# Mitigation Plan
# Banner Branch Mitigation Project
## Stokes County, North Carolina
## FINAL VERSION

NCDEQ DMS Project Identification # 100080
NCDEQ DMS Contract # 7610 and # 7701
Roanoke River Basin (Cataloging Unit 03010103)
USACE Action ID Number: SAW-2018-01760
Contracted Under RFP # 16-007405
DWR Project # 20181154

Prepared for:

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

**July 2020**

Prepared by:

WATER & LAND SOLUTIONS
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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.

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

Kayne Van Stell

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DEPARTMENT OF DEFENSE

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

REPLY TO
ATTENTION OF:

June 23, 2020

Regulatory Division

Re: NCIRT Review and USACE Approval of the NCDMS Banner Branch Mitigation Site / Stokes Co./ SAW-2018-01760/ NCDMS Project # 100080

Mr. Tim Baumgartner
North Carolina Division of Mitigation Services
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 Banner Branch Draft Mitigation Plan, which closed on May 13, 2020. 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* Tyler Crumbley

Enclosures

Electronic Copies Furnished:

NCIRT Distribution List
Jeremiah Dow, Lindsay Crocker—NCDMS
Kayne Van Stell—WLS

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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

REPLY TO
ATTENTION OF:

CESAW-RG/Browning June 5, 2020

MEMORANDUM FOR RECORD

SUBJECT: Banner Branch Mitigation Site - NCIRT Comments during 30-day Mitigation Plan Review

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

NCDMS Project Name: Banner Branch Mitigation Site, Stokes County, NC

USACE AID#: SAW-2018-01760
NCDMS #: 100080
30-Day Comment Deadline: May 13, 2020

*DWR Comments, Mac Haupt & Erin Davis:*

1. DWR appreciates that WLS is conducting pre- and post-restoration benthic and water quality sampling for this project.
2. Page 8, Table 1 – As noted in below comments, DWR has questions about the proposed approach for UT1-R1, credit ratio for UT4-R1, and the credit lengths for UT1B and UT3.
3. Page 31, Section 3.4.5 – When were WLS' field investigations completed? Please include wetland determination data forms in Appendix 9.
4. Page 31, Section 3.5 – DWR considers easement breaks as site constraints since fragmentation impacts the site's potential functional uplift. Please include a discussion on the coordination completed to minimize the quantity and width of proposed stream crossings. Also, please explain why an additional crossing is proposed on UT4-R1 that was not part of the original concept plan.
5. Page 31, Section 3.5.4 – Since proposed wetland restoration credit areas abuts the conservation easement, have you evaluated the risk of hydrologic trespass that may result in the landowner ditching outside the easement?
6. Page 39, Table 14 –
    a. The UT1B existing to mitigation footage increases from 391 LF to 488 LF, with a EII approach please explain this stream length increase.
    b. Please confirm that the section of UT4-R1 within Wetland W3 will be Priority 1. Page 45 appears to indicate that P2 is proposed for this lower reach, which may affect wetland hydrologic uplift.
7. Page 47 – This section notes that proposed BMPs will be located outside of the conservation easement; however, Section 6.7 states that BMPs will be located inside easement. If no long-term maintenance is required, then DWR prefers BMPs be located inside the easement.
8. Page 49, Section 6.2.2 – Please include the location of reference wetland (coordinates/map).

9. Page 55, Section 6.4 – DWR expects that the narrow right side buffer adjacent to the agriculture/recreational pond will limit the potential functional uplift of the restored stream section. To reflect the reduced functional uplift DWR supports a credit ratio of 1.25:1 for the 233LF section of UT4-R1 with buffers of less than 30 feet.
10. Page 57, Section 6.5 – Please indicate the total planted area.
11. Page 58, Table 21 – DWR appreciates the species and stratum diversity; however, we recommend a slight adjustment to the percentages so at least 50% of stems are canopy species.
12. Page 60, 6.5.2 - Please indicate if fescue will be treated prior to or during site construction. DWR recommends early treatment based on observations of fescue impeding planted vegetation establishment and vigor.
13. Page 62, Section 6.8.1 – DWR recommends depressional areas, which are not called out as vernal pools, not exceed 6-8 inches.
14. Page 63 – Please include a discussion/section on evaluated Project Risks and Uncertainties.
15. Page 68 – DWR requests flow gauges be installed in the upper one-third of subject intermittent reach.
16. Page 69 – Please confirm that 16 veg plots represent 2% of the proposed planted area. Since a large area of supplemental planting is proposed, DWR requests an additional 2-3 plots to track survival rates not necessarily tied to success criteria.
17. Figures – Please either show property boundaries on one of the included figures or an additional figure.
18. Figure 9 – It is very difficult to see the restoration and preservation stream color lines over the aerial at this scale.
19. Figure 10 –
    a. Please include flow gauges on the intermittent Restoration reach of UT1C and Enhancement I reach of UT2A. Also, please shift the location of the flow gauge on UT2 upstream at least 150 feet.
    b. In order to demonstrate enhancement please include veg plots within wetlands W5 and W5A; and to demonstrate reestablishment please include veg plots within wetlands W9 and W8A.
    c. Please include additional cross-sections on UT2 and UT3.
20. Sheet 2 – Please add legend icons for vernal pool and the hatching shown on plan view indicating to grade, seed, mat and live stake areas.
21. Sheet 3 – DWR recommends that benches be at least two times bankfull width for C type stream restoration.
22. Sheets 14, 23 & 33 – Please callout stream crossings/easement breaks on the profile views.
23. Sheet 18 – Based on the proposed work, UT1-R1 appears to align more as an Enhancement I approach compared to Restoration, where the full length of stream will have dimension, pattern and profile improvements. Additionally, only partial buffer planting is proposed. Further justification is needed for DWR to support this reach for restoration credit.
24. Sheet 13 – Please confirm the profile callouts for existing ground and design thalweg are indicating the correct features.
25. Sheet 15 – The CE crosses the southwest corner of the existing pond. Please show how this area will be graded within and immediately adjacent to the CE line.
26. Sheet 22 – The tributary connecting with UT1-R3 at Station 43+00 is not mentioned anywhere in the plan. Since a section of this trib. it is located within the project site and may be potential sediment source for BB-R1, please include a brief description of the channel condition.
27. Sheet 26 – DWR echoes DMS' question regarding UT3 and BB-R2 parallel alignment through an existing wetland. At one point the two channels are less than 25 feet apart. Please provide justification why it's not feasible to tie in UT3 further upstream on BB-R2 near Station 68+00. Additionally, please note that channel maintenance measures such as sediment or veg removal should not be completed after MY3 in order to properly evaluate how the system is trending.

28. Appendix 12 - Since reach names have changed, please include the concept figure that corresponds to the IRT site visit meeting minutes.

*NCWRC Comments, Travis Wilson:*

1. The generic permanent stream crossing detail does not illustrate or mention the possible need for culverts set above bankfull elevation. It would be beneficial to including a cross section detail specific to each culverted stream crossing. That will allow a better assessment of the culvert sizing and configuration within the crossing.
2. Note: duel lines of smaller diameter pipe in the channel are not preferred. Pipes typically have to be placed 12”-18” apart causing the channel flow to split and potentially over widen at the inlet and outlet
3. UT 1 R3 Station 34.32 permanent crossing is set at 7% that is extremely steep, aquatic passage will not occur, and downstream scour is almost certain.

*USACE Comments, Kim Browning:*

1. When submitting the PCN, please combine all impacts by reach. For example, if there are three 60’ culverts on reach 1, list it as 180’ of permanent impact rather than listing it as three separate impacts. But permanent and temporary impacts still need to be separated. Also, please estimate the number or acres of trees to be cleared to address the NLEB 4(d) rule.
2. Section 6.4: It would be beneficial to add some coarse woody debris to the depressional areas in the buffers and throughout the adjacent wetlands for habitat, and to help store sediment, increase water storage/infiltration, and absorb water energy during overbank events. I was pleased to see the inclusion of wood in the stream design for habitat.
3. Section 3.5: Please add a section regarding potential future adjacent development or logging.
4. Though Stokes County is considered a mountain county, all analysis and data are based on piedmont ecoregion categorization. I recognize that the conservation easement has probably already been finalized, but It seems more appropriate for 50’ buffers on this site.
5. Considering the very small watershed drainage areas for UT1A and UT2A, there is concern for loss of flow. It would be beneficial to supplement with photo-points to document flow.
6. In the future, please maintain the same reach names throughout the project, including the JD. It’s difficult to refer to our field notes when reaches are renamed. Additionally, it’s difficult to see the channel lines with the colors selected on Figures 9 and 10. Please use the same colors throughout the life of the project to designate the different mitigation approaches.
7. The IRT site visit notes indicate that UT1-R1 above UT1C should be enhancement II, rather than restoration. Section 3.4.1 indicates that this reach is mostly stable with a mature woody buffer. Please explain why restoration is proposed here, especially since the listed functional uplift is only 8% and it scored a Medium NCSAM rating.
8. NCSAM: UT3 was not mentioned in the text on page 30. An interesting observation is that many of the reaches proposed for enhancement II score a Low SAM rating while reach BBR3, which scored Medium, is proposed for restoration. Perhaps cattle exclusion on the EII reaches will provide the most uplift, but it would be interesting to compare the scores of NCSAM and SQT to see the results of the functional assessments.
9. Table 14: The wetland comments section does not distinguish the difference between the different levels of work being performed on wetland rehabilitation versus re-establishment. For example, the work performed is the same for W1 and W1A, but they’re receiving different credit ratios.
10. Table 21: Considering the inclusion of riparian wetlands proposed for this site, it would be beneficial to add additional FACW species to the overstory and understory list.
11. Ephemeral/vernal pools should be 8-14” depressions that dry up yearly so that predatory species cannot colonize, and should not be so numerous that trees do not grow in large areas of the buffer.

12. Please show the location of the rain gauge and fixed photo points on Figure 10. If cross-sections are to be used for photo points, please indicate in the text. Additionally, it would be helpful to have photo points at crossings to show the condition of the culverts.
13. Please show the location of the reference wetland on Figure 11.
14. I'm glad to see the inclusion of water quality and benthic monitoring. Are these reaches proposed for additional credit? If so, please add this to Table 1. Also, please add the monitoring locations to Figure 10.

*USEPA Comments, Todd Bowers:*

I have completed my review for the Banner Branch wetland and stream mitigation site. I have no site-specific comments to submit at this time.

Kim Browning
Mitigation Project Manager
Regulatory Division

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**July 24, 2020**

**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 Banner Branch Mitigation Project, USACE AID# SAW-2018-01760, NCDEQ DMS Full-Delivery Project ID #100080, Contract #7610 and 7701, Roanoke River Basin, Cataloging Unit 03010103, Stokes 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 June 5th, 2020 regarding the Final Draft Mitigation Plan for the Banner Branch 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, Mac Haupt & Erin Davis:***

**1. DWR appreciates that WLS is conducting pre- and post-restoration benthic and water quality sampling for this project.** Response: WLS appreciates this comment as we believe that the WQ sampling will help us determine the associated functional lift that may be achieved considering site constraints and existing conditions.

**2. Page 8, Table 1 – As noted in below comments, DWR has questions about the proposed approach for UT1-R1, credit ratio for UT4-R1, and the credit lengths for UT1B and UT3.** Response: Table 1 has been updated to reflect the credit changes to UT1B per DWR Response #6a, UT4-R1 for the 1.25:1 for the 233 LF adjacent to the pond (DWR Response #9), and revising UT-R1 upper from Restoration to Enhancement I per DWR Response #23. WLS has addressed UT3 per DWR response #27 and there are no changes in Table 1 for UT3.

**3. Page 31, Section 3.4.5 – When were WLS' field investigations completed? Please include wetland determination data forms in Appendix 9.** Response: The field investigations were completed by WLS and George Lankford during March 2018 and September 2019. Section 3.4.5 has been updated and the data forms have been included in Appendix 9.

**4. Page 31, Section 3.5 – DWR considers easement breaks as site constraints since fragmentation impacts the site's potential functional uplift. Please include a discussion on the coordination completed to minimize the quantity and width of proposed stream crossings. Also, please explain why an additional crossing is proposed on UT4-R1 that was not part of the original concept plan.** Response: WLS has added additional language to Section 3.5.7 that discusses the location and number of stream crossings across the project area. We have coordinated with all four landowners to locate the crossings as shown on the plans. The adjoining landowners requested an additional crossing along UT4-R1 after the concept plan stage to accommodate current farm operations and future access if the property was ever sold or subdivided. We understand that stream crossings and easement breaks (i.e. fragmentation) are not favorable and impacts the sites functional uplift potential. However, they are often a landowner requirement for property access and many restoration sites could not be implemented without proper planning and incorporating these crossings. The functional impacts are considered minimal and only account for 1.5% of the total stream length to be permanently protected in the easement as a result of the project.

**5. Page 31, Section 3.5.4 – Since proposed wetland restoration credit areas abuts the conservation easement, have you evaluated the risk of hydrologic trespass that may result in the landowner ditching outside the easement?** Response: WLS has evaluated the risks of hydrologic trespass from potential changes in adjacent land use. We have discussed the proposed design approach with the landowners and explained how the post-restoration conditions will increase groundwater tables and saturation levels within the valley bottom. Fortunately, all the creditable wetland areas within the easement boundary abut pasture areas and not agricultural fields, therefore crop loss will not be a concern. We have taken necessary measures to ensure that project features/elements are not adversely affected by external perturbations. Should situations arise that warrant corrective action, WLS will deal with those issues swiftly and judiciously and in coordination with the IRT.

**6. Page 39, Table 14 –**

> **a. The UT1B existing to mitigation footage increases from 391 LF to 488 LF, with an EII approach please explain this stream length increase.** Response: The increase in stream length along UT1B is the result of extending the reach to connect to UT1-R2. The existing channel terminates in an existing wetland and has lost channel definition. The enhancement approach is to create a natural stable connection to UT1-R2 through a constructed channel with in-stream structures to provide grade control and bedform diversity. WLS has revised Table 14 to split this reach into upper and lower sections. Upper UT1B will match the existing stream length of 391 LF with a proposed Enhancement II approach. Lower UT1B (97 LF) is the extension of this reach needed to connect with UT1-R2, and we propose an EI approach at 1.5:1 credit ratio.
>
> **b. Please confirm that the section of UT4-R1 within Wetland W3 will be Priority 1. Page 45 appears to indicate that P2 is proposed for this lower reach, which may affect wetland hydrologic uplift.** Response: The portion of UT4-R1 within Wetland W3 is being proposed as Priority Level 1 restoration. Language has been added to this section to better describe the proposed design approach in lower UT4-R1 above the ponded area.

**7. Page 47 – This section notes that proposed BMPs will be located outside of the conservation easement; however, Section 6.7 states that BMPs will be located inside easement. If no long-term maintenance is required, then DWR prefers BMPs be located inside the easement.** Response: The BMPs are located inside the conservation easement. WLS has revised Section 6.1.2 and Section 6.7 to state that all BMPs will be within the conservation easement and require no maintenance.

**8. Page 49, Section 6.2.2 – Please include the location of reference wetland (coordinates/map).** Response: The reference wetland ‘W8’ location has been added with coordinates as an insert to Figure 11.

**9. Page 55, Section 6.4 – DWR expects that the narrow right side buffer adjacent to the agriculture/recreational pond will limit the potential functional uplift of the restored stream section. To reflect the reduced functional uplift DWR supports a credit ratio of 1.25:1 for the 233LF section of UT4-R1 with buffers of less than 30 feet.** Response: WLS has updated Section 6.1.2, page 46 to reflect the reduced credit ratio for the 233 LF. Tables 1 and 14 have been updated accordingly. Table 14 has a note about the reduced credit ratio for this 233 LF of UT4-R1.

**10. Page 57, Section 6.5 – Please indicate the total planted area.** Response: WLS has included the total planted area in Section 6.5.1, page 59, of the mitigation plan. 24.3 acres are restoration planting and 5.10 acres are supplemental planting for a total of 29.4 acres.

**11. Page 58, Table 21 – DWR appreciates the species and stratum diversity; however, we recommend a slight adjustment to the percentages so at least 50% of stems are canopy species.** Response: Table 21 has been adjusted to increase the canopy species to approximately 76% of the total stems planted.

**12. Page 60, 6.5.2 - Please indicate if fescue will be treated prior to or during site construction. DWR recommends early treatment based on observations of fescue impeding planted vegetation establishment and vigor.** Response: WLS understands DWR's concern with fescue impeding planted areas. We do not believe that herbicide treatment of fescue is appropriate for this site due to the adverse environmental impacts. The site preparation includes clearing and grubbing which will help reduce fescue pressure. Grading activities will also remove much of the fescue seed/root source. The combination of these two techniques will help control fescue regeneration. If fescue becomes pervasive within the conservation easement, WLS will address the issue through a remedial action plan. Language has been added to Section 6.5.2 to address this concern.

**13. Page 62, Section 6.8.1 – DWR recommends depressional areas, which are not called out as vernal pools, not exceed 6-8 inches.** Response: There are no depressional areas other than those created by common floodplain grading activities as part of this project. The depressional areas will not exceed 8 inches and this language has been added to Section 6.8.1.

**14. Page 63 – Please include a discussion/section on evaluated Project Risks and Uncertainties.** Response: Section 6.8.4 Future Project Risks and Uncertainties has been added to the mitigation plan.

**15. Page 68 – DWR requests flow gauges be installed in the upper one-third of subject intermittent reach.** Response: Section 8.2.3 has been revised to state that flow gauges will be installed in the upper one-third of subject intermittent reaches. On Figure 10 (Monitoring Features), flow gauges have been added to reaches UT1C and UT2A per Comment #19.

**16. Page 69 – Please confirm that 16 veg plots represent 2% of the proposed planted area. Since a large area of supplemental planting is proposed, DWR requests an additional 2-3 plots to track survival rates not necessarily tied to success criteria.** Response: Section 8.4 has been updated to 20 vegetation plots, which is 2% of the estimated riparian planting area (24.3 ac). The planting plan in the design plans has also been revised to reflect Proposed Riparian Planting and Riparian Supplemental Planting Zones. The estimated supplemental planting area is 5.1 acres and dispersed throughout the project areas. These areas will be included in the visual assessment each monitoring year. Based on the final planting locations documented in the as-built report, WLS may add two 50m x 2m transects in the supplemental planting areas to track survival rates that will not be tied to success criteria. These two possible transects have been added to Figure 10 on reaches UT1B and UT4-R2.

**17. Figures – Please either show property boundaries on one of the included figures or an additional figure.** Response: The property boundaries have been added to Figure 6 – Current Conditions.

**18. Figure 9 – It is very difficult to see the restoration and preservation stream color lines over the aerial at this scale.** Response: Figure 9 has been revised to clearly depict the stream mitigation types/colors.

**19. Figure 10 –**

> **a. Please include flow gauges on the intermittent Restoration reach of UT1C and Enhancement I reach of UT2A. Also, please shift the location of the flow gauge on UT2 upstream at least 150 feet.** Response: Flow gauges have been added to UT1C and UT2A. While reach UT1C is intermittent in the upper part of the reach, the project only captures the lower third of this reach. The entire jurisdictional reach is 527 LF, but only 227 LF are in the easement area; the first 69 feet are preservation and the last section is 151 ft of restoration. The location of the flow gauge on UT2 has been moved upstream a bit, but it is already well within the upper third of the reach. UT2 continues past the easement break and is currently 1,315 LF.
>
> **b. In order to demonstrate enhancement please include veg plots within wetlands W5 and W5A; and to demonstrate reestablishment please include veg plots within wetlands W9 and W8A.** Response: Vegetation plots have been added to these four wetland areas.
>
> **c. Please include additional cross-sections on UT2 and UT3.** Response: There was one riffle cross-section shown on UT2 below the crossing, but an additional cross-section has been added. Also, cross-sections have been added to UT3.

**20. Sheet 2 – Please add legend icons for vernal pool and the hatching shown on plan view indicating to grade, seed, mat and live stake areas.** Response: Legend icons for vernal pool and the hatching shown on plan view indicating to grade, seed, mat and live stake areas have been added to sheet 2 of the construction plans.

**21. Sheet 3 – DWR recommends that benches be at least two times bankfull width for C type stream restoration.** Response: Floodplain benches have been minimally designed equal to or greater than an entrenchment ratio of 2.2.

**22. Sheets 14, 23 & 33 – Please callout stream crossings/easement breaks on the profile views.** Response: Stream crossings/easement breaks have been noted in the profile views.

**23. Sheet 18 – Based on the proposed work, UT1-R1 appears to align more as an Enhancement I approach compared to Restoration, where the full length of stream will have dimension, pattern and profile improvements. Additionally, only partial buffer planting is proposed. Further justification is needed for DWR to support this reach for restoration credit.** Response: WLS has revised the approach along UT1-R1 to Enhancement Level I with a 1.5:1 credit ratio. The original concept approach was to relocate and re-establish the incised channel away from the right toe of slope. We have updated Table 1, Table 14, and Section 6.1.2, pg 47 accordingly.

**24. Sheet 13 – Please confirm the profile callouts for existing ground and design thalweg are indicating the correct features.** Response: WLS has revised sheet 13 profile callouts and confirmed other sheets have correct profile callouts as well.

**25. Sheet 15 – The CE crosses the southwest corner of the existing pond. Please show how this area will be graded within and immediately adjacent to the CE line.** Response: WLS has revised the pond grading so that the entire CE break is a flat crossing and does not include the pond or any part of the pond water surface.

**26. Sheet 22 – The tributary connecting with UT1-R3 at Station 43+00 is not mentioned anywhere in the plan. Since a section of this trib. it is located within the project site and may be potential sediment source for BB-R1, please include a brief description of the channel condition.** Response: The tributary shown on sheet 22 is Banner Branch which flows from the east and connects with UT1-R3 near Station 43+00. We have added language to the existing reach condition summary in Section 3.4.1, pg 24 that briefly describes the upstream channel condition.

**27. Sheet 26 – DWR echoes DMS' question regarding UT3 and BB-R2 parallel alignment through an existing wetland. At one point the two channels are less than 25 feet apart. Please provide justification why it's not feasible to tie in UT3 further upstream on BB-R2 near Station 68+00. Additionally, please note that channel maintenance measures such as sediment or veg removal should not be completed after MY3 in order to properly evaluate how the system is trending.** Response: As described in the DMS response comment, WLS designed the reach alignments and confluence for UT3 and BB-R2 not to unnecessarily increase stream length/credit, but to accommodate current stream/valley morphology, gradients and natural floodplain connections so that they are not perpendicular to flow. In theory it is feasible to leave the existing ditch in its current location to maintain base flow. However, in practice it is our design intent to convey future base flow and overbank floods competently and without adverse effects to channel hydraulics and floodplain conditions, and to allow for increased habitat and bedform diversity within the appropriately sized bankfull channel. Furthermore, maintaining perennial stream flows within the single thread channel will decrease concentrated flow energy, excess scour potential and stream degradation while improving wetland hydrology across the wide valley bottom (>150'). As shown on Plan Sheets 25 and Figure 7a historical aerial, the proposed alignment actually ties into the main stem BB-R2/R3 at station 69+85 prior to the remnant channel feature near station 71+30. The channel slope is ~1.14% (drops 6.7 ft across 589 LF) with adequate riffle slopes and pool-to-pool spacing to maintain stream bed/bank characteristics and channel form within the wetland area and valley width. We do not anticipate channel maintenance measures to remove sediment or excess channel vegetation after MY3.

**28. Appendix 12 – Since reach names have changed, please include the concept figure that corresponds to the IRT site visit meeting minutes.** Response: the concept figure that corresponds to the meeting minutes has been included in Appendix 12.

***<u>NCWRC Comments, Travis Wilson:</u>***

**1. The generic permanent stream crossing detail does not illustrate or mention the possible need for culverts set above bankfull elevation. It would be beneficial to including a cross section detail specific to each culverted stream crossing. That will allow a better assessment of the culvert sizing and configuration within the crossing.** Response: The typical culvert crossing detail is not reach specific mainly to limit the number of details within the project plans, so as to minimize duplication and limit the number of plan sheets. Site specific culvert information is shown in the plan/profile sheets of the construction documents. WLS has revised the permanent stream crossing detail to include a bankfull culvert where and when it is called out in the construction documents.

**2. Note: duel lines of smaller diameter pipe in the channel are not preferred. Pipes typically have to be placed 12"-18" apart causing the channel flow to split and potentially over widen at the inlet and outlet.** Response: WLS understands the concern about dual pipes, but have had good success with this design approach without deleterious effects to the stream. However, we have revised the current crossing to include a single channel culvert and two floodplain culverts.

**3. UT1-R3 Station 34+32 permanent crossing is set at 7% that is extremely steep, aquatic passage will not occur, and downstream scour is almost certain.** Response: WLS has revised the culvert slope to be less steep. However, due to the change in grade between reaches we could only reduce the pipe slope to 5.79%.

***<u>USACE Comments, Kim Browning:</u>***

**1. When submitting the PCN, please combine all impacts by reach. For example, if there are three 60' culverts on reach 1, list it as 180' of permanent impact rather than listing it as three separate impacts. But permanent and temporary impacts still need to be separated. Also, please estimate the number or acres of trees to be cleared to address the NLEB 4(d) rule.** Response: WLS will combine all impacts by reach (permanent and temporary separated) for the PCN and will estimate the acres of trees to be cleared per the NLEB 4(d) rule.

**2. Section 6.4: It would be beneficial to add some coarse woody debris to the depressional areas in the buffers and throughout the adjacent wetlands for habitat, and to help store sediment, increase water storage/infiltration, and absorb water energy during overbank events. I was pleased to see the inclusion of wood in the stream design for habitat.** Response: WLS appreciates this comment and will direct the contractor to add coarse woody debris to the depressional areas in the buffers and wetlands for habitat which is also described in the technical specifications. This has been added to Section 6.4 also.

**3. Section 3.5: Please add a section regarding potential future adjacent development or logging.** Response: Section 3.5.6 Potential Future Land-Use has been added, as well as Section 6.8.4 Future Project Risks and Uncertainties per DWR Comment #14.

**4. Though Stokes County is considered a mountain county, all analysis and data are based on piedmont ecoregion categorization. I recognize that the conservation easement has probably already been finalized, but It seems more appropriate for 50' buffers on this site.** Response: WLS understands and agrees with this comment, but Stokes County is currently listed as a mountain county with 30-ft buffers, so WLS followed the current guidance. You are correct that the easements have already been finalized. We will consider this for any future projects in Stokes County.

**5. Considering the very small watershed drainage areas for UT1A and UT2A, there is concern for loss of flow. It would be beneficial to supplement with photo-points to document flow.** Response: WLS will install flow gauges on these reaches instead of photo-points since DWR already requested a flow gauge for UT2A in Comment #19a.

**6. In the future, please maintain the same reach names throughout the project, including the JD. It's difficult to refer to our field notes when reaches are renamed. Additionally, it's difficult to see the channel lines with the colors selected on Figures 9 and 10. Please use the same colors throughout the life of the project to designate the different mitigation approaches.** Response: WLS understands the importance of this request and has made every effort to adhere to this on recent projects. Figures 9 and 10 have been revised to better depict the channel lines without changing colors for the mitigation types.

**7. The IRT site visit notes indicate that UT1-R1 above UT1C should be enhancement II, rather than restoration. Section 3.4.1 indicates that this reach is mostly stable with a mature woody buffer. Please explain why restoration is proposed here, especially since the listed functional**

**uplift is only 8% and it scored a Medium NCSAM rating.** Response: As noted above in DWR response comment #23, WLS has revised the approach along UT1-R1 to Enhancement Level I with a 1.5:1 credit ratio. The meeting minutes state that this area should be Enhancement Level II, then a section of preservation, and that restoration could begin near the old house where the stream is incised. The original concept approach was to relocate and re-establish the incised channel away from the right toe of slope. We will be conducting Enhancement Level I activities such as excavating floodplain bench and installing in-stream structures to increase bedform diversity and aquatic habitat. Table 1, Table 14, and Section 6.1.2, pg 47 have been updated accordingly.

**8. NCSAM: UT3 was not mentioned in the text on page 30. An interesting observation is that many of the reaches proposed for enhancement II score a Low SAM rating while reach BB-R3, which scored Medium, is proposed for restoration. Perhaps cattle exclusion on the EII reaches will provide the most uplift, but it would be interesting to compare the scores of NCSAM and SQT to see the results of the functional assessments.** Response: WLS appreciates the comment and likes the suggested comparative observation. Although there are similarities between the NC SAM and the SQT assessment methods and functional summaries, our understanding is that NC SAM is intended as a more of a rapid functional assessment and the SQT requires more data collection and analysis in order to determine the restoration potential and associated lift that can be achieved for the project, especially considering site constraints and existing conditions. For example, BB-R3 is scored medium primarily because of existing buffer vegetation and limited cattle access at the lower portion of the reach; similarly, UT1-R2 is the longest stretch of Enhancement II and scored medium with a wooded buffer and cattle access.

**9. Table 14: The wetland comments section does not distinguish the difference between the different levels of work being performed on wetland rehabilitation versus re-establishment. For example, the work performed is the same for W1 and W1A, but they're receiving different credit ratios.** Response: Soil manipulation has been added to the re-establishment wetlands. The work being performed on both proposed wetland areas is very similar, however the credit ratios, are different because the wetland rehabilitation areas are jurisdictional wetlands (poorly functioning), while the re-establishment areas contain favorable hydric soils for wetland re-establishment. Both wetland types will receive similar levels of work.

**10. Table 21: Considering the inclusion of riparian wetlands proposed for this site, it would be beneficial to add additional FACW species to the overstory and understory list.** Response: WLS agrees with this comment and Table 21 has been adjusted to include additional FACW species.

**11. Ephemeral/vernal pools should be 8-14" depressions that dry up yearly so that predatory species cannot colonize, and should not be so numerous that trees do not grow in large areas of the buffer.** Response: WLS agrees with this comment and the vernal pools/floodplain depressions will not exceed 8-14" deep as suggested. We have revised our channel plug detail to reflect this intent. Annotations within the design plan sheets will further emphasize the size and depth of the floodplain depressional feature to prevent overly deep pools resulting in stagnant water conditions that prevent tree growth. WLS has corresponded with WRC on past projects to better define the definition, spatial distribution and function of vernal pool ecology as it relates to floodplain depressions in the riparian zone. These are generally intended as floodplain features such as meander scars and tree throws are commonly found in natural riparian systems. These features are appropriately added to provide additional habitat and serve as water storage and sediment sinks throughout the riparian corridor.

**12. Please show the location of the rain gauge and fixed photo points on Figure 10. If cross-sections are to be used for photo points, please indicate in the text. Additionally, it would be helpful to have photo points at crossings to show the condition of the culverts.** Response: The rain gauge has been added to Figure 10. There are no fixed photo points proposed for stream monitoring as WLS opted to install flow gauges instead on those reaches. Cross-sections and vegetation plots will be used as photo points. This language was already in Section 8.2.2, but has also been added to Section 8.1 Visual Monitoring. WLS has added crossing photo points for culverts to Figure 10.

**13. Please show the location of the reference wetland on Figure 11.** Response: Please see DWR response comment #8. The reference wetland 'W8' location has been added with coordinates as an insert to Figure 11.

**14. I'm glad to see the inclusion of water quality and benthic monitoring. Are these reaches proposed for additional credit? If so, please add this to Table 1. Also, please add the monitoring locations to Figure 10.** Response: WLS appreciate this comment, however, these reaches are not proposed for additional credit. WLS is conducting this monitoring independent of credit determination to improve our project implementation and document potential functional uplift. This additional monitoring is not tied to success criteria and the two locations have been added to Figure 10.

***USEPA Comments, Todd Bowers:***

**I have completed my review for the Banner Branch wetland and stream mitigation site. I have no site-specific comments to submit at this time.** Response: Noted and thanks.

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

Sincerely,

**Water & Land Solutions, LLC**

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# 1 Project Introduction

The Banner Branch Mitigation Project ("Project") is a North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) full-delivery stream and wetland mitigation project, contracted with Water & Land Solutions, LLC (WLS) in response to RFP 16-007405. The Project will provide stream and wetland mitigation credits in the Roanoke River Basin (Cataloging Unit 03010103). The Project is located in Stokes County approximately five miles northeast of Lawsonville at 36.525421° North and -80.203265° West. The project site is in NCDEQ Sub-basin 03-02-01, Roanoke River Basin Restoration Priority Plan (RBRP, amended 2015), and Targeted Local Watershed 03010103180010 (Warm Water Thermal Regime), all within the Roanoke River Basin (Figure 1).

The Project will involve the restoration, enhancement, preservation and permanent protection of fourteen stream reaches and their riparian buffers, totaling approximately 15,707 linear feet of streams and 6.18 acres of riparian wetlands. 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 – Stream and Wetland*

| Project Component | Type of Mitigation (Priority Level) | Creditable Units (LF) | Mitigation Ratio | Stream Mitigation Credits (SMCs) |
|---|---|---|---|---|
| **UT1-R1 (upper)** | Stream Enhancement Level I | 373 | 1.5:1 | 248.667 |
| **UT1-R1 (lower)** | Stream Preservation | 136 | 10:1 | 13.600 |
| **UT1-R2** | Stream Enhancement Level II | 1,783 | 2.5:1 | 713.200 |
| **UT1-R3** | Stream Preservation | 822 | 10:1 | 82.200 |
| **UT1A** | Stream Enhancement Level II | 410 | 2.5:1 | 164.000 |
| **UT1B (upper)** | Stream Enhancement Level II | 391 | 2.5:1 | 156.400 |
| **UT1B (lower)** | Stream Enhancement Level I | 97 | 1.5:1 | 64.667 |
| **UT1C (upper)** | Stream Preservation | 69 | 10:1 | 6.900 |
| **UT1C (lower)** | Stream Restoration (PI/PII) | 151 | 1:1 | 151.000 |
| **UT2** | Stream Restoration (PI) | 1,287 | 1:1 | 1,287.000 |
| **UT2A** | Stream Enhancement Level I | 289 | 1.5:1 | 192.667 |
| **UT3** | Stream Restoration (PI) | 589 | 1:1 | 589.000 |
| **BB-R1** | Stream Restoration (PI) | 808 | 1:1 | 808.000 |
| **BB-R2** | Stream Restoration (PI) | 1,835 | 1:1 | 1,835.000 |
| **BB-R3** | Stream Restoration (PI/PII) | 636 | 1:1 | 636.000 |
| **UT4-R1 (upper)** | Stream Restoration (PI/PII) | 2,346 | 1:1 | 2,346.000 |
| **UT4-R1 (lower)** | Stream Restoration (PI) | 1,730 / 233 | 1:1/1.25:1 | 1,916.400 |
| **UT4-R2** | Stream Enhancement Level I | 1,722 | 1.5:1 | 1,148.000 |
| **Totals** | | **15,707** | | **12,358.700** |

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

*Note 2: Credit values in table were rounded to 3rd decimal place.*

*Note 3: 233 LF of UT4-R1 (lower) credited at 1.25:1*

| Project Component | Type of Mitigation (Priority Level) | Creditable Units (AC) | Mitigation Ratio | Riparian Wetland Mitigation Credits (RWMCs) |
|---|---|---|---|---|
| **W1** | Wetland Enhancement | 0.825 | 2:1 | 0.413 |
| **W1A** | Wetland Re-establishment | 1.240 | 1:1 | 1.240 |
| **W2** | Wetland Enhancement | 0.524 | 2:1 | 0.262 |
| **W3** | Wetland Rehabilitation | 0.888 | 1.5:1 | 0.592 |
| **W4** | Wetland Enhancement | 0.321 | 2:1 | 0.161 |
| **W4A** | Wetland Re-establishment | 0.808 | 1:1 | 0.808 |
| **W5** | Wetland Enhancement | 0.203 | 2:1 | 0.102 |
| **W5A** | Wetland Enhancement | 0.097 | 2:1 | 0.048 |
| **W5B** | Wetland Enhancement | 0.010 | 2:1 | 0.005 |
| **W6A** | Wetland Rehabilitation | 0.251 | 1.5:1 | 0.167 |
| **W6B** | Wetland Enhancement | 0.045 | 2:1 | 0.022 |
| **W7** | Wetland Enhancement | 0.041 | 2:1 | 0.020 |
| **W8A** | Wetland Re-establishment | 0.107 | 1:1 | 0.107 |
| **W9** | Wetland Re-establishment | 0.823 | 1:1 | 0.823 |
| **Totals** | | **6.182** | | **4.770** |

Banner Branch and its unnamed tributaries flow to Snow Creek, which flows to the Dan River before eventually draining to the Roanoke River. Banner Branch is listed by the NCDEQ Division of Water Resources as ‘C’ from its source to Snow Creek. 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 Banner Branch, which will provide maximum ecological uplift using a comprehensive watershed approach.

# 2 Watershed Approach and Site Selection

In an effort to update its watershed planning process, DMS amended the original 2001 Roanoke RBRP in 2009, 2015, and 2018. The purpose of the recent amendment was to reevaluate the existing TLWs and current mitigation strategies to offset ecological impacts (e.g. cattle accessing streams, deforested buffers) and provide conservation and restoration recommendations to improve riparian management within the TLWs and Eden Area Local Watershed Plan (LWP). The project recommendations and measures include traditional stream and wetland mitigation, water quality and aquatic habitat improvements, nutrient reduction strategies, including stormwater and agricultural BMPs, and rare, threatened, or endangered (RTE) aquatic species habitat preservation or enhancement (DMS, 2018).

The project is situated in the Dan River headwaters in the Northern Inner Piedmont (Level III Ecoregion) in the westernmost portion of the Roanoke, where the NC Wildlife Resources Commission (NCWRC) considers this HU as a priority area for conservation measures. The USGS 2011 National Land Cover Data (NLCD) GIS Dataset 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 two percent and the dominant land uses are pasture lands (predominantly for hay and cattle), agricultural row crop production (i.e. tobacco) and mixed forest.

As recommended in the Roanoke RBRP, this project provides the ideal opportunity to implement water quality improvement features and agricultural BMPs, or combinations of land management practices and conservation measures. Collectively with the stream restoration, riparian wetland restoration, and riparian buffer restoration, erosion/sedimentation, nutrients and fecal coliform bacteria will be reduced as major stressors to water quality and habitat.

This 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 information 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 understood 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** | Banner Branch Mitigation Project |
| **County** | Stokes |
| **Project Area (acres)** | 40.87 |
| **Project Coordinates (latitude and longitude)** | 36.525421° N, -80.203265° W |

**Project Watershed Summary Information**

| | |
|---|---|
| **Physiographic Province** | Piedmont |
| **River Basin** | Roanoke |
| **USGS Hydrologic Unit** | 03010103180010 |
| **DWR Sub-basin** | 03-02-01 |
| **Project Drainage Area (acres)** | 563 (BB-R3) and 224 (UT4-R2) |
| **Project Drainage Area Percentage of Impervious Area** | <2 |
| **CGIA Land Use Classification** | 2.01.03, 3.02 (50% pasture/hay, 48% mixed forest) |

**Reach Summary Information**

| **Parameters** | UT1-R1 | UT1-R2 | UT1-R3 | UT1A | UT1B | UT1C | UT2 |
|---|---|---|---|---|---|---|---|
| **Length of reach (linear feet)** | 535 | 1,872 | 861 | 410 | 391 | 227 | 1,347 |
| **Valley confinement (Confined, moderately confined, unconfined)** | moderately confined | moderately confined | moderately confined | moderately confined | moderately confined | moderately confined | confined |
| **Drainage area (acres)** | 41.2 | 135 | 166.4 | 4.6 | 41.6 | 15.8 | 28.3 |
| **Perennial, Intermittent, Ephemeral** | Perennial | Perennial | Perennial | Intermittent | Intermittent | Intermittent | Perennial/ Int[1] |
| **NCDWR Water Quality Classification** | C | C | C | C | C | C | C |
| **Stream Classification (existing)** | G4c/B4c | F4 | E4 | G5 | E5 | F4 | F4 |
| **Evolutionary trend (Simon)** | II/III | V/VI | V/VI | VI | III | I | III/IV |
| **FEMA classification** | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

**Reach Summary Information continued…**

| Parameters | UT2A | UT3 | BB-R1 | BB-R2 | BB-R3 | UT4-R1 | UT4-R2 |
|---|---|---|---|---|---|---|---|
| Length of reach (linear feet) | 289 | 338 | 986 | 2,118 | 478 | 4,686 | 1,742 |
| Valley confinement | moderately confined | unconfined | unconfined | unconfined | unconfined | unconfined | unconfined |
| Drainage area (acres) | 3.1 | 76.8 | 409.6 | 480.0 | 563.2 | 153.6 | 224.0 |
| Perennial, Intermittent, Ephemeral | Intermittent | Perennial/ Int[1] | Perennial | Perennial | Perennial | Perennial/ Int[1] | Perennial |
| NCDWR Water Quality Classification | C | C | C | C | C | C | C |
| Stream Classification (existing) | B4a | E5 (incised) | B4c | E4 (incised) | E4 (incised) | B4c/F4 | E5 |
| Evolutionary trend (Simon) | III | II/III | IV | IV/V | IV | IV/V | III/IV |
| 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 | No | PCN |
| Water of the United States - Section 401 | Yes | No | PCN |
| Endangered Species Act | Yes | Yes | Categorical Exclusion |
| Historic Preservation Act | Yes | Yes | Categorical Exclusion |
| Coastal Zone Management Act (CZMA or CAMA) | No | N/A | N/A |
| FEMA Floodplain Compliance | No | N/A | Appendix 12 |
| Essential Fisheries Habitat | No | N/A | N/A |

*Note 1: Indicates that the lower section of the reach was classified as perennial and upper stream reach was classified as intermittent.*

*Note 2: Reach lengths include existing stream through proposed crossing locations.*

## 3.1 Watershed Processes and Resource Conditions

### *3.1.1 Watershed Overview*

Spatial and temporal variability of hydrologic and geomorphic processes have influenced the overall system response and stability trends in many 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*

Banner Branch is a Class C water (Stream Index 22-20-1) “from source to Snow Creek”. 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’.

### *3.1.3 Aquatic Resource Health and Function*

WLS reviewed DWR biological and water quality data within the Banner Branch watershed to identify any potential stressors near receiving waters. Currently, no DWR water quality monitoring stations, or benthic or fish monitoring stations exist in 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, in situ sediments that have deposited over time can often have longer transport times and structural 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 BB-R3 and Site 2 along UT4-R2) within the proposed project area. The sample number and locations were selected based on stream condition, watershed position and 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 October 2, 2019 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 using the Qual 4

Sampling Method and the Unrated Small Stream threshold criteria. Samples were verified by Larry Eaton (Eaton Scientific, LS, Inc.). Sample Site 1 had a Biotic Index (BI) value of 5.94 resulting in a bioclassification rating of “Not Rated”. Site 1 had a habitat assessment score of 71. Sample Site 2 had a BI value of 6.65 resulting in a bioclassification rating of “Not Rated”. Site 2 had a habitat assessment score of 64. The BMI diversity was greater in Sample Site 1 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*

***STEPL Model:*** WLS utilized the Spreadsheet Tool for Estimating Pollutant Loads (STEPL v4.3, 2015) to help quantify how the project may reduce pollutant loads into the Banner Branch Watershed. The STEPL model was developed for the United States Environmental Protection Agency (USEPA, Tetra Tech, 2015) and was used to estimate sediment and nutrient load reductions from the implementation of agricultural BMPs, such as vegetated filter strips, wetland detention, and bank stabilization/stream restoration. Model inputs include land use information, Revised Universal Soil Loss Equation (USLE)/runoff curve numbers, eroded streambank length, streambank height, lateral recession rates, soil type/weight, and BMP type/efficiency applicable to the agricultural Piedmont area. The summary of total annual pollutant loadings and removal estimates are shown Table 3 below.

***Table 3. Total Annual Pollutant Loadings and Removal Estimates from STEPL 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, %) |
|---|---|---|---|---|---|---|---|---|
| 788 | 16,190 | 7,700 | 838.3 | 27,458.8 | 5,831.8 | 531.5, 63.4% | 5,644.1, 20.6% | 1,296.5, 22.2% |

*Note 1: Soil Texture Class is predominantly loam, sandy clay loam.*
*Note 2: Average Bank heights in scour areas ranged 1 to 4 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 STEPL 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 September 17th and 18th, 2019. The BEHI/NBS estimates for the existing conditions (pre-construction) predict that the project reaches contribute approximately 453.6 tons of sediment per year to Snow Creek. The BEHI ratings varied across the project reaches from 'very low' to 'very high' based on shear stress, stream bed/bank stability and controlling vegetation. UT4-R1, UT4-R2, BB-R1, BB-R2, BB-R3 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) |
|---|---|---|---|
| **UT1-R1** | Very Low/Low-Moderate | Very Low/Moderate | 5.1 |
| **UT1-R2** | Very Low/Moderate | Very Low/High | 11.5 |
| **UT1-R3** | Very Low/Moderate | Very Low/Moderate | 6.2 |
| **UT1A** | Very Low/Low | Very Low/Low | 0.7 |
| **UT1B** | Very Low/Moderate-High | Very Low/Moderate | 5.6 |
| **UT1C** | Very Low/Moderate-High | Very Low/Moderate | 2.8 |
| **UT2** | Low/Moderate | Very Low/High | 14.4 |
| **UT2A** | Very Low/Moderate | Low/Moderate | 0.5 |
| **UT3** | Moderate | Very Low | 3.3 |
| **BB-R1** | Very Low/High | Very Low/High | 57.6 |
| **BB-R2** | Low/High | Low/High | 76.1 |
| **BB-R3** | Low/High | Low/High | 93.1 |
| **UT4-R1** | Very Low/High | Very Low/Very High | 128.7 |
| **UT4-R2** | Very Low/High | Low/High | 48.0 |

*Note 1: The lower portion of UT1B and upper UT3 was not assessed due to poor channel definition and limited erosion potential.*

***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 Banner Branch 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 68% as shown on Table 5.

*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] |
|---|---|---|---|---|---|
| 37.9 | 27.0 | 1,378.1 | 114.2 | 2.81E+12 | 1.67E+12 |

*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 ~300 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 ~68 for a 2yr/ 24hr 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 Banner Branch and its tributaries. WLS will conduct pre- and post-restoration water quality sampling and bank erosion/sediment loading analyses (i.e. BEHI) to document improvements related to pollutant load reductions as described in Section 8 and Table 23. *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. 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 area is located north of the Sauratown Mountains and Pilot Mountain monadnock which represents a unique ecotonal transitional zone between Piedmont and Mountain Level III/IV Ecoregions. The underlying geology and metamorphic terrane within the project area is located in the Piedmont geologic province east of the Blue Ridge Mountains. The Brevard fault zone is considered the boundary between the Blue Ridge and Inner Piedmont Belts. More specifically, the project area is located in the foothills of Northern Inner Piedmont and consist of both banded gneiss (*CZbb*) formation interlayered with calc-silicate rock, metaconglomerate, amphibolite, sillimanite-mica schist, granitic rock, and micas schist (*CZms*) interlayered with garnet, staurolite, kyanite, or sillimanite occur locally; lenses and layers of quartz schist, and micaceous (Geologic Map of North Carolina, NCGS, 1998). The tributaries and upper reach of Banner Branch are in banded gneiss interlayered with calcium-bearing silicate rock, metaconglomerate, amphibolite, sillimanite-mica schist, and granitic rock. The lower portion of Banner Branch and its headwaters outside of the project is located within a formation of mica schist containing garnet, staurolite, kyanite, or sillimanite occur locally; lenses and layers of quartz schist, micaceous quartzite, calc-silicate rock, biotite gneiss, amphibolite, and phyllite (NCGS, 2009).

### *3.2.2 Soils*

Based on the geology, alluvial soils found within the project contain a wide variety of minerals and textures. Soils generally tend to be well drained, having a loamy surface with predominantly clayey subsoil that formed in weathered felsic and metamorphic and igneous rock (USDA-NRCS 1995). Floodplain soils formed in recent alluvium and have a loamy surface and underlain by loamy or sandy material. Soils at the project site were initially determined using NRCS soil survey data for Stokes County (NRCS Stokes County Soil Survey, 1995). It should be mentioned that the current online Web Soil Survey (NRCS, 2019) data differs from the published Soil Survey of Stokes County because the area was reclassified from a thermic regime to a mesic after publication. The current classification and soil series are the mesic counterparts to the published survey and are used in this report unless otherwise noted. This reclassification does not change the general soil information available or the interpretation of soils for determining the proposed mitigation approach. The soils within the project area were verified during on-site field investigations as described in the detailed soil report in Appendix 2. Figure 4 illustrates NRCS soil series 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 |
|---|---|---|
| Clifford sandy clay loam (CeC2)<br>(4.0% of project area) | No | Well drained Cecil and similar soils found on broad ridges mainly in the northeastern and southwestern parts of the county. Slope ranges from 2 to 8% on landscapes with moderate erosion and are not flooded. The surface layer is typically yellowish red sandy clay loam 8 inches thick. Depth to bedrock is greater than 60 inches. |
| Codorus loam (CsA)<br>(26.4% of project area) | No | Moderately well drained and somewhat poorly drained floodplain soils found on nearly level slopes. Slopes range from 0 to 2%. Surface layer is typically brown silt loam 9 inches thick. Depth to bedrock is more than 6 feet. |
| Dan River and Comus (DaA)<br>(17.9% of project area) | No | Well drained floodplain soils with frequent to occasionally flooding. Fine-loamy, mixed soils on 0 to 4% slopes. Surface layer is typically dark yellowish-brown loam 9 inches thick. Depth to bedrock is greater than 60 inches. |
| Danripple sandy clay loam (DpB2)<br>(0.2% of project area) | No | Well drained sandy clay loam soils found on stream terraces and low hills. Slopes range from 2 to 8% on landscapes with moderate erosion and are not flooded. The surface layer is typically reddish-brown sandy loam 10 inches thick. Depth to bedrock is greater than 60 inches. |
| Fairview-Poplar Forest Complex (FpC2)<br>(9.1% 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. The surface layer is typically brown sandy clay loam 10 4 inches thick and clay subsoil or clay loam underlying material. Depth to bedrock is greater than 80 inches. |

| Soil Name | Hydric | Description |
|---|---|---|
| Fairview-Poplar Forest Complex (FpD2)<br>(42.1% 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. The surface layer is typically brown sandy clay loam 10 inches thick and clay subsoil or clay loam underlying material. Depth to bedrock is greater than 80 inches. |

The soils within the floodplain and riparian areas are predominantly mapped Fairview-Poplar Forest Complex (FpD2), Codorus loam (CsA), and Dan River and Comus (DaA). 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. The soil survey indicates soil within the project area generally has a loamy surface within the floodplain and loam or sandy loam in the uplands. Floodplain soils formed in loamy alluvium derived from igneous and metamorphic rock eroded from the contributing upland areas. These soils are typically underlain by a sandy clay loam that formed in loamy alluvium derived from uplands of igneous and metamorphic rock (on line NRCS Web Soil Survey 2019). The upland soils are underlain by clayey soils and can be shallow to bedrock on the steeper slopes.

Throughout the project, larger floodplains are mapped as either Codorus loam (CsA) or Dan River and Comus soils (Da). The Codorus loam is somewhat poorly drained with inclusion of poorly drained soils. The poorly drained inclusions are rated as hydric by the NRCS. The other floodplain map unit is the mostly well drained Dan River and Comus soils containing a complex of two similar series. Located on the toe and foot slopes along the drainages, the adjacent uplands soil units consist of well drained, moderately eroded Clifton sandy clay loam (CeC2) or Fairview-Poplar Forest complex (FpC2).

In flatter valley sections, it is common to discover legacy sediment and buried hydric soils in floodplains across the mid-Atlantic Piedmont (Jacobson and Coleman, 1986). In this setting and context, legacy sediment or overburden 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). As such, George Lankford, LSS noted regarding these areas that combining hydraulic stream modifications with limited soil removal, if needed, qualifies the Hydric Soil Unit as a candidate for Wetland Re-establishment and/or Rehabilitation.

### *3.2.3 Climate*

The Project site is located in Stokes 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 177 days, beginning on April 21st and ending October 16th (NRCS Stokes County Soil Survey, WETS Station: Danbury, NC). The average annual precipitation in the Project area is approximately 48.05 inches with a consistent monthly distribution, except for convective storm events or hurricanes that occur during the summer and fall months. In late 2018/2019, the area received approximately 63.20 inches of precipitation as shown on WETS Table 7. Over the past 48 months, the Danbury WETS Station has recorded over 199.3 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) |
|---|---|---|---|
| Sep-18 | 10.15* | 5.49 | + 4.66 |
| Oct-18 | 5.93 | 4.75 | + 1.18 |
| Nov-18 | 5.59 | 3.87 | + 1.72 |
| Dec-18 | 6.75 | 4.25 | + 2.5 |
| Jan-19 | 4.93 | 4.67 | + 0.26 |
| Feb-19 | 6.06 | 3.97 | + 2.09 |
| Mar-19 | 2.59 | 5.55 | - 2.96 |
| Apr-19 | 4.20 | 4.62 | - 0.42 |
| May-19 | 1.72 | 5.37 | - 3.65 |
| Jun-19 | 9.91 | 4.71 | + 5.2 |
| Jul-19 | 3.17 | 5.72 | -2.55 |
| Aug-19 | 2.20 | 4.69 | - 2.49 |
| **Sum** | **63.20** | **57.66** | **+5.54** |

*Note: *Hurricane Florence rainfall total in Lawsonville, NC was approximately 5.70" (NOAA, 9/17/18).*

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 Piedmont Headwater Stream Forest (Typic Subtype) in the lower areas and floodplains (Schafale 2012). 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* |
| | Sweet-gum | *Liquidambar styraciflua* |
| | American sycamore | *Plantanus occidentalis* |
| | Green Ash | *Fraxinus pennsylvanica* |
| | White oak | *Quercus alba* |
| **Understory & Woody Shrubs** | Black willow | *Salix nigra* |
| | Silky willow | *Salix sericea* |
| | Ironwood | *Carpinus caroliniana* |
| | Possumhaw | *Viburnum nudum* |
| | American holly | *Ilex opaca* |
| | Hazel alder | *Alnus serrulata* |
| | Elderberry | *Sambucus canadensis* |
| | Eastern red cedar | *Juniperus virginiana* |
| | Chinese privet | *Ligustrum sinense* |
| | Flowering dogwood | *Cornus florida* |
| **Herbaceous & Vines** | Poison ivy | *Toxicodendron radicans* |
| | Japanese stiltgrass | *Microstegium vimineum* |
| | Joe pye weed | *Eutrochium maculatum* |
| | Canada goldenrod | *Solidago canadensis* |
| | Jewelweed | *Impatiens capensis* |
| | Sawtooth blackberry | *Rubus argutus* |
| | 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 hay, fescues, clovers, and some dog fennel. In smaller wooded riparian areas or clusters within the pastures and fields, the canopy is dominated by red maple and yellow-poplar. Understory species consist of Eastern red cedar and flowering dogwood. Woody shrub and vine species include Chinese privet and greenbrier. Herbaceous species consist of goldenrod and soft rush.

***Mixed Hardwood Forest:*** The mature canopy is dominated by red maple, tulip poplar, American sycamore, and sweet gum, but also includes white oak, black willow, and green ash. Woody shrub and vine species include poison ivy, greenbrier, and hazel alder. Herbaceous species include Japanese stiltgrass and Christmas fern.

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

## 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 788-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 UT2, UT2A, UT3, BB-R1, BB-R2, BB-R3, UT4-R1 and UT4-R2.

Prior to the 1990s, most of the watershed was a mixture of forested area and agricultural fields as illustrated on historic aerials (See Figure 7a). By the late 2000s, much of the headwater area remained a mixture of forest and agricultural fields, but an increase in agricultural production was evident in some areas along UT1 and Banner Branch. Over time, the natural stream and wetland processes and aquatic resource functions have been significantly impacted because of these historic anthropogenic disturbances.

## 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 and 7c). 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 60% of the streambanks have inadequate (less than 30 feet wide) riparian buffers. Figure 9 represents recent aerial photography depicting areas with narrow and/or absent riparian buffers throughout the project boundary.

Continuous livestock intrusion and associated hoof shear have severely impacted the streambanks along many of the Project stream reaches. The stream channels are actively incising in these areas 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 fourteen reaches (UT1-R1, UT1-R2, UT1-R3, UT1A, UT1B, UT1C, UT2, UT2A, UT3, BB-R1, BB-R2, BB-R3, UT4-R1, UT4-R2) totaling approximately 16,280 linear feet of jurisdictional stream channels. Reach breaks were based on drainage area at confluences, changes in existing condition, restoration/enhancement approaches, and/or changes in stream status. Field evaluations conducted by WLS during existing conditions assessments determined that Project reaches UT1-R1, UT1-R2, UT1-R3, BB-R1, BB-R2, BB-R3, and UT4-R2 are perennial streams; UT1A, UT1B, UT1C, UT2A, and UT3 were determined to be intermittent streams; and UT2 and upper UT4-R1 were determined to be intermittent streams in the upper stream reach. WLS field 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.

**UT1-R1:** UT1-R1 begins as a small perennial headwater tributary that extends from the upstream boundary of the project site, downstream just beyond the confluence with UT1C. UT1-R1 has an average valley slope of 3.4 percent and drainage area of 41.2 acres.

Based on field observations, depositional patterns and headwater location, sediment supply appears to be limited to finer grained material mostly from bed/bank materials. The channel is moderately incised and entrenched in most locations, however a significant portion of the bed appears to be mostly stable. Bank erosion was observed in a few localized areas. Historic channel manipulation and straightening has led to poor bedform diversity. Mature woody vegetation is present along most of this reach, however cattle had historically unrestricted access which has led to sparse understory vegetation establishment. Based on the existing channel conditions and anthropogenic disturbances, UT1-R1 is classified as 'G4c/B4c' stream type throughout most of its length.

***Photo of UT1-R1 showing straightened channel conditions.***

**UT1-R2:** UT1-R2 begins downstream of UT1C and flows to an existing culvert crossing. The valley slope is approximately 2.1 percent, and the drainage area is 135 acres. UT1-R2 appears to be relatively stable, with minimal bank erosion present and bank height ratios ranging from 1.2 to 1.7. The sinuosity is moderate and appropriate for the valley setting. Excess sediment was observed within the channel and adjacent floodplain as a result of a historic man-made impoundment and partially blocked culvert further downstream.

*Looking upstream at cattle wallowing area along UT1-R2.*

UT1-R2 appears to have been historically manipulated and cattle have unrestricted access to the entire reach. The riparian buffer consists of a marginal understory with some large trees within the floodplain; any trees of significance will be saved and incorporated as part of the enhancement design. Based on the existing conditions and large gravel/small cobble materials combined with finer gravel materials near the crossing, UT1-R2 is classified as a 'F4' stream type.

**UT1-R3:** UT1-R3 begins downstream of an existing culvert crossing. Along this reach, the degree of incision is low, with bank height ratios near 1.2. However, UT1-R3 has not experienced historic cattle intrusion and associated trampling for most of its length.

*Photo depicts stable stream channel conditions and in-stream habitat along UT1-R3.*

The existing stream appears to be located in the center of the valley and has a sinuosity of approximately 1.3. The valley slope is near 1.2 percent, and the drainage area is 166.4 acres. Localized stream bank erosion was observed throughout the reach, although the stream appears to have a natural floodplain connection and lateral instability does not appear systemic. The entire reach is subject to active water quality stressors, mainly resulting from upstream bank erosion and sediment inputs. Based on the existing conditions and medium gravel substrate, UT1-R3 is classified as an 'E4' stream type.

BB-R1 looking downstream. Note the lack of adequate riparian buffer along the left floodplain.

**BB-R1:** Banner Branch (BB) is a named tributary that begins to the east of the project area before its confluence with BB-R1 and UT1-R3. The upstream channel condition of BB is slightly incised, however the bed and banks are mostly stable and sediment supply is limited to coarse sand and fine gravel. The upper BB watershed has experienced minimal disturbances in the recent past and a mature canopy of vegetation exists across riparian buffer area. BB-R1 begins at UT1-R3 to its confluence with UT2. BB-R1 has a valley slope of 1.1 percent and a drainage area of 409.6 acres. The reach appears to be laterally unstable, with bank erosion present and bank height ratios greater than 1.2. BB-R1 is exposed to cattle intrusion and fecal coliform bacteria along its entire length and the riparian buffer is limited to herbaceous vegetation with a few small woody trees along its banks. BB-R1 is subject to water quality stressors, mainly in the form of cattle access, excess sediment and minimal riparian buffer widths. Based on the existing channel conditions and anthropogenic disturbances, this reach is classified as a 'B4c' stream type.

Looking downstream at BB-R2. Cattle have unrestricted access to this entire reach.

**BB-R2:** Similar to BB-R1, BB-R2 continues as a perennial tributary that has lost its historic floodplain function and has an average bank height ratio of 1.5. BB-R2 has a drainage area of 480 acres, and the valley slope is approximately 0.9 percent. The entire reach is subject to active water quality stressors, mainly resulting sediment inputs from bank erosion, hoof shear from unrestricted cattle access and riparian buffers less than 30 feet in width. Cattle intrusion and lateral bank erosion has also degraded aquatic habitat. Based on the existing channel conditions and historic anthropogenic disturbances, BB-R2 was classified as an incised 'E4' stream type.

**BB-R3:** BB-R3 continues south from BB-R2 and has a drainage area of approximately 563.2 acres near its confluence with the UT4-R2 stream system. The channel is laterally unstable along the entire reach with native woody riparian buffer vegetation corridor greater than 30 feet on both sides of the channel. The valley slope is 0.6 percent along this reach, bank erosion is moderate, and most excess scour is located along the meander bends. The valley floor widens and flattens in this area, however the stream has lost connection to its relic floodplain.

*Looking at unstable conditions along BB-R3. Note the lateral bank erosion and lack of deep rooting vegetation.*

Cattle do not currently have direct access to this reach, however the area was historically disturbed for agricultural use. The representative bank height ratio is 1.4, and the channel is classified as a 'E4' stream type. The reach is subject to active water quality stressors, mainly resulting from excess nutrient and sediment inputs flowing from upstream project reaches.

**UT1A:** UT1A begins at a spring and flows south towards UT1-R1. The valley slope is approximately 2.9 percent and the drainage area is 4.6 acres. UT1A appears to be slightly incised and entrenched, with minimal bank erosion present and a bank height ratio of 1.3. Throughout UT1A, floodplain alterations were observed, mainly evidenced in the form of spoil piles and an access path along the upper portion. Portions of the stream also appear to have been historically manipulated. Cattle have unrestricted access to this stream reach and the riparian buffer is narrow (<30 feet) throughout its entire length. Based on the existing conditions and coarse gravel/small cobble, UT1A is classified as a 'G5' stream type.

*Looking upstream at degraded channel conditions along upper UT1B.*

**UT1B:** UT1B is a small intermittent headwater tributary that begins at a spring head within the upper catchment. The channel flows west to its confluence with UT1-R2. UT1B has a small drainage area of approximately 42 acres. UT1B has experienced cattle trampling for most of its length and the buffer consists of herbaceous vegetation with a few mature trees and a limited understory.

UT1B is actively subject to water quality stressors, mainly in the form of cattle access and fecal coliform bacteria. The reach condition is mostly stable and improves as the valley slope flattens, however, aggradation was observed in the lower section due to a remnant ponding area upstream of the culvert crossing. As a result, the channel loses consistent bed and bank features in this area. The stream and wetland complex will continue to degrade further if not addressed during the restoration design.

**UT1C:** UT1C jurisdictional flow originates near a property line and flows east before its confluence with UT1-R2. The valley slope is approximately 5.5 percent and the drainage area is 15.8 acres. Cattle do not have access to this reach, and according to the landowner, the stream in this area has not been disturbed and is located in its natural valley. A severe headcut was observed in the lower portion of the reach, but a majority of the reach is stable, and undisturbed riparian buffers greater than 30 feet in width along the entire streambanks. Based on the step-pool morphology and gravel/small cobble substrate, upper UT1C is classified as a 'B4' stream type and lower UT1C is classified as a 'F4'.

***Photo depicts degraded stream channel conditions along lower UT1C near an active headcut.***

**UT2:** UT2 begins at a spring and flows southeast to its confluence with BB-R1 and BB-R2. The valley slope is approximately 3.9 percent and the drainage area is 28 acres. According to the landowner, the headwater stream in this area has been a water and shade source for cattle for decades. In this section, the bedform diversity is poor and the degree of incision is low to moderate, with bank height ratios ranging from 1.0 to 2.0. UT2 is subject to water quality stressors, mainly in the form of fecal coliform bacteria from cattle access, excess sediment and marginal riparian buffer widths. Based on the existing channel conditions and historic disturbances, this reach is classified as an incised 'F4' stream type.

***Photo depicts degraded stream channel conditions and lack over buffer vegetation along UT2.***

**UT2A:** UT2A is a small intermittent headwater tributary that begins at a spring head within the upper catchment. The channel flows south to its confluence with UT2. UT2A has a very small drainage area of approximately 3.1 acres and a valley slope of 5.5 percent. UT2A has experienced severe cattle trampling throughout its length and the buffer is limited to herbaceous vegetation with a mix of understory and larger woody trees. UT2A is actively subject to water quality stressors, mainly in the form of fecal coliform bacteria from cattle access and marginal riparian buffer widths. This reach is classified as a 'B4a' stream type. The channel condition is mostly stable, however, the stream will continue to degrade further if not addressed during the restoration design.

*Photo of UT3 showing a straightened channel conditions and lack of riparian buffer vegetation.*

**UT3:** UT3 begins as a small perennial headwater tributary that extends from the upstream boundary of the project site. UT3 has an average valley slope of 1.1 percent and drainage area of 76.8 acres.

Based on field observations and headwater location, the channel appears to have been historically ditched in two locations in an attempt to drain surface hydrology for agricultural use. The channel is slightly incised and bank erosion was observed in a few localized areas. The historic channel manipulation and straightening has led to poor bedform diversity. Mature woody vegetation is absent along most of this reach, however cattle do not currently have direct access which has led to growth of sparse understory vegetation. Based on the existing channel conditions and anthropogenic disturbances, UT3 is difficult to classify and resembles an incised 'E5' stream type throughout most of its length.

**UT4-R1:** UT4-R1 begins as a small perennial headwater tributary that extends from the upstream boundary of the project site. UT4-R1 has a valley slope of 1.7 percent and a drainage area of 154 acres. The reach is laterally unstable, with severe bank erosion present and bank height ratios greater than 2.0.

UT4-R1 is exposed to cattle intrusion along its entire length and the riparian buffer is limited to herbaceous vegetation with a few small woody trees along its banks. UT4-R1 is subject to water quality stressors, mainly in the form of fecal coliform bacteria from cattle access, excess sediment and minimal riparian buffer widths. Based on the existing channel conditions, this reach is classified as a 'B4c/F4' stream type.

*UT4-R1 looking downstream. Note the lack of adequate riparian buffer degraded channel conditions.*

***Looking downstream at UT4-R2. Cattle have unrestricted access to this entire reach.***

**UT4-R2:** Similar to UT4-R1, UT4-R2 continues as a perennial tributary that has lost its historic floodplain function and experiencing degraded stream and wetland conditions. UT4-R2 has a drainage area of 224 acres. The natural valley slope is approximately 1.4 percent has an average bank height ratio of 1.3.

The entire reach is subject to active water quality stressors, mainly resulting sediment inputs from bank erosion, hoof shear from unrestricted cattle access and riparian buffers less than 30 feet in width. Cattle intrusion and lateral bank erosion has also degraded aquatic habitat. Based on the existing channel conditions and historic anthropogenic disturbances, UT4-R2 was classified as an incised 'E4' stream type.

### *3.4.2 Channel Morphology and Stability Assessment*

WLS conducted geomorphic and ecological assessments for the Project reaches to assess the current stream channel condition and overall lateral and vertical stability. Data collection included 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 generally 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 1.0 (upper UT1C) to greater than 2.0 (BB-R1). BHR values greater than 1.5 typically indicate the stream channel is disconnected from its geomorphic 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 1.3 (UT4-R2) to greater than 7.5 (BB-R2) 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) |
|---|---|---|---|---|---|---|---|
| UT1-R1 | 41.2 | 2.5 | 8.1 | 1.4 | 1.27 | 0.0270 | 8.66 |
| UT1-R2 | 135.0 | 1.4 | 18.9 | 1.8 | 1.56 | 0.0155 | 11.86 |
| UT1-R3 | 166.4 | 2.0 | 9.3 | 2.0 | 1.31 | 0.0093 | N/A |
| UT1A | 4.6 | 1.2 | 9.5 | 3.5 | 1.15 | 0.0252 | N/A |
| UT1B | 41.6 | 2.6 | 11.1 | 1.0 | 1.18 | 0.0251 | N/A |
| UT1C (upper) | 15.0 | 1.9 | 11.6 | 2.0 | 1.10 | 0.0497 | 0.11 |
| UT1C (lower) | 15.8 | 1.5 | 7.5 | 5.3 | 1.10 | 0.0497 | 0.11 |
| UT2 | 28.3 | 1.2 | 30.9 | 1.0 | 1.14 | 0.0341 | 32.00 |
| UT2A | 3.1 | 1.3 | 23.3 | 4.9 | 1.20 | 0.0455 | N/A |
| UT3 | 76.8 | 5.7 | 5.1 | 1.4 | 1.03 | 0.0105 | N/A |
| BB-R1 | 409.6 | 1.8 | 13.6 | 1.2 | 1.34 | 0.0080 | 11.44 |
| BB-R2 | 480.0 | 6.8 | 9.0 | 1.5 | 1.31 | 0.0071 | 11.44 |
| BB-R3 | 563.2 | 3.5 | 9.7 | 1.4 | 1.15 | 0.0053 | 20.14 |
| UT4-R1 (upper) | 102.4 | 1.5 | 11.8 | 1.5 | 1.23 | 0.0185 | 6.69 |
| UT4-R1 (lower) | 153.6 | 1.3 | 17.8 | 2.3 | 1.23 | 0.0185 | 4.73 |
| UT4-R2 | 224.0 | 3.7 | 10.5 | 1.2 | 1.21 | 0.0112 | 0.18 |

*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: Representative cross-section locations are shown on Figure 6, Current Conditions Map.*
*Note 3: Geomorphic parameters are based on best professional judgment and field measurements.*
*Note 4: Additional values and dimensionless ratios for meander geometry and facet slopes are provided in Appendix 2. The existing 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 0.4 to 5.0 percent and channel sinuosity's range from 1.03 to 1.56. Most of the vertical grade control along the project reaches appears to be provided by infrequent vegetation root mass, bedrock outcrops, and culverted or ford stream crossings. The surveyed longitudinal profiles indicate active headcutting in some reach locations. 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.

***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 for all project reaches. The Project reach scores ranged from ‘low’ to ‘medium’ to ‘high’. Reaches BB-R1, BB-R2, UT1-R2, UT1A, UT2, UT2A, UT3, UT4-R1, and UT4-R2 scored ‘low’ due to unstable channel and bank conditions, buffer and water quality stressors from cattle access, and altered stream morphology. Reaches BB-R3, UT1B, and UT1-R1 scored ‘’medium” because of improved aquatic habitat, substrate and marginal buffer widths. UT1C upper and UT1-R3 scored high because of the stable channel conditions and mature riparian buffer vegetation along both stream banks.

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. See Appendix 8 for NC SAM rating forms.

### *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 proposed for restoration currently exhibit positive trends towards stability or quasi-equilibrium.

Many of the unstable Project reaches vary between Class ‘III’ and ‘IV’ of the CEM as evidenced by migrating headcuts and oversized channels which will likely continue to degrade and/or widen. BB-R2 and BB-R3 are transitioning from Class ‘IV’ to Class ‘V’ as evidenced by channel widening and excess sediment aggradation. Reaches UT2 and lower UT4-R1 are transitioning from Class ‘II’ to Class ‘III’ resulting from active downcutting. Portions of UT1-R1, UT1-R3 and upper UT1C are stable classified as Class ‘I’. The proposed design 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 the Project stream reaches. Representative bed materials were sampled for the existing streams and consist of predominantly medium to coarse gravel, with some small cobble and fine sand materials. Much of the parent material, which contains fine/medium gravel particle sizes, are mostly buried and still evident in some of the bank profiles in the degraded stream reaches. Field investigations suggest that the sediment supply is being recruited predominantly from streambank erosion along the project stream reaches and upland erosion across adjacent agricultural fields. The streambank erosion along the project stream reaches appears to be delivered during episodic storm flows within the headwater drainages resulting from cattle hoof shear and influences from limited understory vegetation and rotational crop cover.

Over the past few decades, the removal of woody riparian 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 reducing stream bank erosion will facilitate positive adjustments to sediment routing and storage across the reconnected floodplains.

### *3.4.5 Jurisdictional WOTUS*

WLS and George Lankford 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. Determination methods for stream classification utilized the NCDWQ Stream Identification Form (v4.11).

The field investigations were completed during March 2018 and September 2019. The results of the on-site field investigations conducted by WLS and George Lankford indicate that the Project reaches were determined to be jurisdictional stream channels. In addition, ten jurisdictional wetland areas (totaling 3.89 acres) were delineated within the Project area (Figure 6 and Appendix 9). WLS submitted a preliminary jurisdictional determination (PJD) application package to the USACE in November 2019 and a site visit was conducted on February 12th, 2020. The final PJD was issued on February 13th, 2020 is provided 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 PCN 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.

### 3.5.2 *Utility Corridors within the Site*

There are no existing utility crossings within 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.

### 3.5.6 *Potential Future Land-Use*

Future site constraints include, but are not limited to development, silviculture, and infrastructure maintenance. Historic aerial imagery indicates that the Project has been used extensively for agricultural purposes. The surrounding areas remain in an agricultural community with some neighboring forested property. Due to low development potential, the area will likely remain in agricultural use. While there are some forested areas surrounding the project area, they are not extensive enough for silviculture or logging operations. The project area is not adjacent to any roads that might need future maintenance. Project reaches were designed to be self-maintaining and resilient in a dynamic landscape. Riparian buffers in excess of 30 feet in many areas of the project will protect the project reaches from changes in watershed hydrologic regimes.

### 3.5.7 *Stream Crossings*

There are currently six stream crossings with easement breaks proposed across the project area. WLS coordinated with the landowners to accommodate current farm operations and future access if the property was ever sold or subdivided. The impacts are considered minimal and account for 1.5% of the total stream length to be permanently protected in the conservation easement as a result of the project.

## 3.6 Existing Wetland Conditions

Detailed soil mapping, conducted by a licensed soil scientist (George Lankford, LSS), determined that degraded jurisdictional wetlands are present within the stream valleys. On-site streams were manipulated and/or deepened and groundwater elevations were altered such that many of the historic riparian wetland functions along the floodplain were drained and lost. These areas have been utilized for pasture and agriculture (row crop) production over the past few decades and have lost their historic wetland function. These headwater stream valleys were mapped as containing Type 'A' hydric soils, have a presence of soil organics, and retain water following precipitation events. It was observed throughout the Project that there are buried hydric soils and degraded riparian wetlands in the floodplain.

As a result of past ditching activities, cattle intrusion and subsequent groundwater and hydrology impacts, these areas are not currently considered to be existing jurisdictional wetlands. Some areas within the Project site that have not been timbered or where stream sections are not modified maintain the presence of jurisdictional wetlands. Based on assessment of the on-site water features, there are multiple existing wetland systems identified within the Project site boundaries. On-site wetlands have been delineated (flagged) and the PJD was submitted in November 2019.

***NC WAM:*** WLS completed wetland evaluations of the Project wetlands using the *NC Wetland Assessment Method* (NC WAM, Version 5, 2016) developed by the NC Wetland Functional Assessment Team (WFAT). The purpose of NC WAM 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 wetlands within North Carolina. NC WAM 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 wetland characteristics and functions for the regulatory review process. WLS evaluated the NC WAM metrics relevant to the project wetlands, as shown in Appendix 8. The metrics were documented to evaluate various wetland functions. The Project wetland scores ranged from ‘low’ to ‘high’. Wetlands 1 and 6A scored ‘low’ due to altered hydrologic connectivity, water quality, and habitat. Wetland 3 scored ‘’medium” because of altered hydrologic condition and habitat. Wetlands 2, 4, 5A, 5B, 7 and 8 scored high. These 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 wetland ecological conditions and functional ratings, however, these methods are not intended to be used for determining mitigation success on constructed stream and wetland sites.

# 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). 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 |
| Geomorphology (Level 3) | Bank Migration/Lateral Stability | Meander Width Ratio |
| | | Percent Streambank Erosion |
| | Riparian Vegetation | Left Buffer Width (ft) |
| | | Right Buffer Width (ft) |
| | Bed Form Diversity | Pool Depth and Spacing Ratio |
| | | Percent Riffle and Pool |
| | Sinuosity | Planform |
| | Channel Evolution | Simon Channel Evolution Model |
| Physicochemical (Level 4) | Specific Conductance | Percent Shredders, Specific Conductivity |
| Biology (Level 5) | Macrobenthos | Biotic Index<br>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*

| Project Reach Designation | Functional Lift Score (PCS-ECS) | Functional Lift (%) | Overall Existing vs. Proposed Condition |
|---|---|---|---|
| UT1-R1 | 0.03 | 8 | FAR / FAR |
| UT1-R2 | 0.01 | 2 | FAR / FAR |
| UT1-R3 | 0.01 | <1 | F / F |
| UT1A | 0.14 | 56 | NF / FAR |
| UT1B | 0.04 | 39 | FAR / FAR |
| UT1C | 0.01 | 2 | F / F |
| UT2 | 0.14 | 47 | FAR / FAR |
| UT2A | 0.16 | 52 | FAR / FAR |
| UT3 | 0.18 | 53 | NF / FAR |
| BB-R1 | 0.18 | 52 | NF / FAR |
| BB-R2 | 0.16 | 30 | FAR / FAR |
| BB-R3 | 0.36 | 94 | FAR / FAR |
| UT4-R1 | 0.18 | 53 | NF / FAR |
| UT4-R2 | 0.26 | 72 | FAR / FAR |

### *4.1.3 Restoration Potential*

After completing the function-based assessment, the restoration potential was determined to help 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 watershed health must be measurable and sustainable. The overall restoration potential was determined for Level 3 (Geomorphology) for a majority of the Project reaches since the watershed assessments generally scored 'Fair' and may not fully support biological reference conditions in the headwater reaches given the current nutrient inputs and current watershed condition. Level 5 (Biology) was determined for only BB-R3 and UT4-R3 since a significant proportion of the drainage network is included in the project area and riparian buffers will be protected in perpetuity.

Based on the existing condition assessments, the overall bioclassification using Unrated Small Stream criteria is considered 'Not Rated'. It is expected that the implementation of this project will reduce pollutant loads, including sediment and nutrients, improving overall aquatic functions and bioclassification from 'Not Rated' to 'Not Impaired'. Given the landscape position and catchment sizes, the restoration activities will likely provide functional lift within the physicochemical and biological functional categories. Post-restoration efforts will include supplemental monitoring of biological parameters (Level 5) to document any functional improvements and/or identify trends during the monitoring period for BB-R3 and UT4-R2.

***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 water quality and ecological benefits within the subwatershed the project will provide. While many of these benefits are focused on the project area, others, such as nutrient removal, sediment reduction, and improved aquatic and terrestrial habitat, have more far-reaching effects, extending downstream to Snow Creek and the Dan River. The project will meet the general restoration goals and opportunities outlined in the 2009 Roanoke River Basin Restoration Priority Plan (RBRP, amended 2015 and 2018). More specifically, functional goals and conservation objectives described in the Roanoke River Basin wide Water Quality Plan (NCDWQ, 2006) as well as the Dan River Watershed Restoration Plan (PLC, Stokes County SWCD, 2012 and PLC, 2006) will be met by:

- Reducing fine sediment, soil erosion, turbidity, and nutrient inputs such as fecal coliform bacteria, nitrogen, and phosphorus to the Banner Branch 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, wetlands and 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 through local program(s), farmland protection planning and education/outreach.

To accomplish these project-specific goals, the following objectives will be measured to document overall project success:

- Restore stream, wetland and floodplain hydrology by reconnecting historic flow paths and promoting geomorphically stable conditions and more natural flood processes;
- Improve and protect water quality by reducing streambank erosion, nutrient and sediment inputs;
- Restore and protect stream, wetland and riparian buffer functions and habitat connectivity in perpetuity by recording a permanent conservation easement; and
- 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.

*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 for 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 existing streams and reduce direct fecal coliform inputs and increase percent shredders. |
| **Biology (Level 5)** | Improve Macroinvertebrate Community and Aquatic Species Health | Increase 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 streams, wetlands 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 Banner Branch 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 in Table 13.

*Table 13. Project Benefits Summary*

<table>
<tr><th colspan="2">Benefits Related to Hydrology</th></tr>
<tr><td>Rainfall/Runoff</td><td>Improving existing stream crossings and properly sizing pipe culverts and water quality treatment features will re-establish more natural flow conditions and water transport and storage during various storm events.</td></tr>
<tr><th colspan="2">Benefits Related to Hydraulics</th></tr>
<tr><td>Floodplain Connectivity</td><td>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. Raise water table and hydrate riparian wetlands.</td></tr>
<tr><td>Surface Storage and Retention</td><td>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.</td></tr>
<tr><td>Groundwater Recharge/ Hyporheic exchange</td><td>Benefits will be achieved through establishing vegetated buffers, which increase groundwater infiltration, surface water interaction, and recharge rates.</td></tr>
<tr><th colspan="2">Benefits Related to Geomorphology</th></tr>
<tr><td>Proper Channel Form</td><td>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).</td></tr>
<tr><td>Sediment Transport</td><td>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.</td></tr>
<tr><td>Riparian Buffer Vegetation</td><td>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.</td></tr>
<tr><td>Bioengineering Treatments</td><td>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.</td></tr>
<tr><th colspan="2">Benefits Related to Physicochemical (Water Quality)</th></tr>
<tr><td>Nutrient Reduction</td><td>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. Increase nutrient cycling and storage in floodplain and wetland areas.</td></tr>
<tr><td>Sediment Reduction</td><td>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.</td></tr>
</table>

| Benefits Related to Physicochemical (Water Quality) - continued | |
|---|---|
| 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, specific conductance 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, preservation and permanent protection of fourteen stream reaches (UT1-R1, UT1-R2, UT1-R3, UT1A, UT1B, UT1C, UT2, UT2A, UT3, BB-R1, BB-R2, BB-R3, UT4-R1 and UT4-R2) totaling approximately 15,707 linear feet and fourteen wetland areas (W1, W1A, W2, W3, W4, W4A, W5, W5A, W5B, W6A, W6B, W7, W8A and W9) totaling 6.18 acres of riparian wetlands. (See Figure 6). The design approach will utilize a variety of stream and wetland mitigation practices and appropriately addresses all the impaired aquatic resources at the project site. As a design consideration, WLS coordinated with the landowners to extend the easement boundary to capture additional wetland areas and natural drainage features within the Project corridor. Increasing the Project footprint provides wider riparian buffers and allows the implementation of agricultural best management practices, which ultimately improve floodplain functions and pollutant removal effectiveness. Restoring, enhancing and protecting riparian buffers currently in agriculture or pasture, along with permanent livestock exclusion and improving the existing stream crossings, will provide the maximum functional uplift and ideal 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 Segment | Existing Footage or Acreage | Mitigation Plan Footage or Acreage | Mitigation Category | Restoration Level | Priority Level | Mitigation Ratio (X:1) | | | As-Built Footage or Acreage | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| UT1-R1 (upper) | 399 | 373 | Warm | EI | N/A | 1.50 | | | | Floodplain Bench, In-Stream Structures, Supplemental Planting, Exclusion of Livestock, Permanent Conservation Easement |
| UT1-R1 (lower) | 136 | 136 | Warm | P | N/A | 10.00 | | | | Supplemental Planting, Exclusion of Livestock, Permanent Conservation Easement |
| UT1-R2 | 1,827 | 1,783 | Warm | EII | N/A | 2.50 | | | | Riparian Planting, Livestock Exclusion |
| UT1-R3 | 822 | 822 | Warm | P | N/A | 10.00 | | | | Conservation Easement |
| UT1A | 410 | 410 | Warm | EII | N/A | 2.50 | | | | Riparian Planting, Livestock Exclusion |
| UT1B (upper) | 391 | 391 | Warm | EII | N/A | 2.50 | | | | Riparian Planting, Livestock Exclusion |
| UT1B (lower) | 0 | 97 | Warm | EI | N/A | 1.50 | | | | Bank grading, Stabilization, Supplemental planting, Conservation Easement |
| UT1C (upper) | 69 | 69 | Warm | P | N/A | 10.00 | | | | Conservation Easement |
| UT1C (lower) | 158 | 151 | Warm | R | PI | 1.00 | | | | Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement |
| UT2 | 1,315 | 1,287 | Warm | R | PI | 1.00 | | | | Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement |
| UT2A | 289 | 289 | Warm | EI | N/A | 1.50 | | | | Bank grading, Stabilization, Supplemental planting,. Conservation Easement |
| UT3 | 338 | 589 | Warm | R | PI | 1.00 | | | | Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement |
| BB-R1 | 986 | 808 | Warm | R | PI | 1.00 | | | | Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement |
| BB-R2 | 2,080 | 1,835 | Warm | R | PI | 1.00 | | | | Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement |
| BB-R3 | 478 | 636 | Warm | R | PI/PII | 1.00 | | | | Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement |
| UT4-R1 (upper) | 2,394 | 2,346 | Warm | R | PI/PII | 1.00 | | | | Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement |
| UT4-R1 (lower) | 2,230 | 1,730 / 233 | Warm | R | PI | 1.00 /1.25 | | | | Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement. 233 LF adjacent to pond credited at 1.25:1. |
| UT4-R2 | 1,722 | 1,722 | Warm | EI | N/A | 1.50 | | | | Bank Grading, Stabilization, Supplemental Planting, Conservation Easement |
| | | | | | | | | | | |
| W1 | 0.859 | 0.825 | RR | E | | 2.00 | | | | Planted, excluded livestock, remediated compaction and encompasses section of Priority 1 reaches |
| W1A | 0.000 | 1.240 | RR | RE | | 1.00 | | | | Planted, excluded livestock, remediated compaction, soil manipulation, and encompasses section of Priority 1 reach |
| W2 | 0.524 | 0.524 | RR | E | | 2.00 | | | | Planted, excluded livestock, remediated compaction |
| W3 | 0.906 | 0.888 | RR | RH | | 1.50 | | | | Planted, excluded livestock, remediated compaction and encompasses section of Priority 1 reach |
| W4 | 0.321 | 0.321 | RR | E | | 2.00 | | | | Planted, excluded livestock, remediated compaction |
| W4A | 0.000 | 0.808 | RR | RE | | 1.00 | | | | Planted, excluded livestock, remediated compaction, soil manipulation, and encompasses section of EI reach |
| W5 | 0.203 | 0.203 | RR | E | | 2.00 | | | | Planted, excluded livestock, remediated compaction and encompasses section of EII reach |
| W5A | 0.097 | 0.097 | RR | E | | 2.00 | | | | Planted, excluded livestock, remediated compaction, and encompasses section of EII reach |
| W5B | 0.010 | 0.010 | RR | E | | 2.00 | | | | Planted, excluded livestock, remediated compaction |
| W6A | 0.251 | 0.251 | RR | RH | | 1.50 | | | | Planted, excluded livestock, remediated compaction and encompasses section of Priority 1 reach |
| W6B | 0.045 | 0.045 | RR | E | | 2.00 | | | | Planted, excluded livestock, remediated compaction |
| W7 | 0.041 | 0.041 | RR | E | | 2.00 | | | | Planted, excluded livestock, remediated compaction |
| W8A | 0.000 | 0.107 | RR | RE | | 1.00 | | | | Planted, remediated compaction, soil manipulation, and encompasses section of Priority 1 reach of BB-R1 |
| W9 | 0.000 | 0.823 | RR | RE | | 1.00 | | | | Planted, excluded livestock, remediated compaction, soil manipulation, and encompasses section of P1 reach of BB-R2 |

**Project Credits**

| Restoration Level | Stream | | | Wetland | | Non-Rip | Coastal |
|---|---|---|---|---|---|---|---|
| | Warm | Cool | Cold | Riverine | Non-Riv | Wetland | Marsh |
| Restoration | **9568.400** | | | | | | |
| Re-establishment | | | | **2.978** | | | |
| Rehabilitation | | | | **0.759** | | | |
| Enhancement | | | | **1.033** | | | |
| Enhancement I | **1654.000** | | | | | | |
| Enhancement II | **1033.600** | | | | | | |
| Creation | | | | | | | |
| Preservation | **102.700** | | | | | | |
| **Totals** | **12,358.700** | | | **4.770** | **0.000** | **0.000** | |

## 6.1 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. Ascension Land Surveying and Consulting 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 hydraulic model using process-based equations 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 challenging 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.

### *6.1.1 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 | UT1-R1 (upper) | UT2 | UT3 | UT1C (lower) | BB-R1 | BB-R2 | BB-R3 | UT4-R1 (upper) | UT4-R1 (lower) |
|---|---|---|---|---|---|---|---|---|---|
| Drainage Area, DA (sq mi) | 0.064 | 0.044 | 0.120 | 0.026 | 0.64 | 0.75 | 0.880 | 0.160 | 0.240 |
| Stream Type (Rosgen) | B4 | B4 | C4 | B4 | C4 | C4 | C4 | B4c | C4b |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 3.9 | 2.3 | 4.6 | 1.6 | 14.0 | 15.9 | 17.8 | 7.7 | 7.7 |
| Bankfull Mean Velocity, Vbkf (ft/sec) | 4.36 | 4.44 | 5.27 | 3.7 | 3.93 | 3.76 | 3.93 | 3.92 | 3.92 |
| Bankfull Riffle Width, Wbkf (ft) | 8.0 | 6.0 | 8.0 | 4.5 | 13.0 | 14.0 | 15.0 | 11.0 | 11.0 |
| Bankfull Riffle Mean Depth, Dbkf (ft) | 0.49 | 0.38 | 0.57 | 0.36 | 1.08 | 1.14 | 1.19 | 0.7 | 0.7 |
| Width to Depth Ratio, W/D (ft/ft) | 16.4 | 16.0 | 14.1 | 12.5 | 12.1 | 12.3 | 12.6 | 15.8 | 15.8 |
| Width Floodprone Area, Wfpa (ft) | 16 – 26 | 9 – 15 | 20 – 40 | 12 – 20 | 35 – 75 | 65 – 155 | 50 – 120 | 15 – 25 | 37 – 70 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | >2.2 | >2.2 | >2.2 | >2.2 | >2.2 | >2.2 | >2.2 | >2.2 | >2.2 |
| Riffle Max Depth Ratio, Dmax/Dbkf | 1.2 | 1.3 | 1.2 | 1.4 | 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 | 1.0 | 1.0 |
| Meander Length Ratio, Lm/Wbkf | N/A | N/A | 7 – 12 | N/A | 7 – 12 | 7 – 12 | 7 – 12 | N/A | 7 – 12 |
| Radius of Curvature Ratio, Rc/Wbkf | N/A | N/A | 2 – 3 | N/A | 2 – 3 | 2 – 3 | 2 – 3 | N/A | 2 – 3 |
| Meander Width Ratio, Wblt/Wbkf | N/A | N/A | 3.5 – 8 | N/A | 3.5 – 8 | 3.5 – 8 | 3.5 – 8 | N/A | 3.5 – 8 |
| Channel Sinuosity, K | ~1.27 | ~1.10 | ~1.22 | ~1.08 | ~1.15 | ~1.24 | ~1.23 | ~1.14 | ~1.18 |
| Channel Slope, Schan (ft/ft) | 0.0270 | 0.0352 | 0.0088 | 0.0506 | 0.0093 | 0.0075 | 0.0049 | 0.0248 | 0.0145 |
| Riffle Slope Ratio, Sriff/Schan | 1.1 – 1.8 | 1.1 -1.8 | 1.5 – 2.0 | 1.1 -1.8 | 1.5 – 2.0 | 1.5 – 2.0 | 1.5 – 2.0 | 1.1 -1.8 | 1.5 – 2.0 |
| Pool Slope Ratio, Spool/Schan | 0.0 – 0.4 | 0.0 - 0.4 | 0.0 – 0.2 | 0.0 - 0.4 | 0.0 – 0.2 | 0.0 – 0.2 | 0.0 – 0.2 | 0.0 - 0.4 | 0.0 – 0.2 |
| Pool Width Ratio, Wpool/Wbkf | 1.1 – 1.5 | 1.1 -1.5 | 1.3 – 1.7 | 1.1 -1.5 | 1.3 – 1.7 | 1.3 – 1.7 | 1.3 – 1.7 | 1.1 -1.5 | 1.3 – 1.7 |
| Pool-Pool Spacing Ratio, Lps/Wbkf | 1.5 – 5.0 | 1.5 – 5.0 | 4.0 – 7.0 | 1.5 – 5.0 | 4.0 – 7.0 | 4.0 – 7.0 | 4.0 – 7.0 | 1.5 – 5.0 | 4.0 – 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 | 2.0 – 3.5 | 2.0 – 3.5 |

### 6.1.2 *Design Reach Summary*

For design purposes, the stream segments were divided into multiple reaches labeled UT1-R1 (upper and lower), UT1-R2, UT1-R3, UT1A, UT1B, UT1C (upper and lower), UT2, UT2A, UT3, BB-R1, BB-R2, BB-R3, UT4-R1 (upper and lower) and UT4-R2, as shown in Figure 10. The following narrative summarizes the proposed design approach, rationale and justification for each of stream reaches.

## Restoration: UT1C (lower), UT2, UT3, BB-R1, BB-R2, BB-R3, UT4-R1

### *UT1C (lower)*

Due to the severe active headcut along lower UT1C, a Priority Level I/II Restoration approach is proposed to restore headwater stream functions. Given the small drainage area, valley configuration and steeper slopes, the lower reach will be restored as a Rosgen 'B4' stream type using appropriate step-pool morphology with limited meander geometry. The upper reach is currently stable and the restoration activities will reconnect the new channel within the existing valley bottom by raising the vertical profile, providing bankfull benches near the confluence with UT1-R1 further downstream. In-stream structures, including log and rock riffles, log weirs and cascades will be used to dissipate flow energy, protect streambanks, and eliminate potential for future incision.

### *UT2*

Due to the past manipulation and degraded nature of UT2, a Priority Level I/II Restoration approach is proposed to restore headwater stream functions and improve water quality. The reach is currently moderately unstable, as shown by an active bank erosion and localized aggradation. This headwater stream has been a watering source and shade area for cattle over many decades. This ongoing degradation has left the riparian areas devoid of understory woody vegetation. Given the small drainage area, valley configuration and steeper slopes, the reach will be restored as a Rosgen 'B4' stream type using appropriate step-pool morphology with limited meander geometry. A new channel will be constructed within the existing valley bottom by raising the vertical profile, providing bankfull benches and reconnecting with the BB-R2 channel alignment further downstream.

The design width/depth ratio for the new channel will be similar to stable streams in this geologic setting. It is expected that over time, channel widths will narrow slightly over time due to fine grain sediment deposition and vegetation growth along the streambanks. In-stream structures, such as constructed riffles/cascades, log and rock step-pools will be used to control grade in the steeper sections, as well as dissipate flow energy, protect streambanks, and eliminate potential for future incision. Restored streambanks will be graded to stable side slopes and the floodplain will be reconnected to further promote stability and hydrological function.

As part of the restoration activities, the existing channel will be filled to an elevation sufficient to connect the new bankfull channel to floodprone areas using suitable fill material excavated from the newly restored channel, spoil piles and borrow areas. Additionally, permanent fencing and a 30- foot ford stream crossing will be installed to exclude livestock and reduce sediment and nutrient inputs. Riparian buffers of at least 30 feet wide will be established and the proposed restoration activities will provide the maximum possible functional uplift.

### *UT3*

UT3 currently exhibits ditched conditions due to past manipulation and channelization. Therefore, a Priority Level I Restoration approach is proposed to improve stream functions and wetland hydrology in areas with hydric soils. The reach will be restored as a Rosgen 'C4' stream type using appropriate riffle-pool morphology with appropriate meander geometry. Work along this reach will involve filling in the ditches, raising the bed elevation, and reconnecting the existing stream with its relic floodplain. A new channel will be constructed offline before reconnecting with proposed BB-R2 channel alignment further downstream. The proposed design width-to-depth ratio will be comparable to stable streams in this geologic setting. It is expected that channel widths will narrow slightly, over time, due to vegetation growth along the streambanks. In-stream structures, including log and rock riffles, log weirs and log vanes will be used to dissipate flow energy, protect streambanks, and eliminate potential for future incision. Restored streambanks will be graded to stable side slopes and the floodplain will be reconnected to further promote stability and hydrological function across the stream and wetland complex.

### *BB-R1, BB-R2, and BB-R3*

The Banner Branch mainstem tributary (BB-R1) begins upstream of an existing ford stream crossing at the confluence with UT1-R3. The Banner Branch mainstem reaches are moderately to severely incised with BHRs often exceeding 1.5. The existing channel appears to have been historically manipulated in many locations and generally flows along the right side of the valley. Work along these reaches will involve a Priority Level I Restoration by raising the bed elevation upstream of UT1-R3 confluence and reconnecting the existing stream with its relic floodplain in the low point of the valley. BB-R2 begins at the confluence with UT2 and upstream of an existing 30-foot wide ford stream crossing. The ford crossing will be improved and BB-R2 will be relocated to the lowest point in the valley and constructed entirely offline. The lower section of BB-R3 will transition into a Priority Level II restoration to create a floodplain bench and tie into the existing bed elevation near the bottom of the project boundary. 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 mainstem channel has cut down to bedrock in a few locations and currently exhibits lateral instability and overwidening, as evidenced by active bank erosion and irregular sediment deposits observed as mid-channel and transverse bar formations. This systemic degradation is causing excess bank sediments to enter the stream and will likely continue if restoration is not implemented. The existing channel has many vertical banks that are devoid of deep rooting vegetation from active cattle trampling and removing riparian buffer vegetation for pastureland.

These reaches will be restored as Rosgen 'C4' stream type using appropriate riffle-pool morphology with a conservative meander planform geometry that accommodates the flatter valley slope 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. It is anticipated that 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 future channel incision. In-stream structures will likely include constructed riffles for grade control and aquatic habitat and log j-hook vanes, and log and rock weirs for encouraging pool formation, bank stability, and bedform diversity.  In addition to in-stream channel features, shallow depressions will be created in the floodplain to provide habitat diversity, nutrient cycling, and improved treatment of overland flows.

### *UT4-R1 (upper) and UT4-R1 (lower)*

The restoration of upper UT4-R1 will begin near the top of the headwater catchment. Due to the past manipulation and severely degraded nature of UT4-R1, a Priority Level I/II Restoration approach is proposed to restore headwater stream functions and improve water quality. The reach is currently moderately to severely unstable, as shown by an active bank erosion and obvious channel incision. This stream system has been a primary watering source and shade area for cattle over many decades. This ongoing degradation has left the riparian areas devoid of understory woody vegetation. Given the valley configuration and steeper slopes, the upper reach will be restored as a Rosgen 'B4' stream type using appropriate step-pool morphology with limited meander geometry. Within portions of the deeper channel segments, a shallow Priority Level II Restoration approach is proposed within the valley bottom to create bankfull benches. This approach will be outside jurisdictional wetland areas and therefore will not adversely affect wetland hydrology. Additionally, a 30-foot culvert stream crossing will be installed.

The lower reach will be restored as a Rosgen 'C4b' stream type using a Priority Level I Restoration approach to restore stream functions and improve water quality. The design approach will include a riffle-pool morphology with a conservative meander planform geometry that accommodates the flatter valley slope and widths. The design width/depth ratio for the new channel will be similar to stable streams in this geologic setting.  It is expected that over time, channel widths will narrow slightly over time due to fine sediment deposition and vegetation growth along the streambanks. In-stream structures, such as constructed riffles/cascades, log and rock step-pools will be used to control grade in the steeper sections, as well as dissipate flow energy, protect streambanks, and eliminate potential for future incision. Restored streambanks will be graded to stable side slopes and the floodplain will be reconnected to further promote stability and hydrological function.

In the lower section of UT4-R1, the existing channel and valley slope flattens and begins experiencing backwater conditions from a man-made pond dam. The existing farm ponds currently serve as a watering source and wallowing area in support of the landowner's cattle operation. The cattle will be excluded from the conservation easement; however, the ponds will remain for landowner use as a secondary water source and recreation. The buffer width on the left side of the pond ranges from 13 feet to some areas greater than 30 feet. The stream length affected by the less than 30-ft buffer is 233 feet or 1.5% of the total project length. The 233 LF will be credited at 1.25:1 ratio. The existing 30-foot ford stream crossing will be improved, and a small pond will be temporarily drained to construct the new stream channel within the geomorphic floodplain before reconnecting with the existing UT4-R2 channel alignment further downstream. If necessary, channel and floodplain excavation in this reach segment will include the removal of shallow legacy sediments to accommodate a new design channel and in-stream structures, as well as a more natural step-pool morphology using grade control structures in the steeper transitional areas.

Additionally, permanent fencing and a water quality improvement feature will be installed to exclude cattle and capture, attenuate, and treat concentrated flow from existing ephemeral drainages that would otherwise enter the riparian buffer as untreated surface runoff. These proposed restoration activities will provide the maximum possible functional uplift.

## Enhancement Level I: UT1-R1 (upper), UT2A, UT4-R2, UT1B (lower)

### *UT1-R1 (upper)*

Due to the past manipulation, channelization and degraded nature of the upper project reach, an Enhancement Level I approach is proposed to restore natural stream functions and improve water quality. A majority of the upper reaches do not have access to its active floodplain, or a bankfull bench, and portions of the channel have been historically manipulated to accommodate pasture grazing and agricultural production. A bankfull bench will be constructed along the left streambank and a meander bend will be relocated partially offline within the abandoned floodplain area before reconnecting with the stable channel alignment further downstream.

Riparian buffers in excess of 30 feet will be restored and protected along the entire length of all project reaches. Any mature trees or significant native vegetation will be protected and incorporated into the design. Bioengineering techniques, such as geolifts, toe wood, brush layers, and live stakes, will also be used to protect streambanks and promote woody vegetation growth. These proposed activities will improve bedform diversity and aquatic habitat. Any exotic species vegetation will be removed, and native riparian species vegetation will be planted in the resulting disturbed areas. Permanent fencing will be installed or relocated along with alternative watering systems to exclude livestock and reduce direct sediment and nutrient inputs.

### *UT2A*

UT2A begins at a small spring adjacent to Reach UT2. During site investigations, the channel appears to be experiencing bank erosion from hoof shear, but is vertically stable throughout most of its length. An Enhancement Level I approach is proposed along this reach to address localized bank erosion, an active headcut and lateral instability. In-stream structures, such as constructed riffles/cascades, log and rock step-pools, will be used to control grade in the steeper sections, as well as dissipate flow energy, protect streambanks, and eliminate potential for future incision. Construction activities will consist of regrading the streambanks back to the existing stable dimension, installing erosion control matting, and supplemental riparian buffer planting and live stakes. The reach in this section is proposed as a Rosgen ‘B4’ stream type.

### *UT4-R2*

UT4-R2 begins below two existing farm ponds that serve as a watering source and wallowing area in support of the landowner’s cattle operation. The small upstream pond will be partially drained prior to construction to reconnect the new stream channel with its geomorphic floodplain and remove invasive species vegetation. Channel and floodplain excavation in the upper reach segment will include the removal of shallow legacy sediments to accommodate a new design channel and in-stream structures, as well as a more natural step-pool morphology using grade control structures in the steeper transitional areas. The lower section of the channel is vertically stable and enhancement work will consist of bank stabilization, treatment of invasive species and minimal channel relocation and in-stream structure installation. Bioengineering techniques, such as toe wood, brush layers, and live stakes, will be used to protect streambanks and promote native woody vegetation growth. A majority of the right buffer area, including streamside vegetation, contains large clusters of Chinese privet. Any exotic species vegetation will be removed in these areas from approximate station 55+00 to 71+53. The buffer and stream banks will be replanted with native riparian species vegetation in the resulting disturbed areas. Riparian buffers in excess of 30 feet will be restored and protected along the entire length of UT4-R2, and permanent fencing will be installed to exclude livestock and reduce direct sediment and nutrient inputs.

### *UT1B (lower)*

UT1B lower begins immediately downstream of UT1B. Currently this area is experiencing a higher water table and aggradation due to a partially blocked culvert. A pilot channel will be constructed to establish a natural tie-in connection with UT1B (upper) and UT1-R2. Enhancement Level I practices will consist of, new channel construction, in-stream structure installation and invasive species treatment. Bioengineering techniques, such as live stakes, will be used to protect streambanks and promote native woody vegetation growth. Any invasive species vegetation will be removed in these areas. The buffer and stream banks will be replanted with native riparian species vegetation in the resulting disturbed areas in excess of 30 feet. Permanent fencing will be installed to exclude livestock and reduce direct sediment and nutrient inputs.

## Enhancement Level II: UT1A, UT1B (upper), UT1-R2

Work along project reaches UT1A, UT1B (upper), and UT1-R2 will involve Enhancement Level II practices to improve the current channel condition and aquatic function. These areas have been historically disturbed through cattle intrusion, pasture use and agricultural practices, and the channels exhibit poor channel definition and/or degraded conditions in some sections. However, many segments of existing channel have limited bank erosion and/or channel incision. Consequently, WLS will plant and restore the riparian buffer widths to more than 30 feet, stabilize localized bank erosion and permanently exclude livestock. The 40-foot existing culvert crossing on UT1-R2 will be replaced and the 30-foot culvert (approximate 77-foot easement break) between UT1-R2 and UT1-R3 will also be replaced.

Any mature trees or significant native vegetation will be protected and incorporated into the design. Where necessary, 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. Additionally, permanent fencing will be installed to exclude livestock and reduce sediment and nutrient inputs. Any exotic species vegetation will be removed in these areas and native riparian species vegetation will be planted in any disturbed areas. Finally, agricultural BMPs and water quality improvement features will be installed near UT1-R2 to capture, attenuate, and treat concentrated flow from existing ephemeral draws that would otherwise enter the riparian buffer as untreated water. The BMPs will be constructed inside of the conservation easement and will require no maintenance.

### Preservation: UT1C (upper), UT1-R3, UT1-R1 (lower)

Preservation is being proposed along these reaches since the existing stream systems are mostly stable with a mature riparian buffer due to minimal historic impacts. An existing headcut will be stabilized along lower UT1C near the confluence with UT1-R2 and all areas will be protected in perpetuity through a conservation easement. Any exotic species vegetation will be removed in these areas and riparian buffers in excess of 30 feet will be permanently protected along the entire reach length. This approach will extend the wildlife corridor throughout a majority of the riparian corridor, while providing a natural hydrologic connection and critical habitat linkage within the catchment area.

## 6.2 Reference Sites

### *6.2.1 Reference Streams*

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 nearby watersheds and compared them with composite reference data in the northwest Piedmont. The reference reach data set represents small "Rural Piedmont Streams," with similar drainage areas ranging from 40 to 640 acres, flow regimes (small first and second order streams), mixed land use (forested and agricultural with less than 2% impervious surface cover), vegetative communities (Piedmont Headwater Stream Forest), valley morphology and slope ranges (1%-3%) that fall 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 will likely respond to minimal changes within the watershed.

*Table 16. Reference Reach Data Comparison*

| Parameter | Local Reference Data | | Composite Reference Data | |
|---|---|---|---|---|
| | **SCP** | **TCT** | | |
| Stream Type (Rosgen) | C4b | B4 | B4 | C4 |
| Drainage Area, DA (acres) | 36.1 | 40.1 | - | - |
| Bankfull Mean Velocity, Vbkf (ft/s) | 6.0 | 5.4 | 4.0 - 6.0 | 3.5 - 5.0 |
| Width to Depth Ratio, W/D (ft/ft) | 18.4 | 13.4 | 12.0 - 18.0 | 5.0 - 12.0 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 3.7 | 4.9 | >2.2 | >2.2 |
| Riffle Max Depth Ratio, Dmax/Dbkf | 1.3 - 2.1 | 1.4 – 2.3 | 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 | N/a | N/a | N/a | 7.0 - 12.0 |
| Radius of Curvature Ratio, Rc/Wbkf | N/a | N/a | N/a | 1.2 - 2.0 |
| Meander Width Ratio, Wblt/Wbkf | N/a | N/a | N/a | 3.0 - 8.0 |
| Sinuosity, K | 1.17 | 1.13 | 1.1 - 1.2 | 1.2 - 1.5 |
| Valley Slope, Sval (ft/ft) | 0.0242 | 0.0317 | 0.020 - 0.030 | 0.005 - 0.015 |
| Channel Slope, Schan (ft/ft) | 0.0129 | 0.028 | 0.020 - 0.030 | 0.005 - 0.015 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf | 2.1 | 1.7 | 2.0 - 3.5 | 2.0 - 3.5 |
| Pool Width Ratio, Wpool/Wbkf | 1.27 | 1.22 | 1.1 - 1.5 | 0.8 - 1.2 |
| Pool-Pool Spacing Ratio, Lps/Wbkf | 2.2 – 4.8 | 1.9 – 7.2 | 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: Reference reach data was collected at Shoals Community Park (SCP) and the Toms Creek Tributaries (TCT) Project sites, respectively.*

### 6.2.2 *Reference Wetlands*

A reference wetland that is representative of the riparian wetland system to be restored at the Project site was identified adjacent the project area along Banner Branch (W8 in Figure 11, coordinates 36.526851, -80.200571). The reference riparian wetland is an example of a Bottomland Hardwood Forest (NC WAM, 2016). Bottomland Hardwood Forests exist in geomorphic floodplains along second-order and larger streams. These wetlands are generally intermittently to seasonally inundated and overbank flooding is the source of groundwater and surface runoff. Although Banner Branch is slightly incised in this area, hydrology appears to have a higher groundwater table and limited overbank flooding was observed during the existing conditions assessment. This wetland is forested and within a narrow linear depression having a shallow outlet near Banner Branch. Soils have a loamy surface underlain by a slightly more restrictive sandy clay loam. The reference site has experienced minimal disturbances in the past, primarily due to timber harvest; however, cutting of timber occurred long ago, and a mature canopy of vegetation exists across wetland area. Evidence also suggests that the hydrology and soils were minimally affected by timber harvest. A groundwater monitoring well will be installed to document hydrology during the growing season prior to restoration activities. Figure 11 shows the reference site locations as compared to the project site.

## 6.3 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 intermittent 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)<br>-Maintain suitable conditions for water temperature and dissolved oxygen<br>-Provide water source for riparian plants and animals<br>-Enable movement through stream corridor and refuge from predators<br>-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<br>-Create and maintain pools, in-stream and refuge habitat<br>-Redistribute and sort fine and coarse sediments<br>-Reduce encroachment of vegetation in channel and establishment of exotic species<br>-Maintain water quality by flushing pollutants<br>-Maintain hyporheic connection by mobilizing bed and fine material<br>-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<br>-Maintain diversity, function, and health of riparian floodplain vegetation<br>-Create streamside habitat, new channels, sloughs, and off-channel rearing habitat through lateral channel migration and avulsion<br>-Recharge floodplain and storage processes<br>-Recruitment of native wood and organic material into channel |

### *6.3.1 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.

### *6.3.2 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 some of the project 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 Stokes 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.

### *6.3.3 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 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) |
|---|---|---|---|---|---|---|---|---|
| UT1-R1 | 41 | 13.1 | 6.2 | 20.4 | 24.1 | 20.2 | 16.8 | 17.0 |
| UT1C | 16 | 6.6 | 2.9 | 13.5 | 12.2 | 10.8 | 9.3 | 6.0 |
| UT2 | 28 | 10.0 | 4.6 | 10.7 | 18.5 | 15.8 | 13.4 | 10.0 |
| UT3 | 77 | 20.3 | 10.2 | 36.9 | 37.2 | 30.1 | 24.5 | 24.0 |
| BB-R1 | 409 | 66.7 | 39.2 | 61.3 | 122.8 | 86.1 | 63.0 | 55.0 |
| BB-R2 | 480 | 74.7 | 44.5 | 96.6 | 137.4 | 94.9 | 68.5 | 60.0 |
| BB-R3 | 563 | 83.7 | 50.6 | 77.6 | 153.8 | 104.5 | 74.4 | 70.0 |
| UT4-R1 (upper) | 102.4 | 24.9 | 12.9 | 32.9 | 45.9 | 36.2 | 29.0 | 30.0 |
| UT4-R1 (lower) | 153.6 | 33.3 | 17.8 | 40.0 | 61.2 | 46.8 | 36.7 | 30.0 |

*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 0.022 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.

### 6.3.4 *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 (Pavement/Subpavement) 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 6. The sieve data indicate that the dominant bed material in many of 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 restored project reaches. See Appendix 2 for sediment particle size distribution for the project reaches.

*Table 20. Boundary Shear Stress and Stream Power*

| Parameter | UT1-R1 | UT2 | BB-R1 | BB-R2 | BB-R3 | UT4-R1 (upper) | UT4-R1 (lower) |
|---|---|---|---|---|---|---|---|
| Channel Energy Slope (feet/ foot) | 0.0270 | 0.034 | 0.008 | 0.007 | 0.005 | 0.025 | 0.015 |
| Median Particle Size, $D_{50}$ (mm) | 8.7 | 32 | 1.3 | 11.4 | 20.1 | 6.7 | 6.7 |
| Bankfull XSC Area (square feet) | 3.9 | 2.3 | 14.0 | 16.0 | 17.8 | 7.7 | 7.7 |
| Composite Mannings 'n' Value | 0.035 | 0.035 | 0.035 | 0.035 | 0.035 | 0.035 | 0.035 |
| Bankfull Width, W (feet) | 8.0 | 6.0 | 13.0 | 14.0 | 15.0 | 11.0 | 11.0 |
| Bankfull Depth, D (feet) | 0.5 | 0.4 | 1.1 | 1.1 | 1.2 | 0.7 | 0.7 |
| Hydraulic Radius, R (feet) | 0.43 | 0.33 | 0.92 | 0.98 | 1.03 | 0.62 | 0.62 |
| Bankfull Velocity, V (cfs) | 4.4 | 4.44 | 3.93 | 3.76 | 3.93 | 3.92 | 3.92 |
| Bankfull Discharge, Q (cfs) | 17.0 | 10.0 | 55.0 | 60.0 | 70.0 | 30.0 | 30.0 |
| Boundary Shear Stress, τ (lbs/ft2) | 0.73 | 0.71 | 0.46 | 0.43 | 0.31 | 0.96 | 0.56 |
| Stream Power (W/m2) | 46.5 | 45.9 | 26.4 | 23.8 | 17.9 | 54.5 | 31.9 |

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 1.0% to over 4.0%. In general, sections with steeper slopes greater than 1.5% 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, 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 for this project. 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 parent materials directly from streambank erosion with fine sediment contributions from the upland areas. This was evidenced by visual observations of a gravel/cobble lens approximately 2 to 3 feet below the existing top of bank along some portions of the degraded channels. Further field investigations confirmed that the sediment supply from project reaches is transported during larger storm events.

## 6.4 Wetland Design Approach

Degraded and/or drained riparian wetlands were documented within the project boundary. These areas contain hydric soils indicators and total approximately 3.584 acres of hydric soils and 3.889 acres of degraded jurisdictional wetlands. Figure 6 illustrates areas where conditions are favorable for improving wetland conditions. The predominant native wetland vegetation communities are largely devoid or not considered reference quality in areas proposed for restoration. On-site investigations of the soils within the project area were conducted in 2018 and 2019 by licensed soil scientist (LSS), George Lankford, LSS, with George K. Lankford, LLC (See Hydric Soils Investigation in the Appendix 2). The findings were based on hand-turned auger borings and indicate the presence of hydric soils along the floodplains of many of the project reaches. The hydric soils status is based upon the "*Field Indicators of Hydric Soils in the United States*" (USDA, NRCS, 2016, Version 8.1).

***Photo of hand auger boring located in the Banner Branch (BB-R2) floodplain showing hydric soil indicators.***

The presence of hydric soil indicators and hydric inclusions within 12 inches of the soil surface was verified and a hydric soil boundary was identified as containing potential jurisdictional hydrology. Mr. Lankford noted that areas of existing hydric soils have been manipulated by a combination of agricultural use and heavy livestock grazing. Throughout these floodplain areas, existing hydric soils have a disturbed surface underlain with a dark gray sandy clay loam with redoximorphic concentration.

As such, combining the proposed stream modifications to incised channels presents a favorable opportunity for meeting riparian wetland restoration criteria and functional uplift potential. It is anticipated that as a direct result of implementing Priority Level I stream restoration, livestock exclusion, limited overburden soil removal and surface roughening, and revegetation, lost wetland hydrology will be restored and allow the wetlands to regain their natural/historic functions. Coarse woody debris will also be added to the depressional areas in the buffers and wetlands for habitat. The areas proposed for wetland rehabilitation, re-establishment and enhancement are labeled on Figure 9.

After monitoring successful stream and wetland restoration projects in this valley setting and landscape position within the same or similar soil types and over the past decade, WLS and Mr. Lankford concluded these areas will likely experience seasonal wetness for prolonged periods and conditions are favorable to support appropriate wetland hydrology. As described in the reach summary, portions of the existing streams have been channelized to the toe of the adjacent hillslope. As a result, many toe-of-slope seepage wetlands that likely existed on the Project site have been drained and lost. Restoration of the stream channels within the natural topography and adjacent floodplain crenulations will reconnect many of these small seepage and seasonally saturated wetlands after the channelized stream segments are raised as part of the proposed restoration practices.

WLS has compared monitoring data from successful stream and wetland restoration projects in similar valleys with similar soil types and expects these areas will likely experience seasonal wetness for prolonged periods and conditions are favorable to support appropriate wetland hydrology. Based on the 2016 NCIRT guidance and detailed hydric soils study, the suggested wetland saturation and hydroperiod range for the Cordorus and Comus soil series is 7-9%, which exceeds the 5% minimum performance criteria.

### Riparian Wetland Re-establishment: W1A, W4A, W8A and W9

These areas contain hydric soil conditions that are favorable for re-establishing historic wetlands. It is anticipated that as a direct result of implementing Priority Level I stream restoration, limited soil manipulation, removal of livestock, which will rebuild soil structure, revegetation, and restoration of groundwater hydrology, historic wetlands will regain their lost functions. An overbank flooding regime will be restored throughout these areas by raising the stream bed elevation to reconnect the channels to their active floodplain. For W8A, the vertical profile of Banner Branch will be gradually raised and tie into BB-R1/UT1-R3 confluence at station 43+11 thereby increasing the frequency of overbank flows and restoring hydrology necessary for wetland re-establishment. WLS is not proposing stream credit on Banner Branch proper upstream of this confluence.

### Riparian Wetland Rehabilitation: W3 and W6A

Areas of significantly degraded riparian wetlands (poorly functioning) were also documented along portions of the project floodplains areas. These poorly functioning wetland areas will be restored as a direct result of implementing a Priority Level I restoration, removal of livestock trampling, limited soil manipulation and removal (less than 1-foot depth), and planting native vegetation. The groundwater hydrology will be restored and allow the wetland areas to regain their natural or historic functions.

### Riparian Wetland Enhancement: W1, W2, W4, W5, W5A, W5B, W6B, W7

As described above, the proposed restoration activities will provide significant functional uplift across the project area. The proposed activities will also improve and enhance the hyporheic zone interaction and hydrology to existing wetland areas. Wetland enhancement areas will be planted with native wet tolerant species. Restoration of a natural stream system often requires that the new channel be relocated to the lowest part of the valley, which may result in a temporary disturbance of existing marginal or lower functioning wetlands. In some areas, disturbance of the existing wetlands may be unavoidable to restore a stable and fully functioning wetland and riparian system. However, restoration of the stream channels will also improve areas of adjacent wetlands through higher water table conditions (elevated stream profile) and a more frequent over-bank flooding regime.

## 6.5 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. Proposed plantings will be conducted using native species trees and shrubs, in the form of 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 Year 7 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 begin 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, green ash, and American sycamore. The climax species that have proven successful include oaks (*Quercus spp.*) and tulip-tree. The understory and shrub layer species are all considered to be climax species in the riparian buffer community.

### 6.5.1 *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's (2012) guidance on vegetation communities for Piedmont Bottomland Forest (mixed riparian community), Piedmont Headwater Stream Forest 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. The total planted area for the site is 29.4 acres with 24.3 acres being restoration planting and 5.10 acres of supplemental planting.

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

| Scientific Name | Common Name | % Planting by Species | Wetland Tolerance |
|---|---|---|---|
| **Bare Root Plantings – Overstory<br>(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)** | | | |
| *Betula nigra* | River birch | 8% | FACW |
| *Tilia americana* | Basswood | 7% | FACU |
| *Platanus occidentalis* | American sycamore | 10% | FACW |
| *Nyssa sylvatica* | Black gum | 8% | FAC |
| *Liriodendron tulipifera* | Tulip tree | 10% | FACU |
| *Quercus alba* | White oak | 7% | FACU |
| *Quercus michauxii* | Swamp Chestnut Oak | 8% | FACW |
| *Quercus phellos* | Willow Oak | 7% | FACW |
| *Quercus falcata* | Southern red oak | 7% | FACU |
| *Fraxinus pennsylvanica* | Green ash | 4% | FACW |
| **Bare Root Plantings – Understory<br>(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)** | | | |
| *Diospyros virginiana* | Persimmon | 3% | FAC |
| *Amelanchier arborea* | Common serviceberry | 3% | FAC |
| *Carpinus caroliniana* | American hornbeam | 3% | FAC |
| *Hamamelis virginiana* | Witch-hazel | 3% | FACU |
| *Asimina triloba* | Pawpaw | 3% | FAC |
| *Lindera benzoin* | Spicebush | 3% | FACW |
| *Alnus serrulata* | Hazel alder | 3% | OBL |
| *Corylus americana* | Hazelnut | 3% | FACU |

| **Riparian Buffer Live Stake Plantings – Streambanks**<br>**(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 and final planted species will be documented in the as-built report.* | | | |

### *6.5.2 Planting Materials and Methods*

Planting will be conducted during the dormant season, with all trees installed between Mid-November and April 30th. No trees will be planted past April 30th unless otherwise approved by the IRT. 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 paw paw, 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.

All topsoil to be excavated shall be stripped to required depths in a manner to prevent intermingling with underlying subsoil or other waste materials. In areas where excavation depths will exceed 10 inches with side slopes steeper than 3H:1V, native topsoil shall be harvested, if available, stockpiled and placed back over these areas to a minimum depth of 10 inches to achieve design grades and create a soil base for vegetation planting according to the design plans and construction specifications. In areas where topsoil or organic material cannot be salvaged or reused, topsoil from the adjacent areas will be mixed across the restored floodplain to create a more suitable soil base to insure successful vegetation planting, growth, and establishment. Soils across the side slopes and new floodplain, will be prepared by sufficiently disking and/or loosened prior to new channel excavation, in-stream structure installation and vegetation planting.

Herbicide treatment of fescue is not being proposed in the project area to prevent adverse environmental impacts. The site preparation includes clearing and grubbing which will help to reduce fescue pressure. Grading activities will also remove much of the fescue seed/root source. The combination of these two techniques will help control fescue regeneration. If fescue becomes pervasive within the conservation easement, WLS will address the issue through a remedial action plan.

***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 Stokes 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*

| Scientific Name | Common Name | % Proposed for Planting by Species | Seeding Rate (lb/acre) | Wetland Tolerance |
|---|---|---|---|---|
| *Andropogon gerardii* | Big blue stem | 10% | 0.75 | FAC |
| *Dichanthelium clandestinum* | Deer tongue | 10% | 0.75 | FACW |
| *Polygonum pennsylvanicum* | Pennsylvania smartweed | 5% | 0.75 | FACW |
| *Agrostis alba* | Redtop | 5% | 0.75 | FACW |
| *Chasmanthium latifolium* | River oats | 5% | 0.75 | FACU |
| *Elymus virginicus* | Virginia wildrye | 5% | 0.75 | FAC |
| *Juncus effusus* | Soft rush | 5% | 0.75 | FACW+ |
| *Carex lurida* | Lurid sedge | 3% | 0.75 | OBL |
| *Carex crinita* | Fringed sedge | 3% | 0.75 | OBL |
| *Andropogon virginicus* | Broom sedge | 3% | 0.75 | FACU |
| *Vernonia noveboracensis* | New York Ironweed | 3% | 0.75 | FACW |
| *Lobelia cardinalis* | Cardinal flower | 3% | 0.75 | FACW |
| *Andropogon glomeratus* | Bushy bluestem | 5% | 0.75 | FACW |
| *Panicum virgatum* | Switchgrass | 10% | 1.5 | FACW |
| *Bidens frondosa* | Beggars tick | 5% | 0.75 | FACW |
| *Coreopsis lanceolata* | Lance-leaved tick seed | 5% | 0.75 | FACU |
| *Schizachyrium scoparium* | Little blue stem | 5% | 0.75 | FACU |
| *Tripsacum dactyloides* | Eastern gamagrass | 5% | 0.75 | FAC+ |
| *Sorghastrum nutans* | Indiangrass | 5% | 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 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.

## 6.6 Agricultural Best Management Practices

WLS proposes various agricultural best management practices (BMPs) as practices or measures to be implemented with the mitigation activities. 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 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 pollutant inputs are 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. 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 permanent crossings. 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 culverted stream crossings will have pipes sized to pass the 10-year design storm to ensure proper hydraulic function and stream stability, as well as to encourage aquatic passage.

## 6.7 Water Quality Treatment Features

Water quality treatment features in the form of small basins or impoundments designed to 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 small basins will capture overland flow, increase infiltration and groundwater recharge, diffuse flow energies, and allow nutrient uptake within the extended riparian buffer area. The water quality treatment features will be constructed inside the conservation easement and fenced out to prevent livestock intrusion. 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 inside the conservation easement boundary.

The features 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. Over time, as vegetation becomes established, the areas will function as shallow wetland complexes or depressions. The weir and outlet channels will be constructed with suitable material and stabilized with permanent vegetation and stone that will deliver reduced runoff and prevent headcut migration or erosion into the newly constructed areas. This strategy will allow these features to function properly with minimal risk and without long-term maintenance requirements. See Appendix 1 design plan sheets for details and feature locations.

## 6.8 Site Construction Methods

### *6.8.1 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). Depressional areas created by general site grading will not exceed a depth of more than eight inches. 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.

### *6.8.2 In-stream Structures and Site Improvement Features*

A variety of in-stream structures are proposed for the project. Structures include log vanes, constructed log and stone riffles, grade control log j-hook vanes, rootwads, log weirs, and stone 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 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 riparian 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).

### *6.8.3 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 ford and culverted stream crossings and pond dams, 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.

### *6.8.4 Future Project Risks and Uncertainties*

In general, this Project has low risk due to the rural nature of the watershed. There is minimal risk that changes in land use upstream in the project watershed would alter the hydrology or sediment supply enough to damage the project streams after construction. The project area has seen little to no development in recent years and it is unlikely development will the threaten the site. Restoration and reforestation of the site streams will reduce the likelihood of future degradation from watershed changes, as erosive flood flows will spread over a wider reconnected floodplain.

There is potential for landowner encroachment into the permanent conservation easement, but this is also low risk. The majority of the conservation easement will have permanent livestock exclusion fencing, and WLS has had discussions with the landowner regarding the requirements of the conservation easement. The easement boundaries will be clearly marked per NCDMS requirements. Any encroachment issues will be addressed by WLS or the long-term steward.

There are six easement breaks on the Project for landowner crossings. Four of these crossings are already existing and will be improved: ford crossings on UT4-R1 lower, BB-R2, and UT2, and culvert crossings on UT1-R2 and UT1-R3. A new 30-foot culvert crossing will be installed on UT4-R1 upper to allow landowner access to their property.

While there was no evidence of recent beaver activity during recent assessments, there is potential for beavers to colonize the site during the monitoring period of the project. WLS will take steps to trap and remove beaver if they colonize the site during the monitoring period.

# 7 Performance Standards

The applied success criteria for the project will follow the approved performance standards and monitoring protocols presented in this mitigation plan, which have been developed in compliance with the *DMS Stream and Wetland Mitigation Plan Template Guidance*, adopted June 2017, as well as the *USACE Wilmington District Stream and Wetland Compensatory Mitigation Update* issued in October 2016, 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 *DMS's Stream and Wetland Mitigation Monitoring Guidelines* issued April 2015, the *As-built Baseline Monitoring Report Format, Data Requirements, and Content Guidance* issued in June 2017, the *Annual Monitoring Report Format, Data Requirements, and Content Guidance*, issued June 2017, and the *NCDMS Closeout*

*Report Template*, Version 2.2, adopted January 2016. Monitoring activities will be conducted for a period of seven years with the final duration dependent upon performance trends toward achieving project goals and objectives. Specific success criteria components and evaluation methods are described below.

## 7.1 Streams

***Stream Hydrology*:** Four bankfull flow events must be documented within the seven-year monitoring period. The bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until four bankfull events have been documented in separate years.

***Stream Profiles, Vertical Stability, and Floodplain Access:*** Stream profiles, as a measure of vertical stability and floodplain access will be evaluated by looking at Bank Height Ratios (BHR). In addition, observed bedforms should be consistent with those observed for channels of the design stream type(s). The BHR shall not exceed 1.2 along the restored Project stream reaches. This standard only applies to restored reaches of the channel where BHRs were corrected through design and construction. 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 evaluate horizontal stream stability. There should be little change expected in as-built restoration cross-sections. If measurable changes do occur, they should be evaluated to determine if the changes represent a movement toward a more unstable condition (e.g., downcutting, erosion) or a movement towards increased stability (e.g., settling, vegetation establishment, deposition along the streambanks, decrease in width/depth ratio). Cross-sections shall be classified using the Rosgen Stream Classification method and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

***Streambed Material Condition and Stability:*** After construction, it is 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 intermittent streams must exhibit 30 days of continuous flow for some portion of the year during a year with normal rainfall conditions.

## 7.2 Wetlands

***Wetland Hydrology*:** The performance standard for wetland hydrology will be 8% percent based on the suggested wetland saturation thresholds for soils taxonomic subgroups. The proposed success criteria for wetland hydrology will be when the soils are saturated within 12 inches of the soil surface for 8% (14 days) of the 177-day growing season (April through October) based on WETS data table for Stokes County, NC.

The saturated conditions should occur during a period when antecedent precipitation has been normal or drier than normal for a minimum frequency of 5 years in 10 (USACE, 2005 and 2010b). Precipitation data will be obtained from an on-site rain gauge and the Danbury WETS Station, approximately 11 miles south of the Project site. If a normal year of precipitation does not occur during the first seven years of monitoring, WLS will continue to monitor the Project hydrology until the Project site has been saturated for the appropriate hydroperiod. If rainfall amounts for any given year during the monitoring period are abnormally low, reference wetland hydrology data will be compared to determine if there is a correlation with the weather conditions and site variability.

### 7.3 Vegetation

Vegetative restoration success for the project during the intermediate monitoring years will be based on the survival of at least 320, three-year-old planted trees per acre at the end of Year 3 of the monitoring period (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 six feet in height after MY5 and eight feet in height at MY7 before closeout.

## 8 Monitoring Plan

In accordance with the approved mitigation plan, the baseline monitoring document and as-built report documenting the mitigation activities will be developed within 60 days of the completion of planting and monitoring device installation at the restored Project. 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 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 8.4 summarizes the monitoring methods and linkage between the goals, parameters, and expected functional lift outcomes. Figure 6 illustrates the pre-construction and Figure 10 illustrates the post-construction monitoring feature types and location.

In addition to the performance monitoring tied to success criteria, WLS will also collect benthic macroinvertebrate (BMI) communities, aquatic habitat, and water quality samples at two locations (Site 1 along BB-R3 and Site 2 along UT4-R2) within the proposed project area. Pre-restoration sampling was conducted in October 2019 (See assessment forms in Appendix 1) following DWR Biological Assessment Branch protocols and additional sampling will be conducted again in Spring/Summer months during post-construction monitoring years 3 and 7. Water sampling procedures will measure basic parameters such as water temperature (°C), Dissolved oxygen (mg/l), Conductivity (uS/cm) and pH levels to document any changes during the monitoring period.

## 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 and taken at the cross-sections. WLS will also have photo points at the culvert crossing locations. 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 four required bankfull events (overbank flows) within the monitoring period, along with floodplain access by flood flows, will be documented using pressure transducers and photography. The pressure transducers will be installed on the floodplain of the restored channels for monitoring. The pressure transducers will record the flood stage between monitoring site visits and used to determine if a bankfull or significant flow event occurred since the previous site visit. Corresponding photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits. This hydrologic 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*

***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.

***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.

***Dimension:*** Permanent cross-sections will be installed and surveyed at an approximate rate of one cross-section per 20 bankfull widths or an average distance interval (not to exceed 500 LF) of restored stream, with approximately 20 cross-sections with half located at riffles and half 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 looking downstream 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.

***Substrate:*** Representative streambed material samples will be collected in year 5 and 7 at the locations where riffles are installed in reaches that are proposed for restoration 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 gauge will be installed on the site to compare precipitation amounts using tallied data obtained from on site and the Danbury WETS station. 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 restored intermittent reaches will include the installation of flow devices (continuous-read pressure transducers) within the thalweg (bottom) of the channel towards the upper-third portion of the reach. In addition, photographic documentation using a continuous series of remote photos over time may 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 Project site are documented in each monitoring period and will be shown on a plan view map. The devices will be inspected on a quarterly basis to document surface hydrology and provide a basis for evaluating flow response to rainfall events and surface runoff throughout the monitoring period (KCI, 2010).

## 8.3 Wetland Monitoring

Automated groundwater monitoring wells will be installed to document hydrologic conditions of the restored wetland areas to determine hydrologic success criteria are achieved. An additional gauge will be installed in an on-site reference wetland area and used to compare the hydrologic response within the restored wetland area. Groundwater monitoring wells will be installed to record daily groundwater levels in accordance with the USACE standard methods described in "*Technical Standard for Water Table Monitoring of Potential Wetland Sites*" (ERDC TN-WRAP-05-2, June 2005). The objective for the monitoring well data is to demonstrate that the Project site exhibits an increased flood frequency as compared to pre-restoration conditions and on-site reference conditions.

## 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 20 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, 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 noted and if they are on the approved planting list and meet success criteria standards, they will be counted towards success criteria. Other species not included on the list may be considered by the IRT on a case-by-case basis. The presence of invasive species vegetation within the monitoring quadrants will also be noted, as will any wildlife effects.

At the end of the first full growing season (from baseline/year 0) or after 180 days, 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 Stream Base Flow Duration and Overbank Flows (i.e. channel forming discharge); Wetland Hydrology | Well device (pressure transducer), regional curve, regression equations, catchment assessment; Percent saturation with well device | Maintain seasonal flow on intermittent stream for a minimum of 30 consecutive days during normal annual rainfall; Wetland hydrology for 8% of growing season | Create a more natural and higher functioning headwater flow regime and provide aquatic passage; re-establish appropriate wetland hydroperiods and provide hydrologic storage |
| **Hydraulics (Level 2)** | Reconnect Floodplain / Increase Floodprone Area Widths | Bank Height Ratio, Entrenchment Ratio, crest gauge | Maintain average BHRs ≤1.2 and ERs ≥2.2 (1.4 for 'B' stream types) and document out of bank and/or significant flow events using pressure transducers or photographs & crest gauges | 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, sediment sampling | Decrease streambank erosion rates comparable to reference condition cross-section, pattern and vertical profile values. Compare changes to bedform and substrate at year five and seven of monitoring period. | 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, Vigor, 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 | Water temperature (°C), Dissolved oxygen (mg/l), Conductivity (uS/cm) and pH | N/A | Removal of excess nutrients, fecal coliform 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 | 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 DMS and the members of the NCIRT, and will work with DMS and 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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# Figures

## Banner Branch Mitigation Project

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Figure 2 – Existing Geology Map
Figure 3 – USGS Topographic Map
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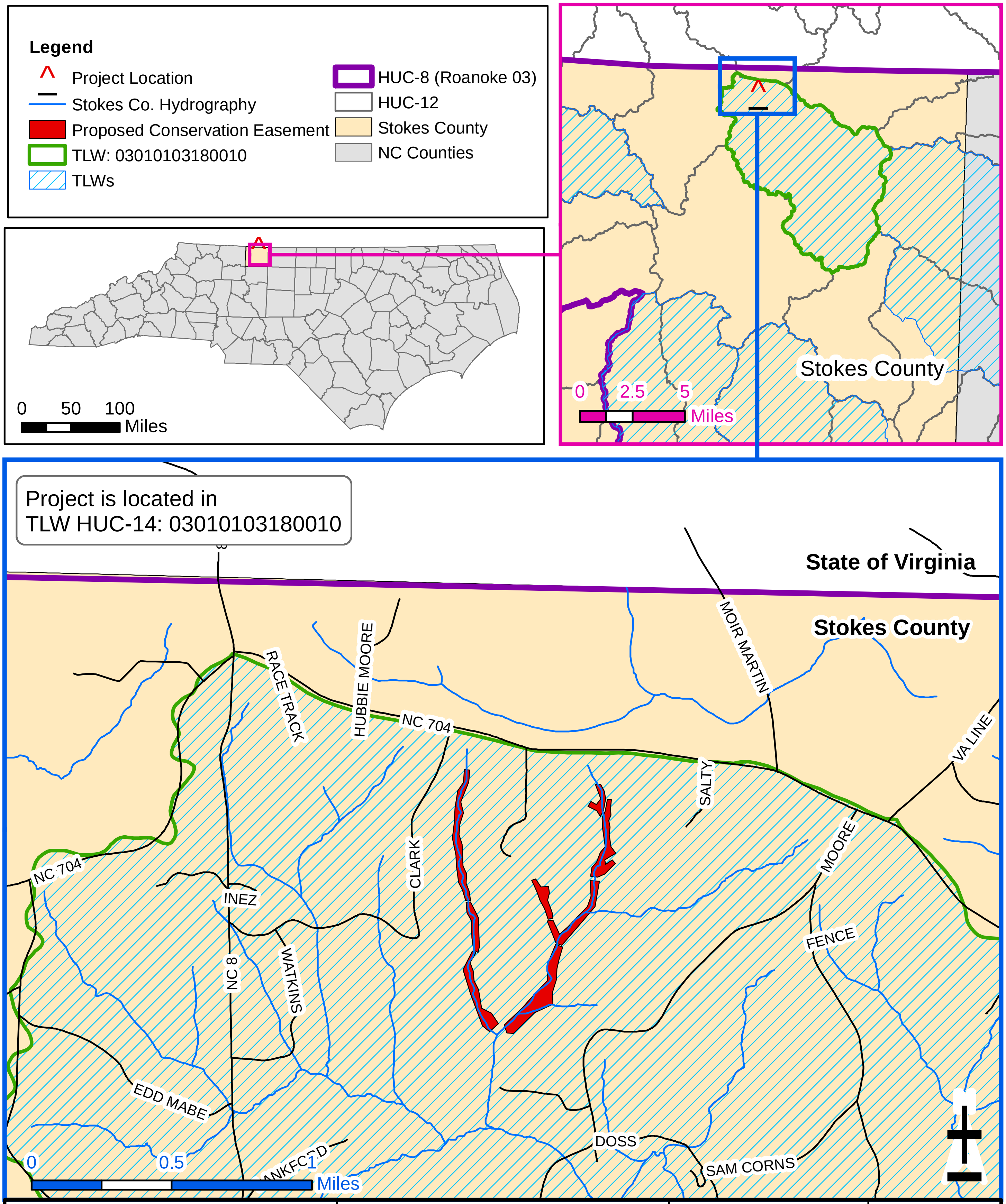
Figure 7b – 2008 Aerial Photograph
Figure 7c – 2013 Aerial Photograph
Figure 8 – FEMA Floodplain Map
Figure 9 – Proposed Mitigation Features Map
Figure 10 – Proposed Monitoring Features Map
Figure 11 – Reference Site Location Map



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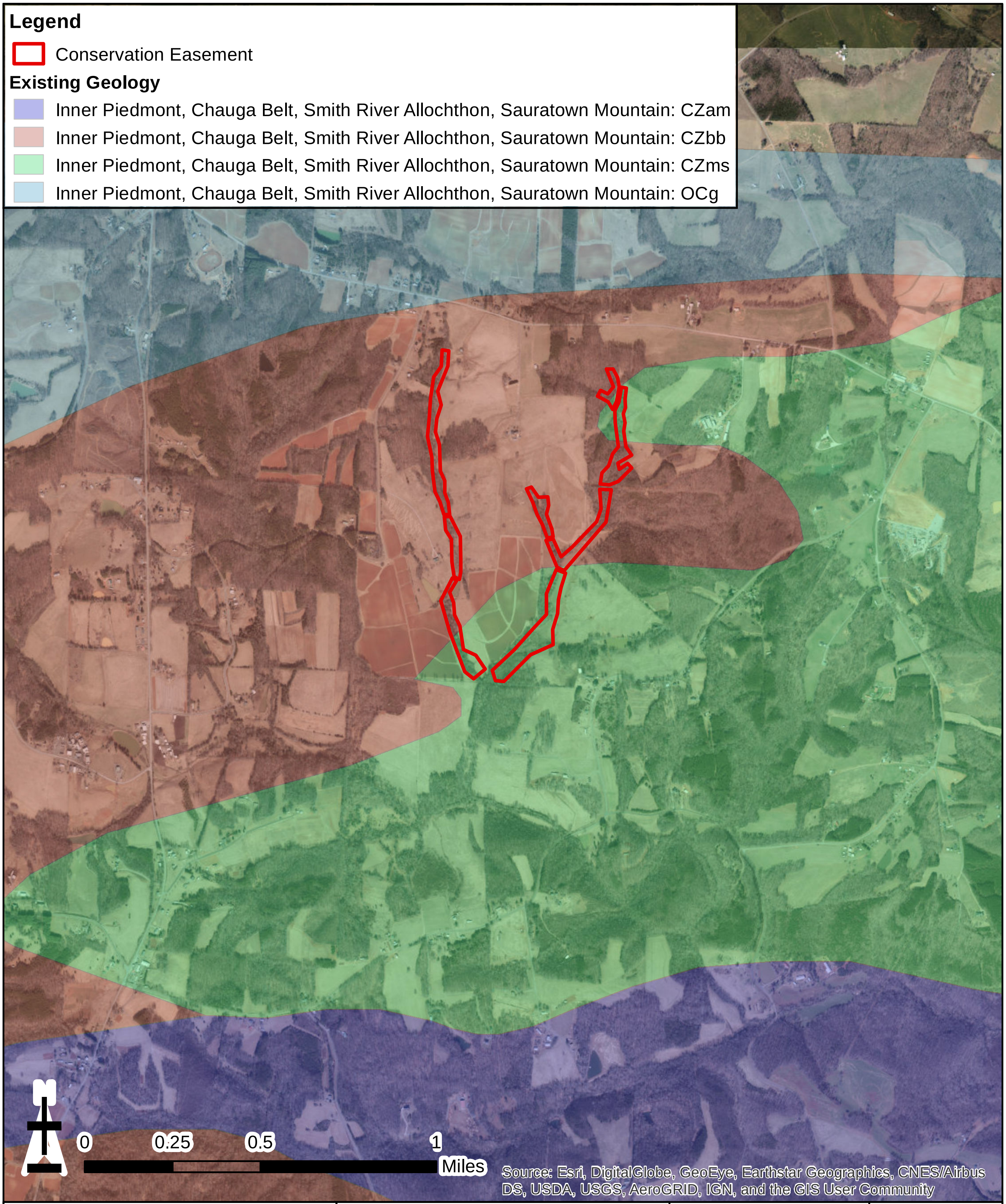
Vicinity Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
1



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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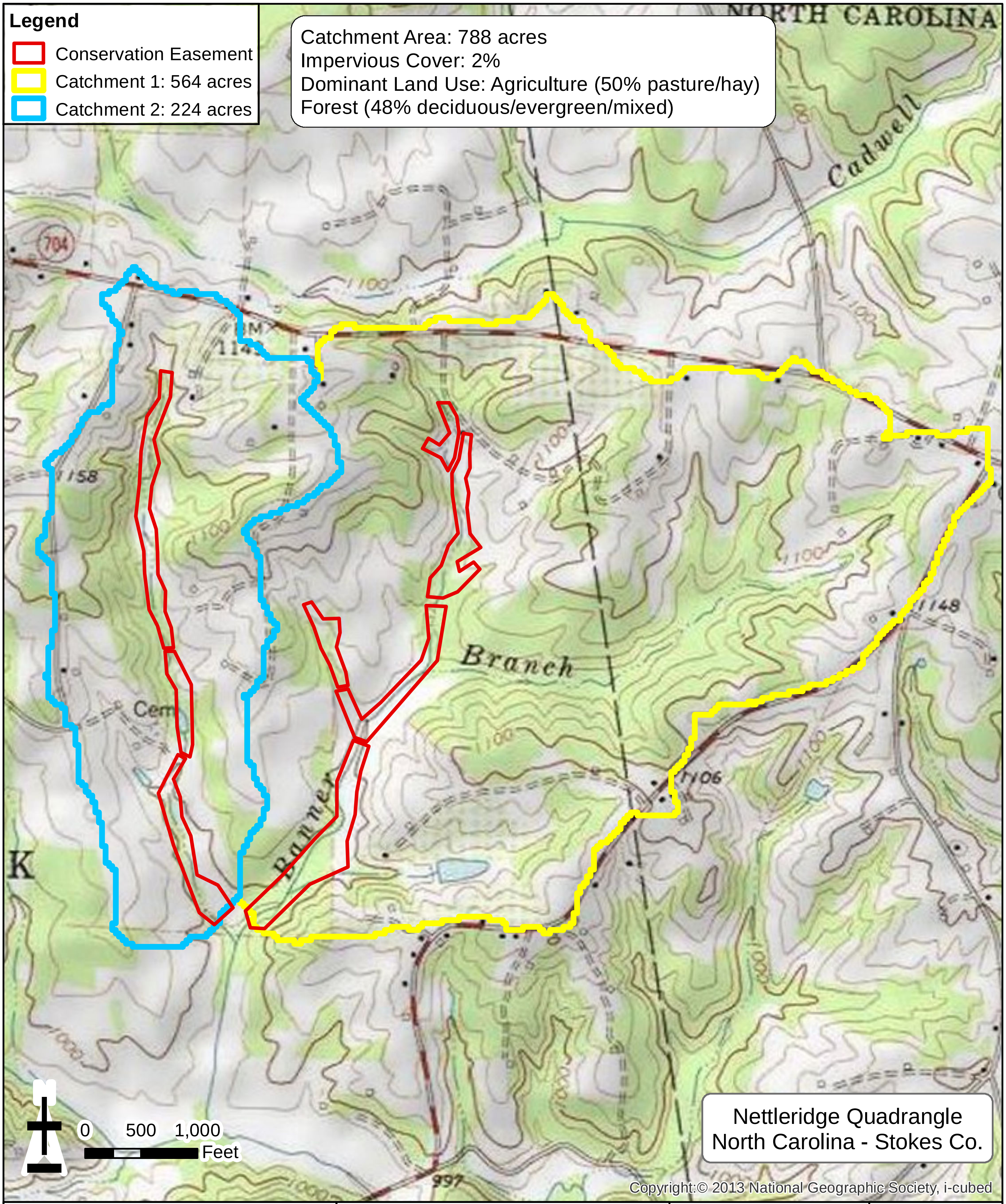
Existing Geology
Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
2



**Legend**

🟥 Conservation Easement
🟨 Catchment 1: 564 acres
🟦 Catchment 2: 224 acres

Catchment Area: 788 acres
Impervious Cover: 2%
Dominant Land Use: Agriculture (50% pasture/hay)
Forest (48% deciduous/evergreen/mixed)

Nettleridge Quadrangle
North Carolina - Stokes Co.

