Mitigation Plan
Horne Creek Tributaries Mitigation Project

Surry County, North Carolina

FINAL VERSION

NCDEQ DMS Project Identification # 100026
NCDEQ DMS Contract # 7181
Yadkin River Basin (Cataloging Unit 03040101)
USACE Action ID Number: SAW-2017-01510
Contracted Under RFP # 16-006993

Prepared for:

Environmental Quality

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

July 2019

Prepared by:

WATER & LAND SOLUTIONS
7721 SIX FORKS ROAD, SUITE 130, RALEIGH, NC 27615
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This mitigation plan has been written in conformance with the requirements of the following:

- Federal rule for compensatory mitigation project sites as described in the Federal Register, Title 33, Navigation and Navigable Waters, Volume 3, Chapter 2, Section § 332.8, paragraphs (c)(2) through (c)(14).
- NCDEQ Division of Mitigation Services In-Lieu Fee Instrument, signed and dated July 28, 2010.
- North Carolina Administrative Code (NCAC), “Consolidated Buffer Mitigation Rule”, Rule 15ANCAC 02B .0295, Effective November 1, 2015, for all Riparian Buffer Mitigation.

These documents govern NCDEQ Division of Mitigation Services operations and procedures for the delivery of compensatory mitigation.

Kayne M. Van Stell
Vice President, Ecosystem Design Services
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DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
69 DARLINGTON AVENUE
WILMINGTON, NORTH CAROLINA 28403-1343

REPLY TO
ATTENTION OF:

July 29, 2019

Regulatory Division

Re: NCIRT Review and USACE Approval of the Horne Creek Tributaries Mitigation Plan; SAW-2017-01510; NCDMS Project # 100026

Mr. Tim Baumgartner
North Carolina Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Dear Mr. Baumgartner:

The purpose of this letter is to provide the North Carolina Division of Mitigation Services (NCDMS) with all comments generated by the North Carolina Interagency Review Team (NCIRT) during the 30-day comment period for the Horne Creek Tributaries Mitigation Plan, which closed on June 21, 2019. These comments are attached for your review.

Based on our review of these comments, we have determined that no major concerns have been identified with the Draft Mitigation Plan, which is considered approved with this correspondence. However, several minor issues were identified, as described in the attached comment memo, which must be addressed in the Final Mitigation Plan.

The Final Mitigation Plan is to be submitted with the Preconstruction Notification (PCN) Application for Nationwide permit approval of the project along with a copy of this letter. Issues identified above must be addressed in the Final Mitigation Plan. All changes made to the Final Mitigation Plan should be summarized in an errata sheet included at the beginning of the document. If it is determined that the project does not require a Department of the Army permit, you must still provide a copy of the Final Mitigation Plan, along with a copy of this letter, to the appropriate USACE field office at least 30 days in advance of beginning construction of the project. Please note that this approval does not preclude the inclusion of permit conditions in the permit authorization for the project, particularly if issues mentioned above are not satisfactorily addressed. Additionally, this letter provides initial approval for the Mitigation Plan, but this does not guarantee that the project will generate the requested amount of mitigation credit. As you are aware, unforeseen issues may arise during construction or monitoring of the project that may require maintenance or reconstruction that may lead to reduced credit.

Thank you for your prompt attention to this matter, and if you have any questions regarding this letter, the mitigation plan review process, or the requirements of the Mitigation Rule, please call me at 919-554-4884, ext 60.

Sincerely,

Kim Browning
Mitigation Project Manager
for Henry Wicker

Enclosures

Electronic Copies Furnished:

NCIRT Distribution List
Paul Wiesner– NCDMS
Matthew Reid—NCDMS
Kayne VanStell—WLS

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
69 DARLINGTON AVENUE
WILMINGTON, NORTH CAROLINA 28403-1343

REPLY TO
ATTENTION OF:

CESAW-RG/Browning July 12, 2019

MEMORANDUM FOR RECORD

SUBJECT: Horne Creek Tributaries Mitigation Site - NCIRT Comments during 30-day Mitigation Plan Review

PURPOSE: The comments listed below were posted to the NCDMS Mitigation Plan Review Portal during the 30-day comment period in accordance with Section 332.8(g) of the 2008 Mitigation Rule.

NCDMS Project Name: Horne Creek Tributaries Mitigation Site, Surry County, NC

USACE AID#: SAW-2017-01510

NCDMS #: 100026

30-Day Comment Deadline: June 21, 2019

<u>*DWR Comments:*</u>

1. Section 3.1.4- Benthic Macroinvertebrates- DWR appreciates WLS performing the preconstruction monitoring for benthic macroinvertebrates. DWR looks forward to the results of post construction monitoring.
2. Table 14: please explain the differing measurement methodologies referred to in note 2.
3. Section 6.4- DWR likes the attention paid to wetlands on the site even though there are no wetland credits proposed for this project. In these cases, DWR is mostly concerned with maintaining the current wetland resources on site and when possible, enhancing or restoring the wetland resources on site.
4. Section 6.7- Water Quality Treatment Features- While DWR appreciates the installation of these features, their placement above reach R3 may negatively affect the flow for this intermittent stream.
5. In the Monitoring Section, there is no mention of macrobenthic monitoring. Does WLS intend to monitor macrobenthics during the monitoring phase and if so, what is your general protocol?
6. Design sheet 3- DWR would prefer to see specific bank slopes identified on the typicals. We realize these slopes may vary, however; we would prefer to see the slopes specified even if they are “on average”.
7. DWR believes that reaches R2 and R3 are at a high risk to lose flow or not have enough flow to maintain stream characteristics.
8. Design sheet 10- DWR would like to see the flow gauge moved to station 12+00 on reach R2.
9. While DWR will not require a flow gauge on reach R3, this reach should probably have at least a camera to document flowing conditions.
10. Design sheet 11- is the crossing on this sheet existing? One concern is it shows the crossing going through a wetland. DWR recommends this crossing be eliminated. In addition, three stream segments (R4, R4a and R4b) will be constructed in or immediately adjacent to wetlands. DWR recommends installation of a gauge at station 22+00 on R4 on stream left. If the crossing is not removed, DWR will want a plan on how the designer will maintain no net loss of wetlands on site.

11. Looking at the photos of reach R4a, particularly at the downstream reach and its confluence with R4, there does not appear to be a need for any channel construction. Please substantiate why channel construction is needed in this area.

Kim Browning, USACE:

1. R2 and R3 have very small watersheds, concern about maintaining flow and jurisdiction. Recommend camera points and flow gauges here.
2. Design Sheet 10: It appears that there are three BMPs within the easement. Please ensure that these features are not in the jurisdictional areas as it is unclear on the maps and design sheets, and that their short-term maintenance is discussed in the text, if any is necessary.
3. Even though there are no wetland credits being sought, and existing wetlands are fairly small, the restoration of reach 4 appears to run through WD. Please ensure that permanent impacts to these wetlands during construction do not result in loss of function, though it is anticipated that overall wetland function will improve from increased hydrology in this area. It's recommended that a temporary veg plot be placed in this area.
4. It would be helpful to depict photo points on Figure 9.
5. Section 4.1.2 Functional Uplift Potential and Table 11: The functional pyramid is cited to show existing conditions for each category, and was used to describe the functional uplift potential of the project, which is appreciated. Please note that the functional pyramid and SQT tool have not been approved for use by the IRT in determining success for mitigation projects. It would be interesting to see the correlation of the NCSAM assessment compared to the SQT throughout the project. Furthermore, three of the reaches are already scored as FAR and the proposed condition is also FAR. Please justify the functional uplift if the conditions are not changing.
6. Table 12 and Table 23: Hydraulics, the BHR goal should read not to exceed 1.2.
7. Page 41, last paragraph and Table 21: please ensure that red maple are not included in the planting plan.
8. Section 7.1: Stream Hydrology—"In addition to the two bankful flow events, two…" is confusing. It should read four bankful events.
    a. Jurisdictional Stream Flow: Please add a statement that intermittent streams should be added requiring at least 30-days consecutive flow within a calendar year.
    b. Stream Profiles: The ER should be no less than 1.4 for B type channels.
    c. Stream Horizontal Stability: It would be beneficial to have a specific measurement parameter, for example, BHR and ER at any measured riffle cross-section should not change by more than 10% from the baseline condition during any given monitoring interval.
9. Section 7.3: Please include a vigor standard for vegetation of 7 feet high in year five and 10 feet high in year 7.
10. Did I miss the section on site constraints or potential risks?
11. Buffer Widths: Portions of R1, R2, and R5 do not meet the minimum buffer width of 30 ft. This is approximately 11% of the total restored length, which exceeds the guidance allowing no more than 5% of the total project length. Would the 11% change if you calculated the total project length, verses only using the restored length? If the result is still over 5%, the buffer tool needs to be used. If the Buffer Tool is used, please clearly show the loss or addition of credits in the Table 1 and 14.
    a. The Buffer calculation table in the appendix, Table 1 and Table 14 all appear to have different credit totals. Please clarify.

Kim Browning
Mitigation Project Manager
Regulatory Division

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July 29, 2019

US Army Corps of Engineers
Regulatory Division, Wilmington District
Attn: Kim Browning
3331 Heritage Trade Drive, Suite 105
Wake Forest, NC 27587

RE: WLS Responses to NCIRT 30-day Review Comments Regarding Task 3 Submittal, Final Mitigation Plan Approval for the Horne Creek Tributaries Mitigation Project, USACE AID# SAW-2017-01510, NCDEQ DMS Full-Delivery Project ID #100026, Contract #7181, Yadkin River Basin, Cataloging Unit 03040101, Surry County, NC

Dear Ms. Browning:

Water & Land Solutions, LLC (WLS) is pleased to provide our written responses to the North Carolina Interagency Review Team (NCIRT) review comments dated July 12th, 2019 regarding the Final Draft Mitigation Plan for the Horne Creek Tributaries Mitigation Project. We are providing our written responses to the NCIRT's review comments below, which includes editing and updating the Final Draft Mitigation Plan and associated deliverables accordingly. Each of the NCIRT review comments is copied below in bold text, followed by the appropriate response from WLS in regular text:

DWR Comments:

1. Section 3.1.4 - Benthic Macroinvertebrates - DWR appreciates WLS performing the preconstruction monitoring for benthic macroinvertebrates. DWR looks forward to the results of post construction monitoring. Response: WLS intends to monitor macroinvertebrate communities and aquatic health post-construction through MY7 using methods and procedures defined by DWR's "*Standard Operating Procedures for the Collection and Analysis of Benthic Macroinvertebrates*" (NCDWR, 2016) as mentioned Section 3.1.4 and in Table 23 'Proposed Monitoring Plan Summary'. The proposed sample locations are shown on Figure 9 and will be taken at restored reaches R1/R5. It should be mentioned that the footnote under Table 23 states "Level 4 and 5 project parameters and monitoring activities states that the results will not be tied to performance standards nor required to demonstrate success for credit release." To provide further emphasis, the following language is also included under Section 4.1.3-Restoration Potential of the mitigation plan, "Not all functional categories and parameters, such as water quality (Physicochemical - Level 4) and performance standards listed in the SQT will be compared or required to determine project success and stream mitigation credit and debit scenarios."

2. Table 14: please explain the differing measurement methodologies referred to in note 2. Response: WLS has deleted the note since it not necessary nor does it clarify the table contents. During the project's proposal stage, we used GIS shapefiles and field hip chains to estimate the total existing stream length. The difference between the existing stream lengths estimated at the proposal stage (and the associated proposed stream mitigation credits) and existing stream lengths measured during the existing conditions survey presented in the mitigation plan is a result of a detailed professional topographic survey conducted in support of project development. Using the existing conditions survey, WLS used the surveyed stream thalweg which provided more accurate data to determine the actual stream thalweg length.

3. Section 6.4 - DWR likes the attention paid to wetlands on the site even though there are no wetland credits proposed for this project. In these cases, DWR is mostly concerned with maintaining the current wetland resources on site and when possible, enhancing or restoring the wetland resources on site. Response: WLS appreciates the comment as we expect the stream restoration activities and design approaches to improve overall wetland hydrology and function as compared to the current conditions. Although the DMS project contract and RFP requirements are for stream mitigation only, we strive to improve aquatic resources to the fullest extent possible. Any expected permanent impacts to existing wetlands as shown on Figure 11 will be documented in the PCN permit application.

4. Section 6.7- Water Quality Treatment Features - While DWR appreciates the installation of these features, their placement above reach R3 may negatively affect the flow for this intermittent stream. Response: WLS appreciates the comment as we expect the water quality treatment features to improve overall downstream hydrology and function as compared to the current conditions. As discussed during the IRT post contract site visit and meeting minutes, the water quality improvement features will be installed above the jurisdictional determination (see stream origin points in PJD App 9 WOTUS information) as approved by the USACE and DWR. We anticipate these water quality improvement features will provide an overall benefit as they will increase infiltration and groundwater recharge, allow nutrient uptake within the riparian buffer areas, and diffuse flow energies rather than a rapid flush under current conditions.

5. In the Monitoring Section, there is no mention of macrobenthic monitoring. Does WLS intend to monitor macrobenthics during the monitoring phase and if so, what is your general protocol? Response: WLS intends to monitor macroinvertebrate communities and aquatic health post-construction through MY7 (in MY3 and MY7) per DWR's "*Standard Operating Procedures for the Collection and Analysis of Benthic Macroinvertebrates*" (NCDWR, 2016) as mentioned in Section 3.1.4 and Table 23 'Proposed Monitoring Plan Summary'. The proposed sample locations are shown on Figure 9 and will be taken at restored reaches R1/R5. However, we did not include in performance monitoring section of the mitigation plan since the results will not be tied to performance standards nor required to demonstrate success for credit release. We are collecting this data across multiple restoration sites with intent that it may potentially be used to support future guidance and restoration goals, even if it does not demonstrate a measurable improvement from pre-construction conditions through the seven-year monitoring period.

6. Design sheet 3 - DWR would prefer to see specific bank slopes identified on the typicals. We realize these slopes may vary, however; we would prefer to see the slopes specified even if they are "on average". Response: Revised the typical sections on design plan sheet 3 to include average side slopes.

7. DWR believes that reaches R2 and R3 are at a high risk to lose flow or not have enough flow to maintain stream characteristics. Response: As mentioned in response comment #3, we expect the restoration activities and proposed design approaches to improve the natural headwater flow regime and hydrological function as compared to the current conditions. We also expect that these water quality improvement features will provide a project benefit as they will increase infiltration and groundwater recharge, allow nutrient uptake within the riparian buffer areas, and diffuse flow energies rather than a rapid flush under current conditions. However, since the existing stream bed elevations will be raised along R2/R3, we will install one (1) automated data logger along R2 near station 12+00 to monitor surface flow and document any changes to stream characteristics during the monitoring period.

8. Design sheet 10 - DWR would like to see the flow gauge moved to station 12+00 on reach R2. Response: The proposed flow gauge has been moved from the R2/R3 confluence (station 13+13) to approximate station 12+00 on the design plan sheet 10 and figure 9.

9. While DWR will not require a flow gauge on reach R3, this reach should probably have at least a camera to document flowing conditions. Response: WLS will install a camera facing upstream at the confluence of R2/R3 to document surface flow conditions during the monitoring period as described in Sections 7 and 8 of the mitigation plan.

10. Design sheet 11 - is the crossing on this sheet existing? One concern is it shows the crossing going through a wetland. DWR recommends this crossing be eliminated. In addition, three stream segments (R4, R4a and R4b) will be constructed in or immediately adjacent to wetlands. DWR recommends installation of a gauge at station 22+00 on R4 on stream left. If the crossing is not removed, DWR will want a plan on how the designer will maintain no net loss of wetlands on site. Response: There is an existing ford stream crossing at approximate station 23+50 that has been heavily impacted by cattle usage (See R4 site photos). WLS understands the concern for this proposed crossing location and rationale for installing a groundwater well for the purpose of monitoring potential impacts to wetland hydrology. We made every effort to omit this crossing and easement break, however the adjoining landowners would not be able to access the property on either side given the existing wetland areas (R4a and R4b) and steep hillslopes along R4 stream left. Therefore, WLS is reconstructing the existing crossing in the same location with a properly sized pipe culvert with embedded substrate that conveys the design discharges and provides adequate fish passage. We expect the restoration activities and proposed approaches to improve overall wetland hydrology and function as compared to the current conditions. Since the existing stream bed elevation will be raised to promote overbank flows and groundwater recharge, we do not expect to negatively affect wetland hydrology in this area. As such, we will install one (1) automated groundwater well within the wetland/left floodplain area along R4 to document groundwater hydrology. Any expected permanent impacts to existing wetlands due to the culvert crossing installation will be documented in the PCN permit application.

11. Looking at the photos of reach R4a, particularly at the downstream reach and its confluence with R4, there does not appear to be a need for any channel construction. Please substantiate why channel construction is needed in this area. Response: Reaches R4/R5 are incised and will be raised to provide access to their historic floodplain and maximize functional uplift. As a result of this restoration approach, WLS needed to raise the existing stream bed along oversized channel portions of R4a (and R4b) to avoid a backwater condition and to restore the natural connection between Reaches R4/R5.

Kim Browning, USACE:

1. R2 and R3 have very small watersheds, concern about maintaining flow and jurisdiction. Recommend camera points and flow gauges here. Response: As described in DWR response comment #9, WLS understands this concern and will install a camera facing upstream at the confluence of R2/R3 and a flow gauge to document surface flow conditions during the monitoring period as described in Sections 7 and 8 of the mitigation plan.

2. Design Sheet 10: It appears that there are three BMPs within the easement. Please ensure that these features are not in the jurisdictional areas as it is unclear on the maps and design sheets, and that their short-term maintenance is discussed in the text, if any is necessary. Response: As discussed during the IRT post contract site visit and meeting minutes, the water quality improvement features are located above the streams jurisdictional determination (origin points) and are designed to be self-maintaining, therefore should not require annual maintenance as cattle are excluded and buffer vegetation becomes established. Please refer to Appendix 9 WOTUS information for the USACE PJD correspondence, including stream and wetland location/origination maps.

3. Even though there are no wetland credits being sought, and existing wetlands are fairly small, the restoration of reach R4 appears to run through WD. Please ensure that permanent impacts to these wetlands during construction do not result in loss of function, though it is anticipated that overall wetland function will improve from increased hydrology in this area. It's recommended that a temporary veg plot be placed in this area. Response: As described in DWR comment response #10, WLS understands the concern for the proposed crossing and relocating the design channel through the existing wetland area (wetland area 'WD' as shown on the PJD Figure 3). However, we have tried to avoid and minimize the permanent wetland impacts as much as possible (~0.04 ac) and expect the stream restoration activities to improve overall wetland functions as compared to the current conditions. A proposed vegetation plot is shown along R4 (see Figure 9) in this area along the right floodplain which can be easily adjusted as requested by the USACE. The existing wetland vegetation in this WD area is highly impacted from cattle trampling and mostly limited to the herbaceous stratum. Since the existing stream bed elevation will be raised to promote overbank flows and groundwater recharge, we do not expect to negatively affect overall wetland hydrology. As such, we will install one (1) automated groundwater well within the wetland/left floodplain area along R4 to document groundwater hydrology. Any expected permanent impacts to existing wetlands due to the culvert crossing installation will be documented in the PCN permit application.

4. It would be helpful to depict photo points on Figure 9. Response: We have added existing conditions photo points on Figure 6 to correspond with the site photographs located in Appendix 2. Post-restoration photo point will be included with the MY0 Baseline Report - Current Conditions Plan View (CCPV) map to document and quantify the visual assessment throughout the monitoring period.

5. Section 4.1.2 Functional Uplift Potential and Table 11: The functional pyramid is cited to show existing conditions for each category, and was used to describe the functional uplift potential of the project, which is appreciated. Please note that the functional pyramid and SQT tool have not been approved for use by the IRT in determining success for mitigation projects. It would be interesting to see the correlation of the NCSAM assessment compared to the SQT throughout the project. Furthermore, three of the reaches are already scored as FAR and the proposed condition is also FAR. Please justify the functional uplift if the conditions are not changing. Response: WLS appreciates USACE's comment regarding our use of the stream quantification tool (SQT) to consider functional lift for the project. Although there are similarities between the NC SAM and the SQT assessment methods and functional summaries (i.e. LOW~NF, MEDIUM~FAR, HIGH~F), NC SAM and the SQT methods were not originally developed for determining mitigation success and credit calculations on constructed stream sites. While we understand the SQT has not yet been approved by the USACE for determining credit, the SQT requires a more robust data collection and analysis effort in order will help determine the highest level of restoration potential and associated lift that can be achieved for the project, considering site constraints and existing conditions. We agree with the concern and understand the limitations of using the SQT, especially in catchments with a Curve Number greater than 56 or shorter reach segments that do not increase restored length and predict a nominal functional lift (i.e. Existing FAR vs Proposed FAR). Based on our use and understanding of the functional lift scoring summary (%), we do expect a functional lift in these reaches (R3, 58%, R4 64%, R5, 116%) even though the score output is still FAR. As a comparison, NC SAM predicts these reaches will be scored 'HIGH' in the restored condition. WLS has verified the SQT inputs and outputs are correct as shown in the table.

6. Table 12 and Table 23: Hydraulics, the BHR goal should read not to exceed 1.2. Response: Revised Table 12 and Table 23 language to state BHRs should not exceed 1.2.

7. Page 41, last paragraph and Table 21: please ensure that red maple are not included in the planting plan. Response: Removed Red maple from Table 21 and the proposed planting plan on sheet 16 and substituted with Northern red oak and Blackgum. It should be noted WLS has implemented numerous successful riparian buffer planting strategies, which has included Red maple, as we believe it provides a functional benefit to natural riparian buffers. However, we understand its distribution is abundant and that the species can propagate aggressively.

8. Section 7.1: Stream Hydrology—"In addition to the two bankfull flow events, two…" is confusing. It should read four bankfull events. Response: Revised language in Section 7.1 stream hydrology stating 'four (4) separate bankfull events must be documented within the seven-year monitoring period. Two of the four bankfull events must occur in separate years.' To avoid confusion and remain consistent with 2016 USACE guidance, we omitted language 'In addition to the two bankfull flow events, two "geomorphically significant" flow events (Qgs=0.66Q2) must also be documented during the monitoring period.'

> **a. Jurisdictional Stream Flow: Please add a statement that intermittent streams should be added requiring at least 30-days consecutive flow within a calendar year.** Response: Revised language in Section 7.1, jurisdictional stream flow, stating any streams classified as intermittent must exhibit base flow for at least 30-days consecutive flow within a calendar year under normal rainfall conditions.
>
> **b. Stream Profiles: The ER should be no less than 1.4 for B type channels.** Response: Revised language in Section 7.1, stream profiles, vertical stability, and floodplain access, stating ERs shall be no less than 2.2 (1.4 for Rosgen 'B' stream types) to be consistent with and Table 23, Level 2 Performance Standards.
>
> **c. Stream Horizontal Stability: It would be beneficial to have a specific measurement parameter, for example, BHR and ER at any measured riffle cross-section should not change by more than 10% from the baseline condition during any given monitoring interval.** Response: Per 2016 USACE guidance, added language in Section 7.1, stream horizontal stability 'In general, BHR and ER at any measured riffle cross-section should not change by more than 10% from the baseline condition during any given monitoring interval'.

9. Section 7.3: Please include a vigor standard for vegetation of 7 feet high in year five and 10 feet high in year 7. Response: Per 2016 USACE guidance, added language stating trees in each veg plot must average 6 feet in height at MY5 and 8 feet in height at MY7 since Surry county is considered a mountain county.

10. Did I miss the section on site constraints or potential risks? Response: WLS added section 3.5 to the mitigation plan to document project site constraints and potential risks.

11. Buffer Widths: Portions of R1, R2, and R5 do not meet the minimum buffer width of 30 ft. This is approximately 11% of the total restored length, which exceeds the guidance allowing no more than 5% of the total project length. Would the 11% change if you calculated the total project length, verses only using the restored length? If the result is still over 5%, the buffer tool needs to be used. If the Buffer Tool is used, please clearly show the loss or addition of credits in the Table 1 and 14. a. The Buffer calculation table in the appendix, Table 1 and Table 14 all appear to have different credit totals. Please clarify. Response: As described in the DMS Final Draft response comments, WLS has made every effort to acquire the necessary easement areas to meet or exceed the minimum buffer width requirements. However, some areas along Reaches R1, R2 and R5 do not meet the minimum 30' buffer requirement. This was due in part to of lack of landowner involvement or where the constraints by ROWs resulted in acute angles in the easement. The total length affected for the entire project is approximately 600 LF which is approximately 11% of the total restored project length. Per the guidance in the Wilmington District Stream and Wetland Compensatory Mitigation Update, North Carolina Interagency Review Team (USACE, 2016) under Section XI. Stream Buffers, heading A. Required Minimum Buffer Widths, subheading 5: Where streams intersect with project boundaries (e.g., property lines, farm crossings, utility easements, etc.), it was not possible for buffers to meet the minimum standard width all the way to the end of the channel where the intersection occurs at an acute angle.

WLS used the DMS buffer calculation tool and USACE-Wilmington District Stream Buffer Credit Calculator to help tabulate stream credit gains/losses. WLS is proposing 5,389 stream mitigation credits for the affected project reaches. The net change after buffer adjustments is approximately +25 stream credits as shown on Figures 11a and 11b and in the Wilmington District Stream Buffer Calculator output in Appendix 2. Many buffer widths greatly exceed the 30-foot minimum which includes the water quality treatment features within the easement boundary. WLS updated Tables 1 and 14 to include the buffer tool calculations as requested and included additional notes to clarify the buffer tool and stream mitigation credit calculations and adjustments as described further in Section 6.1.

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

Sincerely,

Water & Land Solutions, LLC

Kayne Van Stell

Kayne M. Van Stell
Vice President, Ecosystem Design Services
Water and Land Solutions, LLC
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Tables

Figures

Appendices

1 Project Introduction

The Horne Creek Tributaries Mitigation Project ("Project") is a North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) full-delivery stream mitigation project, contracted with Water & Land Solutions, LLC (WLS), on June 01, 2017 in response to RFP 16-006993. The Project will provide stream mitigation credits in the Yadkin River Basin (Cataloging Unit 03040101). The Project is located in Surry County approximately seven miles southwest of the Town of Pilot Mountain at 36.2851950° North and -80.5032100° West. The project site is in NCDEQ Sub-basin 03-07-02, in the 8-digit Hydrologic Unit (HU) 03040101, in the Ararat River & Upper Yadkin River Local Watershed Plan Study Area (Local Watershed Plan ID: LWP-2008-51), and in the Targeted Local Watershed 03040101110070 (Warm Water Thermal Regime), all within the Yadkin River Basin (Figure 1).

The Project will involve the restoration, enhancement, and permanent protection of seven stream reaches (R1, R2, R3, R4, R4a, R4b, and R5) and their riparian buffers, totaling approximately 5,681 linear feet of existing streams. In addition, combinations of different practices or measures will include riparian wetland enhancement and various agricultural best management practices (BMPs). The Project will provide significant ecological improvements and functional uplift through stream and aquatic habitat restoration, and through decreasing nutrient and sediment loads within the watershed. See Section 5 for a detailed benefits summary and Table 1 for a summary of project assets. Figure 9 illustrates the project mitigation components.

Table 1. Project Asset Summary

Project Component	Type of Mitigation (Priority Level)	Creditable Units	Mitigation Ratio	Stream Mitigation Credits (SMCs)
R1	Stream Restoration (PI)	1,320 LF	1:1	1,320
R2	Stream Restoration (PI)	296 LF	1:1	296
R3	Stream Restoration (PI)	76 LF	1:1	76
R4	Stream Restoration (PI)	1,167 LF	1:1	1,167
R4a	Stream Restoration (PI)	111 LF	1:1	111
R4a	Stream Enhancement Level II	57 LF	2.5:1	23
R4b	Stream Restoration (PI)	125	1:1	125
R4b	Stream Enhancement Level II	27 LF	2.5:1	11
R5	Stream Restoration (PI)	2,249 LF	1:1	2,249
Totals		**5,428**		**5,378**
			Credit Loss in Required Buffer	-300
			Credit Gain for Additional Buffer	325
			Net Change in Credit from Buffers	+25
			Total Credits per Buffer Calculator	5,403
			Total Adjusted SMCs	**5,389**

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

Note 2: The Wilmington District Stream Buffer Calculator was used to determine credit losses/gains due to 11% of the total project lengths buffer widths being less than 30'. Based on the stream buffer credit calculator the total net increase in stream credits is 25 credits. This is due in part to many areas within the buffer being greater than 30'. WLS is proposing the adjusted SMCs totaling 5,389 credits.

Note 3: Values in table were rounded to the nearest whole number.

The project streams are all unnamed headwater tributaries to Horne Creek. Horne Creek flows southeast to its confluence with the Yadkin River at Pilot Mountain State Park. Horne Creek is listed by the NCDEQ Division of Water Resources as 'WS-IV' (Water Supply IV) waters from its source all the way downstream to its confluence with the Yadkin River. The project site is located in the Northern Inner Piedmont ('45e') US Environmental Protection Agency Level IV Ecoregion and the North Carolina Piedmont Physiographic Province (Omernik, 2014). The site involves a series of direct headwater tributaries to Horne Creek, which will provide maximum ecological uplift due to our comprehensive watershed approach.

2 Watershed Approach and Site Selection

In an effort to update its watershed planning process, DMS amended the 2003 Upper Yadkin Pee-Dee RBRP in 2009 (Yadkin 01 RBRP, 2009). In 2003, 54 hydrologic units were targeted in the Yadkin-Pee Dee River Basin Watershed Restoration Plan. In the 2009, an additional 37 HUCs were newly identified as Targeted Local Watersheds, and two HUCs had their TLW status removed. In total, 89 HUCs are highlighted as TLWs by DMS in the 2009 RBRP. The purpose of the 2009 RBRP is to identify and prioritize potential mitigation strategies to reduce sediment inputs, restore/enhance aquatic resources, improving riparian corridors, promoting agronomic farm management techniques, and coordinating with landowners and local government agencies the Yadkin 01 basin. The recommendations include traditional stream and wetland mitigation, buffer restoration, nutrient offsets, non-traditional mitigation projects such as stormwater and agricultural BMPs (Yadkin 01 RBRP, 2009).

The project is situated in the northern inner Piedmont in the southern portion of the Yadkin River Basin, where the NC Wildlife Resources Commission (NCWRC) considers this a priority area for conservation measures and aquatic habitat for freshwater mussel species. USGS 2011 National Land Cover Data (NLCD) GIS Datasets and StreamStats was used to estimate the impervious cover and dominant land use information for the project catchment area. Currently, the catchment area has an impervious cover estimated to be less than one percent and the dominant land uses are pasture lands (predominantly for hay and cattle), row-crop agriculture, and mixed forest. The project will extend the wildlife corridor and protect diverse aquatic and terrestrial habitat in the area through a permanent conservation easement, ahead of anticipated development.

As cited in the Yadkin 01 RBRP, the Project site was selected to provide a unique opportunity for implementing a combination of different practices or measures, as part of a comprehensive watershed approach to improve and protect aquatic resource functions, as outlined in the DMS Compensation Planning Framework (CPF) and the Federal Mitigation Rule (USACE, 2008). Developing specific goals and objectives that directly relate to functional improvement is a critical path for implementing a successful restoration project. The expected functional uplift is discussed further and in more detail under Section 4, and project goals and objectives are further described and discussed under Section 5.

3 Baseline Information and Existing Conditions Assessment

WLS performed an existing conditions assessment for the Project by compiling and analyzing baseline information, aerial photography, and field data. The purpose of this assessment was to determine how aquatic resource functions have been impacted within the catchment area. Watershed parameters such as drainage patterns, percent impervious cover, controlling vegetation and hydrology (rainfall/runoff relationships) were evaluated, along with the analysis of physiography, local geology, soils, topographic position (basin relief, landforms, valley morphology), and flow regime (discharge, precipitation, sediment supply).

Combined with historical context, the processes of hydrology and geomorphology must be linked to evaluate current physical and biological conditions and system responses to human activities within the riparian ecosystem (Montgomery and Bolton, 2003). Identifying the hydrogeomorphic variability, site constraints, and cause-and-effect relationships plays a key role in determining the functional loss and maximizing potential uplift (Harman et al., 2012). The following sub-sections further describe the existing site conditions, degrees of impairment, and primary controls that were considered for developing an appropriate restoration design approach. Table 2 represents the project attribute data and baseline summary information.

Table 2. Project Attribute Data and Baseline Summary Information

Project Information	
Project Name	Horne Creek Tributaries Mitigation Project
County	Surry
Project Area (acres)	11.9
Project Coordinates (latitude and longitude)	36.2851950° N, -80.5032100° W
Project Watershed Summary Information	
Physiographic Province	Piedmont
River Basin	Yadkin
USGS Hydrologic Unit	03040101110070
DWR Sub-basin	03-07-02
Project Drainage Area (acres)	166 (R5) and 38 (R1)
Project Drainage Area Percentage of Impervious Area	<1
CGIA Land Use Classification	2.01.03, 2.01.01, 3.02 (46% pasture/hay, 24% row crop, 16% mixed forest)

Reach Summary Information							
Parameters	R1	R2	R3	R4	R4a	R4b	R5
Length of reach (linear feet)	1,397	286	75	1,191	124	89	2,519
Valley confinement (Confined, moderately confined, unconfined)	moderately confined	moderately confined	moderately confined	unconfined	unconfined	unconfined	unconfined
Drainage area (acres)	38	41	29	83	29	2	166
Perennial, Intermittent, Ephemeral	Perennial	Intermittent	Intermittent	Perennial	Perennial/ Int[1]	Perennial/ Int[1]	Perennial
NCDWR Water Quality Classification	C	C, WS-IV,	C	C, WS-IV,	C	C	C, WS-IV,
Stream Classification (existing)	E5b/F5b (incised)	G4 (incised)	E6b(incised)	B4 (incised)	B4c (incised)	G5	B4c/G4c (incised)
Evolutionary trend (Simon)	III/IV	III	III	IV/V	I	I	IV/V
FEMA classification	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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	N/A	Categorical Exclusion				
Historic Preservation Act	No	N/A	Categorical Exclusion				
Coastal Zone Management Act (CZMA or CAMA)	No	N/A	N/A				
FEMA Floodplain Compliance	No	N/A	N/A				
Essential Fisheries Habitat	No	N/A	Categorical Exclusion				
Note 1: Indicates that the lower section of the reach was classified as perennial and upper stream reach was classified as intermittent.							

3.1 Watershed Processes and Resource Conditions

3.1.1 Watershed Overview

Spatial and temporal variability of hydrologic and geomorphic processes, as well as fine sediment have influenced the overall system response and stability trends in multiple reach segments across the Project site. Measurable changes in the landscape ecology were first identified upon review of aerial photography, including native buffer vegetation disturbance and/or removal and stream channel alteration. Evidence of these observed changes were documented throughout the watershed as increased channel widths/depths and bank height ratios, decreased riffle-pool frequency and bedform diversity, as well as limited floodplain connectivity and hyporheic zone interaction. Additionally, direct cattle access to the streams and surrounding agricultural fertilization has likely increased fecal coliform bacteria and nutrient levels within the watershed. These ecological impacts have negatively impacted historic stream and wetland functions at the site and have likely increased over the past few decades due to anthropogenic changes within catchment.

3.1.2 Surface Water Classification

Horne Creek is classified as Water Supply IV (WS-IV) (Stream Index 12-75) "From source to Yadkin River". WS-IV are waters used as sources of water supply for drinking, culinary, or food processing purposes where a WS-I, II, or III classification is not feasible. These waters are also protected for Class 'C' uses (Class 'C' waters are protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture and other uses suitable for Class 'C'). WS-IV waters are generally in moderately to highly developed watersheds or Protected Areas.

3.1.3 Aquatic Resource Health and Function

WLS reviewed DWR biological and water quality data within the Upper Horne Creek watershed to identify any potential stressors near receiving waters. Currently, no DWR water quality monitoring stations, or benthic or fish monitoring stations exist in or near the project watershed. At this time, no known DWR monitoring sites are proposed for monitoring use by WLS for this project. It is generally accepted that nutrient loading and sedimentation from streambank erosion is a significant pollutant to water quality and aquatic habitat. However, there can be data uncertainties and excessive costs for monitoring nutrient levels and sediment delivery in streams (Hess, 2014). Without an extensive nutrient monitoring and management plan, types, application rates, groundwater leaching and lag times can vary considerably, making it difficult to effectively determine water quality improvements in response to various restoration practices. Additionally, measuring in situ sediments that deposit over time can often have longer transport times and legacy effects that can mask the water quality improvements and biologic functions related to common stream and wetland restoration activities (Bain, 2012).

3.1.4 Benthic Macroinvertebrates and Aquatic Habitat

WLS evaluated benthic macroinvertebrate (BMI) communities and aquatic habitat at two locations (Site 1 along R1 and Site 2 along R5) within the proposed project area. The sample number and location where selected based on stream lengths, watershed position and headwater flow regime. Macroinvertebrates are useful biological monitors because they are found in all aquatic environments, are less mobile than many other groups of organisms, and easily collectable. BMI sampling was conducted on June 5, 2018 using methods and procedures defined by DWR's "*Standard Operating Procedures for the Collection and Analysis of Benthic Macroinvertebrates"* (NCDWR, 2016). Samples were collected by WLS staff and verified by Larry Eaton (Eaton Scientific, LS, Inc.). Sample Site 1 had a Biotic Index (BI) value of 6.53 resulting in a bioclassification rating of "Good-Fair". Site 1 had a habitat assessment score of 74. Sample Site 2 had a BI value of 4.99 resulting in a bioclassification rating of "Good-Fair". Site 2 had a habitat assessment score of 80. The BMI diversity was greater in Sample Site 2 with higher total taxa, EPT richness and abundance. Additional sampling will be conducted again in Spring/Summer during post-construction monitoring year 3. The pre-restoration BMI results and habitat assessment score summary is shown in Appendix 2.

3.1.5 Pollutant Load Considerations

EPA Region 5 Model: WLS first utilized the United States Environmental Protection Agency (EPA) Region 5 Model to quantify how the project may reduce pollutant loads into Horne Creek and the Yadkin River Watershed. The Region 5 Model was developed for the EPA (Michigan Department of Environmental Quality, 1999) and is used throughout the United States to determine sediment and nutrient load reductions from the implementation of urban and agricultural BMPs, including, but not limited to, vegetated filter strips, wetland detention, and bank stabilization/stream restoration. Model inputs include eroded streambank length, streambank height, lateral recession rates, soil weight, and BMP type/efficiency applicable to the agricultural Piedmont area. The summary of total annual pollutant loadings and removal estimates are shown in Table 3 below.

Table 3. Total Annual Pollutant Loadings and Removal Estimates from EPA Region 5 Model

Project Watershed (ac)	Existing Stream Length (ft)	Length of Scoured Bank (ft)	Sediment Load (ton/yr)	Nitrogen Load (lb/yr)	Phosphorus Load (lb/yr)	Sediment Reduction w/ BMP (ton/yr, %)	Nitrogen Reduction w/ BMP (lb/yr, %)	Phosphorus Reduction w/ BMP (lb/yr, %)
166.4	5,681	8,014	586.1	402.9	806.0	474.2, 80.9%	205.1, 50.9%	432.0, 53.6%

Note 1: Soil Texture Class is predominantly loam, sandy clay loam.
Note 2: Average Bank heights in scour areas ranged 2 to 5 feet.
Note 3: Lateral Recession Rates (ft/yr) ranged from slight category (0.01 to 0.05) to severe (0.06 to 0.40)
Note 4: Agricultural BMP input used for streambank stabilization/restoration and cattle exclusion fencing.

Although the EPA Region 5 model data is more empirically based, it is intended to be used as a basic planning tool. Inherently, there are certain assumptions and limitations that must be considered when refining model inputs and evaluating the results. For example, water quality calculations and sediment loading are highly dependent on actual BMP efficiencies, sophisticated algorithms, regression analysis, and not calibrated field measurements.

BANCS Method: As a comparison to the EPA Region 5 model results for sediment loading, WLS predicted streambank erosion rates and annual sediment yields using the Bank Assessment for Non-point-source Consequences of Sediment (BANCS) method (Rosgen 1996, 2001a) which considers two streambank erodibility estimation tools: The Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS). This rating method is used to describe existing streambank conditions (i.e., bank migration and lateral stability) and quantify the lateral erosion potential of a stream reach in feet per year. The components of the BANCS methodology can be subjective and vary based on the region's climatic condition, geologic controls, and the experience level and professional training of the observers. However, it is a repeatable estimation method and the intent is to be used as a relative comparison for pre- and post-restoration conditions.

WLS used the unpublished NC Piedmont BEHI and NBS ratings curve (personal communication with NRCS, Walker, 2016) to estimate annual sediment loss based on local observations and streambank measurements taken on May 10th and 11th, 2018. The BEHI/NBS estimates for the existing conditions (pre-construction) predict that the project reaches contribute approximately 732.3 tons of sediment per year to the Yadkin River, which is 146.2 tons higher than the EPA Region 5 Model estimates. The BEHI ratings varied from 'very low' to 'extreme', with Reach R3 average BEHI rating 'moderate/low' based on minimal shear stress, stream bed/bank stability and controlling vegetation. The middle reaches and reach R1 contribute the majority of the bank sediment to the system, due to a lack of bank protection and hoof sheer from cattle which have access to these reaches. The average 'moderate' to 'high' BEHI ratings and observations are typical of a degraded stream system with active bank erosion. See Table 4 below and Appendix 2 for sediment loading assessment sheets.

Table 4. BANCS Reach Assessment

Project Component	BEHI Range	NBS Range	Sediment Loading (tons/yr)
R1	Very-Low/High	Very Low/High	18.9
R2	Low/Moderate-High	Very Low/Moderate	8.5
R3	Low/Very-High	Low/High	11.9
R4/R5	Very-Low/Extreme	Very-Low/Extreme	693.0
Note 1: R4a and R4b were not assessed due to their small size and minimal erosion potential. *Note 2: R4 and R5 were combined due to the reach connection.*			

Fecal Coliform Bacteria: Pollutant load reduction performance standards for nutrients and fecal coliform bacteria are not proposed nor required for this project, however, WLS is interested in evaluating how the proposed project could reduce pollutant loads into the Horne Creek Watershed. Based on DMS referenced studies represented in *Quantifying Benefits to Water Quality from Livestock Exclusion and Riparian Buffer Establishment for Stream Restoration* (DMS, 2016), WLS expects that implementation of this project could reduce Fecal Coliform Bacteria colonies (col), by as much as 80% as shown on Table 4.

Table 5. Pollutant Load Reduction Estimates from Livestock Exclusion and Riparian Buffers

Total Riparian Buffer Area (ac) [1]	Cattle Exclusion: Grazing Pasture (ac)	Nutrient Reduction: TN (lbs/yr) [2]	Nutrient Reduction: TP (lbs/yr) [2]	Fecal Coliform Bacteria from Direct Inputs (col) [3]	Fecal Coliform Bacteria Reduction (col) [4]
10.7	10.0	510.4	42.3	1.20E+12	2.35E+11

Note 1: Applicable for restored buffer widths ranging from 6m to 30m from the top of streambanks.
Note 2: NC Division of Water Quality – Methodology and Calculation (1998) for determining nutrient reductions associated with Riparian Buffer Establishment (DWR, 1998). TN reduction (lbs/yr) = 51.04 (lbs/ac/yr) x Area (ac) and TP reduction (lbs/yr) = 4.23 (lbs/ac/yr) x Area (ac)
Note 3: Fecal Coliform Reduction from Direct Cattle Input (colonies) = 2.2 x 10^11 (col/AU/day) x AU x 0.085 and assumes ~160 black beef cattle (ave. 400 lbs/each)
*Note 4: Fecal Coliform Reduction from Buffer Filtration (colonies) = Runoff's fecal coliform concentration (col/gal) x Runoff volume (Gal) x 0.85 and assumes pastures are under continual grazing year-round (1.894*10^6), runoff curve number (CN) for Soil Group 'B' in pastureland is ~67 for a 1 inch - 24 hr storm event.*

Based on existing condition assessments, findings indicate the overall stream health is considered 'Poor', which is consistent with model estimates and comparisons with numerous referenced studies. WLS expects that the implementation of this restoration project will significantly reduce pollutant loads, including sediment and nutrients, improving the overall aquatic functions and water quality in Upper Horne Creek. WLS will conduct pre- and post-restoration sampling to document improvements directly related to pollutant load reductions. WLS understands that such monitoring activities are not tied to performance standards nor required to demonstrate success for credit release. However, collecting and evaluating pollutant reduction data aligns with the goals and objectives of the project. We believe selecting applicable monitoring and evaluation methods will help develop a more function-based assessment and improve our project implementation process, thereby contributing positively to the advancement of the practice of ecosystem restoration.

3.2 Landscape Characteristics and Regional Controls

3.2.1 Physiography and Geology

The project site is located within the Blue Ridge and Inner Piedmont Belts of the Northern Inner Piedmont physiographic province. The Blue Ridge and Inner Piedmont Belts are separated by the Brevard fault zone. More specifically, the geologic unit is classified as Metagraywacke and Muscovite-Biotite Schist (CZmg) formation interlayered and gradational with muscovite-biotite schist; minor marble and granite rock (Geologic Map of North Carolina, NC Geological Survey, 1998).

The Northern Inner Piedmont province is generally characterized by higher elevations, more rugged topography, higher stream gradients and more mountain outliers than other areas of the Piedmont province (Griffith et al, 2002). The project area is within the Sauratown Mountain Anticlinorium and immediately south of the Pilot Mountain monadnock which represents a unique ecotonal transitional zone between Piedmont and Mountain Level III/IV Ecoregions that is characterized by prominent ridges and knobs that rise above 1,000 feet in elevation.

3.2.2 Soils

Soils at the project site were initially determined using NRCS soil survey data for Surry County (NRCS Surry County Soil Survey, 2007). The soils within the project area were verified during on-site field investigations. Figure 4 illustrates soil conditions throughout the project area and the soil descriptions are provided below in Table 6.

Table 6. Project Soil Type and Descriptions

Soil Name	Hydric	Description
Braddock Fine (BbC) (0.3% of project area)	No	Well drained soils formed mainly on stream terraces and mountain valleys in the Piedmont region. Slope ranges from 8 to 15% on landscapes with moderate erosion and are not flooded. Fine sandy loam surface layer and clay subsoil or clay loam underlying material. Depth to bedrock is greater than 80 inches.
Colvard and Suches (CsA) (43.6% of project area)	No	Well drained soils formed on flood plains and natural levees on flood plains. Typically, the surface layer is fine sandy loam (~10 inches) and subsoil is also fine sandy loam. Slopes range from 0 to 3% in the flood plains in the Piedmont and are occasionally flooded. Permeability, water capacity and shrink-swell are moderately high to high with low to very low surface runoff. Many areas are well suited for pasture and row crops given low runoff and erosion potential.
Fairview (FeB2) (1.5% of project area)	No	Well drained soils formed mainly on ridges and interfluves in the Piedmont region. Slope ranges from 8 to 15% on landscapes with moderate erosion and are not flooded. Sandy clay loam surface layer and clay subsoil or clay loam underlying material. Depth to bedrock is greater than 80 inches.
Fairview (FeC2) (8.3% of project area)	No	Well drained soils formed mainly on ridges and interfluves in the Piedmont region. Slope ranges from 2 to 8% on landscapes with moderate erosion and are not flooded. Sandy clay loam surface layer and clay subsoil or clay loam underlying material. Depth to bedrock is greater than 80 inches.
Fairview (FeD2) (45.8% of project area)	No	Well drained soils formed mainly on ridges and interfluves in the Piedmont Region. Slope ranges from 15 to 25% on landscapes with moderate erosion and are not flooded. Sandy clay loam surface layer and clay subsoil or loam underlying material. Depth to bedrock is greater than 70 inches.

The soils within the floodplain and riparian areas are predominantly mapped Colvard and Suches (CsA) and Fairview (FeD2). The soil properties have been degraded by historic agricultural and silvicultural activities and more recent cattle disturbances (i.e., hoof trampling) have resulted in a significant loss of surface/groundwater interaction, and increased streambank erosion and sedimentation. In the flatter valley sections along R5, it is common to discover legacy sediment in numerous floodplains in the mid-Atlantic Piedmont (Jacobson and Coleman, 1986). In this setting and context, legacy sediment can be defined as alluvium that was deposited following human disturbances in a watershed that represent episodic erosion in response to the colonization of land by European settlers (James, 2013). Interest in legacy sediment and its ecological implications have grown in recent years, as we understand how these deposits influence lateral channel connectivity, sediment budgets, water quality, and appropriateness of geomorphic restoration practices.

3.2.3 Climate

The Project site is located in Surry County, NC and has a warm moderately humid climate with hot summers, minimal snowfall and no dry season (NRCS, 2007). The average growing season for the Project site is 174 days, beginning on April 24th and ending October 16th (NRCS Surry County Soil Survey, Weather Station: Mt. Airy, NC). The average annual precipitation in the Project area is approximately 47.43 inches with a consistent monthly distribution, except for convective storm events or hurricanes that occur during the summer and fall months. In late 2017/2018, the area received over 60.75 inches as shown on WETS Table 7. Over the past 48 months, the Surry County Airport Weather Station (KMWK) has recorded over 185.22 inches of rain.

Table 7. Comparison of Monthly Rainfall Amounts vs. Long-term Averages

Month-Year	Observed Monthly Precipitation (in)	WETS Average Monthly Precipitation (in)	Deviation of Observed from Average (in)
Nov-17	5.89	1.12	+4.77
Dec-17	6.76	4.04	+2.72
Jan-18	9.8	4.76	+5.04
Feb-18	15.8	2.67	+13.13
Mar-18	N/A	4.69	N/A
Apr-18	N/A	6.08	N/A
May-18	0.43	6.37	-5.94
Jun-18	4.29	7.21	-2.92
Jul-18	3.84	11.03	-7.19
Aug-18	2.67	6.07	-3.4
Sep-18	5.23	7.96	-2.73
Oct-18	6.04	0.44	+5.6
Sum	**60.75**	**62.44**	**+108.41**

Throughout much of the southeastern US, average rainfall often exceeds average evapotranspiration (ET) losses and areas experience a moisture excess during normal years, which is typical of the Project site. Excess water leaves the Project site by groundwater flow, surface runoff, channelized surface flow, or seepage. Annual losses due to seepage, or percolation of water are not considered a significant loss pathway for excess water. However, groundwater flow and the hyporheic exchange is critical in small headwater stream and wetland systems like those at the Project site, as most excess water is lost via surface and shallow subsurface flow.

The Project streams' drainage density relative to the geomorphic/geologic character and hydrologic regime is common given the seasonal rainfall patterns, runoff rates, topographic relief, groundwater recharge, and infiltration capacity/depth to impermeable bedrock layer. Further observations of perennial flow frequency, response time to storm events, streambank erosion and groundwater saturation over the past year support this conclusion.

3.2.4 Existing Vegetation

Historic land management surrounding the Project area has been primarily for agricultural and silvicultural purposes. Prior to anthropogenic land disturbances, the riparian vegetation community likely consisted of Mesic Mixed Forest (Piedmont Subtype) in the uplands with Alluvial Forest and Piedmont Bottomland Forest in the lower areas and floodplains (Schafale and Weakley, 1990). The existing vegetation within the project area consists of successional forest, pasture, and agricultural fields. Many of the riparian and upland areas have a narrow tree canopy and lack understory vegetation due to heavy livestock use and grazing. Widespread channel degradation is likely a result of the alteration of natural drainage patterns and the significant removal of native species vegetation.

Table 8. Existing Site Vegetation

	Common Name	Scientific Name
Canopy Vegetation	Red maple	*Acer rubrum*
	Yellow-poplar	*Liriodendron tulipifera*
	River birch	*Betula nigra*
	American sycamore	*Plantanus occidentalis*
	Swamp white oak	*Quercus bicolor*
	White oak	*Quercus alba*
Understory & Woody Shrubs	Black willow	*Salix nigra*
	Silky willow	*Salix sericea*
	Ironwood	*Carpinus caroliniana*
	Umbrella magnolia	*Magnolia tripetala*
	American holly	*Ilex opaca*
	Hazel alder	*Alnus serrulata*
	Elderberry	*Sambucus canadensis*
	Eastern red cedar	*Juniperus virginiana*
	Chinese privet	*Ligustrum sinense*
	Persimmon	*Diospyros virginiana*
Herbaceous & Vines	Poison ivy	*Toxicodendron radicans*
	Virginia creeper	*Parthenocissus quinquefolia*
	Joe pye weed	*Eutrochium maculatum*
	Dog fennel	*Eupatorium capillifolium*
	Jewelweed	*Impatiens capensis*
	Blue-eyed grass	*Sisyrinchium angustifolium*
	Greenbrier	*Smilax rotundifolia*
	Multiflora rose	*Rosa multiflora*
	Christmas fern	*Polystichum acrostichoides*
	Lady fern	*Athyrium filix-femina*
	Fescue	*Fescue sp.*
	Soft rush	*Juncus effusus*

Agricultural Fields and Pasture Areas: Currently, the majority of pasture areas are used for cattle grazing and the vegetation within open fields and pasture areas is primarily comprised of fescues, clovers, and some dog fennel (*Eupatorium capillifolium*). In smaller wooded riparian areas or clusters within the pastures and fields, the canopy is dominated by red maple (*Acer rubrum*), yellow-poplar (*Liridendron tulipifera*), and understory species consist of Eastern red cedar (*Juniperus virginiana*), umbrella magnolia (*Magnolia tripelata*). Woody shrub and vine species include Chinese privet (*Ligustrum sinense*) and greenbrier (*Smilax rotundifolia*). Herbaceous species consist of dog fennel (*Eupatorium capillifolium*) and soft rush (*Juncus effusus*).

Mixed Hardwood Forest: The mature canopy is dominated by American beech (*Fagus grandifolia*), hickory (*Carya* spp.), American sycamore (*Platanus occidentalus*), red maple, but also includes white oak (*Quercus alba*), yellow-poplar, black willow (*Salix nigra*), and river birch (*Betula nigra*). Woody shrub and vine species include poison ivy (*Toxicodendron radicans*), greenbrier, and hazel alder (*Alnus serrulata)*. Herbaceous species include jewelweed (*Woodwardia areolata*) and common juncus (*Juncus effusus*).

Invasive Species Vegetation: The invasive species vegetation present on the Project site are primarily multiflora rose (*Rosa multiflora*) and Chinese privet (*Ligustrum sinense*).

3.3 Land Use and Development Trends

The USGS 2011 National Land Cover Data GIS Dataset and StreamStats was used to estimate the current impervious cover and land use information for the project catchment area. The 647-acre catchment area has an impervious cover approximately one percent and the dominant land uses are 46% pasture/hay, 24% row crops, and 16% mixed forest. WLS conducted extensive field reconnaissance to verify the current land use practices within the catchment, which include active agricultural land managed as pasture for cattle grazing, hay/crop production and forested areas along reaches R1, R2, R3, R4, R4a, R4b, and R5.

Prior to the 1940s, most of the watershed was a mixture of forested area and agricultural fields as illustrated on historic aerials (See Figure 7a). WLS was unable to obtain land use information prior to the 1930s. By the late 1970s, much of the headwater area remained a mixture of forest and agricultural fields, but an increase in agricultural production was evidenced. Over time the natural stream and wetland processes and aquatic resource functions have been significantly impacted because of these historic anthropogenic disturbances.

As a design consideration, WLS coordinated with the landowner to extend the easement boundary to capture additional wetland areas and natural drainage features within the Project corridor. Increasing the Project footprint will provide wider riparian buffers and allow the implementation of agricultural best management practices, which ultimately improve floodplain functions and pollutant removal effectiveness.

3.4 Watershed Disturbance and Response

To determine what actions are needed to restore the riparian corridor structure and lift ecological functions, it is critical to examine the rates and type of disturbances, and how the system responds to those disturbances. Across the Project site, landowners historically cleared large portions of mature forest and manipulated, and/or straightened streams and ditched riparian wetland systems to provide areas for crop production and cattle grazing. These activities have caused changes to historic channel patterns, sediment transport, in-stream habitat and restriction of fish movement, thermal regulation, and dissolved oxygen (DO) content.

Cleared portions of the riparian buffer area are shown on historical aerial photographs (See Figures 7a, 7b, 7c, 7d, and 7e). A majority of the Project reaches has been heavily impacted from these historic and current land use practices, including livestock production, agriculture, and silviculture. Within the Project area, approximately 90% of the streambanks have inadequate (less than 30 feet wide) riparian buffers. Figure 9 represents the most recent aerial photography with clearly narrow and/or absent riparian buffers throughout much of the project area.

Continuous livestock intrusion and associated hoof shear have severely impacted the streambanks along the Project stream reaches. The stream channels are actively incising, and the floodplain connection has been lost in many locations. The lack of adequate and high-quality buffer vegetation, past land use disturbances, active channel degradation, minimal impervious cover, and current agricultural and livestock practices present a significant opportunity for water quality and ecosystem improvements through the implementation of this project.

3.4.1 Existing Reach Condition Summary

The streams at the Project site were categorized into seven reaches (R1, R2, R3, R4, R4a, R4b, and R5) totaling approximately 5,681 linear feet of existing streams. Reach breaks were based on drainage area at confluences, changes in existing condition, restoration/enhancement approaches, and/or changes in intermittent/perennial stream status. Field evaluations conducted by WLS at the proposal stage and during existing conditions assessments determined that Project reaches R1, R4, and R5 are perennial streams R2, and R3 were determined to be intermittent streams, and R4a and R4b were determined to be perennial/intermittent streams. Determinations were based on *NCDWQ's Methodology for Identification of Intermittent and Perennial Streams and Their Origins*, (NCDWQ v4.11, Effective Date: September 1, 2010) stream assessment protocols. Copies of the referenced DWR Stream Identification Forms are included in Appendix 7 and reach condition summaries are provided below.

R1 is a small perennial headwater tributary that extends from the upstream western boundary of the project site. R1 has a stream length of approximately 1,397 feet, average valley slope of 3.2 percent, and drainage area of 38 acres. The reach originates at a stream crossing that has prevented further headcut migration. Based on field observations, depositional patterns and headwater location, sediment supply appears to be limited to finer grained material mostly from bed/bank materials.

Photo of R1 showing severe cattle trampling and a lack of woody riparian buffer vegetation.

The channel is severely incised in most locations. Cattle intrusion has degraded the riparian and aquatic habitat and many areas has resulted is poor channel definition. Bank erosion is widespread throughout as a result of hoof shear and lack of deep rooting vegetation. The riparian buffer along most of the reach is nonexistent as a result of the removal of riparian vegetation along both streambanks.

At the upper end of the reach, a headcut has been arrested by an existing stream crossing and associated rip rap. Further downstream, channel formation is poor as a result of cattle trampling and wallowing. Bank height ratios throughout R1 exceed 4.0 and the reach has a low sinuosity (k=1.12). Severe bank erosion and channel aggradation was observed throughout the reach. A few larger mature trees exist along the downstream portion; however, cattle have unrestricted access to 100 percent of R1, which has resulted in sparse understory vegetation establishment.

R1 is actively subject to water quality stressors, mainly in the form of cattle trampling and minimal riparian buffer widths. Based on the existing channel conditions and historic anthropogenic disturbances, R1 is classified as a severely incised E5b/F5b stream type throughout most of its length.

Looking upstream at headcut, debris in channel, and severe bank erosion along R2.

R2 is an intermittent stream that begins approximately 200 feet downstream of a roadway culvert under Caudle Road. From this culvert, R2 continues for approximately 286 feet to the confluence with R3. The average valley slope is 3.3 percent and the drainage area is 41 acres. R2 is severely incised, with active bank erosion present and bank height ratios exceeding 2.0. The sinuosity is with low sinuosity (k=1.08). Bank erosion appears to have resulted from bank scour and lateral instability caused by high near bank stresses during storm flows.

R2 appears to have been historically manipulated. This is evidenced by the unnatural position of the existing channel where it has been relocated away from the valley center/low point to the toe of the left valley wall. The riparian buffer on the right bank consists of maintained lawn with some large trees along the top of bank. The riparian buffer on the left valley slope consists of some mature trees with little understory vegetation. Based on the existing conditions and medium gravel to small cobble bed materials, R2 is classified as an incised G4 stream type.

R3 is a small intermittent stream that begins at an existing tree root that is providing grade control, approximately 75 feet before its confluence with R2. Along this reach, the bedform diversity is unnatural and the degree of incision is high, with bank height ratios exceeding 2.7, along with low sinuosity (k=1.07). R3 has a small drainage area of approximately 29 acres. R3 has experienced significant cattle intrusion and associated trampling for most of its length and the riparian buffer is limited to herbaceous vegetation with a few small trees.

Photo depicts degraded stream channel conditions along R2 near its confluence with R3.

R3 looking upstream towards existing headcut from confluence with R2 and R4.

Bank erosion is widespread throughout the reach. The entire reach is subject to active water quality stressors, mainly resulting from hoof shear from unrestricted cattle access and little to no riparian buffers on the streambanks. Based on the existing conditions, R3 is classified as an incised E6b stream type.

R4 is a perennial stream that begins at the confluence with R2 and R3. The channel flows south for approximately 1,191 feet before its confluence with R4b. R4 has an average valley slope of 3.8 percent and a drainage area of 83 acres. R4 is exposed to cattle intrusion along its entire length and the riparian buffer is limited to herbaceous vegetation with a few small and larger trees. R4 appears to be highly incised, with active bank erosion present, along with channel aggradation, livestock intrusion and associated trampling, and bank height ratios exceeding 4.0.

Looking downstream at cattle wallowing area of R4. Note poor channel definition resulting from cattle intrusion.

The lower end of R4 at its confluence with R4a has poor channel definition resulting from cattle intrusion and associated trampling and wallowing. R4 is subject to water quality stressors, mainly in the form of cattle access and minimal riparian buffer widths. Based on the existing channel conditions and anthropogenic disturbances, R4 is classified as B4 stream type for most of its length.

R4a is a small perennial headwater tributary that begins at a spring head within the upper catchment. The channel flows south for approximately 124 feet before its confluence with R4. R4a has a small drainage area of approximately 29 acres. R4a has experienced the results of severe cattle intrusion, but beginning downstream of the spring head, the remainder of R4a maintains a stable channel form until it meets R4. The riparian buffer is limited to herbaceous vegetation with a few small trees.

R4a is actively subject to water quality stressors, mainly in the form of cattle access and minimal riparian buffer widths. The reach classifies as a B4 stream type throughout most of the reach that is defined.

Looking upstream along stable section of R4a.

R4b is a small perennial headwater tributary that begins at a spring head within the upper catchment. The channel flows south for approximately 75 feet before its confluence with R4/R5. R4b has a very small drainage area of approximately 1.67 acres. R4b appears to be stable for most of its length except for a short section impacted by a headcut that has propagated upstream from R5.

R4b is subject to water quality stressors, mainly in the form of cattle access and minimal riparian buffer widths. The reach classifies as a G5 in the section below a headcutting propagating upstream.

R5 begins at the confluence of R4 and R4b. R5 flows approximately 2,519 feet before it enters a roadway culvert under Kiger Road. R5 has an average valley slope of 2.4 percent and drainage area of 166 acres. The riparian buffer is limited to an immature hardwood forest with a few larger trees in the upper reaches. The lower section lacks a riparian buffer resulting from current land use practices.

Looking downstream along stable section of R4b. Note stable bed and banks adjacent wetlands and lack of mature forest.

Looking downstream along R5. Note severe bank erosion and lack of mature buffer vegetation.

The channel is severely incised and the upper 1,400 feet exhibits moderate planform geometry. The lower 1,120 feet of the reach appears to have been manipulated and straightened. This is evidenced through its position in valley and observed spoil piles along the top of the streambanks. Bank erosion is widespread throughout this reach. The riparian buffer is nonexistent or consists of immature vegetation, and there is clear evidence that the riparian vegetation has been removed along both streambanks.

Bank height ratios throughout R5 often exceed 3.0 and the reach has a moderate sinuosity (k=1.3) in the upper reach, and a low sinuosity (k=1.02) along the lower reach. Severe bank erosion and channel aggradation was observed throughout the reach. A few mature trees exist the throughout reach, however cattle have unrestricted access to 100 percent of R5, which has led to sparse understory vegetation establishment. R5 is actively subject to water quality stressors, mainly in the form of cattle access and minimal riparian buffer widths. Based on the existing channel conditions and anthropogenic disturbances, R5 is classified as an incised B4c/G4c stream type for most of its length.

3.4.2 Channel Morphology and Stability Assessment

WLS conducted geomorphic and ecological assessments for each Project reach to assess the current stream channel condition and overall lateral and vertical stability. Data collection included seven representative riffle cross-sections, longitudinal profiles, and sediment samples. The existing channel morphology is summarized in Table 9 and detailed geomorphic assessment data is included in Appendix 2. Consistent geomorphic indicators of the bankfull stage were difficult to identify in the field given the modified flow regime and degraded channel conditions. Therefore, bankfull cross-sectional areas were initially compared with the published NC Rural Piedmont Regional Curve (Harman et al., 1999). The surveyed cross-sectional areas were slightly below the regional curve prediction (See Appendix 2 for comparison plots).

Bank Height Ratios (BHR) were measured in the field to assess the degree of channel incision. BHRs ranged from 1.7 (R4a) to greater than 7.1 (R1). BHR values greater than 1.5 typically indicate the stream channel is disconnected from its floodplain and system wide self-recovery is considered unlikely to occur within a desired timeframe (Rosgen, 2001). Entrenchment Ratios (ER) were measured to determine the degree of vertical confinement. ERs ranged from 1.2 (R5) to greater than 4.1 (R1) throughout the project area indicating reach segments are slightly-to-moderately entrenched.

Table 9. Existing Channel Morphology Summary

Project Reach Designation	Watershed Drainage Area (Ac)[1]	Entrenchment Ratio (ER)	Width/Depth Ratio (W/D)	Bank Height Ratio (BHR)	Sinuosity (K)	Channel Slope (S, ft/ft)	D_{50} (mm)
R1	37.8	4.1/1.1	3.3/13.0	3.0/7.2	1.12	0.0326	22.6
R2	41.0	1.2	6.4	2.1	1.08	0.0301	24.6
R3	29.4	4.0	5.8	2.7	1.07	0.0463	16.6
R4	83.2	1.7	8.9	4.4	1.29	0.0296	23.1
R4a	28.8	1.4	10.6	1.7	1.18	0.0197	10.0
R4b	1.66	1.3	7.9	4.3	1.02	0.0255	2.0
R5	166.4	1.9/1.2	7.2/10.6	3.2/4.5	1.3	0.0187	19.6

Note 1: Watershed drainage area was approximated based on topographic and LiDAR information and compared with USGS StreamStats at the downstream end of each reach.
Note 2: Cross-section locations are shown on Figure 8, Channel Stability & Pre-Monitoring Features.
Note 3: Geomorphic parameters for project reaches are based on best professional judgment and rapid field measurements.
Note 4: Additional values and dimensionless ratios for meander geometry and facet slopes are provided in Appendix 2. The existing degraded channel parameters are compared to stable stream systems in the Piedmont Physiographic Region.

WLS also compared historic aerial photographs with BANCS model estimates (Rosgen, 2006) described in Section 3.1.5 to identify areas susceptible to lateral bank erosion or accelerated meander migration. BEHI/NBS rating forms are in Appendix 2. Based on this comparison, most of the laterally unstable reach segments have occurred after riparian buffers where removed over the past few decades. As described in the reach condition summaries, the average valley slopes range from 1.9 to 4.7 percent and channel sinuosities range from 1.02 to 1.30. Most of the vertical grade control along the project reaches appears to be provided by infrequent vegetation root mass, bedrock outcrops, and culvert crossings. The surveyed longitudinal profile indicates reaches R2, R3, and R4a have headcuts near the upper segments and have been heavily manipulated.

Many of the reach segments have poor bedform diversity and minimal habitat features with shallow pools and longer/flatter riffles with higher pool-to-pool spacing. Reach R1 is vertically unstable throughout the reach however, below the dilapidated culvert the reach exhibits marginal bedform morphology and some habitat features (woody debris) with heavy bank erosion. Reaches R2 and R3 are marginally stable due to their drainage area but exhibit poor bedform morphology. Reach R4 is laterally unstable throughout the reach but does have woody and herbaceous vegetation that helps reduce excessive degradation. R4a is relatively stable except but transition to vertically unstable following a headcut resulting from downcutting in Reach R4. Reach R4b is relatively stable but does have a headcut resulting from downcutting occurring in Reach R4. Reach R5 is laterally unstable on the upper portion of the reach and has been channelized in the lower section.

NC SAM: WLS completed stream evaluations of the Project reaches using the *NC Stream Assessment Method* (NC SAM, Version 2.1, 2015) developed by the NC Stream Functional Assessment Team (SFAT). The purpose of NC SAM is to provide the public and private sectors with an accurate, consistent, rapid, observational, and science-based field method to determine the level of function of streams within North Carolina. NC SAM can be used as a tool for the consideration of project restoration design and planning, allowing for impacts to be avoided and/or minimized, and to provide information concerning assessed stream characteristics and functions for the regulatory review process.

WLS evaluated the NC SAM metrics relevant to the project assessment reaches, as shown in Appendix 8. The metrics were documented to evaluate various stream functions. The Project reach scores ranged from 'low' to 'medium'. Reaches R1, R2 and R3 scored 'low' due unstable channel and bank conditions, buffer and water quality stressors from cattle access, and altered stream morphology. Reaches R4, R4A, R4B and R5 scored ''medium" because of improved aquatic habitat, substrate and marginal buffer widths.

These channel stability and ecological assessments incorporated qualitative and quantitative observations using historic aerials, field evaluations, and detailed topographic survey data collected across the site. The conclusions from these assessments help describe the current stream stability, ecological conditions and functional ratings, however, these methods are not intended to be used for determining mitigation success on constructed stream and wetland sites.

3.4.3 Channel Evolution

The modified Simon Channel Evolution Model (CEM) describes a predictable sequence of change in a disturbed channel system (Simon, 1989). Channel evolution typically occurs when a stream system begins to change its morphologic condition, which can be a negative or positive trend towards stability. The channel evolution processes and stage vary across the Project site and have been greatly affected by human-induced disturbances. After reviewing the channel dimension, plan form, and longitudinal profile information, WLS concluded that none of the Project reaches currently exhibit positive trends towards stability or quasi-equilibrium. Project reaches R1, R2 and R3 vary between Class 'III' and 'IV' of the CEM as evidenced by migrating headcuts and will likely continue to degrade and widen. Reach R4 and R5 are transitioning from Class 'IV' to Class 'V' as evidenced by channel widening and sediment aggradation. Reach R4a and R4b are transitioning from Class 'I' to Class 'II' resulting from downcutting occurring in Reach R4. The proposed stream restoration approaches described in Section 6.1 are supported by these observations.

3.4.4 Sediment Supply, Delivery and Storage

Visual inspections of the channel substrate materials were conducted for each of the Project stream reaches. Representative bed materials were bulk sampled from all reaches. The existing streams consist of predominantly medium to coarse gravel, with some small cobble materials (D_{50} ranging from 15.2 mm on R1, 13.7 mm on R4, and 45.6 mm on R5). Subpavement sampling indicating D_{50} ranging from 21 mm on R1 to 45.8 mm. Due to past downcutting associated with headcut migration, most grade control along the project reaches appears to be provided by exposed bedrock knickpoints and ford/culverted stream crossings. Much of the parent material, which contains fine/medium gravel particle sizes, are mostly buried and still evident in some of the bank profiles. Field investigations suggest that the sediment supply is being recruited predominantly from streambank erosion along the project stream reaches. The streambank erosion along the project stream reaches appears to be limited during episodic storm flows due to the small headwater drainages, minimal impervious cover, cattle hoof shear, and influences from herbaceous vegetation and rotational hay crop cover.

Over the past few decades, the removal of woody buffer vegetation from the stream channels has decreased channel stability and increased the episodic pulse deliveries of stored sediment to downstream channels (Bilby, 1984). This anthropogenic derived sediment does not occur uniformly over the landscape (James, 2013) and changes in the amount and local storage areas for water and sediment can substantially affect hydrogeomorphic variability in headwater stream systems (McKenney et al. 1995). Improving the existing stream crossings and restoring more natural flood flows will facilitate positive adjustments to sediment routing and storage across the reconnected floodplain.

3.4.5 Jurisdictional WOTUS

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 (USACE, 1987. Determination methods included stream classification utilizing the NCDWQ Stream Identification Form and the USACE Stream Quality Assessment Worksheet. Potential jurisdictional (JD) wetland areas as well as upland areas were classified using the USACE Wetland Determination Data Form. The results of the on-site field investigation indicated that Project Reaches R1, R2, R3, R4, R4a, R4b, and R5 were determined to be jurisdictional stream channels. Project Reaches R1, R4, R4b, and R5 were determined to be perennial while Project Reaches R2, R3, and R4a were determined to be intermittent. Four (4) jurisdictional wetland areas were delineated within the proposed project area (See Figure 6) and are located within the floodplain areas along the project stream reaches. WLS received a preliminary JD approval letter from the USACE in March 2019 and supporting documents and are located in Appendix 9.

Currently, some of the existing wetland areas located in the floodplain have been impacted by cattle wallowing and past land clearing. After restoration activities, these areas will experience a more natural hydrology and flooding regime, and the riparian buffer area will be planted with native woody vegetation species that is more tolerant of wet conditions. The restoration design approach will likely enhance any areas of adjacent fringe or marginal wetlands. Existing stream profiles will be elevated along all reaches, which will improve local water table conditions adjacent to the channels and encourage more frequent flooding of riparian wetland areas. The proposed stream and wetland impacts are considered temporary and included with the 401/404 permit application.

3.5 Potential Site Constraints

3.5.1 *Existing Easements and Right-Of-Ways on the Site*

No existing easement exists within the project site. There is an area along the left terrace of R1 and the downstream extent of R5 that is impacted by a road right-of-way. The road right-of-way along R1 is impacting the minimum buffer width for approximately 200 linear feet of the left buffer width along R1. This is documented in Figure 11b and is included in the stream buffer credit calculator output in Appendix 2. Additionally, R5 is impacted by a road right-of-way at the downstream reach extent. The road right-of-way is impacting the minimum buffer channel buffer width in the left floodplain for approximately 40 linear feet. This is documented in Figure 11a and is included in the stream buffer credit calculator output in Appendix 2.

3.5.2 *Utility Corridors within the Site*

There is an existing utility crossing on the downstream extent of reach R5 that parallels Kiger Road. This existing utility easement was excluded from the conservation easement boundary.

3.5.3 *Mineral or Water Rights Assurance*

There are no mineral or water rights issues within or adjacent to the Project properties.

3.5.4 *Hydrologic Trespass*

None of the Project reaches are located within a FEMA regulated floodplain. While it is not anticipated that there will be issues associated with FEMA permitting or documentation, WLS will coordinate with the local floodplain administrator as needed and prepare the required documentation to obtain approval for any FEMA regulated impacts. In addition, the Project will be designed so that any increase in flooding will be contained within the Project boundary and will not impact adjacent landowners; therefore, hydrologic trespass will not be a concern.

3.5.5 *Invasive Species Vegetation*

There are currently no substantial communities of invasive plant species within the Project boundaries. Some small, immature Chinese privet plants and multiflora rose were observed within the existing riparian buffer areas. These areas will be monitored by WLS, and any invasive plants found within the Project boundary will be treated to prevent expansion and establishment of a substantial invasive community.

4 Functional Uplift Potential

Harman et al. (2012) provides a framework for conducting function-based assessments to develop project goals and objectives based on a site’s restoration potential and functional uplift. The framework is based on the Stream Functions Pyramid (SFP) which is a conceptual model that can be used to better define project goals and objectives by linking them to stream functions. Stream functions are separated into a hierarchy of functions and structural measures, ranging from Level 1 to Level 5 and include the following functional categories: Hydrology (Level 1), Hydraulic (Level 2), Geomorphic (Level 3), Physiochemical (Level 4), and Biological (Level 5). Chapter 4 of *A Function-Based Framework* (Harman et al., 2012) provides a more detailed description of the SFP and is illustrated in Appendix 2. The SFP framework is applied below to further describe the functional lift potential based on the existing conditions assessment and proposed restoration design elements.

4.1.1 Function-Based Parameters and Measurement Methods

Function-based parameters and measurement methods were evaluated using the NC Stream Functional Lift Quantification Tool (SQT, v3.0) to help assess the existing stream conditions, determine restoration potential and identify risks associated with the project site. The SQT is a qualitative and quantitative resource used to describe the function-based condition of each project reach, as well as evaluate functional capacity and predict the overall proposed lift (Harman and Jones, 2016). WLS applied the SQT to help further define goals and objectives based on the restoration potential. The results of this assessment helped determine the highest level of restoration that may be achieved based on-site constraints and existing conditions. Table 10 shows the function-based condition assessment parameters and measurement methods selected to help quantify and describe each functional category. The complete SQT functional assessment worksheets and summaries are provided in Appendix 2.

Table 10. Existing and Proposed Functional Condition Assessment Summary

Functional Category (Level)	Function-Based Parameters	Measurement Method
Hydrology (Level 1)	Catchment Hydrology	Catchment Assessment/ Curve Number
	Runoff	Curve Number
Hydraulics (Level 2)	Floodplain Connectivity	Bank Height Ratio
		Entrenchment Ratio
	Bank Migration/Lateral Stability	Meander Width Ratio
		BEHI/NBS
	Riparian Vegetation	Left Buffer Width (ft)
		Right Buffer Width (ft)
		Left Density (stems/acre)
		Right Density (stems/acre)
	Bed Form Diversity	Pool Depth and Spacing Ratio
		Percent Riffle and Pool
Geomorphic (Level 3)	Sinuosity	Plan Form
	Channel Evolution	Simon Channel Evolution Model
Physicochemical (Level 4)	Organic Carbon	Percent Shredders
Biology (Level 5)	Macrobenthos	Biotic Index EPT Taxa Present

Note: Table adapted from Harman et al. (2012).

4.1.2 Performance Standards and Functional Capacity

The Pyramid Framework includes performance standards associated with the function-based assessments and measurement methods described above. The performance standards are used to determine the functional capacity and are stratified into three types: *Functioning (F)*, *Functioning-at-Risk (FAR)*, and *Not Functioning (NF)*. The detailed definitions and index value ranges for each type are described further in the SQT (Harman and Jones, 2016). Table 11 summarizes the overall reach scoring and functional lift summary for each project reach.

Table 11. Functional Lift Scoring Summary

Reach Scoring / Rating	R1	R2	R3	R4	R4A	R4B	R5
Overall Existing Condition Score (ECS)	0.15	0.24	0.31	0.31	0.27	0.24	0.38
Overall Proposed Condition Score (PCS)	0.79	0.48	0.49	0.50	0.49	0.49	0.90
Functional Lift Score	0.64	0.24	0.18	0.19	0.22	0.25	0.52
Percent Condition Lift (%)	427%	100%	58%	61%	81%	104%	137%
Functional Foot Score (FFS) Existing vs. Proposed	210	69	14	234	48	53	1106
Functional Lift (%)	412%	107%	58%	63%	144%	249%	116%
Overall Existing vs. Proposed Condition	NF / FAR	NF / FAR	FAR / FAR	FAR / FAR	NF / FAR	NF / FAR	FAR / FAR

4.1.3 Restoration Potential

After completing the function-based assessment, the restoration potential was determined to better define the Project design goals and objectives. It is common for restoration projects to occur at a reach scale that provide minimum functional lift of Level 2 and 3 parameters. However, to achieve goals in Levels 4 and 5, a combination of reach scale restoration and upstream watershed health must be measurable and sustainable. The overall restoration potential was determined at Level 3 (Geomorphology) since the watershed assessment scored 'Fair' and may not fully support biological reference conditions in the upper reaches given the current nutrient inputs, smaller drainages, intermittent flow, and current watershed conditions.

Based on the existing condition assessments, the overall bioclassification is considered 'Fair'. It is expected that the implementation of this project will reduce pollutant loads, including sediment and nutrients, improving overall aquatic functions and bioclassification from 'Fair' to 'Good'. Given the landscape position and catchment size, the restoration activities will likely provide functional lift within the physicochemical and biological functional categories. Post-restoration efforts will also include supplemental monitoring of biological parameters (Level 5 Category) to document any functional improvements and/or identify trends during the monitoring period.

However, any Level 4 and 5 function-based parameters and monitoring activities will not be tied to performance standards nor required to demonstrate success for credit release.

The SQT manual recommends that practitioners, stakeholders and regulators collaborate when selecting appropriate parameters for determining whether project goals and objectives are being met or if any performance standards need to be adjusted based on local site conditions. Not all functional categories and parameters, such as water quality (Physicochemical - Level 4) and performance standards listed in the SQT will be compared or required to determine project success and stream mitigation credit and debit scenarios. However, selecting applicable monitoring and evaluation methods will help develop a more function-based assessment and improve our project implementation process, thereby advancing the practice of ecosystem restoration.

5 Mitigation Project Goals and Objectives

WLS set mitigation project goals and objectives to provide compensatory mitigation credits to DMS based on the resource condition, functional capacity and restoration potential 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 considered the general restoration and resource protection goals and strategies outlined in the Upper Yadkin Pee-Dee River Basin Restoration Priority Plan (RBRP, 2009). More specifically, watershed goals and management strategies described in the Upper Yadkin Local Watershed Plan (LWP) will be met by:

- Reducing sediment, soil erosion, turbidity, and nutrient inputs such as fecal coliform bacteria, nitrogen, and phosphorus to the Horne Creek Watershed.
- Restoring, enhancing, preserving and protecting headwater streams, wetlands, riparian buffers and aquatic habitat functions.
- Improving riparian corridor management and targeting restoration of impacted streams and riparian buffer areas.
- Promoting agronomic farm management techniques and implementing agricultural BMPs and water quality features such as livestock exclusion fencing, alternative watering structures, nutrient management, and wetlands restoration.
- Coordinating with landowners and NRCS/USDA through local program(s), farmland protection planning and education/outreach.

The following site-specific goals were developed to address the primary concerns outlined in the LWP and RBRP 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.

Function-based goals and objectives were considered that relate restoration activities to the appropriate parameters from the SFP framework, which are based on existing conditions, site constraints and overall restoration potential. When developing realistic function-based project goals and design objectives, it is imperative to know why the functions or resources need to be restored (Goal) and what specific restoration activities and measurement methods will be used to validate the predicted results (Objective). To accomplish these site-specific goals, the following function objectives will be measured to document overall project success as described in Table 12 below.

Table 12. Function-Based Goals and Design Objectives Summary

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	Design BHRs to not exceed 1.2 and increase ERs no less than 2.2 Rosgen 'C' and 'E' stream types and 1.4 for 'B' stream types.
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 30' 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 increase percent shredders.
Biology (Level 5)	Improve Macroinvertebrate Community and Aquatic Species Health	Incorporate native woody debris into channel.

As described in Section 4, the function-based assessment suggests that the proposed mitigation activities will result in a higher functioning aquatic ecosystem. The project goals and objectives address water quality stressors by reducing nutrient and sediment inputs through stream restoration, riparian buffer restoration, riparian wetland restoration and implementing agricultural BMPs. Hydrologic functions will be improved by raising the local water table. A more natural flow regime will be restored to riparian wetlands and floodplain areas by implementing a Priority Level I Restoration. The water quality functions will also be improved by installing permanent cattle exclusion fencing. The biologic and habitat functions will be improved by extending wildlife corridors that connect with wooded areas near the upstream and downstream extents of the project reaches.

Additionally, site protection through a conservation easement in excess of 30 feet from the top of banks, will protect all stream reaches and aquatic resources in perpetuity. These mitigation efforts will provide a significant ecological benefit with minimal impacts and constraints during a recovery period that would not otherwise occur through natural processes.

5.1.1 Project Benefits Summary

The project will provide numerous water quality and ecological benefits within the Upper Horne Creek Watershed. While many of these benefits will focus on the project area, others, such as nutrient removal, sediment reduction, and improved aquatic and terrestrial habitat, others have more far-reaching effects that extend downstream. The expected project benefits and ecological improvements are summarized below in Table 13.

Table 13. Project Benefits Summary

Benefits Related to Hydrology	
Rainfall/Runoff	Improving existing stream crossings and properly sizing pipe culverts and water quality treatment features will reestablish more natural flow conditions and water transport during various storm events.
Benefits Related to Hydraulics	
Floodplain Connectivity	The restored streams will be raised and reconnected to their active or relic floodplains to spread higher flow energies onto the floodplain thereby increasing retention time and floodplain roughness.
Surface Storage and Retention	Incorporation of vernal pools, depressional areas, and other constructed floodplain features will improve flow dynamics by reducing runoff velocities and provide additional surface storage and habitat diversity.
Groundwater Recharge/ Hyporheic exchange	Benefits will be achieved through establishing vegetated buffers, which increase groundwater infiltration, surface water interaction, and recharge rates.
Benefits Related to Geomorphology	
Proper Channel Form	Restoring an appropriate dimension, pattern, and profile will efficiently transport and deposit sediment (point bars and floodplain sinks) relative to the stream's power and load that is supplied from banks and uplands. Stream channels that are appropriately sized to convey higher frequency storm flows will greatly improve channel stability by reducing active bank erosion (lateral stability) and bed degradation (vertical stability; i.e. headcuts, downcutting, incision).
Sediment Transport	Boundary conditions, climate, and geologic controls influence stream channel formation and how sediment is transported through its watershed. Adequate channel capacity will ensure sediment supply is distributed such that excessive degradation and aggradation does not occur.
Riparian Buffer Vegetation	Planting buffer vegetation will improve thermal regulation (stream shading) along the riparian corridor, as well as increase woody root mass and density thereby decreasing bank erosion and sedimentation and increasing organic matter and woody debris.
Bioengineering Treatments	Bioengineering practices such as live staking, brush layering, and vegetated soil lifts will help encourage lateral bank stability and prevent further bank erosion and sedimentation.
Benefits Related to Physicochemical (Water Quality)	
Nutrient Reduction	Benefit will be achieved through the removal of cattle manure in the form of fecal coliform bacteria and excess nutrients through exclusion fencing, filtration and nutrient uptake within the restored and enhanced vegetated buffers.
Sediment Reduction	Benefit will be achieved through stabilization of eroding banks; installation of vegetation buffers; and by dissipating stream energy with increased overbank flows during storm events.
DO, NO_3-, DOC Concentration	Benefits will be achieved through the restoration of more natural stream forms including riffle and pool sequences, which will increase dissolved oxygen (DO) concentrations. In addition, as planted riparian buffers mature, the increased shade and wider vegetation density/structure will reduce water temperatures and groundwater nitrates (NO_3-) as well as increase dissolved organic carbon (DOC) (King et al, 2016).

Benefits Related to Biology	
Terrestrial and Aquatic Habitat	Benefits will be achieved through the incorporation of physical structure, removal of invasive species vegetation and returning native vegetation to the restored buffer areas. Benefits to aquatic organisms will be achieved through the installation of appropriate in-stream structures. Adequately transporting and depositing fine-grain sediment onto the floodplain will prevent embeddedness and create interstitial habitat, organic food resources and in-stream cover.
Landscape Connectivity	Benefits to landscape connectivity will be achieved by restoring a healthy stream corridor, promoting aquatic and terrestrial species migration and protecting their shared resources in perpetuity.

6 Design Approach and Mitigation Work Plan

The project includes the restoration, enhancement, and permanent protection of seven stream reaches (R1, R2, R3, R4, R4a, R4b, and R5) totaling approximately 5,681 linear feet of existing tributaries (See Figure 10). The design approach will utilize the entire suite of stream mitigation practices, from Priority Level I Restoration to Enhancement Level II, and appropriately addresses all the intermittent and perennial stream reaches at the project site. The project also includes restoring riparian buffers and riparian wetlands along streams currently in agriculture or pasture, providing permanent livestock exclusion, and improving the existing stream crossings, thus providing the maximum functional uplift and a unique opportunity to implement a comprehensive watershed approach. The mitigation components and proposed credit structure is outlined in Table 14 and the design approach and mitigation work plan are described in the following subsections.

Table 14. Mitigation Components and Proposed Credit Summary

Project Component	Existing Footage or Acreage	Proposed Reach Stationing	Restored Footage, Acreage, or SF	Creditable Footage, Acreage or SF	Restoration Level	Approach Priority Level	Mitigation Ratio (X:1)	Mitigation Credits
R1	1,397	10+00 – 23+40	1,320	1,320	R	PI/PII	1	1,320
R2	286	10+17 – 13+13	296	296	R	PII	1	296
R3	75	11+80 – 12+55	76	76	R	PII	1	76
R4	1,191	13+13 – 25+19	1,167	1,167	R	PI/PII	1	1,167
R4a	124	10+98 – 11+54	57	57	EII	-	2.5	23
R4a	-	11+55 – 12+65	111	111	R	PI	1	111
R4b	89	10+72 – 10+99	27	27	EII	-	2.5	11
R4b	-	10+99 – 12+24	125	125	R	PI	1	125
R5	2,519	25+19 – 48+12	2,249	2,249	R	PI	1	2,249
Totals	**5,681**		**5,428**	**5,428**				**5,378**
Credit Loss in Required Buffer								-300
Credit Gain for Additional Buffer								325
Net Change in Credit from Buffers								+25
Total Credits per Buffer Calculator								5,403
Total Adjusted SMCs								**5,389**

Note 1: No mitigation credits were calculated outside the conservation easement boundaries.
Note 2: The difference in Proposed Reach Stationing length and Restored Footage is the result of permanent crossings.
Note 3: The Wilmington District Stream Buffer Calculator was used to determine credit losses/gains due to 11% of the total project lengths buffer widths being less than 30'. Based on the stream buffer credit calculator the total net increase in stream credits is 25 credits. This is due in part to many areas within the buffer being greater than 30'. WLS is proposing the adjusted SMCs totaling 5,389 credits.
Note 4: Values in table were rounded to the nearest whole number.

6.1 Stream Mitigation Credit Adjustments

To calculate the stream credit adjustments, WLS utilized the USACE-Wilmington District Stream Buffer Credit Calculator (USACE, 2018). To perform this calculation, a GIS analysis was performed to determine the area (in square feet) of ideal buffer zones and actual buffer zones around all streams within the project. Minimum standard buffer widths were measured from the top of bank (50 feet in Piedmont and Coastal Plain counties or 30 feet in Mountain counties). The ideal buffers are the maximum potential size (in square feet) of each buffer zone measured around all creditable stream reaches, calculated using GIS, including areas outside of the easement. The actual buffer is the square feet in each buffer zone, as measured by GIS, excluding non-forested areas, all other credit type (e.g., wetland, nutrient offset, buffer), easement exceptions, open water, areas failing to meet the vegetation performance standard, etc. Additional credit is given to 150 feet in buffer width, so areas within the easement that are more than 150 feet from creditable streams were not included in this measurement. Non-creditable stream reaches within the easement were removed prior to calculating this area with GIS (for both ideal and actual). The stream lengths, mitigation type, ideal buffer, and actual buffer were all entered into the calculator. This is data was processed, and the resulting credit amounts were totaled for the entire project. See Tables 1 and 14, Figures 11a and 11b, and the stream buffer credit calculator in Appendix 2 for additional information.

6.2 Stream Design Approach

As described above in Sections 4 and 5, WLS used function-based assessment methods and data analyses to determine overall restoration potential and functional uplift. The stream design approach generally followed the techniques and methods outlined in the *NRCS Stream Restoration Design–National Engineering Handbook* (NRCS, 2007) and *Hydraulic Design of Stream Restoration Projects* (USACE, 2001). In addition, the natural stable channel design (NCD) procedures outlined in the *Natural Channel Design Review Checklist* (Harman and Starr, 2011) were applied to address specific stream functions lost across the site, while also minimizing disturbances to existing wooded areas and higher functioning resources.

WLS first compiled and assessed watershed information such as drainage areas, historical land use, geologic setting, soil types, sediment inputs and plant communities. Kee Surveying and Mapping then performed detailed existing conditions topographic and planimetric surveying of the project site and produced a 1-foot contour map, based on survey data, to create base mapping and plan sheets (See Appendix 1). Detailed geomorphic surveys were also conducted along the channel and floodplain to determine valley slopes/widths, channel dimensions, longitudinal profile elevations, and to validate the signatures shown on the LiDAR imagery (See Figure 5).

Project stream design criteria was developed using a combination of industry sources and applied approaches, including a review of applicable reference reach data (analog), evaluation of published regression equations and hydraulic geometry relationships (regional curves), monitoring results from stable past projects (empirical), and building a 2D unsteady state hydraulic model using process-based equations (HEC-RAS) to test design channel geometry and bed stability (analytical).

It should be mentioned, while analog and empirical form-based approaches have been proven effective in designing stable stream systems, their application assumes quasi-equilibrium conditions and similar watershed and boundary conditions (i.e. dominant discharge, flow regime, channel roughness, controlling vegetation). Using a static design template that accounts for natural channel variability can be limited by the regional data sets and overlook other local controlling factors such as flow impoundments, bedrock geology, woody debris/abundance, and sediment supply (Skidmore, 2001).

Conversely, analytical or process-based approaches rely heavily upon precise data inputs and a more robust level of effort may not be practical or even necessary to replicate channel geometry given the model sensitivity and desired outcome. Designing dynamic headwater channels is an iterative process that requires a detailed assessment of sediment continuity and predicted channel response for a range of smaller flows. Although it is difficult to definitively predict long term hydrologic conditions in the watershed, designing an appropriate stream channel for the valley characteristics (i.e. slope, width, and confinement) is always the preferred design rationale. Therefore, best professional judgment must be used when selecting appropriate design criteria for lifting the desired ecological functions.

6.2.1 Proposed Design Parameters

The proposed design parameters were developed so that plan view layout, cross-section dimensions, and longitudinal profiles could be described for developing construction documents. The design philosophy considers these parameters as conservative guidelines that allow for more natural variability in stream dimension, facet slopes, and bed features to form over long periods of time under the processes of flooding, re-colonization of vegetation, and other watershed influences (Harman, Starr, 2011).

Evaluating reference reach information and empirical data from monitoring stable rural Piedmont stream restoration projects provided pertinent background information and rationale to determine the appropriate design parameters given the existing conditions and restoration potential. The proposed stream design parameters also considered the *USACE Stream Mitigation Guidelines* issued in April 2003 (rev. October 2005) and the Natural Channel Design Checklist (Harman, 2011).

Table 15. Proposed Design Parameters

Parameter	R1	R2	R3	R4	R4a	R4b	R5
Drainage Area, DA (sq mi)	0.059	0.064	0.046	0.130	0.045	0.003	0.260
Stream Type (Rosgen)	B4	B4	B4a	B4/C4b	B4	B4	C4
Bankfull Riffle XSEC Area, Abkf (sq ft)	2.89	2.75	2.25	5.20	2.28	0.83	7.20
Bankfull Mean Velocity, Vbkf (ft/sec)	4.16	3.93	4.44	4.23	4.39	3.64	3.75
Bankfull Riffle Width, Wbkf (ft)	7.0	6.0	6.0	9.0	6.0	3.5	10.0
Bankfull Riffle Mean Depth, Dbkf (ft)	0.4	0.5	0.4	0.6	0.4	0.3	0.7
Width to Depth Ratio, W/D (ft/ft)	17.0	13.1	16.0	15.6	16.0	14.8	13.9
Width Floodprone Area, Wfpa (ft)	28 – 65	15 – 19	20 – 34	38 – 79	25 – 46	8 – 46	54 – 134
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	4 – 9.3	2.5 – 3.2	3.3 – 5.7	4.2 – 8.8	4.2 – 7.7	2.3 – 13.1	5.4 – 13.4
Riffle Max Depth Ratio, Dmax/Dbkf	1.3	1.2	1.3	1.3	1.3	1.3	1.3
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Meander Length Ratio, Lm/Wbkf	7.0 – 12.0	7.0 – 12.0	7.0 – 12.0	7.0 – 12.0	7.0 – 12.0	7.0 – 12.0	7.0 – 12.0
Radius of Curvature Ratio, Rc/Wbkf	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0	2.0 – 3.0
Meander Width Ratio, Wblt/Wbkf	3.5-8.0	3.5 – 8.0	3.5 – 8.0	3.5 – 8.0	3.5 – 8.0	3.5 – 8.0	3.5 – 8.0
Channel Sinuosity, K	~1.1	~1.1	~1.1	~1.3	~1.1	~1.1	~1.2

Parameter	R1	R2	R3	R4	R4a	R4b	R5
Channel Slope, Schan (ft/ft)	0.0341	0.0302	0.0464	0.0290	0.0205	0.0241	0.0201
Riffle Slope Ratio, Sriff/Schan	1.1 – 1.8	1.1 – 1.8	1.1 – 1.8	1.1 – 1.8	1.1 – 1.8	1.1 – 1.8	1.5 – 2.0
Pool Slope Ratio, Spool/Schan	0.0 – 0.4	0.0 – 0.4	0.0 – 0.4	0.0 – 0.4	0.0 – 0.4	0.0 – 0.4	0.0 – 0.2
Pool Width Ratio, Wpool/Wbkf	1.1 – 1.5	1.1 – 1.5	1.1 – 1.5	1.1 - 1.5	1.1 - 1.5	1.1 - 1.5	1.3 – 1.7
Pool-Pool Spacing Ratio, Lps/Wbkf	1.5 – 5.0	1.5 – 5.0	1.5 – 5.0	1.5 – 5.0	1.5 – 5.0	1.5 – 5.0	1.5 – 7.0
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.0 – 3.5	2.0 – 3.5	2.0 – 3.5	2.0 – 3.5	2.0 – 3.5	2.0 – 3.5	2.0 – 3.5

6.2.2 Design Reach Summary

For design purposes, the stream segments were divided into multiple reaches labeled R1, R2, R3, R4, R4a, R4b, and R5, as shown in Figure 9. The following narrative summarizes the proposed design approach, rationale and justification for each of stream reaches.

R1 – Restoration

R1 begins at the upstream western boundary of the project site immediately downstream of an existing stream crossing. R1 has a stream length of approximately 1,397 feet and average valley slope of 3.4 percent. R1 is severely incised with bank height ratios (BHR) exceeding 4.0. The existing channel generally flows through the low point of the valley. The majority of the reach will be restored in its current location and will tie into the downstream channel. Work along R1 will involve relocating the channel towards the center of the valley and implementing a Priority Level I/II Restoration by raising the bed elevation and reconnecting the stream with its abandoned floodplain.

The reach will be restored as a Rosgen B4 stream type using appropriate riffle-pool and step-pool morphology with minimal meander planform geometry that accommodates the valley slope and width. This approach will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. The proposed design width/depth ratio will range from 12-18, which will be similar to stable streams in this geologic setting. In-stream structures will be incorporated to control grade, dissipate flow energies, protect streambanks, and eliminate the potential for upstream channel incision. In-stream structures will include constructed riffles for grade control and aquatic habitat, log and rock weirs for encouraging step-pool formation, bank stability, and bedform diversity. Additionally, existing stream substrate will be reused in the project structures where appropriate. Bioengineering techniques such as geolifts and live stakes will also be used to protect streambanks and promote woody vegetation growth along the streambanks. Any mature trees or significant native vegetation will be protected and incorporated into the design.

WLS proposes to plant native woody species vegetation and restore the riparian buffer in excess of 30 feet within the conservation easement in most areas. A section of the reach between Station 21+45 and Station 23+11 has a reduced left buffer width (less than 30 feet). This reduced buffer is due to an adjacent roadway Right-Of-Way (ROW) that will not allow for extension of the buffer width to the required 30 feet through the entire reach. To compensate for the reduced left buffer width in this section, WLS proposes to increase the right buffer width. The right buffer width ranges from 44 feet to 70 feet at its widest point.

Permanent fencing will be installed to permanently exclude livestock and reduce sediment and nutrient inputs. A permanent 20-foot culverted crossing will be installed to allow for landowner access between pastures. Additionally, a water quality treatment feature will be installed inside of the conservation easement to reduce direct sediment and nutrient inputs. Permanent fencing will be installed to exclude livestock and reduce sediment and nutrient inputs. These proposed restoration activities will provide the maximum possible functional uplift.

R2 – Restoration

R2 is an intermittent stream that begins approximately 200 downstream of a roadway culvert under Caudle Road. The valley slope is approximately 3.3 percent. R2 is severely incised with BHRs exceeding 2.0. During site investigations, the channel appears to have been historically manipulated and relocated away from the center/low point of the valley. The reach will be restored as a Rosgen B4 stream type using appropriate riffle-pool and step-pool morphology with minimal meander planform geometry that will accommodate the valley slope and width. This approach will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. The proposed design width/depth ratio will range from 12-18, which will be similar to stable streams in this geologic setting. In-stream structures will be incorporated to control grade, dissipate flow energies, protect streambanks, and eliminate the potential for upstream channel incision. In-stream structures will include constructed riffles for grade control and aquatic habitat and rock weirs for encouraging step-pool formation, bank stability, and bedform diversity. Additionally, existing stream substrate will be reused in the project structures where appropriate. Bioengineering techniques such as live stakes will also be used to protect streambanks and promote woody vegetation growth along the streambanks.

WLS proposes to plant native woody species vegetation and restore the riparian buffer in excess of 30 feet within the conservation easement in most areas. Along the entire reach length there is a reduced left buffer width (less than 30 feet). This reduced buffer is due to an adjacent property that is currently not under option. This will not allow for extension of the buffer width to the required 30 feet through the entire reach. Finally, one agricultural BMP is proposed along R2 to capture, attenuate, and treat overland flow that would otherwise enter the riparian buffer as untreated water. The BMP will be constructed within the conservation easement to allow for easy access and maintenance and to protect the structure in perpetuity.

R3 – Restoration

R3 is an intermittent stream that begins approximately 75 feet upstream of the confluence with R2 and R4. The valley slope is approximately 5.0 percent. R3 is severely incised with BHRs exceeding 2.7. Work along R3 will involve Priority Level II by raising the bed elevation and reconnecting the stream with a constructed floodplain. The reach will be restored as a Rosgen B4a stream type using appropriate step-pool morphology with minimal meander planform geometry to accommodate the valley slope and width. This approach will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. The design width/depth ratio will range from 12-18, which will be similar to stable streams in this geologic setting. In-stream structures will be incorporated to control grade, dissipate flow energies, protect streambanks, and eliminate the potential for upstream channel incision. In-stream structures will include constructed riffles for grade control and aquatic habitat and rock weirs for encouraging step-pool formation, bank stability, and bedform diversity. Additionally, existing stream substrate will be reused in the project structures where appropriate. Bioengineering techniques such as live stakes will also be used to protect streambanks and promote woody vegetation growth along the streambanks. Finally, two agricultural BMPs in series are proposed along R3 to capture, attenuate, and treat overland flow that would otherwise enter the riparian buffer as untreated water. The BMP will be constructed within the conservation easement to allow for easy access and maintenance and to protect the structure in perpetuity.

R4 - Restoration

R4 is begins at the confluence of R2 and R3. The valley slope is approximately 3.0 percent with the valley flattening as it nears the confluence with R4a. R4 is severely incised with BHRs exceeding 4.0. The channel appears to have been historically manipulated in a few locations, but generally flows through the low point of the valley. Work along R4 will involve a mix of Priority Level I and II Restoration by raising the bed elevation and reconnecting the stream with its adjacent floodplain or a constructed floodplain. A majority of the channel will be restored in its current location while the lower 200 feet will be relocated to its historic position to meander across the left floodplain to tie into R5.

The reach will be restored as a Rosgen B4/C4b stream type using appropriate riffle-pool and step-pool morphology with a conservative meander planform geometry in the lower 200 feet that accommodates the valley slope and width. This approach will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. The design width/depth ratio will range from 12-18 for the channel will be similar to stable streams in this geologic setting. In-stream structures will be incorporated to control grade, dissipate flow energies, protect streambanks, and eliminate the potential for upstream channel incision. In-stream structures will include constructed riffles for grade control and aquatic habitat, log j-hook vanes, log vanes, and log and rock weirs for encouraging step-pool formation, bank stability, and bedform diversity. Two (2) permanent 20-foot culverted crossings will be installed to allow for landowner access between pastures. Additionally, existing stream substrate will be reused in the project structures where appropriate.

WLS proposes to plant native woody species vegetation and restore the riparian buffer in excess of 30 feet within the conservation easement in most areas. A section of the reach between Station 13+13 and Station 13+60 has a reduced left buffer width (less than 30 feet). This reduced buffer is due to an adjacent property that is currently not under option and will not allow for extension of the buffer width to the required 30 feet through the entire reach.

R4a – Enhancement Level II/Restoration

R4a is small perennial headwater tributary that begins at a spring head within the upper catchment. It flows for approximately 100 ft before it becomes a jurisdictional stream. Work along R4a will involve Enhancement Level II practices in upper 57 linear feet to maintain and improve the stability of the channel. Currently the upper part of the existing channel is fairly stable with limited bank erosion and channel incision. The lower 111 feet will be restored as a Rosgen B4 stream type using appropriate riffle-pool and step-pool morphology with minimal meander planform geometry that will accommodate the valley slope and width. This approach will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. It will also allow the channel to be tied into Reach R4 which is being relocated.

In-stream structures will be incorporated to control grade, dissipate flow energies, protect streambanks, and eliminate the potential for upstream channel incision. In-stream structures will include constructed riffles for grade control and aquatic habitat and log weirs for encouraging step-pool formation, bank stability, and bedform diversity**.** Additionally, existing stream substrate will be reused in the project structures where appropriate.

R4b – Enhancement Level II/Restoration

R4b is another small perennial headwater tributary that begins at a spring head within the upper catchment. A majority of this reach is stable except for a small section at the downstream end where an active headcut has propagated upstream from R5. Work along R4b will involve Enhancement Level II practices in upper 27 linear feet to maintain and improve the stability of the channel. Currently the upper part of the existing channel is moderately stable with limited bank erosion and channel incision.

The lower 125 linear feet will be restored as a Rosgen B4 stream type using appropriate riffle-pool and step-pool morphology with minimal meander planform geometry that will accommodate the valley slope and width. This approach will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. It will also allow the channel to be tied into Reach R4 which is being relocated. The design width/depth ratio for the channel will be similar to stable streams in this geologic setting. In-stream structures will be incorporated to control grade, dissipate flow energies, protect streambanks, and eliminate the potential for upstream channel incision. In-stream structures will include constructed riffles for grade control and aquatic habitat and log weirs for encouraging step-pool formation, bank stability, and bedform diversity. Additionally, existing stream substrate will be reused in the project structures where appropriate.

R5 - Restoration

R5 is begins at the confluence of R4 and R4b. The valley slope is approximately 2.0 percent until the slope flattens further downstream closer to the channel's terminus at Kiger Road. R5 is severely incised with BHRs exceeding 3.0. During site investigations, the channel appears to have been historically manipulated as evidenced by spoil piles, remnant abandoned channels, and position in the valley. Work along R5 will involve Priority Level I Restoration by raising the bed elevation and reconnecting the stream with its adjacent floodplain. A majority of the channel will be constructed offline and the existing channel filled. This approach will promote more frequent over bank flooding in areas with hydric soils, thereby creating favorable conditions for wetland restoration (both rehabilitation and re-establishment).

The reach will be restored as a Rosgen C4 stream type using appropriate riffle-pool morphology with a conservative meander planform geometry accommodates the valley slope (~1.9 percent) and widths. This approach will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. The design width/depth ratio will range from 10-14 which is similar to stable streams in this geologic setting. In-stream structures will be incorporated to control grade, dissipate flow energies, protect streambanks, and eliminate the potential for upstream channel incision. In-stream structures will include constructed riffles for grade control and aquatic habitat, log j-hook vanes, log vanes, and log and rock weirs for encouraging step-pool formation, bank stability, and bedform diversity. Additionally, existing stream substrate will be harvested and reused in the project structures where appropriate. Bioengineering techniques such as geolifts, toe wood, brush layers, and live stakes will also be used to protect streambanks and promote woody vegetation growth along the streambanks.

