND CONCAVE, WITH THE ELEVATION OF THE BED APPROXIMATELY 0.5 FT DEEPER IN THE CENTER THAN AT THE EDGES.
8. AVERAGE POOL TO POOL SPACING SHALL BE SHOWN ON THE PROFILE OR SPECIFIED BY ENGINEER BASED ON EXISTING CONDITIONS SUCH AS SLOPE AND SUITABLE FILL MATERIAL. RIFFLE STEP-POOLS OR CASCADE POOLS MAY BE SUBSTITUTED IN AREAS WHERE EXISTING SLOPES EXCEED 10% AS DETERMINED BY THE ENGINEER.
9. INTERIOR LOGS SHOULD BE AT A SLIGHT ANGLE (~70 DEGREES) FROM THE STREAMBANK AND CROSS SLOPES SHOULD BE 1-2%.
10. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
11. AVERAGE STEP HEIGHTS/DROPS SHALL NOT EXCEED 0.5 UNLESS SHOWN OTHERWISE.
12. CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL BE USED TO CENTER FLOW AND NOT EXCEED 3 INCHES IN DEPTH.
13. THE NUMBER OF STEPS MAY VARY BETWEEN BEGINNING AND END STATIONING. SEE LONGITUDINAL PROFILE FOR STATION AND ELEVATION.
14. USE GEOTEXTILE FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
15. PLACE VEGETATION TRANSPLANTS FROM TOE OF STREAMBANK TO TOP OF STREAMBANK.
16. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

STONE AND LOG STEP POOL
NOT TO SCALE

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS		
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17
D	ISSUED FOR CONSTRUCTION	1-29-18
E	AS-BUILT	11-30-18
NO.	DESCRIPTION	DATE

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

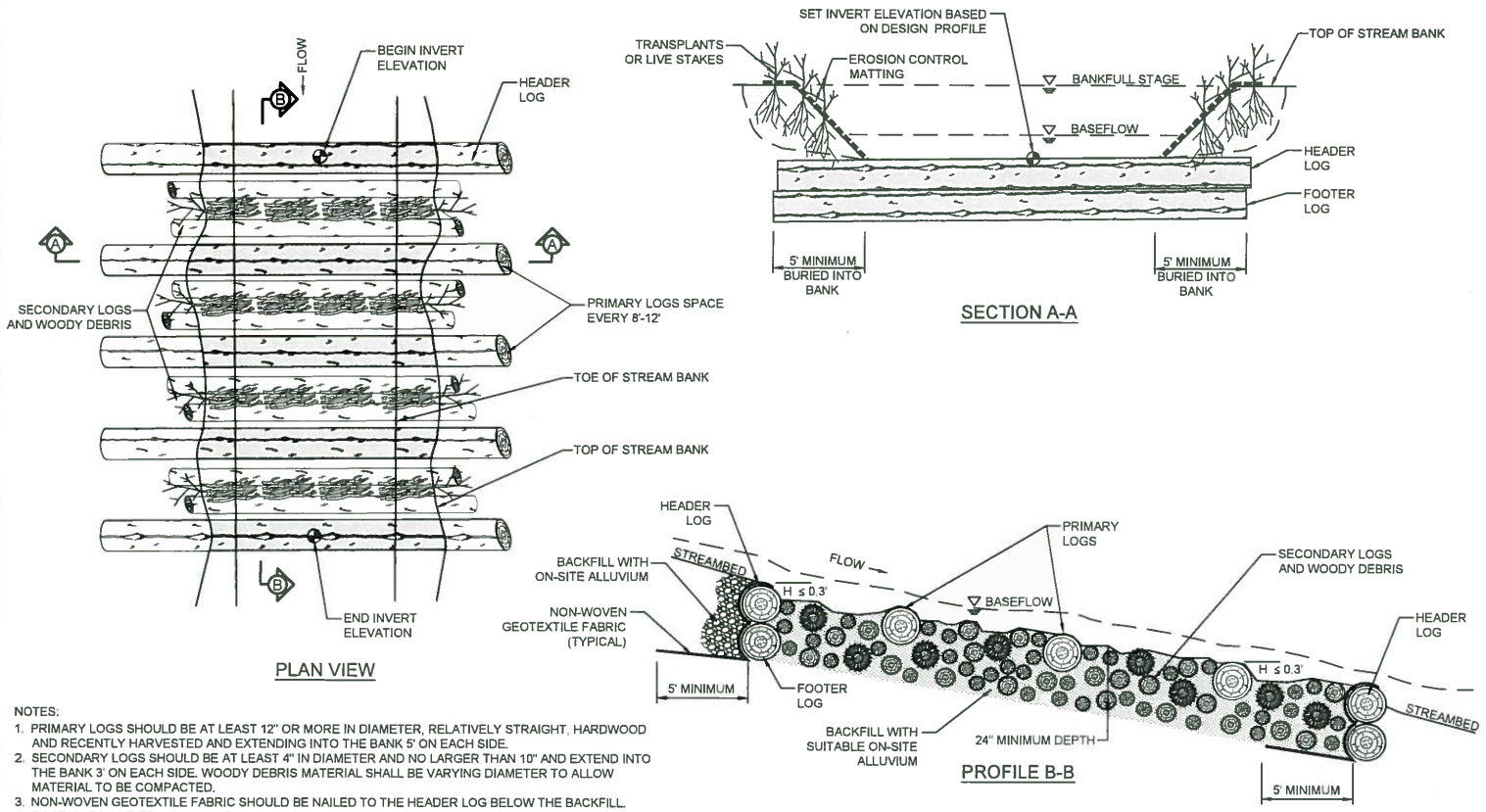
DRAWING INFORMATION	
PROJECT NO. :	97079
FILENAME :	04-07_PEN DELL_DETAIL_SHEETS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

SHEET NAME

DETAILS

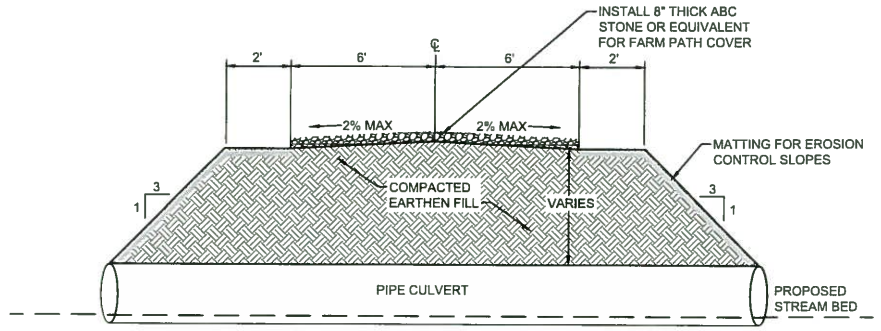
SHEET NUMBER

4



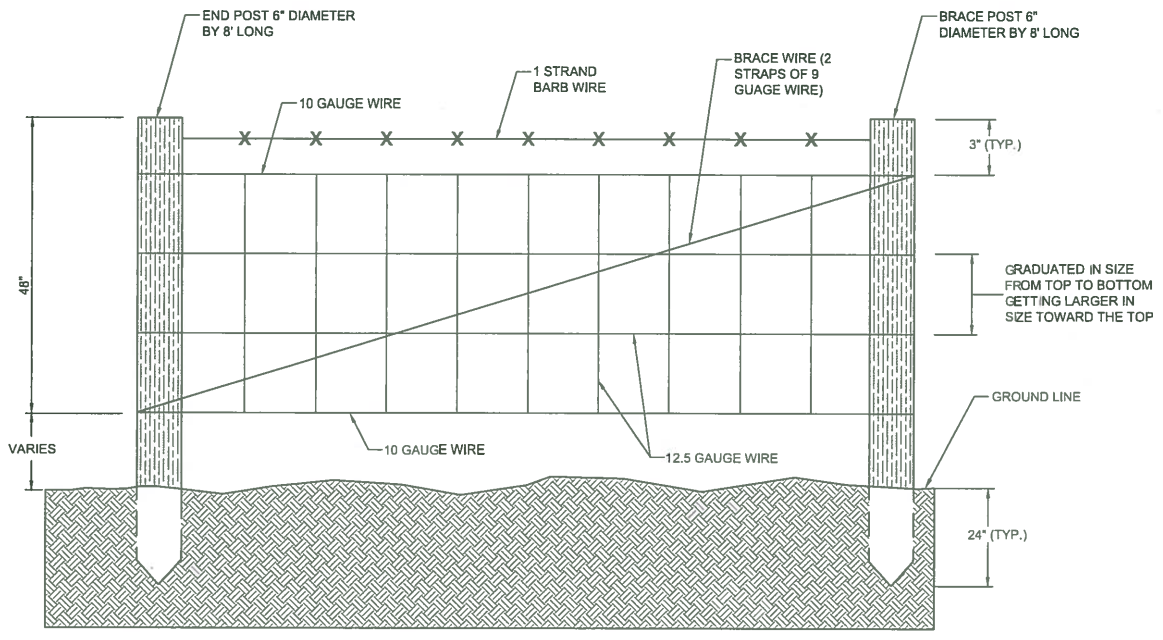
NOTES:
1. PRIMARY LOGS SHOULD BE AT LEAST 12" OR MORE IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD AND RECENTLY HARVESTED AND EXTENDING INTO THE BANK 5' ON EACH SIDE.
2. SECONDARY LOGS SHOULD BE AT LEAST 4" IN DIAMETER AND NO LARGER THAN 10" AND EXTEND INTO THE BANK 3' ON EACH SIDE. WOODY DEBRIS MATERIAL SHALL BE VARYING DIAMETER TO ALLOW MATERIAL TO BE COMPACTED.
3. NON-WOVEN GEOTEXTILE FABRIC SHOULD BE NAILED TO THE HEADER LOG BELOW THE BACKFILL.
4. ROOT WADS AND EROSION CONTROL MATTING CAN BE USED INSTEAD OF TRANSPLANTS OR LIVE STAKES PER DIRECTION OF ENGINEER.
5. AFTER TRENCH HAS BEEN EXCAVATED A LAYER OF SECONDARY LOGS AND WOODY DEBRIS SHOULD BE PLACED WITH MINIMAL GAPS. A LAYER OF ON-SITE ALLUVIUM SHOULD BE APPLIED TO FILL VOIDS BETWEEN SECONDARY LOGS BEFORE ADDITIONAL LAYERS ARE PLACED.
6. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

CONSTRUCTED LOG RIFFLE
NOT TO SCALE



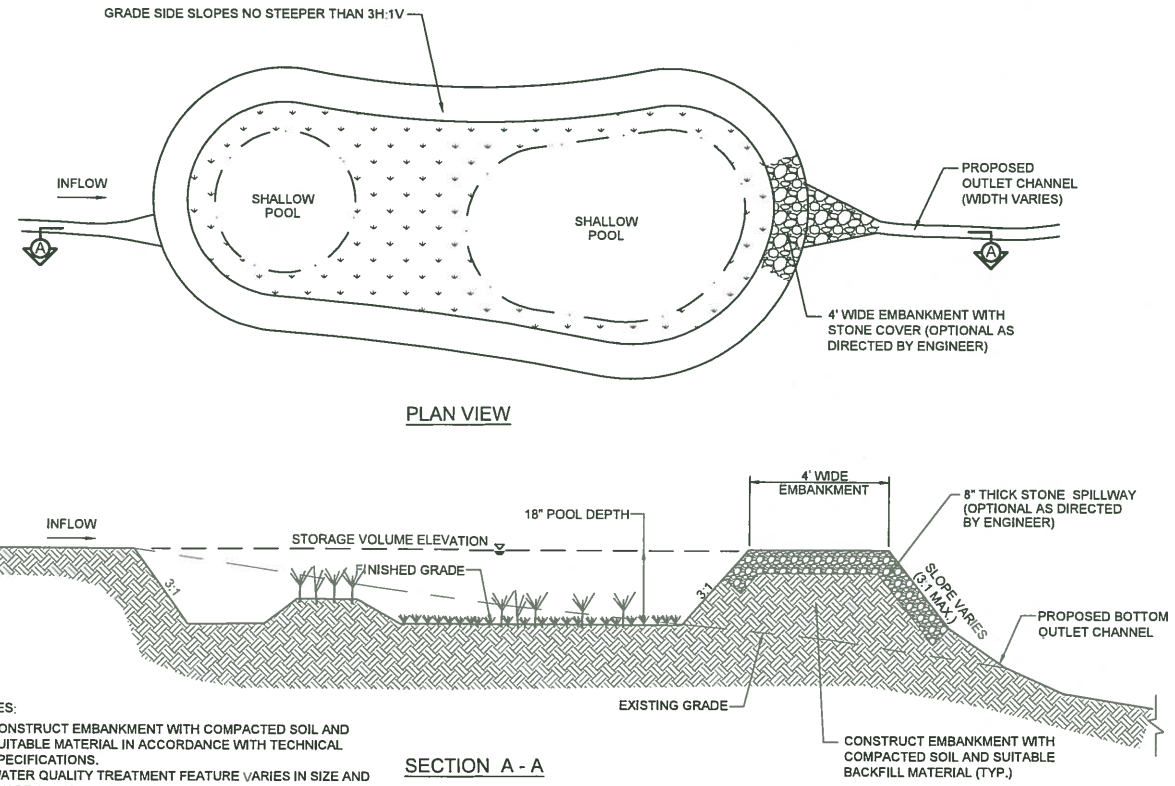
NOTES:
1. INSTALL PIPE CULVERT(S) IN ACCORDANCE WITH DETAIL SPECIFICATIONS. SEE PLANS FOR NUMBER, SIZE AND LENGTH.
2. INSTALL COIR FIBER MATTING FOR EROSION CONTROL ALONG FILL SLOPES IN ACCORDANCE WITH DETAIL SPECIFICATIONS.
3. PIPE CULVERTS ARE TO BE A MINIMUM OF 24" COVER AND SPACING IN ACCORDANCE WITH DETAIL SPECIFICATIONS.

PERMANENT CULVERT STREAM CROSSING
NOT TO SCALE



NOTE:
1. END POSTS SHALL BE INSTALLED AT A SPACING OF 10-15 FEET.

WOVEN FIELD FENCE
NOT TO SCALE



NOTES:
1. CONSTRUCT EMBANKMENT WITH COMPACTED SOIL AND SUITABLE MATERIAL IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS.
2. WATER QUALITY TREATMENT FEATURE VARIES IN SIZE AND SHAPE AS SHOWN ON PLANS.
3. PLANT APPROPRIATE WETLAND SPECIES VEGETATION AS SPECIFIED IN THE PLANTING PLAN.

SECTION A - A

WATER QUALITY TREATMENT FEATURE
NOT TO SCALE

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III 05.01.19

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS		
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
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PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

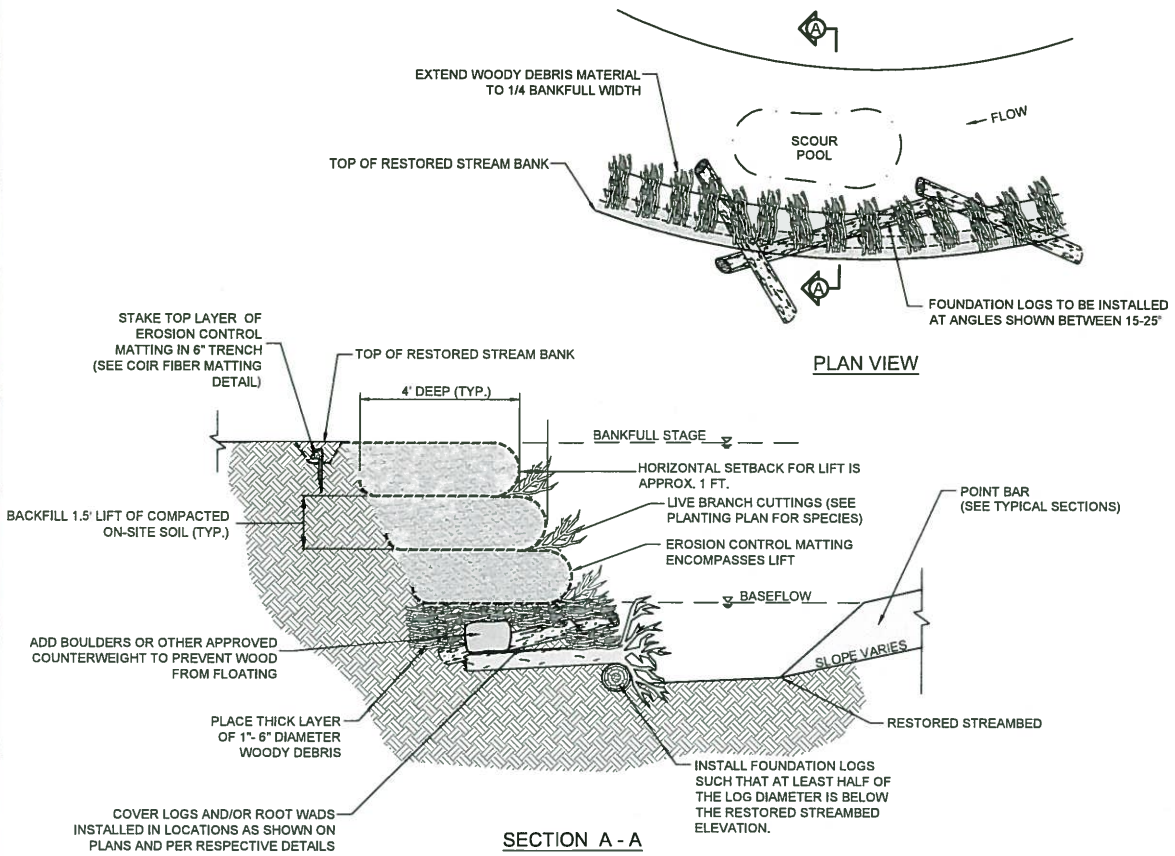
DRAWING INFORMATION	
PROJECT NO. :	97079
FILENAME :	04-07_PEN DELL_DETAIL_SHEETS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