Copyright:© 2013 National Geographic Society, i-cubed

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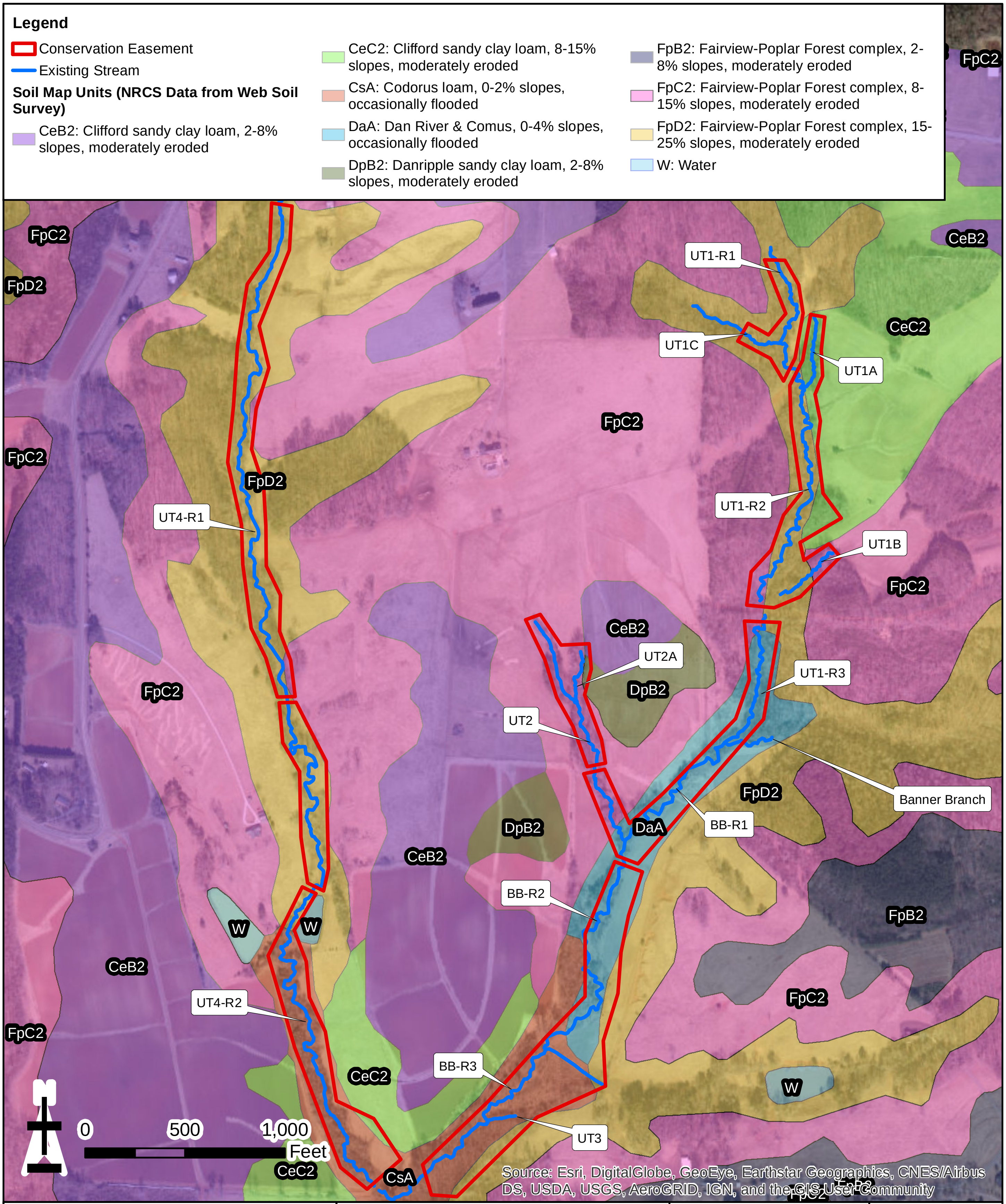
Mitigation Project

USGS
Topographic
Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
3



**Legend**

🟥 Conservation Easement

— Existing Stream

**Soil Map Units (NRCS Data from Web Soil Survey)**

- CeB2: Clifford sandy clay loam, 2-8% slopes, moderately eroded
- CeC2: Clifford sandy clay loam, 8-15% slopes, moderately eroded
- CsA: Codorus loam, 0-2% slopes, occasionally flooded
- DaA: Dan River & Comus, 0-4% slopes, occasionally flooded
- DpB2: Danripple sandy clay loam, 2-8% slopes, moderately eroded
- FpB2: Fairview-Poplar Forest complex, 2-8% slopes, moderately eroded
- FpC2: Fairview-Poplar Forest complex, 8-15% slopes, moderately eroded
- FpD2: Fairview-Poplar Forest complex, 15-25% slopes, moderately eroded
- W: Water

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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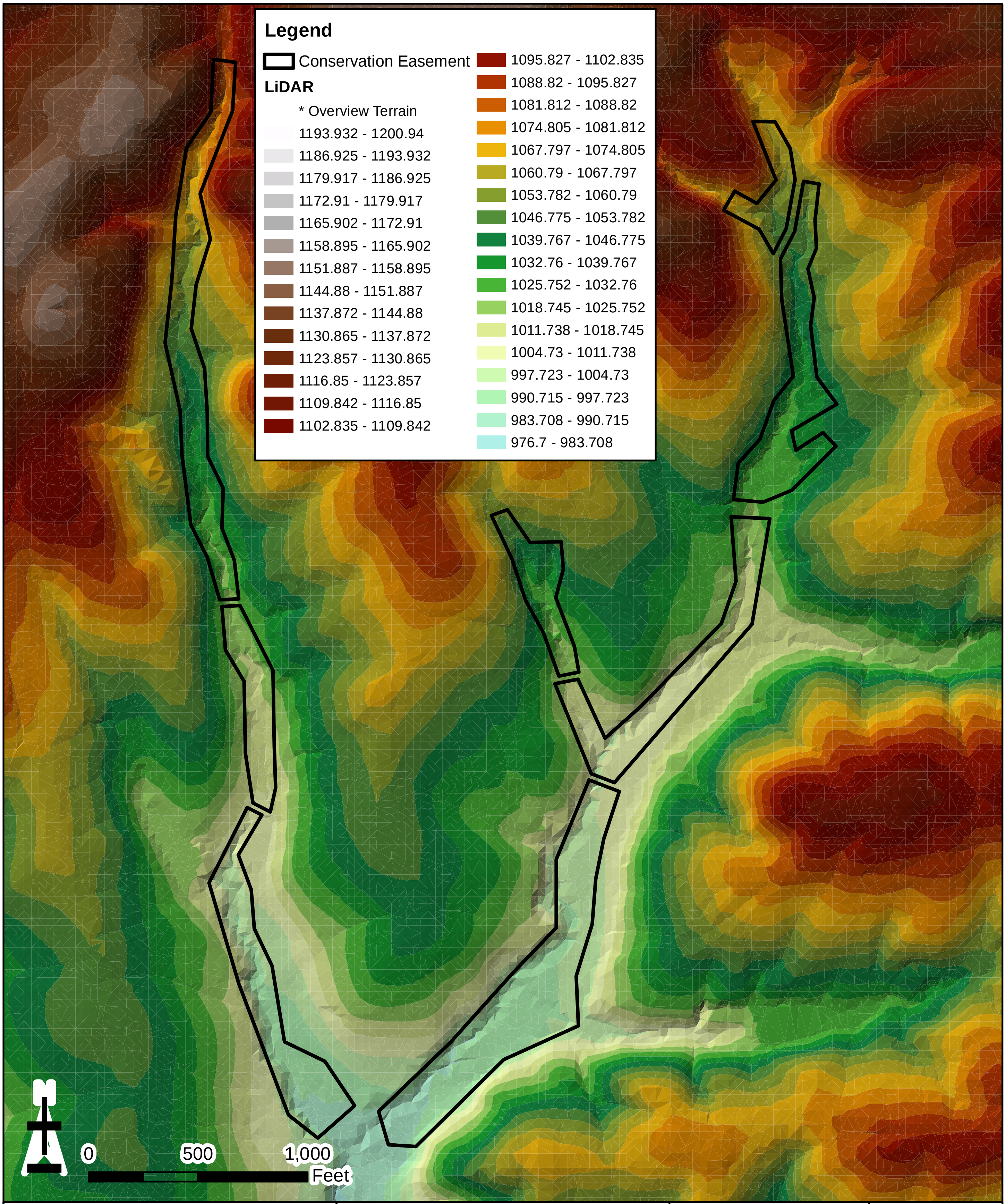
Banner Branch
Mitigation Project

NRCS
Soils Map

**NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US**

FIGURE
4



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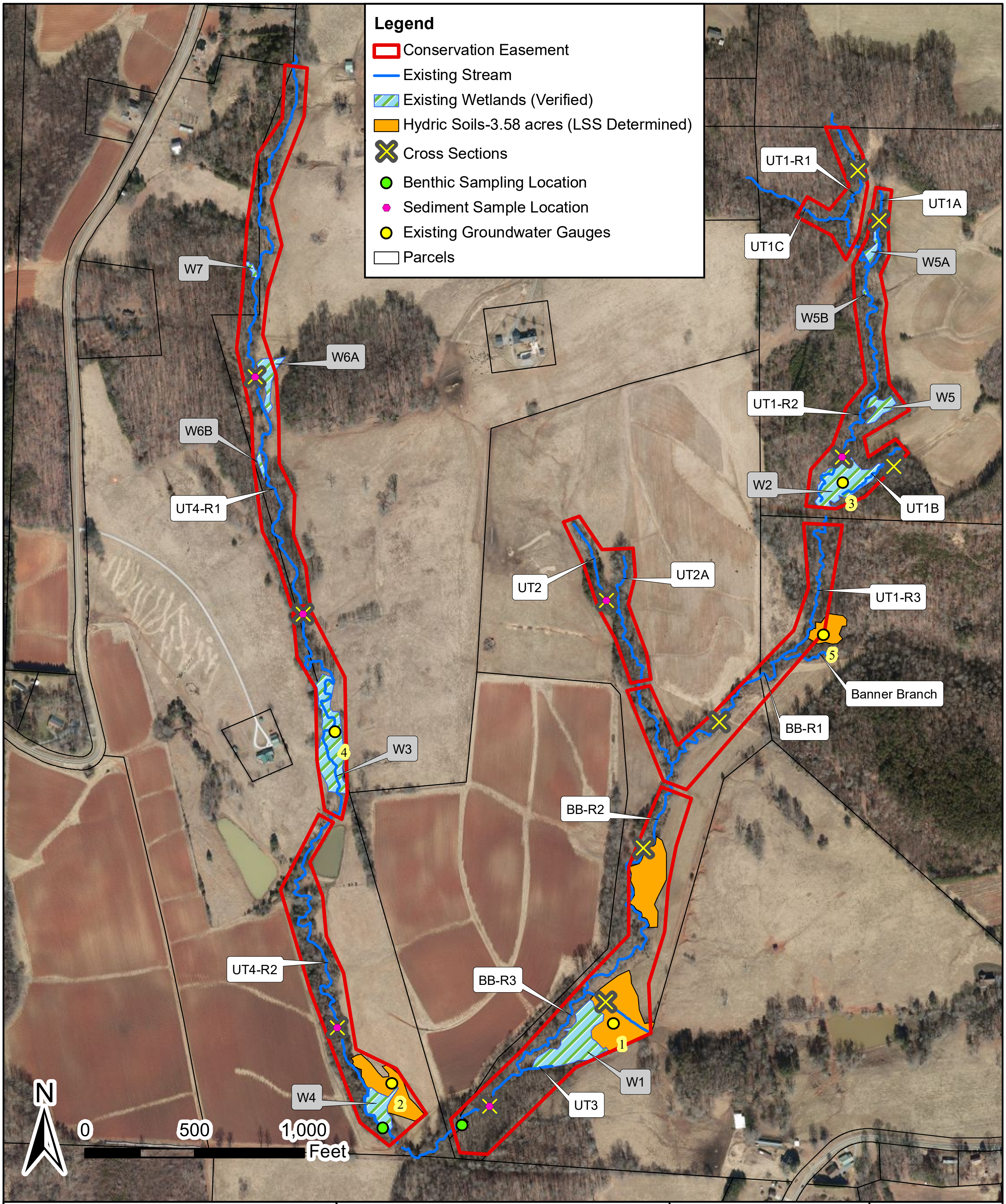
LiDAR Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
5



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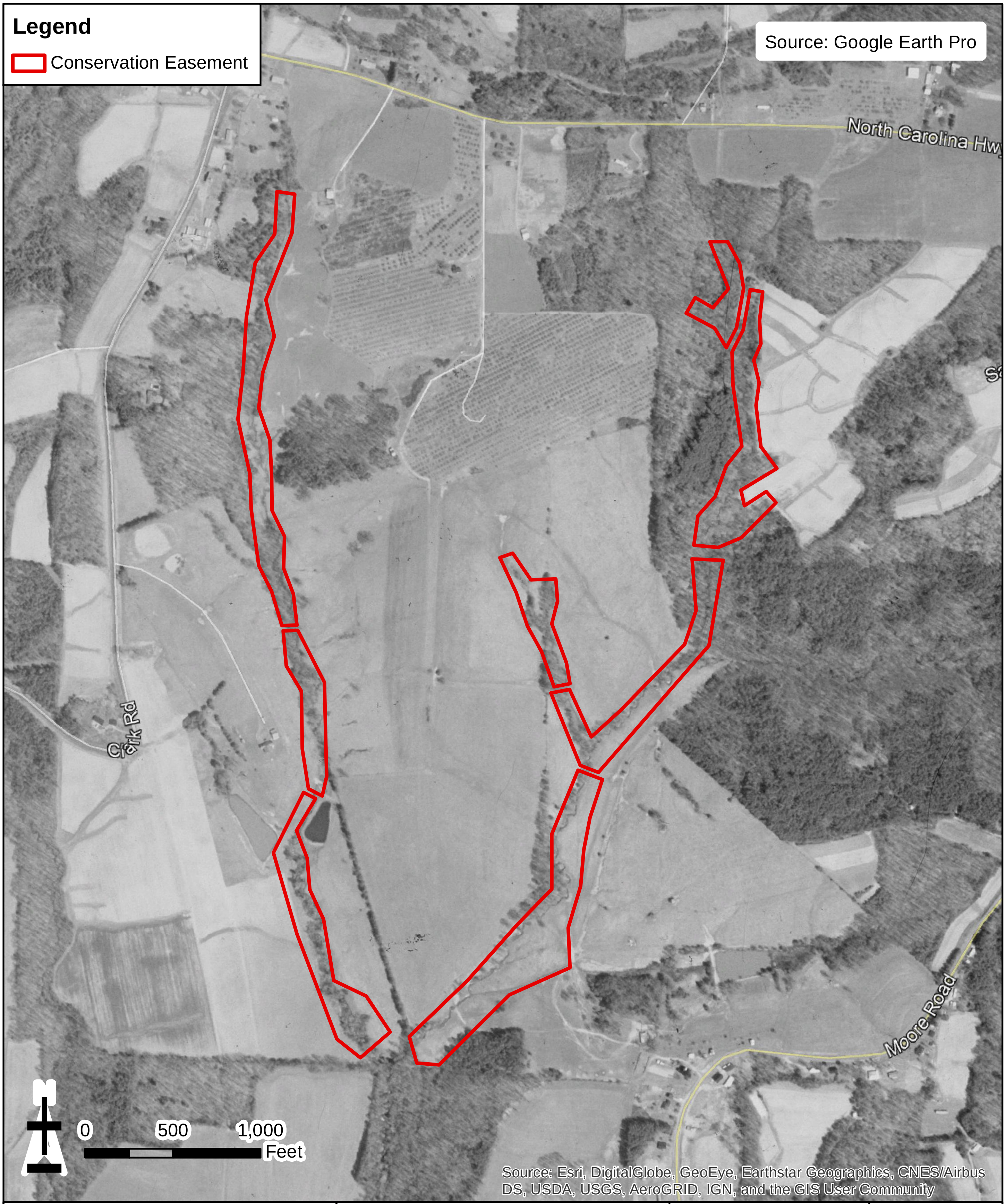
Mitigation Project

Current Conditions
Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
6



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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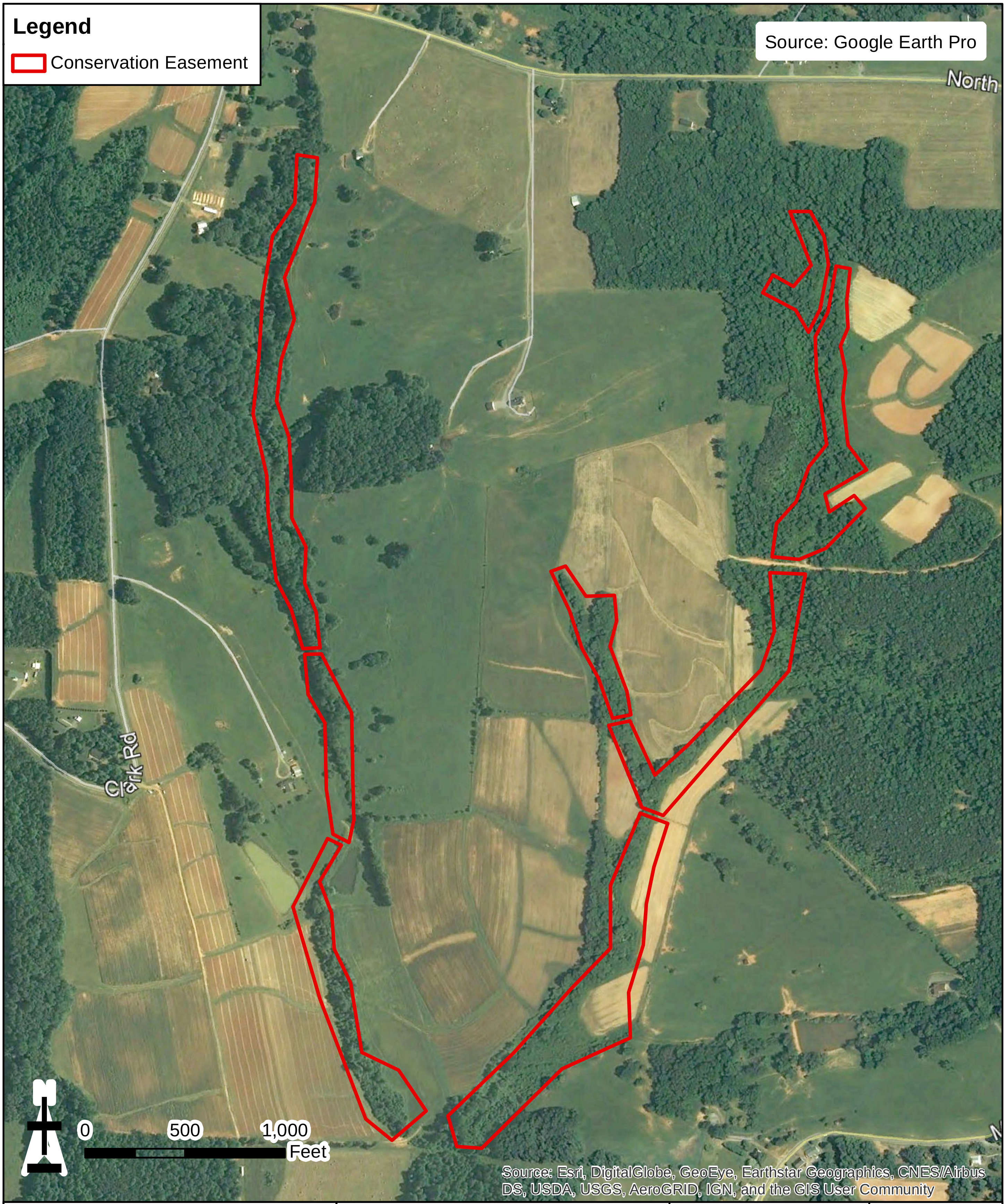
Mitigation Project

1996 Historical
Aerial

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
7a



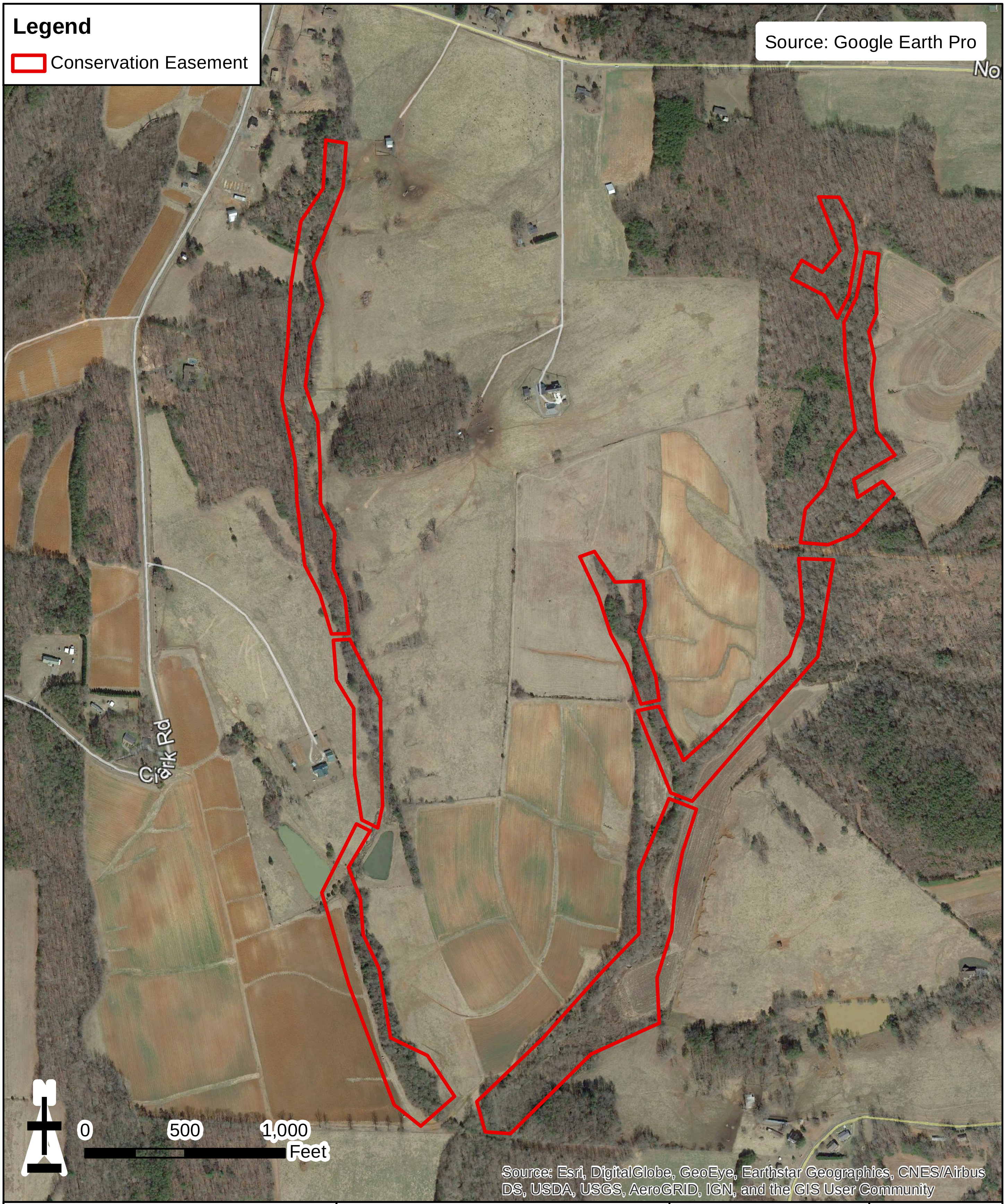
WATER & LAND™ SOLUTIONS

Banner Branch
Mitigation Project

2008 Historical
Aerial

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
7b



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

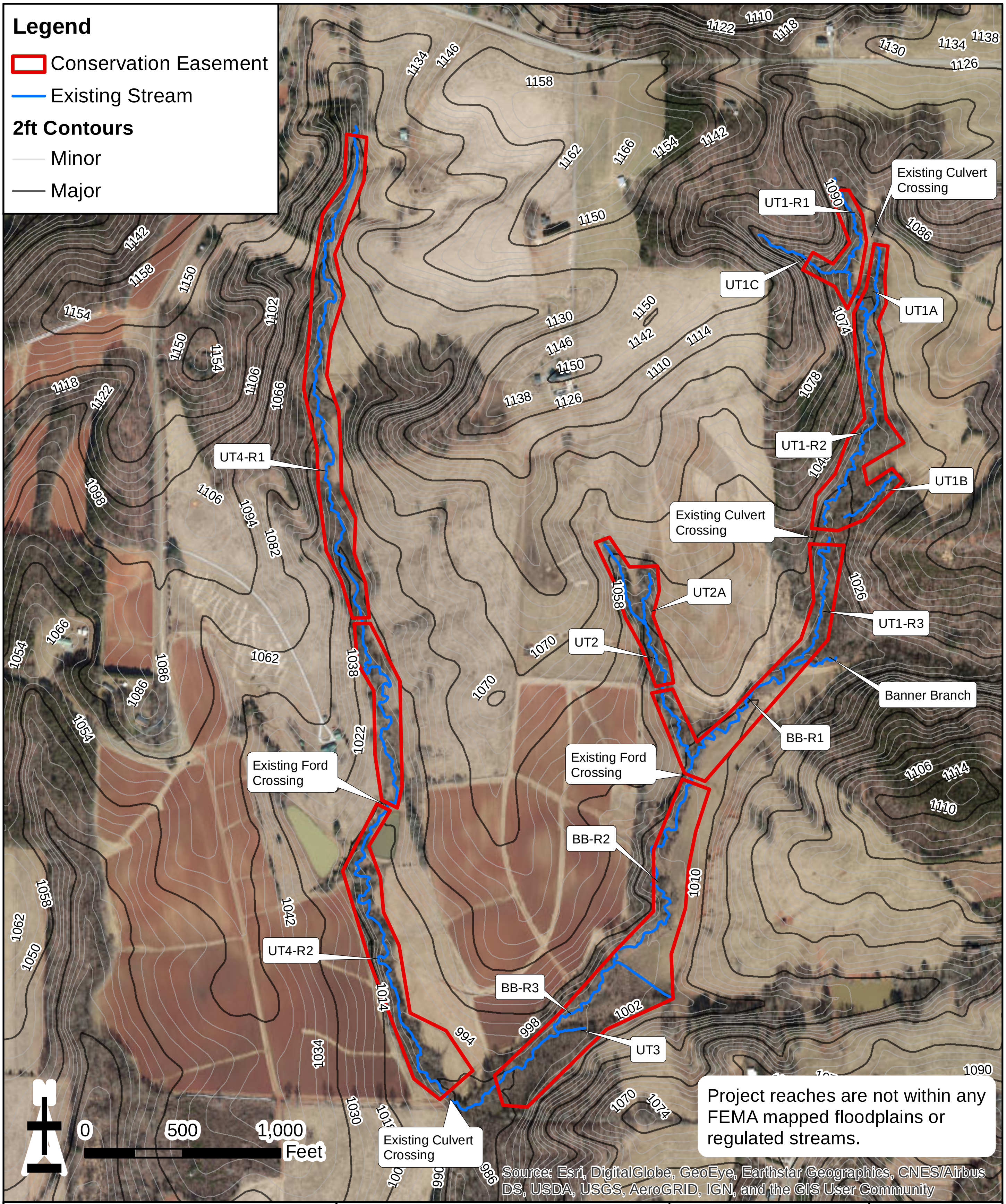
WATER & LAND™
SOLUTIONS

Banner Branch
Mitigation Project

2013 Historical
Aerial

**NAD 1983 2011 State Plane**
**North Carolina FIPS 3200 FT US**

FIGURE
7c



Project reaches are not within any FEMA mapped floodplains or regulated streams.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

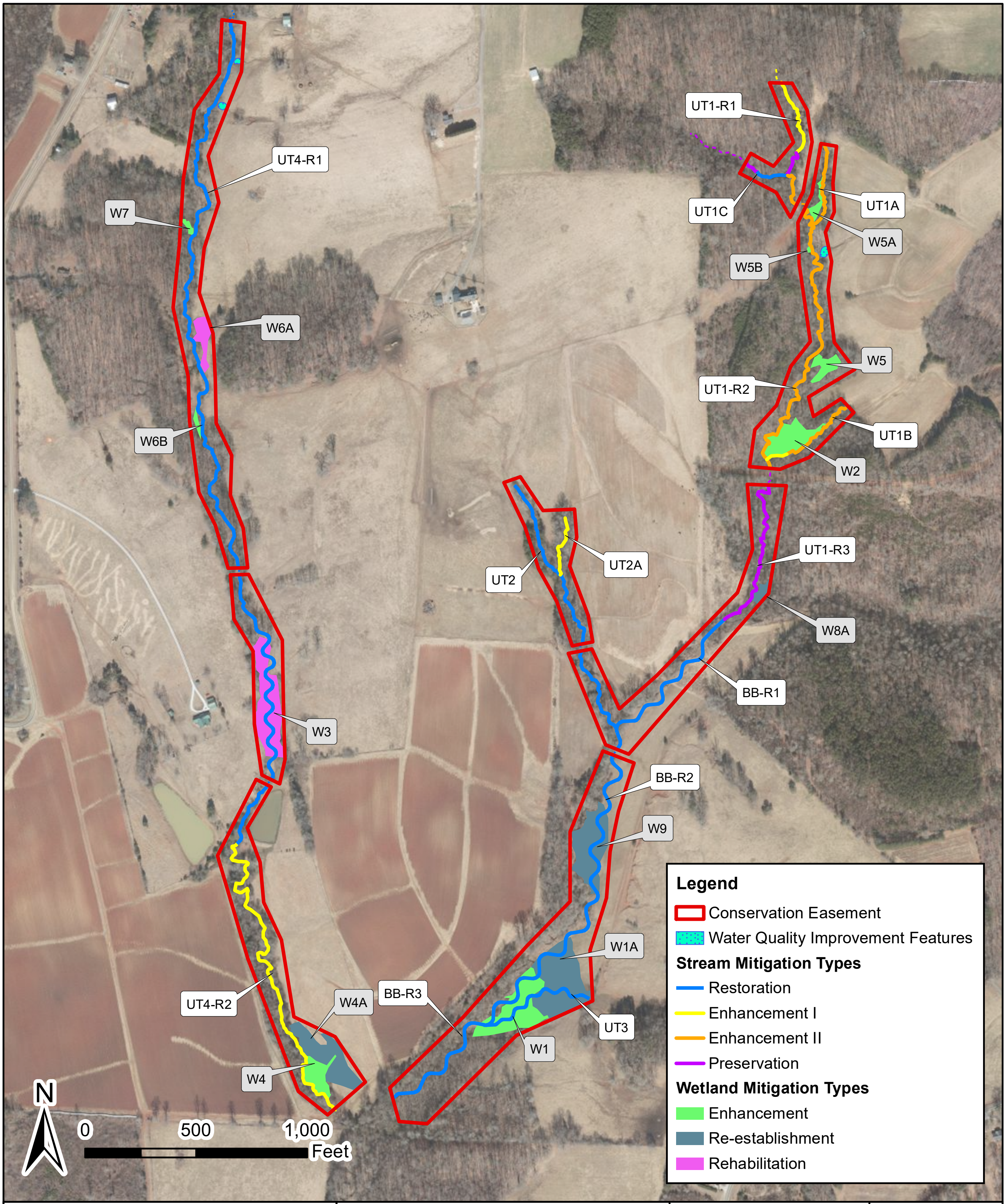
WATER & LAND™ SOLUTIONS

Banner Branch
Mitigation Project

FEMA Floodplain Map

**NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US**

FIGURE
8



**Legend**

🟥 Conservation Easement

▨ Water Quality Improvement Features

**Stream Mitigation Types**

- Restoration
- Enhancement I
- Enhancement II
- Preservation

**Wetland Mitigation Types**

🟩 Enhancement

▨ Re-establishment

▨ Rehabilitation

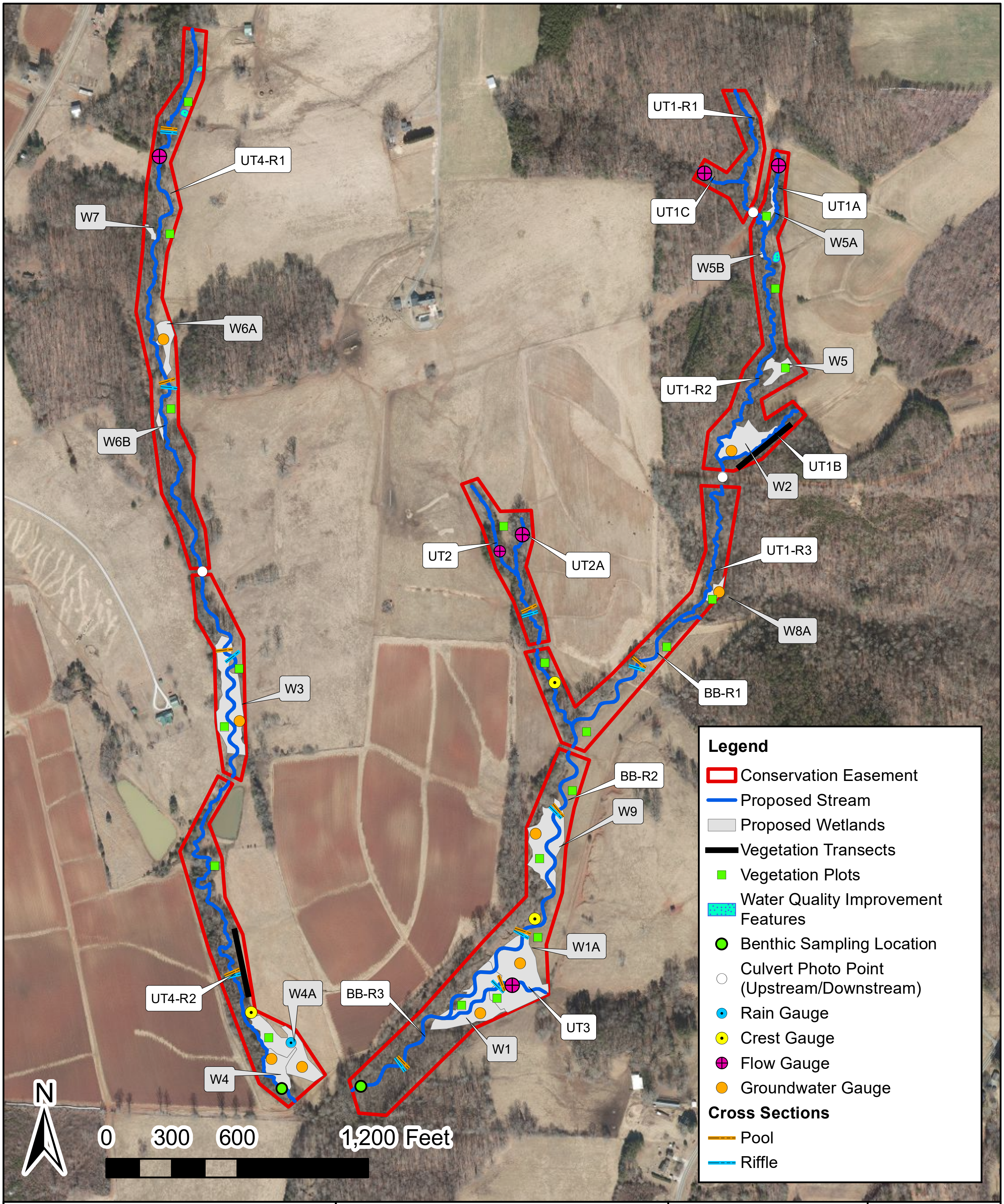
WATER & LAND™ SOLUTIONS

Banner Branch
Mitigation Project

Proposed Mitigation
Features
Map

**NAD 1983 2011 State Plane**
**North Carolina FIPS 3200 FT US**

FIGURE
**9**



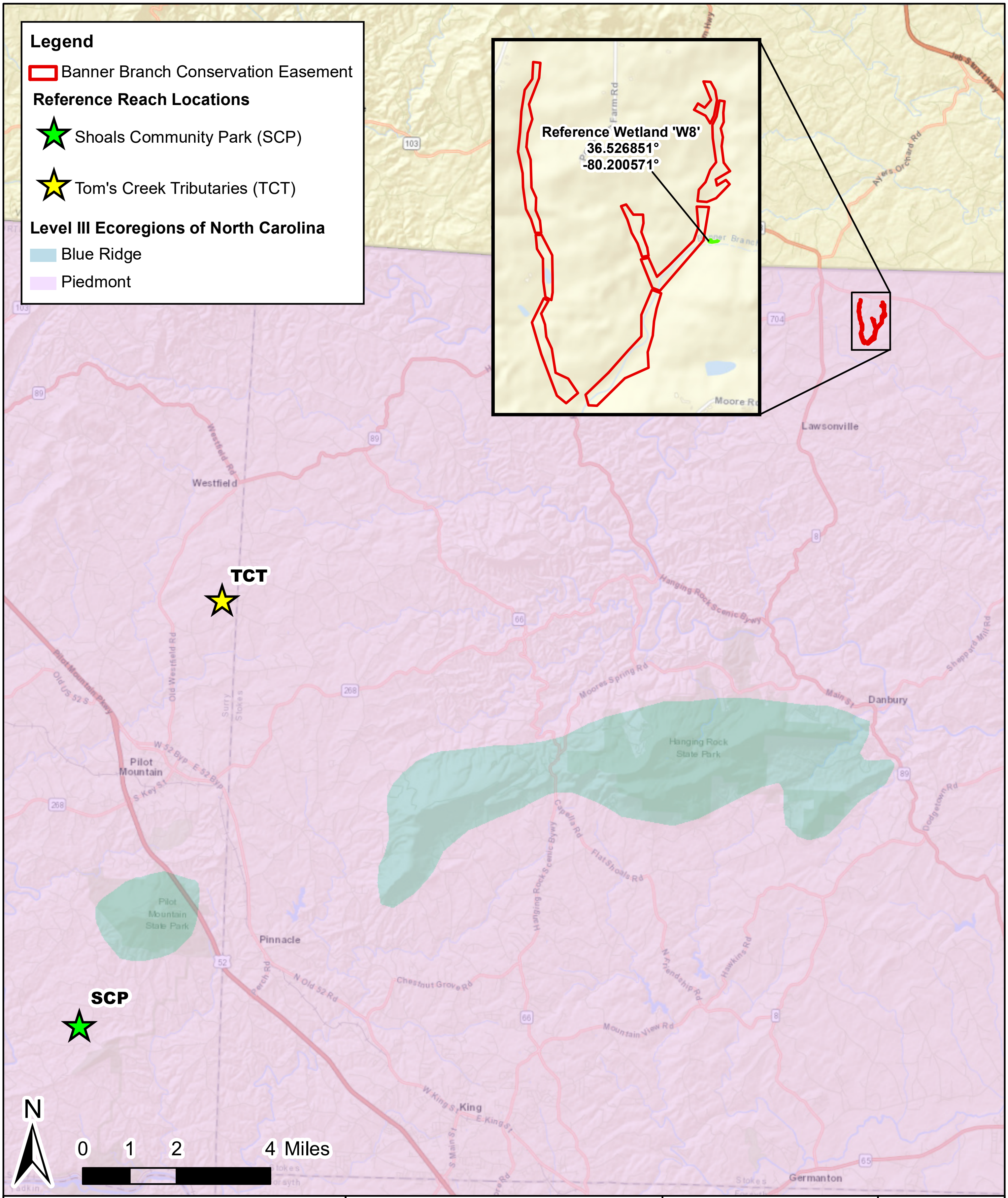
WATER & LAND™
SOLUTIONS

Banner Branch
Mitigation Project

Proposed Monitoring
Features
Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
**10**



**WATER & LAND SOLUTIONS**™

Banner Branch
Mitigation Project

Reference Site
Location
Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
**11**

# Appendix 1 – Plan Sheets

# DEPARTMENT OF ENVIRONMENTAL QUALITY - DIVISION OF MITIGATION SERVICES

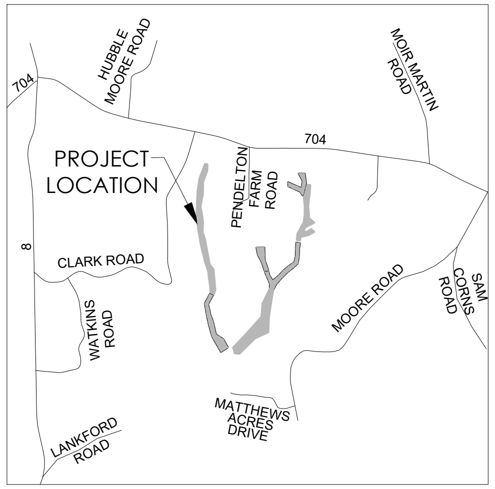
# BANNER BRANCH MITIGATION PROJECT

## STOKES COUNTY, NORTH CAROLINA

NCDEQ - DMS PROJECT ID #100080
NCDEQ - DMS CONTRACT #7610 & #7701 UNDER RFP 16-007405
ROANOKE RIVER BASIN (CU 03010103)
USACE ACTION ID # SAW-2018-01760
TYPE OF WORK : STREAM & WETLAND 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 | Mitigation Type | Proposed Stream Length (LF) | Mitigation Ratio | Stream Mitigation Credits (SMCs) |
|---|---|---|---|---|
| UT1-R1 (upper) | Stream Enhancement Level I | 373 | 1.5:1 | 248.667 |
| UT1-R1 (lower) | Stream Preservation | 136 | 10:1 | 13.600 |
| UT1-R2 | Stream Enhancement Level II | 1,783 | 2.5:1 | 713.200 |
| UT1-R3 | Stream Preservation | 822 | 10:1 | 82.200 |
| UT1A | Stream Enhancement Level II | 410 | 2.5:1 | 164.000 |
| UT1B (upper) | Stream Enhancement Level II | 391 | 2.5:1 | 156.400 |
| UT1B (lower) | Stream Enhancement Level I | 97 | 1.5:1 | 64.667 |
| UT1C (upper) | Stream Preservation | 69 | 10:1 | 6.900 |
| UT1C (lower) | Stream Restoration | 151 | 1:1 | 151.000 |
| UT2 | Stream Restoration (PI) | 1,287 | 1:1 | 1,287.000 |
| UT2A | Stream Enhancement Level I | 289 | 1.5:1 | 192.667 |
| UT3 | Stream Restoration (PI) | 589 | 1:1 | 589.000 |
| BB-R1 | Stream Restoration (PI) | 808 | 1:1 | 808.000 |
| BB-R2 | Stream Restoration (PI) | 1,835 | 1:1 | 1,835.000 |
| BB-R3 | Stream Restoration (PI/PII) | 636 | 1:1 | 636.000 |
| UT4-R1 (upper) | Stream Restoration (PI/PII) | 2,346 | 1:1 | 2,346.000 |
| UT4-R1 (lower) | Stream Restoration (PI) | 1,963 | 1:1 | 1,916.400 |
| UT4-R2 | Stream Enhancement Level I | 1,722 | 1.5:1 | 1,148.000 |
| **Total** | | **15,707** | | **12,358.700** |

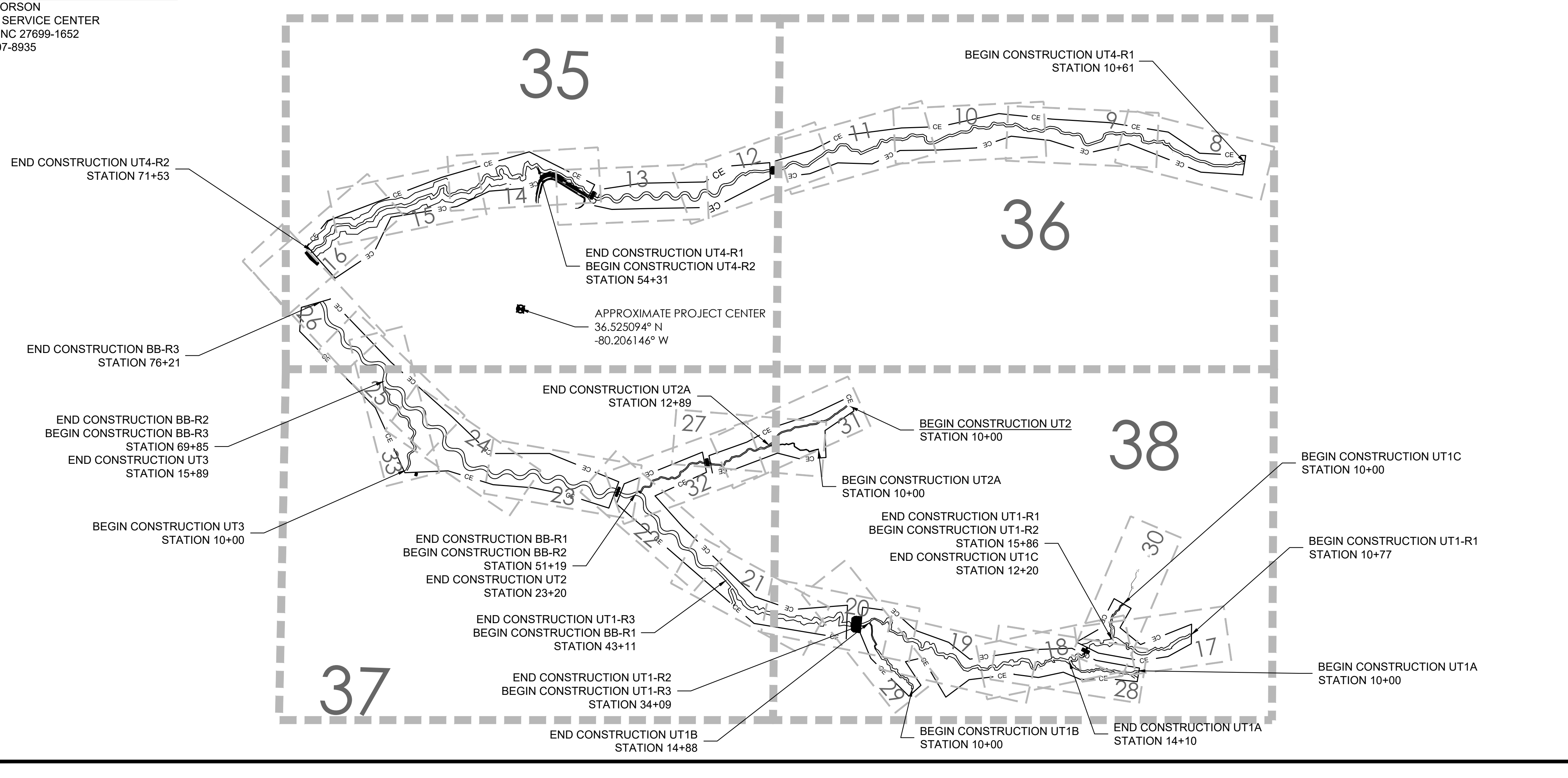
*Note 1: No mitigation credits were calculated outside the conservation easement boundaries.*

| Project Wetland Area | Mitigation Type | Proposed Wetland Acreage (AC) | Mitigation Ratio | Riparian Wetland Mitigation Credits (RWMCs) |
|---|---|---|---|---|
| W1 | Wetland Enhancement | 0.825 | 2:1 | 0.413 |
| W1A | Wetland Re-establishment | 1.240 | 1:1 | 1.240 |
| W2 | Wetland Enhancement | 0.524 | 2:1 | 0.262 |
| W3 | Wetland Rehabilitation | 0.888 | 1.5:1 | 0.592 |
| W4 | Wetland Enhancement | 0.321 | 2:1 | 0.161 |
| W4A | Wetland Re-establishment | 0.808 | 1:1 | 0.808 |
| W5 | Wetland Enhancement | 0.203 | 2:1 | 0.102 |
| W5A | Wetland Enhancement | 0.097 | 2:1 | 0.048 |
| W5B | Wetland Enhancement | 0.010 | 2:1 | 0.005 |
| W6A | Wetland Rehabilitation | 0.251 | 1.5:1 | 0.167 |
| W6B | Wetland Enhancement | 0.045 | 2:1 | 0.022 |
| W7 | Wetland Enhancement | 0.041 | 2:1 | 0.020 |
| W8A | Wetland Re-establishment | 0.107 | 1:1 | 0.107 |
| W9 | Wetland Re-establishment | 0.823 | 1:1 | 0.823 |
| **Total** | | **6.182** | | **4.770** |

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

### SHEET INDEX

| | |
|---|---|
| 1 | COVER SHEET |
| 2 | LEGEND/CONSTRUCTION SEQUENCE /GENERAL NOTES |
| 3 | TYPICAL SECTIONS |
| 4-8 | DETAILS |
| 9-34 | PLAN AND PROFILE |
| 35-39 | REVEGETATION PLAN |



WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

36916
CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

| NO. | DESCRIPTION | DATE |
|---|---|---|
| A | DRAFT MIT PLAN | 12-27-19 |
| B | FINAL DRAFT PLAN | 3-26-20 |
| C | FINAL MIT PLAN | 7-24-20 |
| | | |
| | | |
| | | |

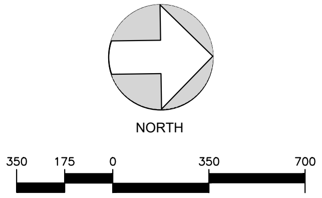
PROJECT NAME

BANNER
BRANCH
MITIGATION
PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

| | |
|---|---|
| PROJECT NO. | 18-007 |
| FILENAME | 01_BANNER BRANCH_COVER.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 700' |
| VERT. SCALE | N/A |



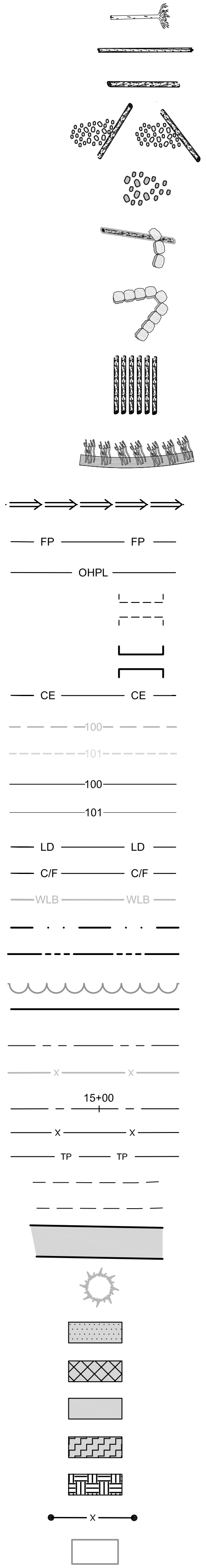
GRAPHIC SCALE

SHEET NAME

COVER SHEET

SHEET NUMBER

# LEGEND



ROOTWAD
LOG VANE
LOG WEIR
STONE AND LOG STEP POOL
CONSTRUCTED STONE RIFFLE
GRADE CONTROL LOG J-HOOK VANE
CONSTRUCTED BOULDER CROSS VANE
CONSTRUCTED LOG RIFFLE
GEOLIFT W/ TOEWOOD
PROPOSED OUTLET CHANNEL
100 YEAR FLOOD PLAIN
EXISTING OVERHEAD ELECTRIC
TEMPORARY STREAM CROSSING
PERMANENT STREAM CROSSING
PROPOSED CONSERVATION EASEMENT BOUNDARY
EXISTING MAJOR CONTOUR
EXISTING MINOR CONTOUR
PROPOSED MAJOR CONTOUR
PROPOSED MINOR CONTOUR
LIMITS OF DISTURBANCE
CUT/FILL LIMITS
EXISTING WETLAND BOUNDARY
EXISTING HYDRIC SOIL BOUNDARY
PROPOSED WETLAND BOUNDARY
EXISTING WOODLINE
PROPOSED TOP OF STREAM BANK
EXISTING PROPERTY BOUNDARY
EXISTING FENCE
PROPOSED CENTERLINE (THALWEG)
PROPOSED FIELD FENCE
PROPOSED TREE PROTECTION FENCE
EXISTING FARM PATH
PROPOSED FARM PATH
EXISTING TREE
PROPOSED WATER QUALITY TREATMENT FEATURE
CHANNEL BLOCK
CHANNEL FILL
FLOODPLAIN DEPRESSION
GRADE, SEED, MATT, AND LIVE STAKE
PROPOSED GATE
EXISTING STRUCTURE

# CONSTRUCTION SEQUENCE

THE ENGINEER WILL PROVIDE CONSTRUCTION OBSERVATION DURING THE CONSTRUCTION PHASE OF THIS PROJECT. THE FOLLOWING CONSTRUCTION SEQUENCE SHALL BE USED DURING PROJECT CONSTRUCTION IMPLEMENTATION. PRIOR TO BEGINNING ANY LAND DISTURBING ACTIVITIES, NOTIFICATION OF AND RECEIPT OF THE CERTIFICATE OF APPROVAL MUST BE RECEIVED FROM NCDEQ -LAND QUALITY SECTION. THE CONTRACTOR SHALL CALL NC DEQ LQS AT 919-791-4200 TO SCHEDULE A PRE-CONSTRUCTION MEETING AT LEAST 72 HOURS PRIOR TO PROJECT ACTIVATION. THE CONTRACTOR SHALL REFER TO THE APPROVED EROSION AND SEDIMENTATION CONTROL PERMIT AND CORRESPONDING PLANS AND TECHNICAL SPECIFICATIONS FOR SPECIFIC CONSTRUCTION SEQUENCING 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 PREPARE STABILIZED CONSTRUCTION ENTRANCES, HAUL ROADS AND SHALL MOBILIZE EQUIPMENT, MATERIALS, PREPARE STAGING AREA(S) AND STOCKPILE AREA(S) AS SHOWN ON THE PLANS. HAUL ROADS SHALL BE PROPERLY MAINTAINED AT ALL TIMES DURING CONSTRUCTION.
3. CONSTRUCTION TRAFFIC SHALL BE RESTRICTED TO THE AREA DENOTED AS LIMITS OF DISTURBANCE OR HAUL ROADS AS SHOWN ON THE PLANS.
4. THE CONTRACTOR SHALL INSTALL TEMPORARY ROCK DAMS AT LOCATIONS INDICATED ON THE
5. THE CONTRACTOR SHALL INSTALL TEMPORARY SILT FENCE AROUND THE 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 APPROVED 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 CHANNEL THAT CAN BE COMPLETED AND STABILIZED WITHIN THE SAME DAY. THE CONTRACTOR SHALL APPLY TEMPORARY AND PERMANENT SEED AND MULCH TO ALL DISTURBED AREAS AT THE END OF EACH WORK DAY, WITH THE REQUIREMENT OF ESTABLISHING TEMPORARY AND PERMANENT GROUND COVER THROUGH VEGETATION ESTABLISHMENT.
8. THE CONTRACTOR SHALL CLEAR AND GRUB AN AREA ADEQUATE TO CONSTRUCT THE STREAM CHANNEL AND GRADING OPERATIONS AFTER ALL EROSION AND SEDIMENTATION MEASURES 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. CONTRACTOR SHALL BEGIN CHANNEL CONSTRUCTION UPSTREAM AND PROCEED IN A DOWNSTREAM DIRECTION WITH CONSTRUCTION. THE DESIGN CHANNEL SHOULD BE CONSTRUCTED OFFLINE AND/OR IN THE DRY WHENEVER POSSIBLE. THE CONTRACTOR SHALL EXCAVATE AND CONSTRUCT THE PROPOSED CHANNEL TO PROPOSED DESIGN GRADES AND SHALL NOT EXTEND EXCAVATION ACTIVITIES ANY CLOSER THAN WITHIN 10 FEET (HORIZONTALLY) OF THE TOP OF EXISTING STREAM BANKS IN ORDER TO PROTECT THE INTEGRITY OF THE EXISTING STREAM CHANNEL UNTIL ABANDONMENT.
10. THE CONTRACTOR WILL CONTINUE CONSTRUCTION BY EXCAVATING CHANNEL FILL MATERIAL. THE CONTRACTOR MAY FILL NON JURISDITRIONAL DITCHES WHICH DO NOT CONTAIN ANY WATER DURING THE GRADING OPERATIONS. ALONG STREAM REACHES EXCAVATED MATERIAL SHOULD BE STOCKPILED IN AREAS SHOWN ON THE PLANS. IN ANY AREAS WHERE EXCAVATION DEPTHS WILL EXCEED 10 INCHES, TOPSOIL SHALL BE HARVESTED, STOCKPILED AND PLACED BACK OVER THESE AREAS TO A MINIMUM DEPTH OF 8 INCHES TO ACHIEVE DESIGN GRADES AND CREATE A SOIL BASE FOR VEGETATION PLANTING ACCORDING TO THE DESIGN PLANS AND CONSTRUCTION SPECIFICATIONS.
11. AFTER EXCAVATING AND CONSTRUCTING THE PROPOSED CHANNEL TO PROPOSED DESIGN GRADES, INSTALL IN-STREAM STRUCTURES, BIOENGINEERING MEASURES, PERMANENT AND TEMPORARY SEEDING AND ALL REQUIRED AMENDMENTS, MULCHING, VEGETATION TRANSPLANTS, TO COMPLETE CHANNEL CONSTRUCTION AND READY THE CHANNEL TO ACCEPT FLOW PER APPROVAL BY THE ENGINEER.
12. STREAM FLOW WILL BE DIVERTED BACK INTO THE CONSTRUCTED CHANNEL ONCE THE RESTORED STREAM CHANNEL AND ASSOCIATED RIPARIAN AREA HAS BEEN STABILIZED, AS DETERMINED BY THE ENGINEER AND IN COMPLIANCE WITH APPROVED PERMIT REQUIREMENTS. ONCE STREAM FLOW IS RETURNED TO A RESTORED STREAM CHANNEL REACH, THE CONTRACTOR SHALL IMMEDIATELY BEGIN PLUGGING, FILLING, AND GRADING THE ASSOCIATED ABANDONED REACH OF STREAM CHANNEL, AS INDICATED ON PLANS, MOVING IN A DOWNSTREAM DIRECTION TO ALLOW FOR POSITIVE AND ADEQUATE DRAINAGE OF THE ABANDONED CHANNEL REACH. STREAM FLOW SHALL NOT BE DIVERTED INTO ANY SECTION OF RESTORED STREAM CHANNEL PRIOR TO THE COMPLETION OF THE CONSTRUCTION OF THAT REACH OF PROPOSED CHANNEL, INCLUDING, BUT NOT LIMITED TO FINAL GRADING, STABILIZATION WITH TEMPORARY AND PERMANENT SEEDING AND ALL REQUIRED AMENDMENTS, MULCHING, VEGETATION TRANSPLANT INSTALLATION, INSTREAM STRUCTURE INSTALLATION, BIOENGINEERING INSTALLATION, AND COIR FIBER MATTING INSTALLATION.
13. THE RESTORED CHANNEL SECTIONS SHALL REMAIN OPEN AT THEIR DOWNSTREAM END TO ALLOW FOR DRAINAGE DURING RAIN EVENTS.
14. ALL GRADING ACTIVITIES ADJACENT TO THE STREAM CHANNEL AND RIPARIAN AREAS SHALL BE COMPLETED PRIOR TO DIVERTING STREAM FLOW INTO THE RESTORED STREAM CHANNEL REACHES. ONCE CONSTRUCTION IS COMPLETED ON A REACH OF PROPOSED STREAM CHANNEL, ADDITIONAL GRADING ACTIVITIES SHALL NOT BE CONDUCTED WITHIN 10 FEET (HORIZONTALLY) OF THE NEWLY RESTORED STREAM CHANNEL BANKS. THE CONTRACTOR SHALL NOT FINALIZE GRADE OR ROUGHEN AREAS WHERE REQUIRED EXCAVATION ACTIVITIES HAVE NOT BEEN COMPLETED.
15. ONCE CONSTRUCTION IS COMPLETE WITHIN A PUMP-AROUND WORK AREA OR CONSTRUCTION WORK PHASE LIMIT, THE CONTRACTOR SHALL APPLY TEMPORARY SEEDING TO ANY AREAS DISTURBED DURING CONSTRUCTION WITHIN HOURS. 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 FROM THE LAST LAND-DISTURBING ACTIVITY.
16. PERMANENT GROUND COVER SHALL BE ESTABLISHED FOR 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. HAUL ROADS TO BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND PRIOR TO CONSTRUCTION.
17. ALL REMAINING DISTURBED AREAS SHALL BE STABILIZED BY TEMPORARY AND PERMANENT SEEDING AND MULCHING BEFORE CONSTRUCTION CLOSEOUT IS REQUESTED AND DEMOBILIZATION CAN OCCUR. ALL WASTE MATERIAL MUST BE REMOVED FROM THE PROJECT SITE.
18. THE CONTRACTOR SHALL TREAT AREAS OF INVASIVE SPECIES VEGETATION THROUGHOUT THE PROJECT AREA ACCORDING TO THE CONSTRUCTION CONTRACT DOCUMENTS, INCLUDING THE APPROVED PERMIT, PLANS AND TECHNICAL SPECIFICATIONS PRIOR TO DEMOBILIZATION.
19. THE CONTRACTOR COMPLETE ALL REMAINING PLANTING ACTIVITIES, INCLUDING SHRUB AND TREE PLANTING, REMAINING TRANSPLANT INSTALLATION, INSTALLATION OF REMAINING BIOENGINEERING MEASURES, AND LIVE STAKE INSTALLATION, ACCORDING TO THE CONSTRUCTION CONTRACT DOCUMENTS, INCLUDING THE APPROVED PERMIT, PLANS AND TECHNICAL SPECIFICATIONS. THE CONTRACTOR SHALL COMPLETE THE RE-FORESTATION PHASE OF THE PROJECT AND CONDUCT REMAINING PERMANENT SEEDING IN ACCORDANCE WITH THE CONSTRUCTION CONTRACT DOCUMENTS, INCLUDING THE APPROVED PERMIT, PLANS AND TECHNICAL SPECIFICATIONS.
20. THE CONTRACTOR SHALL ENSURE THAT THE SITE IS FREE OF TRASH AND LEFTOVER CONSTRUCTION MATERIALS PRIOR TO DEMOBILIZATION FROM THE SITE. 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 APPROXIMATELY THREE AND A HALF MILES NORTHEAST OF THE TOWN OF LAWSONVILLE IN STOKES COUNTY, NC (36.5250946421°, -80.2061457169°) AS SHOWN ON THE COVER SHEET VICINITY MAP. TO ACCESS THE SITE FROM WINSTON-SALEM, TAKE NC-8 NORTH FOR APPROXIMATELY 30 MILES. TURN RIGHT ONTO CLARK ROAD AND CONTINUE APPROXIMATELY 0.9 MILES. CONTINUE APPROXIMATELY 0.2 MILES AND ARRIVE AT THE SITE ENTRANCE ON THE RIGHT.
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 ASCENSION LAND SURVEYING, PC (ALS) IN THE SUMMER OF 2019. 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. 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. 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 AND MATERIALS INCLUDING LOGS, STONE, 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 DESIGN GRADES ARE ACHIEVED AS SHOWN ON THE PLAN AND PLAN AND PROFILE, THE HEADWATER VALLEY, STREAM AND WETLAND, AND FLOODPLAIN AREAS SHALL BE ROUGHENED USING TECHNIQUES DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS.
3. ALL SUITABLE SOIL MATERIAL REQUIRED TO FILL AND/OR PLUG EXISTING DITCHES AND/OR STREAM CHANNEL SHALL BE GENERATED ON-SITE AS DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS. ANY EXCESS SPOIL MATERIAL SHALL BE STOCKPILED IN DESIGNATED AREAS AND OR HAULED OFF-SITE AS APPROVED BY THE ENGINEER.

WATER & LAND
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Raleigh, NC 27615
(919)614-5111
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PROJECT ENGINEER

SEAL
36916
CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
[illegible]ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

| REVISIONS | | |
|---|---|---|
| A | DRAFT MIT PLAN | 12-27-19 |
| B | FINAL DRAFT PLAN | 3-26-20 |
| C | FINAL MIT PLAN | 7-24-20 |
| | | |
| | | |
| | | |
| NO. | DESCRIPTION | DATE |

PROJECT NAME

BANNER
BRANCH
MITIGATION
PROJECT

STOKES COUNTY, NC

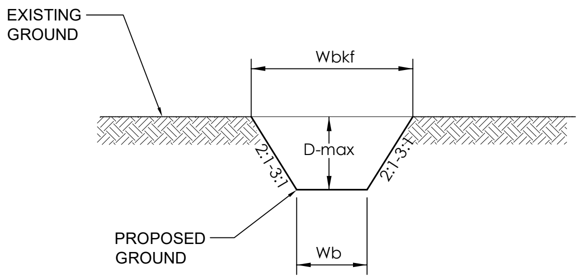
| DRAWING INFORMATION | |
|---|---|
| PROJECT NO. | 18-007 |
| FILENAME | 02_BANNER BRANCH_GENERAL NOTES.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | N.T.S. |
| VERT. SCALE | N/A |

SHEET NAME

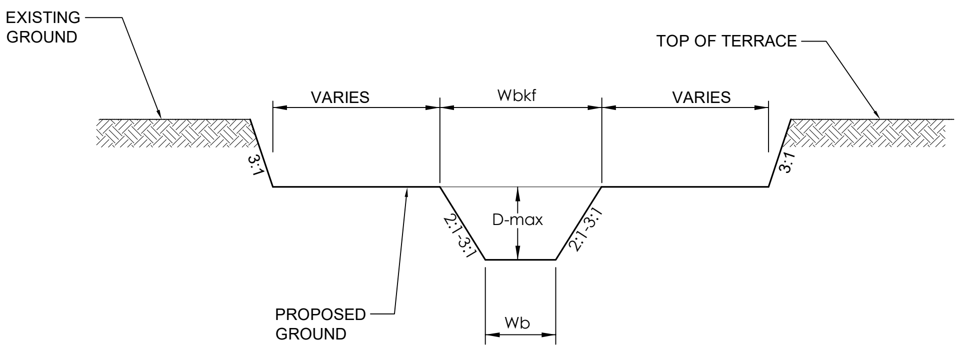
LEGEND/
CONSTRUCTION
SEQUENCE/
GENERAL NOTES

SHEET NUMBER

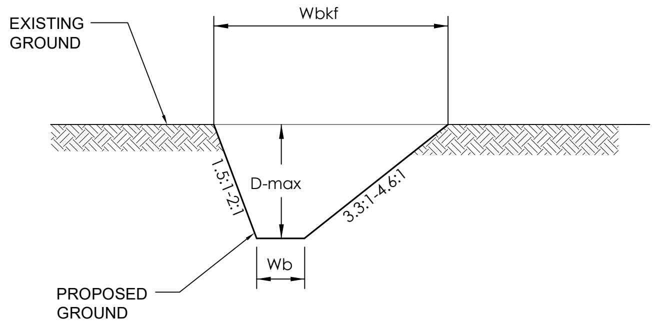
2



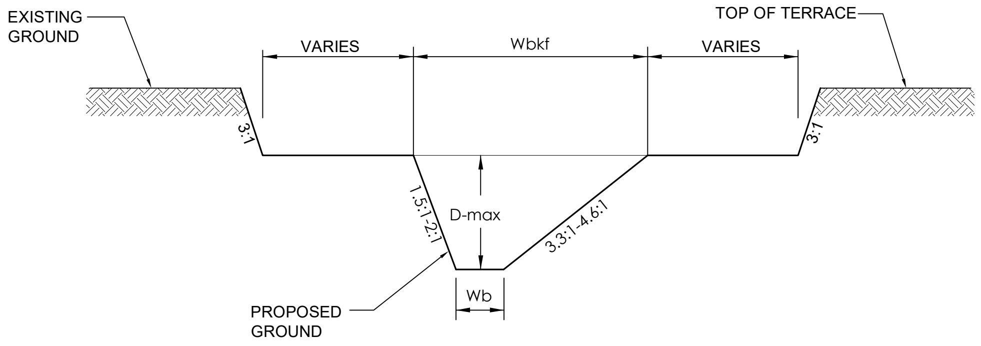
RIFFLE
N.T.S



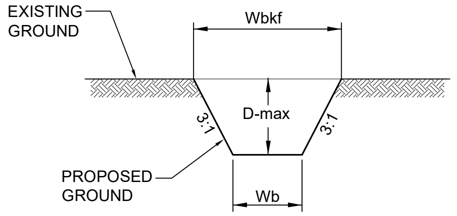
RIFFLE WITH BANKFULL BENCH
N.T.S



POOL
N.T.S



POOL WITH BANKFULL BENCH
N.T.S



STEP POOL CHANNEL
N.T.S

## SINGLE-THREAD CHANNEL

| **Reach Name** | **UT1-R1** | | **UT1-R2** | | **BB-R1** | | **BB-R2** | | BB-R3 | | **UT1B** | | UT1C | | **UT2** | | **UT2A** | | **UT3** | | **UT4-R1** | | **UT4-R2** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Feature** | **Riffle** | **Pool** | **Riffle** | **Pool** | **Riffle** | **Pool** | **Riffle** | **Pool** | **Riffle** | **Pool** | **Riffle** | **Pool** | **Riffle** | **Pool** | **Riffle** | **Pool** | **Riffle** | **Pool** | **Riffle** | **Pool** | **Riffle** | **Pool** | **Riffle** | **Pool** | **Outlet Channel** |
| **Width of Bankfull, Wbkf (ft)** | 8.0 | 11.0 | 9.0 | 14.0 | 13.0 | 20.0 | 14.0 | 21.5 | 15.0 | 22.0 | 7.0 | 10.0 | 4.5 | 6.0 | 6.0 | 8.0 | 3.0 | 4.0 | 8.0 | 12.0 | 11.0 | 15.0 | 12.0 | 18.0 | 3.0 (MIN.) |
| **Average Depth, Dbkf (ft)** | 0.5 | 0.8 | 0.6 | 1.0 | 1.1 | 1.6 | 1.1 | 1.6 | 1.2 | 1.8 | 0.4 | 0.7 | 0.4 | 0.6 | 0.4 | 0.6 | 0.2 | 0.3 | 0.6 | 0.9 | 0.7 | 1.2 | 0.8 | 1.4 | N/A |
| **Maximum Depth, D-Max (ft)** | 0.6 | 1.3 | 0.7 | 1.6 | 1.4 | 2.5 | 1.5 | 2.5 | 1.6 | 2.8 | 6.0 | 1.1 | 0.5 | 0.9 | 0.5 | 1.0 | 0.3 | 0.5 | 0.7 | 1.5 | 0.9 | 2.0 | 1.0 | 2.2 | 0.5 |
| **Width to Depth Ratio, bkf W/D** | 16.4 | 13.3 | 15.4 | 13.6 | 12.1 | 12.8 | 12.3 | 13.5 | 12.6 | 12.6 | 16.2 | 14.0 | 12.5 | 10.7 | 16.0 | 12.8 | 16.0 | 12.8 | 14.1 | 12.8 | 15.8 | 12.5 | 15.2 | 12.8 | N/A |
| **Bankfull Area, Abkf (sq ft)** | 3.9 | 9.1 | 5.3 | 14.4 | 14.0 | 31.3 | 16.0 | 34.4 | 17.8 | 38.5 | 3.0 | 7.2 | 1.6 | 3.4 | 2.3 | 5.0 | 0.6 | 1.3 | 4.6 | 11.3 | 7.7 | 18.0 | 9.5 | 25.3 | N/A |
| **Bottom Width, Wb (ft)** | 5.0 | 3.0 | 6.0 | 4.0 | 7.0 | 5.0 | 8.0 | 6.0 | 8.0 | 6.0 | 4.0 | 3.0 | 2.0 | 1.5 | 3.0 | 2.0 | 1.5 | 1.0 | 5.0 | 3.0 | 6.0 | 3.0 | 7.0 | 5.0 | N/A |

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PROJECT NAME

BANNER
BRANCH
MITIGATION
PROJECT

STOKES COUNTY, NC

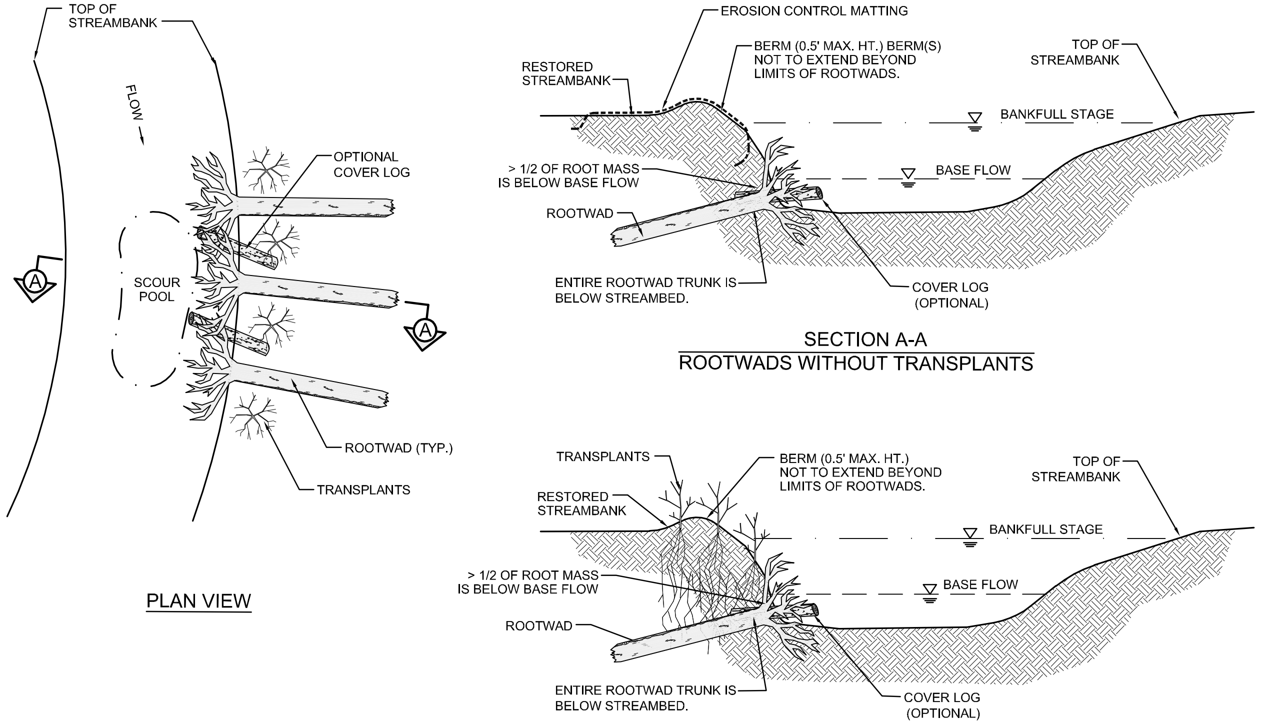
DRAWING INFORMATION

| | |
|---|---|
| PROJECT NO. | 18-007 |
| FILENAME | 03_BANNER BRANCH_TYPICAL_SECTIONS.D\ |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | N.T.S. |
| VERT. SCALE | N/A |

SHEET NAME

TYPICAL
SECTIONS

SHEET NUMBER

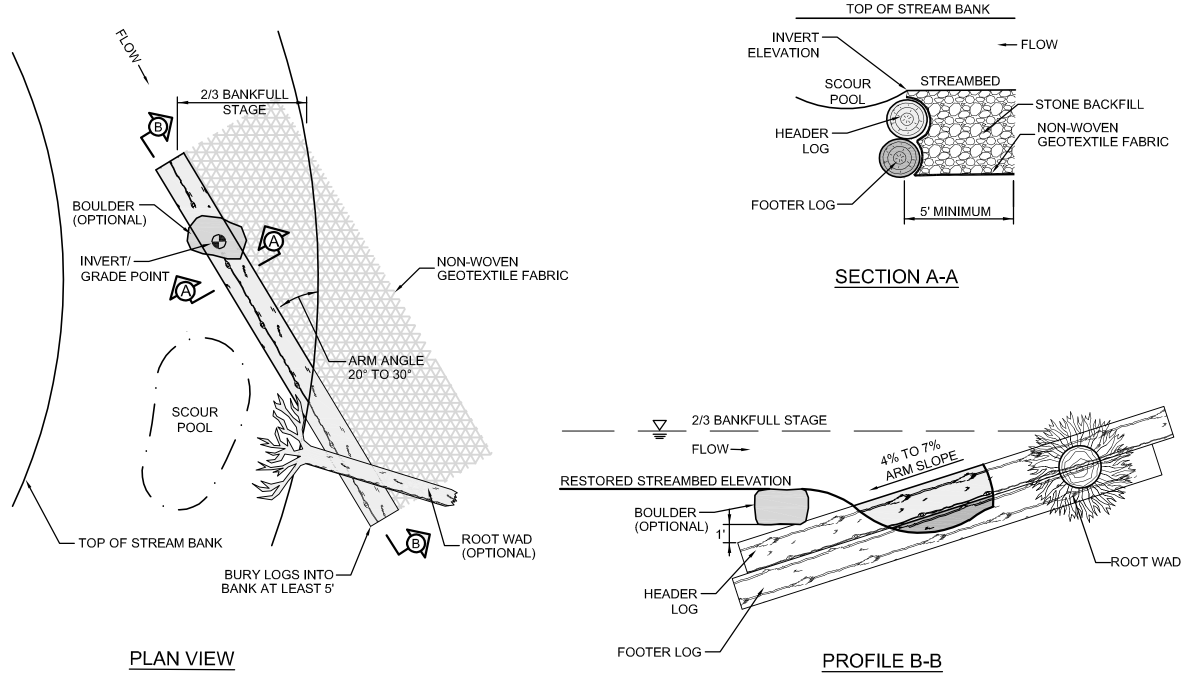


NOTES:

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

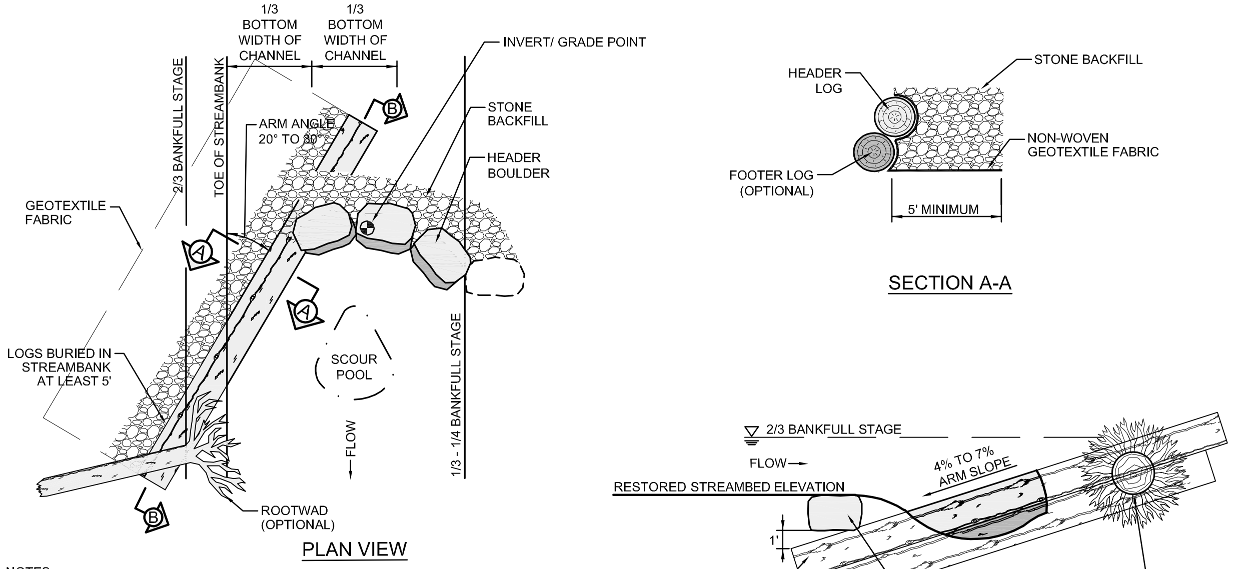


NOTES:

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

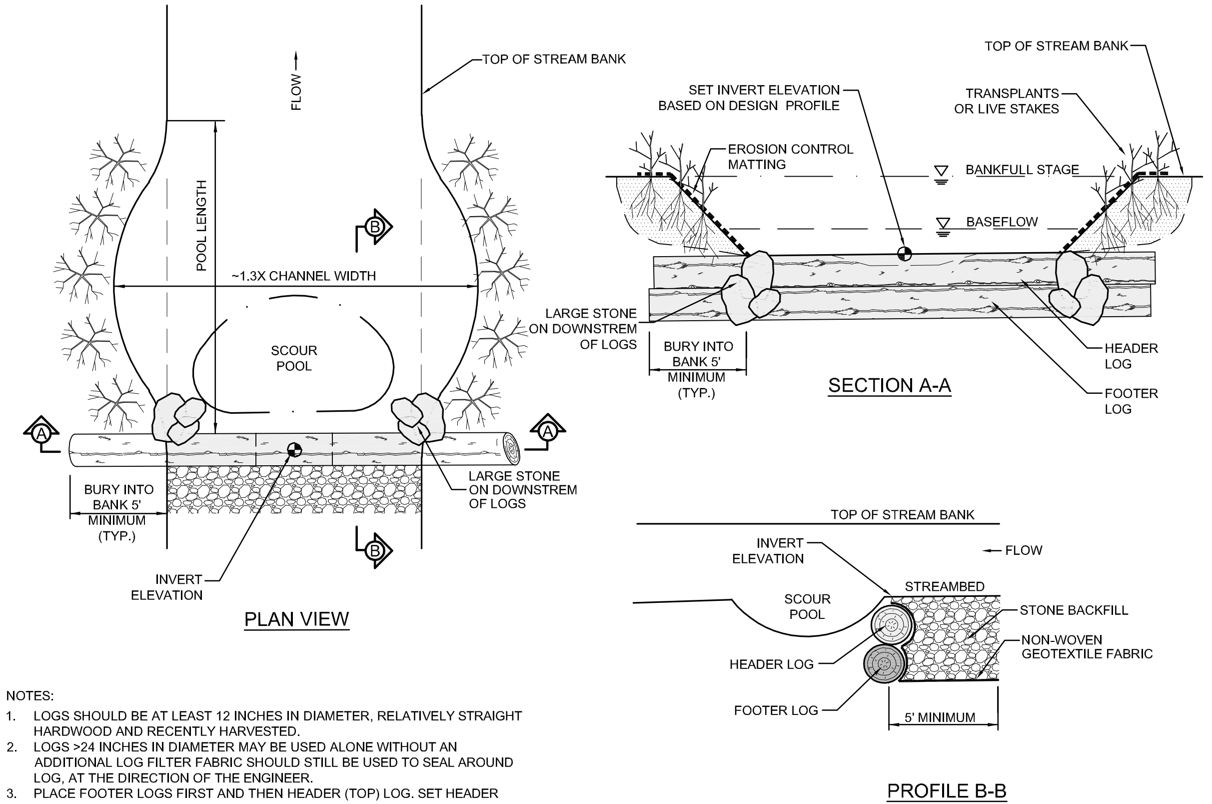


NOTES:

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

## GRADE CONTROL LOG J-HOOK VANE

NOT TO SCALE



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

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| NO. | DESCRIPTION | DATE |

PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

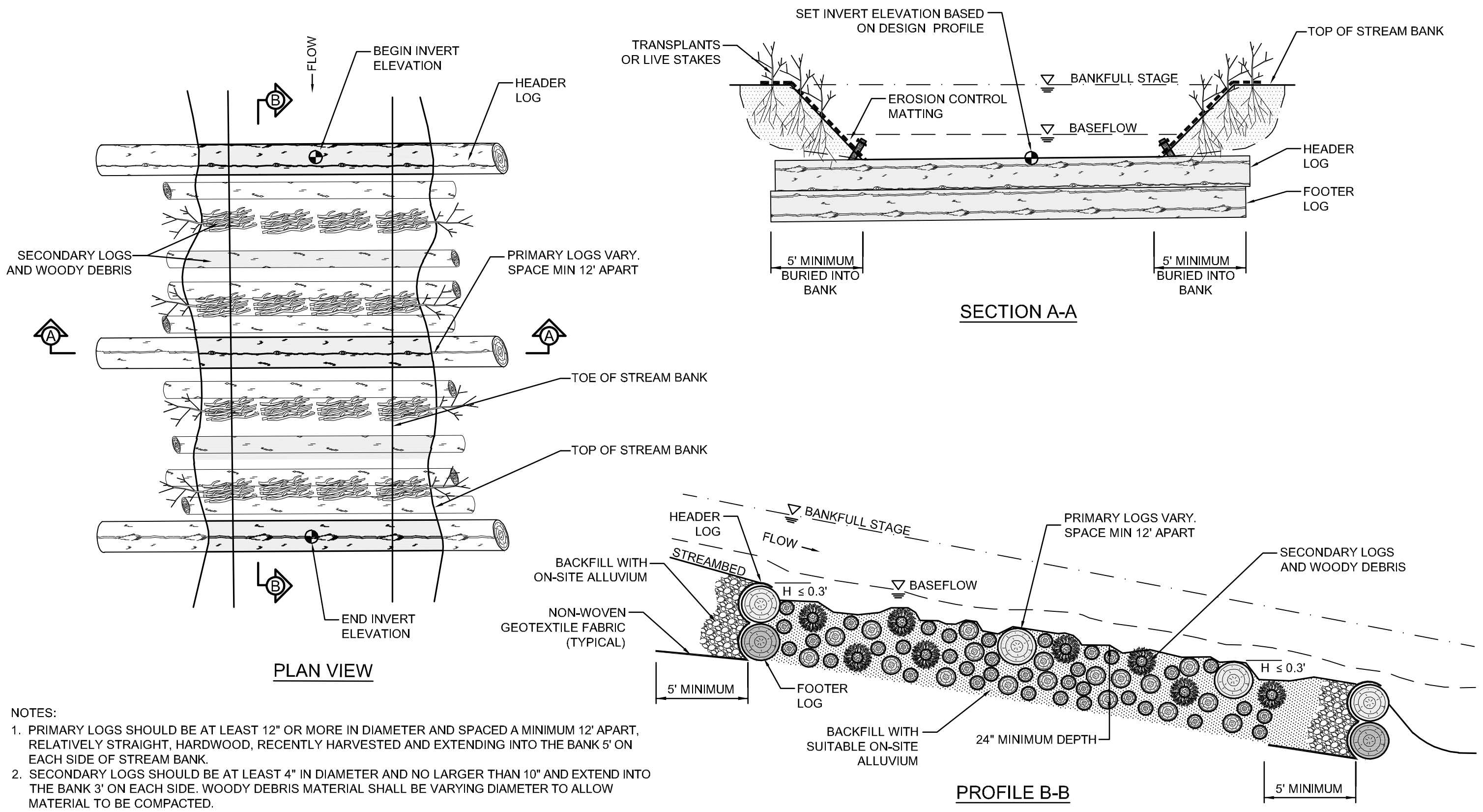
DRAWING INFORMATION

| | |
|---|---|
| PROJECT NO. | 18-007 |
| FILENAME | 04-08_BANNER BRANCH_DETAIL_SHEETS.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | N.T.S. |
| VERT. SCALE | N/A |

SHEET NAME

DETAILS

SHEET NUMBER

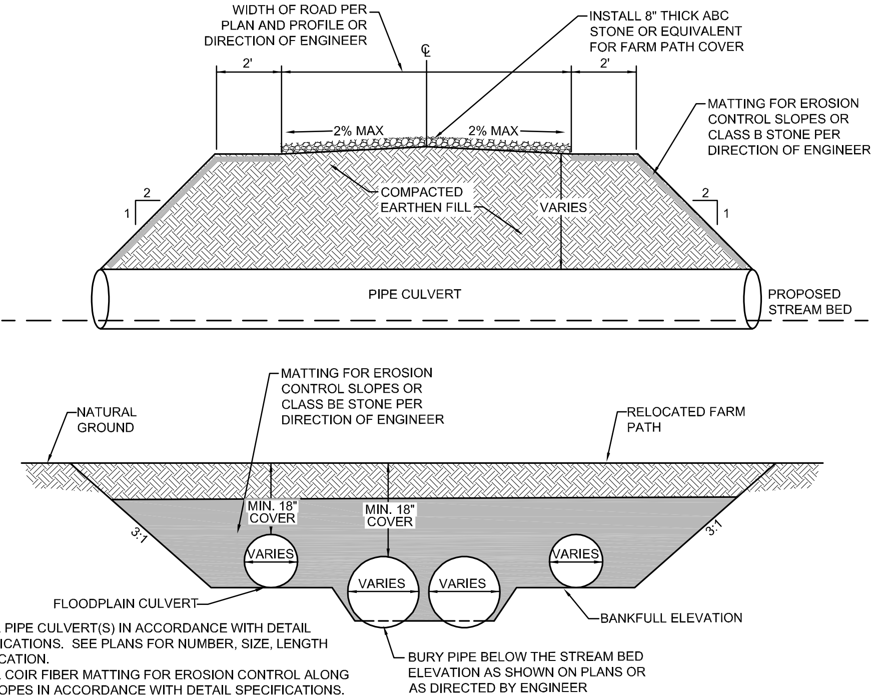


NOTES:

1. PRIMARY LOGS SHOULD BE AT LEAST 12" OR MORE IN DIAMETER AND SPACED A MINIMUM 12' APART, RELATIVELY STRAIGHT, HARDWOOD, RECENTLY HARVESTED AND EXTENDING INTO THE BANK 5' ON EACH SIDE OF STREAM BANK.
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 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

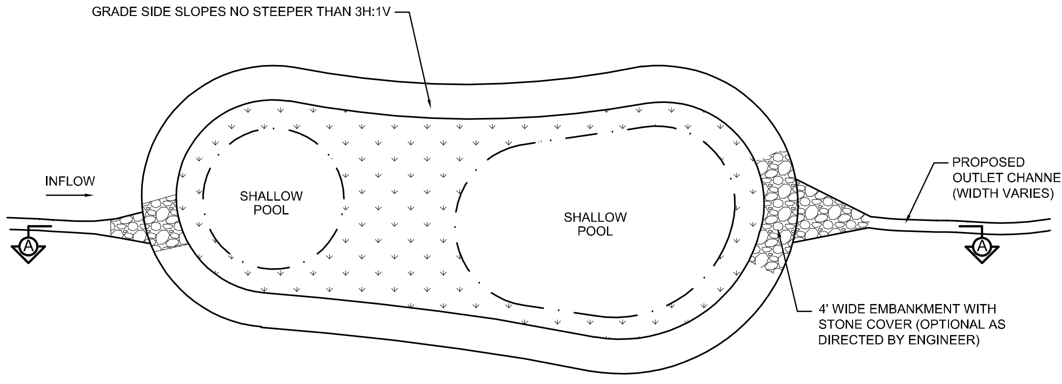


NOTES:

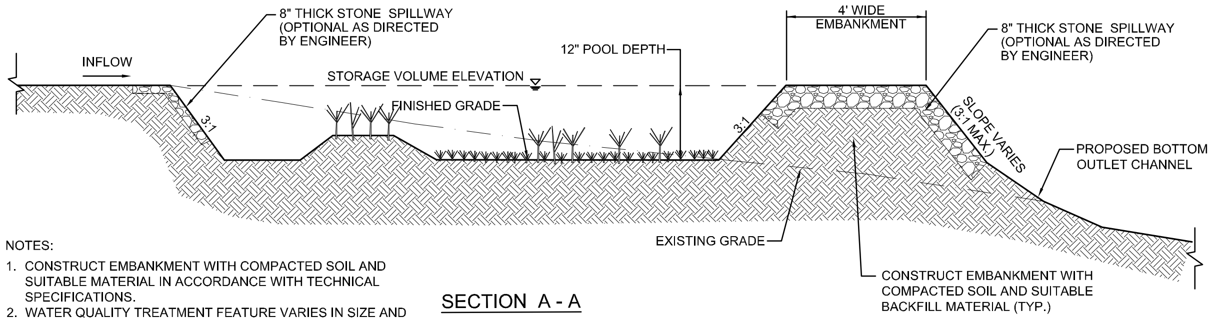
1. INSTALL PIPE CULVERT(S) IN ACCORDANCE WITH DETAIL SPECIFICATIONS. SEE PLANS FOR NUMBER, SIZE, LENGTH AND LOCATION.
2. INSTALL COIR FIBER MATTING FOR EROSION CONTROL ALONG FILL SLOPES IN ACCORDANCE WITH DETAIL SPECIFICATIONS.
3. PIPE CULVERTS ARE TO BE A MINIMUM OF 18" COVER AND SPACING IN ACCORDANCE WITH DETAIL SPECIFICATIONS.

## PERMANENT CULVERT STREAM CROSSING

NOT TO SCALE



PLAN VIEW



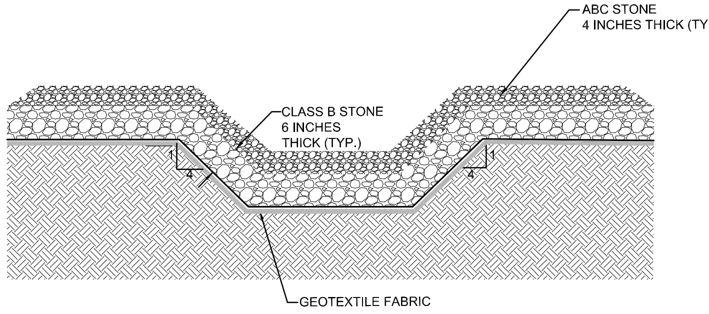
NOTES:

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

SECTION A - A

## WATER QUALITY TREATMENT FEATURE

NOT TO SCALE



NOTES:

1. CONSTRUCT STREAM CROSSING DURING LOW OR BASE FLOW CONDITIONS.
2. HAVE ALL NECESSARY MATERIALS AND EQUIPMENT ON-SITE BEFORE WORK BEGINS.
3. MINIMIZE CLEARING AND EXCAVATION OF STREAM BANKS . DO NOT EXCAVATE CHANNEL BOTTOM. COMPLETE ONE SIDE BEFORE STARTING ON THE OTHER SIDE.
4. INSTALL STREAM CROSSING PERPENDICULAR TO THE FLOW.
5. GRADE SLOPES TO A 4:1 SLOPE. TRANSPLANT SOD OR VEGETATION FROM ORIGINAL STREAM BANK ONTO SIDE SLOPES.
6. MAINTAIN CROSSING SO THAT RUNOFF FROM THE CONSTRUCTION ACCESS ROAD DOES NOT ENTER EXISTING CHANNEL.
7. A STABILIZED PAD OF 6 INCHES THICK CLASS B STONE LINED WITH GEOTEXTILE FABRIC FOR DRAINAGE SHALL BE USED OVER ACCESS SLOPES. ABC STONE APPROXIMATELY 4 INCHES THICK SHALL BE ADDED TO TOP LAYER.
8. WIDTH OF THE CROSSING SHALL BE SUFFICIENT TO ACCOMMODATE THE EQUIPMENT CROSSING THE CHANNEL OR A MINIMUM 12 FEET.
9. CONTRACTOR SHALL DETERMINE AN APPROPRIATE RAMP ANGLE ACCORDING TO EQUIPMENT UTILIZED.

## PERMANENT FORD STREAM CROSSING

NOT TO SCALE

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER
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PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

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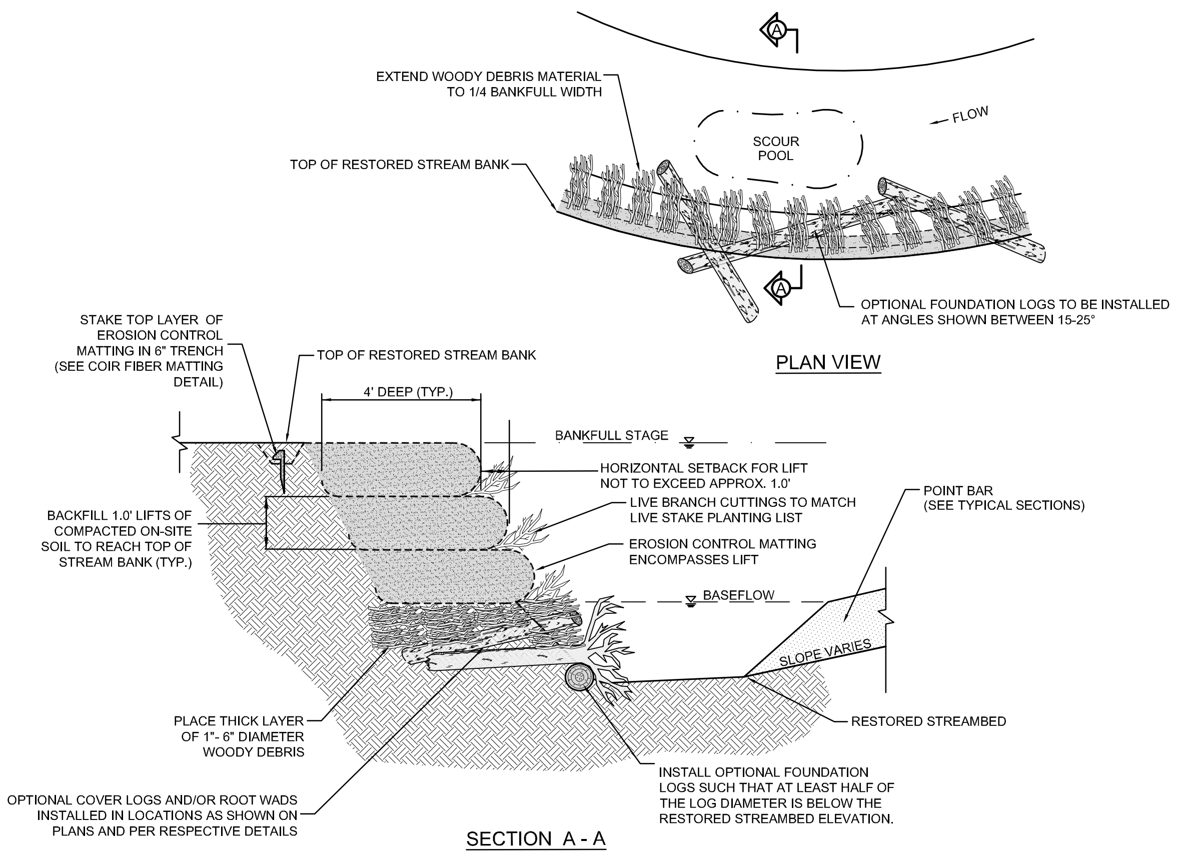
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | N.T.S. |
| VERT. SCALE | N/A |

SHEET NAME

DETAILS

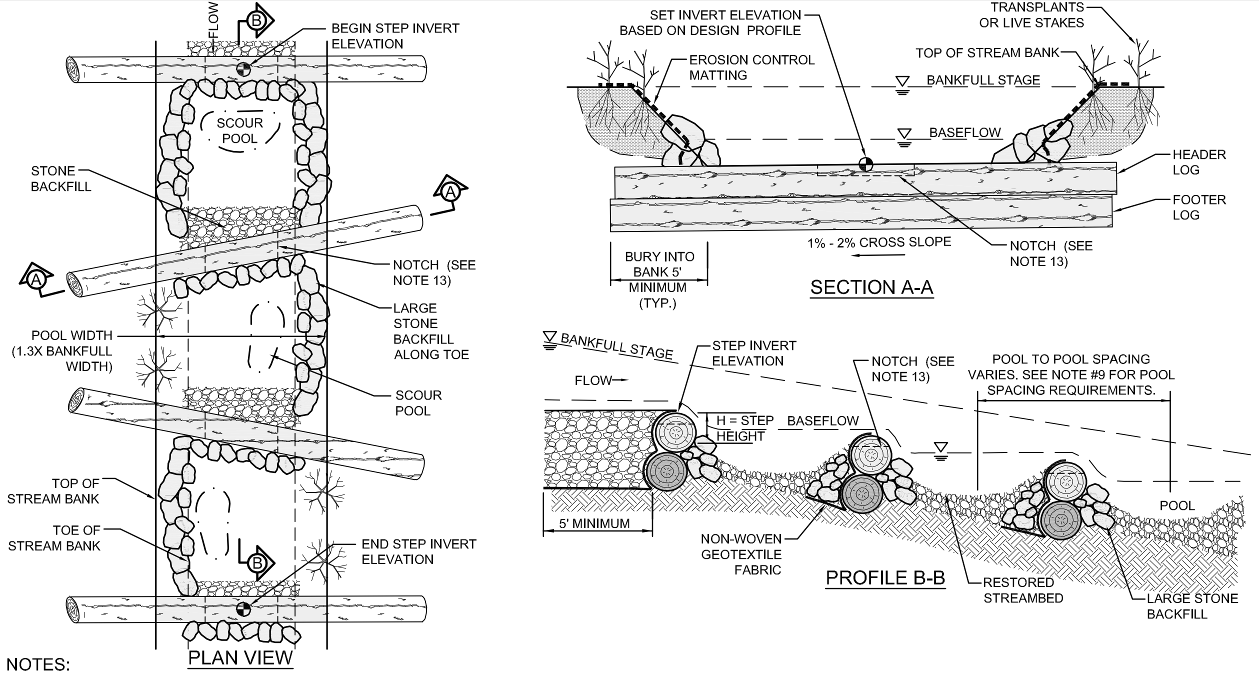
SHEET NUMBER

5



## GEOLIFT W/ TOE WOOD

NOT TO SCALE

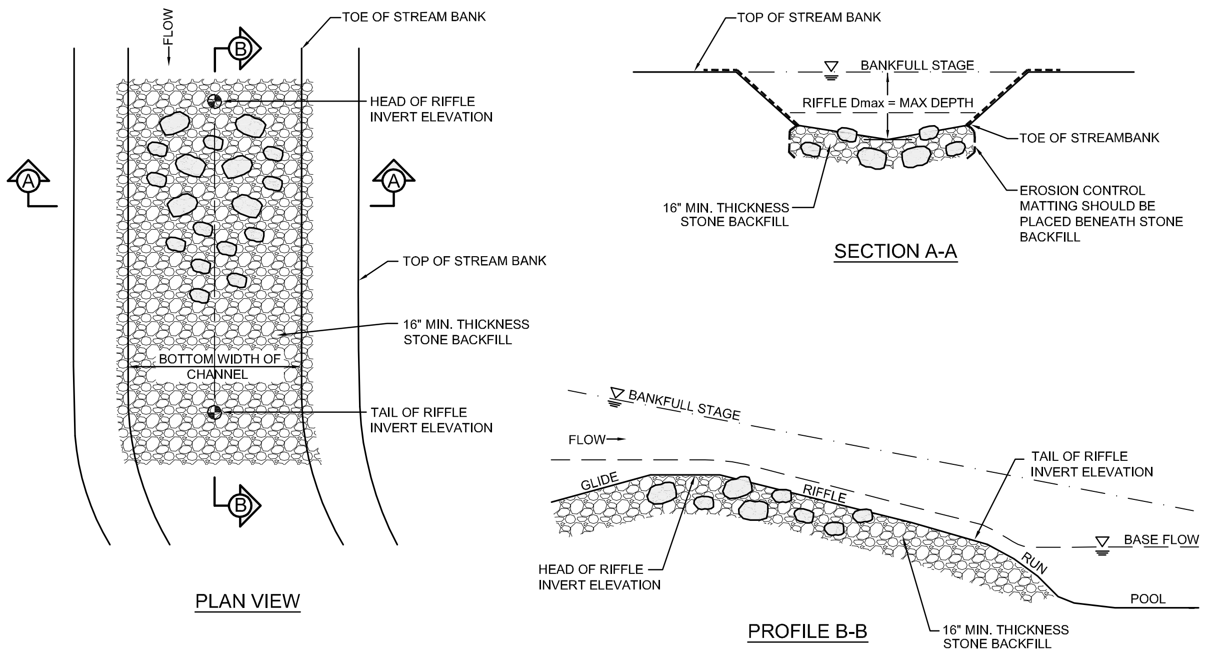


NOTES:

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

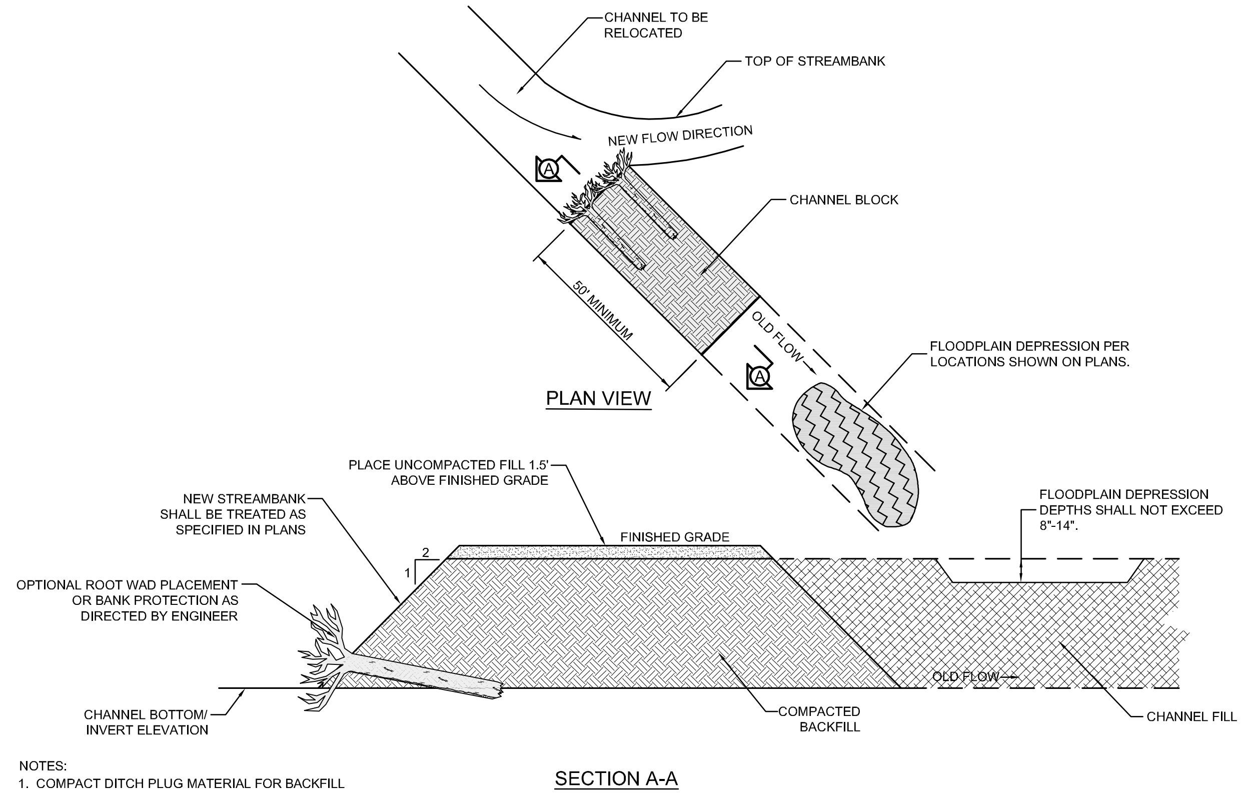


NOTES:

1. DIG A TRENCH BELOW THE RESTORED STREAMBED FOR THE STONE BACKFILL.
2. FILL TRENCH WITH CLASS "A" AND "B" STONE BACKFILL.

## CONSTRUCTED STONE RIFFLE

NOT TO SCALE



NOTES:

1. COMPACT DITCH PLUG MATERIAL FOR BACKFILL USING HEAVY EQUIPMENT IN 10 INCH LIFTS.
2. CONSTRUCT DITCH PLUG WITH COMPACTED SOIL USING SUITABLE MATERIAL IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS.
3. PLACE FILL MATERIAL IN LOCATIONS SHOWN ON PLANS OR AS DIRECTED BY ENGINEER TO ALLOW FOR SETTLING.

## CHANNEL BLOCK

NOT TO SCALE

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PROJECT ENGINEER

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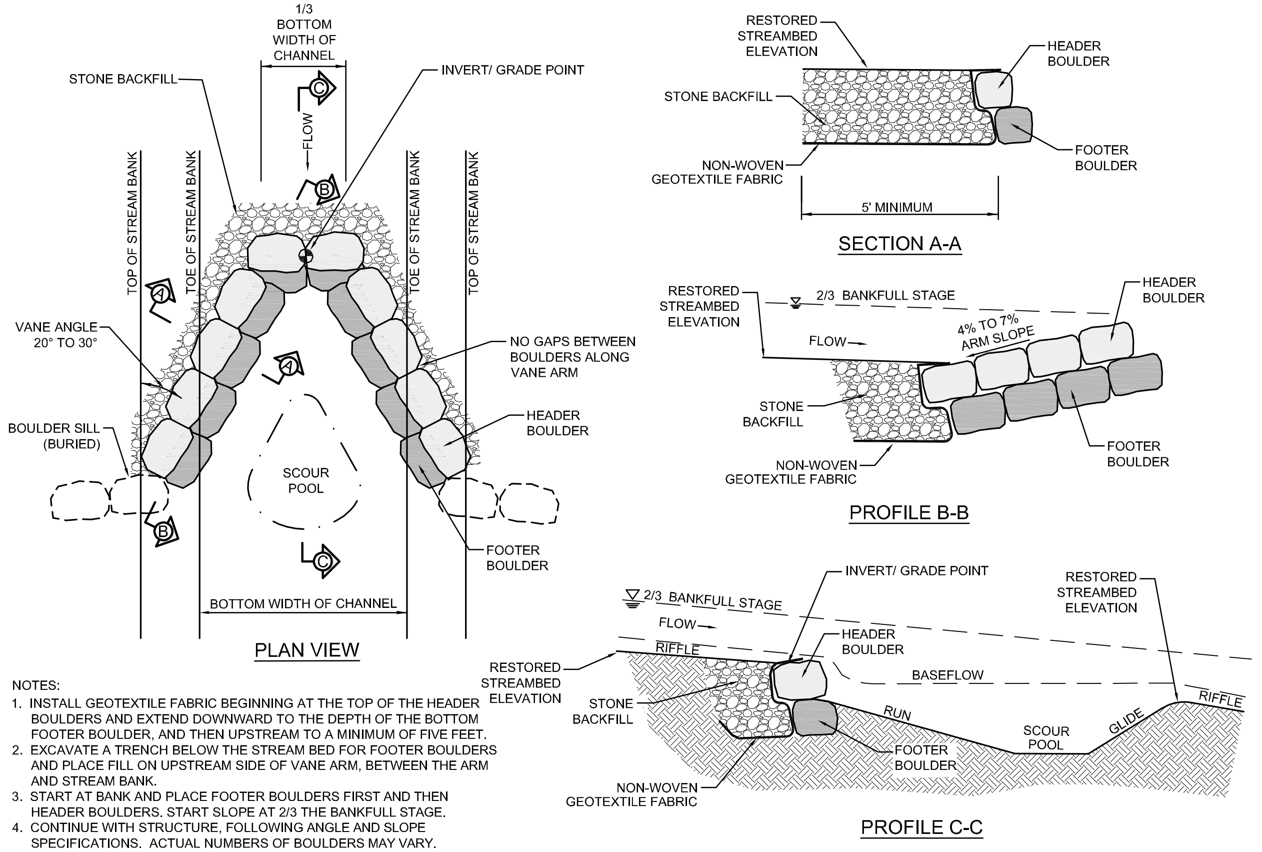
DETAILS

SHEET NUMBER

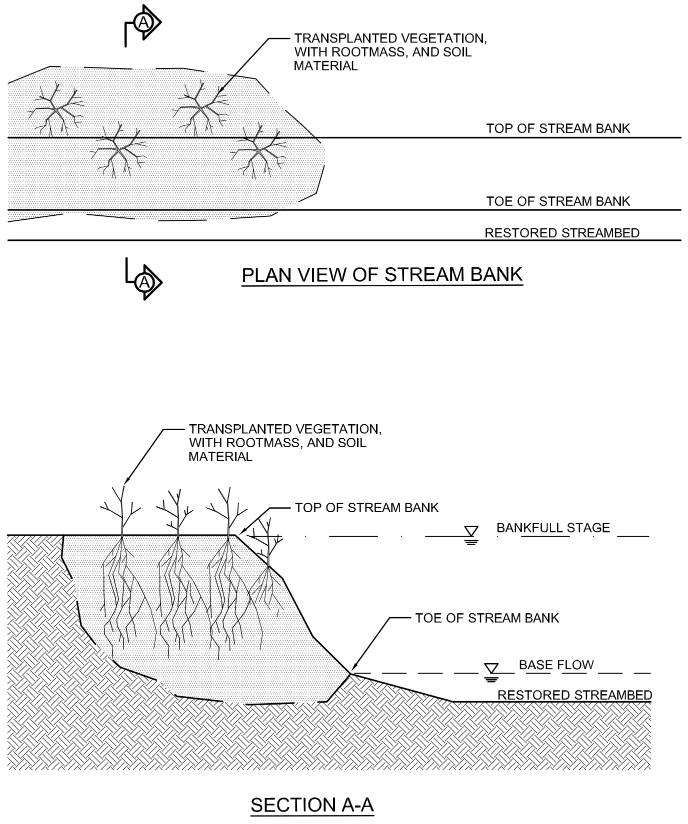


NOTES:

1. INSTALL GEOTEXTILE FABRIC BEGINNING AT THE TOP OF THE HEADER BOULDERS AND EXTEND DOWNWARD TO THE DEPTH OF THE BOTTOM FOOTER BOULDER, AND THEN UPSTREAM TO A MINIMUM OF FIVE FEET.
2. EXCAVATE A TRENCH BELOW THE STREAM BED FOR FOOTER BOULDERS AND PLACE FILL ON UPSTREAM SIDE OF VANE ARM, BETWEEN THE ARM AND STREAM BANK.
3. START AT BANK AND PLACE FOOTER BOULDERS FIRST AND THEN HEADER BOULDERS. START SLOPE AT 2/3 THE BANKFULL STAGE.
4. CONTINUE WITH STRUCTURE, FOLLOWING ANGLE AND SLOPE SPECIFICATIONS. ACTUAL NUMBERS OF BOULDERS MAY VARY.
5. AN EXTRA BOULDER CAN BE PLACED IN SCOUR POOL FOR HABITAT IMPROVEMENT AT DIRECTION OF THE ENGINEER.
6. USE HAND PLACED STONE TO FILL GAPS ON UPSTREAM SIDE OF HEADER AND FOOTER BOULDERS.
7. 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 BOULDERS.

## BOULDER CROSS VANE

NOT TO SCALE

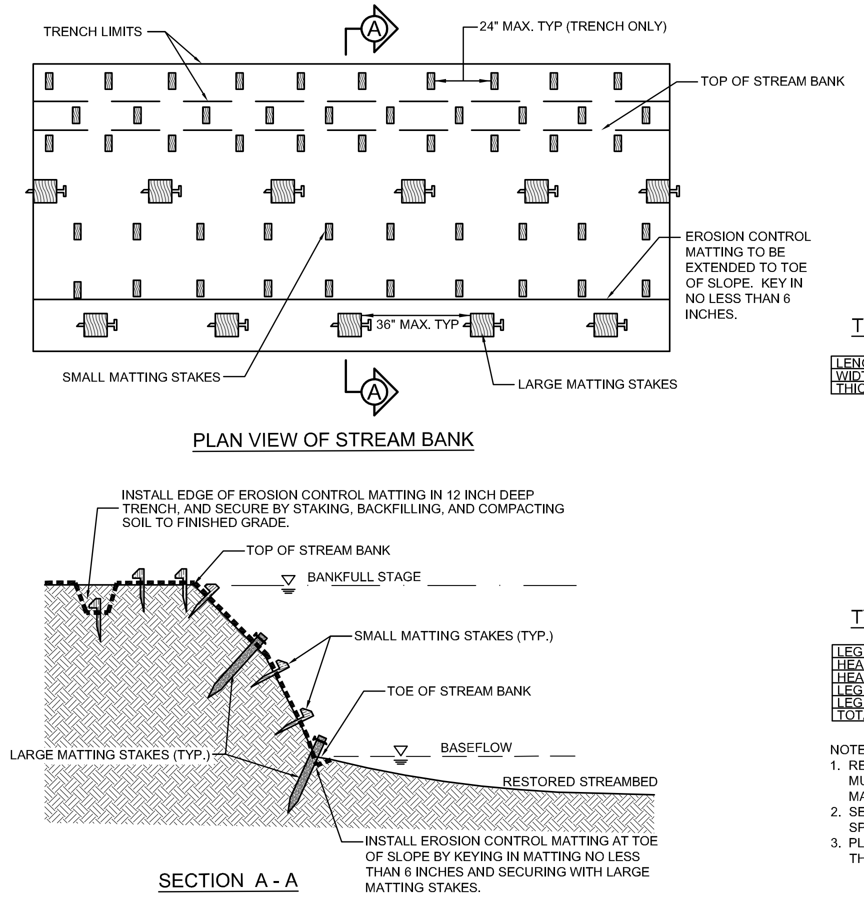


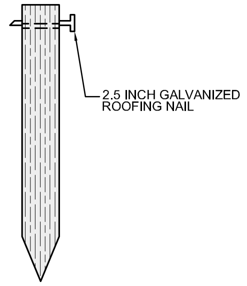
NOTES:

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

## VEGETATION TRANSPLANTS

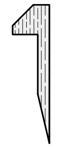
NOT TO SCALE





### 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

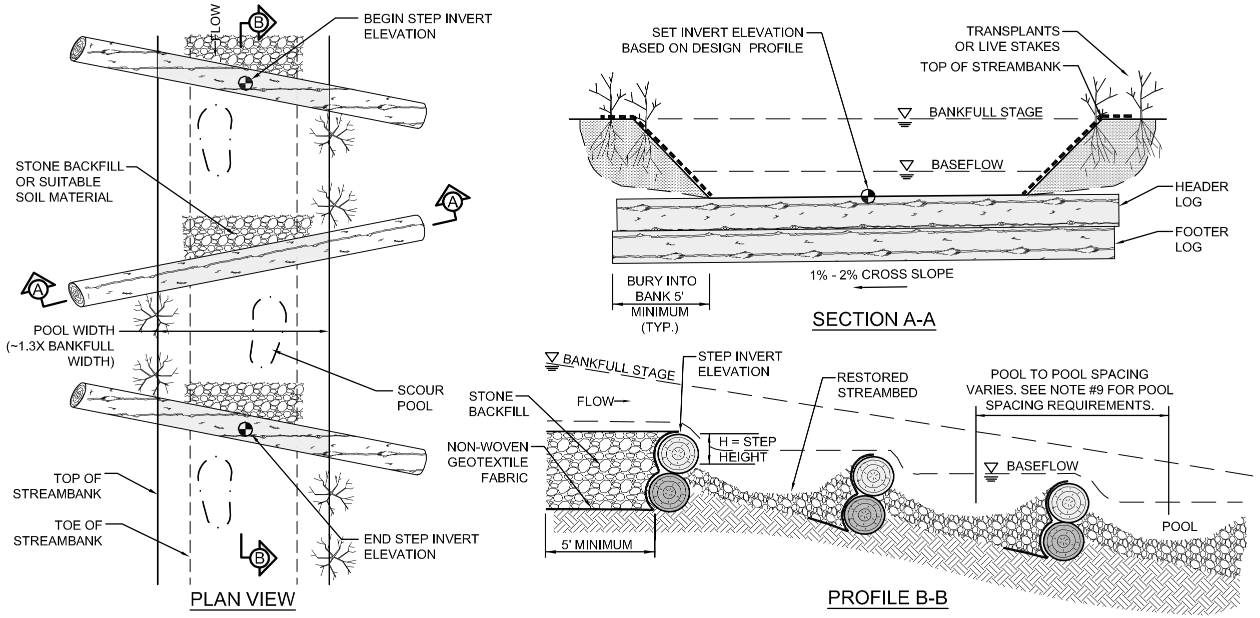
| | |
|---|---|
| LEG LENGTH | 11.00 IN (27.94 CM) |
| HEAD WIDTH | 1.25 IN (3.18 CM) |
| HEAD THICKNESS | 0.40 IN (1.02 CM) |
| LEG WIDTH | 0.60 IN (1.52 CM) (TAPERED TO POINT) |
| LEG THICKNESS | 0.40 IN (1.02 CM) |
| TOTAL LENGTH | 12.00 IN (30.48 CM) |

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.

## EROSION CONTROL MATTING

NOT TO SCALE



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

CHRISTOPHER A. TOMSIC
36[illegible]16

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
[illegible]ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

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PROJECT NAME

BANNER
BRANCH
MITIGATION
PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

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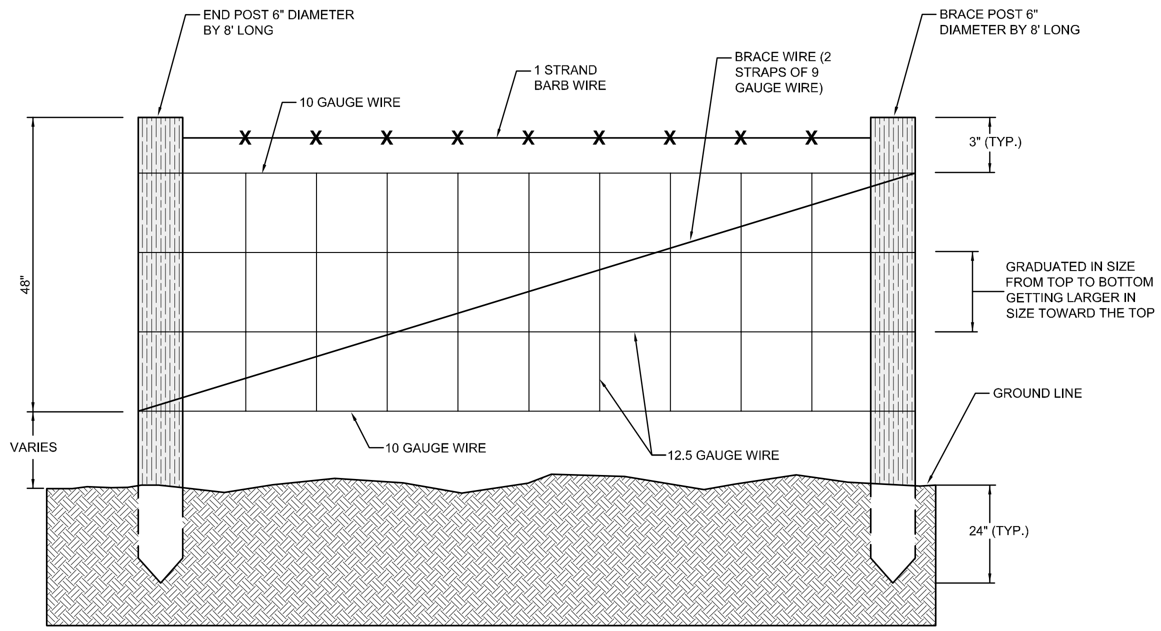
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | N.T.S. |
| VERT. SCALE | N/A |

SHEET NAME

DETAILS

SHEET NUMBER

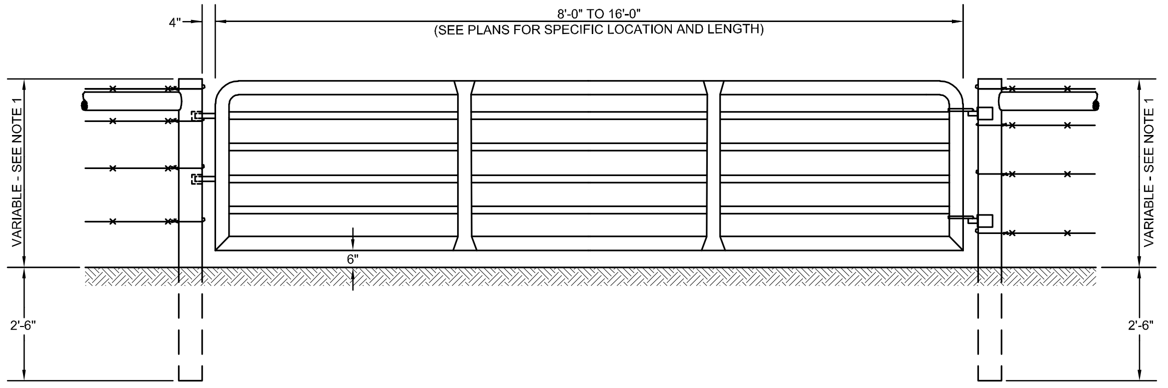
7



NOTE:
1. STANDARD WOVEN FIELD FENCES SHALL HAVE A MAXIMUM POST SPACING OF 16 FEET. HIGH TENSILE WOVEN WIRE MAXIMUM POST SPACING IS 25 FEET.

## WOVEN FIELD FENCE

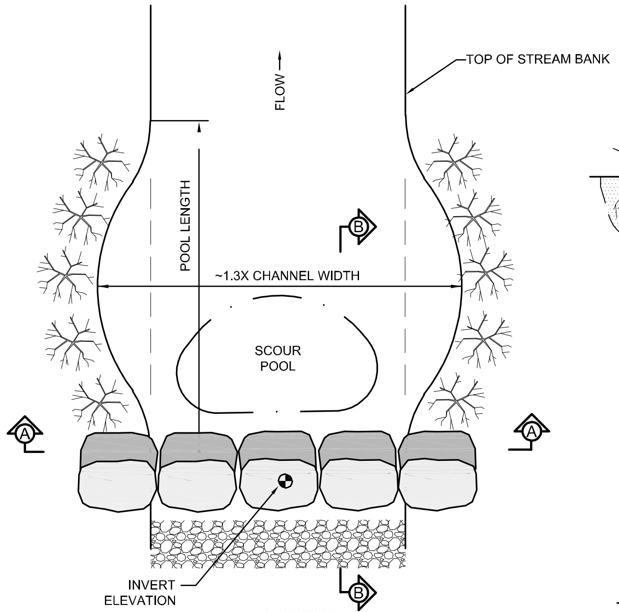
NOT TO SCALE



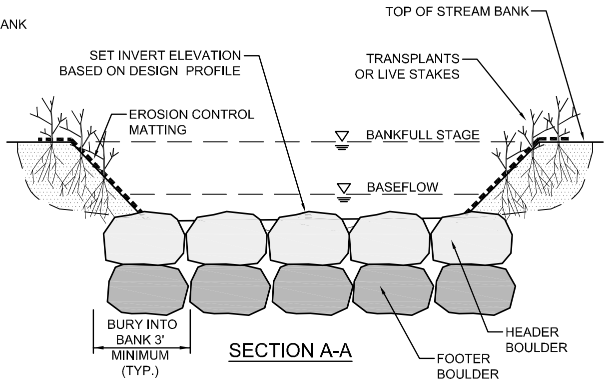
NOTES:
1. POST HEIGHT DIMENSION SHALL BE THE SAME AS REQUIRED FOR THE ADJACENT FENCE.
2. CONSTRUCT ENDS OR STRESS PANELS AS REQUIRED PER THE TECHNICAL SPECIFICATIONS ON EACH SIDE OF THE GATE.
3. HINGES AND LOCKS SHALL BE INSTALLED PER THE TECHNICAL SPECIFICATIONS AS RECOMMENDED BY GATE MANUFACTURER.

## STEEL FRAME GATE

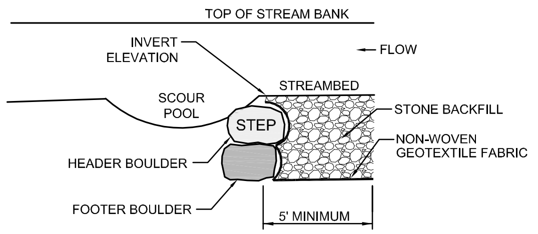
NOT TO SCALE



PLAN VIEW



SECTION A-A



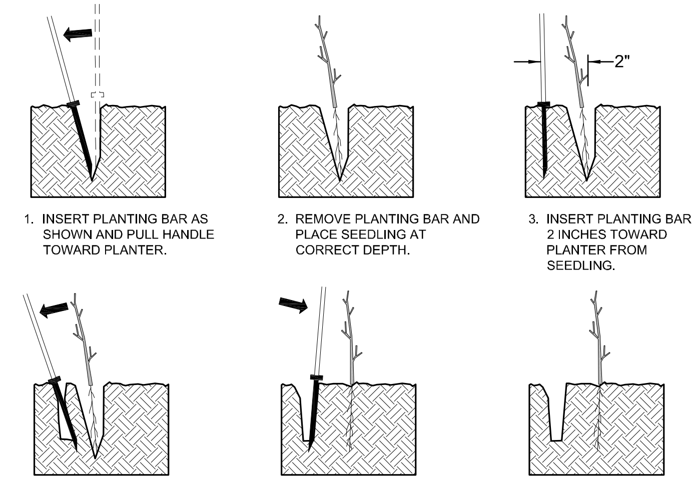
PROFILE B-B

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. AVERAGE STEP HEIGHT (H) SHALL NOT EXCEED 0.5 FT.
7. 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.

## ROCK WEIR

NOT TO SCALE

### PLANTING METHOD USING THE PLANTING BAR

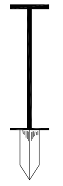


1. INSERT PLANTING BAR AS SHOWN AND PULL HANDLE TOWARD PLANTER.
2. REMOVE PLANTING BAR AND PLACE SEEDLING AT CORRECT DEPTH.
3. INSERT PLANTING BAR 2 INCHES TOWARD PLANTER FROM SEEDLING.
4. PULL HANDLE OF BAR TOWARD PLANTER, FIRMING SOIL AT BOTTOM.
5. PUSH HANDLE FORWARD FIRMING SOIL AT TOP.
6. LEAVE COMPACTION HOLE OPEN. WATER THOROUGHLY.

NOTES:

1. PLANT BARE ROOT VEGETATION TO THE WIDTH OF THE BUFFER/PLANTING ZONE AS SHOWN ON THE PLANS.
2. ALLOW FOR 8-15 FEET SPACING BETWEEN PLANTINGS, AS DEFINED IN THE TECHNICAL SPECIFICATIONS.
3. LOOSEN COMPACTED SOIL.
4. PLANT IN HOLES MADE BY A MATTOCK, DIBBLE, PLANTING BAR OR OTHER APPROVED MEANS.
5. PLANT IN HOLES DEEP AND WIDE ENOUGH TO ALLOW THE ROOTS TO SPREAD OUT AND DOWN WITHOUT J-ROOTING.
6. KEEP ROOTS MOIST WHILE DISTRIBUTING OR WAITING TO PLANT BY MEANS OF WET CANVAS, BURLAP OR STRAW.
7. HEEL-IN PLANTS IN MOIST SOIL OR SAWDUST IF NOT PROMPTLY PLANTED UPON ARRIVAL TO THE PROJECT SITE.
8. DURING PLANTING, SEEDLINGS SHALL BE KEPT IN A MOIST CANVAS BAG OR SIMILAR CONTAINER TO PREVENT ROOT SYSTEMS FROM DYING.
9. PLANTING BAR SHALL HAVE A BLADE WITH A TRIANGULAR CROSS SECTION AND SHALL BE 12 INCHES LONG, 4 INCHES WIDE AND 1 INCH THICK AT CENTER.
10. ALL SEEDLINGS SHALL BE PRUNED IF NECESSARY, SO THAT NO ROOTS EXTEND MORE THAN 10 INCHES BELOW THE ROOT COLLAR.

**PLANTING BAG**



**PLANTING BAR**

## BARE ROOT PLANTING DETAIL

NOT TO SCALE

WATER & LAND SOLUTIONS
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PROJECT ENGINEER

SEAL 36916
CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
… ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

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BANNER
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STOKES COUNTY, NC

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| VERT. SCALE | N/A |

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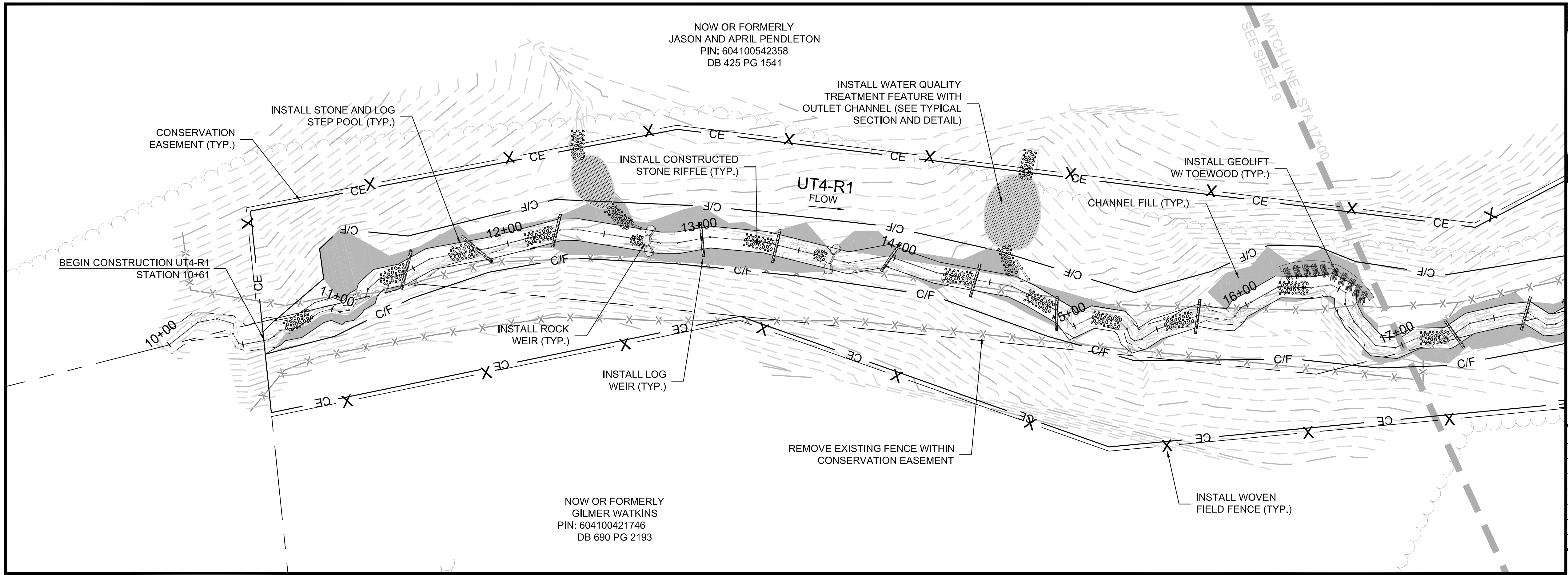
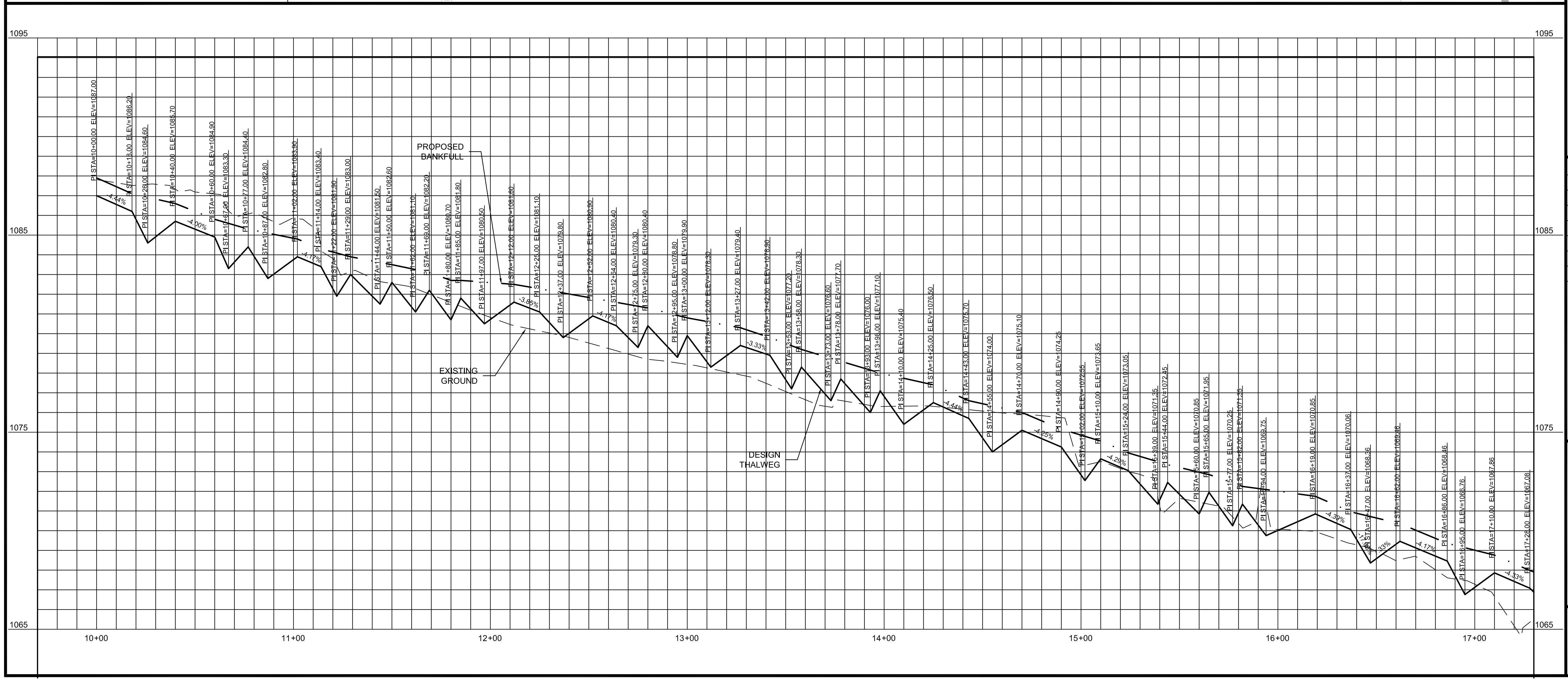
8





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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 36316
CHRISTOPHER A. TOMSIC

PRELIMINARY
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LA SPRINGS RD., WEAVERVILLE, NC 28787
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| VERT. SCALE | 1" = 6' |

NORTH

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GRAPHIC SCALE

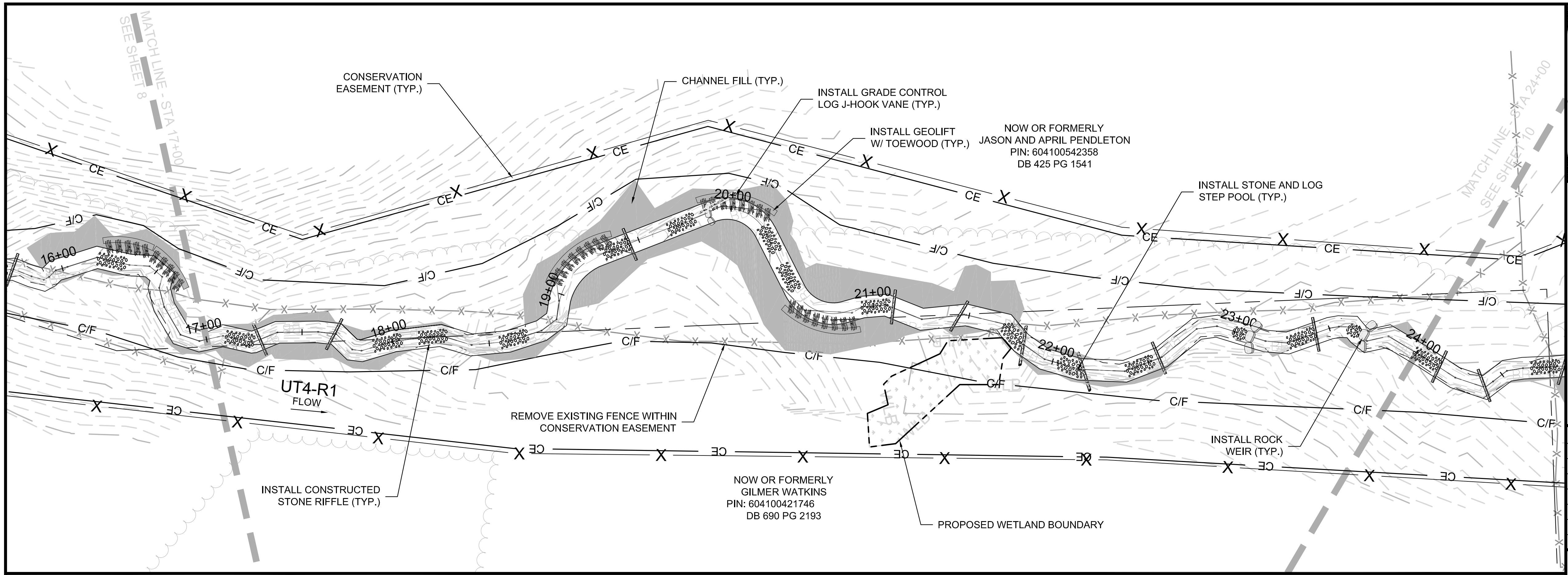
SHEET NAME

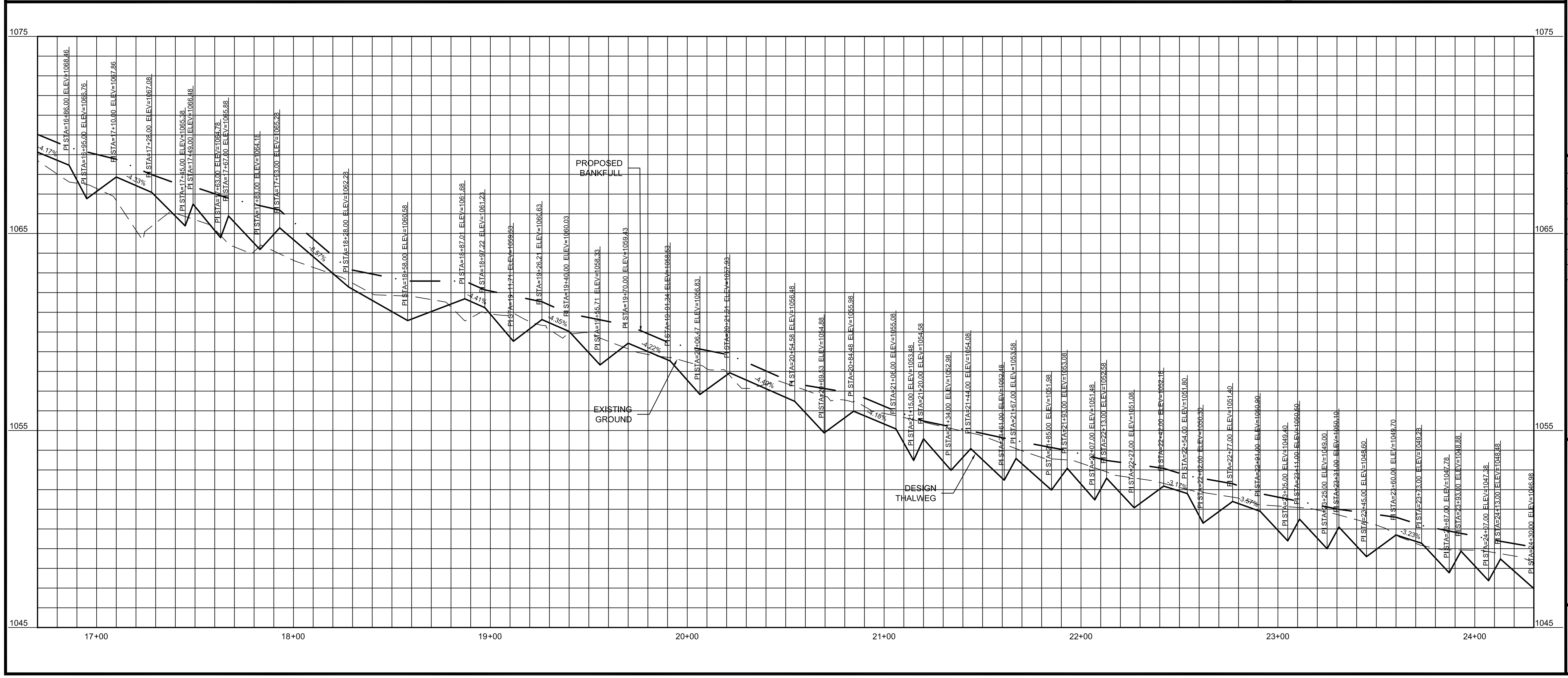
UT4-R1

PLAN AND PROFILE

SHEET NUMBER

9





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PROJECT ENGINEER

CHRISTOPHER A. TOMSIC
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NORTH

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SHEET NAME

## UT4-R1

## PLAN AND PROFILE

SHEET NUMBER

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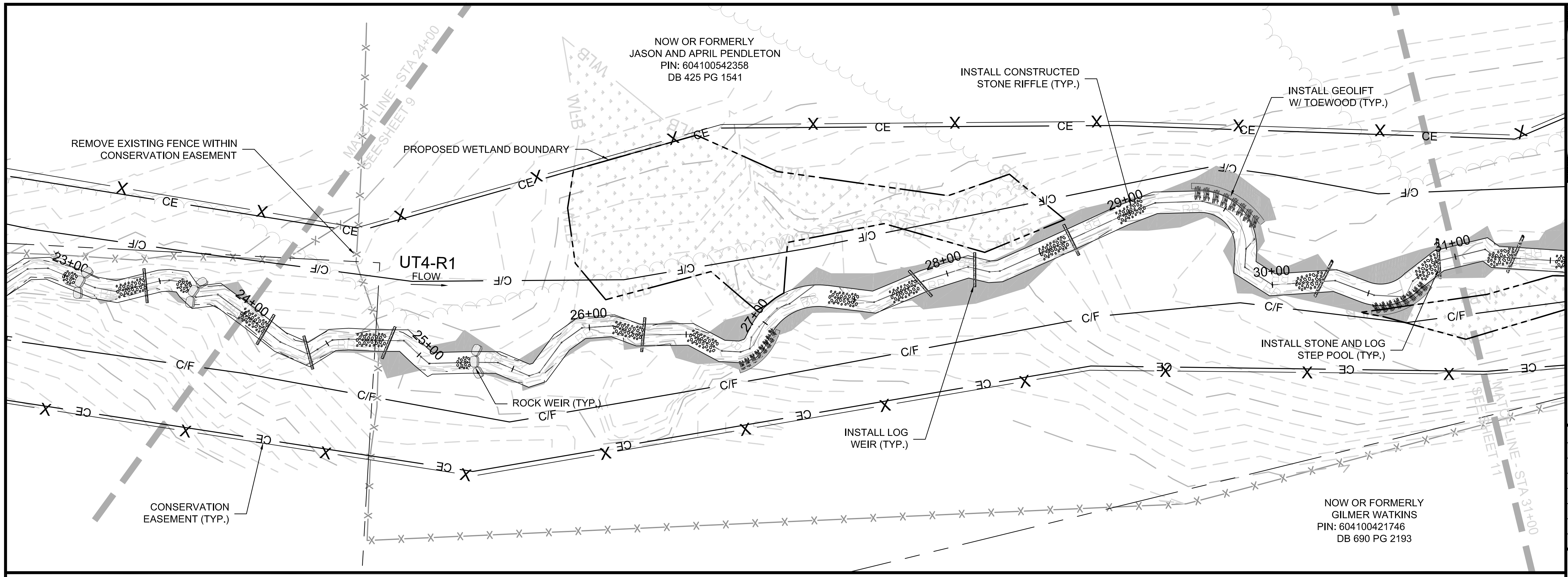

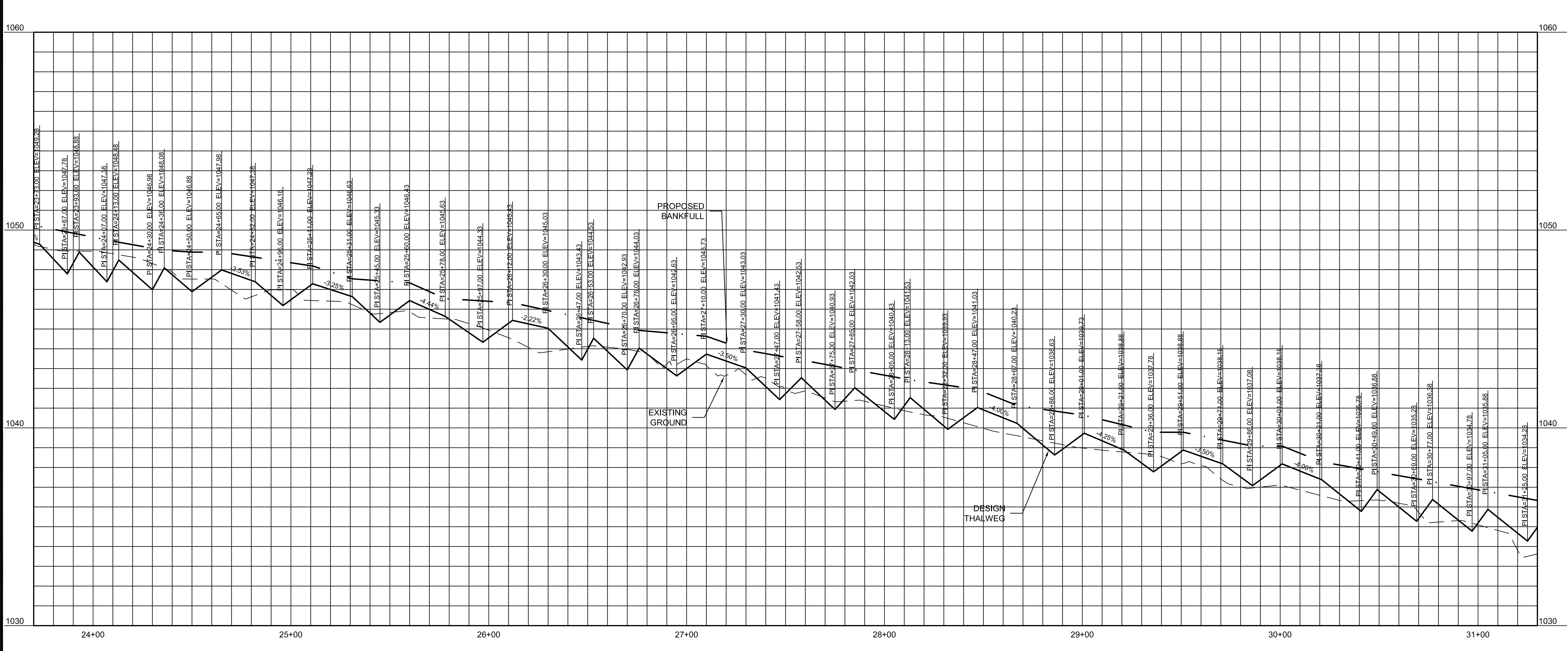

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PROJECT ENGINEER

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CHRISTOPHER A. TOMSIC

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GRAPHIC SCALE

SHEET NAME

*UT4-R1*

PLAN AND PROFILE

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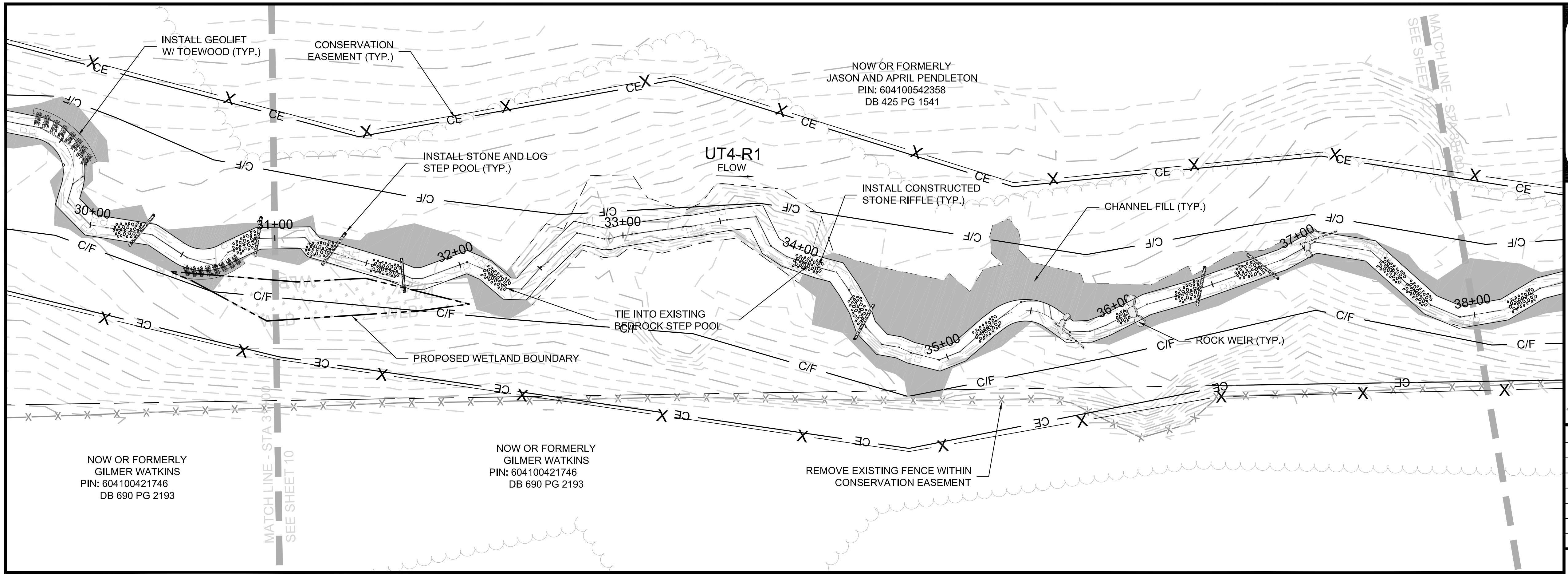
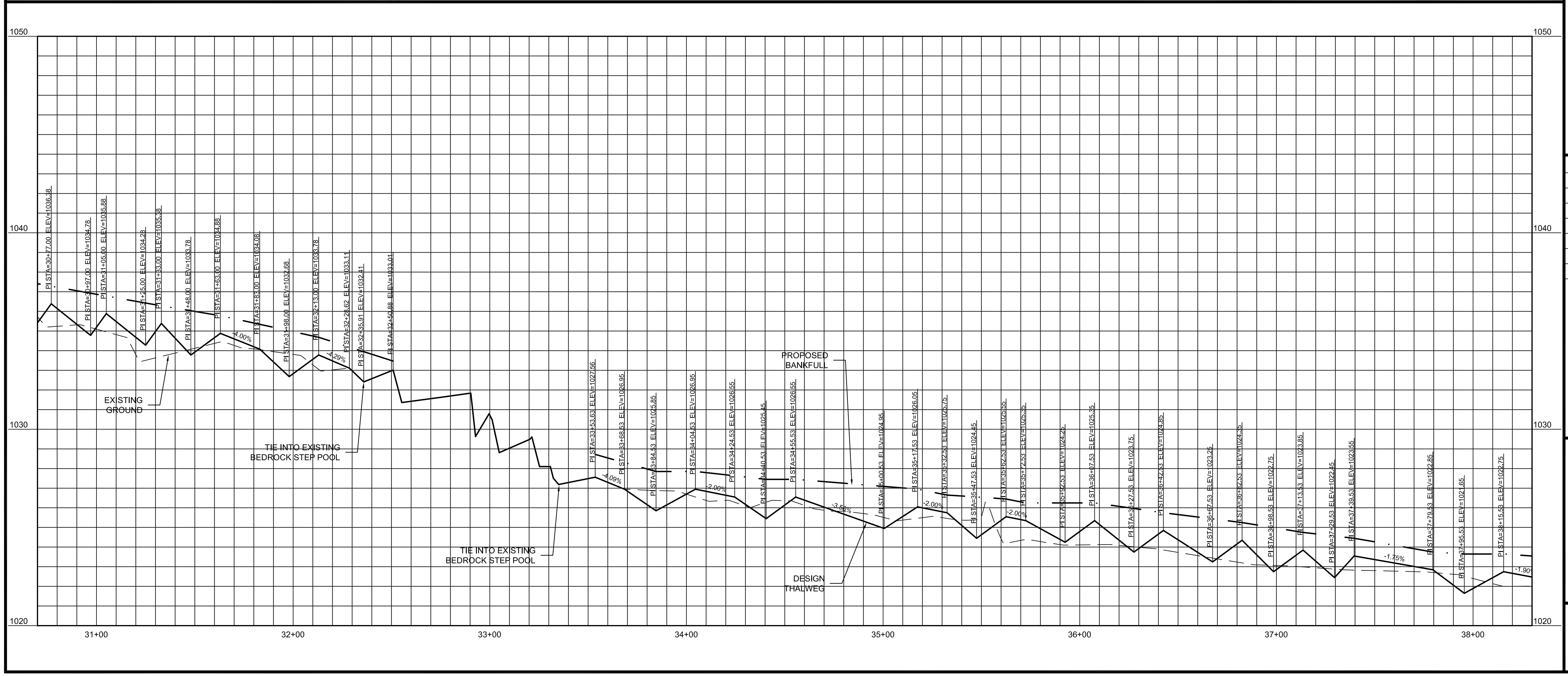
11





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PROJECT ENGINEER

PRELIMINARY PLANS NOT FOR CONSTRUCTION

NORTH CAROLINA PROFESSIONAL SEAL 36316 ENGINEER CHRISTOPHER A. TOMSIC

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
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*UT4-R1*