Riparian buffers in excess of 30 feet will be restored and protected along the entire length of R5 except for a section at the downstream project terminus. The reduced buffer width at the downstream project end is the result of conflicts with an adjacent road ROW. Any mature trees or significant native vegetation will be protected and incorporated into the design. Permanent fencing will be installed to exclude livestock and reduce sediment and nutrient inputs. A permanent 20-foot culverted crossing will be installed to allow for landowner access between pastures. The existing unstable channel will be filled to an elevation sufficient to connect the new bankfull channel to its historic floodplain or an excavated floodplain using suitable fill material from the newly restored channel and remnant spoil piles. Shallow floodplain pools will be created in depressional areas to provide habitat diversity, temporary sediment storage and improved treatment of overland flows. These proposed restoration activities will provide the maximum possible functional uplift. Any exotic species vegetation will be removed in this area and native riparian species vegetation will be planted in the resulting disturbed areas.

6.3 Reference Reach Selection

The morphologic data obtained from reference reach surveys can be a valuable tool for comparison and used as a template for analog design of a stable stream in a similar valley type with similar bed material. To extract the morphological relationships observed in a stable system, dimensionless ratios are developed from the surveyed reference reach. These ratios can be applied to a stream design to allow the designer to 'mimic' the natural, stable form of the target channel type.

While reference reach data can be a useful aid in analog design, they are not always necessary and can have limitations in smaller stream systems (Hey, 2006). The flow patterns and channel formation for many reference reach quality streams are often controlled by slope, bed material, drainage areas and larger trees and/or other deep-rooted vegetation. Some meander geometry parameters, such as radius of curvature, are particularly affected by vegetation control. Pattern ratios observed in reference reaches may not be applicable or are often adjusted in the design criteria to create more conservative designs that are less likely to erode after construction, before the permanent vegetation is established. Often the best reference data is from adjacent stable stream reaches or reaches within the same watershed.

For comparison purposes, WLS selected local reference reaches in the same and nearby watersheds and compared them with composite reference data. The reference reach data set represents small "Rural Piedmont Streams," and falls within the same climatic, hydrophysiographic and ecological region as the project site. The data shown on Table 16 helped to determine how the stream system may have responded to changes within the watershed. Figure 10 shows the reference reach locations as compared to the project site.

Table 16. Reference Reach Data Comparison

Parameter	Local Reference Data		Composite Reference Data	
	SCP	BF		
Stream Type (Rosgen)	C4b	B4	B4	C4
Bankfull Mean Velocity, Vbkf (ft/s)	6.9	5.4	4.0 - 6.0	3.5 - 5.0
Width to Depth Ratio, W/D (ft/ft)	18.4	68	12.0 – 18.0	5.0 – 12.0
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	3.7	1.7	>2.2	>2.2
Riffle Max Depth Ratio, Dmax/Dbkf	2.3	3.0	1.2 - 1.4	1.1 - 1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	1.0	1.0 - 1.1	1.0 - 1.1
Meander Length Ratio, Lm/Wbkf	-	-	-	7.0 - 12.0
Radius of Curvature Ratio, Rc/Wbkf	-	-	-	1.2 – 2.0
Meander Width Ratio, Wblt/Wbkf	-	-	-	3.0 - 8.0
Sinuosity, K	1.10	1.13	1.1 – 1.2	1.2 - 1.6
Valley Slope, Sval (ft/ft)	0.0142	0.0317	0.02 – 0.03	0.005 – 0.150
Channel Slope, Schan (ft/ft)	0.0123	0.028	---	---
Pool Max Depth Ratio, Dmaxpool/Dbkf	-	-	2.0 – 3.5	2.0 – 3.5
Pool Width Ratio, Wpool/Wbkf	-	-	1.1 – 1.5	0.8 – 1.2
Pool-Pool Spacing Ratio, Lps/Wbkf	-	-	1.5 – 5.0	4.0 - 7.0

Note 1: Composite reference reach values and ratios were compared using stable stream restoration projects surveyed and monitored in NC as illustrated in the Natural Channel Design Checklist (Harman, 2011).
Note 2: Local reference reach data was collected at Shoals Community Park (SCP) and Brown Farms (BF) sites respectively.

6.4 Flow Regime

Extensive research demonstrates that a wide range of flows are essential to maintain stable and high functioning habitat across ecological systems. The flow regime has been identified as the primary factor in sustaining the ecological integrity of riparian systems (Poff et al. 1997) and is a key variable in determining the abundance, distribution, and evolution of aquatic and riparian species (Schlosser 1985, Resh et al. 1988, Power et al. 1995, Doyle et al. 2005). The ecological significance of variable stream flows is more relative to flow duration, not necessarily just the flow recurrence interval. Seasonal flow variations correlate to biological relationships and habitat response. The flow conditions can generally be categorized as low flow, channel-forming flow, or flood flows, each with specific ecological significance (Postel and Richter, 2003).

A majority of stream miles (>80 percent) in North Carolina are classified as headwater streams (drainage area <3.9 mi^2), however, less than 10 percent of the 284 USGS stream gages in North Carolina are located on headwater streams (EFSAB, 2013). WLS recognizes the importance of these stream flow variables and the ecological role they play in supporting high functioning headwater steam and wetland systems. As such, flow monitoring will be conducted to demonstrate that the restored headwater stream systems exhibit seasonal base flow during a year with normal rainfall conditions. The stream surface flow documentation methods are further described in Section 8.2. Table 17 summarizes the basic flow levels and ecological roles the restoration design will provide after project implementation.

Table 17. Flow Level and Ecological Role

Low Flow (Base Flow): occurs most frequently/seasonally	-Provide year-round habitat for aquatic organisms (drying/inundation pattern) -Maintain suitable conditions for water temperature and dissolved oxygen -Provide water source for riparian plants and animals -Enable movement through stream corridor and refuge from predators -Support hyporheic functions and aquatic organisms
Channel-forming Flow: infrequent, flow duration of a few days per year	-Shape and maintain physical stream channel form -Create and maintain pools, in-stream and refuge habitat -Redistribute and sort fine and coarse sediments -Reduce encroachment of vegetation in channel and establishment of exotic species -Maintain water quality by flushing pollutants -Maintain hyporheic connection by mobilizing bed and fine material -Create in-channel bars for seed colonization of native riparian plants
Flood Flow: very infrequent, flow duration of a few days per decade or century	-Deposition of fine sediment and nutrients on floodplain -Maintain diversity, function, and health of riparian floodplain vegetation -Create streamside habitat, new channels, sloughs, and off-channel rearing habitat through lateral channel migration and avulsion -Recharge floodplain and storage processes -Recruitment of native wood and organic material into channel

6.4.1 Bankfull Stage and Discharge

Bankfull stage and its corresponding discharge are the primary variables used to develop a natural stable channel design. However, the correct identification of the bankfull stage in the field was difficult and can also be subjective (Williams, 1978; Knighton, 1988; and Johnson and Heil, 1996). Numerous definitions exist of bankfull stage and methods for its identification in the field (Wolman and Leopold, 1957; Nixon, 1959; Schumm, 1960; Kilpatrick and Barnes, 1964; and Williams, 1978). The identification of bankfull stage in the humid Southeast can be especially challenging because of dense understory vegetation and extensive channel modification and subsequent adjustment in channel morphology.

It is generally understood that bankfull stage corresponds with the discharge that fills a channel to the elevation of the active floodplain and represents a breakpoint between processes of channel formation and floodplain development. The bankfull discharge, which also corresponds with the dominant discharge or effective discharge, is the flow that moves the most sediment over time in stable alluvial channels. Field indicators include the back of point bars, significant breaks in slope, changes in vegetation, the highest scour line, or the top of the streambank (Leopold, 1994). The most consistent bankfull indicators for streams in the Piedmont of North Carolina are the backs of point bars, breaks in slope at the front of flat bankfull benches, or the top of the streambanks (Harman et al., 1999).

Upon completion of the field survey and geomorphic assessment, accurate identification of bankfull stage could not be made in all reach sections throughout the site due to incised and impaired channel conditions. Although some field indicators were apparent in segments with lower streambank heights and discernible scour features, the reliability of the indicators was inconsistent due to the altered condition of the stream channels. For this reason, the bankfull stage and discharge were estimated using published regional curve information.

6.4.2 Regional Curve Comparison

Regional curves developed by Dunne and Leopold (1978) relate bankfull channel dimensions to drainage area and are based on the channel forming discharge theory, which states that one unique flow can yield the same channel morphology as the full range of flows. A primary purpose for developing regional curves is to aid in identifying bankfull stage and dimension in un-gaged watersheds, as well as to help predict the bankfull dimension and discharge for natural channel designs (Rosgen, 1994). Gage station analyses throughout the United States have shown that the bankfull discharge has an average return interval of 1.5 years or 66.7% annual exceedance probability on the maximum annual series (Dunne and Leopold, 1978; Leopold, 1994).

Hydraulic geometry relationships are empirically derived and can be developed for a specific river or extrapolated to a watershed in the same physiographic region with similar rainfall/runoff relationships (FISRWG, 1998). Published and unpublished watershed specific bankfull regional curves are available for a range of stream types and physiographic provinces. The NC Rural Piedmont Regional Curve (Harman et al., 1999) and unpublished NC Rural Piedmont Regional Curve developed by the Natural Resources Conservation Service (NRCS, Walker, private communication, 2015) were used for comparison when estimating bankfull discharge. The NC Rural Piedmont Regional Curve and bankfull hydraulic geometry equations are shown in Table 18.

Table 18. North Carolina Rural Piedmont Regional Curve Equations

NC Rural Piedmont Regional Curve Equations (Unpublished Revised NC Rural Piedmont Regional Curve (NRCS, 2015)	NC Rural Piedmont Regional Curve Equations (Published Harman et al., 1999)
$Q_{bkf} = 55.31\ A_w^{0.79}$ R^2=0.97	$Q_{bkf} = 89.04\ A_w^{0.72}$ R^2=0.91
$A_{bkf} = 19.23\ A_w^{0.65}$ R^2=0.97	$A_{bkf} = 21.43\ A_w^{0.68}$ R^2=0.95
$W_{bkf} = 17.41\ A_w^{0.37}$ R^2=0.79	$W_{bkf} = 11.89\ A_w^{0.43}$ R^2=0.81
$D_{bkf} = 1.09\ A_w^{0.29}$ R^2=0.80	$D_{bkf} = 1.50\ A_w^{0.32}$ R^2=0.88

It's important to note these tributaries are classified as first order streams, and generally smaller headwater streams can be poorly represented on the regional curves. Based on our experience, the published NC Rural Piedmont Regional Curve Equations can slightly overestimate discharge and channel dimensions for smaller ungaged streams, such as those present at this site. Furthermore, estimating bankfull parameters subjectively rather than using deterministic values may encourage designers to make decisions on a range of values and beliefs that the bankfull depths must inherently be within that range (Johnson and Heil, 1996).

WLS has implemented numerous projects in ungaged drainages in the piedmont hydrophysiographic province of North Carolina, including nearby projects in Surry and surrounding counties, and has developed "mini-curves" specific to these projects. The data set on these small stream curves help reduce uncertainty by providing additional reference points and supporting evidence for the selection of bankfull indicators that produce slightly smaller dimensions and flow rates than the published regional curve data set. Channel slope, valley setting, channel geometry, and sediment supply, as well as information from the USGS regression and Manning's equations were all considered during examination of the field data.

The estimated bankfull discharges and surveyed cross-sectional areas at the top of bank were plotted on the NC Rural Piedmont Regional Curve and illustrated in Appendix 2.

6.4.3 Channel Forming Discharge

A hydrologic analysis was completed to estimate and validate the design discharge and channel geometry required to provide more frequent overbank flows and floodplain inundation. WLS used multiple methods for evaluating the bankfull stage and dominant discharge for the project reaches. Cross-sections were identified and surveyed to represent reach-wide conditions. Additional bankfull estimation methods, such as the commonly accepted Manning's equation, were compared to help interpret and adjust field observations to select the appropriate design criteria and justification for the design approach.

The bankfull flows in gaged watersheds within the NC Rural Piedmont study documented return intervals (RI) that ranges from 1.1 to 1.8, with a mean of 1.4 years (Harman et al, 1999). WLS also compared the 2-year flow frequency using the published USGS regression equation for small rural streams (DA ≤3 mi^2) within the piedmont hydrologic area of North Carolina (USGS, 2014). As expected, these values fall slightly above the published bankfull discharge, but were extrapolated to represent a wider range of flows. WLS then compared lower flow frequencies in the 1.0-yr, 1.2-yr, and 1.5-yr RI range versus survey data, field observations, and HEC-RAS 2D model outputs (See Appendix 2).

It should be noted that this best fit approach does not always match the dataset, since it falls at the low end of the curve. Therefore, caution should be used when comparing these lower RIs with additional data sets. Using the rationale described above, Table 19 provides the bankfull discharge analyses and comparisons based on the rural piedmont regional curves, the Manning's equation discharges calculated from the representative cross-section geometry for existing reaches, USGS regional regression equations, and the design discharge estimated based on the proposed design cross-sections for all project reaches.

Table 19. Design Discharge Analysis Summary

Project Reach Designation	Watershed Drainage Area (Ac)	Published NC Rural Piedmont Regional Curve (cfs) [1]	Unpublished NC Rural Piedmont Regional Curve (cfs) [2]	Manning's Equation (cfs) [3]	USGS Regression Equation for 2-year Recurrence Interval (cfs) [4]	USGS Regression Equation for 1.5-year Recurrence Interval (cfs) [5]	USGS Regression Equation for 1.2-year Recurrence Interval (cfs) [5]	Design Discharge Estimate (cfs)
R1	38	12.2	5.7	6.6	22.5	19.0	15.9	12.0
R2	41	13.0	6.2	11.4	24.1	20.1	16.8	12.0
R3	29	10.3	4.7	8.6	18.9	16.1	13.6	10.0
R4a	29	10.1	4.6	7.9	18.7	16.0	13.5	10.0
R4b	1.7	1.3	0.5	4.5	2.5	2.4	2.2	3.0
R4	83	21.5	10.9	19.4	39.7	31.7	25.6	22.0
R5	166	35.2	19.0	33.0	64.8	49.3	38.4	27.0

Note 1: Published NC Piedmont Regional Curve (Harman et al., 1999).

Note 2: Unpublished Revised NC Rural Piedmont Regional Curve developed by NRCS (A. Walker personal communication, 2015).

Note 3: Bankfull discharge estimates vary based on Manning's Equation for the representative riffle cross-sections. Bankfull stage roughness estimates (n-values) ranged from approximately 0.047 to 0.059 based on channel slopes, depth, bed material size, and vegetation influence.

*Note 4: USGS rural regression equation for 2-year flood recurrence interval, Q2 =163(DA)^0.7089*10^(0.0133*(IMPNLCD06)) for small rural streams (USGS, 2011)*

Note 5: NC USGS rural regression equation extrapolated for 1.2- and 1.5-year flood recurrence interval (USGS, 2011)

After considering these estimation methods and results (geometry measurements, regional curves, flow frequency and USGS regional regression equations), WLS estimated the design discharge using values between the published NC Rural Piedmont Regional Curve and Manning's equation to select the appropriate design dimensions and flows rates that best correspond to the design channel that will convey the 1.2-yr to 1.5-yr RI.

6.4.4 Channel Stability and Sediment Transport Analysis

The sediment transport capacity and competency (entrainment) was analyzed to help predict stable channel design conditions and discharges for the project reaches. Sediment samples were collected to obtain a sediment size distribution, determine dimensionless critical shear stress, and calculate/predict corresponding slope and depth required to move the largest particle class size (D_{100}). The sample locations are shown on Figure 9. The sieve data indicate that the dominant bed material in the stream reaches is medium gravel under current conditions, with a few localized sections of coarser cobble material and exposed bedrock. Table 20 illustrates boundary shear stress and stream power values under proposed design conditions for the project reaches. See Appendix 2 for sediment particle size distribution for the project reaches.

Table 20. Boundary Shear Stress and Stream Power

Parameter	R1	R2	R3	R4	R4a	R4b	R5
Channel Bottom Width (ft)	3.5	4.0	3.0	4.0	3.0	2.0	6.0
Channel Energy Slope (feet/ foot)	0.0341	0.0302	0.0464	0.0290	0.0205	0.0241	0.0201
Median Particle Size, D_{50} (mm)	15	24.7	16.6	23.1	10.0	2.0	19.6
Bankfull XSC Area (square feet)	2.89	2.75	2.25	5.20	2.25	0.83	7.20
Composite Mannings 'n' Value	0.040	0.053	0.050	0.055	0.035	0.033	0.049
Bankfull Width, W (feet)	7.0	6.0	6.0	9.0	6.0	3.5	10.0
Bankfull Depth, D (feet)	0.41	0.46	0.38	0.58	0.38	0.24	0.72
Hydraulic Radius, R (feet)	0.37	0.40	0.33	0.51	0.39	0.31	0.68
Bankfull Velocity, V (cfs)	4.2	4.0	4.4	4.2	4.4	3.6	3.8
Bankfull Discharge, Q (cfs)	12.0	12.0	10.0	22.0	10.0	3.0	27.0
Boundary Shear Stress, τ (lbs/ft2)	0.79	0.75	0.97	0.93	0.42	0.31	0.79
Stream Power (W/m2)	47.6	43.3	62.4	57.1	27.6	16.6	43.1

As a design consideration, portions of the bed material may contain particle sizes larger than the D_{84} to achieve vertical stability in steeper sections immediately after construction. The proposed channel slopes throughout the project reaches range from approximately 2.0% to over 4.0%. In general, sections with steeper slopes will be addressed by installing a combination of grade control structures such as log/rock riffles and log/boulders step pools in straighter segments. Incorporating these structures will prevent further channel degradation and embeddedness, promote natural scour and sediment storage, and increase bed/bank stability since shear stress and sediment entrainment are directly affected by factors such flow energy distribution and channel resistance. While it is predicted that the restoration and enhancement efforts will reduce stream bed and bank erosion, the channels must still adequately transport finer bedload material while maintaining vertical and lateral stability.

A site-specific sediment rating curve and budget was not developed given the limited sediment supply and headwater position in the watershed. This detailed effort requires using on-site monitoring data from documented flow events within the project watershed. However, empirical relationships from stable streams were compared to published values and reference streams that have similar characteristics and boundary conditions such as slope, controlling vegetation and bedform morphology. Based on field observations within the project watershed, the streams receive most materials directly from streambank erosion with minimal contributions from the upper catchment area. This was evidenced by visual observations of a gravel/cobble lens approximately 2 to 3 feet below the existing top of bank along portions of the degraded channels. Further field investigations confirmed that the sediment supply from project reaches is transported during larger storm events due to small headwater drainage, and influences from vegetation cover.

6.5 Wetland Design Approach

While it is understood that wetland mitigation credits are not contracted nor proposed for this project, the project area will benefit from the restoration of riparian wetland hydrology and improved ecological function along the floodplains of the project stream reaches where Priority Level I Restoration approaches are implemented. The project site is located in an agricultural setting in the Upper Piedmont, within a Priority Sub-watershed as described in the Yadkin-Pee Dee 09 RBWP River Basin Watershed Restoration Plan, where smaller headwater stream and wetland restoration projects are highly recommended and prioritized.

Based on field investigations, soil conditions are favorable for rehabilitating areas of significantly degraded existing riparian wetlands along R4a and R4b. The verified wetland areas are shown on Figure 6 and total approximately 0.35 acres. Riparian wetland rehabilitation is expected to occur in areas of drained hydric soils by improving current hydrologic conditions and overbank flooding across the historic floodplain as a direct result of implementing Priority Level I Restoration, removing cattle from the riparian area which will improve soil structure, and restoration of the riparian buffer. Additionally, the wetland restoration approach will improve the hyporheic zone interaction and both biological and chemical processes associated with aquatic functions of the stream. These activities, including minimal grading and blending of natural microtopography, will provide significant functional uplift across the project area.

6.6 Riparian Buffer Design Approach

One of the primary project goals includes restoring riparian buffer functions and corridor habitat. An objective identified in support of this goal includes planting to re-establish a native species vegetation riparian buffer corridor along the entire length of the project reaches. This objective will be met by establishing riparian buffers which extend a minimum of 30 feet from the top of the streambanks along each of the project stream reaches, as well as permanently protecting those buffers with a conservation easement. For project stream reaches proposed for restoration and enhancement, the riparian buffers will be restored through reforestation.

Many of the proposed riparian buffer widths within the conservation easement are greater than 30 feet along one or both streambanks to provide additional functional uplift potential, such as encompassing adjacent wetland areas. The riparian buffer zone for the project includes the streambanks, floodplain, riparian wetland, and upland transitional areas. The proposed planting boundaries are shown on the revegetation plans in Appendix 1. The conservation easement areas also may include areas outside of the riparian buffer zone that will be revegetated, including areas that lack vegetation species diversity, or areas otherwise disturbed or adversely impacted by construction.

Proposed plantings will be conducted using native species bare-root trees and shrubs, live stakes, and seedlings. Proposed plantings will predominantly consist of bare root vegetation and will generally be planted at a total target density of 680 stems per acre. This planting density has proven successful with the reforestation of past completed mitigation projects, based on successful regulatory project closeout, and including the current USACE regulatory guidelines requiring levels of woody stem survival throughout the monitoring period, with a MY7 final survival rate of 210 stems per acre.

WLS recognizes that riparian buffer conditions at mature reference sites are not reflected at planted or successional buffer sites until the woody species being to establish and compete with herbaceous vegetation. To account for this, we will utilize a successful riparian buffer planting strategy that includes a combination of overstory, or canopy, and understory species. WLS will also consider the supplemental planting of larger and older planting stock to modify species density and type, based on vegetation monitoring results after the first few growing seasons. This consideration will be utilized particularly to increase the rate of buffer establishment and buffer species variety, as well as to decrease the vegetation maintenance costs. An example might include selective supplemental planting of older mast producing species as potted stock in later years for increased survivability.

The site planting strategy also includes early successional, as well as climax species. The vegetation selections will be mixed throughout the project planting areas so that the early successional species will give way to climax species as they mature over time. The early successional species which have proven successful include river birch (*Betula nigra*), green ash (*Fraxinus pennsylvanica*), and American sycamore (*Platanus occidentalis*). The climax species that have proven successful include oaks (*Quercus spp.*) and tulip-tree (*Liriodendron tulipifera*). The understory and shrub layer species are all considered to be climax species in the riparian buffer community.

6.6.1 Proposed Vegetation Planting

The proposed plant selection will help to establish a natural vegetation community that will include appropriate strata (canopy, understory, shrub, and herbaceous species) based on an appropriate reference community. Schafale and Weakley's (1990) guidance on vegetation communities for Piedmont Bottomland Forest (mixed riparian community) and Dry-Mesic Oak-Hickory Forest (Piedmont Subtype), the USACE Wetland Research Program (WRP) Technical Note VN-RS-4.1 (1997), as well as existing mature species identified throughout the project area, were referenced during the development of riparian buffer and adjacent riparian wetland plants for the site. The proposed natural vegetation community will include appropriate strata (canopy, understory, shrub, and herbaceous species) based on the appropriate reference community. Within each of the four strata, a variety of species will be planted to ensure an appropriate and diverse plant community.

Tree species selected for restoration and enhancement areas will be weak to tolerant of flooding. Weakly tolerant species can survive and grow in areas where the soil is saturated or flooded for relatively short periods of time. Moderately tolerant species can survive in soils that are saturated or flooded for several months during the growing season. Flood tolerant species can survive on sites in which the soil is saturated or flooded for extended periods during the growing season (WRP, 1997). Species proposed for revegetation planting are presented in Table 21.

Table 21. Proposed Riparian Buffer Bare Root and Live Stake Plantings

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)			
Betula nigra	River birch	7%	FACW
Tilia americana	Basswood	7%	FACU
Platanus occidentalis	American sycamore	7%	FACW
Nyssa sylvatica	Black gum	6%	FAC
Liriodendron tulipifera	Tulip-poplar	7%	FACU
Quercus alba	White oak	6%	FACU
Quercus alba	Northern red oak	3%	FACU
Fraxinus pennsylvanica	Green ash	3%	FACW
Riparian Buffer Bare Root Plantings – Understory (Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Diospyros virginiana	Persimmon	7%	FAC
Amelanchier arborea	Common serviceberry	5%	FAC
Magnolia tripetala	Umbrella magnolia	6%	FACU
Carpinus caroliniana	American hornbeam	6%	FAC
Hamamelis virginiana	Witch-hazel	6%	FACU
Asimina triloba	Pawpaw	6%	FAC
Lindera benzoin	Spicebush	6%	FACW
Alnus serrulata	Hazel alder	6%	OBL
Corylus americana	Hazelnut	6%	FACU
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
Note: Final species selection may change due to refinement or availability at the time of planting. Species substitutions will be coordinated between WLS and planting contractor prior to the procurement of plant stock.			

6.6.2 Planting Materials and Methods

Planting will be conducted during the dormant season, with all trees installed between Mid-November and early March if possible. However, trees must be installed by the end of May to have the first year of monitoring in that year. Observations will be made during construction of the site regarding the relative wetness of areas to be planted as compared to the revegetation plan. The final planting zone limits may be modified based on these observations and comparisons, and the final selection of the location of the planted species will be matched according the species wetness tolerance and the anticipated wetness of the planting area. It should be noted that smaller tree species planted in the understory, such as American hornbeam (*Carpinus caroliniana*), will unlikely meet the height targets for tree species after seven years.

Plant stock delivery, handling, and installation procedures will be coordinated and scheduled to ensure that woody vegetation can be planted within two days of being delivered to the project site. Soils at the site areas proposed for planting will be prepared by sufficiently loosening prior to planting. Bare root seedlings will be manually planted using a dibble bar, mattock, planting bar, or other approved method. Planting holes prepared for the bare root seedlings will be sufficiently deep to allow the roots to spread outward and downward without "J-rooting." Soil will be loosely re-compacted around each planting, as the last step, to prevent roots from drying out.

Live Staking and Live Branch Cuttings: Where live staking is proposed, live stakes will typically be installed at a minimum of 40 stakes per 1,000 square feet and the stakes will be spaced approximately two to three feet apart in meander bends and six to eight feet apart in the riffle sections, using a triangular spacing pattern along the streambanks, between the toe of the streambank and bankfull elevation. When bioengineering is proposed, live branch cutting bundles comprised of similar live stake species, shall be installed at five linear feet per bundle approximately two to three branches thick. The basal ends of the live branch cuttings, or whips, shall contact the back of the excavated slope and shall extend six inches from the slope face.

Permanent Seeding: Permanent seed mixtures of native species herbaceous vegetation and temporary herbaceous vegetation seed mixtures will be applied to all disturbed areas of the project site. The individual species were specifically selected due to their native occurrence in Surry County, NC. Temporary and permanent seeding will be conducted simultaneously at all disturbed areas of the site during construction and will conducted with mechanical broadcast spreaders. Simultaneous permanent and temporary seeding activities helps to ensure rapid growth and establishment of herbaceous ground cover and promotes soil stability and riparian habitat uplift.

Table 22 lists the proposed species, mixtures, and application rates for permanent seeding. The vegetation species proposed for permanent seeding are deep-rooted and have been shown to proliferate along restored stream channels, providing long-term stability. The vegetation species proposed for temporary seeding germinate quickly to swiftly establish vegetative ground cover and thus, short term stability. The permanent seed mixture proposed is suitable for streambank, floodplain, and adjacent riparian wetland areas, and the upland transitional areas in the riparian buffer. Beyond the riparian buffer areas, temporary seeding will also be applied to all other disturbed areas of the site that are susceptible to erosion. These areas include constructed streambanks, access roads, side slopes, and spoil piles. If temporary seeding is applied from November through April, rye grain will be used and applied at a rate of 130 pounds per acre. If applied from May through October, temporary seeding will consist of browntop millet, applied at a rate of 40 pounds per acre.

Table 22. Proposed Riparian Buffer Permanent Seeding

Botanical Name	Common Name	% Proposed for Planting by Species	Seeding Rate (lb/acre)	Wetland Tolerance
Andropogon gerardii	Big blue stem	10%	1.50	FAC
Dichanthelium clandestinum	Deer tongue	15%	1.50	FACW
Carex intumescens	Bladder sedge	10%	2.25	FACW
Chasmanthium latifolium	River oats	5%	1.50	FACU
Elymus virginicus	Virginia wild rye	15%	1.50	FAC
Juncus effusus	Soft rush	10%	2.25	FACW+
Sisyrinchium angustifolium	Blue-eyed grass	5%	1.50	FAC+
Eutrochium fistulosum	Joe pye weed	5%	0.75	FACW
Schizachyrium scoparium	Little blue stem	10%	0.75	FACU
Tripsacum dactyloides	Eastern gamagrass	5%	0.75	FAC+
Sorghastrum nutans	Indiangrass	10%	0.75	FACU
Note: Final species selection may change due to refinement or availability at the time of planting. Species substitutions will be coordinated between WLS and planting contractor prior to the procurement of seeding stock.				

Invasive species vegetation, such as Chinese privet, multiflora rose, and microstegium (*Microstegium vimineum*), will be treated to allow native plants to become established within the conservation easement. Larger native tree species will be preserved and harvested woody material will be utilized to provide bank stabilization cover and/or nesting habitat. Hardwood species will be planted to provide the appropriate vegetation for the restored riparian buffer areas. During the project implementation, invasive species exotic vegetation will be treated both to control its presence and reduce its spread within the conservation easement areas. These efforts will aid in the establishment of native riparian vegetation species within the restored riparian buffer areas.

6.7 Agricultural Best Management Practices

WLS proposes various agricultural best management practices (BMPs) as practices or measures to be implemented as part of a “project cluster” approach. When combined with stream and riparian buffer, agricultural BMPs can be effective at reducing pollutants, particularly sediment loadings, and therefore provide additional ecological uplift to the project. The agricultural BMPs that are best suited at this project site include no till planting, grassed waterways, restricted grazing, livestock fencing, and alternate watering sources for livestock. Currently, the landowner actively employs the use of grassed waterways and restricted or rotational grazing. Therefore, livestock exclusion fencing, providing alternate watering sources for livestock, and the addition of treatment basins are proposed for this project. WLS will provide a permanent watering source for livestock at the project site through the installation of livestock drinkers and associated watering infrastructure. The livestock watering stations will be designed and located in direct coordination with the landowner and the Surry County Soil and Water Conservation District and/or NRCS staff to ensure that adequate watering facilities are provided. The watering stations will be located outside of the conservation easement boundaries and well away from the restored stream corridors.

As previously discussed, direct livestock access and the resulting sedimentation, erosion, and pollutants are one of the primary stressors for the project site. Permanent livestock exclusion from the applicable conservation easement areas will be provided with fencing, installed to NRCS technical standards. The permanent fencing will be installed to maximize the length of straight fence lines and minimize the number of fence corners. At the active culverted stream crossings, the permanent livestock exclusion fencing will be installed along both the upstream and downstream limits of the conservation easement "alley" or break to prevent livestock from accessing the stream from the actual crossing. The locations of the proposed stream crossings are shown on Figure 9. The proposed conservation easement is broken at each of these proposed crossing locations to best facilitate the landowner's use of the property. The proposed stream crossings will be culverted and the pipes have been sized to pass the 10-year design storm to ensure proper hydraulic function and stream stability, as well as to encourage aquatic passage.

6.8 Water Quality Treatment Features

Water quality treatment features in the form of small basins or impoundments designed to capture and treat runoff from the surrounding active cattle pastures and/or agricultural fields are proposed in multiple locations adjacent to the restored riparian buffer corridor. These basins will increase infiltration and groundwater recharge, diffuse flow energies, and allow nutrient uptake within the extended riparian buffer area. The water quality improvement features will be fenced out, such that they are connected to the easement fencing system, to prevent livestock intrusion and will be included in the conservation easement. These features are sized to treat storage volumes, which have been calculated by comparing the SCS Curve Number Method and Simple Method. The features are intended to function most similar to a stormwater wetland to temporarily store surface runoff in shallow pools that support emergent and native riparian vegetation. They will be designed and constructed such that they do not require any long-term maintenance and will be sited immediately outside of the conservation easement boundary to allow for modifications should that be desired.

The treatment basins will be excavated along non-jurisdictional flat or depressional areas where ephemeral drainages intersect with the proposed restored stream corridor. The areas will be improved by grading flatter side slopes (>3H:1V) and planting appropriate wetland vegetation as outlined in Section 6.5.1. Over time, as vegetation becomes established, the areas will function as shallow wetland complexes or depressions. The outlets will be constructed with suitable material and stabilized with permanent vegetation or stone that will prevent headcut migration or erosion into the newly constructed areas. Each of the basins have been designed with low-maintenance weir outlets. The basins will be planted and located outside the conservation easement area. This strategy will allow these features to function properly with minimal risk and without long term maintenance requirements. A stable outlet channel will be constructed to deliver runoff to the receiving restored stream reach.

6.9 Site Construction Methods

6.9.1 Site Grading and Construction Elements

Following initial evaluation of the design criteria, detailed refinements were made to the design plans in the field to accommodate the existing valley characteristics, vegetation influences and channel morphology. This was done to minimize unnecessary disturbance of the riparian area, and to allow for some natural channel adjustments following construction. The design plans and construction elements have been tailored to produce a cost and resource efficient design that is constructible, using a level of detail that corresponds to the tools of construction. A general construction sequence is included on the project design plan sheets located in Appendix 1.

Much of the grading across the site will be conducted within the existing riparian corridor. The restored streams will be excavated within the existing headwater valley. Suitable fill material will be generated from new channel excavation and adjacent upland areas and hauled to ditch fill/plugs or stockpile locations as necessary. Portions of the existing, unstable channels will be partially to completely filled in along their length using compactable material excavated from construction of the restored channels.

Wetland and floodplain grading activities will focus on restoring pre-disturbance valley topography by removing field crowns, overburden/spoil, surface drains, and legacy pond sediments that were imposed during conversion of the land for agriculture. In general, floodplain grading activities will be minor, with the primary goal of soil scarification, creating depressional areas, water quality and habitat features, and microtopographic crenulations by filling the drainage features on the site back to natural ground elevations (Scherrer, 1999). Any excess material not used for ditch plugging or suitable as a soil base for vegetation will be spread across upland areas outside of the easement boundary and jurisdictional WOTUS.

6.9.2 In-stream Structures and Site Improvement Features

A variety of in-stream structures are proposed for the project. Structures including log vanes, constructed log riffles, constructed stone riffles, grade control log j-hook vanes, log vanes, rootwads, log weirs, stone and log step pools, and log step pools. Geolifts with toe wood, various other bioengineering measures, and native species vegetation transplants will be used to stabilize the newly-restored stream and improve bedform diversity and habitat functions. All in-stream structures will be constructed from native materials such as hardwood trees, trunks/logs, brush/branches, and gravel stone materials. Native woody debris will be harvested on-site during the project construction and incorporated into the stream channel restoration whenever possible. To ensure sustainability of these structures, WLS will use design and construction methods that have proven successful on numerous past projects in the same geographic region and similar site conditions.

Floodplain features such as small sloughs, meander scars, vernal pools, and tree throws are commonly found in natural riparian systems. These features will be appropriately added to provide additional habitat and serve as water storage and sediment sinks throughout the restoration corridor. When appropriate, these depressional features will be added adjacent to abandoned channel sections and/or strategic locations throughout the floodplain to provide habitat and serve as water storage and sediment sinks throughout the corridor (Metcalf, 2004).

6.9.3 Construction Feasibility

WLS has field verified that the project site has adequate, viable construction access, staging, and stockpile areas. Physical constraints or barriers, such as stream crossings or ROWs, account for only a small percentage of the proposed total stream reach length within the project boundary. Existing site access points and features may be used for future access after the completion of construction. Any potential impacts to existing wetland areas will be avoided whenever possible during construction. Only minimal, temporary impacts will be allowed when necessary for maximized permanent stream, wetland, and riparian buffer functional uplift.

7 Performance Standards

The applied success criteria for the project will follow necessary performance standards and monitoring protocols presented in this mitigation plan, once approved, and are developed in compliance with the *DMS Stream and Wetland Mitigation Plan Template Guidance*, adopted August 2016, as well as the *USACE Wilmington District Stream and Wetland Compensatory Mitigation Update* issued in October 20016, and *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule,* issued in 2008.

In addition, the monitoring success criteria, practices, and corresponding reporting will follow the *NCEEP's Stream and Wetland Mitigation Monitoring Guidelines* issued February 2014, the *NCEEP As-built Baseline Monitoring Report Format, Data Requirements, and Content Guidance* issued in February 2014, the *NCEEP Annual Monitoring Report Format, Data Requirements, and Content Guidance*, issued April, 2015, the *NCEEP Closeout Report Template*, Version 2.1, adopted March, 2015, and the *NCEEP Closeout Template Guidance*, Version 2.1, adopted February, 2015. 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. Specific success criteria components and evaluation methods are described below.

7.1 Streams

Stream Hydrology: Four (4) separate bankfull events must be documented within the seven-year monitoring period. Two of the four bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until all four bankfull events have been documented in separate years. In the event that less than four bankfull events occur during the monitoring period, release of these reserve credits is at the discretion of the NCIRT. Surface flow for intermittent streams will be documented using gages or automated data loggers.

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) which is the streams ability to access its floodplains during bankfull events. 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) which is lateral extent of flooding during bankfull. The ER shall be no less than 2.2 (1.4 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.

Stream Horizontal Stability: Cross-sections will be used to document stability of stream dimension. There should be minimal change expected in post-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. In general, BHR and ER at any measured riffle cross-section should not change by more than 10% from the baseline condition during any given monitoring interval.

Streambed Material Condition and Stability: After construction, it anticipated that particle size distributions will migrate to those identified as appropriate for gravel dominated supply as part of the design process. Some fining of stream bed material may occur during the first few years after construction. However, long term trends are anticipated to demonstrate minimal change in the particle size distribution of the streambed materials, over time, given the current watershed conditions and future upstream sediment supply regime. Since the streams are predominantly gravel-bed systems with minimal sand, significant changes in particle size distribution are not expected.

Jurisdictional Stream Flow: The restored stream systems must be classified as at least intermittent, and therefore must exhibit base flow for at least 30-days consecutive flow within a calendar year under normal rainfall conditions as described in Section 8.2.3.

7.2 Wetlands

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

7.3 Vegetation

Vegetative restoration success for the project during the intermediate monitoring years will be based the survival of at least 320, three-year-old planted trees per acre at the end of Year 3 of the monitoring period (MY3) and at least 260, five-year-old, planted trees per acre at the end of Year 5 of the monitoring period (MY5). The final vegetative restoration success criteria will be achieving a density of no less than 210, seven-year-old planted stems per acre in Year Seven of monitoring (MY7). In addition, planted trees in each vegetation plot must average 6 feet in height after MY5 and 8 feet in height at MY7 before closeout.

8 Monitoring Plan

The proposed monitoring plan 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. They specifically include:

- What will be measured,
- How measurements will be taken,
- When measurements will be taken,
- Where measurements will be taken.

In accordance with the approved mitigation plan, the baseline monitoring document and as-built monitoring report documenting the stream and riparian buffer mitigation will be developed within 60 days of the completion of planting and monitoring device installation at the restored project site. In addition, 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 and guidance referenced above, 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 31st 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. The annual monitoring reports will provide a project data chronology for DMS to document the project status and trends, for population of DMS's databases for analyses, for research purposes, and to assist in decision making regarding project close-out. Project success criteria must be met by the final monitoring year prior to project closeout, or monitoring will continue until unmet criteria are successfully met. Table 23 in Section 8.5 summarizes the monitoring methods and linkage between the goals, parameters, and expected functional lift outcomes. Figure 9 illustrates the pre- and post-construction monitoring feature types and location.

8.1 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* as well as a *Current Conditions Plan View (CCPV) drawing* formatted to DMS digital drawing requirements, 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 subjectively 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 the same locations (and view directions) at the site are documented in each monitoring period and will be shown on a plan view map. 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.

8.2 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 Wilmington District Stream and Wetland Compensatory Mitigation Update*, 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 be conducted along these reaches as described herein. For project reaches involving an Enhancement Level II approach, 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.

8.2.1 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 crest gauges and automated photography. Four (4) separate bankfull events must be documented within the seven-year monitoring period. Two of the four bankfull events must occur in separate years. The crest gages will be installed on the floodplain of and across the dimension of the restored channels as needed for monitoring. The crest gages will record the watermark associated with the highest flood stage between monitoring site visits. The gages 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.

8.2.2 Geomorphic Monitoring

Horizontal Pattern: A planimetric survey will be conducted for the entire length of restored channel immediately after construction to document as-built baseline conditions (Monitoring Year 0). The survey will be tied to a permanent benchmark and measurements will include thalweg, bankfull, and top of banks. The plan view measurements such as sinuosity, radius of curvature, meander width ratio will be taken on newly constructed meanders during baseline documentation (Monitoring Year 0) 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.

Longitudinal Profile: A longitudinal profile will be surveyed for the entire length of restored channel immediately after construction to document as-built baseline conditions for the first year of monitoring only. The survey will be tied to a permanent benchmark and measurements will include thalweg, water surface, bankfull, and top of low bank. Each of these measurements will be taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. The longitudinal profile should show 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.

Horizontal Dimension: Permanent cross-sections will be 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, with approximately ten (10) cross-sections located at riffles, and five (5) located at pools. Each cross-section will be 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 0 (as-built), 1, 2, 3, 5, and 7, and will include measurements of bankfull cross-sectional area (Abkf) at low bank height, 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. Given the smaller channel sizes and meander geometry of the proposed steams, bank pin arrays will not be installed unless monitoring results indicate active lateral erosion at cross-sections occurring in meander bends, typically at pools.

Reference photo transects will be taken at each permanent cross-section. Lateral 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.

Streambed Materials: Representative streambed material samples will be collected in locations where riffles are installed as part of the project. 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 changes are observed within stable riffles and pools, additional sediment transport analyses and calculations may be required.

8.2.3 Flow Duration Monitoring

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, a rainfall gage will be installed on the site to compare precipitation amounts using tallied data obtained from the Surry County Airport Weather Station (KMWK), approximately fifteen miles north 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 reaches will include the installation of continuous stream stage recorders within the bottom (toe of slope) of the channel towards the upper portion of reach R2 near the confluence with R3. In addition, photographic documentation using a continuous series of remote photos over time will be used to subjectively evaluate and document channel flow conditions throughout the year. More specifically, the longitudinal photos should indicate the presence of flow within the channel to illustrate water levels within the pools and riffles. The photographs will be taken from a height of approximately five feet to ensure that the same locations (and view directions) at the site are documented in each monitoring period and will be shown on a plan view map.

Monitoring flow gages (continuous-read pressure transducers) will be installed towards the upper portion of restored intermittent reaches. Continuous surface water flow within the channel must be documented to occur every year for at least 30 consecutive days during the prescribed monitoring period. The devices will be inspected on a quarterly basis to document surface flow 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).

8.3 Wetland Monitoring

Wetland mitigation credits are not contracted or proposed for this project. Wetland mitigation monitoring is therefore not included for this project.

8.4 Vegetation 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 will be installed and 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, 2014). The vegetation monitoring plots shall be approximately 2% of the planted portion of the site with a minimum of twelve (12) plots established randomly within the planted riparian buffer areas. The sampling may employ quasi-random plot locations which may vary upon approval from DMS and IRT. Any random plots should comprise no more than 50% of the total required plots, and the location (GPS coordinates and orientation) will identified in the monitoring reports.

No monitoring quadrants will be established within undisturbed wooded areas, such as those along reaches R4a and R4b, 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 will be 100 square meters (10m X 10m or 5m X 20m) for woody tree species and may be adjusted based on site conditions after construction activities have been completed.

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 will be 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 recorded and counted in the total list of species in the plots in all cases, however non-native species counts will be excluded from the calculation of total (planted plus volunteer) densities. 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 15th and November 15th, 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. While measuring species density is the current accepted methodology for evaluating vegetation success on mitigation projects, species density alone may be inadequate for assessing plant community health. For this reason, the vegetation monitoring plan will incorporate the evaluation of native volunteer species, and the presence of invasive species vegetation to assess overall vegetative success. 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.

Table 23. Proposed Monitoring Plan Summary

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 between 1.0-1.2 and ERs no less than 2.2 (1.4 for B stream types) and document over 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 and average eight foot tree heights must be present at year seven.	Increase woody and herbaceous vegetation will provide channel stability and reduce streambank erosion, runoff rates and exotic species vegetation.
Physiochemical (Level 4)	Improve Water Quality	N/A	N/A	Removal of excess nutrients, FC bacteria, and organic pollutants will increase the hyporheic exchange and dissolved oxygen (DO) levels.
Biology (Level 5)	Improve Benthic Macroinvertebrate Communities and Aquatic Health	DWR Small Stream/ Benthic 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.

9 Adaptive Management Plan

In the event the mitigation site or a specific component of the mitigation site fails to achieve the necessary performance standards as specified in the mitigation plan, the sponsor shall notify the members of the NCIRT and work with the NCIRT to develop contingency plans and remedial actions.

10 Long-Term Management Plan

The site will be transferred to the NCDEQ Stewardship Program. This party shall serve as conservation easement holder and long-term steward for the property and will conduct periodic inspection of the site to ensure that restrictions required in the conservation easement are upheld. Funding will be supplied by the responsible party on a yearly basis until such time and endowments are established. The NCDEQ Stewardship Program is developing an endowment system within the non-reverting, interest-bearing Conservation Lands Stewardship Endowment Account. The use of funds from the Endowment Account is governed by NC General Statue GS 113A-232(d) (3). Interest gained by the endowment fund may be used only for stewardship, monitoring, stewardship administration, and land transaction costs, if applicable.
WLS does not expect that easement compliance and management will require any additional or alternative management planning, strategies or efforts beyond those typically prescribed and followed for DMS full-delivery projects.

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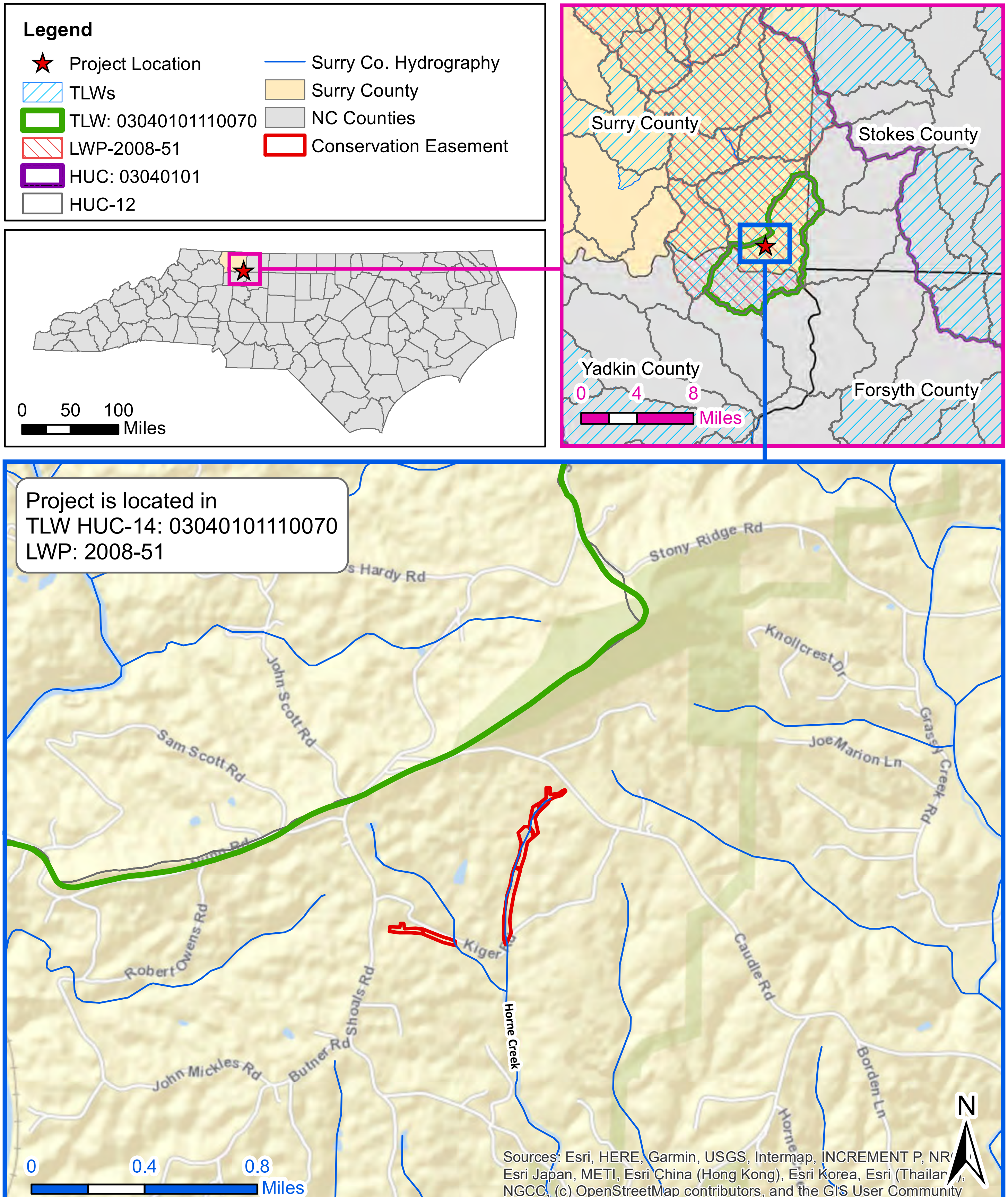


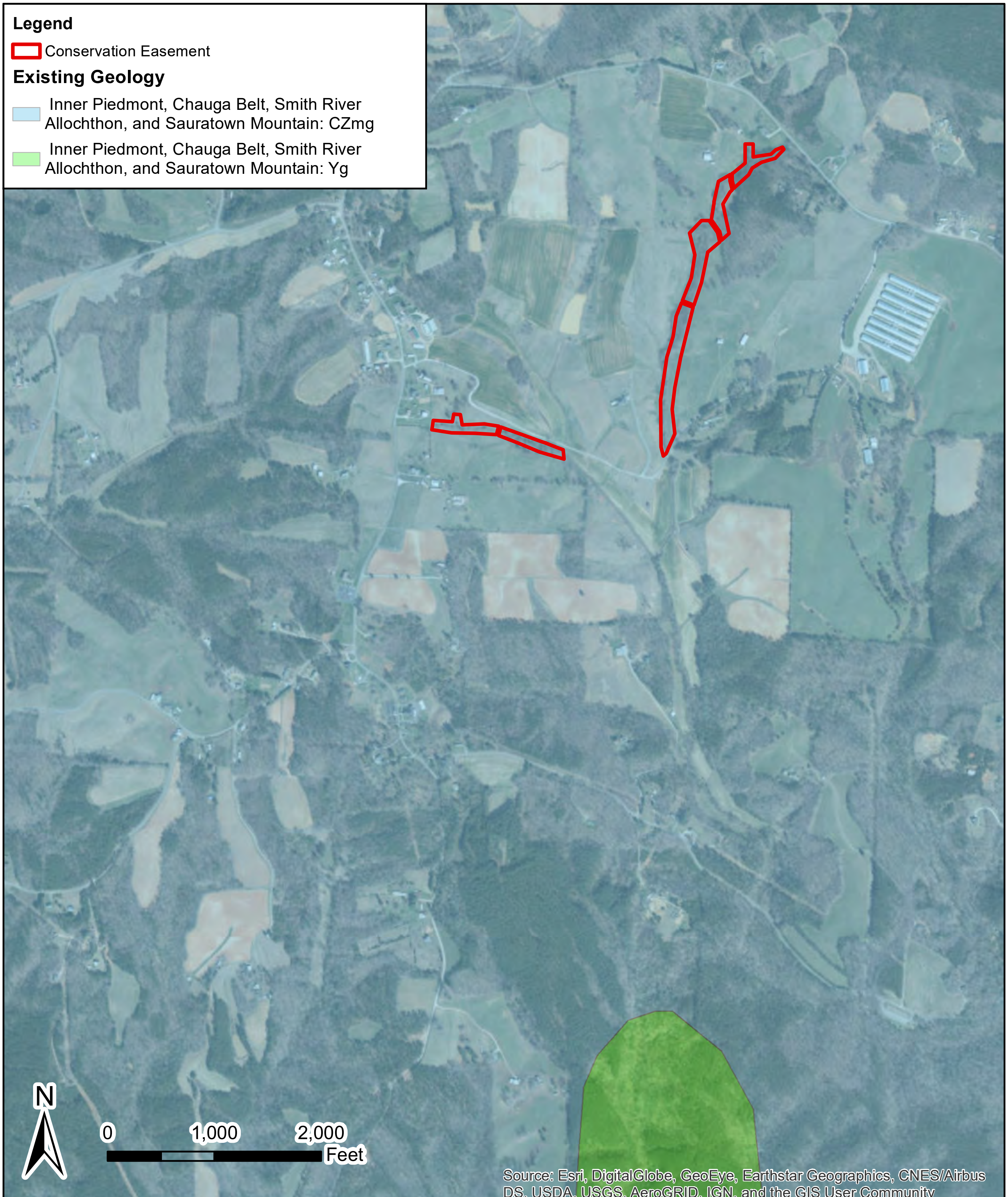
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

Vicinity Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 1



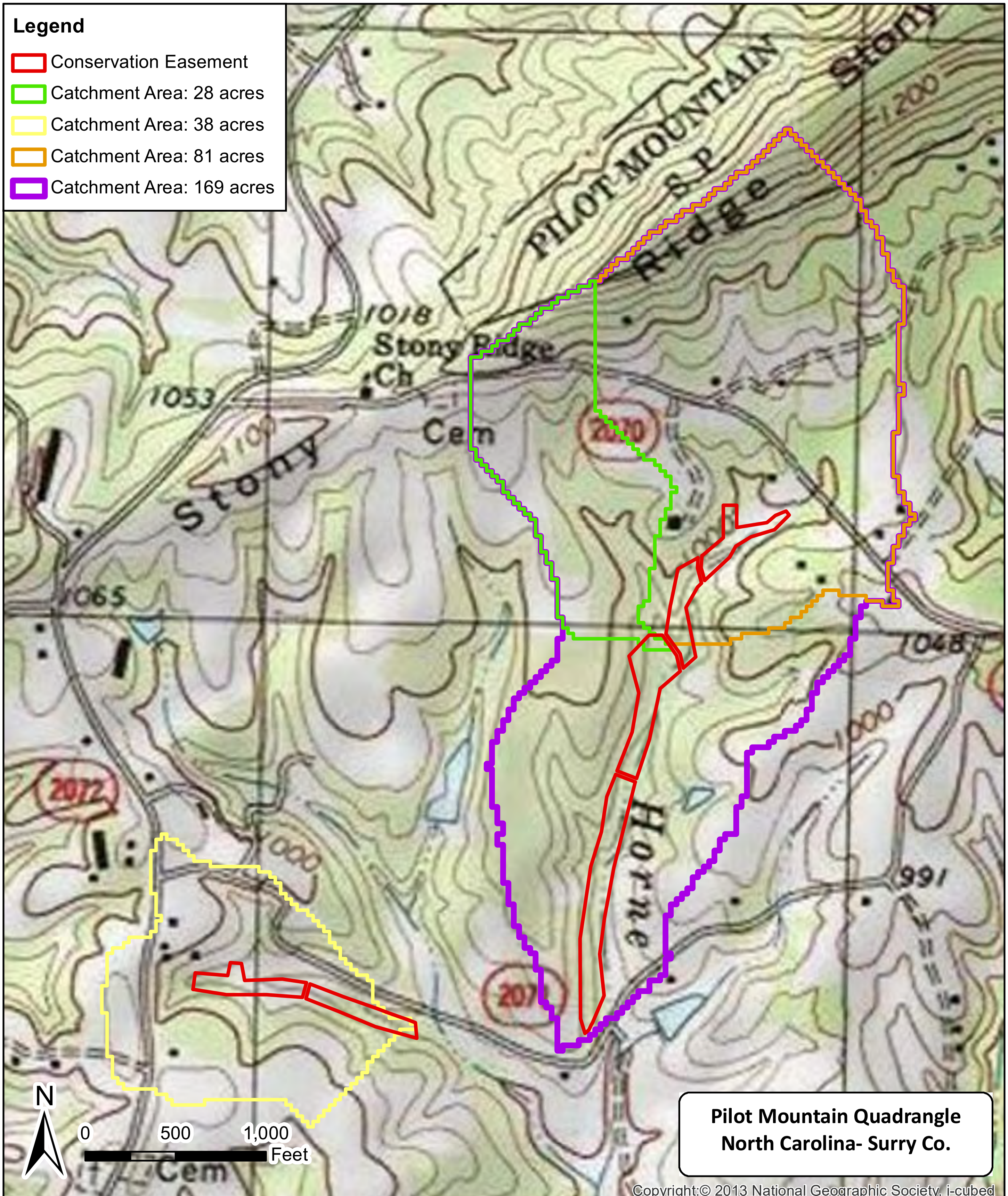
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

Existing Geology Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 2



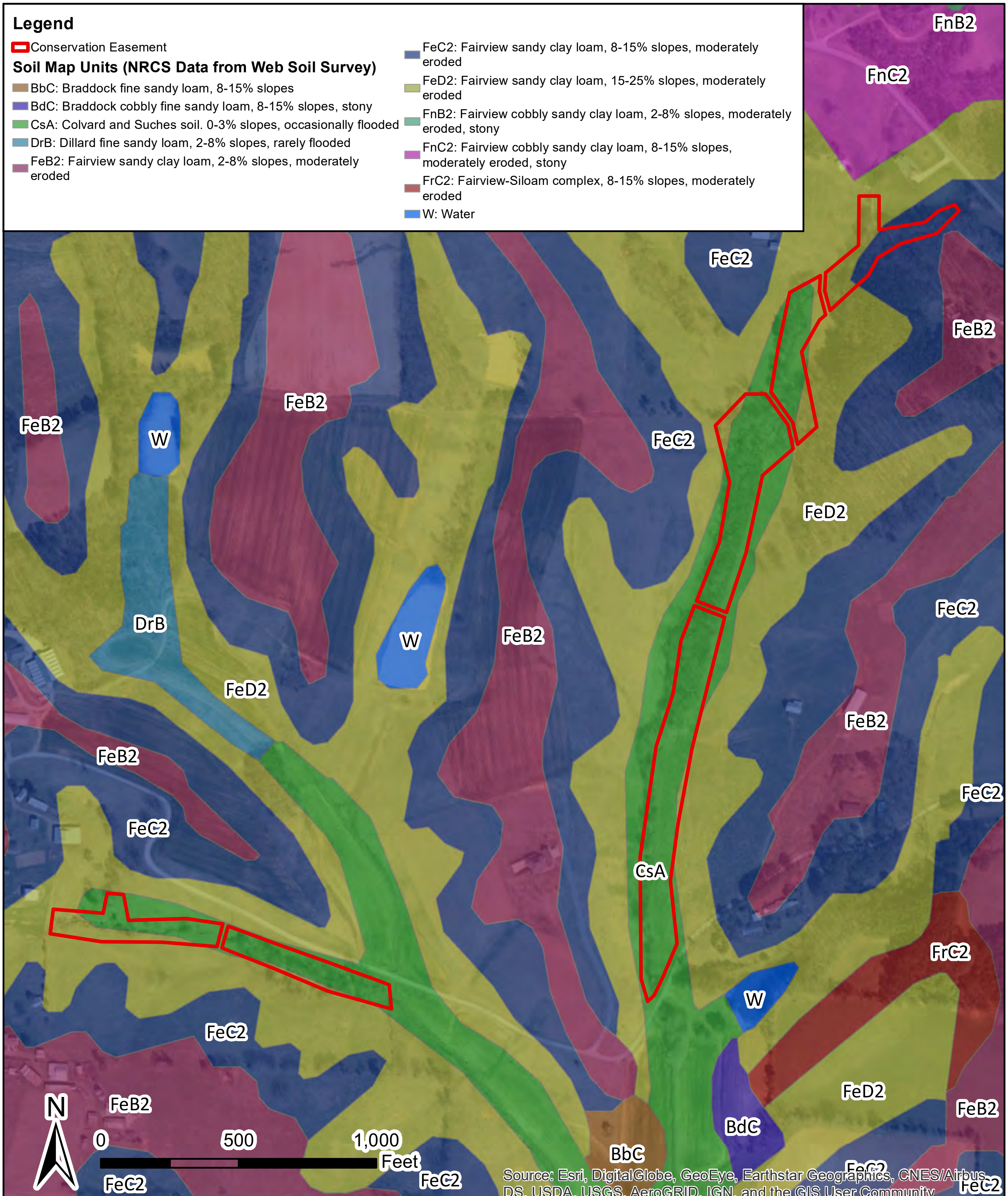
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

USGS Topographic Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 3



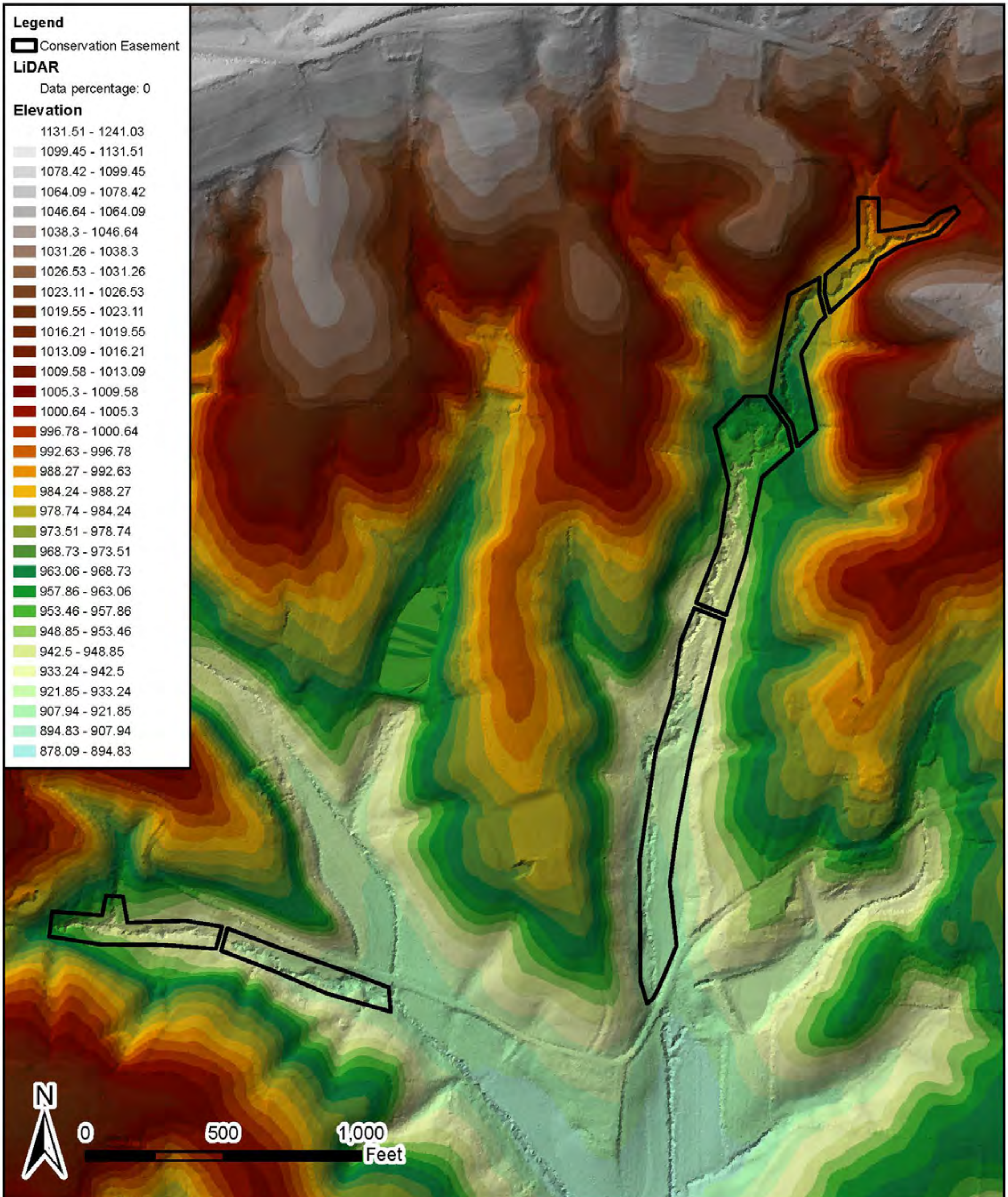
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

NRCS Soils Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 4



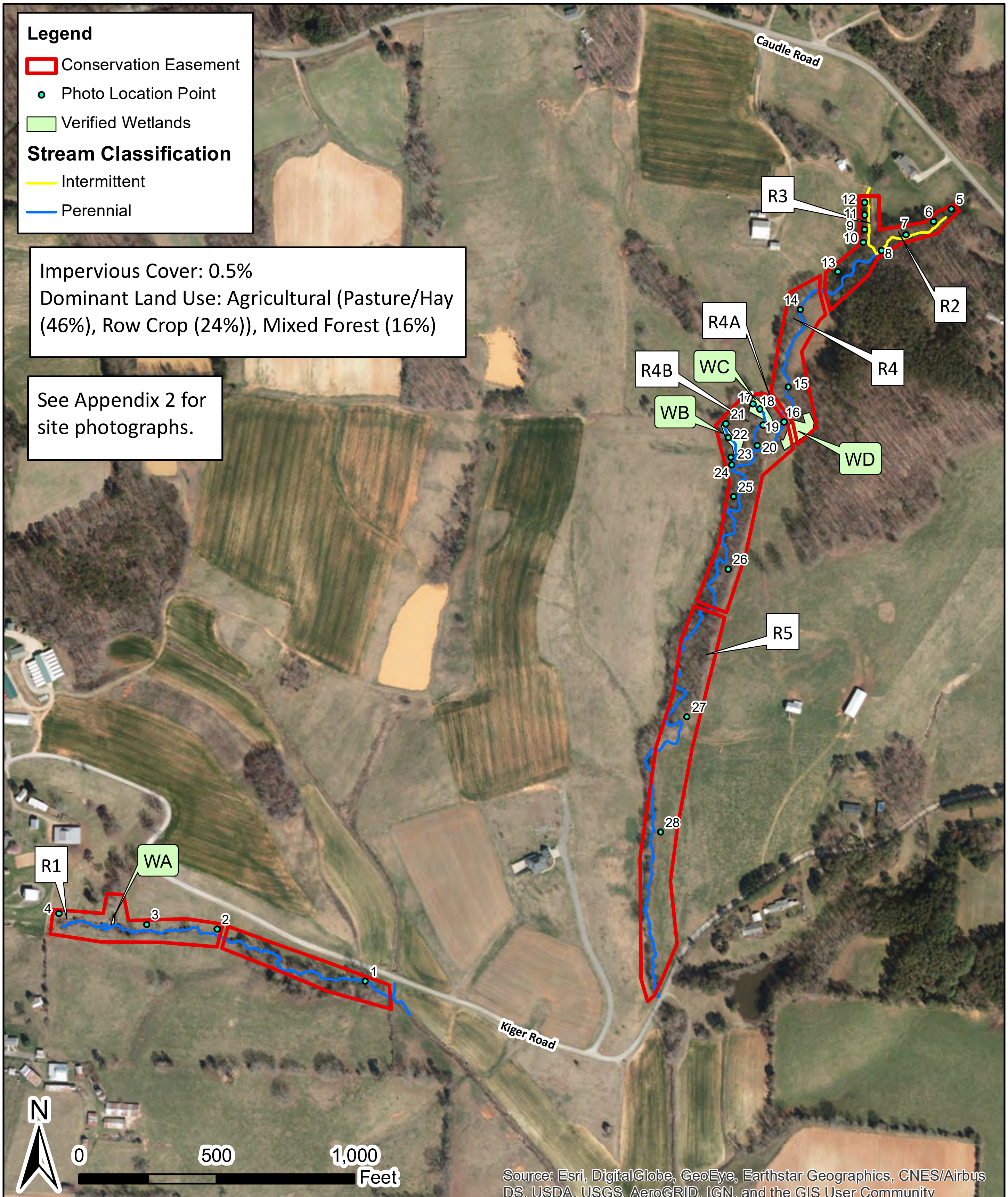
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

LiDAR Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 5



WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

Current Conditions Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 6

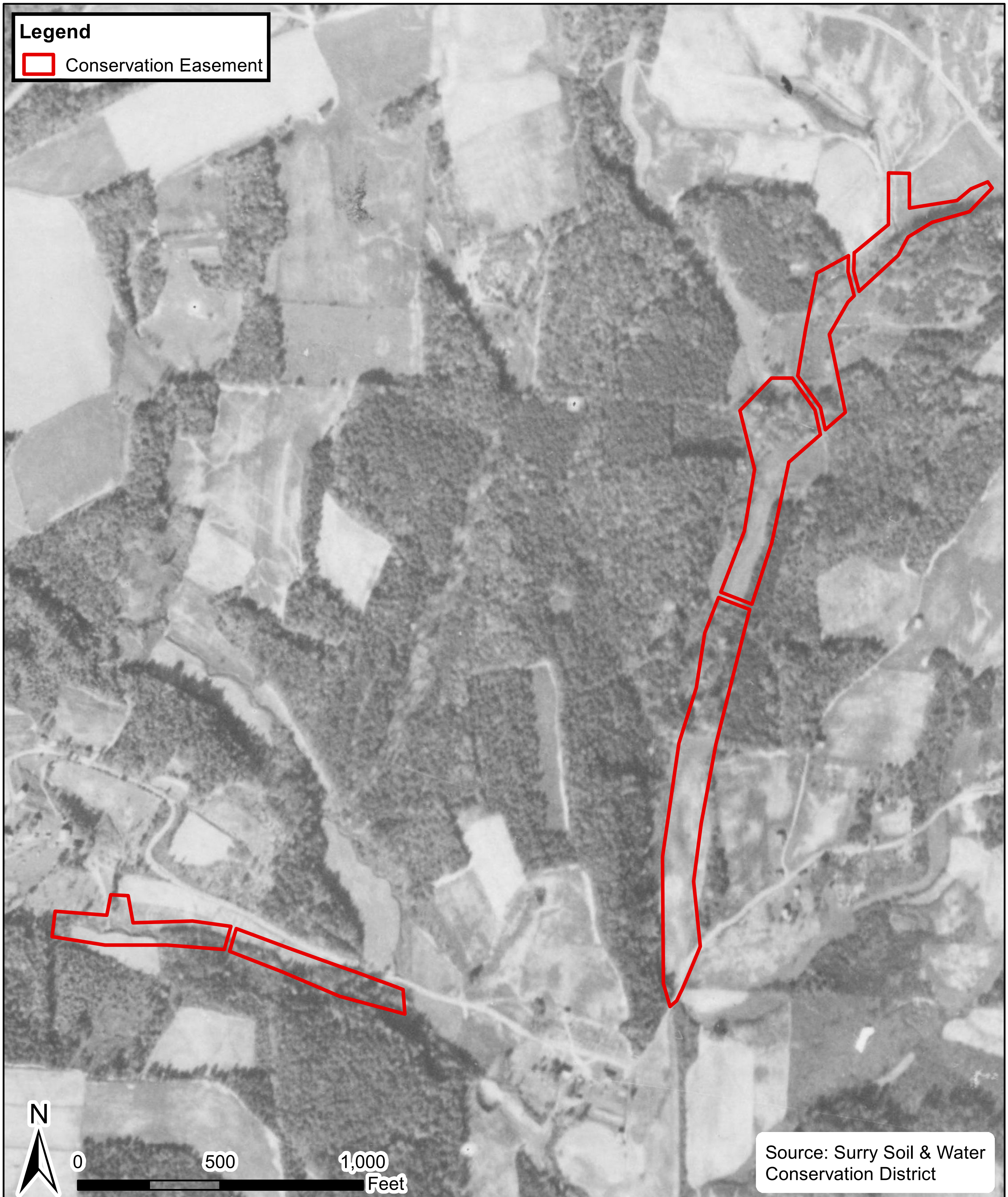
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

1936 Aerial Photograph

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 7a



WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

1940 Aerial Photograph

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 7b

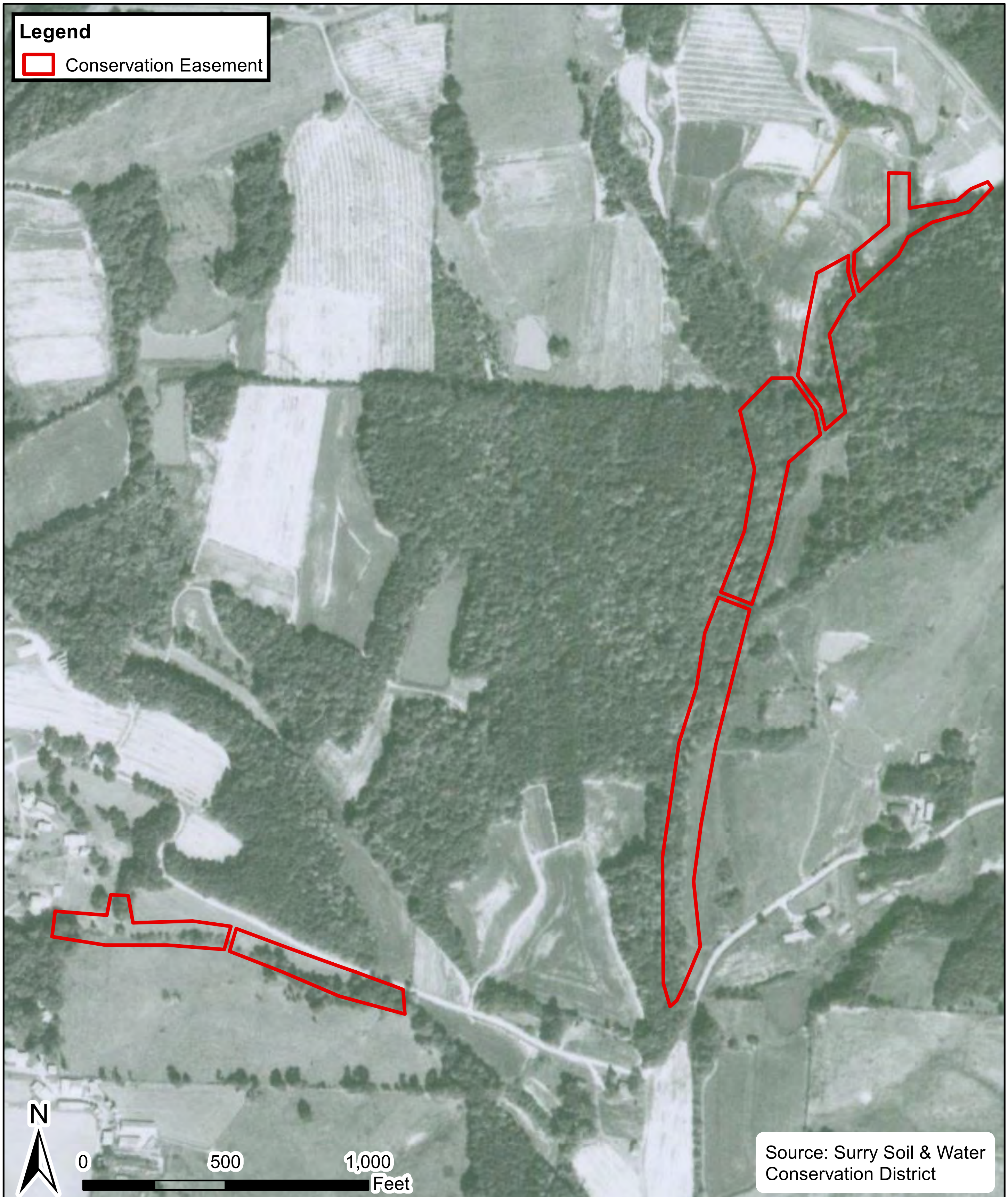
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

1951 Aerial Photograph

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 7c



WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

1992 Aerial Photograph

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 7d

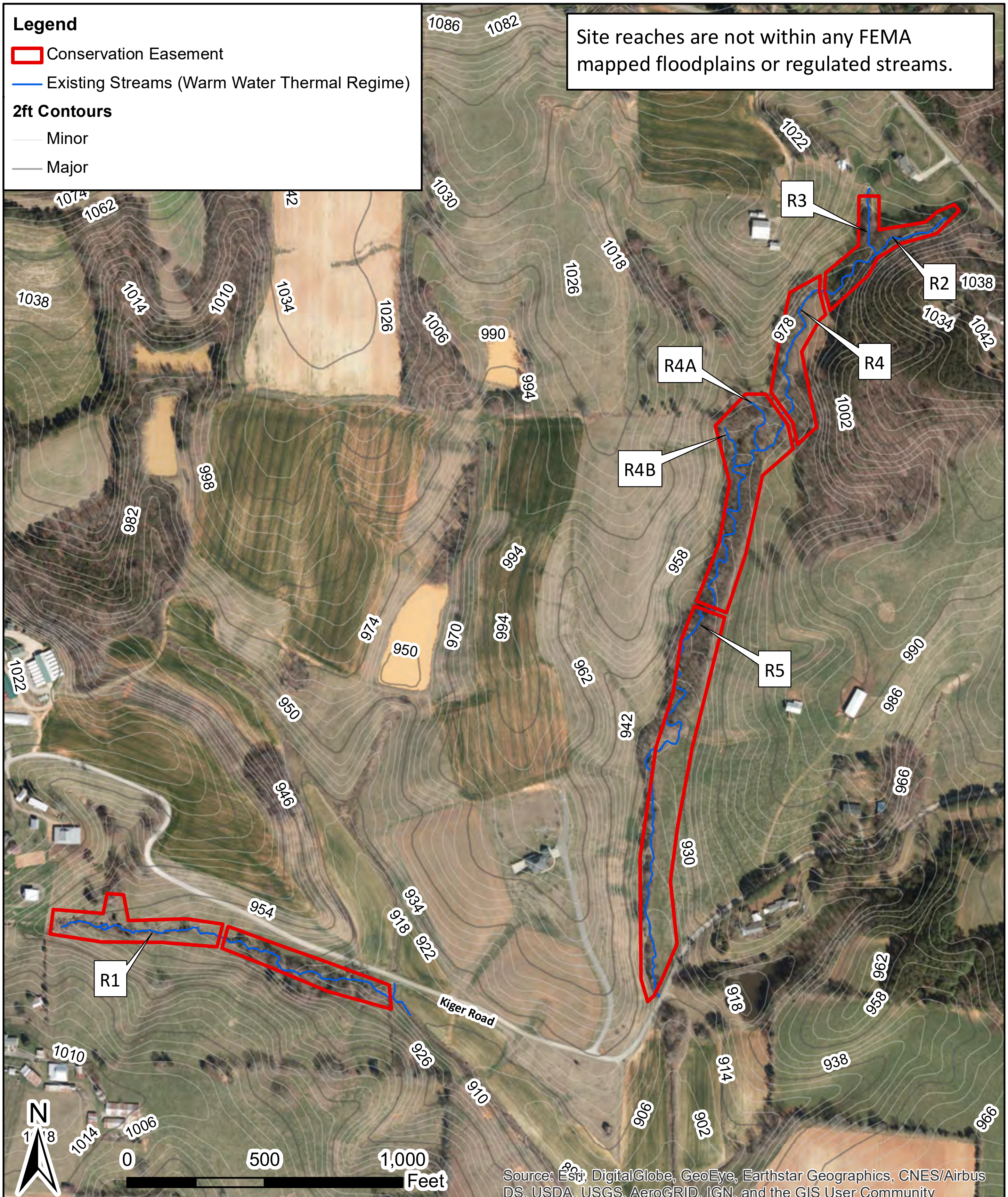
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

2006 Aerial Photograph

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 7e



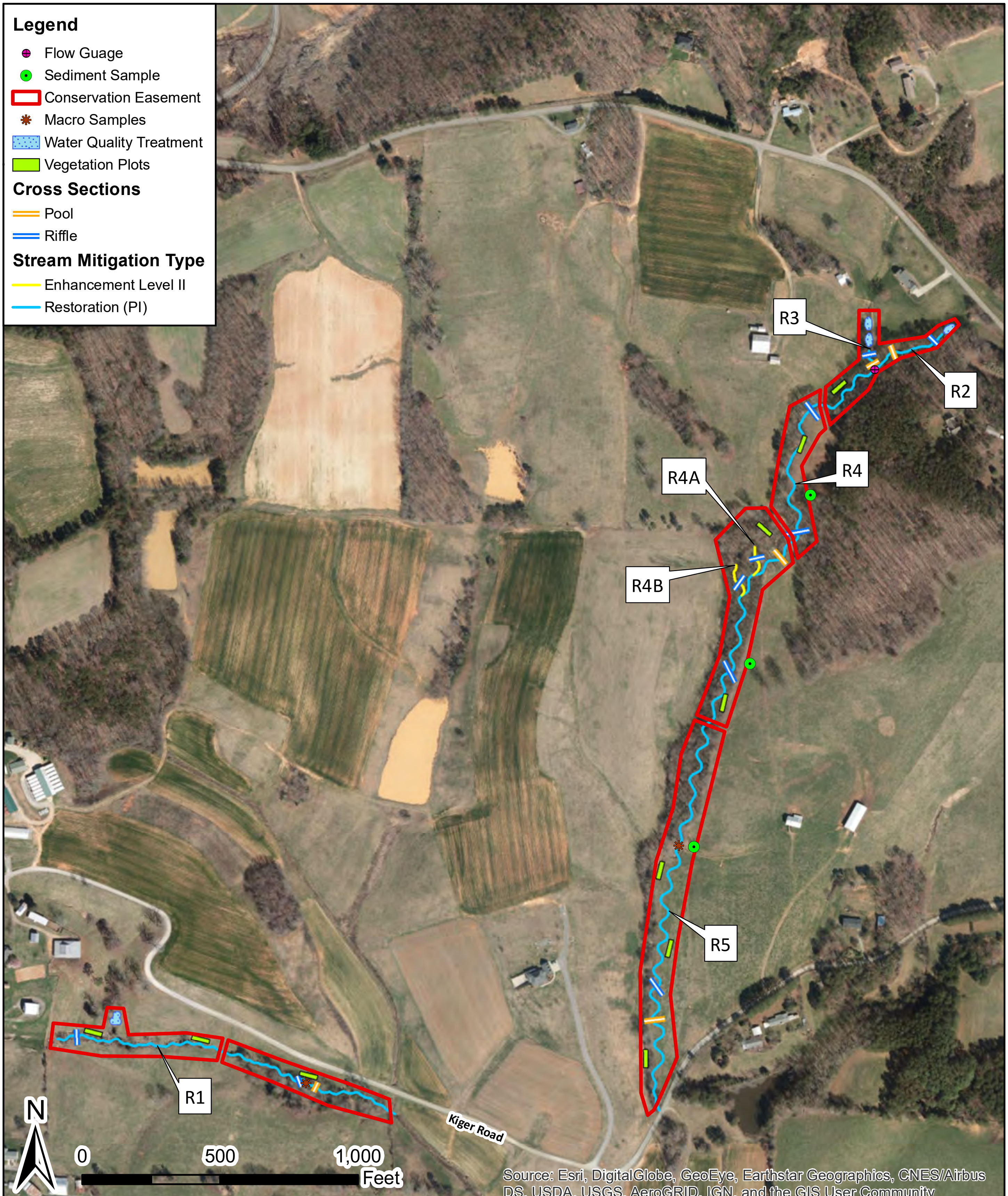
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

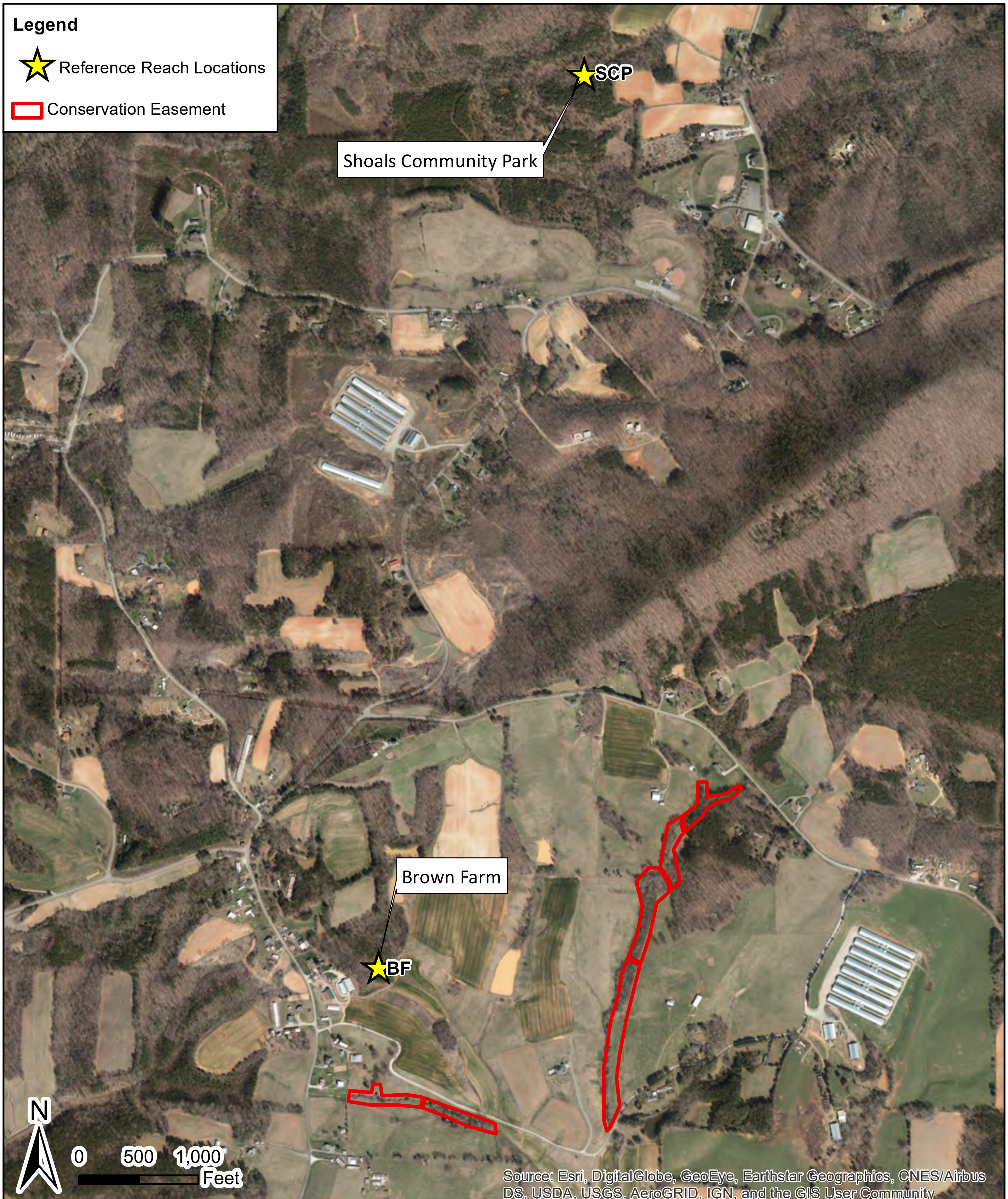
Floodplain Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 8



WATER & LAND™ SOLUTIONS	Horne Creek Tributaries Mitigation Project	Proposed Mitigation Assets & Monitoring Features Map NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 9



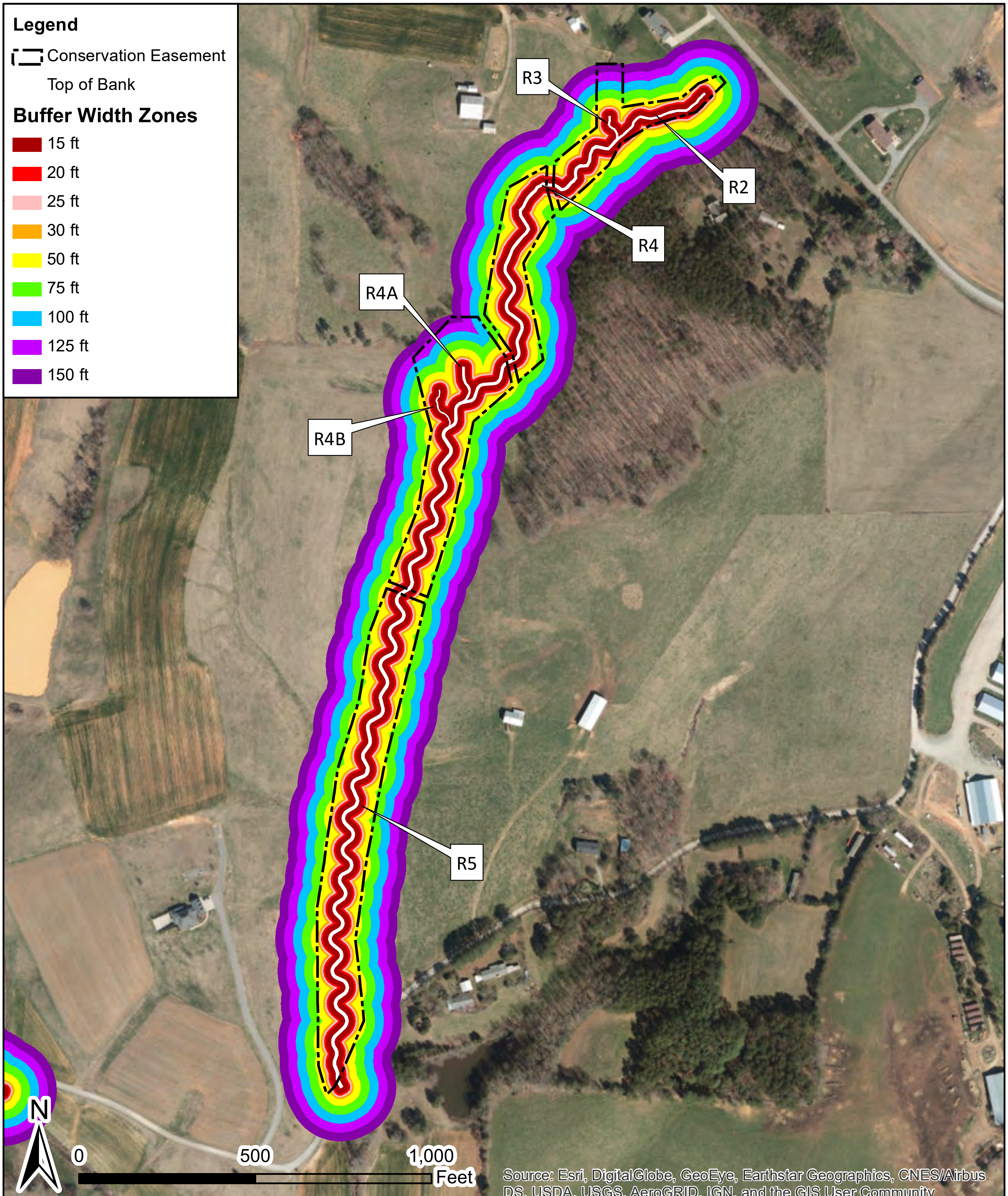
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

Reference Reach Location Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 10



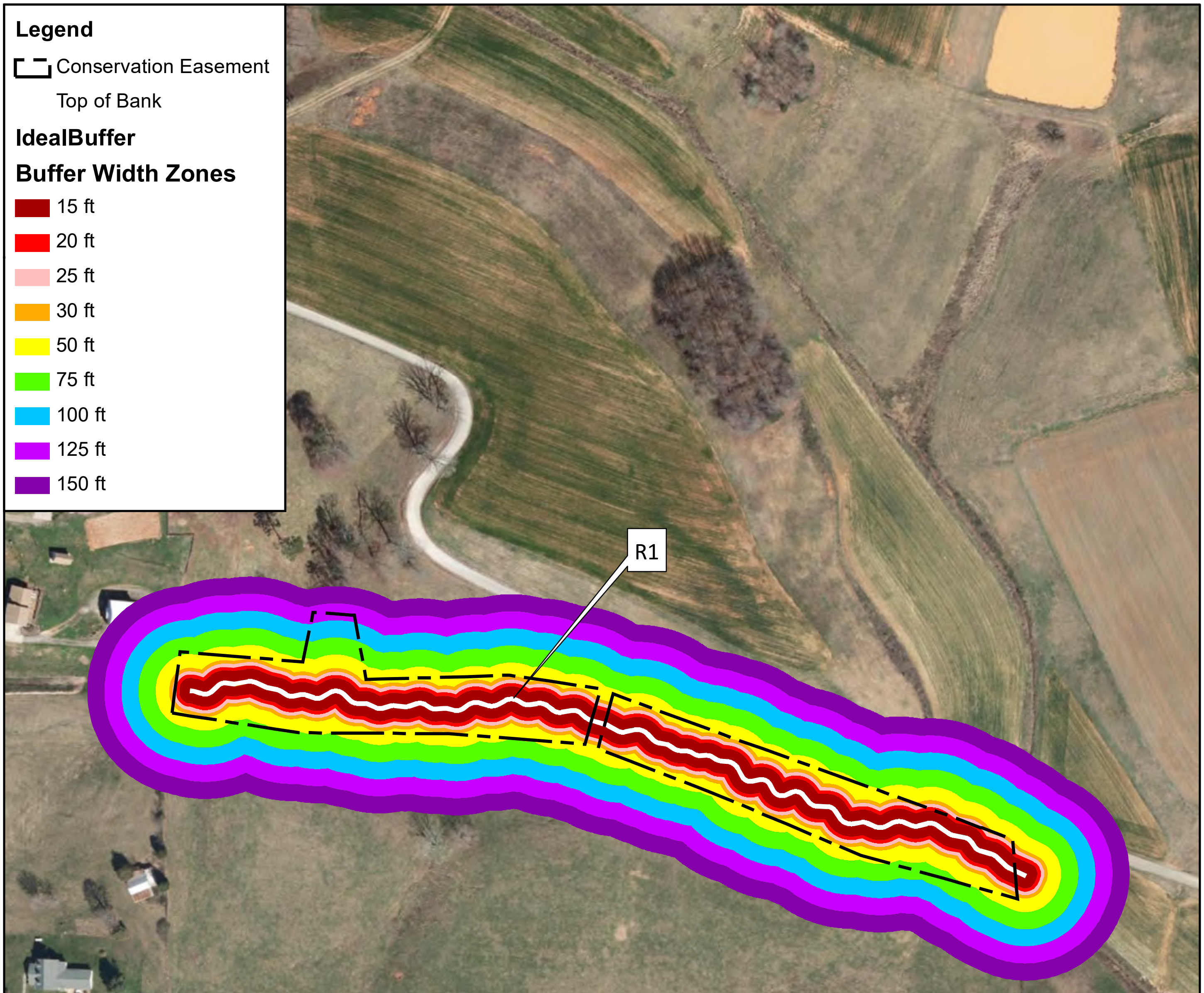
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

Buffer Width Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 11a



Buffer Width Zone (feet from Ordinary High Water Mark)									
Buffer Zones	less than 15 feet	>15 to 20 feet	>20 to 25 feet	>25 to 30 feet	>30 to 50 feet	>50 to 75 feet	>75 to 100 feet	>100 to 125 feet	>125 to 150 feet
Max Possible Buffer (square feet)	162,840	54,280	54,280	54,280	217,120	271,400	271,400	271,400	271,400
Ideal Buffer (square feet)	164,103	54,682	54,341	53,780	210,182	260,415	263,400	268,013	273,997
Actual Buffer (square feet)	158,814	51,210	49,893	48,533	117,951	20,978	11,418	7,748	2,386
Zone Multiplier	50%	20%	15%	15%	9%	7%	6%	5%	3%
Buffer Credit Equivalent	2,689	1,076	807	807	484	376	323	269	161
Percent of Ideal Buffer	97%	94%	92%	90%	56%	8%	4%	3%	1%
Credit Adjustment	-87	-68	-66	-79	272	30	14	8	1

Total Baseline Credit	Credit Loss in Required Buffer	Credit Gain for Additional Buffer	Net Change in Credit from Buffers	Total Credit
5,378	-300	325	25	5,403

WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

Buffer Width Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 11b

Appendix 1 – Plan Sheets

DEPARTMENT OF ENVIRONMENTAL QUALITY - DIVISION OF MITIGATION SERVICES

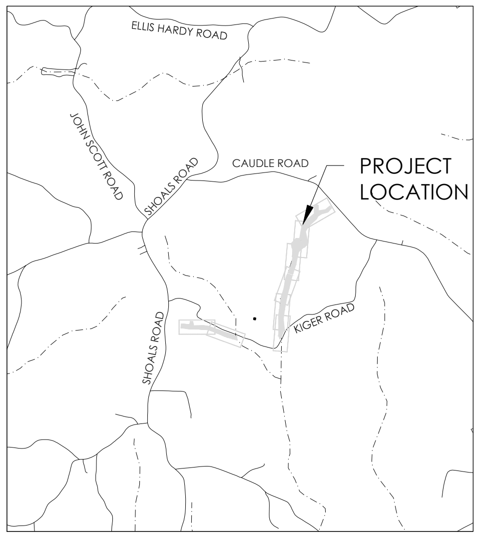
HORNE CREEK TRIBUTARIES MITIGATION PROJECT

SURRY COUNTY, NORTH CAROLINA

NCDEQ - DMS PROJECT ID # 100026
NCDEQ - DMS CONTRACT #7181 UNDER RFP 16-006993
YADKIN RIVER BASIN (CU 03040101)
USACE ACTION ID # SAW-2017-01510
TYPE OF WORK : STREAM MITIGATION

VICINITY MAP

N.T.S.

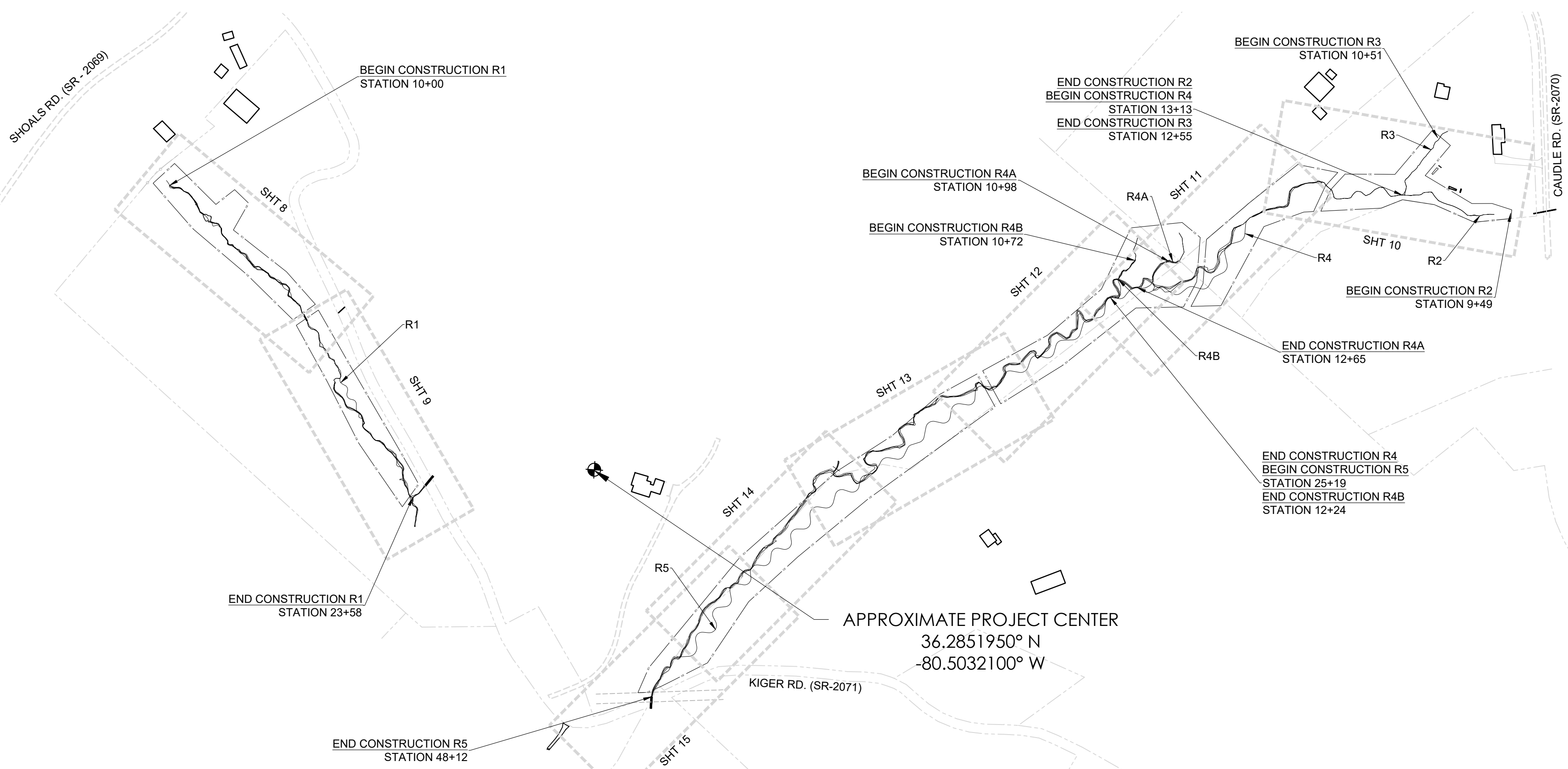


NCDEQ-DMS CONTRACT ADMINISTRATOR:
KRISTIE CORSON
1652 MAIL SERVICE CENTER
RALEIGH, NC 27699-1652
PH: 919-707-8935

PROJECT SUMMARY

Project Reach Designation	Type of Mitigation	Proposed Stream Length (LF)	Mitigation Ratio (X:1)	Proposed Stream Mitigation Credits (SMCs)
R1	Stream Restoration	1320	1	1320
R2	Stream Restoration	296	1	296
R3	Stream Restoration	76	1	76
R4	Stream Restoration	1167	1	1167
R4A	Stream Enhancement II	57	2.5	23
R4A	Stream Restoration	111	1	111
R4B	Stream Enhancement II	27	2.5	11
R4B	Stream Restoration	125	1	125
R5	Stream Restoration	2249	1	2249
Total		**5428**		**5378**
Note: No mitigation credits were calculated outside the conservation easement boundaries.				

SHEET INDEX



WATER & LAND SOLUTIONS
7721 Six Fork Rd., Suite 130
Raleigh, NC 27614
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

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

REVISIONS

NO.		DATE
A	DRAFT MIT PLAN	12-13-18
B	DRAFT FINAL MIT PLAN	5-8-19
C	FINAL MIT PLAN	7-26-19
D		
E		
F		

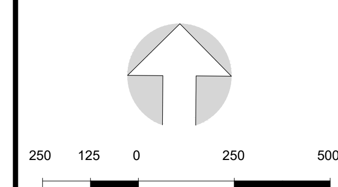
PROJECT NAME

HORNE CREEK TRIBUTARIES MITIGATION PROJECT

SURRY COUNTY, NC

DRAWING INFORMATION

PROJECT NO. :	100026
FILENAME :	01_HORNE CREEK_COVER.DWG
DESIGNED BY :	CAT
DRAWN BY :	CAT/APL
DATE :	7/26/19
HORIZ. SCALE :	1" = 500'
VERT. SCALE :	N/A



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
	BOULDER STEP POOL
	GEOLIFT W/ TOEWOOD
	PROPOSED OUTLET CHANNEL
OHE	EXISTING OVERHEAD ELECTRIC
	TEMPORARY STREAM CROSSING
	PERMANENT STREAM CROSSING
CE CE	PROPOSED CONSERVATION EASEMENT BOUNDARY
100	EXISTING MAJOR CONTOUR
101	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 TP	PROPOSED TREE PROTECTION FENCE
	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 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 SURRY COUNTY, NORTH CAROLINA, APPROXIMATELY 7.5 MILES SOUTH OF THE TOWN OF PILOT MOUNTAIN AS SHOWN ON THE COVER SHEET VICINITY MAP. TO ACCESS THE SITE FROM RALEIGH, TAKE I-40 W TO EXIT 206 (I-40 BUS/US-421 N). TAKE EXIT 6B (NC-8 NC/US-311/US-52 N) FROM I-40 BUS/US-421 N (12.4 MI) TOWARD MT. AIRY. TAKE EXIT 129 TOWARD PINNACLE (20.1 MI). TURN LEFT ONTO PERCH RD. TRAVEL 1.5 MI ON PERCH ROAD TO STONY RIDGE. TURN RIGHT ONTO STONY RIDGE AND TRAVEL 2.7 MI. TURN LEFT ON SHOALS RD. AND TRAVEL 1.3 MI. TURN LEFT ONTO CAUDLE RD. TRAVEL 0.6 MI TO UPPER PROJECT BOUNDARY. LOWER PROJECT BOUNDARY CAN BE ACCESS BY TRAVELING EAST ON CAUDLE RD TO KIGER RD. TURN RIGHT ONTO KIGER RD. AND TRAVEL 0.5 MI TO LOWER PROJECT 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 KEE MAPPING & SURVEYING (KEE) IN THE FALL OF 2017. 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.