SHEET NAME

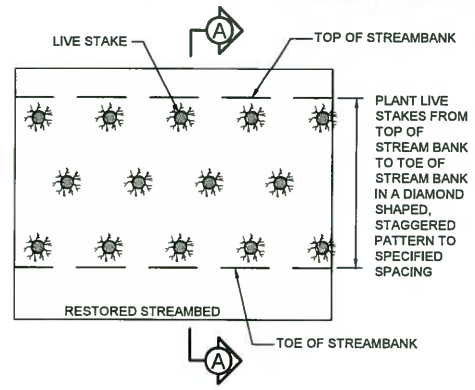
DETAILS

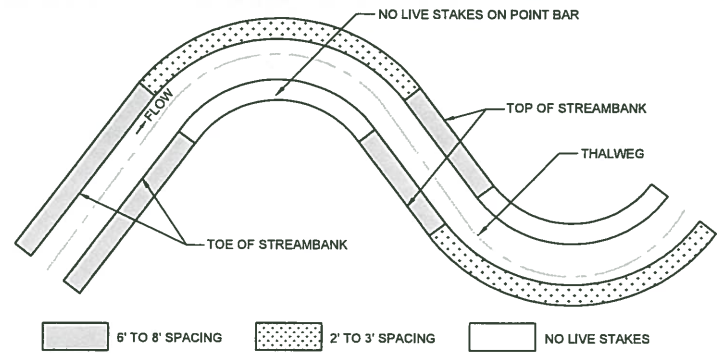
SHEET NUMBER

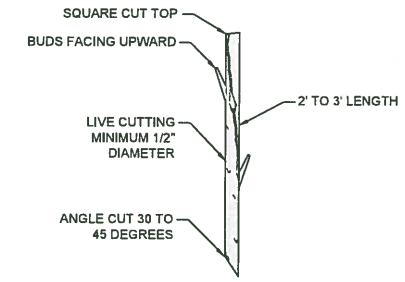
5



GEOLIFT W/ TOE WOOD
NOT TO SCALE

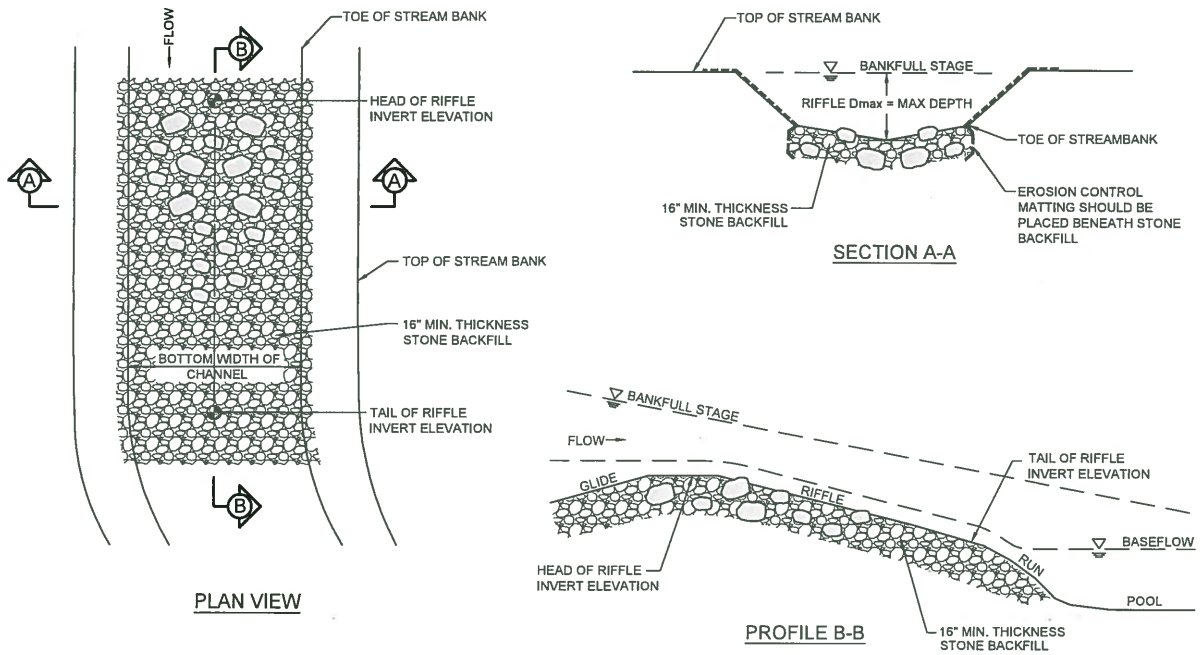






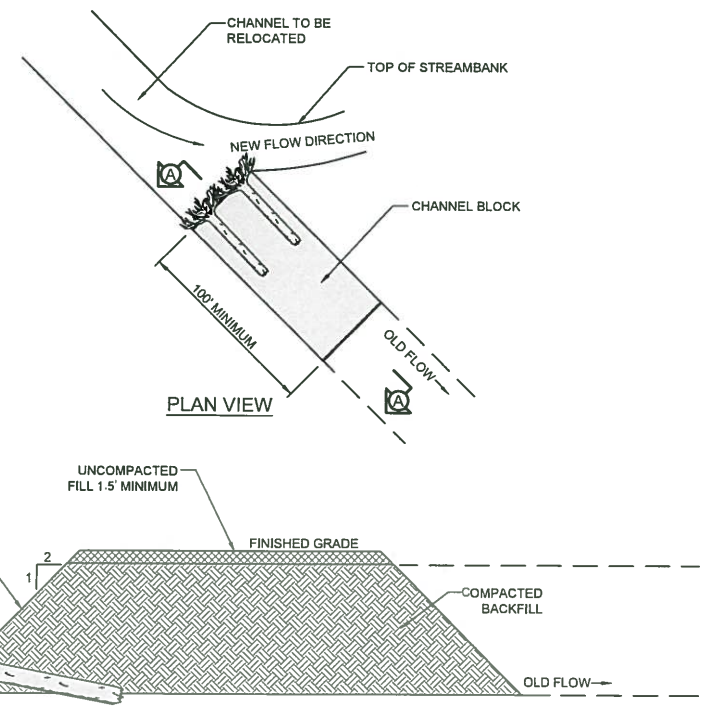
NOTES:
1. LIVE STAKES SHOULD BE CUT AND INSTALLED ON THE SAME DAY.
2. DO NOT INSTALL LIVE STAKES THAT HAVE BEEN SPLIT.
3. LIVE STAKES MUST BE INSTALLED WITH BUDS POINTING UPWARDS.
4. LIVE STAKES SHOULD BE INSTALLED PERPENDICULAR TO BANK.
5. LIVE STAKES SHOULD BE 1/2 TO 2 INCHES IN DIAMETER AND 2 TO 3 FEET LONG.
6. LIVE STAKES SHOULD BE INSTALLED LEAVING 1/5 OF THE LENGTH OF THE LIVE STAKE ABOVE GROUND.

LIVE STAKING
NOT TO SCALE



NOTES:
1. DIG A TRENCH BELOW THE RESTORED STREAMBED FOR THE STONE BACKFILL.
2. FILL TRENCH WITH STONE BACKFILL.

CONSTRUCTED STONE RIFFLE
NOT TO SCALE



NOTES:
1. COMPACT BACKFILL USING ON-SITE HEAVY EQUIPMENT IN 10 INCH LIFTS.
2. FILL DITCH PLUG TO TOP OF BANKS OR AS DIRECTED BY ENGINEER.

CHANNEL BLOCK
NOT TO SCALE

WATER & LAND SOLUTIONS
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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III 03.01.19

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS		
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NO.	DESCRIPTION	DATE

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

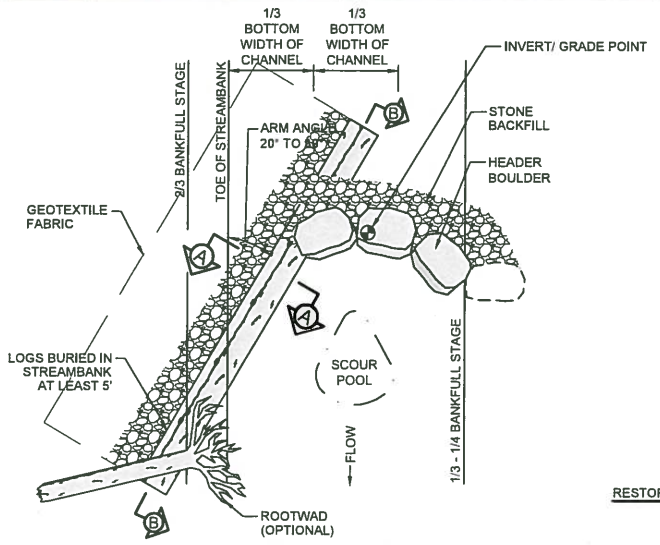
DRAWING INFORMATION	
PROJECT NO. :	97079
FILENAME :	04-07_PEN DELL_DETAIL_SHEETS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

SHEET NAME

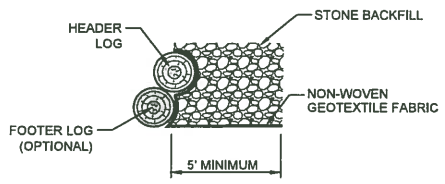
DETAILS

SHEET NUMBER

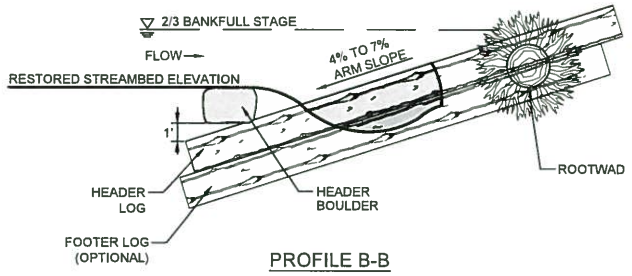
6



PLAN VIEW



SECTION A-A

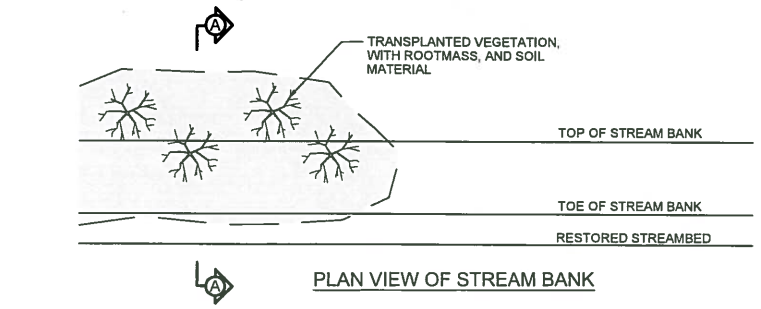


PROFILE B-B

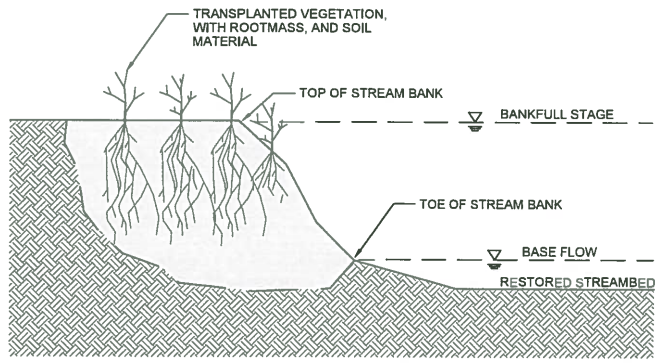
NOTES:
1. LOGS SHOULD BE 12" TO 18" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. LOGS SHOULD BE BURIED INTO THE STREAM BED AND BANKS AT LEAST 5 FEET.
3. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOGS.
4. INSTALL GEOTEXTILE FABRIC BEGINNING AT THE TOP OF THE HEADER LOG AND EXTEND DOWNWARD TO THE DEPTH OF THE BOTTOM FOOTER LOG AND THEN UPSTREAM TO A MINIMUM OF FIVE FEET. GEOTEXTILE FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.
5. EXCAVATE A TRENCH BELOW THE BED FOR FOOTER LOG AND PLACE FILL ON UPSTREAM SIDE OF VANE ARM, BETWEEN THE ARM AND STREAMBANK.
6. START AT BANK AND PLACE FOOTER BOULDERS FIRST AND THEN HEADER BOULDERS.
7. CONTINUE WITH STRUCTURE, FOLLOWING ANGLE AND SLOPE SPECIFICATIONS.
8. AN OPTIONAL COVER LOG CAN BE PLACED IN SCOUR POOL FOR HABITAT IMPROVEMENT AT DIRECTION OF ENGINEER.
9. USE HAND PLACED STONE TO FILL GAPS ON UPSTREAM SIDE OF HEADER AND FOOTER BOULDERS.
10. AFTER ALL STONE BACKFILL HAS BEEN PLACED, FILL IN THE UPSTREAM SIDE OF THE STRUCTURE WITH ON-SITE ALLUVIUM TO THE ELEVATION OF THE TOP OF THE HEADER BOULDER AND LOG.
11. VEGETATION TRANSPLANTS CAN BE USED INSTEAD OF ROOTWADS, PER DIRECTION OF ENGINEER.

GRADE CONTROL LOG J-HOOK VANE

NOT TO SCALE



PLAN VIEW OF STREAM BANK

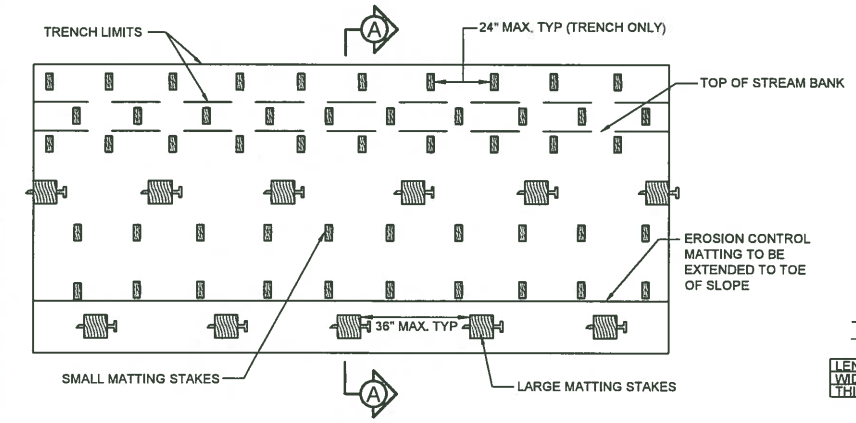


SECTION A-A

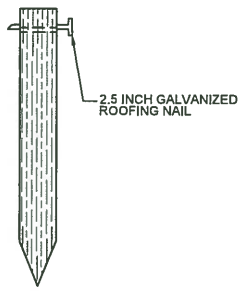
NOTES:
1. EXCAVATE A HOLE IN THE RESTORED STREAM BANK THAT WILL ACCOMMODATE THE SIZE OF TRANSPLANT TO BE PLANTED. BEGIN EXCAVATION AT TOE OF THE STREAM BANK.
2. EXCAVATE THE ENTIRE TRANSPLANT ROOT MASS AND AS MUCH ADDITIONAL SOIL MATERIAL AS POSSIBLE. IF ENTIRE ROOT MASS CAN NOT BE EXCAVATED AT ONCE, THE TRANSPLANT IS TOO LARGE AND ANOTHER SHOULD BE SELECTED.
3. PLANT TRANSPLANT IN THE RESTORED STREAM BANK SO THAT VEGETATION IS ORIENTATED VERTICALLY.
4. FILL IN ANY HOLES OR VOIDS AROUND THE TRANSPLANT AND COMPACT.
5. ANY LOOSE SOIL LEFT IN THE STREAM SHOULD BE REMOVED.
6. WHEN POSSIBLE, PLACE MULTIPLE TRANSPLANTS CLOSE TOGETHER SUCH THAT THEIR ROOT MASSES CONTACT.

VEGETATION TRANSPLANTS

NOT TO SCALE

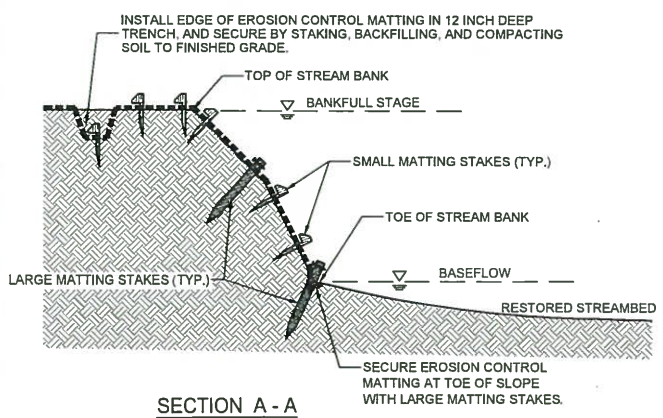


PLAN VIEW OF STREAM BANK

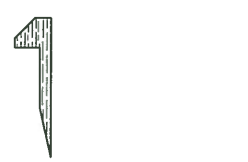


TYPICAL LARGE MATTING STAKE

LENGTH	24.00 IN (60.96 CM) (TAPERED TO POINT)
WIDTH	1.5 IN (3.81 CM)
THICKNESS	1.5 IN (3.81 CM)



SECTION A - A



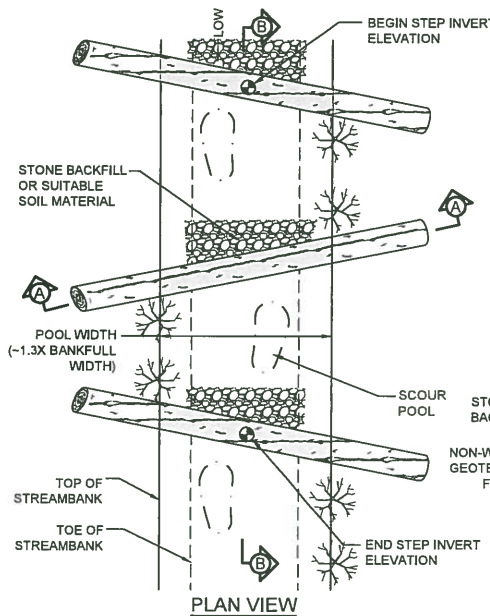
TYPICAL SMALL MATTING STAKE

LEG LENGTH	11.00 IN (27.94 CM)
HEAD WIDTH	1.25 IN (3.18 CM)
HEAD THICKNESS	0.40 IN (1.02 CM)
LEG WIDTH	0.60 IN (1.52 CM) (TAPERED TO POINT)
LEG THICKNESS	0.40 IN (1.02 CM)
TOTAL LENGTH	12.00 IN (30.48 CM)

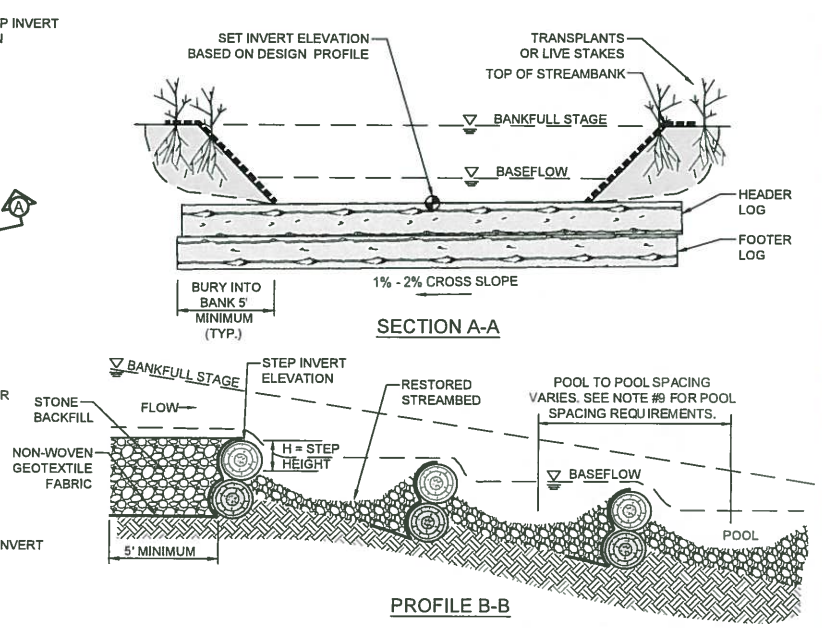
NOTES:
1. RESTORED STREAM BANKS MUST BE SEEDED AND MULCHED PRIOR TO PLACEMENT OF EROSION CONTROL MATTING.
2. SEE TECHNICAL SPECIFICATIONS FOR MATTING STAKE SPACING REQUIREMENTS.
3. PLACE LARGE STAKES ALONG ALL MATTING SEAMS. IN THE CENTER OF STREAM BANK, AND TOE OF SLOPE.