PLAN AND PROFILE

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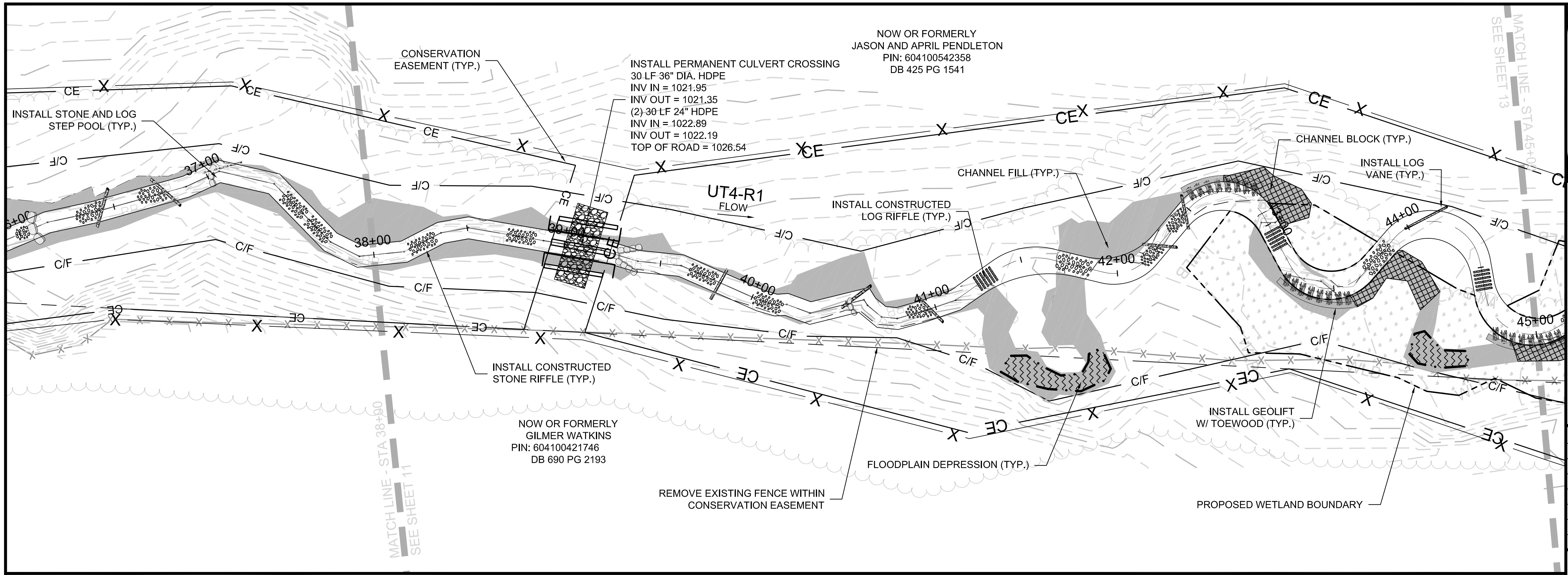
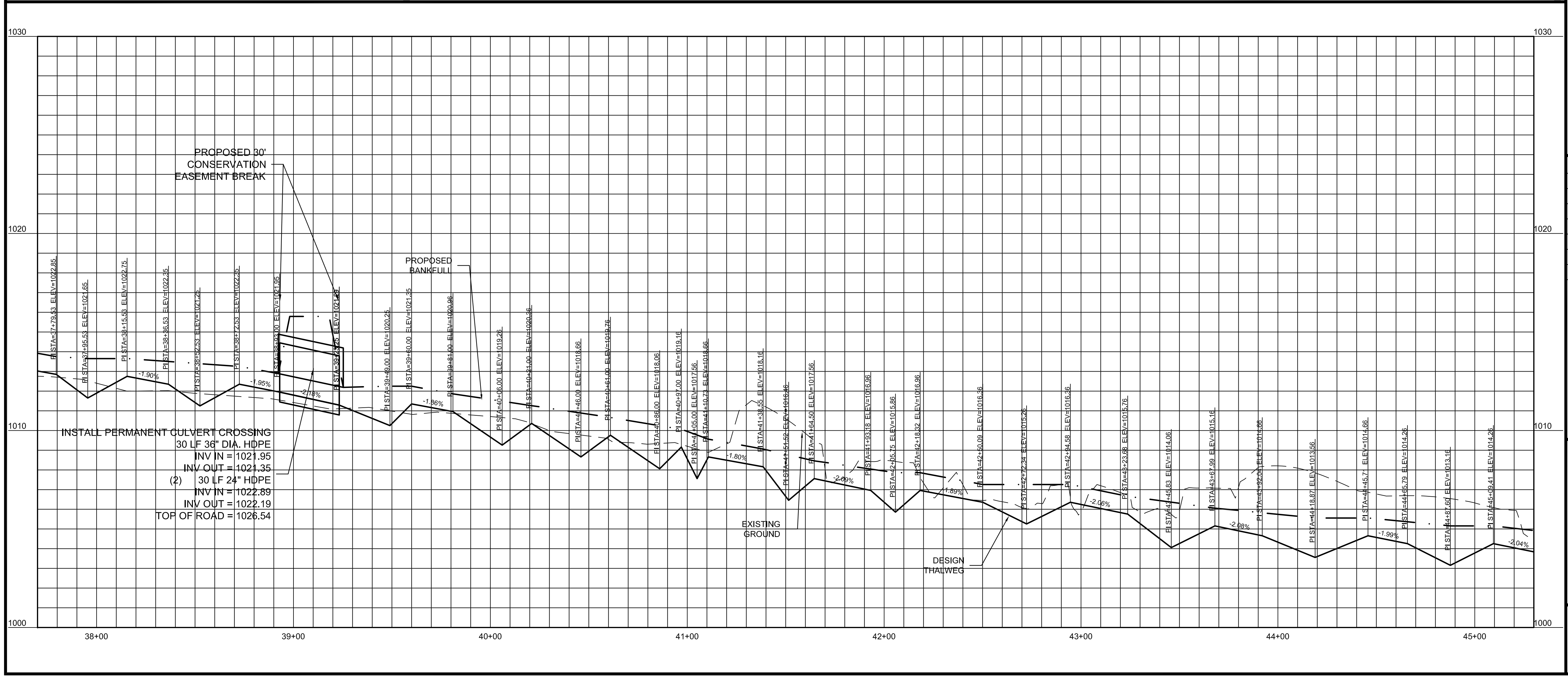
12





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PROJECT ENGINEER

36316
CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS
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| VERT. SCALE | 1" = 6' |

NORTH

30 15 0 30 60
GRAPHIC SCALE

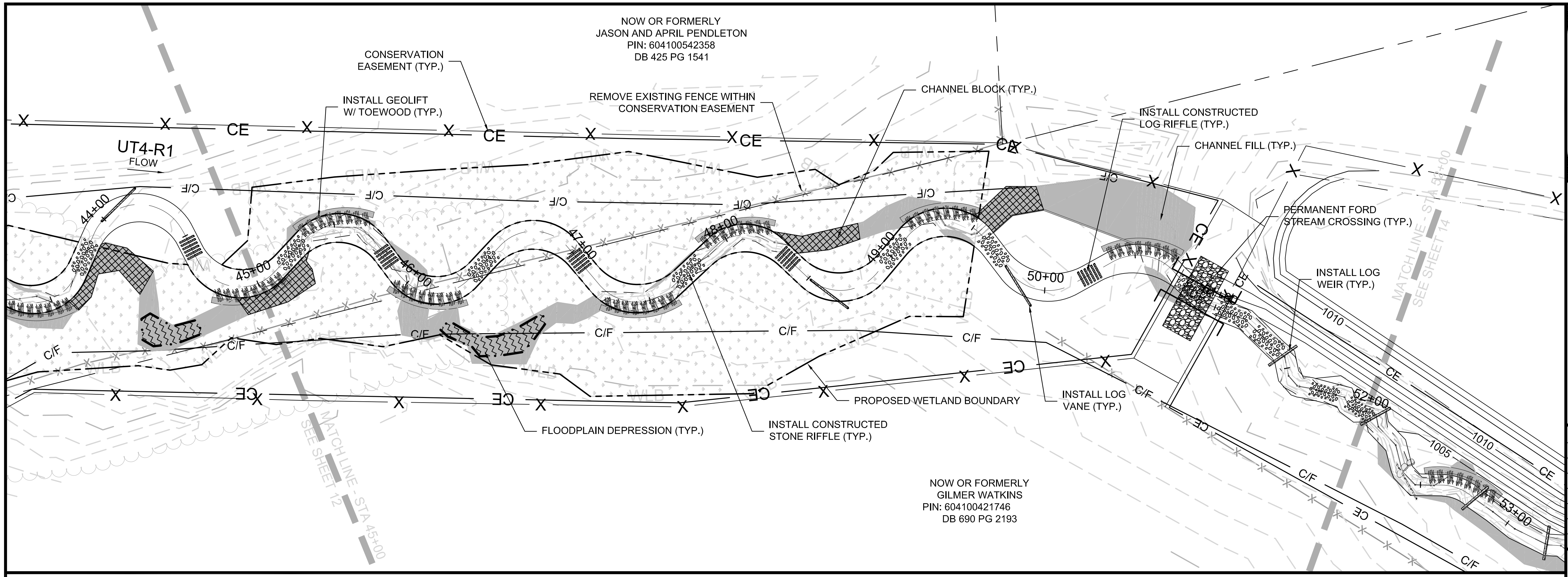
SHEET NAME

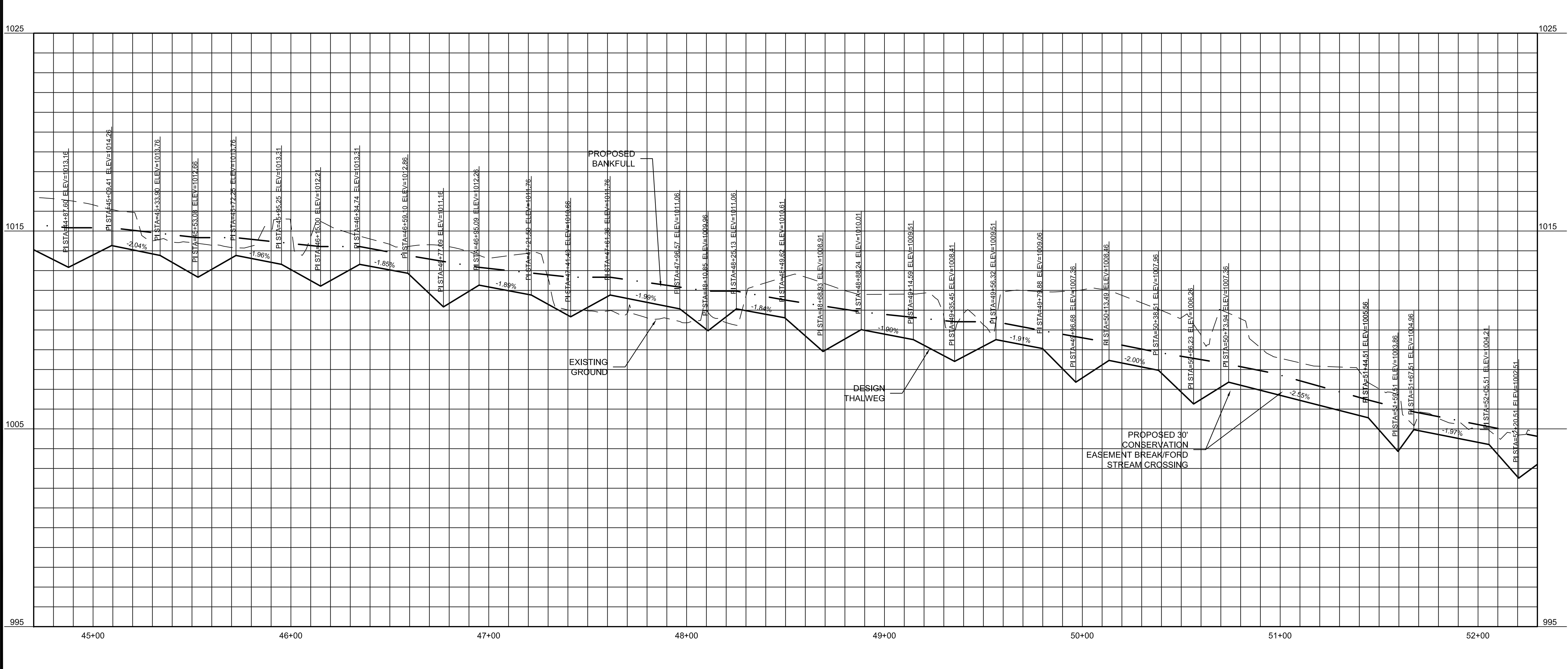
*UT4-R1*

PLAN AND PROFILE

SHEET NUMBER

13





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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
DULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

| NO. | DESCRIPTION | DATE |
|---|---|---|
| A | DRAFT MIT PLAN | 12-27-19 |
| B | FINAL DRAFT PLAN | 3-26-20 |
| C | FINAL MIT PLAN | 7-24-20 |
| | | |
| | | |
| | | |

PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

| | |
|---|---|
| PROJECT NO. | 18-007 |
| FILENAME | 09_34_BANNER BRANCH_PLAN AND PROFILE.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 60' |
| VERT. SCALE | 1" = 6' |

NORTH

30 15 0 30 60
GRAPHIC SCALE

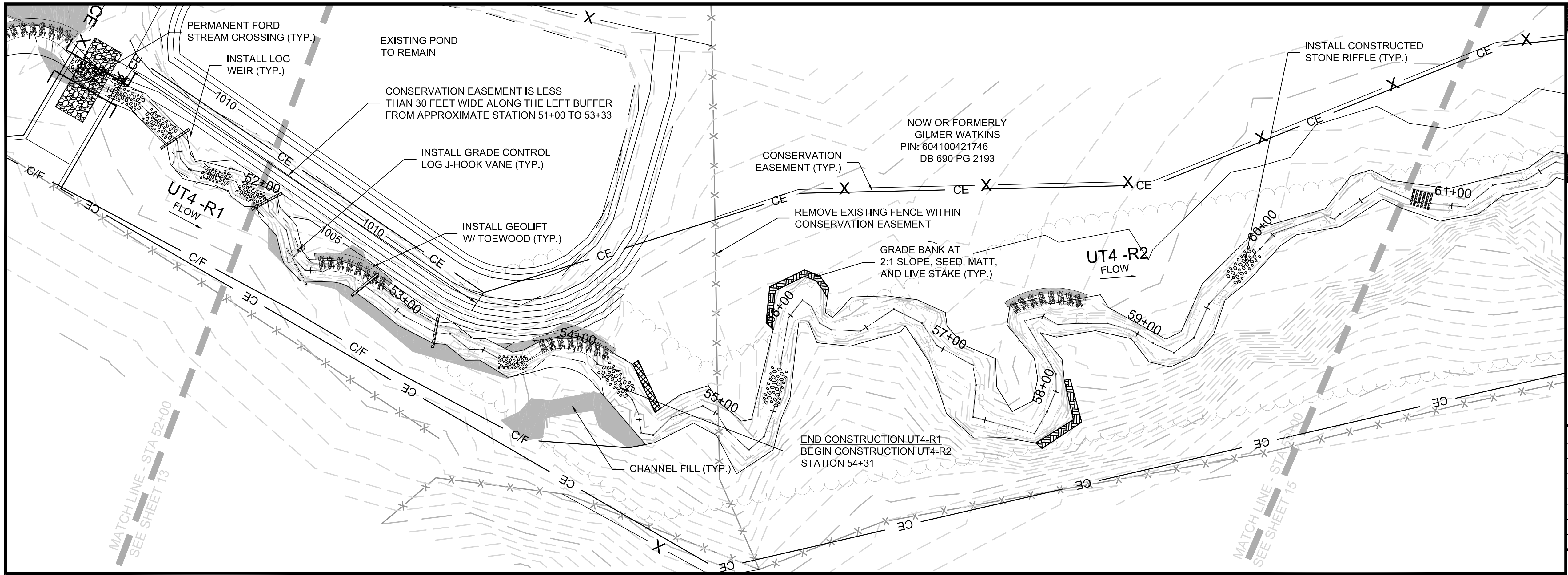
SHEET NAME

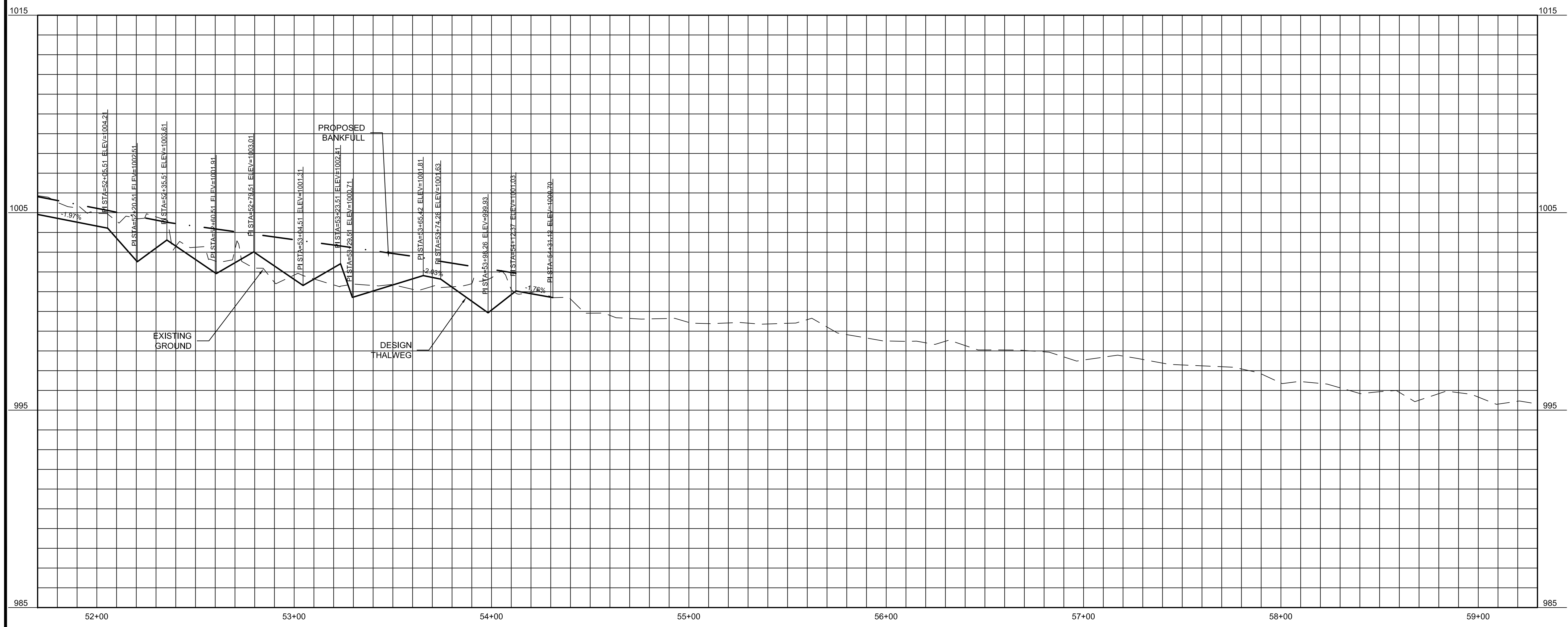
UT4-R1

PLAN AND PROFILE

SHEET NUMBER

14





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PROJECT ENGINEER

PRELIMINARY PLANS NOT FOR CONSTRUCTION

SEAL 36316
CHRISTOPHER A. TOMSIC

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
[illegible]ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

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|---|---|---|
| A | DRAFT MIT PLAN | 12-27-19 |
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| | | |
| NO. | DESCRIPTION | DATE |

PROJECT NAME

BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

| | |
|---|---|
| PROJECT NO. | 18-007 |
| FILENAME | 09_34_BANNER BRANCH_PLAN AND PROFILE.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 60' |
| VERT. SCALE | 1" = 6' |

NORTH

30 15 0 30 60
GRAPHIC SCALE

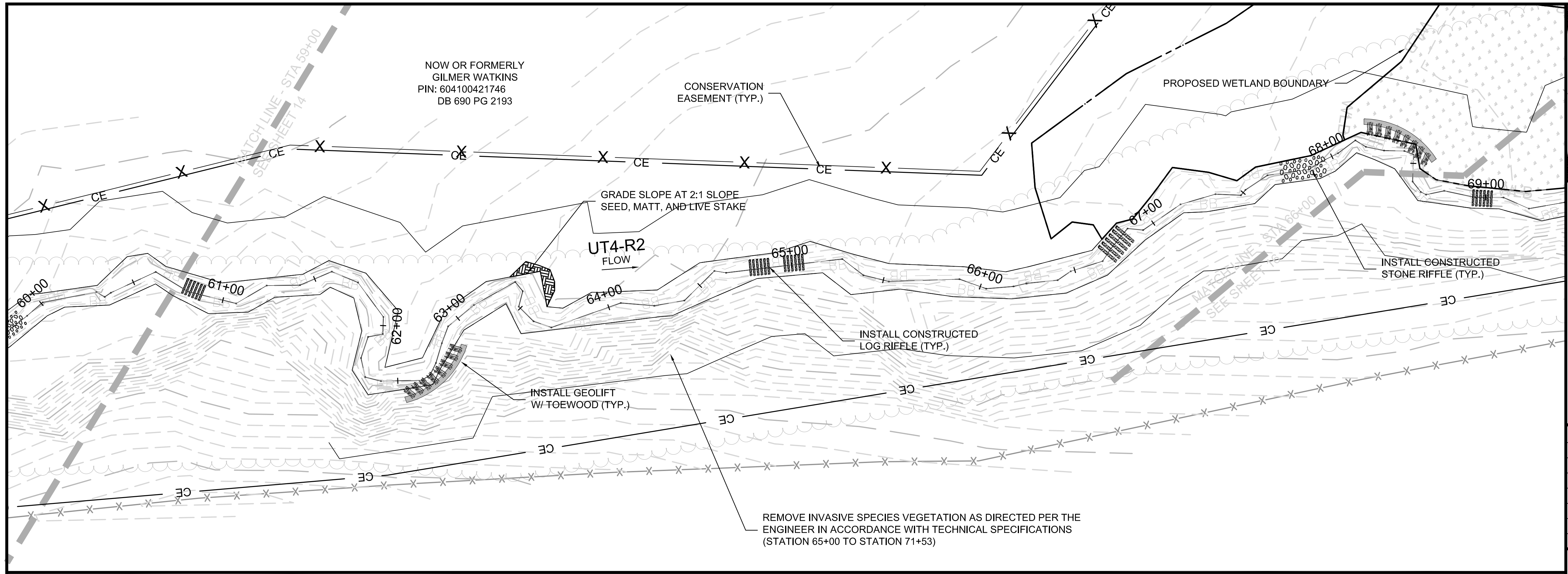
SHEET NAME

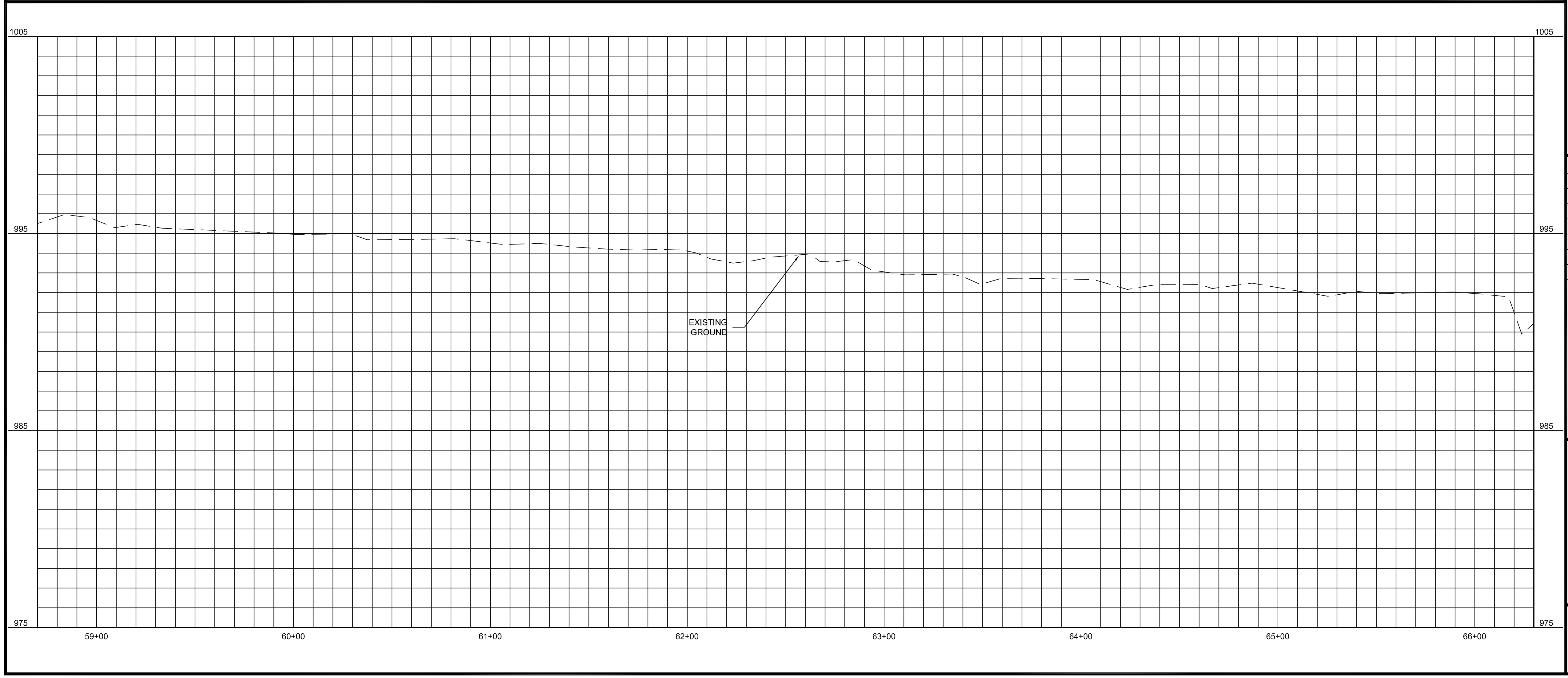
*UT4-R1 & UT4-R2*

PLAN AND PROFILE

SHEET NUMBER

15





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PROJECT ENGINEER

CHRISTOPHER A. TOMSIC
36316

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

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FIRM LICENSE NO. P-1480

REVISIONS

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|---|---|---|
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| C | FINAL MIT PLAN | 7-24-20 |
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PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

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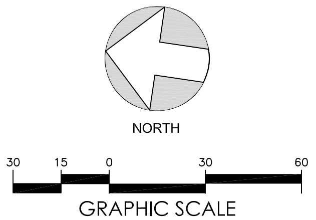
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 60' |
| VERT. SCALE | 1" = 6' |



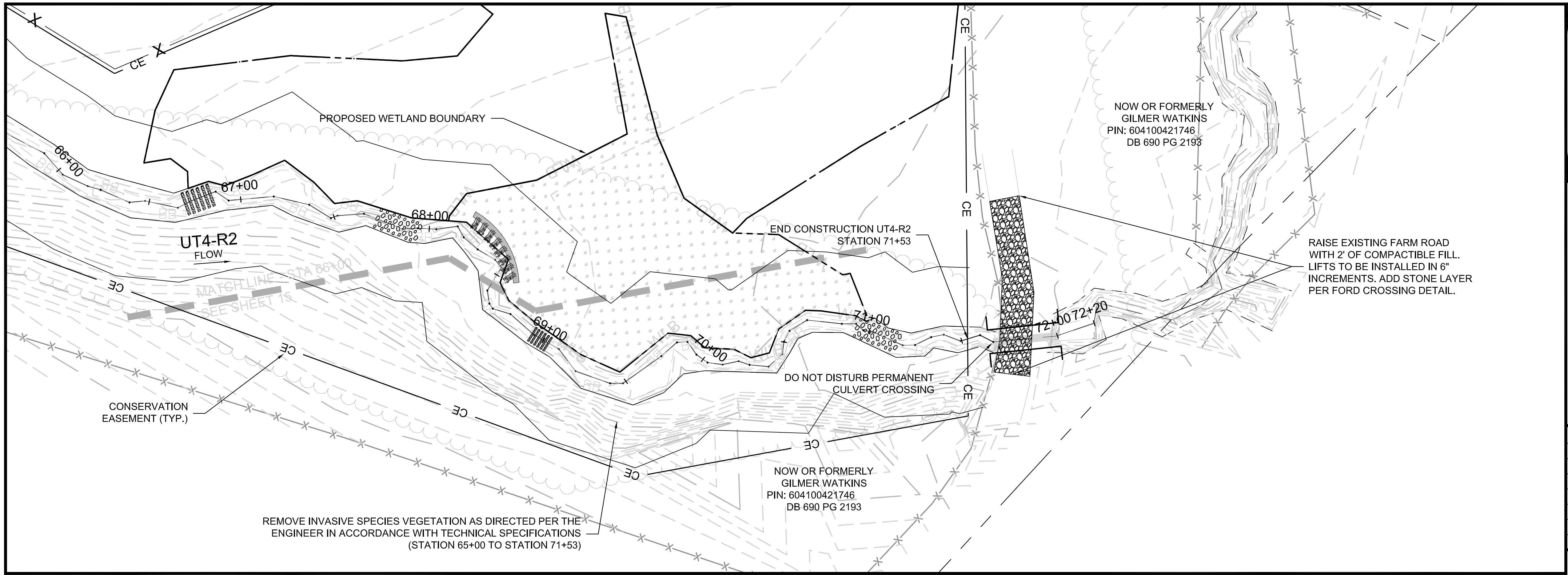
SHEET NAME

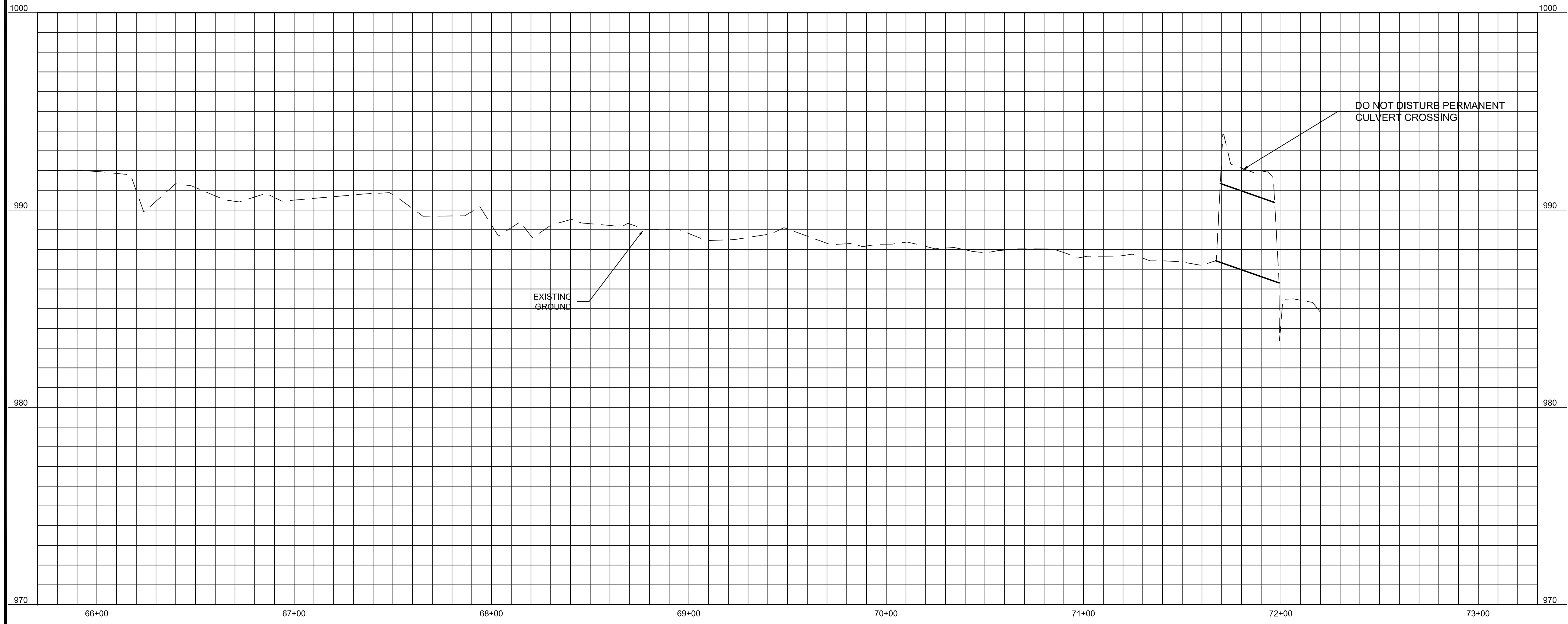
*UT4-R2*

PLAN AND PROFILE

SHEET NUMBER

16





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PROJECT ENGINEER

36316
CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS
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FIRM LICENSE NO. P-1480

REVISIONS

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PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

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| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 60' |
| VERT. SCALE | 1" = 6' |

NORTH

30 15 0 30 60
GRAPHIC SCALE

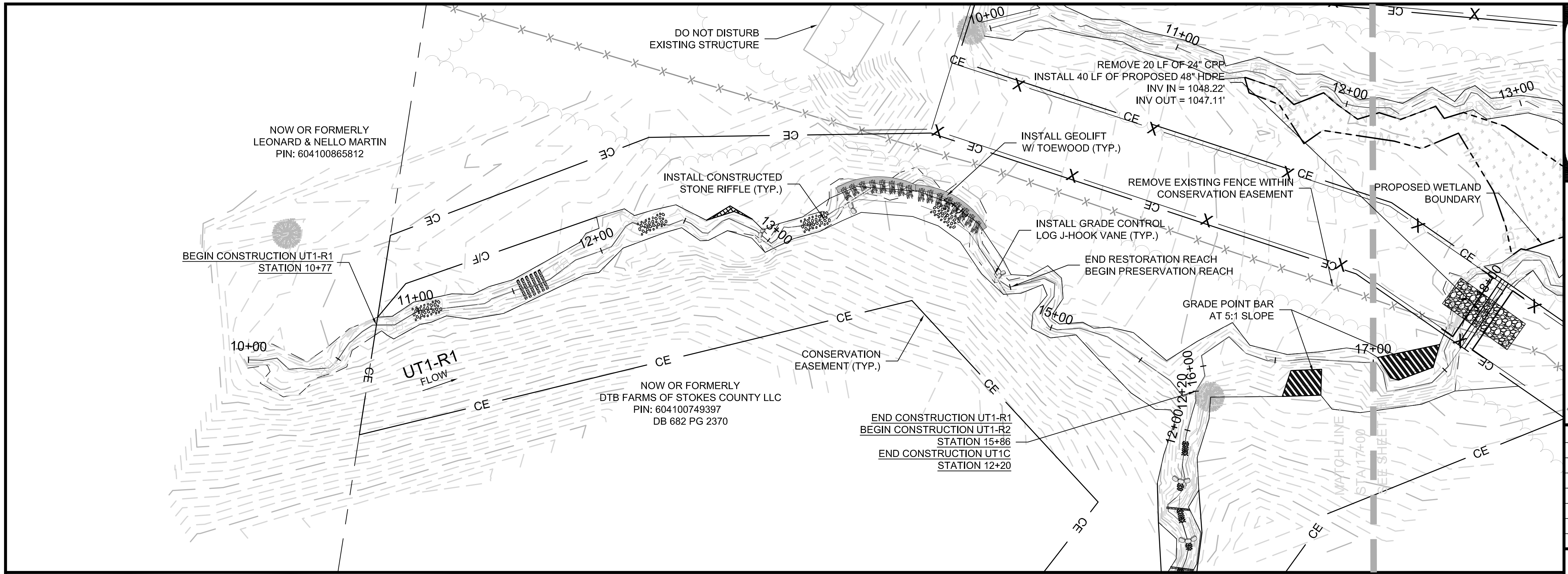
SHEET NAME

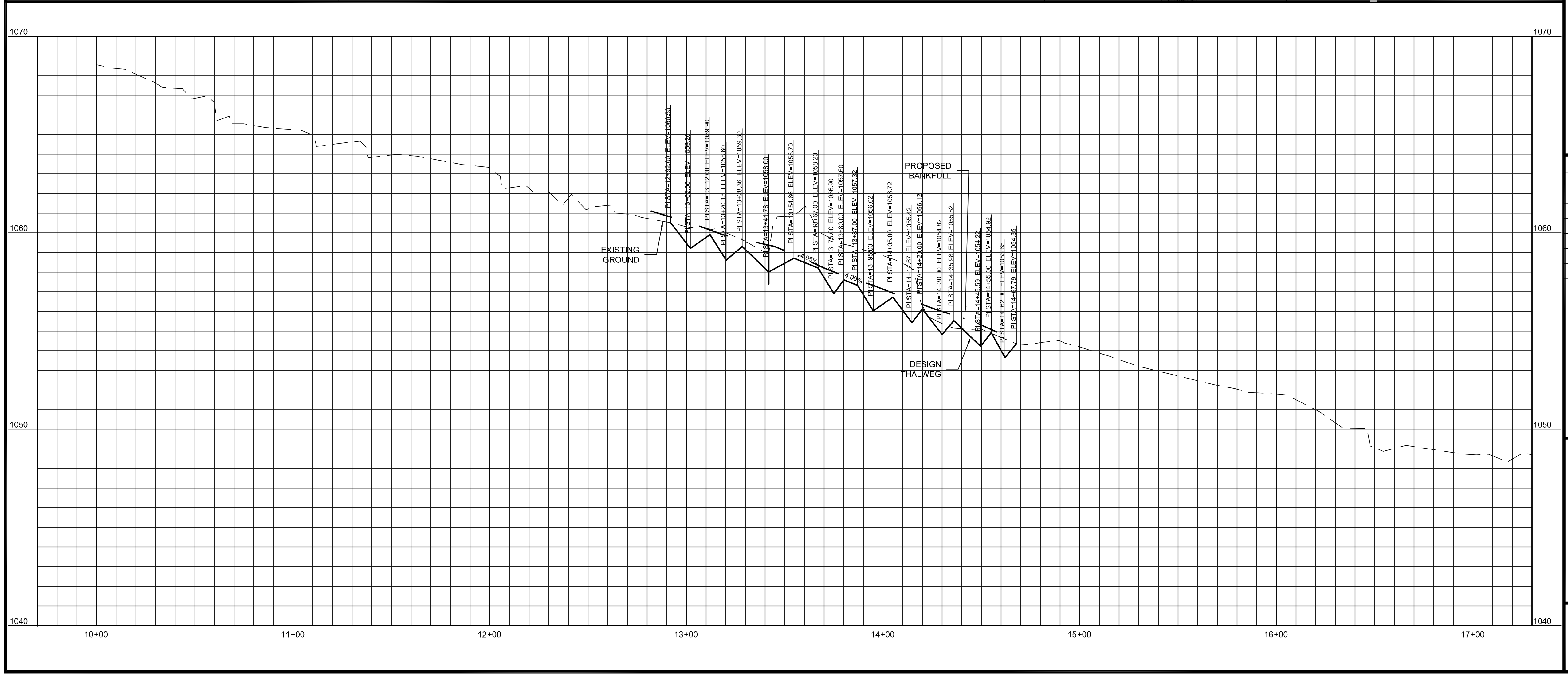
*UT4-R2*

## PLAN AND PROFILE

SHEET NUMBER

17





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PROJECT ENGINEER

SEAL
36916
CHRISTOPHER A. TOMSIC

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FIRM LICENSE NO. P-1480

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| NO. | DESCRIPTION | DATE |

PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

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| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 60' |
| VERT. SCALE | 1" = 6' |

NORTH

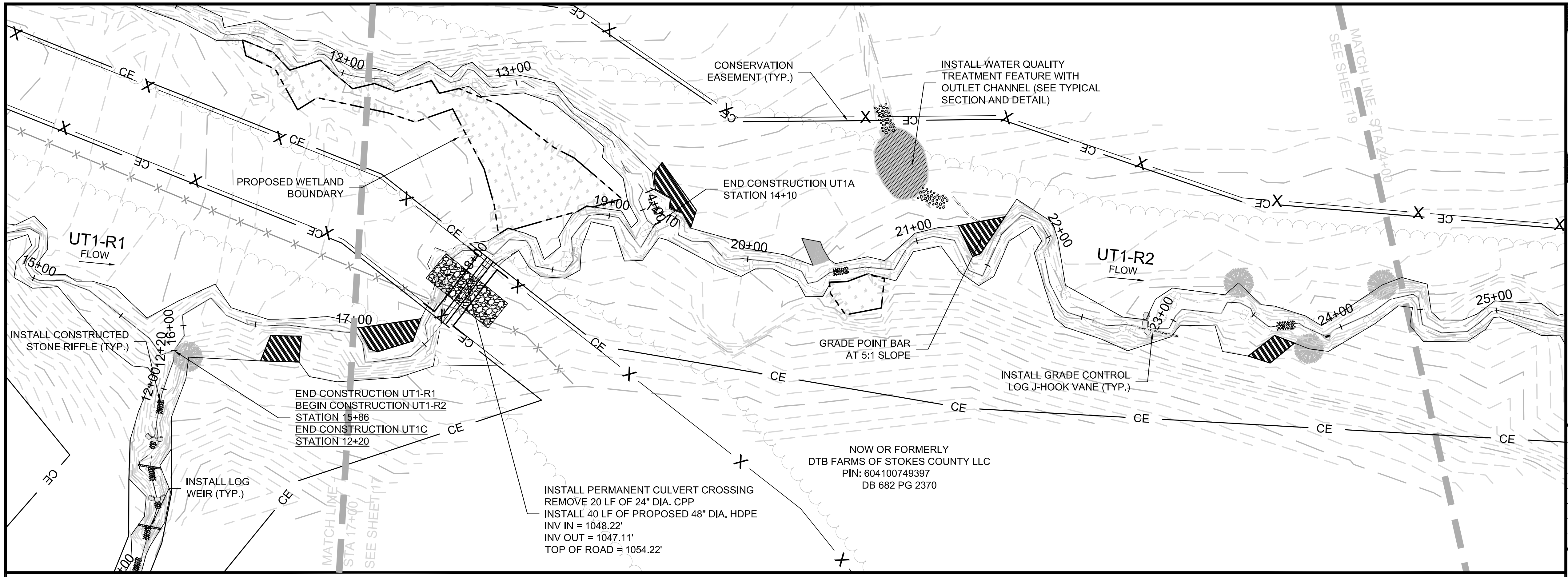
30 15 0 30 60
GRAPHIC SCALE

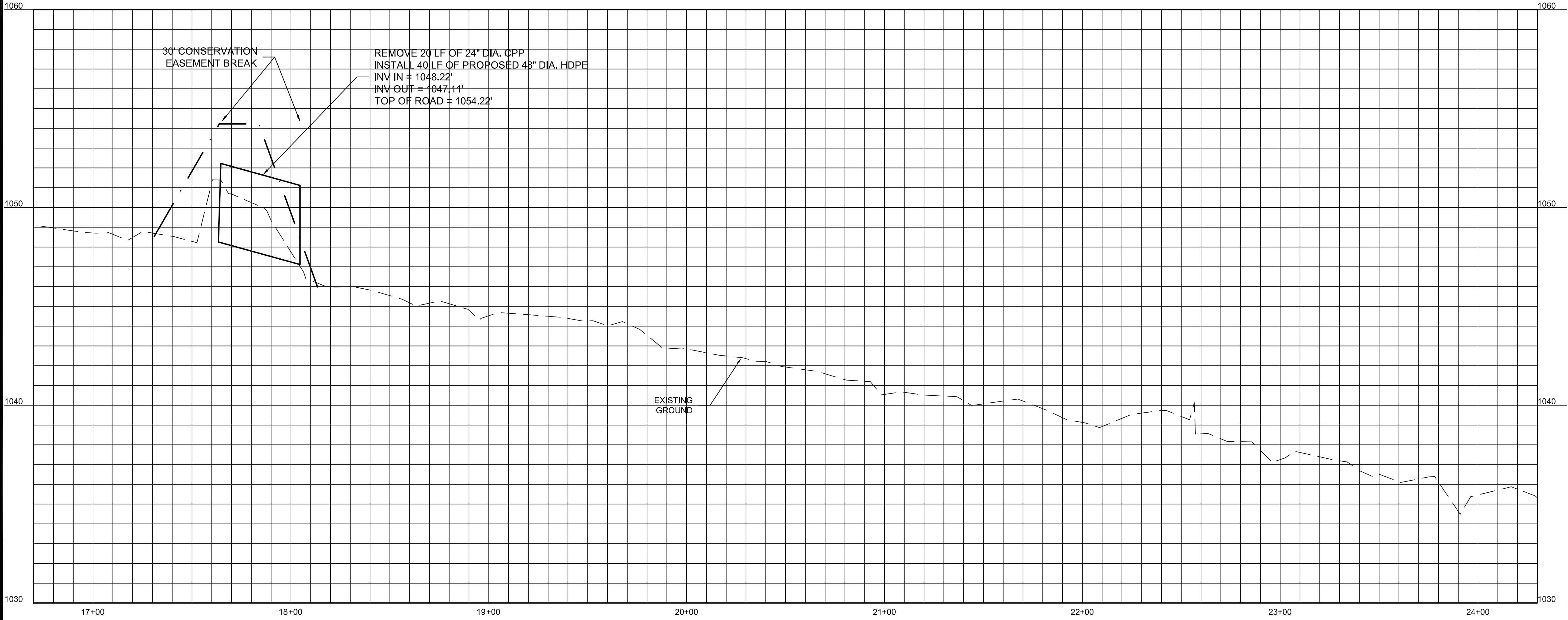
SHEET NAME

*UT1-R1*

## PLAN AND PROFILE

SHEET NUMBER





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PROJECT ENGINEER

CHRISTOPHER A. TOMSIC
36316

PRELIMINARY PLANS
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REVISIONS

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PROJECT NAME

BANNER
BRANCH
MITIGATION
PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

| | |
|---|---|
| PROJECT NO. | 18-007 |
| FILENAME | 09_34_BANNER BRANCH_PLAN AND PROFILE.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 60' |
| VERT. SCALE | 1" = 6' |

NORTH

30 15 0 30 60
GRAPHIC SCALE

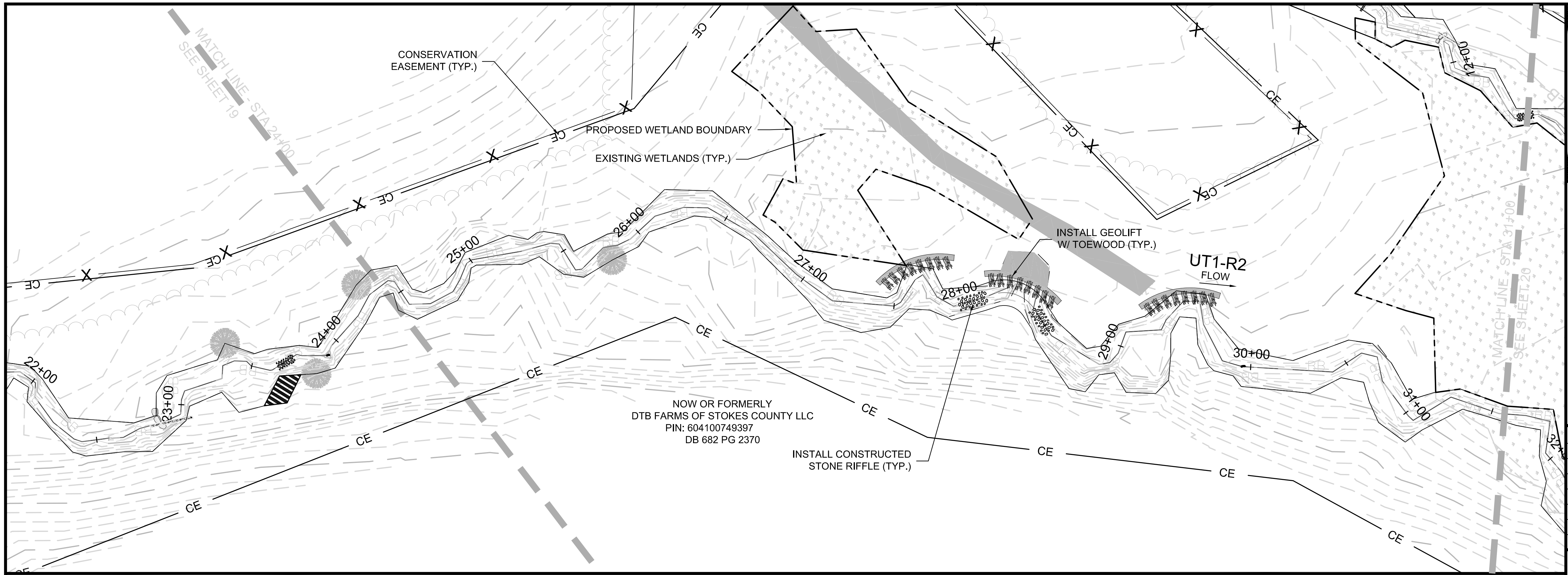
SHEET NAME

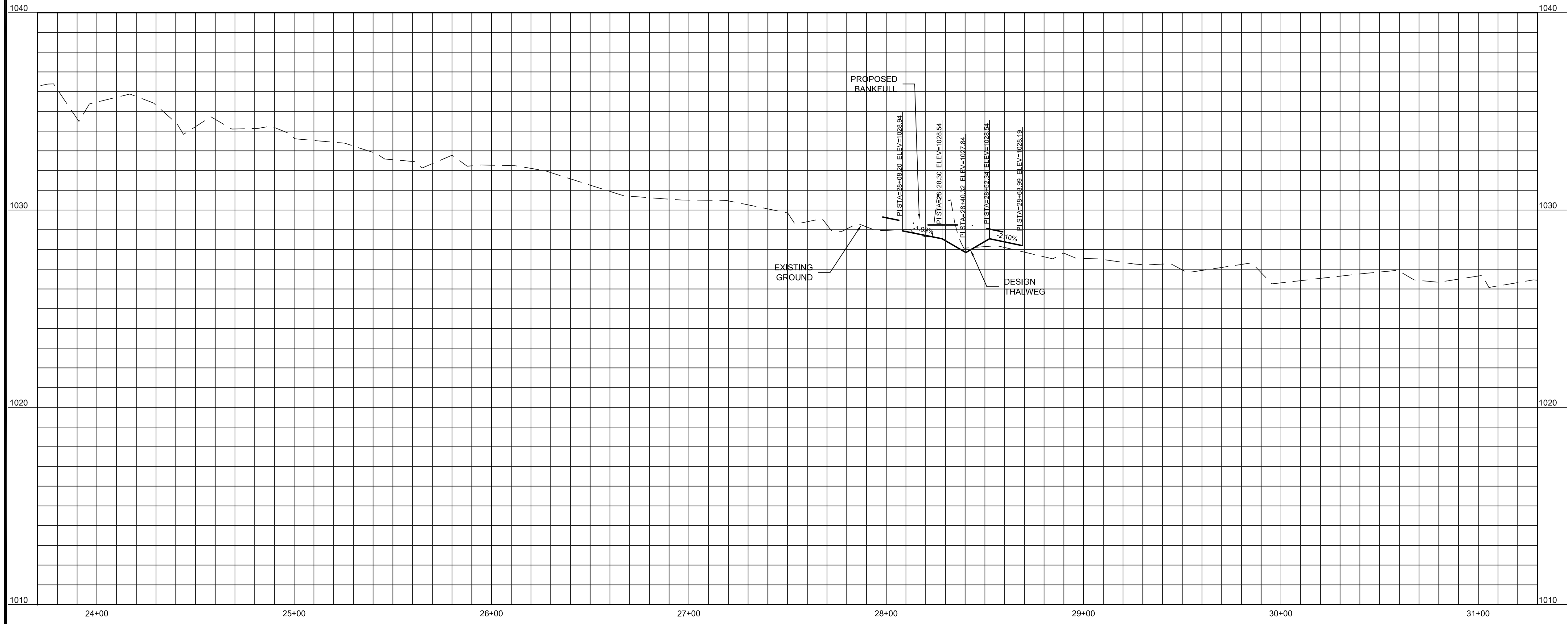
*UT1-R1& UT1-R2*

PLAN AND
PROFILE

SHEET NUMBER

19





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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 36316 CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
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[illegible]ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

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PROJECT NAME

BANNER
BRANCH
MITIGATION
PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

| | |
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| PROJECT NO. | 18-007 |
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| DATE | 7-24-20 |
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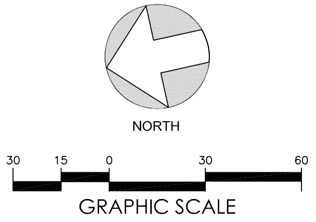


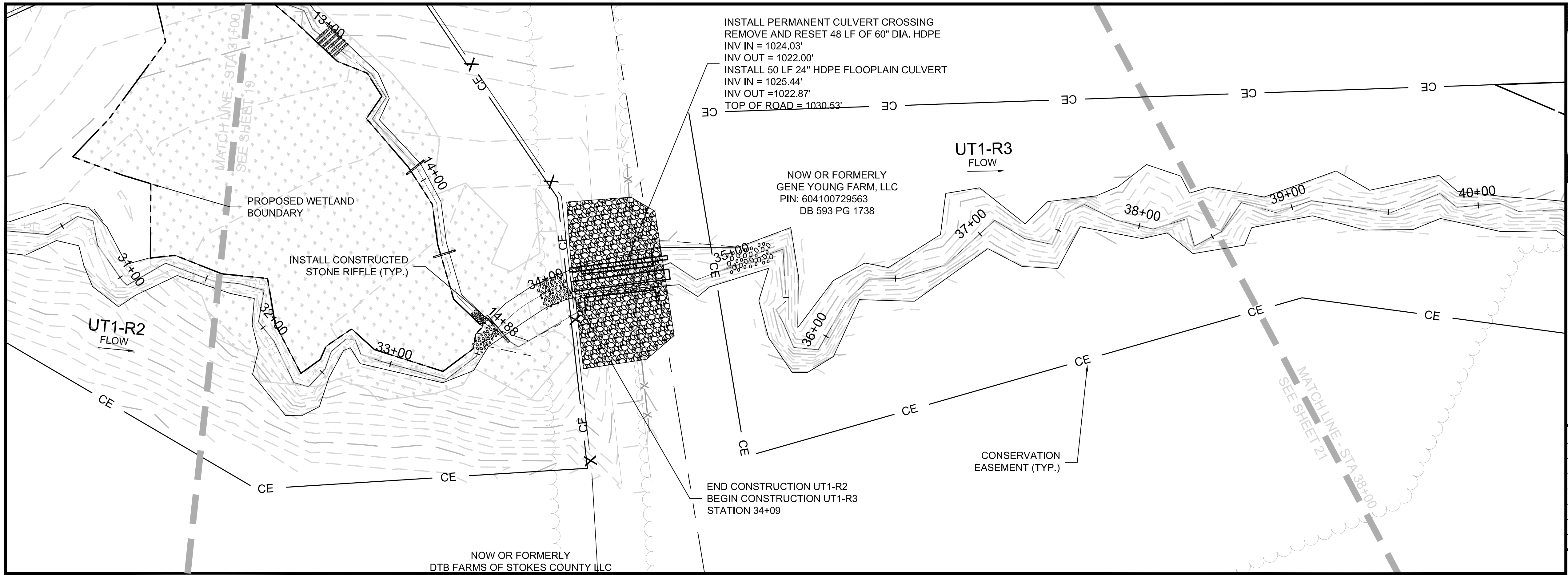
SHEET NAME

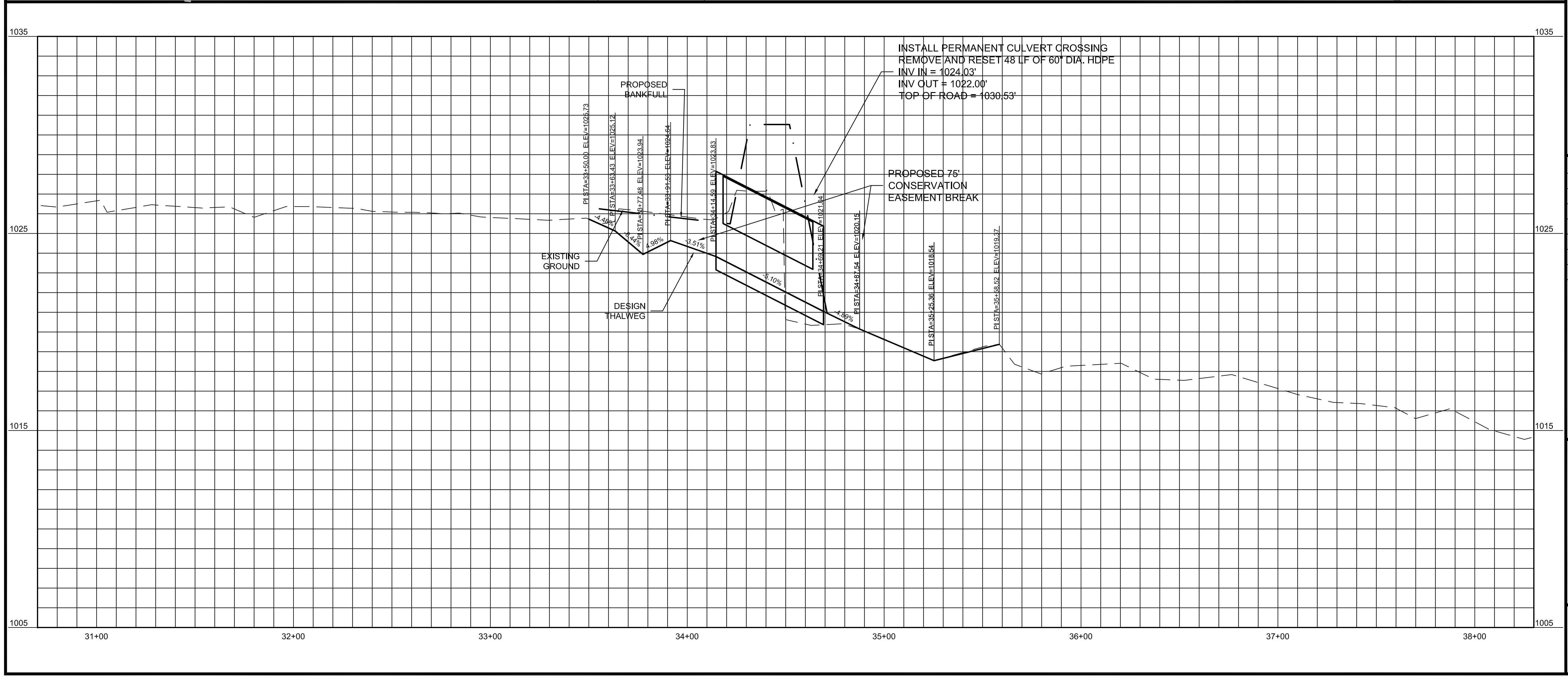
UT1-R2

PLAN AND
PROFILE

SHEET NUMBER

20





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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 36316 CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

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FIRM LICENSE NO. P-1480

REVISIONS

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PROJECT NAME

BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

| | |
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| PROJECT NO. | 18-007 |
| FILENAME | 09_34_BANNER BRANCH_PLAN AND PROFILE.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 60' |
| VERT. SCALE | 1" = 6' |

NORTH

30 15 0 30 60
GRAPHIC SCALE

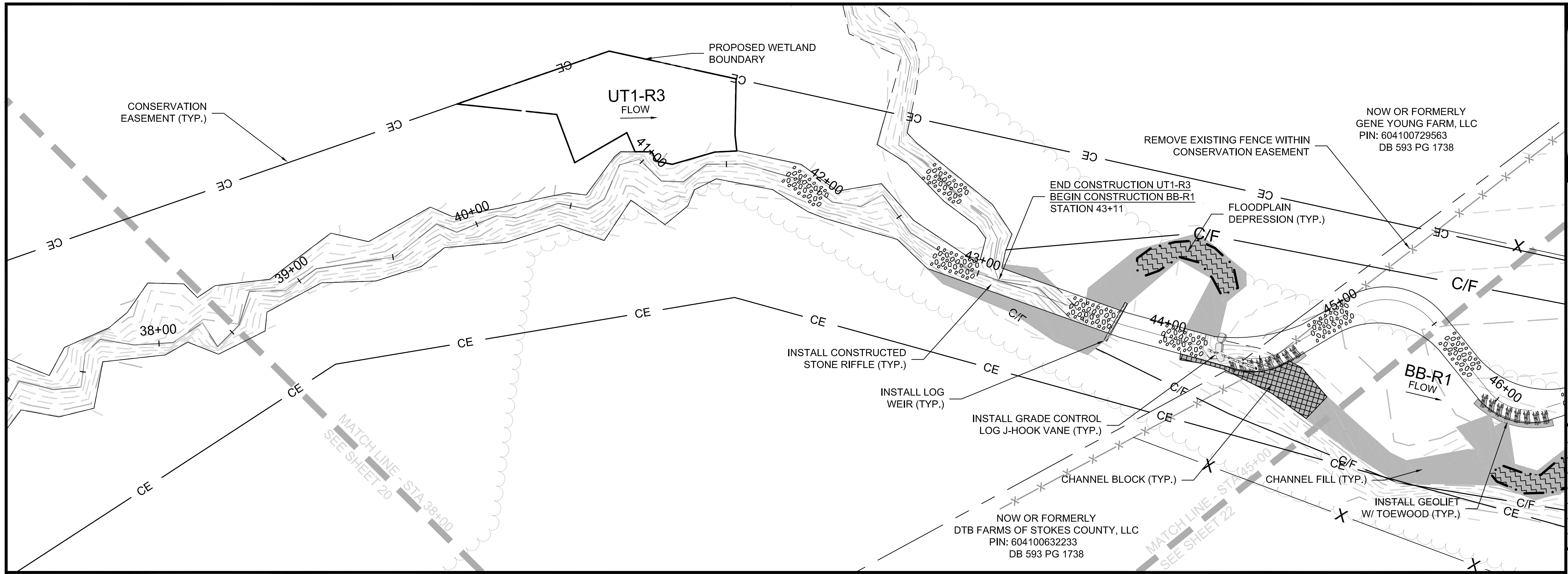
SHEET NAME

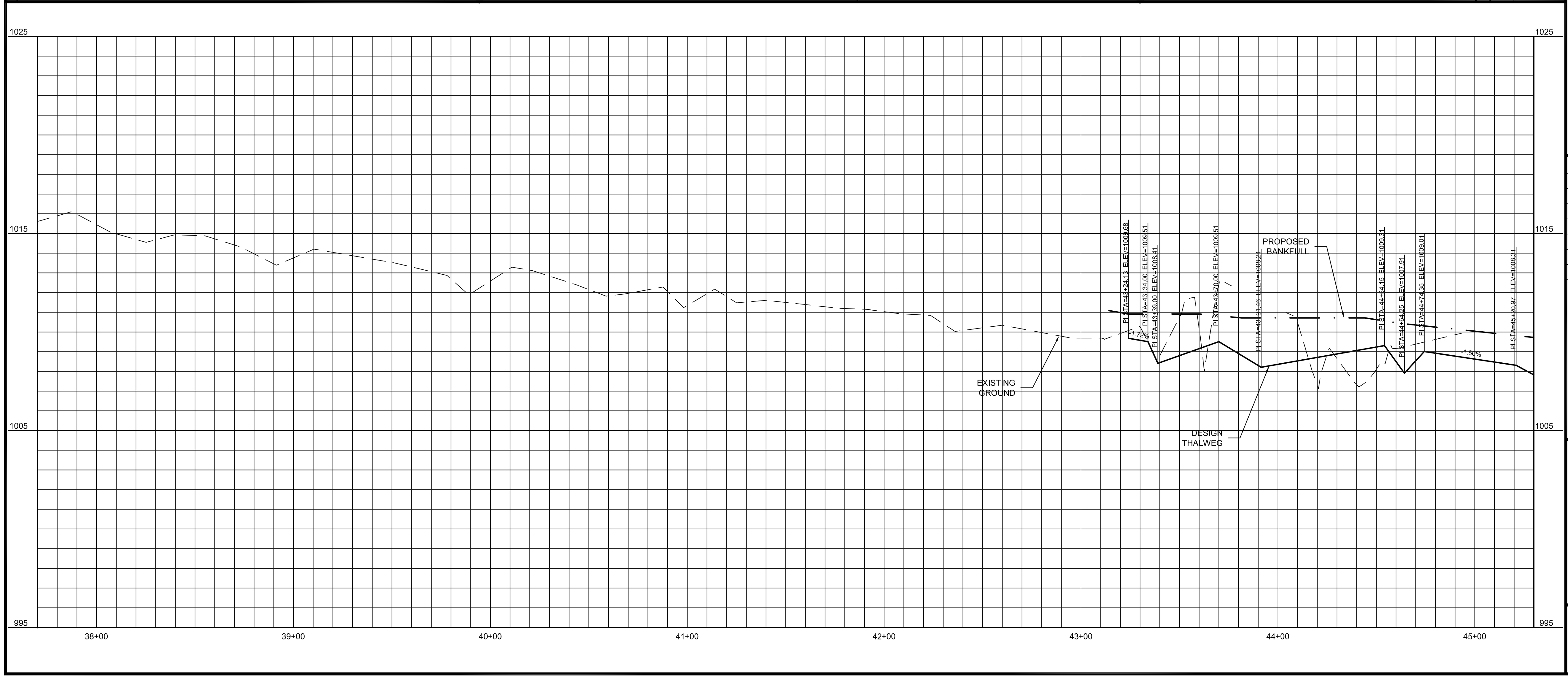
*UT1-R2 & UT1-R3*

PLAN AND PROFILE

SHEET NUMBER

21





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PROJECT ENGINEER

CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
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| | | |
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PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

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| PROJECT NO. | 18-007 |
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| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 60' |
| VERT. SCALE | 1" = 6' |

NORTH

30 15 0 30 60

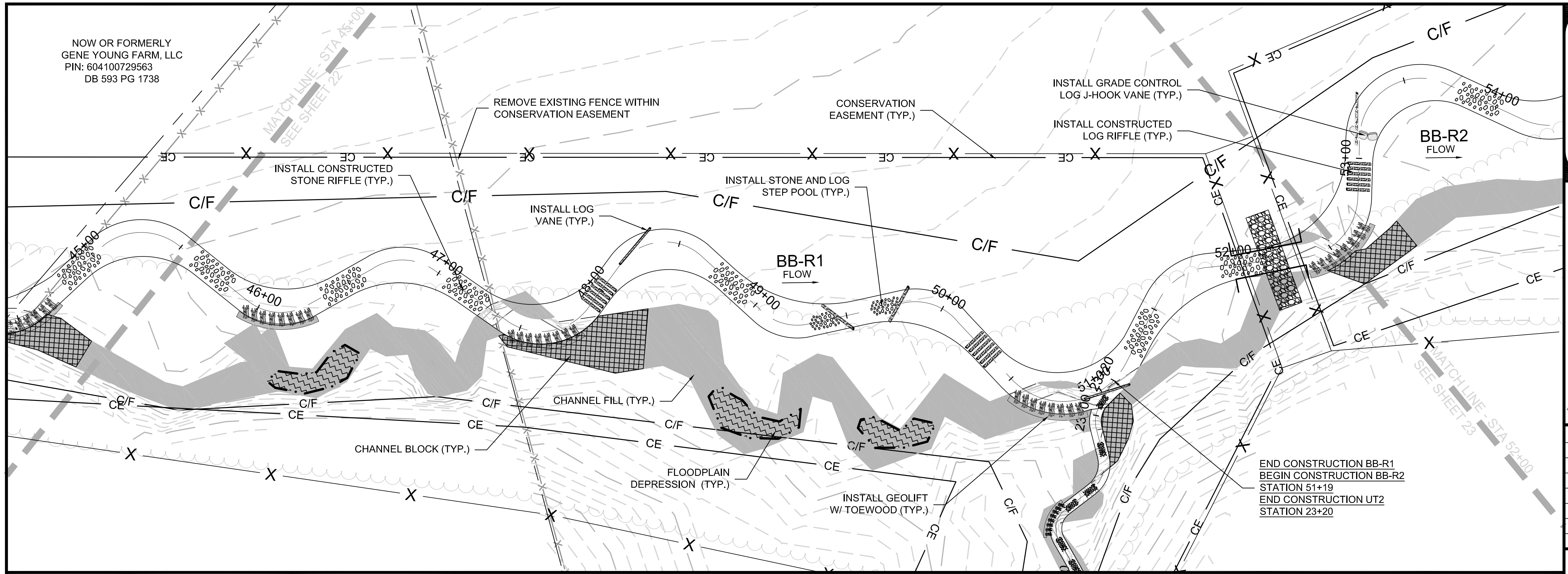
GRAPHIC SCALE

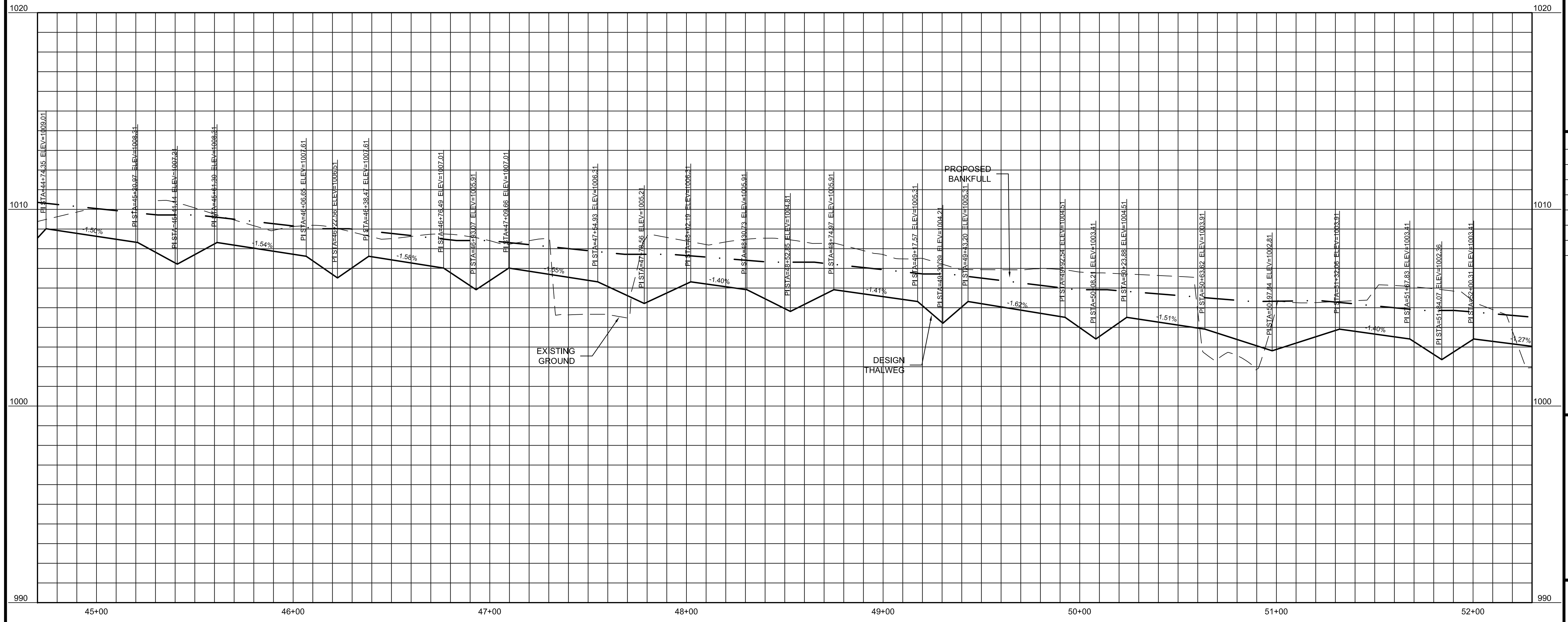
SHEET NAME

*UT1-R3 & BB-R1*

## PLAN AND PROFILE

SHEET NUMBER





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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36316 ENGINEER CHRISTOPHER A. TOMSIC

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PROJECT NAME

BANNER
BRANCH
MITIGATION
PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

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| DATE | 7-24-20 |
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| VERT. SCALE | 1" = 6' |

NORTH

30 15 0 30 60
GRAPHIC SCALE

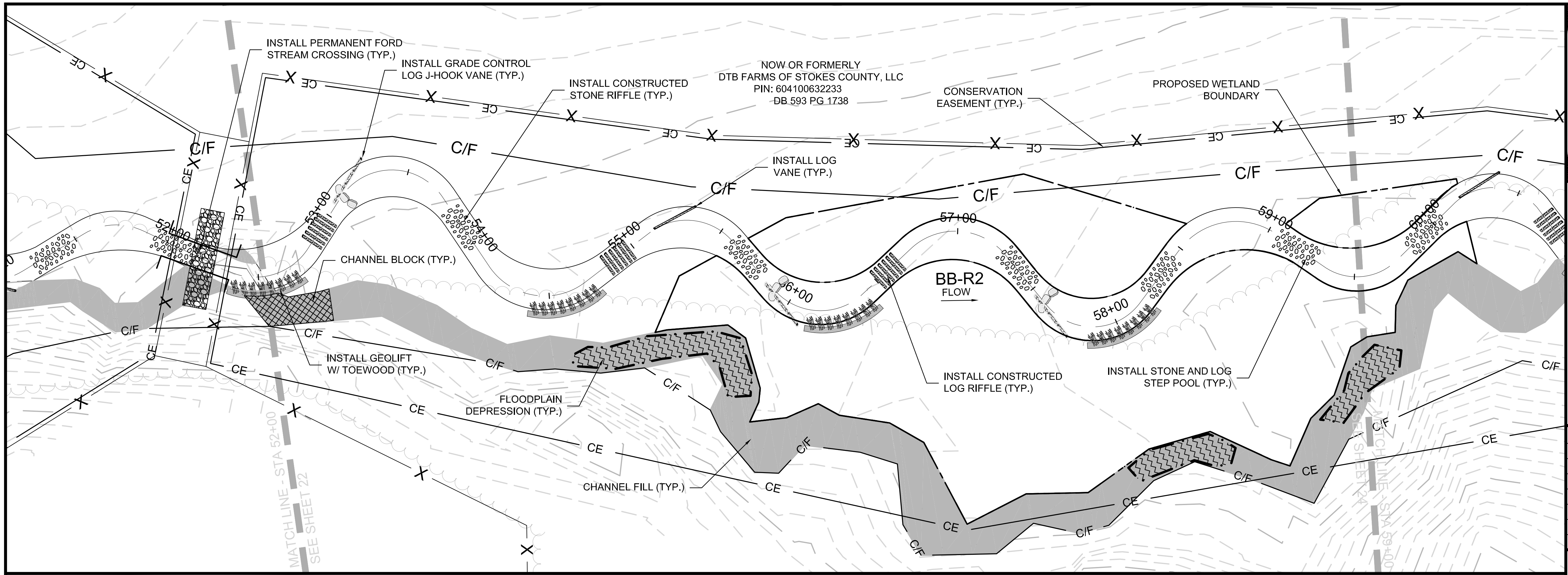
SHEET NAME

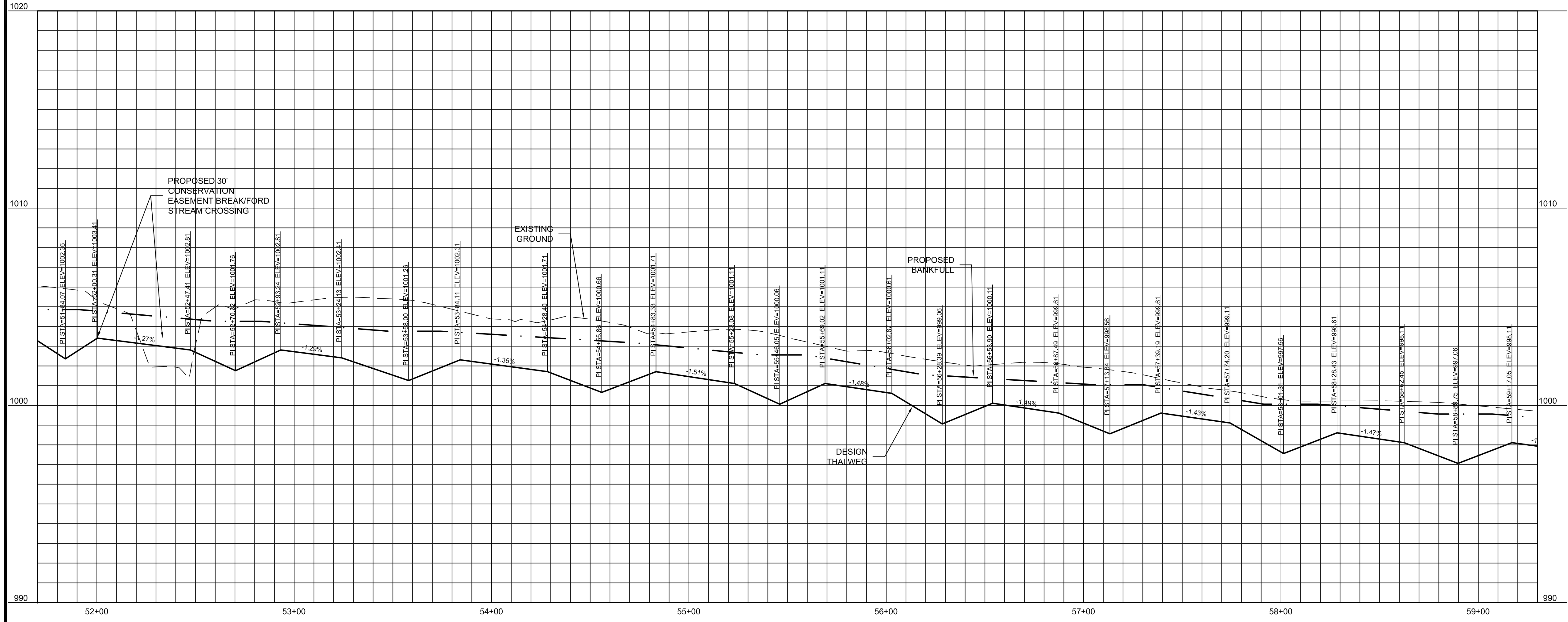
*BB-R1 & BB-R2*

PLAN AND
PROFILE

SHEET NUMBER

23





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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36316 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

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FIRM LICENSE NO. P-1480

REVISIONS

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PROJECT NAME

BANNER
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MITIGATION
PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

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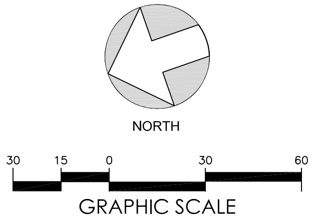
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 60' |
| VERT. SCALE | 1" = 6' |

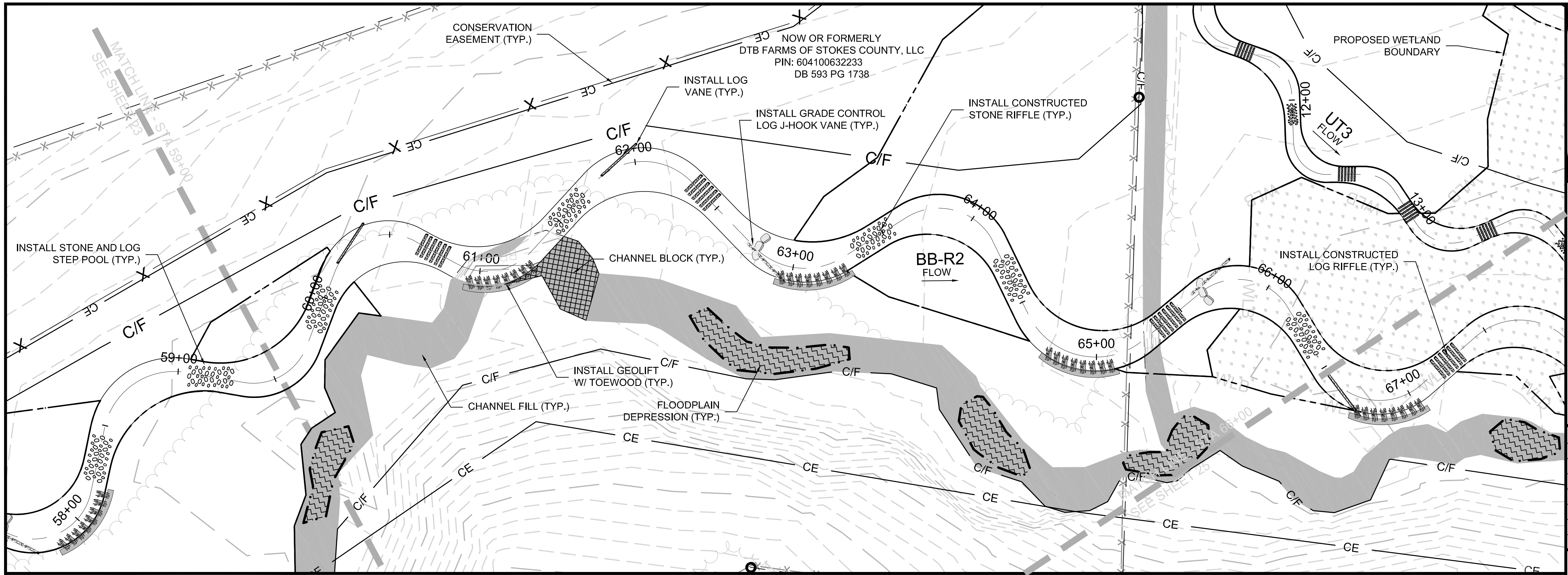


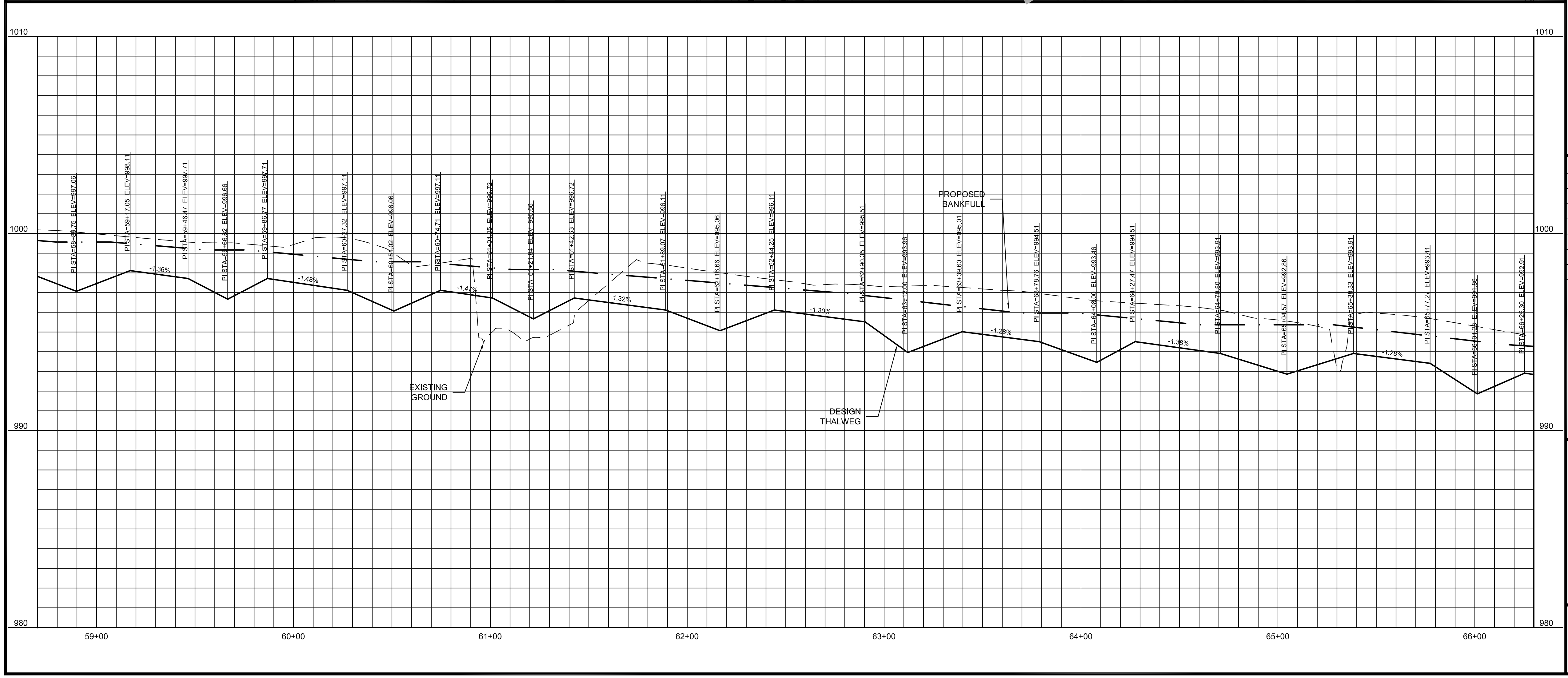
SHEET NAME

BB-R2

PLAN AND PROFILE

SHEET NUMBER





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PROJECT ENGINEER

CHRISTOPHER A. TOMSIC
36316

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PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

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| VERT. SCALE | 1" = 6' |

NORTH

30 15 0 30 60
GRAPHIC SCALE

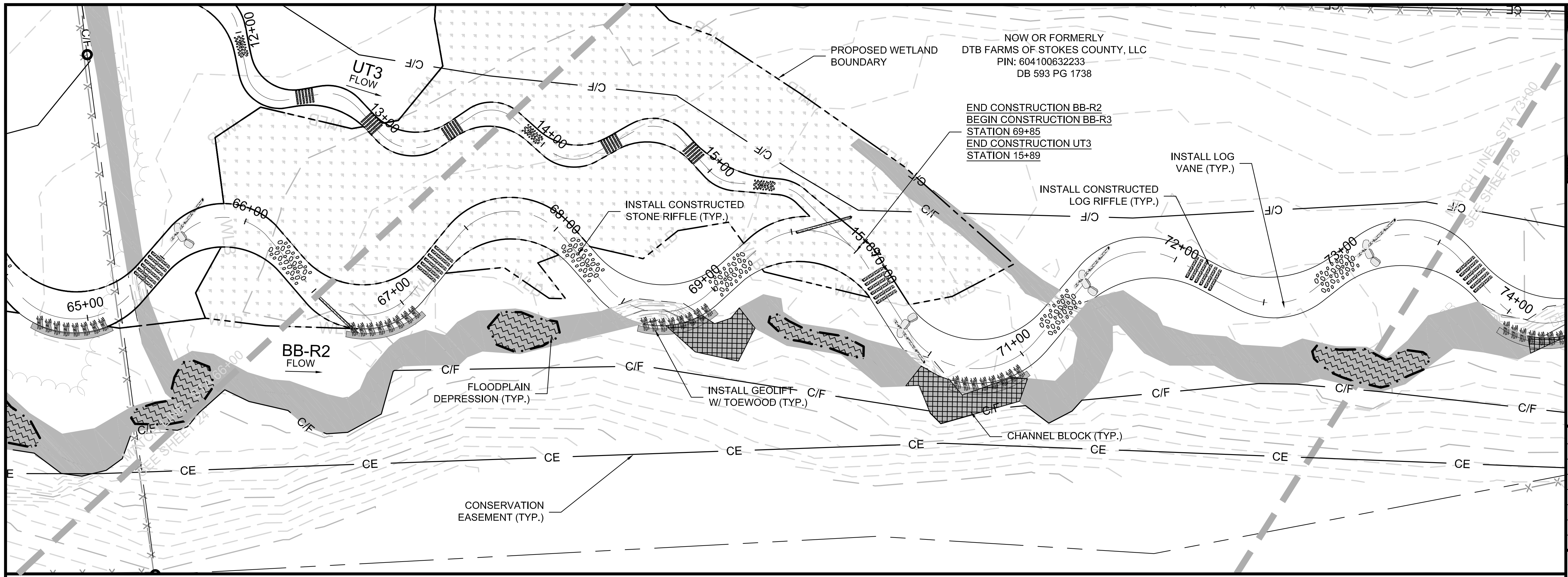
SHEET NAME

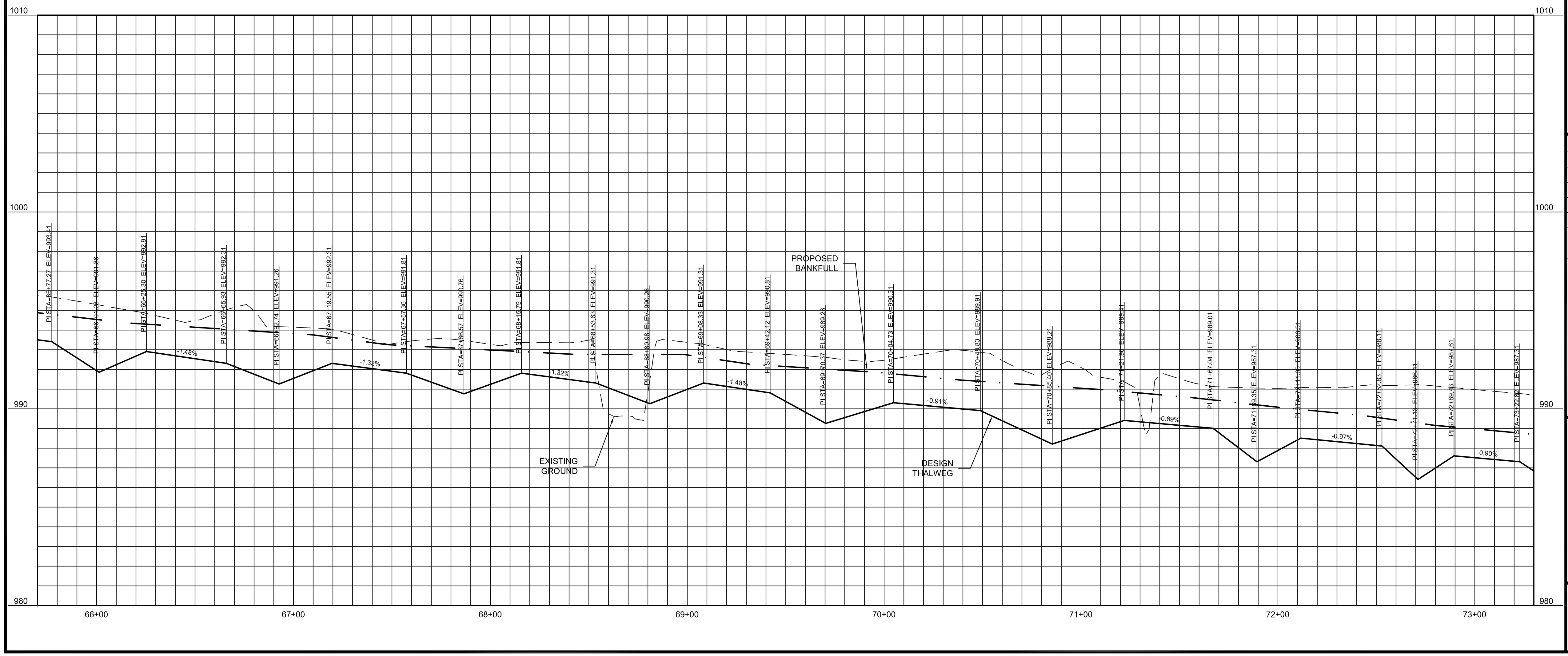
BB-R2

PLAN AND PROFILE

SHEET NUMBER

25





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PROJECT ENGINEER

CHRISTOPHER A. TOMSIC
36316

PRELIMINARY
NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

| | | |
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| B | FINAL DRAFT PLAN | 3-26-20 |
| C | FINAL MIT PLAN | 7-24-20 |
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| NO. | DESCRIPTION | DATE |

PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

| | |
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| PROJECT NO. | 18-007 |
| FILENAME | 09_34_BANNER BRANCH_PLAN AND PROFILE.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 60' |
| VERT. SCALE | 1" = 6' |

NORTH

30 15 0 30 60

GRAPHIC SCALE

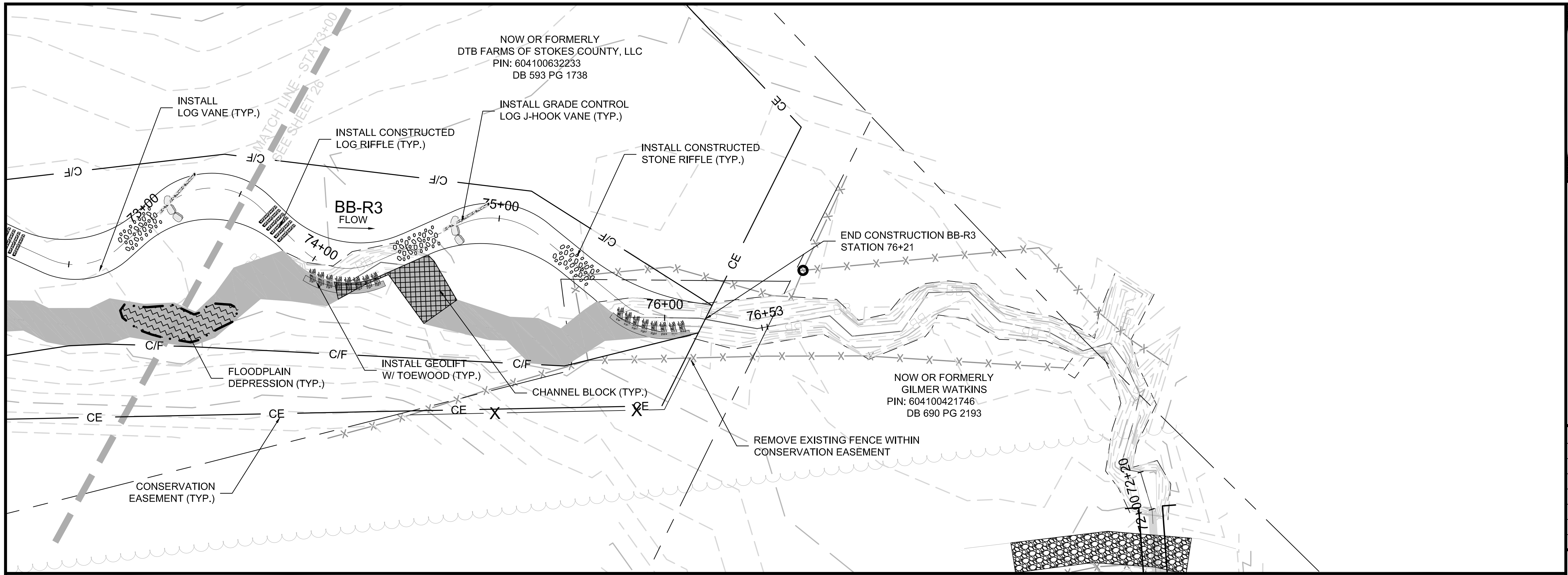
SHEET NAME

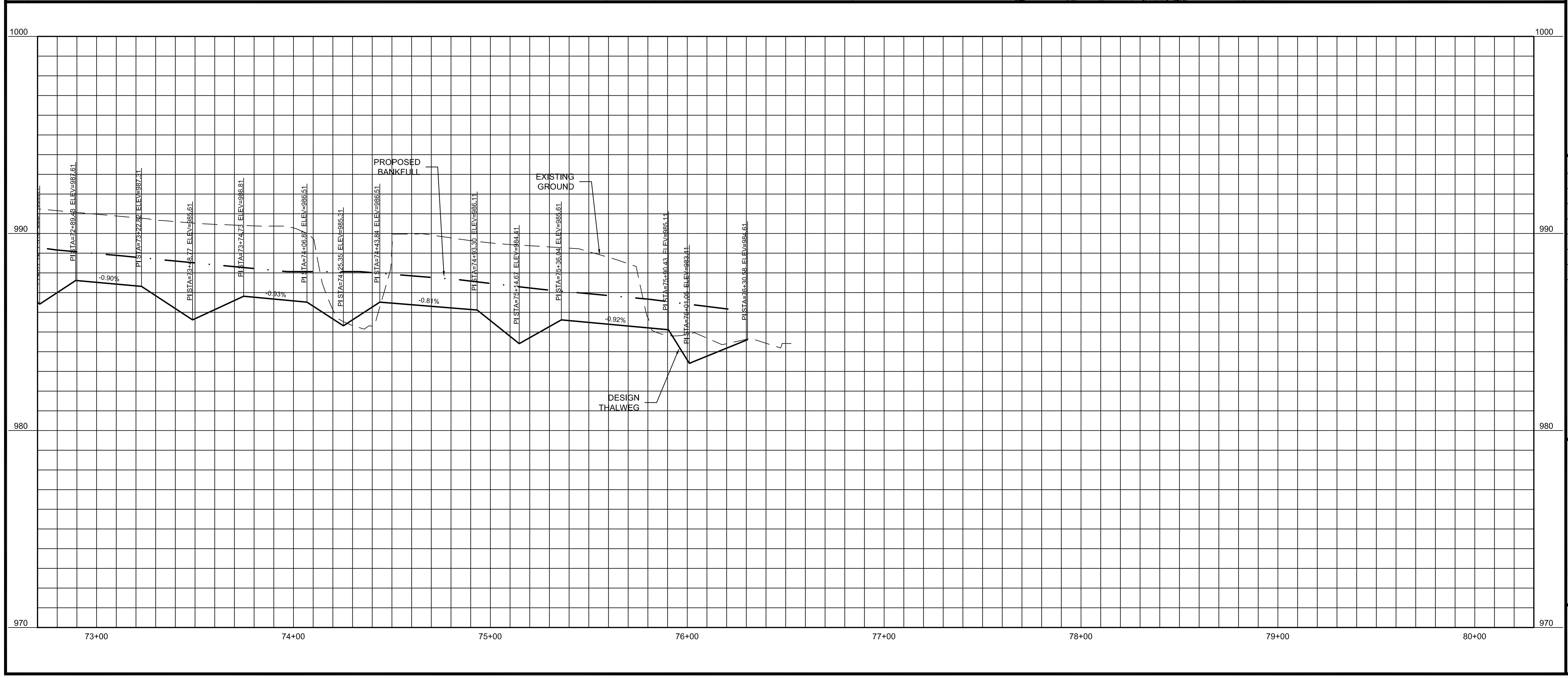
*BB-R2 & BB-R3*

PLAN AND PROFILE

SHEET NUMBER

26





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NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 36316
CHRISTOPHER A. TOMSIC

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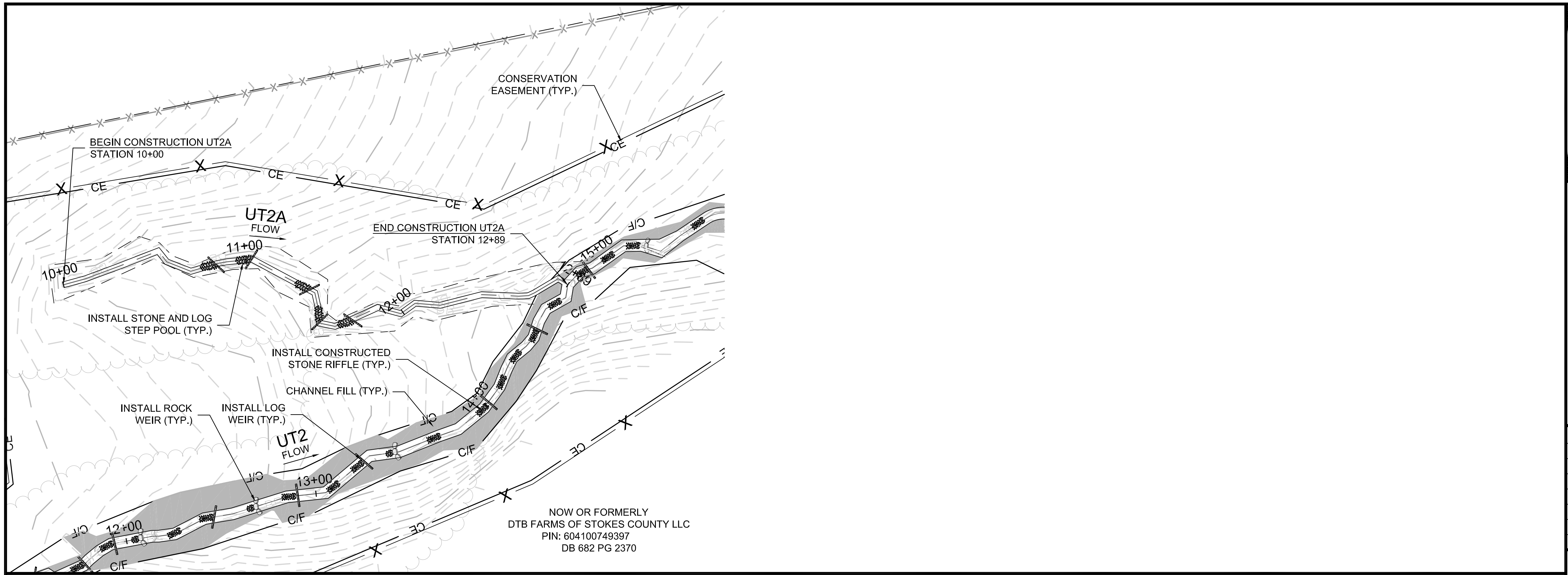
GRAPHIC SCALE

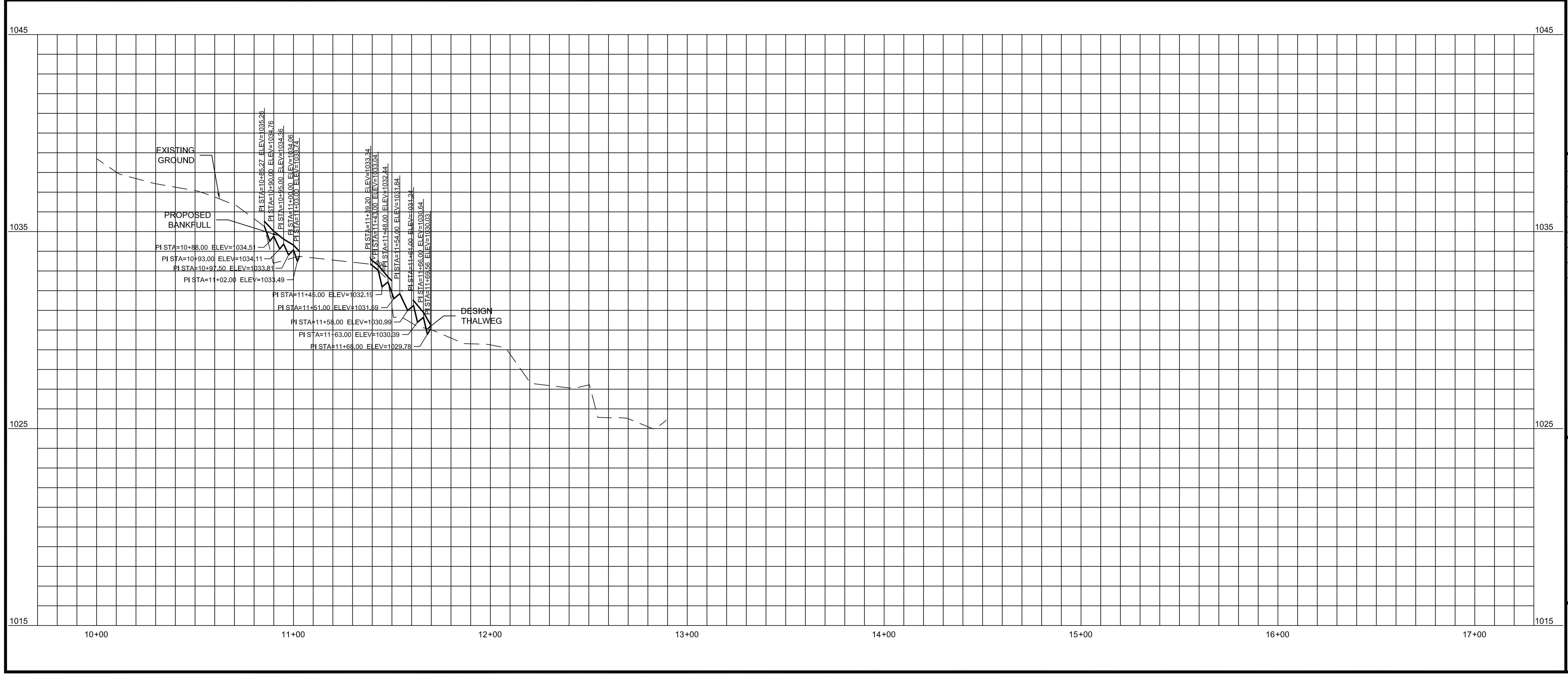
SHEET NAME

BB-R3

PLAN AND PROFILE

SHEET NUMBER





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NORTH

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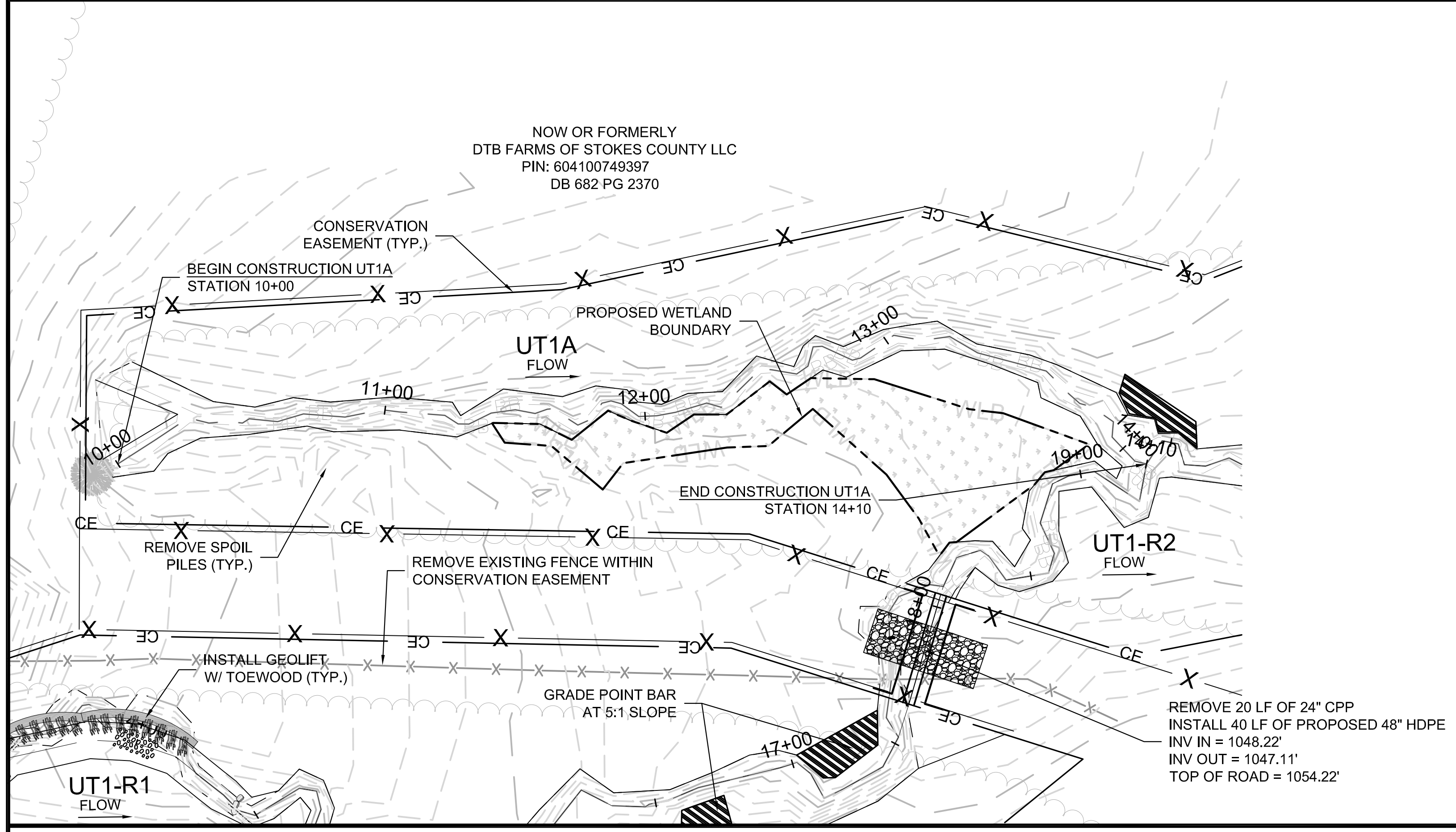
GRAPHIC SCALE

SHEET NAME

*UT2A*

## PLAN AND PROFILE

SHEET NUMBER



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NORTH

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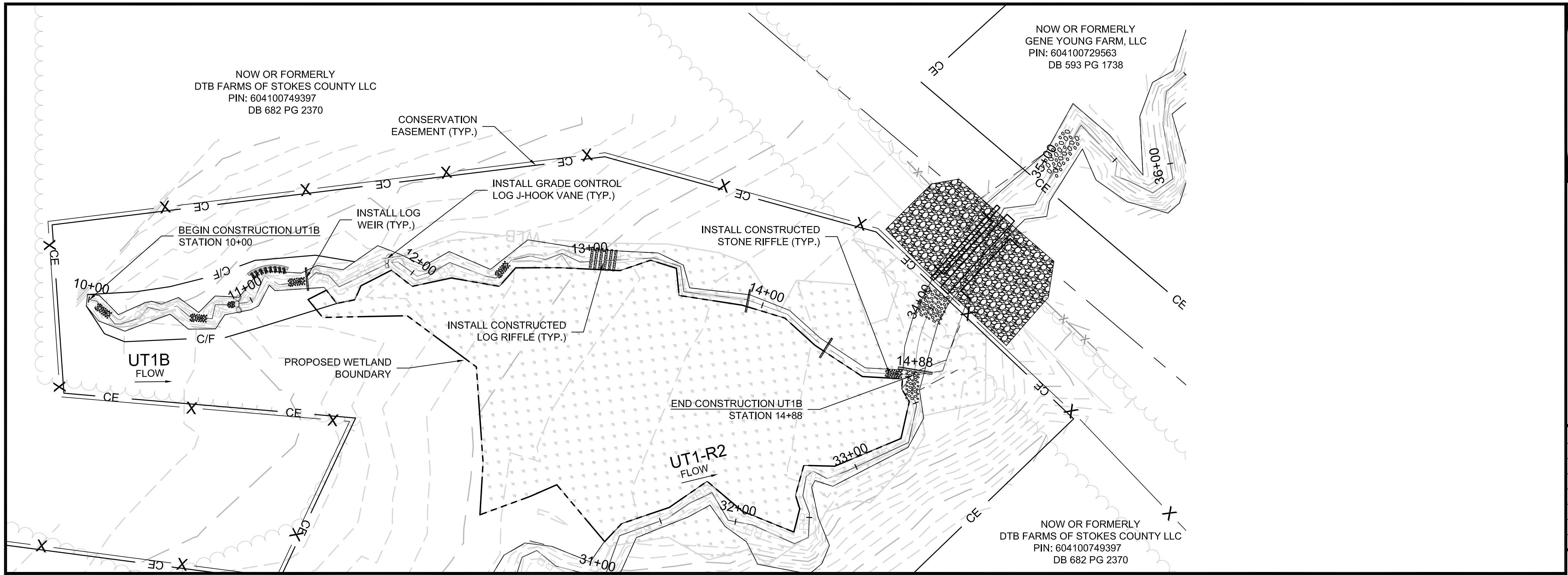
GRAPHIC SCALE

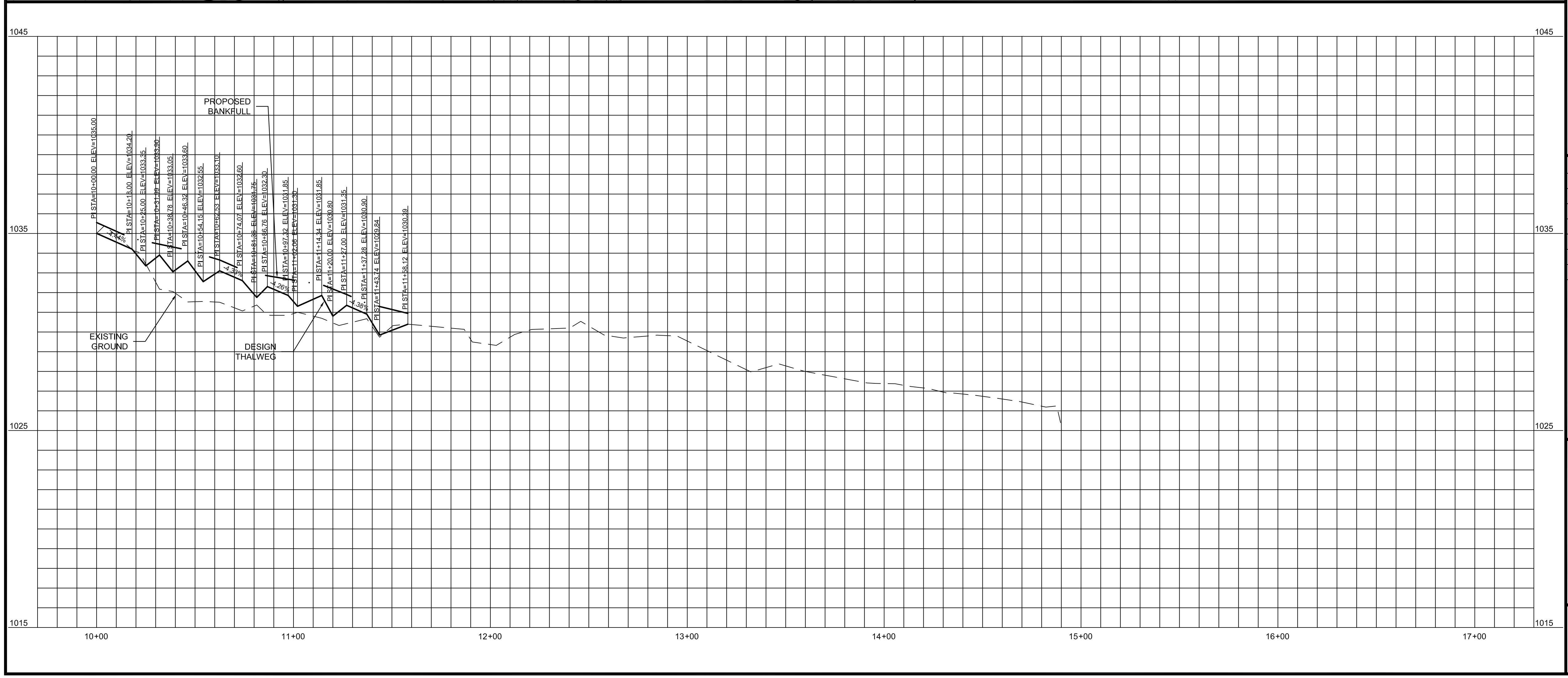
SHEET NAME

*UT1A*

## PLAN AND PROFILE

SHEET NUMBER





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NORTH CAROLINA PROFESSIONAL SEAL 36316 ENGINEER CHRISTOPHER A. TOMSIC

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NORTH

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GRAPHIC SCALE

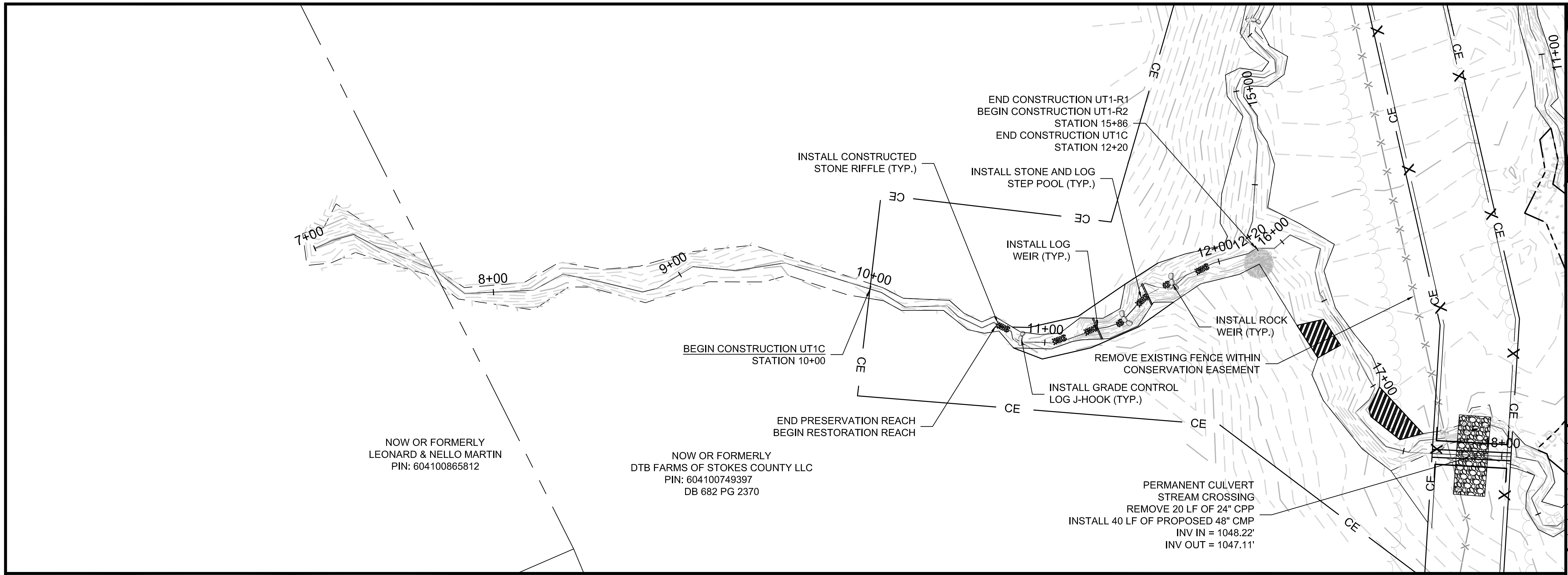
SHEET NAME

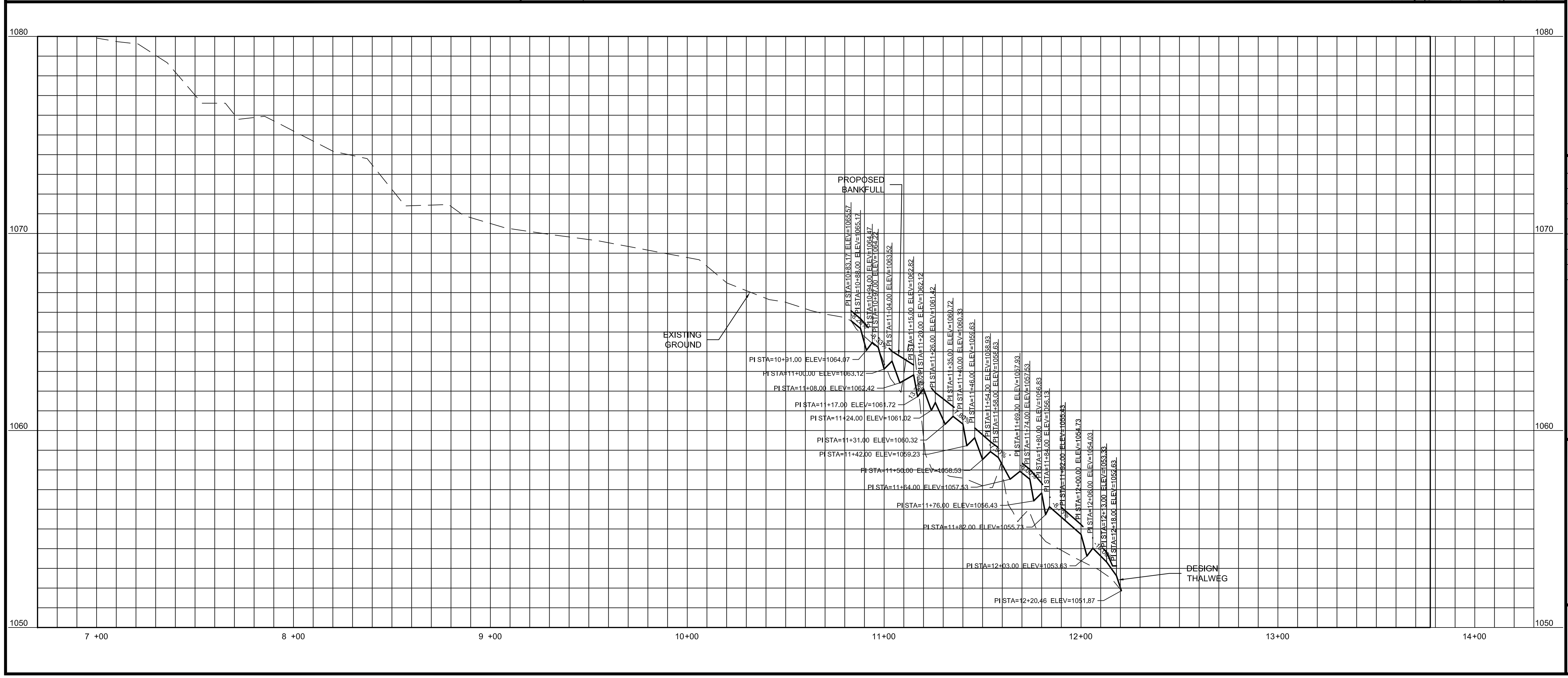
*UT1B*

PLAN AND PROFILE

SHEET NUMBER

30





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NORTH

30 15 0 30 60
GRAPHIC SCALE

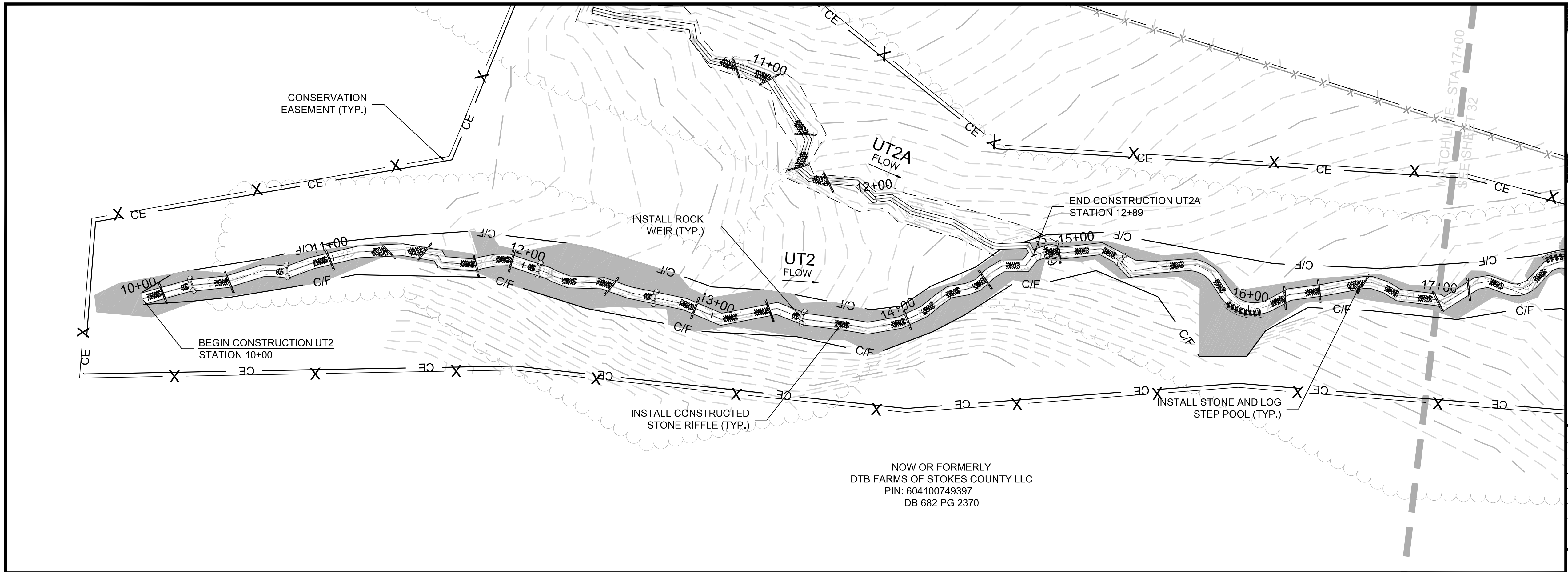
SHEET NAME

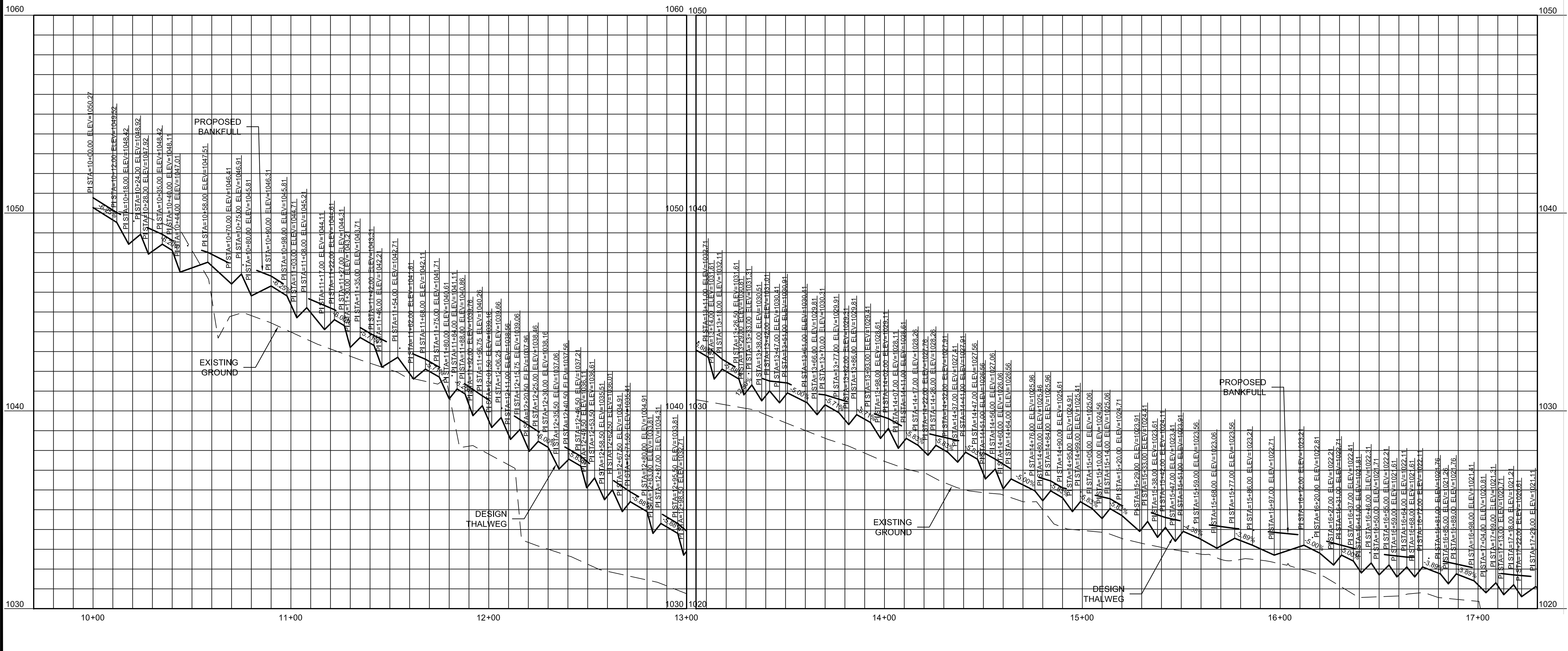
*UT1C*

PLAN AND PROFILE

SHEET NUMBER

31





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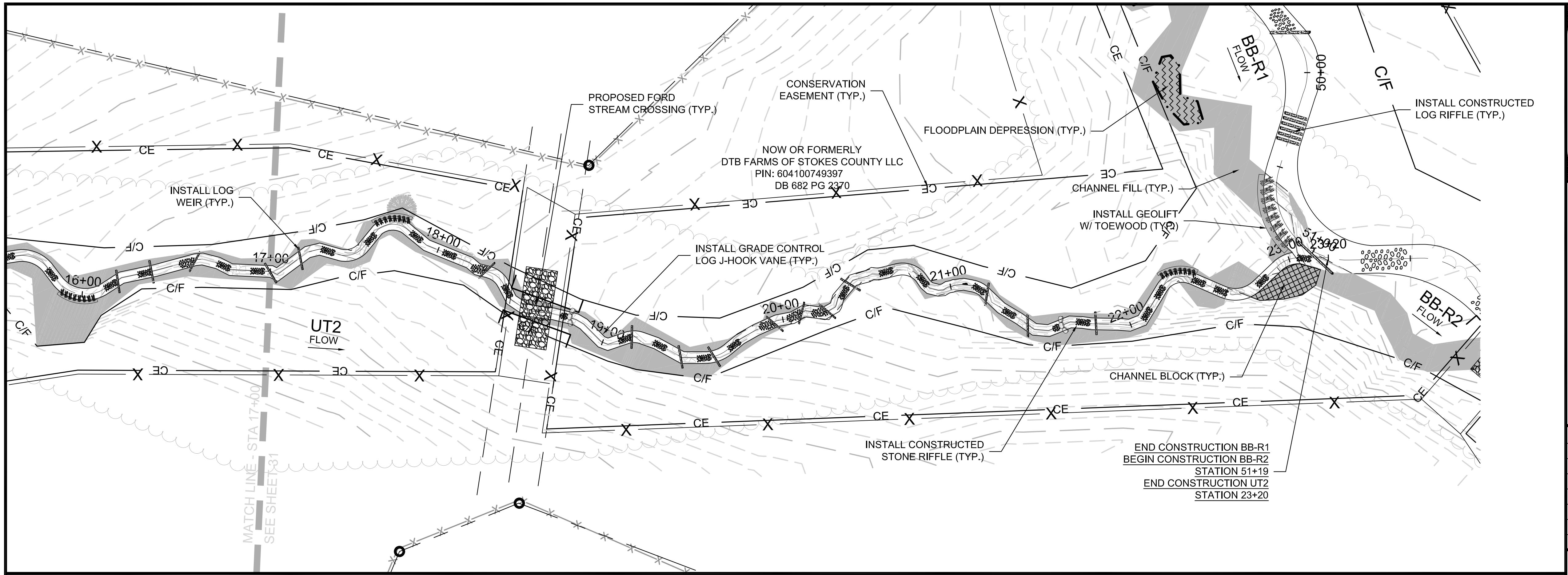
SHEET NAME

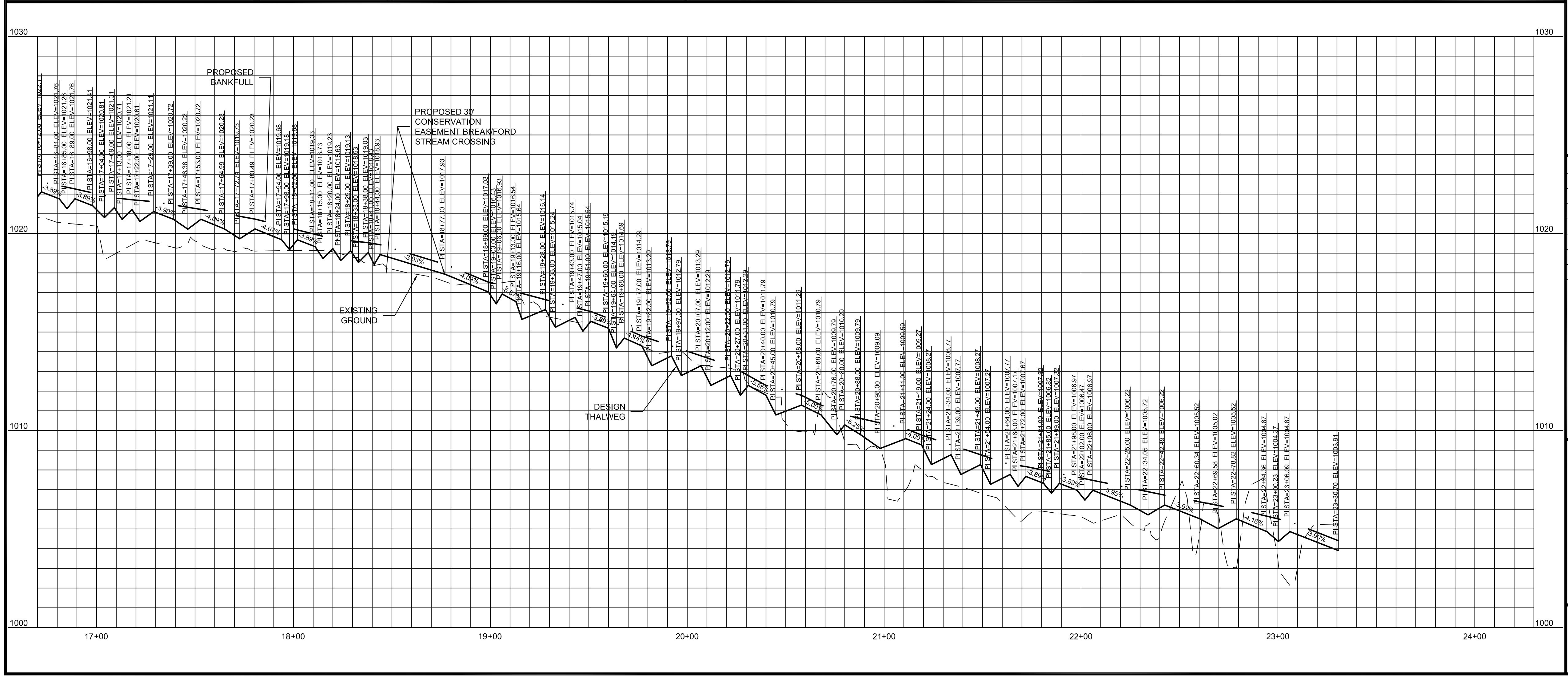
*UT2*

## PLAN AND PROFILE

SHEET NUMBER

32





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UT2

PLAN AND PROFILE

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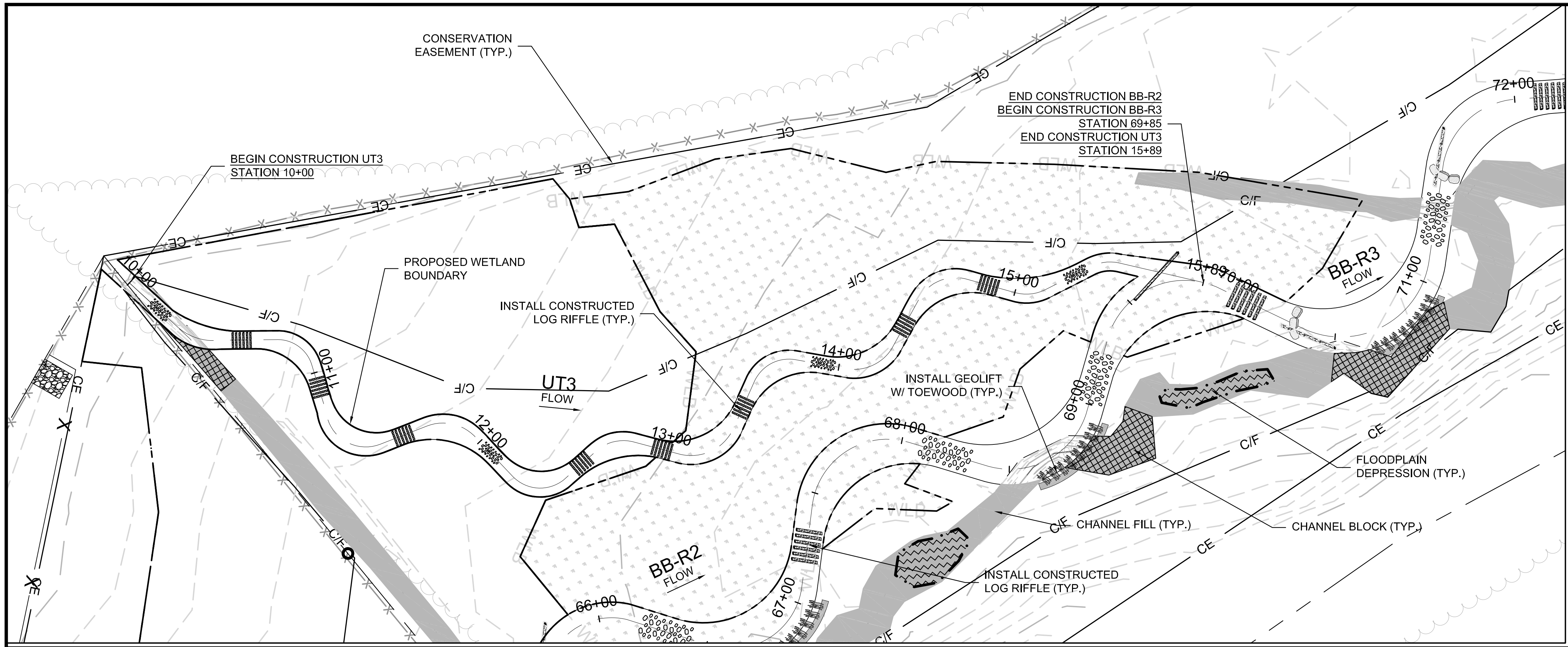
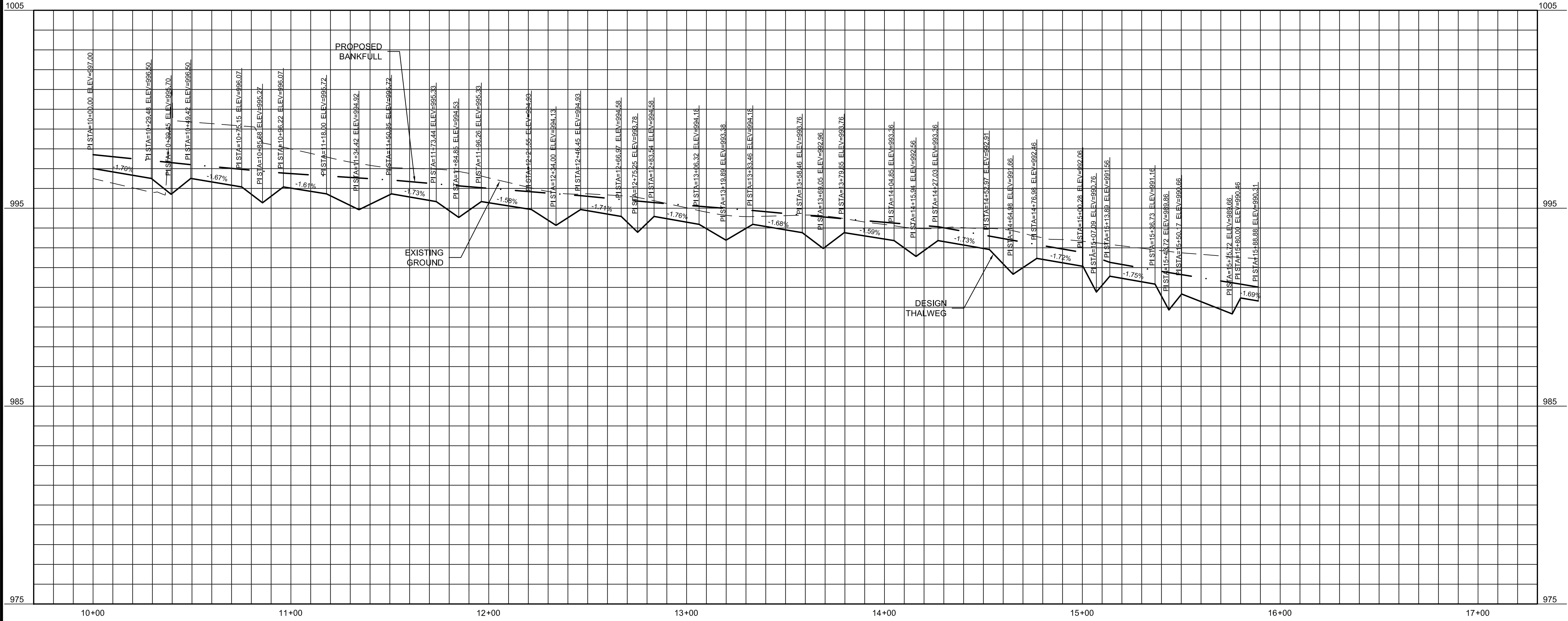
33





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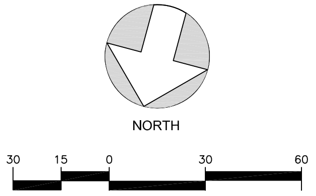

GRAPHIC SCALE

SHEET NAME

*UT3*

PLAN AND PROFILE

SHEET NUMBER

34

## PLANTING NOTES

1. THE FOLLOWING TABLES LIST THE PROPOSED VEGETATION SPECIES SELECTION FOR THE PROJECT REVEGETATION. THE TOTAL PLANTING AREA IS APPROXIMATELY 24.3 ACRES AND WILL VARY BASED ON SITE CONDITIONS AND AREAS DISTURBED 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 TOTAL DENSITY OF APPROXIMATELY 680 STEMS PER ACRE AND A MINIMUM OF 30 FEET FROM THE TOP OF RESTORED STREAMBANKS AND TO THE REVEGETATION LIMITS. EXACT PLACEMENT OF THE PLANT 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 CONSERVATION EASEMENT USING NATIVE SPECIES VEGETATION 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 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 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 | 10% | FACW |
| *Nyssa sylvatica* | Black Gum | 8% | FAC |
| *Liriodendron tulipifera* | Tulip-poplar | 10% | FACU |
| *Quercus alba* | White oak | 7% | FACU |
| *Quercus falcata* | Southern Red Oak | 7% | FACU |
| *Fraxinus pennsylvanica* | Green Ash | 4% | FACW |
| **Riparian Buffer Bare Root Plantings – Understory** | | | |
| **(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)** | | | |
| *Diospyros virginiana* | Persimmon | 3% | FAC |
| *Amelanchier arborea* | Common Serviceberry | 3% | FAC |
| *Carpinus caroliniana* | American hornbeam | 3% | FAC |
| *Hamamelis virginiana* | Witch-hazel | 3% | FACU |
| *Asimina triloba* | Pawpaw | 3% | FAC |
| *Lindera benzoin* | Spicebush | 3% | FACW |
| *Alnus serrulata* | Hazel alder | 3% | OBL |
| *Corylus americana* | Hazelnut | 3% | 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 |

## TEMPORARY SEEDING SCHEDULE

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

## PERMANENT SEEDING SCHEDULE

| Botanical Name | Common Name | % Proposed for Planting by Species | Seeding Rate (lb/acre) | Wetland Tolerance |
|---|---|---|---|---|
| **Permanent Herbaceous Seed Mixture – Streambank, Floodplain, Wetlands and Riparian Buffer Areas** | | | | |
| **(Proposed Seed Rate @ 15 lbs/acre)** | | | | |
| *Andropogon gerardii* | Big blue stem | 10% | 0.75 | FAC |
| *Dichanthelium clandestinum* | Deer tongue | 10% | 0.75 | FACW |
| *Polygonum pennsylvanicum* | Pennsylvania smartweed | 5% | 0.75 | FACW |
| *Agrostis alba* | Redtop | 5% | 0.75 | FACW |
| *Chasmanthium latifolum* | River oats | 5% | 0.75 | FACU |
| *Elymus virginicus* | Virginia wildrye | 5% | 0.75 | FAC |
| *Juncus effusus* | Soft rush | 5% | 0.75 | FACW+ |
| *Carex lurida* | Lurid sedge | 3% | 0.75 | OBL |
| *Carex crinita* | Fringed sedge | 3% | 0.75 | OBL |
| *Andropogon virginicus* | Broom sedge | 3% | 0.75 | FACU |
| *Vernonia noveboracensis* | New York Ironweed | 3% | 0.75 | FACW |
| *Lobelia carinalis* | Cardinal flower | 3% | 0.75 | FACW |
| *Andropogon glomeratus* | Bushy bluestem | 5% | 0.75 | FACW |
| *Panicum virgatum* | Switchgrass | 10% | 1.50 | FACW |
| *Bidens frondosa* | Beggars tick | 5% | 0.75 | FACW |
| *Coreopsis lanceolata* | Lance-leaved tick seed | 5% | 0.75 | FACU |
| *Schizachyrium scoparium* | Little blue stem | 5% | 0.75 | FACU |
| *Tripsacum dactyloides* | Eastern gammagrass | 5% | 0.75 | FAC+ |
| *Sorghastrum nutans* | Indiangrass | 5% | 0.75 | FACU |

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PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

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| VERT. SCALE | N/A |

SHEET NAME

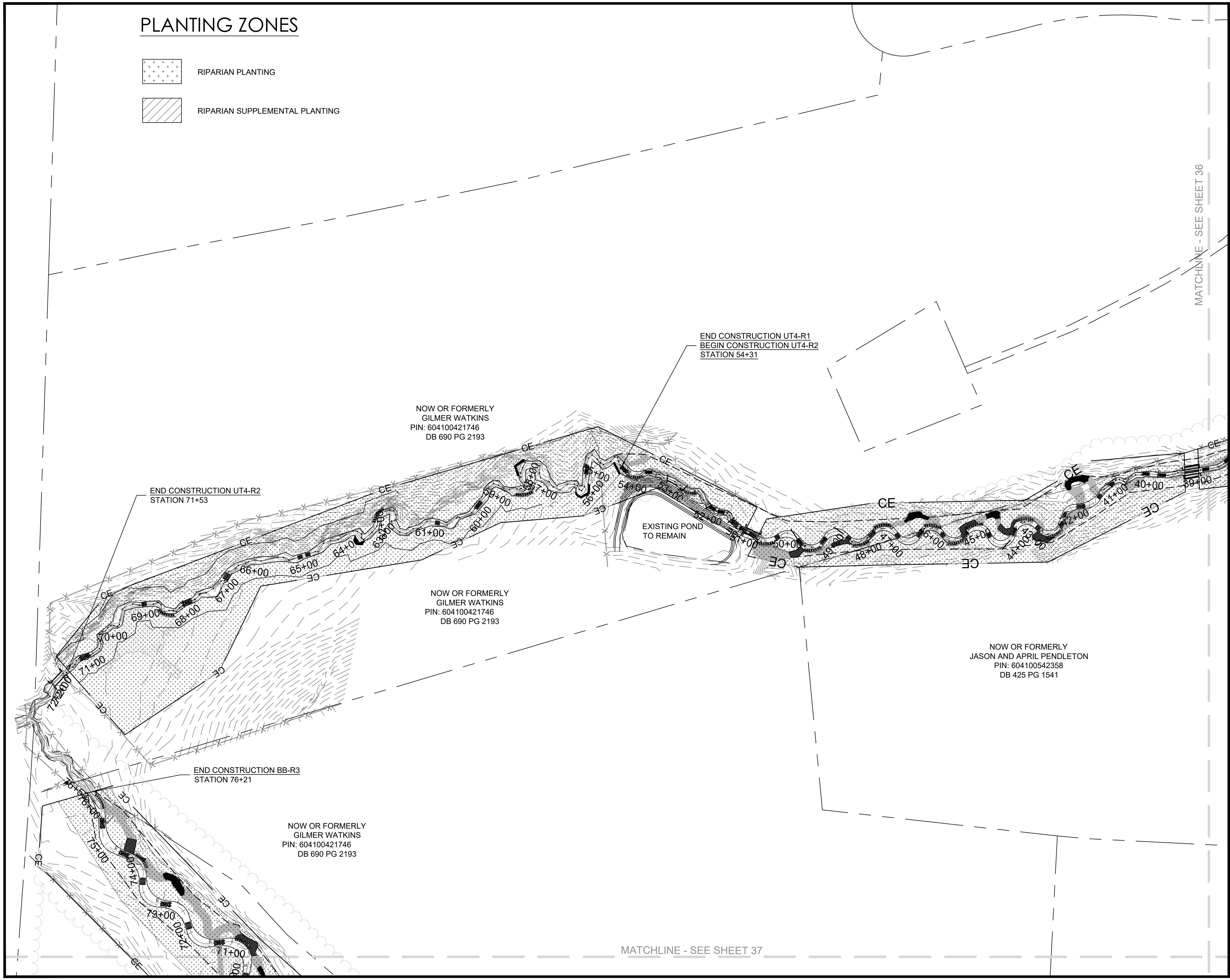
# REVEGETATION PLAN

SHEET NUMBER

## PLANTING ZONES

░ RIPARIAN PLANTING

▨ RIPARIAN SUPPLEMENTAL PLANTING



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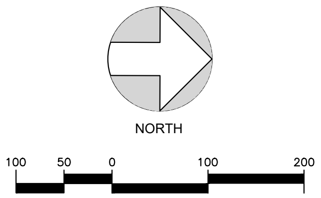
STOKES COUNTY, NC

DRAWING INFORMATION

| | |
|---|---|
| PROJECT NO. | 18-007 |
| FILENAME | 35_39_BANNER BRANCH_REVEGETATION PLAN.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 200' |
| VERT. SCALE | N/A |

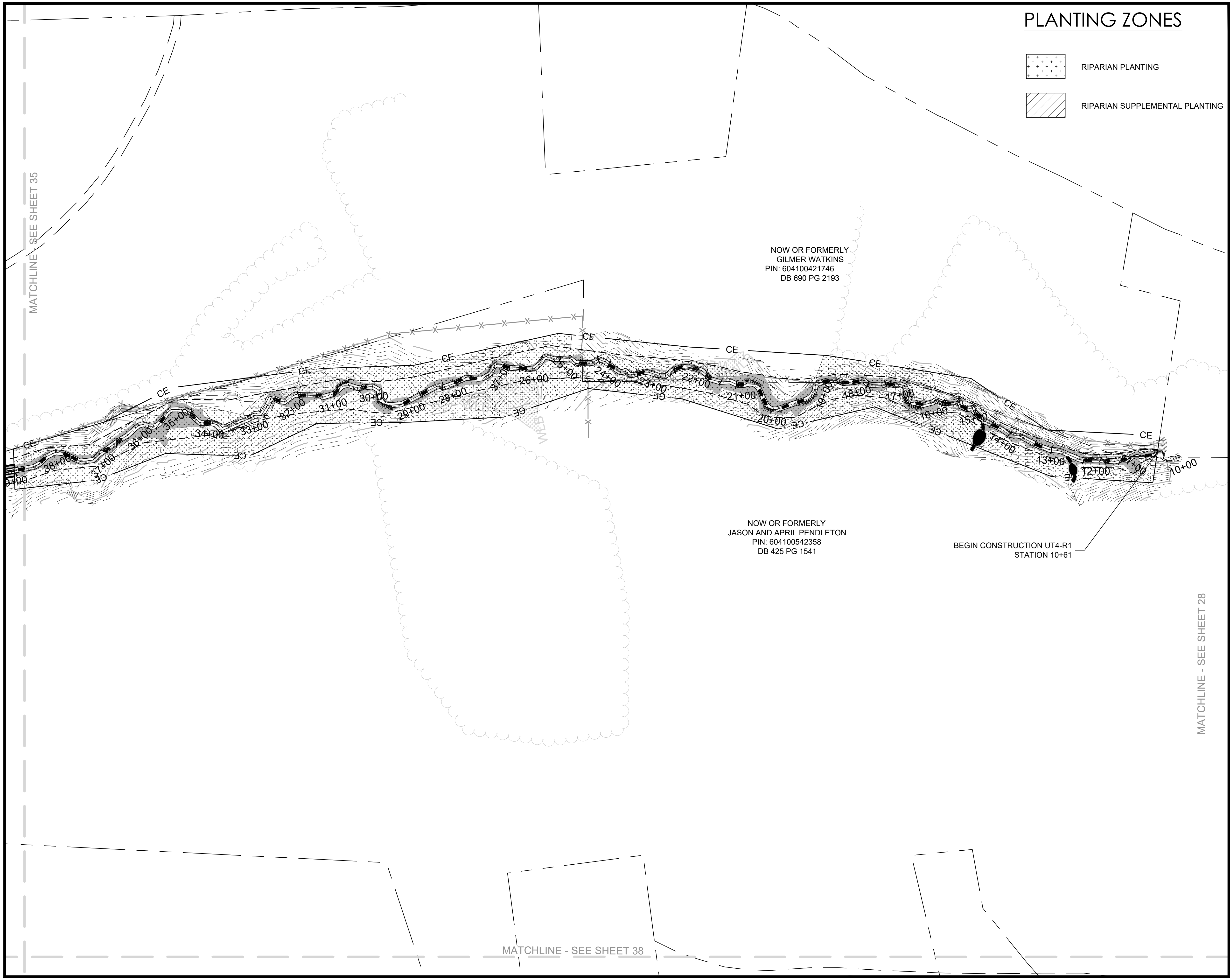


GRAPHIC SCALE

SHEET NAME

REVEGETATION
PLAN

SHEET NUMBER



**WATER & LAND SOLUTIONS**

7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 36916 CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
[illegible]ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

| | | |
|---|---|---|
| A | DRAFT MIT PLAN | 12-27-19 |
| B | FINAL DRAFT PLAN | 3-26-20 |
| C | FINAL MIT PLAN | 7-24-20 |
| | | |
| | | |
| | | |
| NO. | DESCRIPTION | DATE |

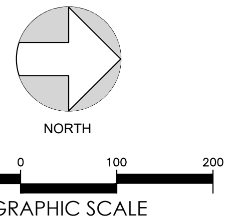
PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

| | |
|---|---|
| PROJECT NO. | 18-007 |
| FILENAME | 35_39_BANNER BRANCH_REVEGETATION PLAN.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 200' |
| VERT. SCALE | N/A |

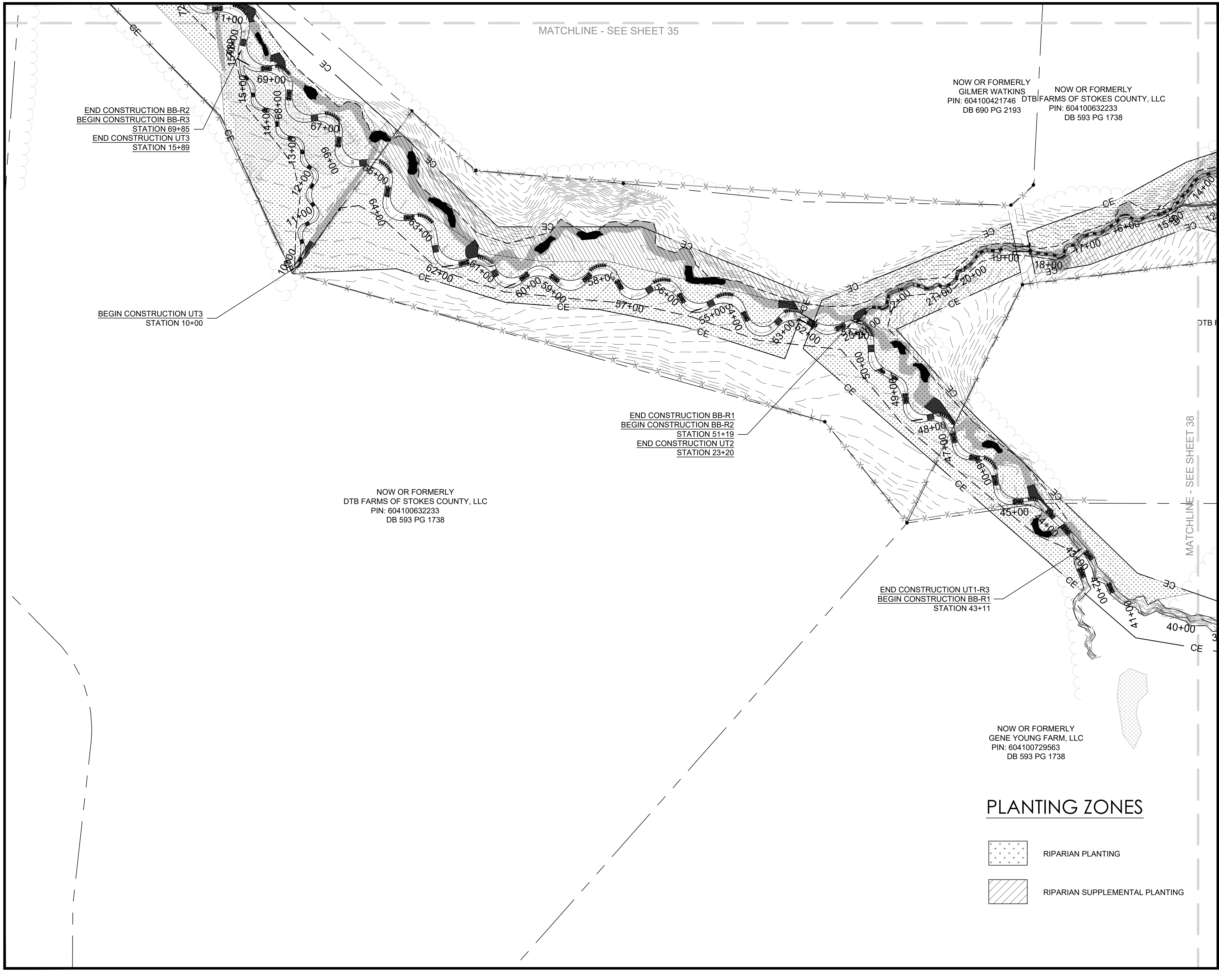


SHEET NAME

## REVEGETATION PLAN

SHEET NUMBER

37



## PLANTING ZONES

| | |
|---|---|
| ⁙ | RIPARIAN PLANTING |
| ▨ | RIPARIAN SUPPLEMENTAL PLANTING |

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PROJECT ENGINEER

SEAL 36316
CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
[illegible]ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

| NO. | DESCRIPTION | DATE |
|---|---|---|
| A | DRAFT MIT PLAN | 12-27-19 |
| B | FINAL DRAFT PLAN | 3-26-20 |
| C | FINAL MIT PLAN | 7-24-20 |

PROJECT NAME

# BANNER BRANCH MITIGATION PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

| | |
|---|---|
| PROJECT NO. | 18-007 |
| FILENAME | 35_38_BANNER BRANCH_REVEGETATION PLAN.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 200' |
| VERT. SCALE | N/A |

NORTH

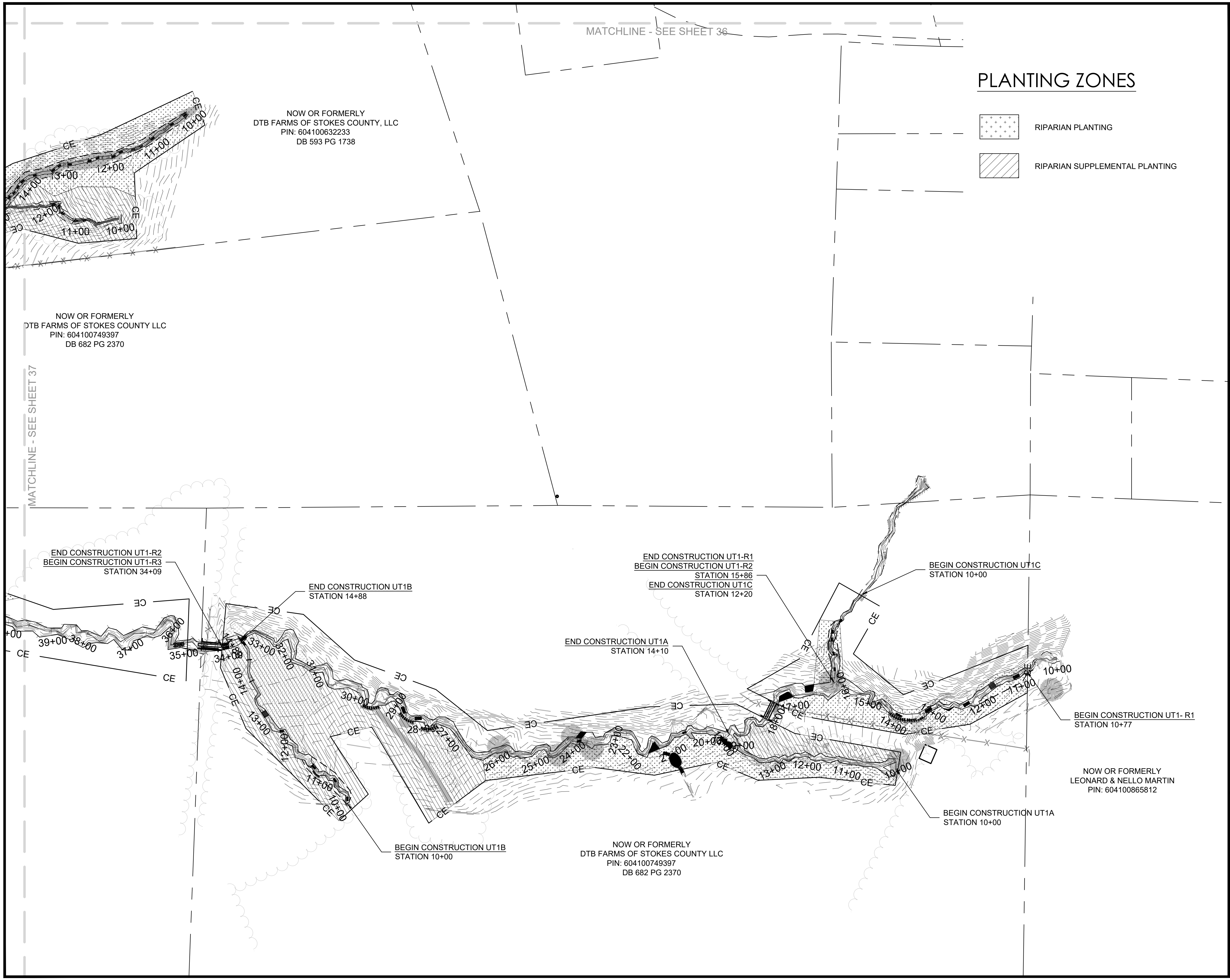
100 50 0 100 200
GRAPHIC SCALE

SHEET NAME

## REVEGETATION PLAN

SHEET NUMBER

38



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PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
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ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

| NO. | DESCRIPTION | DATE |
|---|---|---|
| A | DRAFT MIT PLAN | 12-27-19 |
| B | FINAL DRAFT PLAN | 3-26-20 |
| C | FINAL MIT PLAN | 7-24-20 |
| | | |
| | | |
| | | |

PROJECT NAME

BANNER
BRANCH
MITIGATION
PROJECT

STOKES COUNTY, NC

DRAWING INFORMATION

| | |
|---|---|
| PROJECT NO. | 18-007 |
| FILENAME | 35_39_BANNER BRANCH_REVEGETATION PLAN.DWG |
| DESIGNED BY | CAT |
| DRAWN BY | APL |
| DATE | 7-24-20 |
| HORIZ. SCALE | 1" = 200' |
| VERT. SCALE | N/A |

NORTH

100 50 0 100 200

GRAPHIC SCALE

SHEET NAME

REVEGETATION
PLAN

SHEET NUMBER

39

# Appendix 2 – Site Analysis Data/Supplementary Information

Habitat Assessment Scores and Taxa List

Pre-Construction Gauge Data

Hydric Soils Report

Existing Cross-Sections

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

Site Photographs

11/13 Revision 8

# Habitat Assessment Field Data Sheet
## Mountain/ Piedmont Streams

**Biological Assessment Branch, DWR**

**TOTAL SCORE** 71

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** Banner Branch Location/road: Campbell (Road Name Clark Rd )County Stokes

**Date** 10/02/2019 **CC#** BB1 **Basin** Roanoke **Subbasin** Belews Lake-Dan River

Observer(s) KD/ED Type of Study: ☐ Fish ☒Benthos ☐ Basinwide ☐Special Study (Describe) ______

Latitude 36.52069 Longitude -80.20648 Ecoregion: ☐ MT ☒ P ☐ Slate Belt ☐ Triassic Basin

**Water Quality:** Temperature 21.2 °C DO 6.3 mg/l Conductivity (corr.) 64.7 µS/cm pH 6.75

**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: 48 %Forest 2 %Residential 40 %Active Pasture 10 % Active Crops ____%Fallow Fields ____% Commercial ____%Industrial ____%Other - Describe:______

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

x1 **Width:** (meters) Stream 4.5 Channel (at top of bank) 7.0 **Stream Depth:** (m) Avg .45 Max .85
☐ Width variable ☐ Large river >25m wide

**Bank Height** (from deepest part of riffle to top of bank-first flat surface you stand on): (m) 2.3

**Bank Angle:** 90 ° 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** Stream incised heavily.

**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, 60's **Photos:** ☐N ☒Y ☐ Digital ☐35mm

**Remarks:** Boner Branch mitigation project will restore natural features and stabalize BB. It will also remove direct cattle access upstream of sampling location.