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

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

REVISIONS

NO.		DATE
A	DRAFT MIT PLAN	12-13-18
B	DRAFT FINAL MIT PLAN	5-8-19
C	FINAL MIT PLAN	7-26-19
D		
E		
F		

PROJECT NAME

HORNE CREEK TRIBUTARIES MITIGATION PROJECT

SURRY COUNTY, NC

DRAWING INFORMATION

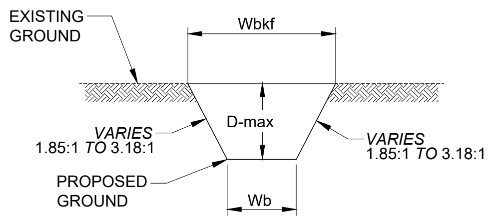
PROJECT NO. :	100026
FILENAME :	02_HORNE CREEK_GENERAL NOTES - SYMBOLS_SHEET.DWG
DESIGNED BY :	CAT
DRAWN BY :	CAT/APL
DATE :	7/26/19
HORIZ. SCALE :	N/A
VERT. SCALE :	N/A

SHEET NAME

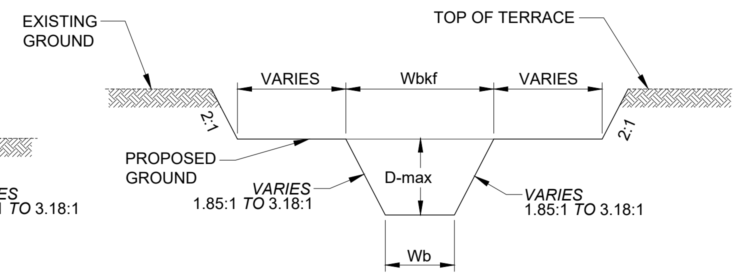
LEGEND/ CONSTRUCTION SEQUENCE/ GENERAL NOTES

SHEET NUMBER

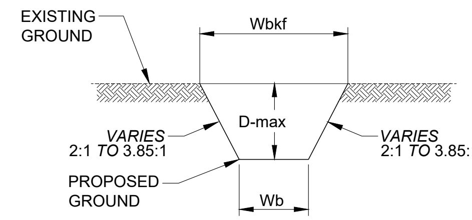
2



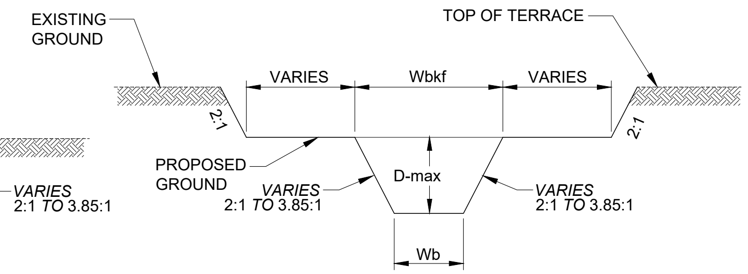
RIFFLE
N.T.S



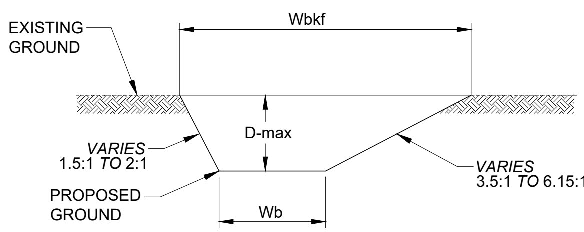
RIFFLE WITH BANKFULL BENCH
N.T.S



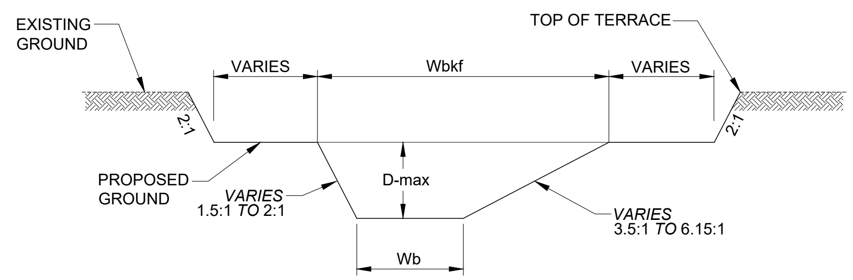
STEP POOL
N.T.S



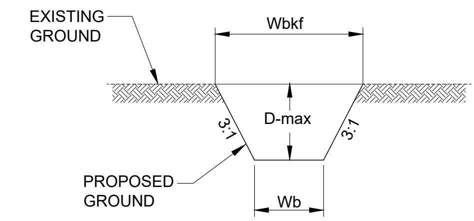
STEP POOL WITH BANKFULL BENCH
N.T.S



MEANDER POOL
N.T.S



MEANDER POOL WITH BANKFULL BENCH
N.T.S



OUTLET CHANNEL
N.T.S

Reach Name	R1		R2		R3		R4		R4A		R4B		R5		
Feature	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	OUTLET CHANNEL
Width of Bankfull, Wbkf (ft)	7.0	9.0	6.0	9.0	6.0	8.0	9.0	12.0	6.0	8.0	3.5	4.0	10.0	16.0	3.00
Average Depth, Dbkf (ft)	0.4	0.7	0.5	0.7	0.4	0.6	0.6	0.9	0.4	0.6	0.2	0.4	0.7	1.0	NA
Maximum Depth, D-Max (ft)	0.6	1.2	0.6	1.0	0.5	0.9	0.8	1.7	0.5	0.9	0.3	0.5	0.9	2.0	0.50
Width to Depth Ratio, bkf W/D	17.0	12.3	13.1	12.5	16.0	12.9	15.6	12.9	16.0	12.9	14.9	10.7	13.9	15.6	NA
Bankfull Area, Abkf (sq ft)	2.9	6.6	2.8	6.5	2.3	5.0	5.2	11.2	2.3	5.0	0.8	1.5	7.2	16.4	NA
Bottom Width, Wb (ft)	3.5	3.5	4.0	4.0	3.0	3.0	4.0	4.0	3.0	3.0	2.0	2.0	6.0	6.0	NA

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

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PROJECT NAME

HORNE CREEK TRIBUTARIES MITIGATION PROJECT

SURRY COUNTY, NC

DRAWING INFORMATION

PROJECT NO. :	100026
FILENAME :	03_HORNE CREEK_TYPICAL_SECTIONS.DWG
DESIGNED BY :	CAT
DRAWN BY :	CAT/APL
DATE :	7/26/19
HORIZ. SCALE :	N/A
VERT. SCALE :	N/A

SHEET NAME

TYPICAL SECTIONS

SHEET NUMBER

3

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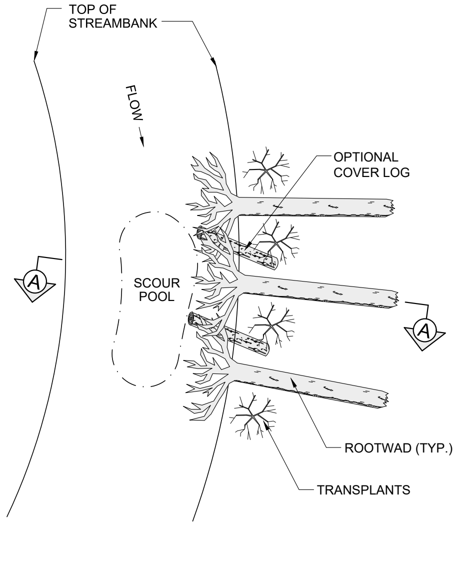
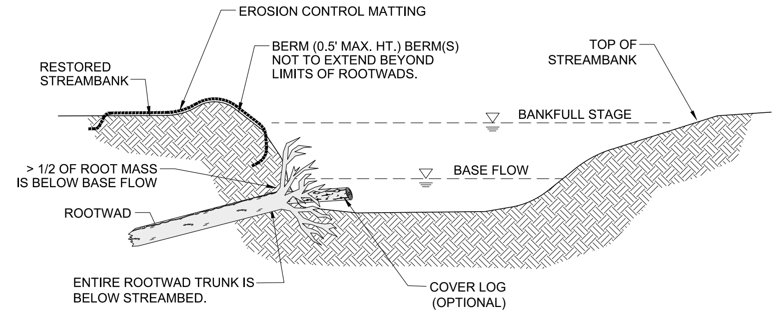
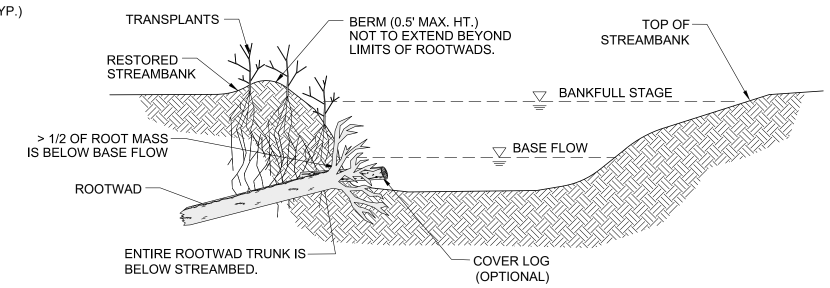


PLAN VIEW



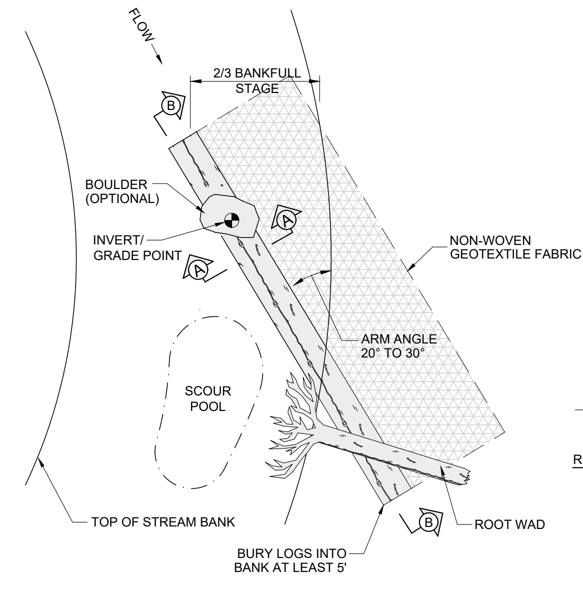
SECTION A-A
ROOTWADS WITHOUT TRANSPLANTS



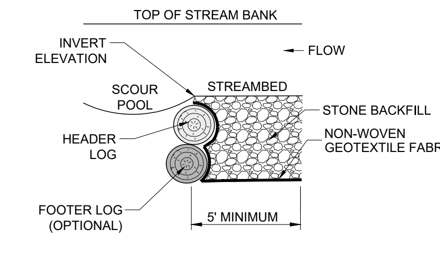
SECTION A-A
ROOTWADS WITH TRANSPLANTS

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.

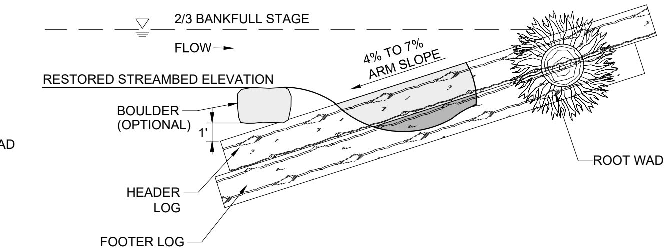
ROOTWADS
NOT TO SCALE



PLAN VIEW



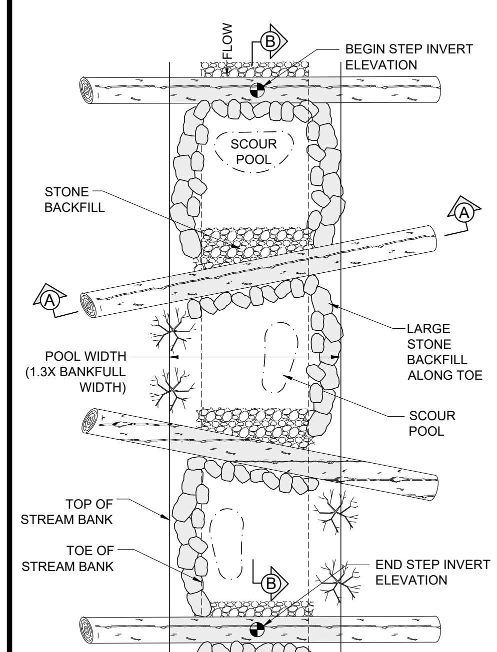
SECTION A-A



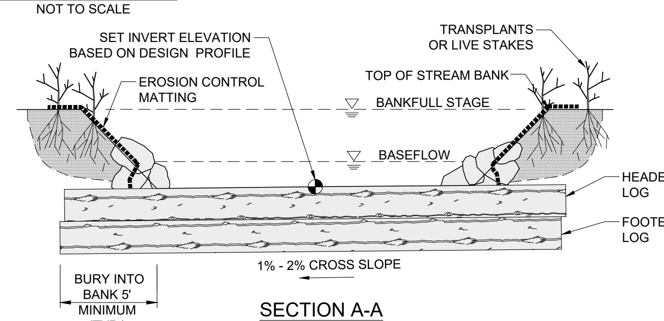
PROFILE B-B

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.

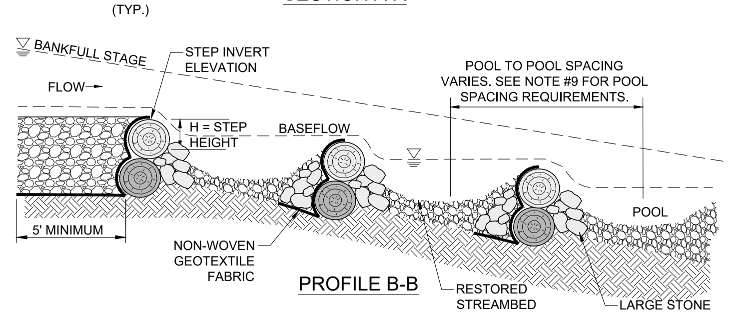
LOG VANE
NOT TO SCALE



PLAN VIEW



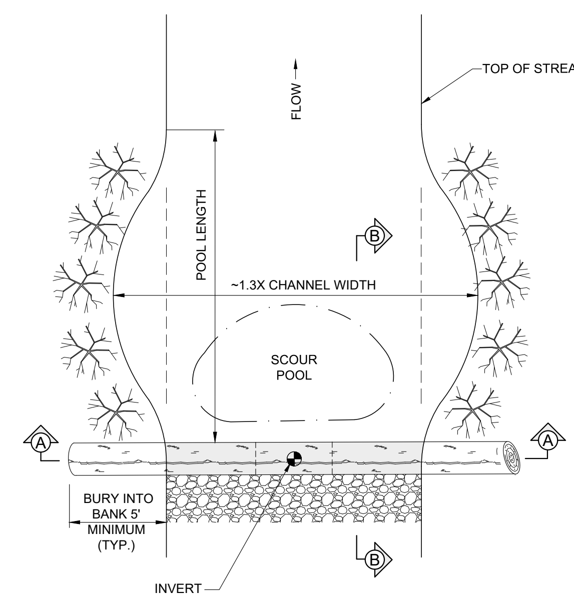
SECTION A-A



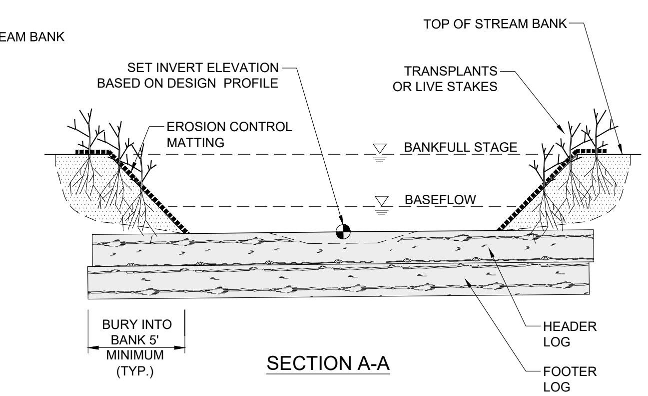
PROFILE B-B

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. 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 GEOTEXTILE FILTER FABRIC UNDERNEATH LOGS.
5. UNDERCUT POOL BED ELEVATION 8 INCHES TO ALLOW FOR LAYER OF STONE. INSTALL LARGE STONE BACKFILL 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 LARGE STONE BACKFILL 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.

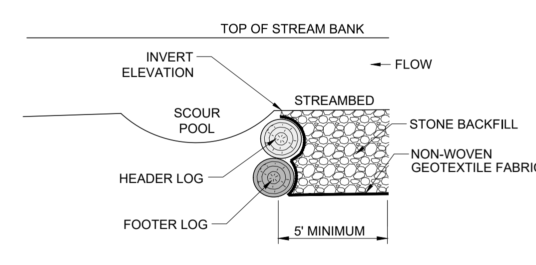
STONE AND LOG STEP POOL
NOT TO SCALE



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

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

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

REVISIONS

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A	DRAFT MIT PLAN	12-13-18
B	DRAFT FINAL MIT PLAN	5-8-19
C	FINAL MIT PLAN	7-26-19
D		
E		
F		

PROJECT NAME

HORNE CREEK TRIBUTARIES MITIGATION PROJECT

SURRY COUNTY, NC

DRAWING INFORMATION

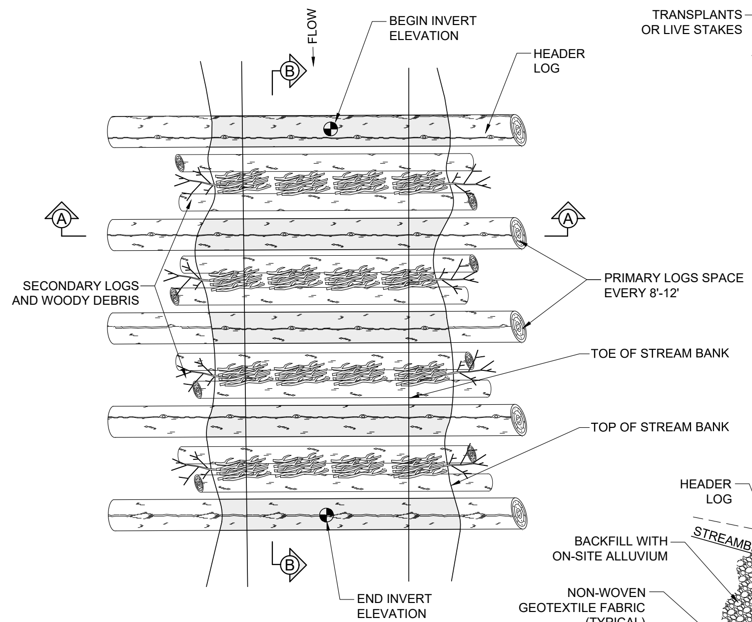
PROJECT NO. :	100026
FILENAME :	04-07_HORNE_CREEK_DETAILS.DWG
DESIGNED BY :	CAT
DRAWN BY :	CAT/APL
DATE :	7/26/19
HORIZ. SCALE :	N/A
VERT. SCALE :	N/A

SHEET NAME

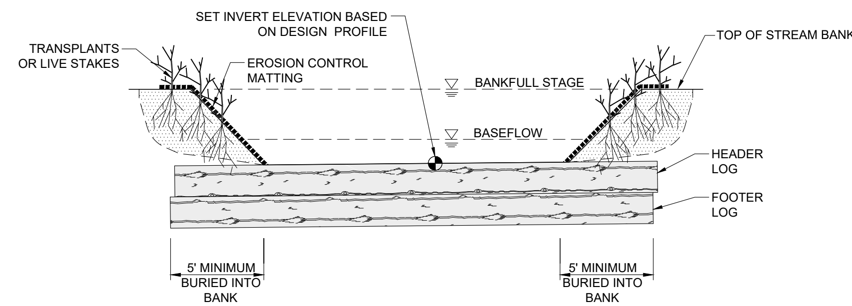
DETAILS

SHEET NUMBER

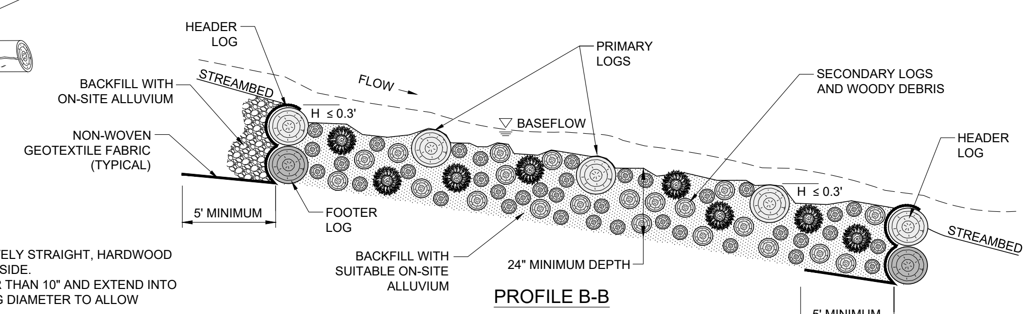
4



PLAN VIEW



SECTION A-A

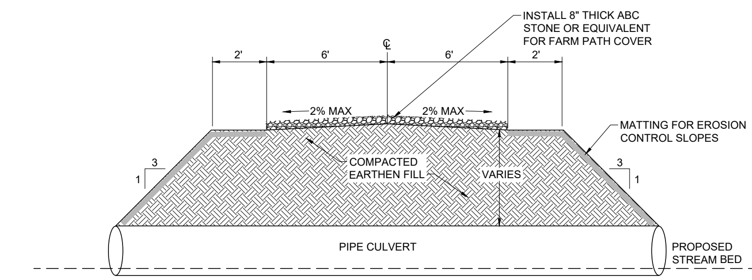


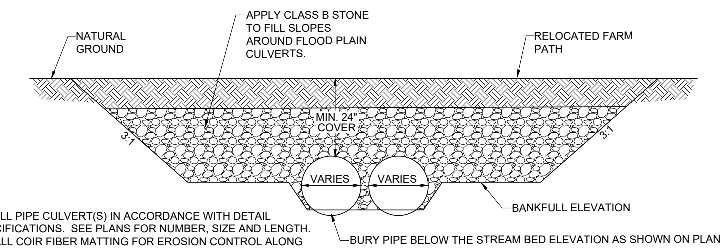
PROFILE B-B

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

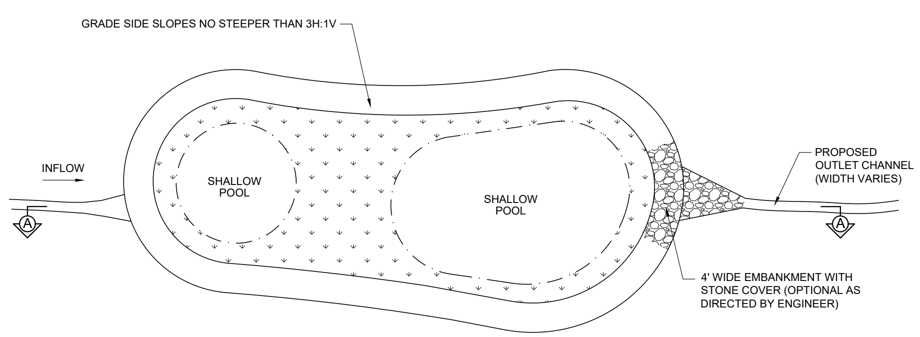




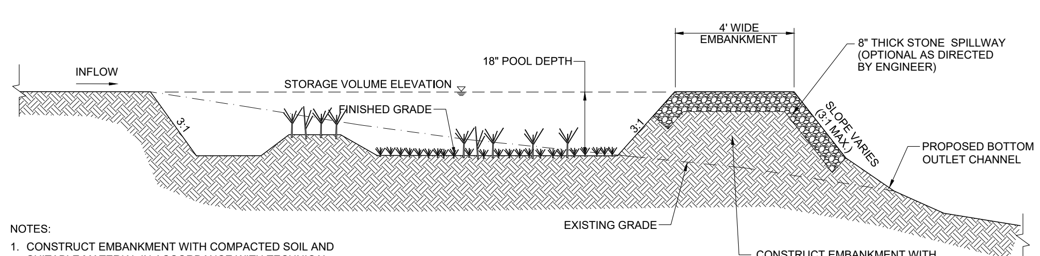
NOTES:
1. INSTALL PIPE CULVERT(S) IN ACCORDANCE WITH DETAIL SPECIFICATIONS. SEE PLANS FOR NUMBER, SIZE AND LENGTH.
2. INSTALL COIR FIBER MATTING FOR EROSION CONTROL ALONG FILL SLOPES IN ACCORDANCE WITH DETAIL SPECIFICATIONS.
3. PIPE CULVERTS ARE TO BE A MINIMUM OF 24" COVER AND SPACING IN ACCORDANCE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

PERMANENT CULVERT STREAM CROSSING

NOT TO SCALE



PLAN VIEW

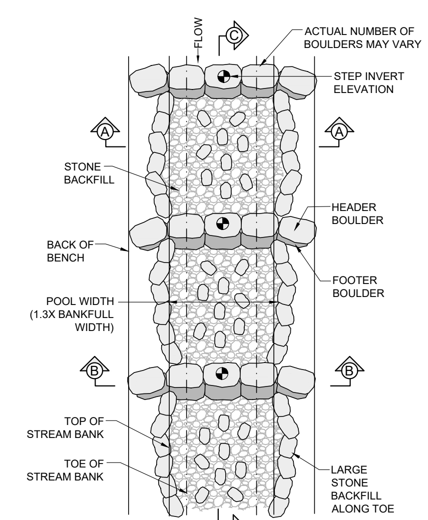


SECTION A - A

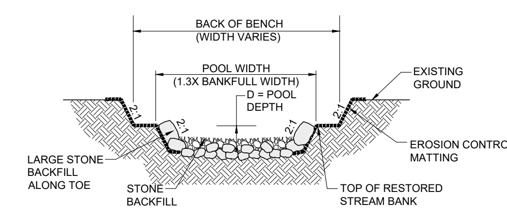
NOTES:
1. CONSTRUCT EMBANKMENT WITH COMPACTED SOIL AND SUITABLE MATERIAL IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS.
2. WATER QUALITY TREATMENT FEATURE VARIES IN SIZE AND SHAPE AS SHOWN ON PLANS.
3. PLANT APPROPRIATE WETLAND SPECIES VEGETATION AS SPECIFIED IN THE PLANTING PLAN.

WATER QUALITY TREATMENT FEATURE

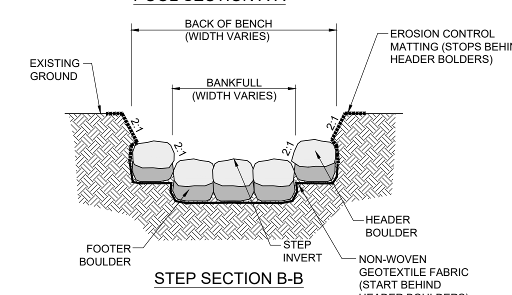
NOT TO SCALE



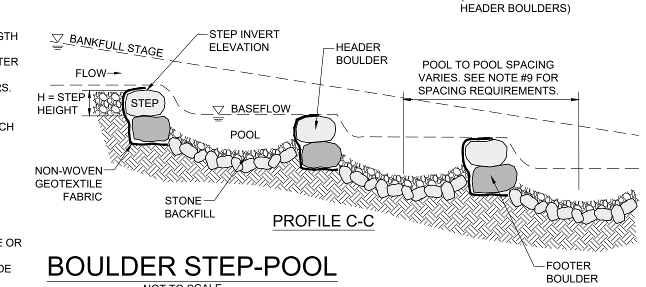
NOTES:
1. FOOTER BOULDERS SHALL BE INSTALLED SUCH THAT 1/4 OF THE LENGTH IS DOWNSTREAM OF THE HEADER BOULDERS.
2. SOIL SHALL BE WELL COMPACTED AROUND BURIED PORTION OF FOOTER BOULDERS WITH BUCKET OF TRACK HOE.
3. INSTALL GEOTEXTILE FILTER FABRIC UNDERNEATH FOOTER BOULDERS.
4. UNDERCUT POOL BED ELEVATION 8 INCHES TO ALLOW FOR LAYER OF STONE.
5. INSTALL EROSION CONTROL MATTING ALONG COMPLETED BANKS SUCH THAT THE EROSION CONTROL MATTING AT THE TOE OF THE BANK EXTENDS DOWN TO THE ELEVATION OF THE BOTTOM OF THE HEADER BOULDERS AND LARGE STONE BACKFILL AT THE TOE.
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 STEP HEIGHT (H) SHALL NOT EXCEED 0.5 FT.
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 5% AS DETERMINED BY THE ENGINEER.



POOL SECTION A-A



STEP SECTION B-B



PROFILE C-C

BOULDER STEP-POOL

NOT TO SCALE

WATER & LAND SOLUTIONS
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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

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

REVISIONS

NO.		DATE
A	DRAFT MIT PLAN	12-13-18
B	DRAFT FINAL MIT PLAN	5-8-19
C	FINAL MIT PLAN	7-26-19
D		
E		
F		

PROJECT NAME

HORNE CREEK TRIBUTARIES MITIGATION PROJECT

SURRY COUNTY, NC

DRAWING INFORMATION

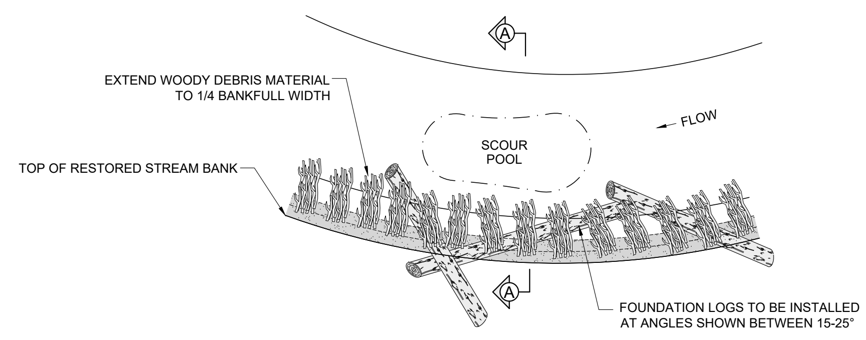
PROJECT NO. :	100026
FILENAME :	04-07_HORNE_CREEK_DETAILS.DWG
DESIGNED BY :	CAT
DRAWN BY :	CAT/APL
DATE :	7/26/19
HORIZ. SCALE :	N/A
VERT. SCALE :	N/A

SHEET NAME

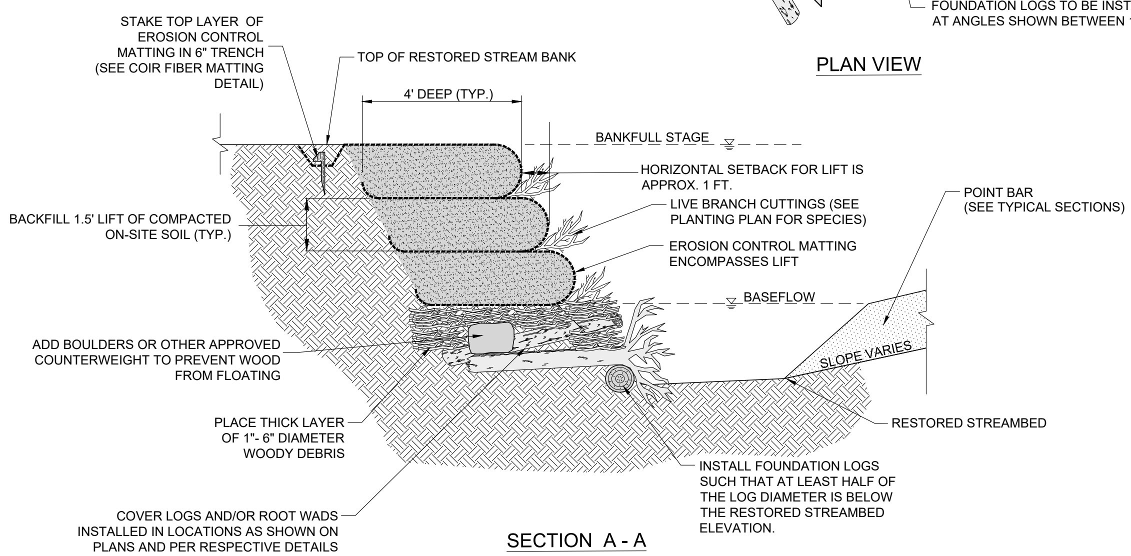
DETAILS

SHEET NUMBER

5



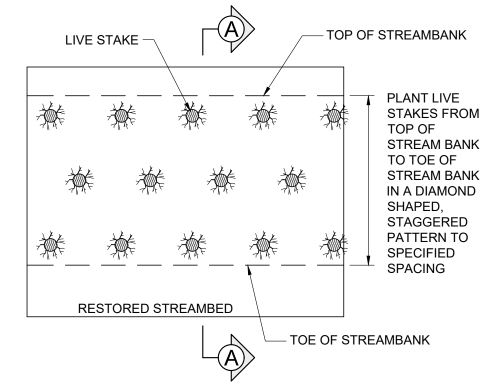
PLAN VIEW



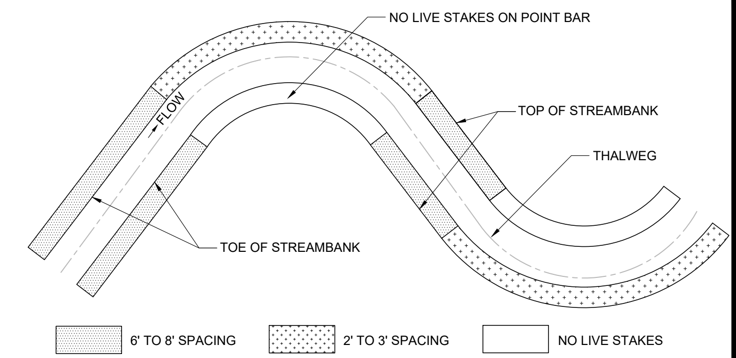
SECTION A - A

GEOLIFT W/ TOE WOOD

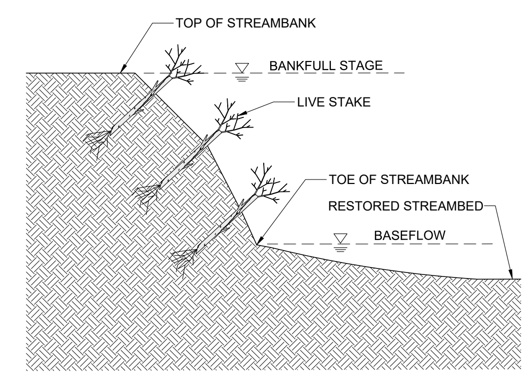
NOT TO SCALE



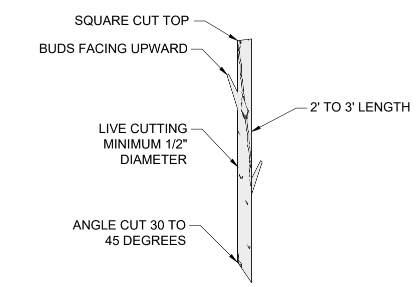
PLAN VIEW OF STREAM BANK



LIVE STAKE SPACING PLAN VIEW



SECTION A - A

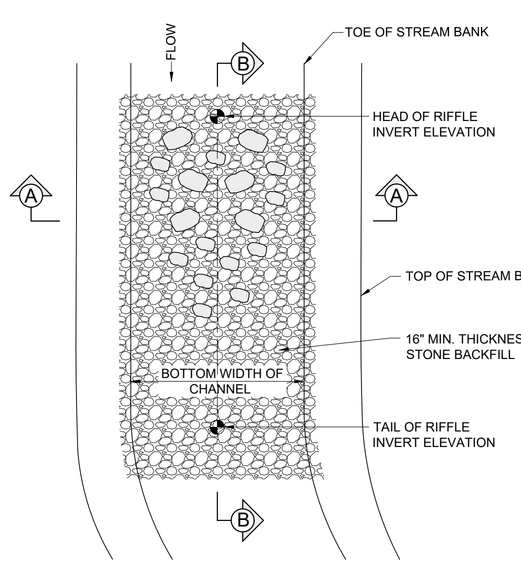


LIVE STAKE DETAIL

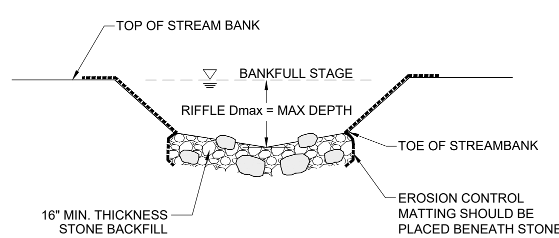
NOTES:
1. LIVE STAKES SHOULD BE CUT AND INSTALLED ON THE SAME DAY.
2. DO NOT INSTALL LIVE STAKES THAT HAVE BEEN SPLIT.
3. LIVE STAKES MUST BE INSTALLED WITH BUDS POINTING UPWARDS.
4. LIVE STAKES SHOULD BE INSTALLED PERPENDICULAR TO BANK.
5. LIVE STAKES SHOULD BE 1/2 TO 2 INCHES IN DIAMETER AND 2 TO 3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

LIVE STAKING

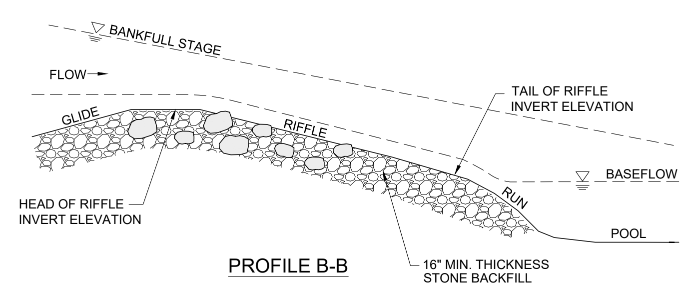
NOT TO SCALE



PLAN VIEW



SECTION A-A

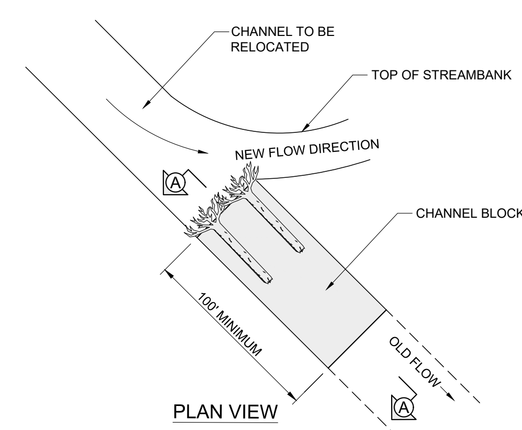


PROFILE B-B

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



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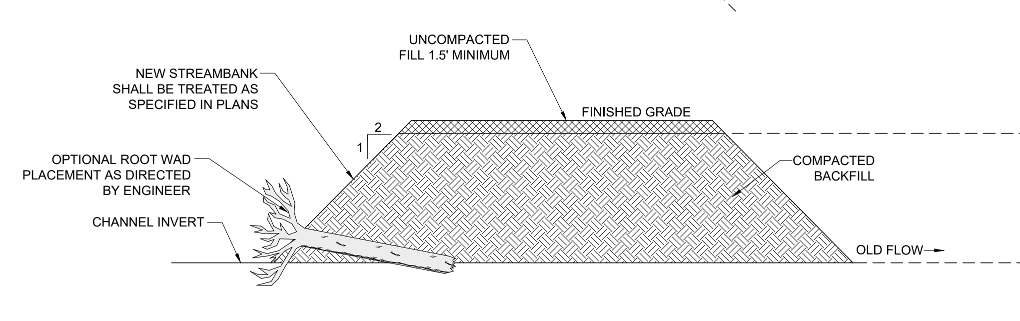

NOTES:
1. COMPACT BACKFILL USING ON-SITE HEAVY EQUIPMENT IN 10 INCH LIFTS.
2. FILL DITCH PLUG TO TOP OF BANKS OR AS DIRECTED BY ENGINEER.

SECTION A-A

CHANNEL BLOCK

NOT TO SCALE

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

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

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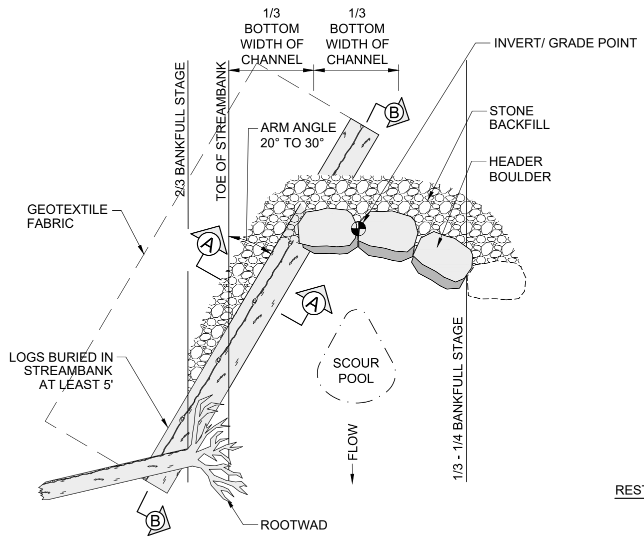

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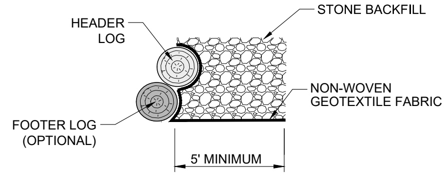
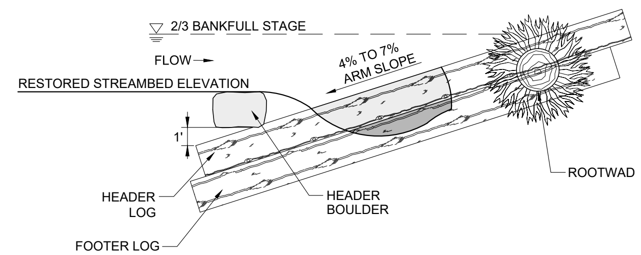


SECTION A-A

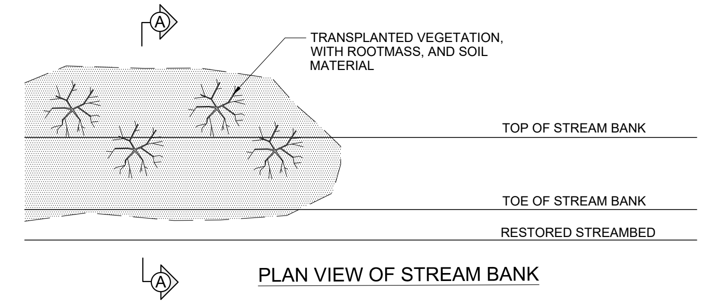


PROFILE B-B

NOTES:
1. LOGS SHOULD BE AT LEAST 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.

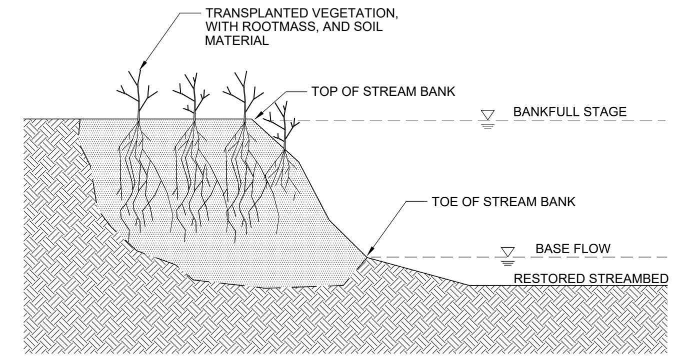
GRADE CONTROL LOG J-HOOK VANE

NOT TO SCALE



PLAN VIEW OF STREAM BANK

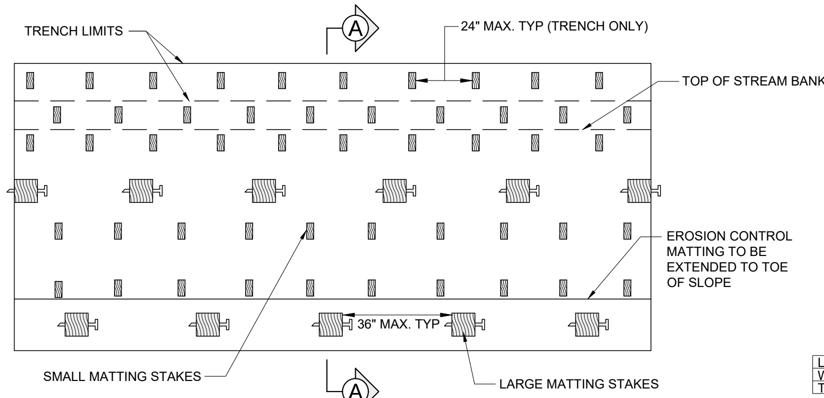
NOTES:
1. EXCAVATE A HOLE IN THE RESTORED STREAM BANK THAT WILL ACCOMMODATE THE SIZE OF TRANSPLANT TO BE PLANTED. BEGIN EXCAVATION AT TOE OF THE STREAM BANK.
2. EXCAVATE THE ENTIRE TRANSPLANT ROOT MASS AND AS MUCH ADDITIONAL SOIL MATERIAL AS POSSIBLE. IF ENTIRE ROOT MASS CAN NOT BE EXCAVATED AT ONCE, 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.



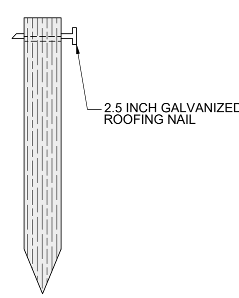
SECTION A-A

VEGETATION TRANSPLANTS

NOT TO SCALE

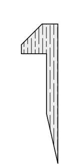


PLAN VIEW OF STREAM BANK



TYPICAL LARGE MATTING STAKE

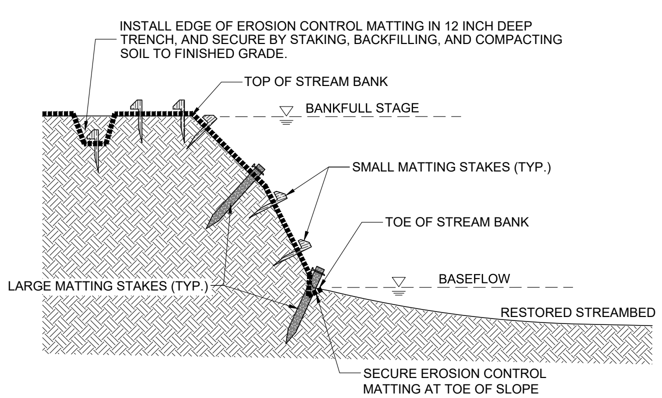
LENGTH	24.00 IN (60.96 CM) (TAPERED TO POINT)
WIDTH	1.5 IN (3.81 CM)
THICKNESS	1.5 IN (3.81 CM)



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)

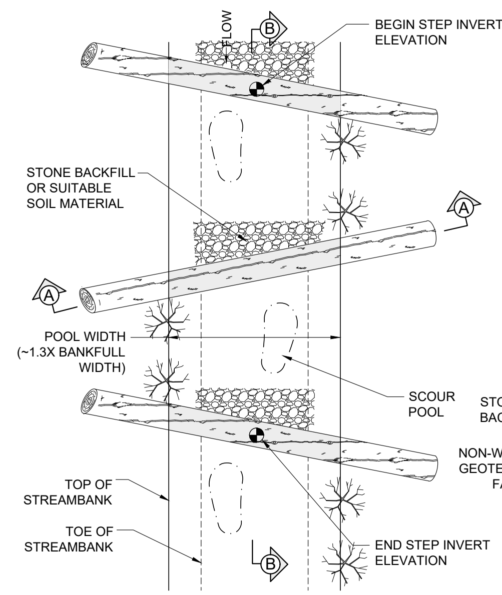
NOTES:
1. RESTORED STREAM BANKS MUST BE SEEDED AND MULCHED PRIOR TO PLACEMENT OF EROSION CONTROL MATTING.
2. SEE TECHNICAL SPECIFICATIONS FOR MATTING STAKE SPACING REQUIREMENTS.
3. PLACE LARGE STAKES ALONG ALL MATTING SEAMS, IN THE CENTER OF STREAM BANK, AND TOE OF SLOPE.



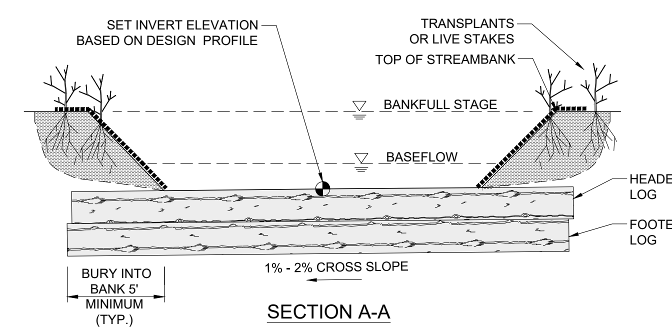
SECTION A - A

EROSION CONTROL MATTING

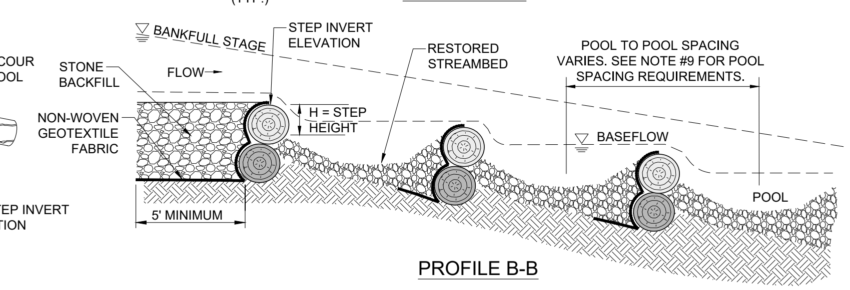
NOT TO SCALE



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

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HORIZ. SCALE :	N/A
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SHEET NAME

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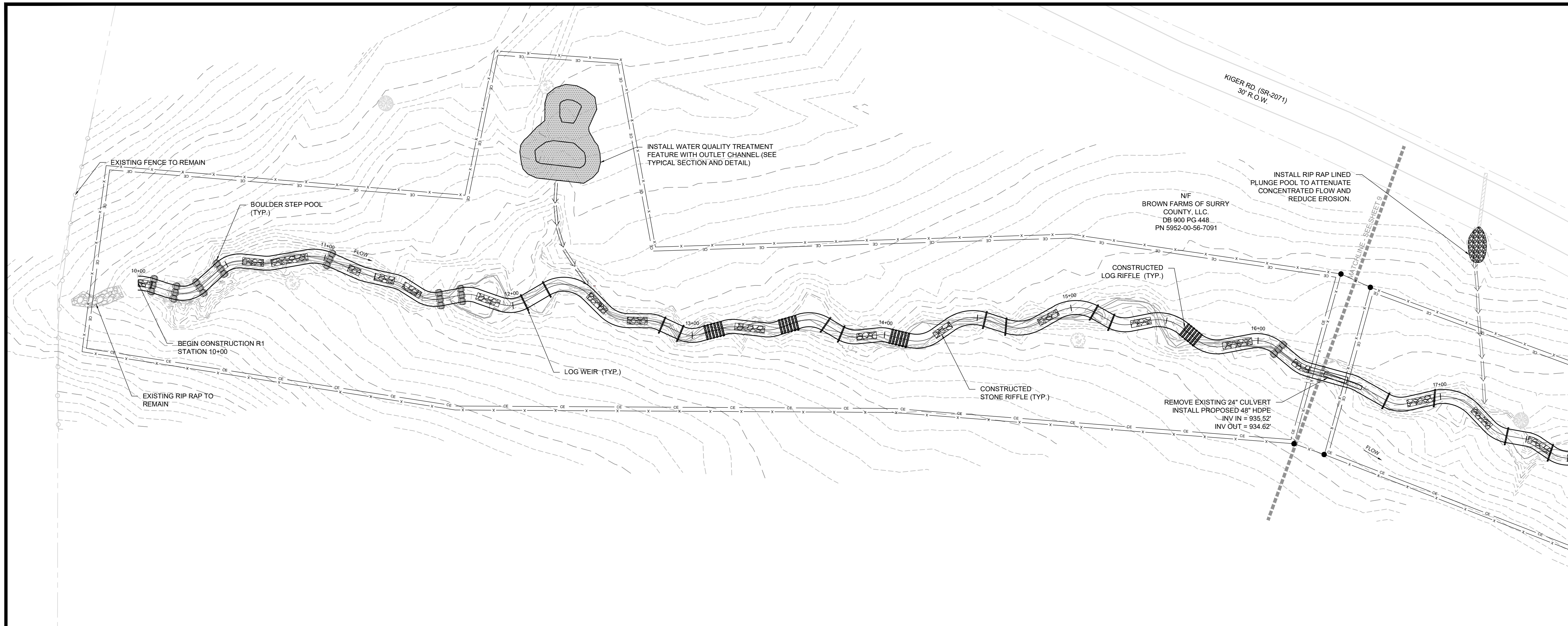
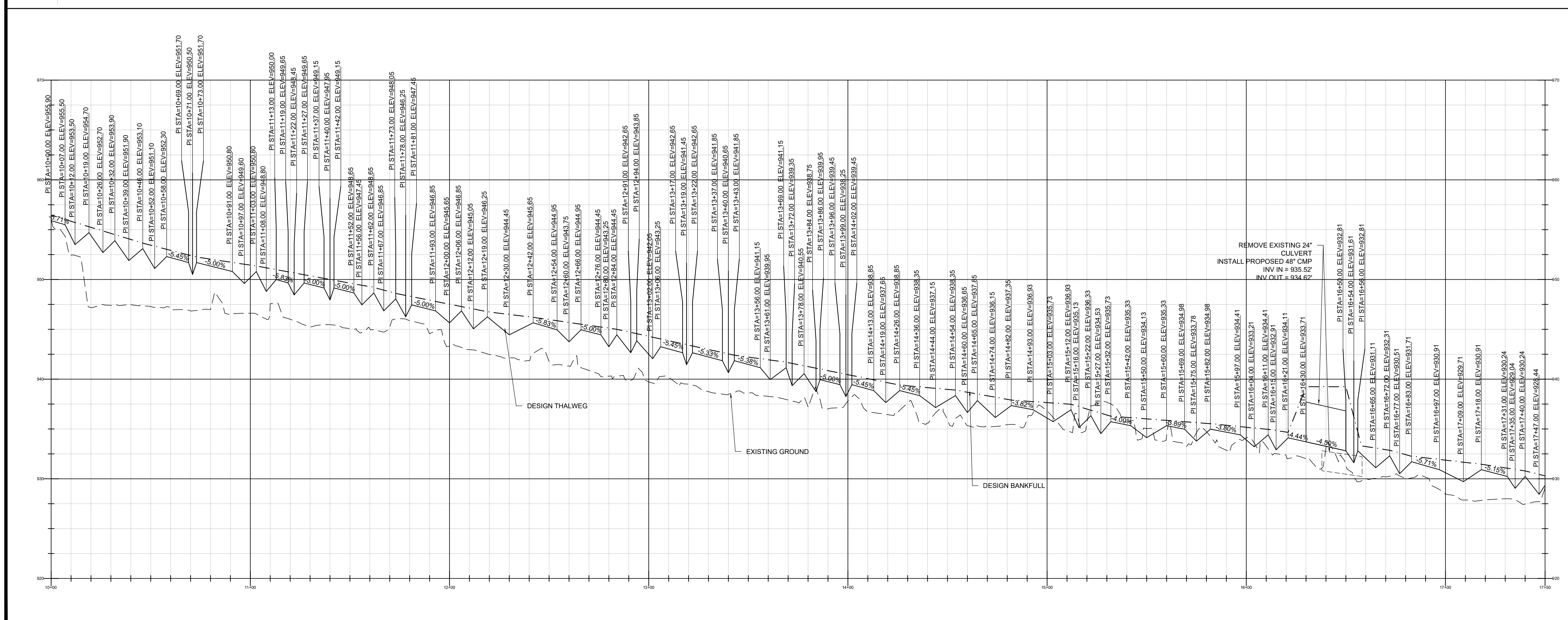
7





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HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 12'

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GRAPHIC SCALE

SHEET NAME

PLAN AND PROFILE

SHEET NUMBER

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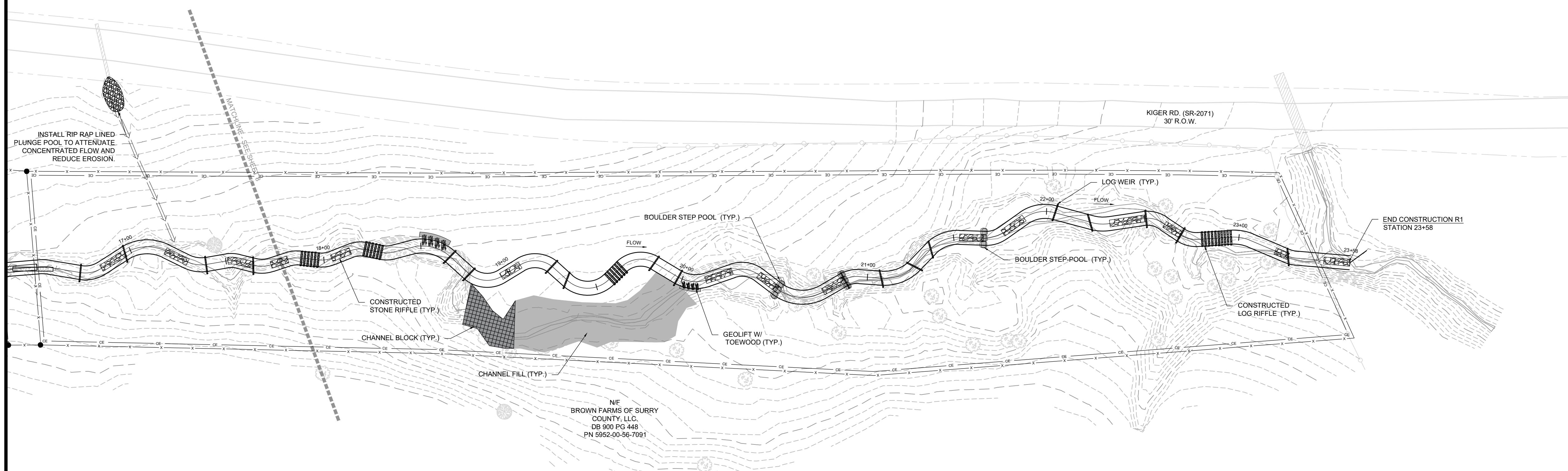

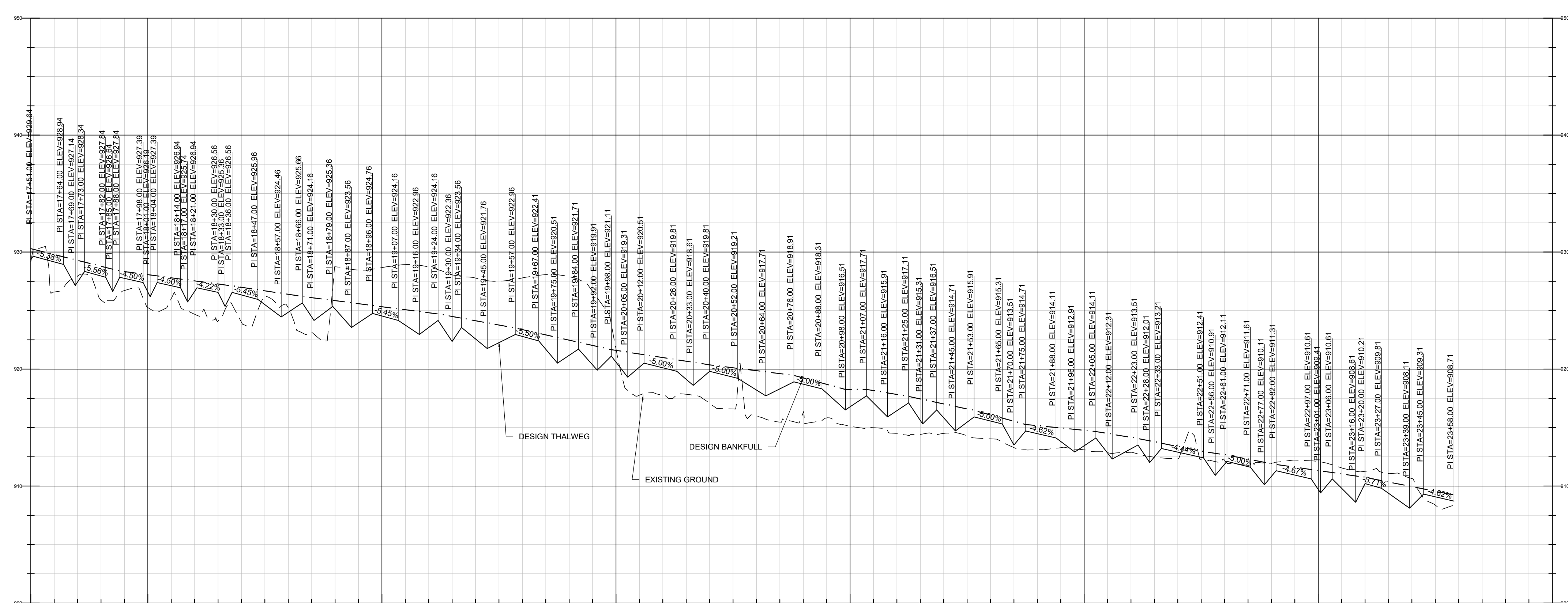

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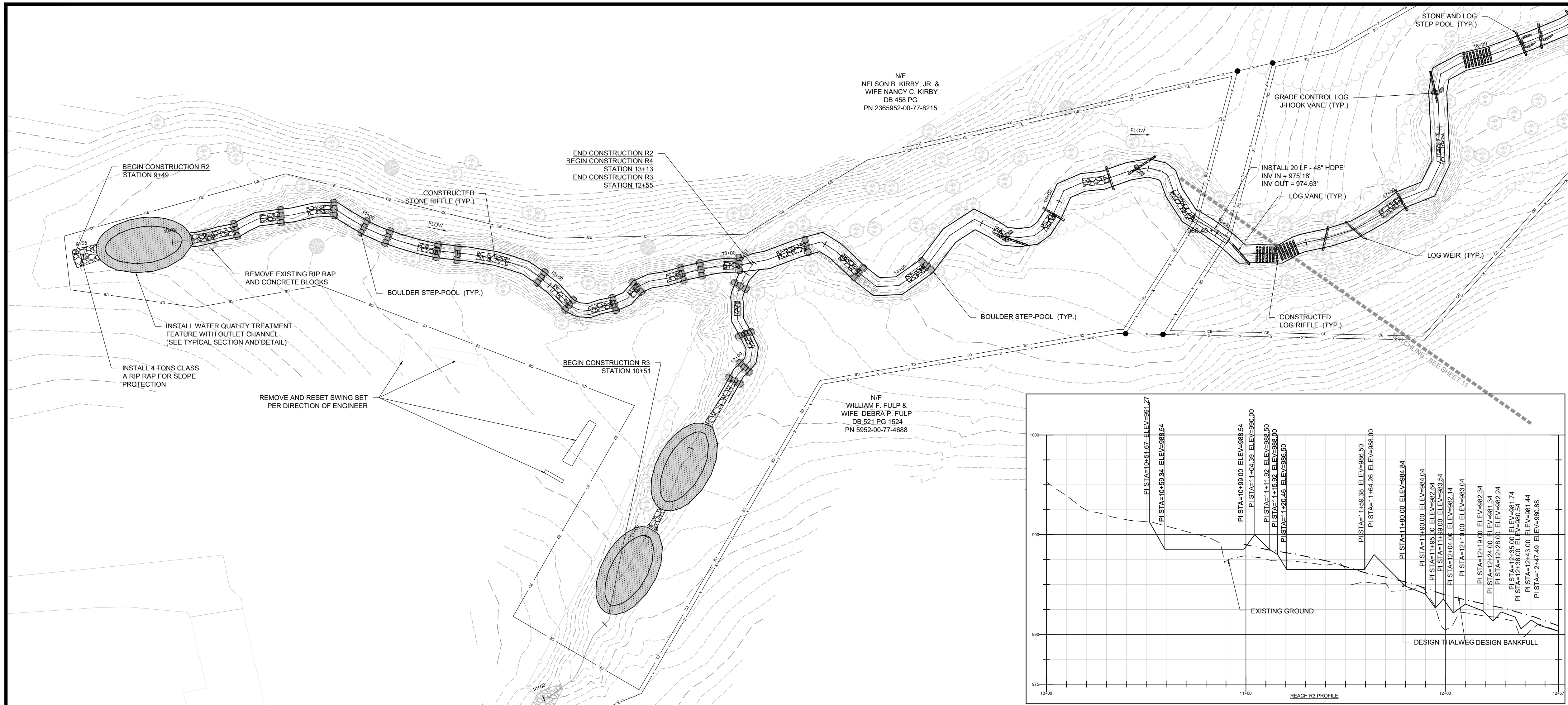

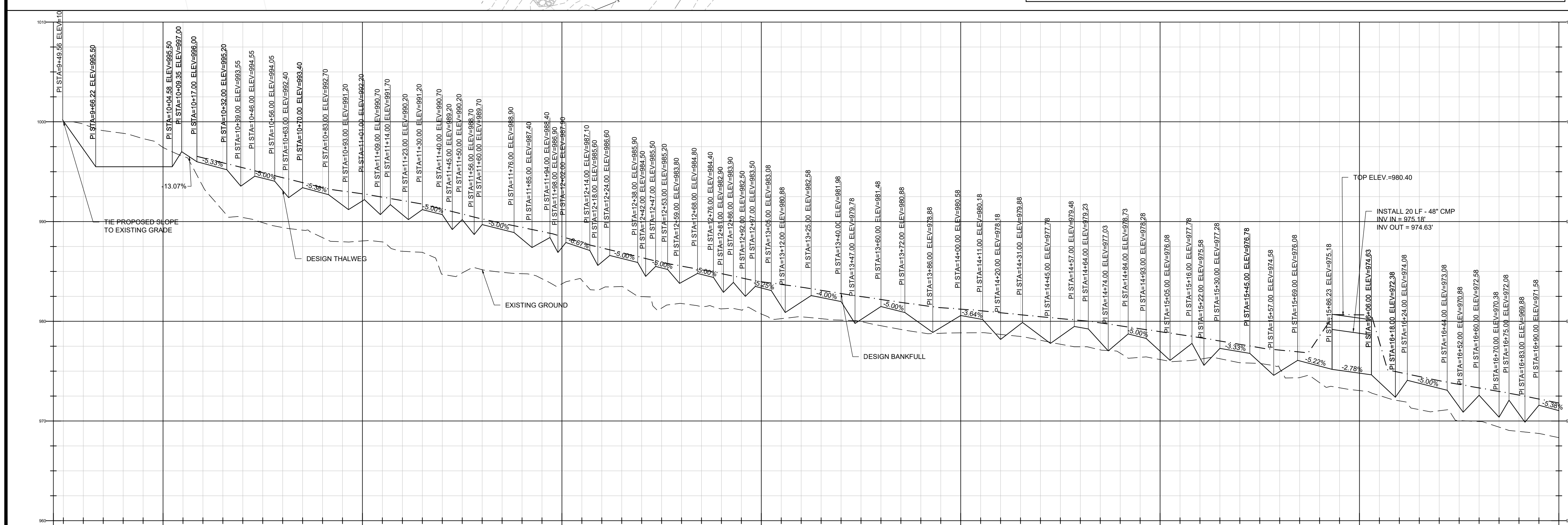

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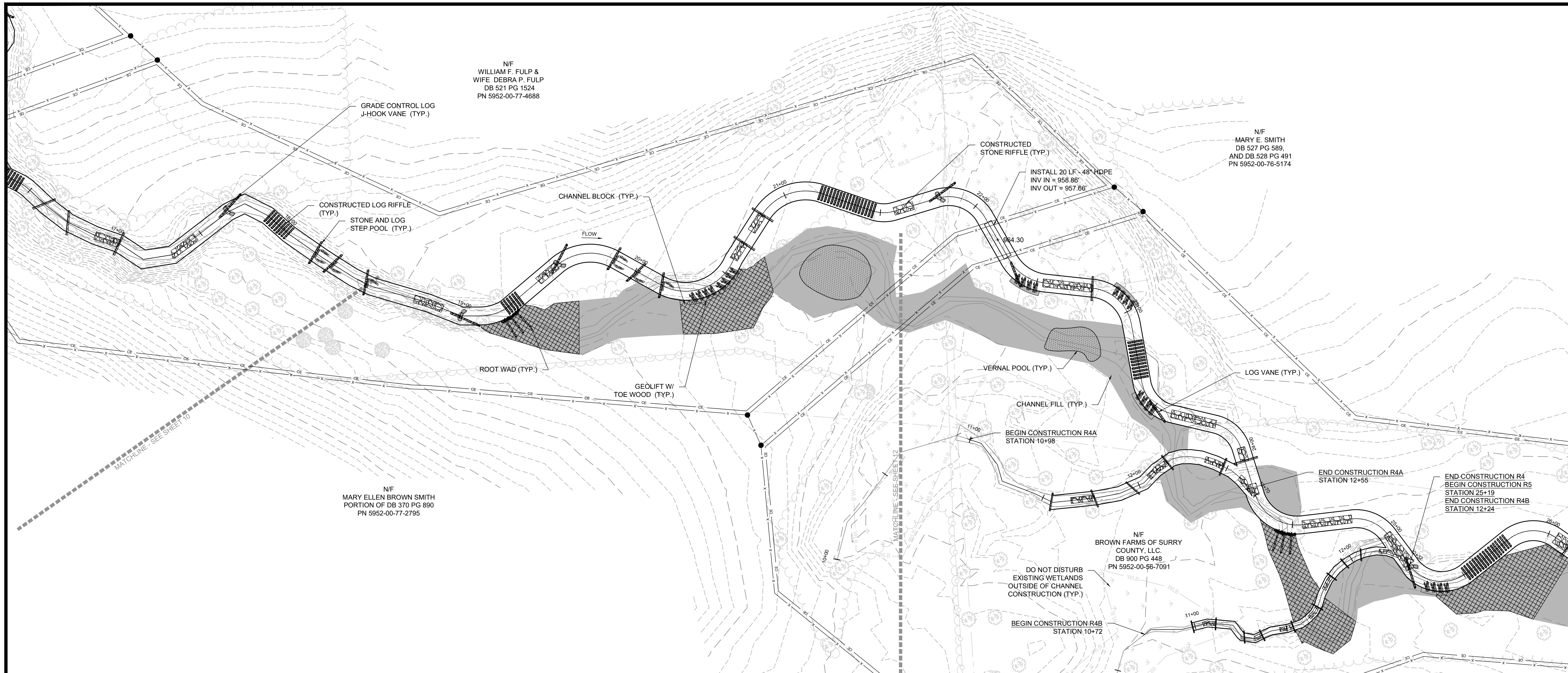
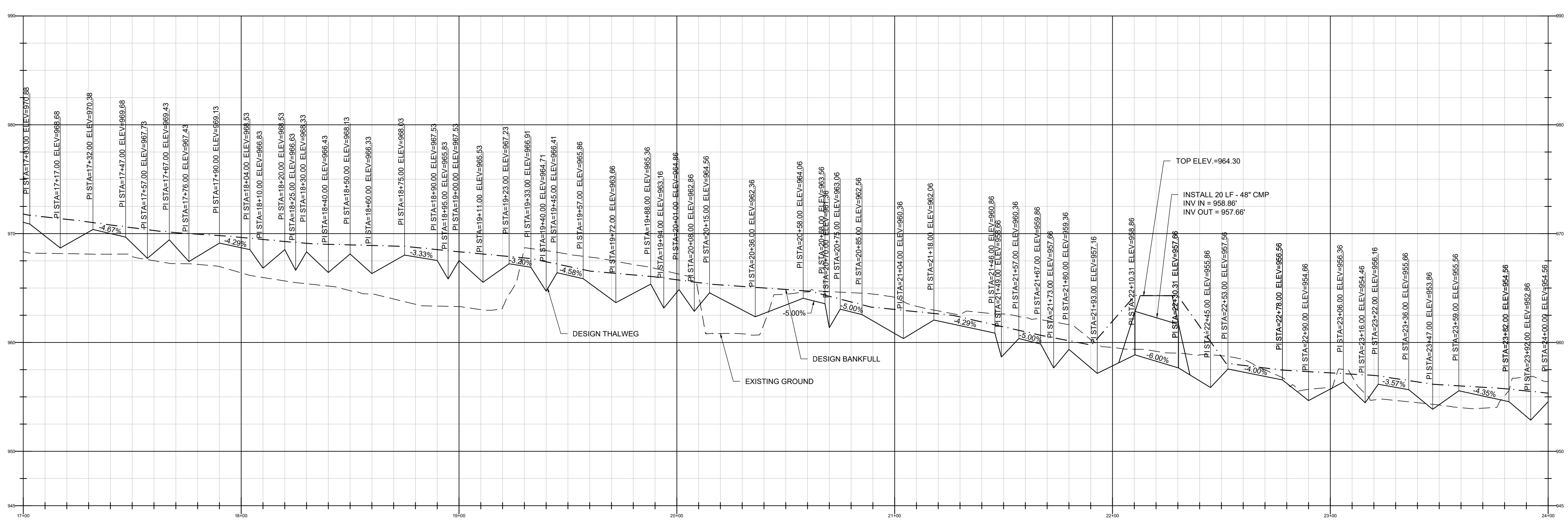
10





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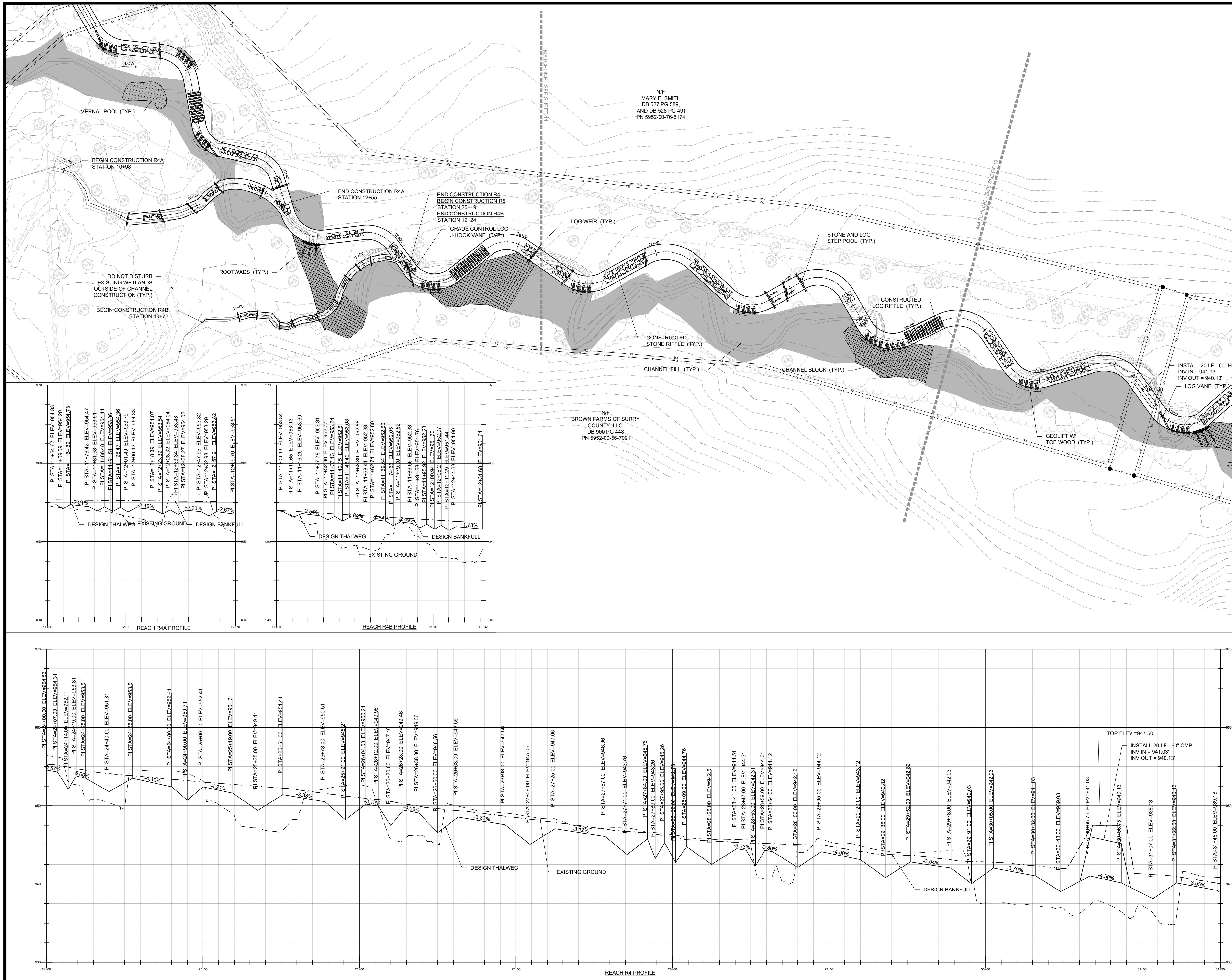

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SURRY COUNTY, NC

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VERT. SCALE :	1" = 12'

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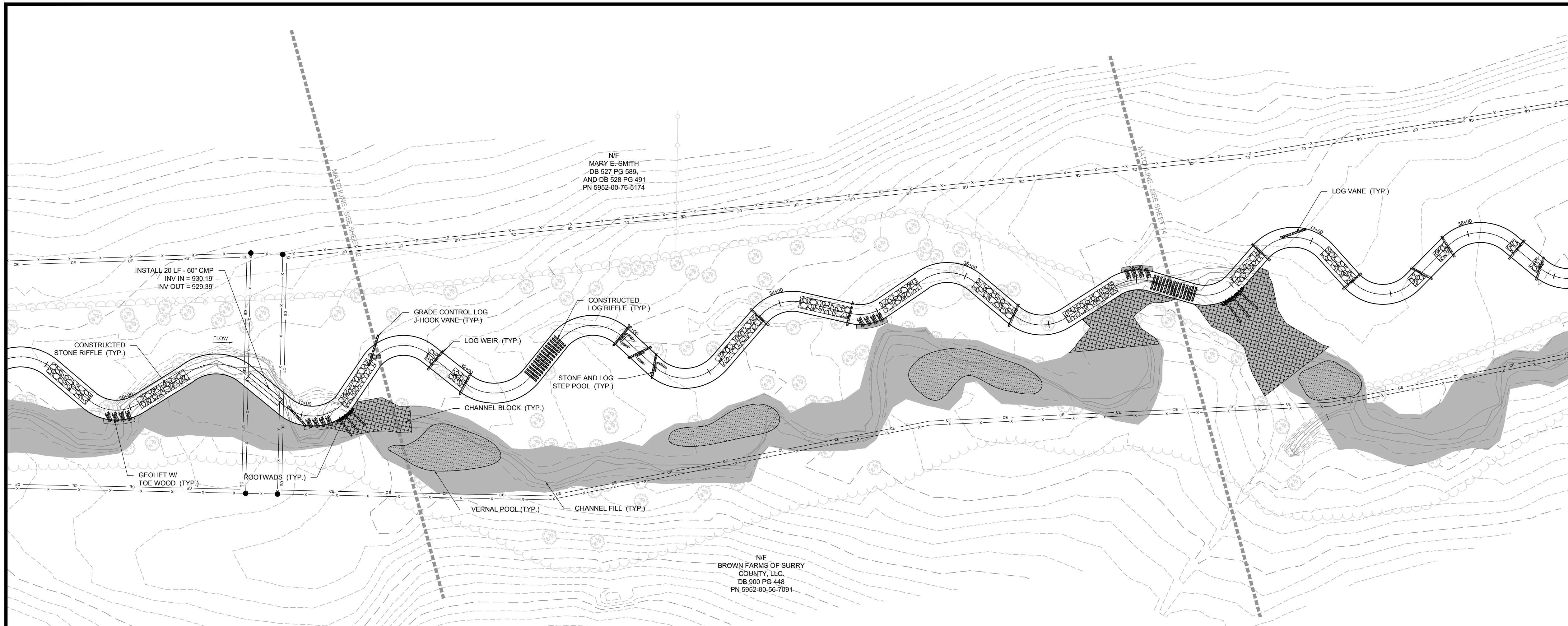
GRAPHIC SCALE

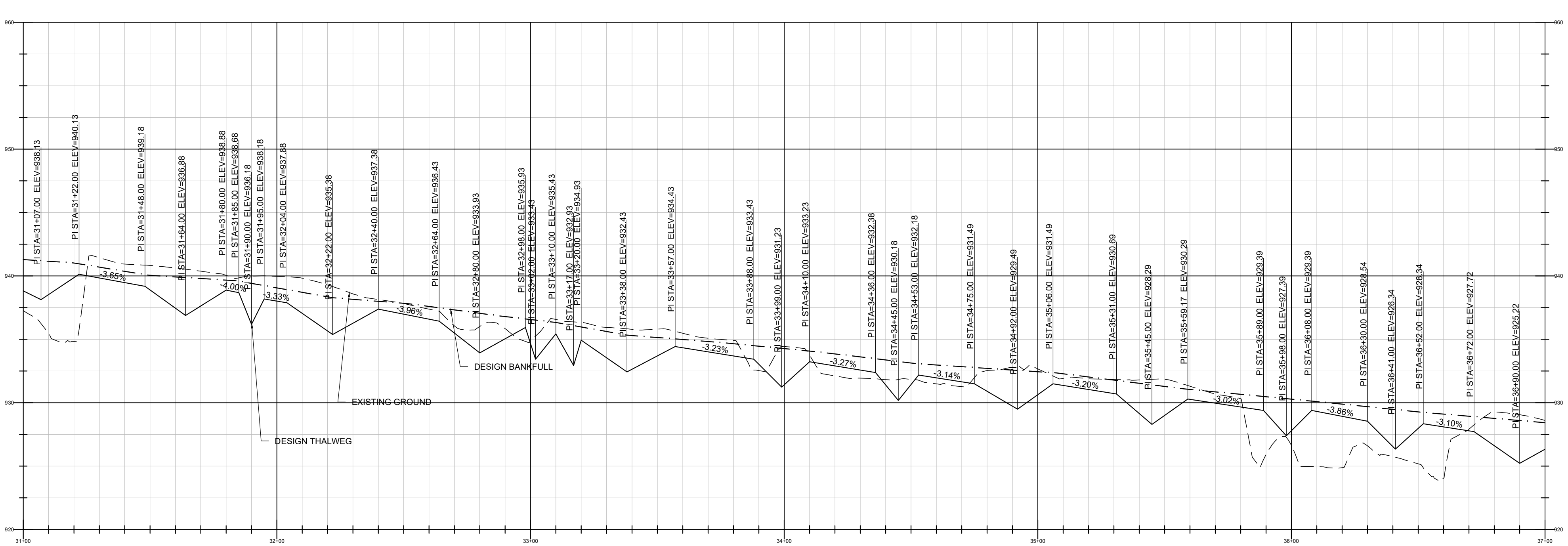
SHEET NAME

PLAN AND PROFILE

SHEET NUMBER

12





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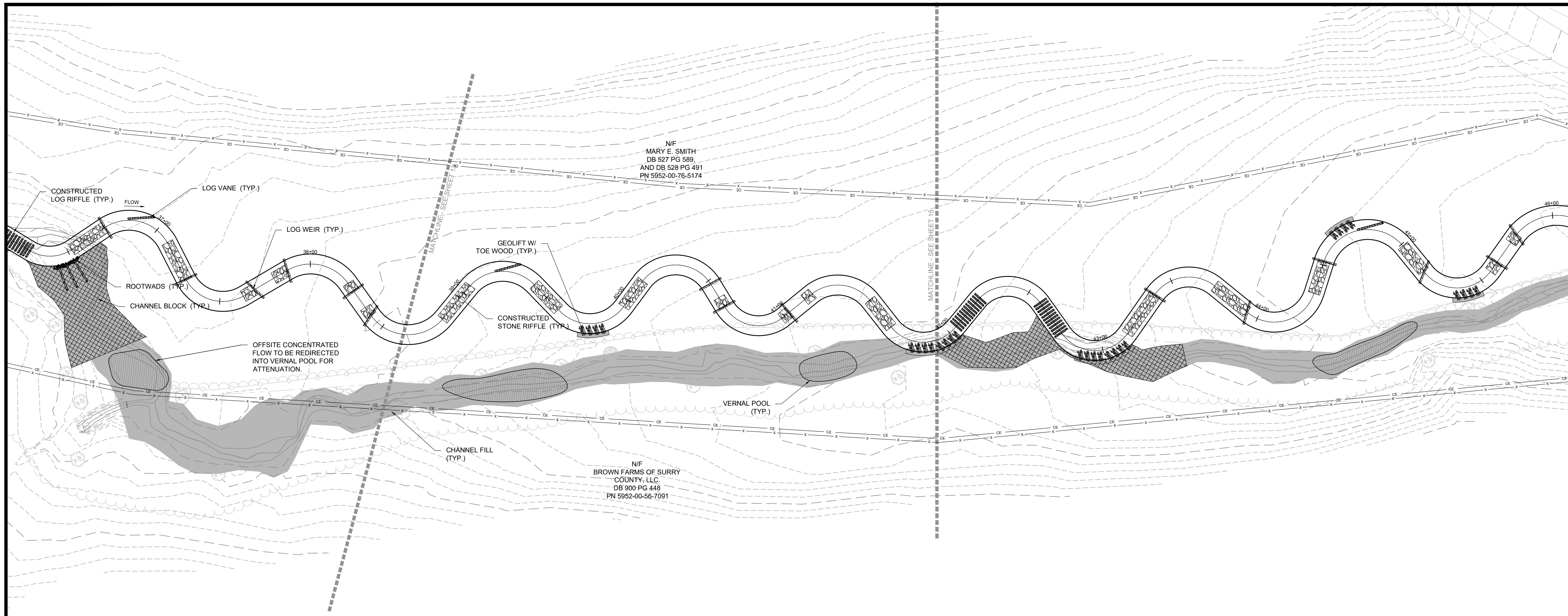

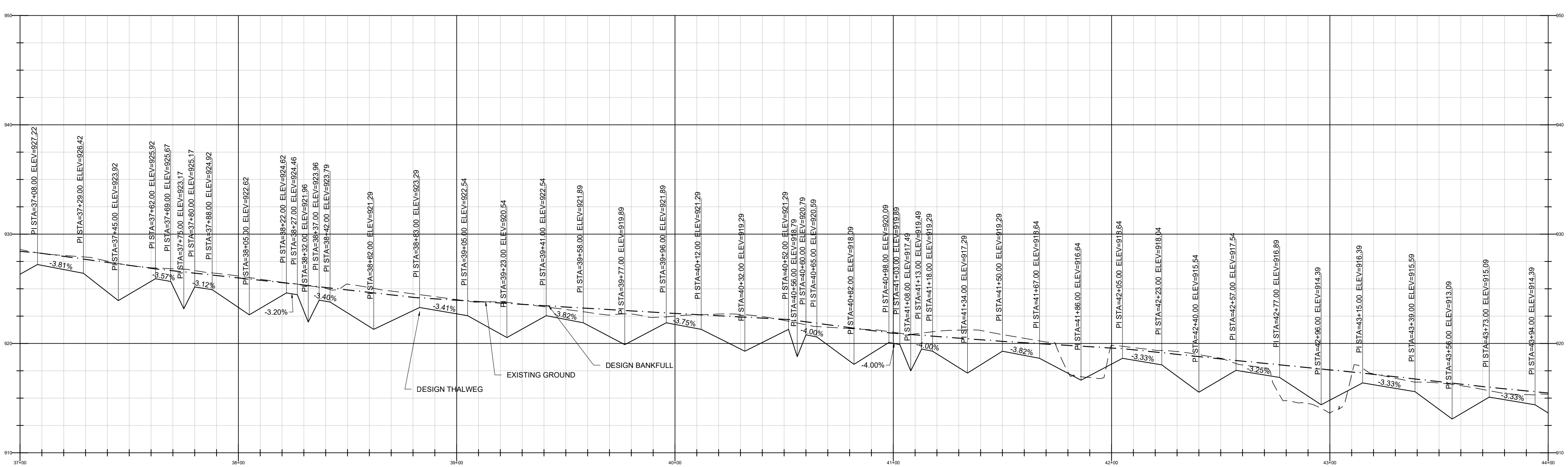

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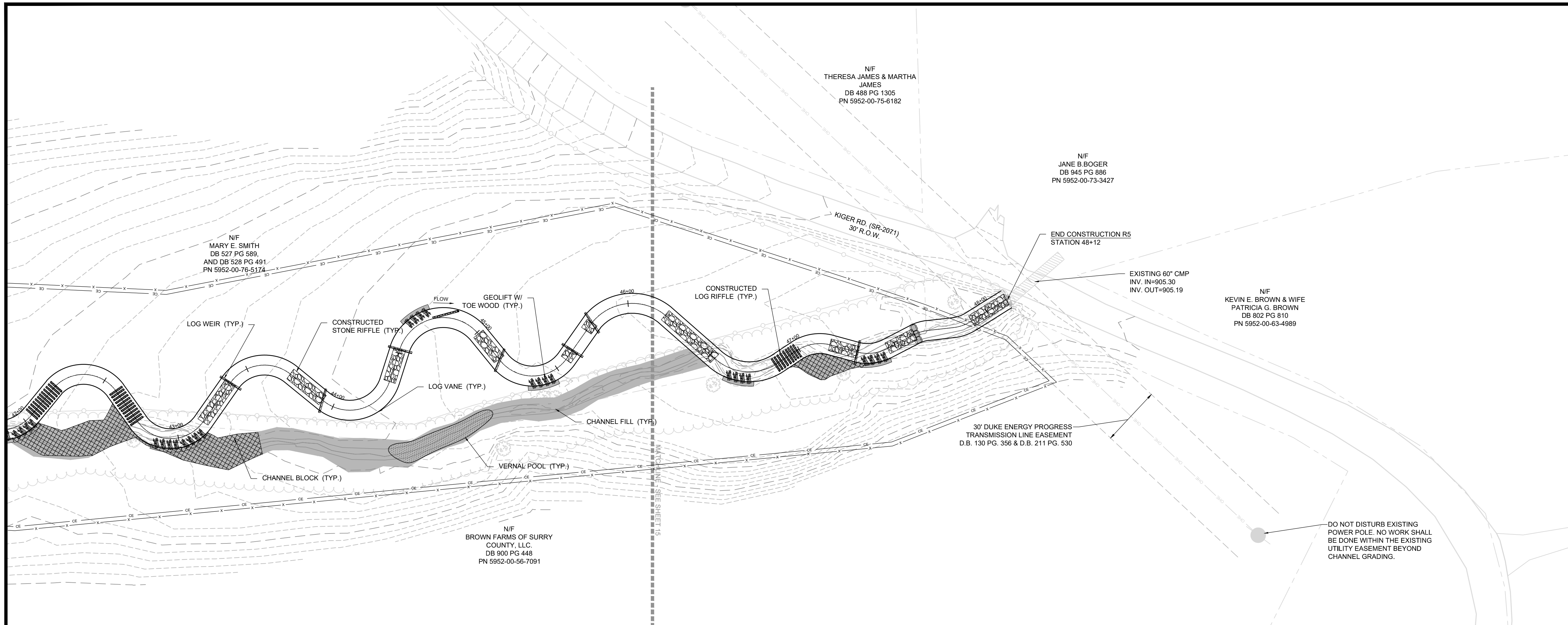

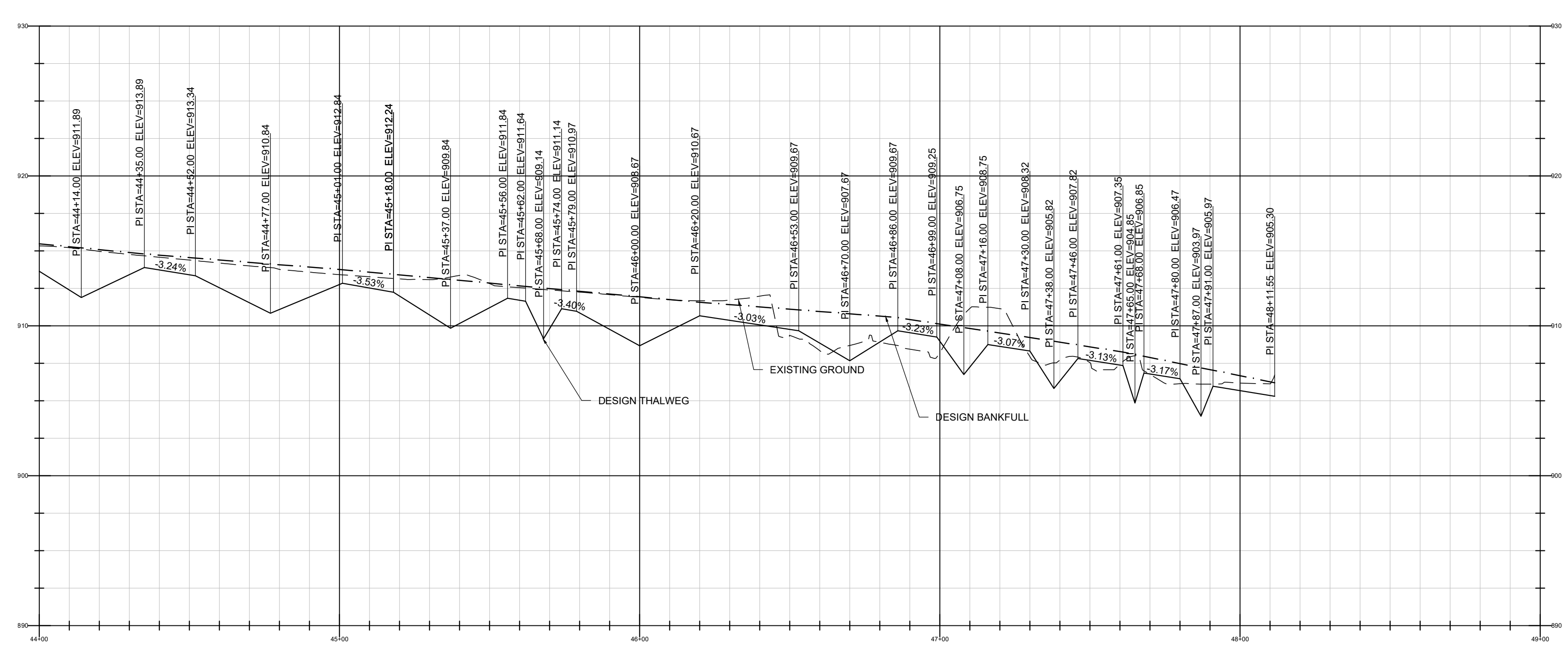

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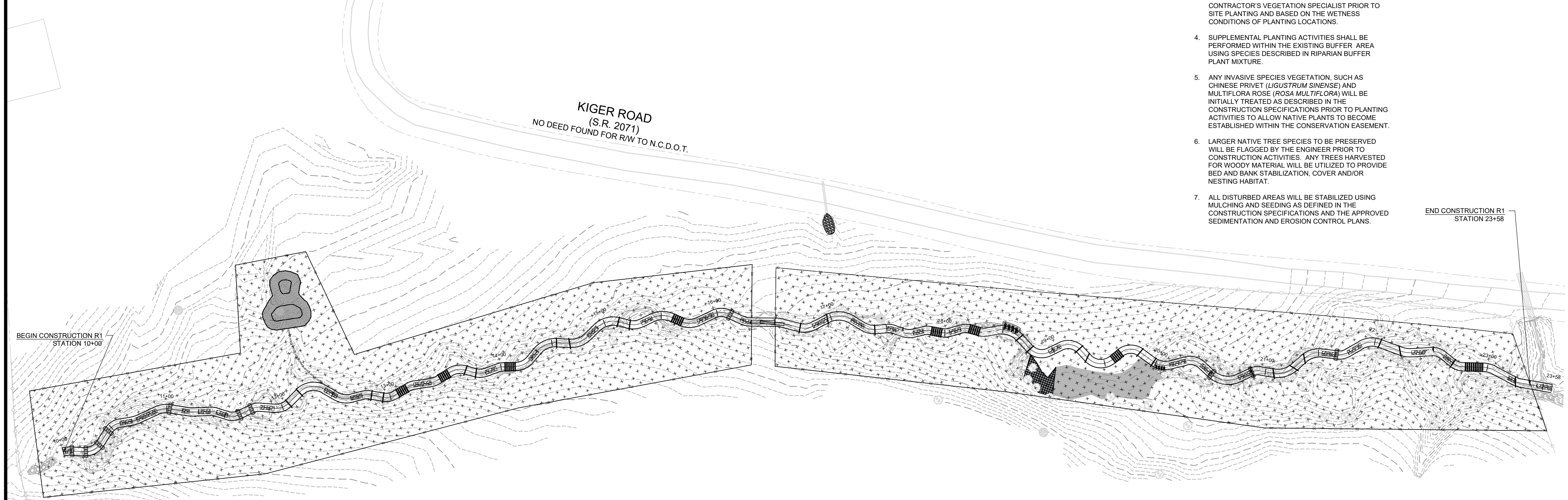

PLANTING NOTES

1. THE FOLLOWING TABLES LIST THE PROPOSED VEGETATION SPECIES SELECTION FOR THE PROJECT REVEGETATION. THE TOTAL PLANTING AREA IS APPROXIMATELY 10.2 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 30 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 AREA USING SPECIES DESCRIBED IN RIPARIAN BUFFER PLANT MIXTURE.
5. ANY INVASIVE SPECIES VEGETATION, SUCH AS CHINESE PRIVET (*LIGUSTRUM SINENSE*) AND MULTIFLORA ROSE (*ROSA MULTIFLORA*) 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.

PLANTING ZONES

RIPARIAN BUFFER RESTORATION

BROWN FARMS OF SURRY COUNTY, LLC.
PIN: 5952-00-56-7091
DB: 936 PG: 448, TRACT 7
FOR PROPERTY DESCRIPTION SEE DB: 709 PG: 1094
REFERENCE: DB: 203 PG: 448
PORTION OF PB: 9 PG: 191, TRACT A
FOR BOUNDARY LINE AGREEMENT SEE DB: 386 PG: 342

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)			
Betula nigra	River Birch	7%	FACW
Tilia americana	Basswood	7%	FACU
Platanus occidentalis	American sycamore	7%	FACW
Nyssa sylvatica	Black Gum	6%	FAC
Liriodendron tulipifera	Tulip-poplar	7%	FACU
Quercus alba	White oak	6%	FACU
Quercus rubra	White oak	3%	FACU
Fraxinus pennsylvanica	Green Ash	3%	FACW
Riparian Buffer Bare Root Plantings – Understory			
(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Diospyros virginiana	Persimmon	7%	FAC
Amelanchier virginiana	Common serviceberry	5%	FAC
Magnolia tripetala	Umbrella magnolia	6%	FACU
Carpinus caroliniana	Ironwood	6%	FAC
Hamamelis virginiana	Witch-hazel	6%	FACU
Asimina triloba	Paw Paw	6%	FAC
Lindera benzoin	Spicebush	6%	FACW
Alnus serrulata	Hazel Alder	6%	OBL
Corylus americana	Hazelnut	6%	FACU
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

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%	1.50	FAC
Dichanthelium clandestinum	Deer Tongue	15%	1.50	FACW
Carex crinata	Fringed sedge	10%	2.25	FACW+
Chasmanthium latifolium	River oats	5%	1.50	FACU
Elymus virginicus	Virginia wild rye	15%	1.50	FAC
Juncus effusus	Soft rush	5%	2.25	FACW+
Panicum virgatum	Switchgrass	10%	1.50	FAC+
Eutrochium fistulosum	Joe-pye-weed	5%	0.75	FACW
Schizachyrium scoparium	Little blue stem	10%	0.75	FACU
Tripsacum dactyloides	Eastern gamagrass	5%	0.75	FAC+
Sorghastrum nutans	Indiangrass	10%	0.75	FACU

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

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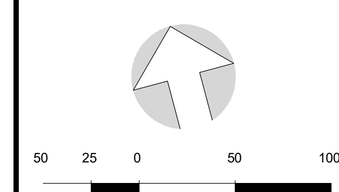

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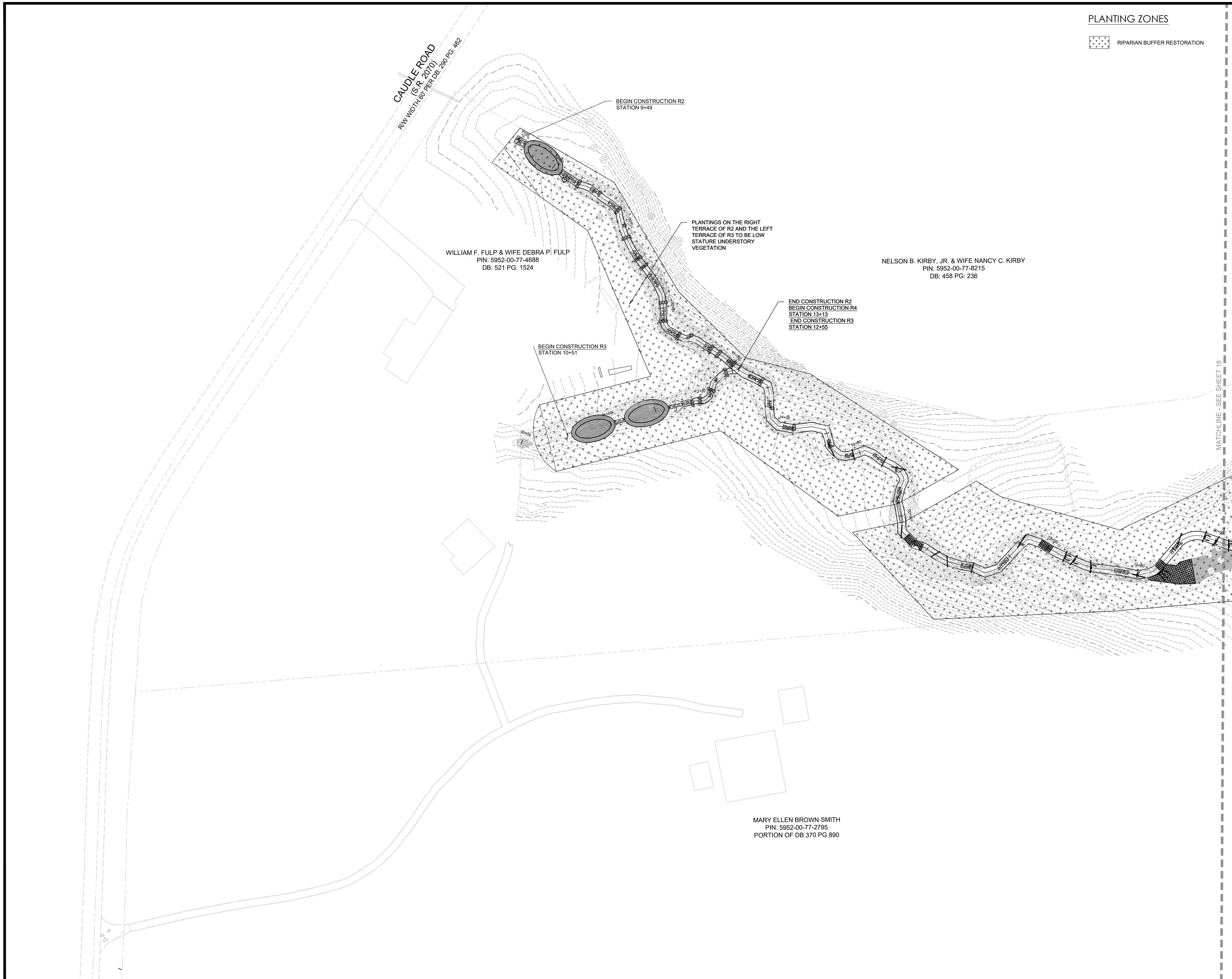

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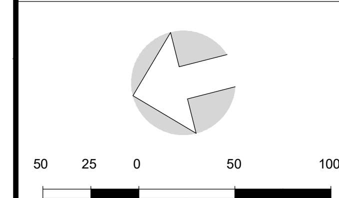

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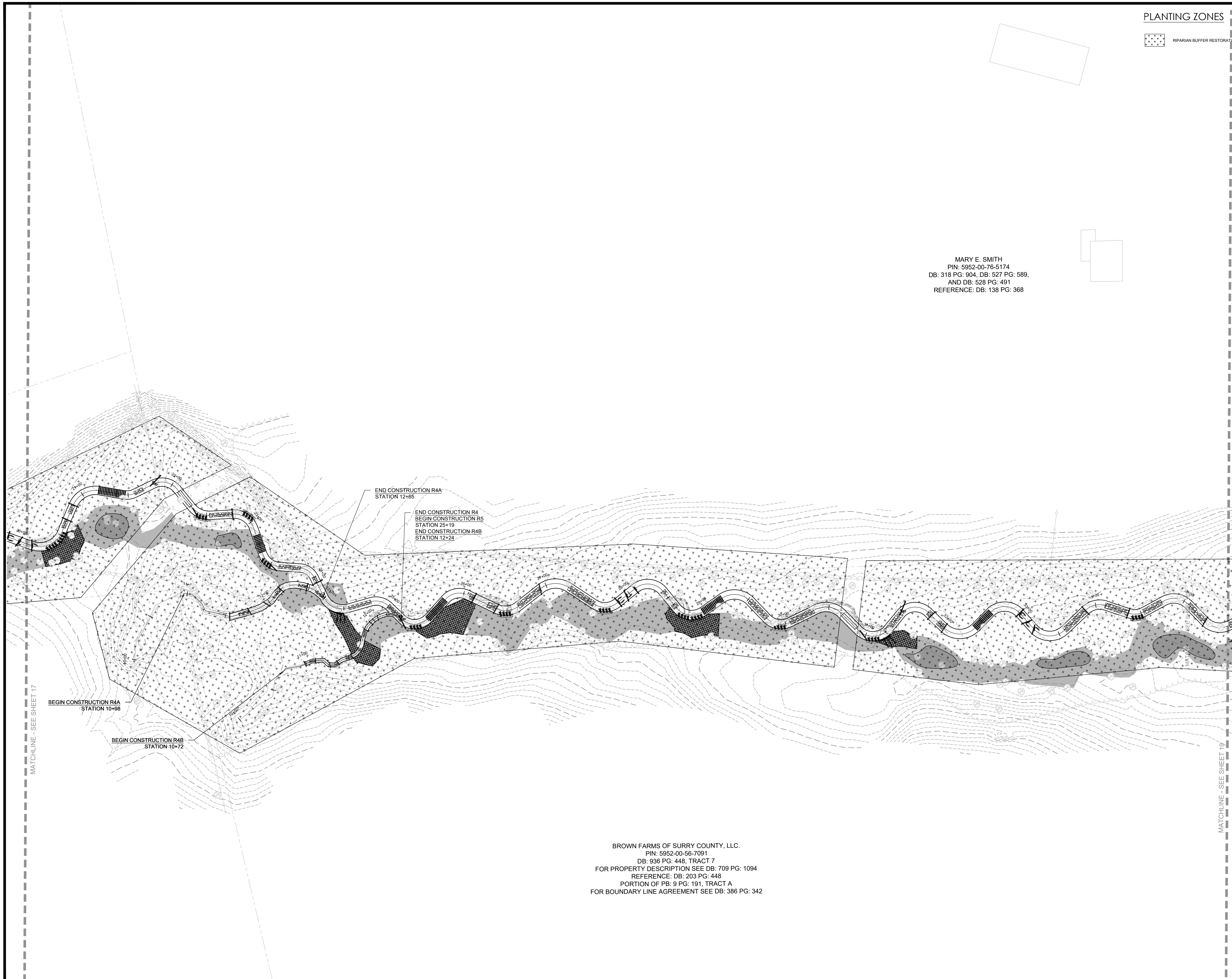

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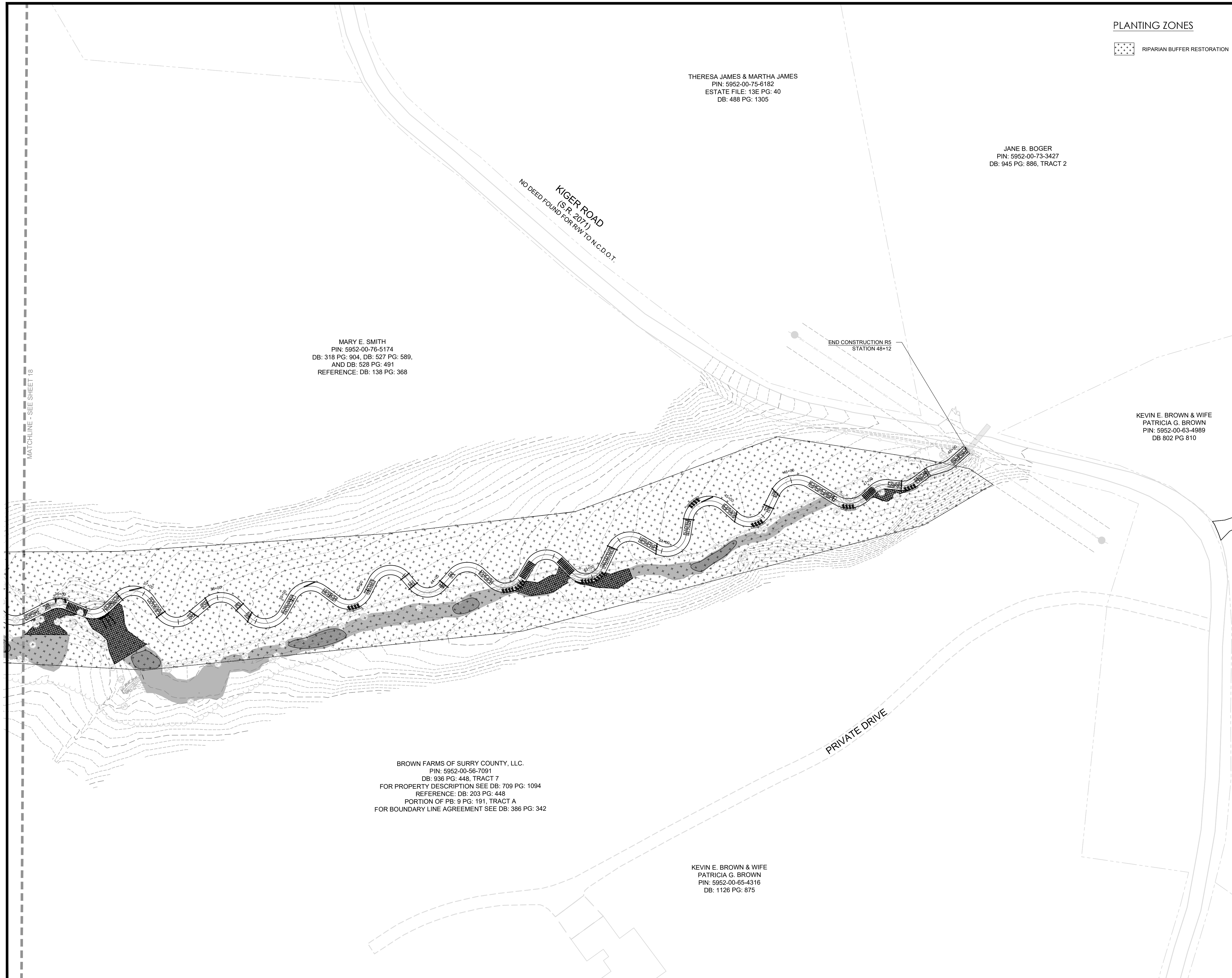

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Appendix 2 – Site Analysis Data/Supplementary Information

Habitat Assessment Scores and Taxa List

Existing Cross-Section and Longitudinal Profile Data

Particle Size Distribution (Sediment Samples)

BANCS (BEHI/NBS) Method Estimates

Watershed Information and Site Runoff Volume

NC Rural Piedmont Regional Curve Comparison

USGS Regression Flow Analysis

Stream Quantification Tool Reach Summary

Design Criteria and Stream Morphology Parameters Table

HEC-RAS Output

Buffer Tool Excel Output

Site Photographs

11/13 Revision 8

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Branch, DWR

TOTAL SCORE 74

Directions for use: The observer is to survey a **minimum of 100 meters with 200 meters preferred** of stream, preferably in an **upstream** direction starting above the bridge pool and the road right-of-way. The segment which is assessed should represent average stream conditions. To perform a proper habitat evaluation the observer needs to get into the stream. To complete the form, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. A final habitat score is determined by adding the results from the different metrics.