EROSION CONTROL MATTING

NOT TO SCALE



PLAN VIEW



SECTION A-A

PROFILE B-B

NOTES:
1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT HARDWOOD AND RECENTLY HARVESTED.
2. LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG. LOGS SHOULD EXTEND INTO THE BANKS 5' ON EACH SIDE.
3. SOIL SHALL BE WELL COMPACTED AROUND BURIED PORTION OF FOOTER LOGS WITH BUCKET OF TRACK HOE.
4. INSTALL NON-WOVEN GEOTEXTILE FABRIC UNDERNEATH LOGS.
5. UNDERCUT POOL BED ELEVATION 8 INCHES TO ALLOW FOR LAYER OF STONE. INSTALL STONE BACKFILL OR SUITABLE ALLUVIUM ALONG SIDE SLOPES.
6. INSTALL EROSION CONTROL MATTING ALONG COMPLETED BANKS SUCH THAT THE EROSION CONTROL MATTING AT THE TOE OF THE BANK EXTENDS DOWN TO THE UNDERCUT ELEVATION.
7. INSTALL STONE BACKFILL OR SUITABLE SOIL MATERIAL ALONG SIDE SLOPES.
8. FINAL CHANNEL BED SHAPE SHOULD BE ROUNDED, COMPACTED, AND CONCAVE, WITH THE ELEVATION OF THE BED APPROXIMATELY 0.5 FT DEEPER IN THE CENTER THAN AT THE EDGES.
9. AVERAGE POOL TO POOL SPACING SHALL BE SHOWN ON THE PROFILE OR SPECIFIED BY ENGINEER BASED ON EXISTING CONDITIONS SUCH AS SLOPE AND SUITABLE FILL MATERIAL. RIFFLE STEP POOLS OR CASCADE POOLS MAY BE SUBSTITUTED IN AREAS WHERE EXISTING SLOPES EXCEED 10% AS DETERMINED BY THE ENGINEER.
10. INTERIOR LOGS SHOULD BE AT A SLIGHT ANGLE (~70 DEGREES) FROM THE STREAMBANK AND CROSS SLOPES SHOULD BE 1-2%.
11. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
12. AVERAGE STEP HEIGHTS/DROPS SHALL NOT EXCEED 0.5 UNLESS SHOWN OTHERWISE.
13. CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL BE USED TO CENTER FLOW AND NOT EXCEED 3 INCHES IN DEPTH.
14. THE NUMBER OF STEPS MAY VARY BETWEEN BEGINNING AND END STATIONING. SEE LONGITUDINAL PROFILE FOR STATION AND ELEVATION.
15. USE GEOTEXTILE FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
16. PLACE VEGETATION TRANSPLANTS FROM TOE OF STREAMBANK TO TOP OF STREAMBANK.
17. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

LOG STEP POOL

NOT TO SCALE

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III 03.01.19

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS

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B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17
D	ISSUED FOR CONSTRUCTION	1-29-18
E	AS-BUILT	11-30-18

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO. :	97079
FILENAME :	04-07_PEN DELL_DETAIL_SHEETS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

SHEET NAME

DETAILS

SHEET NUMBER

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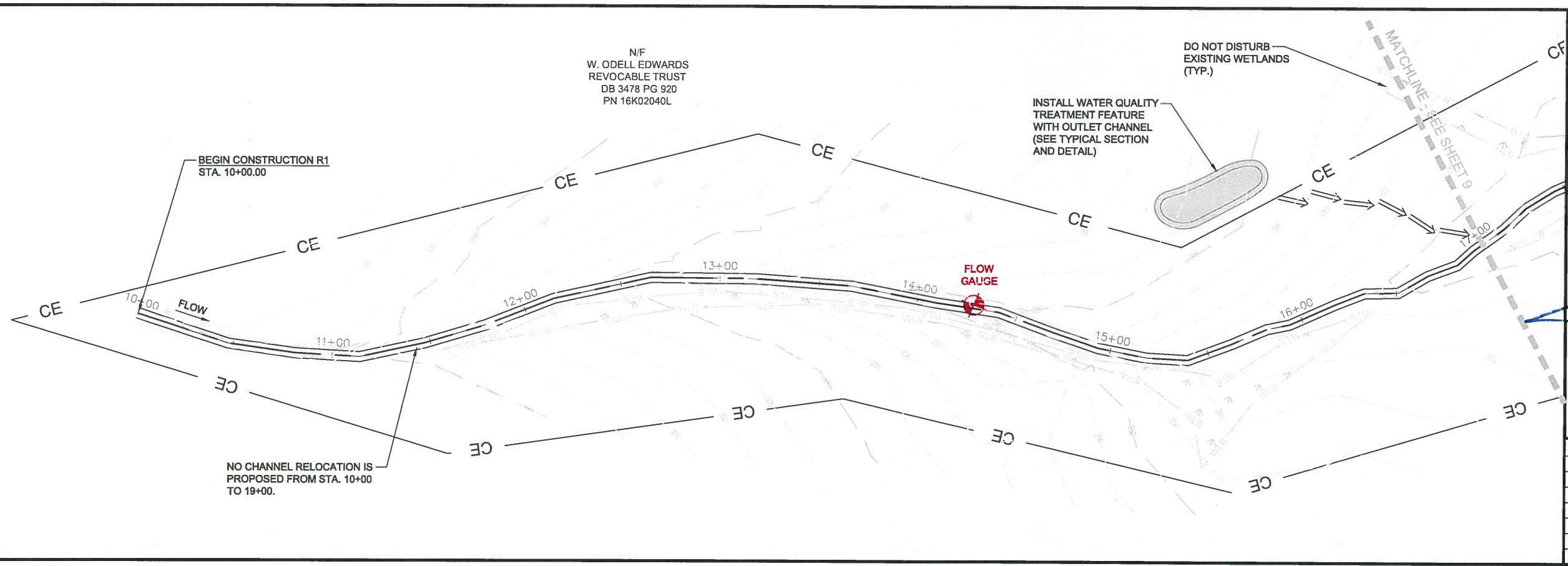

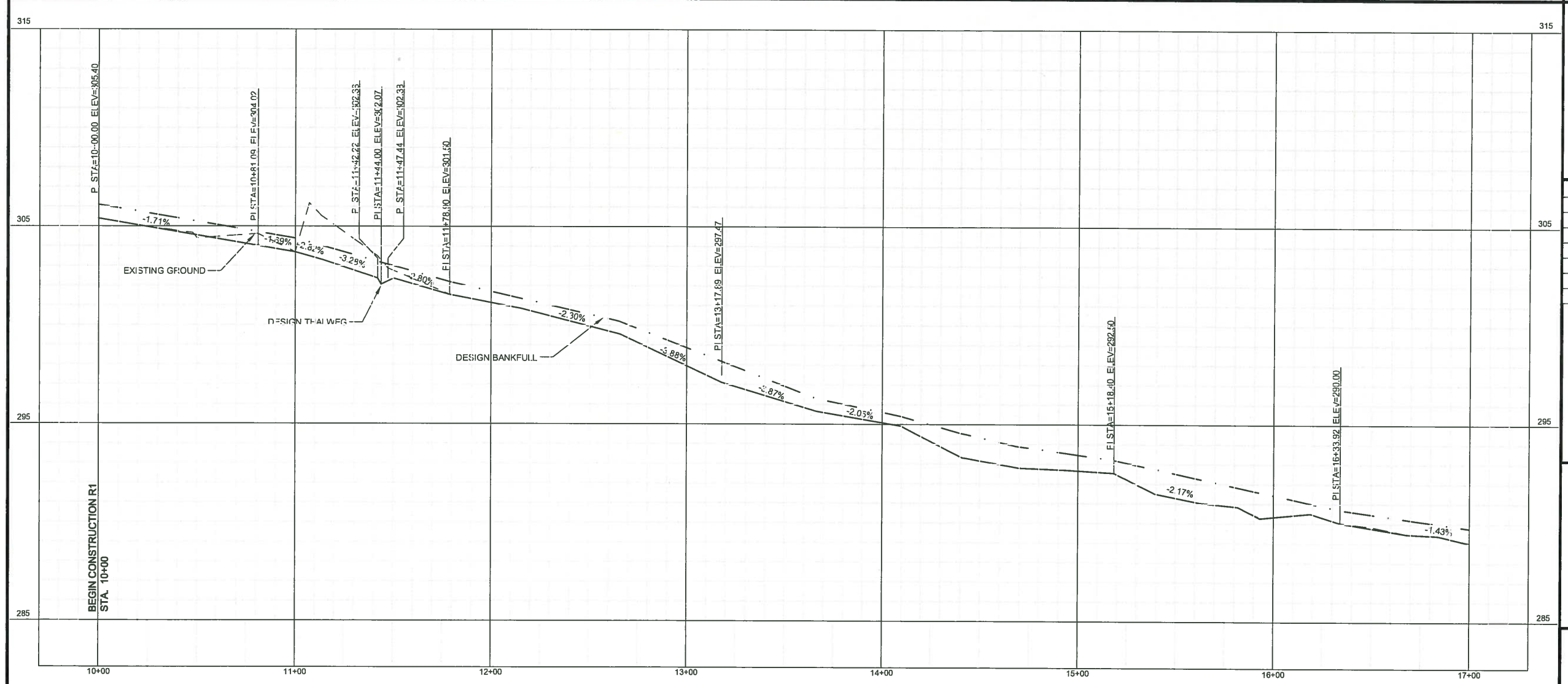

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JOHNSTON COUNTY, NC

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DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 30'
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GRAPHIC SCALE

SHEET NAME

R1

PLAN AND PROFILE

SHEET NUMBER

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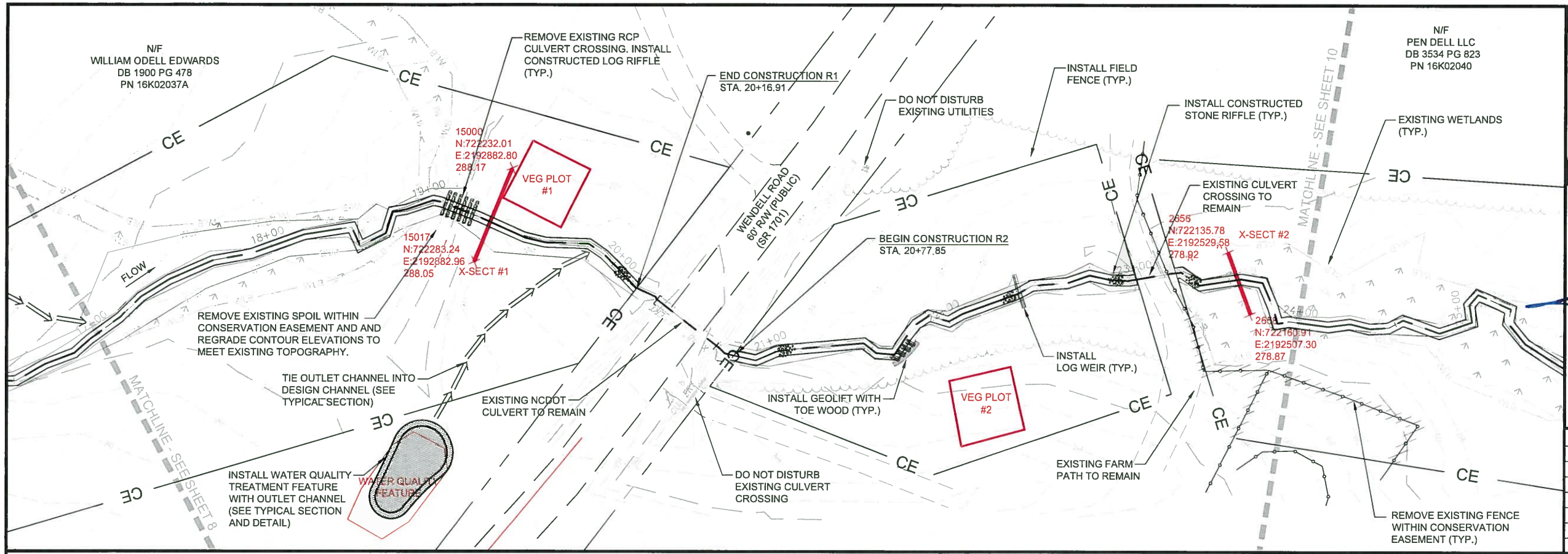

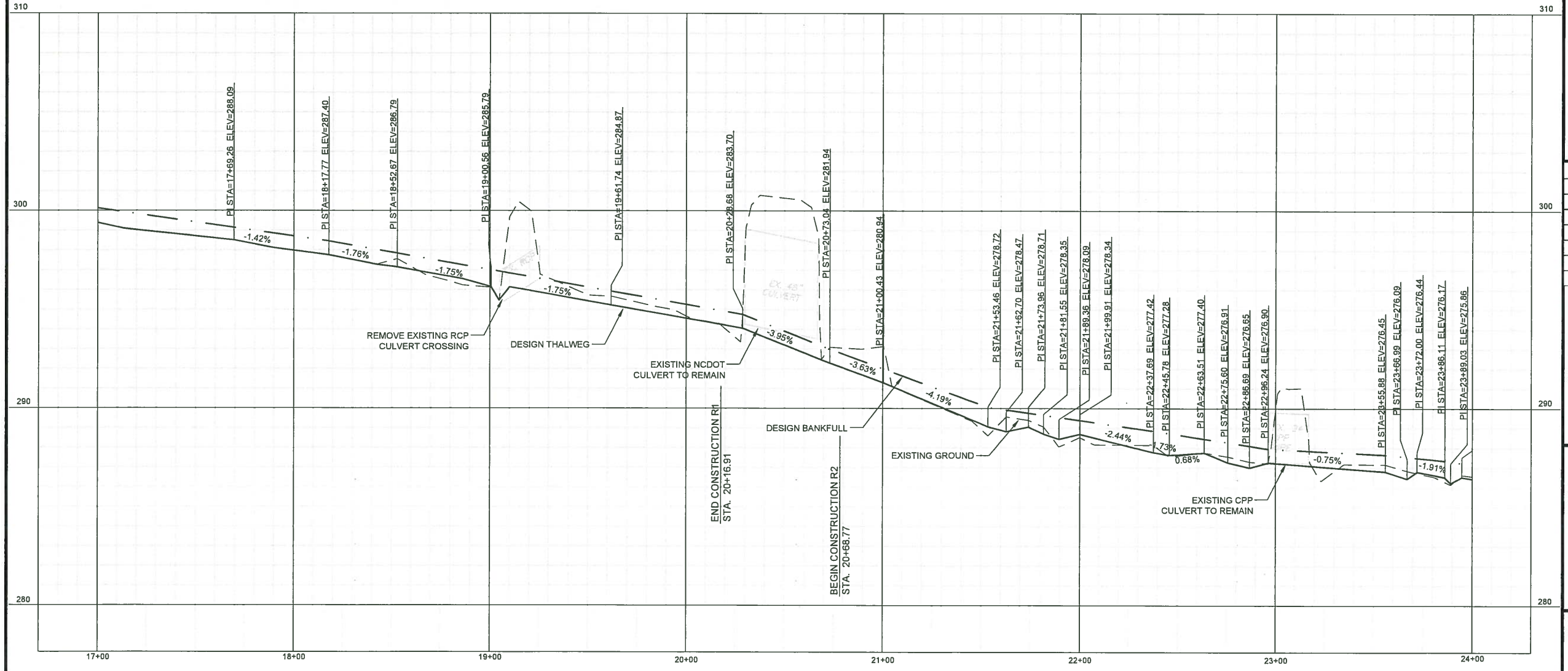

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R1&R2

PLAN AND PROFILE

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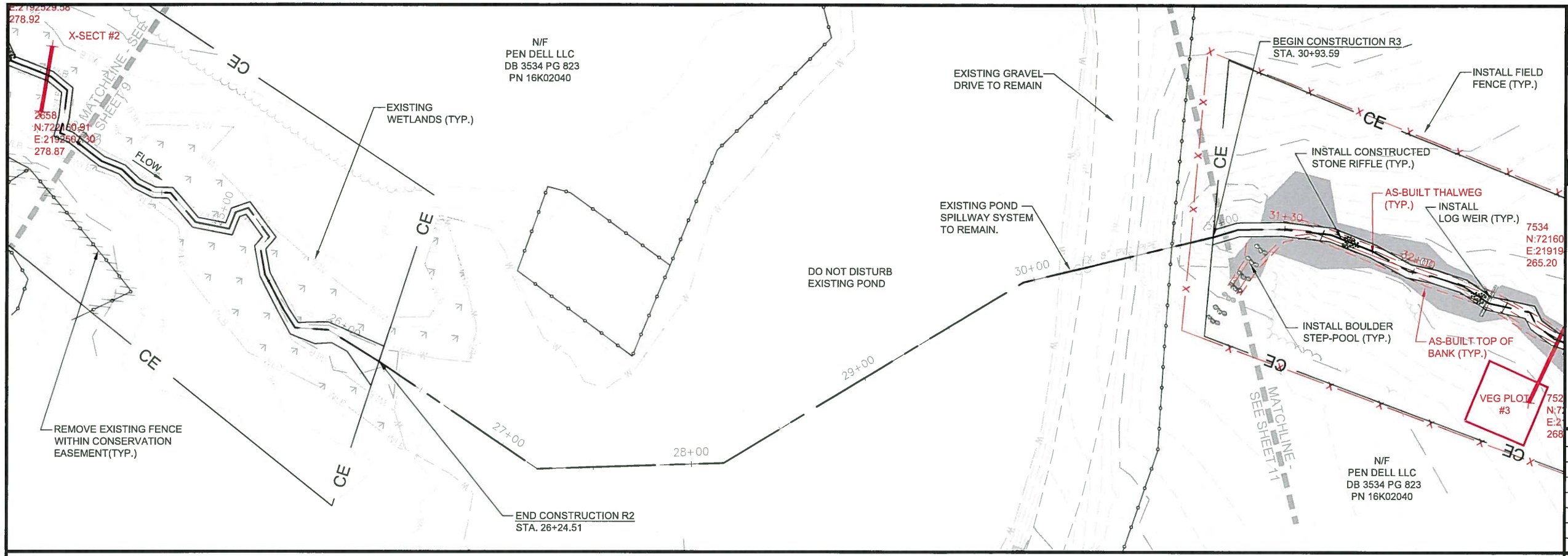