**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.

A **Rocks** R **Macrophytes** R **Sticks and leafpacks** C **Snags and logs** R **Undercut banks or root mats**

## AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

| | >70%<br>Score | 40-70%<br>Score | 20-40%<br>Score | <20%<br>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 habitat primarily rocks 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 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 6

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

Remarks pools less frequent, vary in size

Page Total 39

**V. Riffle Habitats**

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

| | Riffles Frequent<br>Score | Riffles Infrequent<br>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 0

**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 high bank erosion

Subtotal 3

**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 Canopy mixed 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 6

Page Total 32

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

**TOTAL SCORE** 71

11/13 Revision 8

# Habitat Assessment Field Data Sheet
## Mountain/ Piedmont Streams

**Biological Assessment Branch, DWR**

**TOTAL SCORE** 64

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** UT4 - R2 Location/road: Campbell (Road Name Clark Rd. )County Stokes

**Date** 10/02/2019 **CC#** BB2 **Basin** Roanoke **Subbasin** Belews Lake-Dan River

Observer(s)_____ Type of Study: ☐ Fish ☒Benthos ☐ Basinwide ☐Special Study (Describe) _____

Latitude 36.52065 Longitude -80.20771 Ecoregion: ☐ MT ☒P ☐ Slate Belt ☐ Triassic Basin

**Water Quality:** Temperature 21.5 °C DO 7.23 mg/l Conductivity (corr.) 72.6 µS/cm pH 6.9

**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: 15 %Forest 2 %Residential 65 %Active Pasture 18 % Active Crops ____%Fallow Fields ____% Commercial ____%Industrial ____%Other - Describe:_____

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

**Width:** (meters) Stream 3.0 Channel (at top of bank) 4.0 **Stream Depth:** (m) Avg .3 Max .4
☐ Width variable ☐ Large river >25m wide

**Bank Height** (from deepest part of riffle to top of bank-first flat surface you stand on): (m) 2.0

**Bank Angle:** 60 ° 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** UT4-R2 has wetland rehab potential on left bank

**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, recent rain **Photos:** ☐N ☒Y ☐ Digital ☐35mm

**Remarks:** Area was in drought. Rain 2 weeks prior to sampling eliminated drought. Area in stream/wetland restoration project. Cattle access direct to majority of UT4-R2.

**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.

C **Rocks** R **Macrophytes** R **Sticks and leafpacks** C **Snags and logs** R **Undercut banks or root mats**

## AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

| | >70%<br>Score | 40-70%<br>Score | 20-40%<br>Score | <20%<br>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 Sandy / cobble bedform 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 Sand is majority, some gravel exists (20%) Subtotal 3

**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 8

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

Remarks

Page Total 30

**V. Riffle Habitats**

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

| | Riffles Frequent<br>Score | Riffles Infrequent<br>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 14

**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 3

**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 Sparse canopy, mostly small trees

Subtotal 8

**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 Area

Subtotal 4

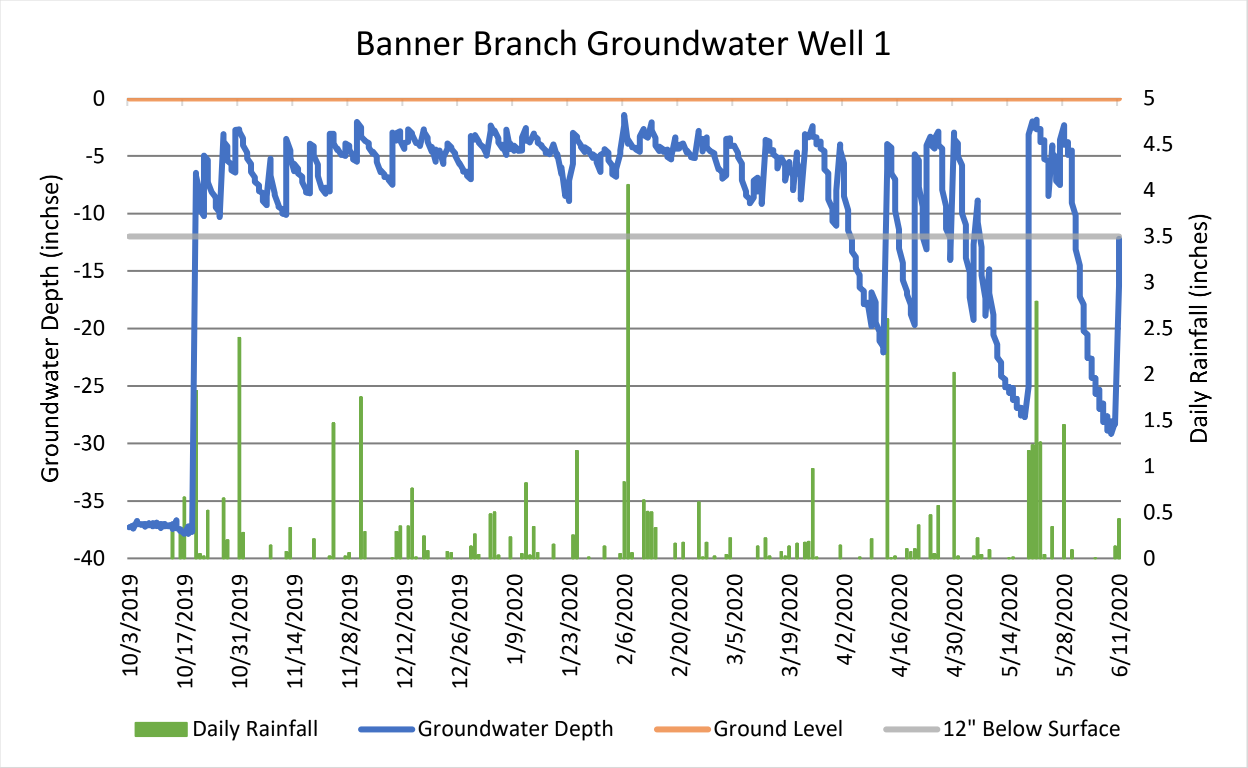
Page Total 34

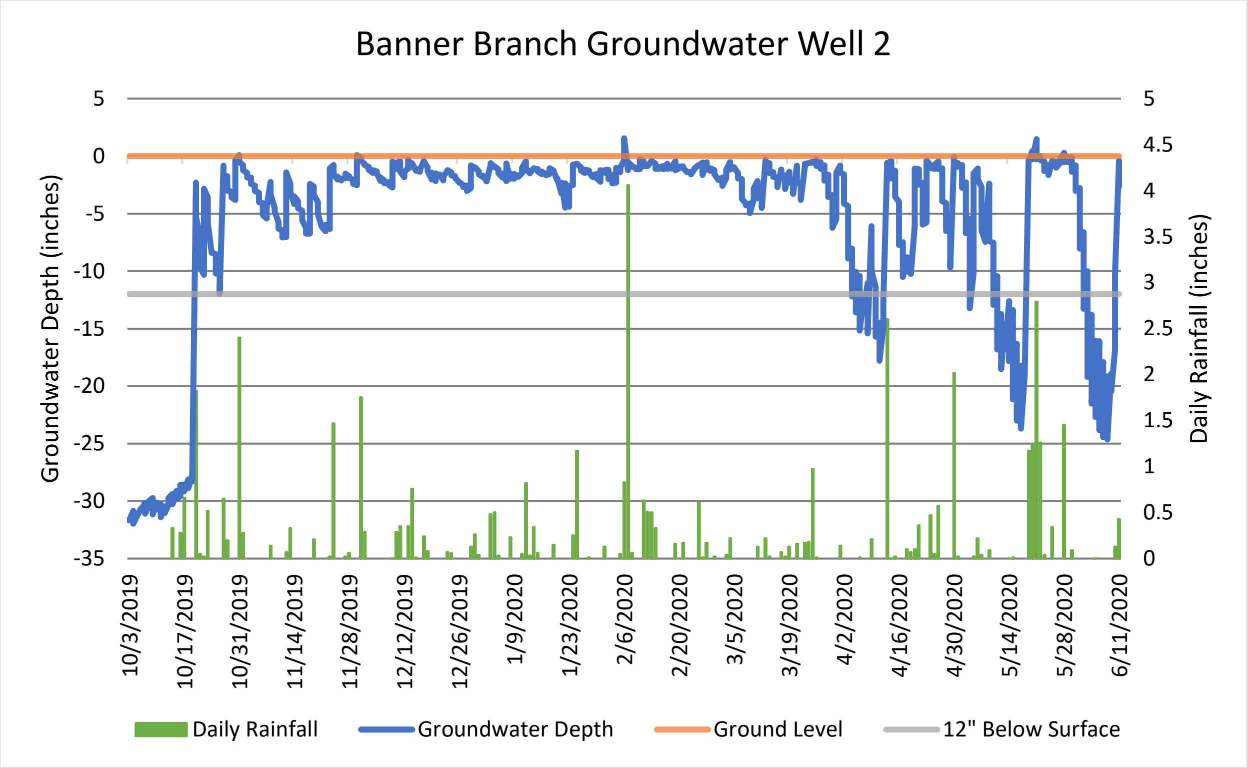
☐ Disclaimer-form filled out, but score doesn't match subjective opinion-atypical stream.

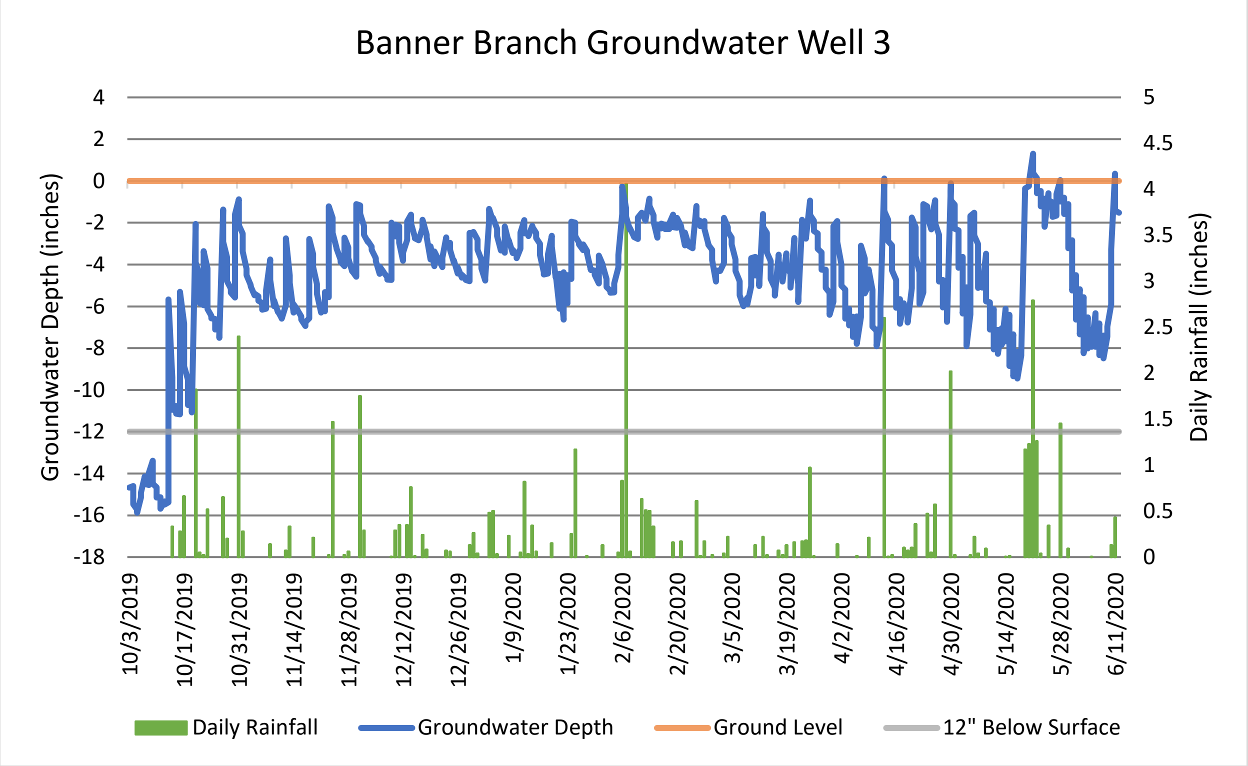
TOTAL SCORE 64

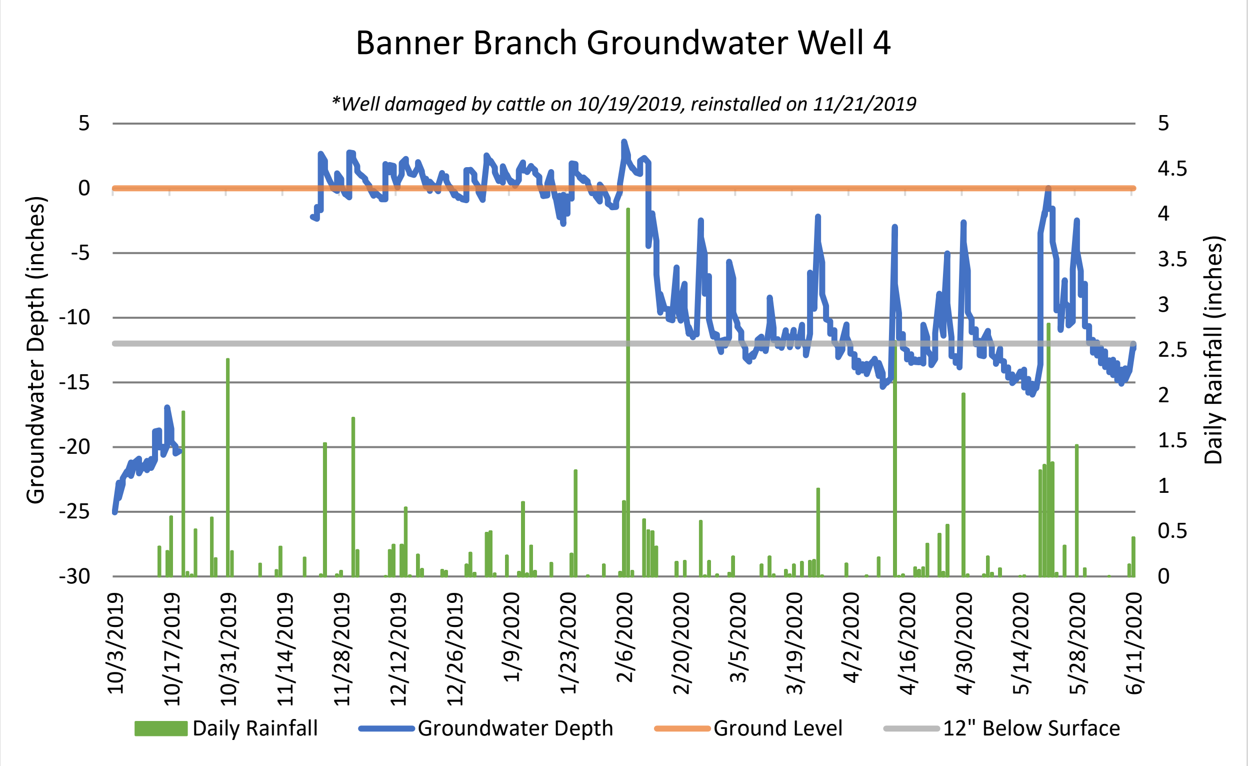
| **Sites** | **BB1 (BB-R3)** | **BB2 (UT4-R2)** |
|---|---|---|
| Taxa / Biotic Index Value | | |
| **EPHEMEROPTERA** | | |
| Family Baetidae | | |
| Baetis pluto (3.4) | | |
| Family Ephemeridae | | |
| Ephemera spp (2.0) | R | |
| Family Heptageniidae | | |
| Maccaffertium modestum (5.7) | | |
| Stenacron carolina (1.3) | | |
| **PLECOPTERA** | | |
| Family Perlidae | | |
| Eccoptura xanthenes (4.7) | C | |
| **TRICHOPTERA** | | |
| Family Hydropsychidae | | |
| Cheumatopsyche spp (6.6) | R | |
| Hydropsyche betteni (7.9) | R | |
| Family Philopotamidae | | |
| Chimarra spp (3.3) | | |
| **MISC DIPTERA** | | |
| Family Culicidae | | |
| Anopholes spp (8.6) | | |
| Empididae | | |
| Family Simuliidae | | |
| Simulium spp (4.9) | | |
| Family Tabanidae | | |
| Chrysops (6.7) | R | |
| Family Tipulidae | | |
| Hexatoma spp (3.5) | R | |
| **DIPTERA; CHIRONOMIDAE** | | |
| Ablabesmyia mallochi (7.4) | | |
| Corynoneura spp (5.7) | | |
| Dicrotendipes neomodestus (7.9) | | |
| Nanocladius (7.4) | R | |
| Rheotanytarsus spp (6.5) | R | |
| Tanytarsus spp (6.6) | R | |
| Thienemannimyia group (8.4) | | |
| Tribelos spp (6.4) | | R |
| **ODONATA** | | |
| Family Aeshnidae | | |
| Boyeria vinosa (5.6) | R | R |
| Family Calopterygidae | | |
| Calopteryx spp (7.5) | C | C |
| Family Coenagrionidae | | |
| Argia spp (8.3) | | |
| Family Gomphidae | | |
| Gomphus spp (5.9) | R | R |

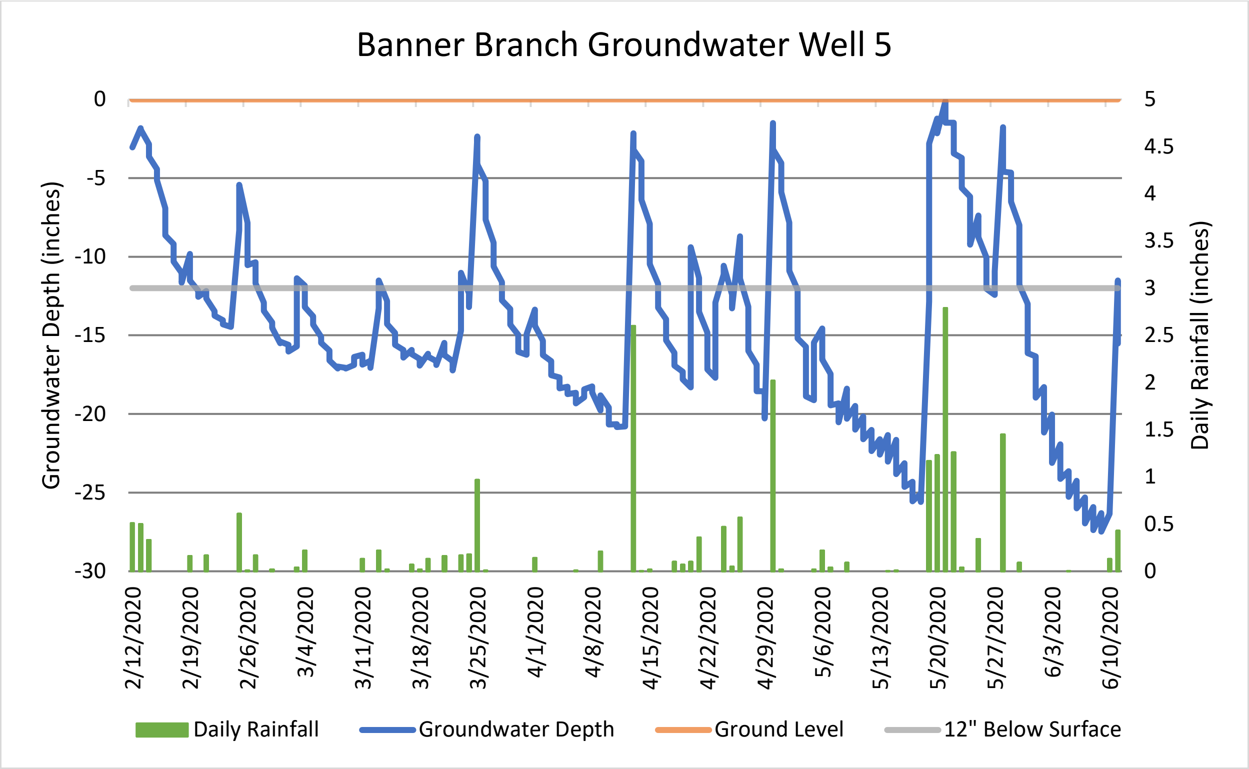
| | | |
|---|---|---|
| Ophiogomphus spp (5.9) | R | |
| Stylogomphus albistylus (5.0) | R | |
| Family Libellulidae | | |
| Plathymis lydia (9.8) | | |
| **OLIGOCHAETA** | | |
| Family Naidae | | |
| Aulodrilus pleuriseta (5.6) | R | R |
| Nais spp (8.7) | R | |
| Pristina spp (7.7) | | |
| **MEGALOPTERA** | | |
| Family Corydalidae | | |
| Nigronia serricornis (4.6) | R | |
| Family Sialidae | | |
| Sialis spp (7.0) | | R |
| | | |
| **Total Taxa Richness** | **17** | **6** |
| **EPT Taxa Richness** | **4** | **0** |
| **EPT Abundance** | **6** | **0** |
| **Biotic Index** | **5.94** | **6.65** |

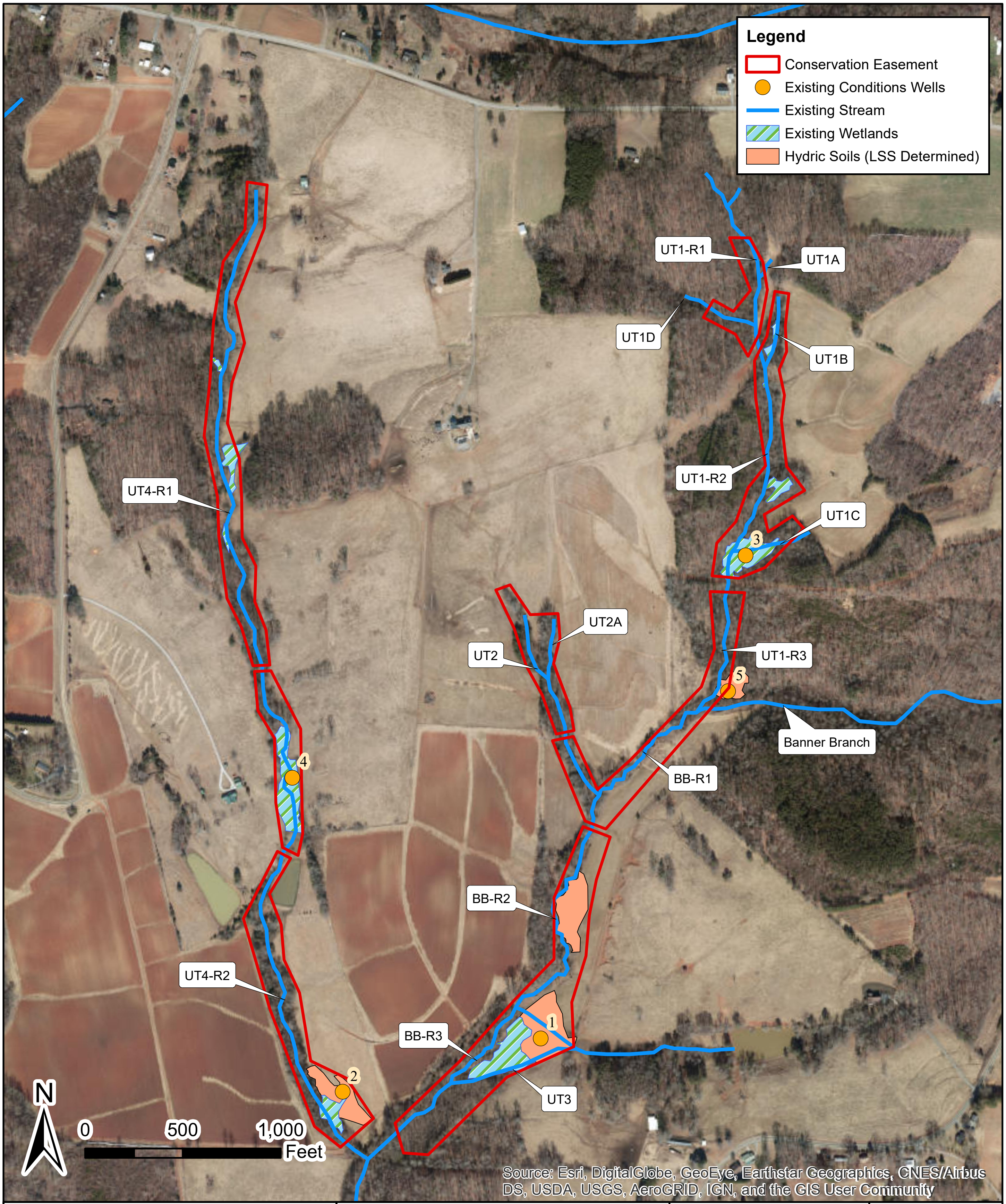

Banner Branch Groundwater Well 1
Groundwater Depth (inchse)
Daily Rainfall (inches)
0
-5
-10
-15
-20
-25
-30
-35
-40
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
10/3/2019
10/17/2019
10/31/2019
11/14/2019
11/28/2019
12/12/2019
12/26/2019
1/9/2020
1/23/2020
2/6/2020
2/20/2020
3/5/2020
3/19/2020
4/2/2020
4/16/2020
4/30/2020
5/14/2020
5/28/2020
6/11/2020
Daily Rainfall
Groundwater Depth
Ground Level
12" Below Surface


Banner Branch Groundwater Well 2
Groundwater Depth (inches)
Daily Rainfall (inches)
5
0
-5
-10
-15
-20
-25
-30
-35
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
10/3/2019
10/17/2019
10/31/2019
11/14/2019
11/28/2019
12/12/2019
12/26/2019
1/9/2020
1/23/2020
2/6/2020
2/20/2020
3/5/2020
3/19/2020
4/2/2020
4/16/2020
4/30/2020
5/14/2020
5/28/2020
6/11/2020
Daily Rainfall
Groundwater Depth
Ground Level
12" Below Surface


Banner Branch Groundwater Well 3
Groundwater Depth (inches)
Daily Rainfall (inches)
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
10/3/2019
10/17/2019
10/31/2019
11/14/2019
11/28/2019
12/12/2019
12/26/2019
1/9/2020
1/23/2020
2/6/2020
2/20/2020
3/5/2020
3/19/2020
4/2/2020
4/16/2020
4/30/2020
5/14/2020
5/28/2020
6/11/2020
Daily Rainfall
Groundwater Depth
Ground Level
12" Below Surface


Banner Branch Groundwater Well 4
*Well damaged by cattle on 10/19/2019, reinstalled on 11/21/2019
Groundwater Depth (inches)
Daily Rainfall (inches)
5
0
-5
-10
-15
-20
-25
-30
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
10/3/2019
10/17/2019
10/31/2019
11/14/2019
11/28/2019
12/12/2019
12/26/2019
1/9/2020
1/23/2020
2/6/2020
2/20/2020
3/5/2020
3/19/2020
4/2/2020
4/16/2020
4/30/2020
5/14/2020
5/28/2020
6/11/2020
Daily Rainfall
Groundwater Depth
Ground Level
12" Below Surface


Banner Branch Groundwater Well 5
Groundwater Depth (inches)
Daily Rainfall (inches)
0
-5
-10
-15
-20
-25
-30
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
2/12/2020
2/19/2020
2/26/2020
3/4/2020
3/11/2020
3/18/2020
3/25/2020
4/1/2020
4/8/2020
4/15/2020
4/22/2020
4/29/2020
5/6/2020
5/13/2020
5/20/2020
5/27/2020
6/3/2020
6/10/2020
Daily Rainfall
Groundwater Depth
Ground Level
12" Below Surface



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

WATER & LAND™ SOLUTIONS

Banner Branch
Mitigation Project

Monitoring Well
Locations

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
1

# DRAFT
# Detailed Hydric Soils Study
# Banner Branch Mitigation Site
# Stokes County NC

Prepared for:
Mr. Kayne Van Stell
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7721 Six Forks Road, Suite 130
Raleigh, NC 27615

Prepared by:
George K Lankford Soil Scientist, LSS #1223
George K Lankford, LLC
238 Shady Grove Rd
Pittsboro, NC 27312

George K. Lankford
1223
December 16, 2019

December 2019

Soil Scientist Seal

This report describes the results of the soil evaluation performed at the Banner Branch Mitigation Site in Stokes County, NC. Any subsequent transfer of the report by the user shall be made by transferring the complete report, including figures, maps, appendices, all attachments and disclaimers.

## Study Objectives and Scope

The purpose of the study was to document and delineate the extent of soils potentially suitable for hydrologic restoration and mitigation. This evaluation is a soil investigation and delineation. All boundaries shown are based on the detailed field evaluation. Hydrologic restoration potential of soils in this study is evaluated considering both historic and existing land uses, current site conditions, and the potential for creating or enhancing a hydroperiod suitable for the landscape setting and soils. In addition to the anticipated restoration of the streams to restore natural overbank flooding frequency, practical modifications suggested utilize the available natural hydrology and may include, but are not limited to surface drainage modifications such as plugging drainage ditches, removal of fill materials, removal of drain tile, and microtopographic alteration such as surface roughening or enhancing existing depressions. Recommendations for the re-establishment or rehabilitation of wetlands follow the Principles of Wetland Restoration (USEPA 2000) that promote successful establishment of a functioning wetland community by restoring ecological integrity through design and construction of a natural structure and function. This site evaluation focuses on evaluating the soils and practical technical solutions available to support restoration of these soils. Recommendations for removal extensive fill material is typically limited by cost and environmental damage. The potential for restoration assumes a successful design and an ability to construct site modifications necessary to restore adequate hydrology. Jurisdictional wetlands are located within the project boundaries and have been delineated as part of the soil delineation.

This report presents an evaluation of the subject property based upon an evaluation and detailed field investigation for the purpose of confirming the presence of and delineating the extent of hydric soil. The site is assessed for the suitability of soils for wetland mitigation. The observations and opinions stated in this report reflect conditions apparent on the subject property at the time of the site evaluation. My findings, opinions, conclusions, and recommendations are based on the soils, drainage patterns, site conditions, and boundaries of the property as evident in the field.

## Project Information and Background

The site is located approximately 22 miles east of Mount Airy NC near the NC/VA state line. It is south of NC Highway 704 East, between Clark Road (SR 1600) and west of Moore Road (SR 1602) in Stokes County (Figure 1). The project is approximately 37 acres along the floodplain of Banner Branch and its tributaries. The site evaluation extended along approximately 14,000 linear feet beside stream channels. This project is along the narrow floodplain of small streams within the western portion of the Piedmont physiographic region. Uplands within the project area slope steeply to the streams and floodplains. Adjacent to the project are scattered farm buildings and single-family residences. Land use within the contributing watershed is primarily agricultural (Figure 2). Evidence of past land use indicates portions with cattle and row crops with ditching to enhance the ability to utilize the rich alluvial soils. Although livestock have had access throughout, a few areas currently attempt to exclude access. Banner Branch drains to Snow Creek, a tributary to the Dan River. Within the watershed runoff potentially contains runoff that is a source for nutrients, agricultural chemicals, sediment, and bacterial contamination that can negatively affect water quality.

The site is located within an active livestock operation with animals having free access to streams and adjacent floodplains. Stream channels within the project appear incised, having steep and unstable banks throughout the project. stream banks exhibit erosion despite narrow wooded buffers. The soil evaluation focused upon floodplains and adjacent slopes as areas having higher potential for containing hydric soil.

## NRCS Soil Mapping

The NRCS Soil Survey mapping units are an area of soil dominated by one or more kind of soil, usually having similar defined soil properties and physical characteristics with similar management criteria base upon these properties. These soil map units are useful for general planning purposes, but cover larger areas and typically include one or more smaller areas of dissimilar soils not discernable without a detailed site evaluation. Map unit properties provide a background for interpreting the range of soil properties that may be encountered across a site.

The current Web Soil Survey data differs from the published Soil Survey of Stokes County (1995) because the area was reclassified from a thermic regime to a mesic after publication. The current classification and soil series are the mesic counterparts to the published survey and are used in this discussion unless otherwise noted. This reclassification does not change the general soil information available or the interpretation of soil for this report.

The current soil survey data indicates mapping units in the project area are either composed of single series with minor inclusions or a complex of two series with minor inclusions. General characteristics of map units are listed in Table 1. The summary is for listed map units, but similar map units occur having different slopes may indicate different inclusions or percent occurrence as some wetter inclusions may not be typical in map units with a steeper slope class.

The soil survey indicates soil within the project area generally has a loamy surface within the floodplain and loam or sandy loam in the uplands. Floodplain soils formed in loamy alluvium derived from igneous and metamorphic rock eroded from the contributing upland areas. These soils are typically underlain by a sandy clay loam that formed in loamy alluvium derived from uplands of igneous and metamorphic rock (on line NRCS Web Soil Survey 2019). The upland soils are underlain by clayey soils and can be shallow to bedrock on the steeper slopes. Throughout the project, larger floodplains are mapped as either *Codorus loam* (CsA) or *Dan River and Comus soils* (Da). The *Codorus loam* is somewhat poorly drained with inclusion of poorly drained soils. The poorly drained inclusions are rated as hydric by the NRCS. The other floodplain map unit is the mostly well drained *Dan River and Comus soils* containing a complex of two similar series. Located on the toe and foot slopes along the drainages, the adjacent uplands soil units consist of well drained, moderately eroded *Clifton sandy clay loam* (CeC2) or *Fairview-Poplar Forest complex* (FpC2).

### *Codorus loam*

The *Codorus loam* map unit is primarily a *Codorus* series with minor inclusions of *Hatboro* and *Haw River*. The *Codorus* is somewhat poorly drained and occasionally flooded with a water table expected to be between 6 and 24 inches. Inclusions of poorly drained *Hatboro* and *Haw River* soils are located within depressions and slack water areas on the floodplain. These poorly drained inclusions are expected to have a water table between 0 and 12 inches. The *Codorus* series is not considered hydric by the NRCS, but *Hatboro and Haw River* soils are rated as hydric.

### *Dan River and Comus soils*

The *Dan River and Comus soils* map unit is an undifferentiated group consisting of two soils shown as one unit because of similar use and management recommendations. This soil ranges from well to somewhat poorly drained and occasionally floods. Found on a nearly level to slightly convex landscape the water table is between 30 and 60 inches. This map unit and expected inclusions are not considered hydric by the NRCS.

### *Upland Soils*

The remaining map units are on surrounding upland slopes of the watershed. These upland soils have a fine sandy loam surface where not eroded to expose a sandy clay loam. These well drained soils have a water table below 80 inches. None of these soils and their expected inclusions are rated as hydric by the NRCS.

## Table 1. NRCS Mapped Soil Units at the Banner Branch Site

| Series | Taxonomic Class | Drainage Class | Hydric (Hydric Rating) | Landscape setting (down across) |
|---|---|---|---|---|
| **Codorus loam, 0 to 2 percent slopes, occasionally flooded (CsA)** (Consociation) *Prime farmland if drained*<br>*Parent material - Loamy alluvium derived from igneous and metamorphic rock*<br>*Depth to water table - 6 to 24 inches*<br>*Flooding – occasional Ponding - none* | | | | |
| **Codorus** (80%) | *Fluvaquentic Dystrudepts* | somewhat poorly | No (B/D) | concave-linear |
| **Hatboro** (5%) | *Fluvaquentic Endoaquepts* | poorly | Yes (D) | |
| **Haw River** (2%) | | | | |
| **Dan River and Comus soils, 0 to 4 percent slopes, occasionally flooded (Da)** (Undifferentiated group) *Prime farmland*<br>*Parent material - Loamy alluvium derived from igneous and metamorphic rock*<br>*Depth to water table – Dan River - 30 to 60 inches Comus – 36 to 60 inches*<br>*Flooding – occasional Ponding - none* | | | | |
| **Dan River** (50%) | *Oxyaquic Dystrudepts* | well | No (C) | convex-linear |
| **Comus** (40%) | *Fluventic Dystrudepts* | | No (A) | linear-convex |
| **Codorus** (4%) | | somewhat poorly | No (B./D) | concave-linear |
| **Ronda** (2%) | *Typic Udipsamments* | excessively | No (A) | convex -linear |
| **Pfafftown** (2%) | *Typic Hapludults* | well | No (B) | |
| **Banister** (2%) | *Aquic Hapludults* | moderately well | No (C) | linear/concave-linear |
| **Fairview-Poplar Forest complex, 8 to 15 percent slopes, moderately eroded (FpC2)** (Complex) *Farmland of Statewide Importance*<br>*Parent material - Saprolite derived from schist and/or gneiss*<br>*Depth to water table – greater than 80 inches*<br>*Flooding – none Ponding - none* | | | | |
| **Fairview** (50%) | *Typic Kanhapludults* | well | No (B) | convex -convex |
| **Poplar Forest** (40%) | | | | |
| **Westfield** (7%) | | | | |
| **Woolwine** (3%) | | | No (C) | |
| **Clifford sandy clay loam, 8 to 15 percent slopes, moderately eroded (CeC2)** (Consociation) *Farmland of Statewide*<br>*Parent material - Saprolite residuum weathered from granite and gneiss and/or saprolite residuum weathered from schist*<br>*Depth to water table – greater than 80 inches*<br>*Flooding – none Ponding - none* | | | | |
| **Clifford** (85%) | *Typic Kanhapludults* | well | No (B) | convex -convex |
| **Westfield** (8%) | | | | |
| **Woolwine** (7%) | | | No (C) | |

Source-NRCS Web Soil Survey (2019 11-11)
Note: Similar map units are adjacent with different slope parameters containing possibly differing inclusions.

This evaluation and report focus upon areas having a suitable landscape position and with high potential for containing hydric soil and the possibility of supporting wetland hydrology.

## Project Approach

The mitigation project approach is to restore natural hydrology on the floodplain that will sustain wetland hydrology to appropriate landscapes and provide a functional uplift. An initial soil evaluation found scattered areas that exhibits the typical hydric soil indicators found in drained wetlands. Although current wetlands exist, their area is reduced from the historic extent due to land management, erosion, and drainage modifications. Farming practices on the uplands within the watershed resulted in past erosion that produced significant deposition within this floodplain. This deposition resulted in fertile topsoil that was immediately used for agricultural purposes of grazing or row crops. Current incision of the streams into the loamy alluvial material has lowered the local water table. Channelization and ditching have further increased drainage of the landscape.

The interpterion of hydric soil indicators did not assume current hydrology. Each area of hydric soil was assessed for current hydrology by evaluating existing drainage modifications (both natural and anthropogenic), the pattern and presentation of soil color and mottles, existing vegetation, and the current water table where observed.

## Methodology

A detailed hydric soil investigation for Banner Branch site was completed in October of 2019. A series of nearly 200 soil borings were performed to evaluate and estimate the extent of hydric soil at the site (Figure 3). Soils and landscapes suitable for reestablishment or rehabilitation were identified. Soils were evaluated using morphologic characteristics to determine hydric indicators and evaluate current hydrology. Using criteria based on "*Field Indicators of Hydric Soils in the United States*" (USDA, NRCS, 2016, Version 8.1). The boring observations do not contain adequate detail to classify these soils to a series. Hydric soil indicators used are valid for the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region Version 2.0* within Major Land Resource Area (MLRA) 136- Southern Piedmont and Land Resource Region (LRR) P- South Atlantic and Gulf Slope Cash Crops, Forest, and Livestock Region. A hydroperiod success criteria is proposed based upon Corps mitigation guidelines (US Army Corps of Engineers 2016). Soil boring locations were approximately located using the Terrain Navigator Pro smart phone application by Trimble and figures were produced from the same software.

Hand auger soil borings were used to described current soil characteristics, investigate indicators of biological soil reduction process, and evaluate the extent of soil suitable for restoration (Appendix B). Borings typically extended below 18 inches, but often ranged to 30 inches or greater. Because of the incised stream channels, depths greater than three feet are exposed longitudinally within the floodplain to assist in verifying historic hydric soils.

General conditions and patterns representative of this floodplain were noted. This report describes these findings, conclusions, and recommendation for wetland restoration at the Banner Branch Site. The current hydrology, management, and existing modifications with relevant soil characteristics that may affect potential hydrology are discussed.

## Results and Discussion

### *Landscape Setting*

This project site is within the central Southern Piedmont physiographic region on the floodplain of Banner Branch and its tributaries. Banner Branch is a tributary to Snow Creek, which flows southward to the Dan River. The surrounding landscape of the area is dominated by the Sauratown Mountains range. It has gently sloping to steep side slopes of the mountains and ridges with steeper slopes typically adjacent to the drainageways.

Geology of the project spans two formations of metamorphic rock. The tributaries and upper reach of Banner Branch are in banded gneiss with interlayered with calcium-bearing silicate rock, metaconglomerate, amphibolite, sillimanite-mica schist, and granitic rock. The lower reach of Banner Branch and the headwater of Banner Branch outside of the project is within a formation of mica schist containing garnet, staurolite, kyanite, or sillimanite occur locally; lenses and layers of quartz schist, micaceous quartzite, calc-silicate rock, biotite gneiss, amphibolite, and phyllite (NCGS 2009). Based on the geology, alluvial soils found within the project contain a wide variety of minerals and textures. Soils generally tend to be well drained, having a loamy surface with predominantly clayey subsoil that formed in weathered felsic and metamorphic and igneous rock (USDA-NRCS 1995). Floodplain soils formed in recent alluvium and have a loamy surface and underlain by loamy or sandy material.

### *Site Conditions*

The site is located on an agricultural landscape within an active livestock operation where animals have access to streams and adjacent floodplains. Surrounding uplands are a mix of pasture and undeveloped forest land. Scattered farm buildings and single-family residences occupy the higher upland ridges and side slopes. The forested vegetative community is hardwoods with limited understory due to cattle grazing. Heavy grazing of pastures was observed and where present, various grasses dominate the herbaceous layer. Stream channels appear incised throughout the project typically and have wooded buffers of varying width.

The project consists of two main drainage features. Banner Branch is the main stream, entering the project from the north east and flowing south west. Three smaller unnamed tributaries, UT1, UT2, and UT3, join this reach within the project. The drainage to the west, UT4, flows south to join Banner Branch just downstream of the project. Banner Branch is a third order or larger stream. It is incised throughout with a moderately wide floodplain having multiple areas suitable for supporting a hydric soil. The downstream 900 feet currently have livestock fenced out, but still exhibits significant incision. Throughout the lower portion of this reach, shallow bedding rows are visible and where livestock are excluded, irrigation tubing is still visible. Along Banner Branch, three areas containing hydric soil were found, two associated with jurisdictional wetland areas. In addition to channel incision, other drainage features were observed. Along the narrow floodplain of UT1 three more areas of hydric soil are present, two of which appear to be jurisdictional. These areas also exhibit signs of additional drainage and the tributary has moderate incision. There was no hydric soil associated with the smaller UT2. Heavily modified, UT3 is limited within the project, but flows through and provides hydrology to a large area of hydric soil located on the floodplain of Banner Branch. To the west, the UT4 has four areas of hydric soil, all of which are jurisdictional or associated with a jurisdictional wetland. These areas have visible drainage modifications. The upper reach of this tributary is deeply incised before entering a farm pond.

This site has eight jurisdictional wetlands and five hydric soil units (Figure 2). They are located in concave and depressional landforms or at slope seepages. The wetlands appears to have adequate hydrology. The hydric soil units appear effectively drained, but are located within backwater areas of the floodplain. Three of the drained soil units are adjacent to wetlands. The hydric soil units are further described in Appendix A.

### *Site Soils*

Within the project, alluvial soils originated from the surrounding upland slopes and reflected in the sandy and loamy nature of soil observed in the floodplain. Soils were found to typically have a loamy surface underlain by a restrictive layer containing more clay, ranging from a sandy clay loam to a denser sandy clay. In some areas, this restrictive layer is also underlain by sand. A few areas have horizons containing small gravel. The clayey layer allows a perched water table to occur where not drained. The depressional area have potential to support limited ponding. Where the floodplain is wider, the nearly level to concave landscapes provides suitable conditions for formation of hydric soil. Where the valley is narrow, hydric soils along the toe slope at areas of seepage. Most hydric soils exhibit a brown loamy surface underlain by dark brown or gray clayey layer having limited structure and is moderately restrictive.

Portions of the evaluation were performed during dry to moderate drought conditions, making interpretations more difficult. Dry soils present a challenge to examine for smaller mottles, which become disturbed and destroyed during excavation. Additionally, much of the areas lies within the livestock operation where compaction and churning of the upper horizons destroy the morphological features. Representative soil profiles can be found in Appendix B.

### *Hydric Soil Indicators*

The soil evaluation delineated area of hydric soil based primarily on soil indicators located within 12 inches of the soil surface. Based on the 20 representative hydric profiles and supported by additional borings, the most common hydric soil indicators are *F3-Depleted Matrix*, *F8-Redox Depression*, and *F19-Floodplain Soils* indicators. Additional indicators of minor occurrence include the *F2-Loamy Gleyed Matrix*, *F6-Redox Dark Surface* and *A12-Thick Dark Surface*. Where a soil is underlain by a depleted matrix having distinct or prominent redoximorphic concentrations the criteria for the *F3* indicator is met. Where the redox concentrations exceed 5 percent and occur within a natural depressional landscape the *F8* indicator is met. Additionally, because some areas contain more than 20 percent distinct or prominent redox concentration and appear in a landscape that under natural condition would potentially pond for brief periods, it also meets the criteria for the *F19* indicator. The *F19* indicator is still a test indicator in this MLRA, but would be considered if the floodplain is active. Many profiles exhibited multiple indicators (Appendix B). The *F2*, *F6*, and *A12* indicators indicate areas of long-term saturation or ponding and were only found in areas considered jurisdictional. Soils having significant disturbance or drainage modifications may have lost one or more of these indicators. Outside of these soil units, deeper horizons that exhibited hydric indicators are not included within the delineation due to the amount of disturbance and potential construction costs. These deeper horizons do indicate historic wetlands were more extensive than the current delineated areas and provide evidence that support this project as having a suitable landscape and geomorphic position.

### *Current Hydrologic Alterations*

The incised channels appear to have lowered groundwater across the floodplains and currently limits overbank flooding events. The past land use and impacts from livestock have resulted in the loss of a natural levee that separated the backwater from the stream, allowing a rapid loss of surface water and limited potential for ponding. In many of these hydric soil units, shallow ditches intercept upland runoff and limits surface storage, especially in depressional areas of the floodplain. Based on the landscape and soils, historic wetlands were more extensive. Outside of the wetland areas, the water table was not encountered within 18 inches of the surface, but much of the site work was performed during the late summer within moderate drought conditions.

Along the toe of slope, many of the hydric soils appear near groundwater discharge areas or at the base of prominent concave landforms on the upland slopes. The jurisdictional soils are located near this type of existing water sources. Although drainage modifications are present within the wetlands, soils still retain limited hydrology to be considered jurisdictional.

## Potential Hydroperiod for Restored Soils

Based upon this detailed study of soils at this site, channel incision, erosion, ditching, and management practices have altered or removed much of the natural hydrology. Hydric indicators are present in landscape positions above the incised channels exhibiting a range of soil characteristics similar to the expected inclusions of *Hatboro* and *Haw River* soils. The backwater areas and floodplain depressions provide suitable landscapes for wetlands and wetland restoration. Raising the streambeds and plugging and filling of ditches and old channels along with enhancing depressional area and surface roughening will restore a more natural hydrology to this landscape.

Using the mitigation guidance for Piedmont soils (US Army Corps of Engineers 2016), the *Hatboro* and *Haw River* soils (*Fluvaquentic Endoaquepts*) are suggested to have a hydroperiod of 12 to 16 percent where the water table is within 12 inches of the surface during the growing season (Table 2). Most of the drier floodplain soils (*Fluvaquentic Dystrudepts*) are suggested to have a hydro period of 7 to 9 percent, lower than typical criteria for mitigation, but above the threshold for jurisdiction. Given the landscape and occasional flooding, areas outside of the hydric soil units identified may provide wetlands functions. Because of variation found in natural systems, small depressional areas may exhibit a hydroperiod of greater than 16 percent. This longer hydroperiod would be normal considering the historic wetland landscape once present.

**Table 2. Banner Branch Success Criteria**

| **Mapping Unit/Series** | **Taxonomic Classification** | **Topographic Slope Setting** (down/across) | **Flooding/Ponding Frequency** | **Hydroperiod Range*** |
|---|---|---|---|---|
| **Codorus** | *Fluvaquentic Dystrudepts* | concave-linear- | occasionally/none | 7-9% |
| **Hatboro** | *Fluvaquentic Endoaquepts* | concave-linear- | occasionally/none | 12-16% |
| **Haw River** | *Fluvaquentic Endoaquepts* | concave-linear- | occasionally/none | **12-16% |
| **Dan River** | *Oxyaquic Dystrudepts* | convex-linear | occasionally/none | NA |
| **Comus** | *Fluventic Dystrudepts* | linear- convex | occasionally/none | **7-9% |
| | | | | |

**Hydroperiod follows US Army Corps of Engineers. 2016. Wilmington District Stream and Wetland Compensatory Mitigation Update. North Carolina Interagency Review Team - October 24, 2016.*
***No guidance on Dan River soils: most likely not be wet due to the convex nature of the landscape where typically found.*

Once restoration is completed, existing wetlands should have a slightly longer hydroperiod. These suggested hydroperiods depend on the factors related to stream design, and construction, soil variability, frequency of flooding, and aspects of surface drainage after construction. Hydrologic restoration should encourage formation of hydric indicators within the disturbed surface horizon.

## Functional Uplift from Hydric Soil Restoration

The site currently has mix of drained hydric soil and jurisdictional wetlands, with wetlands having degraded hydrology and limited connectivity. Ditching and channel incision limit hydrology. Livestock disturb soils and enhance channel erosion while providing direct nutrient contamination to the channels. Currently there is limited treatment of sediment and runoff of pollutants and limited vegetation allows erosion and raises water temperature.

A successful hydrologic restoration at this site will provide numerous soils related functional uplifts to address the above functional losses. As a whole, this project will increase the ability of the wetland system to adequately treat runoff and sediment. Other potential functional benefits include, flood storage, improved water quality, pollutant sequestration and transformations, nutrient cycling, and habitat improvements.

These changes may result in increases in microbial and fungal populations and diversity important for soil health. Functional uplift may include, reestablishment of natural oxidation-reduction cycling, improved nutrient and biochemical transformations, increased carbon sequestration, and better soil structure (surface primarily). Large scale benefits may include improved water quality, diverse wildlife habitat, and connectivity between natural aquatic communities. Given the observed soil characteristics indicating past wetland hydrology, favorable landscape position, and the potential source for reconnecting the floodplain to overbank event, this site appears suitable for hydrologic wetland restoration.

## Summary Conclusions and Recommendations

The Banner Branch project consists of a system of incised and eroding streams within an agricultural landscape. The NRCS soil survey map units indicate the site soils contains areas having potential hydric soil. The site historically contained wetlands, some of which still remain in a degraded state. Previous drainage efforts include shallow ditches and incised streams. These changes have removed much of the natural flooding events while limiting length of saturation. The most common hydric soil indicators are *F3-Depleted Matrix*, *F8-Redox Depression*, and *F19-Floodplain Soils*. Additional indicators only found within current wetland areas include the *F2-Loamy Gleyed Matrix, F6-Redox Dark Surface* and *A12-Thick Dark Surface*.

### *Recommendations*

Numerous restoration techniques can be used to restore hydrology. Many areas require successful stream restoration to raise the local groundwater elevation and allow frequent flooding of the floodplain. Other techniques include plugging of ditches, and surface roughening. Removal of limited deposition, where present, and enhancing or creating natural depressional surfaces will increase infiltration, recharge, storage, sediment capture. Due to livestock activity, the decompaction of surface horizons is highly recommended within pastures and can be accomplished by ripping 14 to 18 inches. Decompaction will help establishment a diverse soil micro habitat to allow multiple biochemical process found in natural wetlands. Benefits of decompaction include, reduced runoff velocity, higher infiltration rate, improved soil structural properties and site storage. Other benefits include enhanced surface and subsurface biogeochemical cycling and storage. Additionally, this will improve planting conditions to increase survival and enhance long-term growth. Surface roughening and creation/enhancement of shallow depressions throughout the restoration area will reestablish more natural conditions and provide an appropriate landscape for diverse habitat. All construction and decompaction activities should be avoided or limited when soils are saturated. Equipment and tillage activities in wet soils permanently damages soils by creating clods, ruts, and increases compaction.

The hydric soils found at this site are be expected to have a hydroperiod of 10 to 16 percent with some more pronounced depressional areas having greater than 16 percent. Soils within suitable landscapes adjacent to restored wetlands may experience 6 to 9 percent hydroperiods.

### *Conclusions*

Given the observed soil characteristics, presence of current and historic hydric soils, and favorable landscape positions, this site appears suitable for wetland re-establishment or rehabilitation throughout the floodplains of Banner Branch and its tributaries. Restored streams can raise local groundwater to within 12 inches of the surface while providing overbank flooding. Flooding can also provide adequate hydrology for ponding in some depressional areas.

Successful hydrologic restoration at this site can provide numerous soils related functional uplifts. These include, storage of floodwaters, trapping of sediments and pollutants from urban runoff, nutrient cycling and a wide range of soil habitat. The wetland will increase infiltration of runoff and reestablish a natural oxidation-reduction cycle that improves nutrient and chemical transformations. Other benefits include increased organic carbon accumulation/capture, improved soil structure (surface primarily), and increases in diversity and beneficial microbial and fungal populations important for soil health. Large scale benefits may include diverse wildlife habitat and community connectivity. Based on the historically wet nature of this site, correct landscape position, appropriate textured soils, and the potential for re-establishment of adequate hydrology, this site is suitable for wetland re-establishment or rehabilitation.

This report describes the results of the soil evaluation performed at the Banner Branch Site in Stokes County, NC. Any subsequent transfer of this report by the user shall be made by transferring the complete report, including figures, maps, appendices, all attachments and disclaimers.

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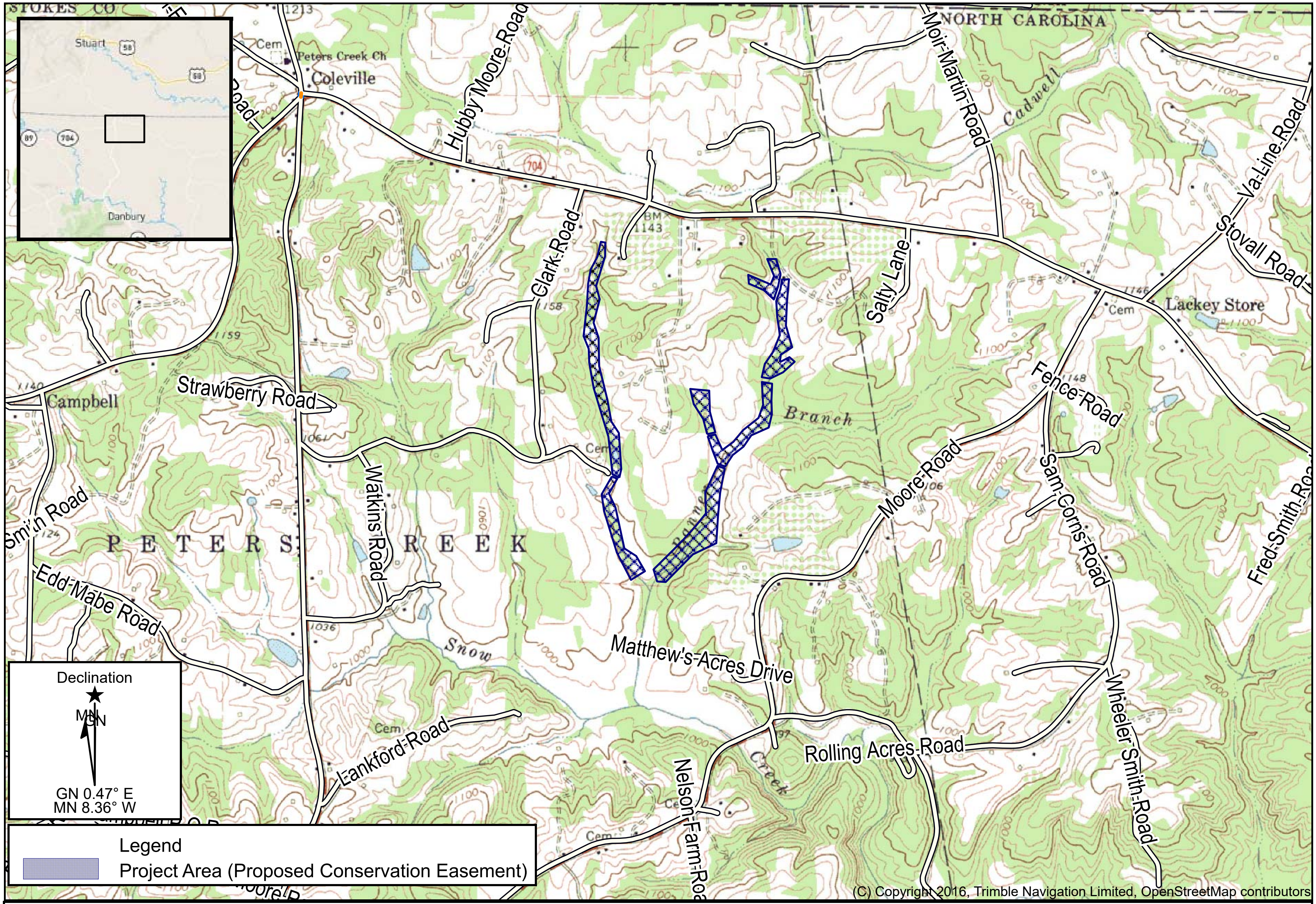
## Figures

## APPENDICES

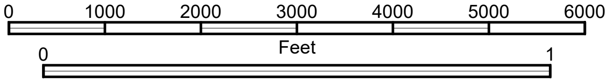
Appendix A Soil and Wetland Unit Descriptions
Appendix B Soil Boring Log
Appendix C Photos
Appendix D NRCS Web Soil Survey Report



Map Name: NETTLERIDGE
Scale: 1 inch = 2,000 ft.

**Figure 1. USGS Vicinity Map**
**Banner Branch Mitigation Site**
**Stokes County, NC**

SCALE 1:24000



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December 16, 2019

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**LEGEND**

| | |
|---|---|
| ▬ | Proposed Easement |
| ▬ | Stream |
| – – – | Drainage Feature |
| ▨ | Hydric Soil |
| ▨ | Existing Wetland (unverified) |

Scale: 1 inch = 400 ft.
Horizontal Datum: WGS84

## Figure 2. Project Aerial Overview - Hydric Soils
## Banner Branch Mitigation Site

N
W
E
S

SCALE 1:4800

0 100 200 300 400 500 600 700
Feet

0.0 0.1
Miles

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**LEGEND**

- Proposed Easement
- Stream
- Drainage Feature
- 🟨 Hydric Soil
- ▨ Existing Wetland (unverified)
- ○ Soil Boring Point
- ● Profile Point

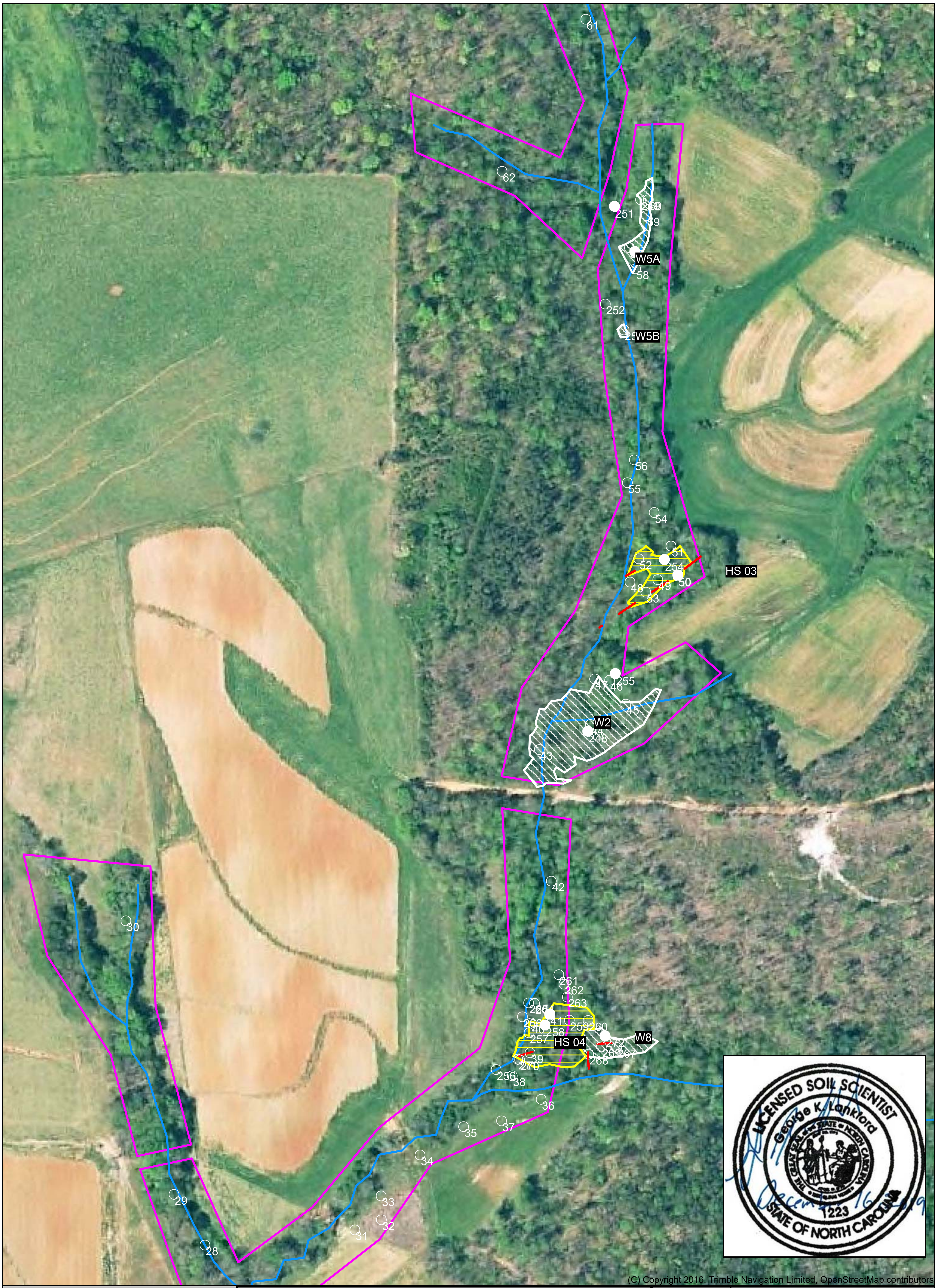
Scale: 1 inch = 200 ft.
Horizontal Datum: WGS84

**Figure 3A. Project Aerial - Hydric Soils Boring Points**
**Banner Branch Mitigation Site**

SCALE 1:2400

0 100 200 300
Feet

0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07
Miles



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**LEGEND**

| | |
|---|---|
| — | Proposed Easement |
| — | Stream |
| – – | Drainage Feature |
| 🟨 | Hydric Soil |
| ▨ | Existing Wetland (unverified) |
| ○ | Soil Boring Point |
| ● | Profile Point |

Scale: 1 inch = 200 ft.
Horizontal Datum: WGS84

**Figure 3B. Project Aerial - Hydric Soils Boring Points**
**Banner Branch Mitigation Site**

SCALE 1:2400

0 100 200 300
Feet

0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07
Miles

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**LEGEND**

| | |
|---|---|
| — | Proposed Easement |
| — | Stream |
| - - | Drainage Feature |
| ■ | Hydric Soil |
| ▨ | Existing Wetland (unverified) |
| ○ | Soil Boring Point |
| ● | Profile Point |

Scale: 1 inch = 200 ft.
Horizontal Datum: WGS84

**Figure 3C. Project Aerial - Hydric Soils Boring Points**
**Banner Branch Mitigation Site**

N
W E
S

SCALE 1:2400

0 100 200 300
Feet

0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07
Miles

## APPENDIX A – SOIL AND WETLAND UNIT DESCRIPTIONS

The Banner Branch site contains multiple areas having hydric soil, with many areas potentially containing jurisdictional hydrology despite land use and drainage modifications. Some areas of hydric soil have been divided into drained and jurisdictional, but historically were one community. Five drained hydric soil and eight wetland units were delineated. Thee of the wetlands are adjacent to a drained soil unit. The individual soil units are described below.

### HS1 and W1 (HS1= 1.41 ac and W1 = 1.01 ac)

Historically, the drained HS 1 and wetland W1 soil units were a single wetland located in the backwater of Banner Branch. Hydrology was a combination of a high water table with overbank flooding from both Banner Branch and UT3. Currently, both Banner Branch and UT3 are incised and channelized, effectively lowering local groundwater and limiting flooding. The channelized UT3 is approximately 3-feet deep and 8-feet wide with spoil berm two to three feet high. This deep incision affects hydrology of H1 and portions of adjacent W1. Most of HS 1 is within fenced pasture. A shallow ditch at the slope that intercepts groundwater and runoff, channeling it to Banner Branch to provide additional drainage of the wetland. Spoil present along both channels restricts natural surface flows. Closer to Banner Branch is a shallow depression that provides a small semi-permanent pool. This ponded community was likely much larger historically. Visible throughout both soil units is evidence of past cultivation practices associated with strawberry production such as shallow raised beds and old irrigation tubing. Livestock fencing is also visible. The soils are loamy surface textures underlain by a clayey layer. Below this clayey horizon some areas exhibit a layer of sandier material that is typical of alluvial landscapes. Sandy subsoils support the effectiveness of ditches and channel incision in lowering of groundwater.

Hydrologic restoration can be accomplished through raising stream beds of Banner Branch and UT3, plugging and filling the old channels, removal of spoil, and surface roughening to remove the shallow bedding. Reconnection of the streams to their floodplain will restore natural hydrology and surface flows into this wetland.

### HS2 (HS2 = 0.97 ac)

This drained hydric soil unit is located on the left floodplain along Banner Branch located upstream from HS-01/W1 and within the fenced pasture. It occurs within a small depressional feature beside the incised channel. Portions of a narrow buffer are present along the channel. No levee was visible along Banner Branch. Soils have a clay loam surface underlain by a sandy clay loam. A deeper, historic hydric layer was observed along the incised stream bank and extends intermittently upstream, but was not delineated due to depth. Deeper silt loam was found. The finer textured soil supports the depressional nature of this unit.

Hydrologic restoration requires raising the stream bed of Banner Branch to raise local groundwater. Other restoration techniques include surface roughening and reconnection to frequent flooding.

### HS3 (HS3= 0.2 ac)

This area is located within a slope crenulation beside stream UT1-R2 on a low terrace that currently does not flood. Hydrology appears to be a small spring or seep at the base of the slope. Shallow ditching is present to provide drainage. Livestock have churned the soil surface throughout and is promoting soil loss. Topography and soils are variable with surface modifications obscuring natural features. Slope seepage and runoff will provide hydrology.

## APPENDIX A – SOIL AND WETLAND UNIT DESCRIPTIONS

Restoration or enhancement techniques require plugging and filling of ditches. Surface roughening in more disturbed areas may be necessary to remove the erosional features. Existing mature trees are currently helping stabilize this area and may limited some work.  Potential slope runoff may necessitate a BMP feature.

### HS4 and W8 (HS4= 0.37 ac and W8 = 0.17 ac)

Historically, the drained HS4 and wetland W8 soil units were a single wetland located at the confluence of UT1-R2 and Banner Branch. Hydrology appear to have been a high groundwater table and overbank flooding. Currently, both Banner Branch and UT1-R2 are incised, effectively lowering local groundwater while limiting flooding. The drained unit is along UT1-R2 and wetland W8 along Banner Branch. The full extent along Banner Branch extended farther upstream out of the project limits and was not evaluated. This wetland is within a narrow linear depression having a shallow outlet near to Banner Branch. Both soil units are within a forested buffer. Soils have a loamy surface underlain by a slightly more restrictive sandy clay loam.

Hydrologic restoration of HS4 requires raising the bed of UT1-R2 to reconnect the floodplain. Due to existing vegetation, surface roughening is limited. Additional consideration may be required to stabilize the bed elevation of Banner Branch as it enters the project.

### HS5 – Not used

### HS6 and W4 (HS6= 0.82 ac and W4 = 0.3 ac)

The drained HS4 and wetland W8 soil units were historically a single wetland located on the floodplain of UT4-R2. The floodplain widens and gently slopes out to the toe of slope. Hydrology appear to have been a high groundwater table, overbank flooding, and slope seepage. Hydrologic modifications include shallow ditching to collect seepage and runoff. It is likely this area has been smoothed for cultivation at some time in the past. Current use is livestock. Upslope is cultivated row crops. Soils are loamy over a moderately restrictive sandy clay loam. Clay content increases with distance from the channel.

Hydrologic restoration can be accomplished by removal of the surface drainage features and surface roughening. It may be possible for minor stream work to increase flooding of the lower elevations. Creation of shallow depressions below the toe of slope will provide surface storage, better infiltration and locally variable water table depth for multiple biochemical process to occur.

### W1 (see HS1 for description)

### W 2 (W2= 0.8 ac)

This wetland is within a natural feature above a farm culvert crossing at the confluence of UT1B and UT1-R2, where a temporary blockage of the culvert has been constructed by the farmer. The culvert restriction was likely an attempt to provide better water access for livestock, but has resulted in a high water table with the lower portions. This feature has limited channel incision and allows deposition of sediment upstream of the culvert. Along the left bank a small channel, UT1B, enters this tributary. The small channel has been dredged and straightened. Areas appearing to be spoil are present, especially near the culvert. Hydrology is from a high water table associated with both streams. It also appears to have groundwater discharge along portions of the slope.

## APPENDIX A – SOIL AND WETLAND UNIT DESCRIPTIONS

Soils are variable, but deposition is present in many places. Within the floodplain, the floodplain soils are underlain by a very gray horizon. More recent sediments are also beginning to develop hydric characteristics due to the high water table.

Because of the constructed blockage at the culvert, this stream will need to be stabilized to limit sediment loss when the blockage is removed. Enhancement of the wetland above the culvert may require limited sediment removal and construction of a stepdown to the existing culvert to permanently maintain hydrology that is currently heavily influenced by the blockage structure. Restoration of UT2b to maintain a high water table and surface roughening will be needed. There will likely be limits due to existing mature trees that are currently helping stabilize this area.  At the upstream end of UT1B, a BMP structure is suggested.

### W 3 (W3= 1.05 ac)

This hydric soil unit is on the floodplain and toe of slope along UT4-R1 upstream of a farm pond. Hydrology is currently from the nearly level floodplain, high groundwater adjacent to UT3-R1, and slope seepage. There is limited channel incision within this wetland, but head cutting is present upstream. Livestock have degraded this wetland and there appears to be sediment deposition present. The downstream end is a proposed crossing above the farm pond. Soils within the floodplain are loamy with sand prominent. Hydric indicators point to the floodplain having a long hydroperiod. The slope soils have a loamy surface underlain by a restrictive clayey horizon.

This wetland can be significantly enhanced by livestock exclusion and planting of appropriate vegetation. Stabilization of the stream at the crossing will prevent head cutting into this wetland.

### W4 (see HS6 for description)

### W 5 (A and B) (W5A= 0.12 ac and W5B = 0.01 ac)

This hydric soil along the floodplain at the confluence of two small streams, UT1-R1 and UT1A, where both streams are moderately incised below the floodplain.  The wetland consists of two slightly separated small floodplain wetlands deriving hydrology from discharge along the slopes. Wetland F5A is below an existing farm crossing with W5B just downstream within a floodplain meander. Soils are loamy over a moderately restrictive clayey layer with a deeper sandy loam horizon. The UT1B originates upstream from as spring with groundwater discharge along the slope and numerous points along the stream banks. The wetland W5B is also supported by discharge along the slope. The discharge water flows along the restrictive clayey horizon to create a perched water table within these wetlands. Both channels are stable and support a stable woody buffer.

Due to the small size and stable nature of these wetlands, no hydrologic enhancements are recommended.

### W6 (A and B) (W6a= 0.29 ac and W6b = 0.05 ac)

This hydric soil consists of two areas along the floodplain adjacent to UT4-R1.  The downstream wetland, W5B, is within an old oxbow. The upstream wetland, W6A, is on the left floodplain within a small crenulation draining into the tributary. It appears to contain a spring along the toe slope and evidence of ditching is visible. An existing drain tile was observed approximately 100 feet downstream potentially providing subsurface drainage. Wetland W6B is downstream of the drain tile on the right floodplain. below an existing farm crossing with W5B just downstream within a floodplain meander.

## APPENDIX A – SOIL AND WETLAND UNIT DESCRIPTIONS

Soils are loamy throughout with lower elevation exhibiting surface or near surface water table. There were numerous observations of drainage manipulation and surface soils are heavily disturbed by livestock. In addition to drain tile, ditching and spoil are visible. Hydrology consists of a spring, slope seepage, and concentrated runoff. Due to the small size and location, raising the stream bed through this reach may not be practical or desirable. Wetland 6A can be enhanced by removing the drain tile, plugging the ditches and removing the spoil. The surface likely experienced significant alteration, therefore it is recommended to explore potentially restoring a natural contour while removing excessive sediment or fill if found. Due to the concentrated runoff, a BMP or other structure is suggested at the upslope portion of the wetland.

### W7 (W7 = 0.04 ac)

This is a small wetland within a natural linear depression just above the floodplain on the right bank of UT4-R1. It does not appear to have significant alteration outside of the adjacent incised tributary. Hydrology is discharge along the slope and base of large boulder or exposed bedrock. Soils are loamy throughout and internal drainage appears to be high. Vegetation is mostly natural for this wetland type. No enhancement for this wetland is suggested.

### W8 (see HS4 for description)

# Appendix B

## Banner Branch Mitigation Site, Stokes County NC
## Soil Boring Descriptions

**Table A1. Representative Soil Profiles at Banner Branch Mitigation Site (MLRA 136, LRR P)**

| Depth (inches) | Color | | Mottle Percentage (Location) | Texture | Notes |
|---|---|---|---|---|---|
| | Matrix | Mottle | | | |
| **SB 273 (HS 1)**<br>**October 10, 2019** | | | Hydric Indicators WT none observed<br>F3-Depleted Matrix | | |
| 0-8 | 7.5 YR 4/4 | | | CL | |
| 8-11 | 7.5 YR 4/2 | 7.5 YR 4/6 | 15% (PL) | CL | |
| 11-23 | 7.5 YR 4/1 | 7.5 YR 5/8 | 20% (PL) | SC | |
| **SB 237 (HS 2)**<br>**September 30, 2019** | | | Hydric Indicators WT none observed<br>F3-Depleted Matrix<br>F19-Piedmont Floodplain Soils | | |
| 0-7 | 10YR 3/3 | | | CL | |
| 7-13 | 10YR 6/2 | 10YR 5/8 | 20% (PL) | SCL | |
| 13-26 | 10YR 6/1 | 10YR 5/8 | 30% (PL) | SiCL | |
| **SB 247 (HS 2)**<br>**September 30, 2019** | | | Hydric Indicators WT none observed<br>F3-Depleted Matrix | | |
| 0-9 | 10YR 4/3 | | | CL | |
| 9-26 | 10YR 4/2 | 10YR 3/6 | 5% (PL) | SCL | |
| **SB 254 (HS 3)**<br>**October 10, 2019** | | | Hydric Indicators WT -18<br>F3-Depleted Matrix<br>F19-Piedmont Floodplain Soils | | |
| 0-6 | 7.5 YR 4/2 | 5 YR 4/6 | 20% (PL) | SCL | |
| 6-13 | 7.5 YR 4/1 | 5 YR 3/4 | 15% (PL) | SCL | |
| 13-25 | 7.5 YR 4/1 | 7.5 YR 4/6 | 7% (PL) | SC | coarse, angular gravel-20% |
| **SB 50 (HS 3)**<br>**May 03, 2018** | | | Hydric Indicators WT -19<br>F3-Depleted Matrix | | |
| 0-2 | 10 YR 3/4 | | | SL | Recent sediment/surface churning |
| 2-6 | 7.5 YR 4/1 | 7.5 YR 4/6 | 20% (PL) | SL | |
| 6-12 | 7.5 YR 4/1 | 7.5 YR 4/6 | 5% (PL) | SCL | |
| 12-20 | 7.5 YR 4/1 | | | cS | |
| **SB 41 (HS 4)**<br>**May 03, 2018** | | | Hydric Indicators WT -17<br>F3-Depleted Matrix | | |
| 0-5 | 7.5 YR 3/4 | | | SL | |
| 5-10 | 7.5 YR 4/4 | 7.5 YR 4/6 | 15% (PL) | SL | |
| 10-17 | 7.5 YR 2.5/1 | 5 YR 4/6 | 15% (PL) | SCL | buried surface horizon |
| 17-22 | 7.5 YR 5/2 | 7.5 YR 4/6 | 20% (PL) | SCL | |
| **SB 258 (HS 4)**<br>**October 10, 2019** | | | Hydric Indicators WT none observed<br>F3-Depleted Matrix | | |
| 0-10 | 7.5 YR 4/4 | 7.5 YR 4/6 | 10% (PL) | SL | |
| 10-27 | 7.5 YR 4/1 | 7.5 YR 4/6 | 10% (PL) | SCL | |

# Appendix B

## Banner Branch Mitigation Site, Stokes County NC
## Soil Boring Descriptions

**Table A1. Representative Soil Profiles at Banner Branch Mitigation Site (MLRA 136, LRR P)**

| Depth (inches) | Color | | Mottle Percentage (Location) | Texture | Notes |
|---|---|---|---|---|---|
| | Matrix | Mottle | | | |
| **SB 210 (HS 6)**<br>**September 12, 2019** | | | Hydric Indicators WT none observed<br>F3-Depleted Matrix<br>F8-Redox Depression | | |
| 0-4 | 7.5 YR 3/4 | | | SL | surface heavily disturbed |
| 4-6 | 7.5 YR 4/6 | | | SL | |
| 6-8 | 7.5 YR 4/2 | 7.5 YR 4/6 | 15% (PL) | S | |
| 8-10 | 7.5 YR 4/6 | | | SL | |
| 10-16 | 7.5 YR 5/2 | 7.5 YR 5/8<br>7.5 YR 4/6 | 20% (PL)<br>5% (PL) | SCL | |
| 16-21 | 7.5 YR 6/1 | 7.5 YR 5/8 | 30% (PL) | SCL | |
| **SB 211 (HS 6)**<br>**September 12, 2019** | | | Hydric Indicators WT none observed<br>F3-Depleted Matrix<br>F8-Redox Depression | | |
| 0-4 | 7.5 YR 3/4 | | | CL | |
| 4-10 | 7.5 YR 4/2 | 7.5 YR 3/4 | 5% (PL) | CL | |
| 10-16 | 7.5 YR 5/1 | 7.5 YR 3/4 | 5% (PL) | CL | |
| 16-27 | 7.5 YR 6/1 | 7.5 YR 5/8 | 30% (PL) | C | |
| **SB 14 (W1 adjacent to HS 1)**<br>**May 03, 2018** | | | Hydric Indicators WT -20<br>F3-Depleted Matrix | | |
| 0-2 | 10 YR 3/2 | | | SL | |
| 2-8 | 10 YR 4/4 | 7.5 YR 3/4 | 10% (PL) | SL | |
| 8-16 | 10 YR 4/2 | 7.5 YR 4/6<br>7.5 YR 3/4 | 15% (PL)<br>4% (PL) | SCL | |
| 16-22 | N 2.5/- | 7.5 YR 3/4 | 7% (PL) | SCL | a buried *F2-Loamy Gleyed Matrix* indicator |
| 22-27 | N 2.5/- | | | SL | |
| **SB 205 (W 1)**<br>**September 12, 2019** | | | Hydric Indicators WT none observed<br>F3-Depleted Matrix<br>F8-Redox Depression None<br>F19-Piedmont Floodplain Soils | | |
| 0-7 | 7.5 YR 4/2 | 7.5 YR 3/4 | 2% (PL) | CL | |
| 7-12 | 7.5 YR 4/2 | 7.5 YR 4/6 | 20% (PL) | CL | |
| 12-18 | 7.5 YR 5/1 | 7.5 YR 5/6<br>2.5 YR 5/8 | 15% (PL)<br>2% (PL) | SC | |
| 18-25 | 7.5 YR 5/1 | 7.5 YR 4/4 | 10% (PL) | SC | |
| **SB 214 (W 1 non hydric)**<br>**September 12, 2019** | | | Hydric Indicators WT -28<br>None (upland point) | | |
| 0-8 | 7.5 YR4/4 | | | SL | |
| 8-14 | 7.5 YR 4/6 | 7.5 YR 5/8 | 4% (PL) | SL | |
| 14-22 | 7.5 YR 4/2 | 7.5 YR 4/6 | 15% (PL) | SL | |
| 22-28 | 7.5 YR 3/1 | 7.5 YR 3/4 | 5% (PL) | SL | |
| 28-36 | 7.5 YR 4/6 | | | cS | gravel 10% |

# Appendix B

## Banner Branch Mitigation Site, Stokes County NC
## Soil Boring Descriptions

**Table A1. Representative Soil Profiles at Banner Branch Mitigation Site (MLRA 136, LRR P)**

| Depth (inches) | Color | | Mottle Percentage (Location) | Texture | Notes |
|---|---|---|---|---|---|
| | Matrix | Mottle | | | |
| **SB 248 (W 2)**<br>**September 30, 2019** | | | Hydric Indicators WT none observed<br>F2-Loamy Gleyed Matrix<br>F3-Depleted Matrix<br>F19-Piedmont Floodplain Soils | | |
| 0-6 | 10YR 4/2 | 10YR 4/6 | 20% (PL) | SCL | |
| 6-11 | 10YR 4/1 | 7.5 YR 4/6 | 20% (PL) | SCL | |
| 11-20 | N 6/- | 7.5 YR 4/6 | 35% (PL/M) | SC | |
| **SB 255 (W 2 non hydric)**<br>**October 10, 2019** | | | Hydric Indicators WT none observed<br>None (upland point) | | |
| 0-12 | 7.5 YR 4/6 | | | CL | |
| 12-20 | 7.5 YR 4/3 | 7.5 YR 4/6 | 10% (PL) | SL | |
| **SB 218 (W 3)**<br>**September 18, 2019** | | | Hydric Indicators WT -8<br>F2-Loamy Gleyed Matrix<br>F3-Depleted Matrix | | |
| 0-4 | 10YR 3/3 | 10YR 4/2 | 10% (PL) | SL | |
| 4-9 | 10YR 5/1 | 10YR 4/6 | 20% (PL) | SC | |
| 9-12 | N 5/- | 10YR 4/6 | 15% (PL) | SC | |
| 12-27 | N 5/- | 10YR 4/2 | 5% (PL) | SL/LS | |
| 27-32 | 10YR 5/6 | 5 YR 4/6 | 2% (PL) | SL | |
| **SB 220 (W 3)**<br>**September 18, 2019** | | | Hydric Indicators WT -15<br>F3-Depleted Matrix<br>F8-Redox Depression | | |
| 0-4 | 10YR 3/3 | | | L | surface heavily disturbed |
| 4-11 | 10 YR4/2 | 10YR 3/4 | 15% (PL) | SL | |
| 11-21 | 10 YR4/3 | | | SL | |
| 21-30 | 10 YR 2/1 | | | SL | |
| **SB 219 (W 3 non hydric)**<br>**September 18, 2019** | | | Hydric Indicators WT none observed<br>None (upland point) | | |
| 0-11 | 5 YR 4/4 | | | SCL | |
| 11-19 | 5 YR 4/6 | | | SCL | |
| 19-25 | 5 YR 5/6 | 5 YR 4/6<br>5 YR 6/4 | 20% (PL)<br>5% (PL) | SC | |
| **SB 209 (W 4)**<br>**September 12, 2019** | | | Hydric Indicators WT none<br>F3-Depleted Matrix<br>F8-Redox Depression | | |
| 0-12 | 7.5 YR 4/2 | 7.5 YR 3/4 | 10% (PL) | SiL | surface churning |
| 12-21 | 7.5 YR 4/1 | 7.5 YR 4/6 | 15% (PL) | SCL | |

# Appendix B

## Banner Branch Mitigation Site, Stokes County NC
## Soil Boring Descriptions

**Table A1. Representative Soil Profiles at Banner Branch Mitigation Site (MLRA 136, LRR P)**

| **Depth (inches)** | **Color** | | **Mottle Percentage (Location)** | **Texture** | **Notes** |
|---|---|---|---|---|---|
| | **Matrix** | **Mottle** | | | |
| **SB 213 (W 4 non hydric)**<br>**September 12, 2019** | | | Hydric Indicators WT none observed<br>None (upland point) | | |
| 0-7 | 7.5YR 3/4 | | | SL | |
| 7-18 | 5YR 4/6 | | | CL | |
| 18-26 | 7.5YR 5/1 | 5 YR 4/6 | 15% (PL) | SCL | |
| **SB 250 (W 5)**<br>**October 10, 2019** | | | Hydric Indicators WT -14<br>A12-Thick Dark Surface<br>F6-Redox Dark Surface<br>F19-Piedmont Floodplain Soils | | |
| 0-2 | 7.5 YR 2.5/2 | | | L | |
| 2-14 | 7.5 YR 3/1 | 5 YR 4/4 | 20% (PL) | SCL | |
| 14-36 | 7.5 YR 3/1 | 7.5 YR 2.5/2 | 5% (PL) | SL | |
| **SB 251 (W 5 non hydric)**<br>**October 10, 2019** | | | Hydric Indicators WT -33<br>None (upland point) | | |
| 0-11 | 7.5 YR 3/4 | | | SL | may be fill/sediment to -19 |
| 11-19 | 7.5 YR 4/6 | | | S | |
| 19-35 | 7.5 YR 3/1 | | | SL | |
| 35-40 | 7.5 YR 3/1 | | | SCL | |
| **SB 221 (W 6B)**<br>**September 18, 2019** | | | Hydric Indicators WT none observed<br>F6-Redox Dark Surface | | |
| 0-3 | 7.5 YR 3/2 | 7.5 YR 3/4 | 20% (PL) | SiL | surface heavily disturbed |
| 3-11 | 7.5 YR 3/1 | 5 YR 4/6 | 15% (PL) | L | |
| 11-22 | 7.5 YR 2.5/1 | | | SL | small gravel/pebbles ~5% |
| **SB 224 (W 6A)**<br>**September 18, 2019** | | | Hydric Indicators WT -12<br>F6-Redox Dark Surface<br>F8-Redox Depression<br>F19-Piedmont Floodplain Soils | | |
| 0-5 | 7.5 YR 3/2 | 5 YR 4/6 | 20% (PL) | SL | |
| 5-12 | 7.5 YR 2.5/1 | 5 YR 4/6 | 10% (PL) | SL | |
| 12-28 | 7.5 YR 2.5/1 | 5 YR 4/6 | 2% (PL) | SL | |

# Appendix B

## Banner Branch Mitigation Site, Stokes County NC
## Soil Boring Descriptions

**Table A1. Representative Soil Profiles at Banner Branch Mitigation Site (MLRA 136, LRR P)**

| Depth (inches) | Color | | Mottle Percentage (Location) | Texture | Notes |
|---|---|---|---|---|---|
| | Matrix | Mottle | | | |
| **SB 222** **(W 6 non hydric)**<br>**September 18, 2019** | | | Hydric Indicators WT -25<br>None (upland point) | | |
| 0-3 | 7.5 YR 4/4 | | | SL | |
| 3-14 | 7.5 YR 4/6 | | | SL | |
| 14-25 | 7.5 YR 5/4 | 7.5 YR 4/6 | 15% (PL) | SL | rounded gravel ~5% |
| 25-28 | 7.5 YR 4/3 | 7.5 YR 4/6 | 5% (PL) | SL | |
| **SB 225** **(W 7)**<br>**September 18, 2019** | | | Hydric Indicators WT at -13<br>F6-Redox Dark Surface | | |
| 0-5 | 7.5 YR 2.5/2 | 7.5 YR 3/4 | 10% (PL) | SL | |
| 5-15 | 7.5 YR 3/1 | | | cSL | gravel ~10%<br>bedrock or cobble at -15 |
| **SB 226** **(W 7 non hydric)**<br>**September 18, 2019** | | | Hydric Indicators WT none observed<br>None (upland point) | | |
| 0-1 | 7.5YR 2.5/2 | | | SL | |
| 1-12 | 5YR 4/6 | | | SL | |
| 12-21 | 5YR 5/6 | 5 YR 4/4 | 10% (PL) | SL | |
| **SB 272** **(W 8 adjacent to HS 4)**<br>**October 10, 2019** | | | Hydric Indicators WT none observed<br>F3-Depleted Matrix<br>F8-Redox Depression | | |
| 0-3 | 7.5 YR 3/2 | | | L | |
| 3-6 | 7.5 YR 4/2 | 7.5 YR 3/4 | 10% (PL) | L | |
| 6-12 | 7.5 YR 5/2 | 7.5 YR 4/6 | 10% (PL) | CL | |
| 12-19 | 7.5 YR 4/3 | 7.5 YR 4/6 | 30% (PL) | SCL | |
| 19-23 | 7.5 YR 4/1 | 7.5 YR 4/6 | 20% (PL) | SCL | |

WT = observed apparent water table
*PL =pore lining, M = matrix
**Texture (follows USDA textural classification)
S = sand, L = loam, Si = silt, C = clay
f = fine, c = coarse (textural modifiers for sand)

LICENSED SOIL SCIENTIST
George K. Lankford
1223
STATE OF NORTH CAROLINA
November 27-2019

Soil Scientist Seal

# Appendix B
## Banner Branch Mitigation Site – Stokes County, NC
## Photo Log

November 2019

1. W4 Wetland profile. Meets the *F3-Depleted Matrix* and *F8-Redox Depression* indicators. SB#209.

2. W4 depressional landscape.

# Appendix B

## Banner Branch Mitigation Site – Stokes County, NC

## Photo Log

November 2019

3. W1 Wetland profile. Meets the *F3-Depleted Matrix* indicator. SB#14.

4. HS1 landscape with bed rows visible.

# Appendix B

## Banner Branch Mitigation Site – Stokes County, NC

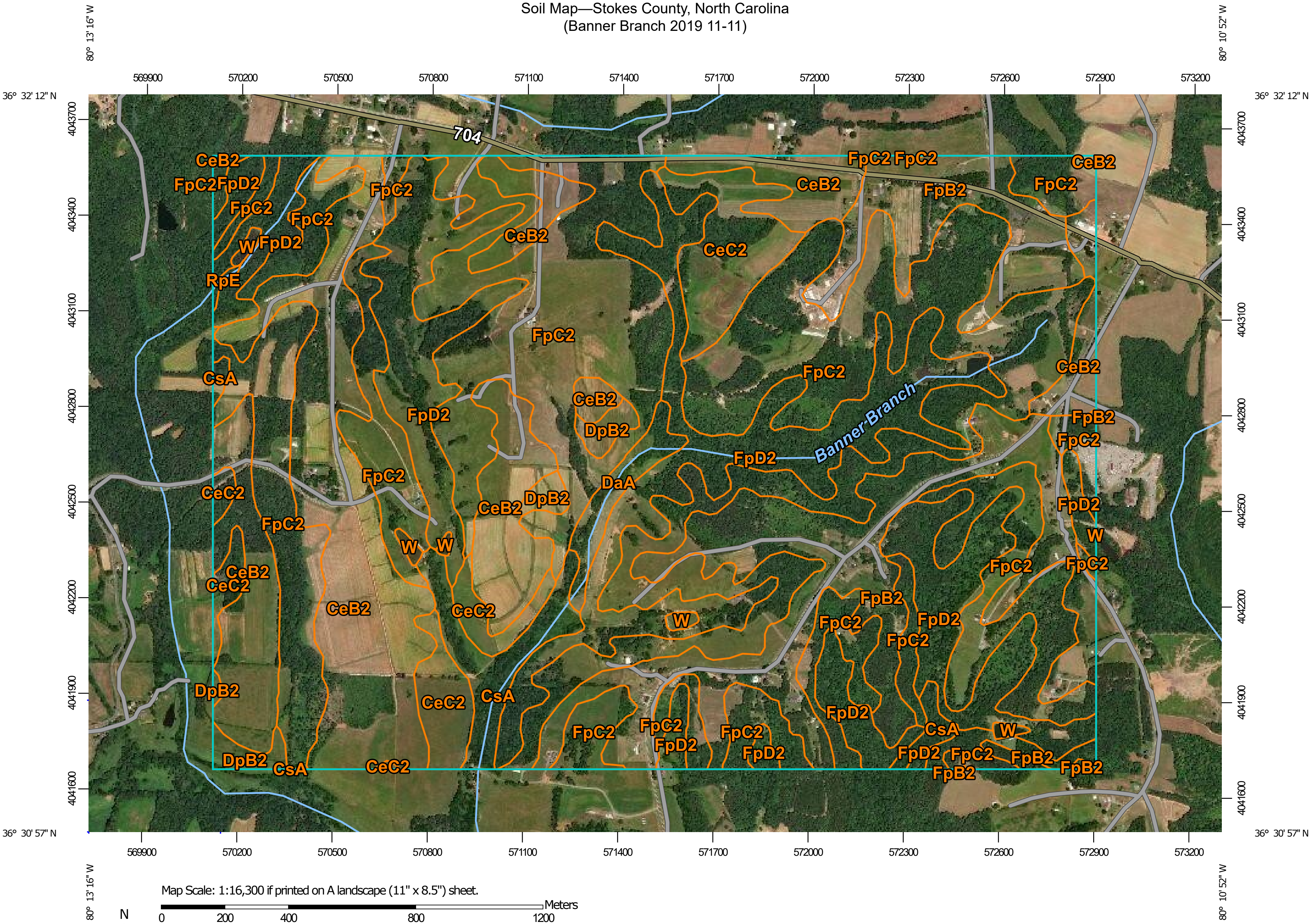
## Photo Log

November 2019

5. Spoil berm in wetland W2.

6. Drain tile below W6 wetland.

# Soil Map—Stokes County, North Carolina
(Banner Branch 2019 11-11)



Map Scale: 1:16,300 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator  Corner coordinates: WGS84  Edge tics: UTM Zone 17N WGS84

## MAP LEGEND

**Area of Interest (AOI)**

🟦 Area of Interest (AOI)

**Soils**

🟧 Soil Map Unit Polygons
〰 Soil Map Unit Lines
■ Soil Map Unit Points

**Special Point Features**

◉ Blowout
⊠ Borrow Pit
✖ Clay Spot
◇ Closed Depression
✕ Gravel Pit
⁖ Gravelly Spot
● Landfill
⋀ Lava Flow
⩛ Marsh or swamp
⚒ Mine or Quarry
◎ Miscellaneous Water
○ Perennial Water
∨ Rock Outcrop
+ Saline Spot
⁙ Sandy Spot
⊖ Severely Eroded Spot
◈ Sinkhole
≽ Slide or Slip
ø Sodic Spot
≡ Spoil Area
● Stony Spot
●● Very Stony Spot
Ψ Wet Spot
△ Other
‐ Special Line Features

**Water Features**

〜 Streams and Canals

**Transportation**

┼┼┼ Rails
〰 Interstate Highways
〰 US Routes
〰 Major Roads
〰 Local Roads

**Background**

▨ Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Stokes County, North Carolina
Survey Area Data: Version 19, Sep 16, 2019

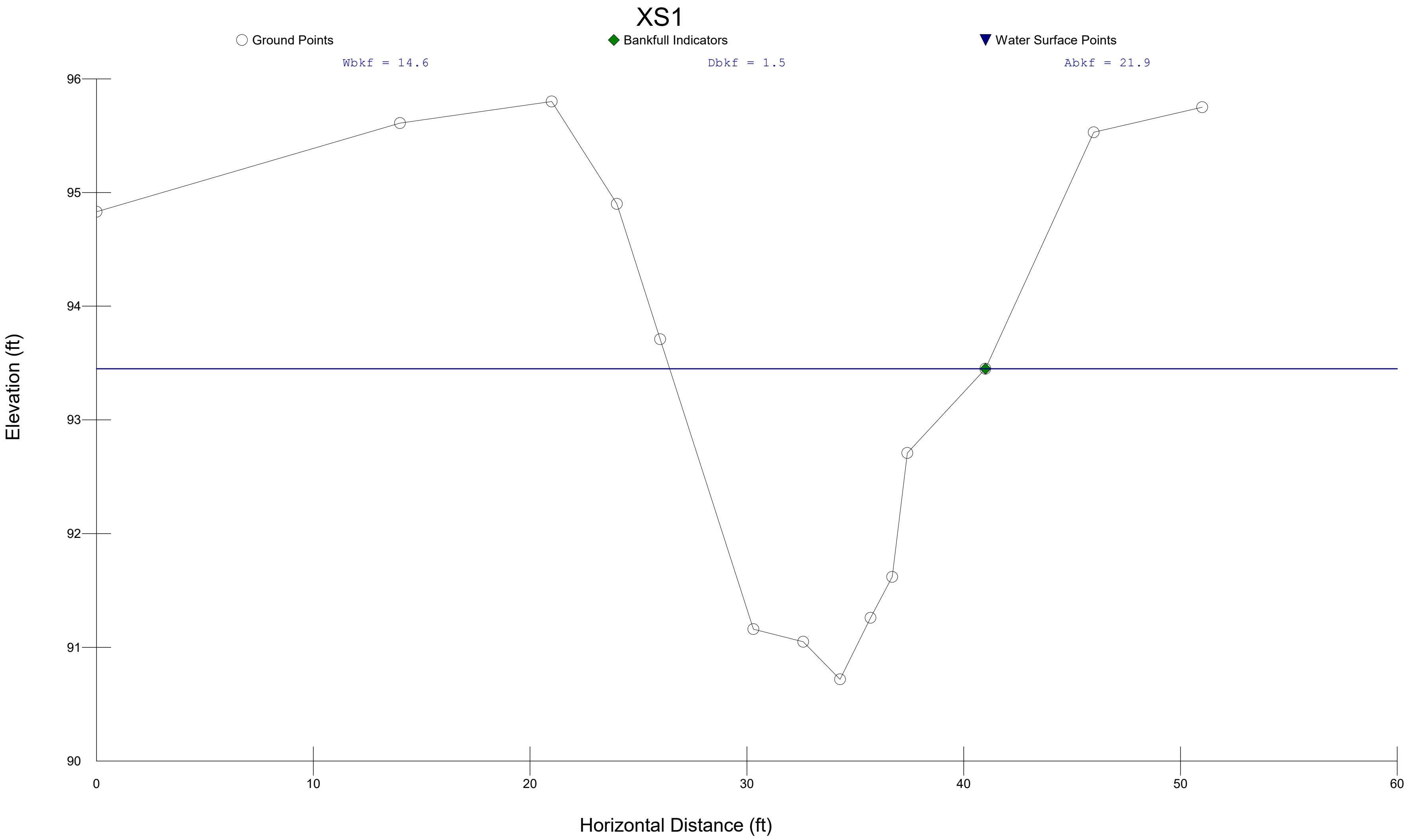
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 28, 2011—Oct 2, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| CeB2 | Clifford sandy clay loam, 2 to 8 percent slopes, moderately eroded | 234.0 | 17.6% |
| CeC2 | Clifford sandy clay loam, 8 to 15 percent slopes, moderately eroded | 64.3 | 4.8% |
| CsA | Codorus loam, 0 to 2 percent slopes, occasionally flooded | 29.8 | 2.2% |
| DaA | Dan River and Comus soils, 0 to 4 percent slopes, occasionally flooded | 13.0 | 1.0% |
| DpB2 | Danripple sandy clay loam, 2 to 8 percent slopes, moderately eroded | 13.6 | 1.0% |
| FpB2 | Fairview-Poplar Forest complex, 2 to 8 percent slopes, moderately eroded | 187.1 | 14.1% |
| FpC2 | Fairview-Poplar Forest complex, 8 to 15 percent slopes, moderately eroded | 533.6 | 40.1% |
| FpD2 | Fairview-Poplar Forest complex, 15 to 25 percent slopes, moderately eroded | 248.0 | 18.7% |
| RpE | Rhodhiss, Fairview, and Stott Knob soils, 25 to 60 percent slopes | 0.8 | 0.1% |
| W | Water | 5.0 | 0.4% |
| **Totals for Area of Interest** | | **1,329.1** | **100.0%** |


XS1
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 14.6
Dbkf = 1.5
Abkf = 21.9
Elevation (ft)
96
95
94
93
92
91
90
0
10
20
30
40
50
60
Horizontal Distance (ft)

```
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         BB-R3
Cross Section Name: XS1
Survey Date:        10/08/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 100 ft
Backsight Rod Reading:        1 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              6.17           94.83          LPIN
14             5.39           95.61          G
21             5.2            95.8           G
24             6.1            94.9           LTB
26             7.29           93.71          G brk
30.3           9.84           91.16          LCH
32.6           9.95           91.05          G
34.3           10.28          90.72          TWG
35.7           9.74           91.26          RCH
36.7           9.38           91.62          brk
37.4           8.29           92.71          brk
41             7.55           93.45          bkf
46             5.47           95.53          brk
51             5.25           95.75          RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  96.18      96.18      96.18
Bankfull Elevation (ft)    93.45      93.45      93.45
Floodprone Width (ft)      51         -----      -----
Bankfull Width (ft)        14.56      7.28       7.28
Entrenchment Ratio         3.5        -----      -----
Mean Depth (ft)            1.5        1.73       1.27
Maximum Depth (ft)         2.73       2.62       2.73
Width/Depth Ratio          9.71       4.2        5.73
Bankfull Area (sq ft)      21.86      12.62      9.24
Wetted Perimeter (ft)      16.06      10.55      10.74
Hydraulic Radius (ft)      1.36       1.2        0.86
Begin BKF Station          26.44      26.44      33.72
End BKF Station            41         33.72      41

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope                      0          0          0
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

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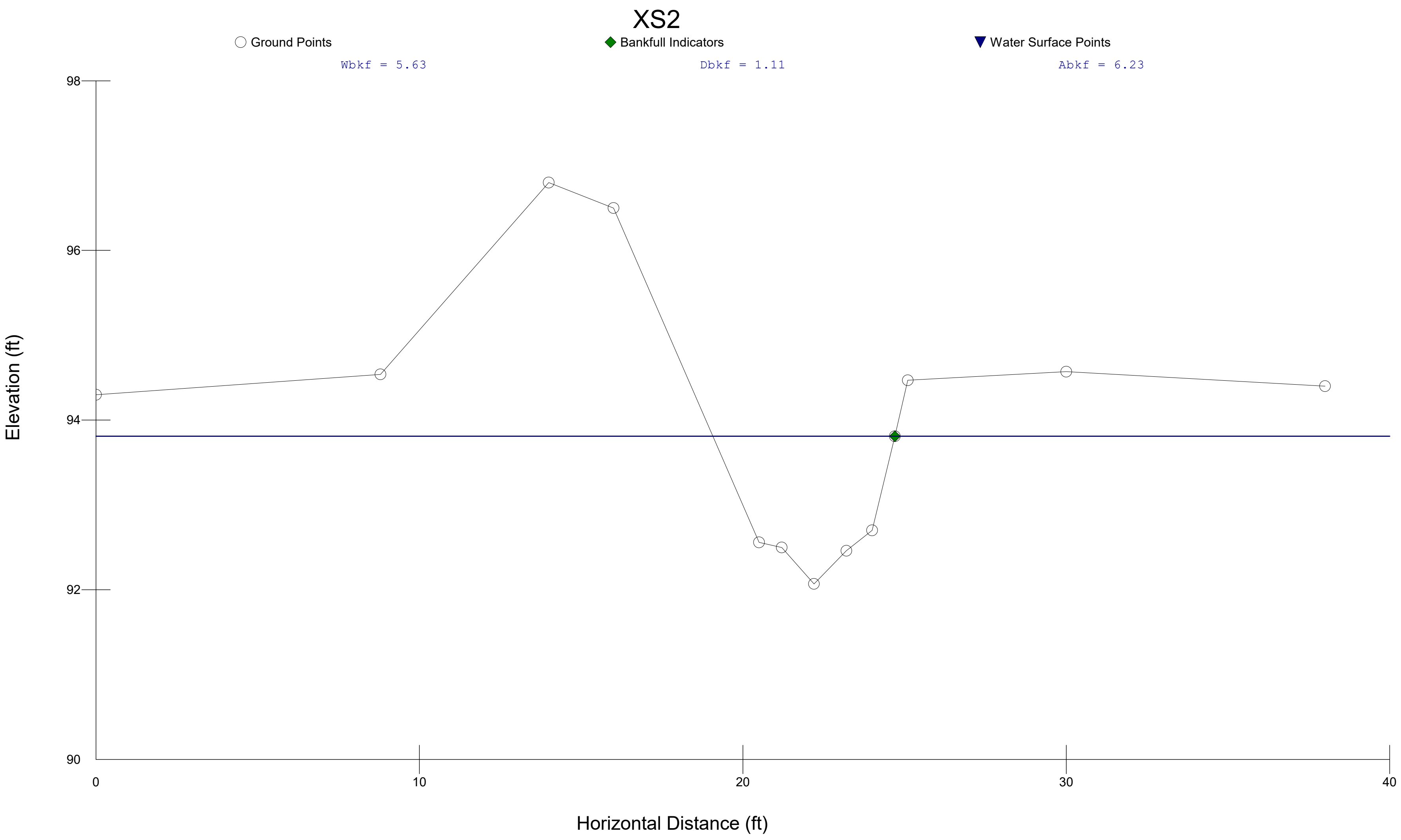
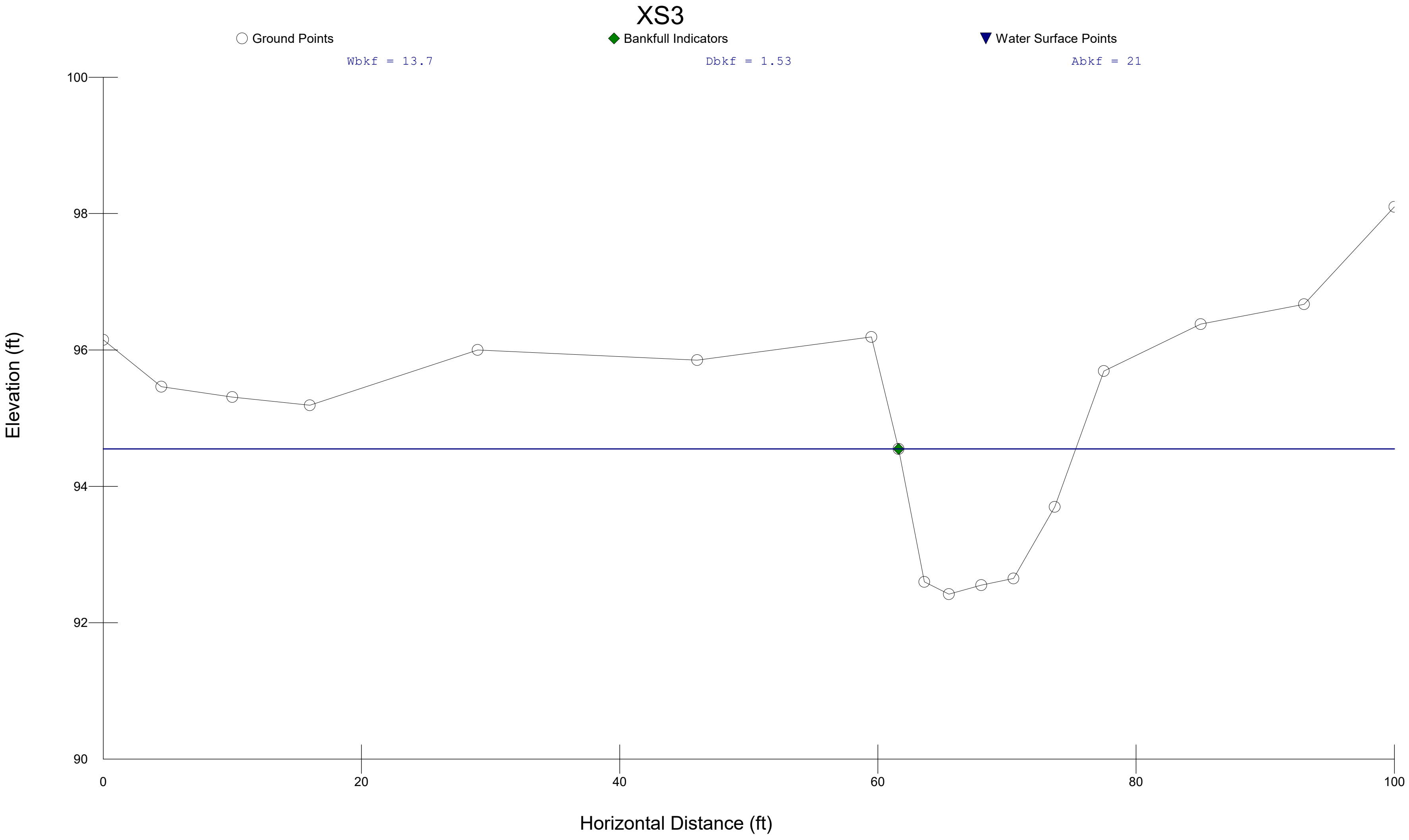
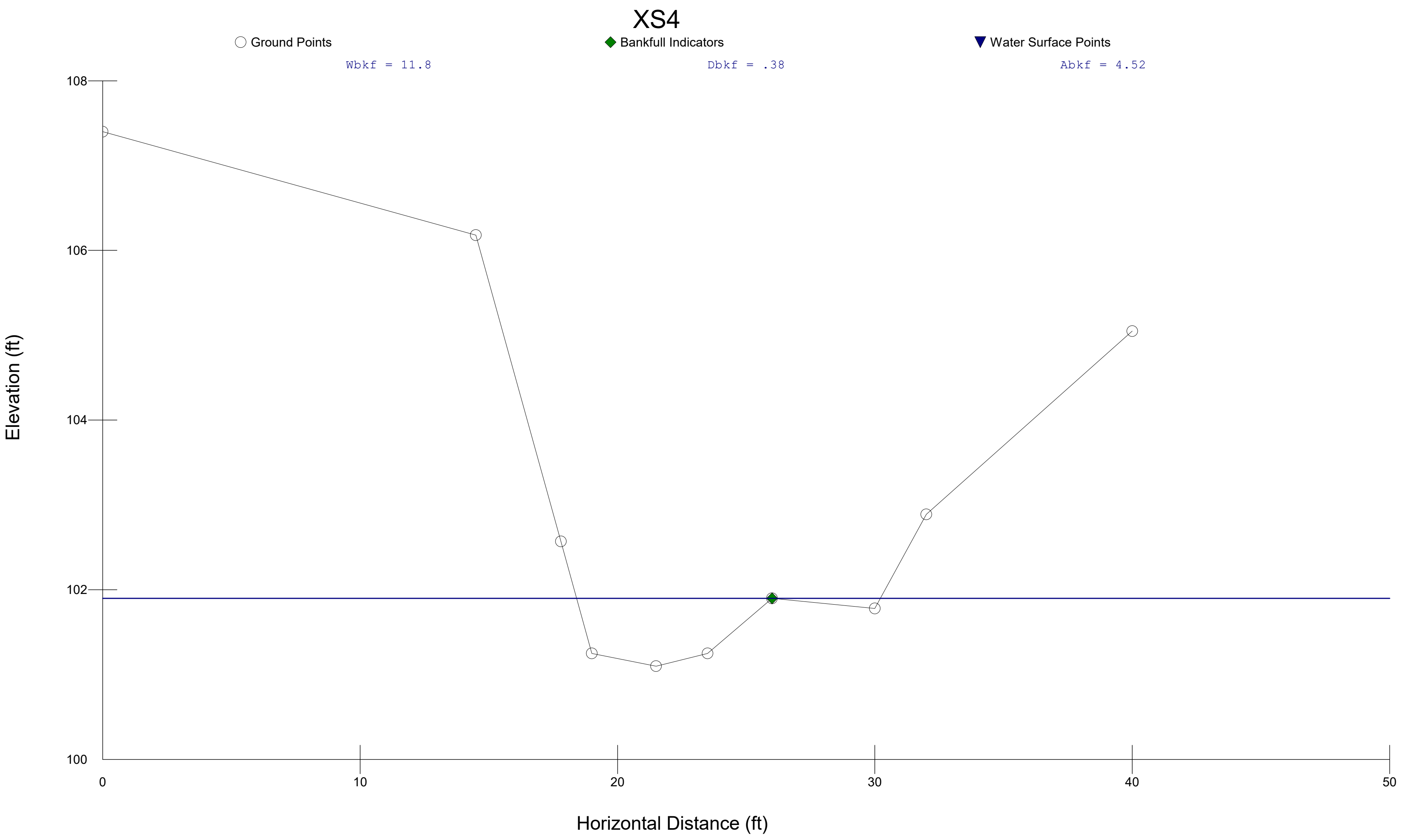

XS2
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 5.63
Dbkf = 1.11
Abkf = 6.23
Elevation (ft)
98
96
94
92
90
Horizontal Distance (ft)
0
10
20
30
40

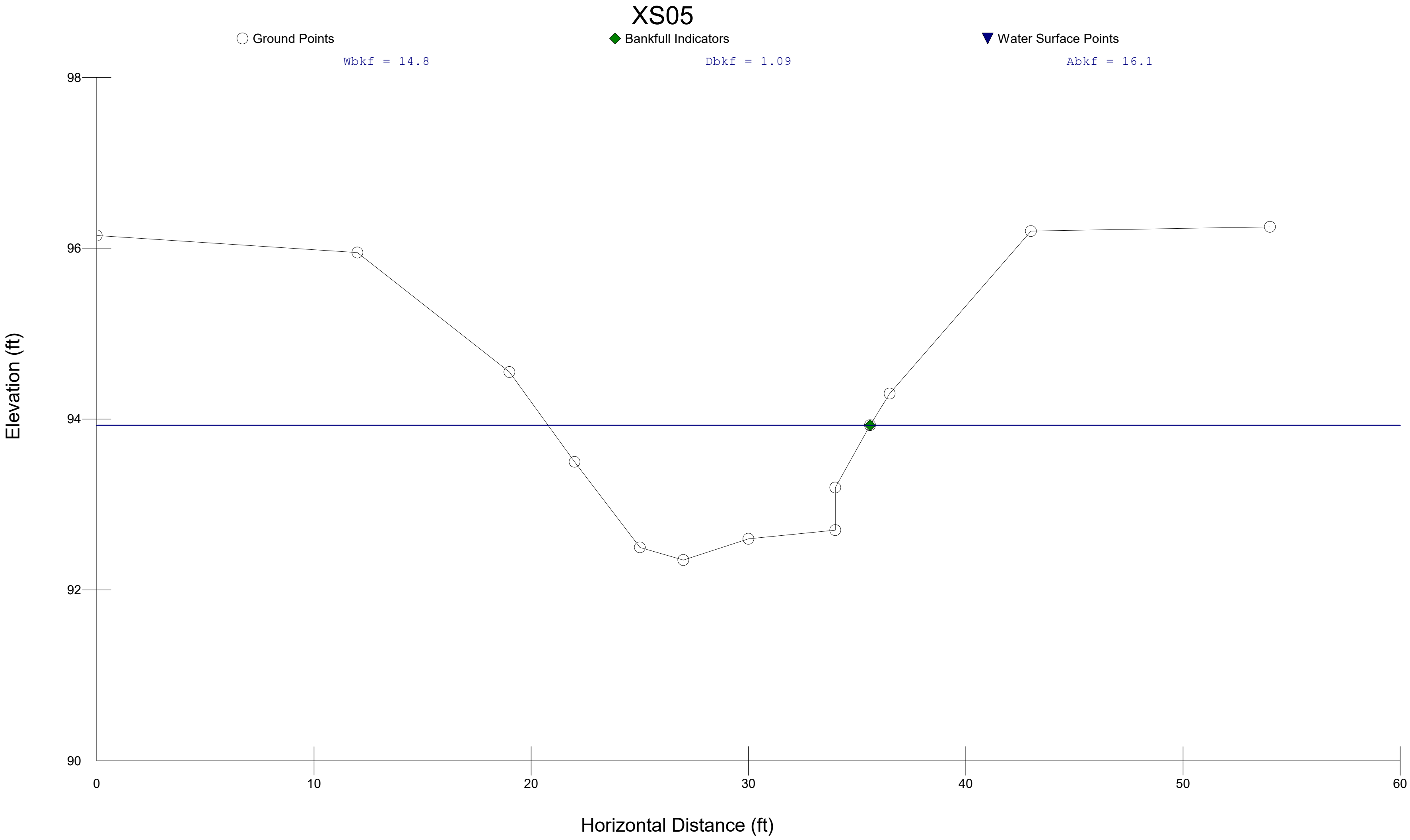
```
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         UT3
Cross Section Name: XS2
Survey Date:        12/18/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 10 ft
Backsight Rod Reading:        90 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              5.7            94.30          LPIN
8.8            5.46           94.54          BRK
14             3.2            96.80          SPOIL
16             3.5            96.50          LTB
20.5           7.44           92.56          LCH
21.2           7.5            92.50          WSF
22.2           7.93           92.07          TWG
23.2           7.54           92.46          BG
24             7.3            92.70          RCH
24.7           6.19           93.81          bkf
25.1           5.53           94.47          RTB
30             5.43           94.57          G
38             5.6            94.40          RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  95.55      95.55      95.55
Bankfull Elevation (ft)    93.81      93.81      93.81
Floodprone Width (ft)      32.04      -----      -----
Bankfull Width (ft)        5.63       2.81       2.81
Entrenchment Ratio         5.69       -----      -----
Mean Depth (ft)            1.11       0.99       1.22
Maximum Depth (ft)         1.74       1.61       1.74
Width/Depth Ratio          5.07       2.84       2.3
Bankfull Area (sq ft)      6.23       2.79       3.44
Wetted Perimeter (ft)      6.91       4.95       5.17
Hydraulic Radius (ft)      0.9        0.56       0.67
Begin BKF Station          19.07      19.07      21.89
End BKF Station            24.7       21.89      24.7

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope
Shear Stress (lb/sq ft)
Movable Particle (mm)
```


XS3
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 13.7
Dbkf = 1.53
Abkf = 21
Elevation (ft)
100
98
96
94
92
90
0
20
40
60
80
100
Horizontal Distance (ft)

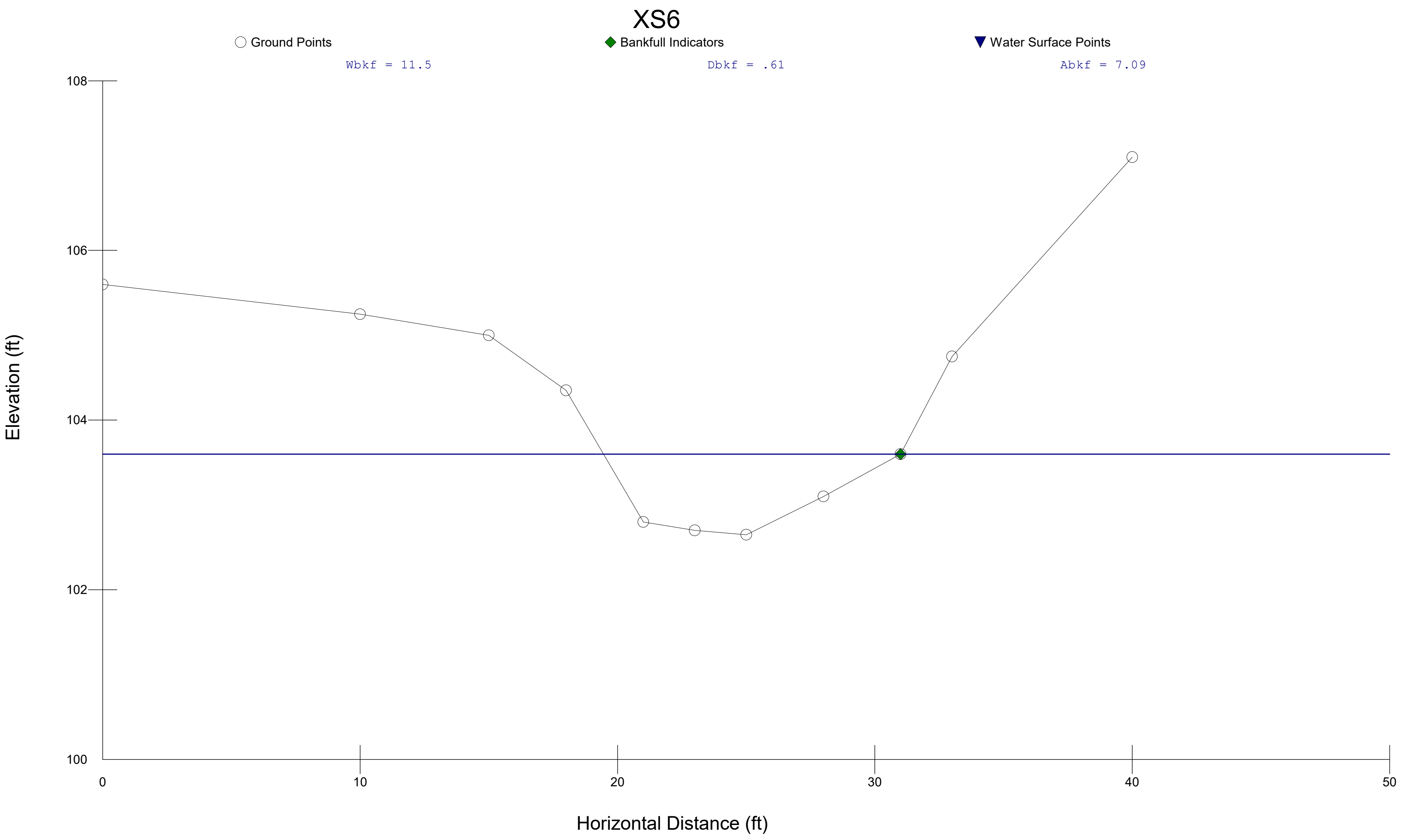
```
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         BB-R2
Cross Section Name: XS3
Survey Date:        10/08/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 100 ft
Backsight Rod Reading:        1 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              4.85           96.15          LPIN
4.5            5.54           95.46          BRK
10             5.69           95.31          BRK
16             5.81           95.19          BRK
29             5              96             BRK
46             5.15           95.85          BRK
59.5           4.81           96.19          LTB
61.6           6.45           94.55          BKF
63.6           8.4            92.6           LCH
65.5           8.58           92.42          TWG
68             8.45           92.55          BRK
70.5           8.35           92.65          RCH
73.7           7.3            93.7           BRK
77.5           5.31           95.69          RTB
85             4.62           96.38          G
93             4.33           96.67          BRK
100            2.9            98.1           RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  96.68      96.68      96.68
Bankfull Elevation (ft)    94.55      94.55      94.55
Floodprone Width (ft)      93.05      -----      -----
Bankfull Width (ft)        13.72      6.86       6.86
Entrenchment Ratio         6.78       -----      -----
Mean Depth (ft)            1.53       1.74       1.32
Maximum Depth (ft)         2.13       2.13       1.98
Width/Depth Ratio          8.97       3.95       5.2
Bankfull Area (sq ft)      20.95      11.9       9.05
Wetted Perimeter (ft)      14.91      9.65       9.22
Hydraulic Radius (ft)      1.41       1.23       0.98
Begin BKF Station          61.6       61.6       68.46
End BKF Station            75.32      68.46      75.32

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope                      0          0          0
Shear Stress (lb/sq ft)
Movable Particle (mm)
```


XS4
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 11.8
Dbkf = .38
Abkf = 4.52
108
106
104
102
100
0
10
20
30
40
50
Elevation (ft)
Horizontal Distance (ft)

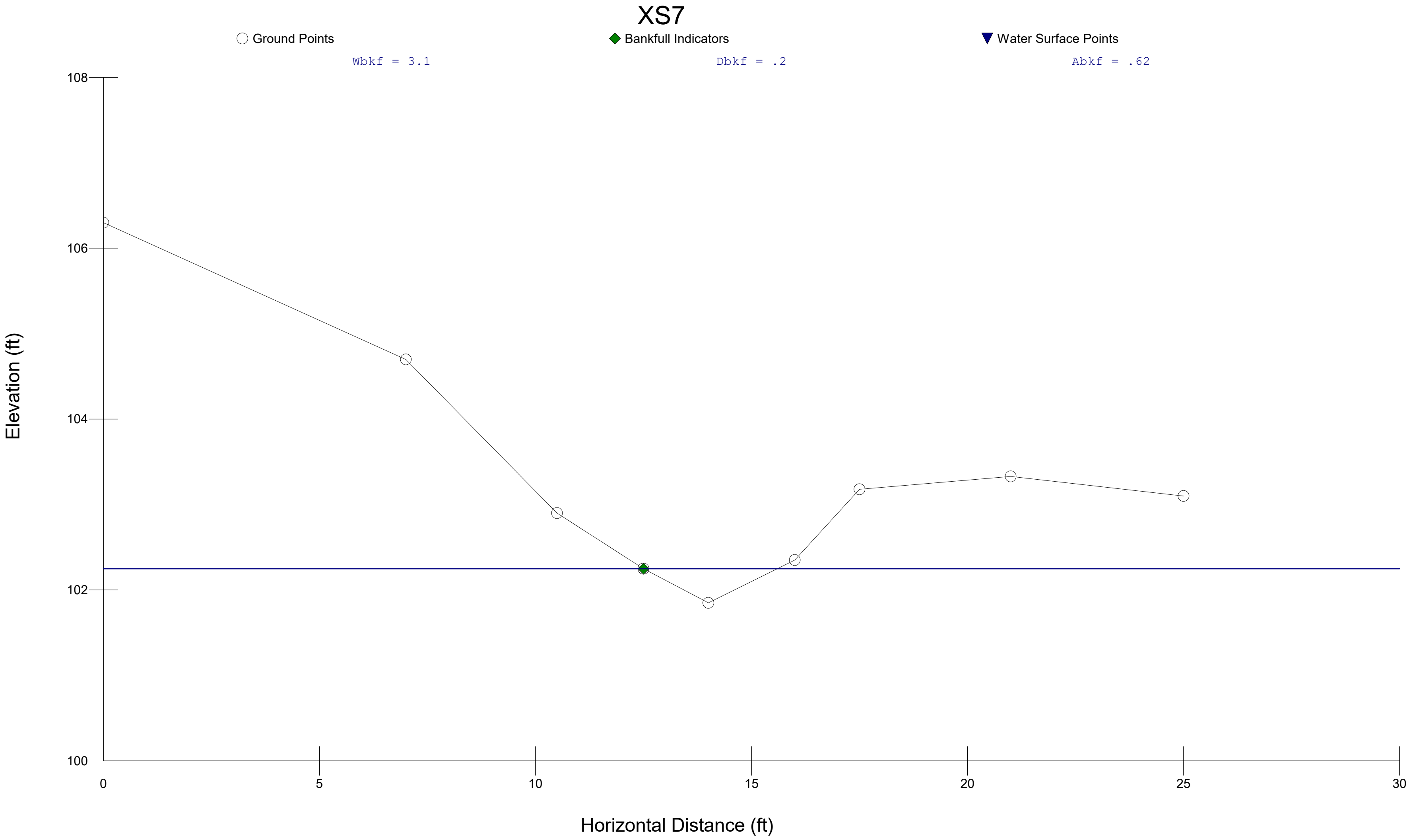
```
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         UT2
Cross Section Name: XS4
Survey Date:        10/10/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 100 ft
Backsight Rod Reading:        10 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              2.6            107.4          LPIN
14.5           3.82           106.18         LTB
17.8           7.43           102.57         BRK
19             8.75           101.25         LCH
21.5           8.9            101.1          TWG
23.5           8.75           101.25         RCH
26             8.1            101.9          BKF
30             8.22           101.78         BACK BENCH
32             7.11           102.89         BRK
40             4.95           105.05         RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  102.7      102.7      102.7
Bankfull Elevation (ft)    101.9      101.9      101.9
Floodprone Width (ft)      13.98      -----      -----
Bankfull Width (ft)        11.81      5.9        5.91
Entrenchment Ratio         1.18       -----      -----
Mean Depth (ft)            0.38       0.66       0.11
Maximum Depth (ft)         0.8        0.8        0.44
Width/Depth Ratio          31.08      8.94       53.73
Bankfull Area (sq ft)      4.52       3.9        0.62
Wetted Perimeter (ft)      12.22      6.66       6.43
Hydraulic Radius (ft)      0.37       0.58       0.1
Begin BKF Station          18.41      18.41      24.31
End BKF Station            30.22      24.31      30.22

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope                      0          0          0
Shear Stress (lb/sq ft)
Movable Particle (mm)
```


XS05
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 14.8
Dbkf = 1.09
Abkf = 16.1
Elevation (ft)
98
96
94
92
90
Horizontal Distance (ft)
0
10
20
30
40
50
60

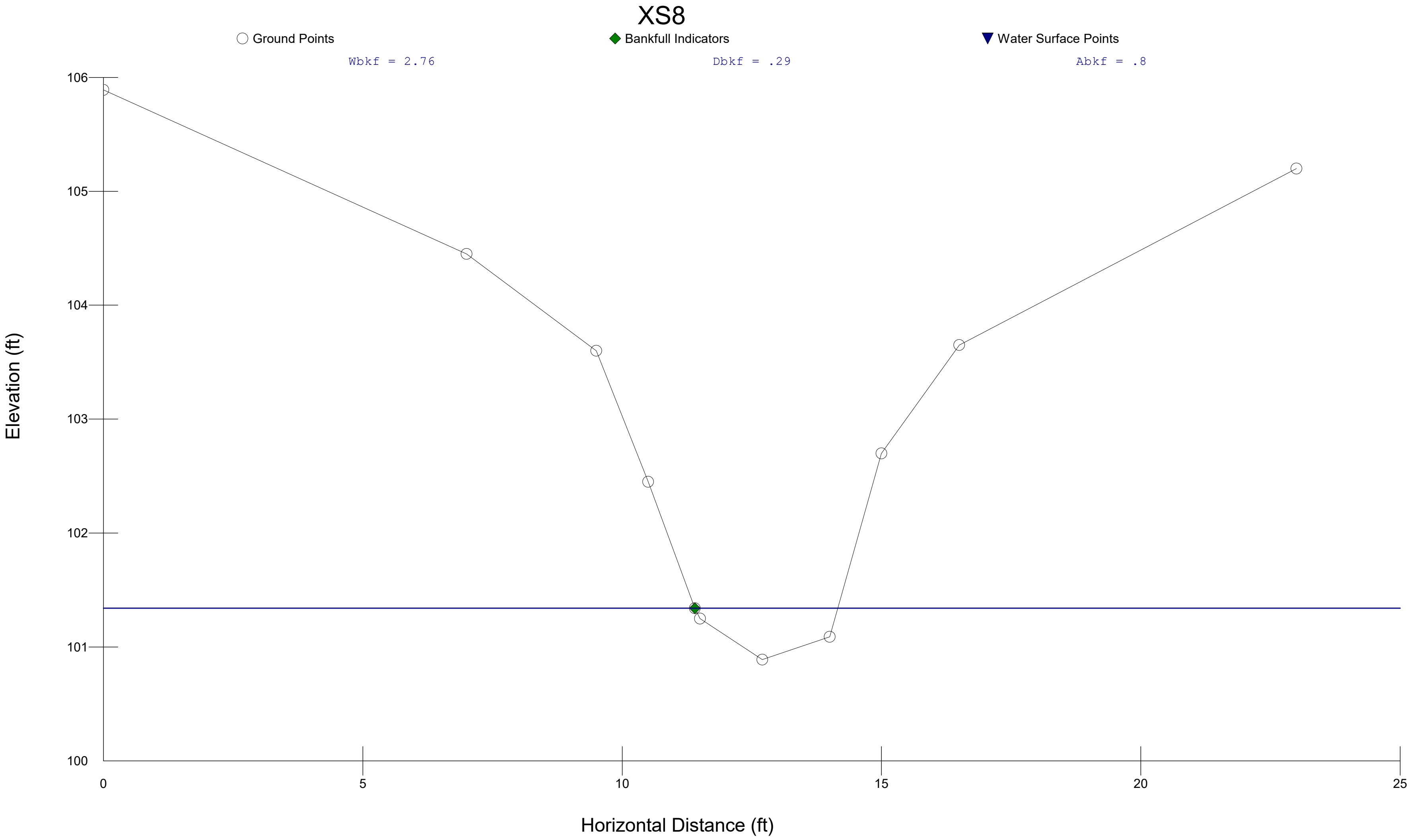
```
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         BB-R1
Cross Section Name:  XS5
Survey Date:        10/08/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 100 ft
Backsight Rod Reading:        1 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              4.85           96.15          LPIN
12             5.05           95.95          BRK
19             6.45           94.55          LTB
22             7.5            93.5           BRK
25             8.5            92.5           LCH
27             8.65           92.35          TWG
30             8.4            92.6           BRK
34             8.3            92.7           RCH
34             7.8            93.2           BRK
35.6           7.07           93.93          BKF
36.5           6.7            94.3           RTB
43             4.8            96.2           BRK
54             4.75           96.25          RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  95.51      95.51      95.51
Bankfull Elevation (ft)    93.93      93.93      93.93
Floodprone Width (ft)      26.44      -----      -----
Bankfull Width (ft)        14.83      7.68       7.15
Entrenchment Ratio         1.78       -----      -----
Mean Depth (ft)            1.09       1.08       1.1
Maximum Depth (ft)         1.58       1.58       1.46
Width/Depth Ratio          13.61      7.13       6.5
Bankfull Area (sq ft)      16.13      8.27       7.87
Wetted Perimeter (ft)      15.74      9.38       9.27
Hydraulic Radius (ft)      1.02       0.88       0.85
Begin BKF Station          20.77      20.77      28.45
End BKF Station            35.6       28.45      35.6

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope                      0          0          0
Shear Stress (lb/sq ft)
Movable Particle (mm)
```


XS6
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 11.5
Dbkf = .61
Abkf = 7.09
Elevation (ft)
108
106
104
102
100
0
10
20
30
40
50
Horizontal Distance (ft)

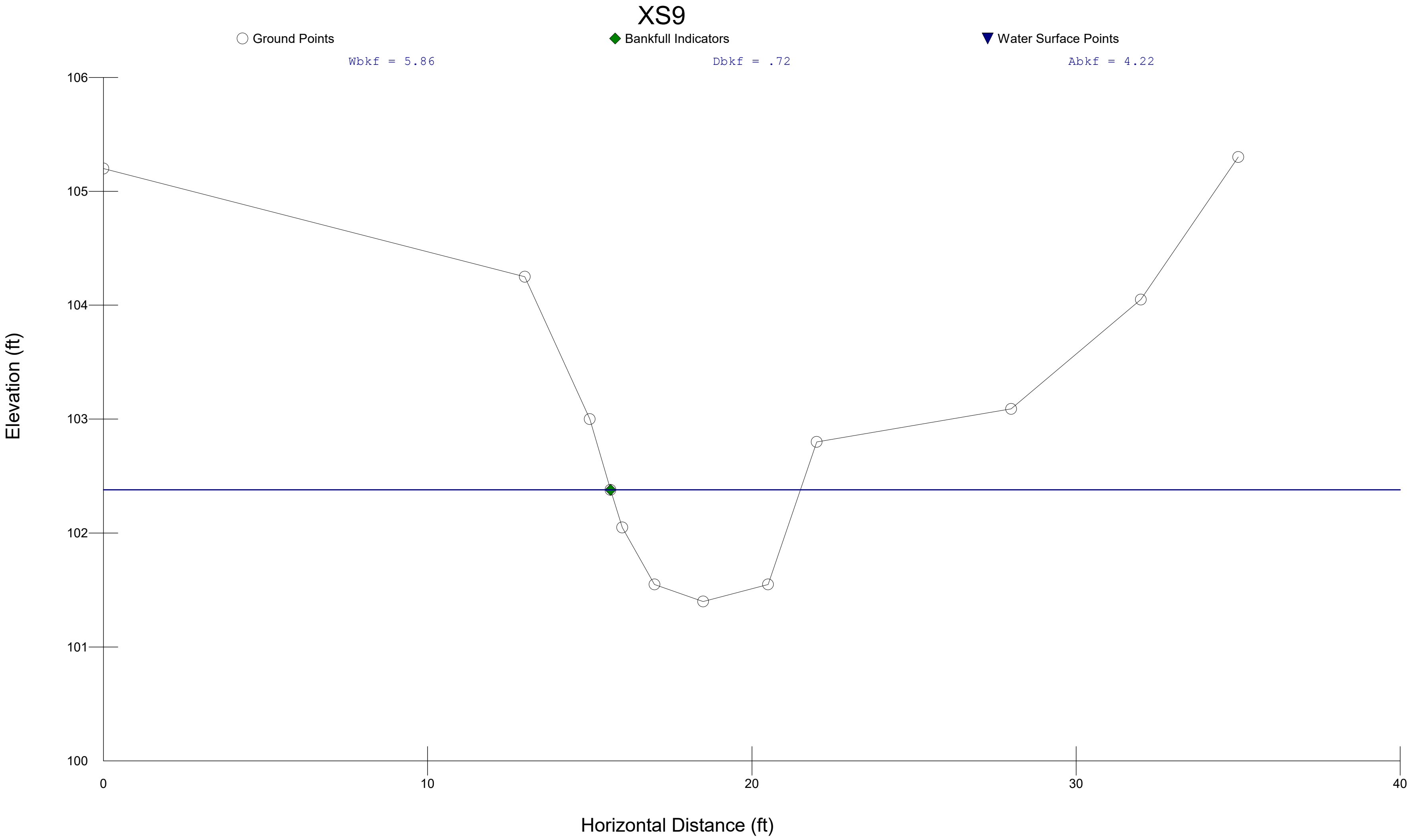
```
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         UT1-R2
Cross Section Name: XS6
Survey Date:        10/10/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 100 ft
Backsight Rod Reading:        10 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              4.4            105.6          LPIN
10             4.75           105.25         NG
15             5              105            BRK
18             5.65           104.35         LTB
21             7.2            102.8          BRK
23             7.3            102.7          LCH
25             7.35           102.65         TWG
28             6.9            103.1          RCH
31             6.4            103.6          BKF
33             5.25           104.75         RTB
40             2.9            107.1          RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  104.53     104.53     104.53
Bankfull Elevation (ft)    103.59     103.59     103.59
Floodprone Width (ft)      15.45      -----      -----
Bankfull Width (ft)        11.47      5.74       5.73
Entrenchment Ratio         1.35       -----      -----
Mean Depth (ft)            0.61       0.75       0.47
Maximum Depth (ft)         0.94       0.94       0.91
Width/Depth Ratio          18.8       7.65       12.19
Bankfull Area (sq ft)      6.98       4.31       2.67
Wetted Perimeter (ft)      11.74      6.85       6.71
Hydraulic Radius (ft)      0.59       0.63       0.4
Begin BKF Station          19.47      19.47      25.21
End BKF Station            30.94      25.21      30.94

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope                      0          0          0
Shear Stress (lb/sq ft)
Movable Particle (mm)
```


XS7
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 3.1
Dbkf = .2
Abkf = .62
Elevation (ft)
108
106
104
102
100
Horizontal Distance (ft)
0
5
10
15
20
25
30

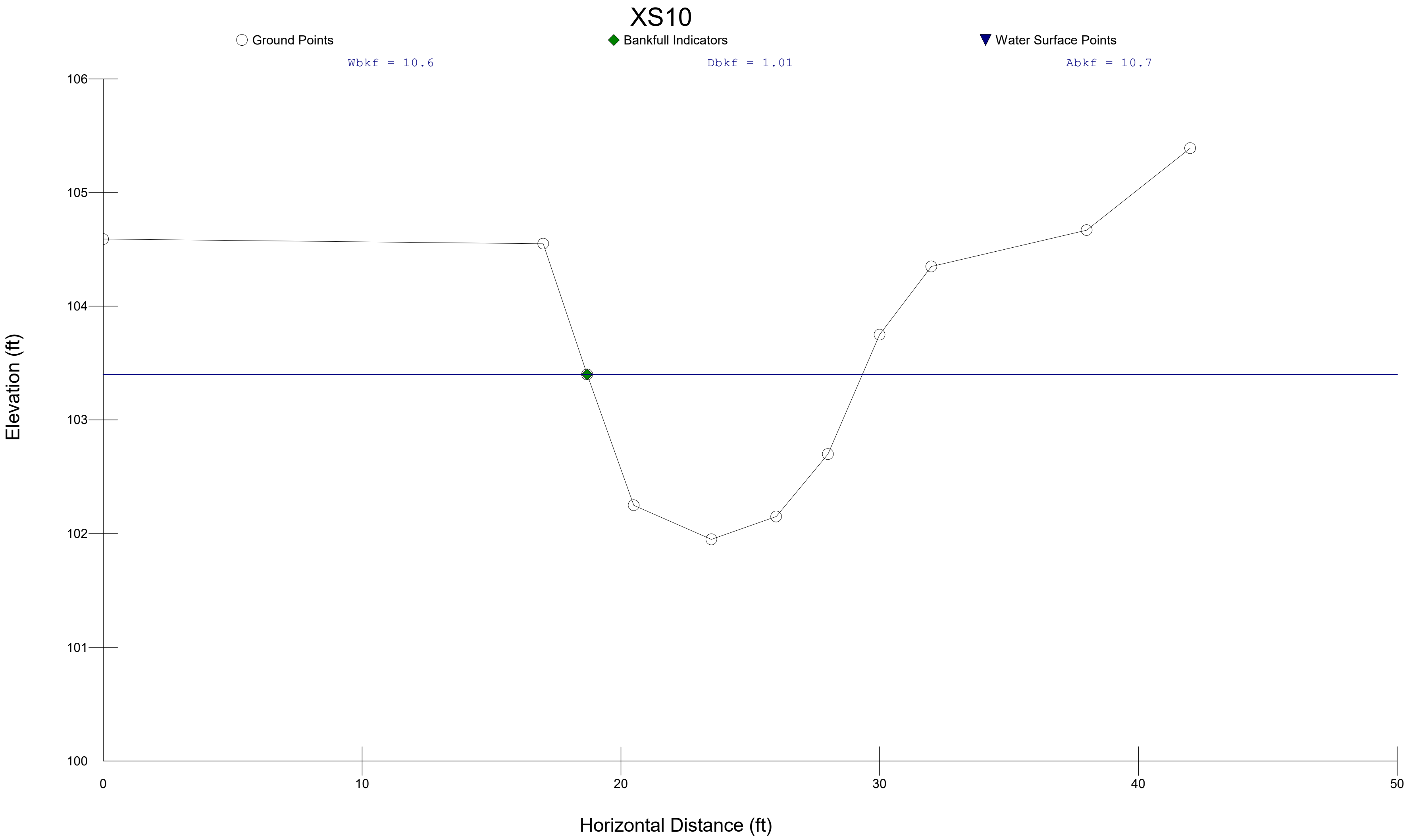
```
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         UT1B
Cross Section Name: XS7
Survey Date:        10/10/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 100 ft
Backsight Rod Reading:        10 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              3.7            106.3          LPIN
7              5.3            104.7          BRK
10.5           7.1            102.9          LTB
12.5           7.75           102.25         BKF
14             8.15           101.85         TWG
16             7.65           102.35         RCH
17.5           6.82           103.18         RTB
21             6.67           103.33         G
25             6.9            103.1          RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  102.65     102.65     102.65
Bankfull Elevation (ft)    102.25     102.25     102.25
Floodprone Width (ft)      5.27       -----      -----
Bankfull Width (ft)        3.1        1.25       1.85
Entrenchment Ratio         1.7        -----      -----
Mean Depth (ft)            0.2        0.17       0.22
Maximum Depth (ft)         0.4        0.33       0.4
Width/Depth Ratio          15.5       7.5        8.41
Bankfull Area (sq ft)      0.62       0.21       0.41
Wetted Perimeter (ft)      3.2        1.63       2.24
Hydraulic Radius (ft)      0.19       0.13       0.18
Begin BKF Station          12.5       12.5       13.75
End BKF Station            15.6       13.75      15.6