Stream UT to Horne Creek - R1 Location/road: Pinnacle, NC (Road Name Kiger Rd)County Surry

Date 6-4-18 **CC#** ______ **Basin** Yadkin **Subbasin** HUC 03040101

Observer(s) JM, JMB Type of Study: ☐ Fish ☑ Benthos ☐ Basinwide ☐ Special Study (Describe) ______

Latitude 36.362145° Longitude -80.508170° Ecoregion: ☐ MT ☑ P ☐ Slate Belt ☐ Triassic Basin

Water Quality: Temperature 22.9 °C DO 7.01 mg/l Conductivity (corr.) 83.2 µS/cm pH 6.91

Physical Characterization: Visible land use refers to immediate area that you can see from sampling location - include what you estimate driving thru the watershed in watershed land use.

Visible Land Use: 5 %Forest ______ %Residential 95 %Active Pasture ______ % Active Crops ______ %Fallow Fields ______ % Commercial ______ %Industrial ______ %Other - Describe: ______

Watershed land use : ☐ Forest ☑ Agriculture ☐ Urban ☑ Animal operations upstream

Width: (meters) Stream 1.5 Channel (at top of bank) 4 **Stream Depth:** (m) Avg 0.07 Max 0.15
☐ Width variable ☐ Large river >25m wide

Bank Height (from deepest part of riffle to top of bank-first flat surface you stand on): (m) 1.25

Bank Angle: 80 ° or ☐ NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)

☐ Channelized Ditch
☑ Deeply incised-steep, straight banks ☐ Both banks undercut at bend ☐ Channel filled in with sediment
☐ Recent overbank deposits ☑ Bar development ☐ Buried structures ☐ Exposed bedrock

☐ Excessive periphyton growth ☐ Heavy filamentous algae growth ☐Green tinge ☐ Sewage smell
Manmade Stabilization: ☒N ☐Y: ☐Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐Berm/levee
Flow conditions : ☐High ☒Normal ☐Low
Turbidity: ☐Clear ☒ Slightly Turbid ☐Turbid ☐Tannic ☐Milky ☐Colored (from dyes)
Good potential for Wetlands Restoration Project?? ☐ YES ☒NO Details____________________

Channel Flow Status

Useful especially under abnormal or low flow conditions.

A. Water reaches base of both lower banks, minimal channel substrate exposed .... ☐
B. Water fills >75% of available channel, or <25% of channel substrate is exposed...................... ☐
C. Water fills 25-75% of available channel, many logs/snags exposed.. ☒
D. Root mats out of water.. ☐
E. Very little water in channel, mostly present as standing pools.. ☐

Weather Conditions: Sunny, 80°F **Photos:** ☐N ☐Y ☐ Digital ☐35mm

Remarks:____________________

I. Channel Modification **Score**

A. channel natural, frequent bends.. 5
B. channel natural, infrequent bends (channelization could be old)....................................... 4
C. some channelization present.. 3
D. more extensive channelization, >40% of stream disrupted... 2
E. no bends, completely channelized or rip rapped or gabioned, etc....................................... 0

☐ Evidence of dredging ☐Evidence of desnagging=no large woody debris in stream ☐Banks of uniform shape/height
Remarks____________________ Subtotal 5

II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. If >70% of the reach is rocks, 1 type is present, circle the score of 17. Definition: leafpacks consist of older leaves that are packed together and have begun to decay (not piles of leaves in pool areas). <u>Mark as Rare, Common, or Abundant.</u>

✓ **Rocks** ____**Macrophytes** ____**Sticks and leafpacks** ____**Snags and logs** ____**Undercut banks or root mats**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>70% Score	40-70% Score	20-40% Score	<20% Score
4 or 5 types present	20	16	12	8
3 types present	19	15	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

☐ No woody vegetation in riparian zone Remarks__________ Subtotal 17

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) Look at entire reach for substrate scoring, but only look at riffle for embeddedness, and use rocks from all parts of riffle-look for "mud line" or difficulty extracting rocks.

	Score
A. substrate with good mix of gravel, cobble and boulders	
1. embeddedness <20% (very little sand, usually only behind large boulders)	15
2. embeddedness 20-40%	12
3. embeddedness 40-80%	8
4. embeddedness >80%	3
B. substrate gravel and cobble	
1. embeddedness <20%	14
2. embeddedness 20-40%	11
3. embeddedness 40-80%	6
4. embeddedness >80%	2
C. substrate mostly gravel	
1. embeddedness <50%	8
2. embeddedness >50%	4
D. substrate homogeneous	
1. substrate nearly all bedrock	3
2. substrate nearly all sand	3
3. substrate nearly all detritus	2
4. substrate nearly all silt/ clay	1

Remarks__________ Subtotal 14

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams, or side eddies.

	Score
A. Pools present	
1. Pools Frequent (>30% of 200m area surveyed)	
a. variety of pool sizes	10
b. pools about the same size (indicates pools filling in)	8

2. Pools Infrequent (<30% of the 200m area surveyed)
   a. variety of pool sizes.. 6
   b. pools about the same size.. 4

B. Pools absent.. 0

Subtotal 6

☐ Pool bottom boulder-cobble=hard ☐ Bottom sandy-sink as you walk ☑ Silt bottom ☐ Some pools over wader depth

Remarks gravel in pools

Page Total 42

V. Riffle Habitats

Definition: Riffle is area of reaeration-can be debris dam, or narrow channel area.

	Riffles Frequent Score	Riffles Infrequent Score
A. well defined riffle and run, riffle as wide as stream and extends 2X width of stream....	16	12
B. riffle as wide as stream but riffle length is not 2X stream width	14	7
C. riffle not as wide as stream and riffle length is not 2X stream width	10	3
D. riffles absent..	0	

Channel Slope: ☑Typical for area ☐Steep=fast flow ☐Low=like a coastal stream

Subtotal 16

VI. Bank Stability and Vegetation

A. Erosion

1. No, or very little, erosion present 7
2. Erosion mostly at outside of meanders................................ 6
3. Less than 50% of banks eroding... 3
4. Massive erosion.. 0

Erosion Score 6

B. Bank Vegetation

1. Mostly mature trees (>12" DBH) present.............................. 7
2. Mostly small trees (<12" DBH) present, large trees rare 5
3. No trees on bank, can have some shrubs and grasses 3
4. Mostly grasses or mosses on bank....................................... 2
5. Little or no bank vegetation, bare soil everywhere............... 0

Vegetation Score 3

Remarks

Subtotal 9

VII. Light Penetration Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead. Note shading from mountains, but not use to score this metric.

	Score
A. Stream with **good** canopy with some breaks for light penetration	10
B. Stream with **full canopy** - breaks for light penetration absent..	8
C. Stream with **partial** canopy - sunlight and shading are essentially equal................................	7
D. Stream with **minimal** canopy - full sun in all but a few areas..	2
E. **No canopy** and no shading..	0

Remarks ______________________________ Subtotal 7

VIII. Riparian Vegetative Zone Width

Definition: Riparian zone for this form is area of natural vegetation adjacent to stream (can go beyond floodplain). Definition: A break in the riparian zone is any place on the stream banks which allows sediment or pollutants to directly enter the stream, such as paths down to stream, storm drains, uprooted trees, otter slides, etc.

FACE UPSTREAM

Dominant vegetation: ☑ Trees ☐ Shrubs ☐ Grasses ☐ Weeds/old field ☐ Exotics (kudzu, etc)

	Lft. Bank Score	Rt. Bank Score
A. Riparian zone intact (no breaks)		
1. width > 18 meters	5	5
2. width 12-18 meters	4	4
3. width 6-12 meters	3	3
4. width < 6 meters	2	2
B. Riparian zone not intact (breaks)		
1. breaks rare		
a. width > 18 meters	4	4
b. width 12-18 meters	3	3
c. width 6-12 meters	2	2
d. width < 6 meters	1	1
2. breaks common		
a. width > 18 meters	3	3
b. width 12-18 meters	2	2
c. width 6-12 meters	1	1
d. width < 6 meters	0	0

Remarks ______________________________ Subtotal 0

Page Total 32

☐ Disclaimer-form filled out, but score doesn't match subjective opinion-atypical stream.

TOTAL SCORE 74

11/13 Revision 8

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Branch, DWR **TOTAL SCORE** 80

Directions for use: The observer is to survey a **minimum of 100 meters with 200 meters preferred** of stream, preferably in an upstream direction starting above the bridge pool and the road right-of-way. The segment which is assessed should represent average stream conditions. To perform a proper habitat evaluation the observer needs to get into the stream. To complete the form, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. A final habitat score is determined by adding the results from the different metrics.

Stream UT to Horne Creek - R4 Location/road: Pinnacle, NC (Road Name Kiger Rd.)County Surry

Date 6-4-18 **CC#** ______ **Basin** Yadkin **Subbasin** HUC 03040101

Observer(s) JM, JMB Type of Study: ☐ Fish ☑ Benthos ☐ Basinwide ☐ Special Study (Describe) ______

Latitude 36.282908° Longitude -80.503651° Ecoregion: ☐ MT ☑ P ☐ Slate Belt ☐ Triassic Basin

Water Quality: Temperature 19.2 °C DO 7.2 mg/l Conductivity (corr.) 69.9 µS/cm pH 6.91

Physical Characterization: Visible land use refers to immediate area that you can see from sampling location - include what you estimate driving thru the watershed in watershed land use.

Visible Land Use: 20 %Forest 5 %Residential 60 %Active Pasture 15 % Active Crops ____ %Fallow Fields ____ % Commercial ____ %Industrial ____ %Other - Describe: ______

Watershed land use : ☑ Forest ☑ Agriculture ☐ Urban ☑ Animal operations upstream

Width: (meters) Stream 2m Channel (at top of bank) 4m **Stream Depth:** (m) Avg 0.1 Max 0.2
☐ Width variable ☐ Large river >25m wide

Bank Height (from deepest part of riffle to top of bank-first flat surface you stand on): (m) 1

Bank Angle: 45 ° or ☐ NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)

☐ Channelized Ditch
☐ Deeply incised-steep, straight banks ☐ Both banks undercut at bend ☐ Channel filled in with sediment
☐ Recent overbank deposits ☐ Bar development ☐ Buried structures ☐ Exposed bedrock

☐ Excessive periphyton growth ☐ Heavy filamentous algae growth ☐Green tinge ☐ Sewage smell
Manmade Stabilization: ☒N ☐Y: ☐Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐Berm/levee
Flow conditions : ☐High ☒Normal ☐Low
Turbidity: ☒Clear ☐ Slightly Turbid ☐Turbid ☐Tannic ☐Milky ☐Colored (from dyes)
Good potential for Wetlands Restoration Project?? ☐ **YES** ☒**NO Details**____________

____

Channel Flow Status

Useful especially under abnormal or low flow conditions.

A. Water reaches base of both lower banks, minimal channel substrate exposed .... ☐
B. Water fills >75% of available channel, or <25% of channel substrate is exposed........................ ☐
C. Water fills 25-75% of available channel, many logs/snags exposed.. ☒
D. Root mats out of water.. ☐
E. Very little water in channel, mostly present as standing pools.. ☐

Weather Conditions: Clear, 80°F **Photos:** ☐N ☐Y ☐ Digital ☐35mm

Remarks:______________________________

I. Channel Modification Score

A. channel natural, frequent bends.. 5
B. channel natural, infrequent bends (channelization could be old).. 4
C. some channelization present.. 3
D. more extensive channelization, >40% of stream disrupted... 2
E. no bends, completely channelized or rip rapped or gabioned, etc.. 0

☐ Evidence of dredging ☐Evidence of desnagging=no large woody debris in stream ☐Banks of uniform shape/height
Remarks____________________ Subtotal 5

II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. If >70% of the reach is rocks, 1 type is present, circle the score of 17. Definition: leafpacks consist of older leaves that are packed together and have begun to decay (not piles of leaves in pool areas). Mark as Rare, Common, or Abundant.

✓ **Rocks** ___**Macrophytes** ___**Sticks and leafpacks** ___**Snags and logs** ✓ **Undercut banks or root mats**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>70% Score	40-70% Score	20-40% Score	<20% Score
4 or 5 types present	20	16	12	8
3 types present	19	15	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

☐ No woody vegetation in riparian zone Remarks__________ Subtotal 14

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) Look at entire reach for substrate scoring, but only look at riffle for embeddedness, and use rocks from all parts of riffle-look for "mud line" or difficulty extracting rocks.

	Score
A. substrate with good mix of gravel, cobble and boulders	
1. embeddedness <20% (very little sand, usually only behind large boulders)	15
2. embeddedness 20-40%	12
3. embeddedness 40-80%	8
4. embeddedness >80%	3
B. substrate gravel and cobble	
1. embeddedness <20%	14
2. embeddedness 20-40%	11
3. embeddedness 40-80%	6
4. embeddedness >80%	2
C. substrate mostly gravel	
1. embeddedness <50%	8
2. embeddedness >50%	4
D. substrate homogeneous	
1. substrate nearly all bedrock	3
2. substrate nearly all sand	3
3. substrate nearly all detritus	2
4. substrate nearly all silt/ clay	1

Remarks__________ Subtotal 11

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams, or side eddies.

	Score
A. Pools present	
1. Pools Frequent (>30% of 200m area surveyed)	
a. variety of pool sizes	10
b. pools about the same size (indicates pools filling in)	8

2. Pools Infrequent (<30% of the 200m area surveyed)
   a. variety of pool sizes.. 6
   b. pools about the same size.. 4

B. Pools absent.. 0

Subtotal 10

☐ Pool bottom boulder-cobble=hard ☑ Bottom sandy-sink as you walk ☐ Silt bottom ☐ Some pools over wader depth

Remarks ____________________

Page Total 40

V. Riffle Habitats

Definition: Riffle is area of reaeration-can be debris dam, or narrow channel area.

	Riffles Frequent Score	Riffles Infrequent Score
A. well defined riffle and run, riffle as wide as stream and extends 2X width of stream....	16	12
B. riffle as wide as stream but riffle length is not 2X stream width	14	7
C. riffle not as wide as stream and riffle length is not 2X stream width	10	3
D. riffles absent........	0	

Channel Slope: ☐Typical for area ☐Steep=fast flow ☐Low=like a coastal stream

Subtotal 16

VI. Bank Stability and Vegetation

A. Erosion

1. No, or very little, erosion present 7
2. Erosion mostly at outside of meanders 6
3. Less than 50% of banks eroding 3
4. Massive erosion 0

Erosion Score 7

B. Bank Vegetation

1. Mostly mature trees (>12" DBH) present 7
2. Mostly small trees (<12" DBH) present, large trees rare 5
3. No trees on bank, can have some shrubs and grasses 3
4. Mostly grasses or mosses on bank 2
5. Little or no bank vegetation, bare soil everywhere............... 0

Vegetation Score 5

Remarks ____________________ Subtotal 12

VII. Light Penetration Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead. Note shading from mountains, but not use to score this metric.

	Score
A. Stream with **good** canopy with some breaks for light penetration	10
B. Stream with **full canopy** - breaks for light penetration absent........	8
C. Stream with **partial** canopy - sunlight and shading are essentially equal........	7
D. Stream with **minimal** canopy - full sun in all but a few areas........	2
E. **No canopy** and no shading........	0

Remarks____________________________ Subtotal 8

VIII. Riparian Vegetative Zone Width

Definition: Riparian zone for this form is area of natural vegetation adjacent to stream (can go beyond floodplain). Definition: A break in the riparian zone is any place on the stream banks which allows sediment or pollutants to directly enter the stream, such as paths down to stream, storm drains, uprooted trees, otter slides, etc.

FACE UPSTREAM

Dominant vegetation: ☐ Trees ☐ Shrubs ☐ Grasses ☐ Weeds/old field ☑ Exotics (kudzu, etc)

	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. width > 18 meters	5	5
2. width 12-18 meters	4	4
3. width 6-12 meters	3	3
4. width < 6 meters	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. width > 18 meters	4	4
b. width 12-18 meters	3	3
c. width 6-12 meters	2	2
d. width < 6 meters	1	1
2. breaks common		
a. width > 18 meters	3	3
b. width 12-18 meters	2	2
c. width 6-12 meters	1	1
d. width < 6 meters	0	0

Remarks____________________________ Subtotal 4

Page Total 40

☐ Disclaimer-form filled out, but score doesn't match subjective opinion-atypical stream. **TOTAL SCORE** 80

Taxa / Biotic Index Value	**Horne 1**	**Horne 2**
EPHEMEROPTERA		
Family Baetidae		
Baetis flavistriga (6.8)		
Baetis pluto (3.4)		C
Diphetor hageni (1.1)		R
Family Caenidae		
Caenis spp (6.8)		
Family Ephemerellidae		
Telagonopsis deficiens (2.6)		
Family Heptageniidae		
Leucrocuta spp (2.0)		
Maccaffertium modestum (5.7)		A
Family Leptophlebiidae		
Habrophlebia vibrans (0.3)		R
Habrophleboides spp		C
Paraleptophlebia spp (1.2)		A
PLECOPTERA		
Family Perlidae		
Agnetina flavescens (1.1)		R
Eccoptura xanthenes (4.7)		C
Isoperla holochlora (1.2)		
TRICHOPTERA		
Family Glossosomatidae		
Glossoma spp (1.4)		
Family Hydropsychidae		
Cheumatopsyche spp (6.6)		A
Diplectrona modesta (2.3)		C
Hydropsyche betteni (7.9)	R	C
Family Limnephilidae		
Neophylax atlanta (1.6)		R
Family Odontoceridae		
Psilotreta spp (0.5)		R
Family Philopotamidae		
Chimarra spp (3.3)		A
Family Rhyacophilidae		
Rhyacophila carolina (0.4)		R
MISC DIPTERA		
Family Culicidae		
Aedes spp	R	
Anopheles (8.6)	R	
Culex spp	R	
Family Dixidae		
Dixa spp (2.5)	R	C
Family Simuliidae		
Simulium spp (4.9)	A	R
Family Tabanidae		

Chrysops (6.7)		
Family Tipulidae		
Dicranota spp (0)		R
Hexatoma spp (3.5)		
Tipula spp (7.5)	R	A
DIPTERA; CHIRONOMIDAE		
Chironomus spp (9.3)	A	
Corynoneura spp (5.7)		
Cricotopus bicintus (C/O sp 1) (8.7)		
Eukieferiella claripennis (6.2)	R	
Limnophyes spp		R
Micropsectra polita (2.4)	C	
Microtendipes pedellus (3.9)		
Nilotanypus fimbratus (4.9)		
Parametriocnemus lundbecki (3.7)		
Phaenopscetra obediens gp (6.6)		
Polypedilum aviceps (3.6)	R	R
Polypedilum fallax (6.5)		
Polypedilum flavum (5.7)		R
Polypedilum illinoense (8.7)		R
Polypedilum tritum		
Psectrotanypus dyari (10)		
Rheocricotpus glabricolis (4.7)		R
Rheotanytarsus spp (6.5)		R
Stictochironomus devinctus (5.4)		
Tanytarsus acifer/buckleyi (6.6)		R
Thienemaniella spp (6.4)		
Thienemannimyia group (8.4)	R	C
Tvetenia bavarica gp (E sp 1) (3.6)		
Zavrelimyia spp (6.1)	R	
COLEOPTERA		
Family Dryopidae		
Helichus spp (4.1)		R
Family Dytiscidae		
Neoporus spp (5.0)		
Platambus spp		
Prodaticus spp	R	
Family Elmidae		
Stenelmis spp (5.6)		C
Family Hydrophilidae		
Cymbiodyta spp	R	
Family Psephenidae		
Psephenus herricki (2.3)		
Family Ptilodactylidae		
Anchytarsus bicolor (2.4)		A
ODONATA		
Family Aeshnidae		

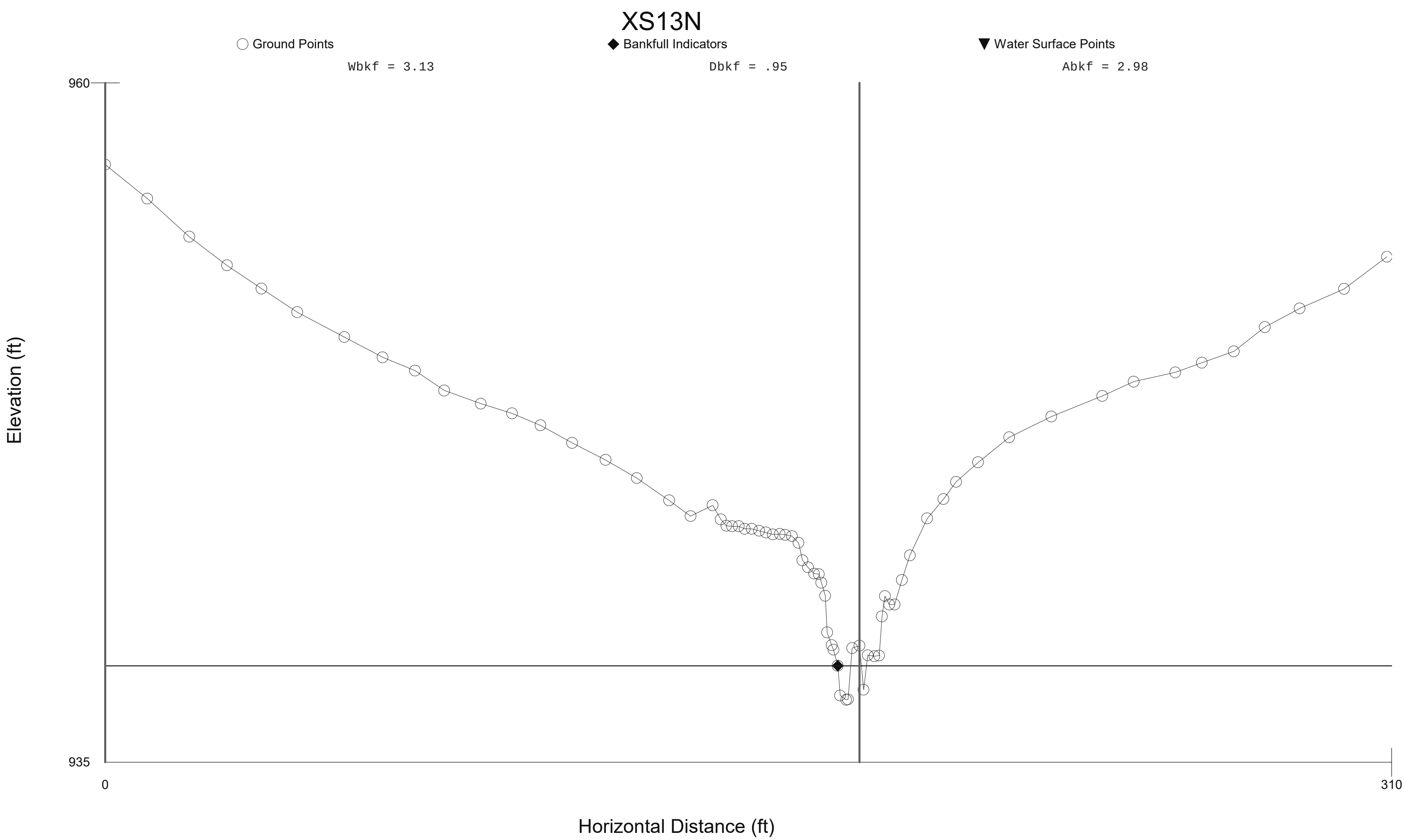
Boyeria vinosa (5.6)		R
Family Calopterygidae		
Calopteryx spp (7.5)		R
Family Cordulegasteridae		
Cordulegaster spp (5.7)		R
Family Gomphidae		
Gomphus spp (5.9)		
Stylogomphus albistylus (5.0)		
OLIGOCHAETA		
Family Lumbriculidae (7.0)		R
Family Naidae		
Nais spp (8.7)		R
Pristina spp (7.7)		R
Slavina appendiculata (8.4)		
MEGALOPTERA		
Family Corydalidae		
Nigronia fasciatus (6.1)		R
CRUSTACEA		
Family Asellidae		
Caecidotea spp (8.4)		
MOLLUSCA		
Family Ancylidae		
Ferrissia spp (6.6)		
Family Pleuroceridae		
Elimia spp (2.7)		C
OTHER TAXA		
Family Planariidae		
Dugesia tigrina (7.1)		
Total Taxa Richness	15	38
EPT Taxa Richness	1	15
EPT Abundance	1	61
Biotic Index	6.53	4.99

RIVERMORPH STREAM CHANNEL CLASSIFICATION

River Name: Horne Creek
Reach Name: Horne Creek <-- This is not a Reference Reach
Drainage Area: 0.059 sq mi
State: North Carolina
County: Surry
Latitude: 36.2841
Longitude: 80.5036
Survey Date: 11/21/2017

Classification Data

Valley Type:	Type VIII(a)
Valley Slope:	0.0366 ft/ft
Number of Channels:	Single
Width:	3.13 ft
Mean Depth:	0.95 ft
Flood-Prone Width:	12.95 ft
Channel Materials D50:	0.39 mm
Water Surface Slope:	0.0326 ft/ft
Sinuosity:	1.12
Discharge:	12 cfs
Velocity:	4.03 fps
Cross Sectional Area:	2.98 sq ft
Entrenchment Ratio:	4.14
Width to Depth Ratio:	3.29
Rosgen Stream Classification:	E 5b

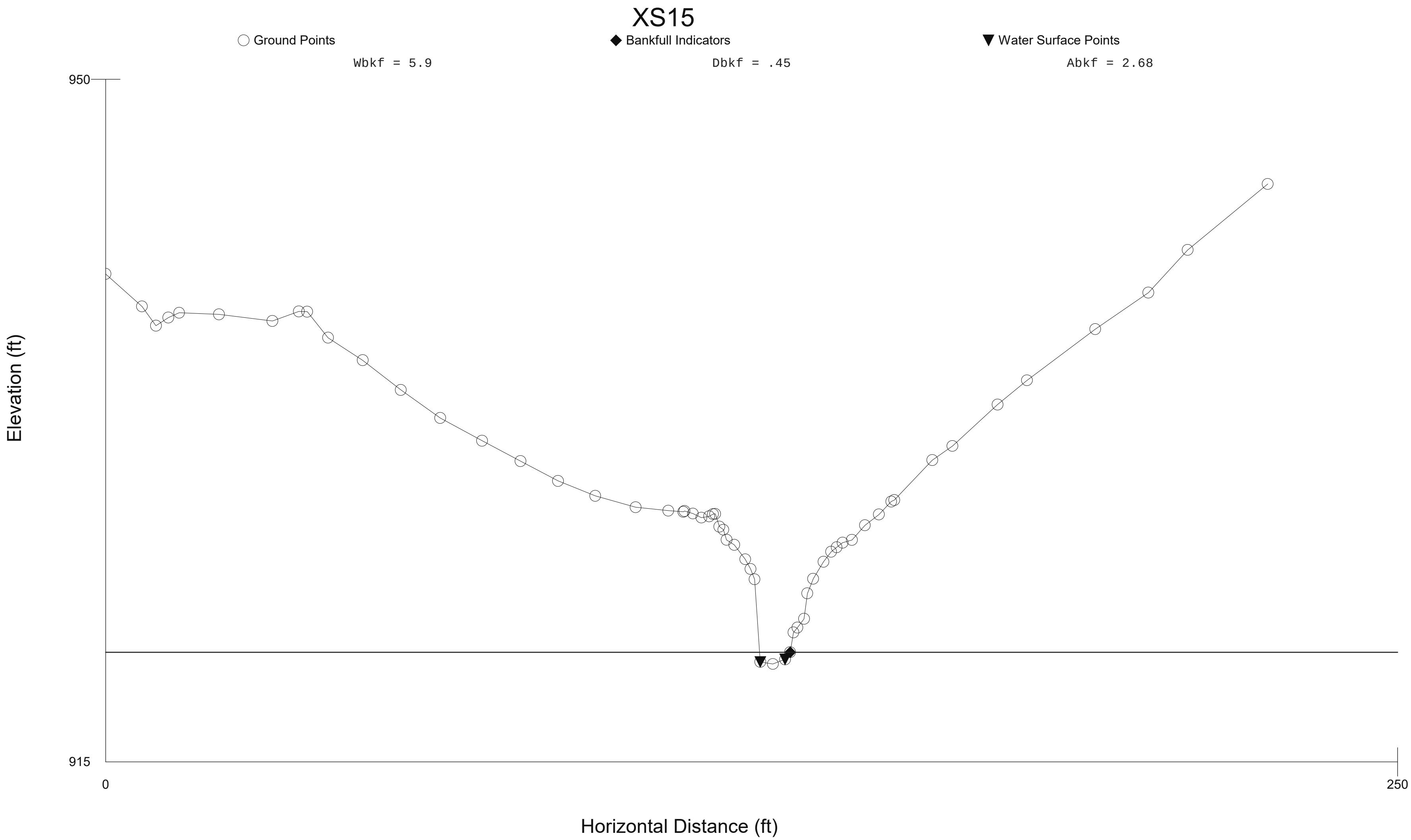

XS13N
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 3.13
Dbkf = .95
Abkf = 2.98
960
935
0
310
Elevation (ft)
Horizontal Distance (ft)

RIVERMORPH STREAM CHANNEL CLASSIFICATION

River Name:	Horne Creek
Reach Name:	Horne Creek <-- This is not a Reference Reach
Drainage Area:	0.059 sq mi
State:	North Carolina
County:	Surry
Latitude:	36.2841
Longitude:	80.5036
Survey Date:	11/21/2017

Classification Data

Valley Type:	Type VIII(a)
Valley Slope:	0.0366 ft/ft
Number of Channels:	Single
Width:	5.9 ft
Mean Depth:	0.45 ft
Flood-Prone Width:	6.44 ft
Channel Materials D50:	0.39 mm
Water Surface Slope:	0.0326 ft/ft
Sinuosity:	1.12
Discharge:	12 cfs
Velocity:	4.48 fps
Cross Sectional Area:	2.68 sq ft
Entrenchment Ratio:	1.09
Width to Depth Ratio:	13.11
Rosgen Stream Classification:	F 5b

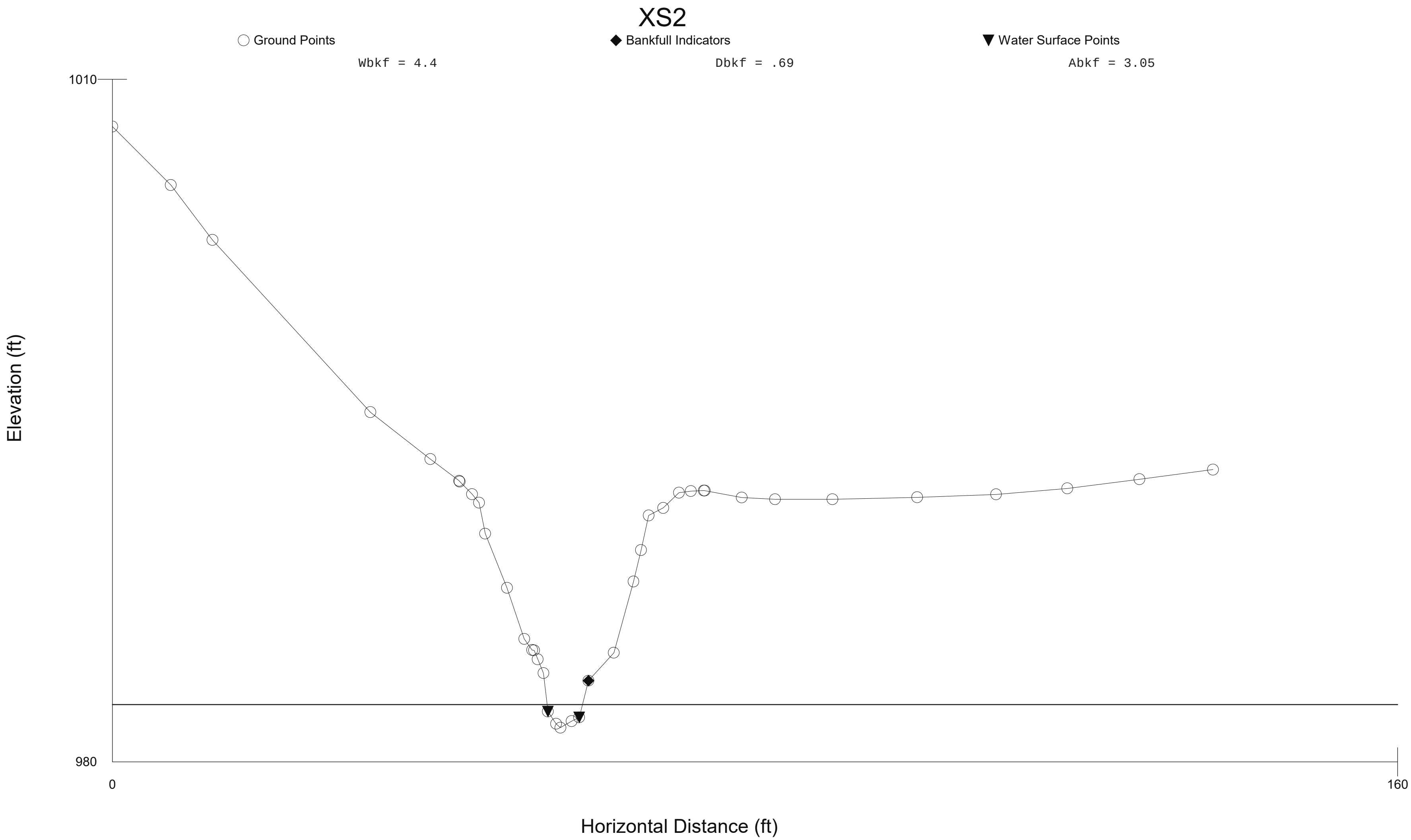

XS15
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 5.9
Dbkf = .45
Abkf = 2.68
950
915
0
250
Elevation (ft)
Horizontal Distance (ft)

RIVERMORPH STREAM CHANNEL CLASSIFICATION

River Name: Horne Creek
Reach Name: Horne Creek <-- This is not a Reference Reach
Drainage Area: 0.0642 sq mi
State: North Carolina
County: Surry
Latitude: 36.2841
Longitude: 80.5036
Survey Date: 11/21/2017

Classification Data

Valley Type:	Type VIII(a)
Valley Slope:	0.0325 ft/ft
Number of Channels:	Single
Width:	4.4 ft
Mean Depth:	0.69 ft
Flood-Prone Width:	5.46 ft
Channel Materials D50:	6.04 mm
Water Surface Slope:	0.0301 ft/ft
Sinuosity:	1.08
Discharge:	12 cfs
Velocity:	3.93 fps
Cross Sectional Area:	3.05 sq ft
Entrenchment Ratio:	1.24
Width to Depth Ratio:	6.38
Rosgen Stream Classification:	G 4



XS2
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 4.4
Dbkf = .69
Abkf = 3.05
1010
980
0
160
Elevation (ft)
Horizontal Distance (ft)

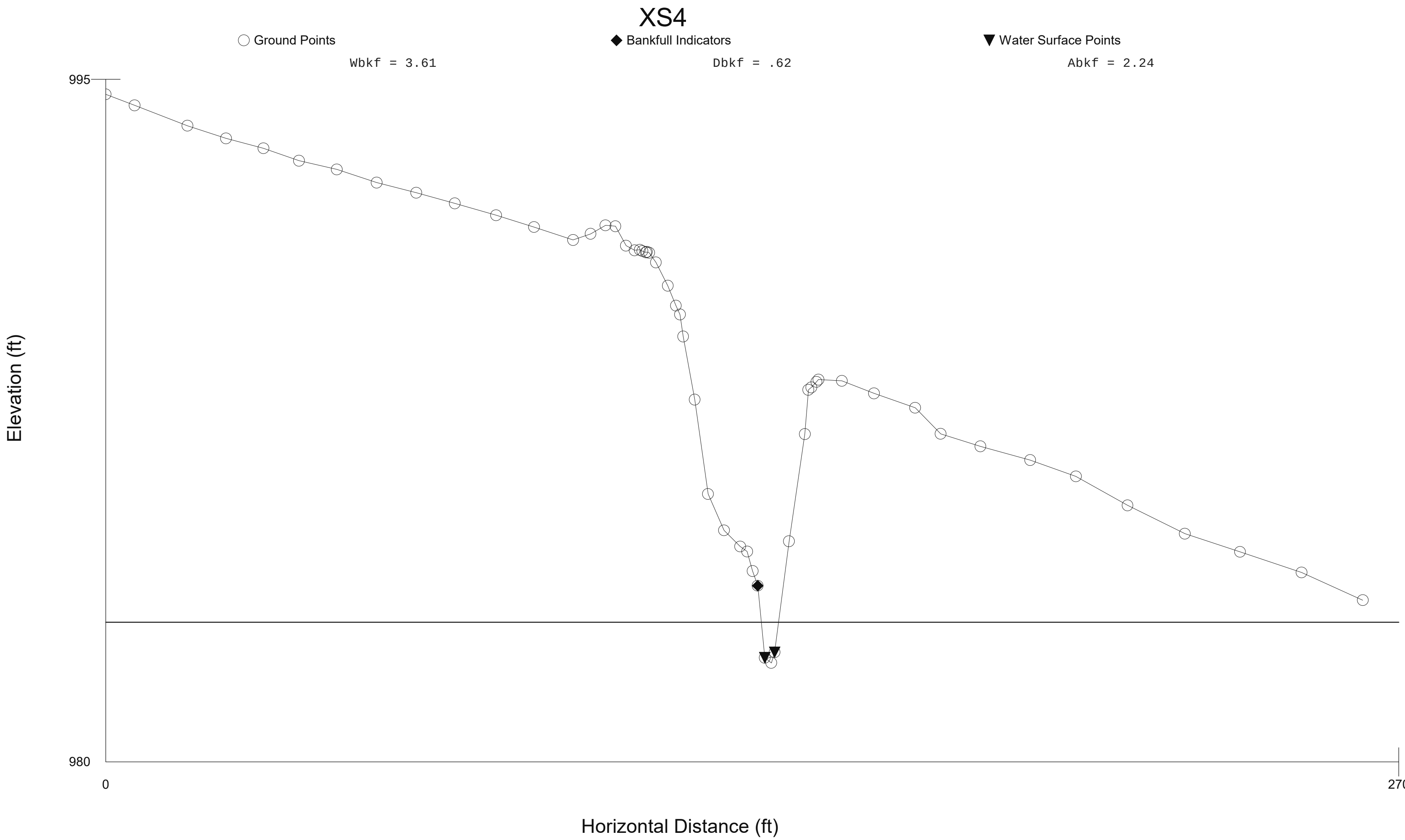
RIVERMORPH STREAM CHANNEL CLASSIFICATION

River Name: Horne Creek
Reach Name: Horne Creek <-- This is not a Reference Reach
Drainage Area: 0.0457 sq mi
State: North Carolina
County: Surry
Latitude: 36.2841
Longitude: 80.5036
Survey Date: 11/21/2017

Classification Data

Valley Type:	Type VIII(a)
Valley Slope:	0.0496 ft/ft
Number of Channels:	Single
Width:	3.61 ft
Mean Depth:	0.62 ft
Flood-Prone Width:	14.42 ft
Channel Materials D50:	0.01 mm
Water Surface Slope:	0.0463 ft/ft
Sinuosity:	1.07
Discharge:	10 cfs
Velocity:	4.46 fps
Cross Sectional Area:	2.24 sq ft
Entrenchment Ratio:	3.99
Width to Depth Ratio:	5.82
Rosgen Stream Classification:	E 6b

Slope is out of range



XS4
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 3.61
Dbkf = .62
Abkf = 2.24
995
980
0
270
Elevation (ft)
Horizontal Distance (ft)

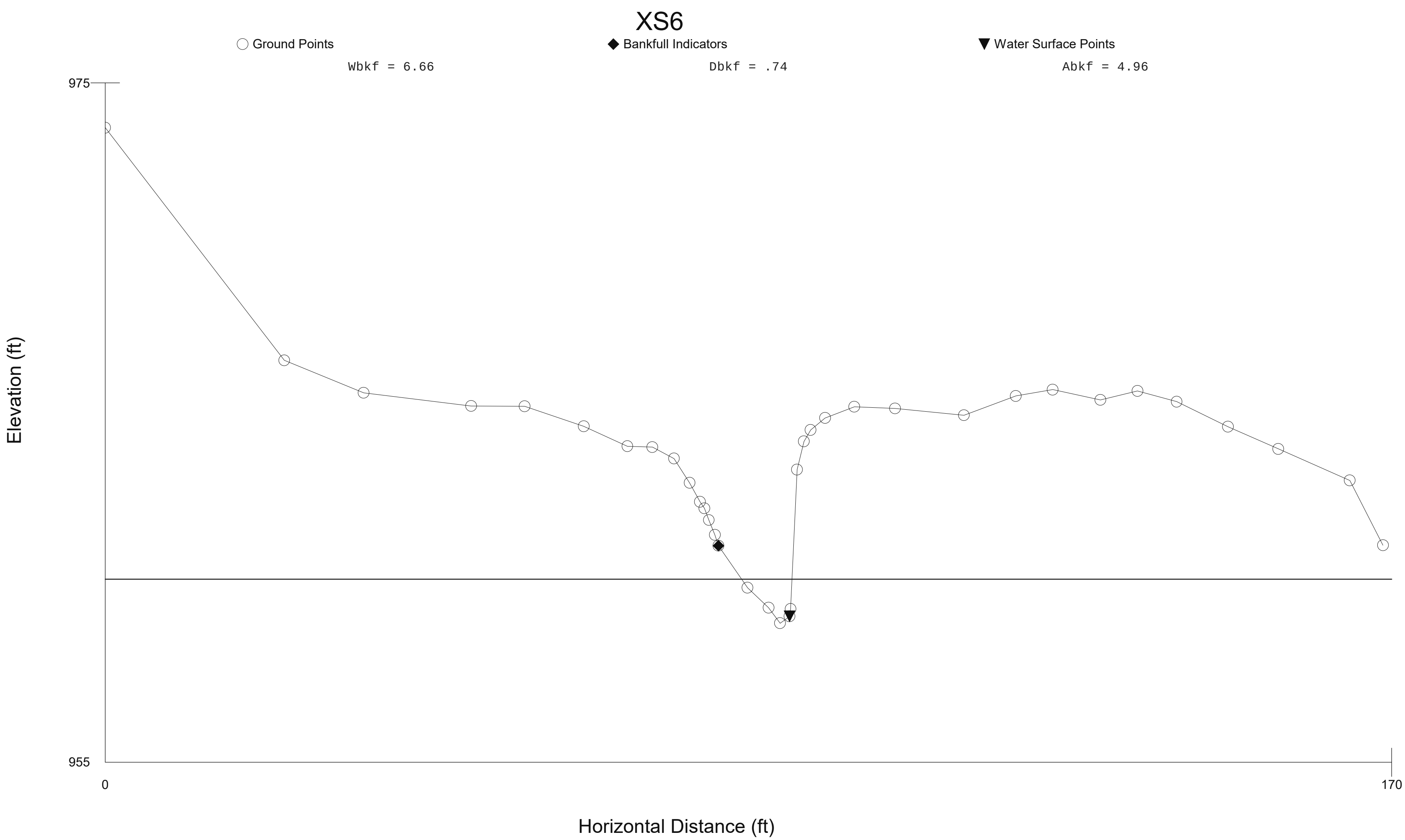
RIVERMORPH STREAM CHANNEL CLASSIFICATION

River Name:	Horne Creek
Reach Name:	Horne Creek <-- This is not a Reference Reach
Drainage Area:	0.13 sq mi
State:	North Carolina
County:	Surry
Latitude:	36.2841
Longitude:	80.5036
Survey Date:	11/21/2017

Classification Data

Valley Type:	Type VIII(a)
Valley Slope:	0.0381 ft/ft
Number of Channels:	Single
Width:	6.66 ft
Mean Depth:	0.74 ft
Flood-Prone Width:	11.13 ft
Channel Materials D50:	17.28 mm
Water Surface Slope:	0.0296 ft/ft
Sinuosity:	1.29
Discharge:	22 cfs
Velocity:	4.44 fps
Cross Sectional Area:	4.96 sq ft
Entrenchment Ratio:	1.67
Width to Depth Ratio:	9
Rosgen Stream Classification:	B 4

W/D is out of range


XS6
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 6.66
Dbkf = .74
Abkf = 4.96
975
955
0
170
Elevation (ft)
Horizontal Distance (ft)

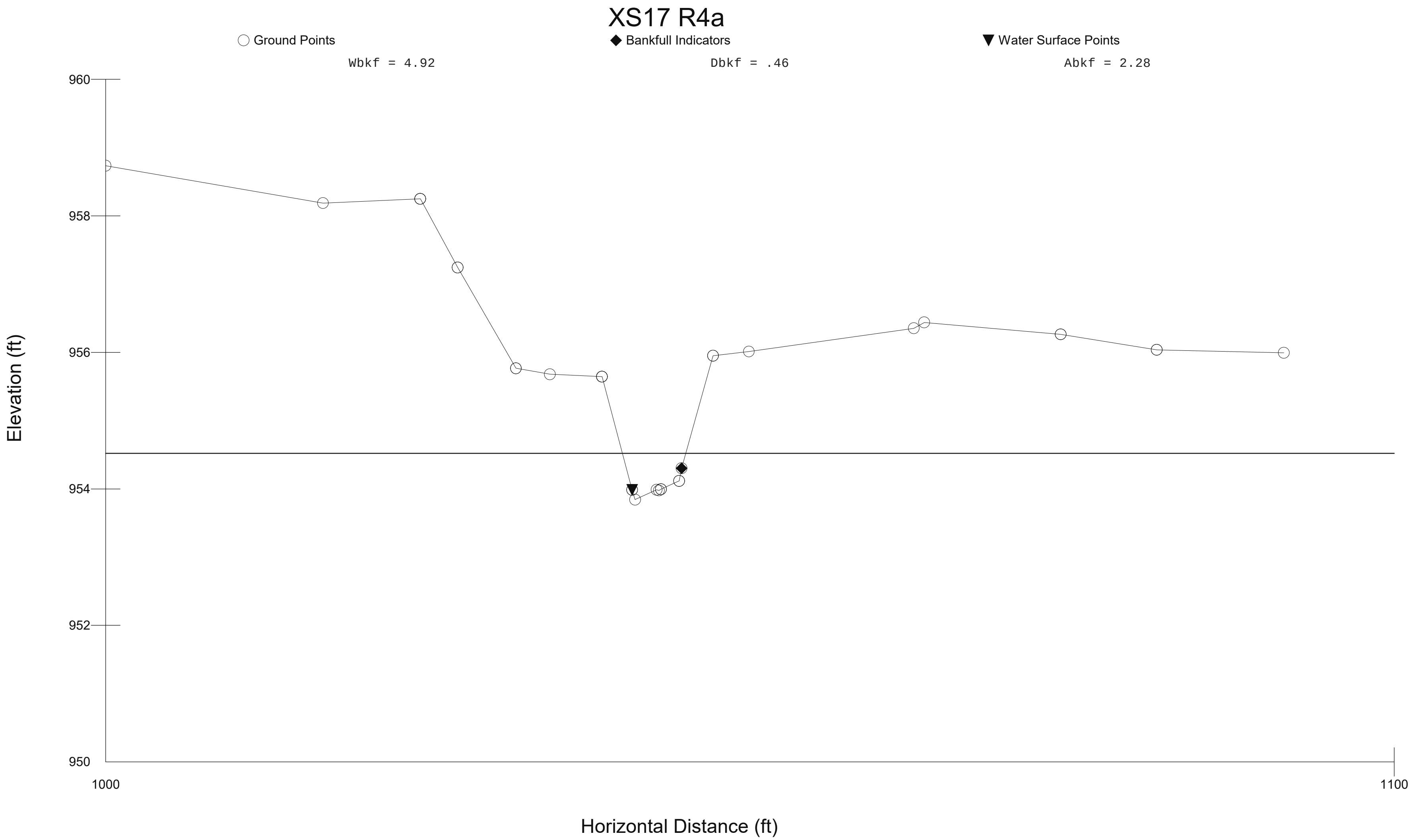
RIVERMORPH STREAM CHANNEL CLASSIFICATION

River Name: Horne Creek
Reach Name: Horne Creek <-- This is not a Reference Reach
Drainage Area: 0.045 sq mi
State: North Carolina
County: Surry
Latitude: 36.2841
Longitude: 80.5036
Survey Date: 11/21/2017

Classification Data

Valley Type:	Type VIII(a)
Valley Slope:	0.0233 ft/ft
Number of Channels:	Single
Width:	4.92 ft
Mean Depth:	0.46 ft
Flood-Prone Width:	6.88 ft
Channel Materials D50:	10 mm
Water Surface Slope:	0.0205 ft/ft
Sinuosity:	1.14
Discharge:	10 cfs
Velocity:	4.39 fps
Cross Sectional Area:	2.28 sq ft
Entrenchment Ratio:	1.4
Width to Depth Ratio:	10.7
Rosgen Stream Classification:	B 4

W/D is out of range

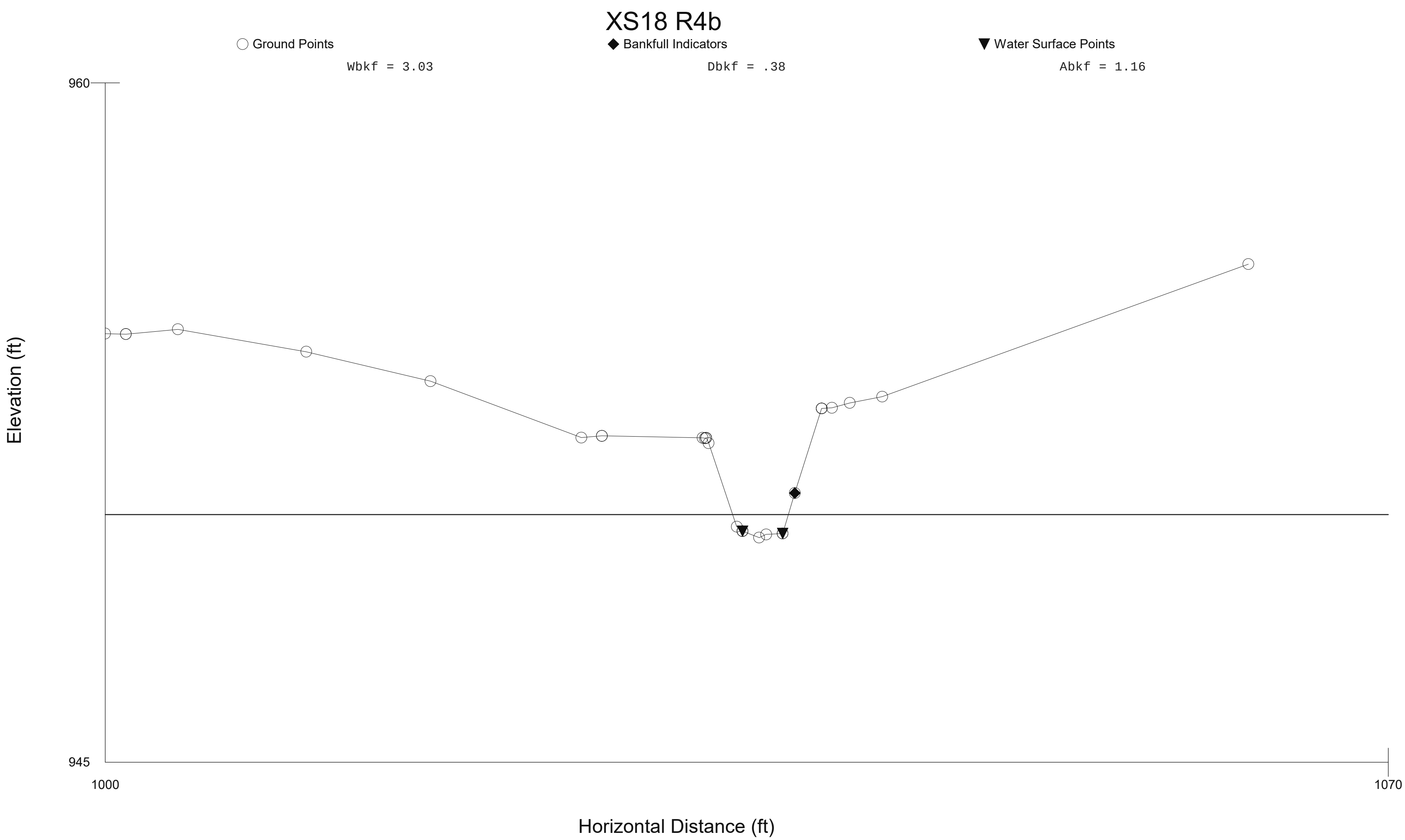

XS17 R4a
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 4.92
Dbkf = .46
Abkf = 2.28
960
958
956
954
952
950
1000
1100
Elevation (ft)
Horizontal Distance (ft)

RIVERMORPH STREAM CHANNEL CLASSIFICATION

River Name: Horne Creek
Reach Name: Horne Creek <-- This is not a Reference Reach
Drainage Area: 0.0026 sq mi
State: North Carolina
County: Surry
Latitude: 36.2841
Longitude: 80.5036
Survey Date: 11/21/2017

Classification Data

Valley Type:	Type VIII(a)
Valley Slope:	0.0262 ft/ft
Number of Channels:	Single
Width:	3.03 ft
Mean Depth:	0.38 ft
Flood-Prone Width:	3.84 ft
Channel Materials D50:	2 mm
Water Surface Slope:	0.0241 ft/ft
Sinuosity:	1.09
Discharge:	4 cfs
Velocity:	3.45 fps
Cross Sectional Area:	1.16 sq ft
Entrenchment Ratio:	1.27
Width to Depth Ratio:	7.97
Rosgen Stream Classification:	G 5


XS18 R4b
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 3.03
Dbkf = .38
Abkf = 1.16
960
945
1000
1070
Elevation (ft)
Horizontal Distance (ft)

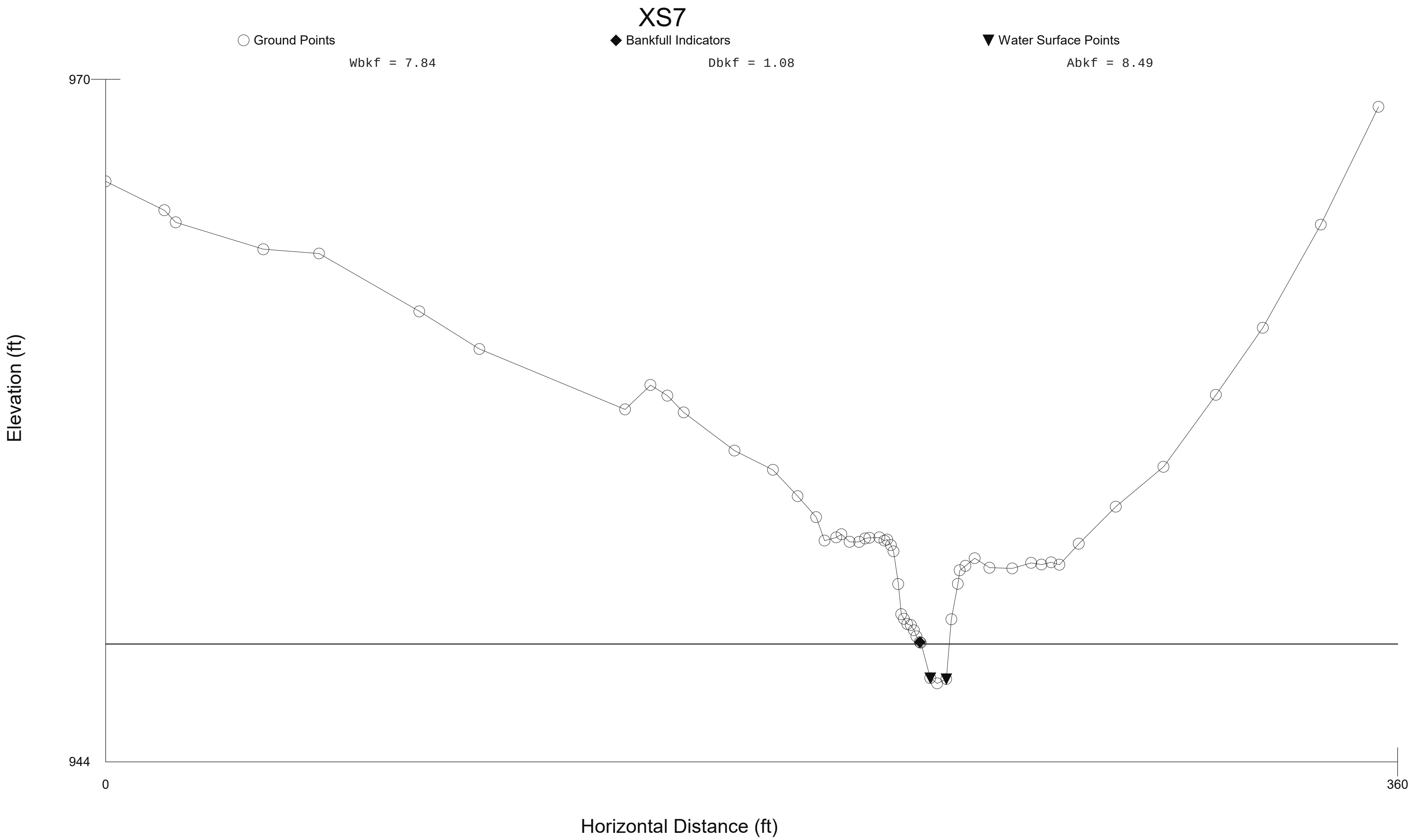
RIVERMORPH STREAM CHANNEL CLASSIFICATION

River Name: Horne Creek
Reach Name: Horne Creek <-- This is not a Reference Reach
Drainage Area: 0.26 sq mi
State: North Carolina
County: Surry
Latitude: 36.2841
Longitude: 80.5036
Survey Date: 11/21/2017

Classification Data

Valley Type:	Type VIII(a)
Valley Slope:	0.0243 ft/ft
Number of Channels:	Single
Width:	7.84 ft
Mean Depth:	1.08 ft
Flood-Prone Width:	14.98 ft
Channel Materials D50:	9.89 mm
Water Surface Slope:	0.0187 ft/ft
Sinuosity:	1.3
Discharge:	27 cfs
Velocity:	3.18 fps
Cross Sectional Area:	8.49 sq ft
Entrenchment Ratio:	1.91
Width to Depth Ratio:	7.26
Rosgen Stream Classification:	B 4c

W/D is out of range

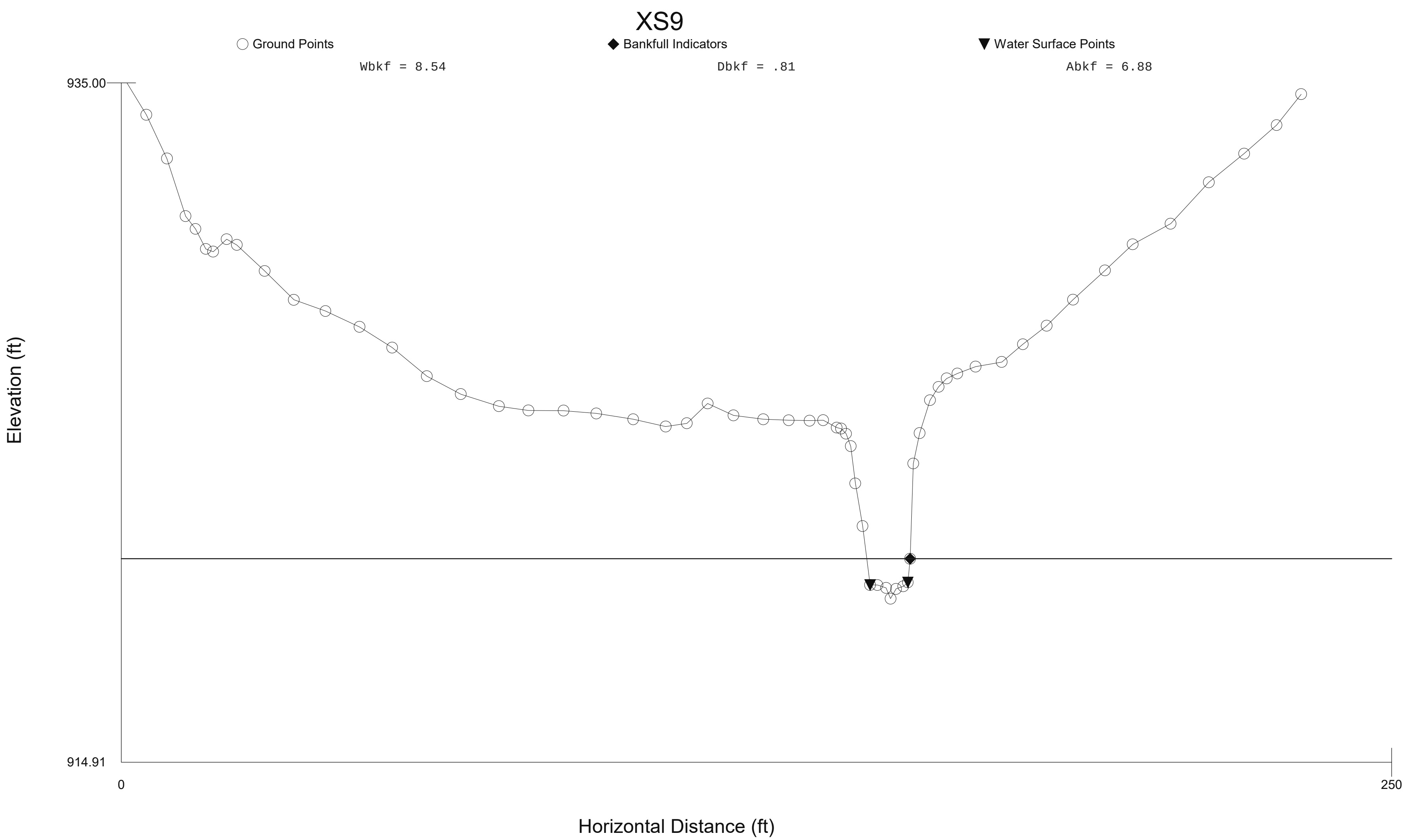

XS7
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 7.84
Dbkf = 1.08
Abkf = 8.49
970
944
0
360
Elevation (ft)
Horizontal Distance (ft)

RIVERMORPH STREAM CHANNEL CLASSIFICATION

River Name: Horne Creek
Reach Name: Horne Creek <-- This is not a Reference Reach
Drainage Area: 0.26 sq mi
State: North Carolina
County: Surry
Latitude: 36.2841
Longitude: 80.5036
Survey Date: 11/21/2017

Classification Data

Valley Type:	Type VIII(a)
Valley Slope:	0.0243 ft/ft
Number of Channels:	Single
Width:	8.54 ft
Mean Depth:	0.81 ft
Flood-Prone Width:	9.87 ft
Channel Materials D50:	9.89 mm
Water Surface Slope:	0.0187 ft/ft
Sinuosity:	1.3
Discharge:	27 cfs
Velocity:	3.92 fps
Cross Sectional Area:	6.88 sq ft
Entrenchment Ratio:	1.16
Width to Depth Ratio:	10.54
Rosgen Stream Classification:	G 4c

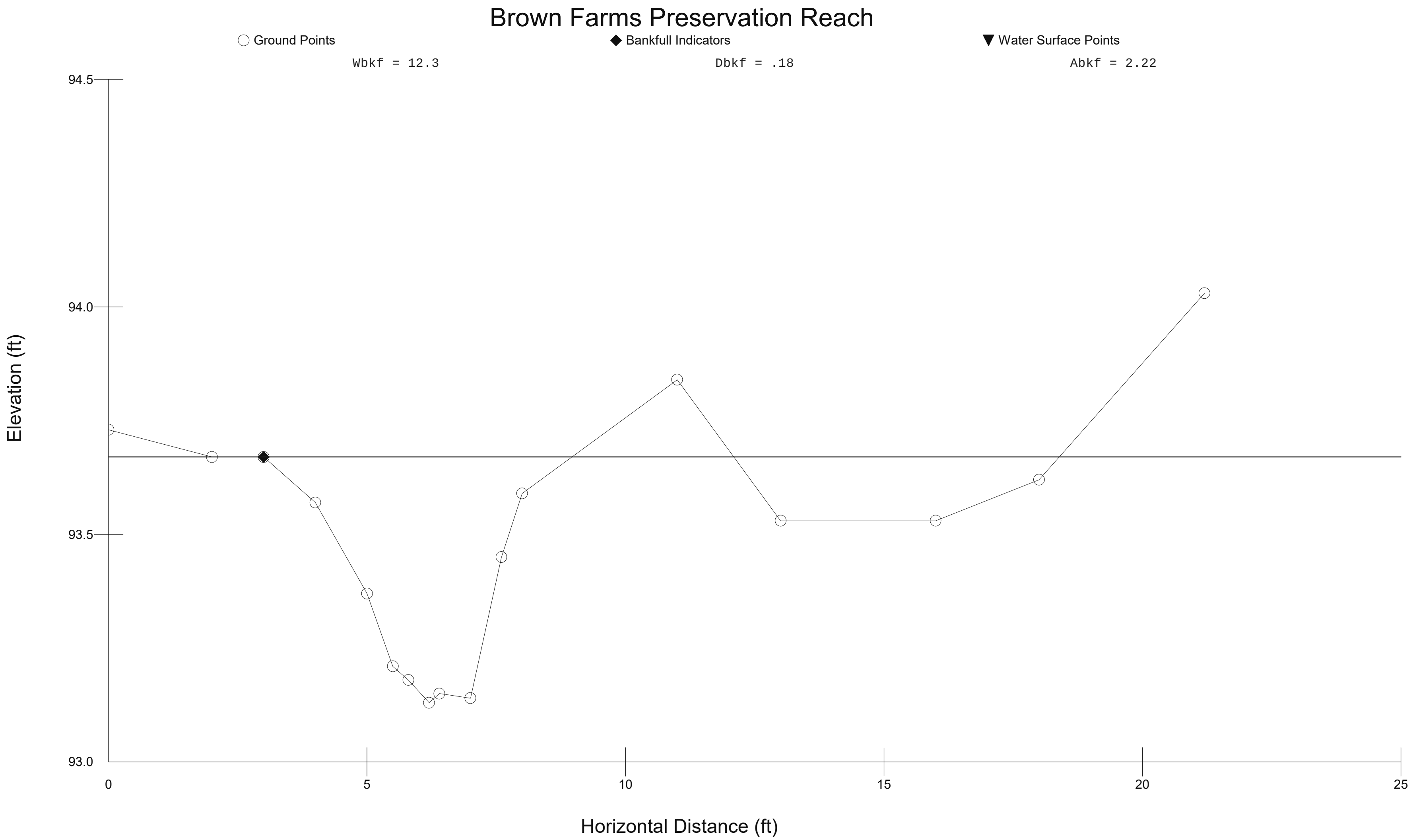

XS9
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 8.54
Dbkf = .81
Abkf = 6.88
935.00
914.91
0
250
Elevation (ft)
Horizontal Distance (ft)

RIVERMORPH STREAM CHANNEL CLASSIFICATION

River Name:	Horne Creek
Reach Name:	Horne Creek <-- This is a Reference Reach
Drainage Area:	0.0518 sq mi
State:	North Carolina
County:	Surry
Latitude:	36.2841
Longitude:	80.5036
Survey Date:	11/21/2017

Classification Data

Valley Type:	Type VIII(a)
Valley Slope:	0.0317 ft/ft
Number of Channels:	Single
Width:	12.25 ft
Mean Depth:	0.18 ft
Flood-Prone Width:	21.2 ft
Channel Materials D50:	3 mm
Water Surface Slope:	0.028 ft/ft
Sinuosity:	1.13
Discharge:	12 cfs
Velocity:	5.41 fps
Cross Sectional Area:	2.22 sq ft
Entrenchment Ratio:	1.73
Width to Depth Ratio:	68.06
Rosgen Stream Classification:	B 4


Brown Farms Preservation Reach
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 12.3
Dbkf = .18
Abkf = 2.22
Elevation (ft)
94.5
94.0
93.5
93.0
0
5
10
15
20
25
Horizontal Distance (ft)

RIVERMORPH STREAM CHANNEL CLASSIFICATION

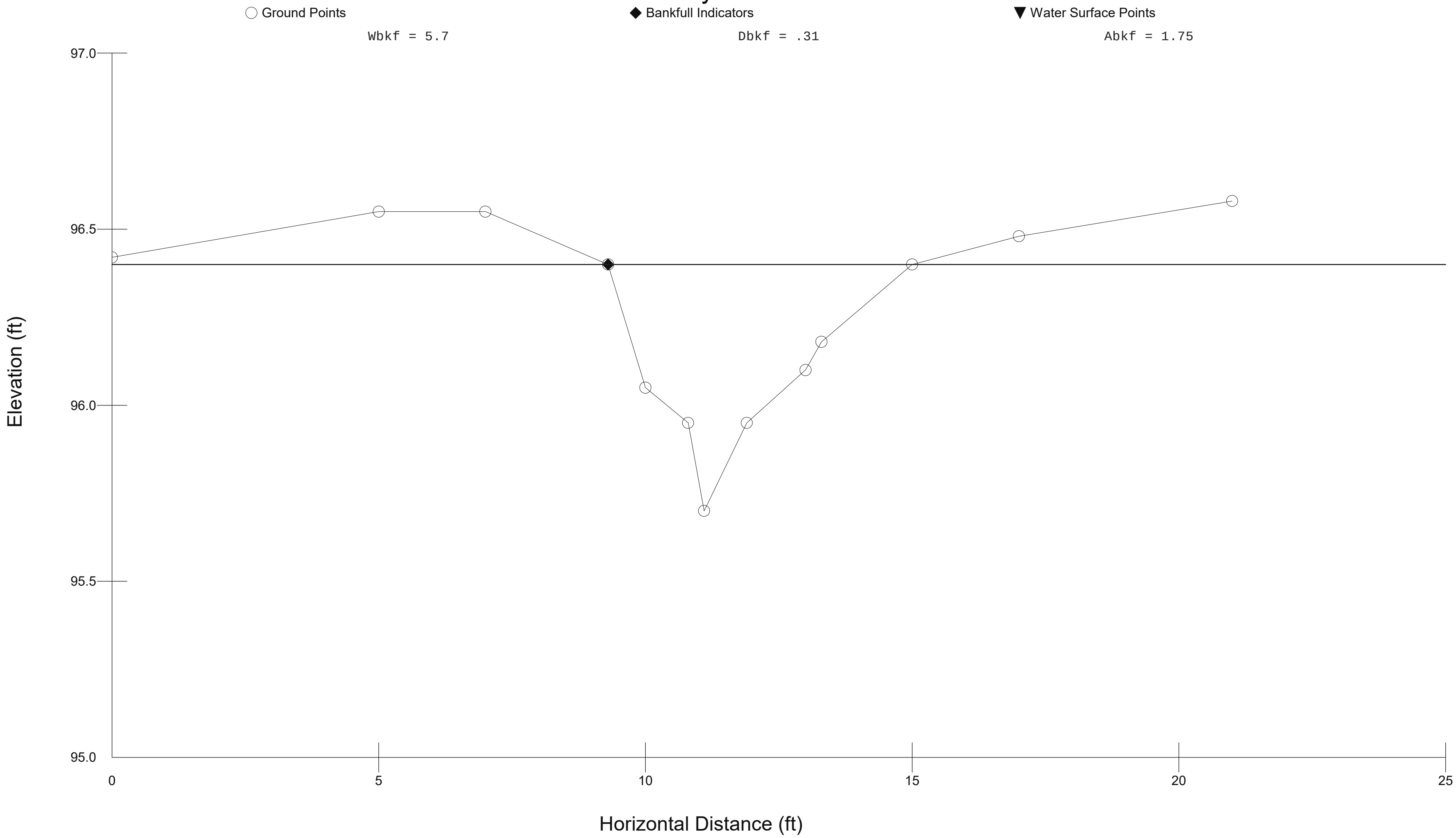
River Name: Horne Creek
Reach Name: Horne Creek <-- This is not a Reference Reach
Drainage Area: 0.0568 sq mi
State: North Carolina
County: Surry
Latitude: 36.2841
Longitude: 80.5036
Survey Date: 11/21/2017

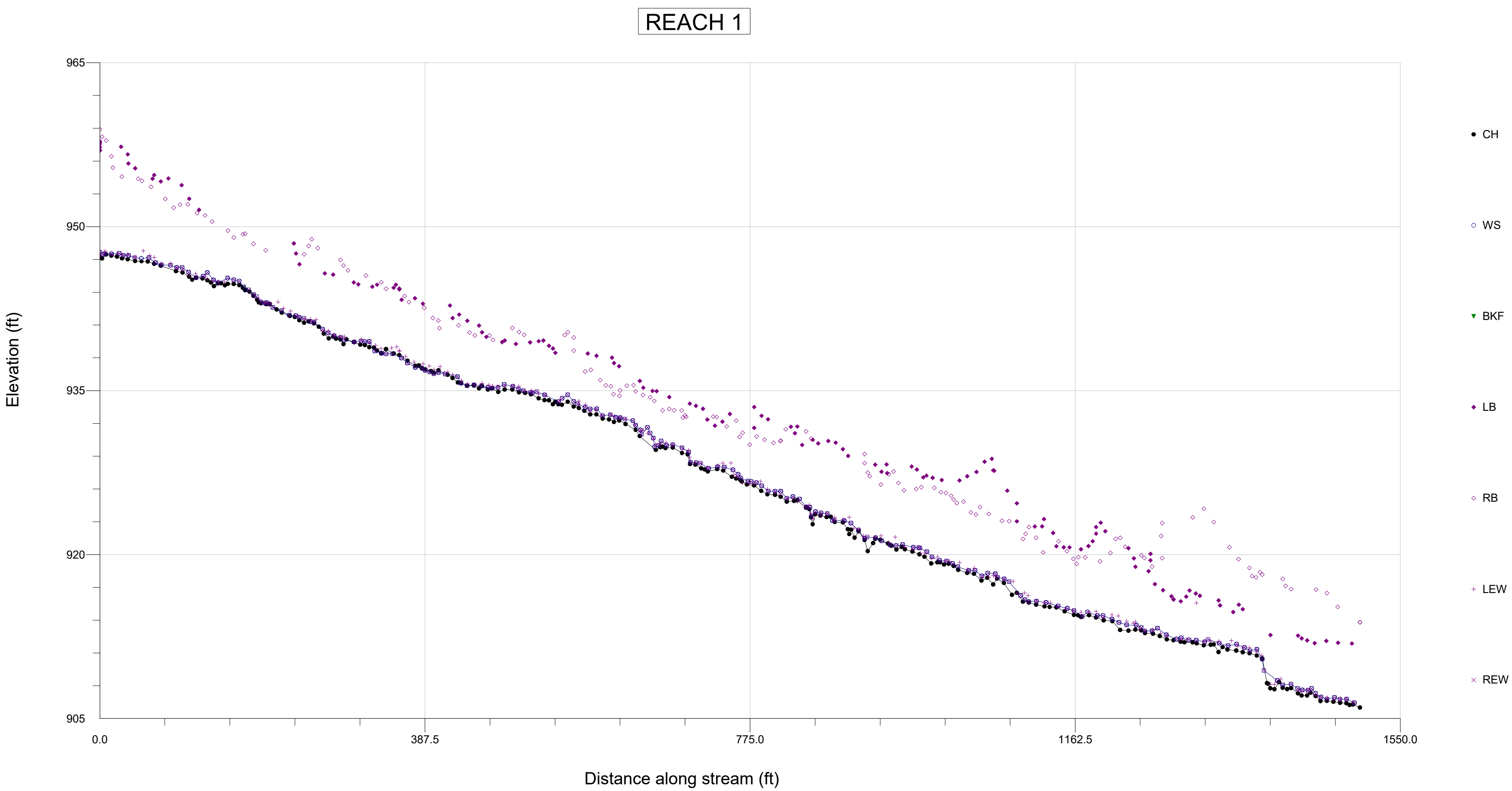
Classification Data

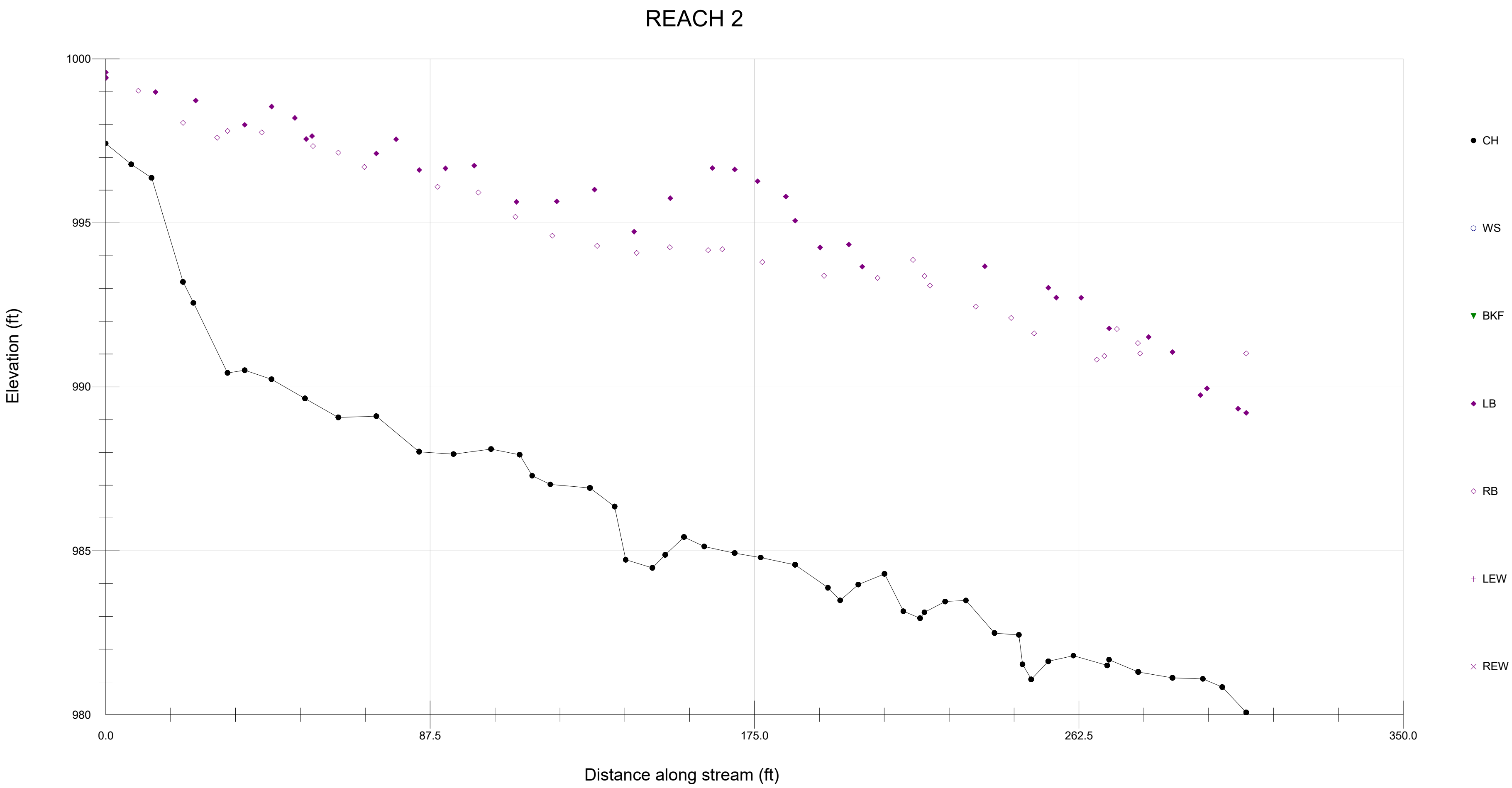
Valley Type:	Type VIII(a)
Valley Slope:	0.0636 ft/ft
Number of Channels:	Single
Width:	5.7 ft
Mean Depth:	0.31 ft
Flood-Prone Width:	21 ft
Channel Materials D50:	5 mm
Water Surface Slope:	0.058 ft/ft
Sinuosity:	1.1
Discharge:	12 cfs
Velocity:	6.86 fps
Cross Sectional Area:	1.77 sq ft
Entrenchment Ratio:	3.68
Width to Depth Ratio:	18.39
Rosgen Stream Classification:	C 4b

Slope is out of range

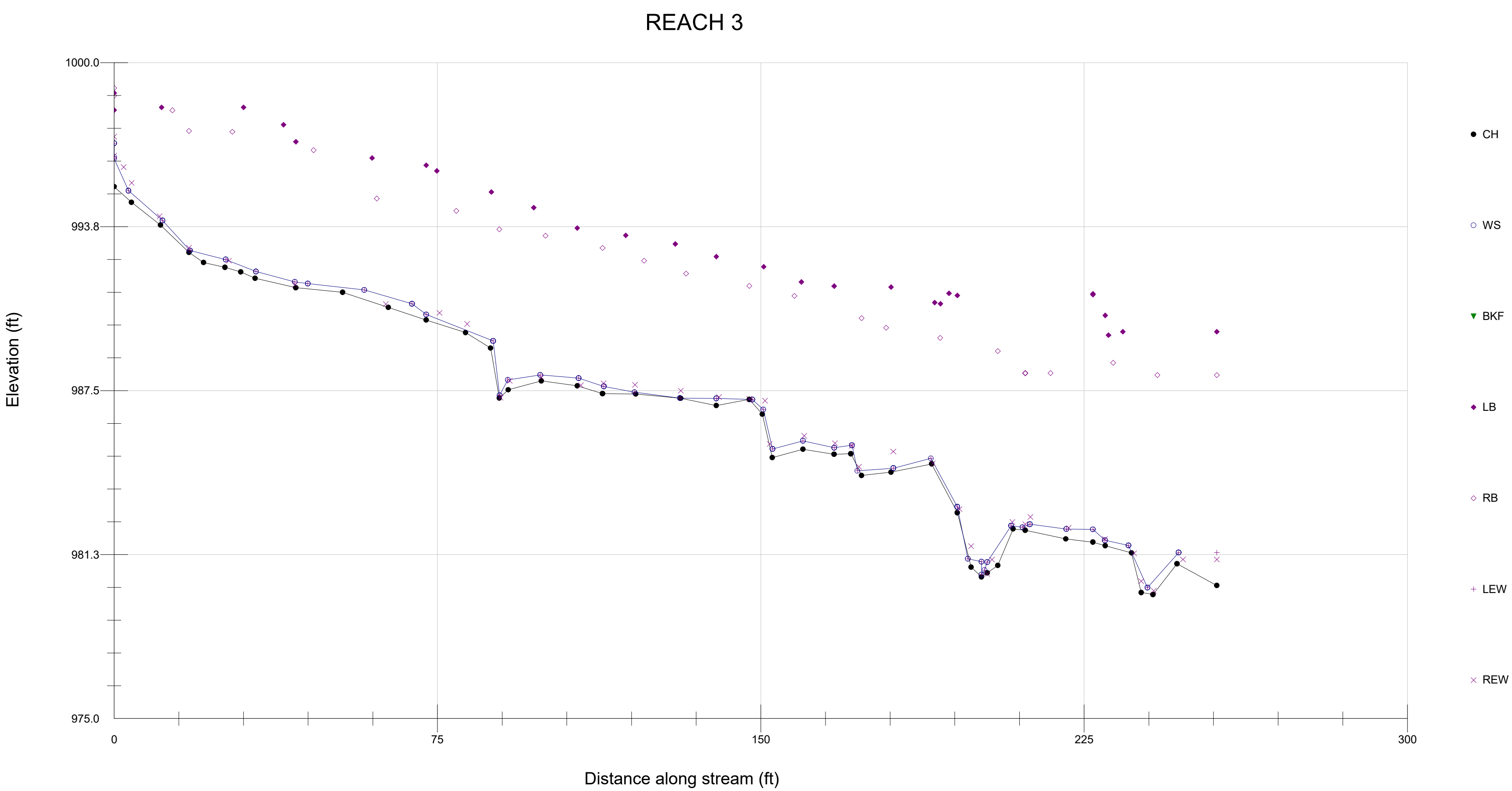
Shoals Community Park Restoration

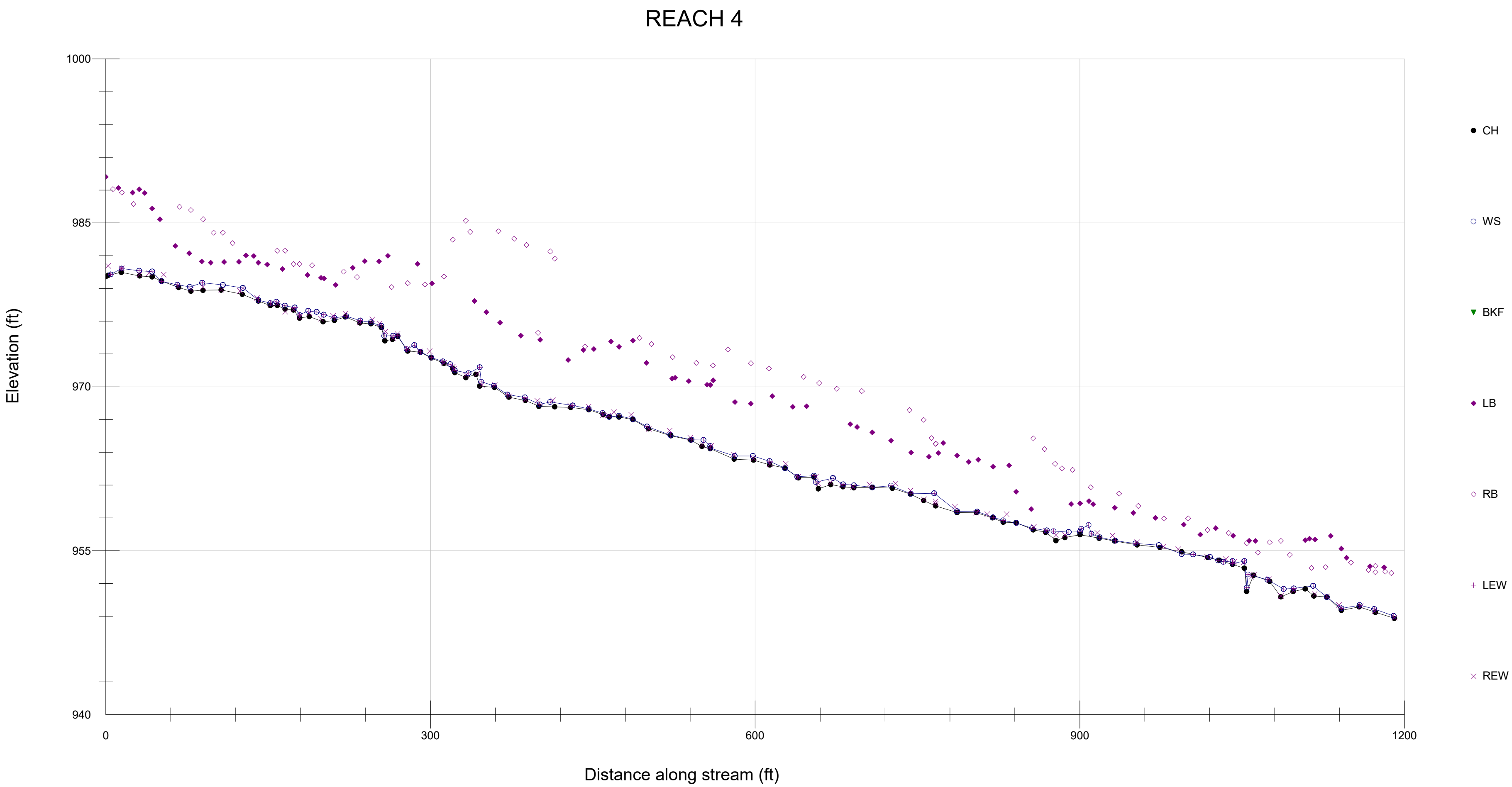



REACH 1
Elevation (ft)
965
950
935
920
905
0.0
387.5
775.0
1162.5
1550.0
Distance along stream (ft)
CH
WS
BKF
LB
RB
LEW
REW

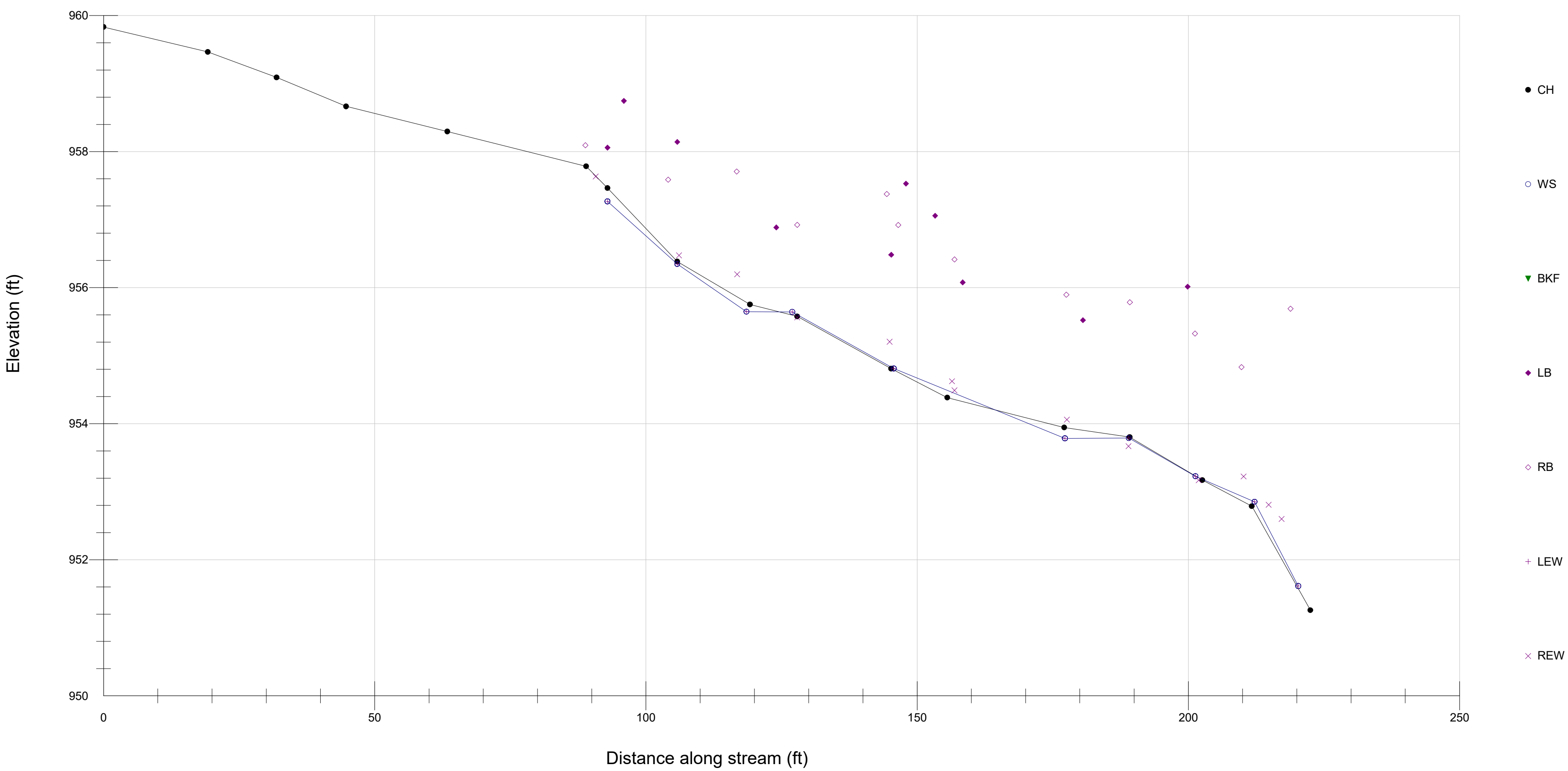


REACH 2
1000
995
990
985
980
Elevation (ft)
0.0
87.5
175.0
262.5
350.0
Distance along stream (ft)
CH
WS
BKF
LB
RB
LEW
REW

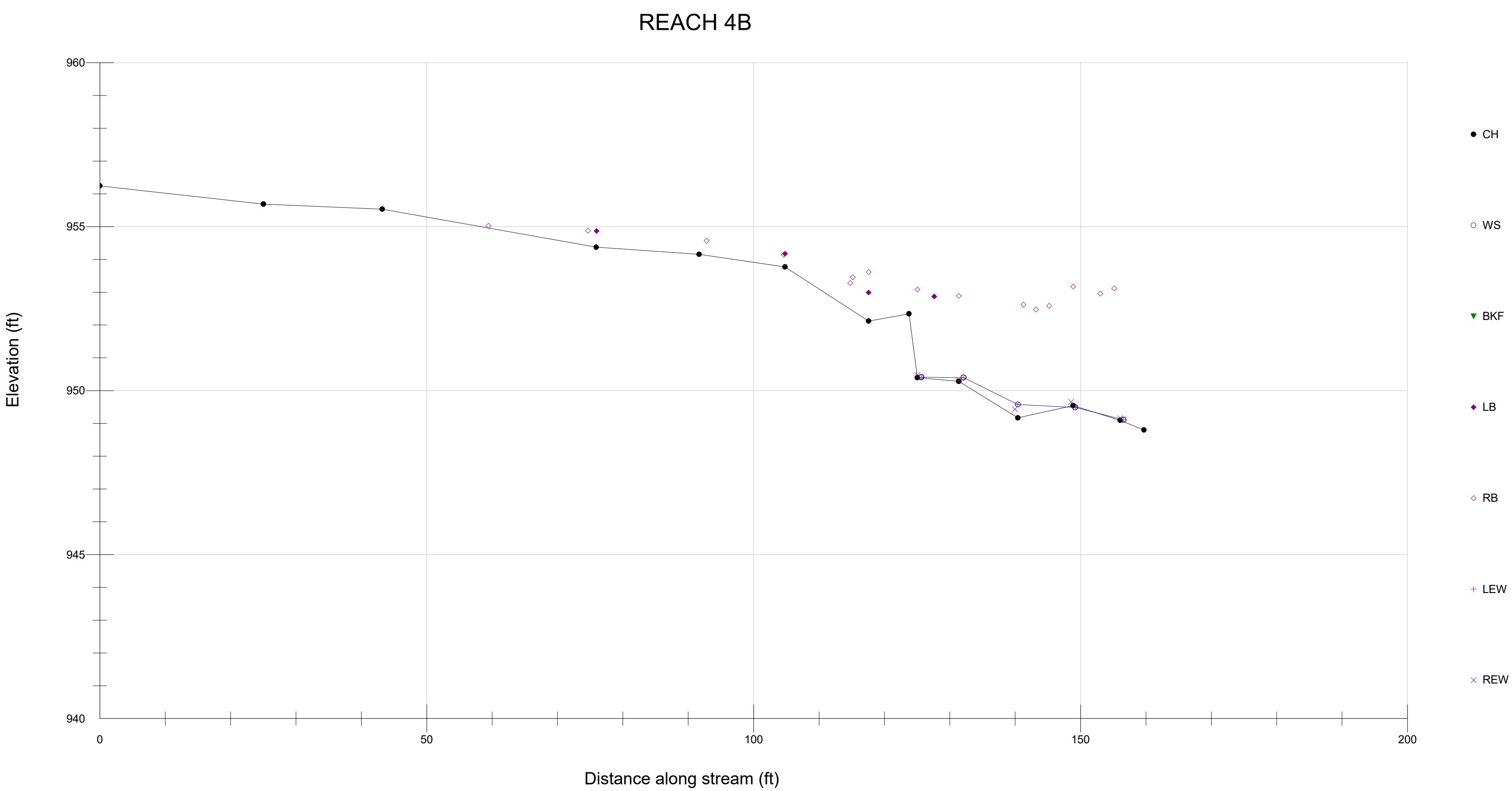

REACH 3
Elevation (ft)
1000.0
993.8
987.5
981.3
975.0
0
75
150
225
300
Distance along stream (ft)
CH
WS
BKF
LB
RB
LEW
REW


REACH 4
Elevation (ft)
Distance along stream (ft)
1000
985
970
955
940
0
300
600
900
1200
CH
WS
BKF
LB
RB
LEW
REW

REACH 4A

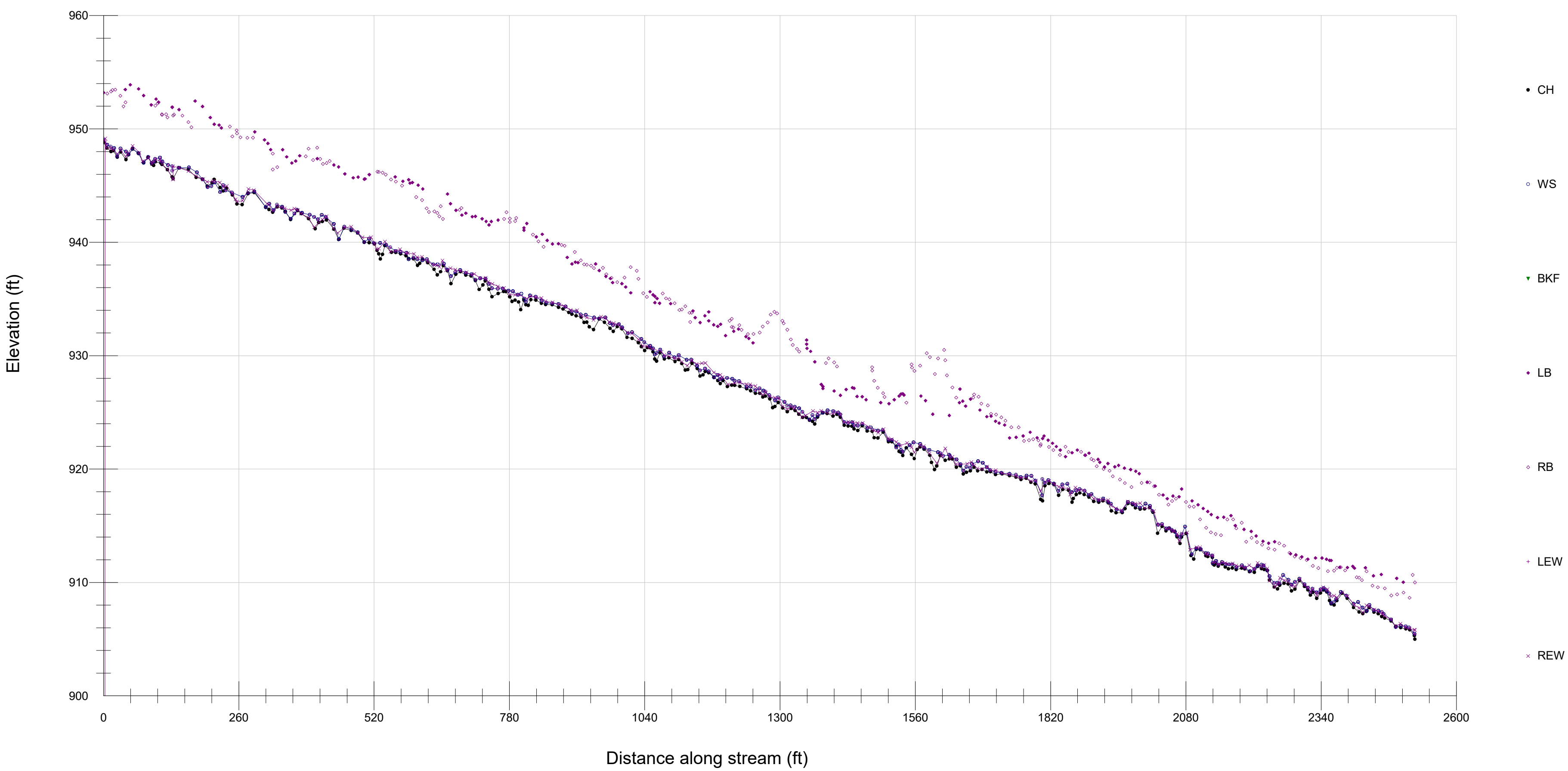


960
958
956
954
952
950
Elevation (ft)
0
50
100
150
200
250
Distance along stream (ft)
CH
WS
BKF
LB
RB
LEW
REW

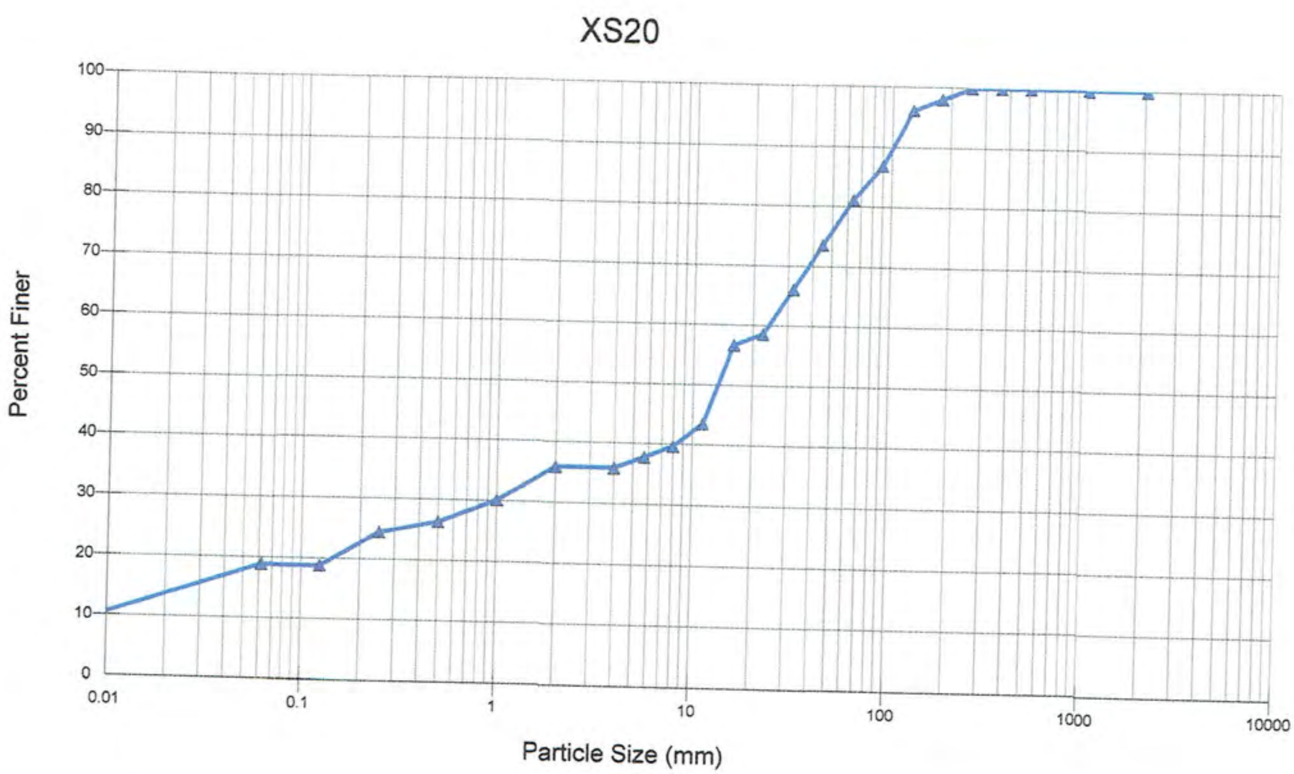


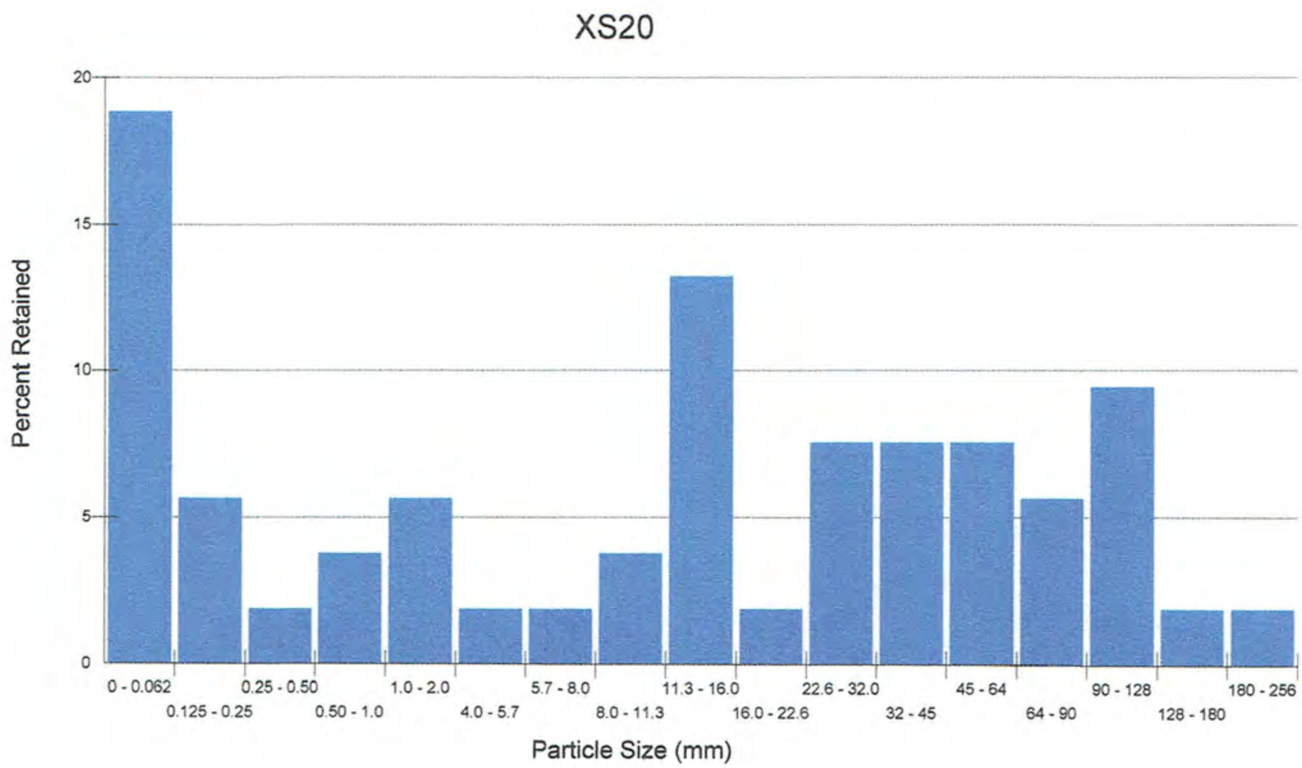
REACH 4B
Elevation (ft)
960
955
950
945
940
0
50
100
150
200
Distance along stream (ft)
CH
WS
BKF
LB
RB
LEW
REW