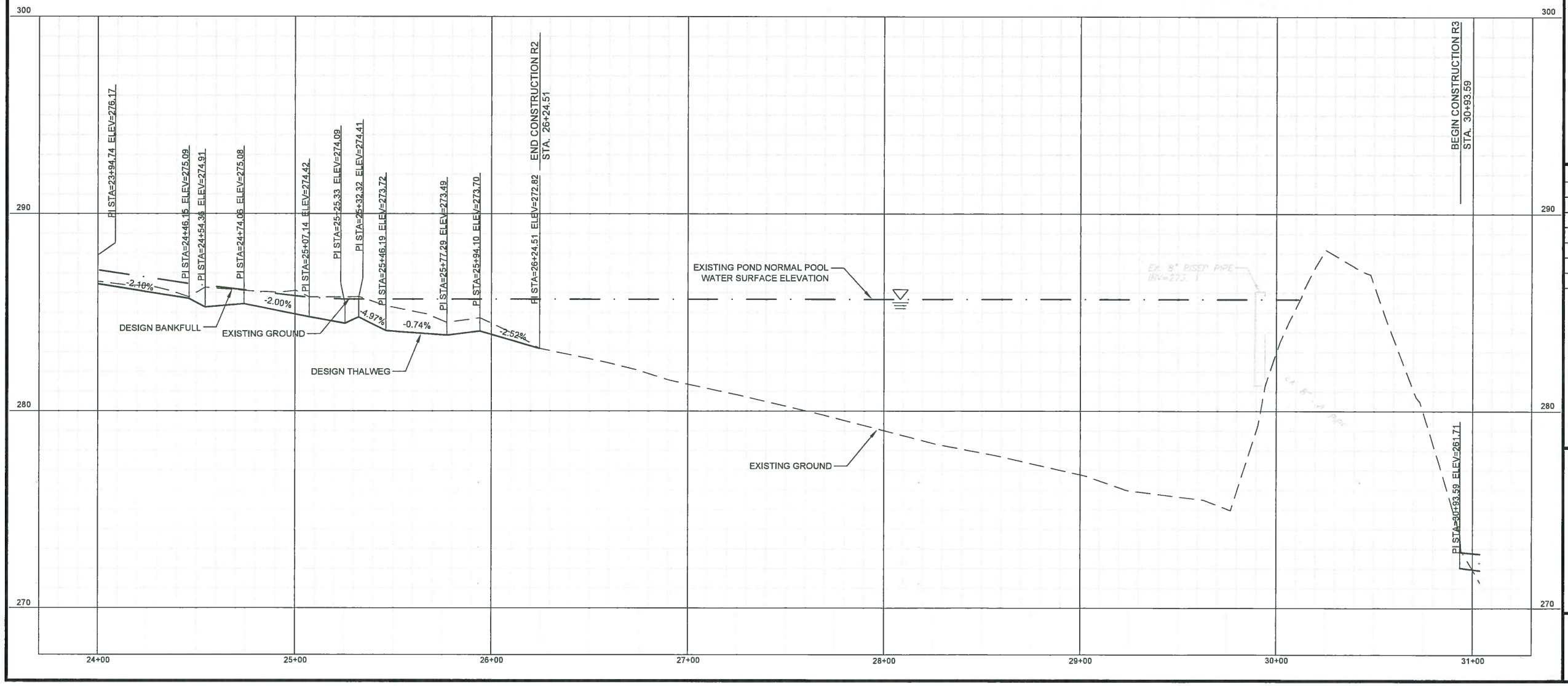

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NORTH

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GRAPHIC SCALE

SHEET NAME

R2&R3

PLAN AND PROFILE

SHEET NUMBER

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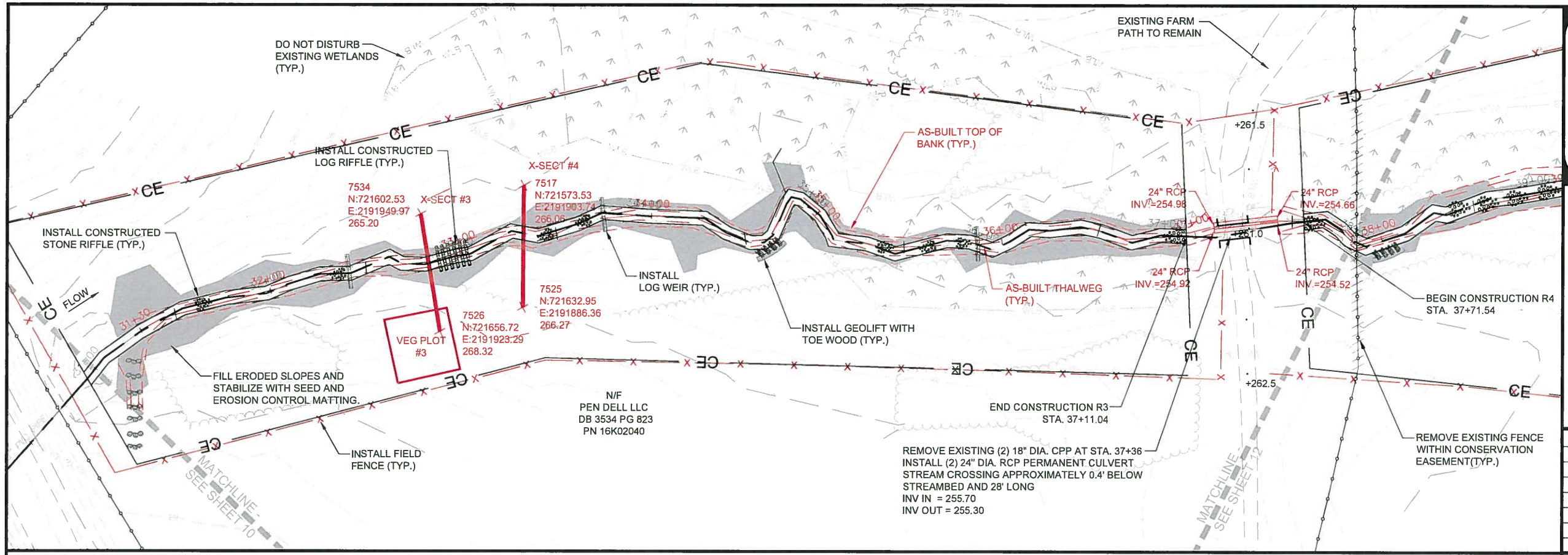

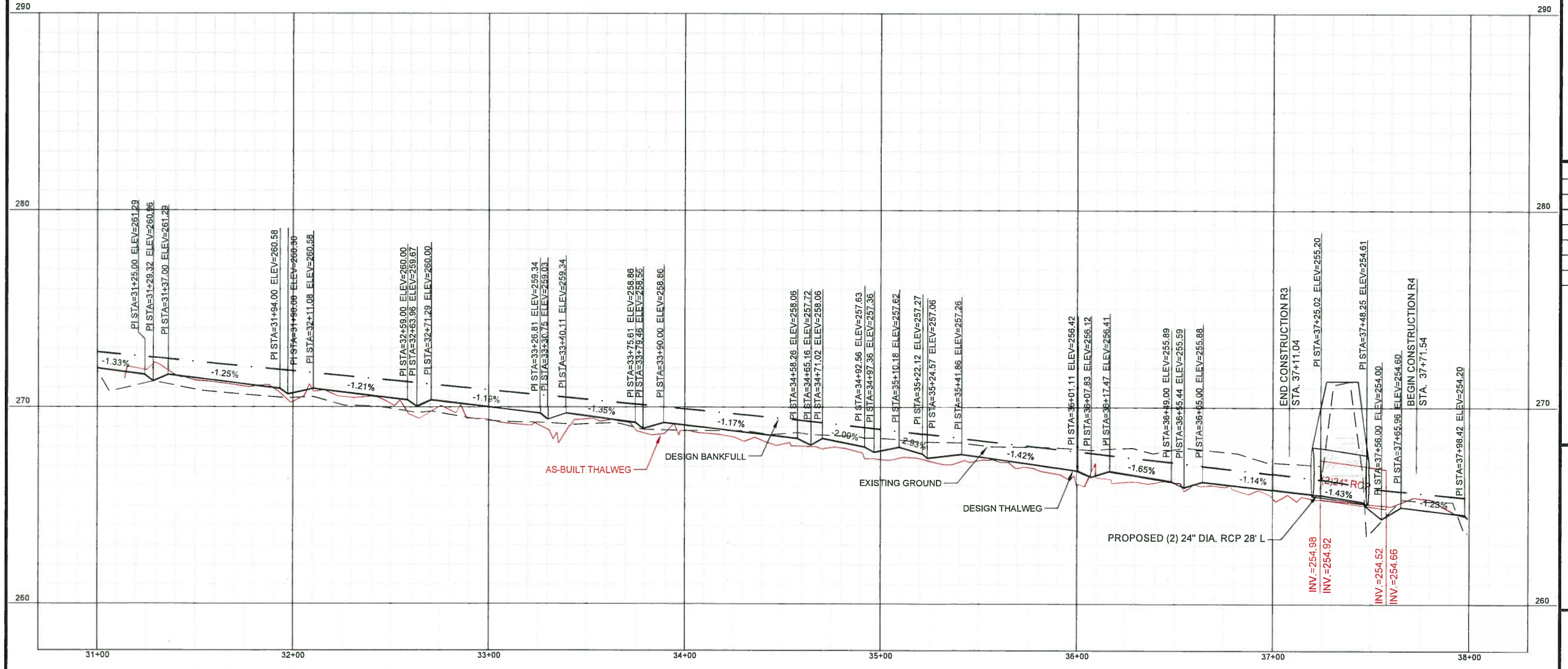

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NORTH

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GRAPHIC SCALE

SHEET NAME

R3&R4

PLAN AND PROFILE

SHEET NUMBER

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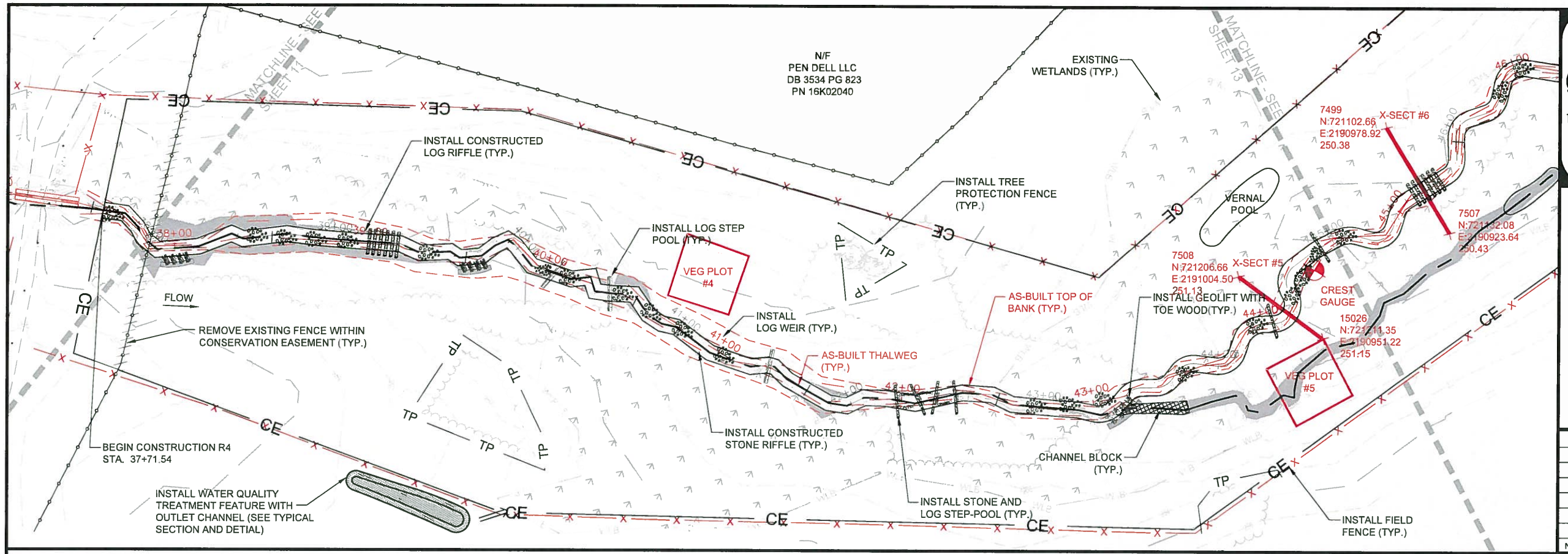

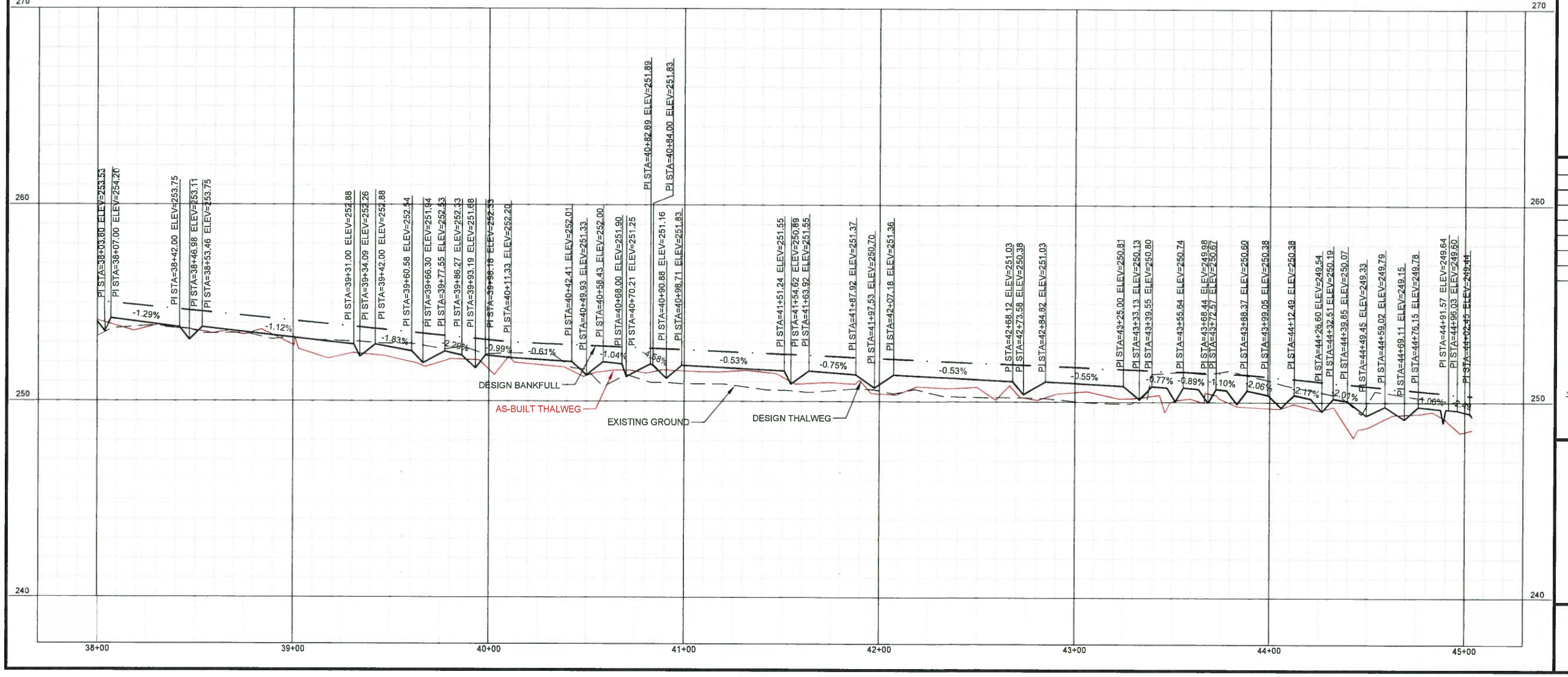

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NORTH

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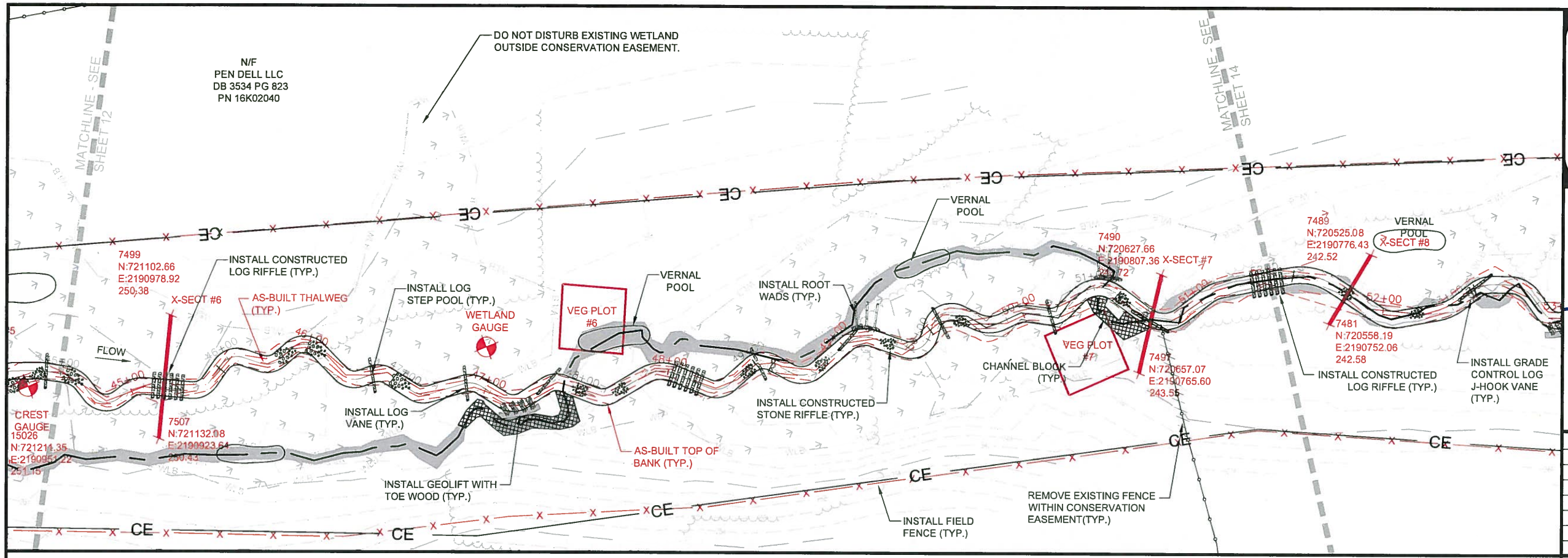
SHEET NAME