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope                      0          0          0
Shear Stress (lb/sq ft)
Movable Particle (mm)
```


XS8
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 2.76
Dbkf = .29
Abkf = .8
106
105
104
103
102
101
100
0
5
10
15
20
25
Elevation (ft)
Horizontal Distance (ft)

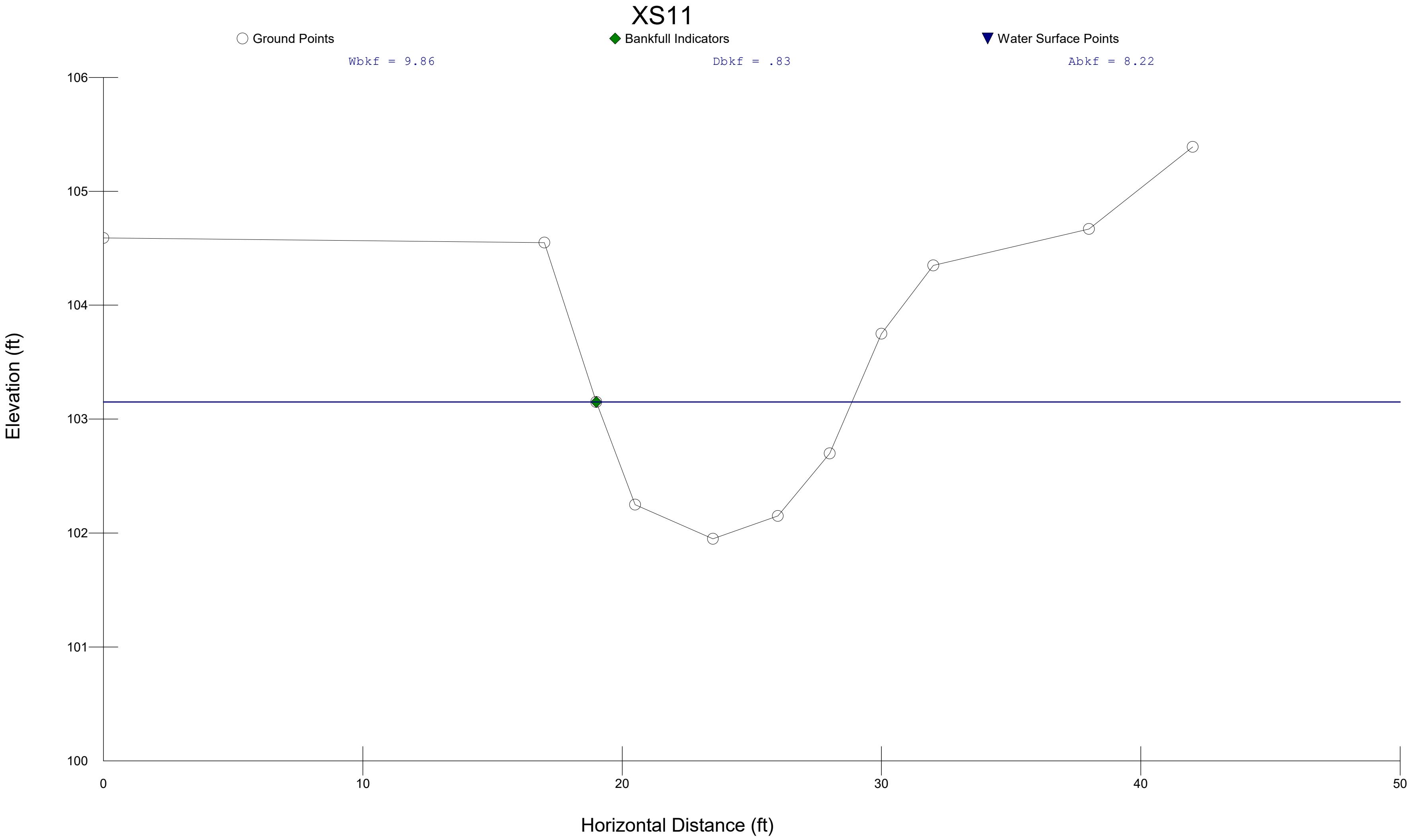
```
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         UT1A
Cross Section Name: XS8
Survey Date:        10/10/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 100 ft
Backsight Rod Reading:        10 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              4.11           105.89         LPIN
7              5.55           104.45         G
9.5            6.4            103.6          G
10.5           7.55           102.45         LTB
11.4           8.66           101.34         BKF
11.5           8.75           101.25         LCH
12.7           9.11           100.89         TWG
14             8.91           101.09         RCH
15             7.3            102.7          RTB
16.5           6.35           103.65         BRK
23             4.8            105.2          RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  101.79     101.79     101.79
Bankfull Elevation (ft)    101.34     101.34     101.34
Floodprone Width (ft)      3.4        -----      -----
Bankfull Width (ft)        2.76       1.27       1.49
Entrenchment Ratio         1.23       -----      -----
Mean Depth (ft)            0.29       0.25       0.33
Maximum Depth (ft)         0.45       0.44       0.45
Width/Depth Ratio          9.52       5.12       4.52
Bankfull Area (sq ft)      0.8        0.32       0.49
Wetted Perimeter (ft)      3          1.8        2.08
Hydraulic Radius (ft)      0.27       0.18       0.23
Begin BKF Station          11.4       11.4       12.67
End BKF Station            14.16      12.67      14.16

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope                      0          0          0
Shear Stress (lb/sq ft)
Movable Particle (mm)
```


XS9
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 5.86
Dbkf = .72
Abkf = 4.22
Elevation (ft)
106
105
104
103
102
101
100
Horizontal Distance (ft)
0
10
20
30
40

```
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         UT1-R1
Cross Section Name: XS9
Survey Date:        10/10/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 100 ft
Backsight Rod Reading:        10 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              4.8            105.2          LPIN
13             5.75           104.25         BRK
15             7              103            BRK
15.64          7.62           102.38         BKF
16             7.95           102.05         BRK
17             8.45           101.55         LCH
18.5           8.6            101.4          TWG
20.5           8.45           101.55         RCH
22             7.2            102.8          RTB
28             6.91           103.09         BRK
32             5.95           104.05         BRK
35             4.7            105.3          RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  103.36     103.36     103.36
Bankfull Elevation (ft)    102.38     102.38     102.38
Floodprone Width (ft)      14.7       -----      -----
Bankfull Width (ft)        5.86       2.93       2.93
Entrenchment Ratio         2.51       -----      -----
Mean Depth (ft)            0.72       0.7        0.74
Maximum Depth (ft)         0.98       0.98       0.97
Width/Depth Ratio          8.14       4.16       3.96
Bankfull Area (sq ft)      4.22       2.07       2.15
Wetted Perimeter (ft)      6.42       4.16       4.21
Hydraulic Radius (ft)      0.66       0.5        0.51
Begin BKF Station          15.64      15.64      18.57
End BKF Station            21.5       18.57      21.5

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope                      0          0          0
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

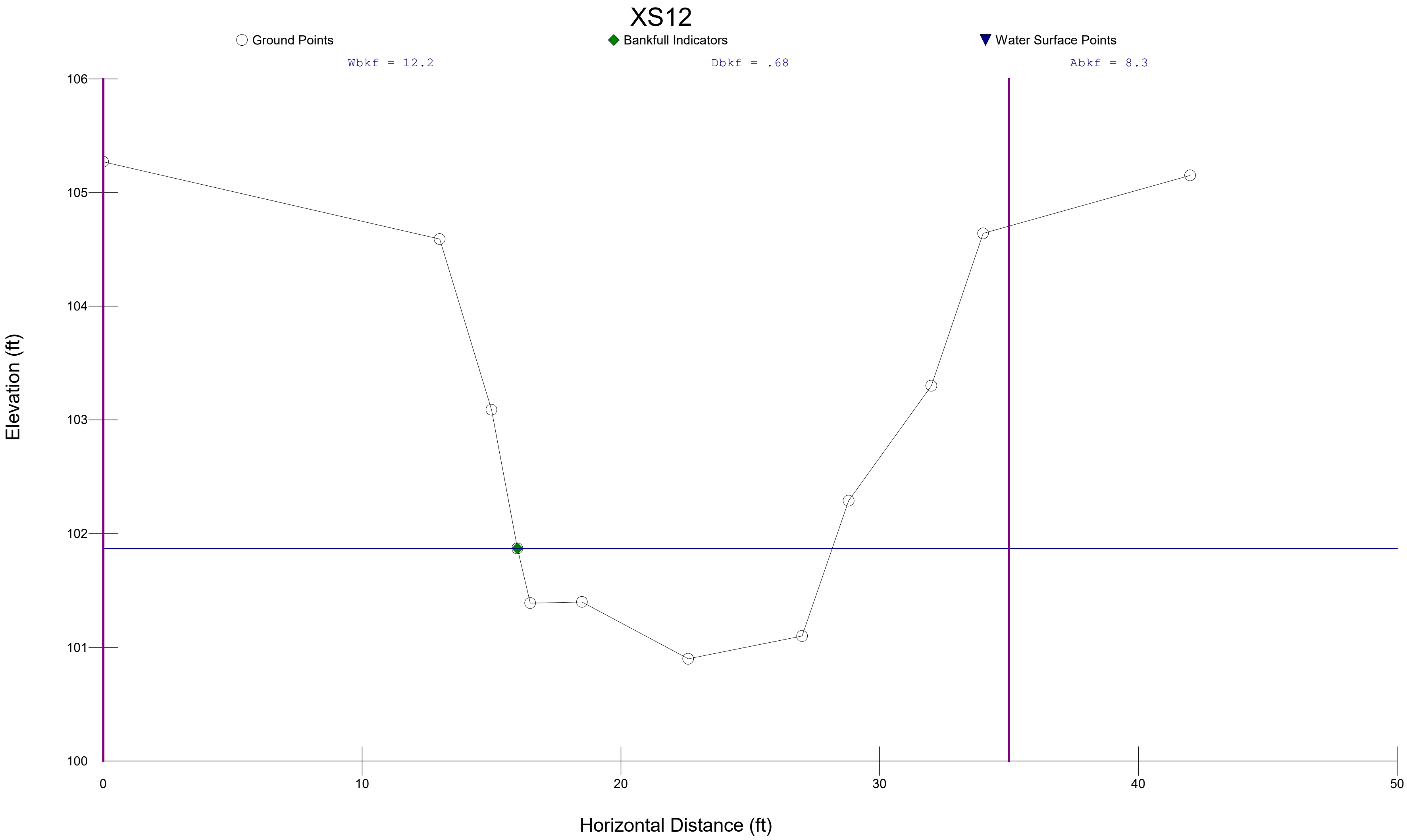

XS10
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 10.6
Dbkf = 1.01
Abkf = 10.7
Elevation (ft)
106
105
104
103
102
101
100
0
10
20
30
40
50
Horizontal Distance (ft)

```
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         UT4-R2
Cross Section Name: XS10
Survey Date:        10/10/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 100 ft
Backsight Rod Reading:        10 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              5.41           104.59         LPIN
17             5.45           104.55         LTB
18.7           6.6            103.4          BKF
20.5           7.75           102.25         LCH
23.5           8.05           101.95         TWG
26             7.85           102.15         RCH
28             7.3            102.7          BRK
30             6.25           103.75         RTB
32             5.65           104.35         BRK
38             5.33           104.67         BRK
42             4.61           105.39         RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  104.85     104.85     104.85
Bankfull Elevation (ft)    103.4      103.4      103.4
Floodprone Width (ft)      39         -----      -----
Bankfull Width (ft)        10.63      5.32       5.31
Entrenchment Ratio         3.67       -----      -----
Mean Depth (ft)            1.01       1.07       0.95
Maximum Depth (ft)         1.45       1.45       1.41
Width/Depth Ratio          10.52      4.98       5.59
Bankfull Area (sq ft)      10.73      5.68       5.05
Wetted Perimeter (ft)      11.24      7.08       6.97
Hydraulic Radius (ft)      0.95       0.8        0.72
Begin BKF Station          18.7       18.7       24.02
End BKF Station            29.33      24.02      29.33

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope                      0          0          0
Shear Stress (lb/sq ft)
Movable Particle (mm)
```


XS11
○ Ground Points
◆ Bankfull Indicators
▼ Water Surface Points
Wbkf = 9.86
Dbkf = .83
Abkf = 8.22
Elevation (ft)
106
105
104
103
102
101
100
0
10
20
30
40
50
Horizontal Distance (ft)

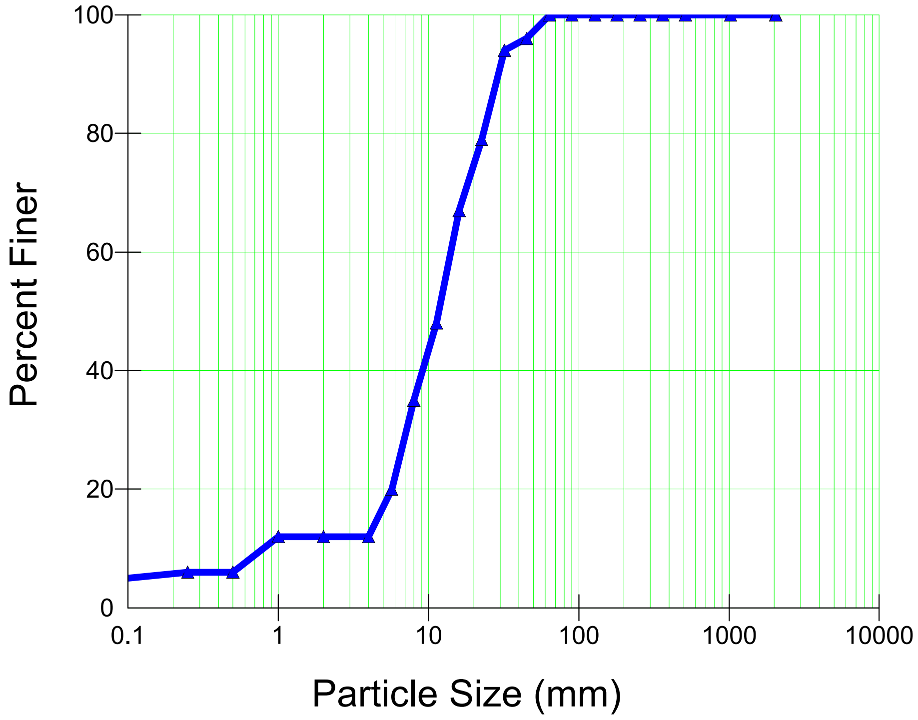
## RIVERMORPH CROSS SECTION SUMMARY

```
----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         UT4-R1
Cross Section Name: XS11
Survey Date:        10/10/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 100 ft
Backsight Rod Reading:        10 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              5.41           104.59         LPIN
17             5.45           104.55         LTB
19             6.85           103.15         BKF
20.5           7.75           102.25         LCH
23.5           8.05           101.95         TWG
26             7.85           102.15         RCH
28             7.3            102.7          BRK
30             6.25           103.75         RTB
32             5.65           104.35         BRK
38             5.33           104.67         BRK
42             4.61           105.39         RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  104.35     104.35     104.35
Bankfull Elevation (ft)    103.15     103.15     103.15
Floodprone Width (ft)      14.71      -----      -----
Bankfull Width (ft)        9.86       4.91       4.95
Entrenchment Ratio         1.49       -----      -----
Mean Depth (ft)            0.83       0.88       0.79
Maximum Depth (ft)         1.2        1.2        1.17
Width/Depth Ratio          11.88      5.59       6.27
Bankfull Area (sq ft)      8.22       4.31       3.91
Wetted Perimeter (ft)      10.31      6.34       6.31
Hydraulic Radius (ft)      0.8        0.68       0.62
Begin BKF Station          19         19         23.91
End BKF Station            28.86      23.91      28.86

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope                      0          0          0
Shear Stress (lb/sq ft)
Movable Particle (mm)
```


XS12
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 12.2
Dbkf = .68
Abkf = 8.3
106
105
104
103
102
101
100
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

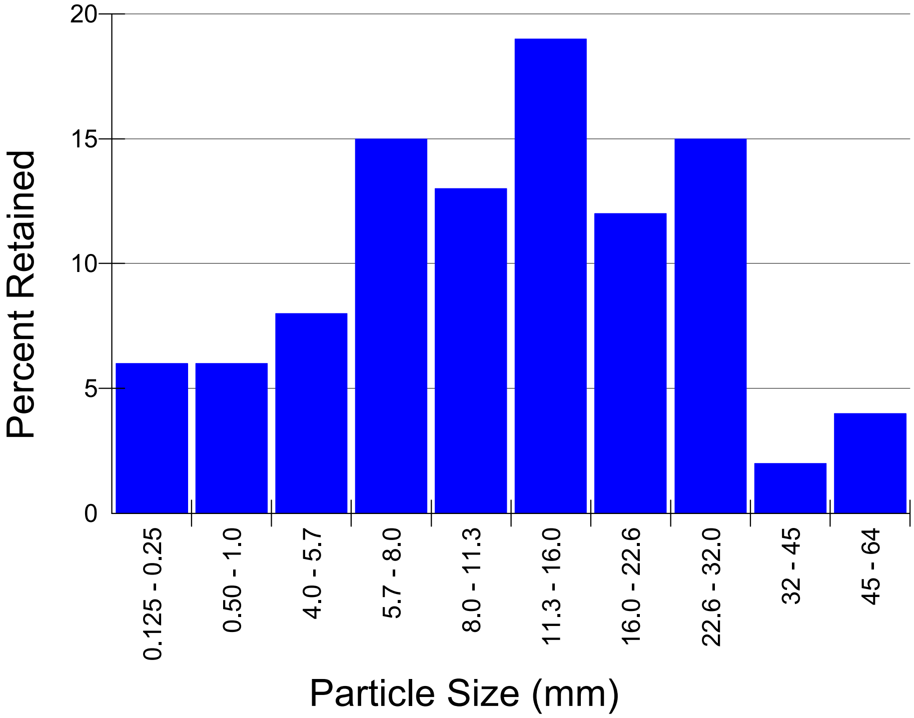
```
                   RIVERMORPH CROSS SECTION SUMMARY

----------------------------------------------------------------------

River Name:         Banner Branch
Reach Name:         UT4-R1
Cross Section Name: XS12
Survey Date:        10/10/2019

----------------------------------------------------------------------
Cross Section Data Entry

BM Elevation:                 100 ft
Backsight Rod Reading:        10 ft

TAPE           FS             ELEV           NOTE
----------------------------------------------------------------------
0              4.73           105.27         LPIN
13             5.41           104.59         BRK
15             6.91           103.09         LTB
16             8.13           101.87         BKF
16.5           8.61           101.39         BRK
18.5           8.6            101.4          LCH
22.6           9.1            100.9          TWG
27             8.9            101.1          RCH
28.8           7.71           102.29         BRK
32             6.7            103.3          RTB
34             5.36           104.64         BRK
42             4.85           105.15         RPIN


----------------------------------------------------------------------
Cross Sectional Geometry
----------------------------------------------------------------------

                           Channel    Left       Right
Floodprone Elevation (ft)  102.84     102.84     102.84
Bankfull Elevation (ft)    101.87     101.87     101.87
Floodprone Width (ft)      15.34      -----      -----
Bankfull Width (ft)        12.16      6.08       6.08
Entrenchment Ratio         1.26       -----      -----
Mean Depth (ft)            0.68       0.58       0.78
Maximum Depth (ft)         0.97       0.91       0.97
Width/Depth Ratio          17.88      10.46      7.79
Bankfull Area (sq ft)      8.3        3.53       4.76
Wetted Perimeter (ft)      12.62      7.21       7.23
Hydraulic Radius (ft)      0.66       0.49       0.66
Begin BKF Station          16         16         22.08
End BKF Station            28.16      22.08      28.16

----------------------------------------------------------------------
Entrainment Calculations
----------------------------------------------------------------------

Entrainment Formula: Rosgen Modified Shields Curve

                           Channel    Left Side  Right Side
Slope                      0          0          0
Shear Stress (lb/sq ft)
Movable Particle (mm)
```

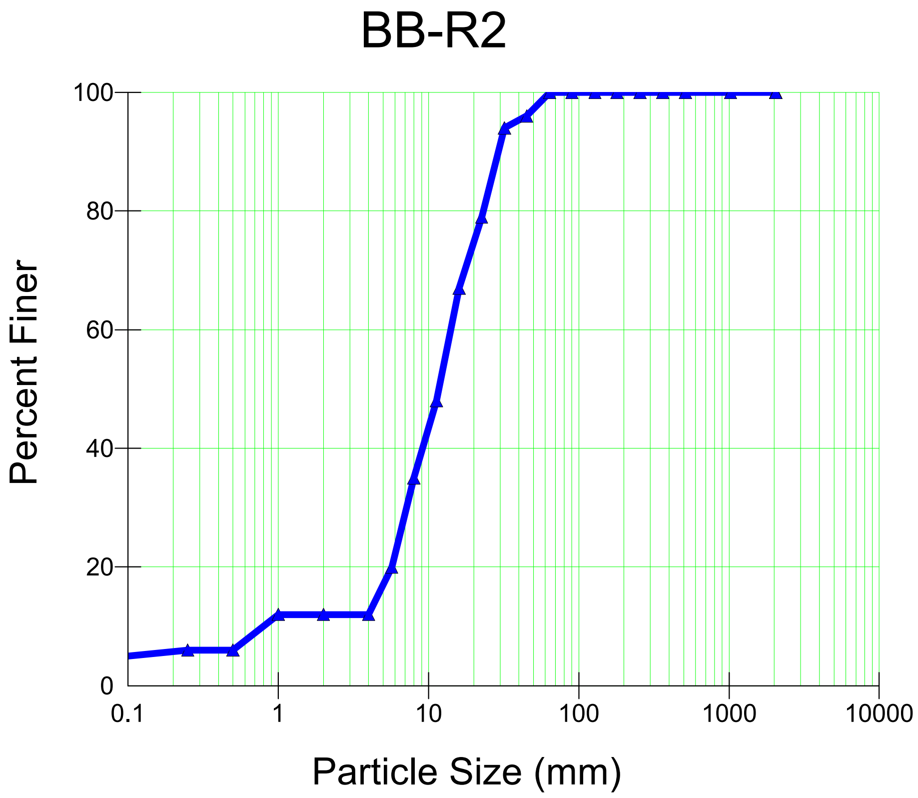
# BB-R1

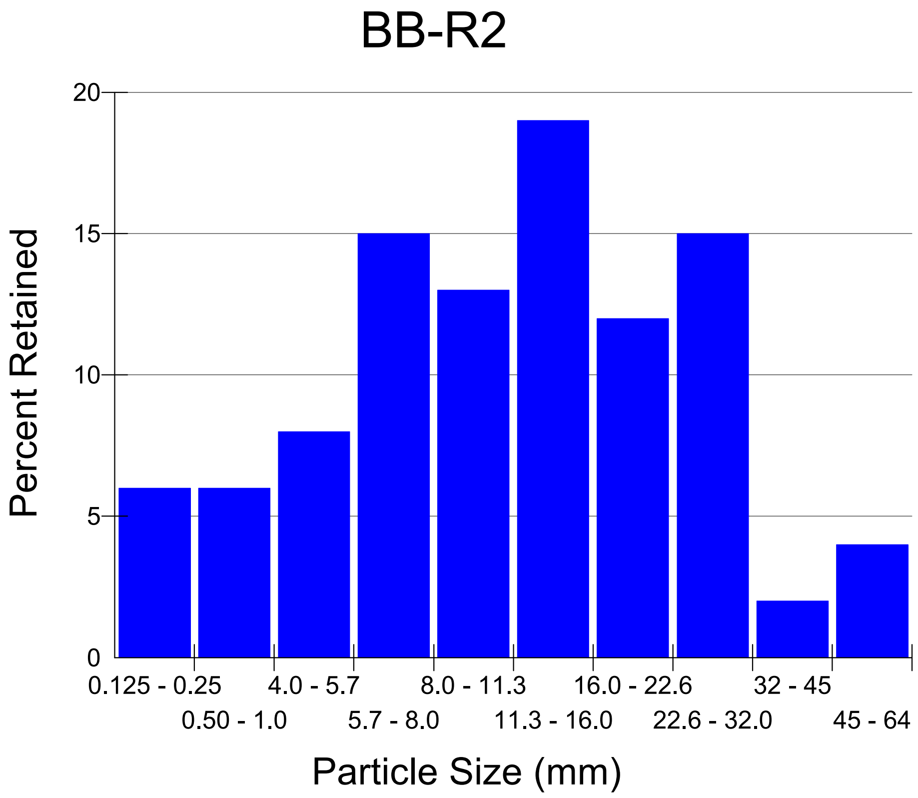


100
80
60
40
20
0
Percent Finer
0.1
1
10
100
1000
10000
Particle Size (mm)

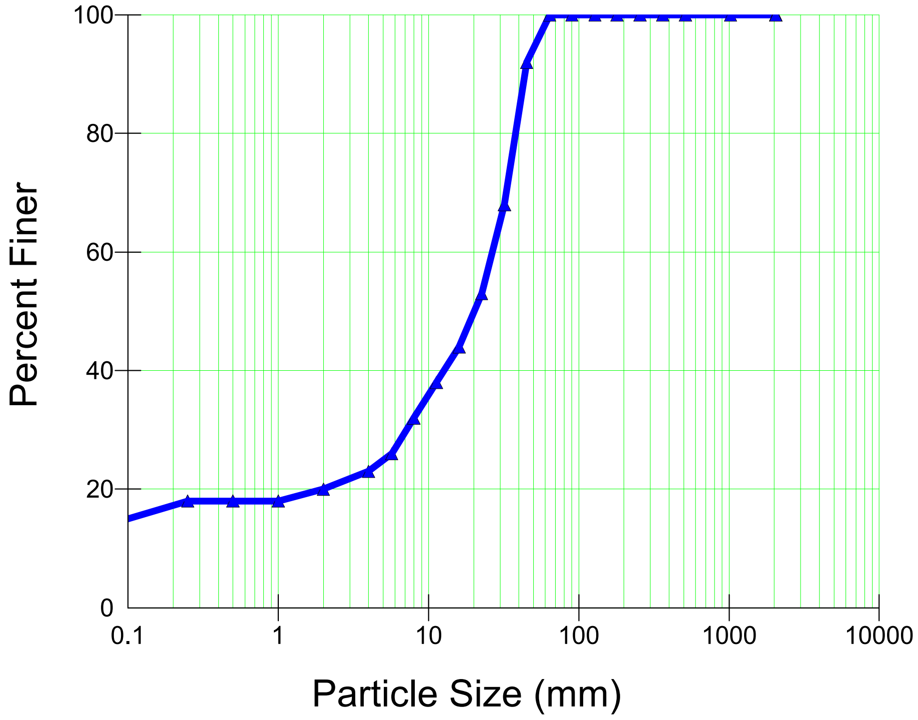
# BB-R1


Percent Retained
20
15
10
5
0
0.125 - 0.25
0.50 - 1.0
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
Particle Size (mm)


BB-R2
Percent Finer
0
20
40
60
80
100
0.1
1
10
100
1000
10000
Particle Size (mm)

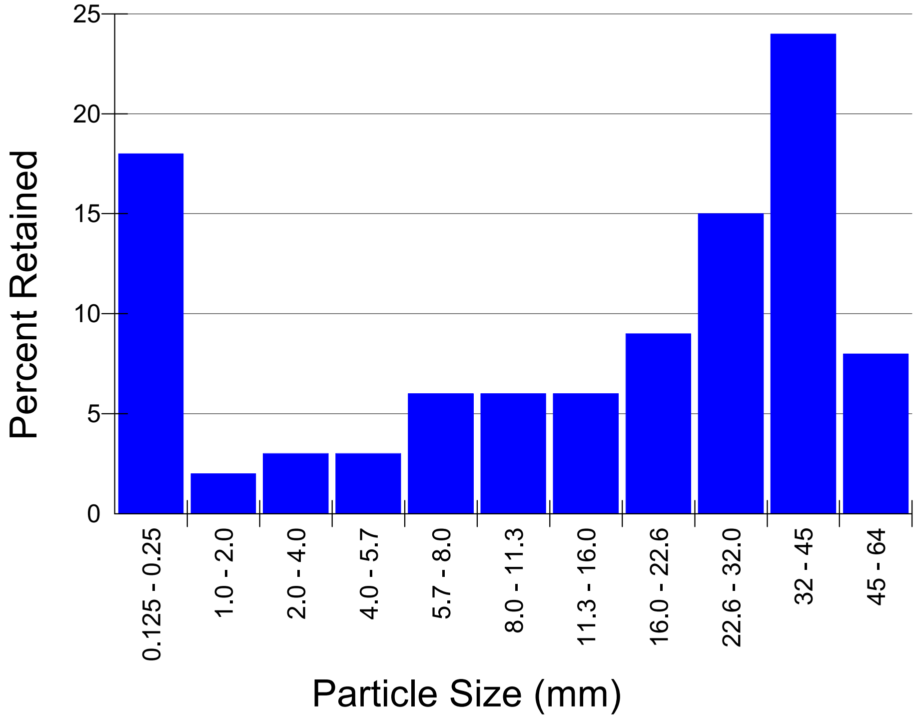

BB-R2
Percent Retained
0
5
10
15
20
0.125 - 0.25
0.50 - 1.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
Particle Size (mm)

## BB-R3



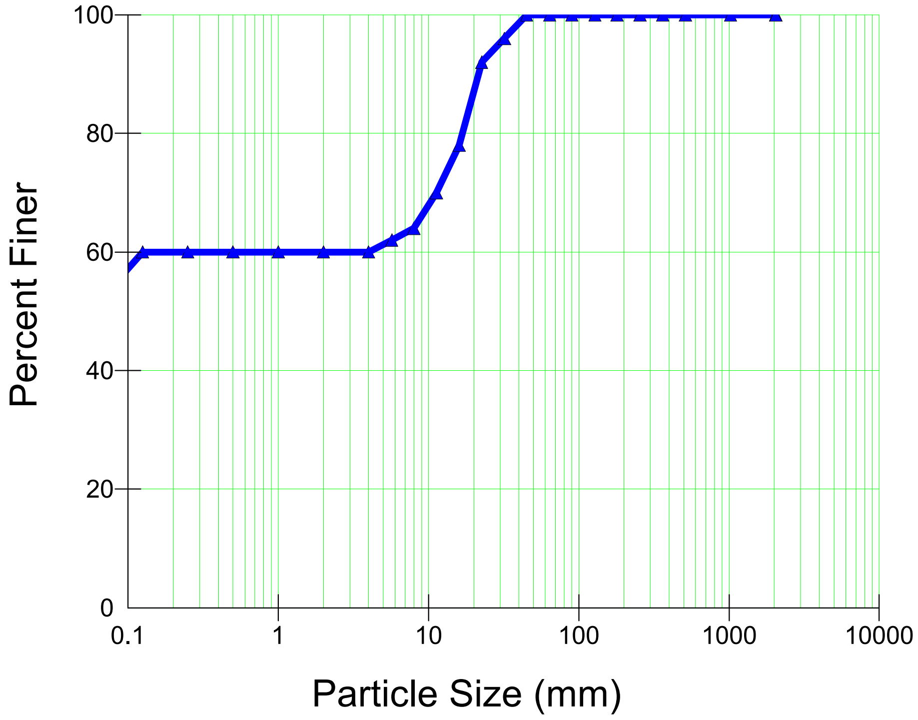
Percent Finer
100
80
60
40
20
0
0.1
1
10
100
1000
10000
Particle Size (mm)

# BB-R3

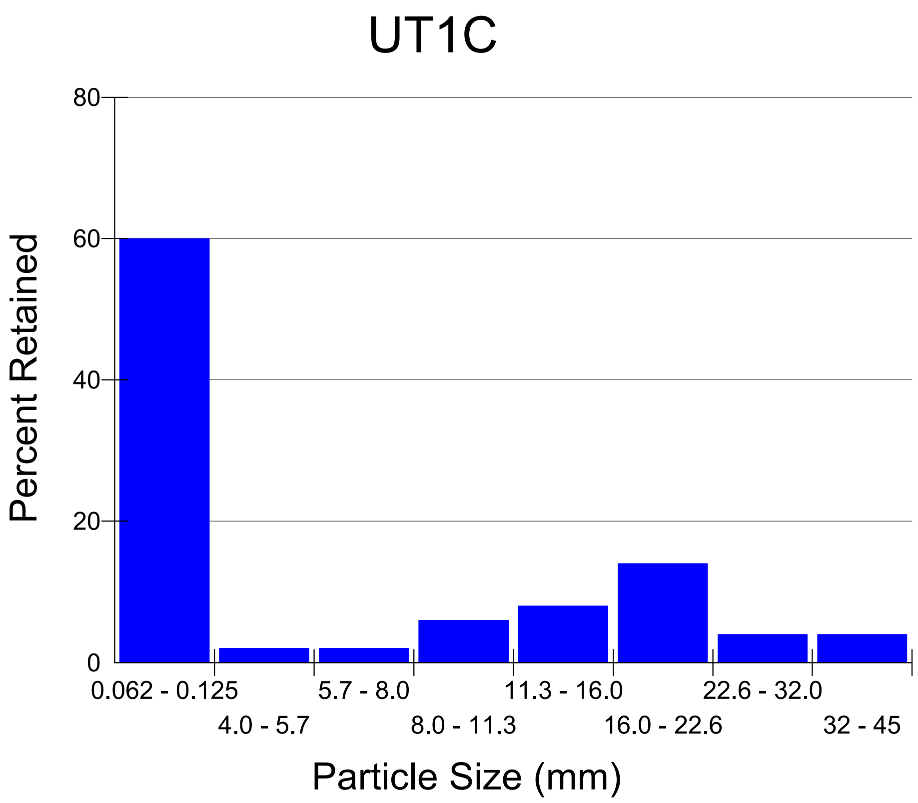


Percent Retained
25
20
15
10
5
0
0.125 - 0.25
1.0 - 2.0
2.0 - 4.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
Particle Size (mm)

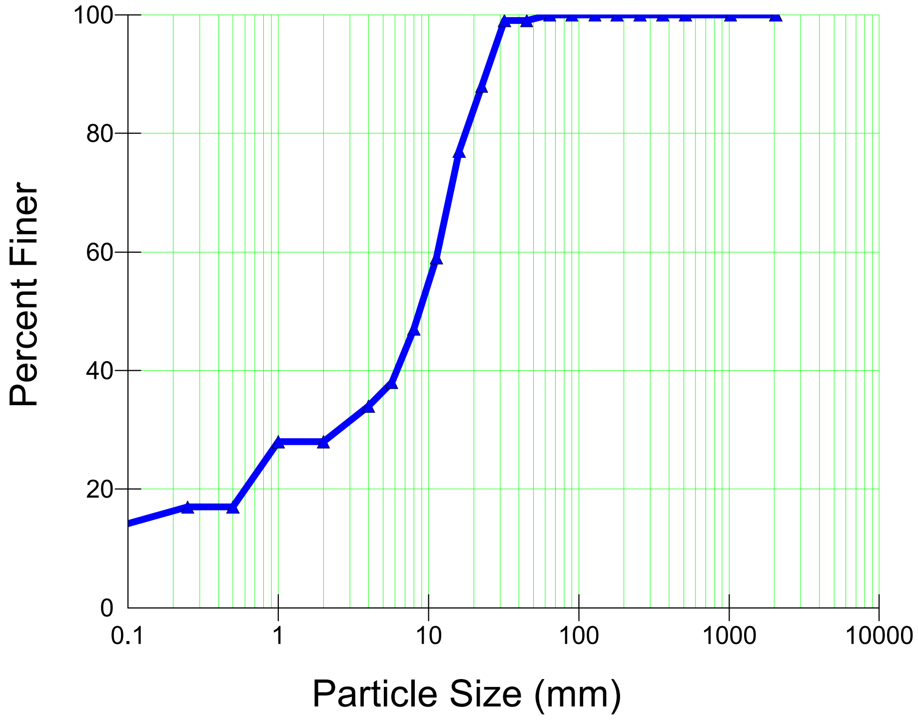
# UT1C



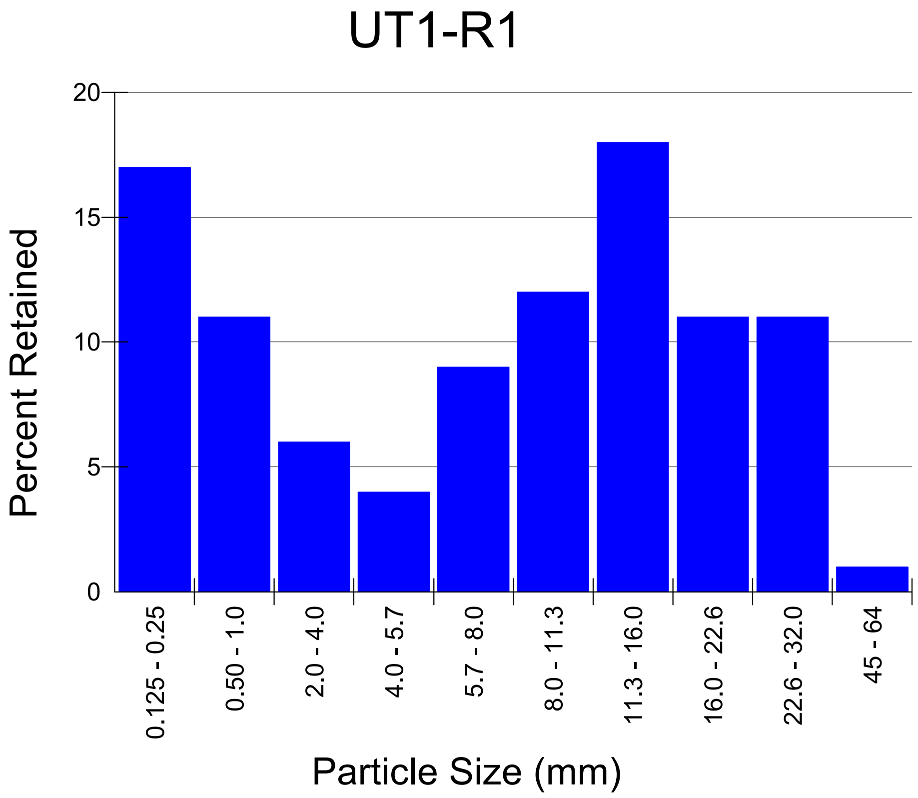
Percent Finer
0
20
40
60
80
100
0.1
1
10
100
1000
10000
Particle Size (mm)


UT1C
Percent Retained
80
60
40
20
0
0.062 - 0.125
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
Particle Size (mm)

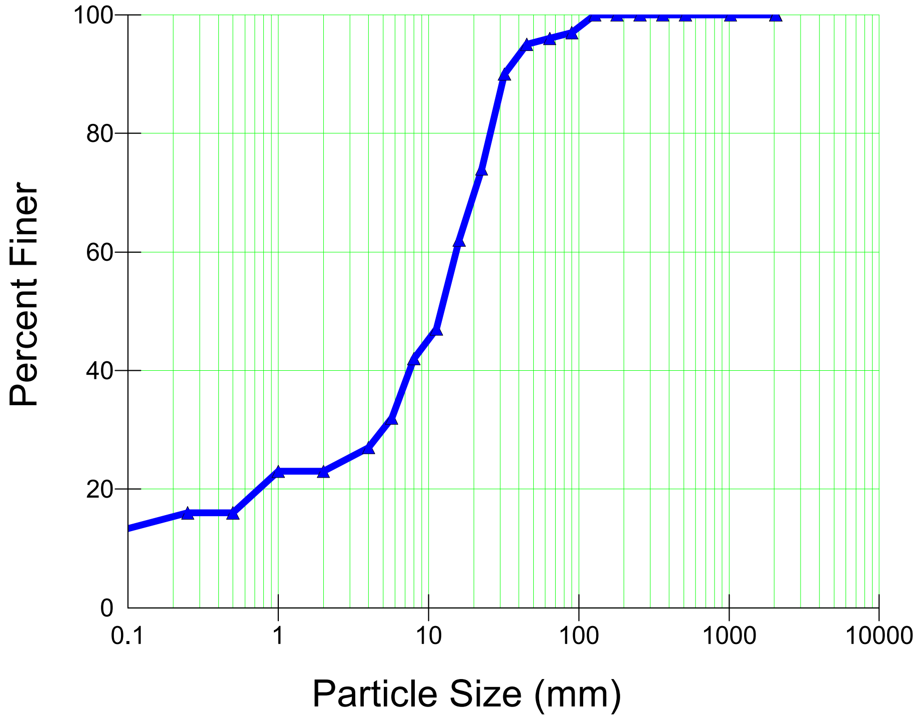
# UT1-R1

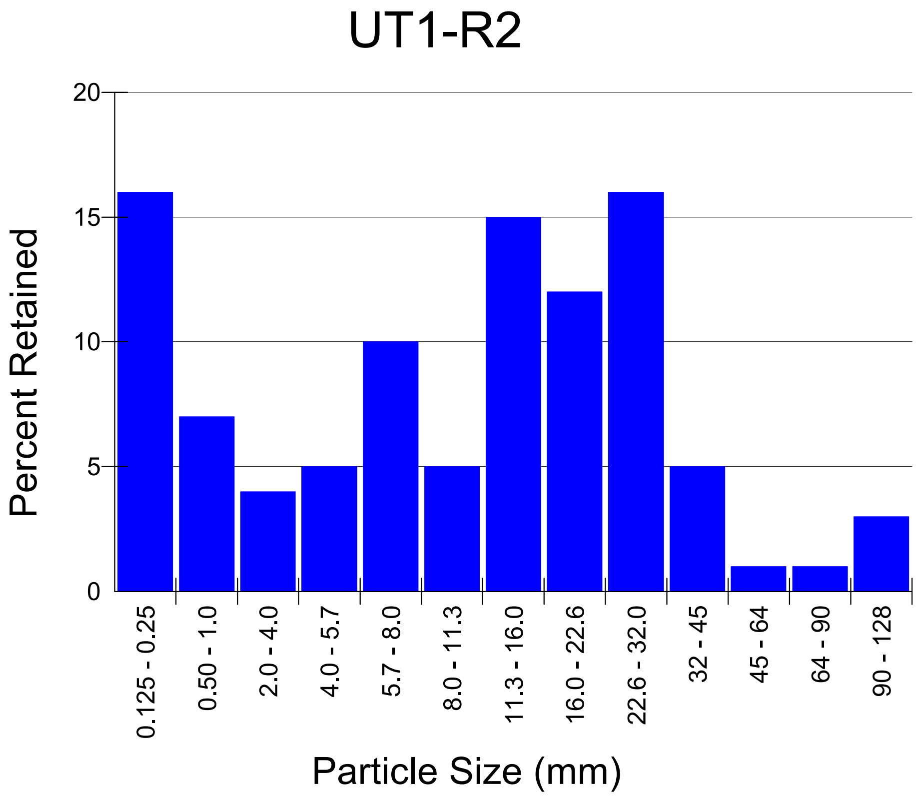


Percent Finer
100
80
60
40
20
0
0.1
1
10
100
1000
10000
Particle Size (mm)

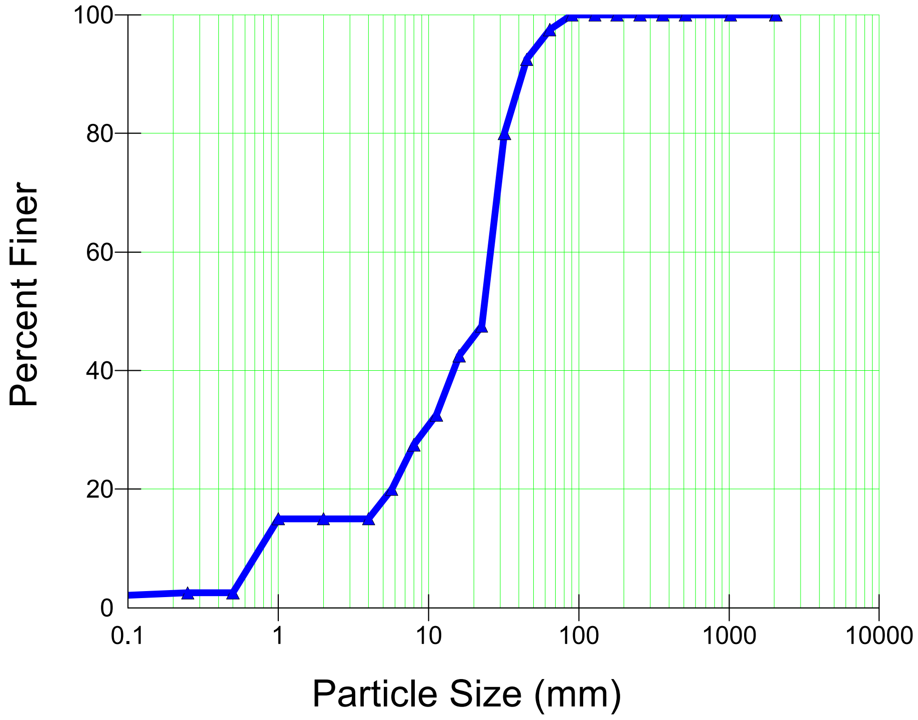

UT1-R1
Percent Retained
20
15
10
5
0
0.125 - 0.25
0.50 - 1.0
2.0 - 4.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
45 - 64
Particle Size (mm)

# UT1-R2

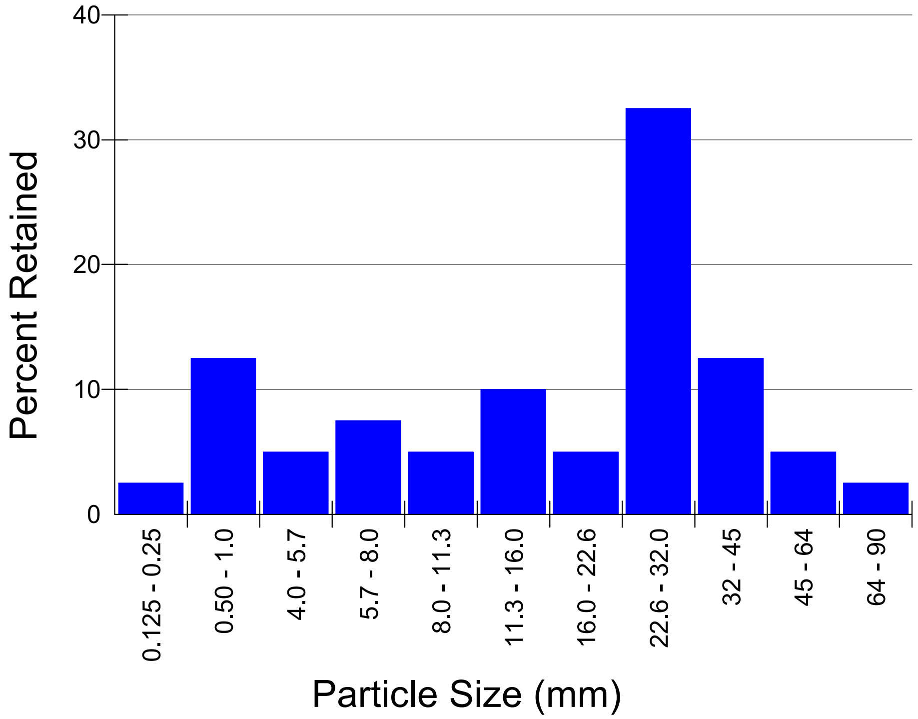

Percent Finer
100
80
60
40
20
0
0.1
1
10
100
1000
10000
Particle Size (mm)


UT1-R2
Percent Retained
20
15
10
5
0
0.125 - 0.25
0.50 - 1.0
2.0 - 4.0
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
Particle Size (mm)

# UT1-R3



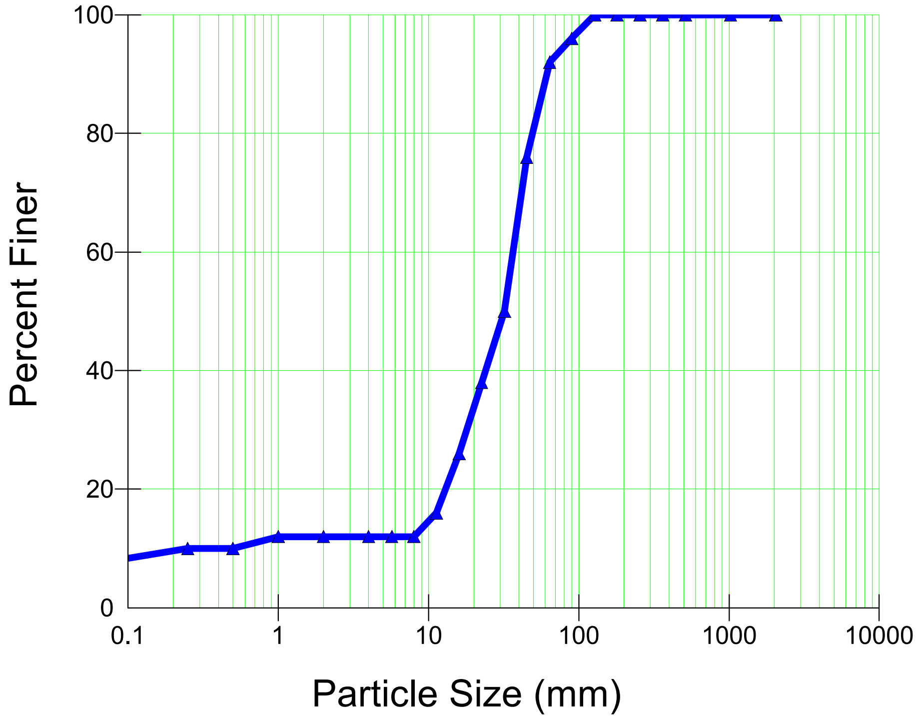
Percent Finer
100
80
60
40
20
0
0.1
1
10
100
1000
10000
Particle Size (mm)



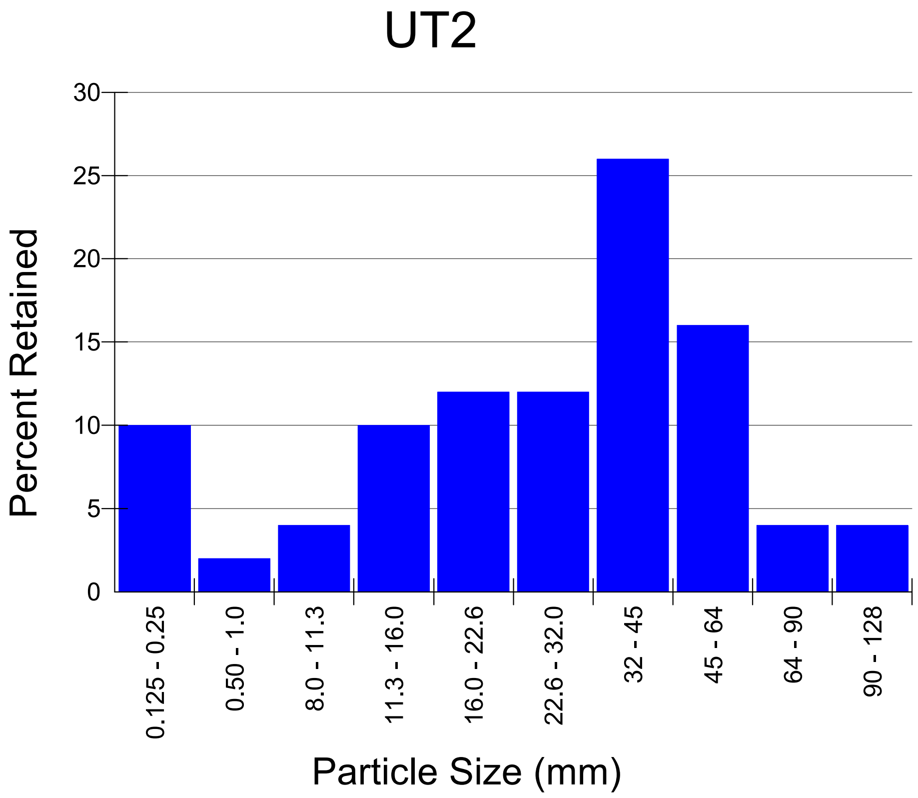
UT1-R3

Percent Retained
0
10
20
30
40
0.125 - 0.25
0.50 - 1.0
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
Particle Size (mm)

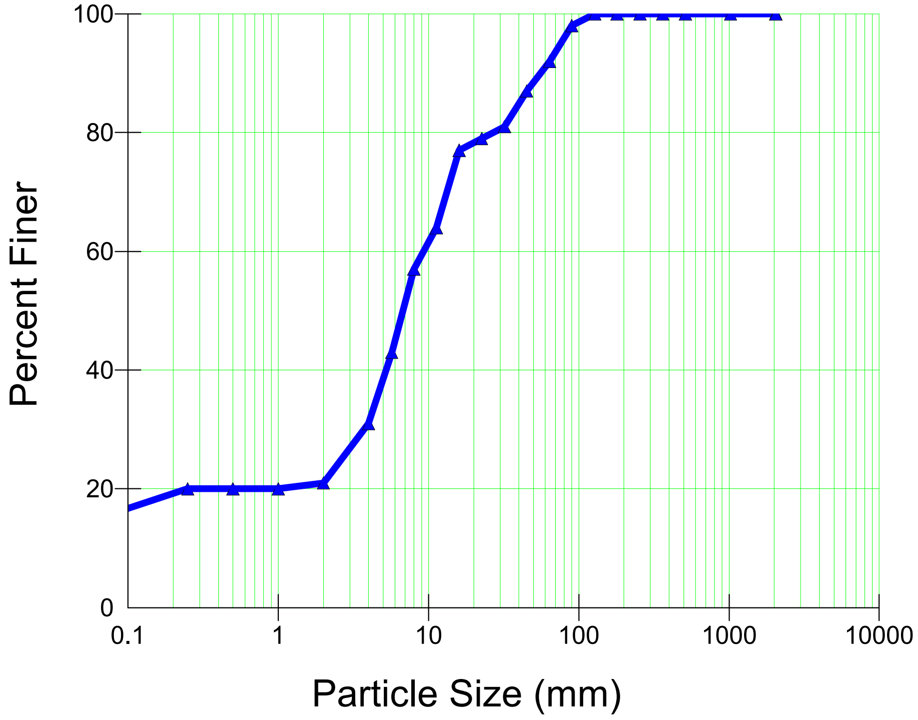
# UT2



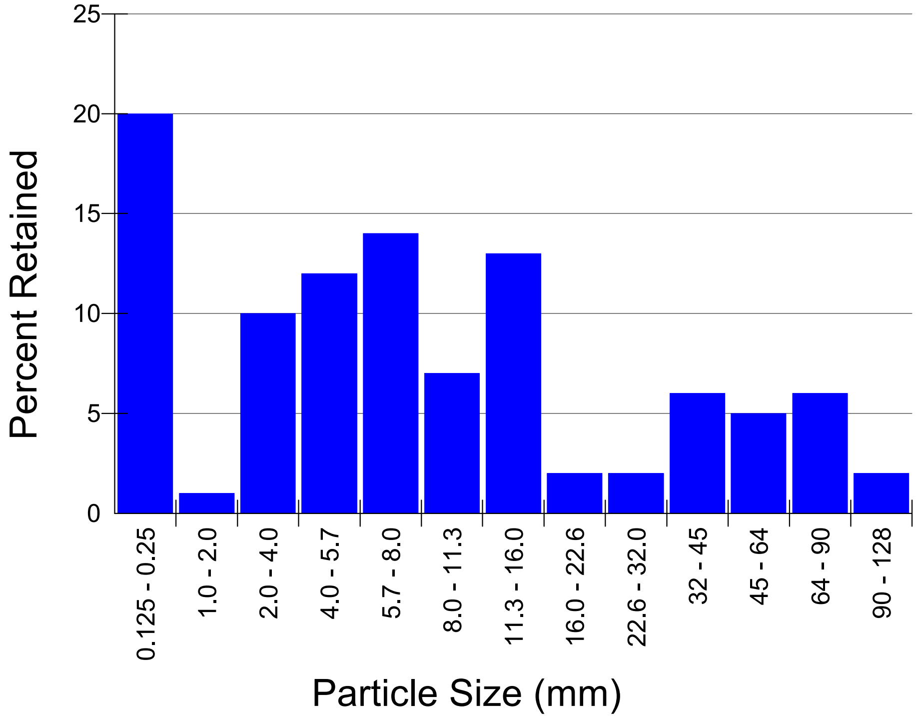
Percent Finer
100
80
60
40
20
0
0.1
1
10
100
1000
10000
Particle Size (mm)


UT2
Percent Retained
30
25
20
15
10
5
0
0.125 - 0.25
0.50 - 1.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
Particle Size (mm)

# UT4-R1

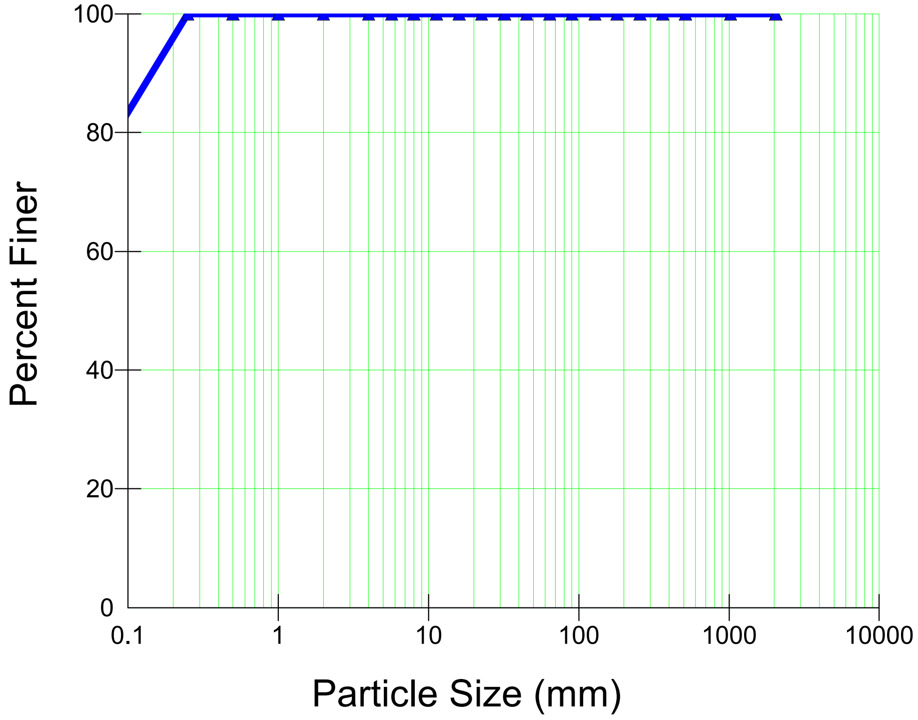

Percent Finer
100
80
60
40
20
0
0.1
1
10
100
1000
10000
Particle Size (mm)

# UT4-R1

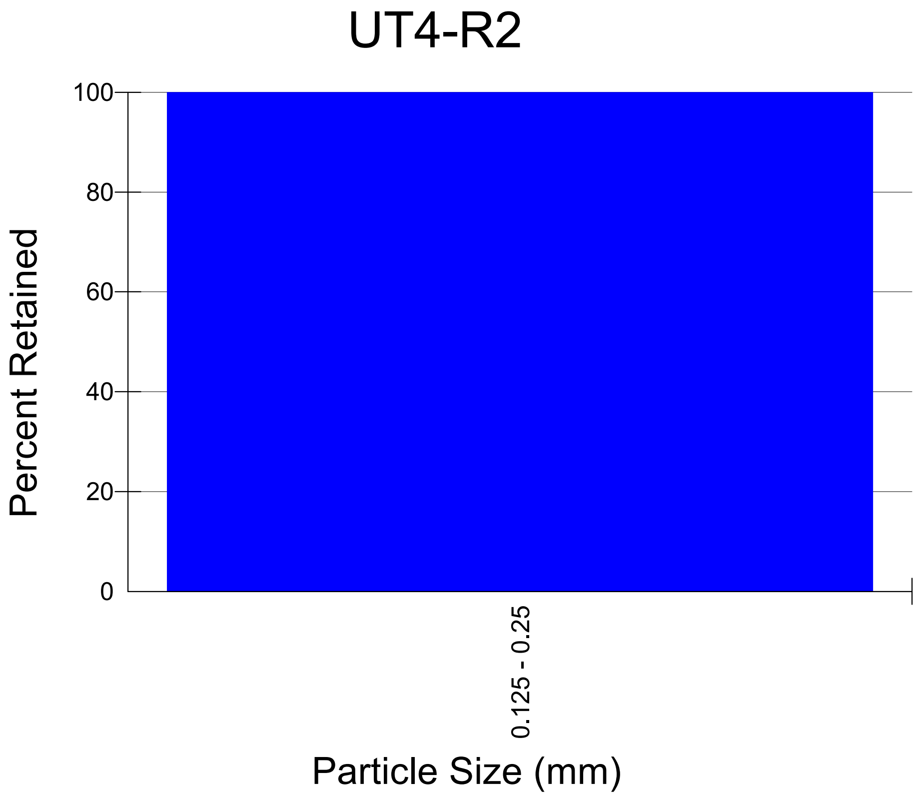


Percent Retained
25
20
15
10
5
0
0.125 - 0.25
1.0 - 2.0
2.0 - 4.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
Particle Size (mm)

## UT4-R2



Percent Finer
100
80
60
40
20
0
0.1
1
10
100
1000
10000
Particle Size (mm)


UT4-R2
Percent Retained
100
80
60
40
20
0
0.125 - 0.25
Particle Size (mm)

BANCS Method Calcs

Appendix 2

Location: Banner Branch Mitigation Project - UT1A   Field Crew: K. VanStell/ C. Tomsic   Date: 9/17/2019

## SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

| A | B | C | D | E | F | |
|---|---|---|---|---|---|---|
| BEHI | NBS | STUDY BANK HEIGHT | FEET/YR (from curve) | DISTANCE (note station for detailed design needs) | TOTAL FT$^3$/yr =(C×D×E) | STA |
| V. Low | V. Low | 2.3 | 0.008 | 119 | 2.2 | 1119 |
| Low | Low | 1.3 | 0.034 | 7 | 0.3 | 1126 |
| V. Low | V. Low | 2.5 | 0.008 | 128 | 2.6 | 1254 |
| V. Low | Low | 1.0 | 0.02 | 24 | 0.5 | 1278 |
| V. Low | V. Low | 1.3 | 0.008 | 131 | 1.4 | 1409 |

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 FT$^3$/yr =(C×D×E) | STA |
| V. Low | V. Low | 1.7 | 0.008 | 167 | 2.3 | 1167 |
| Low | Low | 1.2 | 0.034 | 16 | 0.7 | 1183 |
| V. Low | V. Low | 2.4 | 0.008 | 199 | 3.8 | 1382 |
| V. Low | V. Low | 1.8 | 0.008 | 11 | 0.2 | 1393 |

| | | Left bank | Right bank |
|---|---|---|---|
| | TOTAL FT$^3$/YR | 6.9 | 6.9 |
| Divide FT$^3$/yr by 27 | TOTAL YD$^3$/YR | 0.3 | 0.3 |
| Multiply YD$^3$/yr by 1.3 | **TOTAL TONS/YR** | 0.3 | 0.3 |
| Total Length | | 409 | 393 |

| | |
|---|---|
| Total ft assessed | 802 |
| Total TONS per year | 0.7 |
| Tons per ft per year | 0.0008 |
| Tons per 1000ft | 0.8 |

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** | | | | | | | | | |

BANCS Method Calcs

Location: Banner Branch Mitigation Project - UT1B  Field Crew: K. VanStell/ C. Tomsic  Date: 9/17/2019

## 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 FT$^3$/yr =(C×D×E) | STA | BEHI | NBS | STUDY BANK HEIGHT | FEET/YR (from curve) | DISTANCE (note station for detailed design needs) | TOTAL FT$^3$/yr =(C×D×E) | STA |
| Mod | Low-Mod | 1.6 | 0.135 | 52 | 11.2 | 1052 | Mod-High | Mod | 2.4 | 0.25 | 48 | 28.8 | 1048 |
| Mod-High | Mod | 2.4 | 0.25 | 54 | 32.4 | 1106 | Mod | Low-Mod | 2.1 | 0.135 | 39 | 11.1 | 1087 |
| Mod | Low | 2.0 | 0.09 | 20 | 3.6 | 1126 | Low-Mod | Low | 1.6 | 0.055 | 44 | 3.9 | 1131 |
| Mod-High | Mod | 1.3 | 0.25 | 52 | 16.9 | 1178 | V. Low | V. Low | 1.8 | 0.008 | 36 | 0.5 | 1167 |
| V. Low | Low | 1.6 | 0.02 | 24 | 0.8 | 1202 | Low-Mod | Low | 0.9 | 0.055 | 91 | 4.5 | 1258 |
| V. Low | V. Low | 0.5 | 0.008 | 33 | 0.1 | 1235 | V. Low | V. Low | 1.2 | 0.008 | 129 | 1.2 | 1387 |
| V. Low | V. Low | 0.6 | 0.008 | 24 | 0.1 | 1259 | | | | | | | |
| V. Low | V. Low | 0.3 | 0.008 | 123 | 0.3 | 1382 | | | | | | | |

| | | Left bank | Right bank |
|---|---|---|---|
| | TOTAL FT$^3$/YR | 65.4 | 50.0 |
| Divide FT$^3$/yr by 27 | TOTAL YD$^3$/YR | 2.4 | 1.9 |
| Multiply YD$^3$/yr by 1.3 | **TOTAL TONS/YR** | 3.2 | 2.4 |
| Total Length | | 382 | 387 |

| | |
|---|---|
| Total ft assessed | 769 |
| Total TONS per year | 5.6 |
| Tons per ft per year | 0.0072 |
| Tons per 1000ft | 7.2 |

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 | |
| **NBS** | | | | | | | | | |

BANCS Method Calcs

Appendix 2

Location: Banner Branch Mitigation Project - UT1C Field Crew: K. VanStell/ E. Dunnigan Date: 9/17/2019

**SEDIMENT LOADING ASSESSMENT SHEET**

**LEFT BANK**

| A | B | C | D | E | F | |
|---|---|---|---|---|---|---|
| **BEHI** | **NBS** | **STUDY BANK HEIGHT** | **FEET/YR (from curve)** | **DISTANCE (note station for detailed design needs)** | **TOTAL FT$^3$/yr =(C×D×E)** | **STA** |
| V. Low | V. Low | 0.8 | 0.008 | 78 | 0.5 | 1078 |
| V. Low | V. Low | 1.1 | 0.008 | 33 | 0.3 | 1111 |
| Low | V. Low | 0.7 | 0.02 | 22 | 0.3 | 1133 |
| V. Low | V. Low | 1.8 | 0.008 | 19 | 0.3 | 1152 |
| Low | V. Low | 2.1 | 0.02 | 15 | 0.6 | 1167 |
| Low | Low | 1.1 | 0.034 | 14 | 0.0 | 1181 |
| Low-Mod | Low | 1.7 | 0.055 | 26 | 2.4 | 1207 |
| V. Low | V. Low | 1.4 | 0.008 | 12 | 0.1 | 1219 |
| Low-Mod | Low | 1.9 | 0.055 | 30 | 3.1 | 1249 |
| V. Low | V. Low | 1.5 | 0.008 | 25 | 0.3 | 1274 |
| Low | V. Low | 1.9 | 0.02 | 38 | 1.4 | 1312 |
| V. Low | V. Low | 2.1 | 0.008 | 33 | 0.6 | 1345 |
| Low | V. Low | 1.6 | 0.02 | 35 | 1.1 | 1380 |
| Low | V. Low | 1.1 | 0.02 | 21 | 0.5 | 1401 |
| Mod | Low | 1.7 | 0.09 | 14 | 2.1 | 1415 |
| Mod-High | Low | 0.6 | 0.15 | 55 | 5.0 | 1470 |
| Mod | Low-Mod | 1.5 | 0.135 | 23 | 4.7 | 1493 |
| Low | Low | 1.7 | 0.034 | 12 | 0.7 | 1505 |
| V. Low | V. Low | 1.4 | 0.008 | 16 | 0.2 | 1521 |
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|---|---|
| TOTAL FT$^3$/YR | 24.2 |
| TOTAL YD$^3$/YR | 0.9 |
| **TOTAL TONS/YR** | 1.2 |

**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 FT$^3$/yr =(C×D×E)** | **STA** |
| V. Low | V. Low | 0.7 | 0.008 | 65 | 0.4 | 1065 |
| Low | V. Low | 1.9 | 0.02 | 28 | 1.1 | 1093 |
| V. Low | V. Low | 1.7 | 0.008 | 47 | 0.6 | 1140 |
| V. Low | V. Low | 1.9 | 0.008 | 42 | 0.6 | 1182 |
| V. Low | V. Low | 1.7 | 0.008 | 48 | 0.7 | 1230 |
| V. Low | V. Low | 0.9 | 0.008 | 77 | 0.6 | 1307 |
| V. Low | V. Low | 0.5 | 0.008 | 85 | 0.3 | 1392 |
| Mod-High | Low | 2.2 | 0.15 | 38 | 12.5 | 1430 |
| Mod | Mod | 2.1 | 0.18 | 43 | 16.3 | 1473 |
| V. Low | V. Low | 1.4 | 0.008 | 20 | 0.2 | 1493 |
| V. Low | V. Low | 1.1 | 0.008 | 14 | 0.1 | 1507 |
| V. Low | V. Low | 0.9 | 0.008 | 9 | 0.1 | 1516 |
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|---|---|
| TOTAL FT$^3$/YR | 33.5 |
| TOTAL YD$^3$/YR | 1.2 |
| **TOTAL TONS/YR** | 1.6 |

Divide FT$^3$/yr by 27

Multiply YD$^3$/yr by 1.3

| | | |
|---|---|---|
| Total Length | 521 | 516 |

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 | 1037 |
| Total TONS per year | 2.8 |
| Tons per ft per year | 0.0027 |
| Tons per 1000ft | 2.7 |

BANCS Method Calcs

Appendix 2

Location: Banner Branch Mitigation Project - UT2 Field Crew: K. VanStell/ C. Tomsic Date: 9/17/2019

## SEDIMENT LOADING ASSESSMENT SHEET

| LEFT BANK | | | | | | |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | |
| BEHI | NBS | STUDY BANK HEIGHT | FEET/YR (from curve) | DISTANCE (note station for detailed design needs) | TOTAL FT$^3$/yr =(C×D×E) | STA |
| Low | V. Low | 0.5 | 0.02 | 219 | 2.2 | 1219 |
| V. Low | V. Low | 0.7 | 0.008 | 38 | 0.2 | 1257 |
| V. Low | Low | 1.4 | 0.02 | 282 | 7.9 | 1539 |
| Low-Mod | Mod | 1.9 | 0.1 | 72 | 13.7 | 1611 |
| Mod | Mod | 1.6 | 0.18 | 41 | 11.8 | 1652 |
| Mod | Mod-High | 1.8 | 0.27 | 71 | 0.0 | 1723 |
| V. Low | Low | 0.5 | 0.02 | 178 | 1.8 | 1901 |
| Low | Mod | 1.1 | 0.068 | 37 | 2.8 | 1938 |
| Mod | Mod | 1.7 | 0.18 | 68 | 20.8 | 2006 |
| Low | Low-Mod | 1.3 | 0.051 | 128 | 8.5 | 2134 |
| Mod | Mod | 1.9 | 0.18 | 45 | 15.4 | 2179 |
| Low | Low | 1.5 | 0.034 | 39 | 2.0 | 2218 |
| Mod | Mod | 3.1 | 0.18 | 49 | 27.3 | 2267 |
| Mod | Low-Mod | 3.3 | 0.135 | 53 | 23.6 | 2320 |

| 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 FT$^3$/yr =(C×D×E) | STA |
| Low | V. Low | 1.2 | 0.02 | 198 | 4.8 | 1198 |
| Mod | V. Low | 0.9 | 0.035 | 107 | 3.4 | 1305 |
| Low | Low | 1.2 | 0.034 | 209 | 8.5 | 1514 |
| Mod | High | 1.5 | 0.38 | 19 | 10.8 | 1533 |
| Low | V. Low | 2.3 | 0.02 | 94 | 4.3 | 1627 |
| Mod | V. Low | 1.0 | 0.035 | 85 | 3.0 | 1712 |
| Low | V. Low | 0.9 | 0.02 | 41 | 0.7 | 1753 |
| Low | High | 1.5 | 0.14 | 143 | 30.0 | 1896 |
| Mod | Low | 2.1 | 0.09 | 33 | 6.2 | 1929 |
| Mod | Mod-High | 1.8 | 0.27 | 42 | 20.4 | 1971 |
| Low | Low | 0.8 | 0.034 | 145 | 3.9 | 2116 |
| Low-Mod | Mod | 1.3 | 0.1 | 55 | 7.2 | 2171 |
| Mod | Low-Mod | 1.8 | 0.135 | 78 | 19.0 | 2249 |
| Low-Mod | Mod | 2.4 | 0.1 | 160 | 38.4 | 2409 |

| | Left bank | | Right bank | |
|---|---|---|---|---|
| | TOTAL FT$^3$/YR | 138.0 | TOTAL FT$^3$/YR | 160.6 |
| Divide FT$^3$/yr by 27 | TOTAL YD$^3$/YR | 5.1 | TOTAL YD$^3$/YR | 5.9 |
| Multiply YD$^3$/yr by 1.3 | **TOTAL TONS/YR** | 6.6 | **TOTAL TONS/YR** | 7.7 |
| Total Length | | 1320 | | 1409 |

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 | 2729 |
| Total TONS per year | 14.4 |
| Tons per ft per year | 0.0053 |
| Tons per 1000ft | 5.3 |

BANCS Method Calcs

Location: Banner Branch Mitigation Project - UT2A Field Crew: K. VanStell/ C. Tomsic Date: 9/17/2019

## SEDIMENT LOADING ASSESSMENT SHEET

**LEFT BANK**

| A | B | C | D | E | F | |
|---|---|---|---|---|---|---|
| **BEHI** | **NBS** | **STUDY BANK HEIGHT** | **FEET/YR (from curve)** | **DISTANCE (note station for detailed design needs)** | **TOTAL FT$^3$/yr =(C×D×E)** | **STA** |
| Mod | Low | 1.9 | 0.09 | 155 | 26.5 | 1155 |
| Mod | Mod | 0.7 | 0.18 | 21 | 2.6 | 1176 |
| Low-Mod | Low-Mod | 1.1 | 0.078 | 135 | 11.6 | 1311 |

| | | |
|---|---|---|
| | TOTAL FT$^3$/YR | 40.7 |
| Divide FT$^3$/yr by 27 | TOTAL YD$^3$/YR | 1.5 |
| Multiply YD$^3$/yr by 1.3 | **TOTAL TONS/YR** | 2.0 |

**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 FT$^3$/yr =(C×D×E)** | **STA** |
| Low | V. Low | 1.1 | 0.02 | 148 | 3.3 | 1148 |
| V. Low | V. Low | 1.0 | 0.008 | 18 | 0.1 | 1166 |
| Mod | Low | 1.5 | 0.09 | 46 | 6.2 | 1212 |
| Low | Low | 1.7 | 0.034 | 65 | 3.8 | 1277 |

| | |
|---|---|
| TOTAL FT$^3$/YR | 13.4 |
| TOTAL YD$^3$/YR | 0.5 |
| **TOTAL TONS/YR** | 0.6 |

| | Left Bank | Right Bank |
|---|---|---|
| Total Length | 311 | 277 |

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 | 588 |
| Total TONS per year | 2.6 |
| Tons per ft per year | 0.0044 |
| Tons per 1000ft | 4.4 |

BANCS Method Calcs

Location: Banner Branch Mitigation Project - UT3 Field Crew: K. VanStell/ C. Tomsic Date: 9/17/2019

### 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 FT$^3$/yr =(C×D×E)** | **STA** | **BEHI** | **NBS** | **STUDY BANK HEIGHT** | **FEET/YR (from curve)** | **DISTANCE (note station for detailed design needs)** | **TOTAL FT$^3$/yr =(C×D×E)** | **STA** |
| Mod | V. Low | 3.6 | 0.035 | 319 | 40.2 | 1319 | Mod | V. Low | 2.4 | 0.035 | 340 | 28.6 | 1340 |
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|---|---|---|---|---|
| | TOTAL FT$^3$/YR | 40.2 | TOTAL FT$^3$/YR | 28.6 |
| Divide FT$^3$/yr by 27 | TOTAL YD$^3$/YR | 1.5 | TOTAL YD$^3$/YR | 1.1 |
| Multiply YD$^3$/yr by 1.3 | **TOTAL TONS/YR** | 1.9 | **TOTAL TONS/YR** | 1.4 |
| Total Length | | 319 | | 340 |

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 | 659 |
| Total TONS per year | 3.3 |
| Tons per ft per year | 0.0050 |
| Tons per 1000ft | 5.0 |

BANCS Method Calcs

Appendix 2

Location: Banner Branch Mitigation Project - UT4-R1 Headcut Field Crew: E. Dunnigan/ K. VanStell  Date: 9/17/2019

**SEDIMENT LOADING ASSESSMENT SHEET**

**LEFT 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** |
| V. High | Low | 4.1 | 0.18 | 60 | 44.3 | 1060 |
| High | Low | 3.7 | 0.18 | 30 | 20.0 | 1090 |
| Low | V. Low | 3.9 | 0.02 | 60 | 4.7 | 1150 |
| Low | V. Low | 2.4 | 0.02 | 90 | 4.3 | 1240 |

**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** |
| V. High | Low | 5.0 | 0.18 | 60 | 54.0 | 1060 |
| High | Low | 4.2 | 0.18 | 30 | 22.7 | 1090 |
| Low | V. Low | 3.7 | 0.02 | 60 | 4.4 | 1150 |
| Low | V. Low | 3.4 | 0.02 | 90 | 6.1 | 1240 |

| | | Left bank | | Right bank |
|---|---|---|---|---|
| | TOTAL FT³/YR | 73.3 | TOTAL FT³/YR | 87.2 |
| Divide FT³/yr by 27 | TOTAL YD³/YR | 2.7 | TOTAL YD³/YR | 3.2 |
| Multiply YD³/yr by 1.3 | **TOTAL TONS/YR** | 3.5 | **TOTAL TONS/YR** | 4.2 |
| Total Length | | 240 | | 240 |

| | |
|---|---|
| Total ft assessed | 480 |
| Total TONS per year | 7.7 |
| Tons per ft per year | 0.0161 |
| Tons per 1000ft | 16.1 |

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** | | | | | | | | | |

BANCS Method Calcs

Appendix 2

Location: Banner Branch Mitigation Project - UT4-R1 Field Crew: C. Tomsic/ K. VanStell Date: 9/17/2019

## SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

| A | B | C | D | E | F | |
|---|---|---|---|---|---|---|
| BEHI | NBS | STUDY BANK HEIGHT | FEET/YR (from curve) | DISTANCE (note station for detailed design needs) | TOTAL FT$^3$/yr =(C×D×E) | STA |
| Low | V. Low | 2.5 | 0.02 | 280 | 14.0 | 1280 |
| V. Low | V. Low | 2.8 | 0.008 | 220 | 4.9 | 1500 |
| Mod | Low-Mod | 2.7 | 0.135 | 180 | 65.6 | 1680 |
| Mod-High | Mod | 5.5 | 0.25 | 230 | 316.3 | 1910 |
| Low | Low | 2.1 | 0.034 | 170 | 12.1 | 2080 |
| Low | V. Low | 2.6 | 0.02 | 200 | 10.4 | 2280 |
| Mod | Low | 3.5 | 0.09 | 180 | 56.7 | 2460 |
| V. Low | V. Low | 0.9 | 0.008 | 210 | 1.5 | 2670 |
| Low | V. Low | 0.8 | 0.02 | 310 | 5.0 | 2980 |
| Mod | Low | 2.3 | 0.09 | 220 | 45.5 | 3200 |
| Low-Mod | Low | 2.6 | 0.055 | 280 | 40.0 | 3480 |
| V. Low | V. Low | 2.8 | 0.008 | 110 | 2.5 | 3590 |
| Low-Mod | Low | 1.9 | 0.055 | 305 | 31.9 | 3895 |
| Low | Low | 2.1 | 0.034 | 290 | 20.7 | 4185 |
| Low-Mod | Low | 2.7 | 0.055 | 300 | 44.6 | 4485 |
| V. Low | V. Low | 1.8 | 0.008 | 210 | 3.0 | 4695 |
| Mod | Mod | 2.3 | 0.18 | 200 | 82.8 | 4895 |
| High | High | 2.7 | 0.5 | 245 | 330.8 | 5140 |
| Mod | Mod | 2.9 | 0.18 | 60 | 31.3 | 5200 |
| Mod | Mod-High | 1.7 | 0.27 | 250 | 114.8 | 5450 |
| Mod | Low | 1.9 | 0.09 | 250 | 42.8 | 5700 |
| Low | Low | 2.4 | 0.034 | 300 | 24.5 | 6000 |

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 FT$^3$/yr =(C×D×E) | STA |
| Mod-High | Low | 0.8 | 0.15 | 620 | 74.4 | 1620 |
| High | Mod | 0.9 | 0.3 | 460 | 124.2 | 2080 |
| High | Mod | 3.1 | 0.3 | 130 | 120.9 | 2210 |
| Mod | Mod | 1.8 | 0.18 | 230 | 74.5 | 2440 |
| V. Low | V. Low | 2.5 | 0.008 | 100 | 2.0 | 2540 |
| High | Low | 1.8 | 0.18 | 230 | 74.5 | 2770 |
| V. Low | V. Low | 3.6 | 0.008 | 270 | 7.8 | 3040 |
| Mod-High | Mod | 3.4 | 0.25 | 260 | 221.0 | 3300 |
| Mod | Low | 1.7 | 0.09 | 100 | 15.3 | 3400 |
| Low | Mod | 2.2 | 0.068 | 150 | 22.4 | 3550 |
| Mod-High | Mod | 1.6 | 0.25 | 250 | 100.0 | 3800 |
| High | Low | 2.1 | 0.18 | 260 | 98.3 | 4060 |
| V. Low | Low | 1.9 | 0.02 | 120 | 4.6 | 4180 |
| Mod | Low | 1.8 | 0.09 | 280 | 45.4 | 4460 |
| Low | Low | 1.7 | 0.034 | 100 | 5.8 | 4560 |
| Low | V. Low | 2.1 | 0.02 | 350 | 14.7 | 4910 |
| High | High | 4.9 | 0.5 | 80 | 196.0 | 4990 |
| V. Low | V. Low | 1.9 | 0.008 | 690 | 10.5 | 5680 |

| | | Left bank | | Right bank |
|---|---|---|---|---|
| | TOTAL FT$^3$/YR | 1301.5 | TOTAL FT$^3$/YR | 1212.2 |
| Divide FT$^3$/yr by 27 | TOTAL YD$^3$/YR | 48.2 | TOTAL YD$^3$/YR | 44.9 |
| Multiply YD$^3$/yr by 1.3 | **TOTAL TONS/YR** | 62.7 | **TOTAL TONS/YR** | 58.4 |

| | | |
|---|---|---|
| Total Length | 5000 | 4680 |

| | |
|---|---|
| Total ft assessed | 9680 |
| Total TONS per year | 121.0 |
| Tons per ft per year | 0.0125 |
| Tons per 1000ft | 12.5 |

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** | | | | | | | | | |

## BANCS Method Calcs

Location: Banner Branch Mitigation Project - UT4-R2 Field Crew: C. Tomsic/ K. VanStell Date: 9/17/2019

### 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 FT$^3$/yr =(C×D×E)** | **STA** | **BEHI** | **NBS** | **STUDY BANK HEIGHT** | **FEET/YR (from curve)** | **DISTANCE (note station for detailed design needs)** | **TOTAL FT$^3$/yr =(C×D×E)** | **STA** |
| High | V. High | 2.6 | 0.8 | 80 | 166.4 | 1080 | Mod | Low | 2.5 | 0.09 | 140 | 31.5 | 1140 |
| Mod | Low-Mod | 1.5 | 0.135 | 60 | 12.2 | 1140 | Mod | High | 1.8 | 0.38 | 150 | 102.6 | 1290 |
| Mod | Mod-High | 3.1 | 0.27 | 220 | 184.1 | 1360 | Mod | Low | 2.4 | 0.09 | 260 | 56.2 | 1550 |
| Mod | Low | 2.6 | 0.09 | 220 | 51.5 | 1580 | Low | Low | 1.9 | 0.034 | 100 | 6.5 | 1650 |
| Low | Low | 2.0 | 0.034 | 350 | 23.8 | 1930 | Low | V. Low | 2.1 | 0.02 | 345 | 14.5 | 1995 |
| Low | V. Low | 1.4 | 0.02 | 370 | 10.4 | 2300 | V. High | V. High | 4.9 | 0.8 | 80 | 313.6 | 2075 |
| V. Low | V. Low | 1.5 | 0.008 | 400 | 4.8 | 2700 | V. Low | V. Low | 1.9 | 0.008 | 410 | 6.2 | 2485 |
| | | | | | | | Low | Low | 1.6 | 0.034 | 230 | 12.5 | 2715 |

| | LEFT BANK | | RIGHT BANK | |
|---|---|---|---|---|
| | TOTAL FT$^3$/YR | 453.1 | TOTAL FT$^3$/YR | 543.6 |
| Divide FT$^3$/yr by 27 | TOTAL YD$^3$/YR | 16.8 | TOTAL YD$^3$/YR | 20.1 |
| Multiply YD$^3$/yr by 1.3 | **TOTAL TONS/YR** | 21.8 | **TOTAL TONS/YR** | 26.2 |
| Total Length | | 1700 | | 1715 |

| | |
|---|---|
| Total ft assessed | 3415 |
| Total TONS per year | 48.0 |
| Tons per ft per year | 0.0141 |
| Tons per 1000ft | 14.1 |

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** | | | | | | | | | |

BANCS Method Calcs

Location: Banner Branch Mitigation Project - UT1-R1 Field Crew: E. Dunnigan/ K. Obermiller Date: 9/17/2019

**SEDIMENT LOADING ASSESSMENT SHEET**

**LEFT 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** |
| V. Low | V. Low | 2.2 | 0.008 | 39 | 0.7 | 1039 |
| Low-Mod | V. Low | 2.9 | 0.03 | 167 | 14.5 | 1206 |
| V. Low | V. Low | 1.5 | 0.008 | 142 | 1.7 | 1348 |
| Low | Mod | 1.6 | 0.068 | 17 | 1.8 | 1365 |
| Low | Low | 1.7 | 0.034 | 19 | 1.1 | 1384 |
| Low-Mod | Mod | 2.8 | 0.1 | 86 | 24.1 | 1470 |
| V. Low | Low | 2.4 | 0.02 | 155 | 7.4 | 1625 |
| Low | Low | 1.5 | 0.034 | 150 | 7.7 | 1775 |
| V. Low | V. Low | 1.6 | 0.008 | 56 | 0.7 | 1831 |
| Low | Low | 1.2 | 0.034 | 21 | 0.9 | 1852 |
| V. Low | V. Low | 1.6 | 0.008 | 19 | 0.2 | 1871 |
| Low | Low | 2.5 | 0.034 | 22 | 1.9 | 1893 |
| V. Low | V. Low | 1.5 | 0.008 | 27 | 0.3 | 1920 |
| Low | Low | 1.6 | 0.034 | 36 | 2.0 | 1956 |
| | | | | TOTAL FT³/YR | 65.0 | |
| Divide FT³/yr by 27 | | | | TOTAL YD³/YR | 2.4 | |
| Multiply YD³/yr by 1.3 | | | | **TOTAL TONS/YR** | 3.1 | |

**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** |
| Low | V. Low | 2.3 | 0.02 | 85 | 3.9 | 1085 |
| V. Low | Low | 1.6 | 0.02 | 8 | 0.3 | 1093 |
| V. Low | V. Low | 2.1 | 0.008 | 54 | 0.9 | 1147 |
| Low | Low | 2.0 | 0.034 | 29 | 2.0 | 1176 |
| Low | Low-Mod | 1.9 | 0.051 | 31 | 3.0 | 1207 |
| Low-Mod | Low | 1.6 | 0.055 | 35 | 3.1 | 1242 |
| Low-Mod | Mod | 1.9 | 0.1 | 37 | 7.0 | 1279 |
| V. Low | V. Low | 0.5 | 0.008 | 10 | 0.0 | 1289 |
| Low | Low | 1.7 | 0.034 | 155 | 9.0 | 1444 |
| V. Low | V. Low | 1.3 | 0.008 | 122 | 1.3 | 1566 |
| Low | Low | 1.2 | 0.034 | 27 | 1.1 | 1593 |
| V. Low | V. Low | 1.6 | 0.008 | 33 | 0.4 | 1626 |
| Low | Low | 1.4 | 0.034 | 35 | 1.7 | 1661 |
| V. Low | Low | 1.6 | 0.02 | 39 | 1.2 | 1700 |
| Low | V. Low | 1.4 | 0.02 | 29 | 0.8 | 1729 |
| V. Low | V. Low | 1.6 | 0.008 | 37 | 0.5 | 1766 |
| Low | Low | 1.1 | 0.034 | 34 | 1.3 | 1800 |
| V. Low | Low | 1.2 | 0.02 | 49 | 1.2 | 1849 |
| V. Low | V. Low | 1.5 | 0.008 | 57 | 0.7 | 1906 |
| Low | V. Low | 1.3 | 0.02 | 38 | 1.0 | 1944 |
| | | | | TOTAL FT³/YR | 40.3 | |
| | | | | TOTAL YD³/YR | 1.5 | |
| | | | | **TOTAL TONS/YR** | 1.9 | |

| | Left | Right |
|---|---|---|
| Total Length | 956 | 944 |

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 | 1900 |
| Total TONS per year | 5.1 |
| Tons per ft per year | 0.0027 |
| Tons per 1000ft | 2.7 |

# BANCS Method Calcs

Location: Banner Branch Mitigation Project - UT1-R2 Field Crew: E. Dunnigan/ K. Obermiller Date: 9/17/2019

## 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 FT$^3$/yr =(C×D×E) | STA | BEHI | NBS | STUDY BANK HEIGHT | FEET/YR (from curve) | DISTANCE (note station for detailed design needs) | TOTAL FT$^3$/yr =(C×D×E) | STA |
| Low-Mod | Low-Mod | 2.3 | 0.078 | 17 | 3.0 | 1017 | V. Low | V. Low | 1.6 | 0.008 | 41 | 0.5 | 1041 |
| Low | V. Low | 2.0 | 0.02 | 73 | 2.9 | 1090 | V. Low | V. Low | 1.3 | 0.008 | 30 | 0.3 | 1071 |
| Low-Mod | V. Low | 1.9 | 0.03 | 41 | 2.3 | 1131 | Low-Mod | Mod | 2.1 | 0.1 | 26 | 5.5 | 1097 |
| Low | V. Low | 2.0 | 0.02 | 166 | 6.6 | 1297 | Low | Low | 1.7 | 0.034 | 45 | 2.6 | 1142 |
| V. Low | Low | 2.2 | 0.02 | 85 | 3.7 | 1382 | V. Low | V. Low | 1.3 | 0.008 | 29 | 0.3 | 1171 |
| Low | Low | 1.8 | 0.034 | 44 | 2.7 | 1426 | Low | Low | 1.2 | 0.034 | 87 | 3.5 | 1258 |
| Low-Mod | Low | 2.3 | 0.055 | 29 | 3.7 | 1455 | Low | V. Low | 1.4 | 0.02 | 80 | 2.2 | 1338 |
| Mod-High | High | 3.2 | 0.4 | 41 | 52.5 | 1496 | Low | Low | 1.3 | 0.034 | 29 | 1.3 | 1367 |
| Low-Mod | Low-Mod | 3.5 | 0.078 | 22 | 6.0 | 1518 | V. Low | V. Low | 1.9 | 0.008 | 33 | 0.5 | 1400 |
| Mod | High | 2.4 | 0.38 | 31 | 28.3 | 1549 | Low | Low | 1.7 | 0.034 | 95 | 5.5 | 1495 |
| Low-Mod | Low | 1.9 | 0.055 | 10 | 1.0 | 1559 | Low | Low-Mod | 2.1 | 0.051 | 55 | 5.9 | 1550 |
| Low | Low | 1.8 | 0.034 | 55 | 3.4 | 1614 | Mod | High | 2.3 | 0.38 | 23 | 20.1 | 1573 |
| Low-Mod | Low-Mod | 1.5 | 0.078 | 19 | 2.2 | 1633 | Low | Low | 5.0 | 0.034 | 14 | 2.4 | 1587 |
| Low | V. Low | 1.7 | 0.02 | 21 | 0.7 | 1654 | Low | Low | 3.0 | 0.034 | 50 | 5.1 | 1637 |
| Low | Low-Mod | 1.5 | 0.051 | 12 | 0.9 | 1666 | Low | Low-Mod | 1.3 | 0.051 | 19 | 1.3 | 1656 |
| Low | Low | 1.9 | 0.034 | 17 | 1.1 | 1683 | Low | Low | 1.5 | 0.034 | 13 | 0.7 | 1669 |
| Low | Low-Mod | 1.5 | 0.051 | 12 | 0.9 | 1695 | Low | Low-Mod | 2.5 | 0.051 | 22 | 2.8 | 1691 |
| Low-Mod | Low-Mod | 1.6 | 0.078 | 13 | 1.6 | 1708 | Low | Low | 1.4 | 0.034 | 25 | 1.2 | 1716 |
| Low | Low | 1.7 | 0.034 | 31 | 1.8 | 1739 | Low | Low-Mod | 1.3 | 0.051 | 25 | 1.7 | 1741 |
| Low-Mod | Mod | 1.5 | 0.1 | 14 | 2.1 | 1753 | Low | Low | 2.0 | 0.034 | 70 | 4.8 | 1811 |
| Low | Low | 1.3 | 0.034 | 53 | 2.3 | 1806 | Low-Mod | Low-Mod | 1.1 | 0.078 | 15 | 1.3 | 1826 |
| Low-Mod | Low | 1.4 | 0.055 | 17 | 1.3 | 1823 | V. Low | Low | 1.2 | 0.02 | 25 | 0.6 | 1851 |
| Low | Low | 1.6 | 0.034 | 48 | 2.6 | 1871 | Low | Low | 1.8 | 0.034 | 17 | 1.0 | 1868 |
| Low | V. Low | 1.5 | 0.02 | 11 | 0.3 | 1882 | V. Low | V. Low | 2.2 | 0.008 | 15 | 0.3 | 1883 |
| Low | Low-Mod | 1.5 | 0.051 | 22 | 1.7 | 1904 | Low | Low | 1.8 | 0.034 | 45 | 2.8 | 1928 |
| Low | Low | 1.6 | 0.034 | 23 | 1.3 | 1927 | V. Low | V. Low | 1.3 | 0.008 | 23 | 0.2 | 1951 |
| Low | Low-Mod | 1.4 | 0.051 | 66 | 4.7 | 1993 | Low | Low | 1.4 | 0.034 | 85 | 4.0 | 2036 |
| Low | Low | 1.6 | 0.034 | 45 | 2.4 | 2038 | Low | Low-Mod | 1.5 | 0.051 | 19 | 1.5 | 2055 |
| Low | Low-Mod | 1.3 | 0.051 | 17 | 1.1 | 2055 | V. Low | Low-Mod | 1.3 | 0.03 | 21 | 0.8 | 2076 |
| Low | Low | 1.0 | 0.034 | 21 | 0.7 | 2076 | Low | Low | 1.2 | 0.034 | 42 | 1.7 | 2118 |
| Low | Mod | 1.1 | 0.068 | 9 | 0.7 | 2085 | Low-Mod | Mod | 1.4 | 0.1 | 16 | 2.2 | 2134 |
| V. Low | Low | 0.8 | 0.02 | 68 | 1.1 | 2153 | V. Low | Low | 1.9 | 0.02 | 62 | 2.4 | 2196 |
| Low | Low | 0.6 | 0.034 | 19 | 0.4 | 2172 | V. Low | Low | 1.8 | 0.02 | 17 | 0.6 | 2213 |
| V. Low | V. Low | 0.4 | 0.008 | 283 | 0.9 | 2455 | V. Low | Low | 0.8 | 0.02 | 81 | 1.3 | 2294 |
| | | | | | | | V. Low | V. Low | 0.7 | 0.008 | 215 | 1.2 | 2509 |
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|---|---|---|---|---|
| | TOTAL FT$^3$/YR | 149.2 | TOTAL FT$^3$/YR | 90.0 |
| Divide FT$^3$/yr by 27 | TOTAL YD$^3$/YR | 5.5 | TOTAL YD$^3$/YR | 3.3 |
| Multiply YD$^3$/yr by 1.3 | **TOTAL TONS/YR** | 7.2 | **TOTAL TONS/YR** | 4.3 |

Total Length 1455 1509

| | |
|---|---|
| Total ft assessed | 2964 |
| Total TONS per year | 11.5 |
| Tons per ft per year | 0.0039 |
| Tons per 1000ft | 3.9 |

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** | | | | | | | | | |

BANCS Method Calcs

Location: Banner Branch Mitigation Project - BB Field Crew: K. VanStell/ C. Tomsic Date: 9/17/2019

**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** |
| Low-Mod | Low | 4.4 | 0.055 | 185 | 44.8 | 1185 | Low-Mod | Low | 2.3 | 0.055 | 55 | 7.0 | 1055 |
| Low-Mod | V. Low | 3.8 | 0.03 | 91 | 10.4 | 1276 | Low-Mod | V. Low | 3.0 | 0.03 | 67 | 6.0 | 1122 |
| | | | | | | | Low-Mod | Mod | 2.4 | 0.1 | 45 | 10.8 | 1167 |
| | | | | | | | Low-Mod | Low | 2.5 | 0.055 | 40 | 5.5 | 1207 |
| | | | | | | | Low | V. Low | 2.7 | 0.02 | 66 | 3.6 | 1273 |

| | | | | |
|---|---|---|---|---|
| | TOTAL FT³/YR | 55.1 | TOTAL FT³/YR | 32.9 |
| Divide FT³/yr by 27 | TOTAL YD³/YR | 2.0 | TOTAL YD³/YR | 1.2 |
| Multiply YD³/yr by 1.3 | **TOTAL TONS/YR** | 2.7 | **TOTAL TONS/YR** | 1.6 |
| Total Length | | 276 | | 273 |

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 | 549 |
| Total TONS per year | 4.2 |
| Tons per ft per year | 0.0077 |
| Tons per 1000ft | 7.7 |

BANCS Method Calcs

Appendix 2

Location: Banner Branch Mitigation Project - BB-R1 Field Crew: E. Dunnigan/ K. Obermiller Date: 9/17/2019

## 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 FT$^3$/yr =(C×D×E) | STA | BEHI | NBS | STUDY BANK HEIGHT | FEET/YR (from curve) | DISTANCE (note station for detailed design needs) | TOTAL FT$^3$/yr =(C×D×E) | STA |
| Low | Low | 2.1 | 0.034 | 80 | 5.7 | 1080 | Low | V. Low | 4.9 | 0.02 | 110 | 10.8 | 1110 |
| Mod-High | Low-Mod | 1.9 | 0.2 | 30 | 11.4 | 1110 | V. Low | Low | 3.5 | 0.02 | 35 | 2.5 | 1145 |
| High | High | 3.3 | 0.5 | 40 | 66.0 | 1150 | Low-Mod | Mod | 3.6 | 0.1 | 25 | 9.0 | 1170 |
| Mod-High | Low-Mod | 3.5 | 0.2 | 70 | 49.0 | 1220 | Mod | Mod-High | 2.3 | 0.27 | 60 | 37.3 | 1230 |
| Mod-High | Mod-High | 3.1 | 0.3 | 160 | 148.8 | 1380 | Mod | Low-Mod | 2.1 | 0.135 | 65 | 18.4 | 1295 |
| High | Mod | 3.4 | 0.3 | 90 | 91.8 | 1470 | Mod | Mod-High | 3.3 | 0.27 | 25 | 22.3 | 1320 |
| High | Mod-High | 3.7 | 0.4 | 35 | 51.8 | 1505 | Mod | Low-Mod | 3.8 | 0.135 | 130 | 66.7 | 1450 |
| Mod-High | Mod-High | 3.0 | 0.3 | 55 | 49.5 | 1560 | Mod | Mod-High | 3.5 | 0.27 | 65 | 61.4 | 1515 |
| High | High | 3.4 | 0.5 | 50 | 85.0 | 1610 | Mod | Low-Mod | 4.0 | 0.135 | 60 | 32.4 | 1575 |
| Mod | Low-Mod | 3.1 | 0.135 | 60 | 25.1 | 1670 | Mod | Mod-High | 3.4 | 0.27 | 45 | 41.3 | 1620 |
| High | High | 3.0 | 0.5 | 90 | 135.0 | 1760 | Mod | Low-Mod | 3.7 | 0.135 | 55 | 27.5 | 1675 |
| High | Low | 3.3 | 0.18 | 50 | 29.7 | 1810 | Low-Mod | Low | 2.6 | 0.055 | 55 | 7.9 | 1730 |
| High | Low-Mod | 3.6 | 0.24 | 40 | 34.6 | 1850 | Low | Low | 2.4 | 0.034 | 55 | 4.5 | 1785 |
| Low | Low | 3.0 | 0.034 | 70 | 7.1 | 1920 | Mod-High | High | 2.7 | 0.4 | 55 | 59.4 | 1840 |
| | | | | | | | V. Low | Low | 3.4 | 0.02 | 65 | 4.4 | 1905 |
| | | | | TOTAL FT$^3$/YR | 790.5 | | | | | | TOTAL FT$^3$/YR | 405.7 | |
| Divide FT$^3$/yr by 27 | | | | TOTAL YD$^3$/YR | 29.3 | | | | | | TOTAL YD$^3$/YR | 15.0 | |
| Multiply YD$^3$/yr by 1.3 | | | | **TOTAL TONS/YR** | 38.1 | | | | | | **TOTAL TONS/YR** | 19.5 | |

Total Length 920 905

| | |
|---|---|
| Total ft assessed | 1825 |
| Total TONS per year | 57.6 |
| Tons per ft per year | 0.0316 |
| Tons per 1000ft | 31.6 |

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** | | | | | | | | | |

BANCS Method Calcs

Appendix 2

Location: Banner Branch Mitigation Project - BB-R2 Field Crew: E. Dunnigan/ K. Obermiller Date: 9/17/2019

## SEDIMENT LOADING ASSESSMENT SHEET

| | | | LEFT 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 |
| Mod-High | Mod | 3.1 | 0.25 | 20 | 15.5 | 1020 |
| Mod-High | Low | 2.4 | 0.15 | 230 | 82.8 | 1250 |
| Mod-High | Mod-High | 2.6 | 0.3 | 20 | 15.6 | 1270 |
| Mod-High | Low | 2.5 | 0.15 | 100 | 37.5 | 1370 |
| Mod-High | Mod-High | 3.0 | 0.3 | 120 | 108.0 | 1490 |
| Mod | Low | 3.1 | 0.09 | 40 | 11.2 | 1530 |
| High | Mod-High | 2.9 | 0.4 | 70 | 81.2 | 1600 |
| High | Low | 2.8 | 0.18 | 30 | 15.1 | 1630 |
| Mod | Mod-High | 3.5 | 0.27 | 90 | 85.1 | 1720 |
| Mod | Low | 3.3 | 0.09 | 20 | 5.9 | 1740 |
| High | Mod-High | 4.0 | 0.4 | 30 | 48.0 | 1770 |
| Mod | Low | 3.7 | 0.09 | 40 | 13.3 | 1810 |
| High | Mod-High | 3.2 | 0.4 | 80 | 102.4 | 1890 |
| High | Low | 3.6 | 0.18 | 50 | 32.4 | 1940 |
| High | Mod-High | 3.8 | 0.4 | 65 | 98.8 | 2005 |
| High | Low | 3.5 | 0.18 | 40 | 25.2 | 2045 |
| High | Mod-High | 3.3 | 0.4 | 45 | 59.4 | 2090 |
| Mod | Low | 3.4 | 0.09 | 120 | 36.7 | 2210 |
| High | Mod-High | 3.6 | 0.4 | 100 | 144.0 | 2310 |
| Mod | Low | 3.7 | 0.09 | 90 | 30.0 | 2400 |
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| | | | 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 |
| Low | Low | 3.3 | 0.034 | 120 | 13.5 | 1120 |
| Low-Mod | Low-Mod | 3.6 | 0.078 | 75 | 21.1 | 1195 |
| Low | Low | 3.8 | 0.034 | 35 | 4.5 | 1230 |
| Low-Mod | Mod | 3.9 | 0.1 | 20 | 7.8 | 1250 |
| Mod | Mod | 3.7 | 0.18 | 45 | 30.0 | 1295 |
| High | Mod-High | 3.1 | 0.4 | 30 | 37.2 | 1325 |
| Mod | Low | 2.9 | 0.09 | 40 | 10.4 | 1365 |
| Low-Mod | Low | 3.5 | 0.055 | 55 | 10.6 | 1420 |
| Mod-High | Mod | 2.7 | 0.25 | 35 | 23.6 | 1455 |
| Low | Low | 3.2 | 0.034 | 55 | 6.0 | 1510 |
| Mod | Low | 3.8 | 0.09 | 80 | 27.4 | 1590 |
| Low | Low | 3.1 | 0.034 | 110 | 11.6 | 1700 |
| Mod-High | High | 3.9 | 0.4 | 35 | 54.6 | 1735 |
| Low | Low | 2.2 | 0.034 | 30 | 2.2 | 1765 |
| Mod-High | Mod | 2.8 | 0.25 | 45 | 31.5 | 1810 |
| Mod | Mod | 3.0 | 0.18 | 25 | 13.5 | 1835 |
| Mod | Low | 2.5 | 0.09 | 60 | 13.5 | 1895 |
| Mod | Mod-High | 2.2 | 0.27 | 40 | 23.8 | 1935 |
| Mod | Low | 2.9 | 0.09 | 60 | 15.7 | 1995 |
| High | High | 3.0 | 0.5 | 30 | 45.0 | 2025 |
| Low | Low | 3.2 | 0.034 | 100 | 10.9 | 2125 |
| Mod | Mod | 3.0 | 0.18 | 30 | 16.2 | 2155 |
| Low-Mod | Low | 3.4 | 0.055 | 130 | 24.3 | 2285 |
| Low-Mod | Mod | 4.2 | 0.1 | 55 | 23.1 | 2340 |
| Low | Low | 3.7 | 0.034 | 45 | 5.7 | 2385 |
| High | Mod-High | 4.0 | 0.4 | 30 | 48.0 | 2415 |
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| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

| | Left bank | | Right bank |
|---|---|---|---|
| | TOTAL FT³/YR | 1048.1 | TOTAL FT³/YR | 531.5 |
| Divide FT³/yr by 27 | TOTAL YD³/YR | 38.8 | TOTAL YD³/YR | 19.7 |
| Multiply YD³/yr by 1.3 | **TOTAL TONS/YR** | 50.5 | **TOTAL TONS/YR** | 25.6 |
| Total Length | | 1400 | | 1415 |

| | |
|---|---|
| Total ft assessed | 2815 |
| Total TONS per year | 76.1 |
| Tons per ft per year | 0.0270 |
| Tons per 1000ft | 27.0 |

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** | | | | | | | | | |

Location: Banner Branch Mitigation Project - BB-R3 Field Crew: E. Dunnigan/ K. Obermiller Date: 9/17/2019

## SEDIMENT LOADING ASSESSMENT SHEET

**LEFT BANK**

| A<br>**BEHI** | B<br>**NBS** | C<br>**STUDY BANK HEIGHT** | D<br>**FEET/YR (from curve)** | E<br>**DISTANCE (note station for detailed design needs)** | F<br>**TOTAL FT$^3$/yr =(C×D×E)** | **STA** |
|---|---|---|---|---|---|---|
| Mod-High | Mod | 4.1 | 0.25 | 10 | 10.3 | 1010 |
| Low-Mod | Low | 3.9 | 0.055 | 20 | 4.3 | 1030 |
| Mod-High | Mod | 4.0 | 0.25 | 90 | 90.0 | 1120 |
| Mod-High | Low | 3.2 | 0.15 | 50 | 24.0 | 1170 |
| Mod-High | High | 3.3 | 0.4 | 40 | 52.8 | 1210 |
| Mod-High | Low | 3.8 | 0.15 | 40 | 22.8 | 1250 |
| Mod-High | Low | 4.0 | 0.15 | 20 | 12.0 | 1270 |
| Mod-High | Low | 4.3 | 0.15 | 90 | 58.1 | 1360 |
| Mod-High | High | 4.0 | 0.4 | 30 | 48.0 | 1390 |
| Mod-High | Low | 4.2 | 0.15 | 50 | 31.5 | 1440 |
| Mod-High | Mod | 3.2 | 0.25 | 40 | 32.0 | 1480 |
| Mod-High | Mod | 2.5 | 0.25 | 25 | 15.6 | 1505 |
| Mod-High | High | 3.0 | 0.4 | 100 | 120.0 | 1605 |
| Mod-High | Low | 3.1 | 0.15 | 20 | 9.3 | 1625 |
| Mod-High | High | 3.6 | 0.4 | 30 | 43.2 | 1655 |
| Mod-High | Low | 3.7 | 0.15 | 50 | 27.8 | 1705 |
| Mod-High | High | 4.0 | 0.4 | 40 | 64.0 | 1745 |
| Mod-High | Low | 3.1 | 0.15 | 40 | 18.6 | 1785 |
| Mod-High | Low | 3.9 | 0.15 | 50 | 29.3 | 1835 |
| Mod-High | High | 4.2 | 0.4 | 20 | 33.6 | 1855 |
| Mod-High | Low | 3.7 | 0.15 | 40 | 22.2 | 1895 |
| Mod-High | High | 3.5 | 0.4 | 60 | 84.0 | 1955 |
| Mod-High | Low | 4.2 | 0.15 | 40 | 25.2 | 1995 |
| Mod-High | High | 4.4 | 0.4 | 20 | 35.2 | 2015 |
| Mod | Low | 4.5 | 0.09 | 40 | 16.2 | 2055 |
| Mod-High | High | 4.2 | 0.4 | 50 | 84.0 | 2105 |
| Mod-High | Low | 4.0 | 0.15 | 30 | 18.0 | 2135 |
| Mod-High | High | 4.1 | 0.4 | 20 | 32.8 | 2155 |
| Mod-High | Low | 4.4 | 0.15 | 70 | 46.2 | 2225 |

|  |  |  |
|---|---|---|
|  | TOTAL FT$^3$/YR | 1110.8 |
| Divide FT$^3$/yr by 27 | TOTAL YD$^3$/YR | 41.1 |
| Multiply YD$^3$/yr by 1.3 | **TOTAL TONS/YR** | 53.5 |

**RIGHT BANK**

| A<br>**BEHI** | B<br>**NBS** | C<br>**STUDY BANK HEIGHT** | D<br>**FEET/YR (from curve)** | E<br>**DISTANCE (note station for detailed design needs)** | F<br>**TOTAL FT$^3$/yr =(C×D×E)** | **STA** |
|---|---|---|---|---|---|---|
| Mod | Mod | 2.9 | 0.18 | 40 | 20.9 | 1040 |
| Mod | Low | 3.3 | 0.09 | 55 | 16.3 | 1095 |
| Mod-High | High | 3.0 | 0.4 | 65 | 78.0 | 1160 |
| Mod | High | 3.8 | 0.38 | 35 | 50.5 | 1195 |
| Low | Low | 4.0 | 0.034 | 50 | 6.8 | 1245 |
| Mod | Mod | 4.1 | 0.18 | 45 | 33.2 | 1290 |
| High | Low | 4.0 | 0.18 | 75 | 54.0 | 1365 |
| Mod | Low-Mod | 4.2 | 0.135 | 25 | 14.2 | 1390 |
| Mod | High | 4.1 | 0.38 | 20 | 31.2 | 1410 |
| Low-Mod | Low | 4.3 | 0.055 | 35 | 8.3 | 1445 |
| Mod-High | Low | 4.4 | 0.15 | 30 | 19.8 | 1475 |
| Mod | Low | 4.0 | 0.09 | 40 | 14.4 | 1515 |
| Mod-High | High | 3.6 | 0.4 | 35 | 50.4 | 1550 |
| Mod | Low | 3.5 | 0.09 | 55 | 17.3 | 1605 |
| High | High | 4.0 | 0.5 | 40 | 80.0 | 1645 |
| Mod | Low | 3.8 | 0.09 | 55 | 18.8 | 1700 |
| High | Low | 4.1 | 0.18 | 135 | 99.6 | 1835 |
| Mod | Low | 4.0 | 0.09 | 95 | 34.2 | 1930 |
| High | Mod | 4.1 | 0.3 | 45 | 55.4 | 1975 |
| Mod | Low | 4.0 | 0.09 | 65 | 23.4 | 2040 |
| Mod-High | High | 3.8 | 0.4 | 40 | 60.8 | 2080 |
| Mod | Low | 3.6 | 0.09 | 25 | 8.1 | 2105 |
| Low | Low | 4.1 | 0.034 | 45 | 6.3 | 2150 |
| Mod | Mod | 4.0 | 0.18 | 20 | 14.4 | 2170 |
| Low | Low-Mod | 3.9 | 0.051 | 30 | 6.0 | 2200 |

|  |  |
|---|---|
| TOTAL FT$^3$/YR | 822.2 |
| TOTAL YD$^3$/YR | 30.5 |
| **TOTAL TONS/YR** | 39.6 |

Total Length 1225 1200

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 | 2425 |
| Total TONS per year | 93.1 |
| Tons per ft per year | 0.0384 |
| Tons per 1000ft | 38.4 |

| | | |
|---|---|---|
| Catchment Area | 6.500 | BMP UT4R1 Upper |
| Pervious Area | 6.500 | |
| Impervious Area | 0.000 | |

| **The Simple Method** | | |
|---|---|---|
| **RV = 0.05 + 0.9 * IA** | Step 1 Simple Method | |
| RV = | 0.05 | Runoff coefficient (unitless) |
| IA = | 0 | Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless |
| | | |
| **V = 3630 * RD * RV * A** | Step 2 in the Simple Method | |
| V | 1180 | Volume of runoff that must be controlled for the design storm (cubic feet) |
| V | 0.33 | 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 | 6.5 | 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* = | 0.021 | Runoff depth (in) |
| CN (Composite) | 74 | 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 = | 3.57 | Potential maximum retention after rainfall begins (in) |
| | | |
| Soil Type | Fairview, Clifford | 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*) | 0.14 | SCS Method Volume of Runoff (ac-in) Required Storage Volume |
| V | 499 | SCS Method Volume of Runoff (cubic feet) Required Storage Volume |
| V | 3731 | SCS Method Volume of Runoff (gallons) Required Storage Volume |
| V | 0.33 | Simple Method Volume of Runoff (ac-in) Required Storage Volume |
| V | 1180 | Simple Method Volume of Runoff (cubic feet) Required Storage Volume |
| Required Ponding Depth | 12 | Depends on desired vegetation type and inundation time. Usually 6-12" (in |
| Required BMP Surface Area | 0.011 | (ac) SCS Method |
| Required BMP Surface Area | 499 | (ft^2) SCS Method |
| Required BMP Surface Area | 0.027 | (ac) Simple Method |
| Required BMP Surface Area | 1180 | (ft^2) Simple Method |
| Actual BMP Surface Area | 0.016 | (ac) Measured in Cadd, GIS or by hand. |
| Actual BMP Surface Area | 700 | (ft^2) |
| Actual BMP Surface Volume | 700 | (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"**

| | | |
|---|---|---|
| Catchment Area | 21.46 | BMP UT4 R2 Lower |
| Pervious Area | 21.46 | |
| Impervious Area | 0.00 | |

| **The Simple Method** | | |
|---|---|---|
| **RV = 0.05 + 0.9 * IA** | Step 1 Simple Method | |
| RV = | 0.05 | Runoff coefficient (unitless) |
| IA = | 0 | Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless |
| | | |
| **V = 3630 * RD * RV * A** | Step 2 in the Simple Method | |
| V | 3895 | Volume of runoff that must be controlled for the design storm (cubic feet) |
| V | 1.07 | 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 | 21.46 | 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* = | 0.014 | Runoff depth (in) |
| CN (Composite) | 72 | 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 = | 3.81 | Potential maximum retention after rainfall begins (in) |
| | | |
| Soil Type | Fairview, Clifford | 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*) | 0.30 | SCS Method Volume of Runoff (ac-in) Required Storage Volume |
| V | 1093 | SCS Method Volume of Runoff (cubic feet) Required Storage Volume |
| V | 8176 | SCS Method Volume of Runoff (gallons) Required Storage Volume |
| V | 1.07 | Simple Method Volume of Runoff (ac-in) Required Storage Volume |
| V | 3895 | Simple Method Volume of Runoff (cubic feet) Required Storage Volume |
| Required Ponding Depth | 12 | Depends on desired vegetation type and inundation time. Usually 6-12" (in |
| Required BMP Surface Area | 0.025 | (ac) SCS Method |
| Required BMP Surface Area | 1093 | (ft^2) SCS Method |
| Required BMP Surface Area | 0.089 | (ac) Simple Method |
| Required BMP Surface Area | 3895 | (ft^2) Simple Method |
| Actual BMP Surface Area | 0.025 | (ac) Measured in Cadd, GIS or by hand. |
| Actual BMP Surface Area | 1088 | (ft^2) |
| Actual BMP Surface Volume | 1088 | (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 | 21.46 | BMP UT4 R2 Lower |
| Pervious Area | 21.46 | |
| Impervious Area | 0.00 | |

| **The Simple Method** | | |
|---|---|---|
| **RV = 0.05 + 0.9 * IA** | Step 1 Simple Method | |
| RV = | 0.05 | Runoff coefficient (unitless) |
| IA = | 0 | Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless |
| | | |
| **V = 3630 * RD * RV * A** | Step 2 in the Simple Method | |
| V | 3895 | Volume of runoff that must be controlled for the design storm (cubic feet) |
| V | 1.07 | 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 | 21.46 | 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* = | 0.001 | Runoff depth (in) |
| CN (Composite) | 65 | 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 = | 5.45 | Potential maximum retention after rainfall begins (in) |
| | | |
| Soil Type | Clifford | 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*) | 0.03 | SCS Method Volume of Runoff (ac-in) Required Storage Volume |
| V | 115 | SCS Method Volume of Runoff (cubic feet) Required Storage Volume |
| V | 862 | SCS Method Volume of Runoff (gallons) Required Storage Volume |
| V | 1.07 | Simple Method Volume of Runoff (ac-in) Required Storage Volume |
| V | 3895 | Simple Method Volume of Runoff (cubic feet) Required Storage Volume |
| Required Ponding Depth | 12 | Depends on desired vegetation type and inundation time. Usually 6-12" (in |
| Required BMP Surface Area | 0.003 | (ac) SCS Method |
| Required BMP Surface Area | 115 | (ft^2) SCS Method |
| Required BMP Surface Area | 0.089 | (ac) Simple Method |
| Required BMP Surface Area | 3895 | (ft^2) Simple Method |
| Actual BMP Surface Area | 0.035 | (ac) Measured in Cadd, GIS or by hand. |
| Actual BMP Surface Area | 1522 | (ft^2) |
| Actual BMP Surface Volume | 1522 | (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"**

## Gully and Streambank Pollutant Load Reduction

This sheet contains two input tables: the first table is for inputing the gully dimensions, and the second is for inputing the eroding streambank dimensions.

| | |
|---|---|
| **Gully:** | **Step 1**. Specify the gully dimensions and assign each gully to a watershed<br>**Step 2**. Specify the time (number of years) that the gully has taken to form the current size.<br>**Step 3**. Specify the gully stabilization (BMP) efficiency (0-1) and the gully soil textural class |
| **Streambank:** | **Step 1**. Specify the stream bank dimensions and assign each bank to a watershed.<br>**Step 2**. Specify the lateral recession rate (ft/yr) of the eroding streambank. Click to see "Streambank Lateral Recession Rate" table<br>**Step 3**. Specify the streambank stabilization (BMP) efficiency (0-1) and the streambank soil textural class |

**Close this sheet**

### 1. Gully dimensions in the different watersheds

| Watershed | Gully | Top Width (ft) | Bottom Width (ft) | Depth (ft) | Length (ft) | Years to Form | BMP Efficiency (0-1) | Soil Textural Class | Soil Dry Weight (ton/ft3) | Nutrient Correction Factor | Annual Load (ton) | Load Reduction (ton) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

### 2. Impaired streambank dimensions in the different watersheds

| Watershed | Strm Bank | Length (ft) | Height (ft) | Lateral Recession | Rate Range (ft/yr) | Rate (ft/yr) | BMP Efficiency (0-1) | Soil Textural Class | Soil Dry Weight (ton/ft3) | Nutrient Correction Factor | Annual Load (ton) | Load Reduction (ton) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W1 | UT1-R1 | 612.5 | 1.2 | 1. Slight | 0.01 - 0.05 | 0.01 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 0.3308 | 0.3142 |
| W1 | UT1-R2 | 1915.4 | 1.3 | 1. Slight | 0.01 - 0.05 | 0.01 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 1.1205 | 1.0645 |
| W1 | UT1A | 410.3 | 1.2 | 1. Slight | 0.01 - 0.05 | 0.01 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 0.2216 | 0.2105 |
| W1 | UT1B | 391.3 | 1.1 | 1. Slight | 0.01 - 0.05 | 0.01 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 0.1937 | 0.1840 |
| W1 | UT1C | 527.6 | 0.7 | 1. Slight | 0.01 - 0.05 | 0.01 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 0.1662 | 0.1579 |
| W1 | BB-R1 | 696 | 2.1 | 2. Moderate | 0.06 - 0.2 | 0.06 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 3.9463 | 3.7490 |
| W1 | BB-R2 | 1759 | 2.7 | 3. Severe | 0.3 - 0.5 | 0.02 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 4.2744 | 4.0607 |
| W1 | BB-R3 | 1137 | 3.8 | 2. Moderate | 0.06 - 0.2 | 0.06 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 11.6656 | 11.0823 |
| W1 | UT2 | 1346.7 | 0.4 | 1. Slight | 0.01 - 0.05 | 0.01 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 0.2424 | 0.2303 |
| W1 | UT2A | 289.2 | 0.5 | 1. Slight | 0.01 - 0.05 | 0.01 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 0.0651 | 0.0618 |
| W1 | UT3 | 138.8 | 0.5 | 1. Slight | 0.01 - 0.05 | 0.01 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 0.0312 | 0.0297 |
| W1 | UT4-R1 | 5077.33 | 2.1 | 2. Moderate | 0.06 - 0.2 | 0.06 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 28.7885 | 27.3490 |
| W1 | UT4-R2 | 1889 | 1.8 | 1. Slight | 0.01 - 0.05 | 0.01 | 0.95 | Loams, sandy clay loams | 0.045 | 0.85 | 1.5301 | 1.4536 |

**Total Load** This is the summary of annual nutrient and sediment load for each subwatershed. This sheet is initially protected.

### 1. Total load by subwatershed(s)

| Watershed | N Load (no BMP) | P Load (no BMP) | BOD Load (no BMP) | Sediment Load (no BMP) | E. coli Load (no BMP) | N Reduction | P Reduction | BOD Reduction | Sediment Reduction | E. coli Reduction | N Load (with BMP) | P Load (with BMP) | BOD (with BMP) | Sediment Load (with BMP) | E. coli Load (with BMP) | %N Reduction | %P Reduction | %BOD Reduction | %Sed Reduction | %E. coli Reduction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | lb/year | lb/year | lb/year | t/year | Billion MPN/ye | lb/year | lb/year | lb/year | t/year | Billion MPN/ye | lb/year | lb/year | lb/year | t/year | Billion MPN/ye | % | % | | | |
| W1 | 27458.8 | 5831.8 | 44790.9 | 838.3 | 0.0 | 5644.1 | 1296.5 | 3217.9 | 531.5 | 0.0 | 21814.7 | 4535.3 | 41573.0 | 306.7 | 0.0 | 20.6 | 22.2 | 7.2 | 63.4 | 0.0 |
| Total | 27458.8 | 5831.8 | 44790.9 | 838.3 | 0.0 | 5644.1 | 1296.5 | 3217.9 | 531.5 | 0.0 | 21814.7 | 4535.3 | 41573.0 | 306.7 | 0.0 | 20.6 | 22.2 | 7.2 | 63.4 | 0.0 |

### 2. Total load by land uses (with BMP)

| Sources | N Load (lb/yr) | P Load (lb/yr) | BOD Load (lb/yr) | Sediment Load (t/yr) | E. coli Load (Billion MPN/yr) |
|---|---|---|---|---|---|
| Urban | 265.49 | 46.40 | 1122.62 | 6.20 | 0.00 |
| Cropland | 2246.64 | 639.75 | 7401.69 | 223.40 | 0.00 |
| Pastureland | 890.22 | 125.40 | 8303.66 | 59.10 | 0.00 |
| Forest | 142.40 | 65.53 | 331.34 | 15.42 | 0.00 |
| Feedlots | 18247.75 | 3649.55 | 24330.33 | 0.00 | 0.00 |
| User Defined | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Septic | 18.65 | 7.31 | 76.17 | 0.00 | 0.00 |
| Gully | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Streambank | 3.58 | 1.38 | 7.15 | 2.63 | 0.00 |
| Groundwater | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 21814.74 | 4535.30 | 41572.96 | 306.75 | 0.00 |

# Bankfull Discharge Regional Curves

**Project:** 18-007 Banner Branch Mitigation Project **Date:** 10/7/2019
**Reach:** BB-R1

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.64** **sq mi** **409.60** ***ac***

| | | |
|---|---|---|
| *Average Field Observed Bankfull* ***C.S.A.*** *=* | | **ft** |
| *Average Field Observed Bankfull* ***Width*** *=* | | **ft** |
| *Average Field Observed Bankfull* ***Depth*** *=* | | **ft** |
| ***Mannings Calculated Q =*** | | **ft** |

---

**Rural Coastal Plains Bankfull Regional Curves**

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 10.82 | sf | 7.57 sf | 9.02 sf |
| W = | 9.34 | ft | 8.69 ft | 8.87 ft |
| D = | 1.13 | ft | 0.88 ft | 1.01 ft |
| **Q =** | **12.01** | **cfs** | *22.63 cfs (WCP)* | **21.67 cfs** |
| | | | *10.44 cfs (ECP)* | |
| | | | **16.53 cfs (Average)** | |

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**Rural Piedmont Bankfull Regional Curves**

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 16.31 | sf | 12.58 sf | 8.15 sf | 11.40 sf | 15.82 sf |
| W = | 12.36 | ft | 12.42 ft | 10.70 ft | 10.83 ft | 9.81 ft |
| D = | 1.44 | ft | 1.01 ft | 0.75 ft | 0.99 ft | 1.30 ft |
| **Q =** | **66.74** | **cfs** | **60.24 cfs** | **28.76 cfs** | **39.21 cfs** | **64.57 cfs** |

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**Rural Valley & Ridge Bankfull Regional Curves**

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 15.95 sf | 9.42 sf | 9.13 sf |
| W = | 16.15 ft | 11.40 ft | 10.24 ft |
| D = | 0.97 ft | 0.83 ft | 0.88 ft |
| **Q =** | **71.69 cfs** | **22.36 cfs** | **30.35 cfs** |

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**Weighted Average Rural Regional Curve Values**

| | | | |
|---|---|---|---|
| **CSA =** | **12.85** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **12.03** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **1.10** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **51.90** | **cfs** | *0.00 ft (Observed Value)* |

**Weighted w/ Urban Regional Curve Values**

| | |
|---|---|
| **12.85** | **sf** |
| **12.03** | **ft** |
| **1.10** | **ft** |
| **51.90** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** **18-007 Banner Branch Mitigation Project** **Date:** **10/7/2019**
**Reach:** **BB-R2**

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.75** **sq mi** **480.00** ***ac***

*Average Field Observed Bankfull* ***C.S.A.*** *=* ***21.0*** **ft**
*Average Field Observed Bankfull* ***Width*** *=* ***13.7*** **ft**
*Average Field Observed Bankfull* ***Depth*** *=* ***1.5*** **ft**
***Mannings Calculated Q =*** ***60.0*** **ft**

### Rural Coastal Plains Bankfull Regional Curves

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 12.01 | sf | 8.45 sf | 9.98 sf |
| W = | 9.89 | ft | 9.23 ft | 9.40 ft |
| D = | 1.18 | ft | 0.92 ft | 1.06 ft |
| **Q =** | **13.46** | **cfs** | *25.41 cfs (WCP)*<br>*11.77 cfs (ECP)*<br>**18.59 cfs (Average)** | **23.83 cfs** |

### Rural Piedmont Bankfull Regional Curves

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 18.13 | sf | 14.12 sf | 9.25 sf | 12.83 sf | 17.62 sf |
| W = | 13.08 | ft | 13.21 ft | 11.46 ft | 11.60 ft | 10.51 ft |
| D = | 1.51 | ft | 1.07 ft | 0.80 ft | 1.04 ft | 1.37 ft |
| **Q =** | **74.69** | **cfs** | **67.95 cfs** | **33.43 cfs** | **44.54 cfs** | **72.38 cfs** |

### Rural Valley & Ridge Bankfull Regional Curves

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 17.77 sf | 10.61 sf | 10.23 sf |
| W = | 17.13 ft | 12.22 ft | 10.98 ft |
| D = | 1.02 ft | 0.87 ft | 0.92 ft |
| **Q =** | **80.88 cfs** | **25.96 cfs** | **34.42 cfs** |

### Weighted Average Rural Regional Curve Values

| | | | |
|---|---|---|---|
| **CSA =** | **14.39** | **sf** | *21.00 ft (Observed Value)* |
| **W =** | **13.20** | **ft** | *13.70 ft (Observed Value)* |
| **D =** | **1.16** | **ft** | *1.53 ft (Observed Value)* |
| **Q =** | **58.60** | **cfs** | *60.00 ft (Observed Value)* |

### Weighted w/ Urban Regional Curve Values

| | |
|---|---|
| **14.39** | **sf** |
| **13.20** | **ft** |
| **1.16** | **ft** |
| **58.60** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** **18-007 Banner Branch Mitigation Project** **Date:** **10/7/2019**
**Reach:** **BB-R3**

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.88** **sq mi** **563.20** ***ac***

| | | |
|---|---|---|
| *Average Field Observed Bankfull* ***C.S.A.*** *=* | ***21.9*** | **ft** |
| *Average Field Observed Bankfull* ***Width*** *=* | ***14.6*** | **ft** |
| *Average Field Observed Bankfull* ***Depth*** *=* | ***1.5*** | **ft** |
| ***Mannings Calculated Q =*** | ***75.0*** | **ft** |

**Rural Coastal Plains Bankfull Regional Curves**

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 13.35 | sf | 9.45 sf | 11.05 sf |
| W = | 10.48 | ft | 9.81 ft | 9.97 ft |
| D = | 1.24 | ft | 0.97 ft | 1.11 ft |
| **Q =** | **15.10** | **cfs** | *28.56 cfs (WCP)* | **26.22 cfs** |
| | | | *13.29 cfs (ECP)* | |
| | | | **20.93 cfs (Average)** | |

**Rural Piedmont Bankfull Regional Curves**

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 20.18 | sf | 15.87 sf | 10.51 sf | 14.45 sf | 19.65 sf |
| W = | 13.86 | ft | 14.06 ft | 12.27 ft | 12.43 ft | 11.25 ft |
| D = | 1.58 | ft | 1.13 ft | 0.85 ft | 1.10 ft | 1.44 ft |
| **Q =** | **83.67** | **cfs** | **76.73 cfs** | **38.89 cfs** | **50.65 cfs** | **81.21 cfs** |

**Rural Valley & Ridge Bankfull Regional Curves**

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 19.81 sf | 11.97 sf | 11.48 sf |
| W = | 18.17 ft | 13.11 ft | 11.77 ft |
| D = | 1.07 ft | 0.91 ft | 0.96 ft |
| **Q =** | **91.32 cfs** | **30.17 cfs** | **39.08 cfs** |

**Weighted Average Rural Regional Curve Values**

| | | | |
|---|---|---|---|
| **CSA =** | **16.13** | **sf** | *21.90 ft (Observed Value)* |
| **W =** | **14.50** | **ft** | *14.60 ft (Observed Value)* |
| **D =** | **1.22** | **ft** | *1.50 ft (Observed Value)* |
| **Q =** | **66.23** | **cfs** | *75.00 ft (Observed Value)* |

**Weighted w/ Urban Regional Curve Values**

| | |
|---|---|
| **16.13** | **sf** |
| **14.50** | **ft** |
| **1.22** | **ft** |
| **66.23** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** **18-007 Banner Branch Mitigation Project** **Date:** **10/7/2019**
**Reach:** **UT1A**

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.01** **sq mi** **4.48** ***ac***

*Average Field Observed Bankfull* ***C.S.A.*** *=* **ft**
*Average Field Observed Bankfull* ***Width*** *=* **ft**
*Average Field Observed Bankfull* ***Depth*** *=* **ft**
***Mannings Calculated Q =*** **ft**

### Rural Coastal Plains Bankfull Regional Curves

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 0.55 | sf | 0.32 sf | 0.51 sf |
| W = | 1.84 | ft | 1.56 ft | 1.70 ft |
| D = | 0.29 | ft | 0.21 ft | 0.29 ft |
| **Q =** | **0.47** | **cfs** | *0.84 cfs (WCP)* | **1.45 cfs** |
| | | | *0.34 cfs (ECP)* | |
| | | | **0.59 cfs (Average)** | |

### Rural Piedmont Bankfull Regional Curves

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 0.79 | sf | 0.47 sf | 0.22 sf | 0.40 sf | 0.73 sf |
| W = | 2.43 | ft | 2.13 ft | 1.54 ft | 1.53 ft | 1.41 ft |
| D = | 0.39 | ft | 0.22 ft | 0.14 ft | 0.21 ft | 0.31 ft |
| **Q =** | **2.70** | **cfs** | **1.95 cfs** | **0.40 cfs** | **1.04 cfs** | **2.50 cfs** |

### Rural Valley & Ridge Bankfull Regional Curves

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 0.74 sf | 0.32 sf | 0.35 sf |
| W = | 3.04 ft | 1.56 ft | 1.43 ft |
| D = | 0.24 ft | 0.20 ft | 0.24 ft |
| **Q =** | **2.32 cfs** | **0.32 cfs** | **0.84 cfs** |

### Weighted Average Rural Regional Curve Values

| | | | |
|---|---|---|---|
| **CSA =** | **0.52** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **1.18** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **0.25** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **1.72** | **cfs** | *0.00 ft (Observed Value)* |

### Weighted w/ Urban Regional Curve Values

| | |
|---|---|
| **0.52** | **sf** |
| **1.18** | **ft** |
| **0.25** | **ft** |
| **1.72** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** 18-007 Banner Branch Mitigation Project **Date:** 10/7/2019
**Reach:** UT1B

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.07** **sq mi** **41.60** ***ac***

*Average Field Observed Bankfull* ***C.S.A.*** = ft
*Average Field Observed Bankfull* ***Width*** = ft
*Average Field Observed Bankfull* ***Depth*** = ft
***Mannings Calculated Q*** = ft

**Rural Coastal Plains Bankfull Regional Curves**

| | North Carolina Coastal | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|
| CSA = | 2.39 sf | 1.53 sf | 2.10 sf |
| W = | 4.10 ft | 3.65 ft | 3.85 ft |
| D = | 0.57 ft | 0.42 ft | 0.54 ft |
| **Q =** | **2.31 cfs** | *4.26 cfs (WCP)*<br>*1.84 cfs (ECP)*<br>**3.05 cfs (Average)** | **5.52 cfs** |

**Rural Piedmont Bankfull Regional Curves**

| | North Carolina Piedmont | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|
| CSA = | 3.52 sf | 2.37 sf | 1.31 sf | 2.08 sf | 3.34 sf |
| W = | 5.42 ft | 5.09 ft | 4.01 ft | 4.03 ft | 3.67 ft |
| D = | 0.74 ft | 0.47 ft | 0.32 ft | 0.45 ft | 0.63 ft |
| **Q =** | **13.16 cfs** | **10.59 cfs** | **3.30 cfs** | **6.23 cfs** | **12.44 cfs** |

**Rural Valley & Ridge Bankfull Regional Curves**

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 3.37 sf | 1.70 sf | 1.75 sf |
| W = | 6.93 ft | 4.17 ft | 3.78 ft |
| D = | 0.48 ft | 0.41 ft | 0.46 ft |
| **Q =** | **12.61 cfs** | **2.61 cfs** | **4.94 cfs** |

**Weighted Average Rural Regional Curve Values**

| | | | |
|---|---|---|---|
| **CSA =** | **2.53** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **3.45** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **0.52** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **9.14** | **cfs** | *0.00 ft (Observed Value)* |

**Weighted w/ Urban Regional Curve Values**

| | |
|---|---|
| **2.53** | **sf** |
| **3.45** | **ft** |
| **0.52** | **ft** |
| **9.14** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** **18-007 Banner Branch Mitigation Project** **Date:** **10/7/2019**
**Reach:** **UT1C Lower**

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.02** **sq mi** **15.81** ***ac***

| | | |
|---|---|---|
| *Average Field Observed Bankfull* ***C.S.A.*** *=* | | **ft** |
| *Average Field Observed Bankfull* ***Width*** *=* | | **ft** |
| *Average Field Observed Bankfull* ***Depth*** *=* | | **ft** |
| ***Mannings Calculated Q =*** | | **ft** |

### Rural Coastal Plains Bankfull Regional Curves

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 1.26 | sf | 0.78 sf | 1.13 sf |
| W = | 2.89 | ft | 2.52 ft | 2.70 ft |
| D = | 0.43 | ft | 0.31 ft | 0.42 ft |
| **Q =** | **1.15** | **cfs** | *2.10 cfs (WCP)*<br>*0.88 cfs (ECP)*<br>**1.49 cfs (Average)** | **3.09 cfs** |

### Rural Piedmont Bankfull Regional Curves

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 1.84 | sf | 1.17 sf | 0.61 sf | 1.02 sf | 1.73 sf |
| W = | 3.83 | ft | 3.49 ft | 2.65 ft | 2.65 ft | 2.42 ft |
| D = | 0.56 | ft | 0.34 ft | 0.22 ft | 0.33 ft | 0.46 ft |
| **Q =** | **6.62** | **cfs** | **5.08 cfs** | **1.32 cfs** | **2.86 cfs** | **6.20 cfs** |

### Rural Valley & Ridge Bankfull Regional Curves

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 1.74 sf | 0.82 sf | 0.87 sf |
| W = | 4.84 ft | 2.72 ft | 2.48 ft |
| D = | 0.35 ft | 0.30 ft | 0.34 ft |
| **Q =** | **6.04 cfs** | **1.05 cfs** | **2.29 cfs** |

### Weighted Average Rural Regional Curve Values

| | | | |
|---|---|---|---|
| **CSA =** | **1.27** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **2.13** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **0.38** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **4.42** | **cfs** | *0.00 ft (Observed Value)* |

### Weighted w/ Urban Regional Curve Values

| | |
|---|---|
| **1.27** | **sf** |
| **2.13** | **ft** |
| **0.38** | **ft** |
| **4.42** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** **18-007 Banner Branch Mitigation Project** **Date:** **10/7/2019**
**Reach:** **UT1C Upper**

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.02** **sq mi** **14.98** ***ac***

| | | |
|---|---|---|
| *Average Field Observed Bankfull* ***C.S.A.*** *=* | | **ft** |
| *Average Field Observed Bankfull* ***Width*** *=* | | **ft** |
| *Average Field Observed Bankfull* ***Depth*** *=* | | **ft** |
| ***Mannings Calculated Q =*** | | **ft** |

### Rural Coastal Plains Bankfull Regional Curves

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 1.22 | sf | 0.75 sf | 1.09 sf |
| W = | 2.84 | ft | 2.47 ft | 2.65 ft |
| D = | 0.42 | ft | 0.30 ft | 0.41 ft |
| **Q =** | **1.11** | **cfs** | *2.02 cfs (WCP)* | **2.99 cfs** |
| | | | *0.84 cfs (ECP)* | |
| | | | **1.43 cfs (Average)** | |

### Rural Piedmont Bankfull Regional Curves

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 1.78 | sf | 1.12 sf | 0.58 sf | 0.98 sf | 1.67 sf |
| W = | 3.75 | ft | 3.42 ft | 2.59 ft | 2.59 ft | 2.37 ft |
| D = | 0.55 | ft | 0.33 ft | 0.22 ft | 0.32 ft | 0.45 ft |
| **Q =** | **6.37** | **cfs** | **4.87 cfs** | **1.25 cfs** | **2.74 cfs** | **5.96 cfs** |

### Rural Valley & Ridge Bankfull Regional Curves

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 1.68 sf | 0.79 sf | 0.84 sf |
| W = | 4.75 ft | 2.66 ft | 2.42 ft |
| D = | 0.35 ft | 0.30 ft | 0.34 ft |
| **Q =** | **5.80 cfs** | **1.00 cfs** | **2.20 cfs** |

### Weighted Average Rural Regional Curve Values

| | | | |
|---|---|---|---|
| **CSA =** | **1.22** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **2.08** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **0.37** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **4.24** | **cfs** | *0.00 ft (Observed Value)* |

### Weighted w/ Urban Regional Curve Values

| | |
|---|---|
| **1.22** | **sf** |
| **2.08** | **ft** |
| **0.37** | **ft** |
| **4.24** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** 18-007 Banner Branch Mitigation Project **Date:** 10/7/2019
**Reach:** UT1-R1

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *1%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.06** **sq mi** **41.22** ***ac***

*Average Field Observed Bankfull* ***C.S.A.*** = ft
*Average Field Observed Bankfull* ***Width*** = ft
*Average Field Observed Bankfull* ***Depth*** = ft
***Mannings Calculated Q*** = ft

### Rural Coastal Plains Bankfull Regional Curves

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 2.38 | sf | 1.52 sf | 2.08 sf |
| W = | 4.09 | ft | 3.63 ft | 3.83 ft |
| D = | 0.57 | ft | 0.42 ft | 0.54 ft |
| **Q =** | **2.30** | **cfs** | *4.23 cfs (WCP)* | **5.49 cfs** |
| | | | *1.82 cfs (ECP)* | |
| | | | **3.03 cfs (Average)** | |

### Rural Piedmont Bankfull Regional Curves

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 3.50 | sf | 2.35 sf | 1.30 sf | 2.07 sf | 3.32 sf |
| W = | 5.41 | ft | 5.07 ft | 3.99 ft | 4.01 ft | 3.66 ft |
| D = | 0.74 | ft | 0.46 ft | 0.32 ft | 0.45 ft | 0.62 ft |
| **Q =** | **13.07** | **cfs** | **10.52 cfs** | **3.27 cfs** | **6.19 cfs** | **12.36 cfs** |

### Rural Valley & Ridge Bankfull Regional Curves

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 3.35 sf | 1.68 sf | 1.74 sf |
| W = | 6.91 ft | 4.15 ft | 3.76 ft |
| D = | 0.47 ft | 0.41 ft | 0.45 ft |
| **Q =** | **12.52 cfs** | **2.58 cfs** | **4.90 cfs** |

### Weighted Average Rural Regional Curve Values

| | | | |
|---|---|---|---|
| **CSA =** | **2.51** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **3.43** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **0.52** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **9.08** | **cfs** | *0.00 ft (Observed Value)* |

### Weighted w/ Urban Regional Curve Values

| | |
|---|---|
| **2.51** | **sf** |
| **3.43** | **ft** |
| **0.52** | **ft** |
| **9.08** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** **18-007 Banner Branch Mitigation Project** **Date:** **10/7/2019**
**Reach:** **UT1-R2**

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *1%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.21** **sq mi** **134.98** ***ac***

| | | |
|---|---|---|
| *Average Field Observed Bankfull* ***C.S.A.*** *=* | | **ft** |
| *Average Field Observed Bankfull* ***Width*** *=* | | **ft** |
| *Average Field Observed Bankfull* ***Depth*** *=* | | **ft** |
| ***Mannings Calculated Q =*** | | **ft** |

### Rural Coastal Plains Bankfull Regional Curves

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 5.20 | sf | 3.48 sf | 4.44 sf |
| W = | 6.26 | ft | 5.70 ft | 5.91 ft |
| D = | 0.81 | ft | 0.61 ft | 0.75 ft |
| **Q =** | **5.40** | **cfs** | *10.06 cfs (WCP)*<br>*4.49 cfs (ECP)*<br>**7.28 cfs (Average)** | **11.16 cfs** |

### Rural Piedmont Bankfull Regional Curves

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 7.75 | sf | 5.59 sf | 3.36 sf | 5.00 sf | 7.44 sf |
| W = | 8.29 | ft | 8.05 ft | 6.65 ft | 6.70 ft | 6.09 ft |
| D = | 1.04 | ft | 0.70 ft | 0.50 ft | 0.68 ft | 0.91 ft |
| **Q =** | **30.34** | **cfs** | **25.91 cfs** | **10.05 cfs** | **16.06 cfs** | **29.03 cfs** |

### Rural Valley & Ridge Bankfull Regional Curves

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 7.50 sf | 4.10 sf | 4.09 sf |
| W = | 10.71 ft | 6.99 ft | 6.31 ft |
| D = | 0.69 ft | 0.59 ft | 0.64 ft |
| **Q =** | **30.84 cfs** | **7.88 cfs** | **12.57 cfs** |

### Weighted Average Rural Regional Curve Values

| | | | |
|---|---|---|---|
| **CSA =** | **5.83** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **6.43** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **0.77** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **22.28** | **cfs** | *0.00 ft (Observed Value)* |

### Weighted w/ Urban Regional Curve Values

| | |
|---|---|
| **5.83** | **sf** |
| **6.43** | **ft** |
| **0.77** | **ft** |
| **22.28** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** **18-007 Banner Branch Mitigation Project** **Date:** **10/7/2019**
**Reach:** **UT1-R3**

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.26** **sq mi** **166.40** ***ac***

*Average Field Observed Bankfull* ***C.S.A.*** = ft
*Average Field Observed Bankfull* ***Width*** = ft
*Average Field Observed Bankfull* ***Depth*** = ft
***Mannings Calculated Q*** = ft

### Rural Coastal Plains Bankfull Regional Curves

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 5.97 | sf | 4.03 sf | 5.08 sf |
| W = | 6.75 | ft | 6.17 ft | 6.38 ft |
| D = | 0.86 | ft | 0.66 ft | 0.79 ft |
| **Q =** | **6.28** | **cfs** | *11.73 cfs (WCP)* | **12.64 cfs** |
| | | | *5.26 cfs (ECP)* | |
| | | | **8.49 cfs (Average)** | |

### Rural Piedmont Bankfull Regional Curves

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 8.92 | sf | 6.52 sf | 3.97 sf | 5.84 sf | 8.57 sf |
| W = | 8.93 | ft | 8.74 ft | 7.27 ft | 7.33 ft | 6.66 ft |
| D = | 1.11 | ft | 0.75 ft | 0.54 ft | 0.73 ft | 0.97 ft |
| **Q =** | **35.21** | **cfs** | **30.38 cfs** | **12.25 cfs** | **19.00 cfs** | **33.76 cfs** |

### Rural Valley & Ridge Bankfull Regional Curves

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 8.65 sf | 4.80 sf | 4.76 sf |
| W = | 11.57 ft | 7.67 ft | 6.92 ft |
| D = | 0.73 ft | 0.63 ft | 0.68 ft |
| **Q =** | **36.15 cfs** | **9.59 cfs** | **14.85 cfs** |

| **Weighted Average Rural Regional Curve Values** | | | | **Weighted w/ Urban Regional Curve Values** | |
|---|---|---|---|---|---|
| **CSA =** | **6.76** | **sf** | *0.00 ft (Observed Value)* | **6.76** | **sf** |
| **W =** | **7.21** | **ft** | *0.00 ft (Observed Value)* | **7.21** | **ft** |
| **D =** | **0.82** | **ft** | *0.00 ft (Observed Value)* | **0.82** | **ft** |
| **Q =** | **26.12** | **cfs** | *0.00 ft (Observed Value)* | **26.12** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** 18-007 Banner Branch Mitigation Project **Date:** 10/7/2019
**Reach:** UT2

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.04** **sq mi** **28.35** ***ac***

*Average Field Observed Bankfull* ***C.S.A.*** *=* ft
*Average Field Observed Bankfull* ***Width*** *=* ft
*Average Field Observed Bankfull* ***Depth*** *=* ft
***Mannings Calculated Q =*** ft

### Rural Coastal Plains Bankfull Regional Curves

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 1.86 | sf | 1.17 sf | 1.64 sf |
| W = | 3.57 | ft | 3.15 ft | 3.34 ft |
| D = | 0.51 | ft | 0.37 ft | 0.49 ft |
| **Q =** | **1.76** | **cfs** | *3.22 cfs (WCP)* | **4.39 cfs** |
| | | | *1.37 cfs (ECP)* | |
| | | | **2.30 cfs (Average)** | |

### Rural Piedmont Bankfull Regional Curves

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 2.72 | sf | 1.79 sf | 0.97 sf | 1.57 sf | 2.57 sf |
| W = | 4.72 | ft | 4.38 ft | 3.40 ft | 3.41 ft | 3.11 ft |
| D = | 0.66 | ft | 0.41 ft | 0.28 ft | 0.40 ft | 0.55 ft |
| **Q =** | **10.02** | **cfs** | **7.91 cfs** | **2.29 cfs** | **4.58 cfs** | **9.44 cfs** |

### Rural Valley & Ridge Bankfull Regional Curves

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 2.60 sf | 1.27 sf | 1.33 sf |
| W = | 6.01 ft | 3.52 ft | 3.20 ft |
| D = | 0.42 ft | 0.36 ft | 0.41 ft |
| **Q =** | **9.42 cfs** | **1.82 cfs** | **3.64 cfs** |

### Weighted Average Rural Regional Curve Values

| | | | |
|---|---|---|---|
| **CSA =** | **1.92** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **2.84** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **0.46** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **6.85** | **cfs** | *0.00 ft (Observed Value)* |

### Weighted w/ Urban Regional Curve Values

| | |
|---|---|
| **1.92** | **sf** |
| **2.84** | **ft** |
| **0.46** | **ft** |
| **6.85** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** **18-007 Banner Branch Mitigation Project** **Date:** **10/7/2019**
**Reach:** **UT2A**

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.00** **sq mi** **3.14** ***ac***

*Average Field Observed Bankfull* ***C.S.A.*** = ft
*Average Field Observed Bankfull* ***Width*** = ft
*Average Field Observed Bankfull* ***Depth*** = ft
***Mannings Calculated Q*** = ft

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### Rural Coastal Plains Bankfull Regional Curves

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 0.43 | sf | 0.25 sf | 0.40 sf |
| W = | 1.62 | ft | 1.36 ft | 1.50 ft |
| D = | 0.26 | ft | 0.18 ft | 0.27 ft |
| **Q =** | **0.36** | **cfs** | *0.65 cfs (WCP)* | **1.17 cfs** |
| | | | *0.26 cfs (ECP)* | |
| | | | **0.45 cfs (Average)** | |

### Rural Piedmont Bankfull Regional Curves

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 0.62 | sf | 0.36 sf | 0.17 sf | 0.31 sf | 0.58 sf |
| W = | 2.14 | ft | 1.86 ft | 1.32 ft | 1.32 ft | 1.21 ft |
| D = | 0.35 | ft | 0.19 ft | 0.12 ft | 0.19 ft | 0.27 ft |
| **Q =** | **2.10** | **cfs** | **1.48 cfs** | **0.28 cfs** | **0.78 cfs** | **1.93 cfs** |

### Rural Valley & Ridge Bankfull Regional Curves

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 0.58 sf | 0.24 sf | 0.27 sf |
| W = | 2.66 ft | 1.34 ft | 1.22 ft |
| D = | 0.21 ft | 0.18 ft | 0.22 ft |
| **Q =** | **1.77 cfs** | **0.23 cfs** | **0.63 cfs** |

### Weighted Average Rural Regional Curve Values

| | | | |
|---|---|---|---|
| **CSA =** | **0.41** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **1.01** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **0.23** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **1.32** | **cfs** | *0.00 ft (Observed Value)* |

### Weighted w/ Urban Regional Curve Values

| | |
|---|---|
| **0.41** | **sf** |
| **1.01** | **ft** |
| **0.23** | **ft** |
| **1.32** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** 18-007 Banner Branch Mitigation Project **Date:** 10/7/2019
**Reach:** UT3

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.12** **sq mi** **76.80** ***ac***

*Average Field Observed Bankfull* ***C.S.A.*** = ft
*Average Field Observed Bankfull* ***Width*** = ft
*Average Field Observed Bankfull* ***Depth*** = ft
***Mannings Calculated Q*** = ft

### Rural Coastal Plains Bankfull Regional Curves

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 3.58 | sf | 2.34 sf | 3.10 sf |
| W = | 5.11 | ft | 4.60 ft | 4.81 ft |
| D = | 0.68 | ft | 0.51 ft | 0.64 ft |
| **Q =** | **3.60** | **cfs** | *6.67 cfs (WCP)* | **7.96 cfs** |
| | | | *2.92 cfs (ECP)* | |
| | | | **4.80 cfs (Average)** | |

### Rural Piedmont Bankfull Regional Curves

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 5.31 | sf | 3.71 sf | 2.14 sf | 3.29 sf | 5.07 sf |
| W = | 6.76 | ft | 6.46 ft | 5.22 ft | 5.25 ft | 4.78 ft |
| D = | 0.89 | ft | 0.57 ft | 0.40 ft | 0.56 ft | 0.76 ft |
| **Q =** | **20.33** | **cfs** | **16.88 cfs** | **5.89 cfs** | **10.20 cfs** | **19.35 cfs** |

### Rural Valley & Ridge Bankfull Regional Curves

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 5.11 sf | 2.69 sf | 2.72 sf |
| W = | 8.69 ft | 5.46 ft | 4.94 ft |
| D = | 0.58 ft | 0.49 ft | 0.54 ft |
| **Q =** | **20.09 cfs** | **4.64 cfs** | **8.04 cfs** |