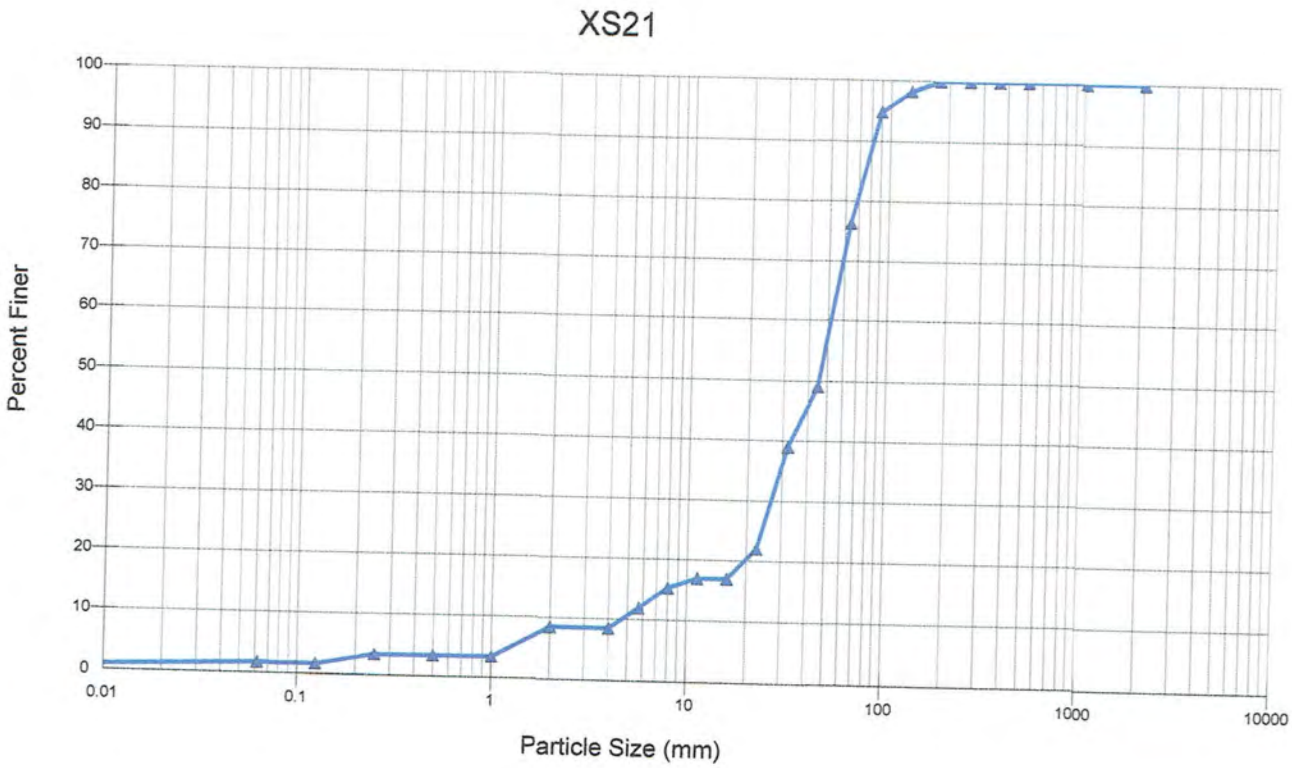
REACH 5

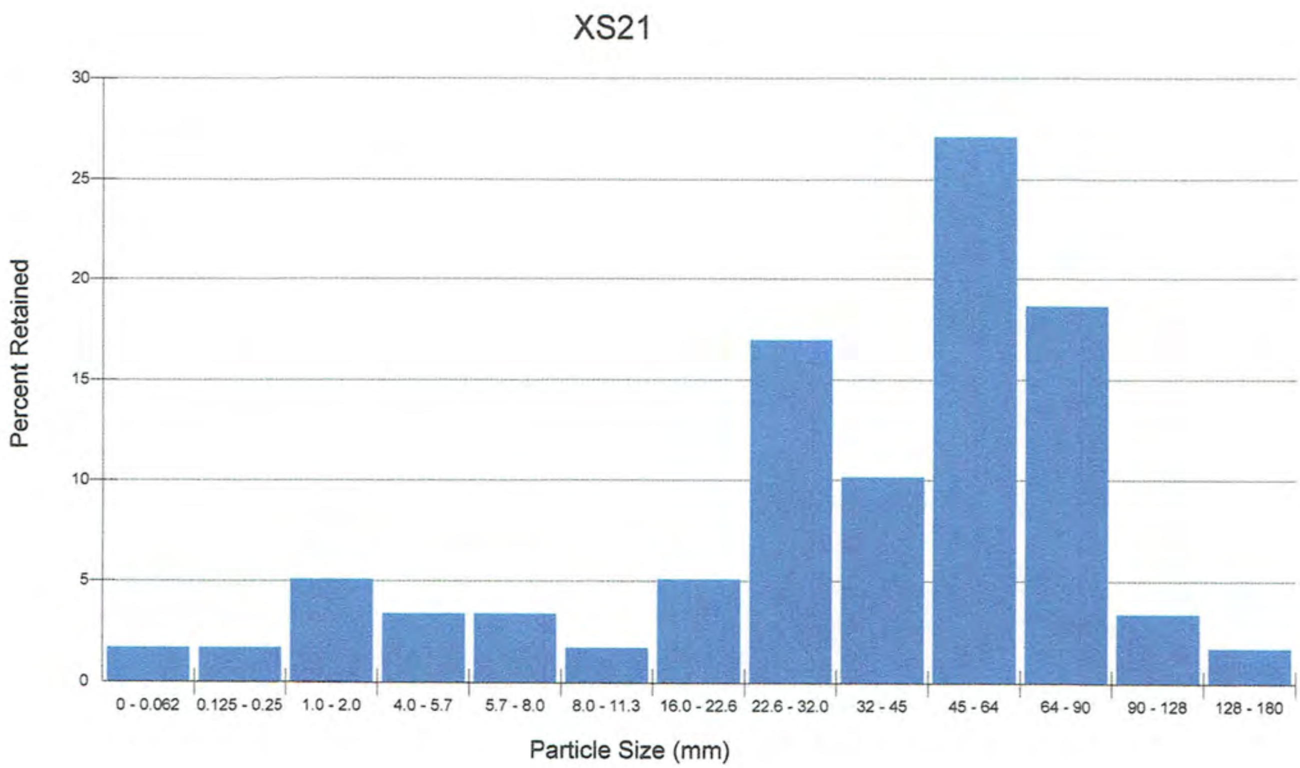


Elevation (ft)
960
950
940
930
920
910
900
0
260
520
780
1040
1300
1560
1820
2080
2340
2600
Distance along stream (ft)
CH
WS
BKF
LB
RB
LEW
REW

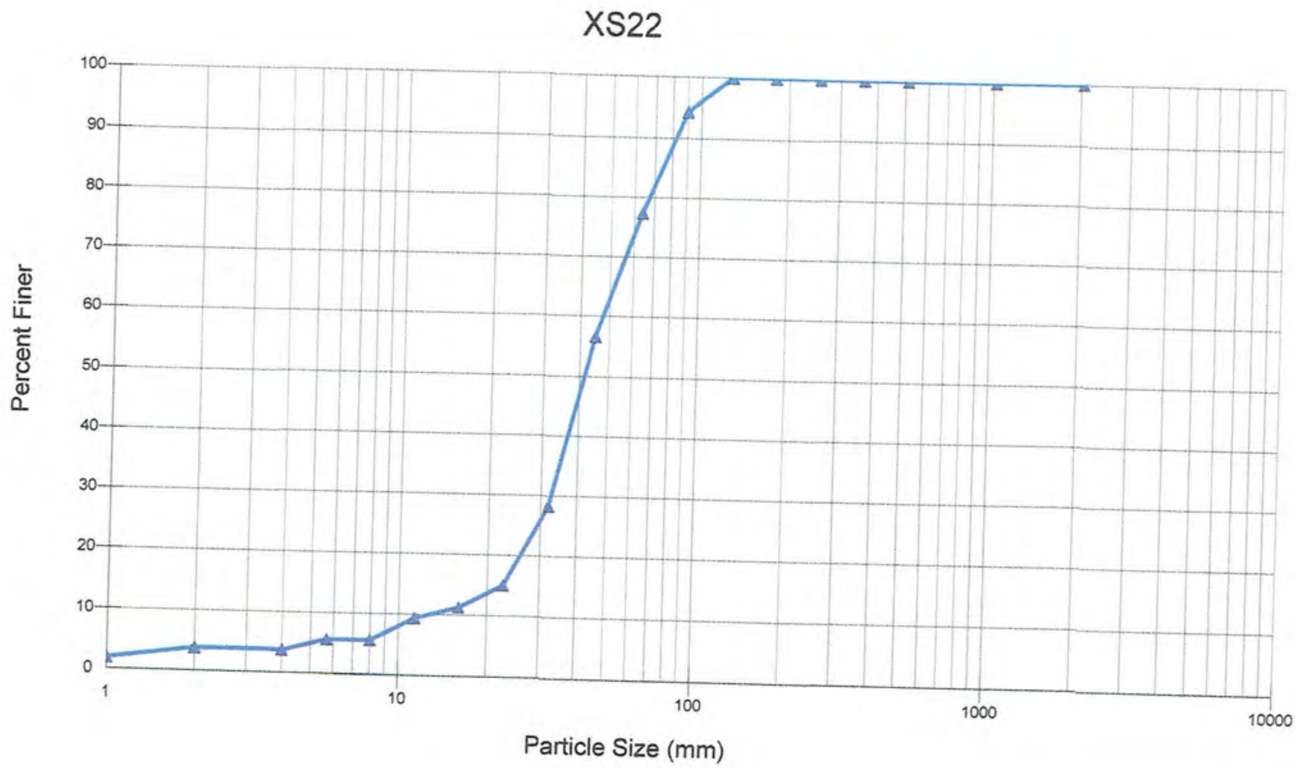

XS20
Percent Finer
Particle Size (mm)
0
10
20
30
40
50
60
70
80
90
100
0.01
0.1
1
10
100
1000
10000


XS20
Percent Retained
20
15
10
5
0
0 - 0.062
0.125 - 0.25
0.25 - 0.50
0.50 - 1.0
1.0 - 2.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
128 - 180
180 - 256
Particle Size (mm)

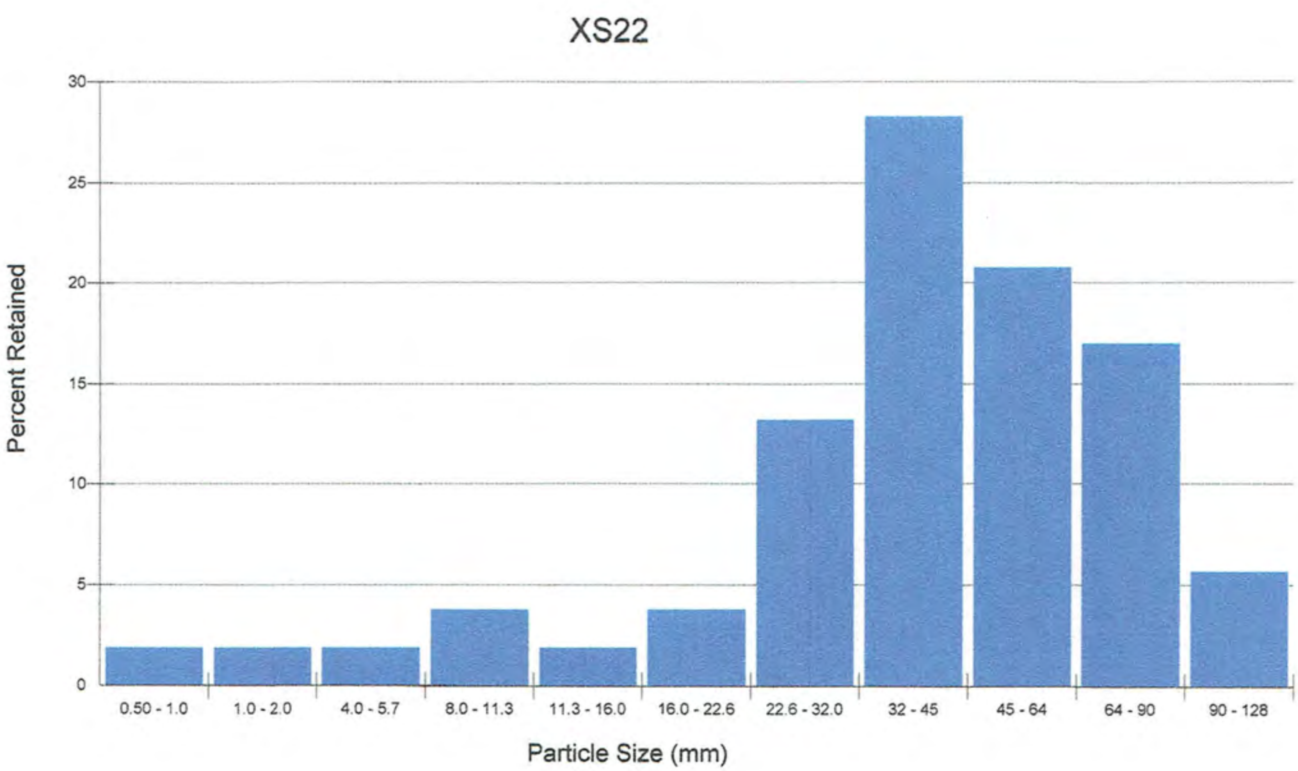

XS21
Percent Finer
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)



XS21
Percent Retained
30
25
20
15
10
5
0
0 - 0.062
0.125 - 0.25
1.0 - 2.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
128 - 180
Particle Size (mm)



XS22
Percent Finer
Particle Size (mm)
0
10
20
30
40
50
60
70
80
90
100
1
10
100
1000
10000



XS22
Percent Retained
0
5
10
15
20
25
30
0.50 - 1.0
1.0 - 2.0
4.0 - 5.7
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
Particle Size (mm)

BANCS Method Calcs | Appendix 2

Location: Horne Creek Mitigation Project - R1 | Field Crew: J. Morgan/ K. VanStell | Date: 5/9/2018

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK A	B	C	D	E	F		RIGHT BANK A	B	C	D	E	F	
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**	**STA**	**BEHI**	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**	**STA**
Low	V. Low	5.5	0.02	13	1.4	1013	Low	V. Low	5.8	0.02	13	1.5	1013
Low-Mod	Low	4.5	0.055	20	5.0	1033	Low	Mod	2.9	0.068	20	3.9	1033
Mod	Low-Mod	4.3	0.135	10	5.8	1043	Low	V. Low	2.1	0.02	33	1.4	1066
V. Low	V. Low	1.7	0.008	23	0.3	1066	V. Low	V. Low	1.7	0.008	70	1.0	1136
Low	Low	2.1	0.034	40	2.9	1106	Mod	Mod-High	2.1	0.27	5	2.8	1141
Low-Mod	Low	2.1	0.055	15	0.0	1121	V. Low	V. Low	1.6	0.008	50	0.6	1191
Low	V. Low	1.9	0.02	15	0.6	1136	Mod	Mod	1.9	0.18	9	3.1	1200
Low	Low	1.9	0.034	13	0.8	1149	V. Low	V. Low	2.1	0.008	34	0.6	1234
Low-Mod	Mod	2.0	0.1	10	2.0	1159	Low	V. Low	2.0	0.02	54	2.2	1288
Low	V. Low	1.4	0.02	15	0.4	1174	Mod-High	High	2.3	0.4	7	6.4	1295
Mod-High	V. High	2.1	0.8	7	11.8	1181	Low	Low	2.0	0.034	56	3.8	1351
Low-Mod	V. Low	1.6	0.03	10	0.0	1191	Low	V. Low	2.5	0.02	54	2.7	1405
Low	Low-Mod	1.7	0.051	22	1.9	1213	High	Mod	3.0	0.3	27	24.3	1432
Low	V. Low	1.3	0.02	20	0.5	1233	V. Low	V. Low	2.2	0.008	81	1.4	1513
High	Mod-High	2.6	0.4	8	8.3	1241	High	V. High	1.8	0.8	6	8.6	1519
Low	V. Low	2.6	0.02	9	0.5	1250	V. Low	V. Low	2.1	0.008	126	2.1	1645
V. Low	V. Low	1.3	0.008	30	0.3	1280	Low	V. Low	1.2	0.02	120	2.9	1765
Low	V. Low	2.2	0.02	12	0.5	1292	High	V. High	2.9	0.8	12	27.8	1777
V. Low	V. Low	2.1	0.008	15	0.3	1307	Low	Low	2.1	0.034	83	5.9	1860
Low	V. Low	1.8	0.02	29	1.0	1336	Low	V. Low	2.8	0.02	18	1.0	1878
Mod	Mod-High	1.7	0.27	5	2.3	1341	Mod	Low	2.6	0.09	27	6.3	1905
V. Low	V. Low	1.1	0.008	36	0.3	1377	High	V. High	2.5	0.8	15	30.0	1920
V. Low	V. Low	1.4	0.008	29	0.3	1406	Low	Low	1.9	0.034	31	2.0	1951
V. Low	V. Low	1.8	0.008	13	0.2	1419	Low	V. Low	2.1	0.02	40	1.7	1991
Mod	High	2.2	0.38	13	10.9	1432	Low	Mod	1.3	0.068	21	1.9	2012
Low	V. Low	1.9	0.02	25	1.0	1457	Low	V. Low	1.7	0.02	33	1.1	2045
Low	V. Low	2.0	0.02	67	2.7	1524	V. Low	V. Low	0.7	0.008	43	0.2	2088
Mod	High	1.9	0.38	20	14.4	1544	High	V. High	2.7	0.8	25	54.0	2113
V. Low	V. Low	0.8	0.008	42	0.3	1586	Low	V. Low	1.1	0.02	48	1.1	2161
Low	V. Low	1.6	0.02	55	1.8	1641	Mod-High	High	1.8	0.4	9	6.5	2170
V. Low	V. Low	0.6	0.008	27	0.1	1668	V. Low	V. Low	0.9	0.008	71	0.5	2241
Low	V. Low	1.5	0.02	52	1.6	1720	Low	Low	1.8	0.034	18	1.1	2259
Mod	Mod-High	1.9	0.27	5	2.6	1725	Mod	Low	2.5	0.09	48	10.8	2307
Low	V. Low	1.7	0.02	104	3.5	1829	V. Low	V. Low	0.7	0.008	22	0.1	2329
Mod-High	High	1.4	0.4	7	3.9	1836	Low	V. Low	1.7	0.02	15	0.5	2344
Low	V. Low	1.6	0.02	50	1.6	1886	Low	Low	0.9	0.034	22	0.7	2366
Mod-High	High	3.4	0.4	11	15.0	1897	Low	Low	0.6	0.034	8	0.2	2374
Mod	Mod-High	2.3	0.27	49	30.4	1946	Low	V. Low	2.5	0.02	13	0.7	2387
Mod	V. Low	1.5	0.035	147	7.7	2093	V. Low	V. Low	0.9	0.008	10	0.1	
V. Low	V. Low	0.7	0.008	201	1.1	2294							
Mod-High	High	3.6	0.4	15	21.6	2309							
V. Low	Low	0.6	0.02	88	1.1	2397							
				TOTAL FT³/YR	168.6						TOTAL FT³/YR	223.5	
Divide FT³/yr by 27				TOTAL YD³/YR	6.2						TOTAL YD³/YR	8.3	
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	8.1						**TOTAL TONS/YR**	10.8	

Total Length 1397 1397

North Carolina unpublished curve (Alan Walker, NRCS)

NBS \ BEHI	V. Low	Low	Low-Mod	Mod	Mod-High	High	V. High	Extreme
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10

Total ft assessed	2794
Total TONS per year	18.9
Tons per ft per year	0.0068
Tons per 1000ft	6.8

BANCS Method Calcs

Appendix 2

Location: Horne Creek Mitigation Project - R2 Field Crew: C. Tomsic, J. Bell Date: 5/9/2018

SEDIMENT LOADING ASSESSMENT SHEET

			LEFT BANK							RIGHT BANK			
A	B	C	D	E	F		A	B	C	D	E	F	
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**	**STA**	**BEHI**	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**	**STA**
Mod	V. Low	8.0	0.035	40	11.2	1040	Mod	V. Low	8.0	0.035	40	11.2	1040
Mod	V. Low	12.0	0.035	47	19.7	1087	Mod	V. Low	12.0	0.035	65	27.3	1105
Low	V. Low	2.0	0.02	50	2.0	1137	Mod-High	Mod	12.0	0.25	23	69.0	1128
Mod	V. Low	12.0	0.035	32	13.4	1169	Mod	V. Low	12.0	0.035	9	3.8	1137
						1169	Mod	V. Low	12.0	0.035	45	18.9	1182
						1169							1182
						1169							1182
						1169							1182
						1169							1182
						1169							1182
						1169							1182
						1169							1182
						1169							1182
						1169							1182
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						1169							1182
						1169							1182
						1169							
						1169							
						1169							
						1169							
				TOTAL FT³/YR	46.4						TOTAL FT³/YR	130.2	
Divide FT³/yr by 27				TOTAL YD³/YR	1.7						TOTAL YD³/YR	4.8	
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	2.2						**TOTAL TONS/YR**	6.3	

Total Length 169 182

Total ft assessed	351
Total TONS per year	8.5
Tons per ft per year	0.0242
Tons per 1000ft	24.2

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	**Low**	**Low-Mod**	**Mod**	**Mod-High**	**High**	**V. High**	**Extreme**	**BEHI**
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	

BANCS Method Calcs — Appendix 2

Location:	Horne Creek Mitigation Project - R2	Field Crew: C. Tomsic, J. Bell	Date:	5/11/2018

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK							RIGHT BANK						
A	B	C	D	E	F		A	B	C	D	E	F	
BEHI	NBS	STUDY BANK HEIGHT	FEET/YR (from curve)	DISTANCE (note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)	STA	BEHI	NBS	STUDY BANK HEIGHT	FEET/YR (from curve)	DISTANCE (note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)	STA
Mod	Low	1.0	0.09	20	1.8	1020	Mod	Low	1.0	0.09	20	1.8	1020
Low	Low	0.5	0.034	30	0.5	1050	V. High	Mod	3.0	0.3	30	27.0	1050
Mod	Low	6.0	0.09	35	18.9	1085	Mod	Low	6.0	0.09	54	29.2	1104
Mod	Low	3.0	0.09	109	29.4	1194	V. High	High	7.0	0.5	40	140.0	1144
						1194							1144
						1194							1144
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						1194							
						1194							
				TOTAL FT³/YR	50.6						TOTAL FT³/YR	198.0	
Divide FT³/yr by 27				TOTAL YD³/YR	1.9						TOTAL YD³/YR	7.3	
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	2.4						**TOTAL TONS/YR**	9.5	
Total Length					194							144	

Total ft assessed	338
Total TONS per year	12.0
Tons per ft per year	0.0354
Tons per 1000ft	35.4

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	Low	Low-Mod	Mod	Mod-High	High	V. High	Extreme	BEHI
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	

BANCS Method Calcs

Appendix 2

Location: Horne Creek Mitigation Project - R2 | Field Crew: C. Tomsic, J. Bell | Date: 5/9/2018

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK							RIGHT BANK						
A	B	C	D	E	F		A	B	C	D	E	F	
BEHI	NBS	STUDY BANK HEIGHT	FEET/YR (from curve)	DISTANCE (note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)	STA	BEHI	NBS	STUDY BANK HEIGHT	FEET/YR (from curve)	DISTANCE (note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)	STA
V. High	Mod	12.0	0.3	182	655.2	1182	Mod	V. Low	7.0	0.035	240	58.8	1240
Mod	V. Low	7.0	0.035	49	12.0	1231	High	Mod-High	8.0	0.4	18	57.6	1258
Mod	V. Low	4.0	0.035	27	3.8	1258	Mod	V. Low	6.0	0.035	20	4.2	1278
V. Low	V. Low	3.0	0.008	37	0.9	1295	V. Low	V. Low	2.0	0.008	40	0.6	1318
Mod	Mod	4.0	0.18	39	28.1	1334	High	Mod	4.0	0.3	16	19.2	1334
Mod	Low	3.0	0.09	60	16.2	1394	Mod	Low	3.0	0.09	60	16.2	1394
Low	V. Low	3.0	0.02	30	1.8	1424	Mod	Low	5.0	0.09	49	22.1	1443
V. Low	V. Low	5.0	0.008	19	0.8	1443	Mod	Low	6.0	0.09	47	25.4	1490
Mod	Low	6.0	0.09	136	73.4	1579	Mod	Low	12.0	0.09	30	32.4	1520
Mod	Mod	6.0	0.18	15	16.2	1594	High	High	12.0	0.5	33	198.0	1553
Mod	Low	6.0	0.09	234	126.4	1828	Mod	Low	3.0	0.09	64	17.3	1617
Mod	Low	4.0	0.09	45	16.2	1873	Mod	Low	6.0	0.09	56	30.2	1673
Mod	Low	4.0	0.09	32	11.5	1905	Mod	Low	8.0	0.09	85	61.2	1758
Mod	High	4.0	0.38	26	39.5	1931	High	High	10.0	0.5	23	115.0	1781
V. Low	V. Low	0.0	0.008	39	0.0	1970	Mod	Low	6.0	0.09	75	40.5	1856
Mod	Low	3.0	0.09	141	38.1	2111	High	Mod	4.0	0.3	17	20.4	1873
Low	Low	3.0	0.034	24	2.4	2135	Mod	Low	4.0	0.09	32	11.5	1905
Low	Low	2.0	0.034	28	1.9	2163	V. Low	V. Low	0.0	0.008	26	0.0	1931
High	High	5.0	0.5	14	35.0	2177	Extreme	Extreme	3.0	10	39	1170.0	1970
Low	Low	4.0	0.034	46	6.3	2223	Mod	Low	3.0	0.09	141	38.1	2111
V. Low	V. Low	0.0	0.008	28	0.0	2251	Low	Low	3.0	0.034	11	1.1	2122
Extreme	Extreme	6.0	10	30	1800.0	2281	Mod	High	4.0	0.38	13	19.8	2135
Low	V. Low	3.0	0.02	26	1.6	2307	Low	Low	3.0	0.034	28	2.9	2163
Mod	V. Low	5.0	0.035	26	4.6	2333	Low	Low	2.0	0.034	29	2.0	2192
Low	V. Low	2.0	0.02	30	1.2	2363	Mod	Low	4.0	0.09	31	11.2	2223
High	High	6.0	0.5	44	132.0	2407	High	Extreme	5.0	1.5	28	210.0	2251
V. Low	V. Low	0.0	0.008	36	0.0	2443	V. Low	V. Low	0.0	0.008	30	0.0	2281
Mod	Low	6.0	0.09	19	10.3	2462	Mod	Mod	5.0	0.18	26	23.4	2307
Extreme	V. High	6.0	6	14	504.0	2476	Low	V. Low	3.0	0.02	100	6.0	2407
Low	Low	6.0	0.034	21	4.3	2497	High	V. High	4.0	0.8	36	115.2	2443
Extreme	Mod	5.0	1.1	20	110.0	2517	Low	Low	3.0	0.034	17	1.7	2460
Low	Low	2.0	0.034	52	3.5	2569	Low	Low	3.0	0.034	57	5.8	2517
Mod	Mod	5.0	0.18	45	40.5	2268	Mod	High	7.0	0.38	52	138.3	2163
Extreme	V. High	5.0	6	17	510.0	2285	Mod-High	Low	3.0	0.15	45	20.3	2208
Low	V. Low	3.0	0.02	22	1.3	2307	V. Low	V. Low	0.0	0.008	17	0.0	2225
Mod	Low	6.0	0.09	20	10.8	2327	High	High	6.0	0.5	22	66.0	2247
V. Low	V. Low	2.0	0.008	13	0.2	2340	Mod	Low	6.0	0.09	20	10.8	2267
High	Mod	1.5	0.3	29	13.1	2369	Mod	Low	4.0	0.09	58	20.9	2325
Low	Low	2.0	0.034	44	3.0	2413	High	High	5.0	0.5	28	70.0	2353
Mod	Low	6.0	0.09	38	20.5	2451	Mod	Low	4.0	0.09	38	13.7	2391
V. High	High	6.0	0.5	50	150.0	2419	Low	Low	3.0	0.034	50	5.1	
V. Low	V. Low	0.0	0.008	25	0.0	2444	V. High	High	6.0	0.5	25	75.0	
Mod	Low	6.0	0.09	69	37.3	2520	Mod	Low	3.0	0.09	69	18.6	
High	Mod	5.0	0.3	23	34.5	2543	Low	V. Low	1.5	0.02	23	0.7	
Low	V. Low	2.0	0.02	31	1.2	2254	High	High	5.0	0.5	31	77.5	2142
Mod	Low	4.0	0.09	85	30.6	2339	Mod	Low	4.0	0.09	85	30.6	2227
V. Low	V. Low	0.0	0.008	20	0.0	2359	Extreme	Mod	4.0	1.1	20	88.0	2247
Mod	Extreme	5.0	1.6	42	336.0	2401	Mod	Low	5.0	0.09	40	18.0	2287
Low	Low	3.0	0.034	8	0.8	2409	V. High	High	5.0	0.5	20	50.0	2307
V. Low	V. Low	2.0	0.008	10	0.2	2419	Low	Low	3.0	0.034	42	4.3	2349
High	High	5.0	0.5	42	105.0	2461	Mod	Low	3.0	0.09	66	17.8	2415
Mod	Low	4.0	0.09	66	23.8	2527	Extreme	V. High	6.0	6	67	2412.0	2482
Mod	Low	3.0	0.09	67	18.1	2486	Mod	V. Low	2.0	0.035	30	2.1	
Mod	V. High	6.0	0.78	30	140.4	2516	Mod	Low	4.0	0.09	24	8.6	
V. Low	V. Low	0.0	0.008	24	0.0	2551	V. Low	V. Low	0.0	0.008	45	0.0	
Extreme	V. High	3.0	6	45	810.0	2596	Low	High	2.0	0.14	58	16.2	
V. Low	V. Low	1.0	0.008	32	0.3	2601	Mod	Low	7.0	0.09	55	34.7	2572
Extreme	V. High	3.0	6	26	468.0	2627	Extreme	V. High	8.0	6	38	1824.0	2610
Mod	Low	4.0	0.09	5	1.8	2632	V. Low	V. Low	0.0	0.008	41	0.0	2651
V. Low	V. Low	2.0	0.008	88	1.4	2720	High	Low	5.0	0.18	17	15.3	2668
High	V. High	6.0	0.8	41	196.8	2761	Mod	Low	5.0	0.09	37	16.7	2705
Mod	Low	4.0	0.09	54	19.4	2570	Mod	Low	3.0	0.09	33	8.9	33
Mod	Low	3.0	0.09	162	43.7	2732	Mod	Low	2.0	0.09	95	17.1	128
Mod	Low	2.0	0.09	47	8.5	2779	Mod	Low	3.0	0.09	34	9.2	162
High	Mod	3.0	0.3	21	18.9	2591	Mod	Low	2.0	0.09	47	8.5	
Mod	Low	2.0	0.09	149	26.8	2740	Low	Low	1.0	0.034	21	0.7	
Mod	Low	3.0	0.09	74	20.0	2853	Mod	Low	2.0	0.09	223	40.1	
Mod	Low	2.0	0.09	100	18.0	2953	Mod	Low	2.0	0.09	100	18.0	
Extreme	Mod	3.0	1.1	15	49.5	2776	V. Low	V. Low	1.0	0.008	15	0.1	2720
Mod	Low	3.0	0.09	150	40.5	2926	Mod	Low	3.0	0.09	150	40.5	2870
						2926							2870
						2776							
						2776							
						2926							
						2926							
				TOTAL FT³/YR	6857.8						TOTAL FT³/YR	7536.0	
Divide FT³/yr by 27				TOTAL YD³/YR	254.0						TOTAL YD³/YR	279.1	
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	330.2						**TOTAL TONS/YR**	362.8	

Total Length 3398 3398

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	Low	Low-Mod	Mod	Mod-High	High	V. High	Extreme	BEHI
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

Total ft assessed	6796
Total TONS per year	693.0
Tons per ft per year	0.1020
Tons per 1000ft	102.0

Catchment Area	7.67	BMP R1
Pervious Area	7.59	
Impervious Area	0.08	

The Simple Method		
RV = 0.05 + 0.9 * IA	Step 1 Simple Method	
RV =	0.05963	Runoff coefficient (unitless)
IA =	0.0107	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless
V = 3630 * RD * RV * A	Step 2 in the Simple Method	
V	1660	Volume of runoff that must be controlled for the design storm (cubic feet)
V	0.46	Volume of runoff that must be controlled for the design storm (acre-in)
RD	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5")
A	7.67	Watershed area (ac)

***CN Method in this spreadsheet is for 2 CN areas only. The equations may be modified if using multiple CNs or use a composite pervious CN

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
S = 1000/CN - 10		
Q* =	0.053	Runoff depth (in)
CN (Composite)	78	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
P =	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S =	2.90	Potential maximum retention after rainfall begins (in)
Soil Type	Colvard and Suches, Fairview	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	A, B, C, and D	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.41	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	1483	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	11094	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	0.46	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	1660	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	10	Depends on desired vegetation type and inundation time. Usually 6-12" (in
Required BMP Surface Area	0.041	(ac) SCS Method
Required BMP Surface Area	1780	(ft^2) SCS Method
Required BMP Surface Area	0.046	(ac) Simple Method
Required BMP Surface Area	1992	(ft^2) Simple Method
Actual BMP Surface Area	0.033	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	1436	(ft^2)
Actual BMP Surface Volume	1986.5	(ft^3)

Per DWQ BMP design manual, the BMP must be designed to treat a volume at least as large as the volume calculated using the simple method

DWQ recommends 9" but requires ponding depth to be less then 12"

Watershed Information and Site Runoff Volume Appendix 2

Catchment Area	29.24	BMP R2
Pervious Area	29.08	
Impervious Area	0.16	

The Simple Method		
RV = 0.05 + 0.9 * IA	Step 1 Simple Method	
RV =	0.05486	Runoff coefficient (unitless)
IA =	0.0054	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless
V = 3630 * RD * RV * A	Step 2 in the Simple Method	
V	5823	Volume of runoff that must be controlled for the design storm (cubic feet)
V	1.60	Volume of runoff that must be controlled for the design storm (acre-in)
RD	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5")
A	29.24	Watershed area (ac)

***CN Method in this spreadsheet is for 2 CN areas only. The equations may be modified if using multiple CNs or use a composite pervious CN

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
S = 1000/CN - 10		
Q* =	0.005	Runoff depth (in)
CN (Composite)	70	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
P =	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S =	4.29	Potential maximum retention after rainfall begins (in)
Soil Type	Colvard and Suches, Fairview	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	A, B, C, and D	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.13	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	489	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	3659	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	1.60	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	5823	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	10	Depends on desired vegetation type and inundation time. Usually 6-12" (in
Required BMP Surface Area	0.013	(ac) SCS Method
Required BMP Surface Area	587	(ft^2) SCS Method
Required BMP Surface Area	0.160	(ac) Simple Method
Required BMP Surface Area	6987	(ft^2) Simple Method
Actual BMP Surface Area	0.024	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	1025	(ft^2)
Actual BMP Surface Volume	1178	(ft^3)

Per DWQ BMP design manual, the BMP must be designed to treat a volume at least as large as the volume calculated using the simple method

DWQ recommends 9" but requires ponding depth to be less then 12"

Watershed Information and Site Runoff Volume

Catchment Area	29.24	BMP R3
Pervious Area	29.07	
Impervious Area	0.17	

The Simple Method		
RV = 0.05 + 0.9 * IA	Step 1 Simple Method	
RV =	0.05522	Runoff coefficient (unitless)
IA =	0.0058	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless
V = 3630 * RD * RV * A	Step 2 in the Simple Method	
V	5861	Volume of runoff that must be controlled for the design storm (cubic feet)
V	1.61	Volume of runoff that must be controlled for the design storm (acre-in)
RD	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5")
A	29.24	Watershed area (ac)

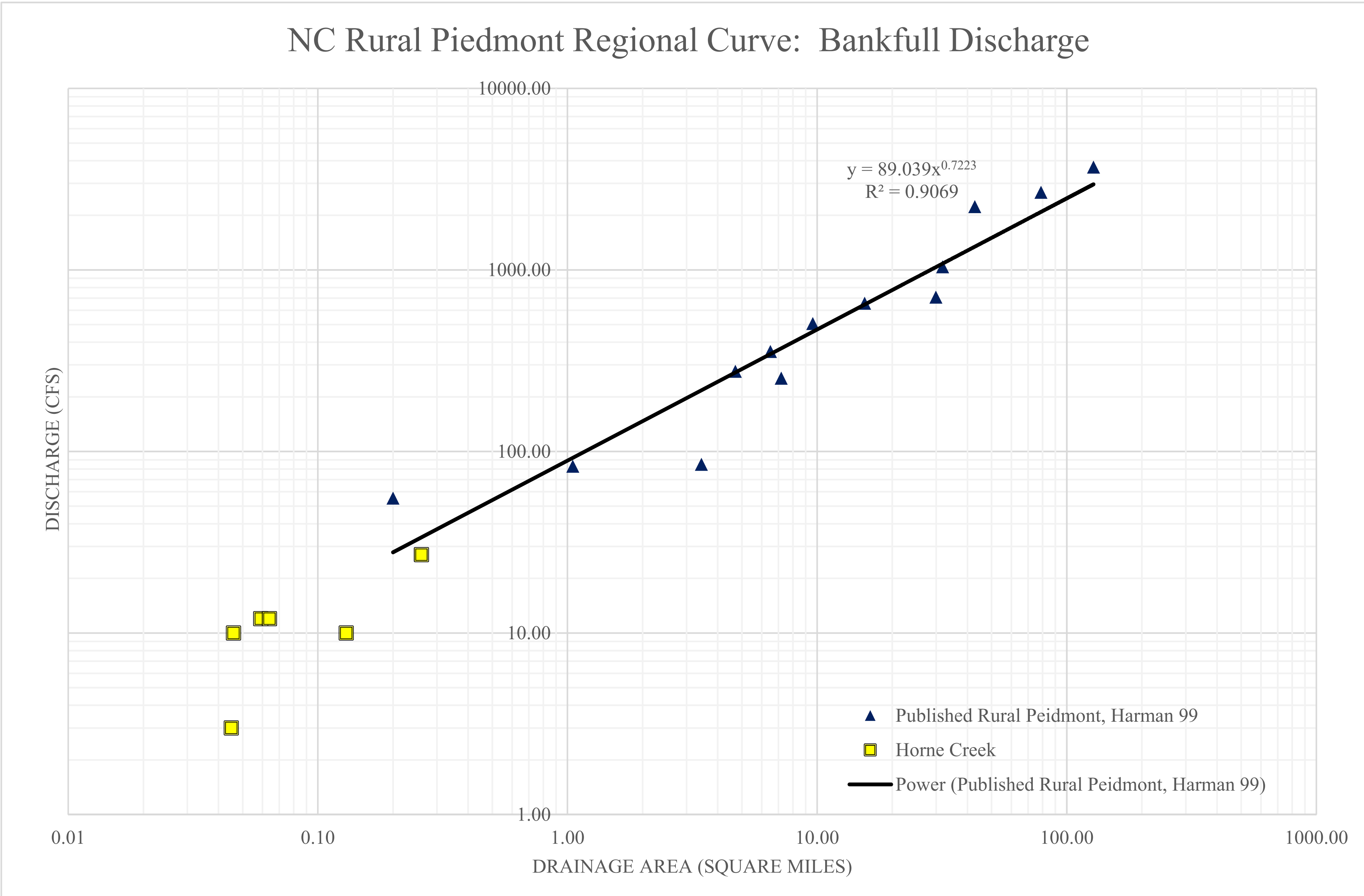
***CN Method in this spreadsheet is for 2 CN areas only. The equations may be modified if using multiple CNs or use a composite pervious CN

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
S = 1000/CN - 10		
Q* =	0.005	Runoff depth (in)
CN (Composite)	70	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
P =	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S =	4.29	Potential maximum retention after rainfall begins (in)
Soil Type	Colvard and Suches, Fairview	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	A, B, C, and D	Refer to DWQ Design Manual after the soil series in the area of interest is identified

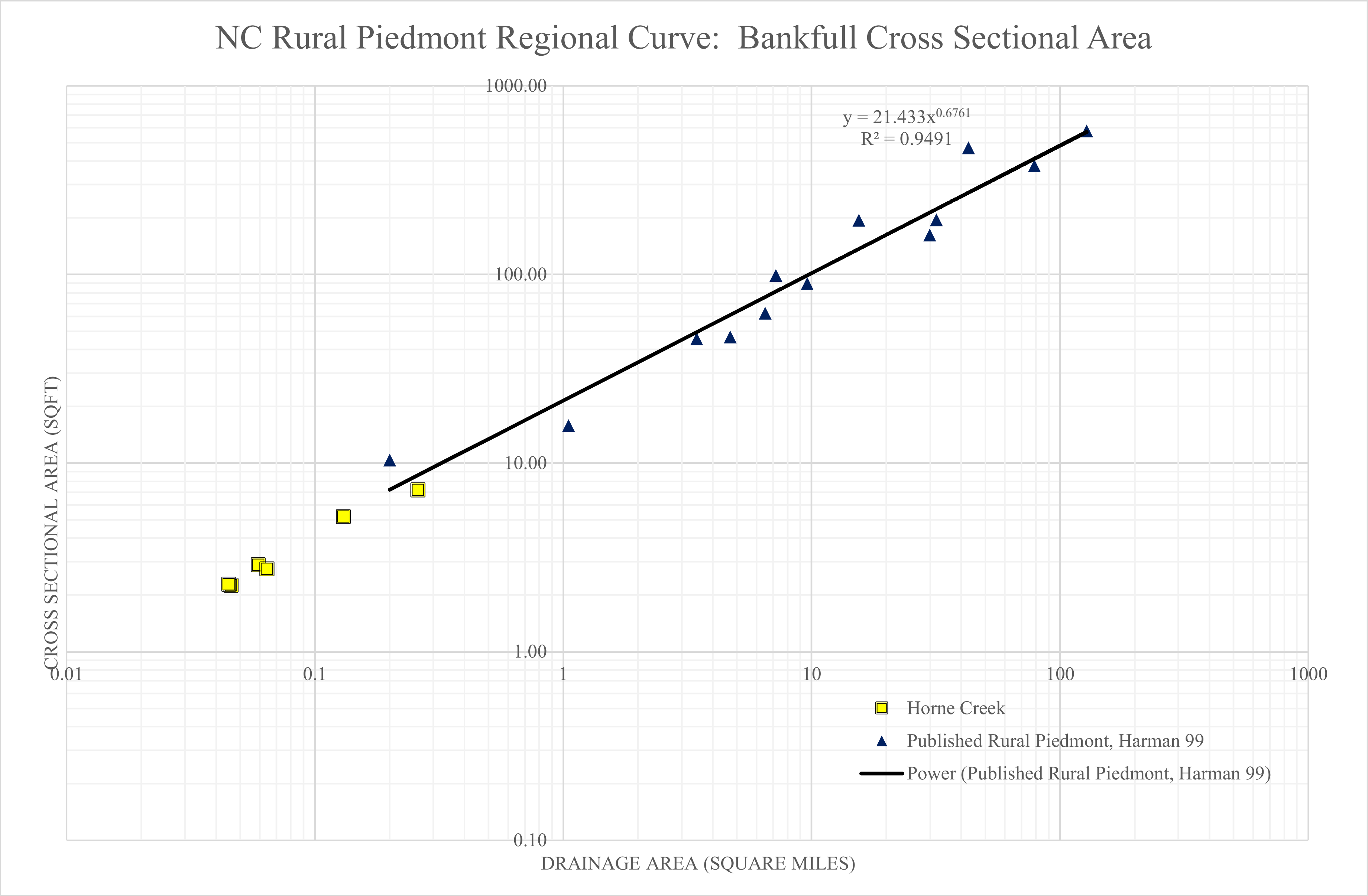
BMP Sizing Reqs		
V = A(Q*)	0.13	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	489	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	3659	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	1.61	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	5861	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	10	Depends on desired vegetation type and inundation time. Usually 6-12" (in
Required BMP Surface Area	0.013	(ac) SCS Method
Required BMP Surface Area	587	(ft^2) SCS Method
Required BMP Surface Area	0.161	(ac) Simple Method
Required BMP Surface Area	7033	(ft^2) Simple Method
Actual BMP Surface Area	0.047	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	2050	(ft^2)
Actual BMP Surface Volume	2356	(ft^3)

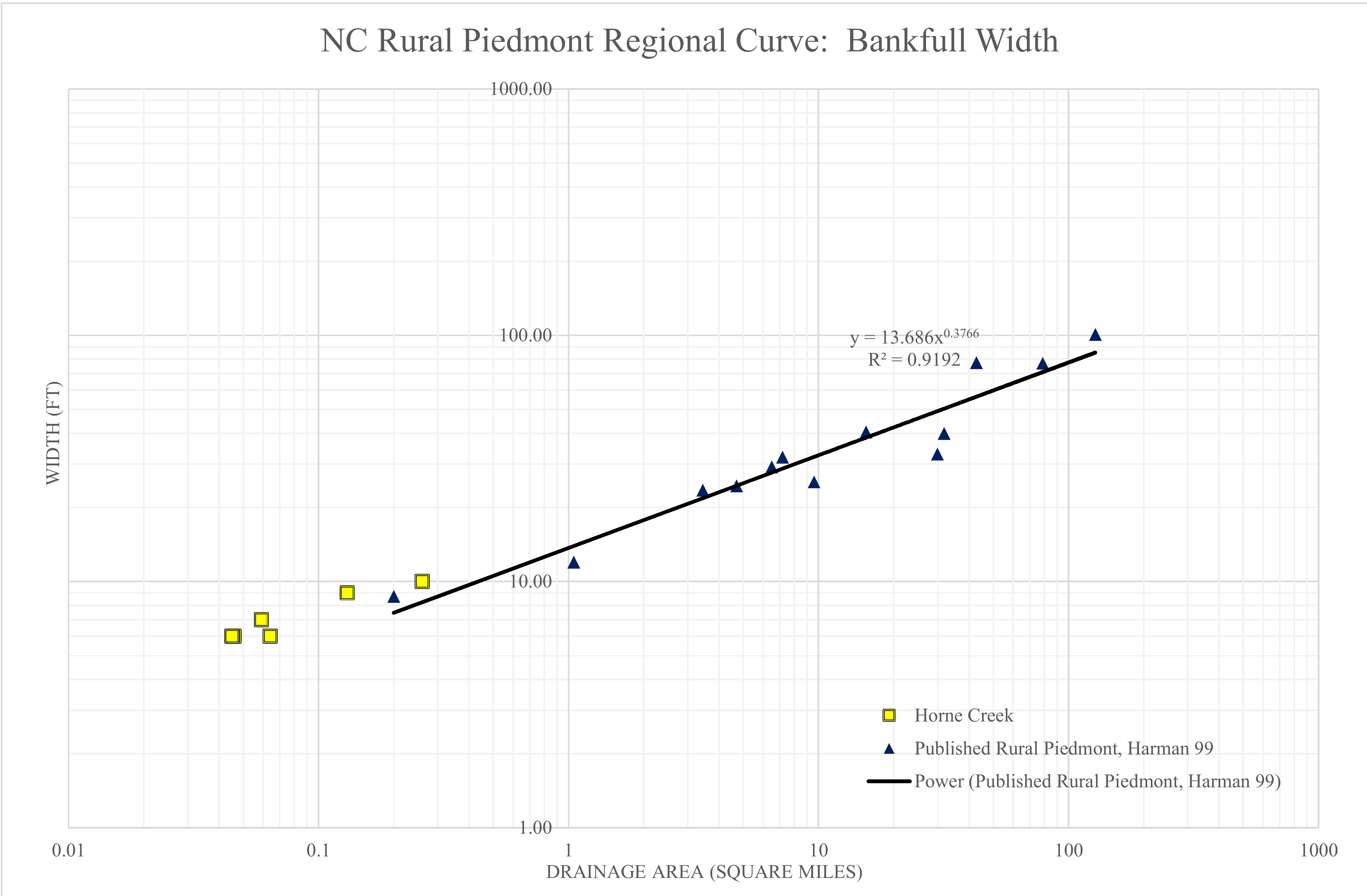
Per DWQ BMP design manual, the BMP must be designed to treat a volume at least as large as the volume calculated using the simple method

DWQ recommends 9" but requires ponding depth to be less then 12"

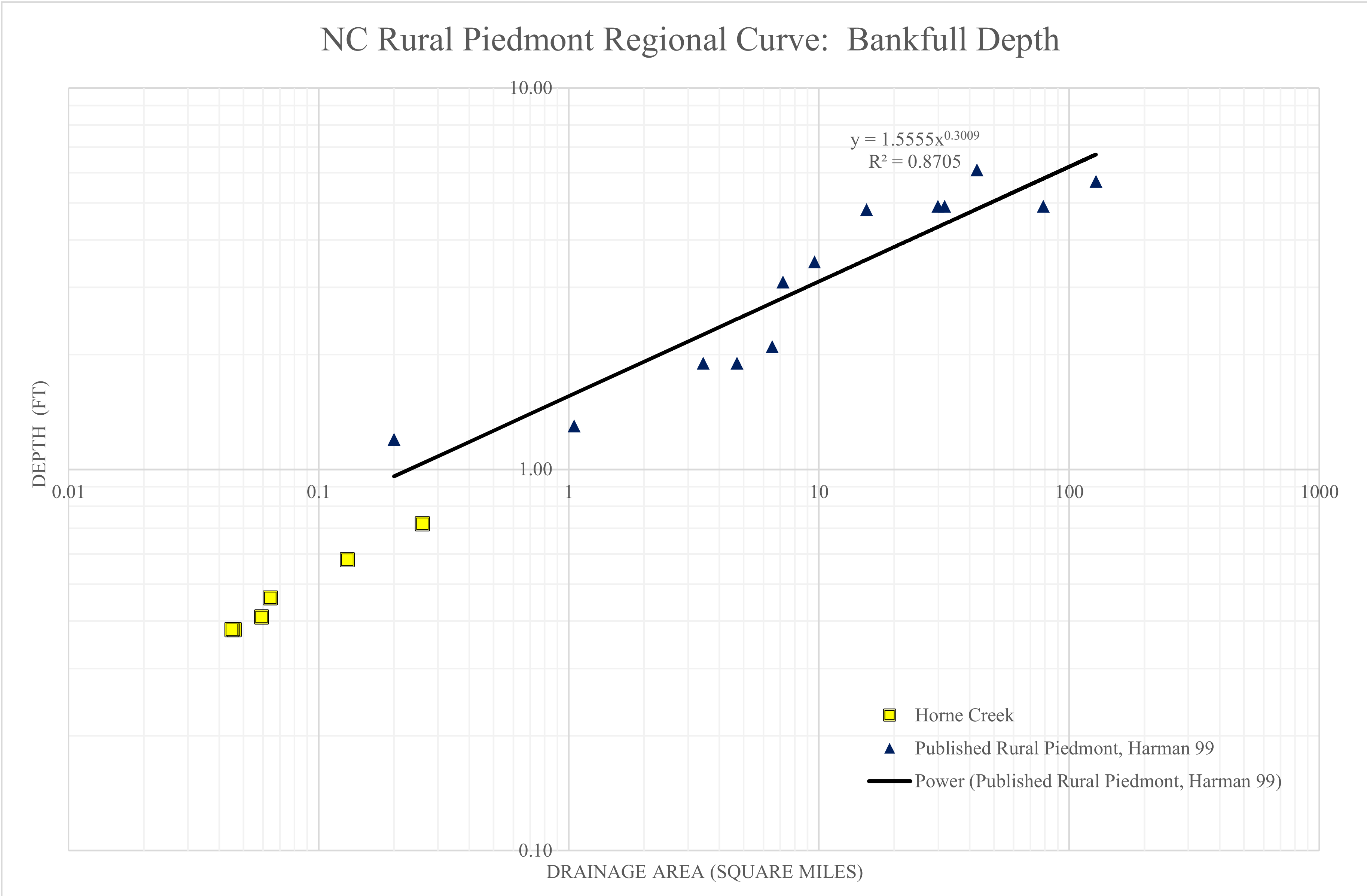


NC Rural Piedmont Regional Curve: Bankfull Discharge
y = 89.039x^0.7223
R² = 0.9069
10000.00
1000.00
100.00
10.00
1.00
DISCHARGE (CFS)
0.01
0.10
1.00
10.00
100.00
1000.00
DRAINAGE AREA (SQUARE MILES)
Published Rural Peidmont, Harman 99
Horne Creek
Power (Published Rural Peidmont, Harman 99)


NC Rural Piedmont Regional Curve: Bankfull Cross Sectional Area
y = 21.433x^0.6761
R² = 0.9491
1000.00
100.00
10.00
1.00
0.10
0.01
0.1
1
10
100
1000
CROSS SECTIONAL AREA (SQFT)
DRAINAGE AREA (SQUARE MILES)
Horne Creek
Published Rural Piedmont, Harman 99
Power (Published Rural Piedmont, Harman 99)



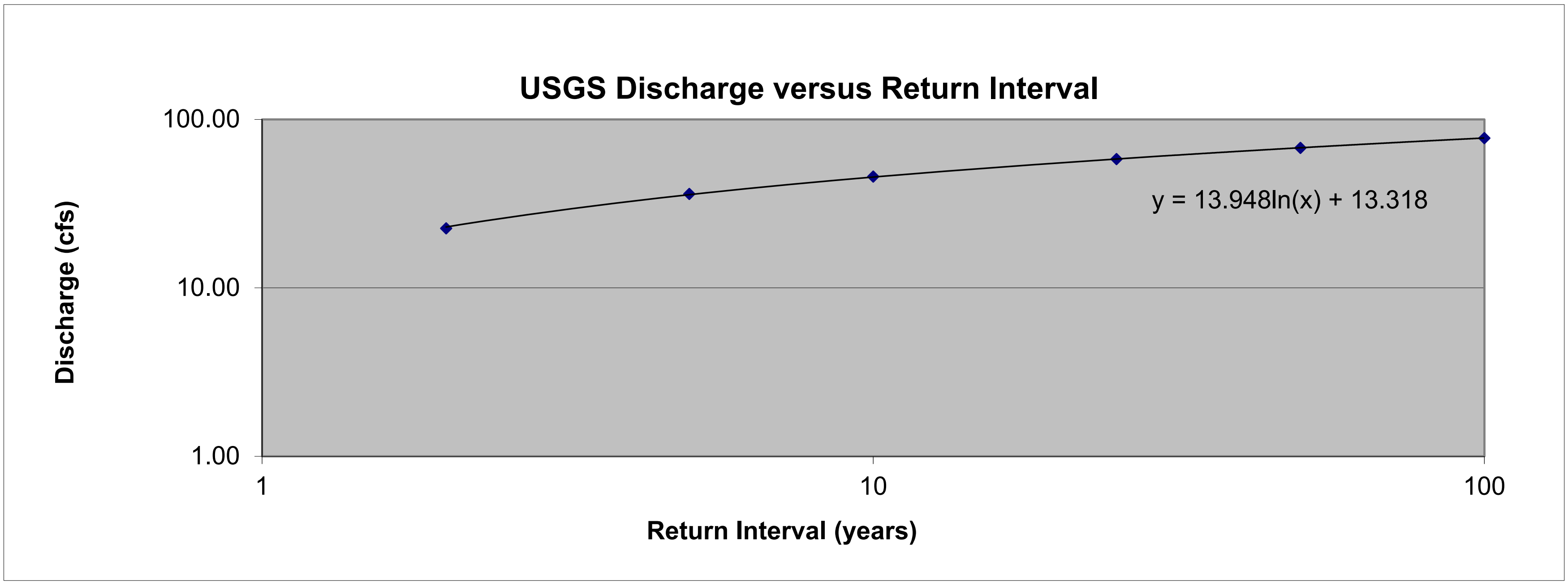
NC Rural Piedmont Regional Curve: Bankfull Width
1000.00
100.00
10.00
1.00
WIDTH (FT)
y = 13.686x^0.3766
R² = 0.9192
Horne Creek
Published Rural Piedmont, Harman 99
Power (Published Rural Piedmont, Harman 99)
0.01
0.1
1
10
100
1000
DRAINAGE AREA (SQUARE MILES)



NC Rural Piedmont Regional Curve: Bankfull Depth
y = 1.5555x^0.3009
R² = 0.8705
10.00
1.00
0.10
0.01
0.1
1
10
100
1000
DEPTH (FT)
DRAINAGE AREA (SQUARE MILES)
Horne Creek
Published Rural Piedmont, Harman 99
Power (Published Rural Piedmont, Harman 99)

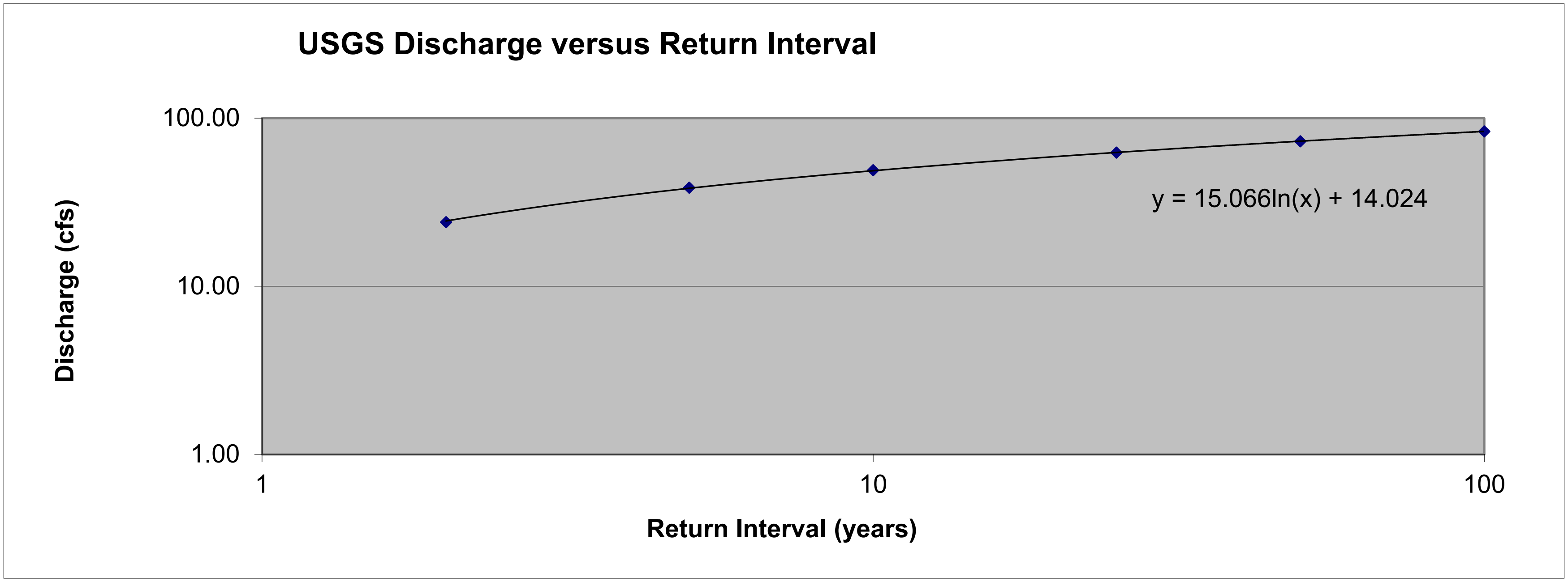
Site Description: Horne Creek Reach R1
Drainage Area = 0.0586 mi^2

Retun Interval	Discharge	Notes
1	13.32	extrapolated
1.2	15.86	extrapolated
1.5	18.97	extrapolated
2	22.54	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	36.13	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	45.77	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	58.19	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	67.76	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	77.45	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



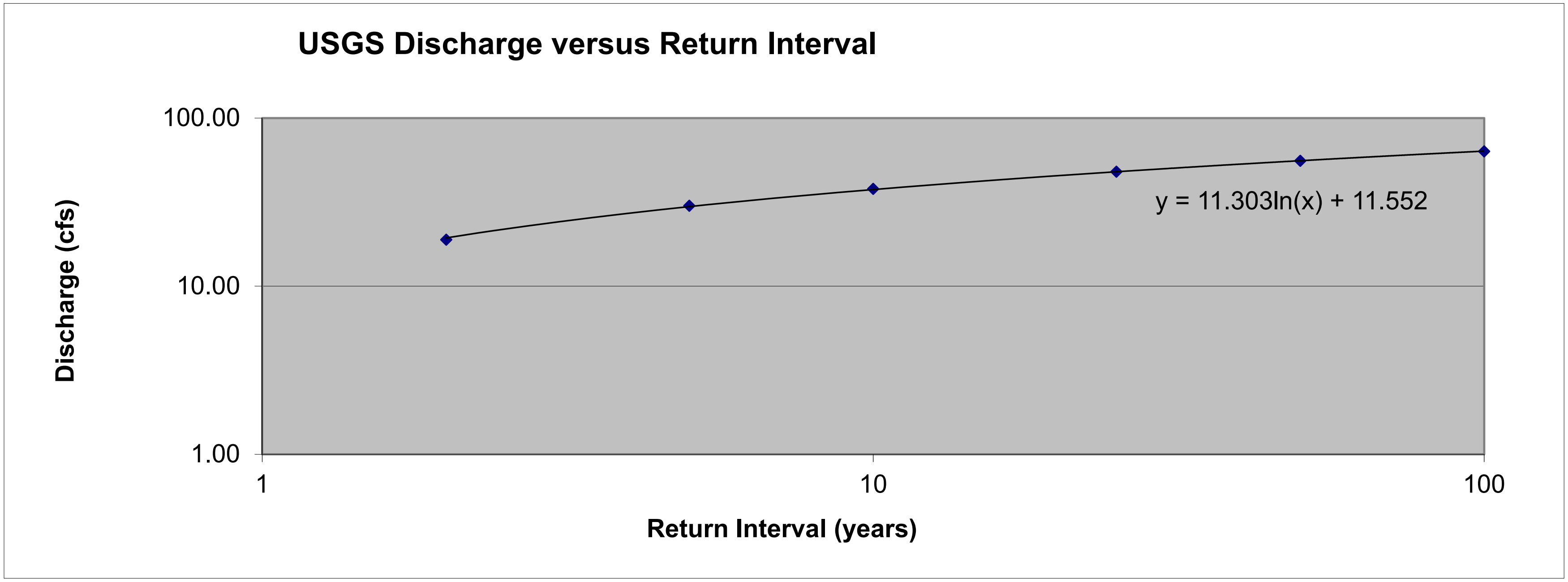
Site Description: Horne Creek Reach R2
Drainage Area = 0.0642 mi^2

Retun Interval	Discharge	Notes
1	14.02	extrapolated
1.2	16.77	extrapolated
1.5	20.13	extrapolated
2	24.05	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	38.64	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	49.02	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	62.46	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	72.82	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	83.34	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



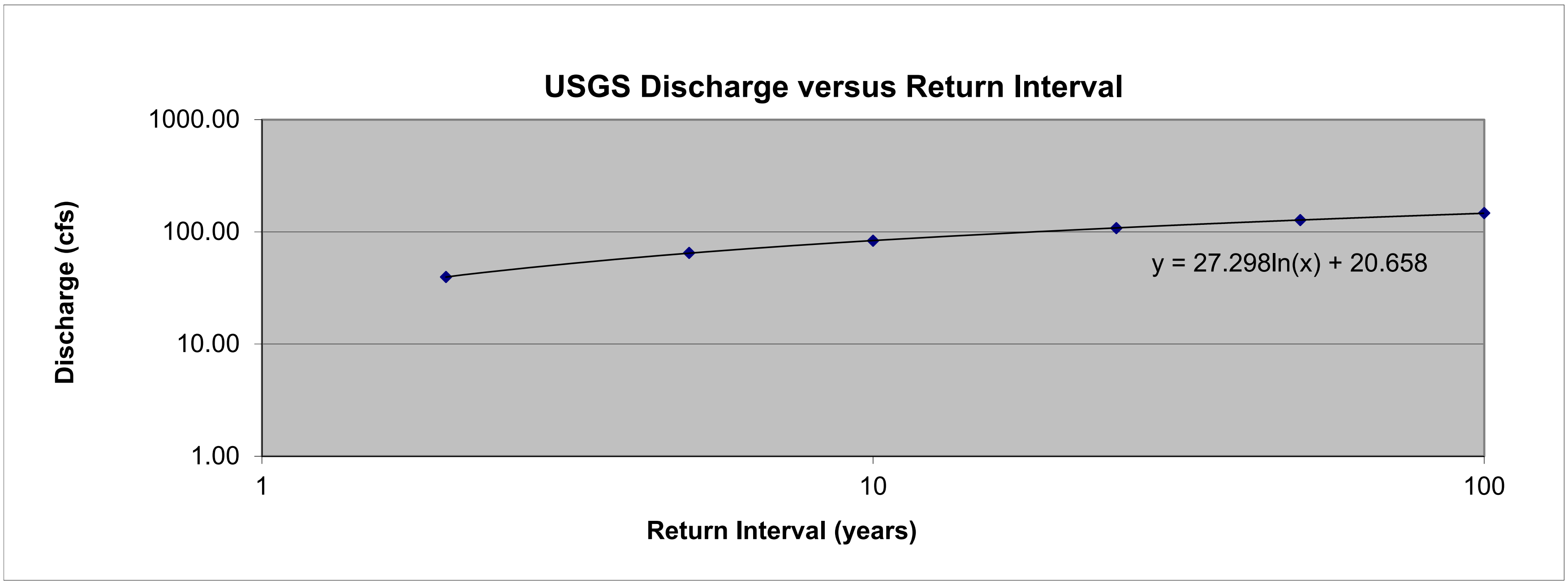
Site Description: Horne Creek Reach R3
Drainage Area = 0.0457 mi^2

Retun Interval	Discharge	Notes
1	11.55	extrapolated
1.2	13.61	extrapolated
1.5	16.13	extrapolated
2	18.90	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	30.10	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	37.95	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	47.99	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	55.67	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	63.42	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



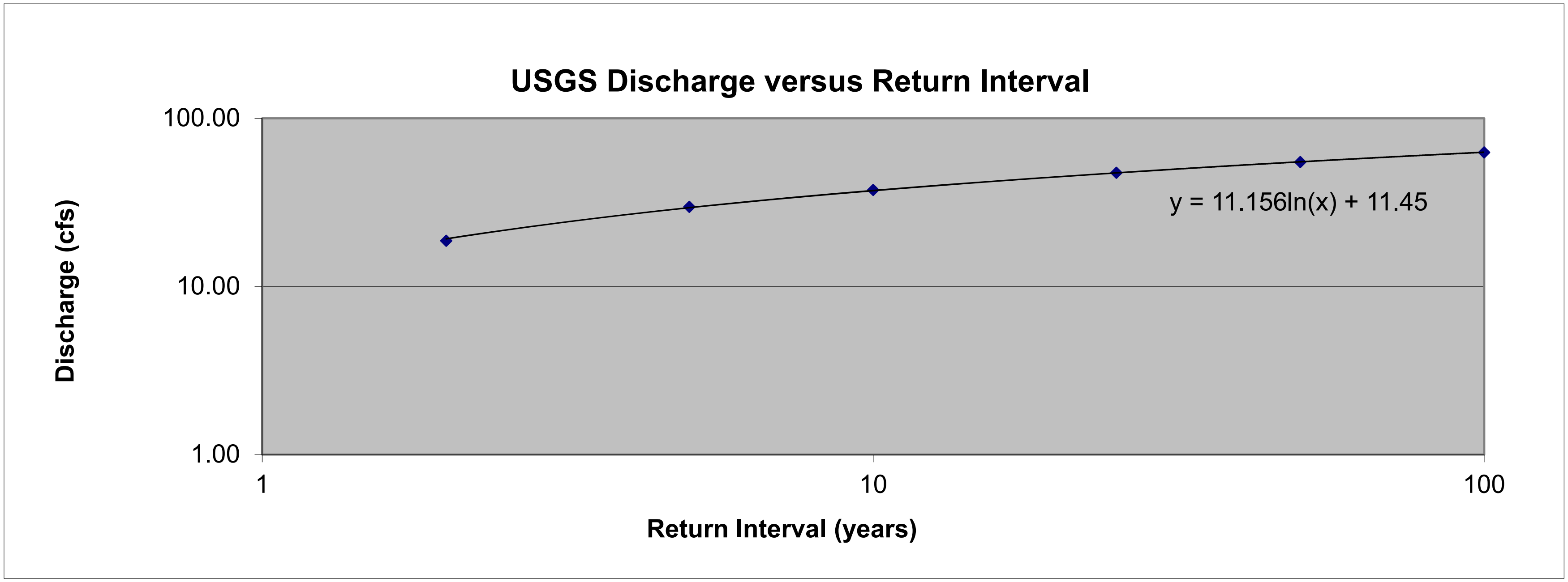
Site Description: Horne Creek Reach R4
Drainage Area = 0.13 mi^2

Retun Interval	Discharge	Notes
1	20.66	extrapolated
1.2	25.64	extrapolated
1.5	31.73	extrapolated
2	39.65	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	64.90	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	83.43	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	107.93	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	127.18	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	146.94	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



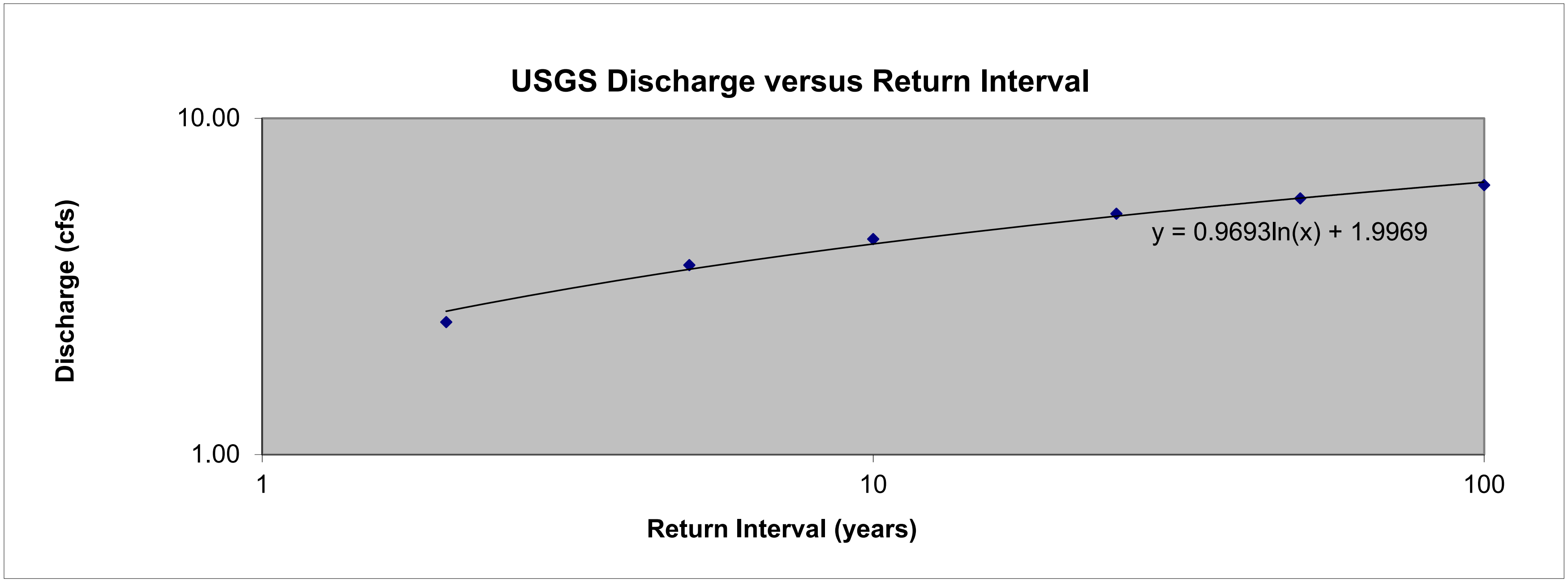
Site Description: Horne Creek Reach R4a
Drainage Area = 0.045 mi^2

Retun Interval	Discharge	Notes
1	11.45	extrapolated
1.2	13.48	extrapolated
1.5	15.97	extrapolated
2	18.69	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	29.76	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	37.51	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	47.42	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	54.99	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	62.63	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



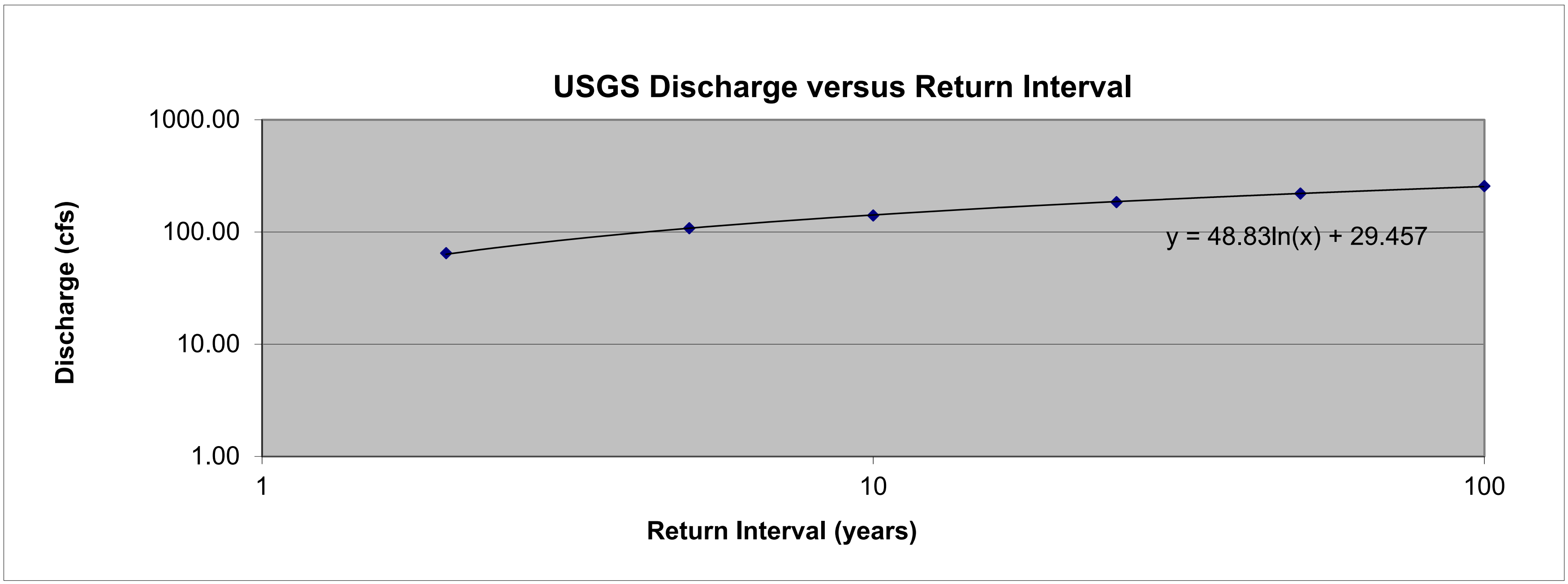
Site Description: Horne Creek Reach R4b
Drainage Area = 0.0026 mi^2

Retun Interval	Discharge	Notes
1	2.00	extrapolated
1.2	2.17	extrapolated
1.5	2.39	extrapolated
2	2.48	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	3.66	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	4.38	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	5.20	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	5.78	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	6.33	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



Site Description: Horne Creek Reach R5
Drainage Area = 0.26 mi^2

Retun Interval	Discharge	Notes
1	29.46	extrapolated
1.2	38.36	extrapolated
1.5	49.26	extrapolated
2	64.82	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	108.03	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	140.66	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	184.71	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	219.95	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	256.52	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



Catchment Assessment Form Horne CrTribs-R1

Rater(s): KMV

Date: 5/9/18

Overall Catchment Condition	**F**
Restoration Potential	**Level 5 - Biology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition			Rating (P/F/G)
		Poor	Fair	Good	
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	G
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	G
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	G
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	G
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	P
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	P
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	G
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	P
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	G
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	F
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Horne Creek Tribs
Reach ID:	R1
Restoration Potential:	Level 5 - Biology
Existing Stream Type:	F
Proposed Stream Type:	B
Region:	Piedmont
Drainage Area (sqmi):	0.06
Proposed Bed Material:	Gravel
Existing Stream Length (ft)	1397
Proposed Stream Length (ft):	1358
Stream Slope (%):	3.2
Flow Type:	Perennial
River Basin:	Yadkin-PeeDee
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.15
Proposed Condition Score (PCS)	0.79
Change in Functional Condition (PCS - ECS)	0.64
Percent Condition Change	427%
Existing Stream Length (ft)	1397
Proposed Stream Length (ft)	1358
Additional Stream Length (ft)	-39
Existing Functional Foot Score (FFS)	210
Proposed Functional Foot Score (FFS)	1073
Proposed FFS - Existing FFS	863
Functional Change (%)	412%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	210
Proposed Stream FFS + Proposed BMP FFS	1073
Total Proposed FFS - Total Existing FFS	863
Functional Change (%)	411%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.30	0.30
	Reach Runoff	0.61	0.70
Hydraulics	Floodplain Connectivity	0.00	1.00
Geomorphology	Large Woody Debris		
	Lateral Stability	0.50	1.00
	Riparian Vegetation	0.13	0.70
	Bed Material	0.36	1.00
	Bed Form Diversity	0.15	1.00
	Plan Form	0.00	0.70
Physicochemical	Temperature		
	Bacteria		
	Organic Matter	0.00	0.75
	Nitrogen		
	Phosphorus		
Biology	Macros	0.06	0.82
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.46	0.50	0.04
Hydraulics	0.00	1.00	1.00
Geomorphology	0.23	0.88	0.65
Physicochemical	0.00	0.75	0.75
Biology	0.06	0.82	0.76

EXISTING CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter (Roll Up Scoring)	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	70	0.3	0.30	0.46	Functioning At Risk	0.15	Not Functioning
	Reach Runoff	Curve Number	59	0.61	0.61				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	2.5	0	0.00	0.00	Not Functioning		
		Entrenchment Ratio	1.1	0					
Geomorphology	Large Woody Debris	LWD Index				0.23	Not Functioning		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			0.50				
		Dominant BEHI/NBS	M/M	0.5					
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)			0.13				
		Right Canopy Coverage (%)							
		Left Buffer Width (ft)	10	0.23					
		Right Buffer Width (ft)	10	0.23					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	15	0.03					
		Right Stem Density (stems/acre)	15	0.03					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.06	0.36	0.36				
	Bed Form Diversity	Pool Spacing Ratio			0.15				
		Pool Depth Ratio	1.2	0.3					
		Percent Riffle	80	0					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.1	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)				0.00	Not Functioning		
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate			0.00				
		Percent Shredders	0	0					
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index	6.53	0.11	0.06	0.06	Not Functioning		
		EPT Taxa Present	1	0					
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter (Roll Up Scoring)	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	70	0.3	0.30	0.50	Functioning At Risk	0.79	Functioning At Risk
	Reach Runoff	Curve Number	55	0.7	0.70				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	2.2	1					
Geomorphology	Large Woody Debris	LWD Index				0.88	Functioning		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.70				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	30	0.7					
		Right Buffer Width (ft)	30	0.7					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.7	1	1.00				
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	60	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.15	0.7	0.70				
Physicochemical	Temperature	Summer Daily Maximum (°F)				0.75	Functioning		
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate			0.75				
		Percent Shredders	9	0.75					
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index	2	1	0.82	0.82	Functioning		
		EPT Taxa Present	20	0.64					
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form Horne CrTribs-R2

Rater(s): KMV

Date: 5/9/18

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition			Rating
		Poor	**Fair**	**Good**	**(P/F/G)**
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	G
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	G
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	G
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	G
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	P
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	P
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	G
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	P
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	G
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	P
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Horne Creek Tribs
Reach ID:	R2
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	G
Proposed Stream Type:	B
Region:	Piedmont
Drainage Area (sqmi):	0.064
Proposed Bed Material:	Gravel
Existing Stream Length (ft)	286
Proposed Stream Length (ft):	296
Stream Slope (%):	3.1
Flow Type:	Intermittent
River Basin:	Yadkin-PeeDee
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.24
Proposed Condition Score (PCS)	0.48
Change in Functional Condition (PCS - ECS)	0.24
Percent Condition Change	100%
Existing Stream Length (ft)	286
Proposed Stream Length (ft)	296
Additional Stream Length (ft)	10
Existing Functional Foot Score (FFS)	69
Proposed Functional Foot Score (FFS)	142
Proposed FFS - Existing FFS	73
Functional Change (%)	107%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	69
Proposed Stream FFS + Proposed BMP FFS	142
Total Proposed FFS - Total Existing FFS	73
Functional Change (%)	106%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.36	0.36
	Reach Runoff	0.63	0.74
Hydraulics	Floodplain Connectivity	0.15	1.00
Geomorphology	Large Woody Debris		
	Lateral Stability	1.00	1.00
	Riparian Vegetation	0.30	0.70
	Bed Material	1.00	1.00
	Bed Form Diversity	0.36	0.94
	Plan Form	0.00	0.70
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.50	0.55	0.05
Hydraulics	0.15	1.00	0.85
Geomorphology	0.53	0.87	0.34
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.50	Functioning At Risk	0.24	Not Functioning
	Reach Runoff	Curve Number	58	0.63	0.63				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	2.1	0	0.15	0.15	Not Functioning		
		Entrenchment Ratio	1.2	0.3					
Geomorphology	Large Woody Debris	LWD Index				0.53	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)							
		Dominant BEHI/NBS	L/L	1	1.00				
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)			0.30				
		Right Canopy Coverage (%)							
		Left Buffer Width (ft)	5	0.12					
		Right Buffer Width (ft)	50	1					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	20	0.04					
		Right Stem Density (stems/acre)	20	0.04					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)	0.8	1	1.00				
	Bed Form Diversity	Pool Spacing Ratio	6	0.4	0.36				
		Pool Depth Ratio	1.5	0.69					
		Percent Riffle	80	0					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.07	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.55	Functioning At Risk	0.48	Functioning At Risk
	Reach Runoff	Curve Number	53	0.74	0.74				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	2.2	1					
Geomorphology	Large Woody Debris	LWD Index				0.87	Functioning		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)							
		Dominant BEHI/NBS	L/L	1	1.00				
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.70				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	30	0.7					
		Right Buffer Width (ft)	30	0.7					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)	0.7	1	1.00				
	Bed Form Diversity	Pool Spacing Ratio	3	0.82	0.94				
		Pool Depth Ratio	2	1					
		Percent Riffle	60	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.15	0.7	0.70				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form Horne CrTribs-R3

Rater(s): KMV

Date: 5/9/18

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition: Poor	Fair	Good	Rating (P/F/G)
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	G
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	G
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	G
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	G
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	P
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	P
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	G
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	P
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	G
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	P
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Horne Creek Tribs
Reach ID:	R3
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	G
Proposed Stream Type:	B
Region:	Piedmont
Drainage Area (sqmi):	0.05
Proposed Bed Material:	Gravel
Existing Stream Length (ft)	76
Proposed Stream Length (ft):	76
Stream Slope (%):	4.6
Flow Type:	Intermittent
River Basin:	Yadkin-PeeDee
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.31
Proposed Condition Score (PCS)	0.49
Change in Functional Condition (PCS - ECS)	0.18
Percent Condition Change	58%
Existing Stream Length (ft)	76
Proposed Stream Length (ft)	76
Additional Stream Length (ft)	0
Existing Functional Foot Score (FFS)	24
Proposed Functional Foot Score (FFS)	37
Proposed FFS - Existing FFS	14
Functional Change (%)	58%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	24
Proposed Stream FFS + Proposed BMP FFS	37
Total Proposed FFS - Total Existing FFS	13
Functional Change (%)	54%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.36	0.36
	Reach Runoff	0.63	0.74
Hydraulics	Floodplain Connectivity	0.50	1.00
Geomorphology	Large Woody Debris		
	Lateral Stability	1.00	1.00
	Riparian Vegetation	0.10	0.75
	Bed Material	0.58	1.00
	Bed Form Diversity	1.00	1.00
	Plan Form	0.00	0.70
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.50	0.55	0.05
Hydraulics	0.50	1.00	0.50
Geomorphology	0.54	0.89	0.35
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.50	Functioning At Risk	0.31	Functioning At Risk
	Reach Runoff	Curve Number	58	0.63	0.63				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	2.7	0	0.50	0.50	Functioning At Risk		
		Entrenchment Ratio	4	1					
Geomorphology	Large Woody Debris	LWD Index				0.54	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	5	0.06	0.10				
		Right Canopy Coverage (%)	5	0.06					
		Left Buffer Width (ft)	10	0.23					
		Right Buffer Width (ft)	10	0.23					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	10	0.02					
		Right Stem Density (stems/acre)	10	0.02					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)	0.09	0.58	0.58				
	Bed Form Diversity	Pool Spacing Ratio	3	1	1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	50	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.07	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.55	Functioning At Risk	0.49	Functioning At Risk
	Reach Runoff	Curve Number	53	0.74	0.74				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	2.2	1					
Geomorphology	Large Woody Debris	LWD Index				0.89	Functioning		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.75				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	50	1					
		Right Buffer Width (ft)	30	0.7					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)	0.7	1	1.00				
	Bed Form Diversity	Pool Spacing Ratio	3	1	1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	60	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.15	0.7	0.70				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form Horne CrTribs-R4

Rater(s): KMV

Date: 5/9/18

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition			Rating (P/F/G)
		Poor	Fair	Good	
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	G
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	G
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	G
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	G
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	P
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	P
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	G
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	P
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	G
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	P
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Horne Creek Tribs
Reach ID:	R4
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	B
Proposed Stream Type:	Bc
Region:	Piedmont
Drainage Area (sqmi):	0.13
Proposed Bed Material:	Gravel
Existing Stream Length (ft)	1191
Proposed Stream Length (ft):	1206
Stream Slope (%):	2.9
Flow Type:	Perennial
River Basin:	Yadkin-PeeDee
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Valley Type:	Unconfined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.31
Proposed Condition Score (PCS)	0.50
Change in Functional Condition (PCS - ECS)	0.19
Percent Condition Change	61%
Existing Stream Length (ft)	1191
Proposed Stream Length (ft)	1206
Additional Stream Length (ft)	15
Existing Functional Foot Score (FFS)	369
Proposed Functional Foot Score (FFS)	603
Proposed FFS - Existing FFS	234
Functional Change (%)	63%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	369
Proposed Stream FFS + Proposed BMP FFS	603
Total Proposed FFS - Total Existing FFS	234
Functional Change (%)	63%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.36	0.36
	Reach Runoff	0.63	0.74
Hydraulics	Floodplain Connectivity	0.41	1.00
Geomorphology	Large Woody Debris		
	Lateral Stability	0.50	1.00
	Riparian Vegetation	0.36	0.70
	Bed Material	0.58	1.00
	Bed Form Diversity	0.85	1.00
	Plan Form	1.00	1.00
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.50	0.55	0.05
Hydraulics	0.41	1.00	0.59
Geomorphology	0.66	0.94	0.28
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.50	Functioning At Risk	0.31	Functioning At Risk
	Reach Runoff	Curve Number	58	0.63	0.63				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	4.4	0	0.41	0.41	Functioning At Risk		
		Entrenchment Ratio	1.7	0.81					
Geomorphology	Large Woody Debris	LWD Index				0.66	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)							
		Dominant BEHI/NBS	M/M	0.5	0.50				
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	50	0.58	0.36				
		Right Canopy Coverage (%)	50	0.58					
		Left Buffer Width (ft)	20	0.47					
		Right Buffer Width (ft)	20	0.47					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	20	0.04					
		Right Stem Density (stems/acre)	20	0.04					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.09	0.58	0.58				
	Bed Form Diversity	Pool Spacing Ratio	4	FALSE	0.85				
		Pool Depth Ratio	1.5	0.69					
		Percent Riffle	70	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.29	1	1.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.55	Functioning At Risk	0.50	Functioning At Risk
	Reach Runoff	Curve Number	53	0.74	0.74				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	2.2	1					
Geomorphology	Large Woody Debris	LWD Index				0.94	Functioning		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)							
		Dominant BEHI/NBS	L/L	1	1.00				
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.70				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	30	0.7					
		Right Buffer Width (ft)	30	0.7					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.7	1	1.00				
	Bed Form Diversity	Pool Spacing Ratio	2	FALSE	1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	60	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.25	1	1.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form Horne CrTribs-R4A

Rater(s): KMV

Date: 5/9/18

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition: Poor	Fair	Good	Rating (P/F/G)
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	G
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	G
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	G
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	G
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	P
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	P
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	G
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	P
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	G
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	P
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Horne Creek Tribs
Reach ID:	R4A
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	G
Proposed Stream Type:	Bc
Region:	Piedmont
Drainage Area (sqmi):	0.05
Proposed Bed Material:	Gravel
Existing Stream Length (ft)	124
Proposed Stream Length (ft):	167
Stream Slope (%):	2
Flow Type:	Perennial
River Basin:	Yadkin-PeeDee
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.27
Proposed Condition Score (PCS)	0.49
Change in Functional Condition (PCS - ECS)	0.22
Percent Condition Change	81%
Existing Stream Length (ft)	124
Proposed Stream Length (ft)	167
Additional Stream Length (ft)	43
Existing Functional Foot Score (FFS)	33
Proposed Functional Foot Score (FFS)	82
Proposed FFS - Existing FFS	48
Functional Change (%)	144%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	33
Proposed Stream FFS + Proposed BMP FFS	82
Total Proposed FFS - Total Existing FFS	49
Functional Change (%)	148%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.36	0.36
	Reach Runoff	0.63	0.74
Hydraulics	Floodplain Connectivity	0.35	1.00
Geomorphology	Large Woody Debris		
	Lateral Stability	0.60	1.00
	Riparian Vegetation	0.49	0.70
	Bed Material	0.58	1.00
	Bed Form Diversity	0.15	1.00
	Plan Form	0.74	0.70
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.50	0.55	0.05
Hydraulics	0.35	1.00	0.65
Geomorphology	0.51	0.88	0.37
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.50	Functioning At Risk	0.27	Not Functioning
	Reach Runoff	Curve Number	58	0.63	0.63				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.7	0	0.35	0.35	Functioning At Risk		
		Entrenchment Ratio	1.4	0.7					
Geomorphology	Large Woody Debris	LWD Index				0.51	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)							
		Dominant BEHI/NBS	M/L	0.6	0.60				
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	70	0.79	0.49				
		Right Canopy Coverage (%)	70	0.79					
		Left Buffer Width (ft)	25	0.58					
		Right Buffer Width (ft)	25	0.58					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	50	0.1					
		Right Stem Density (stems/acre)	50	0.1					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.09	0.58	0.58				
	Bed Form Diversity	Pool Spacing Ratio	4	FALSE	0.15				
		Pool Depth Ratio	1	0					
		Percent Riffle	80	0.3					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.18	0.74	0.74				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.55	Functioning At Risk	0.49	Functioning At Risk
	Reach Runoff	Curve Number	53	0.74	0.74				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	2.2	1					
Geomorphology	Large Woody Debris	LWD Index				0.88	Functioning		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)							
		Dominant BEHI/NBS	L/L	1	1.00				
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.70				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	30	0.7					
		Right Buffer Width (ft)	30	0.7					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.7	1	1.00				
	Bed Form Diversity	Pool Spacing Ratio	3	FALSE	1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	60	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.15	0.7	0.70				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form Horne CrTribs-R4B

Rater(s): KMV

Date: 5/9/18

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition			Rating (P/F/G)
		Poor	Fair	Good	
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	G
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	G
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	G
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	G
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	P
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	P
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	G
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	P
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	G
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	P
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Horne Creek Tribs
Reach ID:	R4B
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	G
Proposed Stream Type:	Bc
Region:	Piedmont
Drainage Area (sqmi):	0.003
Proposed Bed Material:	Gravel
Existing Stream Length (ft)	89
Proposed Stream Length (ft):	152
Stream Slope (%):	2.5
Flow Type:	Perennial
River Basin:	Yadkin-PeeDee
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.24
Proposed Condition Score (PCS)	0.49
Change in Functional Condition (PCS - ECS)	0.25
Percent Condition Change	104%
Existing Stream Length (ft)	89
Proposed Stream Length (ft)	152
Additional Stream Length (ft)	63
Existing Functional Foot Score (FFS)	21
Proposed Functional Foot Score (FFS)	74
Proposed FFS - Existing FFS	53
Functional Change (%)	249%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	21
Proposed Stream FFS + Proposed BMP FFS	74
Total Proposed FFS - Total Existing FFS	53
Functional Change (%)	252%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.36	0.36
	Reach Runoff	0.63	0.74
Hydraulics	Floodplain Connectivity	0.37	1.00
Geomorphology	Large Woody Debris		
	Lateral Stability	0.60	1.00
	Riparian Vegetation	0.50	0.70
	Bed Material	0.58	1.00
	Bed Form Diversity	0.00	1.00
	Plan Form	0.00	0.70
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.50	0.55	0.05
Hydraulics	0.37	1.00	0.63
Geomorphology	0.34	0.88	0.54
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter (Roll Up Scoring)	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.50	Functioning At Risk	0.24	Not Functioning
	Reach Runoff	Curve Number	58	0.63	0.63				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	4.3	0	0.37	0.37	Functioning At Risk		
		Entrenchment Ratio	1.5	0.74					
Geomorphology	Large Woody Debris	LWD Index				0.34	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)							
		Dominant BEHI/NBS	M/L	0.6	0.60				
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	60	0.69	0.50				
		Right Canopy Coverage (%)	60	0.69					
		Left Buffer Width (ft)	30	0.7					
		Right Buffer Width (ft)	30	0.7					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	50	0.1					
		Right Stem Density (stems/acre)	50	0.1					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.09	0.58	0.58				
	Bed Form Diversity	Pool Spacing Ratio			0.00				
		Pool Depth Ratio	1	0					
		Percent Riffle	90	0					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.02	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter (Roll Up Scoring)	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.55	Functioning At Risk	0.49	Functioning At Risk
	Reach Runoff	Curve Number	53	0.74	0.74				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	2.2	1					
Geomorphology	Large Woody Debris	LWD Index				0.88	Functioning		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)							
		Dominant BEHI/NBS	L/L	1	1.00				
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.70				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	30	0.7					
		Right Buffer Width (ft)	30	0.7					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.7	1	1.00				
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	60	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.15	0.7	0.70				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form Horne CrTribs-R5

Rater(s): KMV

Date: 5/9/18

Overall Catchment Condition	**F**
Restoration Potential	**Level 5 - Biology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition: Poor	Fair	Good	Rating (P/F/G)
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	G
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	G
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	G
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	G
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	P
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	P
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	G
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	P
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	G
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	F
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Horne Creek Tribs
Reach ID:	R5
Restoration Potential:	Level 5 - Biology
Existing Stream Type:	Gc
Proposed Stream Type:	Bc
Region:	Piedmont
Drainage Area (sqmi):	0.26
Proposed Bed Material:	Gravel
Existing Stream Length (ft)	2519
Proposed Stream Length (ft):	2293
Stream Slope (%):	1.9
Flow Type:	Perennial
River Basin:	Yadkin-PeeDee
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Valley Type:	Unconfined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.38
Proposed Condition Score (PCS)	0.90
Change in Functional Condition (PCS - ECS)	0.52
Percent Condition Change	137%
Existing Stream Length (ft)	2519
Proposed Stream Length (ft)	2293
Additional Stream Length (ft)	-226
Existing Functional Foot Score (FFS)	957
Proposed Functional Foot Score (FFS)	2064
Proposed FFS - Existing FFS	1106
Functional Change (%)	116%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	957
Proposed Stream FFS + Proposed BMP FFS	2064
Total Proposed FFS - Total Existing FFS	1107
Functional Change (%)	116%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.36	0.36
	Reach Runoff	0.63	0.74
Hydraulics	Floodplain Connectivity	0.25	1.00
Geomorphology	Large Woody Debris		
	Lateral Stability	0.60	1.00
	Riparian Vegetation	0.16	0.70
	Bed Material	0.29	1.00
	Bed Form Diversity	0.80	1.00
	Plan Form	1.00	1.00
Physicochemical	Temperature		
	Bacteria		
	Organic Matter	0.00	1.00
	Nitrogen		
	Phosphorus		
Biology	Macros	0.58	1.00
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.50	0.55	0.05
Hydraulics	0.25	1.00	0.75
Geomorphology	0.57	0.94	0.37
Physicochemical	0.00	1.00	1.00
Biology	0.58	1.00	0.42

EXISTING CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter (Roll Up Scoring)	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.50	Functioning At Risk	0.38	Functioning At Risk
	Reach Runoff	Curve Number	58	0.63	0.63				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	3.9	0	0.25	0.25	Not Functioning		
		Entrenchment Ratio	1.3	0.5					
Geomorphology	Large Woody Debris	LWD Index				0.57	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			0.60				
		Dominant BEHI/NBS	M/L	0.6					
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	20	0.24	0.16				
		Right Canopy Coverage (%)	20	0.24					
		Left Buffer Width (ft)	10	0.23					
		Right Buffer Width (ft)	10	0.23					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	5	0.01					
		Right Stem Density (stems/acre)	5	0.01					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)	0.05	0.29	0.29				
	Bed Form Diversity	Pool Spacing Ratio	4	0.7	0.80				
		Pool Depth Ratio	1.5	0.69					
		Percent Riffle	70	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.3	1	1.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)				0.00	Not Functioning		
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate			0.00				
		Percent Shredders	0	0					
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index	4.99	0.79	0.58	0.58	Functioning At Risk		
		EPT Taxa Present	15	0.36					
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter (Roll Up Scoring)	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	68	0.36	0.36	0.55	Functioning At Risk	0.90	Functioning At Risk
	Reach Runoff	Curve Number	53	0.74	0.74				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	2.2	1					
Geomorphology	Large Woody Debris	LWD Index				0.94	Functioning		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)							
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.70				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	30	0.7					
		Right Buffer Width (ft)	30	0.7					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)	0.7	1	1.00				
	Bed Form Diversity	Pool Spacing Ratio	0.7	1	1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	70	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.25	1	1.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)				1.00	Functioning		
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate			1.00				
		Percent Shredders	12	1					
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index	4.3	1	1.00	1.00	Functioning		
		EPT Taxa Present	28	1					
	Fish	North Carolina Index of Biotic Integrity							

Horne Creek Reach 1	Proposed Stream Values (Restoration)		Notes
Parameter	MIN	MAX	
Stream Length (ft)	1322		
Drainage Area, DA (sq mi)	0.0586		37.504
Stream Type (Rosgen)	B4		
Bankfull Discharge, Qbkf (cfs)	12.00		Calculated from analysis of USGS regression eq., velocity/discharge calcs
Bankfull Riffle XSEC Area, Abkf (sq ft)	2.89		Calcuated from Riffle Tab
Bankfull Mean Velocity, Vbkf (ft/s)	4.16		C-channel 3.5-5, B-channel 4-6
Bankfull Riffle Width, Wbkf (ft)	7.00		
Bankfull Mean Depth, Dbkf (ft)	0.41		
Width to Depth Ratio, W/D (ft/ft)	16.97		C-channel 10-14, B-channel 12-18
Width of Floodprone Area, Wfpa (ft)	28.00	65.00	Must be greater than this value to not be entrenched
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	4.00	9.29	> 2.2 Not entrenched
Riffle Max Depth @ bkf, Dmax (ft)	0.55		
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.33		C-channel 1.1-1.3, B-channel 1.2-1.4
Max Depth @ tob, Dmaxtob (ft)	0.55		
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00		C-channel 1.0-1.1, B-channel 1.0-1.1
Meander Wavelength, Lm (ft)*	49.00	84.00	NA
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00	C-channel 7.0-12.0
Radius of Curvature, Rc (ft)*	14.00	21.00	NA
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00	C-channel 2.0-3.0 (not applicable for B-channel)
Belt Width, Wblt (ft)*	24.50	56.00	NA
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00	C-channel 3.5-8.0 (not applicable for B-channel)
Sinuosity, K (Sval/Schan)	1.07		C-channel between 1.2-1.6, B-channel 1.1-1.2
Valley Slope, Sval (ft/ft)	0.0366		C-channel 0.005-0.015, B-channel 0.020-0.030
Channel Slope, Schan (ft/ft)	0.0341		Calculated from valley slope and sinuosity
Riffle Slope, Srif	0.0376	0.0615	
Riffle Slope Ratio, Srif/Schan	1.10	1.80	C-channel between 1.5-2.0, B-channel 1.1-1.8
Pool Slope, Spool (ft/ft)	0.0000	0.0137	
Pool Slope Ratio, Spool/Schan	0.00	0.40	C-channel 0.0-0.2, B-channel 0.0-0.4
Pool Max Depth @ bkf, Dmaxpool (ft)	0.83	1.44	
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50	C-channel 2.0-3.5, B-channel 2.0-3.5
Pool Width, Wpool (ft)	7.70	10.50	
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.10	1.50	C-channel 1.3-1.7, B-channel 1.1-1.5
Pool Spacing, Lps (ft)	10.50	35.00	
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.50	5.00	C-channel 4.0-7.0, B-channel 1.5-5.0

* Only applicable for C and E type channels.

Horne Creek Reach 2	Proposed Stream Values (Restoration)		Notes
Parameter	**MIN**	**MAX**	
Stream Length (ft)	296		
Drainage Area, DA (sq mi)	0.0642		41.088
Stream Type (Rosgen)	B4		
Bankfull Discharge, Qbkf (cfs)	12.00		Calculated from analysis of USGS regression eq., velocity/discharge calcs
Bankfull Riffle XSEC Area, Abkf (sq ft)	2.75		Calcuated from Riffle Tab
Bankfull Mean Velocity, Vbkf (ft/s)	4.36		C-channel 3.5-5, B-channel 4-6
Bankfull Riffle Width, Wbkf (ft)	6.00		
Bankfull Mean Depth, Dbkf (ft)	0.46		
Width to Depth Ratio, W/D (ft/ft)	13.09		C-channel 10-14, B-channel 12-18
Width of Floodprone Area, Wfpa (ft)	15.00	19.00	Must be greater than this value to not be entrenched
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	2.50	3.17	> 2.2 Not entrenched
Riffle Max Depth @ bkf, Dmax (ft)	0.55		
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.20		C-channel 1.1-1.3, B-channel 1.2-1.4
Max Depth @ tob, Dmaxtob (ft)	0.55		
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00		C-channel 1.0-1.1, B-channel 1.0-1.1
Meander Wavelength, Lm (ft)*	42.00	72.00	NA
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00	C-channel 7.0-12.0
Radius of Curvature, Rc (ft)*	12.00	18.00	NA
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00	C-channel 2.0-3.0 (not applicable for B-channel)
Belt Width, Wblt (ft)*	21.00	48.00	NA
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00	C-channel 3.5-8.0 (not applicable for B-channel)
Sinuosity, K (Sval/Schan)	1.08		C-channel between 1.2-1.6, B-channel 1.1-1.2
Valley Slope, Sval (ft/ft)	0.0325		C-channel 0.005-0.015, B-channel 0.020-0.030
Channel Slope, Schan (ft/ft)	0.0302		Calculated from valley slope and sinuosity
Riffle Slope, Srif	0.0332	0.0543	
Riffle Slope Ratio, Srif/Schan	1.10	1.80	C-channel between 1.5-2.0, B-channel 1.1-1.8
Pool Slope, Spool (ft/ft)	0.0000	0.0121	
Pool Slope Ratio, Spool/Schan	0.00	0.40	C-channel 0.0-0.2, B-channel 0.0-0.4
Pool Max Depth @ bkf, Dmaxpool (ft)	0.92	1.60	
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50	C-channel 2.0-3.5, B-channel 2.0-3.5
Pool Width, Wpool (ft)	6.60	9.00	
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.10	1.50	C-channel 1.3-1.7, B-channel 1.1-1.5
Pool Spacing, Lps (ft)	9.00	30.00	
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.50	5.00	C-channel 4.0-7.0, B-channel 1.5-5.0

* Only applicable for C and E type channels.

Horne Creek Reach 3	Proposed Stream Values (Restoration)		Notes
Parameter	**MIN**	**MAX**	
Stream Length (ft)	154		
Drainage Area, DA (sq mi)	0.046		29.44
Stream Type (Rosgen)	B4a		
Bankfull Discharge, Qbkf (cfs)	10.00		Calculated from analysis of USGS regression eq., velocity/discharge calcs
Bankfull Riffle XSEC Area, Abkf (sq ft)	2.25		Calcuated from Riffle Tab
Bankfull Mean Velocity, Vbkf (ft/s)	4.44		C-channel 3.5-5, B-channel 4-6
Bankfull Riffle Width, Wbkf (ft)	6.00		
Bankfull Mean Depth, Dbkf (ft)	0.38		
Width to Depth Ratio, W/D (ft/ft)	16.00		C-channel 10-14, B-channel 12-18
Width of Floodprone Area, Wfpa (ft)	20.00	34.00	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	3.33	5.67	> 2.2 Not entrenched
Riffle Max Depth @ bkf, Dmax (ft)	0.50		
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.33		C-channel 1.1-1.3, B-channel 1.2-1.4
Max Depth @ tob, Dmaxtob (ft)	0.50		
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00		C-channel 1.0-1.1, B-channel 1.0-1.1
Meander Wavelength, Lm (ft)*	42.00	72.00	Na
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00	C-channel 7.0-12.0
Radius of Curvature, Rc (ft)*	12.00	18.00	Na
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00	C-channel 2.0-3.0 (not applicable for B-channel)
Belt Width, Wblt (ft)*	21.00	48.00	Na
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00	C-channel 3.5-8.0 (not applicable for B-channel)
Sinuosity, K (Sval/Schan)	1.07		C-channel between 1.2-1.6, B-channel 1.1-1.2
Valley Slope, Sval (ft/ft)	0.0496		C-channel 0.005-0.015, B-channel 0.020-0.030
Channel Slope, Schan (ft/ft)	0.0464		Calculated from valley slope and sinuosity
Riffle Slope, Srif	0.0510	0.0835	
Riffle Slope Ratio, Srif/Schan	1.10	1.80	C-channel between 1.5-2.0, B-channel 1.1-1.8
Pool Slope, Spool (ft/ft)	0.0000	0.0186	
Pool Slope Ratio, Spool/Schan	0.00	0.40	C-channel 0.0-0.2, B-channel 0.0-0.4
Pool Max Depth @ bkf, Dmaxpool (ft)	0.75	1.31	
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50	C-channel 2.0-3.5, B-channel 2.0-3.5
Pool Width, Wpool (ft)	6.60	9.00	
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.10	1.50	C-channel 1.3-1.7, B-channel 1.1-1.5
Pool Spacing, Lps (ft)	9.00	30.00	
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.50	5.00	C-channel 4.0-7.0, B-channel 1.5-5.0

* Only applicable for C and E type channels.