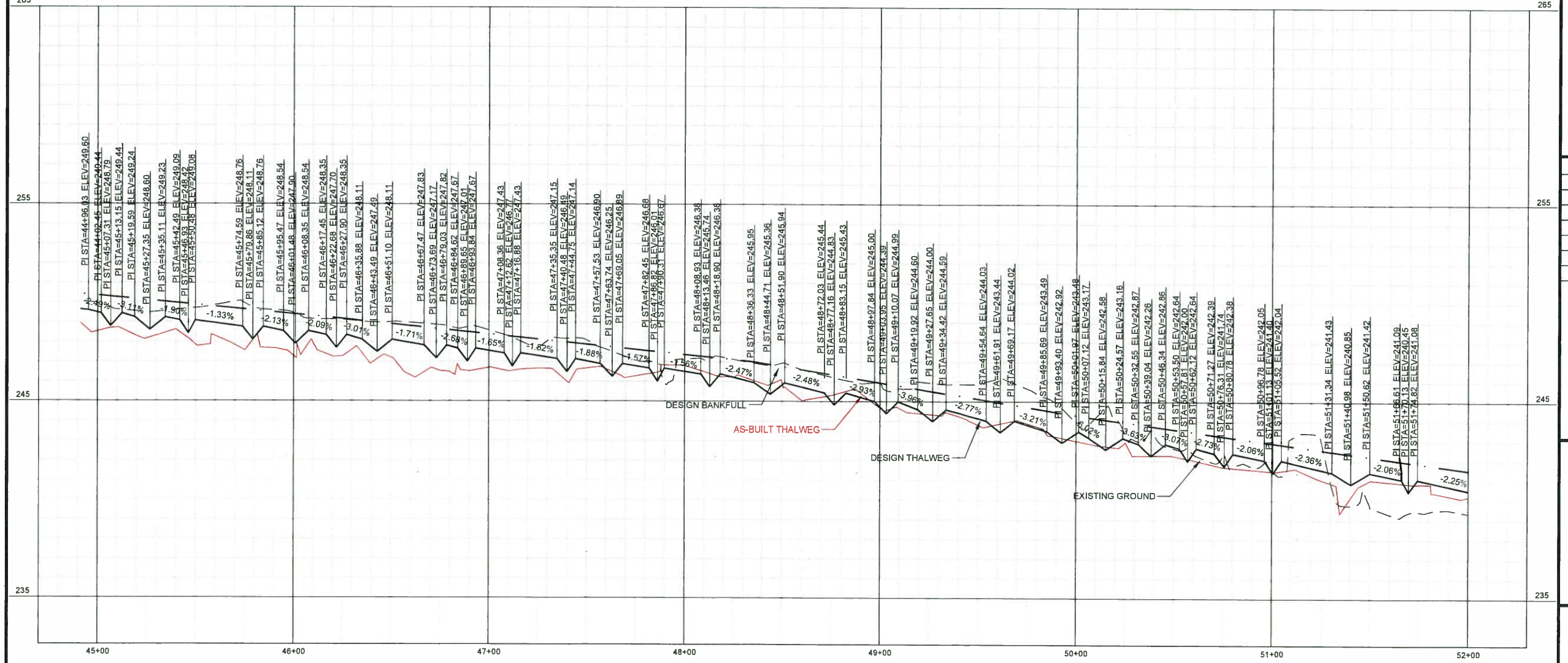
R4

PLAN AND PROFILE

SHEET NUMBER

12





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NORTH

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GRAPHIC SCALE

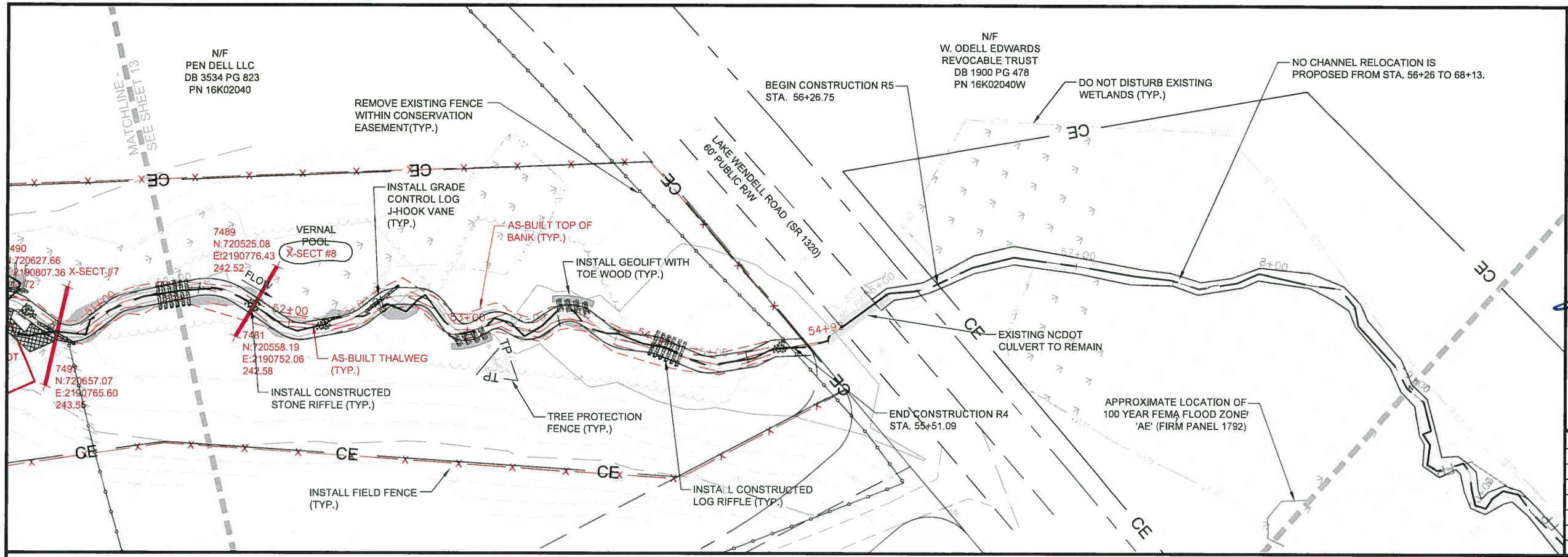
SHEET NAME

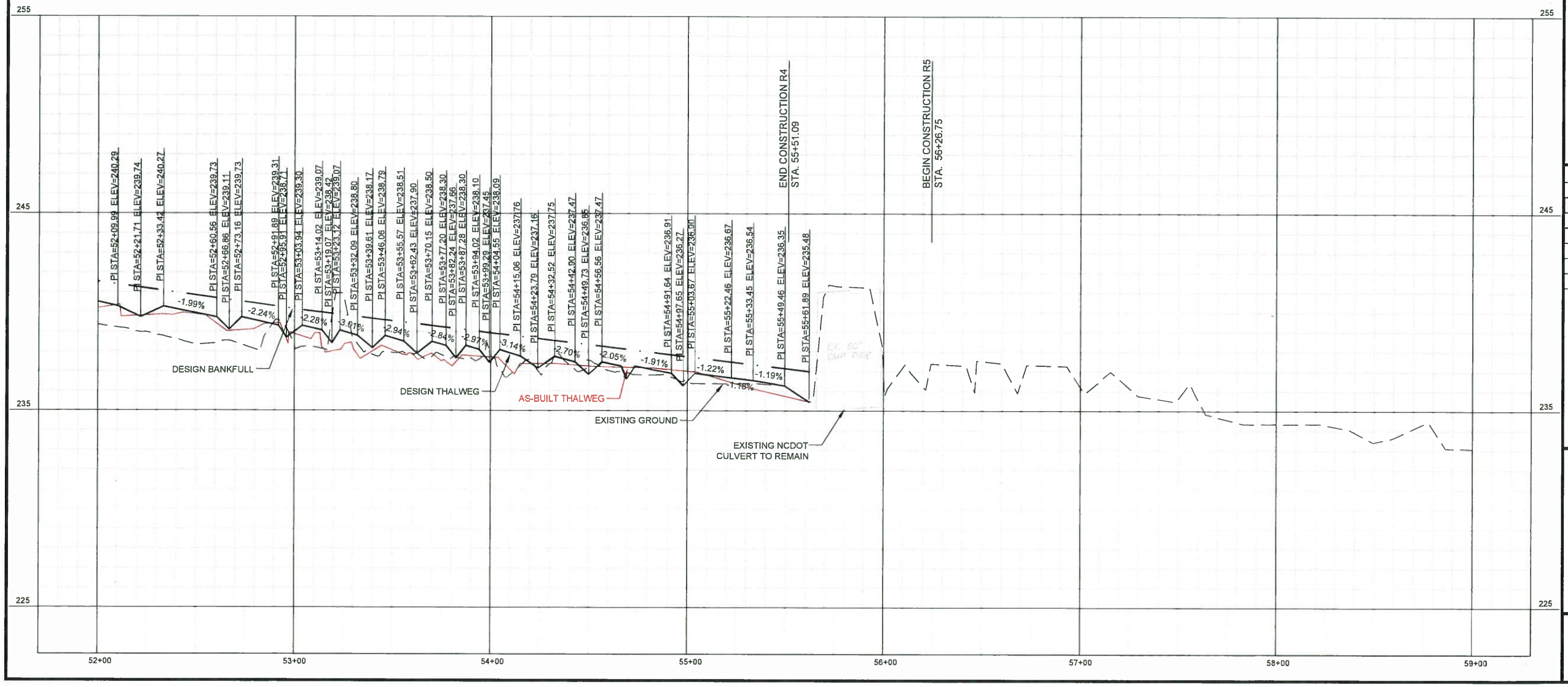
R4

PLAN AND PROFILE

SHEET NUMBER

13





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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

11.01.18

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VERT. SCALE :	1" = 3'

NORTH

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GRAPHIC SCALE

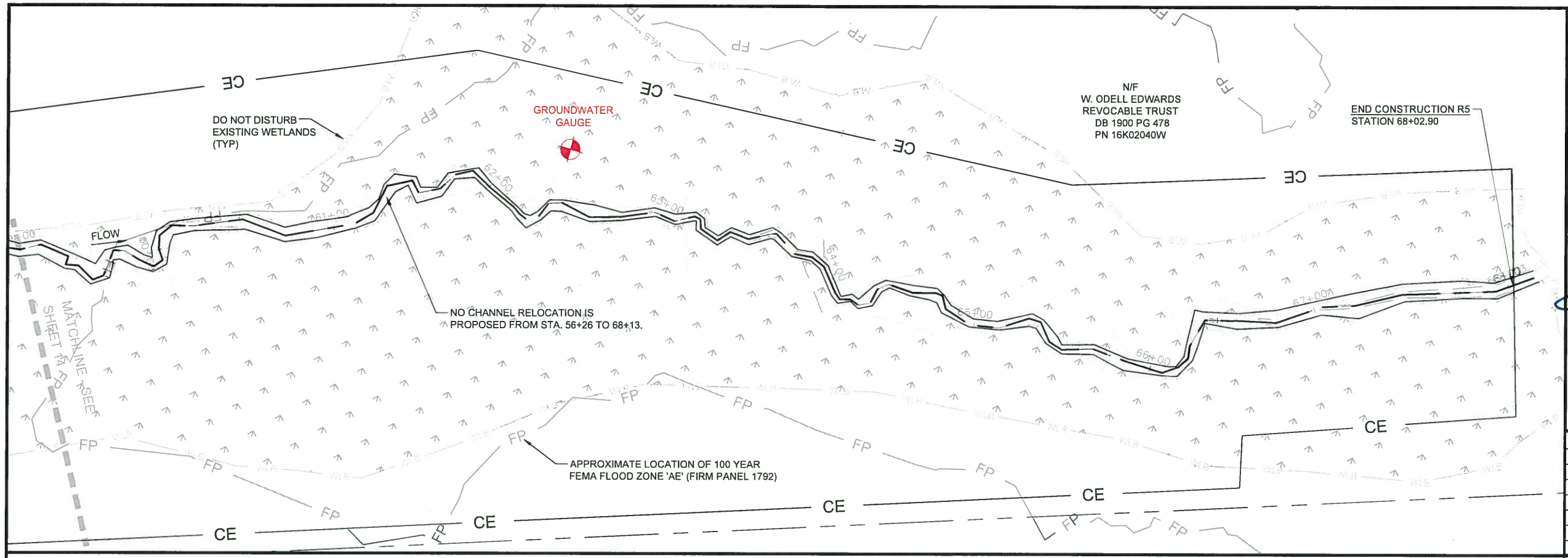
SHEET NAME

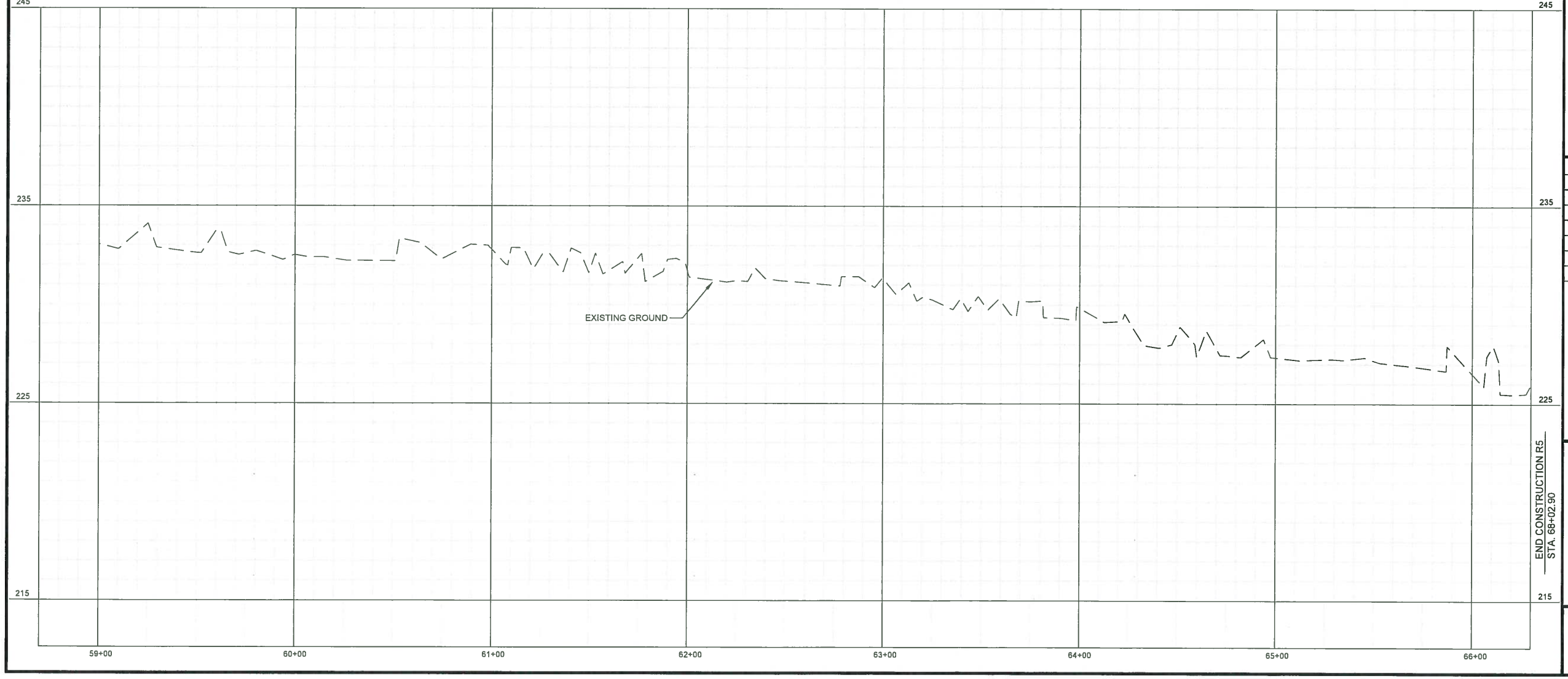
R4&R5

PLAN AND PROFILE

SHEET NUMBER

14





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PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION	
PROJECT NO. :	97079
FILENAME :	08-15_PEN DELL_PP_SHEETS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 30'
VERT. SCALE :	1" = 3'

NORTH

30 15 0 30 60

GRAPHIC SCALE

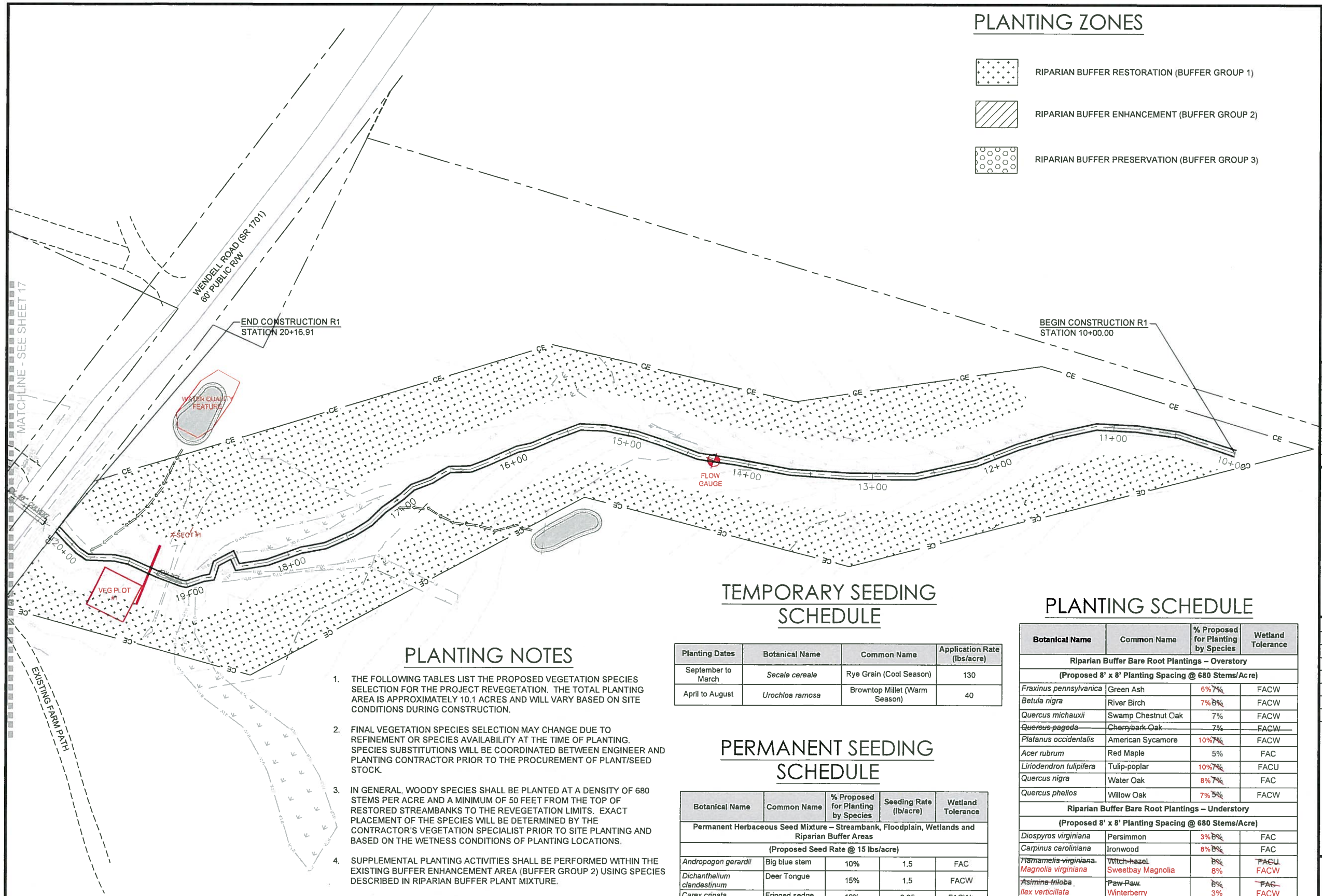
SHEET NAME

R5

PLAN AND PROFILE

SHEET NUMBER

15



PLANTING ZONES

- RIPARIAN BUFFER RESTORATION (BUFFER GROUP 1)
- RIPARIAN BUFFER ENHANCEMENT (BUFFER GROUP 2)
- RIPARIAN BUFFER PRESERVATION (BUFFER GROUP 3)

PLANTING NOTES

1. THE FOLLOWING TABLES LIST THE PROPOSED VEGETATION SPECIES SELECTION FOR THE PROJECT REVEGETATION. THE TOTAL PLANTING AREA IS APPROXIMATELY 10.1 ACRES AND WILL VARY BASED ON SITE CONDITIONS DURING CONSTRUCTION.
2. FINAL VEGETATION SPECIES SELECTION MAY CHANGE DUE TO REFINEMENT OR SPECIES AVAILABILITY AT THE TIME OF PLANTING. SPECIES SUBSTITUTIONS WILL BE COORDINATED BETWEEN ENGINEER AND PLANTING CONTRACTOR PRIOR TO THE PROCUREMENT OF PLANT/SEED STOCK.
3. IN GENERAL, WOODY SPECIES SHALL BE PLANTED AT A DENSITY OF 680 STEMS PER ACRE AND A MINIMUM OF 50 FEET FROM THE TOP OF RESTORED STREAMBANKS TO THE REVEGETATION LIMITS. EXACT PLACEMENT OF THE SPECIES WILL BE DETERMINED BY THE CONTRACTOR'S VEGETATION SPECIALIST PRIOR TO SITE PLANTING AND BASED ON THE WETNESS CONDITIONS OF PLANTING LOCATIONS.
4. SUPPLEMENTAL PLANTING ACTIVITIES SHALL BE PERFORMED WITHIN THE EXISTING BUFFER ENHANCEMENT AREA (BUFFER GROUP 2) USING SPECIES DESCRIBED IN RIPARIAN BUFFER PLANT MIXTURE.
5. ANY INVASIVE SPECIES VEGETATION, SUCH AS CHINESE PRIVET (LIGUSTRUM SINENSE), MULTIFLORA ROSE (ROSA MULTIFLORA), AND MICROSTEGIUM (MICROSTEGIUM VIMINEUM), WILL BE INITIALLY TREATED AS DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS PRIOR TO PLANTING ACTIVITIES TO ALLOW NATIVE PLANTS TO BECOME ESTABLISHED WITHIN THE CONSERVATION EASEMENT.
6. LARGER NATIVE TREE SPECIES TO BE PRESERVED WILL BE FLAGGED BY THE ENGINEER PRIOR TO CONSTRUCTION ACTIVITIES. ANY TREES HARVESTED FOR WOODY MATERIAL WILL BE UTILIZED TO PROVIDE BED AND BANK STABILIZATION, COVER AND/OR NESTING HABITAT.
7. ALL DISTURBED AREAS WILL BE STABILIZED USING MULCHING AND SEEDING AS DEFINED IN THE CONSTRUCTION SPECIFICATIONS AND THE APPROVED SEDIMENTATION AND EROSION CONTROL PLANS.