### Weighted Average Rural Regional Curve Values

| | | | |
|---|---|---|---|
| **CSA =** | **3.90** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **4.75** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **0.64** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **14.53** | **cfs** | *0.00 ft (Observed Value)* |

### Weighted w/ Urban Regional Curve Values

| | |
|---|---|
| **3.90** | **sf** |
| **4.75** | **ft** |
| **0.64** | **ft** |
| **14.53** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** **18-007 Banner Branch Mitigation Project** **Date:** **10/7/2019**
**Reach:** **UT4-R1 Lower**

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.24** **sq mi** **153.60** ***ac***

| | | |
|---|---|---|
| *Average Field Observed Bankfull* ***C.S.A.*** *=* | | **ft** |
| *Average Field Observed Bankfull* ***Width*** *=* | | **ft** |
| *Average Field Observed Bankfull* ***Depth*** *=* | | **ft** |
| ***Mannings Calculated Q =*** | | **ft** |

**Rural Coastal Plains Bankfull Regional Curves**

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 5.66 | sf | 3.81 sf | 4.82 sf |
| W = | 6.56 | ft | 5.99 ft | 6.20 ft |
| D = | 0.84 | ft | 0.64 ft | 0.78 ft |
| **Q =** | **5.93** | **cfs** | *11.06 cfs (WCP)*<br>*4.95 cfs (ECP)*<br>**8.01 cfs (Average)** | **12.05 cfs** |

**Rural Piedmont Bankfull Regional Curves**

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 8.45 | sf | 6.15 sf | 3.73 sf | 5.50 sf | 8.12 sf |
| W = | 8.68 | ft | 8.47 ft | 7.02 ft | 7.09 ft | 6.44 ft |
| D = | 1.08 | ft | 0.73 ft | 0.52 ft | 0.71 ft | 0.95 ft |
| **Q =** | **33.26** | **cfs** | **28.58 cfs** | **11.36 cfs** | **17.82 cfs** | **31.87 cfs** |

**Rural Valley & Ridge Bankfull Regional Curves**

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 8.19 sf | 4.52 sf | 4.49 sf |
| W = | 11.24 ft | 7.40 ft | 6.68 ft |
| D = | 0.71 ft | 0.61 ft | 0.66 ft |
| **Q =** | **34.02 cfs** | **8.89 cfs** | **13.93 cfs** |

**Weighted Average Rural Regional Curve Values**

| | | | |
|---|---|---|---|
| **CSA =** | **6.39** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **6.90** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **0.80** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **24.58** | **cfs** | *0.00 ft (Observed Value)* |

**Weighted w/ Urban Regional Curve Values**

| | |
|---|---|
| **6.39** | **sf** |
| **6.90** | **ft** |
| **0.80** | **ft** |
| **24.58** | **cfs** |

# Bankfull Discharge Regional Curves

**Project:** 18-007 Banner Branch Mitigation Project **Date:** 10/7/2019
**Reach:** UT4-R1 Upper

## Watershed Characteristics

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *0%* | Valley & Ridge | *100%* | *Piedmont* | *0%* | *Coastal* | *0%* | *Urban (> 15% Impervious)* |

**Drainage Area:** **0.16** **sq mi** **102.40** ***ac***

*Average Field Observed Bankfull* ***C.S.A.*** *=* ft
*Average Field Observed Bankfull* ***Width*** *=* ft
*Average Field Observed Bankfull* ***Depth*** *=* ft
***Mannings Calculated Q =*** ft

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### Rural Coastal Plains Bankfull Regional Curves

| | North Carolina Coastal | | FWS - MD (CBFO-S03-02) | *USGS -VA, MD (2007-5162)* |
|---|---|---|---|---|
| CSA = | 4.33 | sf | 2.87 sf | 3.72 sf |
| W = | 5.67 | ft | 5.13 ft | 5.35 ft |
| D = | 0.74 | ft | 0.56 ft | 0.69 ft |
| **Q =** | **4.43** | **cfs** | *8.23 cfs (WCP)* | **9.46 cfs** |
| | | | *3.64 cfs (ECP)* | |
| | | | **5.93 cfs (Average)** | |

### Rural Piedmont Bankfull Regional Curves

| | North Carolina Piedmont | | FWS - MD (CBFO-S02-01) | *USGS -VA, MD (200* | North Carolina Walker Curves | NCSU NC Piedmont ('99) |
|---|---|---|---|---|---|---|
| CSA = | 6.44 | sf | 4.57 sf | 2.70 sf | 4.07 sf | 6.16 sf |
| W = | 7.50 | ft | 7.23 ft | 5.90 ft | 5.95 ft | 5.41 ft |
| D = | 0.96 | ft | 0.63 ft | 0.45 ft | 0.62 ft | 0.83 ft |
| **Q =** | **24.94** | **cfs** | **21.00 cfs** | **7.74 cfs** | **12.86 cfs** | **23.80 cfs** |

### Rural Valley & Ridge Bankfull Regional Curves

| | North Carolina V&R | FWS - MD (CBFO-S03-01) | *USGS -VA, MD (2005-5076)* |
|---|---|---|---|
| CSA = | 6.22 sf | 3.33 sf | 3.35 sf |
| W = | 9.67 ft | 6.19 ft | 5.60 ft |
| D = | 0.63 ft | 0.54 ft | 0.59 ft |
| **Q =** | **25.00 cfs** | **6.08 cfs** | **10.10 cfs** |

### Weighted Average Rural Regional Curve Values

| | | | |
|---|---|---|---|
| **CSA =** | **4.79** | **sf** | *0.00 ft (Observed Value)* |
| **W =** | **5.53** | **ft** | *0.00 ft (Observed Value)* |
| **D =** | **0.70** | **ft** | *0.00 ft (Observed Value)* |
| **Q =** | **18.07** | **cfs** | *0.00 ft (Observed Value)* |

### Weighted w/ Urban Regional Curve Values

| | |
|---|---|
| **4.79** | **sf** |
| **5.53** | **ft** |
| **0.70** | **ft** |
| **18.07** | **cfs** |

# Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch BB-R3 XS1 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | E4 | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 21.86 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 1.50 | $D_{bkf}$ (ft) |
| Bankfull Width | 14.56 | $W_{bkf}$ (ft) | Wetted PERIMETER (~2*$D_{bkf}$+$W_{bkf}$) | 17.56 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 40.17 | Dia (mm) | D84 mm/304.8 = | 0.13 | D84 (ft) |
| Bankfull Slope | 0.0052 | S (ft/ft) | Hydraulic Radius ($A_{bkf}$/$W_{Pbkf}$) | 1.24 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 9.44 | ft/ft |
| Drainage Area | 0.88 | DA (sqmi) | Shear Velocity (u*=(g*R*S)$^{0.5}$ | 0.46 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 3.81 | ft/sec | 83.32 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness. u=1.4895*$R^{2/3}$*$S^{1/2}$/n; n= (from tables 1 and 2) | input 'n' below<br>0.035 | 3.55 | ft/sec | 77.62 | CFS |
| 2. Roughness Coefficient: u=1.4895*$R^{2/3}$*$S^{1/2}$/n<br>b) Manning's 'n' from Jarrett (USGS): n=0.39*$S^{0.38}$$R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: u=1.4895*$R^{2/3}$*$S^{1/2}$/n<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.0375 | 3.31 | ft/sec | 72.45 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 4.78 | ft/sec | 104.53 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 3.83 | ft/sec | 83.78 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 14.49 | ft/sec | 316.72 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 3.83 | ft/sec | 83.67 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 12.95 | ft/sec | 283.06 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 2.32 | ft/sec | 50.65 | CFS |

## Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch BB-R2 XS3 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | E4 | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 20.95 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 1.53 | $D_{bkf}$ (ft) |
| Bankfull Width | 13.72 | $W_{bkf}$ (ft) | Wetted PERIMETER (~2*$D_{bkf}$+$W_{bkf}$) | 16.77 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 25.38 | Dia (mm) | D84 mm/304.8 = | 0.08 | D84 (ft) |
| Bankfull Slope | 0.0073 | S (ft/ft) | Hydraulic Radius ($A_{bkf}$/$W_{Pbkf}$) | 1.25 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 15.00 | ft/ft |
| Drainage Area | 0.75 | DA (sqmi) | Shear Velocity (u*=(g*R*S)$^{0.5}$ | 0.54 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 5.14 | ft/sec | 107.69 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>$u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2) | input 'n' below<br>0.032 | 4.61 | ft/sec | 96.63 | CFS |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.038 | 3.88 | ft/sec | 81.37 | CFS |
| .<br>Chezy C, etc.)_________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)_________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 4.53 | ft/sec | 94.88 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 3.58 | ft/sec | 74.91 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 13.80 | ft/sec | 289.14 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 3.57 | ft/sec | 74.69 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 12.22 | ft/sec | 255.94 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 2.13 | ft/sec | 44.54 | CFS |

## Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT2 XS4 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | F4b | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 4.52 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 0.38 | $D_{bkf}$ (ft) |
| Bankfull Width | 11.81 | $W_{bkf}$ (ft) | Wetted PERIMETER ($\sim 2*D_{bkf}+W_{bkf}$) | 12.58 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 53.67 | Dia (mm) | D84 mm/304.8 = | 0.18 | D84 (ft) |
| Bankfull Slope | 0.0341 | S (ft/ft) | Hydraulic Radius ($A_{bkf}/W_{Pbkf}$) | 0.36 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 2.04 | ft/ft |
| Drainage Area | 0.0443 | DA (sqmi) | Shear Velocity ($u^*=(g^*R^*S)^{0.5}$) | 0.63 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 2.88 | ft/sec | 13.02 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>$u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2) | input 'n' below<br>0.059 | 2.36 | ft/sec | 10.65 | CFS |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.041 | 3.39 | ft/sec | 15.33 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 3.50 | ft/sec | 15.81 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 2.29 | ft/sec | 10.34 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 12.75 | ft/sec | 57.65 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 2.22 | ft/sec | 10.02 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 9.53 | ft/sec | 43.06 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 1.01 | ft/sec | 4.58 | CFS |

## Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch BB-R1 XS5 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | B4c | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 16.13 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 1.09 | $D_{bkf}$ (ft) |
| Bankfull Width | 14.83 | $W_{bkf}$ (ft) | Wetted PERIMETER (~$2^*D_{bkf}+W_{bkf}$) | 17.01 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 25.38 | Dia (mm) | D84 mm/304.8 = | 0.08 | D84 (ft) |
| Bankfull Slope | 0.0076 | S (ft/ft) | Hydraulic Radius ($A_{bkf}/W_{Pbkf}$) | 0.95 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 11.39 | ft/ft |
| Drainage Area | 0.64 | DA (sqmi) | Shear Velocity (u*=(g*R*S)$^{0.5}$ | 0.48 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 4.24 | ft/sec | 68.47 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness. u=1.4895*R$^{2/3}$*S$^{1/2}$/n; n= (from tables 1 and 2) | input 'n' below<br>0.033 | 3.80 | ft/sec | 61.27 | CFS |
| 2. Roughness Coefficient: u=1.4895*R$^{2/3}$*S$^{1/2}$/n<br>b) Manning's 'n' from Jarrett (USGS): n=0.39*S$^{0.38}$R$^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: u=1.4895*R$^{2/3}$*S$^{1/2}$/n<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.056 | 2.24 | ft/sec | 36.11 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 5.34 | ft/sec | 86.14 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 4.16 | ft/sec | 67.04 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 16.38 | ft/sec | 264.15 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 4.14 | ft/sec | 66.74 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 14.36 | ft/sec | 231.61 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 2.43 | ft/sec | 39.21 | CFS |

## Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT1-R2 XS6 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | F4 | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 6.98 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 0.61 | $D_{bkf}$ (ft) |
| Bankfull Width | 11.47 | $W_{bkf}$ (ft) | Wetted PERIMETER (~2*$D_{bkf}$+$W_{bkf}$) | 12.69 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 28.09 | Dia (mm) | D84 mm/304.8 = | 0.09 | D84 (ft) |
| Bankfull Slope | 0.0157 | S (ft/ft) | Hydraulic Radius ($A_{bkf}$/$W_{Pbkf}$) | 0.55 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 5.97 | ft/ft |
| Drainage Area | 0.21 | DA (sqmi) | Shear Velocity (u*=(g*R*S)$^{0.5}$ | 0.53 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 3.81 | ft/sec | 26.58 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>$u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2) | input 'n' below<br>0.039 | 3.21 | ft/sec | 22.43 | CFS |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.041 | 3.06 | ft/sec | 21.33 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 6.17 | ft/sec | 43.05 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 4.40 | ft/sec | 30.73 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 20.05 | ft/sec | 139.95 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 4.33 | ft/sec | 30.25 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 16.44 | ft/sec | 114.78 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 2.29 | ft/sec | 16.00 | CFS |

## Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT1B XS7 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | B4 | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 3.8 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 0.59 | $D_{bkf}$ (ft) |
| Bankfull Width | 6.49 | $W_{bkf}$ (ft) | Wetted PERIMETER ($\sim 2*D_{bkf}+W_{bkf}$) | 7.66 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 1 | Dia (mm) | D84 mm/304.8 = | 0.00 | D84 (ft) |
| Bankfull Slope | 0.0251 | S (ft/ft) | Hydraulic Radius ($A_{bkf}/W_{Pbkf}$) | 0.50 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 151.19 | ft/ft |
| Drainage Area | 0.065 | DA (sqmi) | Shear Velocity ($u^*=(g*R*S)^{0.5}$ | 0.63 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 9.60 | ft/sec | 36.49 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness. $u=1.4895*R^{2/3}*S^{1/2}/n$; n=____ (from tables 1 and 2) | input 'n' below<br>0.021 | 7.04 | ft/sec | 26.76 | CFS |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.048 | 3.08 | ft/sec | 11.71 | CFS |
| .<br>Chezy C, etc.)________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 5.34 | ft/sec | 20.29 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 3.56 | ft/sec | 13.52 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 18.88 | ft/sec | 71.73 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 3.46 | ft/sec | 13.16 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 14.43 | ft/sec | 54.83 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 1.64 | ft/sec | 6.23 | CFS |

# Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT1A XS8 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 0.8 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 0.29 | $D_{bkf}$ (ft) |
| Bankfull Width | 2.73 | $W_{bkf}$ (ft) | Wetted PERIMETER ($\sim 2*D_{bkf}+W_{bkf}$) | 3.32 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 2 | Dia (mm) | D84 mm/304.8 = | 0.01 | D84 (ft) |
| Bankfull Slope | 0.0261 | S (ft/ft) | Hydraulic Radius ($A_{bkf}/W_{Pbkf}$) | 0.24 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 36.77 | ft/ft |
| Drainage Area | 0.007 | DA (sqmi) | Shear Velocity ($u^*=(g*R*S)^{0.5}$ | 0.45 | u* (ft/sec) |

| | | | | | |
|---|---|---|---|---|---|
| **ESTIMATION METHODS** | | **Bankfull VELOCITY** | | **Bankfull DISCHARGE** | |
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 5.26 | ft/sec | 4.21 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>$u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2) | input 'n' below<br>0.021 | 4.44 | ft/sec | 3.55 | CFS |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.056 | 1.67 | ft/sec | 1.33 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 5.82 | ft/sec | 4.66 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 3.55 | ft/sec | 2.84 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 25.17 | ft/sec | 20.14 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 3.38 | ft/sec | 2.70 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 16.83 | ft/sec | 13.47 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 1.30 | ft/sec | 1.04 | CFS |

## Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT1C Lower | | | Location | Lawsonville, NC |
| Date | 10/10/2019 | Stream Type | B4 | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 2.6 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 0.62 | $D_{bkf}$ (ft) |
| Bankfull Width | 4.2 | $W_{bkf}$ (ft) | Wetted PERIMETER ($\sim 2*D_{bkf}+W_{bkf}$) | 5.44 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 18.55 | Dia (mm) | D84 mm/304.8 = | 0.06 | D84 (ft) |
| Bankfull Slope | 0.0497 | S (ft/ft) | Hydraulic Radius ($A_{bkf}/W_{Pbkf}$) | 0.48 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 7.86 | ft/ft |
| Drainage Area | 0.0247 | DA (sqmi) | Shear Velocity ($u^*=(g^*R^*S)^{0.5}$) | 0.87 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 6.91 | ft/sec | 17.96 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>$u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2) | input 'n' below<br>0.039 | 5.21 | ft/sec | 13.54 | CFS |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.059 | 3.44 | ft/sec | 8.95 | CFS |
| .<br>Chezy C, etc.)________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 4.14 | ft/sec | 10.77 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 2.64 | ft/sec | 6.87 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 15.89 | ft/sec | 41.32 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 2.55 | ft/sec | 6.62 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 11.46 | ft/sec | 29.80 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 1.10 | ft/sec | 2.86 | CFS |

# Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT1C Upper | | | Location | Lawsonville, NC |
| Date | 10/10/2019 | Stream Type | B4 | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 2.5 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 0.56 | $D_{bkf}$ (ft) |
| Bankfull Width | 4.5 | $W_{bkf}$ (ft) | Wetted PERIMETER (~2*$D_{bkf}$+$W_{bkf}$) | 5.61 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 18.55 | Dia (mm) | D84 mm/304.8 = | 0.06 | D84 (ft) |
| Bankfull Slope | 0.0497 | S (ft/ft) | Hydraulic Radius ($A_{bkf}$/$W_{Pbkf}$) | 0.45 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 7.32 | ft/ft |
| Drainage Area | 0.0234 | DA (sqmi) | Shear Velocity (u*=(g*R*S)$^{0.5}$ | 0.84 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 6.52 | ft/sec | 16.30 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>u=1.4895*R$^{2/3}$*S$^{1/2}$/n; n= (from tables 1 and 2) | input 'n' below<br>0.037 | 5.24 | ft/sec | 13.09 | CFS |
| 2. Roughness Coefficient: u=1.4895*R$^{2/3}$*S$^{1/2}$/n<br>b) Manning's 'n' from Jarrett (USGS): n=0.39*S$^{0.38}$R$^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: u=1.4895*R$^{2/3}$*S$^{1/2}$/n<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.059 | 3.28 | ft/sec | 8.21 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 4.16 | ft/sec | 10.40 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 2.65 | ft/sec | 6.61 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 16.03 | ft/sec | 40.07 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 2.55 | ft/sec | 6.37 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 11.52 | ft/sec | 28.80 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 1.10 | ft/sec | 2.74 | CFS |

# Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT1-R1 XS9 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | E4b | Valley Type | C-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 4.22 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 0.72 | $D_{bkf}$ (ft) |
| Bankfull Width | 5.86 | $W_{bkf}$ (ft) | Wetted PERIMETER (~$2*D_{bkf}+W_{bkf}$) | 7.30 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 19.93 | Dia (mm) | D84 mm/304.8 = | 0.07 | D84 (ft) |
| Bankfull Slope | 0.0269 | S (ft/ft) | Hydraulic Radius ($A_{bkf}/W_{Pbkf}$) | 0.58 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 8.84 | ft/ft |
| Drainage Area | 0.0644 | DA (sqmi) | Shear Velocity ($u^*=(g*R*S)^{0.5}$ | 0.71 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 5.79 | ft/sec | 24.45 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>$u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2) | input 'n' below<br>0.035 | 4.84 | ft/sec | 20.44 | CFS |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.038 | 4.46 | ft/sec | 18.83 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 4.78 | ft/sec | 20.17 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 3.18 | ft/sec | 13.43 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 16.91 | ft/sec | 71.35 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 3.10 | ft/sec | 13.07 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 12.92 | ft/sec | 54.51 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 1.47 | ft/sec | 6.19 | CFS |

# Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT4-R2 XS10 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | | Valley Type | |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 10.73 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 1.01 | $D_{bkf}$ (ft) |
| Bankfull Width | 10.63 | $W_{bkf}$ (ft) | Wetted PERIMETER ($\sim 2*D_{bkf}+W_{bkf}$) | 12.65 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 0.22 | Dia (mm) | D84 mm/304.8 = | 0.00 | D84 (ft) |
| Bankfull Slope | 0.0098 | S (ft/ft) | Hydraulic Radius ($A_{bkf}/W_{Pbkf}$) | 0.85 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 1175.28 | ft/ft |
| Drainage Area | 0.35 | DA (sqmi) | Shear Velocity ($u^*=(g*R*S)^{0.5}$) | 0.52 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 10.45 | ft/sec | 112.18 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>$u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2) | input 'n' below<br>0.023 | 5.75 | ft/sec | 61.64 | CFS |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.046 | 2.87 | ft/sec | 30.82 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 5.53 | ft/sec | 59.34 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 4.09 | ft/sec | 43.94 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 17.45 | ft/sec | 187.26 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 4.05 | ft/sec | 43.48 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 14.76 | ft/sec | 158.35 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 2.25 | ft/sec | 24.13 | CFS |

# Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT4-R1 XS11 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | B4c | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 8.22 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 0.83 | $D_{bkf}$ (ft) |
| Bankfull Width | 9.86 | $W_{bkf}$ (ft) | Wetted PERIMETER ($\sim 2*D_{bkf}+W_{bkf}$) | 11.53 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 37.95 | Dia (mm) | D84 mm/304.8 = | 0.12 | D84 (ft) |
| Bankfull Slope | 0.0181 | S (ft/ft) | Hydraulic Radius ($A_{bkf}/W_{Pbkf}$) | 0.71 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 5.73 | ft/ft |
| Drainage Area | 0.16 | DA (sqmi) | Shear Velocity ($u^*=(g^*R^*S)^{0.5}$) | 0.64 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 4.59 | ft/sec | 37.73 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>$u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2) | input 'n' below<br>0.04 | 4.00 | ft/sec | 32.87 | CFS |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.057 | 2.81 | ft/sec | 23.07 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 4.41 | ft/sec | 36.22 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 3.09 | ft/sec | 25.40 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 14.58 | ft/sec | 119.86 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 3.03 | ft/sec | 24.94 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 11.76 | ft/sec | 96.71 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 1.56 | ft/sec | 12.86 | CFS |

# Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT4-R1 XS12 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | F4 | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 8.3 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 0.68 | $D_{bkf}$ (ft) |
| Bankfull Width | 12.16 | $W_{bkf}$ (ft) | Wetted PERIMETER (~$2*D_{bkf}+W_{bkf}$) | 13.53 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 10.98 | Dia (mm) | D84 mm/304.8 = | 0.04 | D84 (ft) |
| Bankfull Slope | 0.0181 | S (ft/ft) | Hydraulic Radius ($A_{bkf}/W_{Pbkf}$) | 0.61 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 17.04 | ft/ft |
| Drainage Area | 0.24 | DA (sqmi) | Shear Velocity ($u*=(g*R*S)^{0.5}$ | 0.60 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 5.86 | ft/sec | 48.64 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>$u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2) | input 'n' below<br>0.03 | 4.82 | ft/sec | 40.04 | CFS |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.041 | 3.53 | ft/sec | 29.30 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 5.64 | ft/sec | 46.84 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 4.06 | ft/sec | 33.74 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 18.20 | ft/sec | 151.02 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 4.01 | ft/sec | 33.26 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 15.04 | ft/sec | 124.85 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 2.15 | ft/sec | 17.82 | CFS |

## Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT2A | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | E5b | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 0.7 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 0.17 | $D_{bkf}$ (ft) |
| Bankfull Width | 4.04 | $W_{bkf}$ (ft) | Wetted PERIMETER (~2*$D_{bkf}$+$W_{bkf}$) | 4.39 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 1 | Dia (mm) | D84 mm/304.8 = | 0.00 | D84 (ft) |
| Bankfull Slope | 0.0455 | S (ft/ft) | Hydraulic Radius ($A_{bkf}$/$W_{Pbkf}$) | 0.16 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 48.64 | ft/ft |
| Drainage Area | 0.0049 | DA (sqmi) | Shear Velocity (u*=(g*R*S)$^{0.5}$ | 0.48 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 5.99 | ft/sec | 4.19 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>u=1.4895*$R^{2/3}$*$S^{1/2}$/n; n= (from tables 1 and 2) | input 'n' below<br>0.022 | 4.25 | ft/sec | 2.97 | CFS |
| 2. Roughness Coefficient: u=1.4895*$R^{2/3}$*$S^{1/2}$/n<br>b) Manning's 'n' from Jarrett (USGS): n=0.39*$S^{0.38}$$R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: u=1.4895*$R^{2/3}$*$S^{1/2}$/n<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.047 | 1.99 | ft/sec | 1.39 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 5.24 | ft/sec | 3.67 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 3.16 | ft/sec | 2.21 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 23.48 | ft/sec | 16.43 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 3.00 | ft/sec | 2.10 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 15.37 | ft/sec | 10.76 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 1.11 | ft/sec | 0.78 | CFS |

# Bankfull VELOCITY/DISCHARGE Estimates

| | | | | | |
|---|---|---|---|---|---|
| Site | Banner Branch UT3 | | | Location | Lawsonville, NC |
| Date | 10/7/2019 | Stream Type | E5 | Valley Type | U-AL-FD |
| Observers | CAT | | | HUC (8-digit) | 03010103 |

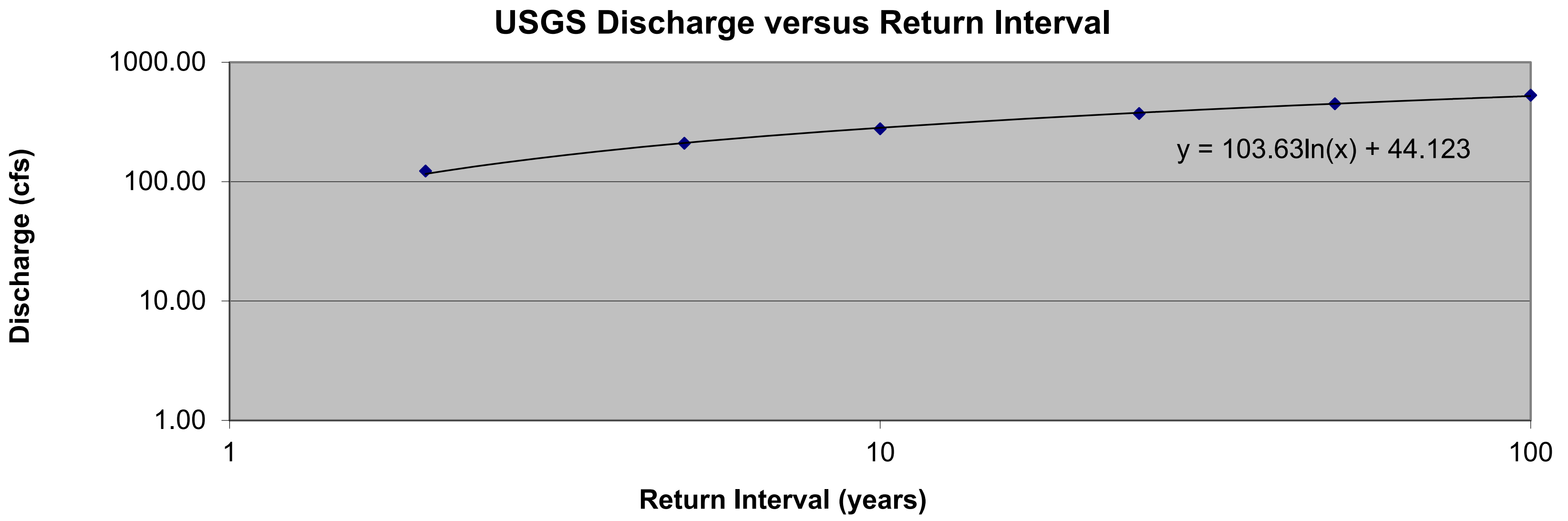
| Input Variables | | | Output Variables | | |
|---|---|---|---|---|---|
| Bankfull Cross-section AREA | 6.2 | $A_{bkf}$ (sqft) | Bankfull Mean DEPTH | 1.11 | $D_{bkf}$ (ft) |
| Bankfull Width | 5.6 | $W_{bkf}$ (ft) | Wetted PERIMETER ($\sim 2*D_{bkf}+W_{bkf}$) | 7.81 | $W_{Pbkf}$ (ft) |
| D84 @Riffle | 2.9 | Dia (mm) | D84 mm/304.8 = | 0.01 | D84 (ft) |
| Bankfull Slope | 0.0105 | S (ft/ft) | Hydraulic Radius ($A_{bkf}/W_{Pbkf}$) | 0.79 | R (ft) |
| Gravitational Acceleration | 32.2 | g (ft/sec$^2$) | Relative Roughness ( R(ft)/D84(ft)) | 83.39 | ft/ft |
| Drainage Area | 0.1187 | DA (sqmi) | Shear Velocity $(u*=(g*R*S)^{0.5}$ | 0.52 | u* (ft/sec) |

| ESTIMATION METHODS | | Bankfull VELOCITY | | Bankfull DISCHARGE | |
|---|---|---|---|---|---|
| 1. Friction Factor/Relative Roughness<br>u=[2.83+5.66*log{R/D84}]*u* | | 7.10 | ft/sec | 44.00 | CFS |
| 2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness.<br>$u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2) | input 'n' below<br>0.022 | 5.95 | ft/sec | 36.86 | CFS |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$ | "n"calcuated | | ft/sec | | CFS |
| NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3) | | | | | |
| 2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$<br>c) Manning's 'n' from Stream Type (Table 3) | input 'n' below<br>0.047 | 2.78 | ft/sec | 17.26 | CFS |
| .<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach,<br>Chezy C, etc.)__________________________________________ | | | ft/sec | | CFS |
| 4. Continuity Equation: b) USGS Gage Data u=Q/A | 1.5 yr Return | 4.83 | ft/sec | 29.93 | CFS |
| 4a. Continuity Equation: a) Regional Curves u=Q/A | Old Rural = | 3.32 | ft/sec | 20.61 | CFS |
| Return Period for Bankfull Discharge Q=______ | Old Urban = | 16.31 | ft/sec | 101.10 | |
| 4b. Continuity Equation: a) Regional Curves u=Q/A | New Rural = | 3.25 | ft/sec | 20.18 | CFS |
| Return Period for Bankfull Discharge Q=______ | New Urban = | 12.92 | ft/sec | 80.12 | |
| 4c. Continuity Equation: a) Walker Curves u=Q/A | Rural = | 1.63 | ft/sec | 10.12 | CFS |

Site Description: Banner Branch BB-R1 XS5

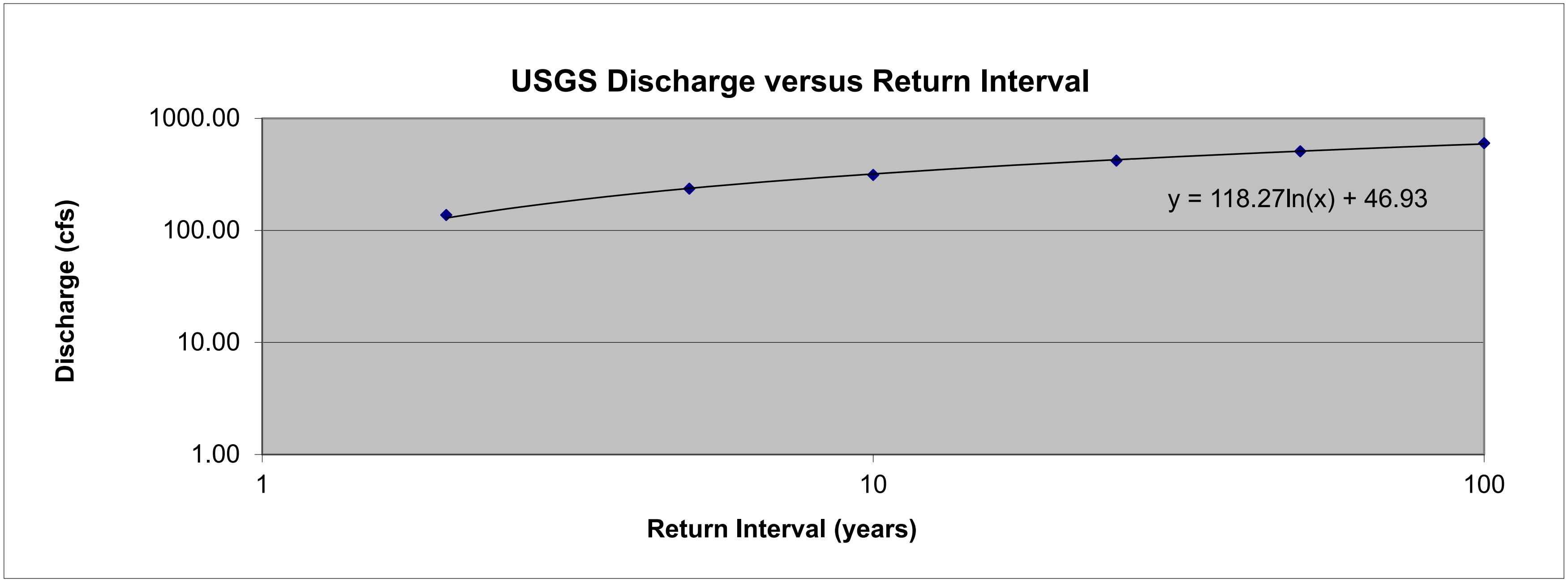
Drainage Area = 0.64 mi$^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 44.12 | extrapolated. Need to use equation generated below. |
| 1.2 | 63.02 | extrapolated. Need to use equation generated below. |
| 1.5 | 86.14 | extrapolated. Need to use equation generated below. |
| 2 | 122.75 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 209.47 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 277.33 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 371.32 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 448.23 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 529.14 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



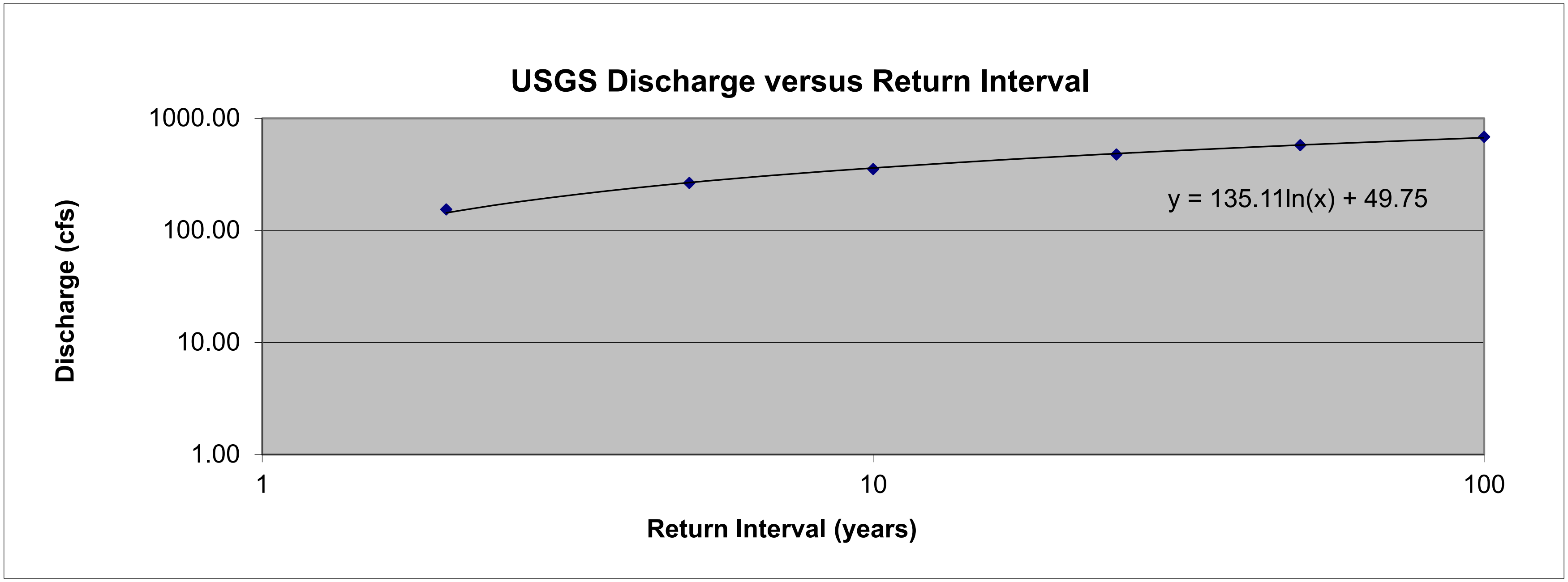
Site Description: Banner Branch BB-R2 XS3
Drainage Area = 0.75 mi$^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 46.93 | extrapolated. Need to use equation generated below. |
| 1.2 | 68.49 | extrapolated. Need to use equation generated below. |
| 1.5 | 94.88 | extrapolated. Need to use equation generated below. |
| 2 | 137.36 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 235.37 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 312.54 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 419.90 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 508.09 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 601.09 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



Site Description: Banner Branch BB-R3 XS1
Drainage Area = 0.88 mi$^2$

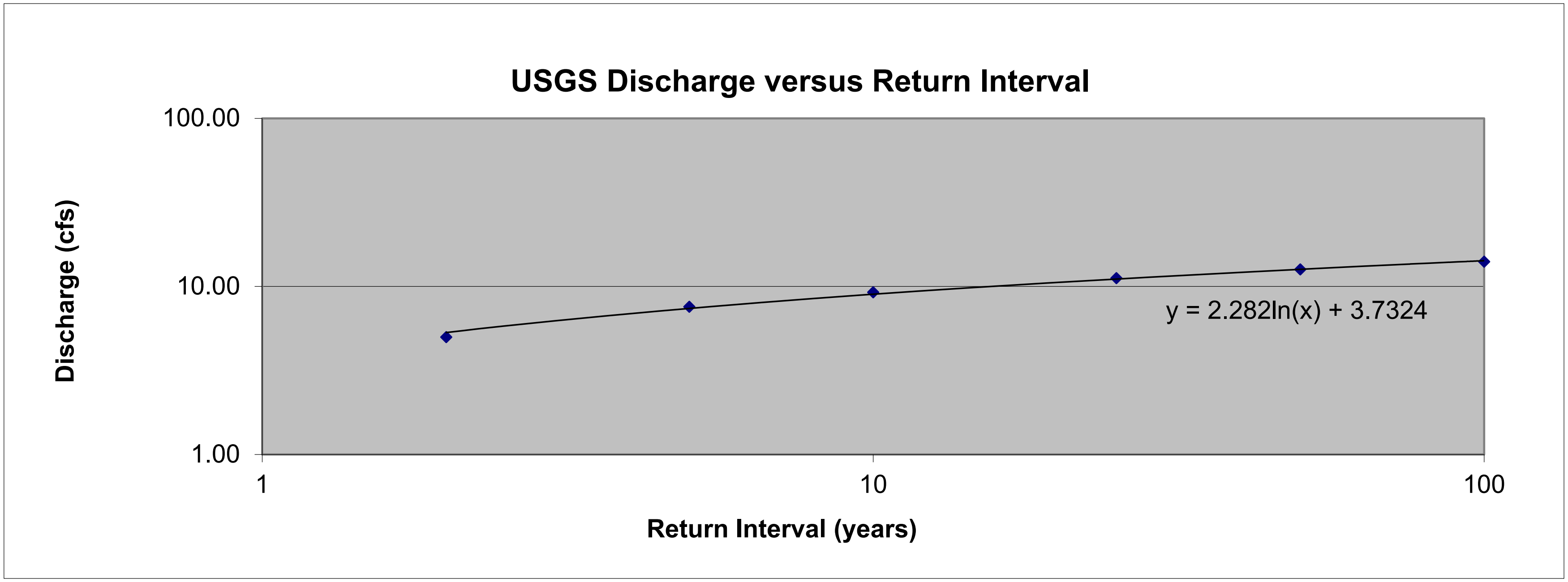
| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 49.75 | extrapolated. Need to use equation generated below. |
| 1.2 | 74.38 | extrapolated. Need to use equation generated below. |
| 1.5 | 104.53 | extrapolated. Need to use equation generated below. |
| 2 | 153.84 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 264.72 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 352.55 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 475.30 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 576.50 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 683.50 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



Site Description: Banner Branch UT1A XS8

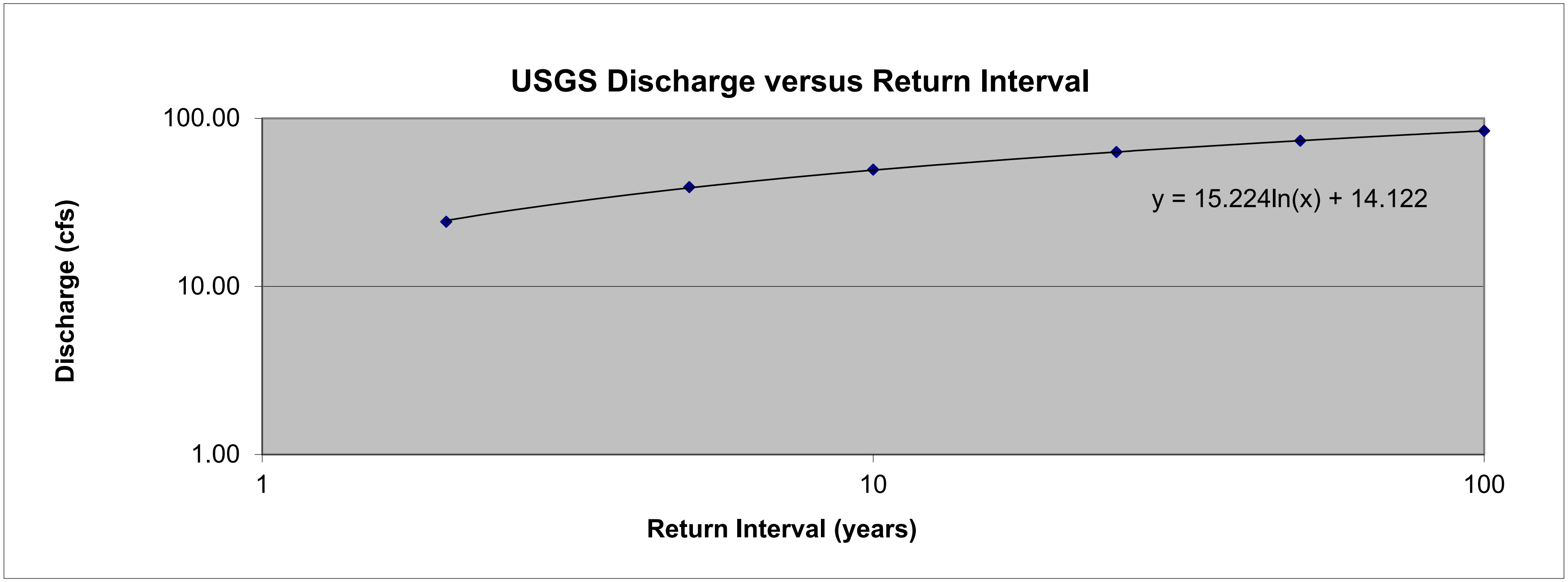
Drainage Area = 0.007 mi$^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 3.73 | extrapolated. Need to use equation generated below. |
| 1.2 | 4.15 | extrapolated. Need to use equation generated below. |
| 1.5 | 4.66 | extrapolated. Need to use equation generated below. |
| 2 | 5.00 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 7.58 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 9.23 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 11.21 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 12.64 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 14.04 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



Site Description: Banner Branch UT1B XS7
Drainage Area = 0.065 $mi^2$

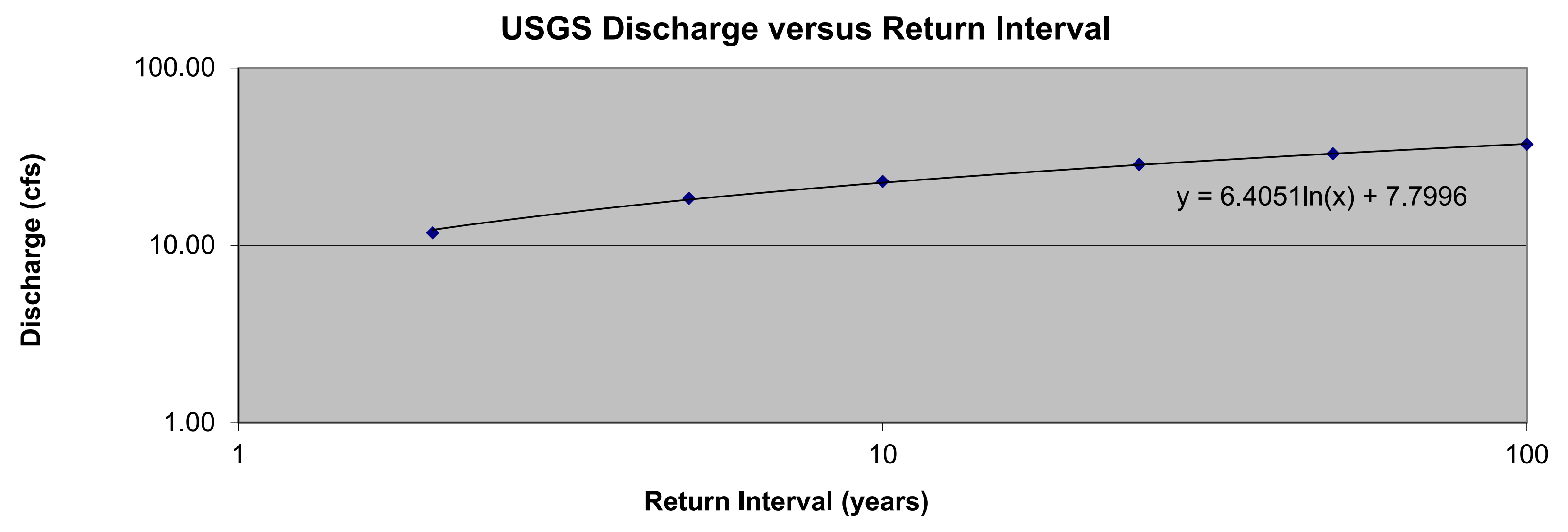
| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 14.12 | extrapolated. Need to use equation generated below. |
| 1.2 | 16.90 | extrapolated. Need to use equation generated below. |
| 1.5 | 20.29 | extrapolated. Need to use equation generated below. |
| 2 | 24.26 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 38.99 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 49.48 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 63.06 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 73.54 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 84.17 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



Site Description: Banner Branch UT1C Upper

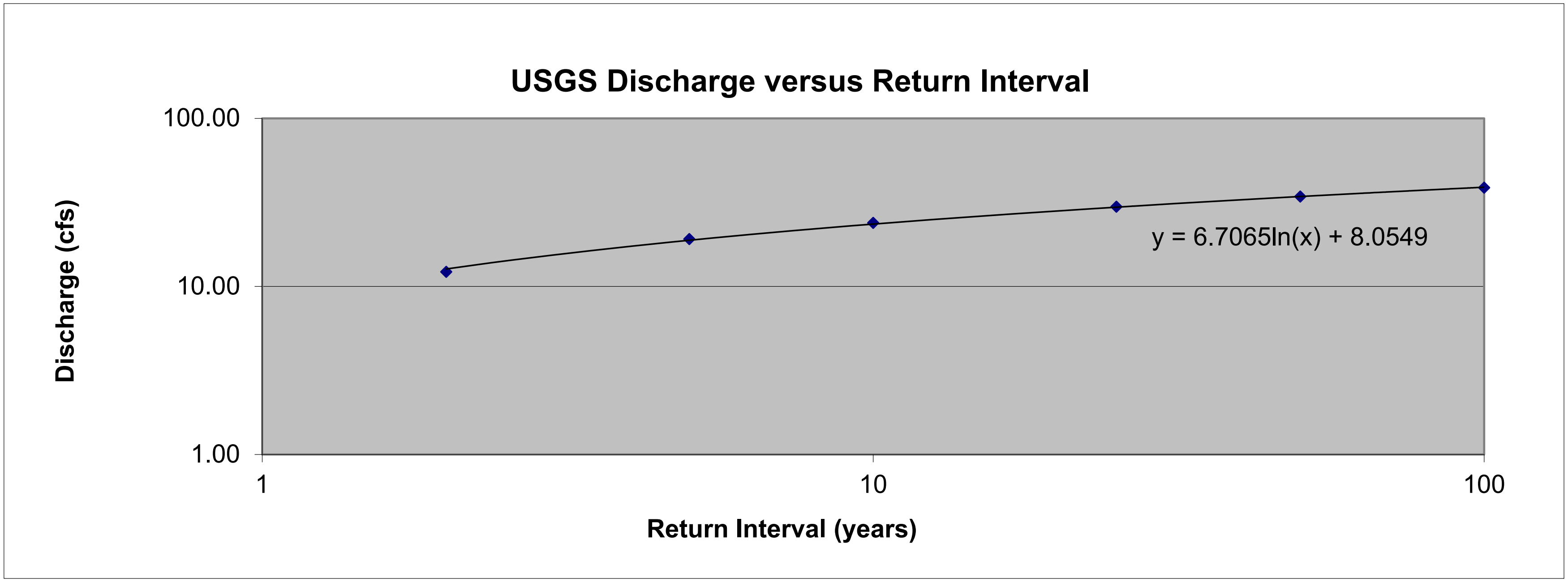
Drainage Area = 0.0234 $mi^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 7.80 | extrapolated. Need to use equation generated below. |
| 1.2 | 8.97 | extrapolated. Need to use equation generated below. |
| 1.5 | 10.40 | extrapolated. Need to use equation generated below. |
| 2 | 11.76 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 18.40 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 22.91 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 28.56 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 32.80 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 37.03 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



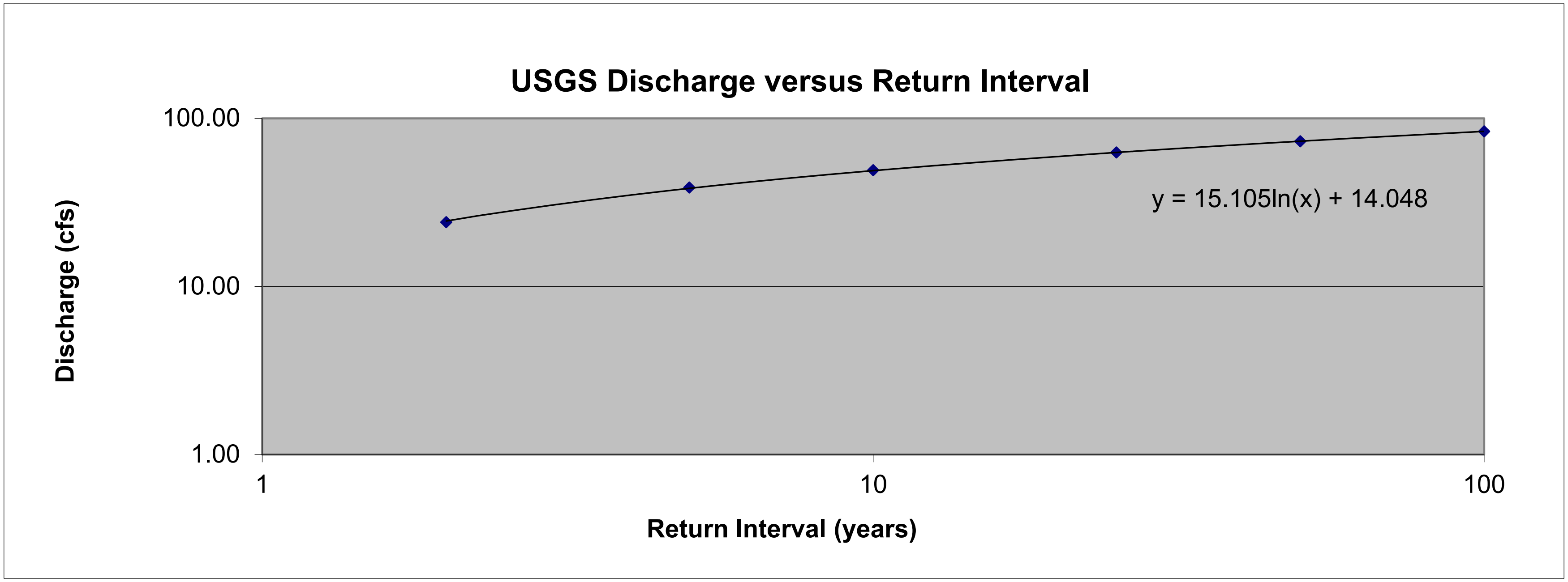
Site Description: Banner Branch UT1C Lower
Drainage Area = 0.0247 mi$^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 8.05 | extrapolated. Need to use equation generated below. |
| 1.2 | 9.28 | extrapolated. Need to use equation generated below. |
| 1.5 | 10.77 | extrapolated. Need to use equation generated below. |
| 2 | 12.22 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 19.15 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 23.87 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 29.79 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 34.23 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 38.67 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



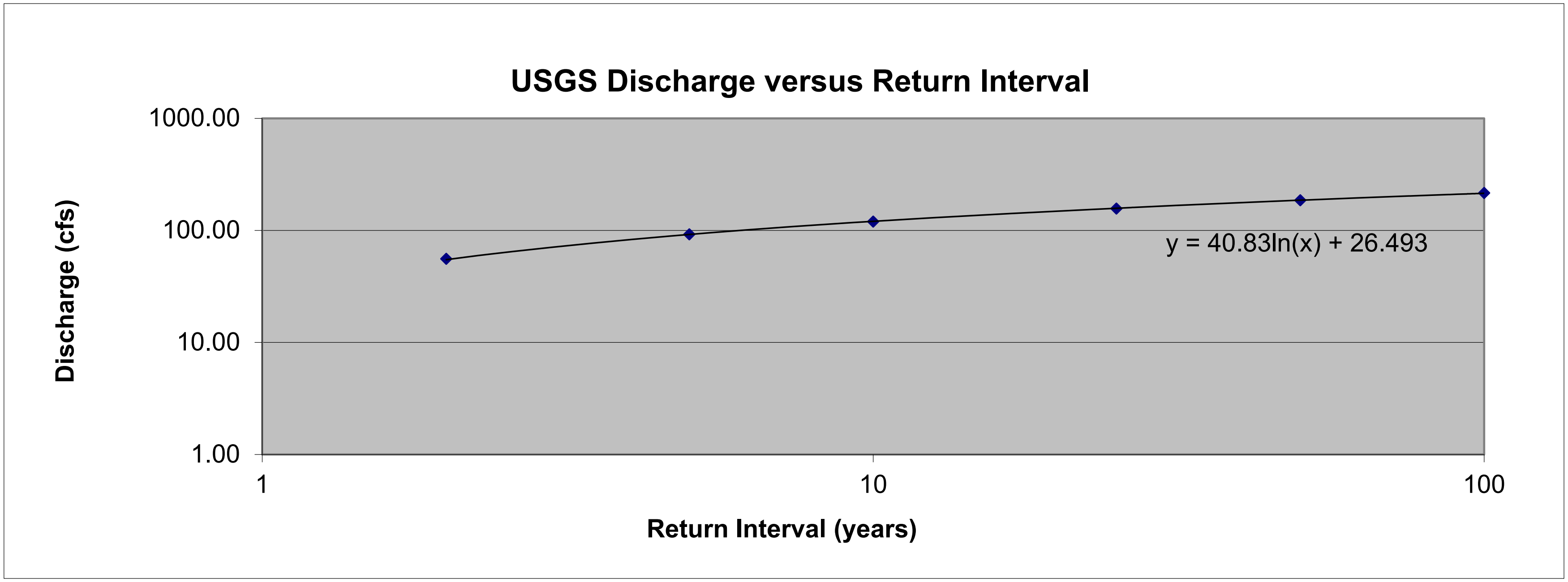
Site Description: Banner Branch UT1-R1 XS9
Drainage Area = 0.0644 mi$^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 14.05 | extrapolated. Need to use equation generated below. |
| 1.2 | 16.80 | extrapolated. Need to use equation generated below. |
| 1.5 | 20.17 | extrapolated. Need to use equation generated below. |
| 2 | 24.10 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 38.73 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 49.14 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 62.61 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 73.00 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 83.55 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



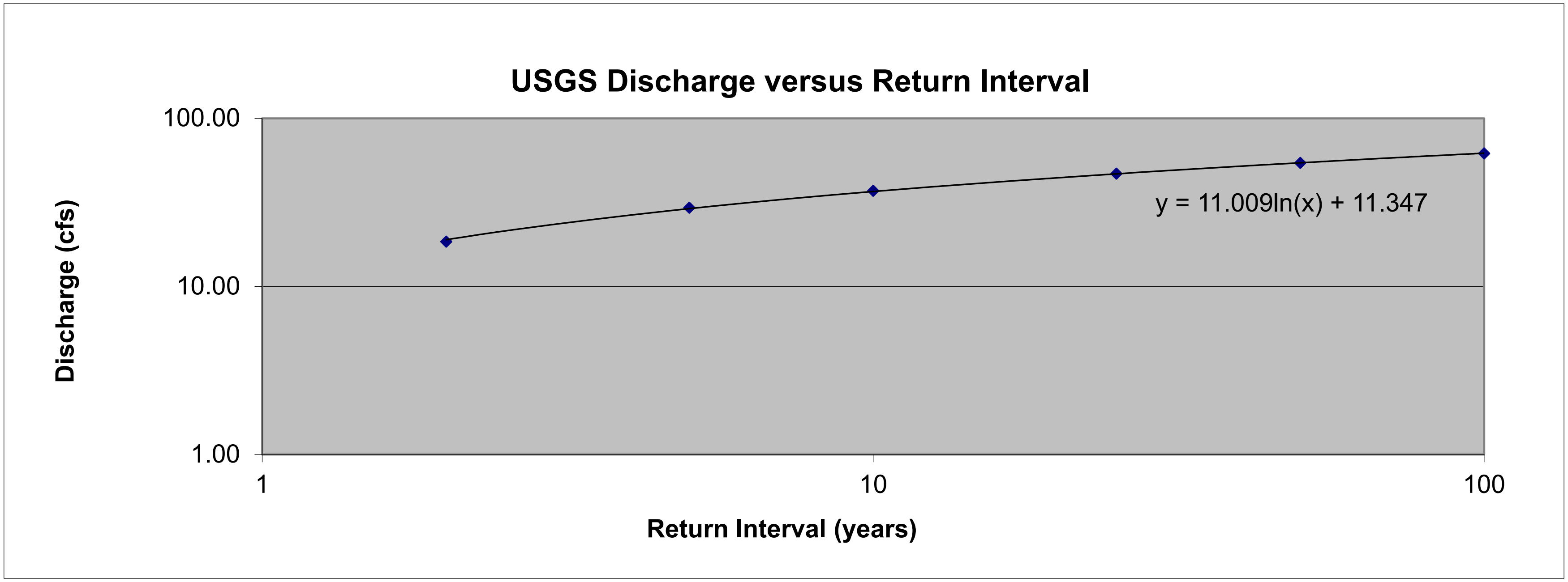
Site Description: Banner Branch UT1-R2 XS6
Drainage Area = 0.21 $mi^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 26.49 | extrapolated. Need to use equation generated below. |
| 1.2 | 33.94 | extrapolated. Need to use equation generated below. |
| 1.5 | 43.05 | extrapolated. Need to use equation generated below. |
| 2 | 55.71 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 92.33 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 119.75 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 156.53 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 185.79 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 216.05 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



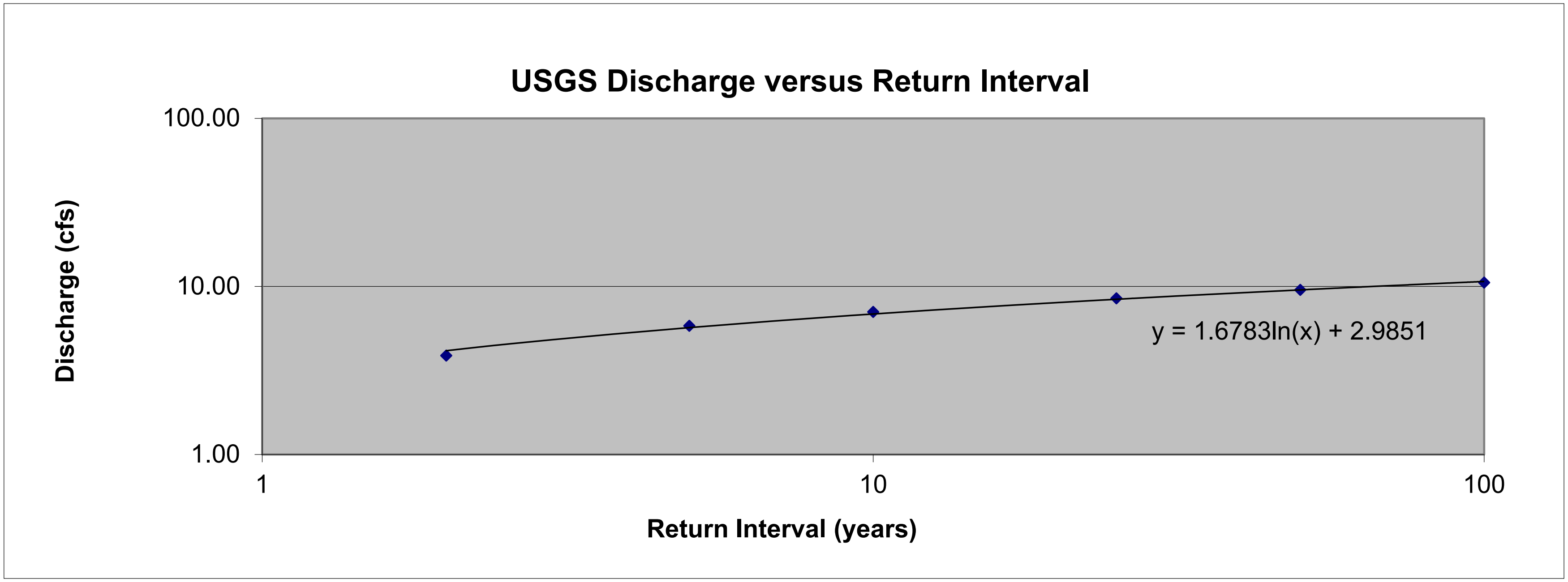
Site Description: Banner Branch UT2 XS4
Drainage Area = 0.0443 $mi^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 11.35 | extrapolated. Need to use equation generated below. |
| 1.2 | 13.35 | extrapolated. Need to use equation generated below. |
| 1.5 | 15.81 | extrapolated. Need to use equation generated below. |
| 2 | 18.49 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 29.41 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 37.07 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 46.85 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 54.32 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 61.85 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



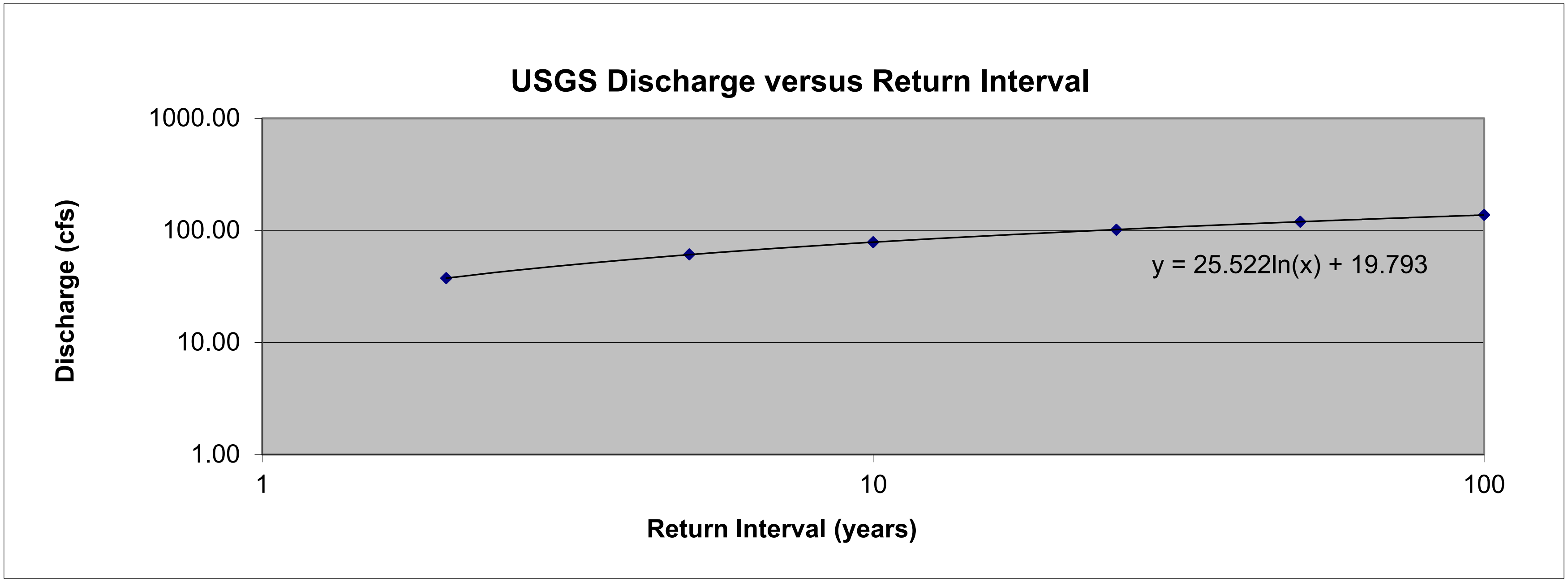
Site Description: Banner Branch UT2A
Drainage Area = 0.0049 mi$^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 2.99 | extrapolated. Need to use equation generated below. |
| 1.2 | 3.29 | extrapolated. Need to use equation generated below. |
| 1.5 | 3.67 | extrapolated. Need to use equation generated below. |
| 2 | 3.88 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 5.83 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 7.05 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 8.50 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 9.53 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 10.54 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



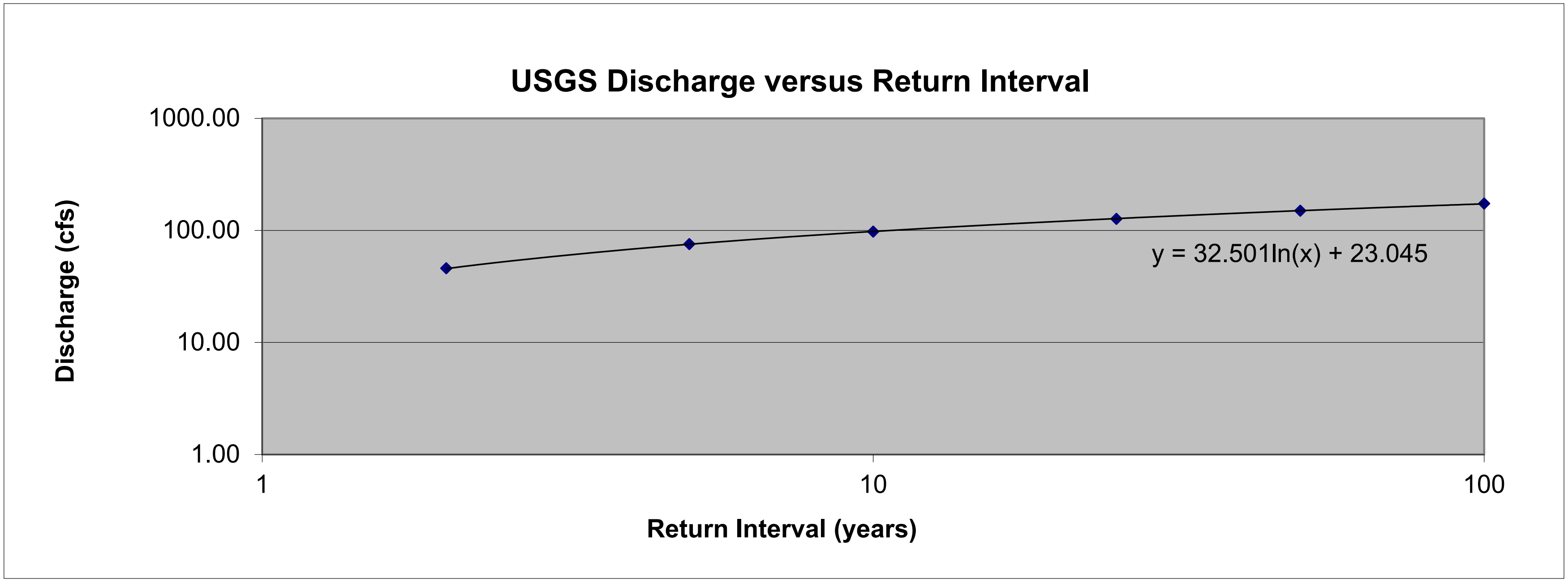
Site Description: Banner Branch UT3
Drainage Area = 0.12 $mi^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 19.79 | extrapolated. Need to use equation generated below. |
| 1.2 | 24.45 | extrapolated. Need to use equation generated below. |
| 1.5 | 30.14 | extrapolated. Need to use equation generated below. |
| 2 | 37.47 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 61.19 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 78.55 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 101.43 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 119.39 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 137.79 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



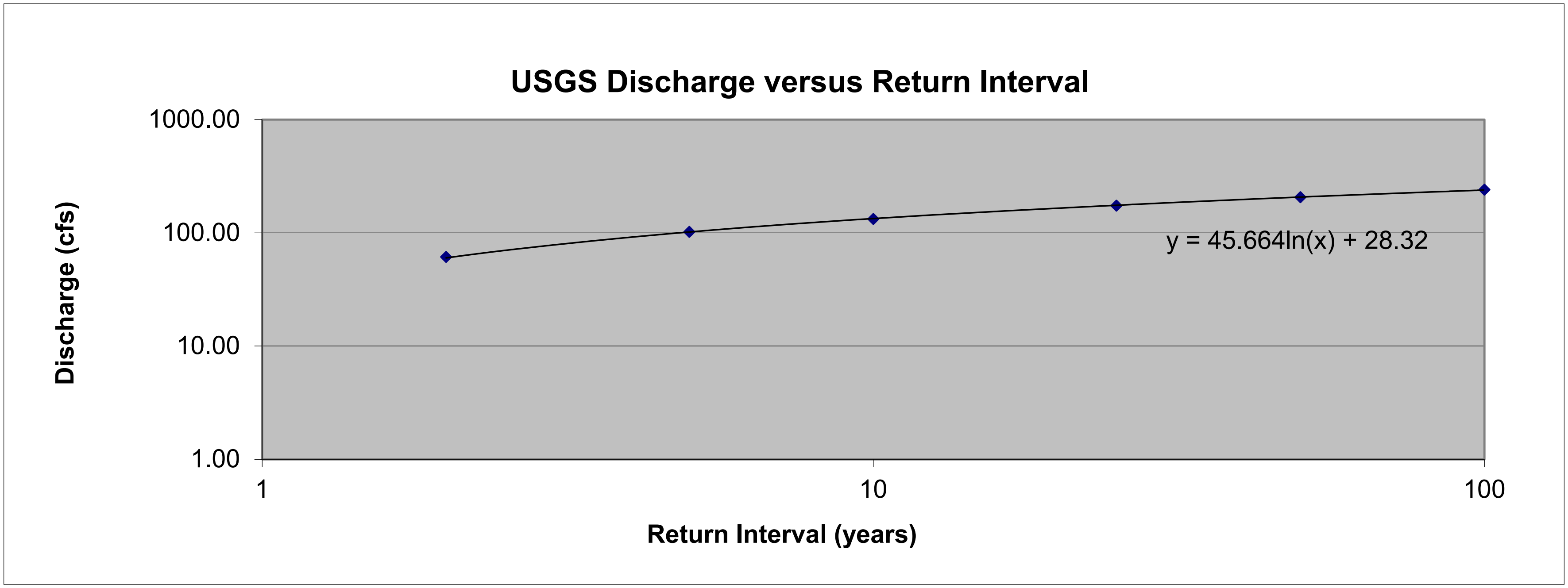
Site Description: Banner Branch UT4-R1 XS11
Drainage Area = 0.16 mi$^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 23.05 | extrapolated. Need to use equation generated below. |
| 1.2 | 28.97 | extrapolated. Need to use equation generated below. |
| 1.5 | 36.22 | extrapolated. Need to use equation generated below. |
| 2 | 45.94 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 75.60 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 97.56 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 126.78 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 149.86 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 173.63 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



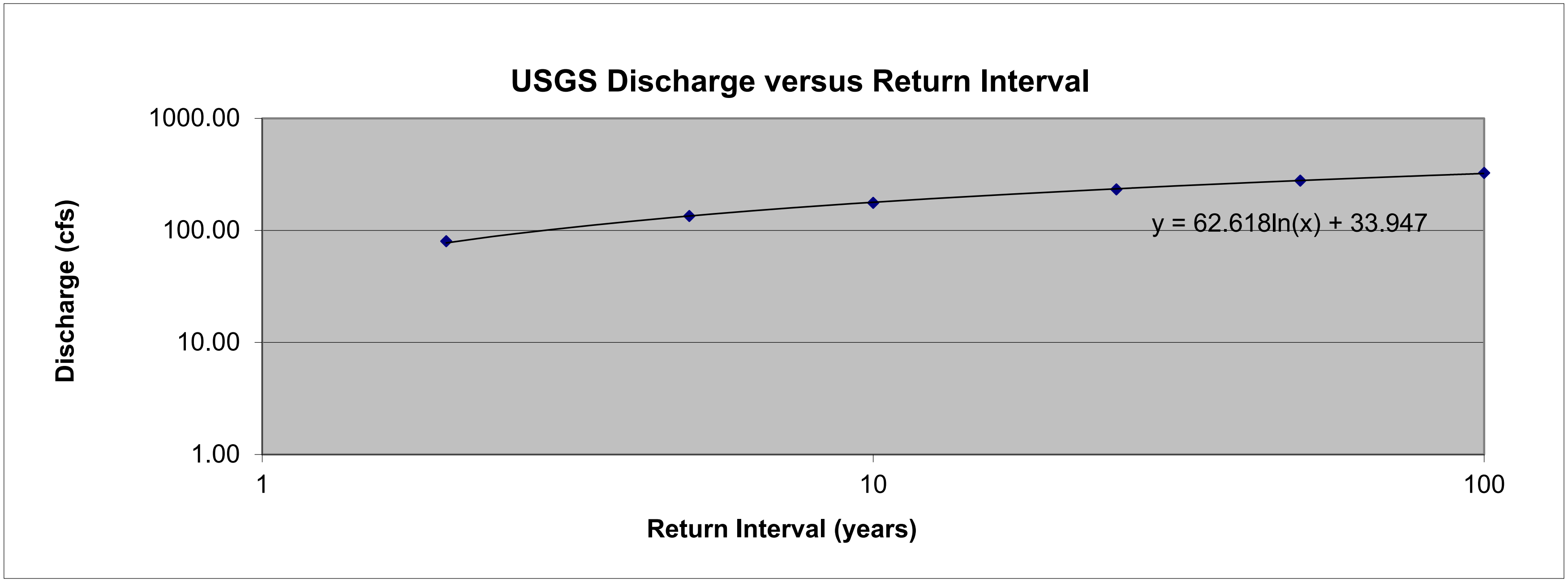
Site Description: Banner Branch UT4-R1 XS12
Drainage Area = 0.24 $mi^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 28.32 | extrapolated. Need to use equation generated below. |
| 1.2 | 36.65 | extrapolated. Need to use equation generated below. |
| 1.5 | 46.84 | extrapolated. Need to use equation generated below. |
| 2 | 61.24 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 101.86 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 132.43 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 173.60 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 206.47 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 240.53 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



Site Description: Banner Branch UT4-R2 XS10
Drainage Area = 0.35 mi$^2$

| Retun Interval | Discharge | Notes |
|---|---|---|
| 1 | 33.95 | extrapolated. Need to use equation generated below. |
| 1.2 | 45.36 | extrapolated. Need to use equation generated below. |
| 1.5 | 59.34 | extrapolated. Need to use equation generated below. |
| 2 | 80.02 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 5 | 134.41 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 10 | 175.98 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 25 | 232.57 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 50 | 278.20 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |
| 100 | 325.75 | USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.) |



**Catchment Assessment Form**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **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 | F |
| 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% | F |
| 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 | F |
| 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 | F |
| 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. | G |
| 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: | Banner Branch |
| Reach ID: | BB-R1 |
| Restoration Potential: | Level 3 - Geomorphology |
| Existing Stream Type: | Bc |
| Proposed Stream Type: | C |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.64 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 935 |
| Proposed Stream Length (ft): | 810 |
| Stream Slope (%): | 1 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.24 |
| Proposed Condition Score (PCS) | 0.42 |
| Change in Functional Condition (PCS - ECS) | 0.18 |
| Percent Condition Change | 75% |
| Existing Stream Length (ft) | 935 |
| Proposed Stream Length (ft) | 810 |
| Additional Stream Length (ft) | -125 |
| Existing Functional Foot Score (FFS) | 224 |
| Proposed Functional Foot Score (FFS) | 340 |
| Proposed FFS - Existing FFS | 116 |
| Functional Change (%) | 52% |

| 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 | 224 |
| Proposed Stream FFS + Proposed BMP FFS | 340 |
| Total Proposed FFS - Total Existing FFS | 116 |
| Functional Change (%) | 52% |

| FUNCTION BASED PARAMETERS SUMMARY | | | |
|---|---|---|---|
| **Functional Category** | **Function-Based Parameters** | **Existing Parameter** | **Proposed Parameter** |
| Hydrology | Catchment Hydrology | 0.45 | 0.45 |
| | Reach Runoff | 0.45 | 0.45 |
| Hydraulics | Floodplain Connectivity | 0.28 | 0.75 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 0.30 | 1.00 |
| | Riparian Vegetation | 0.14 | 0.57 |
| | Bed Material | 0.65 | 1.00 |
| | Bed Form Diversity | 0.15 | 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 | 0.45 | 0.45 | 0.00 |
| Hydraulics | 0.28 | 0.75 | 0.47 |
| Geomorphology | 0.45 | 0.91 | 0.46 |
| 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 | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.24 | Not Functioning |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.3 | 0.56 | 0.28 | 0.28 | Not Functioning | | |
| | | Entrenchment Ratio | 1.8 | 0 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.45 | Functioning At Risk | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | 0.30 | | | | |
| | | Dominant BEHI/NBS | M/H | 0.3 | | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.14 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | Left Buffer Width (ft) | 20 | 0.13 | | | | | |
| | | Right Buffer Width (ft) | 10 | 0.03 | | | | | |
| | | Left Basal Area (sq.ft/acre) | | | | | | | |
| | | Right Basal Area (sq.ft/acre) | | | | | | | |
| | | Left Stem Density (stems/acre) | 100 | 0.19 | | | | | |
| | | Right Stem Density (stems/acre) | 100 | 0.19 | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | 0.1 | 0.65 | 0.65 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 0.15 | | | | |
| | | Pool Depth Ratio | 1.1 | 0 | | | | | |
| | | Percent Riffle | 80 | 0.3 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.3 | 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 | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.42 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1 | 0.75 | 0.75 | Functioning | | |
| | | Entrenchment Ratio | 2.2 | 0.5 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.91 | 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 | 0.57 | | | | |
| | | Right Canopy Coverage (%) | 100 | 1 | | | | | |
| | | Left Buffer Width (ft) | 30 | 0.3 | | | | | |
| | | Right Buffer Width (ft) | 30 | 0.3 | | | | | |
| | | 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) | 0.6 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 1.00 | | | | |
| | | Pool Depth Ratio | 1.8 | 1 | | | | | |
| | | Percent Riffle | 70 | 1 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.2 | 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**

Rater(s): KMV

Date: 10/9/19

| **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 | F |
| 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% | F |
| 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 | F |
| 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 | F |
| 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. | G |
| 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: | Banner Branch |
| Reach ID: | BB-R2 |
| Restoration Potential: | Level 3 - Geomorphology |
| Existing Stream Type: | E |
| Proposed Stream Type: | C |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.75 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 2169 |
| Proposed Stream Length (ft): | 1876 |
| Stream Slope (%): | 0.9 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.32 |
| Proposed Condition Score (PCS) | 0.48 |
| Change in Functional Condition (PCS - ECS) | 0.16 |
| Percent Condition Change | 50% |
| Existing Stream Length (ft) | 2169 |
| Proposed Stream Length (ft) | 1876 |
| Additional Stream Length (ft) | -293 |
| Existing Functional Foot Score (FFS) | 694 |
| Proposed Functional Foot Score (FFS) | 900 |
| Proposed FFS - Existing FFS | 206 |
| Functional Change (%) | 30% |

## 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 | 694 |
| Proposed Stream FFS + Proposed BMP FFS | 900 |
| Total Proposed FFS - Total Existing FFS | 206 |
| Functional Change (%) | 30% |

## FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.45 | 0.45 |
| | Reach Runoff | 0.45 | 0.45 |
| Hydraulics | Floodplain Connectivity | 0.66 | 1.00 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 0.30 | 1.00 |
| | Riparian Vegetation | 0.29 | 0.71 |
| | Bed Material | 0.65 | 1.00 |
| | Bed Form Diversity | 0.15 | 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 | 0.45 | 0.45 | 0.00 |
| Hydraulics | 0.66 | 1.00 | 0.34 |
| Geomorphology | 0.48 | 0.94 | 0.46 |
| Physicochemical | | | |
| Biology | | | |

## EXISTING CONDITION ASSESSMENT

| Functional Category | Function-Based Parameters | Measurement Method | Field Value | Index Value | Roll Up Scoring: Parameter | Category | Category | Overall | Overall |
|---|---|---|---|---|---|---|---|---|---|
| Hydrology | Catchment Hydrology | Curve Number | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.32 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.5 | 0.31 | 0.66 | 0.66 | Functioning At Risk | | |
| | | Entrenchment Ratio | 7.7 | 1 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.48 | Functioning At Risk | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | 0.30 | | | | |
| | | Dominant BEHI/NBS | M/H | 0.3 | | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.29 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | Left Buffer Width (ft) | 15 | 0.07 | | | | | |
| | | Right Buffer Width (ft) | 50 | 0.72 | | | | | |
| | | Left Basal Area (sq.ft/acre) | | | | | | | |
| | | Right Basal Area (sq.ft/acre) | | | | | | | |
| | | Left Stem Density (stems/acre) | 100 | 0.19 | | | | | |
| | | Right Stem Density (stems/acre) | 100 | 0.19 | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | 0.1 | 0.65 | 0.65 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 0.15 | | | | |
| | | Pool Depth Ratio | 1.1 | 0 | | | | | |
| | | Percent Riffle | 80 | 0.3 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.3 | 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

| Functional Category | Function-Based Parameters | Measurement Method | Field Value | Index Value | Roll Up Scoring: Parameter | Category | Category | Overall | Overall |
|---|---|---|---|---|---|---|---|---|---|
| Hydrology | Catchment Hydrology | Curve Number | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.48 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1 | 1.00 | 1.00 | Functioning | | |
| | | Entrenchment Ratio | 5 | 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 | 0.71 | | | | |
| | | Right Canopy Coverage (%) | 100 | 1 | | | | | |
| | | Left Buffer Width (ft) | 50 | 0.72 | | | | | |
| | | Right Buffer Width (ft) | 50 | 0.72 | | | | | |
| | | 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) | 0.6 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 1.00 | | | | |
| | | Pool Depth Ratio | 1.8 | 1 | | | | | |
| | | Percent Riffle | 70 | 1 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.24 | 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**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **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 | F |
| 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% | F |
| 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 | F |
| 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 | F |
| 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 | G |
| 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. | G |
| 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<br>Performance Standard Stratification | |
|---|---|
| Project Name: | Banner Branch |
| Reach ID: | BB-R3 |
| Restoration Potential: | Level 5 - Biology |
| Existing Stream Type: | E |
| Proposed Stream Type: | C |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.88 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 708 |
| Proposed Stream Length (ft): | 657 |
| Stream Slope (%): | 0.5 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.33 |
| Proposed Condition Score (PCS) | 0.69 |
| Change in Functional Condition (PCS - ECS) | 0.36 |
| Percent Condition Change | 109% |
| Existing Stream Length (ft) | 708 |
| Proposed Stream Length (ft) | 657 |
| Additional Stream Length (ft) | -51 |
| Existing Functional Foot Score (FFS) | 234 |
| Proposed Functional Foot Score (FFS) | 453 |
| Proposed FFS - Existing FFS | 220 |
| Functional Change (%) | 94% |

| 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 | 234 |
| Proposed Stream FFS + Proposed BMP FFS | 453 |
| Total Proposed FFS - Total Existing FFS | 219 |
| Functional Change (%) | 94% |

## FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.45 | 0.45 |
| | Reach Runoff | 0.45 | 0.45 |
| Hydraulics | Floodplain Connectivity | 0.63 | 1.00 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 0.50 | 1.00 |
| | Riparian Vegetation | 0.51 | 0.71 |
| | Bed Material | 0.65 | 1.00 |
| | Bed Form Diversity | 0.43 | 1.00 |
| | Plan Form | 0.00 | 1.00 |
| Physicochemical | Temperature | | |
| | Bacteria | | |
| | Organic Matter | 0.00 | 0.36 |
| | Nitrogen | | |
| | Phosphorus | | |
| Biology | Macros | 0.14 | 0.71 |
| | Fish | | |

## FUNCTIONAL CATEGORY REPORT CARD

| Functional Category | ECS | PCS | Functional Change |
|---|---|---|---|
| Hydrology | 0.45 | 0.45 | 0.00 |
| Hydraulics | 0.63 | 1.00 | 0.37 |
| Geomorphology | 0.42 | 0.94 | 0.52 |
| Physicochemical | 0.00 | 0.36 | 0.36 |
| Biology | 0.14 | 0.71 | 0.57 |

## EXISTING CONDITION ASSESSMENT

| Functional Category | Function-Based Parameters | Measurement Method | Field Value | Index Value | Roll Up Scoring<br>Parameter | Category | Category | Overall | Overall |
|---|---|---|---|---|---|---|---|---|---|
| Hydrology | Catchment Hydrology | Curve Number | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.33 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.4 | 0.43 | 0.63 | 0.63 | Functioning At Risk | | |
| | | Entrenchment Ratio | 3.5 | 0.83 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.42 | Functioning At Risk | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | 0.50 | | | | |
| | | Dominant BEHI/NBS | M/M | 0.5 | | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.51 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | Left Buffer Width (ft) | 100 | 0.86 | | | | | |
| | | Right Buffer Width (ft) | 50 | 0.72 | | | | | |
| | | Left Basal Area (sq.ft/acre) | | | | | | | |
| | | Right Basal Area (sq.ft/acre) | | | | | | | |
| | | Left Stem Density (stems/acre) | 120 | 0.23 | | | | | |
| | | Right Stem Density (stems/acre) | 120 | 0.23 | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | 0.1 | 0.65 | 0.65 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 0.43 | | | | |
| | | Pool Depth Ratio | 1.4 | 0.56 | | | | | |
| | | Percent Riffle | 80 | 0.3 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.15 | 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 | 5.94 | 0.27 | 0.14 | 0.14 | Not Functioning | | |
| | | EPT Taxa Present | 4 | 0 | | | | | |
| | Fish | North Carolina Index of Biotic Integrity | | | | | | | |

## PROPOSED CONDITION ASSESSMENT

| Functional Category | Function-Based Parameters | Measurement Method | Field Value | Index Value | Roll Up Scoring<br>Parameter | Category | Category | Overall | Overall |
|---|---|---|---|---|---|---|---|---|---|
| Hydrology | Catchment Hydrology | Curve Number | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.69 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1 | 1.00 | 1.00 | Functioning | | |
| | | Entrenchment Ratio | 5 | 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 | 0.71 | | | | |
| | | Right Canopy Coverage (%) | 100 | 1 | | | | | |
| | | Left Buffer Width (ft) | 50 | 0.72 | | | | | |
| | | Right Buffer Width (ft) | 50 | 0.72 | | | | | |
| | | 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) | 0.6 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 1.00 | | | | |
| | | Pool Depth Ratio | 1.8 | 1 | | | | | |
| | | Percent Riffle | 70 | 1 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.2 | 1 | 1.00 | | | | |
| Physicochemical | Temperature | Summer Daily Maximum (°F) | | | | 0.36 | Functioning At Risk | | |
| | Bacteria | Fecal Coliform (Cfu/100 ml) | | | | | | | |
| | Organic Carbon | Leaf Litter Processing Rate | | | 0.36 | | | | |
| | | Percent Shredders | 5 | 0.36 | | | | | |
| | Nitrogen | Total Nitrogen (mg/L) | | | | | | | |
| | Phosphorus | Total Phosphorus (mg/L) | | | | | | | |
| Biology | Macros | Biotic Index | 5 | 0.78 | 0.71 | 0.71 | Functioning | | |
| | | EPT Taxa Present | 20 | 0.64 | | | | | |
| | Fish | North Carolina Index of Biotic Integrity | | | | | | | |

**Catchment Assessment Form**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **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% | F |
| 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 | F |
| 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 | F |
| 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: | Banner Branch |
| Reach ID: | UT1A |
| Restoration Potential: | Level 3 - Geomorphology |
| Existing Stream Type: | G |
| Proposed Stream Type: | B |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.072 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 410 |
| Proposed Stream Length (ft): | 410 |
| Stream Slope (%): | 2.6 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.25 |
| Proposed Condition Score (PCS) | 0.39 |
| Change in Functional Condition (PCS - ECS) | 0.14 |
| Percent Condition Change | 56% |
| Existing Stream Length (ft) | 410 |
| Proposed Stream Length (ft) | 410 |
| Additional Stream Length (ft) | 0 |
| Existing Functional Foot Score (FFS) | 103 |
| Proposed Functional Foot Score (FFS) | 160 |
| Proposed FFS - Existing FFS | 57 |
| Functional Change (%) | 56% |

| 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 | 103 |
| Proposed Stream FFS + Proposed BMP FFS | 160 |
| Total Proposed FFS - Total Existing FFS | 57 |
| Functional Change (%) | 55% |

## FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.36 | 0.36 |
| | Reach Runoff | 0.36 | 0.36 |
| Hydraulics | Floodplain Connectivity | 0.15 | 0.71 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 1.00 | 1.00 |
| | Riparian Vegetation | 0.19 | 0.70 |
| | Bed Material | 1.00 | 1.00 |
| | Bed Form Diversity | 0.69 | 1.00 |
| | Plan Form | 0.70 | 0.70 |
| Physicochemical | Temperature | | |
| | Bacteria | | |
| | Organic Matter | | |
| | Nitrogen | | |
| | Phosphorus | | |
| Biology | Macros | | |
| | Fish | | |

## FUNCTIONAL CATEGORY REPORT CARD

| Functional Category | ECS | PCS | Functional Change |
|---|---|---|---|
| Hydrology | 0.36 | 0.36 | 0.00 |
| Hydraulics | 0.15 | 0.71 | 0.56 |
| Geomorphology | 0.72 | 0.88 | 0.16 |
| Physicochemical | | | |
| Biology | | | |

## EXISTING CONDITION ASSESSMENT

| 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 | 0.36 | Functioning At Risk | 0.25 | Not Functioning |
| | Reach Runoff | Curve Number | 68 | 0.36 | 0.36 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 3.4 | 0 | 0.15 | 0.15 | Not Functioning | | |
| | | Entrenchment Ratio | 1.2 | 0.3 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.72 | Functioning | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | 1.00 | | | | |
| | | Dominant BEHI/NBS | L/L | 1 | | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.19 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | Left Buffer Width (ft) | 15 | 0.35 | | | | | |
| | | Right Buffer Width (ft) | 15 | 0.35 | | | | | |
| | | 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) | 0.6 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 0.69 | | | | |
| | | Pool Depth Ratio | 1.5 | 0.69 | | | | | |
| | | Percent Riffle | 75 | 0.69 | | | | | |
| | | 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 | | | | | | | |

## PROPOSED CONDITION ASSESSMENT

| 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 | 0.36 | Functioning At Risk | 0.39 | Functioning At Risk |
| | Reach Runoff | Curve Number | 68 | 0.36 | 0.36 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.3 | 0.56 | 0.71 | 0.71 | Functioning | | |
| | | Entrenchment Ratio | 1.8 | 0.85 | | | | | |
| 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) | 0.6 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 1.00 | | | | |
| | | Pool Depth Ratio | 2 | 1 | | | | | |
| | | Percent Riffle | 65 | 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**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **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% | G |
| 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 | F |
| 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 | F |
| 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: | Banner Branch |
| Reach ID: | UT1B |
| Restoration Potential: | Level 3 - Geomorphology |
| Existing Stream Type: | E |
| Proposed Stream Type: | B |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.069 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 391 |
| Proposed Stream Length (ft): | 494 |
| Stream Slope (%): | 2.5 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.41 |
| Proposed Condition Score (PCS) | 0.45 |
| Change in Functional Condition (PCS - ECS) | 0.04 |
| Percent Condition Change | 10% |
| Existing Stream Length (ft) | 391 |
| Proposed Stream Length (ft) | 494 |
| Additional Stream Length (ft) | 103 |
| Existing Functional Foot Score (FFS) | 160 |
| Proposed Functional Foot Score (FFS) | 222 |
| Proposed FFS - Existing FFS | 62 |
| Functional Change (%) | 39% |

## 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 | 160 |
| Proposed Stream FFS + Proposed BMP FFS | 222 |
| Total Proposed FFS - Total Existing FFS | 62 |
| Functional Change (%) | 39% |

## FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.36 | 0.36 |
| | Reach Runoff | 0.36 | 0.36 |
| Hydraulics | Floodplain Connectivity | 0.92 | 1.00 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 1.00 | 1.00 |
| | Riparian Vegetation | 0.52 | 0.80 |
| | Bed Material | 1.00 | 1.00 |
| | Bed Form Diversity | 0.56 | 1.00 |
| | Plan Form | 0.74 | 0.71 |
| Physicochemical | Temperature | | |
| | Bacteria | | |
| | Organic Matter | | |
| | Nitrogen | | |
| | Phosphorus | | |
| Biology | Macros | | |
| | Fish | | |

## FUNCTIONAL CATEGORY REPORT CARD

| Functional Category | ECS | PCS | Functional Change |
|---|---|---|---|
| Hydrology | 0.36 | 0.36 | 0.00 |
| Hydraulics | 0.92 | 1.00 | 0.08 |
| Geomorphology | 0.76 | 0.90 | 0.14 |
| 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 | 0.36 | Functioning At Risk | 0.41 | Functioning At Risk |
| | Reach Runoff | Curve Number | 68 | 0.36 | 0.36 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.1 | 0.84 | 0.92 | 0.92 | Functioning | | |
| | | Entrenchment Ratio | 2.5 | 1 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.76 | Functioning | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | 1.00 | | | | |
| | | Dominant BEHI/NBS | L/L | 1 | | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.52 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | Left Buffer Width (ft) | 100 | 1 | | | | | |
| | | Right Buffer Width (ft) | 50 | 1 | | | | | |
| | | 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) | 0.6 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 0.56 | | | | |
| | | Pool Depth Ratio | 1.3 | 0.43 | | | | | |
| | | Percent Riffle | 75 | 0.69 | | | | | |
| | | 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 | 0.36 | Functioning At Risk | 0.45 | Functioning At Risk |
| | Reach Runoff | Curve Number | 68 | 0.36 | 0.36 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1 | 1.00 | 1.00 | Functioning | | |
| | | Entrenchment Ratio | 2.5 | 1 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.90 | 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 | 0.80 | | | | |
| | | Right Canopy Coverage (%) | 100 | 1 | | | | | |
| | | Left Buffer Width (ft) | 50 | 1 | | | | | |
| | | Right Buffer Width (ft) | 50 | 1 | | | | | |
| | | 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) | 0.6 | 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 | 1.16 | 0.71 | 0.71 | | | | |
| 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**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **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% | G |
| 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 | G |
| 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. | G |
| 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. | G |
| 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: | Banner Branch |
| Reach ID: | UT1C |
| Restoration Potential: | Level 3 - Geomorphology |
| Existing Stream Type: | B |
| Proposed Stream Type: | B |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.025 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 528 |
| Proposed Stream Length (ft): | 528 |
| Stream Slope (%): | 5.1 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.49 |
| Proposed Condition Score (PCS) | 0.50 |
| Change in Functional Condition (PCS - ECS) | 0.01 |
| Percent Condition Change | 2% |
| Existing Stream Length (ft) | 528 |
| Proposed Stream Length (ft) | 528 |
| Additional Stream Length (ft) | 0 |
| Existing Functional Foot Score (FFS) | 259 |
| Proposed Functional Foot Score (FFS) | 264 |
| Proposed FFS - Existing FFS | 5 |
| Functional Change (%) | 2% |

## 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 | 259 |
| Proposed Stream FFS + Proposed BMP FFS | 264 |
| Total Proposed FFS - Total Existing FFS | 5 |
| Functional Change (%) | 2% |

## FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.80 | 0.80 |
| | Reach Runoff | 0.80 | 0.80 |
| Hydraulics | Floodplain Connectivity | 0.92 | 0.92 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 1.00 | 1.00 |
| | Riparian Vegetation | 0.69 | 0.79 |
| | Bed Material | 1.00 | 1.00 |
| | Bed Form Diversity | 1.00 | 1.00 |
| | Plan Form | 0.00 | 0.00 |
| Physicochemical | Temperature | | |
| | Bacteria | | |
| | Organic Matter | | |
| | Nitrogen | | |
| | Phosphorus | | |
| Biology | Macros | | |
| | Fish | | |

## FUNCTIONAL CATEGORY REPORT CARD

| Functional Category | ECS | PCS | Functional Change |
|---|---|---|---|
| Hydrology | 0.80 | 0.80 | 0.00 |
| Hydraulics | 0.92 | 0.92 | 0.00 |
| Geomorphology | 0.74 | 0.76 | 0.02 |
| 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 | 50 | 0.8 | 0.80 | 0.80 | Functioning | 0.49 | Functioning At Risk |
| | Reach Runoff | Curve Number | 50 | 0.8 | 0.80 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.1 | 0.84 | 0.92 | 0.92 | Functioning | | |
| | | Entrenchment Ratio | 2.2 | 1 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.74 | Functioning | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | | | | | |
| | | Dominant BEHI/NBS | L/VL | 1 | 1.00 | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.69 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | Left Buffer Width (ft) | 100 | 1 | | | | | |
| | | Right Buffer Width (ft) | 100 | 1 | | | | | |
| | | Left Basal Area (sq.ft/acre) | | | | | | | |
| | | Right Basal Area (sq.ft/acre) | | | | | | | |
| | | Left Stem Density (stems/acre) | 200 | 0.38 | | | | | |
| | | Right Stem Density (stems/acre) | 200 | 0.38 | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | 0.6 | 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 | 1.1 | 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 | | | | | | | |

**Catchment Assessment Form**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **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% | G |
| 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 | G |
| 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. | G |
| 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. | G |
| 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: | Banner Branch |
| Reach ID: | UT1-R1 |
| Restoration Potential: | Level 3 - Geomorphology |
| Existing Stream Type: | E |
| Proposed Stream Type: | E |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.088 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 612 |
| Proposed Stream Length (ft): | 612 |
| Stream Slope (%): | 2.7 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.38 |
| Proposed Condition Score (PCS) | 0.41 |
| Change in Functional Condition (PCS - ECS) | 0.03 |
| Percent Condition Change | 8% |
| Existing Stream Length (ft) | 612 |
| Proposed Stream Length (ft) | 612 |
| Additional Stream Length (ft) | 0 |
| Existing Functional Foot Score (FFS) | 233 |
| Proposed Functional Foot Score (FFS) | 251 |
| Proposed FFS - Existing FFS | 18 |
| Functional Change (%) | 8% |

## 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 | 233 |
| Proposed Stream FFS + Proposed BMP FFS | 251 |
| Total Proposed FFS - Total Existing FFS | 18 |
| Functional Change (%) | 8% |

## FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.45 | 0.45 |
| | Reach Runoff | 0.45 | 0.45 |
| Hydraulics | Floodplain Connectivity | 0.57 | 0.67 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 1.00 | 1.00 |
| | Riparian Vegetation | 0.60 | 0.73 |
| | Bed Material | 1.00 | 1.00 |
| | Bed Form Diversity | 1.00 | 1.00 |
| | Plan Form | 0.84 | 0.88 |
| Physicochemical | Temperature | | |
| | Bacteria | | |
| | Organic Matter | | |
| | Nitrogen | | |
| | Phosphorus | | |
| Biology | Macros | | |
| | Fish | | |

## FUNCTIONAL CATEGORY REPORT CARD

| Functional Category | ECS | PCS | Functional Change |
|---|---|---|---|
| Hydrology | 0.45 | 0.45 | 0.00 |
| Hydraulics | 0.57 | 0.67 | 0.10 |
| Geomorphology | 0.89 | 0.92 | 0.03 |
| Physicochemical | | | |
| Biology | | | |

## EXISTING CONDITION ASSESSMENT

| 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 | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.38 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.4 | 0.43 | 0.57 | 0.57 | Functioning At Risk | | |
| | | Entrenchment Ratio | 2.5 | 0.71 | | | | | |
| 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 (%) | | | 0.60 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | Left Buffer Width (ft) | 50 | 0.72 | | | | | |
| | | Right Buffer Width (ft) | 100 | 0.86 | | | | | |
| | | 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) | 0.5 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 1.00 | | | | |
| | | Pool Depth Ratio | 1.8 | 1 | | | | | |
| | | Percent Riffle | 70 | 1 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.27 | 0.84 | 0.84 | | | | |
| 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

| 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 | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.41 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.1 | 0.84 | 0.67 | 0.67 | Functioning At Risk | | |
| | | Entrenchment Ratio | 2.2 | 0.5 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.92 | 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 | 0.73 | | | | |
| | | Right Canopy Coverage (%) | 100 | 1 | | | | | |
| | | Left Buffer Width (ft) | 50 | 0.72 | | | | | |
| | | Right Buffer Width (ft) | 100 | 0.86 | | | | | |
| | | 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) | 0.6 | 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 | 1.3 | 0.88 | 0.88 | | | | |
| 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**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **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% | G |
| 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 | G |
| 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. | G |
| 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: | Banner Branch |
| Reach ID: | UT1-R2 |
| Restoration Potential: | Level 3 - Geomorphology |
| Existing Stream Type: | F |
| Proposed Stream Type: | C |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.14 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 1917 |
| Proposed Stream Length (ft): | 1917 |
| Stream Slope (%): | 1.5 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.44 |
| Proposed Condition Score (PCS) | 0.45 |
| Change in Functional Condition (PCS - ECS) | 0.01 |
| Percent Condition Change | 2% |
| Existing Stream Length (ft) | 1917 |
| Proposed Stream Length (ft) | 1917 |
| Additional Stream Length (ft) | 0 |
| Existing Functional Foot Score (FFS) | 843 |
| Proposed Functional Foot Score (FFS) | 863 |
| Proposed FFS - Existing FFS | 19 |
| Functional Change (%) | 2% |

## 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 | 843 |
| Proposed Stream FFS + Proposed BMP FFS | 863 |
| Total Proposed FFS - Total Existing FFS | 20 |
| Functional Change (%) | 2% |

## FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.58 | 0.58 |
| | Reach Runoff | 0.58 | 0.58 |
| Hydraulics | Floodplain Connectivity | 0.77 | 0.77 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 1.00 | 1.00 |
| | Riparian Vegetation | 0.49 | 0.66 |
| | Bed Material | 1.00 | 1.00 |
| | Bed Form Diversity | 1.00 | 1.00 |
| | Plan Form | 0.88 | 0.88 |
| Physicochemical | Temperature | | |
| | Bacteria | | |
| | Organic Matter | | |
| | Nitrogen | | |
| | Phosphorus | | |
| Biology | Macros | | |
| | Fish | | |

## FUNCTIONAL CATEGORY REPORT CARD

| Functional Category | ECS | PCS | Functional Change |
|---|---|---|---|
| Hydrology | 0.58 | 0.58 | 0.00 |
| Hydraulics | 0.77 | 0.77 | 0.00 |
| Geomorphology | 0.87 | 0.91 | 0.04 |
| 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 | 60 | 0.58 | 0.58 | 0.58 | Functioning At Risk | 0.44 | Functioning At Risk |
| | Reach Runoff | Curve Number | 60 | 0.58 | 0.58 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.1 | 0.84 | 0.77 | 0.77 | Functioning | | |
| | | Entrenchment Ratio | 2.4 | 0.7 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.87 | Functioning | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | 1.00 | | | | |
| | | Dominant BEHI/NBS | L/L | 1 | | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.49 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | Left Buffer Width (ft) | 30 | 0.3 | | | | | |
| | | Right Buffer Width (ft) | 100 | 0.86 | | | | | |
| | | 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) | 0.5 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 1.00 | | | | |
| | | Pool Depth Ratio | 1.8 | 1 | | | | | |
| | | Percent Riffle | 70 | 1 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.3 | 0.88 | 0.88 | | | | |
| 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 | 60 | 0.58 | 0.58 | 0.58 | Functioning At Risk | 0.45 | Functioning At Risk |
| | Reach Runoff | Curve Number | 60 | 0.58 | 0.58 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.1 | 0.84 | 0.77 | 0.77 | Functioning | | |
| | | Entrenchment Ratio | 2.4 | 0.7 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.91 | 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 | 0.66 | | | | |
| | | Right Canopy Coverage (%) | 100 | 1 | | | | | |
| | | Left Buffer Width (ft) | 30 | 0.3 | | | | | |
| | | Right Buffer Width (ft) | 100 | 0.86 | | | | | |
| | | 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) | 0.6 | 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 | 1.3 | 0.88 | 0.88 | | | | |
| 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**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **Overall Catchment Condition** | **G** |
| **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% | G |
| 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 | G |
| 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. | F |
| 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. | G |
| 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: | Banner Branch |
| Reach ID: | UT1-R3 |
| Restoration Potential: | Level 3 - Geomorphology |
| Existing Stream Type: | C |
| Proposed Stream Type: | C |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.26 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 861 |
| Proposed Stream Length (ft): | 861 |
| Stream Slope (%): | 1.1 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.50 |
| Proposed Condition Score (PCS) | 0.50 |
| Change in Functional Condition (PCS - ECS) | 0.00 |
| Percent Condition Change | 0% |
| Existing Stream Length (ft) | 861 |
| Proposed Stream Length (ft) | 861 |
| Additional Stream Length (ft) | 0 |
| Existing Functional Foot Score (FFS) | 431 |
| Proposed Functional Foot Score (FFS) | 431 |
| Proposed FFS - Existing FFS | 0 |
| Functional Change (%) | 0% |

| 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 | 431 |
| Proposed Stream FFS + Proposed BMP FFS | 431 |
| Total Proposed FFS - Total Existing FFS | 0 |
| Functional Change (%) | 0% |

## FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.80 | 0.80 |
| | Reach Runoff | 0.80 | 0.80 |
| Hydraulics | Floodplain Connectivity | 0.77 | 0.77 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 1.00 | 1.00 |
| | Riparian Vegetation | 0.66 | 0.76 |
| | Bed Material | 1.00 | 1.00 |
| | Bed Form Diversity | 1.00 | 1.00 |
| | Plan Form | 0.88 | 0.88 |
| Physicochemical | Temperature | | |
| | Bacteria | | |
| | Organic Matter | | |
| | Nitrogen | | |
| | Phosphorus | | |
| Biology | Macros | | |
| | Fish | | |

## FUNCTIONAL CATEGORY REPORT CARD

| Functional Category | ECS | PCS | Functional Change |
|---|---|---|---|
| Hydrology | 0.80 | 0.80 | 0.00 |
| Hydraulics | 0.77 | 0.77 | 0.00 |
| Geomorphology | 0.91 | 0.93 | 0.02 |
| 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 | 50 | 0.8 | 0.80 | 0.80 | Functioning | 0.50 | Functioning At Risk |
| | Reach Runoff | Curve Number | 50 | 0.8 | 0.80 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.1 | 0.84 | 0.77 | 0.77 | Functioning | | |
| | | Entrenchment Ratio | 2.4 | 0.7 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.91 | Functioning | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | 1.00 | | | | |
| | | Dominant BEHI/NBS | L/L | 1 | | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.66 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | Left Buffer Width (ft) | 100 | 0.86 | | | | | |
| | | Right Buffer Width (ft) | 70 | 0.77 | | | | | |
| | | Left Basal Area (sq.ft/acre) | | | | | | | |
| | | Right Basal Area (sq.ft/acre) | | | | | | | |
| | | Left Stem Density (stems/acre) | 400 | 0.5 | | | | | |
| | | Right Stem Density (stems/acre) | 400 | 0.5 | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | 0.5 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 1.00 | | | | |
| | | Pool Depth Ratio | 1.8 | 1 | | | | | |
| | | Percent Riffle | 70 | 1 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.3 | 0.88 | 0.88 | | | | |
| 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 | 50 | 0.8 | 0.80 | 0.80 | Functioning | 0.50 | Functioning At Risk |
| | Reach Runoff | Curve Number | 50 | 0.8 | 0.80 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.1 | 0.84 | 0.77 | 0.77 | Functioning | | |
| | | Entrenchment Ratio | 2.4 | 0.7 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.93 | 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 | 0.76 | | | | |
| | | Right Canopy Coverage (%) | 100 | 1 | | | | | |
| | | Left Buffer Width (ft) | 100 | 0.86 | | | | | |
| | | Right Buffer Width (ft) | 50 | 0.72 | | | | | |
| | | Left Basal Area (sq.ft/acre) | | | | | | | |
| | | Right Basal Area (sq.ft/acre) | | | | | | | |
| | | Left Stem Density (stems/acre) | 400 | 0.5 | | | | | |
| | | Right Stem Density (stems/acre) | 400 | 0.5 | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | 0.6 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 1.00 | | | | |
| | | Pool Depth Ratio | 1.8 | 1 | | | | | |
| | | Percent Riffle | 70 | 1 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.3 | 0.88 | 0.88 | | | | |
| 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**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **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 | F |
| 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% | F |
| 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 | F |
| 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 | F |
| 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. | G |
| 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: | Banner Branch |
| Reach ID: | UT2 |
| Restoration Potential: | Level 3 - Geomorphology |
| Existing Stream Type: | F |
| Proposed Stream Type: | B |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.044 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 1347 |
| Proposed Stream Length (ft): | 1347 |
| Stream Slope (%): | 3.4 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.30 |
| Proposed Condition Score (PCS) | 0.44 |
| Change in Functional Condition (PCS - ECS) | 0.14 |
| Percent Condition Change | 47% |
| Existing Stream Length (ft) | 1347 |
| Proposed Stream Length (ft) | 1347 |
| Additional Stream Length (ft) | 0 |
| Existing Functional Foot Score (FFS) | 404 |
| Proposed Functional Foot Score (FFS) | 593 |
| Proposed FFS - Existing FFS | 189 |
| Functional Change (%) | 47% |

| 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 | 404 |
| Proposed Stream FFS + Proposed BMP FFS | 593 |
| Total Proposed FFS - Total Existing FFS | 189 |
| Functional Change (%) | 47% |

### FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.45 | 0.45 |
| | Reach Runoff | 0.45 | 0.45 |
| Hydraulics | Floodplain Connectivity | 0.57 | 1.00 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 0.50 | 1.00 |
| | Riparian Vegetation | 0.33 | 0.70 |
| | Bed Material | 1.00 | 1.00 |
| | Bed Form Diversity | 0.65 | 1.00 |
| | Plan Form | 0.00 | 0.00 |
| Physicochemical | Temperature | | |
| | Bacteria | | |
| | Organic Matter | | |
| | Nitrogen | | |
| | Phosphorus | | |
| Biology | Macros | | |
| | Fish | | |

### FUNCTIONAL CATEGORY REPORT CARD

| Functional Category | ECS | PCS | Functional Change |
|---|---|---|---|
| Hydrology | 0.45 | 0.45 | 0.00 |
| Hydraulics | 0.57 | 1.00 | 0.43 |
| Geomorphology | 0.50 | 0.74 | 0.24 |
| 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 | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.30 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.1 | 0.84 | 0.57 | 0.57 | Functioning At Risk | | |
| | | Entrenchment Ratio | 1.2 | 0.3 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.50 | Functioning At Risk | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | 0.50 | | | | |
| | | Dominant BEHI/NBS | M/M | 0.5 | | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.33 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | 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) | 100 | 0.19 | | | | | |
| | | Right Stem Density (stems/acre) | 100 | 0.19 | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | 0.5 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 0.65 | | | | |
| | | Pool Depth Ratio | 1.8 | 1 | | | | | |
| | | Percent Riffle | 70 | 0.3 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.14 | 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 | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.44 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1 | 1.00 | 1.00 | Functioning | | |
| | | Entrenchment Ratio | 2.4 | 1 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.74 | 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) | 0.6 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 1.00 | | | | |
| | | Pool Depth Ratio | 1.8 | 1 | | | | | |
| | | Percent Riffle | 60 | 1 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.1 | 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 | | | | | | | |

**Catchment Assessment Form**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **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 | F |
| 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% | F |
| 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 | F |
| 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 | F |
| 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. | G |
| 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: | Banner Branch |
| Reach ID: | UT2A |
| Restoration Potential: | Level 3 - Geomorphology |
| Existing Stream Type: | E |
| Proposed Stream Type: | B |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.005 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 289 |
| Proposed Stream Length (ft): | 289 |
| Stream Slope (%): | 4.5 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.47 |
| Change in Functional Condition (PCS - ECS) | 0.16 |
| Percent Condition Change | 52% |
| Existing Stream Length (ft) | 289 |
| Proposed Stream Length (ft) | 289 |
| Additional Stream Length (ft) | 0 |
| Existing Functional Foot Score (FFS) | 90 |
| Proposed Functional Foot Score (FFS) | 136 |
| Proposed FFS - Existing FFS | 46 |
| Functional Change (%) | 52% |

## 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 | 90 |
| Proposed Stream FFS + Proposed BMP FFS | 136 |
| Total Proposed FFS - Total Existing FFS | 46 |
| Functional Change (%) | 51% |

## FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.45 | 0.45 |
| | Reach Runoff | 0.45 | 0.45 |
| Hydraulics | Floodplain Connectivity | 0.67 | 1.00 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 0.50 | 1.00 |
| | Riparian Vegetation | 0.33 | 0.70 |
| | Bed Material | 1.00 | 1.00 |
| | Bed Form Diversity | 0.43 | 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 | 0.45 | 0.45 | 0.00 |
| Hydraulics | 0.67 | 1.00 | 0.33 |
| Geomorphology | 0.45 | 0.88 | 0.43 |
| 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 | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.31 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.1 | 0.84 | 0.67 | 0.67 | Functioning At Risk | | |
| | | Entrenchment Ratio | 1.3 | 0.5 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.45 | Functioning At Risk | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | 0.50 | | | | |
| | | Dominant BEHI/NBS | M/M | 0.5 | | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.33 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | 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) | 100 | 0.19 | | | | | |
| | | Right Stem Density (stems/acre) | 100 | 0.19 | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | 0.5 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 0.43 | | | | |
| | | Pool Depth Ratio | 1.4 | 0.56 | | | | | |
| | | Percent Riffle | 70 | 0.3 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.13 | 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 | | | | | | | |

**Catchment Assessment Form**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **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 | F |
| 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% | F |
| 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 | F |
| 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 | F |
| 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 | G |
| 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. | G |
| 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: | Banner Branch |
| Reach ID: | UT4-R1 |
| Restoration Potential: | Level 3 - Geomorphology |
| Existing Stream Type: | F |
| Proposed Stream Type: | Bc |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.24 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 4634 |
| Proposed Stream Length (ft): | 4374 |
| Stream Slope (%): | 2 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.29 |
| Proposed Condition Score (PCS) | 0.47 |
| Change in Functional Condition (PCS - ECS) | 0.18 |
| Percent Condition Change | 62% |
| Existing Stream Length (ft) | 4634 |
| Proposed Stream Length (ft) | 4374 |
| Additional Stream Length (ft) | -260 |
| Existing Functional Foot Score (FFS) | 1344 |
| Proposed Functional Foot Score (FFS) | 2056 |
| Proposed FFS - Existing FFS | 712 |
| Functional Change (%) | 53% |

## 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 | 1344 |
| Proposed Stream FFS + Proposed BMP FFS | 2056 |
| Total Proposed FFS - Total Existing FFS | 712 |
| Functional Change (%) | 53% |

## FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.45 | 0.45 |
| | Reach Runoff | 0.45 | 0.45 |
| Hydraulics | Floodplain Connectivity | 0.41 | 0.97 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 0.50 | 1.00 |
| | Riparian Vegetation | 0.38 | 0.80 |
| | Bed Material | 0.65 | 1.00 |
| | Bed Form Diversity | 0.63 | 1.00 |
| | Plan Form | 0.76 | 0.76 |
| Physicochemical | Temperature | | |
| | Bacteria | | |
| | Organic Matter | | |
| | Nitrogen | | |
| | Phosphorus | | |
| Biology | Macros | | |
| | Fish | | |

## FUNCTIONAL CATEGORY REPORT CARD

| Functional Category | ECS | PCS | Functional Change |
|---|---|---|---|
| Hydrology | 0.45 | 0.45 | 0.00 |
| Hydraulics | 0.41 | 0.97 | 0.56 |
| Geomorphology | 0.58 | 0.91 | 0.33 |
| 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 | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.29 | Not Functioning |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.7 | 0 | 0.41 | 0.41 | Functioning At Risk | | |
| | | Entrenchment Ratio | 1.7 | 0.81 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.58 | Functioning At Risk | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | 0.50 | | | | |
| | | Dominant BEHI/NBS | M/M | 0.5 | | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.38 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | Left Buffer Width (ft) | 15 | 0.35 | | | | | |
| | | Right Buffer Width (ft) | 30 | 0.7 | | | | | |
| | | Left Basal Area (sq.ft/acre) | | | | | | | |
| | | Right Basal Area (sq.ft/acre) | | | | | | | |
| | | Left Stem Density (stems/acre) | 120 | 0.23 | | | | | |
| | | Right Stem Density (stems/acre) | 120 | 0.23 | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | 0.1 | 0.65 | 0.65 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 0.63 | | | | |
| | | Pool Depth Ratio | 1.4 | 0.56 | | | | | |
| | | Percent Riffle | 75 | 0.69 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.2 | 0.76 | 0.76 | | | | |
| 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 | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.47 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1 | 1 | 0.97 | 0.97 | Functioning | | |
| | | Entrenchment Ratio | 2 | 0.93 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.91 | 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 | 0.80 | | | | |
| | | Right Canopy Coverage (%) | 100 | 1 | | | | | |
| | | Left Buffer Width (ft) | 50 | 1 | | | | | |
| | | Right Buffer Width (ft) | 50 | 1 | | | | | |
| | | 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) | 0.2 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 1.00 | | | | |
| | | Pool Depth Ratio | 1.8 | 1 | | | | | |
| | | Percent Riffle | 60 | 1 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.2 | 0.76 | 0.76 | | | | |
| 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**

Rater(s): KMV

Date: 10/9/19

| | |
|---|---|
| **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 | F |
| 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% | F |
| 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 | F |
| 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 | F |
| 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 | G |
| 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. | G |
| 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: | Banner Branch |
| Reach ID: | UT4-R2 |
| Restoration Potential: | Level 5 - Biology |
| Existing Stream Type: | E |
| Proposed Stream Type: | C |
| Region: | Piedmont |
| Drainage Area (sqmi): | 0.35 |
| Proposed Bed Material: | Gravel |
| Existing Stream Length (ft): | 1787 |
| Proposed Stream Length (ft): | 1787 |
| Stream Slope (%): | 1.1 |
| Flow Type: | Perennial |
| River Basin: | Roanoke |
| Stream Temperature: | Warmwater |
| Data Collection Season: | Fall |
| 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) | 0.36 |
| Proposed Condition Score (PCS) | 0.62 |
| Change in Functional Condition (PCS - ECS) | 0.26 |
| Percent Condition Change | 72% |
| Existing Stream Length (ft) | 1787 |
| Proposed Stream Length (ft) | 1787 |
| Additional Stream Length (ft) | 0 |
| Existing Functional Foot Score (FFS) | 643 |
| Proposed Functional Foot Score (FFS) | 1108 |
| Proposed FFS - Existing FFS | 465 |
| Functional Change (%) | 72% |

## 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 | 643 |
| Proposed Stream FFS + Proposed BMP FFS | 1108 |
| Total Proposed FFS - Total Existing FFS | 465 |
| Functional Change (%) | 72% |

## FUNCTION BASED PARAMETERS SUMMARY

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.45 | 0.45 |
| | Reach Runoff | 0.45 | 0.45 |
| Hydraulics | Floodplain Connectivity | 0.64 | 0.64 |
| Geomorphology | Large Woody Debris | | |
| | Lateral Stability | 0.70 | 1.00 |
| | Riparian Vegetation | 0.21 | 0.71 |
| | Bed Material | 0.65 | 1.00 |
| | Bed Form Diversity | 0.78 | 1.00 |
| | Plan Form | 1.00 | 1.00 |
| Physicochemical | Temperature | | |
| | Bacteria | | |
| | Organic Matter | 0.00 | 0.36 |
| | Nitrogen | | |
| | Phosphorus | | |
| Biology | Macros | 0.04 | 0.71 |
| | Fish | | |

## FUNCTIONAL CATEGORY REPORT CARD

| Functional Category | ECS | PCS | Functional Change |
|---|---|---|---|
| Hydrology | 0.45 | 0.45 | 0.00 |
| Hydraulics | 0.64 | 0.64 | 0.00 |
| Geomorphology | 0.67 | 0.94 | 0.27 |
| Physicochemical | 0.00 | 0.36 | 0.36 |
| Biology | 0.04 | 0.71 | 0.67 |

| 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 | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.36 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.4 | 0.43 | 0.64 | 0.64 | Functioning At Risk | | |
| | | Entrenchment Ratio | 3.7 | 0.85 | | | | | |
| Geomorphology | Large Woody Debris | LWD Index | | | | 0.67 | Functioning At Risk | | |
| | | # Pieces | | | | | | | |
| | Lateral Stability | Erosion Rate (ft/yr) | | | 0.70 | | | | |
| | | Dominant BEHI/NBS | L/M | 0.7 | | | | | |
| | | Percent Streambank Erosion (%) | | | | | | | |
| | Riparian Vegetation | Left Canopy Coverage (%) | | | 0.21 | | | | |
| | | Right Canopy Coverage (%) | | | | | | | |
| | | Left Buffer Width (ft) | 15 | 0.07 | | | | | |
| | | Right Buffer Width (ft) | 30 | 0.3 | | | | | |
| | | Left Basal Area (sq.ft/acre) | | | | | | | |
| | | Right Basal Area (sq.ft/acre) | | | | | | | |
| | | Left Stem Density (stems/acre) | 120 | 0.23 | | | | | |
| | | Right Stem Density (stems/acre) | 120 | 0.23 | | | | | |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) | 0.1 | 0.65 | 0.65 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 0.78 | | | | |
| | | Pool Depth Ratio | 1.4 | 0.56 | | | | | |
| | | Percent Riffle | 70 | 1 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.2 | 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 | 6.65 | 0.08 | 0.04 | 0.04 | Not Functioning | | |
| | | EPT Taxa Present | 0 | 0 | | | | | |
| | 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 | 65 | 0.45 | 0.45 | 0.45 | Functioning At Risk | 0.62 | Functioning At Risk |
| | Reach Runoff | Curve Number | 65 | 0.45 | 0.45 | | | | |
| | | Concentrated Flow Points | | | | | | | |
| | | Soil Compaction | | | | | | | |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio | 1.4 | 0.43 | 0.64 | 0.64 | Functioning At Risk | | |
| | | Entrenchment Ratio | 3.7 | 0.85 | | | | | |
| 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 | 0.71 | | | | |
| | | Right Canopy Coverage (%) | 100 | 1 | | | | | |
| | | Left Buffer Width (ft) | 50 | 0.72 | | | | | |
| | | Right Buffer Width (ft) | 50 | 0.72 | | | | | |
| | | 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) | 0.2 | 1 | 1.00 | | | | |
| | Bed Form Diversity | Pool Spacing Ratio | | | 1.00 | | | | |
| | | Pool Depth Ratio | 1.8 | 1 | | | | | |
| | | Percent Riffle | 70 | 1 | | | | | |
| | | Aggradation Ratio | | | | | | | |
| | Plan Form | Sinuosity | 1.2 | 1 | 1.00 | | | | |
| Physicochemical | Temperature | Summer Daily Maximum (°F) | | | | 0.36 | Functioning At Risk | | |
| | Bacteria | Fecal Coliform (Cfu/100 ml) | | | | | | | |
| | Organic Carbon | Leaf Litter Processing Rate | | | 0.36 | | | | |
| | | Percent Shredders | 5 | 0.36 | | | | | |
| | Nitrogen | Total Nitrogen (mg/L) | | | | | | | |
| | Phosphorus | Total Phosphorus (mg/L) | | | | | | | |
| Biology | Macros | Biotic Index | 5 | 0.78 | 0.71 | 0.71 | Functioning | | |
| | | EPT Taxa Present | 20 | 0.64 | | | | | |
| | Fish | North Carolina Index of Biotic Integrity | | | | | | | |

| **Banner Branch BB-R1** | **Existing Stream Values-Riffle Cross Section X5** | | **Composite Reference Values** | | **Proposed Stream Values (Restoration)** | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 986 | | --- | | 808 | |
| Drainage Area, DA (sq mi) | 0.6400 | | --- | | 0.6400 | |
| Stream Type (Rosgen) | B4c | | C4 | | C4 | |
| Bankfull Discharge, Qbkf (cfs) | 55.0 | | --- | --- | 55.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 16.1 | | --- | --- | 14.00 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 3.4 | | --- | --- | 3.93 | |
| Bankfull Riffle Width, Wbkf (ft) | 14.8 | | --- | --- | 13.00 | |
| Bankfull Mean Depth, Dbkf (ft) | 1.1 | | --- | --- | 1.08 | |
| Width to Depth Ratio, W/D (ft/ft) | 13.6 | | 10 | 14 | 12.07 | |
| Width of Floodprone Area, Wfpa (ft) | 26.4 | | --- | --- | 35.00 | 75.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 1.8 | | --- | --- | 2.69 | 5.77 |
| Riffle Max Depth @ bkf, Dmax (ft) | 1.6 | | --- | --- | 1.40 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 1.4 | | 1.1 | 1.3 | 1.30 | |
| Max Depth @ tob, Dmaxtob (ft) | 2.0 | | --- | --- | 1.40 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 1.2 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 56.00 | 83.00 | --- | --- | 91.00 | 156.00 |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 3.78 | 5.61 | 7.00 | 12.00 | 7.00 | 12.00 |
| Radius of Curvature, Rc (ft) | 7.00 | 19.00 | --- | --- | 26.00 | 39.00 |
| Rc Ratio, Rc/Wbkf (ft/ft) | 0.47 | 1.28 | 2.00 | 3.00 | 2.00 | 3.00 |
| Belt Width, Wblt (ft) | 54.00 | 76.00 | --- | --- | 45.50 | 104.00 |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 3.65 | 5.14 | 3.50 | 8.00 | 3.50 | 8.00 |
| Sinuosity, K (Sval/Schan) | 1.34 | | 1.20 | 1.60 | 1.15 | |
| Valley Slope, Sval (ft/ft) | 0.0107 | | 0.0050 | 0.0150 | 0.0107 | |
| Channel Slope, Schan (ft/ft) | 0.0080 | | --- | --- | 0.0093 | |
| Riffle Slope, Sriff | 0.0070 | 0.0370 | --- | --- | 0.0140 | 0.0187 |
| Riffle Slope Ratio, Sriff/Schan | 0.8731 | 4.6148 | 1.50 | 2.00 | 1.50 | 2.00 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0019 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.20 | 0.00 | 0.20 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 2.14 | 2.50 | --- | --- | 2.15 | 3.77 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 1.96 | 2.29 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 9.17 | 20.47 | --- | --- | 16.90 | 22.10 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.62 | 1.38 | 1.30 | 1.70 | 1.30 | 1.70 |
| Pool Spacing, Lps (ft) | 44.00 | 227.00 | --- | --- | 52.00 | 91.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 2.97 | 15.34 | 4.00 | 7.00 | 4.00 | 7.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | 4.73, 8.00, 11.44, 25.38, 37.95 | | --- | --- | | |

| Banner Branch BB-R2 | Existing Stream Values-Riffle Cross Section X3 | | Composite Reference Values | | Proposed Stream Values (Restoration) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 2080 | | --- | | 1835 | |
| Drainage Area, DA (sq mi) | 0.7500 | | --- | | 0.7500 | |
| Stream Type (Rosgen) | E4 | | C4 | | C4 | |
| Bankfull Discharge, Qbkf (cfs) | 60.0 | | --- | --- | 60.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 21.0 | | --- | --- | 15.95 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 2.9 | | --- | --- | 3.76 | |
| Bankfull Riffle Width, Wbkf (ft) | 13.7 | | --- | --- | 14.00 | |
| Bankfull Mean Depth, Dbkf (ft) | 1.5 | | --- | --- | 1.14 | |
| Width to Depth Ratio, W/D (ft/ft) | 9.0 | | 10 | 14 | 12.29 | |
| Width of Floodprone Area, Wfpa (ft) | 93.1 | | --- | --- | 65.00 | 155.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 6.8 | | --- | --- | 4.64 | 11.07 |
| Riffle Max Depth @ bkf, Dmax (ft) | 2.1 | | --- | --- | 1.45 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 1.4 | | 1.1 | 1.3 | 1.27 | |
| Max Depth @ tob, Dmaxtob (ft) | 3.3 | | --- | --- | 1.45 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 1.5 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 66.00 | 87.00 | --- | --- | 98.00 | 168.00 |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 4.81 | 6.34 | 7.00 | 12.00 | 7.00 | 12.00 |
| Radius of Curvature, Rc (ft) | 7.00 | 18.00 | --- | --- | 28.00 | 42.00 |
| Rc Ratio, Rc/Wbkf (ft/ft) | 0.51 | 1.31 | 2.00 | 3.00 | 2.00 | 3.00 |
| Belt Width, Wblt (ft) | 60.00 | 119.00 | --- | --- | 49.00 | 112.00 |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 4.37 | 8.67 | 3.50 | 8.00 | 3.50 | 8.00 |
| Sinuosity, K (Sval/Schan) | 1.31 | | 1.20 | 1.60 | 1.24 | |
| Valley Slope, Sval (ft/ft) | 0.0093 | | 0.0050 | 0.0150 | 0.0093 | |
| Channel Slope, Schan (ft/ft) | 0.0071 | | --- | --- | 0.0075 | |
| Riffle Slope, Sriff | 0.0011 | 0.0950 | --- | --- | 0.0113 | 0.0151 |
| Riffle Slope Ratio, Sriff/Schan | 0.1541 | 13.3098 | 1.50 | 2.00 | 1.50 | 2.00 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0015 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.20 | 0.00 | 0.20 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 2.08 | 3.03 | --- | --- | 2.28 | 3.99 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 1.36 | 1.98 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 6.30 | 22.80 | --- | --- | 18.20 | 23.80 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.46 | 1.66 | 1.30 | 1.70 | 1.30 | 1.70 |
| Pool Spacing, Lps (ft) | 12.00 | 303.00 | --- | --- | 56.00 | 98.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 0.87 | 22.08 | 4.00 | 7.00 | 4.00 | 7.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | 4.73, 8.00, 11.44, 25.38, 37.95 | | --- | --- | | |

| Banner Branch BB-R3 | Existing Stream Values-Riffle Cross Section X1 | | Composite Reference Values | | Proposed Stream Values (Restoration) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 478 | | --- | | 636 | |
| Drainage Area, DA (sq mi) | 0.8800 | | --- | | 0.8800 | |
| Stream Type (Rosgen) | E4 | | C4 | | C4 | |
| Bankfull Discharge, Qbkf (cfs) | 70.0 | | --- | --- | 70.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 21.9 | | --- | --- | 17.83 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 3.2 | | --- | --- | 3.93 | |
| Bankfull Riffle Width, Wbkf (ft) | 14.6 | | --- | --- | 15.00 | |
| Bankfull Mean Depth, Dbkf (ft) | 1.5 | | --- | --- | 1.19 | |
| Width to Depth Ratio, W/D (ft/ft) | 9.7 | | 10 | 14 | 12.62 | |
| Width of Floodprone Area, Wfpa (ft) | 51.0 | | --- | --- | 50.00 | 120.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 3.5 | | --- | --- | 3.33 | 8.00 |
| Riffle Max Depth @ bkf, Dmax (ft) | 2.7 | | --- | --- | 1.55 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 1.8 | | 1.1 | 1.3 | 1.30 | |
| Max Depth @ tob, Dmaxtob (ft) | 3.8 | | --- | --- | 1.55 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 1.4 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 67.00 | 69.00 | --- | --- | 105.00 | 180.00 |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 4.60 | 4.74 | 7.00 | 12.00 | 7.00 | 12.00 |
| Radius of Curvature, Rc (ft) | 9.00 | 18.00 | --- | --- | 30.00 | 45.00 |
| Rc Ratio, Rc/Wbkf (ft/ft) | 0.62 | 1.24 | 2.00 | 3.00 | 2.00 | 3.00 |
| Belt Width, Wblt (ft) | 60.00 | 61.00 | --- | --- | 52.50 | 120.00 |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 4.12 | 4.19 | 3.50 | 8.00 | 3.50 | 8.00 |
| Sinuosity, K (Sval/Schan) | 1.15 | | 1.20 | 1.60 | 1.23 | |
| Valley Slope, Sval (ft/ft) | 0.0060 | | 0.0050 | 0.0150 | 0.0060 | |
| Channel Slope, Schan (ft/ft) | 0.0052 | | --- | --- | 0.0049 | |
| Riffle Slope, Sriff | 0.0032 | 0.0336 | --- | --- | 0.0073 | 0.0098 |
| Riffle Slope Ratio, Sriff/Schan | 0.6101 | 6.4056 | 1.50 | 2.00 | 1.50 | 2.00 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0010 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.20 | 0.00 | 0.20 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 2.15 | 2.98 | --- | --- | 2.38 | 4.16 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 1.43 | 1.98 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 11.93 | 17.12 | --- | --- | 19.50 | 25.50 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.82 | 1.18 | 1.30 | 1.70 | 1.30 | 1.70 |
| Pool Spacing, Lps (ft) | 19.00 | 96.00 | --- | --- | 60.00 | 105.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 1.30 | 6.59 | 4.00 | 7.00 | 4.00 | 7.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | 0.23, 9.51, 20.14, 40.17, 51.35 | | --- | --- | | |

| Banner Branch UT1A | Existing Stream Values-Riffle Cross Section X8 | | Composite Reference Values | | Proposed Stream Values (Enhancement) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 410 | | --- | | 410 | |
| Drainage Area, DA (sq mi) | 0.0073 | | --- | | 0.0073 | |
| Stream Type (Rosgen) | G5 | | B4 | | B4 | |
| Bankfull Discharge, Qbkf (cfs) | 2.0 | | --- | --- | 2.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 0.8 | | --- | --- | 0.83 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 2.5 | | --- | --- | 2.42 | |
| Bankfull Riffle Width, Wbkf (ft) | 2.8 | | --- | --- | 3.50 | |
| Bankfull Mean Depth, Dbkf (ft) | 0.3 | | --- | --- | 0.24 | |
| Width to Depth Ratio, W/D (ft/ft) | 9.5 | | 12 | 18 | 14.85 | |
| Width of Floodprone Area, Wfpa (ft) | 3.4 | | --- | --- | 10.00 | 10.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 1.2 | | --- | --- | 2.86 | 2.86 |
| Riffle Max Depth @ bkf, Dmax (ft) | 0.5 | | --- | --- | 0.30 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 1.6 | | 1.2 | 1.4 | 1.27 | |
| Max Depth @ tob, Dmaxtob (ft) | 1.6 | | --- | --- | 0.30 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 3.5 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | NA | NA | --- | --- | N/A | N/A |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | NA | NA | N/A | N/A | N/A | N/A |
| Radius of Curvature, Rc (ft) | 4.00 | 6.00 | --- | --- | N/A | N/A |
| Rc Ratio, Rc/Wbkf (ft/ft) | 1.45 | 2.17 | N/A | N/A | N/A | N/A |
| Belt Width, Wblt (ft) | 38.00 | 38.00 | --- | --- | N/A | N/A |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 13.77 | 13.77 | N/A | N/A | N/A | N/A |
| Sinuosity, K (Sval/Schan) | 1.15 | | 1.10 | 1.20 | 1.14 | |
| Valley Slope, Sval (ft/ft) | 0.0290 | | 0.0200 | 0.0300 | 0.0290 | |
| Channel Slope, Schan (ft/ft) | 0.0252 | | --- | --- | 0.0255 | |
| Riffle Slope, Sriff | 0.0125 | 0.0313 | --- | --- | 0.0280 | 0.0458 |
| Riffle Slope Ratio, Sriff/Schan | 0.4955 | 1.2407 | 1.10 | 1.80 | 1.10 | 1.80 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0102 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.40 | 0.00 | 0.40 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 0.45 | 0.79 | --- | --- | 0.47 | 0.83 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 1.55 | 2.73 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 2.70 | 6.20 | --- | --- | 3.85 | 5.25 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.98 | 2.25 | 1.10 | 1.50 | 1.10 | 1.50 |
| Pool Spacing, Lps (ft) | 12.00 | 89.00 | --- | --- | 5.25 | 17.50 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 4.35 | 32.25 | 1.50 | 5.00 | 1.50 | 5.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | | | --- | --- | | |

| Banner Branch UT1B | Existing Stream Values-Riffle Cross Section X7 | | Composite Reference Values | | Proposed Stream Values (Restoration) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 391 | | --- | | 488 | |
| Drainage Area, DA (sq mi) | 0.0650 | | --- | | 0.0650 | |
| Stream Type (Rosgen) | E5b | | B4 | | B4 | |
| Bankfull Discharge, Qbkf (cfs) | 16.0 | | --- | --- | 16.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 3.8 | | --- | --- | 3.03 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 4.2 | | --- | --- | 5.29 | |
| Bankfull Riffle Width, Wbkf (ft) | 6.5 | | --- | --- | 7.00 | |
| Bankfull Mean Depth, Dbkf (ft) | 0.6 | | --- | --- | 0.43 | |
| Width to Depth Ratio, W/D (ft/ft) | 11.1 | | 12 | 18 | 16.20 | |
| Width of Floodprone Area, Wfpa (ft) | 16.5 | | --- | --- | 25.00 | 150.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 2.5 | | --- | --- | 3.57 | 21.43 |
| Riffle Max Depth @ bkf, Dmax (ft) | 1.1 | | --- | --- | 0.55 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 1.8 | | 1.2 | 1.4 | 1.27 | |
| Max Depth @ tob, Dmaxtob (ft) | 1.1 | | --- | --- | 0.55 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 1.0 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 22.00 | 39.00 | --- | --- | 49.00 | 84.00 |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 3.39 | 6.01 | 7.00 | 12.00 | 7.00 | 12.00 |
| Radius of Curvature, Rc (ft) | 3.00 | 6.00 | --- | --- | 14.00 | 21.00 |
| Rc Ratio, Rc/Wbkf (ft/ft) | 0.46 | 0.92 | 2.00 | 3.00 | 2.00 | 3.00 |
| Belt Width, Wblt (ft) | 27.58 | 31.51 | --- | --- | 24.50 | 56.00 |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 4.25 | 4.86 | 3.50 | 8.00 | 3.50 | 8.00 |
| Sinuosity, K (Sval/Schan) | 1.18 | | 1.10 | 1.20 | 1.16 | |
| Valley Slope, Sval (ft/ft) | 0.0296 | | 0.0200 | 0.0300 | 0.0296 | |
| Channel Slope, Schan (ft/ft) | 0.0251 | | --- | --- | 0.0256 | |
| Riffle Slope, Sriff | 0.0091 | 0.0289 | --- | --- | 0.0282 | 0.0461 |
| Riffle Slope Ratio, Sriff/Schan | 0.3623 | 1.1506 | 1.10 | 1.80 | 1.10 | 1.80 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0102 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.40 | 0.00 | 0.40 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 0.76 | 1.14 | --- | --- | 0.86 | 1.51 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 1.30 | 1.95 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 4.28 | 11.61 | --- | --- | 7.70 | 10.50 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.66 | 1.79 | 1.10 | 1.50 | 1.10 | 1.50 |
| Pool Spacing, Lps (ft) | 21.00 | 129.00 | --- | --- | 10.50 | 35.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 3.24 | 19.88 | 1.50 | 5.00 | 1.50 | 5.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | | | --- | --- | | |

| Banner Branch UT1C Upper | Existing Stream Values-Riffle Cross Section | | Composite Reference Values | | Proposed Stream Values (Preservation) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 69 | | --- | | 69 | |
| Drainage Area, DA (sq mi) | 0.0247 | | --- | | 0.0247 | |
| Stream Type (Rosgen) | B4a | | B4a | | B4a | |
| Bankfull Discharge, Qbkf (cfs) | 6.0 | | --- | --- | 6.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 1.2 | | --- | --- | 1.18 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 5.1 | | --- | --- | 5.08 | |
| Bankfull Riffle Width, Wbkf (ft) | 3.7 | | --- | --- | 3.70 | |
| Bankfull Mean Depth, Dbkf (ft) | 0.3 | | --- | --- | 0.32 | |
| Width to Depth Ratio, W/D (ft/ft) | 11.6 | | 12 | 18 | 11.60 | |
| Width of Floodprone Area, Wfpa (ft) | N/A | | --- | --- | N/A | N/A |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | N/A | | --- | --- | N/A | N/A |
| Riffle Max Depth @ bkf, Dmax (ft) | 0.6 | | --- | --- | 0.64 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 2.0 | | 1.2 | 1.4 | 2.01 | |
| Max Depth @ tob, Dmaxtob (ft) | 1.3 | | --- | --- | 1.28 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 2.0 | | 1.0 | 1.1 | 2.00 | |
| Meander Wavelength, Lm (ft) | N/A | N/A | --- | --- | N/A | N/A |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | N/A | N/A | N/A | N/A | N/A | N/A |
| Radius of Curvature, Rc (ft) | N/A | N/A | --- | --- | N/A | N/A |
| Rc Ratio, Rc/Wbkf (ft/ft) | N/A | N/A | N/A | N/A | N/A | N/A |
| Belt Width, Wblt (ft) | N/A | N/A | --- | --- | N/A | N/A |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | N/A | N/A | N/A | N/A | N/A | N/A |
| Sinuosity, K (Sval/Schan) | 1.10 | | 1.10 | 1.20 | 1.10 | |
| Valley Slope, Sval (ft/ft) | 0.0548 | | 0.0200 | 0.0300 | 0.0548 | |
| Channel Slope, Schan (ft/ft) | 0.0497 | | --- | --- | 0.0497 | |
| Riffle Slope, Sriff | N/A | N/A | --- | --- | N/A | N/A |
| Riffle Slope Ratio, Sriff/Schan | N/A | N/A | 1.10 | 1.80 | N/A | N/A |
| Pool Slope, Spool (ft/ft) | N/A | N/A | --- | --- | N/A | N/A |
| Pool Slope Ratio, Spool/Schan | N/A | N/A | 0.00 | 0.40 | N/A | N/A |
| Pool Max Depth @ bkf, Dmaxpool (ft) | N/A | N/A | --- | --- | N/A | N/A |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | N/A | N/A | 2.00 | 3.50 | N/A | N/A |
| Pool Width, Wpool (ft) | N/A | N/A | --- | --- | N/A | N/A |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | N/A | N/A | 1.10 | 1.50 | N/A | N/A |
| Pool Spacing, Lps (ft) | N/A | N/A | --- | --- | N/A | N/A |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | N/A | N/A | 1.50 | 5.00 | N/A | N/A |
| d16/ d35/ d50/ d84/ d95 (mm) | | | --- | --- | | |

| Banner Branch UT1-R1 | Existing Stream Values-Riffle Cross Section X9 | | Composite Reference Values | | Proposed Stream Values (Restoration) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 535 | | --- | | 509 | |
| Drainage Area, DA (sq mi) | 0.0644 | | --- | | 0.0644 | |
| Stream Type (Rosgen) | Incised E4b | | B4 | | B4 | |
| Bankfull Discharge, Qbkf (cfs) | 17.0 | | --- | --- | 17.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 4.2 | | --- | --- | 3.90 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 4.0 | | --- | --- | 4.36 | |
| Bankfull Riffle Width, Wbkf (ft) | 5.9 | | --- | --- | 8.00 | |
| Bankfull Mean Depth, Dbkf (ft) | 0.7 | | --- | --- | 0.49 | |
| Width to Depth Ratio, W/D (ft/ft) | 8.1 | | 12 | 18 | 16.41 | |
| Width of Floodprone Area, Wfpa (ft) | 14.7 | | --- | --- | 16.00 | 26.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 2.5 | | --- | --- | 2.00 | 3.25 |
| Riffle Max Depth @ bkf, Dmax (ft) | 1.0 | | --- | --- | 0.60 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 1.4 | | 1.2 | 1.4 | 1.23 | |
| Max Depth @ tob, Dmaxtob (ft) | 1.4 | | --- | --- | 0.60 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 1.4 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 30.00 | 33.00 | --- | --- | 56.00 | 96.00 |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 5.12 | 5.63 | 7.00 | 12.00 | 7.00 | 12.00 |
| Radius of Curvature, Rc (ft) | 6.00 | 8.00 | --- | --- | 16.00 | 24.00 |
| Rc Ratio, Rc/Wbkf (ft/ft) | 1.02 | 1.37 | 2.00 | 3.00 | 2.00 | 3.00 |
| Belt Width, Wblt (ft) | 18.80 | 33.00 | --- | --- | 28.00 | 64.00 |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 3.21 | 5.63 | 3.50 | 8.00 | 3.50 | 8.00 |
| Sinuosity, K (Sval/Schan) | 1.27 | | 1.10 | 1.20 | 1.27 | |
| Valley Slope, Sval (ft/ft) | 0.0343 | | 0.0200 | 0.0300 | 0.0343 | |
| Channel Slope, Schan (ft/ft) | 0.0270 | | --- | --- | 0.0270 | |
| Riffle Slope, Sriff | 0.0183 | 0.0916 | --- | --- | 0.0297 | 0.0487 |
| Riffle Slope Ratio, Sriff/Schan | 0.6767 | 3.3872 | 1.10 | 1.80 | 1.10 | 1.80 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0108 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.40 | 0.00 | 0.40 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 1.19 | 2.48 | --- | --- | 0.98 | 1.71 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 1.65 | 3.44 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 5.00 | 7.90 | --- | --- | 8.80 | 12.00 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.85 | 1.35 | 1.10 | 1.50 | 1.10 | 1.50 |
| Pool Spacing, Lps (ft) | 13.00 | 85.00 | --- | --- | 12.00 | 40.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 2.22 | 14.51 | 1.50 | 5.00 | 1.50 | 5.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | 0.24, 4.35, 8.66, 19.93, 28.2 | | --- | --- | | |

| Banner Branch UT1-R2 | Existing Stream Values-Riffle Cross Section X6 | | Composite Reference Values | | Proposed Stream Values (Enhancement) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 1827 | | --- | | 1783 | |
| Drainage Area, DA (sq mi) | 0.2109 | | --- | | 0.2109 | |
| Stream Type (Rosgen) | F4 | | C4 | | C4 | |
| Bankfull Discharge, Qbkf (cfs) | 21.0 | | --- | --- | 21.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 7.0 | | --- | --- | 5.25 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 3.0 | | --- | --- | 4.00 | |
| Bankfull Riffle Width, Wbkf (ft) | 11.5 | | --- | --- | 9.00 | |
| Bankfull Mean Depth, Dbkf (ft) | 0.6 | | --- | --- | 0.58 | |
| Width to Depth Ratio, W/D (ft/ft) | 18.8 | | 10 | 14 | 15.43 | |
| Width of Floodprone Area, Wfpa (ft) | 15.5 | | --- | --- | 34.00 | 73.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 1.3 | | --- | --- | 3.78 | 8.11 |
| Riffle Max Depth @ bkf, Dmax (ft) | 0.9 | | --- | --- | 0.70 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 1.6 | | 1.1 | 1.3 | 1.20 | |
| Max Depth @ tob, Dmaxtob (ft) | 1.7 | | --- | --- | 0.70 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 1.8 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 30.00 | 45.00 | --- | --- | 63.00 | 108.00 |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 2.62 | 3.92 | 7.00 | 12.00 | 7.00 | 12.00 |
| Radius of Curvature, Rc (ft) | 4.00 | 8.00 | --- | --- | 18.00 | 27.00 |
| Rc Ratio, Rc/Wbkf (ft/ft) | 0.35 | 0.70 | 2.00 | 3.00 | 2.00 | 3.00 |
| Belt Width, Wblt (ft) | 33.00 | 65.00 | --- | --- | 31.50 | 72.00 |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 2.88 | 5.67 | 3.50 | 8.00 | 3.50 | 8.00 |
| Sinuosity, K (Sval/Schan) | 1.56 | | 1.20 | 1.60 | 1.34 | |
| Valley Slope, Sval (ft/ft) | 0.0207 | | 0.0050 | 0.0150 | 0.0207 | |
| Channel Slope, Schan (ft/ft) | 0.0133 | | --- | --- | 0.0155 | |
| Riffle Slope, Sriff | 0.0037 | 0.0509 | --- | --- | 0.0170 | 0.0278 |
| Riffle Slope Ratio, Sriff/Schan | 0.2786 | 3.8326 | 1.10 | 1.80 | 1.10 | 1.80 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0062 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.40 | 0.00 | 0.40 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 1.21 | 2.38 | --- | --- | 1.17 | 2.04 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 1.99 | 3.91 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 3.82 | 12.08 | --- | --- | 9.90 | 13.50 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.33 | 1.05 | 1.10 | 1.50 | 1.10 | 1.50 |
| Pool Spacing, Lps (ft) | 19.00 | 189.00 | --- | --- | 13.50 | 45.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 1.66 | 16.48 | 1.50 | 5.00 | 1.50 | 5.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | 0.50, 6.23, 11.86, 28.09, 45.00 | | --- | --- | | |

| Banner Branch UT1-R3 | Existing Stream Values-Riffle Cross Section from CAD | | Composite Reference Values | | Proposed Stream Values (Preservation) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 822 | | --- | | 822 | |
| Drainage Area, DA (sq mi) | 0.2600 | | --- | | 0.2600 | |
| Stream Type (Rosgen) | C4 | | C4 | | C4 | |
| Bankfull Discharge, Qbkf (cfs) | 29.0 | | --- | --- | 29.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 7.8 | | --- | --- | 7.78 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 3.7 | | --- | --- | 3.73 | |
| Bankfull Riffle Width, Wbkf (ft) | 8.5 | | --- | --- | 8.50 | |
| Bankfull Mean Depth, Dbkf (ft) | 0.9 | | --- | --- | 0.92 | |
| Width to Depth Ratio, W/D (ft/ft) | 9.3 | | 10 | 14 | 9.29 | |
| Width of Floodprone Area, Wfpa (ft) | 17.3 | | --- | --- | 17.28 | 17.28 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 2.0 | | --- | --- | 2.03 | 2.03 |
| Riffle Max Depth @ bkf, Dmax (ft) | 1.8 | | --- | --- | 1.81 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 2.0 | | 1.1 | 1.3 | 1.98 | |
| Max Depth @ tob, Dmaxtob (ft) | 3.6 | | --- | --- | 3.62 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 2.0 | | 1.0 | 1.1 | 2.00 | |
| Meander Wavelength, Lm (ft) | 45.00 | 48.00 | --- | --- | 45.00 | 48.00 |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 5.29 | 5.65 | 7.00 | 12.00 | 5.29 | 5.65 |
| Radius of Curvature, Rc (ft) | 7.00 | 11.00 | --- | --- | 7.00 | 11.00 |
| Rc Ratio, Rc/Wbkf (ft/ft) | 0.82 | 1.29 | 2.00 | 3.00 | 0.82 | 1.29 |
| Belt Width, Wblt (ft) | 55.00 | 91.00 | --- | --- | 55.00 | 91.00 |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 6.47 | 10.71 | 3.50 | 8.00 | 6.47 | 10.71 |
| Sinuosity, K (Sval/Schan) | 1.31 | | 1.20 | 1.60 | 1.31 | |
| Valley Slope, Sval (ft/ft) | 0.0122 | | 0.0050 | 0.0150 | 0.0122 | |
| Channel Slope, Schan (ft/ft) | 0.0093 | | --- | --- | 0.0093 | |
| Riffle Slope, Sriff | 0.0180 | 0.0470 | --- | --- | 0.0180 | 0.0470 |
| Riffle Slope Ratio, Sriff/Schan | 1.9321 | 5.0448 | 1.50 | 2.00 | 1.93 | 5.04 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0000 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.20 | 0.00 | 0.00 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 2.40 | 3.50 | --- | --- | 2.40 | 3.50 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 2.62 | 3.82 | 2.00 | 3.50 | 2.62 | 3.82 |
| Pool Width, Wpool (ft) | 8.00 | 22.00 | --- | --- | 8.00 | 22.00 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.94 | 2.59 | 1.30 | 1.70 | 0.94 | 2.59 |
| Pool Spacing, Lps (ft) | 28.00 | 123.00 | --- | --- | 28.00 | 123.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 3.29 | 14.47 | 4.00 | 7.00 | 3.29 | 14.47 |
| d16/ d35/ d50/ d84/ d95 (mm) | | | --- | --- | | |