Horne Creek Reach 4	Proposed Stream Values (Restoration)		Notes
Parameter	MIN	MAX	
Stream Length (ft)	1282		
Drainage Area, DA (sq mi)	0.13		83.2
Stream Type (Rosgen)	B4/C4b		
Bankfull Discharge, Qbkf (cfs)	22.00		Calculated from analysis of USGS regression eq., velocity/discharge calcs
Bankfull Riffle XSEC Area, Abkf (sq ft)	5.20		Calcuated from Riffle Tab
Bankfull Mean Velocity, Vbkf (ft/s)	4.23		C-channel 3.5-5, B-channel 4-6
Bankfull Riffle Width, Wbkf (ft)	9.00		
Bankfull Mean Depth, Dbkf (ft)	0.58		
Width to Depth Ratio, W/D (ft/ft)	15.58		C-channel 10-14, B-channel 12-18
Width of Floodprone Area, Wfpa (ft)	38.00	79.00	Must be greater than this value to not be entrenched
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	4.22	8.78	> 2.2 Not entrenched
Riffle Max Depth @ bkf, Dmax (ft)	0.80		
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.38		C-channel 1.1-1.3, B-channel 1.2-1.4
Max Depth @ tob, Dmaxtob (ft)	0.80		
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00		C-channel 1.0-1.1, B-channel 1.0-1.1
Meander Wavelength, Lm (ft)*	63.00	108.00	
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00	C-channel 7.0-12.0
Radius of Curvature, Rc (ft)*	18.00	27.00	
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00	C-channel 2.0-3.0 (not applicable for B-channel)
Belt Width, Wblt (ft)*	31.50	72.00	
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00	C-channel 3.5-8.0 (not applicable for B-channel)
Sinuosity, K (Sval/Schan)	1.31		C-channel between 1.2-1.6, B-channel 1.1-1.2
Valley Slope, Sval (ft/ft)	0.0381		C-channel 0.005-0.015, B-channel 0.020-0.030
Channel Slope, Schan (ft/ft)	0.0290		Calculated from valley slope and sinuosity
Riffle Slope, Srif	0.0319	0.0522	
Riffle Slope Ratio, Srif/Schan	1.10	1.80	C-channel between 1.5-2.0, B-channel 1.1-1.8
Pool Slope, Spool (ft/ft)	0.0000	0.0116	
Pool Slope Ratio, Spool/Schan	0.00	0.40	C-channel 0.0-0.2, B-channel 0.0-0.4
Pool Max Depth @ bkf, Dmaxpool (ft)	1.16	2.02	
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50	C-channel 2.0-3.5, B-channel 2.0-3.5
Pool Width, Wpool (ft)	9.90	13.50	
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.10	1.50	C-channel 1.3-1.7, B-channel 1.1-1.5
Pool Spacing, Lps (ft)	13.50	45.00	
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.50	5.00	C-channel 4.0-7.0, B-channel 1.5-5.0

* Only applicable for C and E type channels.

Horne Creek Reach 4A	Proposed Stream Values (Restoration)		Notes
Parameter	MIN	MAX	
Stream Length (ft)	167		
Drainage Area, DA (sq mi)	0.045		28.8
Stream Type (Rosgen)	B4c		
Bankfull Discharge, Qbkf (cfs)	10.00		Calculated from analysis of USGS regression eq., velocity/discharge calcs
Bankfull Riffle XSEC Area, Abkf (sq ft)	2.25		Calcuated from Riffle Tab
Bankfull Mean Velocity, Vbkf (ft/s)	4.44		C-channel 3.5-5, B-channel 4-6
Bankfull Riffle Width, Wbkf (ft)	6.00		
Bankfull Mean Depth, Dbkf (ft)	0.38		
Width to Depth Ratio, W/D (ft/ft)	16.00		C-channel 10-14, B-channel 12-18
Width of Floodprone Area, Wfpa (ft)	25.00	46.00	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	4.17	7.67	> 2.2 Not entrenched
Riffle Max Depth @ bkf, Dmax (ft)	0.50		
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.33		C-channel 1.1-1.3, B-channel 1.2-1.4
Max Depth @ tob, Dmaxtob (ft)	0.50		
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00		C-channel 1.0-1.1, B-channel 1.0-1.1
Meander Wavelength, Lm (ft)*	42.00	72.00	Na
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00	C-channel 7.0-12.0
Radius of Curvature, Rc (ft)*	12.00	18.00	Na
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00	C-channel 2.0-3.0 (not applicable for B-channel)
Belt Width, Wblt (ft)*	21.00	48.00	Na
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00	C-channel 3.5-8.0 (not applicable for B-channel)
Sinuosity, K (Sval/Schan)	1.14		C-channel between 1.2-1.6, B-channel 1.1-1.2
Valley Slope, Sval (ft/ft)	0.0233		C-channel 0.005-0.015, B-channel 0.020-0.030
Channel Slope, Schan (ft/ft)	0.0205		Calculated from valley slope and sinuosity
Riffle Slope, Srif	0.0226	0.0369	
Riffle Slope Ratio, Srif/Schan	1.10	1.80	C-channel between 1.5-2.0, B-channel 1.1-1.8
Pool Slope, Spool (ft/ft)	0.0000	0.0082	
Pool Slope Ratio, Spool/Schan	0.00	0.40	C-channel 0.0-0.2, B-channel 0.0-0.4
Pool Max Depth @ bkf, Dmaxpool (ft)	0.75	1.31	
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50	C-channel 2.0-3.5, B-channel 2.0-3.5
Pool Width, Wpool (ft)	6.60	9.00	
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.10	1.50	C-channel 1.3-1.7, B-channel 1.1-1.5
Pool Spacing, Lps (ft)	9.00	30.00	
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.50	5.00	C-channel 4.0-7.0, B-channel 1.5-5.0

* Only applicable for C and E type channels.

Horne Creek Reach 4B	Proposed Stream Values (Restoration)		Notes
Parameter	MIN	MAX	
Stream Length (ft)	151		
Drainage Area, DA (sq mi)	0.0026		1.664
Stream Type (Rosgen)	B4		
Bankfull Discharge, Qbkf (cfs)	3.00		Calculated from analysis of USGS regression eq., velocity/discharge calcs
Bankfull Riffle XSEC Area, Abkf (sq ft)	0.83		Calcuated from Riffle Tab
Bankfull Mean Velocity, Vbkf (ft/s)	3.64		C-channel 3.5-5, B-channel 4-6
Bankfull Riffle Width, Wbkf (ft)	3.50		
Bankfull Mean Depth, Dbkf (ft)	0.24		
Width to Depth Ratio, W/D (ft/ft)	14.85		C-channel 10-14, B-channel 12-18
Width of Floodprone Area, Wfpa (ft)	8.00	46.00	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	2.29	13.14	> 2.2 Not entrenched
Riffle Max Depth @ bkf, Dmax (ft)	0.30		
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.27		C-channel 1.1-1.3, B-channel 1.2-1.4
Max Depth @ tob, Dmaxtob (ft)	0.30		
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00		C-channel 1.0-1.1, B-channel 1.0-1.1
Meander Wavelength, Lm (ft)*	24.50	42.00	Na
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00	C-channel 7.0-12.0
Radius of Curvature, Rc (ft)*	7.00	10.50	Na
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00	C-channel 2.0-3.0 (not applicable for B-channel)
Belt Width, Wblt (ft)*	12.25	28.00	Na
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00	C-channel 3.5-8.0 (not applicable for B-channel)
Sinuosity, K (Sval/Schan)	1.09		C-channel between 1.2-1.6, B-channel 1.1-1.2
Valley Slope, Sval (ft/ft)	0.0262		C-channel 0.005-0.015, B-channel 0.020-0.030
Channel Slope, Schan (ft/ft)	0.0241		Calculated from valley slope and sinuosity
Riffle Slope, Srif	0.0265	0.0433	
Riffle Slope Ratio, Srif/Schan	1.10	1.80	C-channel between 1.5-2.0, B-channel 1.1-1.8
Pool Slope, Spool (ft/ft)	0.0000	0.0096	
Pool Slope Ratio, Spool/Schan	0.00	0.40	C-channel 0.0-0.2, B-channel 0.0-0.4
Pool Max Depth @ bkf, Dmaxpool (ft)	0.47	0.83	
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50	C-channel 2.0-3.5, B-channel 2.0-3.5
Pool Width, Wpool (ft)	3.85	5.25	
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.10	1.50	C-channel 1.3-1.7, B-channel 1.1-1.5
Pool Spacing, Lps (ft)	5.25	17.50	
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.50	5.00	C-channel 4.0-7.0, B-channel 1.5-5.0

* Only applicable for C and E type channels.

Horne Creek Reach 5	Proposed Stream Values (Restoration)		Notes
Parameter	**MIN**	**MAX**	
Stream Length (ft)	2295		
Drainage Area, DA (sq mi)	0.26		167.68
Stream Type (Rosgen)	C4		
Bankfull Discharge, Qbkf (cfs)	27.00		Calculated from analysis of USGS regression eq., velocity/discharge calcs
Bankfull Riffle XSEC Area, Abkf (sq ft)	7.20		Calcuated from Riffle Tab
Bankfull Mean Velocity, Vbkf (ft/s)	3.75		C-channel 3.5-5, B-channel 4-6
Bankfull Riffle Width, Wbkf (ft)	10.00		
Bankfull Mean Depth, Dbkf (ft)	0.72		
Width to Depth Ratio, W/D (ft/ft)	13.89		C-channel 10-14, B-channel 12-18
Width of Floodprone Area, Wfpa (ft)	54.00	134.00	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	5.40	13.40	> 2.2 Not entrenched
Riffle Max Depth @ bkf, Dmax (ft)	0.90		
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.25		C-channel 1.1-1.3, B-channel 1.2-1.4
Max Depth @ tob, Dmaxtob (ft)	0.90		
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00		C-channel 1.0-1.1, B-channel 1.0-1.1
Meander Wavelength, Lm (ft)*	70.00	120.00	
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00	C-channel 7.0-12.0
Radius of Curvature, Rc (ft)*	20.00	30.00	
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00	C-channel 2.0-3.0 (not applicable for B-channel)
Belt Width, Wblt (ft)*	35.00	80.00	
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00	C-channel 3.5-8.0 (not applicable for B-channel)
Sinuosity, K (Sval/Schan)	1.21		C-channel between 1.2-1.6, B-channel 1.1-1.2
Valley Slope, Sval (ft/ft)	0.0243		C-channel 0.005-0.015, B-channel 0.020-0.030
Channel Slope, Schan (ft/ft)	0.0201		Calculated from valley slope and sinuosity
Riffle Slope, Srif	0.0301	0.0401	
Riffle Slope Ratio, Srif/Schan	1.50	2.00	C-channel between 1.5-2.0, B-channel 1.1-1.8
Pool Slope, Spool (ft/ft)	0.0000	0.0040	
Pool Slope Ratio, Spool/Schan	0.00	0.20	C-channel 0.0-0.2, B-channel 0.0-0.4
Pool Max Depth @ bkf, Dmaxpool (ft)	1.44	2.52	
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50	C-channel 2.0-3.5, B-channel 2.0-3.5
Pool Width, Wpool (ft)	13.00	17.00	
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.30	1.70	C-channel 1.3-1.7, B-channel 1.1-1.5
Pool Spacing, Lps (ft)	15.00	70.00	
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.50	7.00	C-channel 4.0-7.0, B-channel 1.5-5.0

* Only applicable for C and E type channels.

Culvert Report

R1 Culvert Crossing

Invert Elev Dn (ft)	=	934.62
Pipe Length (ft)	=	20.00
Slope (%)	=	4.50
Invert Elev Up (ft)	=	935.52
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

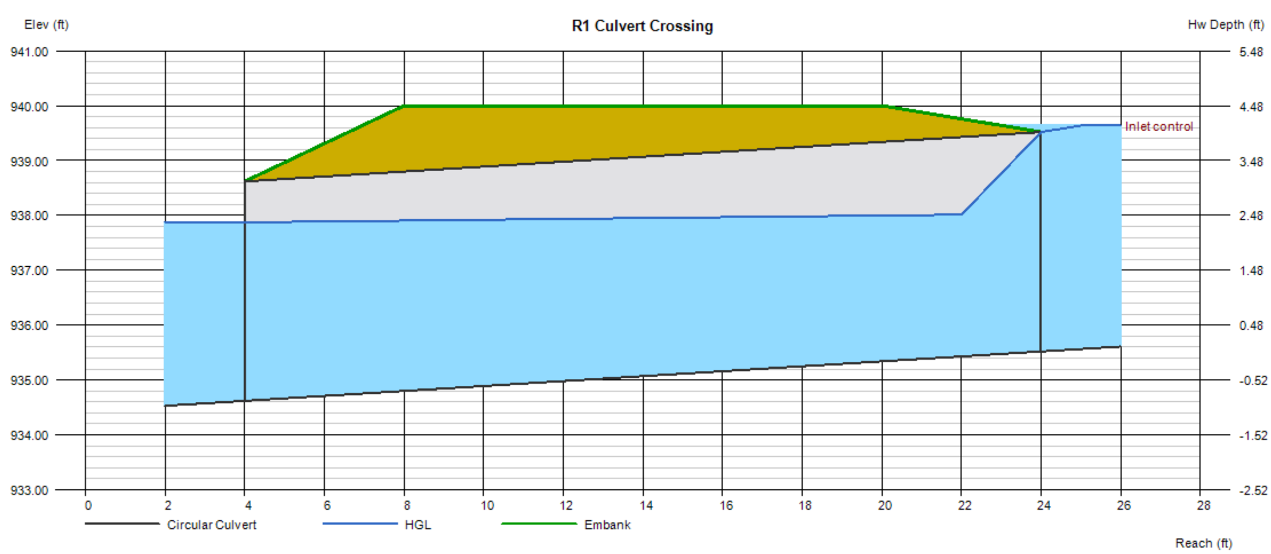
Top Elevation (ft)	=	940.00
Top Width (ft)	=	12.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	25.10
Qmax (cfs)	=	69.20
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	69.10
Qpipe (cfs)	=	69.10
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.31
Veloc Up (ft/s)	=	8.33
HGL Dn (ft)	=	937.87
HGL Up (ft)	=	938.03
Hw Elev (ft)	=	939.64
Hw/D (ft)	=	1.03
Flow Regime	=	Inlet Control



Culvert Report

R4 Upstream Culvert Crossing

Invert Elev Dn (ft)	=	974.63
Pipe Length (ft)	=	20.00
Slope (%)	=	2.80
Invert Elev Up (ft)	=	975.19
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

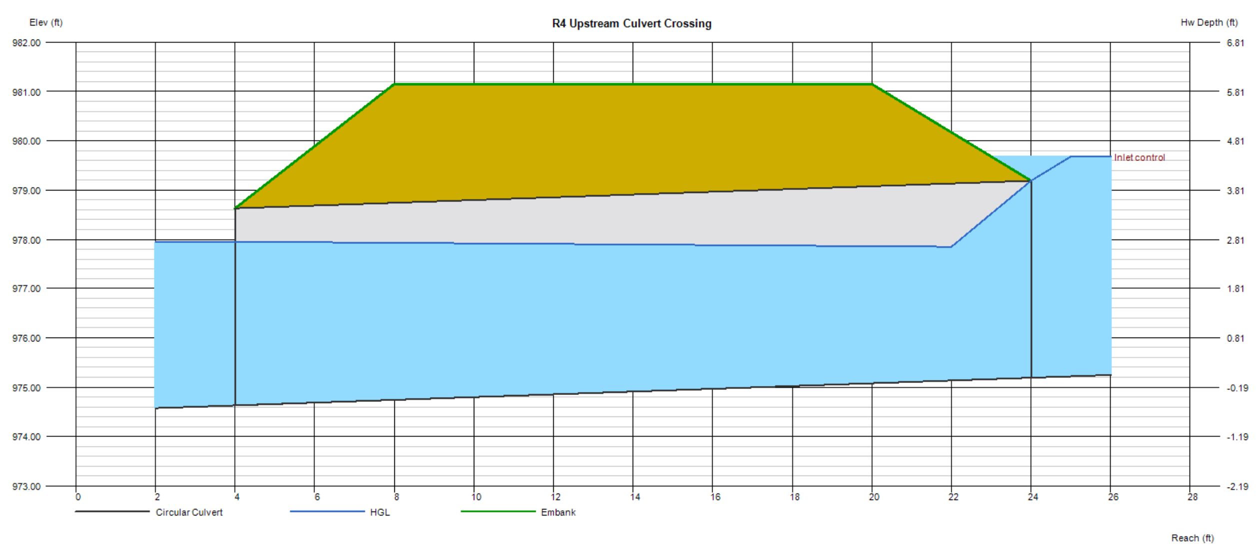
Top Elevation (ft)	=	981.15
Top Width (ft)	=	12.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	36.70
Qmax (cfs)	=	77.50
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	76.70
Qpipe (cfs)	=	76.70
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.87
Veloc Up (ft/s)	=	8.68
HGL Dn (ft)	=	977.95
HGL Up (ft)	=	977.84
Hw Elev (ft)	=	979.68
Hw/D (ft)	=	1.12
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Apr 26 2019

R4 Downstream Culvert Crossing

Invert Elev Dn (ft)	=	957.66
Pipe Length (ft)	=	20.00
Slope (%)	=	6.00
Invert Elev Up (ft)	=	958.86
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

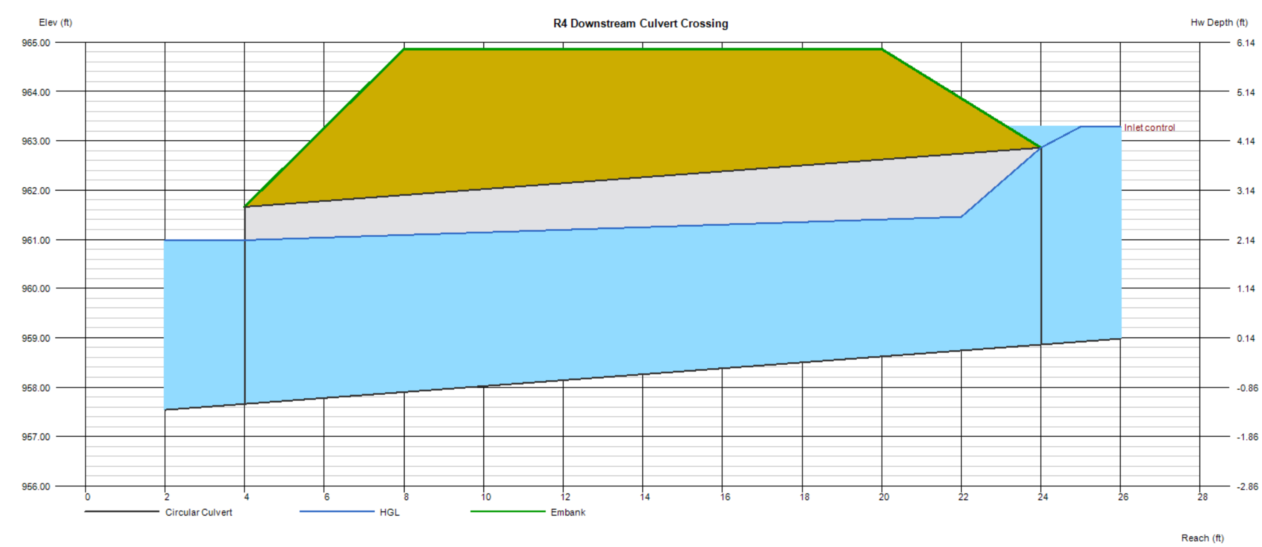
Top Elevation (ft)	=	964.86
Top Width (ft)	=	12.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	36.70
Qmax (cfs)	=	77.50
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	76.70
Qpipe (cfs)	=	76.70
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.87
Veloc Up (ft/s)	=	8.68
HGL Dn (ft)	=	960.98
HGL Up (ft)	=	961.51
Hw Elev (ft)	=	963.29
Hw/D (ft)	=	1.11
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Apr 26 2019

R5 Culvert Crossing

Invert Elev Dn (ft)	= 940.13
Pipe Length (ft)	= 20.00
Slope (%)	= 4.50
Invert Elev Up (ft)	= 941.03
Rise (in)	= 60.0
Shape	= Circular
Span (in)	= 60.0
No. Barrels	= 1
n-Value	= 0.024
Culvert Type	= Circular Corrugate Metal Pipe
Culvert Entrance	= Projecting
Coeff. K,M,c,Y,k	= 0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

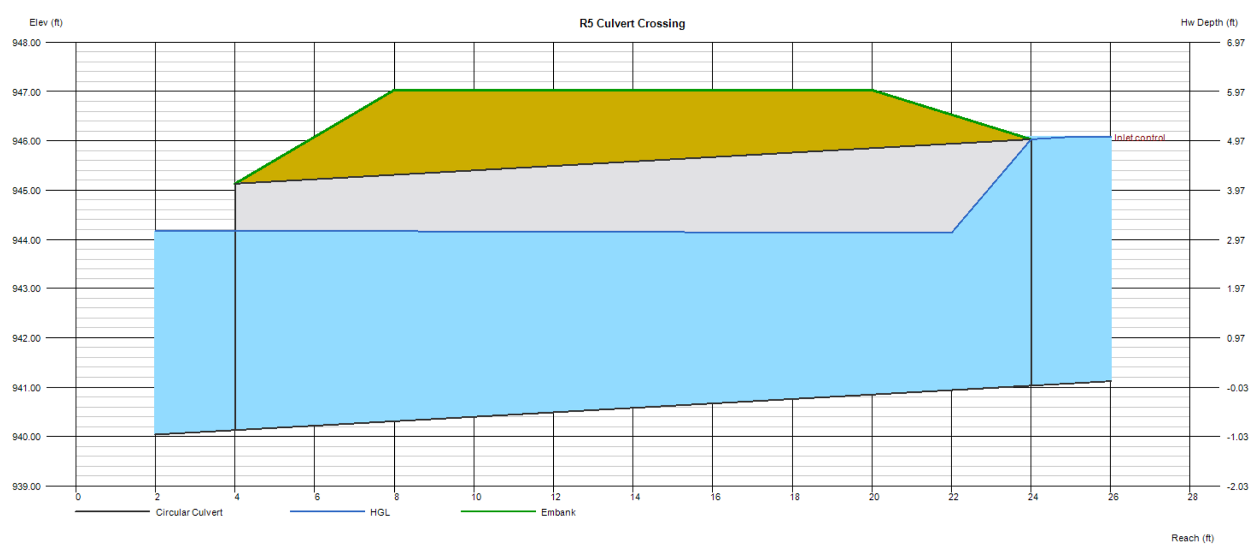
Top Elevation (ft)	= 947.03
Top Width (ft)	= 12.00
Crest Width (ft)	= 100.00

Calculations

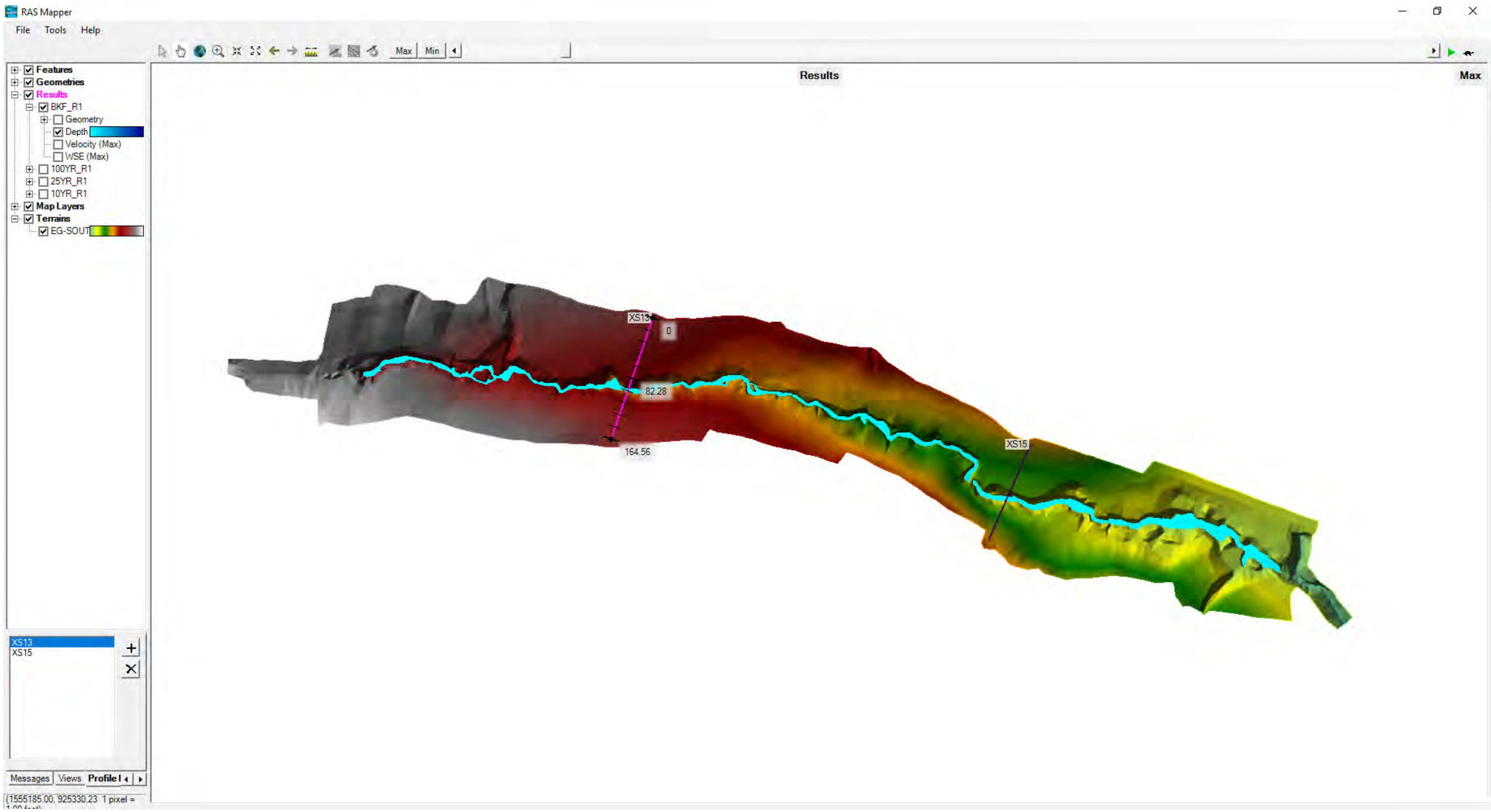
Qmin (cfs)	= 36.70
Qmax (cfs)	= 118.00
Tailwater Elev (ft)	= (dc+D)/2

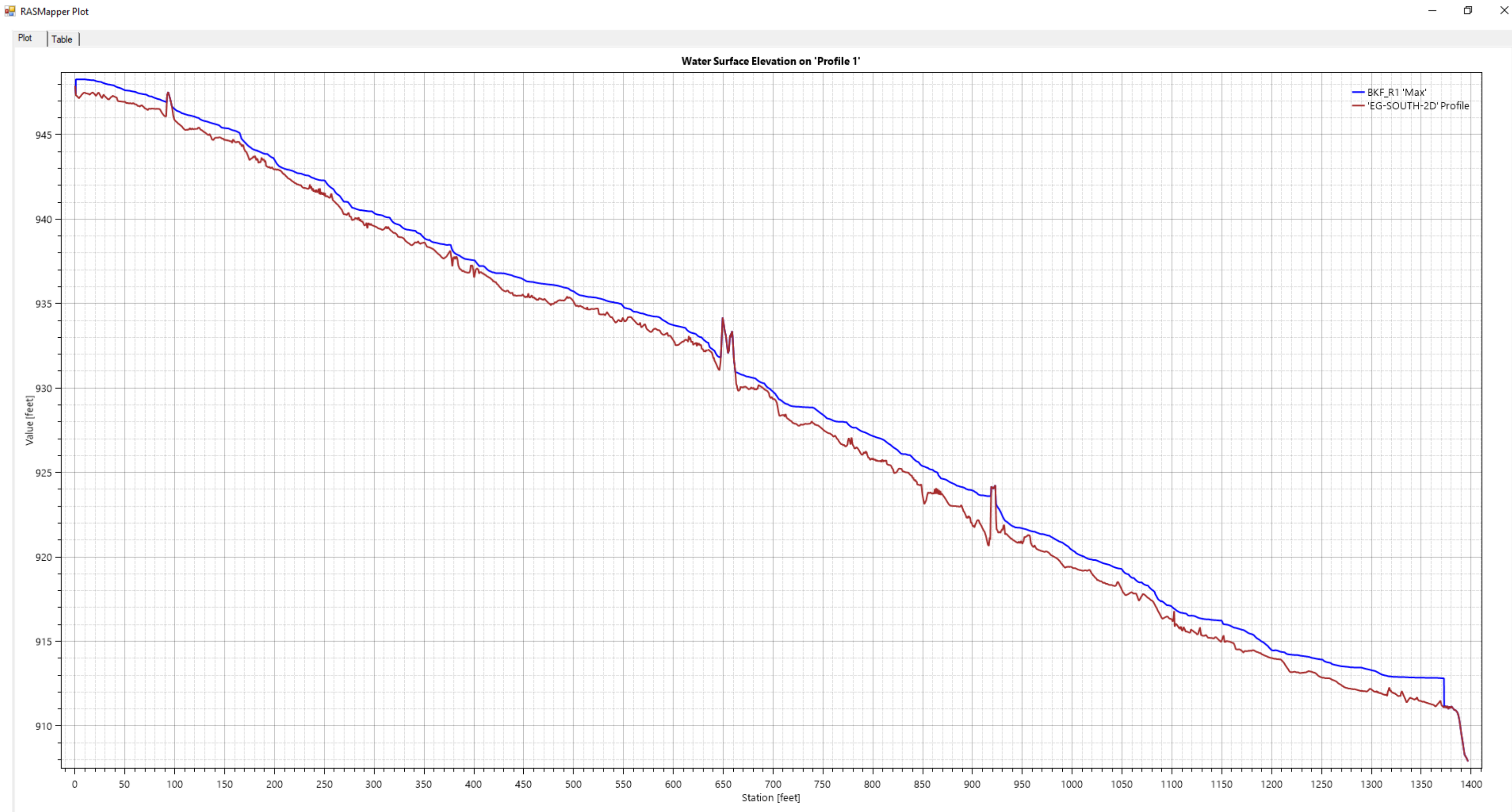
Highlighted

Qtotal (cfs)	= 117.70
Qpipe (cfs)	= 117.70
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 6.91
Veloc Up (ft/s)	= 9.22
HGL Dn (ft)	= 944.18
HGL Up (ft)	= 944.13
Hw Elev (ft)	= 946.08
Hw/D (ft)	= 1.01
Flow Regime	= Inlet Control

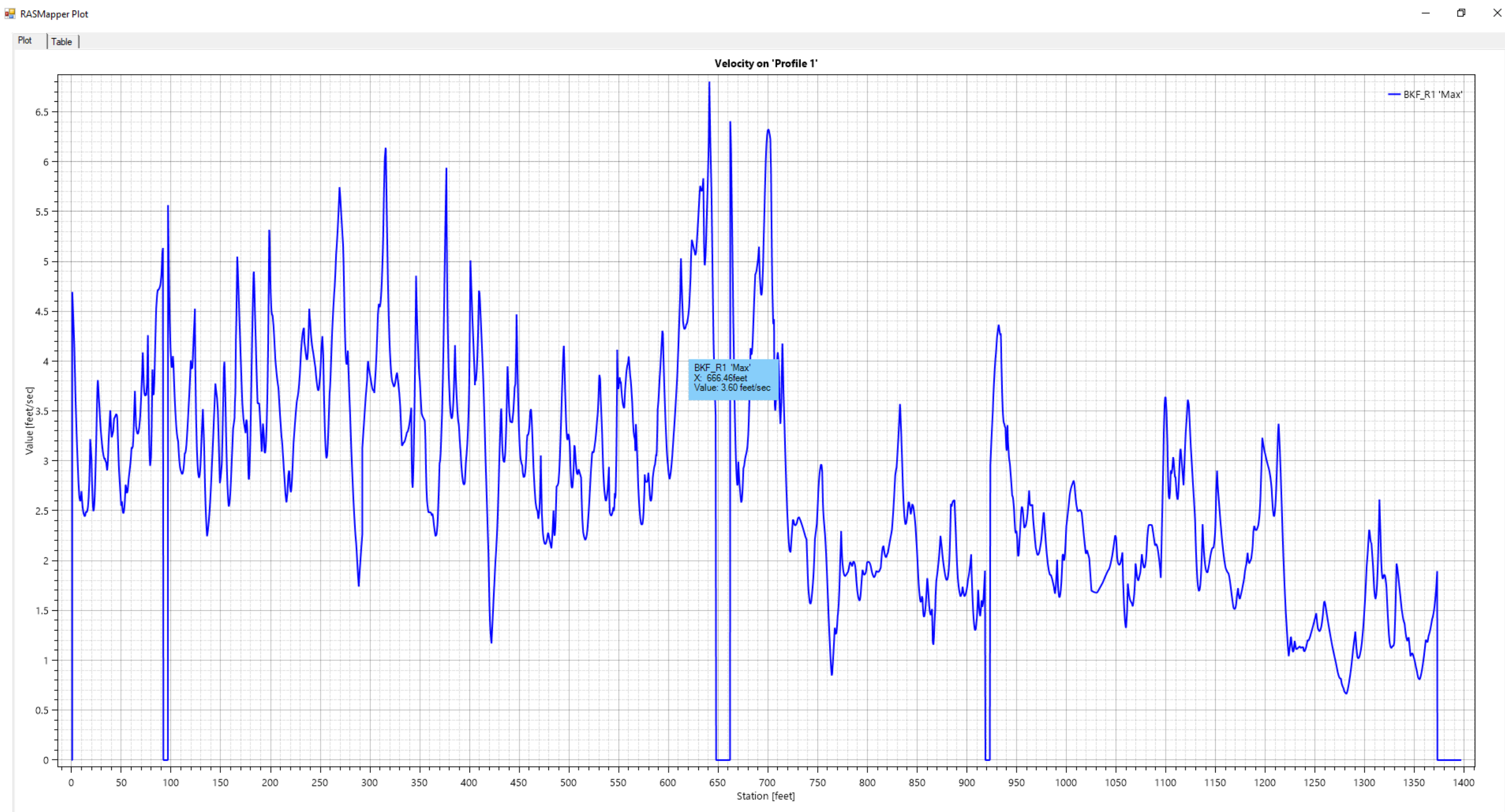


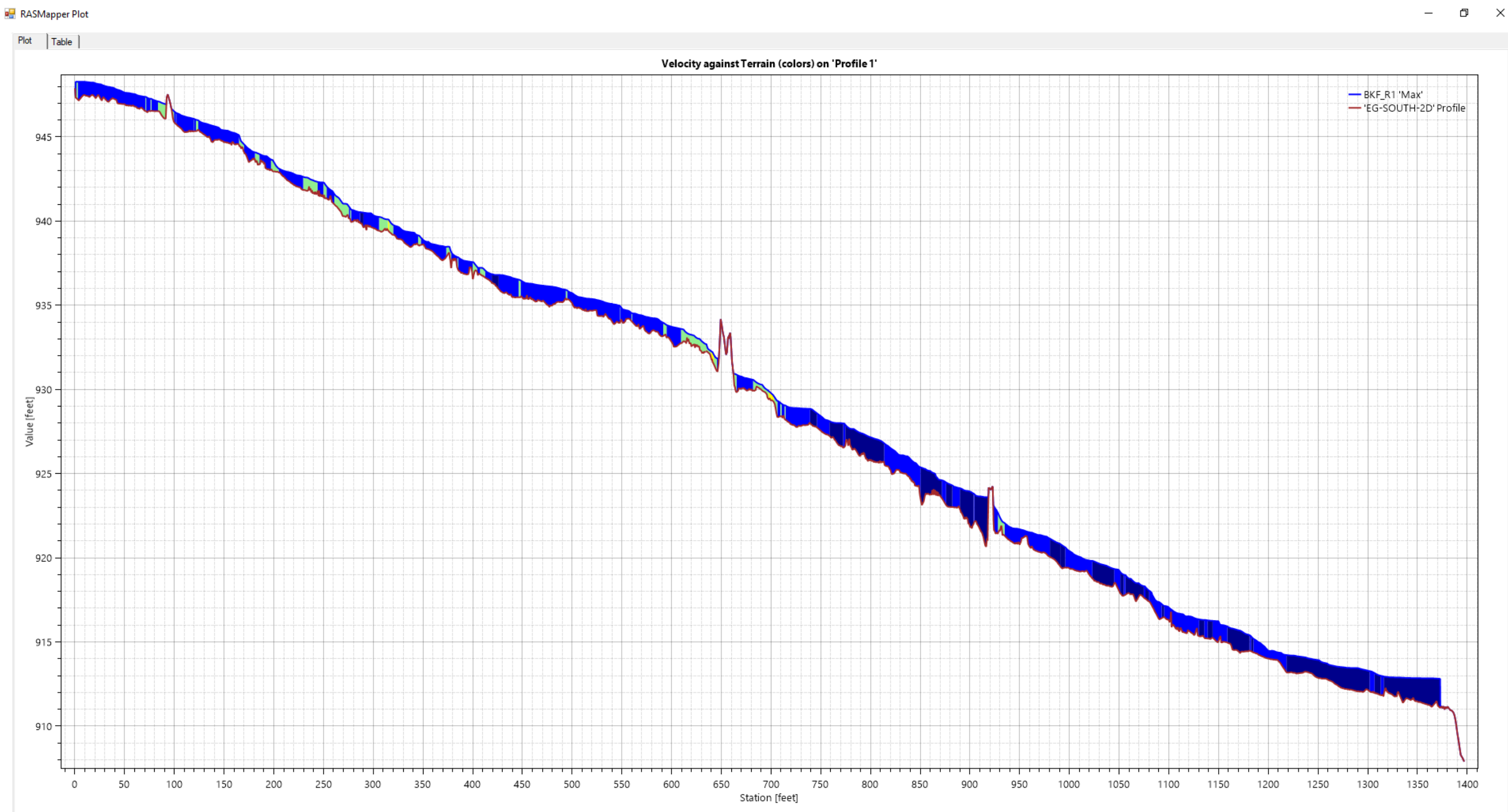
Reach 1 Existing 2D model Results

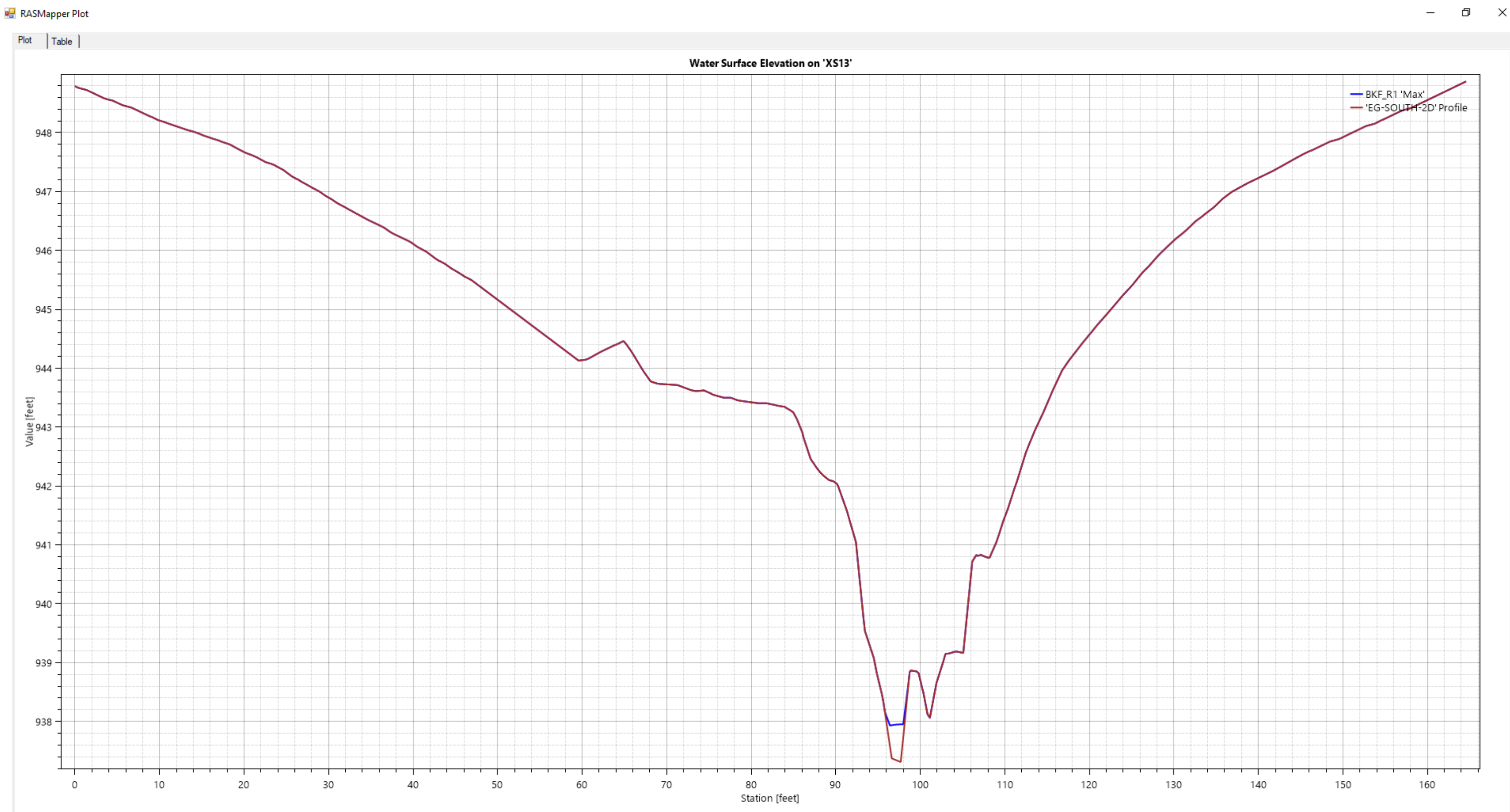


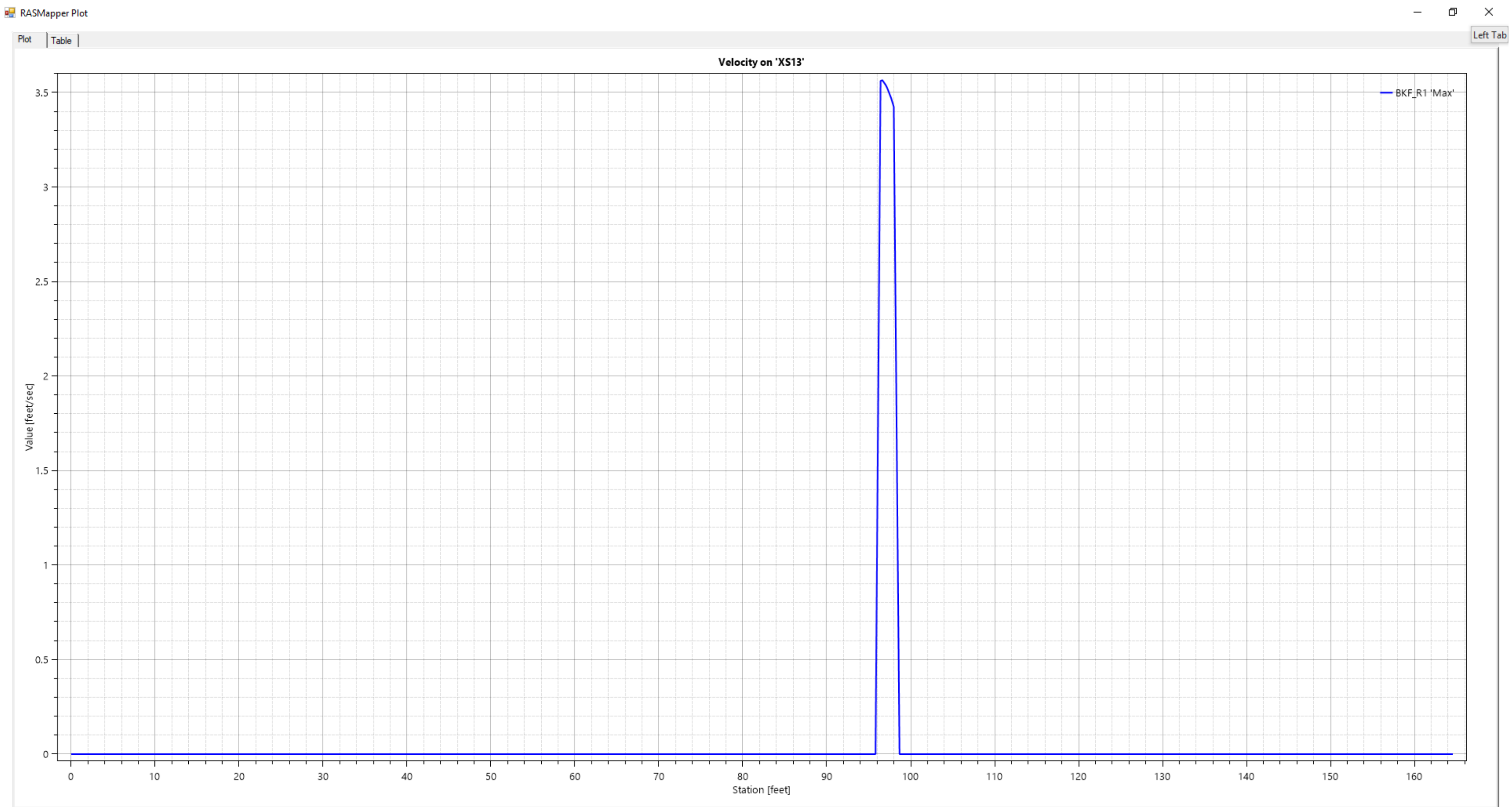


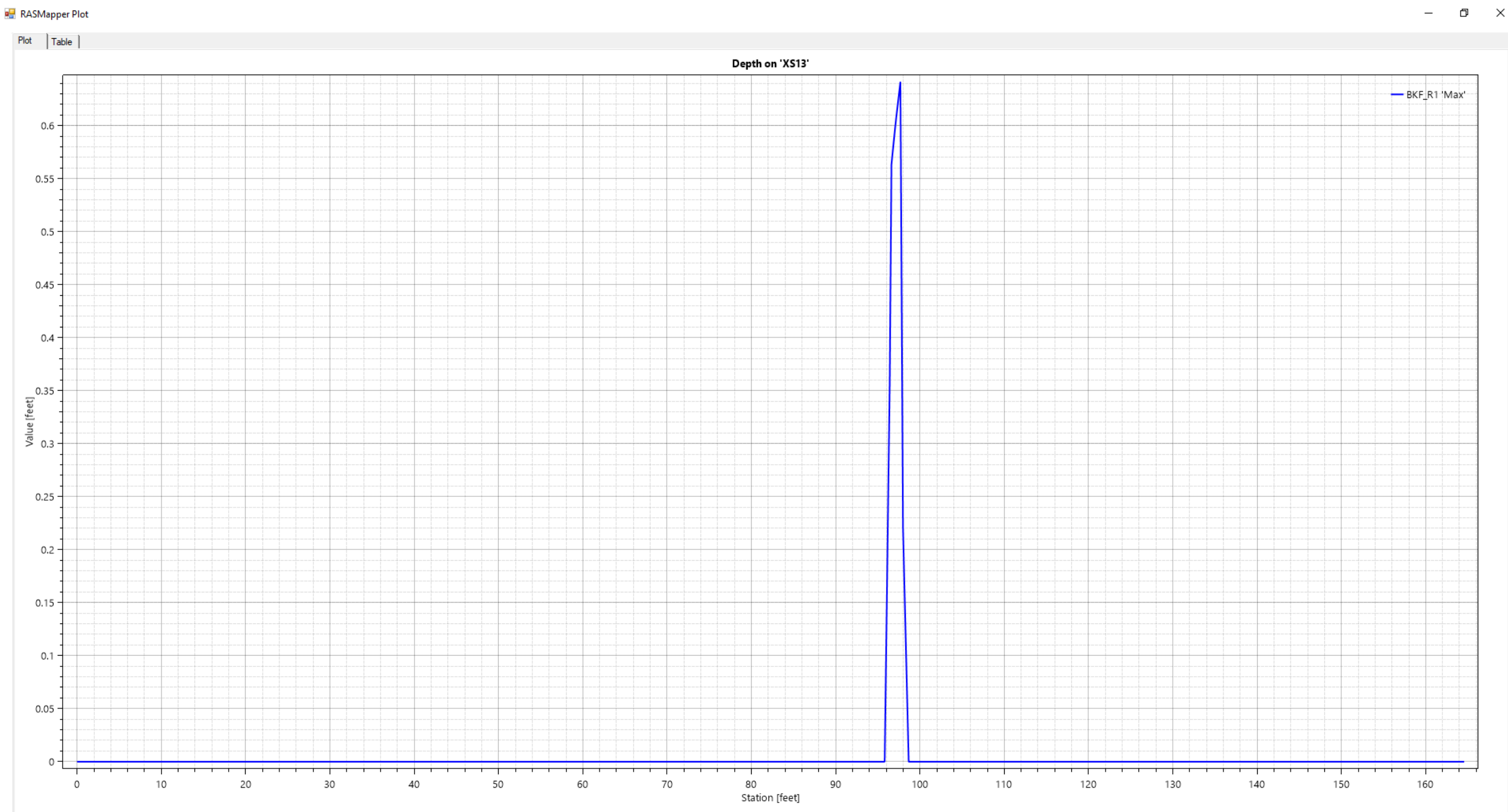
RASMapper Plot
Plot
Table
Water Surface Elevation on 'Profile 1'
BKF_R1 'Max'
'EG-SOUTH-2D' Profile
Value [feet]
945
940
935
930
925
920
915
910
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
1100
1150
1200
1250
1300
1350
1400
Station [feet]

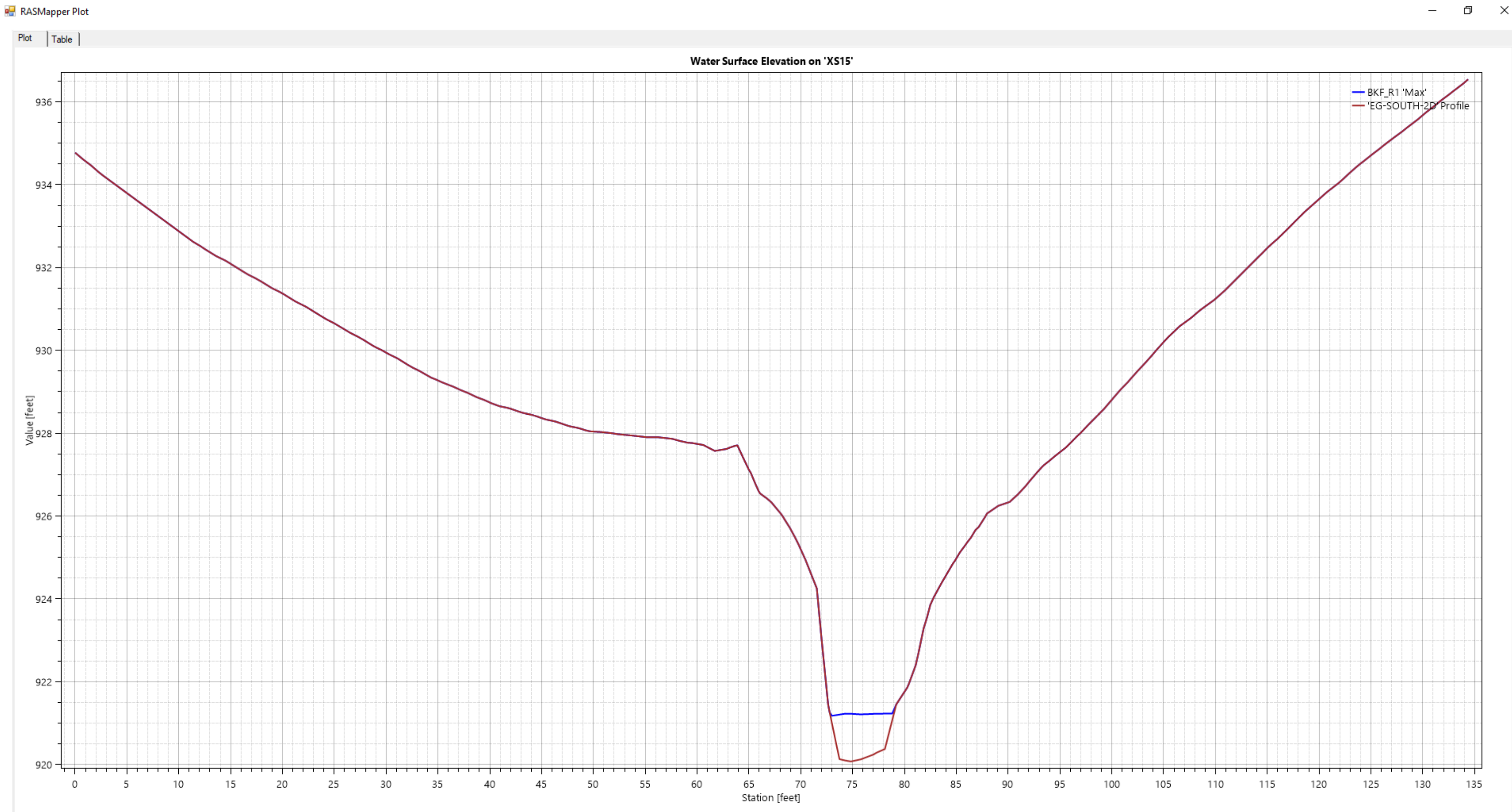

RASMapper Plot
Plot
Table
Velocity on 'Profile 1'
BKF_R1 'Max'
BKF_R1 'Max'
X: 666.46feet
Value: 3.60 feet/sec
Value [feet/sec]
Station [feet]
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
1100
1150
1200
1250
1300
1350
1400

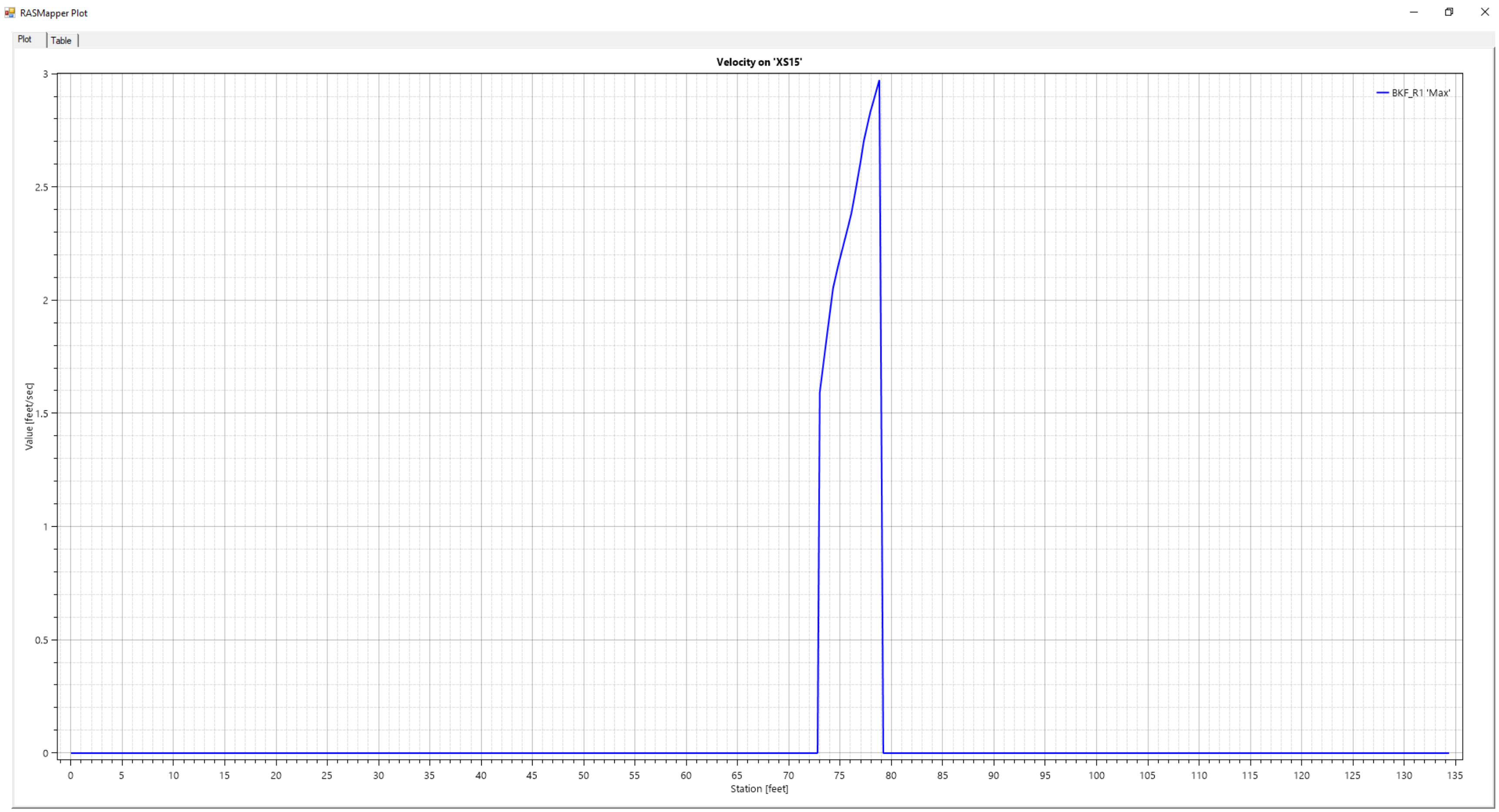

RASMapper Plot
Plot
Table
Velocity against Terrain (colors) on 'Profile 1'
BKF_R1 'Max'
'EG-SOUTH-2D' Profile
Value [feet]
945
940
935
930
925
920
915
910
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050 1100 1150 1200 1250 1300 1350 1400
Station [feet]

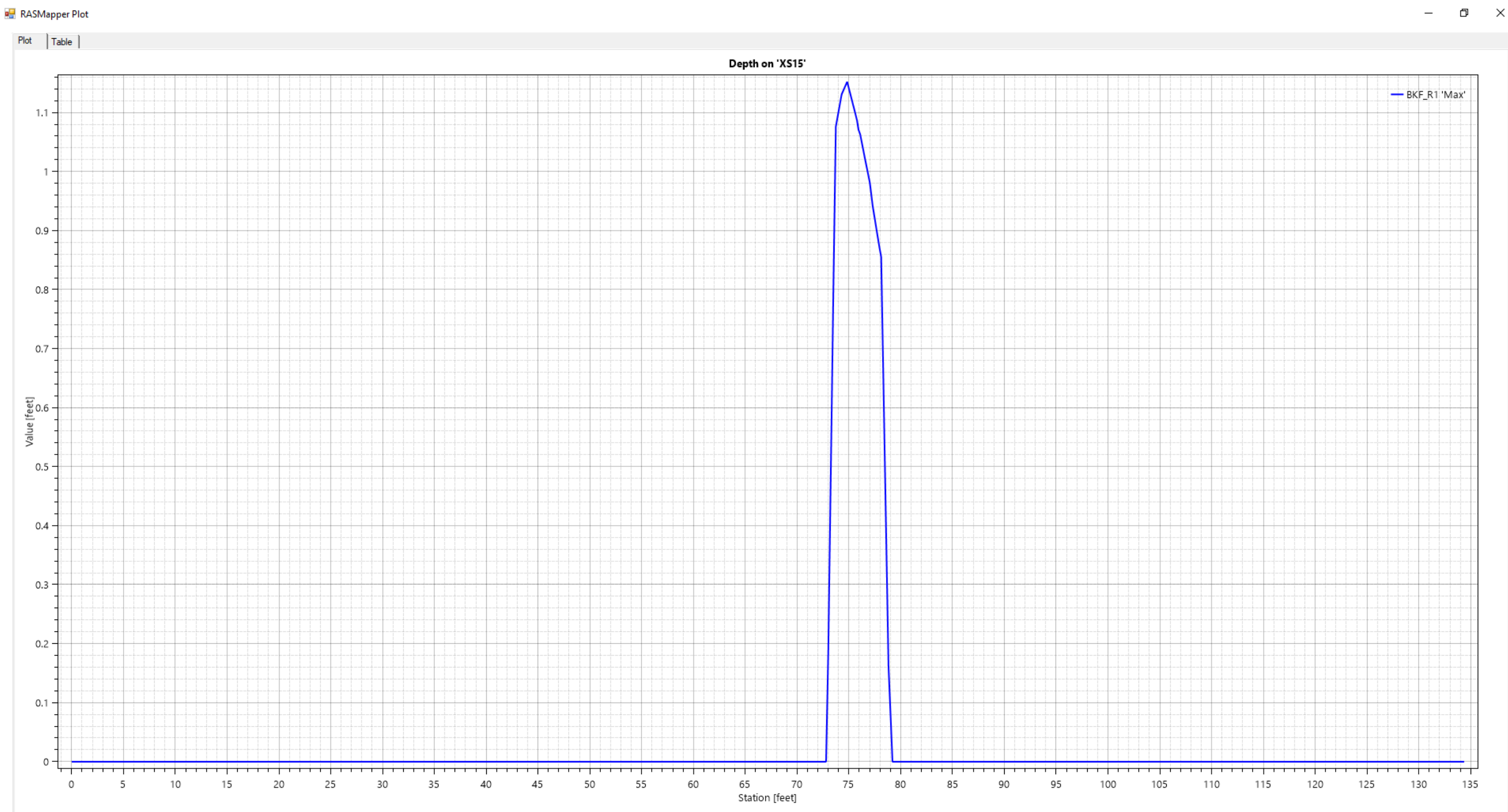

RASMapper Plot
Plot
Table
Water Surface Elevation on 'XS13'
BKF_R1 'Max'
'EG-SOUTH-2D' Profile
Value [feet]
948
947
946
945
944
943
942
941
940
939
938
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
Station [feet]


RASMapper Plot
Plot
Table
Left Tab
Velocity on 'XS13'
BKF_R1 'Max'
Value [feet/sec]
Station [feet]
0
0.5
1
1.5
2
2.5
3
3.5
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160

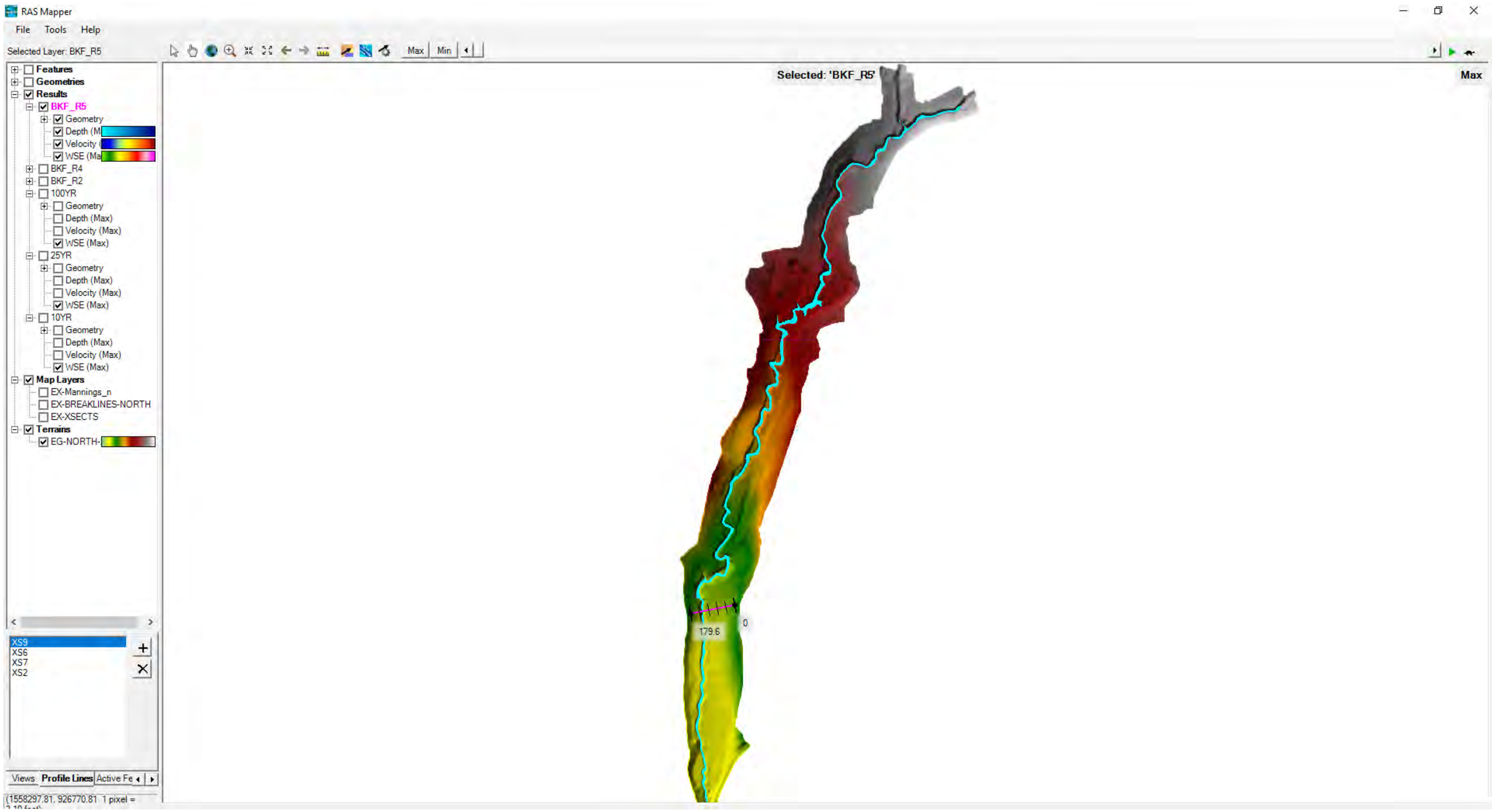

RASMapper Plot
Plot
Table
Depth on 'XS13'
BKF_R1 'Max'
Value [feet]
Station [feet]
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160

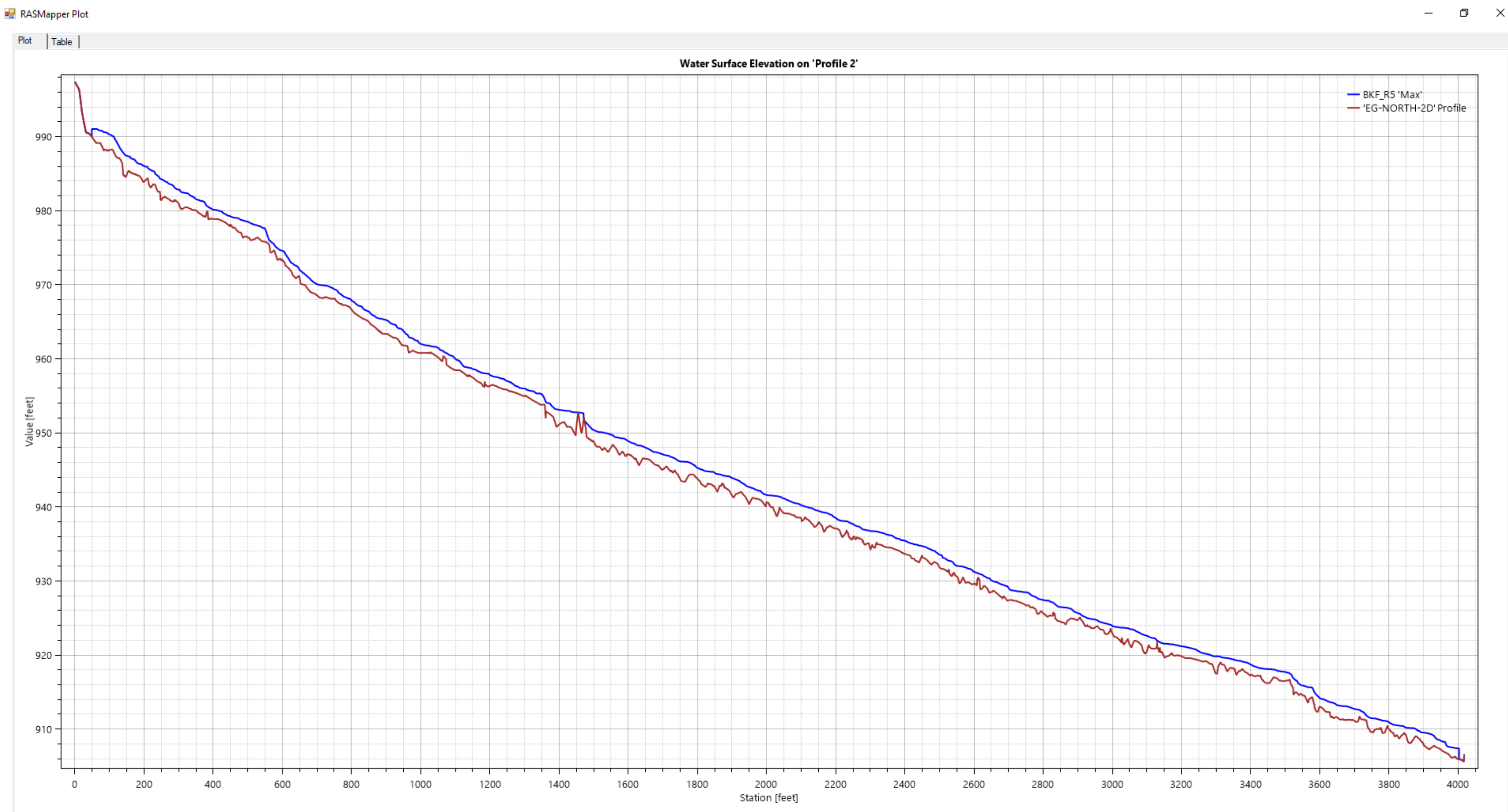

RASMapper Plot
Plot
Table
Water Surface Elevation on 'XS15'
BKF_R1 'Max'
'EG-SOUTH-2D' Profile
Value [feet]
Station [feet]
920
922
924
926
928
930
932
934
936
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135

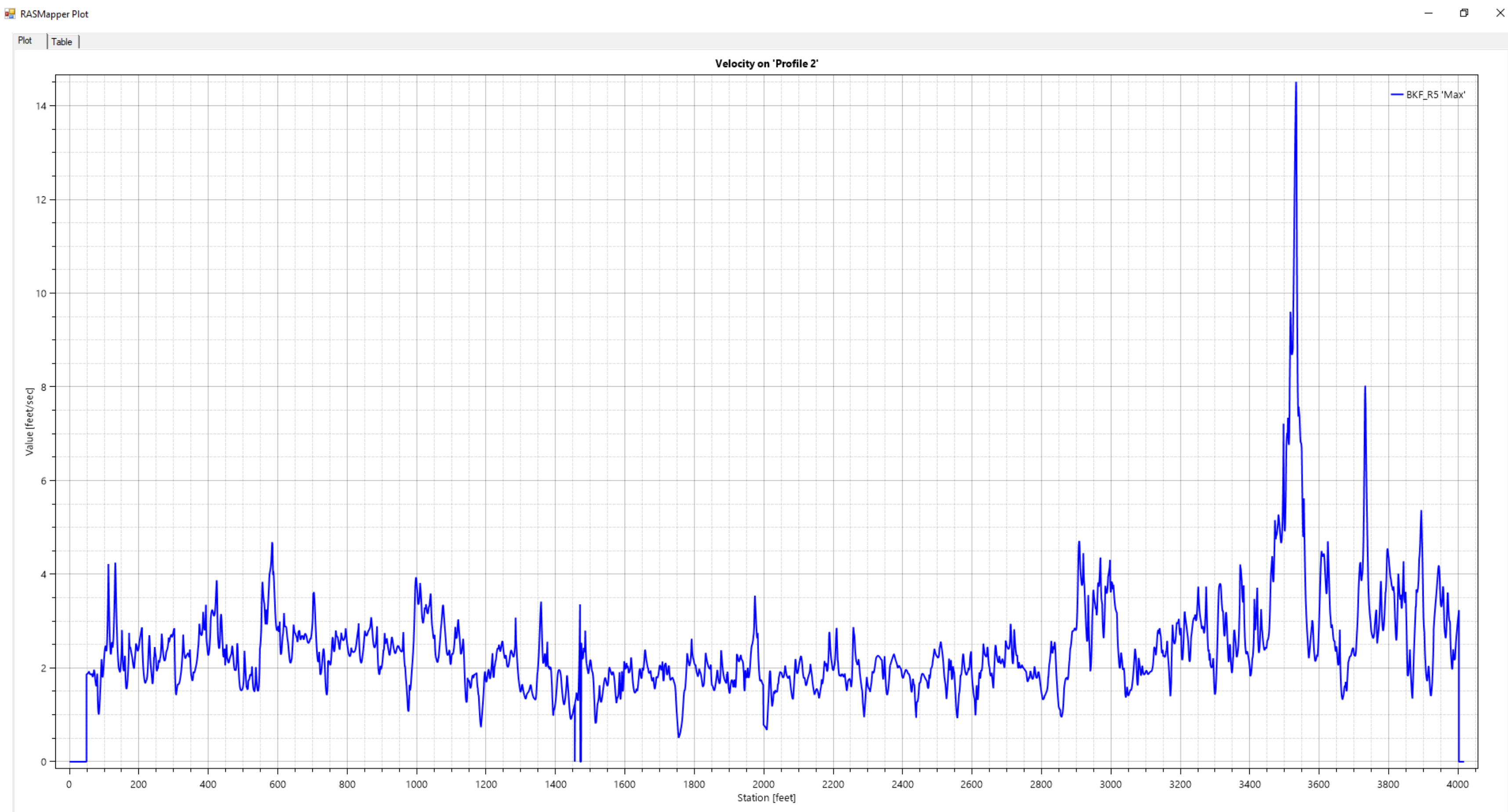

RASMapper Plot
Plot
Table
Velocity on 'XS15'
BKF_R1 'Max'
Value [feet/sec]
Station [feet]
0
0.5
1
1.5
2
2.5
3
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135

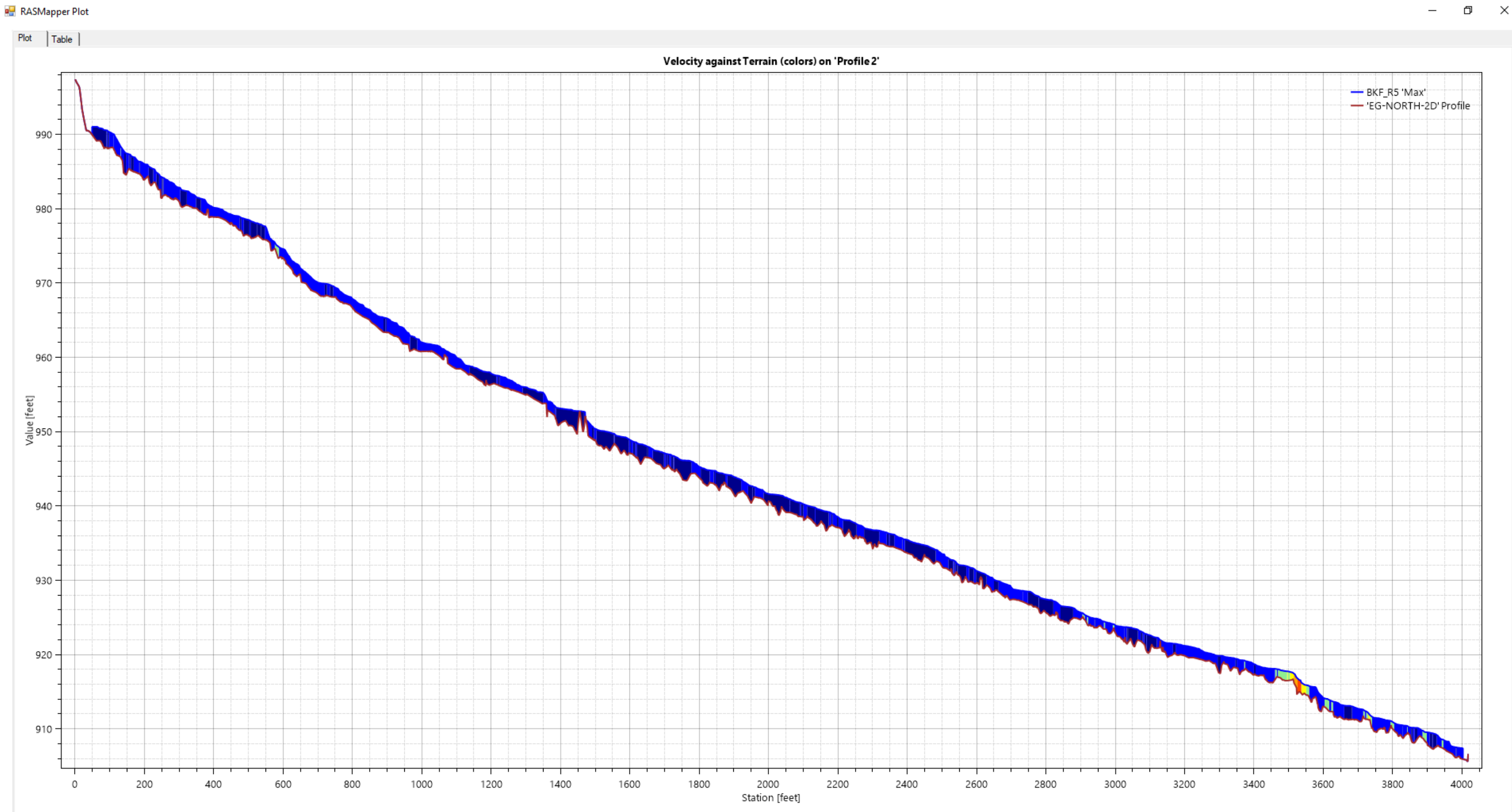

RASMapper Plot
Plot
Table
Depth on 'XS15'
BKF_R1 'Max'
Value [feet]
Station [feet]
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135

Reach 2, 4, and 5 Existing 2D model Results

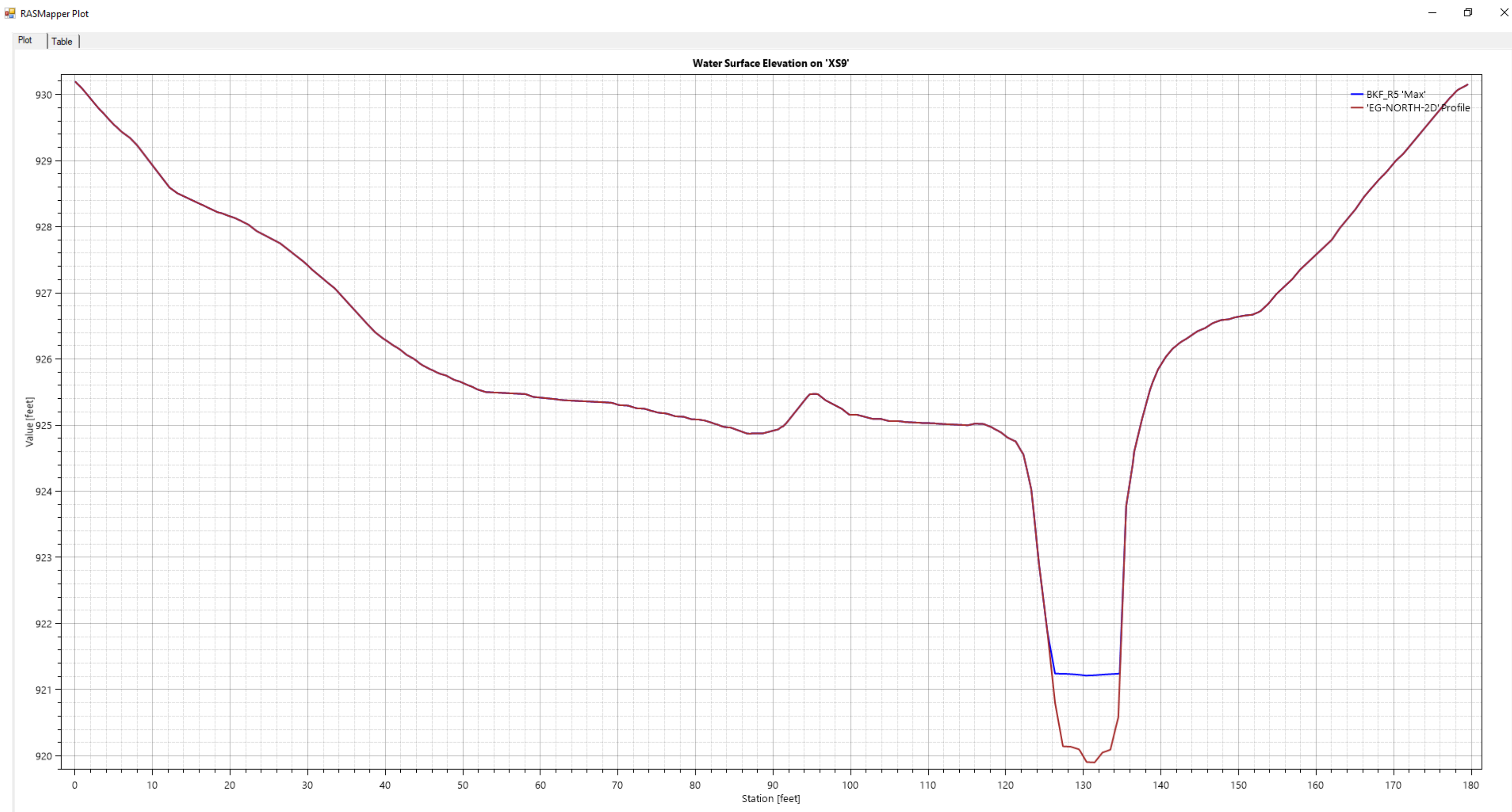



RASMapper Plot
Plot
Table
Water Surface Elevation on 'Profile 2'
BKF_R5 'Max'
'EG-NORTH-2D' Profile
Value [feet]
990
980
970
960
950
940
930
920
910
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Station [feet]

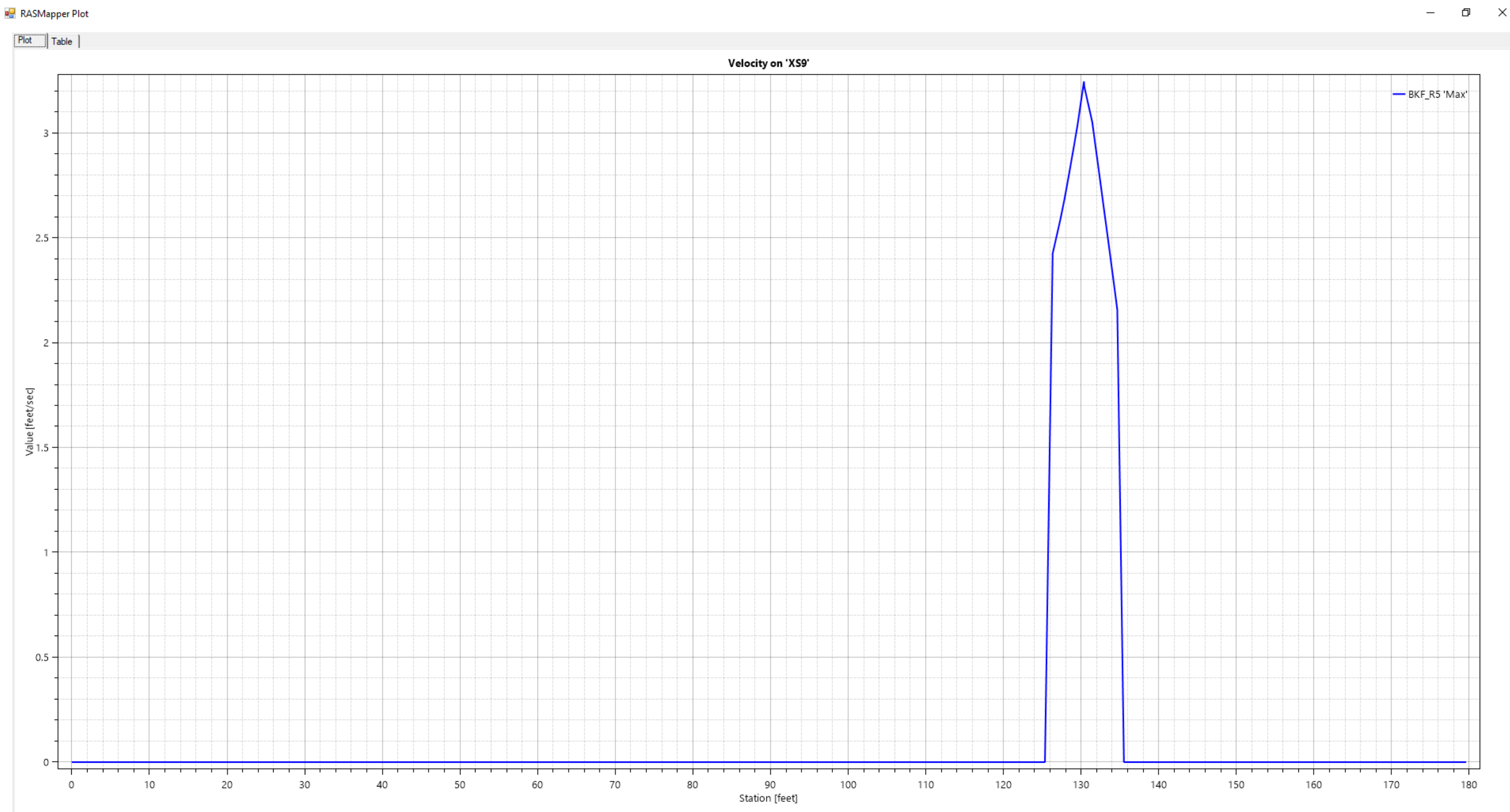

RASMapper Plot
Plot
Table
Velocity on 'Profile 2'
BKF_R5 'Max'
Value [feet/sec]
0
2
4
6
8
10
12
14
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Station [feet]


RASMapper Plot
Plot
Table
Velocity against Terrain (colors) on 'Profile 2'
BKF_R5 'Max'
'EG-NORTH-2D' Profile
Value [feet]
990
980
970
960
950
940
930
920
910
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Station [feet]

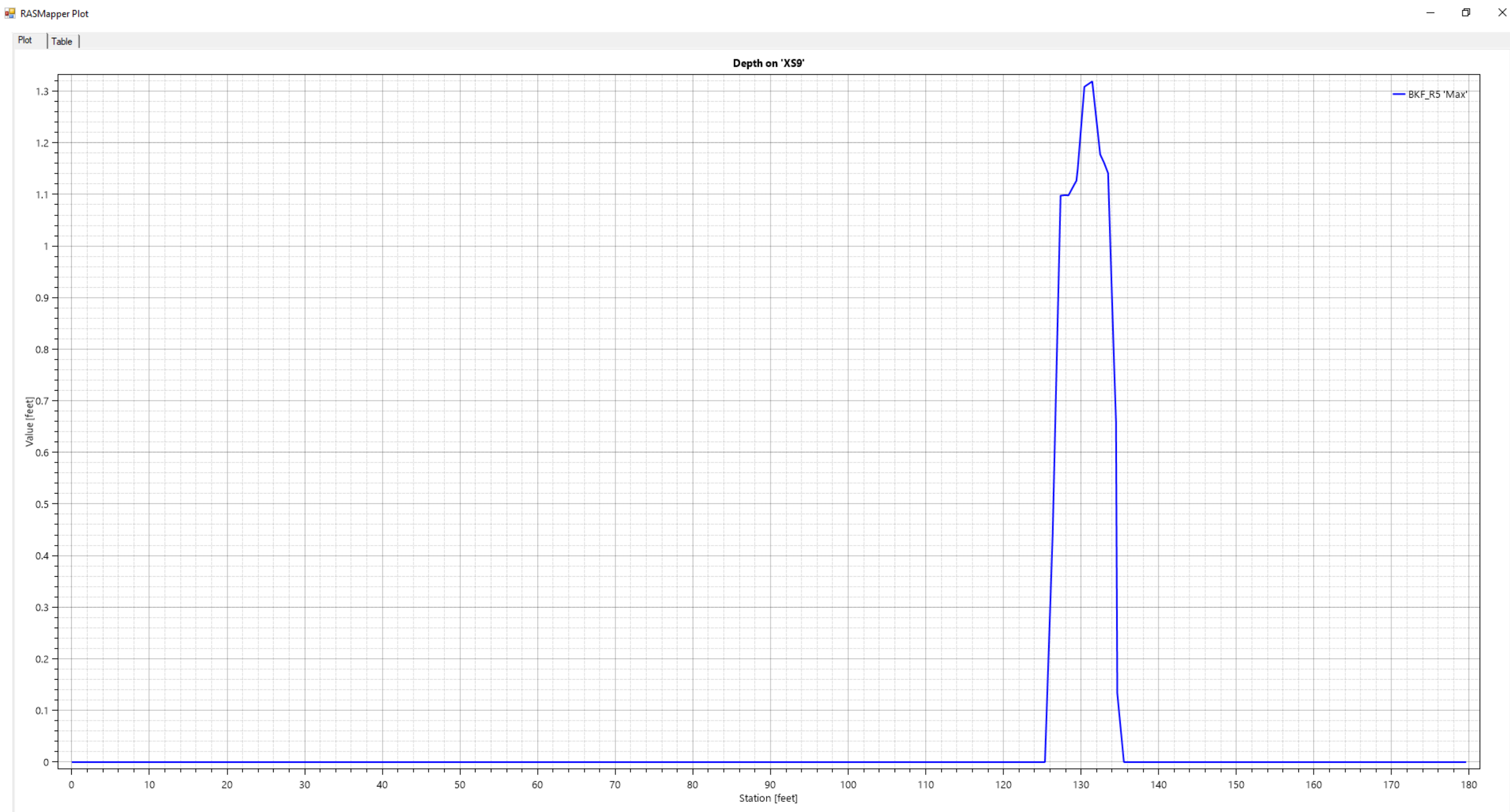
R5 existing water surface



R5 existing velocity

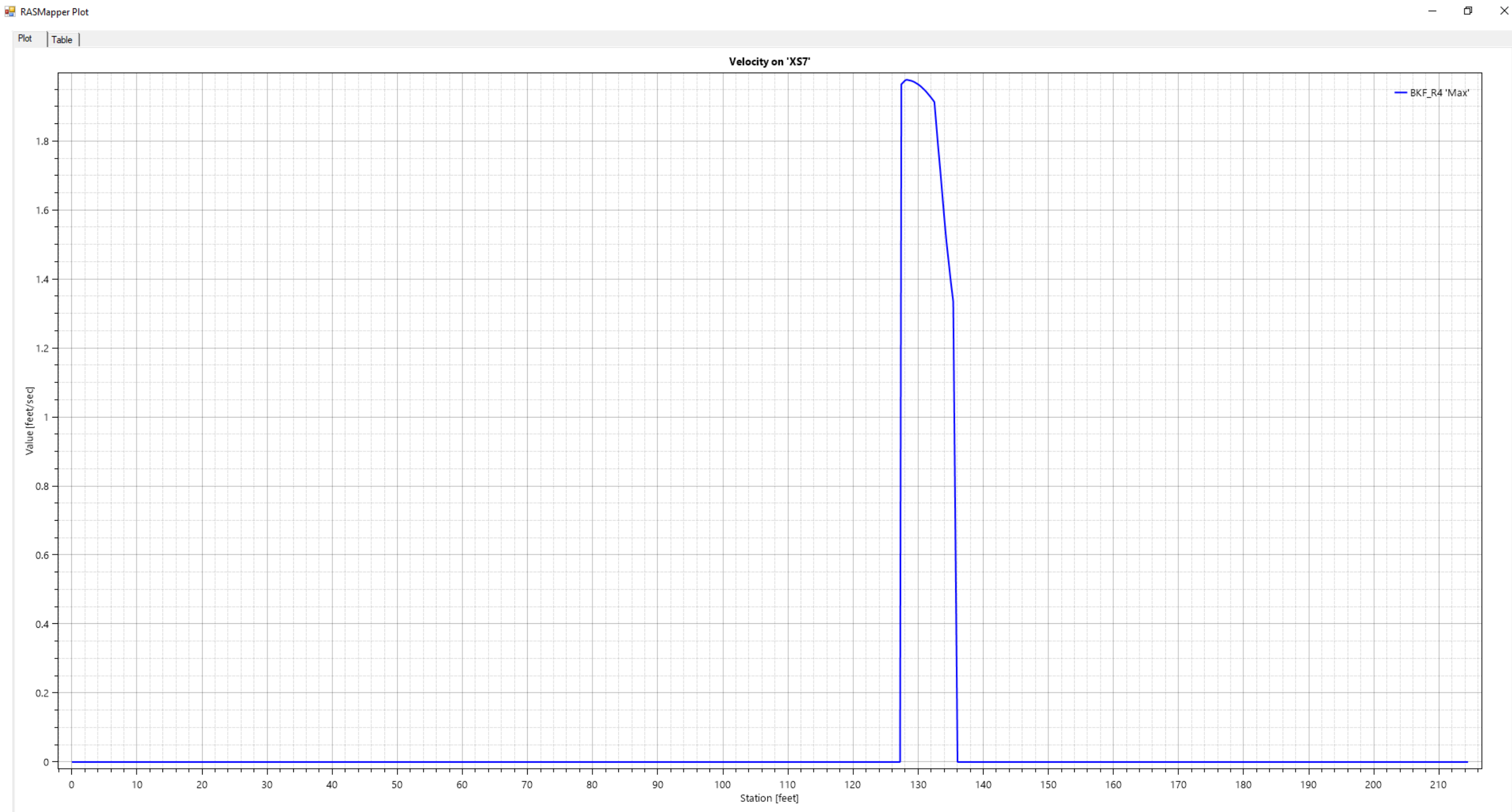


R5 existing Depth

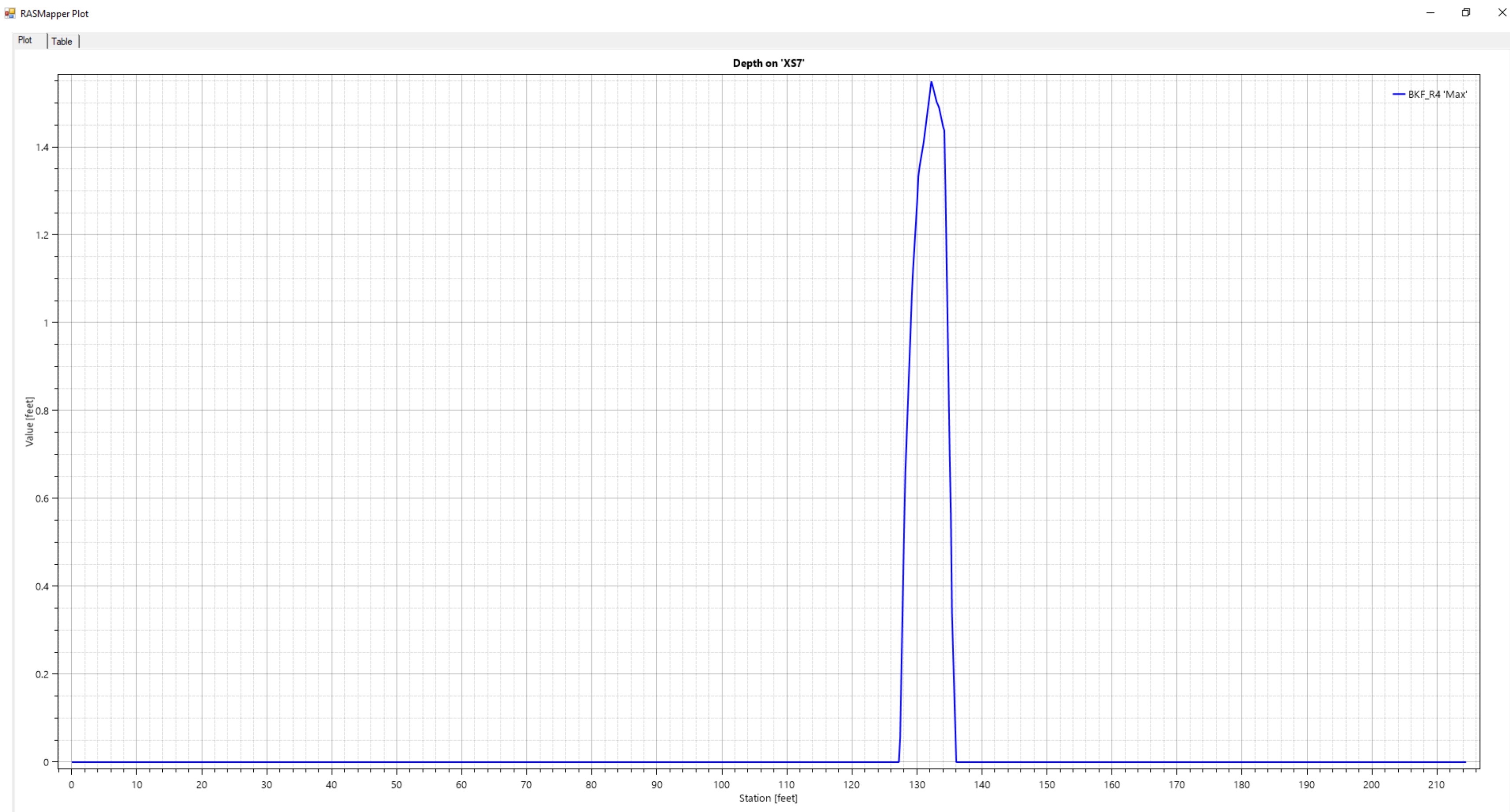


R4 existing water surface

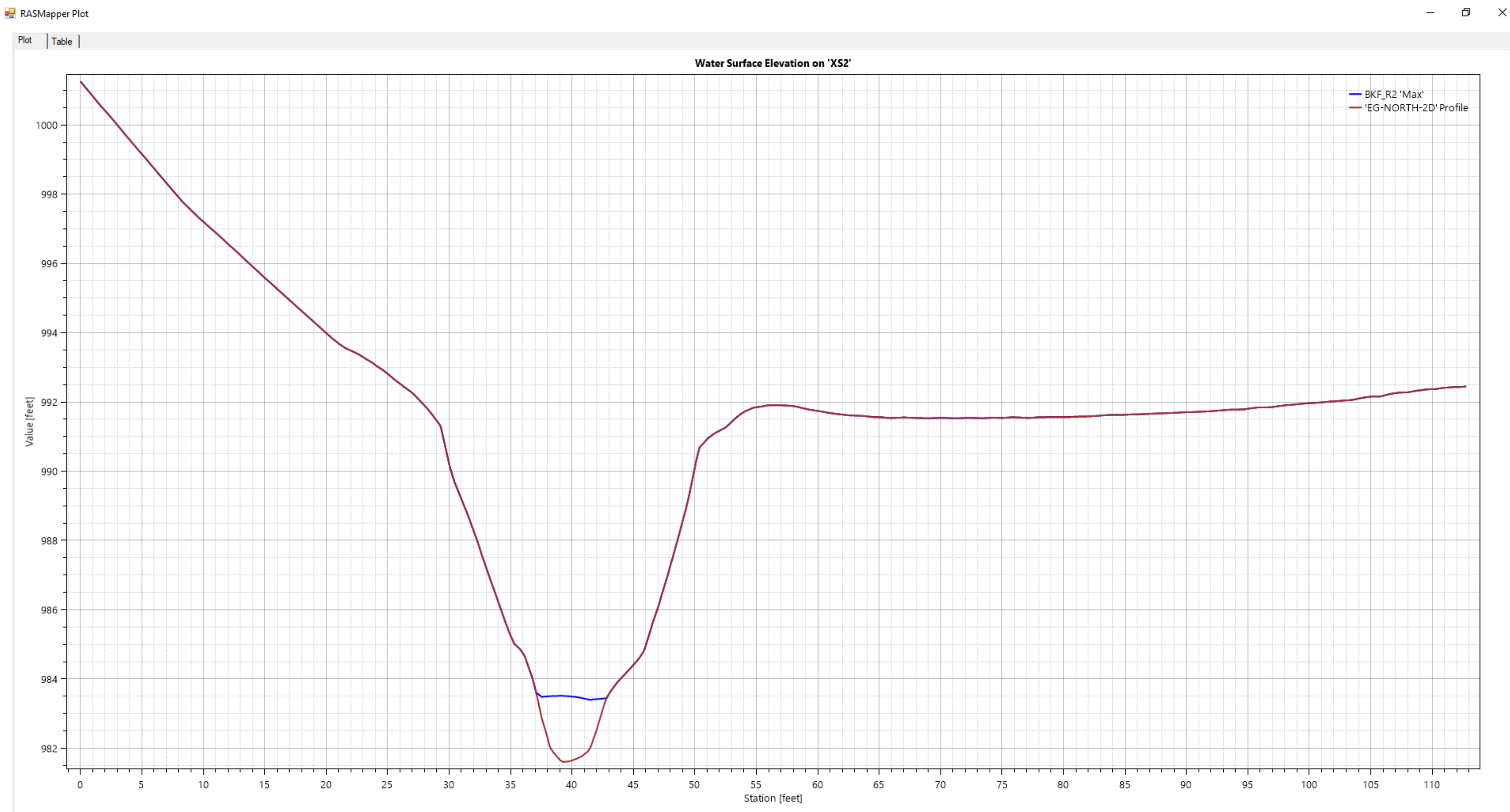
R4 Velocity


RASMapper Plot
Plot
Table
Velocity on 'XS7'
BKF_R4 'Max'
Value [feet/sec]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
Station [feet]
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210

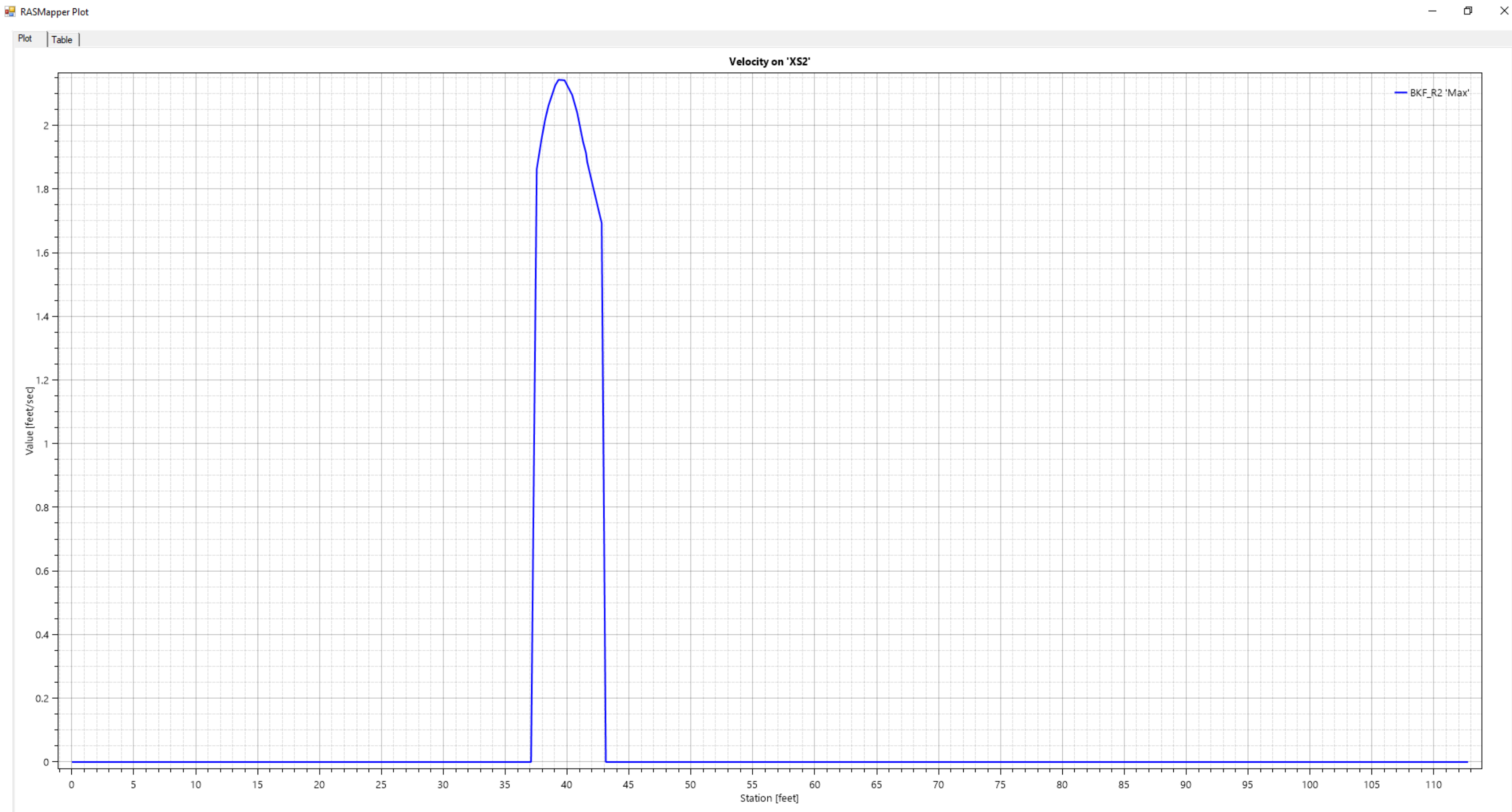
R4 Depth


RASMapper Plot
Plot
Table
Depth on 'XS7'
BKF_R4 'Max'
Value [feet]
Station [feet]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210