TEMPORARY SEEDING SCHEDULE

Planting Dates	Botanical Name	Common Name	Application Rate (lbs/acre)
September to March	*Secale cereale*	Rye Grain (Cool Season)	130
April to August	*Urochloa ramosa*	Browntop Millet (Warm Season)	40

PERMANENT SEEDING SCHEDULE

Botanical Name	Common Name	% Proposed for Planting by Species	Seeding Rate (lb/acre)	Wetland Tolerance
Permanent Herbaceous Seed Mixture – Streambank, Floodplain, Wetlands and Riparian Buffer Areas				
(Proposed Seed Rate @ 15 lbs/acre)				
Andropogon gerardii	Big blue stem	10%	1.5	FAC
Dichanthelium clandestinum	Deer Tongue	15%	1.5	FACW
Carex crinata	Fringed sedge	10%	2.25	FACW+
Chasmanthium latifolium	River oats	5%	1.5	FACU
Elymus virginicus	Virginia wild rye	15%	1.5	FAC
Juncus effusus	Soft rush	5%	2.25	FACW+
Panicum virgatum	Switchgrass	10%	1.5	FAC+
Eutrochium fistulosum	Joe-pye-weed	5%	0.75	FACW
Schizachyrium scoparium	Little blue stem	10%	0.8	FACU
Tripsacum dactyloides	Eastern gamagrass	5%	0.75	FAC+
Sorghastrum nutans	Indiangrass	10%	0.75	FACU

PLANTING SCHEDULE

Botanical Name	Common Name	% Proposed for Planting by Species	Wetland Tolerance
Riparian Buffer Bare Root Plantings – Overstory			
(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Fraxinus pennsylvanica	Green Ash	~~6%~~ 7%	FACW
Betula nigra	River Birch	~~7%~~ 8%	FACW
Quercus michauxii	Swamp Chestnut Oak	7%	FACW
~~*Quercus pagoda*~~	~~Cherrybark Oak~~	~~7%~~	~~FACW~~
Platanus occidentalis	American Sycamore	~~10%~~ 7%	FACW
Acer rubrum	Red Maple	5%	FAC
Liriodendron tulipifera	Tulip-poplar	~~10%~~ 7%	FACU
Quercus nigra	Water Oak	~~8%~~ 7%	FAC
Quercus phellos	Willow Oak	~~7%~~ 5%	FACW
Riparian Buffer Bare Root Plantings – Understory			
(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Diospyros virginiana	Persimmon	~~3%~~ 8%	FAC
Carpinus caroliniana	Ironwood	~~8%~~ 8%	FAC
~~*Hamamelis virginiana*~~ *Magnolia virginiana*	~~Witch-hazel~~ Sweetbay Magnolia	~~8%~~ 8%	~~FACU~~ FACW
~~*Asimina triloba*~~ *Ilex verticillata*	~~Paw Paw~~ Winterberry	~~8%~~ 3%	~~FAC~~ FACW
Lindera benzoin	Spicebush	~~7%~~ 8%	FACW
Alnus serrulata	Tag Alder	~~8%~~ 8%	OBL
~~*Corylus americana*~~ *Cornus amomum*	~~Hazelnut~~ Silky Dogwood	~~8%~~ 3%	~~FACU~~ FACW
Riparian Buffer Live Stake Plantings - Streambanks			
(Proposed 2'-3' Spacing @ Meander Bends and 6'-8' Spacing @ Riffle Sections)			
Sambucus canadensis	Elderberry	20%	FACW
Salix sericea	Silky Willow	30%	OBL
Salix nigra	Black Willow	10%	OBL
Cornus amomum	Silky Dogwood	40%	FACW

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waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
8.01.19

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	7-21-17
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E	AS-BUILT	11-30-18

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO. :	97079
FILENAME :	16-20_PEN DELL_REVEGETATION_PLANS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 40'
VERT. SCALE :	N/A

NORTH

40 20 0 40 80

GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

16

PLANTING ZONES

RIPARIAN BUFFER RESTORATION (BUFFER GROUP 1)

RIPARIAN BUFFER ENHANCEMENT (BUFFER GROUP 2)

RIPARIAN BUFFER PRESERVATION (BUFFER GROUP 3)

END CONSTRUCTION R2
STATION 26+24.51

BEGIN CONSTRUCTION R2
STATION 20+77.85

BEGIN CONSTRUCTION R3
STATION 30+93.59

MATCHLINE - SEE SHEET 18

EXISTING GRAVEL DRIVE

EXISTING FARM PATH

EXISTING POND TO REMAIN

VEG PLOT #2

VEG PLOT #3

X-SECT #2

X-SECT #3

WATER QUALITY FEATURE

WENDELL ROAD (SR 1701)
60' PUBLIC R/W

27+00

28+00

29+00

30+00

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03.01.19

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VERT. SCALE :	N/A

NORTH

40 20 0 40 80
GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

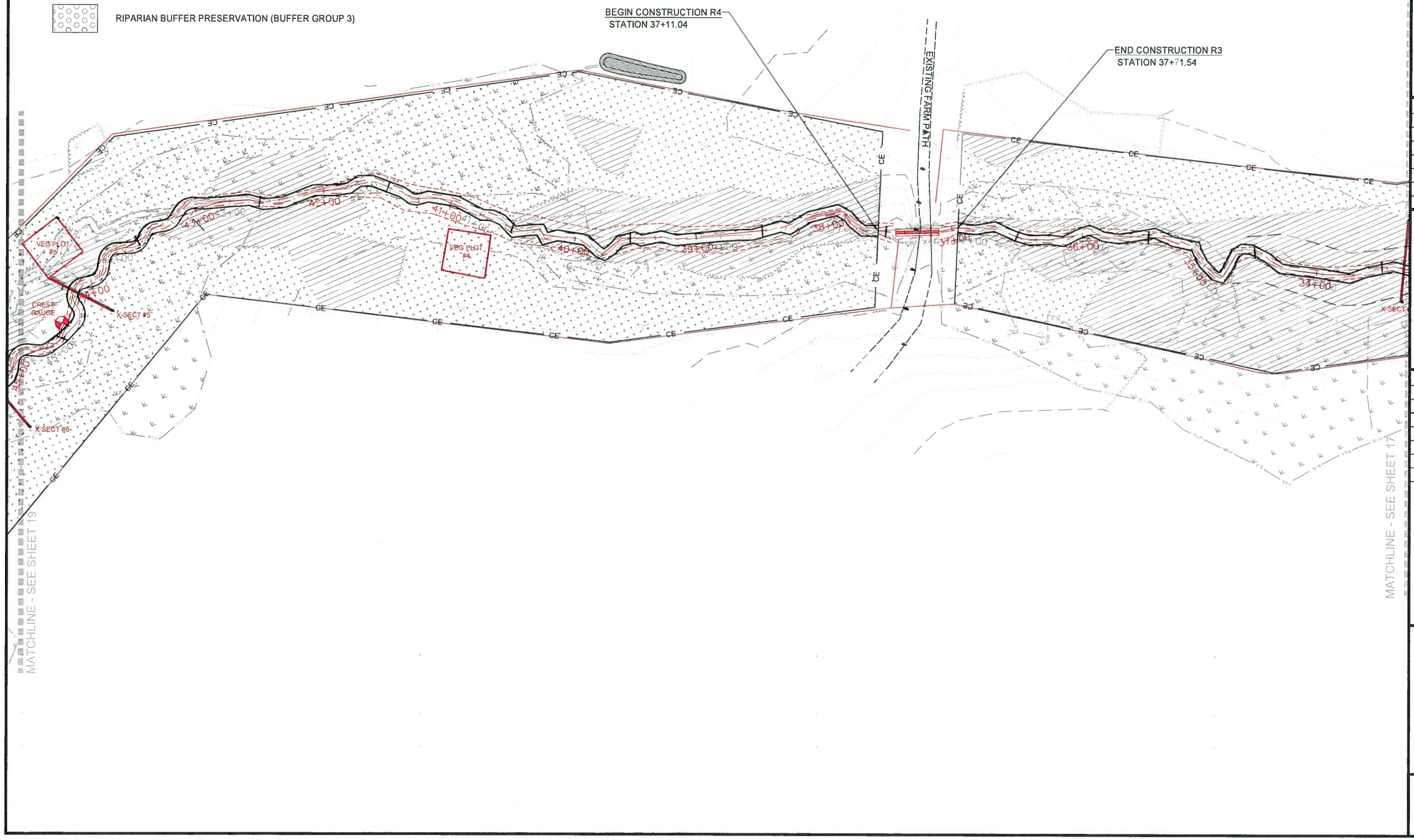
17

PLANTING ZONES

RIPARIAN BUFFER RESTORATION (BUFFER GROUP 1)

RIPARIAN BUFFER ENHANCEMENT (BUFFER GROUP 2)

RIPARIAN BUFFER PRESERVATION (BUFFER GROUP 3)



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40 20 0 40 80

GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

18

PLANTING ZONES

- RIPARIAN BUFFER RESTORATION (BUFFER GROUP 1)
- RIPARIAN BUFFER ENHANCEMENT (BUFFER GROUP 2)
- RIPARIAN BUFFER PRESERVATION (BUFFER GROUP 3)

MATCHLINE - SEE SHEET 20

MATCHLINE - SEE SHEET 18

VEG PLOT #7

VEG PLOT #8

VEG PLOT #5

WETLAND GAUGE

GREST GAUGE

X-SECT #8

X-SECT #7

X-SECT #6

X-SECT #5

54+92

54+00

53+00

52+00

51+00

50+00

49+00

48+00

47+00

46+00

45+00

44+00

END CONSTRUCTION R4
STATION 55+51.09

LAKE WENDELL ROAD (SR 1320)
60' PUBLIC R/W

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

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GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

19

END CONSTRUCTION R4
STATION 55+51.09

BEGIN CONSTRUCTION R5
STATION 56+26.75

LAKE WENDELL ROAD (SR 1320)
60' PUBLIC R/W

END CONSTRUCTION R5
STATION 68+02.90

GROUNDWATER GAUGE

NO PLANTING ACTIVITIES SHALL OCCUR WITHIN R5 PRESERVATION AREA UNLESS OTHERWISE DIRECTED BY ENGINEER.

MATCHLINE - SEE SHEET 1

PLANTING ZONES

RIPARIAN BUFFER RESTORATION (BUFFER GROUP 1)

RIPARIAN BUFFER ENHANCEMENT (BUFFER GROUP 2)

RIPARIAN BUFFER PRESERVATION (BUFFER GROUP 3)

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SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

20

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March 01, 2019

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

RE: WLS Responses to NCDEQ DMS Review Comments for Task 6 Draft Baseline Monitoring Report and Task 7 Draft Monitoring Report Year 1 for the Pen Dell Mitigation Project, NCDEQ DMS Full-Delivery Project ID #97079, Contract #6824, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Ms. Crocker:

Water & Land Solutions, LLC (WLS) is pleased to present the Final Baseline Monitoring Report and Final Monitoring Report Year 1 for the Pen Dell Mitigation Project to the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS). The Final Baseline Monitoring Report and the Final Monitoring Report Year 1 were developed by addressing NCDEQ DMS's review comments.

Under this cover, we are providing the required three (3) hard copies of the Final Baseline Monitoring Report and the Final Monitoring Report Year 1, and the required digital data for each (the .pdf copies of the entire updated reports and the updated digital data) via CDs. We are providing our written responses to NCDEQ DMS's review comments on the Draft Baseline Monitoring Report and Draft Monitoring Report Year 1 below. Each of the DMS review comments is copied below in **bold** text, followed by the appropriate response from WLS in regular text:

Field Notes:

- **DMS Comment: Update posts and/or signage up to specifications in the upper section northeast of Wendell Road.** WLS Response: All conservation easement boundary marking has been re-installed and/or corrected to meet or exceed the specifications as set forth in the NCDEQ DMS "Survey Requirements for Full Delivery Projects", Version 08/13/13, with the installation including the following:
    - Posts:
        - Type: Steel U-channel.
        - Length: 8 foot total length, with posts drive-installed approximately 2 feet deep to provide an installed height of approximately 6 feet above the ground.
        - Weight: 2 lbs/ft.
        - Coating: Factory coated with dark green enamel and at least 6 inches of the top of the post painted bright yellow.
    - Signs:
        - Type: Standard NCDEQ DMS aluminum conservation easement signs supplied by Voss Signs.
        - Spacing: Signs installed at each conservation easement corner, approximately 1 foot outside of each conservation easement corner marker. Signs installed as necessary along conservation easement boundary lines, between conservation easement corners, such that the maximum sign spacing interval is 200 feet.
    - Post attachment: 3/8" aluminum drive rivets.
- **DMS Comment: Ensure the location of the fenced horses north of the pond is not inside easement.** WLS Response: WLS is coordinating with the landowner to resolve this minor encroachment (referenced pasture fence extends approximately 3 feet into the conservation easement boundary at one location).
- **DMS Comment: Review location of the powerline on the north of Lake Wendell Road to ensure it is outside easement.** WLS Response: WLS has contacted Duke Energy to resolve. The existing power pole locations have been surveyed and WLS will verify private/public utility easement type and widths. Hypothetically, a 30-foot wide utility easement off the power poles has been assumed, which would be a ~35 stream credit reduction. This reduction in credits will be reflected in the asset tables.

Electronic Deliverables:

- **DMS Comment: All GIS files should be projected in NAD 83 State Plane coordinate system. These are all in GCS. Update and resubmit (for all projects please).** WLS Response: WLS has updated GIS shapefiles to the correct projections.
- **DMS Comment: DMS does not need Adobe files of any tables or graphs because they are available in the report in that format. Remove from deliverable submittals. Raw files are required.** WLS Response: WLS will removed Adobe pdf files from future deliverable submittals as requested.
- **DMS Comment: It appears that the digital files were submitted for the MY0 only, please also provide files for MY1 (excel and photos, not shapefiles).** WLS Response: The referenced MY1 digital files have been added as requested. Please use the re-submitted version of the referenced files.
- **DMS Comment: Shapefiles: it appears that the fence is inside the easement in the GIS layers provided. Can you check and respond? This is not showing as an issue on the red line as-built.** WLS Response: WLS has field verified the fence is outside the easement boundary and updated the GIS layers for clarification.
- **DMS Comment: Provide existing wetlands shapefile (request, not required).** WLS Response: WLS has provided existing wetlands shapefile as requested.
- **DMS Comment: Provide a shapefile of the stream asset that matches the asset table (from Mitigation Plan shapes). This asset file should match the linear feet of credit in the original asset table and be broken out and attributed (in the attribute table) by stream reach just like the Table 1.** WLS Response: WLS has provided the correct shapefiles that match those reported in the mitigation plan stream asset table.
- **DMS Comment: Although the As-built center line does match the as-built table (Table 1) it appears to have some lengths outside of the easement. Update shapefile to cut out any asset outside the easement and attribute each feature to match Table 1 in the attribute table or work with DMS to figure out what is going on here.** WLS Response: WLS has corrected the shapefile and verified the stream lengths match those reported in the stream asset table.
- **DMS Comment: Provide a shapefile for the riparian buffer asset that contains each are broken out by section on matches the table.** WLS Response: WLS has provided the correct shapefile that matches the riparian buffer asset table.
- **DMS Comment: As a note, once DMS receives and approves GIS data for asset and monitoring features, the only shapes that will be required in future submissions are vegetative areas of concern.** WLS Response: WLS appreciates the clarification and WLS will make sure to provide the correct GIS data as required for the future submissions.

As-Built Report:

1. **DMS Comment: Add the DWR number on the cover page (DWR 2016-0403). This should be true for all report cover pages.** WLS Response: The NCDEQ DWR Project Number (NCDEQ DWR Project # 2016-0403) has been added as requested to the cover page for each of the As-built Baseline Monitoring Reports and Monitoring Reports Year 1 where previously missing.
2. **DMS Comment: Page 1 and 2, WLS lists 5,126 linear feet of stream, but the numbers in the tables don't add up to that (existing showing 5,202). Where is that number from? Please correct and update.** WLS Response: The total existing stream length (5,202 linear feet, pre-restoration) included lengths outside the conservation easement boundary. WLS has verified the mitigation plan (5,115 linear feet) lengths match those reported in the stream asset table.
3. **DMS Comment: Page 1 and 2, the LWP goals and site-specific goals are duplicated on these pages. Remove the sets in the Project Objective and just keep in the Mitigation Objective section.** WLS Response: The referenced language regarding LWP goals and site specific goals have been removed from Section 1 Project Summary as requested.
4. **DMS Comment: Page 3, I don't see the objectives and performance standards listed in this bullet list in the Mitigation Plan. Is this a new addition or possibly from earlier revisions to the Mitigation Plan? See Table 12 in the Mitigation Plan. You can use these same tables from Mitigation Plan in all your future reports to avoid confusion if desired. Decision to leave this section as-is or revise should be consistent on all three project reports.** WLS Response: Sub-section 2.2 Mitigation Project Goals and Objectives and Section 4 Performance Standards have been revised as requested to match those in the approved final mitigation plan, including the addition of the relevant tables from the approved final mitigation plan.
5. **DMS Comment: Page 2, 2.3 this first paragraph contains dates that don't match the dates on the Table 2. Update table and/or section to reflect accurate dates that match.** WLS Response: All references to dates in each of the As-built Baseline Monitoring Reports and Monitoring Reports Year 1 and in Table 2, have been checked and edited/corrected as necessary for consistency, as requested.
6. **DMS Comment: Page 2, 2.3, paragraph 2, please remove first two sentences and reference to WLS contract as this is not relevant to report and does not match asset table in Mitigation Plan or As-built, nor does it reflect project assets.** WLS Response: The referenced sentences have been removed from the Sub-section 2.3 Project History, Contacts, and Timeframe as requested.
7. **DMS Comment: Page 8 references "crest gauges" but only one was installed.** WLS Response: All of the references to crest "gauges" (plural) in the As-built Baseline Monitoring Report and Monitoring Reports Year 1 have been modified

to crest "gage" (singular) to reflect that only one crest gage is being used for stream hydrologic monitoring. Please also note that all references to "gauge" have be change to "gage" for consistency.