| Banner Branch UT2 | Existing Stream Values-Riffle Cross Section X4 | | Composite Reference Values | | Proposed Stream Values (Restoration) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 1315 | | --- | | 1287 | |
| Drainage Area, DA (sq mi) | 0.0442 | | --- | | 0.0442 | |
| Stream Type (Rosgen) | F4 | | B4 | | B4 | |
| Bankfull Discharge, Qbkf (cfs) | 10.0 | | --- | --- | 10.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 4.5 | | --- | --- | 2.25 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 2.2 | | --- | --- | 4.44 | |
| Bankfull Riffle Width, Wbkf (ft) | 11.8 | | --- | --- | 6.00 | |
| Bankfull Mean Depth, Dbkf (ft) | 0.4 | | --- | --- | 0.38 | |
| Width to Depth Ratio, W/D (ft/ft) | 30.9 | | 12 | 18 | 16.00 | |
| Width of Floodprone Area, Wfpa (ft) | 14.0 | | --- | --- | 9.00 | 15.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 1.2 | | --- | --- | 1.50 | 2.50 |
| Riffle Max Depth @ bkf, Dmax (ft) | 0.8 | | --- | --- | 0.50 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 2.1 | | 1.2 | 1.4 | 1.33 | |
| Max Depth @ tob, Dmaxtob (ft) | 0.8 | | --- | --- | 0.50 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 1.0 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 28.00 | 41.00 | --- | --- | N/A | N/A |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 2.37 | 3.47 | N/A | N/A | N/A | N/A |
| Radius of Curvature, Rc (ft) | 5.00 | 18.00 | --- | --- | N/A | N/A |
| Rc Ratio, Rc/Wbkf (ft/ft) | 0.42 | 1.52 | N/A | N/A | N/A | N/A |
| Belt Width, Wblt (ft) | 51.40 | 80.20 | --- | --- | N/A | N/A |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 4.35 | 6.79 | N/A | N/A | N/A | N/A |
| Sinuosity, K (Sval/Schan) | 1.14 | | 1.10 | 1.20 | 1.10 | |
| Valley Slope, Sval (ft/ft) | 0.0389 | | 0.0200 | 0.0300 | 0.0389 | |
| Channel Slope, Schan (ft/ft) | 0.0341 | | --- | --- | 0.0352 | |
| Riffle Slope, Sriff | 0.0094 | 0.0541 | --- | --- | 0.0387 | 0.0634 |
| Riffle Slope Ratio, Sriff/Schan | 0.2758 | 1.5872 | 1.10 | 1.80 | 1.10 | 1.80 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0141 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.40 | 0.00 | 0.40 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 0.86 | 2.90 | --- | --- | 0.75 | 1.31 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 2.25 | 7.58 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 5.40 | 15.56 | --- | --- | 6.60 | 9.00 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.46 | 1.32 | 1.10 | 1.50 | 1.10 | 1.50 |
| Pool Spacing, Lps (ft) | 18.00 | 387.00 | --- | --- | 9.00 | 30.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 1.52 | 32.77 | 1.50 | 5.00 | 1.50 | 5.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | 11.00, 20.73, 32.00, 53.67, 82.65 | | --- | --- | | |

| **Banner Branch UT2A** | **Existing Stream Values-Riffle Cross Section X2** | | **Composite Reference Values** | | **Proposed Stream Values (Restoration)** | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 289 | | --- | | 289 | |
| Drainage Area, DA (sq mi) | 0.0049 | | --- | | 0.0049 | |
| Stream Type (Rosgen) | E5b | | B4a | | B4a | |
| Bankfull Discharge, Qbkf (cfs) | 2.0 | | --- | --- | 2.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 0.7 | | --- | --- | 0.56 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 2.9 | | --- | --- | 3.56 | |
| Bankfull Riffle Width, Wbkf (ft) | 4.0 | | --- | --- | 3.00 | |
| Bankfull Mean Depth, Dbkf (ft) | 0.2 | | --- | --- | 0.19 | |
| Width to Depth Ratio, W/D (ft/ft) | 23.3 | | 12 | 18 | 16.00 | |
| Width of Floodprone Area, Wfpa (ft) | 5.1 | | --- | --- | 17.00 | 28.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 1.3 | | --- | --- | 5.67 | 9.33 |
| Riffle Max Depth @ bkf, Dmax (ft) | 0.7 | | --- | --- | 0.25 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 4.1 | | 1.2 | 1.4 | 1.33 | |
| Max Depth @ tob, Dmaxtob (ft) | 3.5 | | --- | --- | 0.25 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 4.9 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 47.00 | 81.00 | --- | --- | N/A | N/A |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 11.63 | 20.05 | N/A | N/A | N/A | N/A |
| Radius of Curvature, Rc (ft) | 5.00 | 16.00 | --- | --- | N/A | N/A |
| Rc Ratio, Rc/Wbkf (ft/ft) | 1.24 | 3.96 | N/A | N/A | N/A | N/A |
| Belt Width, Wblt (ft) | 46.30 | 50.79 | --- | --- | N/A | N/A |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 11.46 | 12.57 | N/A | N/A | N/A | N/A |
| Sinuosity, K (Sval/Schan) | 1.20 | | 1.10 | 1.20 | 1.13 | |
| Valley Slope, Sval (ft/ft) | 0.0548 | | 0.0200 | 0.0300 | 0.0548 | |
| Channel Slope, Schan (ft/ft) | 0.0455 | | --- | --- | 0.0486 | |
| Riffle Slope, Sriff | 0.0111 | 0.0421 | --- | --- | 0.0534 | 0.0874 |
| Riffle Slope Ratio, Sriff/Schan | 0.2438 | 0.9247 | 1.10 | 1.80 | 1.10 | 1.80 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0194 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.40 | 0.00 | 0.40 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 1.23 | 2.17 | --- | --- | 0.38 | 0.66 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 7.10 | 12.52 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 6.70 | 11.95 | --- | --- | 3.30 | 4.50 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 1.66 | 2.96 | 1.10 | 1.50 | 1.10 | 1.50 |
| Pool Spacing, Lps (ft) | 41.00 | 91.00 | --- | --- | 4.50 | 15.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 10.15 | 22.52 | 1.50 | 5.00 | 1.50 | 5.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | | | --- | --- | | |

| **Banner Branch UT3** | **Existing Stream Values-Riffle Cross Section X2** | | **Composite Reference Values** | | **Proposed Stream Values (Restoration)** | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 338 | | --- | | 589 | |
| Drainage Area, DA (sq mi) | 0.1200 | | --- | | 0.1200 | |
| Stream Type (Rosgen) | E5 | | C4 | | C4 | |
| Bankfull Discharge, Qbkf (cfs) | 24.0 | | --- | --- | 24.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 6.2 | | --- | --- | 4.55 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 3.9 | | --- | --- | 5.27 | |
| Bankfull Riffle Width, Wbkf (ft) | 5.6 | | --- | --- | 8.00 | |
| Bankfull Mean Depth, Dbkf (ft) | 1.1 | | --- | --- | 0.57 | |
| Width to Depth Ratio, W/D (ft/ft) | 5.1 | | 10 | 14 | 14.07 | |
| Width of Floodprone Area, Wfpa (ft) | 32.0 | | --- | --- | 20.00 | 40.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 5.7 | | --- | --- | 2.50 | 5.00 |
| Riffle Max Depth @ bkf, Dmax (ft) | 1.7 | | --- | --- | 0.70 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 1.6 | | 1.1 | 1.3 | 1.23 | |
| Max Depth @ tob, Dmaxtob (ft) | 2.4 | | --- | --- | 0.70 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 1.4 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 0.00 | 0.00 | --- | --- | 56.00 | 96.00 |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 0.00 | 0.00 | 7.00 | 12.00 | 7.00 | 12.00 |
| Radius of Curvature, Rc (ft) | Ditched | Ditched | --- | --- | 16.00 | 24.00 |
| Rc Ratio, Rc/Wbkf (ft/ft) | 0.00 | 0.00 | 2.00 | 3.00 | 2.00 | 3.00 |
| Belt Width, Wblt (ft) | 0.00 | 0.00 | --- | --- | 28.00 | 64.00 |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 0.00 | 0.00 | 3.50 | 8.00 | 3.50 | 8.00 |
| Sinuosity, K (Sval/Schan) | 1.03 | | 1.20 | 1.60 | 1.22 | |
| Valley Slope, Sval (ft/ft) | 0.0108 | | 0.0050 | 0.0150 | 0.0108 | |
| Channel Slope, Schan (ft/ft) | 0.0104 | | --- | --- | 0.0088 | |
| Riffle Slope, Sriff | 0.0160 | 0.0351 | --- | --- | 0.0132 | 0.0176 |
| Riffle Slope Ratio, Sriff/Schan | 1.5326 | 3.3622 | 1.50 | 2.00 | 1.50 | 2.00 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0018 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.20 | 0.00 | 0.20 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 0.53 | 0.61 | --- | --- | 1.14 | 1.99 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 0.48 | 0.55 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 8.34 | 9.97 | --- | --- | 10.40 | 13.60 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 1.48 | 1.77 | 1.30 | 1.70 | 1.30 | 1.70 |
| Pool Spacing, Lps (ft) | 23.00 | 47.00 | --- | --- | 32.00 | 56.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 4.09 | 8.35 | 4.00 | 7.00 | 4.00 | 7.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | | | --- | --- | | |

| Banner Branch UT4-R1 Lower | Existing Stream Values-Riffle Cross Section X12 | | Composite Reference Values | | Proposed Stream Values Lower (Restoration) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 2230 | | --- | | 1963 | |
| Drainage Area, DA (sq mi) | 0.2400 | | --- | | 0.2400 | |
| Stream Type (Rosgen) | F4 | | C4b | | C4b | |
| Bankfull Discharge, Qbkf (cfs) | 34.0 | | --- | --- | 30.0 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 8.3 | | --- | --- | 7.7 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 4.1 | | --- | --- | 3.9 | |
| Bankfull Riffle Width, Wbkf (ft) | 12.2 | | --- | --- | 11.0 | |
| Bankfull Mean Depth, Dbkf (ft) | 0.7 | | --- | --- | 0.7 | |
| Width to Depth Ratio, W/D (ft/ft) | 17.8 | | 10 | 14 | 15.8 | |
| Width of Floodprone Area, Wfpa (ft) | 15.3 | | --- | --- | 37.00 | 70.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 1.3 | | --- | --- | 3.36 | 6.36 |
| Riffle Max Depth @ bkf, Dmax (ft) | 1.0 | | --- | --- | 0.90 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 1.4 | | 1.1 | 1.3 | 1.29 | |
| Max Depth @ tob, Dmaxtob (ft) | 2.2 | | --- | --- | 0.90 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 2.3 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 42.00 | 85.00 | --- | --- | 77.00 | 132.00 |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 3.45 | 6.99 | 7.00 | 12.00 | 7.00 | 12.00 |
| Radius of Curvature, Rc (ft) | 4.00 | 33.00 | --- | --- | 22.00 | 33.00 |
| Rc Ratio, Rc/Wbkf (ft/ft) | 0.33 | 2.71 | 2.00 | 3.00 | 2.00 | 3.00 |
| Belt Width, Wblt (ft) | 47.17 | 135.32 | --- | --- | 38.50 | 88.00 |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 3.88 | 11.13 | 3.50 | 8.00 | 3.50 | 8.00 |
| Sinuosity, K (Sval/Schan) | 1.23 | | 1.20 | 1.60 | 1.18 | |
| Valley Slope, Sval (ft/ft) | 0.0228 | | 0.0050 | 0.0150 | 0.02 | |
| Channel Slope, Schan (ft/ft) | 0.0185 | | --- | --- | 0.01 | |
| Riffle Slope, Sriff | 0.0071 | 0.0380 | --- | --- | 0.0218 | 0.0291 |
| Riffle Slope Ratio, Sriff/Schan | 0.3833 | 2.0514 | 1.50 | 2.00 | 1.50 | 2.00 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0029 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.20 | 0.00 | 0.20 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 1.17 | 3.54 | --- | --- | 1.39 | 2.43 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 1.71 | 5.19 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 5.06 | 34.41 | --- | --- | 14.30 | 18.70 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.42 | 2.83 | 1.30 | 1.70 | 1.30 | 1.70 |
| Pool Spacing, Lps (ft) | 12.00 | 465.00 | --- | --- | 44.00 | 77.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 0.99 | 38.24 | 4.00 | 7.00 | 4.00 | 7.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | 0.20, 3.18, 4.73, 10.98, 28.50 | | --- | --- | | |

| Banner Branch UT4-R1 Upper | Existing Stream Values-Riffle Cross Section X11 | | Composite Reference Values | | Proposed Stream Values Upper (Restoration) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 2394 | | --- | | 2346 | |
| Drainage Area, DA (sq mi) | 0.1600 | | --- | | 0.1600 | |
| Stream Type (Rosgen) | B4c | | B4 | | B4 | |
| Bankfull Discharge, Qbkf (cfs) | 30.0 | | --- | --- | 30.0 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 8.2 | | --- | --- | 7.7 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 3.6 | | --- | --- | 3.9 | |
| Bankfull Riffle Width, Wbkf (ft) | 9.9 | | --- | --- | 11.0 | |
| Bankfull Mean Depth, Dbkf (ft) | 0.8 | | --- | --- | 0.7 | |
| Width to Depth Ratio, W/D (ft/ft) | 11.8 | | 10 | 14 | 15.8 | |
| Width of Floodprone Area, Wfpa (ft) | 14.7 | | --- | --- | 25.00 | 40.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 1.5 | | --- | --- | 2.27 | 3.64 |
| Riffle Max Depth @ bkf, Dmax (ft) | 1.2 | | --- | --- | 0.90 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 1.4 | | 1.2 | 1.4 | 1.29 | |
| Max Depth @ tob, Dmaxtob (ft) | 1.8 | | --- | --- | 0.90 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 1.5 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 42.00 | 85.00 | --- | --- | N/A | N/A |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 4.26 | 8.62 | N/A | N/A | N/A | N/A |
| Radius of Curvature, Rc (ft) | 4.00 | 33.00 | --- | --- | N/A | N/A |
| Rc Ratio, Rc/Wbkf (ft/ft) | 0.41 | 3.35 | N/A | N/A | N/A | N/A |
| Belt Width, Wblt (ft) | 47.17 | 135.32 | --- | --- | N/A | N/A |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 4.78 | 13.72 | N/A | N/A | N/A | N/A |
| Sinuosity, K (Sval/Schan) | 1.23 | | 1.10 | 1.20 | 1.14 | |
| Valley Slope, Sval (ft/ft) | 0.0228 | | 0.0200 | 0.0300 | 0.0282 | |
| Channel Slope, Schan (ft/ft) | 0.0185 | | --- | --- | 0.0248 | |
| Riffle Slope, Sriff | 0.0071 | 0.0380 | --- | --- | 0.0272 | 0.0446 |
| Riffle Slope Ratio, Sriff/Schan | 0.3833 | 2.0514 | 1.10 | 1.80 | 1.10 | 1.80 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0099 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.40 | 0.00 | 0.40 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 1.17 | 3.54 | --- | --- | 1.39 | 2.43 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 1.40 | 4.25 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 5.06 | 34.41 | --- | --- | 12.10 | 16.50 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.51 | 3.49 | 1.10 | 1.50 | 1.10 | 1.50 |
| Pool Spacing, Lps (ft) | 12.00 | 465.00 | --- | --- | 16.50 | 55.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 1.22 | 47.16 | 1.50 | 5.00 | 1.50 | 5.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | 0.22, 4.47, 6.69, 37.95, 75.89 | | --- | --- | | |

| Banner Branch UT4-R2 | Existing Stream Values-Riffle Cross Section X10 | | Composite Reference Values | | Proposed Stream Values (Enhancement) | |
|---|---|---|---|---|---|---|
| **Parameter** | **MIN** | **MAX** | **MIN** | **MAX** | **MIN** | **MAX** |
| Stream Length (ft) | 1722 | | --- | | 1722 | |
| Drainage Area, DA (sq mi) | 0.3500 | | --- | | 0.3500 | |
| Stream Type (Rosgen) | E5 | | C5 | | C5 | |
| Bankfull Discharge, Qbkf (cfs) | 40.0 | | --- | --- | 40.00 | |
| Bankfull Riffle XSEC Area, Abkf (sq ft) | 10.7 | | --- | --- | 9.50 | |
| Bankfull Mean Velocity, Vbkf (ft/s) | 3.7 | | --- | --- | 4.21 | |
| Bankfull Riffle Width, Wbkf (ft) | 10.6 | | --- | --- | 12.00 | |
| Bankfull Mean Depth, Dbkf (ft) | 1.0 | | --- | --- | 0.79 | |
| Width to Depth Ratio, W/D (ft/ft) | 10.5 | | 10 | 14 | 15.16 | |
| Width of Floodprone Area, Wfpa (ft) | 39.0 | | --- | --- | 43.00 | 126.00 |
| Entrenchment Ratio, Wfpa/Wbkf (ft/ft) | 3.7 | | --- | --- | 3.58 | 10.50 |
| Riffle Max Depth @ bkf, Dmax (ft) | 1.5 | | --- | --- | 1.00 | |
| Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft) | 1.4 | | 1.1 | 1.3 | 1.26 | |
| Max Depth @ tob, Dmaxtob (ft) | 1.8 | | --- | --- | 1.00 | |
| Bank Height Ratio, Dmaxtob/Dmax (ft/ft) | 1.2 | | 1.0 | 1.1 | 1.00 | |
| Meander Wavelength, Lm (ft) | 49.00 | 93.00 | --- | --- | 84.00 | 144.00 |
| Meander Wavelength Ratio, Lm/Wbkf (ft/ft) | 4.61 | 8.75 | 7.00 | 12.00 | 7.00 | 12.00 |
| Radius of Curvature, Rc (ft) | 5.00 | 16.00 | --- | --- | 24.00 | 36.00 |
| Rc Ratio, Rc/Wbkf (ft/ft) | 0.47 | 1.51 | 2.00 | 3.00 | 2.00 | 3.00 |
| Belt Width, Wblt (ft) | 50.67 | 100.92 | --- | --- | 42.00 | 96.00 |
| Meander Width Ratio, Wblt/Wbkf (ft/ft) | 4.77 | 9.49 | 3.50 | 8.00 | 3.50 | 8.00 |
| Sinuosity, K (Sval/Schan) | 1.21 | | 1.20 | 1.60 | 1.28 | |
| Valley Slope, Sval (ft/ft) | 0.0136 | | 0.0050 | 0.0150 | 0.0136 | |
| Channel Slope, Schan (ft/ft) | 0.0112 | | --- | --- | 0.0106 | |
| Riffle Slope, Sriff | 0.0031 | 0.0403 | --- | --- | 0.0159 | 0.0212 |
| Riffle Slope Ratio, Sriff/Schan | 0.2766 | 3.5961 | 1.50 | 2.00 | 1.50 | 2.00 |
| Pool Slope, Spool (ft/ft) | 0 | 0 | --- | --- | 0.0000 | 0.0021 |
| Pool Slope Ratio, Spool/Schan | 0 | 0 | 0.00 | 0.20 | 0.00 | 0.20 |
| Pool Max Depth @ bkf, Dmaxpool (ft) | 1.53 | 2.53 | --- | --- | 1.58 | 2.77 |
| Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft) | 1.52 | 2.51 | 2.00 | 3.50 | 2.00 | 3.50 |
| Pool Width, Wpool (ft) | 6.86 | 16.04 | --- | --- | 15.60 | 20.40 |
| Pool Width Ratio, Wpool/Wbkf (ft/ft) | 0.65 | 1.51 | 1.30 | 1.70 | 1.30 | 1.70 |
| Pool Spacing, Lps (ft) | 6.00 | 126.00 | --- | --- | 48.00 | 84.00 |
| Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft) | 0.56 | 11.85 | 4.00 | 7.00 | 4.00 | 7.00 |
| d16/ d35/ d50/ d84/ d95 (mm) | 0.14, .16, 0.18, 0.22, 0.24 | | --- | --- | | |

| **Reach BB-R1** | **Existing Conditions X5** | | **Proposed Conditions** | |
|---|---|---|---|---|
| **Dimensionless Shear Stress Analysis** | **SUBPAVMENT XS** | | | |
| Bankfull Xsec Area, $A_{bkf}$ (sq ft) | 16.13 | | | 14.00 |
| Bankfull Width, $W_{bkf}$ (ft) | 14.83 | | | 13.00 |
| Bankfull Mean Depth, $D_{bkf}$ (ft) = $A_{bkf}/W_{bkf}$ | 1.09 | | | 1.08 |
| Wetted Perimeter, WP = W+2$D_{bkf}$ (ft) | 17.01 | | | 15.15 |
| Hydraulic Radius, R (ft) = $A_{bkf}$/WP | 0.95 | | | 0.92 |
| $S_{chan}$ (ft/ft) | 0.0080 | | | 0.0080 |
| Boundary/Bankfull Shear Stress, t (lb/sq ft) = 62.4*R*$S_{chan}$ | 0.47 | | | 0.46 |
| $d50_{pave}$ - riffle 100 ct (mm) | 1.26 | | | 1.26 |
| $d50_{bar}$ - bar sample or subpavement (mm) | 0.91 | | | 0.91 |
| D100 (di) bar or subpavement (mm) | 40 | | | 40 |
| D100 (di) (ft) = D100*.0032808 | 0.13 | | | 0.13 |
| ratio - $d50_{pave}/d50_{bar}$ (3-7) | 1.38 | | | 1.38 |
| ratio - di/$d50_{pave}$(1.3-3) | 31.75 | | | 31.75 |
| $tci_{eq1}$ (3-7) = $0.0834*(d50_{pave}/d50_{bar})^{-0.872}$ | 0.0628 | | | 0.0628 |
| $tci_{eq2}$ (1.3-3) = $0.0384*(d50_{pave}/di)^{-0.887}$ | 0.0018 | | | 0.0018 |
| $D_{crit1}$ (ft) (3-7) = $tci_{eq1}*1.65*di/S_{chan}$ | 1.70 | | | 1.70 |
| $D_{crit2}$ (ft) (1.3-3) = $tci_{eq2}*1.65*di/S_{chan}$ | 0.05 | | | 0.05 |
| $S_{crit1}$ (3-7) = $tci_{eq1}*1.65*di/D_{bkf}$ | 0.01250 | | | 0.01263 |
| $S_{crit2}$ (1.3-3) = $tci_{eq2}*1.65*di/D_{bkf}$ | 0.00036 | | | 0.00036 |
| Largest moveable particle (Shields/CO curves), mm = $152.02*t^{0.7355}$ | 88.00 | | | 86.00 |
| Largest moveable particle (Shields/CO curves), in = mm*0.0394 | 3.4672 | | | 3.3884 |
| Bankfull Velocity (ft/s) ($V_{bkf}$) | 3.41 | | | 3.93 |
| Unit Stream Power (watts/ sq meter) = 14.56*t*$V_{bkf}$ | 23.51 | | | 26.39 |
| **Dimensional Shear Stress Analysis** | SHIELDS CURVE | ROSGEN CURVE | SHIELDS CURVE | ROSGEN CURVE |
| t = 62.4*R*$S_{chan}$ | 0.4735 | | 0.4612 | |
| $152.02*t^{0.7355}$ | 36.00 | 88.00 | 35.00 | 86.00 |
| Predicted Shear Stress to move Dmax ($t_p$);<br>$t_{p(Shields)} = (di/77.966)^{1/1.042}$, $t_{p(Rosgen)} = (di/152.02)^{1/0.7355}$ | 0.5270 | 0.1628 | 0.5270 | 0.1628 |
| Predicted mean depth to move Dmax ($D_p$);<br>Shields = $t_{p(Sheilds)}/(62.4*S_{chan})$, Rosgen = $t_{p(Rosgen)}/(62.4*S_{chan})$ | 1.06 | 0.33 | 1.06 | 0.33 |
| Predicted slope required to initiate movement of Dmax ($S_p$);<br>Shields = $t_{p(Sheilds)}/(62.4*D_{bkf})$, Rosgen = $t_{p(Rosgen)}/(62.4*D_{bkf})$ | 0.0078 | 0.0024 | 0.0078 | 0.0024 |

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| **Reach BB-R2** | **Existing Conditions X3** | | **Proposed Conditions** | |
|---|---|---|---|---|
| **Dimensionless Shear Stress Analysis** | **SUBPAVMENT XS** | | | |
| Bankfull Xsec Area, $A_{bkf}$ (sq ft) | 20.95 | | | 15.95 |
| Bankfull Width, $W_{bkf}$ (ft) | 13.70 | | | 14.00 |
| Bankfull Mean Depth, $D_{bkf}$ (ft) = $A_{bkf}/W_{bkf}$ | 1.53 | | | 1.14 |
| Wetted Perimeter, WP = W+2$D_{bkf}$ (ft) | 16.76 | | | 16.28 |
| Hydraulic Radius, R (ft) = $A_{bkf}$/WP | 1.25 | | | 0.98 |
| $S_{chan}$ (ft/ft) | 0.0071 | | | 0.0071 |
| Boundary/Bankfull Shear Stress, t (lb/sq ft) = 62.4*R*$S_{chan}$ | 0.55 | | | 0.43 |
| $d50_{pave}$ - riffle 100 ct (mm) | 11.44 | | | 11.44 |
| $d50_{bar}$ - bar sample or subpavement (mm) | 0.91 | | | 0.91 |
| D100 (di) bar or subpavement (mm) | 40 | | | 40 |
| D100 (di) (ft) = D100*.0032808 | 0.13 | | | 0.13 |
| ratio - $d50_{pave}/d50_{bar}$ (3-7) | 12.57 | | | 12.57 |
| ratio - di/$d50_{pave}$(1.3-3) | 3.50 | | | 3.50 |
| $tci_{eq1}$ (3-7) = $0.0834*(d50_{pave}/d50_{bar})^{-0.872}$ | 0.0092 | | | 0.0092 |
| $tci_{eq2}$ (1.3-3) = $0.0384*(d50_{pave}/di)^{-0.887}$ | 0.0127 | | | 0.0127 |
| $D_{crit1}$ (ft) (3-7) = $tci_{eq1}*1.65*di/S_{chan}$ | 0.28 | | | 0.28 |
| $D_{crit2}$ (ft) (1.3-3) = $tci_{eq2}*1.65*di/S_{chan}$ | 0.39 | | | 0.39 |
| $S_{crit1}$ (3-7) = $tci_{eq1}*1.65*di/D_{bkf}$ | 0.00130 | | | 0.00174 |
| $S_{crit2}$ (1.3-3) = $tci_{eq2}*1.65*di/D_{bkf}$ | 0.00179 | | | 0.00240 |
| Largest moveable particle (Shields/CO curves), mm = $152.02*t^{0.7355}$ | 98.00 | | | 82.00 |
| Largest moveable particle (Shields/CO curves), in = mm*0.0394 | 3.8612 | | | 3.2308 |
| Bankfull Velocity (ft/s) ($V_{bkf}$) | 2.86 | | | 3.76 |
| Unit Stream Power (watts/ sq meter) = $14.56*t*V_{bkf}$ | 23.06 | | | 23.76 |
| **Dimensional Shear Stress Analysis** | SHIELDS CURVE | ROSGEN CURVE | SHIELDS CURVE | ROSGEN CURVE |
| t = 62.4*R*$S_{chan}$ | 0.5539 | | 0.4341 | |
| Movable particle size (mm); Sheilds = $77.966*t^{1.042}$, Rosgen = $152.02*t^{0.7355}$ | 42.00 | 98.00 | 33.00 | 82.00 |
| Predicted Shear Stress to move Dmax ($t_p$); $t_{p(Shields)}$ = $(di/77.966)^{1/1.042}$, $t_{p(Rosgen)}$ = $(di/152.02)^{1/0.7355}$ | 0.5270 | 0.1628 | 0.5270 | 0.1628 |
| Predicted mean depth to move Dmax ($D_p$); Shields = $t_{p(Sheilds)}/(62.4*S_{chan})$, Rosgen = $t_{p(Rosgen)}/(62.4*S_{chan})$ | 1.19 | 0.37 | 1.19 | 0.37 |
| Predicted slope required to initiate movement of Dmax ($S_p$); Shields = $t_{p(Sheilds)}/(62.4*D_{bkf})$, Rosgen = $t_{p(Rosgen)}/(62.4*D_{bkf})$ | 0.0055 | 0.0017 | 0.0074 | 0.0023 |
| | **DEGRADATIONAL** | **DEGRADATIONAL** | **AGGRADATIONAL** | **DEGRADATIONAL** |

| Reach BB-R3 | Existing Conditions X3 | | Proposed Conditions | |
|---|---|---|---|---|
| **Dimensionless Shear Stress Analysis** | **SUBPAVMENT XS** | | | |
| Bankfull Xsec Area, $A_{bkf}$ (sq ft) | 21.86 | | | 17.83 |
| Bankfull Width, $W_{bkf}$ (ft) | 14.56 | | | 15.00 |
| Bankfull Mean Depth, $D_{bkf}$ (ft) = $A_{bkf}/W_{bkf}$ | 1.50 | | | 1.19 |
| Wetted Perimeter, WP = W+2$D_{bkf}$ (ft) | 17.56 | | | 17.38 |
| Hydraulic Radius, R (ft) = $A_{bkf}$/WP | 1.24 | | | 1.03 |
| $S_{chan}$ (ft/ft) | 0.0053 | | | 0.0049 |
| Boundary/Bankfull Shear Stress, $\tau$ (lb/sq ft) = 62.4*R*$S_{chan}$ | 0.41 | | | 0.31 |
| $d50_{pave}$ - riffle 100 ct (mm) | 20.14 | | | 20.14 |
| $d50_{bar}$ - bar sample or subpavement (mm) | 0.91 | | | 0.91 |
| D100 (di) bar or subpavement (mm) | 40 | | | 40 |
| D100 (di) (ft) = D100*.0032808 | 0.13 | | | 0.13 |
| ratio - $d50_{pave}/d50_{bar}$ (3-7) | 22.13 | | | 22.13 |
| ratio - di/$d50_{pave}$(1.3-3) | 1.99 | | | 1.99 |
| $tci_{eq1}$ (3-7) = $0.0834*(d50_{pave}/d50_{bar})^{-0.872}$ | 0.0056 | | | 0.0056 |
| $tci_{eq2}$ (1.3-3) = $0.0384*(d50_{pave}/di)^{-0.887}$ | 0.0209 | | | 0.0209 |
| $D_{crit1}$ (ft) (3-7) = $tci_{eq1}*1.65*di/S_{chan}$ | 0.23 | | | 0.25 |
| $D_{crit2}$ (ft) (1.3-3) = $tci_{eq2}*1.65*di/S_{chan}$ | 0.85 | | | 0.92 |
| $S_{crit1}$ (3-7) = $tci_{eq1}*1.65*di/D_{bkf}$ | 0.00081 | | | 0.00102 |
| $S_{crit2}$ (1.3-3) = $tci_{eq2}*1.65*di/D_{bkf}$ | 0.00301 | | | 0.00381 |
| Largest moveable particle (Shields/CO curves), mm = $152.02*\tau^{0.7355}$ | 79.00 | | | 65.00 |
| Largest moveable particle (Shields/CO curves), in = mm*0.0394 | 3.1126 | | | 2.561 |
| Bankfull Velocity (ft/s) ($V_{bkf}$) | 3.20 | | | 3.93 |
| Unit Stream Power (watts/ sq meter) = $14.56*\tau*V_{bkf}$ | 19.18 | | | 17.95 |
| **Dimensional Shear Stress Analysis** | SHIELDS CURVE | ROSGEN CURVE | SHIELDS CURVE | ROSGEN CURVE |
| $\tau$ = 62.4*R*$S_{chan}$ | 0.4116 | | 0.3137 | |
| Movable particle size (mm); Sheilds = $77.966*\tau^{1.042}$, Rosgen = $152.02*\tau^{0.7355}$ | 31.00 | 79.00 | 23.00 | 65.00 |
| Predicted Shear Stress to move Dmax ($\tau_p$);<br>$\tau_{p(Shields)} = (di/77.966)^{1/1.042}$, $\tau_{p(Rosgen)} = (di/152.02)^{1/0.7355}$ | 0.5270 | 0.1628 | 0.5270 | 0.1628 |
| Predicted mean depth to move Dmax ($D_p$);<br>Shields = $\tau_{p(Sheilds)}/(62.4*S_{chan})$, Rosgen = $\tau_{p(Rosgen)}/(62.4*S_{chan})$ | 1.59 | 0.49 | 1.72 | 0.53 |
| Predicted slope required to initiate movement of Dmax ($S_p$);<br>Shields = $\tau_{p(Sheilds)}/(62.4*D_{bkf})$, Rosgen = $\tau_{p(Rosgen)}/(62.4*D_{bkf})$ | 0.0056 | 0.0017 | 0.0071 | 0.0022 |
| | **AGGRADATIONAL** | **DEGRADATIONAL** | **AGGRADATIONAL** | **DEGRADATIONAL** |

| **UT2** | **Existing Conditions X4** | | **Proposed Conditions** | |
|---|---|---|---|---|
| **Dimensionless Shear Stress Analysis** | **SUBPAVMENT XS** | | | |
| Bankfull Xsec Area, $A_{bkf}$ (sq ft) | 4.52 | | | 2.25 |
| Bankfull Width, $W_{bkf}$ (ft) | 11.81 | | | 6.00 |
| Bankfull Mean Depth, $D_{bkf}$ (ft) = $A_{bkf}/W_{bkf}$ | 0.38 | | | 0.38 |
| Wetted Perimeter, WP = W+2$D_{bkf}$ (ft) | 12.58 | | | 6.75 |
| Hydraulic Radius, R (ft) = $A_{bkf}$/WP | 0.36 | | | 0.33 |
| $S_{chan}$ (ft/ft) | 0.0341 | | | 0.0341 |
| Boundary/Bankfull Shear Stress, t (lb/sq ft) = 62.4*R*$S_{chan}$ | 0.76 | | | 0.71 |
| $d50_{pave}$ - riffle 100 ct (mm) | 32 | | | 32 |
| $d50_{bar}$ - bar sample or subpavement (mm) | 27.5 | | | 2.75 |
| D100 (di) bar or subpavement (mm) | 55 | | | 55 |
| D100 (di) (ft) = D100*.0032808 | 0.18 | | | 0.18 |
| ratio - $d50_{pave}/d50_{bar}$ (3-7) | 1.16 | | | 11.64 |
| ratio - di/$d50_{pave}$(1.3-3) | 1.72 | | | 1.72 |
| $tci_{eq1}$ (3-7) = $0.0834*(d50_{pave}/d50_{bar})^{-0.872}$ | 0.0731 | | | 0.0098 |
| $tci_{eq2}$ (1.3-3) = $0.0384*(d50_{pave}/di)^{-0.887}$ | 0.0238 | | | 0.0238 |
| $D_{crit1}$ (ft) (3-7) = $tci_{eq1}*1.65*di/S_{chan}$ | 0.64 | | | 0.09 |
| $D_{crit2}$ (ft) (1.3-3) = $tci_{eq2}*1.65*di/S_{chan}$ | 0.21 | | | 0.21 |
| $S_{crit1}$ (3-7) = $tci_{eq1}*1.65*di/D_{bkf}$ | 0.05685 | | | 0.00779 |
| $S_{crit2}$ (1.3-3) = $tci_{eq2}*1.65*di/D_{bkf}$ | 0.01848 | | | 0.01886 |
| Largest moveable particle (Shields/CO curves), mm = $152.02*t^{0.7355}$ | 125.00 | | | 118.00 |
| Largest moveable particle (Shields/CO curves), in = mm*0.0394 | 4.925 | | | 4.6492 |
| Bankfull Velocity (ft/s) ($V_{bkf}$) | 2.21 | | | 4.44 |
| Unit Stream Power (watts/ sq meter) = $14.56*t*V_{bkf}$ | 24.61 | | | 45.85 |
| **Dimensional Shear Stress Analysis** | SHIELDS CURVE | ROSGEN CURVE | SHIELDS CURVE | ROSGEN CURVE |
| t = 62.4*R*$S_{chan}$ | 0.7648 | | 0.7093 | |
| Movable particle size (mm); Sheilds = $77.966*t^{1.042}$, Rosgen = $152.02*t^{0.7355}$ | 59.00 | 125.00 | 55.00 | 118.00 |
| Predicted Shear Stress to move Dmax ($t_p$); $t_{p(Shields)}$ = $(di/77.966)^{1/1.042}$, $t_{p(Rosgen)}$ = $(di/152.02)^{1/0.7355}$ | 0.7154 | 0.2510 | 0.7154 | 0.2510 |
| Predicted mean depth to move Dmax ($D_p$);<br>Shields = $t_{p(Sheilds)}/(62.4*S_{chan})$, Rosgen = $t_{p(Rosgen)}/(62.4*S_{chan})$ | 0.34 | 0.12 | 0.34 | 0.12 |
| Predicted slope required to initiate movement of Dmax ($S_p$);<br>Shields = $t_{p(Sheilds)}/(62.4*D_{bkf})$, Rosgen = $t_{p(Rosgen)}/(62.4*D_{bkf})$ | 0.0300 | 0.0105 | 0.0306 | 0.0107 |
| | **DEGRADATIONAL** | **DEGRADATIONAL** | **AGGRADATIONAL** | **DEGRADATIONAL** |

| **UT1-R1** | **Existing Conditions X10** | | **Proposed Conditions** | |
|---|---|---|---|---|
| **Dimensionless Shear Stress Analysis** | **SUBPAVMENT XS** | | | |
| Bankfull Xsec Area, $A_{bkf}$ (sq ft) | 4.22 | | | 3.90 |
| Bankfull Width, $W_{bkf}$ (ft) | 5.86 | | | 8.00 |
| Bankfull Mean Depth, $D_{bkf}$ (ft) = $A_{bkf}/W_{bkf}$ | 0.72 | | | 0.49 |
| Wetted Perimeter, WP = W+2$D_{bkf}$ (ft) | 7.30 | | | 8.98 |
| Hydraulic Radius, R (ft) = $A_{bkf}$/WP | 0.58 | | | 0.43 |
| $S_{chan}$ (ft/ft) | 0.0270 | | | 0.0270 |
| Boundary/Bankfull Shear Stress, t (lb/sq ft) = 62.4*R*$S_{chan}$ | 0.97 | | | 0.73 |
| $d50_{pave}$ - riffle 100 ct (mm) | 8.66 | | | 8.66 |
| $d50_{bar}$ - bar sample or subpavement (mm) | 0.94 | | | 0.94 |
| D100 (di) bar or subpavement (mm) | 33 | | | 0.33 |
| D100 (di) (ft) = D100*.0032808 | 0.11 | | | 0.00 |
| ratio - $d50_{pave}/d50_{bar}$ (3-7) | 9.21 | | | 9.21 |
| ratio - di/$d50_{pave}$(1.3-3) | 3.81 | | | 0.04 |
| $tci_{eq1}$ (3-7) = $0.0834*(d50_{pave}/d50_{bar})^{-0.872}$ | 0.0120 | | | 0.0120 |
| $tci_{eq2}$ (1.3-3) = $0.0384*(d50_{pave}/di)^{-0.887}$ | 0.0117 | | | 0.6966 |
| $D_{crit1}$ (ft) (3-7) = $tci_{eq1}*1.65*di/S_{chan}$ | 0.08 | | | 0.00 |
| $D_{crit2}$ (ft) (1.3-3) = $tci_{eq2}*1.65*di/S_{chan}$ | 0.08 | | | 0.05 |
| $S_{crit1}$ (3-7) = $tci_{eq1}*1.65*di/D_{bkf}$ | 0.00298 | | | 0.00004 |
| $S_{crit2}$ (1.3-3) = $tci_{eq2}*1.65*di/D_{bkf}$ | 0.00291 | | | 0.00255 |
| Largest moveable particle (Shields/CO curves), mm = $152.02*t^{0.7355}$ | 149.00 | | | 121.00 |
| Largest moveable particle (Shields/CO curves), in = mm*0.0394 | 5.8706 | | | 4.7674 |
| Bankfull Velocity (ft/s) ($V_{bkf}$) | 4.03 | | | 4.36 |
| Unit Stream Power (watts/ sq meter) = $14.56*t*V_{bkf}$ | 57.15 | | | 46.48 |
| **Dimensional Shear Stress Analysis** | SHIELDS CURVE | ROSGEN CURVE | SHIELDS CURVE | ROSGEN CURVE |
| t = 62.4*R*$S_{chan}$ | 0.9739 | | 0.7321 | |
| Movable particle size (mm); Sheilds = $77.966*t^{1.042}$, Rosgen = $152.02*t^{0.7355}$ | 76.00 | 149.00 | 56.00 | 121.00 |
| Predicted Shear Stress to move Dmax ($t_p$); $t_{p(Shields)}$ = $(di/77.966)^{1/1.042}$, $t_{p(Rosgen)}$ = $(di/152.02)^{1/0.7355}$ | 0.4382 | 0.1253 | 0.0053 | 0.0002 |
| Predicted mean depth to move Dmax ($D_p$); Shields = $t_{p(Sheilds)}/(62.4*S_{chan})$, Rosgen = $t_{p(Rosgen)}/(62.4*S_{chan})$ | 0.26 | 0.07 | 0.00 | 0.00 |
| Predicted slope required to initiate movement of Dmax ($S_p$); Shields = $t_{p(Sheilds)}/(62.4*D_{bkf})$, Rosgen = $t_{p(Rosgen)}/(62.4*D_{bkf})$ | 0.0098 | 0.0028 | 0.0002 | 0.0000 |
| | **DEGRADATIONAL** | **DEGRADATIONAL** | **DEGRADATIONAL** | **DEGRADATIONAL** |

| **UT4-R1** | **Existing Conditions X11** | | **Proposed Conditions (UPPER)** | | **Proposed Conditions (LOWER)** | |
|---|---|---|---|---|---|---|
| **Dimensionless Shear Stress Analysis** | **SUBPAVMENT XS** | | | | | |
| Bankfull Xsec Area, $A_{bkf}$ (sq ft) | 8.22 | | | 7.65 | | 7.65 |
| Bankfull Width, $W_{bkf}$ (ft) | 9.86 | | | 11.00 | | 11.00 |
| Bankfull Mean Depth, $D_{bkf}$ (ft) = $A_{bkf}/W_{bkf}$ | 0.83 | | | 0.70 | | 0.70 |
| Wetted Perimeter, WP = W+2$D_{bkf}$ (ft) | 11.53 | | | 12.39 | | 12.39 |
| Hydraulic Radius, R (ft) = $A_{bkf}$/WP | 0.71 | | | 0.62 | | 0.62 |
| $S_{chan}$ (ft/ft) | 0.0185 | | | 0.0248 | | 0.0145 |
| Boundary/Bankfull Shear Stress, $\tau$ (lb/sq ft) = 62.4*R*$S_{chan}$ | 0.82 | | | 0.96 | | 0.56 |
| $d50_{pave}$ - riffle 100 ct (mm) | 6.69 | | | 6.69 | | 6.69 |
| $d50_{bar}$ - bar sample or subpavement (mm) | 4.36 | | | 4.36 | | 4.36 |
| D100 (di) bar or subpavement (mm) | 80 | | | 80 | | 80 |
| D100 (di) (ft) = D100*.0032808 | 0.26 | | | 0.26 | | 0.26 |
| ratio - $d50_{pave}/d50_{bar}$ (3-7) | 1.53 | | | 1.53 | | 1.53 |
| ratio - di/$d50_{pave}$(1.3-3) | 11.96 | | | 11.96 | | 11.96 |
| $tci_{eq1}$ (3-7) = $0.0834*(d50_{pave}/d50_{bar})^{-0.872}$ | 0.0574 | | | 0.0574 | | 0.0574 |
| $tci_{eq2}$ (1.3-3) = $0.0384*(d50_{pave}/di)^{-0.887}$ | 0.0043 | | | 0.0043 | | 0.0043 |
| $D_{crit1}$ (ft) (3-7) = $tci_{eq1}$*1.65*di/$S_{chan}$ | 1.34 | | | 1.00 | | 1.71 |
| $D_{crit2}$ (ft) (1.3-3) = $tci_{eq2}$*1.65*di/$S_{chan}$ | 0.10 | | | 0.07 | | 0.13 |
| $S_{crit1}$ (3-7) = $tci_{eq1}$*1.65*di/$D_{bkf}$ | 0.02983 | | | 0.03575 | | 0.03575 |
| $S_{crit2}$ (1.3-3) = $tci_{eq2}$*1.65*di/$D_{bkf}$ | 0.00221 | | | 0.00265 | | 0.00265 |
| Largest moveable particle (Shields/CO curves), mm = $152.02*\tau^{0.7355}$ | 132.00 | | | 147.00 | | 147.00 |
| Largest moveable particle (Shields/CO curves), in = mm*0.0394 | 5.2008 | | | 5.7918 | | 5.7918 |
| Bankfull Velocity (ft/s) ($V_{bkf}$) | 3.65 | | | 3.92 | | 3.92 |
| Unit Stream Power (watts/ sq meter) = 14.56*$\tau$*$V_{bkf}$ | 43.75 | | | 54.53 | | 31.88 |
| **Dimensional Shear Stress Analysis** | SHIELDS CURVE | ROSGEN CURVE | SHIELDS CURVE | ROSGEN CURVE | SHIELDS CURVE | ROSGEN CURVE |
| $\tau$ = 62.4*R*$S_{chan}$ | 0.8232 | | 0.9554 | | 0.5586 | |
| $152.02*\tau^{0.7355}$ | 64.00 | 132.00 | 74.00 | 147.00 | 74.00 | 147.00 |
| Predicted Shear Stress to move Dmax ($\tau_p$);<br>$\tau_{p(Shields)} = (di/77.966)^{1/1.042}$, $\tau_{p(Rosgen)} = (di/152.02)^{1/0.7355}$ | 1.0250 | 0.4178 | 1.0250 | 0.4178 | 1.0250 | 0.4178 |
| Predicted mean depth to move Dmax ($D_p$);<br>Shields = $\tau_{p(Sheilds)}/(62.4*S_{chan})$, Rosgen = $\tau_{p(Rosgen)}/(62.4*S_{chan})$ | 0.89 | 0.36 | 0.66 | 0.27 | 1.13 | 0.46 |
| Predicted slope required to initiate movement of Dmax ($S_p$);<br>Shields = $\tau_{p(Sheilds)}/(62.4*D_{bkf})$, Rosgen = $\tau_{p(Rosgen)}/(62.4*D_{bkf})$ | 0.0197 | 0.0080 | 0.0236 | 0.0096 | 0.0236 | 0.0096 |
| | **AGGRADATIONAL** | **DEGRADATIONAL** | **AGGRADATIONAL** | **DEGRADATIONAL** | **AGGRADATIONAL** | **DEGRADATIONAL** |

| UT4-R2 | Existing Conditions X10 | | Proposed Conditions | |
|---|---|---|---|---|
| **Dimensionless Shear Stress Analysis** | **SUBPAVMENT XS** | | | |
| Bankfull Xsec Area, $A_{bkf}$ (sq ft) | 8.22 | | | 10.73 |
| Bankfull Width, $W_{bkf}$ (ft) | 9.86 | | | 10.63 |
| Bankfull Mean Depth, $D_{bkf}$ (ft) = $A_{bkf}/W_{bkf}$ | 0.83 | | | 1.01 |
| Wetted Perimeter, WP = W+2$D_{bkf}$ (ft) | 11.53 | | | 12.65 |
| Hydraulic Radius, R (ft) = $A_{bkf}$/WP | 0.71 | | | 0.85 |
| $S_{chan}$ (ft/ft) | 0.0185 | | | 0.0112 |
| Boundary/Bankfull Shear Stress, $\tau$ (lb/sq ft) = 62.4*R*$S_{chan}$ | 0.82 | | | 0.59 |
| $d50_{pave}$ - riffle 100 ct (mm) | 6.69 | | | 0.18 |
| $d50_{bar}$ - bar sample or subpavement (mm) | 4.36 | | | 4.36 |
| D100 (di) bar or subpavement (mm) | 80 | | | 80 |
| D100 (di) (ft) = D100*.0032808 | 0.26 | | | 0.26 |
| ratio - $d50_{pave}/d50_{bar}$ (3-7) | 1.53 | | | 0.04 |
| ratio - di/$d50_{pave}$(1.3-3) | 11.96 | | | 444.44 |
| $tci_{eq1}$ (3-7) = $0.0834*(d50_{pave}/d50_{bar})^{-0.872}$ | 0.0574 | | | 1.3434 |
| $tci_{eq2}$ (1.3-3) = $0.0384*(d50_{pave}/di)^{-0.887}$ | 0.0043 | | | 0.0002 |
| $D_{crit1}$ (ft) (3-7) = $tci_{eq1}*1.65*di/S_{chan}$ | 1.34 | | | 51.94 |
| $D_{crit2}$ (ft) (1.3-3) = $tci_{eq2}*1.65*di/S_{chan}$ | 0.10 | | | 0.01 |
| $S_{crit1}$ (3-7) = $tci_{eq1}*1.65*di/D_{bkf}$ | 0.02983 | | | 0.57636 |
| $S_{crit2}$ (1.3-3) = $tci_{eq2}*1.65*di/D_{bkf}$ | 0.00221 | | | 0.00007 |
| Largest moveable particle (Shields/CO curves), mm = $152.02*\tau^{0.7355}$ | 132.00 | | | 103.00 |
| Largest moveable particle (Shields/CO curves), in = mm*0.0394 | 5.2008 | | | 4.0582 |
| Bankfull Velocity (ft/s) ($V_{bkf}$) | 3.65 | | | 3.73 |
| Unit Stream Power (watts/ sq meter) = $14.56*\tau*V_{bkf}$ | 43.75 | | | 32.20 |
| **Dimensional Shear Stress Analysis** | SHIELDS CURVE | ROSGEN CURVE | SHIELDS CURVE | ROSGEN CURVE |
| $\tau$ = 62.4*R*$S_{chan}$ | 0.8232 | | 0.5929 | |
| Movable particle size (mm); Sheilds = $77.966*\tau^{1.042}$, Rosgen = $152.02*\tau^{0.7355}$ | 64.00 | 132.00 | 45.00 | 103.00 |
| Predicted Shear Stress to move Dmax ($\tau_p$);<br>$\tau_{p(Shields)} = (di/77.966)^{1/1.042}$, $\tau_{p(Rosgen)} = (di/152.02)^{1/0.7355}$ | 1.0250 | 0.4178 | 1.0250 | 0.4178 |
| Predicted mean depth to move Dmax ($D_p$);<br>Shields = $\tau_{p(Sheilds)}/(62.4*S_{chan})$, Rosgen = $\tau_{p(Rosgen)}/(62.4*S_{chan})$ | 0.89 | 0.36 | 1.47 | 0.60 |
| Predicted slope required to initiate movement of Dmax ($S_p$);<br>Shields = $\tau_{p(Sheilds)}/(62.4*D_{bkf})$, Rosgen = $\tau_{p(Rosgen)}/(62.4*D_{bkf})$ | 0.0197 | 0.0080 | 0.0163 | 0.0066 |
| | **AGGRADATIONAL** | **DEGRADATIONAL** | **AGGRADATIONAL** | **DEGRADATIONAL** |

Reach UT1-R1 – Upstream of UT1C

Reach UT1-R1 - Direct cattle access to stream below UT1A

Reach UT1A -  Bank erosion due to cattle access

Reach UT1C - Preservation section above headcut

Reach UT1C – Headcut before confluence with UT1-R1

Reach UT1-R2 - Bank erosion and direct cattle access

Reach UT1-R2 – Perched/Plugged culvert at farm crossing

Reach UT1B – Erosion and direct cattle access

Reach UT1-R3 - Preservation area

Reach UT2 – Erosion and sedimentation at origin

Reach UT2 – Incised and eroded channel

Reach UT2a – Erosion at headcut

09.17.2019

BB-R1 – Direct cattle access

09.17.2019

BB-R1 – Bank erosion and impaired buffer

BB-R2 – Bank erosion and impaired buffer

BB-R2 – Stream incision and bank erosion

UT3 – Straightened channel along W1

Ditch along W1, removing water from UT3

BB-R3 – Bank erosion and sedimentation

UT4-R1 – Erosion looking downstream from origin

UT4-R1 – Direct cattle access to stream

UT4-R1 – Excavation of channel at pond

UT4-R2 – Stream manipulation below ponds

UT4-R2 – Minor bank erosion through W4

# 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 |
|---|---|---|---|---|---|
| DTB Farms of Stokes County LLC, Anthony Boles | 6041-74-9397,<br>6041-63-2233 | Stokes | Conservation Easement | Book: 682<br>Page: 2370, 2367 | 13.72 |
| Jason M. and April R. Pendleton | 6041-51-6912,<br>6041-54-2358 | Stokes | Conservation Easement | Book: 660<br>Page: 166<br>Book: 425<br>Page: 1541 | 16.55 |
| Gene Young Farm, LLC (Jason and Greg Young) | 6041-72-9563 | Stokes | Conservation Easement | Book: 593<br>Page: 1738 | 2.40 |
| Gilmer O'Neil Watkins | 6041-42-1746 | Stokes | Conservation Easement | Book: 690<br>Page: 2193 | 8.32 |

# Appendix 4 – Credit Release Schedule

All credit releases will be based on the total credit generated as reported in the approved final mitigation plan, unless there are major discrepancies and then a mitigation plan addendum will be submitted. 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 Tables below.

*Table 4-1. Credit Release Schedule – Stream Credits*

| Credit Release Milestone | Credit Release Activity | Interim Release | Total Release |
|---|---|---|---|
| 1 | Site Establishment (includes all required criteria stated above) | 0% | 0% |
| 2 | Completion of all initial physical and biological improvements made pursuant to the Mitigation Plan | 30% | 30% |
| 3 | Year 1 monitoring report demonstrates that channels are stable and interim performance standards have been met | 10% | 40% |
| 4 | Year 2 monitoring report demonstrates that channels are stable and interim performance standards have been met | 10% | 50% |
| 5 | Year 3 monitoring report demonstrates that channels are stable and interim performance standards have been met | 10% | 60% |
| 6* | Year 4 monitoring report demonstrates that channels are stable and interim performance standards have been met | 5% | 65% (75%**) |
| 7 | Year 5 monitoring report demonstrates that channels are stable and interim performance standards have been met | 10% | 75% (85%**) |
| 8* | Year 6 monitoring report demonstrates that channels are stable and interim performance standards have been met | 5% | 80% (90%**) |
| 9 | Year 7 monitoring report demonstrates that channels are stable and performance standards have been met | 10% | 90% (100%**) |

**Please note that vegetation and channel stability data may not be required with monitoring reports submitted during these monitoring years unless otherwise required by the Mitigation Plan or directed by the IRT.*

***10% reserve of credits to be held back until the bankfull event performance standard has been met.*

*Table 4-2. Credit Release Schedule – Wetland Credits*

| Credit Release Milestone | Credit Release Activity | Interim Release | Total Release |
|---|---|---|---|
| 1 | Site Establishment (includes all required criteria stated below) | 0% | 0% |
| 2 | Completion of all initial physical and biological improvement made pursuant to the Mitigation Plan | 30% | 30% |
| 3 | Year 1 monitoring report demonstrates that interim performance standards have been met | 10% | 40% |
| 4 | Year 2 monitoring report demonstrates that interim performance standards have been met | 10% | 50% |
| 5 | Year 3 monitoring report demonstrates that interim performance standards have been met | 15% | 65% |
| 6* | Year 4 monitoring report demonstrates that interim performance standards have been met | 5% | 70% |
| 7 | Year 5 monitoring report demonstrates that interim performance standards have been met | 15% | 85% |
| 8* | Year 6 monitoring report demonstrates that interim performance standards have been met | 5% | 90% |
| 9 | Year 7 monitoring report demonstrates that performance standards have been met | 10% | 100% |

**Please note that vegetation data may not be required with monitoring reports submitted during these monitoring years unless otherwise required by the Mitigation Plan or directed by the IRT.*

**<u>Initial Allocation of Released Credits</u>**

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.

**<u>Subsequent Credit Releases</u>**

All subsequent credit releases must be approved by the DE, in consultation with the IRT, 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 four 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 four bankfull events occur during the monitoring period, release of these reserve credits shall be at the discretion of the IRT. As projects approach milestones associated with credit release, 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 should be expected most often in the first two years following site construction and may include the following:

**Routine Maintenance Components**
**Banner Branch Mitigation Project – NCDEQ DMS Project No. 100080**

| Component/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 prevent bank failures and head-cutting. Stream maintenance activities will be documented and reported in annual monitoring reports. |
| Wetland | Routine wetland maintenance and repair activities may include supplemental installations of target vegetation within the wetland. Areas where stormwater and floodplain flows intercept the wetland may also require maintenance to prevent scour that adversely and persistently threatens wetland habitat or function. |
| 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 be treated by mechanical and/or chemical methods. Any vegetation requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations. Vegetation maintenance activities will be documented and reported in annual monitoring reports. |
| 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. Easement monitoring and staking/signage maintenance will continue in perpetuity as a stewardship activity. |
| 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. Crossings in easement breaks are the responsibility of the landowner to maintain. |
| 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. |
| Livestock Fencing | Livestock fencing is to be placed outside the easement limits. Maintenance of fencing is the responsibility of the landowner. |

# Appendix 7 – DWR Stream Identification Forms

The streams at the project site were categorized into fourteen reaches (UT1-R1, UT1-R2, UT1-R3, UT1B,UT1C, UT1D, UT2, UT2A, UT3, BB-R1, BB-R2, BB-R3, UT4-R1, UT4-R2) totaling approximately 16,044 linear feet of jurisdictional streams within the project area. 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 UT1-R1, UT1-R2, UT1-R3, UT3, BB-R1, BB-R2, BB-R3, UT4-R2 are perennial streams and project Reaches UT1A, UT1B, UT1C, UT2, UT2A, and UT4-R1 were determined to be intermittent streams. 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 |
|---|---|---|---|---|
| UT1-R1 | 535 | 30 | 41.2 | Perennial |
| UT1-R2 | 1,827 | 39.0 | 135.0 | Perennial |
| UT1-R3 | 822 | 40.0 | 166.4 | Perennial |
| UT1A | 410 | 29.5 | 4.6 | Intermittent |
| UT1B | 391 | 24.0 | 41.6 | Intermittent |
| UT1C | 227 | 23.0 | 15.8 | Intermittent |
| UT2 | 1,315 | 26.0 | 28.3 | Intermittent/Perennial |
| UT2A | 289 | 25.5 | 3.1 | Intermittent |
| UT3 | 338 | 32.5 | 76.8 | Perennial |
| BB-R1 | 986 | 40.5 | 409.6 | Perennial |
| BB-R2 | 2,080 | 43.5 | 480.0 | Perennial |
| BB-R3 | 478 | 44.0 | 563.2 | Perennial |
| UT4-R1 | 4,624 | 23.0 | 153.6 | Intermittent/Perennial |
| UT4-R2 | 1,722 | 37.5 | 224.0 | Perennial |

*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: Indicates that the lower section of the reach was classified as perennial and upper stream reach was classified as intermittent.*

## NC DWQ Stream Identification Form Version 4.11 BANNER BRANCH

| | | |
|---|---|---|
| **Date:** 3.8.18 | **Project/Site:** MS-R1 | **Latitude:** 36°31'34.65"N |
| **Evaluator:** K.VAN STELL | **County:** STOKES | **Longitude:** -80°12'7.53"W |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 40.5 | **Stream Determination (circle one)** Ephemeral Intermittent [✓ Perennial] | **Other** NETTLERIDGE, NC VA *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 26.0) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ª 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 = 8.0) | | | | |
|---|---|---|---|---|
| 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) | | | | |
|---|---|---|---|---|
| 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 BANNER BRANCH

| | | |
|---|---|---|
| **Date:** 3.8.18 | **Project/Site:** MS-R2 | **Latitude:** 36°31′25.62″N |
| **Evaluator:** K. VANSTELL | **County:** STOKES | **Longitude:** -80°12′14.31″W |
| **Total Points:** 43.5<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** | **Stream Determination (circle one)**<br>Ephemeral Intermittent [✓ Perennial] | **Other** NETTLERIDGE, NC VA<br>*e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 27.0) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ᵃ 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 = 9.5) | | | | |
|---|---|---|---|---|
| 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 = 7.0) | | | | |
|---|---|---|---|---|
| 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 BANNER BRANCH

| | | |
|---|---|---|
| **Date:** 3.8.18 | **Project/Site:** MS-R3 | **Latitude:** 36°31'13.93"N |
| **Evaluator:** K. VANSTELL | **County:** STOKES | **Longitude:** -80°12'24.32°W |
| **Total Points:** 44.0<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** | **Stream Determination (circle one)**<br>Ephemeral Intermittent [✓ Perennial] | **Other** NETTLERIDGE, NC VA<br>*e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 27.0) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ª 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 = 9.0) | | | | |
|---|---|---|---|---|
| 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 = 8.0) | | | | |
|---|---|---|---|---|
| 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** BANNER BRANCH

| | | |
|---|---|---|
| **Date:** 3.22.18 | **Project/Site:** MS - U/S | **Latitude:** 36°31'36.05"N |
| **Evaluator:** C. Shearts | **County:** STOKES | **Longitude:** -80°12'4.16"W |
| **Total Points:** 39.0<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** | **Stream Determination (circle one)**<br>Ephemeral Intermittent [✓ Perennial] | **Other** NETTLERIDGE NC VA<br>*e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 19.5 ) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ᵃ 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

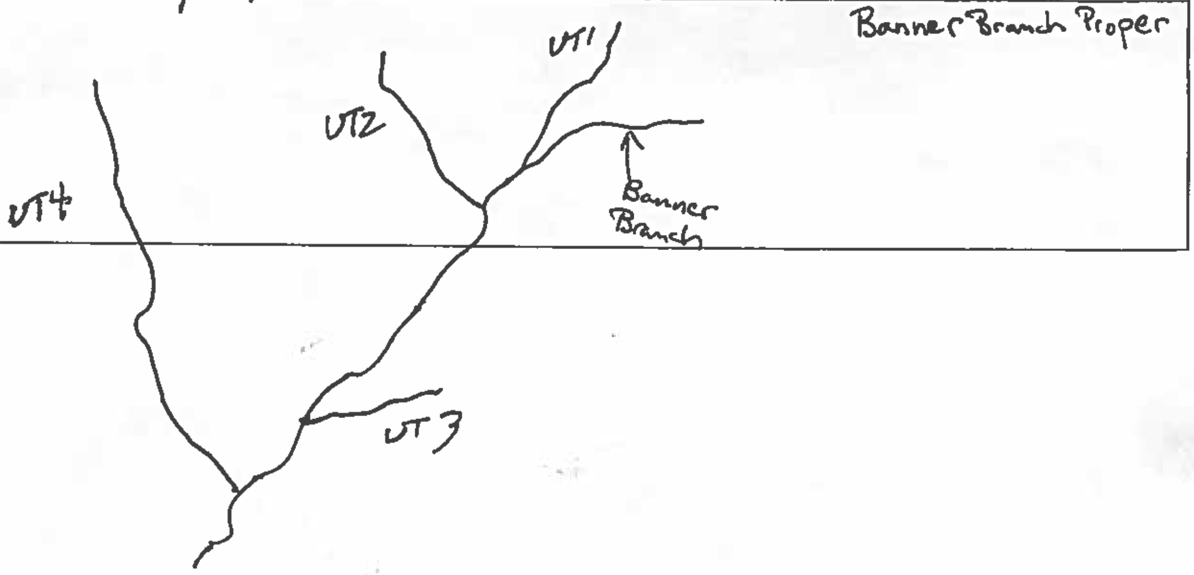
| B. Hydrology (Subtotal = 9.5 ) | | | | |
|---|---|---|---|---|
| 12. Presence of Baseflow | 0 | 1 | ~~[✓ 2]~~ | [✓ 3] |
| 13. Iron oxidizing bacteria | [✓ 0] | 1 | 2 | 3 |
| 14. Leaf litter | [✓ 1.5] | 1 | 0.5 | 0 |
| 15. Sediment on plants or debris | 0 | 0.5 | [✓ 1] | 1.5 |
| 16. Organic debris lines or piles | 0 | 0.5 | [✓ 1] | 1.5 |
| 17. Soil-based evidence of high water table? | No = 0 | | Yes = [✓ 3] | |

| C. Biology (Subtotal = 10.0) | | | | |
|---|---|---|---|---|
| 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: damselfly mayfly, stonefly, caddisfly larvae, Chironomids crayfish, shiner

Sketch:



# NC DWQ Stream Identification Form Version 4.11 BANER BRANCH

| | | |
|---|---|---|
| Date: 3.22.18 | Project/Site: UTI-R1 | Latitude: 36° 31' 5951" N |
| Evaluator: C. Sheets | County: STOKES | Longitude: - 80° 12' 2.46" W |
| **Total Points:**<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 30.0 | Stream Determination (circle one)<br>Ephemeral Intermittent [✓ Perennial] | Other NETTLERIDGE NC, VA<br>*e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 13.5) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ª 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

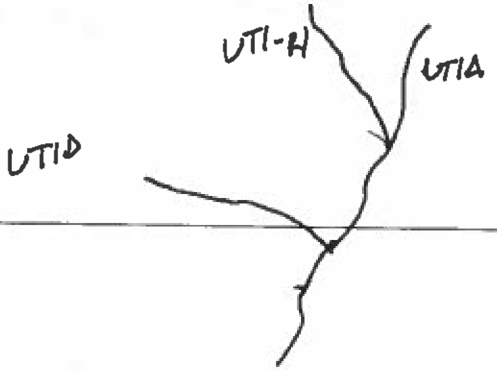
| B. Hydrology (Subtotal = 8.5) | | | | |
|---|---|---|---|---|
| 12. Presence of Baseflow | 0 | 1 | [✓ 2] | 3 |
| 13. Iron oxidizing bacteria | 0 | [✓ 1] | 2 | 3 |
| 14. Leaf litter | 1.5 | [✓ 1] | 0.5 | 0 |
| 15. Sediment on plants or debris | 0 | [✓ 0.5] | 1 | 1.5 |
| 16. Organic debris lines or piles | 0 | 0.5 | [✓ 1] | 1.5 |
| 17. Soil-based evidence of high water table? | No = 0 | | [✓ Yes = 3] | |

| C. Biology (Subtotal = 8.0) | | | | |
|---|---|---|---|---|
| 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: Odonate larvae abundant
Chironomids abundant

Sketch:



perennial to easement

# NC DWQ Stream Identification Form Version 4.11 BANNER BRANCH

| | | |
|---|---|---|
| **Date:** 3.22.18 | **Project/Site:** UT1-R2 | **Latitude:** 36°31'48.38"N |
| **Evaluator:** C. Sheets | **County:** STOKES | **Longitude:** -80°12'1.23"W |
| **Total Points:**<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 39.0 | **Stream Determination (circle one)**<br>Ephemeral Intermittent [✓ Perennial] | **Other** NETTLERIDGE NC VA<br>*e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 21.0) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ᵃ 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 = 9.0) | | | | |
|---|---|---|---|---|
| 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 = 9.0) | | | | |
|---|---|---|---|---|
| 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: crayfish damselfly larvae, mayfly larvae, chironomids

Sketch:

## NC DWQ Stream Identification Form Version 4.11 BANNER BRANCH

| | | |
|---|---|---|
| **Date:** 3.22.18 | **Project/Site:** UT1-R3 | **Latitude:** 36°31'39.38"N |
| **Evaluator:** C. Sheats | **County:** STOKES | **Longitude:** -80°12'3.78"W |
| **Total Points:** 40.0<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** | **Stream Determination (circle one)**<br>Ephemeral Intermittent [✓ Perennial] | **Other** NETTLE RIDGE NC, VA<br>e.g. Quad Name: |

| A. Geomorphology (Subtotal = 19.5 ) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ª 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

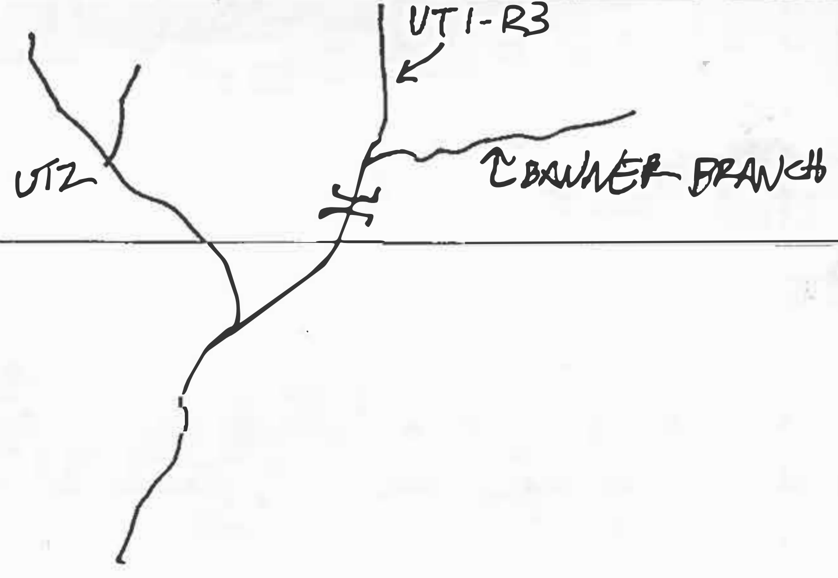
| B. Hydrology (Subtotal = 9.0 ) | | | | |
|---|---|---|---|---|
| 12. Presence of Baseflow | 0 | 1 | 2 | [✓ 3] |
| 13. Iron oxidizing bacteria | [✓ 0] | 1 | 2 | 3 |
| 14. Leaf litter | [✓ 1.5] | 1 | 0.5 | 0 |
| 15. Sediment on plants or debris | 0 | [✓ 0.5] | 1 | 1.5 |
| 16. Organic debris lines or piles | 0 | 0.5 | [✓ 1] | 1.5 |
| 17. Soil-based evidence of high water table? | No = 0 | | Yes = [✓ 3] | |

| C. Biology (Subtotal = 11.5 ) | | | | |
|---|---|---|---|---|
| 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: fish & EPT's present, damselfly larvae, crayfish

Sketch:



# NC DWQ ~~Stream Identification~~ Form Version 4.11 BANNER BRANCH

| | | |
|---|---|---|
| **Date:** 3-22-18 | **Project/Site:** UT1A | **Latitude:** 36°31'54.64"N |
| **Evaluator:** C. Sheats | **County:** STOKES | **Longitude:** 80°12'0.81"W |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 29.5 | **Stream Determination (circle one)** Ephemeral [✓ Intermittent] Perennial | **Other** *e.g. Quad Name:* NETTLERIDGE NC, VA |

| A. Geomorphology (Subtotal = 12.0) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ª 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

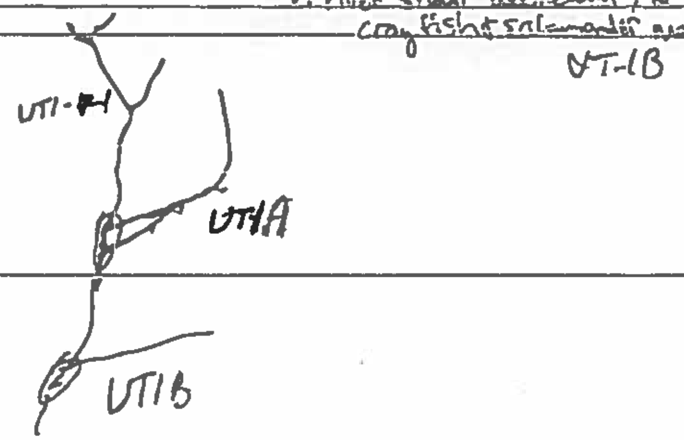
| B. Hydrology (Subtotal = 7.5) | | | | |
|---|---|---|---|---|
| 12. Presence of Baseflow | 0 | 1 | [✓ 2] | 3 |
| 13. Iron oxidizing bacteria | [✓ 0] | 1 | 2 | 3 |
| 14. Leaf litter | 1.5 | [✓ 1] | 0.5 | 0 |
| 15. Sediment on plants or debris | 0 | [✓ 0.5] | 1 | 1.5 |
| 16. Organic debris lines or piles | 0 | 0.5 | [✓ 1] | 1.5 |
| 17. Soil-based evidence of high water table? | No = 0 | | Yes = [✓ 3] | |

| C. Biology (Subtotal = 10.0) | | | | |
|---|---|---|---|---|
| 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:** V. river snail abundant, 2 sp. stonefly lv. crayfish, salamander, mayfly larvae

**Sketch:**



## NC DWQ Stream Identification Form Version 4.11 BANNER BRANCH

| | | | | | |
|---|---|---|---|---|---|
| **Date:** | 3.22.18 | **Project/Site:** | UT1B | **Latitude:** | 36°31'44.41"N |
| **Evaluator:** | C Sheets | **County:** | STOKES | **Longitude:** | -80°12'0.05"W |
| **Total Points:**<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** | 24.0 | **Stream Determination (circle one)**<br>Ephemeral [✓ Intermittent] Perennial | | **Other**<br>*e g Quad Name:* | NETTLERIDGE NC/VA |

| A. Geomorphology (Subtotal = 9.0) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ª 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 = 8.5) | | | | |
|---|---|---|---|---|
| 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 = 6.5) | | | | |
|---|---|---|---|---|
| 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: Chironomids

Sketch:

## NC DWQ Stream Identification Form Version 4.11 BAKER BRANCH

| | | |
|---|---|---|
| Date: 3.22.18 | Project/Site: UT1C | Latitude: 36° 31' 56.29" N |
| Evaluator: C. Sheets | County: STOKES | Longitude: -80° 12' 5.04" W |
| **Total Points:**<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 23.0 | Stream Determination (circle one)<br>Ephemeral [✓ Intermittent] Perennial | Other e.g. Quad Name: NETTLERIDGE NC VA |

### A. Geomorphology (Subtotal = 10.5 )

| | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ª 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 = 5.0 )

| | 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] | |

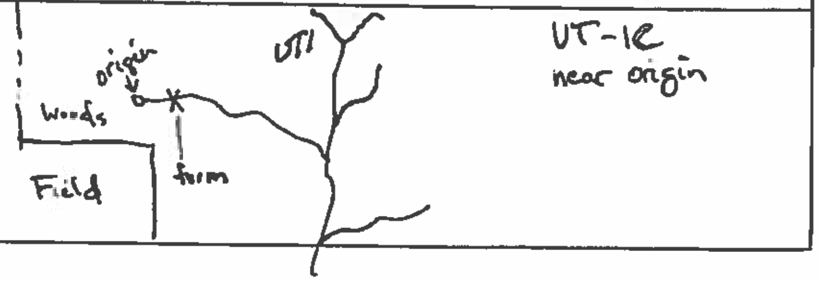
### C. Biology (Subtotal = 7.5 )

| | 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: Salamander larvae, odonate larvae

Sketch:



UT-1C
near origin

## NC DWQ Stream Identification Form Version 4.11 BANNER BRANCH

| | | |
|---|---|---|
| **Date:** 3.8.18 | **Project/Site:** UT2 | **Latitude:** 36°31′36.86″ N |
| **Evaluator:** K. VANSTELL | **County:** STOKES | **Longitude:** 80°12′14.62″ W |
| **Total Points:** 26.0<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** | **Stream Determination (circle one)**<br>Ephemeral [✓ Intermittent] Perennial | **Other** NETTLERIDGE, NC/VA<br>*e.g. Quad Name:* |

A. Geomorphology (Subtotal = 14.5 )

| | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ª 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 = 8.5 )

| | | | | |
|---|---|---|---|---|
| 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 = 3.0 )

| | | | | |
|---|---|---|---|---|
| 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 BANNER BRANCH

| | | |
|---|---|---|
| **Date:** 3.8.18 | **Project/Site:** UT2A | **Latitude:** 36°31'38.55"N |
| **Evaluator:** K. VANSTELL | **County:** STOKES | **Longitude:** 80°12'14.81"W |
| **Total Points:**<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 25.5 | **Stream Determination (circle one)**<br>Ephemeral [✓ Intermittent] Perennial | **Other** NETTLERIDGE NC, VA<br>*e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 16.0 ) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ª 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 = 7.5 ) | 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 = 2.0 ) | 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:

## NC DWQ Stream Identification Form Version 4.11 BANNER BRANCH

| | | |
|---|---|---|
| **Date:** 3-22-18 | **Project/Site:** UT3 | **Latitude:** 36° 31′ 18.44″ N |
| **Evaluator:** C. Sheats | **County:** STOKES | **Longitude:** -80° 12′ 10.61″ W |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 32.5 | **Stream Determination (circle one)** Ephemeral Intermittent [✓ Perennial] | **Other** *e.g. Quad Name:* NETTLERIDGE NC, VA |

| A. Geomorphology (Subtotal = 15.5) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ª 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

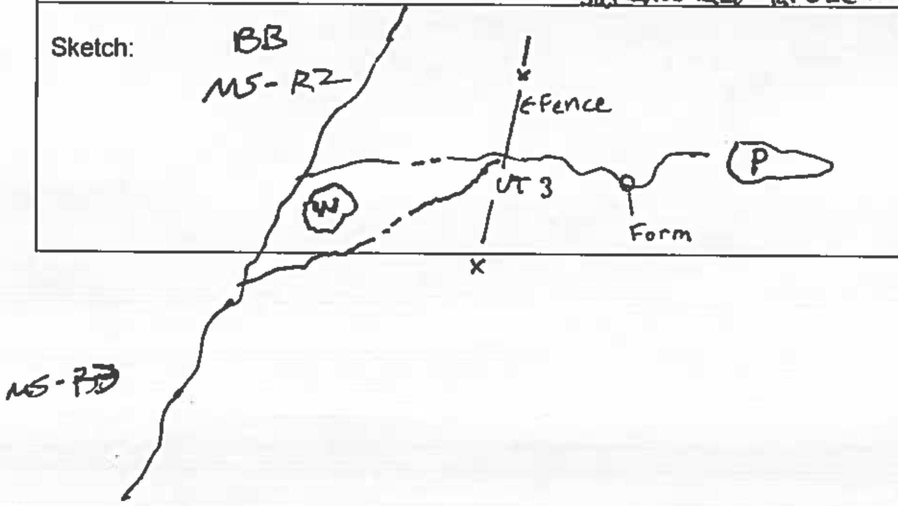
| B. Hydrology (Subtotal = 8.0) | | | | |
|---|---|---|---|---|
| 12. Presence of Baseflow | 0 | 1 | [✓ 2] | 3 |
| 13. Iron oxidizing bacteria | 0 | [✓ 1] | 2 | 3 |
| 14. Leaf litter | 1.5 | [✓ 1] | 0.5 | 0 |
| 15. Sediment on plants or debris | 0 | [✓ 0.5] | 1 | 1.5 |
| 16. Organic debris lines or piles | 0 | [✓ 0.5] | 1 | 1.5 |
| 17. Soil-based evidence of high water table? | No = 0 | | Yes = [✓ 3] | |

| C. Biology (Subtotal = 9.0) | | | | |
|---|---|---|---|---|
| 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 & water boatmen, abundant
Salamander larvae - Desmognathus sp.

Sketch:



Banner Branch
UT-3

- severe cattle impacts
- ditched

## NC DWQ Stream Identification Form Version 4.11 BANNER BRANCH

| | | |
|---|---|---|
| **Date:** 3-22-18 | **Project/Site:** UT4-R1 | **Latitude:** 36°31'50.81" N |
| **Evaluator:** C. Sheats | **County:** STOKES | **Longitude:** -80°12'35.52" W |
| **Total Points:**<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 23.0 | **Stream Determination (circle one)**<br>Ephemeral [✓ Intermittent] Perennial | **Other** NETTLERIDGE NC, VA<br>*e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 8.6) | Absent | Weak | Moderate | Strong | UT4-R1 |
|---|---|---|---|---|---|
| 1ª Continuity of channel bed and bank | 0 | 1 | [✓ 2] | 3 | 3 |
| 2. Sinuosity of channel along thalweg | 0 | [✓ 1] | 2 | 3 | 2 |
| 3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence | 0 | [✓ 1] | 2 | 3 | 2 |
| 4. Particle size of stream substrate | 0 | [✓ 1] | 2 | 3 | 3 |
| 5. Active/relict floodplain | 0 | [✓ 1] | 2 | 3 | 0 |
| 6. Depositional bars or benches | [✓ 0] | 1 | 2 | 3 | 1 |
| 7. Recent alluvial deposits | 0 | [✓ 1] | 2 | 3 | 1 |
| 8. Headcuts | 0 | [✓ 1] | 2 | 3 | 0 |
| 9. Grade control | [✓ 0] | 0.5 | 1 | 1.5 | 0 |
| 10. Natural valley | 0 | [✓ 0.5] | 1 | 1.5 | 1.5 |
| 11. Second or greater order channel | No = [✓ 0] | | Yes = 3 | | ? |
| | | | | | 13.5 ✓ |

ª artificial ditches are not rated; see discussions in manual

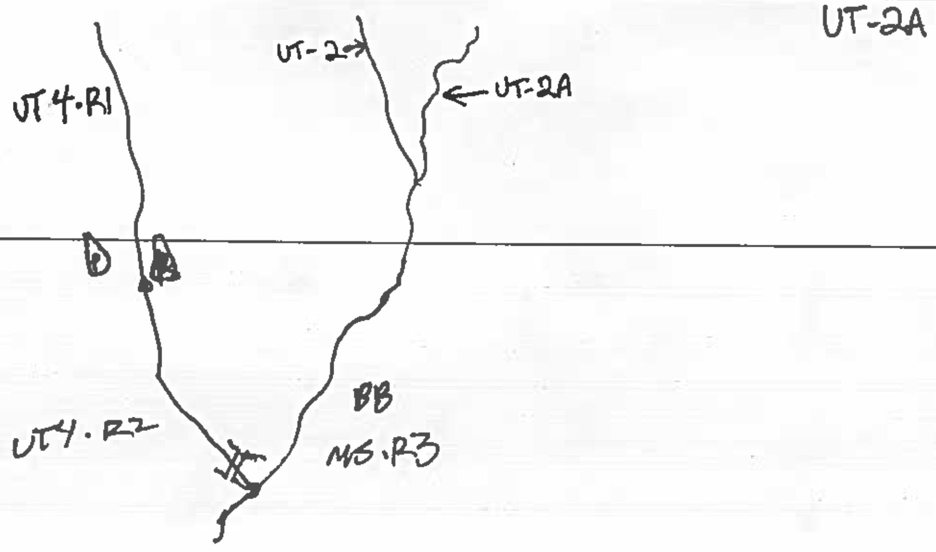
| B. Hydrology (Subtotal = 8.0) | | | | | |
|---|---|---|---|---|---|
| 12. Presence of Baseflow | 0 | [✓ 1] | 2 | 3 | 2 |
| 13. Iron oxidizing bacteria | 0 | [✓ 1] | 2 | 3 | 0 |
| 14. Leaf litter | 1.5 | [✓ 1] | 0.5 | 0 | 1.5 |
| 15. Sediment on plants or debris | 0 | 0.5 | [✓ 1] | 1.5 | 0.5 |
| 16. Organic debris lines or piles | 0 | 0.5 | [✓ 1] | 1.5 | 1 |
| 17. Soil-based evidence of high water table? | No = 0 | | Yes = [✓ 3] | | 3 |
| | | | | | 8 |

| C. Biology (Subtotal = 6.5) | | | | | |
|---|---|---|---|---|---|
| 18. Fibrous roots in streambed | 3 | [✓ 2] | 1 | 0 | 3 |
| 19. Rooted upland plants in streambed | [✓ 3] | 2 | 1 | 0 | 3 |
| 20. Macrobenthos (note diversity and abundance) | 0 | [✓ 1] | 2 | 3 | 1 Chiro. |
| 21. Aquatic Mollusks | [✓ 0] | 1 | 2 | 3 | 0 |
| 22. Fish | [✓ 0] | 0.5 | 1 | 1.5 | 0 |
| 23. Crayfish | [✓ 0] | 0.5 | 1 | 1.5 | 0 |
| 24. Amphibians | [✓ 0] | 0.5 | 1 | 1.5 | 0.5 Sal. lv |
| 25. Algae | 0 | [✓ 0.5] | 1 | 1.5 | 0.5 |
| 26. Wetland plants in streambed | FACW = 0.75; OBL = 1.5 Other = 0 | | | | |
| | | | | | 8 |
| | | | | | 29.5<br>perennial |

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

**Notes:** Chironomids present; water boatmen

**Sketch:**



## NC DWQ Stream Identification Form Version 4.11

| | | |
|---|---|---|
| **Date:** 3-8-18 | **Project/Site:** UT4-R2 | **Latitude:** 36°31'17.48"N |
| **Evaluator:** K. VANSTELL | **County:** STOKES | **Longitude:** -80°12'30.01"W |
| **Total Points:** 37.5<br>*Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** | **Stream Determination (circle one)**<br>Ephemeral Intermittent [✓ Perennial] | **Other** NETTLE RIDGE NC, VA<br>*e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 21.5) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1ª 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

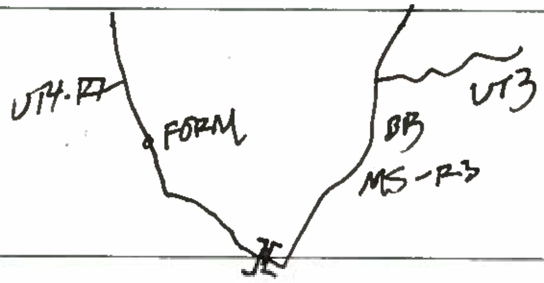
| B. Hydrology (Subtotal = 11.0) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 12. Presence of Baseflow | 0 | 1 | 2 | [✓ 3] |
| 13. Iron oxidizing bacteria | 0 | 1 | 2 | [✓ 3] |
| 14. Leaf litter | 1.5 | 1 | [✓ 0.5] | 0 |
| 15. Sediment on plants or debris | 0 | [✓ 0.5] | 1 | 1.5 |
| 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 = 5.0) | 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

NC WAM

# NC SAM FIELD ASSESSMENT RESULTS

**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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.525886°, -80.202536°

**STREAM INFORMATION: (depth and width can be approximations)**

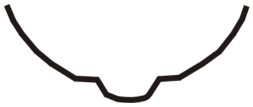
9. Site number (show on attached map): BB-R1
10. Length of assessment reach evaluated (feet): 700
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 2.3 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 14.8
13. Is assessment reach a swamp steam? ☐Yes ☐No
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
☐Essential Fish Habitat
☐Publicly owned property
☐Anadromous fish
☐Classified Trout Waters
☐Primary Nursery Area
☐NCDWR Riparian buffer rule in effect
☐303(d) List
☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐ High Quality Waters/Outstanding Resource Waters
☐Nutrient Sensitive Waters
☐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 <u><</u> 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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | RB | |
| ☒A | ☒A | ☐A | ☐A | ≥ 100 feet wide <u>or</u> 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 <u>or</u> 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 <u>or</u> 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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 <u>or</u> predominantly herbaceous species <u>or</u> 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 <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees. |
| ☒C | ☒C | Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> 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

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Notes/Sketch:

# Draft NC SAM Stream Rating Sheet
# Accompanies User Manual Version 2.1

Stream Site Name: Banner Branch Mitigation
Date of Assessment: 10-2-2019
Stream Category: Pa3
Assessor Name/Organization: Kyle Obermiller/WLS

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 | **LOW** | |
| (3) Stream Stability | **LOW** | |
| (4) Channel Stability | **LOW** | |
| (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 | **LOW** | |
| (2) Intertidal Zone Filtration | NA | |
| (1) Habitat | **LOW** | |
| (2) In-stream Habitat | **LOW** | |
| (3) Baseflow | **HIGH** | |
| (3) Substrate | **LOW** | |
| (3) Stream Stability | **LOW** | |
| (3) In-stream Habitat | **LOW** | |
| (2) Stream-side Habitat | **LOW** | |
| (3) Stream-side Habitat | **LOW** | |
| (3) Thermoregulation | **MEDIUM** | |
| (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 RESULTS
## 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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.523042°, -80.204167°

**STREAM INFORMATION: (depth and width can be approximations)**

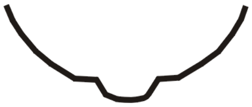
9. Site number (show on attached map): BB-R2
10. Length of assessment reach evaluated (feet): 2,100
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 3.2 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 13.7
13. Is assessment reach a swamp steam? ☐Yes ☐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
☐Essential Fish Habitat
☐Publicly owned property
☐Anadromous fish
☐Classified Trout Waters
☐Primary Nursery Area
☐NCDWR Riparian buffer rule in effect
☐303(d) List
☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐ High Quality Waters/Outstanding Resource Waters
☐Nutrient Sensitive Waters
☐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 <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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | RB | |
| ☒A | ☒A | ☐A | ☐A | ≥ 100 feet wide <u>or</u> 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 <u>or</u> 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 <u>or</u> 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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 <u>or</u> predominantly herbaceous species <u>or</u> 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 <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees. |
| ☒C | ☒C | Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> 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

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Notes/Sketch:

# Draft NC SAM Stream Rating Sheet
## Accompanies User Manual Version 2.1

| | | | |
|---|---|---|---|
| Stream Site Name | Banner Branch Mitigation | Date of Assessment | 10-2-2019 |
| Stream Category | Pa3 | Assessor Name/Organization | Kyle Obermiller/WLS |

| | |
|---|---|
| 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 | **LOW** | |
| (3) Stream Stability | **LOW** | |
| (4) Channel Stability | **LOW** | |
| (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 | **OMITTED** | |
| (2) Intertidal Zone Filtration | NA | |
| (1) Habitat | **LOW** | |
| (2) In-stream Habitat | **LOW** | |
| (3) Baseflow | **HIGH** | |
| (3) Substrate | **LOW** | |
| (3) Stream Stability | **LOW** | |
| (3) In-stream Habitat | **LOW** | |
| (2) Stream-side Habitat | **LOW** | |
| (3) Stream-side Habitat | **LOW** | |
| (3) Thermoregulation | **MEDIUM** | |
| (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 RESULTS
## 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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.520431°, -80.206825°

**STREAM INFORMATION: (depth and width can be approximations)**

9. Site number (show on attached map): BB-R3
10. Length of assessment reach evaluated (feet): 700
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 3.7 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 14.6
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

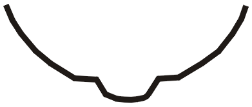
**STREAM CATEGORY INFORMATION:**

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
☐Essential Fish Habitat
☐Publicly owned property
☐Anadromous fish
☐Classified Trout Waters
☐Primary Nursery Area
☐NCDWR Riparian buffer rule in effect
☐303(d) List
☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐ High Quality Waters/Outstanding Resource Waters
☐Nutrient Sensitive Waters
☐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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | RB | |
| ☒A | ☒A | ☐A | ☐A | ≥ 100 feet wide <u>or</u> 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 <u>or</u> 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 <u>or</u> 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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 <u>or</u> predominantly herbaceous species <u>or</u> 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 <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees. |
| ☐C | ☒C | Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> 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

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Notes/Sketch:
Banner Branch reaches 1 and 2 (upstream of BBR3) have direct cattle access and pollution issues draining directly into this reach.

## Draft NC SAM Stream Rating Sheet
## Accompanies User Manual Version 2.1

Stream Site Name: Banner Branch Mitigation
Date of Assessment: 10-2-2019
Stream Category: Pa3
Assessor Name/Organization: Kyle Obermiller/WLS

Notes of Field Assessment Form (Y/N): YES
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 | **HIGH** | |
| (2) Flood Flow | **MEDIUM** | |
| (3) Streamside Area Attenuation | **MEDIUM** | |
| (4) Floodplain Access | **MEDIUM** | |
| (4) Wooded Riparian Buffer | **HIGH** | |
| (4) Microtopography | **LOW** | |
| (3) Stream Stability | **MEDIUM** | |
| (4) Channel Stability | **LOW** | |
| (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 | **MEDIUM** | |
| (2) Baseflow | **HIGH** | |
| (2) Streamside Area Vegetation | **HIGH** | |
| (3) Upland Pollutant Filtration | **HIGH** | |
| (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 | **HIGH** | |
| (3) Stream Stability | **LOW** | |
| (3) In-stream Habitat | **HIGH** | |
| (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 RESULTS
### 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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.532141°, -80.200188°

**STREAM INFORMATION: (depth and width can be approximations)**

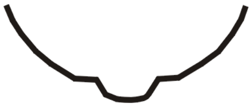
9. Site number (show on attached map): UT1A
10. Length of assessment reach evaluated (feet): 410
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.3 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 3.9
13. Is assessment reach a swamp steam? ☐Yes ☐No
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
☐Essential Fish Habitat
☐Publicly owned property
☐Anadromous fish
☐Classified Trout Waters
☐Primary Nursery Area
☐NCDWR Riparian buffer rule in effect
☐303(d) List
☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐ High Quality Waters/Outstanding Resource Waters
☐Nutrient Sensitive Waters
☐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] <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 <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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | RB | |
| ☐A | ☐A | ☐A | ☐A | ≥ 100 feet wide <u>or</u> 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 <u>or</u> 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 <u>or</u> 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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 <u>or</u> predominantly herbaceous species <u>or</u> 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 <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees. |
| ☐C | ☐C | Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> 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

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Notes/Sketch:

# Draft NC SAM Stream Rating Sheet
## Accompanies User Manual Version 2.1

Stream Site Name: Banner Branch Mitigation
Date of Assessment: 10-2-2019
Stream Category: Pb1
Assessor Name/Organization: Kyle Obermiller/WLS

| | |
|---|---|
| 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 | **MEDIUM** | |
| (4) Floodplain Access | **MEDIUM** | |
| (4) Wooded Riparian Buffer | **MEDIUM** | |
| (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 | **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 | **OMITTED** | |
| (2) Intertidal Zone Filtration | NA | |
| (1) Habitat | **LOW** | |
| (2) In-stream Habitat | **LOW** | |
| (3) Baseflow | **HIGH** | |
| (3) Substrate | **LOW** | |
| (3) Stream Stability | **HIGH** | |
| (3) In-stream Habitat | **LOW** | |
| (2) Stream-side Habitat | **MEDIUM** | |
| (3) Stream-side Habitat | **MEDIUM** | |
| (3) Thermoregulation | **MEDIUM** | |
| (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 RESULTS
### 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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.528892°, -80.199906°

**STREAM INFORMATION: (depth and width can be approximations)**

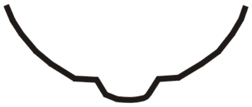
9. Site number (show on attached map): UT1B
10. Length of assessment reach evaluated (feet): 390
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.1 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 6.5
13. Is assessment reach a swamp steam? ☐Yes ☐No
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
- ☐Essential Fish Habitat
- ☐Publicly owned property
- ☐Anadromous fish
- ☐Classified Trout Waters
- ☐Primary Nursery Area
- ☐NCDWR Riparian buffer rule in effect
- ☐303(d) List
- ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
- ☐ High Quality Waters/Outstanding Resource Waters
- ☐Nutrient Sensitive Waters
- ☐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 <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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | RB | |
| ☐A | ☐A | ☐A | ☐A | ≥ 100 feet wide <u>or</u> 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 <u>or</u> 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 <u>or</u> 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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 <u>or</u> predominantly herbaceous species <u>or</u> 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 <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees. |
| ☐C | ☐C | Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> 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

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Notes/Sketch:

# Draft NC SAM Stream Rating Sheet
# Accompanies User Manual Version 2.1

Stream Site Name: Banner Branch Mitigation
Date of Assessment: 10-2-2019
Stream Category: Pb1
Assessor Name/Organization: Kyle Obermiller/WLS

| | |
|---|---|
| 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 | **HIGH** | **HIGH** |
| (2) Baseflow | **HIGH** | **HIGH** |
| (2) Flood Flow | **HIGH** | **HIGH** |
| (3) Streamside Area Attenuation | **HIGH** | **HIGH** |
| (4) Floodplain Access | **HIGH** | **HIGH** |
| (4) Wooded Riparian Buffer | **HIGH** | **HIGH** |
| (4) Microtopography | NA | NA |
| (3) Stream Stability | **HIGH** | **HIGH** |
| (4) Channel Stability | **HIGH** | **HIGH** |
| (4) Sediment Transport | **LOW** | **LOW** |
| (4) Stream Geomorphology | **HIGH** | **HIGH** |
| (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 | **LOW** | **LOW** |
| (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 | **OMITTED** | **NA** |
| (2) Intertidal Zone Filtration | NA | NA |
| (1) Habitat | **LOW** | **MEDIUM** |
| (2) In-stream Habitat | **LOW** | **MEDIUM** |
| (3) Baseflow | **HIGH** | **HIGH** |
| (3) Substrate | **LOW** | **LOW** |
| (3) Stream Stability | **HIGH** | **HIGH** |
| (3) In-stream Habitat | **LOW** | **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** | **MEDIUM** |

## NC SAM FIELD ASSESSMENT RESULTS
**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): Banner Branch Mitigation 2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions 4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes 6. Nearest named water body
7. River basin: Roanoke on USGS 7.5-minute quad: Banner Branch
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.532891°, -80.202525°

**STREAM INFORMATION: (depth and width can be approximations)**

9. Site number (show on attached map): UT1C 10. Length of assessment reach evaluated (feet): 400
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 0.7 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 6.7 13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☐Perennial flow ☒Intermittent flow ☐Tidal Marsh Stream

**STREAM CATEGORY INFORMATION:**

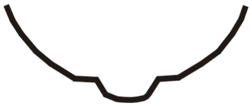
15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

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 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
☐Essential Fish Habitat
☐Publicly owned property
☐Anadromous fish
☐Classified Trout Waters
☐Primary Nursery Area
☐NCDWR Riparian buffer rule in effect
☐303(d) List
☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐ High Quality Waters/Outstanding Resource Waters
☐Nutrient Sensitive Waters
☐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] <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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | RB | |
| ☒A | ☒A | ☒A | ☒A | ≥ 100 feet wide <u>or</u> 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 <u>or</u> 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 <u>or</u> 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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 <u>or</u> predominantly herbaceous species <u>or</u> 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 <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees. |
| ☐C | ☐C | Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> 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

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Notes/Sketch:

ID salamander and caddis casing

## Draft NC SAM Stream Rating Sheet
## Accompanies User Manual Version 2.1

Stream Site Name: Banner Branch Mitigation
Date of Assessment: 10-2-2019
Stream Category: Pb1
Assessor Name/Organization: Kyle Obermiller/WLS

Notes of Field Assessment Form (Y/N): YES
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 | **HIGH** | **HIGH** |
| (2) Baseflow | **HIGH** | **HIGH** |
| (2) Flood Flow | **HIGH** | **HIGH** |
| (3) Streamside Area Attenuation | **HIGH** | **HIGH** |
| (4) Floodplain Access | **HIGH** | **HIGH** |
| (4) Wooded Riparian Buffer | **HIGH** | **HIGH** |
| (4) Microtopography | NA | NA |
| (3) Stream Stability | **HIGH** | **HIGH** |
| (4) Channel Stability | **HIGH** | **HIGH** |
| (4) Sediment Transport | **MEDIUM** | **MEDIUM** |
| (4) Stream Geomorphology | **HIGH** | **HIGH** |
| (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 | **MEDIUM** | **MEDIUM** |
| (3) Upland Pollutant Filtration | **MEDIUM** | **MEDIUM** |
| (3) Thermoregulation | **HIGH** | **HIGH** |
| (2) Indicators of Stressors | **NO** | **NO** |
| (2) Aquatic Life Tolerance | **OMITTED** | **NA** |
| (2) Intertidal Zone Filtration | NA | NA |
| (1) Habitat | **HIGH** | **HIGH** |
| (2) In-stream Habitat | **MEDIUM** | **HIGH** |
| (3) Baseflow | **HIGH** | **HIGH** |
| (3) Substrate | **MEDIUM** | **MEDIUM** |
| (3) Stream Stability | **HIGH** | **HIGH** |
| (3) In-stream Habitat | **MEDIUM** | **HIGH** |
| (2) Stream-side Habitat | **HIGH** | **HIGH** |
| (3) Stream-side Habitat | **HIGH** | **HIGH** |
| (3) Thermoregulation | **HIGH** | **HIGH** |
| (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 | **HIGH** | **HIGH** |

## NC SAM FIELD ASSESSMENT RESULTS
## 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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.532879°, -80.200907°

**STREAM INFORMATION: (depth and width can be approximations)**

9. Site number (show on attached map): UT1-R1
10. Length of assessment reach evaluated (feet): 600
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.5 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 7.0
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

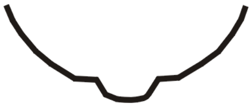
**STREAM CATEGORY INFORMATION:**

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
☐Essential Fish Habitat
☐Publicly owned property
☐Anadromous fish
☐Classified Trout Waters
☐Primary Nursery Area
☐NCDWR Riparian buffer rule in effect
☐303(d) List
☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐ High Quality Waters/Outstanding Resource Waters
☐Nutrient Sensitive Waters
☐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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | RB | |
| ☐A | ☒A | ☐A | ☐A | ≥ 100 feet wide <u>or</u> 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 <u>or</u> 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 <u>or</u> 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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 <u>or</u> predominantly herbaceous species <u>or</u> 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 <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees. |
| ☐C | ☐C | Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> 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

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Notes/Sketch:

# Draft NC SAM Stream Rating Sheet
## Accompanies User Manual Version 2.1

Stream Site Name: Banner Branch Mitigation
Date of Assessment: 10-2-2019
Stream Category: Pb3
Assessor Name/Organization: Kyle Obermiller/WLS

| | |
|---|---|
| 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 | **HIGH** | |
| (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 | **MEDIUM** | |
| (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 | **MEDIUM** | |
| (3) Thermoregulation | **HIGH** | |
| (2) Indicators of Stressors | **NO** | |
| (2) Aquatic Life Tolerance | **OMITTED** | |
| (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 | **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 RESULTS
### 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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.529383°, -80.201149°

**STREAM INFORMATION: (depth and width can be approximations)**

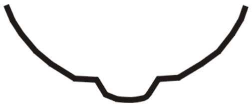
9. Site number (show on attached map): UT1-R2
10. Length of assessment reach evaluated (feet): 1,900
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.7 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 11.5
13. Is assessment reach a swamp steam? ☐Yes ☐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
☐Essential Fish Habitat
☐Publicly owned property
☐Anadromous fish
☐Classified Trout Waters
☐Primary Nursery Area
☐NCDWR Riparian buffer rule in effect
☐303(d) List
☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐ High Quality Waters/Outstanding Resource Waters
☐Nutrient Sensitive Waters
☐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 <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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | RB | |
| ☐A | ☒A | ☐A | ☐A | ≥ 100 feet wide <u>or</u> 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 <u>or</u> 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 <u>or</u> 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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 <u>or</u> predominantly herbaceous species <u>or</u> 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 <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees. |
| ☐C | ☐C | Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> 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

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Notes/Sketch:

# Draft NC SAM Stream Rating Sheet
## Accompanies User Manual Version 2.1

| | | | |
|---|---|---|---|
| Stream Site Name | Banner Branch Mitigation | Date of Assessment | 10-2-2019 |
| Stream Category | Pb3 | Assessor Name/Organization | Kyle Obermiller/WLS |

| | |
|---|---|
| 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 | **HIGH** | |
| (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 | **MEDIUM** | |
| (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 | **LOW** | |
| (2) Baseflow | **HIGH** | |
| (2) Streamside Area Vegetation | **MEDIUM** | |
| (3) Upland Pollutant Filtration | **MEDIUM** | |
| (3) Thermoregulation | **HIGH** | |
| (2) Indicators of Stressors | **YES** | |
| (2) Aquatic Life Tolerance | **OMITTED** | |
| (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 | **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 RESULTS
## Accompanies User Manual Version 2.1

USAACE 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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.527313°, -80.200635°

**STREAM INFORMATION: (depth and width can be approximations)**

9. Site number (show on attached map): UT1-R3
10. Length of assessment reach evaluated (feet): 800
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.5 ☐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

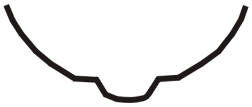
**STREAM CATEGORY INFORMATION:**

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
☐Essential Fish Habitat
☐Publicly owned property
☐Anadromous fish
☐Classified Trout Waters
☐Primary Nursery Area
☐NCDWR Riparian buffer rule in effect
☐303(d) List
☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐ High Quality Waters/Outstanding Resource Waters
☐Nutrient Sensitive Waters
☐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 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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | RB | |
| ☒A | ☒A | ☒A | ☒A | ≥ 100 feet wide <u>or</u> 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 <u>or</u> 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 <u>or</u> 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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 <u>or</u> predominantly herbaceous species <u>or</u> 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 <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees. |
| ☐C | ☐C | Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> 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

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Notes/Sketch:

# Draft NC SAM Stream Rating Sheet
## Accompanies User Manual Version 2.1

Stream Site Name: Banner Branch Mitigation
Date of Assessment: 10-2-2019
Stream Category: Pb3
Assessor Name/Organization: Kyle Obermiller/WLS

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 | **MEDIUM** | |
| (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 | **HIGH** | |
| (2) Baseflow | **HIGH** | |
| (2) Streamside Area Vegetation | **HIGH** | |
| (3) Upland Pollutant Filtration | **HIGH** | |
| (3) Thermoregulation | **HIGH** | |
| (2) Indicators of Stressors | **NO** | |
| (2) Aquatic Life Tolerance | **OMITTED** | |
| (2) Intertidal Zone Filtration | NA | |
| (1) Habitat | **HIGH** | |
| (2) In-stream Habitat | **HIGH** | |
| (3) Baseflow | **HIGH** | |
| (3) Substrate | **MEDIUM** | |
| (3) Stream Stability | **HIGH** | |
| (3) In-stream Habitat | **HIGH** | |
| (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 | **HIGH** | |

# NC SAM FIELD ASSESSMENT RESULTS
## 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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.526111°, -80.203778°

**STREAM INFORMATION: (depth and width can be approximations)**

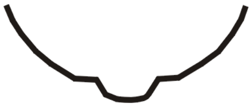
9. Site number (show on attached map): UT2
10. Length of assessment reach evaluated (feet): 1,300
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 2.1 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 11.8
13. Is assessment reach a swamp steam? ☐Yes ☐No
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
☐Essential Fish Habitat
☐Publicly owned property
☐Anadromous fish
☐Classified Trout Waters
☐Primary Nursery Area
☐NCDWR Riparian buffer rule in effect
☐303(d) List
☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐ High Quality Waters/Outstanding Resource Waters
☐Nutrient Sensitive Waters
☐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 <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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | RB | |
| ☒A | ☒A | ☐A | ☐A | ≥ 100 feet wide <u>or</u> 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 <u>or</u> 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 <u>or</u> 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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 <u>or</u> predominantly herbaceous species <u>or</u> 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 <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees. |
| ☒C | ☒C | Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> 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

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Notes/Sketch:
Dissolved oxygen 0.15, Temperature 82.4 degrees, Conductivity 464.2, pH 7.09. Cattle access abundant. Bad odor.

# Draft NC SAM Stream Rating Sheet
# Accompanies User Manual Version 2.1

| | | | |
|---|---|---|---|
| Stream Site Name | Banner Branch Mitigation | Date of Assessment | 10-2-2019 |
| Stream Category | Pb1 | Assessor Name/Organization | Kyle Obermiller/WLS |

| | |
|---|---|
| Notes of Field Assessment Form (Y/N) | YES |
| 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 | **MEDIUM** | **MEDIUM** |
| (4) Floodplain Access | **MEDIUM** | **MEDIUM** |
| (4) Wooded Riparian Buffer | **MEDIUM** | **MEDIUM** |
| (4) Microtopography | NA | NA |
| (3) Stream Stability | **LOW** | **LOW** |
| (4) Channel Stability | **LOW** | **LOW** |
| (4) Sediment Transport | **LOW** | **LOW** |
| (4) Stream Geomorphology | **MEDIUM** | **MEDIUM** |
| (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 | **LOW** | **LOW** |
| (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 | **OMITTED** | **NA** |
| (2) Intertidal Zone Filtration | NA | NA |
| (1) Habitat | **LOW** | **LOW** |
| (2) In-stream Habitat | **LOW** | **LOW** |
| (3) Baseflow | **HIGH** | **HIGH** |
| (3) Substrate | **LOW** | **LOW** |
| (3) Stream Stability | **LOW** | **LOW** |
| (3) In-stream Habitat | **LOW** | **LOW** |
| (2) Stream-side Habitat | **LOW** | **LOW** |
| (3) Stream-side Habitat | **LOW** | **LOW** |
| (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** | **LOW** |

## NC SAM FIELD ASSESSMENT RESULTS
### 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).**

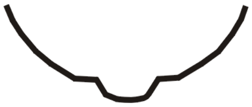
**PROJECT/SITE INFORMATION:**
1. Project name (if any): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.527551°, -80.204080°

**STREAM INFORMATION: (depth and width can be approximations)**
9. Site number (show on attached map): UT2A
10. Length of assessment reach evaluated (feet): 280
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 0.5 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 4.5
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
- ☐Essential Fish Habitat
- ☐Publicly owned property
- ☐Anadromous fish
- ☐Classified Trout Waters
- ☐Primary Nursery Area
- ☐NCDWR Riparian buffer rule in effect
- ☐303(d) List
- ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
- ☐ High Quality Waters/Outstanding Resource Waters
- ☐Nutrient Sensitive Waters
- ☐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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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

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Notes/Sketch:

# Draft NC SAM Stream Rating Sheet
# Accompanies User Manual Version 2.1

Stream Site Name: Banner Branch Mitigation
Date of Assessment: 10-2-2019
Stream Category: Pb1
Assessor Name/Organization: Kyle Obermiller/WLS

| | |
|---|---|
| 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 | **MEDIUM** | **MEDIUM** |
| (2) Baseflow | **HIGH** | **HIGH** |
| (2) Flood Flow | **MEDIUM** | **MEDIUM** |
| (3) Streamside Area Attenuation | **MEDIUM** | **MEDIUM** |
| (4) Floodplain Access | **MEDIUM** | **MEDIUM** |
| (4) Wooded Riparian Buffer | **HIGH** | **HIGH** |
| (4) Microtopography | NA | NA |
| (3) Stream Stability | **MEDIUM** | **MEDIUM** |
| (4) Channel Stability | **MEDIUM** | **MEDIUM** |
| (4) Sediment Transport | **LOW** | **LOW** |
| (4) Stream Geomorphology | **HIGH** | **HIGH** |
| (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 | **LOW** | **LOW** |
| (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 | **OMITTED** | **NA** |
| (2) Intertidal Zone Filtration | NA | NA |
| (1) Habitat | **LOW** | **LOW** |
| (2) In-stream Habitat | **LOW** | **LOW** |
| (3) Baseflow | **HIGH** | **HIGH** |
| (3) Substrate | **LOW** | **LOW** |
| (3) Stream Stability | **MEDIUM** | **MEDIUM** |
| (3) In-stream Habitat | **LOW** | **MEDIUM** |
| (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** | **LOW** |

# NC SAM FIELD ASSESSMENT RESULTS
## 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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.522211°, -80.204180°

**STREAM INFORMATION: (depth and width can be approximations)**

9. Site number (show on attached map): UT3
10. Length of assessment reach evaluated (feet): 340
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.7 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 5.6
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

**STREAM CATEGORY INFORMATION:**

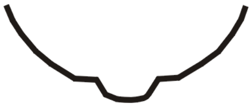
15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

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
☐Essential Fish Habitat
☐Publicly owned property
☐Anadromous fish
☐Classified Trout Waters
☐Primary Nursery Area
☐NCDWR Riparian buffer rule in effect
☐303(d) List
☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐ High Quality Waters/Outstanding Resource Waters
☐Nutrient Sensitive Waters
☐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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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

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Notes/Sketch:
Dissolved oxygen 0.15, Temperature 82.4 degrees, Conductivity 464.2, pH 7.09. Cattle access abundant. Bad odor.

# Draft NC SAM Stream Rating Sheet
## Accompanies User Manual Version 2.1

Stream Site Name: Banner Branch Mitigation
Date of Assessment: 10-2-2019
Stream Category: Pb1
Assessor Name/Organization: Kyle Obermiller/WLS

| | |
|---|---|
| Notes of Field Assessment Form (Y/N) | YES |
| 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 | **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 | **LOW** | |
| (3) Upland Pollutant Filtration | **LOW** | |
| (3) Thermoregulation | **LOW** | |
| (2) Indicators of Stressors | **YES** | |
| (2) Aquatic Life Tolerance | **HIGH** | |
| (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 RESULTS
### 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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.530447°, -80.209968°

**STREAM INFORMATION: (depth and width can be approximations)**

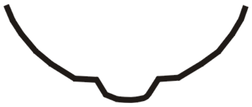
9. Site number (show on attached map): UT4-R1
10. Length of assessment reach evaluated (feet): 4,600
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 2.1 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 10.1
13. Is assessment reach a swamp steam? ☐Yes ☐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
☐Essential Fish Habitat
☐Publicly owned property
☐Anadromous fish
☐Classified Trout Waters
☐Primary Nursery Area
☐NCDWR Riparian buffer rule in effect
☐303(d) List
☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐ High Quality Waters/Outstanding Resource Waters
☐Nutrient Sensitive Waters
☐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 <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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | RB | |
| ☒A | ☒A | ☐A | ☐A | ≥ 100 feet wide <u>or</u> 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 <u>or</u> 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 <u>or</u> 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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 <u>or</u> predominantly herbaceous species <u>or</u> 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 <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees. |
| ☒C | ☒C | Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> 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

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Notes/Sketch:

# Draft NC SAM Stream Rating Sheet
## Accompanies User Manual Version 2.1

| | | | |
|---|---|---|---|
| Stream Site Name | Banner Branch Mitigation | Date of Assessment | 10-2-2019 |
| Stream Category | Pb2 | Assessor Name/Organization | Kyle Obermiller/WLS |

| | |
|---|---|
| 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 | **MEDIUM** | |
| (4) Wooded Riparian Buffer | **LOW** | |
| (4) Microtopography | NA | |
| (3) Stream Stability | **MEDIUM** | |
| (4) Channel Stability | **LOW** | |
| (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 | **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 | **MEDIUM** | |
| (2) In-stream Habitat | **HIGH** | |
| (3) Baseflow | **HIGH** | |
| (3) Substrate | **HIGH** | |
| (3) Stream Stability | **LOW** | |
| (3) In-stream Habitat | **HIGH** | |
| (2) Stream-side Habitat | **LOW** | |
| (3) Stream-side Habitat | **LOW** | |
| (3) Thermoregulation | **MEDIUM** | |
| (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 RESULTS
## 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): Banner Branch Mitigation
2. Date of evaluation: 10-2-2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller/WLS
5. County: Stokes
6. Nearest named water body on USGS 7.5-minute quad: Banner Branch
7. River basin: Roanoke
8. Site coordinates (decimal degrees, at lower end of assessment reach): 36.521520°, -80.208311°

**STREAM INFORMATION: (depth and width can be approximations)**

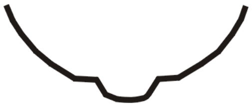
9. Site number (show on attached map): UT4-R2
10. Length of assessment reach evaluated (feet): 1,800
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.8 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 10.6
13. Is assessment reach a swamp steam? ☐Yes ☐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 | | Wooded | | |
|---|---|---|---|---|
| LB | RB | LB | 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 | | < 30 feet | | 30-50 feet | | |
|---|---|---|---|---|---|---|
| LB | RB | LB | RB | LB | 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

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Notes/Sketch:

excess sediment in channel and chinese privet present throughout buffer

## Draft NC SAM Stream Rating Sheet
## Accompanies User Manual Version 2.1

| | | | |
|---|---|---|---|
| Stream Site Name | Banner Branch Mitigation | Date of Assessment | 10-2-2019 |
| Stream Category | Pb2 | Assessor Name/Organization | Kyle Obermiller/WLS |

| | |
|---|---|
| Notes of Field Assessment Form (Y/N) | YES |
| 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 | **MEDIUM** | |
| (4) Microtopography | NA | |
| (3) Stream Stability | **MEDIUM** | |
| (4) Channel Stability | **MEDIUM** | |
| (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 | **LOW** | |
| (2) Baseflow | **HIGH** | |
| (2) Streamside Area Vegetation | **MEDIUM** | |
| (3) Upland Pollutant Filtration | **MEDIUM** | |
| (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 | **MEDIUM** | |
| (3) Stream-side Habitat | **MEDIUM** | |
| (3) Thermoregulation | **MEDIUM** | |
| (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 WAM FIELD ASSESSMENT FORM
### Accompanies User Manual Version 5.0

| | | | |
|---|---|---|---|
| USACE AID # | | NCDWR# | |
| Project Name | Banner Branch | Date of Evaluation | 10/2/2019 |
| Applicant/Owner Name | Water & Land Solutions | Wetland Site Name | W1 |
| Wetland Type | Headwater Forest | Assessor Name/Organization | Emily Dunnigan/WLS |
| Level III Ecoregion | Piedmont | Nearest Named Water Body | Banner Branch |
| River Basin | Roanoke | USGS 8-Digit Catalogue Unit | 03010103 |
| County | Stokes | NCDWR Region | Winston-Salem |
| ☐ Yes ☒ No | Precipitation within 48 hrs? | Latitude/Longitude (deci-degrees) | 36.521738, -80.204754 |

**Evidence of stressors affecting the assessment area (may not be within the assessment area)**

Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

**Is the assessment area intensively managed?** ☐ Yes ☒ No

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

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

**What type of natural stream is associated with the wetland, if any? (check all that apply)**

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

**Is the assessment area on a coastal island?** ☐ Yes ☒ No

**Is the assessment area's surface water storage capacity or duration substantially altered by beaver?** ☐ Yes ☒ No

**Does the assessment area experience overbank flooding during normal rainfall conditions?** ☐ Yes ☒ No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**

**Check a box in each column.** Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

| GS | VS | |
|---|---|---|
| ☒A | ☒A | Not severely altered |
| ☐B | ☐B | Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration) |

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

**Check a box in each column.** Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

| Surf | Sub | |
|---|---|---|
| ☐A | ☐A | Water storage capacity and duration are not altered. |
| ☐B | ☐B | Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation). |
| ☒C | ☒C | Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines). |

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)**

**Check a box in each column**. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

| | AA | WT | |
|---|---|---|---|
| 3a. | ☐A | ☐A | Majority of wetland with depressions able to pond water > 1 deep |
| | ☐B | ☐B | Majority of wetland with depressions able to pond water 6 inches to 1 foot deep |
| | ☒C | ☒C | Majority of wetland with depressions able to pond water 3 to 6 inches deep |
| | ☐D | ☐D | Depressions able to pond water < 3 inches deep |

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☐B Evidence that maximum depth of inundation is between 1 and 2 feet
☒C Evidence that maximum depth of inundation is less than 1 foot

**4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)**

**Check a box from each of the three soil property groups below.** Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☐A Sandy soil
☒B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☐A Soil ribbon < 1 inch
☒B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

**5. Discharge into Wetland – opportunity metric**

**Check a box in each column.** Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Little or no evidence of pollutants or discharges entering the assessment area |
| ☐B | ☐B | Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area |
| ☐C | ☐C | Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor) |

**6. Land Use – opportunity metric (skip for non-riparian wetlands)**

**Check all that apply (at least one box in each column).** Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles <u>and</u> within the watershed draining to the assessment area (5M), <u>and</u> within 2 miles and within the watershed draining to the assessment area (2M).

| WS | 5M | 2M | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 10% impervious surfaces |
| ☐B | ☐B | ☐B | Confined animal operations (or other local, concentrated source of pollutants |
| ☒C | ☒C | ☒C | ≥ 20% coverage of pasture |
| ☐D | ☐D | ☐D | ≥ 20% coverage of agricultural land (regularly plowed land) |
| ☐E | ☐E | ☐E | ≥ 20% coverage of maintained grass/herb |
| ☐F | ☐F | ☐F | ≥ 20% coverage of clear-cut land |
| ☐G | ☐G | ☐G | Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed <u>or</u> hydrologic alterations that prevent drainage <u>and/or</u> overbank flow from affecting the assessment area. |

**7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)**

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☒A ≥ 50 feet
☐B From 30 to < 50 feet
☐C From 15 to < 30 feet
☐D From 5 to < 15 feet
☐E < 5 feet <u>or</u> buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☒Yes ☐No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet <u>and</u> no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet <u>or</u> regular boat traffic.

**8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)**

**Check a box in each column for riverine wetlands only**. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

| WT | WC | |
|---|---|---|
| ☐A | ☒A | ≥ 100 feet |
| ☐B | ☐B | From 80 to < 100 feet |
| ☐C | ☐C | From 50 to < 80 feet |
| ☐D | ☐D | From 40 to < 50 feet |
| ☐E | ☐E | From 30 to < 40 feet |
| ☐F | ☐F | From 15 to < 30 feet |
| ☐G | ☐G | From 5 to < 15 feet |
| ☐H | ☐H | < 5 feet |

**9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)**

Answer for assessment area dominant landform.

☒A Evidence of short-duration inundation (< 7 consecutive days)
☐B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

**10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)**

Consider recent deposition only (no plant growth since deposition).

☒A Sediment deposition is not excessive, but at approximately natural levels.
☐B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

**11. Wetland Size – wetland type/wetland complex condition metric**

**Check a box in each column.** Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

| WT | WC | FW (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | ☐D | From 25 to < 50 acres |
| ☐E | ☐E | ☐E | From 10 to < 25 acres |
| ☐F | ☐F | ☐F | From 5 to < 10 acres |
| ☒G | ☒G | ☒G | From 1 to < 5 acres |
| ☐H | ☐H | ☐H | From 0.5 to < 1 acre |
| ☐I | ☐I | ☐I | From 0.1 to < 0.5 acre |
| ☐J | ☐J | ☐J | From 0.01 to < 0.1 acre |
| ☐K | ☐K | ☐K | < 0.01 acre <u>or</u> assessment area is clear-cut |

**12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

**13. Connectivity to Other Natural Areas – landscape condition metric**

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

| Well | Loosely | |
|---|---|---|
| ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | From 50 to < 100 acres |
| ☒D | ☐D | From 10 to < 50 acres |
| ☐E | ☐E | < 10 acres |
| ☐F | ☐F | Wetland type has a poor or no connection to other natural habitats |

13b. **Evaluate for marshes only**.
☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

**14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)**

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☐A 0
☒B 1 to 4
☐C 5 to 8

**15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)**

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☐B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☒C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

**16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**

☐A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☐B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

**17. Vegetative Structure – assessment area/wetland type condition metric**

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☒A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

| | AA | WT | |
|---|---|---|---|
| Canopy | ☐A | ☐A | Canopy closed, or nearly closed, with natural gaps associated with natural processes |
| | ☐B | ☐B | Canopy present, but opened more than natural gaps |
| | ☒C | ☒C | Canopy sparse or absent |
| Mid-Story | ☐A | ☐A | Dense mid-story/sapling layer |
| | ☐B | ☐B | Moderate density mid-story/sapling layer |
| | ☒C | ☒C | Mid-story/sapling layer sparse or absent |
| Shrub | ☒A | ☒A | Dense shrub layer |
| | ☐B | ☐B | Moderate density shrub layer |
| | ☐C | ☐C | Shrub layer sparse or absent |
| Herb | ☒A | ☒A | Dense herb layer |
| | ☐B | ☐B | Moderate density herb layer |
| | ☐C | ☐C | Herb layer sparse or absent |

**18. Snags – wetland type condition metric (skip for all marshes)**

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).
☒B Not A

**19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)**

☐A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.
☒C Majority of canopy trees are < 6 inches DBH or no trees.

**20. Large Woody Debris – wetland type condition metric (skip for all marshes)**

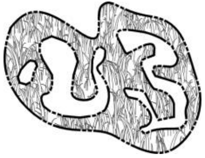
Include both natural debris and man-placed natural debris.

☐A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒B Not A

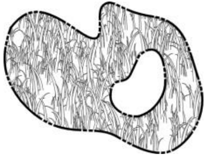
**21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)**

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

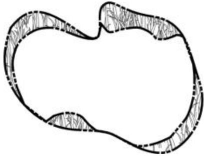
☐A



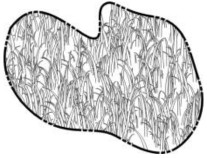
☐B



☐C



☐D



**22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)**

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☐A Overbank and overland flow are not severely altered in the assessment area.
☐B Overbank flow is severely altered in the assessment area.
☐C Overland flow is severely altered in the assessment area.
☒D Both overbank and overland flow are severely altered in the assessment area.

---

Notes

Used as an ag (row crop) field approximatly 10 years ago per landowner. Veg herb dominated. Original stream ditched to both sides of field. Berms and ditches keep water from surrounding drainage area from entering wetland.

# NC WAM Wetland Rating Sheet
## Accompanies User Manual Version 5.0

Wetland Site Name W1

Date of Assessment 10/2/2019

Wetland Type Headwater Forest

Assessor Name/Organization Emily Dunnigan/WLS

| | |
|---|---|
| Notes on Field Assessment Form (Y/N) | YES |
| Presence of regulatory considerations (Y/N) | NO |
| Wetland is intensively managed (Y/N) | NO |
| Assessment area is located within 50 feet of a natural tributary or other open water (Y/N) | YES |
| Assessment area is substantially altered by beaver (Y/N) | NO |
| Assessment area experiences overbank flooding during normal rainfall conditions (Y/N) | NO |
| Assessment area is on a coastal island (Y/N) | NO |

**Sub-function Rating Summary**

| Function | Sub-function | Metrics | Rating |
|---|---|---|---|
| Hydrology | Surface Storage and Retention | Condition | **LOW** |
| | Sub-surface Storage and Retention | Condition | **LOW** |
| Water Quality | Pathogen Change | Condition | **LOW** |
| | | Condition/Opportunity | **LOW** |
| | | Opportunity Presence (Y/N) | **NO** |
| | Particulate Change | Condition | **LOW** |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| | Soluble Change | Condition | **LOW** |
| | | Condition/Opportunity | **LOW** |
| | | Opportunity Presence (Y/N) | **NO** |
| | Physical Change | Condition | **LOW** |
| | | Condition/Opportunity | **LOW** |
| | | Opportunity Presence (Y/N) | **NO** |
| | Pollution Change | Condition | NA |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| Habitat | Physical Structure | Condition | **LOW** |
| | Landscape Patch Structure | Condition | **HIGH** |
| | Vegetation Composition | Condition | **LOW** |

**Function Rating Summary**

| Function | Metrics | Rating |
|---|---|---|
| Hydrology | Condition | **LOW** |
| Water Quality | Condition | **LOW** |
| | Condition/Opportunity | **LOW** |
| | Opportunity Presence (Y/N) | **NO** |
| Habitat | Condition | **LOW** |

**Overall Wetland Rating** **LOW**

## NC WAM FIELD ASSESSMENT FORM
### Accompanies User Manual Version 5.0

USACE AID #
NCDWR#

| | | | |
|---|---|---|---|
| Project Name | Banner Branch | Date of Evaluation | 10/2/2019 |
| Applicant/Owner Name | Water & Land Solutions | Wetland Site Name | W2 |
| Wetland Type | Riverine Swamp Forest | Assessor Name/Organization | Emily Dunnigan/WLS |
| Level III Ecoregion | Piedmont | Nearest Named Water Body | Banner Branch |
| River Basin | Roanoke | USGS 8-Digit Catalogue Unit | 03010103 |
| County | Stokes | NCDWR Region | Winston-Salem |
| ☐ Yes ☒ No | Precipitation within 48 hrs? | Latitude/Longitude (deci-degrees) | 36.528865, -80.200732 |

**Evidence of stressors affecting the assessment area (may not be within the assessment area)**

Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

**Is the assessment area intensively managed?** ☐ Yes ☒ No

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

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

**What type of natural stream is associated with the wetland, if any? (check all that apply)**

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

**Is the assessment area on a coastal island?** ☐ Yes ☒ No

**Is the assessment area's surface water storage capacity or duration substantially altered by beaver?** ☐ Yes ☒ No

**Does the assessment area experience overbank flooding during normal rainfall conditions?** ☐ Yes ☒ No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**

**Check a box in each column.** Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

| GS | VS | |
|---|---|---|
| ☒A | ☒A | Not severely altered |
| ☐B | ☐B | Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration) |

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

**Check a box in each column.** Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Water storage capacity and duration are not altered. |
| ☐B | ☐B | Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation). |
| ☐C | ☐C | Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines). |

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)**

**Check a box in each column**. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

| | AA | WT | |
|---|---|---|---|
| 3a. | ☐A | ☐A | Majority of wetland with depressions able to pond water > 1 deep |
| | ☒B | ☒B | Majority of wetland with depressions able to pond water 6 inches to 1 foot deep |
| | ☐C | ☐C | Majority of wetland with depressions able to pond water 3 to 6 inches deep |
| | ☐D | ☐D | Depressions able to pond water < 3 inches deep |

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☒B Evidence that maximum depth of inundation is between 1 and 2 feet
☐C Evidence that maximum depth of inundation is less than 1 foot

**4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)**

**Check a box from each of the three soil property groups below.** Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☐A Sandy soil
☒B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☐A Soil ribbon < 1 inch
☒B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

**5. Discharge into Wetland – opportunity metric**

**Check a box in each column.** Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Little or no evidence of pollutants or discharges entering the assessment area |
| ☐B | ☐B | Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area |
| ☐C | ☐C | Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor) |

**6. Land Use – opportunity metric (skip for non-riparian wetlands)**

**Check all that apply (at least one box in each column).** Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles <u>and</u> within the watershed draining to the assessment area (5M), <u>and</u> within 2 miles and within the watershed draining to the assessment area (2M).

| WS | 5M | 2M | |
|---|---|---|---|
| ☐A | ☐A | ☐A | <u>></u> 10% impervious surfaces |
| ☐B | ☐B | ☐B | Confined animal operations (or other local, concentrated source of pollutants |
| ☒C | ☒C | ☒C | ≥ 20% coverage of pasture |
| ☐D | ☐D | ☐D | ≥ 20% coverage of agricultural land (regularly plowed land) |
| ☐E | ☐E | ☐E | ≥ 20% coverage of maintained grass/herb |
| ☐F | ☐F | ☐F | ≥ 20% coverage of clear-cut land |
| ☐G | ☐G | ☐G | Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed <u>or</u> hydrologic alterations that prevent drainage <u>and/or</u> overbank flow from affecting the assessment area. |

**7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)**

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☒A ≥ 50 feet
☐B From 30 to < 50 feet
☐C From 15 to < 30 feet
☐D From 5 to < 15 feet
☐E < 5 feet <u>or</u> buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☒Yes ☐No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet <u>and</u> no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet <u>or</u> regular boat traffic.

**8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)**

**Check a box in each column for riverine wetlands only**. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

| WT | WC | |
|---|---|---|
| ☐A | ☐A | ≥ 100 feet |
| ☐B | ☒B | From 80 to < 100 feet |
| ☐C | ☐C | From 50 to < 80 feet |
| ☐D | ☐D | From 40 to < 50 feet |
| ☐E | ☐E | From 30 to < 40 feet |
| ☐F | ☐F | From 15 to < 30 feet |
| ☐G | ☐G | From 5 to < 15 feet |
| ☐H | ☐H | < 5 feet |

**9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)**

Answer for assessment area dominant landform.

☐A Evidence of short-duration inundation (< 7 consecutive days)
☒B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

**10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)**

Consider recent deposition only (no plant growth since deposition).

☐A Sediment deposition is not excessive, but at approximately natural levels.
☒B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

**11. Wetland Size – wetland type/wetland complex condition metric**

**Check a box in each column.** Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

| WT | WC | FW (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | ☐D | From 25 to < 50 acres |
| ☐E | ☐E | ☐E | From 10 to < 25 acres |
| ☐F | ☐F | ☐F | From 5 to < 10 acres |
| ☐G | ☐G | ☐G | From 1 to < 5 acres |
| ☒H | ☒H | ☒H | From 0.5 to < 1 acre |
| ☐I | ☐I | ☐I | From 0.1 to < 0.5 acre |
| ☐J | ☐J | ☐J | From 0.01 to < 0.1 acre |
| ☐K | ☐K | ☐K | < 0.01 acre <u>or</u> assessment area is clear-cut |

**12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

**13. Connectivity to Other Natural Areas – landscape condition metric**

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

| Well | Loosely | |
|---|---|---|
| ☐A | ☐A | ≥ 500 acres |
| ☒B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | From 10 to < 50 acres |
| ☐E | ☐E | < 10 acres |
| ☐F | ☐F | Wetland type has a poor or no connection to other natural habitats |

13b. **Evaluate for marshes only**.

☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

**14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)**

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☒A 0
☐B 1 to 4
☐C 5 to 8

**15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)**

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☒B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☐C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

**16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**

☐A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☐B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

**17. Vegetative Structure – assessment area/wetland type condition metric**

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☒A ≥ 25% coverage of vegetation

☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

| | AA | WT | |
|---|---|---|---|
| Canopy | ☐A | ☐A | Canopy closed, or nearly closed, with natural gaps associated with natural processes |
| | ☒B | ☒B | Canopy present, but opened more than natural gaps |
| | ☐C | ☐C | Canopy sparse or absent |
| Mid-Story | ☐A | ☐A | Dense mid-story/sapling layer |
| | ☒B | ☒B | Moderate density mid-story/sapling layer |
| | ☐C | ☐C | Mid-story/sapling layer sparse or absent |
| Shrub | ☐A | ☐A | Dense shrub layer |
| | ☒B | ☒B | Moderate density shrub layer |
| | ☐C | ☐C | Shrub layer sparse or absent |
| Herb | ☒A | ☒A | Dense herb layer |
| | ☐B | ☐B | Moderate density herb layer |
| | ☐C | ☐C | Herb layer sparse or absent |

**18. Snags – wetland type condition metric (skip for all marshes)**

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).

☒B Not A

**19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)**

☐A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.

☒B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.

☐C Majority of canopy trees are < 6 inches DBH or no trees.

**20. Large Woody Debris – wetland type condition metric (skip for all marshes)**

Include both natural debris and man-placed natural debris.

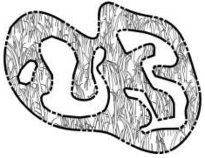
☐A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).

☒B Not A

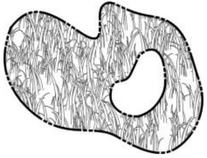
**21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)**

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

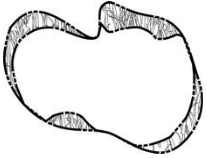
☐A



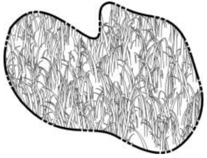
☐B



☐C



☐D



**22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)**

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☒A Overbank and overland flow are not severely altered in the assessment area.

☐B Overbank flow is severely altered in the assessment area.

☐C Overland flow is severely altered in the assessment area.

☐D Both overbank and overland flow are severely altered in the assessment area.

Notes

stream backed up at culvert, formerly used as irrigation pond. Exotics in herb layer.

# NC WAM Wetland Rating Sheet
# Accompanies User Manual Version 5.0

Wetland Site Name W2

Date of Assessment 10/2/2019

Wetland Type Riverine Swamp Forest

Assessor Name/Organization Emily Dunnigan/WLS

| | |
|---|---|
| Notes on Field Assessment Form (Y/N) | YES |
| Presence of regulatory considerations (Y/N) | NO |
| Wetland is intensively managed (Y/N) | NO |
| Assessment area is located within 50 feet of a natural tributary or other open water (Y/N) | YES |
| Assessment area is substantially altered by beaver (Y/N) | NO |
| Assessment area experiences overbank flooding during normal rainfall conditions (Y/N) | NO |
| Assessment area is on a coastal island (Y/N) | NO |

## Sub-function Rating Summary

| Function | Sub-function | Metrics | Rating |
|---|---|---|---|
| Hydrology | Surface Storage and Retention | Condition | **HIGH** |
| | Sub-surface Storage and Retention | Condition | **MEDIUM** |
| Water Quality | Pathogen Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Particulate Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| | Soluble Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Physical Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Pollution Change | Condition | NA |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| Habitat | Physical Structure | Condition | **MEDIUM** |
| | Landscape Patch Structure | Condition | **HIGH** |
| | Vegetation Composition | Condition | **MEDIUM** |

## Function Rating Summary

| Function | Metrics | Rating |
|---|---|---|
| Hydrology | Condition | **HIGH** |
| Water Quality | Condition | **HIGH** |
| | Condition/Opportunity | **HIGH** |
| | Opportunity Presence (Y/N) | **YES** |
| Habitat | Condition | **HIGH** |

**Overall Wetland Rating** **HIGH**

# NC WAM FIELD ASSESSMENT FORM
## Accompanies User Manual Version 5.0

| | | | |
|---|---|---|---|
| USACE AID # | | NCDWR# | |
| Project Name | Banner Branch | Date of Evaluation | 10/2/2019 |
| Applicant/Owner Name | Water & Land Solutions | Wetland Site Name | W3 |
| Wetland Type | Headwater Forest | Assessor Name/Organization | Emily Dunnigan/WLS |
| Level III Ecoregion | Piedmont | Nearest Named Water Body | Banner Branch |
| River Basin | Roanoke | USGS 8-Digit Catalogue Unit | 03010103 |
| County | Stokes | NCDWR Region | Winston-Salem |
| ☐ Yes ☒ No | Precipitation within 48 hrs? | Latitude/Longitude (deci-degrees) | 36.525408, -80.208639 |

**Evidence of stressors affecting the assessment area (may not be within the assessment area)**

Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

**Is the assessment area intensively managed?** ☐ Yes ☒ No

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

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

**What type of natural stream is associated with the wetland, if any? (check all that apply)**

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

**Is the assessment area on a coastal island?** ☐ Yes ☒ No

**Is the assessment area's surface water storage capacity or duration substantially altered by beaver?** ☐ Yes ☒ No

**Does the assessment area experience overbank flooding during normal rainfall conditions?** ☐ Yes ☒ No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**

**Check a box in each column.** Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

| GS | VS | |
|---|---|---|
| ☒A | ☐A | Not severely altered |
| ☐B | ☒B | Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration) |

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

**Check a box in each column.** Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Water storage capacity and duration are not altered. |
| ☐B | ☐B | Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation). |
| ☐C | ☐C | Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines). |

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)**

**Check a box in each column**. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

| | AA | WT | |
|---|---|---|---|
| 3a. | ☐A | ☐A | Majority of wetland with depressions able to pond water > 1 deep |
| | ☐B | ☐B | Majority of wetland with depressions able to pond water 6 inches to 1 foot deep |
| | ☐C | ☐C | Majority of wetland with depressions able to pond water 3 to 6 inches deep |
| | ☒D | ☒D | Depressions able to pond water < 3 inches deep |

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☐B Evidence that maximum depth of inundation is between 1 and 2 feet
☒C Evidence that maximum depth of inundation is less than 1 foot

**4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)**

**Check a box from each of the three soil property groups below.** Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☐A Sandy soil
☒B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☐A Soil ribbon < 1 inch
☒B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

**5. Discharge into Wetland – opportunity metric**

**Check a box in each column.** Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Little or no evidence of pollutants or discharges entering the assessment area |
| ☐B | ☐B | Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area |
| ☐C | ☐C | Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor) |

**6. Land Use – opportunity metric (skip for non-riparian wetlands)**

**Check all that apply (at least one box in each column).** Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M).

| WS | 5M | 2M | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 10% impervious surfaces |
| ☐B | ☐B | ☐B | Confined animal operations (or other local, concentrated source of pollutants |
| ☒C | ☒C | ☒C | ≥ 20% coverage of pasture |
| ☐D | ☐D | ☐D | ≥ 20% coverage of agricultural land (regularly plowed land) |
| ☐E | ☐E | ☐E | ≥ 20% coverage of maintained grass/herb |
| ☐F | ☐F | ☐F | ≥ 20% coverage of clear-cut land |
| ☐G | ☐G | ☐G | Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed or hydrologic alterations that prevent drainage and/or overbank flow from affecting the assessment area. |

**7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)**

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☒A ≥ 50 feet
☐B From 30 to < 50 feet
☐C From 15 to < 30 feet
☐D From 5 to < 15 feet
☐E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☒Yes ☐No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

**8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)**

**Check a box in each column for riverine wetlands only**. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

| WT | WC | |
|---|---|---|
| ☐A | ☒A | ≥ 100 feet |
| ☐B | ☐B | From 80 to < 100 feet |
| ☐C | ☐C | From 50 to < 80 feet |
| ☐D | ☐D | From 40 to < 50 feet |
| ☐E | ☐E | From 30 to < 40 feet |
| ☐F | ☐F | From 15 to < 30 feet |
| ☐G | ☐G | From 5 to < 15 feet |
| ☐H | ☐H | < 5 feet |

**9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)**

Answer for assessment area dominant landform.

☐A Evidence of short-duration inundation (< 7 consecutive days)
☒B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

**10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)**

Consider recent deposition only (no plant growth since deposition).

☒A Sediment deposition is not excessive, but at approximately natural levels.
☐B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

**11. Wetland Size – wetland type/wetland complex condition metric**

**Check a box in each column.** Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

| WT | WC | FW (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | ☐D | From 25 to < 50 acres |
| ☐E | ☐E | ☐E | From 10 to < 25 acres |
| ☐F | ☐F | ☐F | From 5 to < 10 acres |
| ☒G | ☒G | ☐G | From 1 to < 5 acres |
| ☐H | ☐H | ☐H | From 0.5 to < 1 acre |
| ☐I | ☐I | ☒I | From 0.1 to < 0.5 acre |
| ☐J | ☐J | ☐J | From 0.01 to < 0.1 acre |
| ☐K | ☐K | ☐K | < 0.01 acre <u>or</u> assessment area is clear-cut |

**12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

**13. Connectivity to Other Natural Areas – landscape condition metric**

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

| Well | Loosely | |
|---|---|---|
| ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | From 10 to < 50 acres |
| ☐E | ☒E | < 10 acres |
| ☒F | ☐F | Wetland type has a poor or no connection to other natural habitats |

13b. **Evaluate for marshes only**.

☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

**14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)**

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☐A 0
☐B 1 to 4
☒C 5 to 8

**15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)**

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.

☐B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.

☒C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

**16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**

☐A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☐B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

### 17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?
☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.
☐A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

| | AA | WT | |
|---|---|---|---|
| Canopy | ☐A | ☐A | Canopy closed, or nearly closed, with natural gaps associated with natural processes |
| | ☐B | ☐B | Canopy present, but opened more than natural gaps |
| | ☒C | ☒C | Canopy sparse or absent |
| Mid-Story | ☐A | ☐A | Dense mid-story/sapling layer |
| | ☐B | ☐B | Moderate density mid-story/sapling layer |
| | ☒C | ☒C | Mid-story/sapling layer sparse or absent |
| Shrub | ☐A | ☐A | Dense shrub layer |
| | ☐B | ☐B | Moderate density shrub layer |
| | ☒C | ☒C | Shrub layer sparse or absent |
| Herb | ☒A | ☒A | Dense herb layer |
| | ☐B | ☐B | Moderate density herb layer |
| | ☐C | ☐C | Herb layer sparse or absent |

### 18. Snags – wetland type condition metric (skip for all marshes)

☒A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).
☐B Not A

### 19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)

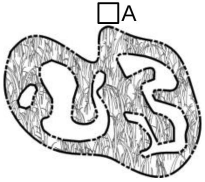
☐A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☒B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.
☐C Majority of canopy trees are < 6 inches DBH or no trees.

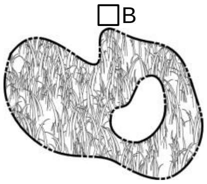
### 20. Large Woody Debris – wetland type condition metric (skip for all marshes)

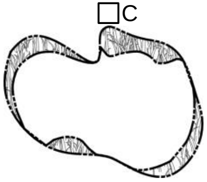
Include both natural debris and man-placed natural debris.
☒A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☐B Not A

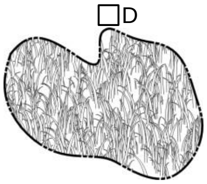
### 21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐A


☐B


☐C


☐D


### 22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.
☒A Overbank and overland flow are not severely altered in the assessment area.
☐B Overbank flow is severely altered in the assessment area.
☐C Overland flow is severely altered in the assessment area.
☐D Both overbank and overland flow are severely altered in the assessment area.

Notes
Wetland is missing most trees due to clearing and grazing pressures. Cows are able to enter the wetland degrading vegeation diversity.

# NC WAM Wetland Rating Sheet
# Accompanies User Manual Version 5.0

Wetland Site Name W3
Date of Assessment 10/2/2019
Wetland Type Headwater Forest
Assessor Name/Organization Emily Dunnigan/WLS

| | |
|---|---|
| Notes on Field Assessment Form (Y/N) | YES |
| Presence of regulatory considerations (Y/N) | NO |
| Wetland is intensively managed (Y/N) | NO |
| Assessment area is located within 50 feet of a natural tributary or other open water (Y/N) | YES |
| Assessment area is substantially altered by beaver (Y/N) | NO |
| Assessment area experiences overbank flooding during normal rainfall conditions (Y/N) | NO |
| Assessment area is on a coastal island (Y/N) | NO |

**Sub-function Rating Summary**

| Function | Sub-function | Metrics | Rating |
|---|---|---|---|
| Hydrology | Surface Storage and Retention | Condition | **MEDIUM** |
| | Sub-surface Storage and Retention | Condition | **MEDIUM** |
| Water Quality | Pathogen Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Particulate Change | Condition | **LOW** |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| | Soluble Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Physical Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Pollution Change | Condition | NA |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| Habitat | Physical Structure | Condition | **MEDIUM** |
| | Landscape Patch Structure | Condition | **LOW** |
| | Vegetation Composition | Condition | **LOW** |

**Function Rating Summary**

| Function | Metrics | Rating |
|---|---|---|
| Hydrology | Condition | **MEDIUM** |
| Water Quality | Condition | **HIGH** |
| | Condition/Opportunity | **HIGH** |
| | Opportunity Presence (Y/N) | **YES** |
| Habitat | Condition | **LOW** |

**Overall Wetland Rating** **MEDIUM**

## NC WAM FIELD ASSESSMENT FORM
### Accompanies User Manual Version 5.0

USACE AID # NCDWR#

| | | | |
|---|---|---|---|
| Project Name | Banner Branch | Date of Evaluation | 10/2/2019 |
| Applicant/Owner Name | Water & Land Solutions | Wetland Site Name | W4 |
| Wetland Type | Headwater Forest | Assessor Name/Organization | Emily Dunnigan/WLS |
| Level III Ecoregion | Piedmont | Nearest Named Water Body | Banner Branch |
| River Basin | Roanoke | USGS 8-Digit Catalogue Unit | 03010103 |
| County | Stokes | NCDWR Region | Winston-Salem |
| ☐ Yes ☒ No | Precipitation within 48 hrs? | Latitude/Longitude (deci-degrees) | 36.520933, -80.207813 |

**Evidence of stressors affecting the assessment area (may not be within the assessment area)**

Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

**Is the assessment area intensively managed?** ☐ Yes ☒ No

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

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

**What type of natural stream is associated with the wetland, if any? (check all that apply)**

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

**Is the assessment area on a coastal island?** ☐ Yes ☒ No

**Is the assessment area's surface water storage capacity or duration substantially altered by beaver?** ☐ Yes ☒ No

**Does the assessment area experience overbank flooding during normal rainfall conditions?** ☐ Yes ☒ No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**

**Check a box in each column.** Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

| GS | VS | |
|---|---|---|
| ☒A | ☐A | Not severely altered |
| ☐B | ☒B | Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration) |

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

**Check a box in each column.** Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Water storage capacity and duration are not altered. |
| ☐B | ☐B | Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation). |
| ☐C | ☐C | Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines). |

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)**

**Check a box in each column**. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

| | AA | WT | |
|---|---|---|---|
| 3a. | ☐A | ☐A | Majority of wetland with depressions able to pond water > 1 deep |
| | ☐B | ☐B | Majority of wetland with depressions able to pond water 6 inches to 1 foot deep |
| | ☐C | ☐C | Majority of wetland with depressions able to pond water 3 to 6 inches deep |
| | ☒D | ☒D | Depressions able to pond water < 3 inches deep |

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☐B Evidence that maximum depth of inundation is between 1 and 2 feet
☒C Evidence that maximum depth of inundation is less than 1 foot

**4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)**

**Check a box from each of the three soil property groups below.** Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☒A Sandy soil
☐B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☒A Soil ribbon < 1 inch
☐B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

**5. Discharge into Wetland – opportunity metric**

**Check a box in each column.** Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Little or no evidence of pollutants or discharges entering the assessment area |
| ☐B | ☐B | Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area |
| ☐C | ☐C | Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor) |

**6. Land Use – opportunity metric (skip for non-riparian wetlands)**

**Check all that apply (at least one box in each column).** Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles <u>and</u> within the watershed draining to the assessment area (5M), <u>and</u> within 2 miles and within the watershed draining to the assessment area (2M).

| WS | 5M | 2M | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 10% impervious surfaces |
| ☐B | ☐B | ☐B | Confined animal operations (or other local, concentrated source of pollutants |
| ☒C | ☒C | ☒C | ≥ 20% coverage of pasture |
| ☐D | ☐D | ☐D | ≥ 20% coverage of agricultural land (regularly plowed land) |
| ☐E | ☐E | ☐E | ≥ 20% coverage of maintained grass/herb |
| ☐F | ☐F | ☐F | ≥ 20% coverage of clear-cut land |
| ☐G | ☐G | ☐G | Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed <u>or</u> hydrologic alterations that prevent drainage <u>and/or</u> overbank flow from affecting the assessment area. |

**7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)**

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☒A ≥ 50 feet
☐B From 30 to < 50 feet
☐C From 15 to < 30 feet
☐D From 5 to < 15 feet
☐E < 5 feet <u>or</u> buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☒Yes ☐No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet <u>and</u> no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet <u>or</u> regular boat traffic.

**8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)**

**Check a box in each column for riverine wetlands only**. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

| WT | WC | |
|---|---|---|
| ☐A | ☐A | ≥ 100 feet |
| ☐B | ☒B | From 80 to < 100 feet |
| ☐C | ☐C | From 50 to < 80 feet |
| ☐D | ☐D | From 40 to < 50 feet |
| ☐E | ☐E | From 30 to < 40 feet |
| ☐F | ☐F | From 15 to < 30 feet |
| ☐G | ☐G | From 5 to < 15 feet |
| ☐H | ☐H | < 5 feet |

**9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)**

Answer for assessment area dominant landform.

☒A Evidence of short-duration inundation (< 7 consecutive days)
☐B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

**10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)**

Consider recent deposition only (no plant growth since deposition).

☒A Sediment deposition is not excessive, but at approximately natural levels.
☐B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

**11. Wetland Size – wetland type/wetland complex condition metric**

**Check a box in each column.** Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

| WT | WC | FW (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | ☐D | From 25 to < 50 acres |
| ☐E | ☐E | ☐E | From 10 to < 25 acres |
| ☐F | ☐F | ☐F | From 5 to < 10 acres |
| ☐G | ☐G | ☐G | From 1 to < 5 acres |
| ☐H | ☐H | ☐H | From 0.5 to < 1 acre |
| ☒I | ☒I | ☒I | From 0.1 to < 0.5 acre |
| ☐J | ☐J | ☐J | From 0.01 to < 0.1 acre |
| ☐K | ☐K | ☐K | < 0.01 acre <u>or</u> assessment area is clear-cut |

**12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

**13. Connectivity to Other Natural Areas – landscape condition metric**

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

| Well | Loosely | |
|---|---|---|
| ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☒D | From 10 to < 50 acres |
| ☒E | ☐E | < 10 acres |
| ☐F | ☐F | Wetland type has a poor or no connection to other natural habitats |

13b. **Evaluate for marshes only**.

☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

**14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)**

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☐A 0
☒B 1 to 4
☐C 5 to 8

**15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)**

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.

☐B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.

☒C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

**16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**

☐A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☐B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

**17. Vegetative Structure – assessment area/wetland type condition metric**

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

|  | AA | WT |  |
|---|---|---|---|
| Canopy | ☐A | ☐A | Canopy closed, or nearly closed, with natural gaps associated with natural processes |
|  | ☒B | ☒B | Canopy present, but opened more than natural gaps |
|  | ☐C | ☐C | Canopy sparse or absent |
| Mid-Story | ☐A | ☐A | Dense mid-story/sapling layer |
|  | ☒B | ☒B | Moderate density mid-story/sapling layer |
|  | ☐C | ☐C | Mid-story/sapling layer sparse or absent |
| Shrub | ☐A | ☐A | Dense shrub layer |
|  | ☐B | ☐B | Moderate density shrub layer |
|  | ☒C | ☒C | Shrub layer sparse or absent |
| Herb | ☒A | ☒A | Dense herb layer |
|  | ☐B | ☐B | Moderate density herb layer |
|  | ☐C | ☐C | Herb layer sparse or absent |

**18. Snags – wetland type condition metric (skip for all marshes)**

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).
☒B Not A

**19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)**

☐A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☒B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.
☐C Majority of canopy trees are < 6 inches DBH or no trees.

**20. Large Woody Debris – wetland type condition metric (skip for all marshes)**

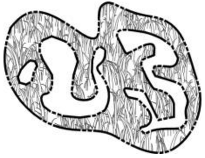
Include both natural debris and man-placed natural debris.

☐A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒B Not A

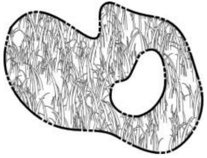
**21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)**

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

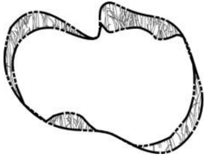
☐A



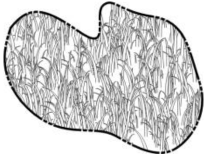
☐B



☐C



☐D



**22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)**

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☒A Overbank <u>and</u> overland flow are not severely altered in the assessment area.
☐B Overbank flow is severely altered in the assessment area.
☐C Overland flow is severely altered in the assessment area.
☐D Both overbank <u>and</u> overland flow are severely altered in the assessment area.