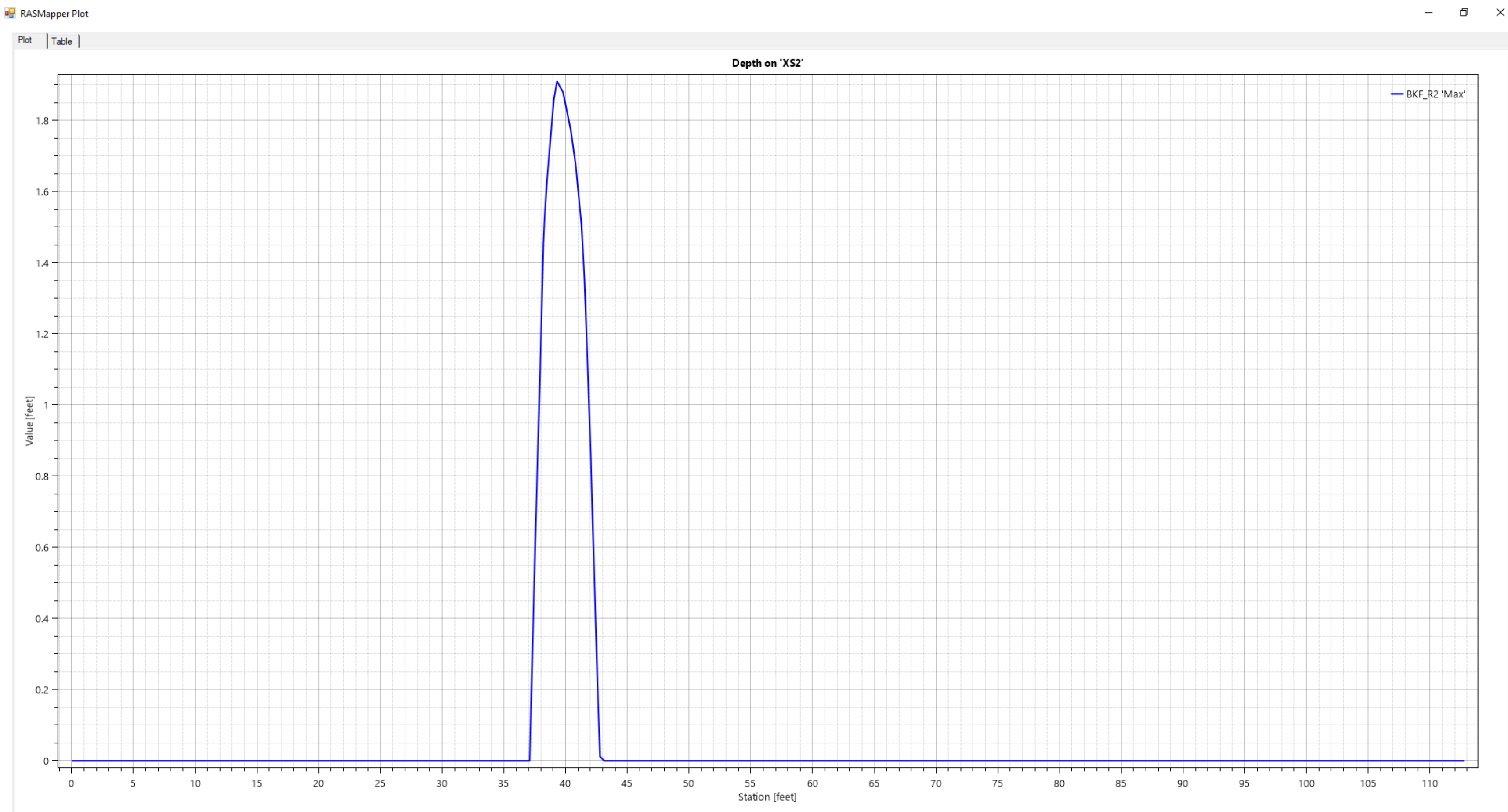
R2 Water Surface



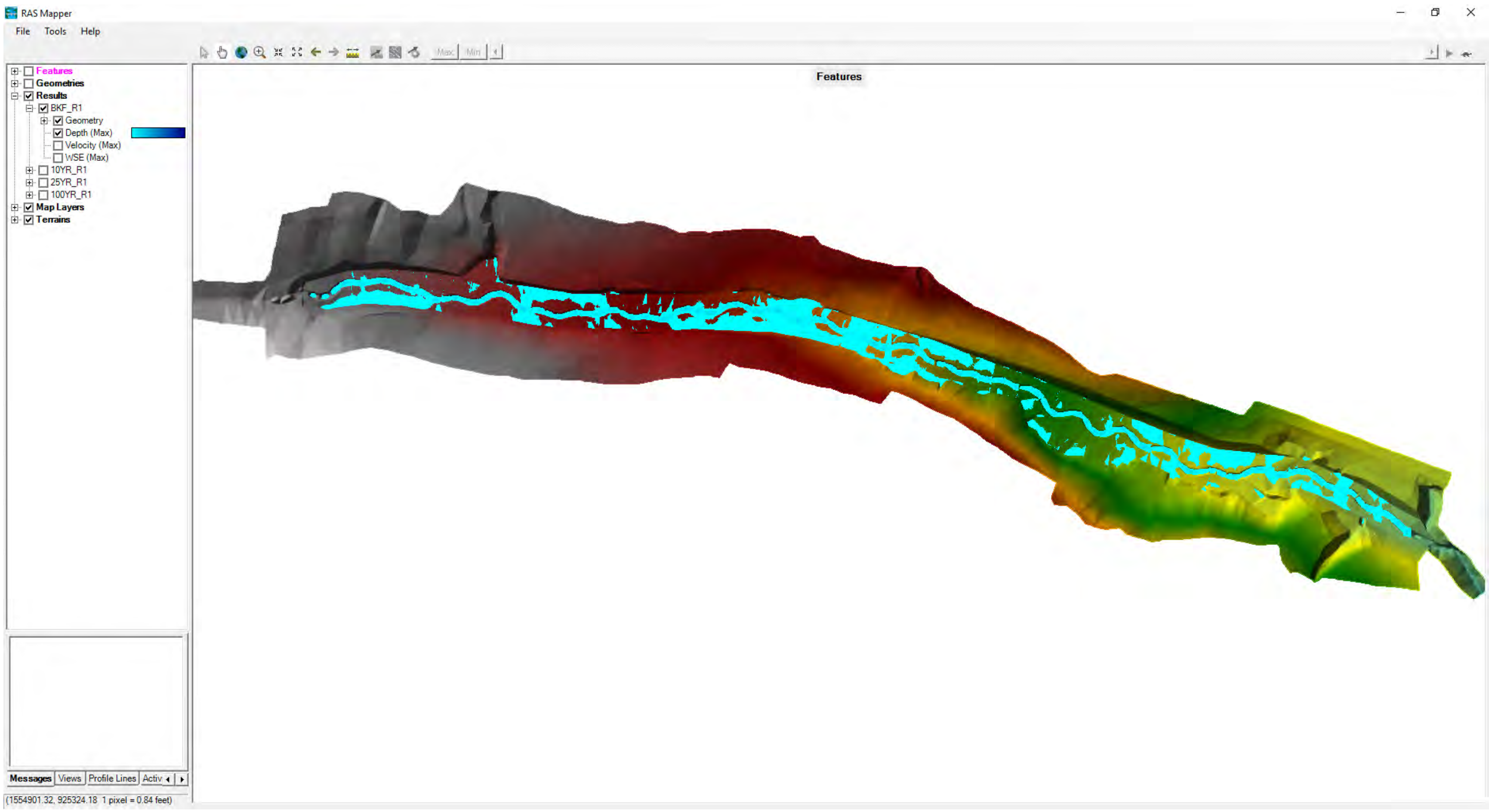
R2 Velocity

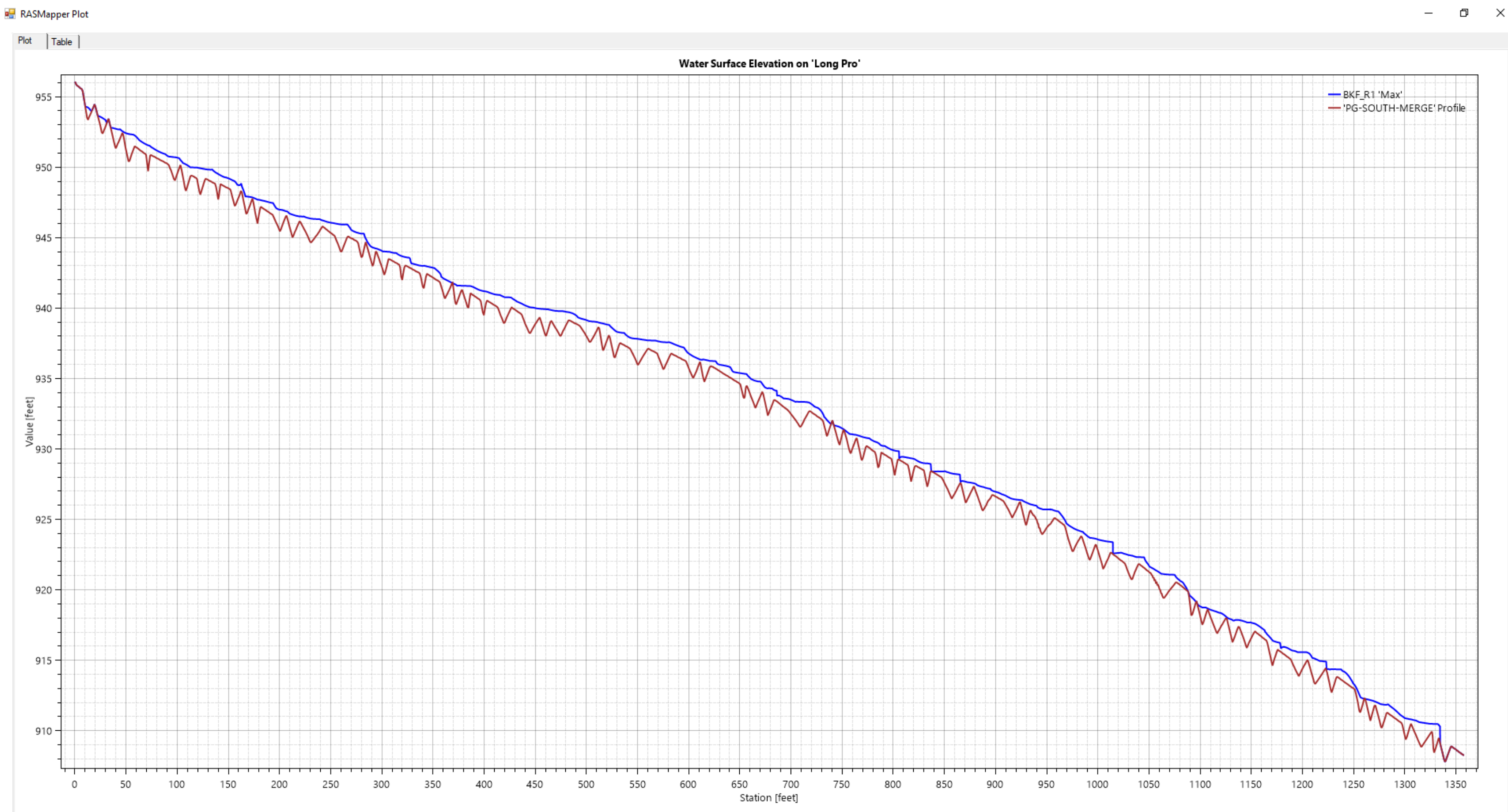

RASMapper Plot
Plot
Table
Velocity on 'XS2'
BKF_R2 'Max'
Value [feet/sec]
Station [feet]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110

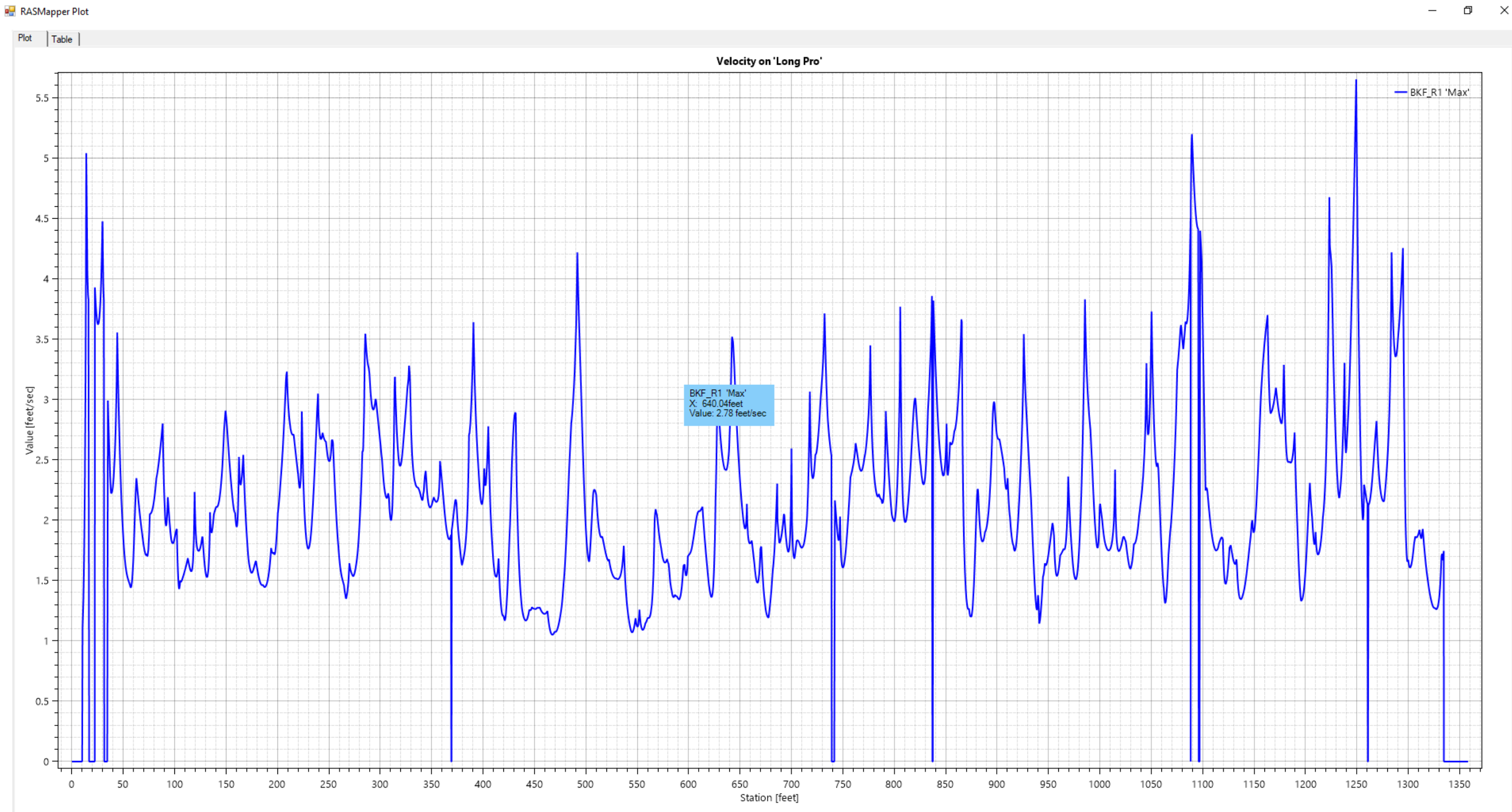
R2 Depth

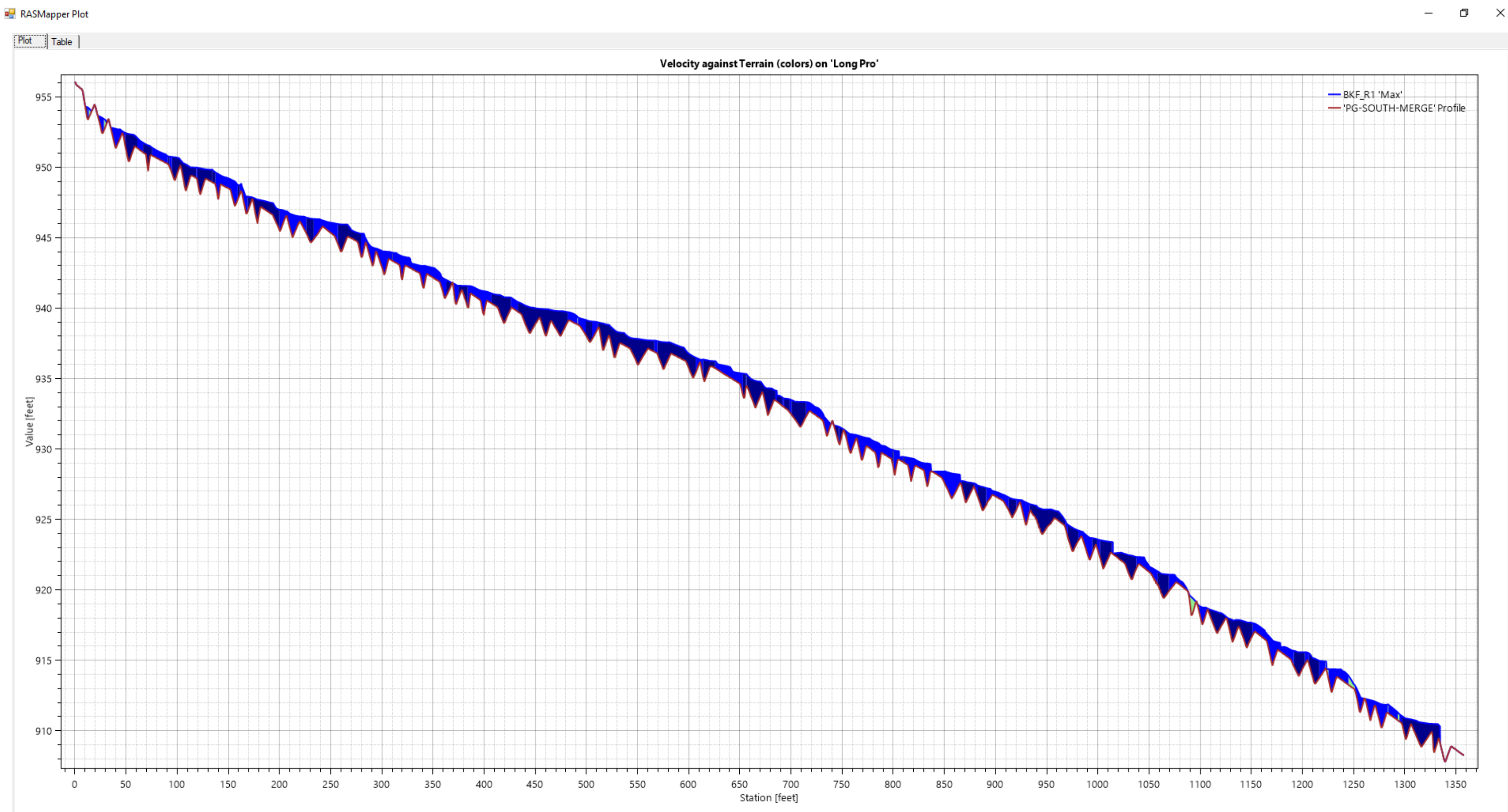

RASMapper Plot
Plot
Table
Depth on 'XS2'
BKF_R2 'Max'
Value [feet]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
Station [feet]

Reach 1 Proposed 2D model Results




RASMapper Plot
Plot
Table
Water Surface Elevation on 'Long Pro'
BKF_R1 'Max'
'PG-SOUTH-MERGE' Profile
Value [feet]
955
950
945
940
935
930
925
920
915
910
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
1100
1150
1200
1250
1300
1350
Station [feet]


RASMapper Plot
Plot
Table
Velocity on 'Long Pro'
BKF_R1 'Max'
BKF_R1 'Max'
X: 640.04feet
Value: 2.78 feet/sec
Value [feet/sec]
Station [feet]


RASMapper Plot
Plot
Table
Velocity against Terrain (colors) on 'Long Pro'
BKF_R1 'Max'
'PG-SOUTH-MERGE' Profile
Value [feet]
Station [feet]
955
950
945
940
935
930
925
920
915
910
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
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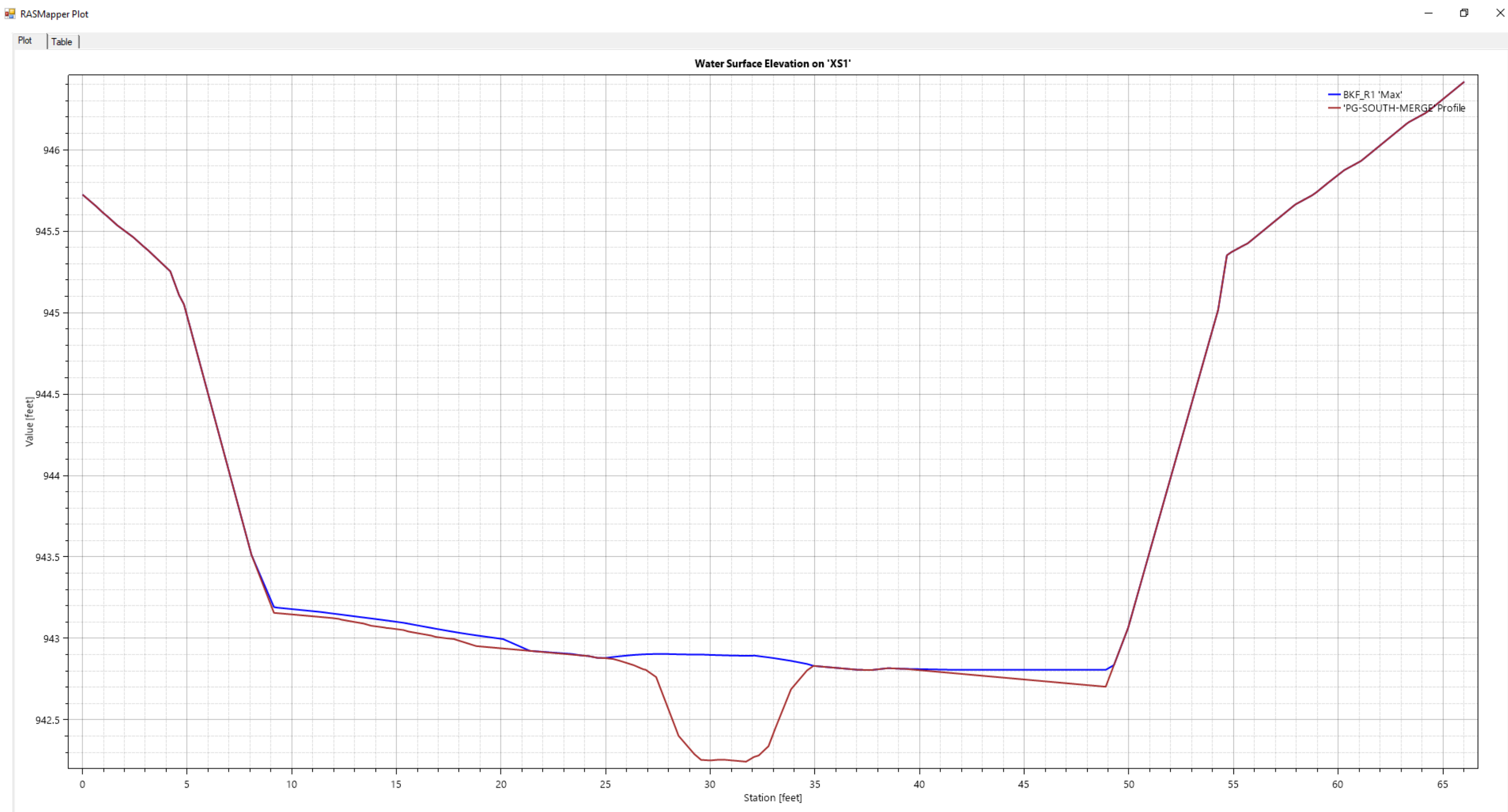
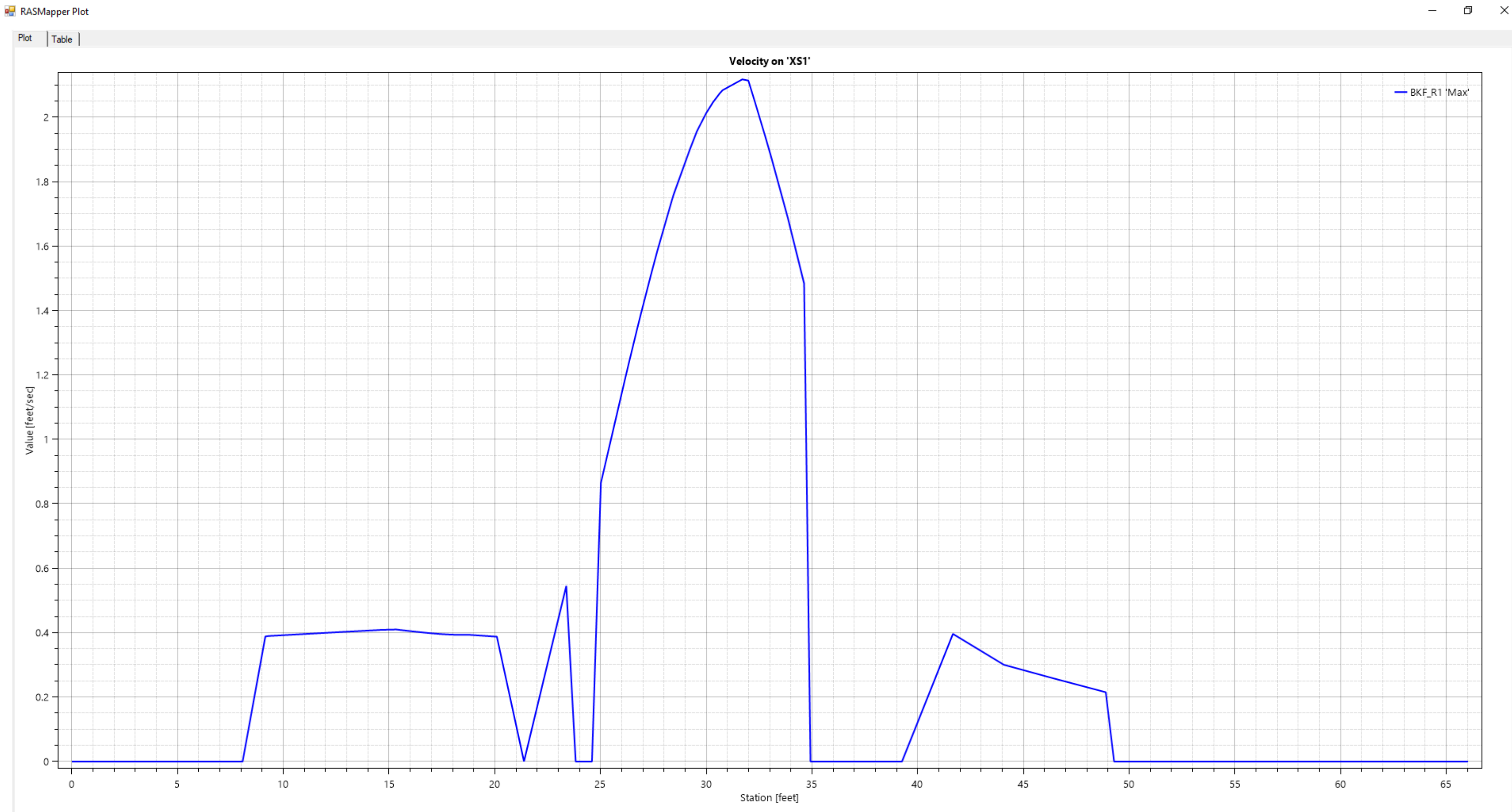
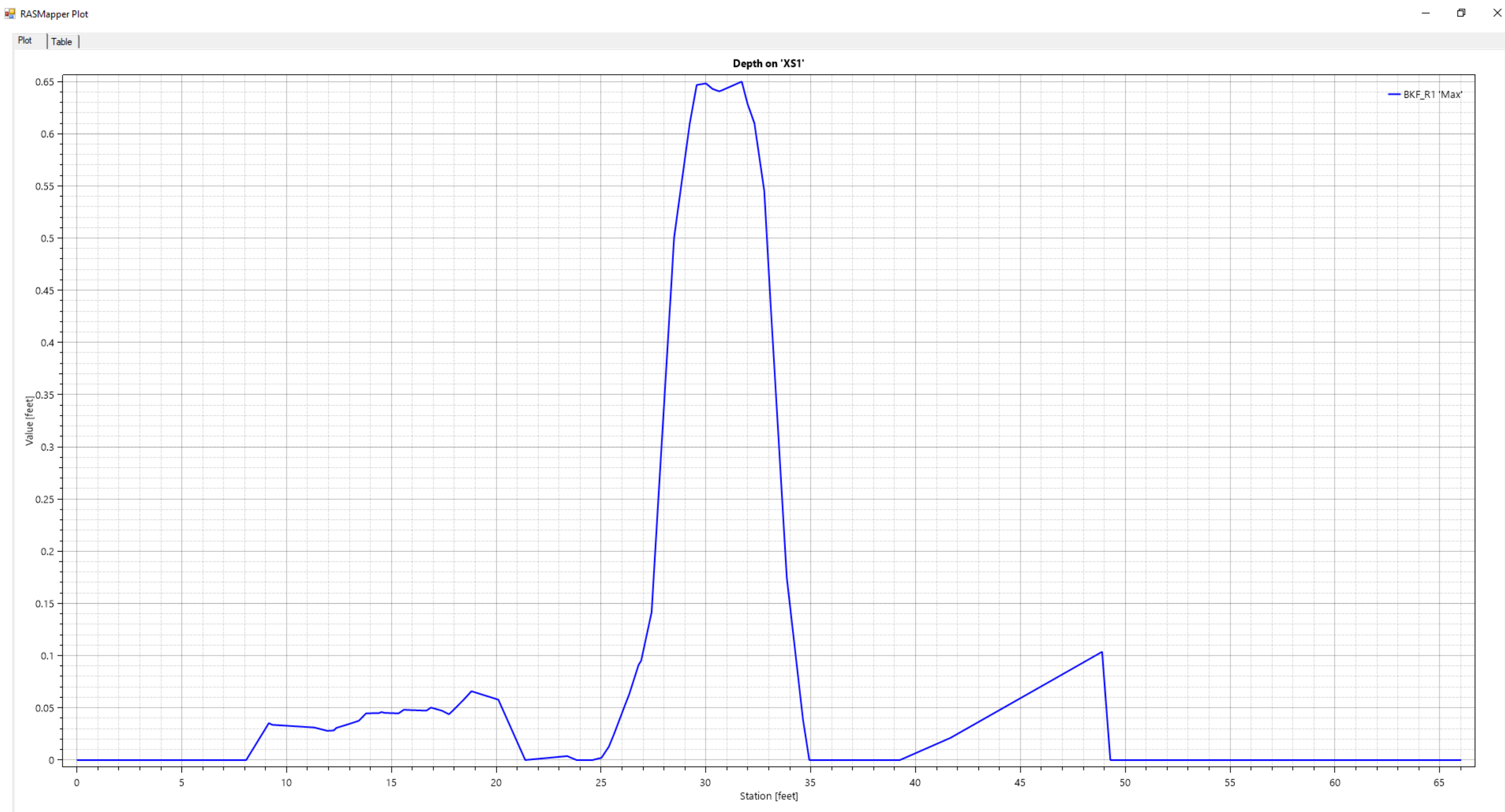
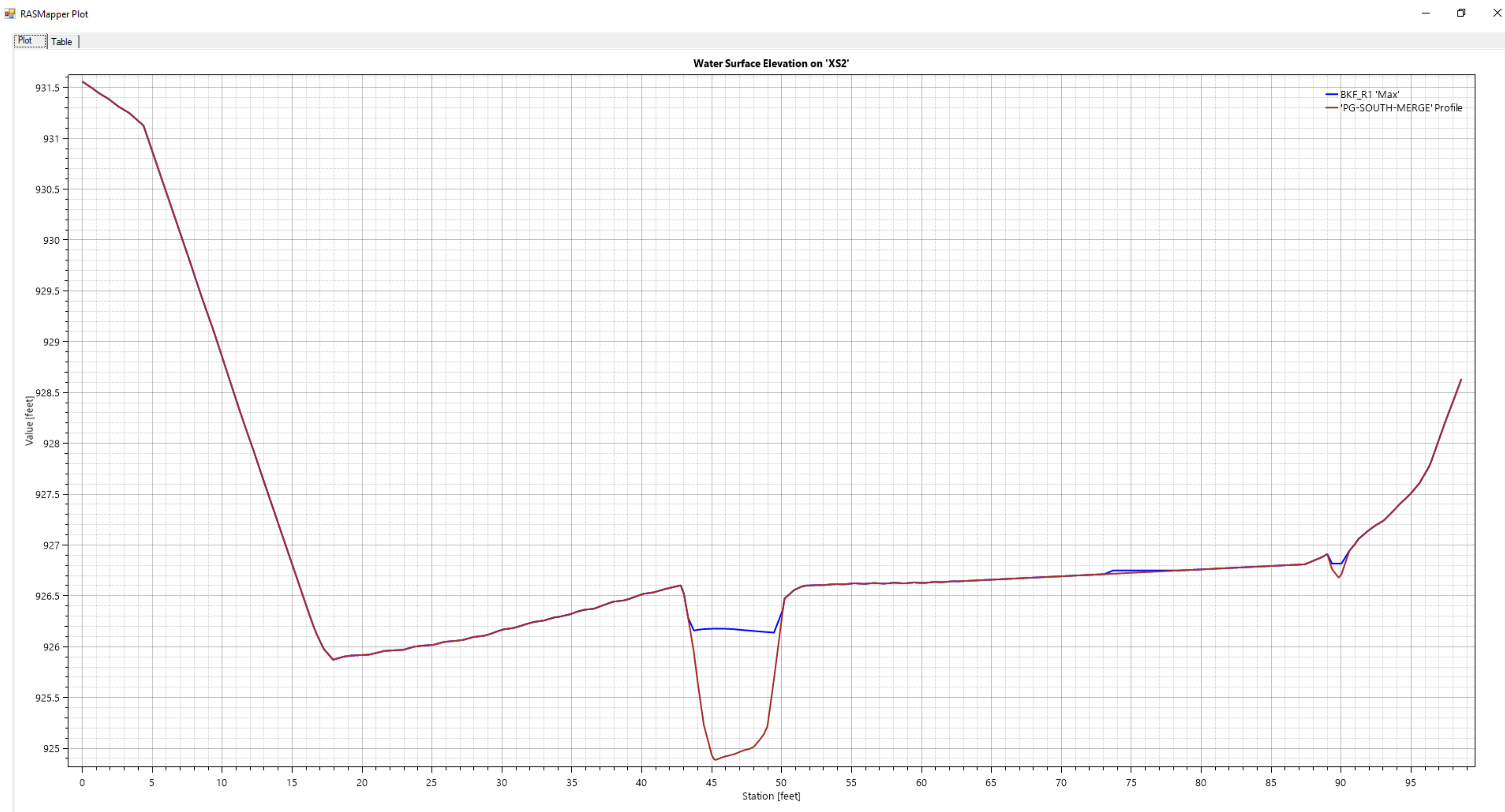
1200
1250
1300
1350

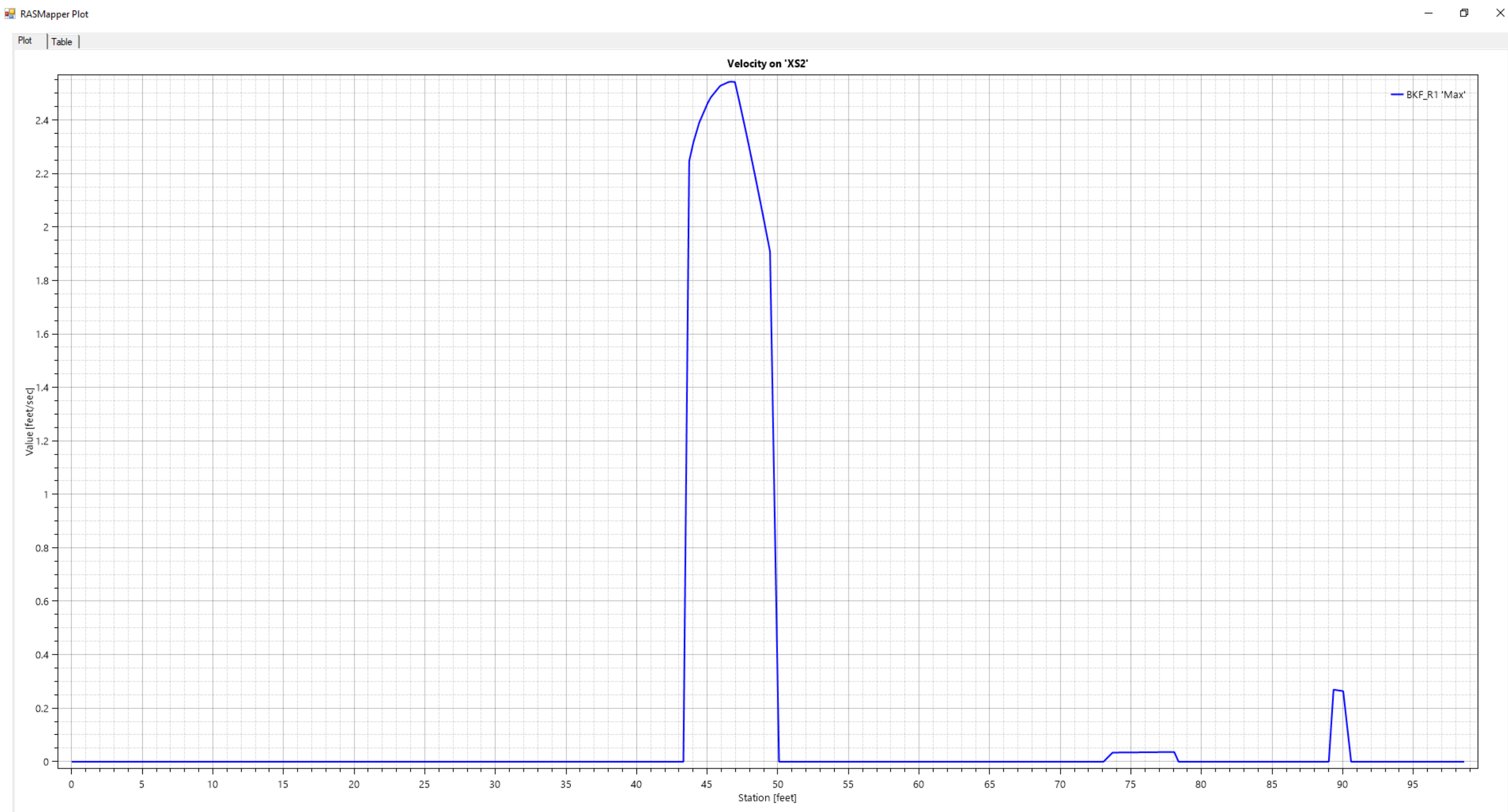

RASMapper Plot
Plot
Table
Water Surface Elevation on 'XS1'
BKF_R1 'Max'
'PG-SOUTH-MERGE' Profile
Value [feet]
946
945.5
945
944.5
944
943.5
943
942.5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Station [feet]

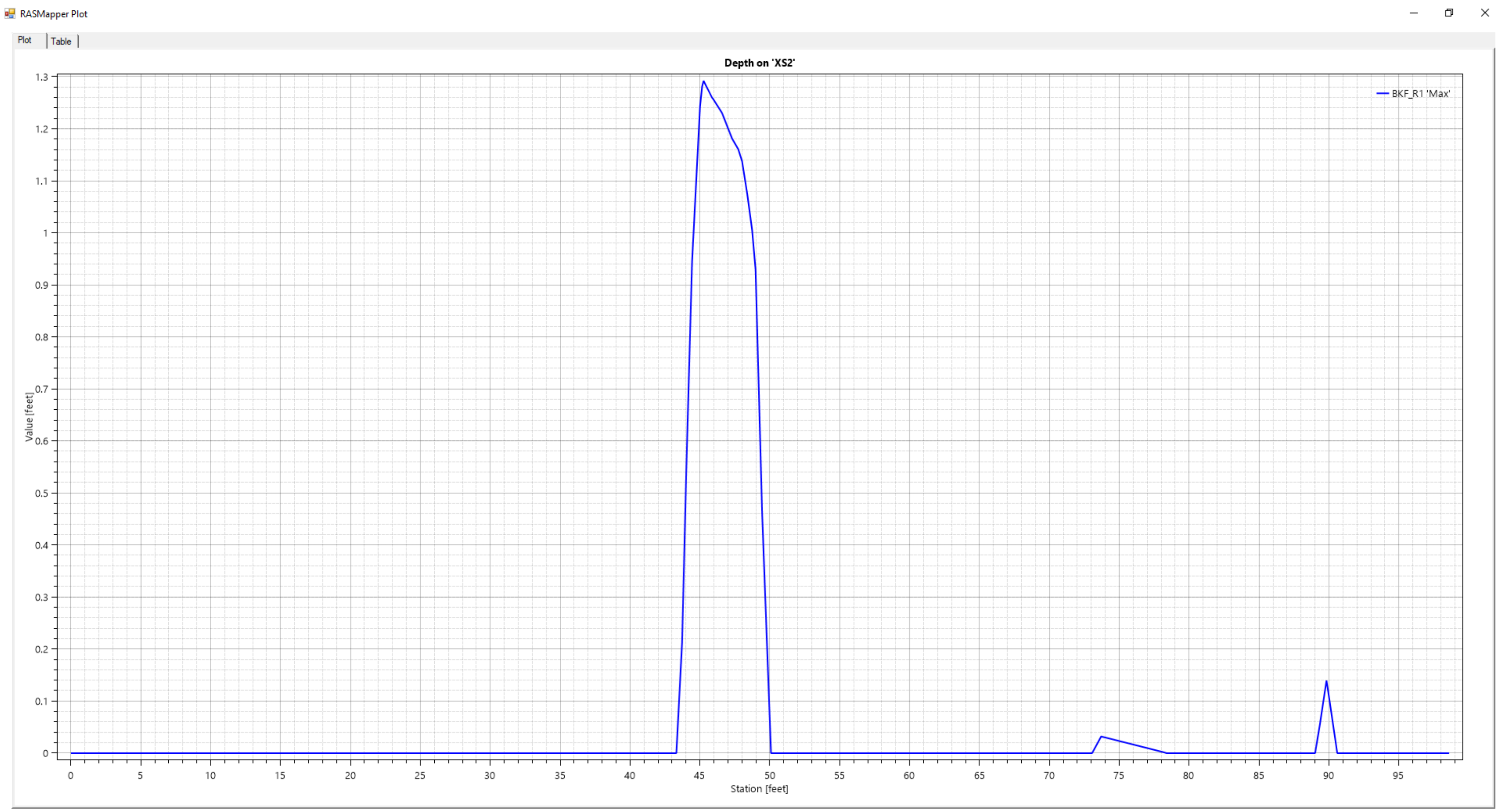


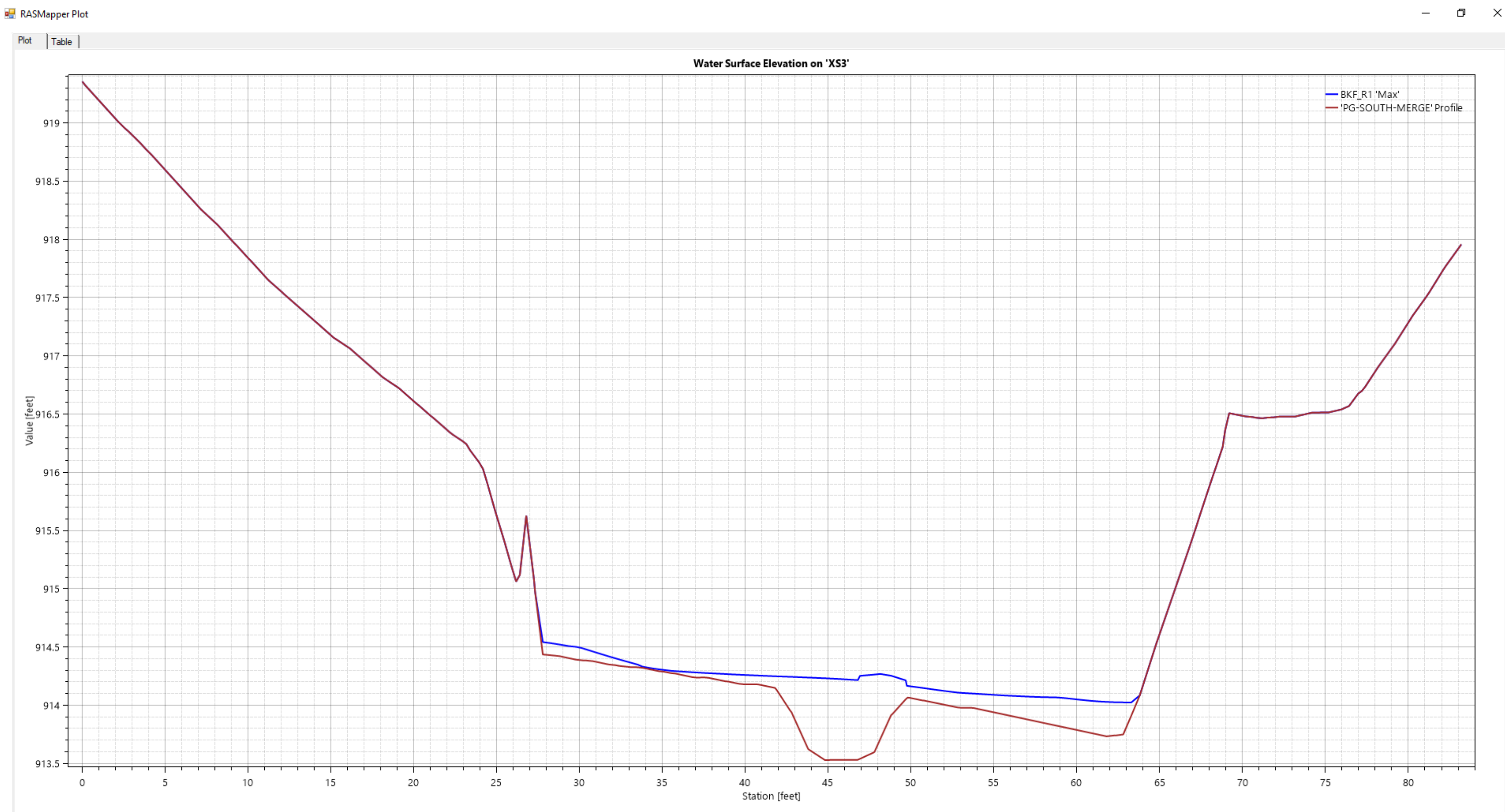
RASMapper Plot
Plot
Table
Velocity on 'XS1'
BKF_R1 'Max'
Value [feet/sec]
Station [feet]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
5
10
15
20
25
30
35
40
45
50
55
60
65

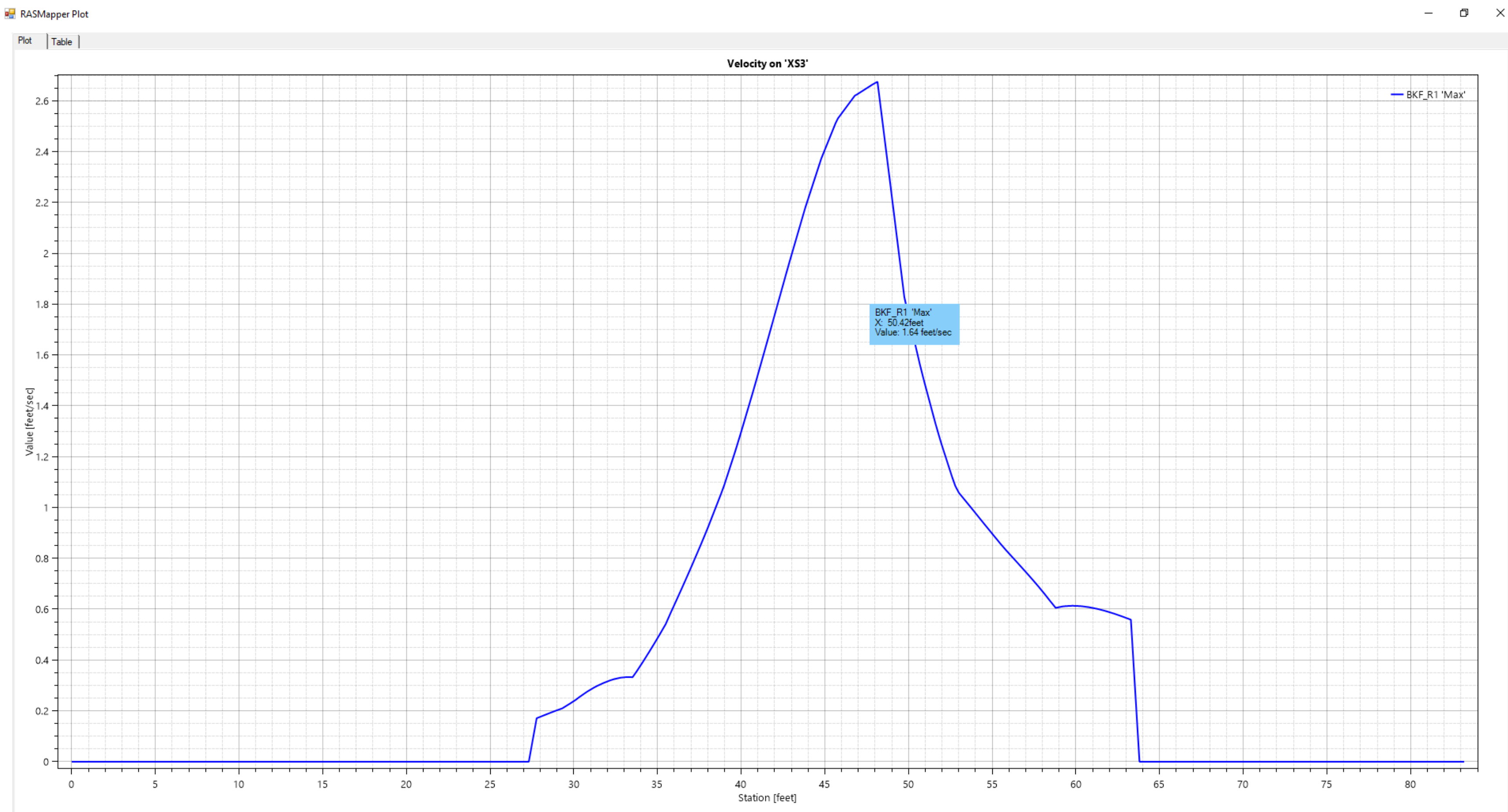

RASMapper Plot
Plot
Table
Depth on 'XS1'
BKF_R1 'Max'
Value [feet]
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Station [feet]

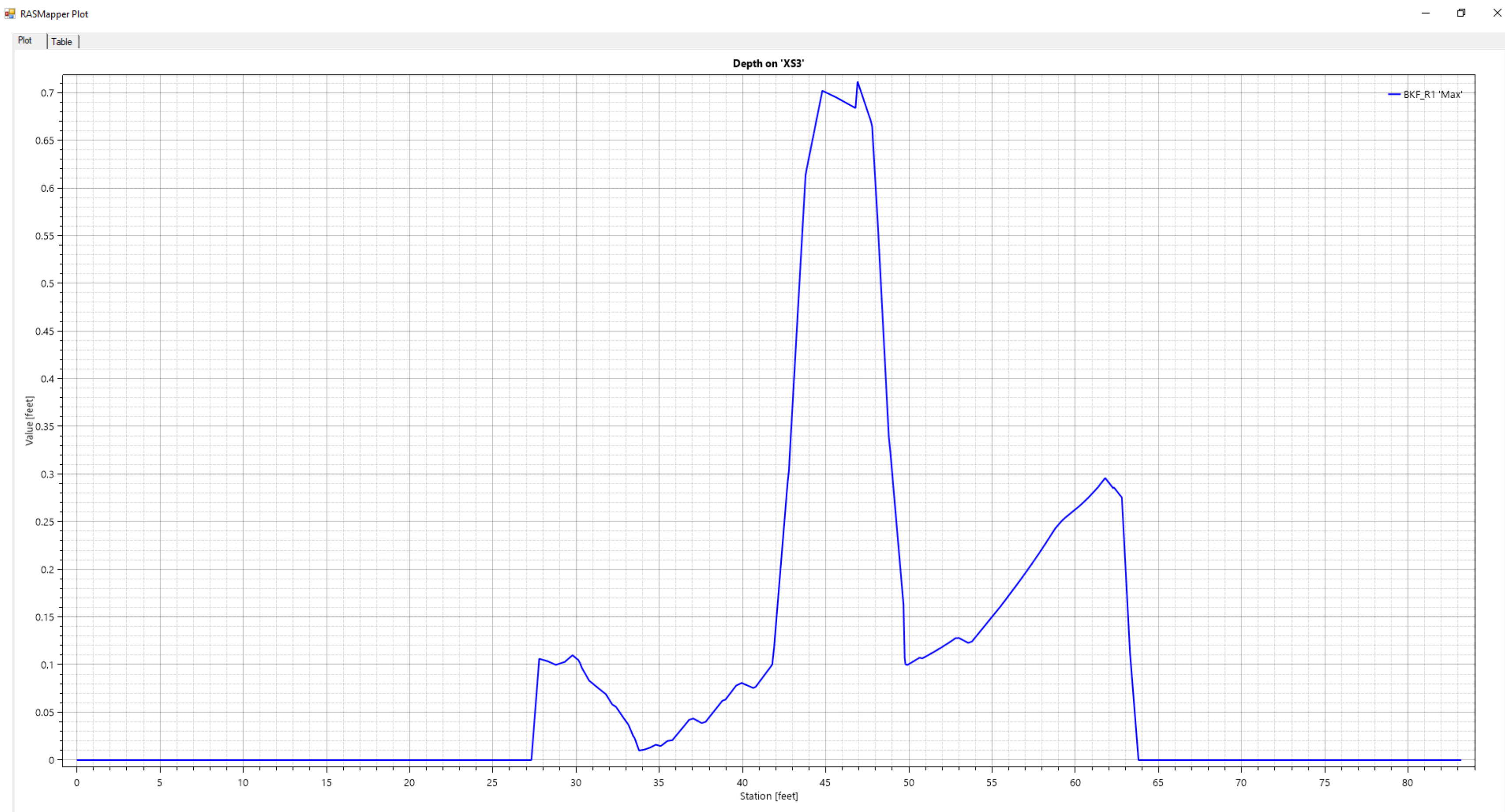

RASMapper Plot
Plot
Table
Water Surface Elevation on 'XS2'
BKF_R1 'Max'
'PG-SOUTH-MERGE' Profile
Value [feet]
Station [feet]
931.5
931
930.5
930
929.5
929
928.5
928
927.5
927
926.5
926
925.5
925
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95


RASMapper Plot
Plot
Table
Velocity on 'XS2'
BKF_R1 'Max'
Value [feet/sec]
Station [feet]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95

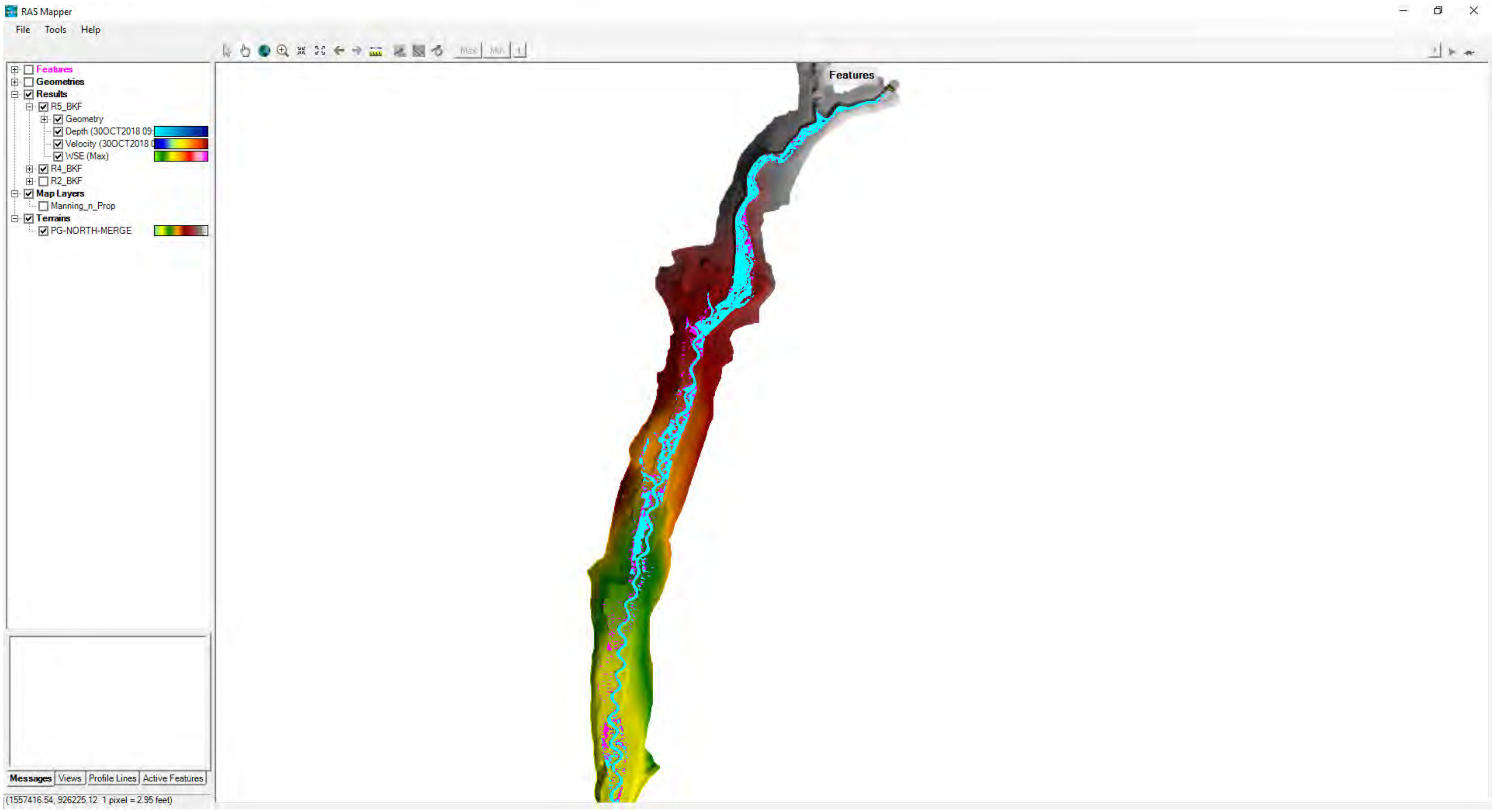

RASMapper Plot
Plot
Table
Depth on 'XS2'
BKF_R1 'Max'
Value [feet]
Station [feet]
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95

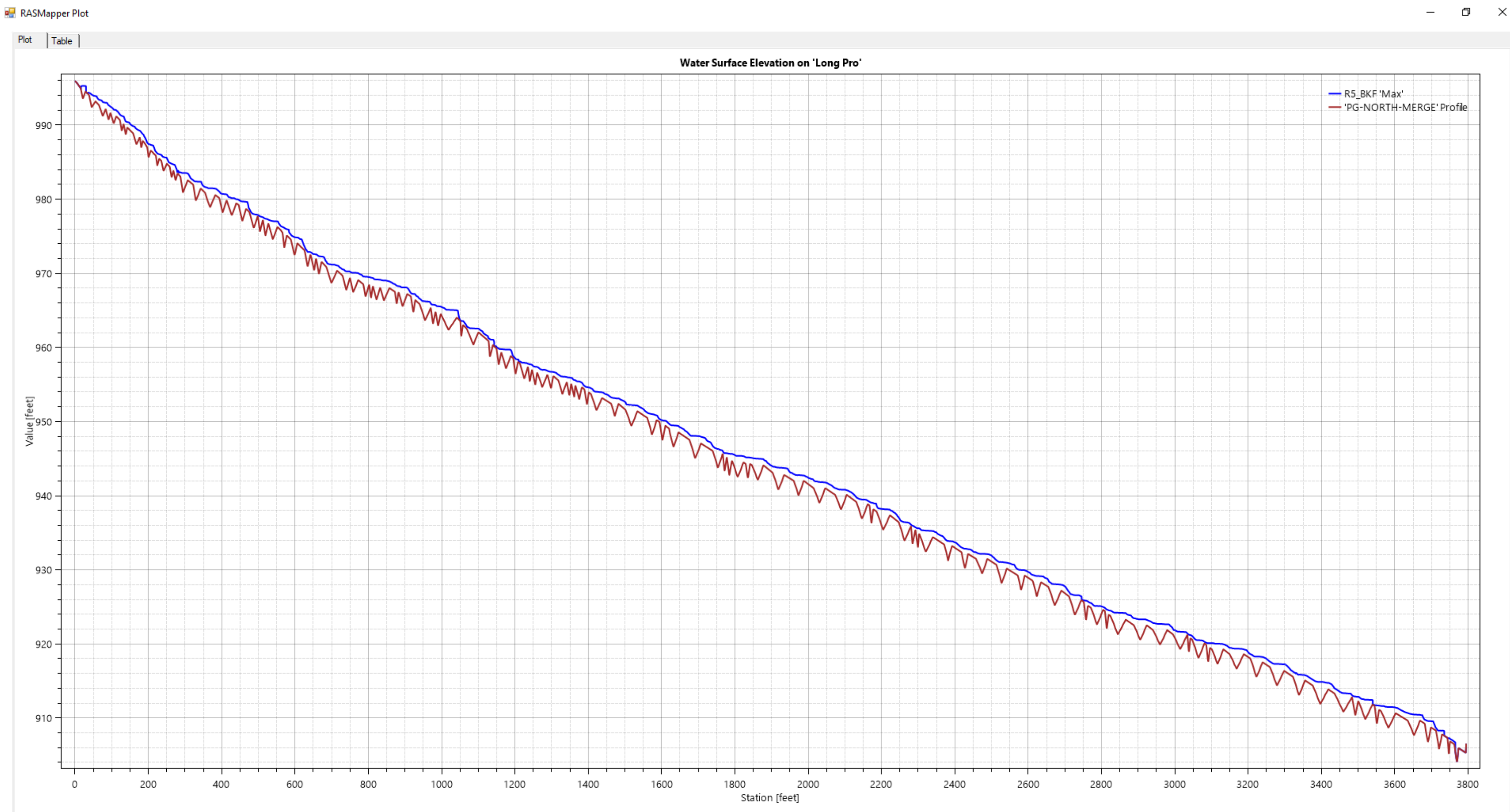

RASMapper Plot
Plot
Table
Water Surface Elevation on 'XS3'
BKF_R1 'Max'
'PG-SOUTH-MERGE' Profile
Value [feet]
Station [feet]
919
918.5
918
917.5
917
916.5
916
915.5
915
914.5
914
913.5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80

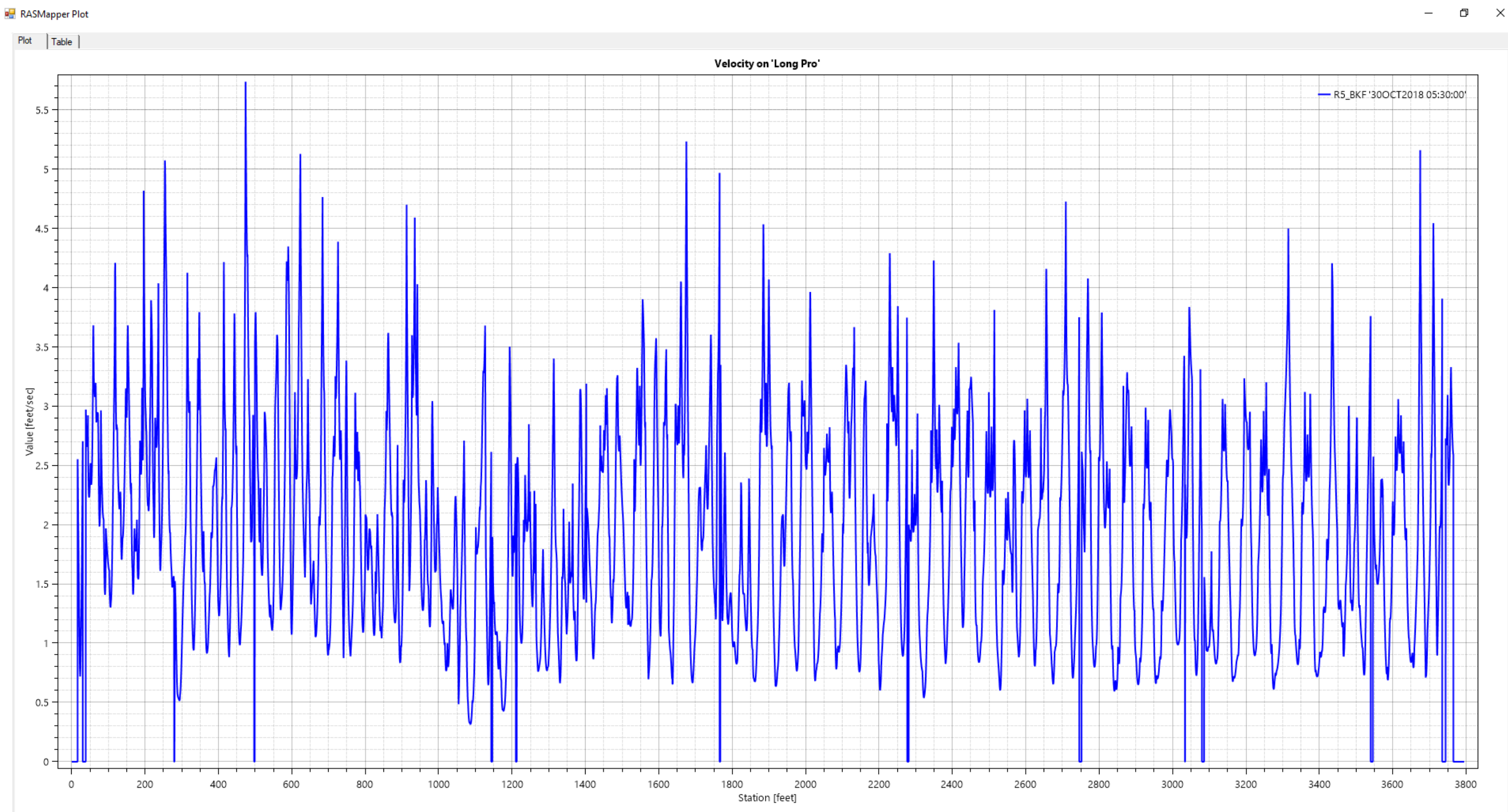

RASMapper Plot
Plot
Table
Velocity on 'XS3'
BKF_R1 'Max'
BKF_R1 'Max'
X: 50.42feet
Value: 1.64 feet/sec
Value [feet/sec]
Station [feet]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80

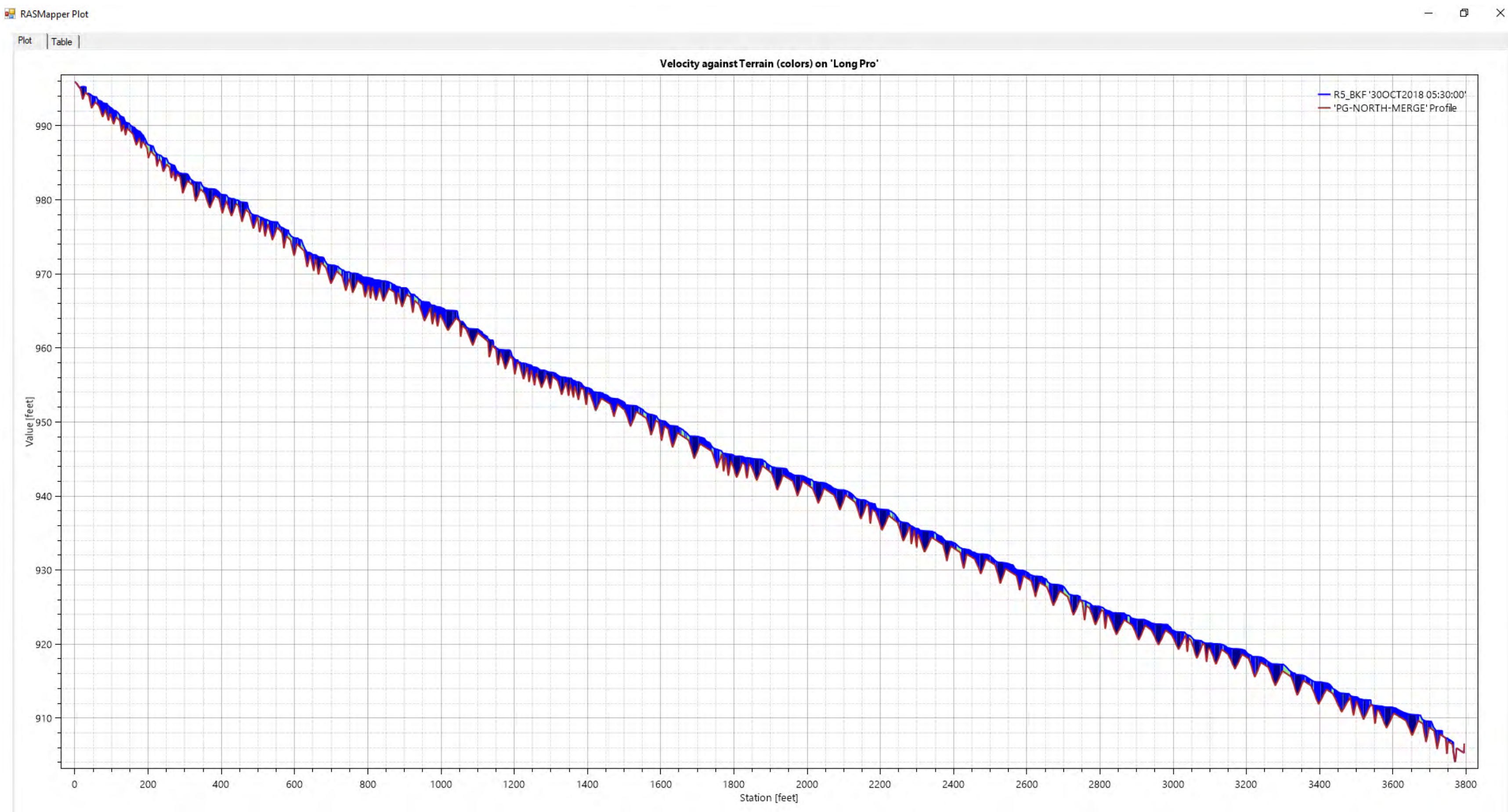

RASMapper Plot
Plot
Table
Depth on 'XS3'
BKF_R1 'Max'
Value [feet]
Station [feet]
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80

Reach 2, 4, 5 Proposed 2D model Results

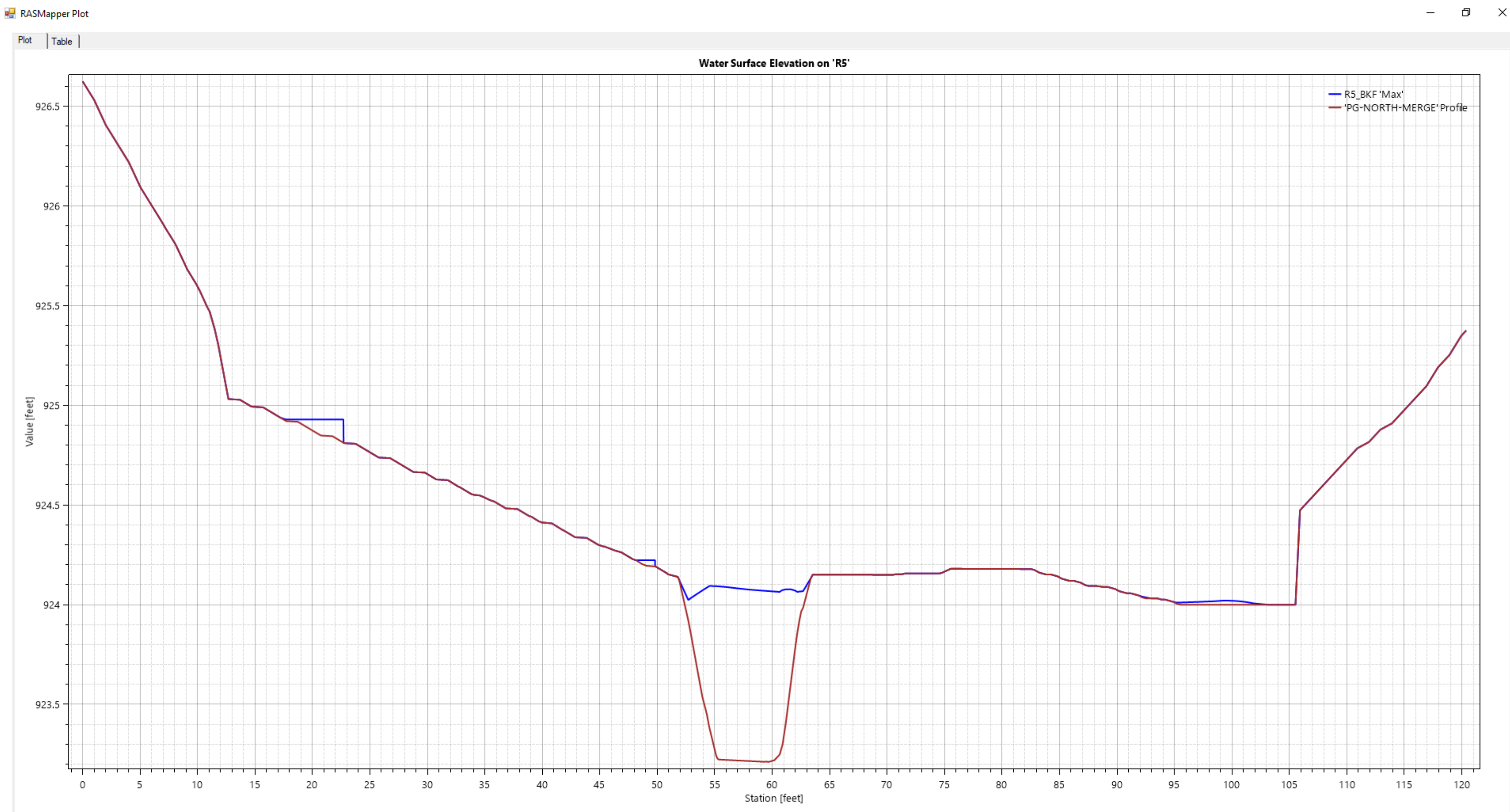



RASMapper Plot
Plot
Table
Water Surface Elevation on 'Long Pro'
R5_BKF 'Max'
'PG-NORTH-MERGE' Profile
Value [feet]
990
980
970
960
950
940
930
920
910
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
Station [feet]

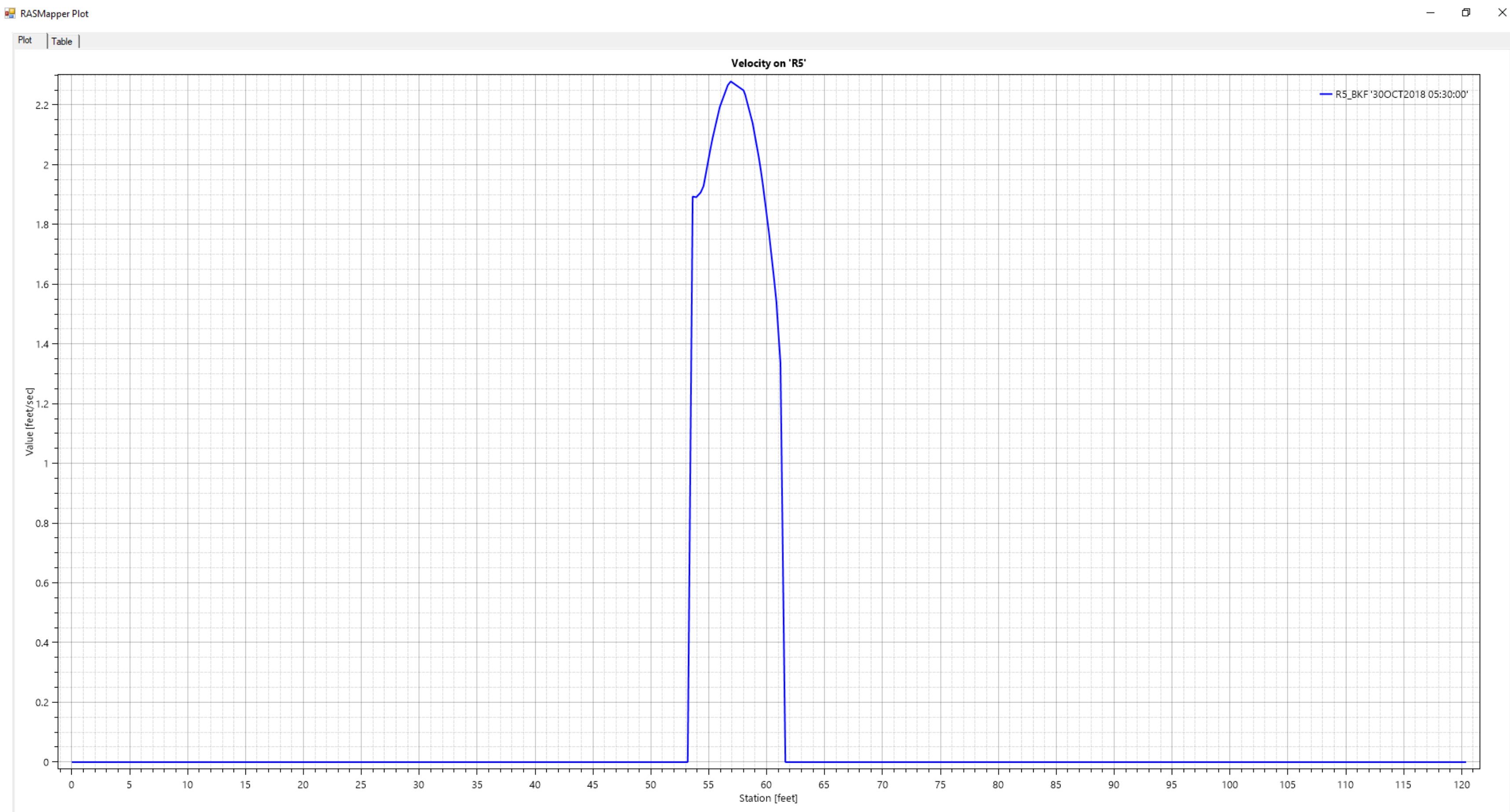

RASMapper Plot
Plot
Table
Velocity on 'Long Pro'
R5_BKF '30OCT2018 05:30:00'
Value [feet/sec]
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
Station [feet]


RASMapper Plot
Plot
Table
Velocity against Terrain (colors) on 'Long Pro'
R5_BKF '30OCT2018 05:30:00'
'PG-NORTH-MERGE' Profile
Value [feet]
990
980
970
960
950
940
930
920
910
Station [feet]
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800

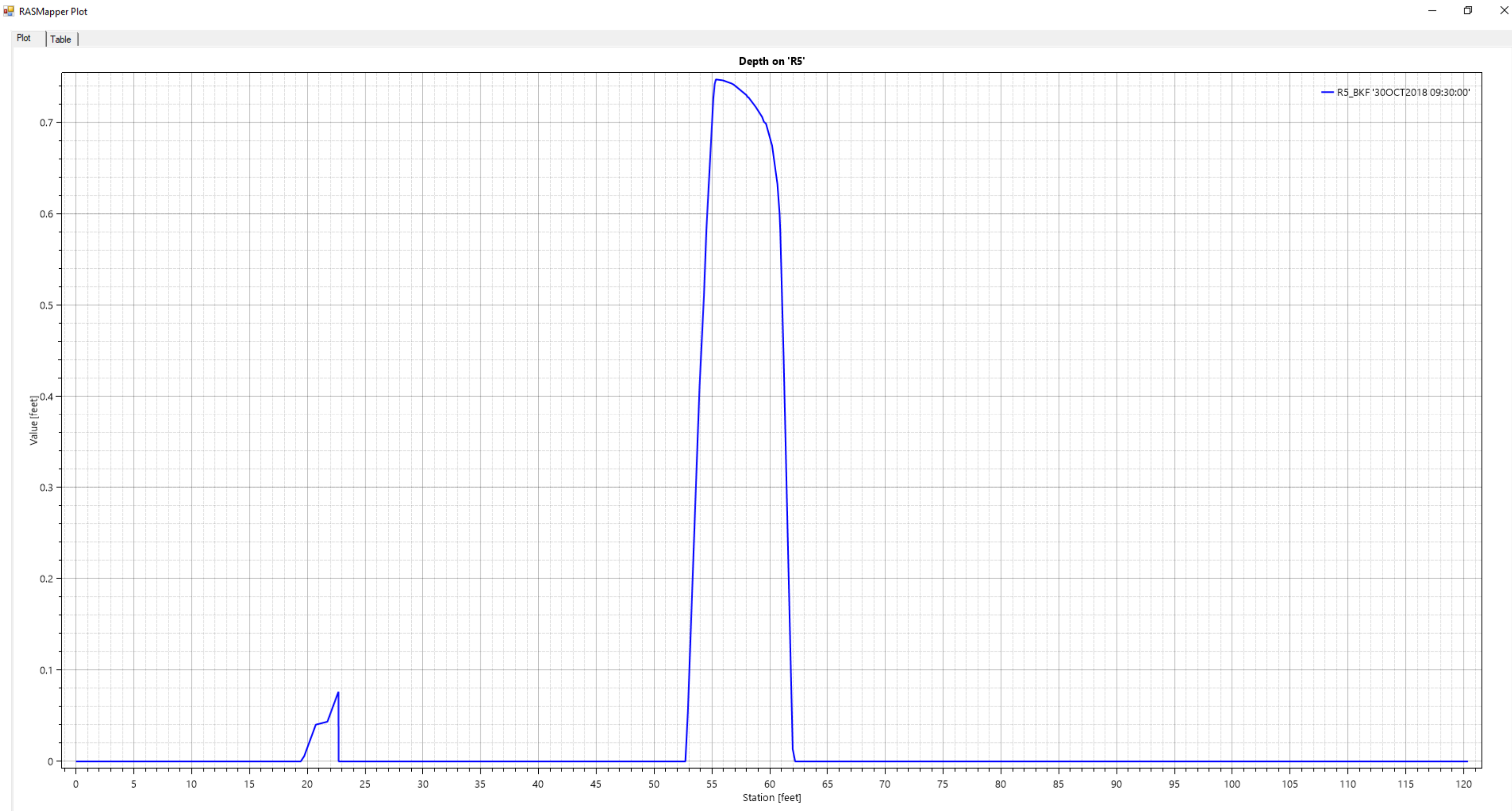
R5 Proposed water surface



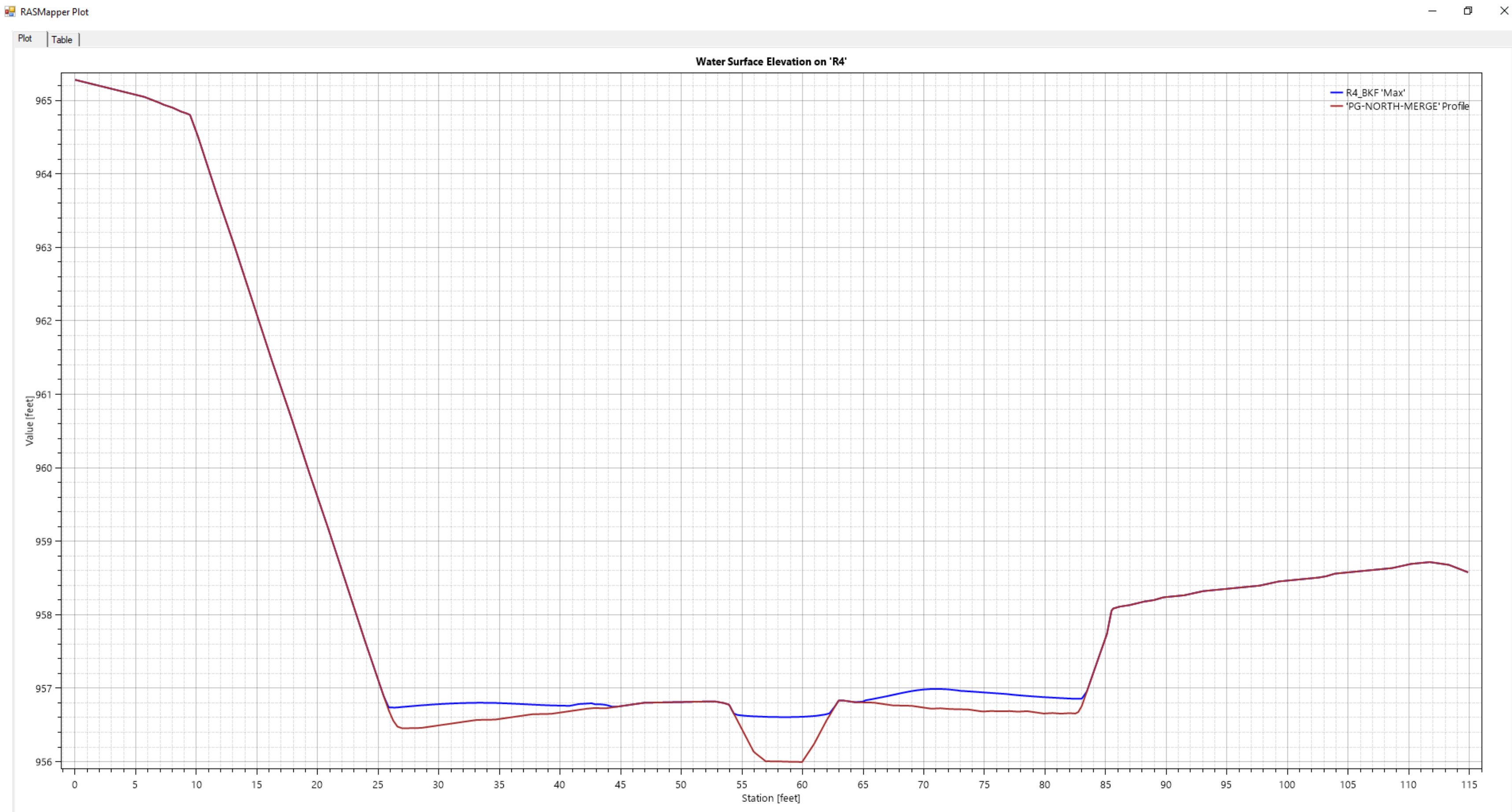
R5 Proposed velocity



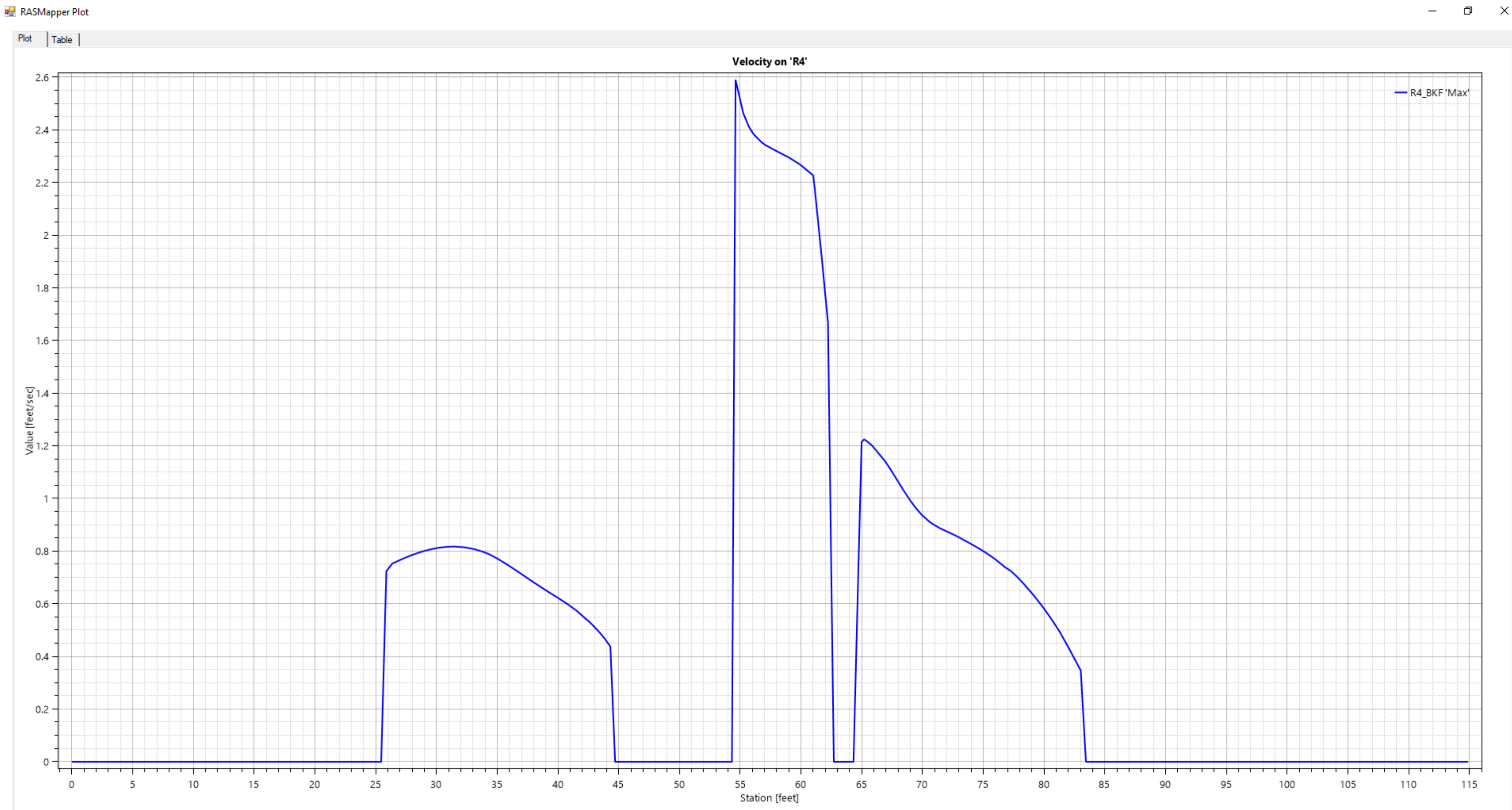
R5 Proposed depth



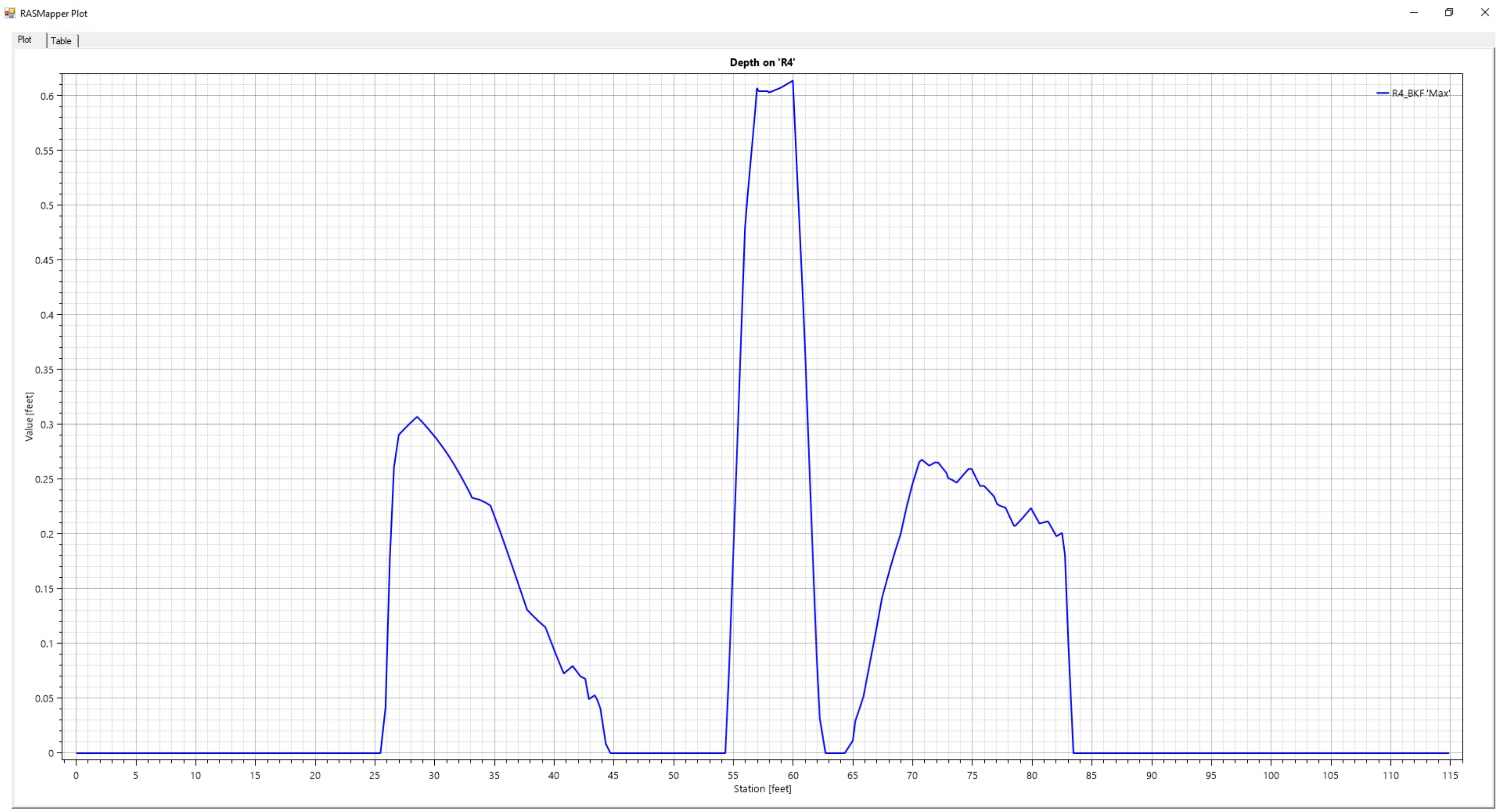
R4 Proposed water surface



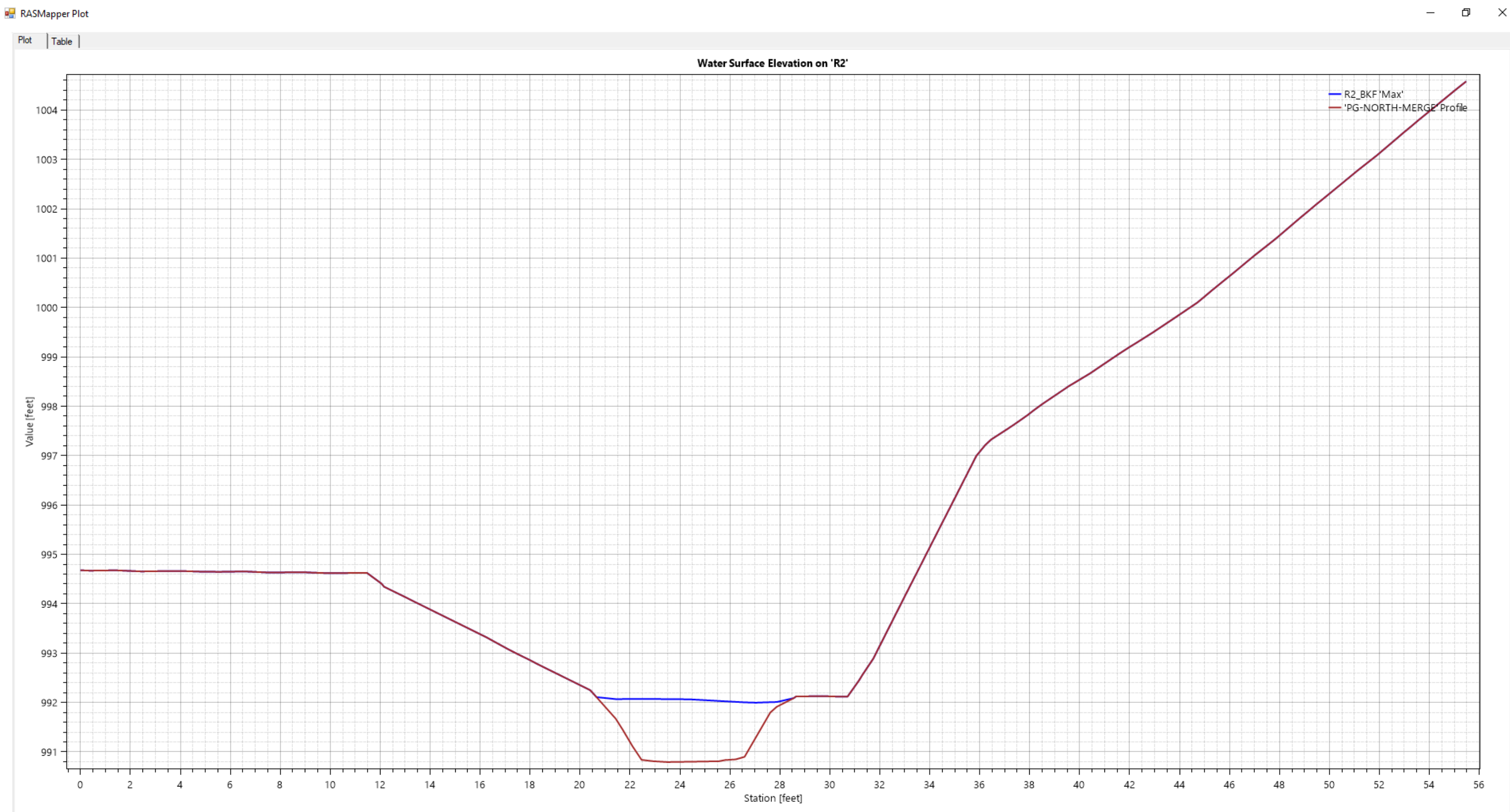
R4 Proposed velocity



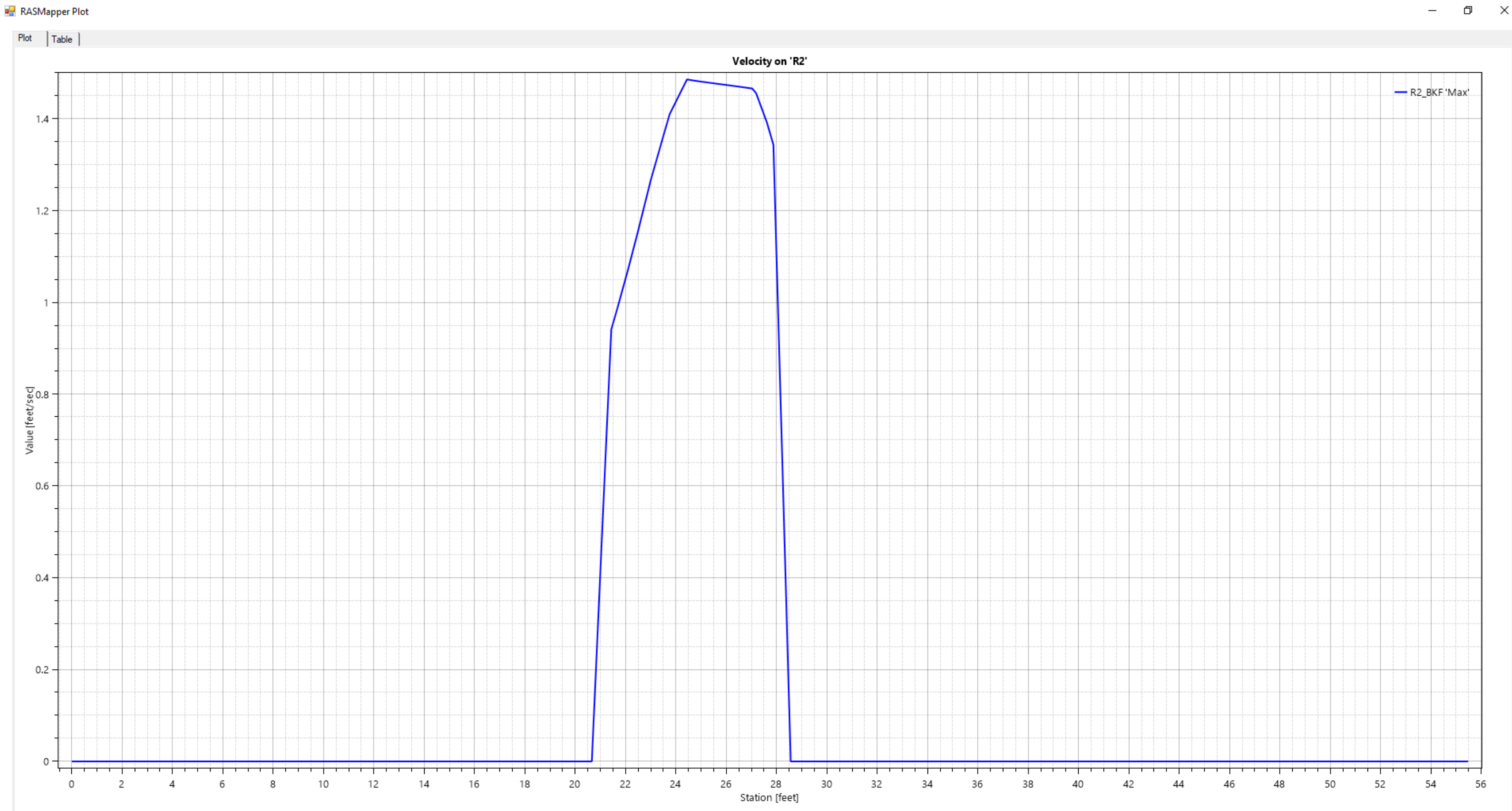
R4 Proposed depth



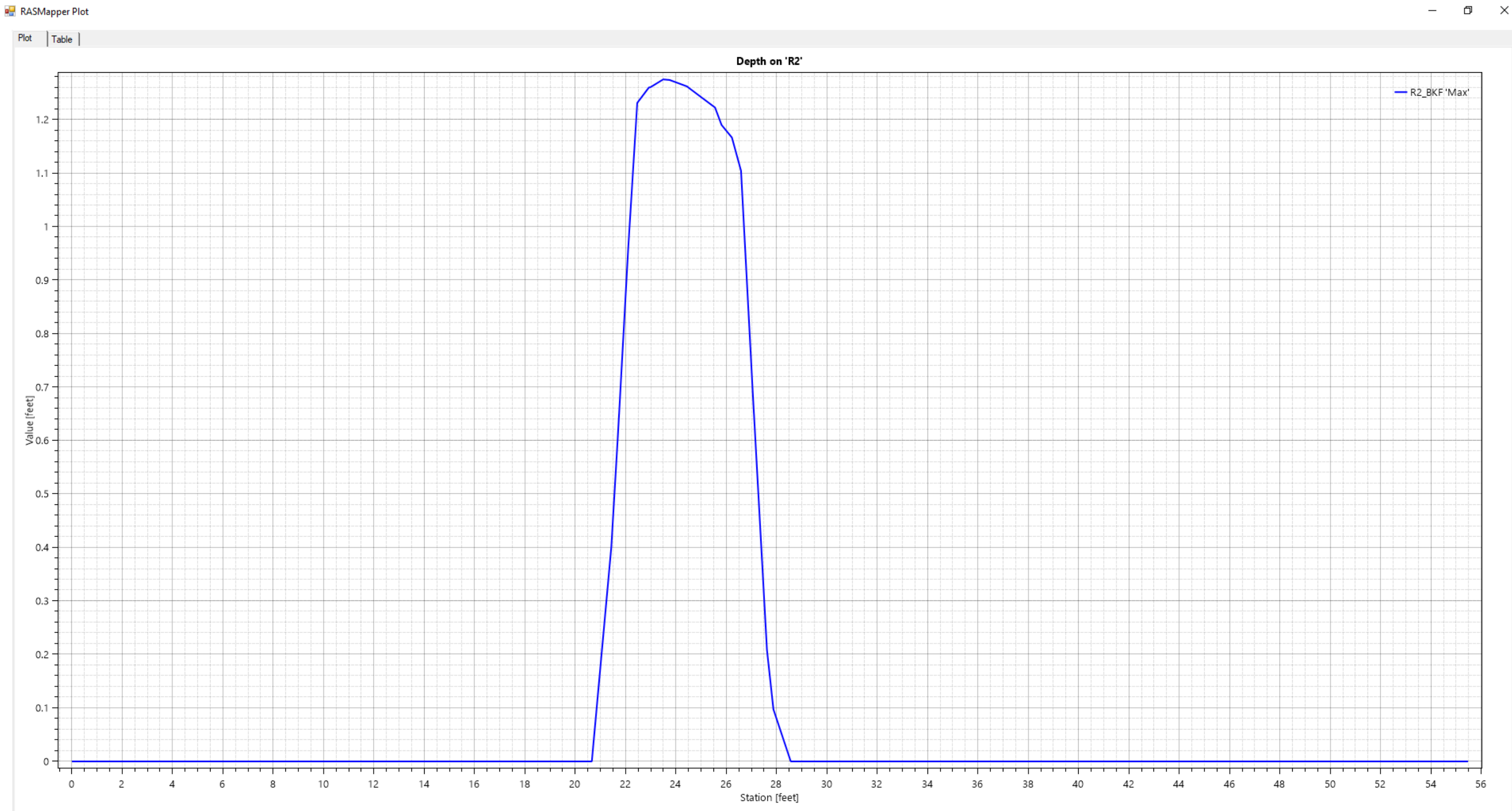
R2 Proposed water surface



R2 Proposed Velocity



R2 Proposed depth



Wilmington District Stream Buffer Credit Calculator

Site Name:	Horne Creek Tributaries
USACE Action ID:	SAW-2017-01510
NCDWR Project Number:	
Sponsor:	Water & Land Solutions, LLC
County:	Surry
Minimum Required Buffer Width[1]:	30

Mitigation Type	**Mitigation Ratio Multiplier[2]**	**Creditable Stream Length[3]**	**Baseline Stream Credit**
Restoration (1:1)	1	5344	5344.00
Enhancement I (1.5:1)	1.5		
Enhancement II (2.5:1)	2.5	84	33.60
Preservation (5:1)	5		
Other (7.5:1)	7.5		
Other (10:1)	10		
Custom Ratio 1			
Custom Ratio 2			
Custom Ratio 3			
Custom Ratio 4			
Custom Ratio 5			
Totals		**5428.00**	**5377.60**

					Buffer Width Zone (feet from Ordinary High Water Mark)				
Buffer Zones	**less than 15 feet**	**>15 to 20 feet**	**>20 to 25 feet**	**>25 to 30 feet**	**>30 to 50 feet**	**>50 to 75 feet**	**>75 to 100 feet**	**>100 to 125 feet**	**>125 to 150 feet**
Max Possible Buffer (square feet)[4]	162840	54280	54280	54280	217120	271400	271400	271400	271400
Ideal Buffer (square feet)[5]	164102.58	54681.85	54340.92	53780.43	210181.79	260414.77	263399.80	268013.31	273997.05
Actual Buffer (square feet)[6]	158813.86	51209.95	49892.56	48532.55	117950.69	20978.24	11417.88	7748.47	2386.06
Zone Multiplier	50%	20%	15%	15%	9%	7%	6%	5%	3%
Buffer Credit Equivalent	2688.80	1075.52	806.64	806.64	483.98	376.43	322.66	268.88	161.33
Percent of Ideal Buffer	97%	94%	92%	90%	56%	8%	4%	3%	1%
Credit Adjustment	-86.66	-68.29	-66.03	-78.71	271.60	30.32	13.99	7.77	1.40

Total Baseline Credit	**Credit Loss in Required Buffer**	**Credit Gain for Additional Buffer**	**Net Change in Credit from Buffers**	**Total Credit**
5377.60	**-299.69**	**325.09**	**25.41**	**5403.01**

[1]Minimum standard buffer width measured from the top of bank (50 feet in piedmont and coastal plain counties or 30 feet in mountain counties)

[2]Use the Custom Ratio fields to enter non-standard ratios, which are equal to the number of feet in the feet-to-credit mitigation ratio (e.g., for a perservation ratio of 8 feet to 1 credit, the multiplier would be 8

[3]Equal to the number of feet of stream in each Mitigation Type. If stream reaches are not creditable, they should be excluded from this measurement, even if they fall within the easement

[4]This amount is the maximum buffer area possible based on the linear footage of stream length if channel were perfectly straight with full buffer width. This number is not used in calculations, but is provided as a reference.

[5]Maximum potential size (in square feet) of each buffer zone measured around all creditable stream reaches, calculated using GIS, including areas outside of the easement. The inner zone (0-15') should be measured from the top of the OHWM or the edge of the average stream width if OHWM is not known. Non-creditable stream reaches within the easement should be removed prior to calculating this area wtih GIS.

[6]Square feet in each buffer zone, as measured by GIS, excluding non-forested areas, all other credit type (e.g., wetland, nutrient offset, buffer), easement exceptions, open water, areas failing to meet the vegetation performance standard, etc. Additional credit is given to 150 feet in buffer width, so areas within the easement that are more than 150 feet from creditable streams should not be included in this measurement. Non-creditable stream reaches within the easement should be removed prior to calculating this area wtih GIS

See Figure 6. Current Condition Map for Photo Locations

Photo 1: R1 – Looking upstream at bank erosion and incision (1/2/2017)

Photo 2: R1 – looking upstream lack of mature buffer and direct cattle access (1/2/2017)

Photo 3: R1 – Looking upstream at undefined channel due to cattle wallowing (1/2/2017)

Photo 4: Reach R1 – Looking downstream at drainage and lack of mature riparian buffer (1/2/2017)

See Figure 6. Current Condition Map for Photo Locations

Photo 5: R2 – Looking downstream at project start (1/2/2017)

Photo 6: R2 – Looking downstream and bank erosion, headcut and incision (1/2/2017)

Photo 7: R2 – Looking upstream at bank erosion and incision (1/2/2017)

Photo 8: R2 – Looking downstream bank erosion and confluence with R3 (1/2/2017)

See Figure 6. Current Condition Map for Photo Locations

Photo 9: R3 – Looking upstream at bank erosion (1/2/2017)

Photo 10: R3 – Looking downstream at bank erosion and confluence with R2 (1/2/2017)

Photo 11: R3 – Looking upstream at headcut (1/2/2017)

Photo 12: R3 – Looking upstream at BMP location (1/2/2017)

See Figure 6. Current Condition Map for Photo Locations

Photo 13: R4 – Looking downstream at bank erosion and US stream crossing location (1/2/2017)

Photo 14: R4 – Looking upstream at bank erosion and incision (1/2/2017)

Photo 15: R4 – Looking downstream at bank erosion (1/2/2017)

Photo 16: R4 – Looking upstream at hoof shear and direct cattle access (1/2/2017)

See Figure 6. Current Condition Map for Photo Locations

Photo 17: R4b – Looking at stream/wetland area (1/2/2017)

Photo 18: R4b – Looking downstream at headcut and minimal riparian buffer (1/2/2017)

Photo 19: Reach R4b – Looking at headcut (1/2/2017)

Photo 20: R4b – Looking downstream at channel incision and confluence with R4 (1/2/2017)

See Figure 6. Current Condition Map for Photo Locations

Photo 21: R4a – Looking upstream at start of reach at cattle wallowing area (1/2/2017)

Photo 22: R4a – Looking downstream at stable headwater channel (1/2/2017)

Photo 23: R4a – Looking downstream at stable headwater channel (1/2/2017)

Photo 24: R4a – Looking downstream at stable channel and confluence with R4 (1/2/2017)

See Figure 6. Current Condition Map for Photo Locations

Photo 25: R5 – Looking downstream at bank erosion and channel incision (1/2/2017)

Photo 26: R5 – Looking upstream in left floodplain at remnant channel feature (1/2/2017)

Photo 27: R5 – Looking downstream at direct cattle access, hoof shear, and bank erosion (1/2/2017)

Photo 28: R5 – Looking upstream at channel incision and narrow riparian buffer (1/2/2017)

Appendix 3 – Site Protection Instrument

WLS is in the process of obtaining a conservation easement from the current landowners for the project area. The easement deed and survey plat will be submitted to DMS and State Property Office (SPO) for approval and will be held by the State of North Carolina. Once recorded, the secured easement will allow WLS to proceed with the project development and protect the mitigation assets in perpetuity. The Table below includes the draft Site Protection Instrument information.