8. **DMS Comment: Page 11, Wetlands. The installation and monitoring of three groundwater monitoring devices was agreed to by WLS and DWR (R4 @ 45+50, 50+50, and 64+50), although DMS advised WLS that they were not contractually required. Can WLS provide email or correspondence from DWR / IRT showing that a lesser number of gauges were accepted for inclusion in the MY0 and/or MY1 report and how do you plan on handling this?** WLS Response: WLS has revised the referenced Wetlands Subsection of the As-built Baseline Monitoring Report and Monitoring Report Year 1 to explain that the three requested and agreed upon groundwater monitoring wells have been installed, as follows: "One groundwater monitoring well was installed during the baseline monitoring within an existing wetland area along Reach R4. Two additional groundwater monitoring wells, including an additional one along Reach R4 and an additional one along Reach R5 (preservation), are being installed after the first year of monitoring, scheduled for March 2019. The wells were installed to document groundwater levels within the stream and wetland restoration and for reference and comparison to the preservation areas, at the request of the NCIRT (DWR)."
9. **DMS Comment: Page 11, 6.1, the dates in this first paragraph don't match the dates on Table 2. Update table and/or section to reflect accurate dates that match.** WLS Response: All references to dates in each of the As-built Baseline Monitoring Reports and Monitoring Reports Year 1 and in Table 2, have been checked and edited/corrected as necessary for consistency, as requested.
10. **DMS Comment: Table 1. Mitigation Plan footage should be 526 for R2.** WLS Response: WLS has corrected and verified that the stream lengths match the mitigation plan footages reported in the assets table.
11. **DMS Comment: Add a footnote below Table 1 indicating that you will use Mitigation Plan numbers for project assets.** WLS Response: The following footnote has been added to Table 1 as suggested: "Mitigation Credits are from the final approved mitigation plan, as verified by the as-built survey."
12. **DMS Comment: Page 12, Vegetation section and Revegetation Plan in As-Built drawings: Please indicate the area that was planted (how much area planted and where on map) and if there were any changes from the planting plan. This should be where you show any substitutions. For instance, 'winterberry' was not on planting plan but in Table 6 as planted, and the vegetation plots are only showing 9 of the proposed 19 plants proposed. Use a red line if they were not all used and add any substitutions. This will be helpful with volunteers (of the same planted species) if you need to meet success with them in the future. Can add as a table if this would be helpful (this number and species of stems is AB requirement).** WLS Response: WLS Response: The Revegetation Plan Sheets in the as-built plan set depict the as-built planted areas correctly, as depicted with the planting zone hatching, as shown in the planting zone legend on each sheet. The planting schedule on the Revegetation Plans has been "redlined", as requested, to reflect the referenced plant substitutions (a total of 1 species deletion and 3 species substitutions).
13. **DMS Comment: Table 6. Missing a lot of common names, and there are multiple common names listed. Is this something going on with CVS? Check and fix please.** WLS Response: The referenced omissions and multiple common names are the result of the mechanics/functions of the CVS tool. WLS has manually edited the referenced table as needed for clarification.
14. **DMS Comment: Morphological tables R2 (E1), R3, R4 it appears you may have some of the max and min of the dimensions parameters switched (max showing min and vis versa) on some portions. Double check this is correct.** WLS Response: WLS has corrected the stream dimensions min/max in the morphological tables.

MY1 Report:

1. **DMS Comment: See comments 1-7, 9-10, and 13 from MY0 report above and update MY1 with same.** WLS Response: The referenced DMS comments listed and addressed herein, along with the corresponding edits, corrections, and additions made to the As-built Baseline Monitoring Reports, have also been addressed and made, respectively, as appropriate, to the Monitoring Reports Year 1 Reports as requested.
2. **DMS Comment: Photos-there are some spots that say 'photo not available' but they are showing in the MY0 report. Update.** WLS Response: The As-built Baseline Monitoring Report and Monitoring Report Year 1 photo logs have been revised and updated to address the referenced concern. This includes ensuring that each provided photo was selected such that the same/similar station, location, and perspective was repeated between the As-built Baseline Monitoring (Monitoring Year 0) photos and Monitoring Reports Year 1 photos, and that each vegetation plot and project stream reach was represented, all as applicable and feasible.
3. **DMS Comment: Page 1, Last paragraph: First paragraph contains dates that don't match the dates on the Table 2. Update table and/or section to reflect accurate dates that match.** WLS Response: All references to dates in each of the As-built Baseline Monitoring Reports and Monitoring Reports Year 1 and in Table 2, have been checked and edited/corrected as necessary for consistency, as requested.
4. **DMS Comment: Page 7, Bankfull events, I don't see a Table 8 documenting any bankfull events nor are there any pictures. WLS can't claim any bankfull events in MY1 without this evidence. Update text to not state bankfull events and appendix if there is no Table 8.** WLS Response: WLS is not sure what the issue is with the Table 8 "worksheet" in the version of the 'PenDell_97079_MY1_Annual_Rep_Tables.xls' file DMS received, as the original WLS file has both the crest gage verification and photographic verification of 2 separate bankfull events (09/17/2019 and 11/21/2019) presented. Please use re-submitted version of the referenced file.

5. **DMS Comment: Page 7, Surface flow data. I don't see this data or Figure 4. Without evidence and monitoring, WLS can't claim flow performance.** WLS Response: This was an unintentional omission by WLS. The flow data and corresponding graph has been added to the 'Hydro Folder' as requested.
6. **DMS Comment: Page 8, wetland gauge: See comment #8 above.** WLS Response: WLS has revised the referenced Wetlands Subsection of the As-built Baseline Monitoring Report and Monitoring Report Year 1 to explain that the three requested and agreed upon groundwater monitoring wells have been installed, as follows: "One groundwater monitoring well was installed during the baseline monitoring within an existing wetland area along Reach R4. Two additional groundwater monitoring wells, including an additional one along Reach R4 and an additional one along Reach R5 (preservation), were installed after the first year of monitoring, scheduled for March 2019. The wells were installed to document groundwater levels within the stream and wetland restoration and for reference and comparison to the preservation areas, at the request of the NCIRT (DWR)."
7. **DMS Comment: Geomorph data: XS-6 (riffle) and XS-7 (pool) look like they have changed a bit from MY0. Do you have any concerns about these? Shouldn't the BHR have updated based on this change with the new method?** WLS Response: WLS is not concerned about the adjustments to the referenced cross sections, as it appears to be a minor channel adjustment towards the expected and desired stream dimension and stability. WLS used the new method for calculating adjusted BHRs. The adjusted bankfull elevation using the comparable as-built cross-sectional is approximately one tenth and therefore the BHR would be ~0.9 (<1). The morph table parameters have been updated to reflect this change.
8. **DMS Comment: Tables after 7c. are not filled out with MY1 data. Update report.** WLS Response: WLS is not sure what the issue is with the "worksheets" following Table 7C in the version of the PenDell_97079_MY1_Annual_Rep_Tables.xls file DMS received, as the original WLS file has all of the appropriate data filled in and presented on the referenced "worksheets". Please use re-submitted version of the referenced file.

Riparian Buffer MY0 & MY1 Report:

- **DMS Comment: Page 3. Check dates in the text with Table 2 to match.** WLS Response: All references to dates in each of the As-built Baseline Monitoring Reports and Monitoring Reports Year 1 and in Table 2, have been checked and edited/corrected as necessary for consistency, as requested.
- **DMS Comment: Page 3, last paragraph, first sentence. Remove contracting information as it is N/A.** WLS Response: The referenced sentences have been removed from the Sub-section 2.3 Project History, Contacts, and Timeframe as requested.
- **DMS Comment: Page 3, last paragraph shows 336,432 sf of riparian buffer credit, but the table shows 336,432. Update.** WLS Response: WLS has verified the riparian buffer credits match those reported in the assets table and removed from the last paragraph for consistency.
- **DMS Comment: Page 7, 6.1 check dates with table.** WLS Response: All references to dates in each of the As-built Baseline Monitoring Reports and Monitoring Reports Year 1 and in Table 2, have been checked and edited/corrected as necessary for consistency, as requested.
- **DMS Comment: Table 6. See comments above (#13 in AB section).** WLS Response: WLS Response: The referenced omissions and multiple common names are the result of the mechanics/functions of the CVS tool. WLS has manually edited the referenced table as needed for clarification.
- **DMS Comment: Table 5a is repeated in two places.** WLS Response: WLS was unable to locate the repeated Table 5a. Please use re-submitted version of the referenced file.
- **DMS Comment: Table 2. Update to show sf to the foot. That should be corrected on our template table. Apologies if it is not.** WLS Response: WLS has corrected the referenced table formatting as requested.
- **DMS Comment: Appendix D. Add the DWR Stream Determination letter for R1.** WLS Response: WLS has added the ""Subject: Buffer Determination Letter, NBRO #16-180 Johnston County"" DWR package to the As-built Baseline Monitoring Report Appendices as requested.
- **DMS Comment: Appendix D is printed twice. Ensure this is not repeated on the final.** WLS Response: WLS has insured that only one copy of Appendix D is included in this submittal. Please use the re-submitted version of the referenced file.
- **DMS Comment: See comment #12. For AB. Table of planted species and number is required.** WLS Response: WLS Response: WLS Response: The Revegetation Plan Sheets in the as-built plan set depict the as-built planted areas correctly, as depicted with the planting zone hatching, as shown in the planting zone legend on each sheet. The planting schedule on the Revegetation Plans has been "redlined", as requested, to reflect the referenced plant substitutions (a total of 1 species deletion and 3 species substitutions).
- **DMS Comment: Restoration credit in the R2 section is legitimate because this area was bare and planted but it was not described in the DWR eligibility letter. Add footnote to plan somewhere explaining why this was assigned restoration (instead of preservation) and this will require Katie Merritt reviewing and agreeing with call (indicate which pictures show this to help).** WLS Response: WLS has added the following text to the referenced subsection of the As-built Baseline Monitoring Report and Monitoring Report Year 1, as requested, for clarification: "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)."

Please contact me if you have any further questions or comments.

Sincerely,

Water & Land Solutions, LLC

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As-Built Baseline Monitoring Report
FINAL VERSION
Pen Dell Mitigation Project (Riparian Buffer Mitigation)
Monitoring Year 0
Calendar Year of Data Collection: 2018

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: March-May 2018, Submission Date: March 2019

Prepared for:

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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, North Carolina between the Community of Archer Lodge and the Town of Wendell at 35˚ 43' 52.51'' North and 78˚ 21' 10.12'' West. The Project site is located in the NCDEQ Sub-basin 03-04-06, in the Lower Buffalo Creek Priority Sub-watershed 030202011504 study area for the Neuse 01 Regional Watershed Plan (RWP), and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin.

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 approximately 5,064 linear feet of existing streams, approximately 633,803 square feet of riparian buffers. The Project construction and planting were completed in April 2018 and as-built survey was completed in June 2018. Planting and baseline monitoring activities occurred between April and May 2018 (Table 2). This report documents the completion of the construction activities and presents as-built baseline monitoring data (MY0) for the post-construction monitoring period. Only minor adjustments were made to the final design during construction. The Project is expected to meet the Year 1 Monitoring Year success criteria.

2 Project Background

2.1 Project Location, Setting, and Existing Conditions

The Pen Dell Mitigation Project (Project) site is located in the Upper Buffalo Creek Sub-watershed 030202011502 study area for the Neuse 01 Regional Watershed Plan (RWP), in the Wake-Johnston Collaborative Local Watershed Plan, and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin. The Project site is situated in the lower piedmont where potential for future development associated with the I-540 corridor and rapidly growing Johnston County area is imminent, as described in the Regional Watershed Plan (RWP) for the Upper Neuse River Basin within Hydrologic Unit (HU) 03020201.

The RWP identified and prioritized potential mitigation strategies to offset aquatic resource impacts from development and provided mitigation project implementation recommendations to improve ecological uplift within the Neuse 01 Sub-basin, which included traditional stream and wetland mitigation, buffer restoration, nutrient offsets, non-traditional mitigation projects such as stormwater and agricultural BMPs, and rare, threatened, or endangered (RTE) species habitat preservation or enhancement.

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 approximately 5,064 linear feet of existing streams, approximately 633,803 square feet of riparian buffers permanently protected by a recorded conservation easement (15.95 acres). The catchment area is 156 acres and has an impervious cover of approximately one percent. The dominant land uses are agriculture and mixed forest. Prior to Project 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

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

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

With regards to riparian buffer mitigation, the following site specific goals were developed to address the primary concerns outlined in the LWP and RWP and include:

- 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.

In addition to DWR correspondence and approval, WLS investigated on-site jurisdictional waters of the US (WOTUS) using the US Army Corps of Engineers (USACE) Routine On-Site Determination Method. This method is defined in the 1987 Corps of Engineers Wetlands Delineation Manual and subsequent Eastern Mountain and Piedmont Regional Supplement. Determination methods included stream classification utilizing the NCDWQ Stream Identification Form and the USACE Stream Quality Assessment Worksheet. The results of the on-site field investigation indicated that Project Reaches R1, R2, R3, R4, and R5 were determined to be jurisdictional stream channels. Project Reaches R2, R3, R4, and R5 were determined to be perennial while Project Reach R1 was determined to be intermittent. USACE representative Samantha Dailey verified Jurisdictional Determinations during a field visit on December 20, 2016.

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.

The project background and attribute summary is 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 will be 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.

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 (5) 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 (4) native hardwood tree species or four (4) native hardwood tree and native shrub species, where no one species is greater than fifty (50) percent of the stems. Native hardwood tree and native shrub volunteer species may be included to meet the final performance criteria of 260 stems per acre. In addition, diffuse flow of runoff shall be maintained in the riparian buffer areas.

5 Monitoring Plan

The monitoring plan is described in the approved mitigation plan and is intended to document the site improvements based on restoration potential, catchment health, ecological stressors and overall constraints. The measurement methods described below provide a connection between project goals and objectives, performance standards, and monitoring requirements to evaluate functional improvement.

5.1 Monitoring Schedule and Reporting

A period of at least six months will separate the as-built baseline measurements and the first-year monitoring measurements. The baseline monitoring document and as-built monitoring report will include all information required by the current DMS templates (June 2017) and applicable guidance referenced in the approved mitigation plan, including planimetric (plan view) information, photographs, sampling plot locations, a description of initial vegetation species composition by community type, and location of monitoring stations. The report will include a list of the vegetation species planted, along with the associated planting densities. WLS will conduct mitigation performance monitoring based on these methods and will submit annual monitoring reports to DMS by December 1st of each monitoring year during which required monitoring is conducted. The annual monitoring reports will organize and present the information resulting from the methods described in detail below.

5.2 Visual Assessment Monitoring

WLS will conduct visual assessments in support of mitigation performance monitoring. Visual assessments of all stream reaches will be conducted twice per monitoring year with at least five months in between each site visit for each of the five years of monitoring. Photographs will be used to visually document system performance and any areas of concern related to plant mortality, impacts from invasive plant species or animal browsing, easement boundary encroachments, and cattle exclusion fence damage. The monitoring activities will be summarized in DMS's *Visual Stream Morphology Stability Assessment Table* and the *Vegetation Conditions Assessment Table*, which are used to document and quantify the visual assessment throughout the monitoring period.

A series of photographs over time will be also be compared to evaluate successful maturation of riparian vegetation. The photographs will be taken from a height of approximately five feet to ensure that similar locations (and view directions) at the site are documented in each monitoring period and will be shown on the current conditions plan view map (CCPV). The results of the visual monitoring assessments will be used to support the development of the annual monitoring document that provides the visual assessment metrics.

5.3 Vegetation Assessment Monitoring

Successful restoration of the vegetation at the project site is dependent upon successful hydrologic restoration, active establishment and survival of the planted preferred canopy vegetation species, and volunteer regeneration of the native plant community. To determine if these criteria are successfully achieved, vegetation-monitoring quadrants or plots have been installed and will be monitored across the restoration site in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2017).

The vegetation monitoring plots are approximately 2% of the planted portion of the site with a total of seven (7) plots established randomly within the planted riparian buffer areas. The sampling may employ quasi-random plot locations which may vary upon approval from DMS, DWR and IRT. Any random plots should comprise more than 50% of the total required plots and the location (GPS coordinates and orientation) will identified in the monitoring reports. No monitoring quadrants were established within undisturbed wooded areas, such as those along Reach R5, however visual observations will be documented in the annual monitoring reports to describe any changes to the existing vegetation community. The size and location of individual quadrants is 100 square meters (10m X 10m) for woody

tree species. The vegetation plot corners have been marked and surveyed with a GPS unit. See Figure 1 in Appendix E for the vegetation monitoring plot locations.

Vegetation monitoring will occur in the fall each required monitoring year, prior to the loss of leaves. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings. Data will be collected at each individual quadrant and will include specific data for monitored stems on diameter, height, species, date planted, and grid location, as well as a collective determination of the survival density within that quadrant. Individual planted seedlings were marked at planting or monitoring baseline setup so that those stems can be found and identified consistently each successive monitoring year. Volunteer species will be noted and their inclusion in quadrant data will be evaluated with DMS on a case-by-case basis. The presence of invasive species vegetation within the monitoring quadrants will also be noted, as will any wildlife effects.

At the end of the first full growing season (from baseline/year 0) or after 180 days between March 1st and November 30th, species composition, stem density, and survival will be evaluated. For each subsequent year, vegetation plots shall be monitored for seven years in years 1, 2, 3, 4, and 5 or until the final success criteria are achieved. WLS will provide required remedial action on a case-by-case basis, such as replanting more wet/drought tolerant species vegetation, conducting beaver and beaver dam management/removal, and removing undesirable/invasive species vegetation, and will continue to monitor vegetation performance until the corrective actions demonstrate that the site is trending towards or meeting the standard requirement. Existing mature woody vegetation will be visually monitored during annual site visits to document any mortality, due to construction activities or changes to the water table, that negatively impact existing forest cover or favorable buffer vegetation.

6 As-Built (Baseline) Condition

6.1 As-built (Baseline) Survey

An as-built survey, conducted under the responsible charge of a North Carolina Professional Land Surveyor (PLS), was utilized to document the as-built or baseline condition of the Project post-construction. The Project construction and planting were completed in April 2018 and as-built survey was completed in June 2018. Planting and baseline monitoring activities occurred between April and May 2018. The as-built survey included locating the constructed stream channels, in-stream structures, monitoring device locations (i.e. veg plots), a longitudinal profile survey, and cross-section surveys. For comparison purposes, the site reaches and riparian buffer areas were divided into the same assessment reaches that were established for the project assessment and design (R1, R2, R3, R4, and R5).

6.2 As-Built (Baseline) Plans/ Record Drawings

The results of the as-built survey are used to establish and document post-construction or baseline conditions and will be used for comparing post-construction monitoring data each monitoring year. The as-built survey plan set includes these same plan sheets (cover, legend/construction sequence/general notes, typical sections, details, plans and profile, and revegetation plan) as the final construction plans. The as-built survey plan set was developed utilizing the final construction plan set as the “background”, and then overlaying the as-built survey information on the plan and profile sheets. Any significant adjustments or deviations made to the final construction plans during construction are shown as redline mark-ups or callouts on the as-built survey plan sheets, as appropriate, to serve as record drawings. The as-built survey plan set is located in Appendix E.

6.3 As-Built/ Baseline Assessment

No deviations of significance were documented between the final construction plans and the as-built condition that may affect channel performance or changes in vegetation species planted. Additionally, no major issues or mitigating factors were observed immediately after construction which require consideration or remedial action.

6.3.1 Vegetation Assessments

The MY0 average planted density is 763 stems per acre, which exceeds the interim measure of vegetative success of at least 260 planted stems per acre at the end of the fifth monitoring year. This density includes enough native species hardwood tree and shrub species to exceed the final performance criteria shall include a minimum of four (4) native hardwood tree species or four (4) native hardwood tree and native shrub species, where no one species is greater than fifty (50) percent of the stems. In addition, diffuse flow of runoff is being maintained in the riparian buffer areas. Summary data and photographs of each plot can be found in Appendix B.

7 References

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

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

North Carolina Department of Environmental Quality, Division of Mitigation Services, 2017. As-built Baseline Monitoring Report Format, Data and Content Requirement. Raleigh, NC.