Notes

Abutting pasture. Cows frequent the wetland area to get to the stream. Microstegium and privet

# NC WAM Wetland Rating Sheet
# Accompanies User Manual Version 5.0

| | | | |
|---|---|---|---|
| Wetland Site Name | W4 | Date of Assessment | 10/2/2019 |
| Wetland Type | Headwater Forest | Assessor Name/Organization | Emily Dunnigan/WLS |

| | |
|---|---|
| Notes on Field Assessment Form (Y/N) | YES |
| Presence of regulatory considerations (Y/N) | NO |
| Wetland is intensively managed (Y/N) | NO |
| Assessment area is located within 50 feet of a natural tributary or other open water (Y/N) | YES |
| Assessment area is substantially altered by beaver (Y/N) | NO |
| Assessment area experiences overbank flooding during normal rainfall conditions (Y/N) | NO |
| Assessment area is on a coastal island (Y/N) | NO |

**Sub-function Rating Summary**

| Function | Sub-function | Metrics | Rating |
|---|---|---|---|
| Hydrology | Surface Storage and Retention | Condition | **MEDIUM** |
| | Sub-surface Storage and Retention | Condition | **HIGH** |
| Water Quality | Pathogen Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Particulate Change | Condition | **HIGH** |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| | Soluble Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Physical Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Pollution Change | Condition | NA |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| Habitat | Physical Structure | Condition | **MEDIUM** |
| | Landscape Patch Structure | Condition | **LOW** |
| | Vegetation Composition | Condition | **LOW** |

**Function Rating Summary**

| Function | Metrics | Rating |
|---|---|---|
| Hydrology | Condition | **HIGH** |
| Water Quality | Condition | **HIGH** |
| | Condition/Opportunity | **HIGH** |
| | Opportunity Presence (Y/N) | **YES** |
| Habitat | Condition | **LOW** |

**Overall Wetland Rating** **HIGH**

## NC WAM FIELD ASSESSMENT FORM
### Accompanies User Manual Version 5.0

USACE AID #
NCDWR#

| | | | |
|---|---|---|---|
| Project Name | Banner Branch | Date of Evaluation | 10/2/2019 |
| Applicant/Owner Name | Water & Land Solutions | Wetland Site Name | W5 A/B |
| Wetland Type | Headwater Forest | Assessor Name/Organization | Emily Dunnigan/WLS |
| Level III Ecoregion | Piedmont | Nearest Named Water Body | Banner Branch |
| River Basin | Roanoke | USGS 8-Digit Catalogue Unit | 03010103 |
| County | Stokes | NCDWR Region | Winston-Salem |
| ☐ Yes ☒ No | Precipitation within 48 hrs? | Latitude/Longitude (deci-degrees) | 36.531706, -80.200317 |

**Evidence of stressors affecting the assessment area (may not be within the assessment area)**

Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

**Is the assessment area intensively managed?** ☐ Yes ☒ No

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

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

**What type of natural stream is associated with the wetland, if any? (check all that apply)**

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

**Is the assessment area on a coastal island?** ☐ Yes ☒ No

**Is the assessment area's surface water storage capacity or duration substantially altered by beaver?** ☐ Yes ☒ No

**Does the assessment area experience overbank flooding during normal rainfall conditions?** ☒ Yes ☐ No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**

**Check a box in each column.** Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

| GS | VS | |
|---|---|---|
| ☒A | ☒A | Not severely altered |
| ☐B | ☐B | Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration) |

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

**Check a box in each column.** Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Water storage capacity and duration are not altered. |
| ☐B | ☐B | Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation). |
| ☐C | ☐C | Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines). |

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)**

**Check a box in each column**. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

| | AA | WT | |
|---|---|---|---|
| 3a. | ☐A | ☐A | Majority of wetland with depressions able to pond water > 1 deep |
| | ☐B | ☐B | Majority of wetland with depressions able to pond water 6 inches to 1 foot deep |
| | ☐C | ☐C | Majority of wetland with depressions able to pond water 3 to 6 inches deep |
| | ☒D | ☒D | Depressions able to pond water < 3 inches deep |

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☐B Evidence that maximum depth of inundation is between 1 and 2 feet
☒C Evidence that maximum depth of inundation is less than 1 foot

**4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)**

**Check a box from each of the three soil property groups below.** Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☐A Sandy soil
☒B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☒A Soil ribbon < 1 inch
☐B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

**5. Discharge into Wetland – opportunity metric**

**Check a box in each column.** Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Little or no evidence of pollutants or discharges entering the assessment area |
| ☐B | ☐B | Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area |
| ☐C | ☐C | Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor) |

**6. Land Use – opportunity metric (skip for non-riparian wetlands)**

**Check all that apply (at least one box in each column).** Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M).

| WS | 5M | 2M | |
|---|---|---|---|
| ☐A | ☐A | ☐A | > 10% impervious surfaces |
| ☐B | ☐B | ☐B | Confined animal operations (or other local, concentrated source of pollutants |
| ☒C | ☒C | ☒C | ≥ 20% coverage of pasture |
| ☐D | ☐D | ☐D | ≥ 20% coverage of agricultural land (regularly plowed land) |
| ☐E | ☐E | ☐E | ≥ 20% coverage of maintained grass/herb |
| ☐F | ☐F | ☐F | ≥ 20% coverage of clear-cut land |
| ☐G | ☐G | ☐G | Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed or hydrologic alterations that prevent drainage and/or overbank flow from affecting the assessment area. |

**7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)**

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☐A ≥ 50 feet
☒B From 30 to < 50 feet
☐C From 15 to < 30 feet
☐D From 5 to < 15 feet
☐E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☒Yes ☐No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

**8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)**

**Check a box in each column for riverine wetlands only**. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

| WT | WC | |
|---|---|---|
| ☐A | ☐A | ≥ 100 feet |
| ☐B | ☐B | From 80 to < 100 feet |
| ☐C | ☐C | From 50 to < 80 feet |
| ☐D | ☐D | From 40 to < 50 feet |
| ☒E | ☒E | From 30 to < 40 feet |
| ☐F | ☐F | From 15 to < 30 feet |
| ☐G | ☐G | From 5 to < 15 feet |
| ☐H | ☐H | < 5 feet |

**9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)**

Answer for assessment area dominant landform.

☒A Evidence of short-duration inundation (< 7 consecutive days)
☐B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

**10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)**

Consider recent deposition only (no plant growth since deposition).

☒A Sediment deposition is not excessive, but at approximately natural levels.
☐B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

**11. Wetland Size – wetland type/wetland complex condition metric**

**Check a box in each column.** Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select “K” for the FW column.

| WT | WC | FW (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | ☐D | From 25 to < 50 acres |
| ☐E | ☐E | ☐E | From 10 to < 25 acres |
| ☐F | ☐F | ☐F | From 5 to < 10 acres |
| ☐G | ☐G | ☐G | From 1 to < 5 acres |
| ☐H | ☐H | ☐H | From 0.5 to < 1 acre |
| ☒I | ☒I | ☒I | From 0.1 to < 0.5 acre |
| ☐J | ☐J | ☐J | From 0.01 to < 0.1 acre |
| ☐K | ☐K | ☐K | < 0.01 acre <u>or</u> assessment area is clear-cut |

**12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

**13. Connectivity to Other Natural Areas – landscape condition metric**

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

| Well | Loosely | |
|---|---|---|
| ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | From 50 to < 100 acres |
| ☒D | ☐D | From 10 to < 50 acres |
| ☐E | ☐E | < 10 acres |
| ☐F | ☐F | Wetland type has a poor or no connection to other natural habitats |

13b. **Evaluate for marshes only**.

☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

**14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)**

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option ”C.”

☐A 0
☒B 1 to 4
☐C 5 to 8

**15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)**

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☒B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☐C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

**16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**

☐A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☐B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

**17. Vegetative Structure – assessment area/wetland type condition metric**

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

| | AA | WT | |
|---|---|---|---|
| Canopy | ☒A | ☒A | Canopy closed, or nearly closed, with natural gaps associated with natural processes |
| | ☐B | ☐B | Canopy present, but opened more than natural gaps |
| | ☐C | ☐C | Canopy sparse or absent |
| Mid-Story | ☐A | ☐A | Dense mid-story/sapling layer |
| | ☒B | ☒B | Moderate density mid-story/sapling layer |
| | ☐C | ☐C | Mid-story/sapling layer sparse or absent |
| Shrub | ☐A | ☐A | Dense shrub layer |
| | ☒B | ☒B | Moderate density shrub layer |
| | ☐C | ☐C | Shrub layer sparse or absent |
| Herb | ☒A | ☒A | Dense herb layer |
| | ☐B | ☐B | Moderate density herb layer |
| | ☐C | ☐C | Herb layer sparse or absent |

**18. Snags – wetland type condition metric (skip for all marshes)**

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).
☒B Not A

**19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)**

☒A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.
☐C Majority of canopy trees are < 6 inches DBH or no trees.

**20. Large Woody Debris – wetland type condition metric (skip for all marshes)**

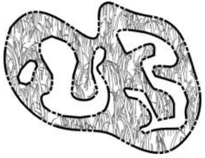
Include both natural debris and man-placed natural debris.

☒A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☐B Not A

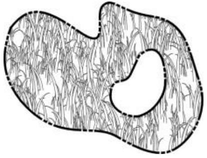
**21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)**

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

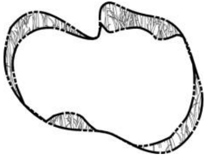
☐A



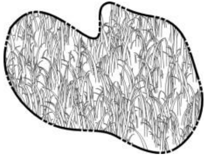
☐B



☐C



☐D



**22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)**

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☒A Overbank and overland flow are not severely altered in the assessment area.
☐B Overbank flow is severely altered in the assessment area.
☐C Overland flow is severely altered in the assessment area.
☐D Both overbank and overland flow are severely altered in the assessment area.

Notes
Cow access.

# NC WAM Wetland Rating Sheet
# Accompanies User Manual Version 5.0

Wetland Site Name W5 A/B

Date of Assessment 10/2/2019

Wetland Type Headwater Forest

Assessor Name/Organization Emily Dunnigan/WLS

| | |
|---|---|
| Notes on Field Assessment Form (Y/N) | YES |
| Presence of regulatory considerations (Y/N) | NO |
| Wetland is intensively managed (Y/N) | NO |
| Assessment area is located within 50 feet of a natural tributary or other open water (Y/N) | YES |
| Assessment area is substantially altered by beaver (Y/N) | NO |
| Assessment area experiences overbank flooding during normal rainfall conditions (Y/N) | YES |
| Assessment area is on a coastal island (Y/N) | NO |

**Sub-function Rating Summary**

| Function | Sub-function | Metrics | Rating |
|---|---|---|---|
| Hydrology | Surface Storage and Retention | Condition | **HIGH** |
| | Sub-surface Storage and Retention | Condition | **HIGH** |
| Water Quality | Pathogen Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Particulate Change | Condition | **HIGH** |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| | Soluble Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Physical Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Pollution Change | Condition | NA |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| Habitat | Physical Structure | Condition | **HIGH** |
| | Landscape Patch Structure | Condition | **LOW** |
| | Vegetation Composition | Condition | **MEDIUM** |

**Function Rating Summary**

| Function | Metrics | Rating |
|---|---|---|
| Hydrology | Condition | **HIGH** |
| Water Quality | Condition | **HIGH** |
| | Condition/Opportunity | **HIGH** |
| | Opportunity Presence (Y/N) | **YES** |
| Habitat | Condition | **MEDIUM** |

**Overall Wetland Rating** **HIGH**

# NC WAM FIELD ASSESSMENT FORM
## Accompanies User Manual Version 5.0

USACE AID # NCDWR#

| | | | |
|---|---|---|---|
| Project Name | Banner Branch | Date of Evaluation | 10/2/2019 |
| Applicant/Owner Name | Water & Land Solutions | Wetland Site Name | W6A |
| Wetland Type | Headwater Forest | Assessor Name/Organization | Emily Dunnigan /WLS |
| Level III Ecoregion | Piedmont | Nearest Named Water Body | Banner Branch |
| River Basin | Roanoke | USGS 8-Digit Catalogue Unit | 03010103 |
| County | Stokes | NCDWR Region | Winston-Salem |
| ☐ Yes ☒ No | Precipitation within 48 hrs? | Latitude/Longitude (deci-degrees) | 36.530159, -80.209670 |

**Evidence of stressors affecting the assessment area (may not be within the assessment area)**

Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

**Is the assessment area intensively managed?** ☐ Yes ☒ No

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

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

**What type of natural stream is associated with the wetland, if any? (check all that apply)**

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

**Is the assessment area on a coastal island?** ☐ Yes ☒ No

**Is the assessment area's surface water storage capacity or duration substantially altered by beaver?** ☐ Yes ☒ No

**Does the assessment area experience overbank flooding during normal rainfall conditions?** ☐ Yes ☒ No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**

**Check a box in each column.** Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

| GS | VS | |
|---|---|---|
| ☒A | ☐A | Not severely altered |
| ☐B | ☒B | Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration) |

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

**Check a box in each column.** Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

| Surf | Sub | |
|---|---|---|
| ☐A | ☐A | Water storage capacity and duration are not altered. |
| ☒B | ☐B | Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation). |
| ☐C | ☒C | Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines). |

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)**

**Check a box in each column**. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

| | AA | WT | |
|---|---|---|---|
| 3a. | ☐A | ☐A | Majority of wetland with depressions able to pond water > 1 deep |
| | ☐B | ☐B | Majority of wetland with depressions able to pond water 6 inches to 1 foot deep |
| | ☒C | ☒C | Majority of wetland with depressions able to pond water 3 to 6 inches deep |
| | ☐D | ☐D | Depressions able to pond water < 3 inches deep |

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☐B Evidence that maximum depth of inundation is between 1 and 2 feet
☒C Evidence that maximum depth of inundation is less than 1 foot

### 4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)

**Check a box from each of the three soil property groups below.** Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☐A Sandy soil
☒B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☐A Soil ribbon < 1 inch
☒B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

### 5. Discharge into Wetland – opportunity metric

**Check a box in each column.** Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Little or no evidence of pollutants or discharges entering the assessment area |
| ☐B | ☐B | Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area |
| ☐C | ☐C | Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor) |

### 6. Land Use – opportunity metric (skip for non-riparian wetlands)

**Check all that apply (at least one box in each column).** Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M).

| WS | 5M | 2M | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 10% impervious surfaces |
| ☐B | ☐B | ☐B | Confined animal operations (or other local, concentrated source of pollutants |
| ☒C | ☒C | ☒C | ≥ 20% coverage of pasture |
| ☐D | ☐D | ☐D | ≥ 20% coverage of agricultural land (regularly plowed land) |
| ☐E | ☐E | ☐E | ≥ 20% coverage of maintained grass/herb |
| ☐F | ☐F | ☐F | ≥ 20% coverage of clear-cut land |
| ☐G | ☐G | ☐G | Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed or hydrologic alterations that prevent drainage and/or overbank flow from affecting the assessment area. |

### 7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☐A ≥ 50 feet
☒B From 30 to < 50 feet
☐C From 15 to < 30 feet
☐D From 5 to < 15 feet
☐E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☒Yes ☐No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

### 8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)

**Check a box in each column for riverine wetlands only**. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

| WT | WC | |
|---|---|---|
| ☐A | ☐A | ≥ 100 feet |
| ☐B | ☐B | From 80 to < 100 feet |
| ☐C | ☒C | From 50 to < 80 feet |
| ☐D | ☐D | From 40 to < 50 feet |
| ☐E | ☐E | From 30 to < 40 feet |
| ☐F | ☐F | From 15 to < 30 feet |
| ☐G | ☐G | From 5 to < 15 feet |
| ☐H | ☐H | < 5 feet |

**9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)**

Answer for assessment area dominant landform.

☒A Evidence of short-duration inundation (< 7 consecutive days)
☐B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

**10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)**

Consider recent deposition only (no plant growth since deposition).

☒A Sediment deposition is not excessive, but at approximately natural levels.
☐B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

**11. Wetland Size – wetland type/wetland complex condition metric**

**Check a box in each column.** Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

| WT | WC | FW (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | ☐D | From 25 to < 50 acres |
| ☐E | ☐E | ☐E | From 10 to < 25 acres |
| ☐F | ☐F | ☐F | From 5 to < 10 acres |
| ☐G | ☐G | ☐G | From 1 to < 5 acres |
| ☐H | ☐H | ☐H | From 0.5 to < 1 acre |
| ☒I | ☒I | ☒I | From 0.1 to < 0.5 acre |
| ☐J | ☐J | ☐J | From 0.01 to < 0.1 acre |
| ☐K | ☐K | ☐K | < 0.01 acre <u>or</u> assessment area is clear-cut |

**12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

**13. Connectivity to Other Natural Areas – landscape condition metric**

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

| Well | Loosely | |
|---|---|---|
| ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | From 50 to < 100 acres |
| ☒D | ☐D | From 10 to < 50 acres |
| ☐E | ☐E | < 10 acres |
| ☐F | ☐F | Wetland type has a poor or no connection to other natural habitats |

13b. **Evaluate for marshes only**.

☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

**14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)**

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☐A 0
☐B 1 to 4
☒C 5 to 8

**15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)**

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.

☐B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.

☒C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

**16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**

☐A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☐B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

### 17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

| | AA | WT | |
|---|---|---|---|
| Canopy | ☐A | ☐A | Canopy closed, or nearly closed, with natural gaps associated with natural processes |
| | ☒B | ☒B | Canopy present, but opened more than natural gaps |
| | ☐C | ☐C | Canopy sparse or absent |
| Mid-Story | ☐A | ☐A | Dense mid-story/sapling layer |
| | ☐B | ☐B | Moderate density mid-story/sapling layer |
| | ☒C | ☒C | Mid-story/sapling layer sparse or absent |
| Shrub | ☐A | ☐A | Dense shrub layer |
| | ☐B | ☐B | Moderate density shrub layer |
| | ☒C | ☒C | Shrub layer sparse or absent |
| Herb | ☒A | ☒A | Dense herb layer |
| | ☐B | ☐B | Moderate density herb layer |
| | ☐C | ☐C | Herb layer sparse or absent |

### 18. Snags – wetland type condition metric (skip for all marshes)

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).
☒B Not A

### 19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)

☐A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☒B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.
☐C Majority of canopy trees are < 6 inches DBH or no trees.

### 20. Large Woody Debris – wetland type condition metric (skip for all marshes)

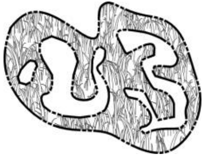
Include both natural debris and man-placed natural debris.

☐A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒B Not A

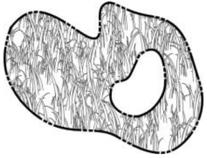
### 21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

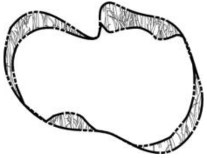
☐A



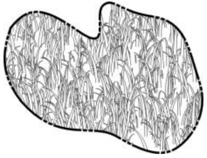
☐B



☐C



☐D



### 22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☐A Overbank <u>and</u> overland flow are not severely altered in the assessment area.
☒B Overbank flow is severely altered in the assessment area.
☐C Overland flow is severely altered in the assessment area.
☐D Both overbank <u>and</u> overland flow are severely altered in the assessment area.

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Notes

Cows have access to wetland. Drain tile is below the wetland draining into the stream.

# NC WAM Wetland Rating Sheet
# Accompanies User Manual Version 5.0

Wetland Site Name W6A

Date of Assessment 10/2/2019

Wetland Type Headwater Forest

Assessor Name/Organization Emily Dunnigan /WLS

| | |
|---|---|
| Notes on Field Assessment Form (Y/N) | YES |
| Presence of regulatory considerations (Y/N) | NO |
| Wetland is intensively managed (Y/N) | NO |
| Assessment area is located within 50 feet of a natural tributary or other open water (Y/N) | YES |
| Assessment area is substantially altered by beaver (Y/N) | NO |
| Assessment area experiences overbank flooding during normal rainfall conditions (Y/N) | NO |
| Assessment area is on a coastal island (Y/N) | NO |

**Sub-function Rating Summary**

| Function | Sub-function | Metrics | Rating |
|---|---|---|---|
| Hydrology | Surface Storage and Retention | Condition | **MEDIUM** |
| | Sub-surface Storage and Retention | Condition | **LOW** |
| Water Quality | Pathogen Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | **MEDIUM** |
| | | Opportunity Presence (Y/N) | **NO** |
| | Particulate Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| | Soluble Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | **MEDIUM** |
| | | Opportunity Presence (Y/N) | **NO** |
| | Physical Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | **MEDIUM** |
| | | Opportunity Presence (Y/N) | **NO** |
| | Pollution Change | Condition | NA |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| Habitat | Physical Structure | Condition | **MEDIUM** |
| | Landscape Patch Structure | Condition | **LOW** |
| | Vegetation Composition | Condition | **LOW** |

**Function Rating Summary**

| Function | Metrics | Rating |
|---|---|---|
| Hydrology | Condition | **LOW** |
| Water Quality | Condition | **MEDIUM** |
| | Condition/Opportunity | **MEDIUM** |
| | Opportunity Presence (Y/N) | **NO** |
| Habitat | Condition | **LOW** |

**Overall Wetland Rating** **LOW**

## NC WAM FIELD ASSESSMENT FORM
### Accompanies User Manual Version 5.0

USACE AID # NCDWR#

| | | | |
|---|---|---|---|
| Project Name | Banner Branch | Date of Evaluation | 10/2/2019 |
| Applicant/Owner Name | Water & Land Solutions | Wetland Site Name | W6B |
| Wetland Type | Headwater Forest | Assessor Name/Organization | Emily Dunnigan/WLS |
| Level III Ecoregion | Piedmont | Nearest Named Water Body | Banner Branch |
| River Basin | Roanoke | USGS 8-Digit Catalogue Unit | 03010103 |
| County | Stokes | NCDWR Region | Winston-Salem |
| ☐ Yes ☒ No | Precipitation within 48 hrs? | Latitude/Longitude (deci-degrees) | 36.528942, -80.209730 |

**Evidence of stressors affecting the assessment area (may not be within the assessment area)**

Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

**Is the assessment area intensively managed?** ☐ Yes ☒ No

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

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

**What type of natural stream is associated with the wetland, if any? (check all that apply)**

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

**Is the assessment area on a coastal island?** ☐ Yes ☒ No

**Is the assessment area's surface water storage capacity or duration substantially altered by beaver?** ☐ Yes ☒ No

**Does the assessment area experience overbank flooding during normal rainfall conditions?** ☐ Yes ☒ No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**

**Check a box in each column.** Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

| GS | VS | |
|---|---|---|
| ☒A | ☐A | Not severely altered |
| ☐B | ☒B | Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration) |

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

**Check a box in each column.** Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Water storage capacity and duration are not altered. |
| ☐B | ☐B | Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation). |
| ☐C | ☐C | Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines). |

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)**

**Check a box in each column**. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

| | AA | WT | |
|---|---|---|---|
| 3a. | ☐A | ☐A | Majority of wetland with depressions able to pond water > 1 deep |
| | ☐B | ☐B | Majority of wetland with depressions able to pond water 6 inches to 1 foot deep |
| | ☐C | ☐C | Majority of wetland with depressions able to pond water 3 to 6 inches deep |
| | ☒D | ☒D | Depressions able to pond water < 3 inches deep |

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☐B Evidence that maximum depth of inundation is between 1 and 2 feet
☒C Evidence that maximum depth of inundation is less than 1 foot

**4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)**

**Check a box from each of the three soil property groups below.** Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☐A Sandy soil
☐B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☒C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☒A Soil ribbon < 1 inch
☐B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

**5. Discharge into Wetland – opportunity metric**

**Check a box in each column.** Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Little or no evidence of pollutants or discharges entering the assessment area |
| ☐B | ☐B | Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area |
| ☐C | ☐C | Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor) |

**6. Land Use – opportunity metric (skip for non-riparian wetlands)**

**Check all that apply (at least one box in each column).** Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M).

| WS | 5M | 2M | |
|---|---|---|---|
| ☐A | ☐A | ☐A | > 10% impervious surfaces |
| ☐B | ☐B | ☐B | Confined animal operations (or other local, concentrated source of pollutants |
| ☒C | ☒C | ☒C | ≥ 20% coverage of pasture |
| ☐D | ☐D | ☐D | ≥ 20% coverage of agricultural land (regularly plowed land) |
| ☐E | ☐E | ☐E | ≥ 20% coverage of maintained grass/herb |
| ☐F | ☐F | ☐F | ≥ 20% coverage of clear-cut land |
| ☐G | ☐G | ☐G | Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed or hydrologic alterations that prevent drainage and/or overbank flow from affecting the assessment area. |

**7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)**

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☐A ≥ 50 feet
☐B From 30 to < 50 feet
☒C From 15 to < 30 feet
☐D From 5 to < 15 feet
☐E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☒Yes ☐No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

**8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)**

**Check a box in each column for riverine wetlands only**. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

| WT | WC | |
|---|---|---|
| ☐A | ☐A | ≥ 100 feet |
| ☐B | ☐B | From 80 to < 100 feet |
| ☐C | ☐C | From 50 to < 80 feet |
| ☐D | ☐D | From 40 to < 50 feet |
| ☐E | ☒E | From 30 to < 40 feet |
| ☐F | ☐F | From 15 to < 30 feet |
| ☐G | ☐G | From 5 to < 15 feet |
| ☐H | ☐H | < 5 feet |

**9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)**

Answer for assessment area dominant landform.

☐A Evidence of short-duration inundation (< 7 consecutive days)
☒B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

**10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)**

Consider recent deposition only (no plant growth since deposition).

☒A Sediment deposition is not excessive, but at approximately natural levels.
☐B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

**11. Wetland Size – wetland type/wetland complex condition metric**

**Check a box in each column.** Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

| WT | WC | FW (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | ☐D | From 25 to < 50 acres |
| ☐E | ☐E | ☐E | From 10 to < 25 acres |
| ☐F | ☐F | ☐F | From 5 to < 10 acres |
| ☒G | ☒G | ☐G | From 1 to < 5 acres |
| ☐H | ☐H | ☒H | From 0.5 to < 1 acre |
| ☐I | ☐I | ☐I | From 0.1 to < 0.5 acre |
| ☐J | ☐J | ☐J | From 0.01 to < 0.1 acre |
| ☐K | ☐K | ☐K | < 0.01 acre <u>or</u> assessment area is clear-cut |

**12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

**13. Connectivity to Other Natural Areas – landscape condition metric**

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

| Well | Loosely | |
|---|---|---|
| ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | From 50 to < 100 acres |
| ☒D | ☐D | From 10 to < 50 acres |
| ☐E | ☐E | < 10 acres |
| ☐F | ☐F | Wetland type has a poor or no connection to other natural habitats |

13b. **Evaluate for marshes only**.

☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

**14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)**

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☐A 0
☒B 1 to 4
☐C 5 to 8

**15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)**

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☒B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☐C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

**16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**

☐A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☐B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

**17. Vegetative Structure – assessment area/wetland type condition metric**

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☒A ≥ 25% coverage of vegetation

☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

| | AA | WT | |
|---|---|---|---|
| Canopy | ☐A | ☐A | Canopy closed, or nearly closed, with natural gaps associated with natural processes |
| | ☐B | ☐B | Canopy present, but opened more than natural gaps |
| | ☒C | ☒C | Canopy sparse or absent |
| Mid-Story | ☐A | ☐A | Dense mid-story/sapling layer |
| | ☐B | ☐B | Moderate density mid-story/sapling layer |
| | ☒C | ☒C | Mid-story/sapling layer sparse or absent |
| Shrub | ☐A | ☐A | Dense shrub layer |
| | ☒B | ☒B | Moderate density shrub layer |
| | ☐C | ☐C | Shrub layer sparse or absent |
| Herb | ☒A | ☒A | Dense herb layer |
| | ☐B | ☐B | Moderate density herb layer |
| | ☐C | ☐C | Herb layer sparse or absent |

**18. Snags – wetland type condition metric (skip for all marshes)**

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).

☒B Not A

**19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)**

☐A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.

☒B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.

☐C Majority of canopy trees are < 6 inches DBH or no trees.

**20. Large Woody Debris – wetland type condition metric (skip for all marshes)**

Include both natural debris and man-placed natural debris.

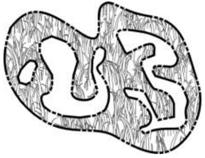
☐A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).

☒B Not A

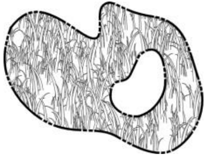
**21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)**

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

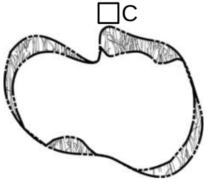
☐A



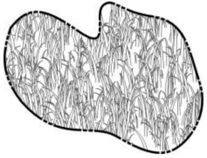
☐B



☐C



☐D



**22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)**

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☒A Overbank <u>and</u> overland flow are not severely altered in the assessment area.

☐B Overbank flow is severely altered in the assessment area.

☐C Overland flow is severely altered in the assessment area.

☐D Both overbank <u>and</u> overland flow are severely altered in the assessment area.

---

Notes

degraded due to cow access. Some areas lack tree cover

# NC WAM Wetland Rating Sheet
## Accompanies User Manual Version 5.0

Wetland Site Name: W6B
Date of Assessment: 10/2/2019
Wetland Type: Headwater Forest
Assessor Name/Organization: Emily Dunnigan/WLS

| | |
|---|---|
| Notes on Field Assessment Form (Y/N) | YES |
| Presence of regulatory considerations (Y/N) | NO |
| Wetland is intensively managed (Y/N) | NO |
| Assessment area is located within 50 feet of a natural tributary or other open water (Y/N) | YES |
| Assessment area is substantially altered by beaver (Y/N) | NO |
| Assessment area experiences overbank flooding during normal rainfall conditions (Y/N) | NO |
| Assessment area is on a coastal island (Y/N) | NO |

**Sub-function Rating Summary**

| Function | Sub-function | Metrics | Rating |
|---|---|---|---|
| Hydrology | Surface Storage and Retention | Condition | **MEDIUM** |
| | Sub-surface Storage and Retention | Condition | **HIGH** |
| Water Quality | Pathogen Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Particulate Change | Condition | **HIGH** |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| | Soluble Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Physical Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Pollution Change | Condition | NA |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| Habitat | Physical Structure | Condition | **LOW** |
| | Landscape Patch Structure | Condition | **MEDIUM** |
| | Vegetation Composition | Condition | **MEDIUM** |

**Function Rating Summary**

| Function | Metrics | Rating |
|---|---|---|
| Hydrology | Condition | **HIGH** |
| Water Quality | Condition | **HIGH** |
| | Condition/Opportunity | **HIGH** |
| | Opportunity Presence (Y/N) | **YES** |
| Habitat | Condition | **LOW** |

**Overall Wetland Rating** **HIGH**

# NC WAM FIELD ASSESSMENT FORM
## Accompanies User Manual Version 5.0

USACE AID # NCDWR#

| | | | |
|---|---|---|---|
| Project Name | Banner Branch | Date of Evaluation | 10/2/2019 |
| Applicant/Owner Name | Water & Land Solutions | Wetland Site Name | W7 |
| Wetland Type | Headwater Forest | Assessor Name/Organization | Emily Dunnigan/WLS |
| Level III Ecoregion | Piedmont | Nearest Named Water Body | Banner Branch |
| River Basin | Roanoke | USGS 8-Digit Catalogue Unit | 03010103 |
| County | Stokes | NCDWR Region | Winston-Salem |
| ☐ Yes ☒ No | Precipitation within 48 hrs? | Latitude/Longitude (deci-degrees) | 36.531412, -80.209907 |

**Evidence of stressors affecting the assessment area (may not be within the assessment area)**

Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

**Is the assessment area intensively managed?** ☐ Yes ☒ No

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

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

**What type of natural stream is associated with the wetland, if any? (check all that apply)**

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

**Is the assessment area on a coastal island?** ☐ Yes ☒ No

**Is the assessment area's surface water storage capacity or duration substantially altered by beaver?** ☐ Yes ☒ No

**Does the assessment area experience overbank flooding during normal rainfall conditions?** ☐ Yes ☒ No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**

**Check a box in each column.** Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

| GS | VS | |
|---|---|---|
| ☒A | ☒A | Not severely altered |
| ☐B | ☐B | Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration) |

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

**Check a box in each column.** Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Water storage capacity and duration are not altered. |
| ☐B | ☐B | Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation). |
| ☐C | ☐C | Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines). |

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)**

**Check a box in each column**. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

| | AA | WT | |
|---|---|---|---|
| 3a. | ☐A | ☐A | Majority of wetland with depressions able to pond water > 1 deep |
| | ☐B | ☐B | Majority of wetland with depressions able to pond water 6 inches to 1 foot deep |
| | ☒C | ☒C | Majority of wetland with depressions able to pond water 3 to 6 inches deep |
| | ☐D | ☐D | Depressions able to pond water < 3 inches deep |

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☐B Evidence that maximum depth of inundation is between 1 and 2 feet
☒C Evidence that maximum depth of inundation is less than 1 foot

**4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)**

**Check a box from each of the three soil property groups below.** Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☒A Sandy soil
☐B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☒A Soil ribbon < 1 inch
☐B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

**5. Discharge into Wetland – opportunity metric**

**Check a box in each column.** Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Little or no evidence of pollutants or discharges entering the assessment area |
| ☐B | ☐B | Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area |
| ☐C | ☐C | Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor) |

**6. Land Use – opportunity metric (skip for non-riparian wetlands)**

**Check all that apply (at least one box in each column).** Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M).

| WS | 5M | 2M | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 10% impervious surfaces |
| ☐B | ☐B | ☐B | Confined animal operations (or other local, concentrated source of pollutants |
| ☒C | ☒C | ☒C | ≥ 20% coverage of pasture |
| ☐D | ☐D | ☐D | ≥ 20% coverage of agricultural land (regularly plowed land) |
| ☐E | ☐E | ☐E | ≥ 20% coverage of maintained grass/herb |
| ☐F | ☐F | ☐F | ≥ 20% coverage of clear-cut land |
| ☐G | ☐G | ☐G | Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed or hydrologic alterations that prevent drainage and/or overbank flow from affecting the assessment area. |

**7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)**

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☐A ≥ 50 feet
☒B From 30 to < 50 feet
☐C From 15 to < 30 feet
☐D From 5 to < 15 feet
☐E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☒Yes ☐No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

**8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)**

**Check a box in each column for riverine wetlands only**. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

| WT | WC | |
|---|---|---|
| ☐A | ☐A | ≥ 100 feet |
| ☐B | ☐B | From 80 to < 100 feet |
| ☐C | ☐C | From 50 to < 80 feet |
| ☐D | ☐D | From 40 to < 50 feet |
| ☐E | ☒E | From 30 to < 40 feet |
| ☐F | ☐F | From 15 to < 30 feet |
| ☐G | ☐G | From 5 to < 15 feet |
| ☐H | ☐H | < 5 feet |

**9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)**

Answer for assessment area dominant landform.

☐A Evidence of short-duration inundation (< 7 consecutive days)
☒B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

**10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)**

Consider recent deposition only (no plant growth since deposition).

☒A Sediment deposition is not excessive, but at approximately natural levels.
☐B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

**11. Wetland Size – wetland type/wetland complex condition metric**

**Check a box in each column.** Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

| WT | WC | FW (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | ☐D | From 25 to < 50 acres |
| ☐E | ☐E | ☐E | From 10 to < 25 acres |
| ☐F | ☐F | ☐F | From 5 to < 10 acres |
| ☐G | ☐G | ☐G | From 1 to < 5 acres |
| ☐H | ☐H | ☐H | From 0.5 to < 1 acre |
| ☐I | ☐I | ☐I | From 0.1 to < 0.5 acre |
| ☒J | ☒J | ☒J | From 0.01 to < 0.1 acre |
| ☐K | ☐K | ☐K | < 0.01 acre <u>or</u> assessment area is clear-cut |

**12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

**13. Connectivity to Other Natural Areas – landscape condition metric**

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

| Well | Loosely | |
|---|---|---|
| ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | From 50 to < 100 acres |
| ☒D | ☐D | From 10 to < 50 acres |
| ☐E | ☐E | < 10 acres |
| ☐F | ☐F | Wetland type has a poor or no connection to other natural habitats |

13b. **Evaluate for marshes only**.
☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

**14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)**

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☒A 0
☐B 1 to 4
☐C 5 to 8

**15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)**

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☒B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☐C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

**16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**

☐A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☐B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

**17. Vegetative Structure – assessment area/wetland type condition metric**

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☒A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

| | AA | WT | |
|---|---|---|---|
| Canopy | ☒A | ☒A | Canopy closed, or nearly closed, with natural gaps associated with natural processes |
| | ☐B | ☐B | Canopy present, but opened more than natural gaps |
| | ☐C | ☐C | Canopy sparse or absent |
| Mid-Story | ☐A | ☐A | Dense mid-story/sapling layer |
| | ☐B | ☐B | Moderate density mid-story/sapling layer |
| | ☒C | ☒C | Mid-story/sapling layer sparse or absent |
| Shrub | ☐A | ☐A | Dense shrub layer |
| | ☐B | ☐B | Moderate density shrub layer |
| | ☒C | ☒C | Shrub layer sparse or absent |
| Herb | ☒A | ☒A | Dense herb layer |
| | ☐B | ☐B | Moderate density herb layer |
| | ☐C | ☐C | Herb layer sparse or absent |

**18. Snags – wetland type condition metric (skip for all marshes)**

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).
☒B Not A

**19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)**

☒A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.
☐C Majority of canopy trees are < 6 inches DBH or no trees.

**20. Large Woody Debris – wetland type condition metric (skip for all marshes)**

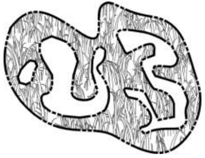
Include both natural debris and man-placed natural debris.

☐A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒B Not A

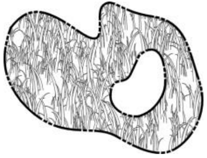
**21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)**

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

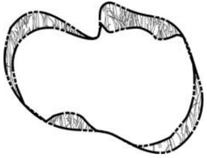
☐A



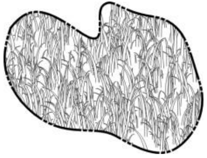
☐B



☐C



☐D



**22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)**

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☒A Overbank and overland flow are not severely altered in the assessment area.
☐B Overbank flow is severely altered in the assessment area.
☐C Overland flow is severely altered in the assessment area.
☐D Both overbank and overland flow are severely altered in the assessment area.

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Notes

Microstegium. Connected to stream. No cattle access

# NC WAM Wetland Rating Sheet
# Accompanies User Manual Version 5.0

Wetland Site Name W7
Date of Assessment 10/2/2019
Wetland Type Headwater Forest
Assessor Name/Organization Emily Dunnigan/WLS

| | |
|---|---|
| Notes on Field Assessment Form (Y/N) | YES |
| Presence of regulatory considerations (Y/N) | NO |
| Wetland is intensively managed (Y/N) | NO |
| Assessment area is located within 50 feet of a natural tributary or other open water (Y/N) | YES |
| Assessment area is substantially altered by beaver (Y/N) | NO |
| Assessment area experiences overbank flooding during normal rainfall conditions (Y/N) | NO |
| Assessment area is on a coastal island (Y/N) | NO |

**Sub-function Rating Summary**

| Function | Sub-function | Metrics | Rating |
|---|---|---|---|
| Hydrology | Surface Storage and Retention | Condition | **HIGH** |
| | Sub-surface Storage and Retention | Condition | **HIGH** |
| Water Quality | Pathogen Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Particulate Change | Condition | **HIGH** |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| | Soluble Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Physical Change | Condition | **HIGH** |
| | | Condition/Opportunity | **HIGH** |
| | | Opportunity Presence (Y/N) | **YES** |
| | Pollution Change | Condition | NA |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| Habitat | Physical Structure | Condition | **HIGH** |
| | Landscape Patch Structure | Condition | **MEDIUM** |
| | Vegetation Composition | Condition | **MEDIUM** |

**Function Rating Summary**

| Function | Metrics | Rating |
|---|---|---|
| Hydrology | Condition | **HIGH** |
| Water Quality | Condition | **HIGH** |
| | Condition/Opportunity | **HIGH** |
| | Opportunity Presence (Y/N) | **YES** |
| Habitat | Condition | **HIGH** |

**Overall Wetland Rating** **HIGH**

## NC WAM FIELD ASSESSMENT FORM
### Accompanies User Manual Version 5.0

USACE AID #

NCDWR#

| | | | |
|---|---|---|---|
| Project Name | Banner Branch | Date of Evaluation | 10/2/2019 |
| Applicant/Owner Name | Water & Land Solutions | Wetland Site Name | W8 |
| Wetland Type | Headwater Forest | Assessor Name/Organization | Emily Dunnigan/WLS |
| Level III Ecoregion | Piedmont | Nearest Named Water Body | Banner Branch |
| River Basin | Roanoke | USGS 8-Digit Catalogue Unit | 03010103 |
| County | Stokes | NCDWR Region | Winston-Salem |
| ☐ Yes ☒ No | Precipitation within 48 hrs? | Latitude/Longitude (deci-degrees) | 36.526936, -80.200528 |

**Evidence of stressors affecting the assessment area (may not be within the assessment area)**

Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

**Is the assessment area intensively managed?** ☐ Yes ☒ No

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

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

**What type of natural stream is associated with the wetland, if any? (check all that apply)**

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

**Is the assessment area on a coastal island?** ☐ Yes ☒ No

**Is the assessment area's surface water storage capacity or duration substantially altered by beaver?** ☐ Yes ☒ No

**Does the assessment area experience overbank flooding during normal rainfall conditions?** ☐ Yes ☒ No

1. **Ground Surface Condition/Vegetation Condition – assessment area condition metric**

**Check a box in each column.** Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

| GS | VS | |
|---|---|---|
| ☒A | ☒A | Not severely altered |
| ☐B | ☐B | Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration) |

2. **Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric**

**Check a box in each column.** Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Water storage capacity and duration are not altered. |
| ☐B | ☐B | Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation). |
| ☐C | ☐C | Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines). |

3. **Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)**

**Check a box in each column**. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

| | AA | WT | |
|---|---|---|---|
| 3a. | ☐A | ☐A | Majority of wetland with depressions able to pond water > 1 deep |
| | ☐B | ☐B | Majority of wetland with depressions able to pond water 6 inches to 1 foot deep |
| | ☐C | ☐C | Majority of wetland with depressions able to pond water 3 to 6 inches deep |
| | ☒D | ☒D | Depressions able to pond water < 3 inches deep |

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☐B Evidence that maximum depth of inundation is between 1 and 2 feet
☒C Evidence that maximum depth of inundation is less than 1 foot

### 4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)

**Check a box from each of the three soil property groups below.** Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☐A Sandy soil
☒B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☒A Soil ribbon < 1 inch
☐B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

### 5. Discharge into Wetland – opportunity metric

**Check a box in each column.** Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

| Surf | Sub | |
|---|---|---|
| ☒A | ☒A | Little or no evidence of pollutants or discharges entering the assessment area |
| ☐B | ☐B | Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area |
| ☐C | ☐C | Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor) |

### 6. Land Use – opportunity metric (skip for non-riparian wetlands)

**Check all that apply (at least one box in each column).** Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M).

| WS | 5M | 2M | |
|---|---|---|---|
| ☐A | ☐A | ☐A | > 10% impervious surfaces |
| ☐B | ☐B | ☐B | Confined animal operations (or other local, concentrated source of pollutants |
| ☒C | ☒C | ☒C | ≥ 20% coverage of pasture |
| ☐D | ☐D | ☐D | ≥ 20% coverage of agricultural land (regularly plowed land) |
| ☐E | ☐E | ☐E | ≥ 20% coverage of maintained grass/herb |
| ☐F | ☐F | ☐F | ≥ 20% coverage of clear-cut land |
| ☐G | ☐G | ☐G | Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed or hydrologic alterations that prevent drainage and/or overbank flow from affecting the assessment area. |

### 7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☐A ≥ 50 feet
☐B From 30 to < 50 feet
☐C From 15 to < 30 feet
☒D From 5 to < 15 feet
☐E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☐Yes ☒No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

### 8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)

**Check a box in each column for riverine wetlands only**. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

| WT | WC | |
|---|---|---|
| ☐A | ☐A | ≥ 100 feet |
| ☐B | ☐B | From 80 to < 100 feet |
| ☐C | ☐C | From 50 to < 80 feet |
| ☐D | ☐D | From 40 to < 50 feet |
| ☒E | ☒E | From 30 to < 40 feet |
| ☐F | ☐F | From 15 to < 30 feet |
| ☐G | ☐G | From 5 to < 15 feet |
| ☐H | ☐H | < 5 feet |

**9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)**

Answer for assessment area dominant landform.

☒A Evidence of short-duration inundation (< 7 consecutive days)
☐B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

**10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)**

Consider recent deposition only (no plant growth since deposition).

☒A Sediment deposition is not excessive, but at approximately natural levels.
☐B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

**11. Wetland Size – wetland type/wetland complex condition metric**

**Check a box in each column.** Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

| WT | WC | FW (if applicable) | |
|---|---|---|---|
| ☐A | ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | ☐B | From 100 to < 500 acres |
| ☐C | ☐C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | ☐D | From 25 to < 50 acres |
| ☐E | ☐E | ☐E | From 10 to < 25 acres |
| ☐F | ☐F | ☐F | From 5 to < 10 acres |
| ☐G | ☐G | ☐G | From 1 to < 5 acres |
| ☐H | ☐H | ☐H | From 0.5 to < 1 acre |
| ☒I | ☒I | ☒I | From 0.1 to < 0.5 acre |
| ☐J | ☐J | ☐J | From 0.01 to < 0.1 acre |
| ☐K | ☐K | ☐K | < 0.01 acre <u>or</u> assessment area is clear-cut |

**12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)**

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

**13. Connectivity to Other Natural Areas – landscape condition metric**

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

| Well | Loosely | |
|---|---|---|
| ☐A | ☐A | ≥ 500 acres |
| ☐B | ☐B | From 100 to < 500 acres |
| ☒C | ☐C | From 50 to < 100 acres |
| ☐D | ☐D | From 10 to < 50 acres |
| ☐E | ☐E | < 10 acres |
| ☐F | ☐F | Wetland type has a poor or no connection to other natural habitats |

13b. **Evaluate for marshes only**.
☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

**14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)**

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☒A 0
☐B 1 to 4
☐C 5 to 8

**15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)**

☒A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☐B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☐C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

**16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)**

☐A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☐B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

**17. Vegetative Structure – assessment area/wetland type condition metric**

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

| | AA | WT | |
|---|---|---|---|
| Canopy | ☒A | ☒A | Canopy closed, or nearly closed, with natural gaps associated with natural processes |
| | ☐B | ☐B | Canopy present, but opened more than natural gaps |
| | ☐C | ☐C | Canopy sparse or absent |
| Mid-Story | ☐A | ☐A | Dense mid-story/sapling layer |
| | ☒B | ☒B | Moderate density mid-story/sapling layer |
| | ☐C | ☐C | Mid-story/sapling layer sparse or absent |
| Shrub | ☐A | ☐A | Dense shrub layer |
| | ☒B | ☒B | Moderate density shrub layer |
| | ☐C | ☐C | Shrub layer sparse or absent |
| Herb | ☒A | ☒A | Dense herb layer |
| | ☐B | ☐B | Moderate density herb layer |
| | ☐C | ☐C | Herb layer sparse or absent |

**18. Snags – wetland type condition metric (skip for all marshes)**

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).
☒B Not A

**19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)**

☒A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.
☐C Majority of canopy trees are < 6 inches DBH or no trees.

**20. Large Woody Debris – wetland type condition metric (skip for all marshes)**

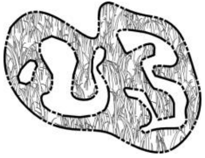
Include both natural debris and man-placed natural debris.

☒A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☐B Not A

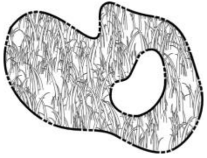
**21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)**

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

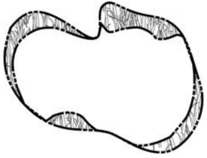
☐A



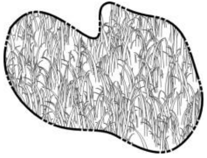
☐B



☐C



☐D



**22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)**

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☐A Overbank and overland flow are not severely altered in the assessment area.
☒B Overbank flow is severely altered in the assessment area.
☐C Overland flow is severely altered in the assessment area.
☐D Both overbank and overland flow are severely altered in the assessment area.

---

Notes

# NC WAM Wetland Rating Sheet
## Accompanies User Manual Version 5.0

Wetland Site Name: W8

Date of Assessment: 10/2/2019

Wetland Type: Headwater Forest

Assessor Name/Organization: Emily Dunnigan/WLS

| | |
|---|---|
| Notes on Field Assessment Form (Y/N) | NO |
| Presence of regulatory considerations (Y/N) | NO |
| Wetland is intensively managed (Y/N) | NO |
| Assessment area is located within 50 feet of a natural tributary or other open water (Y/N) | YES |
| Assessment area is substantially altered by beaver (Y/N) | NO |
| Assessment area experiences overbank flooding during normal rainfall conditions (Y/N) | NO |
| Assessment area is on a coastal island (Y/N) | NO |

**Sub-function Rating Summary**

| Function | Sub-function | Metrics | Rating |
|---|---|---|---|
| Hydrology | Surface Storage and Retention | Condition | **MEDIUM** |
| | Sub-surface Storage and Retention | Condition | **HIGH** |
| Water Quality | Pathogen Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | **MEDIUM** |
| | | Opportunity Presence (Y/N) | **NO** |
| | Particulate Change | Condition | **MEDIUM** |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| | Soluble Change | Condition | **LOW** |
| | | Condition/Opportunity | **LOW** |
| | | Opportunity Presence (Y/N) | **NO** |
| | Physical Change | Condition | **LOW** |
| | | Condition/Opportunity | **LOW** |
| | | Opportunity Presence (Y/N) | **NO** |
| | Pollution Change | Condition | NA |
| | | Condition/Opportunity | NA |
| | | Opportunity Presence (Y/N) | NA |
| Habitat | Physical Structure | Condition | **HIGH** |
| | Landscape Patch Structure | Condition | **MEDIUM** |
| | Vegetation Composition | Condition | **HIGH** |

**Function Rating Summary**

| Function | Metrics | Rating |
|---|---|---|
| Hydrology | Condition | **HIGH** |
| Water Quality | Condition | **LOW** |
| | Condition/Opportunity | **LOW** |
| | Opportunity Presence (Y/N) | **NO** |
| Habitat | Condition | **HIGH** |

**Overall Wetland Rating** **HIGH**

# Appendix 9 – WOTUS Information

# U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action Id. **SAW-2018-01760** County: **Stokes** U.S.G.S. Quad: **NC- Nettleridge**

## NOTIFICATION OF JURISDICTIONAL DETERMINATION

Requestor: **Jason and April Pendleton**
Address: **P.O. Box 1000**
**Lawsonville, NC 27022**
Telephone Number: **336-601-1480**
E-mail: **jpendleton.nc@outlook.com**

| | | | |
|---|---|---|---|
| Size (acres) | **38.2** | Nearest Town | **Lawsonville** |
| Nearest Waterway | **Banner Branch** | River Basin | **Roanoke** |
| USGS HUC | **03010103** | Coordinates | Latitude: **36.525421**<br>Longitude: **-80.203265** |

Location description: **The review area is located on the south side of NC Highway 704E; approximately 1.7-2.0 miles east of the intersection of NC Highway 704E and NC Highway 8. PINs: 6041-51-6912, 6041-54-2358, 6041-74-9397, 6041-63-2233, 6041-72-9563, 6041-42-1746. Reference review area description shown in Jurisdictional Determination Request package entitled "Figure 2, USGS Topographic Map".**

## Indicate Which of the Following Apply:

## A. Preliminary Determination

☒ There appear to be **waters, including wetlands** on the above described project area/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). The **waters, including wetlands** have been delineated, and the delineation has been verified by the Corps to be sufficiently accurate and reliable. The approximate boundaries of these waters are shown on the enclosed delineation map dated **undated**. 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 appear to be **waters, including wetlands** on the above described project area/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, including wetlands** on your project area/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 project area/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 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, including wetlands**on the above described project area/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, including wetlands** on your project area/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, including wetlands** on your project area/property have been delineated and the delineation has been verified by the Corps. The approximate boundaries of these waters are shown on the enclosed delineation map dated **DATE**. We strongly suggest you have this delineation surveyed. Upon completion, this survey should be reviewed and verified by the Corps. Once verified, this survey will provide an accurate depiction of all areas subject to CWA 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, including wetlands** have been delineated and surveyed and are accurately depicted on the plat signed by the Corps Regulatory Official identified below on**DATE**. 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/property 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 in **Morehead City, NC, at (252) 808-2808** to determine their requirements.

Placement of dredged or fill material within waters of the US, including 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 **Bryan Roden-Reynolds at 704-510-1440 or bryan.roden-reynolds@usace.army.mil**.

## C. Basis For Determination: Basis For Determination: See the preliminary jurisdictional determination form dated 2/13/2020.

## D. Remarks: None.

## 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: Phillip Shannin, 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 **Not applicable**.

**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: RODEN REYNOLDS.BRYAN.KENNETH.1263385574 Digitally signed by RODEN REYNOLDS.BRYAN.KENNETH.1263385574 Date: 2020.02.13 12:30:54 -05'00'

Date of JD: **2/13/2020** Expiration Date of JD: **Not applicable**

**SAW-2018-01760**
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 the Customer Satisfaction Survey located at http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0

Copy furnished:

Agent: **Water and Land Solutions**
**Kayne Van Stell**
Address: **7721 Six Forks Road, Suite 130**
**Raleigh, NC 27615**
Telephone Number: **919-818-8481**
E-mail: **kayne@waterlandsolutions.com**

Property Owner: **DTB Farms of Stokes County, LLC**
**Anthony Boles**
Address: **1133 Salty Lane**
**Lawsonville, NC 27022**
Telephone Number: **336-408-6907**
E-mail: **gowatkins.on.behalf.of.wls@gmail.com**

Property Owner: **Gene Young**
**Gregory Young**
Address: **2241 Moore Road**
**Lawsonville, NC 27022**
Telephone Number: **336-430-6805**
E-mail: **youngcw@bellsouth.net**

Property Owner: **Gilmer O’Neil Watkins**
Address: **0 Clark Road**
**Lawsonville, NC 27022**
Telephone Number: **336-817-6495**
E-mail: **gowatkins.on.behalf.of.wls@gmail.com**

# NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL

| | | |
|---|---|---|
| Applicant:, **Jason and April Pendleton** | File Number: **SAW-2018-01760** | Date: **02/24/2020** |

| | |
|---|---|
| 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 or http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx or the 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:<br>**District Engineer, Wilmington Regulatory Division**<br>**Attn: Bryan Roden-Reynolds**<br>**Charlotte Regulatory Office**<br>**U.S Army Corps of Engineers**<br>**8430 University Executive Park Drive, Suite 615**<br>**Charlotte, North Carolina 28262** | If you only have questions regarding the appeal process you may also contact:<br>Mr. Phillip Shannin, Administrative Appeal Review Officer<br>CESAD-PDO<br>U.S. Army Corps of Engineers, South Atlantic Division<br>60 Forsyth Street, Room 10M15<br>Atlanta, Georgia 30303-8801<br>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.

| | | |
|---|---|---|
| _______________________________________<br>Signature of appellant or agent. | Date: | Telephone number: |

*For appeals on Initial Proffered Permits send this form to:*

**District Engineer, Wilmington Regulatory Division**, **Attn: Bryan Roden-Reynolds, 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. Phillip Shannin, Administrative Appeal Officer, CESAD-PDO, 60 Forsyth Street, Room 10M15, Atlanta, Georgia 30303-8801**
**Phone: (404) 562-5137**

## PRELIMINARY JURISDICTIONAL DETERMINATION (PJD) FORM

## BACKGROUND INFORMATION

**A. REPORT COMPLETION DATE FOR PJD:** 02/24/2020

**B. NAME AND ADDRESS OF PERSON REQUESTING PJD:**, Jason and April Pendleton, P.O. Box 1000, Lawsonville, NC 27022

**C. DISTRICT OFFICE, FILE NAME, AND NUMBER:** Wilmington District, Banner Branch Mitigation Project, SAW-2018-01760

**D. PROJECT LOCATION(S) AND BACKGROUND INFORMATION:** The review area is located on the south side of NC Highway 704E; approximately 1.7-2.0 miles east of the intersection of NC Highway 704E and NC Highway 8. PINs: 6041-51-6912, 6041-54-2358, 6041-74-9397, 6041-63-2233, 6041-72-9563, 6041-42-1746. Reference review area description shown in Jurisdictional Determination Request package entitled "Figure 2, USGS Topographic Map".

**(USE THE TABLE BELOW TO DOCUMENT MULTIPLE AQUATIC RESOURCES AND/OR AQUATIC RESOURCES AT DIFFERENT SITES)**

State: NC County: Stokes City: Lawsonville
Center coordinates of site (lat/long in degree decimal format): Latitude: 36.525421 Longitude: -80.203265

Universal Transverse Mercator:

Name of nearest waterbody: Banner Branch

**E. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):**

☐ Office (Desk) Determination. Date:
☒ Field Determination. Date(s): **02/12/2020**

**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 resources in review area (acreage and linear feet, if applicable | Type of aquatic resources (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 ATTACHD TABLE** | | | | | |

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: **Figures 2-4**

☒ 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: **Figure 2, USGS Topographic Map (1:24,000 Nettleridge, NC)**

☒ Natural Resources Conservation Service Soil Survey. Citation: **Figure 3, NRCS Soil Map (Soil Survey of Stokes County)**

☐ 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): **Figure 4, Existing Hydrology**

or ☐ Other (Name & Date):_____________

☐ Previous determination(s). File no. and date of response letter:________________________

☒ Other information (please specify): **NCDWQ Stream Identification Forms (Version 4.11) Dated 03/08/2018 and 03/22/2018**

**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.**

RODEN
REYNOLDS.BRYAN.K
ENNETH.1263385574

Digitally signed by RODEN
REYNOLDS.BRYAN.KENNETH.126
3385574
Date: 2020.02.13 12:30:32 -05'00'

Signature and date of Regulatory staff member completing PJD
2/13/2020

Signature and date of person requesting PJD (REQUIRED, unless obtaining the signature is impracticable)[1]

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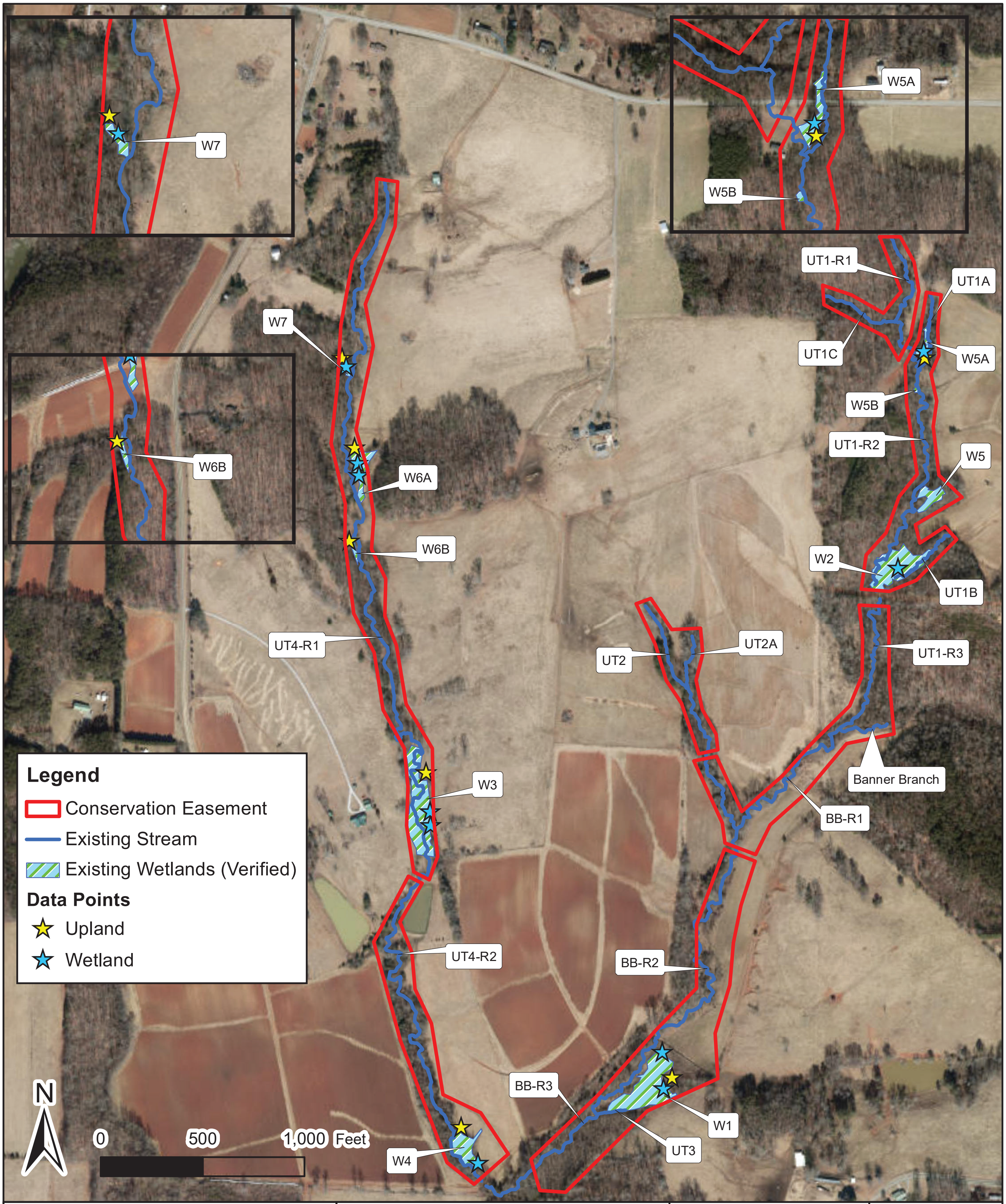
[1] Districts may establish timeframes for requester to return signed PJD forms. If the requester does not respond within the established time frame, the district may presume concurrence and no additional follow up is necessary prior to finalizing an action.

| Feature | Latitude (decimal degrees) | Longitude (decimal degrees) | Estimated amount of aquatic resources in review area (acreage and linear feet, if applicable | Type of aquatic resources (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) |
|---|---|---|---|---|---|
| Stream UT1-R1 | 36.53319700 | -80.20068300 | 612.5 linear feet | Non-wetland | 404 |
| Stream UT1-R2 | 36.53010600 | -80.20034200 | 1915.4 linear feet | Non-wetland | 404 |
| Stream UT1-R3 | 36.52760600 | -80.20105000 | 1081 linear feet | Non-wetland | 404 |
| Stream UT1A | 36.53184400 | -80.20022500 | 410.3 linear feet | Non-wetland | 404 |
| Stream UT1B | 36.52900300 | -80.20001400 | 391.3 linear feet | Non-wetland | 404 |
| Stream UT1C | 36.53230300 | -80.20140000 | 527.6 linear feet | Non-wetland | 404 |
| Stream UT2 | 36.52690600 | -80.20406100 | 1346.7 linear feet | Non-wetland | 404 |
| Stream UT2A | 36.52737500 | -80.20411400 | 289.2 linear feet | Non-wetland | 404 |
| Stream UT3 | 36.52178900 | -80.20294700 | 138.8 linear feet | Non-wetland | 404 |
| Stream BB-R1 | 36.52630000 | -80.20209200 | 696 linear feet | Non-wetland | 404 |
| Stream BB-R2 | 36.52378300 | -80.20397500 | 1759 linear feet | Non-wetland | 404 |
| Stream BB-R3 | 36.52053600 | -80.39008900 | 1137 linear feet | Non-wetland | 404 |
| Stream UT4-R1 | 36.53078100 | -80.20986700 | 5077.33 linear feet | Non-wetland | 404 |
| Stream UT4-R2 | 36.52152200 | -80.20833600 | 1889 linear feet | Non-wetland | 404 |
| Wetland W1 | 36.52225000 | -80.20449600 | 1.01 acres | Wetland | 404 |

| Feature | Latitude (decimal degrees) | Longitude (decimal degrees) | Estimated amount of aquatic resources in review area (acreage and linear feet, if applicable | Type of aquatic resources (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) |
|---|---|---|---|---|---|
| Wetland W2 | 36.52881700 | -80.20065800 | 0.8 acre | Wetland | 404 |
| Wetland W3 | 36.52545400 | -80.20030700 | 1.05 acres | Wetland | 404 |
| Wetland W4 | 36.52104200 | -80.20784000 | 0.32 acre | Wetland | 404 |
| Wetland W5 | 36.52916300 | -80.20045300 | 0.2 acre | Wetland | 404 |
| Wetland W5A | 36.53169600 | -80.20030700 | 0.12 acre | Wetland | 404 |
| Wetland W5B | 36.53121100 | -80.20039500 | 0.01 acre | Wetland | 404 |
| Wetland W6A | 36.52905300 | -80.20971100 | 0.29 acre | Wetland | 404 |
| Wetland W6B | 36.52901500 | -80.20976500 | 0.05 acre | Wetland | 404 |
| Wetland W7 | 36.53149200 | -80.20999400 | 0.04 acre | Wetland | 404 |



**WATER & LAND™ SOLUTIONS**

Banner Branch
Mitigation Project

Existing
Hydrography

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
4

## WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2018 03-09
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 14
Investigator(s): G Lankford Section, Township, Range: 
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.522250 Long: -80.204496 Datum: WGS 84
Soil Map Unit Name: Codorus loam, 0 to 2 percent slopes, occasionally flooded NWI classification: 
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☐
Hydric Soil Present? Yes ☑ No ☐
Wetland Hydrology Present? Yes ☑ No ☐

**Is the Sampled Area within a Wetland?** **Yes** ☑ **No** ☐

Remarks:

MLRA 136 Southern Piedmont
wetland point for W1

## 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 ☑ Depth (inches): 
Water Table Present? Yes ☑ No ☐ Depth (inches): -20
Saturation Present? (includes capillary fringe) Yes ☑ No ☐ Depth (inches): -20

**Wetland Hydrology Present? Yes** ☑ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 14

| Tree Stratum (Plot size: 30" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Salix nigra | 20 | Yes | OBL |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |

65 = Total Cover

50% of total cover: ______ 20% of total cover: ______

| Sapling Stratum (Plot size: 30" radius) | | | |
|---|---|---|---|
| 1. Alnus serrulata | 5 | Yes | OBL |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |

5 = Total Cover

50% of total cover: ______ 20% of total cover: ______

| Shrub Stratum (Plot size: ______) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |

______ = Total Cover

50% of total cover: ______ 20% of total cover: ______

| Herb Stratum (Plot size: 30" radius) | | | |
|---|---|---|---|
| 1. Solidago canadensis | 45 | Yes | FACU |
| 2. Leptochloa panicea | 35 | Yes | FACW |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |

80 = Total Cover

50% of total cover: 40 20% of total cover: 16

| Woody Vine Stratum (Plot size: ______) | | | |
|---|---|---|---|
| 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: 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

**SOIL**

Sampling Point: 14

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix | | Redox Features | | | | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| | Color (moist) | % | Color (moist) | % | Type[1] | Loc[2] | | |
| 0-2 | 7.5YR 3/2 | 98 | | | | | SL | |
| 2-8 | 7.5YR 4/4 | 85 | 7.5YR 3/4 | 10 | C | PL | CL | |
| 8-16 | 7.5YR 4/2 | 83 | 7.5YR 4/6 | 15 | C | PL | SL | |
| -- | -- | -- | 7.5YR 3/4 | 4 | C | M | -- | |
| 16-22 | N 2.5/1 | -- | 7.5YR 3/4 | 7 | C | PL | SCL | |
| 22-27 | N 2.5/1 | 100 | | | | | SL | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[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) **(LRR N, MLRA 147, 148)**
- ☐ 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 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 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ 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:

# WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-12
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 205
Investigator(s): G Lankford Section, Township, Range: ____
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.521760 Long: -80.204466 Datum: WGS 84
Soil Map Unit Name: Codorus loam, 0 to 2 percent slopes, occasionally flooded NWI classification: ____
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☐ | **Is the Sampled Area within a Wetland?** **Yes** ☑ **No** ☐ |
| Hydric Soil Present? | Yes ☑ | No ☐ | |
| Wetland Hydrology Present? | Yes ☑ | No ☐ | |

Remarks:

MLRA 136 Southern Piedmont
wetland point for W1

## 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 ☑ Depth (inches): ____
Water Table Present? Yes ☐ No ☑ Depth (inches): ____
Saturation Present? (includes capillary fringe) Yes ☐ No ☑ Depth (inches): ____

**Wetland Hydrology Present? Yes** ☑ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Area is within a moderate drought in late summer.

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 205

| Tree Stratum (Plot size: 30" radius ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 60 | Yes | FAC |
| 2. Liriodendron tulipifera | 5 | No | FACU |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 65 = Total Cover | | |

50% of total cover: 33 20% of total cover: 13

| Sapling Stratum (Plot size: ) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Shrub Stratum (Plot size: ) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Herb Stratum (Plot size: 30" radius ) | | | |
|---|---|---|---|
| 1. Impatiens capensis | 15 | Yes | FACW |
| 2. Woodwardia areolata | 15 | Yes | FACW |
| 3. Vernonia noveboracensis | 2 | No | FACW |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 32 = Total Cover | | |

50% of total cover: 16 20% of total cover: 6

| Woody Vine Stratum (Plot size: ) | | | |
|---|---|---|---|
| 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: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

**SOIL**

Sampling Point: 205

**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 Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-7 | 7.5YR 4/3 | 98 | 7.5YR 3/4 | 2 | | | CL | |
| 7-12 | 7.5YR 4/2 | 85 | 7.5YR 4/6 | 20 | C | PL | CL | |
| 12-18 | 7.5YR 5/1 | 83 | 7.5YR 5/6 | 15 | C | PL | SC | |
| -- | -- | -- | 2.5YR 5/1 | 2 | C | M | -- | |
| 18-25 | 7.5YR 5/1 | -- | 7.5YR 4/4 | 10 | C | PL | SC | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[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) **(LRR N, MLRA 147, 148)**
- ☐ 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 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 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: clay content (SC)

Depth (inches): 12 inches

**Hydric Soil Present?** Yes ☑ No ☐

Remarks:

# WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-12
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 214
Investigator(s): G Lankford Section, Township, Range:
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.521242 Long: -80.205335 Datum: WGS 84
Soil Map Unit Name: Codorus loam, 0 to 2 percent slopes, occasionally flooded NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☑
Hydric Soil Present? Yes ☐ No ☑
Wetland Hydrology Present? Yes ☐ No ☑

**Is the Sampled Area within a Wetland?** **Yes** ☐ **No** ☑

Remarks:

MLRA 136 Southern Piedmont
upland point for W4

## 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 ☑ Depth (inches):
Water Table Present? Yes ☑ No ☐ Depth (inches): -28
Saturation Present? (includes capillary fringe) Yes ☑ No ☐ Depth (inches): -28

**Wetland Hydrology Present? Yes** ☐ **No** ☑

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Area in a moderate drought in late summer.

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 214

| Tree Stratum (Plot size: 20" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Liriodendron tulipifera | 80 | Yes | FACU |
| 2. Acer rubrum | 5 | No | FAC |
| 3. Salix nigra | 2 | No | OBL |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 87 = Total Cover | | |

50% of total cover: 44 20% of total cover: 17

| Sapling Stratum (Plot size: ) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Shrub Stratum (Plot size: ) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Herb Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Microstegium vimineum | 40 | Yes | FAC |
| 2. Agrimonia parviflora | 2 | No | FACW |
| 3. Elymus virginicus | 2 | No | FACW |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 44 = Total Cover | | |

50% of total cover: 22 20% of total cover: 9

| Woody Vine Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Lonicera japonica | 2 | -- | FACU |
| 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 (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: | |
|---|---|---|---|
| OBL species | 2 | x 1 = | 2 |
| FACW species | 4 | x 2 = | 8 |
| FAC species | 45 | x 3 = | 135 |
| FACU species | 82 | x 4 = | 328 |
| UPL species | | x 5 = | |
| Column Totals: | 133 (A) | | 473 (B) |

Prevalence Index = B/A = 3.56

**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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** **Yes** ☐ **No** ☑

Remarks: (Include photo numbers here or on a separate sheet.)

## SOIL

Sampling Point: 214

**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 |
| 0-8 | 7.5YR 4/4 | 100 | | | | | SL | |
| 8-14 | 7.5YR 4/6 | 96 | 7.5YR 5/8 | 4 | C | PL | SL | |
| 14-22 | 7.5YR 4/2 | 85 | 7.5YR 4/6 | 15 | C | PL | SL | |
| 22-28 | 7.5YR 3/1 | 95 | 7.5YR 3/4 | 5 | C | M | SL | |
| 28-36 | 7.5YR 4/6 | 100 | | | | | cS | gravel ~ 10% |

[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) **(LRR N, MLRA 147, 148)**
- ☐ 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 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 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ 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:

## WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-30
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 248
Investigator(s): G Lankford Section, Township, Range:
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.528817 Long: -80.200658 Datum: WGS 84
Soil Map Unit Name: Fairview-Poplar Forest complex, 15 to 25% slopes, mod.eroded NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐, Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☑, or Hydrology ☐ 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 ☐ | **Is the Sampled Area within a Wetland?** | **Yes** ☑ **No** ☐ |
| Hydric Soil Present? | Yes ☑ | No ☐ | | |
| Wetland Hydrology Present? | Yes ☑ | No ☐ | | |

Remarks:

MLRA 136 Southern Piedmont
wetland data pt for W2

## 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 ☑ Depth (inches):
Water Table Present? Yes ☐ No ☑ Depth (inches):
Saturation Present? (includes capillary fringe) Yes ☐ No ☑ Depth (inches):

**Wetland Hydrology Present? Yes** ☑ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Area above obstructed crossing culvert and wetland is heavily impacted by livestock.

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 248

| Tree Stratum (Plot size: ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Sapling Stratum (Plot size: ) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Shrub Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Alnus serrulata | 25 | Yes | OBL |
| 2. Acer rubrum | 10 | Yes | FAC |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 35 = Total Cover | | |

50% of total cover: 18 20% of total cover: 7

| Herb Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Microstegium vimineum | 70 | Yes | FAC |
| 2. Impatiens capensis | 10 | No | FACW |
| 3. Panicum anceps | 5 | No | FAC |
| 4. Carex lurida | 5 | No | OBL |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 90 = Total Cover | | |

50% of total cover: 45 20% of total cover: 18

| Woody Vine Stratum (Plot size: ) | | | |
|---|---|---|---|
| 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: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

**SOIL**

Sampling Point: 248

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix |  | Redox Features |  |  |  | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
|  | Color (moist) | % | Color (moist) | % | Type[1] | Loc[2] |  |  |
| 0-6 | 7.5YR 4/2 | 100 | 7.5YR 4/6 | 20 | C | PL | SCL |  |
| 6-11 | 7.5YR 4/1 | 90 | 7.5YR 4/6 | 20 | C | PL | SCL |  |
| 11-20 | N 6/- | 90 | 7.5YR 4/6 | 35 | C | PL/M | SC |  |

[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) **(LRR N, MLRA 147, 148)**
- ☐ 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 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 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ 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:

# WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 10-10
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 255
Investigator(s): G Lankford Section, Township, Range:
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): ~2%
Subregion (LRR or MLRA): LRR P Lat: 36.529163 Long: -80.200453 Datum: WGS 84
Soil Map Unit Name: Fairview-Poplar Forest complex, 15 to 25% slopes, mod.eroded NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☐
Hydric Soil Present? Yes ☐ No ☑
Wetland Hydrology Present? Yes ☐ No ☑

**Is the Sampled Area within a Wetland?** **Yes** ☐ **No** ☑

Remarks:

MLRA 136 Southern Piedmont
upland data point for W5

## 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 ☑ Depth (inches): ____
Water Table Present? Yes ☑ No ☐ Depth (inches): ____
Saturation Present? (includes capillary fringe) Yes ☑ No ☐ Depth (inches): ____

**Wetland Hydrology Present? Yes** ☐ **No** ☑

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 255

| Tree Stratum (Plot size: 30" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 15 | Yes | FAC |
| 2. Liriodendron tulipifera | 10 | Yes | FACU |
| 3. Prunus serotina | 4 | No | FACU |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 29 = Total Cover | | |

50% of total cover: 15 20% of total cover: 6

| Sapling Stratum (Plot size: ) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Shrub Stratum (Plot size: 30" radius) | | | |
|---|---|---|---|
| 1. Ligustrum sinense | 2 | Yes | FACU |
| 2. Carpinus caroliniana | 2 | Yes | FAC |
| 3. Fraxinus pennsylvanica | 1 | Yes | FACW |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 5 = Total Cover | | |

50% of total cover: 3 20% of total cover: 1

| Herb Stratum (Plot size: 30" radius) | | | |
|---|---|---|---|
| 1. Microstegium vimineum | 30 | Yes | FAC |
| ~~2.~~ | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 30 = Total Cover | | |

50% of total cover: 20% of total cover:

| Woody Vine Stratum (Plot size: 30" radius) | | | |
|---|---|---|---|
| 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: 4 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

**SOIL**

Sampling Point: 255

**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 |
| 0-12 | 7.5YR 4/6 | 100 | | | | | CL | |
| 12-20 | 7.5YR 4/3 | 90 | 7.5YR 4/6 | 10 | C | PL | SL | angular quartz gravel ~5% |

[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) **(LRR N, MLRA 147, 148)**
- ☐ 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 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 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ 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:

## WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-18
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 218
Investigator(s): G Lankford Section, Township, Range:
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.525454 Long: -80.200307 Datum: WGS 84
Soil Map Unit Name: Fairview-Poplar Forest complex, 15 to 25% slopes, mod.eroded NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐, Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☑, or Hydrology ☐ 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 ☐ | **Is the Sampled Area within a Wetland?** **Yes** ☑ **No** ☐ |
| Hydric Soil Present? | Yes ☑ | No ☐ | |
| Wetland Hydrology Present? | Yes ☑ | No ☐ | |

Remarks:

MLRA 136 Southern Piedmont
wetland point for W3

## 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 ☑ Depth (inches):
Water Table Present? Yes ☑ No ☐ Depth (inches): -8
Saturation Present? (includes capillary fringe) Yes ☑ No ☐ Depth (inches): -8

**Wetland Hydrology Present? Yes** ☑ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Area above is heavily impacted by livestock.

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 218

| Tree Stratum (Plot size: ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Sapling Stratum (Plot size: ) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Shrub Stratum (Plot size: ) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Herb Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Murdannia keisak | 60 | Yes | OBL |
| 2. Vernonia noveboracensis | 10 | No | FACW |
| 3. Carex lurida | 10 | No | OBL |
| 4. Polygonum pensylvanicum | 5 | No | FACW |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 75 = Total Cover | | |

50% of total cover: 38 20% of total cover: 15

| Woody Vine Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 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: 5 (A)

Total Number of Dominant Species Across All Strata: 7 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 72 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** **Yes** ☑ **No** ☐

Remarks: (Include photo numbers here or on a separate sheet.)

In heavily disturbed pasture.

## SOIL

Sampling Point: 218

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix |  | Redox Features |  |  |  | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
|  | Color (moist) | % | Color (moist) | % | Type[1] | Loc[2] |  |  |
| 0-4 | 10YR 3/3 | 100 | 10YR 4/2 | 10 | D | PL | LS |  |
| 4-9 | 10YR 5/1 | 90 | 10YR 4/2 | 20 | C | PL | SC |  |
| 9-12 | N 5/- | 90 | 7.5YR 4/6 | 15 | C | PL | SC |  |
| 12-27 | N 5/- |  | 10YR 4/3 | 5 | C | PL | SL |  |
| 27-32 | 7.5YR 5/6 |  | 5YR 5/6 | 2 | C | PL | SL |  |

[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) **(LRR N, MLRA 147, 148)**
☐ 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 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 136, 122)**
☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
☐ Very Shallow Dark Surface (TF12)
☐ 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:

## WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-18
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 220
Investigator(s): G Lankford Section, Township, Range:
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.525454 Long: -80.208422 Datum: WGS 84
Soil Map Unit Name: Fairview-Poplar Forest complex, 15 to 25% slopes, mod.eroded NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☑, or Hydrology ☐ 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 ☐
Hydric Soil Present? Yes ☑ No ☐
Wetland Hydrology Present? Yes ☑ No ☐

**Is the Sampled Area within a Wetland?** **Yes** ☑ **No** ☐

Remarks:

MLRA 136 Southern Piedmont
wetland point for W3

## 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 ☑ Depth (inches):
Water Table Present? Yes ☑ No ☐ Depth (inches): -15
Saturation Present? (includes capillary fringe) Yes ☑ No ☐ Depth (inches): -15

**Wetland Hydrology Present? Yes** ☑ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Area above is heavily impacted by livestock.

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 220

| Tree Stratum (Plot size: 20" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 55 | Yes | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 55 = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

| Sapling Stratum (Plot size: ________) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

| Shrub Stratum (Plot size: ________) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

| Herb Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Microstegium vimineum | 55 | Yes | FAC |
| 2. Polygonum pensylvanicum | 75 | Yes | FACW |
| 3. Impatiens capensis | 2 | No | OBL |
| 4. Amaranthus spinosus | 2 | No | FACU |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 134 = Total Cover | | |

50% of total cover: 37 20% of total cover: 27

| Woody Vine Stratum (Plot size: ________) | | | |
|---|---|---|---|
| 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: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** **Yes** ☑ **No** ☐

Remarks: (Include photo numbers here or on a separate sheet.)

In heavily disturbed pasture.

## SOIL

Sampling Point: 220

**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 |
| 0-4 | 10YR 3/3 | 100 | | | | | L | |
| 4-11 | 10YR 4/2 | 10 | 10YR 3/4 | 20 | C | PL | SL | |
| 11-21 | 10YR 4/3 | 100 | | | | | SL | |
| 21-30 | 10YR 2/1 | 100 | | | | | SL | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[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) **(LRR N, MLRA 147, 148)**
☐ 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 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 136, 122)**
☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
☐ Very Shallow Dark Surface (TF12)
☐ 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:

# WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-18
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 219
Investigator(s): G Lankford Section, Township, Range:
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): linear-concvex Slope (%): ~4%
Subregion (LRR or MLRA): LRR P Lat: 36.525454 Long: -80.208422 Datum: WGS 84
Soil Map Unit Name: Fairview-Poplar Forest complex, 15 to 25% slopes, mod.eroded NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☑ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are “Normal Circumstances” present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☑
Hydric Soil Present? Yes ☐ No ☑
Wetland Hydrology Present? Yes ☐ No ☑

**Is the Sampled Area within a Wetland?** **Yes** ☐ **No** ☑

Remarks:

MLRA 136 Southern Piedmont
upland point for W3
on toe slope

## 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 ☑ Depth (inches):
Water Table Present? Yes ☐ No ☑ Depth (inches):
Saturation Present? (includes capillary fringe) Yes ☐ No ☑ Depth (inches):

**Wetland Hydrology Present?** **Yes** ☐ **No** ☑

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 219

| Tree Stratum (Plot size: 20" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 50 | Yes | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 50 = Total Cover | | |

50% of total cover: _____ 20% of total cover: _____

| Sapling Stratum (Plot size: _____) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | _____ = Total Cover | | |

50% of total cover: _____ 20% of total cover: _____

| Shrub Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Lindera benzoin | 4 | Yes | FAC |
| 2. Ligustrum japonicum | 2 | Yes | UPL |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 6 = Total Cover | | |

50% of total cover: 3 20% of total cover: 2

| Herb Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Digitaria sanguinalis | 60 | Yes | FACU |
| 2. Paspalum notatum | 5 | No | FACU |
| 3. Andropogon virginicus | 5 | No | FACU |
| 4. Eleusine indica | 5 | No | FACU |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 75 = Total Cover | | |

50% of total cover: 38 20% of total cover: 15

| Woody Vine Stratum (Plot size: _____) | | | |
|---|---|---|---|
| 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: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50 (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: |
|---|---|---|
| OBL species | | x 1 = |
| FACW species | | x 2 = |
| FAC species | 54 | x 3 = 162 |
| FACU species | 75 | x 4 = 300 |
| UPL species | 2 | x 5 = 10 |
| Column Totals: | 131 (A) | 472 (B) |

Prevalence Index = B/A = 3.60

**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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** **Yes** ☐ **No** ☑

Remarks: (Include photo numbers here or on a separate sheet.)

Area is heavily grazed.

**SOIL**

Sampling Point: 219

**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 Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-11 | 5YR 4/4 | 100 | | | | | SCL | |
| 11-19 | 5YR 4/6 | 100 | | | | | SCL | |
| 19-24 | 5YR 5/6 | 75 | 5YR 4/6 | 20 | C | PL | SC | |
| -- | -- | -- | 5YR 6/4 | 5 | C | PL | -- | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[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) **(LRR N, MLRA 147, 148)**
☐ 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 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 136, 122)**
☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
☐ Very Shallow Dark Surface (TF12)
☐ 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:

# WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: Sept 9 2019
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 209
Investigator(s): G Lankford Section, Township, Range: ______
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.521042 Long: -80.20784 Datum: WGS 84
Soil Map Unit Name: Codorus loam, 0 to 2 percent slopes, occasionally flooded NWI classification: ______
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☐
Hydric Soil Present? Yes ☑ No ☐
Wetland Hydrology Present? Yes ☑ No ☐

**Is the Sampled Area within a Wetland?** **Yes** ☑ **No** ☐

Remarks:

MLRA 136 Southern Piedmont
wetland point for W4

## 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 ☑ Depth (inches): ______
Water Table Present? Yes ☐ No ☑ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ☐ No ☑ Depth (inches): ______

**Wetland Hydrology Present?** **Yes** ☑ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

At the time of the investigation the area is within a moderate drought in late summer.

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 209

| Tree Stratum (Plot size: 30" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 5 | Yes | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 5 = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

| Sapling Stratum (Plot size: 30" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Alnus serrulata | 10 | Yes | OBL |
| 2. Ligustrum sinense | 10 | Yes | FACU |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 10 = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

| Shrub Stratum (Plot size: ________) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

| Herb Stratum (Plot size: 30" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Polygonum pensylvanicum | 70 | Yes | FACW |
| 2. Polygonum sagittatum | 10 | No | OBL |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 80 = Total Cover | | |

50% of total cover: 40 20% of total cover: 16

| Woody Vine Stratum (Plot size: 30" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Lonicera japonica | 3 | -- | FACU |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | 3 = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

## SOIL

Sampling Point: 209

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix |  | Redox Features |  |  |  | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
|  | Color (moist) | % | Color (moist) | % | Type[1] | Loc[2] |  |  |
| 0-12 | 7.5YR 4/2 | 90 | 7.5YR 3/4 | 10 | C | PL | SiL |  |
| 12-21 | 7.5YR 4/1 | 85 | 7.5YR 4/6 | 15 | C | PL | SCL |  |

[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) **(LRR N, MLRA 147, 148)**
☐ 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 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 136, 122)**
☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
☐ Very Shallow Dark Surface (TF12)
☐ 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:

# WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-12

Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 213

Investigator(s): G Lankford Section, Township, Range:

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%

Subregion (LRR or MLRA): LRR P Lat: 36.520728 Long: -80.207552 Datum: WGS 84

Soil Map Unit Name: Codorus loam, 0 to 2 percent slopes, occasionally flooded NWI classification:

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐

Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☐ |
| Hydric Soil Present? | Yes ☐ | No ☑ |
| Wetland Hydrology Present? | Yes ☐ | No ☑ |

**Is the Sampled Area within a Wetland?** **Yes** ☐ **No** ☑

Remarks:

MLRA 136 Southern Piedmont
upland point for W1

## 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 ☑ | Depth (inches): |
| Water Table Present? | Yes ☐ | No ☑ | Depth (inches): |
| Saturation Present? (includes capillary fringe) | Yes ☐ | No ☑ | Depth (inches): |

**Wetland Hydrology Present? Yes** ☐ **No** ☑

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

At the time of the investigation the area is within a moderate drought in late summer.

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 213

| Tree Stratum (Plot size: ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Sapling Stratum (Plot size: ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Shrub Stratum (Plot size: ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Herb Stratum (Plot size: 20" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Digitaria serotina | 50 | Yes | FAC |
| 2. Panicum anceps | 30 | Yes | FAC |
| 3. Polygonum pensylvanicum | 20 | Yes | FACW |
| 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: ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 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: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** **Yes** ☑ **No** ☐

Remarks: (Include photo numbers here or on a separate sheet.)

Point is within active pasture. Recently mowed for hay.

## SOIL

Sampling Point: 213

**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 |
| 0-7 | 7.5YR 3/4 | 100 | | | | | SL | |
| 7-18 | 7.5YR 4/6 | 100 | | | | | CL | |
| 18-26 | 7.5YR 5/6 | 85 | 5YR 4/6 | C | PL | PL | SCL | |

[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) **(LRR N, MLRA 147, 148)**
☐ 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 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 136, 122)**
☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
☐ Very Shallow Dark Surface (TF12)
☐ 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:

## WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 10-10
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 250
Investigator(s): G Lankford Section, Township, Range: 
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.531696 Long: -80.200307 Datum: WGS 84
Soil Map Unit Name: Clifford sandy clay loam, 8 to 15% slopes, mod. eroded NWI classification: 
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☑, or Hydrology ☐ 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 ☐ |
| Hydric Soil Present? | Yes ☑ | No ☐ |
| Wetland Hydrology Present? | Yes ☑ | No ☐ |

**Is the Sampled Area within a Wetland?** **Yes** ☑ **No** ☐

Remarks:

MLRA 136 Southern Piedmont
wetland data pt for W5

## 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 ☑ Depth (inches): 
Water Table Present? Yes ☑ No ☐ Depth (inches): -14
Saturation Present? (includes capillary fringe) Yes ☑ No ☐ Depth (inches): -14

**Wetland Hydrology Present? Yes** ☑ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Area above obstructed crossing culvert and wetland is heavily impacted by livestock.

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 250

| Tree Stratum (Plot size: 20" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 75 | Yes | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 75 = Total Cover | | |

50% of total cover: ______ 20% of total cover: ______

| Sapling Stratum (Plot size: ______) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | ______ = Total Cover | | |

50% of total cover: ______ 20% of total cover: ______

| Shrub Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Lindera benzoin | 5 | Yes | FAC |
| 2. Prunus serotina | 2 | Yes | FACU |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 7 = Total Cover | | |

50% of total cover: 4 20% of total cover: 2

| Herb Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Microstegium vimineum | 80 | Yes | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 80 = Total Cover | | |

50% of total cover: ______ 20% of total cover: ______

| Woody Vine Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Lonicera japonica | 3 | Yes | FACU |
| 2. Toxicodendron radicans | 2 | Yes | FAC |
| 3. Smilax rotundifolia | 2 | Yes | FAC |
| 4. | | | |
| 5. | | | |
| | 7 = Total Cover | | |

50% of total cover: 4 20% of total cover: 2

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 7 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 72 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

## SOIL

Sampling Point: 250

**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 Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-2 | 7.5YR 2.5/2 | 100 | | | | | L | |
| 2-14 | 7.5YR 3/1 | 90 | 5YR 3/4 | 20 | C | PL | SCL | micaeous |
| 14-36 | 7.5YR 3/1 | 90 | 7.5YR 2.5/2 | 5 | C | PL | SL | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[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) **(LRR N, MLRA 147, 148)**
☐ 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 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 136, 122)**
☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
☐ Very Shallow Dark Surface (TF12)
☐ 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:

## WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 10-10
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 251
Investigator(s): G Lankford Section, Township, Range:
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): linear-concvex Slope (%): ~2%
Subregion (LRR or MLRA): LRR P Lat: 36.531968 Long: -80.200459 Datum: WGS 84
Soil Map Unit Name: Fairview-Poplar Forest complex, 15 to 25% slopes, mod.eroded NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☑ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are “Normal Circumstances” present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☐ | **Is the Sampled Area within a Wetland?** | **Yes** ☐ **No** ☑ |
| Hydric Soil Present? | Yes ☐ No ☑ | | |
| Wetland Hydrology Present? | Yes ☐ No ☑ | | |

Remarks:

MLRA 136 Southern Piedmont
upland data point for W5
HS 04W

## 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 ☑ Depth (inches):
Water Table Present? Yes ☑ No ☐ Depth (inches): -33
Saturation Present? (includes capillary fringe) Yes ☑ No ☑ Depth (inches): -33

**Wetland Hydrology Present? Yes** ☐ **No** ☑

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

**VEGETATION (Five Strata) – Use scientific names of plants.** Sampling Point: 251

Tree Stratum (Plot size: 20" radius )

| | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 50 | Yes | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 50 = Total Cover | | |

50% of total cover: ______ 20% of total cover: ______

Sapling Stratum (Plot size: ______ )

| | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: ______ 20% of total cover: ______

Shrub Stratum (Plot size: 20" radius )

| | | | |
|---|---|---|---|
| 1. Lindera benzoin | 4 | Yes | FAC |
| 2. Ligustrum japonicum | 2 | Yes | UPL |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 6 = Total Cover | | |

50% of total cover: 3 20% of total cover: 2

Herb Stratum (Plot size: 20" radius )

| | | | |
|---|---|---|---|
| 1. Microstegium vimineum | 60 | Yes | FAC |
| 2. Carex lurida | 5 | No | OBL |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 65 = Total Cover | | |

50% of total cover: 33 20% of total cover: 13

Woody Vine Stratum (Plot size: ______ )

| | | | |
|---|---|---|---|
| 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: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

Prevalence index appear more representative of hydrophytic character of vegetation.

**SOIL** Sampling Point: 251

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix | | Redox Features | | | | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| | Color (moist) | % | Color (moist) | % | Type[1] | Loc[2] | | |
| 0-11 | 7.5YR 3/4 | 100 | | | | | SL | |
| 11-19 | 7.5YR 4/6 | 100 | | | | | S | |
| 19-35 | 7.5YR 3/1 | 100 | | | | | SL | |
| 35-40 | 7.5YR 3/1 | 100 | | | | | SCL | |

[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) **(LRR N, MLRA 147, 148)**
- ☐ 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 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 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ 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:

## WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-18
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 221
Investigator(s): G Lankford Section, Township, Range:
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-linear Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.529053 Long: -80.209711 Datum: WGS 84
Soil Map Unit Name: Fairview-Poplar Forest complex, 15 to 25% slopes, mod.eroded NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☐ | **Is the Sampled Area within a Wetland?** **Yes** ☑ **No** ☐ |
| Hydric Soil Present? | Yes ☑ No ☐ | |
| Wetland Hydrology Present? | Yes ☑ No ☐ | |

Remarks:

MLRA 136 Southern Piedmont
wetland point for W6
area is oxbow adjacent to channel

## 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 ☑ Depth (inches):
Water Table Present? Yes ☐ No ☑ Depth (inches):
Saturation Present? (includes capillary fringe) Yes ☐ No ☑ Depth (inches):

**Wetland Hydrology Present? Yes** ☑ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Area above is heavily impacted by livestock.

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 221

| Tree Stratum (Plot size: 20" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 15 | Yes | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 15 = Total Cover | | |

50% of total cover: ______ 20% of total cover: ______

| Sapling Stratum (Plot size: ______) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | ______ = Total Cover | | |

50% of total cover: ______ 20% of total cover: ______

| Shrub Stratum (Plot size: ______) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | ______ = Total Cover | | |

50% of total cover: ______ 20% of total cover: ______

| Herb Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Microstegium vimineum | 70 | Yes | FAC |
| 2. Polygonum pensylvanicum | 5 | No | FACW |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 75 = Total Cover | | |

50% of total cover: 38 20% of total cover: 15

| Woody Vine Stratum (Plot size: ______) | | | |
|---|---|---|---|
| 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: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** **Yes** ☑ **No** ☐

Remarks: (Include photo numbers here or on a separate sheet.)

In heavily disturbed pasture.

**SOIL**

Sampling Point: 221

**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 Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-3 | 10YR 3/2 | 80 | 10YR 3/4 | 20 | C | PL | SiL | churned by livestock |
| 3-11 | 10YR 3/1 | 85 | 10YR 4/6 | 15 | C | PL | L | |
| 11-22 | 10YR 2.5/1 | 100 | | | | | SL | pebbles/small gravel ~5% |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[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) **(LRR N, MLRA 147, 148)**
☐ 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 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 136, 122)**
☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
☐ Very Shallow Dark Surface (TF12)
☐ 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:

# WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-18
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 224
Investigator(s): G Lankford Section, Township, Range: 
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-linear Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.530144 Long: -80.209699 Datum: WGS 84
Soil Map Unit Name: Fairview-Poplar Forest complex, 15 to 25% slopes, mod.eroded NWI classification: 
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☐
Hydric Soil Present? Yes ☑ No ☐
Wetland Hydrology Present? Yes ☑ No ☐

**Is the Sampled Area within a Wetland?** **Yes** ☑ **No** ☐

Remarks:

MLRA 136 Southern Piedmont
wetland data pt for 224
area appears to have significant disturbance to soils

## 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 ☑ Depth (inches): 
Water Table Present? Yes ☑ No ☐ Depth (inches): -24
Saturation Present? (includes capillary fringe) Yes ☑ No ☐ Depth (inches): -12

**Wetland Hydrology Present? Yes** ☑ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Area above is heavily impacted by livestock.
water table rising

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 224

Tree Stratum (Plot size: 20" radius )

| | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 15 | Yes | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 15 = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

Sapling Stratum (Plot size: ________ )

| | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | ____ = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

Shrub Stratum (Plot size: 20" radius )

| | | | |
|---|---|---|---|
| 1. Alnus serrulata | 25 | Yes | OBL |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 25 = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

Herb Stratum (Plot size: 20" radius )

| | | | |
|---|---|---|---|
| 1. Microstegium vimineum | 30 | Yes | FAC |
| 2. Murdannia keisak | 25 | Yes | OBL |
| 3. Perilla frutescens | 15 | Yes | FACU |
| 4. Polygonum pensylvanicum | 5 | No | FACW |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 75 = Total Cover | | |

50% of total cover: 38 20% of total cover: 15

Woody Vine Stratum (Plot size: ________ )

| | | | |
|---|---|---|---|
| 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: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

In heavily disturbed pasture.

**SOIL**

Sampling Point: 224

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | % | Redox Features Color (moist) | % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-5 | 7.5YR 3/2 | 80 | 5YR 4/6 | 20 | C | PL | SL | |
| 5-12 | 7.5YR 2.5/1 | 85 | 5YR 4/6 | 10 | C | PL | SL | |
| 12-28 | 7.5YR 2.5/1 | 100 | 5YR 4/6 | 2 | C | PL | SL | |

[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) **(LRR N, MLRA 147, 148)**
- ☐ 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 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 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ 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:

## WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-18
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 222
Investigator(s): G Lankford Section, Township, Range:
Landform (hillslope, terrace, etc.): toe slope Local relief (concave, convex, none): linear-concvex Slope (%): ~1%
Subregion (LRR or MLRA): LRR P Lat: 36.529978 Long: -80.209679 Datum: WGS 84
Soil Map Unit Name: Fairview-Poplar Forest complex, 15 to 25% slopes, mod.eroded NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☑ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☑
Hydric Soil Present? Yes ☐ No ☑
Wetland Hydrology Present? Yes ☐ No ☑

**Is the Sampled Area within a Wetland?** **Yes** ☐ **No** ☑

Remarks:

MLRA 136 Southern Piedmont
upland data point for W6
area appears to have significant disturbance to soils

## 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 ☑ Depth (inches):
Water Table Present? Yes ☐ No ☑ Depth (inches):
Saturation Present? (includes capillary fringe) Yes ☑ No ☐ Depth (inches): -25

**Wetland Hydrology Present? Yes** ☐ **No** ☑

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

**VEGETATION (Five Strata) – Use scientific names of plants.**

Sampling Point: 222

| Tree Stratum (Plot size: ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: ______ 20% of total cover: ______

| Sapling Stratum (Plot size: ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: ______ 20% of total cover: ______

| Shrub Stratum (Plot size: ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: ______ 20% of total cover: ______

| Herb Stratum (Plot size: 20" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Perilla frutescens | 55 | Yes | FACU |
| 2. Microstegium vimineum | 5 | No | FAC |
| 3. Panicum anceps | 5 | No | FAC |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 65 = Total Cover | | |

50% of total cover: 33 20% of total cover: 13

| Woody Vine Stratum (Plot size: ) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 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: ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** Yes ☐ No ☑

Remarks: (Include photo numbers here or on a separate sheet.)

Area is heavily grazed.

**SOIL**

Sampling Point: 222

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix | | Redox Features | | | | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| | Color (moist) | % | Color (moist) | % | Type[1] | Loc[2] | | |
| 0-3 | 7.5YR 4/4 | 100 | | | | | SL | |
| 3-14 | 7.5YR 4/6 | 100 | | | | | SL | |
| 14-25 | 7.5YR 5/4 | 85 | 7.5YR 4/6 | 15 | C | PL | SL | small rounded gravel ~5% |
| 25-28 | 7.5YR 4/3 | 95 | 7.5YR 4/6 | 5 | C | PL | SL | |

[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) **(LRR N, MLRA 147, 148)**
☐ 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 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 136, 122)**
☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
☐ Very Shallow Dark Surface (TF12)
☐ 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:

# WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-18
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 225
Investigator(s): G Lankford Section, Township, Range:
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.531492 Long: -80.209994 Datum: WGS 84
Soil Map Unit Name: Fairview-Poplar Forest complex, 15 to 25% slopes, mod.eroded NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☐<br>Hydric Soil Present? Yes ☑ No ☐<br>Wetland Hydrology Present? Yes ☑ No ☐ | **Is the Sampled Area within a Wetland?** | **Yes** ☑ **No** ☐ |

Remarks:

MLRA 136 Southern Piedmont
wetland data pt for W7
area appears to have significant disturbance to soils

## 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 ☑ Depth (inches):
Water Table Present? Yes ☑ No ☐ Depth (inches): -13
Saturation Present? (includes capillary fringe) Yes ☑ No ☐ Depth (inches): -13

**Wetland Hydrology Present? Yes** ☑ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Area above is heavily impacted by livestock.
water table rising

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 225

| Tree Stratum (Plot size: 20" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 5 | Yes | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 5 = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

| Sapling Stratum (Plot size: ________) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | ____ = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

| Shrub Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Alnus serrulata | 5 | Yes | OBL |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 5 = Total Cover | | |

50% of total cover: ________ 20% of total cover: ________

| Herb Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Impatiens capensis | 30 | Yes | FACW |
| 2. Microstegium vimineum | 25 | Yes | FAC |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 55 = Total Cover | | |

50% of total cover: 28 20% of total cover: 11

| Woody Vine Stratum (Plot size: ________) | | | |
|---|---|---|---|
| 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: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** **Yes** ☑ **No** ☐

Remarks: (Include photo numbers here or on a separate sheet.)

Relatively undisturbed and forested.

**SOIL**

Sampling Point: 225

**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 Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-5 | 7.5YR 2.5/2 | 80 | 7.5YR 3/4 | 10 | C | PL | SL | |
| 5-15 | 7.5YR 3/1 | 100 | 5YR 4/6 | 10 | C | PL | cSL | gravel ~10 |
| | | | | | | | | AR @ -15 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[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) **(LRR N, MLRA 147, 148)**
- ☐ 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 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 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ 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: AR -auger refusal at -15 - rock (boulder or bedrock)

## WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 09-18
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 226
Investigator(s): G Lankford Section, Township, Range: 
Landform (hillslope, terrace, etc.): toe slope Local relief (concave, convex, none): linear-concave Slope (%): ~5%
Subregion (LRR or MLRA): LRR P Lat: 36.531516 Long: -80.209919 Datum: WGS 84
Soil Map Unit Name: Fairview-Poplar Forest complex, 15 to 25% slopes, mod.eroded NWI classification: 
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☑ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☐
Hydric Soil Present? Yes ☐ No ☑
Wetland Hydrology Present? Yes ☐ No ☑

**Is the Sampled Area within a Wetland?** **Yes** ☐ **No** ☑

Remarks:

MLRA 136 Southern Piedmont
upland data point for W7
area appears to have significant disturbance to soils

## 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 ☑ Depth (inches): 
Water Table Present? Yes ☐ No ☑ Depth (inches): 
Saturation Present? (includes capillary fringe) Yes ☐ No ☑ Depth (inches):

**Wetland Hydrology Present? Yes** ☐ **No** ☑

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 226

Tree Stratum (Plot size: 30" radius)

| | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 10 | Yes | FAC |
| 2. Liriodendron tulipifera | 5 | No | FACU |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 15 = Total Cover | | |

50% of total cover: 8 20% of total cover: 3

Sapling Stratum (Plot size: 30" radius)

| | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Cornus florida | 35 | Yes | FACU |
| 2. Diospyros virginiana | 10 | Yes | FAC |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 45 = Total Cover | | |

50% of total cover: 23 20% of total cover: 9

Shrub Stratum (Plot size: )

| | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

Herb Stratum (Plot size: 30" radius)

| | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Microstegium vimineum | 80 | Yes | FAC |
| 2. Rubus argutus | 5 | No | FACU |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | 85 = Total Cover | | |

50% of total cover: 43 20% of total cover: 17

Woody Vine Stratum (Plot size: )

| | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 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: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** Yes ☑ No ☐

Remarks: (Include photo numbers here or on a separate sheet.)

**SOIL** Sampling Point: 226

**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 | 7.5YR 2.5/2 | 100 | | | | | SL | |
| 1-12 | 5YR 4/6 | 100 | | | | | SL | |
| 12-21 | 5YR 5/6 | 85 | 5YR 4/4 | 10 | C | PL | SL | rounded gravel ~5% |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[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) **(LRR N, MLRA 147, 148)**
- ☐ 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 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 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ 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:

# WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2019 10-10
Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 272
Investigator(s): G Lankford Section, Township, Range:
Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%
Subregion (LRR or MLRA): LRR P Lat: 36.526989 Long: -80.200530 Datum: WGS 84
Soil Map Unit Name: Dan River and Comus soils, 0 to 4 percent slopes, occa. flooded NWI classification:
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are “Normal Circumstances” present? Yes ☑ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☐ | **Is the Sampled Area within a Wetland?** **Yes** ☑ **No** ☐ |
| Hydric Soil Present? | Yes ☑ | No ☐ | |
| Wetland Hydrology Present? | Yes ☑ | No ☐ | |

Remarks:

MLRA 136 Southern Piedmont
wetland point for W8

## 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 ☑ | Depth (inches): |
| Water Table Present? | Yes ☐ | No ☑ | Depth (inches): |
| Saturation Present?<br>(includes capillary fringe) | Yes ☐ | No ☑ | Depth (inches): |

**Wetland Hydrology Present?** **Yes** ☑ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 272

| Tree Stratum (Plot size: 20" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 50 | Yes | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 50 = Total Cover | | |

50% of total cover: ____ 20% of total cover: ____

| Sapling Stratum (Plot size: ____) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: ____ 20% of total cover: ____

| Shrub Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Ilex opaca | 15 | Yes | FACU |
| 2. Rhododendron periclymenoides | 5 | Yes | FAC |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 20 = Total Cover | | |

50% of total cover: 10 20% of total cover: 4

| Herb Stratum (Plot size: 20" radius) | | | |
|---|---|---|---|
| 1. Microstegium vimineum | 35 | Yes | FAC |
| 2. Woodwardia virginica | 5 | No | OBL |
| 3. Polygonum sagittatum | 5 | No | OBL |
| 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: 30" radius) | | | |
|---|---|---|---|
| 1. Lonicera japonica | 3 | -- | FACU |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | 3 = Total Cover | | |

50% of total cover: ____ 20% of total cover: ____

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** **Yes** ☑ **No** ☐

Remarks: (Include photo numbers here or on a separate sheet.)

## SOIL

Sampling Point: 272

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix | | Redox Features | | | | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| | Color (moist) | % | Color (moist) | % | Type[1] | Loc[2] | | |
| 0-3 | 7.5YR 3/2 | 100 | | | | | L | |
| 3-6 | 7.5YR 4/2 | 90 | 7.5YR 3/4 | 10 | C | PL | L | |
| 6-12 | 7.5YR 5/2 | 90 | 5YR 4/6 | 10 | C | PL | CL | |
| 12-19 | 7.5YR 4/3 | 70 | 7.5YR 4/6 | 30 | C | PL | SCL | |
| 19-23 | 7.5YR 4/1 | 80 | 7.5YR 4/6 | 20 | C | PL | SCL | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[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) **(LRR N, MLRA 147, 148)**
- ☐ 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 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 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ 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:

## WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Banner Branch Mitigation Site City/County: Stokes Sampling Date: 2018 03-09

Applicant/Owner: Water & Land Solutions State: NC Sampling Point: 41

Investigator(s): G Lankford Section, Township, Range:

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave-concave Slope (%): <1%

Subregion (LRR or MLRA): LRR P Lat: 36.527119 Long: -80.200942 Datum: WGS 84

Soil Map Unit Name: Dan River and Comus soils, 0 to 4 percent slopes, occ. flooded NWI classification:

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐ Soil ☐, or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐

Are Vegetation ☐, Soil ☐, or Hydrology ☐ 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 ☑ |
| Hydric Soil Present? | Yes ☐ | No ☑ |
| Wetland Hydrology Present? | Yes ☐ | No ☑ |

**Is the Sampled Area within a Wetland?** **Yes** ☐ **No** ☑

Remarks:

MLRA 136 Southern Piedmont
upland data point for W8

## 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 ☑ | Depth (inches): |
| Water Table Present? | Yes ☑ | No ☐ | Depth (inches): -17 |
| Saturation Present? (includes capillary fringe) | Yes ☑ | No ☐ | Depth (inches): -17 |

**Wetland Hydrology Present? Yes** ☐ **No** ☑

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

## VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: 41

| Tree Stratum (Plot size: 30" radius) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Acer rubrum | 45 | Yes | FAC |
| 2. Liriodendron tulipifera | 35 | Yes | FACU |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | 80 = Total Cover | | |

50% of total cover: 40 20% of total cover: 16

| Sapling Stratum (Plot size: 30" radius) | | | |
|---|---|---|---|
| 1. Prunus serotina | 2 | -- | FACU |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Shrub Stratum (Plot size: ) | | | |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Herb Stratum (Plot size: ) | | | |
|---|---|---|---|
| 1. | | | |
| ~~2.~~ | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| | = Total Cover | | |

50% of total cover: 20% of total cover:

| Woody Vine Stratum (Plot size: 30" radius) | | | |
|---|---|---|---|
| 1. Lonicera japonica | 2 | -- | FACU |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| | 2 = Total Cover | | |

50% of total cover: 20% of total cover:

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50 (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 Five Vegetation Strata:**

**Tree** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

**Sapling** – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

**Shrub** – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

**Herb** – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

**Woody vine** – All woody vines, regardless of height.

**Hydrophytic Vegetation Present?** **Yes** ☐ **No** ☑

Remarks: (Include photo numbers here or on a separate sheet.)

**SOIL** Sampling Point: 41

**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 |
| 0-5 | 7.5YR 3/4 | 100 |  |  |  |  | SL |  |
| 5-10 | 7.5YR 4/4 | 85 | 7.5YR 4/6 | 15 | C | PL | SL |  |
| 10-17 | 7.5YR 2.5/- |  | 5YR 4/6 | 15 | C | PL | SCL |  |
| 17-22 | 7.5YR 5/2 |  | 7.5YR 4/6 | 20 | C | PL | SCL |  |

[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) **(LRR N, MLRA 147, 148)**
☐ 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 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 136, 122)**
☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
☐ Red Parent Material (F21) **(MLRA 127, 147)**

**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)**
☐ Very Shallow Dark Surface (TF12)
☐ 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:

# 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

WATER & LAND SOLUTIONS
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**October 10, 2018**

**NC Department of Environmental Quality**
**Division of Mitigation Services**
**Attn: Jeff Schaffer, Eastern Supervisor, Project Management**
**217 West Jones Street, Suite 3000-A**
**Raleigh, NC 27603**

**RE: Categorical Exclusion for Banner Branch Mitigation Project, NCDEQ DMS Full-Delivery Project ID #100080, Contract #7610, Roanoke River Basin, Cataloging Unit 03010103, Stokes County, NC**

Dear Mr. Schaffer:

The project is located in Stokes County near the Lawsonville Community. In addition, the project is located in the North Carolina Department of Environmental Quality (NCDEQ) Sub-basin 03-02-01, in the Targeted Local Watershed 03010103180010, all of the Roanoke River Basin. The project reaches are along Banner Branch and unnamed tributaries to Banner Branch. Banner Branch flows south to its confluence with Snow Creek near Lawsonville, North Carolina. Banner Branch is listed by the NCDEQ NCDWR as 'C' from its source to Snow Creek.

The Banner Branch Mitigation Project is a full-delivery project for the NCDEQ Division of Mitigation Services (DMS) identified and contracted to provide stream and wetland mitigation credits for permitted, unavoidable impacts in the Roanoke River Basin, Cataloging Unit 03010103. The project will involve the potential restoration, enhancement, preservation, and permanent protection of unnamed tributaries (Reaches UT1-R1, UT1-R2, UT1-R3, UT1A, UT1B, UT1C, UT1D, UT2, UT2A, UT3, BB-R1, BB-R2, BB-R3, UT4-R1 and UT4-R2), totaling over 14,000 linear feet of existing streams. In addition, approximately 4.0 acres of degraded riparian wetlands will be returned to their natural function, utilizing wetland re-establishment, rehabilitation and enhancement approaches by implementing Priority Level I Stream Restoration, livestock exclusion, and limited removal of overburden soil above the hydric soils, and re-vegetation. 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, approximately 37.5 acres in size, 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 a riparian corridor between active agricultural fields and then into Banner Branch, which eventually drains to the Roanoke River. The proposed restoration project not only has the potential to provide at least 12,000 stream mitigation credits and 3.0 wetland 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.

Based on the review of the United States Fish and Wildlife Service (USFWS) county list (06-27-2018), the following species are considered federally-listed in Stokes County:

| Species Type | Scientific Name | Common Name | Federal Status Code |
|---|---|---|---|
| Invertebrate | *Parvaspina collina* | James spinymussel | E |
| Vascular Plant | *Cardamine micranthera* | Small-anthered bittercress | E |
| Vascular Plant | *Helianthus schweinitzii* | Schweinitz's sunflower | E |
| Vertebrate | *Myotis septentrionalis* | Northern Long-eared bat | T |

**Definitions of Federal Status Codes:**

**E** = **endangered.** A taxon "in danger of extinction throughout all or a significant portion of its range."
**T = threatened.** A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

(Federal status information referenced from https://ecos.fws.gov/ipac/)

## Invertebrates

### James spinymussel *(Parvaspina collina)*

Federal Status: Endangered

Habitat: This freshwater mussel is found in the James River drainage and the Dan/Mayo River systems within the Roanoke River drainage in Virginia, North Carolina, and West Virginia. The James spinymussel is a small freshwater mussel slightly less than three inches in length. Adults have a dark brown shell with prominent growth rings and occasionally, short spines on each valve. Young mussels have a shiny yellow shell with or without one to three short spines.

Range: The species historical range included Virginia, West Virginia.

(Species profile information referenced from: https://ecos.fws.gov/ecp/species/2212)

**Biological Conclusion: No Effect**

Streams were assessed for the presence of freshwater mussels and none nor their associates (e.g. Asian clams) were observed during the stream investigations. Due to the small size and landscape position of the headwater stream systems that comprise the project, suitable habitat was not observed within the project area. A review of the July 2018 NCNHP database indicates no known occurrence within 1.0 mile of the project area.

## Vascular Plants

### Schweinitz's sunflower *(Helianthus schweinitzii)*

Family: *Asteraceae*

Federal Status: Endangered

Best Search Time: late August through October

Description: Schweinitz's sunflower is a perennial that regularly grows approximately 6½ feet tall (though it can be shorter if young or injured) and can occasionally reach heights of 16 feet. It has thickened roots that are specially designed to store starch. The stem is purple, and the upper third bears secondary branches at 45-degree angles. The leaves are arranged in pairs on the lower part of the stem but usually occur singly on the upper part. Leaves grow out from the stem at a right angle, and the tips of the leaves tend to droop. The leaves are thick and stiff, with a rough upper surface. They have broad spiny hairs that are directed toward the tip, and soft white hairs cover the underside. The plant produces small yellow flowers. Schweinitz's sunflower blooms from late August until frost. It's able to colonize through the dispersal of seeds that readily germinate without a dormant period. In good conditions, it can grow 3 to 6 feet in a year and can live for decades.

Habitat: It occurs in full to partial sun and is found in areas with poor soils, such as thin clays that vary from wet to dry. This preference for poor soil helps minimize competition from other species.

Range: Piedmont region of North and South Carolina.

Threats: Habitat destruction, fire suppression, alteration of native habitat, roadside and utility right-of-way maintenance, industrial development, mining, encroachment by exotic species, and highway construction and improvement have all contributed to the decline of Schweinitz's sunflower. This species occurs in many rapidly developing areas within the piedmont region of North and South Carolina. As these areas develop, Schweinitz's sunflower loses habitat.

**Biological Conclusion: No Effect**

WLS biologists conducted numerous field reviews of the project site during the Winter, Spring and Summer of 2018 and no occurrence or evidence of Schweinitz's sunflower was observed in the project area. Marginal habitat for Schweinitz's sunflower exists within the project area. Based on a review of the NCDEQ Natural Heritage Program's available Natural Heritage Element Occurrences (NHEO) GIS shapefile (https://ncnhde.natureserve.org/content/data-download), updated in July 2018, there are no occurrences within the project area. The implementation of the proposed project is not anticipated to have an adverse effect on the Schweinitz's sunflower.

(Species profile information referenced from:
https://www.fws.gov/asheville/htmls/listed_species/Schweinitzs_sunflower.html)

**Small-anthered bittercress *(Cardamine micranthera)***

Family: *Brassicaceae*

Federal Status: Endangered

Best Search Time: April through May

Description: Small-anthered bittercress is an erect, slender perennial herb with fibrous roots and one (or rarely more) simple or branched stem growing 7.9 – 15.8 inches (in) 2 - 4 decimeters tall. Basal leaves are 0.4 – 2 in (1 – 5 centimeters; cm) long, and 0.2 – 0.8 in (0.5 - 2 cm) wide. The stem leaves are alternate and mostly unlobed, 0.4 – 0.6 in (1 - 1.5 cm) long. Flowering and fruiting occur in April and May. The flowers, surrounded by leafy bracts, have four white petals, six stamens, and small, round anthers.

Habitat: Small-anthered bittercress is found in seepages, wet rock crevices, stream banks, sandbars, and wet woods along small streams, in fully to partially-shaded areas.

Range: Small-anthered bittercress is known only from the Dan River basin in north-central North Carolina (Stokes County) and south-central Virginia (Patrick County).

Threats: With a very limited range, and found in close association with water, the plant is threatened by stream impoundments, channelization, water contamination, as well increased stormwater runoff which can abnormally increase the volume and velocity of stream flows, eroding stream banks and beds. Encroachment of invasive exotic plant species, like Japanese honeysuckle, is also a threat. Many remaining sites are adjacent to agricultural fields and pastures. Accidental herbicide drift or run off could be detrimental, as could trampling and erosion on sites where livestock are allowed free access.

**Biological Conclusion: No Effect**

WLS biologists conducted numerous field reviews of the project site during the Winter, Spring and Summer of 2018 and no occurrence or evidence of Small-anthered bittercress was observed in the project area. Marginal habitat for Small-anthered bittercress exists within the project area. Based on a review of the NCDEQ Natural Heritage Program's available Natural Heritage Element Occurrences (NHEO) GIS shapefile (https://ncnhde.natureserve.org/content/data-download), updated in July 2018, there are no occurrences within the project area. The implementation of the proposed project is not anticipated to have an adverse effect on the Small-anthered bittercress.

(Species profile information referenced from: https://www.fws.gov/raleigh/species/es_small-anthered_bittercress.html)

**Vertebrates**

**Northern Long-eared Bat (*Myotis septentrionalis*)**

Family: *Vespertilionidae*

Federal Status: Threatened

Description: The northern long-eared bat is a medium-sized bat about 3.0 to 3.7 inches in length but with a wingspan of 9 to 10 inches. As its name suggests, this bat is distinguished by its long ears, particularly as compared to other bats in its genus, Myotis, which are actually bats noted for their small ears (Myotis means mouse-eared).

Northern long-eared bats emerge at dusk to fly through the understory of forested hillsides and ridges feeding on moths, flies, leafhoppers, caddisflies, and beetles, which they catch while in flight using echolocation. This bat also feeds by gleaning motionless insects from vegetation and water surfaces.

Breeding begins in late summer or early fall when males begin swarming near hibernacula. After copulation, females store sperm during hibernation until spring, when they emerge from their hibernacula, ovulate, and the stored sperm fertilizes an egg. This strategy is called delayed fertilization. After fertilization, pregnant females migrate to summer areas where they roost in small colonies and give birth to a single pup. Maternity colonies, with young, generally have 30 to 60 bats, although larger maternity colonies have been observed. Most females within a maternity colony give birth around the same time, which may occur from late May or early June to late July, depending where the colony is located within the species range. Young bats start flying by 18 to 21 days after birth. Adult northern long-eared bats can live up to 19 years.

Habitat: During summer, northern long-eared bats roost singly or in colonies underneath bark, in cavities, or in crevices of both live and dead trees. Males and non-reproductive females may also roost in cooler places, like caves and mines. This bat seems opportunistic in selecting roosts, using tree species based on suitability to retain bark or provide cavities or crevices. It has also been found, rarely, roosting in structures like barns and sheds. Northern long-eared bats spend winter hibernating in caves and mines, called hibernacula. They typically use large caves or mines with large passages and entrances; constant temperatures; and high humidity with no air currents. Specific areas where they hibernate have very high humidity, so much so that droplets of water are often seen on their fur. Within hibernacula, surveyors find them in small crevices or cracks, often with only the nose and ears visible.

Range: The species historical range included Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, Wyoming. See below for information about where the species is known or believed to occur.

Threats: White-nose syndrome, a fungal disease known to affect bats, is currently the predominant threat to this bat, especially throughout the Northeast where the species has declined by up to 99 percent from pre-white-nose syndrome levels at many hibernation sites. Although the disease has not yet spread throughout the northern long-eared bats entire range (white-nose syndrome is currently found in at least 25 of 37 states where the northern long-eared bat occurs), it continues to spread. Experts expect that where it spreads, it will have the same impact as seen in the Northeast.

**Biological Conclusion: May Affect**

WLS biologists conducted numerous field reviews of the project site during the Winter, Spring and Summer of 2018 and no occurrence or evidence of Northern Long-eared Bats was observed in the project area. Based on a review of the NCDEQ Natural Heritage Program's available Natural Heritage Element Occurrences (NHEO) GIS shapefile (https://ncnhde.natureserve.org/content/data-download), updated in July 2018, and the USFWS Asheville Field Office website (updated September 4, 2018), the project area is located entirely outside of the red highlighted areas (12 digit HUC) that the USFWS has determined the be representative of any area that may require consultation. The implementation of the proposed project is not anticipated to have an adverse effect on the Northern Long-eared Bat.

(Species profile information referenced from: https://ecos.fws.gov/ecp/species/9045)

The implementation of the Banner Branch Mitigation Project is considered a "Ground-disturbing Activity", and therefore the required "Appendix A, Categorical Exclusion Form for Ecosystem Enhancement Program Projects, Version 1.4" "Checklist" (Parts 1 through 3) has been completed and is attached. Copies of required correspondence and supporting documentation, including the following are also attached:

- Project figures and photolog sent to each of the review/regulatory agencies:
    - Figure 1 Project Location
    - Figure 2 USGS Topographic Map
    - Figure 3 NRCS Soils Map
    - Figure 4 LiDAR Map
    - Banner Branch Mitigation Project Pre-Restoration Photo Log
- Environmental Data Resources, Inc. (EDR) Environmental Risk Review Report.
- Copy of consultation correspondence with the USFWS through the IPAC system.
- Copy of correspondence with and resulting minimal comments from the NCWRC.
- Copy of correspondence with and resulting finding of "no comment" from the North Carolina State Historic Preservation Office (NCSHPO) due to their finding of no historic resources that would be affected by the project.
- NCSHPO Map of Records.
- Copy of correspondence with and resulting finding regarding farmland conversion from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS).
- USDA Farmland Conversion Impact Rating Worksheet (Form AD-1006).
- Copy of written landowner correspondence required under the Uniform Relocation Assistance and Real Property Acquisition Policies Act.

Submission of this Categorical Exclusion document fulfills the environmental documentation requirements mandated under the National Environmental Policy Act (NEPA; 40 CFR Parts 1500-1508).

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

Sincerely,

**Water & Land Solutions, LLC**

Kayne Van Stell

Kayne M. Van Stell
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**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:** | Banner Branch Mitigation Project |
| **County Name:** | Stokes County |
| **EEP Number:** | DMS Project #100080, DMS Contract #7610 |
| **Project Sponsor:** | Water & Land Solutions, LLC |
| **Project Contact Name:** | Kayne VanStell |
| **Project Contact Address:** | 10940 Raven Ridge Road, Ste. 200, Raleigh, NC 27614 |
| **Project Contact E-mail:** | kayne@waterlandsolutions.com |
| **EEP Project Manager:** | Jeff Schaffer |

## Project Description

The Banner Branch Mitigation Project is a full-delivery project for the NCDEQ Division of Mitigation Services (DMS) identified and contracted to provide stream and wetland mitigation credits for permitted, unavoidable impacts in the Roanoke River Basin, Cataloging Unit 03010103. The project will involve the potential restoration, enhancement, preservation, and permanent protection of unnamed tributaries (Reaches UT1-R1, UT1-R2, UT1-R3, UT1A, UT1B, UT1C, UT1D, UT2, UT2A, UT3, BB-R1, BB-R2, BB-R3, UT4-R1 and UT4-R2), totaling over 14,000 linear feet of existing streams. In addition, approximately 4.0 acres of degraded riparian wetlands will be returned to their natural function, utilizing wetland re-establishment, rehabilitation and enhancement approaches by implementing Priority Level I Stream Restoration, livestock exclusion, and limited removal of overburden soil above the hydric soils, and re-vegetation. 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, approximately 37.5 acres in size, 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 a riparian corridor between active agricultural fields and then into Banner Branch Creek, which eventually drains to the Roanoke River. The proposed restoration project not only has the potential to provide at least 12,000 stream mitigation credits and 3 wetland 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.

## For Official Use Only

**Reviewed By:**

10/11/2018

**Date**

Jeff Schaffer

**EEP Project Manager**

**Conditional Approved By:**

**Date**

**For Division Administrator**
**FHWA**

☐ **Check this box if there are outstanding issues**

**Final Approval By:**

10-11-18

**Date**

**For Division Administrator**
**FHWA**

| Part 2: All Projects<br>Regulation/Question | Response |
|---|---|
| **Coastal Zone Management Act (CZMA)** | |
| 1. Is the project located in a CAMA county? | ☐ Yes<br>☒ No |
| 2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)? | ☐ Yes<br>☐ No<br>☒ N/A |
| 3. Has a CAMA permit been secured? | ☐ Yes<br>☐ No<br>☒ N/A |
| 4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program? | ☐ Yes<br>☐ No<br>☒ N/A |
| **Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)** | |
| 1. Is this a “full-delivery” project? | ☒ Yes<br>☐ No |
| 2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial? | ☐ Yes<br>☒ No<br>☐ 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<br>☒ No<br>☐ 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<br>☐ No<br>☒ 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<br>☐ No<br>☒ N/A |
| 6. Is there an approved hazardous mitigation plan? | ☐ Yes<br>☐ No<br>☒ 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<br>☒ No |
| 2. Does the project affect such properties and does the SHPO/THPO concur? | ☐ Yes<br>☐ No<br>☒ N/A |
| 3. If the effects are adverse, have they been resolved? | ☐ Yes<br>☐ No<br>☒ N/A |
| **Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)** | |
| 1. Is this a “full-delivery” project? | ☒ Yes<br>☐ No |
| 2. Does the project require the acquisition of real estate? | ☒ Yes<br>☐ No<br>☐ N/A |
| 3. Was the property acquisition completed prior to the intent to use federal funds? | ☐ Yes<br>☒ No<br>☐ N/A |
| 4. Has the owner of the property been informed:<br>* prior to making an offer that the agency does not have condemnation authority; and<br>* what the fair market value is believed to be? | ☒ Yes<br>☐ No<br>☐ N/A |

| Part 3: Ground-Disturbing Activities<br>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<br>☒ No |
| 2. Is the site of religious importance to American Indians? | ☐ Yes<br>☐ No<br>☒ N/A |
| 3. Is the project listed on, or eligible for listing on, the National Register of Historic Places? | ☐ Yes<br>☐ No<br>☒ N/A |
| 4. Have the effects of the project on this site been considered? | ☐ Yes<br>☐ No<br>☒ N/A |
| **Antiquities Act (AA)** | |
| 1. Is the project located on Federal lands? | ☐ Yes<br>☒ No |
| 2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity? | ☐ Yes<br>☐ No<br>☒ N/A |
| 3. Will a permit from the appropriate Federal agency be required? | ☐ Yes<br>☐ No<br>☒ N/A |
| 4. Has a permit been obtained? | ☐ Yes<br>☐ No<br>☒ N/A |
| **Archaeological Resources Protection Act (ARPA)** | |
| 1. Is the project located on federal or Indian lands (reservation)? | ☐ Yes<br>☒ No |
| 2. Will there be a loss or destruction of archaeological resources? | ☐ Yes<br>☐ No<br>☒ N/A |
| 3. Will a permit from the appropriate Federal agency be required? | ☐ Yes<br>☐ No<br>☒ N/A |
| 4. Has a permit been obtained? | ☐ Yes<br>☐ No<br>☒ N/A |
| **Endangered Species Act (ESA)** | |
| 1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county? | ☒ Yes<br>☐ No |
| 2. Is Designated Critical Habitat or suitable habitat present for listed species? | ☒ Yes<br>☐ No<br>☐ N/A |
| 3. Are T&E species present or is the project being conducted in Designated Critical Habitat? | ☐ Yes<br>☒ No<br>☐ N/A |
| 4. Is the project "likely to adversely affect" the specie and/or "likely to adversely modify" Designated Critical Habitat? | ☐ Yes<br>☐ No<br>☒ N/A |
| 5. Does the USFWS/NOAA-Fisheries concur in the effects determination? | ☒ Yes<br>☐ No<br>☐ N/A |
| 6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination? | ☐ Yes<br>☐ No<br>☒ 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<br>☒ No |
| 2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project? | ☐ Yes<br>☐ No<br>☒ N/A |
| 3. Have accommodations been made for access to and ceremonial use of Indian sacred sites? | ☐ Yes<br>☐ No<br>☒ N/A |

### Farmland Protection Policy Act (FPPA)

| | |
|---|---|
| 1. Will real estate be acquired? | ☒ Yes<br>☐ No |
| 2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland? | ☒ Yes<br>☐ No<br>☐ N/A |
| 3. Has the completed Form AD-1006 been submitted to NRCS? | ☒ Yes<br>☐ No<br>☐ N/A |

### Fish and Wildlife Coordination Act (FWCA)

| | |
|---|---|
| 1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body? | ☒ Yes<br>☐ No |
| 2. Have the USFWS and the NCWRC been consulted? | ☒ Yes<br>☐ No<br>☐ 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<br>☒ No |
| 2. Has the NPS approved of the conversion? | ☐ Yes<br>☐ No<br>☒ N/A |

### Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)

| | |
|---|---|
| 1. Is the project located in an estuarine system? | ☐ Yes<br>☒ No |
| 2. Is suitable habitat present for EFH-protected species? | ☐ Yes<br>☐ No<br>☒ N/A |
| 3. Is sufficient design information available to make a determination of the effect of the project on EFH? | ☐ Yes<br>☐ No<br>☒ N/A |
| 4. Will the project adversely affect EFH? | ☐ Yes<br>☐ No<br>☒ N/A |
| 5. Has consultation with NOAA-Fisheries occurred? | ☐ Yes<br>☐ No<br>☒ N/A |

### Migratory Bird Treaty Act (MBTA)

| | |
|---|---|
| 1. Does the USFWS have any recommendations with the project relative to the MBTA? | ☐ Yes<br>☒ No |
| 2. Have the USFWS recommendations been incorporated? | ☐ Yes<br>☐ No<br>☒ N/A |

### Wilderness Act

| | |
|---|---|
| 1. Is the project in a Wilderness area? | ☐ Yes<br>☒ No |
| 2. Has a special use permit and/or easement been obtained from the maintaining federal agency? | ☐ Yes<br>☐ No<br>☒ N/A |

# Appendix 12 – Agency Correspondence & Floodplain Checklist

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# Meeting Minutes

## Roanoke 03010103 DMS Full-Delivery Project:

## Banner Branch Mitigation Project (DMS Contract #7610, Proj. ID# 100080)

**Subject:** NCIRT Post-Contract Site Meeting

**Date Prepared:** September 4, 2018

**Meeting Date and Time:** August 20, 2018 @ 0930

**Meeting Location:** On-site (Stokes County, NC)

**Recorded By:** Kayne VanStell and Scott Hunt

**Attendees:** USACE: Todd Tugwell (NCIRT)

NCDEQ DWR: Mac Haupt (NCIRT)

NCDEQ DMS: Jeff Schaffer

NCWRC: Travis Wilson (NCIRT) and Andrea Leslie

WLS: Kayne VanStell and Scott Hunt

George K. Lankford, LLC: George Lankford

These meeting minutes document notes and discussion points from the North Carolina Interagency Review Team (NCIRT) Post-Contract Site Meeting for the Banner Branch Mitigation Project (Roanoke River Basin, CU 03010103). This full-delivery project was contracted on June 15, 2018, by the North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS), with Water & Land Solutions, LLC (WLS), under RFP 16-007405. The project site is located in Stokes County, near Lawsonville, North Carolina.

The Banner Branch Mitigation Project (project) Post-Contract Site Meeting began on-site at 0930. Meeting was moved from proposed starting location at Clark Road entrance to pasture area upslope from UT1-R3, due to extremely wet site conditions. Kayne opened meeting with introductions, a project description and summary of the overall mitigation 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 attendees agreed to start reach walks at the existing stream crossing separating UT1-R2 and UT1-R3, traverse clockwise and downstream to end of BB-R3, and then upstream from UT4-R2 to UT4-R1, and across drainage divide to project headwaters at UT1-R1, and then downstream back to meeting starting point. The project site review notes are presented below in the order they were visited.

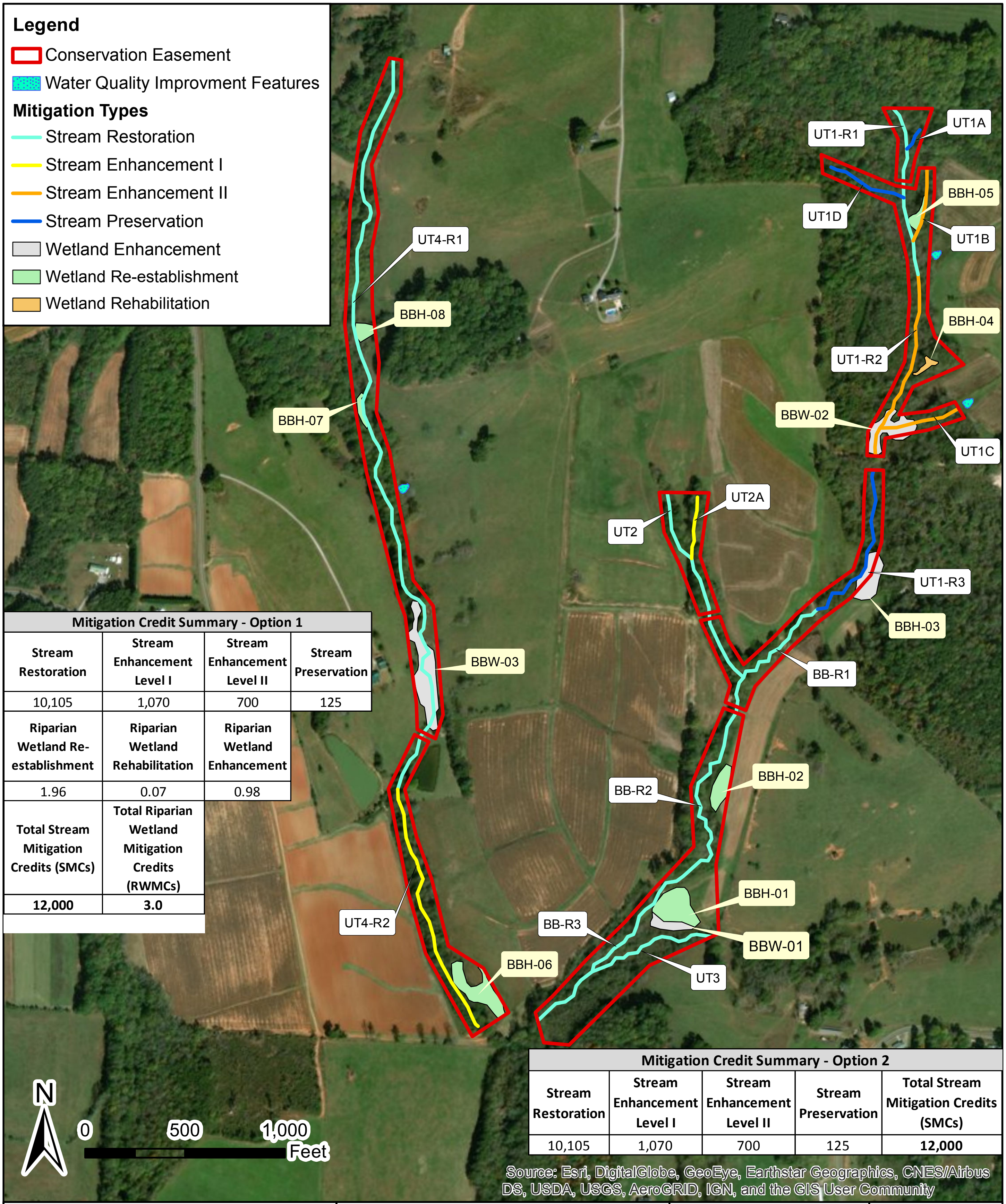
1. UT1-R3: Started walk at existing stream crossing. Travis noted that WLS address typical bankfull culvert requirements and fish passage concerns. Todd asked if proposed buffer width along right floodplain was proposed for 30 or 50 feet. Kayne clarified that 30-foot minimum buffer widths are proposed since Stokes County is a mountain county. The group also discussed that this reach is proposed for Preservation at a 10:1 ratio. Discussion was also held about the wetland functional uplift strategy for the floodplain area along this reach. George noted invasive species vegetation will be treated and raising the bed elevation along Banner Branch would improve hydrology. Todd and Mac noted that a groundwater well should be installed to document pre- post-restoration conditions.
2. BB-R1 and BB-R2: These reaches are proposed for Restoration. Mac and George augered to observe soil conditions on the left floodplain area of BB-R1. The group continued walking along BB-R2. Discussion was held to stabilize and construct these reaches in-place, versus the proposed Priority Level I approach and relocating the proposed channel onto the left floodplain, and removing left top of the bank and floodplain spoil piles for backfilling and plugging. Discussion was held about leaving open sections of remnant channel along these reaches as floodplain depressions and habitat features. Travis reminded us that true vernal pools or floodplain depressions should be very shallow (i.e. <1 ft deep). Todd augered and observed soils on the left floodplain approximately midway down BB-R2. Andrea also discussed the idea and possibility of using on-site spoil material to repair/stabilize pasture hillsides against left floodplain of BB-R2. Some general discussion was held regarding agency preference for sites to have 50-foot buffers, versus 30-foot, understanding that mountain counties require a minimum 30-foot buffer.
3. BB-R3 and UT3: These reaches are proposed for Restoration. The group discussed approach for stream restoration, as well as corresponding wetland restoration areas BBH01 and BBW01. Kayne and George noted that the polygons in the proposal delimiting the areas proposed for wetland restoration and enhancement are intentionally conservative for credit estimating purposes. This discussion included George explaining his soil boring analyses and preliminary investigation methods in greater detail. All agreed that jurisdictional determinations (JDs) were needed to help determine the appropriate mitigation approaches in areas such as the wetter pasture area that is fenced out from the left floodplain of BB-R3 and UT3. Todd augered and observed soils in this area and noted that the JD will help determine what areas are existing jurisdictional wetlands. Jeff showed that the proposed mapping is near the existing jurisdictional wetlands (unverified) and areas proposed for wetland restoration. Mac and George augered another soil boring further downstream on the right floodplain of BB-R3 and discussed hydric soil characteristics. Todd noted further downstream, on the left floodplain of BB-R3/ UT3, the JDs will be extremely important, and will help determine the proposed project mitigation approaches and extents.

4. The attendees completed the field review of reaches UT1-R3, BB-R1, BB-R2, BB-R3, and UT3, as well as the associated riparian wetland mitigation areas BBH-03, BBH-02, BBH-01, and BBW-01. In summary, Mac and Todd discussed the importance of pre-and post-groundwater monitoring/modeling, particularly to support Priority Level I stream restoration versus an approach of heavy stream enhancement within the existing channel. Mac and Todd also suggested that such modeling would help justify that Priority Level I stream restoration is the best approach with regards to stream and wetland functional uplift.
5. UT4-R2: The attendees started at downstream end of the reach and traversed upstream along areas proposed for Enhancement Level I. Travis noted that the large culvert at the existing crossing at the downstream end of this project reach needs to be properly designed, sized, and replaced with regards to the typical bankfull culvert requirements and fish passage concerns. Mac noted that by the time you remove the dense stand of Chinese privet along this reach, particularly on the top of banks, it will justify an Enhancement Level I approach. Todd generally agreed, and noted that adding woody bank and toe protection structures to replace the root mass lost due to the Chinese privet root mass removal will be warranted. The group discussed the existing pond reconfiguration at the top of the reach, noting that the pond is currently off-line and will remain off-line, and that the right pond berm/embankment will be moved to allow for adequate proposed buffer and floodplain width. The pond will be improved as an amenity for the landowners.
6. UT4-R1: This reach is proposed for Restoration, with most grading activities within the natural valley and existing channel corridor. Mac and Todd discussed the idea of potentially splitting out some reach segments as Enhancement Level 1. WLS generally disagreed with this approach, proposing that the entire reach warrants restoration to provide the maximum functional uplift and to minimize risk. The NCIRT suggested that WLS address and discuss the design rationale and justification in the mitigation plan in order to support this approach. The importance of harvesting and re-using existing natural substrate (gravel, cobble materials) was discussed and stressed. Upstream of the natural bedrock step-pool (knickpoint), Mac and Todd expressed that they have concerns for justifying Restoration along the entire reach, suggesting the splitting mitigation types/approaches versus lumping all into restoration. The attendees moved upstream to a deeply entrenched section of the reach, with Kayne explaining this was representative of the remaining reach length. The group finished the walk along this reach and traversed eastward across drainage divide to project headwaters near UT1-R1.
7. UT1-R1 and UT1-R2: The group started walking along UT1-R2, proposed for Enhancement Level II, and walked upstream to UT1-R1, proposed for Restoration. The NCIRT recommended moving the limits of Restoration along UT1-R2 upstream to the culvert crossing, as the condition in that reach below the culvert does not warrant Restoration and is more similar to the proposed Enhancement Level II condition downstream. Upstream of this culvert, Todd recommended changing the mitigation type to Preservation, until the channel conditions become more incised near the old house.
8. UT1A: The group agreed to remove this reach from the project, as it does not appear to be jurisdictional.

9. UT1D: NCIRT suggested WLS will need to consider stream jurisdiction carefully, particularly upstream of the headcut. However, as the group walked upstream along the reach, it was noted that the reach is a flowing headwater stream system. The reach walks were completed here, and the attendees went directly back to vehicles due to NCIRT and DMS time constraints. Travis requested that WLS identify opportunities to install the typical water quality treatment basins/ agricultural BMPs where non-jurisdictional drainages intersect the project easement.

**Concluding Comments**

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.



**Mitigation Credit Summary - Option 1**

| Stream Restoration | Stream Enhancement Level I | Stream Enhancement Level II | Stream Preservation |
|---|---|---|---|
| 10,105 | 1,070 | 700 | 125 |
| **Riparian Wetland Re-establishment** | **Riparian Wetland Rehabilitation** | **Riparian Wetland Enhancement** | |
| 1.96 | 0.07 | 0.98 | |
| **Total Stream Mitigation Credits (SMCs)** | **Total Riparian Wetland Mitigation Credits (RWMCs)** | | |
| **12,000** | **3.0** | | |

**Mitigation Credit Summary - Option 2**

| Stream Restoration | Stream Enhancement Level I | Stream Enhancement Level II | Stream Preservation | Total Stream Mitigation Credits (SMCs) |
|---|---|---|---|---|
| 10,105 | 1,070 | 700 | 125 | **12,000** |

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

**WATER & LAND**
SOLUTIONS

Banner Branch
Mitigation Project

Proposed
Mitigation Features

**NAD 1983 2011 State Plane**
**North Carolina FIPS 3200 FT US**

FIGURE
**10**

# EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. State NFIP Engineer), NC Floodplain Mapping Unit (attn. State NFIP Coordinator) and NC Ecosystem Enhancement Program.

## Project Location

| | |
|---|---|
| Name of project: | Banner Branch Mitigation Project |
| Name if stream or feature: | Banner Branch and unnamed tributaries |
| County: | Stokes |
| Name of river basin: | Roanoke |
| Is project urban or rural? | Rural |
| Name of Jurisdictional municipality/county: | Stokes County |
| DFIRM panel number for entire site: | 6040 (map number 3711604000J, effective date 5/16/2007) |
| Consultant name: | Water & Land Solutions |
| Phone number: | 919-614-5111 |
| Address: | 7721 Six Forks Road, Suite 130<br>Raleigh, NC 27615 |

## Design Information

The Banner Branch Mitigation Project (Project) is located within a rural watershed in Stokes County, within the Roanoke River Basin and USGS 14-digit HUC 03010103180010. The Project proposes to restore, enhance, and preserve over 15,707 linear feet of stream, and provide a water quality benefit for a 788 acre drainage area. The stream mitigation components are summarized in the table below. The purpose of the Project is to meet water quality improvements described in the River Basin Restoration Priorities and improve overall aquatic resource health.

| Reach Name | Length (feet) | Mitigation Type |
|---|---|---|
| UT1-R1 | 509 | Stream Enhancement I/Preservation |
| UT1-R2 | 1,783 | Stream Enhancement Level II |
| UT1-R3 | 822 | Stream Preservation |
| UT1A | 410 | Stream Enhancement Level II |
| UT1B | 488 | Stream Enhancement Level I/II |
| UT1C | 220 | Stream Preservation/Restoration |
| UT2 | 1,287 | Stream Restoration (PI) |
| UT2A | 289 | Stream Enhancement Level I |
| UT3 | 589 | Stream Restoration (PI) |
| BB-R1 | 808 | Stream Restoration (PI) |
| BB-R2 | 1,835 | Stream Restoration (PI) |
| BB-R3 | 636 | Stream Restoration (PI/PII) |
| UT4-R1 | 4,309 | Stream Restoration (PI/PII) |
| UT4-R2 | 1,722 | Stream Enhancement Level I |

## Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

○ Yes ● No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☐ Detailed Study

☐ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation: Zone X Minimal Flood Risk

Check if applies:

☐ AE Zone

○ Floodway

○ Floodway

○ Non-Encroachment

● None

☐ A Zone

○ Local Setbacks Required

○ No Local Setbacks Required

If local setbacks are required, list how many feet:

Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks?

○ Yes ● No

Land Acquisition (Check)

☐ State owned (fee simple)

☐ Conservation easment (Design Bid Build)

☑ Conservation Easement (Full Delivery Project)

Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)

Is community/county participating in the NFIP program?

○ Yes ● No

Note: if community is not participating, then all requirements should be addressed to NFIP (attn: State NFIP Engineer, 919-715-8000

Name of Local Floodplain Administrator: Stokes County Planning, David Sudderth
Phone Number: 336-593-2439

## Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☑ No Action

☐ No Rise

☐ Letter of Map Revision

☐ Conditional Letter of Map Revision (CLOMR)

☐ Other Requirements

List other requirements:
N/a

Comments:
Project is not in a FEMA zone

Name: KAYNE VAN STELL Signature:

Title: VP, ECOSYSTEM DESIGN SERVICES Date: 12.20.19

This digital Flood Insurance Rate Map (FIRM) was produced through a unique cooperative partnership between the State of North Carolina and the Federal Emergency Management Agency (FEMA). The State of North Carolina has implemented a long term approach to floodplain management to decrease the costs associated with flooding. This is demonstrated by the State's commitment to map flood hazard areas at the local level. As a part of this effort, the State of North Carolina has joined in a Cooperating Technical State agreement with FEMA to produce and maintain this digital FIRM.

## FLOOD HAZARD INFORMATION

**SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP**

**THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT**

**HTTP://FRIS.NC.GOV/FRIS**

| | | |
|---|---|---|
| SPECIAL FLOOD HAZARD AREAS | ▨ | Without Base Flood Elevation (BFE) *Zone A,V, A99*<br>With BFE or Depth *Zone AE, AO, AH, VE, AR* |
| | ▨ | Regulatory Floodway |
| OTHER AREAS OF FLOOD HAZARD | ▨ | 0.2% Annual Chance Flood Hazard, Areas of 1% Annual Chance Flood with Average Depth Less Than One Foot or With Drainage Areas of Less Than One Square Mile *Zone X* |
| | ▨ | Future Conditions 1% Annual Chance Flood Hazard *Zone X* |
| | ▨ | Area with Reduced Flood Risk due to Levee See Notes *Zone X* |
| OTHER AREAS | ▨ | Areas Determined to be Outside the 0.2% Annual Chance Floodplain *Zone X* |
| GENERAL STRUCTURES | - - - - - - | Channel, Culvert, or Storm Sewer |
| | ⊏⊏⊏⊏⊏ | Accredited or Provisionally Accredited Levee, Dike, or Floodwall |
| | ꞁꞁꞁꞁꞁꞁ | Non-accredited Levee, Dike, or Floodwall |
| | BM5510 × | North Carolina Geodetic Survey bench mark |
| | BM5510 ⊗ | National Geodetic Survey bench mark |
| | BM5510 ◈ | Contractor Est. NCFMP Survey bench mark |
| | 012 —18.2— | Cross Sections with 1% Annual Chance Water Surface Elevation (BFE) |
| | 8 - - - - - | Coastal Transect |
| | —·—·— | Coastal Transect Baseline |
| | — – — | Profile Baseline |
| | —— | Hydrographic Feature |
| | —— | Limit of Study |
| OTHER FEATURES | —— | Jurisdiction Boundary |

## NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at http://msc.fema.gov. An accompanying Flood Insurance Study report, Letter of Map Revision (LOMR) or Letter of Map Amendment (LOMA) revising portions of this panel, and digital versions of this FIRM may be available. Visit the North Carolina Floodplain Mapping Program website at http://www.ncfloodmaps.com, or contact the FEMA Map Service Center.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in the community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this FIRM was provided in digital format by the North Carolina Floodplain Mapping Program (NCFMP). The source of this information can be determined from the metadata available in the digital FLOOD database and in the Technical Support Data Notebook (TSDN).

ACCREDITED LEVEE NOTES TO USERS: If an accredited levee note appears on this panel check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at http://www.fema.gov/business/nfip/index.shtm.

PROVISIONALLY ACCREDITED LEVEE NOTES TO USERS: If a Provisionally Accredited Levee (PAL) note appears on this panel, check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection. To maintain accreditation, the levee owner or community is required to submit the data and documentation necessary to comply with Section 65.10 of the NFIP regulations. If the community or owner does not provide the necessary data and documentation or if the data and documentation provided indicates the levee system does not comply with Section 65.10 requirements, FEMA will revise the flood hazard and risk information for this area to reflect de-accreditation of the levee system. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at http://www.fema.gov/business/nfip/index.shtm.

LIMIT OF MODERATE WAVE ACTION NOTES TO USERS: For some coastal flooding zones the AE Zone category has been divided by a Limit of Moderate Wave Action (LiMWA). The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The effects of wave hazards between the VE Zone and the LiMWA (or between the shoreline and the LiMWA for areas where VE Zones are not identified) will be similar to, but less severe than those in the VE Zone.

—— Limit of Moderate Wave Action (LiMWA)

### COASTAL BARRIER RESOURCES SYSTEM (CBRS) NOTE

This map may include approximate boundaries of the CBRS for informational purposes only. Flood insurance is not available within CBRS areas for structures that are newly built or substantially improved on or after the date(s) indicated on the map. For more information see http://www.fws.gov/habitatconservation/coastal_barrier.html, the FIS Report, or call the U.S. Fish and Wildlife Service Customer Service Center at 1-800-344-WILD.

▨ CBRS Area ▨ Otherwise Protected Area

## SCALE

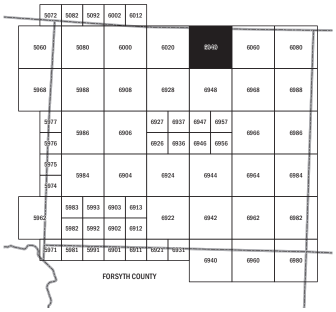
**Map Projection:**
North Carolina State Plane Projection Feet (Zone 3200)
Datum: NAD 1983 (Horizontal), NAVD 1988 (Vertical)

**1 inch = 1,000 feet** **1:12,000**

0 500 1,000 2,000 Feet

0 150 300 600 Meters

## PANEL LOCATOR



**FEMA**

**National Flood Insurance Program**

NORTH CAROLINA FLOODPLAIN MAPPING PROGRAM
NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

# NORTH CAROLINA

PANEL 6040

Panel Contains:

| COMMUNITY | CID | PANEL | SUFFIX |
|---|---|---|---|
| STOKES COUNTY | 370362 | 6040 | J |

MAP NUMBER
3711604000J

MAP REVISED
05/16/07