Table 3-1. Site Protection Instrument Information

Owner of Record (N/F)	PIN	County	Site Protection Instrument	Deed Book and Page Numbers	Acreage Protected
William Franklin Fulp and Debra P. Fulp	595200774688	Surry	Conservation Easement	---	2.66
Mary Ellen Smith	595200765174	Surry	Conservation Easement	---	2.75
Mary Ellen Smith	595200772795	Surry	Conservation Easement	---	0.28
Brown Farms of Surry County, LLC (c/o Edward Thomas Brown)	595200567091	Surry	Conservation Easement	---	6.07
Jane B. Boger	595200733427	Surry	Conservation Easement	---	0.002

Appendix 4 – Credit Release Schedule

All credit releases will be based on the total credit generated as reported by the as-built survey of the mitigation site. Under no circumstances shall any mitigation project be debited until the necessary Department of the Army (DA) authorization has been received for its construction or the District Engineer (DE) has otherwise provided written approval for the project in the case where no DA authorization is required for construction of the mitigation project. The DE, in consultation with the NC Interagency Review Team (NCIRT), will determine if performance standards have been satisfied sufficiently to meet the requirements of the release schedules below. In cases where some performance standards have not been met, credits may still be released depending on the specifics of the case. Monitoring may be required to restart or be extended, depending on the extent to which the site fails to meet the specified performance standard. The release of project credits will be subject to the criteria described in the Table below.

Table 4-1. Credit Release Schedule

Stream Credits			
Monitoring Year	**Credit Release Activity**	**Interim Release**	**Total Release**
0	Initial Allocation - see requirements below	30%	30%
1	First year monitoring report demonstrates performance standards are being met	10%	40%
2	Second year monitoring report demonstrates performance standards are being met	10%	50% (60%*)
3	Third year monitoring report demonstrates performance standards are being met	10%	60% (70%*)
4	Fourth year monitoring report demonstrates performance standards are being met	5%	65% (75%*)
5	Fifth year monitoring report demonstrates performance standards are being met.	10%	75% (85%*)
6	Sixth year monitoring report demonstrates performance standards are being met.	5%	80% (90%*)
7	Seventh year monitoring report demonstrates performance standards are being met and project has received closeout approval.	10%	90% (100%)

**See Initial Allocation of Released Credits and Subsequent Credit Release descriptions below.*

Initial Allocation of Released Credits

The initial allocation of released credits, as specified in the mitigation plan can be released by the NCDEQ DMS without prior written approval of the DE upon satisfactory completion of the following activities:

a. Approval of the Final Mitigation Plan
b. Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property.
c. Completion of project construction (the initial physical and biological improvements to the mitigation site) pursuant to the mitigation plan; Per the NCDEQ DMS Instrument, construction means that a mitigation site has been constructed in its entirety, to include planting, and an as-built report has been produced. As-built reports must be sealed by an engineer prior to project closeout, if appropriate but not prior to the initial allocation of released credits.
d. Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.

Subsequent Credit Releases

All subsequent credit releases must be approved by the DE, in consultation with the NCIRT, based on a determination that required performance standards have been achieved. For stream projects a reserve of 10% of a site's total stream credits shall be released after two bankfull events have occurred, in separate years, provided the channel is stable and all other performance standards are met. In the event that less than two bankfull events occur during the monitoring period, release of these reserve credits shall be at the discretion of the NCIRT. As projects approach milestones associated with credit release, the NCDEQ DMS will submit a request for credit release to the DE along with documentation substantiating achievement of criteria required for release to occur. This documentation will be included with the annual monitoring report.

Appendix 5 – Financial Assurance

Pursuant to Section IV H and Appendix III of the NCDEQ DMS (formerly Ecosystem Enhancement Program) In-Lieu Fee Instrument dated July 28, 2010, the North Carolina Department of Environmental Quality (NCDEQ) has provided the USACE-Wilmington District with a formal commitment to fund projects to satisfy mitigation requirements assumed by NCDEQ DMS. This commitment provides financial assurance for all mitigation projects implemented by the program.

Appendix 6 – Maintenance Plan

The site will be monitored on a regular basis and a physical inspection of the site will take place at least once a year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance will be most likely in the first two years following site construction and may include the following components as described in the Table below:

Routine Maintenance Components Horne Creek Mitigation Project – NCDEQ DMS Project No. 100026	
Feature	Maintenance through project close-out
Stream	Routine channel maintenance and repair activities may include modifying in-stream structures to prevent piping, securing loose coir matting, and supplemental installations of live stakes and other target vegetation along the project reaches. Areas of concentrated stormwater and floodplain flows that intercept the channel may also require maintenance to
Wetland	N/A
Vegetation	Vegetation will be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, and fertilizing. Exotic invasive plant species will treated by mechanical and/or chemical methods. Any invasive plant species control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.
Site Boundary	Site boundaries will be demarcated in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.
Stream Crossing	The stream crossing(s) within the site may be maintained only as allowed by the recorded Conservation Easement, deed restrictions, rights of way, or corridor agreements.
Beaver Management	Routine maintenance and repair activities caused by beaver activity may include supplemental planting, pruning, and dewatering/dam removal. Beaver management will be implemented using accepted trapping and removal methods only within the recorded Conservation Easement.

Appendix 7 – DWR Stream Identification Forms

The streams at the project site were categorized into five reaches (R1, R2, R3, R4 and R5) totaling approximately 5,203 linear feet of existing streams. Reach breaks were based on drainage area breaks at confluences, changes in restoration/enhancement approaches, and/or changes in intermittent/perennial stream status. Field evaluations conducted at the proposal stage and during existing conditions assessments determined that Reaches R2, R3, R4 and R5 are perennial streams and project Reach R1 was determined to be an intermittent stream. Determinations were based on *NCDWQ's Methodology for Identification of Intermittent and Perennial Streams and Their Origins*, (v4.11, Effective Date: September 1, 2010) stream assessment protocols. Copies of the supporting field forms are included herein.

Table 7-1. Summary of Field Investigations to Determine Intermittent/Perennial Status

Project Reach Designation	Existing Project Reach Length (ft)	NCDWQ Stream Classification Form Score[1]	Watershed Drainage Area (acres)[1]	Stream Status Based on Field Analyses
R1	1,397	33	38	Perennial
R2	286	22	41	Intermittent
R3	75	29.75	29	Intermittent
R4	1,191	31.5	83	Perennial
R4a	124	30.5	29	Perennial/ Intermittent
R4b	89	30	2	Perennial/ Intermittent
R5	2,519	37	166	Perennial

NC DWQ Stream Identification Form Version 4.11

Date: 1/18/17	Project/Site: Horne Crk R1	Latitude:
Evaluator: CA/SH	County: Surry	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 33	Stream Determination (circle one) Ephemeral Intermittent Perennial	Other *e.g. Quad Name:*

A. Geomorphology (Subtotal = 21)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 9)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 3)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

Horne Crk Rch 2

NC DWQ Stream Identification Form Version 4.11

Date: 2/9/14	Project/Site: FOLP	Latitude:
Evaluator: C Tomsic / B. Wagner	County: Surry	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 22	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 14.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

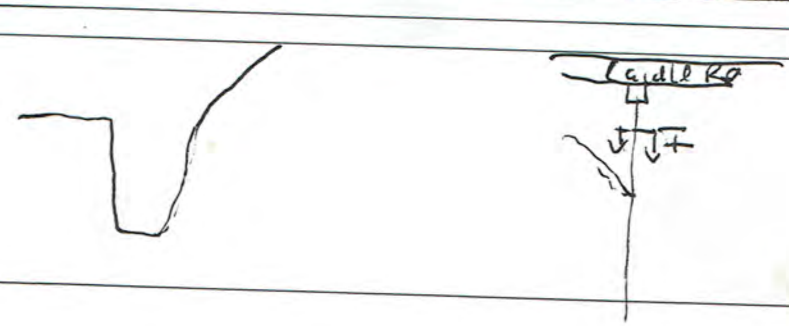
B. Hydrology (Subtotal = 1.5)	Absent	Weak	Moderate	Strong
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 6)	Absent	Weak	Moderate	Strong
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:



Horne Creek Rch 3

NC DWQ Stream Identification Form Version 4.11

Date: 12/9/16	Project/Site: Fulp	Latitude:
Evaluator: C. Tomsic / B. Wagner	County: Surry	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 29.75	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	Other *e.g. Quad Name:*

A. Geomorphology (Subtotal = 16)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	~~1~~ No	2	~~3~~
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7)	Absent	Weak	Moderate	Strong
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 6.75)	Absent	Weak	Moderate	Strong
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed		FACW = 0.75; OBL = 1.5 Other = 0		

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

29.75

NC DWQ Stream Identification Form Version 4.11

RcH 4

Date: 1/18/17	**Project/Site:** Horne Crk	**Latitude:**
Evaluator: CF / SH	**County:** Surry	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 31.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 21.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 5.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 4.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	~~1.5~~
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

R4A

Date: 1/19/17	Project/Site: Horne Crk	Latitude:	
Evaluator: CY/SH	County: Surry	Longitude:	
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** ~~29~~ 30.5	Stream Determination (circle one) Ephemeral Intermittent Perennial	Other *e.g. Quad Name:*	

A. Geomorphology (Subtotal = 17.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	1	2	3
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = [illegible])	Absent	Weak	Moderate	Strong
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0 No	1	2	3
14. Leaf litter	1.5	1	0.5	~~0~~ No
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		~~Yes = 3~~ No	

C. Biology (Subtotal = ~~4~~ 5)	Absent	Weak	Moderate	Strong
18. Fibrous roots in streambed	3	2	~~1~~	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	1	2	3
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

Wolfe

R4B

NC DWQ Stream Identification Form Version 4.11

Date: 1/18/17	**Project/Site:** Horne Crk	**Latitude:**
Evaluator: CT/SH	**County:** Surry	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 30	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 16)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 9)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

R5

NC DWQ Stream Identification Form Version 4.11

Date: 1/18/17	**Project/Site:** Horne Crk	**Latitude:**
Evaluator: CT/~~W~~SH	**County:** Surry	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 37	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 24.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	~~1~~	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6)	Absent	Weak	Moderate	Strong
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 6.5)	Absent	Weak	Moderate	Strong
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed		FACW = 0.75; OBL = 1.5 Other = 0		

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

Appendix 8 – USACE District Assessment Methods/Forms

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Horne Creek Tribs Mitigation Project 2. Date of evaluation: 5-9-2018
3. Applicant/owner name: Water & Land Solutions 4. Assessor name/organization: J. Morgan
5. County: Surry 6. Nearest named water body
7. River basin: Yadkin-PeeDee on USGS 7.5-minute quad: Ararat River
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.321882º -80.465275º

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R1 10. Length of assessment reach evaluated (feet): 1,400
11. Channel depth from bed (in riffle, if present) to top of bank (feet): ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☐A  (more sinuous stream, flatter valley slope)

☒B  (less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☒Size 1 (< 0.1 mi²) ☐Size 2 (0.1 to < 0.5 mi²) ☐Size 3 (0.5 to < 5 mi²) ☐Size 4 (≥ 5 mi²)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐Section 10 water ☐Classified Trout Waters ☐Water Supply Watershed (☐I ☐II ☐III ☒IV ☐V)
☐Essential Fish Habitat ☐Primary Nursery Area ☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property ☐NCDWR Riparian buffer rule in effect ☐Nutrient Sensitive Waters
☐Anadromous fish ☐303(d) List ☐CAMA Area of Environmental Concern (AEC)
☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species:
☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. **Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)**
   - ☒A Water throughout assessment reach.
   - ☐B No flow, water in pools only.
   - ☐C No water in assessment reach.

2. **Evidence of Flow Restriction – assessment reach metric**
   - ☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
   - ☒B Not A

3. **Feature Pattern – assessment reach metric**
   - ☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
   - ☒B Not A

4. **Feature Longitudinal Profile – assessment reach metric**
   - ☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
   - ☐B Not A

5. **Signs of Active Instability – assessment reach metric**
   Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
   - ☐A < 10% of channel unstable
   - ☒B 10 to 25% of channel unstable
   - ☐C > 25% of channel unstable

6. Streamside Area Interaction – streamside area metric
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. Water Quality Stressors – assessment reach/intertidal zone metric
Check all that apply.

☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
☐B Excessive sedimentation (burying of stream features or intertidal zone)
☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
☐D Odor (not including natural sulfide odors)
☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in "Notes/Sketch" section.
☒F Livestock with access to stream or intertidal zone
☐G Excessive algae in stream or intertidal zone
☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
☒I Other: ____________________ (explain in "Notes/Sketch" section)
☐J Little to no stressors

8. Recent Weather – watershed metric (skip for Tidal Marsh Streams)
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
☒C No drought conditions

9. Large or Dangerous Stream – assessment reach metric
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. Natural In-stream Habitat Types – assessment reach metric
10a. ☒Yes ☐No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐B Multiple sticks and/or leaf packs and/or emergent vegetation
☐C Multiple snags and logs (including lap trees)
☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
☒E Little or no habitat

Check for Tidal Marsh Streams Only

☐F 5% oysters or other natural hard bottoms
☐G Submerged aquatic vegetation
☐H Low-tide refugia (pools)
☐I Sand bottom
☐J 5% vertical bank along the marsh
☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*****************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☐Yes ☒No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
☒A Riffle-run section **(evaluate 11c)**
☒B Pool-glide section **(evaluate 11d)**
☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☐	☒	☐	☐	☐	Bedrock/saprolite
☐	☒	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☐	☒	☐	☐	Cobble (64 – 256 mm)
☐	☐	☐	☒	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☐	☒	☐	Silt/clay (< 0.062 mm)
☐	☒	☐	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. **Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)**

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☒Other: ______________________

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☒	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☒	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea*)
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. **Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☒C	☒C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. **Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C	☒C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. **Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)**
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. **Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)**
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. **Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)**
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. **Shading – assessment reach metric (skip for Tidal Marsh Streams)**
Consider aspect. Consider "leaf-on" condition.

☐A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☒B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☒B	☒B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☒D	From 10 to < 30 feet wide
☐E	☐E	☒E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☐B	☐B	Non-mature woody vegetation or modified vegetation structure
☒C	☒C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☒D	☒D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☐A	☐A	Medium to high stem density
☒B	☒B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☐A	☐A	The total length of buffer breaks is < 25 percent.
☒B	☒B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: No equipment during evaluation

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Horne Creek Tribs Mitigation Project	Date of Assessment	5-9-2018
Stream Category	Pb1	Assessor Name/Organization	J. Morgan

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	USACE/ All Streams	NCDWR Intermittent
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**LOW**	
(4) Microtopography	NA	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**MEDIUM**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**MEDIUM**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**LOW**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**LOW**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**MEDIUM**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**MEDIUM**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**LOW**	
(2) In-stream Habitat	**LOW**	
(3) Baseflow	**HIGH**	
(3) Substrate	**LOW**	
(3) Stream Stability	**MEDIUM**	
(3) In-stream Habitat	**LOW**	
(2) Stream-side Habitat	**LOW**	
(3) Stream-side Habitat	**LOW**	
(3) Thermoregulation	**LOW**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**LOW**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Horne Creek Tribs Mitigation Project
2. Date of evaluation: 5-29-2018
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: J. Morgan
5. County: Surry
6. Nearest named water body on USGS 7.5-minute quad: Ararat River
7. River basin: Yadkin-PeeDee
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.172135º -80.300390º

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R2
10. Length of assessment reach evaluated (feet): 240
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 3.3 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 13.1
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☐Perennial flow ☒Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☐A 
(more sinuous stream, flatter valley slope)

☒B 
(less sinuous stream, steeper valley slope)

17. Watershed size: **(skip for Tidal Marsh Stream)** ☒Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
    - ☐Section 10 water
    - ☐Classified Trout Waters
    - ☒Water Supply Watershed (☐I ☐II ☐III ☒IV ☐V)
    - ☐Essential Fish Habitat
    - ☐Primary Nursery Area
    - ☐ High Quality Waters/Outstanding Resource Waters
    - ☐Publicly owned property
    - ☐NCDWR Riparian buffer rule in effect
    - ☐Nutrient Sensitive Waters
    - ☐Anadromous fish
    - ☐303(d) List
    - ☐CAMA Area of Environmental Concern (AEC)
    - ☐Documented presence of a federal and/or state listed protected species within the assessment area.
      List species:
    - ☐Designated Critical Habitat (list species)
19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☐A Water throughout assessment reach.
☒B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☒B Not A

3. Feature Pattern – assessment reach metric

☒A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☐B Not A

4. Feature Longitudinal Profile – assessment reach metric

☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☒A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☐C > 25% of channel unstable

6. Streamside Area Interaction – streamside area metric
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☒B	☒B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☐C	☐C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. Water Quality Stressors – assessment reach/intertidal zone metric
Check all that apply.

- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in "Notes/Sketch" section.
- ☐F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☐I Other: ______________________ (explain in "Notes/Sketch" section)
- ☐J Little to no stressors

8. Recent Weather – watershed metric (skip for Tidal Marsh Streams)
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. Large or Dangerous Stream – assessment reach metric
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. Natural In-stream Habitat Types – assessment reach metric
10a. ☒Yes ☐No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☒B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only

- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*****************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☐Yes ☒No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

- ☒A Riffle-run section **(evaluate 11c)**
- ☒B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☐	☒	☐	☐	☐	Bedrock/saprolite
☐	☒	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☐	☒	☐	☐	Cobble (64 – 256 mm)
☐	☐	☐	☒	☐	Gravel (2 – 64 mm)
☐	☐	☒	☐	☐	Sand (.062 – 2 mm)
☐	☒	☐	☐	☐	Silt/clay (< 0.062 mm)
☐	☐	☒	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☐Yes ☒No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☒Other: ____________________

12b. ☐Yes ☒No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1 >1 Numbers over columns refer to “individuals” for Size 1 and 2 streams and “taxa” for Size 3 and 4 streams.

☐ ☐Adult frogs
☐ ☐Aquatic reptiles
☐ ☐Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐ ☐Beetles
☐ ☐Caddisfly larvae (T)
☐ ☐Asian clam (*Corbicula*)
☐ ☐Crustacean (isopod/amphipod/crayfish/shrimp)
☐ ☐Damselfly and dragonfly larvae
☐ ☐Dipterans
☐ ☐Mayfly larvae (E)
☐ ☐Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐ ☐Midges/mosquito larvae
☐ ☐Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea*)
☐ ☐Mussels/Clams (not *Corbicula*)
☐ ☐Other fish
☐ ☐Salamanders/tadpoles
☐ ☐Snails
☐ ☐Stonefly larvae (P)
☐ ☐Tipulid larvae
☐ ☐Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)

Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☒A	☒A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)

Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C	☒C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)

Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)

Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)

Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)

Consider aspect. Consider “leaf-on” condition.

☐A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☒B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☒A	☒A	☐A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☒C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☒D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☒B	☒B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☒B	☒B	☒B	☐B	☒B	☒B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☐A	☐A	Medium to high stem density
☒B	☒B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☐A	☐A	The total length of buffer breaks is < 25 percent.
☒B	☒B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)

25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ______________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Horne Creek Tribs Mitigation Project	Date of Assessment	5-29-2018
Stream Category	Pb1	Assessor Name/Organization	J. Morgan

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Intermittent

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	**LOW**
(2) Baseflow	**HIGH**	**HIGH**
(2) Flood Flow	**LOW**	**LOW**
(3) Streamside Area Attenuation	**LOW**	**LOW**
(4) Floodplain Access	**MEDIUM**	**MEDIUM**
(4) Wooded Riparian Buffer	**LOW**	**LOW**
(4) Microtopography	NA	NA
(3) Stream Stability	**MEDIUM**	**MEDIUM**
(4) Channel Stability	**HIGH**	**HIGH**
(4) Sediment Transport	**HIGH**	**HIGH**
(4) Stream Geomorphology	**LOW**	**LOW**
(2) Stream/Intertidal Zone Interaction	NA	NA
(2) Longitudinal Tidal Flow	NA	NA
(2) Tidal Marsh Stream Stability	NA	NA
(3) Tidal Marsh Channel Stability	NA	NA
(3) Tidal Marsh Stream Geomorphology	NA	NA
(1) Water Quality		
(2) Baseflow	**HIGH**	**HIGH**
(2) Streamside Area Vegetation	**LOW**	**LOW**
(3) Upland Pollutant Filtration	**LOW**	**LOW**
(3) Thermoregulation	**MEDIUM**	**MEDIUM**
(2) Indicators of Stressors		
(2) Aquatic Life Tolerance	**HIGH**	**NA**
(2) Intertidal Zone Filtration	NA	NA
(1) Habitat	**HIGH**	**HIGH**
(2) In-stream Habitat	**HIGH**	**HIGH**
(3) Baseflow	**HIGH**	**HIGH**
(3) Substrate	**HIGH**	**HIGH**
(3) Stream Stability	**MEDIUM**	**MEDIUM**
(3) In-stream Habitat	**HIGH**	**HIGH**
(2) Stream-side Habitat	**MEDIUM**	**MEDIUM**
(3) Stream-side Habitat	**MEDIUM**	**MEDIUM**
(3) Thermoregulation	**MEDIUM**	**MEDIUM**
(2) Tidal Marsh In-stream Habitat	NA	NA
(3) Flow Restriction	NA	NA
(3) Tidal Marsh Stream Stability	NA	NA
(4) Tidal Marsh Channel Stability	NA	NA
(4) Tidal Marsh Stream Geomorphology	NA	NA
(3) Tidal Marsh In-stream Habitat	NA	NA
(2) Intertidal Zone	NA	NA
Overall		**LOW**

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the “Notes/Sketch” section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Horne Creek Tribs Mitigation Project
2. Date of evaluation: 5-9-2018
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: J. Morgan
5. County: Surry
6. Nearest named water body on USGS 7.5-minute quad: Ararat River
7. River basin: Yadkin-PeeDee
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.319821º -80.463861º

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R3
10. Length of assessment reach evaluated (feet): 180
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 4.1 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 17.7
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☐Perennial flow ☒Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☐A 
(more sinuous stream, flatter valley slope)

☒B 
(less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☒Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐Section 10 water	☐Classified Trout Waters	☒Water Supply Watershed (☐I ☐II ☐III ☒IV ☐V)
☐Essential Fish Habitat	☐Primary Nursery Area	☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property	☐NCDWR Riparian buffer rule in effect	☐Nutrient Sensitive Waters
☐Anadromous fish	☐303(d) List	☐CAMA Area of Environmental Concern (AEC)

☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species:
☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in “Notes/Sketch” section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☐A Water throughout assessment reach.
☒B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction <u>or</u> fill to the point of obstructing flow <u>or</u> a channel choked with aquatic macrophytes <u>or</u> ponded water <u>or</u> impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☒B Not A

3. Feature Pattern – assessment reach metric

☒A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☐B Not A

4. Feature Longitudinal Profile – assessment reach metric

☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☒A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☐C > 25% of channel unstable

6. Streamside Area Interaction – streamside area metric
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☒B	☒B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☐C	☐C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. Water Quality Stressors – assessment reach/intertidal zone metric
Check all that apply.

☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
☐B Excessive sedimentation (burying of stream features or intertidal zone)
☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
☐D Odor (not including natural sulfide odors)
☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in "Notes/Sketch" section.
☒F Livestock with access to stream or intertidal zone
☐G Excessive algae in stream or intertidal zone
☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
☒I Other: ____________________ (explain in "Notes/Sketch" section)
☐J Little to no stressors

8. Recent Weather – watershed metric (skip for Tidal Marsh Streams)
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
☒C No drought conditions

9. Large or Dangerous Stream – assessment reach metric
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. Natural In-stream Habitat Types – assessment reach metric
10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☒B Multiple sticks and/or leaf packs and/or emergent vegetation
☐C Multiple snags and logs (including lap trees)
☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
☐E Little or no habitat

Check for Tidal Marsh Streams Only

☐F 5% oysters or other natural hard bottoms
☐G Submerged aquatic vegetation
☐H Low-tide refugia (pools)
☐I Sand bottom
☐J 5% vertical bank along the marsh
☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*****************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☐Yes ☒No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
☒A Riffle-run section **(evaluate 11c)**
☒B Pool-glide section **(evaluate 11d)**
☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☐	☒	☐	☐	☐	Bedrock/saprolite
☐	☒	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☒	☐	☐	☐	Cobble (64 – 256 mm)
☐	☐	☐	☒	☐	Gravel (2 – 64 mm)
☐	☐	☒	☐	☐	Sand (.062 – 2 mm)
☐	☐	☐	☒	☐	Silt/clay (< 0.062 mm)
☐	☐	☒	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☐Yes ☒No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☒Other: ____________________

12b. ☐Yes ☒No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☒B	☒B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C	☒C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

☐A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☒B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☒D	☒D	☒D	☒D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☐B	☐B	Non-mature woody vegetation or modified vegetation structure
☒C	☒C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☒B	☐B	☒B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☒D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☐A	☐A	Medium to high stem density
☒B	☒B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☐A	☐A	The total length of buffer breaks is < 25 percent.
☒B	☒B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ____________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Horne Creek Tribs Mitigation Project	Date of Assessment	5-9-2018
Stream Category	Pb1	Assessor Name/Organization	J. Morgan

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Intermittent

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	**LOW**
(2) Baseflow	**HIGH**	**HIGH**
(2) Flood Flow	**LOW**	**LOW**
(3) Streamside Area Attenuation	**LOW**	**LOW**
(4) Floodplain Access	**MEDIUM**	**MEDIUM**
(4) Wooded Riparian Buffer	**LOW**	**LOW**
(4) Microtopography	NA	NA
(3) Stream Stability	**LOW**	**LOW**
(4) Channel Stability	**HIGH**	**HIGH**
(4) Sediment Transport	**LOW**	**LOW**
(4) Stream Geomorphology	**LOW**	**LOW**
(2) Stream/Intertidal Zone Interaction	NA	NA
(2) Longitudinal Tidal Flow	NA	NA
(2) Tidal Marsh Stream Stability	NA	NA
(3) Tidal Marsh Channel Stability	NA	NA
(3) Tidal Marsh Stream Geomorphology	NA	NA
(1) Water Quality	**MEDIUM**	**MEDIUM**
(2) Baseflow	**HIGH**	**HIGH**
(2) Streamside Area Vegetation	**LOW**	**LOW**
(3) Upland Pollutant Filtration	**LOW**	**LOW**
(3) Thermoregulation	**MEDIUM**	**MEDIUM**
(2) Indicators of Stressors	**YES**	**YES**
(2) Aquatic Life Tolerance	**HIGH**	**NA**
(2) Intertidal Zone Filtration	NA	NA
(1) Habitat	**LOW**	**LOW**
(2) In-stream Habitat	**LOW**	**MEDIUM**
(3) Baseflow	**HIGH**	**HIGH**
(3) Substrate	**LOW**	**LOW**
(3) Stream Stability	**MEDIUM**	**MEDIUM**
(3) In-stream Habitat	**LOW**	**HIGH**
(2) Stream-side Habitat	**LOW**	**LOW**
(3) Stream-side Habitat	**MEDIUM**	**MEDIUM**
(3) Thermoregulation	**LOW**	**LOW**
(2) Tidal Marsh In-stream Habitat	NA	NA
(3) Flow Restriction	NA	NA
(3) Tidal Marsh Stream Stability	NA	NA
(4) Tidal Marsh Channel Stability	NA	NA
(4) Tidal Marsh Stream Geomorphology	NA	NA
(3) Tidal Marsh In-stream Habitat	NA	NA
(2) Intertidal Zone	NA	NA
Overall	**LOW**	**LOW**

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Horne Creek Tribs Mitigation Project 2. Date of evaluation: 5-9-2018
3. Applicant/owner name: Water & Land Solutions 4. Assessor name/organization: J. Morgan
5. County: Surry 6. Nearest named water body
7. River basin: Yadkin-PeeDee on USGS 7.5-minute quad: Ararat River
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.171541º -80.300730º

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R4 10. Length of assessment reach evaluated (feet): 860
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 2.9 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 12.9 13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):
☐A  (more sinuous stream, flatter valley slope)
☒B  (less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☐Size 1 (< 0.1 mi^2) ☒Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
   - ☐Section 10 water ☐Classified Trout Waters ☒Water Supply Watershed (☐I ☐II ☐III ☒IV ☐V)
   - ☐Essential Fish Habitat ☐Primary Nursery Area ☐ High Quality Waters/Outstanding Resource Waters
   - ☐Publicly owned property ☐NCDWR Riparian buffer rule in effect ☐Nutrient Sensitive Waters
   - ☐Anadromous fish ☐303(d) List ☐CAMA Area of Environmental Concern (AEC)
   - ☐Documented presence of a federal and/or state listed protected species within the assessment area.
     List species:
   - ☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)
- ☒A Water throughout assessment reach.
- ☐B No flow, water in pools only.
- ☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric
- ☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
- ☒B Not A

3. Feature Pattern – assessment reach metric
- ☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
- ☒B Not A

4. Feature Longitudinal Profile – assessment reach metric
- ☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
- ☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
- ☐A < 10% of channel unstable
- ☒B 10 to 25% of channel unstable
- ☐C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☒B	☒B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☐C	☐C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.
- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☒F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☒I Other: ______________________ (explain in “Notes/Sketch” section)
- ☐J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☒B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only
- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

*********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☐Yes ☒No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
- ☒A Riffle-run section **(evaluate 11c)**
- ☒B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☐	☒	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☐	☐	☒	☐	Cobble (64 – 256 mm)
☐	☐	☐	☒	☐	Gravel (2 – 64 mm)
☐	☐	☒	☐	☐	Sand (.062 – 2 mm)
☐	☒	☐	☐	☐	Silt/clay (< 0.062 mm)
☐	☐	☒	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☐Yes ☒No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☒No Water ☐Other: ______

12b. ☐Yes ☒No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☒A	☒A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C	☒C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☐Y	Are wetlands present in the streamside area?
☐N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☒C	☒C	☒C	☒C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☒B	☒B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☒D	☒D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)

25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ____________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Horne Creek Tribs Mitigation Project	Date of Assessment	5-9-2018
Stream Category	Pb2	Assessor Name/Organization	J. Morgan

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**MEDIUM**	
(2) Baseflow	**MEDIUM**	
(2) Flood Flow	**MEDIUM**	
(3) Streamside Area Attenuation	**MEDIUM**	
(4) Floodplain Access	**MEDIUM**	
(4) Wooded Riparian Buffer	**HIGH**	
(4) Microtopography	NA	
(3) Stream Stability	**MEDIUM**	
(4) Channel Stability	**MEDIUM**	
(4) Sediment Transport	**HIGH**	
(4) Stream Geomorphology	**MEDIUM**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**LOW**	
(2) Baseflow	**MEDIUM**	
(2) Streamside Area Vegetation	**MEDIUM**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**LOW**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**HIGH**	
(2) In-stream Habitat	**HIGH**	
(3) Baseflow	**MEDIUM**	
(3) Substrate	**HIGH**	
(3) Stream Stability	**MEDIUM**	
(3) In-stream Habitat	**HIGH**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**MEDIUM**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**MEDIUM**	

NC SAM FIELD ASSESSMENT FORM
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USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Horne Creek Tribs Mitigation Project
2. Date of evaluation: 5-9-2018
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: J. Morgan
5. County: Surry
6. Nearest named water body on USGS 7.5-minute quad: Ararat River
7. River basin: Yadkin-PeeDee
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.170456º -80.301271º

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R4A
10. Length of assessment reach evaluated (feet): 200
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.4 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 8.1
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☐A  (more sinuous stream, flatter valley slope)

☒B  (less sinuous stream, steeper valley slope)

17. Watershed size: **(skip for Tidal Marsh Stream)** ☒Size 1 (< 0.1 mi²) ☐Size 2 (0.1 to < 0.5 mi²) ☐Size 3 (0.5 to < 5 mi²) ☐Size 4 (≥ 5 mi²)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐Section 10 water	☐Classified Trout Waters	☒Water Supply Watershed (☐I ☐II ☐III ☒IV ☐V)
☐Essential Fish Habitat	☐Primary Nursery Area	☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property	☐NCDWR Riparian buffer rule in effect	☐Nutrient Sensitive Waters
☐Anadromous fish	☐303(d) List	☐CAMA Area of Environmental Concern (AEC)

☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species:
☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

- ☒A Water throughout assessment reach.
- ☐B No flow, water in pools only.
- ☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

- ☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
- ☒B Not A

3. Feature Pattern – assessment reach metric

- ☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
- ☒B Not A

4. Feature Longitudinal Profile – assessment reach metric

- ☐A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
- ☒B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

- ☒A < 10% of channel unstable
- ☐B 10 to 25% of channel unstable
- ☐C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☒A	☒A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☐C	☐C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] <u>or</u> too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) <u>or</u> floodplain/intertidal zone unnaturally absent <u>or</u> assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.
- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B <u>Excessive</u> sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach <u>and</u> causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☒F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☒I Other: ____________________ (explain in “Notes/Sketch” section)
- ☐J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
- ☐A Drought conditions <u>and</u> no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions <u>and</u> rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ☒Yes ☐No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☒B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only
- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

*********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☐Yes ☒No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
- ☒A Riffle-run section **(evaluate 11c)**
- ☒B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☒	☐	☐	☐	Cobble (64 – 256 mm)
☐	☐	☒	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☐	☒	☐	Silt/clay (< 0.062 mm)
☐	☐	☒	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. **Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)**

12a. ☐Yes ☒No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☒Other: ____________________

12b. ☐Yes ☒No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1 >1 Numbers over columns refer to “individuals” for Size 1 and 2 streams and “taxa” for Size 3 and 4 streams.

☐ ☐Adult frogs
☐ ☐Aquatic reptiles
☐ ☐Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐ ☐Beetles
☐ ☐Caddisfly larvae (T)
☐ ☐Asian clam (*Corbicula*)
☐ ☐Crustacean (isopod/amphipod/crayfish/shrimp)
☐ ☐Damselfly and dragonfly larvae
☐ ☐Dipterans
☐ ☐Mayfly larvae (E)
☐ ☐Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐ ☐Midges/mosquito larvae
☐ ☐Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐ ☐Mussels/Clams (not *Corbicula*)
☐ ☐Other fish
☐ ☐Salamanders/tadpoles
☐ ☐Snails
☐ ☐Stonefly larvae (P)
☐ ☐Tipulid larvae
☐ ☐Worms/leeches

13. **Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB RB
☒A ☒A Little or no alteration to water storage capacity over a majority of the streamside area
☐B ☐B Moderate alteration to water storage capacity over a majority of the streamside area
☐C ☐C Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. **Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB RB
☒A ☒A Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B ☐B Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C ☐C Majority of streamside area with depressions able to pond water < 3 inches deep

15. **Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)**
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB RB
☒Y ☒Y Are wetlands present in the streamside area?
☐N ☐N

16. **Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)**
Check all contributors within the assessment reach or within view of and draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. **Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)**
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. **Shading – assessment reach metric (skip for Tidal Marsh Streams)**
Consider aspect. Consider “leaf-on” condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☒B	☒B	☒B	☒B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☒B	☒B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☒D	☒D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Horne Creek Tribs Mitigation Project	Date of Assessment	5-9-2018
Stream Category	Pb1	Assessor Name/Organization	J. Morgan

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**HIGH**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**HIGH**	
(3) Streamside Area Attenuation	**HIGH**	
(4) Floodplain Access	**HIGH**	
(4) Wooded Riparian Buffer	**HIGH**	
(4) Microtopography	NA	
(3) Stream Stability	**HIGH**	
(4) Channel Stability	**HIGH**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**HIGH**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**MEDIUM**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**MEDIUM**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**MEDIUM**	
(2) In-stream Habitat	**LOW**	
(3) Baseflow	**HIGH**	
(3) Substrate	**LOW**	
(3) Stream Stability	**HIGH**	
(3) In-stream Habitat	**LOW**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**MEDIUM**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Horne Creek Tribs Mitigation Project 2. Date of evaluation: 5-9-2018
3. Applicant/owner name: Water & Land Solutions 4. Assessor name/organization: J. Morgan
5. County: Surry 6. Nearest named water body
7. River basin: Yadkin-PeeDee on USGS 7.5-minute quad: Ararat River
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.170418º -80.301295º

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R4B 10. Length of assessment reach evaluated (feet): 160
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 0.4 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 3.9 13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):
☐A  (more sinuous stream, flatter valley slope)
☒B  (less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☒Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐Section 10 water	☐Classified Trout Waters	☒Water Supply Watershed (☐I ☐II ☐III ☒IV ☐V)
☐Essential Fish Habitat	☐Primary Nursery Area	☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property	☐NCDWR Riparian buffer rule in effect	☐Nutrient Sensitive Waters
☐Anadromous fish	☐303(d) List	☐CAMA Area of Environmental Concern (AEC)

☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species:
☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☒A Water throughout assessment reach.
☐B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction <u>or</u> fill to the point of obstructing flow <u>or</u> a channel choked with aquatic macrophytes <u>or</u> ponded water <u>or</u> impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☒B Not A

3. Feature Pattern – assessment reach metric

☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☒B Not A

4. Feature Longitudinal Profile – assessment reach metric

☐A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☒B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☒A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☐C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☒A	☒A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☐C	☐C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.
- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in "Notes/Sketch" section.
- ☒F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☒I Other: ______________________ (explain in "Notes/Sketch" section)
- ☐J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☒B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only
- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

***********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*******************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☐Yes ☒No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
- ☒A Riffle-run section **(evaluate 11c)**
- ☒B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☒	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☐	☒	☐	Silt/clay (< 0.062 mm)
☐	☐	☒	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. **Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)**

12a. ☐Yes ☒No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☒Other: ____________________

12b. ☐Yes ☒No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. **Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☒A	☒A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. **Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☒A	☒A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. **Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)**
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☒Y	Are wetlands present in the streamside area?
☐N	☐N	

16. **Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)**
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. **Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)**
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. **Shading – assessment reach metric (skip for Tidal Marsh Streams)**
Consider aspect. Consider "leaf-on" condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)

Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☒B	☒B	☒B	☒B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)

Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☒B	☒B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)

Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).

If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☒D	☒D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)

Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)

Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)

Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☒A	☒A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☐B	☐B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)

25a. ☐Yes ☒No Was conductivity measurement recorded?

If No, select one of the following reasons. ☐No Water ☒Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).

☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Horne Creek Tribs Mitigation Project	Date of Assessment	5-9-2018
Stream Category	Pb1	Assessor Name/Organization	J. Morgan

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**HIGH**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**HIGH**	
(3) Streamside Area Attenuation	**HIGH**	
(4) Floodplain Access	**HIGH**	
(4) Wooded Riparian Buffer	**HIGH**	
(4) Microtopography	NA	
(3) Stream Stability	**HIGH**	
(4) Channel Stability	**HIGH**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**HIGH**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**MEDIUM**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**MEDIUM**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**MEDIUM**	
(2) In-stream Habitat	**LOW**	
(3) Baseflow	**HIGH**	
(3) Substrate	**LOW**	
(3) Stream Stability	**HIGH**	
(3) In-stream Habitat	**LOW**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**MEDIUM**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Horne Creek Tribs Mitigation Project
2. Date of evaluation: 5-9-2018
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: J. Morgan
5. County: Surry
6. Nearest named water body on USGS 7.5-minute quad: Ararat River
7. River basin: Yadkin-PeeDee
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.165990º -80.301303º

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R5
10. Length of assessment reach evaluated (feet): 2,600
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 4.9 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 16.9
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☐A 
(more sinuous stream, flatter valley slope)

☒B 
(less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☐Size 1 (< 0.1 mi^2) ☒Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐Section 10 water	☐Classified Trout Waters	☒Water Supply Watershed (☐I ☐II ☐III ☒IV ☐V)
☐Essential Fish Habitat	☐Primary Nursery Area	☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property	☐NCDWR Riparian buffer rule in effect	☐Nutrient Sensitive Waters
☐Anadromous fish	☐303(d) List	☐CAMA Area of Environmental Concern (AEC)

☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species:
☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☒A Water throughout assessment reach.
☐B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☒B Not A

3. Feature Pattern – assessment reach metric

☒A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☐B Not A

4. Feature Longitudinal Profile – assessment reach metric

☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☐A < 10% of channel unstable
☒B 10 to 25% of channel unstable
☐C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.
- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☒F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☒I Other: ____________________ (explain in “Notes/Sketch” section)
- ☐J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☒B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☒C Multiple snags and logs (including lap trees)
- ☒D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only
- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☐Yes ☒No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
- ☒A Riffle-run section **(evaluate 11c)**
- ☒B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☐	☒	☐	☐	☐	Bedrock/saprolite
☐	☒	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☐	☒	☐	☐	Cobble (64 – 256 mm)
☐	☐	☐	☒	☐	Gravel (2 – 64 mm)
☐	☐	☒	☐	☐	Sand (.062 – 2 mm)
☐	☐	☒	☐	☐	Silt/clay (< 0.062 mm)
☐	☐	☒	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☒Other: ______

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☒	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☒	Dipterans
☐	☒	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☒	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☒	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)

Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☒B	☒B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)

Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C	☒C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)

Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)

Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)

Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☒E Assessment reach relocated to valley edge
☐F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)

Consider aspect. Consider "leaf-on" condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☒B	☒B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☒D	☒D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☒B	☒B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☒D	☒D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Horne Creek Tribs Mitigation Project	Date of Assessment	5-9-2018
Stream Category	Pb2	Assessor Name/Organization	J. Morgan

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	USACE/ All Streams	NCDWR Intermittent
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**MEDIUM**	
(4) Microtopography	NA	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**MEDIUM**	
(4) Sediment Transport	**MEDIUM**	
(4) Stream Geomorphology	**LOW**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**MEDIUM**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**MEDIUM**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**HIGH**	
(2) In-stream Habitat	**HIGH**	
(3) Baseflow	**HIGH**	
(3) Substrate	**MEDIUM**	
(3) Stream Stability	**MEDIUM**	
(3) In-stream Habitat	**HIGH**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**MEDIUM**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**MEDIUM**	

Appendix 9 – WOTUS Information

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

January 24, 2019

US Army Corps of Engineers

Asheville Regulatory Field Office

Attn: William Elliott

151 Patton Avenue, Room 208

Asheville, NC 28801

Subject: **Horne Creek Tributaries Mitigation Project, Preliminary Jurisdictional Determination Concurrence Request, Surry County, NC**

Dear Mr. Elliot:

Please find the attached Preliminary Jurisdictional Determination Request attached for the Horne Creek Tributaries Stream Mitigation Project. The project is located in Surry County, North Carolina, approximately seven miles southwest of the Town of Pilot Mountain. Attached you will find the following:

- Preliminary Jurisdictional Determination (PJD) Form
- North Carolina Division of Mitigation Services Landowner Authorization Forms
- Three Maps: Project Vicinity Map, USGS Topographic Map, and Preliminary Jurisdictional Waters Map.
- Army Corps of Engineers Wetland Determination Forms
- NC DWR Stream Identification Forms

If you need any additional information, please feel free to contact me directly.

Sincerely,

Adam V. McIntyre

7721 Six Forks Road, Suite 130
Raleigh, NC 27615
Office Phone: (919)614-5111
Mobile Phone: (919) 632-5910
Email: adam@waterlandsolution.com

Appendix 2 - PRELIMINARY JURISDICTIONAL DETERMINATION (PJD) FORM

BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR PJD: 12/13/2018

B. NAME AND ADDRESS OF PERSON REQUESTING PJD: Chris Sheats, 10940 Raven Ridge Rd, Ste. 200, Raleigh, NC 27614

C. DISTRICT OFFICE, FILE NAME, AND NUMBER:

D. PROJECT LOCATION(S) AND BACKGROUND INFORMATION:
(USE THE TABLE BELOW TO DOCUMENT MULTIPLE AQUATIC RESOURCES AND/OR AQUATIC RESOURCES AT DIFFERENT SITES)

State: NC County/parish/borough: Surry City: Pilot Mountain

Center coordinates of site (lat/long in degree decimal format):

Lat.: 36.2850000° Long.: -80.5032028°

Universal Transverse Mercator: 17

Name of nearest waterbody: Horne Creek

E. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):

☐ Office (Desk) Determination. Date:

☐ Field Determination. Date(s):

TABLE OF AQUATIC RESOURCES IN REVIEW AREA WHICH "MAY BE" SUBJECT TO REGULATORY JURISDICTION.

Site number	Latitude (decimal degrees)	Longitude (decimal degrees)	Estimated amount of aquatic resource in review area (acreage and linear feet, if applicable)	Type of aquatic resource (i.e., wetland vs. non-wetland waters)	Geographic authority to which the aquatic resource "may be" subject (i.e., Section 404 or Section 10/404)
	See	Attached	List		

1) The Corps of Engineers believes that there may be jurisdictional aquatic resources in the review area, and the requestor of this PJD is hereby advised of his or her option to request and obtain an approved JD (AJD) for that review area based on an informed decision after having discussed the various types of JDs and their characteristics and circumstances when they may be appropriate.
2) In any circumstance where a permit applicant obtains an individual permit, or a Nationwide General Permit (NWP) or other general permit verification requiring "pre-construction notification" (PCN), or requests verification for a non-reporting NWP or other general permit, and the permit applicant has not requested an AJD for the activity, the permit applicant is hereby made aware that: (1) the permit applicant has elected to seek a permit authorization based on a PJD, which does not make an official determination of jurisdictional aquatic resources; (2) the applicant has the option to request an AJD before accepting the terms and conditions of the permit authorization, and that basing a permit authorization on an AJD could possibly result in less compensatory mitigation being required or different special conditions; (3) the applicant has the right to request an individual permit rather than accepting the terms and conditions of the NWP or other general permit authorization; (4) the applicant can accept a permit authorization and thereby agree to comply with all the terms and conditions of that permit, including whatever mitigation requirements the Corps has determined to be necessary; (5) undertaking any activity in reliance upon the subject permit authorization without requesting an AJD constitutes the applicant's acceptance of the use of the PJD; (6) accepting a permit authorization (e.g., signing a proffered individual permit) or undertaking any activity in reliance on any form of Corps permit authorization based on a PJD constitutes agreement that all aquatic resources in the review area affected in any way by that activity will be treated as jurisdictional, and waives any challenge to such jurisdiction in any administrative or judicial compliance or enforcement action, or in any administrative appeal or in any Federal court; and (7) whether the applicant elects to use either an AJD or a PJD, the JD will be processed as soon as practicable. Further, an AJD, a proffered individual permit (and all terms and conditions contained therein), or individual permit denial can be administratively appealed pursuant to 33 C.F.R. Part 331. If, during an administrative appeal, it becomes appropriate to make an official determination whether geographic jurisdiction exists over aquatic resources in the review area, or to provide an official delineation of jurisdictional aquatic resources in the review area, the Corps will provide an AJD to accomplish that result, as soon as is practicable. This PJD finds that there *"may be"* waters of the U.S. and/or that there *"may be"* navigable waters of the U.S. on the subject review area, and identifies all aquatic features in the review area that could be affected by the proposed activity, based on the following information:

SUPPORTING DATA. Data reviewed for PJD (check all that apply)

Checked items should be included in subject file. Appropriately reference sources below where indicated for all checked items:

- ☒ Maps, plans, plots or plat submitted by or on behalf of the PJD requestor:
  Map: ______________________.
- ☒ Data sheets prepared/submitted by or on behalf of the PJD requestor.
  - ☐ Office concurs with data sheets/delineation report.
  - ☐ Office does not concur with data sheets/delineation report. Rationale: ______________.
- ☐ Data sheets prepared by the Corps: ______________________.
- ☐ Corps navigable waters' study: ______________________.
- ☐ U.S. Geological Survey Hydrologic Atlas: ______________________.
  - ☐ USGS NHD data.
  - ☐ USGS 8 and 12 digit HUC maps.
- ☒ U.S. Geological Survey map(s). Cite scale & quad name: 1:24,000 SILOAM.
- ☒ Natural Resources Conservation Service Soil Survey. Citation: 1999 Surry County Soil Survey.
- ☐ National wetlands inventory map(s). Cite name: ______________________.
- ☐ State/local wetland inventory map(s): ______________________.
- ☐ FEMA/FIRM maps: ______________________.
- ☐ 100-year Floodplain Elevation is: ____________.(National Geodetic Vertical Datum of 1929)
- ☐ Photographs: ☐ Aerial (Name & Date): ______________________.
  or ☐ Other (Name & Date): ______________________.
- ☐ Previous determination(s). File no. and date of response letter: ______________________.
- ☐ Other information (please specify): ______________________.

IMPORTANT NOTE: The information recorded on this form has not necessarily been verified by the Corps and should not be relied upon for later jurisdictional determinations.

______________________	______________________
Signature and date of Regulatory staff member completing PJD	Signature and date of person requesting PJD (REQUIRED, unless obtaining the signature is impracticable)[1]

[1] Districts may establish timeframes for requestor to return signed PJD forms. If the requestor does not respond within the established time frame, the district may presume concurrence and no additional follow up is necessary prior to finalizing an action.

Site #	Latitude	Longitude	Estimated amount of resource in review area (acreage and linear ft, if applicable)	Type of aquatic resource (i.e. wetland vs. non-wetland waters)	Geographic authority to which the aquatic resource “may be” subject (i.e. Section 404 or Section 10/401)
WA	36.282565	-80.510192	0.005 ac	Wetland	Section 404/401
WB	36.287452	-80.50265	0.076 ac	Wetland	Section 404/401
WC	36.287756	-80.50232	0.093 ac	Wetland	Section 404/401
WD	36.28756	-80.501849	0.175 ac	Wetland	Section 404/401
S1	36.289687	-80.500118	291 lf	Non-wetland	Section 404/401
S2	36.289516	-80.501029	41 lf	Non-wetland	Section 404/401
S3	36.289357	-80.500934	3,340 lf	Non-wetland	Section 404/401
S4	36.287641	-80.502223	123 lf	Non-wetland	Section 404/401
S5	36.287410	-80.502623	71 lf	Non-wetland	Section 404/401
S6	36.282523	-80.510805	1,267	Non-wetland	Section 404/401

LANDOWNER AUTHORIZATION FORM

PROPERTY LEGAL DESCRITION:

Deed Book: 00521 Page: 1524 County: Surry

Parcel ID Number: 595200774688

Street Address: 410 Caudle Rd.

Pinnacle, NC 27043-9464

Property Owner (please print: William F. Fulp

Property Owner (please print): Debra P. Fulp

The undersigned, registered property owner(s) of the above property, do hereby authorize

Mathew Reid of DMS
(Contractor/Agent/Project Manager)[1] (Name of Contractor/Agent Firm/Agency)[2]

to take all actions necessary for the evaluation of the property as a potential stream, wetland and/or riparian buffer mitigation project, including conducting stream and/or wetland determinations and delineations, as well as issuance and acceptance of any required permit(s) or certification(s). I agree to allow regulatory agencies, including the US Army Corps of Engineers, to visit the property as part of these environmental reviews.

Property Owners(s) Address: ______________________
(if different from above)

____

Property Owner Telephone Number: (336) 705-0342

Property Owner Telephone Number: (336) 705-0348

We hereby certify the above information to be true and accurate to the best of our knowledge.

William F. Fulp 7/24/17
(Property Owner Authorized Signature) (Date)

Debra P. Fulp 7/24/17
(Property Owner Authorized Signature) (Date)

[1]Name of full delivery staff member (full-deliveries) or DMS project manager (design-bid-build).
[2]Name of company (full-deliveries) or DMS (design-bid-build).

LANDOWNER AUTHORIZATION FORM

PROPERTY LEGAL DESCRITION:

Deed Book: 00527 **Page:** 0589 **County:** Surry

Parcel ID Number: 595200765174

Street Address: Kiger Rd.
Pinnacle, NC 27043-9288

Property Owner (please print: Mary Ellen Smith

Property Owner (please print): ______

The undersigned, registered property owner(s) of the above property, do hereby authorize

Mathew Reid **of** DMS
(Contractor/Agent/Project Manager)[1] **(Name of Contractor/Agent Firm/Agency)**[2]

to take all actions necessary for the evaluation of the property as a potential stream, wetland and/or riparian buffer mitigation project, including conducting stream and/or wetland determinations and delineations, as well as issuance and acceptance of any required permit(s) or certification(s). I agree to allow regulatory agencies, including the US Army Corps of Engineers, to visit the property as part of these environmental reviews.

Property Owners(s) Address: 3953 Shoals Rd.
(if different from above) Pinnacle, NC 27043-9289

Property Owner Telephone Number: (336) 705-0342

Property Owner Telephone Number: (336) 325-2454

We hereby certify the above information to be true and accurate to the best of our knowledge.

Mary Ellen Smith 7-24-17
(Property Owner Authorized Signature) **(Date)**

______
(Property Owner Authorized Signature) **(Date)**

[1]Name of full delivery staff member (full-deliveries) or DMS project manager (design-bid-build).
[2]Name of company (full-deliveries) or DMS (design-bid-build).

LANDOWNER AUTHORIZATION FORM

PROPERTY LEGAL DESCRITION:

Deed Book: 00370 Page: 0890 County: Surry

Parcel ID Number: 595200772795

Street Address: Cardle Rd.

Pinnacle, NC 27043-9464

Property Owner (please print: Mary Ellen Smith

Property Owner (please print):

The undersigned, registered property owner(s) of the above property, do hereby authorize

Mathew Reid of DMS

(Contractor/Agent/Project Manager)[1] (Name of Contractor/Agent Firm/Agency)[2]

to take all actions necessary for the evaluation of the property as a potential stream, wetland and/or riparian buffer mitigation project, including conducting stream and/or wetland determinations and delineations, as well as issuance and acceptance of any required permit(s) or certification(s). I agree to allow regulatory agencies, including the US Army Corps of Engineers, to visit the property as part of these environmental reviews.

Property Owners(s) Address: 3953 Shoals Rd.
(if different from above)

Pinnacle, NC 27043-9289

Property Owner Telephone Number: (336) 705-0342

Property Owner Telephone Number: (336) 325-2454

We hereby certify the above information to be true and accurate to the best of our knowledge.

Mary Ellen Smith 7-24-17

(Property Owner Authorized Signature) (Date)

(Property Owner Authorized Signature) (Date)

[1]Name of full delivery staff member (full-deliveries) or DMS project manager (design-bid-build).
[2]Name of company (full-deliveries) or DMS (design-bid-build).

LANDOWNER AUTHORIZATION FORM

PROPERTY LEGAL DESCRITION:

Deed Book: 00936 **Page:** 0448 **County:** Surry

Parcel ID Number: 595200567091

Street Address: 363 Kiger Rd.
Pinnacle, NC 27043-9288

Property Owner (please print: Brown Farms of Surry Co LLC

Property Owner (please print): ____________________

The undersigned, registered property owner(s) of the above property, do hereby authorize

Mathew Reid of DMS
(Contractor/Agent/Project Manager)[1] **(Name of Contractor/Agent Firm/Agency)[2]**

to take all actions necessary for the evaluation of the property as a potential stream, wetland and/or riparian buffer mitigation project, including conducting stream and/or wetland determinations and delineations, as well as issuance and acceptance of any required permit(s) or certification(s). I agree to allow regulatory agencies, including the US Army Corps of Engineers, to visit the property as part of these environmental reviews.

Property Owners(s) Address: 3865 Shoals Rd.
(if different from above) Pinnacle, NC 27043-9288

Property Owner Telephone Number: (336) 325-2456

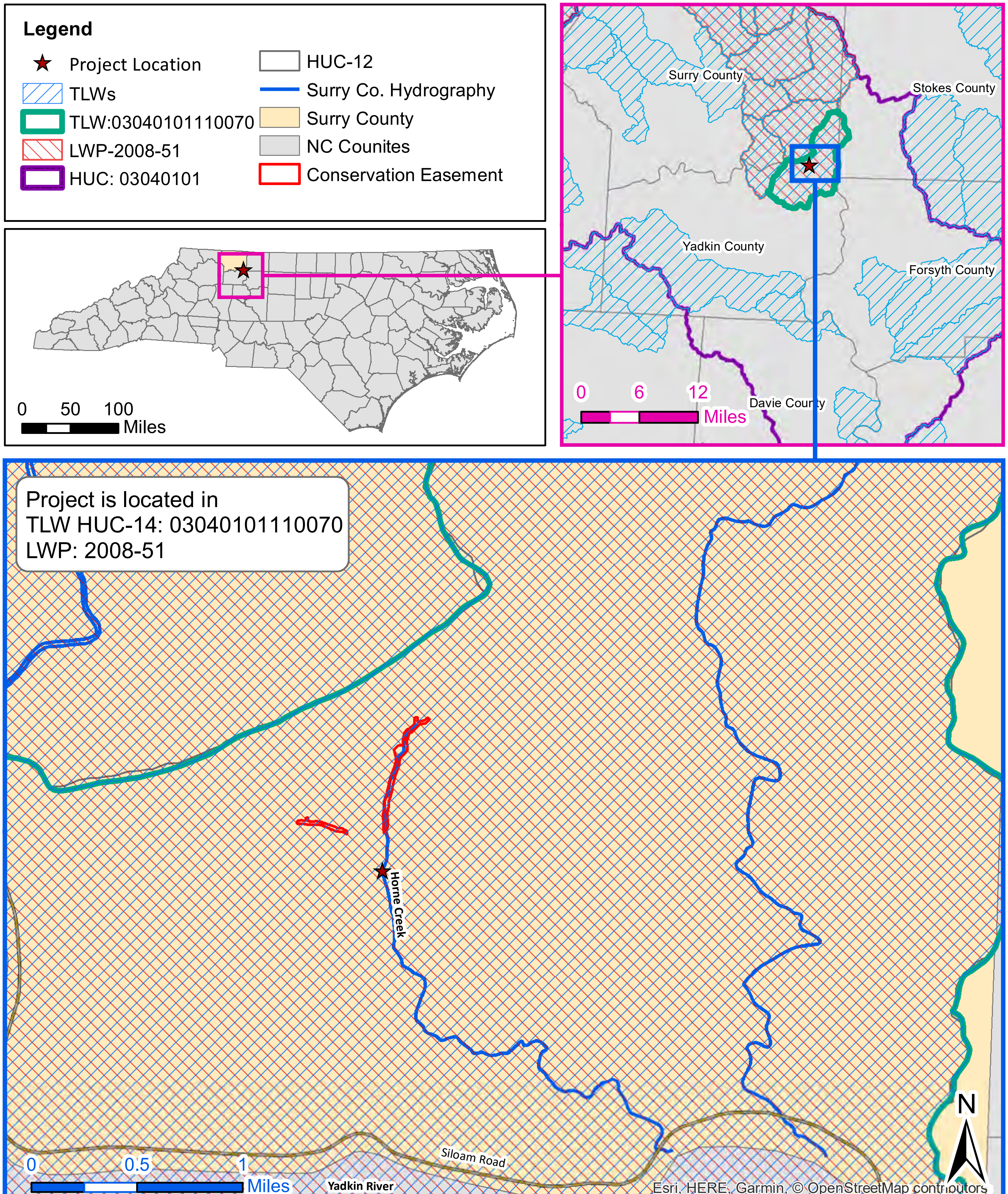
Property Owner Telephone Number: ____________________

We hereby certify the above information to be true and accurate to the best of our knowledge.

Edward T Brown 7-25-17
(Property Owner Authorized Signature) **(Date)**

____
(Property Owner Authorized Signature) **(Date)**

[1]Name of full delivery staff member (full-deliveries) or DMS project manager (design-bid-build).
[2]Name of company (full-deliveries) or DMS (design-bid-build).



WATER & LAND™ SOLUTIONS

Horne Creek Tributaries Mitigation Project

Vicinity Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 1

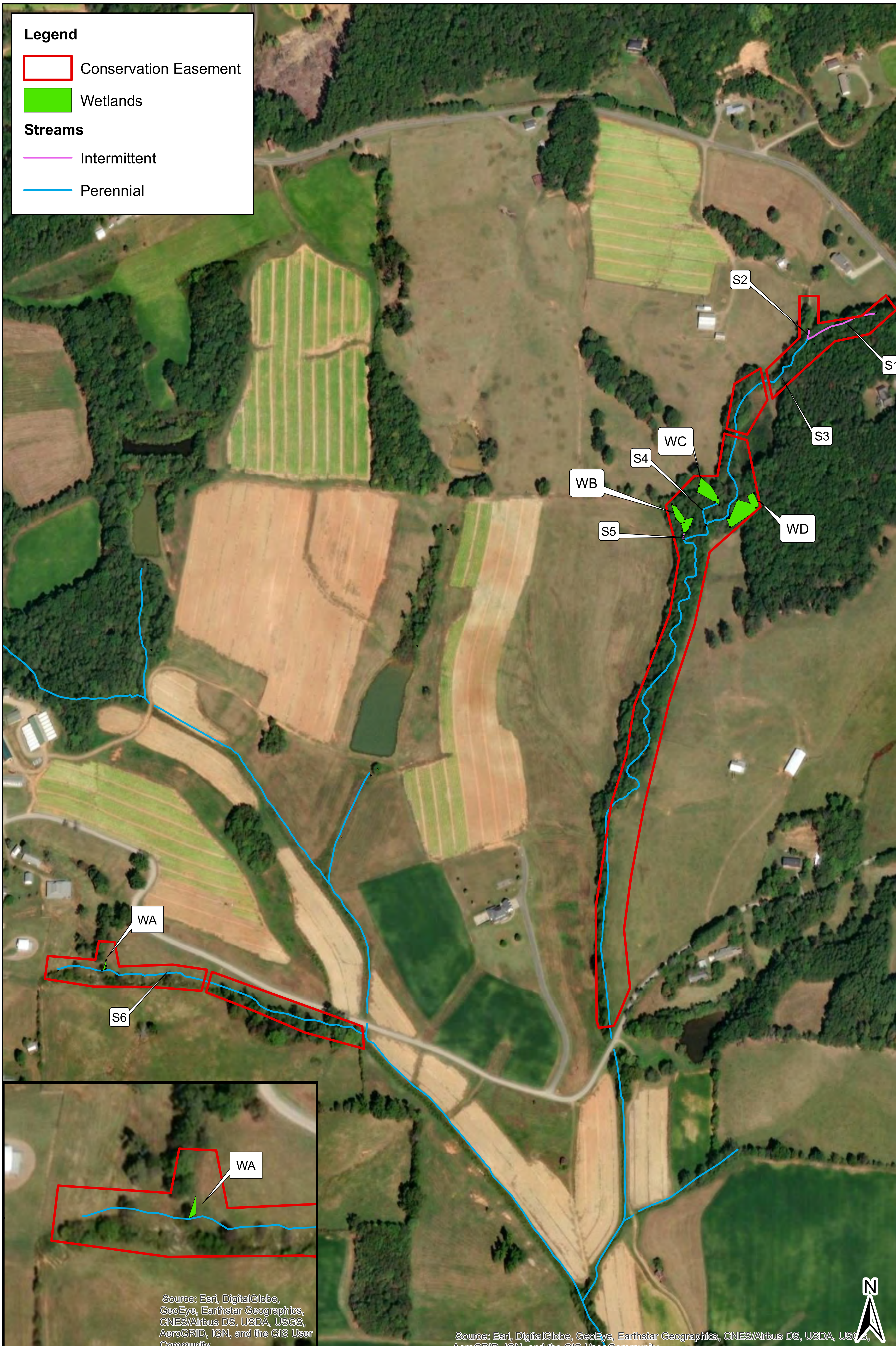
WATER & LAND™ SOLUTIONS

Horne Creek Tributaries
Stream & Wetland
Mitigation Project
Surry County, North Carolina

USGS Topographic Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
2



WATER & LAND™ SOLUTIONS

Horne Creek Tributaries
Stream & Wetland
Mitigation Project
Surry County, North Carolina

Jurisdictional Waters
Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
3

U.S. Army Corps of Engineers **WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region** See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R	***Requirement Control Symbol EXEMPT (Authority: AR 335-15, paragraph 5-2a)***

Project/Site: Horne Creek Tributaries Mitigation Site City/County: Surry Sampling Date: 6-4-18

Applicant/Owner: Water and Land Solutions State: NC Sampling Point: WA-1

Investigator(s): C. Sheats Section, Township, Range: Shoals, NC

Landform (hillside, terrace, etc.): hillside slope Local relief (concave, convex, none): slope Slope (%): 20

Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: 36.28247 Long: -80.501021 Datum: NAD83

Soil Map Unit Name: Colvard and Suches Soils NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation No , Soil No , or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation No , Soil No , or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No X	**Is the Sampled Area within a Wetland?**	**Yes** ___ **No** X
Hydric Soil Present?	Yes ___ No X		
Wetland Hydrology Present?	Yes ___ No X		

Remarks:
This form represents the upland adjacent to wetland WA, which is cattle pasture dominated by tall fescue. This also represents conditions adjacent to wetlands WB, WC, and WD.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Aquatic Fauna (B13)
___ True Aquatic Plants (B14)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres on Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

___ Surface Soil Cracks (B6)
___ Sparsely Vegetated Concave Surface (B8)
___ Drainage Patterns (B10)
___ Moss Trim Lines (B16)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Stunted or Stressed Plants (D1)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ Microtopographic Relief (D4)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___	No x	Depth (inches): ___
Water Table Present?	Yes ___	No X	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
No wetland hydrology present.

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WA-1

Tree Stratum (Plot size: 4X10 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
		=Total Cover	
50% of total cover:		20% of total cover:	
Sapling/Shrub Stratum (Plot size: 4x10ft)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
		=Total Cover	
50% of total cover:		20% of total cover:	
Herb Stratum (Plot size: 4x10ft)			
1. *Schedonorus arundinaceus*	100	Yes	FACU
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	100	=Total Cover	
50% of total cover:	50	20% of total cover:	20
Woody Vine Stratum (Plot size: 4x10)			
1.			
2.			
3.			
4.			
5.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** ___ **No** X

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: WA-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 4/4	100					Loamy/Clayey	
3-14	10YR 5/4	100					Loamy/Clayey	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ 2 cm Muck (A10) **(LRR N)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7)
___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
___ Thin Dark Surface (S9) **(MLRA 147, 148)**
___ Loamy Mucky Mineral (F1) **(MLRA 136)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
___ Umbric Surface (F13) **(MLRA 122, 136)**
___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10) **(MLRA 147)**
___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
___ Very Shallow Dark Surface (F22)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):
Type: ________
Depth (inches): ________

Hydric Soil Present? **Yes** ___ **No** X

Remarks:
Soils have been disturbed by cattle.

U.S. Army Corps of Engineers WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R	*Requirement Control Symbol EXEMPT (Authority: AR 335-15, paragraph 5-2a)*

Project/Site: Horne Creek Tributaries Mitigation Site City/County: Surry Sampling Date: 6-4-18

Applicant/Owner: Water and Land Solutions State: NC Sampling Point: WA-1

Investigator(s): C. Sheats Section, Township, Range: Shoals, NC

Landform (hillside, terrace, etc.): hillside drainage crenulation Local relief (concave, convex, none): concave Slope (%): 0-2

Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: 36.28247 Long: -80.501021 Datum: NAD83

Soil Map Unit Name: Colvard and Suches Soils NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation No , Soil No , or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation No , Soil No , or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland?** **Yes** X **No** ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:
This form represents wetland WA, which is a small depression within a topographic crenulation near the confluence of an unnamed tributary to Horne Creek.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- X Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- X Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- X Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes X	No ___	Depth (inches): 0.5
Water Table Present?	Yes X	No ___	Depth (inches): 9
Saturation Present? (includes capillary fringe)	Yes X	No ___	Depth (inches): 0

Wetland Hydrology Present? Yes X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: WA-1

Tree Stratum (Plot size: 4X10 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Sapling/Shrub Stratum (Plot size: 4x10ft)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Herb Stratum (Plot size: 4x10ft)			
1. *Persicaria maculosa*	20	Yes	FACW
2. *Lobelia cardinalis*	10	Yes	FACW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	30	=Total Cover	
50% of total cover: 15		20% of total cover:	6

Woody Vine Stratum (Plot size: 4x10)			
1.			
2.			
3.			
4.			
5.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: WA-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 3/2	100					Mucky Loam/Clay	
3-14	10YR 4/2	90	10YR 5/6	10	C	M	Loamy/Clayey	Prominent redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ 2 cm Muck (A10) **(LRR N)**
X Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7)
___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
___ Thin Dark Surface (S9) **(MLRA 147, 148)**
___ Loamy Mucky Mineral (F1) **(MLRA 136)**
___ Loamy Gleyed Matrix (F2)
X Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
___ Umbric Surface (F13) **(MLRA 122, 136)**
___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10) **(MLRA 147)**
___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
___ Very Shallow Dark Surface (F22)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):
Type: ______
Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ___

Remarks:
Soils have been disturbed by cattle.

U.S. Army Corps of Engineers **WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region** See ERDC/EL TR-07-24; the proponent agency is CECW-CO-R	***Requirement Control Symbol EXEMPT (Authority: AR 335-15, paragraph 5-2a)***

Project/Site: Horne Creek Tributaties Mitigation Site City/County: Surry Sampling Date: 6-4-18

Applicant/Owner: Water and Land Solutions State: NC Sampling Point: WB-4

Investigator(s): C. Sheats Section, Township, Range: Shoals, NC

Landform (hillside, terrace, etc.): hillside drainage crenulation Local relief (concave, convex, none): concave Slope (%): 0-2

Subregion (LRR or MLRA): LRR P, MLRA 136 Lat: 36.28247 Long: -80.501021 Datum: NAD83

Soil Map Unit Name: Colvard and Suches Soils NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)

Are Vegetation No , Soil No , or Hydrology No significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation No , Soil No , or Hydrology No naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ____ Hydric Soil Present? Yes X No ____ Wetland Hydrology Present? Yes X No ____	**Is the Sampled Area within a Wetland? Yes** X **No** ____

Remarks:
This form is for wetland WB which represent similar conditions in wetlands WC and WD, which are depressions within topographic crenulations in the floodplain near Horne Creek.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- X Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- X Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- X Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes X	No ____	Depth (inches): 0.5
Water Table Present?	Yes X	No ____	Depth (inches): 6
Saturation Present? (includes capillary fringe)	Yes X	No ____	Depth (inches): 0

Wetland Hydrology Present? Yes X **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WB-4

Tree Stratum (Plot size: 5m radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Fraxinus pennsylvanica*	40	Yes	FACW
2.			
3.			
4.			
5.			
6.			
7.			
	40	=Total Cover	
50% of total cover: 20		20% of total cover:	8

Sapling/Shrub Stratum (Plot size: 5m radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Acer rubrum*	20	Yes	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	20	=Total Cover	
50% of total cover: 10		20% of total cover:	4

Herb Stratum (Plot size: 2m radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Persicaria maculosa*	35	Yes	FACW
2. *Murdannia keisak*	10	Yes	OBL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	45	=Total Cover	
50% of total cover: 23		20% of total cover:	9

Woody Vine Stratum (Plot size: 2m radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. None			
2.			
3.			
4.			
5.			
		=Total Cover	
50% of total cover:		20% of total cover:	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

X 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody Vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: WB-4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-1	10YR 4/2	100					Mucky Loam/Clay	
1-7	10YR 4/2	75	10YR 5/6	25	C	M	Loamy/Clayey	Prominent redox concentrations
7-14	10YR 5/2	85	10YR 5/6	15	C	M	Loamy/Clayey	Prominent redox concentrations

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5)
___ 2 cm Muck (A10) **(LRR N)**
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Dark Surface (S7)
___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
___ Thin Dark Surface (S9) **(MLRA 147, 148)**
___ Loamy Mucky Mineral (F1) **(MLRA 136)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
___ Umbric Surface (F13) **(MLRA 122, 136)**
___ Piedmont Floodplain Soils (F19) **(MLRA 148)**
___ Red Parent Material (F21) **(MLRA 127, 147, 148)**

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10) **(MLRA 147)**
___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
___ Red Parent Material (F21) **(outside MLRA 127, 147, 148)**
___ Very Shallow Dark Surface (F22)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):
Type: ____________
Depth (inches): ____________

Hydric Soil Present? **Yes** _____ **No** _____

Remarks:
Soils have been disturbed by cattle in Wetland C and D. Soils within Wetland B and C are mapped as Colvard and Suches, and Fairview sandy clay loam in Wetland D. The Hydric soil indicator here is an F3. Yes, hydric soils are present. Macros in form not allowing to autofill for hydric soil indicators.

NC DWQ Stream Identification Form Version 4.11

Date: 10-15-18	**Project/Site:** Horne Creek	**Latitude:** 36.28748
Evaluator: C. Sheats	**County:** Surry	**Longitude:** -80.50265
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 25.25	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name*: Siloam

A. Geomorphology (Subtotal = 10)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

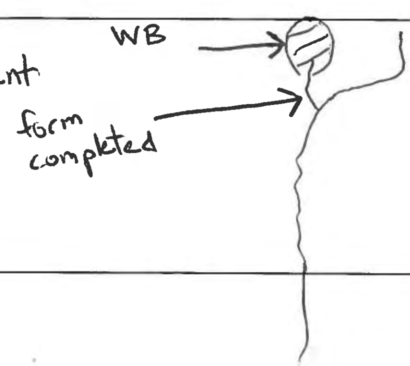
B. Hydrology (Subtotal = 6.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 6.75)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: some chironomids
maybe perennial flow in
this channel although
score reflects intermittent

Sketch:



NC DWQ Stream Identification Form Version 4.11

Date: 10-15-18	Project/Site: Horne Creek	Latitude: 36.28773
Evaluator: C. Sheats	County: Surry	Longitude: -80.50227
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 28	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* Siloam

A. Geomorphology (Subtotal = 12)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 9)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 7)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

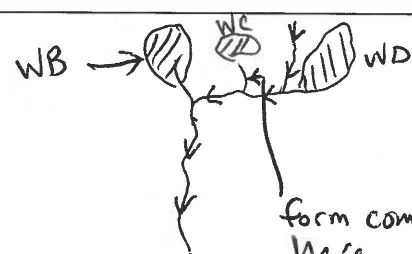
*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Chironomids

Sketch:

Possibly perennial although form reflects 'intermittent' score



form completed here

NC DWQ Stream Identification Form Version 4.11

Date: 10-15-18	Project/Site: Horne Creek	Latitude: 36.28962
Evaluator: C. Sheats	County: Surry	Longitude: -80.50101
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 24	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* Siloam

A. Geomorphology (Subtotal = 10)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

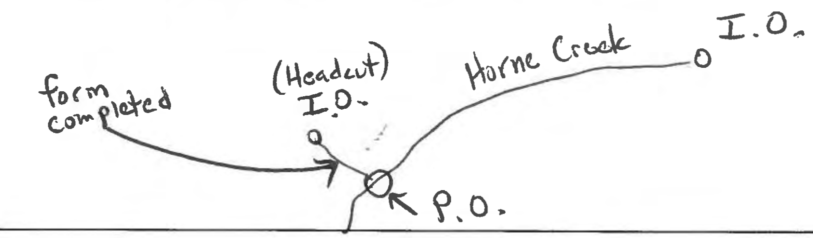
B. Hydrology (Subtotal = 8)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 6)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:



NC DWQ Stream Identification Form Version 4.11

Date: 10-15-18	**Project/Site:** Horne Crk	**Latitude:** 36.28955
Evaluator: C. Sheats	**County:** Surry	**Longitude:** -80.50038
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 24.5	**Stream Determination (circle one)** Ephemeral **Intermittent** Perennial	**Other** *e.g. Quad Name:* Siloam

A. Geomorphology (Subtotal = 15.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

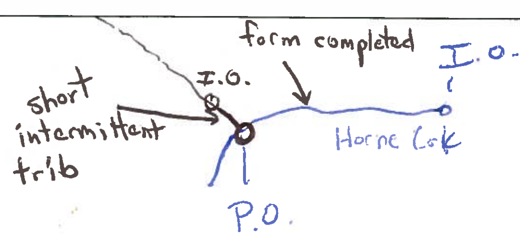
B. Hydrology (Subtotal = 3.5)	Absent	Weak	Moderate	Strong
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 5)	Absent	Weak	Moderate	Strong
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: no benthics observed

Sketch:



U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action ID: **SAW-2017-01510** County: **Surry** U.S.G.S. Quad: **Siloam**

NOTIFICATION OF JURISDICTIONAL DETERMINATION

Property Owner: **Edward Brown**
Address: **3865 Shoals Rd,**
Pinnacle, NC 27043
Telephone Number: **336-325-2456**

Size (acres): **121.34** Nearest Town: **Pinnacle**
Nearest Waterway: **Horne Creek** Coordinates: **36.28519, -80.50321**
River Basin/ HUC: **Upper Pee Dee**

Location description: **The site is located at 363 Kiger Rd., Pinnacle, NC 27043**

Indicate Which of the Following Apply:

A. Preliminary Determination

X There are waters, including wetlands, on the above described project area, that may be subject to Section 404 of the Clean Water Act (CWA)(33 USC § 1344) and/or Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403). The waters, including wetlands, have been delineated, and the delineation has been verified by the Corps to be sufficiently accurate and reliable. Therefore this preliminary jurisdiction determination may be used in the permit evaluation process, including determining compensatory mitigation. For purposes of computation of impacts, compensatory mitigation requirements, and other resource protection measures, a permit decision made on the basis of a preliminary JD will treat all waters and wetlands that would be affected in any way by the permitted activity on the site as if they are jurisdictional waters of the U.S. This preliminary determination is not an appealable action under the Regulatory Program Administrative Appeal Process (Reference 33 CFR Part 331). However, you may request an approved JD, which is an appealable action, by contacting the Corps district for further instruction.

_ There are wetlands on the above described property, that may be subject to Section 404 of the Clean Water Act (CWA)(33 USC § 1344) and/or Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403). However, since the waters, including wetlands, have not been properly delineated, this preliminary jurisdiction determination may not be used in the permit evaluation process. Without a verified wetland delineation, this preliminary determination is merely an effective presumption of CWA/RHA jurisdiction over all of the waters, including wetlands, at the project area, which is not sufficiently accurate and reliable to support an enforceable permit decision. We recommend that you have the waters of the U.S. on your property delineated. As the Corps may not be able to accomplish this wetland delineation in a timely manner, you may wish to obtain a consultant to conduct a delineation that can be verified by the Corps.

B. Approved Determination

_ There are Navigable Waters of the United States within the above described property subject to the permit requirements of Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403) and Section 404 of the Clean Water Act (CWA)(33 USC § 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ There are waters of the U.S. including wetlands on the above described property subject to the permit requirements of Section 404 of the Clean Water Act (CWA)(33 USC § 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ We recommend you have the waters of the U.S. on your property delineated. As the Corps may not be able to accomplish this wetland delineation in a timely manner, you may wish to obtain a consultant to conduct a delineation that can be verified by the Corps.

_ The waters of the U.S. including wetlands on your project area have been delineated and the delineation has been verified by the Corps. If you wish to have the delineation surveyed, the Corps can review and verify the survey upon completion. Once verified, this survey will provide an accurate depiction of all areas subject to CWA and/or RHA jurisdiction on your property which, provided there is no change in the law or our published regulations, may be relied upon for a period not to exceed five years.

_ The waters of the U.S. including wetlands have been delineated and surveyed and are accurately depicted on the plat signed by the Corps Regulatory Official identified below on_____. Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ There are no waters of the U.S., to include wetlands, present on the above described project area which are subject to the permit requirements of Section 404 of the Clean Water Act (33 USC 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ The property is located in one of the 20 Coastal Counties subject to regulation under the Coastal Area Management Act (CAMA). You should contact the Division of Coastal Management to determine their requirements.

Placement of dredged or fill material within waters of the US and/or wetlands without a Department of the Army permit may constitute a violation of Section 301 of the Clean Water Act (33 USC § 1311). Placement of dredged or fill material, construction or placement of structures, or work within navigable waters of the United States without a Department of the Army permit may constitute a violation of Sections 9 and/or 10 of the Rivers and Harbors Act (33 USC § 401 and/or 403). If you have any questions regarding this determination and/or the Corps regulatory program, please contact **William Elliott** at **828-271-7980, ext. 4225** or **amanda.jones@usace.army.mil.**

C. Basis for Determination:

See attached preliminary jurisdictional determination form.

The site contains wetlands as determined by the 1987 Corps of Engineers Wetland Delineation Manual and the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Eastern Mountain and Piedmont Region (version 2.0). These wetlands are adjacent to stream channels located on the property that exhibit indicators of ordinary high water marks. The stream channel on the property is an unnamed tributary (UT) to" **Horne Creek** which flows into the Yadkin River.

D. Remarks:

The potential waters of the U.S., at this site, were verified on-site by the Corps on 2/19/2019and are as approximately depicted on the attached Potential Wetland/Waters Map

E. Attention USDA Program Participants

This delineation/determination has been conducted to identify the limits of Corps' Clean Water Act jurisdiction for the particular site identified in this request. The delineation/determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985. If you or your tenant are USDA Program participants, or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resources Conservation Service, prior to starting work.

F. Appeals Information **(This information applies only to approved jurisdictional determinations as indicated in B. above)**

This correspondence constitutes an approved jurisdictional determination for the above described site. If you object to this determination, you may request an administrative appeal under Corps regulations at 33 CFR Part 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet and request for appeal (RFA) form. If you request to appeal this determination you must submit a completed RFA form to the following address:

US Army Corps of Engineers
South Atlantic Division
Attn: Jason Steele, Review Officer
60 Forsyth Street SW, Room 10M15
Atlanta, Georgia 30303-8801

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR part 331.5, and that it has been received by the Division Office within 60 days of the date of the NAP. Should you decide to submit an RFA form, it must be received at the above address by **N/A (Preliminary-JD).**

It is not necessary to submit an RFA form to the Division Office if you do not object to the determination in this correspondence.

Corps Regulatory Official: William Elliott
William Elliott

Issue Date of JD: **March 26, 2019** Expiration Date: N/A Preliminary JD

The Wilmington District is committed to providing the highest level of support to the public. To help us ensure we continue to do so, please complete our Customer Satisfaction Survey, located online at http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0.

Copy furnished:
Adam V. McIntyre-Water & Land Solutions, 7721 Six Forks Rd. Ste 130, Raleigh, NC 27615

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL		
Applicant: **Edward Brown**	File Number: **SAW-SAW-2017-01510**	Date: **March 26, 2019**

Attached is:	See Section below
☐ INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)	A
☐ PROFFERED PERMIT (Standard Permit or Letter of permission)	B
☐ PERMIT DENIAL	C
☐ APPROVED JURISDICTIONAL DETERMINATION	D
☒ PRELIMINARY JURISDICTIONAL DETERMINATION	E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.
- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the district engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT		
REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)		
ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.		
POINT OF CONTACT FOR QUESTIONS OR INFORMATION:		
If you have questions regarding this decision and/or the appeal process you may contact: **District Engineer, Wilmington Regulatory Division,** **Attn: William Elliott** **151 Patton Avenue, Room 208** **Asheville, North Carolina 28801-5006** **828-271-7980, ext. 4232**	If you only have questions regarding the appeal process you may also contact: Mr. Jason Steele, Administrative Appeal Review Officer CESAD-PDO U.S. Army Corps of Engineers, South Atlantic Division 60 Forsyth Street, Room 10M15 Atlanta, Georgia 30303-8801 Phone: (404) 562-5137	
RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.		
Signature of appellant or agent.	Date:	Telephone number:

For appeals on Initial Proffered Permits send this form to:

District Engineer, Wilmington Regulatory Division, Attn.: William Elliott, 69 Darlington Avenue, Wilmington, North Carolina 28403

For Permit denials, Proffered Permits and approved Jurisdictional Determinations send this form to:

Division Engineer, Commander, U.S. Army Engineer Division, South Atlantic, Attn: Mr. Jason Steele, Administrative Appeal Officer, CESAD-PDO, 60 Forsyth Street, Room 10M15, Atlanta, Georgia 30303-8801 Phone: (404) 562-5137

PRELIMINARY JURISDICTIONAL DETERMINATION (JD) FORM
U.S. Army Corps of Engineers

BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR PRELIMINARY JD: March 26, 2019

B. NAME AND ADDRESS OF PERSON REQUESTING PRELIMINARY JD:
Edward Brown
3865 Shoals Rd,
Pinnacle, NC 27043

C. DISTRICT OFFICE, FILE NAME, AND NUMBER:
CESAW-RG-A, SAW-2017-01510,

D. PROJECT LOCATION(S) AND BACKGROUND INFORMATION:
The site is located at 363 Kiger Rd., Pinnacle, NC 27043

State: **NC** County/parish/borough: **Surry** City: **Pinnacle**
Center coordinates of site (lat/long in degree decimal format): **36.28519, -80.50321**
Universal Transverse Mercator: **N/A**
Name of nearest waterbody: **Horne Creek**

E. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):
☒ Office (Desk) Determination. Date: **March 26, 2019**
☒ Field Determination. Date(s): **2/19/2019**

Use the table below to document aquatic resources and/or aquatic resources at different sites

TABLE OF AQUATIC RESOURCES IN REVIEW AREA WHICH "MAY BE" SUBJECT TO REGULATORY JURISDICTION

Site Number	Centered Coordinates (decimal degrees) Latitude	Longitude	Estimated Amount of Aquatic Resource in Review Area (linear feet or acre)	Type of Aquatic Resources	Geographic Authority to Which Aquatic Resource "May Be" Subject
	See Attach List			☐ Wetland ☐ Non-wetland Waters	☐ Section 404 ☐ Section 10/404
				☐ Wetland ☐ Non-wetland Waters	☐ Section 404 ☐ Section 10/404
				☐ Wetland ☐ Non-wetland Waters	☐ Section 404 ☐ Section 10/404
				☐ Wetland ☐ Non-wetland Waters	☐ Section 404 ☐ Section 10/404
				☐ Wetland ☐ Non-wetland Waters	☐ Section 404 ☐ Section 10/404
				☐ Wetland ☐ Non-wetland Waters	☐ Section 404 ☐ Section 10/404
				☐ Wetland ☐ Non-wetland Waters	☐ Section 404 ☐ Section 10/404
				☐ Wetland ☐ Non-wetland Waters	☐ Section 404 ☐ Section 10/404

1. The Corps of Engineers believes that there may be jurisdictional aquatic resources in the review area, and the requestor of this PJD is hereby advised of his or her option to request and obtain an approved JD (AJD) for that review area based on an informed decision after having discussed the various types of JDs and their characteristics and circumstances when they may be appropriate.

2. In any circumstance where a permit applicant obtains an individual permit, or a Nationwide General Permit (NWP) or other general permit verification requiring "pre- construction notification" (PCN), or requests verification for a non-reporting NWP or other general permit, and the permit applicant has not requested an AJD for the activity, the permit applicant is hereby made aware that: (1) the permit applicant has elected to seek a permit authorization based on a PJD, which does not make an official determination of jurisdictional aquatic resources; (2) the applicant has the option to request an AJD before accepting the terms and conditions of the permit authorization, and that basing a permit authorization on an AJD could possibly result in less compensatory mitigation being required or different special conditions; (3) the applicant has the right to request an individual permit rather than accepting the terms and conditions of the NWP or other general permit authorization; (4) the applicant can accept a permit authorization and thereby agree to comply with all the terms and conditions of that permit, including whatever mitigation requirements the Corps has determined to be necessary; (5) undertaking any activity in reliance upon the subject permit authorization without requesting an AJD constitutes the applicant's acceptance of the use of the PJD; (6) accepting a permit authorization (e.g., signing a proffered individual permit) or undertaking any activity in reliance on any form of Corps permit authorization based on a PJD constitutes agreement that all aquatic resources in the review area affected in any way by that activity will be treated as jurisdictional, and waives any challenge to such jurisdiction in any administrative or judicial compliance or enforcement action, or in any administrative appeal or in any Federal court; and (7) whether the applicant elects to use either an AJD or a PJD, the JD will be processed as soon as practicable. Further, an AJD, a proffered individual permit (and all terms and conditions contained therein), or individual permit denial can be administratively appealed pursuant to 33 C.F.R. Part 331. If, during an administrative appeal, it becomes appropriate to make an official determination whether geographic jurisdiction exists over aquatic resources in the review area, or to provide an official delineation of jurisdictional aquatic resources in the review area, the Corps will provide an AJD to accomplish that result, as soon as is practicable. This PJD finds that there *"may be"* waters of the U.S. and/or that there *"may be"* navigable waters of the U.S. on the subject review area, and identifies all aquatic features in the review area that could be affected by the proposed activity, based on the following information:

SUPPORTING DATA

Data reviewed for preliminary JD (check all that apply) - Checked items should be included in subject file. Appropriately reference sources below where indicated for all checked items:

☒ Maps, plans, plots or plat submitted by or on behalf of preliminary JD requester:
☒ Data sheets prepared/submitted by or on behalf of preliminary JD requester.
 ☒ Office concurs with data sheets/delineation report.
 ☐ Office does not concur with data sheets/delineation report. Rational:
☐ Data sheets prepared by the Corps:
☐ Corps navigable waters' study:
☒ U.S. Geological Survey (USGS) Hydrologic Atlas:
 ☐ USGS NHD data.
 ☒ USGS 8 and 12 digit HUC maps.
☐ USGS map(s). Cite scale & quad name: **Siloam.**
☒ Natural Resources Conservation Service (NRCS) Soil Survey.
 Citation: **Surry County, NC**
☐ National wetlands inventory (NWI) map(s). Cite name:
☐ State/Local wetland inventory map(s):
☐ Federal Emergency Management Agency (FEMA) / Flood Insurance Rate Map (FIRM) maps:
☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date):
 or ☐ Other (Name & Date):
☐ Previous determination(s). File no. and date of response letter:
☐ Applicable/supporting scientific literature:
☐ Other information (please specify):

IMPORTANT NOTE: The information recorded on this form has not necessarily been verified by the Corps and should not be relied upon for later jurisdictional determinations.

William Elliott

William Elliott, March 26, 2019
Signature and date of Regulatory staff member completing preliminary JD

On File

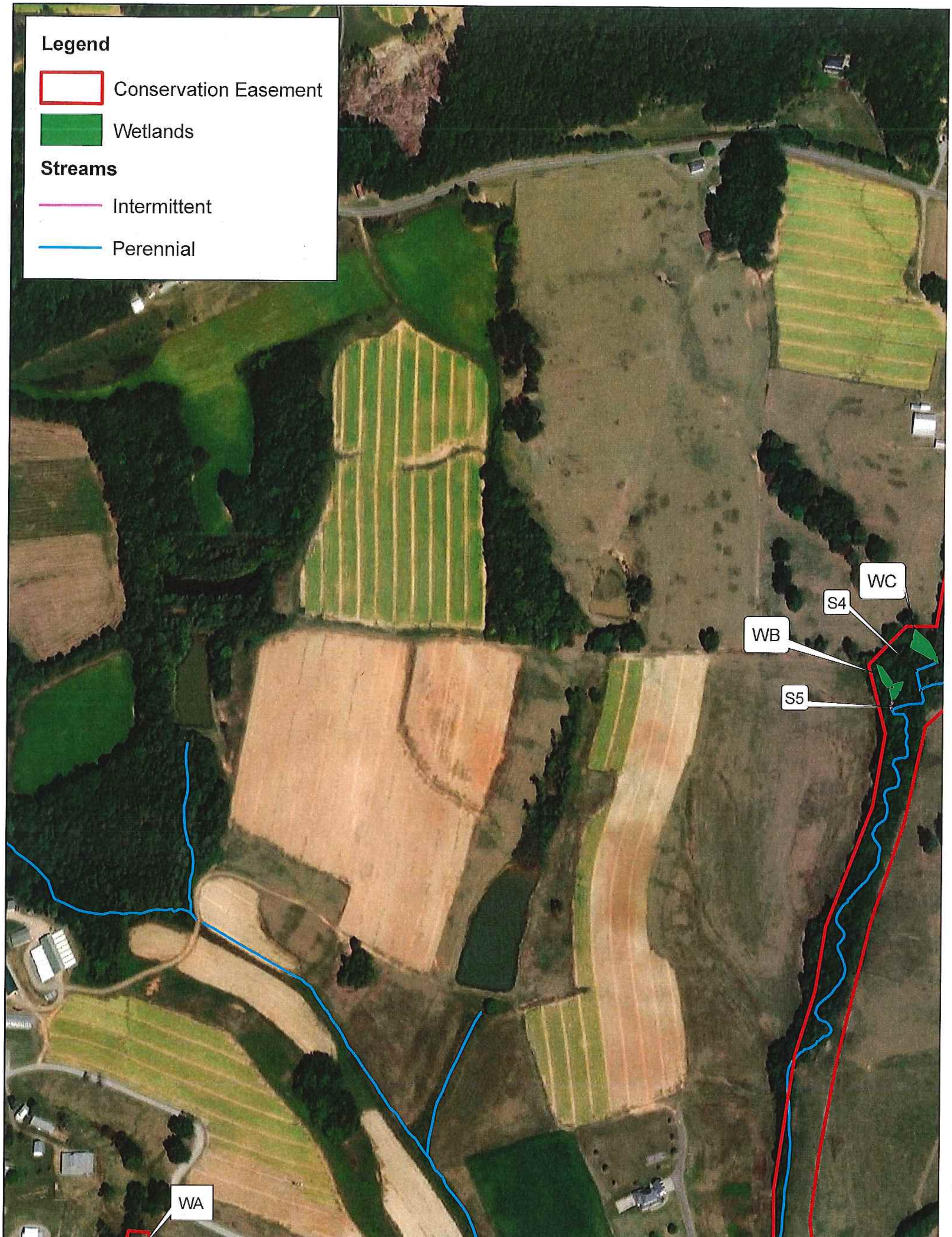
Edward Brown
Signature and date of person requesting preliminary JD (REQUIRED, unless obtaining the signature is impracticable)

Two copies of this Preliminary JD Form have been provided. Please sign both copies. Keep one signed copy for your record and return a signed copy to the Asheville Regulatory Field Office by mail or e-mail.

US Army Corps of Engineers-Wilmington District
Asheville Regulatory Field Office
151 Patton Avenue, Room 208
Asheville, NC 28801-5006

[1] Districts may establish timeframes for requester to return signed PJD forms. If the requester does not respond within the established time frame, the district may presume concurrence and no additional follow up is necessary prior to finalizing an action.

Site #	Latitude	Longitude	Estimated amount of resource in review area (acreage and linear ft, if applicable)	Type of aquatic resource (i.e. wetland vs. non-wetland waters)	Geographic authority to which the aquatic resource "may be" subject (i.e. Section 404 or Section 10/401)
WA	36.282565	-80.510192	0.005 ac	Wetland	Section 404/401
WB	36.287452	-80.50265	0.076 ac	Wetland	Section 404/401
WC	36.287756	-80.50232	0.093 ac	Wetland	Section 404/401
WD	36.28756	-80.501849	0.175 ac	Wetland	Section 404/401
S1	36.289687	-80.500118	291 lf	Non-wetland	Section 404/401
S2	36.289516	-80.501029	41 lf	Non-wetland	Section 404/401
S3	36.289357	-80.500934	3,340 lf	Non-wetland	Section 404/401
S4	36.287641	-80.502223	123 lf	Non-wetland	Section 404/401
S5	36.287410	-80.502623	71 lf	Non-wetland	Section 404/401
S6	36.282523	-80.510805	1,267	Non-wetland	Section 404/401


Legend
Conservation Easement
Wetlands
Streams
Intermittent
Perennial
WC
S4
WB
S5
WA

Appendix 10 – Invasive Species Plan

WLS will treat invasive species vegetation within the project area and provide remedial action on a case by-case basis. Common invasive species vegetation, such as Chinese privet (*Ligustrum sinense*) and Multiflora rose (*Rosa multiflora*), will be removed to allow native plants to become established within the conservation easement. Invasive species vegetation will be treated by approved mechanical and/or chemical methods such that the percent composition of exotic/invasive species vegetation is less than 5% of the total riparian buffer area. Any control methods requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations. If necessary, these removal treatments (i.e., cutting and/or spraying) will continue until the corrective actions demonstrate that the site is trending towards or meeting the standard monitoring requirement.

Appendix 11 – Approved FHWA Categorical Exclusion Form

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information	
Project Name:	Horne Creek Tributaries Mitigation Project
County Name:	Surry County
EEP Number:	DMS Proj. #100026, DMS Contract #7181
Project Sponsor:	Water & Land Solutions, LLC
Project Contact Name:	William "Scott" Hunt, III, PE
Project Contact Address:	11030 Raven Ridge Road, Ste. 119, Raleigh, NC 27614
Project Contact E-mail:	scott@waterlandsolutions.com
EEP Project Manager:	Matthew Reid

Project Description

The Horne Creek Tributaries Mitigation Project is a full-delivery project for the NCDEQ Division of Mitigation Services (DMS) identified and contracted to provide stream mitigation credits for permitted, unavoidable impacts in the Yadkin River Basin, Cataloging Unit 03040101. The project will involve the restoration, enhancement, and permanent protection of seven stream reaches (Reaches R1, R2, R3, R4, R4a, R4b, and R5), totaling approximately 5,139 linear feet of existing streams that comprise the headwaters of Horne Creek. In addition, the adjacent riparian wetlands and riparian buffers will be restored, and the entire restored corridor will be protected by a permanent conservation easement to be held by the State of North Carolina. The project site consists of a degraded headwater stream and riparian wetland system that flows through active cattle pastures, into the headwaters of Horne Creek. The proposed restoration project not only has the potential to provide at least 5,389 stream mitigation credits, but will also provide significant ecological improvements and functional uplift through habitat restoration, and through decreasing nutrient and sediment loads from the project watershed. The project is located in Surry County approximately seven miles southwest of the Town of Pilot Mountain.

For Official Use Only

Reviewed By:

1/2/2018

Date

EEP Project Manager

Conditional Approved By:

Date

For Division Administrator
FHWA

☐ **Check this box if there are outstanding issues**

Final Approval By:

12-21-17

Date

For Division Administrator
FHWA

Part 2: All Projects Regulation/Question	Response
Coastal Zone Management Act (CZMA)	
1. Is the project located in a CAMA county?	☐ Yes ☒ No
2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)?	☐ Yes ☐ No ☒ N/A
3. Has a CAMA permit been secured?	☐ Yes ☐ No ☒ N/A
4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program?	☐ Yes ☐ No ☒ N/A
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	
1. Is this a "full-delivery" project?	☒ Yes ☐ No
2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial?	☐ Yes ☒ No ☐ N/A
3. As a result of a limited Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☒ No ☐ N/A
4. As a result of a Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☒ N/A
5. As a result of a Phase II Site Assessment, are there known or potential hazardous waste sites within the project area?	☐ Yes ☐ No ☒ N/A
6. Is there an approved hazardous mitigation plan?	☐ Yes ☐ No ☒ N/A
National Historic Preservation Act (Section 106)	
1. Are there properties listed on, or eligible for listing on, the National Register of Historic Places in the project area?	☐ Yes ☒ No
2. Does the project affect such properties and does the SHPO/THPO concur?	☐ Yes ☐ No ☒ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☒ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a "full-delivery" project?	☒ Yes ☐ No
2. Does the project require the acquisition of real estate?	☒ Yes ☐ No ☐ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☐ Yes ☒ No ☐ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☒ Yes ☐ No ☐ N/A

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☐ Yes ☒ No
2. Is the site of religious importance to American Indians?	☐ Yes ☐ No ☒ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☒ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☒ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☒ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☒ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☒ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☒ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☒ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☒ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☒ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☒ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☒ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species?	☒ Yes ☐ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☐ Yes ☒ No ☐ N/A
4. Is the project "likely to adversely affect" the specie and/or "likely to adversely modify" Designated Critical Habitat?	☐ Yes ☒ No ☐ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☐ Yes ☐ No ☒ N/A
6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination?	☐ Yes ☐ No ☒ N/A

Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as "territory" by the EBCI?	☐ Yes ☒ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project?	☐ Yes ☐ No ☒ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☒ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☒ Yes ☐ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☒ Yes ☐ No ☐ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☒ Yes ☐ No ☐ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☒ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☒ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☒ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☒ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☒ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☒ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☒ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☒ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☒ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☒ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☒ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☒ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☒ N/A

Appendix 12 – Agency Correspondence

Meeting Minutes

Yadkin 03040101 Full-Delivery Project:

Horne Creek Tributaries Mitigation Project (NCDEQ DMS Contract # 7181, Project ID # 1000026)

Subject: NCIRT Post-Contract Site Meeting

Date Prepared: September 19, 2017

Meeting Date and Time: August 30, 2017 @ 1000

Meeting Location: On-site (Surry County, NC)

Recorded By: Kayne VanStell and Chris Tomsic

Attendees: USACE: Todd Tugwell (NCIRT) and Kim Browning (NCIRT)

NCDEQ DWR: Mac Haupt (NCIRT)

NCWRC: Andrea Leslie and Olivia Munzer

NCDEQ DMS: Paul Wiesner and Matthew Reid

ES: Chris Tomsic and Kip Mumaw

WLS: Kayne VanStell and Scott Hunt

These meeting minutes document notes and discussion points from the North Carolina Interagency Review Team (NCIRT) Post-Contract Site Meeting for the Horne Creek Tributaries Mitigation Project (Yadkin River Basin, CU 03040101, Warm Water Thermal Regime). This full-delivery project was contracted on June 1, 2017, by the North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS), with Water & Land Solutions, LLC (WLS), under RFP 16-006993. The project site is located in Surry County, North Carolina, in the Shoals Community, near Pilot Mountain, North Carolina.

The meeting began at 1000 with introductions and a general summary of the overall project concepts. After the project introduction and overview, attendees toured the project site to review existing conditions and proposed mitigation types, strategies, and design concepts. The project site review notes are presented below in the order they were visited.

1. Todd Tugwell asked where the jurisdictional stream call for Reach 2 was located. It was noted that the unverified jurisdictional stream call was approximately 100’ downstream from the start of the water quality improvement feature. The NCIRT generally agreed with the approximate location, but suggested that the determination could be conservative and may be considered approximately 100’ upstream of the initial stream call.
2. Andrea Leslie asked how the water quality improvement features would be designed and operate. It was explained that the water quality improvement features will be designed for initial stream flow attenuation and nutrient treatment. The water quality improvement feature would start at an existing rip rap/rock outfall and flow through a series of step-pools/depressions. The NCIRT agreed with the approach for the water quality improvement features.
3. It was explained that the Water quality improvement features would be excluded from the conservation easement. It was WLS’s understanding based on previous conversations that this was the NCIRT’s position. Andrea Leslie suggested that incorporating the water quality improvement features within the conservation easement should be considered so that they can be protected from future development. There was a concern about how the water quality improvement features could/would be maintained after the project went into stewardship. It was explained that there could be a maintenance agreement to allow for periodic maintenance. However, it was expressed that the water quality improvement features will be designed to be self-maintaining and therefore should not require annual maintenance following project close-out.
4. Todd Tugwell commented that a concern of his in Reach 2 is maintaining stream jurisdiction following restoration. It was explained that design approach and past experience with similar projects within the watershed will allow for maintaining stream jurisdiction. It was further discussed that the water quality improvement feature will allow for a slower release of water to Reach 2 allowing for some attenuation rather than a rapid flush that is currently occurring. Todd Tugwell suggested that this should be clearly explained in the mitigation plan.
5. Andrea Leslie asked about the stream design approach on Reach 2. It was explained that the stream would start at the downstream extent of the water quality improvement feature and would designed as a nested Rosgen ‘B’ or ‘Bc’ stream type channel. The existing channel would be filled several feet, and a floodplain bench would be created to maintain proper entrenchment, and banks would be sloped up to existing ground. In general, the channel would be restored more like a shallow Priority Level 2 approach. Any large trees would be protected and/or incorporated into the design. Todd Tugwell suggested that the channel could be relocated into the right floodplain. WLS made note of this suggestion and commented that all options will be explored to design and construct a stable stream system.
6. General discussion about Reach 3. It was noted where the jurisdiction determination was made and Todd Tugwell generally agreed with the jurisdictional determination, but suggested that the determination could be conservative and may be considered approximately 100’ upstream of the initial stream call.

7. Similar conversations about Reach 2, water quality improvement features were discussed in regards to Reach 3 water quality improvement features.
8. General discussions about the restoration approach on Reach 4. It was explained that the stream bed will be raised gradually and the existing channel will be filled starting from Reach 2 and transitioning into Reach 4. The new design channel will be gradually relocated to tie from the existing top of bank in order to meet the design top of bank. The design will capture relic channels in areas through the Reach.
9. General discussions about Reach 4A and 4B design approaches. The NCIRT members agreed with the proposed design approach on both these reaches.
10. Olivia Munzer asked about existing large trees throughout the project and the option to maintain tree snags for terrestrial habitat. It was explained that all efforts will be made to preserve and/or incorporate large trees within the project limits. Any trees that must be removed will be fully utilized in the stream design. Any dead standing trees that serve as habitat for terrestrial species will be incorporated into the design where appropriate and applicable. New tree snags will be included in the design where appropriate and applicable so as to not detrimentally effect the stream design and surrounding project amenities including fencing and cattle waterers. Olivia agreed with this approach.
11. General discussion regarding Reach 5. It was explained that the new channel alignment would utilize more of the left floodplain in the area where the Reach has minimal riparian corridor and has been generally straightened. The NCIRT members agreed with this proposed mitigation approach.
12. General discussion regarding Reach 1. There was further conversation about the water quality improvement feature being excluded from the conservation easement. It was reiterated by WLS that this was the preferred approach by the NCIRT. Andrea Leslie again stated that protecting the water quality improvement feature minimally with fencing around the feature or including in the conservation easement is strongly encouraged. WLS agreed with this recommendation and indicated that this would be addressed fully in the mitigation plan.

Additional and Concluding Comments

The NCIRT expressed that overall, they accepted the proposed project mitigation approaches for all seven (7) Reaches. Todd Tugwell reiterated that he does have concern with maintaining stream jurisdiction in Reaches in 2 and 3. WLS explained that this concern would be incorporated in the design process and would be abated based on the design approach and past experience with similar projects, as well as the water quality improvement features ability to allow for slow release of water into stream Reaches. Todd Tugwell also said that WLS should have a jurisdictional determination conducted on Reaches 2 and 3 for final stream nexus location.

Please be aware that although some intermittent/ephemeral break locations were discussed during the site visit, a full Jurisdictional Determination will need to be completed for each of the project reaches at the site and included in the Mitigation Plan.

There were several occasions throughout the meeting where the need for flow gages and/or trail cameras would be used to document flow in reaches of concern. The gage type, locations (map), sampling frequency and the associated success criteria should be presented in the mitigation plan.

The above minutes represents Water & Land Solutions' interpretation and understanding of the meeting discussion and actions. If recipients of these minutes should find any information contained in these minutes to be in error, incomplete, please notify the author with appropriate corrections and/or additions within five (5) business days to allow adequate time for correction and redistribution.