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

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

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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)	371,215
Types of Credits	Riparian Buffer
Mitigation Plan Date	Nov-18
Initial Planting Date	Mar-18
Baseline Report Date	Nov-18
MY1 Report Date	
MY2 Report Date	
MY3 Report Date	
MY4 Report Date	
MY5 Report Date	

Table 2. Buffer Project Areas and Assets

RIPARIAN BUFFER (15A NCAC 02B.0295)

Location	Jurisdictional Streams	Restoration Type	Reach ID/Component	Buffer Width (ft)	Total Area (sf)	Creditable Area (sf)*	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits	Convertible to Nutrient Offset (Yes or No)	If Converted to Nutrient Offset: Nutrient Offset: N (lbs)	If Converted to Nutrient Offset: Nutrient Offset: P (lbs)
Rural or Urban	Subject or Nonsubject	Restoration		20-29			1	75%	1.33333	0.000		-	0.000
Rural or Urban	Subject or Nonsubject	Restoration	Restoration	0-100	286,888	286,888	1	100%	1.00000	286,888.000	Yes	14,970.199	--
Rural or Urban	Subject or Nonsubject	Restoration		101-200			1	33%	3.03030	0.000		-	0.000
Rural or Urban	Subject or Nonsubject	Enhancement		20-29			2	75%	2.66667	0.000		-	0.000
Rural or Urban	Subject or Nonsubject	Enhancement	Cattle Exc. Enh	0-100	124,088	124,088	2	100%	2.00000	62,044.000	No	-	0.000
Rural or Urban	Subject or Nonsubject	Enhancement		101-200			2	33%	6.06061	0.000		-	0.000
					SUBTOTALS	**410,976**				**348,932.000**		**14,970.199**	**0.000**

ELIGIBLE PRESERVATION AREA					**136,992**	

Location	Jurisdictional Streams	Restoration Type	Reach ID/Component	Buffer Width (ft)	Total Area (sf)	Creditable Area (sf)*	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits
Rural	Subject	Preservation		20-29			10	75%	13.33333	0.000
Rural	Subject	Preservation	Preservation	0-100	222,827	136,992	10	100%	10.00000	13,699.200
Rural	Subject	Preservation		101-200			10	33%	30.30303	0.000
Rural	Nonsubject	Preservation		20-29			5	75%	6.66667	0.000
Rural	Nonsubject	Preservation		0-100			5	100%	5.00000	0.000
Rural	Nonsubject	Preservation		101-200			5	33%	15.15152	0.000
Urban	Subject or Nonsubject	Preservation		20-29			3	75%	4.00000	0.000
Urban	Subject or Nonsubject	Preservation		0-100			3	100%	3.00000	0.000
Urban	Subject or Nonsubject	Preservation		101-200			3	33%	9.09091	0.000
					SUBTOTALS	**136,992**				**13,699.200**
					TOTALS	**547,968**				**362,631.200**

**Area eligible for preservation may be no more than 25% of total area, where total area is back-calculated with the equation R+E/0.75.*

**Buffers must be at minimum 20' wide for riparian buffer credit, buffers must be 50' wide for nutrient offset credit*

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

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

Table 3. Project Contacts Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)	
Mitigation Provider Primary Project POC	Water & Land Solutions, LLC 11030 Raven Ridge Road, Suite 200, Raleigh, NC 27614 William Scott Hunt, III, PE Phone: 919-270-4646
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 11030 Raven Ridge Road, Suite 200, Raleigh, NC 27614
Stream Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646
Vegetation Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646
Wetland Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646

Appendix B – Visual Assessment Data

Legend

- Conservation Easement
- Stream
- Top of Bank
- CVS Plot Origin
- CVS Plots

Buffer Mitigation Types

- Preservation
- Enhancement
- Restoration

R1
R2
R3
R4
R5

Access point:
35°43'57.28"N
78°21'1.66"W

Access point:
35°43'51.87"N
78°21'4.08"W

Access point:
35°43'38.33"N
78°21'28.78"W

Wendell Rd

Lake Wendell Rd

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

647 809 688 1093

0 200 400 Feet

N

Aerial: Google Earth Spring 2018

WATER & LAND™ SOLUTIONS

Pen Dell Mitigation Project
Johnston County, North Carolina

NCDMS Contract No. 6824
NCDMS Project No. 97079
April 2018
MY0

Riparian Buffer &
Nutrient Offset Buffer
Mitigation Plan View

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
1

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%

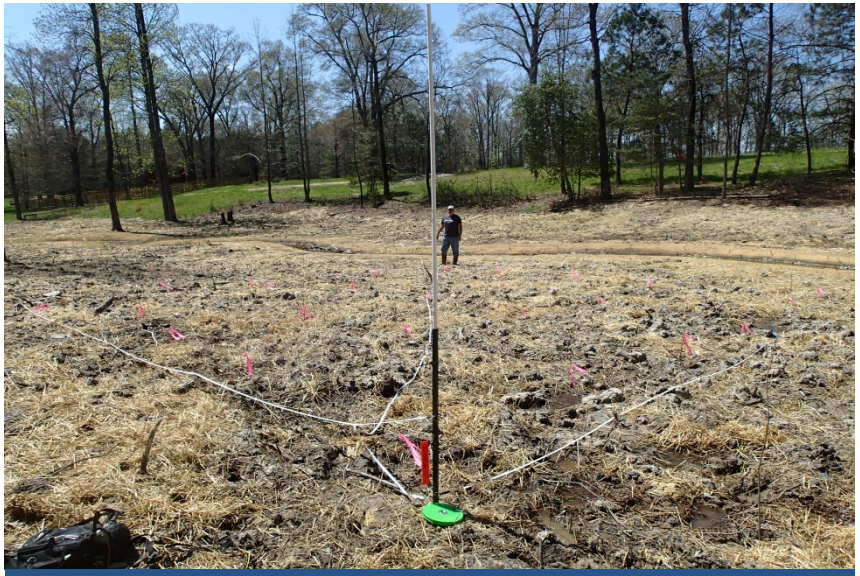
Veg Plot 1 April 12, 2018 (MY-00)

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

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

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

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



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

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

Appendix C – Vegetation Plot Data

Table 6. Baseline Vegetation

Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)

			Current Plot Data (MY0-2018)																					Annual Means		
			002-01-0001			002-01-0002			002-01-0003			002-01-0004			002-01-0005			002-01-0006			002-01-0007			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**
Acer rubrum	Red Maple	Tree													2	2	2	1	1	1				3	3	3
Alnus serrulata	Tag Alder, Smooth Alder, Hazel Alder	Shrub Tree							1	1	1							1	1	1	1	1	1	3	3	3
Betula nigra	River Birch, Red Birch	Tree	3	3	3				1	1	1	4	4	4	2	2	2	4	4	4				14	14	14
Carpinus caroliniana	Ironwood	Shrub Tree							3	3	3				2	2	2	4	4	4	1	1	1	10	10	10
Cornus amomum	Silky Dogwood	Shrub Tree	1	1	1				2	2	2				1	1	1	1	1	1	1	1	1	6	6	6
Diospyros virginiana	American Persimmon, Possumwood	Tree										1	1	1				1	1	1				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
Ilex verticillata	Winterberry	Shrub Tree				3	3	3																3	3	3
Lindera benzoin	Northern Spicebush	Shrub Tree	1	1	1	6	6	6	2	2	2										4	4	4	13	13	13
Liriodendron tulipifera	Tulip Tree	Tree	4	4	4	2	2	2				4	4	4				2	2	2	1	1	1	13	13	13
Magnolia virginiana	Sweetbay Magnolia	Shrub Tree	2	2	2	5	5	5	2	2	2	2	2	2				1	1	1	2	2	2	14	14	14
Platanus occidentalis	Sycamore, Plane-tree	Tree							2	2	2	2	2	2	5	5	5	4	4	4	1	1	1	14	14	14
Quercus michauxii	Basket Oak, Swamp Chestnut Oak	Tree							2	2	2	2	2	2	1	1	1	3	3	3	1	1	1	9	9	9
Quercus nigra	Water Oak, Paddle Oak	Tree	3	3	3	2	2	2	1	1	1	2	2	2							1	1	1	9	9	9
Quercus phellos	Willow Oak	Tree	1	1	1	2	2	2				1	1	1	1	1	1	3	3	3				8	8	8
Viburnum nudum	Southern Wild Raisin, Possumhaw	Shrub Tree																			1	1	1	1	1	1
		Stem count	16	16	16	20	20	20	17	17	17	20	20	20	16	16	16	27	27	27	16	16	16	132	132	132
		size (ares)	1			1			1			1			1			1			1			7		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.17		
		Species count	8	8	8	6	6	6	10	10	10	9	9	9	8	8	8	12	12	12	11	11	11	16	16	16
		Stems per ACRE	647	647	647	809	809	809	688	688	688	809	809	809	647	647	647	1093	1093	1093	647	647	647	763	763	763

Color for Density

Exceeds requirements by 10%

Exceeds requirements, but by less than 10%

Fails to meet requirements, by less than 10%

Fails to meet requirements by more than 10%

Appendix D – NC DWR Correspondence and Approvals

Water Resources
ENVIRONMENTAL QUALITY

PAT MCCRORY
Governor

DONALD R. VAN DER VAART
Secretary

S. JAY ZIMMERMAN
Director

April 28, 2016

DWR Project #: 2016-0403

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

Re: Site Viability for Buffer Mitigation & Nutrient Offset – Pen Dell
Located near 2505 Wendell Rd, Wendell, NC
Johnston County

Dear Mr. Hunt,

On April 8, 2016, Katie Merritt, with the Division of Water Resources (DWR), assisted you and others from Water & Land Solutions, LLC at the proposed Pen Dell Mitigation Site (Site) in Wendell, NC. The Site is located in the Neuse River Basin within the 8-digit Hydrologic Unit Code 03020201. The Site is being proposed as part of a full-delivery stream restoration project for the Division of Mitigation Services (RFP #16-006477). The Interagency Review Team (IRT) was also present onsite. At your request, Ms. Merritt performed a site assessment of features onsite to determine suitability for buffer and nutrient offset mitigation. Features are more accurately shown in the attached maps signed by Ms. Merritt on April 25, 2016. If approved, mitigating this site could provide stream mitigation credits, riparian buffer credits and/or nutrient offset credits.

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

Feature	Classification	[1]Subject to Buffer Rule	Adjacent Land uses	Buffer Credit Viable	[2]Nutrient Offset Viable at 2,273 lbs/acre	Mitigation Type/Comments
R1 (wood line to road)	Undetermined conveyance	n/a	Active and pre-existing row crop; Land use along the conveyance consisted of a +/- 25' narrow forested fringe w/ canopy from 1999-2010	n/a	Yes	Restoration for nutrient offset outside of 25' on both sides of conveyance w/ plantings and easement starting at TOB back max 200'; Need stream determination by DWR if pursuing buffer credit; if feature is a stream, feature is viable for buffer restoration per 15A NCAC 02B .0295 (o)(3) outside of 25' on both sides of conveyance.

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

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

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

Maps showing the project site and the features are provided and are signed by Ms. Merritt on April 25, 2016. This letter should be provided in all future mitigation plans for this Site. In addition, all vegetative plantings, performance criteria and other mitigation requirements for riparian restoration, enhancement and preservation must follow the requirements in 15A NCAC 02B .0295 to be eligible for buffer and/or nutrient offset credits. Where buffer and nutrient offset credits are viable in the same area, only one credit type is allowed to be generated for credit, not both.

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

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

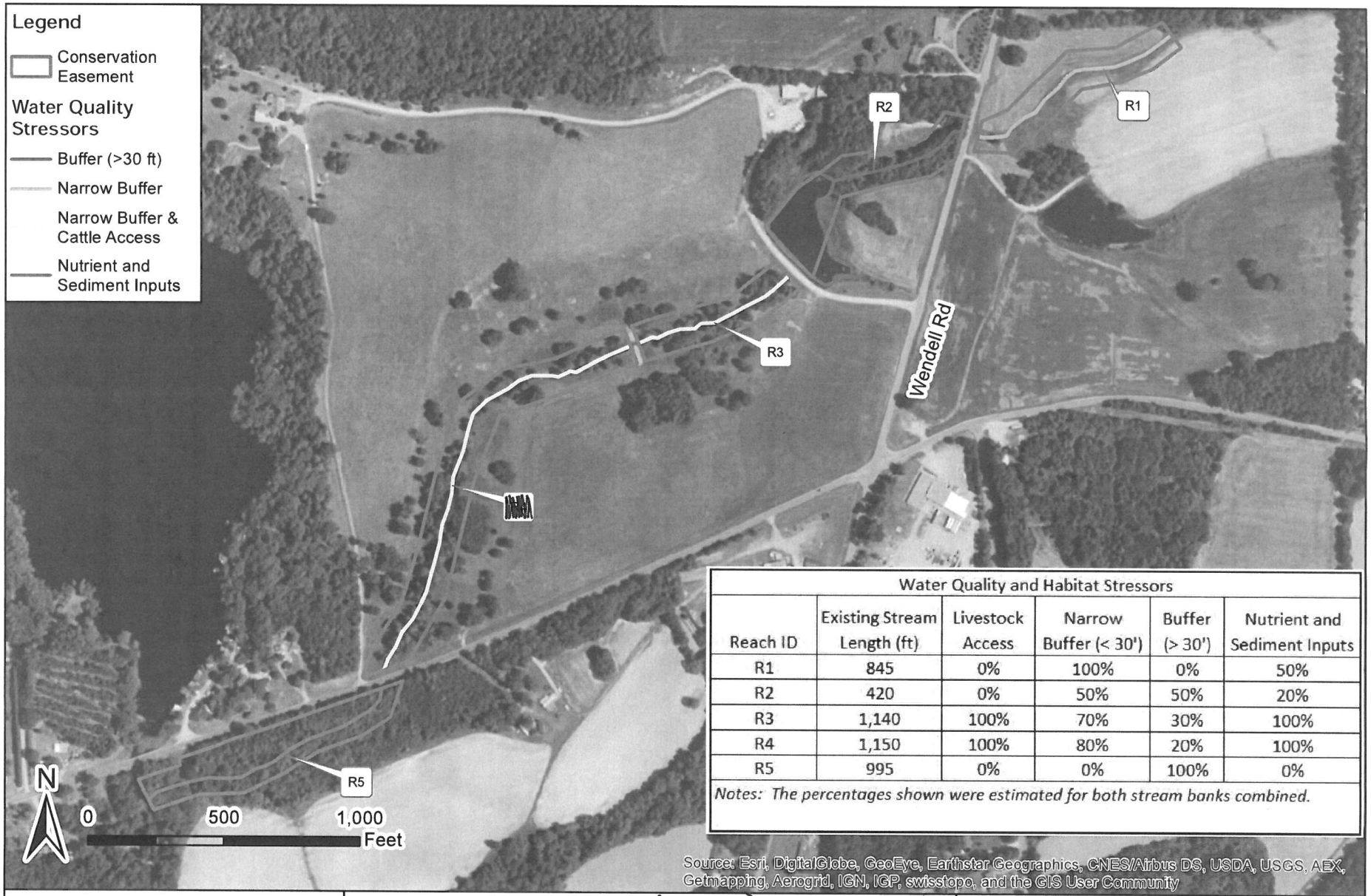
Sincerely,

Karen Higgins

Karen Higgins, Supervisor
401 and Buffer Permitting Branch

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

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



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

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

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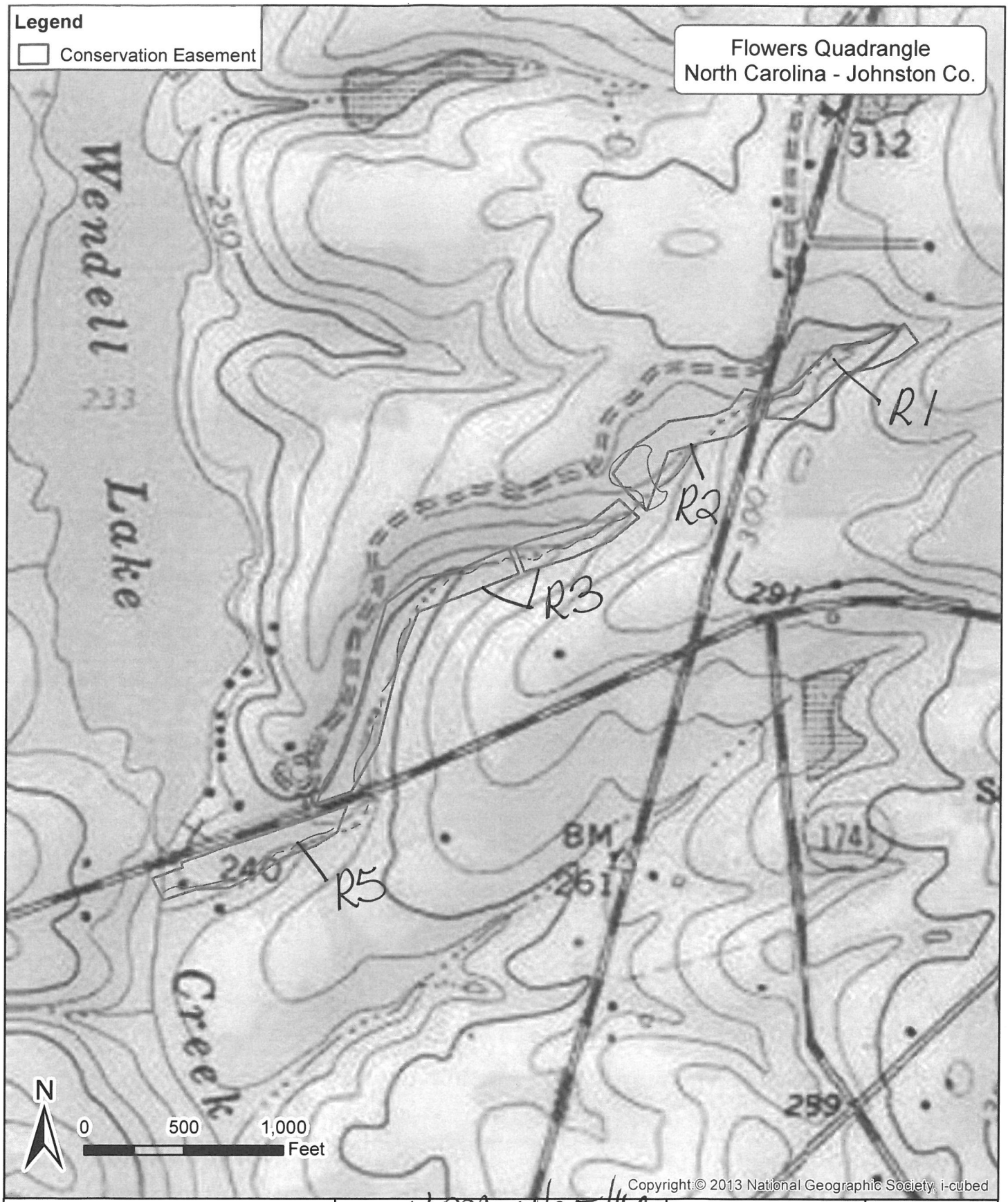
Site Aerial (Current) Kym 4/25/16

Pen Dell
Mitigation Project DWR # 2016-0403

Water Quality Stressors

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
9



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KJM 4/25/14

Pen Dell
Mitigation Project
DWR#2016-0403

USGS
Topographic
Map

NAD 1983 2011 State Plane

FIGURE
2

Google earth feet 600 meters 100

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

Google earth

feet 400
meters 100

Aerial dated 7/2010

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

Appendix E – As-Built Plans / Record Drawings